SECTION 23

ROADS

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LIST OF REVISIONS DURING PERMIT TERM

REV. NUMBER	REVISION DESCRIPTION	DATE APPROVED

23 ROADS

23.1 Existing Roads

Transportation facilities at Navajo Mine consist of approximately 90 to 100 miles of road and 15.4 miles of railroad. Exhibits 10-1 through 10-6 show the existing roads (Primary and Ancillary) and the existing railroad. In the construction of the roads and the railroad, the following were taken into consideration: the mine's safety program, minimization of erosion, impact on wildlife, and alteration of existing drainage channels. All routes of travel defined as roads in 30 CFR § 701.5, are included in this section of the permit. "As-Built" drawings of road designs approved by OSMRE are kept on file at Navajo Mine and will be available within 30 days of completed construction of the design. Presently, Navajo Mine does not have plans to retain any roads for post-mining use. Refer to Section 30 – Reclamation Plan of the Permit Application Package for more information on post-mining land use.

23.1.1 Mine Roads

Per 30 CFR § 816.150 (a), the Navajo Mine roads are classified into two broad categories. The two classifications are Primary and Ancillary roads. The roads which fall into these two classifications are

A. Primary Roads

1. **Access Roads –** Frequently used roads by the mine personnel for direct access to permit facilities, or for transporting/tramming of large coal mining equipment between coal stockpiles or to shop areas.
2. **Coal Mine Haulroads** – Roads used to transport coal to stockpiles or dump hopper. These roads run from the top of pit ramps to stockpiles or hopper areas.

Primary roads are constructed to the same standards, whether they are an access road or a haulroad. The only real difference in these roads is their usage and widths. Since the construction standards are the same for each type of road, one typical cross section drawing is provided to cover all Primary Roads. The typical drawing common to both access roads and haulroads is numbered Exhibit 23-1. Information on individual road segment width is provided in Table 23-1. Routes of travel for which drainage control is otherwise provided, or which will be obliterated during the process of mining or reclamation, are not considered either primary or ancillary roads.

B. Ancillary Roads

1. Service or inspection roads for power lines and substations.
2. Environmental Service Roads used for:
    a. Topsoil Stockpiling and Maintenance.
    b. Maintenance of Revegetated Plots.
    c. Air Quality Monitoring Stations.
    d. Hydrologic Sampling Stations; Surface & Ground Water.
    e. 16 Inch Diameter Irrigation Pipeline Access.
    f. Access to Experimental Research Plots.

g. Access to ponds and other surface water control structures

3. Railroad access road used for inspection and maintenance.
4. Access Road to equipment and parts storage yard.
5. Access road to vital mine Support Facilities.

Ancillary roads are mostly small vehicle service roads, used infrequently for inspection or monitoring purposes. Ancillary roads with in the planned mining area will be removed as part of the normal mining operation and reclaimed as part of normal reclamation. Other ancillary roads will be reclaimed when they are no longer required.

23.1.2 Primary Roads

The existing roads which are classified as primary roads are shown on Exhibits 10-1 through 10-6.

The existing primary roads were constructed for a maximum service life of anywhere between 5 to 20 years. Most primary roads are generally aligned to accommodate the mining pits and overall strip design layouts. Generally, primary roads are located to facilitate the coal haulage from the pits to the railroad stockpiles.

As shown in Exhibits 10-1 through 10-6 one continuous Primary road is shown traversing through Areas 1, 2, 3 and 4 North. This road is the main Primary road with an approximate length of 15 miles. The point of beginning for the road is the North Area facilities, ending at Area 4 North. There are several turnouts off this road which are also considered as Primary roads. Refer to Table 23-1 for more detail.

23.1.3 Ancillary Roads

Locations of roads classified as Ancillary are shown in Exhibits 10-1 through 10-6.

Where it is appropriate, most Ancillary roads are located where minimal or no road work is required for construction. Ancillary roads are usually one lane (7 feet to 12 feet) roads with no embankment.

23.1.4 Ancillary Roads Construction

Ancillary roads will be constructed or reconstructed according to the typical cross-section shown in Exhibit 23-2. Approval will not be required prior to construction of any ancillary road. Instead, the actual alignment of any new road will be determined and added to the appropriate exhibit (Exhibit 10-1 through 10-6). The revised exhibit will then be certified and submitted to OSM within 60 days after completion of construction of the ancillary road.

23.2 Primary Road Conditions

Refer to Exhibit 23-1, Exhibit 23-2, and Exhibit 23-3 (Area 3 Main Access Road) for Primary Road Typical Cross Sections. Table 23-1 contains information on each of the Primary Road segments.

23.2.1 Pinto Haulroad and Pinto Reroute

This haulroad was built during the early periods of Area I coal mining operations. The approximate date of Pinto Haulroad construction is 1965. The road is approximately 60 feet in width. Presently the road is in good condition and maintained by periodic blade work and side ditch cleaning.

A portion of the Pinto Haulroad was rerouted in 1989. The newer section of the road is shown as Pinto Reroute in Exhibit 10-2.

At the present time, the road is occasionally used for coal haulage from Pinto Pit. The majority of the time, however, it is used as a major access route to the Area I industrial complex. The termination of the haulroad is in the emergency coal stockpile area. The road's present sub-grade and surface course condition are excellent.

23.2.2 Doby Haulroad

The Doby Haulroad was built in 1970 and was used at that time primarily to mine the Doby Pit coal. This road, in conjunction with the Pinto Road, was once used for long haul from Doby Pit Ramp #14 to the North Plant.

Presently, the Doby Road is used as a main access road between Yazzie Pit and Pinto Pit. The roads present sub-grade and surface course condition are excellent.

23.2.3 Yazzie Skyline Road

This road was used as a haulroad for the mining of Yazzie Pit coal via ramps 3 and 4. It is now used as the primary access route from the southern portions of the mine to the north facilities. Equipment and vehicles traveling this route continues from the Burn’s Pass road through Yazzie Skyline Road, Doby Road and Pinto Road to the Plant. This road is located on regraded spoils the entire length of the road up to the Yazzie "Y" intersection (see Exhibit 10-3).

The current condition of the road is good to excellent for the sub-grade.

23.2.4 Neck Road

The Neck Road was constructed in 1978 for access to the Area 3 coal reserves. After the Neck Road was constructed, the Area 3 reserves were developed.

During the next few years, following the opening of Area 3 Coal reserves, this road was primarily used as a dragline walk-road. Also anticipated at the time of construction was eventually placing the railroad through this route. However, the railroad roadway was built at a separate location on a later date.

The current condition of this road's sub-grade is excellent. Traffic on this road consists of small vehicles, coal trucks, and coal and overburden drills and also provides access to, and along, segments of the main irrigation pipeline.

23.2.5 Big Fill Road

The Big Fill Road begins at Turnout #1 (Exhibits 10-2 and 10-3) on the Doby Road and ends at the Barber Railroad Stockpile. The road was built in 1973 primarily as a railroad access road. During this period, the Yazzie Skyline Road did not join the Hosteen Pit Roads, so the Big Fill Road was the primary access to Hosteen and Barber Stockpiles.

The Big Fill Road shares its sub-grade with the railroad roadway. Thus, the road sub-grade was constructed in accordance with "AREA" (American Railway Engineering Associated) sub-grade specifications. Over the years, a surface course of railroad ballast has drifted onto the road by blade work. This surface course of ballast has greatly improved the structural integrity of the road's sub-grade structure. At the present time, this road is mainly used for access purposes only. For safety reasons, this road is no longer used as a coal haulage road due to its narrow width. For emergency hauling situations, this road may be utilized. Occasionally, an escorted, oversized piece of equipment will be trammed or transported on this road to get to the Barber or Hosteen Stockpiles.

23.2.6 Dixon Haulroad

The Dixon Haulroad begins at the south end of Dixon pit, bends to the west toward the spoils, and then follows the regraded area north to the Lowe Coal Stockpile. The road will be used for truck haulage for coal mining and reclamation, and as an access road to south Dixon and eventually to Area 4 North. The road is designed to Primary Road standards per this section. The road design and location can be found in Exhibits 23-4 and 10-5, respectively. The road information is included in Table 23-1. Hydrology information for culvert design on CP-128 is located in Appendix 23.A, with the culvert location on Exhibit 26-6. The road shall be constructed and maintained as outlined in Section 23 – Roads General Performance Standards.

23.2.7 Burn's Pass Road

The Burn's Pass Road begins at Turnout #2 (shown on Exhibit 10-3) and ends at the intersection with North Hosteen Ramp #1.

This road is primarily a maintenance access road to North Hosteen Ramp #1 and the main irrigation line. The road's sub-grade is mostly original ground that has been bladed. The road is in good condition.

23.2.8 Hosteen Haulroad

The Hosteen Haul Road serves Hosteen Pit Ramps #1 and #3. The haulroad is also the continuation of the Burn's Pass Road at the top of Ramp #1.

This road is used mainly for hauling the Hosteen Pit coal to the railroad stockpile. The majority of the road is built on reclaimed surface and is presently in good condition. The condition of the existing road sub-grade is excellent with no visible failure or deterioration of road surface course.

23.2.9 Ramp 7 Road

The Ramp 7 Road is an existing mine primary road which has been re-aligned to improve road safety and to facilitate reclamation in the area. The re-aligned Ramp 7 Road is designed to Primary road standards, refer to Exhibit 23-5, Exhibit 23-6, and Exhibit 23-7 for design drawings and Appendix 23.B for supporting design data.

23.2.10 Lynch Skyline Haulroad

This road is a mining haulroad which connects North Barber Ramp #2 with Barber Railroad Stockpile.

The road was built in 1983 by dozers and graders. The road is presently in good condition. The road is located on regraded spoils to more closely accommodate the spoil Ramp #2 location and the mining of coal seams #7 and #8.

23.2.11 Coal Plant Road

The Coal Plant Road is located at the North Industrial Complex. The function of the road is to provide access from the eastern side of the North Industrial Complex to the Coal Plant. The road will be used primarily by Coal Plant personnel and equipment. The road was redesigned as a Primary road per the requirements of Section 11.5.6.1 of the PAP, and meets the performance standards of 30 CFR Part 816.151. The length of the road is approximately 3,300 feet. The average width of the road is 40 feet Road design and cross-sections are shown in Exhibit 23-9 (Sheet 1, Sheet 2, Sheet 3, and Sheet 4). The road's maximum and minimum elevations are 5,349 feet and 5,335 feet, respectively.

The Plant Road watershed is approximately 3.8 acres. All surface runoff from the Plant Road will drain as sheet flow down the sides of the road. Flow from station 0 to 21.5 and 21.5 to 38, will be captured by Pond 5 and Cell A2 respectively (see Exhibit 26-1).

23.2.12 Yazzie Spoil Side Road

This road connects Yazzie Pit activities with the Yazzie Skyline Road. Yazzie Spoil Side road is used for coal haulage, pit access, reclamation haulage, access around the east end of the pit, and power line access. The location of the road is shown on Exhibit 10-3 and the design is shown on Exhibit 23-10. Road information can be found on Table 23-1. Yazzie Spoil Side road contains two culverts (shown on Exhibit 10-5) the Sedcad for these pipes can be found in Appendix 23.A. The road is constructed and maintained as outlined in Section 23.5.4 Roads General Performance Standards .

23.2.13 Area 3 Access Roads

Main Access Road was constructed in 1992 and provides small vehicle paved access to the Area 3 Facilities from the east. This 0.86 mile paved road connects the Area 3 Facilities to BIA Road N4104. The road is maintained and in excellent condition. As required under the Grant of Easement for Right-of-Way, this road will be operated and maintained under the stipulations therein (see Part 1 Section 6).

23.2.14 Employee Coal Dump Access Road

The Employee Coal Dump Access Road will be used to facilitate the Area 3 employee coal dump. The road alleviates the safety concerns associated with the current traffic pattern. The road is designed to the Primary Road standards per Section 11.5.6.1 of the PAP and 30 CFR 816.151. The general road design can be found on Exhibit 23-11. The typical road cross section and location can be found in Exhibit 23-1 and Exhibit 10-4, respectively. The road information is included in Table 23-1. For hydrology information on the added watershed to the Area 3 Employee Coal Dump, refer to Appendix 22.A and Exhibit 26-11. The road shall be constructed and maintained as outlined in Section 23 Roads General Performance Standards.

23.2.15 Mason Road

Mason Road commences at Turnout #5 (shown on Exhibit 10-4) near the north end of the Neck Road. This road was built in 1980 for access to Mason and Barber Pit Ramps. In 1998, NTEC formerly known as BHP submitted to OSM, a modification to widen the Mason Road to a width of 70 feet to facilitate coal haul from the new Barber Ramp 6 to Barber Stockpile. Barber Ramp 6 is no longer active but the road has been left in place to facilitate other mine operations

23.2.16 Barber Haulroad

The Mason Road turns into Barber Haulroad serving Ramp 5 and the Barber Stockpile area. Barber Ramp 5 is no longer active but the road has been left in place to facilitate other mine operations

In 1997, NTEC formerly known as BHP submitted to OSM, a modification to widen the Barber Haulroad to the width of 50 ft. to eliminate safety concerns associated with road width. The modification of Barber Haulroad included widening a 2,796 ft. section from the end of Mason Road to the intersection of Ramp No. 5. A culvert (CP-119) was installed to provide adequate drainage for the road.

In 2012, NTEC formerly known as BHP submitted to OSM, a modification to realign the Barber Haulroad to meet at a 90 degree intersection with the Barber By-pass Road, at Barber Stockpile. This modification improves sight distance at this intersection and better controls traffic flow. A culvert (CP-324) was also installed to provide adequate drainage through the new alignment.

23.2.17 Block B Access Road

This road connects with the Hosteen Yazzie Haulroad at the north end and terminates at the Area 3 facilities. The Block B Access Road is used for pre-strip material haulage, access to Hosteen and Yazzie Pit, and power line access. In 2004 the final strip in Barber Pit disturbed the Block B Access Road, the layback of the highwall has narrowed up the road significantly in some reaches. The road will be reconstructed to facilitate the haulage of pre-strip material from Hosteen Pit to South Barber Pit. The reconstruction requires backfilling portion of the pit along the highwall to obtain the road width required. The design for the reconstruction of the road is presented on Exhibit 23-12 (Sheet 1, Sheet 2, and Sheet 3). The location of the road is shown on Exhibit 10-4. The road is constructed and maintained as outlined in Section 23.5 – Roads General Performance Standards.

23.2.18 Lowe Bypass Road

The Lowe Bypass Road is located in the southwestern Lowe Pit area near the Lowe Stockpile. It was constructed in 1994 as an ancillary road for light vehicles to obtain access to Dixon Pit, Lowe Stockpile, and the southern Lowe Pit area without using the main haulroads. The north end of this road ties into Lowe Ramp #2; the southern portion crosses South Corridor Road and ties into the Dixon Haulroad (see Exhibit 23-13). In 1995 the road status was changed from Ancillary to Primary. The primary function of this road is an access road for light vehicles.

23.2.19 Lowe Boxcut Road

The Lowe Boxcut Road is located in the northwestern Lowe area and replaces the northern portion of the current Lowe Road (see Exhibits 10-5 and Exhibit 23-14). The road is classified as a Primary road and is used for access by light and heavy vehicle types. The road offers access to the Neck Road (north of proposed road), the Lowe Coal Stockpile area, and Lowe Ramps 1 and 2. The road was constructed to meet the performance standards noted in Section 23.5.4. Location and design information for this road is available in Exhibits 10-5, and Exhibit 23-14, Exhibit 23-15, Exhibit 23-16, Table 23-1; and Appendix 23.C. The length of the road is 5,402 feet and is approximately 70 feet wide. Other details and as-builts can be obtained from Exhibit 23-14, Exhibit 23-15, Exhibit 23-16, and Exhibit 23-17 (Sheet 1, Sheet 2, Sheet 3, Sheet 4,and Sheet 5).

23.2.20 Gorman Haulroad

Gorman Haulroad is located in the North Barber area. The Gorman Haulroad comes off the Barber Ramp haul route, connecting this route with the Barber Coal Stockpile. The road width will be increased to 70-feet to accommodate coal truck traffic. Exhibit 23-18 shows the design plan/profile and the hydrology information is shown in Exhibit 26-87. The haulroad data is listed in Table 23-1.

The design to widen this road has been approved by the Regulatory Authority, but the field construction has not commenced. The design was submitted in the anticipation of hauling coal between Barber and Hosteen Coal Stockpiles. In the event that this need should arise in the future, Navajo Mine proposes to retain the approved design discussion for future construction.

23.2.21 Hosteen Yazzie Haulroad

The Hosteen Yazzie Haulroad will be used to facilitate the Area 2 pre-stripping activities in the North Barber and Hosteen Yazzie Pits. The primary function of the road shall serve as a truck haulage road. The road is designed to Primary Road standards per Section 23.5 of the PAP and 30 CFR 816.151. The road design and as-builts can be found in Exhibit 23-19 and Exhibit 23-20 and Exhibit 10-3. The road information is included in Table 23-1, Section 23.5. For hydrology information on culvert designs CP-129 through CP-149 (excluding CP-135, 140, and 147), refer to Appendix 23.A and Exhibit 26-3. The road was constructed and will be maintained as outlined in Section 23.5 Roads General Performance Standards.

23.2.22 Cottonwood Crossing

The Cottonwood Crossing connects with the south end of the Dixon Haulroad and continues south across the Cottonwood Arroyo connecting with the Area 4 North East and West Perimeter Roads. This road serves as the primary access to the mining activities in Area 4 North. The Cottonwood Crossing is used for coal haulage, pit access, and power line access. The location of the crossing is shown on Exhibit 10-6 and the detail designs are presented in Appendix 23.D. Only the detail civil drawings and the hydraulic analysis of the box culverts and spillway are included in Appendix 23.D. The structural and geotechnical detail engineering data and drawings were not included in Appendix 23.D. This information however can be made available upon request. The road is constructed and maintained as outlined in Section 23.5 – Roads General Performance Standards.

23.2.23 Area 4 North West Perimeter Road

This road connects with the Cottonwood crossing and bends around the west end of the Area 4 North pit. This road intersects with the ramps coming out the Area 4 North pit. The West Perimeter Road is used for coal haulage, pit access, access around the west end of the pit, and power line access. The location of the road is shown on Exhibit 10-6 and the design is shown on Exhibit 23-21 (Sheet 1, Sheet 2, and Sheet 3). Road information can be found on Table 23-1. The road is constructed and maintained as outlined in Section 23.5 Roads General Performance Standards. Slope stability analysis for the road embankments have been completed, see Appendix 23.E.

23.2.24 Area 4 North East Perimeter Road

This road connects with the Cottonwood crossing and bends around the east end of the Area 4 North pit. This road intersects with the ramps coming out the Area 4 North pit. The East Perimeter Road is used for coal haulage, pit access, access around the east end of the pit, and power line access. The location of the road is shown on Exhibit 10-6 and the design is shown on Exhibit 23-21 (Sheet 1, Sheet 2, and Sheet 3). Road information can be found on Table 23-1. The road is constructed and maintained as outlined in Section 23.5 – Roads General Performance Standards. Slope stability analysis for the road embankments have been completed, see Appendix 23.E.

23.2.25 Area 3 By-pass Road

Exhibit 10-4 shows the Area 3 By-pass Road is located west of the Area 3 Facility Complex. In order to facilitate the uninterrupted mining of the remaining South Barber strips, a single reroute around the remaining mining strips was constructed in December 1994. Design parameters for this road are located on Exhibit 11-90 and Table 23-1.

Typical traffic will consist of pickup trucks and passenger vehicles using the road for pit access. Other traffic will include: 1) one-ton service trucks, 2) large mining equipment traveling to/from the maintenance shop or low boy delivery of dozers, drills, and dragline buckets, 3) forty-ton fuel and lube trucks, and 4) special delivery to the north area of the mine.

23.2.26 Dixon By-Pass Road

Exhibit 26-90 shows the Dixon By-Pass Road which begins at the South Corridor Road and continues south to the Dixon Haul Road. This road intersects two roads to the west – the Dixon Ramp 2 Road (see Exhibit 26-91 and the Power Line Road (ancillary). This road provides access to two ramps to the east – Dixon Ramp 2 and Dixon Ramp 3. The Dixon By-Pass Road is to be used primarily by light vehicles, haulage trucks, and maintenance equipment. The road provides convenient access between the Dixon ramps.

23.2.27 Dixon Ramp-2 Road

The Dixon Ramp-2 Road stretches from Dixon Haul Road on the west end to Dixon By-Pass Road on the east end. This road was originally a ramp but as the Dixon pit advanced to the east, the ramp was reclassified as a primary road. Exhibit 26.91 shows the Dixon Ramp-2 Road. The primary function of this road is to accommodate haulage trucks from the Dixon pit to the Lowe Coal Stockpile.

23.2.28 North and South Corridor Roads

The North and South Corridor Roads are shown in Exhibit 26.89. North Corridor Road is a light vehicle access road. South Corridor Road is primarily a haulage road. Both roads were originally ramps but with the advance of the Lowe and Dixon pits, the roads were reclassified from ramp status to primary road status. These roads begin in the west at Lowe By-Pass Road and continue east to the Lowe and Dixon pits. They are intersected by the West Corridor By-Pass Road which connects the two roads. The South Corridor Road is also intersected by the Dixon By-Pass Road.

23.3 Ancillary Road Conditions

Ancillary roads are either: a two track road, or a well maintained road (see Exhibit 23-2 for Typical Cross-Sections). These roads are used periodically to:

1. service and/or inspect the powerlines,
2. service and/or inspect the railroad tracks,

3. obtain access to survey control points,
4. transport various equipment or parts,
5. obtain access to monitoring stations (i.e., air and water sites),
6. service and operate the irrigation system,
7. obtain access to reclaimed areas,
8. obtain access to stockpiles (either to inspect or to commence reclamation operations),
9. obtain access to equipment and parts storage yard,
10. obtain access to research plots, and
11. service and/or maintain the potable water system.

Some roads which are established during topsoil stockpiling operations remain until the stockpile is depleted. These roads are not serviced unless it is needed during stockpile idle periods.

Air Quality monitoring station roads are one-lane roads, which are used on a weekly basis. The monitoring sites are shown on Exhibit 12-1 and discussion is also in Section 42 – Monitoring, Maintenance, Inspections and Examinations. Hydrologic sampling stations roads are also one-lane roads, which are used on a weekly basis.

The irrigation pipeline access roads parallel the pipeline where no other means of access is available. Typically, the road traffic is traveled during the spring and summer month's irrigation season. Very little blading is usually conducted on these roads due to the small amount of traffic.

23.4 Protection of Fish, Wildlife, their Habitat and Related Environmental Values

Roads and railroads will be located and constructed in such a manner to minimize the impact to fish and wildlife habitat and related environmental values, as outlined in Section 16 – Fish and Wildlife. This program to minimize or prevent impacts to wildlife during operation of the mine (including road location and construction) includes:

1. Limiting the amount of vegetation and topography disturbed to only that necessary to conduct mining,
2. Designing facilities to prevent mortality of raptors, and
3. Monitoring important wildlife habitats so appropriate plans can be developed and implemented to avoid significant undesirable impact.

23.5 Construction

All roads are built with minimization of embankment fill materials. Where fills are required, the nearest road cut material is used until the desired material balance is achieved. The compaction of road surfaces is achieved by repetitive travel of water trucks, scrapers, compactors, and dozers during construction.

23.5.1 Primary Road Construction Dates

Table 23-1 presents the approximate construction dates of the Primary roads.

23.5.2 Primary Roads Surfacing

Depending upon site specific conditions such as geomorphological factors, material availability, and economics, present Primary Roads are commonly surfaced with one or more of the following:

1. Compacted shale, silty clay, and sandy silt,
2. Compacted gravel or crushed stone,
3. Asphalt coating in some areas,
4. Aggregate red dog (scoria).

All road surfacing materials are non-toxic and non-acid forming. Also see Section 14 – Soils.

23.5.3 Primary Road Safety Controls

To better facilitate and optimize road safety in accordance with the mine's safety program, NTEC will utilize separation barriers on the road surface of primary roads to improve on safety conditions for the interaction of light vehicles and surface mobile equipment. These separation barriers shall be installed within the running surface of the roadway and will not inhibit the roads performance standard. The separation barriers may be temporary or permanent, based on the mines operational needs. These separation barriers may include one, or a combination, of the following safety features.

- Reflectors,
- Barriers,
- Barricades,
- Guardrails,
- Berms,
- Bollards,
- Gates,
- Barrels.

23.5.4 Road Maintenance

Routine road maintenance will consist of surface repairs; blading of side ditches and roadway surfaces; application of water and chemical road stabilizers; maintaining drainage control structures to standards of engineered design; and maintaining safety berms. Periodic inspections will be conducted to insure proper maintenance and safe operating conditions.

23.5.5 Roads General Performance Standards

23.1.1.1 Primary Roads Dust Control

Fugitive dust control measures of Primary roads are outlined in Section 40 – Probable Hydrologic Consequences.

23.5.5.1 Ancillary Roads Dust Control

Ancillary roads are usually not treated or watered.

References

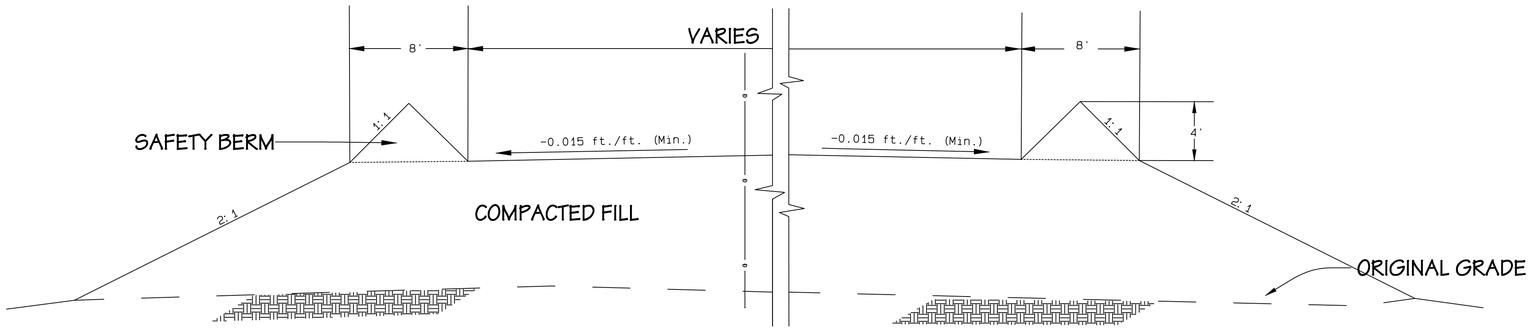
Table 23-1 Primary Road Segments

Road Areas	Length (feet)	Width (feet)	Grade (%)	Surface Material	Use	Area (acres)	Constr. Date	Anticipated Removal Date	Located on Exhibit	References
Area 3 By-Pass Road	3,970	70	0-4%	Gravel/Dirt	Access/Haul	6.37	1982	2019	10-1	Exhibit 23-22 - A3 By-Pass Rd. Design
Area 3 Main Access Road	5,160	60	0-4%	Pavement	Access	7.09	1982	2019	10-1	Exhibit 23-3, 23-37 (3 sheets), 23-38 - A3 Main Access Rd. Design
Barber By-Pass Road	7,355	70	0-6%	Gravel/Dirt	Access/Haul	11.82	2003	2019	10-1	Exhibit 23-23 (3 sheets) & Exhibit 23-23 (3 sheets) As-built folder - Barber By-Pass Rd. Design
Barber Haulroad	11,000	60	0-6%	Dirt	Haul	15.12	1978	2019	10-1	Exhibit 23-41 - Barber Haulroad Modification Design
Barber Hosteen By-Pass (Gorman Road)	4,850	70	0-6%	Dirt	Access	7.78	1978	2019	10-6, 10-1	Exhibit 23-18 - Gorman Rd. As-Built
Big Fill Road	19,450	60	0-5%	Gravel/Dirt	Access	26.74	1973	2019	10-6	Typical shown on Exhibit 23-1 - Pre-Law Rd. No Design or As-Built
Block B Access Road	13,220	60	0-4%	Gravel/Dirt	Access	18.17	1992	2019	10-1	Exhibit 23-12 (3 sheets) - Block B Rd. Modification Design
Burn's Pass Road	2,980	70	0-7%	Dirt	Access/Haul	4.78	1977	2019	10-6	Exhibit 23-24 - Burns Pass Rd. Design
Coal Plant Road	3,780	40	0-8%	Gravel/Dirt	Access	3.46	1996	2019	10-5	Exhibit 23-9 (4 sheets) - A1 Coal Plant Rd. As-Built
Dixon Haul Road	10,039	70	0-4%	Gravel/Dirt	Access/Haul	16.13	1999	2019	10-2	Exhibit 23-4 & 23-40 - Dixon Haulroad Design
Doby Road	6,175	60	0-5%	Gravel/Dirt	Access	8.49	1970	2019	10-5	Exhibit 11-55 & 111-55A -C - Doby/Pinto Re-Route Haulroad As-Built folder
Hosteen Haulroad	7,000	60	0-6%	Dirt	Haul	9.62	1977	2019	10-6	Exhibit 23-35 (3 sheets) - Hosteen Rd. Design
Hosteen Yazzie Haulroad	11,700	60	0-5%	Dirt	Haul	16.08	2000	2019	10-1	Exhibit 23-19 & 23-20 - Hosteen/Yazzie Rd. Re-Alignment Design
Lowe Boxcut Road	5,720	70	0-6%	Gravel/Dirt	Access	9.17	1996	2019	10-1	Exhibit 23-14, 23-15 & 23-16 - Lowe Boxcut Rd. Design
Lowe By-Pass Road	5,910	30	0-6%	Gravel/Dirt	Access	4.06	1994	2019	10-2	Exhibit 23-13 - Lowe By-Pass Rd. Modification Design
Lynch Skyline	2,050	65	1-6%	Dirt	Access	3.05	1983	2019	10-6, 10-1	Exhibit 23-23 - A2 Lynch Skyline Rd. As-Built folder
Mason Road	5,225	70	0-2%	Dirt	Access/Haul	8.38	1980	2019	10-1	Exhibit 23-27 (3 Sheets) - A2 Mason Haulroad As-Built
Neck Road	8,500	120	0-6%	Gravel/Dirt	Access	23.37	1978	2019	10-5	Exhibit 11-93 - Area 3 Neck Haulroad As-Built folder(3 Sheets)

Table 23-1 (Continued)

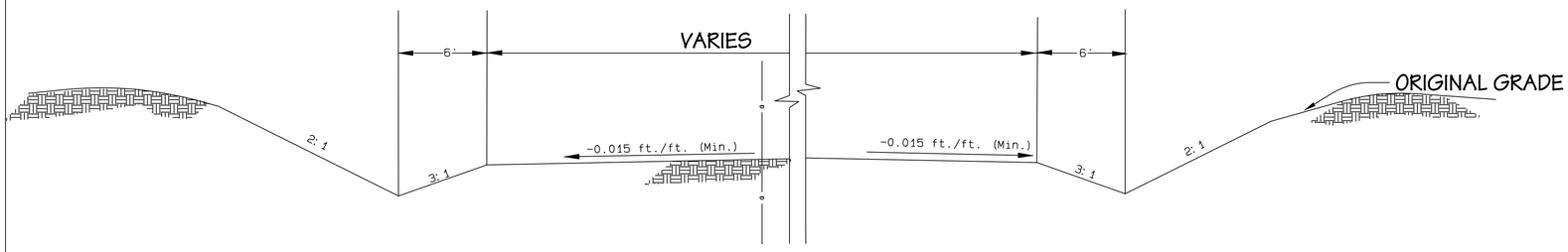
Road Areas	Length (feet)	Width (feet)	Grade (%)	Surface Material	Use	Area (acres)	Constr. Date	Anticipated Removal Date	Located on Exhibit	References
Pinto Reroute	4,500	70	0-5%	Gravel/Dirt	Access	7.22	1989	2019	10-5	Exhibit 11-55 & 11-55A -C - Doby/Pinto Re-Route Haulroad As-Built folder
Pinto Road	5,500	60	0-5%	Gravel/Dirt	Access/Haul	7.56	1965	2019	10-5	Typical shown on Exhibit 23-1 - Pre-Law Rd. No Design or As-Built
Re-Aligned Ramp 7 Road	5,225	30	0-6%	Gravel/Dirt	Access	3.59	1998	2019	10-5	Exhibit 11-119 & 11-119A & B - Ramp 7 Rd. Re-Alignment Design
Yazzie Skyline Road	6,450	65	0-7%	Dirt	Access	9.60	1970	2019	10-6	Exhibit 11-56 & 11-56A & 11-56B - Yazzie Skyline Rd. As-Built folder
Yazzie Spoil Side Road	3,450	70	0-4%	Dirt	Access/Haul	5.53	2004	2019	10-6	Exhibit 23-9 - Yazzie Spoil Side Rd. Design
Lowe Ramp-2 Haulroad	687	70	4%	Dirt	Access/Haul	1.40	2008	2019	10-2	Exhibit 23-32 - Lowe Ramp 2 Haulroad As-Built
Dixon Ramp-2 Haulroad	4,472	85	0-5%	Dirt	Access/Haul	8.73	2008	2019	10-2	Exhibit 26-91 - Dixon Ramp -2 Haulroad Design
Cottonwood Crossing Road	1,250	120	0-3%	Gravel/Dirt	Access/Haul	3.40	2009	2019	10-7	As-built shown in Appendix 23.D
Area 4N Perimeter Haulroad (East segment)	2,200	120	0-1%	Gravel/Dirt	Access/Haul	6.05	2009	2019	10-7	Exhibit 23-21 (5 Sheets) - A4N East & West Perimeter Rd. Design
Area 4N Perimeter Haulroad (West segment)	4,388	120	0-4%	Gravel/Dirt	Access/Haul	12.06	2009	2019	10-7	Exhibit 23-21 (5 Sheets) - A4N East & West Perimeter Rd. Design
North Corridor Road	4,007	40	0-2%	Dirt	Access	3.68	2013	2019	10-2	Exhibit 26-89 - North Corridor Rd. Design
South Corridor Road	4,081	85	0-2%	Dirt	Access/Haul	7.96	2013	2019	10-2	Exhibit 26-89 - South Corridor Rd. Design
Dixon By-Pass Road	7,738	85	0-6%	Dirt	Access/Haul	15.10	2013	2019	10-2	Exhibit 26-90 (2 sheets) - Dixon By-Pass Rd. Design
West Corridor By-Pass Road	753	40	0-4%	Dirt	Access	0.69	2013	2019	10-2	Exhibit 26-89 - West Corridor By-Pass Rd. Design
North Facilities Access Road	5,951	55	0-2%	Dirt	Access/Haul	7.51	2013	2019	10-5	Exhibit 11-155 (3 Sheets) - North Facilities Access Rd. As-Built folder
Total Length/Area Primary Roads [miles/acres]	36.9					299.8				

PRIMARY ROAD TYPICALS



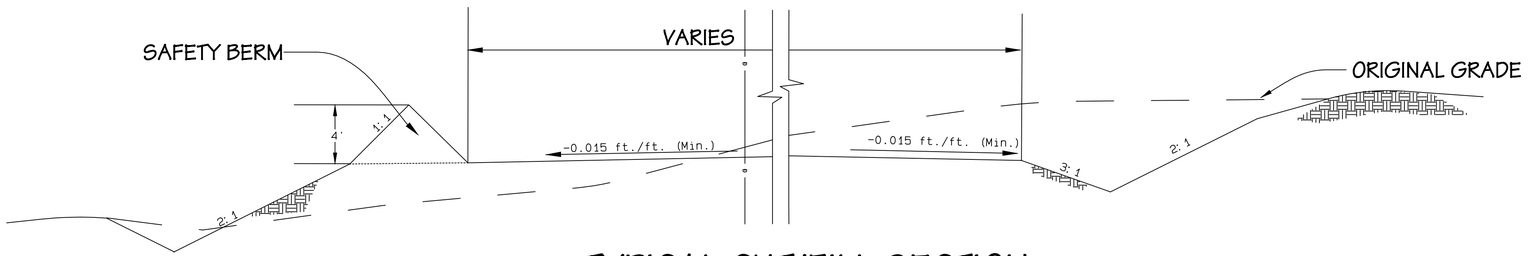
TYPICAL FILL SECTION

SCALE: 1"=5'



TYPICAL CUT SECTION

SCALE: 1"=5'



TYPICAL CUT/FILL SECTION

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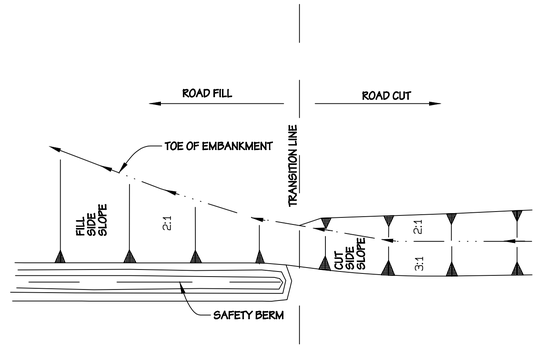
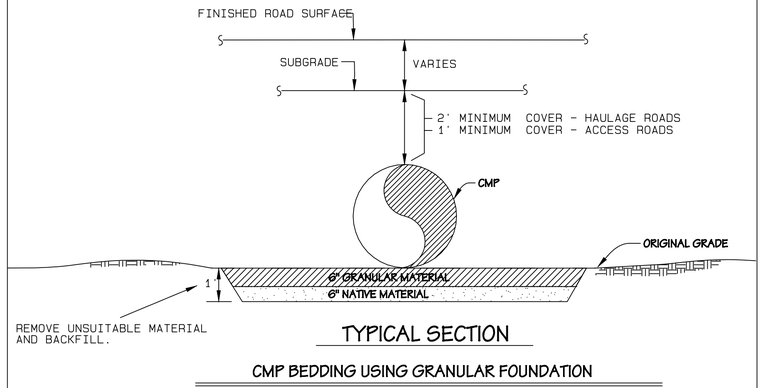


DETAIL ROAD SIDE DITCH CUT/FILL LOCATIONS

NOT TO SCALE



TYPICAL SECTION

CMP BEDDING USING GRANULAR FOUNDATION

SCALE:1"=2'

NOTE:

1. DIMENSIONS AND SLOPES SHOWN ABOVE ARE APPROXIMATE.

2. FOR ROAD WIDTH, GRADE, AND OTHER ROAD INFORMATION REFER TO TABLE 11-11.

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
13-A	11/15/13	CJB	UPDATED TYPICAL SECTION INFORMATION TO ALIGN WITH SUBMITTAL.	BH	TR	LR		
4	9/23/98	RY	RE-GENERATED DRAWING FOR COMPUTER FILE AND ADDED NOTE 2.	BH	MC	LR		
3	9/14/95	PJF	CHANGE THIS DWG. EXH.11-84 TO 11-84A.					
2	8/28/93	JG	CHANGE EXHIBIT NO. 11-84 AND CHANGE COMPANY NAME.	JER				
1	5/11/89	PJF	ADDED APPROX. DIMENSIONS STATEMENT, DELETED 2' FLAT BOTTOM OF DITCHES.	JER				GAP

APPROVALS

EXHIBIT 23-1

bhpbilliton

BHP Navajo Coal Company

P.O. Box 1717
Fruitland, New Mexico, 87416

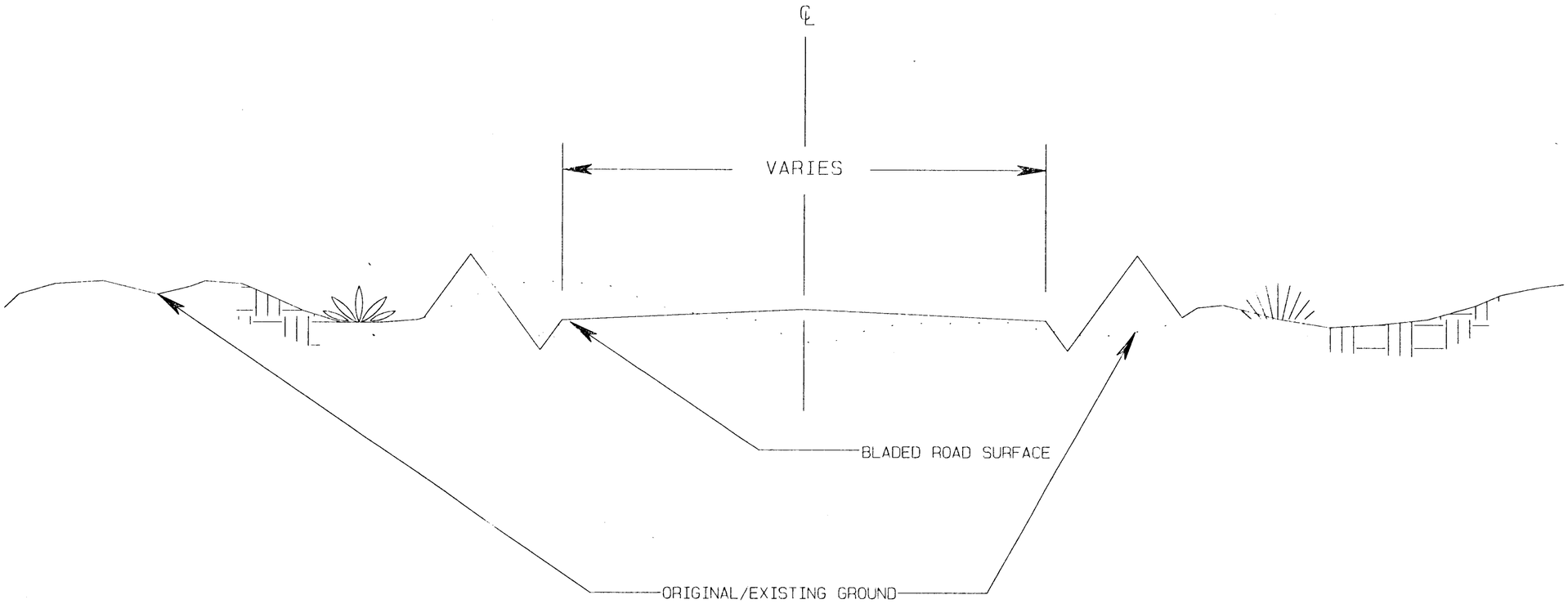
Phone: 505-598-4200
Fax: 505-568-3361

TYPICAL CROSS SECTIONS FOR PRIMARY ROADS AND CULVERTS

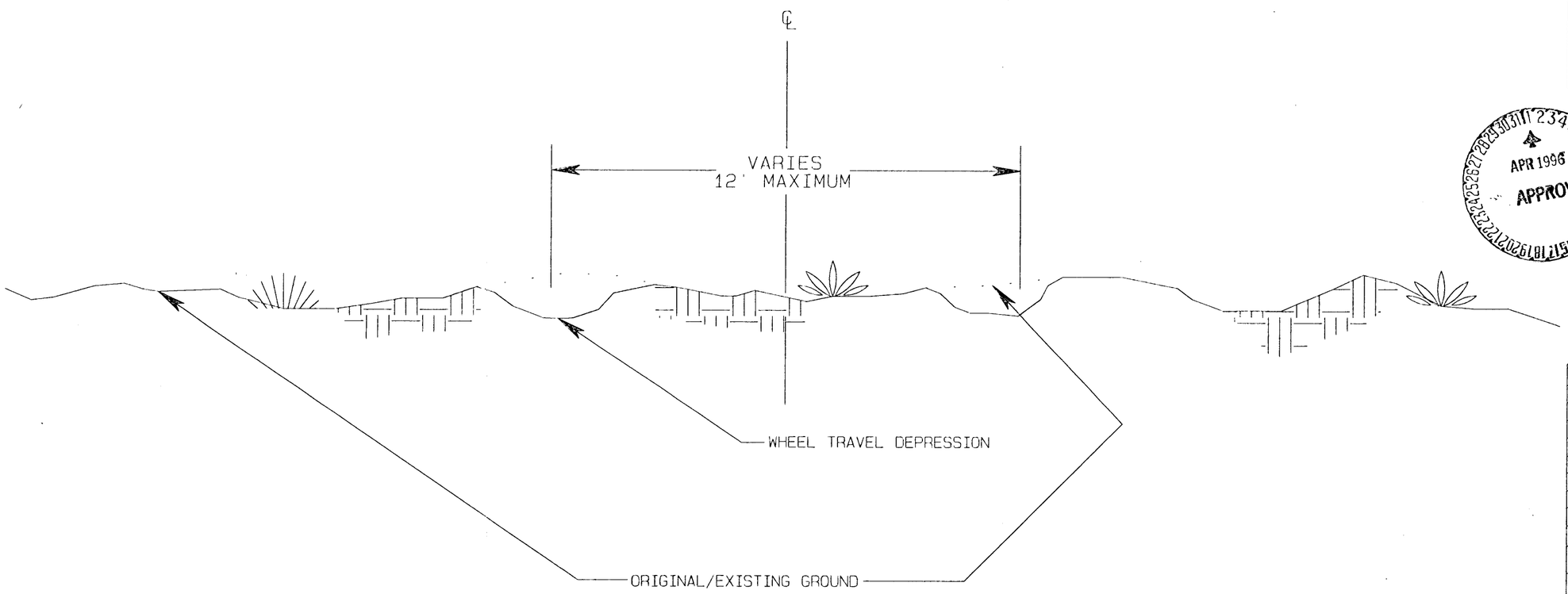
PREPARED BY RY	DRAWN BY RY	SCALE AS NOTED
APPROVED BY LR	DATE 09/23/98	REF DWG

MAP LOCATION: (See Lower Left Coner)

G:\Gs\OSM_SUBMJ\PER PROJ\CH_11_PAP EXHIBITS\11-079_084_PDS-PRD\NM PAP DATA\Exh 11-84a.pro
NM PAP Tue Mar 16 13:53:39 2010



MAINTAINED MINE SERVICE ROAD - TYPICAL SECTION



"TWO-TRACK" ROAD - TYPICAL SECTION

LEGEND

EXISTING GROUND

℄ CENTERLINE OF ROAD

ROAD SURFACE

ORIGINAL GROUND

APR 1996 APPROVED

LEONARD RAYMONE NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER 9-14-95

REV NO.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E G	P E	P S	CHIEF ENG
A	9-13-95	DJR	SUBMITTED TO OSM FOR APPROVAL.					

APPROVALS

EXHIBIT 23-2

BHP MINERALS INTERNATIONAL INC.

NAVAJO MINE

P O. BOX 155 FRUITLAND, NEW MEXICO 87416

ANCILLARY ROADS TYPICAL CROSS-SECTIONS

PREPARED BY DJR	DRAWN BY DJR	SCALE NO SCALE
APPROVED BY	DATE	DWG. LOC.
DWG. NO.	REF. DWG.	

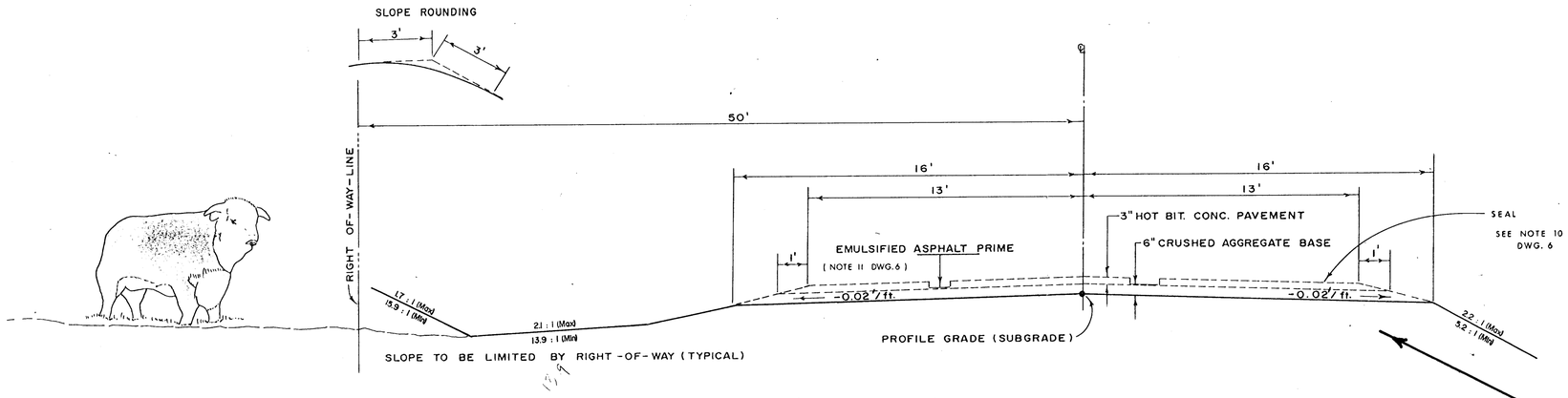
SHOP/OFFICE ACCESS ROAD
TYPICAL CROSS SECTION
PROJECT N4000 SERIES

NOTES:

1. FOR ROAD PLAN AND PROFILE SEE EXH. II-I2A THRU II-I2C.
2. FOR CATTLE CROSSING STRUCTURE SEE EXH. II-I2E & II-I2F.
3. FINAL ROAD CENTER LINE MARKINGS AND SHOULDER MARKINGS SHALL BE EQUIVALENT TO MARKINGS ON EXISTING N4000 SERIES ROADS.
4. The Crushed Aggregate Shall Conform to the A.A.S.H.T.O. M-147 Specifications and Shall Range from Course to Fine Within the Following Limits:

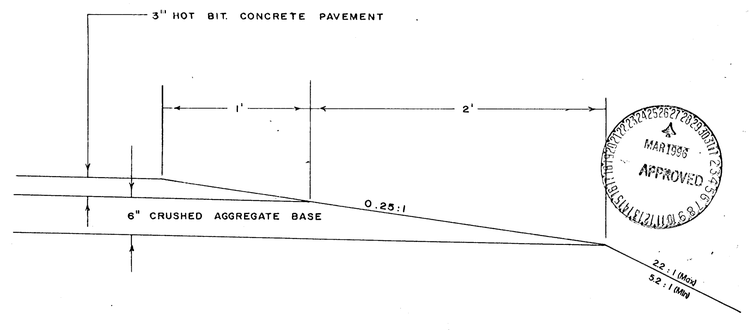
Sieve Size	% Passing by Wt.
1"	100
#4	40 - 65
#200	2 - 10

5. The Furrow Ditch Shall be Located in All Cut Sections, On Both Sides of the Road and Shall be Constructed to the Following Specifications: Triangular in Shape; 2H:1V Side Slopes; 1 Foot in Depth. It should be Sloped to Provide Adequate Drainage.
6. FOR CUT SECTION C-C SEE EXH. II-I2G.



ESTIMATED QUANTITIES				AS BUILT	
ITEM NO.	DESCRIPTION	QUANTITY	UNIT	QUANTITY	UNIT
1	CLEANING AND GRUBBING	0.983	MI.		
2	UNCLASSIFIED EXCAVATION	19,800.00	C.Y.		
3	COMPACTED FILL	19,200.00	C.Y.		
4	CRUSHED AGGREGATE	2,885.00	C.Y.		
5	8' DIA., 3 x 1 CORR., BIT. COATED CATTLE CROSSING	86	L.F.		
6	FURROW DITCH	5,900.00	L.F.		
7	HEAVY DUTY, TYPE CATTLE GUARDS	1	EA.		

SHOULDER DETAIL



MAR 1996 APPROVED

LEONARD RAYMONDC NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

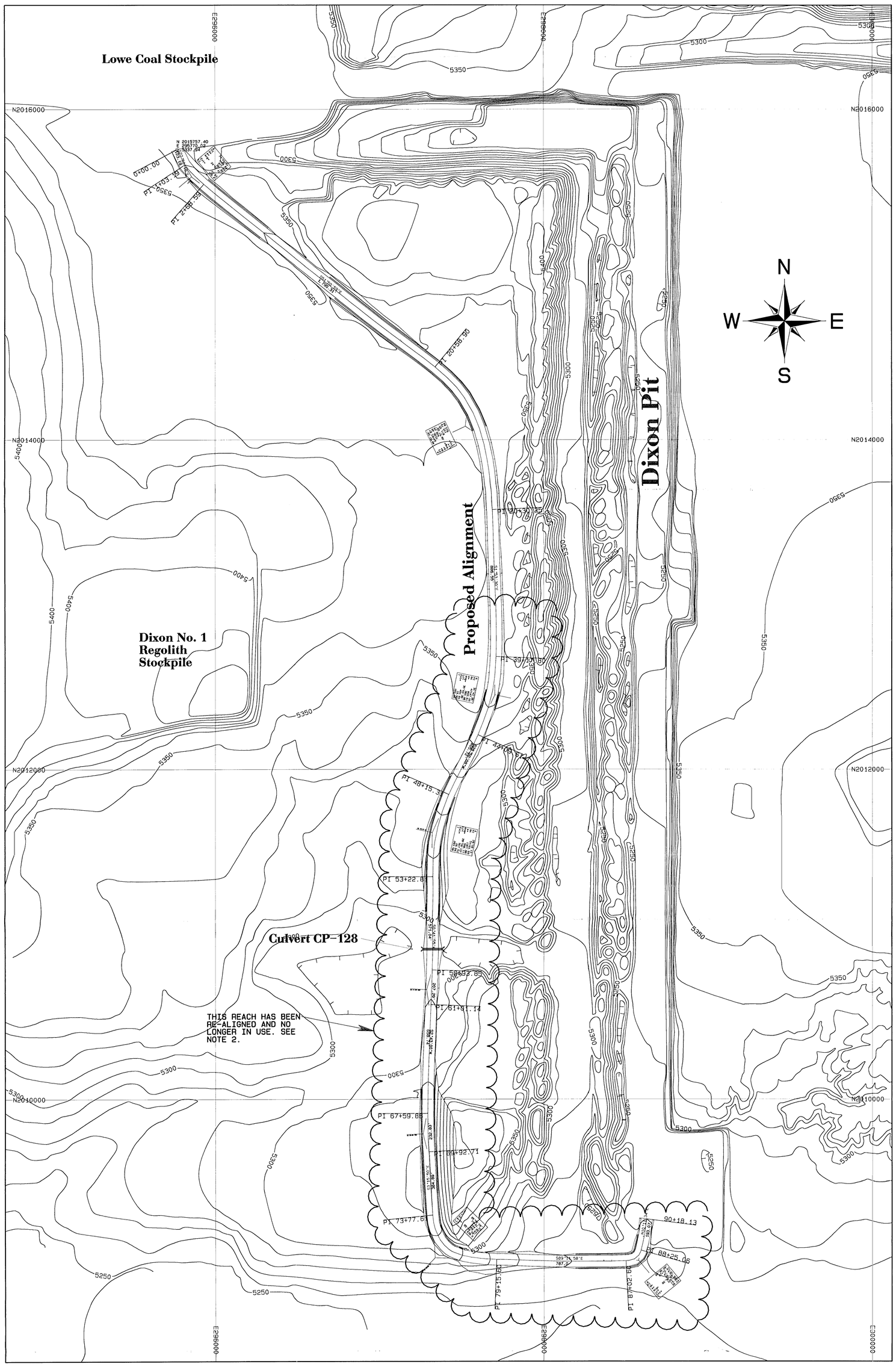
EXHIBIT 23-3

BHP MINERALS INTERNATIONAL INC.
NAVAJO MINE
FRUITLAND, NEW MEXICO

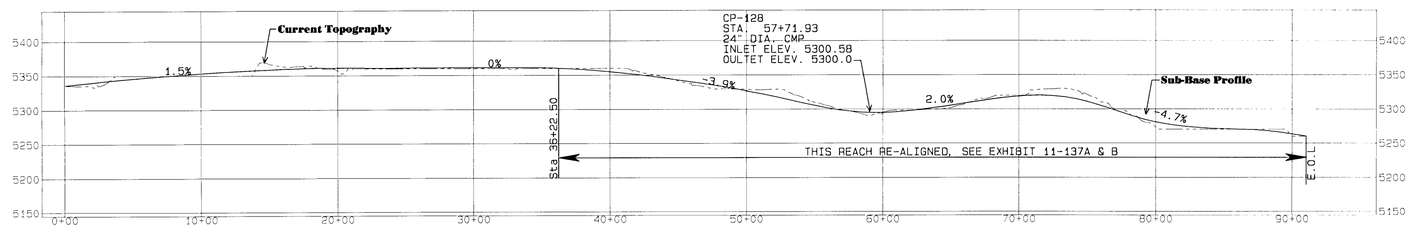
SHOP/OFFICE ACCESS ROAD
TYPICAL CROSS SECTION
PROJECT N4000 SERIES

DRAWN BY J.GOLBE	SCALE AS SHOWN		
APPROVED BY	DATE 6/13/82		
DRAWING NO.		LOCATION NO.	

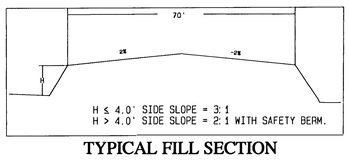
REV. 2 | 03-08-1996 | AS-BUILT
REV. 1 | 7-19-82



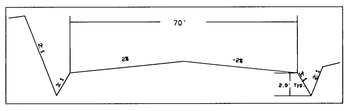
PLAN VIEW OF ROAD ALIGNMENT
SCALE 1" = 250'



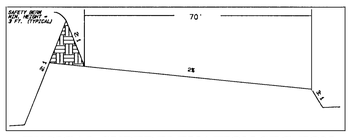
PROFILE VIEW OF ROAD ALIGNMENT
SCALE 1"= 500'



TYPICAL FILL SECTION
NTS



TYPICAL CUT SECTION
NTS



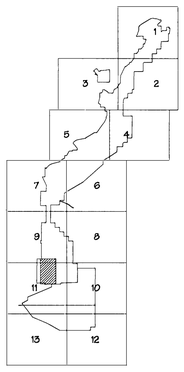
TYPICAL SUPERELEVATION SECTION
NTS

LEGEND

- ROAD
- TRAIL
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 — SPOT ELEVATION
- 5300 — INDEX CONTOUR
- 5298 — INTERMEDIATE CONTOUR
- 218 5422.45 — L-30 — LEASE CORNER

NOTES

1. For hydrology and design information refer to Appendix 11-V in the approved PAP.
2. The Haulroad from sta. 36+22 to E.O.L. has been re-aligned. Refer to Exhibit 11-137A & B for current Alignment.



CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
5600
REGISTERED PROFESSIONAL ENGINEER
8-23-02

APPROVED
MAR 2003

REV. NO.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
B	08/20/02	RY	ADDED NOTES ON PLAN AND PROFILE AND ADDED NOTE 2. SUBMITTED TO OSM FOR REVIEW.	LR	MC	LR	SM	
A	03/29/99	KB	SUBMITTED TO OSM FOR APPROVAL					

APPROVALS

EXHIBIT 23-4

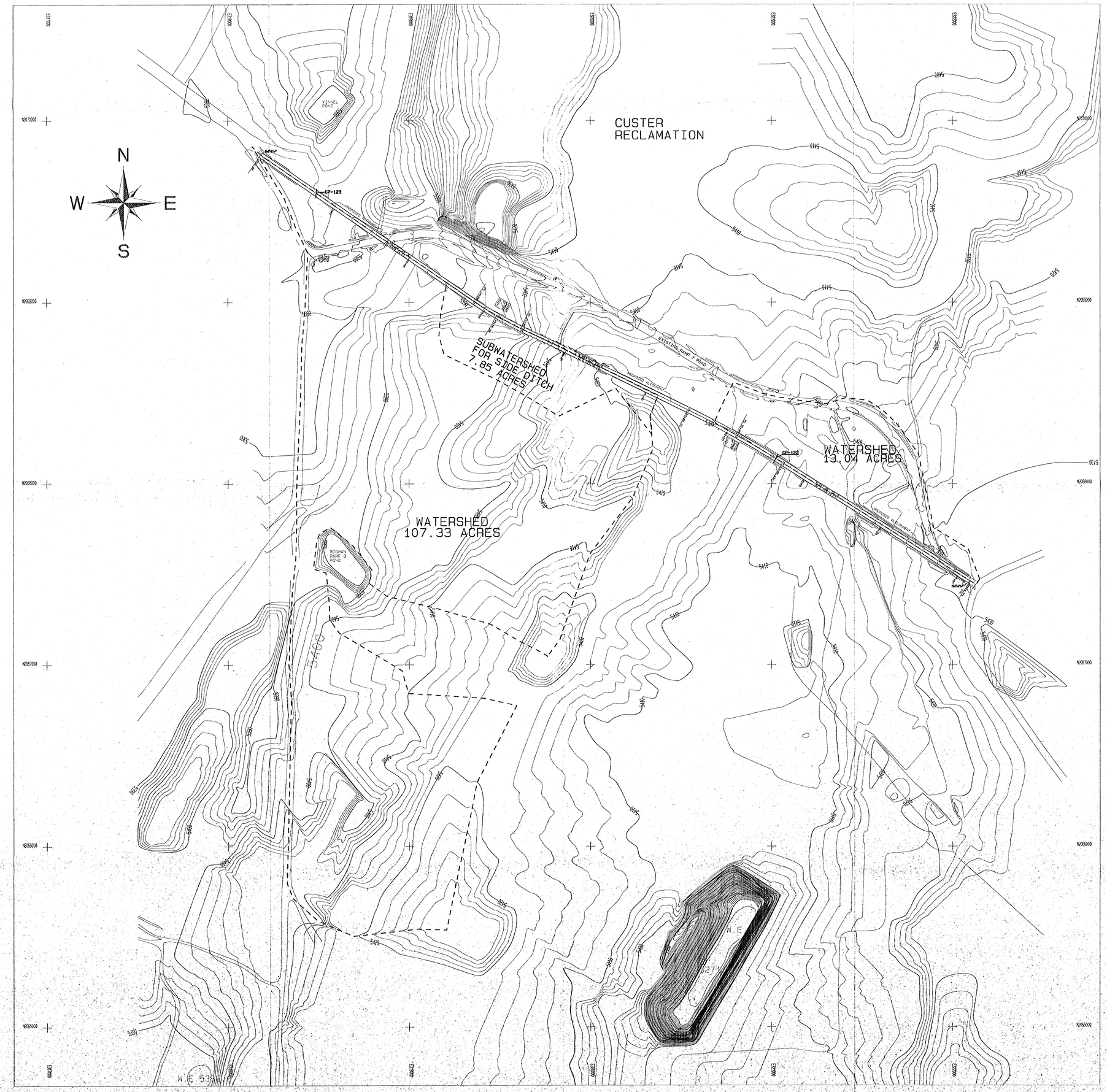
NAVAJO COAL COMPANY

NAVAJO MINE
SAFETY FAITH

P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

Dixon Haul Road Design

PREPARED BY KB	DRAWN BY KB	SCALE AS NOTED
APPROVED BY LR	DATE 03/29/99	REF DWG
DWG LOC	J:\OSM_BUSKIPER_PROJECT_11\11-137\Dixon HaulRoad design.pro	



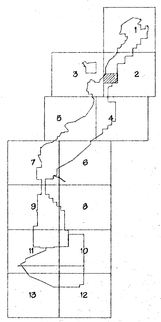
LOCATION/WATERSHED MAP

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWER LINE
- x 5338.5 — SPOT ELEVATION
- 5300 — INDEX CONTOUR
- 5298 — INTERMEDIATE CONTOUR
- 218 / 5422.45 — LEASE CORNER
- L-30

NOTES

1. For hydrology and design information refer to Appendix 11-2 in the approved PAP.



CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 8800 REGISTERED PROFESSIONAL ENGINEER

11-13-97

MAR 1998 APPROVED

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	G.S.	P.E.	P.S.	CHIEF ENG.
A	11/12/97	RY	SUBMITTED TO OSM FOR APPROVAL					

APPROVALS

EXHIBIT 23-5

NAVAJO COAL COMPANY

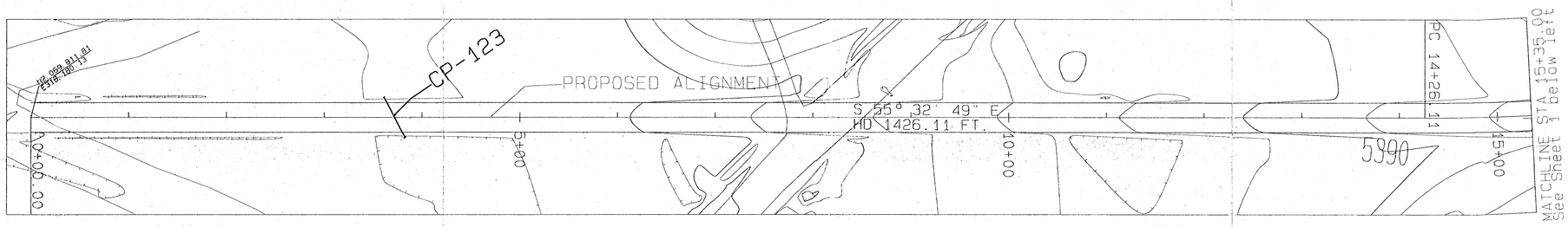
NAVAJO MINE

P.O. BOX 195 FRUITLAND, NEW MEXICO 87416

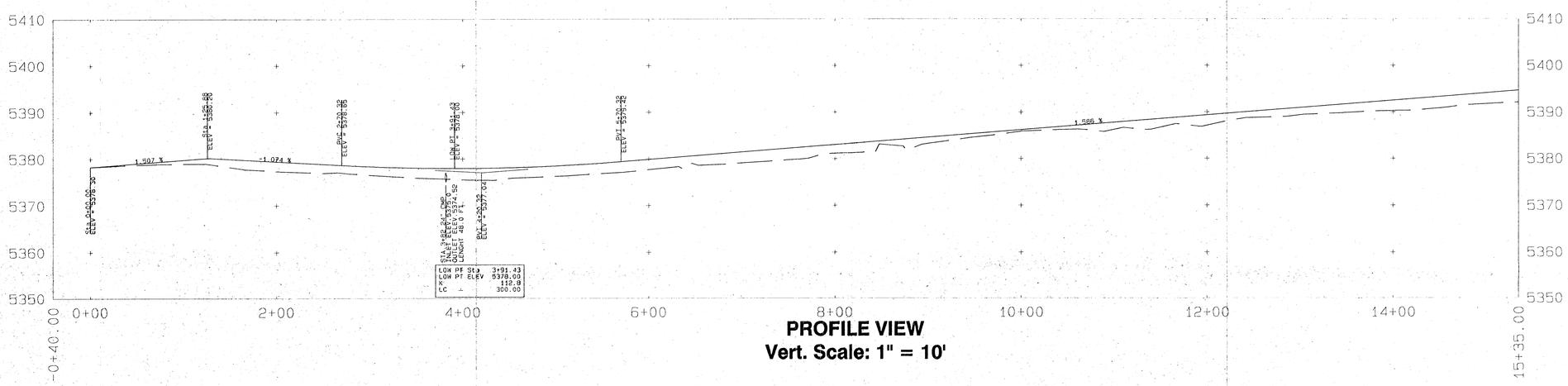
RAMP 7 ROAD REALIGNMENT
LOCATION/WATERSHED MAP

PREPARED BY: RY	DRAWN BY: RY	SCALE: 1" = 200' FT.
APPROVED BY: LR	DATE: 11/12/97	REF. DWG.

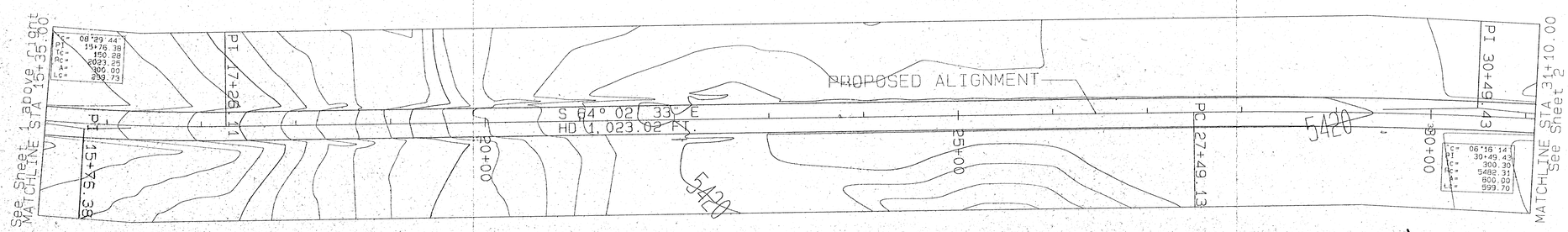
DWG LOC: J:\OSM_SUBM\REA_PROG\CH_11\11-119\EXHIBITS\RAMP7ROAD.PRO



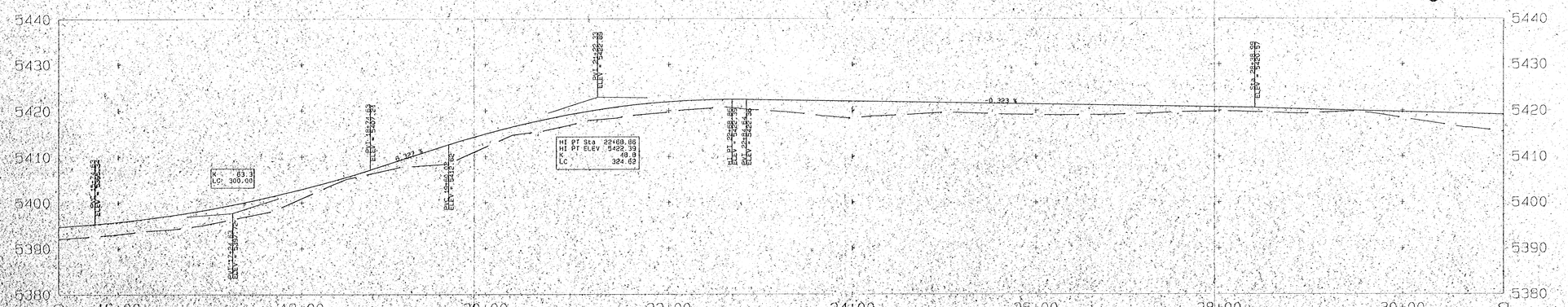
PLAN VIEW
Hztl. Scale: 1" = 50'



PROFILE VIEW
Vert. Scale: 1" = 10'



PLAN VIEW
Hztl. Scale: 1" = 50'



PROFILE VIEW
Vert. Scale: 1" = 10'

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- x5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 219 5492.45
- L-30 LEASE CORNER

NOTES

1. For hydrology and design information refer to Appendix 11-2 in the approved PAP.

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 PROFESSIONAL ENGINEER

11-13-97

REV. NO.	DATE	DRAFT BY	REVISION DESCRIPTION	DWG.	E.S.	P.M.	P.E.	CHK.
A	11/12/97	BY	SUBMITTED TO OSM FOR APPROVAL					

APPROVED

EXHIBIT 23-6

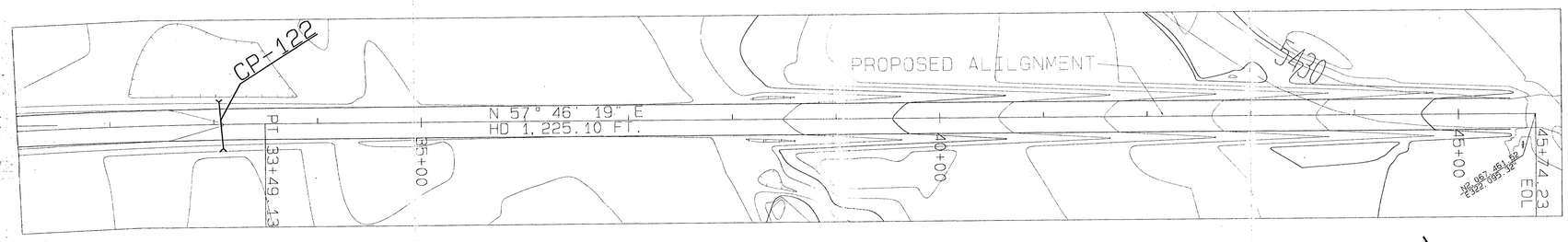
NAVAJO COAL COMPANY

NAVAJO MINE

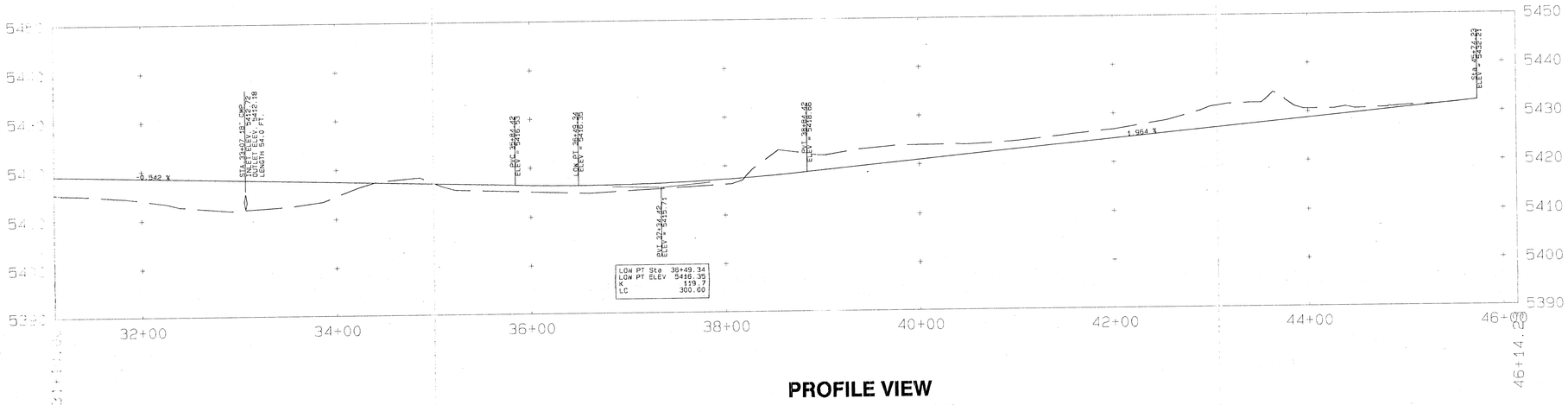
P.O. BOX 159 FRUITLAND, NEW MEXICO 87416

RAMP 7 ROAD REALIGNMENT
PLAN / PROFILE

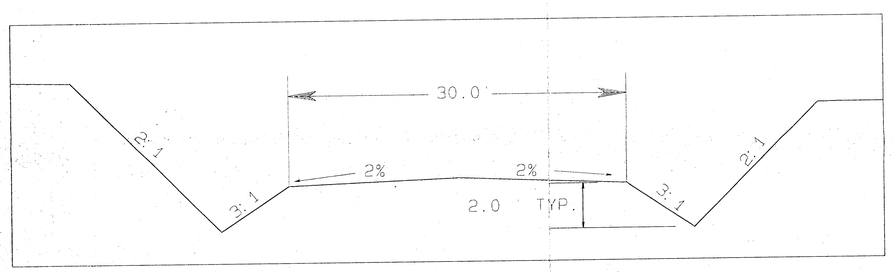
PREPARED BY BY	DRAWN BY AY	SCALE AS NOTED
APPROVED BY LR	DATE 11/12/97	REF. DWG
DWG LOC	J:\OSM\SCHFER_PROJ\CH_11\11-113\EXHIBITS\23-6 ROAD.DWG	



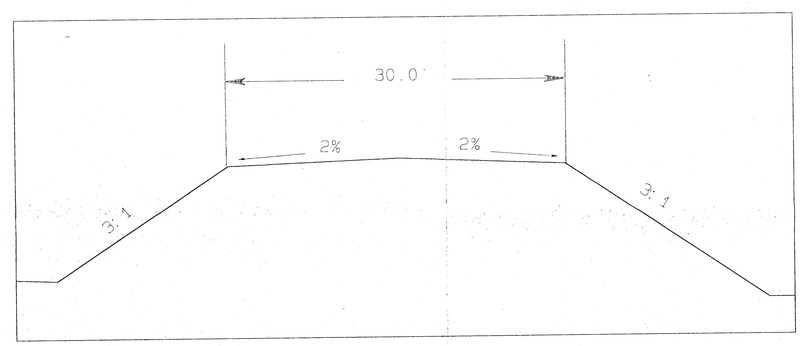
PLAN VIEW
Hztl. Scale: 1" = 50'



PROFILE VIEW
Vert. Scale: 1" = 10'



TYPICAL CUT SECTION
NOT TO SCALE



TYPICAL FILL SECTION
NOT TO SCALE

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWER LINE
- ×5338.9 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45
- L-30 LEASE CORNER

NOTES

1. For hydrology and design information refer to Appendix 11-2 in the approved PAP.

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6630 PROFESSIONAL ENGINEER

11-13-97

REV NO	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	K.A.	P.K.	P.S.	CHIEF ENG.
A	11/12/97	RY	SUBMIT FOR REGULATORY APPROVAL	APPROVALS				

JAN 1998 APPROVED

EXHIBIT 23-7

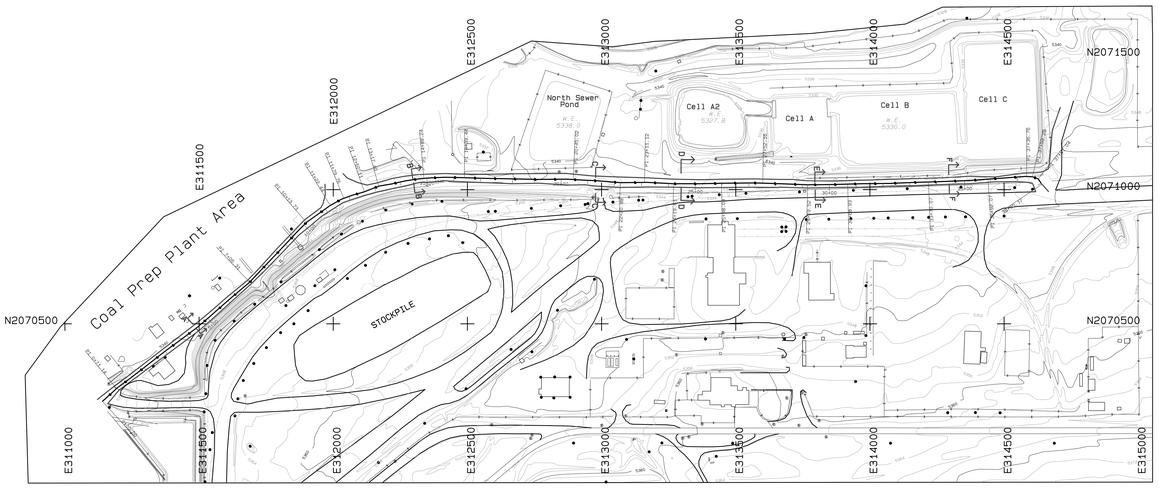
NAVAJO COAL COMPANY

NAVAJO MINE

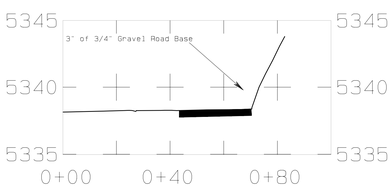
P.O. BOX 159 FRUITLAND, NEW MEXICO 87416

RAMP 7 ROAD REALIGNMENT
PLAN / PROFILE AND TYPICAL SECTIONS

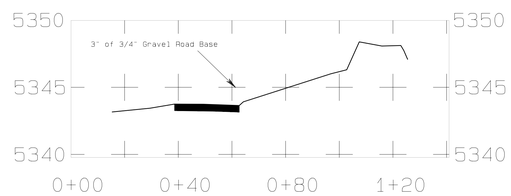
PREPARED BY RY	DRAWN BY RY	SCALE AS NOTED
APPROVED BY LR	DATE 11/12/97	REF. DWG
DWG LOC	\\QSM_SUBM\PER_FACG\CH_33\11-119\EXHIBIT3\B-R7ROAD.PRO	



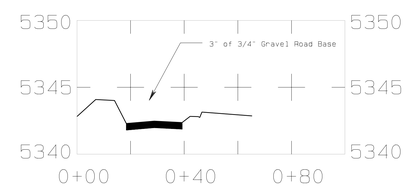
LOCATION MAP
SCALE: 1" = 200'



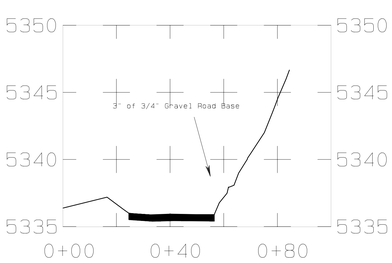
Section A - A



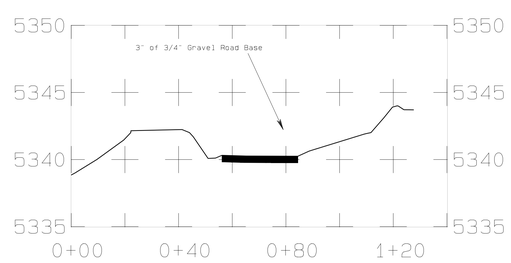
Section C - C



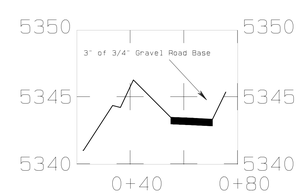
Section E - E



Section B - B



Section D - D



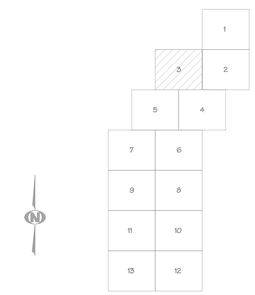
Section F - F

CROSS SECTIONAL SCALES
VERTICAL: 1" = 5'
HORIZONTAL: 1" = 20'

LEGEND

- PAVED ROAD
- DIRT ROAD
- HAUL ROAD
- TRAIL
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- POWERLINE
- × 5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- INTERMEDIATE CONTOUR
- 218 5422.45 HORIZ. & VERT. CONTROL
- L-30 LEASE CORNER
- LEASE BOUNDARY
- CENTER LINE

NOTES



CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
A	10/8/96	VAH	SUBMITTED TO OSM					

APPROVALS

EXHIBIT 23-9

NAVAJO COAL COMPANY

NAVAJO MINE
SAFETY PRIDE

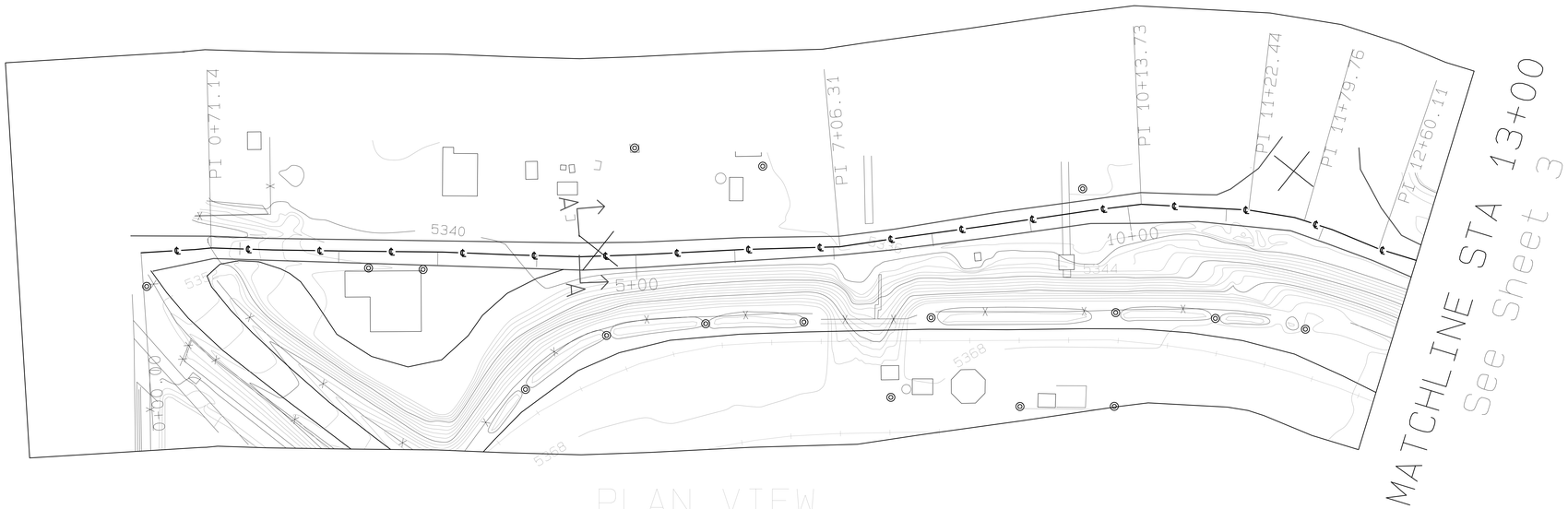
P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

AREA I

"AS-BUILT"

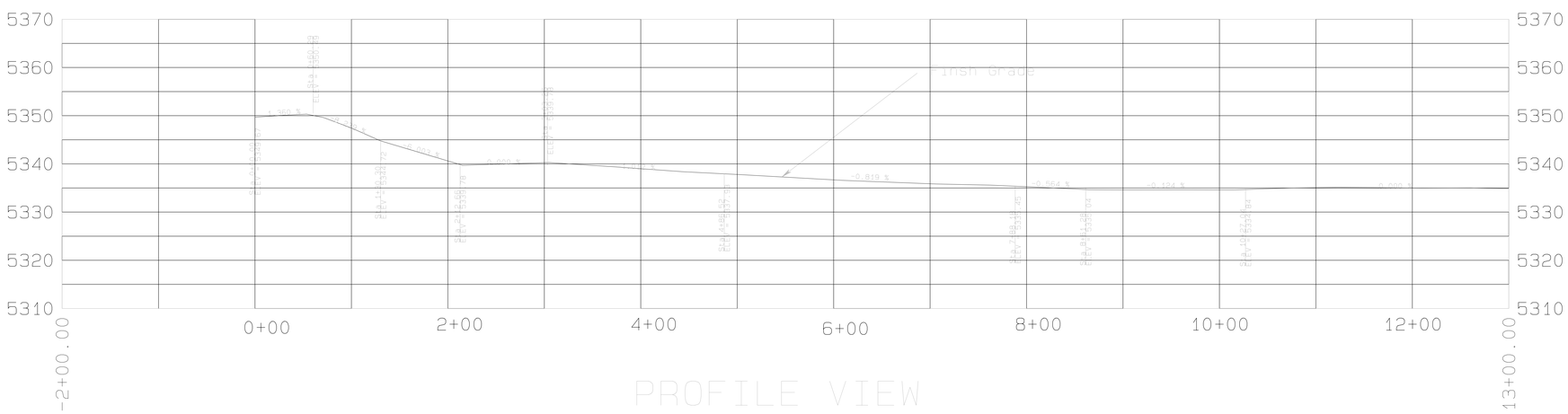
COAL PLANT ROAD

PREPARED BY VAH	DRAWN BY VAH	SCALE AS NOTED
APPROVED BY LR	DATE 10/8/96	REF DWG EX. 11-80
DWG LOC C:\VIC\PROJ\CLPLNTRD\ASBUILD.PRO		SHEET 1 OF 4



PLAN VIEW

Hztl. Scale: 1" = 50'



PROFILE VIEW

Vert. Scale: 1" = 10'

LEGEND

- PAVED ROAD
- DIRT ROAD
- HAUL ROAD
- TRAIL
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- POWERLINE
- × 5338.5 — SPOT ELEVATION
- 5300 — INDEX CONTOUR
- INTERMEDIATE CONTOUR
- 218 5422.45 — HORIZ. & VERT. CONTROL
- L-30 — LEASE CORNER
- LEASE BOUNDARY
- CENTER LINE

NOTES

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
A	10/8/96	VAH	SUBMITTED TO OSM					

APPROVALS

EXHIBIT 23-9

NAVAJO COAL COMPANY

NAVAJO MINE — SAFETY PRIDE

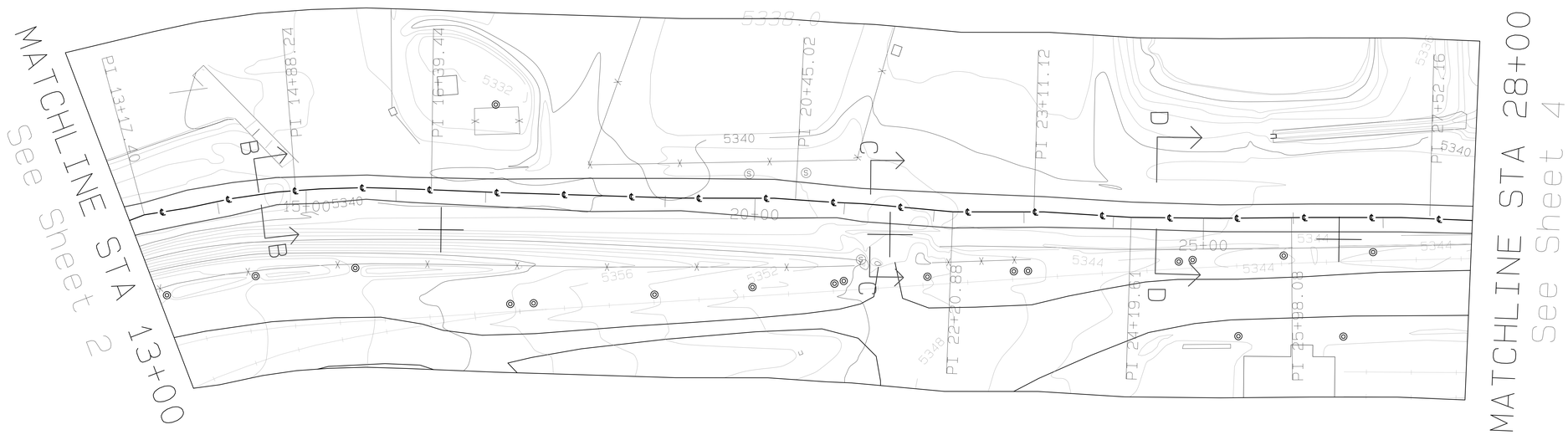
P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

AREA I

"AS - BUILT"

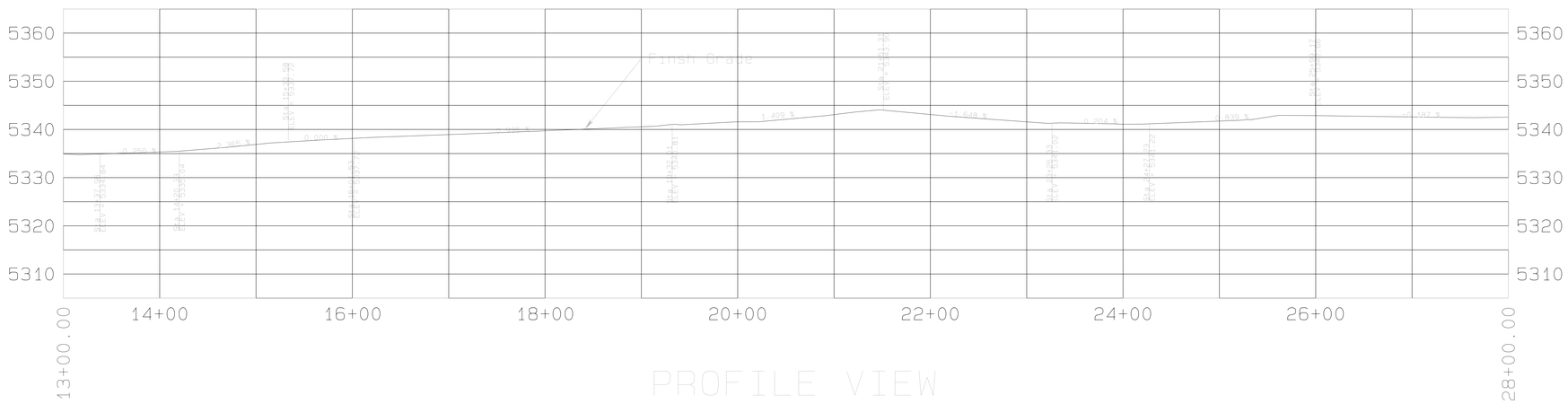
COAL PLANT ROAD

PREPARED BY VAH	DRAWN BY VAH	SCALE AS NOTED
APPROVED BY LR	DATE 10/8/96	REF DWG EX. 11-80
DWG LOC C:\VIC\PROJ\CLPLNTRD\ASBUILD.PRO		SHEET 2 OF 4



PLAN VIEW

Hztl. Scale: 1" = 50'



PROFILE VIEW

Vert. Scale: 1" = 10'

LEGEND

- PAVED ROAD
- DIRT ROAD
- HAUL ROAD
- TRAIL
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- POWERLINE
- 5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- INTERMEDIATE CONTOUR
- 218 5422.45 HORIZ. & VERT. CONTROL
- L-30 LEASE CORNER
- LEASE BOUNDARY
- CENTER LINE

NOTES

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND JAMES NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	OPER ENG.
A	10/8/96	VAH	SUBMITTED TO OSM					

APPROVALS

EXHIBIT 23-9

NAVAJO COAL COMPANY

NAVAJO MINE

SAFETY PRIDE

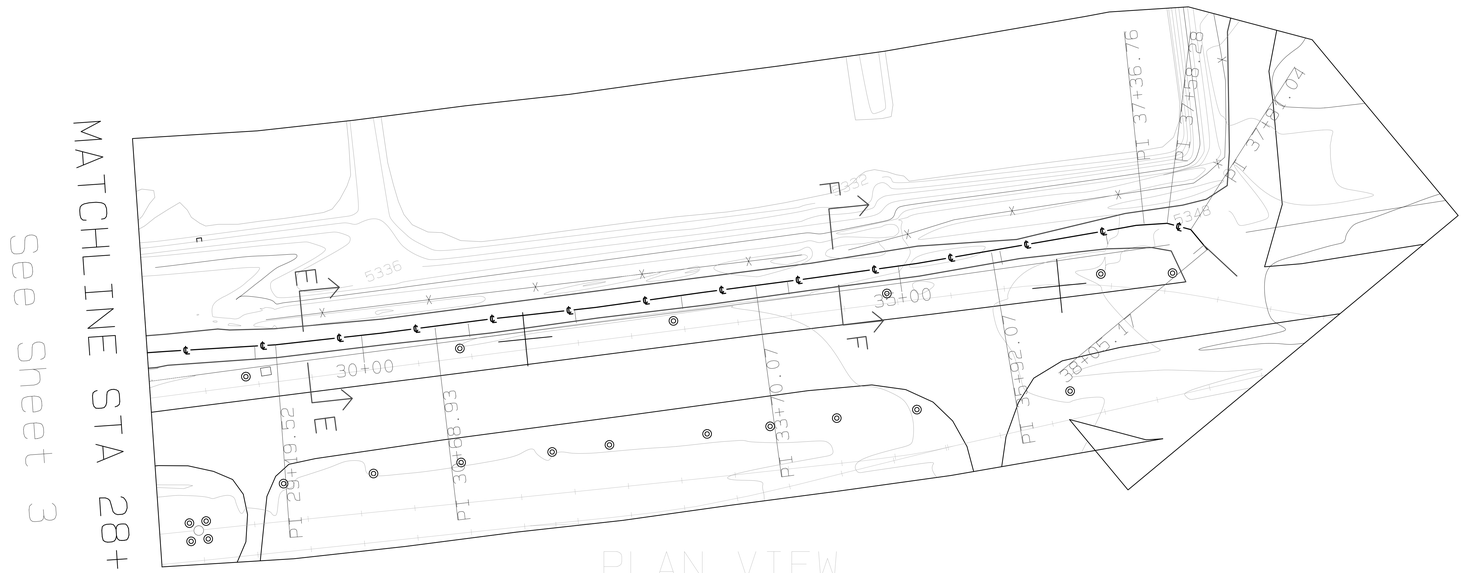
P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

AREA I

"AS — BUILT"

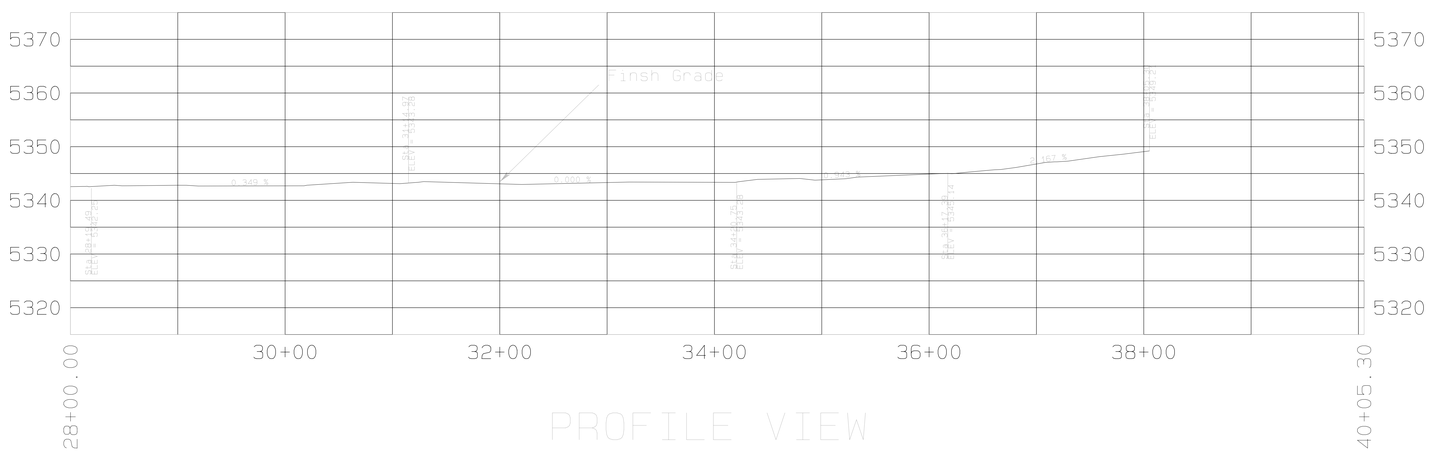
COAL PLANT ROAD

PREPARED BY VAH	DRAWN BY VAH	SCALE AS NOTED
APPROVED BY LR	DATE 10/8/96	REF DWG EX. 11-80
DWG LOC C:\VIC\PROJ\CLPLNTRD\ASBUILD.PRO		SHEET 3 OF 4



PLAN VIEW

Hztl. Scale: 1" = 50'



PROFILE VIEW

Vert. Scale: 1" = 10'

LEGEND

- PAVED ROAD
- DIRT ROAD
- HAUL ROAD
- TRAIL
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- POWERLINE
- 5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- INTERMEDIATE CONTOUR
- 218 5422.45 HORIZ. & VERT. CONTROL
- L-30 LEASE CORNER
- LEASE BOUNDARY
- CENTER LINE

NOTES

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.S.	P.E.	P.S.	CHIEF ENG.
A	10/8/96	VAH	SUBMITTED TO OSM					

APPROVALS

EXHIBIT 23-9

NAVAJO COAL COMPANY

NAVAJO MINE

SAFETY PAYS

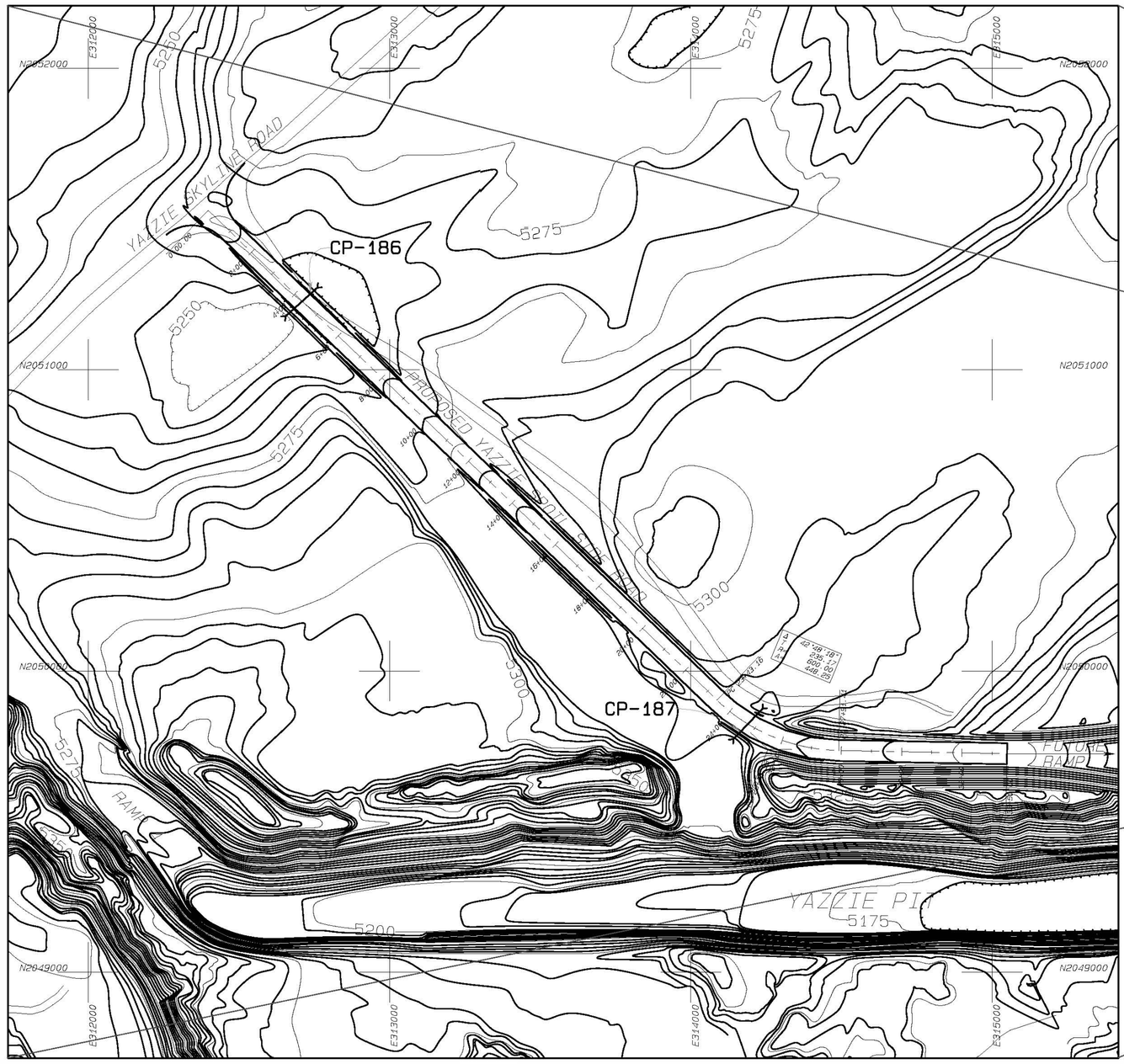
P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

AREA I

"AS-BUILT"

COAL PLANT ROAD

PREPARED BY VAH	DRAWN BY VAH	SCALE AS NOTED
APPROVED BY LR	DATE 10/8/96	REF DWG EX. 11-80
DWG LOC C:\VIC\PROJ\CLPLNTRD\ASBUILD.PRO		SHEET 4 OF 4



PLAN
Scale: 1" = 300'

LOCATION MAP
Scale: 1" = 1000'

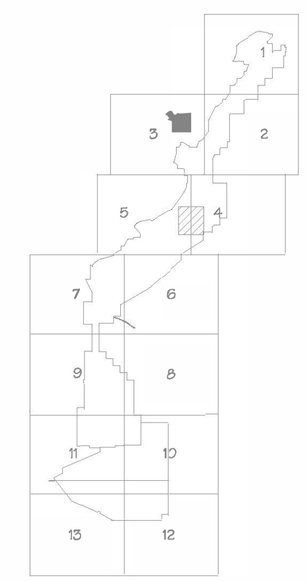
N
W E
S

LEGEND

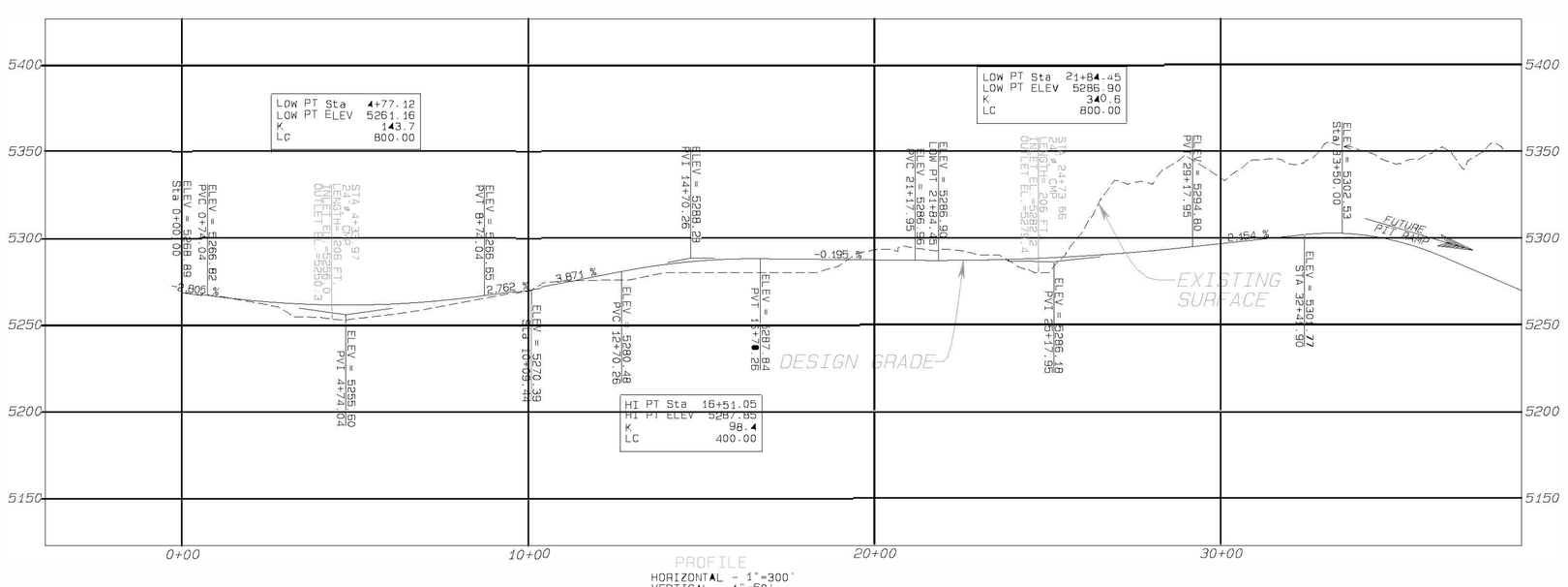
- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5299 INTERMEDIATE CONTOUR
- 218 5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY

NOTES

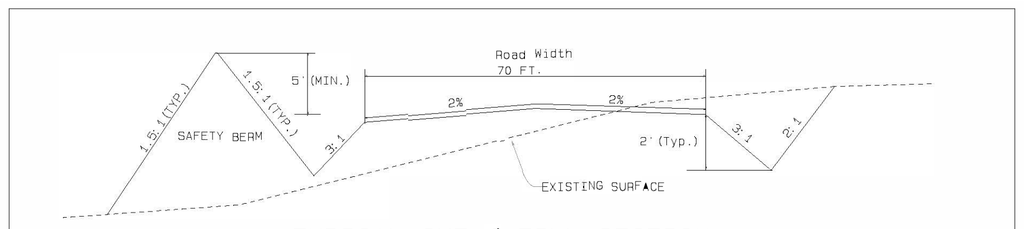
1. For hydrology and design information refer to Appendix 11-V in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-12C.



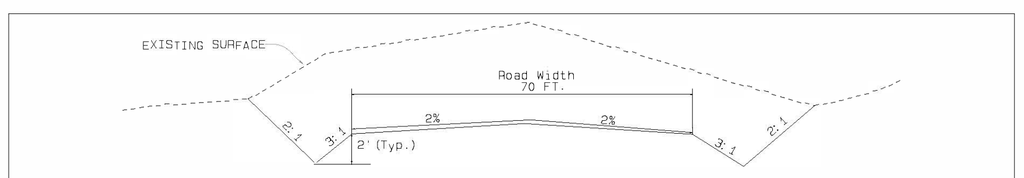
SCALE AS NOTED



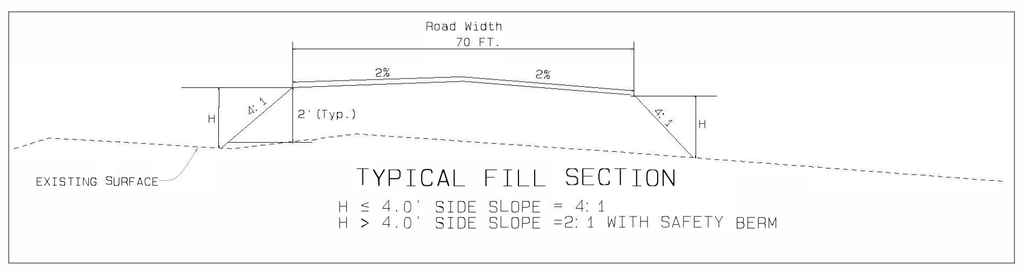
PROFILE
HORIZONTAL - 1"=300'
VERTICAL - 1"=60'



TYPICAL CUT / FILL SECTION



TYPICAL CUT SECTION



TYPICAL FILL SECTION
H ≤ 4.0' SIDE SLOPE = 4:1
H > 4.0' SIDE SLOPE =2:1 WITH SAFETY BERM

ABOVE SECTIONS
N.T.S.

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

REV. NO.	DESCRIPTION	REV. BY	DATE
1	SUBMITTED TO OSM FOR APPROVAL		10-06-04
2			
3			
4			
5			

PROJECT MANAGER: DEREK RAMSON
ENGR. of RECORD: L. RAYMOND REG. NO: 6600
SRVYR of RECORD: REG. NO:

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

ACCOUNT:
DATE: 10-06-04
DESIGNED BY: RY
DRAWN BY: RY
CHECKED BY: LR
APPROVED BY:

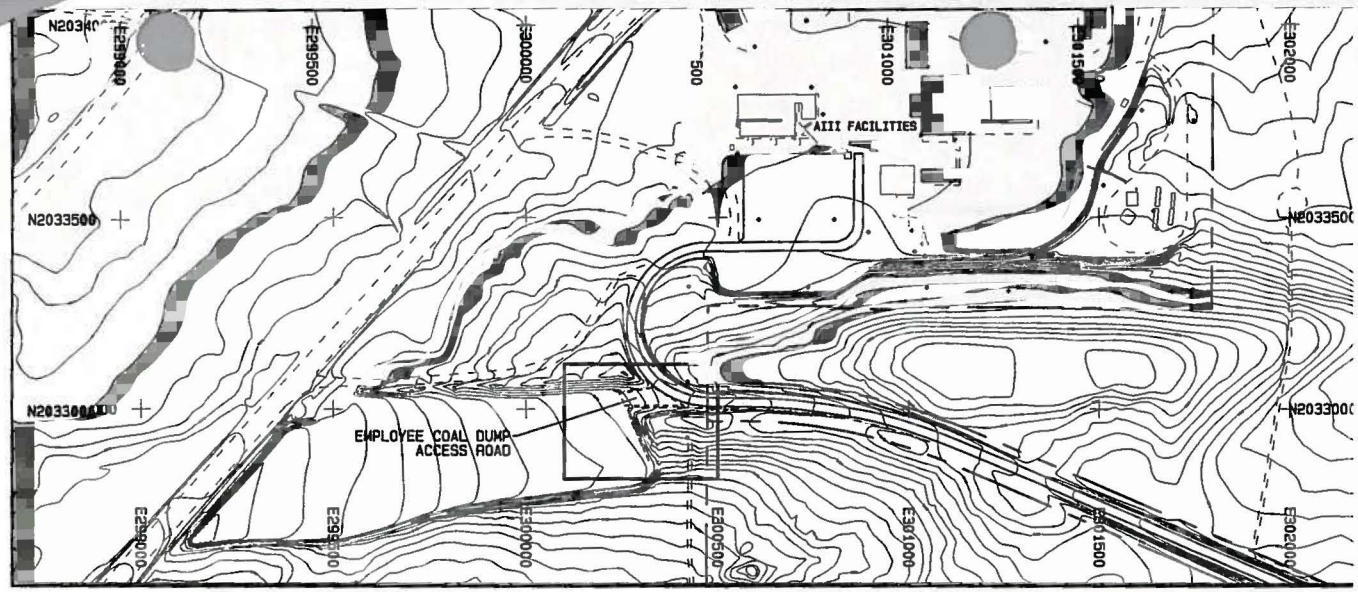
PLAN, PROFILE AND SECTIONS

EXHIBIT 23-10
YAZZIE SPOIL SIDE ROAD DESIGN

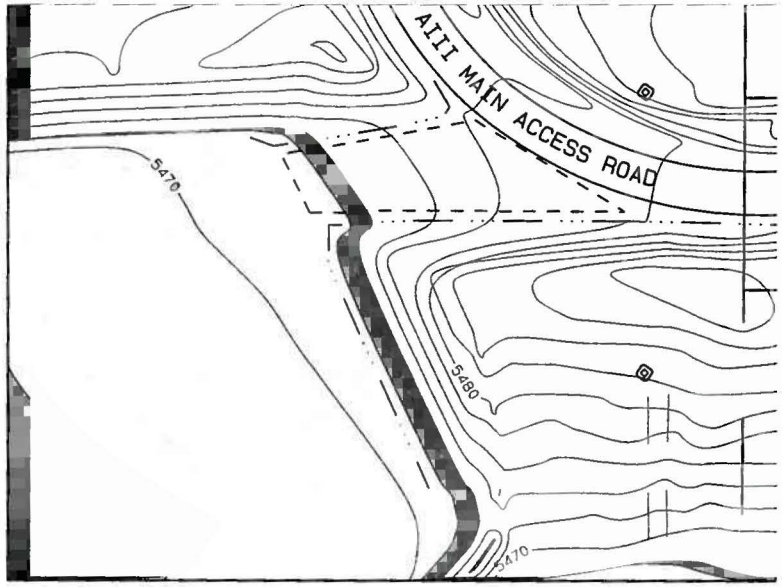
DRAWING

SHEET 1 OF 1

Path: C:\Departments\Op\OSM_SUBMITS_PROJ\Ch_11_PAP_Exhibit11-10B Yazzie Spoil Road\Exhibit11Yazzie Spoil Side road Design.dwg



SCALE: 1" = 500'



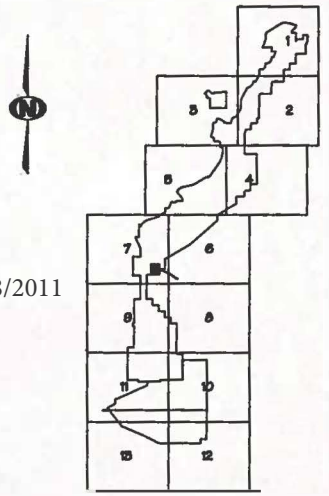
SCALE: 1" = 100'

NOTES:

1. REFER EXHIBIT 11-132 FOR DESIGN POND INFORMATION. Removed Revision 1118 dated 9/8/2011
2. FOR POND WATERSHED REFER EXHIBIT 26-11.
3. FOR ROAD INFORMATION REFER EXHIBIT 10-1.
4. SEE APPENDIX 26.C FOR SUPPORTING DESIGN DATA.
5. FOR TYPICAL ROAD SECTION REFER EXHIBIT 23.1.

LEGEND

5300	INDEX CONTOUR
5298	INTERMEDIATE CONTOUR
	PAVED ROAD
	DIRT ROAD
	SIDE DITCH DRAINAGE
	PERMIT/LEASE BOUNDARY
	POWERLINE
×5338.5	SPOT ELEVATION



REV. NO.	DATE SUBMITTED	DRAFT. BY	REVISION DESCRIPTION	P.E.	P.S.	DATE APPROVED BY OSM
A	10/29/99	BH	SUBMITTED TO OSM			

EXHIBIT 23-11

NAVAJO COAL COMPANY

NAVAJO MINE

P.O. BOX 1717 FRUITLAND, NEW MEXICO 87416

AREA III EMPLOYEE COAL DUMP ACCESS ROAD

PREPARED BY BH	DRAWN BY BH	SCALE: AS NOTED
APPROVED BY LR	DATE 10/29/99	REF DWG AS NOTED

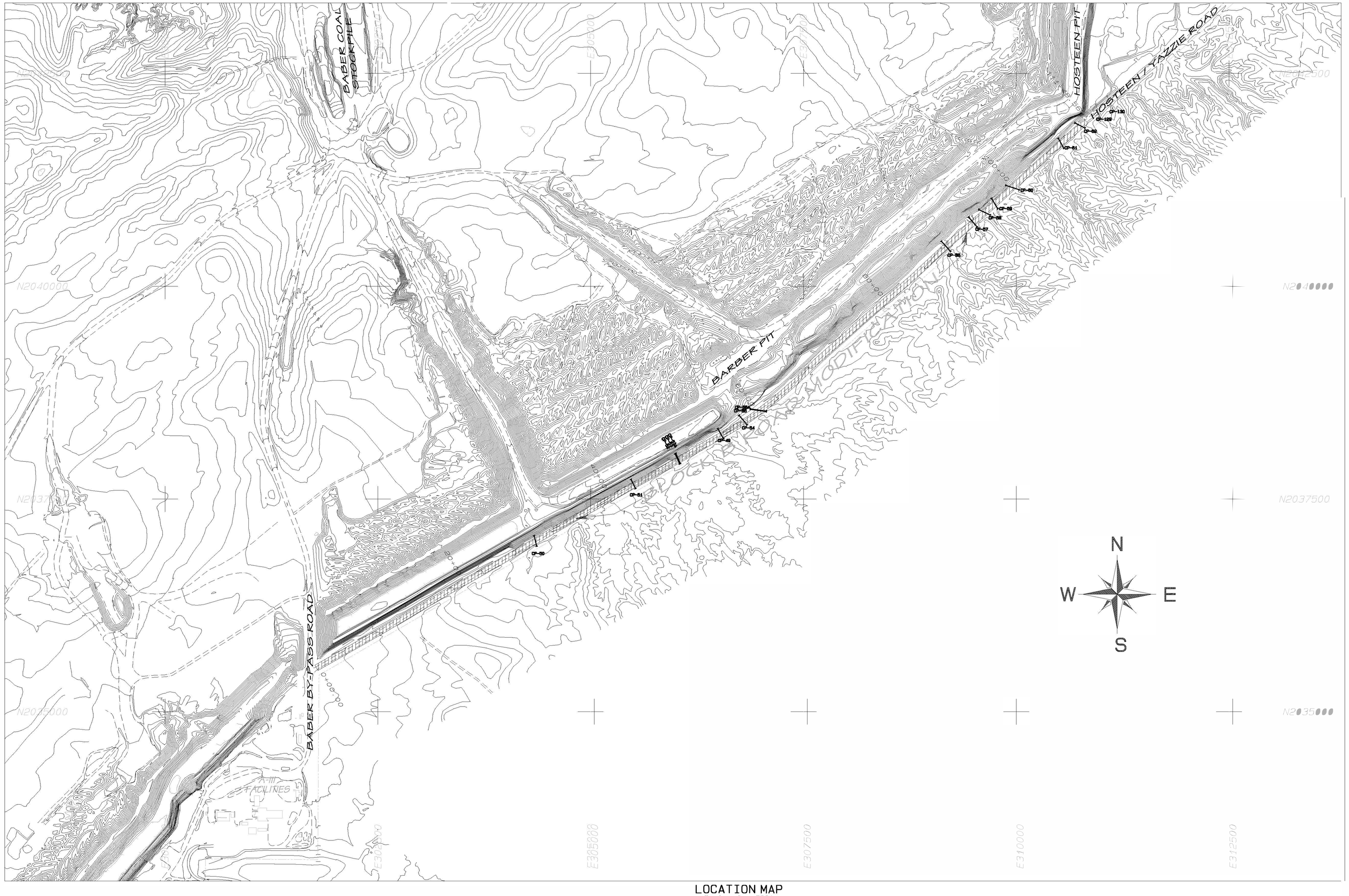
DWG LOC J:\OSM_SUBM\PER_PROG\Ch_11_Figures\emcd_road\emcdrd_des 00

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

11-2-99

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.



LOCATION MAP

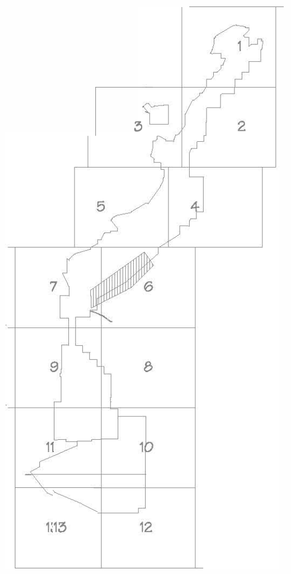
SCALE: 1" = 600'

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- x5338.5 SPOT ELEVATION
- 530 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY

NOTES

1. For hydrology and design information refer to Appendix 11-V in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-12D



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

REV. BY	DATE	DESCRIPTION
	03-08-05	SUBMITTED TO OSM FOR APPROVAL

REV.	DATE	BY	REVISION RECORD
1			
2			
3			
4			
5			

PROJECT MANAGER: DR
START OF RECORD: 01-01-00
REV NO: 0000
START OF RECORD: 00-00-00

ACCOUNT:
DATE: 3-08-05
DESIGNED BY:
DRAWN BY:
CHECKED BY: LR
APPROVED BY:

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717 FARMINGTON, NEW MEXICO 87416

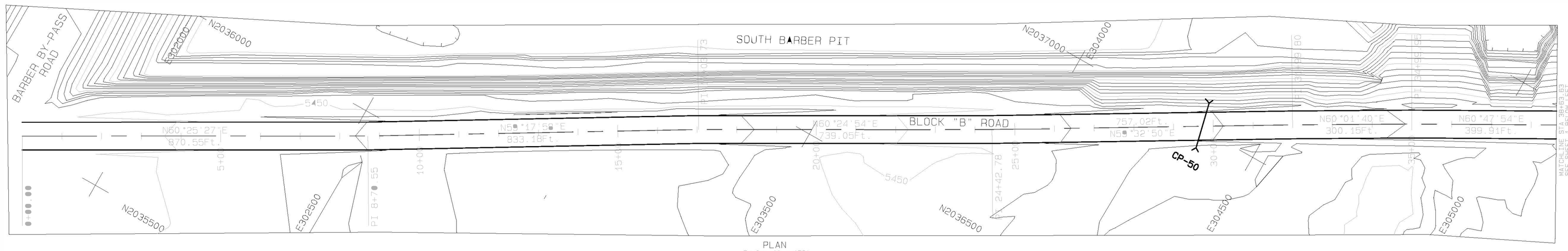
LOCATION MAP

EXHIBIT 23-12
BLOCK "B" ROAD MODIFICATION DESIGN

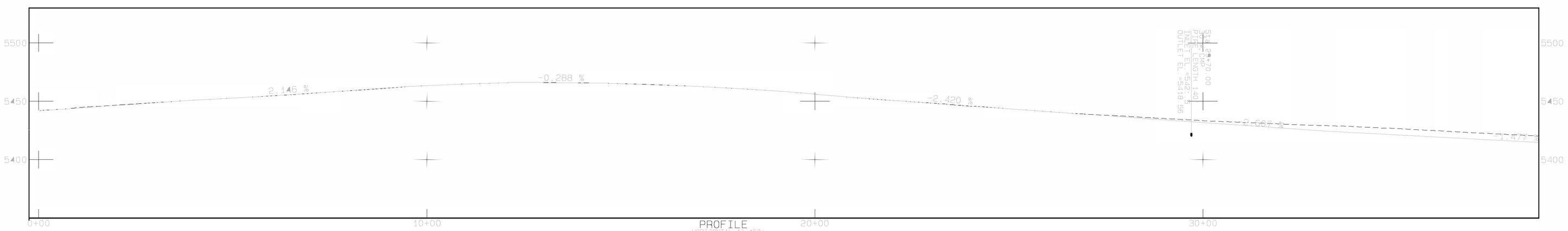
DRAWING

SHEET 1 OF 3

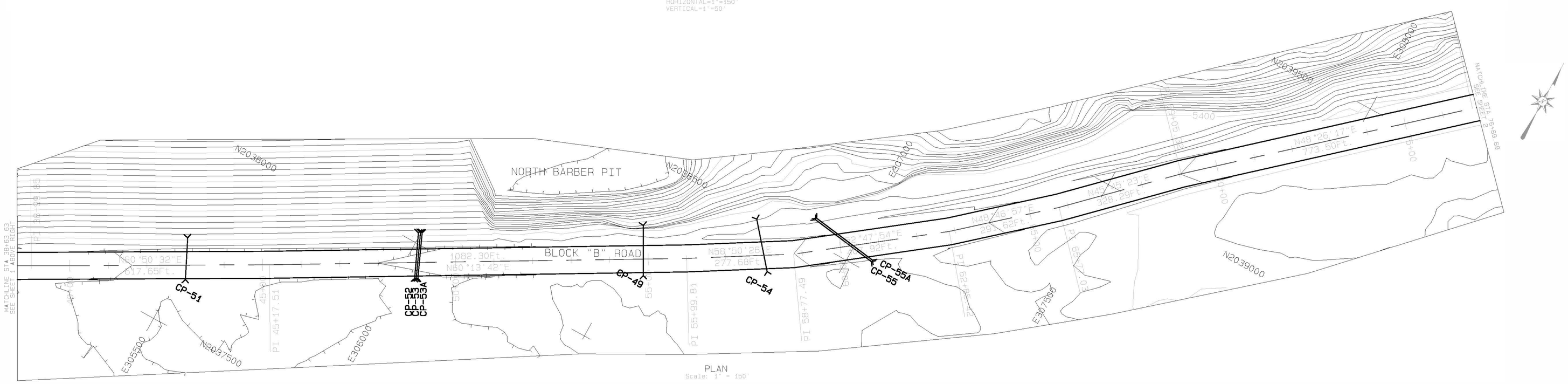
Path: G:\Departments\Eng\DGN\Subwin\Permit\Exhibit11-003 Block B Road Modification\Block B Road Mod. Location Design.dgn



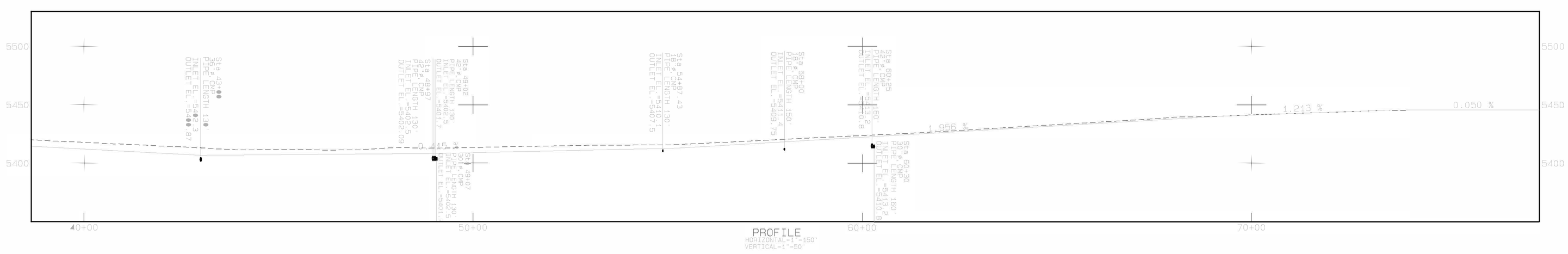
PLAN
Scale: 1" = 150'



PROFILE
HORIZONTAL=1"=150'
VERTICAL=1"=50'



PLAN
Scale: 1" = 150'



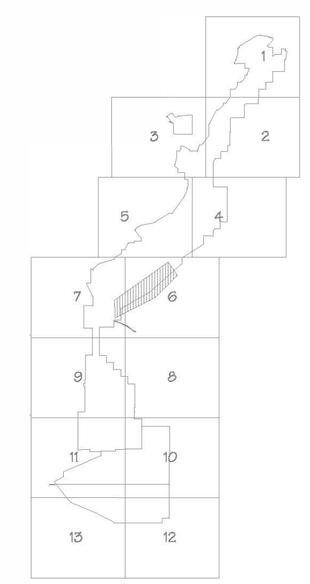
PROFILE
HORIZONTAL=1"=150'
VERTICAL=1"=50'

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 21B 5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY

NOTES

1. For hydrology and design information refer to Appendix 11-V in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-12D.



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6500
REGISTERED PROFESSIONAL ENGINEER

REV. NO.	DESCRIPTION	DATE
1	SUBMITTED TO OSM FOR APPROVAL	03-08-05
2		
3		
4		
5		

PROJECT MANAGER: DR
ENGR. AT RECORD: LB
REG. NO: 6500
SRVYR of RECORD:
REG. NO:

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

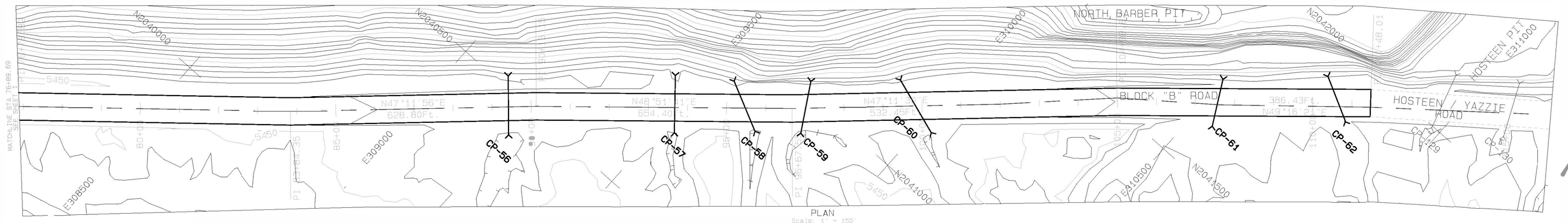
ACCOUNT:
DATE: 3-08-05
DESIGNED BY: RY
DRAWN BY: RY
CHECKED BY: LB
APPROVED BY: LB

PLAN AND PROFILE

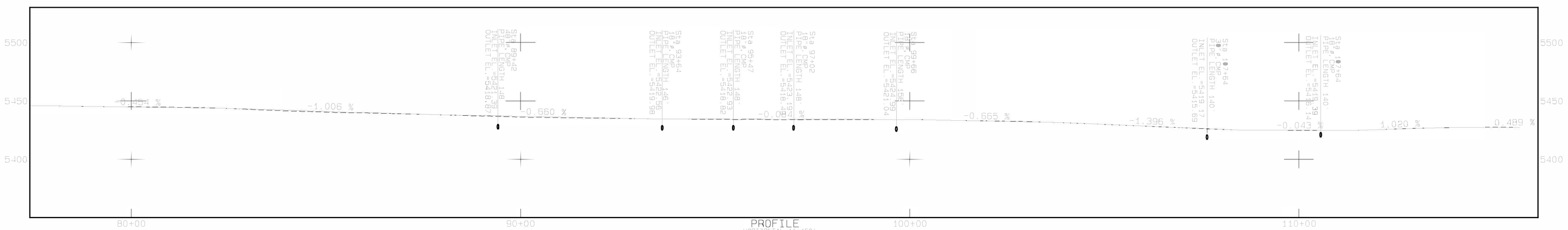
EXHIBIT 23-12
BLOCK "B"ROAD MODIFICATION DESIGN

DRAWING
SHEET 2 OF 3

Path: G:\Departments\Eng\DGN_Subfolder_PROJ\C _ 1-083 Block B Road Modification\Block B Road Modification Design.pmc



PLAN
Scale: 1" = 150'



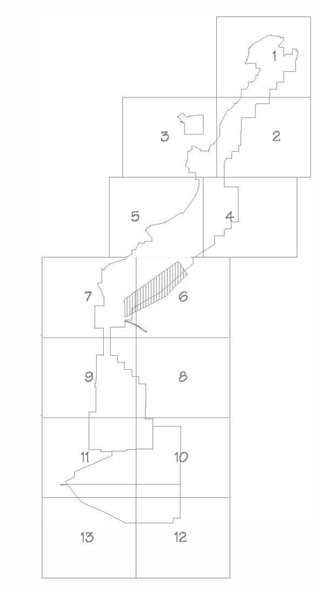
PROFILE
HORIZONTAL=1"=150'
VERTICAL=1"=50'

LEGEND

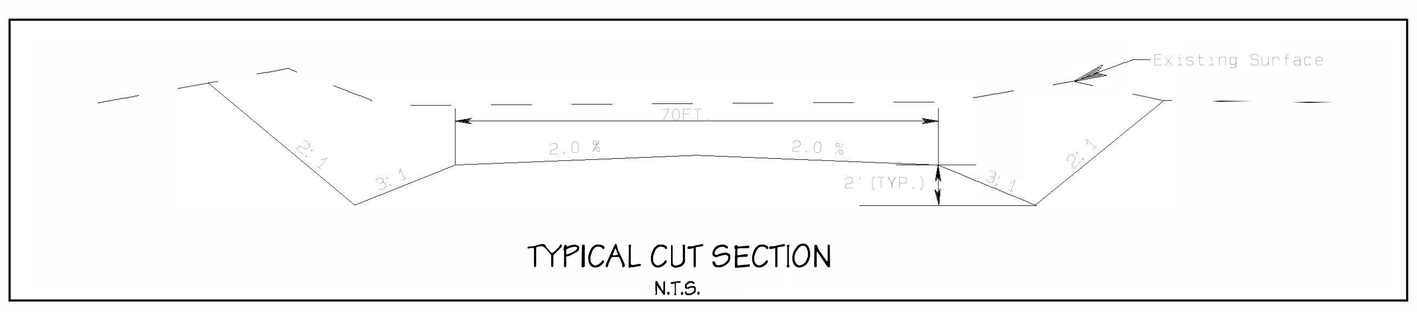
- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY

NOTES

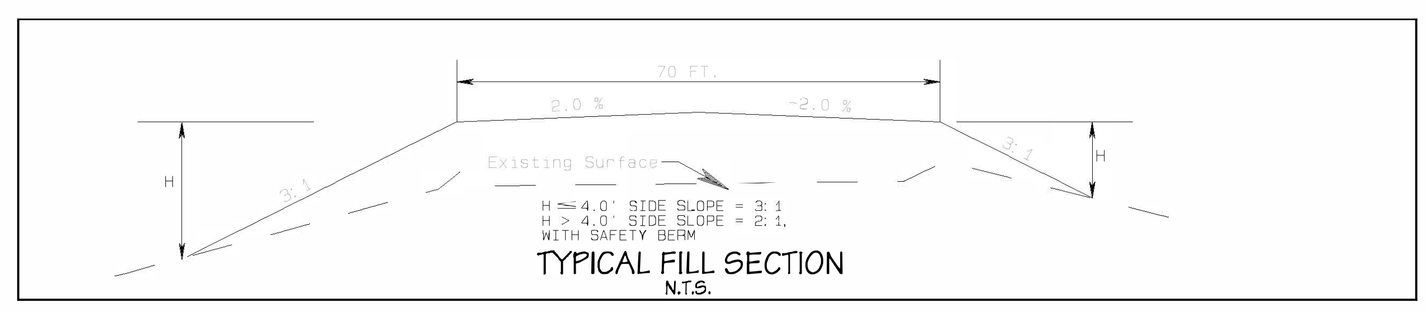
1. For hydrology and design information refer to Appendix 11-V in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-12■.



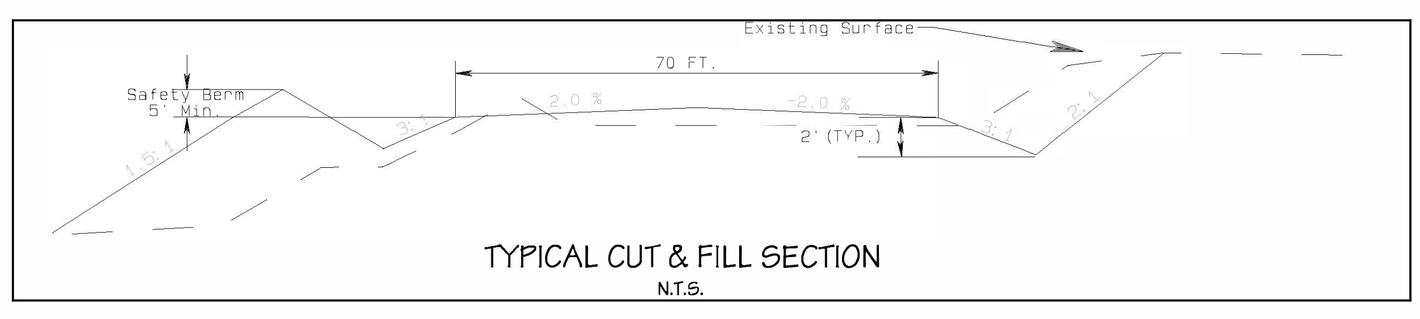
SCALE AS NOTED



TYPICAL CUT SECTION
N.T.S.



TYPICAL FILL SECTION
N.T.S.



TYPICAL CUT & FILL SECTION
N.T.S.

ABOVE TYPICAL SECTIONS
N.T.S

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

REV. NO.	DATE	DESCRIPTION
1	03-08-05	SUBMITTED TO DOM FOR APPROVAL
2		
3		
4		
5		

PROJECT MANAGER: DR
ENGR. of RECORD: LB
REG. NO: 6600
SRVYR of RECORD:
REG. NO:

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

ACCOUNT:
DATE: 03-08-05
DESIGNED BY: DR
DRAWN BY: DR
CHECKED BY: LB
APPROVED BY: LB

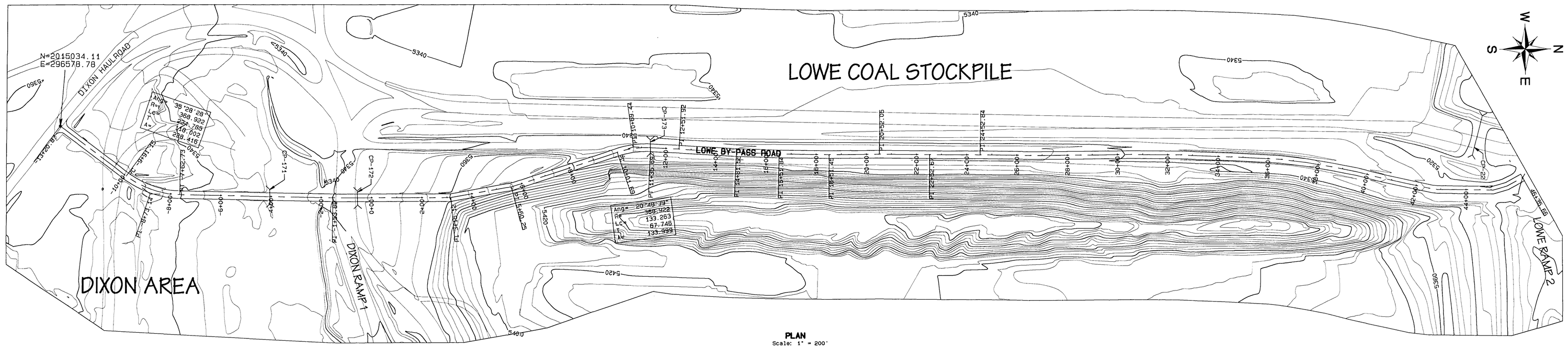
PLAN, PROFILE AND SECTION

EXHIBIT 23-12
BLOCK "B" ROAD MODIFICATION DESIGN

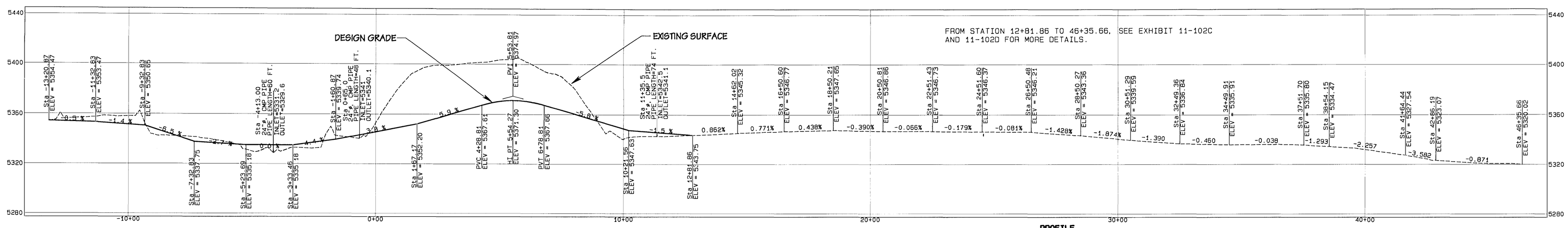
DRAWING

SHEET 3 OF 3

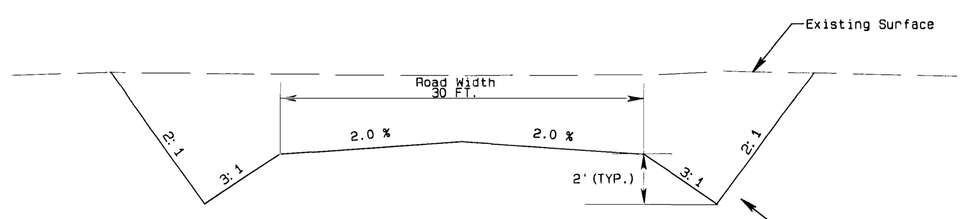
Path: G:\Departments\Dm\DOM_SUBMITTED_PROD\Ch_11_pap exhibit11-12 Block B Road Modification Design.pre



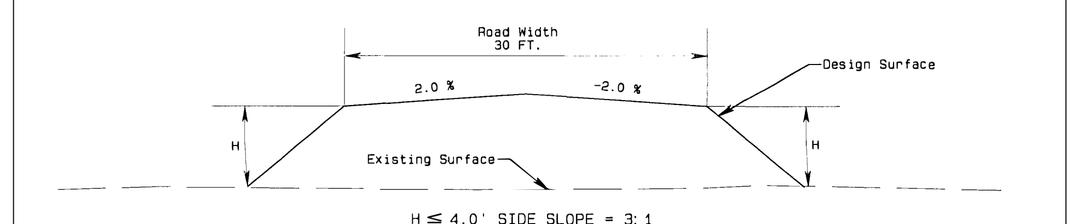
PLAN
Scale: 1" = 200'



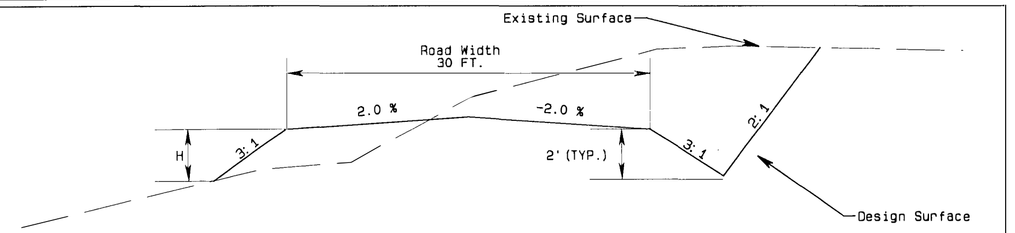
PROFILE
HORIZONTAL - 1"=200'
VERTICAL - 1"=40'



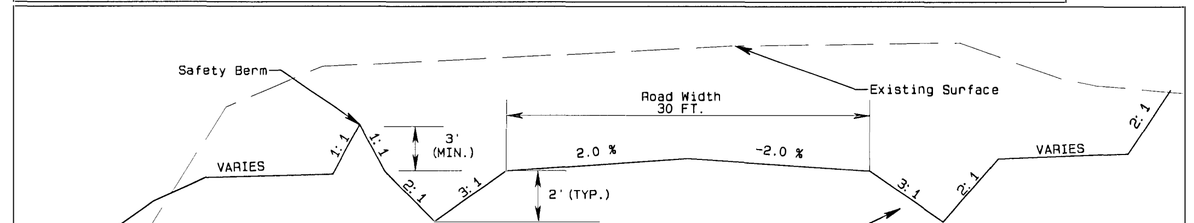
TYPICAL CUT SECTION
FROM STA.-13+20.87 TO -1+10.0
N.T.S.



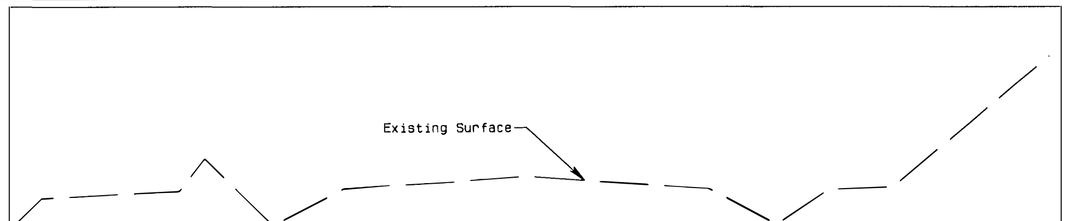
TYPICAL FILL SECTION
FROM STA.-13+20.87 TO -1+10.0
N.T.S.



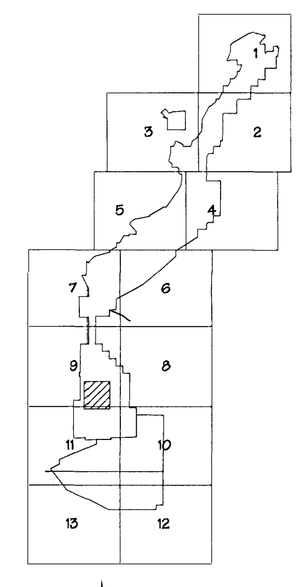
TYPICAL CUT & FILL SECTION
FROM STA.-13+20.87 TO -1+10.0 & FROM 5+75.0 TO 12+81.86
N.T.S.



TYPICAL SECTION
FROM STA.-1+10.0 & TO 5+75.0
N.T.S.



TYPICAL SECTION
FROM STA.12+81.86 TO 46+35.66 (EXISTING ROAD)
N.T.S.



SCALE AS NOTED

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 △5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY

NOTES

1. For hydrology and design information refer to Appendix 11-V in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-12E.

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 5600 REGISTERED PROFESSIONAL ENGINEER

APPROVED MAY 2003

REV BY	DATE	DESCRIPTION
	02-7-03	SUBMITTED TO OSM FOR APPROVAL

REV	
1	
2	
3	
4	
5	

PROJECT MANAGER: DERICK HANSON
ENGR. of RECORD: LEONARD RAYMOND
REG. NO. 5600
SRVYR. of RECORD: REGISTERED
REG. NO.

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

ACCOUNT: P:\PROJECTS\NAVAJO
DATE: February 7, 2003
DESIGNED BY: RY
DRAWN BY: RY
CHECKED BY: LR
APPROVED BY:

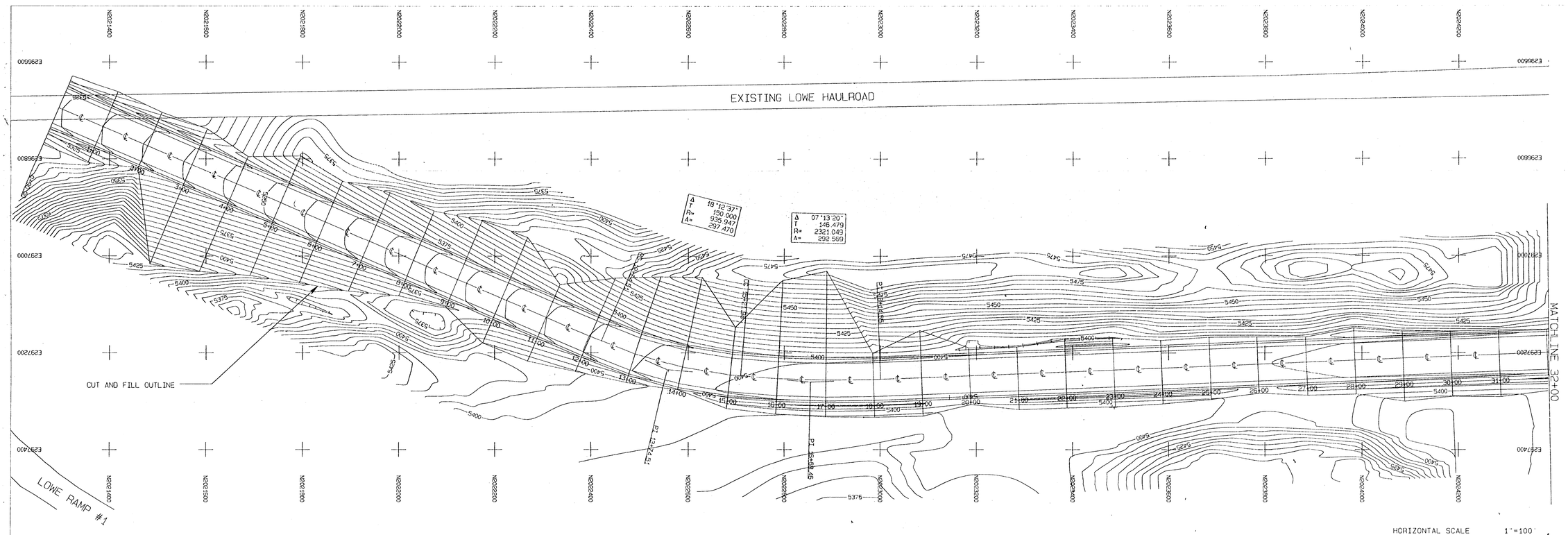
PLAN, PROFILE AND SECTIONS

EXHIBIT 23-13
LOWE BY-PASS ROAD MODIFICATION DESIGN

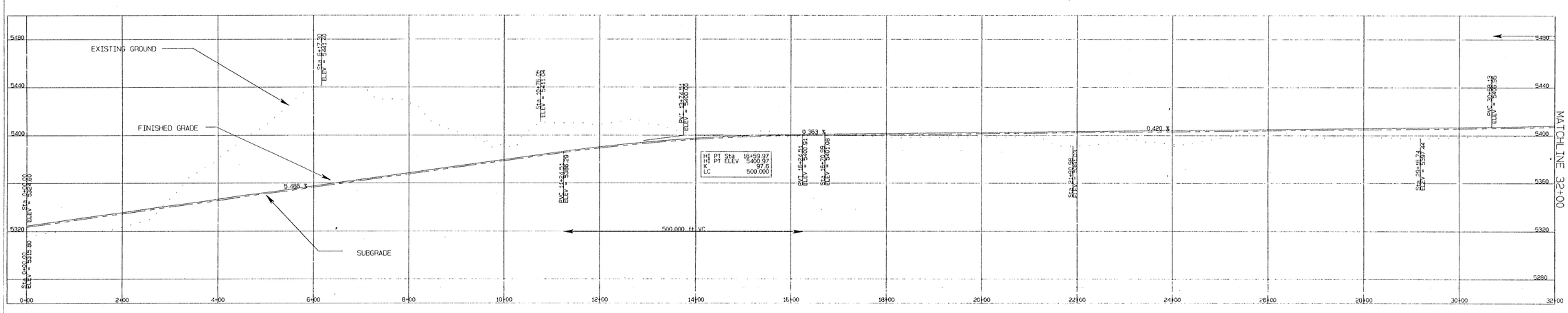
DRAWING

SHEET 1 OF 1

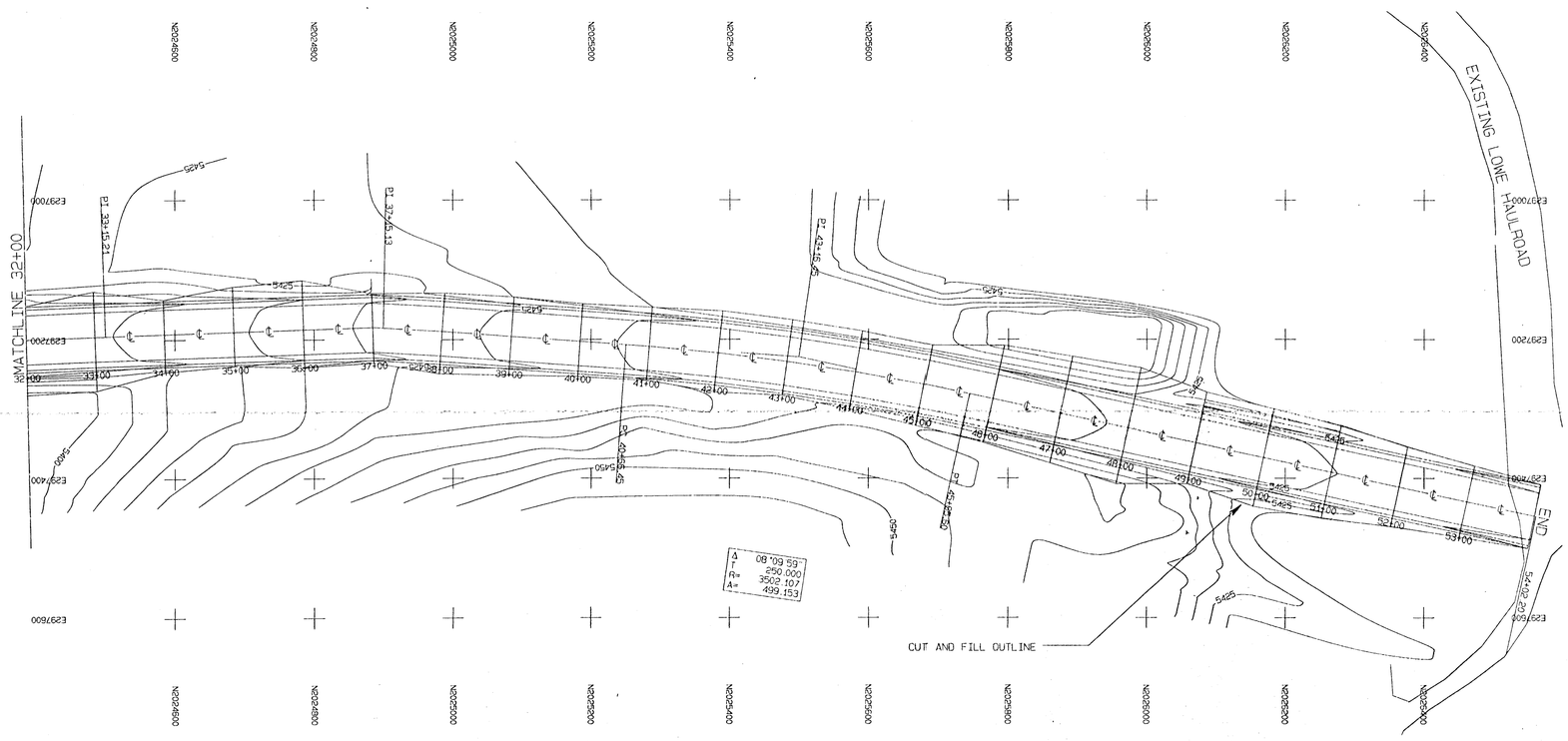
PATH: J:\OSM_SUBMITTALS\MODIFICATIONS\11-102C\11-102C-Lowe Bypass Road\Lowe Bypass Road.dwg



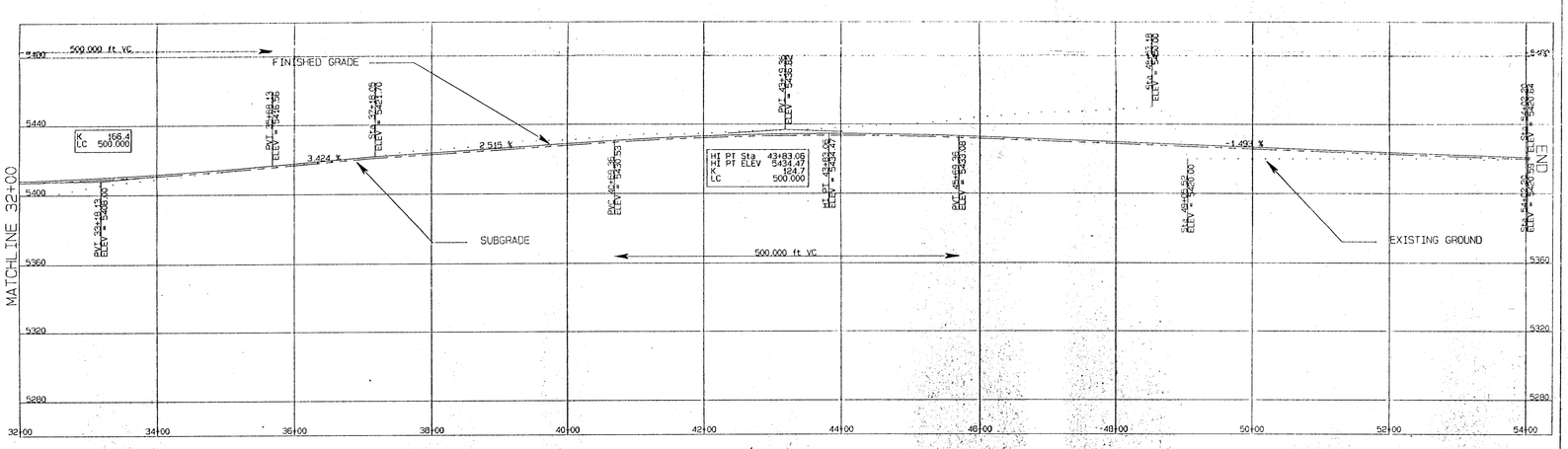
PLAN VIEW STA. 0+00 TO STA. 32+00



PROFILE VIEW STA. 0+00 TO STA. 32+00



PLAN VIEW STA. 32+00 TO END (54+02.20)



PROFILE VIEW STA. 32+00 TO END (54+02.20)

LEGEND

- CONTOUR INTERVAL W/ TEXT
- GRID TIC W/ TEXT
- CENTERLINE OF ROAD
- PROFILE OF SUBGRADE
- PROFILE OF EXISTING GROUND

REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
A	9-14-95	DJR	ISSUED FOR APPROVAL					

APPROVALS

EXHIBIT 23-14

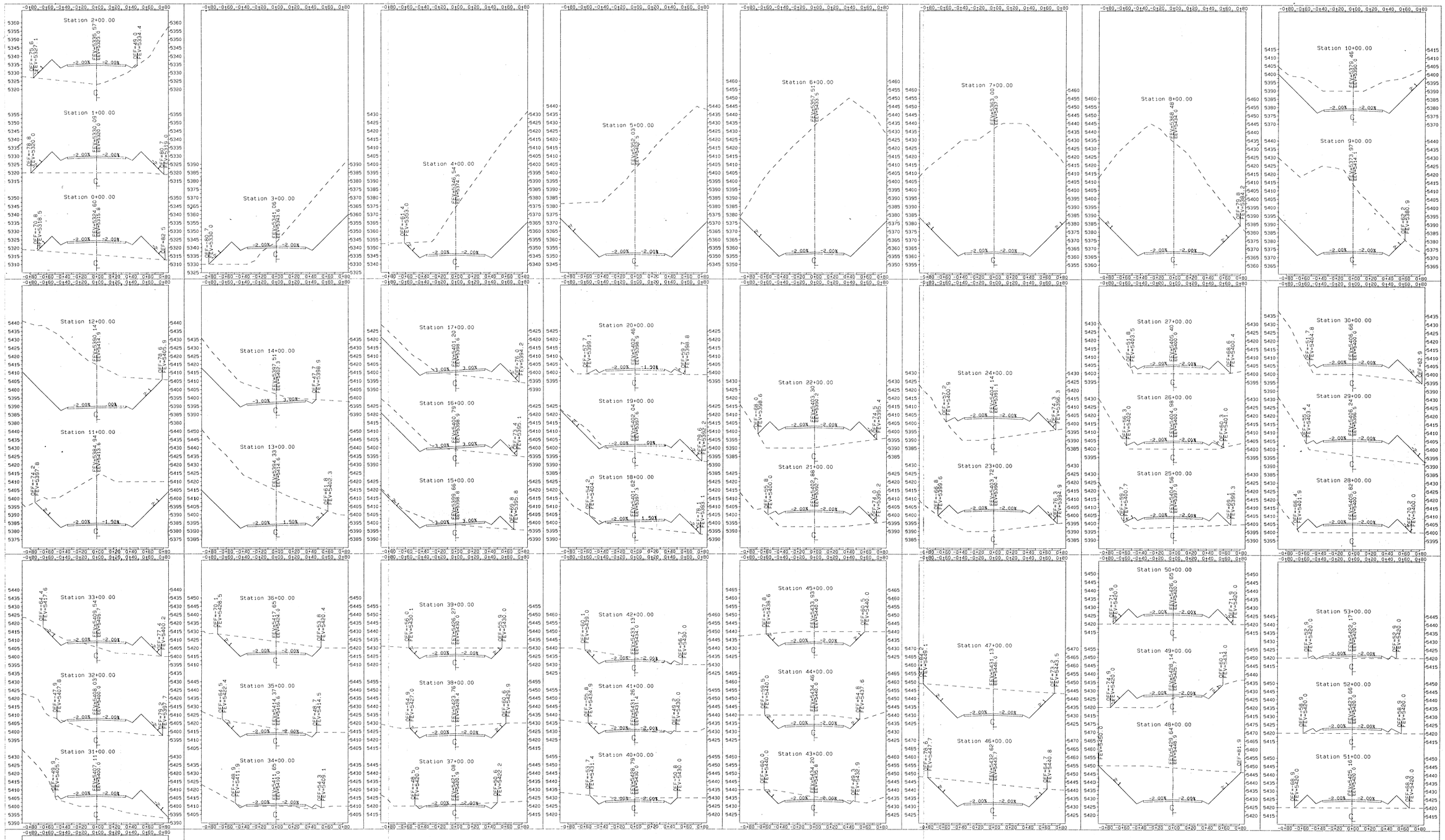
BHP MINERALS INTERNATIONAL INC.

NAVAJO MINE

P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

LOWE BOXCUT ROAD PLAN/PROFILE DESIGNS

PREPARED BY DJR	DRAWN BY DJR	SCALE AS NOTED
APPROVED BY	DATE	DWG. LOC.
DWG. NO.	REF. DWG.	



LEGEND

EXISTING GROUND

FINISHED GRADE W/ SUBGRADE

CENTER LINE MARKER W/ ELEVATIONS

CATCH POINT MARKERS

DESIGN SPECIFICATIONS

ROAD DITCH DEPTH = 2'

BERM HEIGHT (where road is elevated 4' or greater) = 5.25'

ROAD WIDTH = 70'

DITCH WIDTH (top) = 12'

MAX. SUPERELEVATION GRADE = 3%

ROAD BASE THICKNESS (gravel) = 12"

CUT-SLOPE GRADE = 2:1

FILL-SLOPE GRADE = 4:1 IF SLOPE <= 4' LONG
2:1 IF SLOPE > 4' LONG

SUPERELEVATION RUNOUT DISTANCES = 200'

HORIZONTAL SCALE 1"=40'
0 40 80 120

VERTICAL SCALE 1"=20'
0 20 40 60

LEONARD RAYMOND JONES
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
A	9-14-95	DJR	ISSUED FOR APPROVAL					

APPROVALS

JUL 1995 APPROVED

EXHIBIT 23-15

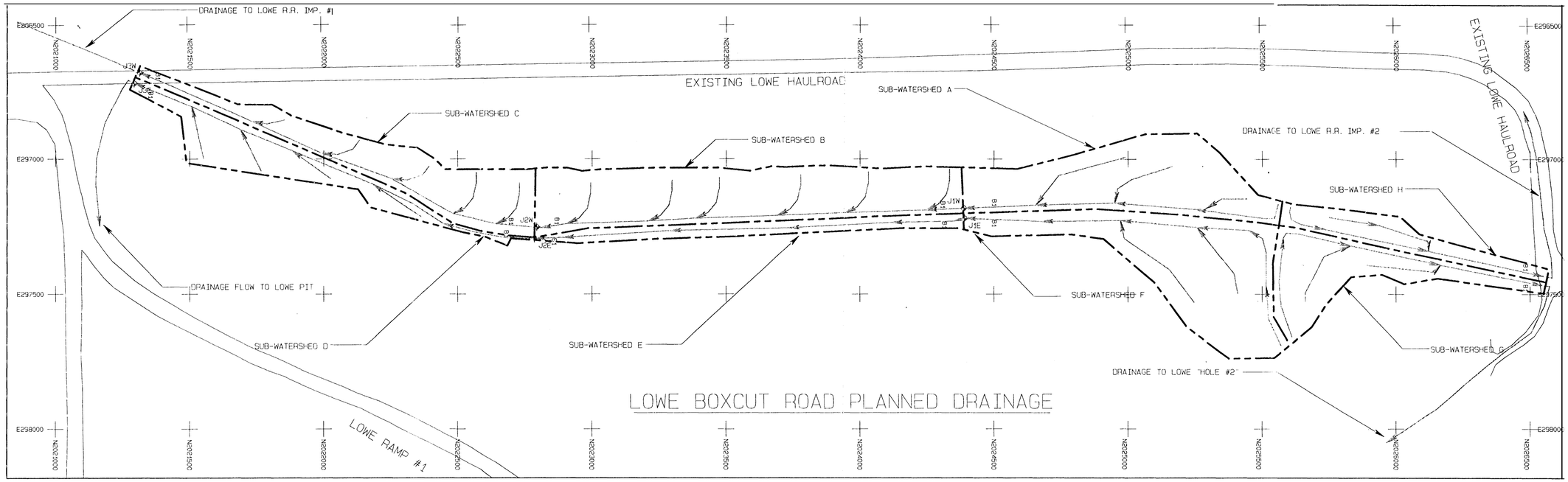
BHP MINERALS INTERNATIONAL INC.

NAVAJO MINE

P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

LOWE BOXCUT ROAD
DESIGN CROSS SECTIONS

PREPARED BY DJR	DRAWN BY DJR	SCALE AS NOTED
APPROVED BY	DATE	DWG. LOC.
DWG. NO.	REF. DWG.	



LOWE BOXCUT ROAD PLANNED DRAINAGE

GRAPHIC SCALE 1"=200'

0 200 400 600

SUB-WATERSHED PROPERTIES	A	B	C	D	E	F	G	H
AREA (ac)	5.67	7.26	4.57	6.58	1.73	3.33	3.39	2.01
LENGTH (ft)	1237	1666	1724	1470	1617	1620	1225	1070
DELTA Z (ft)	27.5	65	150	65	10	75	45	17.5
Tc (hrs)	.23	.204	.162	.194	.571	.209	.177	.232
CURVE NUMBER	89	89	89	89	89	89	89	89
RUNOFF VOL (ac-ft)	.23	.29	.18	.27	.07	.13	.14	.08
PK. DISCHARGE (cfs)	3.86	5.18	3.54	4.79	.73	2.35	2.57	1.36

LEGEND

N2021000 E298000 — GRID TIC W/ TEXT

WATERSHED BOUNDARY

WATER FLOW PATH

JUNCTION POINT

JAN 1998 APPROVED

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

REV NO	DATE	DRAFT BY	REVISION DESCRIPTION	ENG	G S	P R	P S	CHIEF ENGR
A	7-11-95	DJR	ISSUED FOR APPROVAL					

APPROVALS

EXHIBIT 23-16

BHP MINERALS INTERNATIONAL INC.

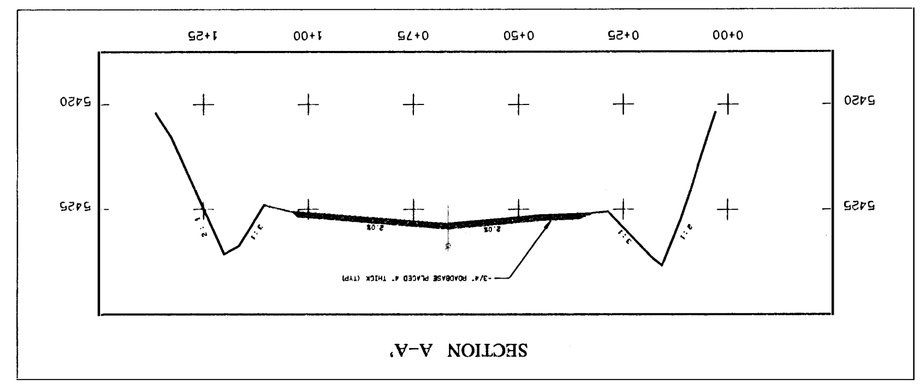
NAVAJO MINE

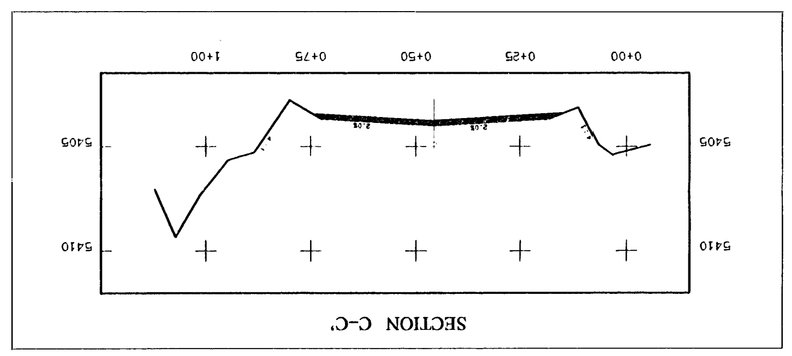
P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

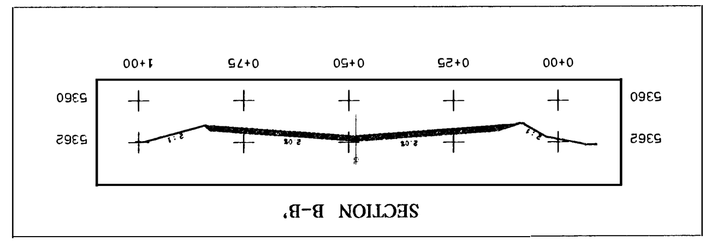
LOWE BOXCUT ROAD PLANNED WATERSHED

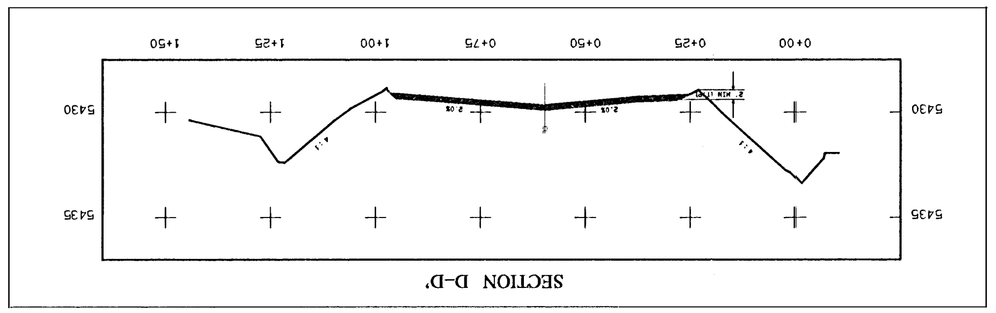
PREPARED BY DJR	DRAWN BY DJR	SCALE AS NOTED	
APPROVED BY	DATE	DWG. LOC.	
DWG. NO.		REF. DWG.	

PLAN VIEW
SCALE: 1" = 200'









APPROVED
AUG 1996

LOWE BOX-CUT HAULRD
AS-BUILT MINING HAULROADS
(PROJ_Proj_name2)

SHEET 1 OF 5

PLAN & PROFILE
EXHIBIT 23-17

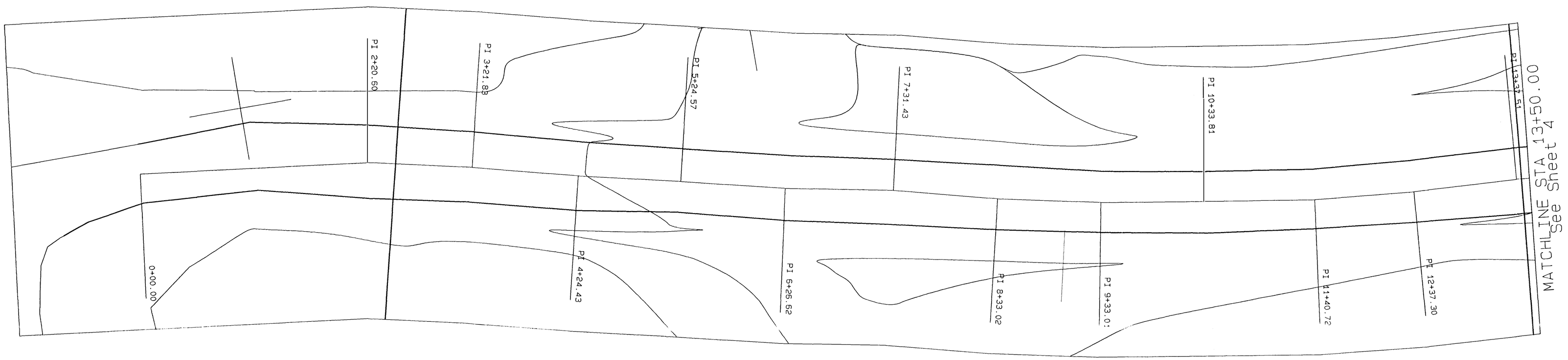
BHP-NAVAJO COAL CO.
PO BOX 155, FRUITLAND, NEW MEXICO 87416

ACCOUNT: PROJ. 15NW/18SN
DATE: JUNE 7, 1995
DESIGNED BY: D RANSON/BTSAMBITSKY
DRAWN BY: PJFOSTER
CHECKED BY: BTSAMBITSKY/LEONARD RAYMOND
APPROVED BY: LEONARD RAYMOND

PROJECT MANAGER: L. RAYMOND/TRAMEL W. BAKER
ENGR. OF RECORD: BTSAMBITSKY/PJFOSTER
SURVR OF RECORD: REC. NO. NAME
REC. NO. NAME

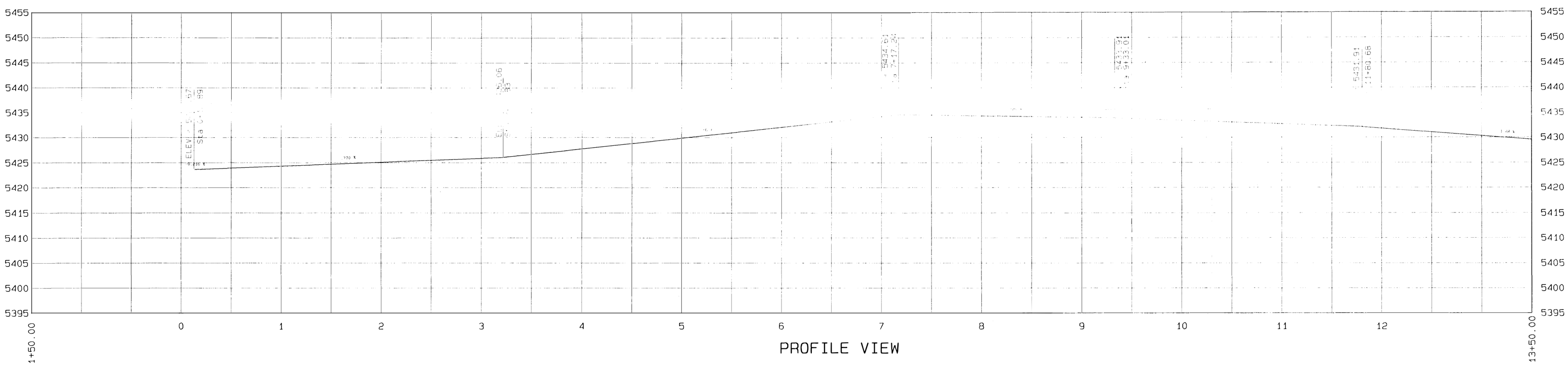
REVISION | DATE
1
2
3
4
5

Project Dwgs:: LOWE BOX-CUT ROAD "AS-BUILT" Plot: G:\COMMON\BTS\LONGRD.PRO Plot time: Tue Jul 16 08:06:05 1996



PLAN VIEW

Hztl. Scale: 1" = 50'



PROFILE VIEW

Vert. Scale: 1" = 10'

LEONARD RAYMOND NEW MEXICO 5609 REGISTERED PROFESSIONAL ENGINEER 1-24-96

APPROVED AUG 1996

BHP-NAVAJO COAL CO.

PO BOX 155, FRUITLAND, NEW MEXICO 87416

PROJECT MANAGER: L. RAYMOND/CAMPBELL
REG. NO: ----
ENGR. of RECORD: STANDISH/LAFORTE
REG. NO: 11960
SRVYR of RECORD: ADAMS/BENALLY
REG. NO: 11960

REVISION | DATE

ACCOUNT: PROJ_151N/15SN
DATE: JUNE 7, 1995
DESIGNED BY: D.KAMBITSCH/MATOSKY
DRAWN BY: P.FORTER
CHECKED BY: BTS/MATOSKY/LEONARD RAYMOND
APPROVED BY: LEONARD RAYMOND

PLANS AND PROFILES

EXHIBIT 23-17

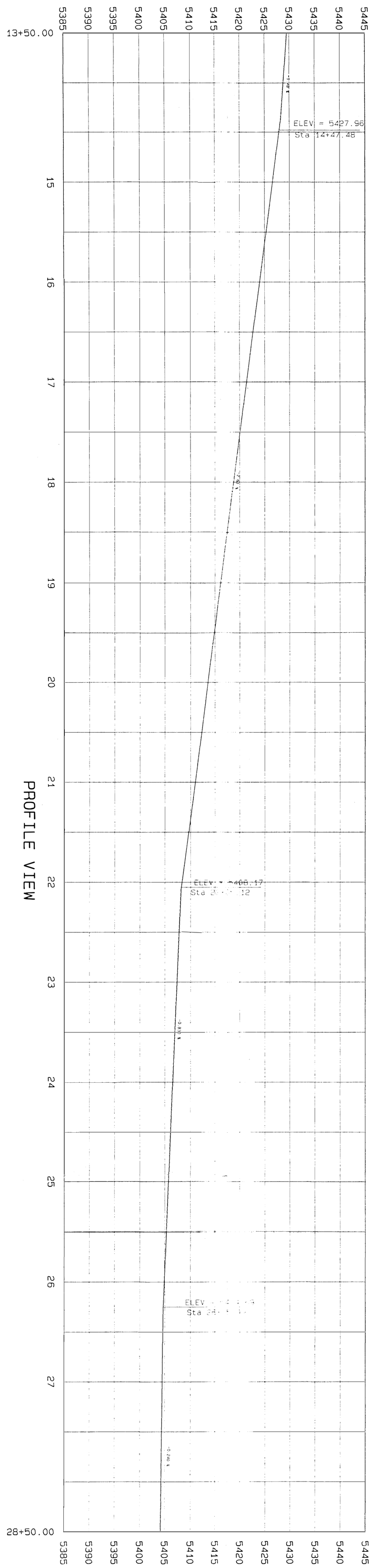
LOWE BOX-CUT HAULRD

AS-BUILT MINING HAULROADS

(PROJ_PROJ_name2)

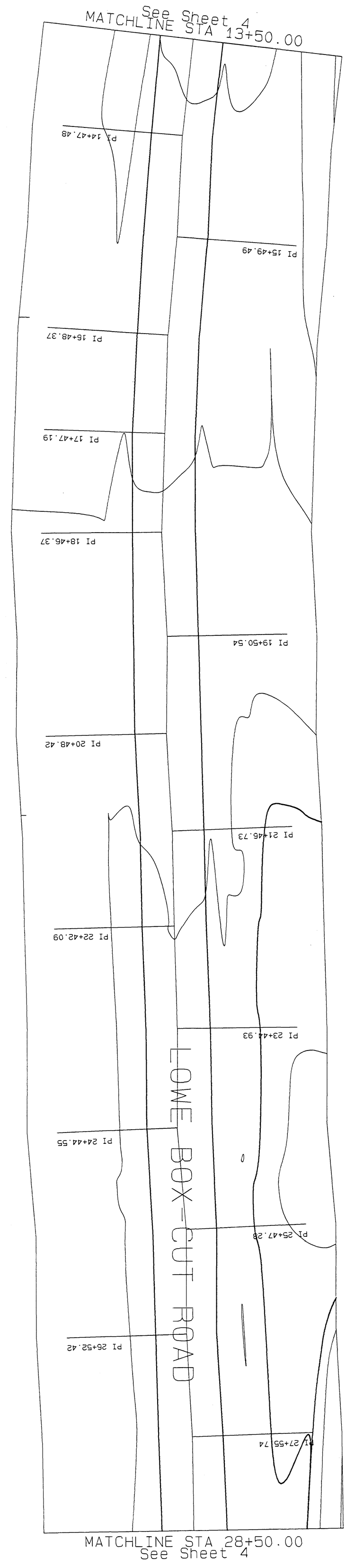
SHEET 2 OF 5

Project Desc.: LOWE BOX-CUT ROAD AS-BUILT Path: G:\COMMON\BTS\LOWEAB.PRO Plot time: Tue Jul 16 16:06:44 1996



PROFILE VIEW

Vert. Scale: 1" = 10'



PLAN VIEW

Hztl. Scale: 1" = 50'

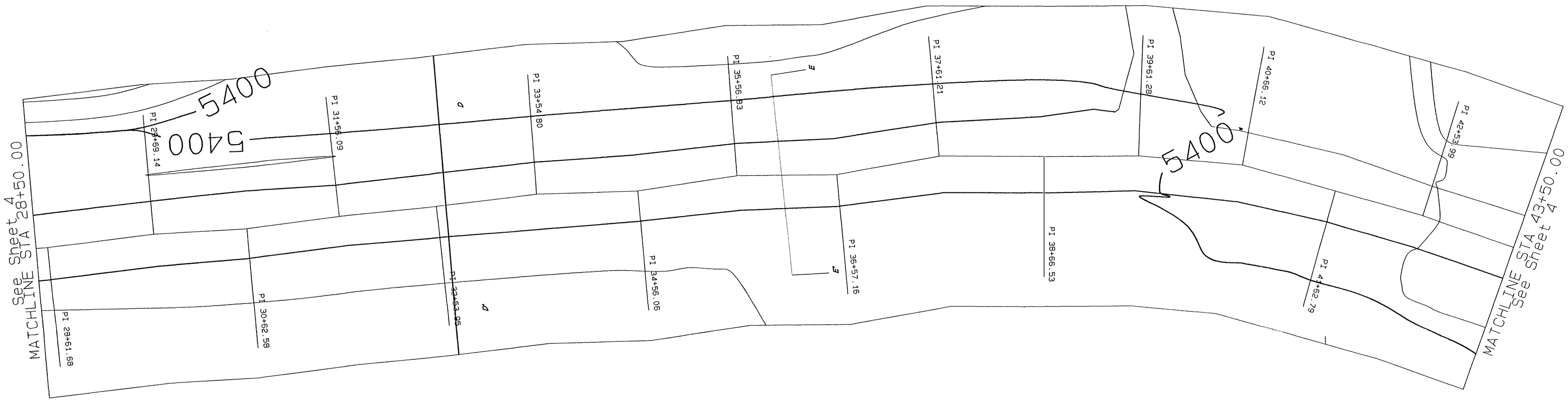
APPROVED 4 AUG 1996

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

SHEET 3 OF 5	**LOWE BOX-CUT HAULRD** AS-BUILT MINING HAULROADS (PRJD_proj_name2)	**PLAN & PROFILE** **EXHIBIT 23-17**	ACCOUNT: PRJD_151N/185N DATE: June 7, 1995 DESIGNED BY: D RAWSON/BTSAMBIRSKY DRAWN BY: PJFOSTER CHECKED BY: BTSAMBIRSKY/LEONARD RAYMOND APPROVED BY: LEONARD RAYMOND	**BHP-NAVAJO COAL CO.** PO BOX 155, FRUITLAND, NEW MEXICO, 87416	PROJECT MANAGER: L. RAYMOND/PE/BSRng. No.6600 ENGR. of RECORD: BTSAMBIRSKY/PJFOSTER REG. NO: None SRVYR of RECORD: WILBERT GENALLY REG. NO: 11952

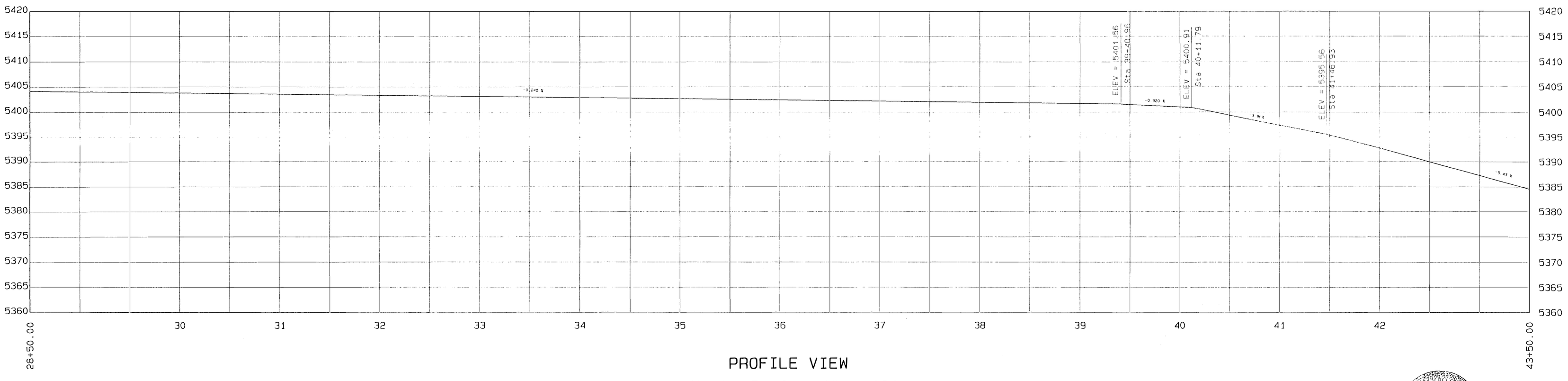
	REVISION	DATE
1		
2		
3		
4		
5		

Project Desc.: LOWE BOX-CUT ROAD "AS-BUILT" Path: G:\COMMON\BTS\LOWERD.PRO Plot time: Tue Jul 16 18:07:13 1996



PLAN VIEW

Hztl. Scale: 1" = 50'



PROFILE VIEW

Vert. Scale: 1" = 10'

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

REVISION | DATE

PROJECT MANAGER: L. RAYMOND/WILLIAMS, INC.
ENGR. of RECORD: STANSBERRY/FOSTER
REG. NO: ---
SRVYR of RECORD: WARREN BERNALT
REG. NO: 7863

BHP-NAVAJO COAL CO.

PO BOX 155, FRUITLAND, NEW MEXICO, 87416

ACCOUNT: PROJ 15 INVIRON
DATE: MARCH 27, 1996
DESIGNED BY: D DAWSON/BTS/MEDTSKY
DRAWN BY: P.FOSTER
CHECKED BY: BTS/MEDTSKY/LEONARD RAYMOND
APPROVED BY: LEONARD RAYMOND

LOWE BOX-CUT HAULRD
AS-BUILT MINING HAULROADS
(PROJ_proj_name2)

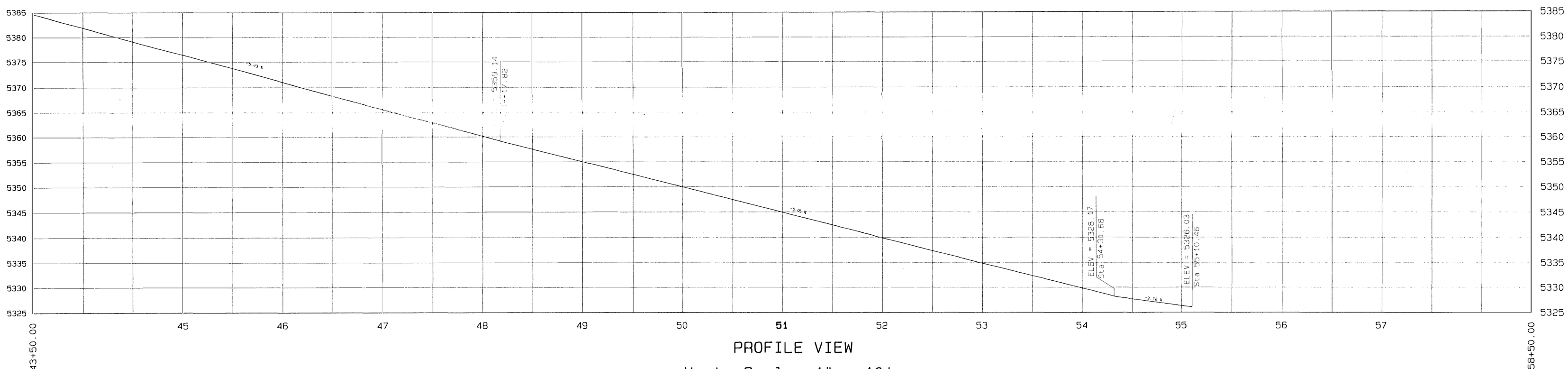
PLANS AND PROFILES
EXHIBIT 23-17

SHEET 4 OF 5

Project Desc:: LOWE BOX-CUT ROAD "AS-BUILT" Path: G:\COMMON\BTS\LOWEHD.PRO Plot time: Tue Jul 16 18:06:10 1996

PLAN VIEW

Hztl. Scale: 1" = 50'



PROFILE VIEW

Vert. Scale: 1" = 10'

BHP-NAVAJO COAL CO.

PO BOX 155, FRUITLAND, NEW MEXICO, 87416

PROJECT MANAGER:
ENGR. of RECORD:
REG. NO:
SPVYR of RECORD:
REG. NO:

REVISION | DATE

LOWE BOX-CUT HAULRD

AS-BUILT MINING HAULROADS

(PROJ_proj_name2)

PLAN AND PROFILE

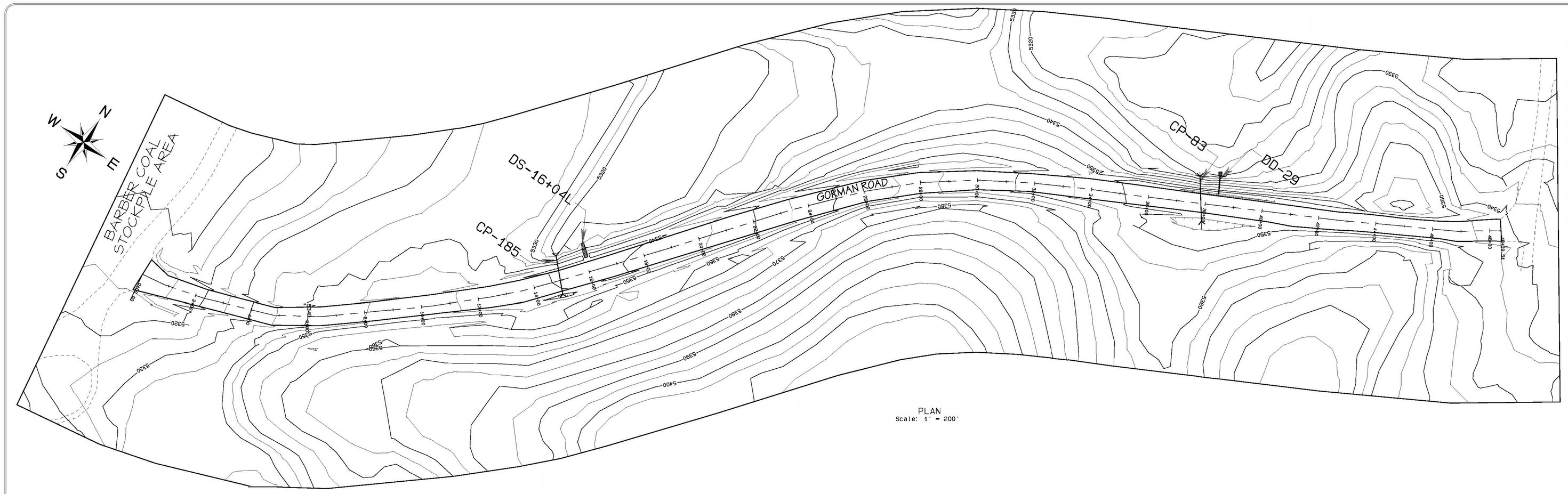
EXHIBIT 23-17

SHEET 5 OF 5

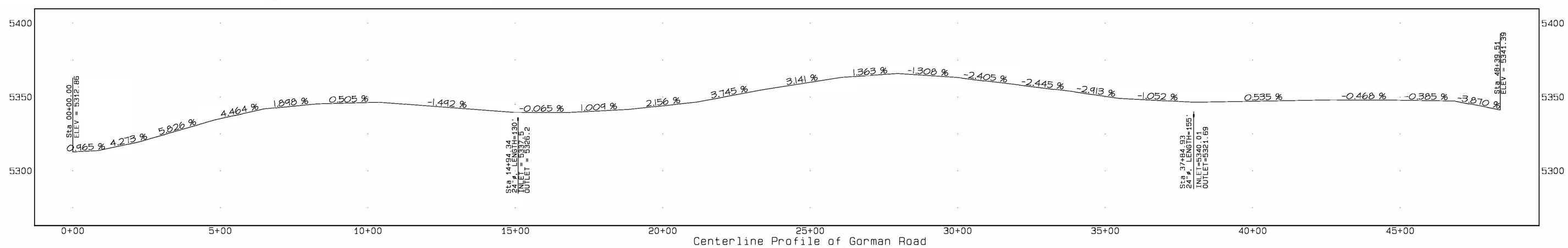
ACCOM: PROJ-25N/16SN
CLIENT: NAVAJO COAL
DESIGNED BY: D HANSON/BTSAMBETHSUY
DRAWN BY: PJ FOSTER
REVIEWED BY: DONNA BOYT/LEONARD RAYMOND
APPROVED BY: LEONARD RAYMOND

Project Dwg:: LOWE BOX-CUT ROAD AS-BUILT Path: G:\COMMON\BTS\LONGRED.PRO Plot time: Wed Jul 10 10:08:48 1996

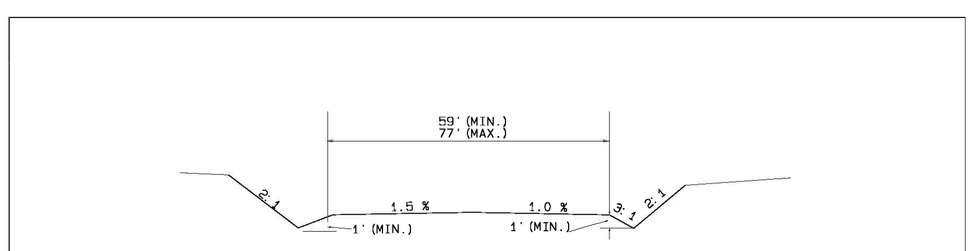
LEONARD RAYMOND LEWIS
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER



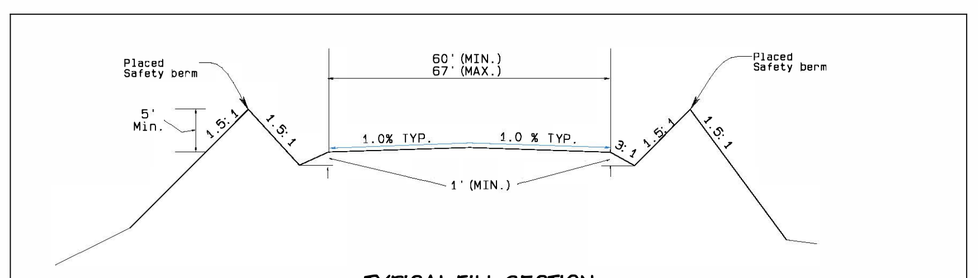
PLAN
Scale: 1" = 200'



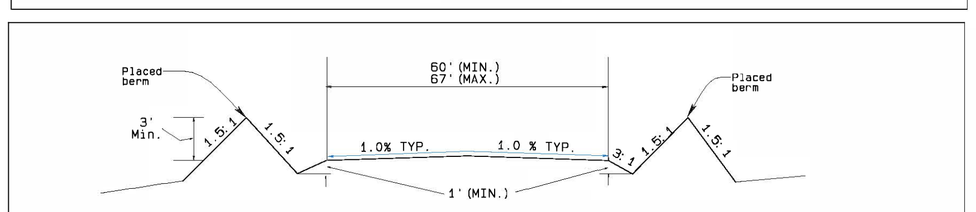
Centerline Profile of Gorman Road
HORIZONTAL=1"=200'
VERTICAL=1"=40'



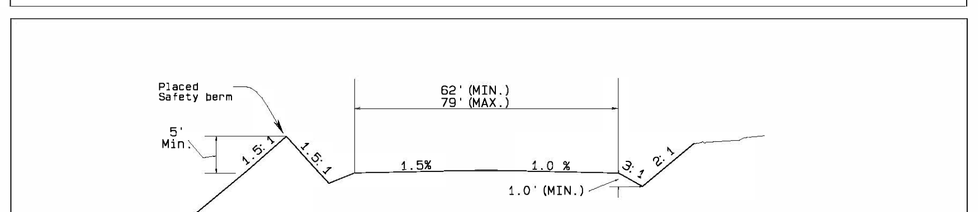
TYPICAL CUT SECTION
FROM STA. 2+00 TO 12+75 AND
FROM STA. 42+80 TO 48+39.51



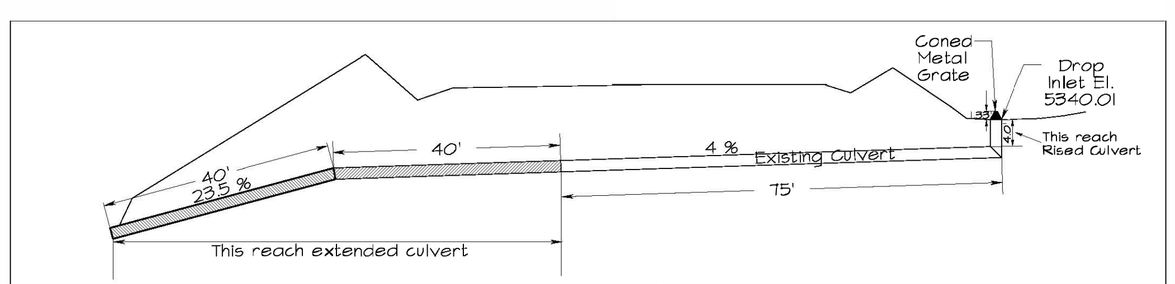
TYPICAL FILL SECTION
FROM STA 36+00 TO 40+25.



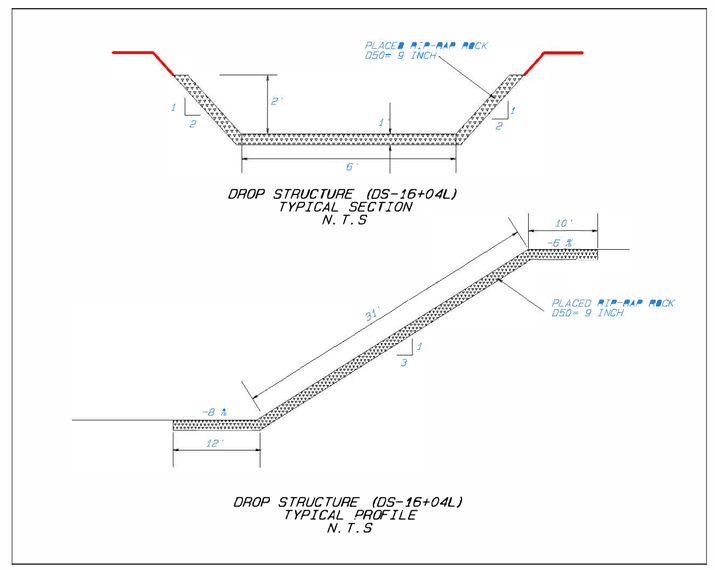
TYPICAL FILL SECTION
FROM STA.00+00 TO 2+00.



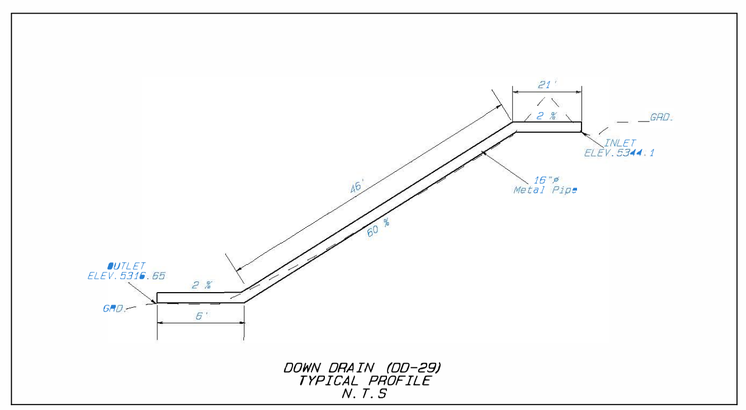
TYPICAL CUT / FILL SECTION
FROM STA. 12+75TO 36+00 AND
FROM STA. 40+25 TO 42+80.



TYPICAL SECTION
ALONG CULVERT CP-83



DROP STRUCTURE (DS-16+04L)
TYPICAL PROFILE
N.T.S



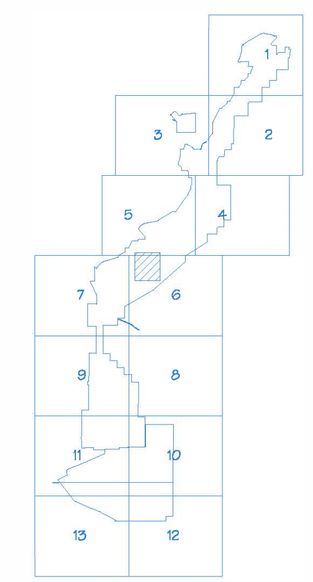
DOWN DRAIN (DD-29)
TYPICAL PROFILE
N.T.S

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5339.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45 L-38 LEASE CORNER
- PERMIT/LEASE BOUNDARY

NOTES

1. For hygrology and design information refer to Appendix 11-V in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-12C.
3. The hydrology data and design for drop structure DS-16+04L is in Appendix 11-Z.



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this haulroad has been constructed in accordance with the approved design plans and that the information shown is complete and accurate to the best of my knowledge, except as noted below:

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

1. The road was widened to a minimum of 60' and up to a maximum. of 80' wide.
2. Added culvert CP-185.
3. Added down drains DD-29 and DS-16+04L.
4. The jurisdictional land status were effected at approximately stations 16+00 and 38+50.

The appropiate exhibits were updated accordingly.

REV NO.	DESCRIPTION	REV BY	DATE
1	SUBMITTED TO NOW FOR REVIEW	RT	11-01-05
2	ADDED PARCEL DETAIL FOR CP-83 AND CHANGED DESIGN FOR CP-83	RT	11-01-05
3	Changed slope grade, DD-29	RT	01-26-06
4	Added CP-185 Culvert modification	RT	02-24-06
5			

PROJECT MANAGER: N/A
ENGR. of RECORD: LB
REG. NO: 6600
SRVYR of RECORD:
REG. NO:

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

ACCOUNT:
DATE: 8-11-05
DESIGNED BY: RT
DRAWN BY: RT
CHECKED BY: LB
APPROVED BY: LB

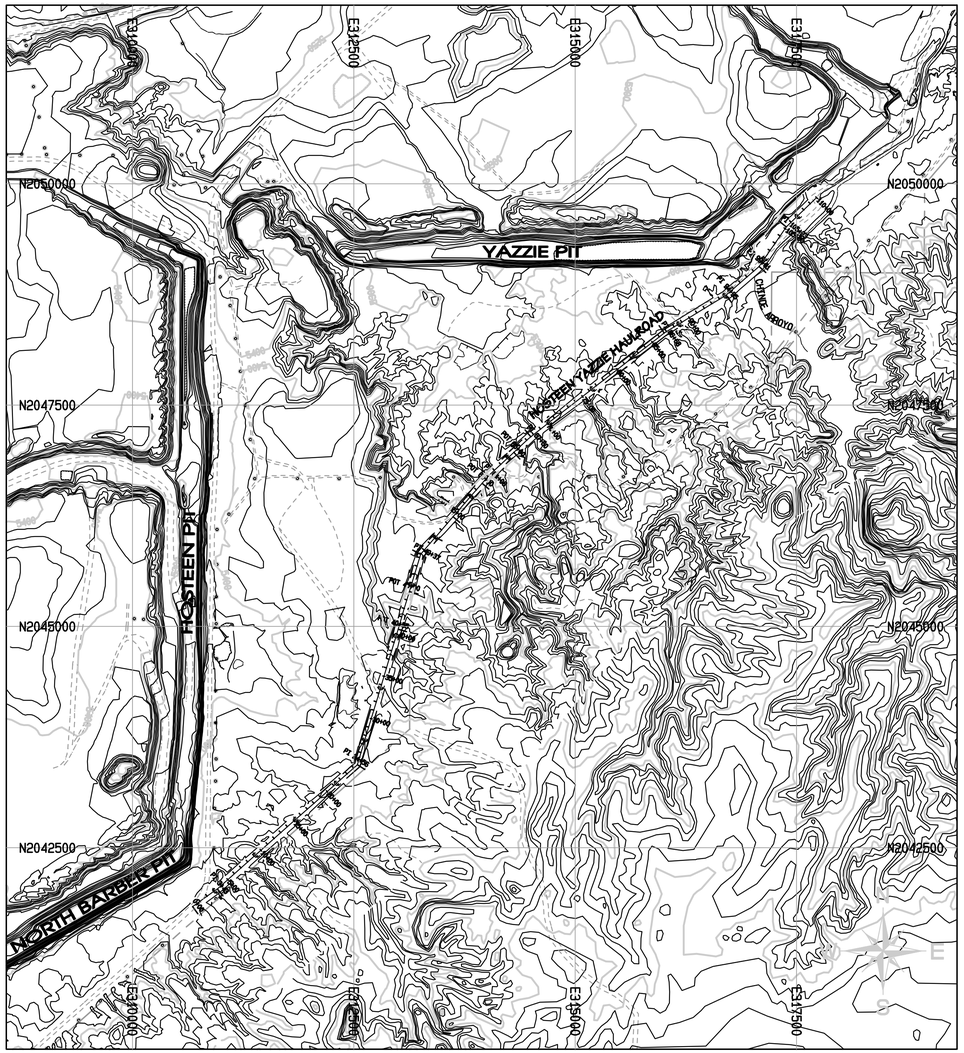
PLAN, PROFILE AND SECTION

EXHIBIT 23-18
GORMAN ROAD AS-BUILT

DRAWING

SHEET 1
OF 1

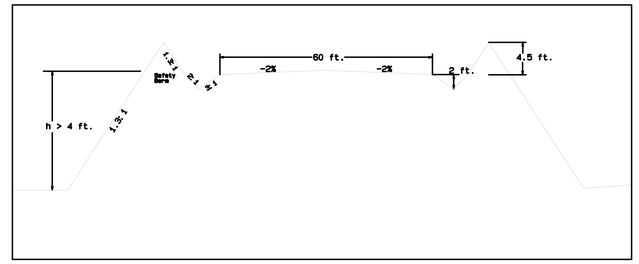
PATH: \\SUCHCMCPW1.BHPCOAL.COM\DATA\Departments\ENGINEERING\Exhibits\11-06\ Gorman Road\Gorman Road_As_Built.dwg



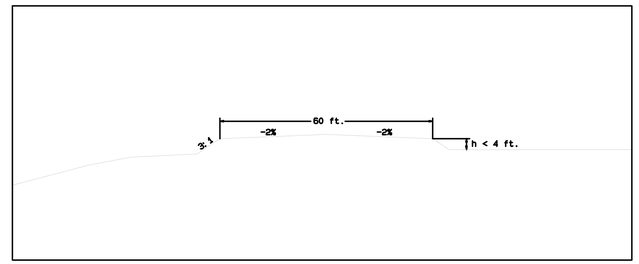
LOCATION - PLAN VIEW
SCALE: 1" = 800'

LEGEND

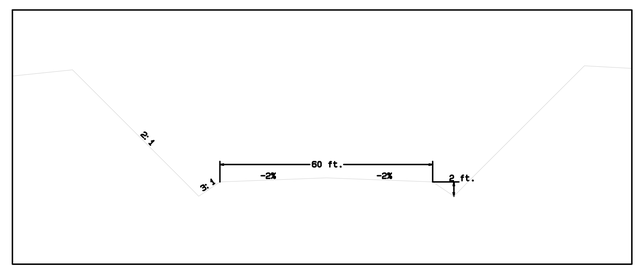
- DIRT ROAD
- LEASE/PERMIT BOUNDARY
- IRRIGATION LINE
- CULVERT
- DRAINAGE
- RAILROAD
- POWERLINE
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR



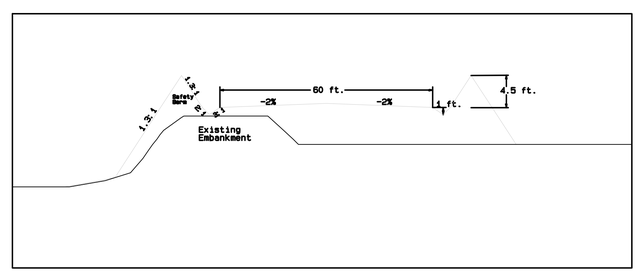
TYPICAL FILL SECTION
FILL HEIGHT (h) > 4 ft.
N.T.S.



TYPICAL FILL SECTION
FILL HEIGHT (h) < 4 ft.
N.T.S.



TYPICAL CUT SECTION
N.T.S.



TYPICAL SECTION STA 94+00 to 101+00
N.T.S.

NOTES

1. For hydrology and design information, refer to Appendix 11-V in the approved PAP.
2. Refer to Exhibit 11-12C & 12C-1 for culvert watershed information and TABLE 11-12a for culvert schedule.
3. Refer to Exhibit 11-82 for road classification.
4. Culverts CP-129 through CP-149 (excluding CP-140) are designed at a minimum slope of 1 %.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

REVISION	DATE
1 Submit to OSM for approval	01/28/2021
2	
3	
4	
5	

PROJECT MANAGER: COREY NELSON
DNRR, of RECORD: LEONARD RAYMOND
REG. NO: NM 6600
SRMR of RECORD:
REG. NO:

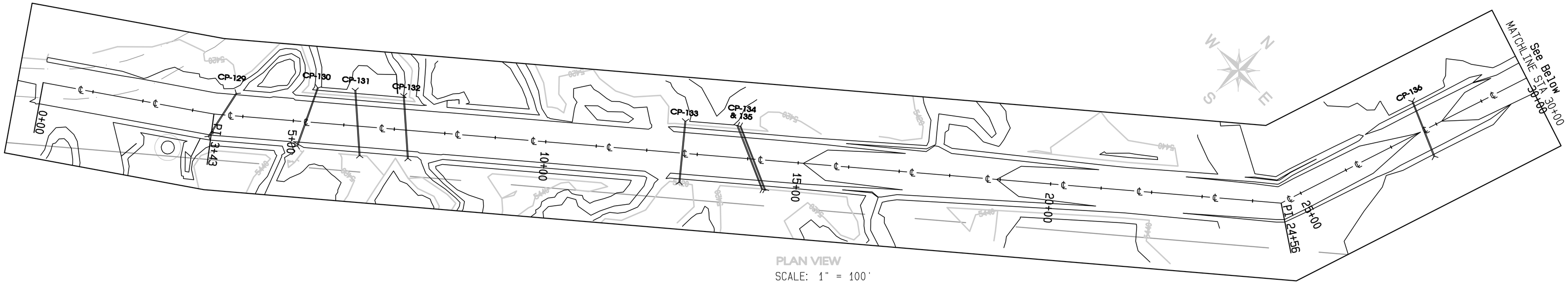
BHP-NAVAJO COAL CO.
PO BOX 155, FRUITLAND, NEW MEXICO, 87416

ACCOUNT:
DATE: 28 JANUARY 2020
DESIGNED BY: BEN MOSKIE
DRAWN BY: BEN MOSKIE
CHECKED BY: LEONARD RAYMOND
APPROVED BY: LEONARD RAYMOND

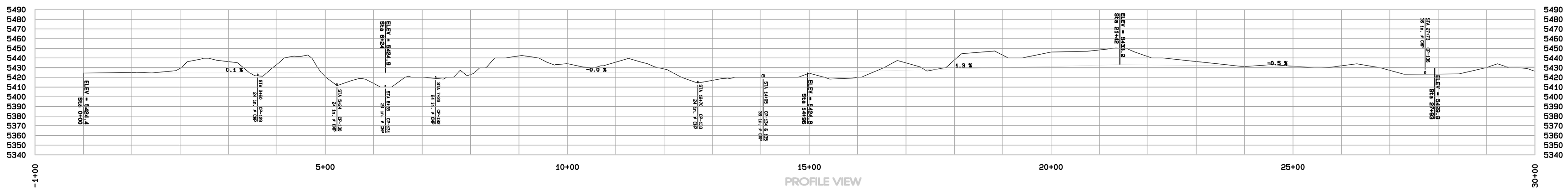
LOCATION & TYPICAL CROSS SECTIONS

EXHIBIT 23-19
HOSTEEN YAZZIE HAULROAD DESIGN

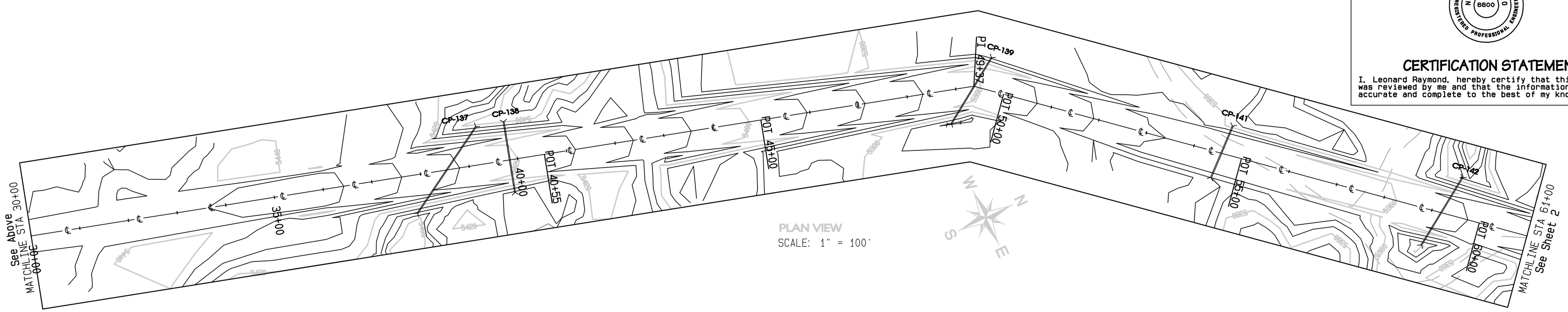
DRAWING



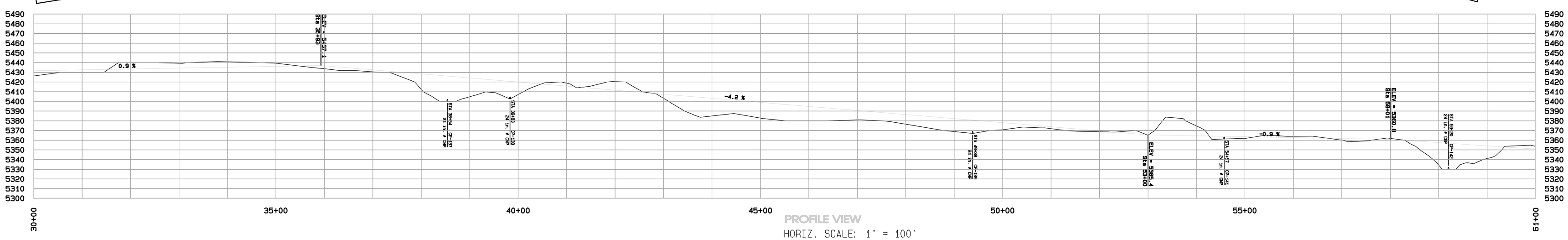
PLAN VIEW
SCALE: 1" = 100'



PROFILE VIEW
HORIZ. SCALE: 1" = 100'
VERT. SCALE: 1" = 50'



PLAN VIEW
SCALE: 1" = 100'



PROFILE VIEW
HORIZ. SCALE: 1" = 100'
VERT. SCALE: 1" = 50'

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

REVISION	DATE
1 Submit to OSM for approval	01/28/2010
2	
3	
4	
5	

PROJECT MANAGER: COREY NELSON
DWGS. of RECORD: LEONARD RAYMOND REG. NO. NM 6600
SPVYR of RECORD: REG. NO.

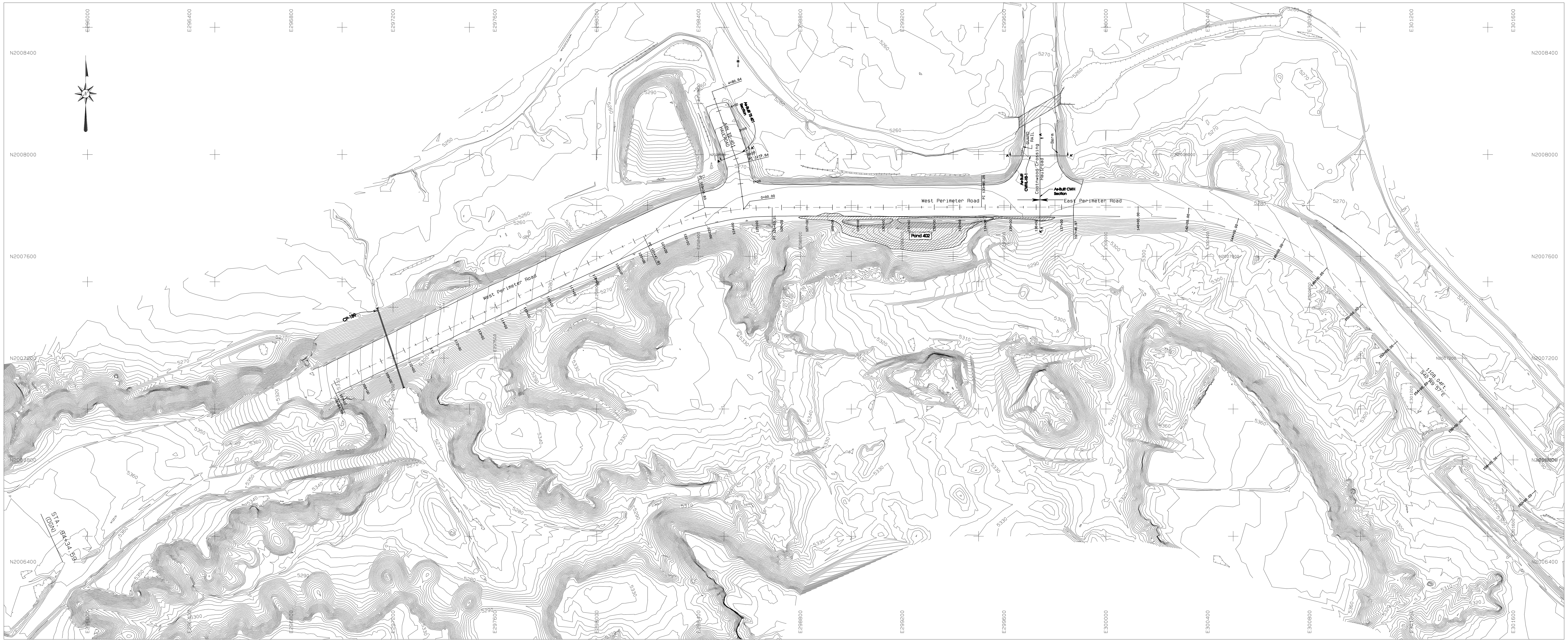
BHP-NAVAJO COAL CO.
PO BOX 155, FRUITLAND, NEW MEXICO, 87416

AUTHORITY:
ACTION: 28 JANUARY 2010
DESIGNED BY: BEN HOSKITE
DRAWN BY: BEN HOSKITE
CHECKED BY: LEONARD RAYMOND
APPROVED BY: LEONARD RAYMOND

PLAN & PROFILE

EXHIBIT 23-20
EASTERN YAZZIE HAULROAD DESIGN

DRAWING
SHEET 2 OF 3



DRAWING INDEX

EXH 11-94A_AREA 4 NORTH WEST AND EAST PERIMETER ROAD AND
TS-401 HAULROAD/AS-BUILT-DESIGN MODIFICATION/LOCATION MAP /REV-12B-1 OF 5

EXH 11-94A_AREA 4 NORTH WEST AND EAST PERIMETER ROAD
HAULROAD/AS-BUILT DESIGN-MODIFICATION/ PLAN/PROFILE /REV-12B-2 OF 5

EXH 11-94A_AREA 4 NORTH WEST AND EAST PERIMETER ROAD
HAULROAD/AS-BUILT-DESIGN MODIFICATION/ PLAN/PROFILE /REV-12B-3 OF 5

EXH 11-94A_AREA 4 NORTH WEST AND EAST PERIMETER ROAD
HAULROAD/AS-BUILT-DESIGN MODIFICATION/ PLAN/PROFILE /REV-12B-4 OF 5

EXH 11-94A_AREA 4 NORTH WEST AND EAST PERIMETER ROAD
HAULROAD/AS-BUILT-DESIGN MODIFICATION/ TYPICAL SECTIONS /REV-12B-5 OF 5

NOTE:

THE REACH OF ROAD FROM STA.94+34.59 TO STA.106+84.58 WILL NOT BE CONSTRUCTED. IT IS WITHIN THE ACTIVE MINING AREA, THE BOXCUT SPOILS WILL BE PLACED ONTO THE AREA.

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing has been reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

	REVISION	Rev By	DATE
12-A	AS-BUILT A4N ROAD AND SUBMITTED TO OSM FOR REVIEW AND APPROVAL	PJF	5-30-2012
12-B	REVISED TYPICAL SECTION FOR FIELD REVISION SUBMITTED TO OSM ALBUQUERQUE	RY	6-26-2012

PROJECT MANAGER: Ben Hoskie
ENGR. of RECORD: Leonard Raymond
REG. NO: NM_6600
SRVYR of RECORD: Jamie Brandt
REG. NO:

PROJECT: Area 4 North As-Built Road
DATE:
DESIGNED BY: Leonard Raymond
DRAWN BY: P. Foster
CHECKED BY: L. Raymond
APPROVED BY: L. Raymond

bhpbilliton
BHP Navajo Coal Company
P.O. Box 1717
Fruitland, New Mexico, 87416
Phone: 505-598-4200
Fax: 505-568-3361

PLAN VIEW

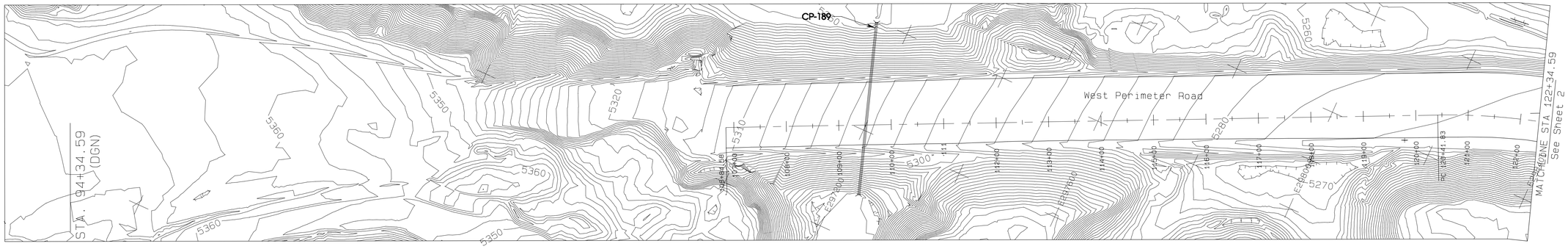
Exhibit 23-21

AREA 4 NORTH WEST AND EAST PERIMETER ROAD/ TS-401 HAULROAD DESIGN MODIFICATION LOCATION MAP

DRAWING

SHEET 1 OF 5

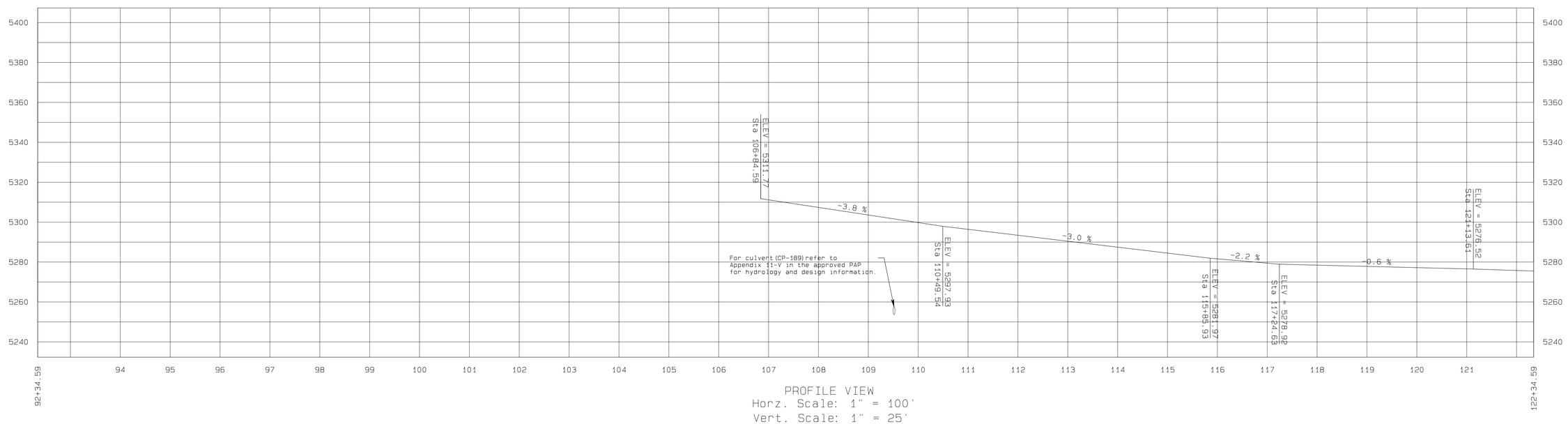
G:\Gs\Permit F\Ch 11\Exh 11-094_A4N Perimeter Rd\Design-As-Built Sept-2012\Exh 11-94_A4N_W-E Perimter Rd_As-Built_Mod_Design_Rev-12B-2012.pro
Thu Sep 13 13:09:34 2012



NOTE:

THE REACH OF ROAD FROM STA.94+34.59 TO STA.106+84.58 WILL NOT BE CONSTRUCTED. IT IS WITHIN THE ACTIVE MINING AREA. THE BOXCUT SPOILS WILL BE PLACED ONTO THE AREA.

PLAN VIEW
Scale: 1" = 100'



PROFILE VIEW
Horz. Scale: 1" = 100'
Vert. Scale: 1" = 25'

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing has been reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

REV#	BY	DATE
12-A	25-BUILT AND SUBMITTED TO OSM FOR REVIEW AND APPROVAL.	PJF 5-30-2012
12-B	REVISED TYPICAL SECTION FOR FIELD REVISION SUBMITTED TO OSM AUGUST 2012	RF 6-26-2012

PROJECT: Area 4 North As-Built Road
DATE:
DESIGNED BY: Leonard Raymond
DRAWN BY: P. Foster
CHECKED BY: L. Raymond
APPROVED BY: L. Raymond

PROJECT MANAGER Ben Nesbit
ENGR. or RECORD Leonard Raymond
REG. NO. NM 6600
SRVR or RECORD Jamie Brandt
REG. NO.

bhpbilliton

BHP Navajo Coal Company

P.O. Box 1717
Fruitland, New Mexico, 87416

Phone: 505-598-4200
Fax: 505-598-3361

PLAN/PROFILE AND X-SECTIONS

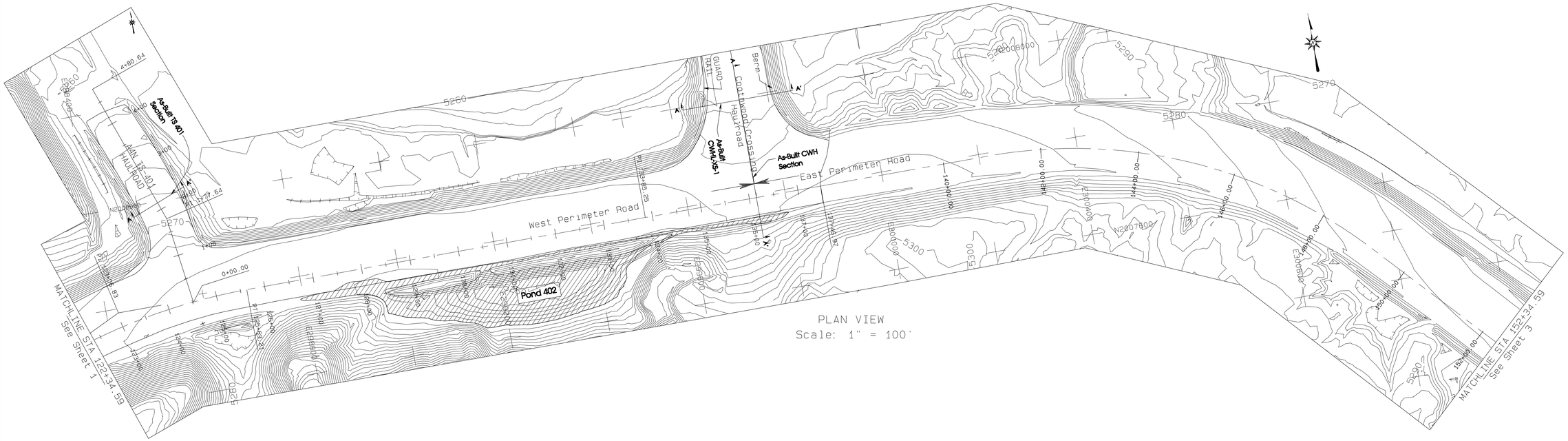
Exhibit 23-21

AREA 4 NORTH WEST AND EAST PERIMETER ROAD HAULROAD DESIGN MODIFICATION

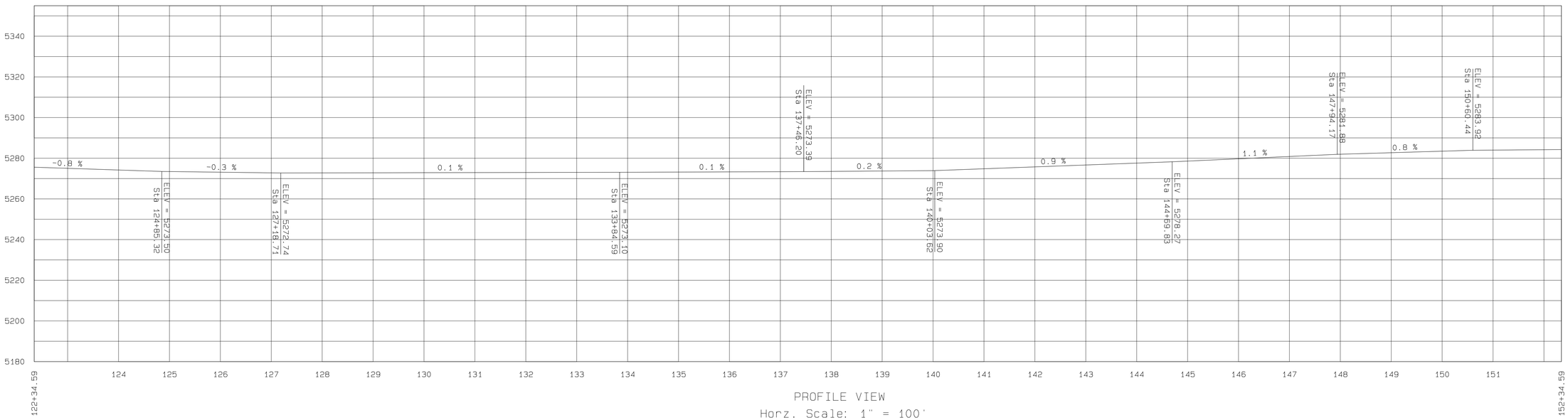
DRAWING

SHEET 2 OF 5

G:\GeoTech\FOX FTCh 11-094_LAW Perimeter Rd\Design-As-Built Sept-2012\Con 11-94_LAW_W E Perimeter Rd_As-Built_Rev_12B-2012.prp
Thu Sep 13 12:32:45 2012



PLAN VIEW
Scale: 1" = 100'



PROFILE VIEW
Horz. Scale: 1" = 100'
Vert. Scale: 1" = 25'

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing has been reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

Rev By	DATE
12-A AS-BUILT 4th ROAD AND SUBMITTED TO DSM FOR REVIEW AND APPROVAL.	PJF 5-30-2012
12-B REVISED TYPICAL SECTION FOR FIELD REVISION SUBMITTED TO DSM & MSHA/OMC	RF 6-26-2012

PROJECT: Area 4 North As-Built Road
DATE:
DESIGNED BY: Leonard Raymond
DRAWN BY: P. Foster
CHECKED BY: L. Raymond
APPROVED BY: L. Raymond

PROJECT MANAGER Ben Nesbitt
ENGR. of RECORD: Leonard Raymond
REG. NO: NM-5600
SURVE of RECORD: Jamie Bryant
REG. NO:

bhpbilliton

BHP Navajo Coal Company

P.O. Box 1717
Fruitland, New Mexico 87416
Phone: 505-598-4200
Fax: 505-598-3361

PLAN/PROFILE
AND
X-SECTIONS

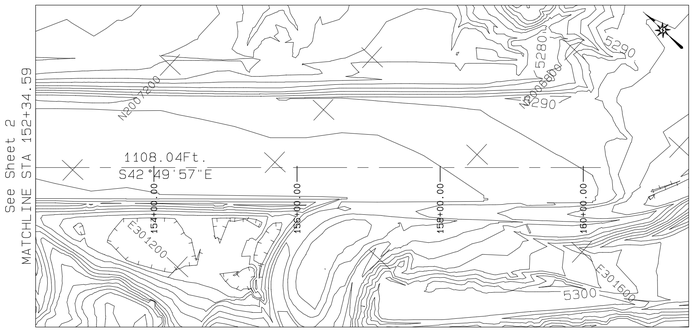
Exhibit 23-21

AREA 4 NORTH
WEST AND EAST
PERIMETER ROAD
HAULROAD
DESIGN MODIFICATION

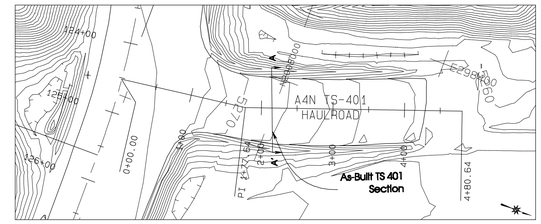
DRAWING

SHEET 3
OF 5

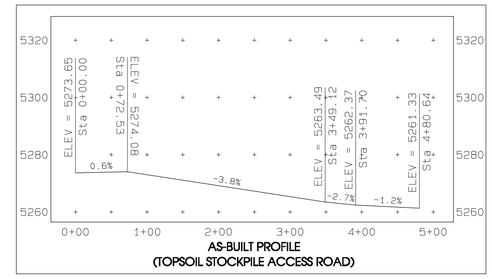
G:\Grp1\Proj1\Grp11\G4_LAW Perimeter Rd\Design-As-Built Sept-2012\Exh 11-94_LAW_E Perimeter Rd_As-Built_Mod_Design_Rev 12B-2012.pro
Th, Sep 13 12:55:29 2012



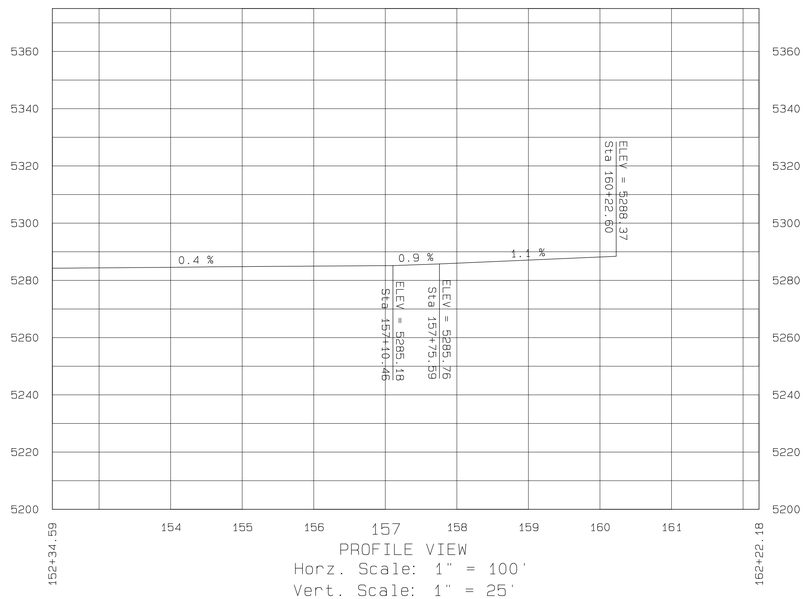
PLAN VIEW
Scale: 1" = 100'



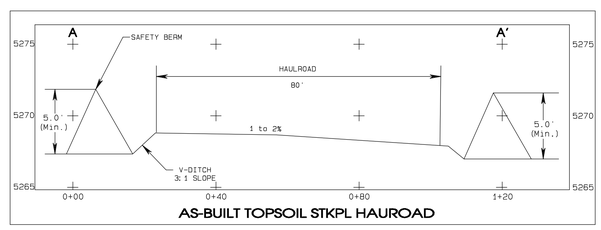
PLAN VIEW
Scale: 1" = 100'



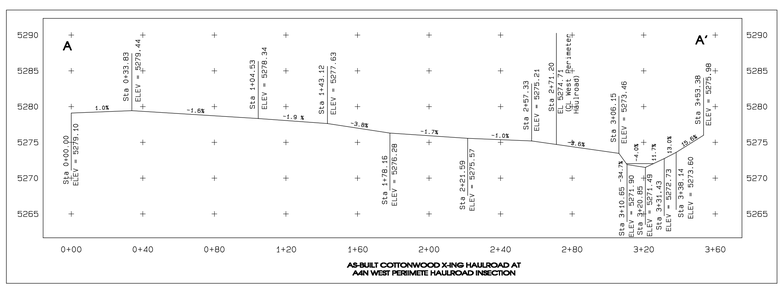
PROFILE VIEW
Horz. Scale: 1" = 100'
Vert. Scale: 1" = 25'



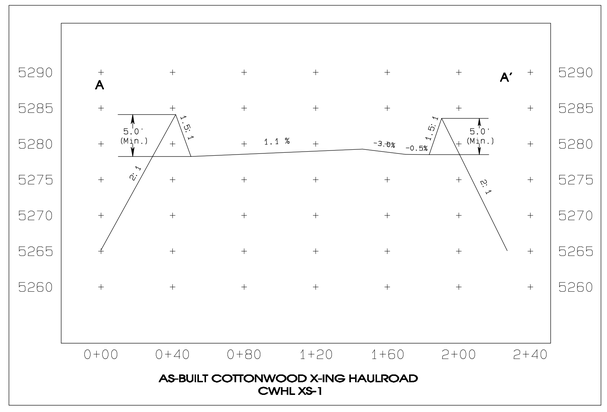
PROFILE VIEW
Horz. Scale: 1" = 100'
Vert. Scale: 1" = 25'



Horz. Scale: 1" = 20'
Vert. Scale: 1" = 5'



Horz. Scale: 1" = 40'
Vert. Scale: 1" = 10'



Horz. Scale: 1" = 40'
Vert. Scale: 1" = 10'

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing has been reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND — NEW MEXICO — 6600 — REGISTERED PROFESSIONAL ENGINEER

Rev By	DATE
REVISIONS	
12-A AS-BUILT A4N ROAD AND SUBMITTED TO DGM FOR REVIEW AND APPROVAL.	PJF 5-30-2012
12-B REVISED TYPICAL SECTION FOR FIELD REVISION SUBMITTED TO DGM FOR APPROVAL.	RF 6-26-2012

PROJECT: Area 4 North As-Built Road
DATE:
DESIGNED BY: Leonard Raymond
DRAWN BY: P. Foster
CHECKED BY: L. Raymond
APPROVED BY: L. Raymond

PROJECT MANAGER Ben Nesbit
ENGR. of RECORD Leonard Raymond
REG. NO. NM_6600
SURV. of RECORD Jamie Bryant
REG. NO.

bhpbilliton

BHP Navajo Coal Company
P.O. Box 1717
Fruitland, New Mexico, 87416
Phone: 505-598-4200
Fax: 505-598-3361

PLAN/PROFILE AND X-SECTIONS

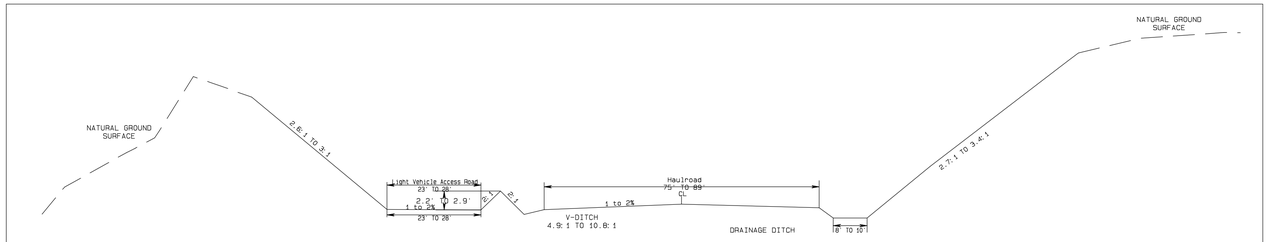
Exhibit 23-21

AREA 4 NORTH WEST AND EAST PERIMETER ROAD/ TS-401 HAULROAD DESIGN MODIFICATION

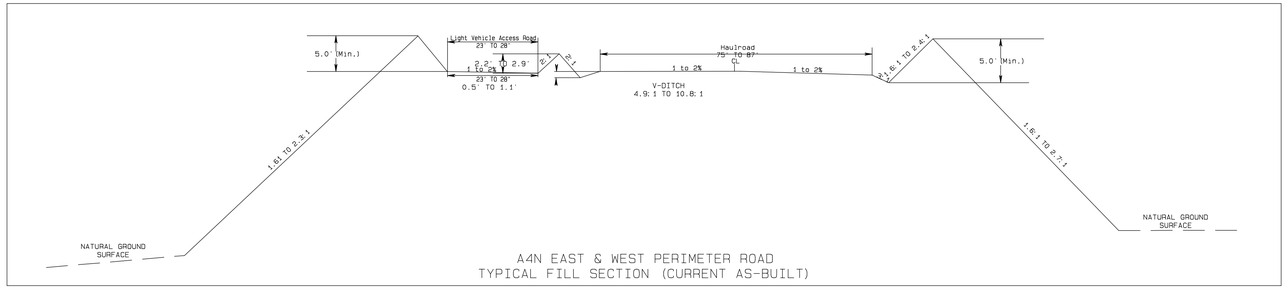
DRAWING

SHEET 4 OF 5

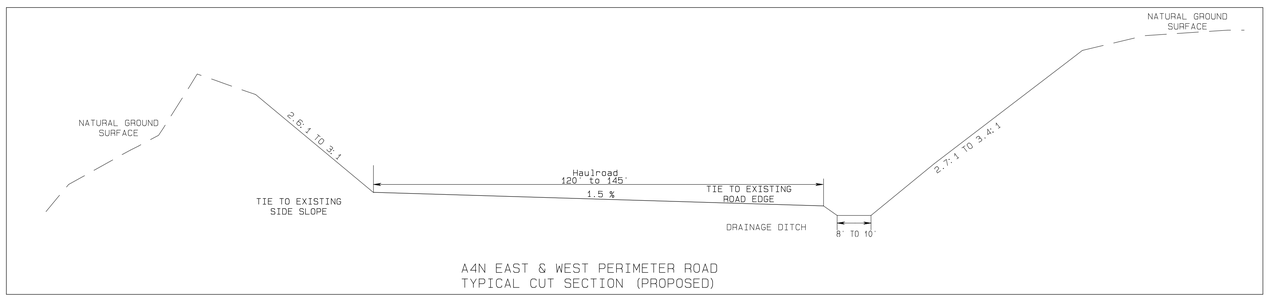
G:\Surfaces\FOR FIELD\11-094_A4N Perimeter Rd\Design-As-Built Sept-2012\Sch 11-94_A4N_N-E Perimeter Rd_As-Built_Rev_Design_Rev-128-2012.pro
Thu Sep 13 12:56:37 2012



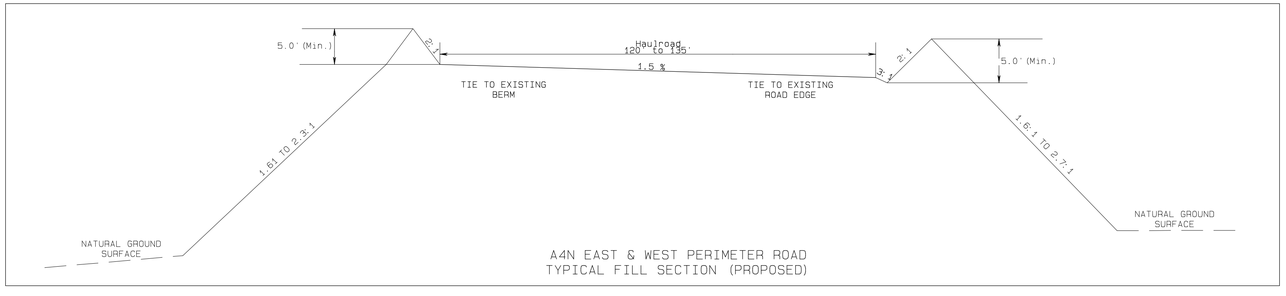
A4N EAST & WEST PERIMETER ROAD
TYPICAL CUT SECTION (CURRENT AS-BUILT)



A4N EAST & WEST PERIMETER ROAD
TYPICAL FILL SECTION (CURRENT AS-BUILT)



A4N EAST & WEST PERIMETER ROAD
TYPICAL CUT SECTION (PROPOSED)



A4N EAST & WEST PERIMETER ROAD
TYPICAL FILL SECTION (PROPOSED)

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing has been reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

Rev	By	DATE
12-A	AS-BUILT A4N ROAD AND SUBMITTED TO OSM FOR REVIEW AND APPROVAL.	PJF 5-30-2012
12-B	REVISED TYPICAL SECTION FOR FIELD REVISION SUBMITTED TO OSM 4/26/2012.	RY 6-26-2012

PROJECT: Area 4 North As-Built Road
DATE:
DESIGNED BY: Leonard Raymond
DRAWN BY: P. Foster
CHECKED BY: L. Raymond
APPROVED BY: L. Raymond

PROJECT MANAGER: Ben Nesbitt
ENGR. or RECORD: Leonard Raymond
REG. NO: NM_6600
SRVYR or RECORD: Jamie Bryant
REG. NO:

bhpbilliton

BHP Navajo Coal Company

P.O. Box 1717
Fruitland, New Mexico, 87416

Phone: 505-598-4200
Fax: 505-598-3361

TYPICAL SECTIONS

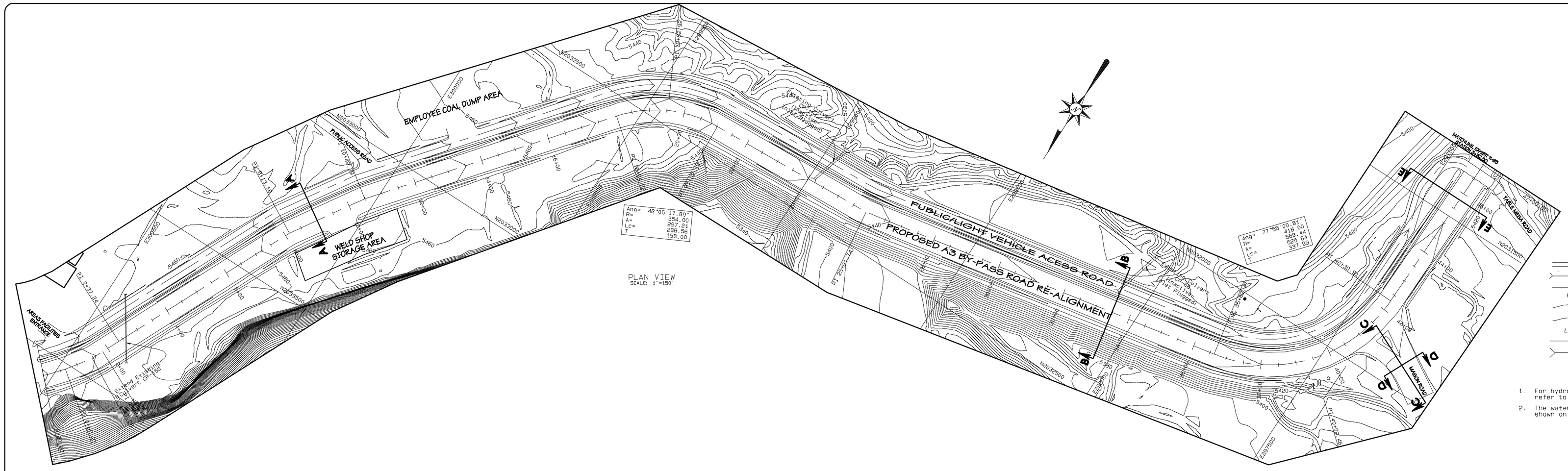
Exhibit 23-21

AREA 4 NORTH
WEST AND EAST
PERIMETER ROAD/
TS-401 HAULROA
DESIGN MODIFICATION
LOCATION MAP

DRAWING

SHEET 5
OF 5

G:\eng\Permit\FCRs\11-094_A4N Perimeter Rd\Design-As-Built Sept-2012\Exh 11-94_A4N_N-E Perimeter Rd_As-Built_Road_Design_Rev-12B-2012.prp
Thu Sep 13 12:31:59 2012

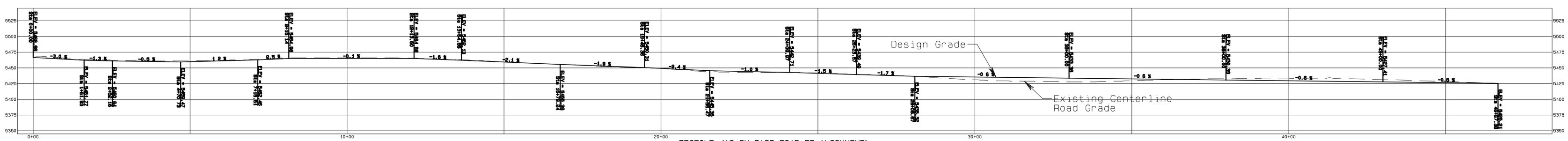


LEGEND

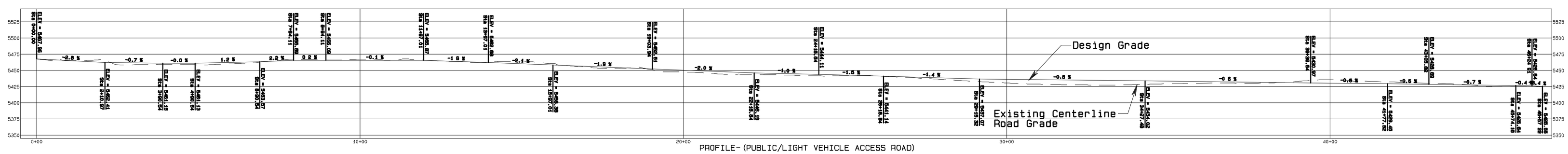
- ROAD
- CULVERT
- DRAINAGE
- POWERLINE
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY
- CULVERT

NOTES

1. For hydrology and design information refer to Appendix 11-V in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-12D.

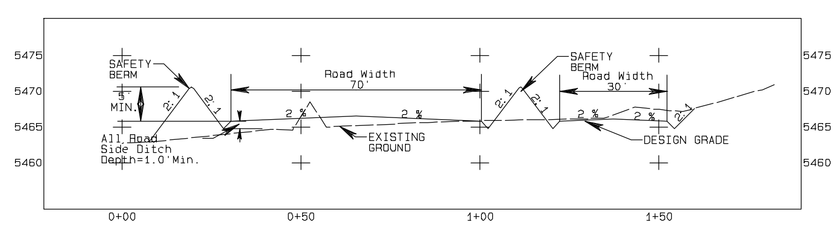


PROFILE (A3 BY-PASS ROAD RE-ALIGNMENT)

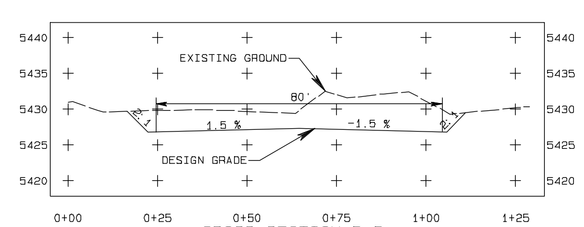


PROFILE-(PUBLIC/LIGHT VEHICLE ACCESS ROAD)

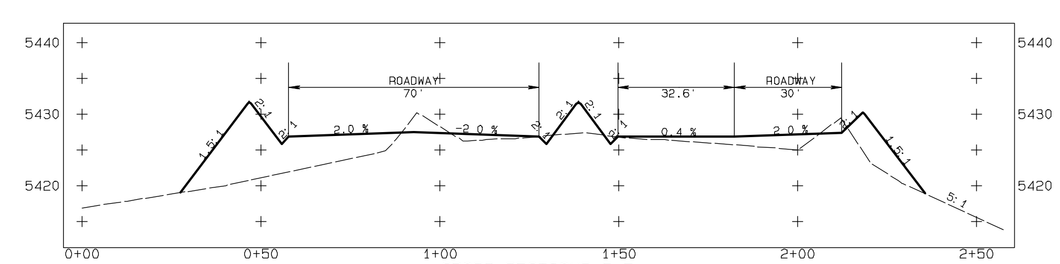
ABOVE PROFILES
SCALE: HORZ. 1"=160'
VERT. 1"=80'



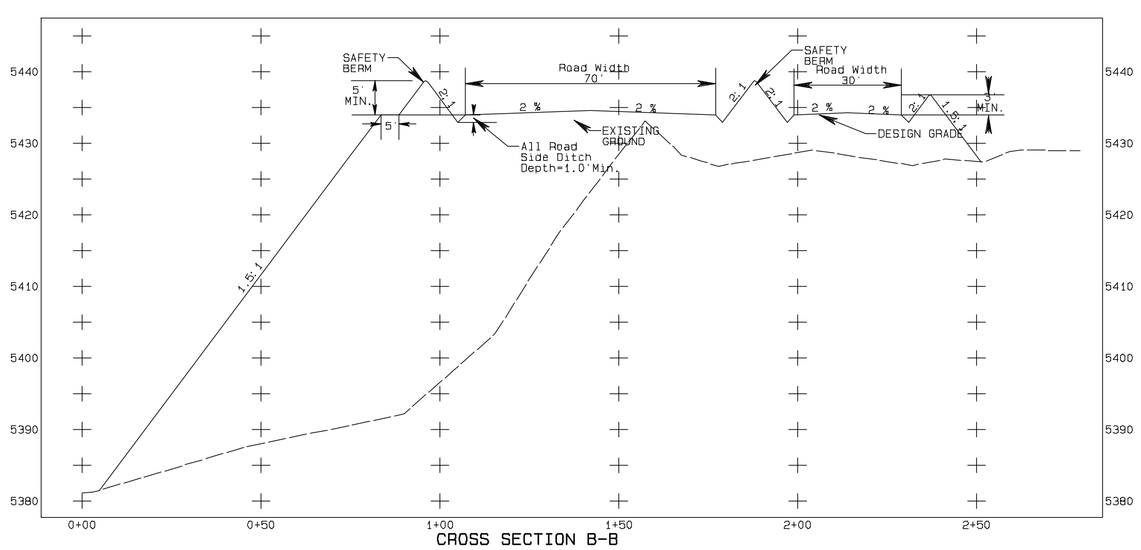
CROSS SECTION A-A



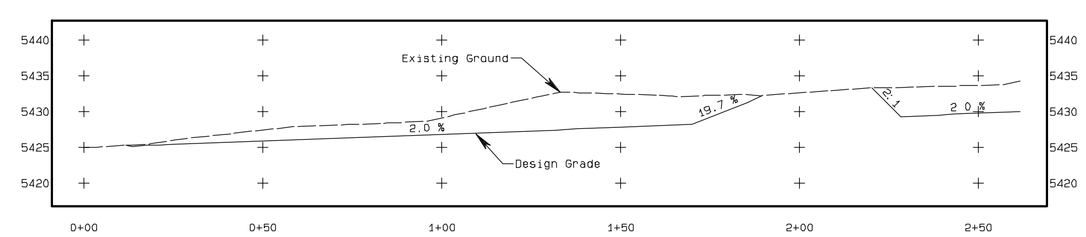
CROSS SECTION D-D



CROSS SECTIONS E-E

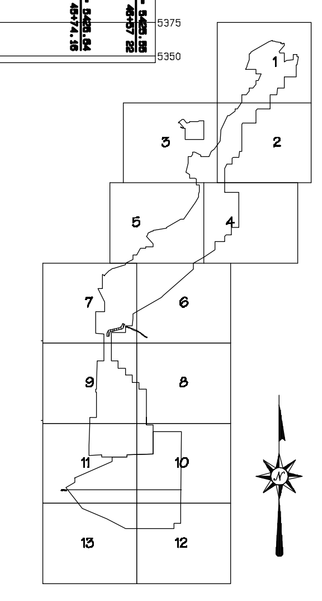


CROSS SECTION B-B



CROSS SECTIONS C-C

ABOVE CROSS SECTIONS
SCALE: HORZ. 1"=30'
VERT. 1"=15'



CERTIFICATION STATEMENT

I, Ron C. VAN VALKENBURG, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG
NEW MEXICO
9263
LICENSED PROFESSIONAL ENGINEER

Rev By	DATE
11-4 SUBMITTED TO OSM FOR APPROVAL	3-16-11

PROJECT: ROAD DESIGN
DATE: 3/16/11
DESIGNED BY: RY
DRAWN BY: RY
CHECKED BY: RCV
APPROVED BY: RCV
PROJECT MANAGER: RCV
ENGR. of RECORD: RCB
REG. NO: 0653
SRVYR of RECORD:
REG. NO:

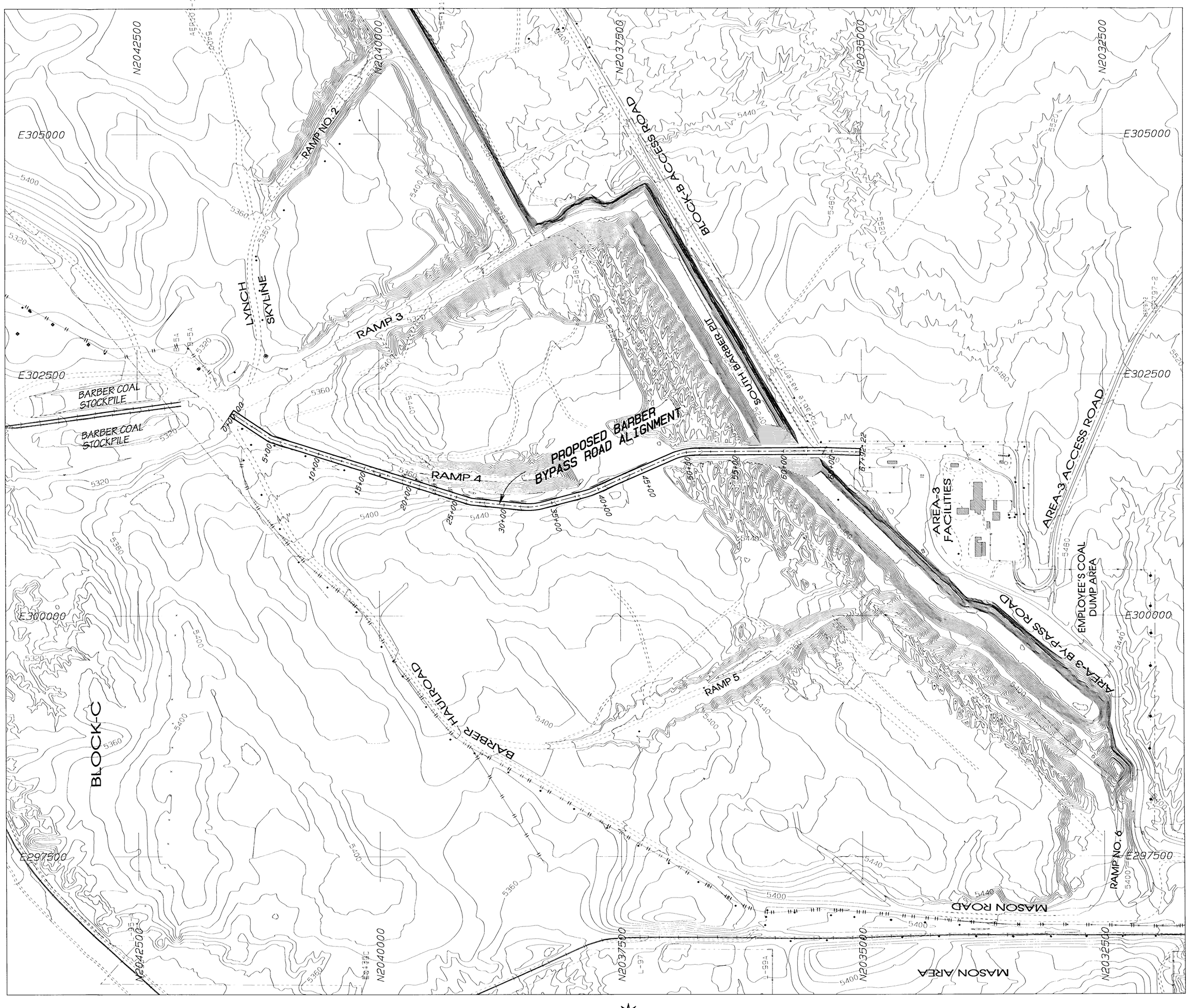
bhpbilliton
BHP NAVAJO COAL COMPANY
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416 / PHONE 505-598-4200/FAX 505-598-3351

PLAN, PROFILE AND CROSS SECTIONS

Exhibit 23-22
AREA-3
BY-PASS ROAD
DESIGN

DRAWING 1

SHEET 1 OF 1



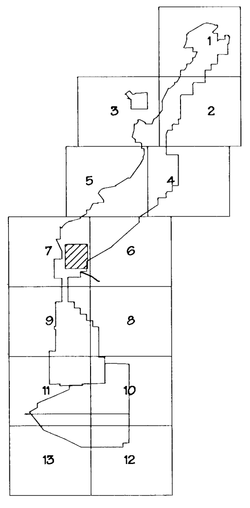
1"=500 FT.

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- x5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45 LEASE CORNER
- L-30 PERMIT/LEASE BOUNDARY

NOTES

1. For hydrology and design information refer to Appendix 11-F in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-120.



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

11-22-02

REV. NO.	DESCRIPTION	REV. BY	DATE
1	SUBMITTED TO SMCRA DIVISION	SS	11-22-02
2			
3			
4			
5			

PROJECT MANAGER: SS
ENGR. OF RECORD: LR
REG. NO. 6600
SRVYR. OF RECORD:
REG. NO.

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

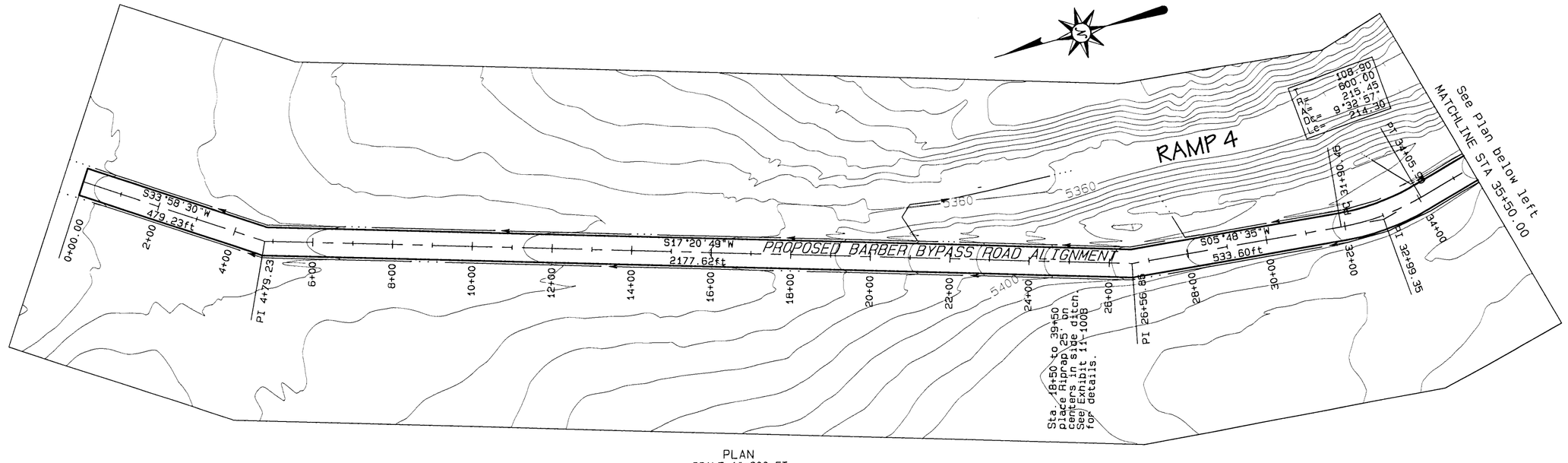
ACCOUNT:
DATE: NOV. 22, 2002
DESIGNED BY: RJ
DRAWN BY: RJ
CHECKED BY: LR
APPROVED BY: LR

LOCATION MAP

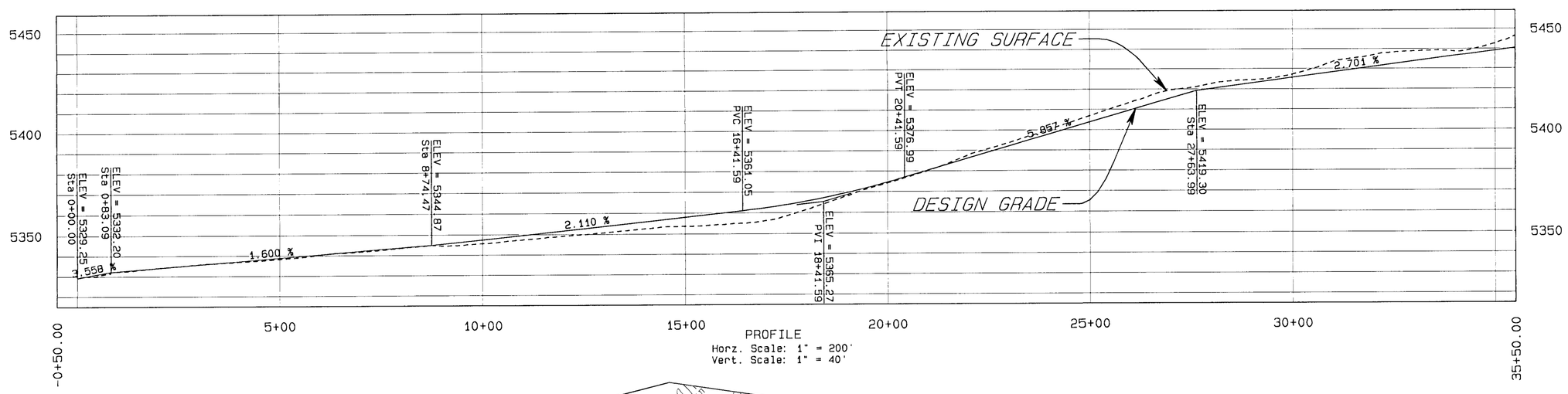
EXHIBIT 23-23
BARBER BYPASS ROAD DESIGN

DRAWING

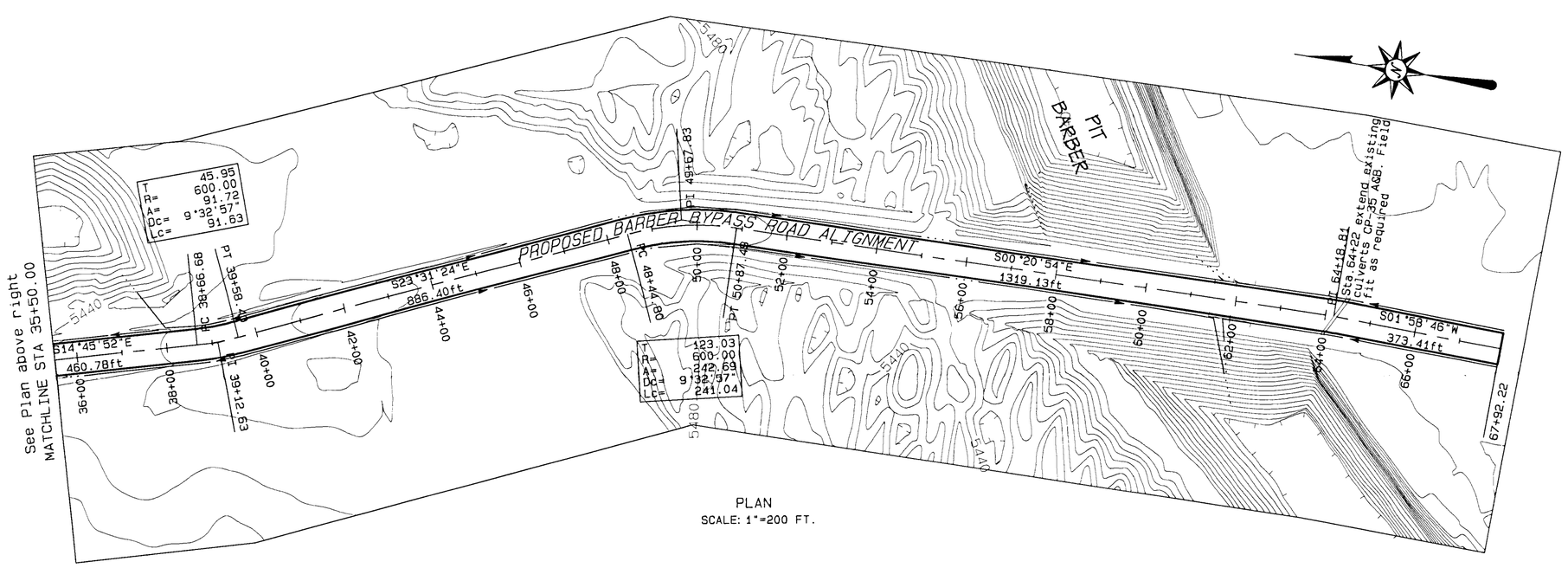
SHEET 1 OF 3



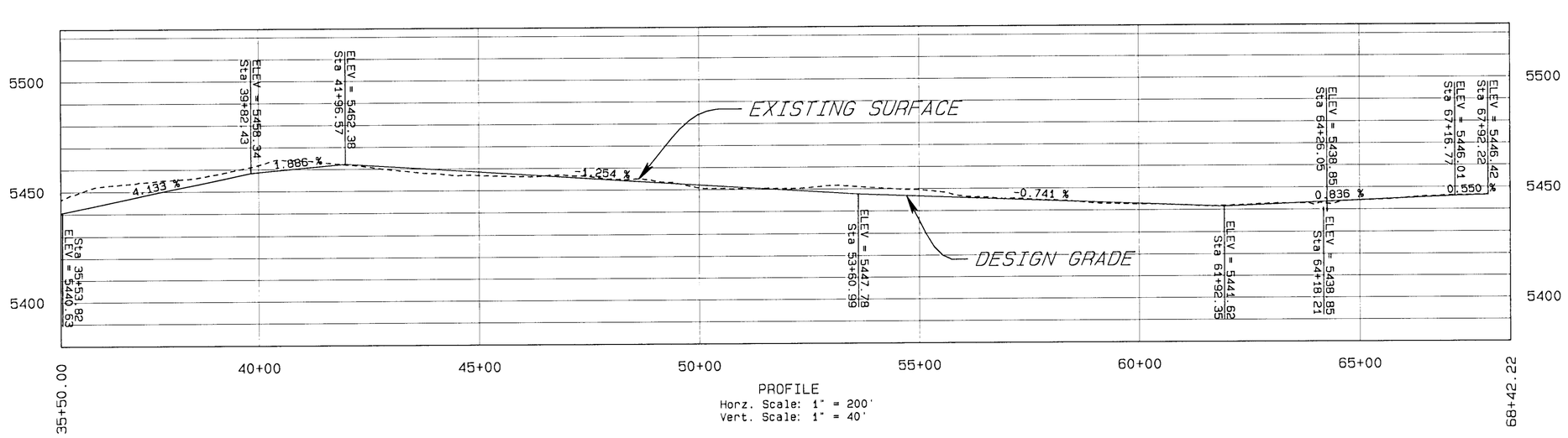
PLAN
SCALE: 1"=200 FT.



PROFILE
Horz. Scale: 1" = 200'
Vert. Scale: 1" = 40'



PLAN
SCALE: 1"=200 FT.



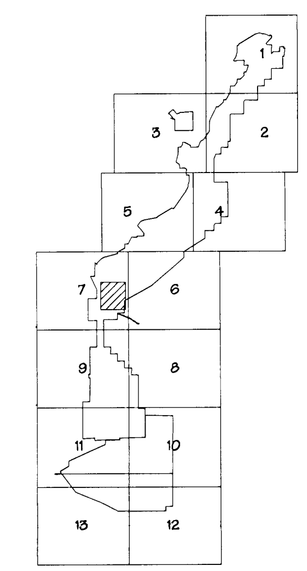
PROFILE
Horz. Scale: 1" = 200'
Vert. Scale: 1" = 40'

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- x5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY

NOTES

1. For hydrology and design information refer to Appendix 11-F in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-120.



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

11-22-02

REV NO.	DESCRIPTION	REV BY	DATE
1	ISSUED FOR 11-20-02 APPROVAL	KH	11-22-02
2			
4			
5			

PROJECT MANAGER: SG
ENGR. of RECORD: LM
REG. NO: 16600
SRVYR of RECORD:
REG. NO:

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

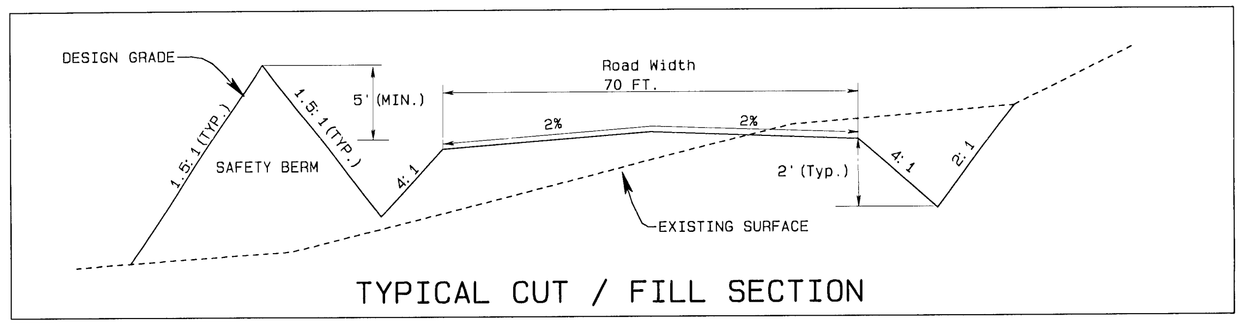
ACCOUNT:
DATE: NOV 22, 2002
DESIGNED BY: KH
DRAWN BY: KH
CHECKED BY: LR
APPROVED BY: LR

PLAN AND PROFILE

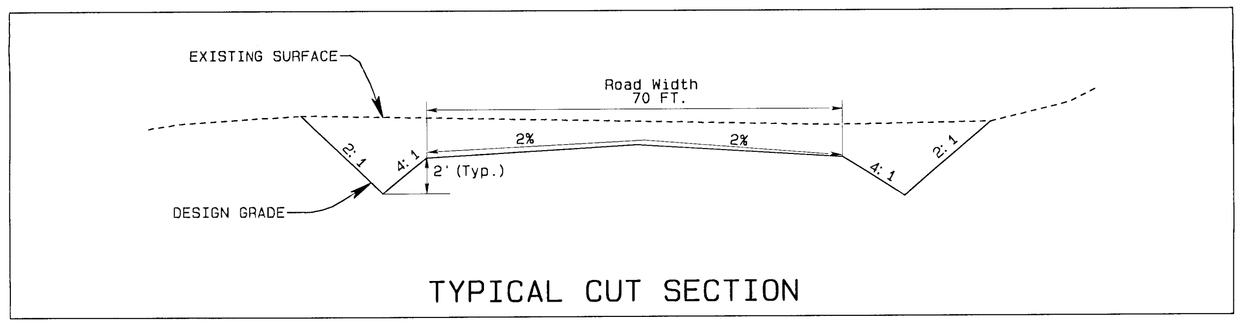
EXHIBIT 23-23
BARBER BYPASS ROAD DESIGN

DRAWING
SHEET 2 OF 3

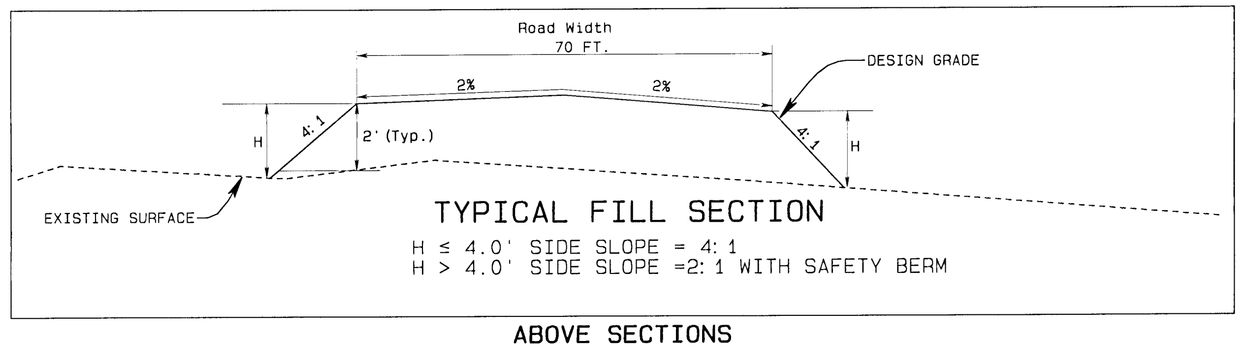
Path: \\CDR_SERVER\11\PROJECT\11120\CATB\Barber Bypass Design.dwg



TYPICAL CUT / FILL SECTION



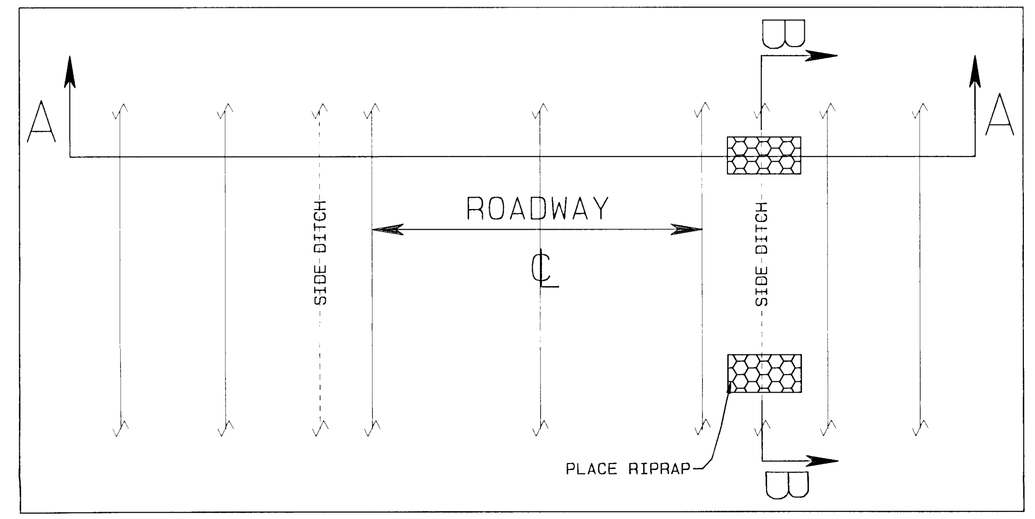
TYPICAL CUT SECTION



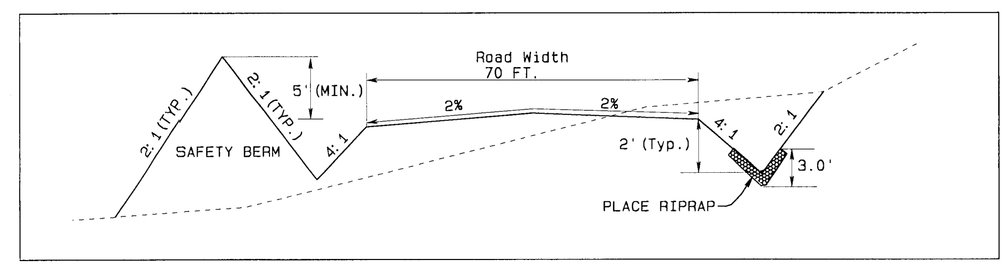
TYPICAL FILL SECTION

H ≤ 4.0' SIDE SLOPE = 4:1
H > 4.0' SIDE SLOPE =2:1 WITH SAFETY BERM

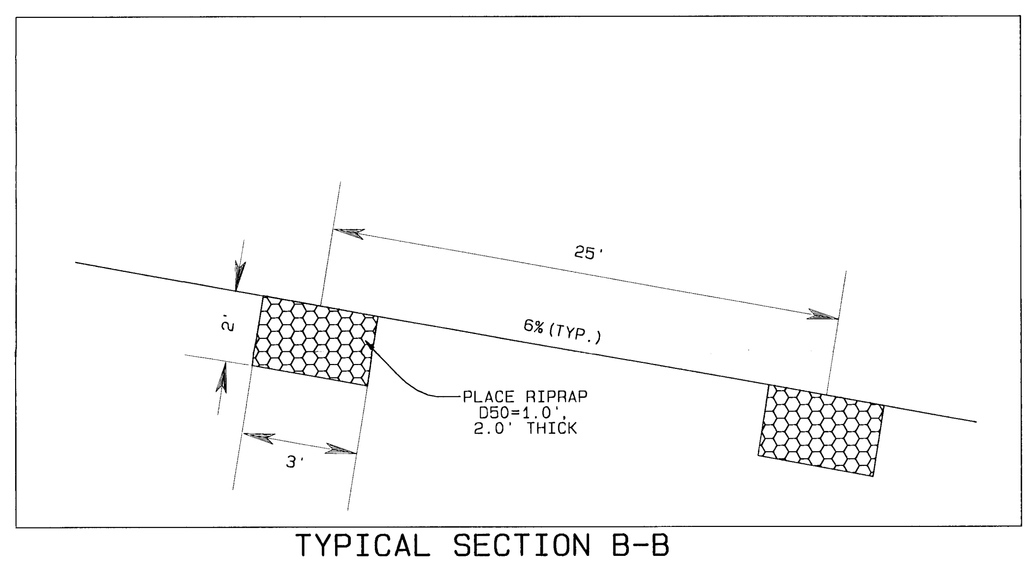
ABOVE SECTIONS
N.T.S



TYPICAL PLAN
Station 18+50 to 39+50



TYPICAL SECTION A-A



TYPICAL SECTION B-B

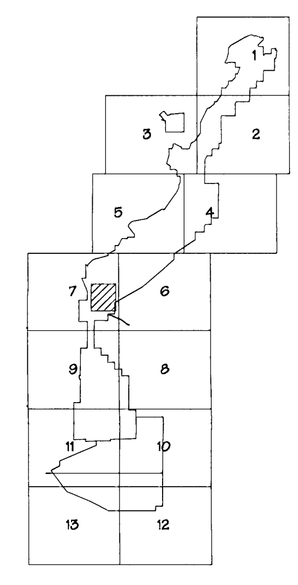
N.T.S

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 — SPOT ELEVATION
- 5300 — INDEX CONTOUR
- 5298 — INTERMEDIATE CONTOUR
- 218 / 5422.45
- L-30 — LEASE CORNER
- PERMIT/LEASE BOUNDARY

NOTES

1. For hydrology and design information refer to Appendix 11-F in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-12D.



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

11-22-11

APPROVED

REV NO.	DESCRIPTION	BY	DATE
1	SUBMITTED TO OSM FOR APPROVAL	RY	11-22-02
2			
4			
5			

PROJECT MANAGER: JG
ENGR. of RECORD: LR
REG. NO. 6600
SRVYR of RECORD:
REG. NO.

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

ACCOUNT:
DATE: NOV. 22, 2002
DESIGNED BY: LR
DRAWN BY: RY
CHECKED BY: LR
APPROVED BY: LR

PLAN, PROFILE AND SECTIONS

EXHIBIT 23-23
BARBER BYPASS ROAD DESIGN

DRAWING

SHEET 3 OF 3

Date: - NOW JUBAPERI PROJECT 11115-100\Exhibit\Barber Bypass Design.pmz

EXHIBIT 23-24
BURNS PASS ROAD RE-ALIGNMENT DESIGN

PLAN, PROFILE AND SECTION

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

REV	DATE	DESCRIPTION
1	04-22-05	SUBMITTED TO OSM FOR APPROVAL
2		
3		
4		
5		

PROJECT MANAGER: DH
ENGRL. SP. RECORD: LH
SRVYR. SP. RECORD: LH
REG. NO.

ACCOUNT:
DATE: 04-22-05
DESIGNED BY: DH
DRAWN BY: RH
CHECKED BY: LH
APPROVED BY: LH

DRAWING
SHEET 1 OF 1

PATH: G:\Departments\MINE PROJECT\DESIGN\SURVEY\ Burn Pass Road Re-alignment\burn pass road re-alignment dgn.dgn

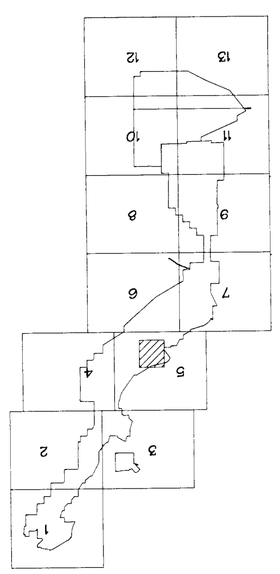
CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

4-27-05

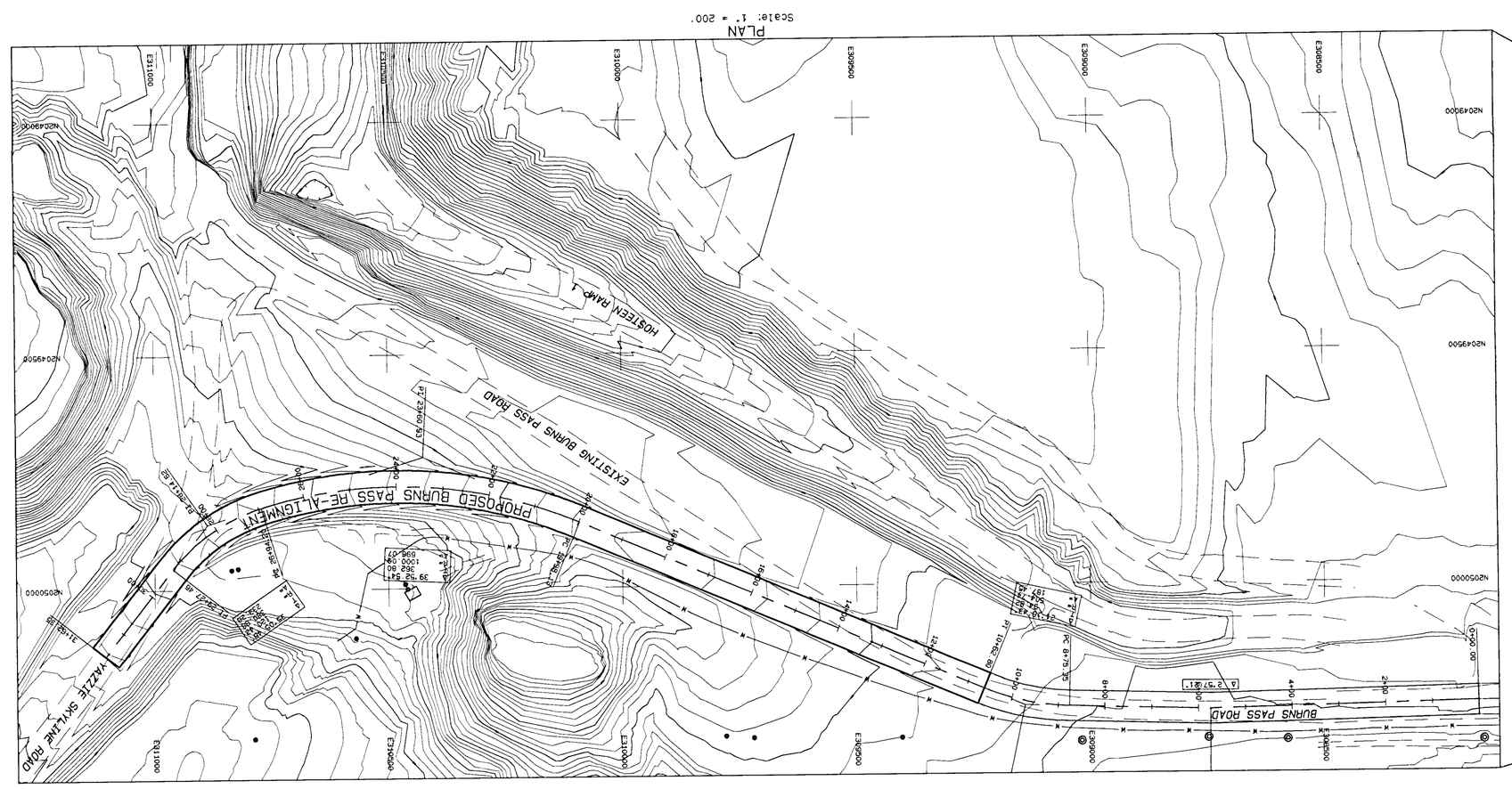
LEONARD RAYMOND, NEW MEXICO, 8600, REGISTERED PROFESSIONAL ENGINEER

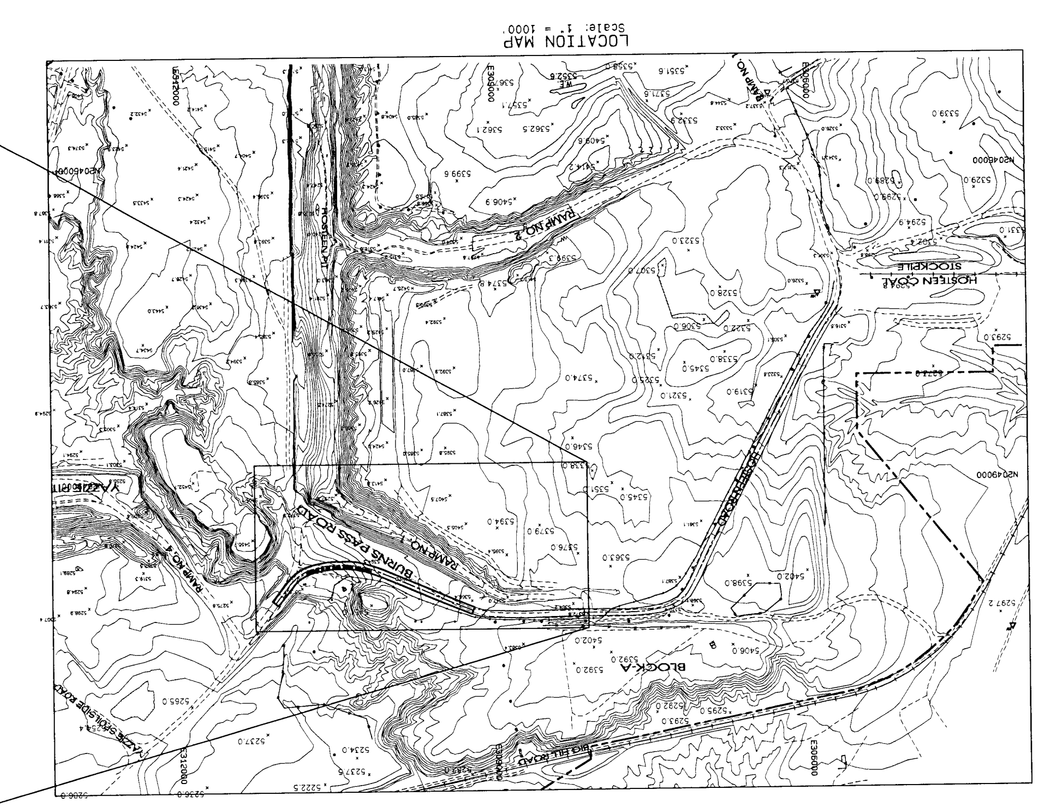
SCALE AS NOTED

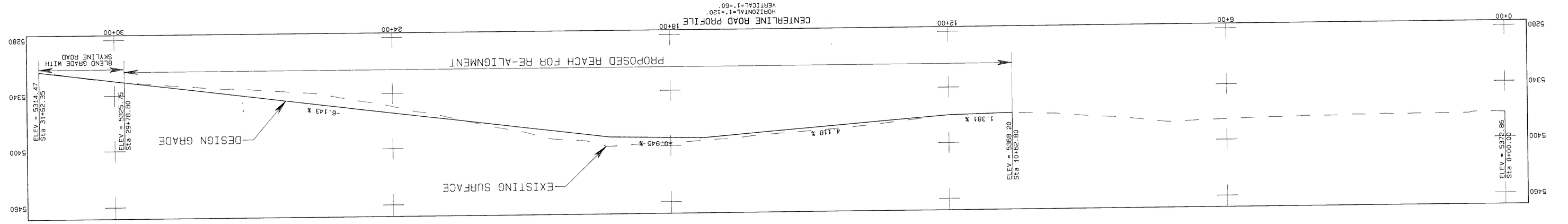


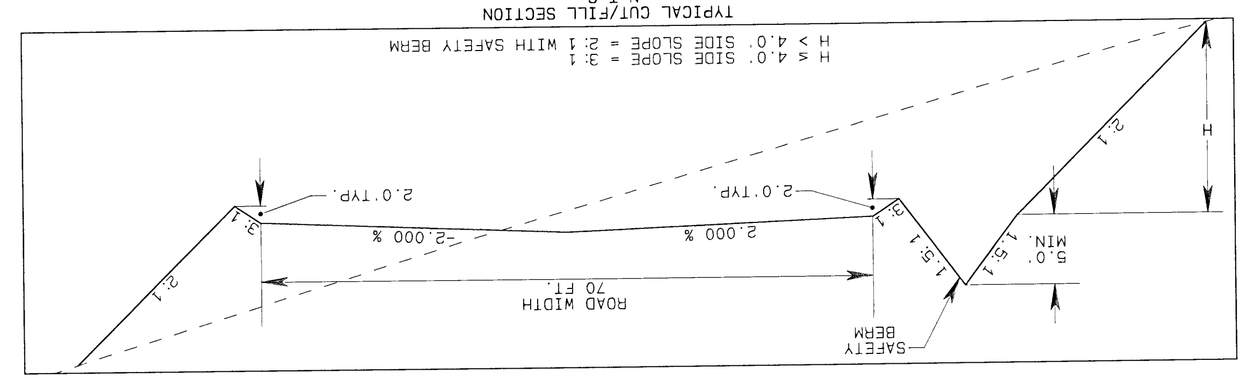
LEGEND

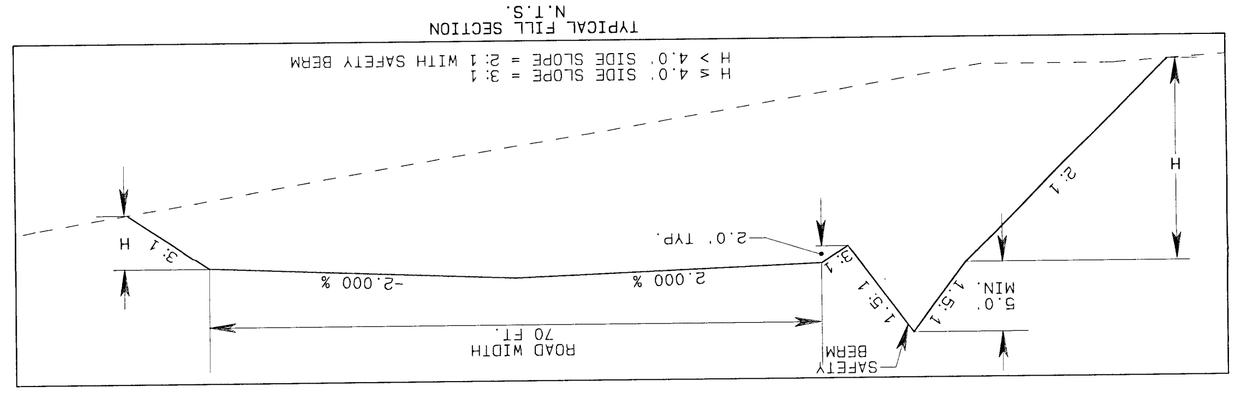
ROAD
BULLDING
FENCE
IRRIGATION LINE
CULVERT
DAM
DRAINAGE
RAILROAD
TREES
POWERLINE
SPOT ELEVATION ×5338.5
INDEX CONTOUR 5300
INTERMEDIATE CONTOUR 5298
218 5422.45
LEASE CORNER L-30
PERMIT/LEASE BOUNDARY

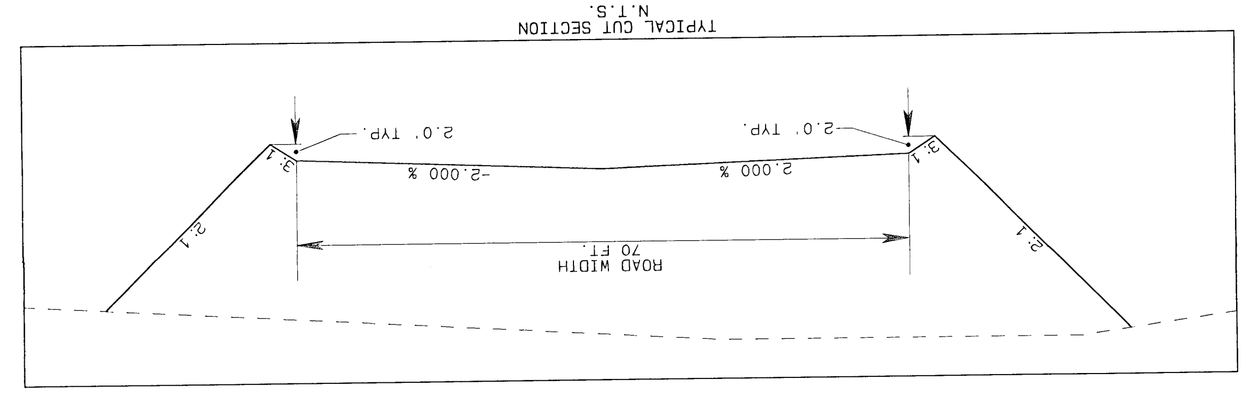




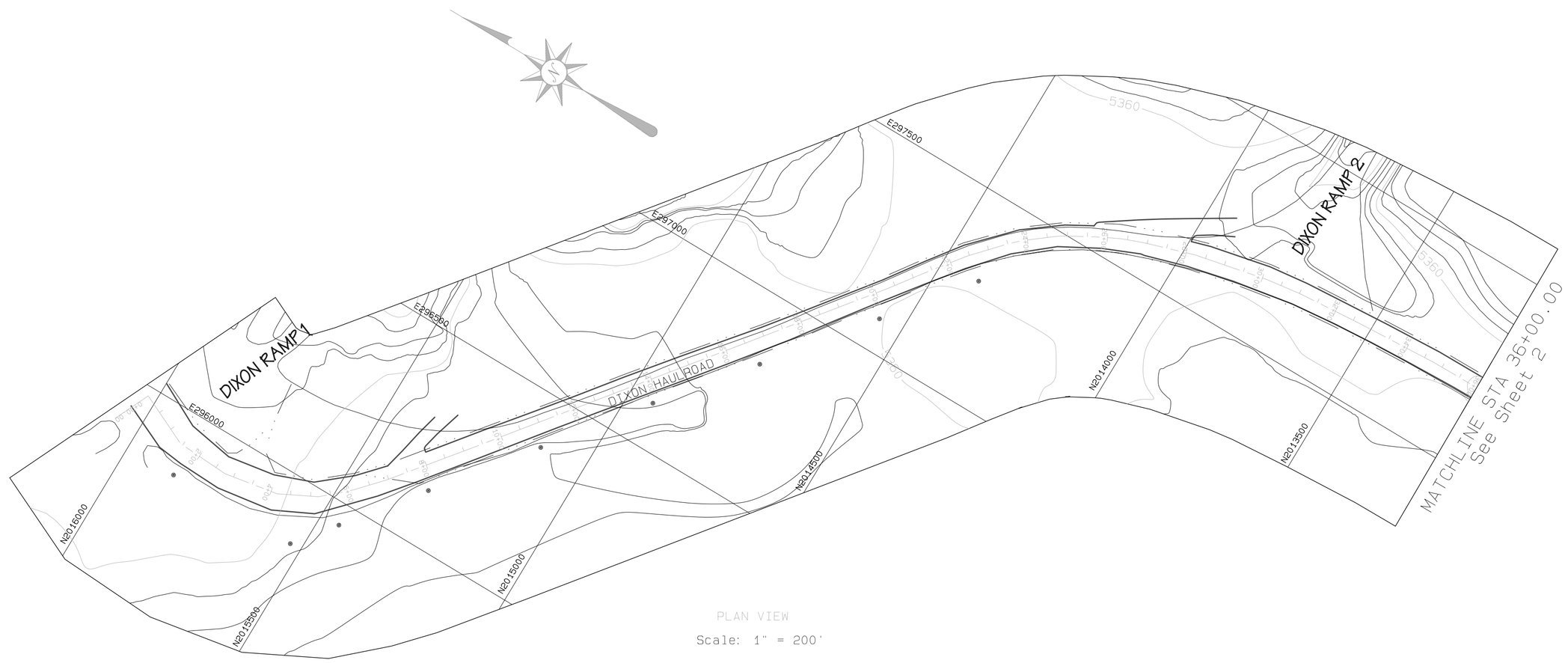






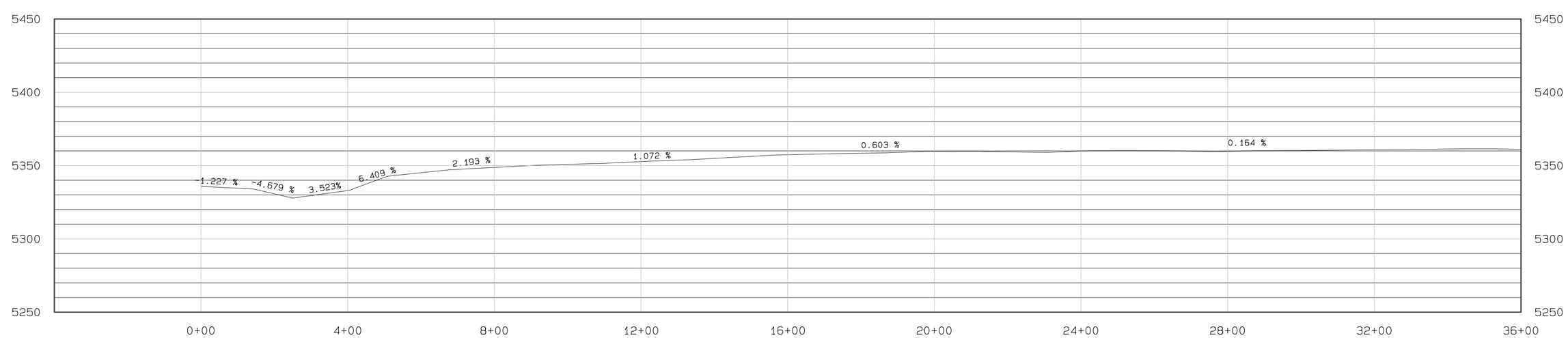


ABOVE SECTIONS N.T.S.



PLAN VIEW

Scale: 1" = 200'

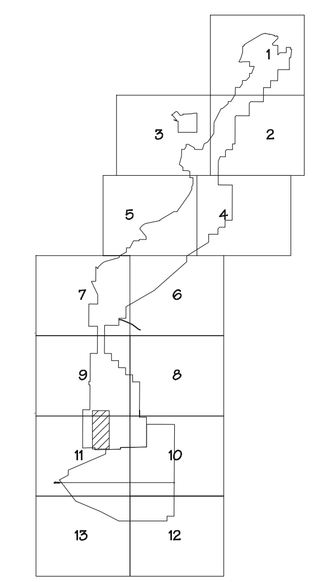


PROFILE VIEW

Horz. Scale: 1" = 200'
Vert. Scale: 1" = 50'

LEGEND

- ROAD
- TRAIL
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45 L-30 LEASE CORNER



SCALE AS NOTED

NOTES

1. For hydrology and design information refer to Appendix 11-V in the approved PAP.

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this haulroad has been constructed in accordance with the approved design plans and that the information shown is complete and accurate to the best of my knowledge, except as noted below.

1. The 24 inch diameter culvert shown on the design drawing (Exhibit 11-137) at Station 57+71.93 was not installed. It will be installed when the spoil piles on the east side of the roadway are graded to the AOC surface or when the precise location of the AOC drainage crossing the road is known.

2. A 10 inch diameter HDPE pipe not shown on the design drawing was installed at Station 51+84. The pipe functions as a power cable sleeve. It was installed to route the drag-line power cable across the roadway. A Powerline has been installed and this is no longer needed.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

REVISION	DATE
1 AS-BUILT	01/20/00
2 MOVED MATCHLINE TO STA. 36+00	08/20/02
3	
4	
5	

PROJECT MANAGER COREY NELSON
ENGR. OF RECORD LEONARD RAYMOND REG. NO. 6600
DRVTR OF RECORD BRIS RO

BHP-NAVAJO COAL CO.
PO BOX 159, FRUITLAND, NEW MEXICO, 87416

ACCOUNT: 1854
DATE: January 26, 2000
DESIGNED BY:
DRAWN BY: RY
CHECKED BY: LR
APPROVED BY: R

PLAN AND PROFILE

EXHIBIT 23-25
DIXON HAULROAD
AS-BUILT

DRAWING PP1

SHEET 1 OF 2

Project Date: Path: J:\DGN_SUBMWNER_PROJ\CH_11\11-137\As-built\Dixon Haulroad Realignment As-built.dgn Plot Time: Thu Apr 17 12:20:14 2003

EXHIBIT 23-25
DIXON HAULROAD
AS-BUILT

PLAN, PROFILE & SECTIONS

BHP-NAVAJO COAL CO.
PO BOX 105, FRUITLAND, NEW MEXICO 87416

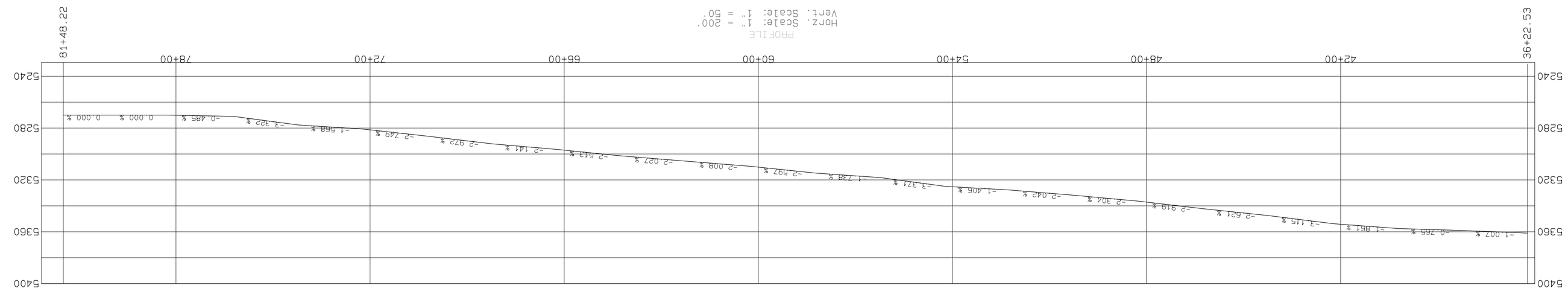
PROJECT MANAGER: COPY NELSON
ENGR. of RECORD: LEONARD RAYMOND
REG. NO: 6600
SRVYR of RECORD:
REG. NO:

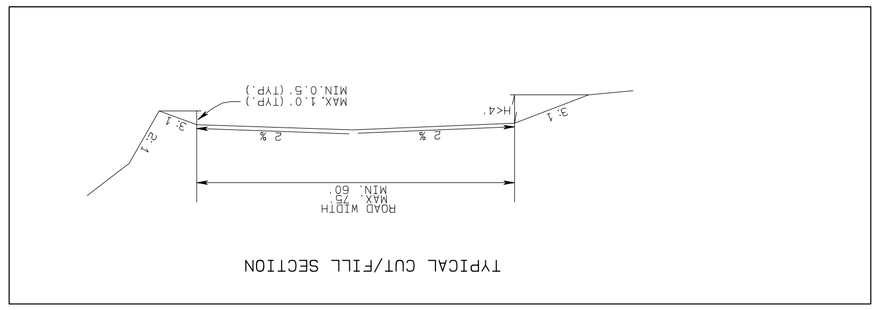
ACCOUNT: 1854
DATE: JANUARY 26, 2000
DESIGNED BY:
DRAWN BY:
CHECKED BY: LR
APPROVED BY: LR

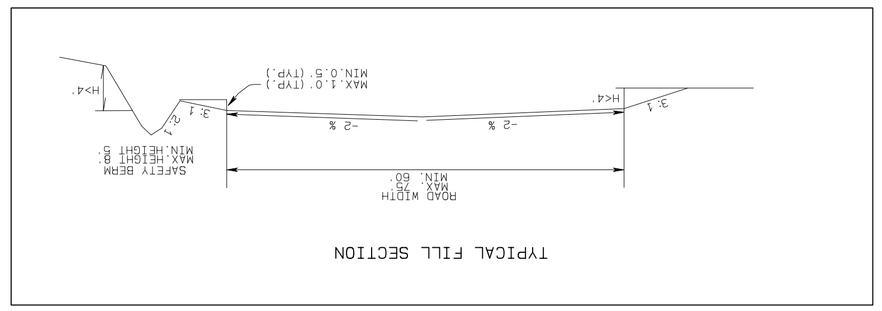
	REVISION	DATE
1	AS-BUILT	
2	RE-ALIGN AND ASBUILT HAULROAD FROM STA.78+00 TO 81+48.22	01/28/00
3		08/20/02
4		
5		

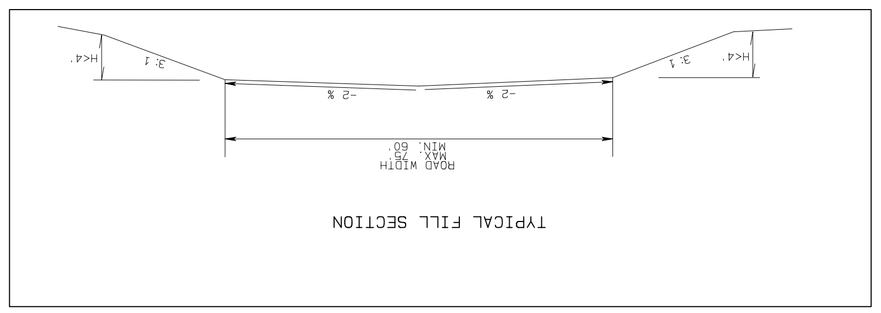
DRAWING: PP2
SHEET 2 OF

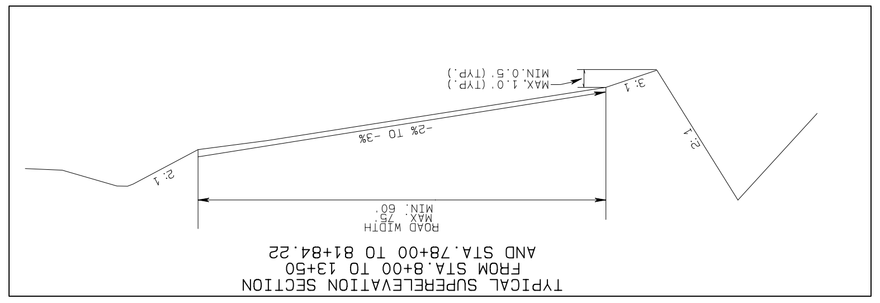
Project Desc.: Path: J:\DGN_SUBWORKER_PROD\CPJ_1111-1371\Arcnu1111\01\Haulroad-Re-Alignment-As-Built.dgn Plot time: Thu Apr 11 12:20:08 2003

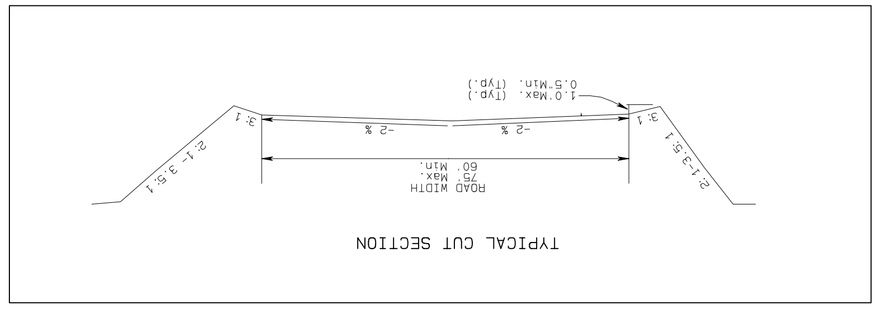


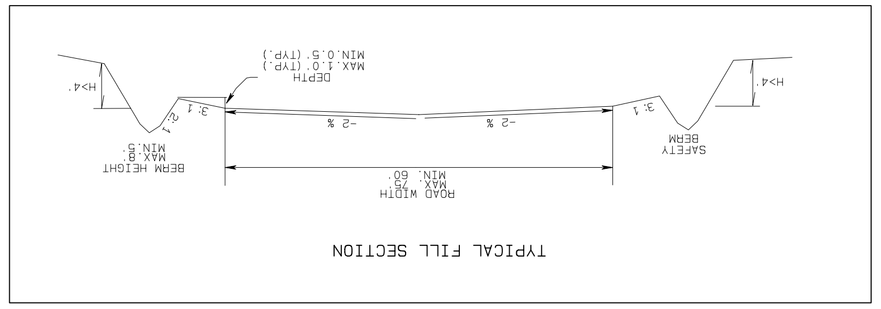








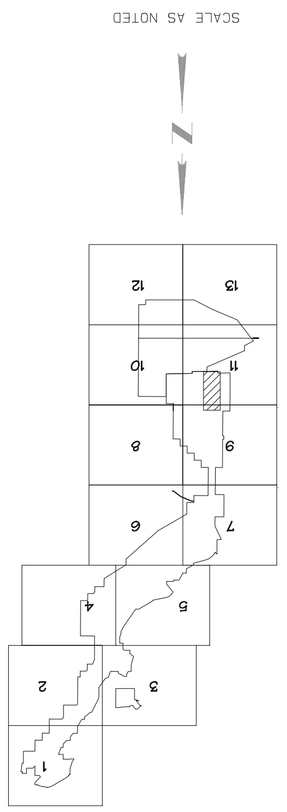




SECTIONS
N.T.S

NOTES

1. For hydrology and design information refer to Appendix 11-V in the approved PAP.



LEGEND

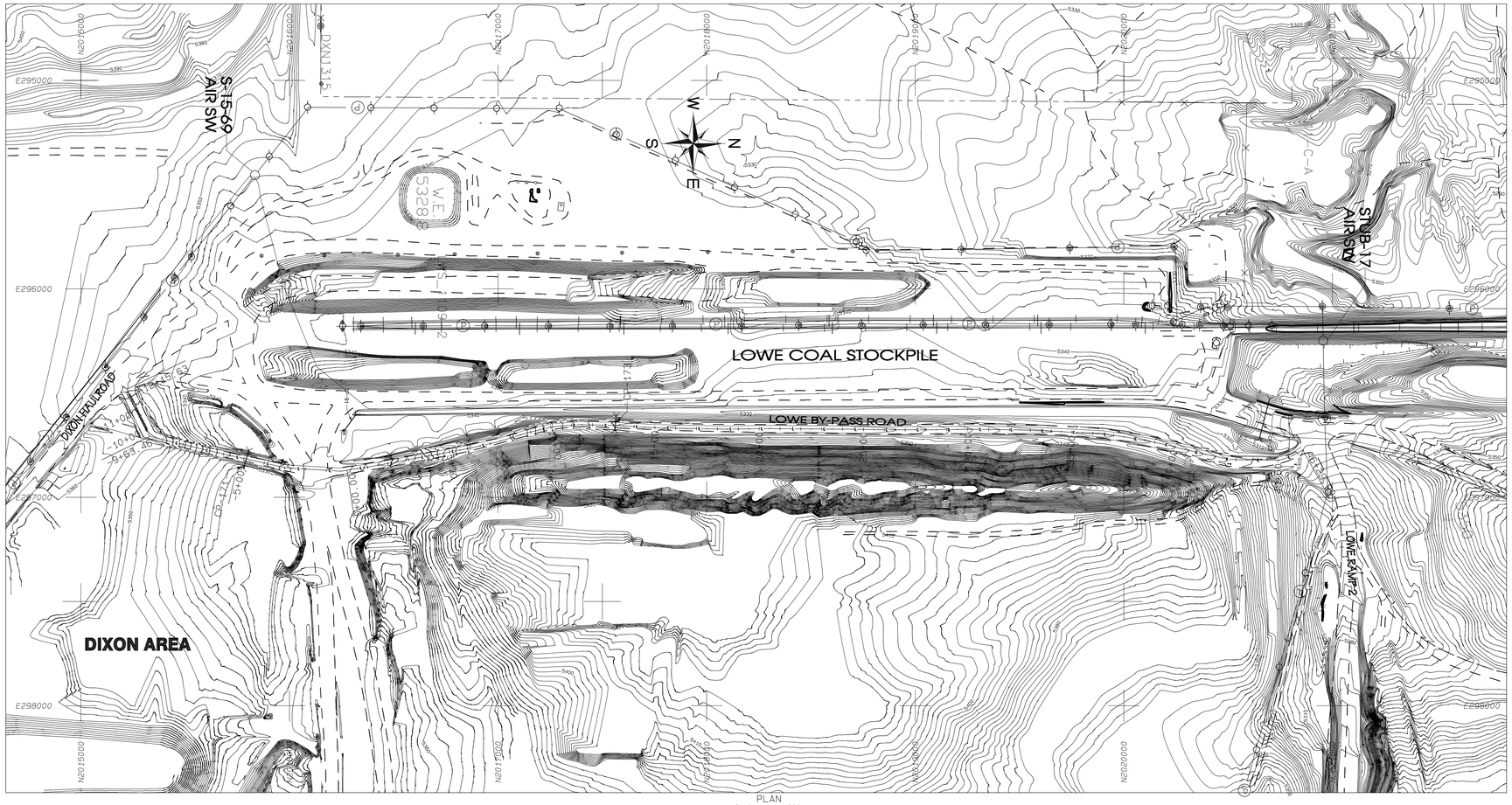
- ROAD
- TRAIL
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- 5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5296 INTERMEDIATE CONTOUR
- 5422.45 218
- L-30 LEASE CORNER

CERTIFICATION STATEMENT

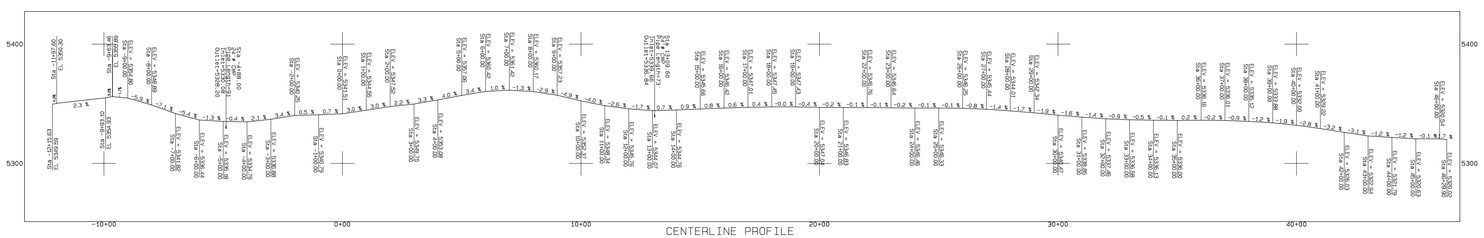
I, Leonard Raymond, hereby certify that this haulroad has been constructed in accordance with the approved design plans and that the information shown is complete and accurate to the best of my knowledge, except as noted below.

1. The 24 inch diameter culvert shown on the design drawing (Exhibit 11-137) at Station 57+71.93 was not installed. It will be installed when the spoil piles on the east side of the roadway are graded to the ACC surface or when the precise location of the ACC drainage crossing the road is known.

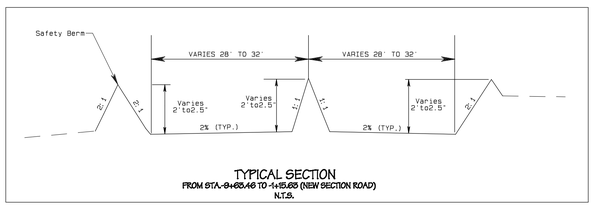
2. A 10 inch diameter HDPE pipe not shown on the design drawing was installed at Station 51+84. The pipe functions as a power cable sleeve. It was installed to route the drainline power cable across the roadway. A Powerline has been installed and this is no longer needed.



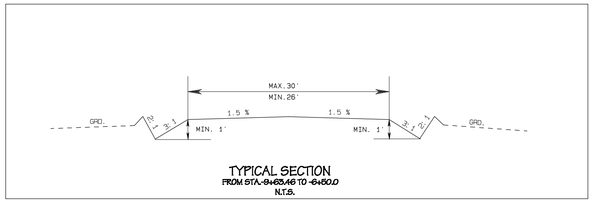
PLAN
Scale: 1" = 300'



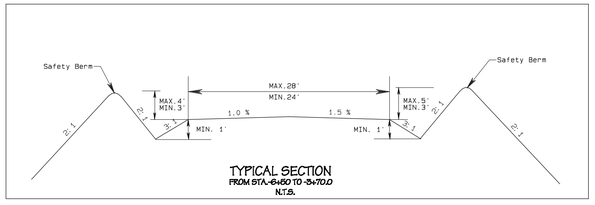
CENTERLINE PROFILE
HORIZONTAL - 1"=300'
VERTICAL - 1"=60'



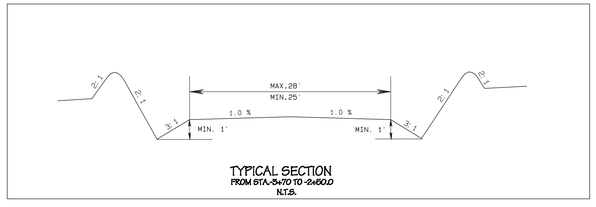
TYPICAL SECTION
FROM STA.-9+63.46 TO -14+15.63 (NEW SECTION ROAD)
N.T.S.



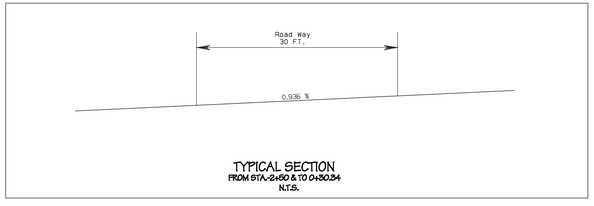
TYPICAL SECTION
FROM STA.-9+63.46 TO -6+50.0
N.T.S.



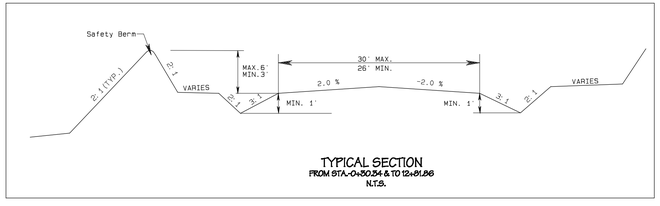
TYPICAL SECTION
FROM STA.-6+50 TO -3+70.0
N.T.S.



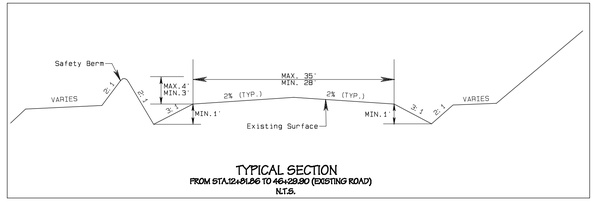
TYPICAL SECTION
FROM STA.-3+70 TO -2+50.0
N.T.S.



TYPICAL SECTION
FROM STA.-2+50 & TO 0+30.24
N.T.S.



TYPICAL SECTION
FROM STA.-0+30.24 & TO 12+91.86
N.T.S.



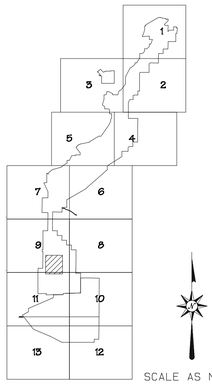
TYPICAL SECTION
FROM STA.12+91.86 TO 46+22.90 (EXISTING ROAD)
N.T.S.

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 — SPOT ELEVATION
- 5300 — INDEX CONTOUR
- 5298 — INTERMEDIATE CONTOUR
- 218 / 5422.45 — LEASE CORNER
- L-30 — PERMIT/LEASE BOUNDARY

NOTES

1. For hydrology and design information refer to Appendix 11-V in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-12E.



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this light vehicle access road has been constructed in accordance with the approved design plans and that the information shown is complete and accurate to the best of my knowledge, except as noted below.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

1. Culvert CP-172 at approximately sta. 0+00 was not required therefore it was not installed. Drainage will cross the roadway and into culvert CP-91.
2. The alignment from approximately sta -5+00 to -12+75 was slightly changed to better fit the topograghy.
3. Per an approved Field Revision dated November 28, 2011, the intersection with Dixon Haulroad was changed to approximately a 90 degree angle to create a safer intersection.

REV NO.	DESCRIPTION	REV BY	DATE
	EXHIBIT 11-12D, REPLACES EXHIBIT 11-12D, AND D, SUBMITTED TO OSM	RY	12-31-03
12-4	ESPANOLA ROAD FROM STA. (-9+63.46 TO -14+15.63) WAS REALIGNED AS PER REVIEW	RF	8-02-12

PROJECT MANAGER: DEREK RAWSON
ENGR. of RECORD: LEONARD
REG. NO: 6600
SURVR. of RECORD:
REG. NO:

ACCOUNT:
DATE: December 7, 2003
DESIGNED BY: RY
DRAWN BY: RY
CHECKED BY: LR
APPROVED BY:

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

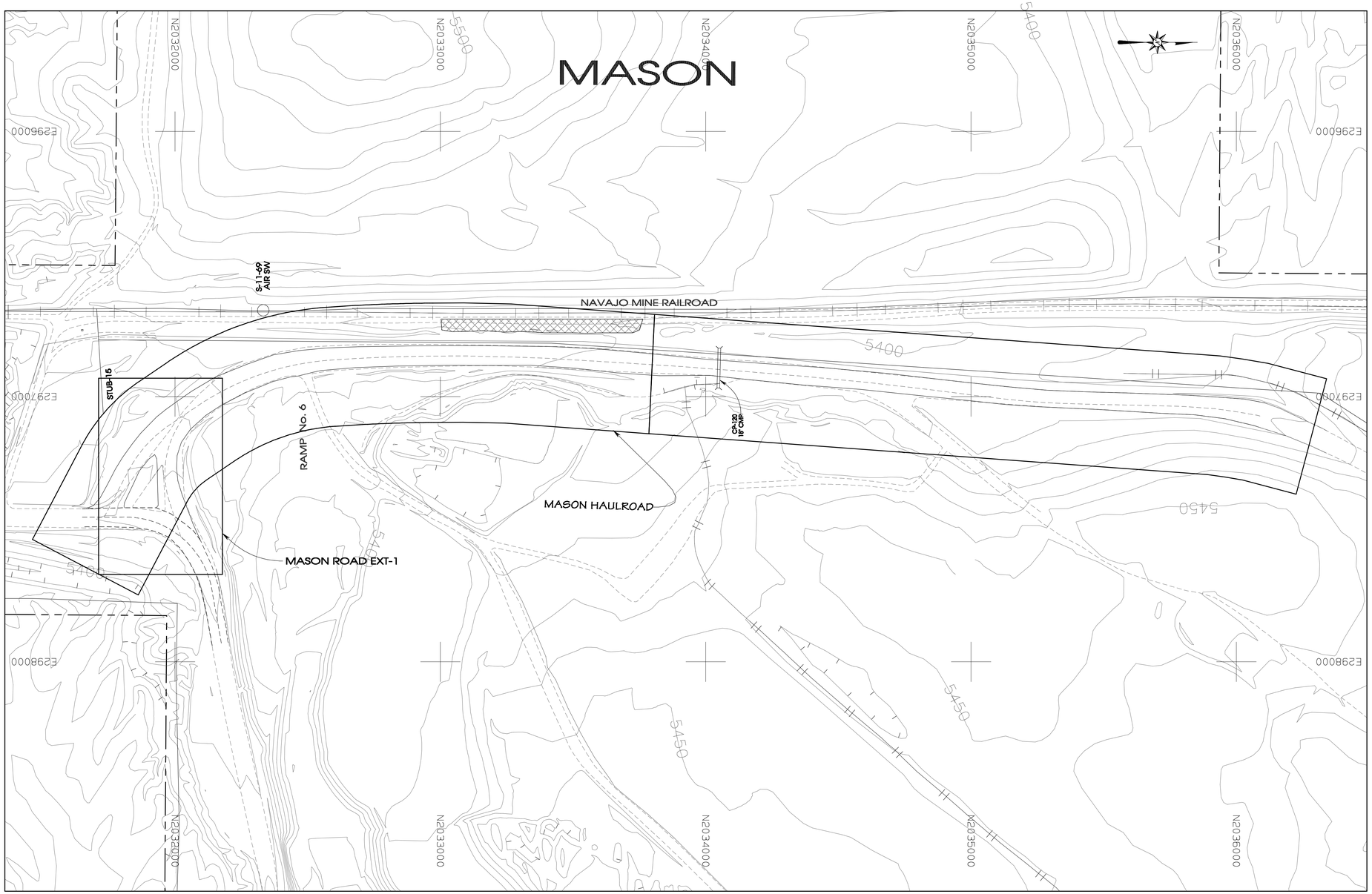
PLAN, PROFILE AND SECTIONS

Exhibit 23-26
LOWE BY-PASS ROAD
AS-BUILT

DRAWING

SHEET 1
OF 1

Path: C:\bhpnavajo Files\11-12D_Lowe By-Pass REVISED\Stnb-Built-July-2012\Ex 11-12D_Lowe Bypass Road Asbuilt_July-2012_A.dwg

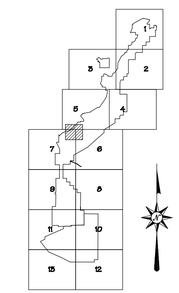


LOCATION MAP

SCALE: 1"=200'

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5299 INTERMEDIATE CONTOUR
- 218 5422.45 LEASE CORNER
- L-30 LEASE CORNER
- LEASE/PERMIT BOUNDARY



REV. No.	DATE	DRAWT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.
09-A	3-23-09	PJF	REPLACE PREVIOUS AS-BUILT MASON HAULROAD, ALSO ADDED MASON ROAD EXT-1 AND SUBMITTED TO OSM FOR REVIEW.	RCV	YB	RCV

APPROVALS

CERTIFICATION STATEMENT

I, Ron C. Van Valkenburg, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG
NEW MEXICO
9263
LICENSED PROFESSIONAL ENGINEER

EXHIBIT 23-27

NAVAJO COAL COMPANY

bhpbilliton

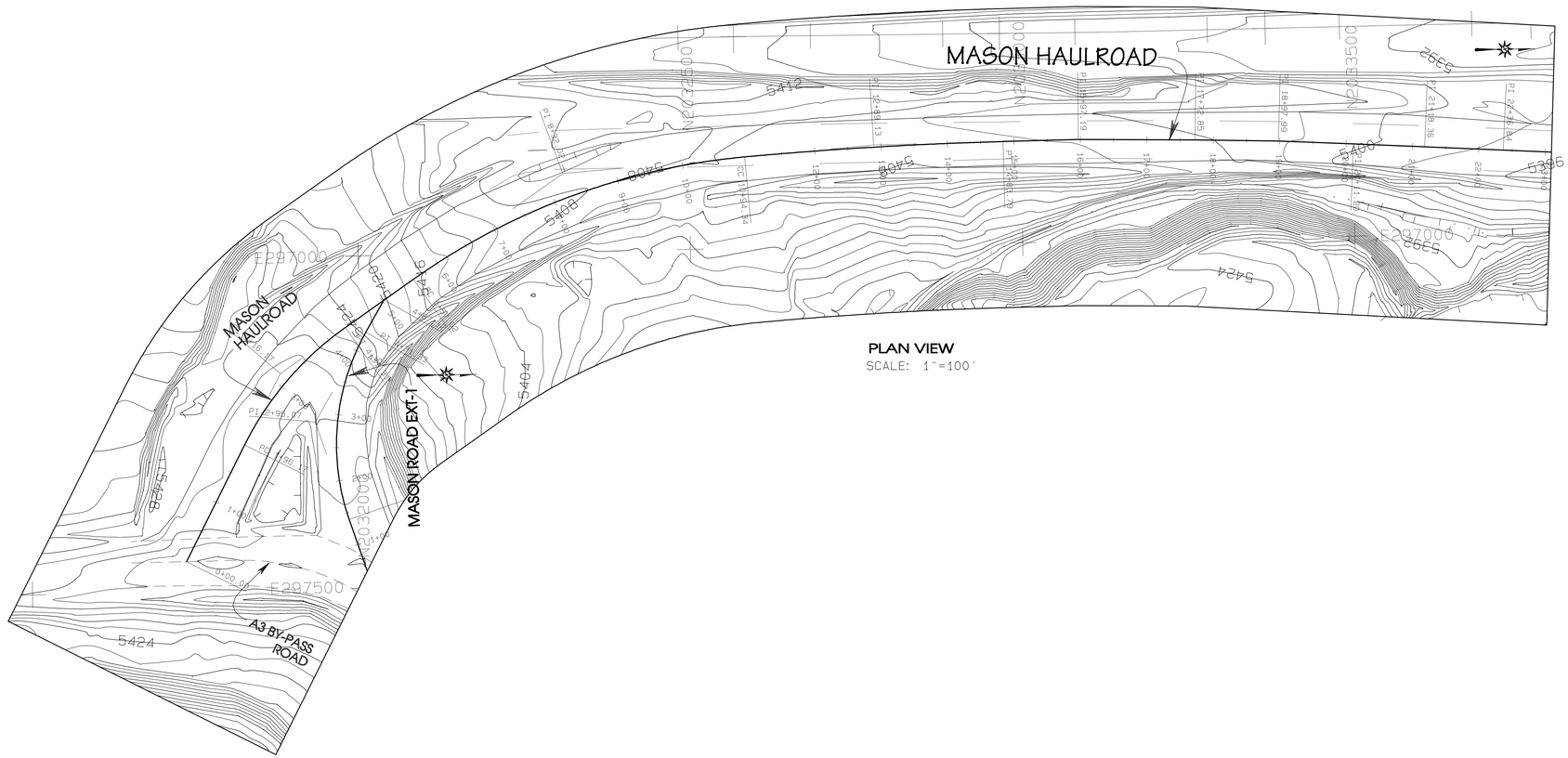
P.O.BOX 1717 FRUITLAND, NEW MEXICO 87416/PHONE 505-598-4200/FAX 505-598-3361

Area 2

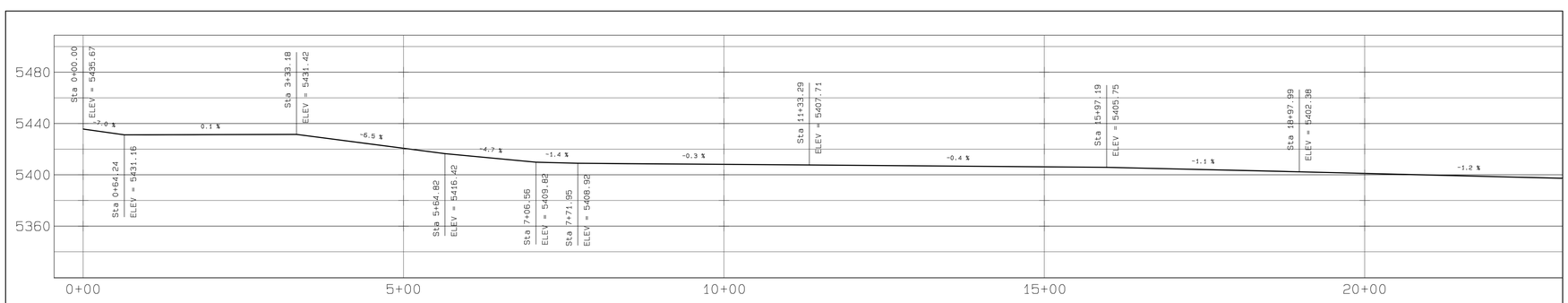
MASON HAULROAD AS-BUILT LOCATION MAP

PREPARED BY PJF	DRAWN BY PJF	AS NOTED
APPROVED BY RVV	DATE 3-13-09	**Sheet 1 of 3**

Path: \\ENCWMCFMN-SRV02\Data\Departments\Ge\OSM_SUBM\PER_PROG\CH_11_PAP EXHIBITS\11-138-MASON HAULRD\2009 DATA\EXH 11-138_Mason_Haulroad.pro
PJFoster \Plot time: Fri May 22 12:57:01 2009



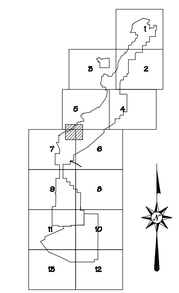
PLAN VIEW
SCALE: 1"=100'



MASON HAULROAD - PROFILE VEIW
HORIZONTAL: 1-"=200'
VERTICAL: 1"=20'

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 — SPOT ELEVATION
- 5300 — INDEX CONTOUR
- 5299 — INTERMEDIATE CONTOUR
- 218 5422.45 — LEASE CORNER
- L-30 — LEASE/PERMIT BOUNDARY



REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.
09-4	3-23-09	PJF	REPLACE PREVIOUS AS-BUILT MASON HAULROAD, ALSO ADDED MASON ROAD EXT-1 AND SUBMITTED TO OSM FOR REVIEW.	RCVV	TB	RCVV

APPROVALS

CERTIFICATION STATEMENT

I, Ron C. Van Valkenburg, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG
NEW MEXICO
9263
LICENSED PROFESSIONAL ENGINEER

EXHIBIT 23-27

NAVAJO COAL COMPANY

bhpbilliton

P.O.BOX 1717 FRUITLAND, NEW MEXICO 87416/PHONE 505-598-4200/FAX 505-598-3361

Area 2

MASON HAULROAD
PLAN/PROFILE AS-BUILT

PREPARED BY PJF	DRAWN BY PJF	AS NOTED	
APPROVED BY RVV	DATE 3-13-09	**Sheet 2 of 3**	

Path: \\ENCNMCFMN-SRV02\Data\Departments\Gs\OSM_SUBM\PER_PROG\CH_11_PAP EXHIBITS\11-138-MASON HAULRD\2009 DATA\EXH 11-138_Mason_Haulroad.pro
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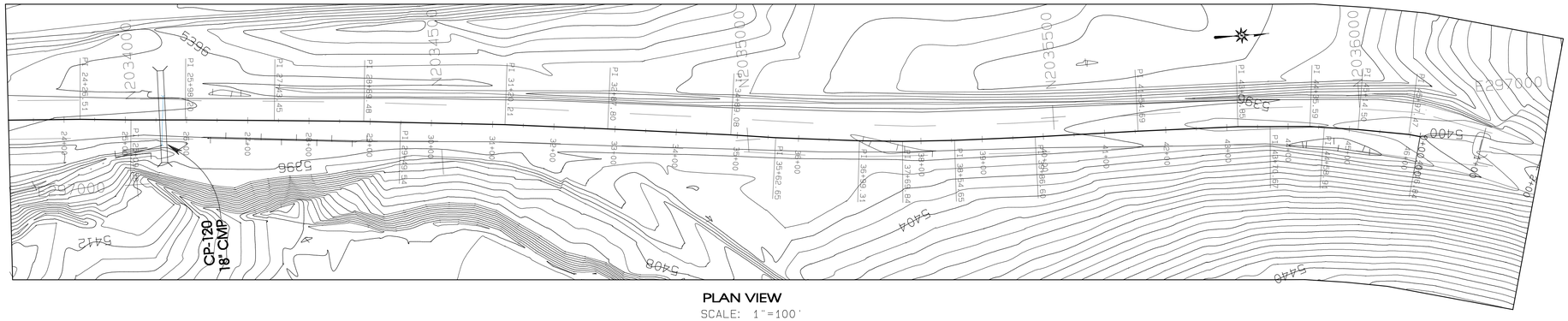
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Location Map

Scale 1"=150 Ft.

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 △5422.45 L-30 LEASE CORNER

NOTES

1. For hydrology and design information refer to Appendix 11-2 in the approved PAP.

N
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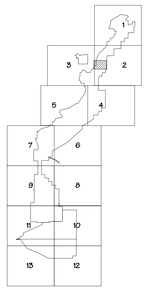

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND JONES
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	DWG.	E.S.	P.E.	P.S.	PROJ. ENG.
A	6/19/98	RY	ASBUILT					

APPROVALS

EXHIBIT 23-28

NAVAJO COAL COMPANY

NAVAJO MINE — SAFETY PRODUCTIVITY PEOPLE

P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

ASBUILT
RAMP 7 ROAD REALIGNMENT
LOCATION MAP

PREPARED BY:RY	DRAWN BY:RY	SCALE:AS NOTED
APPROVED BY:LR	DATE:6/19/98	REF. DWG:
DWG LOC: G:\Departments\OS\OSM_SUBMITTER_PROJ\CH_11_PAP_EXHIBIT\11-119-GAP		

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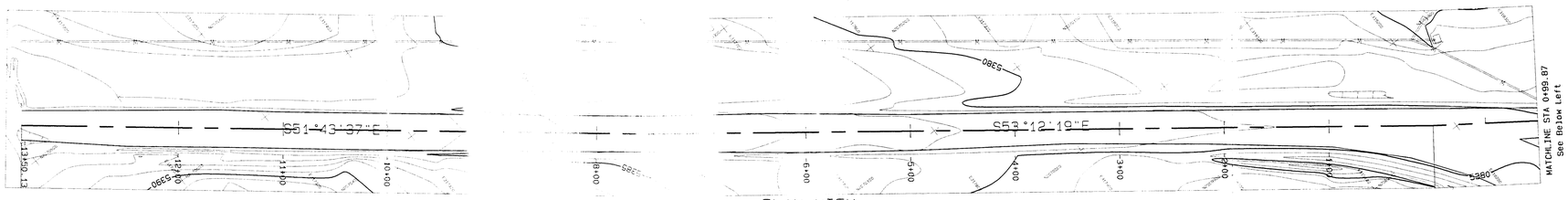
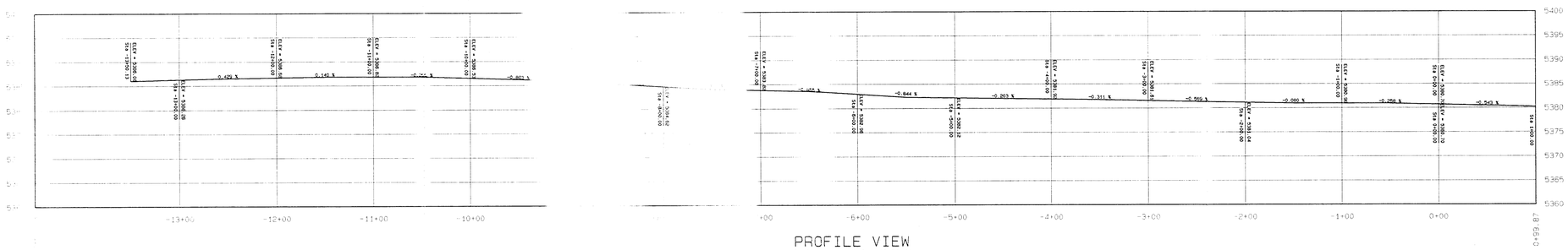
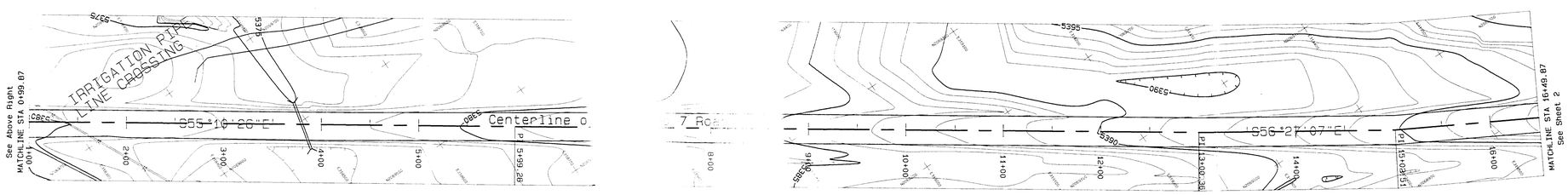


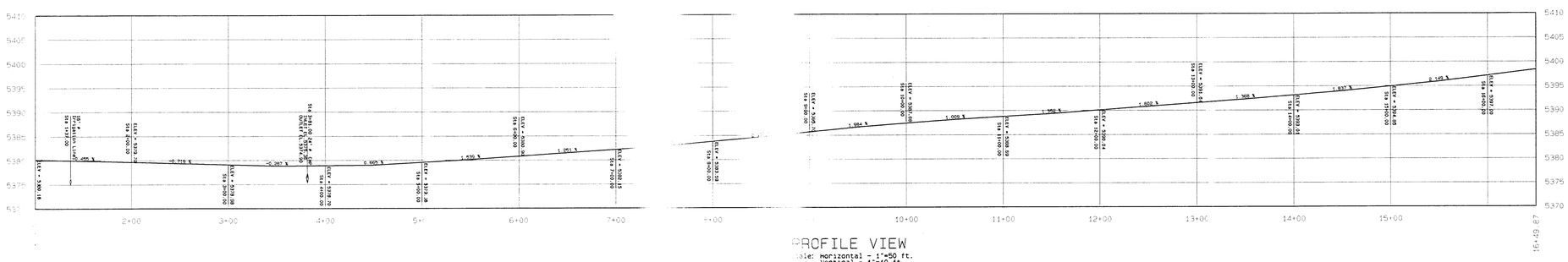
PLAN VIEW
Scale 1"=50 FT.



PROFILE VIEW
Scale: Horizontal - 1"=50 ft.
Vertical - 1"=10 ft.



PLAN VIEW
Scale 1"=50 FT.



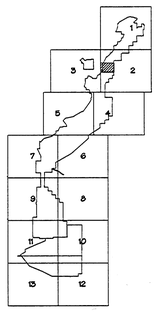
PROFILE VIEW
Scale: Horizontal - 1"=50 ft.
Vertical - 1"=10 ft.

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 — SPOT ELEVATION
- 5300 — INDEX CONTOUR
- 5298 — INTERMEDIATE CONTOUR
- 218 5422.45 — L-30 — LEASE CORNER

NOTES

1. For hydrology and design information refer to Appendix II-2 in the approved PAP.



CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 PROFESSIONAL ENGINEER

6-23-98

JUL 1998 APPROVED

REV. NO.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
A	06/19/98	RY	ASBUILT					

APPROVALS

EXHIBIT 23-29

NAVAJO COAL COMPANY

NAVAJO MINE — SAFETY PAYS

P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

ASBUILT
RAMP 7 ROAD REALIGNMENT
PLAN / PROFILE

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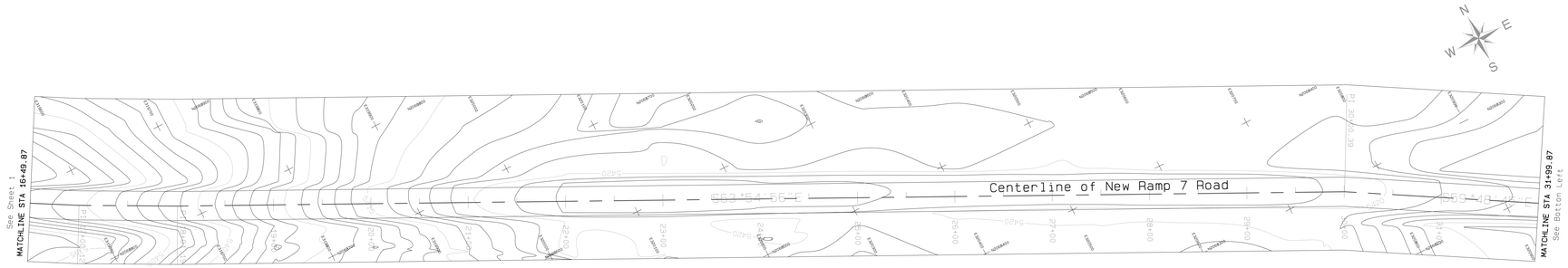
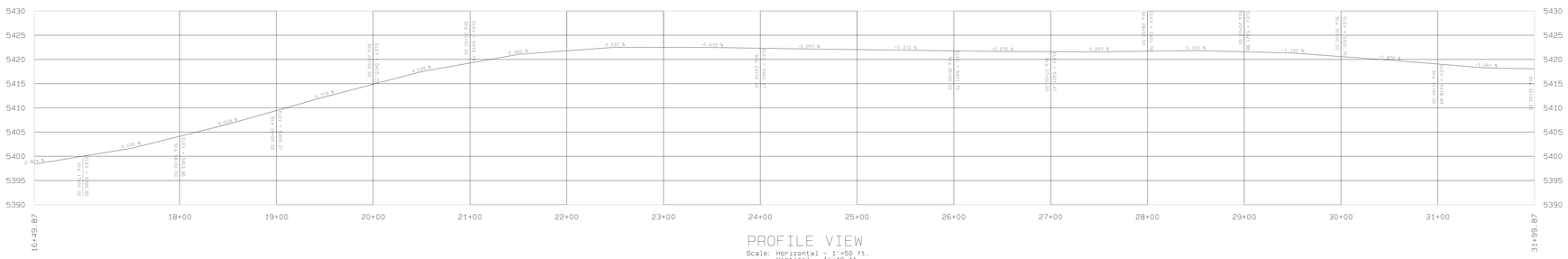
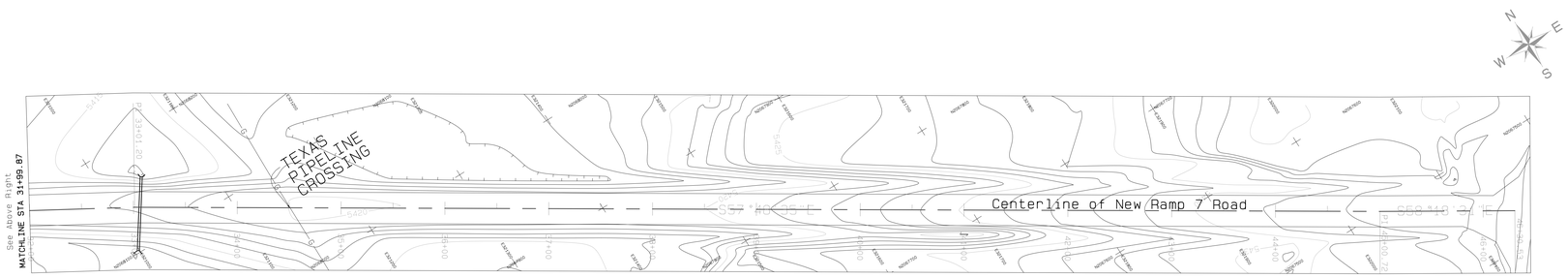
APPROVED BY LR	DATE 06/19/98	REF DWG
DWG LOC	J:\OSM_SUBM\PER_PROG\Ch_11\11-119\asbuilt\Exhibits\ASBUILT.prp	



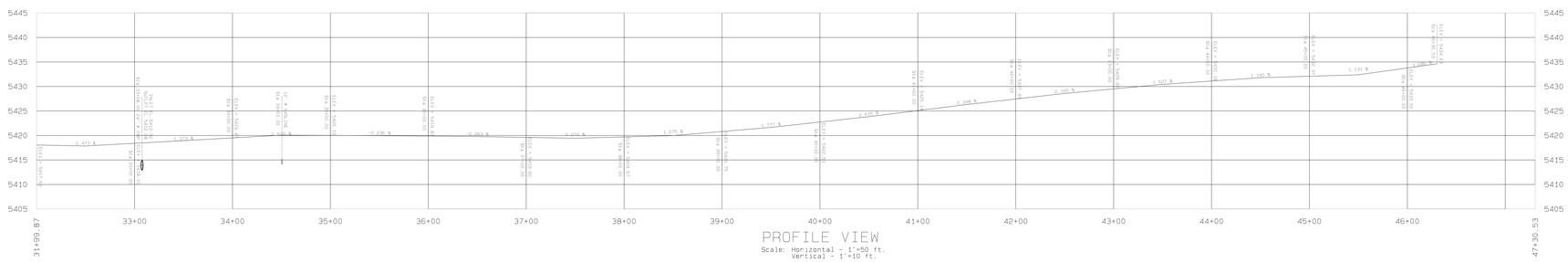
PLAN VIEW
Scale 1"=50 FT.



PROFILE VIEW
Scale: Horizontal - 1"=50 ft.
Vertical - 1"=10 ft.



PLAN VIEW
Scale 1"=50 FT.



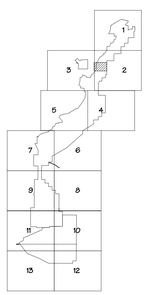
PROFILE VIEW
Scale: Horizontal - 1"=50 ft.
Vertical - 1"=10 ft.

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45 L-30 LEASE CORNER

NOTES

1. For hydrology and design information refer to Appendix 11.2 in the approved PAP.



CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND JOHNSON NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CONT. APPROVALS
A	06/19/98	RY	ASBUILT					

EXHIBIT 23-30

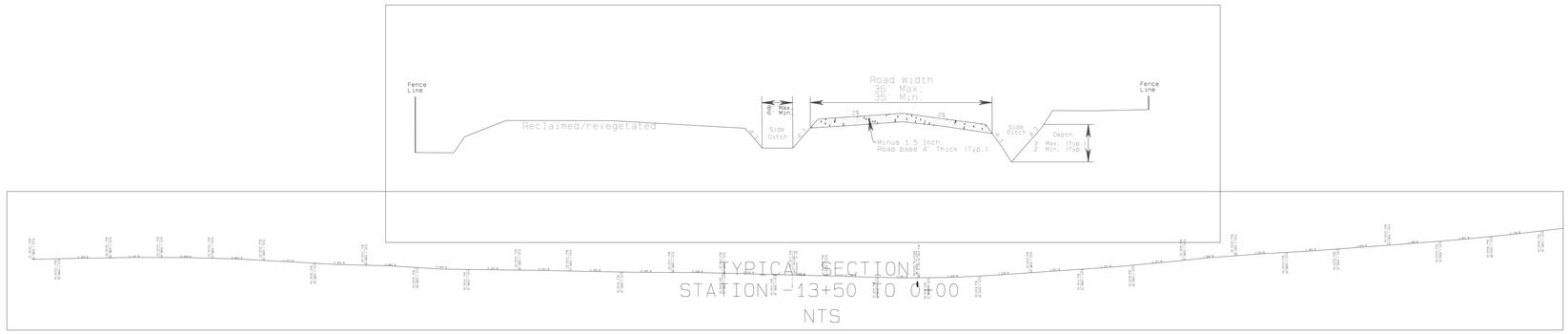
NAVAJO COAL COMPANY

NAVAJO MINE — SAFETY PEOPLE PRIDE

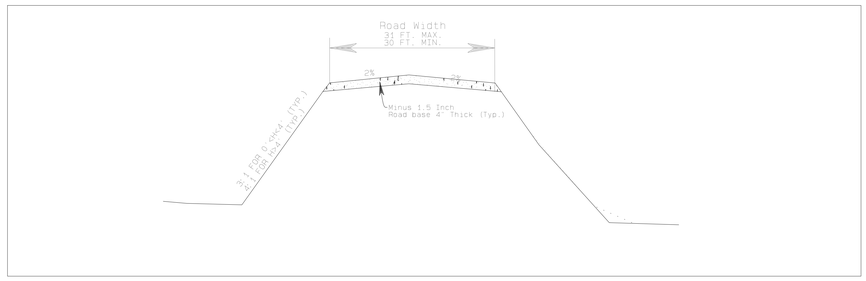
P.O. BOX 109 · FRUITLAND, NEW MEXICO 87416

ASBUILT
RAMP 7 ROAD REALIGNMENT
PLAN / PROFILE

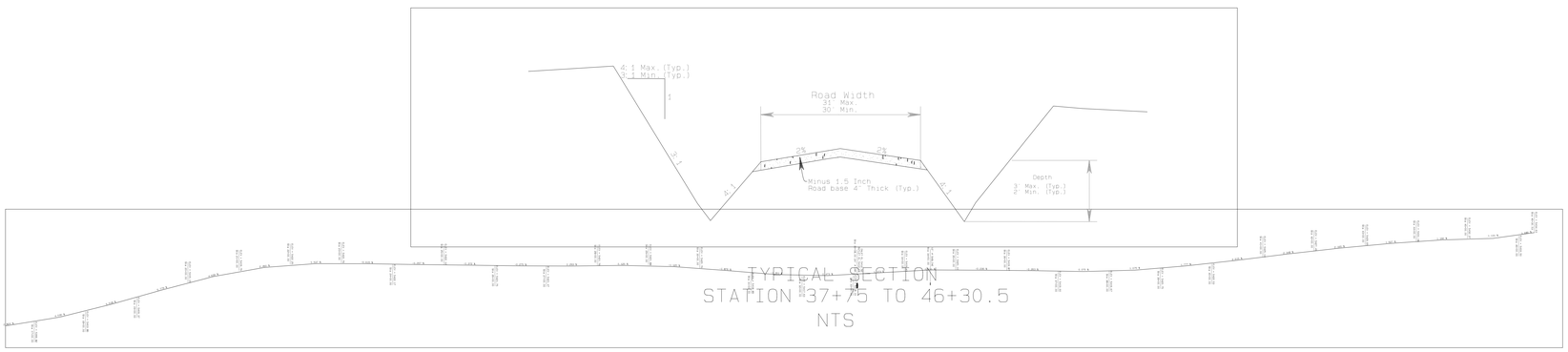
PREPARED BY RY	DRAWN BY RY	SCALE AS NOTED
APPROVED BY LR	DATE 06/19/98	REF DWG
DWG LOC	G:\Departments\Ds\DSM_SUBM\PER_PROT\CH_11_PAP EXHIBIT\11-119-PAP	



TYPICAL SECTION
STATION -13+50 TO 0+00
NTS



TYPICAL SECTION
STATION 0+00 TO 37+75
NTS



TYPICAL SECTION
STATION 37+75 TO 46+30.5
NTS

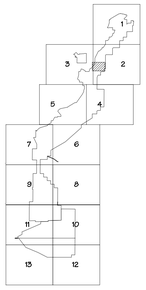
LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45 LEASE CORNER
- L-30

NOTES

1. For hydrology and design information refer to Appendix II-AA in the approved PAP.

N
W E
S



CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
PROFESSIONAL SURVEYOR

REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	E & P	P.S.	CHIEF ENGR. APPROVALS
A	06/19/98	RY	ASBUILT				

EXHIBIT 23-31

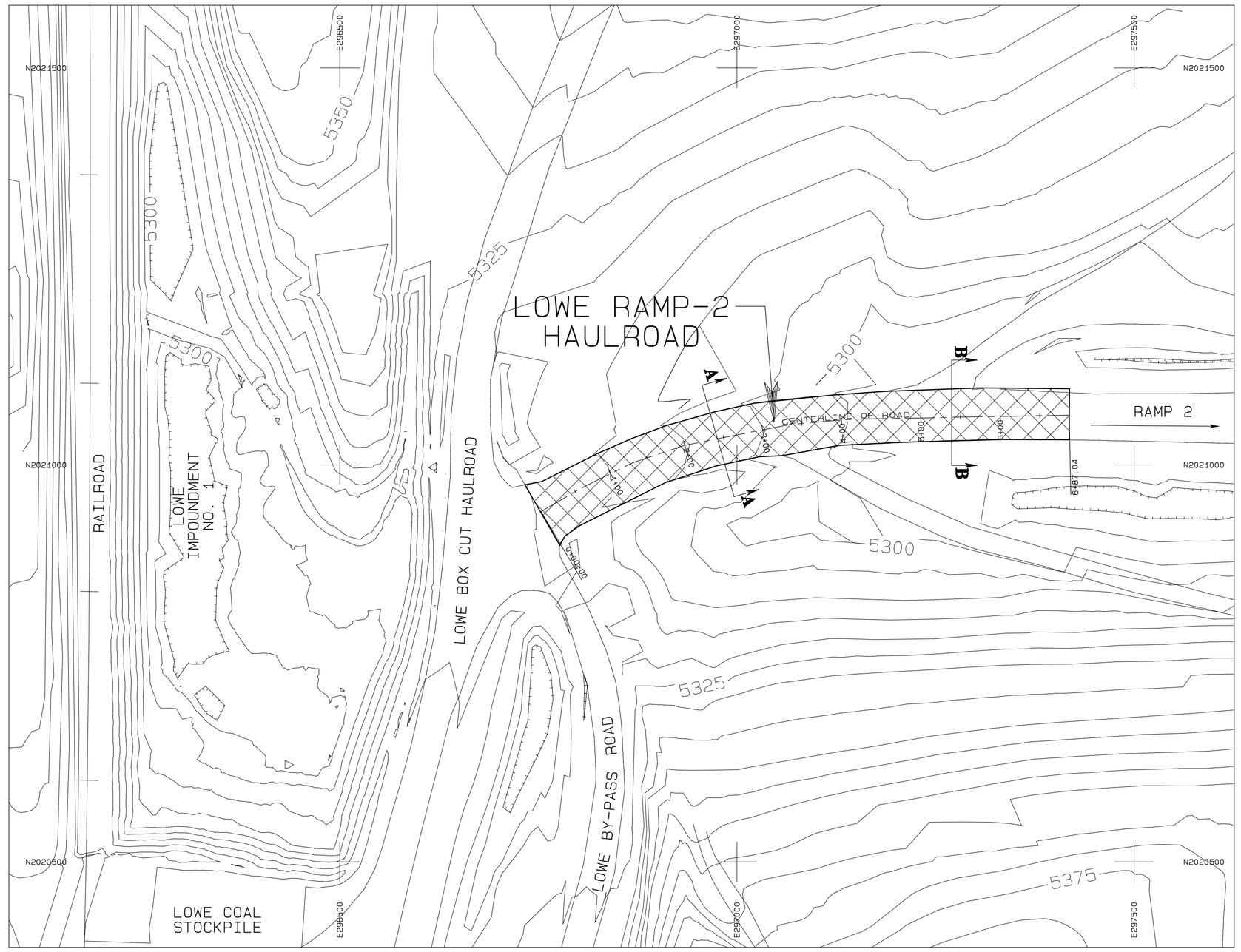
NAVAJO COAL COMPANY

NAVAJO SAFETY MINE PAYS

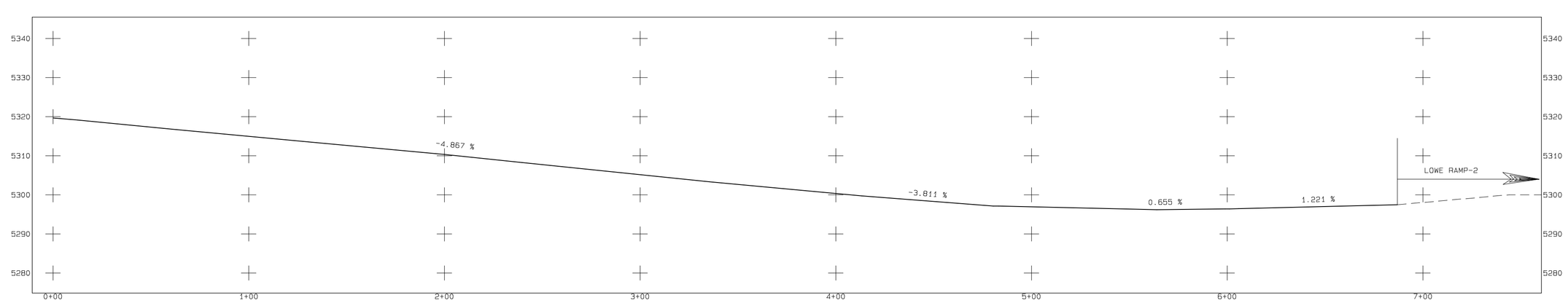
P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

ASBUILT
RAMP 7 RE ALIGNMENT
CROSS SECTION MAP

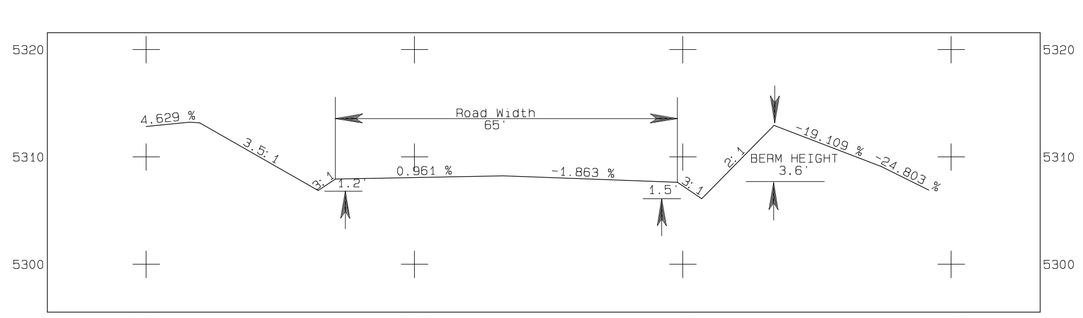
PREPARED BY RY	DRAWN BY RY	AS NOTED
APPROVED BY LR	DATE 06/19/98	REF DWG
DWG LOC	G:\Departments\Ds\DSM_SUBM\PER_PROD\CH_II_PAP EXHIBITS\II-119-RAMP	



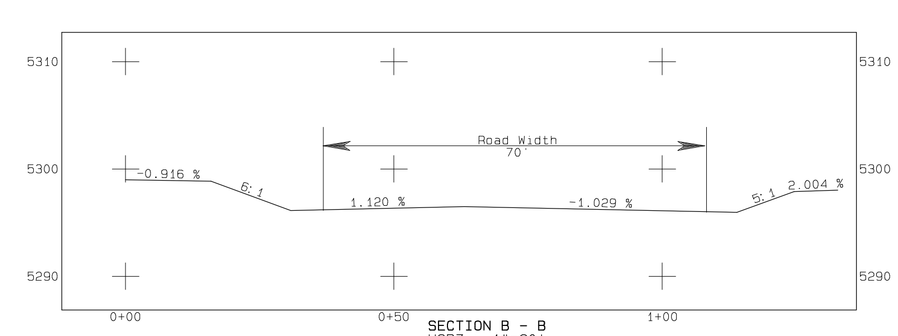
PLAN AND LOCATION MAP
SCALE: 1"=100'



PROFILE (CENTERLINE OF ROAD)
HORZ.: 1"=40'
VERT.: 1"=20'



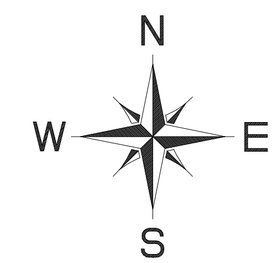
SECTION A - A
HORZ.: 1"=20'
VERT.: 1"=10'

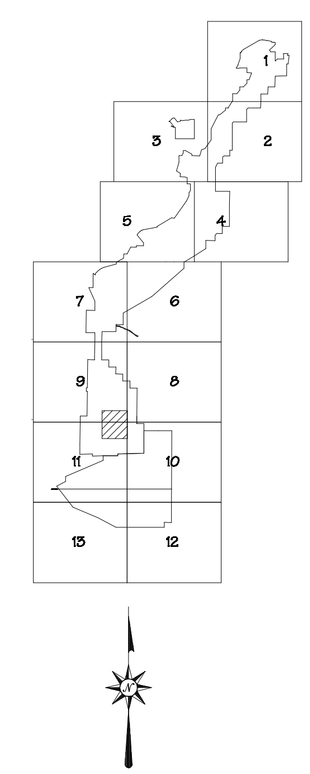


SECTION B - B
HORZ.: 1"=20'
VERT.: 1"=10'

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY





SCALE AS NOTED

CERTIFICATION STATEMENT

I, Kevin A. Bahe, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

KEVIN A. BAHE
NEW MEXICO
17850
LICENSED PROFESSIONAL ENGINEER

REVISION	DATE
SUBMITTED TO OSM FOR REVIEW	08-12-08

PROJECT MANAGER: EG
ENGR. OF RECORD: RCV
REG. NO. 9863
SRVYR OF RECORD:
REG. NO.

Submitted to OSM for Approval Oct. 21, 99

bhpbilliton
NAVAJO COAL COMPANY
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416 PHONE 505-598-3209/FAX 505-598-3361

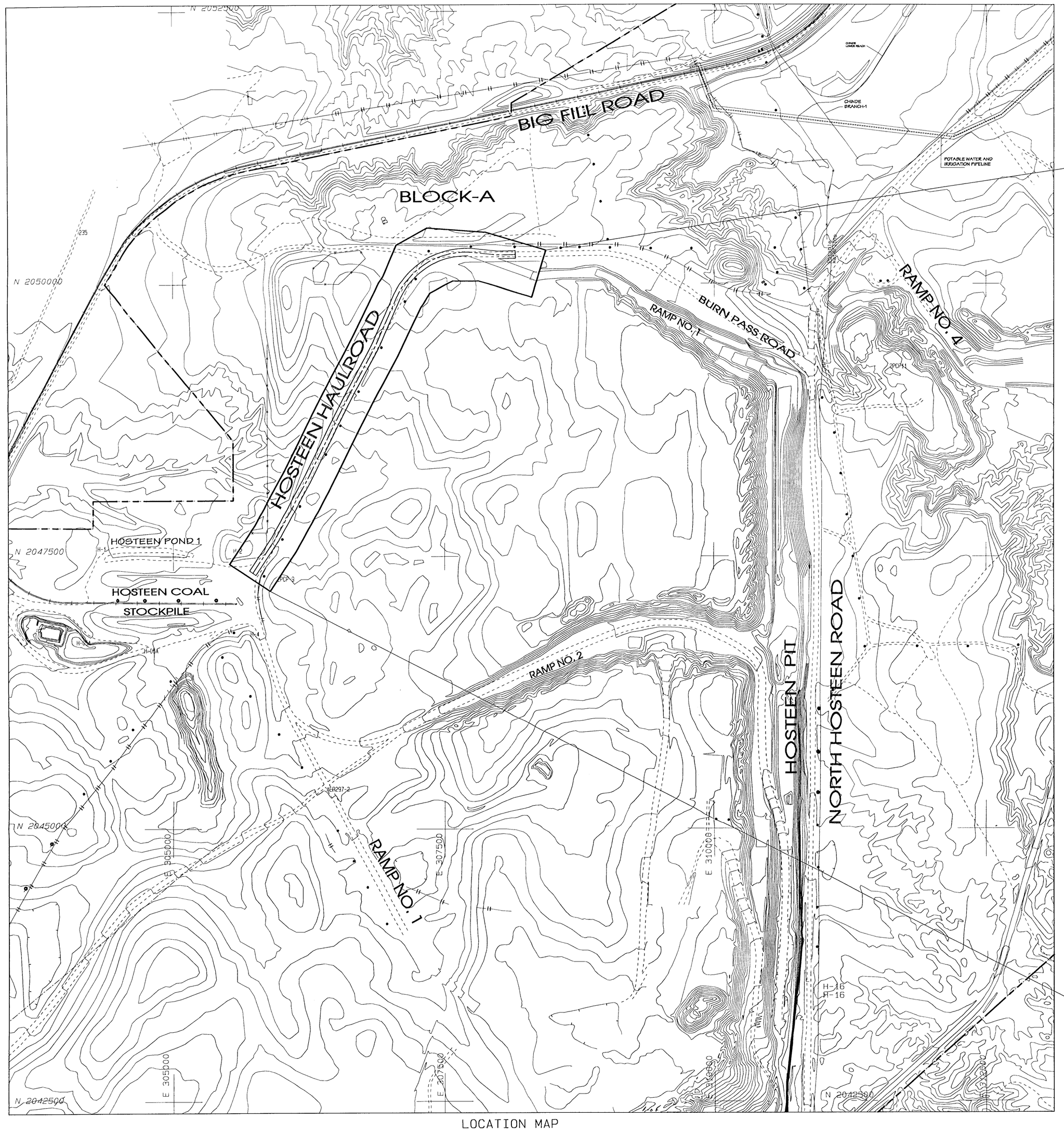
PROJECT:
DATE: 08-12-08
DESIGNED BY:
DRAWN BY: RY
CHECKED BY: RCV
APPROVED BY: RCV

PLAN, PROFILE AND SECTION

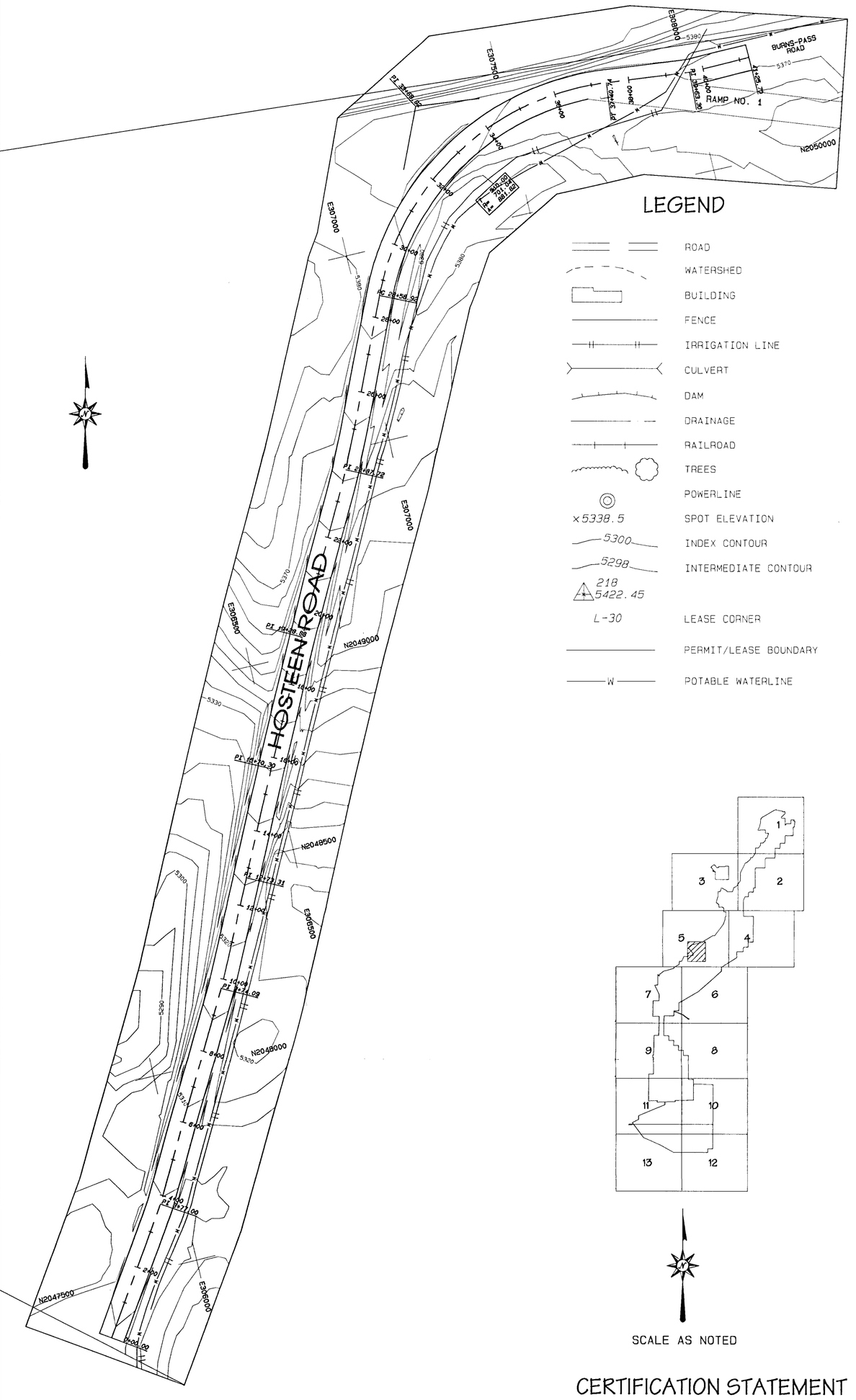
EXHIBIT 23-32
LOWE RAMP - 2
HAULROAD
AS-BUILT

DRAWING

SHEET 1 OF 1



LOCATION MAP
1"=500 FT.



1"=200 FT.

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 / 5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY
- —W— POTABLE WATERLINE

SCALE AS NOTED

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

11-15-04

APPROVED DEC 2004 SURFACE MANAGEMENT

NO.	DESCRIPTION	BY	DATE
1	SUBMITTED TO DOM FOR APPROVAL	HY	01-02-04
2			
3			
4			
5			

PROJECT MANAGER: SG
ENGR. of RECORD: LR
REG. NO. 6600
SRVYR. of RECORD:
REG. NO.

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

ACCOUNT:
DATE: SEPT 15, 2002
DESIGNED BY: HY
DRAWN BY:
CHECKED BY: LR
APPROVED BY: LR

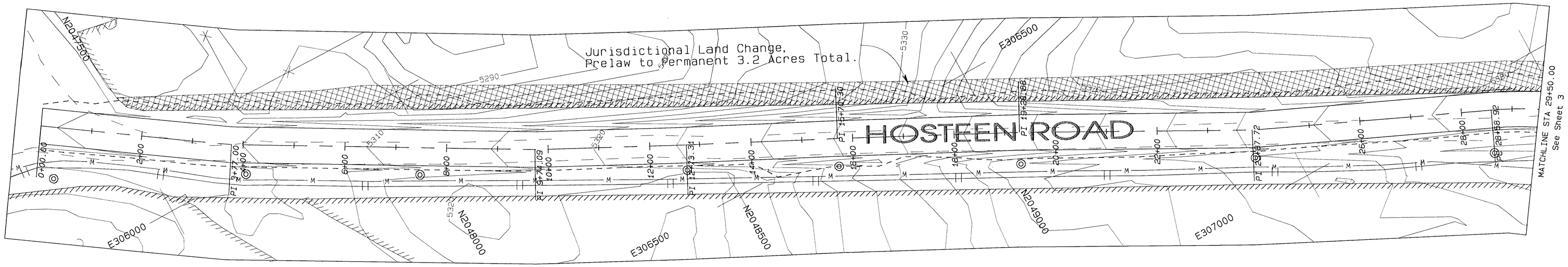
LOCATION MAP

EXHIBIT 23-35 HOSTEEN ROAD DESIGN

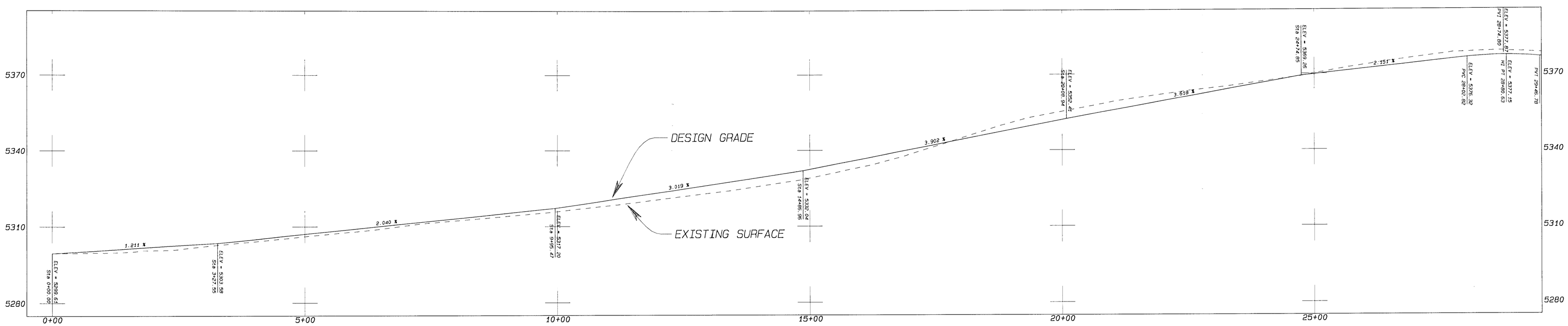
DRAWING

SHEET 1 OF 3

PATH: C:\Navy\Hosteen\23-35\Hosteen Road Sp.prt



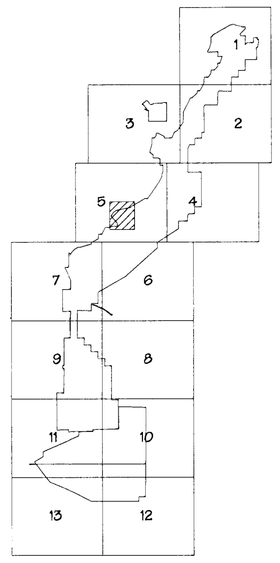
PLAN
1"=100 FT.



CENTERLINE ROAD PROFILE
HORZONTAL-1"=100 FT.
VERTICAL-1"=20 FT.

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 21B 5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY
- W POTABLE WATERLINE
- JURISDICTIONAL BOUNDARY
- CUT / FILL CATCHLINE
- PROPOSED JURISDICTIONAL BOUNDARY CHANGE, PRELAW TO PERMANENT



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6800 REGISTERED PROFESSIONAL ENGINEER

11-15-04

8-2-04

DEC 2004 APPROVED

REV. NO.	DESCRIPTION	REV. BY	DATE
1	SUBMITTED TO DOM FOR APPROVAL	RY	8-02-04
2	REVISED PER DEFICIENCIES LETTER DATED 10-27-04 (E-MAIL)	RY	11-09-04
3			
4			
5			

PROJECT MANAGER: DH
ENGR. of RECORD: LG
REG. NO. 6800
SRVYR. of RECORD:
REG. NO.

BHP NAVAJO COAL CO.
NAVAJO MINE

PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

ACCOUNT:
DATE: AUG 02, 2004
DESIGNED BY: RY
DRAWN BY: RY
CHECKED BY: LG
APPROVED BY: LG

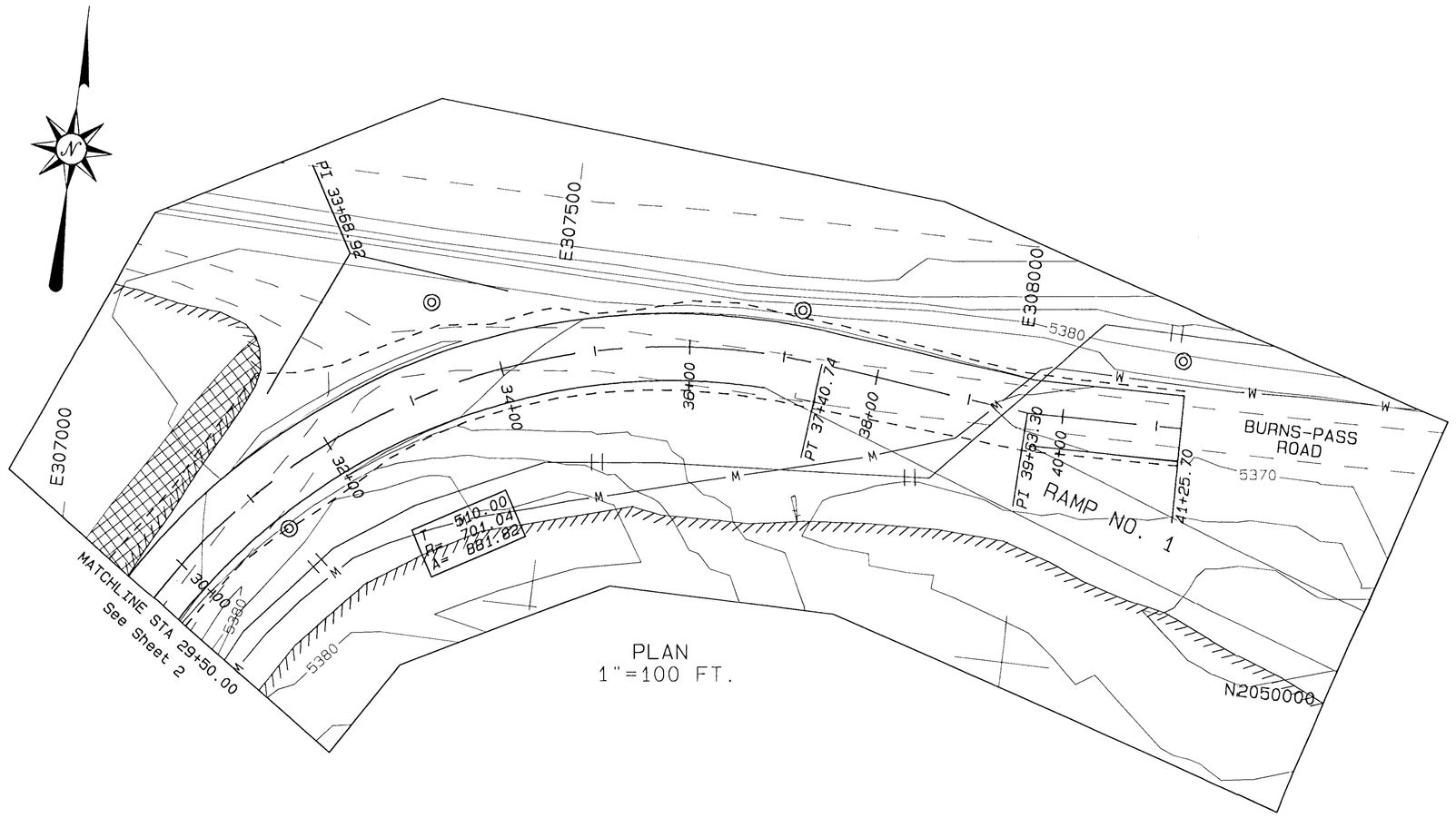
PLAN AND PROFILE

EXHIBIT 23-35
HOSTEEN ROAD DESIGN

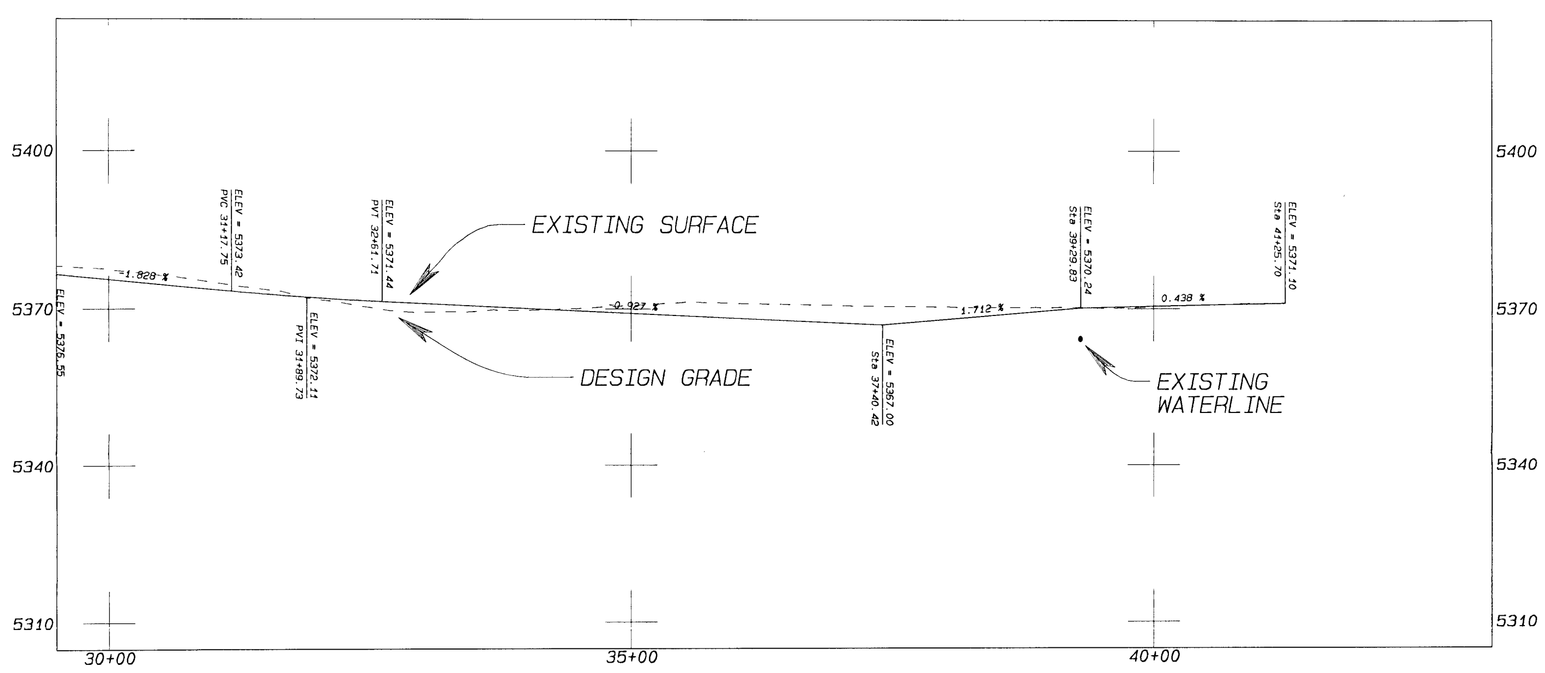
DRAWING

SHEET 2 OF 3

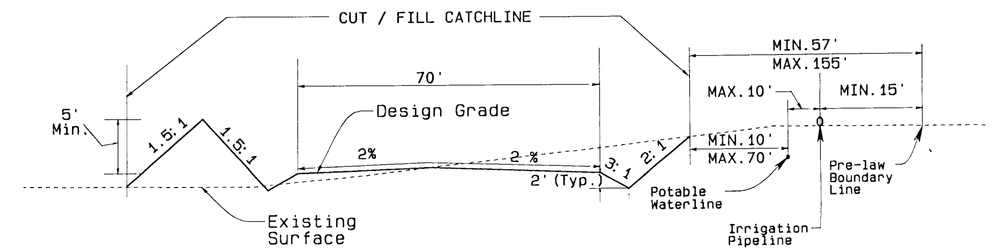
PATH: J:\DOM_SUBMITTAL\PROJECT\15-OPERATION PERMIT EXH 15\15-06C HOSTEEN ROAD\Hosteen Road Dgn.dgn



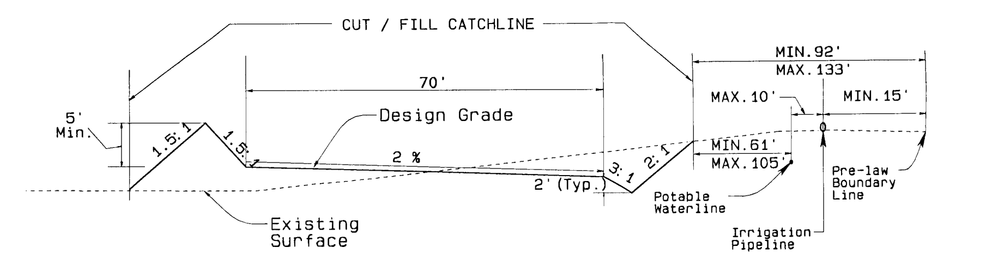
PLAN
1"=100 FT.



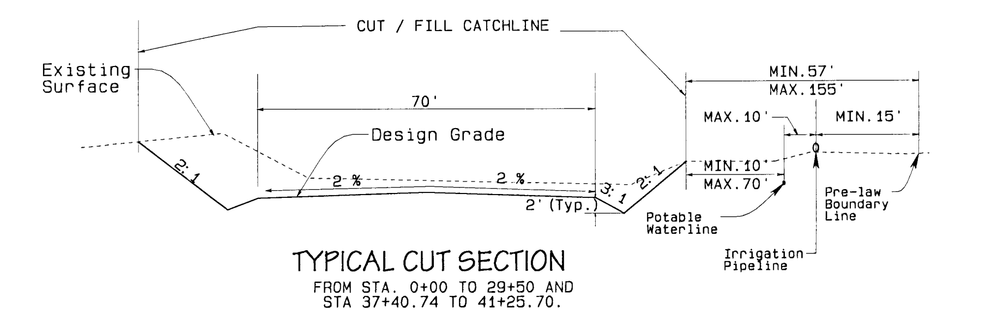
CENTERLINE ROAD PROFILE
HORZONTAL-1"=100 FT.
VERTICAL-1"=20 FT.



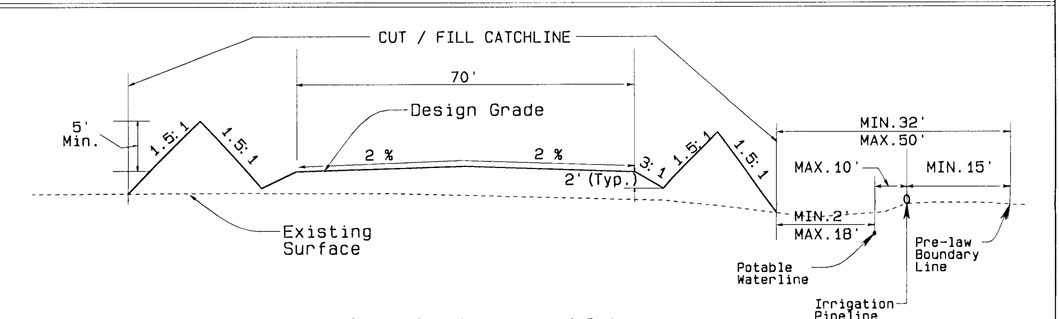
TYPICAL CUT AND FILL SECTION
FROM STA. 0+00 TO 29+50 AND
STA 37+40.74 TO 41+25.70.



TYPICAL SUPERELEVATED SECTION
FROM STA. 29+50 TO 37+40.74



TYPICAL CUT SECTION
FROM STA. 0+00 TO 29+50 AND
STA 37+40.74 TO 41+25.70.

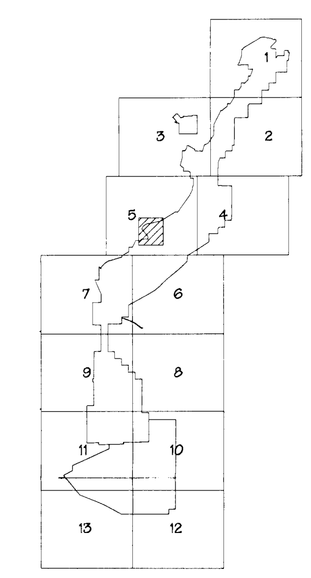


TYPICAL FILL SECTION
FROM STA. 0+00 TO 29+50 AND
STA 37+40.74 TO 41+25.70.

ABOVE SECTIONS
N.T.S.

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY
- W POTABLE WATERLINE
- JURISDICTIONAL BOUNDARY
- CUT / FILL CATCHLINE
- PROPOSED JURISDICTIONAL BOUNDARY CHANGE. PRELAW TO PERMANENT



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

11-15-04

APPROVED DEC 2004

NO.	DESCRIPTION	BY	DATE
1	SUBMITTED TO FOR APPROVAL	RT	8-02-04
2	REVISED TO INCLUDE WATERLINE DATED 10-30-04 (E-MAIL)	RT	11-09-04
4			
5			

PROJECT MANAGER: DA
ENGR. of RECORD: LR
REG. NO. 6600
SRVYR of RECORD:
REG. NO.

BHP NAVAJO COAL CO.
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416

ACCOUNT:
DATE: AUG. 02, 2004
DESIGNED BY: RT
DRAWN BY: RT
CHECKED BY: LR
APPROVED BY: LR

PLAN, PROFILE AND SECTIONS

EXHIBIT 23-35 HOSTEEN ROAD DESIGN

DRAWING

SHEET 3 OF 3

29-2-02

PATH: J:\CDR_SUBMITTALS\PROJECT_DIRECTORY\EXH-23-35-DRP PROFILES ROAD\Hosteen Road Dgn.pmp

BHP MINERALS INTERNATIONAL INC.

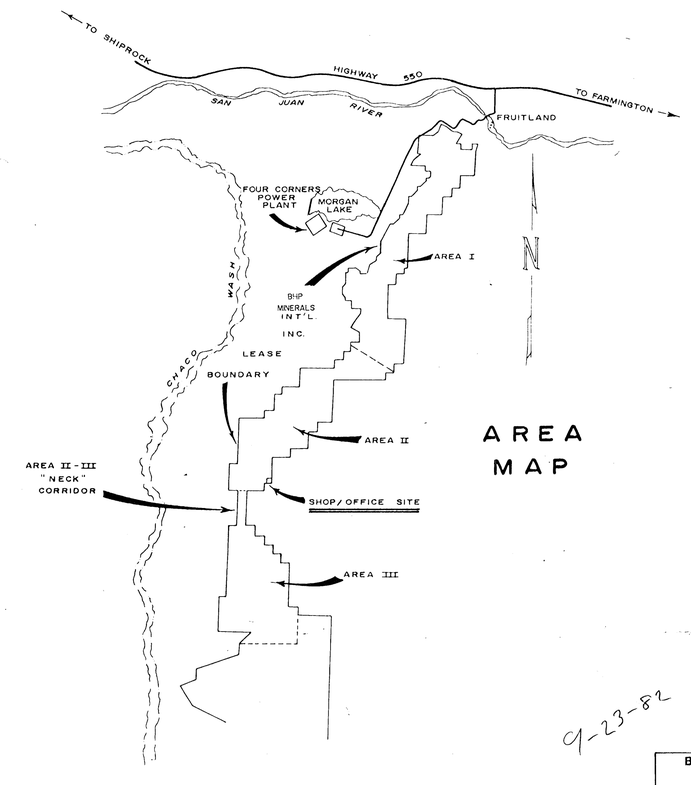
NAVAJO MINE

AREA 2 SHOP/OFFICE

ACCESS ROAD

INDEX OF DRAWINGS

EXHIBIT 23-37 Sheet 1	PLAN & PROFILE, STA. 0+00 TO 6+74
EXHIBIT 23-37 Sheet 2	PLAN & PROFILE, STA. 0+00 TO 30+00
EXHIBIT 23-37 Sheet 3	PLAN & PROFILE, STA. 30+00 TO 45+17
EXHIBIT 23-3	TYPICAL CROSS-SECTION
EXHIBIT 23-38	CATTLE CROSSING PLAN VIEW (CP-66)
EXHIBIT 23-39	CATTLE CROSSING CROSS-SECTION (CP-66)



AREA MAP

MAR 1996 APPROVED

DAVID KISH NEW MEXICO No 8304 REGISTERED PROFESSIONAL ENGINEER

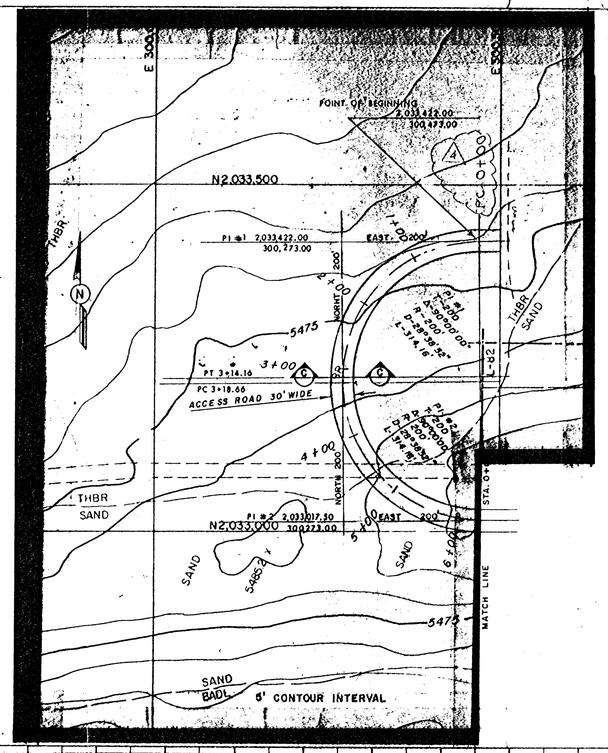
9-23-82

REV.	DATE	DESCRIPTION
3	03-08-1996	ADDED EXHIBIT NUMBER.
REV.-2	11-11-82	AS BUILTS
REV. 1	10-1-82	ISSUED FOR PAVING CONSTRUCT.
REV-0	9-23-82	ISSUED FOR PAVING BIDDING

BHP MINERALS INTERNATIONAL INC.
NAVAJO MINE
FRUITLAND, NEW MEXICO

EXHIBIT 23-36
INDEX SHEET

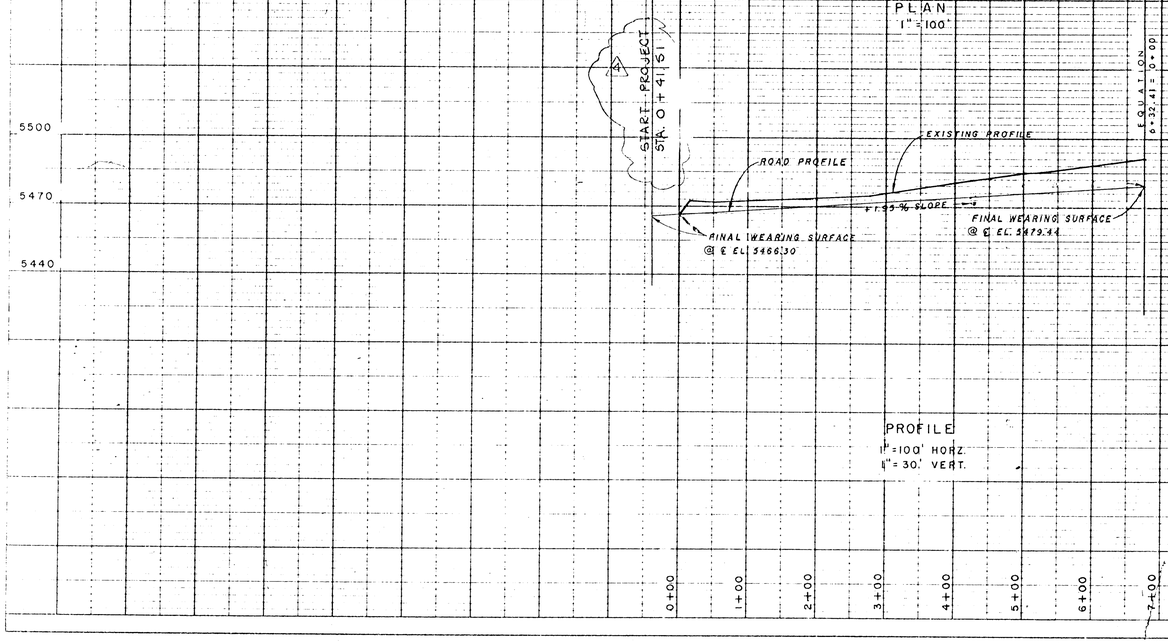
DRAWN BY	SCALE	
APPROVED BY	DATE	
DRAWING NO.		LOCATION NO.



NOTES:

1. FOR TYPICAL CROSS SECTION SEE EXH. II-112D.
2. FOR CATTLE CROSSING STRUCTURE SEE EXH. II-112E & II-112F. (BY OTHERS) 2
3. FINAL ROAD CENTER LINE MARKINGS AND SHOULDER MARKINGS SHALL BE EQUIVALENT TO MARKINGS ON EXISTING N4000 SERIES ROADS.
4. CATTLE GUARDS SHALL BE CONSTRUCTED AND INSTALLED AS PER BUREAU OF INDIAN AFFAIRS SPECIFICATIONS FOR HEAVY DUTY, TYPE CATTLE GUARDS. (BY OTHERS) 2
5. FOR CUT SECTION C-C SEE EXH. II-112G.
6. TOP SOIL, AS IDENTFIED ON LEASE AND STAKED IN THE FIELD, IS TO BE RELOCATED AS DIRECTED BY OWNER'S CONSTRUCTION MANAGER (BY OTHERS) 2

PLAN
1" = 100'



MAR 1996 APPROVED

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

DAVID KIRK BROWN NEW MEXICO No. 8304 REGISTERED PROFESSIONAL SURVEYOR

EXHIBIT 23-37

BHP MINERALS INTERNATIONAL INC.
NAVAJO MINE
FRUITLAND, NEW MEXICO

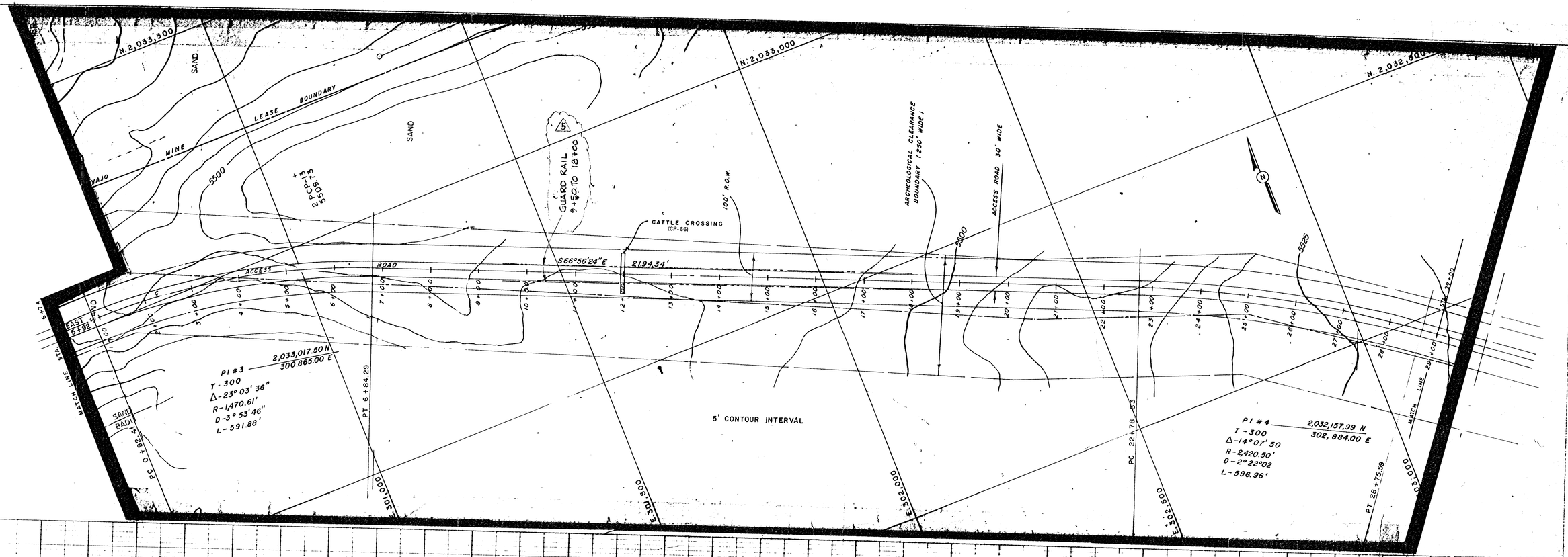
SHOP/OFFICE ACCESS ROAD
STA. 0+00 TO 6+74

SHEET #1

DRAWN BY F.B.	SCALE As Shown		
APPROVED BY B.M. 7/30/82	DATE 4-7-82		
DRAWING NO		LOCATION NO	

REV. 5	03-08-1996	ADDED EXHIBIT NUMBER AND REMOVED CATTLE GUARD	REV. 1	7-19-82	
REV. 4	11-11-1982	AS BUILTS	REV. 2	9-23-82	ISSUED FOR PAVING BIDDING
			REV. 3	10-1-82	ISSUED FOR PAVING CONSTRUCT.

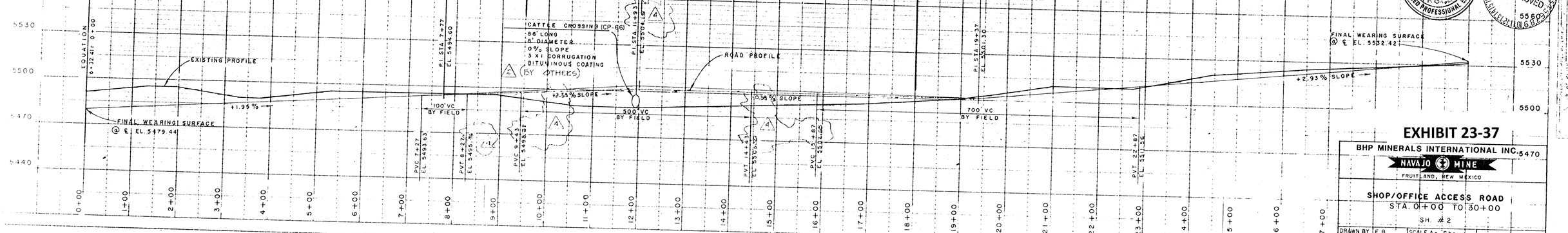
bOLITE



PLAN
1" = 100'

PROFILE
1" = 100' HORZ
1" = 20' VERT

GUARD RAIL
9+50 TO 18+00



NOTES:

1. FOR TYPICAL CROSS SECTION SEE EXH. II-12D.
2. FOR CATTLE CROSSING STRUCTURE SEE EXH. II-12E & II-12F. (BY OTHERS) 2
3. FINAL ROAD CENTER LINE MARKINGS AND SHOULDER MARKINGS SHALL BE EQUIVALENT TO MARKINGS ON EXISTING N4000 SERIES ROADS.
4. CATTLE GUARDS SHALL BE CONSTRUCTED AND INSTALLED AS PER BUREAU OF INDIAN AFFAIRS SPECIFICATIONS FOR HEAVY DUTY, TYPE CATTLE GUARDS. (BY OTHERS) 2
5. FOR CUT SECTION C-C SEE EXH. II-12G.

DAVID KIRK BROWN
NEW MEXICO
No. 8304
REGISTERED PROFESSIONAL ENGINEER

APPROVED
MAR 1993

EXHIBIT 23-37

BHP MINERALS INTERNATIONAL INC.
NAVAJO MINE
FRUITLAND, NEW MEXICO

SHOP/OFFICE ACCESS ROAD
STA. 0+00 TO 30+00
SH. #2

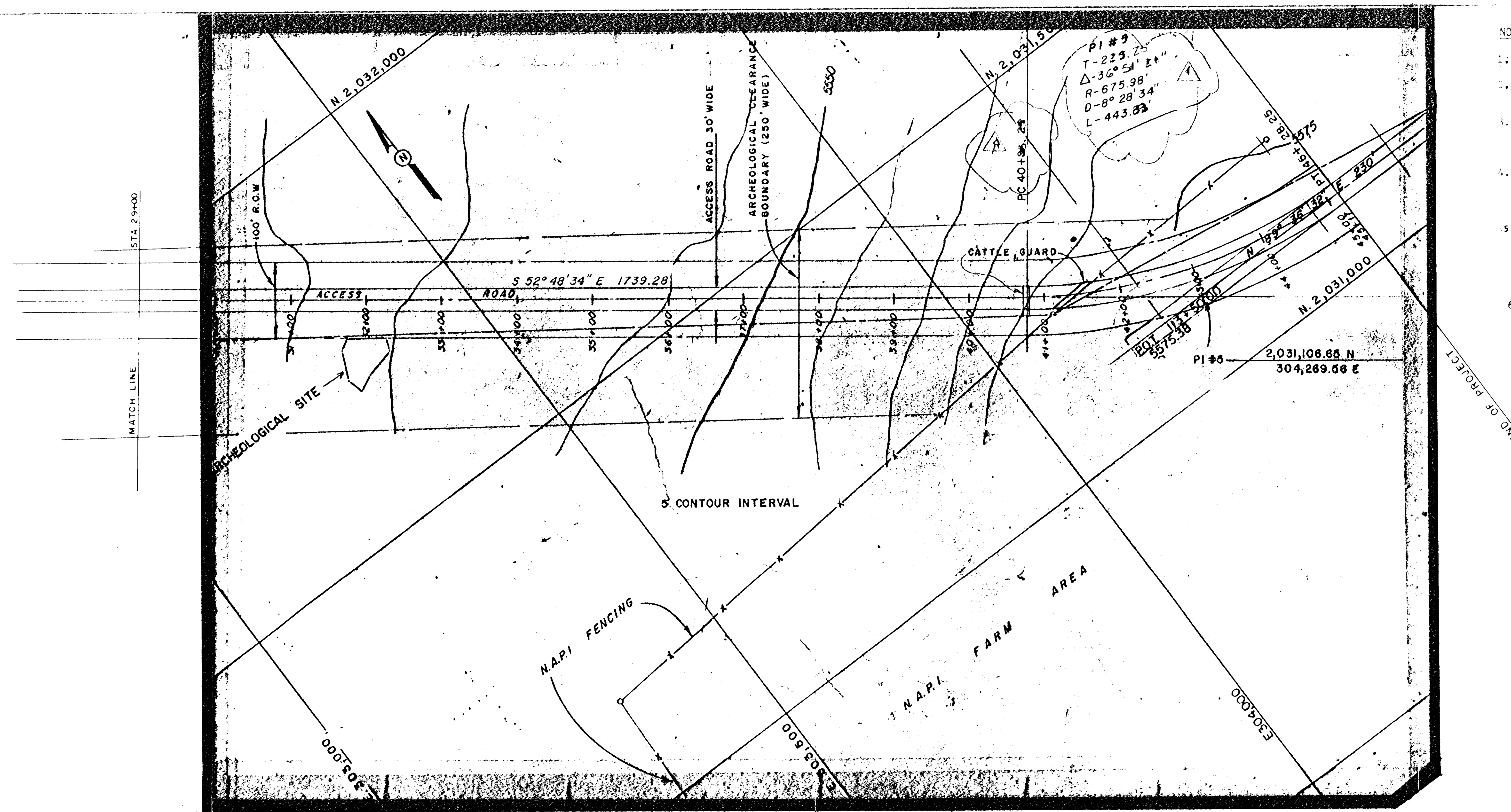
DRAWN BY	F.B.	SCALE As Shown	
APPROVED BY		DATE 4-8-82	
DRAWING NO.		LOCATION NO.	

REV. 6	03-08-1996	ADDED EXHIBIT NUMBER	
REV. 4	11-11-1982	AS BUILTS	
REV. 5	12-13-82	ADDED GUARD RAIL	

REV. 1	7-19-82	
REV. 2	8-23-82	ISSUED FOR PAVING BIDDING
REV. 3	10-1-82	ISSUED FOR PAVING CONSTRUCT

NOTES:

1. FOR TYPICAL CROSS SECTION SEE EXH. II-112D.
2. FOR CATTLE CROSSING STRUCTURE SEE EXH. II-112E & II-112F. (BY OTHERS) △
3. FINAL ROAD CENTER LINE MARKINGS AND SHOULDER MARKINGS SHALL BE EQUIVALENT TO MARKINGS ON EXISTING N4000 SERIES ROADS.
4. CATTLE GUARDS SHALL BE CONSTRUCTED AND INSTALLED AS PER BUREAU OF INDIAN AFFAIRS SPECIFICATIONS FOR HEAVY DUTY, TYPE CATTLE GUARDS. (BY OTHERS) △2
5. FOR CUT SECTION C-C SEE EXH.II-112G.
6. TOPSOIL, AS IDENTIFIED ON LEASE AND STAKED IN THE FIELD, IS TO BE RELOCATED AS DIRECTED BY OWNER'S CONSTRUCTION MANAGER. (BY OTHERS) △2



17 MAR 1996 APPROVED

DAVID KIRK BROWN NEW MEXICO No. 8304 REGISTERED PROFESSIONAL ENGINEER

EXHIBIT 23-37

BHP MINERALS INTERNATIONAL INC.

NAVAJO MINE

FRUITLAND, NEW MEXICO

SHOP/OFFICE ACCESS ROAD

STA. 30+00 TO 45+17

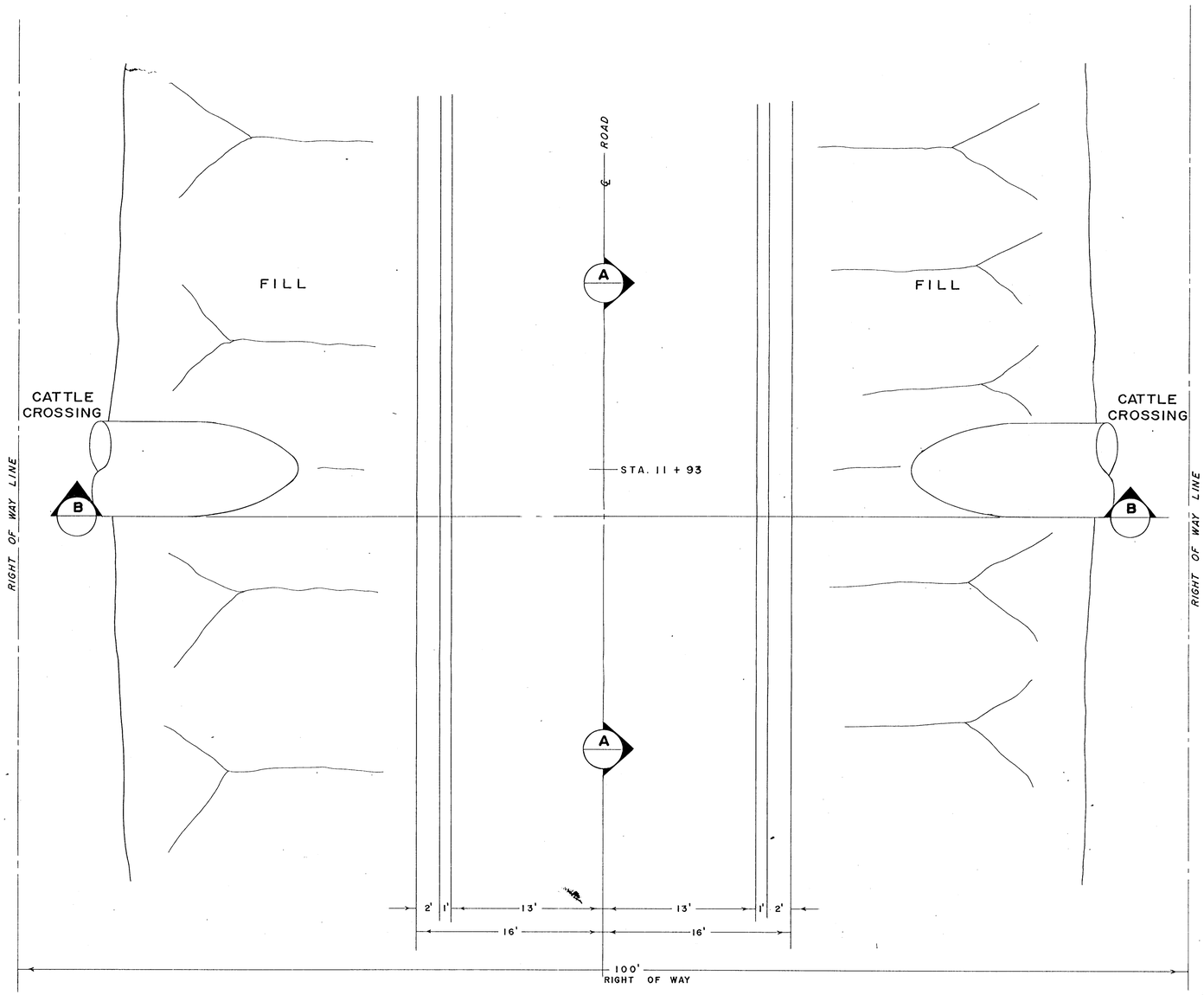
SH. # 3

DRAWN BY F.B	SCALE As Shown
APPROVED BY B.K.	DATE 4-8-82
DRAWING NO.	LOCATION NO.

7/30/82

REV. 5	03-08-1996	ADDED EXHIBIT NUMBER.
REV. 4	11-11-1982	AS BUILTS
REV. 1	7-19-82	
REV. 2	9-23-82	ISSUED FOR PAVING BIDDING
REV. 3	10-1-82	ISSUED FOR PAVING CONSTRUCT.

CATTLE CROSSING
(CP-66)
PLAN VIEW



NOTES:

1. FOR ROAD PLAN AND PROFILE SEE EXH. II-112A THRU II-112C.
2. FOR TYPICAL CROSS SECTION SEE EXH.II-112D.
3. CATTLE CROSSING IS TO BE CORRUGATED METAL PIPE, 86 FT. LONG, 12 GAUGE, 3 x 1 CORRUGATIONS, BITUMINOUS COATED.
4. FOR CUT SECTION C-C SEE EXH.II-112G.

MAR 1996 APPROVED

LEONARD NAVENONA NEW MEXICO 6800 REGISTERED PROFESSIONAL ENGINEER

EXHIBIT 23-38

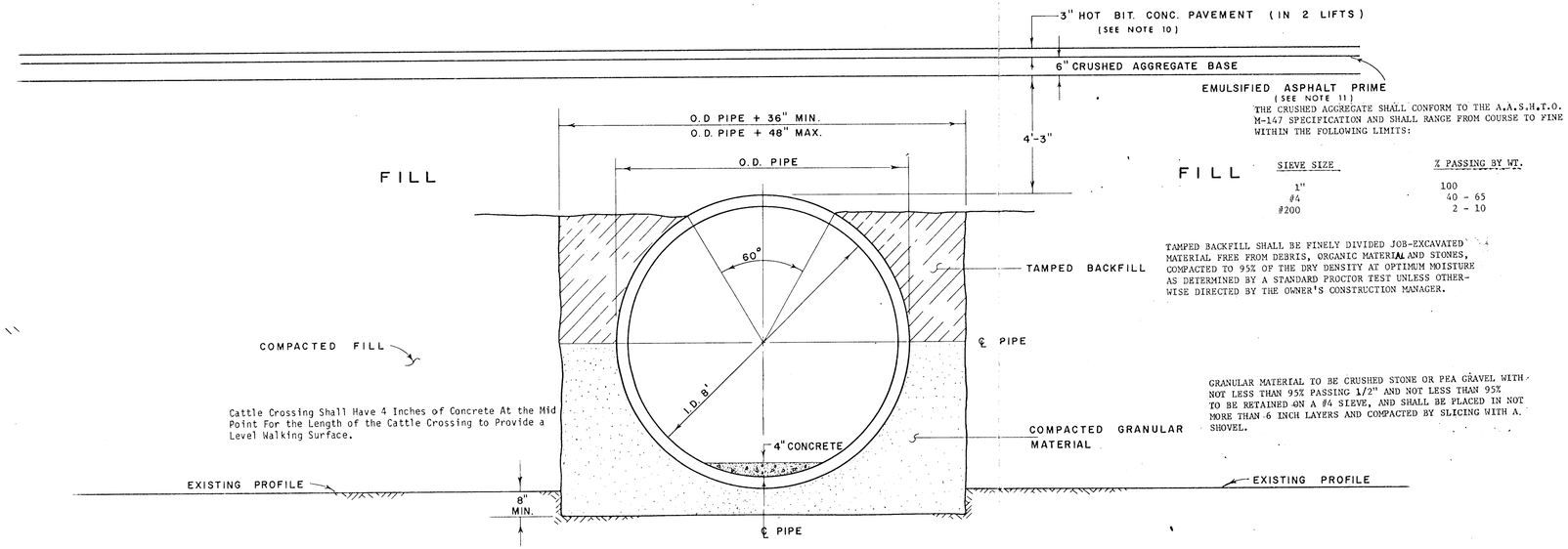
BHP MINERALS INTERNATIONAL INC.
NAVAJO MINE
FRUITLAND, NEW MEXICO

SHOP/OFFICE ACCESS ROAD
CATTLE CROSSING
PLAN VIEW

DRAWN BY J.GOLBE	SCALE AS SHOWN	
APPROVED BY	DATE 6/3/82	
DRAWING NO.		LOCATION NO.

REV. 1	03-08-1996	"AS-BUILT"	

CATTLE CROSSING (CP-66)
CROSS SECTION



SIEVE SIZE	% PASSING BY WT.
1"	100
#4	40 - 65
#200	2 - 10

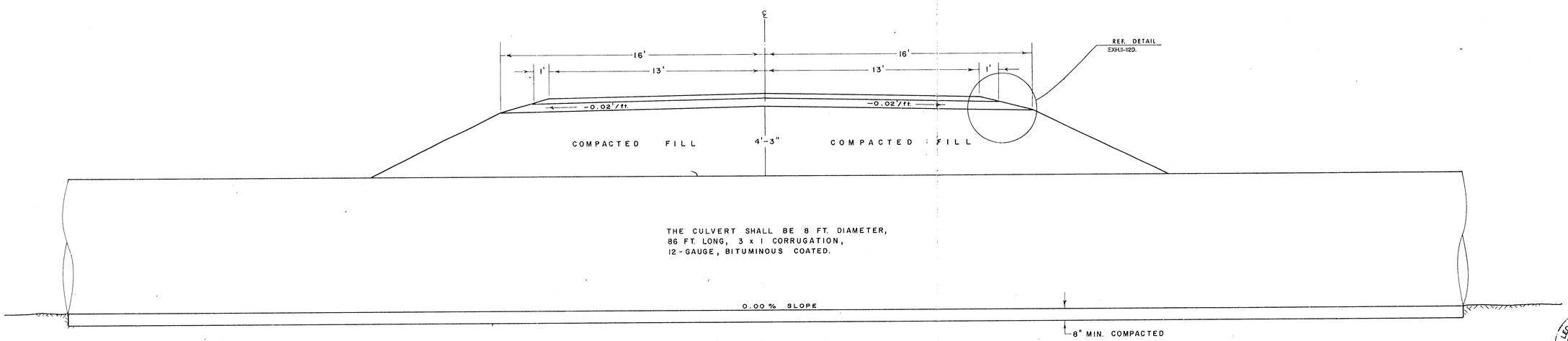
THE CRUSHED AGGREGATE SHALL CONFORM TO THE A.A.S.H.T.O. M-147 SPECIFICATION AND SHALL RANGE FROM COURSE TO FINE WITHIN THE FOLLOWING LIMITS:

TAMPED BACKFILL SHALL BE FINELY DIVIDED JOB-EXCAVATED MATERIAL FREE FROM DEBRIS, ORGANIC MATERIAL AND STONES, COMPACTED TO 95% OF THE DRY DENSITY AT OPTIMUM MOISTURE AS DETERMINED BY A STANDARD PROCTOR TEST UNLESS OTHERWISE DIRECTED BY THE OWNER'S CONSTRUCTION MANAGER.

GRANULAR MATERIAL TO BE CRUSHED STONE OR PEA GRAVEL WITH NOT LESS THAN 95% PASSING 1/2" AND NOT LESS THAN 95% TO BE RETAINED ON A #4 SIEVE, AND SHALL BE PLACED IN NOT MORE THAN 6 INCH LAYERS AND COMPACTED BY SLICING WITH A SHOVEL.

SECTION A-A

SCALE: 1" = 2'



SECTION B-B

SCALE: 1" = 3'

NOTES:

1. FOR ROAD PLAN AND PROFILE SEE EXH. II-12A THRU II-12C.
2. FOR TYPICAL CROSS SECTION SEE EXH.II-12D.
3. CATTLE CROSSING IS TO BE CORRUGATED METAL PIPE, 86 FT. LONG, 12 GAUGE, 3 x 1 CORRUGATIONS, BITUMINOUS COATED.
4. FOR CUT SECTION C-C SEE EXH.II-12G.
5. ALL SUBGRADE SOILS, TO A DEPTH OF MINIMUM 6 IN., SHOULD BE THOROUGHLY COMPACTED TO A DENSITY EQUIVALENT TO AT LEAST 95% OF A.A.H.T.O. 180 (A.S.T.M. D 1557 "MODIFIED PROCTOR").
6. COMPACTION OPERATION OF THE CRUSHED STONE BASE SHOULD CONTINUE UNTIL THE BASE HAS A DRY WEIGHT DENSITY OF NOT LESS THAN 100% OF THE MAXIMUM LABORATORY DENSITY AT OPTIMUM MOISTURE (± 1.5%) AS DETERMINED BY A.S.T.M. D 1557, METHOD D (A.S.S.H.T.O. T-180).

   IN PLACE, DENSITY SHOULD BE MEASURED BY A.S.T.M. D 2167 METHOD D OR OTHER SUITABLE METHODS.
7. HOT MIXED BITUMINOUS MIXTURES SHALL BE SPREAD AND COMPACTED WITH APPROVED EQUIPMENT AT THE TEMPERATURES AND WEATHER LIMITATIONS SET IN ACCORDANCE WITH B.I.A. HIGHWAY DEPARTMENT SPECIFICATIONS.
8. THE BITUMINOUS MATERIAL SHALL BE ASPHALT CEMENT OF AN APPROPRIATE GRADE CONFORMING TO A.S.T.M. SPECIFICATION D 946 (A.S.S.H.T.O. M-20).
9. THE COMPOSITE MIXTURE OF CRUSHED STONE AGGREGATES, MINERAL FILLER (IF NEEDED) AND BITUMINOUS MATERIAL SHALL CONFORM TO AN APPROPRIATE B.I.A. HIGHWAY DEPARTMENT GRADING SPECIFICATION, OR TO AN APPROPRIATE GRADING FROM A.S.T.M. STANDARD D 1663. IT SHALL ALSO CONFORM TO AN APPROVED JOB MIX FORMULA WITHIN A RANGE OF TOLERANCES PERMITTED BY THE LOCAL HIGHWAY DEPARTMENT.
10. RECOMMENDED SEAL: SS-1 OIL AT 50% DILUTION .10 GALLON PER SQUARE YARD OR APPROVED EQUILIBRIUM.
11. USE .25 GALLON PER SQUARE YARD OF MC-70 OR APPROVED EQUAL.

MAR 1996 APPROVED

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

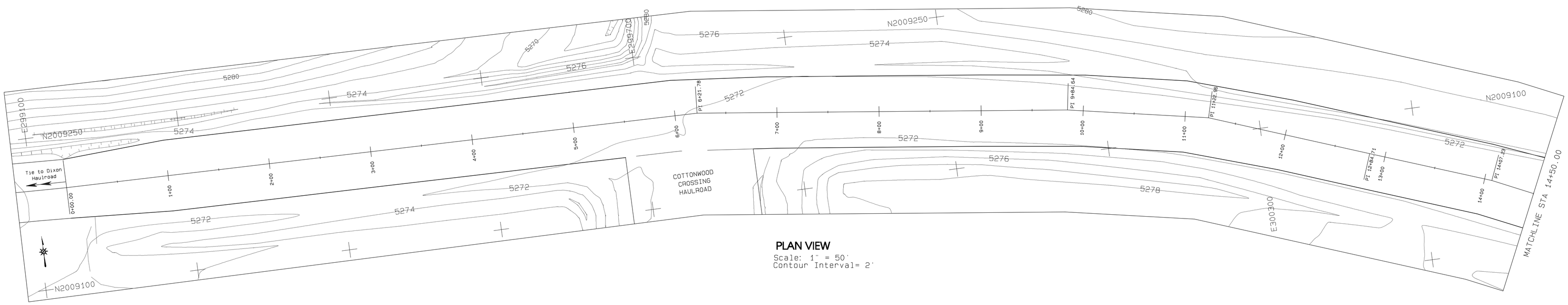
EXHIBIT 23-39

BHP MINERALS INTERNATIONAL INC.
NAVAJO MINE
FRUITLAND, NEW MEXICO

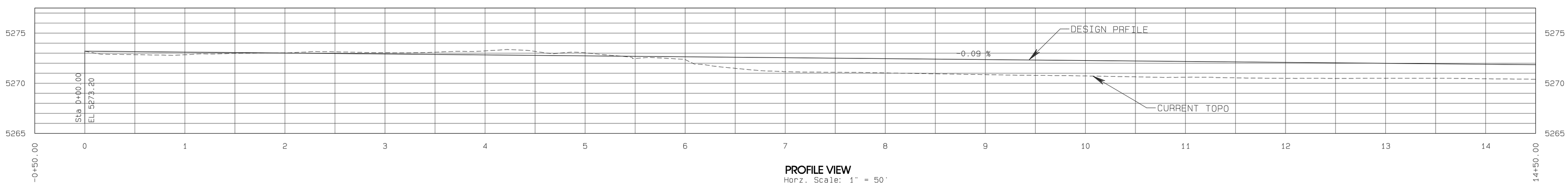
SHOP/OFFICE ACCESS ROAD
CATTLE CROSSING
CROSS-SECTION

DRAWN BY J.GOLBE	SCALE AS SHOWN		
APPROVED BY	DATE 6/3/82		
DRAWING NO.	LOCATION NO.		

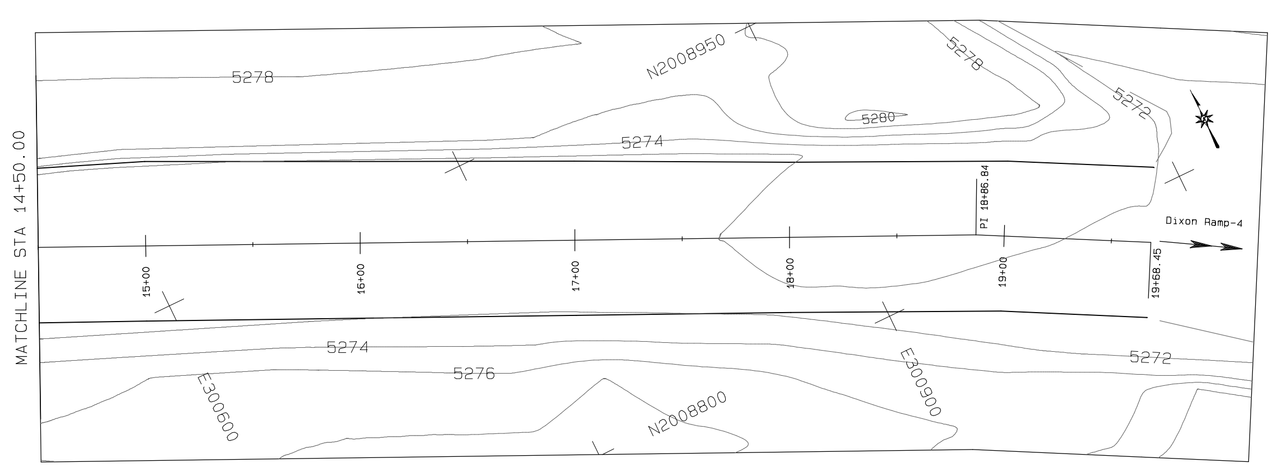
REV. 2A	03-08-1996	ADDED EXHIBIT NUMBER.	
REV. 1	7-19-82		



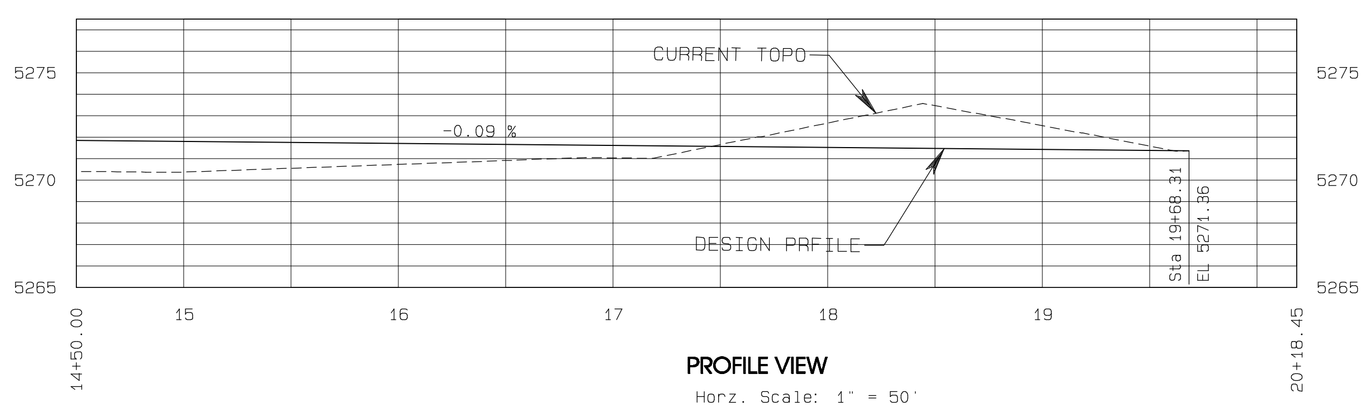
PLAN VIEW
Scale: 1" = 50'
Contour Interval= 2'



PROFILE VIEW
Horz. Scale: 1" = 50'
Vert. Scale: 1" = 5'



PLAN VIEW
Scale: 1" = 50'
Contour Interval= 2'



PROFILE VIEW
Horz. Scale: 1" = 50'
Vert. Scale: 1" = 5'

NOTE:
FOR DESIGN X-SECTIONS, REFER TO
EXHIBIT 11-84A "TYPICAL CROSS-SECTIONS
FOR PRIMARY ROADS AND CULVERTS".

CERTIFICATION STATEMENT

I, Ron C. Van Valkenburg, hereby certify that this drawings was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG
NEW MEXICO
9263
LICENSED PROFESSIONAL ENGINEER

REVISION		DATE
10-4	PREPARED A3 DIXON RAMP 4 DESIGN AND SUBMITTED TO OSM FOR REVIEW.	DEC 30, 2010

PROJECT MANAGER: Ron C.Van Valkenburg
ENGR. of RECORD: Ron C.Van Valkenburg
REG. NO: 9263
SRVYR of RECORD: Wilson Begay
REG. NO: 18528

bhpbilliton
NAVAJO COAL COMPANY
NAVAJO MINE
PO BOX 1717, FRUITLAND, NEW MEXICO, 87416 / PHONE 505-598-4200/FAX 505-598-3361

PROJECT: A3 Dixon Ramp 4 Design
DATE: Dec 27, 2010
DESIGNED BY: Ron C. Van Valkenburg
DRAWN BY: P. Foster
CHECKED BY: Ron C. Van Valkenburg
APPROVED BY: Ron C. Van Valkenburg

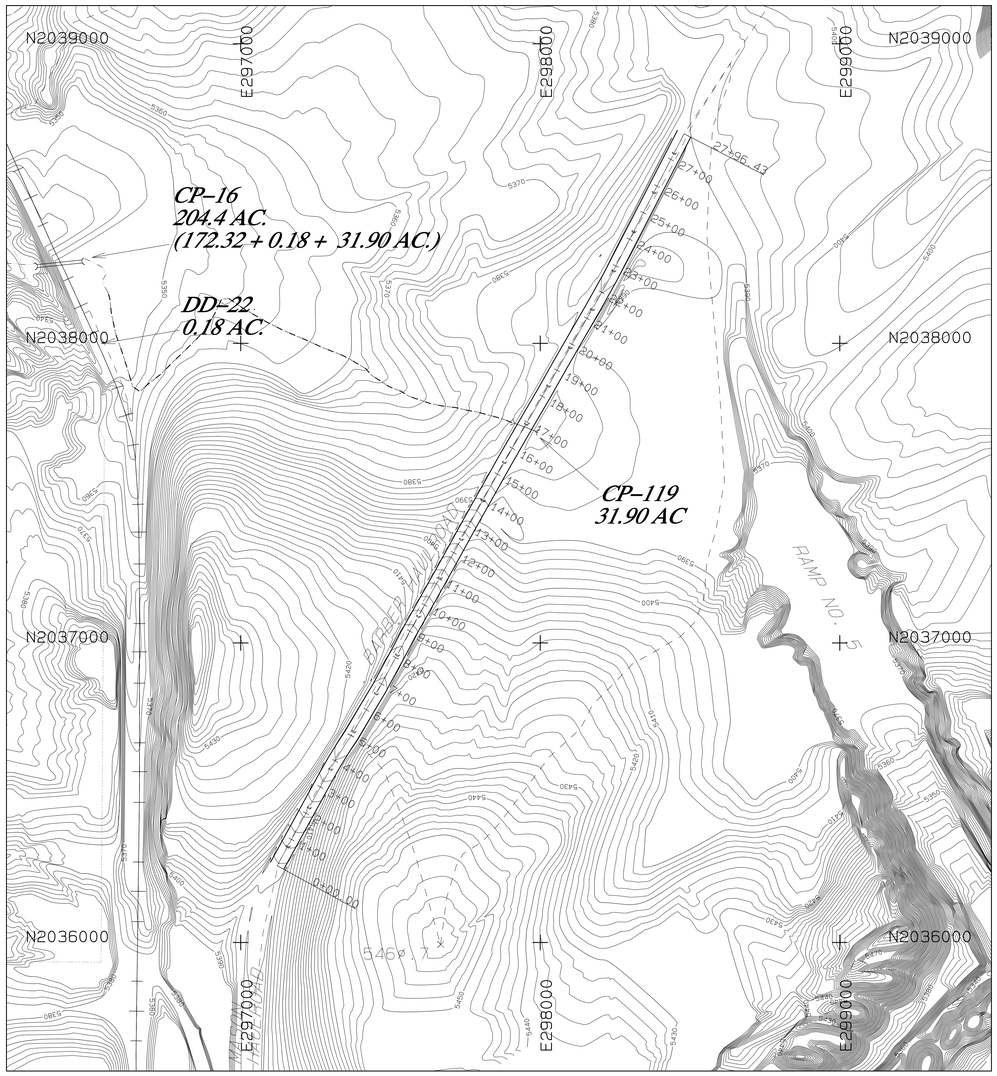
PLAN, PROFILE AND X-SECTIONS

EXHIBIT 23-40
DIXON RAMP 4 HAULROAD DESIGN

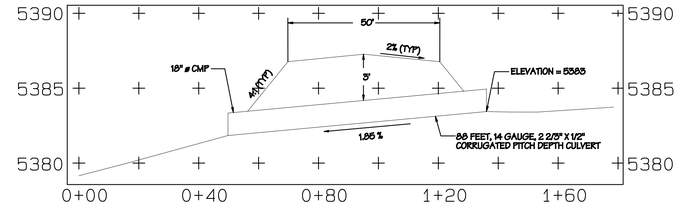
DRAWING
PLAN1

SHEET 1
OF 1

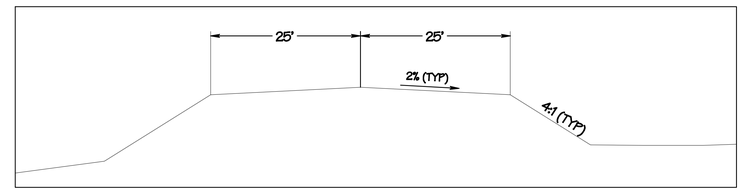
G:\GaVbenit FVCh 11\Exh 11-137_Dixon Haulroad\Exhibit 2010\As-Built\Exh 11-137C_A3 Dixon Ramp 4.pro Plot Date/
Wed Dec 29,2010 / 12:45:05



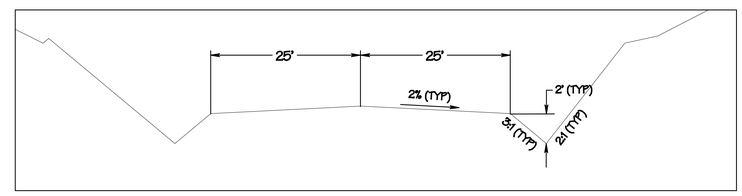
PLAN
SCALE 1" = 200'



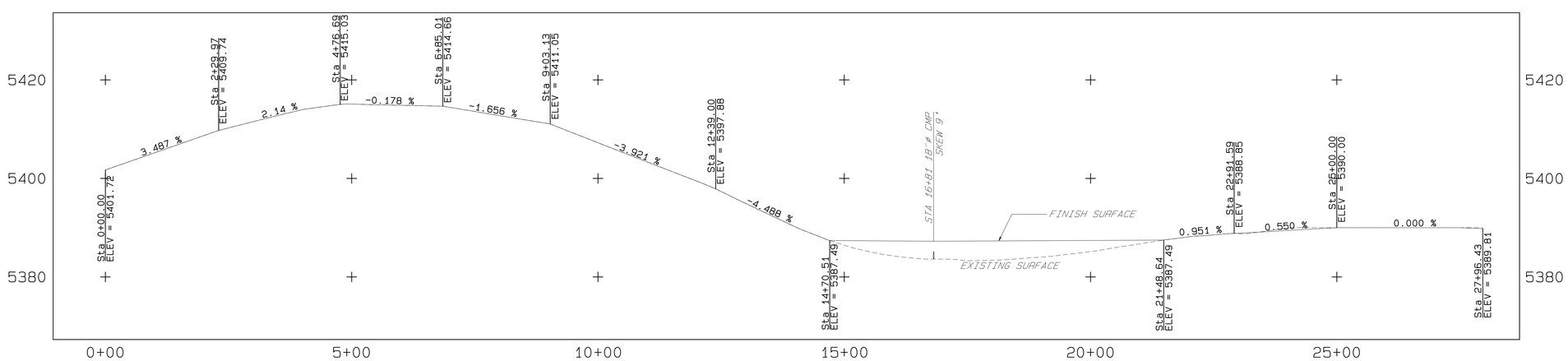
CP-119 @ STA 16+81
SCALE: H 1" = 20'
V 1" = 4'



TYPICAL FILL SECTION
NTS



TYPICAL CUT SECTION
NTS



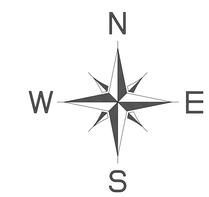
PROFILE
SCALE: H 1" = 100'
V 1" = 10'

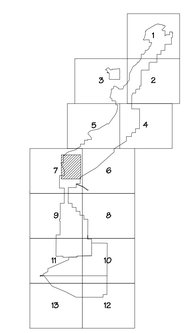
LEGEND

- ROAD
- PERMIT/LEASE BOUNDARY
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45
- L-30 LEASE CORNER
- WATERSHED

NOTES

1. For hydrology and design information refer to Appendix 11-V in the approved PAP.





CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND NEW MEXICO 6600 REGISTERED PROFESSIONAL ENGINEER

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	P.E.	P.S.	CHIEF ENG.
B	1/30/98	BH	ADDED CP-16 & DD-22, DRAINAGE PATH, TEXT & MS AREA.					
A	8/26/97	BH	SUBMITTED TO OSM FOR APPROVAL					

APPROVALS

EXHIBIT 23-41

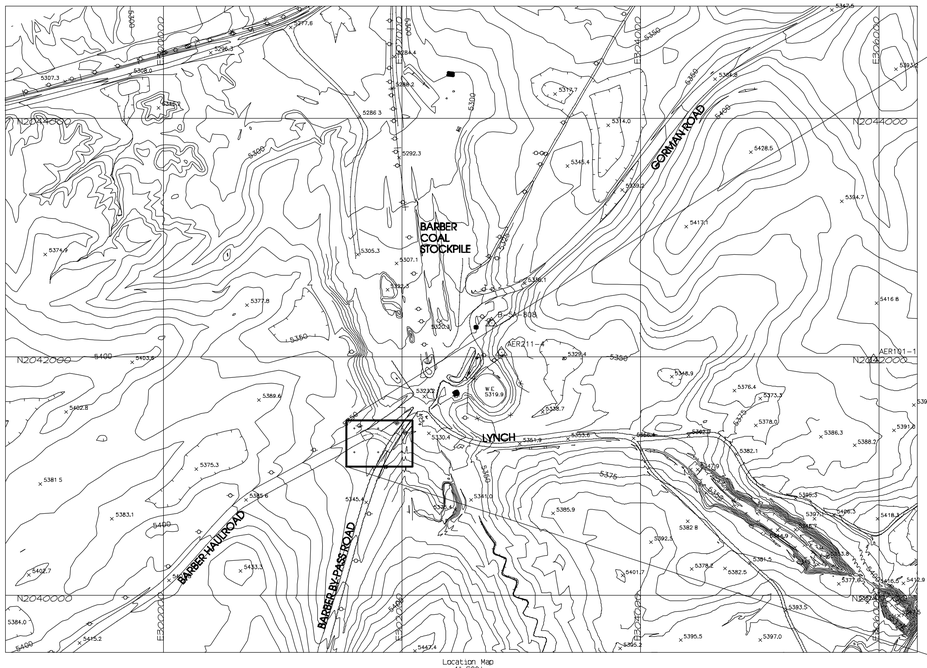
NAVAJO COAL COMPANY

NAVAJO MINE — SAFETY PAYS

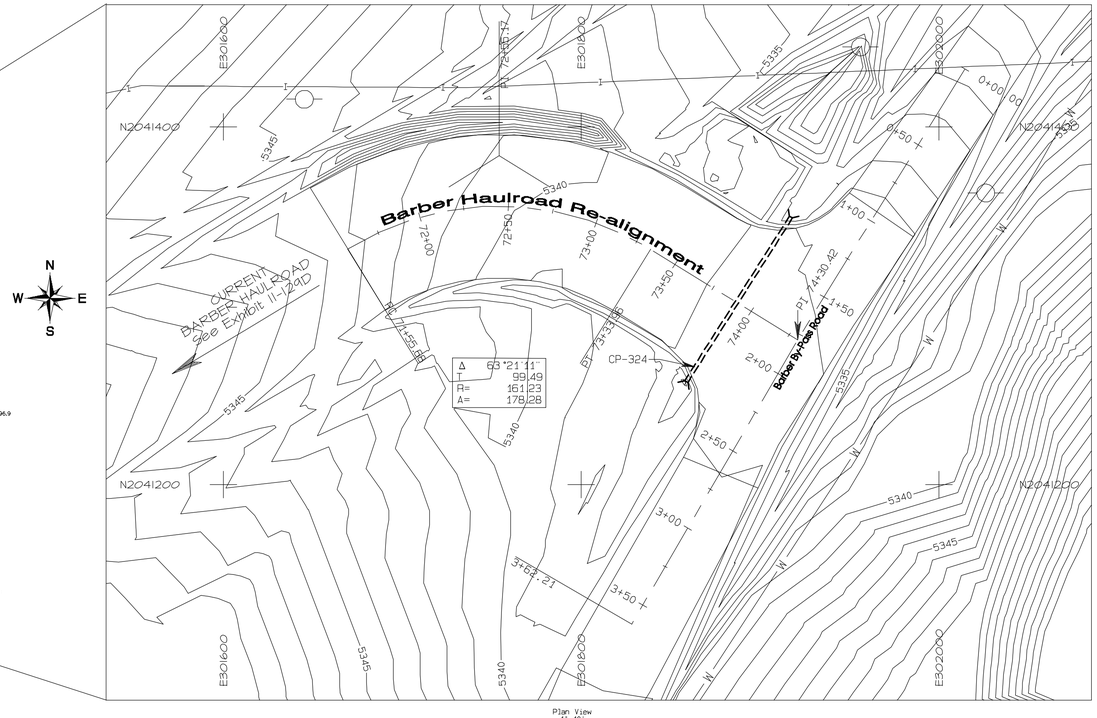
P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

AREA 2
"DESIGN"
BARBER HAULROAD MODIFICATION

PREPARED BY BH	DRAWN BY BH	SCALE AS NOTED
APPROVED BY LR	DATE 8/26/97	REF DWG
DWG LOC J: \OSM_SUBM\PER_PROG\CH_11\11-129\BARBCUL.PRO		



Location Map
1"=500'



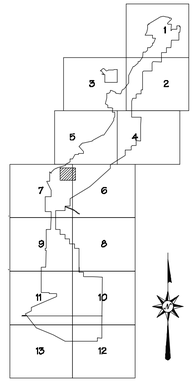
Plan View
1"=40'

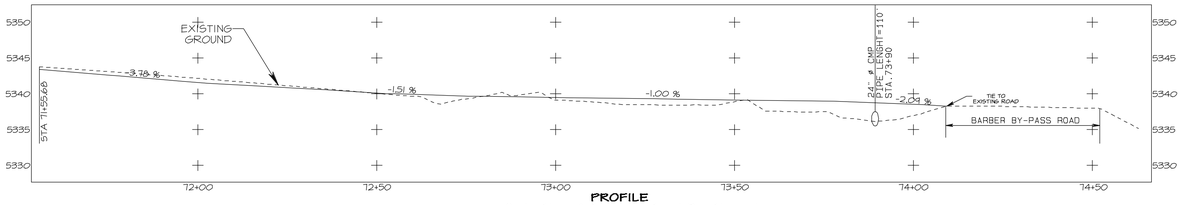
LEGEND

- ROAD
- CULVERT
- DRAINAGE
- POWERLINE
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY
- WATER LINE
- IRRIGATION LINE

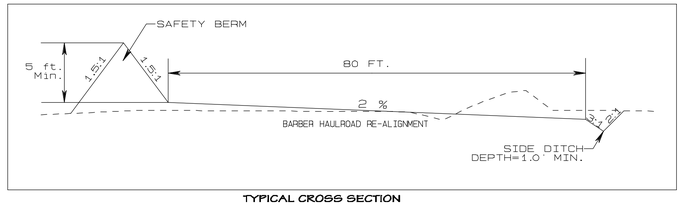
NOTES

1. For hydrology and design information refer to Appendix 11-V in the approved PAP.
2. The watershed areas for culverts are shown on Exhibit 11-12D.

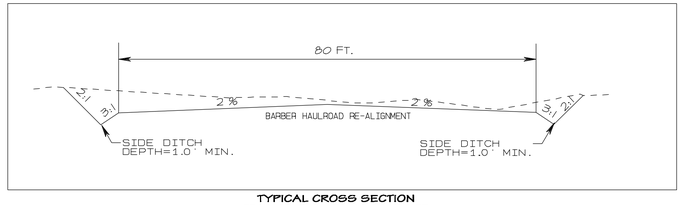




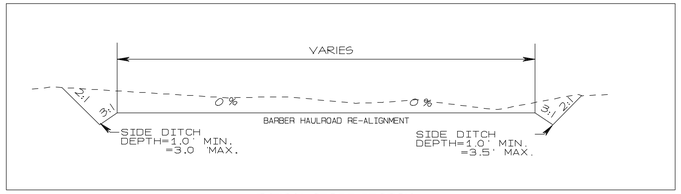
PROFILE
Centerline of Barber Haulroad Re-alignment



TYPICAL CROSS SECTION
FROM STATION 71+55.68 TO STA.73+00



TYPICAL CROSS SECTION
FROM STATION 73+00 TO 73+75



TYPICAL CROSS SECTION
FROM STATION 73+75 TO 74+30.42

ABOVE TYPICAL CROSS SECTIONS
N.T.S.

CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

REVISION	DATE
12-4 Submitted to DSM for Approval	1-27-12

PROJECT MANAGER: J.G.
ENGR. of RECORD: LR
REG. NO: 6600
SRVYR of RECORD:
REG. NO:

bhpbilliton
NAVAJO COAL COMPANY
NAVAJO MINE
PO BOX 1717 FRUITLAND, NEW MEXICO 87416 PHONE 505-598-3209/FAX 505-598-3261

PROJECT: BARBER HAULROAD RE-ALIGNMENT
DATE: 1-27-12
DESIGN BY: RY
DRAWN BY: RY
CHECKED BY: LR
APPROVED BY: LR

PLAN, PROFILE AND SECTIONS

Exhibit 23-45
BARBER HAULROAD AND BARBER BY-PASS INTERSECTION
DESIGN

DRAWING

SHEET 1 OF 1

Appendix 23.A

Culverts Navajo Mine Hydrology Backup

APPENDIX 23.A

TABLE OF CONTENTS

STRUCTURE DESIGNATION **PAGE NO.**

SEDCAD BACKUP, HYDROLOGY CALCULATIONS FOR CULVERTS AND DOWNDRAINS:

CP-1 and CP-69 2
CP-3 11
CP-4 17
CP-5, CP-31, CP-32, CP-33, and CP-34 23
CP-6 32
CP-7 38
CP-8 44
CP-9 50
CP-10 56
CP-11 62
CP-12 68
CP-13 74
CP-14 80
CP-15 86
CP-16 (Located at Pg. 618 also) 92
CP-17 & CP-18, Downdrains 19, 20, & 21 98
CP-19 and CP-20 111
CP-21 120
CP-22 842
CP-25 1322
CP-26 1322
CP-27 1322
CP-28 & Channels A, B & C 1337
Channels D & E 1353
CP-30 ..... 143a
CP-35A & 35B 144
CP-36 150
CP-37 156
CP-45 1200
CP-49 162
CP-50 163
CP-51 169
CP-52, CP-53 175
CP-54 181
CP-55 187
CP-56 195
CP-57 201

APPENDIX 23.A

TABLE OF CONTENTS

STRUCTURE DESIGNATION **PAGE NO.**

SEDCAD BACKUP, HYDROLOGY CALCULATIONS FOR CULVERTS AND DOWNDRAINS:

CP-58 207
CP-59 213
CP-60 219
CP-61 225
CP-62 231
CP-63 237
CP-70, 71, & 72 264
CP-74 280
CP-75, 86, and 87.....286
CP-76 298
CP-77 304
CP-82 334
CP-83 340
CP-84 and CP-85 346
CP-86 292
CP-88 355
CP-91 842
CP-92 372
CP-93 378
CP-94 384
DD-1, DD-2, DD-3 390
DD-4 402
DD-5 408
DD-6 414
DD-7 to DD-12 420
DD-13 to DD-18 441
DD-19, DD-20, DD21 98
CP-95 482
CP-96 488
DD-22 494
CP-103 500
CP-104 510
CP-106 518
CP-107 526
CP-108 534
CP-119 553
CP-120 560

APPENDIX 23.A

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CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-1 AND CP-69

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\1_69

Date: 12-18-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\1_69 User: Brian Sambirsky
Date: 12-18-1995 Time: 15:23:43
As built design specifications for CP-1 and CP-69
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	7.10	89	M	0.205	0.000	0.000	0.0	0.29	5.05
			Type: Null			Label: CP-69				
111	Structure	7.10							0.29	
111	Total IN/OUT	7.10							0.29	5.05
211	1	85.00	89	M	0.515	0.000	0.000	0.0	3.43	38.36
			Type: Null			Label: CP-1				
211	Structure	85.00							3.72	
211	Total IN/OUT	92.10							3.72	40.02
111 to 211 Routing						0.510	0.244			
			Type: Null			Label: CP-19				
311	Structure	85.00							3.72	
311	Total IN/OUT	92.10							3.72	40.02
211 to 311 Routing						0.000	0.000			

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Company Name: BHP MINERALS
Filename: C:\BRIAN\1_69 User: Brian Sambirsky
Date: 12-18-1995 Time: 15:23:43
As built design specifications for CP-1 and CP-69
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	650.00	0.77	0.88	0.21	0.205		
2	1	1	1	-a	5	3200.00	2.97	1.72	0.52	0.515		

SEDCAD+ CULVERT SIZING UTILITY

CP-1

Design Discharge	=	40.020 cfs
Entrance Loss Coefficient	=	0.2
Pipe Length	=	76.000 feet
Pipe Slope	=	2.500 %
Manning's n	=	0.020
Maximum Headwater	=	13.700 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 24 inches

PERFORMANCE CURVES:

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.37	5.04	Inlet (Supercritical)	3
2.74	11.32	Inlet	5
4.11	14.55	Outlet	6
5.48	16.53	Outlet	6
6.85	18.30	Outlet	6
8.22	19.92	Outlet	6
9.59	21.39	Outlet	6
10.96	22.78	Outlet	6
12.33	24.11	Outlet	6
13.70	25.34	Outlet	6
15.07	26.53	Outlet	6
16.44	27.67	Outlet	6
17.81	28.75	Outlet	6
19.18	29.81	Outlet	6
20.55	30.81	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.37	5.88	Inlet (Supercritical)	3
2.74	14.53	Inlet	5
4.11	20.19	Inlet	5
5.48	23.80	Outlet	6
6.85	26.43	Outlet	6
8.22	28.81	Outlet	6
9.59	31.01	Outlet	6
10.96	33.07	Outlet	6
12.33	35.01	Outlet	6
13.70	36.84	Outlet	6
15.07	38.59	Outlet	6
16.44	40.27	Outlet	6
17.81	41.88	Outlet	6
19.18	43.42	Outlet	6
20.55	44.91	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.37	6.72	Inlet (Supercritical)	3
2.74	17.81	Inlet	5
4.11	25.53	Inlet	5
5.48	31.40	Inlet	5
6.85	36.11	Outlet	6
8.22	39.46	Outlet	6
9.59	42.55	Outlet	6
10.96	45.43	Outlet	6
12.33	48.14	Outlet	6
13.70	50.70	Outlet	6
15.07	53.14	Outlet	6
16.44	55.48	Outlet	6
17.81	57.72	Outlet	6
19.18	59.88	Outlet	6
20.55	61.96	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.37	8.40	Inlet (Supercritical)	3
2.74	23.74	Inlet (Supercritical)	3
4.11	37.11	Inlet	5
5.48	46.84	Inlet	5
6.85	54.88	Inlet	5
8.22	61.88	Inlet	5
9.59	68.16	Inlet	5
10.96	73.92	Inlet	5
12.33	79.25	Inlet	5
13.70	84.25	Inlet	5
15.07	88.96	Inlet	5
16.44	93.44	Inlet	5
17.81	97.65	Outlet	6
19.18	101.40	Outlet	6
20.55	105.00	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.37	10.07	Inlet (Supercritical)	3
2.74	28.49	Inlet (Supercritical)	3
4.11	49.10	Inlet	5
5.48	64.08	Inlet	5
6.85	76.16	Inlet	5
8.22	86.57	Inlet	5
9.59	95.86	Inlet	5
10.96	104.33	Inlet	5
12.33	112.16	Inlet	5
13.70	119.47	Inlet	5

15.07	126.36	Inlet	5
16.44	132.88	Inlet	5
17.81	139.12	Inlet	5
19.18	145.09	Inlet	5
20.55	150.81	Inlet	5

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.37	11.75	Inlet (Supercritical)	3
2.74	33.24	Inlet (Supercritical)	3
4.11	61.06	Inlet (Supercritical)	3
5.48	82.35	Inlet	5
6.85	99.61	Inlet	5
8.22	114.29	Inlet	5
9.59	127.28	Inlet	5
10.96	139.06	Inlet	5
12.33	149.93	Inlet	5
13.70	160.06	Inlet	5
15.07	169.58	Inlet	5
16.44	178.59	Inlet	5
17.81	187.17	Inlet	5
19.18	195.38	Inlet	5
20.55	203.25	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

CP-69

Design Discharge	=	5.050 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	83.000 feet
Pipe Slope	=	1.100 %
Manning's n	=	0.026
Maximum Headwater	=	7.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	0.64	Inlet (Supercritical)	4
1.40	1.08	Outlet	6
2.10	1.25	Outlet	6
2.80	1.42	Outlet	6
3.50	1.59	Outlet	6
4.20	1.76	Outlet	6
4.90	1.93	Outlet	6
5.60	2.06	Outlet	6
6.30	2.16	Outlet	6
7.00	2.27	Outlet	6
7.70	2.37	Outlet	6
8.40	2.47	Outlet	6
9.10	2.57	Outlet	6
9.80	2.68	Outlet	6
10.50	2.78	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	1.02	Outlet (Subcritical)	1
1.40	2.19	Outlet (Subcritical)	2
2.10	2.62	Inlet (Supercritical)	4
2.80	3.04	Outlet	6
3.50	3.36	Outlet	6
4.20	3.68	Outlet	6
4.90	4.00	Outlet	6
5.60	4.26	Outlet	6
6.30	4.51	Outlet	6
7.00	4.76	Outlet	6
7.70	5.01	Outlet	6
8.40	5.21	Outlet	6
9.10	5.42	Outlet	6
9.80	5.62	Outlet	6
10.50	5.83	Outlet	6

7.70	19.71	Outlet	6
8.40	20.66	Outlet	6
9.10	21.56	Outlet	6
9.80	22.43	Outlet	6
10.50	23.27	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	4.72	Outlet (Subcritical)	1
1.40	6.35	Outlet (Subcritical)	1
2.10	11.33	Outlet (Subcritical)	1
2.80	14.56	Outlet	6
3.50	16.91	Outlet	6
4.20	18.97	Outlet	6
4.90	20.83	Outlet	6
5.60	22.53	Outlet	6
6.30	24.11	Outlet	6
7.00	25.59	Outlet	6
7.70	27.00	Outlet	6
8.40	28.33	Outlet	6
9.10	29.60	Outlet	6
9.80	30.82	Outlet	6
10.50	32.01	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	1.78	Outlet (Subcritical)	1
1.40	3.37	Inlet (Supercritical)	3
2.10	4.41	Outlet	6
2.80	5.16	Outlet	6
3.50	5.80	Outlet	6
4.20	6.37	Outlet	6
4.90	6.92	Outlet	6
5.60	7.40	Outlet	6
6.30	7.87	Outlet	6
7.00	8.30	Outlet	6
7.70	8.71	Outlet	6
8.40	9.12	Outlet	6
9.10	9.49	Outlet	6
9.80	9.86	Outlet	6
10.50	10.21	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	2.54	Outlet (Subcritical)	1
1.40	4.57	Outlet (Subcritical)	1
2.10	6.66	Inlet (Supercritical)	4
2.80	7.84	Outlet	6
3.50	8.90	Outlet	6
4.20	9.84	Outlet	6
4.90	10.70	Outlet	6
5.60	11.50	Outlet	6
6.30	12.25	Outlet	6
7.00	12.95	Outlet	6
7.70	13.61	Outlet	6
8.40	14.25	Outlet	6
9.10	14.86	Outlet	6
9.80	15.44	Outlet	6
10.50	16.01	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	3.53	Outlet (Subcritical)	1
1.40	5.23	Outlet (Subcritical)	1
2.10	9.25	Outlet (Subcritical)	2
2.80	11.02	Outlet	6
3.50	12.62	Outlet	6
4.20	14.06	Outlet	6
4.90	15.35	Outlet	6
5.60	16.55	Outlet	6
6.30	17.67	Outlet	6
7.00	18.72	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-3

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\03

Date: 12-05-1995

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Company Name: BHP MINERALS
Filename: C:\BRIAN\03 User: Brian Sambirsky
Date: 12-06-1995 Time: 09:38:45
As built design specifications for CP-3
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	87.60	89	M	0.424	0.000	0.000	0.0	3.54	44.35
			Type: Null			Label: CP-3				
111	Structure	87.60							3.54	
111	Total IN/OUT	87.60							3.54	44.35

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Company Name: BHP MINERALS
Filename: C:\BRIAN\03 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:27
As built design specifications for CP-3
Storm: 1.30 inches, 10 year- 6 hour, Type II-65 :
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2950.00	3.73	1.93	0.42	0.424		

SEDCAD+ CULVERT SIZING UTILITY

CP-3

Design Discharge	=	44.350	cfs
Entrance Loss Coefficient	=	0.2	
Pipe Length	=	100.000	feet
Pipe Slope	=	2.600	%
Manning's n	=	0.020	
Maximum Headwater	=	18.600	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 24 inches

PERFORMANCE CURVES:

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.86	7.76	Inlet	5
3.72	13.40	Outlet	6
5.58	15.86	Outlet	6
7.44	17.87	Outlet	6
9.30	19.67	Outlet	6
11.16	21.31	Outlet	6
13.02	22.85	Outlet	6
14.88	24.30	Outlet	6
16.74	25.65	Outlet	6
18.60	26.94	Outlet	6
20.46	28.18	Outlet	6
22.32	29.35	Outlet	6
24.18	30.48	Outlet	6
26.04	31.58	Outlet	6
27.90	32.63	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.86	9.30	Inlet (Supercritical)	3
3.72	18.75	Inlet	5
5.58	22.98	Outlet	6
7.44	26.00	Outlet	6
9.30	28.67	Outlet	6
11.16	31.13	Outlet	6
13.02	33.41	Outlet	6
14.88	35.54	Outlet	6
16.74	37.55	Outlet	6
18.60	39.46	Outlet	6
20.46	41.28	Outlet	6
22.32	43.02	Outlet	6
24.18	44.70	Outlet	6
26.04	46.32	Outlet	6
27.90	47.88	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.86	10.64	Inlet (Supercritical)	3
3.72	23.59	Inlet	5
5.58	31.41	Outlet	6
7.44	35.77	Outlet	6
9.30	39.56	Outlet	6
11.16	43.01	Outlet	6
13.02	46.22	Outlet	6
14.88	49.20	Outlet	6
16.74	52.03	Outlet	6
18.60	54.70	Outlet	6
20.46	57.25	Outlet	6
22.32	59.69	Outlet	6
24.18	62.04	Outlet	6
26.04	64.30	Outlet	6
27.90	66.48	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.86	13.29	Inlet (Supercritical)	3
3.72	33.84	Inlet	5
5.58	47.48	Inlet	5
7.44	58.00	Inlet	5
9.30	66.78	Inlet	5
11.16	73.03	Outlet	6
13.02	78.65	Outlet	6
14.88	83.90	Outlet	6
16.74	88.83	Outlet	6
18.60	93.51	Outlet	6
20.46	97.94	Outlet	6
22.32	102.21	Outlet	6
24.18	106.31	Outlet	6
26.04	110.24	Outlet	6
27.90	114.03	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.86	15.94	Inlet (Supercritical)	3
3.72	43.94	Inlet	5
5.58	65.03	Inlet	5
7.44	80.81	Inlet	5
9.30	93.98	Inlet	5
11.16	105.50	Inlet	5
13.02	115.90	Inlet	5
14.88	125.42	Inlet	5
16.74	134.27	Inlet	5
18.60	142.58	Inlet	5

20.46	150.44	Outlet	6
22.32	157.17	Outlet	6
24.18	163.57	Outlet	6
26.04	169.73	Outlet	6
27.90	175.69	Outlet	6

Diameter: 42 inches :

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.86	18.60	Inlet (Supercritical)	3
3.72	52.58	Inlet (Supercritical)	3
5.58	83.74	Inlet	5
7.44	106.18	Inlet	5
9.30	124.63	Inlet	5
11.16	140.70	Inlet	5
13.02	155.10	Inlet	5
14.88	168.28	Inlet	5
16.74	180.51	Inlet	5
18.60	191.95	Inlet	5
20.46	202.74	Inlet	5
22.32	212.99	Inlet	5
24.18	222.77	Inlet	5
26.04	232.15	Inlet	5
27.90	241.16	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-4

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\04

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\04 User: Brian Sambirsky
Date: 12-06-1995 Time: 09:38:24
As built design specifications for CP-4
Storm: 1.30 inches, 10 year- 6 hour, Type II-65 :
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	40.90	89	M	0.280	0.000	0.000	0.0	1.65	25.50
			Type: Null		Label: CP-4					
111	Structure	40.90							1.65	
111	Total IN/OUT	40.90							1.65	25.50

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Company Name: BHP MINERALS
Filename: C:\BRIAN\04 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:30
As built design specifications for CP-4
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2170.00	4.61	2.15	0.28	0.280		

SEDCAD+ CULVERT SIZING UTILITY

CP-4

Design Discharge	=	25.500 cfs
Entrance Loss Coefficient	=	0.2
Pipe Length	=	68.000 feet
Pipe Slope	=	1.800 %
Manning's n	=	0.020
Maximum Headwater	=	13.800 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 18 inches

PERFORMANCE CURVES:

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.38	3.09	Inlet	5
2.76	4.44	Outlet	6
4.14	5.34	Outlet	6
5.52	6.12	Outlet	6
6.90	6.79	Outlet	6
8.28	7.41	Outlet	6
9.66	7.99	Outlet	6
11.04	8.51	Outlet	6
12.42	9.02	Outlet	6
13.80	9.49	Outlet	6
15.18	9.95	Outlet	6
16.56	10.37	Outlet	6
17.94	10.79	Outlet	6
19.32	11.19	Outlet	6
20.70	11.57	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.38	4.22	Inlet (Supercritical)	3
2.76	7.56	Outlet	6
4.14	9.18	Outlet	6
5.52	10.55	Outlet	6
6.90	11.76	Outlet	6
8.28	12.87	Outlet	6
9.66	13.88	Outlet	6
11.04	14.79	Outlet	6
12.42	15.70	Outlet	6
13.80	16.53	Outlet	6
15.18	17.32	Outlet	6
16.56	18.11	Outlet	6
17.94	18.82	Outlet	6
19.32	19.53	Outlet	6
20.70	20.22	Outlet	6

15.18	54.04	Outlet	6
16.56	56.51	Outlet	6
17.94	58.88	Outlet	6
19.32	61.17	Outlet	6
20.70	63.37	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.38	8.49	Inlet (Supercritical)	3
2.76	24.00	Inlet (Supercritical)	3
4.14	37.35	Inlet	5
5.52	47.10	Inlet	5
6.90	55.15	Inlet	5
8.28	62.17	Inlet	5
9.66	68.47	Inlet	5
11.04	74.24	Inlet	5
12.42	79.59	Inlet	5
13.80	84.60	Inlet	5
15.18	89.33	Inlet	5
16.56	93.83	Inlet	5
17.94	98.12	Inlet	5
19.32	102.23	Inlet	5
20.70	106.18	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.38	5.09	Inlet (Supercritical)	3
2.76	11.31	Inlet	5
4.14	14.10	Outlet	6
5.52	16.29	Outlet	6
6.90	18.24	Outlet	6
8.28	20.01	Outlet	6
9.66	21.60	Outlet	6
11.04	23.10	Outlet	6
12.42	24.51	Outlet	6
13.80	25.85	Outlet	6
15.18	27.11	Outlet	6
16.56	28.33	Outlet	6
17.94	29.48	Outlet	6
19.32	30.60	Outlet	6
20.70	31.68	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.38	5.94	Inlet (Supercritical)	3
2.76	14.63	Inlet	5
4.14	20.05	Outlet	6
5.52	23.34	Outlet	6
6.90	26.24	Outlet	6
8.28	28.83	Outlet	6
9.66	31.21	Outlet	6
11.04	33.43	Outlet	6
12.42	35.51	Outlet	6
13.80	37.47	Outlet	6
15.18	39.33	Outlet	6
16.56	41.11	Outlet	6
17.94	42.82	Outlet	6
19.32	44.46	Outlet	6
20.70	46.05	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.38	6.79	Inlet (Supercritical)	3
2.76	17.96	Inlet	5
4.14	25.67	Inlet	5
5.52	31.56	Outlet	6
6.90	35.71	Outlet	6
8.28	39.36	Outlet	6
9.66	42.70	Outlet	6
11.04	45.80	Outlet	6
12.42	48.69	Outlet	6
13.80	51.43	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT HYDROLOGY CALCULATIONS FOR CP-5, CP-31, CP-32, CP-33 & CP-34

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\5_31-34

Date: 12-19-1995

Culvert CP-31, CP-32, CP-33 and CP-34 (Yazzie "Y") and CP-5 Chinde Arroyo Post-Mining Hydrology

The Hydrology model is presented on Exhibit 11-75. The location of Culvert CP-31 thru CP-34 and CP-5 are at Structure 41 and 23, respectively.

LR

Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

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General Information

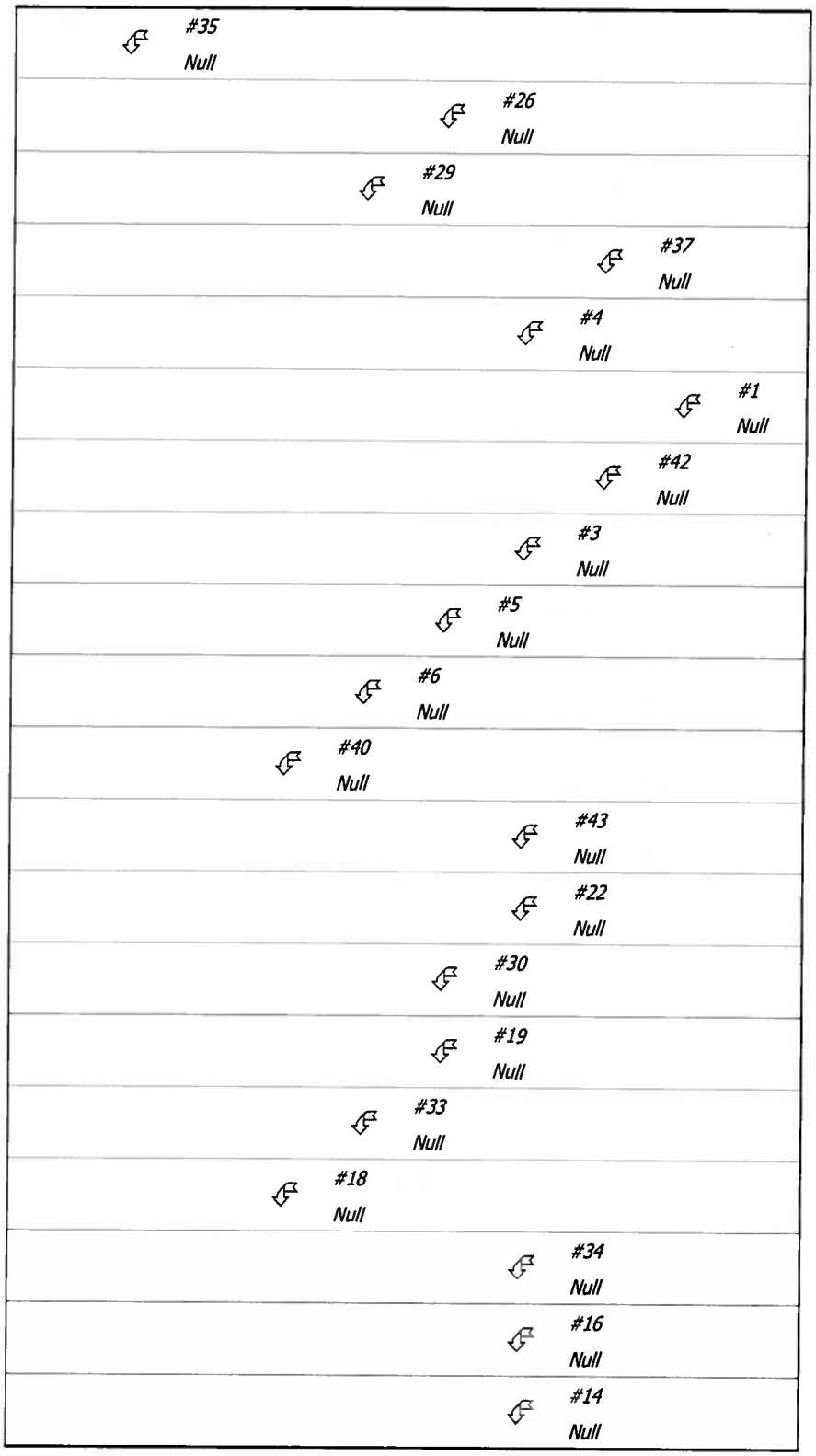
Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#42	1.386	0.156	
Null	#3	==>	#5	0.000	0.000	
Null	#4	==>	#5	0.000	0.000	
Null	#5	==>	#6	0.778	0.334	
Null	#6	==>	#40	1.118	0.289	
Null	#7	==>	#27	1.112	0.333	
Null	#8	==>	#27	0.980	0.337	
Null	#9	==>	#27	0.967	0.336	
Null	#10	==>	#27	0.897	0.335	
Null	#11	==>	#27	0.809	0.337	
Null	#12	==>	#27	0.706	0.342	
Null	#13	==>	#27	0.598	0.352	
Null	#14	==>	#38	0.749	0.206	
Null	#15	==>	#41	0.000	0.000	
Null	#16	==>	#38	0.153	0.368	
Null	#17	==>	#32	0.000	0.000	
Null	#18	==>	#41	0.076	0.313	
Null	#19	==>	#33	0.000	0.000	
Null	#21	==>	#27	0.467	0.332	
Null	#22	==>	#30	0.621	0.218	
Culvert	#23	==>	#24	0.494	0.312	Culvert CP-5
Null	#24	==>	End	0.000	0.000	
Null	#25	==>	#27	0.302	0.350	
Null	#26	==>	#29	0.144	0.211	
Null	#27	==>	#28	0.348	0.313	
Null	#28	==>	#23	0.101	0.361	
Null	#29	==>	#40	0.653	0.305	
Null	#30	==>	#33	0.000	0.000	
Null	#31	==>	#32	0.274	0.297	
Null	#32	==>	#23	0.403	0.327	
Null	#33	==>	#18	0.349	0.315	
Null	#34	==>	#38	0.601	0.202	
Null	#35	==>	#23	0.080	0.367	
Null	#36	==>	#27	1.462	0.217	
Null	#37	==>	#4	1.717	0.316	
Null	#38	==>	#39	0.165	0.329	Doby Channel
Null	#39	==>	#15	0.342	0.321	Doby Permanent Imp.
Null	#40	==>	#41	0.000	0.000	
Culvert	#41	==>	#32	0.307	0.299	Culvert CP-31, 32, 33 & 34 (Yazzie "Y")
Null	#42	==>	#3	1.479	0.221	

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#43	==>	#30	0.479	0.208	



				#38 *Null*
			#39 *Null*	
		#15 *Null*		
	#41 *Culvert*			
	#31 *Null*			
	#17 *Null*			
#32 *Null*				
		#36 *Null*		
		#25 *Null*		
		#21 *Null*		
		#13 *Null*		
		#12 *Null*		
		#11 *Null*		
		#10 *Null*		
		#9 *Null*		
		#8 *Null*		
		#7 *Null*		
	#27 *Null*			
#28 *Null*				
#23 *Culvert*				
#24 *Null*				

Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	5. Nearly bare and untilled, and alluvial valley fans	0.60	23.00	3,844.22	0.77	1.386
#1	**Muskingum K:**					**1.386**
#5	8. Large gullies, diversions, and low flowing streams	1.30	124.00	9,554.00	3.41	0.778
#5	**Muskingum K:**					**0.778**
#6	8. Large gullies, diversions, and low flowing streams	0.61	57.00	9,384.26	2.33	1.118
#6	**Muskingum K:**					**1.118**
#7	8. Large gullies, diversions, and low flowing streams	1.28	174.00	13,577.00	3.39	1.112
#7	**Muskingum K:**					**1.112**
#8	8. Large gullies, diversions, and low flowing streams	1.37	169.00	12,356.00	3.50	0.980
#8	**Muskingum K:**					**0.980**
#9	8. Large gullies, diversions, and low flowing streams	1.36	165.00	12,151.00	3.49	0.967
#9	**Muskingum K:**					**0.967**
#10	8. Large gullies, diversions, and low flowing streams	1.33	149.00	11,179.00	3.46	0.897
#10	**Muskingum K:**					**0.897**
#11	8. Large gullies, diversions, and low flowing streams	1.38	142.00	10,259.00	3.52	0.809
#11	**Muskingum K:**					**0.809**
#12	8. Large gullies, diversions, and low flowing streams	1.51	142.00	9,382.00	3.69	0.706
#12	**Muskingum K:**					**0.706**
#13	8. Large gullies, diversions, and low flowing streams	1.81	157.00	8,689.00	4.03	0.598
#13	**Muskingum K:**					**0.598**
#14	5. Nearly bare and untilled, and alluvial valley fans	1.43	46.00	3,212.06	1.19	0.749
#14	**Muskingum K:**					**0.749**
#16	8. Large gullies, diversions, and low flowing streams	2.51	66.00	2,630.00	4.75	0.153
#16	**Muskingum K:**					**0.153**
#18	8. Large gullies, diversions, and low flowing streams	0.90	7.00	780.00	2.84	0.076
#18	**Muskingum K:**					**0.076**
#21	8. Large gullies, diversions, and low flowing streams	1.27	72.00	5,674.00	3.37	0.467
#21	**Muskingum K:**					**0.467**
#22	5. Nearly bare and untilled, and alluvial valley fans	1.74	51.00	2,930.02	1.31	0.621
#22	**Muskingum K:**					**0.621**
#23	8. Large gullies, diversions, and low flowing streams	0.88	44.00	5,006.00	2.81	0.494

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#23	**Muskingum K:**					**0.494**
#25	8. Large gullies, diversions, and low flowing streams	1.76	76.00	4,325.00	3.97	0.302
#25	**Muskingum K:**					**0.302**
#26	5. Nearly bare and untilled, and alluvial valley fans	1.55	10.00	646.03	1.24	0.144
#26	**Muskingum K:**					**0.144**
#27	8. Large gullies, diversions, and low flowing streams	0.90	32.00	3,558.00	2.84	0.348
#27	**Muskingum K:**					**0.348**
#28	8. Large gullies, diversions, and low flowing streams	2.16	35.00	1,618.00	4.41	0.101
#28	**Muskingum K:**					**0.101**
#29	8. Large gullies, diversions, and low flowing streams	0.80	50.00	6,282.00	2.67	0.653
#29	**Muskingum K:**					**0.653**
#31	8. Large gullies, diversions, and low flowing streams	0.69	17.00	2,459.00	2.49	0.274
#31	**Muskingum K:**					**0.274**
#32	8. Large gullies, diversions, and low flowing streams	1.14	53.00	4,654.00	3.20	0.403
#32	**Muskingum K:**					**0.403**
#33	8. Large gullies, diversions, and low flowing streams	0.93	34.00	3,640.25	2.89	0.349
#33	**Muskingum K:**					**0.349**
#34	5. Nearly bare and untilled, and alluvial valley fans	1.32	33.00	2,492.07	1.15	0.601
#34	**Muskingum K:**					**0.601**
#35	8. Large gullies, diversions, and low flowing streams	2.44	33.00	1,354.00	4.68	0.080
#35	**Muskingum K:**					**0.080**
#36	5. Nearly bare and untilled, and alluvial valley fans	1.71	117.00	6,844.00	1.30	1.462
#36	**Muskingum K:**					**1.462**
#37	5. Nearly bare and untilled, and alluvial valley fans	1.35	55.00	4,071.00	1.16	0.974
	8. Large gullies, diversions, and low flowing streams	1.49	146.00	9,792.00	3.66	0.743
#37	**Muskingum K:**					**1.717**
#38	8. Large gullies, diversions, and low flowing streams	1.19	23.00	1,938.00	3.26	0.165
#38	**Muskingum K:**					**0.165**
#39	8. Large gullies, diversions, and low flowing streams	1.04	39.00	3,758.00	3.05	0.342
#39	**Muskingum K:**					**0.342**
#41	8. Large gullies, diversions, and low flowing streams	0.71	20.00	2,800.00	2.53	0.307
#41	**Muskingum K:**					**0.307**

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#42	5. Nearly bare and untilled, and alluvial valley fans	1.84	132.00	7,189.15	1.35	1.479
#42	**Muskingum K:**					**1.479**
#43	5. Nearly bare and untilled, and alluvial valley fans	1.48	31.00	2,090.07	1.21	0.479
#43	**Muskingum K:**					**0.479**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#35	104.800	104.800	14.85	0.82
#26	217.200	217.200	149.15	8.41
#29	90.200	307.400	148.23	9.55
#37	3,024.600	3,024.600	7.61	3.80
#4	2,965.700	5,990.300	111.72	22.46
#1	755.100	755.100	12.86	3.10
#42	2,360.600	3,115.700	16.14	7.29
#3	1,550.000	4,665.700	20.47	10.68
#5	0.000	10,656.000	117.92	33.14
#6	2,008.700	12,664.700	174.09	52.92
#40	155.400	13,127.500	177.29	63.67
#43	817.400	817.400	83.09	19.78
#22	163.500	163.500	79.81	5.25
#30	138.800	1,119.700	94.64	26.11
#19	452.600	452.600	68.58	8.30
#33	0.000	1,572.300	154.66	34.41
#18	119.500	1,691.800	154.23	35.34
#34	239.400	239.400	1.35	0.40
#16	1,217.400	1,217.400	8.84	2.66
#14	6,694.399	6,694.399	83.52	20.56
#38	0.000	8,151.199	87.49	23.63
#39	0.000	8,151.199	87.17	23.63
#15	640.700	8,791.899	97.64	29.31
#41	0.000	23,611.200	340.70	128.32
#31	120.200	120.200	14.23	0.94
#17	846.700	846.700	51.02	9.66
#32	178.400	24,756.500	357.69	140.31
#36	14.200	14.200	19.33	0.69
#25	359.300	359.300	125.36	11.55
#21	90.300	90.300	55.89	2.65
#13	23.300	23.300	19.75	0.92
#12	75.500	75.500	63.34	2.97
#11	154.900	154.900	121.44	5.98
#10	32.500	32.500	23.91	1.26
#9	15.000	15.000	20.41	0.72
#8	58.800	58.800	80.02	2.84
#7	204.800	204.800	115.07	7.23
#27	619.300	1,647.900	413.86	41.61

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#28	508.400	2,156.300	412.04	45.55
#23	192.200	27,209.800	631.09	188.87
#24	548.700	27,758.500	640.08	203.68

Structure Detail:

Structure #35 (Null)

Structure #26 (Null)

Structure #29 (Null)

Structure #37 (Null)

Structure #4 (Null)

Structure #1 (Null)

Structure #42 (Null)

Structure #3 (Null)

Structure #5 (Null)

Structure #6 (Null)

Structure #40 (Null)

Structure #43 (Null)

Structure #22 (Null)

Structure #30 (Null)

Structure #19 (Null)

Structure #33 (Null)

Structure #18 (Null)

Structure #34 (Null)

Structure #16 (Null)

Structure #14 (Null)

Structure #38 (Null)

Doby Channel

Structure #39 (Null)

Doby Permanent Imp.

Structure #15 (Null)

Structure #41 (Culvert)

Culvert CP-31, 32, 33 & 34 (Yazzie "Y")

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
150.00	3.10	0.0200	9.00	0.00	0.90

Culvert Results:

Design Discharge = 340.70 cfs

Minimum pipe diameter: 1 - 84 inch pipe(s) required

Structure #31 (Null)

Structure #17 (Null)

Structure #32 (Null)

Structure #36 (Null)

Structure #25 (Null)

Structure #21 (Null)

Structure #13 (Null)

Structure #12 (Null)

Structure #11 (Null)

Structure #10 (Null)

Structure #9 (Null)

Structure #8 (Null)

Structure #7 (Null)

Structure #27 (Null)

Structure #28 (Null)

Structure #23 (Culvert)

Culvert CP-5

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
311.00	0.70	0.0200	70.00	0.00	0.90

Culvert Results:

Design Discharge = 631.09 cfs

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Minimum pipe diameter: 1 - 66 inch pipe(s) required

Structure #24 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#35	1	104.800	0.255	0.000	0.000	76.000	M	14.85	0.818
	Σ	**104.800**						**14.85**	**0.818**
#26	1	217.200	0.311	0.000	0.000	91.000	M	149.15	8.407
	Σ	**217.200**						**149.15**	**8.407**
#29	1	90.200	0.179	0.000	0.000	79.750	M	25.94	1.146
	Σ	**307.400**						**148.23**	**9.554**
#37	1	3,024.600	5.355	0.000	0.000	67.000	M	7.61	3.796
	Σ	**3,024.600**						**7.61**	**3.796**
#4	1	654.900	1.236	0.423	0.345	69.000	M	7.48	1.431
	2	699.700	1.092	0.423	0.345	74.620	M	29.76	4.435
	3	547.300	0.989	0.423	0.345	75.300	M	28.19	3.837
	4	1,063.800	1.498	0.000	0.000	76.610	M	50.29	8.961
	Σ	**5,990.300**						**111.72**	**22.460**
#1	1	755.100	2.032	0.000	0.000	72.000	M	12.86	3.096
	Σ	**755.100**						**12.86**	**3.096**
#42	1	1,327.100	2.923	3.078	0.144	69.000	M	8.93	2.898
	2	894.200	3.620	0.000	0.000	67.000	M	2.97	1.122
	3	139.300	1.214	0.000	0.000	67.000	M	0.85	0.175
	Σ	**3,115.700**						**16.14**	**7.291**
#3	1	1,550.000	2.670	0.000	0.000	69.000	M	11.07	3.385
	Σ	**4,665.700**						**20.47**	**10.677**
#5	Σ	**10,656.000**						**117.92**	**33.137**
#6	1	505.100	2.338	0.620	0.328	72.000	M	7.81	2.071
	2	638.400	4.585	0.478	0.304	72.000	M	6.07	2.617
	3	557.000	2.219	0.000	0.000	82.000	M	39.86	8.960
	4	308.200	0.485	0.478	0.304	84.000	M	84.65	6.131
	Σ	**12,664.700**						**174.09**	**52.917**
#40	1	155.400	1.202	0.000	0.000	76.000	M	7.84	1.204
	Σ	**13,127.500**						**177.29**	**63.674**
#43	1	817.400	2.463	0.000	0.000	86.000	M	83.09	19.779
	Σ	**817.400**						**83.09**	**19.779**
#22	1	163.500	0.425	0.000	0.000	88.960	M	79.81	5.252

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Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
	Σ	**163.500**						**79.81**	**5.252**
#30	1	138.800	0.282	0.000	0.000	76.000	M	18.54	1.081
	Σ	**1,119.700**						**94.64**	**26.111**
#19	1	452.600	1.009	0.000	0.000	83.230	M	68.58	8.300
	Σ	**452.600**						**68.58**	**8.300**
#33	Σ	**1,572.300**						**154.66**	**34.411**
#18	1	119.500	0.376	0.000	0.000	76.000	M	13.35	0.926
	Σ	**1,691.800**						**154.23**	**35.337**
#34	1	239.400	2.496	0.000	0.000	68.000	M	1.35	0.404
	Σ	**239.400**						**1.35**	**0.404**
#16	1	1,217.400	2.604	0.000	0.000	69.000	M	8.84	2.659
	Σ	**1,217.400**						**8.84**	**2.659**
#14	1	2,999.900	5.968	5.461	0.261	67.000	M	6.93	3.765
	2	1,855.400	3.914	1.286	0.322	67.000	M	5.85	2.329
	3	730.800	1.418	0.000	0.000	83.000	M	83.52	13.078
	4	1,108.300	2.763	1.418	0.312	67.000	M	4.31	1.391
	Σ	**6,694.399**						**83.52**	**20.563**
#38	Σ	**8,151.199**						**87.49**	**23.625**
#39	Σ	**8,151.199**						**87.17**	**23.625**
#15	1	640.700	1.116	0.000	0.000	77.000	M	39.99	5.686
	Σ	**8,791.899**						**97.64**	**29.311**
#41	Σ	**23,611.200**						**340.70**	**128.323**
#31	1	120.200	0.344	0.000	0.000	76.000	M	14.23	0.936
	Σ	**120.200**						**14.23**	**0.936**
#17	1	725.500	1.232	0.713	0.220	78.000	M	48.87	7.328
	2	121.200	0.456	0.000	0.000	83.700	M	33.49	2.334
	Σ	**846.700**						**51.02**	**9.662**
#32	1	128.500	0.672	0.108	0.329	76.000	M	9.72	0.997
	2	49.900	0.493	0.000	0.000	76.000	M	4.66	0.387
	Σ	**24,756.500**						**357.69**	**140.305**
#36	1	14.200	0.048	0.000	0.000	91.000	M	19.33	0.686
	Σ	**14.200**						**19.33**	**0.686**
#25	1	359.300	0.731	0.000	0.000	89.000	M	125.36	11.552

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
	Σ	**359.300**						**125.36**	**11.552**
#21	1	90.300	0.204	0.000	0.000	88.000	M	55.89	2.652
	Σ	**90.300**						**55.89**	**2.652**
#13	1	23.300	0.162	0.000	0.000	91.000	M	19.75	0.917
	Σ	**23.300**						**19.75**	**0.917**
#12	1	75.500	0.172	0.000	0.000	91.000	M	63.34	2.965
	Σ	**75.500**						**63.34**	**2.965**
#11	1	154.900	0.208	0.000	0.000	91.000	M	121.44	5.983
	Σ	**154.900**						**121.44**	**5.983**
#10	1	32.500	0.258	0.000	0.000	91.000	M	23.91	1.261
	Σ	**32.500**						**23.91**	**1.261**
#9	1	15.000	0.099	0.000	0.000	91.000	M	20.41	0.725
	Σ	**15.000**						**20.41**	**0.725**
#8	1	58.800	0.116	0.000	0.000	91.000	M	80.02	2.842
	Σ	**58.800**						**80.02**	**2.842**
#7	1	204.800	0.394	0.000	0.000	90.000	M	115.07	7.230
	Σ	**204.800**						**115.07**	**7.230**
#27	1	619.300	1.560	0.000	0.000	76.000	M	25.82	4.797
	Σ	**1,647.900**						**413.86**	**41.609**
#28	1	508.400	0.555	0.000	0.000	76.000	M	43.82	3.941
	Σ	**2,156.300**						**412.04**	**45.550**
#23	1	192.200	0.380	0.000	0.000	79.000	M	33.29	2.198
	Σ	**27,209.800**						**631.09**	**188.871**
#24	1	341.800	0.456	0.000	0.000	87.620	M	141.34	9.666
	2	72.600	0.247	0.479	0.310	86.530	M	36.82	1.867
	3	134.300	0.224	0.023	0.370	86.000	M	67.57	3.281
	Σ	**27,758.500**						**640.08**	**203.685**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	4.45	103.00	2,312.00	2.110	0.304
		8. Large gullies, diversions, and low flowing streams	2.03	110.00	5,414.45	4.270	0.352

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		5. Nearly bare and untilled, and alluvial valley fans	1.57	97.00	6,194.12	1.250	1.376
#1	**1**	**Time of Concentration:**					**2.032**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	1.32	140.00	10,633.45	1.140	2.590
		8. Large gullies, diversions, and low flowing streams	5.53	113.00	2,042.00	7.050	0.080
#3	**1**	**Time of Concentration:**					**2.670**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	1.72	60.00	3,483.10	1.310	0.738
		8. Large gullies, diversions, and low flowing streams	1.45	94.00	6,477.39	3.610	0.498
#4	**1**	**Time of Concentration:**					**1.236**
#4	2	5. Nearly bare and untilled, and alluvial valley fans	5.90	110.00	1,863.01	2.420	0.213
		8. Large gullies, diversions, and low flowing streams	1.43	163.00	11,361.26	3.590	0.879
#4	**2**	**Time of Concentration:**					**1.092**
#4	3	5. Nearly bare and untilled, and alluvial valley fans	5.81	100.00	1,722.00	2.400	0.199
		8. Large gullies, diversions, and low flowing streams	2.04	248.00	12,174.16	4.280	0.790
#4	**3**	**Time of Concentration:**					**0.989**
#4	4	5. Nearly bare and untilled, and alluvial valley fans	4.95	105.00	2,123.01	2.220	0.265
		8. Large gullies, diversions, and low flowing streams	1.96	366.00	18,657.28	4.200	1.233
#4	**4**	**Time of Concentration:**					**1.498**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	1.36	125.00	9,201.32	1.160	2.203
		8. Large gullies, diversions, and low flowing streams	3.46	94.00	2,715.03	5.580	0.135
#6	**1**	**Time of Concentration:**					**2.338**
#6	2	5. Nearly bare and untilled, and alluvial valley fans	0.88	130.00	14,813.12	0.930	4.424
		8. Large gullies, diversions, and low flowing streams	4.76	181.00	3,801.00	6.540	0.161
#6	**2**	**Time of Concentration:**					**4.585**
#6	3	5. Nearly bare and untilled, and alluvial valley fans	0.70	35.00	5,028.01	0.830	1.682
		8. Large gullies, diversions, and low flowing streams	2.49	228.00	9,161.04	4.730	0.537
#6	**3**	**Time of Concentration:**					**2.219**
#6	4	5. Nearly bare and untilled, and alluvial valley fans	4.17	73.00	1,752.02	2.040	0.238
		8. Large gullies, diversions, and low flowing streams	3.61	183.00	5,073.04	5.690	0.247
#6	**4**	**Time of Concentration:**					**0.485**
#7	1	8. Large gullies, diversions, and low flowing streams	3.49	195.00	5,587.07	5.600	0.277

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		5. Nearly bare and untilled, and alluvial valley fans	4.84	45.00	930.00	2.190	0.117
#7	**1**	**Time of Concentration:**					**0.394**
#8	1	8. Large gullies, diversions, and low flowing streams	4.91	123.00	2,506.06	6.640	0.104
		5. Nearly bare and untilled, and alluvial valley fans	38.04	105.00	276.00	6.160	0.012
#8	**1**	**Time of Concentration:**					**0.116**
#9	1	5. Nearly bare and untilled, and alluvial valley fans	8.33	45.00	540.00	2.880	0.052
		8. Large gullies, diversions, and low flowing streams	5.57	67.00	1,203.00	7.070	0.047
#9	**1**	**Time of Concentration:**					**0.099**
#10	1	5. Nearly bare and untilled, and alluvial valley fans	4.68	83.00	1,775.02	2.160	0.228
		5. Nearly bare and untilled, and alluvial valley fans	20.83	105.00	504.00	4.560	0.030
#10	**1**	**Time of Concentration:**					**0.258**
#11	1	8. Large gullies, diversions, and low flowing streams	4.55	190.00	4,176.00	6.390	0.181
		5. Nearly bare and untilled, and alluvial valley fans	12.60	45.00	357.00	3.550	0.027
#11	**1**	**Time of Concentration:**					**0.208**
#12	1	8. Large gullies, diversions, and low flowing streams	4.07	120.00	2,950.07	6.050	0.135
		5. Nearly bare and untilled, and alluvial valley fans	10.05	43.00	428.00	3.160	0.037
#12	**1**	**Time of Concentration:**					**0.172**
#13	1	5. Nearly bare and untilled, and alluvial valley fans	3.65	30.00	823.00	1.900	0.120
		8. Large gullies, diversions, and low flowing streams	5.15	53.00	1,030.00	6.800	0.042
#13	**1**	**Time of Concentration:**					**0.162**
#14	1	5. Nearly bare and untilled, and alluvial valley fans	1.01	216.00	21,486.12	1.000	5.968
#14	**1**	**Time of Concentration:**					**5.968**
#14	2	5. Nearly bare and untilled, and alluvial valley fans	1.41	235.00	16,630.10	1.180	3.914
#14	**2**	**Time of Concentration:**					**3.914**
#14	3	5. Nearly bare and untilled, and alluvial valley fans	2.19	43.00	1,966.00	1.470	0.371
		8. Large gullies, diversions, and low flowing streams	1.60	105.00	6,562.00	3.790	0.480
		5. Nearly bare and untilled, and alluvial valley fans	1.08	23.00	2,124.12	1.040	0.567
#14	**3**	**Time of Concentration:**					**1.418**
#14	4	5. Nearly bare and untilled, and alluvial valley fans	1.08	112.00	10,345.00	1.040	2.763
#14	**4**	**Time of Concentration:**					**2.763**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#15	1	5. Nearly bare and untilled, and alluvial valley fans	1.51	43.00	2,851.08	1.220	0.649
		8. Large gullies, diversions, and low flowing streams	2.54	42.00	1,652.04	4.780	0.096
		8. Large gullies, diversions, and low flowing streams	1.03	42.00	4,065.04	3.040	0.371
#15	**1**	**Time of Concentration:**					**1.116**
#16	1	5. Nearly bare and untilled, and alluvial valley fans	1.26	96.00	7,647.57	1.120	1.896
		8. Large gullies, diversions, and low flowing streams	0.18	6.00	3,264.41	1.280	0.708
#16	**1**	**Time of Concentration:**					**2.604**
#17	1	5. Nearly bare and untilled, and alluvial valley fans	2.23	127.00	5,692.00	1.490	1.061
		8. Large gullies, diversions, and low flowing streams	1.94	50.00	2,574.00	4.180	0.171
#17	**1**	**Time of Concentration:**					**1.232**
#17	2	5. Nearly bare and untilled, and alluvial valley fans	4.36	149.00	3,419.07	2.080	0.456
#17	**2**	**Time of Concentration:**					**0.456**
#18	1	5. Nearly bare and untilled, and alluvial valley fans	3.11	25.00	804.01	1.760	0.126
		8. Large gullies, diversions, and low flowing streams	1.41	45.00	3,196.02	3.550	0.250
#18	**1**	**Time of Concentration:**					**0.376**
#19	1	5. Nearly bare and untilled, and alluvial valley fans	4.92	45.00	914.00	2.210	0.114
		8. Large gullies, diversions, and low flowing streams	2.64	185.00	7,019.00	4.870	0.400
		5. Nearly bare and untilled, and alluvial valley fans	1.12	21.00	1,872.15	1.050	0.495
#19	**1**	**Time of Concentration:**					**1.009**
#21	1	5. Nearly bare and untilled, and alluvial valley fans	8.40	63.00	750.00	2.890	0.072
		8. Large gullies, diversions, and low flowing streams	4.57	140.00	3,064.06	6.410	0.132
#21	**1**	**Time of Concentration:**					**0.204**
#22	1	5. Nearly bare and untilled, and alluvial valley fans	4.15	54.00	1,300.01	2.030	0.177
		8. Large gullies, diversions, and low flowing streams	3.22	155.00	4,807.09	5.380	0.248
#22	**1**	**Time of Concentration:**					**0.425**
#23	1	5. Nearly bare and untilled, and alluvial valley fans	6.91	43.00	622.00	2.620	0.065
		8. Large gullies, diversions, and low flowing streams	2.65	147.00	5,545.07	4.880	0.315
#23	**1**	**Time of Concentration:**					**0.380**
#24	1	5. Nearly bare and untilled, and alluvial valley fans	5.30	55.00	1,038.01	2.300	0.125

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	3.06	191.00	6,252.04	5.240	0.331
#24	**1**	**Time of Concentration:**					**0.456**
#24	2	5. Nearly bare and untilled, and alluvial valley fans	4.80	62.00	1,291.02	2.190	0.163
		8. Large gullies, diversions, and low flowing streams	5.86	130.00	2,217.03	7.260	0.084
#24	**2**	**Time of Concentration:**					**0.247**
#24	3	5. Nearly bare and untilled, and alluvial valley fans	9.91	145.00	1,463.00	3.140	0.129
		8. Large gullies, diversions, and low flowing streams	4.59	101.00	2,199.09	6.420	0.095
#24	**3**	**Time of Concentration:**					**0.224**
#25	1	5. Nearly bare and untilled, and alluvial valley fans	3.33	55.00	1,653.04	1.820	0.252
		8. Large gullies, diversions, and low flowing streams	2.90	256.00	8,816.03	5.110	0.479
#25	**1**	**Time of Concentration:**					**0.731**
#26	1	5. Nearly bare and untilled, and alluvial valley fans	9.72	75.00	772.00	3.110	0.068
		8. Large gullies, diversions, and low flowing streams	3.54	175.00	4,938.06	5.640	0.243
#26	**1**	**Time of Concentration:**					**0.311**
#27	1	5. Nearly bare and untilled, and alluvial valley fans	3.85	40.00	1,038.00	1.960	0.147
		8. Large gullies, diversions, and low flowing streams	0.84	117.00	13,940.18	2.740	1.413
#27	**1**	**Time of Concentration:**					**1.560**
#28	1	5. Nearly bare and untilled, and alluvial valley fans	7.19	120.00	1,669.00	2.680	0.172
		8. Large gullies, diversions, and low flowing streams	1.41	69.00	4,904.39	3.550	0.383
#28	**1**	**Time of Concentration:**					**0.555**
#29	1	8. Large gullies, diversions, and low flowing streams	3.73	105.00	2,814.03	5.790	0.135
		5. Nearly bare and untilled, and alluvial valley fans	2.15	5.00	233.00	1.460	0.044
#29	**1**	**Time of Concentration:**					**0.179**
#30	1	5. Nearly bare and untilled, and alluvial valley fans	16.59	38.00	229.00	4.070	0.015
		8. Large gullies, diversions, and low flowing streams	1.79	69.00	3,856.04	4.010	0.267
#30	**1**	**Time of Concentration:**					**0.282**
#31	1	5. Nearly bare and untilled, and alluvial valley fans	2.13	26.00	1,218.02	1.460	0.231
		9. Small streams flowing bankfull	0.97	35.00	3,606.01	8.860	0.113
#31	**1**	**Time of Concentration:**					**0.344**
#32	1	5. Nearly bare and untilled, and alluvial valley fans	2.41	27.00	1,118.00	1.550	0.200

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	2.98	88.00	2,957.00	5.170	0.158
		5. Nearly bare and untilled, and alluvial valley fans	1.83	28.00	1,528.00	1.350	0.314
#32	**1**	**Time of Concentration:**					**0.672**
#32	2	5. Nearly bare and untilled, and alluvial valley fans	2.41	31.00	1,284.00	1.550	0.230
		8. Large gullies, diversions, and low flowing streams	0.71	17.00	2,394.02	2.520	0.263
#32	**2**	**Time of Concentration:**					**0.493**
#34	1	5. Nearly bare and untilled, and alluvial valley fans	1.50	164.00	10,964.76	1.220	2.496
#34	**1**	**Time of Concentration:**					**2.496**
#35	1	8. Large gullies, diversions, and low flowing streams	3.24	144.00	4,442.11	5.400	0.228
		5. Nearly bare and untilled, and alluvial valley fans	8.78	26.00	296.00	2.960	0.027
#35	**1**	**Time of Concentration:**					**0.255**
#36	1	5. Nearly bare and untilled, and alluvial valley fans	6.55	15.00	229.00	2.550	0.024
		8. Large gullies, diversions, and low flowing streams	8.56	66.00	771.00	8.770	0.024
#36	**1**	**Time of Concentration:**					**0.048**
#37	1	5. Nearly bare and untilled, and alluvial valley fans	1.16	240.00	20,629.19	1.070	5.355
#37	**1**	**Time of Concentration:**					**5.355**
#40	1	5. Nearly bare and untilled, and alluvial valley fans	2.78	20.00	720.00	1.660	0.120
		8. Large gullies, diversions, and low flowing streams	0.62	57.00	9,200.00	2.360	1.082
#40	**1**	**Time of Concentration:**					**1.202**
#42	1	5. Nearly bare and untilled, and alluvial valley fans	3.45	93.00	2,694.01	1.850	0.404
		8. Large gullies, diversions, and low flowing streams	2.37	100.00	4,211.05	4.620	0.253
		5. Nearly bare and untilled, and alluvial valley fans	1.17	103.00	8,811.70	1.080	2.266
#42	**1**	**Time of Concentration:**					**2.923**
#42	2	5. Nearly bare and untilled, and alluvial valley fans	0.62	63.00	10,166.21	0.780	3.620
#42	**2**	**Time of Concentration:**					**3.620**
#42	3	5. Nearly bare and untilled, and alluvial valley fans	1.24	60.00	4,853.19	1.110	1.214
#42	**3**	**Time of Concentration:**					**1.214**
#43	1	5. Nearly bare and untilled, and alluvial valley fans	1.12	93.00	8,290.98	1.050	2.193
		8. Large gullies, diversions, and low flowing streams	3.42	185.00	5,404.14	5.550	0.270
#43	**1**	**Time of Concentration:**					**2.463**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#4	1	8. Large gullies, diversions, and low flowing streams	1.61	93.00	5,787.18	3.800	0.423
#4	**1**	**Muskingum K:**					**0.423**
#4	2	8. Large gullies, diversions, and low flowing streams	1.61	93.00	5,787.18	3.800	0.423
#4	**2**	**Muskingum K:**					**0.423**
#4	3	8. Large gullies, diversions, and low flowing streams	1.61	93.00	5,787.00	3.800	0.423
#4	**3**	**Muskingum K:**					**0.423**
#6	1	8. Large gullies, diversions, and low flowing streams	1.16	84.00	7,218.35	3.230	0.620
#6	**1**	**Muskingum K:**					**0.620**
#6	2	8. Large gullies, diversions, and low flowing streams	0.77	35.00	4,531.33	2.630	0.478
#6	**2**	**Muskingum K:**					**0.478**
#6	4	8. Large gullies, diversions, and low flowing streams	0.77	35.00	4,531.33	2.630	0.478
#6	**4**	**Muskingum K:**					**0.478**
#14	1	5. Nearly bare and untilled, and alluvial valley fans	0.99	153.00	15,503.09	0.990	4.349
		8. Large gullies, diversions, and low flowing streams	1.65	125.00	7,564.29	3.850	0.545
		5. Nearly bare and untilled, and alluvial valley fans	1.08	23.00	2,124.12	1.040	0.567
#14	**1**	**Muskingum K:**					**5.461**
#14	2	8. Large gullies, diversions, and low flowing streams	1.65	125.00	7,564.29	3.850	0.545
		5. Nearly bare and untilled, and alluvial valley fans	1.46	11.00	755.02	1.200	0.174
		5. Nearly bare and untilled, and alluvial valley fans	1.08	23.00	2,124.12	1.040	0.567
#14	**2**	**Muskingum K:**					**1.286**
#14	4	5. Nearly bare and untilled, and alluvial valley fans	2.19	43.00	1,966.00	1.470	0.371
		8. Large gullies, diversions, and low flowing streams	1.60	105.00	6,562.00	3.790	0.480
		5. Nearly bare and untilled, and alluvial valley fans	1.08	23.00	2,124.00	1.040	0.567
#14	**4**	**Muskingum K:**					**1.418**
#17	1	5. Nearly bare and untilled, and alluvial valley fans	1.80	62.00	3,443.10	1.340	0.713
#17	**1**	**Muskingum K:**					**0.713**
#24	2	8. Large gullies, diversions, and low flowing streams	0.86	41.00	4,786.36	2.770	0.479
#24	**2**	**Muskingum K:**					**0.479**
#24	3	8. Large gullies, diversions, and low flowing streams	2.63	11.00	419.01	4.860	0.023

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#24	**3**	**Muskingum K:**					**0.023**
#32	1	8. Large gullies, diversions, and low flowing streams	1.18	15.00	1,268.00	3.260	0.108
#32	**1**	**Muskingum K:**					**0.108**
#42	1	5. Nearly bare and untilled, and alluvial valley fans	0.48	37.00	7,646.20	0.690	3.078
#42	**1**	**Muskingum K:**					**3.078**

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-6

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\06

Date: 12-05-1995

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Company Name: BHP MINERALS
Filename: C:\BRIAN\06 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:33
As built design specifications for CP-6
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	195.10	89	M	0.754	0.000	0.000	0.0	7.87	68.54
			Type: Null			Label: CP-6				
111	Structure	195.10							7.87	
111	Total IN/OUT	195.10							7.87	68.54

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Company Name: BHP MINERALS
Filename: C:\BRIAN\06 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:33
As built design specifications for CP-6
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	4800.00	3.13	1.77	0.75	0.754		

SEDCAD+ CULVERT SIZING UTILITY

CP-6

Design Discharge	=	68.540	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	218.000	feet
Pipe Slope	=	2.100	%
Manning's n	=	0.024	
Maximum Headwater	=	36.000	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 30 inches

PERFORMANCE CURVES:

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
3.60	14.07	Outlet	6
7.20	17.47	Outlet	6
10.80	20.30	Outlet	6
14.40	22.80	Outlet	6
18.00	25.04	Outlet	6
21.60	27.09	Outlet	6
25.20	29.01	Outlet	6
28.80	30.79	Outlet	6
32.40	32.48	Outlet	6
36.00	34.08	Outlet	6
39.60	35.62	Outlet	6
43.20	37.10	Outlet	6
46.80	38.51	Outlet	6
50.40	39.87	Outlet	6
54.00	41.20	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
3.60	19.57	Outlet	6
7.20	24.42	Outlet	6
10.80	28.45	Outlet	6
14.40	31.98	Outlet	6
18.00	35.16	Outlet	6
21.60	38.07	Outlet	6
25.20	40.78	Outlet	6
28.80	43.31	Outlet	6
32.40	45.70	Outlet	6
36.00	47.98	Outlet	6
39.60	50.12	Outlet	6
43.20	52.19	Outlet	6
46.80	54.24	Outlet	6
50.40	56.12	Outlet	6
54.00	58.01	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
3.60	32.76	Inlet	5
7.20	42.33	Outlet	6
10.80	49.59	Outlet	6
14.40	55.89	Outlet	6
18.00	61.58	Outlet	6
21.60	66.79	Outlet	6
25.20	71.62	Outlet	6
28.80	76.15	Outlet	6
32.40	80.42	Outlet	6
36.00	84.49	Outlet	6
39.60	88.36	Outlet	6
43.20	92.05	Outlet	6
46.80	95.61	Outlet	6
50.40	99.07	Outlet	6
54.00	102.37	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
3.60	42.32	Inlet (Supercritical)	4
7.20	65.67	Outlet	6
10.80	77.44	Outlet	6
14.40	87.65	Outlet	6
18.00	96.78	Outlet	6
21.60	105.13	Outlet	6
25.20	112.86	Outlet	6
28.80	120.09	Outlet	6
32.40	126.90	Outlet	6
36.00	133.39	Outlet	6
39.60	139.56	Outlet	6
43.20	145.46	Outlet	6
46.80	151.14	Outlet	6
50.40	156.61	Outlet	6
54.00	161.90	Outlet	6

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
3.60	50.07	Inlet (Supercritical)	3
7.20	94.48	Outlet	6
10.80	112.13	Outlet	6
14.40	127.38	Outlet	6
18.00	140.98	Outlet	6
21.60	153.39	Outlet	6
25.20	164.86	Outlet	6
28.80	175.58	Outlet	6
32.40	185.69	Outlet	6
36.00	195.27	Outlet	6

39.60	204.42	Outlet	6
43.20	213.16	Outlet	6
46.80	221.55	Outlet	6
50.40	229.65	Outlet	6
54.00	237.46	Outlet	6

Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
3.60	53.64	Inlet (Supercritical)	3
7.20	110.81	Outlet	6
10.80	132.01	Outlet	6
14.40	150.26	Outlet	6
18.00	166.50	Outlet	6
21.60	181.31	Outlet	6
25.20	194.99	Outlet	6
28.80	207.78	Outlet	6
32.40	219.82	Outlet	6
36.00	231.23	Outlet	6
39.60	242.10	Outlet	6
43.20	252.51	Outlet	6
46.80	262.51	Outlet	6
50.40	272.14	Outlet	6
54.00	281.44	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-7

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\07

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\07 User: Brian Sambirsky
Date: 12-06-1995 Time: 09:38:26
As built design specifications for CP-7
Storm: 1.30 inches, 10 year- 6 hour, Type II-65 ..
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	87.80	89	M	0.548	0.000	0.000	0.0	3.54	38.10
			Type: Null			Label: CP-7				
111	Structure	87.80							3.54	
111	Total IN/OUT	87.80							3.54	38.10

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Company Name: BHP MINERALS
Filename: C:\BRIAN\07 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:36
As built design specifications for CP-7
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	3500.00	3.14	1.77	0.55	0.548		

SEDCAD+ CULVERT SIZING UTILITY

CP-7

Design Discharge	=	38.100	cfs
Entrance Loss Coefficient	=	0.2	
Pipe Length	=	158.000	feet
Pipe Slope	=	1.100	%
Manning's n	=	0.020	
Maximum Headwater	=	12.200	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 30 inches

PERFORMANCE CURVES:

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.22	5.79	Outlet (Subcritical)	1
2.44	12.41	Inlet	5
3.66	15.00	Outlet	6
4.88	17.15	Outlet	6
6.10	19.09	Outlet	6
7.32	20.84	Outlet	6
8.54	22.47	Outlet	6
9.76	24.00	Outlet	6
10.98	25.40	Outlet	6
12.20	26.74	Outlet	6
13.42	28.04	Outlet	6
14.64	29.25	Outlet	6
15.86	30.43	Outlet	6
17.08	31.56	Outlet	6
18.30	32.65	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.22	5.65	Inlet (Supercritical)	3
2.44	15.85	Inlet (Supercritical)	4
3.66	20.44	Outlet	6
4.88	23.58	Outlet	6
6.10	26.34	Outlet	6
7.32	28.84	Outlet	6
8.54	31.14	Outlet	6
9.76	33.28	Outlet	6
10.98	35.30	Outlet	6
12.20	37.20	Outlet	6
13.42	39.01	Outlet	6
14.64	40.74	Outlet	6
15.86	42.41	Outlet	6
17.08	44.01	Outlet	6
18.30	45.55	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.22	7.05	Inlet (Supercritical)	3
2.44	22.39	Outlet (Subcritical)	1 *
3.66	33.30	Inlet	5
4.88	39.44	Outlet	6
6.10	44.47	Outlet	6
7.32	48.99	Outlet	6
8.54	53.13	Outlet	6
9.76	56.97	Outlet	6
10.98	60.56	Outlet	6
12.20	63.96	Outlet	6
13.42	67.18	Outlet	6
14.64	70.26	Outlet	6
15.86	73.20	Outlet	6
17.08	76.03	Outlet	6
18.30	78.76	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.22	8.47	Inlet (Supercritical)	3
2.44	23.94	Inlet (Supercritical)	3
3.66	43.72	Inlet (Supercritical)	4
4.88	58.00	Inlet	5
6.10	67.15	Outlet	6
7.32	74.50	Outlet	6
8.54	81.18	Outlet	6
9.76	87.35	Outlet	6
10.98	93.12	Outlet	6
12.20	98.55	Outlet	6
13.42	103.69	Outlet	6
14.64	108.59	Outlet	6
15.86	113.28	Outlet	6
17.08	117.79	Outlet	6
18.30	122.12	Outlet	6

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.22	9.88	Inlet (Supercritical)	3
2.44	27.93	Inlet (Supercritical)	3
3.66	51.32	Inlet (Supercritical)	3
4.88	73.53	Inlet	5
6.10	90.57	Inlet	5
7.32	104.77	Inlet	5
8.54	114.94	Outlet	6
9.76	124.17	Outlet	6
10.98	132.76	Outlet	6

12.20	140.83	Outlet	6
13.42	148.44	Outlet	6
14.64	155.71	Outlet	6
15.86	162.63	Outlet	6
17.08	169.28	Outlet	6
18.30	175.69	Outlet	6

Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.22	10.58	Inlet (Supercritical)	3
2.44	29.93	Inlet (Supercritical)	3
3.66	54.98	Inlet (Supercritical)	3
4.88	81.13	Inlet	5
6.10	101.32	Inlet	5
7.32	118.11	Inlet	5
8.54	132.80	Inlet	5
9.76	144.86	Outlet	6
10.98	155.12	Outlet	6
12.20	164.74	Outlet	6
13.42	173.84	Outlet	6
14.64	182.49	Outlet	6
15.86	190.75	Outlet	6
17.08	198.65	Outlet	6
18.30	206.27	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-8

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\08

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\08 User: Brian Sambirsky
Date: 12-06-1995 Time: 09:38:28
As built design specifications for CP-8
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	48.50	89	M	0.336	0.000	0.000	0.0	1.96	27.74
			Type: Null			Label: CP-8				
111	Structure	48.50							1.96	
111	Total IN/OUT	48.50							1.96	27.74

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\08 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:34
As built design specifications for CP-8
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
.	1	1	1	-a	5	2175.00	3.22	1.79	0.34	0.336		

SEDCAD+ CULVERT SIZING UTILITY

CP-8

Design Discharge	=	27.740 cfs
Entrance Loss Coefficient	=	0.2
Pipe Length	=	80.000 feet
Pipe Slope	=	0.100 %
Manning's n	=	0.018
Maximum Headwater	=	10.700 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 21 inches

PERFORMANCE CURVES:

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.07	2.41	Outlet (Subcritical)	1
2.14	4.95	Outlet	6
3.21	6.87	Outlet	6
4.28	8.35	Outlet	6
5.35	9.61	Outlet	6
6.42	10.73	Outlet	6
7.49	11.74	Outlet	6
8.56	12.67	Outlet	6
9.63	13.54	Outlet	6
10.70	14.35	Outlet	6
11.77	15.13	Outlet	6
12.84	15.86	Outlet	6
13.91	16.55	Outlet	6
14.98	17.23	Outlet	6
16.05	17.88	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.07	3.00	Outlet (Subcritical)	1
2.14	7.03	Outlet	6
3.21	10.26	Outlet	6
4.28	12.70	Outlet	6
5.35	14.74	Outlet	6
6.42	16.53	Outlet	6
7.49	18.14	Outlet	6
8.56	19.61	Outlet	6
9.63	20.98	Outlet	6
10.70	22.29	Outlet	6
11.77	23.51	Outlet	6
12.84	24.67	Outlet	6
13.91	25.78	Outlet	6
14.98	26.84	Outlet	6
16.05	27.87	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.07	3.73	Outlet (Subcritical)	1
2.14	9.02	Outlet	6
3.21	14.15	Outlet	6
4.28	17.86	Outlet	6
5.35	20.91	Outlet	6
6.42	23.59	Outlet	6
7.49	26.00	Outlet	6
8.56	28.19	Outlet	6
9.63	30.22	Outlet	6
10.70	32.13	Outlet	6
11.77	33.93	Outlet	6
12.84	35.63	Outlet	6
13.91	37.26	Outlet	6
14.98	38.82	Outlet	6
16.05	40.33	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.07	4.58	Outlet (Subcritical)	1
2.14	12.05	Outlet (Subcritical)	1
3.21	18.33	Outlet	6
4.28	23.72	Outlet	6
5.35	28.10	Outlet	6
6.42	31.88	Outlet	6
7.49	35.24	Outlet	6
8.56	38.33	Outlet	6
9.63	41.17	Outlet	6
10.70	43.84	Outlet	6
11.77	46.35	Outlet	6
12.84	48.73	Outlet	6
13.91	51.00	Outlet	6
14.98	53.18	Outlet	6
16.05	55.27	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.07	6.69	Outlet (Subcritical)	1
2.14	15.67	Outlet (Subcritical)	1
3.21	26.67	Outlet	6
4.28	36.95	Outlet	6
5.35	44.94	Outlet	6
6.42	51.71	Outlet	6
7.49	57.69	Outlet	6
8.56	63.10	Outlet	6
9.63	68.09	Outlet	6
10.70	72.73	Outlet	6

11.77	77.09	Inlet	5 *
12.84	81.14	Inlet	5
13.91	84.99	Inlet	5
14.98	88.66	Inlet	5
16.05	92.19	Inlet	5

* (Transition Region - Data may need to be smoothed.)

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.07	8.78	Outlet (Subcritical)	1
2.14	19.03	Outlet (Subcritical)	1
3.21	35.83	Outlet (Subcritical)	1
4.28	50.87	Outlet	6
5.35	62.81	Inlet	5 *
6.42	72.58	Inlet	5
7.49	81.19	Inlet	5
8.56	88.97	Inlet	5
9.63	96.12	Inlet	5
10.70	102.77	Inlet	5
11.77	109.02	Inlet	5
12.84	114.93	Inlet	5
13.91	120.55	Inlet	5
14.98	125.92	Inlet	5
16.05	131.07	Inlet	5

* (Transition Region - Data may need to be smoothed.)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-9

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\09

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\09 User: Brian Sambirsky
Date: 12-06-1995 Time: 09:38:31
As built design specifications for CP-9
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	48.50	89	M	0.336	0.000	0.000	0.0	1.96	27.74
			Type: Null			Label: CP-9				
111	Structure	48.50							1.96	
111	Total IN/OUT	48.50							1.96	27.74

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\09 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:32
As built design specifications for CP-9
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	2175.00	3.22	1.79	0.34	0.336		

SEDCAD+ CULVERT SIZING UTILITY

CP-9

Design Discharge	=	27.740 cfs
Entrance Loss Coefficient	=	0.2
Pipe Length	=	48.000 feet
Pipe Slope	=	4.300 %
Manning's n	=	0.018
Maximum Headwater	=	6.500 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 24 inches

PERFORMANCE CURVES:

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	1.67	Inlet (Supercritical)	3
1.30	4.66	Inlet (Supercritical)	3
1.95	8.19	Inlet	5
2.60	10.83	Inlet	5
3.25	12.95	Inlet	5
3.90	14.76	Inlet	5
4.55	16.37	Inlet	5
5.20	17.84	Inlet	5
5.85	19.20	Inlet	5
6.50	20.46	Inlet	5
7.15	21.66	Inlet	5
7.80	22.79	Inlet	5
8.45	23.87	Inlet	5
9.10	24.90	Inlet	5
9.75	25.89	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	1.93	Inlet (Supercritical)	3
1.30	5.44	Inlet (Supercritical)	3
1.95	9.98	Inlet (Supercritical)	3
2.60	13.85	Inlet	5
3.25	16.88	Inlet	5
3.90	19.44	Inlet	5
4.55	21.70	Inlet	5
5.20	23.75	Inlet	5
5.85	25.63	Inlet	5
6.50	27.39	Inlet	5
7.15	29.04	Inlet	5
7.80	30.59	Inlet	5
8.45	32.09	Inlet	5
9.10	33.50	Inlet	5
9.75	34.86	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	2.21	Inlet (Supercritical)	3
1.30	6.21	Inlet (Supercritical)	3
1.95	11.41	Inlet (Supercritical)	3
2.60	16.83	Inlet	5
3.25	21.03	Inlet	5
3.90	24.51	Inlet	5
4.55	27.56	Inlet	5
5.20	30.30	Inlet	5
5.85	32.81	Inlet	5
6.50	35.15	Inlet	5
7.15	37.34	Inlet	5
7.80	39.41	Inlet	5
8.45	41.37	Inlet	5
9.10	43.25	Inlet	5
9.75	45.05	Inlet	5

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	2.76	Inlet (Supercritical)	3
1.30	7.76	Inlet (Supercritical)	3
1.95	14.26	Inlet (Supercritical)	3
2.60	21.95	Inlet (Supercritical)	3
3.25	29.41	Inlet	5
3.90	35.38	Inlet	5
4.55	40.49	Inlet	5
5.20	45.02	Inlet	5
5.85	49.14	Inlet	5
6.50	52.94	Inlet	5
7.15	56.48	Inlet	5
7.80	59.82	Inlet	5
8.45	62.97	Inlet	5
9.10	65.99	Inlet	5
9.75	68.86	Inlet	5

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	3.30	Inlet (Supercritical)	3
1.30	9.31	Inlet (Supercritical)	3
1.95	17.11	Inlet (Supercritical)	3
2.60	26.34	Inlet (Supercritical)	3
3.25	36.81	Inlet (Supercritical)	3
3.90	46.39	Inlet	5
4.55	54.37	Inlet	5
5.20	61.31	Inlet	5
5.85	67.55	Inlet	5
6.50	73.26	Inlet	5

7.15	78.56	Inlet	5
7.80	83.52	Inlet	5
8.45	88.20	Inlet	5
9.10	92.65	Inlet	5
9.75	96.89	Inlet	5

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	3.85	Inlet (Supercritical)	3
1.30	10.86	Inlet (Supercritical)	3
1.95	19.96	Inlet (Supercritical)	3
2.60	30.73	Inlet (Supercritical)	3
3.25	42.94	Inlet (Supercritical)	3
3.90	56.44	Inlet (Supercritical)	3
4.55	68.20	Inlet	5
5.20	78.36	Inlet	5
5.85	87.35	Inlet	5
6.50	95.50	Inlet	5
7.15	103.00	Inlet	5
7.80	110.00	Inlet	5
8.45	116.57	Inlet	5
9.10	122.79	Inlet	5
9.75	128.71	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-10

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\10

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\10 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:37
As built design specifications for CP-10
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	24.70	89	M	0.129	0.000	0.000	0.0	1.00	19.15
			Type: Null		Label: CP-10					
111	Structure	24.70							1.00	
111	Total IN/OUT	24.70							1.00	19.15

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Company Name: BHP MINERALS
Filename: C:\BRIAN\10 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:37
As built design specifications for CP-10
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1150.00	6.09	2.47	0.13	0.129		

SEDCAD+ CULVERT SIZING UTILITY

CP-10

Design Discharge	=	19.150 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	119.000 feet
Pipe Slope	=	4.000 %
Manning's n	=	0.016
Maximum Headwater	=	8.200 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 18 inches

PERFORMANCE CURVES:

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.82	1.58	Inlet (Supercritical)	3
1.64	3.72	Inlet	5
2.46	5.14	Inlet	5
3.28	6.11	Inlet	5
4.10	6.56	Outlet	6
4.92	7.01	Outlet	6
5.74	7.31	Outlet	6
6.56	7.61	Outlet	6
7.38	7.92	Outlet	6
8.20	8.20	Outlet	6
9.02	8.46	Outlet	6
9.84	8.73	Outlet	6
10.66	9.00	Outlet	6
11.48	9.24	Outlet	6
12.30	9.48	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.82	1.95	Inlet (Supercritical)	3
1.64	5.24	Inlet	5
2.46	7.61	Inlet	5
3.28	9.41	Inlet	5
4.10	10.92	Inlet	5
4.92	12.11	Inlet	5
5.74	12.67	Outlet	6
6.56	13.21	Outlet	6
7.38	13.73	Outlet	6
8.20	14.23	Outlet	6
9.02	14.71	Outlet	6
9.84	15.18	Outlet	6
10.66	15.63	Outlet	6
11.48	16.08	Outlet	6
12.30	16.50	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.82	2.35	Inlet (Supercritical)	3
1.64	6.60	Inlet (Supercritical)	3
2.46	10.32	Inlet	5
3.28	13.04	Inlet	5
4.10	15.27	Inlet	5
4.92	17.22	Inlet	5
5.74	18.98	Inlet	5
6.56	20.40	Inlet	5
7.38	21.36	Outlet	6
8.20	22.15	Outlet	6
9.02	22.92	Outlet	6
9.84	23.65	Outlet	6
10.66	24.36	Outlet	6
11.48	25.05	Outlet	6
12.30	25.74	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.82	2.73	Inlet (Supercritical)	3
1.64	7.70	Inlet (Supercritical)	3
2.46	13.11	Inlet	5
3.28	17.01	Inlet	5
4.10	20.16	Inlet	5
4.92	22.89	Inlet	5
5.74	25.31	Inlet	5
6.56	27.54	Inlet	5
7.38	29.59	Inlet	5
8.20	31.52	Inlet	5
9.02	32.95	Inlet	5
9.84	34.19	Outlet	6
10.66	35.24	Outlet	6
11.48	36.27	Outlet	6
12.30	37.26	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.82	3.11	Inlet (Supercritical)	3
1.64	8.80	Inlet (Supercritical)	3
2.46	15.81	Inlet	5
3.28	21.20	Inlet	5
4.10	25.48	Inlet	5
4.92	29.14	Inlet	5
5.74	32.40	Inlet	5
6.56	35.36	Inlet	5
7.38	38.09	Inlet	5
8.20	40.63	Inlet	5

9.02	43.02	Inlet	5
9.84	45.29	Inlet	5
10.66	47.45	Inlet	5
11.48	49.52	Inlet	5
12.30	51.06	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.82	3.89	Inlet (Supercritical)	3
1.64	10.99	Inlet (Supercritical)	3
2.46	20.20	Inlet (Supercritical)	3
3.28	29.70	Inlet	5
4.10	37.03	Inlet	5
4.92	43.13	Inlet	5
5.74	48.47	Inlet	5
6.56	53.28	Inlet	5
7.38	57.69	Inlet	5
8.20	61.78	Inlet	5
9.02	65.62	Inlet	5
9.84	69.25	Inlet	5
10.66	72.69	Inlet	5
11.48	75.99	Inlet	5
12.30	79.13	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-11

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\11

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\11 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:39
As built design specifications for CP-11
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	12.20	89	M	0.034	0.000	0.000	0.0	0.49	13.15
			Type: Null			Label: CP-11				
111	Structure	12.20							0.49	
111	Total IN/OUT	12.20							0.49	13.15

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Company Name: BHP MINERALS
Filename: C:\BRIAN\11 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:39
As built design specifications for CP-11
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	500.00	16.00	4.00	0.03	0.034		

SEDCAD+ CULVERT SIZING UTILITY

CP-11

Design Discharge	=	13.150 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	107.000 feet
Pipe Slope	=	0.600 %
Manning's n	=	0.016
Maximum Headwater	=	8.600 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 18 inches

PERFORMANCE CURVES:

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.86	1.78	Outlet (Subcritical)	1
1.72	3.02	Outlet	6
2.58	3.76	Outlet	6
3.44	4.39	Outlet	6
4.30	4.97	Outlet	6
5.16	5.45	Outlet	6
6.02	5.92	Outlet	6
6.88	6.33	Outlet	6
7.74	6.73	Outlet	6
8.60	7.11	Outlet	6
9.46	7.46	Outlet	6
10.32	7.81	Outlet	6
11.18	8.14	Outlet	6
12.04	8.44	Outlet	6
12.90	8.75	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.86	2.23	Outlet (Subcritical)	1
1.72	4.87	Inlet	5
2.58	6.29	Outlet	6
3.44	7.44	Outlet	6
4.30	8.44	Outlet	6
5.16	9.33	Outlet	6
6.02	10.15	Outlet	6
6.88	10.90	Outlet	6
7.74	11.60	Outlet	6
8.60	12.26	Outlet	6
9.46	12.90	Outlet	6
10.32	13.49	Outlet	6
11.18	14.07	Outlet	6
12.04	14.62	Outlet	6
12.90	15.15	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.86	3.13	Outlet (Subcritical)	1
1.72	7.02	Outlet (Subcritical)	1
2.58	9.36	Outlet	6
3.44	11.25	Outlet	6
4.30	12.86	Outlet	6
5.16	14.29	Outlet	6
6.02	15.58	Outlet	6
6.88	16.79	Outlet	6
7.74	17.91	Outlet	6
8.60	18.96	Outlet	6
9.46	19.96	Outlet	6
10.32	20.91	Outlet	6
11.18	21.81	Outlet	6
12.04	22.68	Outlet	6
12.90	23.51	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.86	4.22	Outlet (Subcritical)	1
1.72	8.30	Outlet (Subcritical)	1
2.58	12.86	Outlet	6
3.44	15.72	Outlet	6
4.30	18.15	Outlet	6
5.16	20.28	Outlet	6
6.02	22.21	Outlet	6
6.88	23.97	Outlet	6
7.74	25.62	Outlet	6
8.60	27.19	Outlet	6
9.46	28.65	Outlet	6
10.32	30.04	Outlet	6
11.18	31.38	Outlet	6
12.04	32.66	Outlet	6
12.90	33.89	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.86	5.51	Outlet (Subcritical)	1
1.72	9.28	Outlet (Subcritical)	1
2.58	16.55	Outlet	6
3.44	20.75	Outlet	6
4.30	24.19	Outlet	6
5.16	27.23	Outlet	6
6.02	29.94	Outlet	6
6.88	32.43	Outlet	6
7.74	34.75	Outlet	6
8.60	36.93	Outlet	6

9.46	38.98	Outlet	6
10.32	40.92	Outlet	6
11.18	42.78	Outlet	6
12.04	44.56	Outlet	6
12.90	46.26	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.86	8.36	Outlet (Subcritical)	1
1.72	12.38	Outlet (Subcritical)	1
2.58	21.91	Outlet (Subcritical)	1
3.44	31.27	Inlet	5
4.30	38.18	Outlet	6
5.16	43.62	Outlet	6
6.02	48.46	Outlet	6
6.88	52.86	Outlet	6
7.74	56.92	Outlet	6
8.60	60.70	Outlet	6
9.46	64.26	Outlet	6
10.32	67.64	Outlet	6
11.18	70.86	Outlet	6
12.04	73.93	Outlet	6
12.90	76.89	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-12 HYDROLOGY - BLOCK C AREA

by

Name: BH

Company Name: BHP MINERALS
File Name: C:\CP12\CP12

Date: 01-29-1999

Civil Software Design -- SEDCAD+ Version 3.1
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Cp12
Company Name: BHP MINERALS
Filename: C:\CP12\CP12 User: BH
Date: 01-29-1999 Time: 14:44:08
CP-12 HYDROLOGY - BLOCK C AREA
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

==========
SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
==========

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	26.50	89	M	0.177	0.000	0.000	0.0	1.07	18.52
			Type: Null		Label: CP-12					
111	Structure	26.50							1.07	
111	Total IN/OUT	26.50							1.07	18.52

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\CP12\CP12 User: BH
Date: 01-29-1999 Time: 14:44:08
CP-12 HYDROLOGY - BLOCK C AREA
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

==========
DETAILED SUBWATERSHED INPUT/OUTPUT TABLE
==========

Seg. Land Flow Segment Time M

Cp12

uskingum

J	B	S	SWS X	#	Condition	Distance (ft)	Slope (%)	Velocity (fps)	Time (hr)	Conc. (hr)	K (hr)
1	1	1	1	-a	5	1600.00	6.25	2.50	0.18	0.177	

Cp12culv
SEDCAD+ CULVERT SIZING UTILITY

CP-12 BLOCK C AREA

Design Discharge	=	18.520	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	101.000	feet
Pipe Slope	=	2.200	%
Manning's n	=	0.016	
Maximum Headwater	=	6.300	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 21 inches

PERFORMANCE CURVES:

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.63	1.33	Inlet (Supercritical)	3
1.26	3.71	Inlet (Supercritical)	3
1.89	6.07	Inlet	5
2.52	7.76	Inlet	5
3.15	9.08	Inlet	5
3.78	9.72	Outlet	6
4.41	10.32	Outlet	6
5.04	10.90	Outlet	6
5.67	11.43	Outlet	6
6.30	11.96	Outlet	6
6.93	12.44	Outlet	6
7.56	12.93	Outlet	6
8.19	13.38	Outlet	6
8.82	13.83	Outlet	6
9.45	14.26	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.63	1.60	Inlet (Supercritical)	3

Cpl2culv

1.26	4.45	Inlet (Supercritical)	3
1.89	7.91	Inlet	5
2.52	10.54	Inlet	5
3.15	12.64	Inlet	5
3.78	14.44	Inlet	5
4.41	15.80	Outlet	6
5.04	16.75	Outlet	6
5.67	17.60	Outlet	6
6.30	18.42	Outlet	6
6.93	19.21	Outlet	6
7.56	19.97	Outlet	6
8.19	20.69	Outlet	6
8.82	21.39	Outlet	6
9.45	22.07	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.63	1.85	Inlet (Supercritical)	3
1.26	5.19	Inlet (Supercritical)	3
1.89	9.53	Inlet (Supercritical)	3
2.52	13.42	Inlet	5
3.15	16.44	Inlet	5
3.78	19.00	Inlet	5
4.41	21.24	Inlet	5
5.04	23.26	Inlet	5
5.67	25.09	Inlet	5
6.30	26.35	Outlet	6
6.93	27.51	Outlet	6
7.56	28.62	Outlet	6
8.19	29.69	Outlet	6
8.82	30.72	Outlet	6
9.45	31.70	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.63	2.10	Inlet (Supercritical)	3

Cp12culv

1.26	5.92	Inlet (Supercritical)	3
1.89	10.88	Inlet (Supercritical)	3
2.52	16.24	Inlet	5
3.15	20.43	Inlet	5
3.78	23.91	Inlet	5
4.41	26.94	Inlet	5
5.04	29.65	Inlet	5
5.67	32.13	Inlet	5
6.30	34.45	Inlet	5
6.93	36.62	Inlet	5
7.56	38.66	Inlet	5
8.19	40.30	Outlet	6
8.82	41.77	Outlet	6
9.45	43.16	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.63	2.63	Inlet (Supercritical)	3
1.26	7.41	Inlet (Supercritical)	3
1.89	13.60	Inlet (Supercritical)	3
2.52	20.94	Inlet (Supercritical)	3
3.15	28.37	Inlet	5
3.78	34.35	Inlet	5
4.41	39.45	Inlet	5
5.04	43.95	Inlet	5
5.67	48.04	Inlet	5
6.30	51.80	Inlet	5
6.93	55.31	Inlet	5
7.56	58.61	Inlet	5
8.19	61.73	Inlet	5
8.82	64.71	Inlet	5
9.45	67.55	Inlet	5

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.63	3.15	Inlet (Supercritical)	3

	Cp12culv			
1.26	8.89	Inlet	(Supercritical)	3
1.89	16.32	Inlet	(Supercritical)	3
2.52	25.13	Inlet	(Supercritical)	3
3.15	35.12	Inlet	(Supercritical)	3
3.78	44.76	Inlet		5
4.41	52.75	Inlet		5
5.04	59.68	Inlet		5
5.67	65.88	Inlet		5
6.30	71.55	Inlet		5
6.93	76.81	Inlet		5
7.56	81.72	Inlet		5
8.19	86.36	Inlet		5
8.82	90.76	Inlet		5
9.45	94.96	Inlet		5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-13

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\13

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\13 User: Brian Sambirsky
Date: 12-06-1995 Time: 09:38:36
As built design specifications for CP-13
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	79.30	89	M	0.485	0.000	0.000	0.0	3.20	37.13
			Type: Null			Label: CP-13				
111	Structure	79.30							3.20	
111	Total IN/OUT	79.30							3.20	37.13

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\13 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:43
As built design specifications for CP-13
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2900.00	2.76	1.66	0.49	0.485		

SEDCAD+ CULVERT SIZING UTILITY

CP-13

Design Discharge	=	37.130 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	73.000 feet
Pipe Slope	=	3.500 %
Manning's n	=	0.018
Maximum Headwater	=	13.400 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 21 inches

PERFORMANCE CURVES:

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.34	4.05	Inlet (Supercritical)	3
2.68	8.14	Inlet	5
4.02	10.69	Outlet	6
5.36	12.05	Outlet	6
6.70	13.17	Outlet	6
8.04	14.20	Outlet	6
9.38	15.15	Outlet	6
10.72	16.08	Outlet	6
12.06	16.92	Outlet	6
13.40	17.75	Outlet	6
14.74	18.53	Outlet	6
16.08	19.27	Outlet	6
17.42	20.02	Outlet	6
18.76	20.69	Outlet	6
20.10	21.37	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.34	4.88	Inlet (Supercritical)	3
2.68	11.12	Inlet	5
4.02	15.04	Inlet	5
5.36	18.14	Inlet	5
6.70	20.24	Outlet	6
8.04	21.88	Outlet	6
9.38	23.39	Outlet	6
10.72	24.81	Outlet	6
12.06	26.18	Outlet	6
13.40	27.45	Outlet	6
14.74	28.68	Outlet	6
16.08	29.87	Outlet	6
17.42	30.99	Outlet	6
18.76	32.09	Outlet	6
20.10	33.13	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.34	5.69	Inlet (Supercritical)	3
2.68	14.25	Inlet	5
4.02	19.88	Inlet	5
5.36	24.22	Inlet	5
6.70	27.91	Inlet	5
8.04	31.09	Outlet	6
9.38	33.51	Outlet	6
10.72	35.59	Outlet	6
12.06	37.56	Outlet	6
13.40	39.43	Outlet	6
14.74	41.22	Outlet	6
16.08	42.93	Outlet	6
17.42	44.58	Outlet	6
18.76	46.17	Outlet	6
20.10	47.70	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.34	6.50	Inlet (Supercritical)	3
2.68	17.38	Inlet	5
4.02	25.09	Inlet	5
5.36	30.93	Inlet	5
6.70	35.85	Inlet	5
8.04	40.15	Inlet	5
9.38	44.04	Inlet	5
10.72	47.61	Inlet	5
12.06	50.91	Inlet	5
13.40	53.67	Outlet	6
14.74	56.14	Outlet	6
16.08	58.50	Outlet	6
17.42	60.77	Outlet	6
18.76	62.96	Outlet	6
20.10	65.07	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.34	8.12	Inlet (Supercritical)	3
2.68	22.97	Inlet (Supercritical)	3
4.02	36.38	Inlet	5
5.36	46.08	Inlet	5
6.70	54.06	Inlet	5
8.04	61.00	Inlet	5
9.38	67.23	Inlet	5
10.72	72.94	Inlet	5
12.06	78.23	Inlet	5
13.40	83.18	Inlet	5

14.74	87.85	Inlet	5
16.08	92.29	Inlet	5
17.42	96.52	Inlet	5
18.76	100.58	Inlet	5
20.10	104.48	Inlet	5

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.34	9.75	Inlet (Supercritical)	3
2.68	27.56	Inlet (Supercritical)	3
4.02	47.96	Inlet	5
5.36	62.91	Inlet	5
6.70	74.93	Inlet	5
8.04	85.28	Inlet	5
9.38	94.50	Inlet	5
10.72	102.89	Inlet	5
12.06	110.65	Inlet	5
13.40	117.91	Inlet	5
14.74	124.74	Inlet	5
16.08	131.21	Inlet	5
17.42	137.37	Inlet	5
18.76	143.28	Inlet	5
20.10	148.96	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-14

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\14

Date: 12-05-1995

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Company Name: BHP MINERALS
Filename: C:\BRIAN\14 User: Brian Sambirsky
Date: 12-06-1995 Time: 09:38:33
As built design specifications for CP-14
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	79.30	89	M	0.485	0.000	0.000	0.0	3.20	37.13
		Type: Null Label: CP-14								
111	Structure	79.30							3.20	
111	Total IN/OUT	79.30							3.20	37.13

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Company Name: BHP MINERALS
Filename: C:\BRIAN\14 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:44
As built design specifications for CP-14
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2900.00	2.76	1.66	0.49	0.485		

SEDCAD+ CULVERT SIZING UTILITY

CP-14

Design Discharge	=	37.130	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	129.000	feet
Pipe Slope	=	3.700	%
Manning's n	=	0.018	
Maximum Headwater	=	8.500	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 24 inches

PERFORMANCE CURVES:

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.85	2.48	Inlet (Supercritical)	3
1.70	6.96	Inlet (Supercritical)	3
2.55	10.65	Inlet	5
3.40	13.38	Inlet	5
4.25	15.65	Inlet	5
5.10	17.29	Inlet	5
5.95	18.15	Outlet	6
6.80	18.96	Outlet	6
7.65	19.72	Outlet	6
8.50	20.46	Outlet	6
9.35	21.17	Outlet	6
10.20	21.86	Outlet	6
11.05	22.53	Outlet	6
11.90	23.17	Outlet	6
12.75	23.79	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.85	2.88	Inlet (Supercritical)	3
1.70	8.12	Inlet (Supercritical)	3
2.55	13.58	Inlet	5
3.40	17.50	Inlet	5
4.25	20.69	Inlet	5
5.10	23.44	Inlet	5
5.95	25.80	Inlet	5
6.80	27.48	Outlet	6
7.65	28.62	Outlet	6
8.50	29.71	Outlet	6
9.35	30.77	Outlet	6
10.20	31.78	Outlet	6
11.05	32.77	Outlet	6
11.90	33.72	Outlet	6
12.75	34.66	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.85	3.29	Inlet (Supercritical)	3
1.70	9.29	Inlet (Supercritical)	3
2.55	16.46	Inlet	5
3.40	21.88	Inlet	5
4.25	26.18	Inlet	5
5.10	29.89	Inlet	5
5.95	33.19	Inlet	5
6.80	36.17	Inlet	5
7.65	38.95	Inlet	5
8.50	40.83	Outlet	6
9.35	42.33	Outlet	6
10.20	43.75	Outlet	6
11.05	45.14	Outlet	6
11.90	46.47	Outlet	6
12.75	47.77	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.85	4.11	Inlet (Supercritical)	3
1.70	11.61	Inlet (Supercritical)	3
2.55	21.32	Inlet (Supercritical)	3
3.40	30.89	Inlet	5
4.25	38.22	Inlet	5
5.10	44.36	Inlet	5
5.95	49.74	Inlet	5
6.80	54.61	Inlet	5
7.65	59.07	Inlet	5
8.50	63.22	Inlet	5
9.35	67.11	Inlet	5
10.20	70.78	Inlet	5
11.05	74.27	Inlet	5
11.90	77.61	Inlet	5
12.75	80.75	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.85	4.93	Inlet (Supercritical)	3
1.70	13.92	Inlet (Supercritical)	3
2.55	25.58	Inlet (Supercritical)	3
3.40	39.38	Inlet (Supercritical)	3
4.25	50.84	Inlet	5
5.10	60.30	Inlet	5
5.95	68.46	Inlet	5
6.80	75.75	Inlet	5
7.65	82.40	Inlet	5
8.50	88.55	Inlet	5

9.35	94.30	Inlet	5
10.20	99.72	Inlet	5
11.05	104.86	Inlet	5
11.90	109.76	Inlet	5
12.75	114.45	Inlet	5

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.85	5.75	Inlet (Supercritical)	3
1.70	16.25	Inlet (Supercritical)	3
2.55	29.85	Inlet (Supercritical)	3
3.40	45.95	Inlet (Supercritical)	3
4.25	62.97	Inlet	5
5.10	76.89	Inlet	5
5.95	88.65	Inlet	5
6.80	99.03	Inlet	5
7.65	108.42	Inlet	5
8.50	117.06	Inlet	5
9.35	125.10	Inlet	5
10.20	132.66	Inlet	5
11.05	139.81	Inlet	5
11.90	146.61	Inlet	5
12.75	153.11	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-15

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\15

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\15 User: Brian Sambirsky
Date: 12-06-1995 Time: 09:38:35
As built design specifications for CP-15
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	28.00	89	M	0.184	0.000	0.000	0.0	1.13	20.88
			Type: Null			Label: CP-15				
111	Structure	28.00							1.13	
111	Total IN/OUT	28.00							1.13	20.88

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Company Name: BHP MINERALS
Filename: C:\BRIAN\15 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:46
As built design specifications for CP-15
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1300.00	3.85	1.96	0.18	0.184		

SEDCAD+ CULVERT SIZING UTILITY

CP-15

Design Discharge	=	20.880	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	108.000	feet
Pipe Slope	=	2.600	%
Manning's n	=	0.016	
Maximum Headwater	=	11.900	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 18 inches

PERFORMANCE CURVES:

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.19	2.65	Inlet (Supercritical)	4
2.38	5.01	Inlet	5
3.57	5.72	Outlet	6
4.76	6.33	Outlet	6
5.95	6.88	Outlet	6
7.14	7.37	Outlet	6
8.33	7.85	Outlet	6
9.52	8.29	Outlet	6
10.71	8.71	Outlet	6
11.90	9.11	Outlet	6
13.09	9.49	Outlet	6
14.28	9.86	Outlet	6
15.47	10.22	Outlet	6
16.66	10.56	Outlet	6
17.85	10.90	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.19	3.41	Inlet (Supercritical)	3
2.38	7.41	Inlet	5
3.57	9.76	Outlet	6
4.76	10.90	Outlet	6
5.95	11.86	Outlet	6
7.14	12.74	Outlet	6
8.33	13.56	Outlet	6
9.52	14.34	Outlet	6
10.71	15.09	Outlet	6
11.90	15.79	Outlet	6
13.09	16.45	Outlet	6
14.28	17.09	Outlet	6
15.47	17.73	Outlet	6
16.66	18.33	Outlet	6
17.85	18.90	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.19	4.08	Inlet (Supercritical)	3
2.38	10.02	Inlet	5
3.57	13.87	Inlet	5
4.76	16.57	Inlet	5
5.95	18.31	Outlet	6
7.14	19.71	Outlet	6
8.33	21.01	Outlet	6
9.52	22.26	Outlet	6
10.71	23.42	Outlet	6
11.90	24.53	Outlet	6
13.09	25.60	Outlet	6
14.28	26.62	Outlet	6
15.47	27.60	Outlet	6
16.66	28.55	Outlet	6
17.85	29.47	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.19	4.76	Inlet (Supercritical)	3
2.38	12.66	Inlet	5
3.57	18.18	Inlet	5
4.76	22.38	Inlet	5
5.95	25.91	Inlet	5
7.14	28.31	Outlet	6
8.33	30.24	Outlet	6
9.52	32.06	Outlet	6
10.71	33.77	Outlet	6
11.90	35.39	Outlet	6
13.09	36.95	Outlet	6
14.28	38.45	Outlet	6
15.47	39.90	Outlet	6
16.66	41.28	Outlet	6
17.85	42.62	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.19	5.44	Inlet (Supercritical)	3
2.38	15.27	Inlet (Supercritical)	4
3.57	22.79	Inlet	5
4.76	28.47	Inlet	5
5.95	33.18	Inlet	5
7.14	37.31	Inlet	5
8.33	40.96	Inlet	5
9.52	43.72	Outlet	6
10.71	46.10	Outlet	6
11.90	48.36	Outlet	6

13.09	50.53	Outlet	6
14.28	52.60	Outlet	6
15.47	54.60	Outlet	6
16.66	56.52	Outlet	6
17.85	58.39	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.19	6.80	Inlet (Supercritical)	3
2.38	19.23	Inlet (Supercritical)	3
3.57	32.48	Inlet	5
4.76	42.02	Inlet	5
5.95	49.75	Inlet	5
7.14	56.43	Inlet	5
8.33	62.41	Inlet	5
9.52	67.86	Inlet	5
10.71	72.90	Inlet	5
11.90	77.61	Inlet	5
13.09	82.06	Inlet	5
14.28	86.28	Inlet	5
15.47	90.30	Inlet	5
16.66	94.15	Inlet	5
17.85	97.71	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-16 HYDROLOGY

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: C:\BEN\BARMOD\CP_16

Date: 05-22-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\CP_16 User: BEN HOSKIE
Date: 05-21-1998 Time: 13:24:02
CP-16 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	31.90	76	X	1.256	0.000	0.000	0.0	0.30	4.15
			Type: Null			Label: CP-119				
111	Structure	31.90							0.30	
111	Total IN/OUT	31.90							0.30	4.15
211	1	164.52	76	X	1.635	0.000	0.000	0.0	1.54	11.89
			Type: Null			Label: CP-16				
211	Structure	164.52							1.84	
211	Total IN/OUT	196.42							1.84	15.18
111 to 211 Routing						0.127	0.359			

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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\CP_16 User: BEN HOSKIE
Date: 05-22-1998 Time: 13:24:02
CP-16 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1875.00	4.12	2.03	0.26	0.256		
2	1	1	1	-a	5	3325.00	2.11	1.45	0.64	0.635		

SEDCAD+ CULVERT SIZING UTILITY

CP-16

Design Discharge	=	15.180 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	153.000 feet
Pipe Slope	=	1.100 %
Manning's n	=	0.017
Maximum Headwater	=	42.500 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
4.25	2.18	Outlet	6
8.50	2.98	Outlet	6
12.75	3.55	Outlet	6
17.00	4.08	Outlet	6
21.25	4.47	Outlet	6
25.50	4.87	Outlet	6
29.75	5.26	Outlet	6
34.00	5.66	Outlet	6
38.25	6.04	Outlet	6
42.50	6.32	Outlet	6
46.75	6.60	Outlet	6
51.00	6.89	Outlet	6
55.25	7.17	Outlet	6
59.50	7.45	Outlet	6
63.75	7.73	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
4.25	4.48	Outlet	6
8.50	6.16	Outlet	6
12.75	7.41	Outlet	6
17.00	8.51	Outlet	6
21.25	9.47	Outlet	6
25.50	10.36	Outlet	6
29.75	11.15	Outlet	6
34.00	11.95	Outlet	6
38.25	12.62	Outlet	6
42.50	13.29	Outlet	6
46.75	13.96	Outlet	6
51.00	14.55	Outlet	6
55.25	15.13	Outlet	6

59.50	15.71	Outlet	6
63.75	16.26	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
4.25	7.88	Outlet	6
8.50	10.76	Outlet	6
12.75	13.04	Outlet	6
17.00	14.98	Outlet	6
21.25	16.70	Outlet	6
25.50	18.27	Outlet	6
29.75	19.70	Outlet	6
34.00	21.02	Outlet	6
38.25	22.29	Outlet	6
42.50	23.47	Outlet	6
46.75	24.60	Outlet	6
51.00	25.68	Outlet	6
55.25	26.71	Outlet	6
59.50	27.72	Outlet	6
63.75	28.68	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
4.25	12.21	Outlet	6
8.50	16.87	Outlet	6
12.75	20.52	Outlet	6
17.00	23.61	Outlet	6
21.25	26.34	Outlet	6
25.50	28.81	Outlet	6
29.75	31.08	Outlet	6
34.00	33.20	Outlet	6
38.25	35.20	Outlet	6
42.50	37.08	Outlet	6
46.75	38.88	Outlet	6
51.00	40.59	Outlet	6
55.25	42.24	Outlet	6
59.50	43.77	Outlet	6
63.75	45.30	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
4.25	17.52	Outlet	6
8.50	24.51	Outlet	6
12.75	29.93	Outlet	6
17.00	34.48	Outlet	6

21.25	38.51	Outlet	6
25.50	42.16	Outlet	6
29.75	45.46	Outlet	6
34.00	48.59	Outlet	6
38.25	51.56	Outlet	6
42.50	54.30	Outlet	6
46.75	56.99	Outlet	6
51.00	59.46	Outlet	6
55.25	61.94	Outlet	6
59.50	64.22	Outlet	6
63.75	66.50	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
4.25	23.79	Outlet	6
8.50	33.68	Outlet	6
12.75	41.26	Outlet	6
17.00	47.63	Outlet	6
21.25	53.25	Outlet	6
25.50	58.34	Outlet	6
29.75	63.03	Outlet	6
34.00	67.41	Outlet	6
38.25	71.50	Outlet	6
42.50	75.35	Outlet	6
46.75	79.03	Outlet	6
51.00	82.57	Outlet	6
55.25	85.93	Outlet	6
59.50	89.17	Outlet	6
63.75	92.33	Outlet	6

Culvert CP-17 & 18, Downdrains 19, 20 & 21

Revised 7/14/03

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

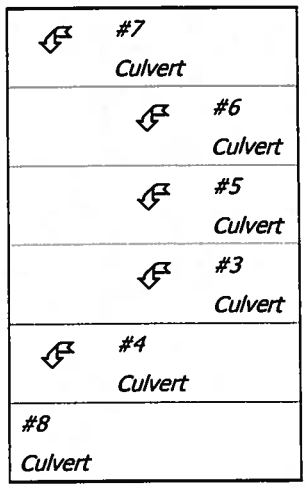
General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#3	==>	#4	0.284	0.339	Culvert CP-92
Culvert	#4	==>	#8	0.048	0.380	Culvert CP-18
Culvert	#5	==>	#4	0.000	0.000	Downdrain DD-19
Culvert	#6	==>	#4	0.000	0.000	Downdrain DD-20
Culvert	#7	==>	#8	0.023	0.413	Downdrain DD-21
Culvert	#8	==>	End	0.000	0.000	Culvert CP-17



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	8. Large gullies, diversions, and low flowing streams	1.42	52.00	3,660.16	3.57	0.284
#3	**Muskingum K:**					**0.284**
#4	8. Large gullies, diversions, and low flowing streams	3.22	30.00	932.00	5.38	0.048
#4	**Muskingum K:**					**0.048**
#7	8. Large gullies, diversions, and low flowing streams	7.24	50.00	691.00	8.06	0.023
#7	**Muskingum K:**					**0.023**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#7	5.300	5.300	3.86	0.26
#6	1.400	1.400	1.62	0.07
#5	4.300	4.300	4.98	0.21
#3	138.700	138.700	50.60	6.71
#4	321.000	465.400	143.32	22.53
#8	21.900	492.600	145.80	23.85

Structure Detail:

Structure #7 (Culvert)

Downdrain DD-21

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
68.00	45.00	0.0200	5.00	0.00	0.90

Culvert Results:

Design Discharge = 3.86 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Structure #6 (Culvert)

Downdrain DD-20

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
55.00	36.00	0.0200	4.50	0.00	0.90

Culvert Results:

Design Discharge = 1.62 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

Structure #5 (Culvert)

Downdrain DD-19

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
55.00	36.00	0.0200	5.00	0.00	0.90

Culvert Results:

Design Discharge = 4.98 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Structure #3 (Culvert)

Culvert CP-92

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	3.50	0.0200	4.00	0.00	0.90

Culvert Results:

Design Discharge = 50.60 cfs

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Structure #4 (Culvert)

Culvert CP-18

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
305.00	3.00	0.0200	36.60	0.00	0.90

Culvert Results:

Design Discharge = 143.32 cfs

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Structure #8 (Culvert)

Culvert CP-17

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
187.00	0.30	0.0160	8.60	0.00	0.90

Culvert Results:

Design Discharge = 145.80 cfs

Minimum pipe diameter: 1 - 54 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#7	1	5.300	0.141	0.000	0.000	91.000	M	3.86	0.257
	Σ	**5.300**						**3.86**	**0.257**
#6	1	1.400	0.075	0.000	0.000	91.000	M	1.62	0.068
	Σ	**1.400**						**1.62**	**0.068**
#5	1	4.300	0.119	0.000	0.000	91.000	M	4.98	0.208
	Σ	**4.300**						**4.98**	**0.208**
#3	1	138.700	0.772	0.000	0.000	91.000	M	50.60	6.715
	Σ	**138.700**						**50.60**	**6.715**
#4	1	321.000	1.070	0.000	0.000	91.000	M	94.22	15.540
	Σ	**465.400**						**143.32**	**22.530**
#8	1	21.900	0.119	0.000	0.000	91.000	M	25.35	1.060
	Σ	**492.600**						**145.80**	**23.847**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	1	5. Nearly bare and untilled, and alluvial valley fans	2.72	125.00	4,590.00	1.650	0.772
#3	**1**	**Time of Concentration:**					**0.772**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	2.75	175.00	6,360.00	1.650	1.070
#4	**1**	**Time of Concentration:**					**1.070**
#5	1	8. Large gullies, diversions, and low flowing streams	3.66	90.00	2,459.00	5.730	0.119
#5	**1**	**Time of Concentration:**					**0.119**
#6	1	8. Large gullies, diversions, and low flowing streams	1.50	15.00	998.00	3.670	0.075
#6	**1**	**Time of Concentration:**					**0.075**
#7	1	8. Large gullies, diversions, and low flowing streams	3.02	80.00	2,653.00	5.200	0.141
#7	**1**	**Time of Concentration:**					**0.141**
#8	1	5. Nearly bare and untilled, and alluvial valley fans	6.62	55.00	831.00	2.570	0.089
		8. Large gullies, diversions, and low flowing streams	2.11	10.00	473.01	4.360	0.030

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#8	**1**	**Time of Concentration:**					**0.119**

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Due to CP-18, CP-19, Downdrains 19, 20, & 21 data update

CP-68 data removed in 4/18/2000 submission
CP-151 data removed in 7/15/2003 submission

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-19 & CP-20 CULVERT AT THE NECK AREA

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: C:\BEN\CP19\19_20

Date: 05-28-1998

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Company Name: BHP MINERALS
Filename: C:\BEN\CP19\19_20 User: BEN HOSKIE
Date: 05-28-1998 Time: 11:44:00
CP-19 & CP-20 CULVERT AT THE NECK AREA
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	42.20	89	M	0.260	0.000	0.000	0.0	1.70	27.18
			Type: Null		Label: CP-20					
111	Structure	42.20							1.70	
111	Total IN/OUT	42.20							1.70	27.18
			Type: Null		Label: CP-20					
112	Structure	42.20							1.70	
112	Total IN/OUT	42.20							1.70	27.18
111 to 112 Routing						0.022	0.325			
			Type: Null		Label: CP-20					
113	Structure	42.20							1.70	
113	Total IN/OUT	42.20							1.70	24.88
112 to 113 Routing						0.090	0.287			
121	1	30.13	89	M	0.116	0.000	0.000	0.0	1.22	32.48
			Type: Null		Label: CP-19					
121	Structure	30.13							1.22	
121	Total IN/OUT	30.13							1.22	32.48
			Type: Null		Label: CP-19					
211	Structure	30.13							2.92	
211	Total IN/OUT	72.33							2.92	49.45
113 to 211 Routing						0.036	0.239			

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Company Name: BHP MINERALS
Filename: C:\BEN\CP19\19_20 User: BEN HOSKIE
Date: 05-28-1998 Time: 11:44:00
CP-19 & CP-20 CULVERT AT THE NECK AREA
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2130.00	5.16	2.27	0.26	0.260		
1	2	1	1	-a	5	810.00	3.70	1.92	0.12	0.116		

SEDCAD+ CULVERT SIZING UTILITY

CP-19

Design Discharge	=	49.450 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	203.000 feet
Pipe Slope	=	0.600 %
Manning's n	=	0.013
Maximum Headwater	=	23.400 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 30 inches

PERFORMANCE CURVES:

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.34	10.02	Outlet	6
4.68	14.60	Outlet	6
7.02	18.09	Outlet	6
9.36	20.98	Outlet	6
11.70	23.54	Outlet	6
14.04	25.84	Outlet	6
16.38	27.96	Outlet	6
18.72	29.92	Outlet	6
21.06	31.76	Outlet	6
23.40	33.49	Outlet	6
25.74	35.14	Outlet	6
28.08	36.72	Outlet	6
30.42	38.24	Outlet	6
32.76	39.70	Outlet	6
35.10	41.10	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.34	12.87	Inlet (Supercritical)	3
4.68	19.90	Outlet	6
7.02	24.82	Outlet	6
9.36	28.93	Outlet	6
11.70	32.52	Outlet	6
14.04	35.76	Outlet	6
16.38	38.72	Outlet	6
18.72	41.47	Outlet	6
21.06	44.06	Outlet	6
23.40	46.49	Outlet	6
25.74	48.81	Outlet	6
28.08	51.02	Outlet	6
30.42	53.14	Outlet	6

32.76	88.18	Outlet	6
35.10	87.14	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.34	16.58	Outlet (Subcritical)	1
4.68	32.64	Outlet	6
7.02	41.55	Outlet	6
9.36	48.86	Outlet	6
11.70	55.21	Outlet	6
14.04	60.91	Outlet	6
16.38	66.12	Outlet	6
18.72	70.94	Outlet	6
21.06	75.45	Outlet	6
23.40	79.69	Outlet	6
25.74	83.73	Outlet	6
28.08	87.59	Outlet	6
30.42	91.31	Outlet	6
32.76	94.84	Outlet	6
35.10	98.26	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.34	19.60	Outlet (Subcritical)	1
4.68	47.78	Outlet	6
7.02	62.28	Outlet	6
9.36	74.00	Outlet	6
11.70	84.06	Outlet	6
14.04	93.07	Outlet	6
16.38	101.30	Outlet	6
18.72	108.88	Outlet	6
21.06	116.00	Outlet	6
23.40	122.67	Outlet	6
25.74	129.01	Outlet	6
28.08	135.06	Outlet	6
30.42	140.85	Outlet	6
32.76	146.41	Outlet	6
35.10	151.76	Outlet	6

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.34	26.51	Outlet (Subcritical)	1
4.68	64.45	Outlet	6
7.02	86.47	Outlet	6
9.36	103.92	Outlet	6

11.70	113.85	Outlet	6
14.04	132.11	Outlet	6
16.38	144.14	Outlet	6
18.72	155.26	Outlet	6
21.06	165.63	Outlet	6
23.40	175.38	Outlet	6
25.74	184.61	Outlet	6
28.08	193.40	Outlet	6
30.42	201.82	Outlet	6
32.76	209.90	Outlet	6
35.10	217.67	Outlet	6

Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.34	30.51	Outlet (Subcritical)	1
4.68	73.02	Outlet	6
7.02	99.66	Outlet	6
9.36	120.57	Outlet	6
11.70	138.34	Outlet	6
14.04	154.08	Outlet	6
16.38	168.36	Outlet	6
18.72	181.53	Outlet	6
21.06	193.78	Outlet	6
23.40	205.33	Outlet	6
25.74	216.25	Outlet	6
28.08	226.64	Outlet	6
30.42	236.58	Outlet	6
32.76	246.12	Outlet	6
35.10	255.30	Outlet	6

SEDCAD+ CULVERT SIZING UTILITY

CP-20

Design Discharge	=	27.180	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	262.000	feet
Pipe Slope	=	2.500	%
Manning's n	=	0.016	
Maximum Headwater	=	27.000	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 21 inches

PERFORMANCE CURVES:

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.70	7.61	Inlet	5
5.40	9.69	Outlet	6
8.10	10.87	Outlet	6
10.80	11.87	Outlet	6
13.50	12.85	Outlet	6
16.20	13.72	Outlet	6
18.90	14.56	Outlet	6
21.60	15.35	Outlet	6
24.30	16.08	Outlet	6
27.00	16.82	Outlet	6
29.70	17.49	Outlet	6
32.40	18.15	Outlet	6
35.10	18.80	Outlet	6
37.80	19.41	Outlet	6
40.50	20.00	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.70	11.18	Inlet	5
5.40	15.31	Outlet	6
8.10	17.15	Outlet	6
10.80	18.80	Outlet	6
13.50	20.31	Outlet	6
16.20	21.72	Outlet	6
18.90	23.07	Outlet	6
21.60	24.30	Outlet	6
24.30	25.50	Outlet	6
27.00	26.64	Outlet	6
29.70	27.73	Outlet	6
32.40	28.79	Outlet	6
35.10	29.80	Outlet	6
37.80	30.79	Outlet	6
40.50	31.73	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.70	14.33	Inlet	5
5.40	22.28	Outlet	6
8.10	25.08	Outlet	6
10.80	27.53	Outlet	6
13.50	29.78	Outlet	6
16.20	31.87	Outlet	6
18.90	33.83	Outlet	6
21.60	35.69	Outlet	6
24.30	37.46	Outlet	6
27.00	39.15	Outlet	6
29.70	40.76	Outlet	6
32.40	42.31	Outlet	6
35.10	43.81	Outlet	6
37.80	45.27	Outlet	6
40.50	46.67	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.70	17.52	Inlet	5
5.40	30.73	Outlet	6
8.10	34.70	Outlet	6
10.80	38.15	Outlet	6
13.50	41.31	Outlet	6
16.20	44.24	Outlet	6
18.90	47.01	Outlet	6
21.60	49.60	Outlet	6
24.30	52.07	Outlet	6
27.00	54.43	Outlet	6
29.70	56.69	Outlet	6
32.40	58.87	Outlet	6
35.10	60.97	Outlet	6
37.80	62.99	Outlet	6
40.50	64.96	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.70	23.23	Inlet (Supercritical)	3
5.40	46.33	Inlet	5
8.10	59.11	Outlet	6
10.80	65.17	Outlet	6
13.50	70.68	Outlet	6
16.20	75.82	Outlet	6
18.90	80.63	Outlet	6
21.60	85.17	Outlet	6
24.30	89.48	Outlet	6
27.00	93.60	Outlet	6

29.70	97.55	Outlet	6
32.40	101.34	Outlet	6
35.10	104.97	Outlet	6
37.80	108.50	Outlet	6
40.50	111.94	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
2.70	27.87	Inlet (Supercritical)	3
5.40	63.30	Inlet	5
8.10	85.69	Inlet	5
10.80	99.86	Outlet	6
13.50	108.59	Outlet	6
16.20	116.69	Outlet	6
18.90	124.22	Outlet	6
21.60	131.36	Outlet	6
24.30	138.11	Outlet	6
27.00	144.54	Outlet	6
29.70	150.71	Outlet	6
32.40	156.64	Outlet	6
35.10	162.35	Outlet	6
37.80	167.86	Outlet	6
40.50	173.19	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-21

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\21

Date: 12-05-1995

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Company Name: BHP MINERALS
Filename: C:\BRIAN\21 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:53
As built design specifications for CP-21
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	37.30	89	M	0.479	0.000	0.000	0.0	1.51	17.59
			Type: Null			Label: CP-21				
111	Structure	37.30							1.51	
111	Total IN/OUT	37.30							1.51	17.59

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Company Name: BHP MINERALS
Filename: C:\BRIAN\21 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:04:53
As built design specifications for CP-21
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	3100.00	3.23	1.80	0.48	0.479		

SEDCAD+ CULVERT SIZING UTILITY

CP-21

Design Discharge	=	17.590	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	191.000	feet
Pipe Slope	=	1.500	%
Manning's n	=	0.024	
Maximum Headwater	=	12.800	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 21 inches

PERFORMANCE CURVES:

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.28	3.38	Outlet (Subcritical)	1
2.56	4.98	Outlet	6
3.84	5.65	Outlet	6
5.12	6.26	Outlet	6
6.40	6.82	Outlet	6
7.68	7.33	Outlet	6
8.96	7.82	Outlet	6
10.24	8.27	Outlet	6
11.52	8.70	Outlet	6
12.80	9.11	Outlet	6
14.08	9.50	Outlet	6
15.36	9.88	Outlet	6
16.64	10.24	Outlet	6
17.92	10.59	Outlet	6
19.20	10.93	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.28	3.98	Outlet (Subcritical)	1
2.56	7.76	Inlet	5
3.84	8.90	Outlet	6
5.12	9.90	Outlet	6
6.40	10.80	Outlet	6
7.68	11.63	Outlet	6
8.96	12.40	Outlet	6
10.24	13.14	Outlet	6
11.52	13.83	Outlet	6
12.80	14.49	Outlet	6
14.08	15.12	Outlet	6
15.36	15.71	Outlet	6
16.64	16.29	Outlet	6
17.92	16.87	Outlet	6
19.20	17.41	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.28	5.47	Outlet (Subcritical)	1
2.56	11.26	Outlet	6
3.84	12.96	Outlet	6
5.12	14.46	Outlet	6
6.40	15.80	Outlet	6
7.68	17.08	Outlet	6
8.96	18.22	Outlet	6
10.24	19.33	Outlet	6
11.52	20.36	Outlet	6
12.80	21.36	Outlet	6
14.08	22.30	Outlet	6
15.36	23.21	Outlet	6
16.64	24.07	Outlet	6
17.92	24.93	Outlet	6
19.20	25.73	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.28	7.24	Outlet (Subcritical)	1
2.56	15.11	Outlet (Subcritical)	1
3.84	17.82	Outlet	6
5.12	19.97	Outlet	6
6.40	21.92	Outlet	6
7.68	23.71	Outlet	6
8.96	25.37	Outlet	6
10.24	26.94	Outlet	6
11.52	28.40	Outlet	6
12.80	29.80	Outlet	6
14.08	31.14	Outlet	6
15.36	32.42	Outlet	6
16.64	33.65	Outlet	6
17.92	34.85	Outlet	6
19.20	35.99	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.28	7.59	Inlet (Supercritical)	3
2.56	18.49	Outlet (Subcritical)	1 *
3.84	29.96	Outlet	6
5.12	33.90	Outlet	6
6.40	37.42	Outlet	6
7.68	40.64	Outlet	6
8.96	43.62	Outlet	6
10.24	46.41	Outlet	6
11.52	49.05	Outlet	6
12.80	51.54	Outlet	6

14.08	53.92	Outlet	6
15.36	56.20	Outlet	6
16.64	58.40	Outlet	6
17.92	60.51	Outlet	6
19.20	62.55	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.28	9.10	Inlet (Supercritical)	3
2.56	23.79	Outlet (Subcritical)	2 *
3.84	44.94	Outlet	6
5.12	51.43	Outlet	6
6.40	57.17	Outlet	6
7.68	62.37	Outlet	6
8.96	67.19	Outlet	6
10.24	71.67	Outlet	6
11.52	75.89	Outlet	6
12.80	79.89	Outlet	6
14.08	83.70	Outlet	6
15.36	87.34	Outlet	6
16.64	90.84	Outlet	6
17.92	94.20	Outlet	6
19.20	97.46	Outlet	6

* (Transition Region - Data may need to be smoothed.)

For CP-22 data, please see Lowe By-pass Road Modification Culverts CP-172, CP173, CP22 and Road Side Ditch Designs

Pages 126 through 131 blank due to text reformatting.

Pages 132 through 143 Appendix 11-V

Blank due to Update

CP-30

Revised/Supplemental

Design Information

1/29/98

Reference Design Data for CP-121 & Exhibit 11-130

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

RIP RAP DROP STRUCTURE @ STA 14+64

by

Name: BH

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-130\SEDCAD\DROP_STR\N_HOST

Date: 01-05-1998

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\BEN\NHOST\N_HOST User: BH
Date: 11-05-1997 Time: 15:11:24
RIP RAP DROP STRUCTURE @ STA 14+64
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	31.77	78	M	0.245	0.000	0.000	0.0	0.40	6.09
		Type: Null		Label: J1B1S1 @ SIDE DITCH						
111	Structure	31.77							0.40	
111	Total IN/OUT	31.77							0.40	6.09

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\BEN\NHOST\N_HOST User: BH
Date: 11-05-1997 Time: 15:11:24
RIP RAP DROP STRUCTURE @ STA 14+64
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1474.00	2.78	1.67	0.25	0.245		

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-30 HYDROLOGY

by

Name: BH

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-130\SEDCAD\CP_30\CP_30

Date: 01-05-1998

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\BEN\CP_30 User: BEN HOSKIE
Date: 11-12-1997 Time: 15:38:38
CP-30 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	31.77	78	M	0.245	0.000	0.000	0.0	0.40	6.09
		Type: Null			Label: DROP STRUC STA 14+64					
111	Structure	31.77							0.40	
111	Total IN/OUT	31.77							0.40	6.09
211	1	32.00	89	M	0.299	0.000	0.000	0.0	1.29	19.36
		Type: Null			Label: CP-30					
211	Structure	32.00							1.69	
211	Total IN/OUT	63.77							1.69	23.74
111 to 211 Routing						0.124	0.314			

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\CP_30 User: BEN HOSKIE
Date: 11-12-1997 Time: 15:38:38
CP-30 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1474.00	2.78	1.67	0.25	0.245		
2	1	1	1	-a	5	1800.00	2.78	1.67	0.30	0.299		

SEDCAD+ CULVERT SIZING UTILITY

CP-30 NORTH HOSTEEN ROAD

Design Discharge	=	23.740	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	104.000	feet
Pipe Slope	=	2.800	%
Manning's n	=	0.020	
Maximum Headwater	=	14.400	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 21 inches

PERFORMANCE CURVES:

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.44	4.46	Inlet (Supercritical)	4
2.88	7.69	Outlet	6
4.32	8.85	Outlet	6
5.76	9.83	Outlet	6
7.20	10.72	Outlet	6
8.64	11.54	Outlet	6
10.08	12.31	Outlet	6
11.52	13.04	Outlet	6
12.96	13.69	Outlet	6
14.40	14.35	Outlet	6
15.84	15.00	Outlet	6
17.28	15.57	Outlet	6
18.72	16.15	Outlet	6
20.16	16.72	Outlet	6
21.60	17.26	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.44	5.43	Inlet (Supercritical)	3
2.88	11.79	Inlet	5
4.32	13.66	Outlet	6
5.76	15.24	Outlet	6
7.20	16.66	Outlet	6
8.64	17.96	Outlet	6
10.08	19.20	Outlet	6
11.52	20.33	Outlet	6
12.96	21.42	Outlet	6
14.40	22.45	Outlet	6
15.84	23.44	Outlet	6
17.28	24.38	Outlet	6
18.72	25.30	Outlet	6
20.16	26.18	Outlet	6
21.60	27.04	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type

1.44	6.34	Inlet (Supercritical)	3
2.88	15.22	Inlet	5
4.32	19.61	Outlet	6
5.76	21.93	Outlet	6
7.20	24.03	Outlet	6
8.64	25.96	Outlet	6
10.08	27.76	Outlet	6
11.52	29.45	Outlet	6
12.96	31.06	Outlet	6
14.40	32.57	Outlet	6
15.84	34.01	Outlet	6
17.28	35.41	Outlet	6
18.72	36.75	Outlet	6
20.16	38.03	Outlet	6
21.60	39.29	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.44	7.24	Inlet (Supercritical)	3
2.88	18.75	Inlet	5
4.32	26.35	Outlet	6
5.76	29.87	Outlet	6
7.20	32.83	Outlet	6
8.64	35.52	Outlet	6
10.08	38.03	Outlet	6
11.52	40.38	Outlet	6
12.96	42.61	Outlet	6
14.40	44.72	Outlet	6
15.84	46.74	Outlet	6
17.28	48.68	Outlet	6
18.72	50.53	Outlet	6
20.16	52.33	Outlet	6
21.60	54.06	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
1.44	9.05	Inlet (Supercritical)	3
2.88	25.47	Inlet (Supercritical)	3
4.32	38.77	Inlet	5
5.76	48.60	Inlet	5
7.20	54.49	Outlet	6
8.64	59.21	Outlet	6
10.08	63.56	Outlet	6
11.52	67.64	Outlet	6
12.96	71.49	Outlet	6
14.40	75.15	Outlet	6
15.84	78.63	Outlet	6
17.28	81.96	Outlet	6
18.72	85.17	Outlet	6
20.16	88.25	Outlet	6
21.60	91.24	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type

1.44	10.86	Inlet (Supercritical)	3
2.88	30.70	Inlet (Supercritical)	3
4.32	51.68	Inlet	5
5.76	66.73	Inlet	5
7.20	78.95	Inlet	5
8.64	88.68	Outlet	6
10.08	95.51	Outlet	6
11.52	101.88	Outlet	6
12.96	107.88	Outlet	6
14.40	113.56	Outlet	6
15.84	118.98	Outlet	6
17.28	124.15	Outlet	6
18.72	129.11	Outlet	6
20.16	133.89	Outlet	6
21.60	138.50	Outlet	6

CULVERT CP-35A & B

The culvert watershed is presented on Exhibit 11-12D. CP-35A & B are existing 24 inch diameter culverts.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

CULVERT CP-35 WATERSHED
CURVE NUMBER (CN) DETERMINATION

NRCS Soil Mapping Symbol	Hydrologic Group	Estimated % of Watershed	CN	Weighted CN
Du, So, Da & Sp	B	55	78	42.9
Sc & Sd	A	10	65	6.5
Ba & Mo	D	35	91	31.9
			Weighted Average CN	**81.3**

Used CN of 82 in Sedcad analysis

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CP-35

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	662.400	662.400	36.44	13.39

Structure Detail:

Structure #1 (Null)

CP-35

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	662.400	2.801	0.000	0.000	82.000	M	36.44	13.389
	Σ	**662.400**						**36.44**	**13.389**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.43	171.58	12,000.00	1.190	2.801
#1	**1**	**Time of Concentration:**					**2.801**

CULVERT CP-35A & B - (Design Discharge = 36.44/2 or 18.3 cfs)

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
70.00	0.80	0.0160	4.30	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 18.30 cfs

Maximum Headwater = 4.30 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (18 in)	**Discharge (cfs) (21 in)**	Discharge (cfs) (24 in)
0.43	0.90	**1.04**	1.18
0.86	2.51	**2.93**	3.34
1.29	3.94	**5.37**	6.14
1.72	6.23	**6.93**	9.45
2.15	8.67	**10.19**	11.21
2.58	9.89	**13.30**	16.69
3.01	10.96	**14.93**	19.21
3.44	11.95	**16.40**	21.30
3.87	12.86	**17.76**	23.21
4.30	13.71	**19.01**	24.97
4.73	14.50	**20.18**	26.62
5.16	15.26	**21.29**	28.17
5.59	15.98	**22.35**	29.64
6.02	16.68	**23.36**	31.04
6.45	17.34	**24.32**	32.38

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-36

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\CP36

Date: 02-17-1996

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\BRIAN\CP36 User: Brian Sambirsky
Date: 02-17-1996 Time: 07:33:03
As built design specifications for CP-36
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharg (cfs)
111	1	19.10	93	M	0.325	0.000	0.000	0.0	1.11	15.97
		Type: Null Label: CP-36								
111	Structure	19.10							1.11	
111	Total IN/OUT	19.10							1.11	15.97

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\CP36 User: Brian Sambirsky
Date: 02-17-1996 Time: 07:33:03
As built design specifications for CP-36
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1900.00	2.63	1.62	0.33	0.325		

SEDCAD+ CULVERT SIZING UTILITY

CP-36

Design Discharge	=	15.970 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	70.000 feet
Pipe Slope	=	0.600 %
Manning's n	=	0.020
Maximum Headwater	=	6.500 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 21 inches

PERFORMANCE CURVES:

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	1.61	Outlet (Subcritical)	1
1.30	3.25	Outlet (Subcritical)	2
1.95	4.67	Outlet	6
2.60	5.73	Outlet	6
3.25	6.61	Outlet	6
3.90	7.39	Outlet	6
4.55	8.11	Outlet	6
5.20	8.75	Outlet	6
5.85	9.36	Outlet	6
6.50	9.93	Outlet	6
7.15	10.46	Outlet	6
7.80	10.98	Outlet	6
8.45	11.46	Outlet	6
9.10	11.94	Outlet	6
9.75	12.38	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	2.25	Outlet (Subcritical)	1
1.30	4.05	Outlet (Subcritical)	1
1.95	6.72	Inlet	5
2.60	8.43	Outlet	6
3.25	9.89	Outlet	6
3.90	11.15	Outlet	6
4.55	12.28	Outlet	6
5.20	13.32	Outlet	6
5.85	14.28	Outlet	6
6.50	15.18	Outlet	6
7.15	16.04	Outlet	6
7.80	16.84	Outlet	6
8.45	17.61	Outlet	6
9.10	18.35	Outlet	6
9.75	19.06	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	3.05	Outlet (Subcritical)	1
1.30	4.79	Outlet (Subcritical)	1
1.95	8.83	Outlet (Subcritical)	1
2.60	11.43	Outlet	6
3.25	13.65	Outlet	6
3.90	15.55	Outlet	6
4.55	17.24	Outlet	6
5.20	18.78	Outlet	6
5.85	20.21	Outlet	6
6.50	21.54	Outlet	6
7.15	22.79	Outlet	6
7.80	23.98	Outlet	6
8.45	25.11	Outlet	6
9.10	26.19	Outlet	6
9.75	27.23	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	3.89	Outlet (Subcritical)	1
1.30	5.89	Outlet (Subcritical)	1
1.95	10.15	Outlet (Subcritical)	1
2.60	14.55	Outlet	6
3.25	17.78	Outlet	6
3.90	20.50	Outlet	6
4.55	22.91	Outlet	6
5.20	25.08	Outlet	6
5.85	27.08	Outlet	6
6.50	28.94	Outlet	6
7.15	30.68	Outlet	6
7.80	32.34	Outlet	6
8.45	33.92	Outlet	6
9.10	35.42	Outlet	6
9.75	36.86	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	5.66	Outlet (Subcritical)	1
1.30	9.03	Outlet (Subcritical)	1
1.95	12.12	Outlet (Subcritical)	1
2.60	19.70	Outlet (Subcritical)	1
3.25	26.43	Outlet	6
3.90	31.50	Outlet	6
4.55	35.87	Outlet	6
5.20	39.76	Outlet	6
5.85	43.29	Outlet	6
6.50	46.56	Outlet	6

7.15	49.62	Outlet	6
7.80	52.50	Outlet	6
8.45	55.23	Outlet	6
9.10	57.83	Outlet	6
9.75	60.32	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.65	7.42	Outlet (Subcritical)	1
1.30	12.47	Outlet (Subcritical)	1
1.95	16.65	Outlet (Subcritical)	1
2.60	23.00	Outlet (Subcritical)	1
3.25	33.14	Outlet (Subcritical)	1
3.90	42.85	Outlet	6
4.55	50.11	Outlet	6
5.20	56.44	Outlet	6
5.85	62.13	Outlet	6
6.50	67.33	Outlet	6
7.15	72.17	Outlet	6
7.80	76.70	Outlet	6
8.45	80.98	Outlet	6
9.10	85.04	Outlet	6
9.75	88.92	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-37

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\37

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\BRIAN\37
User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:04
As built design specifications for CP-37
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	21.30	89	M	0.330	0.000	0.000	0.0	0.86	12.29
			Type: Null			Label: CP-37				
111	Structure	21.30							0.86	
111	Total IN/OUT	21.30							0.86	12.29

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\37
User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:04
As built design specifications for CP-37
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2150.00	3.26	1.80	0.33	0.330		

SEDCAD+ CULVERT SIZING UTILITY

CP-37

Design Discharge	=	12.290 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	160.000 feet
Pipe Slope	=	1.500 %
Manning's n	=	0.016
Maximum Headwater	=	5.500 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 18 inches

PERFORMANCE CURVES:

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.55	0.90	Inlet (Supercritical)	3
1.10	2.38	Inlet (Supercritical)	4
1.65	3.43	Inlet	5
2.20	4.04	Outlet	6
2.75	4.31	Outlet	6
3.30	4.58	Outlet	6
3.85	4.85	Outlet	6
4.40	5.09	Outlet	6
4.95	5.31	Outlet	6
5.50	5.53	Outlet	6
6.05	5.75	Outlet	6
6.60	5.97	Outlet	6
7.15	6.16	Outlet	6
7.70	6.34	Outlet	6
8.25	6.53	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.55	1.08	Inlet (Supercritical)	3
1.10	3.02	Inlet (Supercritical)	3
1.65	5.27	Inlet	5
2.20	6.83	Outlet	6
2.75	7.44	Outlet	6
3.30	7.94	Outlet	6
3.85	8.38	Outlet	6
4.40	8.82	Outlet	6
4.95	9.23	Outlet	6
5.50	9.63	Outlet	6
6.05	10.02	Outlet	6
6.60	10.38	Outlet	6
7.15	10.73	Outlet	6
7.70	11.08	Outlet	6
8.25	11.41	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.55	1.31	Inlet (Supercritical)	3
1.10	3.63	Inlet (Supercritical)	3
1.65	6.66	Inlet (Supercritical)	3
2.20	9.29	Inlet	5
2.75	11.22	Inlet	5
3.30	12.25	Outlet	6
3.85	13.00	Outlet	6
4.40	13.69	Outlet	6
4.95	14.36	Outlet	6
5.50	15.00	Outlet	6
6.05	15.61	Outlet	6
6.60	16.20	Outlet	6
7.15	16.76	Outlet	6
7.70	17.31	Outlet	6
8.25	17.84	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.55	1.52	Inlet (Supercritical)	3
1.10	4.23	Inlet (Supercritical)	3
1.65	7.77	Inlet (Supercritical)	3
2.20	11.59	Inlet	5
2.75	14.60	Inlet	5
3.30	17.09	Inlet	5
3.85	18.65	Outlet	6
4.40	19.70	Outlet	6
4.95	20.69	Outlet	6
5.50	21.64	Outlet	6
6.05	22.55	Outlet	6
6.60	23.42	Outlet	6
7.15	24.27	Outlet	6
7.70	25.09	Outlet	6
8.25	25.87	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.55	1.73	Inlet (Supercritical)	3
1.10	4.84	Inlet (Supercritical)	3
1.65	8.88	Inlet (Supercritical)	3
2.20	13.67	Inlet (Supercritical)	3
2.75	17.89	Inlet	5
3.30	21.31	Inlet	5
3.85	24.26	Inlet	5
4.40	26.72	Outlet	6
4.95	28.21	Outlet	6
5.50	29.55	Outlet	6

6.05	30.83	Outlet	6
6.60	32.07	Outlet	6
7.15	33.25	Outlet	6
7.70	34.40	Outlet	6
8.25	35.50	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.55	2.14	Inlet (Supercritical)	3
1.10	6.04	Inlet (Supercritical)	3
1.65	11.10	Inlet (Supercritical)	3
2.20	17.08	Inlet (Supercritical)	3
2.75	23.87	Inlet (Supercritical)	3
3.30	29.91	Inlet	5
3.85	34.97	Inlet	5
4.40	39.37	Inlet	5
4.95	43.34	Inlet	5
5.50	46.97	Inlet	5
6.05	50.34	Inlet	5
6.60	53.29	Outlet	6
7.15	55.52	Outlet	6
7.70	57.54	Outlet	6
8.25	59.49	Outlet	6

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BLOCK B ROAD MODIFICATION

Culvert CP-49

The location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-49

#1
Culvert

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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	2.600	2.600	3.01	0.13

Structure Detail:

Structure #1 (Culvert)

CP-49

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
140.00	2.00	0.0150	8.00	0.00	0.90

Culvert Results:

Design Discharge = 3.01 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	2.600	0.026	0.000	0.000	91.000	M	3.01	0.126
	Σ	**2.600**						**3.01**	**0.126**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.60	3.00	83.24	1.890	0.012
		8. Large gullies, diversions, and low flowing streams	5.56	19.90	358.17	7.070	0.014
#1	**1**	**Time of Concentration:**					**0.026**

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BLOCK B ROAD MODIFICATION

Culvert CP-50

The location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-50

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	72.200	72.200	49.00	3.50

Structure Detail:

Structure #1 (Culvert)

CP-50

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
140.00	2.10	0.0150	7.00	0.00	0.90

Culvert Results:

Design Discharge = 49.00 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	72.200	0.203	0.000	0.000	91.000	M	49.00	3.495
	Σ	**72.200**						**49.00**	**3.495**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.59	5.00	313.48	1.260	0.069
		8. Large gullies, diversions, and low flowing streams	3.82	108.50	2,837.20	5.860	0.134
#1	**1**	**Time of Concentration:**					**0.203**

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BLOCK B ROAD MODIFICATION

Culvert CP-51

The location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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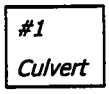
General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-51



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	122.100	122.100	71.06	5.91

Structure Detail:

Structure #1 (Culvert)

CP-51

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
134.00	1.10	0.0150	6.70	0.00	0.90

Culvert Results:

Design Discharge = 71.06 cfs

Minimum pipe diameter: 1 - 36 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	122.100	0.327	0.000	0.000	91.000	M	71.06	5.911
	Σ	**122.100**						**71.06**	**5.911**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.50	2.74	182.31	1.220	0.041
		8. Large gullies, diversions, and low flowing streams	3.09	167.70	5,427.70	5.270	0.286
#1	**1**	**Time of Concentration:**					**0.327**

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BLOCK B ROAD MODIFICATION

Culverts CP-52 & 53, see utility runs for culvert sizing.The location and watershed are shown on Exhibit 11-12D.

RYazzie

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PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CP-52 & 53

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	510.600	510.600	223.96	24.72

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	510.600	0.571	0.000	0.000	91.000	M	223.96	24.718
	Σ	**510.600**						**223.96**	**24.718**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.08	5.00	462.88	1.030	0.124
		8. Large gullies, diversions, and low flowing streams	2.72	217.50	7,982.89	4.950	0.447
#1	**1**	**Time of Concentration:**					**0.571**

Culvert CP-52 and 53, Design Storm 10 yr- 6 hr

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
142.00	0.70	0.0150	8.60	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 112.00 cfs

Maximum Headwater = 8.60 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (36 in)	**Discharge (cfs) (42 in)**	Discharge (cfs) (45 in)
0.86	5.01	**5.85**	6.27
1.72	14.17	**16.53**	17.72
2.58	26.04	**30.37**	32.54
3.44	37.80	**46.76**	50.10
4.30	51.44	**60.10**	70.01
5.16	59.55	**77.77**	86.18
6.02	66.27	**89.24**	100.10
6.88	72.38	**98.38**	112.32
7.74	78.00	**106.69**	122.20
8.60	83.26	**114.36**	131.32
9.46	88.17	**121.58**	139.85
10.32	92.85	**128.37**	147.90
11.18	97.31	**134.82**	155.53
12.04	101.56	**140.99**	162.81
12.90	105.63	**146.91**	169.76

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BLOCK B ROAD MODIFICATION

Culvert CP-54

The location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-54

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	18.500	18.500	13.47	0.90

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Structure Detail:

Structure #1 (Culvert)

CP-54

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
178.00	1.10	0.0150	12.50	0.00	0.90

Culvert Results:

Design Discharge = 13.47 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	18.500	0.154	0.000	0.000	91.000	M	13.47	0.896
	Σ	**18.500**						**13.47**	**0.896**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.12	3.53	314.01	1.060	0.082
		8. Large gullies, diversions, and low flowing streams	4.00	62.13	1,554.64	5.990	0.072
#1	**1**	**Time of Concentration:**					**0.154**

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BLOCK B ROAD MODIFICATION

Culvert: CP-55

The location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-55

#1
Culvert

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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	319.070	319.070	139.63	14.11

Structure Detail:

Structure #1 (Culvert)

CP-55

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
204.00	1.60	0.0150	11.50	0.00	0.90

Culvert Results:

Design Discharge = 139.63 cfs

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	319.070	0.483	0.000	0.000	90.000	M	139.63	14.110
	Σ	**319.070**						**139.63**	**14.110**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.26	10.00	441.74	1.500	0.081
		8. Large gullies, diversions, and low flowing streams	2.83	206.80	7,301.32	5.040	0.402
#1	**1**	**Time of Concentration:**					**0.483**

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BLOCK B ROAD MODIFICATION

Culvert CP-56

The location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-56

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	195.100	195.100	109.90	9.44

Structure Detail:

Structure #1 (Culvert)

CP-56

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
170.00	1.70	0.0150	16.50	0.00	0.90

Culvert Results:

Design Discharge = 109.90 cfs

Minimum pipe diameter: 1 - 36 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	195.100	0.354	0.000	0.000	91.000	M	109.90	9.445
	Σ	**195.100**						**109.90**	**9.445**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.45	5.00	204.23	1.560	0.036
		8. Large gullies, diversions, and low flowing streams	3.22	198.61	6,169.46	5.380	0.318
#1	**1**	**Time of Concentration:**					**0.354**

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BLOCK B ROAD MODIFICATION

Culvert CP-57

The location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-57

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	3.700	3.700	4.28	0.18

Structure Detail:

Structure #1 (Culvert)

CP-57

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
174.00	3.00	0.0150	10.40	0.00	0.90

Culvert Results:

Design Discharge = 4.28 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	3.700	0.011	0.000	0.000	91.000	M	4.28	0.179
	Σ	**3.700**						**4.28**	**0.179**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	40.14	3.40	8.47	6.330	0.000
		8. Large gullies, diversions, and low flowing streams	11.49	47.44	412.81	10.160	0.011
#1	**1**	**Time of Concentration:**					**0.011**

BLOCK B ROAD MODIFICATION

Culvert CP-58

The location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-58

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	4.700	4.700	5.44	0.23

Structure Detail:

Structure #1 (Culvert)

CP-58

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
140.00	3.30	0.0150	9.80	0.00	0.90

Culvert Results:

Design Discharge = 5.44 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	4.700	0.059	0.000	0.000	91.000	M	5.44	0.228
	Σ	**4.700**						**5.44**	**0.228**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.71	2.50	146.30	1.300	0.031
		8. Large gullies, diversions, and low flowing streams	7.85	67.07	854.59	8.400	0.028
#1	**1**	**Time of Concentration:**					**0.059**

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BLOCK B ROAD MODIFICATION

Culvert CP-59

The location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-59

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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	4.530	4.530	5.24	0.22

Structure Detail:

Structure #1 (Culvert)

CP-59

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
142.00	3.40	0.0150	9.60	0.00	0.90

Culvert Results:

Design Discharge = 5.24 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	4.530	0.028	0.000	0.000	91.000	M	5.24	0.219
	Σ	**4.530**						**5.24**	**0.219**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	12.06	10.80	89.58	3.470	0.007
		8. Large gullies, diversions, and low flowing streams	8.41	56.81	675.60	8.690	0.021
#1	**1**	**Time of Concentration:**					**0.028**

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BLOCK B ROAD MODIFICATION

Culvert CP-60

The location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-60

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	13.780	13.780	15.95	0.67

Structure Detail:

Structure #1 (Culvert)

CP-60

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
230.00	2.50	0.0150	7.00	0.00	0.90

Culvert Results:

Design Discharge = 15.95 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	13.780	0.116	0.000	0.000	91.000	M	15.95	0.667
	Σ	**13.780**						**15.95**	**0.667**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.16	13.00	411.22	1.770	0.064
		8. Large gullies, diversions, and low flowing streams	5.59	75.01	1,342.88	7.090	0.052
#1	**1**	**Time of Concentration:**					**0.116**

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BLOCK B ROAD MODIFICATION

Culvert CP-61

The location and watershed are shown on Exhibit 11-12.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 Inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-61

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	53.870	53.870	39.23	2.61

Structure Detail:

Structure #1 (Culvert)

CP-61

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
140.00	2.90	0.0150	6.50	0.00	0.90

Culvert Results:

Design Discharge = 39.23 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	53.870	0.158	0.000	0.000	91.000	M	39.23	2.608
	Σ	**53.870**						**39.23**	**2.608**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.75	1.00	134.15	0.860	0.043
		8. Large gullies, diversions, and low flowing streams	5.95	180.83	3,041.26	7.310	0.115
#1	**1**	**Time of Concentration:**					**0.158**

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BLOCK B ROAD MODIFICATION

Culvert CP-62

the location and watershed are shown on Exhibit 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

Copyright 1998 Pamela J. Schwab

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-62

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	8.700	8.700	10.07	0.42

Structure Detail:

Structure #1 (Culvert)

CP-62

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
128.00	3.60	0.0150	3.70	0.00	0.90

Culvert Results:

Design Discharge = 10.07 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	8.700	0.059	0.000	0.000	91.000	M	10.07	0.421
	Σ	**8.700**						**10.07**	**0.421**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	10.45	10.00	95.69	3.230	0.008
		8. Large gullies, diversions, and low flowing streams	5.92	80.61	1,360.65	7.300	0.051
#1	**1**	**Time of Concentration:**					**0.059**

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-63

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\63

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\63 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:11
As built design specifications for CP-63
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	9.40	89	M	0.105	0.000	0.000	0.0	0.38	10.13
		Type: Null			Label: CP-63					
111	Structure	9.40							0.38	
111	Total IN/OUT	9.40							0.38	10.13

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Company Name: BHP MINERALS
Filename: C:\BRIAN\63 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:11
As built design specifications for CP-63
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	950.00	6.32	2.51	0.11	0.105		

SEDCAD+ CULVERT SIZING UTILITY

CP-63a

Design Discharge	=	10.130 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	40.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.013
Maximum Headwater	=	4.740 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.47	0.64	Outlet (Subcritical)	2
0.95	1.30	Inlet (Supercritical)	4
1.42	1.99	Outlet	6
1.90	2.31	Outlet	6
2.37	2.63	Outlet	6
2.84	2.95	Outlet	6
3.32	3.19	Outlet	6
3.79	3.42	Outlet	6
4.27	3.65	Outlet	6
4.74	3.88	Outlet	6
5.21	4.08	Outlet	6
5.69	4.26	Outlet	6
6.16	4.43	Outlet	6
6.64	4.61	Outlet	6
7.11	4.79	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.47	0.78	Outlet (Subcritical)	2
0.95	1.94	Inlet (Supercritical)	3
1.42	3.25	Inlet	5
1.90	4.19	Inlet	5
2.37	4.90	Outlet	6
2.84	5.47	Outlet	6
3.32	6.01	Outlet	6
3.79	6.47	Outlet	6
4.27	6.93	Outlet	6
4.74	7.34	Outlet	6
5.21	7.73	Outlet	6
5.69	8.12	Outlet	6
6.16	8.47	Outlet	6
6.64	8.82	Outlet	6
7.11	9.15	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.47	0.90	Inlet (Supercritical)	3
0.95	2.43	Inlet (Supercritical)	3
1.42	4.39	Inlet (Supercritical)	4
1.90	6.09	Inlet	5
2.37	7.39	Inlet	5
2.84	8.50	Inlet	5
3.32	9.48	Inlet	5
3.79	10.34	Outlet	6
4.27	11.10	Outlet	6
4.74	11.81	Outlet	6
5.21	12.47	Outlet	6
5.69	13.11	Outlet	6
6.16	13.72	Outlet	6
6.64	14.30	Outlet	6
7.11	14.86	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.47	1.03	Inlet (Supercritical)	3
0.95	2.90	Inlet (Supercritical)	3
1.42	5.33	Inlet (Supercritical)	3
1.90	7.94	Inlet	5
2.37	9.99	Inlet	5
2.84	11.67	Inlet	5
3.32	13.15	Inlet	5
3.79	14.47	Inlet	5
4.27	15.69	Inlet	5
4.74	16.82	Inlet	5
5.21	17.87	Inlet	5
5.69	18.87	Inlet	5
6.16	19.82	Inlet	5
6.64	20.72	Inlet	5
7.11	21.59	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.47	1.22	Inlet (Supercritical)	3
0.95	3.39	Inlet (Supercritical)	3
1.42	6.22	Inlet (Supercritical)	3
1.90	9.57	Inlet (Supercritical)	3
2.37	12.60	Inlet	5
2.84	15.06	Inlet	5
3.32	17.16	Inlet	5
3.79	19.04	Inlet	5
4.27	20.74	Inlet	5
4.74	22.32	Inlet	5

5.21	23.79	Inlet	5
5.69	25.18	Inlet	5
6.16	26.49	Inlet	5
6.64	27.74	Inlet	5
7.11	28.94	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.47	1.39	Inlet (Supercritical)	3
0.95	3.87	Inlet (Supercritical)	3
1.42	7.10	Inlet (Supercritical)	3
1.90	10.93	Inlet (Supercritical)	3
2.37	15.20	Inlet (Supercritical)	3
2.84	18.51	Inlet	5
3.32	21.41	Inlet	5
3.79	23.97	Inlet	5
4.27	26.27	Inlet	5
4.74	28.39	Inlet	5
5.21	30.36	Inlet	5
5.69	32.21	Inlet	5
6.16	33.97	Inlet	5
6.64	35.63	Inlet	5
7.11	37.22	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

CP-63b

Design Discharge	=	10.130 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	133.000 feet
Pipe Slope	=	2.800 %
Manning's n	=	0.013
Maximum Headwater	=	4.500 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	0.61	Outlet (Subcritical)	2
0.90	1.25	Inlet (Supercritical)	4
1.35	1.97	Inlet	5
1.80	2.34	Inlet	5
2.25	2.69	Outlet	6
2.70	3.01	Outlet	6
3.15	3.11	Outlet	6
3.60	3.21	Outlet	6
4.05	3.31	Outlet	6
4.50	3.41	Outlet	6
4.95	3.52	Outlet	6
5.40	3.62	Outlet	6
5.85	3.72	Outlet	6
6.30	3.82	Outlet	6
6.75	3.92	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	0.74	Outlet (Subcritical)	2
0.90	1.81	Inlet (Supercritical)	3
1.35	3.09	Inlet	5
1.80	4.05	Inlet	5
2.25	4.82	Inlet	5
2.70	5.48	Inlet	5
3.15	6.05	Inlet	5
3.60	6.34	Inlet	5
4.05	6.64	Outlet	6
4.50	6.93	Outlet	6
4.95	7.15	Outlet	6
5.40	7.35	Outlet	6
5.85	7.54	Outlet	6
6.30	7.74	Outlet	6
6.75	7.94	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	0.85	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
1.35	4.10	Inlet (Supercritical)	3
1.80	5.78	Inlet	5
2.25	7.09	Inlet	5
2.70	8.18	Inlet	5
3.15	9.15	Inlet	5
3.60	10.03	Inlet	5
4.05	10.83	Inlet	5
4.50	11.57	Inlet	5
4.95	12.15	Inlet	5
5.40	12.50	Inlet	5
5.85	12.85	Outlet	6
6.30	13.19	Outlet	6
6.75	13.51	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	0.97	Inlet (Supercritical)	3
0.90	2.70	Inlet (Supercritical)	3
1.35	4.93	Inlet (Supercritical)	3
1.80	7.46	Inlet (Supercritical)	4
2.25	9.50	Inlet	5
2.70	11.18	Inlet	5
3.15	12.64	Inlet	5
3.60	13.96	Inlet	5
4.05	15.15	Inlet	5
4.50	16.25	Inlet	5
4.95	17.29	Inlet	5
5.40	18.27	Inlet	5
5.85	19.20	Inlet	5
6.30	20.06	Inlet	5
6.75	20.63	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	1.12	Inlet (Supercritical)	3
0.90	3.13	Inlet (Supercritical)	3
1.35	5.75	Inlet (Supercritical)	3
1.80	8.85	Inlet (Supercritical)	3
2.25	11.90	Inlet	5
2.70	14.35	Inlet	5
3.15	16.44	Inlet	5
3.60	18.30	Inlet	5
4.05	19.99	Inlet	5
4.50	21.54	Inlet	5

4.95	22.99	Inlet	5
5.40	24.35	Inlet	5
5.85	25.63	Inlet	5
6.30	26.86	Inlet	5
6.75	28.04	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	1.29	Inlet (Supercritical)	3
0.90	3.59	Inlet (Supercritical)	3
1.35	6.57	Inlet (Supercritical)	3
1.80	10.11	Inlet (Supercritical)	3
2.25	14.13	Inlet (Supercritical)	3
2.70	17.54	Inlet	5
3.15	20.43	Inlet	5
3.60	22.97	Inlet	5
4.05	25.25	Inlet	5
4.50	27.34	Inlet	5
4.95	29.28	Inlet	5
5.40	31.10	Inlet	5
5.85	32.82	Inlet	5
6.30	34.46	Inlet	5
6.75	36.02	Inlet	5

Page 245-263 Blank due to culvert removals and updates.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-70, CP-71 AND CP-72

by

Name: bts

Company Name: BHP MINERALS
File Name: C:\BRIAN\707172

Date: 07-05-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\707172 User: bts
Date: 07-05-1996 Time: 05:58:26
As built design specifications for cp-70, cp-71 and cp-72
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	6.10	82	M	0.496	0.000	0.000	0.0	0.12	1.31
		Type: Culvert Label: CP-70								
111	Structure	6.10							0.12	
111	Total IN/OUT	6.10							0.12	1.31
112	1	25.40	89	M	0.319	0.000	0.000	0.0	1.03	14.89
		Type: Null Label: CP-71								
112	Structure	25.40							1.15	
112	Total IN/OUT	31.50							1.15	15.64
111 to 112 Routing						0.155	0.208			
121	1	20.30	89	M	0.329	0.000	0.000	0.0	0.82	11.73
		Type: Null Label: CP-72								
121	Structure	20.30							0.82	
121	Total IN/OUT	20.30							0.82	11.73

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\707172 User: bts
Date: 07-05-1996 Time: 05:58:26
As built design specifications for cp-70, cp-71 and cp-72
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	2000.00	1.25	1.12	0.50	0.496		
1	1	2	1	-a	5	2100.00	3.33	1.82	0.32	0.319		
1	2	1	1	-a	5	1520.00	1.64	1.28	0.33	0.329		

4.40	6.23	Outlet	6
4.80	6.45	Outlet	6
5.20	6.67	Outlet	6
5.60	6.89	Outlet	6
6.00	7.10	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.76	Outlet (Subcritical)	2
0.80	1.88	Inlet (Supercritical)	3
1.20	3.45	Inlet (Supercritical)	3
1.60	5.10	Inlet	5
2.00	6.39	Inlet	5
2.40	7.46	Inlet	5
2.80	8.40	Inlet	5
3.20	9.15	Inlet	5
3.60	9.63	Outlet	6
4.00	10.09	Outlet	6
4.40	10.49	Outlet	6
4.80	10.89	Outlet	6
5.20	11.26	Outlet	6
5.60	11.63	Outlet	6
6.00	11.99	Outlet	6

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.49	Outlet (Subcritical)	2
0.80	0.99	Inlet	5
1.20	1.19	Inlet	5
1.60	1.39	Inlet	5
2.00	1.59	Outlet	6
2.40	1.79	Outlet	6
2.80	1.99	Outlet	6
3.20	2.07	Outlet	6
3.60	2.15	Outlet	6
4.00	2.22	Outlet	6
4.40	2.30	Outlet	6
4.80	2.38	Outlet	6
5.20	2.45	Outlet	6
5.60	2.53	Outlet	6
6.00	2.61	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.54	Outlet (Subcritical)	2
0.80	1.10	Inlet (Supercritical)	3
1.20	1.73	Inlet (Supercritical)	4
1.60	2.09	Inlet	5
2.00	2.25	Inlet	5
2.40	2.40	Inlet	5
2.80	2.56	Outlet	6
3.20	2.71	Outlet	6
3.60	2.87	Outlet	6
4.00	3.02	Outlet	6
4.40	3.12	Outlet	6
4.80	3.21	Outlet	6
5.20	3.31	Outlet	6
5.60	3.41	Outlet	6
6.00	3.51	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.65	Outlet (Subcritical)	2
0.80	1.53	Inlet (Supercritical)	3
1.20	2.68	Inlet (Supercritical)	4
1.60	3.63	Inlet	5
2.00	4.35	Inlet	5
2.40	4.95	Outlet	6
2.80	5.24	Outlet	6
3.20	5.50	Outlet	6
3.60	5.76	Outlet	6
4.00	6.01	Outlet	6

SEDCAD+ CULVERT SIZING UTILITY

CP-70

Design Discharge	=	1.310 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	101.000 feet
Pipe Slope	=	1.900 %
Manning's n	=	0.014
Maximum Headwater	=	4.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.01		0
0.80	0.02		0
1.20	0.03		0
1.60	0.05		0
2.00	0.06		0
2.40	0.07		0
2.80	0.08		0
3.20	0.09	Outlet (Subcritical)	1
3.60	0.10	Outlet (Subcritical)	1
4.00	0.12	Outlet (Subcritical)	1
4.40	0.13	Outlet (Subcritical)	1
4.80	0.14	Outlet (Subcritical)	1
5.20	0.15	Outlet (Subcritical)	1
5.60	0.16	Outlet (Subcritical)	1
6.00	0.17	Outlet (Subcritical)	1

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.13	Outlet (Subcritical)	1
0.80	0.27	Outlet (Subcritical)	2
1.20	0.40	Outlet (Subcritical)	2
1.60	0.53	Inlet (Supercritical)	3
2.00	0.67	Inlet (Supercritical)	4
2.40	0.80	Inlet	5
2.80	0.94	Outlet	6
3.20	1.02	Outlet	6
3.60	1.05	Outlet	6
4.00	1.07	Outlet	6
4.40	1.10	Outlet	6
4.80	1.13	Outlet	6
5.20	1.16	Outlet	6
5.60	1.19	Outlet	6
6.00	1.22	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.66	Outlet (Subcritical)	2
0.70	1.56	Inlet (Supercritical)	3
1.05	2.83	Inlet (Supercritical)	3
1.40	4.30	Inlet (Supercritical)	4
1.75	5.61	Inlet	5
2.10	6.67	Inlet	5
2.45	7.48	Inlet	5
2.80	8.12	Outlet	6
3.15	8.55	Outlet	6
3.50	8.99	Outlet	6
3.85	9.37	Outlet	6
4.20	9.76	Outlet	6
4.55	10.13	Outlet	6
4.90	10.48	Outlet	6
5.25	10.83	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.75	Outlet (Subcritical)	2
0.70	1.85	Inlet (Supercritical)	3
1.05	3.39	Inlet (Supercritical)	3
1.40	5.21	Inlet (Supercritical)	3
1.75	7.22	Inlet (Supercritical)	3
2.10	8.87	Inlet	5
2.45	10.28	Inlet	5
2.80	11.52	Inlet	5
3.15	12.64	Inlet	5
3.50	13.44	Inlet	5
3.85	14.09	Outlet	6
4.20	14.69	Outlet	6
4.55	15.28	Outlet	6
4.90	15.84	Outlet	6
5.25	16.38	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.83	Outlet (Subcritical)	2
0.70	2.15	Inlet (Supercritical)	3
1.05	3.94	Inlet (Supercritical)	3
1.40	6.07	Inlet (Supercritical)	3
1.75	8.49	Inlet (Supercritical)	3
2.10	10.97	Inlet	5
2.45	13.05	Inlet	5
2.80	14.85	Inlet	5
3.15	16.44	Inlet	5
3.50	17.91	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

CP-71A & CP-71B

Design Discharge	=	7.820	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	101.000	feet
Pipe Slope	=	1.400	%
Manning's n	=	0.014	
Maximum Headwater	=	3.500	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.47	Outlet (Subcritical)	1
0.70	0.95	Inlet (Supercritical)	3
1.05	1.39	Inlet (Supercritical)	4
1.40	1.82	Inlet	5
1.75	2.07	Outlet	6
2.10	2.19	Outlet	6
2.45	2.31	Outlet	6
2.80	2.43	Outlet	6
3.15	2.56	Outlet	6
3.50	2.68	Outlet	6
3.85	2.80	Outlet	6
4.20	2.92	Outlet	6
4.55	3.03	Outlet	6
4.90	3.11	Outlet	6
5.25	3.20	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.57	Outlet (Subcritical)	2
0.70	1.25	Inlet (Supercritical)	3
1.05	2.24	Inlet (Supercritical)	3
1.40	3.20	Inlet	5
1.75	3.96	Inlet	5
2.10	4.28	Inlet	5
2.45	4.58	Outlet	6
2.80	4.88	Outlet	6
3.15	5.14	Outlet	6
3.50	5.36	Outlet	6
3.85	5.59	Outlet	6
4.20	5.82	Outlet	6
4.55	6.04	Outlet	6
4.90	6.23	Outlet	6
5.25	6.42	Outlet	6

3.85	19.25	Inlet	5
4.20	20.45	Inlet	5
4.55	21.40	Outlet	6
4.90	22.22	Outlet	6
5.25	23.02	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.91	Inlet (Supercritical)	3
0.70	2.47	Inlet (Supercritical)	3
1.05	4.51	Inlet (Supercritical)	3
1.40	6.94	Inlet (Supercritical)	3
1.75	9.70	Inlet (Supercritical)	3
2.10	12.75	Inlet (Supercritical)	3
2.45	15.74	Inlet (Supercritical)	4
2.80	18.22	Inlet	5
3.15	20.43	Inlet	5
3.50	22.43	Inlet	5
3.85	24.26	Inlet	5
4.20	25.97	Inlet	5
4.55	27.56	Inlet	5
4.90	29.07	Inlet	5
5.25	30.51	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

CP-72A & CP-72B

Design Discharge	=	5.870 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	81.000 feet
Pipe Slope	=	2.300 %
Manning's n	=	0.013
Maximum Headwater	=	4.500 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	0.55	Inlet (Supercritical)	3
0.90	1.08	Inlet	5
1.35	1.50	Inlet	5
1.80	1.91	Outlet	6
2.25	2.09	Outlet	6
2.70	2.20	Outlet	6
3.15	2.32	Outlet	6
3.60	2.43	Outlet	6
4.05	2.54	Outlet	6
4.50	2.65	Outlet	6
4.95	2.77	Outlet	6
5.40	2.88	Outlet	6
5.85	2.99	Outlet	6
6.30	3.08	Outlet	6
6.75	3.16	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	0.61	Outlet (Subcritical)	2
0.90	1.25	Inlet (Supercritical)	4
1.35	1.97	Inlet	5
1.80	2.30	Inlet	5
2.25	2.62	Outlet	6
2.70	2.93	Outlet	6
3.15	3.11	Outlet	6
3.60	3.26	Outlet	6
4.05	3.40	Outlet	6
4.50	3.54	Outlet	6
4.95	3.69	Outlet	6
5.40	3.83	Outlet	6
5.85	3.97	Outlet	6
6.30	4.09	Outlet	6
6.75	4.20	Outlet	6

4.95	17.29	Inlet	5
5.40	18.27	Inlet	5
5.85	19.20	Inlet	5
6.30	20.08	Inlet	5
6.75	20.87	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	1.12	Inlet (Supercritical)	3
0.90	3.13	Inlet (Supercritical)	3
1.35	5.75	Inlet (Supercritical)	3
1.80	8.85	Inlet (Supercritical)	3
2.25	11.90	Inlet	5
2.70	14.35	Inlet	5
3.15	16.44	Inlet	5
3.60	18.30	Inlet	5
4.05	19.99	Inlet	5
4.50	21.54	Inlet	5
4.95	22.99	Inlet	5
5.40	24.35	Inlet	5
5.85	25.63	Inlet	5
6.30	26.86	Inlet	5
6.75	28.04	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	0.74	Outlet (Subcritical)	2
0.90	1.81	Inlet (Supercritical)	3
1.35	3.09	Inlet	5
1.80	4.05	Inlet	5
2.25	4.82	Inlet	5
2.70	5.48	Inlet	5
3.15	6.05	Inlet	5
3.60	6.38	Inlet	5
4.05	6.70	Outlet	6
4.50	7.02	Outlet	6
4.95	7.29	Outlet	6
5.40	7.56	Outlet	6
5.85	7.83	Outlet	6
6.30	8.09	Outlet	6
6.75	8.32	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	0.85	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
1.35	4.10	Inlet (Supercritical)	3
1.80	5.78	Inlet	5
2.25	7.09	Inlet	5
2.70	8.18	Inlet	5
3.15	9.15	Inlet	5
3.60	10.03	Inlet	5
4.05	10.83	Inlet	5
4.50	11.53	Outlet	6
4.95	12.13	Outlet	6
5.40	12.60	Outlet	6
5.85	13.05	Outlet	6
6.30	13.48	Outlet	6
6.75	13.91	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.45	0.97	Inlet (Supercritical)	3
0.90	2.70	Inlet (Supercritical)	3
1.35	4.93	Inlet (Supercritical)	3
1.80	7.46	Inlet (Supercritical)	4
2.25	9.50	Inlet	5
2.70	11.18	Inlet	5
3.15	12.64	Inlet	5
3.60	13.96	Inlet	5
4.05	15.15	Inlet	5
4.50	16.25	275Inlet	5

Page 276-279 blank due to text re-formatting

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-74

by

Name: BRIAN SAMBIRSKY

Company Name: BHP MINERALS
File Name: C:\BRIAN\74

Date: 12-05-1995

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Company Name: BHP MINERALS
Filename: C:\BRIAN\74 User: BRIAN SAMBIRSKY
Date: 12-05-1995 Time: 10:05:02
AS BUILT DESIGN SPECIFICATIONS FOR CP-74
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	15.70	89	M	0.125	0.000	0.000	0.0	0.63	16.93
		Type: Null			Label: CP-74					
111	Structure	15.70							0.63	
111	Total IN/OUT	15.70							0.63	16.93

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Company Name: BHP MINERALS
Filename: C:\BRIAN\74 User: BRIAN SAMBIRSKY
Date: 12-05-1995 Time: 10:05:02
AS BUILT DESIGN SPECIFICATIONS FOR CP-74
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	850.00	3.53	1.88	0.13	0.125		

SEDCAD+ CULVERT SIZING UTILITY

CP-74

Design Discharge	=	16.930 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	110.000 feet
Pipe Slope	=	1.100 %
Manning's n	=	0.027
Maximum Headwater	=	7.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 24 inches

PERFORMANCE CURVES:

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	2.59	Outlet (Subcritical)	1
1.40	4.53	Outlet (Subcritical)	1
2.10	6.25	Outlet	6
2.80	7.25	Outlet	6
3.50	8.13	Outlet	6
4.20	8.93	Outlet	6
4.90	9.65	Outlet	6
5.60	10.32	Outlet	6
6.30	10.97	Outlet	6
7.00	11.56	Outlet	6
7.70	12.13	Outlet	6
8.40	12.67	Outlet	6
9.10	13.20	Outlet	6
9.80	13.70	Outlet	6
10.50	14.18	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	3.57	Outlet (Subcritical)	1
1.40	5.22	Outlet (Subcritical)	1
2.10	8.72	Inlet	5
2.80	10.30	Outlet	6
3.50	11.64	Outlet	6
4.20	12.85	Outlet	6
4.90	13.96	Outlet	6
5.60	14.98	Outlet	6
6.30	15.93	Outlet	6
7.00	16.83	Outlet	6
7.70	17.68	Outlet	6
8.40	18.50	Outlet	6
9.10	19.28	Outlet	6
9.80	20.03	Outlet	6
10.50	20.75	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	4.84	Outlet (Subcritical)	1
1.40	6.03	Outlet (Subcritical)	1
2.10	11.21	Outlet (Subcritical)	1
2.80	13.79	Outlet	6
3.50	15.75	Outlet	6
4.20	17.48	Outlet	6
4.90	19.07	Outlet	6
5.60	20.52	Outlet	6
6.30	21.88	Outlet	6
7.00	23.17	Outlet	6
7.70	24.38	Outlet	6
8.40	25.53	Outlet	6
9.10	26.64	Outlet	6
9.80	27.70	Outlet	6
10.50	28.71	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	7.83	Outlet (Subcritical)	1
1.40	9.88	Outlet (Subcritical)	1
2.10	13.87	Outlet (Subcritical)	1
2.80	21.67	Outlet (Subcritical)	1
3.50	25.40	Outlet	6
4.20	28.63	Outlet	6
4.90	31.53	Outlet	6
5.60	34.20	Outlet	6
6.30	36.66	Outlet	6
7.00	38.97	Outlet	6
7.70	41.15	Outlet	6
8.40	43.22	Outlet	6
9.10	45.20	Outlet	6
9.80	47.09	Outlet	6
10.50	48.91	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	11.34	Outlet (Subcritical)	1
1.40	14.58	Outlet (Subcritical)	1
2.10	17.38	Outlet (Subcritical)	1
2.80	26.11	Outlet (Subcritical)	1
3.50	36.28	Outlet (Subcritical)	2
4.20	41.73	Outlet	6
4.90	46.55	Outlet	6
5.60	50.92	Outlet	6
6.30	54.95	Outlet	6
7.00	58.70	Outlet	6

7.70	62.23	Outlet	6
8.40	65.56	Outlet	6
9.10	68.74	Outlet	6
9.80	71.77	Outlet	6
10.50	74.68	Outlet	6

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	15.22	Outlet (Subcritical)	1
1.40	19.97	Outlet (Subcritical)	1
2.10	24.06	Outlet (Subcritical)	1
2.80	29.43	Outlet (Subcritical)	1
3.50	42.94	Outlet (Subcritical)	1
4.20	55.79	Inlet	5
4.90	63.35	Outlet	6
5.60	70.07	Outlet	6
6.30	76.20	Outlet	6
7.00	81.87	Outlet	6
7.70	87.17	Outlet	6
8.40	92.17	Outlet	6
9.10	96.91	Outlet	6
9.80	101.43	Outlet	6
10.50	105.76	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-75, CP-86 AND CP-87

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\75

Date: 12-18-1995

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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST User: Brian Sambirsky
Date: 12-18-1995 Time: 15:06:52
As built design Specifications for CP-75, CP-86 and CP-87
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	23.90	89	M	0.243	0.000	0.000	0.0	0.96	15.89
			Type: Null			Label: CP-86				
111 Structure		23.90							0.96	
111 Total IN/OUT		23.90							0.96	15.89
121	1	6.00	89	M	0.127	0.000	0.000	0.0	0.24	4.65
			Type: Null			Label: CP-87				
121 Structure		6.00							0.24	
Total IN/OUT		6.00							0.24	4.65
211	1	7.50	89	M	0.251	0.000	0.000	0.0	0.30	4.91
			Type: Null			Label: CP-75				
211 Structure		7.50							1.51	
211 Total IN/OUT		37.40							1.51	20.88
111 to 211 Routing						0.176	0.227			
			Type: Null			Label: CP-75				
311 Structure		7.50							1.51	
311 Total IN/OUT		37.40							1.51	20.88
211 to 311 Routing						0.000	0.000			

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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST User: Brian Sambirsky
Date: 12-18-1995 Time: 15:06:52
As built design Specifications for CP-75, CP-86 and CP-87
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1320.00	2.27	1.51	0.24	0.243		
1	2	1	1	-a	5	750.00	2.66	1.63	0.13	0.127		
2	1	1	1	-a	5	1270.00	1.97	1.40	0.25	0.251		

SEDCAD+ CULVERT SIZING UTILITY

CP-75A and CP-75B

Design Discharge	=	10.440 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	106.000 feet
Pipe Slope	=	0.600 %
Manning's n	=	0.012
Maximum Headwater	=	2.300 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 21 inches

PERFORMANCE CURVES:

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.23	0.44	Outlet (Subcritical)	1
0.46	0.87	Inlet (Supercritical)	3
0.69	1.53	Inlet (Supercritical)	3
0.92	2.32	Inlet (Supercritical)	3
1.15	3.24	Inlet (Supercritical)	3
1.38	4.22	Inlet (Supercritical)	3
1.61	5.13	Inlet	5
1.84	5.91	Inlet	5
2.07	6.54	Outlet	6
2.30	7.10	Outlet	6
2.53	7.51	Outlet	6
2.76	7.92	Outlet	6
2.99	8.30	Outlet	6
3.22	8.66	Outlet	6
3.45	9.02	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.23	0.49	Outlet (Subcritical)	1
0.46	0.99	Inlet (Supercritical)	3
0.69	1.82	Inlet (Supercritical)	3
0.92	2.78	Inlet (Supercritical)	3
1.15	3.88	Inlet (Supercritical)	3
1.38	5.09	Inlet (Supercritical)	3
1.61	6.42	Inlet (Supercritical)	3
1.84	7.66	Inlet (Supercritical)	4
2.07	8.74	Inlet	5
2.30	9.70	Inlet	5
2.53	10.58	Inlet	5
2.76	11.39	Inlet	5
2.99	12.14	Inlet	5
3.22	12.81	Outlet	6
3.45	13.39	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.23	0.55	Outlet (Subcritical)	2
0.46	1.16	Inlet (Supercritical)	3
0.69	2.11	Inlet (Supercritical)	3
0.92	3.24	Inlet (Supercritical)	3
1.15	4.53	Inlet (Supercritical)	3
1.38	5.94	Inlet (Supercritical)	3
1.61	7.49	Inlet (Supercritical)	3
1.84	9.15	Inlet (Supercritical)	3
2.07	10.77	Inlet	5
2.30	12.20	Inlet	5
2.53	13.48	Inlet	5
2.76	14.65	Inlet	5
2.99	15.73	Inlet	5
3.22	16.75	Inlet	5
3.45	17.70	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.23	0.60	Outlet (Subcritical)	2
0.46	1.33	Inlet (Supercritical)	3
0.69	2.42	Inlet (Supercritical)	3
0.92	3.71	Inlet (Supercritical)	3
1.15	5.17	Inlet (Supercritical)	3
1.38	6.79	Inlet (Supercritical)	3
1.61	8.56	Inlet (Supercritical)	3
1.84	10.46	Inlet (Supercritical)	3
2.07	12.47	Inlet (Supercritical)	3
2.30	14.61	Inlet (Supercritical)	3
2.53	16.31	Inlet	5
2.76	17.96	Inlet	5
2.99	19.45	Inlet	5
3.22	20.85	Inlet	5
3.45	22.16	Inlet	5

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.23	0.69	Outlet (Subcritical)	2
0.46	1.66	Inlet (Supercritical)	3
0.69	3.00	Inlet (Supercritical)	3
0.92	4.63	Inlet (Supercritical)	3
1.15	6.46	Inlet (Supercritical)	3
1.38	8.49	Inlet (Supercritical)	3
1.61	10.70	Inlet (Supercritical)	3
1.84	13.07	Inlet (Supercritical)	3
2.07	15.59	Inlet (Supercritical)	3
2.30	18.26	Inlet (Supercritical)	3

2.53	21.07	Inlet (Supercritical)	3
2.76	24.00	Inlet (Supercritical)	3
2.99	26.71	Inlet (Supercritical)	4
3.22	29.10	Inlet	5
3.45	31.37	Inlet	5

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.23	0.78	Outlet (Subcritical)	2
0.46	1.96	Inlet (Supercritical)	3
0.69	3.61	Inlet (Supercritical)	3
0.92	5.55	Inlet (Supercritical)	3
1.15	7.75	Inlet (Supercritical)	3
1.38	10.19	Inlet (Supercritical)	3
1.61	12.83	Inlet (Supercritical)	3
1.84	15.68	Inlet (Supercritical)	3
2.07	18.71	Inlet (Supercritical)	3
2.30	21.91	Inlet (Supercritical)	3
2.53	25.28	Inlet (Supercritical)	3
2.76	28.80	Inlet (Supercritical)	3
2.99	32.48	Inlet (Supercritical)	3
3.22	36.30	Inlet (Supercritical)	3
3.45	40.25	Inlet (Supercritical)	3

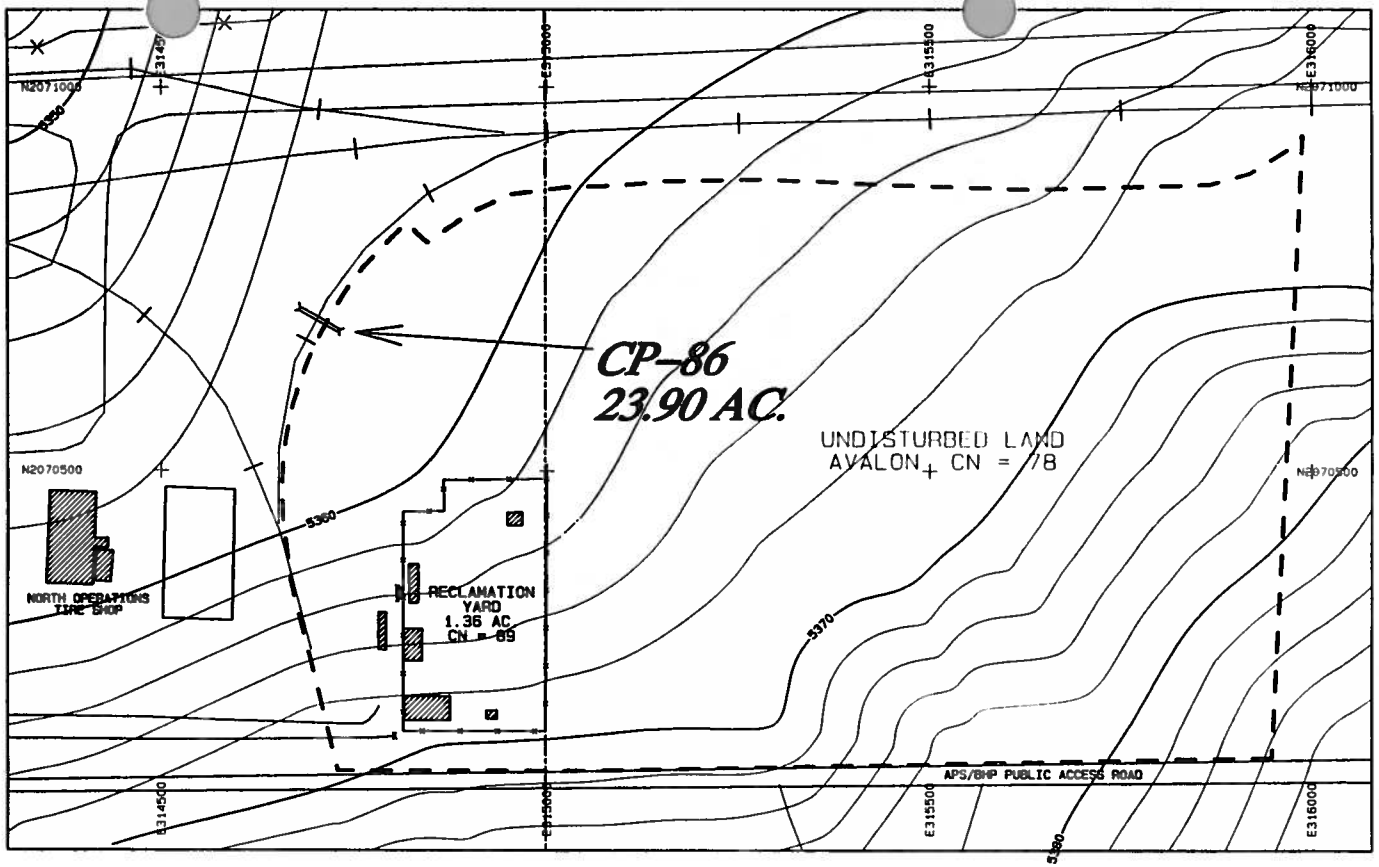
CP-86

Revised/Supplemental

Design Information

1/29/98

Reference Design Data for CP-121 & Exhibit 11-130



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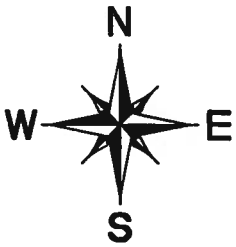
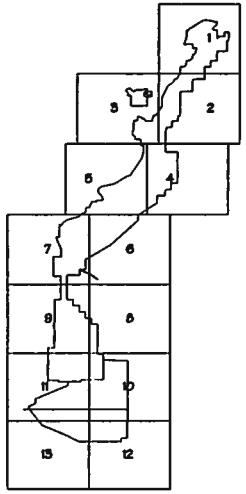


CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEGEND

- ROAD
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- WATERSHED
- LEASE BOUNDARY



REV. NO.	DATE	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.O.	P.E.	P.S.	CHIEF ENG.
A	01/30/98	BH	SUBMITTED TO OSM					

APPROVALS

NAVAJO COAL COMPANY

NAVAJO MINE

P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

CP-86 HYDROLOGY

PREPARED BY BH	DRAWN BY BH	SCALE AS NOTED
APPROVED BY LR	DATE 01/30/98	REF DWG

DWG LOC G: \USER\KFHOSBN\N_HOST\CP86.PRO

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-86 HYDROLOGY

by

Name: BH

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-130\SEDCAD\CP_86\CP_86

Date: 01-05-1998

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\BEN\CP_86 User: BEN HOSKIE
Date: 11-12-1997 Time: 09:46:00
CP-86 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	23.90	79	M	0.243	0.000	0.000	0.0	0.33	**5.02**
			Type: Null		Label: CP-86					
111	Structure	23.90							0.33	
111	Total IN/OUT	23.90							0.33	5.02

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\CP_86 User: BEN HOSKIE
Date: 11-12-1997 Time: 09:46:00
CP-86 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1320.00	2.27	1.51	0.24	0.243		

SEDCAD+ CULVERT SIZING UTILITY

CP-86

Design Discharge	=	5.020	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	14.000	feet
Pipe Slope	=	11.000	%
Manning's n	=	0.013	
Maximum Headwater	=	2.250	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.30	Outlet (Subcritical)	1
0.45	0.61	Outlet (Subcritical)	2
0.67	0.91	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
1.13	1.61	Inlet (Supercritical)	4
1.35	1.97	Inlet	5
1.58	2.20	Inlet	5
1.80	2.42	Inlet	5
2.03	2.63	Inlet	5
2.25	2.85	Inlet	5
2.47	3.05	Inlet	5
2.70	3.21	Inlet	5
2.92	3.36	Inlet	5
3.15	3.52	Inlet	5
3.37	3.67	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.37	Outlet (Subcritical)	1
0.45	0.74	Outlet (Subcritical)	2
0.67	1.18	Inlet (Supercritical)	3
0.90	1.81	Inlet (Supercritical)	3
1.13	2.46	Inlet (Supercritical)	4
1.35	3.09	Inlet	5
1.58	3.58	Inlet	5
1.80	4.05	Inlet	5
2.03	4.44	Inlet	5
2.25	4.82	Inlet	5
2.47	5.16	Inlet	5
2.70	5.48	Inlet	5
2.92	5.79	Inlet	5
3.15	6.09	Inlet	5
3.37	6.35	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type

0.22	0.43	Outlet (Subcritical)	1
0.45	0.85	Inlet (Supercritical)	3
0.67	1.48	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
1.13	3.13	Inlet (Supercritical)	3
1.35	4.10	Inlet (Supercritical)	3
1.58	5.01	Inlet	5
1.80	5.78	Inlet	5
2.03	6.46	Inlet	5
2.25	7.09	Inlet	5
2.47	7.65	Inlet	5
2.70	8.18	Inlet	5
2.92	8.68	Inlet	5
3.15	9.15	Inlet	5
3.37	9.59	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.48	Outlet (Subcritical)	1
0.45	0.97	Inlet (Supercritical)	3
0.67	1.76	Inlet (Supercritical)	3
0.90	2.70	Inlet (Supercritical)	3
1.13	3.76	Inlet (Supercritical)	3
1.35	4.93	Inlet (Supercritical)	3
1.58	6.21	Inlet (Supercritical)	3
1.80	7.46	Inlet (Supercritical)	4
2.03	8.53	Inlet	5
2.25	9.50	Inlet	5
2.47	10.37	Inlet	5
2.70	11.18	Inlet	5
2.92	11.94	Inlet	5
3.15	12.64	Inlet	5
3.37	13.31	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.53	Outlet (Subcritical)	2
0.45	1.12	Inlet (Supercritical)	3
0.67	2.03	Inlet (Supercritical)	3
0.90	3.13	Inlet (Supercritical)	3
1.13	4.38	Inlet (Supercritical)	3
1.35	5.75	Inlet (Supercritical)	3
1.58	7.25	Inlet (Supercritical)	3
1.80	8.85	Inlet (Supercritical)	3
2.03	10.47	Inlet (Supercritical)	4
2.25	11.90	Inlet	5
2.47	13.19	Inlet	5
2.70	14.35	Inlet	5
2.92	15.43	Inlet	5
3.15	16.44	Inlet	5
3.37	17.40	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type

0.22	0.58	Outlet (Subcritical)	2
0.45	1.29	Inlet (Supercritical)	3
0.67	2.34	Inlet (Supercritical)	3
0.90	3.59	Inlet (Supercritical)	3
1.13	5.00	Inlet (Supercritical)	3
1.35	6.57	Inlet (Supercritical)	3
1.58	8.28	Inlet (Supercritical)	3
1.80	10.11	Inlet (Supercritical)	3
2.03	12.07	Inlet (Supercritical)	3
2.25	14.13	Inlet (Supercritical)	3
2.47	15.91	Inlet	5
2.70	17.54	Inlet	5
2.92	19.05	Inlet	5
3.15	20.43	Inlet	5
3.37	21.74	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

CP-87

Design Discharge	=	4.650 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	19.000 feet
Pipe Slope	=	10.220 %
Manning's n	=	0.013
Maximum Headwater	=	3.800 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.47	Outlet (Subcritical)	2
0.76	0.94	Inlet	5
1.14	1.33	Inlet	5
1.52	1.71	Inlet	5
1.90	2.06	Inlet	5
2.28	2.29	Inlet	5
2.66	2.52	Inlet	5
3.04	2.74	Inlet	5
3.42	2.97	Inlet	5
3.80	3.14	Inlet	5
4.18	3.31	Inlet	5
4.56	3.47	Inlet	5
4.94	3.64	Inlet	5
5.32	3.80	Inlet	5
5.70	3.96	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.51	Outlet (Subcritical)	2
0.76	1.03	Inlet (Supercritical)	3
1.14	1.64	Inlet (Supercritical)	4
1.52	2.15	Inlet	5
1.90	2.51	Inlet	5
2.28	2.88	Inlet	5
2.66	3.18	Inlet	5
3.04	3.44	Inlet	5
3.42	3.70	Inlet	5
3.80	3.96	Inlet	5
4.18	4.18	Inlet	5
4.56	4.38	Inlet	5
4.94	4.58	Inlet	5
5.32	4.79	Inlet	5
5.70	4.99	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.62	Outlet (Subcritical)	2
0.76	1.42	Inlet (Supercritical)	3
1.14	2.50	Inlet (Supercritical)	4
1.52	3.46	Inlet	5
1.90	4.22	Inlet	5
2.28	4.87	Inlet	5
2.66	5.42	Inlet	5
3.04	5.95	Inlet	5
3.42	6.40	Inlet	5
3.80	6.85	Inlet	5
4.18	7.26	Inlet	5
4.56	7.64	Inlet	5
4.94	8.03	Inlet	5
5.32	8.37	Inlet	5
5.70	8.71	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.72	Outlet (Subcritical)	2
0.76	1.75	Inlet (Supercritical)	3
1.14	3.19	Inlet (Supercritical)	3
1.52	4.79	Inlet	5
1.90	6.10	Inlet	5
2.28	7.16	Inlet	5
2.66	8.09	Inlet	5
3.04	8.93	Inlet	5
3.42	9.68	Inlet	5
3.80	10.39	Inlet	5
4.18	11.06	Inlet	5
4.56	11.67	Inlet	5
4.94	12.26	Inlet	5
5.32	12.83	Inlet	5
5.70	13.37	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.81	Outlet (Subcritical)	2
0.76	2.09	Inlet (Supercritical)	3
1.14	3.83	Inlet (Supercritical)	3
1.52	5.89	Inlet (Supercritical)	3
1.90	7.96	Inlet	5
2.28	9.62	Inlet	5
2.66	11.05	Inlet	5
3.04	12.30	Inlet	5
3.42	13.44	Inlet	5
3.80	14.49	Inlet	5

4.18	15.47	Inlet	5
4.56	16.39	Inlet	5
4.94	17.27	Inlet	5
5.32	18.10	Inlet	5
5.70	18.90	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.90	Inlet (Supercritical)	3
0.76	2.44	Inlet (Supercritical)	3
1.14	4.47	Inlet (Supercritical)	3
1.52	6.87	Inlet (Supercritical)	3
1.90	9.60	Inlet (Supercritical)	3
2.28	12.08	Inlet	5
2.66	14.16	Inlet	5
3.04	15.97	Inlet	5
3.42	17.58	Inlet	5
3.80	19.07	Inlet	5
4.18	20.44	Inlet	5
4.56	21.74	Inlet	5
4.94	22.96	Inlet	5
5.32	24.11	Inlet	5
5.70	25.21	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-76

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\76

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\76 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:26
As built design specifications for CP-76
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	4.10	89	M	0.135	0.000	0.000	0.0	0.17	3.18
		Type: Null Label: CP-76								
111	Structure	4.10							0.17	
111	Total IN/OUT	4.10							0.17	3.18

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Company Name: BHP MINERALS
Filename: C:\BRIAN\76 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:26
As built design specifications for CP-76
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	755.00	2.38	1.54	0.14	0.135		

SEDCAD+ CULVERT SIZING UTILITY

CP-76

Design Discharge	=	3.180	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	89.140	feet
Pipe Slope	=	1.300	%
Manning's n	=	0.016	
Maximum Headwater	=	3.000	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.30	0.37	Outlet (Subcritical)	2
0.60	0.74	Inlet (Supercritical)	4
0.90	1.03	Inlet	5
1.20	1.12	Inlet	5
1.50	1.21	Inlet	5
1.80	1.30	Inlet	5
2.10	1.39	Inlet	5
2.40	1.49	Inlet	5
2.70	1.58	Outlet	6
3.00	1.67	Outlet	6
3.30	1.76	Outlet	6
3.60	1.85	Outlet	6
3.90	1.95	Outlet	6
4.20	2.02	Outlet	6
4.50	2.07	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.30	0.41	Outlet (Subcritical)	1
0.60	0.81	Outlet (Subcritical)	2
0.90	1.12	Inlet (Supercritical)	3
1.20	1.35	Inlet (Supercritical)	4
1.50	1.58	Inlet	5
1.80	1.80	Inlet	5
2.10	2.01	Outlet	6
2.40	2.11	Outlet	6
2.70	2.20	Outlet	6
3.00	2.29	Outlet	6
3.30	2.39	Outlet	6
3.60	2.48	Outlet	6
3.90	2.57	Outlet	6
4.20	2.66	Outlet	6
4.50	2.76	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.30	0.49	Outlet (Subcritical)	1
0.60	0.98	Inlet (Supercritical)	3
0.90	1.81	Inlet (Supercritical)	3
1.20	2.68	Inlet (Supercritical)	4
1.50	3.22	Inlet	5
1.80	3.58	Outlet	6
2.10	3.93	Outlet	6
2.40	4.17	Outlet	6
2.70	4.39	Outlet	6
3.00	4.61	Outlet	6
3.30	4.82	Outlet	6
3.60	5.03	Outlet	6
3.90	5.21	Outlet	6
4.20	5.38	Outlet	6
4.50	5.56	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.30	0.57	Outlet (Subcritical)	2
0.60	1.24	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
1.20	3.45	Inlet (Supercritical)	3
1.50	4.71	Inlet (Supercritical)	4
1.80	5.78	Inlet	5
2.10	6.40	Inlet	5
2.40	6.91	Outlet	6
2.70	7.32	Outlet	6
3.00	7.70	Outlet	6
3.30	8.08	Outlet	6
3.60	8.42	Outlet	6
3.90	8.76	Outlet	6
4.20	9.09	Outlet	6
4.50	9.39	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.30	0.64	Outlet (Subcritical)	2
0.60	1.49	Inlet (Supercritical)	3
0.90	2.70	Inlet (Supercritical)	3
1.20	4.13	Inlet (Supercritical)	3
1.50	5.78	Inlet (Supercritical)	3
1.80	7.46	Inlet (Supercritical)	4
2.10	8.87	Inlet	5
2.40	10.07	Inlet	5
2.70	10.89	Outlet	6
3.00	11.52	Outlet	6

3.30	12.11	Outlet	6
3.60	12.66	Outlet	6
3.90	13.20	Outlet	6
4.20	13.71	Outlet	6
4.50	14.21	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.30	0.71	Outlet (Subcritical)	2
0.60	1.73	Inlet (Supercritical)	3
0.90	3.13	Inlet (Supercritical)	3
1.20	4.82	Inlet (Supercritical)	3
1.50	6.74	Inlet (Supercritical)	3
1.80	8.85	Inlet (Supercritical)	3
2.10	10.97	Inlet	5
2.40	12.77	Inlet	5
2.70	14.35	Inlet	5
3.00	15.78	Inlet	5
3.30	16.81	Outlet	6
3.60	17.66	Outlet	6
3.90	18.45	Outlet	6
4.20	19.21	Outlet	6
4.50	19.95	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-77

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\77

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\77
User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:22
As built design specifications for CP-77
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	46.50	89	M	0.920	0.000	0.000	0.0	1.88	14.22
			Type: Null			Label: CP-77				
111	Structure	46.50							1.88	
111	Total IN/OUT	46.50							1.88	14.22

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\77 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:22
As built design specifications for CP-77
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	3800.00	1.32	1.15	0.92	0.920		

SEDCAD+ CULVERT SIZING UTILITY

CP-77

Design Discharge	=	14.220 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	231.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.019
Maximum Headwater	=	6.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 21 inches

PERFORMANCE CURVES:

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.60	2.30	Outlet (Subcritical)	1
1.20	3.45	Outlet (Subcritical)	1
1.80	4.62	Inlet (Supercritical)	4
2.40	5.21	Outlet	6
3.00	5.61	Outlet	6
3.60	6.02	Outlet	6
4.20	6.36	Outlet	6
4.80	6.71	Outlet	6
5.40	7.05	Outlet	6
6.00	7.35	Outlet	6
6.60	7.65	Outlet	6
7.20	7.94	Outlet	6
7.80	8.21	Outlet	6
8.40	8.48	Outlet	6
9.00	8.74	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.60	3.39	Outlet (Subcritical)	1
1.20	3.99	Outlet (Subcritical)	1
1.80	7.17	Outlet (Subcritical)	2
2.40	8.11	Outlet	6
3.00	8.78	Outlet	6
3.60	9.41	Outlet	6
4.20	10.01	Outlet	6
4.80	10.56	Outlet	6
5.40	11.10	Outlet	6
6.00	11.60	Outlet	6
6.60	12.09	Outlet	6
7.20	12.55	Outlet	6
7.80	13.01	Outlet	6
8.40	13.44	Outlet	6
9.00	13.86	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.60	4.71	Outlet (Subcritical)	1
1.20	5.59	Outlet (Subcritical)	1
1.80	8.93	Outlet (Subcritical)	1
2.40	11.61	Outlet	6
3.00	12.70	Outlet	6
3.60	13.66	Outlet	6
4.20	14.55	Outlet	6
4.80	15.40	Outlet	6
5.40	16.20	Outlet	6
6.00	16.97	Outlet	6
6.60	17.70	Outlet	6
7.20	18.40	Outlet	6
7.80	19.08	Outlet	6
8.40	19.73	Outlet	6
9.00	20.36	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.60	2.00	Inlet (Supercritical)	3
1.20	7.37	Outlet (Subcritical)	1 *
1.80	9.91	Outlet (Subcritical)	1
2.40	15.48	Inlet (Supercritical)	3
3.00	17.33	Outlet	6
3.60	18.72	Outlet	6
4.20	20.02	Outlet	6
4.80	21.22	Outlet	6
5.40	22.37	Outlet	6
6.00	23.46	Outlet	6
6.60	24.50	Outlet	6
7.20	25.50	Outlet	6
7.80	26.46	Outlet	6
8.40	27.39	Outlet	6
9.00	28.29	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.60	2.45	Inlet (Supercritical)	3
1.20	6.88	Inlet (Supercritical)	3
1.80	12.64	Inlet (Supercritical)	3
2.40	19.18	Outlet (Subcritical)	1 *
3.00	26.84	Inlet (Supercritical)	4
3.60	31.15	Outlet	6
4.20	33.52	Outlet	6
4.80	35.73	Outlet	6
5.40	37.83	Outlet	6

6.00	39.81	Outlet	6
6.60	41.69	Outlet	6
7.20	43.50	Outlet	6
7.80	45.24	Outlet	6
8.40	46.91	Outlet	6
9.00	48.52	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.60	2.92	Inlet (Supercritical)	3
1.20	8.26	Inlet (Supercritical)	3
1.80	15.17	Inlet (Supercritical)	3
2.40	23.36	Inlet (Supercritical)	3
3.00	32.18	Outlet (Subcritical)	1 *
3.60	42.42	Inlet (Supercritical)	4
4.20	49.83	Inlet	5
4.80	53.78	Outlet	6
5.40	57.22	Outlet	6
6.00	60.45	Outlet	6
6.60	63.52	Outlet	6
7.20	66.45	Outlet	6
7.80	69.26	Outlet	6
8.40	71.95	Outlet	6
9.00	74.55	Outlet	6

* (Transition Region - Data may need to be smoothed.)

PAGES 310 THROUGH 315 BLANK
DUE TO CULVERT REMOVAL

Pages 316 through 333 Appendix 11-V

Blank due to Update

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-82

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\82

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\82
User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:29
As built design specifications for CP-82
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	37.00	89	M	0.394	0.000	0.000	0.0	1.49	19.50
			Type: Null			Label: CP-82				
111	Structure	37.00							1.49	
111	Total IN/OUT	37.00							1.49	19.50

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Company Name: BHP MINERALS
Filename: C:\BRIAN\82 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:29
As built design specifications for CP-82
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2720.00	3.68	1.92	0.39	0.394		

SEDCAD+ CULVERT SIZING UTILITY

CP-82

Design Discharge	=	19.500 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	49.000 feet
Pipe Slope	=	2.780 %
Manning's n	=	0.013
Maximum Headwater	=	2.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 42 inches

PERFORMANCE CURVES:

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.60	Outlet (Subcritical)	2
0.40	1.35	Inlet (Supercritical)	3
0.60	2.45	Inlet (Supercritical)	3
0.80	3.75	Inlet (Supercritical)	3
1.00	5.24	Inlet (Supercritical)	3
1.20	6.88	Inlet (Supercritical)	3
1.40	8.68	Inlet (Supercritical)	3
1.60	10.60	Inlet (Supercritical)	3
1.80	12.64	Inlet (Supercritical)	3
2.00	14.81	Inlet (Supercritical)	3
2.20	17.08	Inlet (Supercritical)	3
2.40	19.46	Inlet (Supercritical)	3
2.60	21.95	Inlet (Supercritical)	3
2.80	24.53	Inlet (Supercritical)	3
3.00	26.80	Inlet	5

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.68	Outlet (Subcritical)	2
0.40	1.62	Inlet (Supercritical)	3
0.60	2.92	Inlet (Supercritical)	3
0.80	4.50	Inlet (Supercritical)	3
1.00	6.29	Inlet (Supercritical)	3
1.20	8.26	Inlet (Supercritical)	3
1.40	10.41	Inlet (Supercritical)	3
1.60	12.72	Inlet (Supercritical)	3
1.80	15.17	Inlet (Supercritical)	3
2.00	17.77	Inlet (Supercritical)	3
2.20	20.50	Inlet (Supercritical)	3
2.40	23.36	Inlet (Supercritical)	3
2.60	26.34	Inlet (Supercritical)	3
2.80	29.43	Inlet (Supercritical)	3
3.00	32.64	Inlet (Supercritical)	3

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.75	Outlet (Subcritical)	2
0.40	1.87	Inlet (Supercritical)	3
0.60	3.42	Inlet (Supercritical)	3
0.80	5.25	Inlet (Supercritical)	3
1.00	7.33	Inlet (Supercritical)	3
1.20	9.64	Inlet (Supercritical)	3
1.40	12.14	Inlet (Supercritical)	3
1.60	14.83	Inlet (Supercritical)	3
1.80	17.70	Inlet (Supercritical)	3
2.00	20.73	Inlet (Supercritical)	3
2.20	23.91	Inlet (Supercritical)	3
2.40	27.25	Inlet (Supercritical)	3
2.60	30.72	Inlet (Supercritical)	3
2.80	34.34	Inlet (Supercritical)	3
3.00	38.08	Inlet (Supercritical)	3

Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.79	Outlet (Subcritical)	2
0.40	1.99	Inlet (Supercritical)	3
0.60	3.66	Inlet (Supercritical)	3
0.80	5.63	Inlet (Supercritical)	3
1.00	7.85	Inlet (Supercritical)	3
1.20	10.32	Inlet (Supercritical)	3
1.40	13.01	Inlet (Supercritical)	3
1.60	15.89	Inlet (Supercritical)	3
1.80	18.96	Inlet (Supercritical)	3
2.00	22.21	Inlet (Supercritical)	3
2.20	25.62	Inlet (Supercritical)	3
2.40	29.19	Inlet (Supercritical)	3
2.60	32.92	Inlet (Supercritical)	3
2.80	36.79	Inlet (Supercritical)	3
3.00	40.80	Inlet (Supercritical)	3

Diameter: 48 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.82	Outlet (Subcritical)	2
0.40	2.13	Inlet (Supercritical)	3
0.60	3.90	Inlet (Supercritical)	3
0.80	5.99	Inlet (Supercritical)	3
1.00	8.38	Inlet (Supercritical)	3
1.20	11.01	Inlet (Supercritical)	3
1.40	13.87	Inlet (Supercritical)	3
1.60	16.95	Inlet (Supercritical)	3
1.80	20.23	Inlet (Supercritical)	3
2.00	23.69	Inlet (Supercritical)	3

2.20	27.33	Inlet (Supercritical)	3
2.40	31.14	Inlet (Supercritical)	3
2.60	35.11	Inlet (Supercritical)	3
2.80	39.24	Inlet (Supercritical)	3
3.00	43.52	Inlet (Supercritical)	3

Diameter: 54 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.89	Inlet (Supercritical)	3
0.40	2.40	Inlet (Supercritical)	3
0.60	4.39	Inlet (Supercritical)	3
0.80	6.75	Inlet (Supercritical)	3
1.00	9.43	Inlet (Supercritical)	3
1.20	12.39	Inlet (Supercritical)	3
1.40	15.61	Inlet (Supercritical)	3
1.60	19.07	Inlet (Supercritical)	3
1.80	22.76	Inlet (Supercritical)	3
2.00	26.65	Inlet (Supercritical)	3
2.20	30.75	Inlet (Supercritical)	3
2.40	35.03	Inlet (Supercritical)	3
2.60	39.50	Inlet (Supercritical)	3
2.80	44.15	Inlet (Supercritical)	3
3.00	48.96	Inlet (Supercritical)	3

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GORMAN ROAD
CULVERT CP-83

THE CULVERT LOCATION AND WATERSHED AREA ARE SHOWN ON EXHIBIT 11-12C.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-83

#1
Culvert

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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	64.650	64.650	7.99	0.69

Structure Detail:

Structure #1 (Culvert)

CP-83

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
155.00	14.00	0.0150	10.54	0.00	0.90

Culvert Results:

Design Discharge = 7.99 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	64.650	0.250	0.000	0.000	76.700	M	7.99	0.692
	Σ	**64.650**						**7.99**	**0.692**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.25	4.00	319.24	1.110	0.079
		8. Large gullies, diversions, and low flowing streams	2.52	73.94	2,935.89	4.760	0.171
#1	**1**	**Time of Concentration:**					**0.250**

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-84 AND CP-85

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\84_85

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\BRIAN\84_85 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:46
As built design specifications for CP-84 and CP-85
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111 1	5.20	89	M	0.187	0.000	0.000	0.0	0.21	3.85
		Type: Null			Label: CP-85				
111 Structure	5.20							0.21	
111 Total IN/OUT	5.20							0.21	3.85
		Type: Null			Label: CP-85				
211 Structure	5.20							0.21	
211 Total IN/OUT	5.20							0.21	3.85
1 to 211 Routing					0.022	0.258			
		Type: Null			Label: CP-85				
212 Structure	5.20							0.21	
212 Total IN/OUT	5.20							0.21	3.85
211 to 212 Routing					0.022	0.258			
221 1	0.30	89	M	0.022	0.000	0.000	0.0	0.01	0.32
		Type: Null			Label: CP-84				
221 Structure	0.30							0.01	
221 Total IN/OUT	0.30							0.01	0.32
		Type: Null			Label: CP-84				
311 Structure	0.30							0.22	
311 Total IN/OUT	5.50							0.22	3.90
212 to 311 Routing					0.001	0.416			

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Company Name: BHP MINERALS
Filename: C:\BRIAN\84_85
User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:46
As built design specifications for CP-84 and CP-85
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1220.00	3.28	1.81	0.19	0.187		
2	2	1	1	-a	5	150.00	3.33	1.83	0.02	0.022		

SEDCAD+ CULVERT SIZING UTILITY

CP-84

Design Discharge	=	3.900 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	48.000 feet
Pipe Slope	=	0.900 %
Manning's n	=	0.013
Maximum Headwater	=	2.500 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.31	Outlet (Subcritical)	2
0.50	0.62	Inlet (Supercritical)	3
0.75	0.92	Inlet	5
1.00	1.12	Inlet	5
1.25	1.29	Inlet	5
1.50	1.46	Inlet	5
1.75	1.62	Outlet	6
2.00	1.79	Outlet	6
2.25	1.95	Outlet	6
2.50	2.07	Outlet	6
2.75	2.16	Outlet	6
3.00	2.25	Outlet	6
3.25	2.34	Outlet	6
3.50	2.43	Outlet	6
3.75	2.52	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.34	Outlet (Subcritical)	1
0.50	0.68	Outlet (Subcritical)	2
0.75	1.01	Inlet (Supercritical)	3
1.00	1.36	Inlet (Supercritical)	4
1.25	1.71	Inlet	5
1.50	2.03	Outlet	6
1.75	2.19	Outlet	6
2.00	2.34	Outlet	6
2.25	2.50	Outlet	6
2.50	2.66	Outlet	6
2.75	2.82	Outlet	6
3.00	2.98	Outlet	6
3.25	3.10	Outlet	6
3.50	3.22	Outlet	6
3.75	3.33	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.41	Outlet (Subcritical)	1
0.50	0.82	Outlet (Subcritical)	2
0.75	1.39	Inlet (Supercritical)	3
1.00	2.09	Inlet (Supercritical)	3
1.25	2.83	Inlet	5
1.50	3.42	Inlet	5
1.75	3.96	Inlet	5
2.00	4.32	Inlet	5
2.25	4.67	Outlet	6
2.50	5.01	Outlet	6
2.75	5.29	Outlet	6
3.00	5.56	Outlet	6
3.25	5.83	Outlet	6
3.50	6.09	Outlet	6
3.75	6.32	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.47	Outlet (Subcritical)	1
0.50	0.95	Inlet (Supercritical)	3
0.75	1.72	Inlet (Supercritical)	3
1.00	2.63	Inlet (Supercritical)	3
1.25	3.67	Inlet (Supercritical)	3
1.50	4.71	Inlet (Supercritical)	4
1.75	5.61	Inlet	5
2.00	6.39	Inlet	5
2.25	7.09	Inlet	5
2.50	7.71	Inlet	5
2.75	8.29	Inlet	5
3.00	8.83	Outlet	6
3.25	9.29	Outlet	6
3.50	9.73	Outlet	6
3.75	10.15	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.54	Outlet (Subcritical)	2
0.50	1.12	Inlet (Supercritical)	3
0.75	2.04	Inlet (Supercritical)	3
1.00	3.15	Inlet (Supercritical)	3
1.25	4.40	Inlet (Supercritical)	3
1.50	5.78	Inlet (Supercritical)	3
1.75	7.22	Inlet (Supercritical)	3
2.00	8.42	Inlet	5
2.25	9.50	Inlet	5
2.50	10.47	Inlet	5

2.75	11.35	Inlet	5
3.00	12.18	Inlet	5
3.25	12.95	Inlet	5
3.50	13.67	Inlet	5
3.75	14.36	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.59	Outlet (Subcritical)	2
0.50	1.32	Inlet (Supercritical)	3
0.75	2.40	Inlet (Supercritical)	3
1.00	3.67	Inlet (Supercritical)	3
1.25	5.12	Inlet (Supercritical)	3
1.50	6.74	Inlet (Supercritical)	3
1.75	8.49	Inlet (Supercritical)	3
2.00	10.31	Inlet (Supercritical)	4
2.25	11.90	Inlet	5
2.50	13.32	Inlet	5
2.75	14.60	Inlet	5
3.00	15.78	Inlet	5
3.25	16.88	Inlet	5
3.50	17.91	Inlet	5
3.75	18.88	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

CP-85

Design Discharge	=	3.850 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	65.000 feet
Pipe Slope	=	0.900 %
Manning's n	=	0.013
Maximum Headwater	=	2.500 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.31	Outlet (Subcritical)	2
0.50	0.62	Inlet (Supercritical)	3
0.75	0.92	Inlet	5
1.00	1.11	Inlet	5
1.25	1.25	Inlet	5
1.50	1.39	Inlet	5
1.75	1.53	Outlet	6
2.00	1.67	Outlet	6
2.25	1.81	Outlet	6
2.50	1.95	Outlet	6
2.75	2.05	Outlet	6
3.00	2.12	Outlet	6
3.25	2.20	Outlet	6
3.50	2.28	Outlet	6
3.75	2.35	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.34	Outlet (Subcritical)	1
0.50	0.68	Outlet (Subcritical)	2
0.75	1.01	Inlet (Supercritical)	3
1.00	1.33	Inlet (Supercritical)	4
1.25	1.64	Inlet	5
1.50	1.95	Outlet	6
1.75	2.12	Outlet	6
2.00	2.25	Outlet	6
2.25	2.38	Outlet	6
2.50	2.52	Outlet	6
2.75	2.65	Outlet	6
3.00	2.79	Outlet	6
3.25	2.92	Outlet	6
3.50	3.04	Outlet	6
3.75	3.14	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.41	Outlet (Subcritical)	1
0.50	0.82	Outlet (Subcritical)	2
0.75	1.39	Inlet (Supercritical)	3
1.00	2.09	Inlet (Supercritical)	3
1.25	2.83	Inlet	5
1.50	3.40	Inlet	5
1.75	3.92	Outlet	6
2.00	4.25	Outlet	6
2.25	4.54	Outlet	6
2.50	4.83	Outlet	6
2.75	5.10	Outlet	6
3.00	5.34	Outlet	6
3.25	5.58	Outlet	6
3.50	5.82	Outlet	6
3.75	6.05	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.47	Outlet (Subcritical)	1
0.50	0.95	Inlet (Supercritical)	3
0.75	1.72	Inlet (Supercritical)	3
1.00	2.63	Inlet (Supercritical)	3
1.25	3.67	Inlet (Supercritical)	3
1.50	4.71	Inlet (Supercritical)	4
1.75	5.61	Inlet	5
2.00	6.39	Inlet	5
2.25	7.08	Inlet	5
2.50	7.65	Outlet	6
2.75	8.16	Outlet	6
3.00	8.60	Outlet	6
3.25	9.03	Outlet	6
3.50	9.41	Outlet	6
3.75	9.80	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.54	Outlet (Subcritical)	2
0.50	1.12	Inlet (Supercritical)	3
0.75	2.04	Inlet (Supercritical)	3
1.00	3.15	Inlet (Supercritical)	3
1.25	4.40	Inlet (Supercritical)	3
1.50	5.78	Inlet (Supercritical)	3
1.75	7.22	Inlet (Supercritical)	3
2.00	8.42	Inlet	5
2.25	9.50	Inlet	5
2.50	10.47	Inlet	5

2.75	11.35	Inlet	5
3.00	12.18	Inlet	5
3.25	12.95	Inlet	5
3.50	13.67	Inlet	5
3.75	14.31	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.25	0.59	Outlet (Subcritical)	2
0.50	1.32	Inlet (Supercritical)	3
0.75	2.40	Inlet (Supercritical)	3
1.00	3.67	Inlet (Supercritical)	3
1.25	5.12	Inlet (Supercritical)	3
1.50	6.74	Inlet (Supercritical)	3
1.75	8.49	Inlet (Supercritical)	3
2.00	10.31	Inlet (Supercritical)	4
2.25	11.90	Inlet	5
2.50	13.32	Inlet	5
2.75	14.60	Inlet	5
3.00	15.78	Inlet	5
3.25	16.88	Inlet	5
3.50	17.91	Inlet	5
3.75	18.88	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-88

by

Name: BRIAN SAMBIRSKY

Company Name: BHP MINERALS
File Name: C:\BRIAN\88

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\88
User: BRIAN SAMBIRSKY
Date: 12-05-1995 Time: 10:05:30
AS BUILT DESIGN SPECIFICATIONS FOR CP-88
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	3.90	89	M	0.596	0.000	0.000	0.0	0.16	1.60
		Type: Null			Label: CP-88					
111	Structure	3.90							0.16	
111	Total IN/OUT	3.90							0.16	1.60

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Company Name: BHP MINERALS
Filename: C:\BRIAN\88
User: BRIAN SAMBIRSKY
Date: 12-05-1995 Time: 10:05:30
AS BUILT DESIGN SPECIFICATIONS FOR CP-88
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2400.00	1.25	1.12	0.60	0.596		

SEDCAD+ CULVERT SIZING UTILITY

CP-88

Design Discharge	=	1.600 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	39.000 feet
Pipe Slope	=	1.790 %
Manning's n	=	0.012
Maximum Headwater	=	2.700 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.27	0.02		0
0.54	0.04		0
0.81	0.06		0
1.08	0.09	Outlet (Subcritical)	1
1.35	0.11	Outlet (Subcritical)	1
1.62	0.13	Outlet (Subcritical)	1
1.89	0.15	Outlet (Subcritical)	1
2.16	0.17	Outlet (Subcritical)	1
2.43	0.19	Outlet (Subcritical)	1
2.70	0.21	Outlet (Subcritical)	1
2.97	0.23	Outlet (Subcritical)	1
3.24	0.26	Outlet (Subcritical)	2
3.51	0.28	Outlet (Subcritical)	2
3.78	0.30	Outlet (Subcritical)	2
4.05	0.32	Outlet (Subcritical)	2

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.27	0.17	Outlet (Subcritical)	1
0.54	0.35	Outlet (Subcritical)	2
0.81	0.52	Inlet (Supercritical)	3
1.08	0.70	Inlet (Supercritical)	4
1.35	0.87	Inlet	5
1.62	1.01	Outlet	6
1.89	1.06	Outlet	6
2.16	1.11	Outlet	6
2.43	1.16	Outlet	6
2.70	1.21	Outlet	6
2.97	1.26	Outlet	6
3.24	1.31	Outlet	6
3.51	1.36	Outlet	6
3.78	1.41	Outlet	6
4.05	1.46	Outlet	6

2.97	5.85	Inlet	5
3.24	6.19	Inlet	5
3.51	6.51	Inlet	5
3.78	6.83	Inlet	5
4.05	7.12	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.27	0.51	Outlet (Subcritical)	2
0.54	1.04	Inlet (Supercritical)	3
0.81	1.92	Inlet (Supercritical)	3
1.08	2.94	Inlet (Supercritical)	3
1.35	4.10	Inlet (Supercritical)	3
1.62	5.17	Inlet	5
1.89	6.07	Inlet	5
2.16	6.84	Inlet	5
2.43	7.54	Inlet	5
2.70	8.18	Inlet	5
2.97	8.77	Inlet	5
3.24	9.33	Inlet	5
3.51	9.86	Inlet	5
3.78	10.35	Inlet	5
4.05	10.83	Inlet	5

Pages 360 through 371 Appendix 11-V

Blank due to Update

Culvert CP-92

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM 87416

Phone: 505-598-5861

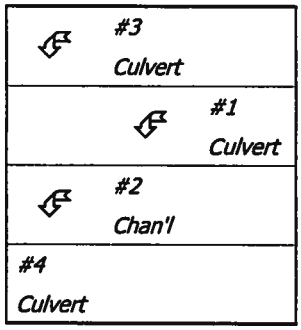
General Information

Storm Information:

Storm Type:	Type II - 60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	#2	0.000	0.000	Culvert CP-151
Channel	#2	==>	#4	0.198	0.337	Riprap @ CP-151 Outlet
Culvert	#3	==>	#4	0.284	0.339	Culvert CP-92
Culvert	#4	==>	End	0.000	0.000	Culvert CP-18



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	8. Large gullies, diversions, and low flowing streams	1.39	35.00	2,520.00	3.53	0.198
#2	**Muskingum K:**					**0.198**
#3	8. Large gullies, diversions, and low flowing streams	1.42	52.00	3,660.00	3.57	0.284
#3	**Muskingum K:**					**0.284**

Structure Detail:

Structure #3 (Culvert)

Culvert CP-92

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	3.50	0.0200	4.00	0.00	0.90

Culvert Results:

Design Discharge = 18.89 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Structure #1 (Culvert)

Culvert CP-151

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
110.00	1.36	0.0200	4.00	0.00	0.90

Culvert Results:

Design Discharge = 0.69 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

Structure #2 (Riprap Channel)

Riprap @ CP-151 Outlet

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	3.0:1	3.0:1	15.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.69 cfs	
Depth:	0.10 ft	1.10 ft
Top Width:	2.60 ft	8.60 ft
Velocity*:		
X-Section Area:	0.23 sq ft	
Hydraulic Radius:	0.087	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #4 (Culvert)

Culvert CP-18

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
305.00	3.00	0.0200	36.60	0.00	0.90

Culvert Results:

Design Discharge = 53.41 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	138.800	0.772	0.000	0.000	91.000	M	18.89	2.636
	Σ	**138.800**						**18.89**	**2.636**
#1	1	3.100	0.238	0.000	0.000	90.000	M	0.69	0.051
	Σ	**3.100**						**0.69**	**0.051**
#2	Σ	**3.100**						**0.69**	**0.051**
#4	1	318.700	1.070	0.000	0.000	91.000	M	35.00	6.053
	Σ	**460.600**						**53.41**	**8.740**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.15	27.00	1,255.00	1.460	0.238
#1	**1**	**Time of Concentration:**					**0.238**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	2.72	125.00	4,590.00	1.650	0.772
#3	**1**	**Time of Concentration:**					**0.772**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	2.75	175.00	6,360.00	1.650	1.070
#4	**1**	**Time of Concentration:**					**1.070**

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-93

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\93

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\93
User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:34
As built design specifications for CP-93
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	51.20	89	M	0.516	0.000	0.000	0.0	2.07	23.08
		Type: Null			Label: CP-93					
111	Structure	51.20							2.07	
111	Total IN/OUT	51.20							2.07	23.08

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Company Name: BHP MINERALS
Filename: C:\BRIAN\93
User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:34
As built design specifications for CP-93
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2400.00	1.67	1.29	0.52	0.516		

SEDCAD+ CULVERT SIZING UTILITY

CP-93

Design Discharge	=	23.080 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	230.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.020
Maximum Headwater	=	4.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 30 inches

PERFORMANCE CURVES:

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	4.33	Outlet (Subcritical)	1
0.80	4.72	Outlet (Subcritical)	1
1.20	5.35	Outlet (Subcritical)	1
1.60	7.37	Outlet (Subcritical)	1
2.00	10.16	Outlet (Subcritical)	2
2.40	11.17	Outlet	6
2.80	11.85	Outlet	6
3.20	12.48	Outlet	6
3.60	13.10	Outlet	6
4.00	13.67	Outlet	6
4.40	14.23	Outlet	6
4.80	14.77	Outlet	6
5.20	15.28	Outlet	6
5.60	15.79	Outlet	6
6.00	16.27	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	5.95	Outlet (Subcritical)	1
0.80	6.50	Outlet (Subcritical)	1
1.20	7.06	Outlet (Subcritical)	1
1.60	8.15	Outlet (Subcritical)	1
2.00	11.93	Outlet (Subcritical)	1
2.40	15.16	Outlet (Subcritical)	2
2.80	16.17	Outlet	6
3.20	17.09	Outlet	6
3.60	17.97	Outlet	6
4.00	18.81	Outlet	6
4.40	19.61	Outlet	6
4.80	20.37	Outlet	6
5.20	21.12	Outlet	6
5.60	21.83	Outlet	6
6.00	22.53	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	2.88	Inlet (Supercritical)	3
0.80	3.75	Inlet (Supercritical)	3
1.20	6.88	Inlet (Supercritical)	3
1.60	12.70	Outlet (Subcritical)	1 *
2.00	14.11	Outlet (Subcritical)	1
2.40	19.40	Outlet (Subcritical)	1
2.80	24.87	Outlet (Subcritical)	1
3.20	28.33	Outlet	6
3.60	29.97	Outlet	6
4.00	31.51	Outlet	6
4.40	32.99	Outlet	6
4.80	34.40	Outlet	6
5.20	35.76	Outlet	6
5.60	37.06	Outlet	6
6.00	38.32	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	2.91	Inlet (Supercritical)	3
0.80	4.50	Inlet (Supercritical)	3
1.20	8.26	Inlet (Supercritical)	3
1.60	12.72	Inlet (Supercritical)	3
2.00	17.77	Inlet (Supercritical)	3
2.40	22.05	Outlet (Subcritical)	1 *
2.80	28.97	Outlet (Subcritical)	1
3.20	36.32	Outlet (Subcritical)	1
3.60	42.61	Inlet (Supercritical)	3
4.00	47.10	Outlet	6
4.40	49.54	Outlet	6
4.80	51.88	Outlet	6
5.20	54.11	Outlet	6
5.60	56.25	Outlet	6
6.00	58.32	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.99	Inlet (Supercritical)	3
0.80	5.25	Inlet (Supercritical)	3
1.20	9.64	Inlet (Supercritical)	3
1.60	14.83	Inlet (Supercritical)	3
2.00	20.73	Inlet (Supercritical)	3
2.40	27.25	Inlet (Supercritical)	3
2.80	34.34	Inlet (Supercritical)	3
3.20	40.77	Outlet (Subcritical)	1 *

3.60	50.02	Outlet (Subcritical)	1
4.00	59.45	Outlet (Subcritical)	1
4.40	65.63	Inlet	5
4.80	72.16	Inlet	5
5.20	75.69	Outlet	6
5.60	78.96	Outlet	6
6.00	82.11	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	2.00	Inlet (Supercritical)	3
0.80	5.63	Inlet (Supercritical)	3
1.20	10.32	Inlet (Supercritical)	3
1.60	15.89	Inlet (Supercritical)	3
2.00	22.21	Inlet (Supercritical)	3
2.40	29.19	Inlet (Supercritical)	3
2.80	36.79	Inlet (Supercritical)	3
3.20	44.95	Inlet (Supercritical)	3
3.60	52.59	Outlet (Subcritical)	1 *
4.00	63.04	Outlet (Subcritical)	1
4.40	72.68	Outlet (Subcritical)	2
4.80	79.63	Inlet	5
5.20	86.88	Inlet	5
5.60	91.45	Outlet	6
6.00	95.25	Outlet	6

* (Transition Region - Data may need to be smoothed.)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR CP-94

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\94

Date: 12-05-1995

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Company Name: BHP MINERALS
Filename: C:\BRIAN\94 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:41
As built design specifications for CP-94
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
					-Hydrology-					
111	1	1.70	92	M	0.034	0.000	0.000	0.0	0.09	2.22
		Type: Null			Label: CP-94					
111	Structure	1.70							0.09	
111	Total IN/OUT	1.70							0.09	2.22

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Company Name: BHP MINERALS
Filename: C:\BRIAN\94
User: Brian Sambirsky
Date: 12-05-1995 Time: 10:05:41
As built design specifications for CP-94
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	390.00	10.00	3.16	0.03	0.034		

SEDCAD+ CULVERT SIZING UTILITY

CP-94

Design Discharge	=	2.220 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	30.000 feet
Pipe Slope	=	0.900 %
Manning's n	=	0.012
Maximum Headwater	=	2.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 9 inches

PERFORMANCE CURVES:

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.12	Outlet (Subcritical)	1
0.40	0.23	Outlet (Subcritical)	1
0.60	0.35	Outlet (Subcritical)	2
0.80	0.46	Inlet (Supercritical)	3
1.00	0.58	Inlet (Supercritical)	3
1.20	0.69	Inlet (Supercritical)	4
1.40	0.81	Inlet	5
1.60	0.92	Outlet	6
1.80	1.01	Outlet	6
2.00	1.06	Outlet	6
2.20	1.10	Outlet	6
2.40	1.14	Outlet	6
2.60	1.18	Outlet	6
2.80	1.23	Outlet	6
3.00	1.27	Outlet	6

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.25	Outlet (Subcritical)	1
0.40	0.49	Outlet (Subcritical)	2
0.60	0.74	Inlet (Supercritical)	4
0.80	0.99	Inlet	5
1.00	1.16	Inlet	5
1.20	1.34	Inlet	5
1.40	1.51	Outlet	6
1.60	1.68	Outlet	6
1.80	1.86	Outlet	6
2.00	2.02	Outlet	6
2.20	2.11	Outlet	6
2.40	2.21	Outlet	6
2.60	2.30	Outlet	6
2.80	2.40	Outlet	6
3.00	2.50	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.27	Outlet (Subcritical)	1
0.40	0.54	Outlet (Subcritical)	2
0.60	0.81	Outlet (Subcritical)	2
0.80	1.10	Inlet (Supercritical)	3
1.00	1.41	Inlet (Supercritical)	4
1.20	1.73	Inlet (Supercritical)	4
1.40	2.03	Inlet	5
1.60	2.19	Inlet	5
1.80	2.36	Inlet	5
2.00	2.53	Outlet	6
2.20	2.69	Outlet	6
2.40	2.86	Outlet	6
2.60	3.02	Outlet	6
2.80	3.13	Outlet	6
3.00	3.25	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.33	Outlet (Subcritical)	1
0.40	0.65	Outlet (Subcritical)	2
0.60	0.98	Inlet (Supercritical)	3
0.80	1.53	Inlet (Supercritical)	3
1.00	2.09	Inlet (Supercritical)	3
1.20	2.68	Inlet (Supercritical)	4
1.40	3.20	Inlet	5
1.60	3.63	Inlet	5
1.80	4.05	Inlet	5
2.00	4.39	Inlet	5
2.20	4.73	Inlet	5
2.40	5.06	Inlet	5
2.60	5.34	Inlet	5
2.80	5.61	Inlet	5
3.00	5.89	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.38	Outlet (Subcritical)	1
0.40	0.76	Outlet (Subcritical)	2
0.60	1.24	Inlet (Supercritical)	3
0.80	1.88	Inlet (Supercritical)	3
1.00	2.63	Inlet (Supercritical)	3
1.20	3.45	Inlet (Supercritical)	3
1.40	4.30	Inlet (Supercritical)	4
1.60	5.10	Inlet	5
1.80	5.78	Inlet	5
2.00	6.39	Inlet	5

2.20	6.96	Inlet	5
2.40	7.46	Inlet	5
2.60	7.96	Inlet	5
2.80	8.40	Inlet	5
3.00	8.84	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.43	Outlet (Subcritical)	1
0.40	0.86	Inlet (Supercritical)	3
0.60	1.49	Inlet (Supercritical)	3
0.80	2.26	Inlet (Supercritical)	3
1.00	3.15	Inlet (Supercritical)	3
1.20	4.13	Inlet (Supercritical)	3
1.40	5.21	Inlet (Supercritical)	3
1.60	6.36	Inlet (Supercritical)	3
1.80	7.46	Inlet (Supercritical)	3
2.00	8.42	Inlet	4
2.20	9.29	Inlet	5
2.40	10.10	Inlet	5
2.60	10.83	Inlet	5
2.80	11.52	Inlet	5
3.00	12.18	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR DD-1, DD-2 AND DD-3

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\DD1_2_3

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\DD1_2_3 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:37
As built design specifications for DD-1, DD-2 and DD-3
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	19.50	89	M	0.888	0.000	0.000	0.0	0.79	6.11
		Type: Null		Label: DD-1, DD-2 and DD-3						
111	Structure	19.50							0.79	
111	Total IN/OUT	19.50							0.79	6.11

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\DD1_2_3 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:37
As built design specifications for DD-1, DD-2 and DD-3
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	3130.00	0.96	0.98	0.89	0.888		

SEDCAD+ CULVERT SIZING UTILITY

DD-1

Design Discharge	=	2.040 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	36.000 feet
Pipe Slope	=	34.010 %
Manning's n	=	0.018
Maximum Headwater	=	4.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.04		0
0.80	0.09	Outlet (Subcritical)	1
1.20	0.13	Outlet (Subcritical)	1
1.60	0.18	Outlet (Subcritical)	1
2.00	0.22	Outlet (Subcritical)	1
2.40	0.26	Outlet (Subcritical)	2
2.80	0.31	Outlet (Subcritical)	2
3.20	0.35	Outlet (Subcritical)	2
3.60	0.39	Outlet (Subcritical)	2
4.00	0.44	Inlet (Supercritical)	3
4.40	0.48	Inlet (Supercritical)	3
4.80	0.53	Inlet (Supercritical)	3
5.20	0.57	Inlet (Supercritical)	3
5.60	0.61	Inlet (Supercritical)	4
6.00	0.66	Inlet (Supercritical)	4

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.28	Outlet (Subcritical)	1
0.80	0.57	Inlet (Supercritical)	3
1.20	0.85	Inlet (Supercritical)	4
1.60	1.06	Inlet	5
2.00	1.19	Inlet	5
2.40	1.32	Inlet	5
2.80	1.44	Inlet	5
3.20	1.57	Inlet	5
3.60	1.70	Inlet	5
4.00	1.82	Inlet	5
4.40	1.95	Inlet	5
4.80	2.03	Inlet	5
5.20	2.08	Inlet	5
5.60	2.14	Inlet	5
6.00	2.19	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.49	Outlet (Subcritical)	2
0.80	0.99	Inlet	5
1.20	1.39	Inlet	5
1.60	1.79	Inlet	5
2.00	2.12	Inlet	5
2.40	2.36	Inlet	5
2.80	2.60	Inlet	5
3.20	2.84	Inlet	5
3.60	3.06	Inlet	5
4.00	3.23	Inlet	5
4.40	3.40	Inlet	5
4.80	3.58	Inlet	5
5.20	3.75	Inlet	5
5.60	3.92	Inlet	5
6.00	4.07	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.54	Outlet (Subcritical)	2
0.80	1.10	Inlet (Supercritical)	3
1.20	1.73	Inlet (Supercritical)	4
1.60	2.22	Inlet	5
2.00	2.61	Inlet	5
2.40	3.00	Inlet	5
2.80	3.27	Inlet	5
3.20	3.55	Inlet	5
3.60	3.83	Inlet	5
4.00	4.08	Inlet	5
4.40	4.29	Inlet	5
4.80	4.51	Inlet	5
5.20	4.72	Inlet	5
5.60	4.94	Inlet	5
6.00	5.13	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.65	Outlet (Subcritical)	2
0.80	1.53	Inlet (Supercritical)	3
1.20	2.68	Inlet (Supercritical)	4
1.60	3.63	Inlet	5
2.00	4.39	Inlet	5
2.40	5.06	Inlet	5
2.80	5.61	Inlet	5
3.20	6.14	Inlet	5
3.60	6.61	Inlet	5
4.00	7.07	Inlet	5

4.40	7.48	Inlet	5
4.80	7.89	Inlet	5
5.20	8.26	Inlet	5
5.60	8.62	Inlet	5
6.00	8.98	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.76	Outlet (Subcritical)	2
0.80	1.88	Inlet (Supercritical)	3
1.20	3.45	Inlet (Supercritical)	3
1.60	5.10	Inlet	5
2.00	6.39	Inlet	5
2.40	7.46	Inlet	5
2.80	8.40	Inlet	5
3.20	9.25	Inlet	5
3.60	10.03	Inlet	5
4.00	10.74	Inlet	5
4.40	11.41	Inlet	5
4.80	12.06	Inlet	5
5.20	12.65	Inlet	5
5.60	13.23	Inlet	5
6.00	13.78	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-2

Design Discharge	=	2.040 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	53.000 feet
Pipe Slope	=	34.940 %
Manning's n	=	0.018
Maximum Headwater	=	4.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.04		0
0.80	0.07		0
1.20	0.11	Outlet (Subcritical)	1
1.60	0.14	Outlet (Subcritical)	1
2.00	0.18	Outlet (Subcritical)	1
2.40	0.21	Outlet (Subcritical)	1
2.80	0.25	Outlet (Subcritical)	1
3.20	0.28	Outlet (Subcritical)	2
3.60	0.32	Outlet (Subcritical)	2
4.00	0.35	Outlet (Subcritical)	2
4.40	0.39	Outlet (Subcritical)	2
4.80	0.42	Inlet (Supercritical)	3
5.20	0.46	Inlet (Supercritical)	3
5.60	0.49	Inlet (Supercritical)	3
6.00	0.53	Inlet (Supercritical)	3

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.28	Outlet (Subcritical)	1
0.80	0.57	Inlet (Supercritical)	3
1.20	0.85	Inlet (Supercritical)	4
1.60	1.06	Inlet	5
2.00	1.19	Inlet	5
2.40	1.32	Inlet	5
2.80	1.44	Inlet	5
3.20	1.57	Inlet	5
3.60	1.70	Inlet	5
4.00	1.82	Inlet	5
4.40	1.95	Inlet	5
4.80	2.02	Inlet	5
5.20	2.06	Inlet	5
5.60	2.10	Inlet	5
6.00	2.14	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.49	Outlet (Subcritical)	2
0.80	0.99	Inlet	5
1.20	1.39	Inlet	5
1.60	1.79	Inlet	5
2.00	2.12	Inlet	5
2.40	2.36	Inlet	5
2.80	2.60	Inlet	5
3.20	2.84	Inlet	5
3.60	3.06	Inlet	5
4.00	3.23	Inlet	5
4.40	3.40	Inlet	5
4.80	3.58	Inlet	5
5.20	3.75	Inlet	5
5.60	3.92	Inlet	5
6.00	4.07	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.54	Outlet (Subcritical)	2
0.80	1.10	Inlet (Supercritical)	3
1.20	1.73	Inlet (Supercritical)	4
1.60	2.22	Inlet	5
2.00	2.61	Inlet	5
2.40	3.00	Inlet	5
2.80	3.27	Inlet	5
3.20	3.55	Inlet	5
3.60	3.83	Inlet	5
4.00	4.08	Inlet	5
4.40	4.29	Inlet	5
4.80	4.51	Inlet	5
5.20	4.72	Inlet	5
5.60	4.94	Inlet	5
6.00	5.13	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.65	Outlet (Subcritical)	2
0.80	1.53	Inlet (Supercritical)	3
1.20	2.68	Inlet (Supercritical)	4
1.60	3.63	Inlet	5
2.00	4.39	Inlet	5
2.40	5.06	Inlet	5
2.80	5.61	Inlet	5
3.20	6.14	Inlet	5
3.60	6.61	Inlet	5
4.00	7.07	Inlet	5

4.40	7.48	Inlet	5
4.80	7.89	Inlet	5
5.20	8.26	Inlet	5
5.60	8.62	Inlet	5
6.00	8.98	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.76	Outlet (Subcritical)	2
0.80	1.88	Inlet (Supercritical)	3
1.20	3.45	Inlet (Supercritical)	3
1.60	5.10	Inlet	5
2.00	6.39	Inlet	5
2.40	7.46	Inlet	5
2.80	8.40	Inlet	5
3.20	9.25	Inlet	5
3.60	10.03	Inlet	5
4.00	10.74	Inlet	5
4.40	11.41	Inlet	5
4.80	12.06	Inlet	5
5.20	12.65	Inlet	5
5.60	13.23	Inlet	5
6.00	13.78	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-3

Design Discharge	=	2.040 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	53.000 feet
Pipe Slope	=	37.600 %
Manning's n	=	0.018
Maximum Headwater	=	4.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.04		0
0.80	0.08		0
1.20	0.12	Outlet (Subcritical)	1
1.60	0.16	Outlet (Subcritical)	1
2.00	0.20	Outlet (Subcritical)	1
2.40	0.24	Outlet (Subcritical)	1
2.80	0.28	Outlet (Subcritical)	2
3.20	0.32	Outlet (Subcritical)	2
3.60	0.36	Outlet (Subcritical)	2
4.00	0.40	Outlet (Subcritical)	2
4.40	0.44	Inlet (Supercritical)	3
4.80	0.48	Inlet (Supercritical)	3
5.20	0.52	Inlet (Supercritical)	3
5.60	0.56	Inlet (Supercritical)	3
6.00	0.60	Inlet (Supercritical)	4

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.28	Outlet (Subcritical)	1
0.80	0.57	Inlet (Supercritical)	3
1.20	0.85	Inlet (Supercritical)	4
1.60	1.06	Inlet	5
2.00	1.19	Inlet	5
2.40	1.32	Inlet	5
2.80	1.44	Inlet	5
3.20	1.57	Inlet	5
3.60	1.70	Inlet	5
4.00	1.82	Inlet	5
4.40	1.95	Inlet	5
4.80	2.03	Inlet	5
5.20	2.07	Inlet	5
5.60	2.12	Inlet	5
6.00	2.16	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.49	Outlet (Subcritical)	2
0.80	0.99	Inlet	5
1.20	1.39	Inlet	5
1.60	1.79	Inlet	5
2.00	2.12	Inlet	5
2.40	2.36	Inlet	5
2.80	2.60	Inlet	5
3.20	2.84	Inlet	5
3.60	3.06	Inlet	5
4.00	3.23	Inlet	5
4.40	3.40	Inlet	5
4.80	3.58	Inlet	5
5.20	3.75	Inlet	5
5.60	3.92	Inlet	5
6.00	4.07	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.54	Outlet (Subcritical)	2
0.80	1.10	Inlet (Supercritical)	3
1.20	1.73	Inlet (Supercritical)	4
1.60	2.22	Inlet	5
2.00	2.61	Inlet	5
2.40	3.00	Inlet	5
2.80	3.27	Inlet	5
3.20	3.55	Inlet	5
3.60	3.83	Inlet	5
4.00	4.08	Inlet	5
4.40	4.29	Inlet	5
4.80	4.51	Inlet	5
5.20	4.72	Inlet	5
5.60	4.94	Inlet	5
6.00	5.13	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.65	Outlet (Subcritical)	2
0.80	1.53	Inlet (Supercritical)	3
1.20	2.68	Inlet (Supercritical)	4
1.60	3.63	Inlet	5
2.00	4.39	Inlet	5
2.40	5.06	Inlet	5
2.80	5.61	Inlet	5
3.20	6.14	Inlet	5
3.60	6.61	Inlet	5
4.00	7.07	Inlet	5

4.40	7.48	Inlet	5
4.80	7.89	Inlet	5
5.20	8.26	Inlet	5
5.60	8.62	Inlet	5
6.00	8.98	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.76	Outlet (Subcritical)	2
0.80	1.88	Inlet (Supercritical)	3
1.20	3.45	Inlet (Supercritical)	3
1.60	5.10	Inlet	5
2.00	6.39	Inlet	5
2.40	7.46	Inlet	5
2.80	8.40	Inlet	5
3.20	9.25	Inlet	5
3.60	10.03	Inlet	5
4.00	10.74	Inlet	5
4.40	11.41	Inlet	5
4.80	12.06	Inlet	5
5.20	12.65	Inlet	5
5.60	13.23	Inlet	5
6.00	13.78	Inlet	5

DD-04

Shawn Smith

Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	DD-04

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.710	1.710	1.12	0.07

Structure Detail:

Structure #1 (Culvert)

DD-04

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
64.70	66.34	0.0130	2.00	0.00	0.90

Culvert Results:

Design Discharge = 1.12 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.710	0.433	0.000	0.000	89.000	F	1.12	0.065
	Σ	**1.710**						**1.12**	**0.065**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.75	10.05	1,341.00	0.860	0.433
#1	**1**	**Time of Concentration:**					**0.433**

DD-05

Shawn Smith

Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	DD-05

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	10.410	10.410	3.22	0.25

Structure Detail:

Structure #1 (Culvert)

DD-05

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
29.00	28.62	0.0150	4.00	0.00	0.90

Culvert Results:

Design Discharge = 3.22 cfs

Minimum pipe diameter: 1 - 8 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	10.410	0.560	0.000	0.000	86.000	M	3.22	0.252
	Σ	**10.410**						**3.22**	**0.252**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.72	90.00	3,309.00	1.640	0.560
#1	**1**	**Time of Concentration:**					**0.560**

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR DD-6

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\DD6

Date: 12-05-1995

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Company Name: BHP MINERALS
Filename: C:\BRIAN\DD6
User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:40
As built design specifications for DD-6
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	15.20	89	M	0.810	0.000	0.000	0.0	0.61	5.08
			Type: Null			Label: DD-6				
111	Structure	15.20							0.61	
111	Total IN/OUT	15.20							0.61	5.08

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Company Name: BHP MINERALS
Filename: C:\BRIAN\DD6 User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:40
As built design specifications for DD-6
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	4800.00	2.71	1.65	0.81	0.810		

SEDCAD+ CULVERT SIZING UTILITY

DD-6

Design Discharge	=	5.080 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	44.000 feet
Pipe Slope	=	19.690 %
Manning's n	=	0.013
Maximum Headwater	=	4.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.49	Outlet (Subcritical)	2
0.80	0.99	Inlet	5
1.20	1.39	Inlet	5
1.60	1.79	Inlet	5
2.00	2.12	Inlet	5
2.40	2.36	Inlet	5
2.80	2.60	Inlet	5
3.20	2.84	Inlet	5
3.60	3.06	Inlet	5
4.00	3.23	Inlet	5
4.40	3.40	Inlet	5
4.80	3.58	Inlet	5
5.20	3.75	Inlet	5
5.60	3.92	Inlet	5
6.00	4.07	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.54	Outlet (Subcritical)	2
0.80	1.10	Inlet (Supercritical)	3
1.20	1.73	Inlet (Supercritical)	4
1.60	2.22	Inlet	5
2.00	2.61	Inlet	5
2.40	3.00	Inlet	5
2.80	3.27	Inlet	5
3.20	3.55	Inlet	5
3.60	3.83	Inlet	5
4.00	4.08	Inlet	5
4.40	4.29	Inlet	5
4.80	4.51	Inlet	5
5.20	4.72	Inlet	5
5.60	4.94	Inlet	5
6.00	5.13	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.65	Outlet (Subcritical)	2
0.80	1.53	Inlet (Supercritical)	3
1.20	2.68	Inlet (Supercritical)	4
1.60	3.63	Inlet	5
2.00	4.39	Inlet	5
2.40	5.06	Inlet	5
2.80	5.61	Inlet	5
3.20	6.14	Inlet	5
3.60	6.61	Inlet	5
4.00	7.07	Inlet	5
4.40	7.48	Inlet	5
4.80	7.89	Inlet	5
5.20	8.26	Inlet	5
5.60	8.62	Inlet	5
6.00	8.98	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.76	Outlet (Subcritical)	2
0.80	1.88	Inlet (Supercritical)	3
1.20	3.45	Inlet (Supercritical)	3
1.60	5.10	Inlet	5
2.00	6.39	Inlet	5
2.40	7.46	Inlet	5
2.80	8.40	Inlet	5
3.20	9.25	Inlet	5
3.60	10.03	Inlet	5
4.00	10.74	Inlet	5
4.40	11.41	Inlet	5
4.80	12.06	Inlet	5
5.20	12.65	Inlet	5
5.60	13.23	Inlet	5
6.00	13.78	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.86	Inlet (Supercritical)	3
0.80	2.26	Inlet (Supercritical)	3
1.20	4.13	Inlet (Supercritical)	3
1.60	6.36	Inlet (Supercritical)	3
2.00	8.42	Inlet	5
2.40	10.10	Inlet	5
2.80	11.52	Inlet	5
3.20	12.80	Inlet	5
3.60	13.96	Inlet	5
4.00	15.02	Inlet	5

4.40	16.02	Inlet	5
4.80	16.96	Inlet	5
5.20	17.84	Inlet	5
5.60	18.69	Inlet	5
6.00	19.50	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.95	Inlet (Supercritical)	3
0.80	2.64	Inlet (Supercritical)	3
1.20	4.82	Inlet (Supercritical)	3
1.60	7.42	Inlet (Supercritical)	3
2.00	10.31	Inlet (Supercritical)	4
2.40	12.77	Inlet	5
2.80	14.85	Inlet	5
3.20	16.66	Inlet	5
3.60	18.30	Inlet	5
4.00	19.81	Inlet	5
4.40	21.20	Inlet	5
4.80	22.51	Inlet	5
5.20	23.75	Inlet	5
5.60	24.93	Inlet	5
6.00	26.05	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR DOWNDRAINS 7, 8, 9, 10, 11 AND 12

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\BIGFILLA

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\BIGFILLA User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:22
As built design specifications for downdrains 7, 8, 9, 10, 11 and 12
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	56.20	89	M	1.056	0.000	0.000	0.0	2.27	15.56
		Type: Null		Label: Downdrains 7, 8 & 9						
111 Structure		56.20							2.27	
111 Total IN/OUT		56.20							2.27	15.56
121	1	4.60	89	M	1.464	0.000	0.000	0.0	0.19	1.00
		Type: Null		Label: Downdrains 10,11&12						
121 Structure		4.60							0.19	
121 Total IN/OUT		4.60							0.19	1.00
		Type: Null		Label: Downdrains 10,11&12						
211 Structure		4.60							2.45	
211 Total IN/OUT		60.80							2.45	16.39
111 to 211 Routing						0.001	0.271			

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Company Name: BHP MINERALS
Filename: C:\BRIAN\BIGFILLA User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:22
As built design specifications for downdrains 7, 8, 9, 10, 11 and 12
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	5800.00	2.33	1.53	1.06	1.056		
1	2	1	1	-a	5	4600.00	0.76	0.87	1.46	1.464		

SEDCAD+ CULVERT SIZING UTILITY

DD-7

Design Discharge	=	5.180 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	325.000 feet
Pipe Slope	=	20.350 %
Manning's n	=	0.013
Maximum Headwater	=	2.250 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.30	Outlet (Subcritical)	1
0.45	0.61	Outlet (Subcritical)	2
0.67	0.91	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
1.13	1.61	Inlet (Supercritical)	4
1.35	1.97	Inlet	5
1.58	2.20	Inlet	5
1.80	2.42	Inlet	5
2.03	2.63	Inlet	5
2.25	2.85	Inlet	5
2.47	3.05	Inlet	5
2.70	3.21	Inlet	5
2.92	3.36	Inlet	5
3.15	3.52	Inlet	5
3.37	3.67	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.37	Outlet (Subcritical)	1
0.45	0.74	Outlet (Subcritical)	2
0.67	1.18	Inlet (Supercritical)	3
0.90	1.81	Inlet (Supercritical)	3
1.13	2.46	Inlet (Supercritical)	4
1.35	3.09	Inlet	5
1.58	3.58	Inlet	5
1.80	4.05	Inlet	5
2.03	4.44	Inlet	5
2.25	4.82	Inlet	5
2.47	5.16	Inlet	5
2.70	5.48	Inlet	5
2.92	5.79	Inlet	5
3.15	6.09	Inlet	5
3.37	6.35	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.43	Outlet (Subcritical)	1
0.45	0.85	Inlet (Supercritical)	3
0.67	1.48	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
1.13	3.13	Inlet (Supercritical)	3
1.35	4.10	Inlet (Supercritical)	3
1.58	5.01	Inlet	5
1.80	5.78	Inlet	5
2.03	6.46	Inlet	5
2.25	7.09	Inlet	5
2.47	7.65	Inlet	5
2.70	8.18	Inlet	5
2.92	8.68	Inlet	5
3.15	9.15	Inlet	5
3.37	9.59	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.48	Outlet (Subcritical)	1
0.45	0.97	Inlet (Supercritical)	3
0.67	1.76	Inlet (Supercritical)	3
0.90	2.70	Inlet (Supercritical)	3
1.13	3.76	Inlet (Supercritical)	3
1.35	4.93	Inlet (Supercritical)	3
1.58	6.21	Inlet (Supercritical)	3
1.80	7.46	Inlet (Supercritical)	4
2.03	8.53	Inlet	5
2.25	9.50	Inlet	5
2.47	10.37	Inlet	5
2.70	11.18	Inlet	5
2.92	11.94	Inlet	5
3.15	12.64	Inlet	5
3.37	13.31	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.53	Outlet (Subcritical)	2
0.45	1.12	Inlet (Supercritical)	3
0.67	2.03	Inlet (Supercritical)	3
0.90	3.13	Inlet (Supercritical)	3
1.13	4.38	Inlet (Supercritical)	3
1.35	5.75	Inlet (Supercritical)	3
1.58	7.25	Inlet (Supercritical)	3
1.80	8.85	Inlet (Supercritical)	3
2.03	10.47	Inlet (Supercritical)	4
2.25	11.90	Inlet	5

2.47	13.19	Inlet	5
2.70	14.35	Inlet	5
2.92	15.43	Inlet	5
3.15	16.44	Inlet	5
3.37	17.40	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.58	Outlet (Subcritical)	2
0.45	1.29	Inlet (Supercritical)	3
0.67	2.34	Inlet (Supercritical)	3
0.90	3.59	Inlet (Supercritical)	3
1.13	5.00	Inlet (Supercritical)	3
1.35	6.57	Inlet (Supercritical)	3
1.58	8.28	Inlet (Supercritical)	3
1.80	10.11	Inlet (Supercritical)	3
2.03	12.07	Inlet (Supercritical)	3
2.25	14.13	Inlet (Supercritical)	3
2.47	15.91	Inlet	5
2.70	17.54	Inlet	5
2.92	19.05	Inlet	5
3.15	20.43	Inlet	5
3.37	21.74	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-8

Design Discharge	=	5.180 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	90.000 feet
Pipe Slope	=	67.420 %
Manning's n	=	0.013
Maximum Headwater	=	2.250 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.30	Outlet (Subcritical)	1
0.45	0.61	Outlet (Subcritical)	2
0.67	0.91	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
1.13	1.61	Inlet (Supercritical)	4
1.35	1.97	Inlet	5
1.58	2.20	Inlet	5
1.80	2.42	Inlet	5
2.03	2.63	Inlet	5
2.25	2.85	Inlet	5
2.47	3.05	Inlet	5
2.70	3.21	Inlet	5
2.92	3.36	Inlet	5
3.15	3.52	Inlet	5
3.37	3.67	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.37	Outlet (Subcritical)	1
0.45	0.74	Outlet (Subcritical)	2
0.67	1.18	Inlet (Supercritical)	3
0.90	1.81	Inlet (Supercritical)	3
1.13	2.46	Inlet (Supercritical)	4
1.35	3.09	Inlet	5
1.58	3.58	Inlet	5
1.80	4.05	Inlet	5
2.03	4.44	Inlet	5
2.25	4.82	Inlet	5
2.47	5.16	Inlet	5
2.70	5.48	Inlet	5
2.92	5.79	Inlet	5
3.15	6.09	Inlet	5
3.37	6.35	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.43	Outlet (Subcritical)	1
0.45	0.85	Inlet (Supercritical)	3
0.67	1.48	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
1.13	3.13	Inlet (Supercritical)	3
1.35	4.10	Inlet (Supercritical)	3
1.58	5.01	Inlet	5
1.80	5.78	Inlet	5
2.03	6.46	Inlet	5
2.25	7.09	Inlet	5
2.47	7.65	Inlet	5
2.70	8.18	Inlet	5
2.92	8.68	Inlet	5
3.15	9.15	Inlet	5
3.37	9.59	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.48	Outlet (Subcritical)	1
0.45	0.97	Inlet (Supercritical)	3
0.67	1.76	Inlet (Supercritical)	3
0.90	2.70	Inlet (Supercritical)	3
1.13	3.76	Inlet (Supercritical)	3
1.35	4.93	Inlet (Supercritical)	3
1.58	6.21	Inlet (Supercritical)	3
1.80	7.46	Inlet (Supercritical)	4
2.03	8.53	Inlet	5
2.25	9.50	Inlet	5
2.47	10.37	Inlet	5
2.70	11.18	Inlet	5
2.92	11.94	Inlet	5
3.15	12.64	Inlet	5
3.37	13.31	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.53	Outlet (Subcritical)	2
0.45	1.12	Inlet (Supercritical)	3
0.67	2.03	Inlet (Supercritical)	3
0.90	3.13	Inlet (Supercritical)	3
1.13	4.38	Inlet (Supercritical)	3
1.35	5.75	Inlet (Supercritical)	3
1.58	7.25	Inlet (Supercritical)	3
1.80	8.85	Inlet (Supercritical)	3
2.03	10.47	Inlet (Supercritical)	4
2.25	11.90	Inlet	5

2.47	13.19	Inlet	5
2.70	14.35	Inlet	5
2.92	15.43	Inlet	5
3.15	16.44	Inlet	5
3.37	17.40	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.58	Outlet (Subcritical)	2
0.45	1.29	Inlet (Supercritical)	3
0.67	2.34	Inlet (Supercritical)	3
0.90	3.59	Inlet (Supercritical)	3
1.13	5.00	Inlet (Supercritical)	3
1.35	6.57	Inlet (Supercritical)	3
1.58	8.28	Inlet (Supercritical)	3
1.80	10.11	Inlet (Supercritical)	3
2.03	12.07	Inlet (Supercritical)	3
2.25	14.13	Inlet (Supercritical)	3
2.47	15.91	Inlet	5
2.70	17.54	Inlet	5
2.92	19.05	Inlet	5
3.15	20.43	Inlet	5
3.37	21.74	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-9

Design Discharge	=	5.180 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	87.000 feet
Pipe Slope	=	66.340 %
Manning's n	=	0.013
Maximum Headwater	=	2.250 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.30	Outlet (Subcritical)	1
0.45	0.61	Outlet (Subcritical)	2
0.67	0.91	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
1.13	1.61	Inlet (Supercritical)	4
1.35	1.97	Inlet	5
1.58	2.20	Inlet	5
1.80	2.42	Inlet	5
2.03	2.63	Inlet	5
2.25	2.85	Inlet	5
2.47	3.05	Inlet	5
2.70	3.21	Inlet	5
2.92	3.36	Inlet	5
3.15	3.52	Inlet	5
3.37	3.67	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.37	Outlet (Subcritical)	1
0.45	0.74	Outlet (Subcritical)	2
0.67	1.18	Inlet (Supercritical)	3
0.90	1.81	Inlet (Supercritical)	3
1.13	2.46	Inlet (Supercritical)	4
1.35	3.09	Inlet	5
1.58	3.58	Inlet	5
1.80	4.05	Inlet	5
2.03	4.44	Inlet	5
2.25	4.82	Inlet	5
2.47	5.16	Inlet	5
2.70	5.48	Inlet	5
2.92	5.79	Inlet	5
3.15	6.09	Inlet	5
3.37	6.35	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.43	Outlet (Subcritical)	1
0.45	0.85	Inlet (Supercritical)	3
0.67	1.48	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
1.13	3.13	Inlet (Supercritical)	3
1.35	4.10	Inlet (Supercritical)	3
1.58	5.01	Inlet	3
1.80	5.78	Inlet	5
2.03	6.46	Inlet	5
2.25	7.09	Inlet	5
2.47	7.65	Inlet	5
2.70	8.18	Inlet	5
2.92	8.68	Inlet	5
3.15	9.15	Inlet	5
3.37	9.59	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.48	Outlet (Subcritical)	1
0.45	0.97	Inlet (Supercritical)	3
0.67	1.76	Inlet (Supercritical)	3
0.90	2.70	Inlet (Supercritical)	3
1.13	3.76	Inlet (Supercritical)	3
1.35	4.93	Inlet (Supercritical)	3
1.58	6.21	Inlet (Supercritical)	3
1.80	7.46	Inlet (Supercritical)	3
2.03	8.53	Inlet	4
2.25	9.50	Inlet	5
2.47	10.37	Inlet	5
2.70	11.18	Inlet	5
2.92	11.94	Inlet	5
3.15	12.64	Inlet	5
3.37	13.31	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.53	Outlet (Subcritical)	2
0.45	1.12	Inlet (Supercritical)	3
0.67	2.03	Inlet (Supercritical)	3
0.90	3.13	Inlet (Supercritical)	3
1.13	4.38	Inlet (Supercritical)	3
1.35	5.75	Inlet (Supercritical)	3
1.58	7.25	Inlet (Supercritical)	3
1.80	8.85	Inlet (Supercritical)	3
2.03	10.47	Inlet (Supercritical)	3
2.25	11.90	Inlet	4
			5

2.47	13.19	Inlet	5
2.70	14.35	Inlet	5
2.92	15.43	Inlet	5
3.15	16.44	Inlet	5
3.37	17.40	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.22	0.58	Outlet (Subcritical)	2
0.45	1.29	Inlet (Supercritical)	3
0.67	2.34	Inlet (Supercritical)	3
0.90	3.59	Inlet (Supercritical)	3
1.13	5.00	Inlet (Supercritical)	3
1.35	6.57	Inlet (Supercritical)	3
1.58	8.28	Inlet (Supercritical)	3
1.80	10.11	Inlet (Supercritical)	3
2.03	12.07	Inlet (Supercritical)	3
2.25	14.13	Inlet (Supercritical)	3
2.47	15.91	Inlet	5
2.70	17.54	Inlet	5
2.92	19.05	Inlet	5
3.15	20.43	Inlet	5
3.37	21.74	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-10

Design Discharge	=	0.330	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	105.000	feet
Pipe Slope	=	50.340	%
Manning's n	=	0.013	
Maximum Headwater	=	1.250	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 4 inches

PERFORMANCE CURVES:

Diameter: 2 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.00		0
0.25	0.00		0
0.38	0.00		0
0.50	0.00		0
0.63	0.00		0
0.75	0.00		0
0.88	0.00		0
1.00	0.00		0
1.13	0.00		0
1.25	0.00		0
1.38	0.00		0
1.50	0.00		0
1.63	0.00		0
1.75	0.00		0
1.88	0.00		0

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.02		0
0.25	0.05		0
0.38	0.07		0
0.50	0.09		0
0.63	0.11	Outlet (Subcritical)	1
0.75	0.14	Outlet (Subcritical)	1
0.88	0.16	Outlet (Subcritical)	1
1.00	0.18	Outlet (Subcritical)	1
1.13	0.20	Outlet (Subcritical)	1
1.25	0.23	Outlet (Subcritical)	1
1.38	0.25	Outlet (Subcritical)	1
1.50	0.27	Outlet (Subcritical)	1
1.63	0.29	Outlet (Subcritical)	1
1.75	0.32	Outlet (Subcritical)	2
1.88	0.34	Outlet (Subcritical)	2

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.09		0
0.25	0.18	Outlet (Subcritical)	1
0.38	0.27	Outlet (Subcritical)	1
0.50	0.36	Outlet (Subcritical)	2
0.63	0.44	Outlet (Subcritical)	2
0.75	0.53	Inlet (Supercritical)	3
0.88	0.62	Inlet (Supercritical)	3
1.00	0.71	Inlet (Supercritical)	4
1.13	0.80	Inlet (Supercritical)	4
1.25	0.89	Inlet (Supercritical)	4
1.38	0.98	Inlet	5
1.50	1.03	Inlet	5
1.63	1.07	Inlet	5
1.75	1.11	Inlet	5
1.88	1.15	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.15	Outlet (Subcritical)	1
0.25	0.31	Outlet (Subcritical)	2
0.38	0.46	Outlet (Subcritical)	2
0.50	0.62	Inlet (Supercritical)	3
0.63	0.77	Inlet (Supercritical)	4
0.75	0.92	Inlet	5
0.88	1.06	Inlet	5
1.00	1.19	Inlet	5
1.13	1.32	Inlet	5
1.25	1.44	Inlet	5
1.38	1.57	Inlet	5
1.50	1.69	Inlet	5
1.63	1.82	Inlet	5
1.75	1.94	Inlet	5
1.88	2.04	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.17	Outlet (Subcritical)	1
0.25	0.34	Outlet (Subcritical)	1
0.38	0.51	Outlet (Subcritical)	2
0.50	0.68	Outlet (Subcritical)	2
0.63	0.84	Inlet (Supercritical)	3
0.75	1.02	Inlet (Supercritical)	3
0.88	1.21	Inlet (Supercritical)	3
1.00	1.41	Inlet (Supercritical)	4
1.13	1.61	Inlet (Supercritical)	4
1.25	1.81	Inlet	5

1.38	2.01	Inlet	5
1.50	2.13	Inlet	5
1.63	2.25	Inlet	5
1.75	2.37	Inlet	5
1.88	2.49	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-11

Design Discharge	=	0.330	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	408.000	feet
Pipe Slope	=	12.120	%
Manning's n	=	0.013	
Maximum Headwater	=	1.250	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 4 inches

PERFORMANCE CURVES:

Diameter: 2 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.00		0
0.25	0.00		0
0.38	0.00		0
0.50	0.00		0
0.63	0.00		0
0.75	0.00		0
0.88	0.00		0
1.00	0.00		0
1.13	0.00		0
1.25	0.00		0
1.38	0.00		0
1.50	0.00		0
1.63	0.00		0
1.75	0.00		0
1.88	0.00		0

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.00		0
0.25	0.00		0
0.38	0.01		0
0.50	0.01		0
0.63	0.01		0
0.75	0.01		0
0.88	0.02		0
1.00	0.02		0
1.13	0.02		0
1.25	0.02		0
1.38	0.02		0
1.50	0.03		0
1.63	0.03		0
1.75	0.03		0
1.88	0.03		0

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.09		0
0.25	0.18	Outlet (Subcritical)	1
0.38	0.27	Outlet (Subcritical)	1
0.50	0.36	Outlet (Subcritical)	2
0.63	0.44	Outlet (Subcritical)	2
0.75	0.53	Inlet (Supercritical)	3
0.88	0.62	Inlet (Supercritical)	3
1.00	0.71	Inlet (Supercritical)	4
1.13	0.80	Inlet (Supercritical)	4
1.25	0.89	Inlet (Supercritical)	4
1.38	0.98	Inlet	5
1.50	1.03	Inlet	5
1.63	1.07	Inlet	5
1.75	1.11	Inlet	5
1.88	1.15	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.15	Outlet (Subcritical)	1
0.25	0.31	Outlet (Subcritical)	2
0.38	0.46	Outlet (Subcritical)	2
0.50	0.62	Inlet (Supercritical)	3
0.63	0.77	Inlet (Supercritical)	4
0.75	0.92	Inlet	5
0.88	1.06	Inlet	5
1.00	1.19	Inlet	5
1.13	1.32	Inlet	5
1.25	1.44	Inlet	5
1.38	1.57	Inlet	5
1.50	1.69	Inlet	5
1.63	1.82	Inlet	5
1.75	1.94	Inlet	5
1.88	2.04	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.17	Outlet (Subcritical)	1
0.25	0.34	Outlet (Subcritical)	1
0.38	0.51	Outlet (Subcritical)	2
0.50	0.68	Outlet (Subcritical)	2
0.63	0.84	Inlet (Supercritical)	3
0.75	1.02	Inlet (Supercritical)	3
0.88	1.21	Inlet (Supercritical)	3
1.00	1.41	Inlet (Supercritical)	4
1.13	1.61	Inlet (Supercritical)	4
1.25	1.81	Inlet	5

1.38	2.01	Inlet	5
1.50	2.13	Inlet	5
1.63	2.25	Inlet	5
1.75	2.37	Inlet	5
1.88	2.49	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-12

Design Discharge	=	0.330 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	67.500 feet
Pipe Slope	=	58.770 %
Manning's n	=	0.013
Maximum Headwater	=	1.250 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 4 inches

PERFORMANCE CURVES:

Diameter: 2 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.00		0
0.25	0.00		0
0.38	0.00		0
0.50	0.00		0
0.63	0.00		0
0.75	0.00		0
0.88	0.00		0
1.00	0.00		0
1.13	0.00		0
1.25	0.00		0
1.38	0.00		0
1.50	0.00		0
1.63	0.00		0
1.75	0.00		0
1.88	0.00		0

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.02		0
0.25	0.05		0
0.38	0.07		0
0.50	0.09		0
0.63	0.11	Outlet (Subcritical)	1
0.75	0.14	Outlet (Subcritical)	1
0.88	0.16	Outlet (Subcritical)	1
1.00	0.18	Outlet (Subcritical)	1
1.13	0.20	Outlet (Subcritical)	1
1.25	0.23	Outlet (Subcritical)	1
1.38	0.25	Outlet (Subcritical)	1
1.50	0.27	Outlet (Subcritical)	1
1.63	0.29	Outlet (Subcritical)	1
1.75	0.32	Outlet (Subcritical)	2
1.88	0.34	Outlet (Subcritical)	2

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.09		0
0.25	0.18	Outlet (Subcritical)	1
0.38	0.27	Outlet (Subcritical)	1
0.50	0.36	Outlet (Subcritical)	2
0.63	0.44	Outlet (Subcritical)	2
0.75	0.53	Inlet (Supercritical)	3
0.88	0.62	Inlet (Supercritical)	3
1.00	0.71	Inlet (Supercritical)	4
1.13	0.80	Inlet (Supercritical)	4
1.25	0.89	Inlet (Supercritical)	4
1.38	0.98	Inlet	5
1.50	1.03	Inlet	5
1.63	1.07	Inlet	5
1.75	1.11	Inlet	5
1.88	1.15	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.15	Outlet (Subcritical)	1
0.25	0.31	Outlet (Subcritical)	2
0.38	0.46	Outlet (Subcritical)	2
0.50	0.62	Inlet (Supercritical)	3
0.63	0.77	Inlet (Supercritical)	4
0.75	0.92	Inlet	5
0.88	1.06	Inlet	5
1.00	1.19	Inlet	5
1.13	1.32	Inlet	5
1.25	1.44	Inlet	5
1.38	1.57	Inlet	5
1.50	1.69	Inlet	5
1.63	1.82	Inlet	5
1.75	1.94	Inlet	5
1.88	2.04	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.17	Outlet (Subcritical)	1
0.25	0.34	Outlet (Subcritical)	1
0.38	0.51	Outlet (Subcritical)	2
0.50	0.68	Outlet (Subcritical)	2
0.63	0.84	Inlet (Supercritical)	3
0.75	1.02	Inlet (Supercritical)	3
0.88	1.21	Inlet (Supercritical)	3
1.00	1.41	Inlet (Supercritical)	4
1.13	1.61	Inlet (Supercritical)	4
1.25	1.81	Inlet	5

1.38	2.01	Inlet	5
1.50	2.13	Inlet	5
1.63	2.25	Inlet	5
1.75	2.37	Inlet	5
1.88	2.49	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

AS BUILT DESIGN SPECIFICATIONS FOR DOWNDRAINS 13,14,15,16,17,&18

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: C:\BRIAN\BIGFILLB

Date: 12-05-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\BIGFILLB User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:18
As built design specifications for downdrains 13,14,15,16,17,&18
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	15.00	89	M	1.679	0.000	0.000	0.0	0.61	2.92
		Type: Null		Label: Downdrains 13,14,15						
111 Structure		15.00							0.61	
111 Total IN/OUT		15.00							0.61	2.92
121	1	61.60	89	M	0.674	0.000	0.000	0.0	2.49	23.36
		Type: Null		Label: Downdrains 16,17,18						
121 Structure		61.60							2.49	
Total IN/OUT		61.60							2.49	23.36
		Type: Null		Label: Downdrains 16,17,18						
211 Structure		61.60							3.09	
211 Total IN/OUT		76.60							3.09	24.90
111 to 211 Routing						0.001	0.271			

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\BIGFILLB User: Brian Sambirsky
Date: 12-05-1995 Time: 10:06:18
As built design specifications for downdrains 13,14,15,16,17,&18
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	6350.00	1.10	1.05	1.68	1.679		
1	2	1	1	-a	5	4300.00	3.14	1.77	0.67	0.674		

SEDCAD+ CULVERT SIZING UTILITY

DD-13

Design Discharge	=	0.970 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	206.000 feet
Pipe Slope	=	27.880 %
Manning's n	=	0.013
Maximum Headwater	=	1.250 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.02		0
0.25	0.05		0
0.38	0.07		0
0.50	0.09		0
0.63	0.11	Outlet (Subcritical)	1
0.75	0.14	Outlet (Subcritical)	1
0.88	0.16	Outlet (Subcritical)	1
1.00	0.18	Outlet (Subcritical)	1
1.13	0.20	Outlet (Subcritical)	1
1.25	0.23	Outlet (Subcritical)	1
1.38	0.25	Outlet (Subcritical)	1
1.50	0.27	Outlet (Subcritical)	1
1.63	0.29	Outlet (Subcritical)	1
1.75	0.32	Outlet (Subcritical)	2
1.88	0.34	Outlet (Subcritical)	2

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.09		0
0.25	0.18	Outlet (Subcritical)	1
0.38	0.27	Outlet (Subcritical)	1
0.50	0.36	Outlet (Subcritical)	2
0.63	0.44	Outlet (Subcritical)	2
0.75	0.53	Inlet (Supercritical)	3
0.88	0.62	Inlet (Supercritical)	3
1.00	0.71	Inlet (Supercritical)	4
1.13	0.80	Inlet (Supercritical)	4
1.25	0.89	Inlet (Supercritical)	4
1.38	0.98	Inlet	5
1.50	1.03	Inlet	5
1.63	1.07	Inlet	5
1.75	1.11	Inlet	5
1.88	1.15	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.15	Outlet (Subcritical)	1
0.25	0.31	Outlet (Subcritical)	2
0.38	0.46	Outlet (Subcritical)	2
0.50	0.62	Inlet (Supercritical)	3
0.63	0.77	Inlet (Supercritical)	4
0.75	0.92	Inlet	5
0.88	1.06	Inlet	5
1.00	1.19	Inlet	5
1.13	1.32	Inlet	5
1.25	1.44	Inlet	5
1.38	1.57	Inlet	5
1.50	1.69	Inlet	5
1.63	1.82	Inlet	5
1.75	1.94	Inlet	5
1.88	2.04	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.17	Outlet (Subcritical)	1
0.25	0.34	Outlet (Subcritical)	1
0.38	0.51	Outlet (Subcritical)	2
0.50	0.68	Outlet (Subcritical)	2
0.63	0.84	Inlet (Supercritical)	3
0.75	1.02	Inlet (Supercritical)	3
0.88	1.21	Inlet (Supercritical)	3
1.00	1.41	Inlet (Supercritical)	4
1.13	1.61	Inlet (Supercritical)	4
1.25	1.81	Inlet	5
1.38	2.01	Inlet	5
1.50	2.13	Inlet	5
1.63	2.25	Inlet	5
1.75	2.37	Inlet	5
1.88	2.49	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.20	Outlet (Subcritical)	1
0.25	0.41	Outlet (Subcritical)	1
0.38	0.61	Outlet (Subcritical)	2
0.50	0.82	Outlet (Subcritical)	2
0.63	1.04	Inlet (Supercritical)	3
0.75	1.39	Inlet (Supercritical)	3
0.88	1.74	Inlet (Supercritical)	3
1.00	2.09	Inlet (Supercritical)	3
1.13	2.46	Inlet (Supercritical)	4
1.25	2.83	Inlet	5

1.38	3.14	Inlet	5
1.50	3.42	Inlet	5
1.63	3.69	Inlet	5
1.75	3.96	Inlet	5
1.88	4.18	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.24	Outlet (Subcritical)	1
0.25	0.47	Outlet (Subcritical)	1
0.38	0.71	Outlet (Subcritical)	2
0.50	0.95	Inlet (Supercritical)	3
0.63	1.32	Inlet (Supercritical)	3
0.75	1.72	Inlet (Supercritical)	3
0.88	2.15	Inlet (Supercritical)	3
1.00	2.63	Inlet (Supercritical)	3
1.13	3.13	Inlet (Supercritical)	3
1.25	3.67	Inlet (Supercritical)	3
1.38	4.20	Inlet (Supercritical)	3
1.50	4.71	Inlet (Supercritical)	3
1.63	5.18	Inlet	4
1.75	5.61	Inlet	5
1.88	6.03	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-14

Design Discharge	=	0.970	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	153.000	feet
Pipe Slope	=	34.390	%
Manning's n	=	0.013	
Maximum Headwater	=	1.250	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.02		0
0.25	0.05		0
0.38	0.07		0
0.50	0.09		0
0.63	0.11	Outlet (Subcritical)	1
0.75	0.14	Outlet (Subcritical)	1
0.88	0.16	Outlet (Subcritical)	1
1.00	0.18	Outlet (Subcritical)	1
1.13	0.20	Outlet (Subcritical)	1
1.25	0.23	Outlet (Subcritical)	1
1.38	0.25	Outlet (Subcritical)	1
1.50	0.27	Outlet (Subcritical)	1
1.63	0.29	Outlet (Subcritical)	1
1.75	0.32	Outlet (Subcritical)	2
1.88	0.34	Outlet (Subcritical)	2

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.09		0
0.25	0.18	Outlet (Subcritical)	1
0.38	0.27	Outlet (Subcritical)	1
0.50	0.36	Outlet (Subcritical)	2
0.63	0.44	Outlet (Subcritical)	2
0.75	0.53	Inlet (Supercritical)	3
0.88	0.62	Inlet (Supercritical)	3
1.00	0.71	Inlet (Supercritical)	4
1.13	0.80	Inlet (Supercritical)	4
1.25	0.89	Inlet (Supercritical)	4
1.38	0.98	Inlet	5
1.50	1.03	Inlet	5
1.63	1.07	Inlet	5
1.75	1.11	Inlet	5
1.88	1.15	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.15	Outlet (Subcritical)	1
0.25	0.31	Outlet (Subcritical)	2
0.38	0.46	Outlet (Subcritical)	2
0.50	0.62	Inlet (Supercritical)	3
0.63	0.77	Inlet (Supercritical)	4
0.75	0.92	Inlet	5
0.88	1.06	Inlet	5
1.00	1.19	Inlet	5
1.13	1.32	Inlet	5
1.25	1.44	Inlet	5
1.38	1.57	Inlet	5
1.50	1.69	Inlet	5
1.63	1.82	Inlet	5
1.75	1.94	Inlet	5
1.88	2.04	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.17	Outlet (Subcritical)	1
0.25	0.34	Outlet (Subcritical)	1
0.38	0.51	Outlet (Subcritical)	2
0.50	0.68	Outlet (Subcritical)	2
0.63	0.84	Inlet (Supercritical)	3
0.75	1.02	Inlet (Supercritical)	3
0.88	1.21	Inlet (Supercritical)	3
1.00	1.41	Inlet (Supercritical)	4
1.13	1.61	Inlet (Supercritical)	4
1.25	1.81	Inlet	5
1.38	2.01	Inlet	5
1.50	2.13	Inlet	5
1.63	2.25	Inlet	5
1.75	2.37	Inlet	5
1.88	2.49	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.20	Outlet (Subcritical)	1
0.25	0.41	Outlet (Subcritical)	1
0.38	0.61	Outlet (Subcritical)	2
0.50	0.82	Outlet (Subcritical)	2
0.63	1.04	Inlet (Supercritical)	3
0.75	1.39	Inlet (Supercritical)	3
0.88	1.74	Inlet (Supercritical)	3
1.00	2.09	Inlet (Supercritical)	3
1.13	2.46	Inlet (Supercritical)	4
1.25	2.83	Inlet	5

1.38	3.14	Inlet	5
1.50	3.42	Inlet	5
1.63	3.69	Inlet	5
1.75	3.96	Inlet	5
1.88	4.18	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.24	Outlet (Subcritical)	1
0.25	0.47	Outlet (Subcritical)	1
0.38	0.71	Outlet (Subcritical)	2
0.50	0.95	Inlet (Supercritical)	3
0.63	1.32	Inlet (Supercritical)	3
0.75	1.72	Inlet (Supercritical)	3
0.88	2.15	Inlet (Supercritical)	3
1.00	2.63	Inlet (Supercritical)	3
1.13	3.13	Inlet (Supercritical)	3
1.25	3.67	Inlet (Supercritical)	3
1.38	4.20	Inlet (Supercritical)	3
1.50	4.71	Inlet (Supercritical)	4
1.63	5.18	Inlet	5
1.75	5.61	Inlet	5
1.88	6.03	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-15

Design Discharge	=	0.970 cfs
Entrance Loss Coefficient	=	0.5
Pipe Length	=	154.000 feet
Pipe Slope	=	32.420 %
Manning's n	=	0.013
Maximum Headwater	=	1.250 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.02		0
0.25	0.05		0
0.38	0.07		0
0.50	0.09		0
0.63	0.11	Outlet (Subcritical)	1
0.75	0.14	Outlet (Subcritical)	1
0.88	0.16	Outlet (Subcritical)	1
1.00	0.18	Outlet (Subcritical)	1
1.13	0.20	Outlet (Subcritical)	1
1.25	0.23	Outlet (Subcritical)	1
1.38	0.25	Outlet (Subcritical)	1
1.50	0.27	Outlet (Subcritical)	1
1.63	0.29	Outlet (Subcritical)	1
1.75	0.32	Outlet (Subcritical)	2
1.88	0.34	Outlet (Subcritical)	2

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.09		0
0.25	0.18	Outlet (Subcritical)	1
0.38	0.27	Outlet (Subcritical)	1
0.50	0.36	Outlet (Subcritical)	2
0.63	0.44	Outlet (Subcritical)	2
0.75	0.53	Inlet (Supercritical)	3
0.88	0.62	Inlet (Supercritical)	3
1.00	0.71	Inlet (Supercritical)	4
1.13	0.80	Inlet (Supercritical)	4
1.25	0.89	Inlet (Supercritical)	4
1.38	0.98	Inlet	5
1.50	1.03	Inlet	5
1.63	1.07	Inlet	5
1.75	1.11	Inlet	5
1.88	1.15	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.15	Outlet (Subcritical)	1
0.25	0.31	Outlet (Subcritical)	2
0.38	0.46	Outlet (Subcritical)	2
0.50	0.62	Inlet (Supercritical)	3
0.63	0.77	Inlet (Supercritical)	4
0.75	0.92	Inlet	5
0.88	1.06	Inlet	5
1.00	1.19	Inlet	5
1.13	1.32	Inlet	5
1.25	1.44	Inlet	5
1.38	1.57	Inlet	5
1.50	1.69	Inlet	5
1.63	1.82	Inlet	5
1.75	1.94	Inlet	5
1.88	2.04	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.17	Outlet (Subcritical)	1
0.25	0.34	Outlet (Subcritical)	1
0.38	0.51	Outlet (Subcritical)	2
0.50	0.68	Outlet (Subcritical)	2
0.63	0.84	Inlet (Supercritical)	3
0.75	1.02	Inlet (Supercritical)	3
0.88	1.21	Inlet (Supercritical)	3
1.00	1.41	Inlet (Supercritical)	4
1.13	1.61	Inlet (Supercritical)	4
1.25	1.81	Inlet	5
1.38	2.01	Inlet	5
1.50	2.13	Inlet	5
1.63	2.25	Inlet	5
1.75	2.37	Inlet	5
1.88	2.49	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.20	Outlet (Subcritical)	1
0.25	0.41	Outlet (Subcritical)	1
0.38	0.61	Outlet (Subcritical)	2
0.50	0.82	Outlet (Subcritical)	2
0.63	1.04	Inlet (Supercritical)	3
0.75	1.39	Inlet (Supercritical)	3
0.88	1.74	Inlet (Supercritical)	3
1.00	2.09	Inlet (Supercritical)	3
1.13	2.46	Inlet (Supercritical)	4
1.25	2.83	Inlet	5

1.38	3.14	Inlet	5
1.50	3.42	Inlet	5
1.63	3.69	Inlet	5
1.75	3.96	Inlet	5
1.88	4.18	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.13	0.24	Outlet (Subcritical)	1
0.25	0.47	Outlet (Subcritical)	1
0.38	0.71	Outlet (Subcritical)	2
0.50	0.95	Inlet (Supercritical)	3
0.63	1.32	Inlet (Supercritical)	3
0.75	1.72	Inlet (Supercritical)	3
0.88	2.15	Inlet (Supercritical)	3
1.00	2.63	Inlet (Supercritical)	3
1.13	3.13	Inlet (Supercritical)	3
1.25	3.67	Inlet (Supercritical)	3
1.38	4.20	Inlet (Supercritical)	3
1.50	4.71	Inlet (Supercritical)	4
1.63	5.18	Inlet	5
1.75	5.61	Inlet	5
1.88	6.03	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-16

Design Discharge	=	7.790	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	160.000	feet
Pipe Slope	=	28.910	%
Manning's n	=	0.013	
Maximum Headwater	=	2.750	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.37	Outlet (Subcritical)	1
0.55	0.74	Outlet (Subcritical)	2
0.83	1.14	Inlet (Supercritical)	3
1.10	1.57	Inlet (Supercritical)	4
1.38	2.01	Inlet	5
1.65	2.27	Inlet	5
1.92	2.54	Inlet	5
2.20	2.80	Inlet	5
2.48	3.05	Inlet	5
2.75	3.24	Inlet	5
3.03	3.43	Inlet	5
3.30	3.62	Inlet	5
3.58	3.81	Inlet	5
3.85	4.00	Inlet	5
4.13	4.15	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.45	Outlet (Subcritical)	1
0.55	0.90	Inlet (Supercritical)	3
0.83	1.60	Inlet (Supercritical)	3
1.10	2.38	Inlet (Supercritical)	4
1.38	3.14	Inlet	5
1.65	3.74	Inlet	5
1.92	4.27	Inlet	5
2.20	4.73	Inlet	5
2.48	5.16	Inlet	5
2.75	5.55	Inlet	5
3.03	5.93	Inlet	5
3.30	6.26	Inlet	5
3.58	6.58	Inlet	5
3.85	6.91	Inlet	5
4.13	7.20	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.52	Outlet (Subcritical)	2
0.55	1.08	Inlet (Supercritical)	3
0.83	1.96	Inlet (Supercritical)	3
1.10	3.02	Inlet (Supercritical)	3
1.38	4.20	Inlet (Supercritical)	3
1.65	5.27	Inlet	5
1.92	6.17	Inlet	5
2.20	6.96	Inlet	5
2.48	7.65	Inlet	5
2.75	8.29	Inlet	5
3.03	8.90	Inlet	5
3.30	9.45	Inlet	5
3.58	9.99	Inlet	5
3.85	10.48	Inlet	5
4.13	10.96	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.59	Outlet (Subcritical)	2
0.55	1.31	Inlet (Supercritical)	3
0.83	2.37	Inlet (Supercritical)	3
1.10	3.63	Inlet (Supercritical)	3
1.38	5.07	Inlet (Supercritical)	3
1.65	6.66	Inlet (Supercritical)	3
1.92	8.08	Inlet	5
2.20	9.29	Inlet	5
2.48	10.37	Inlet	5
2.75	11.35	Inlet	5
3.03	12.25	Inlet	5
3.30	13.10	Inlet	5
3.58	13.88	Inlet	5
3.85	14.63	Inlet	5
4.13	15.34	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.65	Outlet (Subcritical)	2
0.55	1.52	Inlet (Supercritical)	3
0.83	2.76	Inlet (Supercritical)	3
1.10	4.23	Inlet (Supercritical)	3
1.38	5.91	Inlet (Supercritical)	3
1.65	7.77	Inlet (Supercritical)	3
1.92	9.79	Inlet (Supercritical)	3
2.20	11.59	Inlet	5
2.48	13.19	Inlet	5
2.75	14.60	Inlet	5

3.03	15.90	Inlet	5
3.30	17.09	Inlet	5
3.58	18.20	Inlet	5
3.85	19.25	Inlet	5
4.13	20.25	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.71	Outlet (Subcritical)	2
0.55	1.73	Inlet (Supercritical)	3
0.83	3.14	Inlet (Supercritical)	3
1.10	4.84	Inlet (Supercritical)	3
1.38	6.76	Inlet (Supercritical)	3
1.65	8.88	Inlet (Supercritical)	3
1.92	11.19	Inlet (Supercritical)	3
2.20	13.67	Inlet (Supercritical)	3
2.48	15.91	Inlet	5
2.75	17.89	Inlet	5
3.03	19.67	Inlet	5
3.30	21.31	Inlet	5
3.58	22.84	Inlet	5
3.85	24.26	Inlet	5
4.13	25.61	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-17

Design Discharge	=	7.790	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	126.000	feet
Pipe Slope	=	29.360	%
Manning's n	=	0.013	
Maximum Headwater	=	2.750	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.37	Outlet (Subcritical)	1
0.55	0.74	Outlet (Subcritical)	2
0.83	1.14	Inlet (Supercritical)	3
1.10	1.57	Inlet (Supercritical)	4
1.38	2.01	Inlet	5
1.65	2.27	Inlet	5
1.92	2.54	Inlet	5
2.20	2.80	Inlet	5
2.48	3.05	Inlet	5
2.75	3.24	Inlet	5
3.03	3.43	Inlet	5
3.30	3.62	Inlet	5
3.58	3.81	Inlet	5
3.85	4.00	Inlet	5
4.13	4.15	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.45	Outlet (Subcritical)	1
0.55	0.90	Inlet (Supercritical)	3
0.83	1.60	Inlet (Supercritical)	3
1.10	2.38	Inlet (Supercritical)	4
1.38	3.14	Inlet	5
1.65	3.74	Inlet	5
1.92	4.27	Inlet	5
2.20	4.73	Inlet	5
2.48	5.16	Inlet	5
2.75	5.55	Inlet	5
3.03	5.93	Inlet	5
3.30	6.26	Inlet	5
3.58	6.58	Inlet	5
3.85	6.91	Inlet	5
4.13	7.20	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.52	Outlet (Subcritical)	2
0.55	1.08	Inlet (Supercritical)	3
0.83	1.96	Inlet (Supercritical)	3
1.10	3.02	Inlet (Supercritical)	3
1.38	4.20	Inlet (Supercritical)	3
1.65	5.27	Inlet	5
1.92	6.17	Inlet	5
2.20	6.96	Inlet	5
2.48	7.65	Inlet	5
2.75	8.29	Inlet	5
3.03	8.90	Inlet	5
3.30	9.45	Inlet	5
3.58	9.99	Inlet	5
3.85	10.48	Inlet	5
4.13	10.96	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.59	Outlet (Subcritical)	2
0.55	1.31	Inlet (Supercritical)	3
0.83	2.37	Inlet (Supercritical)	3
1.10	3.63	Inlet (Supercritical)	3
1.38	5.07	Inlet (Supercritical)	3
1.65	6.66	Inlet (Supercritical)	3
1.92	8.08	Inlet	5
2.20	9.29	Inlet	5
2.48	10.37	Inlet	5
2.75	11.35	Inlet	5
3.03	12.25	Inlet	5
3.30	13.10	Inlet	5
3.58	13.88	Inlet	5
3.85	14.63	Inlet	5
4.13	15.34	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.65	Outlet (Subcritical)	2
0.55	1.52	Inlet (Supercritical)	3
0.83	2.76	Inlet (Supercritical)	3
1.10	4.23	Inlet (Supercritical)	3
1.38	5.91	Inlet (Supercritical)	3
1.65	7.77	Inlet (Supercritical)	3
1.92	9.79	Inlet (Supercritical)	3
2.20	11.59	Inlet	5
2.48	13.19	Inlet	5
2.75	14.60	Inlet	5

3.03	15.90	Inlet	5
3.30	17.09	Inlet	5
3.58	18.20	Inlet	5
3.85	19.25	Inlet	5
4.13	20.25	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.71	Outlet (Subcritical)	2
0.55	1.73	Inlet (Supercritical)	3
0.83	3.14	Inlet (Supercritical)	3
1.10	4.84	Inlet (Supercritical)	3
1.38	6.76	Inlet (Supercritical)	3
1.65	8.88	Inlet (Supercritical)	3
1.92	11.19	Inlet (Supercritical)	3
2.20	13.67	Inlet (Supercritical)	3
2.48	15.91	Inlet	5
2.75	17.89	Inlet	5
3.03	19.67	Inlet	5
3.30	21.31	Inlet	5
3.58	22.84	Inlet	5
3.85	24.26	Inlet	5
4.13	25.61	Inlet	5

SEDCAD+ CULVERT SIZING UTILITY

DD-18

Design Discharge	=	7.790	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	170.000	feet
Pipe Slope	=	23.810	%
Manning's n	=	0.013	
Maximum Headwater	=	2.750	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.37	Outlet (Subcritical)	1
0.55	0.74	Outlet (Subcritical)	2
0.83	1.14	Inlet (Supercritical)	3
1.10	1.57	Inlet (Supercritical)	4
1.38	2.01	Inlet	5
1.65	2.27	Inlet	5
1.92	2.54	Inlet	5
2.20	2.80	Inlet	5
2.48	3.05	Inlet	5
2.75	3.24	Inlet	5
3.03	3.43	Inlet	5
3.30	3.62	Inlet	5
3.58	3.81	Inlet	5
3.85	4.00	Inlet	5
4.13	4.15	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.45	Outlet (Subcritical)	1
0.55	0.90	Inlet (Supercritical)	3
0.83	1.60	Inlet (Supercritical)	3
1.10	2.38	Inlet (Supercritical)	4
1.38	3.14	Inlet	5
1.65	3.74	Inlet	5
1.92	4.27	Inlet	5
2.20	4.73	Inlet	5
2.48	5.16	Inlet	5
2.75	5.55	Inlet	5
3.03	5.93	Inlet	5
3.30	6.26	Inlet	5
3.58	6.58	Inlet	5
3.85	6.91	Inlet	5
4.13	7.20	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.52	Outlet (Subcritical)	2
0.55	1.08	Inlet (Supercritical)	3
0.83	1.96	Inlet (Supercritical)	3
1.10	3.02	Inlet (Supercritical)	3
1.38	4.20	Inlet (Supercritical)	3
1.65	5.27	Inlet	5
1.92	6.17	Inlet	5
2.20	6.96	Inlet	5
2.48	7.65	Inlet	5
2.75	8.29	Inlet	5
3.03	8.90	Inlet	5
3.30	9.45	Inlet	5
3.58	9.99	Inlet	5
3.85	10.48	Inlet	5
4.13	10.96	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.59	Outlet (Subcritical)	2
0.55	1.31	Inlet (Supercritical)	3
0.83	2.37	Inlet (Supercritical)	3
1.10	3.63	Inlet (Supercritical)	3
1.38	5.07	Inlet (Supercritical)	3
1.65	6.66	Inlet (Supercritical)	3
1.92	8.08	Inlet	5
2.20	9.29	Inlet	5
2.48	10.37	Inlet	5
2.75	11.35	Inlet	5
3.03	12.25	Inlet	5
3.30	13.10	Inlet	5
3.58	13.88	Inlet	5
3.85	14.63	Inlet	5
4.13	15.34	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.65	Outlet (Subcritical)	2
0.55	1.52	Inlet (Supercritical)	3
0.83	2.76	Inlet (Supercritical)	3
1.10	4.23	Inlet (Supercritical)	3
1.38	5.91	Inlet (Supercritical)	3
1.65	7.77	Inlet (Supercritical)	3
1.92	9.79	Inlet (Supercritical)	3
2.20	11.59	Inlet	5
2.48	13.19	Inlet	5
2.75	14.60	Inlet	5

3.03	15.90	Inlet	5
3.30	17.09	Inlet	5
3.58	18.20	Inlet	5
3.85	19.25	Inlet	5
4.13	20.25	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.28	0.71	Outlet (Subcritical)	2
0.55	1.73	Inlet (Supercritical)	3
0.83	3.14	Inlet (Supercritical)	3
1.10	4.84	Inlet (Supercritical)	3
1.38	6.76	Inlet (Supercritical)	3
1.65	8.88	Inlet (Supercritical)	3
1.92	11.19	Inlet (Supercritical)	3
2.20	13.67	Inlet (Supercritical)	3
2.48	15.91	Inlet	5
2.75	17.89	Inlet	5
3.03	19.67	Inlet	5
3.30	21.31	Inlet	5
3.58	22.84	Inlet	5
3.85	24.26	Inlet	5
4.13	25.61	Inlet	5

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Due to CP-18, CP-19, Downdrains 19, 20, & 21 data update

See CP-17 and CP-18 for downdrain data

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-95 CULVERT AT AREA III FACILITIES.

by

Name: lr

Company Name: BHP MINERALS
File Name: C:\LR\CP95

Date: 09-30-1996

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Company Name: BHP MINERALS
Filename: C:\LR\CP95 User: lr
Date: 09-30-1996 Time: 12:27:46
cp-95 culvert at area III facilities.
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	7.90	91	F	0.138	0.000	0.000	0.0	0.38	8.44
111	2	1.70	91	F	0.027	0.079	0.311	0.0	0.08	2.09
		Type: Null			Label: culvert cp-95					
111	Structure	9.60							0.46	
111	Total IN/OUT	9.60				-			0.46	9.94

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Company Name: BHP MINERALS
Filename: C:\LR\CP95 User: lr
Date: 09-30-1996 Time: 12:27:46
cp-95 culvert at area III facilities.
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1000.00	4.00	2.00	0.14	0.138		
1	1	1	2	-a	5	325.00	10.77	3.28	0.03	0.027		
1	1	1	2	-1	8	800.03	0.88	2.81	0.08		0.079	0.311

SEDCAD+ CULVERT SIZING UTILITY

cp-95 culvert at area III facilities

Design Discharge	=	9.940 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	26.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.015
Maximum Headwater	=	3.500 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 18 inches

PERFORMANCE CURVES:

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.57	Outlet (Subcritical)	2
0.70	1.25	Inlet (Supercritical)	3
1.05	2.24	Inlet (Supercritical)	3
1.40	3.19	Inlet	5
1.75	3.91	Outlet	6
2.10	4.45	Outlet	6
2.45	4.97	Outlet	6
2.80	5.40	Outlet	6
3.15	5.82	Outlet	6
3.50	6.21	Outlet	6
3.85	6.57	Outlet	6
4.20	6.93	Outlet	6
4.55	7.25	Outlet	6
4.90	7.56	Outlet	6
5.25	7.87	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.66	Outlet (Subcritical)	2
0.70	1.56	Inlet (Supercritical)	3
1.05	2.83	Inlet (Supercritical)	3
1.40	4.30	Inlet (Supercritical)	4
1.75	5.61	Inlet	5
2.10	6.67	Inlet	5
2.45	7.59	Inlet	5
2.80	8.40	Inlet	5
3.15	9.15	Inlet	5
3.50	9.82	Outlet	6
3.85	10.44	Outlet	6
4.20	11.03	Outlet	6
4.55	11.58	Outlet	6
4.90	12.11	Outlet	6
5.25	12.61	Outlet	6

3.85	24.26	Inlet	5
4.20	25.97	Inlet	5
4.55	27.56	Inlet	5
4.90	29.07	Inlet	5
5.25	30.51	Inlet	5

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	1.09	Inlet (Supercritical)	3
0.70	3.07	Inlet (Supercritical)	3
1.05	5.64	Inlet (Supercritical)	3
1.40	8.68	Inlet (Supercritical)	3
1.75	12.12	Inlet (Supercritical)	3
2.10	15.93	Inlet (Supercritical)	3
2.45	20.07	Inlet (Supercritical)	3
2.80	24.53	Inlet (Supercritical)	3
3.15	28.37	Inlet	5
3.50	31.84	Inlet	5
3.85	34.97	Inlet	5
4.20	37.83	Inlet	5
4.55	40.50	Inlet	5
4.90	43.00	Inlet	5
5.25	45.36	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.75	Outlet (Subcritical)	2
0.70	1.85	Inlet (Supercritical)	3
1.05	3.39	Inlet (Supercritical)	3
1.40	5.21	Inlet (Supercritical)	3
1.75	7.22	Inlet (Supercritical)	3
2.10	8.87	Inlet	5
2.45	10.28	Inlet	5
2.80	11.52	Inlet	5
3.15	12.64	Inlet	5
3.50	13.67	Inlet	5
3.85	14.63	Inlet	5
4.20	15.52	Inlet	5
4.55	16.37	Inlet	5
4.90	17.18	Inlet	5
5.25	17.95	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.83	Outlet (Subcritical)	2
0.70	2.15	Inlet (Supercritical)	3
1.05	3.94	Inlet (Supercritical)	3
1.40	6.07	Inlet (Supercritical)	3
1.75	8.49	Inlet (Supercritical)	3
2.10	10.97	Inlet	5
2.45	13.05	Inlet	5
2.80	14.85	Inlet	5
3.15	16.44	Inlet	5
3.50	17.91	Inlet	5
3.85	19.25	Inlet	5
4.20	20.51	Inlet	5
4.55	21.70	Inlet	5
4.90	22.83	Inlet	5
5.25	23.90	Inlet	5

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.91	Inlet (Supercritical)	3
0.70	2.47	Inlet (Supercritical)	3
1.05	4.51	Inlet (Supercritical)	3
1.40	6.94	Inlet (Supercritical)	3
1.75	9.70	Inlet (Supercritical)	3
2.10	12.75	Inlet (Supercritical)	3
2.45	15.74	Inlet (Supercritical)	4
2.80	18.22	Inlet	5
3.15	20.43	Inlet	5
3.50	22.43	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-96 CULVERT AT TURNOUT TO TIRE SHOP

by

Name: lr

Company Name: BHP MINERALS
File Name: C:\LR\CP96

Date: 09-27-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\CP96 User: lr
Date: 09-27-1996 Time: 15:29:34
cp-96 culvert at turnout to tire shop
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	2.30	91	F	0.415	0.000	0.000	0.0	0.11	1.75
		Type: Null			Label: culvert cp-96					
111	Structure	2.30							0.11	
111	Total IN/OUT	2.30							0.11	1.75

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Company Name: BHP MINERALS
Filename: C:\LR\CP96 User: lr
Date: 09-27-1996 Time: 15:29:34
cp-96 culvert at turnout to tire shop
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	1700.00	1.29	1.14	0.42	0.415		

SEDCAD+ CULVERT SIZING UTILITY

cp-96 culvert at turnout to tire shop

Design Discharge	=	1.800	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	144.000	feet
Pipe Slope	=	0.500	%
Manning's n	=	0.015	
Maximum Headwater	=	2.000	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.14	Outlet (Subcritical)	1
0.40	0.29	Outlet (Subcritical)	2
0.60	0.43	Inlet (Supercritical)	3
0.80	0.57	Inlet (Supercritical)	3
1.00	0.71	Inlet (Supercritical)	4
1.20	0.86	Inlet	5
1.40	1.00	Outlet	6
1.60	1.04	Outlet	6
1.80	1.09	Outlet	6
2.00	1.13	Outlet	6
2.20	1.17	Outlet	6
2.40	1.21	Outlet	6
2.60	1.26	Outlet	6
2.80	1.30	Outlet	6
3.00	1.34	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.25		0
0.40	0.50		0
0.60	0.74	Outlet (Subcritical)	1
0.80	0.99	Outlet (Subcritical)	1
1.00	1.08	Outlet (Subcritical)	1
1.20	1.16	Outlet (Subcritical)	2
1.40	1.24	Outlet (Subcritical)	2
1.60	1.32	Inlet (Supercritical)	3
1.80	1.39	Inlet (Supercritical)	3
2.00	1.47	Inlet (Supercritical)	3
2.20	1.55	Inlet (Supercritical)	4
2.40	1.63	Inlet (Supercritical)	4
2.60	1.71	Inlet	5
2.80	1.79	Inlet	5
3.00	1.87	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	0.41		0
0.40	0.81	Outlet (Subcritical)	1
0.60	1.19	Outlet (Subcritical)	1
0.80	1.56	Outlet (Subcritical)	1
1.00	1.92	Outlet (Subcritical)	1
1.20	2.18	Outlet (Subcritical)	2
1.40	2.41	Inlet (Supercritical)	3
1.60	2.63	Inlet (Supercritical)	4
1.80	2.86	Inlet	5
2.00	3.06	Outlet	6
2.20	3.20	Outlet	6
2.40	3.34	Outlet	6
2.60	3.49	Outlet	6
2.80	3.63	Outlet	6
3.00	3.78	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	1.28	Outlet (Subcritical)	1
0.40	1.49	Outlet (Subcritical)	1
0.60	1.70	Outlet (Subcritical)	1
0.80	1.91	Outlet (Subcritical)	1
1.00	2.38	Outlet (Subcritical)	1
1.20	3.06	Outlet (Subcritical)	1
1.40	3.88	Outlet (Subcritical)	1
1.60	4.31	Inlet (Supercritical)	3
1.80	4.67	Inlet (Supercritical)	4
2.00	5.03	Outlet	6
2.20	5.30	Outlet	6
2.40	5.58	Outlet	6
2.60	5.86	Outlet	6
2.80	6.11	Outlet	6
3.00	6.35	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	1.92	Outlet (Subcritical)	1
0.40	2.24	Outlet (Subcritical)	1
0.60	2.54	Outlet (Subcritical)	1
0.80	2.85	Outlet (Subcritical)	1
1.00	3.25	Outlet (Subcritical)	1
1.20	3.77	Outlet (Subcritical)	1
1.40	4.60	Outlet (Subcritical)	1
1.60	5.72	Outlet (Subcritical)	1
1.80	6.68	Inlet (Supercritical)	4
2.00	7.32	Outlet	6

2.20	7.82	Outlet	6
2.40	8.28	Outlet	6
2.60	8.72	Outlet	6
2.80	9.14	Outlet	6
3.00	9.53	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.20	2.56	Outlet (Subcritical)	1
0.40	3.08	Outlet (Subcritical)	1
0.60	3.51	Outlet (Subcritical)	1
0.80	3.95	Outlet (Subcritical)	1
1.00	4.32	Outlet (Subcritical)	1
1.20	4.69	Outlet (Subcritical)	1
1.40	5.19	Outlet (Subcritical)	1
1.60	6.50	Outlet (Subcritical)	1
1.80	7.92	Outlet (Subcritical)	1
2.00	9.34	Outlet (Subcritical)	1
2.20	10.49	Inlet (Supercritical)	3
2.40	11.31	Outlet	6
2.60	11.99	Outlet	6
2.80	12.62	Outlet	6
3.00	13.23	Outlet	6

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

DD-22 RR DOWNDRAIN NORTH OF MASON

by

Name: lr

Company Name: BHP MINERALS
File Name: C:\LR\DD22

Date: 09-27-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\DD22 User: lr
Date: 09-27-1996 Time: 15:49:56
dd-22 rr downdrain north of mason
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	0.18	91	F	0.098	0.000	0.000	0.0	0.01	0.22
		Type: Null			Label: downdrain dd-22					
111	Structure	0.18							0.01	
111	Total IN/OUT	0.18							0.01	0.22

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Company Name: BHP MINERALS
Filename: C:\LR\DD22 User: lr
Date: 09-27-1996 Time: 15:49:56
dd-22 rr downdrain north of mason
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	370.00	1.08	1.04	0.10	0.098		

SEDCAD+ CULVERT SIZING UTILITY

rr downdrain dd-22 north of mason

Design Discharge	=	0.220	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	250.000	feet
Pipe Slope	=	50.000	%
Manning's n	=	0.015	
Maximum Headwater	=	1.500	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 4 inches

PERFORMANCE CURVES:

Diameter: 2 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.00		0
0.30	0.00		0
0.45	0.00		0
0.60	0.00		0
0.75	0.00		0
0.90	0.00		0
1.05	0.00		0
1.20	0.00		0
1.35	0.00		0
1.50	0.00		0
1.65	0.00		0
1.80	0.00		0
1.95	0.00		0
2.10	0.00		0
2.25	0.00		0

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.03		0
0.30	0.05		0
0.45	0.08		0
0.60	0.11	Outlet (Subcritical)	1
0.75	0.14	Outlet (Subcritical)	1
0.90	0.16	Outlet (Subcritical)	1
1.05	0.19	Outlet (Subcritical)	1
1.20	0.22	Outlet (Subcritical)	1
1.35	0.24	Outlet (Subcritical)	1
1.50	0.27	Outlet (Subcritical)	1
1.65	0.30	Outlet (Subcritical)	1
1.80	0.32	Outlet (Subcritical)	2
1.95	0.35	Outlet (Subcritical)	2
2.10	0.38	Outlet (Subcritical)	2
2.25	0.41	Outlet (Subcritical)	2

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.11	Outlet (Subcritical)	1
0.30	0.21	Outlet (Subcritical)	1
0.45	0.32	Outlet (Subcritical)	2
0.60	0.43	Outlet (Subcritical)	2
0.75	0.53	Inlet (Supercritical)	3
0.90	0.64	Inlet (Supercritical)	3
1.05	0.75	Inlet (Supercritical)	4
1.20	0.85	Inlet (Supercritical)	4
1.35	0.96	Inlet	5
1.50	1.03	Inlet	5
1.65	1.08	Inlet	5
1.80	1.12	Inlet	5
1.95	1.17	Inlet	5
2.10	1.22	Inlet	5
2.25	1.27	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.18	Outlet (Subcritical)	1
0.30	0.37	Outlet (Subcritical)	2
0.45	0.55	Inlet (Supercritical)	3
0.60	0.74	Inlet (Supercritical)	4
0.75	0.92	Inlet	5
0.90	1.09	Inlet	5
1.05	1.24	Inlet	5
1.20	1.39	Inlet	5
1.35	1.54	Inlet	5
1.50	1.69	Inlet	5
1.65	1.84	Inlet	5
1.80	1.99	Inlet	5
1.95	2.09	Inlet	5
2.10	2.18	Inlet	5
2.25	2.27	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.20	Outlet (Subcritical)	1
0.30	0.41	Outlet (Subcritical)	1
0.45	0.61	Outlet (Subcritical)	2
0.60	0.81	Outlet (Subcritical)	2
0.75	1.02	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
1.05	1.49	Inlet (Supercritical)	4
1.20	1.73	Inlet (Supercritical)	4
1.35	1.97	Inlet	5
1.50	2.13	Inlet	5

1.65	2.27	Inlet	5
1.80	2.42	Inlet	5
1.95	2.56	Inlet	5
2.10	2.71	Inlet	5
2.25	2.85	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

HYDROLOGY FOR CP-103 CULVERT

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: A:\CP-103

Date: 05-19-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: A:\CP-103 User: BEN HOSKIE
Date: 05-19-1998 Time: 13:51:41
HYDROLOGY FOR CP-103 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	17.00	89	M	0.113	0.000	0.000	0.0	0.69	18.33
			Type: Null			Label: J1B1				
111	Structure	17.00							0.69	
111	Total IN/OUT	17.00							0.69	18.33
121	1	11.60	89	M	0.401	0.000	0.000	0.0	0.47	6.06
			Type: Null			Label: J1B2				
121	Structure	11.60							0.47	
121	Total IN/OUT	11.60							0.47	6.06
131	1	0.60	89	M	0.256	0.000	0.000	0.0	0.02	0.39
			Type: Null			Label: J1B3				
131	Structure	0.60							0.02	
131	Total IN/OUT	0.60							0.02	0.39
211	1	0.00	0	M	0.000	0.000	0.000	0.0	0.00	0.00
			Type: Null			Label: J2B1				
211	Structure	0.00							1.18	
211	Total IN/OUT	29.20							1.18	22.75
111 to 211 Routing						0.009	0.227			

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Company Name: BHP MINERALS
Filename: A:\CP-103 User: BEN HOSKIE
Date: 05-19-1998 Time: 13:51:41
HYDROLOGY FOR CP-103 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	2	1	1	-a	5	2028.00	1.97	1.40	0.40	0.401		

SEDCAD+ CULVERT SIZING UTILITY

CP-103

Design Discharge	=	22.750 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	124.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.024
Maximum Headwater	=	5.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 30 inches

PERFORMANCE CURVES:

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.50	3.46	Outlet (Subcritical)	1
1.00	4.24	Outlet (Subcritical)	1
1.50	5.89	Outlet (Subcritical)	1
2.00	9.03	Outlet (Subcritical)	1
2.50	10.13	Outlet	6
3.00	11.19	Outlet	6
3.50	12.17	Outlet	6
4.00	13.08	Outlet	6
4.50	13.92	Outlet	6
5.00	14.71	Outlet	6
5.50	15.46	Outlet	6
6.00	16.19	Outlet	6
6.50	16.88	Outlet	6
7.00	17.54	Outlet	6
7.50	18.18	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.50	4.66	Outlet (Subcritical)	1
1.00	5.58	Outlet (Subcritical)	1
1.50	6.81	Outlet (Subcritical)	1
2.00	10.57	Outlet (Subcritical)	1
2.50	13.52	Inlet (Supercritical)	4
3.00	15.02	Outlet	6
3.50	16.43	Outlet	6
4.00	17.73	Outlet	6
4.50	18.95	Outlet	6
5.00	20.09	Outlet	6
5.50	21.16	Outlet	6
6.00	22.19	Outlet	6
6.50	23.17	Outlet	6

7.00	24.11	Outlet	6
7.50	25.01	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.50	7.46	Outlet (Subcritical)	1
1.00	9.10	Outlet (Subcritical)	1
1.50	10.53	Outlet (Subcritical)	1
2.00	12.69	Outlet (Subcritical)	1
2.50	18.51	Outlet (Subcritical)	1
3.00	23.74	Inlet	5
3.50	26.44	Outlet	6
4.00	28.87	Outlet	6
4.50	31.10	Outlet	6
5.00	33.18	Outlet	6
5.50	35.13	Outlet	6
6.00	36.99	Outlet	6
6.50	38.75	Outlet	6
7.00	40.44	Outlet	6
7.50	42.07	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.50	10.70	Outlet (Subcritical)	1
1.00	13.27	Outlet (Subcritical)	1
1.50	15.53	Outlet (Subcritical)	1
2.00	17.58	Outlet (Subcritical)	1
2.50	21.41	Outlet (Subcritical)	1
3.00	29.19	Outlet (Subcritical)	1
3.50	36.92	Outlet (Subcritical)	1
4.00	41.77	Outlet	6
4.50	45.49	Outlet	6
5.00	48.92	Outlet	6
5.50	52.14	Outlet	6
6.00	55.15	Outlet	6
6.50	58.03	Outlet	6
7.00	60.75	Outlet	6
7.50	63.37	Outlet	6

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.50	14.21	Outlet (Subcritical)	1
1.00	17.95	Outlet (Subcritical)	1
1.50	21.25	Outlet (Subcritical)	1
2.00	24.25	Outlet (Subcritical)	1

2.50	26.99	Outlet (Subcritical)	1
3.00	32.91	Outlet (Subcritical)	1
3.50	42.82	Outlet (Subcritical)	1
4.00	52.85	Outlet (Subcritical)	1
4.50	61.26	Outlet	6
5.00	66.57	Outlet	6
5.50	71.49	Outlet	6
6.00	76.09	Outlet	6
6.50	80.42	Outlet	6
7.00	84.54	Outlet	6
7.50	88.46	Outlet	6

Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.50	16.03	Outlet (Subcritical)	1
1.00	20.43	Outlet (Subcritical)	1
1.50	24.34	Outlet (Subcritical)	1
2.00	27.88	Outlet (Subcritical)	1
2.50	31.13	Outlet (Subcritical)	1
3.00	34.44	Outlet (Subcritical)	1
3.50	45.22	Outlet (Subcritical)	1
4.00	56.44	Outlet (Subcritical)	1
4.50	67.45	Outlet (Subcritical)	1
5.00	75.81	Outlet	6
5.50	81.78	Outlet	6
6.00	87.34	Outlet	6
6.50	92.57	Outlet	6
7.00	97.53	Outlet	6
7.50	102.24	Outlet	6

SEDCAD+ BASIN DISCHARGE UTILITY

CP-103 DROP STRUCTURE

DROP INLET INPUTS:

Riser Diameter	30.000 inches
Riser Height	4.200 feet
Barrel Diameter	30.000 inches
Barrel Length	124.000 feet
Barrel Slope	1.000 %
Manning's n of Pipe	0.019
Pipe Spillway Elevation	5274.50

Elevation	Drop Inlet (cfs)	Total Discharge (cfs)
5274.00	0.0	0.0
5274.50	0.0	0.0
5275.00	8.6	8.6
5275.50	23.6	23.6
5276.00	28.9	28.9
5276.50	33.4	33.4
5277.00	37.4	37.4

Pages 507 to 509 blank due to text reformatting

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

HYDROLOGY FOR CP-104 CULVERT

by

Name: RUSSELL HARRIS

Company Name: BHP MINERALS
File Name: C:\RUSSWORK\JENSEN\CP-104

Date: 01-30-1997

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\RUSSWORK\JENSEN\CP-104 User: RUSSELL HARRIS
Date: 01-30-1997 Time: 09:38:38
HYDROLOGY FOR CP-104 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111 1	27.00	89	M	0.275	0.000	0.000	0.0	1.09	16.97
Type: Null	Label: J1B1								
111 Structure	27.00							1.09	
111 Total IN/OUT	27.00							1.09	16.97
121 1	36.00	89	M	0.555	0.000	0.000	0.0	1.45	15.50
Type: Null	Label: J1B2								
121 Structure	36.00							1.45	
121 Total IN/OUT	36.00							1.45	15.50
131 1	6.00	89	M	0.398	0.000	0.000	0.0	0.24	3.14
Type: Null	Label: J1B3								
131 Structure	6.00							0.24	
131 Total IN/OUT	6.00							0.24	3.14
211 1	0.00	0	M	0.000	0.000	0.000	0.0	0.00	0.00
Type: Null	Label: J2B1								
211 Structure	0.00							2.78	
211 Total IN/OUT	69.00							2.78	31.55
111 to 211 Routing					0.009	0.227			

SEDCAD+ RIPRAP CHANNEL DESIGN

CP-104-INLET-RIPRAP

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	31.55 cfs	
Slope	20.00 %	
Sideslopes (L and R)	3.00:1	5.00:1
Bottom Width	10.00 feet	
Freeboard	0.6 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.42 ft
with Freeboard	1.02 ft
Top Width	13.33 ft
with Freeboard	18.13 ft
Velocity	6.50 fps
Cross Sectional Area	4.85 sq ft
Hydraulic Radius	0.36 ft
Manning's n	0.052
Froude Number	1.90
Dmax	0.625 ft (7.50 in)
D50	0.500 ft (6.00 in)
D10	0.167 ft (2.00 in)

SEDCAD+ CULVERT SIZING UTILITY

CP-104

Design Discharge =	31.550 cfs
Entrance Loss Coefficient =	0.9
Pipe Length =	161.000 feet
Pipe Slope =	2.000 %
Manning's n =	0.024
Maximum Headwater =	4.000 feet
Tailwater Depth =	0.000 feet

Smallest Diameter Required to Pass Flow is 30 inches.
Allowing for a factor of safety, a 36 inch pipe will be used.

PERFORMANCE CURVES:

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.95	Inlet (Supercritical)	3
0.80	2.64	Inlet (Supercritical)	3
1.20	4.82	Inlet (Supercritical)	3
1.60	7.42	Inlet (Supercritical)	3
2.00	8.93	Outlet (Subcritical)	1 *
2.40	12.24	Inlet	5
2.80	12.96	Outlet	6
3.20	13.52	Outlet	6
3.60	14.06	Outlet	6
4.00	14.57	Outlet	6
4.40	15.08	Outlet	6
4.80	15.56	Outlet	6
5.20	16.03	Outlet	6
5.60	16.48	Outlet	6
6.00	16.93	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.07	Inlet (Supercritical)	3
0.80	3.00	Inlet (Supercritical)	3
1.20	5.51	Inlet (Supercritical)	3
1.60	8.48	Inlet (Supercritical)	3
2.00	11.85	Inlet (Supercritical)	3

2.40	13.78	Outlet (Subcritical)	1 *
2.80	17.59	Outlet	6
3.20	18.54	Outlet	6
3.60	19.32	Outlet	6
4.00	20.06	Outlet	6
4.40	20.77	Outlet	6
4.80	21.46	Outlet	6
5.20	22.13	Outlet	6
5.60	22.78	Outlet	6
6.00	23.41	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.35	Inlet (Supercritical)	3
0.80	3.75	Inlet (Supercritical)	3
1.20	6.88	Inlet (Supercritical)	3
1.60	10.60	Inlet (Supercritical)	3
2.00	14.81	Inlet (Supercritical)	3
2.40	19.46	Inlet (Supercritical)	3
2.80	24.53	Inlet (Supercritical)	3
3.20	28.90	Inlet	5
3.60	32.30	Inlet	5
4.00	33.69	Outlet	6
4.40	34.99	Outlet	6
4.80	36.24	Outlet	6
5.20	37.45	Outlet	6
5.60	38.62	Outlet	6
6.00	39.76	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.62	Inlet (Supercritical)	3
0.80	4.50	Inlet (Supercritical)	3
1.20	8.26	Inlet (Supercritical)	3
1.60	12.72	Inlet (Supercritical)	3
2.00	17.77	Inlet (Supercritical)	3
2.40	23.36	Inlet (Supercritical)	3
2.80	29.43	Inlet (Supercritical)	3
3.20	35.96	Inlet (Supercritical)	3
3.60	42.48	Inlet (Supercritical)	4
4.00	47.70	Inlet	5

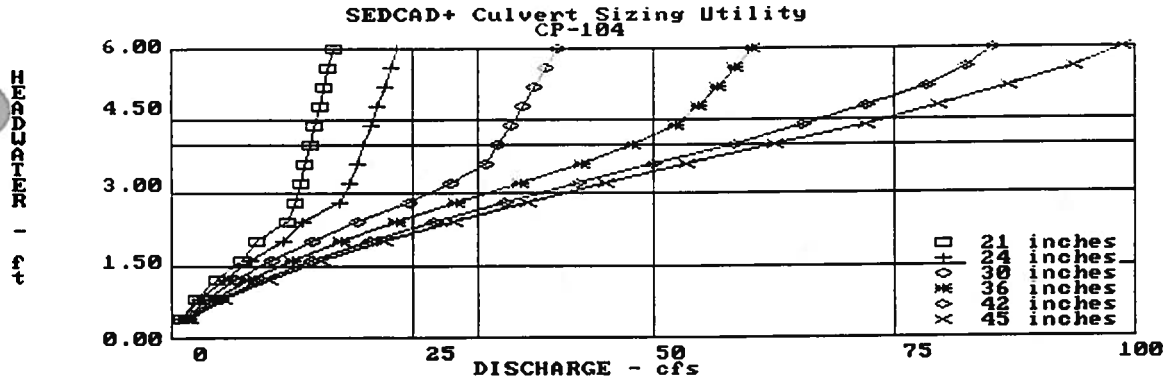
4.40	52.35	Inlet	5
4.80	54.74	Outlet	6
5.20	56.71	Outlet	6
5.60	58.61	Outlet	6
6.00	60.45	Outlet	6

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.87	Inlet (Supercritical)	3
0.80	5.25	Inlet (Supercritical)	3
1.20	9.64	Inlet (Supercritical)	3
1.60	14.83	Inlet (Supercritical)	3
2.00	20.73	Inlet (Supercritical)	3
2.40	27.25	Inlet (Supercritical)	3
2.80	34.34	Inlet (Supercritical)	3
3.20	41.95	Inlet (Supercritical)	3
3.60	50.06	Inlet (Supercritical)	3
4.00	58.63	Inlet (Supercritical)	3
4.40	65.63	Inlet	5
4.80	72.28	Inlet	5
5.20	78.36	Inlet	5
5.60	82.38	Outlet	6
6.00	85.15	Outlet	6

Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.99	Inlet (Supercritical)	3
0.80	5.63	Inlet (Supercritical)	3
1.20	10.32	Inlet (Supercritical)	3
1.60	15.89	Inlet (Supercritical)	3
2.00	22.21	Inlet (Supercritical)	3
2.40	29.19	Inlet (Supercritical)	3
2.80	36.79	Inlet (Supercritical)	3
3.20	44.95	Inlet (Supercritical)	3
3.60	53.63	Inlet (Supercritical)	3
4.00	62.82	Inlet (Supercritical)	3
4.40	72.29	Inlet (Supercritical)	3
4.80	79.63	Inlet	5
5.20	86.88	Inlet	5
5.60	93.58	Inlet	5
6.00	98.84	Outlet	6


SEDCAD+ Culvert Sizing Utility
CP-104
HEADWATER - ft
6.00
4.50
3.00
1.50
0.00
0
25
50
75
100
DISCHARGE - cfs
21 inches
24 inches
30 inches
36 inches
42 inches
45 inches

SEDCAD+ RIPRAP CHANNEL DESIGN

CP-104-OUTLET-RIPRAP

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	31.55 cfs	
Slope	10.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	4.00 feet	
Freeboard	0.6 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.77 ft
with Freeboard	1.37 ft
Top Width	8.59 ft
with Freeboard	12.19 ft
Velocity	6.55 fps
Cross Sectional Area	4.82 sq ft
Hydraulic Radius	0.54 ft
Manning's n	0.048
Froude Number	1.54
Dmax	0.625 ft (7.50 in)
D50	0.500 ft (6.00 in)
D10	0.167 ft (2.00 in)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-106?

HYDROLOGY FOR CP-104 CULVERT

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: C:\BEN\CP104\CP-104

Date: 05-20-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\CP104\CP-104 User: BEN HOSKIE
Date: 05-20-1998 Time: 07:04:56
HYDROLOGY FOR CP-104 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	22.20	89	M	0.275	0.000	0.000	0.0	0.90	13.96
			Type: Null			Label: J1B1				
111	Structure	22.20							0.90	
111	Total IN/OUT	22.20							0.90	13.96
121	1	35.60	89	M	0.555	0.000	0.000	0.0	1.44	15.33
			Type: Null			Label: J1B2				
121	Structure	35.60							1.44	
121	Total IN/OUT	35.60							1.44	15.33
131	1	6.40	89	M	0.398	0.000	0.000	0.0	0.26	3.35
			Type: Null			Label: J1B3				
131	Structure	6.40							0.26	
131	Total IN/OUT	6.40							0.26	3.35
211	1	0.00	0	M	0.000	0.000	0.000	0.0	0.00	0.00
			Type: Null			Label: J2B1				
211	Structure	0.00							2.59	
211	Total IN/OUT	64.20							2.59	28.78
111 to 211 Routing						0.009	0.227			

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Company Name: BHP MINERALS
Filename: C:\BEN\CP104\CP-104 User: BEN HOSKIE
Date: 05-20-1998 Time: 07:04:56
HYDROLOGY FOR CP-104 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

==========
DETAILED SUBWATERSHED INPUT/OUTPUT TABLE
==========

SEDCAD+ CULVERT SIZING UTILITY

CP-104

Design Discharge	=	28.780 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	161.000 feet
Pipe Slope	=	2.000 %
Manning's n	=	0.024
Maximum Headwater	=	4.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 30 inches

PERFORMANCE CURVES:

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.95	Inlet (Supercritical)	3
0.80	2.64	Inlet (Supercritical)	3
1.20	4.82	Inlet (Supercritical)	3
1.60	7.42	Inlet (Supercritical)	3
2.00	8.93	Outlet (Subcritical)	1 *
2.40	12.24	Inlet	5
2.80	12.96	Outlet	6
3.20	13.52	Outlet	6
3.60	14.06	Outlet	6
4.00	14.57	Outlet	6
4.40	15.08	Outlet	6
4.80	15.56	Outlet	6
5.20	16.03	Outlet	6
5.60	16.48	Outlet	6
6.00	16.93	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.07	Inlet (Supercritical)	3
0.80	3.00	Inlet (Supercritical)	3
1.20	5.51	Inlet (Supercritical)	3
1.60	8.48	Inlet (Supercritical)	3
2.00	11.85	Inlet (Supercritical)	3
2.40	13.78	Outlet (Subcritical)	1 *
2.80	17.59	Outlet	6
3.20	18.54	Outlet	6
3.60	19.32	Outlet	6
4.00	20.06	Outlet	6
4.40	20.77	Outlet	6
4.80	21.46	Outlet	6

5.20	22.13	Outlet	6
5.60	22.78	Outlet	6
6.00	23.41	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.35	Inlet (Supercritical)	3
0.80	3.75	Inlet (Supercritical)	3
1.20	6.88	Inlet (Supercritical)	3
1.60	10.60	Inlet (Supercritical)	3
2.00	14.81	Inlet (Supercritical)	3
2.40	19.46	Inlet (Supercritical)	3
2.80	24.53	Inlet (Supercritical)	3
3.20	28.90	Inlet	5
3.60	32.30	Inlet	5
4.00	33.69	Outlet	6
4.40	34.99	Outlet	6
4.80	36.24	Outlet	6
5.20	37.45	Outlet	6
5.60	38.62	Outlet	6
6.00	39.76	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.62	Inlet (Supercritical)	3
0.80	4.50	Inlet (Supercritical)	3
1.20	8.26	Inlet (Supercritical)	3
1.60	12.72	Inlet (Supercritical)	3
2.00	17.77	Inlet (Supercritical)	3
2.40	23.36	Inlet (Supercritical)	3
2.80	29.43	Inlet (Supercritical)	3
3.20	35.96	Inlet (Supercritical)	3
3.60	42.48	Inlet (Supercritical)	4
4.00	47.70	Inlet	5
4.40	52.35	Inlet	5
4.80	54.74	Outlet	6
5.20	56.71	Outlet	6
5.60	58.61	Outlet	6
6.00	60.45	Outlet	6

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.87	Inlet (Supercritical)	3
0.80	5.25	Inlet (Supercritical)	3

1.20	9.64	Inlet (Supercritical)	3
1.60	14.83	Inlet (Supercritical)	3
2.00	20.73	Inlet (Supercritical)	3
2.40	27.25	Inlet (Supercritical)	3
2.80	34.34	Inlet (Supercritical)	3
3.20	41.95	Inlet (Supercritical)	3
3.60	50.06	Inlet (Supercritical)	3
4.00	58.63	Inlet (Supercritical)	3
4.40	65.63	Inlet	5
4.80	72.28	Inlet	5
5.20	78.36	Inlet	5
5.60	82.38	Outlet	6
6.00	85.15	Outlet	6

Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.99	Inlet (Supercritical)	3
0.80	5.63	Inlet (Supercritical)	3
1.20	10.32	Inlet (Supercritical)	3
1.60	15.89	Inlet (Supercritical)	3
2.00	22.21	Inlet (Supercritical)	3
2.40	29.19	Inlet (Supercritical)	3
2.80	36.79	Inlet (Supercritical)	3
3.20	44.95	Inlet (Supercritical)	3
3.60	53.63	Inlet (Supercritical)	3
4.00	62.82	Inlet (Supercritical)	3
4.40	72.29	Inlet (Supercritical)	3
4.80	79.63	Inlet	5
5.20	86.88	Inlet	5
5.60	93.58	Inlet	5
6.00	98.84	Outlet	6

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CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

HYDROLOGY FOR CP-107

by

Name: VAH

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-12\SEDCAD\CP-107

Date: 06-03-1997

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\11-12\CP-107B User: VAH
Date: 06-03-1997 Time: 09:13:27
Hydrology for CP-107
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

==========
SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
==========

-Hydrology-

SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
1	4.57	90	M	0.575	0.000	0.000	0.0	0.20	2.12
Type: Culvert Label: CP-107									
Structure	4.57							0.20	
Total IN/OUT	4.57							0.20	2.12

Civil Software Design -- SEDCAD+ Version 3.1

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Company Name: BHP MINERALS

Filename: C:\11-12\CP-107B User: VAH

Date: 06-03-1997 Time: 09:13:27

Hydrology for CP-107

Storm: 1.30 inches, 10 year- 6 hour, type II-65

Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	-a	5	1410.00	0.57	0.75	0.58	0.575		

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\11-12\CP-107B User: VAH
Date: 06-03-1997 Time: 09:13:27
Hydrology for CP-107
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

==========
NON-POND STRUCTURE INPUT/OUTPUT TABLE
==========

J1, B1, S1
CP-107

Drainage Area from J1, B1, S1, SWS(s)1: 4.6 acres
Total Contributing Drainage Area: 4.6 acres

Entrance Loss Coefficient	Maximum Headwater (ft)	Pipe Length (ft)	Pipe Slope (%)	Manning's n	Tailwater (ft)
0.90	1.5	75.0	9.0	0.017	0.0

Minimum Pipe Diameter Required: 9.0 inches
(See Culvert Utility Program for full performance curves)

	Runoff Volume (ac-ft)	Peak Discharge (cfs)
IN/OUT	0.20	2.12

****

SEDCAD+ CULVERT SIZING UTILITY

CP-107

Design Discharge	=	2.120	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	75.000	feet
Pipe Slope	=	9.000	%
Manning's n	=	0.017	
Maximum Headwater	=	1.500	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 9 inches

PERFORMANCE CURVES:

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.11	Outlet (Subcritical)	1
0.30	0.21	Outlet (Subcritical)	1
0.45	0.32	Outlet (Subcritical)	2
0.60	0.43	Outlet (Subcritical)	2
0.75	0.53	Inlet (Supercritical)	3
0.90	0.64	Inlet (Supercritical)	3
1.05	0.75	Inlet (Supercritical)	4
1.20	0.85	Inlet (Supercritical)	4
1.35	0.96	Inlet	5
1.50	1.01	Inlet	5
1.65	1.02	Inlet	5
1.80	1.03	Inlet	5
1.95	1.05	Inlet	5
2.10	1.06	Inlet	5
2.25	1.07	Inlet	5

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.18	Outlet (Subcritical)	1
0.30	0.37	Outlet (Subcritical)	2
0.45	0.55	Inlet (Supercritical)	3
0.60	0.74	Inlet (Supercritical)	4
0.75	0.92	Inlet	5
0.90	1.09	Inlet	5
1.05	1.24	Inlet	5
1.20	1.39	Inlet	5
1.35	1.54	Inlet	5
1.50	1.69	Inlet	5
1.65	1.84	Inlet	5
1.80	1.99	Inlet	5
1.95	2.07	Inlet	5
2.10	2.14	Inlet	5
2.25	2.21	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.20	Outlet (Subcritical)	1
0.30	0.41	Outlet (Subcritical)	1
0.45	0.61	Outlet (Subcritical)	2
0.60	0.81	Outlet (Subcritical)	2
0.75	1.02	Inlet (Supercritical)	3
0.90	1.25	Inlet (Supercritical)	4
1.05	1.49	Inlet (Supercritical)	4
1.20	1.73	Inlet (Supercritical)	4
1.35	1.97	Inlet	5
1.50	2.13	Inlet	5
1.65	2.27	Inlet	5
1.80	2.42	Inlet	5
1.95	2.56	Inlet	5
2.10	2.71	Inlet	5
2.25	2.85	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.25	Outlet (Subcritical)	1
0.30	0.49	Outlet (Subcritical)	1
0.45	0.74	Outlet (Subcritical)	2
0.60	0.98	Inlet (Supercritical)	3
0.75	1.39	Inlet (Supercritical)	3
0.90	1.81	Inlet (Supercritical)	3
1.05	2.24	Inlet (Supercritical)	3
1.20	2.68	Inlet (Supercritical)	4
1.35	3.09	Inlet	5
1.50	3.42	Inlet	5
1.65	3.74	Inlet	5
1.80	4.05	Inlet	5
1.95	4.31	Inlet	5
2.10	4.56	Inlet	5
2.25	4.82	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.28	Outlet (Subcritical)	1
0.30	0.57	Outlet (Subcritical)	2
0.45	0.85	Inlet (Supercritical)	3
0.60	1.24	Inlet (Supercritical)	3
0.75	1.72	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
1.05	2.83	Inlet (Supercritical)	3
1.20	3.45	Inlet (Supercritical)	3
1.35	4.10	Inlet (Supercritical)	3
1.50	4.71	Inlet (Supercritical)	4

1.65	5.27	Inlet	5
1.80	5.78	Inlet	5
1.95	6.24	Inlet	5
2.10	6.67	Inlet	5
2.25	7.09	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.15	0.32	Outlet (Subcritical)	1
0.30	0.64	Outlet (Subcritical)	2
0.45	0.97	Inlet (Supercritical)	3
0.60	1.49	Inlet (Supercritical)	3
0.75	2.04	Inlet (Supercritical)	3
0.90	2.70	Inlet (Supercritical)	3
1.05	3.39	Inlet (Supercritical)	3
1.20	4.13	Inlet (Supercritical)	3
1.35	4.93	Inlet (Supercritical)	3
1.50	5.78	Inlet (Supercritical)	3
1.65	6.66	Inlet (Supercritical)	3
1.80	7.46	Inlet (Supercritical)	4
1.95	8.19	Inlet	5
2.10	8.87	Inlet	5
2.25	9.50	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-108 MC

YAZZIE CULVERT DESIGN

by

Name: FTJ

Company Name: BHP MINERALS
File Name: C:\FTJ\YAZZIE

Date: 06-07-1997

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\FTJ\YAZZIE User: FTJ
Date: 06-07-1997 Time: 12:35:00
YAZZIE CULVERT DESIGN
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

==========
GENERAL INPUT TABLE
==========

STORM #1:

User-Defined Distribution

Label: type II-65

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.012
4	1.5	0.019
5	2.0	0.026
6	2.5	0.034
7	3.0	0.043
8	3.5	0.055
9	4.0	0.067
10	4.5	0.083
11	5.0	0.105
12	5.5	0.139
13	6.0	0.711
14	6.5	0.789
15	7.0	0.819
16	7.5	0.837
17	8.0	0.851
18	8.5	0.861
19	9.0	0.872
20	9.5	0.880
21	10.0	0.888
22	10.5	0.894
23	11.0	0.900
24	11.5	0.905
25	12.0	0.910
26	12.5	0.915
27	13.0	0.920
28	13.5	0.925
29	14.0	0.930
30	14.5	0.934
31	15.0	0.938
32	15.5	0.943
33	16.0	0.947
34	16.5	0.951
35	17.0	0.954
36	17.5	0.958
37	18.0	0.962

38	18.5	0.966
39	19.0	0.969
40	19.5	0.973
41	20.0	0.976
42	20.5	0.979
43	21.0	0.982
44	21.5	0.985
45	22.0	0.988
46	22.5	0.991
47	23.0	0.994
48	23.5	0.997
49	24.0	1.000

****

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Company Name: BHP MINERALS
Filename: C:\FTJ\YAZZIE User: FTJ
Date: 06-07-1997 Time: 12:35:00
YAZZIE CULVERT DESIGN
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	**Peak Discharge (cfs)**
111	1	332.00	93	M	1.643	0.000	0.000	0.0	8.32	**40.86**
		Type: Null			Label: YAZZIE CULVERT				.	
111	Structure	332.00							8.32	
111	Total IN/OUT	332.00							8.32	**40.86**

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Company Name: BHP MINERALS
Filename: C:\FTJ\YAZZIE User: FTJ
Date: 06-07-1997 Time: 12:35:00
YAZZIE CULVERT DESIGN
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	10385.00	3.08	1.76	1.64	1.643		

SEDCAD+ CULVERT SIZING UTILITY

Yazzie Culvert

Design Discharge	=	40.860	cfs
Entrance Loss Coefficient	=	0.9	
Pipe Length	=	34.000	feet
Pipe Slope	=	8.500	%
Manning's n	=	0.024	
Maximum Headwater	=	7.000	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is **30 inches**

PERFORMANCE CURVES:

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	2.15	Inlet (Supercritical)	3
1.40	6.07	Inlet (Supercritical)	3
2.10	10.97	Inlet	5
2.80	14.85	Inlet	5
3.50	17.91	Inlet	5
4.20	20.51	Inlet	5
4.90	22.83	Inlet	5
5.60	24.93	Inlet	5
6.30	26.86	Inlet	5
7.00	28.66	Inlet	5
7.70	30.31	Inlet	5
8.40	31.70	Outlet	6
9.10	32.85	Outlet	6
9.80	33.94	Outlet	6
10.50	34.98	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	2.47	Inlet (Supercritical)	3
1.40	6.94	Inlet (Supercritical)	3
2.10	12.75	Inlet (Supercritical)	3
2.80	18.22	Inlet	5
3.50	22.43	Inlet	5
4.20	25.97	Inlet	5
4.90	29.06	Inlet	5
5.60	31.88	Inlet	5
6.30	34.45	Inlet	5
7.00	36.84	Inlet	5
7.70	39.10	Inlet	5
8.40	41.23	Inlet	5
9.10	43.25	Inlet	5
9.80	45.18	Inlet	5
10.50	46.97	Inlet	5

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	3.07	Inlet (Supercritical)	3
1.40	8.68	Inlet (Supercritical)	3
2.10	15.93	Inlet (Supercritical)	3
2.80	24.53	Inlet (Supercritical)	3
3.50	31.84	Inlet	5
4.20	37.83	Inlet	5
4.90	42.99	Inlet	5
5.60	47.60	Inlet	5
6.30	51.81	Inlet	5
7.00	55.69	Inlet	5
7.70	59.32	Inlet	5
8.40	62.74	Inlet	5
9.10	65.99	Inlet	5
9.80	69.07	Inlet	5
10.50	72.04	Inlet	5

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	3.69	Inlet (Supercritical)	3
1.40	10.41	Inlet (Supercritical)	3
2.10	19.12	Inlet (Supercritical)	3
2.80	29.44	Inlet (Supercritical)	3
3.50	41.13	Inlet (Supercritical)	3
4.20	50.23	Inlet	5
4.90	58.21	Inlet	5
5.60	65.22	Inlet	5
6.30	71.55	Inlet	5
7.00	77.37	Inlet	5
7.70	82.77	Inlet	5
8.40	87.85	Inlet	5
9.10	92.65	Inlet	5
9.80	97.21	Inlet	5
10.50	101.56	Inlet	5

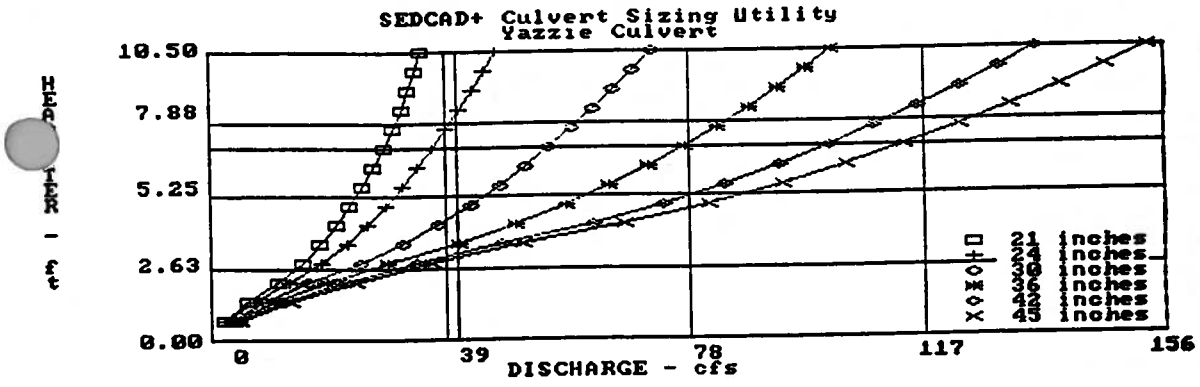
Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	4.30	Inlet (Supercritical)	3
1.40	12.14	Inlet (Supercritical)	3
2.10	22.30	Inlet (Supercritical)	3
2.80	34.34	Inlet (Supercritical)	3
3.50	47.99	Inlet (Supercritical)	3
4.20	62.62	Inlet (Supercritical)	4
4.90	73.85	Inlet	5
5.60	84.01	Inlet	5
6.30	93.06	Inlet	5
7.00	101.32	Inlet	5

7.70	108.94	Inlet	5
8.40	116.08	Inlet	5
9.10	122.79	Inlet	5
9.80	129.16	Inlet	5
10.50	135.22	Inlet	5

Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.70	4.61	Inlet (Supercritical)	3
1.40	13.01	Inlet (Supercritical)	3
2.10	23.90	Inlet (Supercritical)	3
2.80	36.79	Inlet (Supercritical)	3
3.50	51.42	Inlet (Supercritical)	3
4.20	67.59	Inlet (Supercritical)	3
4.90	81.50	Inlet	5
5.60	93.58	Inlet	5
6.30	104.26	Inlet	5
7.00	113.95	Inlet	5
7.70	122.87	Inlet	5
8.40	131.19	Inlet	5
9.10	139.02	Inlet	5
9.80	146.42	Inlet	5
10.50	153.47	Inlet	5


SEDCAD+ Culvert Sizing Utility
Yazzie Culvert
HEAD - ft
10.50
7.88
5.25
2.63
0.00
0
39
78
117
156
DISCHARGE - cfs
21 inches
24 inches
30 inches
36 inches
42 inches
45 inches

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-108

YAZZIE POWERLINE SERVICE ROAD CULVERT - AS BUILT

by

Name: Francis T. Johnson

Company Name: BHP MINERALS
File Name: C:\FTJ\YAZZIE2

Date: 02-05-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\FTJ\YAZZIE2 User: Francis T. Johnson
Date: 02-05-1998 Time: 08:38:41
Yazzie Powerline Service Road Culvert - As Built
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

==========
GENERAL INPUT TABLE
==========

STORM #1:

User-Defined Distribution

Label: type II-65

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.012
4	1.5	0.019
5	2.0	0.026
6	2.5	0.034
7	3.0	0.043
8	3.5	0.055
9	4.0	0.067
10	4.5	0.083
11	5.0	0.105
12	5.5	0.139
13	6.0	0.711
14	6.5	0.789
15	7.0	0.819
16	7.5	0.837
17	8.0	0.851
18	8.5	0.861
19	9.0	0.872
20	9.5	0.880
21	10.0	0.888
22	10.5	0.894
23	11.0	0.900
24	11.5	0.905
25	12.0	0.910
26	12.5	0.915
27	13.0	0.920
28	13.5	0.925
29	14.0	0.930
30	14.5	0.934
31	15.0	0.938
32	15.5	0.943
33	16.0	0.947
34	16.5	0.951
35	17.0	0.954
36	17.5	0.958
37	18.0	0.962
38	18.5	0.966
39	19.0	0.969
40	19.5	0.973
41	20.0	0.976
42	20.5	0.979
43	21.0	0.982

44	21.5	0.985
45	22.0	0.988
46	22.5	0.991
47	23.0	0.994
48	23.5	0.997
49	24.0	1.000

****

Detailed Between Structure Routing:

J	B	To S	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Muskingum K (hr)	X
2	1	1	1	5	1.00	0.00	0.03	0.01	0.008	0.009

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Company Name: BHP MINERALS
Filename: C:\FTJ\YAZZIE2 User: Francis T. Johnson
Date: 02-05-1998 Time: 08:38:41
Yazzie Powerline Service Road Culvert - As Built
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	24.40	91	M	0.148	0.000	0.000	0.0	0.46	8.98
		Type: Null			Label: Yazzie North Area					
111	Structure	24.40							0.46	
111	Total IN/OUT	24.40							0.46	8.98
121	1	307.90	91	M	1.643	0.000	0.000	0.0	5.85	28.06
		Type: Null			Label: Yazzie South Area					
121	Structure	307.90							5.85	
121	Total IN/OUT	307.90							5.85	28.06
211	1	0.00	0	M	0.000	0.000	0.000	0.0	0.00	0.00
		Type: Null			Label: Yazzie Total					
211	Structure	0.00							6.31	
211	Total IN/OUT	332.30							6.31	29.08
111 to 211 Routing						0.008	0.009			

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Company Name: BHP MINERALS
Filename: C:\FTJ\YAZZIE2 User: Francis T. Johnson
Date: 02-05-1998 Time: 08:38:41
Yazzie Powerline Service Road Culvert - As Built
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1717.00	10.25	3.20	0.15	0.148		
1	2	1	1	-a	5	10385.00	3.08	1.76	1.64	1.643		
2	1	1	1	-a	5	1.00	0.00	0.03	0.01	0.000		

SEDCAD+ CULVERT SIZING UTILITY

Yazzie Culvert - As Built

Design Discharge	=	29.080 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	28.000 feet
Pipe Slope	=	0.139 %
Manning's n	=	0.024
Maximum Headwater	=	5.400 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 30 inches

PERFORMANCE CURVES:

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.54	1.72	Outlet (Subcritical)	1
1.08	3.57	Outlet (Subcritical)	1
1.62	6.36	Outlet (Subcritical)	1
2.16	8.97	Outlet	6
2.70	11.85	Outlet	6
3.24	14.18	Outlet	6
3.78	16.17	Outlet	6
4.32	17.95	Outlet	6
4.86	19.56	Outlet	6
5.40	21.06	Outlet	6
5.94	22.45	Outlet	6
6.48	23.76	Outlet	6
7.02	25.01	Outlet	6
7.56	26.19	Outlet	6
8.10	27.32	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.54	2.05	Outlet (Subcritical)	1
1.08	4.41	Outlet (Subcritical)	1
1.62	7.25	Outlet (Subcritical)	1
2.16	11.43	Outlet (Subcritical)	1
2.70	14.62	Outlet	6
3.24	18.03	Outlet	6
3.78	20.88	Outlet	6
4.32	23.39	Outlet	6
4.86	25.66	Outlet	6
5.40	27.74	Outlet	6
5.94	29.68	Outlet	6
6.48	31.49	Outlet	6
7.02	33.21	Outlet	6
7.56	34.85	Outlet	6
8.10	36.40	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type

0.54	2.63	Outlet (Subcritical)	1
1.08	6.32	Outlet (Subcritical)	1
1.62	9.41	Outlet (Subcritical)	1
2.16	14.27	Outlet (Subcritical)	1
2.70	20.36	Outlet (Subcritical)	1
3.24	25.36	Outlet	6
3.78	30.73	Outlet	6
4.32	35.29	Outlet	6
4.86	39.32	Outlet	6
5.40	42.99	Outlet	6
5.94	46.35	Outlet	6
6.48	49.49	Outlet	6
7.02	52.45	Outlet	6
7.56	55.25	Outlet	6
8.10	57.90	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.54	3.10	Outlet (Subcritical)	1
1.08	8.20	Outlet (Subcritical)	1
1.62	12.76	Outlet (Subcritical)	1
2.16	16.84	Outlet (Subcritical)	1
2.70	24.30	Outlet (Subcritical)	1
3.24	32.46	Outlet (Subcritical)	1
3.78	39.67	Outlet	6
4.32	47.38	Outlet	6
4.86	53.98	Outlet	6
5.40	59.87	Outlet	6
5.94	65.23	Outlet	6
6.48	70.18	Outlet	6
7.02	74.80	Outlet	6
7.56	79.16	Outlet	6
8.10	83.28	Outlet	6

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.54	3.50	Outlet (Subcritical)	1
1.08	9.97	Outlet (Subcritical)	1
1.62	16.18	Outlet (Subcritical)	1
2.16	21.64	Outlet (Subcritical)	1
2.70	27.79	Outlet (Subcritical)	1
3.24	37.63	Outlet (Subcritical)	1
3.78	48.02	Outlet (Subcritical)	1
4.32	57.85	Outlet	6
4.86	68.21	Outlet	6
5.40	77.20	Outlet	6
5.94	85.24	Outlet	6
6.48	92.58	Outlet	6
7.02	99.39	Outlet	6
7.56	105.75	Outlet	6
8.10	111.76	Outlet	6

Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type

0.54	3.68	Outlet	(Subcritical)	1
1.08	10.80	Outlet	(Subcritical)	1
1.62	17.89	Outlet	(Subcritical)	1
2.16	24.19	Outlet	(Subcritical)	1
2.70	29.79	Outlet	(Subcritical)	1
3.24	39.95	Outlet	(Subcritical)	1
3.78	51.40	Outlet	(Subcritical)	1
4.32	62.96	Outlet	(Subcritical)	1
4.86	74.61	Outlet		6
5.40	85.57	Outlet		6
5.94	95.29	Outlet		6
6.48	104.10	Outlet		6
7.02	112.22	Outlet		6
7.56	119.79	Outlet		6
8.10	126.91	Outlet		6

Pages 543 through 552 Appendix 11-V

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CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CULVERT CP-119 HYDROLOGY

by

Name: BH

Company Name: BHP MINERALS
File Name: C:\BEN\CP-119

Date: 08-15-1997

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\CP-119 User: BH
Date: 08-15-1997 Time: 08:16:03
CULVERT CP-119 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	32.43	76	M	0.256	0.000	0.000	0.0	0.30	4.22
		Type: Null			Label: CP-119 HYDROLOGY					
111	Structure	32.43							0.30	
111	Total IN/OUT	32.43							0.30	4.22

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Company Name: BHP MINERALS
Filename: C:\BEN\CP-119 User: BH
Date: 08-15-1997 Time: 08:16:03
CULVERT CP-119 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1875.00	4.12	2.03	0.26	0.256		

SEDCAD+ CULVERT SIZING UTILITY

CP-119

Design Discharge	=	4.220 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	90.000 feet
Pipe Slope	=	1.854 %
Manning's n	=	0.017
Maximum Headwater	=	3.830 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.47	Outlet (Subcritical)	2
0.77	0.94	Inlet	5
1.15	1.10	Inlet	5
1.53	1.22	Inlet	5
1.91	1.34	Inlet	5
2.30	1.45	Inlet	5
2.68	1.57	Outlet	6
3.06	1.69	Outlet	6
3.45	1.81	Outlet	6
3.83	1.92	Outlet	6
4.21	2.02	Outlet	6
4.60	2.08	Outlet	6
4.98	2.14	Outlet	6
5.36	2.20	Outlet	6
5.74	2.26	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.52	Outlet (Subcritical)	2
0.77	1.02	Inlet (Supercritical)	3
1.15	1.38	Inlet (Supercritical)	4
1.53	1.73	Inlet	5
1.91	2.03	Outlet	6
2.30	2.13	Outlet	6
2.68	2.24	Outlet	6
3.06	2.35	Outlet	6
3.45	2.45	Outlet	6
3.83	2.56	Outlet	6
4.21	2.67	Outlet	6
4.60	2.78	Outlet	6
4.98	2.88	Outlet	6
5.36	2.99	Outlet	6
5.74	3.07	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.63	Outlet (Subcritical)	2
0.77	1.43	Inlet (Supercritical)	3
1.15	2.53	Inlet (Supercritical)	4
1.53	3.38	Inlet	5
1.91	4.02	Outlet	6
2.30	4.27	Outlet	6
2.68	4.52	Outlet	6
3.06	4.77	Outlet	6
3.45	5.02	Outlet	6
3.83	5.23	Outlet	6
4.21	5.43	Outlet	6
4.60	5.64	Outlet	6
4.98	5.84	Outlet	6
5.36	6.04	Outlet	6
5.74	6.22	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.73	Outlet (Subcritical)	2
0.77	1.77	Inlet (Supercritical)	3
1.15	3.23	Inlet (Supercritical)	3
1.53	4.84	Inlet	5
1.91	6.14	Inlet	5
2.30	7.11	Inlet	5
2.68	7.59	Outlet	6
3.06	8.06	Outlet	6
3.45	8.46	Outlet	6
3.83	8.85	Outlet	6
4.21	9.23	Outlet	6
4.60	9.58	Outlet	6
4.98	9.94	Outlet	6
5.36	10.27	Outlet	6
5.74	10.59	Outlet	6

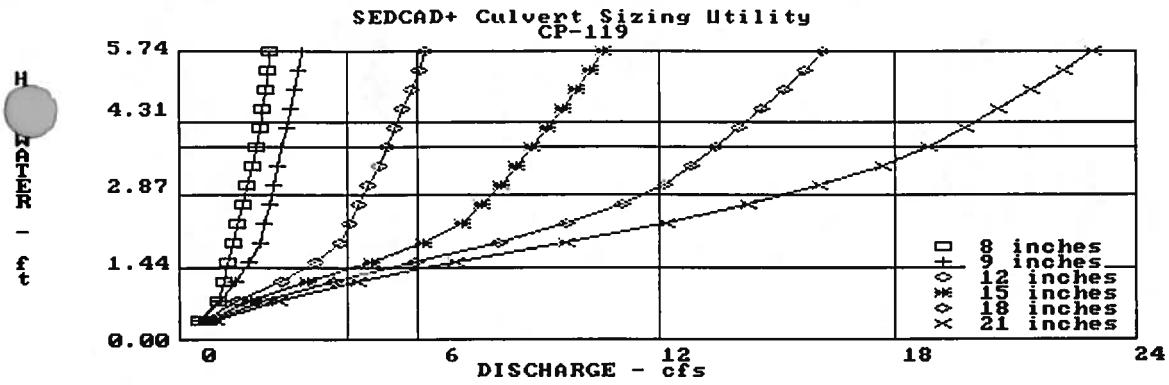
Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.82	Outlet (Subcritical)	2
0.77	2.11	Inlet (Supercritical)	3
1.15	3.87	Inlet (Supercritical)	3
1.53	5.96	Inlet (Supercritical)	3
1.91	8.03	Inlet	5
2.30	9.69	Inlet	5
2.68	11.11	Inlet	5
3.06	12.15	Outlet	6
3.45	12.80	Outlet	6
3.83	13.42	Outlet	6

4.21	14.03	Outlet	6
4.60	14.59	Outlet	6
4.98	15.15	Outlet	6
5.36	15.67	Outlet	6
5.74	16.19	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.38	0.91	Inlet (Supercritical)	3
0.77	2.47	Inlet (Supercritical)	3
1.15	4.52	Inlet (Supercritical)	3
1.53	6.95	Inlet (Supercritical)	3
1.91	9.71	Inlet (Supercritical)	3
2.30	12.19	Inlet	5
2.68	14.26	Inlet	5
3.06	16.07	Inlet	5
3.45	17.69	Inlet	5
3.83	18.87	Outlet	6
4.21	19.77	Outlet	6
4.60	20.61	Outlet	6
4.98	21.42	Outlet	6
5.36	22.21	Outlet	6
5.74	22.96	Outlet	6


SEDCAD+ Culvert Sizing Utility
CP-119
5.74
4.31
2.87
1.44
0.00
H WATER - ft
0
6
12
18
24
DISCHARGE - cfs
8 inches
9 inches
12 inches
15 inches
18 inches
21 inches

CULVERT CP-120
(MASON HAULROAD)

The location and watershed area are presented on Exhibit 11-12D.

LR

BHP Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87416

Phone: 505-598-4200

General Information

Storm Information:

Storm Type:	NM TYPE II 70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.230 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CULVERT CP-120

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	95.200	95.200	35.03	1.83

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-120

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	1.50	0.0160	5.00	0.00	0.90

Culvert Results:

Design Discharge = 35.03 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	95.200	0.272	0.000	0.000	84.900	M	35.03	1.831
	Σ	**95.200**						**35.03**	**1.831**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	6.06	14.00	231.00	2.460	0.026
		8. Large gullies, diversions, and low flowing streams	1.46	47.00	3,216.00	3.620	0.246
#1	**1**	**Time of Concentration:**					**0.272**

CMP CP-121 NORTH HOSTEEN ROAD

1.0 LOCATION AND FUNCTION

CMP CP-121 will be installed on North Hosteen Road to discharge surface runoff (from the watershed area located due east) into Hosteen Pit. Facilitating the culvert, will be a down drain pipe and rip-rap drop structure placed along the road. Placement of these structures will provide erosion control on the cut slopes and ultimately to protect the underlying water pipe.

2.0 BACKGROUND AND CONCERN

Currently, North Hosteen Road has improper drainage with erosional problems in certain areas. Specifically, the drainage problem is characterized by excessive ponding in the eastern side ditch. In addition, routing of the surface runoff from the undisturbed land to the side ditch causes erosion of the cut slope. For proper drainage and control of erosion, placement of a culvert, downdrain pipe, and rip-rap drop structure are proposed.

3.0 DESIGN

3.1 Culvert Design

The watershed area for CP-121 is measured to be 40.52 acres, yielding a calculated peak flow of 7.49 CFS. The soil type is predominately Avalon (AZ) soil with properties of hydrologic group B and a curve number of 78. For this undisturbed landtype, the SEDCAD program computed a culvert sizing of 18 inches. Installation of the culvert will include a minimum cover of 2 ft. and a slope of 1%.

3.2 Drop Structure Design

The watershed area for DD-26 is measured to be 20.65 acres, giving a peak flow of 4.25 CFS. Similar to the culvert, the curve number utilized in this calculation was 78. The down drain is modeled to be an 18 in. corrugated metal pipe with a 28° elbow and measuring a total length of 30 feet. This structure will have a 6 in. concrete head wall projecting 2 ft. above and below the diameter of the pipe.

The designed rip-rap channel has a watershed area of 31.81 acres with a peak flow of 6.09 CFS. Again, the curve number 78 was used for the hydrology calculation. The channel geometry will include a trapezoidal shape with side slopes of 3:1 and a bottom width of 3 ft. The channel will be sloped at 14 % from the catchment area to the side ditch of the road.

The drainage control structures shall be maintained as outlined in CHAPTER 11, Section 11.5.6.1.6. For hydrology and design information on the culvert, down drain pipe, and rip-rap drop structure, refer to Appendix 11-Z in the approved PAP.

5.0 REMOVAL AND RECLAMATION

Refer to the CHAPTER 12, Section 12.3.2 of the Navajo Mine PAP for culvert/drop structure removal and reclamation of Primary Roads.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-121 NORTH HOSTEEN ROAD

by

Name: BH

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-130\SEDCAD\CP_121\CP_121

Date: 09-29-1997

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\CP_121 User: BH
Date: 09-29-1997 Time: 06:37:00
CP-121 NORTH HOSTEEN ROAD
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	20.65	78	M	0.211	0.000	0.000	0.0	0.26	4.26
111	2	19.87	78	M	0.327	0.017	0.340	0.0	0.25	3.23
			Type: Null		Label: J1B1S1					
111	Structure	40.52							0.51	
111	Total IN/OUT	40.52							0.51	7.49

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Company Name: BHP MINERALS
Filename: C:\BEN\CP_121 User: BH
Date: 09-29-1997 Time: 06:37:00
CP-121 NORTH HOSTEEN ROAD
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1515.00	3.95	1.99	0.21	0.211		
1	1	1	2	-a	5	2159.87	3.36	1.83	0.33	0.327		
1	1	1	2	-1	8	230.73	1.47	3.63	0.02		0.017	0.340

SEDCAD+ CULVERT SIZING UTILITY

CP-121 NORTH HOSTEEN ROAD

Design Discharge	=	7.490 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	88.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.018
Maximum Headwater	=	3.500 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 18 inches

PERFORMANCE CURVES:

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	1.11	Outlet (Subcritical)	1
0.70	1.56	Outlet (Subcritical)	1
1.05	2.00	Outlet (Subcritical)	1
1.40	2.64	Inlet (Supercritical)	4
1.75	3.12	Outlet	6
2.10	3.40	Outlet	6
2.45	3.67	Outlet	6
2.80	3.95	Outlet	6
3.15	4.18	Outlet	6
3.50	4.39	Outlet	6
3.85	4.61	Outlet	6
4.20	4.82	Outlet	6
4.55	5.03	Outlet	6
4.90	5.21	Outlet	6
5.25	5.38	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	1.67	Outlet (Subcritical)	1
0.70	2.10	Outlet (Subcritical)	1
1.05	2.72	Outlet (Subcritical)	1
1.40	3.86	Outlet (Subcritical)	1
1.75	5.10	Outlet	6
2.10	5.63	Outlet	6
2.45	6.14	Outlet	6
2.80	6.58	Outlet	6
3.15	7.03	Outlet	6
3.50	7.42	Outlet	6
3.85	7.81	Outlet	6
4.20	8.17	Outlet	6
4.55	8.51	Outlet	6
4.90	8.86	Outlet	6
5.25	9.18	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.75	Outlet (Subcritical)	2
0.70	1.85	Inlet (Supercritical)	3
1.05	3.22	Inlet (Supercritical)	3
1.40	4.38	Outlet (Subcritical)	1 *
1.75	6.46	Outlet (Subcritical)	1
2.10	8.29	Outlet	6
2.45	9.11	Outlet	6
2.80	9.85	Outlet	6
3.15	10.54	Outlet	6
3.50	11.19	Outlet	6
3.85	11.81	Outlet	6
4.20	12.39	Outlet	6
4.55	12.96	Outlet	6
4.90	13.48	Outlet	6
5.25	14.01	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.83	Outlet (Subcritical)	2
0.70	2.15	Inlet (Supercritical)	3
1.05	3.94	Inlet (Supercritical)	3
1.40	6.03	Inlet (Supercritical)	3
1.75	7.17	Outlet (Subcritical)	1 *
2.10	9.86	Outlet (Subcritical)	1
2.45	12.47	Outlet	6
2.80	13.61	Outlet	6
3.15	14.65	Outlet	6
3.50	15.63	Outlet	6
3.85	16.55	Outlet	6
4.20	17.42	Outlet	6
4.55	18.25	Outlet	6
4.90	19.05	Outlet	6
5.25	19.81	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.91	Inlet (Supercritical)	3
0.70	2.47	Inlet (Supercritical)	3
1.05	4.51	Inlet (Supercritical)	3
1.40	6.94	Inlet (Supercritical)	3
1.75	9.24	Inlet (Supercritical)	3
2.10	10.80	Outlet (Subcritical)	1 *
2.45	14.12	Outlet (Subcritical)	1
2.80	17.74	Outlet	6

3.15	19.24	Outlet	6
3.50	20.64	Outlet	6
3.85	21.95	Outlet	6
4.20	23.18	Outlet	6
4.55	24.35	Outlet	6
4.90	25.46	Outlet	6
5.25	26.53	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	1.09	Inlet (Supercritical)	3
0.70	3.07	Inlet (Supercritical)	3
1.05	5.64	Inlet (Supercritical)	3
1.40	8.68	Inlet (Supercritical)	3
1.75	12.12	Inlet (Supercritical)	3
2.10	15.93	Inlet (Supercritical)	3
2.45	20.07	Inlet (Supercritical)	3
2.80	21.74	Outlet (Subcritical)	2 *
3.15	25.38	Outlet (Subcritical)	1 *
3.50	31.77	Outlet	6
3.85	34.19	Outlet	6
4.20	36.41	Outlet	6
4.55	38.50	Outlet	6
4.90	40.49	Outlet	6
5.25	42.39	Outlet	6

* (Transition Region - Data may need to be smoothed.)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

DD-26 NORTH HOSTEEN ROAD HYDROLOGY

by

Name: BH

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-30\SEDCAD\DD_26\N_HOST3

Date: 09-28-1997

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\N_HOST3 User: BH
Date: 09-28-1997 Time: 06:10:15
DD-26 NORTH HOSTEEN ROAD HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	20.65	78	M	0.212	0.000	0.000	0.0	0.26	4.25
			Type: Null		Label: J1B1S1					
111	Structure	20.65							0.26	
111	Total IN/OUT	20.65							0.26	4.25

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Company Name: BHP MINERALS
Filename: C:\BEN\N_HOST3 User: BH
Date: 09-28-1997 Time: 06:10:15
DD-26 NORTH HOSTEEN ROAD HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1420.00	3.44	1.85	0.21	0.212		

SEDCAD+ CULVERT SIZING UTILITY

DD-26 NORTH HOSTEEN ROAD

Design Discharge	=	4.250	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	31.000	feet
Pipe Slope	=	59.000	%
Manning's n	=	0.018	
Maximum Headwater	=	3.500	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 12 inches

PERFORMANCE CURVES:

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.43	Outlet (Subcritical)	2
0.70	0.86	Inlet (Supercritical)	4
1.05	1.24	Inlet	5
1.40	1.59	Inlet	5
1.75	1.94	Inlet	5
2.10	2.18	Inlet	5
2.45	2.39	Inlet	5
2.80	2.60	Inlet	5
3.15	2.81	Inlet	5
3.50	3.02	Inlet	5
3.85	3.17	Inlet	5
4.20	3.32	Inlet	5
4.55	3.47	Inlet	5
4.90	3.62	Inlet	5
5.25	3.77	Inlet	5

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.47	Outlet (Subcritical)	1
0.70	0.95	Inlet (Supercritical)	3
1.05	1.49	Inlet (Supercritical)	4
1.40	2.03	Inlet	5
1.75	2.37	Inlet	5
2.10	2.71	Inlet	5
2.45	3.03	Inlet	5
2.80	3.27	Inlet	5
3.15	3.52	Inlet	5
3.50	3.76	Inlet	5
3.85	4.00	Inlet	5
4.20	4.19	Inlet	5
4.55	4.37	Inlet	5
4.90	4.56	Inlet	5
5.25	4.75	Inlet	5

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.57	Outlet (Subcritical)	2
0.70	1.25	Inlet (Supercritical)	3
1.05	2.24	Inlet (Supercritical)	3
1.40	3.20	Inlet	5
1.75	3.96	Inlet	5
2.10	4.56	Inlet	5
2.45	5.13	Inlet	5
2.80	5.61	Inlet	5
3.15	6.09	Inlet	5
3.50	6.50	Inlet	5
3.85	6.91	Inlet	5
4.20	7.28	Inlet	5
4.55	7.63	Inlet	5
4.90	7.99	Inlet	5
5.25	8.30	Inlet	5

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.66	Outlet (Subcritical)	2
0.70	1.56	Inlet (Supercritical)	3
1.05	2.83	Inlet (Supercritical)	3
1.40	4.30	Inlet (Supercritical)	4
1.75	5.61	Inlet	5
2.10	6.67	Inlet	5
2.45	7.59	Inlet	5
2.80	8.40	Inlet	5
3.15	9.15	Inlet	5
3.50	9.84	Inlet	5
3.85	10.48	Inlet	5
4.20	11.09	Inlet	5
4.55	11.66	Inlet	5
4.90	12.20	Inlet	5
5.25	12.73	Inlet	5

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.75	Outlet (Subcritical)	2
0.70	1.85	Inlet (Supercritical)	3
1.05	3.39	Inlet (Supercritical)	3
1.40	5.21	Inlet (Supercritical)	3
1.75	7.22	Inlet (Supercritical)	3
2.10	8.87	Inlet	5
2.45	10.28	Inlet	5
2.80	11.52	Inlet	5
3.15	12.64	Inlet	5
3.50	13.67	Inlet	5

3.85	14.63	Inlet	5
4.20	15.52	Inlet	5
4.55	16.37	Inlet	5
4.90	17.18	Inlet	5
5.25	17.95	Inlet	5

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.35	0.83	Outlet (Subcritical)	2
0.70	2.15	Inlet (Supercritical)	3
1.05	3.94	Inlet (Supercritical)	3
1.40	6.07	Inlet (Supercritical)	3
1.75	8.49	Inlet (Supercritical)	3
2.10	10.97	Inlet	5
2.45	13.05	Inlet	5
2.80	14.85	Inlet	5
3.15	16.44	Inlet	5
3.50	17.91	Inlet	5
3.85	19.25	Inlet	5
4.20	20.51	Inlet	5
4.55	21.70	Inlet	5
4.90	22.83	Inlet	5
5.25	23.90	Inlet	5

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

RIP RAP DROP STRUCTURE @ STA 14+64

by

Name: BH

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-130\SEDCAD\DROP_STR\N_HOST

Date: 09-30-1997

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\N_HOST User: BH
Date: 09-30-1997 Time: 12:46:29
RIP RAP DROP STRUCTURE @ STA 14+64
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	31.81	78	M	0.245	0.000	0.000	0.0	0.40	6.09
		Type: Null			Label: J1B1S1 @ SIDE DITCH					
111	Structure	31.81							0.40	
111	Total IN/OUT	31.81							0.40	6.09

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\N_HOST User: BH
Date: 09-30-1997 Time: 12:46:29
RIP RAP DROP STRUCTURE @ STA 14+64
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1474.00	2.78	1.67	0.25	0.245		

SEDCAD+ RIPRAP CHANNEL DESIGN

RIP RAP DROP STRUCTURE @ STA 14+64

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	6.09 cfs	
Slope	14.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	3.00 feet	
Freeboard	1 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.33 ft
with Freeboard	1.33 ft
Top Width	5.00 ft
with Freeboard	11.00 ft
Velocity	4.56 fps
Cross Sectional Area	1.34 sq ft
Hydraulic Radius	0.26 ft
Manning's n	0.050
Froude Number	1.55
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-119 HYDROLOGY

by

Name: BEN HOSKIE

Company Name: BHP MINERALS

File Name: J:\OSM_SUBM\PER_PRCG\CH_11\11-129\SEDCAD\CP-119

Date: 01-30-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS User: BH
Filename: C:\BEN\CP-119 Date: 11-07-1997 Time: 10:08:29
CULVERT CP-119 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	31.90	76	M	0.256	0.000	0.000	0.0	0.30	4.15
		Type: Null			Label: CP-119 HYDROLOGY					
111	Structure	31.90							0.30	4.15
111	Total IN/OUT	31.90								

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Company Name: BHP MINERALS
User: BH
Filename: C:\BEN\CP-119
Date: 11-07-1997 Time: 10:08:29
CULVERT CP-119 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1875.00	4.12	2.03	0.26	0.256		

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

NORTHWEST DITCH HYDROLOGY-STA 0+00 TO 5+00 BARBER MODIFICATION

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-129\SEDCAD\NW_DIT

Date: 01-30-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\NW_DIT User: BEN HOSKIE
Date: 11-04-1997 Time: 13:11:34
NORTHWEST DITCH HYDROLOGY-STA 0+00 TO 5+00 BARBER MODIFICATION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	3.92	77	M	0.081	0.000	0.000	0.0	0.05	1.50
			Type: Null			Label: J1B1S1				
111	Structure	3.92							0.05	
111	Total IN/OUT	3.92							0.05	1.50

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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\NW_DIT User: BEN HOSKIE
Date: 11-04-1997 Time: 13:11:34
NORTHWEST DITCH HYDROLOGY-STA 0+00 TO 5+00 BARBER MODIFICATION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	753.00	6.61	2.57	0.08	0.081		

SEDCAD+ ERODIBLE CHANNEL DESIGN

NW DITCH HYDROLOGY STA 0+00 TO 5+00

Limiting Velocity Technique
Sediment-laden Water

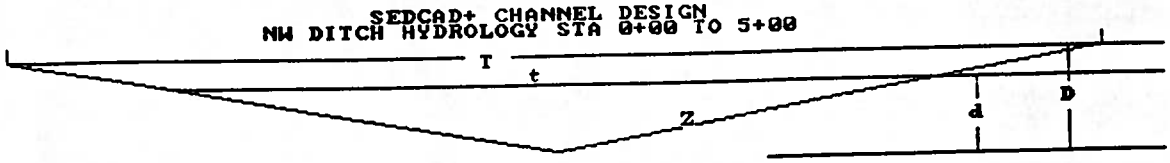
INPUT VALUES:

Shape	TRIANGULAR	
Discharge	1.50 cfs	
Slope	3.50 %	
Sideslopes	3.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	CLAYEY SPOIL MATERIAL	
Freeboard	1 ft	

RESULTS:

Actual Discharge	1.50 cfs
Depth	0.40 ft
with Freeboard	1.40 ft
Top Width	2.02 ft
with Freeboard	7.02 ft
Velocity	3.66 fps
Cross Sectional Area	0.41 sq ft
Hydraulic Radius	0.19 ft
Froude Number	1.43

SEDCAD+ CHANNEL DESIGN
NW DITCH HYDROLOGY STA 0+00 TO 5+00



MATERIAL: CLAYEY SPOIL MATERIAL
Limiting Variable: Velocity = 5.000 fps
Sediment-laden Water

Discharge	=	1.50 cfs				w/ Freeboard:	
			Depth (d)	=	0.40	(D =	1.40) ft
			Top width (t)	=	2.02	(T =	7.02) ft
Side slopes (Z)	=	3.0:1(L) 2.0:1(R)	Velocity	=	3.66 fps		
Bed Slope	=	3.50 %	Hydraulic Radius	=	0.19 ft		
Manning's n	=	0.025	Froude number	=	1.43		

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

SOUTHWEST DITCH HYDROLOGY-STA 0+00 TO 5+00 BARBER MODIFICATION

by

Name: BEN HOSKIE

Company Name: EHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-129\SEDCAD\SW_DIT

Date: 01-30-1998

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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\SW_DIT User: BEN HOSKIE
Date: 11-04-1997 Time: 13:16:02
SOUTHWEST DITCH HYDROLOGY-STA 0+00 TO 5+00 BARBER MODIFICATION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	**Peak Discharge (cfs)**
111	1	3.68	77	M	0.079	0.000	0.000	0.0	0.04	**1.40**
			Type: Null			Label: J1B1S1				
111	Structure	3.68							0.04	
111	Total IN/OUT	3.68							0.04	**1.40**

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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\SW_DIT User: BEN HOSKIE
Date: 11-04-1997 Time: 13:16:02
SOUTHWEST DITCH HYDROLOGY-STA 0+00 TO 5+00 BARBER MODIFICATION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	789.00	7.58	2.75	0.08	0.079		

SEDCAD+ ERODIBLE CHANNEL DESIGN

SW DITCH HYDROLOGY STA 0+00 TO 5+00

Limiting Velocity Technique
Sediment-laden Water

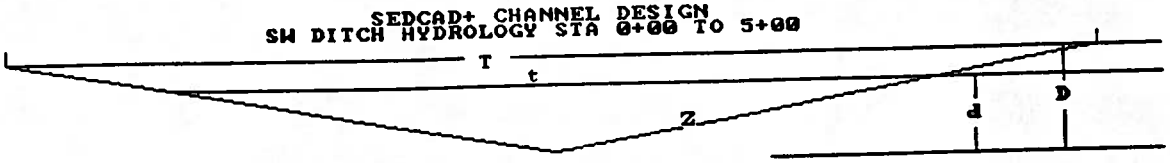
INPUT VALUES:

Shape	TRIANGULAR	
Discharge	1.40 cfs	
Slope	3.50 %	
Sideslopes	3.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	CLAYEY SPOIL MATERIAL	
Freeboard	1 ft	

RESULTS:

Actual Discharge	1.40 cfs
Depth	0.39 ft
with Freeboard	1.39 ft
Top Width	1.97 ft
with Freeboard	6.97 ft
Velocity	3.60 fps
Cross Sectional Area	0.39 sq ft
Hydraulic Radius	0.18 ft
Froude Number	1.43

SEDCAD+ CHANNEL DESIGN
SW DITCH HYDROLOGY STA 0+00 TO 5+00



MATERIAL: CLAYEY SPOIL MATERIAL
Limiting Variable: Velocity = 5.000 fps
Sediment-laden Water

					w/ Freeboard:	
Discharge	= 1.40 cfs	Depth (d)	=	0.39	(D =	1.39) ft
		Top width (t)	=	1.97	(T =	6.97) ft
Side slopes (Z)	= 3.0:1(L) 2.0:1(R)	Velocity	=	3.60 fps		
Bed Slope	= 3.50 %	Hydraulic Radius	=	0.18 ft		
Manning's n	= 0.025	Froude number	=	1.43		

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

NORTHEAST DITCH HYDROLOGY-STA 5+00 TO 12-00 BARBER MODIFICATION

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-129\SEDCAD\NE_DIT

Date: 01-30-1998

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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\NE_DIT User: BEN HOSKIE
Date: 11-04-1997 Time: 13:19:25
NORTHEAST DITCH HYDROLOGY-STA 5+00 TO 12+00 BARBER MODIFICATION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	4.36	78	M	0.130	0.000	0.000	0.0	0.05	0.97
			Type: Null			Label: J1B1S1				
111	Structure	4.36							0.05	
111	Total IN/OUT	4.36							0.05	0.97

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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\NE_DIT User: BEN HOSKIE
Date: 11-04-1997 Time: 13:19:25
NORTHEAST DITCH HYDROLOGY-STA 5+00 TO 12+00 BARBER MODIFICATION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1049.00	5.00	2.24	0.13	0.130		

SEDCAD+ ERODIBLE CHANNEL DESIGN

NE DITCH HYDROLOGY STA 5+00 TO 12+00

Limiting Velocity Technique
Sediment-laden Water

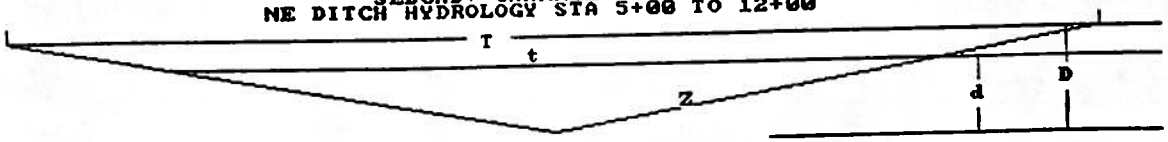
INPUT VALUES:

Shape	TRIANGULAR	
Discharge	0.97 cfs	
Slope	4.50 %	
Sideslopes	3.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	CLAYEY SPOIL MATERIAL	
Freeboard	1 ft	

RESULTS:

Actual Discharge	0.97 cfs
Depth	0.33 ft
with Freeboard	1.33 ft
Top Width	1.64 ft
with Freeboard	6.64 ft
Velocity	3.61 fps
Cross Sectional Area	0.27 sq ft
Hydraulic Radius	0.15 ft
Froude Number	1.57

SEDCAD+ CHANNEL DESIGN
NE DITCH HYDROLOGY STA 5+00 TO 12+00



MATERIAL: CLAYEY SPOIL MATERIAL
Limiting Variable: Velocity = 5.000 fps
Sediment-laden Water

						w/ Freeboard:
Discharge	=	0.97 cfs	Depth (d)	=	0.33	(D = 1.33) ft
			Top width (t)	=	1.64	(T = 6.64) ft
Side slopes (Z)	=	3.0:1(L) 2.0:1(R)	Velocity	=	3.61 fps	
Bed Slope	=	4.50 %	Hydraulic Radius	=	0.15 ft	
Manning's n	=	0.025	Froude number	=	1.57	

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

SOUTHEAST DITCH HYDROLOGY-STA 5+00 TO 12+00 BARBER MODIFICATION

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-129\SEDCAD\SE_DIT

Date: 01-30-1998

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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\SE_DIT User: BEN HOSKIE
Date: 11-04-1997 Time: 13:21:45
SOUTHEAST DITCH HYDROLOGY-STA 5+00 TO 12+00 BARBER MODIFICATION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	**Peak Discharge (cfs)**
111	1	2.23	79	M	0.134	0.000	0.000	0.0	0.03	**0.61**
			Type: Null			Label: J1B1S1				
111	Structure	2.23							0.03	
111	Total IN/OUT	2.23							0.03	**0.61**

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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\SE_DIT User: BEN HOSKIE
Date: 11-04-1997 Time: 13:21:45
SOUTHEAST DITCH HYDROLOGY-STA 5+00 TO 12+00 BARBER MODIFICATION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1010.00	4.36	2.09	0.13	0.134		

SEDCAD+ ERODIBLE CHANNEL DESIGN

SE DITCH HYDROLOGY STA 5+00 TO 12+00

Limiting Velocity Technique
Sediment-laden Water

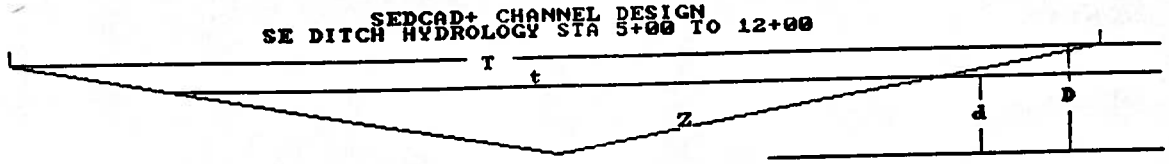
INPUT VALUES:

Shape	TRIANGULAR	
Discharge	0.61 cfs	
Slope	4.50 %	
Sideslopes	3.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Max. Velocity	5.00 fps	
Material	CLAYEY SPOIL MATERIAL	
Freeboard	1 ft	

RESULTS:

Actual Discharge	0.61 cfs
Depth	0.28 ft
with Freeboard	1.28 ft
Top Width	1.38 ft
with Freeboard	6.38 ft
Velocity	3.21 fps
Cross Sectional Area	0.19 sq ft
Hydraulic Radius	0.13 ft
Froude Number	1.52

SEDCAD+ CHANNEL DESIGN
SE DITCH HYDROLOGY STA 5+00 TO 12+00



MATERIAL: CLAYEY SPOIL MATERIAL
Limiting Variable: Velocity = 5.000 fps
Sediment-laden Water

						w/ Freeboard:	
Discharge	=	0.61 cfs	Depth (d)	=	0.28	(D = 1.28)	ft
			Top width (t)	=	1.38	(T = 6.38)	ft
Side slopes (Z)	=	3.0:1(L) 2.0:1(R)	Velocity	=	3.21	fps	
Bed Slope	=	4.50 %	Hydraulic Radius	=	0.13	ft	
Manning's n	=	0.025	Froude number	=	1.52		

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

SOUTH DITCH HYDROLOGY-FILL AREA STA 12+00 TO 17+00 BARBER MODIFICATION

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-129\SEDCAD\S_DIT

Date: 01-30-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\S_DIT User: BEN HOSKIE
Date: 11-04-1997 Time: 13:41:13
SOUTH DITCH HYDROLOGY-FILL AREA STA 12+00 TO 17+00 BARBER MODIFICATION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	2.89	80	M	0.212	0.000	0.000	0.0	0.05	0.82
			Type: Null			Label: J1B1S1				
111	Structure	2.89							0.05	
111	Total IN/OUT	2.89							0.05	0.82

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\BARMOD\S_DIT User: BEN HOSKIE
Date: 11-04-1997 Time: 13:41:13
SOUTH DITCH HYDROLOGY-FILL AREA STA 12+00 TO 17+00 BARBER MODIFICATION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1510.00	3.91	1.98	0.21	0.212		

SEDCAD+ ERODIBLE CHANNEL DESIGN

S DITCH HYDROLOGY STA 12+00 TO 17+00

Limiting Velocity Technique
Sediment-laden Water

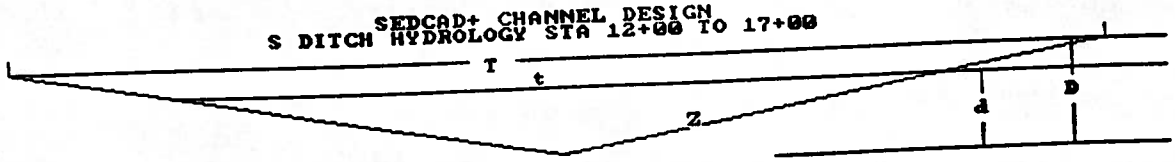
INPUT VALUES:

Shape	TRIANGULAR
Discharge	0.82 cfs
Slope	4.50 %
Sideslopes	4.00:1 (L) 58.00:1 (R)
Manning's n	0.020
Max. Velocity	3.00 fps
Material	SILT LOAM NONCOLLOIDAL
Freeboard	1 ft

RESULTS:

Actual Discharge	0.82 cfs
Depth	0.11 ft
with Freeboard	1.11 ft
Top Width	6.71 ft
with Freeboard	68.71 ft
Velocity	2.26 fps
Cross Sectional Area	0.36 sq ft
Hydraulic Radius	0.05 ft
Froude Number	1.71

SEDCAD+ CHANNEL DESIGN
S DITCH HYDROLOGY STA 12+00 TO 17+00



MATERIAL: SILT LOAM NONCOLLOIDAL
Limiting Variable: Velocity = 3.000 fps
Sediment-laden Water

Discharge	=	0.82 cfs	Depth (d)	=	0.11	w/ Freeboard: (D = 1.11) ft
Side slopes (Z)	=	4.0:1(L) 58.0:1(R)	Top width (t)	=	6.71	(T = 68.71) ft
Bed Slope	=	4.50 %	Velocity	=	2.26 fps	
Manning's n	=	0.020	Hydraulic Radius	=	0.05 ft	
			Froude number	=	1.71	

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CMP CP-119 HYDROLOGY DOWN STREAM

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-129\SEDCAD\BARBER

Date: 01-30-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\BARBER User: BH
Date: 11-07-1997 Time: 10:11:07
CMP CP-119 HYDROLOGY DOWN STREAM
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	31.52	76	M	0.346	0.000	0.000	0.0	0.29	3.40
			Type: Null			Label: J1B1S1				
111	Structure	31.52							0.29	
111	Total IN/OUT	31.52							0.29	3.40

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Company Name: BHP MINERALS
User: BH
Filename: C:\BEN\BARBER
Date: 11-07-1997 Time: 10:11:07
CMP CP-119 HYDROLOGY DOWN STREAM
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Condition	Flow	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5		2488.00	3.98	1.99	0.35	0.346		

BHP MINERALS
NAVAJO MINE

07-Nov-97

PROJECT: CMP-119 DOWNSTREAM HYDROLOGY
ENGINEER: Ben Hoskie
FILE NO :
DRWG NO : EXHIBIT 11-129
MMD REF:

Channel Design:

Precipitation Event:	10yr-6hr		
Design Flow	Q10	7.55	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	22.00	
(Z2:1)	Z2 =	22.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.76	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	1.38	0.12	2.64	1.92
0.50	5.50	0.25	16.79	3.05
0.75	12.38	0.37	49.58	4.01
1.00	22.00	0.50	106.89	4.86
1.25	34.38	0.62	193.94	5.64
1.50	49.50	0.75	315.56	6.38
1.75	67.38	0.87	476.25	7.07
2.00	88.00	1.00	680.26	7.73
2.25	111.38	1.12	931.64	8.36
2.50	137.50	1.25	1234.31	8.98
2.75	166.38	1.37	1591.99	9.57
3.00	198.00	1.50	2008.34	10.14
3.25	232.38	1.62	2486.86	10.70
3.50	269.50	1.75	3030.99	11.25
3.75	309.38	1.87	3644.07	11.78
4.00	352.00	2.00	4329.36	12.30
4.25	397.38	2.12	5090.04	12.81

Flow Depth at Peak Discharge	0.38	Ft
Minimum Channel Depth Required	0.68	Ft
Critical Depth	0.38	Ft
Flow Type	Subcritical flow	
Froude Number	0.73	
Flow Velocity	2.54	fps
Soil Type: SANDY LOAM		
Erosive Velocity	3.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15; Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas Chapter 3; B.J. Barfield and R.C. Warner University of Kentucky

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-16 HYDROLOGY

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: J:\OSM_SUBM\PER_PROG\CH_11\11-129\SEDCAD\CP_16

Date: 01-30-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\CP_16 User: BEN HOSKIE
Date: 11-10-1997 Time: 15:14:56
CULVERT CP-16
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	31.90	76	M	0.256	0.000	0.000	0.0	0.30	4.15
			Type: Null			Label: CP-119				
111	Structure	31.90							0.30	
111	Total IN/OUT	31.90							0.30	4.15
211	1	172.50	76	M	0.635	0.000	0.000	0.0	1.61	12.47
			Type: Null			Label: CP-16				
211	Structure	172.50							1.91	
211	Total IN/OUT	204.40							1.91	15.76
111 to 211 Routing						0.127	0.359			

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Company Name: BHP MINERALS
Filename: C:\BEN\CP_16 User: BEN HOSKIE
Date: 11-10-1997 Time: 15:14:56
CULVERT CP-16
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1875.00	4.12	2.03	0.26	0.256		
2	1	1	1	-a	5	3325.00	2.11	1.45	0.64	0.635		

SEDCAD+ CULVERT SIZING UTILITY

CP-16 RAILROAD CULVERT

Design Discharge	=	15.760	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	153.000	feet
Pipe Slope	=	1.100	%
Manning's n	=	0.017	
Maximum Headwater	=	42.500	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
4.25	2.18	Outlet	6
8.50	2.98	Outlet	6
12.75	3.55	Outlet	6
17.00	4.08	Outlet	6
21.25	4.47	Outlet	6
25.50	4.87	Outlet	6
29.75	5.26	Outlet	6
34.00	5.66	Outlet	6
38.25	6.04	Outlet	6
42.50	6.32	Outlet	6
46.75	6.60	Outlet	6
51.00	6.89	Outlet	6
55.25	7.17	Outlet	6
59.50	7.45	Outlet	6
63.75	7.73	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
4.25	4.48	Outlet	6
8.50	6.16	Outlet	6
12.75	7.41	Outlet	6
17.00	8.51	Outlet	6
21.25	9.47	Outlet	6
25.50	10.36	Outlet	6
29.75	11.15	Outlet	6
34.00	11.95	Outlet	6
38.25	12.62	Outlet	6
42.50	13.29	Outlet	6
46.75	13.96	Outlet	6
51.00	14.55	Outlet	6
55.25	15.13	Outlet	6
59.50	15.71	Outlet	6
63.75	16.26	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type

4.25	7.88	Outlet	6
8.50	10.76	Outlet	6
12.75	13.04	Outlet	6
17.00	14.98	Outlet	6
21.25	16.70	Outlet	6
25.50	18.27	Outlet	6
29.75	19.70	Outlet	6
34.00	21.02	Outlet	6
38.25	22.29	Outlet	6
42.50	23.47	Outlet	6
46.75	24.60	Outlet	6
51.00	25.68	Outlet	6
55.25	26.71	Outlet	6
59.50	27.72	Outlet	6
63.75	28.68	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
4.25	12.21	Outlet	6
8.50	16.87	Outlet	6
12.75	20.52	Outlet	6
17.00	23.61	Outlet	6
21.25	26.34	Outlet	6
25.50	28.81	Outlet	6
29.75	31.08	Outlet	6
34.00	33.20	Outlet	6
38.25	35.20	Outlet	6
42.50	37.08	Outlet	6
46.75	38.88	Outlet	6
51.00	40.59	Outlet	6
55.25	42.24	Outlet	6
59.50	43.77	Outlet	6
63.75	45.30	Outlet	6

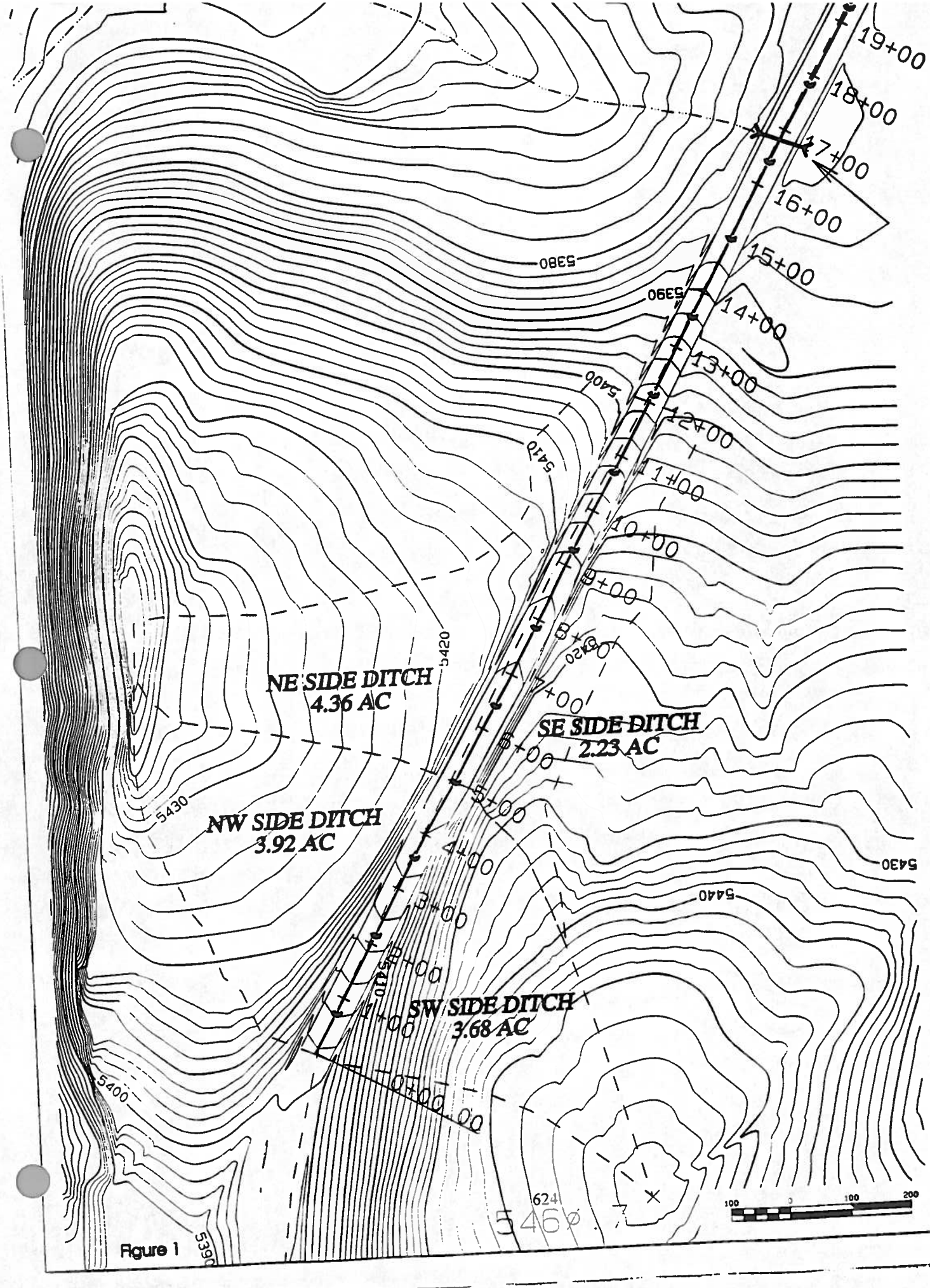
Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
4.25	17.52	Outlet	6
8.50	24.51	Outlet	6
12.75	29.93	Outlet	6
17.00	34.48	Outlet	6
21.25	38.51	Outlet	6
25.50	42.16	Outlet	6
29.75	45.46	Outlet	6
34.00	48.59	Outlet	6
38.25	51.56	Outlet	6
42.50	54.30	Outlet	6
46.75	56.99	Outlet	6
51.00	59.46	Outlet	6
55.25	61.94	Outlet	6
59.50	64.22	Outlet	6
63.75	66.50	Outlet	6

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type

4.25	23.79	Outlet	6
8.50	33.68	Outlet	6
12.75	41.26	Outlet	6
17.00	47.63	Outlet	6
21.25	53.25	Outlet	6
25.50	58.34	Outlet	6
29.75	63.03	Outlet	6
34.00	67.41	Outlet	6
38.25	71.50	Outlet	6
42.50	75.35	Outlet	6
46.75	79.03	Outlet	6
51.00	82.57	Outlet	6
55.25	85.93	Outlet	6
59.50	89.17	Outlet	6
63.75	92.33	Outlet	6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NW SIDE DITCH
3.92 AC
SE SIDE DITCH
2.23 AC
SW SIDE DITCH
3.68 AC
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17+00
16+00
15+00
14+00
13+00
12+00
11+00
10+00
9+00
8+00
7+00
6+00
5+00
4+00
3+00
2+00
1+00
0+00
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5410
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5430
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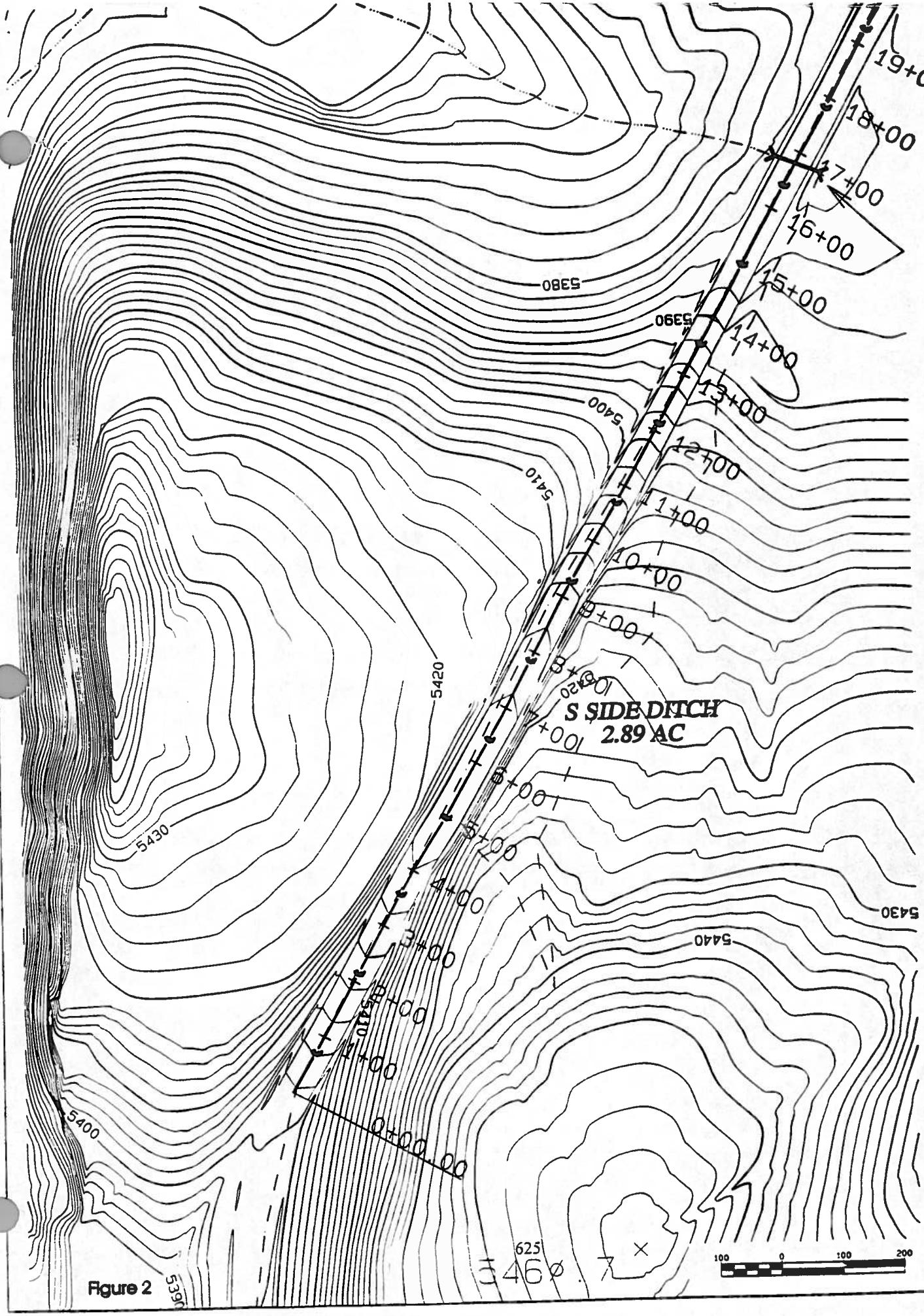
5430
5400
5390
100
0
100
200

Figure 1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9+00
8+00
7+00
6+00
5+00
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5430
5440
100 0 100 200

Figure 2

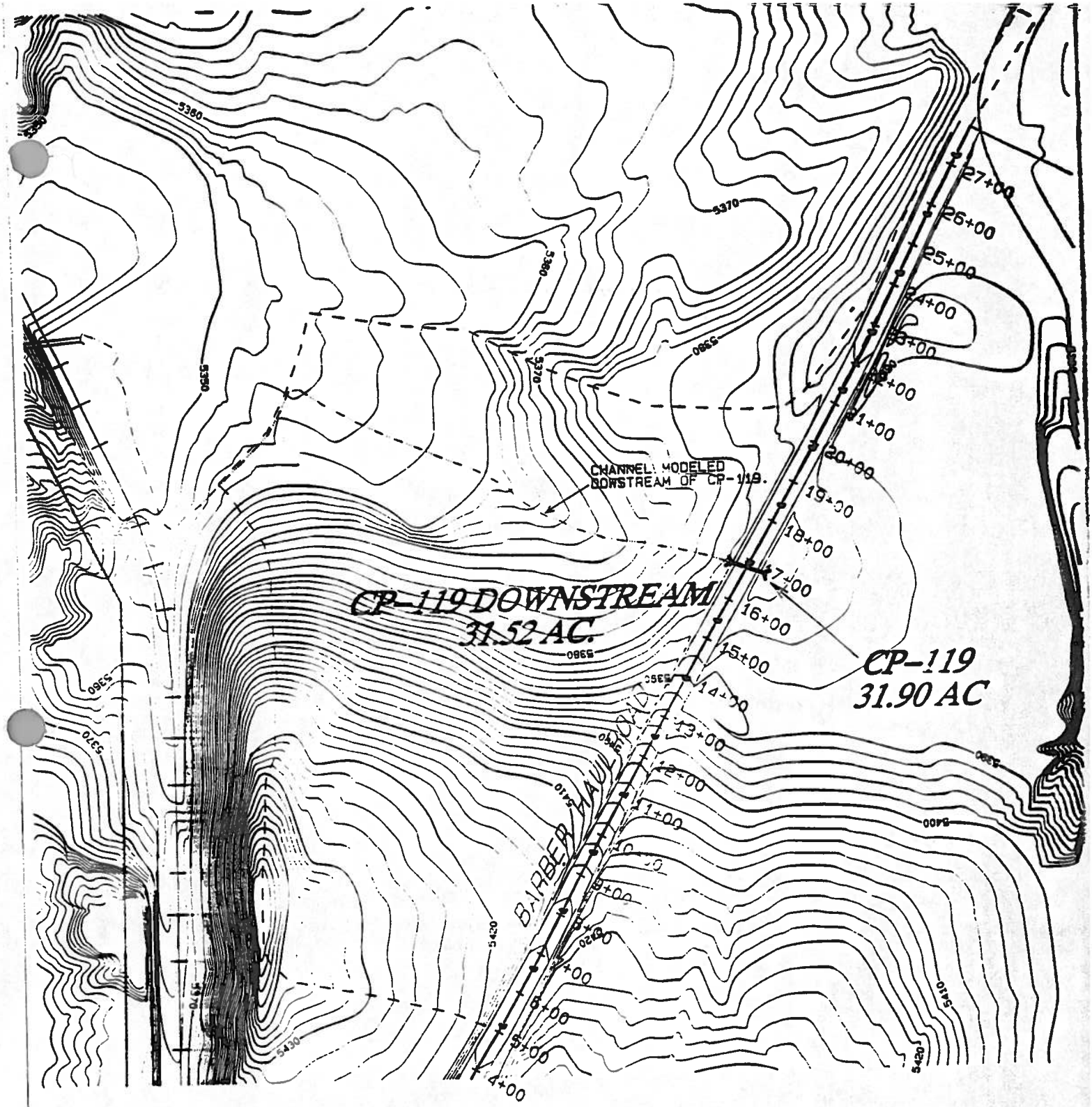
CHANNEL MODELED
DOWNSTREAM OF CP-119.
CP-119 DOWNSTREAM
31.52 AC.
CP-119
31.90 AC
BARBER HAUL ROAD
27+00
26+00
25+00
24+00
23+00
22+00
21+00
20+00
19+00
18+00
17+00
16+00
15+00
14+00
13+00
12+00
11+00
10+00
9+00
8+00
7+00
6+00
5+00
4+00
5380
5370
5390
5400
5410
5420
5430

Figure 3

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CULVERT CP-124 RAMP 7

by

Name: RY

Company Name: BHP MINERALS
File Name: C:\RAY\CP-124

Date: 04-01-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\RAY\CP-124 User: RY
Date: 04-01-1998 Time: 12:02:57
CULVERT CP-124 RAMP 7
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	372.00	72	M	1.566	0.000	0.000	0.0	1.92	7.74
			Type: Null		Label: CP-124					
111	Structure	372.00							1.92	
111	Total IN/OUT	372.00							1.92	7.74

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Company Name: BHP MINERALS
Filename: C:\RAY\CP-124 User: RY
Date: 04-01-1998 Time: 12:02:57
CULVERT CP-124 RAMP 7
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr	Muskingum K (hr)	X
1	1	1	1	-a	5	6566.00	1.36	1.16	1.57	1.566		

SEDCAD+ CULVERT SIZING UTILITY

CP-124

Design Discharge	=	7.740 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	50.000 feet
Pipe Slope	=	3.000 %
Manning's n	=	0.018
Maximum Headwater	=	3.300 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.45	Outlet (Subcritical)	1
0.66	0.89	Inlet (Supercritical)	3
0.99	1.40	Inlet (Supercritical)	4
1.32	1.92	Inlet	5
1.65	2.12	Inlet	5
1.98	2.27	Inlet	5
2.31	2.41	Inlet	5
2.64	2.56	Outlet	6
2.97	2.70	Outlet	6
3.30	2.85	Outlet	6
3.63	2.99	Outlet	6
3.96	3.09	Outlet	6
4.29	3.18	Outlet	6
4.62	3.28	Outlet	6
4.95	3.37	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.54	Outlet (Subcritical)	2
0.66	1.14	Inlet (Supercritical)	3
0.99	2.06	Inlet (Supercritical)	3
1.32	3.02	Inlet	5
1.65	3.74	Inlet	5
1.98	4.32	Inlet	5
2.31	4.81	Outlet	6
2.64	5.15	Outlet	6
2.97	5.39	Outlet	6
3.30	5.64	Outlet	6
3.63	5.88	Outlet	6
3.96	6.10	Outlet	6
4.29	6.31	Outlet	6

4.62	6.52	Outlet	6
4.95	6.72	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.63	Outlet (Subcritical)	2
0.66	1.43	Inlet (Supercritical)	3
0.99	2.59	Inlet (Supercritical)	3
1.32	3.97	Inlet (Supercritical)	3
1.65	5.27	Inlet	5
1.98	6.33	Inlet	5
2.31	7.24	Inlet	5
2.64	8.05	Inlet	5
2.97	8.77	Inlet	5
3.30	9.30	Inlet	5
3.63	9.74	Outlet	6
3.96	10.16	Outlet	6
4.29	10.52	Outlet	6
4.62	10.89	Outlet	6
4.95	11.24	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.71	Outlet (Subcritical)	2
0.66	1.71	Inlet (Supercritical)	3
0.99	3.10	Inlet (Supercritical)	3
1.32	4.77	Inlet (Supercritical)	3
1.65	6.66	Inlet (Supercritical)	3
1.98	8.33	Inlet	5
2.31	9.74	Inlet	5
2.64	10.98	Inlet	5
2.97	12.08	Inlet	5
3.30	13.10	Inlet	5
3.63	14.04	Inlet	5
3.96	14.92	Inlet	5
4.29	15.70	Outlet	6
4.62	16.33	Outlet	6
4.95	16.88	Outlet	6

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.78	Outlet (Subcritical)	2
0.66	1.97	Inlet (Supercritical)	3
0.99	3.62	Inlet (Supercritical)	3
1.32	5.56	Inlet (Supercritical)	3

1.65	7.77	Inlet (Supercritical)	3
1.98	10.19	Inlet (Supercritical)	3
2.31	12.26	Inlet	3
2.64	14.06	Inlet	3
2.97	15.64	Inlet	3
3.30	17.09	Inlet	3
3.63	18.42	Inlet	3
3.96	19.66	Inlet	3
4.29	20.83	Inlet	3
4.62	21.94	Inlet	3
4.95	22.99	Inlet	3

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.86	Inlet (Supercritical)	3
0.66	2.26	Inlet (Supercritical)	3
0.99	4.13	Inlet (Supercritical)	3
1.32	6.36	Inlet (Supercritical)	3
1.65	8.88	Inlet (Supercritical)	3
1.98	11.67	Inlet (Supercritical)	3
2.31	14.70	Inlet (Supercritical)	3
2.64	17.12	Inlet	3
2.97	19.33	Inlet	3
3.30	21.31	Inlet	3
3.63	23.13	Inlet	3
3.96	24.81	Inlet	3
4.29	26.38	Inlet	3
4.62	27.87	Inlet	3
4.95	29.28	Inlet	3

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-125 HYDROLOGY

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: C:\BEN\CP125\CP_125

Date: 05-03-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\CP125\CP_125 User: BEN HOSKIE
Date: 05-03-1998 Time: 11:46:18
CP-125 HYDROLOGY
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	4.18	89	M	0.178	0.000	0.000	0.0	0.06	1.12
		Type: Culvert Label: CP-125								
111	Structure	4.18							0.06	
111	Total IN/OUT	4.18							0.06	1.12

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\CP125\CP_125 User: BEN HOSKIE
Date: 05-03-1998 Time: 11:46:18
CP-125 HYDROLOGY
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	1475.00	5.24	2.29	0.18	0.178		

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\CP125\CP_125 User: BEN HOSKIE
Date: 05-03-1998 Time: 11:46:18
CP-125 HYDROLOGY
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

==========
NON-POND STRUCTURE INPUT/OUTPUT TABLE
==========

J1, B1, S1
CP-125

Drainage Area from J1, B1, S1, SWS(s)1: 4.2 acres
Total Contributing Drainage Area: 4.2 acres

Entrance Loss Coefficient	Maximum Headwater (ft)	Pipe Length (ft)	Pipe Slope (%)	Manning's n	Tailwater (ft)
0.90	1.8	28.4	1.3	0.017	0.0

Minimum Pipe Diameter Required: 8.0 inches
(See Culvert Utility Program for full performance curves)

	Runoff Volume (ac-ft)	Peak Discharge (cfs)
IN/OUT	0.06	1.12

****

SEDCAD+ CULVERT SIZING UTILITY

CP-125

Design Discharge	=	1.120 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	28.400 feet
Pipe Slope	=	1.300 %
Manning's n	=	0.017
Maximum Headwater	=	1.800 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 8 inches

PERFORMANCE CURVES:

Diameter: 4 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.18	0.01		0
0.36	0.02		0
0.54	0.03		0
0.72	0.04		0
0.90	0.05		0
1.08	0.06		0
1.26	0.07		0
1.44	0.08	Outlet (Subcritical)	1
1.62	0.09	Outlet (Subcritical)	1
1.80	0.10	Outlet (Subcritical)	1
1.98	0.12	Outlet (Subcritical)	1
2.16	0.13	Outlet (Subcritical)	1
2.34	0.14	Outlet (Subcritical)	1
2.52	0.15	Outlet (Subcritical)	1
2.70	0.16	Outlet (Subcritical)	1

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.18	0.08		0
0.36	0.15	Outlet (Subcritical)	1
0.54	0.23	Outlet (Subcritical)	1
0.72	0.30	Outlet (Subcritical)	2
0.90	0.38	Outlet (Subcritical)	2
1.08	0.46	Inlet (Supercritical)	3
1.26	0.53	Inlet (Supercritical)	3
1.44	0.61	Inlet (Supercritical)	4
1.62	0.69	Inlet (Supercritical)	4
1.80	0.76	Inlet	5
1.98	0.84	Inlet	5
2.16	0.91	Inlet	5
2.34	0.99	Outlet	6

2.52	1.02	Outlet	6
2.70	1.05	Outlet	6

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.18	0.22	Outlet (Subcritical)	1
0.36	0.44	Outlet (Subcritical)	2
0.54	0.67	Inlet (Supercritical)	3
0.72	0.89	Inlet (Supercritical)	4
0.90	1.05	Inlet	5
1.08	1.16	Inlet	5
1.26	1.27	Inlet	5
1.44	1.37	Inlet	5
1.62	1.48	Inlet	5
1.80	1.59	Outlet	6
1.98	1.69	Outlet	6
2.16	1.80	Outlet	6
2.34	1.91	Outlet	6
2.52	2.01	Outlet	6
2.70	2.07	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.18	0.22		0
0.36	0.44		0
0.54	0.65	Outlet (Subcritical)	1
0.72	0.87	Outlet (Subcritical)	1
0.90	1.10	Outlet (Subcritical)	1
1.08	1.33	Inlet (Supercritical)	3
1.26	1.57	Inlet (Supercritical)	4
1.44	1.81	Inlet	5
1.62	2.02	Outlet	6
1.80	2.13	Outlet	6
1.98	2.24	Outlet	6
2.16	2.35	Outlet	6
2.34	2.46	Outlet	6
2.52	2.57	Outlet	6
2.70	2.68	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.18	0.29	Outlet (Subcritical)	1
0.36	0.59	Outlet (Subcritical)	2
0.54	0.88	Inlet (Supercritical)	3
0.72	1.30	Inlet (Supercritical)	3

0.90	1.81	Inlet (Supercritical)	3
1.08	2.32	Inlet (Supercritical)	4
1.26	2.85	Inlet	5
1.44	3.24	Inlet	5
1.62	3.56	Outlet	6
1.80	3.89	Outlet	6
1.98	4.16	Outlet	6
2.16	4.39	Outlet	6
2.34	4.62	Outlet	6
2.52	4.85	Outlet	6
2.70	5.07	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.18	0.34	Outlet (Subcritical)	1
0.36	0.68	Outlet (Subcritical)	2
0.54	1.04	Inlet (Supercritical)	3
0.72	1.63	Inlet (Supercritical)	3
0.90	2.25	Inlet (Supercritical)	3
1.08	2.94	Inlet (Supercritical)	3
1.26	3.71	Inlet (Supercritical)	3
1.44	4.46	Inlet (Supercritical)	4
1.62	5.17	Inlet	5
1.80	5.78	Inlet	5
1.98	6.32	Inlet	5
2.16	6.82	Outlet	6
2.34	7.25	Outlet	6
2.52	7.63	Outlet	6
2.70	8.01	Outlet	6

CP-126 Block C Haul Road

ry

BHP Ccal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-126

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	24.600	24.600	13.21	1.05

Structure Detail:

Structure #1 (Culvert)

CP-126

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
144.00	1.50	0.0240	3.60	0.00	0.90

Culvert Results:

Minimum pipe diameter required: 24 inches

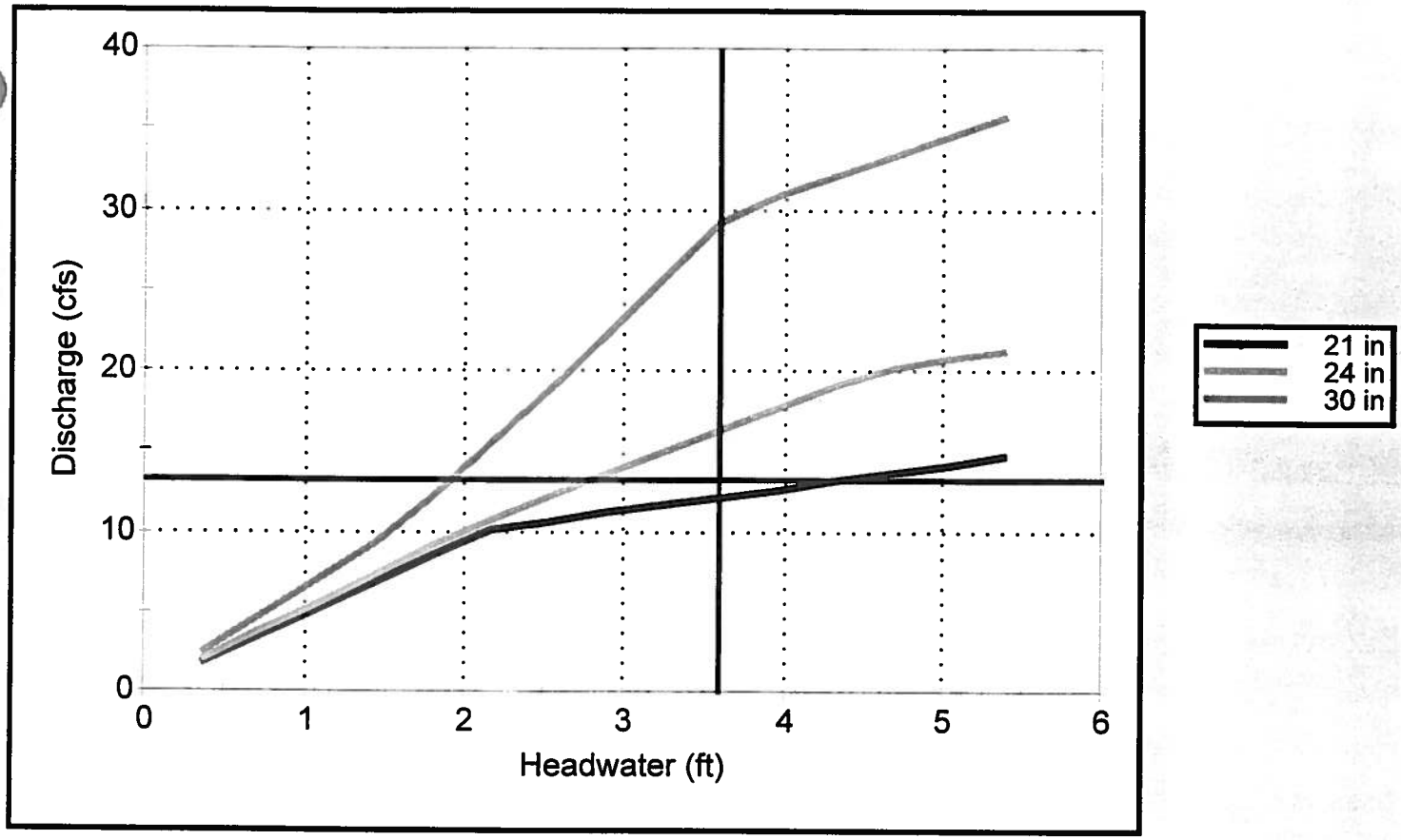
Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	24.600	0.291	0.000	0.000	89.650	M	13.21	1.05
	Σ	**24.600**						**13.21**	**1.05**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	4.56	102.00	2,237.00	2.130	0.291
#1	**1**	**Time of Concentration:**					**0.291**

Culvert Performance Curves - Structure # 1



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Dixon Haulroad Culvert: CP-128

Kriss Bergethon

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-128

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	58.640	58.640	14.23	0.95

Structure Detail:

Structure #1 (Culvert)

CP-128

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
120.00	1.00	0.0150	8.00	0.00	0.90

Culvert Results:

Minimum pipe diameter required: 18 inches

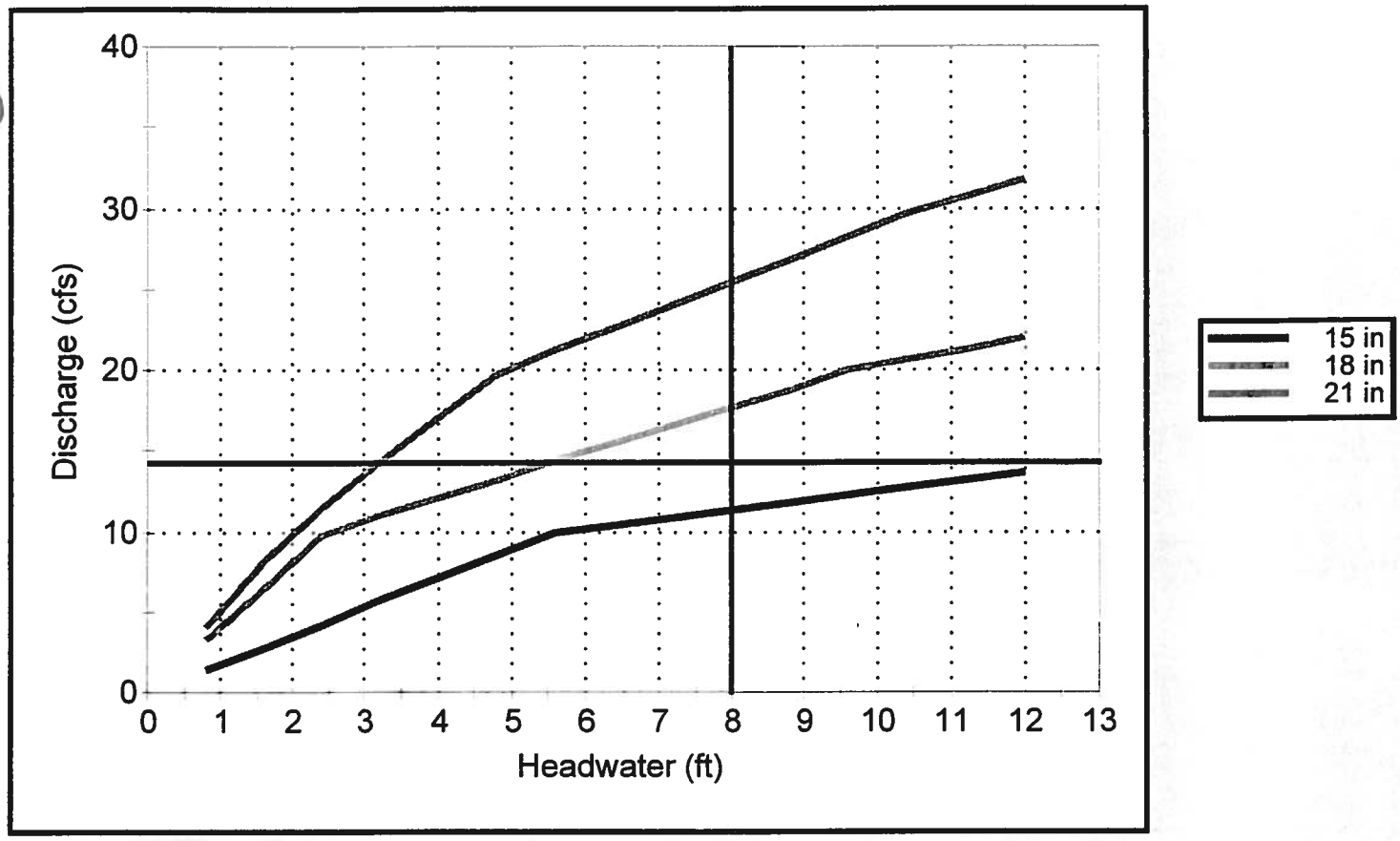
Subwatershed Hydrology Detail:

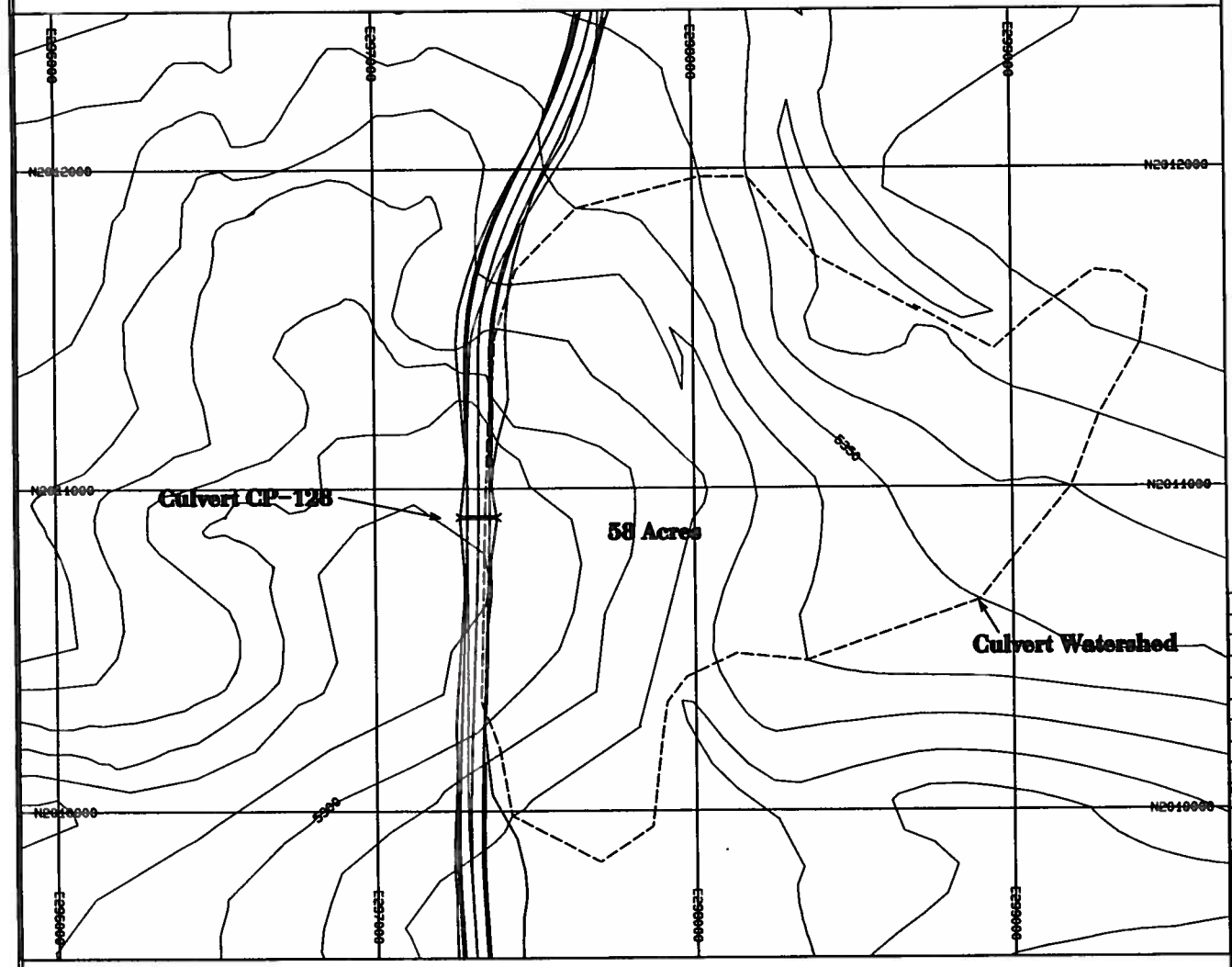
Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	58.640	0.131	0.000	0.000	80.000	M	14.23	0.95
	Σ	**58.640**						**14.23**	**0.95**

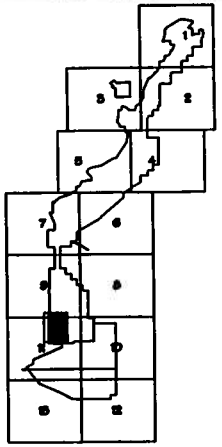
Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	7.14	90.00	1,260.01	2.670	0.131
#1	**1**	**Time of Concentration:**					**0.131**

Culvert Performance Curves - Structure # 1







CERTIFICATION STATEMENT

I, Leonard Raymond, hereby certify that this drawing was reviewed by me and that the information shown is accurate and complete to the best of my knowledge.

LEONARD RAYMOND
NEW MEXICO
6600
REGISTERED PROFESSIONAL ENGINEER

4-28-99

REV. NO.	DATE	DRAFT. BY	REVISION DESCRIPTION	DES.	E.G.	P.E.	P.S.	PROJ. ENG.
A	03/29/99	KB	SUBMITTED TO OSM FOR APPROVAL					

APPROVALS

Appendix 11-V

NAVAJO COAL COMPANY

NAVAJO MINE

P.O. BOX 195 FRUITLAND, NEW MEXICO 87416

CP-128 Watershed FSC Topography

PREPARED BY KB	DRAWN BY KB	SCALE AS NOTED
APPROVED BY LR	DATE 03/29/99	REF DWG
DWG LOC		

AS-BUILT
Mason Road Culvert: CP-140
Mason Pond East Inlet Riprap

AAY

BHP-Navajo Mine
P.O. Box 1717
Fruitland, NM 87416

Phone: (505) 598-5861

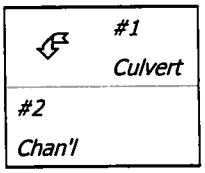
General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	#2	0.000	0.000	CP-140
Channel	#2	==>	End	0.000	0.000	Pond Inlet



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	19.520	19.520	2.61	0.19
#2	0.000	19.520	2.61	0.19

Structure Detail:

Structure #1 (Culvert)

CP-140

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	1.50	0.0240	2.50	0.00	0.90

Culvert Results:

Design Discharge = 2.61 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure #2 (Riprap Channel)

Pond Inlet

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	4.0:1	3.5:1	21.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.61 cfs	
Depth:	0.06 ft	1.06 ft
Top Width:	4.45 ft	11.95 ft
Velocity*:		
X-Section Area:	0.26 sq ft	
Hydraulic Radius:	0.057	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	19.520	0.142	0.000	0.000	76.000	M	2.61	0.190
	Σ	**19.520**						**2.61**	**0.190**
#2	Σ	**19.520**						**2.61**	**0.190**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	4.44	48.00	1,080.01	2.100	0.142
#1	**1**	**Time of Concentration:**					**0.142**

HOSTEEN YAZZIE HAULROAD
HYDROLOGY

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HOSTEEN YAZZIE HAULROAD
CP-129 HYDROLOGY

BH

BHP Coal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

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Civil Software Design

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.700	0.051	0.000	0.000	91.000	M	1.97	0.082
	Σ	**1.700**						**1.97**	**0.082**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	8.22	44.00	535.00	2.860	0.051
#1	**1**	**Time of Concentration:**					**0.051**

CP-129 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
102.00	1.00	0.0240	3.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 1.97 cfs

Maximum Headwater = 3.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (8 in)	**Discharge (cfs) (10 in)**	Discharge (cfs) (12 in)
0.30	0.36	**0.64**	0.90
0.60	0.50	**0.77**	1.14
0.90	0.65	**1.08**	1.55
1.20	0.79	**1.35**	1.99
1.50	0.85	**1.46**	2.27
1.80	0.90	**1.58**	2.46
2.10	0.96	**1.70**	2.65
2.40	1.01	**1.81**	2.82
2.70	1.07	**1.90**	2.98
3.00	1.12	**1.99**	3.13
3.30	1.18	**2.08**	3.28
3.60	1.23	**2.17**	3.42
3.90	1.29	**2.26**	3.55
4.20	1.33	**2.34**	3.68
4.50	1.36	**2.41**	3.81

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HOSTEEN YAZZIE HAULROAD
CP-130

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BHP Coal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	0.900	0.027	0.000	0.000	91.000	M	1.04	0.044
	Σ	**0.900**						**1.04**	**0.044**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	10.63	34.00	320.00	3.250	0.027
#1	**1**	**Time of Concentration:**					**0.027**

CP-130 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
122.00	1.00	0.0240	7.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 8 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 1.04 cfs

Maximum Headwater = 7.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (6 in)	**Discharge (cfs) (8 in)**	Discharge (cfs) (10 in)
0.70	0.23	**0.61**	0.92
1.40	0.30	**0.76**	1.36
2.10	0.37	**0.90**	1.64
2.80	0.45	**1.04**	1.84
3.50	0.52	**1.15**	2.03
4.20	0.60	**1.23**	2.20
4.90	0.63	**1.32**	2.35
5.60	0.66	**1.40**	2.51
6.30	0.69	**1.49**	2.65
7.00	0.72	**1.57**	2.78
7.70	0.75	**1.64**	2.91
8.40	0.78	**1.70**	3.03
9.10	0.80	**1.76**	3.15
9.80	0.83	**1.82**	3.26
10.50	0.86	**1.88**	3.37

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HOSTEEN YAZZIE HAULROAD

CP-131

BH

BHP Coal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	19.000	0.232	0.000	0.000	91.000	M	12.47	0.920
	Σ	**19.000**						**12.47**	**0.920**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	7.89	185.00	2,345.00	2.800	0.232
#1	**1**	**Time of Concentration:**					**0.232**

CP-131 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
129.00	1.00	0.0240	8.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 12.47 cfs

Maximum Headwater = 8.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (15 in)	**Discharge (cfs) (18 in)**	Discharge (cfs) (21 in)
0.80	1.93	**2.76**	3.89
1.60	3.83	**5.59**	6.55
2.40	4.58	**6.98**	9.86
3.20	5.23	**8.06**	11.52
4.00	5.80	**9.01**	12.96
4.80	6.33	**9.87**	14.26
5.60	6.82	**10.67**	15.45
6.40	7.27	**11.40**	16.56
7.20	7.70	**12.09**	17.59
8.00	8.10	**12.74**	18.57
8.80	8.49	**13.36**	19.48
9.60	8.86	**13.96**	20.38
10.40	9.21	**14.53**	21.22
11.20	9.56	**15.07**	22.04
12.00	9.88	**15.61**	22.83

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CP-132

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	12.000	0.268	0.000	0.000	91.000	M	7.51	0.581
	Σ	**12.000**						**7.51**	**0.581**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	7.16	185.00	2,585.00	2.670	0.268
#1	**1**	**Time of Concentration:**					**0.268**

CP-132 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
124.00	1.00	0.0240	3.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 7.51 cfs

Maximum Headwater = 3.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (15 in)	**Discharge (cfs) (18 in)**	Discharge (cfs) (21 in)
0.30	1.47	**2.26**	3.19
0.60	1.65	**2.54**	3.62
0.90	1.95	**2.83**	4.01
1.20	3.02	**3.56**	4.47
1.50	3.68	**5.10**	5.89
1.80	4.04	**6.07**	7.87
2.10	4.34	**6.57**	9.18
2.40	4.61	**7.03**	9.90
2.70	4.88	**7.47**	10.57
3.00	5.12	**7.88**	11.20
3.30	5.36	**8.27**	11.80
3.60	5.58	**8.64**	12.36
3.90	5.81	**8.99**	12.90
4.20	6.01	**9.34**	13.42
4.50	6.22	**9.67**	13.92

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HOSTEEN YAZZIE HAULROAD

CP-133

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BHP Coal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	4.600	0.098	0.000	0.000	91.000	M	5.32	0.223
	Σ	**4.600**						**5.32**	**0.223**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	6.44	58.00	900.00	2.530	0.098
#1	**1**	**Time of Concentration:**					**0.098**

CP-133 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
121.00	1.00	0.0240	10.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 5.32 cfs

Maximum Headwater = 10.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (12 in)	**Discharge (cfs) (15 in)**	Discharge (cfs) (18 in)
1.00	1.71	**2.25**	2.98
2.00	2.51	**4.25**	6.39
3.00	3.00	**5.13**	7.90
4.00	3.41	**5.90**	9.15
5.00	3.78	**6.59**	10.25
6.00	4.13	**7.19**	11.25
7.00	4.44	**7.76**	12.16
8.00	4.72	**8.28**	13.01
9.00	4.99	**8.78**	13.81
10.00	5.25	**9.24**	14.56
11.00	5.51	**9.70**	15.25
12.00	5.75	**10.11**	15.94
13.00	5.97	**10.53**	16.62
14.00	6.19	**10.92**	17.22
15.00	6.41	**11.30**	17.83

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HOSTEEN YAZZIE HAULROAD CULVERT CP-134

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

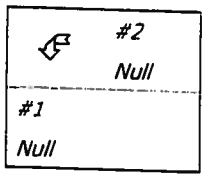
General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CP-134&135
Null	#2	==>	#1	0.121	0.369	



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	8. Large gullies, diversions, and low flowing streams	2.54	53.00	2,090.00	4.77	0.121
#2	**Muskingum K:**					**0.121**

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	82.200	0.245	0.000	0.000	90.800	M	52.10	3.908
	Σ	**82.200**						**52.10**	**3.908**
#1	1	54.800	0.331	0.000	0.000	91.000	M	31.74	2.653
	Σ	**137.000**						**81.03**	**6.561**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	5.18	140.00	2,705.00	2.270	0.331
#1	**1**	**Time of Concentration:**					**0.331**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	6.66	152.00	2,282.00	2.580	0.245
#2	**1**	**Time of Concentration:**					**0.245**

CP-134, 10 yr - 6 hr storm event, used 42" culvert

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
132.00	1.66	0.0200	13.50	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 36 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 81.00 cfs

Maximum Headwater = 13.50 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (30 in)	**Discharge (cfs) (36 in)**	Discharge (cfs) (42 in)
1.35	8.21	**9.86**	11.51
2.70	23.23	**27.87**	32.51
4.05	36.54	**48.35**	59.75
5.40	42.10	**62.40**	81.23
6.75	47.01	**70.26**	97.47
8.10	51.46	**77.34**	107.93
9.45	55.55	**83.80**	117.48
10.80	59.32	**89.81**	126.31
12.15	62.91	**95.45**	134.53
13.50	66.33	**100.78**	142.31
14.85	69.51	**105.83**	149.67
16.20	72.61	**110.65**	156.70
17.55	75.57	**115.26**	163.40
18.90	78.40	**119.70**	169.86
20.25	81.17	**123.98**	176.08

HOSTEEN YAZZIE HAULROAD
CP-138

Installed for Hosteen/Yazzie Road Re-Alignment. Watershed information in Exhibit 11-12C

BH

BHPBilliton
PO Box 1717
Fruitland, NM 87415

Phone: 505 598 5861

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	2.200	2.200	2.06	0.11

CP-138

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
218.00	1.00	0.0240	15.00	0.00	0.90

Culvert Results:

Minimum pipe diameter required: 10 inches

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HOSTEEN YAZZIE HAULROAD
CP-139

BH

BHP Coal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	22.600	22.600	16.45	1.09

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	22.600	0.167	0.000	0.000	91.000	M	16.45	1.094
	Σ	**22.600**						**16.45**	**1.094**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	6.08	90.00	1,480.00	2.460	0.167
#1	**1**	**Time of Concentration:**					**0.167**

CP-139 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
158.00	1.00	0.0240	6.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 16.45 cfs

Maximum Headwater = 6.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (21 in)	**Discharge (cfs) (24 in)**	Discharge (cfs) (30 in)
0.60	3.73	**5.07**	8.31
1.20	4.46	**5.96**	9.89
1.80	7.85	**8.92**	11.35
2.40	9.68	**12.98**	17.33
3.00	10.78	**14.60**	23.53
3.60	11.79	**16.04**	26.26
4.20	12.71	**17.37**	28.73
4.80	13.57	**18.61**	30.99
5.40	14.38	**19.76**	33.11
6.00	15.14	**20.85**	35.09
6.60	15.87	**21.89**	36.98
7.20	16.57	**22.88**	38.77
7.80	17.23	**23.83**	40.48
8.40	17.88	**24.75**	42.11
9.00	18.50	**25.61**	43.69

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HOSTEEN YAZZIE HAULROAD
CP-141

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BHP Coal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	6.000	0.049	0.000	0.000	91.000	M	6.95	0.290
	Σ	**6.000**						**6.95**	**0.290**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	10.43	60.00	575.00	3.230	0.049
#1	**1**	**Time of Concentration:**					**0.049**

CP-141 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
114.00	1.00	0.0240	3.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 6.95 cfs

Maximum Headwater = 3.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (15 in)	**Discharge (cfs) (18 in)**	Discharge (cfs) (21 in)
0.30	1.45	**2.21**	3.11
0.60	1.64	**2.52**	3.57
0.90	1.96	**2.82**	3.99
1.20	3.02	**3.56**	4.47
1.50	3.71	**5.10**	5.89
1.80	4.07	**6.09**	7.87
2.10	4.39	**6.63**	9.22
2.40	4.68	**7.12**	9.98
2.70	4.96	**7.57**	10.69
3.00	5.22	**8.00**	11.35
3.30	5.47	**8.41**	11.97
3.60	5.71	**8.81**	12.57
3.90	5.94	**9.18**	13.14
4.20	6.16	**9.54**	13.68
4.50	6.37	**9.88**	14.20

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HOSTEEN YAZZIE HAULROAD
CP-142

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BHP Coal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	4.000	0.052	0.000	0.000	91.000	M	4.63	0.194
	Σ	**4.000**						**4.63**	**0.194**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	12.21	80.00	655.00	3.490	0.052
#1	**1**	**Time of Concentration:**					**0.052**

CP-142 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
160.00	1.00	0.0240	24.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 4.63 cfs

Maximum Headwater = 24.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (10 in)	**Discharge (cfs) (12 in)**	Discharge (cfs) (15 in)
2.40	1.62	**2.53**	4.39
4.80	2.12	**3.37**	5.96
7.20	2.51	**4.07**	7.11
9.60	2.90	**4.63**	8.19
12.00	3.21	**5.15**	9.08
14.40	3.48	**5.61**	9.97
16.80	3.76	**6.05**	10.70
19.20	4.03	**6.41**	11.42
21.60	4.25	**6.77**	12.13
24.00	4.46	**7.13**	12.74
26.40	4.68	**7.49**	13.35
28.80	4.89	**7.85**	13.97
31.20	5.09	**8.16**	14.51
33.60	5.27	**8.44**	15.04
36.00	5.44	**8.72**	15.57

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HOSTEEN YAZZIE HAULROAD

CP-143

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BHP Coal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	4.200	0.051	0.000	0.000	91.000	M	4.86	0.203
	Σ	**4.200**						**4.86**	**0.203**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	13.33	90.00	675.00	3.650	0.051
#1	**1**	**Time of Concentration:**					**0.051**

CP-143 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
192.00	1.00	0.0240	18.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 4.86 cfs

Maximum Headwater = 18.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (10 in)	**Discharge (cfs) (12 in)**	Discharge (cfs) (15 in)
1.80	1.39	**2.26**	3.84
3.60	1.80	**2.84**	5.00
5.40	2.12	**3.37**	5.93
7.20	2.39	**3.80**	6.74
9.00	2.62	**4.20**	7.47
10.80	2.83	**4.58**	8.11
12.60	3.03	**4.90**	8.71
14.40	3.24	**5.22**	9.25
16.20	3.44	**5.53**	9.79
18.00	3.61	**5.80**	10.32
19.80	3.76	**6.07**	10.80
21.60	3.92	**6.33**	11.24
23.40	4.07	**6.58**	11.68
25.20	4.23	**6.81**	12.13
27.00	4.38	**7.04**	12.56

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CP-144

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BHP Coal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

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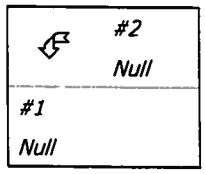
General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CP-144
Null	#2	==>	#1	0.130	0.366	



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	8. Large gullies, diversions, and low flowing streams	2.39	52.00	2,180.00	4.63	0.130
#2	**Muskingum K:**					**0.130**

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Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	59.300	0.315	0.000	0.000	91.000	M	35.02	2.871
	Σ	**59.300**						**35.02**	**2.871**
#1	1	46.400	0.292	0.000	0.000	91.000	M	28.19	2.246
	Σ	**105.700**						**58.82**	**5.117**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	5.13	122.00	2,377.00	2.260	0.292
#1	**1**	**Time of Concentration:**					**0.292**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	6.03	168.00	2,785.00	2.450	0.315
#2	**1**	**Time of Concentration:**					**0.315**

CP-144 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
183.00	1.00	0.0240	23.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 58.82 cfs

Maximum Headwater = 23.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (24 in)	**Discharge (cfs) (30 in)**	Discharge (cfs) (36 in)
2.30	12.35	**16.15**	19.31
4.60	17.63	**29.53**	44.05
6.90	21.50	**36.56**	55.64
9.20	24.77	**42.46**	65.18
11.50	27.67	**47.63**	73.50
13.80	30.28	**52.31**	80.98
16.10	32.65	**56.58**	87.82
18.40	34.85	**60.54**	94.15
20.70	37.04	**64.26**	100.09
23.00	38.96	**67.82**	105.70
25.30	40.87	**71.17**	111.03
27.60	42.70	**74.35**	116.11
29.90	44.41	**77.45**	120.97
32.20	46.11	**80.38**	125.65
34.50	47.73	**83.24**	130.16

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HOSTEEN YAZZIE HAULROAD
CP-145

BH

BHP Coal Company - Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3206

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	23.000	0.210	0.000	0.000	91.000	M	15.46	1.113
	Σ	**23.000**						**15.46**	**1.113**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	5.20	90.00	1,730.00	2.280	0.210
#1	**1**	**Time of Concentration:**					**0.210**

CP-145 HYDROLOGY- 10 yr-6 hr event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
162.00	1.00	0.0240	5.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 15.46 cfs

Maximum Headwater = 5.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (21 in)	**Discharge (cfs) (24 in)**	Discharge (cfs) (30 in)
0.50	3.63	**4.93**	8.08
1.00	4.17	**5.69**	9.42
1.50	5.89	**6.62**	10.62
2.00	8.84	**10.56**	12.70
2.50	9.84	**13.25**	18.51
3.00	10.74	**14.55**	23.55
3.50	11.57	**15.74**	25.77
4.00	12.34	**16.86**	27.84
4.50	13.07	**17.90**	29.76
5.00	13.75	**18.89**	31.57
5.50	14.41	**19.82**	33.28
6.00	15.04	**20.72**	34.91
6.50	15.64	**21.58**	36.45
7.00	16.22	**22.40**	37.95
7.50	16.78	**23.20**	39.39

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HOSTEEN YAZZIE HAULROAD

CULVERT CP-146

BH

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

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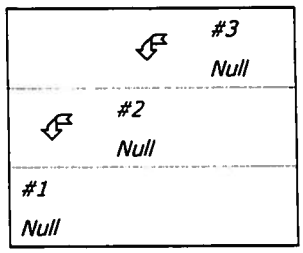
General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CP-146&147
Null	#2	==>	#1	0.169	0.345	
Null	#3	==>	#2	0.164	0.379	



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	8. Large gullies, diversions, and low flowing streams	1.60	37.00	2,310.18	3.79	0.169
#2	**Muskingum K:**					**0.169**
#3	8. Large gullies, diversions, and low flowing streams	3.17	100.00	3,158.00	5.33	0.164
#3	**Muskingum K:**					**0.164**

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	215.900	1.056	0.000	0.000	87.500	M	44.81	7.577
	Σ	**215.900**						**44.81**	**7.577**
#2	1	121.300	0.467	0.000	0.000	91.000	M	59.69	5.872
	Σ	**337.200**						**74.31**	**13.449**
#1	1	62.000	0.599	0.000	0.000	91.000	M	26.44	3.001
	Σ	**399.200**						**95.70**	**16.451**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.80	52.00	2,890.00	1.340	0.599
#1	**1**	**Time of Concentration:**					**0.599**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	5.13	195.00	3,800.00	2.260	0.467
#2	**1**	**Time of Concentration:**					**0.467**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	3.08	205.00	6,655.00	1.750	1.056
#3	**1**	**Time of Concentration:**					**1.056**

CP-146, 10 yr - 6 hr storm event

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
162.00	2.67	0.0200	11.50	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 95.80 cfs

Maximum Headwater = 11.50 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (36 in)	**Discharge (cfs) (42 in)**	Discharge (cfs) (45 in)
1.15	7.75	**9.04**	9.69
2.30	21.92	**25.57**	27.39
3.45	40.26	**46.96**	50.32
4.60	54.94	**69.01**	75.73
5.75	66.60	**86.01**	95.95
6.90	76.18	**100.18**	112.59
8.05	82.19	**112.54**	127.08
9.20	86.87	**122.64**	140.10
10.35	91.32	**129.47**	150.91
11.50	95.57	**135.68**	158.28
12.65	99.63	**141.61**	165.34
13.80	103.50	**147.31**	172.08
14.95	107.25	**152.80**	178.59
16.10	110.89	**158.10**	184.87
17.25	114.41	**163.23**	190.93

Pages 738 – 745 Appendix 11-V

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Culvert CP-150

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM 87416

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	Type II - 60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	12.800	12.800	13.91	0.57

Structure Detail:

Structure #1 (Culvert)

Culvert CP-150

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
110.00	2.18	0.0200	4.00	0.00	0.90

Culvert Results:

Design Discharge = 13.91 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	12.800	0.097	0.000	0.000	90.000	M	13.91	0.566
	Σ	**12.800**						**13.91**	**0.566**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	4.00	28.00	700.00	2.000	0.097
#1	**1**	**Time of Concentration:**					**0.097**

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Due to CP-18 data update and removal of CP-151

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CULVERT CP-157

The watershed areas for the culverts are shown on Exhibits 11-12F and 11-12F.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	28.700	28.700	20.90	1.39

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-157

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
86.00	2.33	0.0200	4.10	0.00	0.90

Culvert Results:

Design Discharge = 20.90 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

CULVERT CP-158

The watershed areas for the culverts are shown on Exhibits 11-12E and 11-12F.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

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Civil Software Design

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	38.900	38.900	28.33	1.88

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-158

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
94.00	2.02	0.0200	6.10	0.00	0.90

Culvert Results:

Design Discharge = 28.33 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

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CULVERT CP-159

The watershed areas for the culverts are shown on Exhibits 11-12E and 11-12F

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	11.400	11.400	13.20	0.55

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-159

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
94.00	4.79	0.0200	4.70	0.00	0.90

Culvert Results:

Design Discharge = 13.20 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

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CULVERT CP-160

The watershed areas for the culverts are shown on Exhibits 11-12E and 11-12F.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

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Civil Software Design

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	23.700	23.700	16.66	1.15

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-160

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
90.00	0.89	0.0200	4.90	0.00	0.90

Culvert Results:

Design Discharge = 16.66 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

CULVERT CP-161

The watershed areas for the culverts are shown on Exhibits 11-12E and 11-12F.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	102.100	102.100	59.76	4.94

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-161

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	3.00	0.0200	4.40	0.00	0.90

Culvert Results:

Design Discharge = 59.76 cfs

Minimum pipe diameter: 1 - 42 inch pipe(s) required

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CULVERT CP-162

The watershed areas for the culverts are shown on Exhibits 11-12E and 11-12F.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	40.200	40.200	28.88	1.95

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-162

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
86.00	2.09	0.0200	8.00	0.00	0.90

Culvert Results:

Design Discharge = 28.88 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Culvert CP-163, 10yr-6hr Event, Refer to Sedcad run in Appendix 11-X Structure 33

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
150.00	0.93	0.0220	13.60	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 96 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 647.00 cfs

Maximum Headwater = 13.60 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (84 in)	**Discharge (cfs) (96 in)**	Discharge (cfs) (108 in)
1.36	23.25	**26.57**	29.89
2.72	65.76	**75.15**	84.53
4.08	120.80	**138.05**	155.30
5.44	184.66	**212.54**	239.10
6.80	218.03	**297.03**	334.16
8.16	301.13	**328.67**	439.26
9.52	403.63	**432.09**	469.20
10.88	455.57	**565.88**	591.60
12.24	502.18	**636.62**	759.66
13.60	544.80	**697.26**	844.58
14.96	584.33	**752.90**	921.73
16.32	621.35	**804.70**	992.89
17.68	656.28	**853.36**	1,059.30
19.04	689.46	**899.40**	1,121.76
20.40	721.09	**943.18**	1,180.94

CULVERT CP-164

The watershed areas for the culverts are shown on Exhibits 11-12E and 11-12F.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	45.500	45.500	27.11	2.20

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-164

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
94.00	1.49	0.0200	4.50	0.00	0.90

Culvert Results:

Design Discharge = 27.11 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

CULVERT CP-165

The watershed areas for the culverts are shown on Exhibits 11-12E and 11-12F.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	14.700	14.700	10.54	0.71

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-165

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
86.00	1.40	0.0200	3.60	0.00	0.90

Culvert Results:

Design Discharge = 10.54 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

CULVERT CP-166

The watershed areas for the culverts are shown on Exhibits 11-12E and 11-12F.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	13.000	13.000	15.05	0.63

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-166

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	2.00	0.0200	5.00	0.00	0.90

Culvert Results:

Design Discharge = 15.05 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

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CULVERT CP-167

The watershed areas for the culverts are shown on Exhibits 11-12E and 11-12F.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.300	1.300	1.50	0.06

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-167

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
136.00	8.80	0.0200	5.00	0.00	0.90

Culvert Results:

Design Discharge = 1.50 cfs

Minimum pipe diameter: 1 - 8 inch pipe(s) required

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CULVERT CP-168

The watershed areas for the culverts are shown on Exhibits 11-12E and 11-12F.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

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General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	0.700	0.700	0.81	0.03

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-168

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
110.00	9.73	0.0200	2.50	0.00	0.90

Culvert Results:

Design Discharge = 0.81 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

LOWE BY-PASS ROAD
CULVERT CP-171

The culvert location and watershed area are presented on Exhibit 11-12E.

A schematic of the hydrology model is attached.

CJB

BHP Billiton Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87416

General Information

Storm Information:

Storm Type:	NM TYPE II 70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.230 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Lowe-Dixon Pond 310
Channel	#2	==>	#1	0.000	0.000	West Channel
Channel	#3	==>	#1	0.000	0.000	South Channel
Channel	#4	==>	#1	0.000	0.000	East Channel
Channel	#5	==>	#1	0.000	0.000	North Channel
Culvert	#6	==>	#2	0.000	0.000	CP-171
Culvert	#7	==>	#4	0.000	0.000	CP-327

	#5 Chan'l	
		#7 Culvert
	#4 Chan'l	
	#3 Chan'l	
		#6 Culvert
	#2 Chan'l	
#1 Null		

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#5	24.130	24.130	9.72	0.52
#7	71.130	71.130	13.60	0.79
#4	161.830	232.960	32.01	2.56
#3	34.520	34.520	8.94	0.39
#6	19.480	19.480	12.79	0.57
#2	14.120	33.600	18.26	0.77
#1	6.760	331.970	43.81	4.38

Structure Detail:

Structure #5 (Riprap Channel)

North Channel

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	3.0:1	3.0:1	16.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	9.72 cfs	
Depth:	0.12 ft	1.12 ft
Top Width:	8.72 ft	14.72 ft
Velocity*:		
X-Section Area:	1.00 sq ft	
Hydraulic Radius:	0.114 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #7 (Culvert)

CP-327

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
142.00	1.40	0.0150	3.00	0.00	0.90

Culvert Results:

Design Discharge = 13.60 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Structure #4 (Riprap Channel)

East Channel

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
12.00	3.0:1	3.0:1	17.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	32.01 cfs	
Depth:	0.21 ft	1.21 ft
Top Width:	13.28 ft	19.28 ft
Velocity*:		
X-Section Area:	2.69 sq ft	
Hydraulic Radius:	0.201 ft	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Riprap Channel)

South Channel

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	3.0:1	3.0:1	14.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	8.94 cfs	
Depth:	0.12 ft	1.12 ft
Top Width:	8.73 ft	14.73 ft
Velocity*:		

	w/o Freeboard	w/ Freeboard
X-Section Area:	1.01 sq ft	
Hydraulic Radius:	0.116 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #6 (Culvert)

CP-171

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
91.00	2.10	0.0150	6.00	0.00	0.90

Culvert Results:

Design Discharge = 12.79 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Structure #2 (Riprap Channel)

West Channel

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	3.0:1	3.0:1	14.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	18.26 cfs	
Depth:	0.21 ft	1.21 ft
Top Width:	9.24 ft	15.24 ft
Velocity*:		
X-Section Area:	1.79 sq ft	
Hydraulic Radius:	0.192 ft	
Froude Number*:		

	w/o Freeboard	w/ Freeboard
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #1 (Null)

Lowe-Dixon Pond 310

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#5	1	24.130	0.285	0.000	0.000	86.000	M	9.72	0.519
	Σ	**24.130**						**9.72**	**0.519**
#7	1	71.130	0.231	0.300	0.303	80.000	M	15.86	0.786
	Σ	**71.130**						**13.60**	**0.786**
#4	1	161.830	0.679	0.000	0.000	80.000	M	18.41	1.773
	Σ	**232.960**						**32.01**	**2.559**
#3	1	34.520	0.162	0.000	0.000	80.000	M	8.94	0.386
	Σ	**34.520**						**8.94**	**0.386**
#6	1	19.480	0.125	0.028	0.302	89.000	M	12.79	0.574
	Σ	**19.480**						**12.79**	**0.574**
#2	1	14.120	0.084	0.000	0.000	80.000	M	7.62	0.194
	Σ	**33.600**						**18.26**	**0.768**
#1	1	6.760	0.130	0.000	0.000	86.000	M	3.39	0.148
	Σ	**331.970**						**43.81**	**4.380**

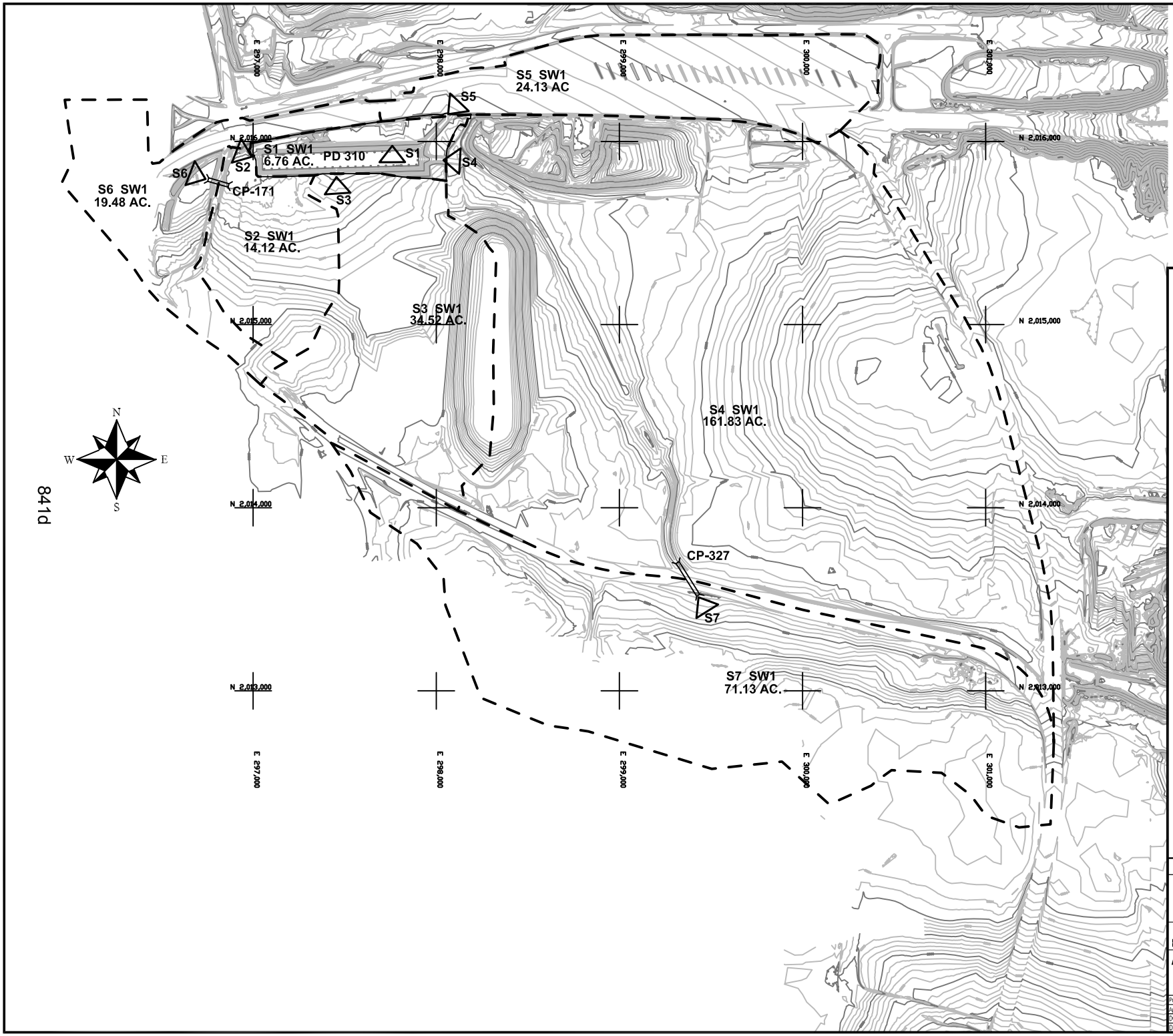
Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.26	16.00	706.43	1.500	0.130
#1	**1**	**Time of Concentration:**					**0.130**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	1.64	2.00	122.29	1.270	0.026
		8. Large gullies, diversions, and low flowing streams	3.42	40.00	1,170.72	5.540	0.058
#2	**1**	**Time of Concentration:**					**0.084**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	3.71	8.00	215.91	1.920	0.031
		8. Large gullies, diversions, and low flowing streams	1.79	34.00	1,896.47	4.010	0.131
#3	**1**	**Time of Concentration:**					**0.162**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	0.91	11.94	1,308.06	0.950	0.382
		8. Large gullies, diversions, and low flowing streams	0.71	19.35	2,709.32	2.530	0.297
#4	**1**	**Time of Concentration:**					**0.679**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#5	1	5. Nearly bare and untilled, and alluvial valley fans	1.15	2.00	173.39	1.070	0.045
		8. Large gullies, diversions, and low flowing streams	0.95	24.00	2,528.44	2.920	0.240
#5	**1**	**Time of Concentration:**					**0.285**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	3.82	10.00	261.87	1.950	0.037
		8. Large gullies, diversions, and low flowing streams	2.14	30.00	1,399.05	4.390	0.088
#6	**1**	**Time of Concentration:**					**0.125**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	0.79	2.50	315.05	0.890	0.098
		8. Large gullies, diversions, and low flowing streams	1.84	36.00	1,956.41	4.060	0.133
#7	**1**	**Time of Concentration:**					**0.231**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#6	1	8. Large gullies, diversions, and low flowing streams	0.75	2.00	266.31	2.590	0.028
#6	**1**	**Muskingum K:**					**0.028**
#7	1	8. Large gullies, diversions, and low flowing streams	0.76	21.50	2,826.34	2.610	0.300
#7	**1**	**Muskingum K:**					**0.300**


S5 SW1
24.13 AC
S5
S1 SW1
6.76 AC.
PD 310
S1
S2
S4
S6
CP-171
S3
S6 SW1
19.48 AC.
S2 SW1
14.12 AC.
S3 SW1
34.52 AC.
S4 SW1
161.83 AC.
CP-327
S7
S7 SW1
71.13 AC.
N 2,016,000
N 2,015,000
N 2,014,000
N 2,013,000
E 297,000
E 298,000
E 299,000
E 300,000
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S
E
W
LEGEND
ROAD
WATERSHED
BUILDING
FENCE
IRRIGATION LINE
CULVERT
DAM
DRAINAGE
RAILROAD
TREES
POWERLINE
SPOT ELEVATION
INDEX CONTOUR
INTERMEDIATE CONTOUR
LEASE CORNER
LEASE/PERMIT BOUNDARY
STRUCTURE
1
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bhpbilliton
BHP Navajo Coal Company
LOWE-DIXON POND 310
SCHEMATIC OF
HYDROLOGY MODEL
Prepared By: RY
Drawn By: RRY
Scale: 1" = 700'
Approved By: LR
Plot Date: 6/3/13
Layout: 8.5X11_LS
Dwg. Path: C:\Documents And Settings\jsczar\My Documents\Ramsey Yazzie Documents
Drawing: Dx Bypass 2ft Contours RRY 053113_recover.dwg

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Lowe By-pass Road Modification Culverts CP-91, CP173 , CP22 and Lowe By-Pass Ditch Designs

The hydrology model is presented on the attached sheet. The watershed for the culverts are also presented on Exhibit 11-12E.

Shawn Smith

Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

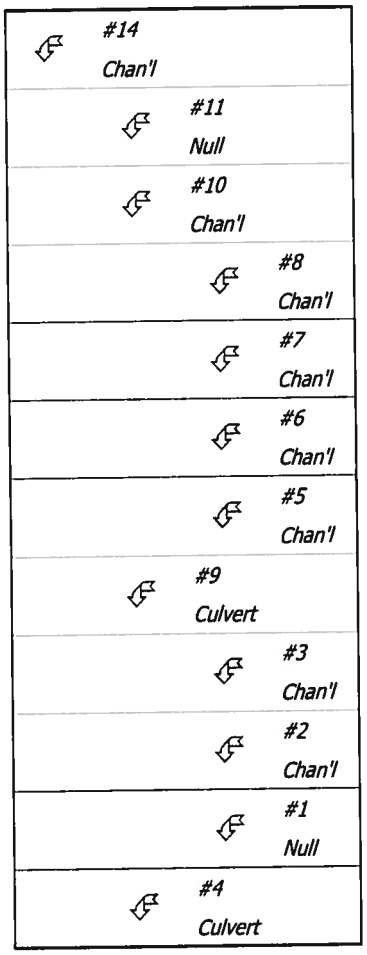
General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#4	0.000	0.000	
Channel	#2	==>	#4	0.000	0.000	E road ditch N of Str. 1
Channel	#3	==>	#4	0.000	0.000	W road ditch N of Str. 1
Culvert	#4	==>	#12	0.509	0.299	CP-91
Channel	#5	==>	#9	0.000	0.000	E road ditch S of CP173
Channel	#6	==>	#9	0.000	0.000	E road ditch N of CP173
Channel	#7	==>	#9	0.000	0.000	W road ditch N of CP173
Channel	#8	==>	#9	0.000	0.000	W road ditch S of CP173
Culvert	#9	==>	#12	0.323	0.314	Culvert CP-173
Channel	#10	==>	#12	0.000	0.000	W road ditch S of CP22
Null	#11	==>	#12	0.000	0.000	
Culvert	#12	==>	#15	0.000	0.000	Culvert CP-22 (outlet str.)
Channel	#14	==>	#15	0.000	0.000	E road ditch S of Ramp 2
Null	#15	==>	End	0.000	0.000	Dummy structure



	#12 *Culvert*
#15 *Null*	

Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#4	8. Large gullies, diversions, and low flowing streams	0.71	33.00	4,639.00	2.53	0.509
#4	**Muskingum K:**					**0.509**
#9	8. Large gullies, diversions, and low flowing streams	0.92	31.00	3,359.00	2.88	0.323
#9	**Muskingum K:**					**0.323**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#14	15.020	15.020	9.12	0.49
#11	54.200	54.200	21.62	1.74
#10	1.800	1.800	1.11	0.06
#8	0.320	0.320	0.39	0.01
#7	0.430	0.430	0.52	0.02
#6	4.020	4.020	4.85	0.16
#5	2.030	2.030	2.45	0.08
#9	0.000	6.800	8.21	0.27
#3	0.270	0.270	0.33	0.01
#2	3.000	3.000	3.62	0.12
#1	14.570	14.570	9.35	0.47
#4	0.000	17.840	10.95	0.60
#12	0.000	80.640	32.15	2.68
#15	0.000	95.660	37.76	3.16

Structure Detail:

Structure #14 (Erodible Channel)

E road ditch S of Ramp 2

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	2.0:1	3.6	0.0250	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	9.12 cfs	
Depth:	0.79 ft	1.79 ft
Top Width:	3.96 ft	8.96 ft
Velocity:	5.81 fps	
X-Section Area:	1.57 sq ft	
Hydraulic Radius:	0.368 ft	
Froude Number:	1.63	

Structure #11 (Null)

Structure #10 (Erodible Channel)

W road ditch S of CP22

Triangular Erodible Channel Inputs:

Material: Stiff clay very colloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	3.0:1	3.6	0.0290	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.11 cfs	
Depth:	0.38 ft	1.38 ft
Top Width:	1.90 ft	6.90 ft
Velocity:	3.07 fps	

	w/o Freeboard	w/ Freeboard
X-Section Area:	0.36 sq ft	
Hydraulic Radius:	0.176 ft	
Froude Number:	1.24	

Structure #8 (Erodible Channel)

W road ditch S of CP173

Triangular Erodible Channel Inputs:

Material: Stiff clay very colloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	3.0:1	4.9	0.0290	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.39 cfs	
Depth:	0.24 ft	1.24 ft
Top Width:	1.20 ft	6.20 ft
Velocity:	2.64 fps	
X-Section Area:	0.14 sq ft	
Hydraulic Radius:	0.112 ft	
Froude Number:	1.34	

Structure #7 (Erodible Channel)

W road ditch N of CP173

Triangular Erodible Channel Inputs:

Material: Stiff clay very colloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	3.0:1	0.9	0.0290	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.52 cfs	
Depth:	0.37 ft	1.37 ft
Top Width:	1.85 ft	6.85 ft

	w/o Freeboard	w/ Freeboard
Velocity:	1.51 fps	
X-Section Area:	0.34 sq ft	
Hydraulic Radius:	0.172 ft	
Froude Number:	0.62	

Structure #6 (Erodible Channel)

E road ditch N of CP173

Triangular Erodible Channel Inputs:

Material: Stiff clay very colloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	3.0:1	0.9	0.0290	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	4.85 cfs	
Depth:	0.86 ft	1.86 ft
Top Width:	4.29 ft	9.29 ft
Velocity:	2.64 fps	
X-Section Area:	1.84 sq ft	
Hydraulic Radius:	0.398 ft	
Froude Number:	0.71	

Structure #5 (Erodible Channel)

E road ditch S of CP173

Triangular Erodible Channel Inputs:

Material: Stiff clay very colloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	3.0:1	4.9	0.0290	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.45 cfs	
Depth:	0.48 ft	1.48 ft

	w/o Freeboard	w/ Freeboard
Top Width:	2.41 ft	7.41 ft
Velocity:	4.20 fps	
X-Section Area:	0.58 sq ft	
Hydraulic Radius:	0.224 ft	
Froude Number:	1.51	

Structure #9 (Culvert)

Culvert CP-173

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
74.00	3.50	0.0160	4.30	0.00	0.90

Culvert Results:

Design Discharge = 8.21 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure #3 (Erodible Channel)

W road ditch N of Str. 1

Triangular Erodible Channel Inputs:

Material: Stiff clay very colloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	3.0:1	5.9	0.0290	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.33 cfs	
Depth:	0.22 ft	1.22 ft
Top Width:	1.10 ft	6.10 ft
Velocity:	2.72 fps	
X-Section Area:	0.12 sq ft	
Hydraulic Radius:	0.102 ft	
Froude Number:	1.45	

Structure #2 (Erodible Channel)

E road ditch N of Str. 1

Triangular Erodible Channel Inputs:

Material: Stiff clay very colloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	2.0:1	3.0	0.0290	1.00			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.62 cfs	
Depth:	0.61 ft	1.61 ft
Top Width:	3.06 ft	8.06 ft
Velocity:	3.85 fps	
X-Section Area:	0.94 sq ft	
Hydraulic Radius:	0.284 ft	
Froude Number:	1.23	

Structure #1 (Null)

Structure #4 (Culvert)

CP-91

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
70.00	1.00	0.0150	2.80	0.00	0.90

Culvert Results:

Design Discharge = 10.95 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Structure #12 (Culvert)

Culvert CP-22 (outlet str.)

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
282.00	1.00	0.0200	10.00	0.00	0.90

Culvert Results:

Design Discharge = 32.15 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Structure #15 (Null)

Dummy structure

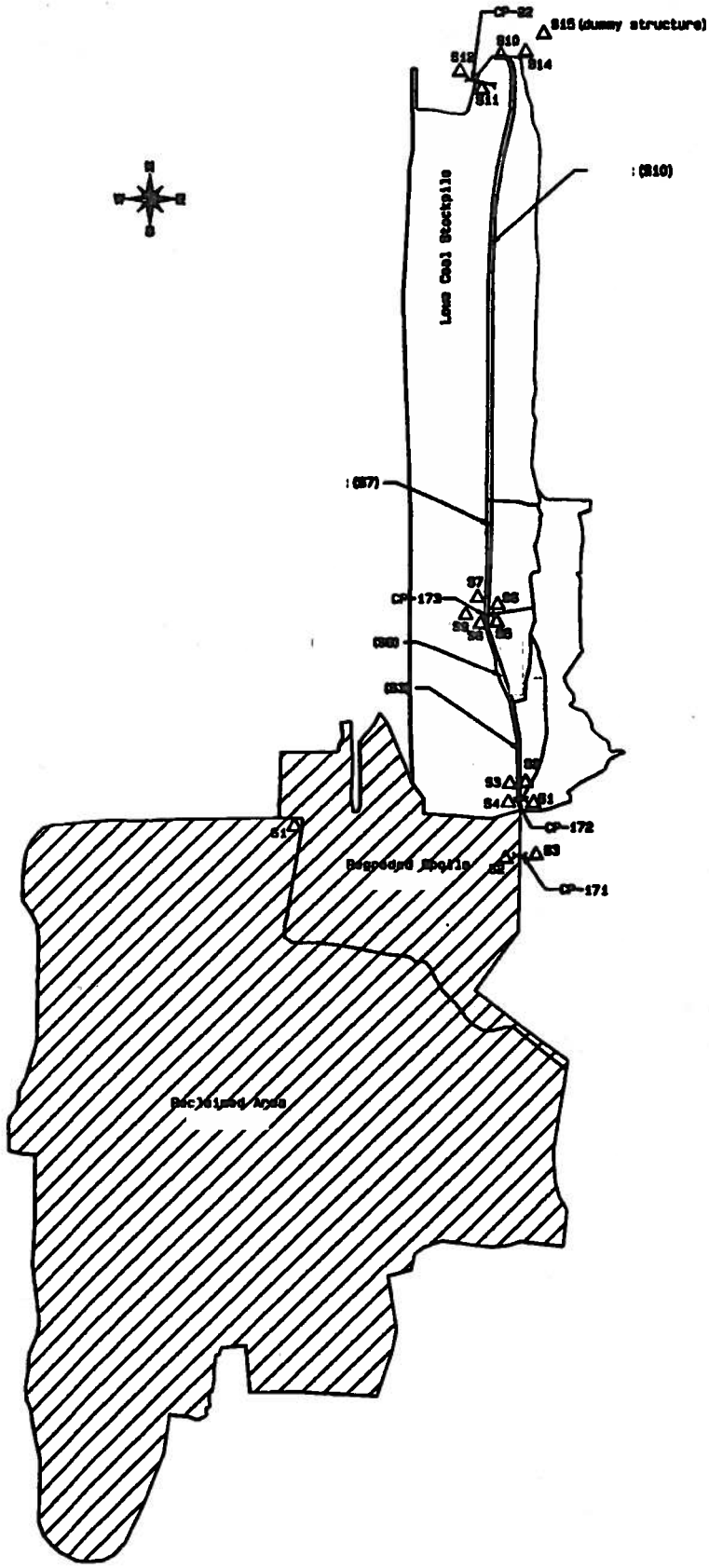
Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#14	1	15.020	0.270	0.000	0.000	89.000	M	9.12	0.485
	Σ	**15.020**						**9.12**	**0.485**
#11	1	54.200	0.598	0.000	0.000	89.000	M	21.62	1.744
	Σ	**54.200**						**21.62**	**1.744**
#10	1	1.800	0.257	0.000	0.000	89.000	M	1.11	0.058
	Σ	**1.800**						**1.11**	**0.058**
#8	1	0.320	0.018	0.000	0.000	89.000	M	0.39	0.012
	Σ	**0.320**						**0.39**	**0.012**
#7	1	0.430	0.078	0.000	0.000	89.000	M	0.52	0.017
	Σ	**0.430**						**0.52**	**0.017**
#6	1	4.020	0.078	0.000	0.000	89.000	M	4.85	0.162
	Σ	**4.020**						**4.85**	**0.162**
#5	1	2.030	0.022	0.000	0.000	89.000	M	2.45	0.082
	Σ	**2.030**						**2.45**	**0.082**
#9	Σ	**6.800**						**8.21**	**0.272**
#3	1	0.270	0.026	0.000	0.000	89.000	M	0.33	0.010
	Σ	**0.270**						**0.33**	**0.010**
#2	1	3.000	0.058	0.000	0.000	89.000	M	3.62	0.121
	Σ	**3.000**						**3.62**	**0.121**
#1	1	14.570	0.234	0.000	0.000	89.000	M	9.35	0.473
	Σ	**14.570**						**9.35**	**0.473**
#4	Σ	**17.840**						**10.95**	**0.604**
#12	Σ	**80.640**						**32.15**	**2.679**
#15	Σ	**95.660**						**37.76**	**3.164**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	4.00	20.00	500.00	2.000	0.069

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		5. Nearly bare and untilled, and alluvial valley fans	5.19	70.00	1,350.00	2.270	0.165
#1	**1**	**Time of Concentration:**					**0.234**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	16.41	85.00	518.00	4.050	0.035
		8. Large gullies, diversions, and low flowing streams	4.64	25.00	539.00	6.460	0.023
#2	**1**	**Time of Concentration:**					**0.058**
#3	1	8. Large gullies, diversions, and low flowing streams	4.49	27.00	602.00	6.350	0.026
#3	**1**	**Time of Concentration:**					**0.026**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	50.00	60.00	120.00	7.070	0.004
		8. Large gullies, diversions, and low flowing streams	4.38	18.00	411.00	6.270	0.018
#5	**1**	**Time of Concentration:**					**0.022**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	50.19	130.00	259.00	7.080	0.010
		8. Large gullies, diversions, and low flowing streams	0.77	5.00	647.00	2.630	0.068
#6	**1**	**Time of Concentration:**					**0.078**
#7	1	8. Large gullies, diversions, and low flowing streams	0.70	5.00	712.00	2.510	0.078
#7	**1**	**Time of Concentration:**					**0.078**
#8	1	8. Large gullies, diversions, and low flowing streams	4.34	18.00	415.00	6.240	0.018
#8	**1**	**Time of Concentration:**					**0.018**
#10	1	8. Large gullies, diversions, and low flowing streams	0.98	27.00	2,750.00	2.970	0.257
#10	**1**	**Time of Concentration:**					**0.257**
#11	1	5. Nearly bare and untilled, and alluvial valley fans	1.56	7.00	450.00	1.240	0.100
		8. Large gullies, diversions, and low flowing streams	0.60	25.00	4,162.00	2.320	0.498
#11	**1**	**Time of Concentration:**					**0.598**
#14	1	5. Nearly bare and untilled, and alluvial valley fans	48.33	130.00	269.00	6.950	0.010
		8. Large gullies, diversions, and low flowing streams	0.92	25.00	2,706.00	2.880	0.260
#14	**1**	**Time of Concentration:**					**0.270**



Note: The cross hatched area is the model for culvert CP-171.
This map is to show how the watershed is divided. For acreage please see Appendix 11-V and actual watershed boundary is on Exhibit 11-12E

CULVERT CP-175

South Dixon Powerline Road, see Exhibit 11-12E for culvert location and watershed.

RYazzie

BHP NAVAJO COAL COMPANY
P.O. BOX 1717
FRUITLAND, NM, 87416

Phone: 505-598-3203

General Information

Storm Information:

Storm Type:	NRCS TYPE II-60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-175

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	14.400	14.400	5.88	0.21

Structure Detail:

Structure #1 (Culvert)

CP-175

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
40.00	1.50	0.0160	2.20	0.00	0.90

Culvert Results:

Design Discharge = 5.88 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	14.400	0.084	0.000	0.000	89.000	M	5.88	0.205
	Σ	**14.400**						**5.88**	**0.205**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.62	3.40	94.00	1.900	0.013
		8. Large gullies, diversions, and low flowing streams	4.47	72.80	1,630.00	6.340	0.071
#1	**1**	**Time of Concentration:**					**0.084**

CULVERT CP-176

South Dixon Powerline Road, see Exhibit 11-12E for culvert location and watershed.

RYazzie

BHP NAVAJO COAL COMPANY
P.O. BOX 1717
FRUITLAND, NM, 87416

Phone: 505-598-3203

General Information

Storm Information:

Storm Type:	NRCS TYPE II-60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-176

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	2.600	2.600	1.06	0.04

Structure Detail:

Structure #1 (Culvert)

CP-176

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
35.00	4.50	0.0160	1.90	0.00	0.90

Culvert Results:

Design Discharge = 1.06 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	2.600	0.042	0.000	0.000	89.000	M	1.06	0.037
	Σ	**2.600**						**1.06**	**0.037**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	5.49	7.31	133.20	2.340	0.015
		8. Large gullies, diversions, and low flowing streams	6.49	48.61	749.03	7.640	0.027
#1	**1**	**Time of Concentration:**					**0.042**

CULVERT CP-177

South Dixon Powerline Road, see Exhibit 11-12E for culvert location and watershed.

RYazzie

BHP NAVAJO COAL COMPANY
P.O. BOX 1717
FRUITLAND, NM, 87416

Phone: 505-598-3203

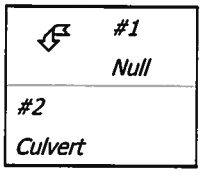
General Information

Storm Information:

Storm Type:	NRCS TYPE II-60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.054	0.341	
Culvert	#2	==>	End	0.000	0.000	CP-177



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	1.47	10.54	717.30	3.63	0.054
#1	**Muskingum K:**					**0.054**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	26.950	26.950	11.01	0.38
#2	31.650	58.600	16.58	0.83

Structure Detail:

Structure #1 (Null)

Structure #2 (Culvert)

CP-177

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
40.00	3.00	0.0150	3.50	0.00	0.90

Culvert Results:

Design Discharge = 16.58 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	9.250	0.065	0.020	0.336	89.000	M	3.78	0.132
	2	17.700	0.075	0.000	0.000	89.000	M	7.23	0.252
	Σ	**26.950**						**11.01**	**0.384**
#2	1	23.470	0.208	0.007	0.383	89.000	M	4.74	0.334
	2	8.180	0.101	0.000	0.000	89.000	M	3.34	0.116
	Σ	**58.600**						**16.58**	**0.834**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	9.06	7.00	77.25	3.010	0.007
		8. Large gullies, diversions, and low flowing streams	2.24	21.13	943.89	4.480	0.058
#1	**1**	**Time of Concentration:**					**0.065**
#1	2	5. Nearly bare and untilled, and alluvial valley fans	6.60	10.00	151.46	2.560	0.016
		8. Large gullies, diversions, and low flowing streams	2.46	24.53	999.10	4.700	0.059
#1	**2**	**Time of Concentration:**					**0.075**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	2.40	10.00	416.52	1.540	0.075
		8. Large gullies, diversions, and low flowing streams	1.34	22.20	1,660.30	3.460	0.133
#2	**1**	**Time of Concentration:**					**0.208**
#2	2	5. Nearly bare and untilled, and alluvial valley fans	3.80	10.00	262.94	1.950	0.037
		8. Large gullies, diversions, and low flowing streams	2.76	20.00	723.43	4.980	0.040
		8. Large gullies, diversions, and low flowing streams	1.11	2.20	197.86	3.160	0.017
		8. Large gullies, diversions, and low flowing streams	3.47	5.07	146.28	5.580	0.007
#2	**2**	**Time of Concentration:**					**0.101**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	1.35	3.40	252.71	3.470	0.020
#1	**1**	**Muskingum K:**					**0.020**
#2	1	8. Large gullies, diversions, and low flowing streams	3.47	5.07	146.28	5.580	0.007
#2	**1**	**Muskingum K:**					**0.007**

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CULVERT CP-178

South Dixon Powerline Road, see Exhibit 11-12E for culvert location and watershed.

RYazzie

BHP NAVAJO COAL COMPANY
P.O. BOX 1717
FRUITLAND, NM, 87416

Phone: 505-598-3203

General Information

Storm Information:

Storm Type:	NRCS TYPE II-60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-178

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	0.600	0.600	0.25	0.01

Structure Detail:

Structure #1 (Culvert)

CP-178

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
36.00	3.00	0.0160	1.60	0.00	0.90

Culvert Results:

Design Discharge = 0.25 cfs

Minimum pipe diameter: 1 - 4 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	0.600	0.018	0.000	0.000	89.000	M	0.25	0.009
	Σ	**0.600**						**0.25**	**0.009**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	9.17	10.00	109.00	3.020	0.010
		8. Large gullies, diversions, and low flowing streams	4.18	8.31	198.60	6.130	0.008
#1	**1**	**Time of Concentration:**					**0.018**

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CULVERT CP-179

South Dixon Powerline Road, see Exhibit 11-12E for culvert location and watershed.

RYazzie

BHP NAVAJO COAL COMPANY
P.O. BOX 1717
FRUITLAND, NM, 87416

Phone: 505-598-3203

General Information

Storm Information:

Storm Type:	NRCS TYPE II-60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-179

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	0.700	0.700	0.29	0.01

Structure Detail:

Structure #1 (Culvert)

CP-179

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
40.00	4.00	0.0160	1.90	0.00	0.90

Culvert Results:

Design Discharge = 0.29 cfs

Minimum pipe diameter: 1 - 4 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	0.700	0.020	0.000	0.000	89.000	M	0.29	0.010
	Σ	**0.700**						**0.29**	**0.010**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	8.26	10.00	121.00	2.870	0.011
		8. Large gullies, diversions, and low flowing streams	4.90	10.96	223.72	6.640	0.009
#1	**1**	**Time of Concentration:**					**0.020**

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CULVERT CP-181 A&B

South Dixon Powerline Road, see Exhibit 11-12E for culvert location and watershed.

RYazzie

BHP NAVAJO COAL COMPANY
P.O. BOX 1717
FRUITLAND, NM, 87416

Phone: 505-598-3203

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General Information

Storm Information:

Storm Type:	NRCS TYPE II-60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Culvert CP-181A&B

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	23.000	23.000	9.39	0.33

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	23.000	0.113	0.000	0.000	89.000	M	9.39	0.327
	Σ	**23.000**						**9.39**	**0.327**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	5.13	10.00	195.00	2.260	0.023
		8. Large gullies, diversions, and low flowing streams	2.73	44.00	1,610.00	4.950	0.090
#1	**1**	**Time of Concentration:**					**0.113**

Culvert CP-181A&B

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
33.00	2.40	0.0160	2.70	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 4.70 cfs

Maximum Headwater = 2.70 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (10 in)	**Discharge (cfs) (12 in)**	Discharge (cfs) (15 in)
0.27	0.25	**0.29**	0.38
0.54	0.70	**0.83**	1.05
0.81	1.27	**1.53**	1.91
1.08	1.87	**2.35**	2.94
1.35	2.35	**3.09**	4.11
1.62	2.74	**3.70**	5.18
1.89	3.04	**4.22**	6.07
2.16	3.32	**4.68**	6.85
2.43	3.51	**5.10**	7.55
2.70	3.69	**5.46**	8.19
2.97	3.87	**5.77**	8.78
3.24	4.03	**6.03**	9.34
3.51	4.20	**6.29**	9.86
3.78	4.36	**6.53**	10.36
4.05	4.50	**6.76**	10.84

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CULVERT CP-182

Shop By-Pass Road. See Exhibit 11-12D for Culvert location and watershed.

RYazzie

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

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Civil Software Design

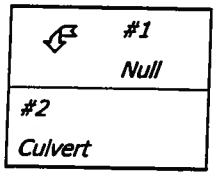
General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.040	0.361	
Culvert	#2	==>	End	0.000	0.000	CP-182



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	2.19	14.00	639.31	4.43	0.040
#1	**Muskingum K:**					**0.040**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	19.100	19.100	11.21	0.77
#2	15.000	34.100	24.91	1.38

Structure Detail:

Structure #2 (Culvert)

CP-182

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
140.00	2.00	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 24.91 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	19.100	0.192	0.000	0.000	89.000	M	11.21	0.771
	Σ	**19.100**						**11.21**	**0.771**
#2	1	15.000	0.068	0.000	0.000	89.000	M	15.26	0.605
	Σ	**34.100**						**24.91**	**1.376**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.00	2.00	200.84	0.990	0.056
		5. Nearly bare and untilled, and alluvial valley fans	13.53	20.00	147.83	3.670	0.011
		8. Large gullies, diversions, and low flowing streams	1.07	15.00	1,397.94	3.100	0.125
#1	**1**	**Time of Concentration:**					**0.192**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	7.63	5.00	65.53	2.760	0.006
		8. Large gullies, diversions, and low flowing streams	2.33	24.00	1,032.25	4.570	0.062
#2	**1**	**Time of Concentration:**					**0.068**

CULVERT CP-183

Shop By-Pass Road. See Exhibit 11-12D for Culvert location and watershed.

RYazzie

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-183

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	6.500	6.500	6.61	0.26

Structure Detail:

Structure #1 (Culvert)

CP-183

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
130.00	2.00	0.0150	3.85	0.00	0.90

Culvert Results:

Design Discharge = 6.61 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	6.500	0.088	0.000	0.000	89.000	M	6.61	0.262
	Σ	**6.500**						**6.61**	**0.262**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.67	5.00	300.00	1.290	0.064
		8. Large gullies, diversions, and low flowing streams	3.22	15.00	465.42	5.380	0.024
#1	**1**	**Time of Concentration:**					**0.088**

Yazzie Spoil Side Road

Cp - 186

RYazzie

BHP NAVAJO COAL COMPANY
P.O. BOX 1717
FRUITLAND, NM, 87416

Phone: 505-598-3203

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General Information

Storm Information:

Storm Type:	NRCS TYPE II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-186

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	108.450	108.450	13.02	1.06

Structure Detail:

Structure #1 (Culvert)

CP-186

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
206.00	2.95	0.0150	5.30	0.00	0.90

Culvert Results:

Design Discharge = 13.02 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	108.450	0.208	0.000	0.000	76.000	M	13.02	1.055
	Σ	**108.450**						**13.02**	**1.055**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.24	5.00	154.31	1.800	0.023
		8. Large gullies, diversions, and low flowing streams	2.17	64.00	2,948.90	4.410	0.185
#1	**1**	**Time of Concentration:**					**0.208**

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YAZZIE SPOIL SIDE ROAD

CP - 187

RYazzie

BHP NAVAJO COAL COMPANY
P.O. BOX 1717
FRUITLAND, NM, 87416

Phone: 505-598-3203

General Information

Storm Information:

Storm Type:	NRCS TYPE II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-187

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	54.490	54.490	4.95	0.53

Structure Detail:

Structure #1 (Culvert)

CP-187

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
206.00	1.50	0.0150	3.95	0.00	0.90

Culvert Results:

Design Discharge = 4.95 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	54.490	0.345	0.000	0.000	76.000	M	4.95	0.530
	Σ	**54.490**						**4.95**	**0.530**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.30	11.21	861.71	1.140	0.209
		8. Large gullies, diversions, and low flowing streams	1.13	17.79	1,570.99	3.190	0.136
#1	**1**	**Time of Concentration:**					**0.345**

Culvert CP-190

Yazzie Powerline Road

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM 87416

Phone: 505-598-5861

General Information

Storm Information:

Storm Type:	NRCS Type II - 60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	Culvert CP-190

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.100	1.100	0.56	0.02

Structure Detail:

Structure #1 (Culvert)

Culvert CP-190

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
40.00	1.30	0.0160	4.80	0.00	0.90

Culvert Results:

Design Discharge = 0.56 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.100	0.005	0.000	0.000	91.000	M	0.56	0.021
	Σ	**1.100**						**0.56**	**0.021**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	14.92	3.94	26.40	3.860	0.001
		8. Large gullies, diversions, and low flowing streams	27.34	75.61	276.59	15.680	0.004
#1	**1**	**Time of Concentration:**					**0.005**

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GORMAN ROAD
CULVERT CP-185

THE CULVERT LOCATION AND WATERSHED AREA ARE SHOWN ON EXHIBIT 11-12C.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-185

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	24.380	24.380	9.94	0.32

Structure Detail:

Structure #1 (Culvert)

CP-185

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
130.00	9.00	0.0150	3.20	0.00	0.90

Culvert Results:

Design Discharge = 9.94 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	24.380	0.094	0.000	0.000	78.200	M	9.94	0.317
	Σ	**24.380**						**9.94**	**0.317**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.34	1.50	111.53	1.150	0.026
		8. Large gullies, diversions, and low flowing streams	4.97	82.50	1,658.26	6.690	0.068
#1	**1**	**Time of Concentration:**					**0.094**

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GORMAN ROAD
DOWN DRAIN DD-29

THE CULVERT LOCATION AND WATERSHED AREA ARE SHOWN ON EXHIBIT 11-12C.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-185

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.810	1.810	1.84	0.07

Structure Detail:

Structure #1 (Culvert)

CP-185

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
73.00	49.00	0.0160	5.00	0.00	0.90

Culvert Results:

Design Discharge = 1.84 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.260	0.066	0.000	0.000	89.000	M	1.28	0.051
	2	0.550	0.046	0.000	0.000	89.000	M	0.56	0.022
	Σ	**1.810**						**1.84**	**0.073**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	2.14	22.50	1,052.93	4.380	0.066
#1	**1**	**Time of Concentration:**					**0.066**
#1	2	8. Large gullies, diversions, and low flowing streams	0.82	3.76	458.00	2.710	0.046
#1	**2**	**Time of Concentration:**					**0.046**

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CULVERT CP-202

SOUTH OF EMPLOYEE COAL DUMP ALONG POWERLINE ROAD. THE WATERSHED AREA IS SHOWN ON EXHIBIT 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-202

#1
Culvert

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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	2.900	2.900	1.18	0.04

Structure Detail:

Structure #1 (Culvert)

CP-202

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
30.00	3.80	0.0150	3.50	0.00	0.90

Culvert Results:

Design Discharge = 1.18 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	2.900	0.031	0.000	0.000	89.000	M	1.18	0.041
	Σ	**2.900**						**1.18**	**0.041**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	4.62	5.50	119.00	2.140	0.015
		8. Large gullies, diversions, and low flowing streams	6.38	28.23	442.53	7.570	0.016
#1	**1**	**Time of Concentration:**					**0.031**

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CULVERT CP-203

SOUTH OF EMPLOYEE COAL DUMP ALONG POWERLINE ROAD. THE WATERSHED AREA IS SHOWN ON EXHIBIT 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-203

#1
Culvert

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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	4.200	4.200	1.72	0.06

Structure Detail:

Structure #1 (Culvert)

CP-203

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
30.00	4.90	0.0150	2.50	0.00	0.90

Culvert Results:

Design Discharge = 1.72 cfs

Minimum pipe diameter: 1 - 8 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	4.200	0.030	0.000	0.000	89.000	M	1.72	0.060
	Σ	**4.200**						**1.72**	**0.060**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.52	1.00	65.83	1.230	0.014
		8. Large gullies, diversions, and low flowing streams	6.25	27.50	439.69	7.500	0.016
#1	**1**	**Time of Concentration:**					**0.030**

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CULVERT CP-204

SOUTH OF EMPLOYEE COAL DUMP ALONG POWERLINE ROAD. THE WATERSHED AREA IS SHOWN ON EXHIBIT 11-12D.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-204

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	3.500	3.500	1.43	0.05

Structure Detail:

Structure #1 (Culvert)

CP-204

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
61.00	2.60	0.0150	6.00	0.00	0.90

Culvert Results:

Design Discharge = 1.43 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	3.500	0.052	0.000	0.000	89.000	M	1.43	0.050
	Σ	**3.500**						**1.43**	**0.050**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.90	1.50	78.98	1.370	0.016
		8. Large gullies, diversions, and low flowing streams	4.87	42.11	864.57	6.620	0.036
#1	**1**	**Time of Concentration:**					**0.052**

Ancillary Culvert (CP-184)

The watershed is presented on Exhibit 11-12E. SedCad is being updated to reflect watershed changes due to mining. Road is desined for a 2 year-6 hour storm event (Ancillary Road design).

Shawn Smith

Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-184

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	11.430	11.430	4.04	0.16

Structure Detail:

Structure #1 (Culvert)

CP-184

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
191.00	0.20	0.0140	2.00	0.00	0.90

Culvert Results:

Design Discharge = 4.04 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	11.430	0.152	0.000	0.000	89.000	F	4.04	0.157
	Σ	**11.430**						**4.04**	**0.157**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.84	0.52	18.31	1.680	0.003
		8. Large gullies, diversions, and low flowing streams	1.48	29.13	1,966.38	3.650	0.149
#1	**1**	**Time of Concentration:**					**0.152**

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DOWN DRAIN CULVERT(DD-30)

The watershed is presented on Exhibit 11-12D.

RYazzie

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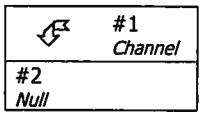
General Information

Storm Information:

Storm Type:	NRCS TYPE 11-60
Design Storm:	2 yr - 6 hr
Rainfall Depth:	0.800 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#2	0.000	0.000	
Null	#2	==>	End	0.000	0.000	DD-30



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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	6.300	6.300	1.09	0.09
#2	0.000	0.000	1.09	0.09

Structure Detail:

Structure #1 (Riprap Channel)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	6.0:1	6.0:1	15.0			

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Depth:	0.07 ft	0.00 ft
Top Width:	4.86 ft	0.00 ft
Velocity*:		
X-Section Area:	0.32 sq ft	
Hydraulic Radius:	0.065	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #2 (Null)

DD-30

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	4.990	0.223	0.000	0.000	89.000	M	0.98	0.07
	2	1.310	0.078	0.000	0.000	89.000	M	0.54	0.02
	S	**6.300**						**1.09**	**0.09**
#2	**S**	**0.000**						**1.09**	**0.09**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	11.76	4.10	34.87	3.420	0.002
		8. Large gullies, diversions, and low flowing streams	0.63	11.85	1,893.54	2.370	0.221
#1	**1**	**Time of Concentration:**					**0.223**
#1	2	5. Nearly bare and untilled, and alluvial valley fans	4.18	1.09	26.06	2.040	0.003
		8. Large gullies, diversions, and low flowing streams	2.10	24.85	1,182.48	4.340	0.075
#1	**2**	**Time of Concentration:**					**0.078**

Burnham Road Re-alignment

Construction Yard Access Road Culvert CP-205

The Watershed area for the culverts are shown on Exhibit 11-12F.

RYazzie

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-205

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	10.760	10.760	14.64	0.52

Structure Detail:

Structure #1 (Culvert)

CP-205

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	1.50	0.0150	3.40	0.00	0.90

Culvert Results:

Minimum pipe diameter required: 21 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	10.760	0.081	0.000	0.000	91.000	M	14.64	0.52
	S	**10.760**						**14.64**	**0.52**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.39	2.00	59.00	1.840	0.008
		8. Large gullies, diversions, and low flowing streams	2.20	26.00	1,181.63	4.450	0.073
#1	**1**	**Time of Concentration:**					**0.081**

Burnham Road Re-alignment
Construction Yard Access Road
Culvert CP-206

The Watershed area for the culverts are shown on Exhibit 11-12F.

RYazzie

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-206

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	12.670	12.670	17.24	0.61

Structure Detail:

Structure #1 (Culvert)

CP-206

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	2.00	0.0150	3.50	0.00	0.90

Culvert Results:

Minimum pipe diameter required: 21 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	12.670	0.109	0.000	0.000	91.000	M	17.24	0.61
	S	**12.670**						**17.24**	**0.61**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	28.00	7.00	25.00	5.290	0.001
		8. Large gullies, diversions, and low flowing streams	2.03	34.00	1,675.00	4.270	0.108
#1	**1**	**Time of Concentration:**					**0.109**

Burnham Road Re-alignment
Construction Yard Access Road
Culvert CP-207

The Watershed area for the culverts are shown on Exhibit 11-12F.

RYazzie

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-207

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	5.120	5.120	6.97	0.25

Structure Detail:

Structure #1 (Culvert)

CP-207

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
44.00	1.50	0.0150	3.20	0.00	0.90

Culvert Results:

Minimum pipe diameter required: 15 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	5.120	0.047	0.000	0.000	91.000	M	6.97	0.25
	S	**5.120**						**6.97**	**0.25**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	7.40	7.13	96.38	2.710	0.009
		8. Large gullies, diversions, and low flowing streams	1.93	11.28	583.45	4.170	0.038
#1	**1**	**Time of Concentration:**					**0.047**

Lowe Silos Access Road
Culvert CP-45

The watershed area for the culvert are shown on Exhibit 11-12E.

RYazzie

BHP Navajo Coal Company

Fruitland, NM 87416

General Information

Storm Information:

Storm Type:	NM TYPE II 70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.230 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CULVERT CP-45

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	219.670	219.670	18.42	2.40

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-45

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
76.00	1.04	0.0150	4.00	0.00	0.90

Culvert Results:

Design Discharge = 18.42 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	219.670	1.049	0.000	0.000	80.000	M	18.42	2.404
	Σ	**219.670**						**18.42**	**2.404**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.96	6.00	625.00	0.970	0.178
		8. Large gullies, diversions, and low flowing streams	0.81	68.30	8,442.52	2.690	0.871
#1	**1**	**Time of Concentration:**					**1.049**

(Culvert CP-300)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-300

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	8.870	8.870	4.59	0.22

Structure Detail:

Structure #1 (Culvert)

CP-300

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
110.00	8.20	0.0150	3.20	0.00	0.90

Culvert Results:

Design Discharge = 4.59 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	8.870	0.207	0.000	0.000	86.000	M	4.59	0.215
	Σ	**8.870**						**4.59**	**0.215**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.53	2.00	131.00	1.230	0.029
		8. Large gullies, diversions, and low flowing streams	0.70	11.20	1,602.05	2.500	0.178
#1	**1**	**Time of Concentration:**					**0.207**

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(Culvert CP-301)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-301

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.250	1.250	1.24	0.04

Structure Detail:

Structure #1 (Culvert)

CP-301

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
122.00	6.30	0.0150	8.90	0.00	0.90

Culvert Results:

Design Discharge = 1.24 cfs

Minimum pipe diameter: 1 - 6 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.250	0.021	0.000	0.000	86.000	M	1.24	0.038
	Σ	**1.250**						**1.24**	**0.038**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.56	1.00	64.00	1.250	0.014
		8. Large gullies, diversions, and low flowing streams	10.66	28.00	262.56	9.790	0.007
#1	**1**	**Time of Concentration:**					**0.021**

(Culvert CP-302)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-302

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	8.380	8.380	8.31	0.25

Structure Detail:

Structure #1 (Culvert)

CP-302

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
80.00	5.60	0.0150	3.50	0.00	0.90

Culvert Results:

Design Discharge = 8.31 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	8.380	0.074	0.000	0.000	86.000	M	8.31	0.254
	Σ	**8.380**						**8.31**	**0.254**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.24	2.00	161.00	1.110	0.040
		8. Large gullies, diversions, and low flowing streams	5.81	51.48	886.54	7.220	0.034
#1	**1**	**Time of Concentration:**					**0.074**

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(Culvert CP-303)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-303

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	2.360	2.360	2.85	0.10

Structure Detail:

Structure #1 (Culvert)

CP-303

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
86.00	4.10	0.0150	3.30	0.00	0.90

Culvert Results:

Design Discharge = 2.85 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	2.360	0.032	0.000	0.000	89.000	M	2.85	0.095
	Σ	**2.360**						**2.85**	**0.095**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.00	1.00	50.00	1.410	0.009
		8. Large gullies, diversions, and low flowing streams	7.46	51.80	694.80	8.190	0.023
#1	**1**	**Time of Concentration:**					**0.032**

(Culvert CP-304)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-304

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	2.250	2.250	2.23	0.07

Structure Detail:

Structure #1 (Culvert)

CP-304

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
80.00	5.00	0.0150	2.80	0.00	0.90

Culvert Results:

Design Discharge = 2.23 cfs

Minimum pipe diameter: 1 - 8 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	2.250	0.021	0.000	0.000	86.000	M	2.23	0.068
	Σ	**2.250**						**2.23**	**0.068**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.78	1.00	36.00	1.660	0.006
		8. Large gullies, diversions, and low flowing streams	8.03	38.20	475.46	8.500	0.015
#1	**1**	**Time of Concentration:**					**0.021**

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(Culvert CP-305A and CP-305B)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-305A_CP-305B

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	14.620	14.620	8.23	0.36

Structure Detail:

Structure #1 (Culvert)

CP-305A_CP-305B

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
120.00	6.30	0.0150	2.60	0.00	0.90

Culvert Results:

Design Discharge = 8.23 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	14.620	0.125	0.000	0.000	86.000	M	8.23	0.361
	Σ	**14.620**						**8.23**	**0.361**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.93	2.08	223.00	0.960	0.064
		8. Large gullies, diversions, and low flowing streams	4.14	55.50	1,340.00	6.100	0.061
#1	**1**	**Time of Concentration:**					**0.125**

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(Culvert CP-306)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-306

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	2.690	2.690	2.67	0.08

Structure Detail:

Structure #1 (Culvert)

CP-306

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
80.00	3.30	0.0150	5.50	0.00	0.90

Culvert Results:

Design Discharge = 2.67 cfs

Minimum pipe diameter: 1 - 8 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	2.690	0.021	0.000	0.000	86.000	M	2.67	0.082
	Σ	**2.690**						**2.67**	**0.082**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	4. Cultivated, straight row	14.71	5.00	34.00	3.420	0.002
		8. Large gullies, diversions, and low flowing streams	7.42	41.47	559.03	8.170	0.019
#1	**1**	**Time of Concentration:**					**0.021**

(Culvert CP-307)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-307

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	20.610	20.610	11.50	0.51

Structure Detail:

Structure #1 (Culvert)

CP-307

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
80.00	5.40	0.0150	6.80	0.00	0.90

Culvert Results:

Design Discharge = 11.50 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	20.610	0.171	0.000	0.000	86.000	M	11.50	0.509
	Σ	**20.610**						**11.50**	**0.509**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.12	2.00	178.00	1.050	0.047
		8. Large gullies, diversions, and low flowing streams	2.85	64.50	2,259.73	5.060	0.124
#1	**1**	**Time of Concentration:**					**0.171**

(Culvert CP-308A and CP-308B)

Burnham Road Temporary Re-route

Added 2-18" culverts.

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-308A_CP-308B

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	22.230	22.230	12.01	0.55

Structure Detail:

Structure #1 (Culvert)

CP-308A_CP-308B

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
80.00	2.70	0.0150	2.30	0.00	0.90

Culvert Results:

Design Discharge = 12.01 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	22.230	0.186	0.000	0.000	86.000	M	12.01	0.545
	Σ	**22.230**						**12.01**	**0.545**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.08	2.00	186.00	1.030	0.050
		8. Large gullies, diversions, and low flowing streams	2.66	63.88	2,398.47	4.890	0.136
#1	**1**	**Time of Concentration:**					**0.186**

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(Culvert CP-309)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-309

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	9.160	9.160	9.08	0.28

Structure Detail:

Structure #1 (Culvert)

CP-309

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
80.00	2.30	0.0150	5.00	0.00	0.90

Culvert Results:

Design Discharge = 9.08 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	9.160	0.052	0.000	0.000	86.000	M	9.08	0.278
	Σ	**9.160**						**9.08**	**0.278**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.94	5.00	127.00	1.980	0.017
		8. Large gullies, diversions, and low flowing streams	6.07	57.20	943.10	7.380	0.035
#1	**1**	**Time of Concentration:**					**0.052**

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UPDATE 1307

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(Culvert CP-318)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-318

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	5.150	5.150	6.22	0.21

Structure Detail:

Structure #1 (Culvert)

CP-318

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
92.00	1.60	0.0150	5.60	0.00	0.90

Culvert Results:

Design Discharge = 6.22 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	5.150	0.078	0.000	0.000	89.000	M	6.22	0.207
	Σ	**5.150**						**6.22**	**0.207**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.56	2.30	147.00	1.250	0.032
		8. Large gullies, diversions, and low flowing streams	3.32	30.10	907.61	5.460	0.046
#1	**1**	**Time of Concentration:**					**0.078**

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(Culvert CP-319)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-319

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	6.230	6.230	7.52	0.25

Structure Detail:

Structure #1 (Culvert)

CP-319

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	2.40	0.0150	4.00	0.00	0.90

Culvert Results:

Design Discharge = 7.52 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	6.230	0.059	0.000	0.000	89.000	M	7.52	0.251
	Σ	**6.230**						**7.52**	**0.251**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.34	3.00	128.00	1.530	0.023
		8. Large gullies, diversions, and low flowing streams	3.76	28.86	768.00	5.810	0.036
#1	**1**	**Time of Concentration:**					**0.059**

CP-320A AND CP-320B

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-320A_CP-320B

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	9.950	9.950	12.01	0.40

Structure Detail:

Structure #1 (Culvert)

CP-320A_CP-320B

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
80.00	1.30	0.0150	4.90	0.00	0.90

Culvert Results:

Design Discharge = 12.01 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	9.950	0.065	0.000	0.000	89.000	M	12.01	0.401
	Σ	**9.950**						**12.01**	**0.401**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	9.28	9.00	97.00	3.040	0.008
		8. Large gullies, diversions, and low flowing streams	3.24	36.50	1,125.01	5.400	0.057
#1	**1**	**Time of Concentration:**					**0.065**

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(Culvert CP-321)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-321

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	28.440	28.440	34.34	1.15

Structure Detail:

Structure #1 (Culvert)

CP-321

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	1.40	0.0150	7.10	0.00	0.90

Culvert Results:

Design Discharge = 34.34 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	28.440	0.118	0.000	0.000	89.000	M	34.34	1.146
	Σ	**28.440**						**34.34**	**1.146**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and aliuvial valley fans	3.13	4.00	128.00	1.760	0.020
		8. Large gullies, diversions, and low flowing streams	2.92	53.00	1,815.60	5.120	0.098
#1	**1**	**Time of Concentration:**					**0.118**

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(Culvert CP-322)

Burnham Road Temporary Re-route

R. Yazzie

BHP Navajo Coal Company
P.O, Box 1717
Fruitland, NM, 87416

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-322

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	28.680	28.680	20.79	0.94

Structure Detail:

Structure #1 (Culvert)

CP-322

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	1.30	0.0150	4.80	0.00	0.90

Culvert Results:

Design Discharge = 20.79 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	28.680	0.131	0.000	0.000	89.000	M	20.79	0.941
	Σ	**28.680**						**20.79**	**0.941**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	16.67	5.00	30.00	4.080	0.002
		8. Large gullies, diversions, and low flowing streams	2.36	50.53	2,144.00	4.600	0.129
#1	**1**	**Time of Concentration:**					**0.131**

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Culvert (CP-323)

Culvert Location along Dixon Haulroad.

R. Yazzie

BHP Billiton
Navajo Mine
PO Box 1717
Fruitland, NM 87416

Phone: 505 598 2007

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-323

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	106.800	106.800	7.03	0.44

Structure Detail:

Structure #1 (Culvert)

CP-323

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
124.00	1.00	0.0150	3.00	0.00	0.90

Culvert Results:

Design Discharge = 7.03 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	106.800	0.245	0.000	0.000	72.000	M	7.03	0.442
	Σ	**106.800**						**7.03**	**0.442**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	4.34	22.00	507.47	2.080	0.067
		8. Large gullies, diversions, and low flowing streams	2.38	70.50	2,963.43	4.620	0.178
#1	**1**	**Time of Concentration:**					**0.245**

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CULVERT (Barber Haul Rd and Barber By-pass Road Intersection)

CULVERT (CP-324)

R. Yazzie

General Information

Storm Information:

Storm Type:	NM TYPE II 70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-324

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	42.000	42.000	10.41	0.48

Structure Detail:

Structure #1 (Culvert)

CP-324

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
110.00	0.60	0.0150	3.25	0.00	0.90

Culvert Results:

Design Discharge = 10.41 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	42.000	0.202	0.000	0.000	79.000	M	10.41	0.481
	Σ	**42.000**						**10.41**	**0.481**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	11.25	11.40	101.34	3.350	0.008
		8. Large gullies, diversions, and low flowing streams	3.26	123.70	3,789.71	5.420	0.194
#1	**1**	**Time of Concentration:**					**0.202**

Navajo Mine Area 3 Light Vehicle Traffic & Pedestrian Seperation

10-YR 6-HR STORM

Culvert CP-25, CP-26, & CP-27

See Exhibit 11-12D-1 for location and watershed delineation.The HY8 software was utilized to size the culverts, HY8 reports are attach.

GEOMAT Inc.
915 Malta Avenue
Farmington, NM 87401

Phone: (505) 327-7928

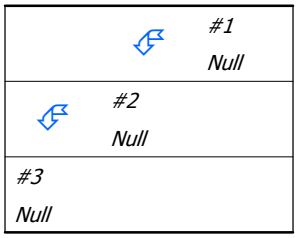
General Information

Storm Information:

Storm Type:	NM TYPE II 70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.230 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	CULVERT CP-27
Null	#2	==>	#3	0.000	0.000	CULVERT CP-26
Null	#3	==>	End	0.000	0.000	CULVERT CP-25



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	0.910	0.910	1.61	0.08
#2	0.920	1.830	3.23	0.15
#3	1.400	3.230	5.70	0.27

Structure Detail:

Structure #1 (Null)

CULVERT CP-27

Structure #2 (Null)

CULVERT CP-26

Structure #3 (Null)

CULVERT CP-25

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	0.910	0.034	0.000	0.000	98.000	F	1.61	0.077
	Σ	**0.910**						**1.61**	**0.077**
#2	1	0.920	0.035	0.000	0.000	98.000	F	1.62	0.078
	Σ	**1.830**						**3.23**	**0.154**
#3	1	1.400	0.035	0.000	0.000	98.000	F	2.47	0.118
	Σ	**3.230**						**5.70**	**0.272**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	7. Paved area and small upland gullies	2.23	8.35	373.79	3.000	0.034
#1	**1**	**Time of Concentration:**					**0.034**
#2	1	7. Paved area and small upland gullies	2.33	9.27	397.29	3.070	0.035
#2	**1**	**Time of Concentration:**					**0.035**
#3	1	7. Paved area and small upland gullies	2.47	9.97	404.00	3.160	0.035
#3	**1**	**Time of Concentration:**					**0.035**

CULVERT CP-25
HY-8 Culvert Analysis Report

Culvert Data Summary - CULVERT CP-25

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0160

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Site Data - CULVERT CP-25

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5460.10 ft

Outlet Station: 15.00 ft

Outlet Elevation: 5459.98 ft

Number of Barrels: 1

Table 1 - Culvert Summary Table: CULVERT CP-25

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5460.14	0.000	0.040	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.57	0.57	5460.56	0.463	0.0*	1-S2n	0.241	0.246	0.245	0.097	3.668	2.346
1.14	1.14	5460.60	0.497	0.189	1-S2n	0.345	0.360	0.350	0.149	3.034	3.050
1.71	1.71	5460.72	0.625	0.233	1-S2n	0.430	0.446	0.436	0.193	3.436	3.544
2.28	2.28	5460.82	0.715	0.272	1-S2n	0.494	0.516	0.506	0.232	3.616	3.935
2.85	2.85	5460.91	0.807	0.308	1-S2n	0.558	0.587	0.566	0.268	3.886	4.261
3.42	3.42	5460.99	0.893	0.341	1-S2n	0.617	0.642	0.621	0.301	4.125	4.543
3.99	3.99	5461.06	0.965	0.373	1-S2n	0.666	0.694	0.673	0.333	4.282	4.794
4.56	4.56	5461.14	1.039	0.403	1-S2n	0.715	0.746	0.719	0.363	4.474	5.019
5.13	5.13	5461.21	1.112	0.433	1-S2n	0.764	0.798	0.767	0.393	4.620	5.222
5.70	5.70	5461.28	1.182	0.461	1-S2n	0.811	0.840	0.812	0.421	4.763	5.410

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5460.10 ft, Outlet Elevation (invert): 5459.98 ft

Culvert Length: 15.00 ft, Culvert Slope: 0.0080

****

Roadway Data for Crossing: CULVERT CP-25

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 3.64 ft

Crest Elevation: 5462.95 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: CULVERT CP-25)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5460.14	0.00	0.00	0.00	0.00
0.57	5460.24	0.10	2.35	0.05	1.33
1.14	5460.29	0.15	3.05	0.08	1.39
1.71	5460.33	0.19	3.54	0.11	1.42
2.28	5460.37	0.23	3.94	0.13	1.44
2.85	5460.41	0.27	4.26	0.15	1.45
3.42	5460.44	0.30	4.54	0.17	1.46
3.99	5460.47	0.33	4.79	0.18	1.46
4.56	5460.50	0.36	5.02	0.20	1.47
5.13	5460.53	0.39	5.22	0.22	1.47
5.70	5460.56	0.42	5.41	0.23	1.47

Tailwater Channel Data - CULVERT CP-25

Tailwater Channel Option: Rectangular Channel

Bottom Width: 2.50 ft

Channel Slope: 0.0089

Channel Manning's n: 0.0120

Channel Invert Elevation: 5460.14 ft

CULVERT CP-26
HY-8 Culvert Analysis Report

Culvert Data Summary - CULVERT CP-26

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0160

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Site Data - CULVERT CP-26

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5461.52 ft

Outlet Station: 173.00 ft

Outlet Elevation: 5460.14 ft

Number of Barrels: 1

Table 1 - Culvert Summary Table: CULVERT CP-26

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5461.52	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.32	0.32	5461.77	0.252	0.0*	1-S2n	0.188	0.189	0.188	0.068	1.983	1.887
0.65	0.65	5461.89	0.368	0.0*	1-S2n	0.255	0.261	0.260	0.105	2.602	2.463
0.97	0.97	5461.97	0.455	0.0*	1-S2n	0.314	0.325	0.315	0.135	2.962	2.871
1.29	1.29	5462.05	0.533	0.0*	1-S2n	0.373	0.390	0.380	0.162	3.084	3.196
1.62	1.62	5462.12	0.605	0.0*	1-S2n	0.420	0.434	0.424	0.186	3.357	3.470
1.94	1.94	5462.18	0.656	0.0*	1-S2n	0.456	0.474	0.464	0.209	3.477	3.710
2.26	2.26	5462.23	0.712	0.0*	1-S2n	0.492	0.514	0.504	0.231	3.609	3.923
2.58	2.58	5462.28	0.765	0.0*	1-S2n	0.528	0.554	0.533	0.251	3.820	4.116
2.91	2.91	5462.34	0.816	0.0*	1-S2n	0.565	0.594	0.573	0.271	3.899	4.293
3.23	3.23	5462.38	0.865	0.0*	1-S2n	0.601	0.625	0.601	0.290	4.068	4.454

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5461.52 ft, Outlet Elevation (invert): 5460.14 ft

Culvert Length: 173.01 ft, Culvert Slope: 0.0080

****

Roadway Data for Crossing: CULVERT CP-26

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 3.64 ft

Crest Elevation: 5464.39 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: CULVERT CP-26)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5461.52	0.00	0.00	0.00	0.00
0.32	5461.59	0.07	1.89	0.04	1.27
0.65	5461.62	0.10	2.46	0.06	1.34
0.97	5461.66	0.14	2.87	0.07	1.38
1.29	5461.68	0.16	3.20	0.09	1.40
1.62	5461.71	0.19	3.47	0.10	1.42
1.94	5461.73	0.21	3.71	0.12	1.43
2.26	5461.75	0.23	3.92	0.13	1.44
2.58	5461.77	0.25	4.12	0.14	1.45
2.91	5461.79	0.27	4.29	0.15	1.45
3.23	5461.81	0.29	4.45	0.16	1.46

Tailwater Channel Data - CULVERT CP-26

Tailwater Channel Option: Rectangular Channel

Bottom Width: 2.50 ft

Channel Slope: 0.0089

Channel Manning's n: 0.0120

Channel Invert Elevation: 5461.52 ft

CULVERT CP-27
HY-8 Culvert Analysis Report

Culvert Data Summary - CULVERT CP-27

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0160

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Site Data - CULVERT CP-27

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5462.64 ft

Outlet Station: 135.00 ft

Outlet Elevation: 5461.56 ft

Number of Barrels: 1

Table 1 - Culvert Summary Table: CULVERT CP-27

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5462.68	0.000	0.040	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.16	0.16	5462.76	0.124	0.0*	1-S2n	0.094	0.094	0.094	0.045	1.370	1.440
0.32	0.32	5462.89	0.251	0.0*	1-S2n	0.187	0.188	0.187	0.068	1.977	1.884
0.48	0.48	5463.01	0.374	0.0*	1-S2n	0.225	0.228	0.227	0.088	3.009	2.205
0.64	0.64	5463.01	0.368	0.0*	1-S2n	0.255	0.260	0.259	0.105	2.600	2.459
0.81	0.81	5463.05	0.412	0.0*	1-S2n	0.284	0.293	0.292	0.120	2.744	2.677
0.97	0.97	5463.09	0.454	0.0*	1-S2n	0.313	0.325	0.315	0.135	2.960	2.868
1.13	1.13	5463.13	0.494	0.0*	1-S2n	0.343	0.357	0.347	0.148	3.029	3.037
1.29	1.29	5463.17	0.532	0.0*	1-S2n	0.372	0.389	0.379	0.161	3.083	3.192
1.45	1.45	5463.21	0.568	0.0*	1-S2n	0.401	0.413	0.401	0.174	3.228	3.335
1.61	1.61	5463.24	0.603	0.0*	1-S2n	0.419	0.433	0.423	0.186	3.353	3.468

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5462.64 ft, Outlet Elevation (invert): 5461.56 ft

Culvert Length: 135.00 ft, Culvert Slope: 0.0080

****

Roadway Data for Crossing: CULVERT CP-27

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 3.64 ft

Crest Elevation: 5465.51 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: CULVERT CP-27)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5462.68	0.00	0.00	0.00	0.00
0.16	5462.72	0.04	1.44	0.02	1.20
0.32	5462.75	0.07	1.88	0.04	1.27
0.48	5462.77	0.09	2.20	0.05	1.31
0.64	5462.78	0.10	2.46	0.06	1.34
0.81	5462.80	0.12	2.68	0.07	1.36
0.97	5462.81	0.13	2.87	0.07	1.38
1.13	5462.83	0.15	3.04	0.08	1.39
1.29	5462.84	0.16	3.19	0.09	1.40
1.45	5462.85	0.17	3.34	0.10	1.41
1.61	5462.87	0.19	3.47	0.10	1.42

Tailwater Channel Data - CULVERT CP-27

Tailwater Channel Option: Rectangular Channel

Bottom Width: 2.50 ft

Channel Slope: 0.0089

Channel Manning's n: 0.0120

Channel Invert Elevation: 5462.68 ft

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Navajo Mine Area 3 Light Vehicle Traffic & Pedestrian Seperation Project 10-YR 6-HR STORM

CULVERT CP-28 AND CHANNEL A, B & C

See Exhibit 11-12D-1 for location and watershed delineation. The HY8 software was utilized to size the culvert, HY8 reports are attach.

GEOMAT Inc.
915 Malta Avenue
Farmington, NM 87401

Phone: (505) 327-7928

General Information

Storm Information:

Storm Type:	NM TYPE II 70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.230 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#4	0.000	0.000	CHANNEL A
Channel	#2	==>	#4	0.000	0.000	CHANNEL B
Channel	#3	==>	#4	0.000	0.000	CHANNEL C
Null	#4	==>	End	0.000	0.000	CULVERT CP-28

	#3 Chan'l
	#2 Chan'l
	#1 Chan'l
#4 Null	

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#3	3.180	3.180	2.38	0.08
#2	2.140	2.140	1.16	0.03
#1	1.200	1.200	1.31	0.05
#4	0.000	6.520	4.84	0.16

Structure Detail:

Structure #3 (Erodible Channel)

CHANNEL C

Triangular Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.0:1	2.0:1	3.0	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.38 cfs	
Depth:	0.49 ft	0.79 ft
Top Width:	2.96 ft	4.76 ft
Velocity:	3.26 fps	
X-Section Area:	0.73 sq ft	
Hydraulic Radius:	0.234 ft	
Froude Number:	1.16	

Structure #2 (Riprap Channel)

CHANNEL B

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.00	3.0:1	3.0:1	50.0	0.30		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.16 cfs	
Depth:	0.04 ft	0.34 ft
Top Width:	3.21 ft	5.01 ft
Velocity*:		
X-Section Area:	0.11 sq ft	

	w/o Freeboard	w/ Freeboard
Hydraulic Radius:	0.034 ft	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #1 (Erodible Channel)

CHANNEL A

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	4.0:1	4.0:1	0.5	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.31 cfs	
Depth:	0.26 ft	0.56 ft
Top Width:	5.11 ft	7.51 ft
Velocity:	1.23 fps	
X-Section Area:	1.07 sq ft	
Hydraulic Radius:	0.206 ft	
Froude Number:	0.47	

Structure #4 (Null)

CULVERT CP-28

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	0.540	0.010	0.000	0.000	98.000	F	0.95	0.045
	2	2.640	0.055	0.000	0.000	80.000	M	1.43	0.036
	Σ	**3.180**						**2.38**	**0.082**
#2	1	2.140	0.027	0.000	0.000	80.000	M	1.16	0.029
	Σ	**2.140**						**1.16**	**0.029**
#1	1	0.540	0.006	0.000	0.000	98.000	F	0.95	0.045
	2	0.660	0.028	0.000	0.000	80.000	M	0.36	0.008
	Σ	**1.200**						**1.31**	**0.054**
#4	Σ	**6.520**						**4.84**	**0.164**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	7. Paved area and small upland gullies	1.13	0.58	51.40	2.130	0.006
#1	**1**	**Time of Concentration:**					**0.006**
#1	2	8. Large gullies, diversions, and low flowing streams	4.06	25.50	627.50	6.040	0.028
#1	**2**	**Time of Concentration:**					**0.028**
#2	1	8. Large gullies, diversions, and low flowing streams	5.83	42.50	729.11	7.240	0.027
#2	**1**	**Time of Concentration:**					**0.027**
#3	1	7. Paved area and small upland gullies	1.22	1.00	82.00	2.220	0.010
#3	**1**	**Time of Concentration:**					**0.010**
#3	2	8. Large gullies, diversions, and low flowing streams	3.60	40.50	1,126.34	5.680	0.055
#3	**2**	**Time of Concentration:**					**0.055**

CULVERT CP-28
HY-8 Culvert Analysis Report

Culvert Data Summary - CULVERT CP-28

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0160

Inlet Type: Conventional

Inlet Edge Condition: Thin Edge Projecting

Inlet Depression: NONE

Site Data - CULVERT CP-28

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5465.50 ft

Outlet Station: 190.00 ft

Outlet Elevation: 5463.60 ft

Number of Barrels: 1

Table 1 - Culvert Summary Table: CULVERT CP-28

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5465.50	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.48	0.48	5465.91	0.415	0.0*	1-S2n	0.216	0.228	0.218	0.085	2.985	1.412
0.97	0.97	5465.99	0.490	0.0*	1-S2n	0.295	0.325	0.315	0.124	2.961	1.741
1.45	1.45	5466.11	0.611	0.0*	1-S2n	0.374	0.414	0.383	0.154	3.436	1.958
1.94	1.94	5466.21	0.706	0.0*	1-S2n	0.432	0.474	0.434	0.178	3.912	2.124
2.42	2.42	5466.29	0.794	0.0*	1-S2n	0.481	0.533	0.483	0.199	4.092	2.261
2.90	2.90	5466.38	0.876	0.0*	1-S2n	0.530	0.593	0.532	0.218	4.297	2.377
3.39	3.39	5466.46	0.956	0.0*	1-S2n	0.578	0.639	0.578	0.236	4.487	2.479
3.87	3.87	5466.52	1.022	0.0*	1-S2n	0.620	0.683	0.622	0.252	4.659	2.570
4.36	4.36	5466.59	1.092	0.0*	1-S2n	0.658	0.727	0.666	0.266	4.740	2.653
4.84	4.84	5466.66	1.159	0.0*	1-S2n	0.695	0.771	0.700	0.280	4.919	2.729

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5465.50 ft, Outlet Elevation (invert): 5463.60 ft

Culvert Length: 190.01 ft, Culvert Slope: 0.0100

****

Roadway Data for Crossing: CULVERT CP-28

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 5468.50 ft

Roadway Surface: Paved

Roadway Top Width: 120.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: CULVERT CP-28)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5462.57	0.00	0.00	0.00	0.00
0.48	5462.66	0.09	1.41	0.24	0.95
0.97	5462.69	0.12	1.74	0.34	1.00
1.45	5462.72	0.15	1.96	0.43	1.03
1.94	5462.75	0.18	2.12	0.49	1.05
2.42	5462.77	0.20	2.26	0.55	1.07
2.90	5462.79	0.22	2.38	0.61	1.08
3.39	5462.81	0.24	2.48	0.65	1.10
3.87	5462.82	0.25	2.57	0.70	1.11
4.36	5462.84	0.27	2.65	0.74	1.11
4.84	5462.85	0.28	2.73	0.78	1.12

Tailwater Channel Data - CULVERT CP-28

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0445

User Defined Channel Cross-Section:

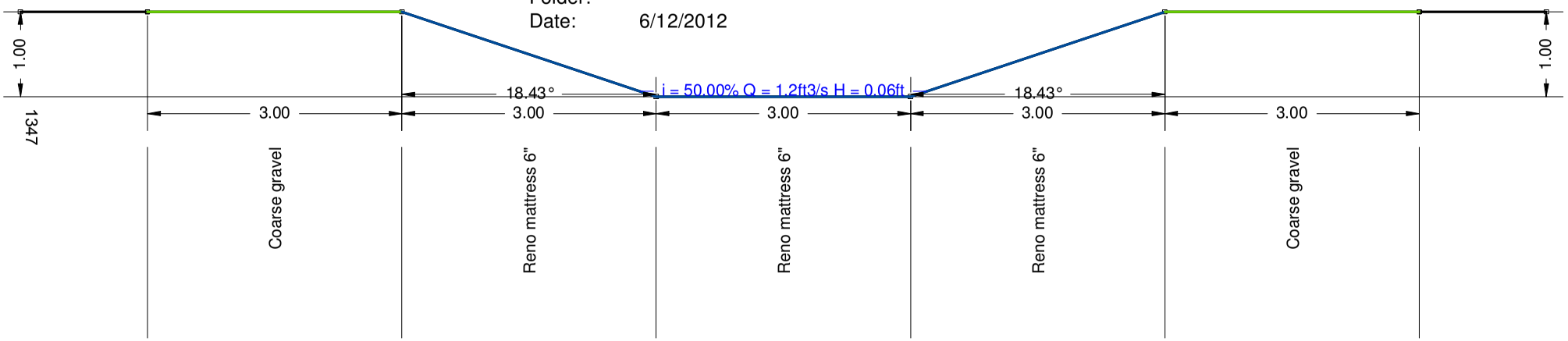
Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5464.98	0.0370
2	2.03	5464.00	0.0370
3	3.99	5463.00	0.0370
4	5.76	5462.57	0.0370
5	7.26	5462.57	0.0370
6	8.76	5462.57	0.0370
7	17.21	5463.00	0.0370
8	22.78	5464.00	0.0370
9	28.68	5465.00	0.0000

Macra1 2006

Maccaferri River Analysis
Bank Protections

Title: Channel B
Description: Navajo Mine Area 3 Light Vehicle Traffic and Pedestri n Seperation Project

Folder:
Date: 6/12/2012



Title: Channel B
Description: Navajo Mine Area 3 Light Vehicle Traffic Pedestrian Seperation Project

Folder:
Date: 6/12/2012

Notice
Maccaferri is not responsible for the drawings and the calculations trasmitted, since they should be intended as general design outlines and advice,aiming only to the best use of the products.

Run n.1

Gradient [%]	50.00	Froude number	4.24
Discharge [ft3/s]	1.16	Cross section [ft2]	0.20
Water level [ft]	0.06	Wetted perimeter [ft]	3.39
Average velocity [ft/s]	5.83	Hydraulic radius [ft]	0.06

Stretch	Length [ft]	V [ft/s]	K	Vadm [ft/s]	Vb Material [ft/s]	V	tau max [lb/ft2]	tau adm [lb/ft2]	GeoFil
2	3.00	0.00	1.00						
2.1	3.00			-	- Coarse gravel	N	-	-	N
3	3.16	3.63	1.00						
3.1	3.16			6.00	5.25 Reno mattress 6"	N	1.51	4.36	Y
4	3.00	5.97	1.00						
4.1	3.00			6.00	5.25 Reno mattress 6"	N	1.99	4.68	Y
5	3.16	3.63	1.00						
5.1	3.16			6.00	5.25 Reno mattress 6"	N	1.51	4.36	Y
6	3.00	0.00	1.00						
6.1	3.00			-	- Coarse gravel	N	-	-	N

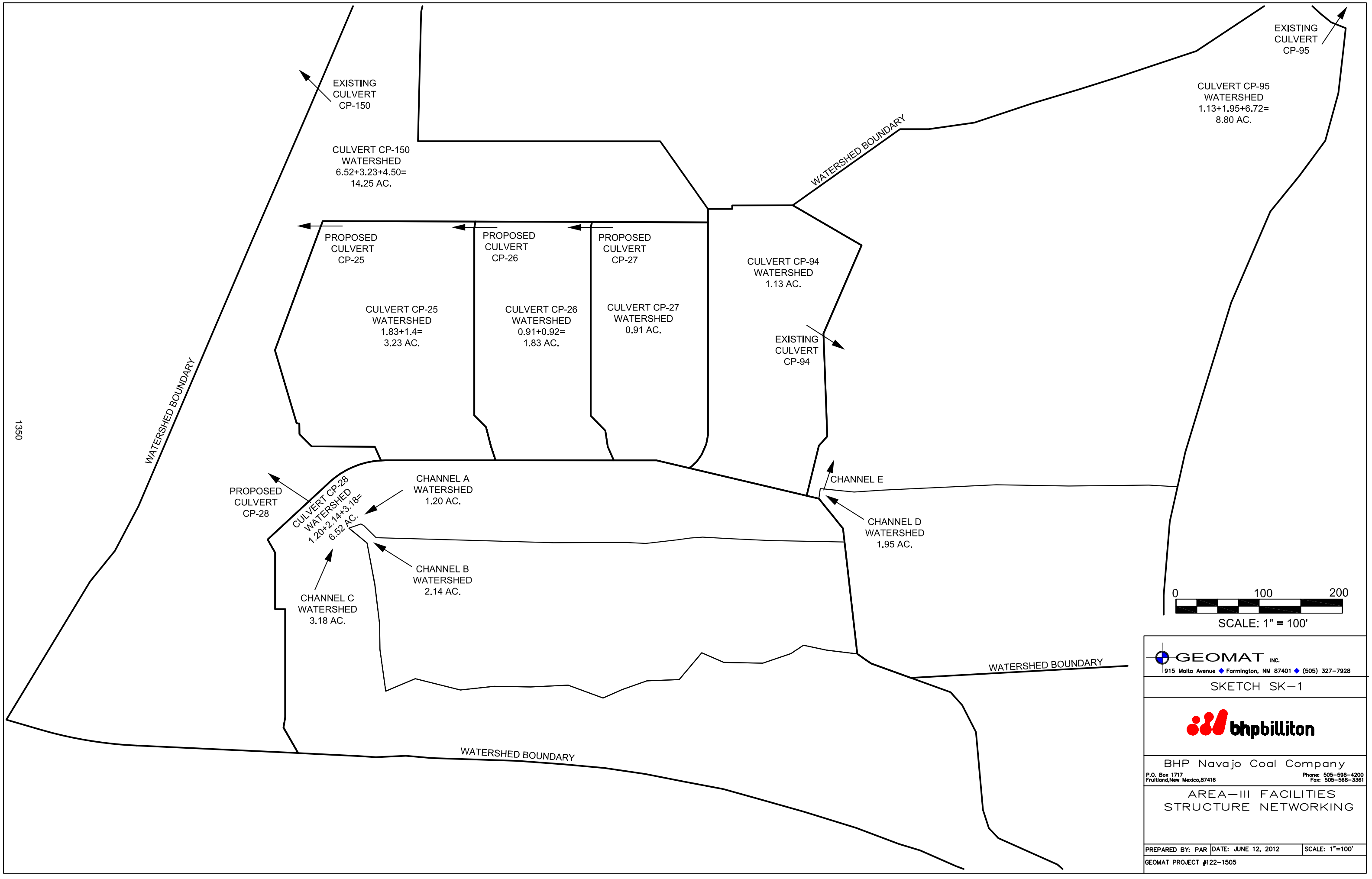
Title: Channel B
Description: Navajo Mine Area 3 Light Vehicle Traffic Pedestrian Seperation Project

Folder:
Date: 6/12/2012

Notice
Maccaferri is not responsible for the drawings and the calculations trasmitted, since they should be intended as general design outlines and advice,aiming only to the best use of the products.

Materials used

Description	Roughness	Allow. shear stress [lb/ft2]	V	Rock d50 [inch]	Thickness [ft]	Rockfill unit we [lb/ft3]	Time [h]	C Shields
Coarse gravel	0.0250	0.67	Y					
Reno mattress 6"	0.0277	4.68	N	3.94	0.56	165.51		0.140



GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ (505) 327-7928

SKETCH SK-1

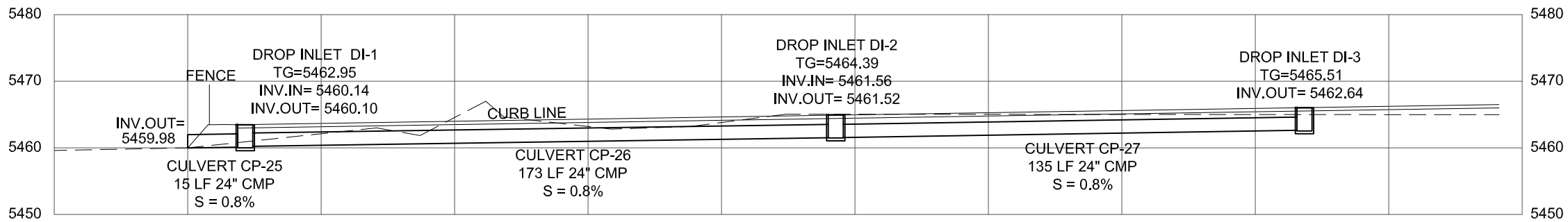
bhpbilliton

BHP Navajo Coal Company
P.O. Box 1717
Fruitland,New Mexico,87416
Phone: 505-598-4200
Fax: 505-568-3361

AREA-III FACILITIES
STRUCTURE NETWORKING

PREPARED BY: PAR	DATE: JUNE 12, 2012	SCALE: 1"=100'

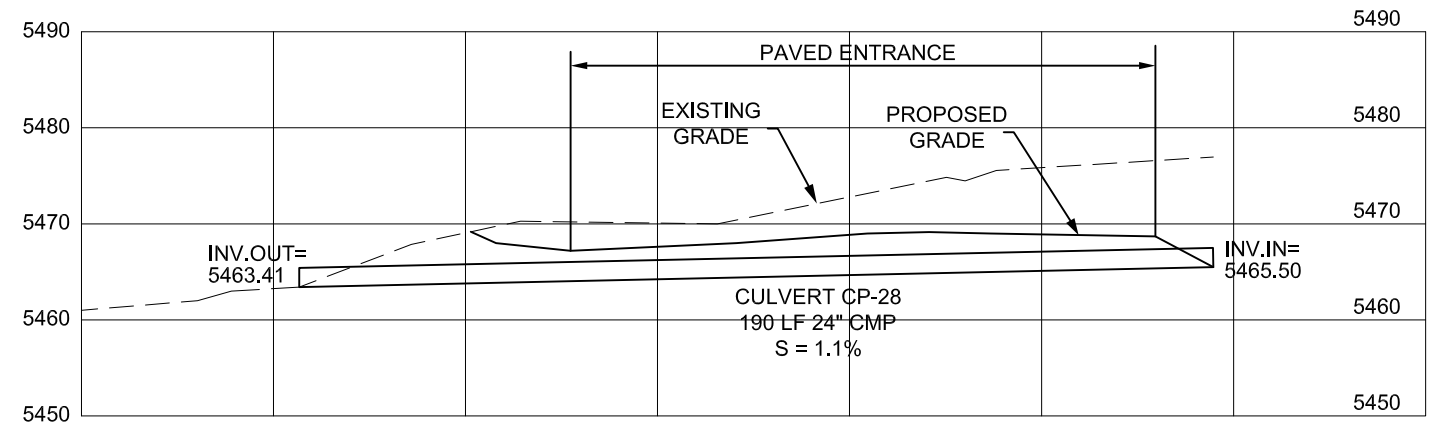
GEOMAT PROJECT #122-1505



NOTE: INSTALL A FLARED END SECTION
AT THE OUTLET OF CULVERT CP-25

CULVERTS CP-25, CP-26 & CP-27 PROFILE

SCALE: 1"=40'H, 1"=20'V



NOTE: INSTALL A FLARED END SECTION
AT THE OUTLET OF CULVERT CP-28

CULVERT CP-28 PROFILE

SCALE: 1"=40'H, 1"=20'V

1351

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915 Malta Avenue ◆ Farmington, NM 87401 ◆ (505) 327-7928

SKETCH SK-2

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BHP Navajo Coal Company

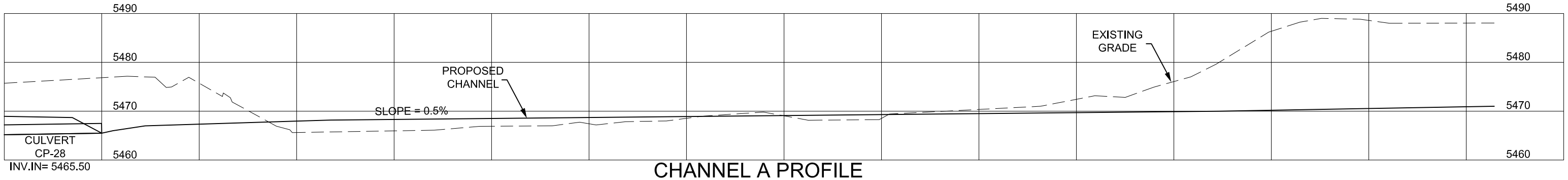
P.O. Box 1717
Fruitland,New Mexico,87416

Phone: 505-598-4200
Fax: 505-568-3361

AREA-III FACILITIES
CULVERT PROFILES

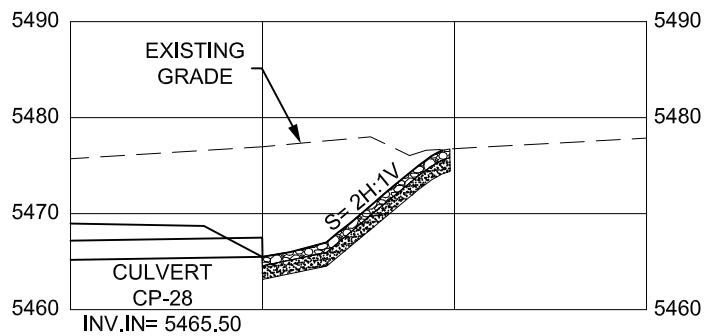
PREPARED BY: PAR	DATE: JUNE 12, 2012	SCALE: AS SHOWN

GEOMAT PROJECT #122-1505



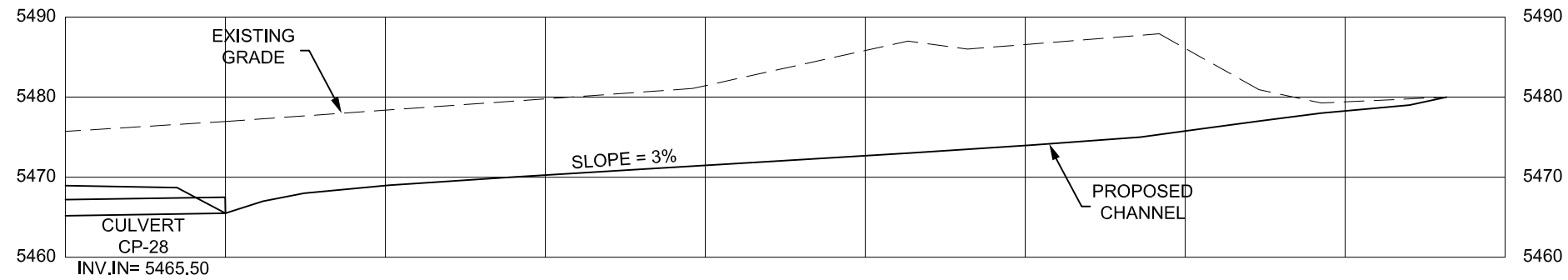
CHANNEL A PROFILE

SCALE: 1"=40'H, 1"=20'V



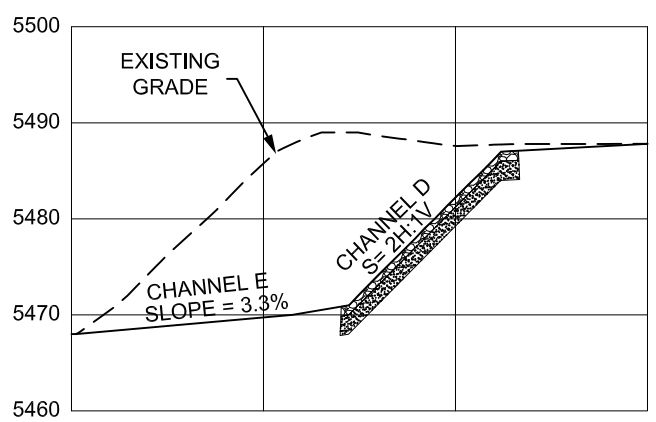
CHANNEL B PROFILE

SCALE: 1"=40'H, 1"=20'V



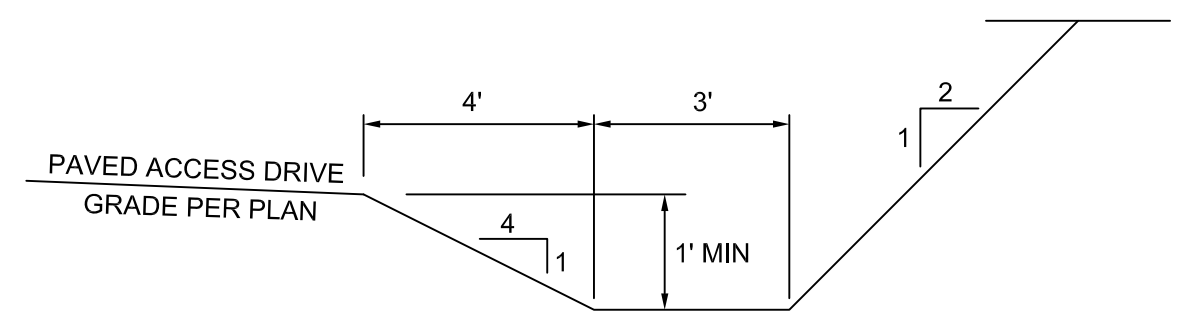
CHANNEL C PROFILE

SCALE: 1"=40'H, 1"=20'V



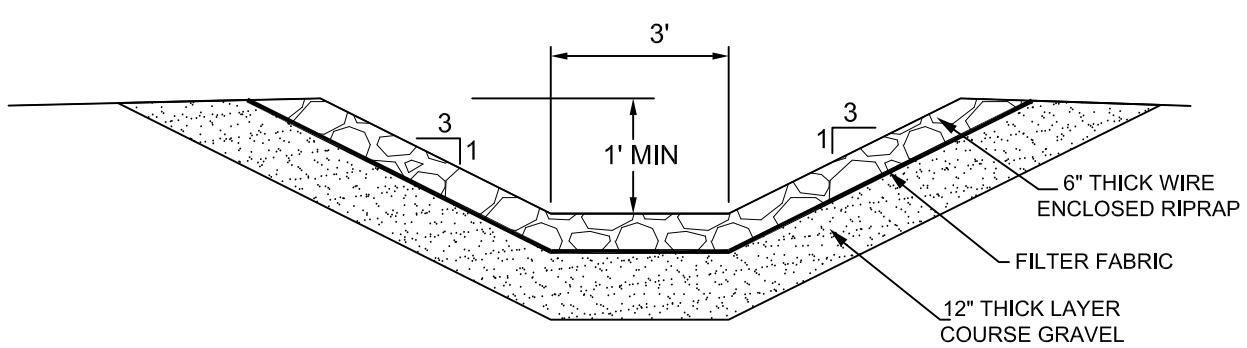
CHANNEL D & E PROFILE

SCALE: 1"=40'H, 1"=20'V



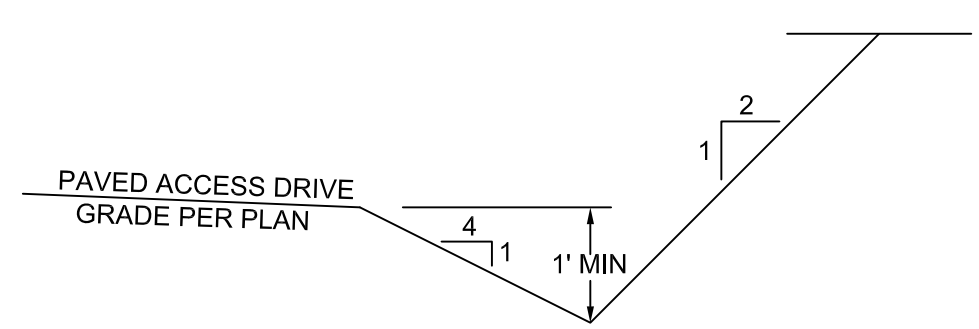
CHANNEL A & E SECTION

N.T.S.



CHANNEL B & D SECTION

N.T.S.



CHANNEL C SECTION

N.T.S.

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915 Malta Avenue ◆ Farmington, NM 87401 ◆ (505) 327-7928

SKETCH SK-3

bhpbilliton

BHP Navajo Coal Company

P.O. Box 1717
Fruitland,New Mexico,87416
Phone: 505-598-4200
Fax: 505-568-3361

AREA-III FACILITIES
CHANNEL PROFILES
AND TYP. SECTIONS

PREPARED BY: PAR	DATE: JUNE 12, 2012	SCALE: AS SHOWN

GEOMAT PROJECT #122-1505

1352

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Navajo Mine Area 3 Light Vehicle Traffic & Pedestrian Seperation Project

CHANNEL D & E

See Exhibit 11-12D-1 for location and watershed delineation.

GEOMAT Inc.
915 Malta Avenue
Farmington, NM 87401

Phone: (505) 327-7928

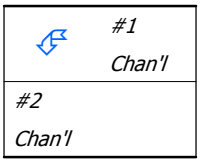
General Information

Storm Information:

Storm Type:	NM TYPE II 70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.230 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#2	0.000	0.000	CHANNEL D
Channel	#2	==>	End	0.000	0.000	CHANNEL E



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.950	1.950	1.05	0.03
#2	0.000	1.950	1.05	0.03

Structure Detail:

Structure #1 (Riprap Channel)

CHANNEL D

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.00	3.0:1	3.0:1	50.0	0.30		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.05 cfs	
Depth:	0.03 ft	0.33 ft
Top Width:	3.21 ft	5.01 ft
Velocity*:		
X-Section Area:	0.11 sq ft	
Hydraulic Radius:	0.033 ft	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #2 (Erodible Channel)

CHANNEL E

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	4.0:1	2.0:1	3.3	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.05 cfs	
Depth:	0.14 ft	0.44 ft

	w/o Freeboard	w/ Freeboard
Top Width:	3.83 ft	5.63 ft
Velocity:	2.23 fps	
X-Section Area:	0.47 sq ft	
Hydraulic Radius:	0.122 ft	
Froude Number:	1.12	

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.950	0.023	0.000	0.000	80.000	M	1.05	0.027
	Σ	**1.950**						**1.05**	**0.027**
#2	Σ	**1.950**						**1.05**	**0.027**

Subwatershed Time of Concentration Details:

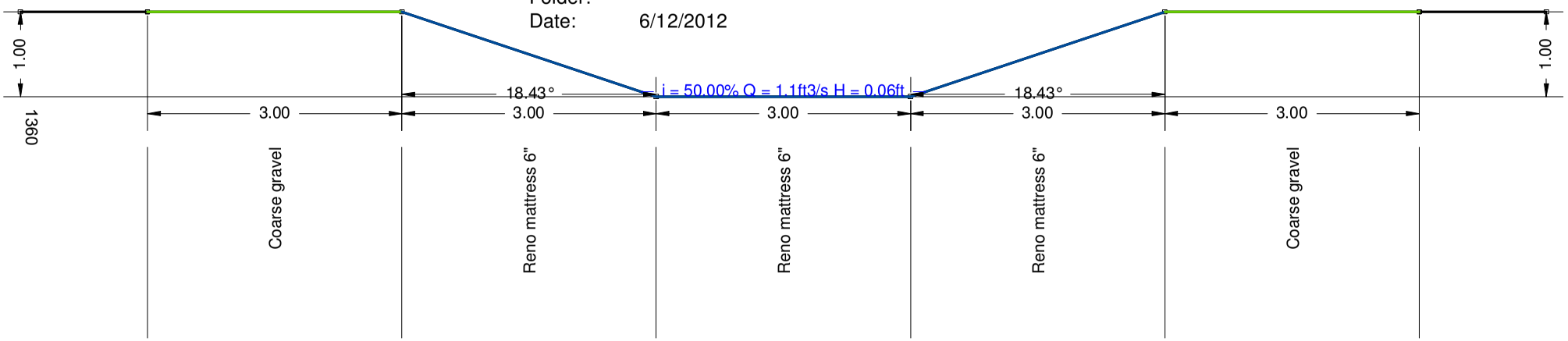
Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	5.93	37.00	623.75	7.300	0.023
#1	**1**	**Time of Concentration:**					**0.023**

Macra1 2006

Maccaferri River Analysis
Bank Protections

Title: Channel D
Description: Navajo Mine Area 3 Light Vehicle Traffic & Pedestrian Seperation Project

Folder:
Date: 6/12/2012



Title: Channel D
Description: Navajo Mine Area 3 Light Vehicle Traffic Pedestrian Seperation Project

Folder:
Date: 6/12/2012

Notice
Maccaferri is not responsible for the drawings and the calculations trasmitted, since they should be intended as general design outlines and advice,aiming only to the best use of the products.

Run n.1

Gradient [%]	50.00	Froude number	4.19
Discharge [ft3/s]	1.05	Cross section [ft2]	0.19
Water level [ft]	0.06	Wetted perimeter [ft]	3.37
Average velocity [ft/s]	5.61	Hydraulic radius [ft]	0.06

Stretch	Length [ft]	V [ft/s]	K	Vadm [ft/s]	Vb Material [ft/s]	V	tau max [lb/ft2]	tau adm [lb/ft2]	GeoFil
2	3.00	0.00	1.00						
2.1	3.00			-	- Coarse gravel	N	-	-	N
3	3.16	3.49	1.00						
3.1	3.16			6.00	5.25 Reno mattress 6"	N	1.43	4.36	Y
4	3.00	5.74	1.00						
4.1	3.00			6.00	5.25 Reno mattress 6"	N	1.87	4.68	Y
5	3.16	3.49	1.00						
5.1	3.16			6.00	5.25 Reno mattress 6"	N	1.43	4.36	Y
6	3.00	0.00	1.00						
6.1	3.00			-	- Coarse gravel	N	-	-	N

Title: Channel D
Description: Navajo Mine Area 3 Light Vehicle Traffic Pedestrian Seperation Project

Folder:
Date: 6/12/2012

Notice
Maccaferri is not responsible for the drawings and the calculations trasmitted, since they should be intended as general design outlines and advice,aiming only to the best use of the products.

Materials used

Description	Roughness	Allow. shear stress [lb/ft2]	V	Rock d50 [inch]	Thickness [ft]	Rockfill unit we [lb/ft3]	Time [h]	C Shields
Coarse gravel	0.0250	0.67	Y					
Reno mattress 6"	0.0277	4.68	N	3.94	0.56	165.51		0.140

GILMORE SILOS (AN/HEF)

CULVERT CP-325 & 326

For culvert locations and watersheds refer to Exhibit 11-12E.
The hydrology model is presented on the attach sheet.

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM 87416

Phone: (505) 598-3317

1322

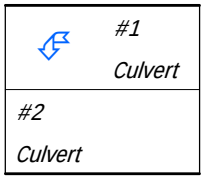
General Information

Storm Information:

Storm Type:	NM TYPE II 70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.230 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	#2	0.065	0.296	CULVERT CP-325
Culvert	#2	==>	End	0.000	0.000	CULVERT CP-326



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	0.68	4.00	586.00	2.47	0.065
#1	**Muskingum K:**					**0.065**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.510	1.510	2.13	0.08
#2	2.090	3.600	4.97	0.19

Structure Detail:

Structure #1 (Culvert)

CULVERT CP-325

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	1.00	0.0150	2.50	0.00	0.90

Culvert Results:

Design Discharge = 2.13 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Structure #2 (Culvert)

CULVERT CP-326

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	1.00	0.0150	2.50	0.00	0.90

Culvert Results:

Design Discharge = 4.97 cfs

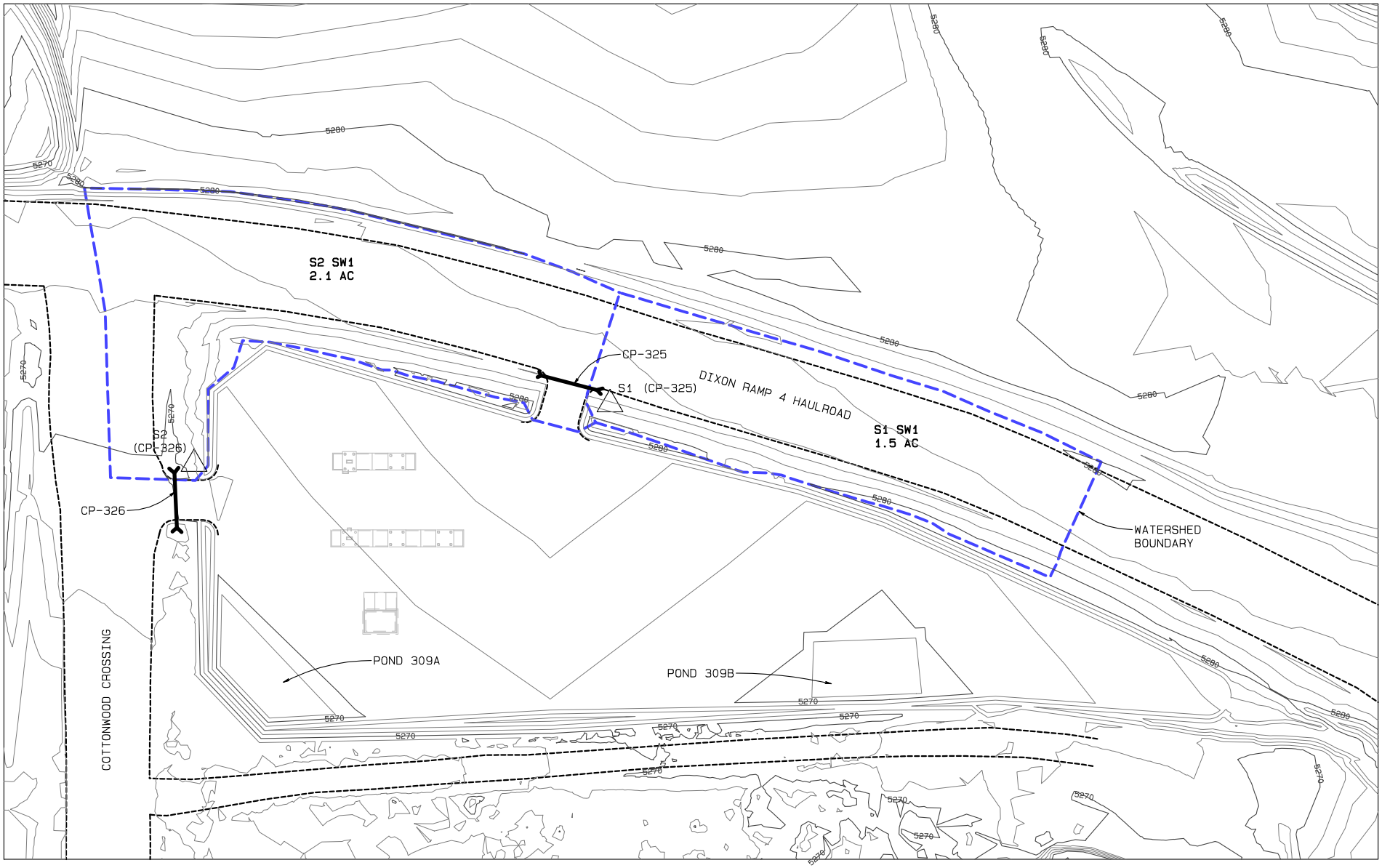
Minimum pipe diameter: 1 - 15 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.510	0.075	0.000	0.000	93.000	M	2.13	0.080
	Σ	**1.510**						**2.13**	**0.080**
#2	1	2.090	0.071	0.000	0.000	93.000	M	2.95	0.111
	Σ	**3.600**						**4.97**	**0.190**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	8.20	5.00	61.00	2.860	0.005
		8. Large gullies, diversions, and low flowing streams	0.41	2.00	487.00	1.920	0.070
#1	**1**	**Time of Concentration:**					**0.075**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	3.45	4.00	116.00	1.850	0.017
		8. Large gullies, diversions, and low flowing streams	0.77	4.00	519.00	2.630	0.054
#2	**1**	**Time of Concentration:**					**0.071**



GILMORE SILOS (AN/HEF)
CULVERT CP-325 & 326
HYDROLOGY MODEL

DIXON RAMP 2 HAULROAD

CULVERT CP-327

The culvert location and watershed are presented on Exhibit 11-12E.

A schematic of the hydrology model is attached.

CJB

BHP Billiton Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87416

General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.230 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Pond 310
Channel	#2	==>	#1	0.000	0.000	West Channel
Channel	#3	==>	#1	0.000	0.000	South Channel
Channel	#4	==>	#1	0.000	0.000	East Channel
Channel	#5	==>	#1	0.000	0.000	North Channel
Culvert	#6	==>	#2	0.000	0.000	CP-171
Culvert	#7	==>	#4	0.000	0.000	CP-327

	#5 Chan'l	
		#7 Culvert
	#4 Chan'l	
	#3 Chan'l	
		#6 Culvert
	#2 Chan'l	
#1 Null		

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#5	24.130	24.130	9.70	0.52
#7	71.130	71.130	13.57	0.79
#4	161.830	232.960	31.94	2.56
#3	34.520	34.520	8.91	0.39
#6	19.480	19.480	12.78	0.57
#2	14.120	33.600	18.23	0.77
#1	6.760	331.970	43.72	4.38

Structure Detail:

Structure #5 (Riprap Channel)

North Channel

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	3.0:1	3.0:1	16.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	9.70 cfs	
Depth:	0.12 ft	1.12 ft
Top Width:	8.71 ft	14.71 ft
Velocity*:		
X-Section Area:	0.99 sq ft	
Hydraulic Radius:	0.114 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #7 (Culvert)

CP-327

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
142.00	1.40	0.0150	3.00	0.00	0.90

Culvert Results:

Design Discharge = 13.57 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Structure #4 (Riprap Channel)

East Channel

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
14.00	3.0:1	3.0:1	17.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	31.94 cfs	
Depth:	0.17 ft	1.17 ft
Top Width:	15.05 ft	21.05 ft
Velocity*:		
X-Section Area:	2.54 sq ft	
Hydraulic Radius:	0.168 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Riprap Channel)

South Channel

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	3.0:1	3.0:1	18.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	8.91 cfs	
Depth:	0.10 ft	1.10 ft
Top Width:	8.61 ft	14.61 ft
Velocity*:		
X-Section Area:	0.85 sq ft	
Hydraulic Radius:	0.098 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #6 (Culvert)

CP-171

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
91.00	1.88	0.0150	6.00	0.00	0.90

Culvert Results:

Design Discharge = 12.78 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Structure #2 (Riprap Channel)

West Channel

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	3.0:1	3.0:1	14.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	18.23 cfs	
Depth:	0.21 ft	1.21 ft

	w/o Freeboard	w/ Freeboard
Top Width:	9.24 ft	15.24 ft
Velocity*:		
X-Section Area:	1.78 sq ft	
Hydraulic Radius:	0.192 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #1 (Null)

Pond 310

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#5	1	24.130	0.285	0.000	0.000	86.000	M	9.70	0.519
	Σ	**24.130**						**9.70**	**0.519**
#7	1	71.130	0.231	0.300	0.303	80.000	M	15.82	0.786
	Σ	**71.130**						**13.57**	**0.786**
#4	1	161.830	0.679	0.000	0.000	80.000	M	18.37	1.773
	Σ	**232.960**						**31.94**	**2.559**
#3	1	34.520	0.162	0.000	0.000	80.000	M	8.91	0.386
	Σ	**34.520**						**8.91**	**0.386**
#6	1	19.480	0.125	0.028	0.302	89.000	M	12.78	0.574
	Σ	**19.480**						**12.78**	**0.574**
#2	1	14.120	0.084	0.000	0.000	80.000	M	7.61	0.194
	Σ	**33.600**						**18.23**	**0.768**
#1	1	6.760	0.130	0.000	0.000	86.000	M	3.39	0.148
	Σ	**331.970**						**43.72**	**4.380**

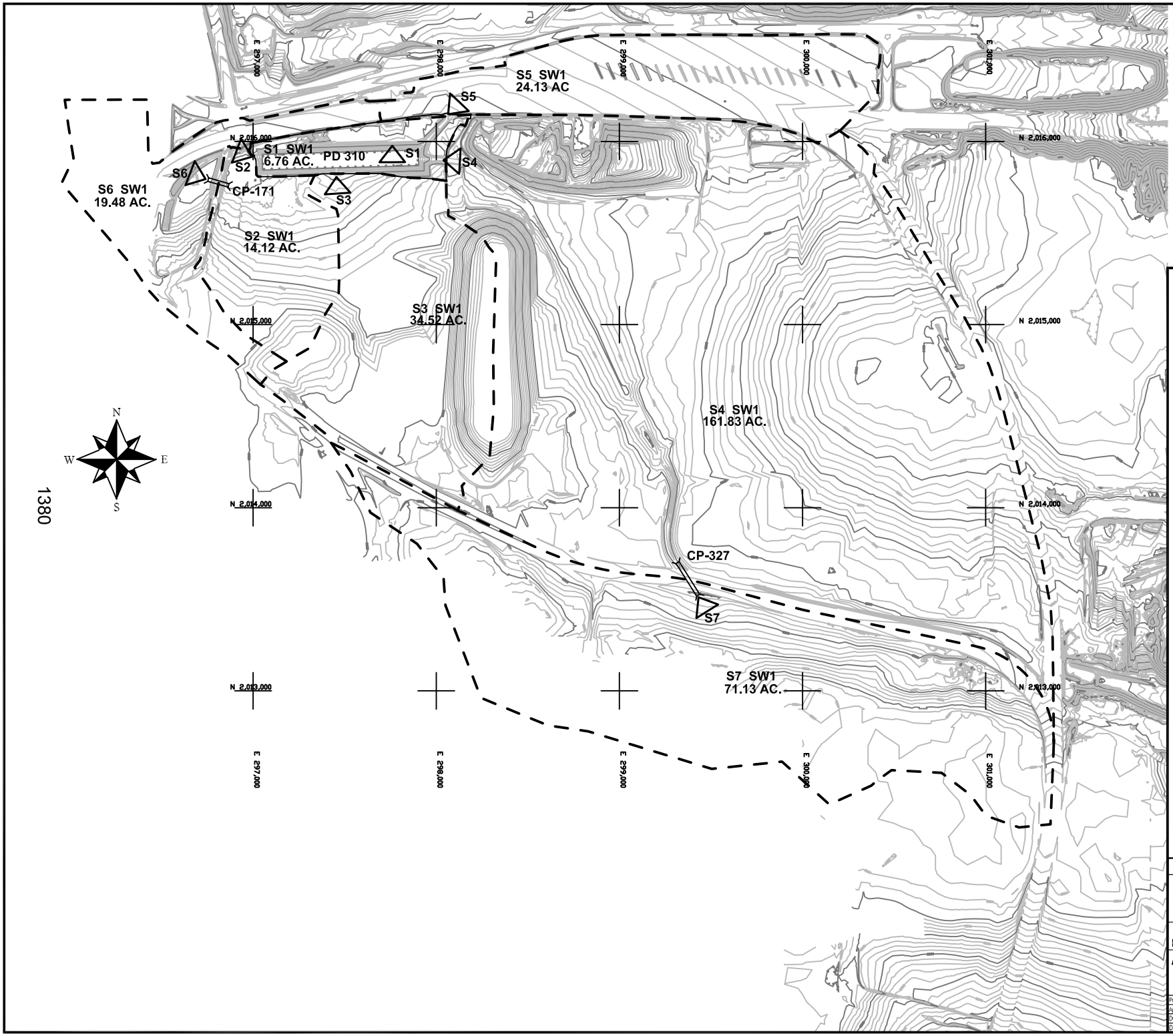
Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.26	16.00	706.43	1.500	0.130
#1	**1**	**Time of Concentration:**					**0.130**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	1.64	2.00	122.29	1.270	0.026
		8. Large gullies, diversions, and low flowing streams	3.42	40.00	1,170.72	5.540	0.058
#2	**1**	**Time of Concentration:**					**0.084**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	3.71	8.00	215.91	1.920	0.031
		8. Large gullies, diversions, and low flowing streams	1.79	34.00	1,896.47	4.010	0.131
#3	**1**	**Time of Concentration:**					**0.162**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	0.91	11.94	1,308.06	0.950	0.382
		8. Large gullies, diversions, and low flowing streams	0.71	19.35	2,709.32	2.530	0.297

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#4	**1**	**Time of Concentration:**					**0.679**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	1.15	2.00	173.39	1.070	0.045
		8. Large gullies, diversions, and low flowing streams	0.95	24.00	2,528.44	2.920	0.240
#5	**1**	**Time of Concentration:**					**0.285**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	3.82	10.00	261.87	1.950	0.037
		8. Large gullies, diversions, and low flowing streams	2.14	30.00	1,399.05	4.390	0.088
#6	**1**	**Time of Concentration:**					**0.125**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	0.79	2.50	315.05	0.890	0.098
		8. Large gullies, diversions, and low flowing streams	1.84	36.00	1,956.41	4.060	0.133
#7	**1**	**Time of Concentration:**					**0.231**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#6	1	8. Large gullies, diversions, and low flowing streams	0.75	2.00	266.31	2.590	0.028
#6	**1**	**Muskingum K:**					**0.028**
#7	1	8. Large gullies, diversions, and low flowing streams	0.76	21.50	2,826.34	2.610	0.300
#7	**1**	**Muskingum K:**					**0.300**


S5 SW1
24.13 AC
S5
S1 SW1
6.76 AC.
PD 310
S1
S2
S4
S6
CP-171
S3
S6 SW1
19.48 AC.
S2 SW1
14.12 AC.
S3 SW1
34.52 AC.
S4 SW1
161.83 AC.
CP-327
S7
S7 SW1
71.13 AC.
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N 2,015,000
N 2,014,000
N 2,013,000
E 297,000
E 298,000
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ROAD
WATERSHED
BUILDING
FENCE
IRRIGATION LINE
CULVERT
DAM
DRAINAGE
RAILROAD
TREES
POWERLINE
SPOT ELEVATION
INDEX CONTOUR
INTERMEDIATE CONTOUR
LEASE CORNER
LEASE/PERMIT BOUNDARY
STRUCTURE
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bhpbilliton
BHP Navajo Coal Company
LOWE-DIXON POND 310
SCHEMATIC OF
HYDROLOGY MODEL
Prepared By: RY
Drawn By: RRY
Scale: 1" = 700'
Approved By: LR
Plot Date: 6/3/13
Layout: 8.5X11_LS
Dwg. Path: C:\Documents And Settings\jsczar\My Documents\Ramsey Yazzie Documents
Drawing: Dx Bypass 2ft Contours RRY 053113_recover.dwg

DIXON BYPASS ROAD

CULVERT CP-328

The culvert location and watershed area are presented on Exhibit 11-12E.

CJB

BHB Billiton Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87416

General Information

Storm Information:

Storm Type:	NM TYPE II 70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.230 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	End	0.000	0.000	CP-328

#1
Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	81.660	81.660	11.25	0.90

Structure Detail:

Structure #1 (Culvert)

CP-328

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
142.00	0.50	0.0150	4.30	0.00	0.90

Culvert Results:

Design Discharge = 11.25 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	81.660	0.511	0.000	0.000	80.000	M	11.25	0.895
	Σ	**81.660**						**11.25**	**0.895**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.58	6.00	1,026.96	0.760	0.375
		8. Large gullies, diversions, and low flowing streams	3.63	102.00	2,806.09	5.710	0.136
#1	**1**	**Time of Concentration:**					**0.511**

Appendix 23.B

Miscellaneous Hydrologic Structures

APPENDIX 23.B

Miscellaneous Hydrologic Structures

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BHP Minerals Navajo Mine
Project NM-0003D-I-35 [CP-2 Embankment]
CP-2 Impoundment

1. Proposal

BHP Minerals International, Inc., Navajo Mine hereby submits the proposed installation of a drainage channel from the CP-2 impoundment to the CP-2 culvert. The proposed channel addition will eliminate and detour any water that has collected against the existing railroad embankment to CP-2 culvert.

2. Discussion

2.1 Reason for the proposal

The Office of Surface Mining Albuquerque Field Office (OSM/AFO) did an on-site inspection in June of 1994. The inspection revealed a small impoundment to the N.E. of CP-2 which is now referred to as CP-2 impoundment. The final result of the inspection stated that the total impoundment area was not included within the permit area as required by 30 CFR 773.17(a). A deficiency letter dated June 24, 1994, was sent to BHP from the office of OSM Western Regional Coordinating Center (WRCC) requesting BHP to correct the problem.

2.2 Background to proposal

The propose location of the drainage channel is shown on the attached 8.5" X 11" (copied from EXHIBIT 11-12) drawing. Several concepts were discussed an installing a drainage channel from the impoundment to the culvert CP-2 was agree on with OSM/AFO official and BHP - O.J. Estrada. Additional discussions have been held between the permittee and BHP. All parities are agreeable to the concept. The drainage channel would run parallel with the railroad tracks.

2.3 Drainage

Culvert information for CP-2 is provided on TABLE 11-13 (see CHAPTER 11, page 11-136), and the corresponding watershed are shown in EXHIBIT 11-12 (8.5" X 11" sketch attached). The present watershed configuration for the area of CP-2 will increase from 79.5 acres to 133.5 as noted by the delineation of the watersheds for CP-2.

2.4 Channel Design

The drainage channel will have a gradual slope of approximately .4% from north to south. The grade of channel will come on top of grade at the south end of the channel. The terrain between the impoundment and CP-2 culvert shows signs of sandstone, more so at the south end of the location.

The south end of the proposed drainage channel will stop at approximately 44' from CP-2 culvert, this is due to the elevation change and the existing terrain. Drainage water will have a natural flow atop of sandstone into CP-2 inlet culvert. CP-2 culvert was checked for capacity and adequacy for a peak discharge from a 10-yr, 6-hr event. The peak flow discharge was determined with the SEDCAD+ computer program and also the channel design (attached). Due to the sandstone in the area rip-rap inside the channel will not be required.

3. Reference

Upon approval, the 8.5" X 11" proposed copy will be added to the current EXHIBIT 11-12, "Location of Ponds, Impoundments, and Culverts" and be resubmitted for insertion into the permit.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP2 CULVERT

by

Name: ET

Company Name: BHP MINERALS
File Name: C:\SEDCAD3\CP2CULV

Date: 08-07-1995

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\SEDCAD3\CP2CULV User: ET
Date: 08-07-1995 Time: 12:24:00
CP2 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

==========
GENERAL INPUT TABLE
==========

STORM #1:

User-Defined Distribution

Label: Type II-60

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.013
4	1.5	0.021
5	2.0	0.029
6	2.5	0.039
7	3.0	0.049
8	3.5	0.062
9	4.0	0.076
10	4.5	0.094
11	5.0	0.118
12	5.5	0.156
13	6.0	0.672
14	6.5	0.756
15	7.0	0.789
16	7.5	0.810
17	8.0	0.826
18	8.5	0.837
19	9.0	0.849
20	9.5	0.858
21	10.0	0.867
22	10.5	0.874
23	11.0	0.882
24	11.5	0.888
25	12.0	0.895
26	12.5	0.900
27	13.0	0.906
28	13.5	0.911
29	14.0	0.917
30	14.5	0.922
31	15.0	0.927
32	15.5	0.932
33	16.0	0.937
34	16.5	0.941
35	17.0	0.946
36	17.5	0.950
37	18.0	0.955

38	18.5	0.959
39	19.0	0.963
40	19.5	0.967
41	20.0	0.971
42	20.5	0.975
43	21.0	0.978
44	21.5	0.982
45	22.0	0.986
46	22.5	0.990
47	23.0	0.993
48	23.5	0.997
49	24.0	1.000

****

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\CP2CULV User: ET
Date: 08-07-1995 Time: 12:24:00
CP2 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	54.00	89	M	0.399	0.000	0.000	0.0	2.18	26.29
111	2	79.50	89	M	0.205	0.000	0.000	0.0	3.21	52.21
		Type: Null			Label: cp2 culvert					
111	Structure	133.50							5.39	
111	Total IN/OUT	133.50							5.39	76.61

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\CP2CULV User: ET
Date: 08-07-1995 Time: 12:24:00
CP2 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2884.00	4.02	2.01	0.40	0.399		
1	1	1	2	-a	5	2400.00	10.54	3.25	0.21	0.205		

SEDCAD+ CULVERT SIZING UTILITY

cp2 culvert

Design Discharge	=	76.610	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	183.000	feet
Pipe Slope	=	3.200	%
Manning's n	=	0.016	
Maximum Headwater	=	8.000	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 36 inches

PERFORMANCE CURVES:

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	3.00	Inlet (Supercritical)	3
1.60	8.48	Inlet (Supercritical)	3
2.40	15.40	Inlet (Supercritical)	4
3.20	20.73	Inlet	5
4.00	25.01	Inlet	5
4.80	28.64	Inlet	5
5.60	31.87	Inlet	5
6.40	34.81	Inlet	5
7.20	37.49	Inlet	5
8.00	39.52	Outlet	6
8.80	40.80	Outlet	6
9.60	42.04	Outlet	6
10.40	43.25	Outlet	6
11.20	44.42	Outlet	6
12.00	45.56	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	3.75	Inlet (Supercritical)	3
1.60	10.60	Inlet (Supercritical)	3
2.40	19.46	Inlet (Supercritical)	3
3.20	28.89	Inlet	5
4.00	36.21	Inlet	5
4.80	42.29	Inlet	5
5.60	47.60	Inlet	5
6.40	52.37	Inlet	5
7.20	56.75	Inlet	5
8.00	60.81	Inlet	5
8.80	64.61	Inlet	5
9.60	68.20	Inlet	5
10.40	71.62	Inlet	5
11.20	74.88	Inlet	5
12.00	77.55	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	4.50	Inlet (Supercritical)	3
1.60	12.72	Inlet (Supercritical)	3
2.40	23.36	Inlet (Supercritical)	3
3.20	35.96	Inlet (Supercritical)	3
4.00	47.70	Inlet	5
4.80	57.14	Inlet	5
5.60	65.23	Inlet	5
6.40	72.41	Inlet	5
7.20	78.95	Inlet	5
8.00	84.99	Inlet	5
8.80	90.62	Inlet	5
9.60	95.92	Inlet	5
10.40	100.96	Inlet	5
11.20	105.74	Inlet	5
12.00	110.32	Inlet	5

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	5.25	Inlet (Supercritical)	3
1.60	14.83	Inlet (Supercritical)	3
2.40	27.25	Inlet (Supercritical)	3
3.20	41.95	Inlet (Supercritical)	3
4.00	58.63	Inlet (Supercritical)	3
4.80	72.28	Inlet	5
5.60	84.01	Inlet	5
6.40	94.29	Inlet	5
7.20	103.55	Inlet	5
8.00	112.06	Inlet	5
8.80	119.96	Inlet	5
9.60	127.37	Inlet	5
10.40	134.37	Inlet	5
11.20	141.03	Inlet	5
12.00	147.39	Inlet	5

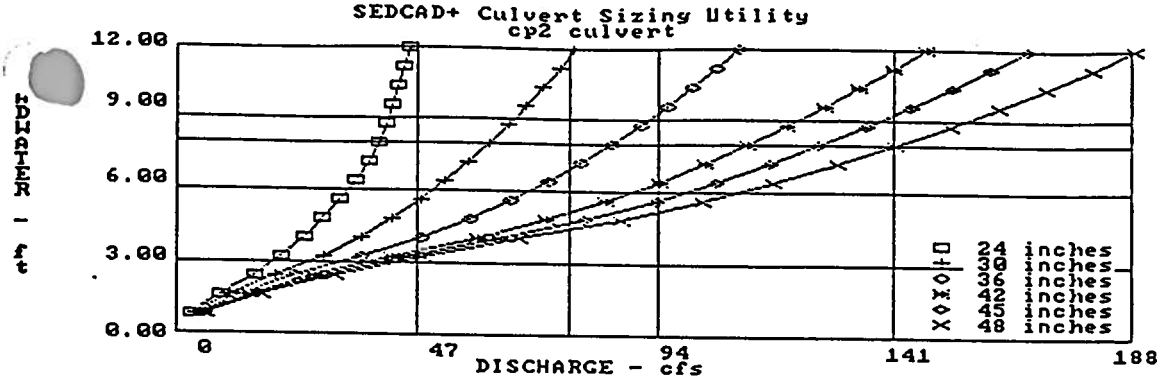
Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	5.63	Inlet (Supercritical)	3
1.60	15.89	Inlet (Supercritical)	3
2.40	29.20	Inlet (Supercritical)	3
3.20	44.95	Inlet (Supercritical)	3
4.00	62.82	Inlet (Supercritical)	3
4.80	79.63	Inlet	5
5.60	93.58	Inlet	5
6.40	105.70	Inlet	5
7.20	116.57	Inlet	5
8.00	126.51	Inlet	5

8.80	135.72	Inlet	5
9.60	144.35	Inlet	5
10.40	152.48	Inlet	5
11.20	160.21	Inlet	5
12.00	167.58	Inlet	5

Diameter: 48 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	5.99	Inlet (Supercritical)	3
1.60	16.95	Inlet (Supercritical)	3
2.40	31.14	Inlet (Supercritical)	3
3.20	47.95	Inlet (Supercritical)	3
4.00	67.00	Inlet (Supercritical)	3
4.80	86.75	Inlet	5
5.60	103.12	Inlet	5
6.40	117.30	Inlet	5
7.20	129.95	Inlet	5
8.00	141.47	Inlet	5
8.80	152.12	Inlet	5
9.60	162.08	Inlet	5
10.40	171.45	Inlet	5
11.20	180.34	Inlet	5
12.00	188.82	Inlet	5


SEDCAD+ Culvert Sizing Utility
cp2 culvert
HEADWATER - ft
12.00
9.00
6.00
3.00
0.00
0
47
94
141
188
DISCHARGE - cfs
24 inches
30 inches
36 inches
42 inches
45 inches
48 inches

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

RAILROAD SIDE DITCH/CHANNEL AT CP-2

by

Name: ET

Company Name: BHP MINERALS
File Name: C:\SEDCAD\CP2CHAN

Date: 08-07-1995

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\SEDCAD\CP2CHAN User: ET
Date: 08-07-1995 Time: 12:44:01
RAILROAD SIDE DITCH/CHANNEL AT CP-2
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

==========
GENERAL INPUT TABLE
==========

STORM #1:

User-Defined Distribution

Label: Type II-60

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.013
4	1.5	0.021
5	2.0	0.029
6	2.5	0.039
7	3.0	0.049
8	3.5	0.062
9	4.0	0.076
10	4.5	0.094
11	5.0	0.118
12	5.5	0.156
13	6.0	0.672
14	6.5	0.756
15	7.0	0.789
16	7.5	0.810
17	8.0	0.826
18	8.5	0.837
19	9.0	0.849
20	9.5	0.858
21	10.0	0.867
22	10.5	0.874
23	11.0	0.882
24	11.5	0.888
25	12.0	0.895
26	12.5	0.900
27	13.0	0.906
28	13.5	0.911
29	14.0	0.917
30	14.5	0.922
31	15.0	0.927
32	15.5	0.932
33	16.0	0.937
34	16.5	0.941
35	17.0	0.946
36	17.5	0.950
37	18.0	0.955

38	18.5	0.959
39	19.0	0.963
40	19.5	0.967
41	20.0	0.971
42	20.5	0.975
43	21.0	0.978
44	21.5	0.982
45	22.0	0.986
46	22.5	0.990
47	23.0	0.993
48	23.5	0.997
49	24.0	1.000

****

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Company Name: BHP MINERALS
Filename: C:\SEDCAD\CP2CHAN User: ET
Date: 08-07-1995 Time: 12:44:01
RAILROAD SIDE DITCH/CHANNEL AT CP-2
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	54.00	89	M	0.399	0.000	0.000	0.0	2.18	26.29
		Type: Null			Label: channel					
111	Structure	54.00							2.18	
111	Total IN/OUT	54.00							2.18	26.29

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Company Name: BHP MINERALS
Filename: C:\SEDCAD\CP2CHAN User: ET
Date: 08-07-1995 Time: 12:44:01
RAILROAD SIDE DITCH/CHANNEL AT CP-2
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Condition	Flow	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5		2884.00	4.02	2.01	0.40	0.399		

SEDCAD+ ERODIBLE CHANNEL DESIGN

RAILROAD SIDE DITCH/CHANNEL AT CP-2

Limiting Velocity Technique
Sediment-laden Water

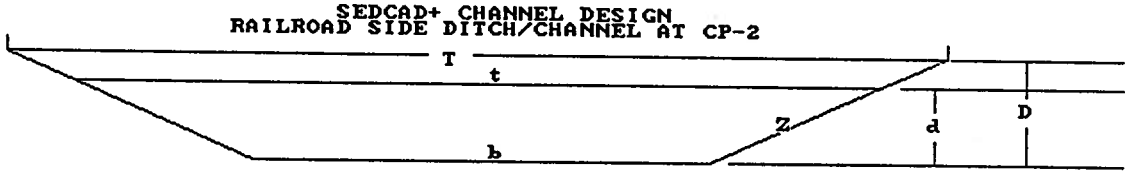
INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	26.30 cfs	
Slope	0.40 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	15.00 ft	
Manning's n	0.025	
Max. Velocity	6.00 fps	
Material	SANDSTONE	
Freeboard	1 ft	

RESULTS:

Actual Discharge	26.30 cfs
Depth	0.62 ft
with Freeboard	1.62 ft
Top Width	17.50 ft
with Freeboard	21.50 ft
Velocity	2.59 fps
Cross Sectional Area	10.15 sq ft
Hydraulic Radius	0.57 ft
Froude Number	0.60

SEDCAD+ CHANNEL DESIGN
RAILROAD SIDE DITCH/CHANNEL AT CP-2



MATERIAL: SANDSTONE
Limiting Variable: Velocity = 6.000 fps
Sediment-laden Water

Discharge	= 26.30 cfs		Depth (d)	= 0.62	w/ Freeboard: (D = 1.62) ft
Bottom (b)	= 15.00 ft		Top width (t)	= 17.50	(T = 21.50) ft
Side slopes (Z)	= 2.0:1(L)	2.0:1(R)	Velocity	= 2.59 fps	
Bed Slope	= 0.40 %		Hydraulic Radius	= 0.57 ft	
Manning's n	= 0.025		Froude number	= 0.60	

Area III Shop Temporary Diversion

Design:

The temporary diversion ditch is located on the eastern edge of the lease line at the Area III facilities. The ditch is designed for a 2 yr. - 6 hr storm event. The purpose of the berm/embankment is to divert surface runoff from a 602.3 ac watershed that is presently flowing through CP-36 (into the Area III Shop Pond) and route the runoff through CP-35. The combined watershed diverted to CP-35 is 662.4 ac. The ditch is an approximately 3 ft. berm with side slopes ranging from 1.5/1.0 to 3/1. Two additional 24" culverts were added at CP-35 to accommodate the additional flow.

A 3.0 ac watershed associated with the southern end of the diversion is itemized because it represents the amount of runoff to which the southern end of the diversion would be exposed. The diversion channel is not riprapped and a summary of the hydrology and design data is provided below. The design data in conjunction with EXHIBIT 11-116, provide justification for the unarmored channel. The southern end of the ditch from station 0 + 00 to 6 + 00 will have an insignificant amount of flow due to the small watershed, therefore no riprap will be required in this area.

	Channel Slope	Erosive Velocity	Flow Velocity	Riprap Required	Minimum Depth of Channel
Station 4 + 91 to 6 + 71	2.72 %	3.5 fps	2.51 fps	No	0.70 ft
Station 6 + 71 to 7 + 35	2.23 %	3.5 fps	2.24 fps	No	0.68 ft
Station 7 + 35 to 13 + 22	1.00 %	5.0 fps	3.54 fps	No	1.67 ft

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

2YR-6HR FOR BERM FOR CP-36 DITCH

by

Name: bts

Company Name: BHP MINERALS
File Name: C:\BRIAN\TEST

Date: 02-16-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST User: bts
Date: 02-16-1996 Time: 15:20:51
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	602.30	89	M	2.787	0.000	0.000	0.0	8.57	26.41
		Type: Null		Label: Area III Temp Div						
111	Structure	602.30							8.57	
111	Total IN/OUT	602.30							8.57	26.41

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST
User: bts
Date: 02-16-1996 Time: 15:20:51
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)
1	1	1	1	-a	5	12000.00	1.43	1.20	2.79	2.787	

BHP MINERALS
NAVAJO MINE

22-Apr-96

PROJECT: Area III Shop Temporary Diversion
ENGINEER BTS
FILE NO :
DRWG NO Exhibit 11-116

Channel Design

Precipitation Event:	2yr-6hr		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	3.00	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.00	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.25	0.12	0.28	1.13
0.50	1.00	0.24	1.80	1.80
0.75	2.25	0.36	5.31	2.36
1.00	4.00	0.48	11.46	2.86
1.25	6.25	0.61	20.79	3.33
1.50	9.00	0.73	33.82	3.76
1.75	12.25	0.85	51.05	4.17
2.00	16.00	0.97	72.91	4.56
2.25	20.25	1.09	99.86	4.93
2.50	25.00	1.21	132.30	5.29
2.75	30.25	1.33	170.64	5.64
3.00	36.00	1.45	215.26	5.98
3.25	42.25	1.57	266.55	6.31
3.50	49.00	1.69	324.87	6.63
3.75	56.25	1.82	390.59	6.94
4.00	64.00	1.94	464.04	7.25
4.25	72.25	2.06	545.57	7.55

Flow Depth at Peak Discharge	1.37 Ft
Minimum Channel Depth Required	1.67 Ft
Critical Depth	1.23 Ft
Flow Type	Subcritical flow
Froude Number	0.53
Flow Velocity	3.54 fps
Soil Type: Clay	
Erosive Velocity	5.00 fps

Flow Velocity Is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15; Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas Chapter 3; B.J. Barfield and R.C. Warner University of Kentucky

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

2YR-6HR FOR BERM FOR CP-36 DITCH

by

Name: bts

Company Name: BHP MINERALS
File Name: C:\BRIAN\TEST

Date: 02-16-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST User: bts
Date: 02-16-1996 Time: 15:18:49
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingu K (hr)
1	1	1	1	-a	5	750.00	4.53	2.13	0.10	0.097	

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST User: bts
Date: 02-16-1996 Time: 15:18:49
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharg (cfs)
111	1	3.00	89	M	0.097	0.000	0.000	0.0	0.04	1.29
		Type: Null			Label: Area III Temp Div					
111 Structure		3.00								
									0.04	
111 Total IN/OUT		3.00								
									0.04	1.29

BHP MINERALS
NAVAJO MINE

22-Apr-96

PROJECT: Area III Shop Temporary Diversion
ENGINEER BTS
FILE NO :
DRWG NO Exhibit 11-116

Channel Design

Precipitation Event:	2yr-6hr		
Design Flow	Q10	1.29	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.72	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.20	0.12	0.37	1.83
0.50	0.81	0.24	2.37	2.91
0.75	1.83	0.35	6.99	3.82
1.00	3.25	0.47	15.07	4.64
1.25	5.08	0.59	27.34	5.38
1.50	7.31	0.71	44.49	6.08
1.75	9.95	0.82	67.14	6.75
2.00	13.00	0.94	95.90	7.38
2.25	16.45	1.06	131.34	7.98
2.50	20.31	1.18	174.00	8.57
2.75	24.58	1.29	224.43	9.13
3.00	29.25	1.41	283.12	9.68
3.25	34.33	1.53	350.58	10.21
3.50	39.81	1.65	427.29	10.73
3.75	45.70	1.77	513.72	11.24
4.00	52.00	1.88	610.33	11.74
4.25	58.70	2.00	717.56	12.22

Flow Depth at Peak Discharge	0.40	Ft
Minimum Channel Depth Required	0.70	Ft
Critical Depth	0.40	Ft
Flow Type	Subcritical flow	
Froude Number	0.70	
Flow Velocity	2.51	fps
Soil Type: Sandy Clay		
Erosive Velocity	3.50	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

BHP MINERALS
NAVAJO MINE

22-Apr-96

PROJECT: Area III Shop Temporary Diversion
ENGINEER BTS
FILE NO :
DRWG NO Exhibit 11-116

Channel Design

Precipitation Event:	2yr-6hr		
Design Flow	Q10	1.29	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	3.00	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.23	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.25	0.12	0.42	1.69
0.50	1.00	0.24	2.69	2.69
0.75	2.25	0.36	7.94	3.53
1.00	4.00	0.48	17.11	4.28
1.25	6.25	0.61	31.04	4.97
1.50	9.00	0.73	50.51	5.61
1.75	12.25	0.85	76.23	6.22
2.00	16.00	0.97	108.88	6.81
2.25	20.25	1.09	149.12	7.36
2.50	25.00	1.21	197.56	7.90
2.75	30.25	1.33	254.81	8.42
3.00	36.00	1.45	321.46	8.93
3.25	42.25	1.57	398.05	9.42
3.50	49.00	1.69	485.14	9.90
3.75	56.25	1.82	583.27	10.37
4.00	64.00	1.94	692.96	10.83
4.25	72.25	2.06	814.71	11.28

Flow Depth at Peak Discharge	0.38	Ft
Minimum Channel Depth Required	0.68	Ft
Critical Depth	0.37	Ft
Flow Type	Subcritical flow	
Froude Number	0.64	
Flow Velocity	2.24	fps
Soil Type: Sandy Clay		
Erosive Velocity	3.50	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

Pages 29 – 124 Appendix 11-Z

Blank due to Removal of Area III Dragline Erection Site

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT: A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER: BEN HOSKIE
FILE NO.:
DRWG NO.: EXHIBIT 11-116A
MMD REF.:

Channel Design: STA. 6+00

Precipitation Event:	2YR 6HR		
Design Flow	Q10	1.29	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.28	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.20	0.12	0.34	1.68
0.50	0.81	0.24	2.17	2.67
0.75	1.83	0.35	6.40	3.50
1.00	3.25	0.47	13.80	4.24
1.25	5.08	0.59	25.03	4.93
1.50	7.31	0.71	40.73	5.57
1.75	9.95	0.82	61.47	6.18
2.00	13.00	0.94	87.80	6.75
2.25	16.45	1.06	120.25	7.31
2.50	20.31	1.18	159.31	7.84
2.75	24.58	1.29	205.48	8.36
3.00	29.25	1.41	259.21	8.86
3.25	34.33	1.53	320.98	9.35
3.50	39.81	1.65	391.21	9.83
3.75	45.70	1.77	470.34	10.29
4.00	52.00	1.88	558.78	10.75
4.25	58.70	2.00	656.97	11.19

Flow Depth at Peak Discharge	0.42	Ft
Minimum Channel Depth Required	0.72	Ft
Critical Depth	0.40	Ft
Flow Type	Subcritical flow	
Froude Number	0.65	
Flow Velocity	2.37	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15;
   Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
   Chapter 3: B.J. Barfield and R.C. Warner
   University of Kentucky

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT: A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER: BEN HOSKIE
FILE NO:
DRWG NO: EXHIBIT 11-116A
MMD REF:

Channel Design: @ STA 8+00

Precipitation Event:	2YR-6HR		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	2.00	
(Z2:1)	Z2 =	4.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.44	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.19	0.12	0.25	1.33
0.50	0.75	0.24	1.59	2.12
0.75	1.69	0.35	4.70	2.79
1.00	3.00	0.47	10.13	3.38
1.25	4.69	0.59	18.39	3.92
1.50	6.75	0.71	29.92	4.43
1.75	9.19	0.83	45.15	4.91
2.00	12.00	0.94	64.49	5.37
2.25	15.19	1.06	88.32	5.82
2.50	18.75	1.18	117.01	6.24
2.75	22.69	1.30	150.92	6.65
3.00	27.00	1.42	190.39	7.05
3.25	31.69	1.53	235.75	7.44
3.50	36.75	1.65	287.34	7.82
3.75	42.19	1.77	345.46	8.19
4.00	48.00	1.89	410.42	8.55
4.25	54.19	2.00	482.54	8.90

Flow Depth at Peak Discharge	1.44	Ft
Minimum Channel Depth Required	1.74	Ft
Critical Depth	1.37	Ft
Flow Type	Subcritical flow	
Froude Number	0.63	
Flow Velocity	4.31	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineenng Circular No. 15; Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas Chapter 3; B.J. Barfield and R.C. Warner University of Kentucky

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT: A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER: BEN HOSKIE
FILE NO :
DRWG NO : EXHIBIT 11-116A
MMD REF:

Channel Design: @ STA 10+00

Precipitation Event:	2YR-6HR		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	4.60	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.19	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.19	0.12	0.23	1.21
0.50	0.76	0.23	1.47	1.92
0.75	1.72	0.35	4.33	2.52
1.00	3.05	0.47	9.34	3.06
1.25	4.77	0.59	16.94	3.56
1.50	6.86	0.70	27.57	4.02
1.75	9.34	0.82	41.60	4.45
2.00	12.20	0.94	59.42	4.87
2.25	15.44	1.05	81.38	5.27
2.50	19.06	1.17	107.82	5.66
2.75	23.07	1.29	139.07	6.03
3.00	27.45	1.41	175.44	6.39
3.25	32.22	1.52	217.24	6.74
3.50	37.36	1.64	264.77	7.09
3.75	42.89	1.76	318.33	7.42
4.00	48.80	1.87	378.19	7.75
4.25	55.09	1.99	444.64	8.07

Flow Depth at Peak Discharge	1.48	Ft
Minimum Channel Depth Required	1.78	Ft
Critical Depth	1.37	Ft
Flow Type	Subcritical flow	
Froude Number	0.58	
Flow Velocity	3.98	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15;
   Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
   Chapter 3, B.J. Barfield and R.C. Warner
   University of Kentucky

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT. A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER. BEN HOSKIE
FILE NO :
DRWG NO : EXHIBIT 11-116A
MMD REF.

Channel Design: WORST CASE SCENARIO STA. 6+00 TO 13+23.69

Precipitation Event:	2YR-6HR		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	4.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.44	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.17	0.12	0.23	1.32
0.50	0.69	0.23	1.44	2.10
0.75	1.55	0.35	4.26	2.75
1.00	2.75	0.46	9.19	3.34
1.25	4.30	0.58	16.67	3.88
1.50	6.19	0.70	27.12	4.38
1.75	8.42	0.81	40.93	4.86
2.00	11.00	0.93	58.47	5.32
2.25	13.92	1.04	80.07	5.75
2.50	17.19	1.16	106.09	6.17
2.75	20.80	1.28	136.83	6.58
3.00	24.75	1.39	172.61	6.97
3.25	29.05	1.51	213.74	7.36
3.50	33.69	1.62	260.51	7.73
3.75	38.67	1.74	313.20	8.10
4.00	44.00	1.86	372.10	8.46
4.25	49.67	1.97	437.48	8.81

Flow Depth at Peak Discharge	1.49	Ft
Minimum Channel Depth Required	1.79	Ft
Critical Depth	1.42	Ft
Flow Type	Subcritical flow	
Froude Number	0.63	
Flow Velocity	4.36	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15;
   Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
   Chapter 3; B.J. Barfield and R.C. Warner
   University of Kentucky

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-122 BIGHAN RAMP7 ROAD

by

Name: RY

Company Name: BHP MINERALS
File Name: C:\LR\DATA\BHR7_CP1

Date: 10-08-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\DATA\BHR7_CP1 User: RY
Date: 10-08-1997 Time: 14:22:37
CP-122 BIGHAN RAMP7 ROAD
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

BS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
11	1	13.04	78	M	0.293	0.000	0.000	0.0	0.17	2.26
			Type: Null		Label: CP-122					
11	Structure	13.04							0.17	
11	Total IN/OUT	13.04							0.17	2.26

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\DATA\BHR7_CP1 User: RY
Date: 10-08-1997 Time: 14:22:37
CP-122 BIGHAN RAMP7 ROAD
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	-a	5	1311.58	1.54	1.24	0.29	0.293		

SEDCAD+ CULVERT SIZING UTILITY

CULVERT CP-122

Design Discharge	=	2.260 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	54.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.018
Maximum Headwater	=	4.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 9 inches

PERFORMANCE CURVES:

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.10	Outlet (Subcritical)	1
0.80	0.20	Outlet (Subcritical)	1
1.20	0.30	Outlet (Subcritical)	2
1.60	0.41	Outlet (Subcritical)	2
2.00	0.51	Inlet (Supercritical)	3
2.40	0.61	Inlet (Supercritical)	4
2.80	0.71	Inlet (Supercritical)	4
3.20	0.81	Inlet	5
3.60	0.91	Inlet	5
4.00	1.00	Outlet	6
4.40	1.04	Outlet	6
4.80	1.07	Outlet	6
5.20	1.10	Outlet	6
5.60	1.14	Outlet	6
6.00	1.17	Outlet	6

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.41	Outlet (Subcritical)	2
0.80	0.82	Inlet	5
1.20	1.08	Outlet	6
1.60	1.22	Outlet	6
2.00	1.36	Outlet	6
2.40	1.50	Outlet	6
2.80	1.64	Outlet	6
3.20	1.78	Outlet	6
3.60	1.92	Outlet	6
4.00	2.04	Outlet	6
4.40	2.12	Outlet	6
4.80	2.20	Outlet	6
5.20	2.29	Outlet	6
5.60	2.37	Outlet	6
6.00	2.46	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.50	Outlet (Subcritical)	1
0.80	1.00	Outlet (Subcritical)	1
1.20	1.28	Outlet (Subcritical)	2
1.60	1.57	Inlet (Supercritical)	4
2.00	1.85	Inlet	5
2.40	2.07	Outlet	6
2.80	2.22	Outlet	6
3.20	2.37	Outlet	6
3.60	2.52	Outlet	6
4.00	2.67	Outlet	6
4.40	2.82	Outlet	6
4.80	2.98	Outlet	6
5.20	3.09	Outlet	6
5.60	3.20	Outlet	6
6.00	3.31	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.01	Outlet (Subcritical)	1
0.80	1.62	Outlet (Subcritical)	1
1.20	2.35	Inlet (Supercritical)	3
1.60	3.14	Outlet	6
2.00	3.58	Outlet	6
2.40	4.02	Outlet	6
2.80	4.36	Outlet	6
3.20	4.70	Outlet	6
3.60	5.04	Outlet	6
4.00	5.32	Outlet	6
4.40	5.60	Outlet	6
4.80	5.88	Outlet	6
5.20	6.14	Outlet	6
5.60	6.37	Outlet	6
6.00	6.61	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.53	Outlet (Subcritical)	1
0.80	2.14	Outlet (Subcritical)	1
1.20	2.98	Outlet (Subcritical)	1
1.60	4.84	Inlet	5
2.00	5.75	Outlet	6
2.40	6.48	Outlet	6
2.80	7.15	Outlet	6
3.20	7.75	Outlet	6
3.60	8.31	Outlet	6
4.00	8.84	Outlet	6

4.40	9.33	Outlet	6
4.80	9.80	Outlet	6
5.20	10.25	Outlet	6
5.60	10.68	Outlet	6
6.00	11.10	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.86	Inlet (Supercritical)	3
0.80	2.26	Inlet (Supercritical)	3
1.20	3.63	Outlet (Subcritical)	2 *
1.60	5.52	Outlet (Subcritical)	1 *
2.00	8.18	Outlet	6
2.40	9.39	Outlet	6
2.80	10.46	Outlet	6
3.20	11.43	Outlet	6
3.60	12.32	Outlet	6
4.00	13.16	Outlet	6
4.40	13.94	Outlet	6
4.80	14.68	Outlet	6
5.20	15.39	Outlet	6
5.60	16.07	Outlet	6
6.00	16.71	Outlet	6

* (Transition Region - Data may need to be smoothed.)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-123 HYDROLOGY

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: C:\BEN\VINNEL\CP123\CP_123

Date: 08-19-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\VINNEL\CP123\CP_123 User: BEN HOSKIE
Date: 08-19-1998 Time: 11:41:00
CP-123 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-60
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	187.40	76	M	1.830	0.000	0.000	0.0	1.70	6.32
			Type: Null		Label: CP-123					
111	Structure	187.40							1.70	
111	Total IN/OUT	187.40							1.70	6.32

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\VINNEL\CP123\CP_123 User: BEN HOSKIE
Date: 08-19-1998 Time: 11:41:00
CP-123 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-60
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	6785.00	1.06	1.03	1.83	1.830		

SEDCAD+ CULVERT SIZING UTILITY

CP-123

Design Discharge	=	6.320 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	50.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.018
Maximum Headwater	=	3.300 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.41		0
0.66	0.83	Outlet (Subcritical)	1
0.99	1.14	Outlet (Subcritical)	2
1.32	1.39	Inlet (Supercritical)	3
1.65	1.63	Inlet (Supercritical)	4
1.98	1.88	Inlet	5
2.31	2.07	Outlet	6
2.64	2.20	Outlet	6
2.97	2.33	Outlet	6
3.30	2.46	Outlet	6
3.63	2.59	Outlet	6
3.96	2.72	Outlet	6
4.29	2.86	Outlet	6
4.62	2.99	Outlet	6
4.95	3.08	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.80	Outlet (Subcritical)	1
0.66	1.39	Outlet (Subcritical)	1
0.99	1.91	Outlet (Subcritical)	1
1.32	2.66	Inlet (Supercritical)	4
1.65	3.22	Outlet	6
1.98	3.60	Outlet	6
2.31	3.98	Outlet	6
2.64	4.28	Outlet	6
2.97	4.58	Outlet	6
3.30	4.88	Outlet	6
3.63	5.14	Outlet	6
3.96	5.39	Outlet	6
4.29	5.63	Outlet	6
4.62	5.87	Outlet	6
4.95	6.10	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	1.39	Outlet (Subcritical)	1
0.66	1.88	Outlet (Subcritical)	1
0.99	2.53	Outlet (Subcritical)	1
1.32	3.49	Outlet (Subcritical)	1
1.65	5.05	Outlet	6
1.98	5.75	Outlet	6
2.31	6.39	Outlet	6
2.64	6.98	Outlet	6
2.97	7.50	Outlet	6
3.30	8.02	Outlet	6
3.63	8.47	Outlet	6
3.96	8.93	Outlet	6
4.29	9.34	Outlet	6
4.62	9.75	Outlet	6
4.95	10.14	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.71	Outlet (Subcritical)	2
0.66	1.71	Inlet (Supercritical)	3
0.99	3.06	Inlet (Supercritical)	3
1.32	3.96	Outlet (Subcritical)	1 *
1.65	5.81	Outlet (Subcritical)	1
1.98	8.14	Outlet	6
2.31	9.19	Outlet	6
2.64	10.13	Outlet	6
2.97	11.00	Outlet	6
3.30	11.79	Outlet	6
3.63	12.53	Outlet	6
3.96	13.24	Outlet	6
4.29	13.91	Outlet	6
4.62	14.55	Outlet	6
4.95	15.16	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.78	Outlet (Subcritical)	2
0.66	1.97	Inlet (Supercritical)	3
0.99	3.62	Inlet (Supercritical)	3
1.32	5.56	Inlet (Supercritical)	3
1.65	6.77	Outlet (Subcritical)	1 *
1.98	8.86	Outlet (Subcritical)	1
2.31	12.17	Outlet	6
2.64	13.60	Outlet	6
2.97	14.90	Outlet	6
3.30	16.09	Outlet	6
3.63	17.20	Outlet	6
3.96	18.25	Outlet	6
4.29	19.23	Outlet	6
4.62	20.17	Outlet	6
4.95	21.07	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.86	Inlet (Supercritical)	3
0.66	2.26	Inlet (Supercritical)	3
0.99	4.13	Inlet (Supercritical)	3
1.32	6.36	Inlet (Supercritical)	3
1.65	8.88	Inlet (Supercritical)	3
1.98	9.91	Outlet (Subcritical)	1 *
2.31	12.70	Outlet (Subcritical)	1
2.64	17.11	Inlet	5
2.97	19.07	Outlet	6
3.30	20.77	Outlet	6
3.63	22.34	Outlet	6
3.96	23.81	Outlet	6
4.29	25.20	Outlet	6
4.62	26.51	Outlet	6
4.95	27.76	Outlet	6

* (Transition Region - Data may need to be smoothed.)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

RAMP 7 ROAD SIDE DITCH - WORSE CASE (SO. SIDE)

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\DATA\R7RDSD

Date: 11-11-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\DATA\R7RDSD User: LR
Date: 11-11-1997 Time: 13:10:48
RAMP 7 ROAD SIDE DITCH - WORSE CASE (SO. SIDE)
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

3S	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
11	1	7.85	75	M	0.242	0.000	0.000	0.0	0.07	0.92
		Type: Null		Label: SIDE DITCH-SO. SIDE						
11	Structure	7.85							0.07	
11	Total IN/OUT	7.85							0.07	0.92

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\DATA\R7RDSD User: LR
Date: 11-11-1997 Time: 13:10:48
RAMP 7 ROAD SIDE DITCH - WORSE CASE (SO. SIDE)
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	-a	5	1451.00	2.76	1.66	0.24	0.242		

NAVAJO COAL COMPANY
NAVAJO MINE

13-Nov-97

PROJECT: Ramp 7 Road Realignment (So side ditch)
ENGINEER lr
FILE NO : 17.3.29
DRWG NO Exhibits 11-119 to 119B

Channel Design

Precipitation Event:	10 yr - 6 hr		
Design Flow	Q10	1.00	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	3.00	
(Z2:1)	Z2 =	12.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	6.30	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.47	0.12	1.34	2.85
0.50	1.88	0.25	8.50	4.53
0.75	4.22	0.37	25.09	5.95
1.00	7.50	0.49	54.08	7.21
1.25	11.72	0.62	98.12	8.37
1.50	16.88	0.74	159.66	9.46
1.75	22.97	0.86	240.95	10.49
2.00	30.00	0.99	344.17	11.47
2.25	37.97	1.11	471.36	12.41
2.50	46.88	1.23	624.49	13.32
2.75	56.72	1.36	805.46	14.20
3.00	67.50	1.48	1016.10	15.05
3.25	79.22	1.60	1258.21	15.88
3.50	91.88	1.73	1533.50	16.69
3.75	105.47	1.85	1843.68	17.48
4.00	120.00	1.97	2190.40	18.25
4.25	135.47	2.10	2575.26	19.01

Flow Depth at Peak Discharge	0.23	Ft
Minimum Channel Depth Required	0.53	Ft
Critical Depth	0.26	Ft
Flow Type	Supercritical flow	
Froude Number	0.99	
Flow Velocity	2.69	fps
Soil Type: sandy clay		
Erosive Velocity	3.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

Pages 145 – 156 Appendix 11-Z
Blank due to removal of CP-113 and CP-114, February 2006.

Pages 157 – 162 Appendix 11-Z
Blank due to removal of CP-115, November 2006.

COAL STOCKPILE BERM

WORST CASE SCENARIO

JULY 15, 1998

Coal Stockpile Berm

A worst case hydrological analysis was done to demonstrate that the typical berm shown on Figure 11-7 is adequate to pass the peak discharge from a 10 yr-24 hr storm event. The watersheds at the Hosteen and Lowe Coal Stockpiles were modeled in Sedcad+ to determine the maximum peak discharge. As a worst case, it was assumed that the berm would control the entire surface runoff from the maximum watershed area. The maximum peak discharge occurs at Lowe Coal Stockpile. The berm is capable of safely passing the peak discharge from the design storm. For more details see the attached Sedcad+ runs.

The watersheds for Barber Stockpile Pond #1 and Hosteen Stockpile Pond #1 were used in the analysis. Refer to Exhibit 11-13C and D for the watershed areas used.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

COAL SROCKPILE BERM - WORST CASE SENARIO (HOSTEEN STOCKPILE)

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\HS_BERM

Date: 07-14-1998

Civil Software Design -- SEDCAD- Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\HS_BERM User: LR
Date: 07-14-1998 Time: 13:58:21
COAL SROCKPILE BERM - WORST CASE SENARIO (HOSTEEN STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	227.00	79	M	0.926	0.000	0.000	0.0	5.79	27.73
			Type: Null		Label: BERM					
111	Structure	227.00							5.79	
111	Total IN/OUT	227.00							5.79	27.73

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Company Name: BHP MINERALS
Filename: C:\LR\HS_BERM User: LR
Date: 07-14-1998 Time: 13:58:21
COAL SROCKPILE BERM - WORST CASE SENARIO (HOSTEEN STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	5600.00	2.82	1.68	0.93	0.926		

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

COAL STOCKPILE BERM - WORST CASE SENARIO (LOWE STOCKPILE)

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\LS_BERM

Date: 07-14-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\LS_BERM User: LR
Date: 07-14-1998 Time: 14:02:32
COAL STOCKPILE BERM - WORST CASE SENARIO (LOWE STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	99.80	89	M	0.792	0.000	0.000	0.0	5.88	39.08
			Type: Null			Label: BERM				
111	Structure	99.80							5.88	
111	Total IN/OUT	99.80							5.88	39.08

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\LS_BERM User: LR
Date: 07-14-1998 Time: 14:02:32
COAL STOCKPILE BERM - WORST CASE SENARIO (LOWE STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	4500.00	2.49	1.58	0.79	0.792		

SEDCAD+ ERODIBLE CHANNEL DESIGN

COAL STOCKPILE BERM - WORST CASE SENARIO

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR
Discharge	39.10 cfs (Lowe Coal Stkp)
Slope	2.00 %
Sideslopes	20.00:1 (L) 1.50:1 (R)
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SPOILS - SHALE AND SANDSTONE
Freeboard	.3 ft

RESULTS:

Actual Discharge	39.10 cfs
Depth	0.87 ft
with Freeboard	1.17 ft
Top Width	18.68 ft
with Freeboard	25.13 ft
Velocity	4.82 fps
Cross Sectional Area	8.11 sq ft
Hydraulic Radius	0.43 ft
Froude Number	1.29

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GORMAN ROAD

DROP STRUCTURE DS-16+04L

THE DROP STRUCTURE LOCATION AND WATERSHED AREA ARE SHOWN ON EXHIBIT 11-12C. THE DESIGN IS PRESENTED ON EXHIBIT 11-87A.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows Into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	DS-16+O4L

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	2.340	2.340	2.38	0.09

Structure Detail:

Structure #1 (Riprap Channel)

DS-16+04L

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.75	2.0:1	2.0:1	33.3	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.38 cfs	
Depth:	0.03 ft	1.03 ft
Top Width:	5.85 ft	9.85 ft
Velocity*:		
X-Section Area:	0.15 sq ft	
Hydraulic Radius:	0.026	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	2.340	0.073	0.000	0.000	89.000	M	2.38	0.094
	Σ	**2.340**						**2.38**	**0.094**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	2.37	29.05	1,224.90	4.610	0.073
#1	**1**	**Time of Concentration:**					**0.073**

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Mason Drainage Along Railroad

The watershed area is presented on a 8 1/2 X 11 sheet attached and on Exhibit 11-12D. The design is presented on Exhibit 11-30 in the PAP.

Updated 10/20/06

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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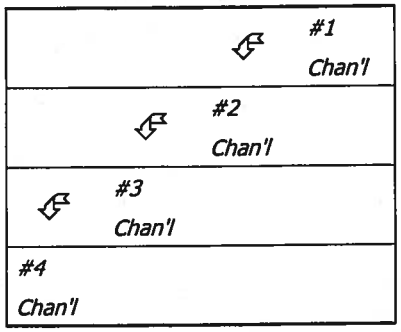
General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#2	0.000	0.000	Max. grade
Channel	#2	==>	#3	0.000	0.000	Riprap A
Channel	#3	==>	#4	0.000	0.000	Riprap B
Channel	#4	==>	End	0.000	0.000	Riprap C



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	5.500	5.500	2.71	0.09
#2	0.000	5.500	2.71	0.09
#3	0.000	5.500	2.71	0.09
#4	0.000	5.500	2.71	0.09

Structure Detail:

Structure #1 (Erodible Channel)

Max. grade

Trapezoidal Erodible Channel Inputs:

Material: Spoils w/sandstone cobbles

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.50	3.0:1	3.0:1	1.8	0.0270	1.00			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.19 ft	1.19 ft
Top Width:	6.66 ft	12.66 ft
Velocity:	2.31 fps	
X-Section Area:	1.17 sq ft	
Hydraulic Radius:	0.175	
Froude Number:	0.97	

Structure #2 (Riprap Channel)

Riprap A

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	3.0:1	3.0:1	12.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.07 ft	1.07 ft
Top Width:	8.39 ft	14.39 ft

	w/o Freeboard	w/ Freeboard
Velocity*:		
X-Section Area:	0.54 sq ft	
Hydraulic Radius:	0.064	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Riprap Channel)

Riprap B

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	2.0:1	2.0:1	10.9	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.09 ft	1.09 ft
Top Width:	5.37 ft	9.37 ft
Velocity*:		
X-Section Area:	0.48 sq ft	
Hydraulic Radius:	0.088	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #4 (Riprap Channel)

Riprap C

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	2.0:1	2.0:1	21.3	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.06 ft	1.06 ft
Top Width:	4.24 ft	8.24 ft
Velocity*:		
X-Section Area:	0.25 sq ft	
Hydraulic Radius:	0.058	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	5.500	0.106	0.000	0.000	80.000	M	2.71	0.089
	Σ	**5.500**						**2.71**	**0.089**
#2	Σ	**5.500**						**2.71**	**0.089**
#3	Σ	**5.500**						**2.71**	**0.089**
#4	Σ	**5.500**						**2.71**	**0.089**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.31	18.00	543.00	1.820	0.082
		8. Large gullies, diversions, and low flowing streams	5.06	30.00	593.00	6.740	0.024
#1	**1**	**Time of Concentration:**					**0.106**

MASON DRAINAGE ALONG RAILROAD
WATERSHED AREA
NTS

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YAZZIE SPOIL SIDE ROAD EAST RIPRAP DOWNDRAIN AT CP-186

The location of the riprap downdrain is presented on Exhibit 11-95A.

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	

#1
Chan'l

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.600	1.600	1.74	0.07

Structure Detail:

Structure #1 (Riprap Channel)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	1.5:1	1.5:1	34.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.74 cfs	
Depth:	0.03 ft	1.03 ft
Top Width:	4.10 ft	7.10 ft
Velocity*:		
X-Section Area:	0.13 sq ft	
Hydraulic Radius:	0.032	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.600	0.059	0.000	0.000	90.000	M	1.74	0.071
	Σ	**1.600**						**1.74**	**0.071**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	3.26	38.00	1,165.00	5.410	0.059
#1	**1**	**Time of Concentration:**					**0.059**

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YAZZIE SPOIL SIDE ROAD WEST RIPRAP DOWNDRAIN AT CP-186

The location of the riprap downdrain is presented on Exhibit 11-95A.

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	

#1
Chan'l

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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.700	1.700	1.85	0.08

Structure Detail:

Structure #1 (Riprap Channel)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	1.5:1	1.5:1	34.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.85 cfs	
Depth:	0.03 ft	1.03 ft
Top Width:	5.08 ft	8.08 ft
Velocity*:		
X-Section Area:	0.13 sq ft	
Hydraulic Radius:	0.026	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.700	0.059	0.000	0.000	90.000	M	1.85	0.075
	Σ	**1.700**						**1.85**	**0.075**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	3.26	38.00	1,165.00	5.410	0.059
#1	**1**	**Time of Concentration:**					**0.059**

Doby Channel Design

The Doby Drainage is approximately 1,630 acres. The watershed is rough with many small depression and contains NAPI fields. Based on the above criteria about 1,570 acres would meet the slow criteria for the Hydrographic Response.

Shawn Smith

Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	See attached SedCad for Downdrain Riprap sizing

#1
Chan'l

Structure Detail:

Structure #1 (Erodible Channel)

See attached SedCad for Downdrain Riprap sizing

Trapezoidal Erodible Channel Inputs:

Material: Alluvial silts colloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
25.00	3.0:1	3.0:1	1.5	0.0250				5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	57.46 cfs	
Depth:	0.49 ft	
Top Width:	27.97 ft	
Velocity:	4.39 fps	
X-Section Area:	13.10 sq ft	
Hydraulic Radius:	0.466 ft	
Froude Number:	1.13	

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
16.00	3.0:1	3.0:1	33.0			

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	50.00 cfs	
Depth:	0.43 ft	
Top Width:	18.61 ft	
Velocity:	6.65 fps	
X-Section Area:	7.52 sq ft	
Hydraulic Radius:	0.401 ft	
Froude Number:	1.84	
Manning's n:	0.0700	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

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Area III Facilities
Sandy Hill Drainage Control

Design for the temporary diversion along the Area III Access Road and Parking Area using a 10 year - 6 hour storm event.

Shawn Smith

Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

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General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Detail:

Structure #4 (Erodible Channel)

Section S-2

Trapezoidal Erodible Channel Inputs:

Material: Sandy loam noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.80	2.0:1	2.0:1	4.2	0.0200				2.5

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.71 cfs	
Depth:	0.06 ft	
Top Width:	5.05 ft	
Velocity:	2.33 fps	
X-Section Area:	0.30 sq ft	
Hydraulic Radius:	0.060 ft	
Froude Number:	1.68	

Structure #5 (Riprap Channel)

Section S-1

Triangular Riprap Channel Inputs:

Material: Riprap

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.0:1	4.0:1	32.0			

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.71 cfs	
Depth:	0.05 ft	
Top Width:	0.43 ft	
Velocity*:		

	w/o Freeboard	w/ Freeboard
X-Section Area:	0.01 sq ft	
Hydraulic Radius:	0.026 ft	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #1 (Erodible Channel)

Section N-2

Trapezoidal Erodible Channel Inputs:

Material: Sandy loam noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.50	4.0:1	4.0:1	1.5	0.0200				2.5

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.89 cfs	
Depth:	0.15 ft	
Top Width:	5.73 ft	
Velocity:	2.41 fps	
X-Section Area:	0.79 sq ft	
Hydraulic Radius:	0.136 ft	
Froude Number:	1.15	

Structure #2 (Riprap Channel)

Section N-1

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	2.5:1	2.0:1	6.8			

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.89 cfs	
Depth:	0.14 ft	
Top Width:	4.65 ft	
Velocity*:		
X-Section Area:	0.62 sq ft	
Hydraulic Radius:	0.132 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Riprap Channel)

Section N-1A

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	3.0:1	2.0:1	24.2			

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.89 cfs	
Depth:	0.04 ft	
Top Width:	4.19 ft	
Velocity*:		
X-Section Area:	0.16 sq ft	
Hydraulic Radius:	0.037 ft	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #6 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#4	1	0.970	0.056	0.000	0.000	82.000	M	0.71	0.020
	Σ	**0.970**						**0.71**	**0.020**
#5	Σ	**0.970**						**0.71**	**0.020**
#1	1	2.580	0.040	0.000	0.000	82.000	M	1.89	0.052
	Σ	**2.580**						**1.89**	**0.052**
#2	Σ	**2.580**						**1.89**	**0.052**
#3	Σ	**2.580**						**1.89**	**0.052**
#6	Σ	**3.550**						**2.61**	**0.072**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	8.00	12.00	150.00	2.820	0.014
		8. Large gullies, diversions, and low flowing streams	2.86	14.00	490.00	5.070	0.026
		8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#1	**1**	**Time of Concentration:**					**0.040**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	9.39	20.00	213.00	3.060	0.019
		8. Large gullies, diversions, and low flowing streams	2.89	18.00	622.00	5.100	0.033
		8. Large gullies, diversions, and low flowing streams	7.81	10.00	128.00	8.380	0.004
#4	**1**	**Time of Concentration:**					**0.056**

APPENDIX 11-Z
Miscellaneous Hydrologic Structures

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BHP Minerals Navajo Mine
Project NM-0003D-I-35 [CP-2 Embankment]
CP-2 Impoundment

1. Proposal

BHP Minerals International, Inc., Navajo Mine hereby submits the proposed installation of a drainage channel from the CP-2 impoundment to the CP-2 culvert. The proposed channel addition will eliminate and detour any water that has collected against the existing railroad embankment to CP-2 culvert.

2. Discussion

2.1 Reason for the proposal

The Office of Surface Mining Albuquerque Field Office (OSM/AFO) did an on-site inspection in June of 1994. The inspection revealed a small impoundment to the N.E. of CP-2 which is now referred to as CP-2 impoundment. The final result of the inspection stated that the total impoundment area was not included within the permit area as required by 30 CFR 773.17(a). A deficiency letter dated June 24, 1994, was sent to BHP from the office of OSM Western Regional Coordinating Center (WRCC) requesting BHP to correct the problem.

2.2 Background to proposal

The propose location of the drainage channel is shown on the attached 8.5" X 11" (copied from EXHIBIT 11-12) drawing. Several concepts were discussed an installing a drainage channel from the impoundment to the culvert CP-2 was agree on with OSM/AFO official and BHP - O.J. Estrada. Additional discussions have been held between the permittee and BHP. All parities are agreeable to the concept. The drainage channel would run parallel with the railroad tracks.

2.3 Drainage

Culvert information for CP-2 is provided on TABLE 11-13 (see CHAPTER 11, page 11-136), and the corresponding watershed are shown in EXHIBIT 11-12 (8.5" X 11" sketch attached). The present watershed configuration for the area of CP-2 will increase from 79.5 acres to 133.5 as noted by the delineation of the watersheds for CP-2.

2.4 Channel Design

The drainage channel will have a gradual slope of approximately .4% from north to south. The grade of channel will come on top of grade at the south end of the channel. The terrain between the impoundment and CP-2 culvert shows signs of sandstone, more so at the south end of the location.

The south end of the proposed drainage channel will stop at approximately 44' from CP-2 culvert, this is due to the elevation change and the existing terrain. Drainage water will have a natural flow atop of sandstone into CP-2 inlet culvert. CP-2 culvert was checked for capacity and adequacy for a peak discharge from a 10-yr, 6-hr event. The peak flow discharge was determined with the SEDCAD+ computer program and also the channel design (attached). Due to the sandstone in the area rip-rap inside the channel will not be required.

3. Reference

Upon approval, the 8.5" X 11" proposed copy will be added to the current EXHIBIT 11-12, "Location of Ponds, Impoundments, and Culverts" and be resubmitted for insertion into the permit.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP2 CULVERT

by

Name: ET

Company Name: BHP MINERALS
File Name: C:\SEDCAD3\CP2CULV

Date: 08-07-1995

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\SEDCAD3\CP2CULV User: ET
Date: 08-07-1995 Time: 12:24:00
CP2 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

GENERAL INPUT TABLE

STORM #1:

User-Defined Distribution

Label: Type II-60

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.013
4	1.5	0.021
5	2.0	0.029
6	2.5	0.039
7	3.0	0.049
8	3.5	0.062
9	4.0	0.076
10	4.5	0.094
11	5.0	0.118
12	5.5	0.156
13	6.0	0.672
14	6.5	0.756
15	7.0	0.789
16	7.5	0.810
17	8.0	0.826
18	8.5	0.837
19	9.0	0.849
20	9.5	0.858
21	10.0	0.867
22	10.5	0.874
23	11.0	0.882
24	11.5	0.888
25	12.0	0.895
26	12.5	0.900
27	13.0	0.906
28	13.5	0.911
29	14.0	0.917
30	14.5	0.922
31	15.0	0.927
32	15.5	0.932
33	16.0	0.937
34	16.5	0.941
35	17.0	0.946
36	17.5	0.950
37	18.0	0.955

38	18.5	0.959
39	19.0	0.963
40	19.5	0.967
41	20.0	0.971
42	20.5	0.975
43	21.0	0.978
44	21.5	0.982
45	22.0	0.986
46	22.5	0.990
47	23.0	0.993
48	23.5	0.997
49	24.0	1.000

****

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\CP2CULV User: ET
Date: 08-07-1995 Time: 12:24:00
CP2 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	54.00	89	M	0.399	0.000	0.000	0.0	2.18	26.29
111	2	79.50	89	M	0.205	0.000	0.000	0.0	3.21	52.21
		Type: Null			Label: cp2 culvert					
111	Structure	133.50							5.39	
111	Total IN/OUT	133.50							5.39	76.61

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\SEDCAD3\CP2CULV User: ET
Date: 08-07-1995 Time: 12:24:00
CP2 CULVERT
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2884.00	4.02	2.01	0.40	0.399		
1	1	1	2	-a	5	2400.00	10.54	3.25	0.21	0.205		

SEDCAD+ CULVERT SIZING UTILITY

cp2 culvert

Design Discharge	=	76.610	cfs
Entrance Loss Coefficient	=	0.5	
Pipe Length	=	183.000	feet
Pipe Slope	=	3.200	%
Manning's n	=	0.016	
Maximum Headwater	=	8.000	feet
Tailwater Depth	=	0.000	feet

Smallest Diameter Required to Pass Flow is 36 inches

PERFORMANCE CURVES:

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	3.00	Inlet (Supercritical)	3
1.60	8.48	Inlet (Supercritical)	3
2.40	15.40	Inlet (Supercritical)	4
3.20	20.73	Inlet	5
4.00	25.01	Inlet	5
4.80	28.64	Inlet	5
5.60	31.87	Inlet	5
6.40	34.81	Inlet	5
7.20	37.49	Inlet	5
8.00	39.52	Outlet	6
8.80	40.80	Outlet	6
9.60	42.04	Outlet	6
10.40	43.25	Outlet	6
11.20	44.42	Outlet	6
12.00	45.56	Outlet	6

Diameter: 30 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	3.75	Inlet (Supercritical)	3
1.60	10.60	Inlet (Supercritical)	3
2.40	19.46	Inlet (Supercritical)	3
3.20	28.89	Inlet	5
4.00	36.21	Inlet	5
4.80	42.29	Inlet	5
5.60	47.60	Inlet	5
6.40	52.37	Inlet	5
7.20	56.75	Inlet	5
8.00	60.81	Inlet	5
8.80	64.61	Inlet	5
9.60	68.20	Inlet	5
10.40	71.62	Inlet	5
11.20	74.88	Inlet	5
12.00	77.55	Outlet	6

Diameter: 36 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	4.50	Inlet (Supercritical)	3
1.60	12.72	Inlet (Supercritical)	3
2.40	23.36	Inlet (Supercritical)	3
3.20	35.96	Inlet (Supercritical)	3
4.00	47.70	Inlet	5
4.80	57.14	Inlet	5
5.60	65.23	Inlet	5
6.40	72.41	Inlet	5
7.20	78.95	Inlet	5
8.00	84.99	Inlet	5
8.80	90.62	Inlet	5
9.60	95.92	Inlet	5
10.40	100.96	Inlet	5
11.20	105.74	Inlet	5
12.00	110.32	Inlet	5

Diameter: 42 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	5.25	Inlet (Supercritical)	3
1.60	14.83	Inlet (Supercritical)	3
2.40	27.25	Inlet (Supercritical)	3
3.20	41.95	Inlet (Supercritical)	3
4.00	58.63	Inlet (Supercritical)	3
4.80	72.28	Inlet	5
5.60	84.01	Inlet	5
6.40	94.29	Inlet	5
7.20	103.55	Inlet	5
8.00	112.06	Inlet	5
8.80	119.96	Inlet	5
9.60	127.37	Inlet	5
10.40	134.37	Inlet	5
11.20	141.03	Inlet	5
12.00	147.39	Inlet	5

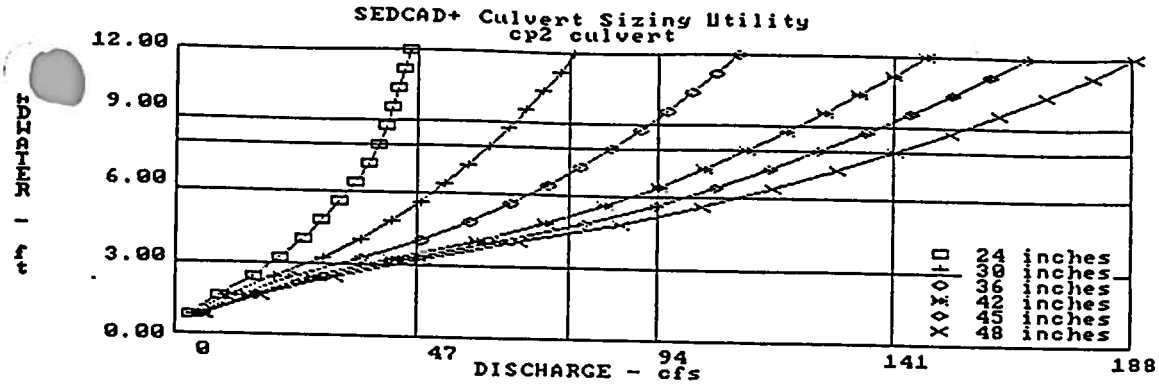
Diameter: 45 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	5.63	Inlet (Supercritical)	3
1.60	15.89	Inlet (Supercritical)	3
2.40	29.20	Inlet (Supercritical)	3
3.20	44.95	Inlet (Supercritical)	3
4.00	62.82	Inlet (Supercritical)	3
4.80	79.63	Inlet	5
5.60	93.58	Inlet	5
6.40	105.70	Inlet	5
7.20	116.57	Inlet	5
8.00	126.51	Inlet	5

8.80	135.72	Inlet	5
9.60	144.35	Inlet	5
10.40	152.48	Inlet	5
11.20	160.21	Inlet	5
12.00	167.58	Inlet	5

Diameter: 48 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.80	5.99	Inlet (Supercritical)	3
1.60	16.95	Inlet (Supercritical)	3
2.40	31.14	Inlet (Supercritical)	3
3.20	47.95	Inlet (Supercritical)	3
4.00	67.00	Inlet (Supercritical)	3
4.80	86.75	Inlet	5
5.60	103.12	Inlet	5
6.40	117.30	Inlet	5
7.20	129.95	Inlet	5
8.00	141.47	Inlet	5
8.80	152.12	Inlet	5
9.60	162.08	Inlet	5
10.40	171.45	Inlet	5
11.20	180.34	Inlet	5
12.00	188.82	Inlet	5


SEDCAD+ Culvert Sizing Utility
cp2 culvert
12.00
9.00
6.00
3.00
0.00
HEADWATER - ft
0
47
94
141
188
DISCHARGE - cfs
24 inches
30 inches
36 inches
42 inches
45 inches
48 inches

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

RAILROAD SIDE DITCH/CHANNEL AT CP-2

by

Name: ET

Company Name: BHP MINERALS
File Name: C:\SEDCAD\CP2CHAN

Date: 08-07-1995

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\SEDCAD\CP2CHAN User: ET
Date: 08-07-1995 Time: 12:44:01
RAILROAD SIDE DITCH/CHANNEL AT CP-2
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

==========
GENERAL INPUT TABLE
==========

STORM #1:

User-Defined Distribution

Label: Type II-60

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.013
4	1.5	0.021
5	2.0	0.029
6	2.5	0.039
7	3.0	0.049
8	3.5	0.062
9	4.0	0.076
10	4.5	0.094
11	5.0	0.118
12	5.5	0.156
13	6.0	0.672
14	6.5	0.756
15	7.0	0.789
16	7.5	0.810
17	8.0	0.826
18	8.5	0.837
19	9.0	0.849
20	9.5	0.858
21	10.0	0.867
22	10.5	0.874
23	11.0	0.882
24	11.5	0.888
25	12.0	0.895
26	12.5	0.900
27	13.0	0.906
28	13.5	0.911
29	14.0	0.917
30	14.5	0.922
31	15.0	0.927
32	15.5	0.932
33	16.0	0.937
34	16.5	0.941
35	17.0	0.946
36	17.5	0.950
37	18.0	0.955

38	18.5	0.959
39	19.0	0.963
40	19.5	0.967
41	20.0	0.971
42	20.5	0.975
43	21.0	0.978
44	21.5	0.982
45	22.0	0.986
46	22.5	0.990
47	23.0	0.993
48	23.5	0.997
49	24.0	1.000

****

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\SEDCAD\CP2CHAN User: ET
Date: 08-07-1995 Time: 12:44:01
RAILROAD SIDE DITCH/CHANNEL AT CP-2
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	54.00	89	M	0.399	0.000	0.000	0.0	2.18	26.29
		Type: Null			Label: channel					
111	Structure	54.00							2.18	
111	Total IN/OUT	54.00							2.18	26.29

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\SEDCAD\CP2CHAN User: ET
Date: 08-07-1995 Time: 12:44:01
RAILROAD SIDE DITCH/CHANNEL AT CP-2
Storm: 1.30 inches, 10 year- 6 hour, Type II-60
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	2884.00	4.02	2.01	0.40	0.399		

SEDCAD+ ERODIBLE CHANNEL DESIGN

RAILROAD SIDE DITCH/CHANNEL AT CP-2

Limiting Velocity Technique
Sediment-laden Water

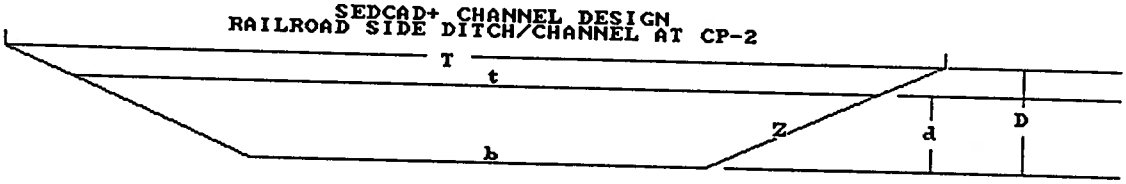
INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	26.30 cfs	
Slope	0.40 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Bottom Width	15.00 ft	
Manning's n	0.025	
Max. Velocity	6.00 fps	
Material	SANDSTONE	
Freeboard	1 ft	

RESULTS:

Actual Discharge	26.30 cfs
Depth	0.62 ft
with Freeboard	1.62 ft
Top Width	17.50 ft
with Freeboard	21.50 ft
Velocity	2.59 fps
Cross Sectional Area	10.15 sq ft
Hydraulic Radius	0.57 ft
Froude Number	0.60

SEDCAD+ CHANNEL DESIGN
RAILROAD SIDE DITCH/CHANNEL AT CP-2



MATERIAL: SANDSTONE
Limiting Variable: Velocity = 6.000 fps
Sediment-laden Water

Discharge	=	26.30 cfs					
Bottom (b)	=	15.00 ft					
Side slopes (Z)	=	2.0:1(L)	2.0:1(R)				
Bed Slope	=	0.40 %					
Manning's n	=	0.025					
Depth (d)	=	0.62	(D =	1.62)	ft	w/ Freeboard:	
Top width (t)	=	17.50	(T =	21.50)	ft		
Velocity	=	2.59 fps					
Hydraulic Radius	=	0.57 ft					
Froude number	=	0.60					

Area III Shop Temporary Diversion

Design:

The temporary diversion ditch is located on the eastern edge of the lease line at the Area III facilities. The ditch is designed for a 2 yr. - 6 hr storm event. The purpose of the berm/embankment is to divert surface runoff from a 602.3 ac watershed that is presently flowing through CP-36 (into the Area III Shop Pond) and route the runoff through CP-35. The combined watershed diverted to CP-35 is 662.4 ac. The ditch is an approximately 3 ft. berm with side slopes ranging from 1.5/1.0 to 3/1. Two additional 24" culverts were added at CP-35 to accommodate the additional flow.

A 3.0 ac watershed associated with the southern end of the diversion is itemized because it represents the amount of runoff to which the southern end of the diversion would be exposed. The diversion channel is not riprapped and a summary of the hydrology and design data is provided below. The design data in conjunction with EXHIBIT 11-116, provide justification for the unarmored channel. The southern end of the ditch from station 0 + 00 to 6 + 00 will have an insignificant amount of flow due to the small watershed, therefore no riprap will be required in this area.

	Channel Slope	Erosive Velocity	Flow Velocity	Riprap Required	Minimum Depth of Channel
Station 4 + 91 to 6 + 71	2.72 %	3.5 fps	2.51 fps	No	0.70 ft
Station 6 + 71 to 7 + 35	2.23 %	3.5 fps	2.24 fps	No	0.68 ft
Station 7 + 35 to 13 + 22	1.00 %	5.0 fps	3.54 fps	No	1.67 ft

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

2YR-6HR FOR BERM FOR CP-36 DITCH

by

Name: bts

Company Name: BHP MINERALS
File Name: C:\BRIAN\TEST

Date: 02-16-1996

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST User: bts
Date: 02-16-1996 Time: 15:20:51
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	602.30	89	M	2.787	0.000	0.000	0.0	8.57	26.41
		Type: Null			Label: Area III Temp Div					
111	Structure	602.30							8.57	
111	Total IN/OUT	602.30							8.57	26.41

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST User: bts
Date: 02-16-1996 Time: 15:20:51
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	12000.00	1.43	1.20	2.79	2.787		

BHP MINERALS
NAVAJO MINE

22-Apr-96

PROJECT: Area III Shop Temporary Diversion
ENGINEER BTS
FILE NO :
DRWG NO Exhibit 11-116

Channel Design

Precipitation Event:	2yr-6hr		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	3.00	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.00	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.25	0.12	0.28	1.13
0.50	1.00	0.24	1.80	1.80
0.75	2.25	0.36	5.31	2.36
1.00	4.00	0.48	11.46	2.86
1.25	6.25	0.61	20.79	3.33
1.50	9.00	0.73	33.82	3.76
1.75	12.25	0.85	51.05	4.17
2.00	16.00	0.97	72.91	4.56
2.25	20.25	1.09	99.86	4.93
2.50	25.00	1.21	132.30	5.29
2.75	30.25	1.33	170.64	5.64
3.00	36.00	1.45	215.26	5.98
3.25	42.25	1.57	266.55	6.31
3.50	49.00	1.69	324.87	6.63
3.75	56.25	1.82	390.59	6.94
4.00	64.00	1.94	464.04	7.25
4.25	72.25	2.06	545.57	7.55

Flow Depth at Peak Discharge	1.37 Ft
Minimum Channel Depth Required	1.67 Ft
Critical Depth	1.23 Ft
Flow Type	Subcritical flow
Froude Number	0.53
Flow Velocity	3.54 fps
Soil Type: Clay	
Erosive Velocity	5.00 fps

Flow Velocity Is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

2YR-6HR FOR BERM FOR CP-36 DITCH

by

Name: bts

Company Name: BHP MINERALS
File Name: C:\BRIAN\TEST

Date: 02-16-1996

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST User: bts
Date: 02-16-1996 Time: 15:18:49
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingu K (hr)
1	1	1	1	-a	5	750.00	4.53	2.13	0.10	0.097	

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BRIAN\TEST User: bts
Date: 02-16-1996 Time: 15:18:49
2yr-6hr for berm for cp-36 ditch
Storm: 0.80 inches, 2 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharg (cfs)
111	1	3.00	89	M	0.097	0.000	0.000	0.0	0.04	1.29
		Type: Null			Label: Area III Temp Div					
111	Structure	3.00							0.04	
111	Total IN/OUT	3.00							0.04	1.29

BHP MINERALS
NAVAJO MINE

22-Apr-96

PROJECT: Area III Shop Temporary Diversion
ENGINEER BTS
FILE NO :
DRWG NO Exhibit 11-116

Channel Design

Precipitation Event:	2yr-6hr		
Design Flow	Q10	1.29	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.72	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.20	0.12	0.37	1.83
0.50	0.81	0.24	2.37	2.91
0.75	1.83	0.35	6.99	3.82
1.00	3.25	0.47	15.07	4.64
1.25	5.08	0.59	27.34	5.38
1.50	7.31	0.71	44.49	6.08
1.75	9.95	0.82	67.14	6.75
2.00	13.00	0.94	95.90	7.38
2.25	16.45	1.06	131.34	7.98
2.50	20.31	1.18	174.00	8.57
2.75	24.58	1.29	224.43	9.13
3.00	29.25	1.41	283.12	9.68
3.25	34.33	1.53	350.58	10.21
3.50	39.81	1.65	427.29	10.73
3.75	45.70	1.77	513.72	11.24
4.00	52.00	1.88	610.33	11.74
4.25	58.70	2.00	717.56	12.22

Flow Depth at Peak Discharge		0.40 Ft
Minimum Channel Depth Required		0.70 Ft
Critical Depth		0.40 Ft
Flow Type		Subcritical flow
Froude Number		0.70
Flow Velocity		2.51 fps
Soil Type:	Sandy Clay	
Erosive Velocity		3.50 fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

BHP MINERALS
NAVAJO MINE

22-Apr-96

PROJECT: Area III Shop Temporary Diversion
ENGINEER BTS
FILE NO :
DRWG NO Exhibit 11-116

Channel Design

Precipitation Event:	2yr-6hr		
Design Flow	Q10	1.29	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	3.00	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.23	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.25	0.12	0.42	1.69
0.50	1.00	0.24	2.69	2.69
0.75	2.25	0.36	7.94	3.53
1.00	4.00	0.48	17.11	4.28
1.25	6.25	0.61	31.04	4.97
1.50	9.00	0.73	50.51	5.61
1.75	12.25	0.85	76.23	6.22
2.00	16.00	0.97	108.88	6.81
2.25	20.25	1.09	149.12	7.36
2.50	25.00	1.21	197.56	7.90
2.75	30.25	1.33	254.81	8.42
3.00	36.00	1.45	321.46	8.93
3.25	42.25	1.57	398.05	9.42
3.50	49.00	1.69	485.14	9.90
3.75	56.25	1.82	583.27	10.37
4.00	64.00	1.94	692.96	10.83
4.25	72.25	2.06	814.71	11.28

Flow Depth at Peak Discharge	0.38	Ft
Minimum Channel Depth Required	0.68	Ft
Critical Depth	0.37	Ft
Flow Type	Subcritical flow	
Froude Number	0.64	
Flow Velocity	2.24	fps
Soil Type: Sandy Clay		
Erosive Velocity	3.50	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

Pages 29 – 124 Appendix 11-Z

Blank due to Removal of Area III Dragline Erection Site

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT: A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER: BEN HOSKIE
FILE NO:
DRWG NO: EXHIBIT 11-116A
MMD REF:

Channel Design: STA. 6+00

Precipitation Event:	2YR 6HR		
Design Flow	Q10	1.29	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	5.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.28	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.20	0.12	0.34	1.68
0.50	0.81	0.24	2.17	2.67
0.75	1.83	0.35	6.40	3.50
1.00	3.25	0.47	13.80	4.24
1.25	5.08	0.59	25.03	4.93
1.50	7.31	0.71	40.73	5.57
1.75	9.95	0.82	61.47	6.18
2.00	13.00	0.94	87.80	6.75
2.25	16.45	1.06	120.25	7.31
2.50	20.31	1.18	159.31	7.84
2.75	24.58	1.29	205.48	8.36
3.00	29.25	1.41	259.21	8.86
3.25	34.33	1.53	320.98	9.35
3.50	39.81	1.65	391.21	9.83
3.75	45.70	1.77	470.34	10.29
4.00	52.00	1.88	558.78	10.75
4.25	58.70	2.00	656.97	11.19

Flow Depth at Peak Discharge	0.42	Ft
Minimum Channel Depth Required	0.72	Ft
Critical Depth	0.40	Ft
Flow Type	Subcritical flow	
Froude Number	0.65	
Flow Velocity	2.37	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15; Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas Chapter 3: B.J. Barfield and R.C. Warner University of Kentucky

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT: A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER: BEN HOSKIE
FILE NO:
DRWG NO: EXHIBIT 11-116A
MMD REF.

Channel Design: @ STA 8+00

Precipitation Event:	2YR-6HR		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	2.00	
(Z2:1)	Z2 =	4.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.44	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.19	0.12	0.25	1.33
0.50	0.75	0.24	1.59	2.12
0.75	1.69	0.35	4.70	2.79
1.00	3.00	0.47	10.13	3.38
1.25	4.69	0.59	18.39	3.92
1.50	6.75	0.71	29.92	4.43
1.75	9.19	0.83	45.15	4.91
2.00	12.00	0.94	64.49	5.37
2.25	15.19	1.06	88.32	5.82
2.50	18.75	1.18	117.01	6.24
2.75	22.69	1.30	150.92	6.65
3.00	27.00	1.42	190.39	7.05
3.25	31.69	1.53	235.75	7.44
3.50	36.75	1.65	287.34	7.82
3.75	42.19	1.77	345.46	8.19
4.00	48.00	1.89	410.42	8.55
4.25	54.19	2.00	482.54	8.90

Flow Depth at Peak Discharge	1.44	Ft
Minimum Channel Depth Required	1.74	Ft
Critical Depth	1.37	Ft
Flow Type	Subcritical flow	
Froude Number	0.63	
Flow Velocity	4.31	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15;
   Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
   Chapter 3; B.J. Barfield and R.C. Warner
   University of Kentucky

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT: A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER: BEN HOSKIE
FILE NO :
DRWG NO : EXHIBIT 11-116A
MMD REF.

Channel Design: @ STA 10+00

Precipitation Event:	2YR-6HR		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	4.60	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.19	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.19	0.12	0.23	1.21
0.50	0.76	0.23	1.47	1.92
0.75	1.72	0.35	4.33	2.52
1.00	3.05	0.47	9.34	3.06
1.25	4.77	0.59	16.94	3.56
1.50	6.86	0.70	27.57	4.02
1.75	9.34	0.82	41.60	4.45
2.00	12.20	0.94	59.42	4.87
2.25	15.44	1.05	81.38	5.27
2.50	19.06	1.17	107.82	5.66
2.75	23.07	1.29	139.07	6.03
3.00	27.45	1.41	175.44	6.39
3.25	32.22	1.52	217.24	6.74
3.50	37.36	1.64	264.77	7.09
3.75	42.89	1.76	318.33	7.42
4.00	48.80	1.87	378.19	7.75
4.25	55.09	1.99	444.64	8.07

Flow Depth at Peak Discharge	1.48	Ft
Minimum Channel Depth Required	1.78	Ft
Critical Depth	1.37	Ft
Flow Type	Subcritical flow	
Froude Number	0.58	
Flow Velocity	3.98	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15;
   Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
   Chapter 3; B.J. Barfield and R.C. Warner
   University of Kentucky

BHP MINERALS
NAVAJO MINE

07-Aug-97

PROJECT: A-III TEMPORARY DIVERSION AS-BUILT HYDROLOGY
ENGINEER: BEN HOSKIE
FILE NO:
DRWG NO: EXHIBIT 11-116A
MMD REF:

Channel Design: WORST CASE SCENARIO STA. 6+00 TO 13+23.69

Precipitation Event:	2YR-6HR		
Design Flow	Q10	26.41	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.50	
(Z2:1)	Z2 =	4.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.44	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.17	0.12	0.23	1.32
0.50	0.69	0.23	1.44	2.10
0.75	1.55	0.35	4.26	2.75
1.00	2.75	0.46	9.19	3.34
1.25	4.30	0.58	16.67	3.88
1.50	6.19	0.70	27.12	4.38
1.75	8.42	0.81	40.93	4.86
2.00	11.00	0.93	58.47	5.32
2.25	13.92	1.04	80.07	5.75
2.50	17.19	1.16	106.09	6.17
2.75	20.80	1.28	136.83	6.58
3.00	24.75	1.39	172.61	6.97
3.25	29.05	1.51	213.74	7.36
3.50	33.69	1.62	260.51	7.73
3.75	38.67	1.74	313.20	8.10
4.00	44.00	1.86	372.10	8.46
4.25	49.67	1.97	437.48	8.81

Flow Depth at Peak Discharge	1.49	Ft
Minimum Channel Depth Required	1.79	Ft
Critical Depth	1.42	Ft
Flow Type	Subcritical flow	
Froude Number	0.63	
Flow Velocity	4.36	fps
Soil Type: CLAY		
Erosive Velocity	5.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference:
1. Hydraulic Engineering Circular No. 15; Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas Chapter 3; B.J. Barfield and R.C. Warner University of Kentucky

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-122 BIGHAN RAMP7 ROAD

by

Name: RY

Company Name: BHP MINERALS
File Name: C:\LR\DATA\BHR7_CP1

Date: 10-08-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\DATA\BHR7_CP1 User: RY
Date: 10-08-1997 Time: 14:22:37
CP-122 BIGHAN RAMP7 ROAD
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

BS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
11	1	13.04	78	M	0.293	0.000	0.000	0.0	0.17	2.26
			Type: Null		Label: CP-122					
11	Structure	13.04							0.17	
11	Total IN/OUT	13.04							0.17	2.26

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\DATA\BHR7_CP1 User: RY
Date: 10-08-1997 Time: 14:22:37
CP-122 BIGHAN RAMP7 ROAD
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	-a	5	1311.58	1.54	1.24	0.29	0.293		

SEDCAD+ CULVERT SIZING UTILITY

CULVERT CP-122

Design Discharge	=	2.260 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	54.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.018
Maximum Headwater	=	4.000 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 9 inches

PERFORMANCE CURVES:

Diameter: 6 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.10	Outlet (Subcritical)	1
0.80	0.20	Outlet (Subcritical)	1
1.20	0.30	Outlet (Subcritical)	2
1.60	0.41	Outlet (Subcritical)	2
2.00	0.51	Inlet (Supercritical)	3
2.40	0.61	Inlet (Supercritical)	4
2.80	0.71	Inlet (Supercritical)	4
3.20	0.81	Inlet	5
3.60	0.91	Inlet	5
4.00	1.00	Outlet	6
4.40	1.04	Outlet	6
4.80	1.07	Outlet	6
5.20	1.10	Outlet	6
5.60	1.14	Outlet	6
6.00	1.17	Outlet	6

Diameter: 8 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.41	Outlet (Subcritical)	2
0.80	0.82	Inlet	5
1.20	1.08	Outlet	6
1.60	1.22	Outlet	6
2.00	1.36	Outlet	6
2.40	1.50	Outlet	6
2.80	1.64	Outlet	6
3.20	1.78	Outlet	6
3.60	1.92	Outlet	6
4.00	2.04	Outlet	6
4.40	2.12	Outlet	6
4.80	2.20	Outlet	6
5.20	2.29	Outlet	6
5.60	2.37	Outlet	6
6.00	2.46	Outlet	6

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.50	Outlet (Subcritical)	1
0.80	1.00	Outlet (Subcritical)	1
1.20	1.28	Outlet (Subcritical)	2
1.60	1.57	Inlet (Supercritical)	4
2.00	1.85	Inlet	5
2.40	2.07	Outlet	6
2.80	2.22	Outlet	6
3.20	2.37	Outlet	6
3.60	2.52	Outlet	6
4.00	2.67	Outlet	6
4.40	2.82	Outlet	6
4.80	2.98	Outlet	6
5.20	3.09	Outlet	6
5.60	3.20	Outlet	6
6.00	3.31	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.01	Outlet (Subcritical)	1
0.80	1.62	Outlet (Subcritical)	1
1.20	2.35	Inlet (Supercritical)	3
1.60	3.14	Outlet	6
2.00	3.58	Outlet	6
2.40	4.02	Outlet	6
2.80	4.36	Outlet	6
3.20	4.70	Outlet	6
3.60	5.04	Outlet	6
4.00	5.32	Outlet	6
4.40	5.60	Outlet	6
4.80	5.88	Outlet	6
5.20	6.14	Outlet	6
5.60	6.37	Outlet	6
6.00	6.61	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	1.53	Outlet (Subcritical)	1
0.80	2.14	Outlet (Subcritical)	1
1.20	2.98	Outlet (Subcritical)	1
1.60	4.84	Inlet	5
2.00	5.75	Outlet	6
2.40	6.48	Outlet	6
2.80	7.15	Outlet	6
3.20	7.75	Outlet	6
3.60	8.31	Outlet	6
4.00	8.84	Outlet	6

4.40	9.33	Outlet	6
4.80	9.80	Outlet	6
5.20	10.25	Outlet	6
5.60	10.68	Outlet	6
6.00	11.10	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.40	0.86	Inlet (Supercritical)	3
0.80	2.26	Inlet (Supercritical)	3
1.20	3.63	Outlet (Subcritical)	2 *
1.60	5.52	Outlet (Subcritical)	1 *
2.00	8.18	Outlet	6
2.40	9.39	Outlet	6
2.80	10.46	Outlet	6
3.20	11.43	Outlet	6
3.60	12.32	Outlet	6
4.00	13.16	Outlet	6
4.40	13.94	Outlet	6
4.80	14.68	Outlet	6
5.20	15.39	Outlet	6
5.60	16.07	Outlet	6
6.00	16.71	Outlet	6

* (Transition Region - Data may need to be smoothed.)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

CP-123 HYDROLOGY

by

Name: BEN HOSKIE

Company Name: BHP MINERALS
File Name: C:\BEN\VINNEL\CP123\CP_123

Date: 08-19-1998

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\BEN\VINNEL\CP123\CP_123 User: BEN HOSKIE
Date: 08-19-1998 Time: 11:41:00
CP-123 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-60
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	187.40	76	M	1.830	0.000	0.000	0.0	1.70	6.32
			Type: Null		Label: CP-123					
111	Structure	187.40							1.70	
111	Total IN/OUT	187.40							1.70	6.32

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\BEN\VINNEL\CP123\CP_123 User: BEN HOSKIE
Date: 08-19-1998 Time: 11:41:00
CP-123 HYDROLOGY
Storm: 1.30 inches, 10 year- 6 hour, type II-60
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	6785.00	1.06	1.03	1.83	1.830		

SEDCAD+ CULVERT SIZING UTILITY

CP-123

Design Discharge	=	6.320 cfs
Entrance Loss Coefficient	=	0.9
Pipe Length	=	50.000 feet
Pipe Slope	=	1.000 %
Manning's n	=	0.018
Maximum Headwater	=	3.300 feet
Tailwater Depth	=	0.000 feet

Smallest Diameter Required to Pass Flow is 15 inches

PERFORMANCE CURVES:

Diameter: 9 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.41		0
0.66	0.83	Outlet (Subcritical)	1
0.99	1.14	Outlet (Subcritical)	2
1.32	1.39	Inlet (Supercritical)	3
1.65	1.63	Inlet (Supercritical)	4
1.98	1.88	Inlet	5
2.31	2.07	Outlet	6
2.64	2.20	Outlet	6
2.97	2.33	Outlet	6
3.30	2.46	Outlet	6
3.63	2.59	Outlet	6
3.96	2.72	Outlet	6
4.29	2.86	Outlet	6
4.62	2.99	Outlet	6
4.95	3.08	Outlet	6

Diameter: 12 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.80	Outlet (Subcritical)	1
0.66	1.39	Outlet (Subcritical)	1
0.99	1.91	Outlet (Subcritical)	1
1.32	2.66	Inlet (Supercritical)	4
1.65	3.22	Outlet	6
1.98	3.60	Outlet	6
2.31	3.98	Outlet	6
2.64	4.28	Outlet	6
2.97	4.58	Outlet	6
3.30	4.88	Outlet	6
3.63	5.14	Outlet	6
3.96	5.39	Outlet	6
4.29	5.63	Outlet	6
4.62	5.87	Outlet	6
4.95	6.10	Outlet	6

Diameter: 15 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	1.39	Outlet (Subcritical)	1
0.66	1.88	Outlet (Subcritical)	1
0.99	2.53	Outlet (Subcritical)	1
1.32	3.49	Outlet (Subcritical)	1
1.65	5.05	Outlet	6
1.98	5.75	Outlet	6
2.31	6.39	Outlet	6
2.64	6.98	Outlet	6
2.97	7.50	Outlet	6
3.30	8.02	Outlet	6
3.63	8.47	Outlet	6
3.96	8.93	Outlet	6
4.29	9.34	Outlet	6
4.62	9.75	Outlet	6
4.95	10.14	Outlet	6

Diameter: 18 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.71	Outlet (Subcritical)	2
0.66	1.71	Inlet (Supercritical)	3
0.99	3.06	Inlet (Supercritical)	3
1.32	3.96	Outlet (Subcritical)	1 *
1.65	5.81	Outlet (Subcritical)	1
1.98	8.14	Outlet	6
2.31	9.19	Outlet	6
2.64	10.13	Outlet	6
2.97	11.00	Outlet	6
3.30	11.79	Outlet	6
3.63	12.53	Outlet	6
3.96	13.24	Outlet	6
4.29	13.91	Outlet	6
4.62	14.55	Outlet	6
4.95	15.16	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 21 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.78	Outlet (Subcritical)	2
0.66	1.97	Inlet (Supercritical)	3
0.99	3.62	Inlet (Supercritical)	3
1.32	5.56	Inlet (Supercritical)	3
1.65	6.77	Outlet (Subcritical)	1 *
1.98	8.86	Outlet (Subcritical)	1
2.31	12.17	Outlet	6
2.64	13.60	Outlet	6
2.97	14.90	Outlet	6
3.30	16.09	Outlet	6
3.63	17.20	Outlet	6
3.96	18.25	Outlet	6
4.29	19.23	Outlet	6
4.62	20.17	Outlet	6
4.95	21.07	Outlet	6

* (Transition Region - Data may need to be smoothed.)

Diameter: 24 inches

Headwater (ft)	Discharge (cfs)	Control	Flow Type
0.33	0.86	Inlet (Supercritical)	3
0.66	2.26	Inlet (Supercritical)	3
0.99	4.13	Inlet (Supercritical)	3
1.32	6.36	Inlet (Supercritical)	3
1.65	8.88	Inlet (Supercritical)	3
1.98	9.91	Outlet (Subcritical)	1 *
2.31	12.70	Outlet (Subcritical)	1
2.64	17.11	Inlet	5
2.97	19.07	Outlet	6
3.30	20.77	Outlet	6
3.63	22.34	Outlet	6
3.96	23.81	Outlet	6
4.29	25.20	Outlet	6
4.62	26.51	Outlet	6
4.95	27.76	Outlet	6

* (Transition Region - Data may need to be smoothed.)

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

RAMP 7 ROAD SIDE DITCH - WORSE CASE (SO. SIDE)

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\DATA\R7RDSD

Date: 11-11-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\DATA\R7RDSD User: LR
Date: 11-11-1997 Time: 13:10:48
RAMP 7 ROAD SIDE DITCH - WORSE CASE (SO. SIDE)
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

==========
SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
==========

-Hydrology-

3S	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
11	1	7.85	75	M	0.242	0.000	0.000	0.0	0.07	0.92
		Type: Null			Label: SIDE DITCH-SO. SIDE					
11	Structure	7.85							0.07	
11	Total IN/OUT	7.85							0.07	0.92

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\DATA\R7RDSD User: LR
Date: 11-11-1997 Time: 13:10:48
RAMP 7 ROAD SIDE DITCH - WORSE CASE (SO. SIDE)
Storm: 1.30 inches, 10 year- 6 hour, Type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	-a	5	1451.00	2.76	1.66	0.24	0.242		

NAVAJO COAL COMPANY
NAVAJO MINE

13-Nov-97

PROJECT: Ramp 7 Road Realignment (So side ditch)
ENGINEER lr
FILE NO : 17.3.29
DRWG NO Exhibits 11-119 to 119B

Channel Design

Precipitation Event:	10 yr - 6 hr		
Design Flow	Q10	1.00	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	3.00	
(Z2:1)	Z2 =	12.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	6.30	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.47	0.12	1.34	2.85
0.50	1.88	0.25	8.50	4.53
0.75	4.22	0.37	25.09	5.95
1.00	7.50	0.49	54.08	7.21
1.25	11.72	0.62	98.12	8.37
1.50	16.88	0.74	159.66	9.46
1.75	22.97	0.86	240.95	10.49
2.00	30.00	0.99	344.17	11.47
2.25	37.97	1.11	471.36	12.41
2.50	46.88	1.23	624.49	13.32
2.75	56.72	1.36	805.46	14.20
3.00	67.50	1.48	1016.10	15.05
3.25	79.22	1.60	1258.21	15.88
3.50	91.88	1.73	1533.50	16.69
3.75	105.47	1.85	1843.68	17.48
4.00	120.00	1.97	2190.40	18.25
4.25	135.47	2.10	2575.26	19.01

Flow Depth at Peak Discharge	0.23	Ft
Minimum Channel Depth Required	0.53	Ft
Critical Depth	0.26	Ft
Flow Type	Supercritical flow	
Froude Number	0.99	
Flow Velocity	2.69	fps
Soil Type: sandy clay		
Erosive Velocity	3.00	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

Pages 145 – 156 Appendix 11-Z
Blank due to removal of CP-113 and CP-114. February 2006.

Pages 157 – 162 Appendix 11-Z
Blank due to removal of CP-115. November 2006.

COAL STOCKPILE BERM

WORST CASE SCENARIO

JULY 15, 1998

Coal Stockpile Berm

A worst case hydrological analysis was done to demonstrate that the typical berm shown on Figure 11-7 is adequate to pass the peak discharge from a 10 yr-24 hr storm event. The watersheds at the Hosteen and Lowe Coal Stockpiles were modeled in Sedcad+ to determine the maximum peak discharge. As a worst case, it was assumed that the berm would control the entire surface runoff from the maximum watershed area. The maximum peak discharge occurs at Lowe Coal Stockpile. The berm is capable of safely passing the peak discharge from the design storm. For more details see the attached Sedcad+ runs.

The watersheds for Barber Stockpile Pond #1 and Hosteen Stockpile Pond #1 were used in the analysis. Refer to Exhibit 11-13C and D for the watershed areas used.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

COAL SROCKPILE BERM - WORST CASE SENARIO (HOSTEEN STOCKPILE)

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\HS_BERM

Date: 07-14-1998

Civil Software Design -- SEDCAD- Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\HS_BERM User: LR
Date: 07-14-1998 Time: 13:58:21
COAL SROCKPILE BERM - WORST CASE SENARIO (HOSTEEN STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	227.00	79	M	0.926	0.000	0.000	0.0	5.79	27.73
			Type: Null			Label: BERM				
111	Structure	227.00							5.79	
111	Total IN/OUT	227.00							5.79	27.73

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: C:\LR\HS_BERM User: LR
Date: 07-14-1998 Time: 13:58:21
COAL SROCKPILE BERM - WORST CASE SENARIO (HOSTEEN STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	5600.00	2.82	1.68	0.93	0.926		

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

COAL STOCKPILE BERM - WORST CASE SENARIO (LOWE STOCKPILE)

by

Name: LR

Company Name: BHP MINERALS
File Name: C:\LR\LS_BERM

Date: 07-14-1998

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\LS_BERM User: LR
Date: 07-14-1998 Time: 14:02:32
COAL STOCKPILE BERM - WORST CASE SENARIO (LOWE STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	99.80	89	M	0.792	0.000	0.000	0.0	5.88	39.08
			Type: Null			Label: BERM				
111	Structure	99.80							5.88	
111	Total IN/OUT	99.80							5.88	39.08

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\LR\LS_BERM User: LR
Date: 07-14-1998 Time: 14:02:32
COAL STOCKPILE BERM - WORST CASE SENARIO (LOWE STOCKPILE)
Storm: 1.60 inches, 10 year-24 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	4500.00	2.49	1.58	0.79	0.792		

SEDCAD+ ERODIBLE CHANNEL DESIGN

COAL STOCKPILE BERM - WORST CASE SENARIO

Limiting Velocity Technique
Sediment-laden Water

INPUT VALUES:

Shape	TRIANGULAR
Discharge	39.10 cfs (Lowe Coal Stkp)
Slope	2.00 %
Sideslopes	20.00:1 (L) 1.50:1 (R)
Manning's n	0.025
Max. Velocity	5.00 fps
Material	SPOILS - SHALE AND SANDSTONE
Freeboard	.3 ft

RESULTS:

Actual Discharge	39.10 cfs
Depth	0.87 ft
with Freeboard	1.17 ft
Top Width	18.68 ft
with Freeboard	25.13 ft
Velocity	4.82 fps
Cross Sectional Area	8.11 sq ft
Hydraulic Radius	0.43 ft
Froude Number	1.29

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GORMAN ROAD

DROP STRUCTURE DS-16+04L

THE DROP STRUCTURE LOCATION AND WATERSHED AREA ARE SHOWN ON EXHIBIT 11-12C. THE DESIGN IS PRESENTED ON EXHIBIT 11-87A.

RYazzie

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	DS-16+O4L

#1
Chan'l

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	2.340	2.340	2.38	0.09

Structure Detail:

Structure #1 (Riprap Channel)

DS-16+04L

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.75	2.0:1	2.0:1	33.3	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.38 cfs	
Depth:	0.03 ft	1.03 ft
Top Width:	5.85 ft	9.85 ft
Velocity*:		
X-Section Area:	0.15 sq ft	
Hydraulic Radius:	0.026	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	2.340	0.073	0.000	0.000	89.000	M	2.38	0.094
	Σ	**2.340**						**2.38**	**0.094**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	2.37	29.05	1,224.90	4.610	0.073
#1	**1**	**Time of Concentration:**					**0.073**

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Mason Drainage Along Railroad

The watershed area is presented on a 8 1/2 X 11 sheet attached and on Exhibit 11-12D. The design is presented on Exhibit 11-30 in the PAP.

Updated 10/20/06

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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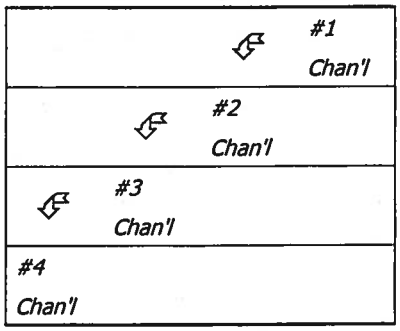
General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#2	0.000	0.000	Max. grade
Channel	#2	==>	#3	0.000	0.000	Riprap A
Channel	#3	==>	#4	0.000	0.000	Riprap B
Channel	#4	==>	End	0.000	0.000	Riprap C



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	5.500	5.500	2.71	0.09
#2	0.000	5.500	2.71	0.09
#3	0.000	5.500	2.71	0.09
#4	0.000	5.500	2.71	0.09

Structure Detail:

Structure #1 (Erodible Channel)

Max. grade

Trapezoidal Erodible Channel Inputs:

Material: Spoils w/sandstone cobbles

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.50	3.0:1	3.0:1	1.8	0.0270	1.00			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.19 ft	1.19 ft
Top Width:	6.66 ft	12.66 ft
Velocity:	2.31 fps	
X-Section Area:	1.17 sq ft	
Hydraulic Radius:	0.175	
Froude Number:	0.97	

Structure #2 (Riprap Channel)

Riprap A

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	3.0:1	3.0:1	12.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.07 ft	1.07 ft
Top Width:	8.39 ft	14.39 ft

	w/o Freeboard	w/ Freeboard
Velocity*:		
X-Section Area:	0.54 sq ft	
Hydraulic Radius:	0.064	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Riprap Channel)

Riprap B

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	2.0:1	2.0:1	10.9	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.09 ft	1.09 ft
Top Width:	5.37 ft	9.37 ft
Velocity*:		
X-Section Area:	0.48 sq ft	
Hydraulic Radius:	0.088	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #4 (Riprap Channel)

Riprap C

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	2.0:1	2.0:1	21.3	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.71 cfs	
Depth:	0.06 ft	1.06 ft
Top Width:	4.24 ft	8.24 ft
Velocity*:		
X-Section Area:	0.25 sq ft	
Hydraulic Radius:	0.058	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

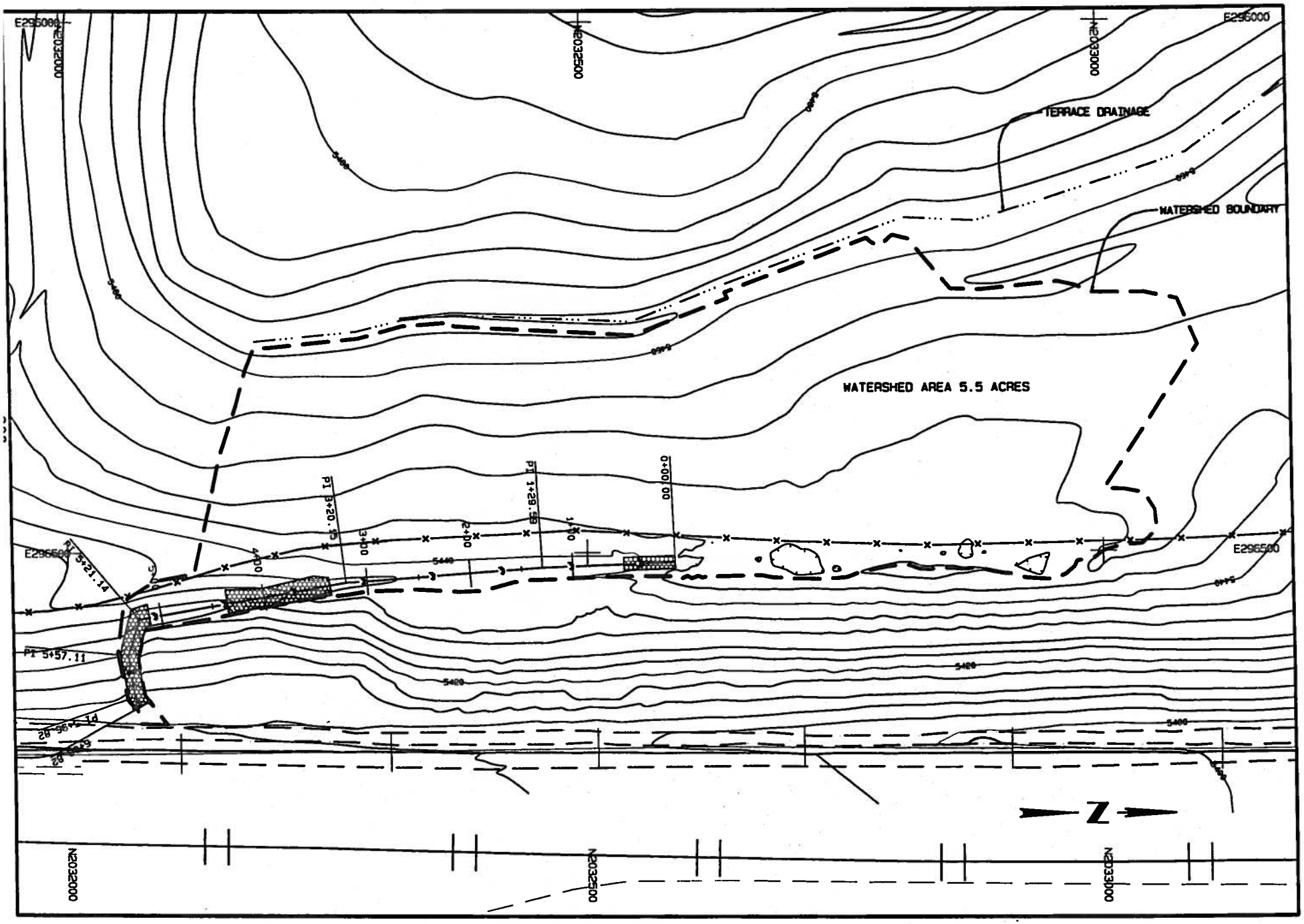
Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	5.500	0.106	0.000	0.000	80.000	M	2.71	0.089
	Σ	**5.500**						**2.71**	**0.089**
#2	Σ	**5.500**						**2.71**	**0.089**
#3	Σ	**5.500**						**2.71**	**0.089**
#4	Σ	**5.500**						**2.71**	**0.089**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.31	18.00	543.00	1.820	0.082
		8. Large gullies, diversions, and low flowing streams	5.06	30.00	593.00	6.740	0.024
#1	**1**	**Time of Concentration:**					**0.106**



MASON DRAINAGE ALONG RAILROAD
WATERSHED AREA
NTS

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YAZZIE SPOIL SIDE ROAD EAST RIPRAP DOWNDRAIN AT CP-186

The location of the riprap downdrain is presented on Exhibit 11-95A.

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	

#1
Chan'l

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.600	1.600	1.74	0.07

Structure Detail:

Structure #1 (Riprap Channel)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	1.5:1	1.5:1	34.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.74 cfs	
Depth:	0.03 ft	1.03 ft
Top Width:	4.10 ft	7.10 ft
Velocity*:		
X-Section Area:	0.13 sq ft	
Hydraulic Radius:	0.032	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.600	0.059	0.000	0.000	90.000	M	1.74	0.071
	Σ	**1.600**						**1.74**	**0.071**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	3.26	38.00	1,165.00	5.410	0.059
#1	**1**	**Time of Concentration:**					**0.059**

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YAZZIE SPOIL SIDE ROAD WEST RIPRAP DOWNDRAIN AT CP-186

The location of the riprap downdrain is presented on Exhibit 11-95A.

LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	

#1
Chan'l

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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	1.700	1.700	1.85	0.08

Structure Detail:

Structure #1 (Riprap Channel)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
5.00	1.5:1	1.5:1	34.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.85 cfs	
Depth:	0.03 ft	1.03 ft
Top Width:	5.08 ft	8.08 ft
Velocity*:		
X-Section Area:	0.13 sq ft	
Hydraulic Radius:	0.026	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.700	0.059	0.000	0.000	90.000	M	1.85	0.075
	Σ	**1.700**						**1.85**	**0.075**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	3.26	38.00	1,165.00	5.410	0.059
#1	**1**	**Time of Concentration:**					**0.059**

Doby Channel Design

The Doby Drainage is approximately 1,630 acres. The watershed is rough with many small depression and contains NAPI fields. Based on the above criteria about 1,570 acres would meet the slow criteria for the Hydrographic Response.

Shawn Smith

Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	See attached SedCad for Downdrain Riprap sizing

#1
Chan'l

Structure Detail:

Structure #1 (Erodible Channel)

See attached SedCad for Downdrain Riprap sizing

Trapezoidal Erodible Channel Inputs:

Material: Alluvial silts colloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
25.00	3.0:1	3.0:1	1.5	0.0250				5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	57.46 cfs	
Depth:	0.49 ft	
Top Width:	27.97 ft	
Velocity:	4.39 fps	
X-Section Area:	13.10 sq ft	
Hydraulic Radius:	0.466 ft	
Froude Number:	1.13	

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
16.00	3.0:1	3.0:1	33.0			

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	50.00 cfs	
Depth:	0.43 ft	
Top Width:	18.61 ft	
Velocity:	6.65 fps	
X-Section Area:	7.52 sq ft	
Hydraulic Radius:	0.401 ft	
Froude Number:	1.84	
Manning's n:	0.0700	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

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Area III Facilities
Sandy Hill Drainage Control

Design for the temporary diversion along the Area III Access Road and Parking Area using a 10 year - 6 hour storm event.

Shawn Smith

Navajo Coal Company
P.O. Box 1717
Fruitland, NM 87414

Phone: (505) 598-3376
Email: shawn.smith@bhpbilliton.com

Structure Detail:

Structure #4 (Erodible Channel)

Section S-2

Trapezoidal Erodible Channel Inputs:

Material: Sandy loam noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.80	2.0:1	2.0:1	4.2	0.0200				2.5

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.71 cfs	
Depth:	0.06 ft	
Top Width:	5.05 ft	
Velocity:	2.33 fps	
X-Section Area:	0.30 sq ft	
Hydraulic Radius:	0.060 ft	
Froude Number:	1.68	

Structure #5 (Riprap Channel)

Section S-1

Triangular Riprap Channel Inputs:

Material: Riprap

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.0:1	4.0:1	32.0			

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.71 cfs	
Depth:	0.05 ft	
Top Width:	0.43 ft	
Velocity*:		

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.89 cfs	
Depth:	0.14 ft	
Top Width:	4.65 ft	
Velocity*:		
X-Section Area:	0.62 sq ft	
Hydraulic Radius:	0.132 ft	
Froude Number*:		
Manning's n*:		
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	7.50 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Riprap Channel)

Section N-1A

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.00	3.0:1	2.0:1	24.2			

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.89 cfs	
Depth:	0.04 ft	
Top Width:	4.19 ft	
Velocity*:		
X-Section Area:	0.16 sq ft	
Hydraulic Radius:	0.037 ft	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#4	1	0.970	0.056	0.000	0.000	82.000	M	0.71	0.020
	Σ	**0.970**						**0.71**	**0.020**
#5	Σ	**0.970**						**0.71**	**0.020**
#1	1	2.580	0.040	0.000	0.000	82.000	M	1.89	0.052
	Σ	**2.580**						**1.89**	**0.052**
#2	Σ	**2.580**						**1.89**	**0.052**
#3	Σ	**2.580**						**1.89**	**0.052**
#6	Σ	**3.550**						**2.61**	**0.072**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	8.00	12.00	150.00	2.820	0.014
		8. Large gullies, diversions, and low flowing streams	2.86	14.00	490.00	5.070	0.026
		8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#1	**1**	**Time of Concentration:**					**0.040**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	9.39	20.00	213.00	3.060	0.019
		8. Large gullies, diversions, and low flowing streams	2.89	18.00	622.00	5.100	0.033
		8. Large gullies, diversions, and low flowing streams	7.81	10.00	128.00	8.380	0.004
#4	**1**	**Time of Concentration:**					**0.056**

Appendix 23.C

Lowe Boxcut Road Proposal

SEDCAD Calculations

APPENDIX 23.C

LOWE BOXCUT ROAD PROPOSAL, SEDCAD CALCULATIONS
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SEDCAD "Lowe Boxcut Road Planned Drainage, NE Portion; (10 year - 6 hour)"	16
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LOWE BOXCUT ROAD PROPOSAL,
SEDCAD CALCULATIONS

SEDCAD Calculations

SEDCAD was used to make all drainage calculations. Parameters used for each watershed are shown on EXHIBIT 11-103c, and in the SEDCAD calculations that follow in this appendices. The SEDCAD is laid out such that each of the drainage patterns comes first followed by its respective channel (ditch) calculations. The only problem that SEDCAD detected is that the two southern ditches will incur some erosion during major storm events, but this is acceptable providing that the ditches are repaired after any such storm event and none of the effluent leaves the permit area.

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

LOWE BOXCUT ROAD PLANNED DRAINAGE, SW PORTION

by

Name: DJR

Company Name: BHP MINERALS
File Name: C:\SEDCAD3\LBRSW1

Date: 09-06-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRSW1 User: DJR
Date: 09-06-1995 Time: 09:02:59
LOWE BOXCUT ROAD PLANNED DRAINAGE, SW PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

GENERAL INPUT TABLE

STORM #1:

User-Defined Distribution

Label: type II-65

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.012
4	1.5	0.019
5	2.0	0.026
6	2.5	0.034
7	3.0	0.043
8	3.5	0.055
9	4.0	0.067
10	4.5	0.083
11	5.0	0.105
12	5.5	0.139
13	6.0	0.711
14	6.5	0.789
15	7.0	0.819
16	7.5	0.837
17	8.0	0.851
18	8.5	0.861
19	9.0	0.872
20	9.5	0.880
21	10.0	0.888
22	10.5	0.894
23	11.0	0.900
24	11.5	0.905
25	12.0	0.910
26	12.5	0.915
27	13.0	0.920
28	13.5	0.925
29	14.0	0.930
30	14.5	0.934
31	15.0	0.938
32	15.5	0.943
33	16.0	0.947
34	16.5	0.951
35	17.0	0.954
36	17.5	0.958
37	18.0	0.962

38	18.5	0.966
39	19.0	0.969
40	19.5	0.973
41	20.0	0.976
42	20.5	0.979
43	21.0	0.982
44	21.5	0.985
45	22.0	0.988
46	22.5	0.991
47	23.0	0.994
48	23.5	0.997
49	24.0	1.000

****

Detailed Between Structure Routing:

J	B	To S	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Muskingum K (hr)	Muskingum X
2	1	2	1	5	1604.01	0.42	0.65	0.69	0.687	0.138
3	1	2	1	5	1616.43	5.49	2.34	0.19	0.191	0.289

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRSW1 User: DJR
Date: 09-06-1995 Time: 09:02:59
LOWE BOXCUT ROAD PLANNED DRAINAGE, SW PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	5.67	89	M	0.230	0.000	0.000	0.0	0.23	3.86
		Type: Null			Label: SUB-WATERSHED A					
111	Structure	5.67							0.23	
111	Total IN/OUT	5.67							0.23	3.86
		Type: Null			Label: SUB-WATERSHED A					
211	Structure	5.67							0.23	
	Total IN/OUT	5.67							0.23	3.86
111	to 211 Routing					0.000	0.000			
212	1	7.26	89	M	0.204	0.000	0.000	0.0	0.29	5.18
		Type: Null			Label: SUB-WATERSHED B					
212	Structure	7.26							0.52	
212	Total IN/OUT	12.93							0.52	5.27
211	to 212 Routing					0.687	0.138			
		Type: Null			Label: SUB-WATERSHED B					
311	Structure	7.26							0.52	
311	Total IN/OUT	12.93							0.52	5.27
212	to 311 Routing					0.000	0.000			
312	1	4.57	89	M	0.162	0.000	0.000	0.0	0.18	3.54
		Type: Null			Label: SUB-WATERSHED C					
312	Structure	4.57							0.71	
312	Total IN/OUT	17.50							0.71	6.90
	to 312 Routing					0.191	0.289			
		Type: Null			Label: SUB-WATERSHED C					
411	Structure	4.57							0.71	
411	Total IN/OUT	17.50							0.71	6.90

312 to 411 Routing	0.000	0.000

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRSW1 User: DJR
Date: 09-06-1995 Time: 09:02:59
LOWE BOXCUT ROAD PLANNED DRAINAGE, SW PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1237.00	2.22	1.49	0.23	0.230		
2	1	2	1	-a	5	1666.00	5.10	2.26	0.20	0.204		
3	1	2	1	-a	5	1724.00	8.70	2.95	0.16	0.162		

BHP MINERALS
NAVAJO MINE

12-Dec-95

PROJECT: LOWE BOXCUT RD SW DITCH
ENGINEER DJR
FILE NO : 17.3.29
DRWG NO :
MMD REF:

Channel Design

Precipitation Event:	10yr-6hr Event	
Design Flow	Q10	6.90 CFS
Bottom Channel Width	W =	0.00 Ft (min)
Side Slopes (Z1:1)	Z1 =	2.00
(Z2:1)	Z2 =	4.00
Manning's Roughness Coefficient	n =	0.032
Channel Bed Slope	S =	5.49 %

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.19	0.12	0.49	2.61
0.50	0.75	0.24	3.11	4.15
0.75	1.69	0.35	9.18	5.44
1.00	3.00	0.47	19.79	6.60
1.25	4.69	0.59	35.90	7.66
1.50	6.75	0.71	58.41	8.65
1.75	9.19	0.83	88.16	9.60
2.00	12.00	0.94	125.92	10.49
2.25	15.19	1.06	172.45	11.35
2.50	18.75	1.18	228.47	12.19
2.75	22.69	1.30	294.68	12.99
3.00	27.00	1.42	371.75	13.77
3.25	31.69	1.53	460.33	14.53
3.50	36.75	1.65	561.05	15.27
3.75	42.19	1.77	674.53	15.99
4.00	48.00	1.89	801.38	16.70
4.25	54.19	2.00	942.18	17.39

Flow Depth at Peak Discharge	0.68 Ft
Minimum Channel Depth Required	0.98 Ft
Critical Depth	0.81 Ft
Flow Type	Supercritical flow
Froude Number	1.09
Flow Velocity	5.09 fps
Soil Type:	SPOILS W/ SHALE AND SANDSTONE COBBLES
Erosive Velocity	5.50 fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

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CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

LOWE BOXCUT ROAD PLANNED DRAINAGE, SE PORTION

by

Name: DJR

Company Name: BHP MINERALS
File Name: C:\SEDCAD3\LBRSE1

Date: 09-06-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRSE1 User: DJR
Date: 09-06-1995 Time: 11:35:19
LOWE BOXCUT ROAD PLANNED DRAINAGE, SW PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

==========
GENERAL INPUT TABLE
==========

STORM #1:

User-Defined Distribution

Label: type II-65

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.012
4	1.5	0.019
5	2.0	0.026
6	2.5	0.034
7	3.0	0.043
8	3.5	0.055
9	4.0	0.067
10	4.5	0.083
11	5.0	0.105
12	5.5	0.139
13	6.0	0.711
14	6.5	0.789
15	7.0	0.819
16	7.5	0.837
17	8.0	0.851
18	8.5	0.861
19	9.0	0.872
20	9.5	0.880
21	10.0	0.888
22	10.5	0.894
23	11.0	0.900
24	11.5	0.905
25	12.0	0.910
26	12.5	0.915
27	13.0	0.920
28	13.5	0.925
29	14.0	0.930
30	14.5	0.934
31	15.0	0.938
32	15.5	0.943
33	16.0	0.947
34	16.5	0.951
35	17.0	0.954
36	17.5	0.958
37	18.0	0.962

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRSE1 User: DJR
Date: 09-06-1995 Time: 11:35:19
LOWE BOXCUT ROAD PLANNED DRAINAGE, SW PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	6.58	89	M	0.194	0.000	0.000	0.0	0.27	4.79
		Type: Null			Label: SUB-WATERSHED D					
111	Structure	6.58							0.27	
111	Total IN/OUT	6.58							0.27	4.79
		Type: Null			Label: SUB-WATERSHED A					
211	Structure	6.58							0.27	
	Total IN/OUT	6.58							0.27	4.79
111	to 211 Routing					0.000	0.000			
212	1	1.73	89	M	0.571	0.000	0.000	0.0	0.07	0.73
		Type: Null			Label: SUB-WATERSHED E					
212	Structure	1.73							0.34	
212	Total IN/OUT	8.31							0.34	3.25
211	to 212 Routing					0.687	0.138			
		Type: Null			Label: SUB-WATERSHED B					
311	Structure	1.73							0.34	
311	Total IN/OUT	8.31							0.34	3.25
212	to 311 Routing					0.000	0.000			
312	1	3.33	89	M	0.209	0.000	0.000	0.0	0.13	2.35
		Type: Null			Label: SUB-WATERSHED F					
312	Structure	3.33							0.47	
312	Total IN/OUT	11.64							0.47	3.45
	to 312 Routing					0.191	0.289			
		Type: Null			Label: SUB-WATERSHED C					
411	Structure	3.33							0.47	
411	Total IN/OUT	11.64							0.47	3.45

312 to 411 Routing	0.000	0.000

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRSE1 User: DJR
Date: 09-06-1995 Time: 11:35:19
LOWE BOXCUT ROAD PLANNED DRAINAGE, SW PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1470.00	4.42	2.10	0.19	0.194		
2	1	2	1	-a	5	1617.00	0.62	0.79	0.57	0.571		
3	1	2	1	-a	5	1619.53	4.63	2.15	0.21	0.209		

BHP MINERALS
NAVAJO MINE

12-Dec-95

PROJECT: LOWE BOXCUT RD SE DITCH
ENGINEER DJR
FILE NO : 17.3.29
DRWG NO :
MMD REF:

Channel Design

Precipitation Event:	10yr-6hr Event	
Design Flow	Q10	4.79 CFS
Bottom Channel Width	W =	0.00 Ft (min)
Side Slopes (Z1:1)	Z1 =	2.00
(Z2:1)	Z2 =	4.00
Manning's Roughness Coefficient	n =	0.032
Channel Bed Slope	S =	5.49 %

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.19	0.12	0.49	2.61
0.50	0.75	0.24	3.11	4.15
0.75	1.69	0.35	9.18	5.44
1.00	3.00	0.47	19.79	6.60
1.25	4.69	0.59	35.90	7.66
1.50	6.75	0.71	58.41	8.65
1.75	9.19	0.83	88.16	9.60
2.00	12.00	0.94	125.92	10.49
2.25	15.19	1.06	172.45	11.35
2.50	18.75	1.18	228.47	12.19
2.75	22.69	1.30	294.68	12.99
3.00	27.00	1.42	371.75	13.77
3.25	31.69	1.53	460.33	14.53
3.50	36.75	1.65	561.05	15.27
3.75	42.19	1.77	674.53	15.99
4.00	48.00	1.89	801.38	16.70
4.25	54.19	2.00	942.18	17.39

Flow Depth at Peak Discharge	0.59 Ft
Minimum Channel Depth Required	0.89 Ft
Critical Depth	0.70 Ft
Flow Type	Supercritical flow
Froude Number	1.06
Flow Velocity	4.63 fps
Soil Type:	SPOILS W/ SHALE AND SANDSTONE COBBLES
Erosive Velocity	5.50 fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

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CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

LOWE BOXCUT ROAD PLANNED DRAINAGE, NE PORTION

by

Name: DJR

Company Name: BHP MINERALS
File Name: C:\SEDCAD3\LBRNE1

Date: 09-06-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRNE1 User: DJR
Date: 09-06-1995 Time: 11:56:09
LOWE BOXCUT ROAD PLANNED DRAINAGE, NE PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	3.39	89	M	0.177	0.000	0.000	0.0	0.14	2.57
		Type: Null			Label: SUB-WATERSHED G					
111	Structure	3.39							0.14	
111	Total IN/OUT	3.39							0.14	2.57

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRNE1 User: DJR
Date: 09-06-1995 Time: 11:56:09
LOWE BOXCUT ROAD PLANNED DRAINAGE, NE PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	1225.00	3.67	1.92	0.18	0.177		

BHP MINERALS
NAVAJO MINE

12-Dec-95

PROJECT: LOWE BOXCUT RD NE DITCH
ENGINEER DJR
FILE NO : 17.3.29
DRWG NO :
MMD REF:

Channel Design

Precipitation Event:	10yr-6hr Event		
Design Flow	Q10	2.57	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	2.00	
(Z2:1)	Z2 =	4.00	
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	1.49	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.19	0.12	0.25	1.36
0.50	0.75	0.24	1.62	2.16
0.75	1.69	0.35	4.78	2.83
1.00	3.00	0.47	10.31	3.44
1.25	4.69	0.59	18.70	3.99
1.50	6.75	0.71	30.43	4.51
1.75	9.19	0.83	45.93	5.00
2.00	12.00	0.94	65.60	5.47
2.25	15.19	1.06	89.84	5.92
2.50	18.75	1.18	119.03	6.35
2.75	22.69	1.30	153.52	6.77
3.00	27.00	1.42	193.67	7.17
3.25	31.69	1.53	239.81	7.57
3.50	36.75	1.65	292.28	7.95
3.75	42.19	1.77	351.40	8.33
4.00	48.00	1.89	417.49	8.70
4.25	54.19	2.00	490.84	9.06

Flow Depth at Peak Discharge	0.60 Ft
Minimum Channel Depth Required	0.90 Ft
Critical Depth	0.54 Ft
Flow Type	Subcritical flow
Froude Number	0.56
Flow Velocity	2.44 fps
Soil Type:	SPOILS W/ SHALE AND SANDSTONE COBBLES
Erosive Velocity	5.50 fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

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SEDCAD+ Version 3

LOWE BOXCUT ROAD PLANNED DRAINAGE, NW PORTION

by

Name: DJR

Company Name: BHP MINERALS
File Name: C:\SEDCAD3\LBRNW1

Date: 09-06-1995

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRNW1 User: DJR
Date: 09-06-1995 Time: 12:07:58
LOWE BOXCUT ROAD PLANNED DRAINAGE, NE PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

==========
GENERAL INPUT TABLE
==========

STORM #1:

User-Defined Distribution

Label: type II-65

	Accumulated Time (hrs)	Accumulated Dimensionless Depth
1	0.0	0.000
2	0.5	0.006
3	1.0	0.012
4	1.5	0.019
5	2.0	0.026
6	2.5	0.034
7	3.0	0.043
8	3.5	0.055
9	4.0	0.067
10	4.5	0.083
11	5.0	0.105
12	5.5	0.139
13	6.0	0.711
14	6.5	0.789
15	7.0	0.819
16	7.5	0.837
17	8.0	0.851
18	8.5	0.861
19	9.0	0.872
20	9.5	0.880
21	10.0	0.888
22	10.5	0.894
23	11.0	0.900
24	11.5	0.905
25	12.0	0.910
26	12.5	0.915
27	13.0	0.920
28	13.5	0.925
29	14.0	0.930
30	14.5	0.934
31	15.0	0.938
32	15.5	0.943
33	16.0	0.947
34	16.5	0.951
35	17.0	0.954
36	17.5	0.958
37	18.0	0.962

38	18.5	0.966
39	19.0	0.969
40	19.5	0.973
41	20.0	0.976
42	20.5	0.979
43	21.0	0.982
44	21.5	0.985
45	22.0	0.988
46	22.5	0.991
47	23.0	0.994
48	23.5	0.997
49	24.0	1.000

****

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRNW1 User: DJR
Date: 09-06-1995 Time: 12:07:58
LOWE BOXCUT ROAD PLANNED DRAINAGE, NE PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	2.01	89	M	0.232	0.000	0.000	0.0	0.08	1.36
		Type: Null			Label: SUB-WATERSHED H					
111	Structure	2.01							0.08	
111	Total IN/OUT	2.01							0.08	1.36

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Company Name: BHP MINERALS
Filename: C:\SEDCAD3\LBRNW1 User: DJR
Date: 09-06-1995 Time: 12:07:58
LOWE BOXCUT ROAD PLANNED DRAINAGE, NE PORTION
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	X
1	1	1	1	-a	5	1070.00	1.64	1.28	0.23	0.232		

BHP MINERALS
NAVAJO MINE

12-Dec-95

PROJECT: LOWE BOXCUT RD NW DITCH
ENGINEER DJR
FILE NO : 17.3.29
DRWG NO :
MMD REF:

Channel Design

Precipitation Event:	10yr-6hr Event	
Design Flow	Q10	1.36 CFS
Bottom Channel Width	W =	0.00 Ft (min)
Side Slopes (Z1:1)	Z1 =	2.00
(Z2:1)	Z2 =	4.00
Manning's Roughness Coefficient	n =	0.032
Channel Bed Slope	S =	1.49 %

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.19	0.12	0.25	1.36
0.50	0.75	0.24	1.62	2.16
0.75	1.69	0.35	4.78	2.83
1.00	3.00	0.47	10.31	3.44
1.25	4.69	0.59	18.70	3.99
1.50	6.75	0.71	30.43	4.51
1.75	9.19	0.83	45.93	5.00
2.00	12.00	0.94	65.60	5.47
2.25	15.19	1.06	89.84	5.92
2.50	18.75	1.18	119.03	6.35
2.75	22.69	1.30	153.52	6.77
3.00	27.00	1.42	193.67	7.17
3.25	31.69	1.53	239.81	7.57
3.50	36.75	1.65	292.28	7.95
3.75	42.19	1.77	351.40	8.33
4.00	48.00	1.89	417.49	8.70
4.25	54.19	2.00	490.84	9.06

Flow Depth at Peak Discharge	0.47 Ft
Minimum Channel Depth Required	0.77 Ft
Critical Depth	0.42 Ft
Flow Type	Subcritical flow
Froude Number	0.53
Flow Velocity	2.07 fps
Soil Type:	SPOILS W/ SHALE AND SANDSTONE COBBLES
Erosive Velocity	5.50 fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

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Appendix 23.D

Cottonwood Arroyo Crossing

Final Design Report

Prepared by URS

and

Cottonwood Arroyo Pre-Mine Hydrology and Sedimentology

Prepared by BNCC

FINAL DESIGN REPORT

Cottonwood Arroyo Crossing
BHP Navajo Coal Company
Fruitland, New Mexico

VOLUME 1 OF 2

Final Design Report and
Appendices A through D

Prepared for:
BHP Navajo Coal Company
P.O. Box 1717
Fruitland, New Mexico 87416

Prepared by:
URS Corporation
One Park Square, Suite 900
6501 Americas Parkway NE
Albuquerque, New Mexico 87110

MAY 2007

APPROVALS

The contents of this Design Report and associated construction drawings and specifications have been reviewed and approved by:

KENT M. WHITMAN
NEW MEXICO
6170
REGISTERED PROFESSIONAL ENGINEER

Kent M. Whitman, P.E.
Chief Engineer (Civil)

5/2/07
Date

DONALD T. LOPEZ
NEW MEXICO
5122
REGISTERED PROFESSIONAL ENGINEER

Donald T. Lopez, P.E.
Chief Engineer (Civil)

5/3/07
Date

BARRY T. CHUNG
NEW MEXICO
15471
LICENSED PROFESSIONAL ENGINEER

Barry T. Chung, P.E.
Chief Engineer (Structural)

05/02/07
Date

Christi Tanner, P.E. (Texas)
Senior Consultant (Civil)

5/3/07
Date

J. Steven Raugust, R.G.
Chief Engineer/Project Manager

5/3/07
Date

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ACRONYMS AND ABBREVIATIONS

asl	above sea level
bgs	below ground surface
BHP	Broken Hills Proprietary
BNCC	BHP Navajo Coal Company
CBR	California Bearing Ratio
CFR	*Code of Federal Regulations*
cfs	cubic foot (feet) per second
ESAL	Equivalent Standard Axle Load
FHWA	Federal Highway Administration
fps	foot (feet) per second
ft	foot (feet)
in.	inch(es)
lb(s)	pound(s)
MSE	Mechanically Stabilized Earth
MSHA	Mine Safety and Health Administration
MWH	MWH Americas, Inc.
NFF	National Flood Frequency
NMBR	New Mexico Board of Registration for Professional Engineers and Land Surveyors
psf	pound(s) per square foot
sq ft	square foot
URS	URS Corporation
USCS	Unified Soil Classification System

1.0 PROJECT SCOPE

1.1 INTRODUCTION

URS Corporation (URS) was retained by BHP Navajo Coal Company (BNCC) to provide professional engineering services for the revision of final design report, design drawings, and construction bid specification packages from a design proposed by URS (2006). The original URS design was based on the review of a design prepared by MWH Americas, Inc. (MWH) for permitting that consisted of an aggregate haul road, and low-flow culvert (MWH, 2004). URS' final design report is dated June 2006 and titled, Cottonwood Arroyo Crossing, BHP Navajo Coal Mine, Farmington, New Mexico (URS, 2006). Subsequent to the June 2006 design report, BNCC provided a purchase requisition to URS on May 2, 2006 to:

- Review the design previously proposed by MWH for compliance with acceptable standards of practices of the New Mexico Board of Registration for Professional Engineers and Land Surveyors (NMBR);
- Assess the availability of materials specified on the drawings and identify those with long procurement times that could impact the project schedule;
- Revise the design drawings per a list of items provided in Appendix A of this report;
- Finalize the engineering drawings for issue of bidding and construction;
- Prepare detailed material and construction specifications covering all aspects of earth, concrete, and steel construction; and
- Prepare and provide a final engineering report that contains drawings and appendices.

The June 2006 design consists of:

- A box culvert structure in the existing arroyo channel to drain runoff from the low flow storm event;
- Heavy vehicle haul roads to accommodate the frequent use of 735,000-pound (lb) haul truck and the occasional use by a 13-million-pound excavator; and
- An emergency light vehicle bridge (conceptual)

In February 2007, BNCC issued a scope of work to revise the June 2006 design per the following:

- General
    - Provide professional engineering services in accordance with acceptable practices of the State of New Mexico Board of Registration for Professional Engineers and Professional Land Surveyors.
    - Provide all supervision, labor, materials and equipment required to perform the engineering services.
- Work shall include but not limited to the following:
    - Assess the availability of the materials specified on the drawings and identify those with long procurement time that could impact the project schedule.

- Revise the engineering drawings and report with the following changes:
  - Eliminate the emergency bridge and revise the drawings accordingly.
  - Evaluate and provide an estimated cost for armoring the down stream side of the haul road at the spillway; consider the 25 year-6 hour and 50 year – 6 hour storm events.
  - Consult with Owner in selecting the armoring option and revise the drawings accordingly.
  - Update the pay item quantities.
  - Evaluate box culvert design based on changes in flow rate based on revised BNCC hydrologic model.
  - Finalize the engineering drawings.
  - If necessary update/modify the detailed material and construction specifications covering all aspects of earth, concrete and steel construction.

- Final Engineering Report
  - Provide updated/modified sections for the engineering report, and update/modified drawings and appendices.
  - Provide electronic files on a CD of all the contents in the report in PDF format and the drawings in dwg format including PDF format.

1.2 DESIGN CRITERIA

The following design criteria were established by BNCC:

- The design flow for the box culverts is 2,186 cubic feet per second (cfs) without impoundment and this is equivalent to the maximum flow generated by the 10-year, 6-hour storm event;
- The design flow for the spillway is 4,040 cfs and this is equivalent to the maximum flow generated by the 50-year, 6-hour storm event;
- A minimum 120-ft (ft)-wide crossing is required to provide a drag-line walk-road and an 80-ft heavy vehicle haul road and 40-ft regular vehicle access road;
- The design drag-line load is created by a Marion model 8750 with 116-ft outside width, 13,050,000-lb working weight, and two 16-ft by 80-ft shoes with a bearing pressure of 5,098 pounds per square foot (psf);
- The design heavy vehicle load is created by a Kress CH-220C 114-ton coal hauler with a maximum operating weight of 735,000 lbs. Each dual wheel unit has a bearing pressure of 14,700 psf on an 12.54-square-foot (sq ft) area;
- The frequency of one-way haul truck trips per week is 720 (BNCC, 2006); and

1.3 DESIGN ASSUMPTIONS

- BNCC is responsible for inspecting the haul road and associated structures for maintenance issues after each significant storm event, which is not limited to the 50-year event.

- URS provided alternatives for armoring the downstream portions of the haul road during the 25-year and 50-year, 6-hour events. URS also recommended armoring critical portions of the haul road the upstream. BNCC notified URS that they selected the 50-year, 6-hour armoring alternative in an email from Kevin Bahe on April 10, 2007 BNCC will also monitor and maintain the haul road integrity as required.
- BNCC directed that an un-compacted, 7-ft-high safety berm with 1.5H:1.0V slopes be constructed along the west side of the haul road where a 3.0-ft drop-off exists. BNCC also requested that a Mine Safety and Health Administration (MSHA)-approved double-railed guardrail be placed along the west side of the haul road where the haul road crosses the box culvert.
- BNCC directed that the haul road tie-in elevations are 5272 ft at the north and 5280 ft at the south.
- Net cut and fill materials (run-of-mine) are within 0.50 mile of the project site.

1.4 TERMS OF REFERENCE

BNCC provided a purchase requisition under contract SA# 612, Change Order #2 to URS on March 12, 2007 to conduct the following work:

Task 1 incorporates the bulk of the design revisions. The purpose of this task is to ensure that the final design package meets the Scope of Work and is in accordance with the State of New Mexico Board of Registration for Professional Engineers and Professional Land Surveyors. URS will ensure that all aspects of the design and design documentation meet these requirements to the extent that the project team will affix their professional seals to the design drawings and specifications. Task 1 is broken down in to three subtasks:

Subtask 1.1 - Drainage Scope

1. Review original construction drawings, specifications, and quantities to determine the extent of changes, affected work, and long term procurement issues, as well as, coordinate with other URS engineering disciplines.
2. Review the revised hydrologic data as provided to URS by BNCC on February 7, 2007.
3. Revise hydraulic computations to reflect necessary changes. The HEC-RAS model will be revised to reflect the elimination of the bridge and to modify discharge values as needed. The culvert computations will be revised to reflect a shorter length to reflect the smaller roadway footprint. Based on the hydrologic data changes, the culvert sizing will be re-evaluated to determine if the size can be decreased or a barrel(s) can be eliminated.
4. Revise roadway and structural drawings with respect to hydrology and update appropriate material quantities
5. Respond to and incorporate any client comments to construction documents.

Subtask 1.1.1 – Erosion Protection Alternatives Analysis and Drawings

1. Perform erosion protection calculations for two options:
    a. Armoring Downstream Face of Haul Road for the 25-year event
    b. Armoring Downstream Face of Haul Road for the 50-year event
2. Develop cost estimates for the two options for armoring of the haul road downstream face.
3. Revise the drainage drawings to reflect the updated roadway footprint and embankment grading and selected armoring alternative.

Subtask 1.2 – Structural Scope

1. Review original construction drawings, specifications and quantities to determine extent of changes, affected work, and long term procurement issues as well as, coordinate with other disciplines.
2. Revise structural drawings to meet drainage hydraulic and soil grading requirements including CAD and detail check revisions. It is anticipated that culvert lengths and end treatments, and the number of culvert barrels may change. Integrate review of roadway and hydrology drawings with respect to structure and update appropriate material quantities.
3. Respond to and incorporate any client comments to construction documents.

Subtask 1.3 – Ramps and Haul Road Scope

1. Review original construction drawings, specifications and quantities to determine extent of changes, affected work, and long term procurement issues, as well as, coordinate with other disciplines.
2. Revise haul road drawings to meet drainage group hydraulic and soil grading requirements including CAD and detail check revisions.
3. Respond to and incorporate any client comments to construction documents

Task 2 This task includes revising and resealing the design report to incorporate the above design revisions. This task also includes project management and internal URS Independent Technical Review on all calculations, plan sheets, report, and cost estimates. URS will provide BHP with two hard copies of this report, drawings, and appendices. URS will provide electronic files of the report, drawings, and appendices on a CD in PDF format. In addition, the drawing will also be provided in AutoCad format.

Both the May 2, 2006 and the March 12, 2007 Change Orders are presented in Appendix A.

2.0 SITE DESCRIPTION

The site is located at approximate elevation 5,260-ft above sea level (asl) on the Cottonwood Arroyo approximately 24 miles southwest of Farmington, New Mexico and within the BNCC mine permit area on the Navajo Reservation as shown on Figure 1 – Key Plan (MWH, 2004).

Cottonwood Arroyo is a major sand-bed ephemeral drainage with a watershed area of approximately 77 square miles (Figure 2 – Area of Proposed Crossing Site). Approximately 14 percent (%) of the watershed lies within the permit area. This drainage area includes approximately 12.4 square miles of the adjacent Chinde Wash drainage to the north that is diverted into Cottonwood Arroyo by the Navajo Indian Irrigation Project's Ojo Amarillo canal into the Cottonwood drainage. About 49% of the watershed is covered by badlands, direct contributors to the high runoff/discharge, flow intensities and sediment load observed in this drainage (MWH, 2004).

Typically, the channel at the crossing site will experience a rapid increase in discharge from a dry channel to peak flow, followed by a recession to a low discharge in a matter of several hours. These conditions can result in the transport of large of amounts of sediment and cause extensive change to the shape of the channel during just one event. The dynamic character of the channel is clearly evidenced by the traces of previously abandoned channels along the edges of the current Cottonwood Arroyo channel (MWH, 2004).

Sources of strong durable rock for riprap and channel armor protection are limited in the immediate vicinity of the site and this is an important cost consideration for the project. The best locally available material for riprap and channel armor is fairly durable, compact, cemented sandstone from an old BNCC pit, but that this material is available in only very limited quantities. Durable rounded river rock, sand, gravel, and good-quality concrete aggregate is available from sources in Farmington, New Mexico, and Durango, Colorado (MWH, 2004); however, the river rock D_{50} dimensions do not meet the wire enclosed Class A rip rap specifications. Therefore, river rock gabions, gabion mats and Reno mattresses will be utilized for all erosion protection structures.

Progressive overburden stripping, coal extraction and land reclamation activities are ongoing immediately north of the site at the Dixon Pit. The ground surface slopes gently from the mining areas at approximate elevation 5,280-ft above sea level (asl), across the broad floodplain of the Arroyo at approximate elevation 5,263-ft asl and into the incised main channel with thalweg invert at approximate elevation 5,258-ft asl. The ground surface then rises rapidly to the south to reach a plateau elevation of approximately 5,300-ft asl. At the crossing site, the topography is gently rolling (see Figure 3 – Oblique View of Proposed Crossing Site) (MWH, 2004).

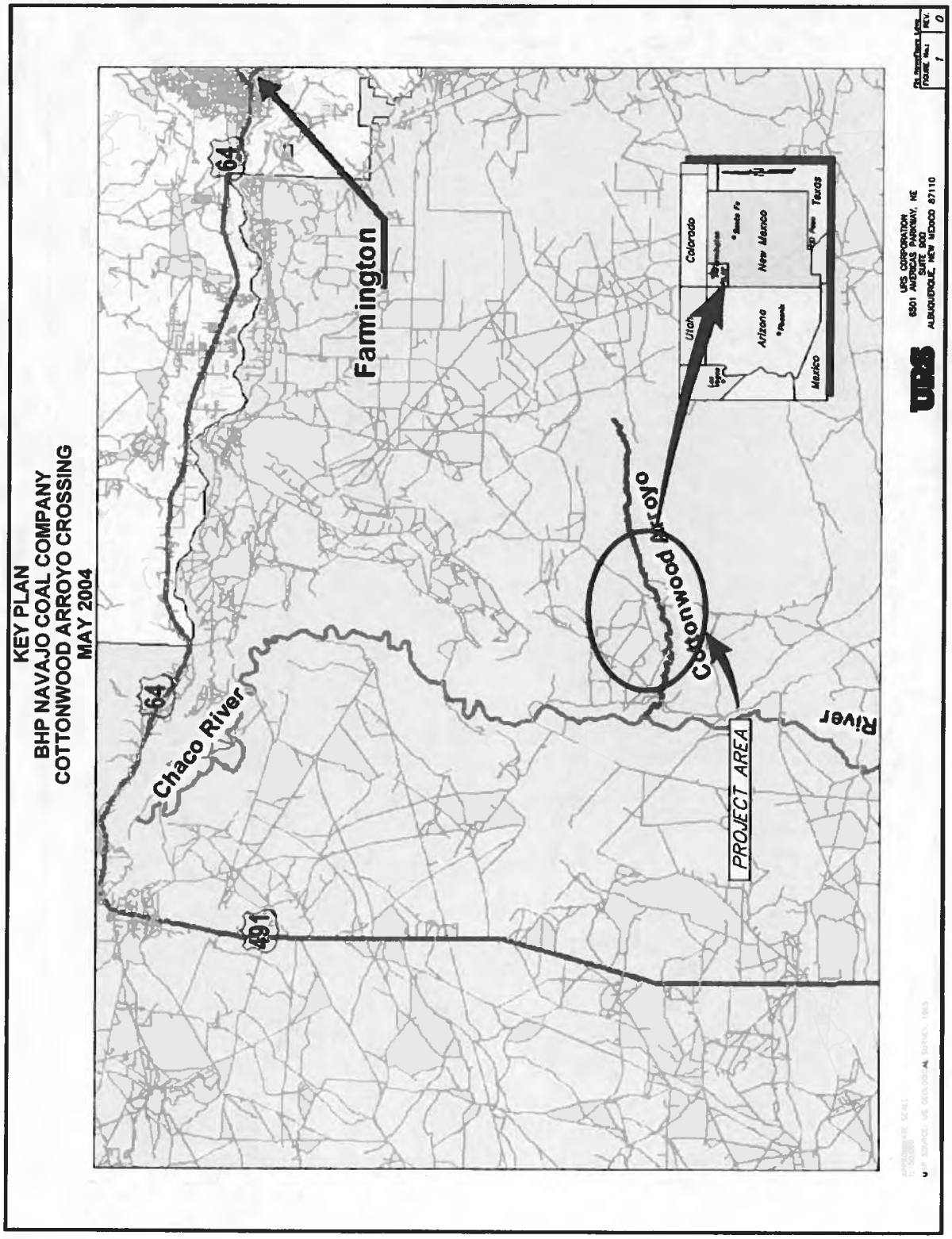

Figure 1 – Key Plan

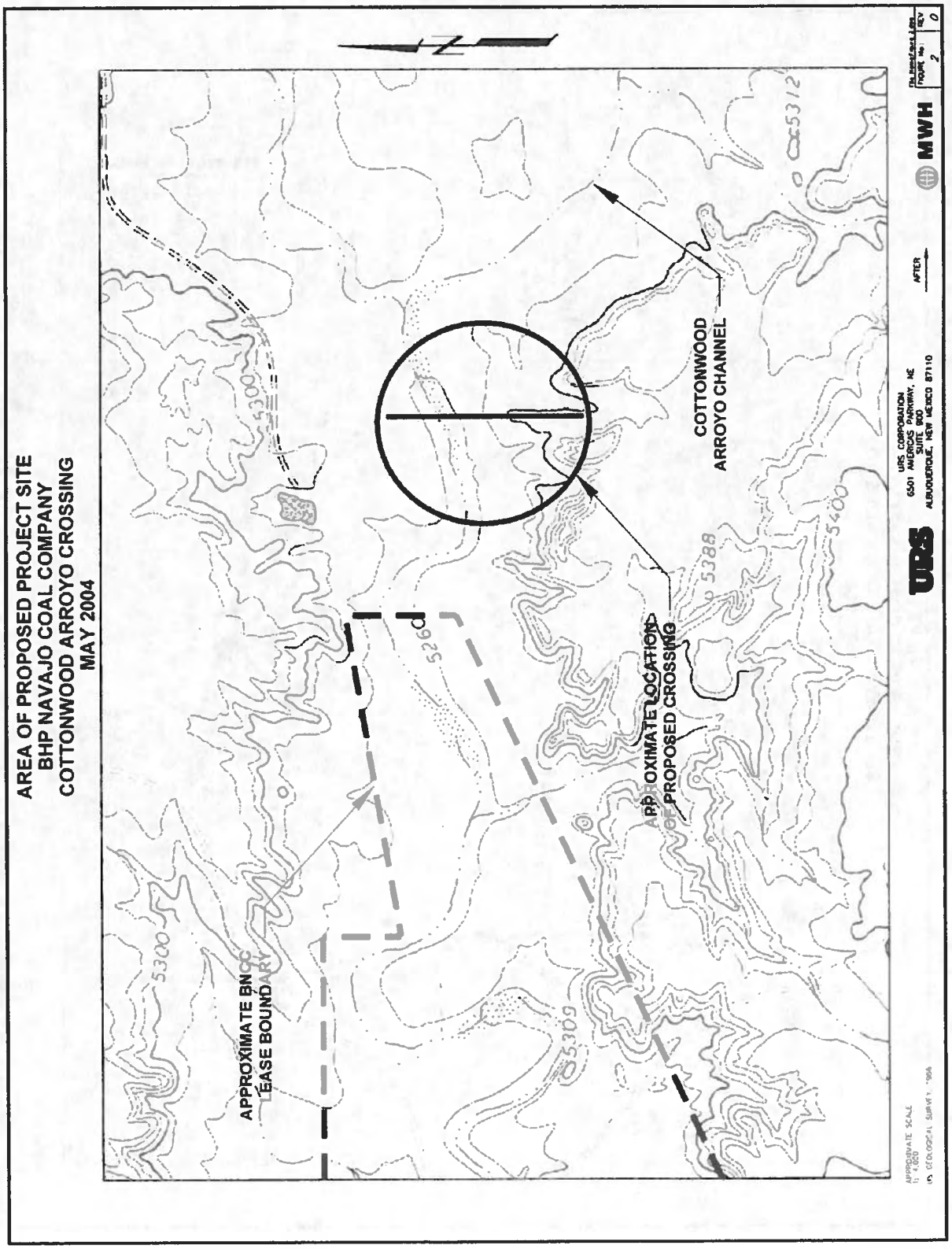

Figure 2 – Area of Proposed Crossing Site

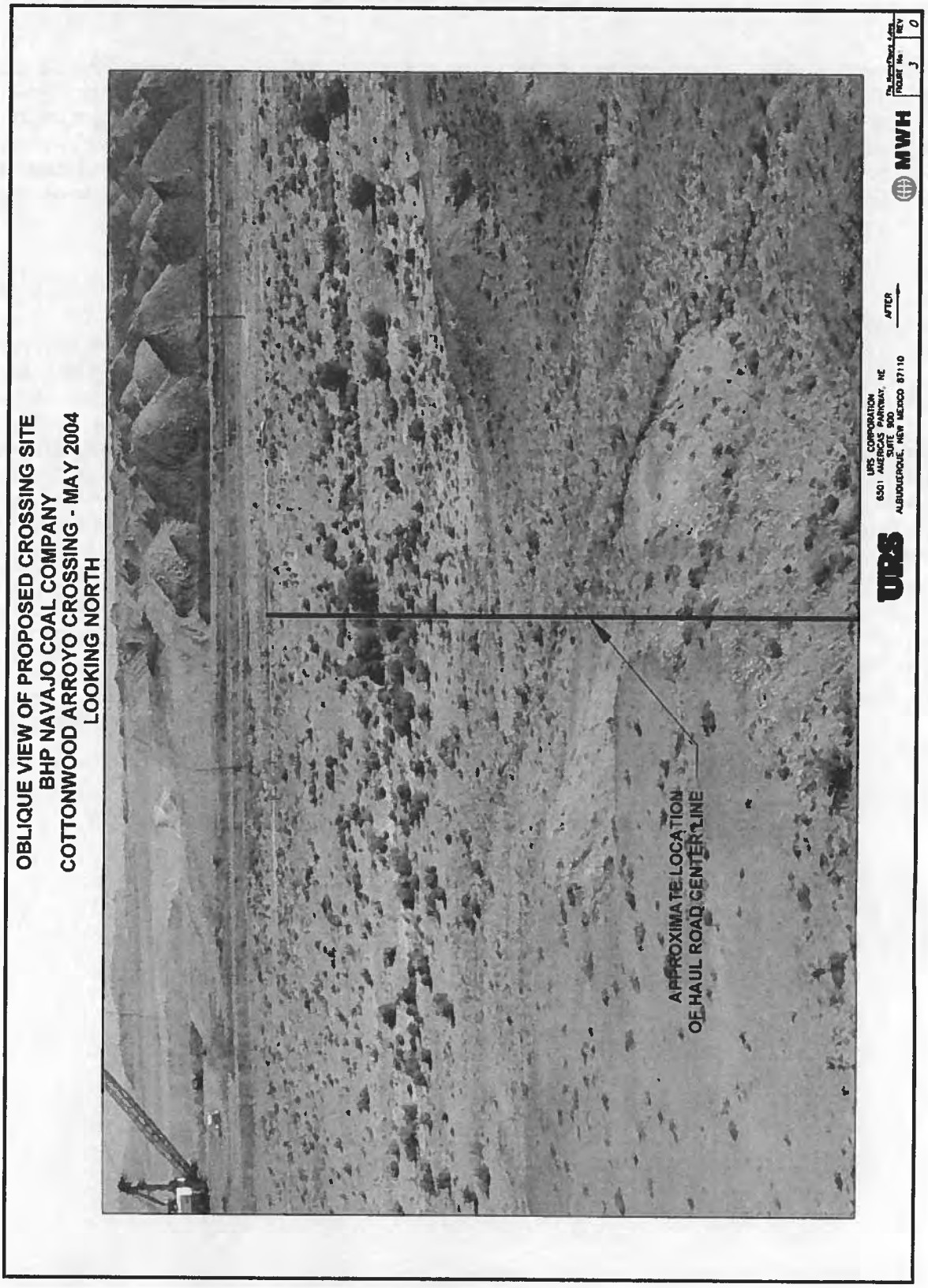

Figure 3 – Oblique View of Proposed Crossing Site

3.0 SITE INVESTIGATIONS

MWH conducted a geotechnical site investigation, which included three soil borings and six test pits. Geotechnical testing was performed by GEOMAT, Inc, of Farmington, New Mexico for in-situ density and moisture, Unified Soil Classification System (USCS) classification, gradations, compaction characteristics, and direct shear. Run-of-mine materials were tested for R-value. Soil boring and test pit locations are shown on Drawing C-2. Details of the geotechnical investigation are presented in MWH's permitting design report along with summary tables, soil boring and test pit logs, and geotechnical laboratory results (MWH, 2004).

3.1 SUMMARY OF MWH GEOTECHNICAL INVESTIGATION RESULTS

Generally, the subsurface conditions were investigated from a floodplain elevation of 5264 ft asl with a poorly graded, medium dense, dry sand being encountered to an approximate elevation of 5257-ft-asl. Underlying the poorly graded sand is a well-graded, medium dense, moist sand and sand with gravel that extends to an approximately elevation of 5243-ft asl. Groundwater was encountered at approximately 20-ft below ground surface (bgs) in all three soil borings (approximately 5243-ft asl). North of the arroyo channel, soft and plastic clay was encountered from approximately 19 to 24-ft bgs (5242 to 5239-ft asl). However, this soft clay material was not encountered in DH-3 south of the channel. On both sides of the channel and at an elevation of approximately 5239-ft asl, a hard, dry siltstone was encountered. The siltstone has seams of black coal up to 6 in. thick and it extends to at least an elevation of 5226-ft asl (MWH, 2004).

4.0 CROSSING DESIGN

The crossing design is presented on 12 civil drawings (C-1 through C-12), four hydrology and hydraulics drawings (D1 through D-4) and four structural drawings (S-1 through S-4).

4.1 HAUL ROAD

A 120-ft-wide haul road is required across Cottonwood Arroyo to carry a Marion 8750 dragline weighing 13,050,000 lbs south to the Area IV - North Development and to carry Kress CH-220C haul trucks with loaded weight of 735,000 lbs, north to the coal blending area. The haul road was designed to withstand one-way truck traffic frequency of 720 trips per week and routine maintenance would be performed by BNCC. The haul road surface profile is constrained by:

- The elevation of existing haul roads on the north side of the Arroyo;
- The elevation of proposed haul roads on the south side of the Arroyo;
- Vertical curvature and gradient constraints on operating equipment;
- Minimum cover over proposed box culvert sections; and
- The required spillway's invert elevation.

A proposed profile has been developed that consists of a series of three vertical curves with lengths of 120 ft, 300 ft, and 100 ft and maximum 4% grades. The haul road drops from 5272 ft asl to the north into a sag curve. The low point of the crossing acts as a proposed low-level spillway crossing of the existing floodplain on the north side of the Arroyo and rises above a proposed box culvert crossing of the existing channel reaching elevation 5280 ft asl on the south side of the Arroyo. The minimum cover area of the box culvert is 4-ft The haul road will be divided into an 80-ft-wide haul truck traffic-way to the west (downstream of centerline) and a 40-ft-wide regular vehicle traffic-way to the east (upstream of centerline). The road surface will be crowned between the two traffic-ways and will be graded with outward cross slopes of 2.5% in each direction to facilitate rapid drainage during rainfall and snowmelt events. In addition, a downstream earthen safety berm has been added where the elevation differential between the edge of the road is 3-ft or greater above the native ground surface. In the constricted area along the culvert, an MSHA approved guardrail will be constructed instead of an earthen berm. Typical roadway sections are shown on Drawing C-3. In the 2006 design, Drawings C8 and C9 presented roadway sections though the proposed emergency access road, which is no longer required. Therefore, current equivalent drawings C-7 and C-8 have been deleted from this design as indicated on the cover sheet. Due to the curvature of the haul road and presence of protected 2H:1V drop-offs, and the potential for night usage, URS recommends that the posted speed limit of the haul road be 30 miles per hour. Because the roadway will be subject to over-topping during major storm events, URS also recommends signage warning drivers not to cross arroyo when water is flowing over the road. Details of the surfacing, base and sub-base for the haul road are indicated on Drawing C-4. The plan and profile for the haul road is shown on Drawing C-5. Guardrail location plan view is shown on Drawing C-6. Drawings C9 through C-12 show metal barrier and guardrail details. Pavement design calculations are presented as Appendix B.

BNCC requires a pavement design to handle 25 years of extremely heavy mining haul road trucks on the order of 368,500 lbs/axle load, for a significant number of axle passes over the life of the project. This would correspond to over 20,000,000 Equivalent Standard Axle Loads

(ESALs) in the standard 18 kip axle load design method; therefore, geogrid is recommended to prevent a punching failure of the road pavement cross-section. At the request of URS, BNCC provided traffic loadings for the period 2007 through 2031; therefore, the 25-year design life for the haul road pavement design was selected. URS reviewed the previously furnished pavement section developed by MWH, which was:

- 6-in. Wearing course (California Bearing Ratio [CBR] 80)
- 10-in. Base course (CBR 80)
- 42-in. Alluvial sand (sub-base course) (CBR 80)
- Sub-grade preparation (CBR 3) (MWH, 2004)

URS determined that the above pavement section was inadequate based on the wheel loads for the mine haul trucks (the tire pressure) and the 25-year expected traffic loadings. Based on the pavement design calculations in Appendix B, the required un-reinforced (no geogrid) pavement section would need to be 82 in. Therefore, URS has prepared the pavement section illustrated in Appendix B and the contract drawings and it is expected that the reduction in the sub-base course thickness, and the lower CBR requirement (40 versus 80), will enable BNCC to save contract dollars in the final bid and construction of the haul road. Furthermore, the recommended pavement section will have significant constructability benefits and, because of the sub-grade improvement reinforcement to be provided, is expected to provide a full 25-year design life.

4.2 CONCRETE BOX CULVERTS

4.2.1 Introduction

The MWH Permitting Design Report had developed the concept for this project whereby the 10% annual chance event flows of the Cottonwood Arroyo would be carried through an eight-barrel, 8-ft by 8-ft pre-cast concrete box culvert, located in the natural channel beneath the crossing. Based on the revised flow data provided by BNCC and results obtained from analyses performed by URS, it was determined that a four-barrel box culvert would be sufficient to contain a 10% annual chance event. Larger design storm events would overtop the haul road, and the haul road would then essentially act as a spillway. The culvert crosses beneath the haul road (MWH, 2004).

4.2.2 Structure Selection

Culverts are used to convey water beneath a roadway. Box shapes are typically used to accommodate large flows without excessive vertical headroom requirements. Box culverts have been proposed for this project because of their low profile and their high vertical load carrying capacity.

Box culverts may be either cast in place or pre-cast. Due to the distance of the site from the nearest Redi-Mix plant, pre-cast concrete box culverts are expected to be more cost effective. The pre-cast units could be manufactured at a location such as the Albuquerque Rinker Materials - Concrete Pipe Division (Bernalillo), New Mexico. As an example, details of the Rinker MEGA Box Culvert are presented in Appendix C.

Alternative culvert concepts may be available, and we recommend providing flexibility in the design drawings for the Contractor to bid on creative alternatives. The alternatives would be

constrained to maintain cover and hydraulic design parameters. One alternative that may be practical is the use of multiple pre-cast concrete arch culverts.

4.2.3 Hydraulic Analysis

Refer to Section 5.2 of this report for discussion on the culvert.

4.2.4 Culvert Description

The final hydraulic analysis shows that for the design flow, a four-barrel, 8-ft by 8-ft concrete box culvert is required. The culvert is aligned approximately parallel with the natural channel and is approximately 187-ft long with a slope of 0.24%. The invert elevation is approximately coincident with the bottom of the existing Cottonwood Arroyo channel, and a 4-ft minimum cover was used during the design of the vertical roadway profile of the haul road. The ends of the box culvert are skewed 30 degrees to improve the hydraulic efficiency of the culvert. Because the skew angle is too great for the pre-caster to fabricate, a cast in place concrete headwall is proposed.

Inlet/outlet concrete aprons will be incorporated into the box culvert structure to control scour. Gabion mattresses are proposed at the inlet and outlet to control erosion and scour. Gabion mattresses, 18-inch thick, will extend up the embankment on the inlet side to the Elevation of 5264 for the 10-yr storm event. 18-inch gabion mattresses are proposed on the outlet structure up to Elevation 5264 for scour control.

The depth of sub-excavation and replacement of foundation material to develop suitable bearing for the culvert structure will need to be determined during construction since test pit excavation and drilling in the stream channel was not possible during the investigation phase. It is anticipated that 1 or 2-ft of sub-excavation and backfill with compacted native sand will be all that is required.

4.2.5 Culvert Design

The culvert design will be robust due to the very large vehicle loads imposed on top of the boxes. The design vehicles consist of a dragline and haul truck. Design information regarding vehicle geometry, and loads can be found in Appendix C. In the MWH Permitting Design Report, design vehicle loads were reduced to 80% for the dragline and almost 60% for the haul truck. After consultation with BNCC, URS was unable to determine the justification for allowing such a reduction, so final design will use the total vehicle weights. This will result in a substantial increase in the box section.

URS approached Rinker Materials - Concrete Pipe Division to provide preliminary design information for the pre-cast reinforced concrete box (RCB) culverts. Their preliminary design is provided in Appendix C and consists of walls and slabs having a thickness of 8 – 10-inches. The culvert design details are presented in Drawings S-1 through S-4.

5.0 HYDROTECHNICAL ANALYSIS

5.1 HYDROLOGICAL ANALYSIS

For the proposed Cottonwood Arroyo crossing, BNCC had provided MWH preliminary discharge values. These values were based on a BNCC hydrologic model generated in 2003, in the software SEDCAD 4 and were used for the permitting process (MWH, 2004). SEDCAD 4 is the regulatory software approved by the Office of Surface Mining. Since 2003, BNCC had updated their hydrologic model to represent the ever changing mine topography. As a result of the BNCC update, there were differences between the 2003 and 2007 calculated peak discharge values for each storm. The new 2007 peak flow values were 2186 cfs, 3263 cfs, and 4040 cfs for the 10%, 4%, and 2% annual chance storm events, respectively. These values reflected a 23% decrease from the values reported in the previous design report.

URS completed a general overview of the BNCC hydrology. The review was performed as a check of the reasonableness of the BNCC discharge values. URS evaluated the post mine watershed area (77 square miles) and calculated a peak discharge using the National Flood Frequency (NFF). The equations from NFF for New Mexico's Northwest Plateau are the following:

- $Q_{10} = 3.06 \times 10^2 A^{0.46}$, where A is in square miles
- $Q_{25} = 4.86 \times 10^2 A^{0.45}$, where A is in square miles
- $Q_{50} = 6.54 \times 10^2 A^{0.45}$, where A is in square miles

The values calculated by the NFF program were 2260 cfs, 3430 cfs, and 4620 cfs for the 10%, 4%, and 2% annual chance storm events, respectively. The values obtained from the NFF program appeared reasonable as a check of the SEDCAD 4 values.

Based on the precedent set by BNCC to provide MWH with the peak discharge values from the BNCC model for the permitting document and preliminary modeling, URS continued to use peak discharge values generated by BNCC. Therefore, peak discharge values of 2186 cfs, 3263 cfs, and 4040 cfs were used for the 10%, 4%, and 2% annual chance storm events were used for hydraulic calculations.

5.2 HYDRAULIC ANALYSIS

The scope of this study is to determine the number of 8-ft by 8-ft concrete box culverts necessary to pass the revised 10-year flood event without overtopping the haul road. Utilizing the aforementioned scenario, the overtopping flow velocities, as a result of the revised 50-year flood event, will also be determined. The U.S. Army Corps of Engineers' one-dimensional hydraulic model, HEC-RAS, was used for the analysis. Of the two models developed during the analysis, one model was used to simulate the overall hydraulics of the channel/culvert, while the second one simulated the hydraulics of the overtopping flow.

5.2.1 Culvert Analysis (10-year Event)

The revised peak flow for the 10-year flood event is approximately 2,186 cfs, which is lower than the original estimate of 2,936 cfs. Utilizing the revised flow rate, it has been determined that the 10-year flood event can be passed through four 8-ft by 8-ft concrete box culverts without overtopping the haul road. The maximum water surface elevation, upstream of the culverts, is

expected to be approximately 5,265.4-ft asl. The upstream culvert inverts and crowns have been modeled at elevations 5,257.6-ft asl and 5265.7-ft asl, respectively. Therefore, the flow depth at the upstream end of the culvert is expected to be approximately 7.8-ft, leaving approximately 1.2-ft of freeboard between the maximum water surface elevation and the lowest crown elevation of the haul road (El. 5,266.7-ft asl). As flow passes through the culverts, the HEC-RAS model indicates possible critical depth near the culvert exit. Therefore, a hydraulic jump may occur either in the downstream end of the culvert or on the downstream apron. Additionally, the exit velocities from the culvert are expected to approach 13 ft/s with a flow depth of approximately 5-ft. Consequently, scour protection downstream of the culvert must be provided. The culvert plan and profile and grading plan are presented as drawings D-1 and D-2, respectively. Gabion armoring details are presented on Drawings D-3 and D-4.

5.2.2 Overtopping Analysis (50-year Event)

The revised peak flow for the 50-year flood event is approximately 4,040 cfs, which is lower than the original estimate of 5,173 cfs. Four 8-ft by 8-ft concrete box culverts will not be able to pass the 50-year flood event without overtopping the haul road. The culverts are expected to pass approximately 2,731 cfs; therefore, approximately 1,309 cfs is expected to overtop the haul road. The maximum water surface elevation, upstream of the culverts and haul road, will be approximately 5,268.4-ft asl. The upstream edge of the haul road traffic lane has an elevation of approximately 5,265.7-ft asl, therefore, approximately 2.8-ft of overtopping is expected at this location. Flow velocities are expected to be relatively low (i.e. less than 2 ft/s) on the upstream embankment face and the haul road traffic lane, as flow approaches the crown of the haul road. The overtopping flow is expected to pass through critical depth at the crown, before transitioning to supercritical flow over the haul road truck haul lane. The overtopping flow on the haul road truck lane and the downstream embankment is controlled by the tailwater from the downstream channel, which reaches the upper section of the embankment face. The flow velocities are expected to be approximately 5.2 ft/s near the haul road crown and increase to approximately 8.2 ft/s at the downstream edge of the road. The flow velocity on the downstream embankment face is expected to decrease as the overtopping flow interacts with the downstream channel tailwater.

5.2.3 Gabion Armoring

The haul road is to be armored using gabions to protect the road during the 50 year design storm. Fifty year protection plus one foot of freeboard will be provided. Maccaferri gabions, gabion mat and Reno mattress will be used. All Reno mattresses are 9-in thick. Gabion mat and gabion blocks are 18-in thick. Filter cloth will be required around all armoring. The gabion layout is shown on plan sheet D-3. Details are shown on plan sheet D-4 including the sections described below.

<u>East/upstream side of haul road</u>
An 8-ft width of Reno mattress with an additional 3-ft cut off wall, Section B on the detail sheet, D-4, will extend from Station 0+10 to 2+30 with a 3-ft cut off wall. A 14-ft wide plus 3-ft cut off wall, Section A, extends from 2+30 to 4+47. Reno mattress extends from Station 4+47 to 5+62, Section F, to the culvert. Section F varies from 18-ft to 30-ft in width with a 5-ft cut off wall.

<u>West/downstream side of haul road</u>
An 8-ft width of Reno mattress, with 3-ft cut off wall, identical to Section B on the east side, extends from Station 0+11 to 3+00. A stepped gabion structure consisting of gabions and gabion mat, with a 10-ft deep concrete cut off wall, labeled Sections C and G, extends from

Station 3+00 to 4+00. The roadway grade begins to rise from existing ground at about Station 2+50 and extends up at 3 percent. Thus the west side of the road is approximately 2-ft to 6-ft above existing ground, creating the need for the stepped structure.

APPENDIX B

PAVEMENT DESIGN

APPENDIX B

PAVEMENT DESIGN – MINING HAUL ROAD BNCC COTTONWOOD ARROYO CROSSING

Project Description

BNCC requires a pavement design to handle 25 years of extremely heavy mining haul road trucks on the order of 368,500 lbs/axle load, for a significant number of axle passes over the 25-year life of the project. This would correspond to over 20,000,000 ESALs in the standard 18 kip axle load design method; therefore, the use of geogrids is recommended to prevent punching failure in the road pavement cross-section.

DESIGNER	CLIENT
URS Corporation	
One Park Square, Suite 900	BNCC
6501 Americas Parkway NE	300 West Arrington
Albuquerque, NM 87110, US	Farmington, NM 87416, US
ATTN: Donald T. Lopez, PE, URS New Mexico	ATTN: Leonard Raymond
Phone: (505) 855-7500	Phone: (505) 598-4209
FAX: (505) 855-7555	FAX: (505) 598-3361
don_lopez@urscorp.com	Leonard.L.R.Raymond@bhpbilliton.com

SUBGRADE IMPROVEMENT CALCULATION

Design Methodology

The aggregate fill thicknesses determined in the Results section below are based on the methodology prescribed in Giroud and Han (2004). The design method is intended for the calculation of the required unbound aggregate layer thickness for unpaved roads (such as haul roads) constructed on weak sub-grades.

Validation of the thicknesses achieved for pavement sections reinforced with Tensar biaxial geogrids using this method were achieved through calibration with several sets of test data, including the results obtained from work undertaken in the pavement test facility at North Carolina State University (Gabr, 2001).

Design Parameters

a) Trafficking Requirements

Property	Value
Axle Load (kips)	368.5
Tire Pressure (psi)	102
Axle Passes (per week)	See Pages B-3 through B-5
Maximum Rut Depth (in.)	1.5

b) Pavement Soil Properties

Property	Value
Aggregate Fill CBR (%)	40
Field Subgrade CBR (%)	3

c) Geosynthetic Properties

Parameter	BX1200
Geogrid Type	Integrally formed, single layer
Rib Shape	Rectangular/square
Rib Thickness (in.)	0.05
Aperture stability modulus (m-N/degree)	0.65
Junction Efficiency (%)	90
Aperture dimensions (in.) -Machine direction -Cross machine	 1.0 1.3
Thickness adjustment factor	1.0

AGGREGATE FILL THICKNESS SAVINGS

Geosynthetic	Aggregate Fill Thickness (in.)		Aggregate Fill Thickness Savings (in.)	
	Calculated	Required	(in.)	(%)
Unreinforced	102	82	N/A	N/A
Tensar BX1100	67.7	68	34	33
Tensar BX1200	45.2	46	56	55

COTTONWOOD CROSSING TRUCK FREQUENCY

---- Forwarded by Steve Raugust/Albuquerque/URSCorp on 05/17/2006 03:29 PM ----

"Raymond, Leonard LR" <Leonard.LR.Raymond@burlingtonnorthern.com>
05/17/2006 03:28 PM

To "Steve_Raugust (E-mail)" <Steve_Raugust@URSCorp.com>
cc "Hoskie, Ben BN" <Ben.BN.Hoskie@burlingtonnorthern.com>
Subject Cottonwood Crossing truck frequency

Steve: Attach is a spreadsheet showing the frequency of the trucks for 20, 15 and 10 shifts per week work schedule. The trucks will most likely be on 15 shifts per week work schedule but on some occasions may run 20 shifts per week depending on production requirements.

L. Raymond

<<CWC Frequency2 051706.xls>>

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[attachment "CWC Frequency2 051706.xls" deleted by Michele Anderson/Albuquerque/URSCorp]

TRUCK LOADS PER SHIFT FOR 20, 15 AND 10 SHIFTS PER WEEK

	Avg	Min	Max	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
Total Tons Mined	8,791	7,753	9,567	8,909	8,976	8,940	9,313	8,602	8,908	8,875	9,135	8,850
A4 Tons Mined	5,708	-	9,373	-	-	-	-	546	2,353	4,928	5,126	5,001
20 Shifts/Wk	858	550	1,000							550	550	550
15 Shifts/Wk	643	413	750							413	413	413
10 Shifts/Wk	429	275	500							275	275	275
Freq for 20 Shifts/Wk	36	29	39							37	39	38
Freq for 15 Shifts/Wk	48	39	52							50	52	51
Freq for 10 Shifts/Wk	72	58	78							75	78	76

All tons from A3 & A2

Freq is number of trucks per shift, max payload of 240 tons loaded one way.
Tons Mined is from FY07 LR mine plan at high burn.
A4 tons mined are the tons hauled over the Cottonwood Crossing

FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030	FY2031
8,428	8,601	8,658	9,567	8,319	8,928	8,760	9,373	8,887	8,384	8,737	9,087	9,094	8,496	7,753	8,189
4,543	4,290	4,890	7,014	8,319	8,928	8,760	9,373	8,887	8,384	8,737	9,087	9,094	8,496	7,753	8,189
550	550	550	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
413	413	413	750	750	750	750	750	750	750	750	750	750	750	750	750
275	275	275	500	500	500	500	500	500	500	500	500	500	500	500	500
34	32	37	29	35	37	36	39	37	35	36	38	38	35	32	34
46	43	49	39	46	50	49	52	49	47	49	50	51	47	43	45
69	65	74	58	69	74	73	78	74	70	73	76	76	71	65	68

EQUIPMENT DESIGN LOAD DATA -BNCC OPERATIONS

DRESSER
Construction & Mining Equipment

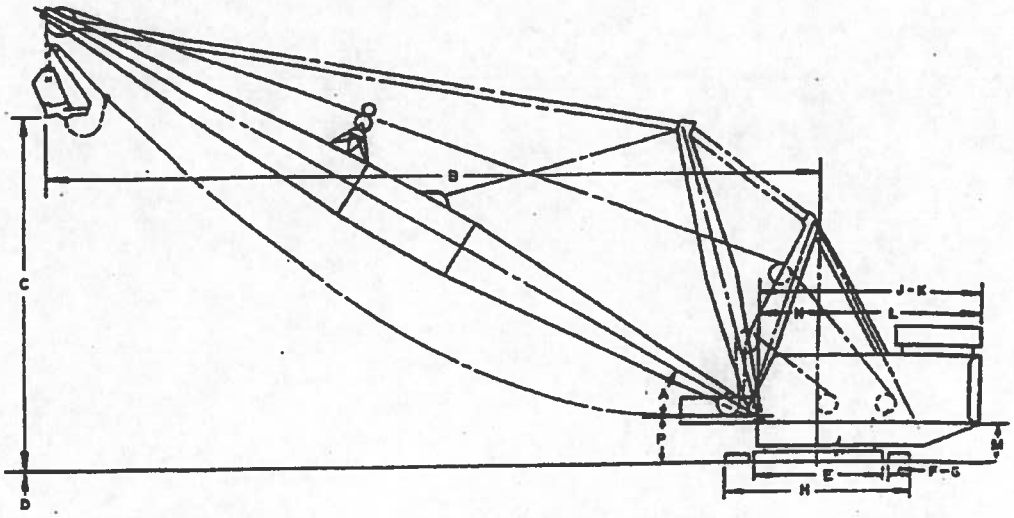
DRESSER INDUSTRIES, INC. • MARION DIVISION
MACHINE SPECIFICATIONS

Model: 8750 WALKING DRAGLINE

Description: Ward Leonard — Static Control — Independent Propel

NAVAJO

KEY #7



WORKING RANGES

Boom Length	335'-0"
Boom Point Sheave, Pitch Diameter	90"
A - Boom Angle, Approx.	32.5°
B - Dumping Radius	310'-0"
C - Dumping Height	123'-0"
D - Depth	150'-0"
Maximum Allowable Load, lbs.	571,000
Hoist Drum, Pitch Dia.	132"
Hoist Ropes, Four, Dia. Each	3-1/4"
Drag Drum, Pitch Dia.	132"
Drag Rope, Four, Dia. Each	3-1/4"

BASE

E - Outside Diameter - Nominal	80'-0"
Bearing Area - Effective, sq. ft.	5040
Bearing Pressure, psi	18.03
Rail Circle - Mean Dia.	53'-0"
Circle Rollers - Mean Dia.	16"
Main Swing Gear - Pitch Dia., Approx.	45'-0"

WALKING TRACTION

F - Width of Shoe	16'-0"
G - Length of Shoe	80'-0"
H - Width Over Both Shoes	116'-0"
Bearing Area of Both Shoes, sq. ft.	2560
Bearing Pressure @ 80% of Working Weight, psi	28.3
Length of Step - Approx.	6'-2"

ROTATING FRAME

J - Width @ Herr End	80'-0"
K - Length	109'-0"
Depth Sill Members	144"
L - Clearance Radius - Rear End	77'-0"
M - Clearance Under Frame	15'-10"
N - Center Rotation to Boom Foot	24'-0"
P - Ground to Boom Foot	22'-0"

ELECTRICAL EQUIPMENT

Hoist Motors, Eight, 1300 hp each @ 475 V, Total hp	10400
Drag Motors, Six, 1300 hp each @ 475 V, Total hp	7800
Swing Motors, Six, 1045 hp each @ 475 V, Total hp	6270
Propel Motors, Four, 800 hp each @ 475 V, Total hp	3200
AC Driving Motors, Total hp	13000

WEIGHTS

Domestic Shipping Weight (Inc. Bucket), lbs.	11,450,000
Working Weight, lbs.	13,850,000
Ballast (Furnished by Purchaser), lbs.	1,800,000

Shipping Weight Subject to 5% Variation.

Patents Pending
Printed in U.S.A.

The Company reserves the right to improve or change the design of its products and specifications thereof and the Company shall incur no liability thereby or any obligations to install such improvements on products previously sold.

Tensar INTERNATIONAL

Kenneth P. Akins, Jr., P.E.
Manager of Consulting Engineering

5883 Glenridge Drive
Suite 200
Atlanta, GA 30328
Tel. 404•214•5322
Fax. 404•250•9185
email:kakins@tensarcorp.com

May 2, 2007

URS Corporation
6501 Americas Parkway, NE
Suite 900
Alberquerque, NM 87110-5311

Atten: Mr. Samrat Mohanty
Mining Engineer

VIA E-MAIL: Samrat_Mohanty@ URScorp.com

Re: BHP Navajo Mine Haul Road

Mr. Mohanty:

Thank you for the opportunity to assist you on the Haul Road for the BHP Navajo Mine. We have considered the proposed section provided in your e-mail of April 26, 2007. Vehicle information and loads were supplied previously. Our evaluation included three basic considerations:

- Section geometry
- Layered elastic analysis
- Damage model

Last year, URS developed a proposed section based on the US Bureau of Mines approach by Kaufman. As an alternative design procedure to establish a basic geometry, Tensar considered the British Ports Design method. The British Ports method provides material equivalencies for CBR=80. We have considered the effect of a CBR of 40 rather than 80 using the Kaufman curves. The increase can be overcome by the geogrid reinforcement. The section in the April 26 e-mail is similar to that developed from the two design methods. The URS method last year considered a thicker but lower quality base. The British Ports method considers a capping and subbase layers now addressed by the prepared subgrade layer (Calculation Sheet attached).

We performed a layered elastic analysis to determine the vertical strain at the top of each layer. In all cases, the strain was less than recommended 2000 μ-strain (Analysis attached). Minor variations and rather thicknesses of vary similar layers will not appreciably affect strains.

URS Corporation
BHP Navajo Mine Haul Road

May 2, 2007
Page 2 of 2

We then evaluated the damage from repetitive loads to determine the layers at greatest risk to aid in the selection of geogrid placement to protect those layers. The SpectraPave analysis was set to model the four aggregate layers and subgrade. Layers limiting performance were the first subbase layer and subgrade, thus grid would be of most benefit if placed above those layers (Analysis attached).

Based on our evaluation and our discussions, we recommend that he two layers of BX 1200 be placed 12 inches above the position currently show, or a high as possible in the subbase consistent with constructability requirements, and at the bottom of the subbase, directly on the prepared subgrade.

By specific request, we have included an earlier index analysis for bearing capacity, modified for current loading. The bearing capacity is insensitive to geogrid placement is long as it is reasonably distributed in the zone.

If you should have any questions please call (800-836-7271) or e-mail (kakins@tensarcorp.com).

Regards,
Tensar International Corporation

Kenneth P. Akins, Jr., P.E. (GA 10186)
Manager of Consulting Engineering

cc: Nicholas Reck, TIC

Attachments
- British Ports Analysis
- Layered Elastic Analyses
- Damage Model
- Index Analysis-Bearing Capacity

TENSAR

PROJECT NM Mine Haul - BHP Navajo

PROJECT NO. PAGE 1 OF 1

BY KM DATE 5/1/07 CHK

CALCULATED BY KM DATE 5/2/07 CHK

REVISIONS

BRITISH PORTS METHOD

Page 48. wheel Load = 352 kN > 300

∴ go to p. 48

250,000 passes ≈ 1000/yr 30-40 day

2,500,000 300-400 day

(240/day)(365 days/yr)(25 yrs) = 2,190,000 ~~over~~ /1.ft

250,000 → 370 mm C10 Base × 3 1,100 CBR = 80

2,500,000 → 430 mm C10 BASE × 3 = 1290 mm

Subgrade CBR = 3 -

Foundation Thickness

Capping 250 mm } pg 35.36

Subbase 150 mm

400 mm

∴ 1.1 - 1.3 m CBR = 80 51.2"

0.4 m capping & subbase 15.7"

66.9 6/21/06

1.2 m } = 47"

0.4 m } 15.7"

Approved subgrade 5/1/07

BY KD DATE 6/21/06

CHK BY DATE

ADJUST FOR CBR 40, AFTER Kaufman

Δ = 5" ∴ 52" Total

Tensar Earth Technologies, Inc.

Pavement Situation At Start of Phase 1 of 1

Method: Distinct Phase Calculation Without Adjustment For Incremental Damage

Design Name: Tensar BHP Mine Haul Section

Pavement Description: Changed 18" Subbase to lower position, to provide greater overlying protection to the thicker layer, as the grid will offer less support to the layer from the bottom up. The 12" Subbase Layer will however benefit more from the grid.

Detailed view for axle type: BHP Mine Haul Truck

Total Capacity for All Phases is 25 thousand

Critical layer for this phase and axle: Layer 5

Phase starts in year 0 and ends in year 0.25

Note: Damages & critical parameters shown are for this axle type only.

Thickness = 6 Inches; Wearing Course Stiffness = 600 MPa; Poisson = 0.35; Criterion: BC Granular Materials Cat A Cohesion = 9.17 psi; Angle of Friction = 54.2	Shear Safety Factor: 8.66 Position: Between Loads/Middle of Layer Axle Capacity: >100 million (Effective: > 100 million) Cum. Damage, Phase Start to End: < 0.01 to < 0.01
Thickness = 12 Inches; Course Crushed Rock Base Course Stiffness = 600 MPa; Poisson = 0.35; Criterion: SG 20mm Rut, Cat A No special material properties needed	Vertical Compressive Strain: 643 Microstrain Position: Load Centreline/Top of Layer Axle Capacity: >100 million (Effective: > 100 million) Cum. Damage, Phase Start to End: < 0.01 to < 0.01
Thickness = 12 Inches; Subbase Course Stiffness = 400 MPa; Poisson = 0.35; Criterion: SG 20mm Rut, Cat A No special material properties needed	Vertical Compressive Strain: 772 Microstrain Position: Load Centreline/Top of Layer Axle Capacity: 26.53 million (Effective: 26.53 million) Cum. Damage, Phase Start to End: < 0.01 to < 0.01
Thickness = 18 Inches; Selected Subbase Course Stiffness = 400 MPa; Poisson = 0.35; Criterion: SG 20mm Rut, Cat A No special material properties needed	Vertical Compressive Strain: 539 Microstrain Position: Load Centreline/Top of Layer Axle Capacity: >100 million (Effective: > 100 million) Cum. Damage, Phase Start to End: < 0.01 to < 0.01
Thickness = Semi-Infinite; Prepared Subgrade Stiffness = 34.5 MPa; Poisson = 0.35; Criterion: SG 20mm Rut, Cat A No special material properties needed	Vertical Compressive Strain: 1548 Microstrain Position: Load Centreline/Top of Layer Axle Capacity: 25 thousand (Effective: 25 thousand) Cum. Damage, Phase Start to End: < 0.01 to > 1.0

Standard Axle Load Details:

Setup: BHP Mine Haul Truck ; Daily Count = 240; Growth Rate = 1 (%)

Description: Equivalent Tridem Wheel Axle Configuration

Pavement Notes: BX1200 to be inserted at top of subgrade and above the lower 18" subbase layer.

Tensar

BHP Mine Haul Road

Tensar Proposed Alternative - Rutting Analysis

1

Rubicon Toolbox: LET: Standard Axle Analysis / Ver: 2.6.3 / (Licenced)

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SUBGRADE IMPROVEMENT

INPUT DATA

Axle Load =	368.5(kip)	Tire Pressure =	102(psi)
Number of Axle Passes =	1872000	Rut Depth =	1.5(in)
Field Subgrade CBR =	3 (%)	Field Subbase CBR =	40 (%)

GEOGRID PROPERTIES

	BX1100	BX1200
Geogrid Type	Integrally formed single layer	Integrally formed single layer
Rib Shape	Rectangular/Square	Rectangular/Square
Rib Thickness (in)	0.03	0.05
Aperture Stability Modulus(cm-kg/deg)	3.2	6.5
Junction Efficiency (%) (Percent of Tult)	90	90
Aperture Dimensions (Inside to inside)		
MD (in)	1.0	1.0
XMD (in)	1.3	1.3

ANALYSIS RESULTS

	Unreinforced	BX1100	BX1200
Subbase Thickness (in) =	102.0	67.7	45.2
Subbase Saving (in) =		34.3	56.8

Base Course Reinforcement

Design Methodology

The calculations contained in this section are based on the methodology prescribed in the AASHTO (1993) guide. When reference is made to the 'AASHTO (1993) Equation', the equation concerned is that given at the top of Figure 3 1 on Page II-32 of the document.

In addition to ensuring that the overall Structural Number of the pavement is at least equal to that required to carry the intended traffic load, it is also recommended to ensure that individual layers are designed in accordance with the Layered Analysis approach prescribed in Section 3.1, Part II of the AASHTO (1993) documen

Design Parameters

a) Pavement Layer Properties

Layer	Description	Elastic modulus, E (psi)	Cost ($/CY)	Layer coefficient	Drainage factor
ACC1	Wearing Course	90,000	130	0.14	N/A
ACC2	Coarse Crushed Rock Base	90,000	118	0.14	N/A
ABC	Subbase Course	50,000	43	0.14	1 0
SBC	Selected Subbase Course	50,000	30	0.14	1 0

b) Input Parameters for AASHTO (1993) Equation

Parameter	Value
Reliability (%)	95
Standard Normal Deviate	-1 645
Standard Deviation	0.49
Initial Serviceability	4.2
Terminal Serviceability	2 0
Change in Serviceability	-2.2
Subgrade Resilient Modulus (psi)	5,000

c) Input Parameters for Tensar Geogrid

Parameter	Value
Supply cost for Tensar BX1100 $/SY	2.00
Supply cost for Tensar BX1200 $/SY	3.00
TBR value for Tensar BX1100	3
TBR value for Tensar BX1200	3
Cost to install geogrid $/SY	0.25

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Base Course Reinforcement

Results

Table 1 - Proposed Pavement Section

Layer	Thickness (in)	ai	mi	SN
ACC1	6.0	0.14	N/A	0.84
ACC2	12.0	0.14	N/A	1.68
ABC	12.0	0.14	1.0	1.68
SBC	18.0	0.14	1.0	2.52
Overall Structural Number (SN)				6.72

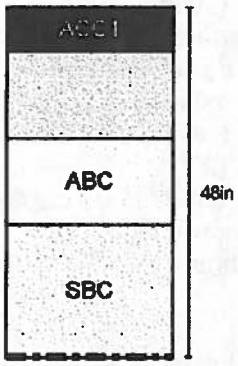


Table 2a - Calculated Trafficking Based on Overall Structural Number

Allowable traffic load (ESAL's)	Unreinforced	Reinforced	
		BX1100	BX1200
	40,308,000	120,924,000	120,924,000

Table 2b - Calculated Trafficking Based on a Layered Analysis

Layer	Underlying layer		SN of overlying layers	Allowable traffic (ESAL's)		
	Name	Modulus (psi)		Unreinforced	BX1100	BX1200
ACC2	ABC	50,000	2.52	7,881,000	23,643,000	23,643,000
ABC	SBC	50,000	4.2	240,787,000	722,361,000	722,361,000

A Layered Analysis ensures that individual layers within the pavement remain intact during its design life; full details are presented in Section 3.1.5, Part II of AASHTO (1993)

ctrlPave2 Version 2.1 Unlitled.xls

References

1. Gabr, M. (2001)
Cyclic plate loading tests on geogrid reinforced roads.
Research report to Tensar Earth Technologies Inc., N.C. State University

2. Giroud, J.P., and Han, J. (2004)
Design method for geogrid-reinforced unpaved roads:
Part 1 – Development of design method
ASCE Journal of Geotechnical and Geoenvironmental Engineering

3. Giroud, J.P., and Han, J. (2004)
Design method for geogrid-reinforced unpaved roads:
Part II – Calibration and applications
ASCE Journal of Geotechnical and Geoenvironmental Engineering

4. AASHTO (1993)
Guide for the design of pavement structures;
The American Association of State Highway and Transportation Officials

5. AASHTO (2003)
"Recommended Practice for Geosynthetic Reinforcement of the Aggregate Base Course of Flexible Pavement Structures"
The American Association of State Highway and Transportation Officials Publication PP46-01, Washington, DC

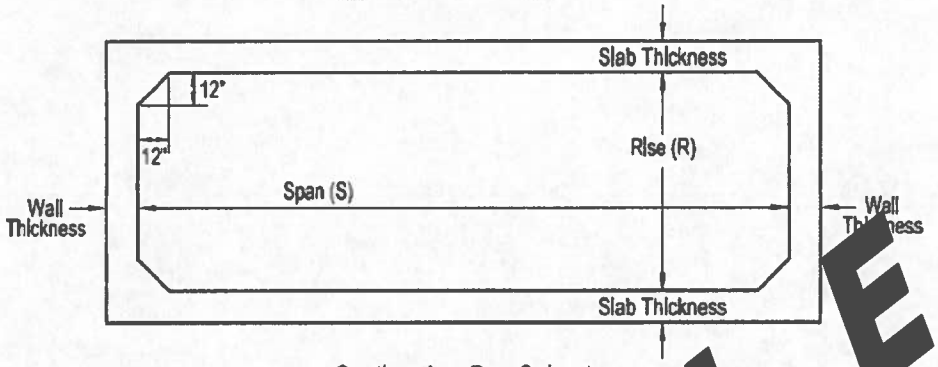
APPENDIX C

CULVERT DESIGN

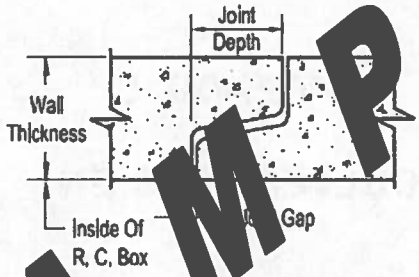
Rinker MATERIALS™

Concrete Pipe Division

Reinforced Concrete MEGA Box Culvert



Section thru Box Culvert



Section thru Box Joint

Span (S)	13	14	15	16	17	18	19	20	21	22	23	24
Weights (lbs.) Per Foot												
4	6000	6300	6600	6900	7700	8000	8900	9200	10200	10500	11500	11900
5	6300	6600	6900	7200	8000	8300	9200	9500	10500	10800	11800	12200
6	6600	6900	7200	7500	8300	8600	9500	9800	10800	11100	12100	12500
7	6900	7200	7500	7800	8600	8900	9800	10100	11100	11400	12400	12800
8	7200	7500	7800	8100	8900	9200	10100	10400	11400	11700	12700	13100
Wall Thickness (inches)	12	12	12	12	12	12	12	12	12	12	12	12
Slab Thickness (inches)	12	12	12	12	13	13	14	14	15	15	16	16

Box dimensions may vary depending upon equipment availability and location.

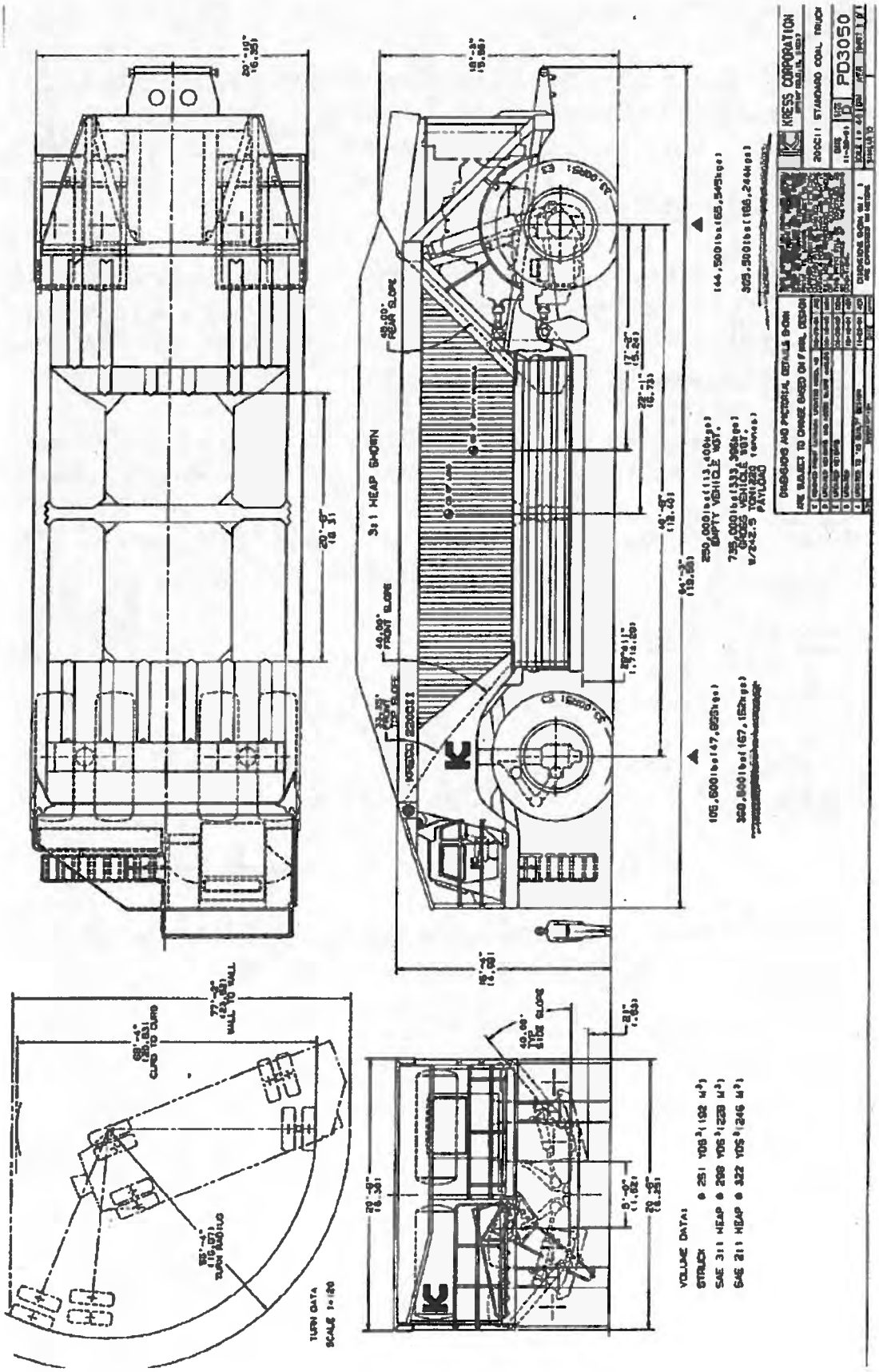
Notes:

1. Produced to meet ASTM Specifications.
2. Contact a Concrete Pipe Division representative for details not listed on this sheet.

Rinker 014

EXAMPLE

EQUIPMENT DESIGN LOAD DATA - BNCC OPERATIONS



URS

Job BHP/Navajo Cottonwood Crossing Project No. 24342727 Page ___ of ___
Description Revised Machine Loads Computed by BR Sheet 1 of 2
Date 4/19/07
Checked by Samrat Mohanty Date 4/21/07
Reference

DESCRIPTION

- Compare original design haul truck load to revised haul truck to determine effect on the culvert design
- Apparently, this coal hauler was specifically made for BHP/Navajo

CULVERT COVER

→ from phone conversation with Curti 4/18/07, soil cover for revised 4 barrel culvert ranges between 6' to 10'.

→ for preliminary culvert design, used fill height of 8'

REVISED COAL TRUCK

→ See attached revised haul truck specs and tyre data

→ Model KRESS 200 C11
→ Loaded gross vehicle wt = 735,000 lb

→ Critical axle load = 368,500 lbs (front axle)

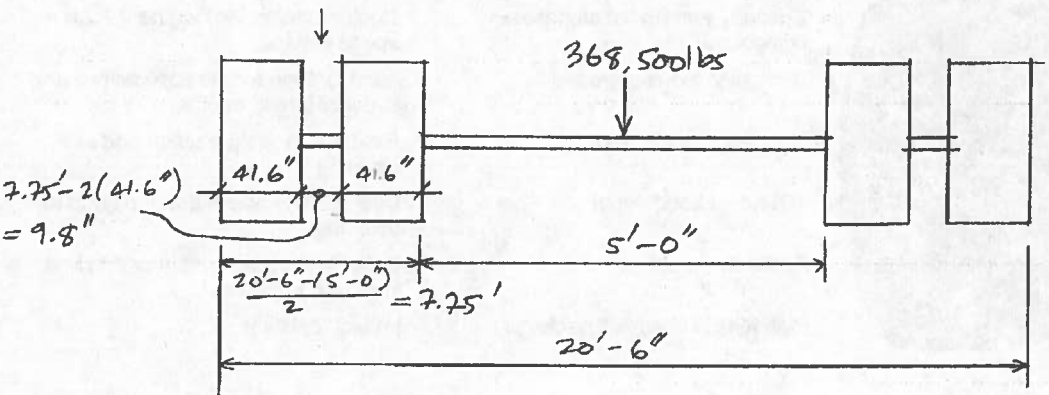
→ See attach tyre data spec sheets. Use 33.00R51 (E3) tyre as indicated in Coal Hauler Spec sheet.

→ Contact area = 970 in²
→ Loaded tyre width = 41.6 in

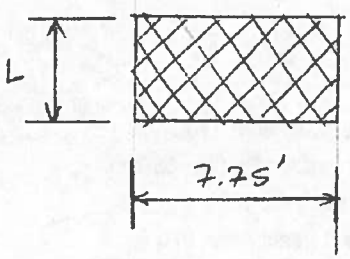
URS

Job BHP/Navajo Cottonwood Crossing Project No. 24342727 Page ___ of ___
Description Revised Machine Loads Computed by BC Sheet 2 of 2
Checked by Samrat Mohanty Date 4/19/07
Date 4/21/07
Reference

$\frac{368{,}500}{2 \text{ wheels}} = 184{,}250 \text{ lb}$



→ Tyres 9.8" apart close enough together to assume a single contact area



→ from tyre data sheet – gross contact area of tyre = 970 in²
– tyre pressure = 102 lb/in²

$$\sigma = \frac{F}{A}$$

$$A = \frac{F}{\sigma} = \frac{184250 \text{ lb}}{102 \text{ lb/in}^2} = 1806 \text{ in}^2 = 12.54 \text{ ft}^2$$

(compare 970×2 = 1940 in²)

$$L = \frac{12.54 \text{ ft}^2}{7.75 \text{ ft}} = 1.62 \text{ ft}$$

∴ Bearing Pressure = 102 lb/in² = 14,690 say <u>14,700 psf</u>
Bearing Area = <u>12.54 ft²</u>

(check load = 12.54 ft² × 14.7 k/ft² = 184.34 k cf 184.25 k ✓ o.k)

Goodyear Off-the-Road Tire Data Sheet

33.00R51 2* RL-3J Haulage (E-3)

FEATURES	BENEFITS
Specially formulated all natural compound	Cooler running for long haul, high speed service
Centerline zig-zag groove	Ideal for high torque applications and superior lateral traction
Tapered shoulder lugs	Excellent forward traction and self-cleaning
100-Level tread depth	Cool running, value tire and good fuel economy
Radial construction	Better fuel economy, softer ride and improved treadwear
High tensile steel belt package	Impact resistant

SUMMARY STATEMENT:

This 100-level radial rock tire is specifically designed for 130-150 ton dump trucks used in high speed service. Tapered shoulder lugs and a centerline zig-zag groove make this radial ideal for high torque applications and give it superior forward and lateral traction. The radial construction also allows for a softer ride, improved treadwear and better fuel economy.

DIMENSIONAL SPECS

Tread Depth: 63 /32"
Design Rim Width: 24.00-5.0 in.
New Tire Width: 36.5 in.
Loaded Tire Width: 41.6 in.
Minimum Dual Spacing: 42.3
Performance Capability Data:
Industry Code: E-3

Overall Diameter: 118.7 in.
Static Loaded Radius: 53.7 in.
Revs per mile: 177
Gross Contact Area: 970 sq.in.
Compound/Construction: 2S
Product Code: 154-070-746
Ply Rating: 2*

RATED LOAD/INFLATION TABLE
(Per ETRO & T&RA Industry Standards)

Operation Speed (mph)	0.0	2.5	5.0	10.0	15.0	25.0	30.0	45.0
Rated Load (lbs)							85500	
Inflation (psi)							102	

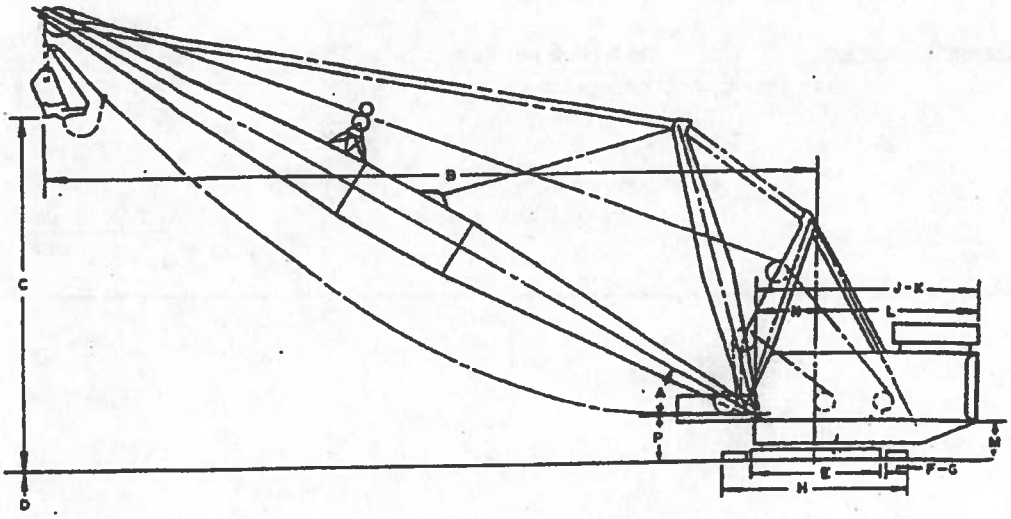
DRESSER
Construction & Mining Equipment

DRESSER INDUSTRIES, INC. • MARION DIVISION
MACHINE SPECIFICATIONS

Model: 8750 WALKING DRAGLINE

Description: Ward Leonard — Static Control — Independent Propel

NAVAJO
KEY #7



WORKING RANGES

Boom Length	335'-0"
Boom Point Sheave, Pitch Diameter	90"
A - Boom Angle, Approx.	32.5°
B - Dumping Radius	310'-0"
C - Dumping Height	132'-0"
D - Depth	150'-0"
Maximum Allowable Load, lbs.	571,000
Hoist Drum, Pitch Dia.	132"
Hoist Ropes, Four, Dia. Each	3-1/4"
Drag Drum, Pitch Dia.	132"
Drag Rope, Four, Dia. Each	3-1/4"

BASE

E - Outside Diameter - Nominal	80'-0"
Bearing Area - Effective, sq. ft.	5040
Bearing Pressure, psi	18.03
Ball Circle - Mean Dia.	55'-0"
Circle Rollers - Mean Dia.	16"
Main Swing Gear - Pitch Dia., Approx.	45'-0"

WALKING TRACTION

F - Width of Shoe	16'-0"
G - Length of Shoe	80'-0"
H - Width Over Both Shoes	116'-0"
Bearing Area of Both Shoes, sq. ft.	2560
Bearing Pressure @ 80% of Working Weight, psi	28.3
Length of Step - Approx.	8'-2"

ROTATING FRAME

J - Width @ Rear End	80'-0"
K - Length	109'-0"
Depth Sill Members	144"
L - Clearance Radius - Rear End	77'-0"
M - Clearance Under Frame	15'-10"
N - Center Rotation to Boom Foot	24'-0"
P - Ground to Boom Foot	22'-0"

ELECTRICAL EQUIPMENT

Hoist Motors, Eight, 1300 hp each @ 475 V, Total hp	10400
Drag Motors, Six, 1300 hp each @ 475 V, Total hp	7800
Swing Motors, Six, 1045 hp each @ 475 V, Total hp	6270
Propel Motors, Four, 800 hp each @ 475 V, Total hp	3200
AC Driving Motors, Total hp	13000

WEIGHTS

Domestic Shipping Weight (Inc. Bucket), lbs.	11,450,000
Working Weight, lbs.	13,050,000
Ballast (Furnished by Purchaser), lbs.	1,600,000

Shipping Weight Subject to 5% Variation.

Patents Pending
Printed in U.S.A.

The Company reserves the right to improve or change the design of its products and specifications thereof and the Company shall incur no liability thereby or any obligations to install such improvements on products previously sold.

PRECAST BOX CULVERT DESIGNS

Spec.	Box Size	Fill Ht.	Live Load	Slab / Wall Thickness Top	Btm	Side	Haunch	Bx Wt. (lb/ft)	Circumf. Reinf. Areas, in.^{2} / ft. A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s7}	A_{s8}	Long. A_{s5}	A_{s6}	M	Clear Concrete Cover, in. c_1	c_2	c_3	c_4	c_7	c_8	f'c ksi	f_y ksi
C1433	8' x 8'	8'	❶	10"	10"	8"	12"	4,233	0.44	1.21	1.21	0.60	-	-	-	-	❷	1.00	1.00	1.00	1.00	-	-	5.0	65

Notes:

❶ All loadings are per criteria stated on MWH Drawing Number S-3, except as follows:
- Dragline surface loading of 5,098 psf on two 16' x 80' shoes.
- Haul truck tire surface loading of 14,700 psf on 12.54 sq. ft. contact area.

❷ As1 must extend the entire length of the top and bottom slab.

Allowable Soil Pressure Requirements:

Dragline loading @ 8' depth	=	2314 psf
Surcharge loading	=	120 psf
Seismic loading	=	80 psf
Earth load	=	1104 psf
Weigth of box culvert	=	454 psf
Weight of water inside box culvert	=	400 psf
Total	=	4472 psf

Barry Chung/Tampa/URSCorp
04/26/2007 12:35 PM

To Christi Tanner/Albuquerque/URSCorp@URSCorp
cc
bcc
Subject Cottonwood - Rinker Culvert Design

Christi -

Here is the Rinker culvert design to place into the design report. Note that the roof, base and walls are thinner, which will save the client money.

The top slab is 2" thinner so the headwall will be 2" higher than the 1'-5" we discussed, but it is still OK.

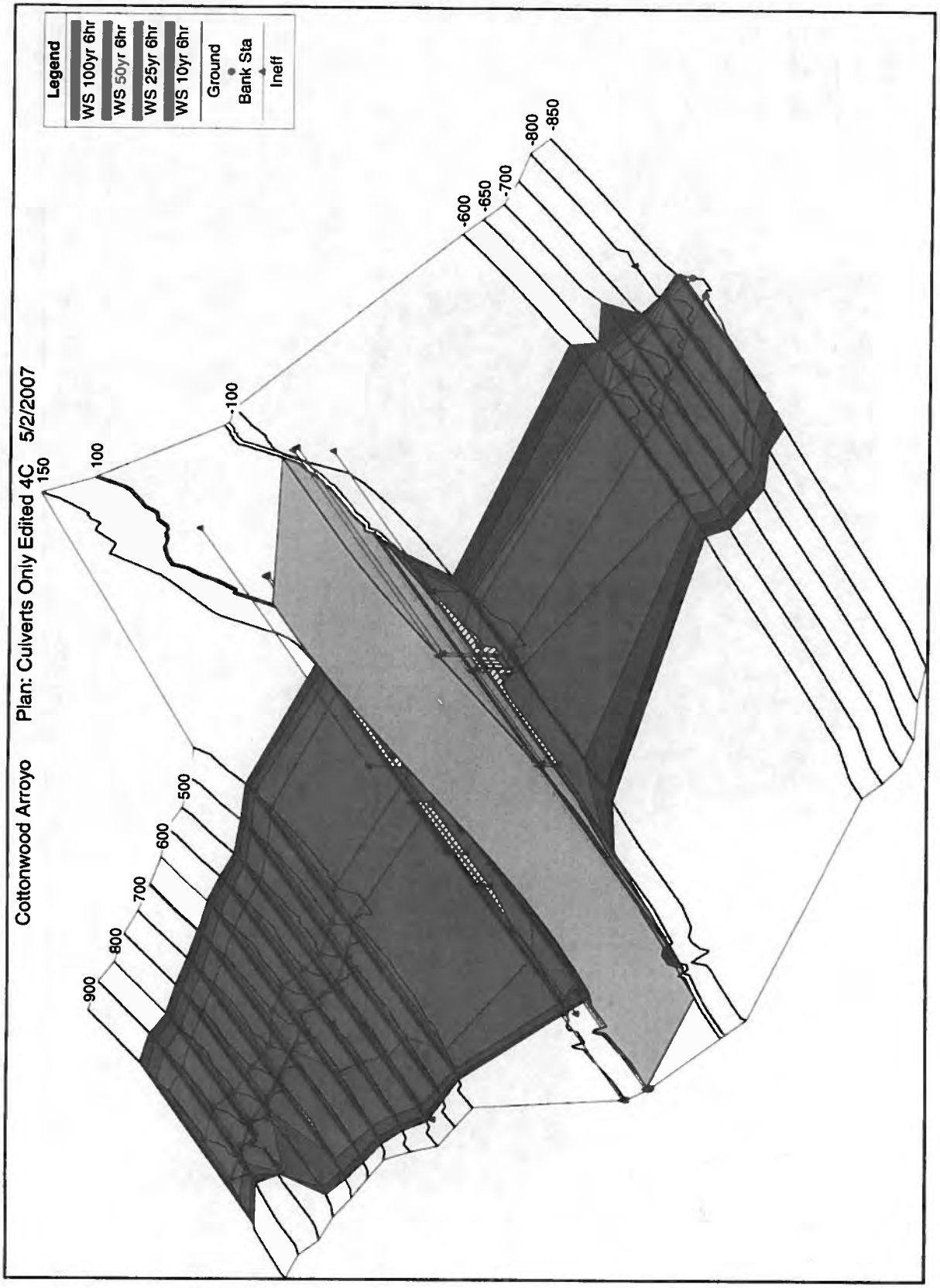
RCB Designs.pdf

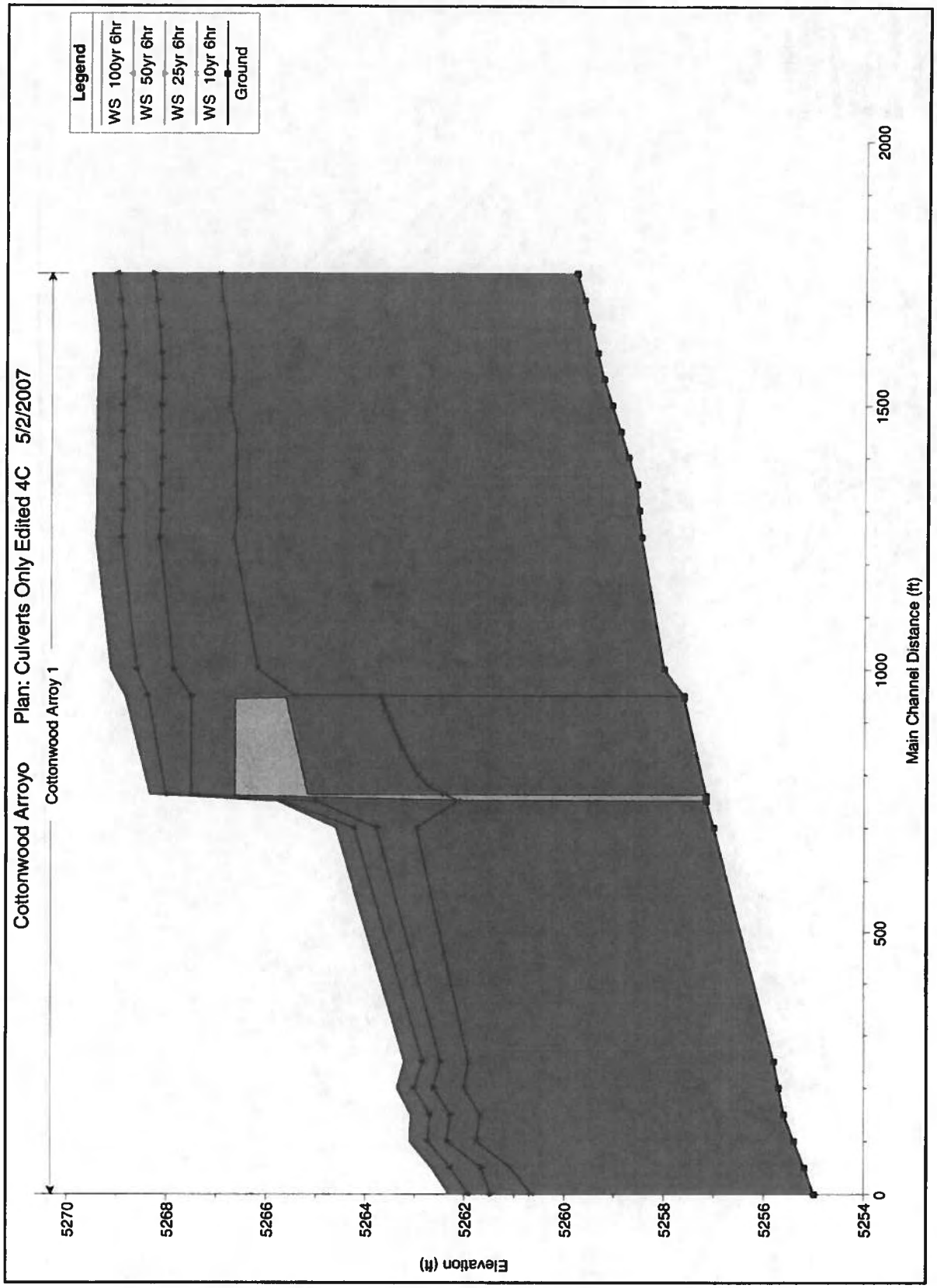
Barry

This e-mail and any attachments are confidential. If you receive this message in error or are not the intended recipient, you should not retain, distribute, disclose or use any of this information and you should destroy the e-mail and any attachments or copies.

APPENDIX D

HYDRAULICS – HEC-RAS ANALYSIS


Cottonwood Arroyo Plan: Culverts Only Edited 4C 5/2/2007
Legend
WS 100yr 6hr
WS 50yr 6hr
WS 25yr 6hr
WS 10yr 6hr
Ground
Bank Sta
Ineff
150
100
-100
-600
-650
-700
-800
-850
900
800
700
600
500


Cottonwood Arroyo Plan: Culverts Only Edited 4C 5/2/2007
Cottonwood Arroy 1
Legend
WS 100yr 6hr
WS 50yr 6hr
WS 25yr 6hr
WS 10yr 6hr
Ground
Elevation (ft)
5270
5268
5266
5264
5262
5260
5258
5256
5254
0
500
1000
1500
2000
Main Channel Distance (ft)

HEC-RAS Plan: 4 Culverts River: Cottonwood Arroy Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	900	100yr 6hr	4853.00	5259.78	5269.52	5265.75	5269.83	0.000651	4.95	1340.14	383.64	0.31
1	900	50yr 6hr	4040.00	5259.78	5269.01	5265.15	5269.29	0.000615	4.61	1151.93	342.49	0.30
1	900	25yr 6hr	3263.00	5259.78	5268.29	5264.55	5268.55	0.000628	4.35	931.93	279.37	0.29
1	900	10yr 6hr	2186.00	5259.78	5266.95	5263.66	5267 19	0.000704	4.02	615.32	208.19	0.30
1	850	100yr 6hr	4853.00	5259.63	5269.44	5265.58	5269.79	0.000678	5.22	1271.45	354.92	0.32
1	850	50yr 6hr	4040.00	5259.63	5268.94	5264.99	5269.25	0.000632	4.83	1101.36	319.50	0.30
1	850	25yr 6hr	3263.00	5259.63	5268.22	5264.39	5268.51	0.000635	4.54	891.30	266.13	0.30
1	850	10yr 6hr	2186.00	5259.63	5266.91	5263.43	5267.16	0.000668	4.07	590.27	197.20	0.30
1	800	100yr 6hr	4853.00	5259 48	5269.38	5266.80	5269.75	0.000810	5.68	1206.25	353.55	0.34
1	800	50yr 6hr	4040.00	5259.48	5268.88	5266.28	5269.21	0.000750	5.25	1064.93	334.62	0.33
1	800	25yr 6hr	3263.00	5259.48	5268.16	5264.83	5268.47	0.000765	4.98	874.46	274.08	0.33
1	800	10yr 6hr	2186.00	5259.48	5266.80	5263.73	5267.11	0.000895	4.73	571.32	198.81	0.34
1	750	100yr 6hr	4853.00	5259.36	5269.35	5265.97	5269.71	0.000728	5.69	1259.15	462.74	0.33
1	750	50yr 6hr	4040.00	5259.36	5268.85	5265.55	5269.18	0.000673	5.27	1111.82	366.46	0 32
1	750	25yr 6hr	3263.00	5259.36	5268.12	5264.72	5268.44	0.000689	5.02	909.97	265.93	0.32
1	750	10yr 6hr	2186.00	5259.36	5266.75	5263.53	5267.07	0.000796	4.75	580.56	213.01	0.33
1	700	100yr 6hr	4853.00	5259.23	5269.40	5266.76	5269.64	0.000558	5.04	1686.34	526.61	0.29
1	700	50yr 6hr	4040.00	5259.23	5268.88	5266.31	5269.12	0.000563	4.87	1420.05	493.73	0.29
1	700	25yr 6hr	3263.00	5259.23	5268.10	5265.58	5268.40	0.000692	5.08	942 39	428.99	0.32
1	700	10yr 6hr	2186.00	5259.23	5266.72	5263.87	5267.02	0.000828	4.90	616.84	215.15	0.33
1	650	100yr 6hr	4853.00	5259.06	5269.41	5266.13	5269.60	0.000448	4.31	1803.42	552.82	0.26
1	650	50yr 6hr	4040.00	5259.06	5268.89	5265.44	5269.08	0.000447	4.13	1524.12	523.40	0.26
1	650	25yr 6hr	3263.00	5259.06	5268.12	5264.68	5268.34	0.000530	4.22	1042.44	469.87	0.27
1	650	10yr 6hr	2186.00	5259.06	5266.75	5263.45	5266.96	0.000604	3.92	702.74	225.61	0.28
1	600	100yr 6hr	4853.00	5258.89	5269.41	5266.70	5269.57	0.000433	4.19	1979.09	580.87	0.25
1	600	50yr 6hr	4040.00	5258.89	5268.89	5266.26	5269.05	0.000446	4.07	1682.75	552.19	0.25
1	600	25yr 6hr	3263.00	5258.89	5268.12	5265.76	5268.31	0.000550	4.23	1274.79	508.10	0.28
1	600	10yr 6hr	2186.00	5258.89	5266.61	5263.99	5266.91	0.000967	4.80	606.76	308.52	0.35
1	550	100yr 6hr	4853.00	5258.73	5269.40	5266.29	5269.55	0.000363	4.05	2104.02	608.03	0.23
1	550	50yr 6hr	4040.00	5258.73	5268.88	5265.88	5269.02	0.000369	3.93	1792.67	582.33	0.23
1	550	25yr 6hr	3263.00	5258.73	5268 11	5265.37	5268.28	0.000444	4.06	1358.49	542.68	0.25

HEC-RAS Plan: 4 Culverts River: Cottonwood Arroy Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	550	10yr 6hr	2186.00	5258.73	5266.62	5263.45	5266.85	0.000652	4.29	711.00	294.72	0.29
1	500	100yr 6hr	4853.00	5258.56	5269.41	5266.05	5269.52	0.000282	3.48	2367.44	640.46	0.20
1	500	50yr 6hr	4040.00	5258.56	5268.89	5265.65	5268.99	0.000284	3.35	2039.02	617.04	0.20
1	500	25yr 6hr	3263.00	5258.56	5268.13	5264.87	5268.24	0.000341	3.45	1579.78	580.33	0.22
1	500	10yr 6hr	2186.00	5258.56	5266.63	5263.28	5266.81	0.000564	3.83	783.51	383.37	0.27
1	450	100yr 6hr	4853.00	5258.51	5269.41	5265.95	5269.50	0.000245	3.41	2548.00	672.30	0.19
1	450	50yr 6hr	4040.00	5258.51	5268.89	5265.45	5268.98	0.000247	3.30	2201.96	651.12	0.19
1	450	25yr 6hr	3263.00	5258.51	5268.12	5265.00	5268.22	0.000298	3.42	1712.59	619.95	0.21
1	450	10yr 6hr	2186.00	5258.51	5266.60	5263.03	5266.78	0.000506	3.92	814.47	436.66	0.26
1	400	100yr 6hr	4853.00	5258.46	5269.43	5265.44	5269.48	0.000129	2.36	3283.67	707.39	0.14
1	400	50yr 6hr	4040.00	5258.46	5268.91	5264.96	5268.95	0.000125	2.23	2919.55	689.50	0.13
1	400	25yr 6hr	3263.00	5258.46	5268.15	5264.44	5268.19	0.000141	2.23	2404.62	664.26	0.14
1	400	10yr 6hr	2186.00	5258.46	5266.67	5262.56	5266.72	0.000222	2.44	1479.33	579.60	0.17
1	150	100yr 6hr	4853.00	5258.00	5269.12	5265.47	5269.37	0.000506	4.79	1638.09	829.18	0.28
1	150	50yr 6hr	4040.00	5258.00	5268.60	5264.86	5268.84	0.000510	4.63	1396.11	804.75	0.28
1	150	25yr 6hr	3263.00	5258.00	5267.87	5264.19	5268.09	0.000496	4.30	1106.15	770.01	0.27
1	150	10yr 6hr	2186.00	5258.00	5266.17	5263.02	5266.54	0.000901	4.93	462.63	623.81	0.35
1	100	100yr 6hr	4853.00	5257.60	5268.83	5267.14	5269.31	0.000824	7.13	1326.89	889.75	0.37
1	100	50yr 6hr	4040.00	5257.60	5268.37	5266.48	5268.79	0.000724	6.50	1137.73	878.02	0.35
1	100	25yr 6hr	3263.00	5257.60	5267.51	5264.07	5268.02	0.000868	6.73	847.86	813.88	0.38
1	100	10yr 6hr	2186.00	5257.60	5265 43	5262.55	5266.42	0.001666	7.97	274.16	573.01	0.50
1	0		Culvert									
1	-100	100yr 6hr	4853.00	5257.15	5265.77	5265.77	5267.72	0.003645	12.57	617.06	710.86	0.75
1	-100	50yr 6hr	4040.00	5257.15	5265.68	5265.68	5267.12	0.002695	10.73	594.86	700.49	0.65
1	-100	25yr 6hr	3263.00	5257.15	5265.01	5265.01	5266.49	0.002829	10.41	447.56	625.46	0.65
1	-100	10yr 6hr	2186.00	5257.15	5262.14	5262.14	5264.57	0.007468	12.51	174.79	130.17	0.99
1	-150	100yr 6hr	4853.00	5257.00	5264.59	5262.81	5265.15	0.001837	6.46	1030.67	529.55	0.47
1	-150	50yr 6hr	4040.00	5257.00	5264.23	5262.35	5264.76	0.001801	6.13	853.53	473.51	0.46
1	-150	25yr 6hr	3263.00	5257.00	5263.77	5261.77	5264.23	0.001681	5.59	667.28	306.91	0.44
1	-150	10yr 6hr	2186.00	5257.00	5262.97	5260.60	5263.30	0.001440	4.61	503.58	166.21	0.39

HEC-RAS Plan: 4 Culverts River: Cottonwood Arroy Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	-600	100yr 6hr	4853.00	5255.80	5263.21	5263.00	5264.07	0.003239	8.01	819.29	451.84	0.67
1	-600	50yr 6hr	4040.00	5255.80	5262.84	5262.54	5263.68	0.003259	7.73	659.50	388.95	0.68
1	-600	25yr 6hr	3263.00	5255.80	5262.48	5261.87	5263.23	0.003019	7.17	543.30	298.90	0.66
1	-600	10yr 6hr	2186.00	5255.80	5261.92	5260.32	5262.47	0.002341	5.99	389.98	232.58	0.60
1	-650	100yr 6hr	4853.00	5255.70	5263.35	5262.29	5263.82	0.001753	6.35	1108.43	437.52	0.48
1	-650	50yr 6hr	4040.00	5255.70	5263.00	5261.87	5263.43	0.001665	5.96	961.15	402.66	0.46
1	-650	25yr 6hr	3263.00	5255.70	5262.62	5261.39	5263.00	0.001554	5.51	814.47	364.65	0.45
1	-650	10yr 6hr	2186.00	5255.70	5262.01	5260.48	5262.30	0.001274	4.63	611.06	304.19	0.40
1	-700	100yr 6hr	4853.00	5255.60	5263.08	5262.55	5263.70	0.002645	7.47	984.29	486.48	0.58
1	-700	50yr 6hr	4040.00	5255.60	5262.69	5262.21	5263.31	0.002750	7.23	812.75	391.62	0.59
1	-700	25yr 6hr	3263.00	5255.60	5262.28	5261.91	5262.88	0.002863	6.93	659.28	350.50	0.59
1	-700	10yr 6hr	2186.00	5255.60	5261.68	5260.90	5262.19	0.002729	6.12	465.05	297.35	0.56
1	-750	100yr 6hr	4853.00	5255.40	5263.10	5261.91	5263.54	0.001651	6.51	1138.49	410.25	0.47
1	-750	50yr 6hr	4040.00	5255.40	5262.74	5261.56	5263.13	0.001568	6.09	996.00	378.46	0.45
1	-750	25yr 6hr	3263.00	5255.40	5262.35	5261.25	5262.69	0.001465	5.61	854.54	344.00	0.43
1	-750	10yr 6hr	2186.00	5255.40	5261.76	5260.65	5262.02	0.001189	4.66	666.39	302.13	0.38
1	-800	100yr 6hr	4853.00	5255.19	5262.66	5262.25	5263.40	0.003353	8.26	876.24	363.14	0.65
1	-800	50yr 6hr	4040.00	5255.19	5262.28	5261.97	5262.99	0.003463	7.96	742.82	336.62	0.65
1	-800	25yr 6hr	3263.00	5255.19	5261.66	5261.66	5262.53	0.004682	8.41	547.39	300.91	0.74
1	-800	10yr 6hr	2186.00	5255.19	5261.07	5261.07	5261.87	0.004735	7.61	378.60	271.03	0.73
1	-850	100yr 6hr	4853.00	5255.00	5262.31	5262.11	5263.21	0.003503	9.74	858.66	361.67	0.68
1	-850	50yr 6hr	4040.00	5255.00	5261.92	5261.62	5262.80	0.003502	9.34	725.51	323.49	0.67
1	-850	25yr 6hr	3263.00	5255.00	5261.47	5261.14	5262.32	0.003506	8.88	590.92	277.21	0.66
1	-850	10yr 6hr	2186.00	5255.00	5260.66	5260.00	5261.42	0.003501	7.99	398.27	197.04	0.64

Cottonwood Arroyo Pre-mine Hydrology and Sedimentology

The drainage subdivisions used to model the hydrology is shown on Exhibit 7-4.

Revised January 2007

AAY/LR

BHP Navajo Coal Company
PO Box 1717
Fruitland, NM
87416

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.961	0.307	
Null	#2	==>	#3	0.068	0.331	
Null	#3	==>	#4	0.000	0.000	
Null	#4	==>	#9	0.718	0.281	
Null	#5	==>	#6	1.717	0.314	
Null	#6	==>	#7	0.222	0.298	
Null	#7	==>	#8	0.000	0.000	
Null	#8	==>	#10	1.278	0.289	
Null	#9	==>	#11	0.000	0.000	
Null	#10	==>	#11	0.000	0.000	
Null	#11	==>	#21	0.495	0.453	
Null	#12	==>	#13	0.076	0.330	
Null	#13	==>	#14	3.790	0.314	
Null	#14	==>	#16	1.198	0.286	
Null	#15	==>	#16	1.198	0.286	
Null	#16	==>	#20	0.911	0.280	
Null	#17	==>	#19	0.000	0.000	
Null	#18	==>	#19	0.000	0.000	
Null	#19	==>	#20	0.915	0.252	
Null	#20	==>	#22	0.000	0.000	
Null	#21	==>	#22	0.000	0.000	
Null	#22	==>	#23	0.811	0.247	
Null	#23	==>	#35	0.000	0.000	
Null	#24	==>	#25	0.964	0.340	
Null	#25	==>	#27	1.454	0.333	
Null	#26	==>	#27	1.454	0.333	
Null	#27	==>	#29	0.800	0.323	
Null	#28	==>	#29	0.800	0.323	
Null	#29	==>	#32	0.479	0.298	
Null	#30	==>	#32	0.479	0.298	
Null	#31	==>	#33	0.000	0.000	
Null	#32	==>	#33	0.000	0.000	
Null	#33	==>	#34	1.372	0.293	Inlet to North Fork Diversion
Null	#34	==>	#35	0.000	0.000	
Null	#35	==>	#36	0.735	0.251	
Null	#36	==>	#37	3.388	0.246	
Null	#37	==>	End	0.000	0.000	

#30
Null

#28
Null

#26
Null

#24
Null

#25
Null

#27
Null

#29
Null

#32
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#31
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#33
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#10
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#1
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#2
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#3
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#4
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#9
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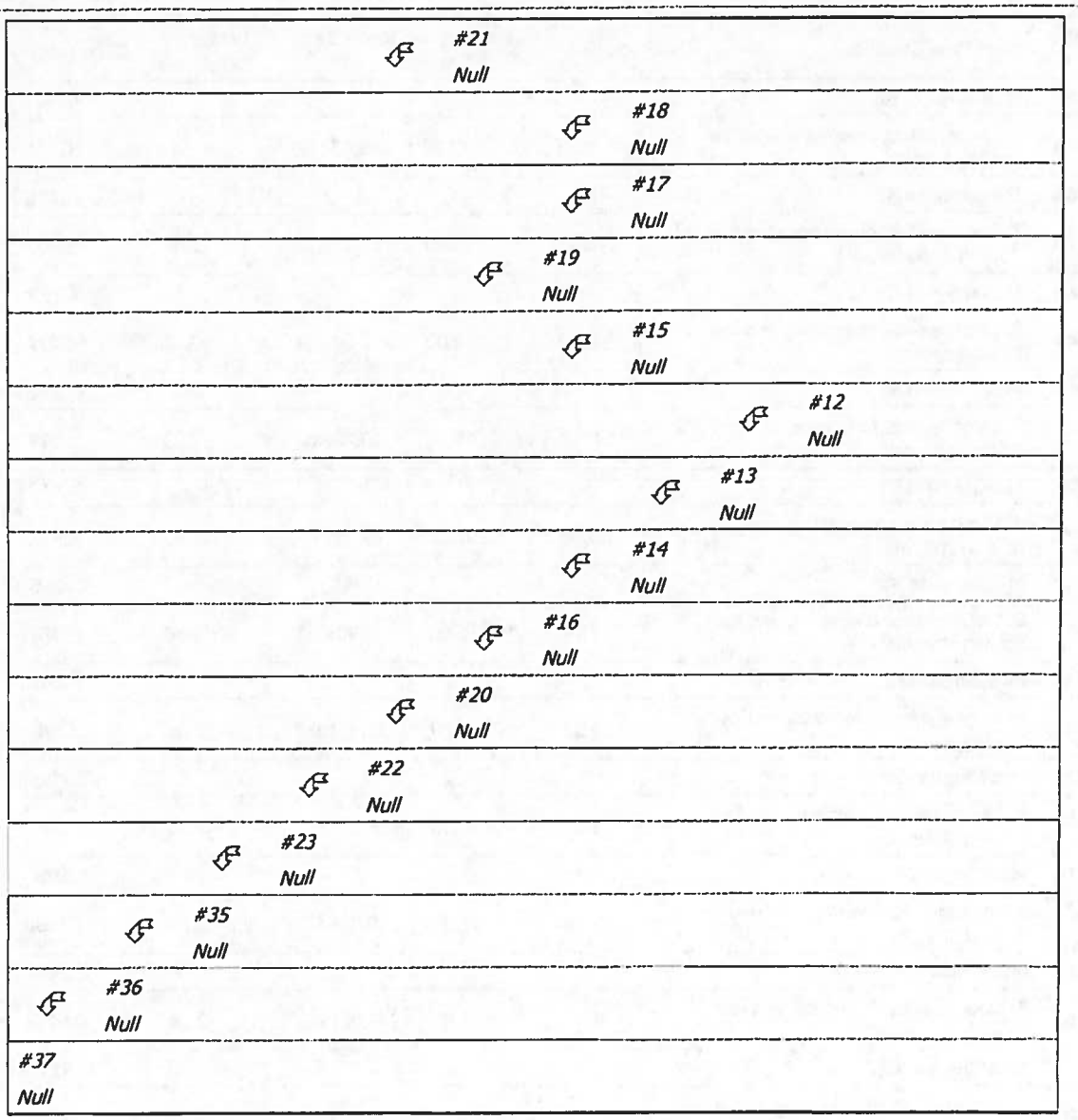
#11
Null



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	0.81	76.00	9,347.00	2.70	0.961
#1	**Muskingum K:**					**0.961**
#2	8. Large gullies, diversions, and low flowing streams	1.23	10.00	814.00	3.32	0.068
#2	**Muskingum K:**					**0.068**
#3	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.00	0.000

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	**Muskingum K:**					**0.000**
#4	8. Large gullies, diversions, and low flowing streams	0.53	30.00	5,637.00	2.18	0.718
#4	**Muskingum K:**					**0.718**
#5	8. Large gullies, diversions, and low flowing streams	0.93	165.00	17,810.88	2.88	1.717
#5	**Muskingum K:**					**1.717**
#6	8. Large gullies, diversions, and low flowing streams	0.70	14.00	2,006.01	2.50	0.222
#6	**Muskingum K:**					**0.222**
#8	8. Large gullies, diversions, and low flowing streams	0.61	65.00	10,726.07	2.33	1.278
#8	**Muskingum K:**					**1.278**
#11	8. Large gullies, diversions, and low flowing streams	30.00	8,801.00	29,336.66	16.43	0.495
#11	**Muskingum K:**					**0.495**
#12	8. Large gullies, diversions, and low flowing streams	1.21	11.00	906.00	3.30	0.076
#12	**Muskingum K:**					**0.076**
#13	8. Large gullies, diversions, and low flowing streams	0.92	363.00	39,301.00	2.88	3.790
#13	**Muskingum K:**					**3.790**
#14	8. Large gullies, diversions, and low flowing streams	0.58	57.00	9,834.00	2.28	1.198
#14	**Muskingum K:**					**1.198**
#15	8. Large gullies, diversions, and low flowing streams	0.58	57.00	9,834.00	2.28	1.198
#15	**Muskingum K:**					**1.198**
#16	8. Large gullies, diversions, and low flowing streams	0.52	37.00	7,084.00	2.16	0.911
#16	**Muskingum K:**					**0.911**
#19	8. Large gullies, diversions, and low flowing streams	0.33	19.00	5,699.00	1.73	0.915
#19	**Muskingum K:**					**0.915**
#22	8. Large gullies, diversions, and low flowing streams	0.31	15.00	4,852.00	1.66	0.811
#22	**Muskingum K:**					**0.811**
#24	8. Large gullies, diversions, and low flowing streams	1.46	184.00	12,568.00	3.62	0.964
#24	**Muskingum K:**					**0.964**
#25	8. Large gullies, diversions, and low flowing streams	1.28	228.00	17,755.00	3.39	1.454
#25	**Muskingum K:**					**1.454**
#26	8. Large gullies, diversions, and low flowing streams	1.28	228.00	17,755.62	3.39	1.454
#26	**Muskingum K:**					**1.454**
#27	8. Large gullies, diversions, and low flowing streams	1.07	96.00	8,938.00	3.10	0.800

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#27	**Muskingum K:**					**0.800**
#28	8. Large gullies, diversions, and low flowing streams	1.07	96.00	8,938.00	3.10	0.800
#28	**Muskingum K:**					**0.800**
#29	8. Large gullies, diversions, and low flowing streams	0.70	30.00	4,313.00	2.50	0.479
#29	**Muskingum K:**					**0.479**
#30	8. Large gullies, diversions, and low flowing streams	0.70	30.00	4,313.00	2.50	0.479
#30	**Muskingum K:**					**0.479**
#33	8. Large gullies, diversions, and low flowing streams	0.65	77.00	11,910.00	2.41	1.372
#33	**Muskingum K:**					**1.372**
#35	8. Large gullies, diversions, and low flowing streams	0.33	15.00	4,554.00	1.72	0.735
#35	**Muskingum K:**					**0.735**
#36	8. Large gullies, diversions, and low flowing streams	0.30	60.00	20,005.00	1.64	3.388
#36	**Muskingum K:**					**3.388**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#30	476.400	476.400	6.98	1.76
#28	1,217.900	1,217.900	283.47	46.07
#26	2,486.400	2,486.400	46.07	18.65
#24	8,061.800	8,061.800	65.88	51.67
#25	1,015.700	9,077.500	80.90	66.70
#27	1,783.700	13,347.600	183.29	111.80
#29	966.000	15,531.500	426.99	193.50
#32	293.700	16,301.600	441.67	209.47
#31	957.100	957.100	271.94	43.43
#33	0.000	17,258.700	525.37	252.90
#34	932.500	18,191.200	549.99	286.55
#5	2,023.000	2,023.000	353.61	61.88
#6	1,743.200	3,766.200	378.03	119.94
#7	2,395.300	6,161.500	660.04	232.04
#8	0.000	6,161.500	660.04	232.04
#10	1,053.200	7,214.700	695.02	272.19
#1	2,411.100	2,411.100	280.48	56.33
#2	1,497.000	3,908.100	345.41	120.02
#3	862.700	4,770.800	457.63	149.88
#4	0.000	4,770.800	457.63	149.88
#9	425.500	5,196.300	481.74	169.93
#11	0.000	12,411.000	1,064.62	442.12
#21	1,080.800	13,491.800	1,112.92	480.32
#18	848.500	848.500	134.32	28.24
#17	182.200	182.200	90.17	8.82
#19	0.000	1,030.700	209.51	37.06
#15	1,992.700	1,992.700	314.41	62.84
#12	3,494.500	3,494.500	146.72	38.48
#13	2,720.700	6,215.200	284.84	69.00
#14	5,096.800	11,312.000	400.59	209.40
#16	876.500	14,181.200	676.40	313.93
#20	681.900	15,893.800	724.23	382.40
#22	0.000	29,385.600	1,750.57	862.72
#23	752.900	30,138.500	1,749.20	888.40
#35	0.000	48,329.700	2,189.60	1,174.95
#36	891.700	49,221.400	2,186.29	1,195.57
#37	2,208.500	51,429.900	2,165.91	1,247.56

Structure Detail:

Structure #30 (Null)

Structure #28 (Null)

Structure #26 (Null)

Structure #24 (Null)

Structure #25 (Null)

Structure #27 (Null)

Structure #29 (Null)

Structure #32 (Null)

Structure #31 (Null)

Structure #33 (Null)

- *Inlet to North Fork Diversion*

Structure #34 (Null)

Structure #5 (Null)

Structure #6 (Null)

Structure #7 (Null)

Structure #8 (Null)

Structure #10 (Null)

Structure #1 (Null)

Structure #2 (Null)

Structure #3 (Null)

Structure #4 (Null)

Structure #9 (Null)

Structure #11 (Null)

Structure #21 (Null)

Structure #18 (Null)

Structure #17 (Null)

Structure #19 (Null)

Structure #15 (Null)

Structure #12 (Null)

Structure #13 (Null)

Structure #14 (Null)

Structure #16 (Null)

Structure #20 (Null)

Structure #22 (Null)

Structure #23 (Null)

Structure #35 (Null)

Structure #36 (Null)

Structure #37 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#30	1	476.400	1.131	0.000	0.000	70.300	M	6.98	1.757
	Σ	**476.400**						**6.98**	**1.757**
#28	1	772.300	0.657	0.523	0.334	88.300	M	238.37	29.212
	2	445.600	0.587	0.000	0.000	88.300	M	147.51	16.855
	Σ	**1,217.900**						**283.47**	**46.067**
#26	1	447.600	2.192	0.000	0.000	71.800	M	6.36	2.223
	2	2,038.800	3.000	0.000	0.000	74.700	M	39.98	16.427
	Σ	**2,486.400**						**46.07**	**18.649**
#24	1	2,607.500	5.367	2.377	0.305	72.800	M	24.68	15.479
	2	2,331.900	4.813	2.431	0.304	72.300	M	21.92	12.683
	3	1,758.500	2.231	1.788	0.297	73.900	M	36.70	12.518
	4	1,363.900	2.618	0.000	0.000	74.700	M	29.33	10.989
	Σ	**8,061.800**						**65.88**	**51.669**
#25	1	515.200	0.990	0.342	0.357	75.900	M	24.69	4.943
	2	130.500	0.787	0.342	0.357	75.800	M	6.99	1.235
	3	370.000	0.516	0.000	0.000	83.600	M	79.10	8.853
	Σ	**9,077.500**						**80.90**	**66.700**
#27	1	354.400	0.612	1.233	0.337	81.000	M	49.31	6.418
	2	305.200	0.529	1.054	0.328	81.900	M	52.11	6.103
	3	289.800	0.692	0.551	0.328	72.900	M	9.52	1.750
	4	253.000	0.361	0.551	0.328	77.200	M	27.66	2.896
	5	581.300	0.980	0.000	0.000	79.900	M	51.62	9.286
	Σ	**13,347.600**						**183.29**	**111.802**
#29	1	508.800	0.409	0.416	0.312	87.300	M	187.01	17.522
	2	233.200	0.521	0.291	0.312	89.600	M	94.22	9.944
	3	224.000	0.467	0.000	0.000	87.900	M	81.36	8.162
	Σ	**15,531.500**						**426.99**	**193.497**
#32	1	293.700	0.576	0.000	0.000	91.000	M	128.15	14.218
	Σ	**16,301.600**						**441.67**	**209.472**
#31	1	431.100	0.588	0.450	0.336	89.400	M	159.20	18.049
	2	325.800	0.432	0.149	0.327	91.000	M	167.10	15.772
	3	200.200	0.373	0.000	0.000	90.900	M	109.10	9.605
	Σ	**957.100**						**271.94**	**43.426**

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#33	**∑**	**17,258.700**						**525.37**	**252.898**
#34	1	91.700	0.244	0.965	0.300	90.300	M	55.63	4.167
	2	105.200	0.256	0.965	0.300	91.000	M	66.86	5.093
	3	735.600	0.885	0.000	0.000	86.900	M	161.37	24.388
	∑	**18,191.200**						**549.99**	**286.547**
#5	1	503.600	0.707	0.000	0.000	85.600	M	110.93	14.726
	2	406.500	0.492	0.747	0.336	82.800	M	81.19	8.949
	3	439.600	0.626	1.036	0.331	85.800	M	107.12	13.109
	4	162.600	0.332	1.036	0.331	84.000	M	46.98	4.053
	5	294.100	0.505	1.413	0.336	90.000	M	125.65	13.006
	6	216.600	0.341	1.413	0.336	88.100	M	93.95	8.042
	∑	**2,023.000**						**353.61**	**61.884**
#6	1	149.100	0.331	0.000	0.000	90.600	M	83.23	6.962
	2	245.000	0.529	0.228	0.320	85.900	M	67.10	7.377
	3	276.200	0.450	0.605	0.306	87.400	M	97.37	9.602
	4	158.400	0.380	0.605	0.306	91.000	M	86.41	7.668
	5	206.200	0.402	1.110	0.307	87.400	M	77.23	7.169
	6	414.000	0.430	1.512	0.309	85.200	M	118.75	11.639
	7	294.300	0.535	1.512	0.309	84.400	M	67.58	7.639
	∑	**3,766.200**						**378.03**	**119.941**
#7	1	731.700	1.274	0.000	0.000	91.000	M	189.49	35.422
	2	445.800	1.486	0.000	0.000	91.000	M	102.97	21.581
	3	270.800	1.110	0.000	0.000	91.000	M	77.45	13.110
	4	78.900	0.260	1.207	0.322	91.000	M	49.86	3.820
	5	154.900	0.320	1.207	0.322	91.000	M	90.90	7.499
	6	101.400	0.313	1.318	0.323	90.900	M	59.49	4.865
	7	117.700	0.300	1.547	0.323	90.200	M	65.80	5.301
	8	494.100	0.645	1.547	0.323	89.300	M	170.71	20.498
	∑	**6,161.500**						**660.04**	**232.036**
#8	1	0.000	0.000	0.000	0.000	1.000	0.00	0.000	
	∑	**6,161.500**						**660.04**	**232.036**
#10	1	355.500	1.046	0.000	0.000	91.000	M	106.00	17.210
	2	307.100	1.282	0.724	0.301	80.800	M	25.62	5.438
	3	147.300	1.245	0.587	0.297	88.600	M	30.47	5.729
	4	126.400	0.585	0.587	0.297	91.000	M	54.65	6.119
	5	116.900	1.179	0.716	0.297	91.000	M	32.03	5.659
	∑	**7,214.700**						**695.02**	**272.191**
#1	1	557.400	0.941	0.000	0.000	81.200	M	60.60	10.322

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
	2	169.600	1.616	0.677	0.333	91.000	M	36.76	8.210
	3	636.400	1.842	0.729	0.333	78.800	M	31.75	8.918
	4	223.400	0.846	1.005	0.336	82.100	M	29.20	4.565
	5	77.700	0.330	1.392	0.341	79.400	M	12.50	1.170
	6	746.600	0.678	1.392	0.341	86.200	M	180.72	23.145
	∑	**2,411.100**						**280.48**	**56.330**
#2	1	257.000	0.423	0.000	0.000	91.000	M	133.24	12.442
	2	180.500	0.562	0.478	0.281	89.700	M	70.50	7.767
	3	200.700	0.687	0.574	0.283	91.000	M	78.80	9.716
	4	438.600	0.811	0.574	0.283	91.000	M	155.00	21.233
	5	420.200	1.247	0.801	0.293	85.800	M	64.79	12.530
	∑	**3,908.100**						**345.41**	**120.018**
#3	1	172.600	0.443	0.000	0.000	91.000	M	87.36	8.356
	2	311.200	0.890	0.000	0.000	86.900	M	68.02	10.318
	3	378.900	0.632	0.209	0.314	85.700	M	90.77	11.189
	∑	**4,770.800**						**457.63**	**149.880**
#4	**∑**	**4,770.800**						**457.63**	**149.880**
#9	1	425.500	0.830	0.000	0.000	90.700	M	143.84	20.049
	∑	**5,196.300**						**481.74**	**169.929**
#11	**∑**	**12,411.000**						**1,064.62**	**442.120**
#21	1	272.800	0.819	0.000	0.000	86.900	M	62.96	9.044
	2	230.500	0.388	0.694	0.266	89.200	M	104.58	9.475
	3	181.100	0.289	0.877	0.256	89.300	M	94.29	7.513
	4	396.400	0.939	0.877	0.256	86.100	M	76.84	12.170
	∑	**13,491.800**						**1,112.92**	**480.323**
#18	1	301.700	0.652	0.000	0.000	91.000	M	122.31	14.605
	2	546.800	0.768	0.561	0.320	84.000	M	95.48	13.630
	∑	**848.500**						**134.32**	**28.235**
#17	1	182.200	0.462	0.000	0.000	91.000	M	90.17	8.820
	∑	**182.200**						**90.17**	**8.820**
#19	**∑**	**1,030.700**						**209.51**	**37.056**
#15	1	437.400	0.803	0.000	0.000	89.300	M	131.37	18.146
	2	549.000	0.637	0.654	0.327	89.300	M	191.13	22.775
	3	1,006.300	1.023	0.768	0.331	82.700	M	124.93	21.920
	∑	**1,992.700**						**314.41**	**62.841**
#12	1	517.800	0.791	0.000	0.000	79.800	M	52.01	8.176

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
	2	229.000	0.571	0.043	0.418	78.100	M	21.91	2.943
	3	592.700	0.706	0.044	0.417	79.500	M	61.27	9.034
	4	1,806.900	1.542	0.487	0.362	74.400	M	51.82	13.908
	5	348.100	0.618	0.487	0.362	78.000	M	31.17	4.417
	∑	**3,494.500**						**146.72**	**38.478**
#13	1	411.600	0.725	0.000	0.000	77.600	M	31.27	4.963
	2	636.400	0.774	0.322	0.336	78.700	M	55.18	8.810
	3	319.000	0.575	0.685	0.318	83.500	M	62.92	7.554
	4	231.700	0.314	0.923	0.328	78.400	M	33.16	3.091
	5	1,122.000	1.308	0.923	0.328	72.300	M	23.88	6.102
	∑	**6,215.200**						**284.84**	**68.999**
#14	1	405.900	0.384	0.000	0.000	88.700	M	176.21	15.934
	2	411.100	0.452	0.707	0.308	88.600	M	162.89	15.989
	3	787.400	0.658	0.975	0.307	89.300	M	268.72	32.665
	4	144.200	0.341	1.716	0.310	84.000	M	41.09	3.594
	5	343.800	0.289	1.970	0.312	84.500	M	112.09	9.014
	6	392.800	0.806	2.107	0.316	79.700	M	38.45	6.130
	7	528.200	0.518	2.544	0.316	85.200	M	135.63	14.850
	8	890.900	1.253	2.544	0.316	81.500	M	82.72	17.053
	9	741.400	1.076	3.047	0.316	82.700	M	88.91	16.150
	10	451.100	0.916	3.354	0.316	81.900	M	54.62	9.020
	∑	**11,312.000**						**400.59**	**209.398**
#16	1	329.600	0.641	0.000	0.000	91.000	M	134.99	15.956
	2	348.400	0.542	0.509	0.286	90.500	M	149.98	16.122
	3	198.500	0.266	0.943	0.279	91.000	M	124.54	9.610
	∑	**14,181.200**						**676.40**	**313.926**
#20	1	296.300	0.667	0.000	0.000	89.700	M	104.34	12.750
	2	385.600	0.713	0.476	0.440	91.000	M	147.90	18.667
	∑	**15,893.800**						**724.23**	**382.399**
#22	**∑**	**29,385.600**						**1,750.57**	**862.722**
#23	1	442.400	0.960	0.000	0.000	85.300	M	77.45	12.561
	2	310.500	0.538	0.559	0.291	89.500	M	121.94	13.119
	∑	**30,138.500**						**1,749.20**	**888.402**
#35	**∑**	**48,329.700**						**2,189.60**	**1,174.949**
#36	1	298.200	0.987	0.000	0.000	85.000	M	49.57	8.219
	2	196.800	0.441	0.000	0.000	87.900	M	73.77	7.171
	3	396.700	0.433	0.166	0.372	78.300	M	46.46	5.227

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
	Σ	**49,221.400**						**2,186.29**	**1,195.566**
#37	1	744.000	1.756	0.000	0.000	82.800	M	63.54	16.378
	2	296.000	0.439	1.780	0.243	85.800	M	89.55	8.827
	3	237.700	0.333	1.649	0.246	85.500	M	80.62	6.883
	4	561.400	1.502	1.780	0.243	84.100	M	62.58	14.137
	5	369.400	0.817	2.236	0.284	79.700	M	35.86	5.765
	Σ	**51,429.900**						**2,165.91**	**1,247.556**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.65	50.00	1,369.00	1.910	0.199
		8. Large gullies, diversions, and low flowing streams	1.57	157.00	10,030.00	3.750	0.742
#1	**1**	**Time of Concentration:**					**0.941**
#1	2	5. Nearly bare and untilled, and alluvial valley fans	6.63	70.00	1,056.00	2.570	0.114
		5. Nearly bare and untilled, and alluvial valley fans	1.98	150.00	7,573.00	1.400	1.502
#1	**2**	**Time of Concentration:**					**1.616**
#1	3	5. Nearly bare and untilled, and alluvial valley fans	1.65	117.00	7,070.00	1.280	1.534
		8. Large gullies, diversions, and low flowing streams	2.43	126.00	5,188.00	4.670	0.308
#1	**3**	**Time of Concentration:**					**1.842**
#1	4	5. Nearly bare and untilled, and alluvial valley fans	5.77	260.00	4,506.00	2.400	0.521
		8. Large gullies, diversions, and low flowing streams	2.84	168.00	5,924.00	5.050	0.325
#1	**4**	**Time of Concentration:**					**0.846**
#1	5	5. Nearly bare and untilled, and alluvial valley fans	19.93	180.00	903.00	4.460	0.056
		8. Large gullies, diversions, and low flowing streams	3.30	178.00	5,393.00	5.450	0.274
#1	**5**	**Time of Concentration:**					**0.330**
#1	6	5. Nearly bare and untilled, and alluvial valley fans	13.43	105.00	782.00	3.660	0.059
		8. Large gullies, diversions, and low flowing streams	2.62	283.00	10,822.00	4.850	0.619
#1	**6**	**Time of Concentration:**					**0.678**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	6.84	70.00	1,024.00	2.610	0.108

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	1.62	70.00	4,325.00	3.810	0.315
#2	**1**	**Time of Concentration:**					**0.423**
#2	2	5. Nearly bare and untilled, and alluvial valley fans	5.56	45.00	810.00	2.350	0.095
		8. Large gullies, diversions, and low flowing streams	0.86	40.00	4,663.00	2.770	0.467
#2	**2**	**Time of Concentration:**					**0.562**
#2	3	5. Nearly bare and untilled, and alluvial valley fans	5.89	50.00	849.00	2.420	0.097
		8. Large gullies, diversions, and low flowing streams	1.17	80.00	6,862.00	3.230	0.590
#2	**3**	**Time of Concentration:**					**0.687**
#2	4	5. Nearly bare and untilled, and alluvial valley fans	12.63	95.00	752.00	3.550	0.058
		8. Large gullies, diversions, and low flowing streams	1.40	135.00	9,630.00	3.550	0.753
#2	**4**	**Time of Concentration:**					**0.811**
#2	5	5. Nearly bare and untilled, and alluvial valley fans	11.02	70.00	635.00	3.320	0.053
		8. Large gullies, diversions, and low flowing streams	0.46	40.00	8,732.00	2.030	1.194
#2	**5**	**Time of Concentration:**					**1.247**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	1.24	10.00	805.00	1.110	0.201
		8. Large gullies, diversions, and low flowing streams	1.33	40.00	3,017.00	3.450	0.242
#3	**1**	**Time of Concentration:**					**0.443**
#3	2	5. Nearly bare and untilled, and alluvial valley fans	0.68	10.00	1,478.00	0.820	0.500
		8. Large gullies, diversions, and low flowing streams	1.78	100.00	5,622.00	4.000	0.390
#3	**2**	**Time of Concentration:**					**0.890**
#3	3	5. Nearly bare and untilled, and alluvial valley fans	4.66	70.00	1,501.00	2.150	0.193
		8. Large gullies, diversions, and low flowing streams	1.17	60.00	5,126.00	3.240	0.439
#3	**3**	**Time of Concentration:**					**0.632**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	17.19	110.00	640.00	4.140	0.042
		8. Large gullies, diversions, and low flowing streams	2.72	322.00	11,831.00	4.940	0.665
#5	**1**	**Time of Concentration:**					**0.707**
#5	2	5. Nearly bare and untilled, and alluvial valley fans	11.58	105.00	907.00	3.400	0.074
		8. Large gullies, diversions, and low flowing streams	3.52	298.00	8,475.00	5.620	0.418
#5	**2**	**Time of Concentration:**					**0.492**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#5	3	5. Nearly bare and untilled, and alluvial valley fans	1.53	25.00	1,638.00	1.230	0.369
		8. Large gullies, diversions, and low flowing streams	4.30	248.00	5,762.00	6.220	0.257
#5	**3**	**Time of Concentration:**					**0.626**
#5	4	5. Nearly bare and untilled, and alluvial valley fans	14.19	85.00	599.00	3.760	0.044
		8. Large gullies, diversions, and low flowing streams	3.99	248.00	6,219.00	5.990	0.288
#5	**4**	**Time of Concentration:**					**0.332**
#5	5	5. Nearly bare and untilled, and alluvial valley fans	4.15	85.00	2,049.00	2.030	0.280
		8. Large gullies, diversions, and low flowing streams	3.24	142.00	4,377.00	5.400	0.225
#5	**5**	**Time of Concentration:**					**0.505**
#5	6	5. Nearly bare and untilled, and alluvial valley fans	8.67	125.00	1,441.00	2.940	0.136
		8. Large gullies, diversions, and low flowing streams	4.81	234.00	4,865.00	6.570	0.205
#5	**6**	**Time of Concentration:**					**0.341**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	5.36	75.00	1,399.00	2.310	0.168
		8. Large gullies, diversions, and low flowing streams	2.41	66.00	2,742.00	4.650	0.163
#6	**1**	**Time of Concentration:**					**0.331**
#6	2	5. Nearly bare and untilled, and alluvial valley fans	3.39	80.00	2,359.00	1.840	0.356
		8. Large gullies, diversions, and low flowing streams	2.63	80.00	3,039.00	4.860	0.173
#6	**2**	**Time of Concentration:**					**0.529**
#6	3	5. Nearly bare and untilled, and alluvial valley fans	4.60	34.00	739.00	2.140	0.095
		8. Large gullies, diversions, and low flowing streams	2.33	136.00	5,845.00	4.570	0.355
#6	**3**	**Time of Concentration:**					**0.450**
#6	4	5. Nearly bare and untilled, and alluvial valley fans	6.06	85.00	1,402.03	2.460	0.158
		8. Large gullies, diversions, and low flowing streams	2.52	96.00	3,810.12	4.760	0.222
#6	**4**	**Time of Concentration:**					**0.380**
#6	5	5. Nearly bare and untilled, and alluvial valley fans	7.24	70.00	967.00	2.690	0.099
		8. Large gullies, diversions, and low flowing streams	2.34	117.00	5,003.00	4.580	0.303
#6	**5**	**Time of Concentration:**					**0.402**
#6	6	5. Nearly bare and untilled, and alluvial valley fans	31.83	183.00	575.00	5.640	0.028
		8. Large gullies, diversions, and low flowing streams	3.38	270.00	7,990.00	5.510	0.402

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#6	**6**	**Time of Concentration:**					**0.430**
#6	7	5. Nearly bare and untilled, and alluvial valley fans	23.08	325.00	1,408.00	4.800	0.081
		8. Large gullies, diversions, and low flowing streams	2.88	240.00	8,327.00	5.090	0.454
#6	**7**	**Time of Concentration:**					**0.535**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	11.42	90.00	788.00	3.370	0.064
		8. Large gullies, diversions, and low flowing streams	1.46	230.00	15,769.62	3.620	1.210
#7	**1**	**Time of Concentration:**					**1.274**
#7	2	5. Nearly bare and untilled, and alluvial valley fans	11.19	60.00	536.00	3.340	0.044
		8. Large gullies, diversions, and low flowing streams	1.26	220.00	17,444.00	3.360	1.442
#7	**2**	**Time of Concentration:**					**1.486**
#7	3	5. Nearly bare and untilled, and alluvial valley fans	5.35	60.00	1,121.00	2.310	0.134
		8. Large gullies, diversions, and low flowing streams	1.43	180.00	12,585.00	3.580	0.976
#7	**3**	**Time of Concentration:**					**1.110**
#7	4	5. Nearly bare and untilled, and alluvial valley fans	14.29	35.00	245.00	3.770	0.018
		8. Large gullies, diversions, and low flowing streams	2.76	120.00	4,349.00	4.980	0.242
#7	**4**	**Time of Concentration:**					**0.260**
#7	5	5. Nearly bare and untilled, and alluvial valley fans	5.36	65.00	1,213.00	2.310	0.145
		8. Large gullies, diversions, and low flowing streams	2.57	78.00	3,034.00	4.810	0.175
#7	**5**	**Time of Concentration:**					**0.320**
#7	6	5. Nearly bare and untilled, and alluvial valley fans	5.64	65.00	1,153.00	2.370	0.135
		8. Large gullies, diversions, and low flowing streams	2.63	82.00	3,119.00	4.860	0.178
#7	**6**	**Time of Concentration:**					**0.313**
#7	7	5. Nearly bare and untilled, and alluvial valley fans	11.90	85.00	714.00	3.450	0.057
		8. Large gullies, diversions, and low flowing streams	2.93	132.00	4,503.00	5.130	0.243
#7	**7**	**Time of Concentration:**					**0.300**
#7	8	5. Nearly bare and untilled, and alluvial valley fans	3.61	25.00	693.00	1.890	0.101
		8. Large gullies, diversions, and low flowing streams	4.12	492.00	11,931.00	6.090	0.544
#7	**8**	**Time of Concentration:**					**0.645**
#9	1	5. Nearly bare and untilled, and alluvial valley fans	3.35	90.00	2,687.00	1.830	0.407

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	0.58	20.00	3,463.00	2.270	0.423
#9	**1**	**Time of Concentration:**					**0.830**
#10	1	5. Nearly bare and untilled, and alluvial valley fans	1.76	22.00	1,252.00	1.320	0.263
		8. Large gullies, diversions, and low flowing streams	0.63	42.00	6,683.00	2.370	0.783
#10	**1**	**Time of Concentration:**					**1.046**
#10	2	5. Nearly bare and untilled, and alluvial valley fans	2.25	125.00	5,554.07	1.500	1.028
		8. Large gullies, diversions, and low flowing streams	2.13	85.00	3,997.36	4.370	0.254
#10	**2**	**Time of Concentration:**					**1.282**
#10	3	5. Nearly bare and untilled, and alluvial valley fans	1.39	68.00	4,904.00	1.170	1.164
		8. Large gullies, diversions, and low flowing streams	4.73	90.00	1,904.00	6.520	0.081
#10	**3**	**Time of Concentration:**					**1.245**
#10	4	5. Nearly bare and untilled, and alluvial valley fans	3.76	51.00	1,357.00	1.930	0.195
		8. Large gullies, diversions, and low flowing streams	0.65	22.00	3,385.00	2.410	0.390
#10	**4**	**Time of Concentration:**					**0.585**
#10	5	5. Nearly bare and untilled, and alluvial valley fans	1.63	88.00	5,391.16	1.270	1.179
#10	**5**	**Time of Concentration:**					**1.179**
#12	1	5. Nearly bare and untilled, and alluvial valley fans	4.50	75.00	1,667.00	2.120	0.218
		8. Large gullies, diversions, and low flowing streams	1.85	155.00	8,400.00	4.070	0.573
#12	**1**	**Time of Concentration:**					**0.791**
#12	2	5. Nearly bare and untilled, and alluvial valley fans	2.99	50.00	1,674.03	1.720	0.270
		8. Large gullies, diversions, and low flowing streams	1.67	70.00	4,201.17	3.870	0.301
#12	**2**	**Time of Concentration:**					**0.571**
#12	3	5. Nearly bare and untilled, and alluvial valley fans	4.04	57.00	1,411.00	2.000	0.195
		8. Large gullies, diversions, and low flowing streams	1.55	107.00	6,884.00	3.740	0.511
#12	**3**	**Time of Concentration:**					**0.706**
#12	4	5. Nearly bare and untilled, and alluvial valley fans	2.23	84.00	3,771.04	1.490	0.703
		8. Large gullies, diversions, and low flowing streams	1.62	186.00	11,515.60	3.810	0.839
#12	**4**	**Time of Concentration:**					**1.542**
#12	5	5. Nearly bare and untilled, and alluvial valley fans	3.68	53.00	1,442.00	1.910	0.209

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	1.95	120.00	6,155.00	4.180	0.409
#12	**5**	**Time of Concentration:**					**0.618**
#13	1	5. Nearly bare and untilled, and alluvial valley fans	4.62	62.00	1,342.00	2.140	0.174
		8. Large gullies, diversions, and low flowing streams	1.91	157.00	8,225.00	4.140	0.551
#13	**1**	**Time of Concentration:**					**0.725**
#13	2	5. Nearly bare and untilled, and alluvial valley fans	2.91	50.00	1,717.00	1.700	0.280
		8. Large gullies, diversions, and low flowing streams	2.28	183.00	8,039.00	4.520	0.494
#13	**2**	**Time of Concentration:**					**0.774**
#13	3	5. Nearly bare and untilled, and alluvial valley fans	6.18	95.00	1,537.00	2.480	0.172
		8. Large gullies, diversions, and low flowing streams	2.13	135.00	6,347.00	4.370	0.403
#13	**3**	**Time of Concentration:**					**0.575**
#13	4	5. Nearly bare and untilled, and alluvial valley fans	3.17	10.00	315.00	1.780	0.049
		8. Large gullies, diversions, and low flowing streams	2.30	100.00	4,344.00	4.550	0.265
#13	**4**	**Time of Concentration:**					**0.314**
#13	5	5. Nearly bare and untilled, and alluvial valley fans	3.10	70.00	2,255.00	1.760	0.355
		8. Large gullies, diversions, and low flowing streams	1.23	140.00	11,392.00	3.320	0.953
#13	**5**	**Time of Concentration:**					**1.308**
#14	1	5. Nearly bare and untilled, and alluvial valley fans	10.59	63.00	595.00	3.250	0.050
		8. Large gullies, diversions, and low flowing streams	2.60	151.00	5,808.00	4.830	0.334
#14	**1**	**Time of Concentration:**					**0.384**
#14	2	5. Nearly bare and untilled, and alluvial valley fans	7.28	67.00	920.00	2.690	0.095
		8. Large gullies, diversions, and low flowing streams	2.17	123.00	5,670.00	4.410	0.357
#14	**2**	**Time of Concentration:**					**0.452**
#14	3	5. Nearly bare and untilled, and alluvial valley fans	21.46	150.00	699.00	4.630	0.041
		8. Large gullies, diversions, and low flowing streams	3.10	364.00	11,728.00	5.280	0.617
#14	**3**	**Time of Concentration:**					**0.658**
#14	4	5. Nearly bare and untilled, and alluvial valley fans	3.39	35.00	1,032.00	1.840	0.155
		8. Large gullies, diversions, and low flowing streams	2.97	103.00	3,470.00	5.160	0.186
#14	**4**	**Time of Concentration:**					**0.341**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#14	5	5. Nearly bare and untilled, and alluvial valley fans	28.15	125.00	444.00	5.300	0.023
		8. Large gullies, diversions, and low flowing streams	4.18	246.00	5,886.00	6.130	0.266
#14	**5**	**Time of Concentration:**					**0.289**
#14	6	5. Nearly bare and untilled, and alluvial valley fans	3.18	40.00	1,257.00	1.780	0.196
		8. Large gullies, diversions, and low flowing streams	2.29	228.00	9,963.00	4.530	0.610
#14	**6**	**Time of Concentration:**					**0.806**
#14	7	5. Nearly bare and untilled, and alluvial valley fans	16.72	100.00	598.00	4.080	0.040
		8. Large gullies, diversions, and low flowing streams	2.81	243.00	8,649.00	5.020	0.478
#14	**7**	**Time of Concentration:**					**0.518**
#14	8	5. Nearly bare and untilled, and alluvial valley fans	1.70	47.00	2,765.00	1.300	0.590
		8. Large gullies, diversions, and low flowing streams	2.44	274.00	11,208.00	4.690	0.663
#14	**8**	**Time of Concentration:**					**1.253**
#14	9	5. Nearly bare and untilled, and alluvial valley fans	2.87	105.00	3,657.00	1.690	0.601
		8. Large gullies, diversions, and low flowing streams	2.43	194.00	7,991.00	4.670	0.475
#14	**9**	**Time of Concentration:**					**1.076**
#14	10	5. Nearly bare and untilled, and alluvial valley fans	2.75	80.00	2,907.00	1.650	0.489
		8. Large gullies, diversions, and low flowing streams	2.41	172.00	7,149.00	4.650	0.427
#14	**10**	**Time of Concentration:**					**0.916**
#15	1	5. Nearly bare and untilled, and alluvial valley fans	12.80	54.00	422.00	3.570	0.032
		8. Large gullies, diversions, and low flowing streams	1.68	181.00	10,781.00	3.880	0.771
#15	**1**	**Time of Concentration:**					**0.803**
#15	2	5. Nearly bare and untilled, and alluvial valley fans	44.22	260.00	588.00	6.640	0.024
		8. Large gullies, diversions, and low flowing streams	2.45	254.00	10,354.00	4.690	0.613
#15	**2**	**Time of Concentration:**					**0.637**
#15	3	5. Nearly bare and untilled, and alluvial valley fans	10.04	85.00	847.00	3.160	0.074
		8. Large gullies, diversions, and low flowing streams	2.34	366.00	15,663.00	4.580	0.949
#15	**3**	**Time of Concentration:**					**1.023**
#16	1	5. Nearly bare and untilled, and alluvial valley fans	4.17	15.00	360.00	2.040	0.049
		8. Large gullies, diversions, and low flowing streams	1.42	108.00	7,618.00	3.570	0.592

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#16	**1**	**Time of Concentration:**					**0.641**
#16	2	5. Nearly bare and untilled, and alluvial valley fans	8.70	62.00	713.00	2.940	0.067
		8. Large gullies, diversions, and low flowing streams	1.99	144.00	7,241.00	4.230	0.475
#16	**2**	**Time of Concentration:**					**0.542**
#16	3	5. Nearly bare and untilled, and alluvial valley fans	6.88	32.00	465.00	2.620	0.049
		8. Large gullies, diversions, and low flowing streams	2.29	81.00	3,543.00	4.530	0.217
#16	**3**	**Time of Concentration:**					**0.266**
#17	1	5. Nearly bare and untilled, and alluvial valley fans	9.37	65.00	694.00	3.060	0.062
		8. Large gullies, diversions, and low flowing streams	1.19	56.00	4,712.00	3.270	0.400
#17	**1**	**Time of Concentration:**					**0.462**
#18	1	5. Nearly bare and untilled, and alluvial valley fans	9.00	60.00	667.00	2.990	0.061
		8. Large gullies, diversions, and low flowing streams	0.97	61.00	6,287.00	2.950	0.591
#18	**1**	**Time of Concentration:**					**0.652**
#18	2	5. Nearly bare and untilled, and alluvial valley fans	2.47	33.00	1,336.00	1.570	0.236
		8. Large gullies, diversions, and low flowing streams	2.01	164.00	8,154.00	4.250	0.532
#18	**2**	**Time of Concentration:**					**0.768**
#20	1	5. Nearly bare and untilled, and alluvial valley fans	11.87	45.00	379.00	3.440	0.030
		8. Large gullies, diversions, and low flowing streams	0.75	45.00	5,969.00	2.600	0.637
#20	**1**	**Time of Concentration:**					**0.667**
#20	2	5. Nearly bare and untilled, and alluvial valley fans	5.40	45.00	833.00	2.320	0.099
		8. Large gullies, diversions, and low flowing streams	1.30	98.00	7,547.00	3.410	0.614
#20	**2**	**Time of Concentration:**					**0.713**
#21	1	5. Nearly bare and untilled, and alluvial valley fans	4.09	60.00	1,467.00	2.020	0.201
		8. Large gullies, diversions, and low flowing streams	0.93	60.00	6,433.00	2.890	0.618
#21	**1**	**Time of Concentration:**					**0.819**
#21	2	5. Nearly bare and untilled, and alluvial valley fans	3.50	50.00	1,430.00	1.860	0.213
		8. Large gullies, diversions, and low flowing streams	2.15	60.00	2,785.00	4.400	0.175
#21	**2**	**Time of Concentration:**					**0.388**
#21	3	5. Nearly bare and untilled, and alluvial valley fans	1.70	15.00	881.00	1.300	0.188
		9. Small streams flowing bankfull	1.49	60.00	4,014.00	11.000	0.101

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#21	**3**	**Time of Concentration:**					**0.289**
#21	4	5. Nearly bare and untilled, and alluvial valley fans	2.21	40.00	1,811.02	1.480	0.339
		8. Large gullies, diversions, and low flowing streams	0.84	50.00	5,949.54	2.750	0.600
#21	**4**	**Time of Concentration:**					**0.939**
#23	1	5. Nearly bare and untilled, and alluvial valley fans	2.44	65.00	2,660.01	1.560	0.473
		8. Large gullies, diversions, and low flowing streams	0.33	10.00	3,017.50	1.720	0.487
#23	**1**	**Time of Concentration:**					**0.960**
#23	2	5. Nearly bare and untilled, and alluvial valley fans	3.49	60.00	1,718.01	1.860	0.256
		8. Large gullies, diversions, and low flowing streams	1.66	65.00	3,926.06	3.860	0.282
#23	**2**	**Time of Concentration:**					**0.538**
#24	1	5. Nearly bare and untilled, and alluvial valley fans	1.71	430.00	25,118.00	1.300	5.367
#24	**1**	**Time of Concentration:**					**5.367**
#24	2	5. Nearly bare and untilled, and alluvial valley fans	1.84	430.00	23,393.00	1.350	4.813
#24	**2**	**Time of Concentration:**					**4.813**
#24	3	5. Nearly bare and untilled, and alluvial valley fans	1.82	155.00	8,498.00	1.350	1.748
		8. Large gullies, diversions, and low flowing streams	0.84	40.00	4,771.00	2.740	0.483
#24	**3**	**Time of Concentration:**					**2.231**
#24	4	5. Nearly bare and untilled, and alluvial valley fans	1.24	50.00	4,042.00	1.110	1.011
		8. Large gullies, diversions, and low flowing streams	0.49	60.00	12,150.00	2.100	1.607
#24	**4**	**Time of Concentration:**					**2.618**
#25	1	5. Nearly bare and untilled, and alluvial valley fans	0.51	10.00	1,950.00	0.710	0.762
		8. Large gullies, diversions, and low flowing streams	1.81	60.00	3,322.00	4.030	0.228
#25	**1**	**Time of Concentration:**					**0.990**
#25	2	5. Nearly bare and untilled, and alluvial valley fans	1.11	25.00	2,254.00	1.050	0.596
		8. Large gullies, diversions, and low flowing streams	2.36	75.00	3,178.00	4.600	0.191
#25	**2**	**Time of Concentration:**					**0.787**
#25	3	5. Nearly bare and untilled, and alluvial valley fans	3.23	30.00	929.00	1.790	0.144
		8. Large gullies, diversions, and low flowing streams	2.45	154.00	6,297.00	4.690	0.372
#25	**3**	**Time of Concentration:**					**0.516**
#26	1	5. Nearly bare and untilled, and alluvial valley fans	1.20	103.00	8,602.00	1.090	2.192

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#26	**1**	**Time of Concentration:**					**2.192**
#26	2	5. Nearly bare and untilled, and alluvial valley fans	1.23	120.00	9,780.00	1.100	2.469
		8. Large gullies, diversions, and low flowing streams	2.18	184.00	8,454.00	4.420	0.531
#26	**2**	**Time of Concentration:**					**3.000**
#27	1	5. Nearly bare and untilled, and alluvial valley fans	4.32	50.00	1,158.02	2.070	0.155
		8. Large gullies, diversions, and low flowing streams	2.53	198.00	7,838.16	4.760	0.457
#27	**1**	**Time of Concentration:**					**0.612**
#27	2	5. Nearly bare and untilled, and alluvial valley fans	5.26	30.00	570.00	2.290	0.069
		8. Large gullies, diversions, and low flowing streams	3.15	278.00	8,822.00	5.320	0.460
#27	**2**	**Time of Concentration:**					**0.529**
#27	3	5. Nearly bare and untilled, and alluvial valley fans	16.33	80.00	490.00	4.040	0.033
		8. Large gullies, diversions, and low flowing streams	2.15	225.00	10,443.00	4.400	0.659
#27	**3**	**Time of Concentration:**					**0.692**
#27	4	5. Nearly bare and untilled, and alluvial valley fans	12.43	65.00	523.00	3.520	0.041
		8. Large gullies, diversions, and low flowing streams	3.49	225.00	6,454.00	5.600	0.320
#27	**4**	**Time of Concentration:**					**0.361**
#27	5	5. Nearly bare and untilled, and alluvial valley fans	9.40	25.00	266.00	3.060	0.024
		8. Large gullies, diversions, and low flowing streams	2.32	364.00	15,700.00	4.560	0.956
#27	**5**	**Time of Concentration:**					**0.980**
#28	1	5. Nearly bare and untilled, and alluvial valley fans	5.25	40.00	762.00	2.290	0.092
		8. Large gullies, diversions, and low flowing streams	2.96	310.00	10,479.34	5.150	0.565
#28	**1**	**Time of Concentration:**					**0.657**
#28	2	5. Nearly bare and untilled, and alluvial valley fans	25.86	105.00	406.00	5.080	0.022
		8. Large gullies, diversions, and low flowing streams	2.96	310.00	10,479.34	5.150	0.565
#28	**2**	**Time of Concentration:**					**0.587**
#29	1	5. Nearly bare and untilled, and alluvial valley fans	11.58	30.00	259.00	3.400	0.021
		8. Large gullies, diversions, and low flowing streams	3.61	288.00	7,976.00	5.700	0.388
#29	**1**	**Time of Concentration:**					**0.409**
#29	2	5. Nearly bare and untilled, and alluvial valley fans	8.06	40.00	496.00	2.830	0.048

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	2.90	252.00	8,693.55	5.100	0.473
#29	**2**	**Time of Concentration:**					**0.521**
#29	3	5. Nearly bare and untilled, and alluvial valley fans	7.25	25.00	345.00	2.690	0.035
		8. Large gullies, diversions, and low flowing streams	2.26	158.00	7,001.00	4.500	0.432
#29	**3**	**Time of Concentration:**					**0.467**
#30	1	5. Nearly bare and untilled, and alluvial valley fans	4.93	35.00	710.00	2.220	0.088
		8. Large gullies, diversions, and low flowing streams	1.67	243.00	14,540.00	3.870	1.043
#30	**1**	**Time of Concentration:**					**1.131**
#31	1	5. Nearly bare and untilled, and alluvial valley fans	2.91	15.00	515.00	1.700	0.084
		8. Large gullies, diversions, and low flowing streams	2.74	247.00	9,006.00	4.960	0.504
#31	**1**	**Time of Concentration:**					**0.588**
#31	2	5. Nearly bare and untilled, and alluvial valley fans	7.46	25.00	335.00	2.730	0.034
		8. Large gullies, diversions, and low flowing streams	2.18	138.00	6,335.00	4.420	0.398
#31	**2**	**Time of Concentration:**					**0.432**
#31	3	5. Nearly bare and untilled, and alluvial valley fans	3.84	20.00	521.00	1.950	0.074
		8. Large gullies, diversions, and low flowing streams	2.24	108.00	4,826.00	4.480	0.299
#31	**3**	**Time of Concentration:**					**0.373**
#32	1	5. Nearly bare and untilled, and alluvial valley fans	3.48	22.00	632.00	1.860	0.094
		8. Large gullies, diversions, and low flowing streams	1.56	101.00	6,494.00	3.740	0.482
#32	**1**	**Time of Concentration:**					**0.576**
#34	1	5. Nearly bare and untilled, and alluvial valley fans	3.21	25.00	779.00	1.790	0.120
		8. Large gullies, diversions, and low flowing streams	2.80	63.00	2,251.00	5.010	0.124
#34	**1**	**Time of Concentration:**					**0.244**
#34	2	5. Nearly bare and untilled, and alluvial valley fans	5.75	40.00	696.00	2.390	0.080
		8. Large gullies, diversions, and low flowing streams	23.00	2,100.00	9,130.43	14.380	0.176
#34	**2**	**Time of Concentration:**					**0.256**
#34	3	5. Nearly bare and untilled, and alluvial valley fans	2.67	40.00	1,500.00	1.630	0.255
		8. Large gullies, diversions, and low flowing streams	1.28	98.00	7,675.00	3.380	0.630
#34	**3**	**Time of Concentration:**					**0.885**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#36	1	5. Nearly bare and untilled, and alluvial valley fans	3.21	105.00	3,274.00	1.790	0.508
		8. Large gullies, diversions, and low flowing streams	0.21	5.00	2,367.00	1.370	0.479
#36	**1**	**Time of Concentration:**					**0.987**
#36	2	5. Nearly bare and untilled, and alluvial valley fans	5.50	140.00	2,547.00	2.340	0.302
		8. Large gullies, diversions, and low flowing streams	1.58	30.00	1,897.00	3.770	0.139
#36	**2**	**Time of Concentration:**					**0.441**
#36	3	5. Nearly bare and untilled, and alluvial valley fans	1.72	20.00	1,166.00	1.300	0.249
		8. Large gullies, diversions, and low flowing streams	2.31	70.00	3,029.00	4.560	0.184
#36	**3**	**Time of Concentration:**					**0.433**
#37	1	5. Nearly bare and untilled, and alluvial valley fans	4.68	129.00	2,754.05	2.160	0.354
		8. Large gullies, diversions, and low flowing streams	0.16	10.00	6,108.73	1.210	1.402
#37	**1**	**Time of Concentration:**					**1.756**
#37	2	5. Nearly bare and untilled, and alluvial valley fans	7.32	90.00	1,229.00	2.700	0.126
		8. Large gullies, diversions, and low flowing streams	1.62	70.00	4,309.01	3.820	0.313
#37	**2**	**Time of Concentration:**					**0.439**
#37	3	5. Nearly bare and untilled, and alluvial valley fans	8.10	100.00	1,234.00	2.840	0.120
		8. Large gullies, diversions, and low flowing streams	2.66	100.00	3,763.21	4.890	0.213
#37	**3**	**Time of Concentration:**					**0.333**
#37	4	5. Nearly bare and untilled, and alluvial valley fans	5.09	90.00	1,768.03	2.250	0.218
		8. Large gullies, diversions, and low flowing streams	0.36	30.00	8,326.39	1.800	1.284
#37	**4**	**Time of Concentration:**					**1.502**
#37	5	5. Nearly bare and untilled, and alluvial valley fans	0.81	20.00	2,466.09	0.900	0.761
		8. Large gullies, diversions, and low flowing streams	4.06	50.00	1,231.01	6.040	0.056
#37	**5**	**Time of Concentration:**					**0.817**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	2	8. Large gullies, diversions, and low flowing streams	1.29	107.00	8,294.57	3.400	0.677
#1	**2**	**Muskingum K:**					**0.677**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	3	8. Large gullies, diversions, and low flowing streams	1.27	113.00	8,880.15	3.380	0.729
#1	**3**	**Muskingum K:**					**0.729**
#1	4	8. Large gullies, diversions, and low flowing streams	1.35	171.00	12,634.84	3.490	1.005
#1	**4**	**Muskingum K:**					**1.005**
#1	5	8. Large gullies, diversions, and low flowing streams	1.49	274.00	18,351.08	3.660	1.392
#1	**5**	**Muskingum K:**					**1.392**
#1	6	8. Large gullies, diversions, and low flowing streams	1.49	274.00	18,349.00	3.660	1.392
#1	**6**	**Muskingum K:**					**1.392**
#2	2	8. Large gullies, diversions, and low flowing streams	0.53	20.00	3,756.57	2.180	0.478
#2	**2**	**Muskingum K:**					**0.478**
#2	3	8. Large gullies, diversions, and low flowing streams	0.55	25.00	4,570.38	2.210	0.574
#2	**3**	**Muskingum K:**					**0.574**
#2	4	8. Large gullies, diversions, and low flowing streams	0.55	25.00	4,570.00	2.210	0.574
#2	**4**	**Muskingum K:**					**0.574**
#2	5	8. Large gullies, diversions, and low flowing streams	0.65	45.00	6,955.17	2.410	0.801
#2	**5**	**Muskingum K:**					**0.801**
#3	3	8. Large gullies, diversions, and low flowing streams	0.92	20.00	2,168.02	2.880	0.209
#3	**3**	**Muskingum K:**					**0.209**
#5	1	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#5	**1**	**Muskingum K:**					**0.000**
#5	2	8. Large gullies, diversions, and low flowing streams	1.34	125.00	9,339.51	3.470	0.747
#5	**2**	**Muskingum K:**					**0.747**
#5	3	8. Large gullies, diversions, and low flowing streams	1.24	155.00	12,461.81	3.340	1.036
#5	**3**	**Muskingum K:**					**1.036**
#5	4	8. Large gullies, diversions, and low flowing streams	1.24	155.00	12,461.81	3.340	1.036
#5	**4**	**Muskingum K:**					**1.036**
#5	5	8. Large gullies, diversions, and low flowing streams	1.35	239.00	17,712.88	3.480	1.413
#5	**5**	**Muskingum K:**					**1.413**
#5	6	8. Large gullies, diversions, and low flowing streams	1.35	239.00	17,712.00	3.480	1.413
#5	**6**	**Muskingum K:**					**1.413**
#6	2	8. Large gullies, diversions, and low flowing streams	1.01	25.00	2,481.38	3.010	0.228
#6	**2**	**Muskingum K:**					**0.228**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#6	3	8. Large gullies, diversions, and low flowing streams	0.80	47.00	5,846.00	2.680	0.605
#6	**3**	**Muskingum K:**					**0.605**
#6	4	8. Large gullies, diversions, and low flowing streams	0.80	47.00	5,846.00	2.680	0.605
#6	**4**	**Muskingum K:**					**0.605**
#6	5	8. Large gullies, diversions, and low flowing streams	0.82	89.00	10,838.00	2.710	1.110
#6	**5**	**Muskingum K:**					**1.110**
#6	6	8. Large gullies, diversions, and low flowing streams	0.84	125.00	14,917.00	2.740	1.512
#6	**6**	**Muskingum K:**					**1.512**
#6	7	8. Large gullies, diversions, and low flowing streams	0.84	125.00	14,917.00	2.740	1.512
#6	**7**	**Muskingum K:**					**1.512**
#7	1	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#7	**1**	**Muskingum K:**					**0.000**
#7	2	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#7	**2**	**Muskingum K:**					**0.000**
#7	4	8. Large gullies, diversions, and low flowing streams	1.05	140.00	13,344.77	3.070	1.207
#7	**4**	**Muskingum K:**					**1.207**
#7	5	8. Large gullies, diversions, and low flowing streams	1.05	140.00	13,344.00	3.070	1.207
#7	**5**	**Muskingum K:**					**1.207**
#7	6	8. Large gullies, diversions, and low flowing streams	1.07	158.00	14,716.84	3.100	1.318
#7	**6**	**Muskingum K:**					**1.318**
#7	7	8. Large gullies, diversions, and low flowing streams	1.08	187.00	17,322.83	3.110	1.547
#7	**7**	**Muskingum K:**					**1.547**
#7	8	8. Large gullies, diversions, and low flowing streams	1.08	187.00	17,322.00	3.110	1.547
#7	**8**	**Muskingum K:**					**1.547**
#10	2	8. Large gullies, diversions, and low flowing streams	0.74	50.00	6,729.00	2.580	0.724
#10	**2**	**Muskingum K:**					**0.724**
#10	3	8. Large gullies, diversions, and low flowing streams	0.69	36.00	5,241.00	2.480	0.587
#10	**3**	**Muskingum K:**					**0.587**
#10	4	8. Large gullies, diversions, and low flowing streams	0.69	36.00	5,241.00	2.480	0.587
#10	**4**	**Muskingum K:**					**0.587**
#10	5	8. Large gullies, diversions, and low flowing streams	0.69	44.00	6,399.00	2.480	0.716
#10	**5**	**Muskingum K:**					**0.716**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#12	2	8. Large gullies, diversions, and low flowing streams	8.24	111.00	1,347.00	8.610	0.043
#12	**2**	**Muskingum K:**					**0.043**
#12	3	8. Large gullies, diversions, and low flowing streams	8.01	109.00	1,360.00	8.490	0.044
#12	**3**	**Muskingum K:**					**0.044**
#12	4	8. Large gullies, diversions, and low flowing streams	2.24	176.00	7,866.00	4.480	0.487
#12	**4**	**Muskingum K:**					**0.487**
#12	5	8. Large gullies, diversions, and low flowing streams	2.24	176.00	7,866.00	4.480	0.487
#12	**5**	**Muskingum K:**					**0.487**
#13	2	8. Large gullies, diversions, and low flowing streams	1.34	54.00	4,025.00	3.470	0.322
#13	**2**	**Muskingum K:**					**0.322**
#13	3	8. Large gullies, diversions, and low flowing streams	0.98	72.00	7,333.00	2.970	0.685
#13	**3**	**Muskingum K:**					**0.685**
#13	4	8. Large gullies, diversions, and low flowing streams	1.18	127.00	10,806.00	3.250	0.923
#13	**4**	**Muskingum K:**					**0.923**
#13	5	8. Large gullies, diversions, and low flowing streams	1.18	127.00	10,806.00	3.250	0.923
#13	**5**	**Muskingum K:**					**0.923**
#14	1	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#14	**1**	**Muskingum K:**					**0.000**
#14	2	8. Large gullies, diversions, and low flowing streams	0.83	58.00	6,957.00	2.730	0.707
#14	**2**	**Muskingum K:**					**0.707**
#14	3	8. Large gullies, diversions, and low flowing streams	0.81	77.00	9,480.00	2.700	0.975
#14	**3**	**Muskingum K:**					**0.975**
#14	4	8. Large gullies, diversions, and low flowing streams	0.86	147.00	17,117.00	2.770	1.716
#14	**4**	**Muskingum K:**					**1.716**
#14	5	8. Large gullies, diversions, and low flowing streams	0.88	175.00	19,934.00	2.810	1.970
#14	**5**	**Muskingum K:**					**1.970**
#14	6	8. Large gullies, diversions, and low flowing streams	0.95	211.00	22,155.00	2.920	2.107
#14	**6**	**Muskingum K:**					**2.107**
#14	7	8. Large gullies, diversions, and low flowing streams	0.96	257.00	26,835.00	2.930	2.544
#14	**7**	**Muskingum K:**					**2.544**
#14	8	8. Large gullies, diversions, and low flowing streams	0.96	257.00	26,835.00	2.930	2.544
#14	**8**	**Muskingum K:**					**2.544**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#14	9	8. Large gullies, diversions, and low flowing streams	0.95	307.00	32,146.59	2.930	3.047
#14	**9**	**Muskingum K:**					**3.047**
#14	10	8. Large gullies, diversions, and low flowing streams	0.96	339.00	35,382.00	2.930	3.354
#14	**10**	**Muskingum K:**					**3.354**
#15	1	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#15	**1**	**Muskingum K:**					**0.000**
#15	2	8. Large gullies, diversions, and low flowing streams	1.14	86.00	7,535.00	3.200	0.654
#15	**2**	**Muskingum K:**					**0.654**
#15	3	8. Large gullies, diversions, and low flowing streams	1.25	115.00	9,236.00	3.340	0.768
#15	**3**	**Muskingum K:**					**0.768**
#16	2	8. Large gullies, diversions, and low flowing streams	0.58	24.00	4,161.00	2.270	0.509
#16	**2**	**Muskingum K:**					**0.509**
#16	3	8. Large gullies, diversions, and low flowing streams	0.51	37.00	7,269.00	2.140	0.943
#16	**3**	**Muskingum K:**					**0.943**
#17	1	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#17	**1**	**Muskingum K:**					**0.000**
#18	1	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#18	**1**	**Muskingum K:**					**0.000**
#18	2	8. Large gullies, diversions, and low flowing streams	1.02	62.00	6,103.00	3.020	0.561
#18	**2**	**Muskingum K:**					**0.561**
#20	2	8. Large gullies, diversions, and low flowing streams	17.00	3,605.00	21,205.88	12.360	0.476
#20	**2**	**Muskingum K:**					**0.476**
#21	1	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#21	**1**	**Muskingum K:**					**0.000**
#21	2	8. Large gullies, diversions, and low flowing streams	0.41	20.00	4,824.00	1.930	0.694
#21	**2**	**Muskingum K:**					**0.694**
#21	3	8. Large gullies, diversions, and low flowing streams	0.36	20.00	5,626.00	1.780	0.877
#21	**3**	**Muskingum K:**					**0.877**
#21	4	8. Large gullies, diversions, and low flowing streams	0.36	20.00	5,626.00	1.780	0.877
#21	**4**	**Muskingum K:**					**0.877**
#23	1	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#23	**1**	**Muskingum K:**					**0.000**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#23	2	8. Large gullies, diversions, and low flowing streams	0.63	30.00	4,771.75	2.370	0.559
#23	**2**	**Muskingum K:**					**0.559**
#24	1	8. Large gullies, diversions, and low flowing streams	0.79	180.00	22,769.00	2.660	2.377
#24	**1**	**Muskingum K:**					**2.377**
#24	2	8. Large gullies, diversions, and low flowing streams	0.78	180.00	23,111.00	2.640	2.431
#24	**2**	**Muskingum K:**					**2.431**
#24	4	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#24	**4**	**Muskingum K:**					**0.000**
#25	1	8. Large gullies, diversions, and low flowing streams	1.99	104.00	5,220.00	4.230	0.342
#25	**1**	**Muskingum K:**					**0.342**
#25	2	8. Large gullies, diversions, and low flowing streams	1.99	104.00	5,220.00	4.230	0.342
#25	**2**	**Muskingum K:**					**0.342**
#25	3	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#25	**3**	**Muskingum K:**					**0.000**
#27	1	8. Large gullies, diversions, and low flowing streams	1.38	216.00	15,629.00	3.520	1.233
#27	**1**	**Muskingum K:**					**1.233**
#27	2	8. Large gullies, diversions, and low flowing streams	1.17	144.00	12,301.00	3.240	1.054
#27	**2**	**Muskingum K:**					**1.054**
#27	3	8. Large gullies, diversions, and low flowing streams	1.18	76.00	6,454.00	3.250	0.551
#27	**3**	**Muskingum K:**					**0.551**
#27	4	8. Large gullies, diversions, and low flowing streams	1.18	76.00	6,454.00	3.250	0.551
#27	**4**	**Muskingum K:**					**0.551**
#28	1	8. Large gullies, diversions, and low flowing streams	1.30	84.00	6,445.17	3.420	0.523
#28	**1**	**Muskingum K:**					**0.523**
#29	1	8. Large gullies, diversions, and low flowing streams	0.88	37.00	4,210.00	2.810	0.416
#29	**1**	**Muskingum K:**					**0.416**
#29	2	8. Large gullies, diversions, and low flowing streams	0.88	26.00	2,949.00	2.810	0.291
#29	**2**	**Muskingum K:**					**0.291**
#31	1	8. Large gullies, diversions, and low flowing streams	1.35	76.00	5,639.00	3.480	0.450
#31	**1**	**Muskingum K:**					**0.450**
#31	2	8. Large gullies, diversions, and low flowing streams	1.15	20.00	1,734.00	3.220	0.149
#31	**2**	**Muskingum K:**					**0.149**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#34	1	8. Large gullies, diversions, and low flowing streams	0.73	65.00	8,900.00	2.560	0.965
#34	**1**	**Muskingum K:**					**0.965**
#34	2	8. Large gullies, diversions, and low flowing streams	0.73	65.00	8,900.00	2.560	0.965
#34	**2**	**Muskingum K:**					**0.965**
#36	3	8. Large gullies, diversions, and low flowing streams	2.71	80.00	2,957.00	4.930	0.166
#36	**3**	**Muskingum K:**					**0.166**
#37	2	8. Large gullies, diversions, and low flowing streams	0.29	30.00	10,319.91	1.610	1.780
#37	**2**	**Muskingum K:**					**1.780**
#37	3	8. Large gullies, diversions, and low flowing streams	0.31	30.00	9,800.71	1.650	1.649
#37	**3**	**Muskingum K:**					**1.649**
#37	4	8. Large gullies, diversions, and low flowing streams	0.29	30.00	10,319.91	1.610	1.780
#37	**4**	**Muskingum K:**					**1.780**
#37	5	8. Large gullies, diversions, and low flowing streams	0.56	100.00	17,956.54	2.230	2.236
#37	**5**	**Muskingum K:**					**2.236**

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General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	25 yr - 6 hr
Rainfall Depth:	1.600 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#30	476.400	476.400	20.29	4.54
#28	1,217.900	1,217.900	424.40	68.00
#26	2,486.400	2,486.400	99.26	38.78
#24	8,061.800	8,061.800	143.61	112.28
#25	1,015.700	9,077.500	147.45	138.55
#27	1,783.700	13,347.600	319.11	223.74
#29	966.000	15,531.500	673.55	344.54
#32	293.700	16,301.600	697.34	369.21
#31	957.100	957.100	395.36	62.12
#33	0.000	17,258.700	785.16	431.33
#34	932.500	18,191.200	818.88	481.33
#5	2,023.000	2,023.000	540.04	94.54
#6	1,743.200	3,766.200	575.19	181.93
#7	2,395.300	6,161.500	982.59	341.46
#8	0.000	6,161.500	982.59	341.46
#10	1,053.200	7,214.700	1,026.78	400.15
#1	2,411.100	2,411.100	450.10	89.93
#2	1,497.000	3,908.100	539.84	181.84
#3	862.700	4,770.800	673.76	226.50
#4	0.000	4,770.800	673.76	226.50
#9	425.500	5,196.300	707.87	255.01
#11	0.000	12,411.000	1,567.95	655.16
#21	1,080.800	13,491.800	1,637.22	712.16
#18	848.500	848.500	210.88	42.35
#17	182.200	182.200	128.80	12.48
#19	0.000	1,030.700	301.55	54.83
#15	1,992.700	1,992.700	484.43	95.22
#12	3,494.500	3,494.500	276.49	72.29
#13	2,720.700	6,215.200	528.75	128.90
#14	5,096.800	11,312.000	706.02	346.80
#16	876.500	14,181.200	1,014.86	501.20
#20	681.900	15,893.800	1,080.51	600.87
#22	0.000	29,385.600	2,595.82	1,313.03
#23	752.900	30,138.500	2,593.51	1,351.53
#35	0.000	48,329.700	3,267.78	1,832.86
#36	891.700	49,221.400	3,263.49	1,865.82
#37	2,208.500	51,429.900	3,234.48	1,949.23

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	50 yr - 6 hr
Rainfall Depth:	1.800 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#30	476.400	476.400	32.83	6.99
#28	1,217.900	1,217.900	525.53	83.61
#26	2,486.400	2,486.400	143.85	55.25
#24	8,061.800	8,061.800	208.85	162.63
#25	1,015.700	9,077.500	214.09	197.55
#27	1,783.700	13,347.600	423.24	314.60
#29	966.000	15,531.500	856.40	463.26
#32	293.700	16,301.600	887.94	494.50
#31	957.100	957.100	482.72	75.24
#33	0.000	17,258.700	973.26	569.73
#34	932.500	18,191.200	1,013.26	631.43
#5	2,023.000	2,023.000	673.75	118.20
#6	1,743.200	3,766.200	718.40	226.70
#7	2,395.300	6,161.500	1,214.13	419.42
#8	0.000	6,161.500	1,214.13	419.42
#10	1,053.200	7,214.700	1,264.38	491.32
#1	2,411.100	2,411.100	576.49	114.84
#2	1,497.000	3,908.100	683.05	226.67
#3	862.700	4,770.800	828.28	281.95
#4	0.000	4,770.800	828.28	281.95
#9	425.500	5,196.300	868.93	316.37
#11	0.000	12,411.000	1,927.22	807.69
#21	1,080.800	13,491.800	2,011.10	878.14
#18	848.500	848.500	267.05	52.51
#17	182.200	182.200	155.60	15.04
#19	0.000	1,030.700	366.68	67.55
#15	1,992.700	1,992.700	608.76	118.63
#12	3,494.500	3,494.500	379.69	99.03
#13	2,720.700	6,215.200	721.87	176.27
#14	5,096.800	11,312.000	942.87	450.84
#16	876.500	14,181.200	1,258.26	640.88
#20	681.900	15,893.800	1,337.03	762.67
#22	0.000	29,385.600	3,203.79	1,640.81
#23	752.900	30,138.500	3,200.38	1,688.52
#35	0.000	48,329.700	4,045.08	2,319.96
#36	891.700	49,221.400	4,039.79	2,362.07
#37	2,208.500	51,429.900	4,005.46	2,468.74

General Information

Storm Information:

Storm Type:	Type II-60
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.000 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#30	476.400	476.400	48.15	9.85
#28	1,217.900	1,217.900	630.72	99.84
#26	2,486.400	2,486.400	194.88	73.81
#24	8,061.800	8,061.800	283.23	219.79
#25	1,015.700	9,077.500	289.91	264.16
#27	1,783.700	13,347.600	536.81	416.52
#29	966.000	15,531.500	1,051.27	594.15
#32	293.700	16,301.600	1,091.37	632.47
#31	957.100	957.100	573.16	88.75
#33	0.000	17,258.700	1,188.90	721.22
#34	932.500	18,191.200	1,217.27	795.10
#5	2,023.000	2,023.000	815.52	143.06
#6	1,743.200	3,766.200	868.02	273.64
#7	2,395.300	6,161.500	1,455.93	500.51
#8	0.000	6,161.500	1,455.93	500.51
#10	1,053.200	7,214.700	1,512.16	586.13
#1	2,411.100	2,411.100	711.39	141.39
#2	1,497.000	3,908.100	834.50	273.80
#3	862.700	4,770.800	988.87	340.16
#4	0.000	4,770.800	988.87	340.16
#9	425.500	5,196.300	1,036.48	380.66
#11	0.000	12,411.000	2,314.22	966.80
#21	1,080.800	13,491.800	2,400.12	1,051.28
#18	848.500	848.500	326.50	63.15
#17	182.200	182.200	182.95	17.67
#19	0.000	1,030.700	433.80	80.82
#15	1,992.700	1,992.700	740.10	143.20
#12	3,494.500	3,494.500	493.90	128.59
#13	2,720.700	6,215.200	935.07	228.65
#14	5,096.800	11,312.000	1,201.98	563.09
#16	876.500	14,181.200	1,513.07	790.26
#20	681.900	15,893.800	1,605.07	934.99
#22	0.000	29,385.600	3,839.19	1,986.27
#23	752.900	30,138.500	3,834.77	2,043.61
#35	0.000	48,329.700	4,859.19	2,838.72
#36	891.700	49,221.400	4,853.45	2,890.59
#37	2,208.500	51,429.900	4,813.30	3,022.02

Cottonwood Crossing As-built Drawings

Cottonwood Arroyo Crossing - Haul Rd

BNCC - Area IV Expansion

As - Built Drawings

RECORD DRAWING CERTIFICATION

The Record Drawing information shown hereon reflect field changes as recorded by the Contractor, and is correct to the best of my knowledge and belief.

David L. Eberhart — NAME

4.27.2009 — DATE

DAVID L. EBERHART
NEW MEXICO
14290
PROFESSIONAL ENGINEER

bhpbilliton

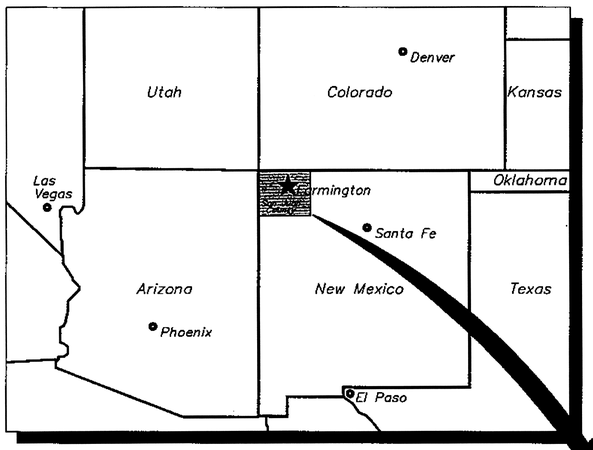
BHP Navajo Coal Co.

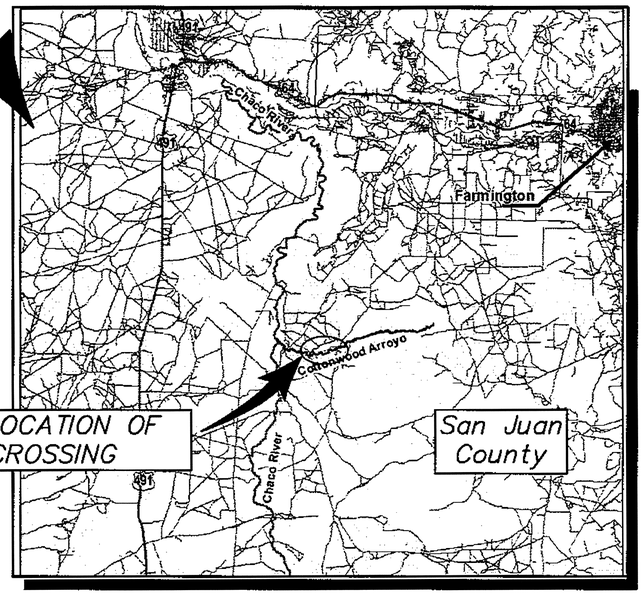
300 W. Arrington, Suite 200
Farmington, NM 87401
Tel: (505) 598-3312

Ames Construction, Inc.

3410 E. University Dr.
Suite #380
Phoenix, AZ 85034
Tel: (602) 431-2111

COTTONWOOD ARROYO CROSSING
CONSTRUCTION PLANS
MAY 2007





APPROXIMATE LOCATION OF PROPOSED CROSSING

LIST OF DRAWINGS

DRAWING NO.	DRAWING TITLE
C-1	TITLE SHEET AND PROJECT LOCATION MAP
C-2	SITE PLAN
C-3	TYPICAL ROADWAY SECTION
C-4	PAVEMENT SECTIONS
C-5	HAUL ROAD PLAN AND PROFILE
C-6	GUARDRAIL AT CULVERT DETAIL
C-7	TYPICAL ROADWAY CROSS SECTIONS (SHEET 7 DELETED)
C-8	TYPICAL ROADWAY CROSS SECTIONS (SHEET 8 DELETED)
C-9	METAL BARRIER W-BEAM DETAILS (NMDOT # 606-01-1/4)
C-10	METAL BARRIER POSTS AND BLOCKS (NMDOT # 606-01-3/4)
C-11	METAL BARRIER COMPONENTS (NMDOT 606-01-4/4)
C-12	CURVED GUARD RAIL TYPE B END ANCHOR (NMDOT 606-06-2/3)
D-1	CULVERT PLAN AND PROFILE
D-2	CULVERT GRADING PLAN
D-3	GABION ARMORING DETAIL
D-4	GABION AND EROSION CONTROL DETAILS
S-1	BOX CULVERT STRUCTURAL PLAN
S-2	BOX CULVERT DETAILS
S-3	EXCAVATION AND BACKFILL FOR WALLS AND CBC'S (NMDOT # 210-01-1/1)
S-4	WINGWALLS FOR PIPE OR BOX CULVERTS (CDOT # M-601-20)

KENT W. WHITMAN NEW MEXICO 6170 REGISTERED PROFESSIONAL ENGINEER

BARRY T. CHUNG NEW MEXICO 15471 LICENSED PROFESSIONAL ENGINEER

DONALD T. LOPEZ NEW MEXICO 5122 REGISTERED PROFESSIONAL ENGINEER

PREPARED FOR:

BHP Navajo Coal Company
300 W. Arrington, Suite 200
Farmington, NM 87401
Tel: (505) 598-3312
Fax: (505) 598-3361

RECORD DRAWING CERTIFICATION

The Record Drawing information shown hereon reflect field changes as recorded by the Contractor, and is correct to the best of my knowledge and belief.

David L. Eberhart 4-27-09
NAME DATE

DAVID L. EBERHART NEW MEXICO 14290 PROFESSIONAL ENGINEER

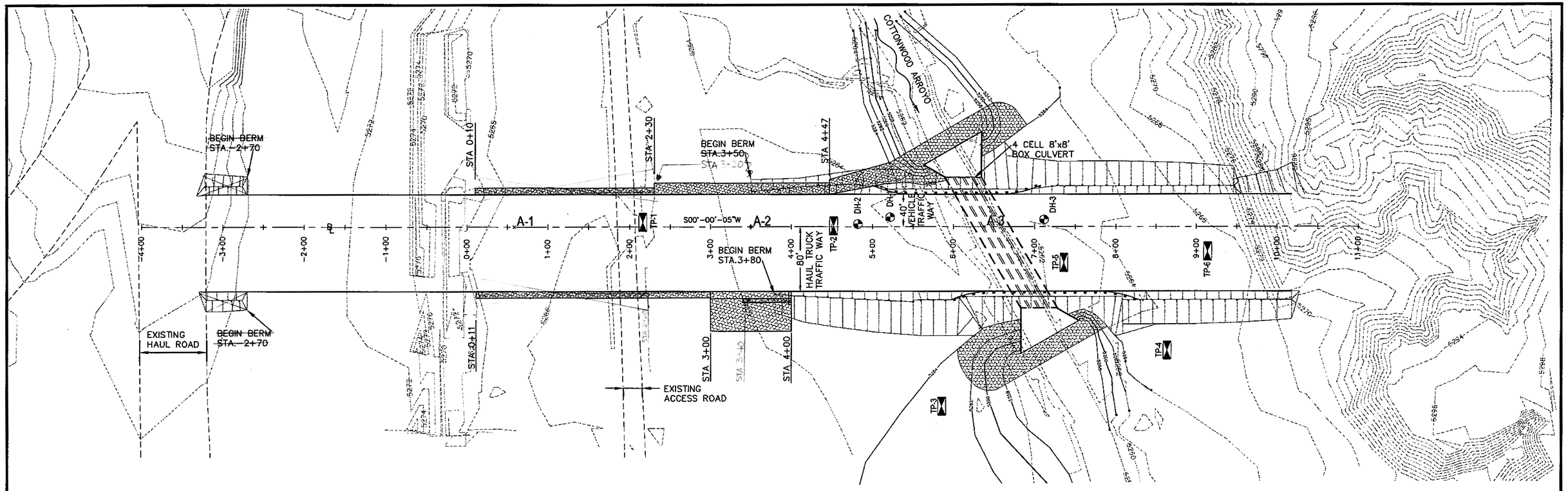
PREPARED BY:

URS

URS CORPORATION
6501 Americas Parkway, NE
Suite 900
Albuquerque, NM 87110
Tel: (505)855-7500
Fax: (505)855-7555

FIGURE No :	REV
C-1	0

C-1 Cover Sheet.dwg



LEGEND

5255	EXISTING TOPOGRAPHY– IN FEET
TP-2	TEST PIT LOCATION
DH-1	DRILL HOLE LOCATION
℄	BASELINE
	GABION ARMORING
	BERM

CONTROL POINT LISTING			
POINT NO.	EASTING	NORTHING	ELEVATION
CENTERLINE STATIONS AT FINAL GRADE			
A–1 (STA 0+58.50)	299,760.000	2,008,778.500	5,273.000
A–2 (STA 3+50.00)	299,760.000	2,008,487.000	5,266.000
A–3 (STA 6+41.50)	299,760.000	2,008,195.500	5,273.000

NOTES: 1. OWNERS SURVEYORS WILL RE–ESTABLISH CONTROL POINTS

2. COORDINATES LISTED ARE A LOCAL SYSTEM BASED ON THIS MONUMENTATION

NOTES:

GENERAL

1. EXISTING GROUND TOPOGRAPHY AND CONTOURS WITHIN SITE PLAN LIMITS SHOWN ON THIS DRAWING ARE BASED ON 2004 GROUND SURVEY PROVIDED BY BNCC. TOPOGRAPHY OUTSIDE THESE LIMITS ARE UNKNOWN.

2. COORDINATES AND ELEVATIONS FROM THE 2004 BNCC GROUND SURVEY ARE BASED ON BNCC MINE SURVEY CONTROL AND DATUM. THE CONTRACTOR SHALL CONFIRM ALL COORDINATES AND ELEVATIONS AND ENSURE TIE–IN OF THIS PROJECT WITH THE BNCC SURVEY CONTROL AND DATUM PRIOR TO CONSTRUCTION.

3. EXISTING GROUND TOPOGRAPHY AND CONTOURS USED TO DEVELOP THE DESIGN OF THE ROADWAY TIE–IN AT STA –3+38 HAVE BEEN BASED ON EXTRAPOLATED AERIAL TOPOGRAPHY INFORMATION PROVIDED BY BNCC. THE CONTRACTOR SHALL CONFIRM THE EXISTING GROUND CONTOURS AT THIS LOCATION PRIOR TO CONSTRUCTION. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE PROJECT MANAGER FOR RESOLUTION.

CONSTRUCTION

1. NEW MEXICO DEPARTMENT OF TRANSPORTATION 2005 INTERIM SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION SHALL APPLY.

GEOTECHNICAL DATA

1. FOR BORELOG AND TEST PIT GEOTECHNICAL INFORMATION REFER TO THE DESIGN REPORT.

ESTIMATED QUANTITIES

ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATE
203000	CUT AND FILL WITHIN PROJECT BOUNDARIES	CU. YD.	57516
203100	CUT AND FILL FROM STOCK PILE	CU. YD.	14948
207000	SUB–GRADE PREPARATION	CU. YD.	13058
304000	SUB–BASE	CU. YD.	16323
304100	BASE COURSE	CU. YD.	6529
400000	WEARING COURSE	CU. YD.	3014
511200	STRUCTURAL REINFORCED CONCRETE, CLASS AA	CU. YD.	204
517000	PRECAST CONCRETE BOX CULVERT	LIN. FT.	1582
602000	GABIONS	CU. YD.	860
602000A	GABION MATTRESSES (CULVERT)	CU. YD.	820
606100	DOUBLE METAL BARRIER W–BEAM	LIN. FT.	368
668100	GEOGRID BX 1200	SQ. FT.	352560

SCALE

60' 0 60' 120'

CONTOUR INTERVAL 2' FT.

DAVID L. EBERHART 4-27-09
NEW MEXICO 14290 PROFESSIONAL ENGINEER
Record Drawing Only

KENT W. WHITMAN NEW MEXICO 6170 REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
O	ISSUED FOR CONSTRUCTION	05/07	BTC	JAK	KMW
A	ISSUED FOR PERMITTING	12/04	MWH	JTU	AHR

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CROSSING SITE PLAN

URS

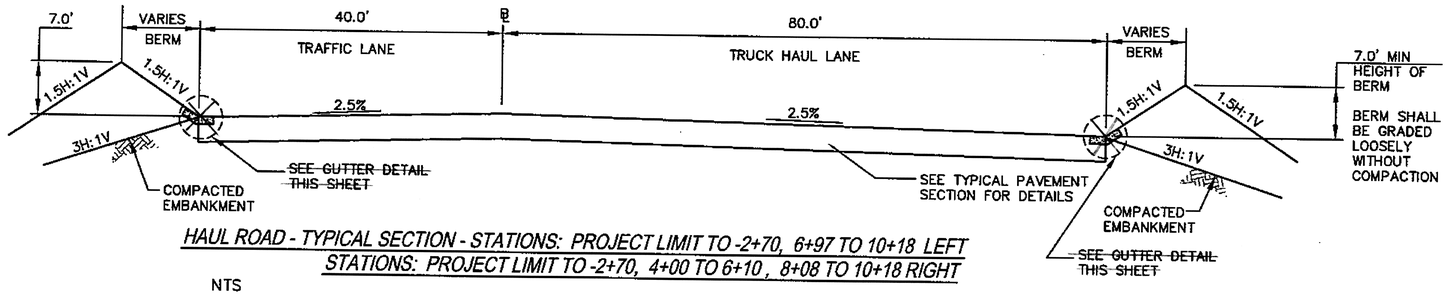
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 2 Of 20 Sheets

SCALE: AS NOTED

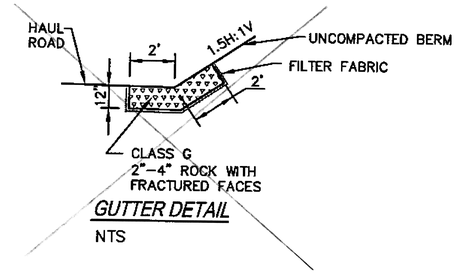
C-2

FILE: C-2 Plan View.dwg PROJECT NUMBER: 24342727



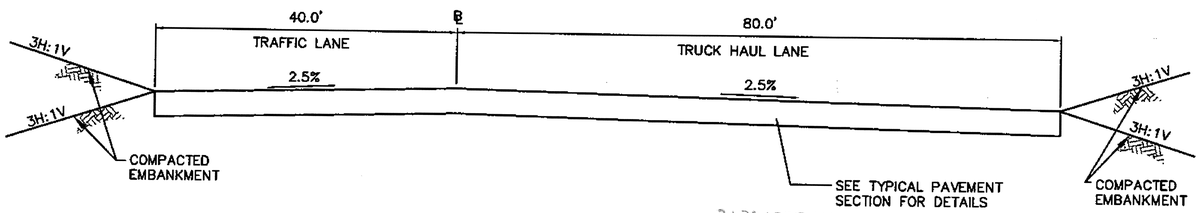
HAUL ROAD - TYPICAL SECTION - STATIONS: PROJECT LIMIT TO -2+70, 6+97 TO 10+18 LEFT
STATIONS: PROJECT LIMIT TO -2+70, 4+00 TO 6+10 , 8+08 TO 10+18 RIGHT

NTS



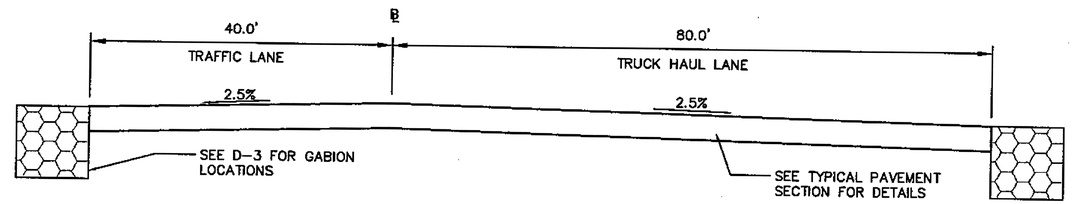
GUTTER DETAIL

NTS



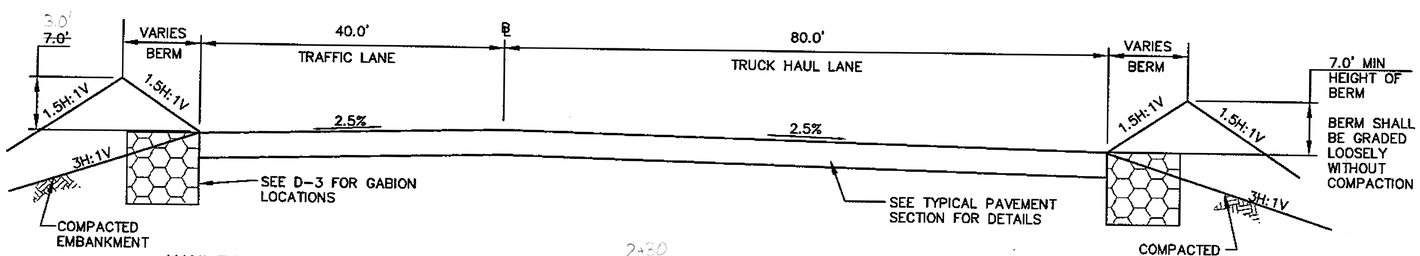
HAUL ROAD - TYPICAL SECTION - STATIONS -2+70 TO ~~0+10 LEFT AND RIGHT~~ 2+30 LEFT AND 2+20 RIGHT

NTS



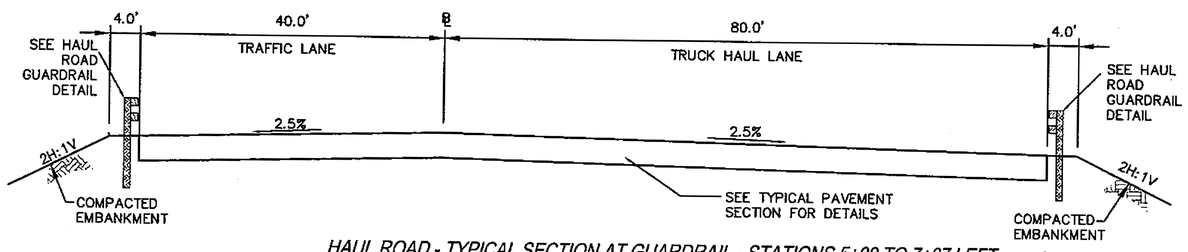
HAUL ROAD - TYPICAL SECTION - ~~STATIONS 0+10 TO 3+50 LEFT~~
STATIONS ~~0+10~~ TO 3+80 RIGHT 2+20

NTS



HAUL ROAD - TYPICAL SECTION AT BERM - STATIONS ~~3+50~~ 2+50 TO 5+00 LEFT, STATIONS 3+80 TO 4+00 RIGHT

NTS



HAUL ROAD - TYPICAL SECTION AT GUARDRAIL - STATIONS 5+00 TO 7+07 LEFT
STATIONS 6+00 TO 8+28 RIGHT

NTS

LEGEND

GABION ARMORING
SEE SHEET D–4

David L. Eberhart 4-27-09
DAVID L. EBERHART NEW MEXICO 14290 PROFESSIONAL ENGINEER
Record Drawing Only

KENT W. WHITMAN NEW MEXICO 6170 REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	MMA	JAK	KMW

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CROSSING TYPICAL ROADWAY SECTIONS

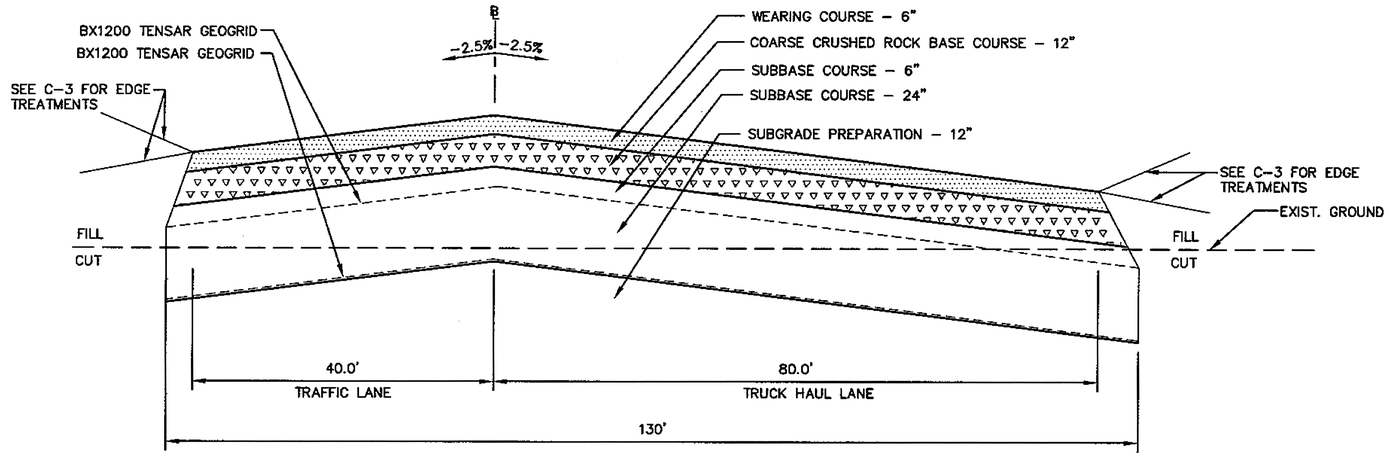
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 3 Of 20 Sheets

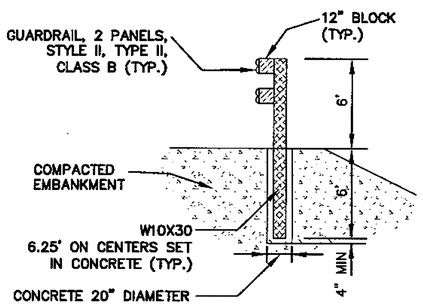
SCALE: AS NOTED

C–3

FILE: C-3 TYP Sections.dwg PROJECT NUMBER: 24342727



HAUL ROAD - TYPICAL PAVEMENT SECTION
NTS



HAUL ROAD GUARDRAIL DETAIL
NTS

David L. Eberhart 4-27-09
DAVID L. EBERHART NEW MEXICO 14290 PROFESSIONAL ENGINEER
Record Drawing Only

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	MMA	JAK	DTL

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

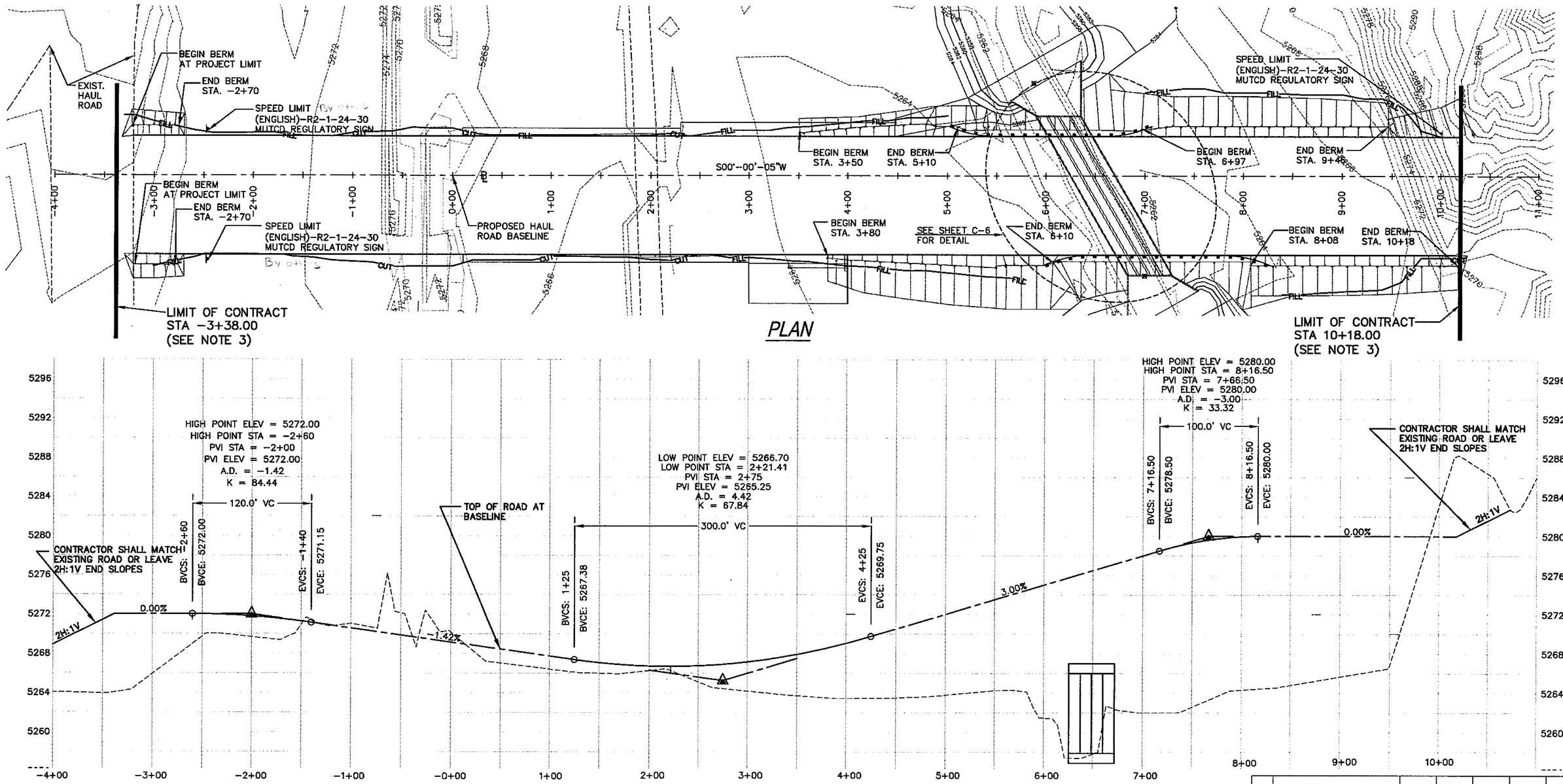
DRAWING TITLE: COTTONWOOD ARROYO CROSSING PAVEMENT SECTIONS

DONALD T. LOPEZ NEW MEXICO 5122 REGISTERED PROFESSIONAL ENGINEER

URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 4 Of 20 Sheets
SCALE: AS NOTED
C-4

FILE: C-4 Misc Pavement Sections.dwg PROJECT NUMBER: 24342727



NOTES:

1. SEE SHT C−2 FOR NOTES.
2. LOW POINT ON HAUL ROAD PROFILE SHALL BE MAINTAINED TO ENSURE HAUL ROAD DOES NOT OVERTOP DURING THE 10 YEAR STORM EVENT.
3. CONTRACTOR SHALL COORDINATE WITH BNCC REGARDING TIE−IN WITH APPROACH ROAD. TIE−IN ELEVATIONS PROVIDED BY BNCC.
4. MAXIMUM TRAFFIC (ANY VEHICLE) SPEED IS 30 MPH.
5. CONTRACTOR SHALL FIELD VERIFY GUARD RAIL POSTS DO NOT CONTACT TOP OF BOX CULVERT.

PROFILE ALONG HAUL ROAD ℄

David L. Eberhart 4-27-09
DAVID L. EBERHART NEW MEXICO 14290 PROFESSIONAL ENGINEER
Record Drawing Only

SCALE
50' 0 50' 100'
CONTOUR INTERVAL 2' FT.

SCALE
0 2.5' 5'
FEET (VERTICAL)

KENT W. WHITMAN NEW MEXICO 6170 REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	EAI	JAK	KMW

BHP Navajo Coal Co.

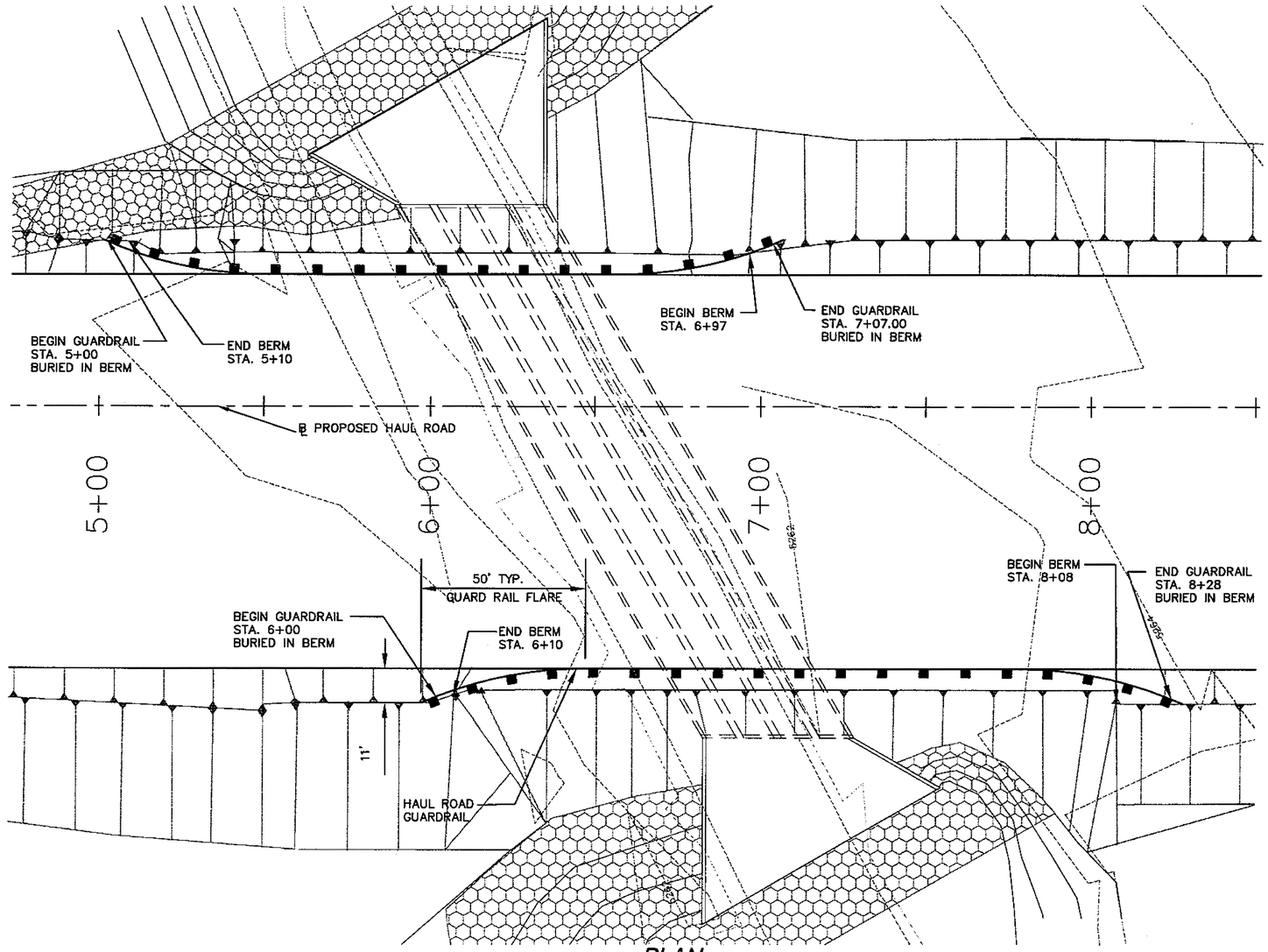
PROJECT: BNCC − AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CROSSING HAUL ROAD PLAN AND PROFILE

URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 5 of 20 Sheets
SCALE: AS NOTED
C−5

FILE: C−5 Haul Road Plan Profile.dwg
PROJECT NUMBER: 24342727



PLAN

David L. Eberhart 4-27-07
DAVID L. EBERHART
NEW MEXICO
14290
PROFESSIONAL ENGINEER
Record Drawing Only

SCALE
20' 0 20' 40'
CONTOUR INTERVAL 2' FT.

KENT W. WHITMAN
NEW MEXICO
6170
REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	EAI	JAK	KMW

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CROSSING GUARDRAIL AT CULVERT DETAIL

URS

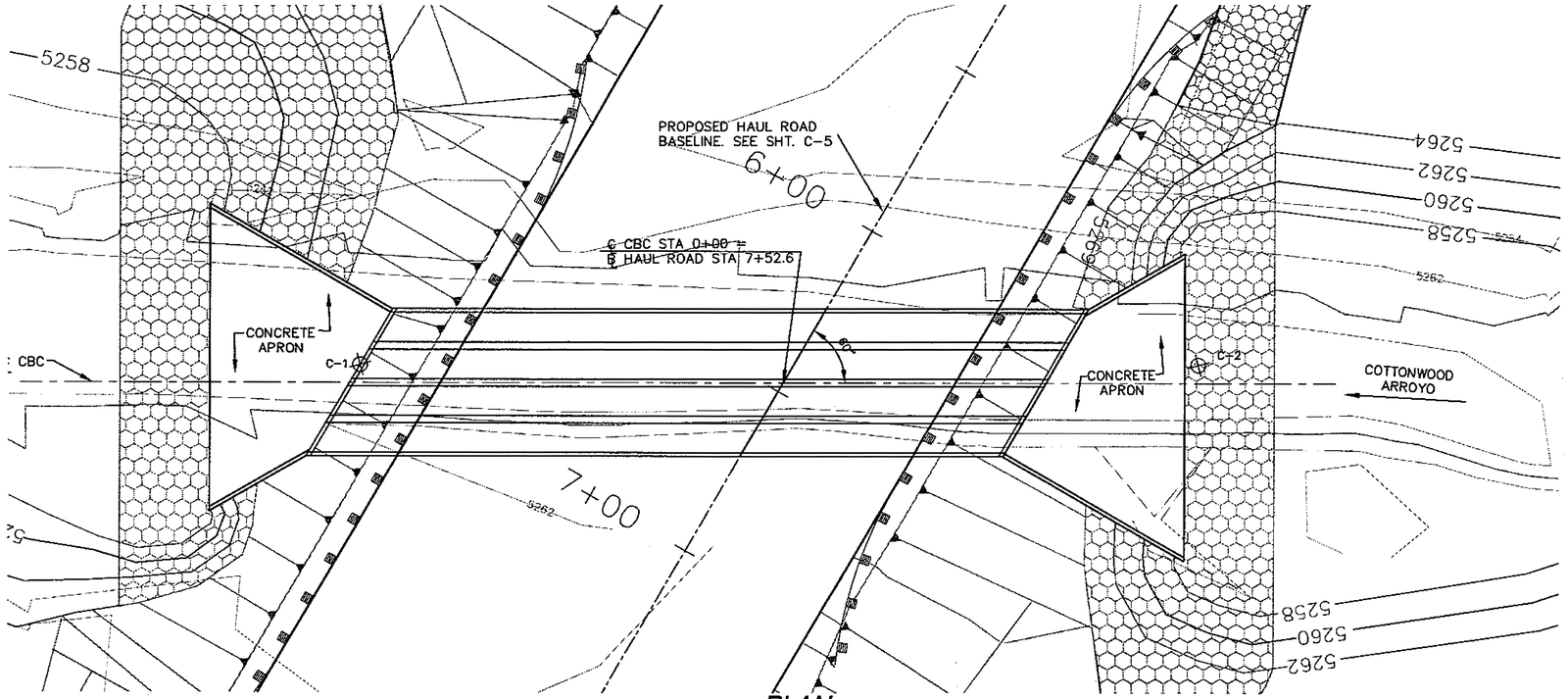
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 6 Of 20 Sheets

SCALE: AS NOTED

C-6

FILE: C-6 Haul road culvert detail.dwg PROJECT NUMBER: 24342727



PLAN

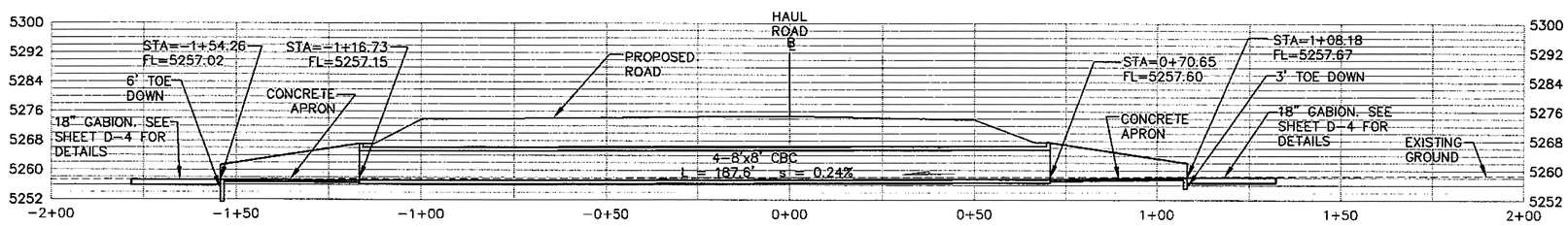
SCALE

20' 0 20' 40'

CONTOUR INTERVAL 2' FT.

LEGEND

- 5250 — EXISTING TOPOGRAPHY- IN FEET
- CONTROL POINT
- FLOW ARROW
- EMBANKMENT FILL SLOPE
- PROPOSED GUARDRAIL
- PROPOSED ROAD CENTERLINE



℄ PROFILE

SCALE

20' 0 20' 40'

FEET

NOTES:

1. EXISTING GROUND TOPOGRAPHY AND CONTOURS WITHIN SITE PLAN LIMITS SHOWN ON THIS DRAWING ARE BASED ON 2004 GROUND SURVEY PROVIDED BY BNCC. TOPOGRAPHY OUTSIDE THESE LIMITS ARE UNKNOWN.
2. COORDINATES AND ELEVATIONS FROM THE 2004 BNCC GROUND SURVEY ARE BASED ON BNCC MINE SURVEY CONTROL AND DATUM. THE CONTRACTOR SHALL CONFIRM ALL COORDINATES AND ELEVATIONS AND ENSURE TIE-IN OF THIS PROJECT WITH THE BNCC SURVEY CONTROL AND DATUM PRIOR TO CONSTRUCTION.
3. THE HYDROLOGIC DATA HAS BEEN FURNISHED BY BNCC, AND/OR THIRD PARTIES, WHICH WAS USED IN DESIGN PREPARATION. URS HAS RELIED ON THIS INFORMATION AS FURNISHED, AND IS NEITHER RESPONSIBLE FOR NOR HAS CONFIRMED THE ACCURACY OF THIS INFORMATION.
4. FOR PROPOSED GRADING AT THE CULVERT INLET AND OUTLET, SEE COTTONWOOD ARROYO CULVERT GRADING PLAN, SHEET D-2.
5. FOR PROPOSED EROSION PROTECTION, SEE EROSION CONTROL DETAILS SHEET D-4.
6. FOR DETAILED DIMENSIONING OF THE CONCRETE APRON, AND WINGWALLS, SEE STRUCTURAL DETAILS ON SHEETS S-1 - S-4.

ABBREVIATIONS

CBC	CONCRETE BOX CULVERT
FL	FLOWLINE ELEVATION
BL	BASELINE
STA	STATION
L	LENGTH
s	SLOPE

HYDROLOGIC & HYDRAULIC DATA
DRAINAGE AREA = 76.99 SQ. MI.
DESIGN FREQUENCY = 10 YEAR, 6 HOUR
DESIGN DISCHARGE = 2186 CFS
DESIGN SURFACE WATER (DSW) ELEV. = 5265.43
DESIGN TAILWATER ELEVATION = 5262.14
OUTLET VELOCITY = 13.01 FT/SEC
ROADWAY OVERTOPPING
HIGH WATER FREQUENCY = 50 YEAR, 6 HOUR
HIGH WATER DISCHARGE = 4040 CFS
HIGH WATER ELEVATION = 5268.37
ROADWAY FLOODING DEPTH @ BL = 1.67 FT

CONTROL POINT LISTING				
POINT NO.	HAUL ROAD		EASTING	NORTHING
	STA.	OFFSET		
C-1	7+00.00	101.09' RT	299,659.04	2,008,136.88
C-2	5+87.13	94.40' LT	299,854.53	2,008,249.75

NOTES: 1. OWNERS SURVEYORS WILL RE-ESTABLISH CONTROL POINTS

2. COORDINATES LISTED ARE A LOCAL SYSTEM BASED ON THIS MONUMENTATION

REV. NO.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	RLR	JAK	KMW

David L. Eberhart 4-27-07
DAVID L. EBERHART NEW MEXICO 14290 PROFESSIONAL ENGINEER
Record Drawing Only

KENT W. WHITMAN NEW MEXICO 6170 REGISTERED PROFESSIONAL ENGINEER

BHP Navajo Coal Co.

PROJECT: BNCC - AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CULVERT PLAN AND PROFILE

URS

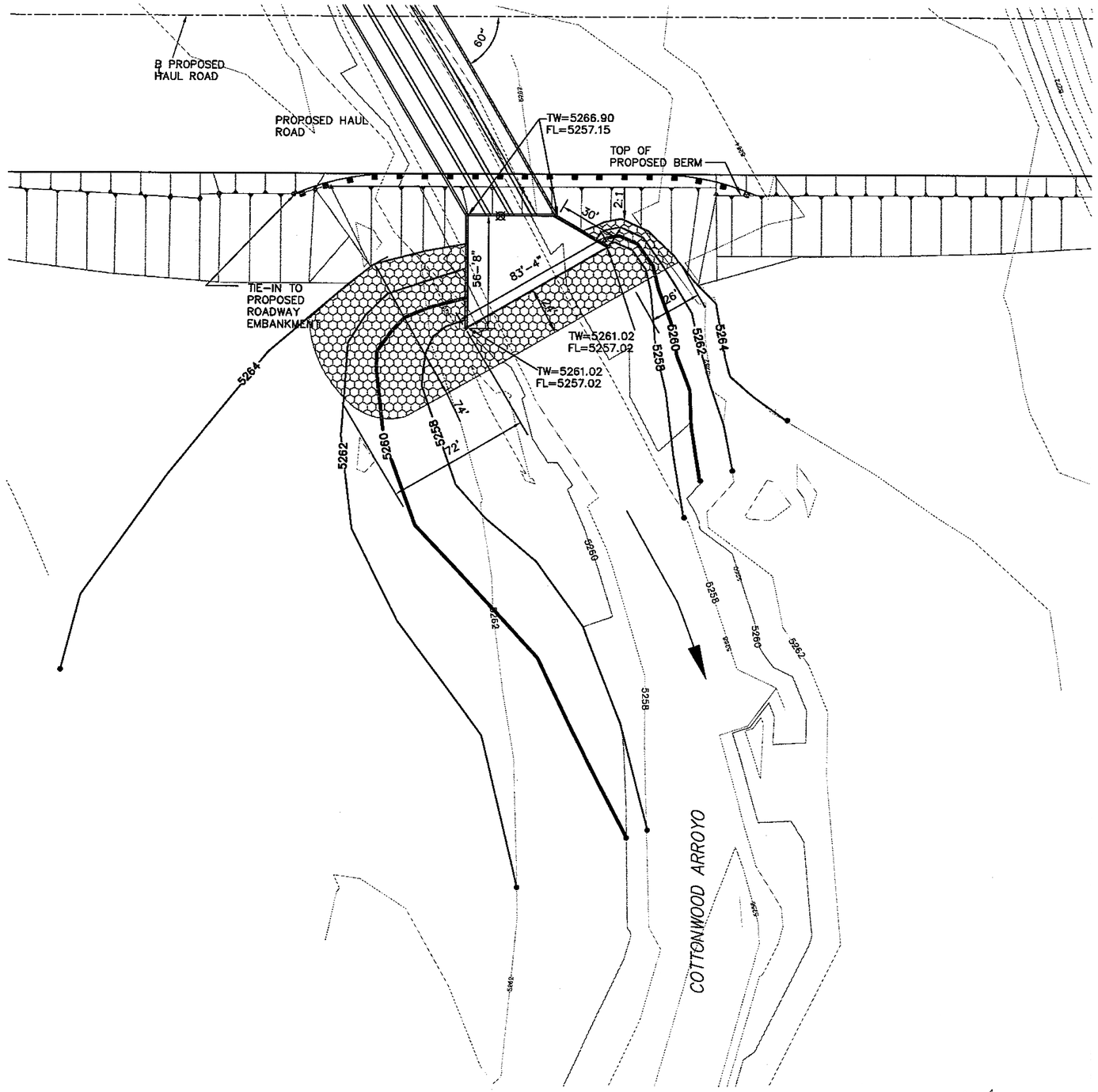
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 13 Of 20 Sheets

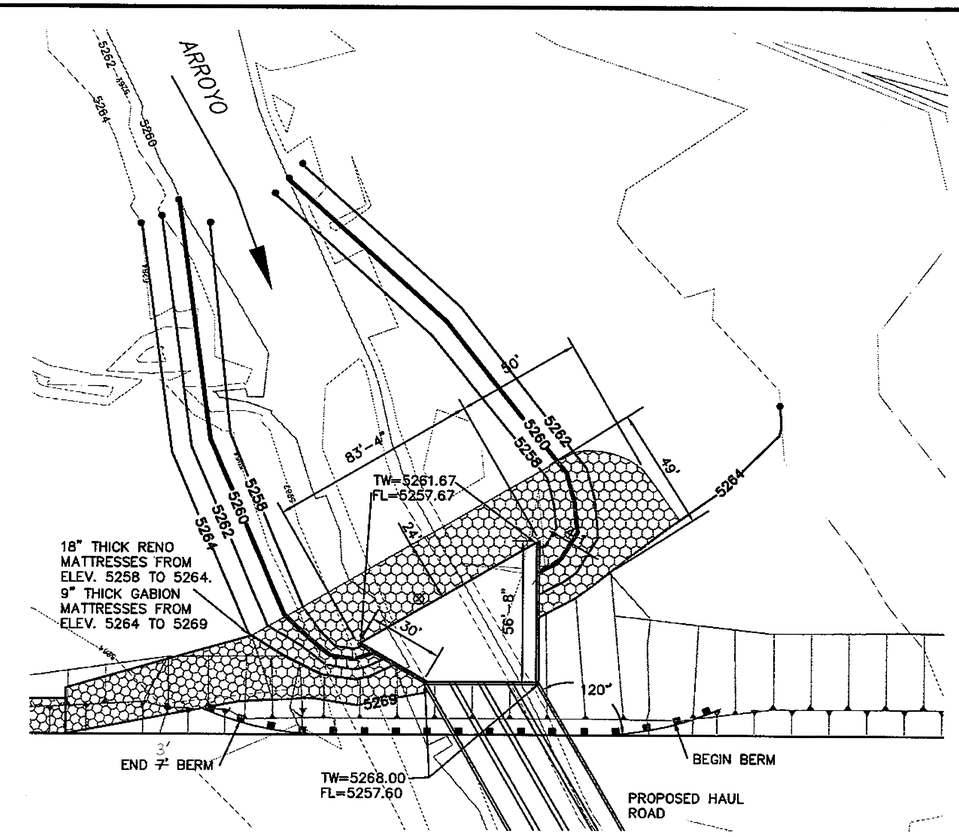
SCALE: AS NOTED

D-1

FILE: D-1 Plan and Prof.dwg PROJECT NUMBER: 24342727



CULVERT OUTLET



CULVERT INLET

ABBREVIATIONS

TW TOP OF WALL
FL FLOWLINE ELEVATION

LEGEND

5258 — EXISTING TOPOGRAPHY - IN FEET
5250 — PROPOSED CONTOUR - IN FEET
GABION ARMORING

BOX CULVERT GRADING PLAN

NOTES:

1. EXISTING GROUND TOPOGRAPHY AND CONTOURS WITHIN SITE PLAN LIMITS SHOWN ON THIS DRAWING ARE BASED ON 2004 GROUND SURVEY PROVIDED BY BNCC. TOPOGRAPHY OUTSIDE THESE LIMITS ARE UNKNOWN.
2. COORDINATES AND ELEVATIONS FROM THE 2004 BNCC GROUND SURVEY ARE BASED ON BNCC MINE SURVEY CONTROL AND DATUM. THE CONTRACTOR SHALL CONFIRM ALL COORDINATES AND ELEVATIONS AND ENSURE TIE-IN OF THIS PROJECT WITH THE BNCC SURVEY CONTROL AND DATUM PRIOR TO CONSTRUCTION.

SCALE
30' 0 30' 60'
CONTOUR INTERVAL 2' FT.

David L. Eberhart 4-27-09
DAVID L. EBERHART NEW MEXICO 14290 PROFESSIONAL ENGINEER
Record Drawing Only

KENT W. WHITMAN NEW MEXICO 6170 REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	RLR	JAK	KMW

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CULVERT GRADING PLAN

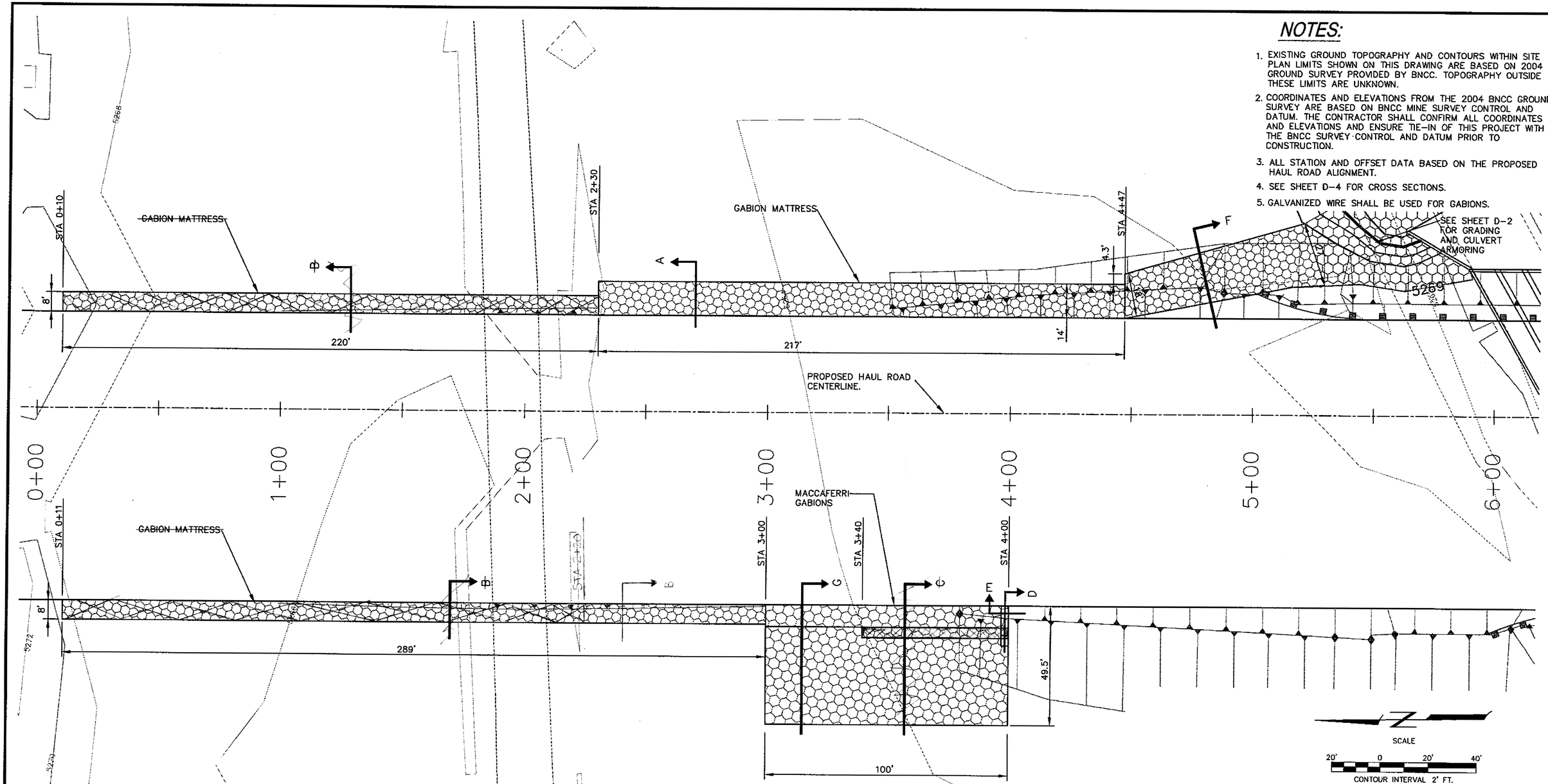
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 14 of 20 Sheets
SCALE: AS NOTED
D-2

FILE: D-2 GRADING.dwg PROJECT NUMBER: 24342727

NOTES:

1. EXISTING GROUND TOPOGRAPHY AND CONTOURS WITHIN SITE PLAN LIMITS SHOWN ON THIS DRAWING ARE BASED ON 2004 GROUND SURVEY PROVIDED BY BNCC. TOPOGRAPHY OUTSIDE THESE LIMITS ARE UNKNOWN.
2. COORDINATES AND ELEVATIONS FROM THE 2004 BNCC GROUND SURVEY ARE BASED ON BNCC MINE SURVEY CONTROL AND DATUM. THE CONTRACTOR SHALL CONFIRM ALL COORDINATES AND ELEVATIONS AND ENSURE TIE-IN OF THIS PROJECT WITH THE BNCC SURVEY CONTROL AND DATUM PRIOR TO CONSTRUCTION.
3. ALL STATION AND OFFSET DATA BASED ON THE PROPOSED HAUL ROAD ALIGNMENT.
4. SEE SHEET D-4 FOR CROSS SECTIONS.
5. GALVANIZED WIRE SHALL BE USED FOR GABIONS.



REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
D	ISSUED FOR CONSTRUCTION	05/07	SJ	JK	DTL

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO GABION ARMORING DETAIL

HAUL ROAD SOUTH APPROACH

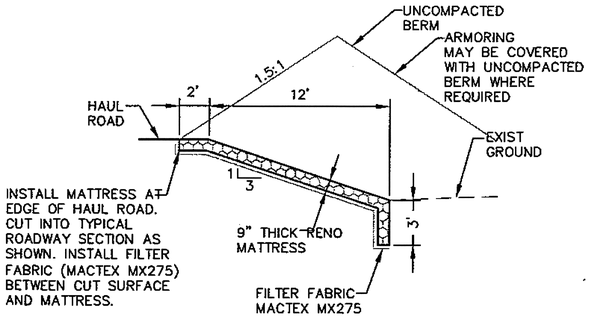
David L. Eberhart 4-27-09
DAVID L. EBERHART NEW MEXICO 14290 PROFESSIONAL ENGINEER
Record Drawing Only

DONALD T. LOPEZ NEW MEXICO 5122 REGISTERED PROFESSIONAL ENGINEER

URS CORPORATION
5501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

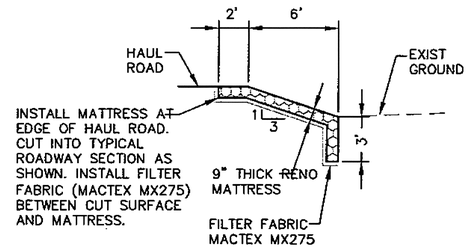
Sheet 15 of 20 Sheets
SCALE: AS NOTED
D-3

FILE: D-3 GABION detail sheet.dwg PROJECT NUMBER: 24342727



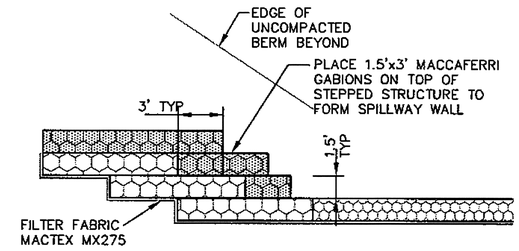
ARMORING SECTION A
STA 2+30 TO ~~4+47~~ 3+00

SCALE:
HZ 1" = 5'
VT 1" = 5'

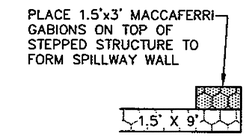


ARMORING SECTION B
~~STA. 0+10 TO 2+30 EAST~~
STA ~~0+11~~ TO 3+00 WEST

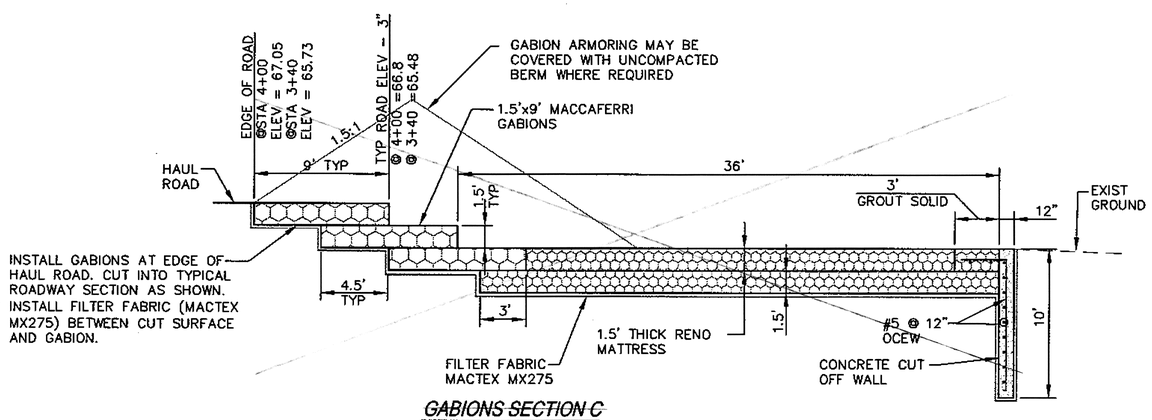
SCALE: 2+20
HZ 1" = 5'
VT 1" = 5'



GABIONS SECTION D
SCALE:
HZ 1" = 5'
VT 1" = 5'

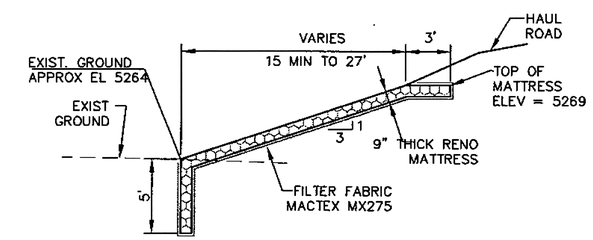


GABIONS SECTION E
SCALE:
HZ 1" = 5'
VT 1" = 5'



~~GABIONS SECTION C~~
~~STA 3+40 TO 4+00~~

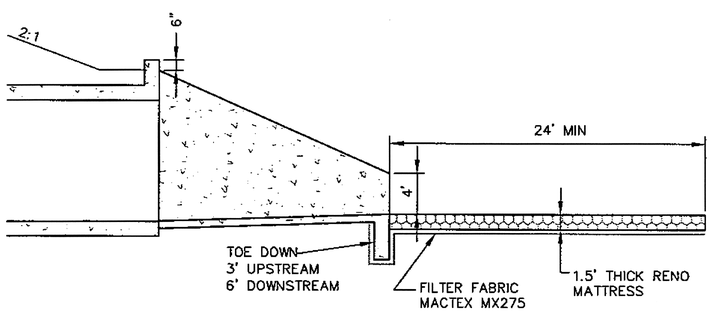
SCALE:
HZ 1" = 5'
VT 1" = 5'



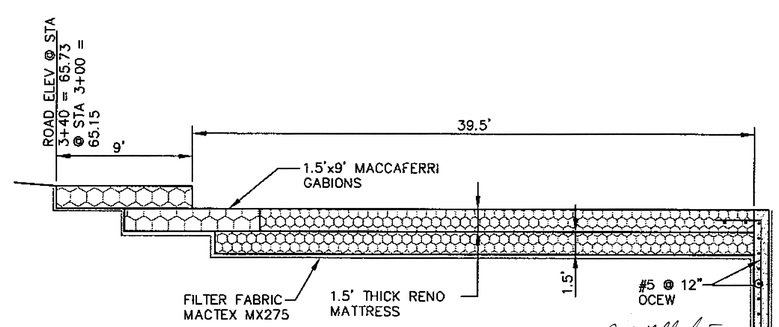
GABIONS SECTION F
STA 4+47 TO 5+62

SCALE:
HZ 1" = 5'
VT 1" = 5'

NOTES:
1. GALVANIZED WIRE SHALL BE USED FOR GABIONS.



BOX CULVERTS WITH APRONS SECTION
NTS



ARMORING SECTION G
STA 3+00 TO ~~3+40~~ 4+00

SCALE:
HZ 1" = 5'
VT 1" = 5'

David L. Eberhart 4-27-09
DAVID L. EBERHART NEW MEXICO 14290 PROFESSIONAL ENGINEER
Record Drawing Only

DONALD T. LOPEZ NEW MEXICO 5122 REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	SJ	JK	DTL

BHP Navajo Coal Co.

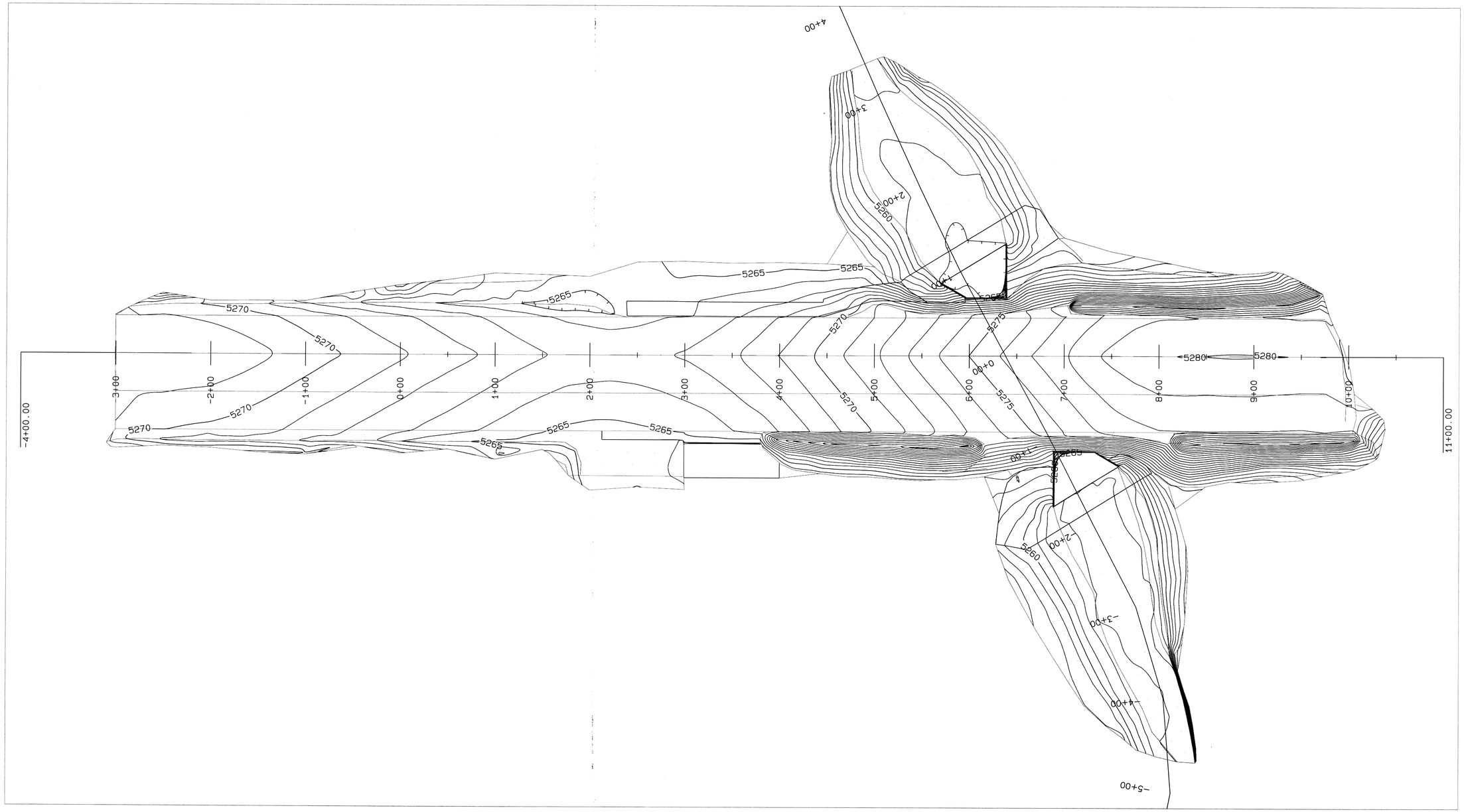
PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO GABION AND EROSION CONTROL DETAILS

URS CORPORATION
5501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 16 of 20 Sheets
SCALE: AS NOTED
D-4

FILE: D-4 EROSION AND GABION DETAILS.dwg DRAWING NUMBER: 24342727



David L. Eberhart 4-27-09

DAVID L. EBERHART
NEW MEXICO
14290
PROFESSIONAL ENGINEER

Record Drawing Only

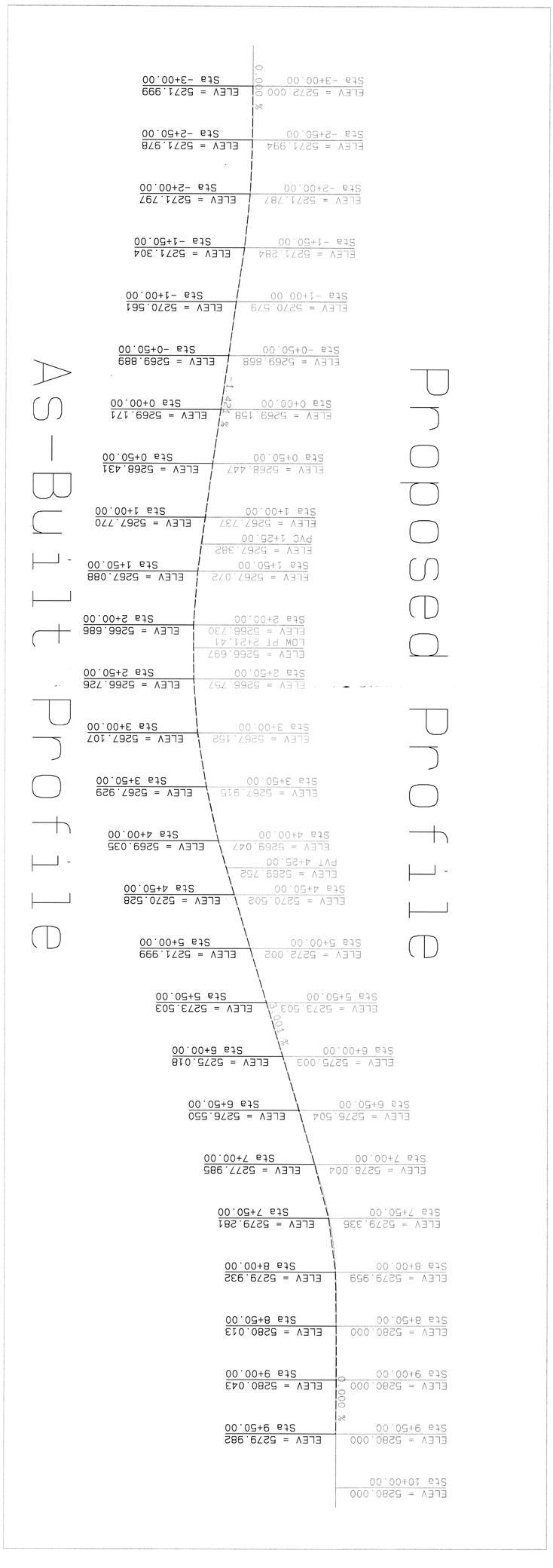
Ames Construction, Inc.

3410 E. University Dr., Suite #380, Phoenix, AZ 85034

Plan View
Scale 1:50

COTTONWOOD ARROYO CROSSING
As-Built Drawings

Project Desc:: Path: C:\Users\Mike Petko\Desktop\Documents\Job BHP - Cottonwood Crossing - NM\Job BHP - Cottonwood Crossing.pro Plot Date/Time: Thu Apr 23,2009 / 14:10:23



Record Drawing Only

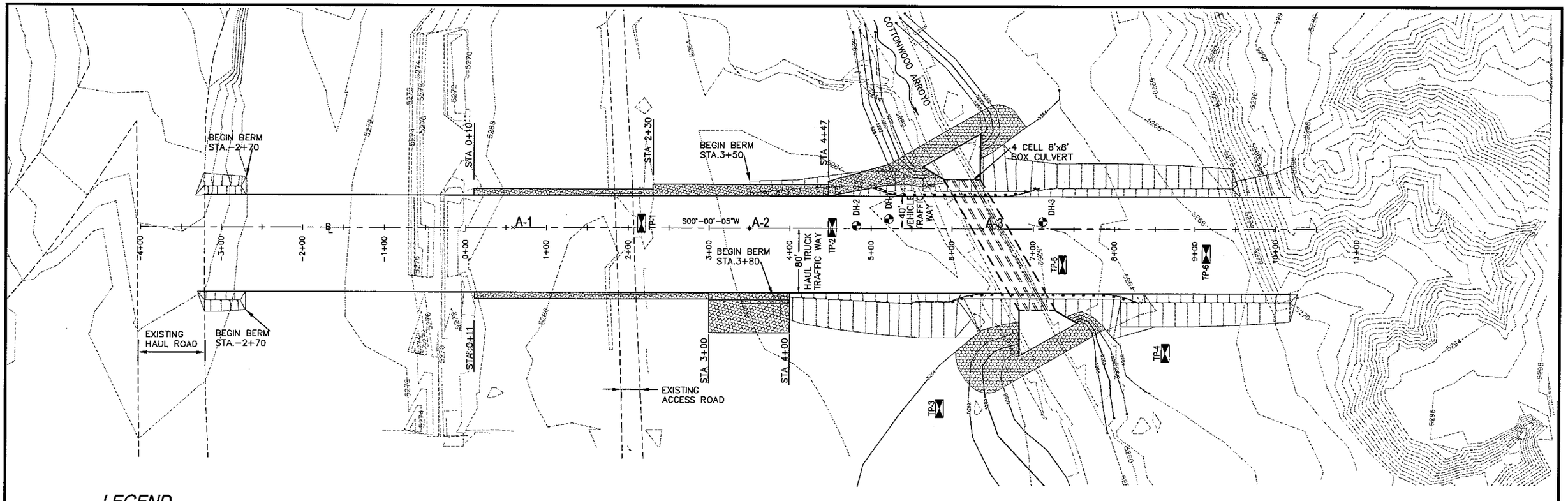
DAVID L. EGGERT
NEW MEXICO
14290
PROFESSIONAL ENGINEER

4-27-09

COTTONWOOD ARROYO CROSSING
As-Built Drawings

Proposed and As-Built Prof
Scale 1:50

Ames Construction, Inc.
3410 E. University Dr., Suite #380, Phoenix, AZ 85034



LEGEND

5256	EXISTING TOPOGRAPHY– IN FEET
TP-2	TEST PIT LOCATION
DH-1	DRILL HOLE LOCATION
℄	BASELINE
	GABION ARMORING
	BERM

CONTROL POINT LISTING			
POINT NO.	EASTING	NORTHING	ELEVATION
CENTERLINE STATIONS AT FINAL GRADE			
A–1 (STA 0+58.50)	299,760.000	2,008,778.500	5,273.000
A–2 (STA 3+50.00)	299,760.000	2,008,487.000	5,266.000
A–3 (STA 6+41.50)	299,760.000	2,008,195.500	5,273.000

NOTES: 1. OWNERS SURVEYORS WILL RE–ESTABLISH CONTROL POINTS

2. COORDINATES LISTED ARE A LOCAL SYSTEM BASED ON THIS MONUMENTATION

NOTES:

GENERAL

1. EXISTING GROUND TOPOGRAPHY AND CONTOURS WITHIN SITE PLAN LIMITS SHOWN ON THIS DRAWING ARE BASED ON 2004 GROUND SURVEY PROVIDED BY BNCC. TOPOGRAPHY OUTSIDE THESE LIMITS ARE UNKNOWN.

2. COORDINATES AND ELEVATIONS FROM THE 2004 BNCC GROUND SURVEY ARE BASED ON BNCC MINE SURVEY CONTROL AND DATUM. THE CONTRACTOR SHALL CONFIRM ALL COORDINATES AND ELEVATIONS AND ENSURE TIE–IN OF THIS PROJECT WITH THE BNCC SURVEY CONTROL AND DATUM PRIOR TO CONSTRUCTION.

3. EXISTING GROUND TOPOGRAPHY AND CONTOURS USED TO DEVELOP THE DESIGN OF THE ROADWAY TIE–IN AT STA –3+38 HAVE BEEN BASED ON EXTRAPOLATED AERIAL TOPOGRAPHY INFORMATION PROVIDED BY BNCC. THE CONTRACTOR SHALL CONFIRM THE EXISTING GROUND CONTOURS AT THIS LOCATION PRIOR TO CONSTRUCTION. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE PROJECT MANAGER FOR RESOLUTION.

CONSTRUCTION

1. NEW MEXICO DEPARTMENT OF TRANSPORTATION 2005 INTERIM SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION SHALL APPLY.

GEOTECHNICAL DATA

1. FOR BORELOG AND TEST PIT GEOTECHNICAL INFORMATION REFER TO THE DESIGN REPORT.

ESTIMATED QUANTITIES

ITEM NO.	DESCRIPTION OF ITEM	UNIT	ESTIMATE
203000	CUT AND FILL WITHIN PROJECT BOUNDARIES	CU. YD.	57516
203100	CUT AND FILL FROM STOCK PILE	CU. YD.	14948
207000	SUB–GRADE PREPARATION	CU. YD.	13058
304000	SUB–BASE	CU. YD.	16323
304100	BASE COURSE	CU. YD.	6529
400000	WEARING COURSE	CU. YD.	3014
511200	STRUCTURAL REINFORCED CONCRETE, CLASS AA	CU. YD.	204
517000	PRECAST CONCRETE BOX CULVERT	LIN. FT.	1582
602000	GABIONS	CU. YD.	860
602000A	GABION MATTRESSES (CULVERT)	CU. YD.	820
606100	DOUBLE METAL BARRIER W–BEAM	LIN. FT.	368
668100	GEOGRID BX 1200	SQ. FT.	352560

SCALE

60' 0 60' 120'

CONTOUR INTERVAL 2' FT.

KENT W. WHITMAN
NEW MEXICO
6170
REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	BTC	JAK	KMW
A	ISSUED FOR PERMITTING	12/04	MWH	JTU	AHR

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CROSSING SITE PLAN

URS

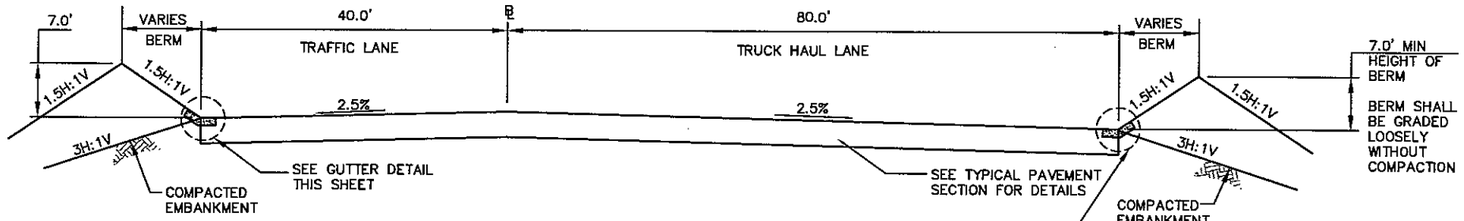
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 2 of 20 Sheets

SCALE: AS NOTED

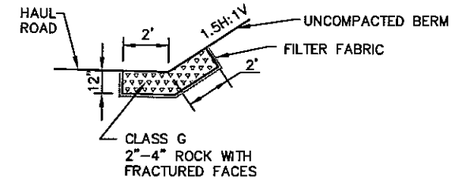
C–2

FILE: C-2 Plan View.dwg PROJECT NUMBER: 24342727



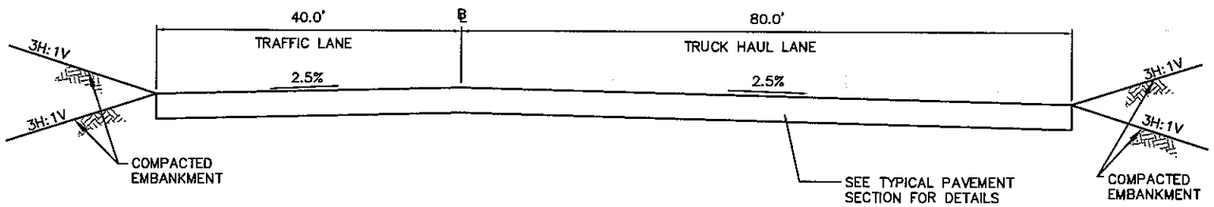
HAUL ROAD - TYPICAL SECTION - STATIONS: PROJECT LIMIT TO -2+70, 6+97 TO 10+18 LEFT
STATIONS: PROJECT LIMIT TO -2+70, 4+00 TO 6+10, 8+08 TO 10+18 RIGHT

NTS



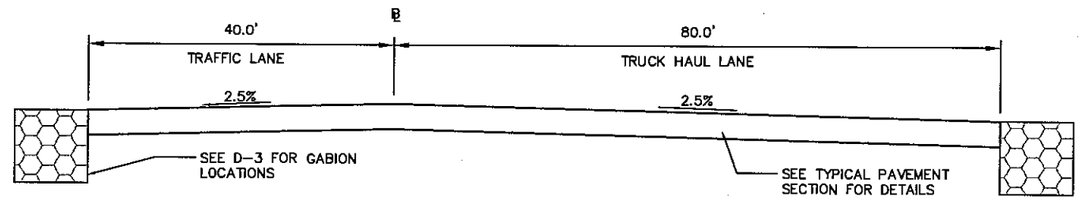
GUTTER DETAIL

NTS



HAUL ROAD - TYPICAL SECTION - STATIONS -2+70 TO 0+10 LEFT AND RIGHT

NTS

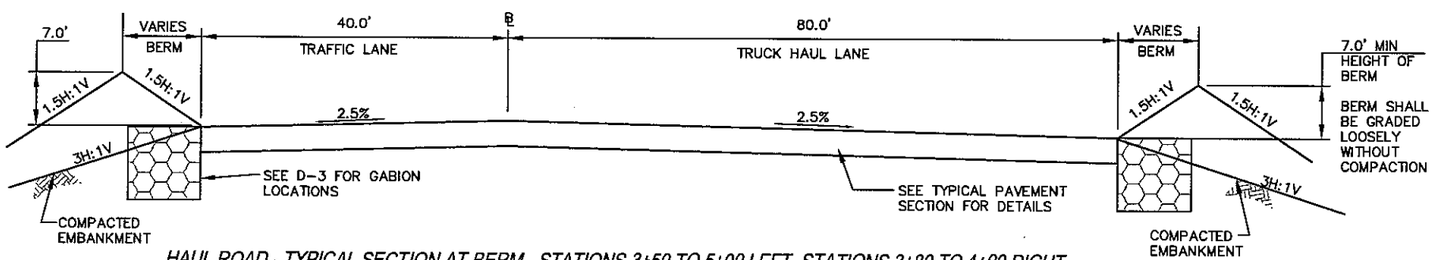


HAUL ROAD - TYPICAL SECTION - STATIONS 0+10 TO 3+50 LEFT
STATIONS 0+10 TO 3+80 RIGHT

NTS

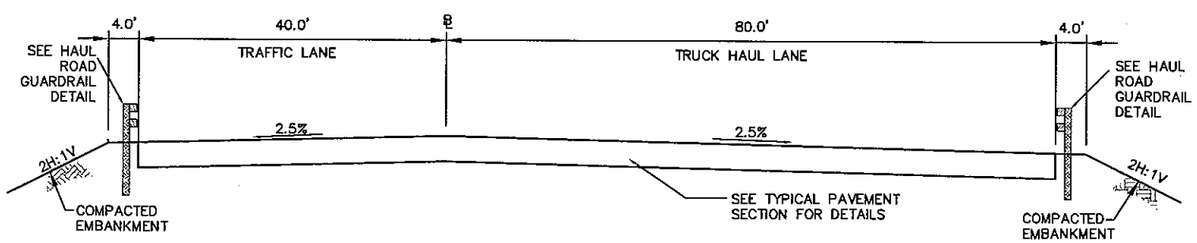
LEGEND

GABION ARMORING
SEE SHEET D–4



HAUL ROAD - TYPICAL SECTION AT BERM - STATIONS 3+50 TO 5+00 LEFT, STATIONS 3+80 TO 4+00 RIGHT

NTS



HAUL ROAD - TYPICAL SECTION AT GUARDRAIL - STATIONS 5+00 TO 7+07 LEFT
STATIONS 6+00 TO 8+28 RIGHT

NTS

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	MMA	JAK	KMW

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CROSSING TYPICAL ROADWAY SECTIONS

KENT W. WHITMAN NEW MEXICO 6170 REGISTERED PROFESSIONAL ENGINEER

URS

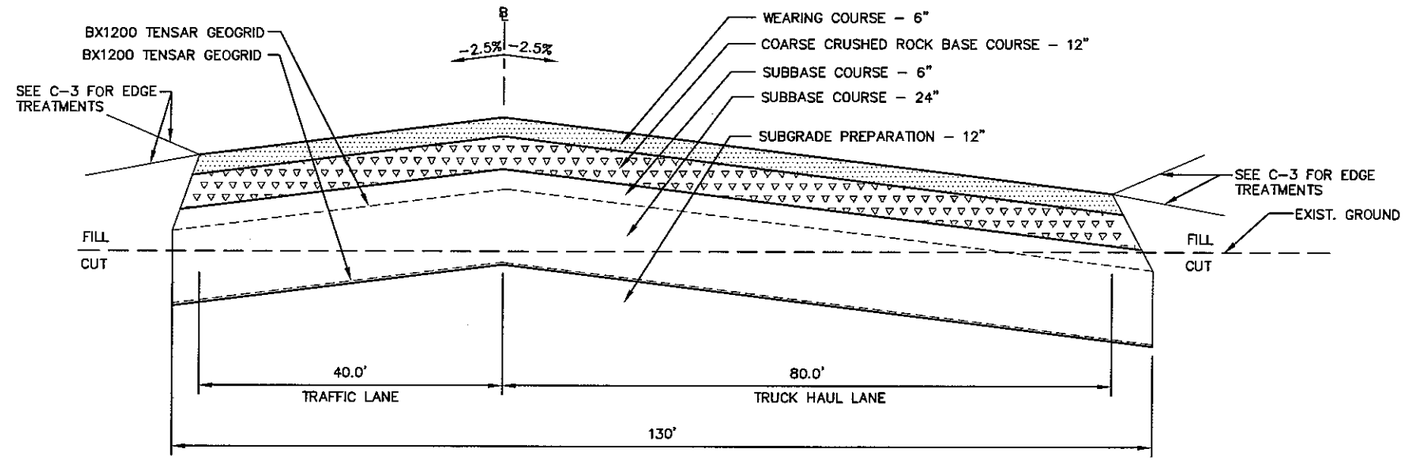
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 3 Of 20 Sheets

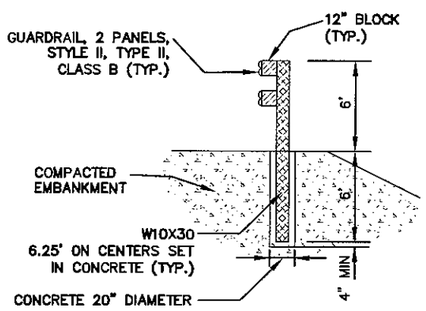
SCALE: AS NOTED

C–3

FILE: C-3 TYP Sections.dwg PROJECT NUMBER: 24342727



HAUL ROAD - TYPICAL PAVEMENT SECTION
NTS



HAUL ROAD GUARDRAIL DETAIL
NTS

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	MMA	JAK	DTL

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CROSSING PAVEMENT SECTIONS

DONALD T. LOPEZ NEW MEXICO 5122 REGISTERED PROFESSIONAL ENGINEER

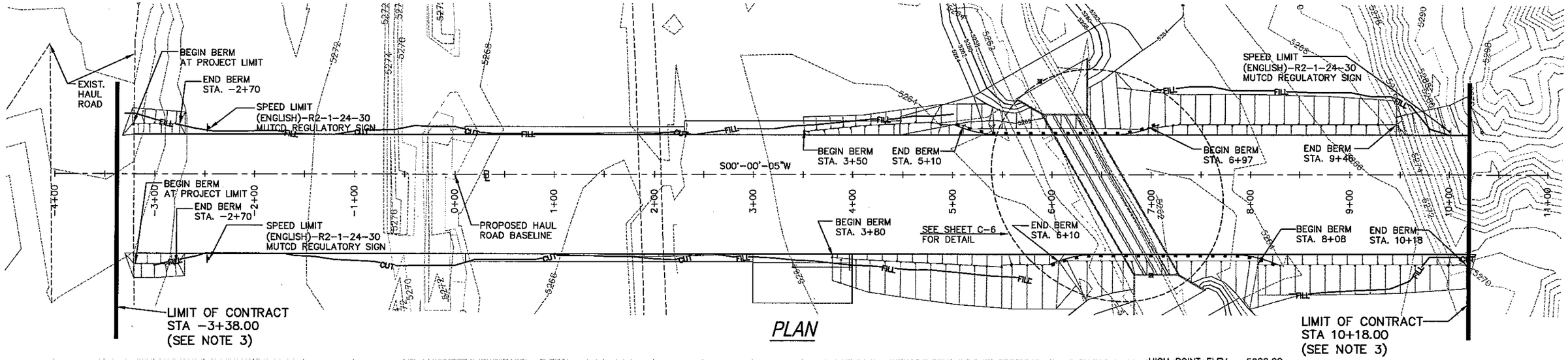
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 4 Of 20 Sheets

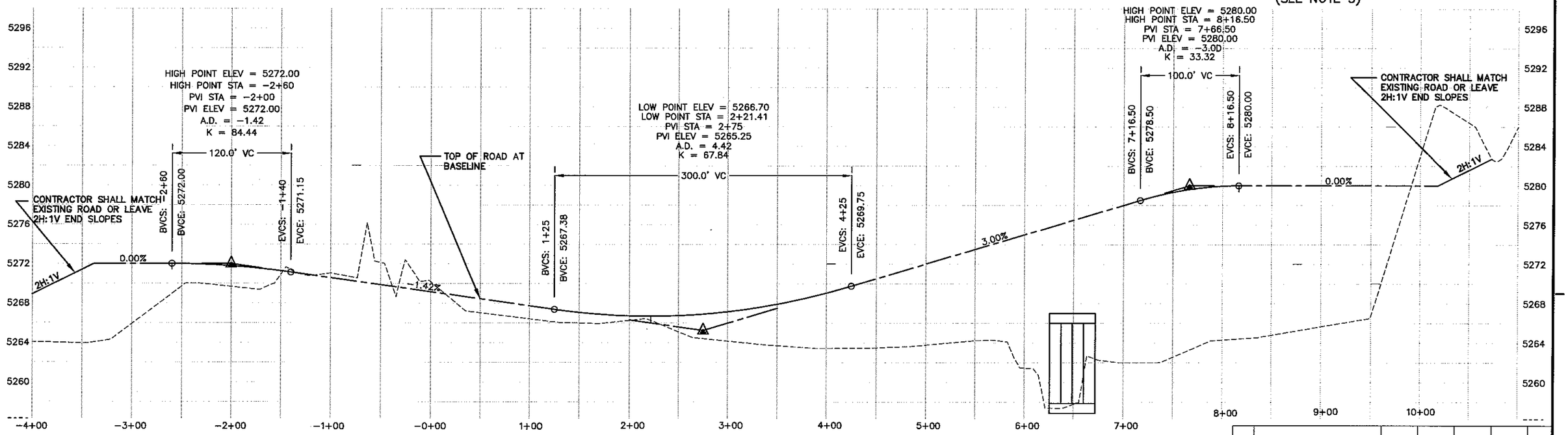
SCALE: AS NOTED

C-4

FILE: C-4 Misc Pavement Sections.dwg PROJECT NUMBER: 24342727



PLAN



PROFILE ALONG HAUL ROAD ℄

NOTES:

1. SEE SHT C−2 FOR NOTES.
2. LOW POINT ON HAUL ROAD PROFILE SHALL BE MAINTAINED TO ENSURE HAUL ROAD DOES NOT OVERTOP DURING THE 10 YEAR STORM EVENT.
3. CONTRACTOR SHALL COORDINATE WITH BNCC REGARDING TIE−IN WITH APPROACH ROAD. TIE−IN ELEVATIONS PROVIDED BY BNCC.
4. MAXIMUM TRAFFIC (ANY VEHICLE) SPEED IS 30 MPH.
5. CONTRACTOR SHALL FIELD VERIFY GUARD RAIL POSTS DO NOT CONTACT TOP OF BOX CULVERT.

SCALE
50' 0 50' 100'
CONTOUR INTERVAL 2' FT.

SCALE
0 2.5' 5'
FEET (VERTICAL)

KENT W. WHITMAN
NEW MEXICO
6170
REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	EAI	JAK	KMW

BHP Navajo Coal Co.

PROJECT: BNCC — AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CROSSING HAUL ROAD PLAN AND PROFILE

URS

URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

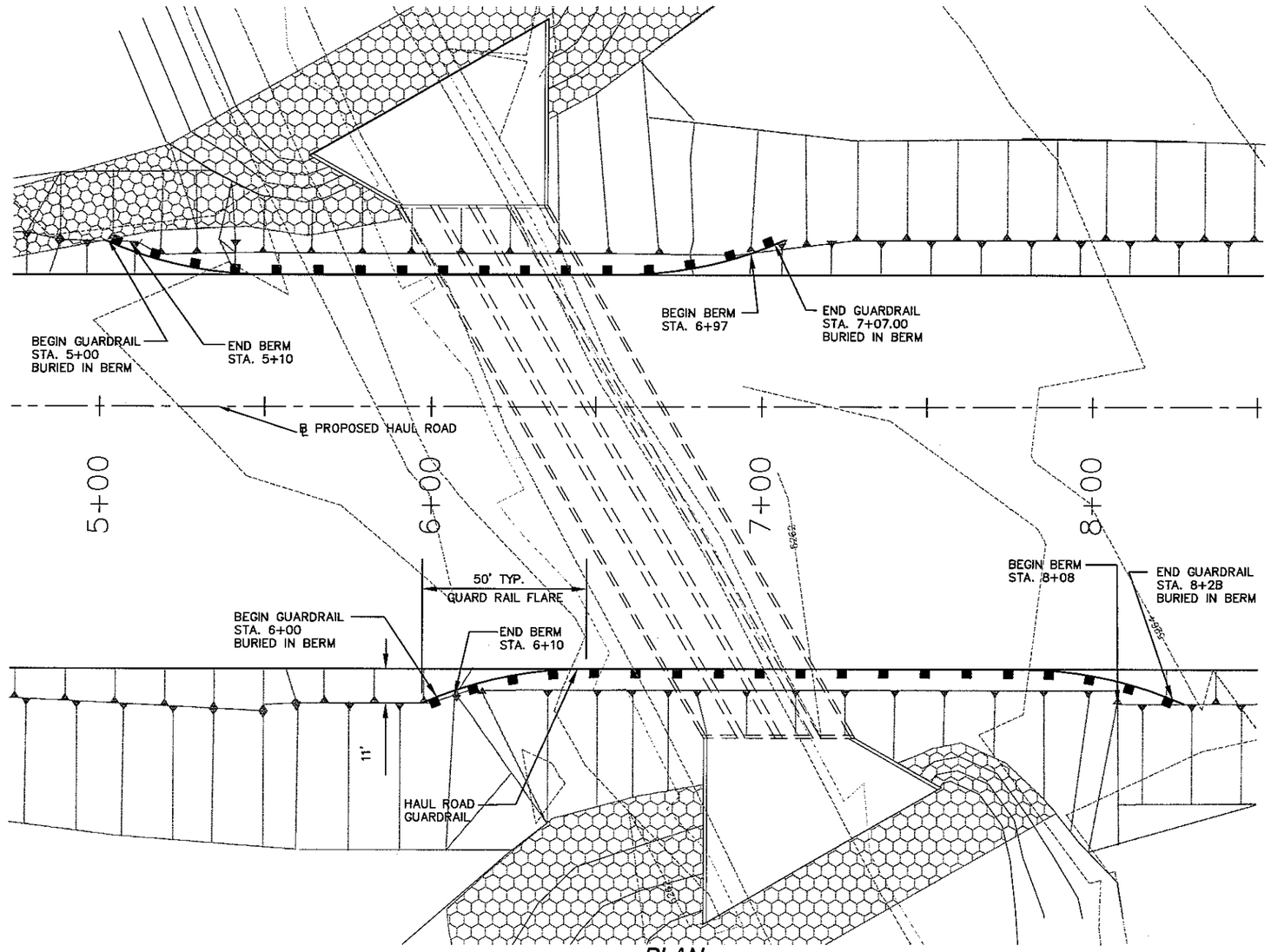
Sheet 5 Of 20 Sheets

SCALE: AS NOTED

C−5

FILE: C−5 Haul Road Plan Profile.dwg

PROJECT NUMBER: 24342727



PLAN

SCALE

20' 0 20' 40'

CONTOUR INTERVAL 2' FT.

KENT W. WHITMAN
NEW MEXICO
6170
REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	EAI	JAK	KMW

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE:
COTTONWOOD ARROYO CROSSING
GUARDRAIL AT CULVERT DETAIL

URS

URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

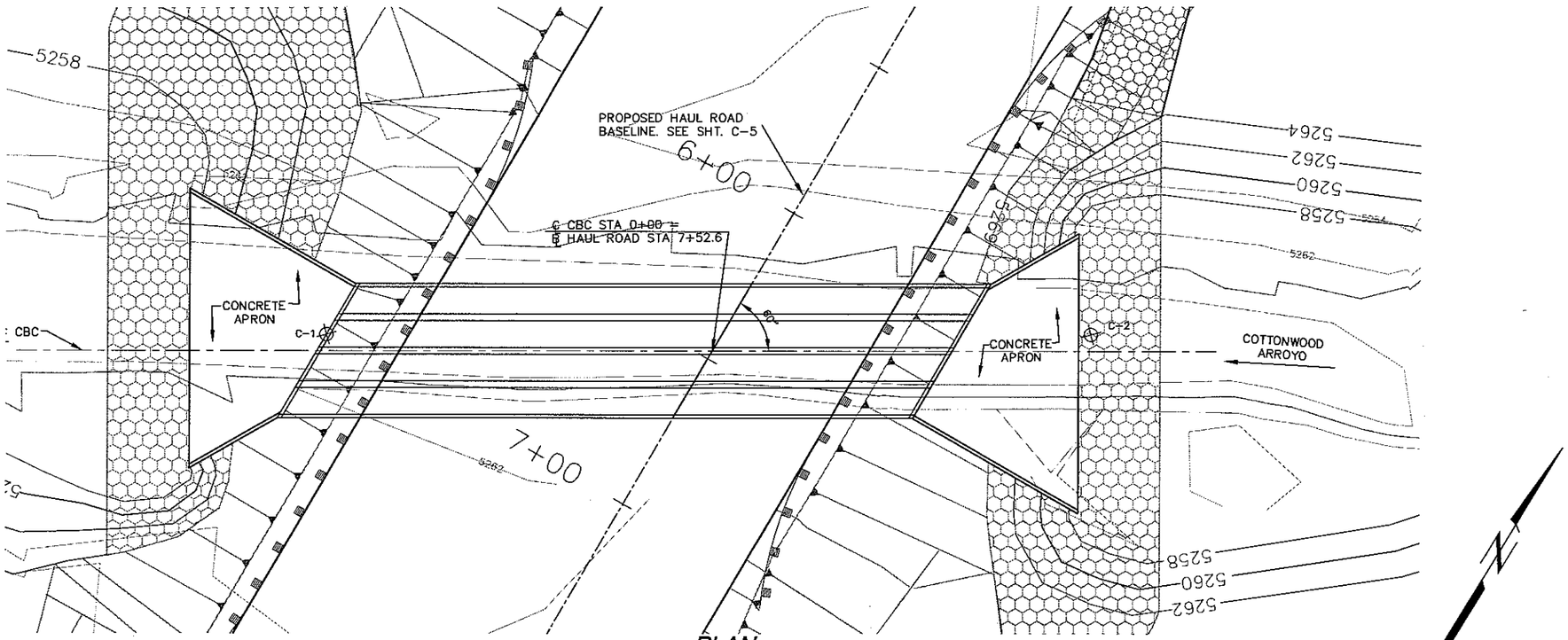
Sheet 6 Of 20 Sheets

SCALE: AS NOTED

C-6

FILE: C-6 Haul road culvert detail.dwg

PROJECT NUMBER: 24342727



PLAN

SCALE

20' 0 20' 40'

CONTOUR INTERVAL 2' FT.

LEGEND

5250	EXISTING TOPOGRAPHY- IN FEET
	CONTROL POINT
	FLOW ARROW
	EMBANKMENT FILL SLOPE
	PROPOSED GUARDRAIL
	PROPOSED ROAD CENTERLINE

NOTES:

1. EXISTING GROUND TOPOGRAPHY AND CONTOURS WITHIN SITE PLAN LIMITS SHOWN ON THIS DRAWING ARE BASED ON 2004 GROUND SURVEY PROVIDED BY BNCC. TOPOGRAPHY OUTSIDE THESE LIMITS ARE UNKNOWN.
2. COORDINATES AND ELEVATIONS FROM THE 20D4 BNCC GROUND SURVEY ARE BASED ON BNCC MINE SURVEY CONTROL AND DATUM. THE CONTRACTOR SHALL CONFIRM ALL COORDINATES AND ELEVATIONS AND ENSURE TIE-IN OF THIS PROJECT WITH THE BNCC SURVEY CONTROL AND DATUM PRIOR TO CONSTRUCTION.
3. THE HYDROLOGIC DATA HAS BEEN FURNISHED BY BNCC, AND/OR THIRD PARTIES, WHICH WAS USED IN DESIGN PREPARATION. URS HAS RELIED ON THIS INFORMATION AS FURNISHED, AND IS NEITHER RESPONSIBLE FOR NOR HAS CONFIRMED THE ACCURACY OF THIS INFORMATION.
4. FOR PROPOSED GRADING AT THE CULVERT INLET AND OUTLET, SEE COTTONWOOD ARROYO CULVERT GRADING PLAN, SHEET D-2.
5. FOR PROPOSED EROSION PROTECTION, SEE EROSION CONTROL DETAILS SHEET D-4.
6. FOR DETAILED DIMENSIONING OF THE CONCRETE APRON, AND WINGWALLS, SEE STRUCTURAL DETAILS ON SHEETS S-1 – S-4.

ABBREVIATIONS

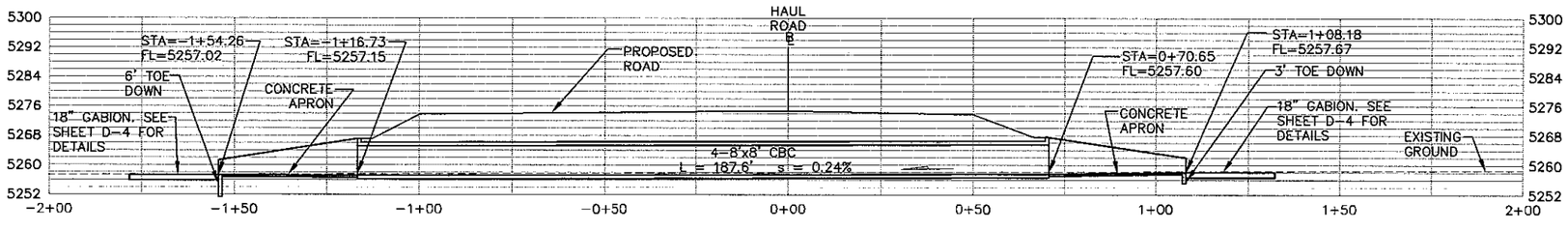
CBC	CONCRETE BOX CULVERT
FL	FLOWLINE ELEVATION
BL	BASELINE
STA	STATION
L	LENGTH
s	SLOPE

HYDROLOGIC & HYDRAULIC DATA
DRAINAGE AREA = 76.99 SQ. MI.
DESIGN FREQUENCY = 10 YEAR, 6 HOUR
DESIGN DISCHARGE = 2186 CFS
DESIGN SURFACE WATER (DSW) ELEV. = 5265.43
DESIGN TAILWATER ELEVATION = 5262.14
OUTLET VELOCITY = 13.01 FT/SEC
ROADWAY OVERTOPPING
HIGH WATER FREQUENCY = 50 YEAR, 6 HOUR
HIGH WATER DISCHARGE = 4040 CFS
HIGH WATER ELEVATION = 5268.37
ROADWAY FLOODING DEPTH @ BL = 1.67 FT

CONTROL POINT LISTING				
POINT NO.	HAUL ROAD		EASTING	NORTHING
	STA.	OFFSET		
C-1	7+00.00	101.09' RT	299,659.04	2,008,136.88
C-2	5+87.13	94.40' LT	299,854.53	2,008,249.75

NOTES: 1. OWNERS SURVEYDRS WILL RE-ESTABLISH CONTROL POINTS

2. COORDINATES LISTED ARE A LOCAL SYSTEM BASED ON THIS MONUMENTATION



℄ PROFILE

SCALE

20' 0 20' 40'

FEET

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	RLR	JAK	KMW

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CULVERT PLAN AND PROFILE

URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

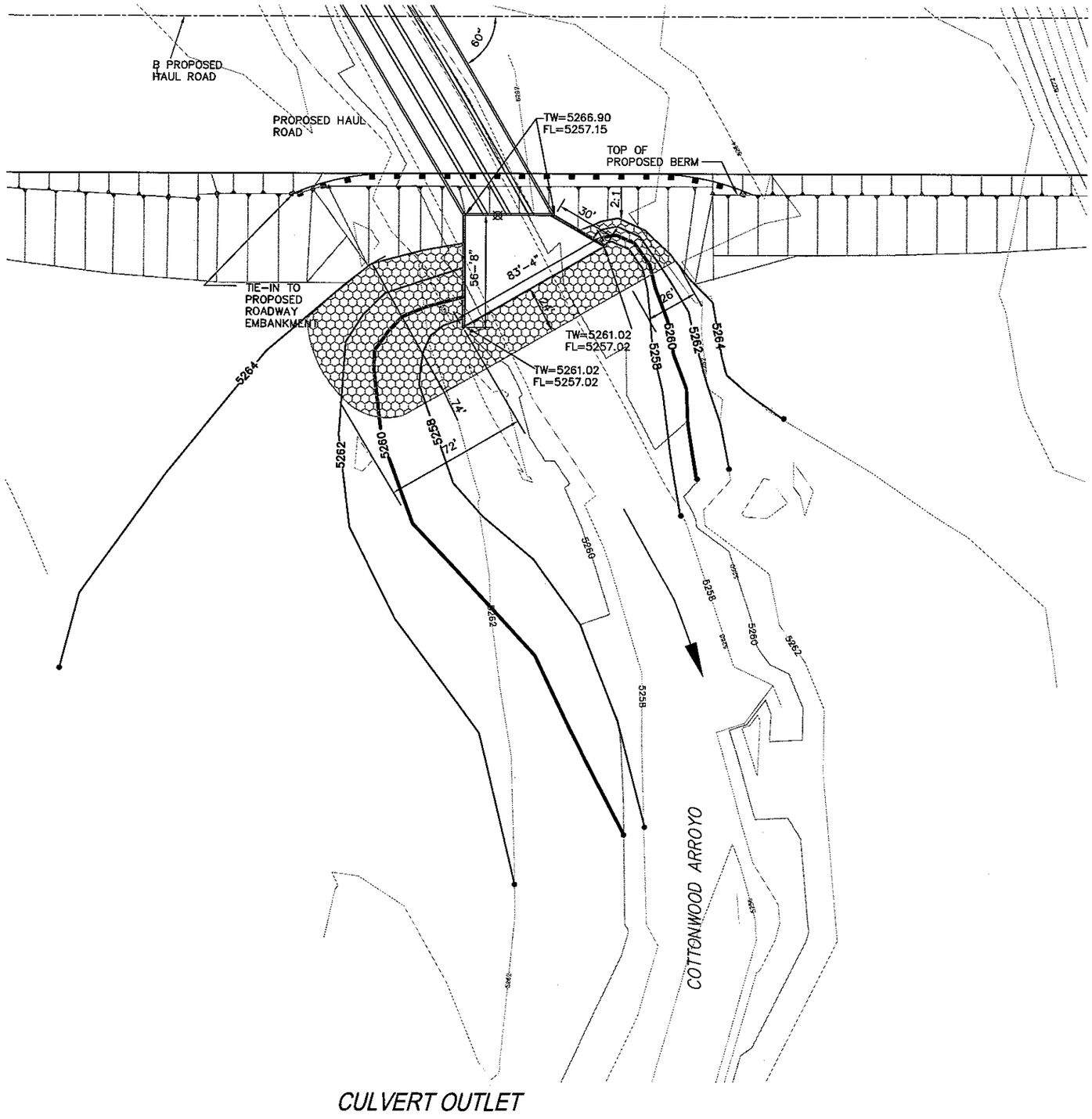
Sheet 13 of 20 Sheets

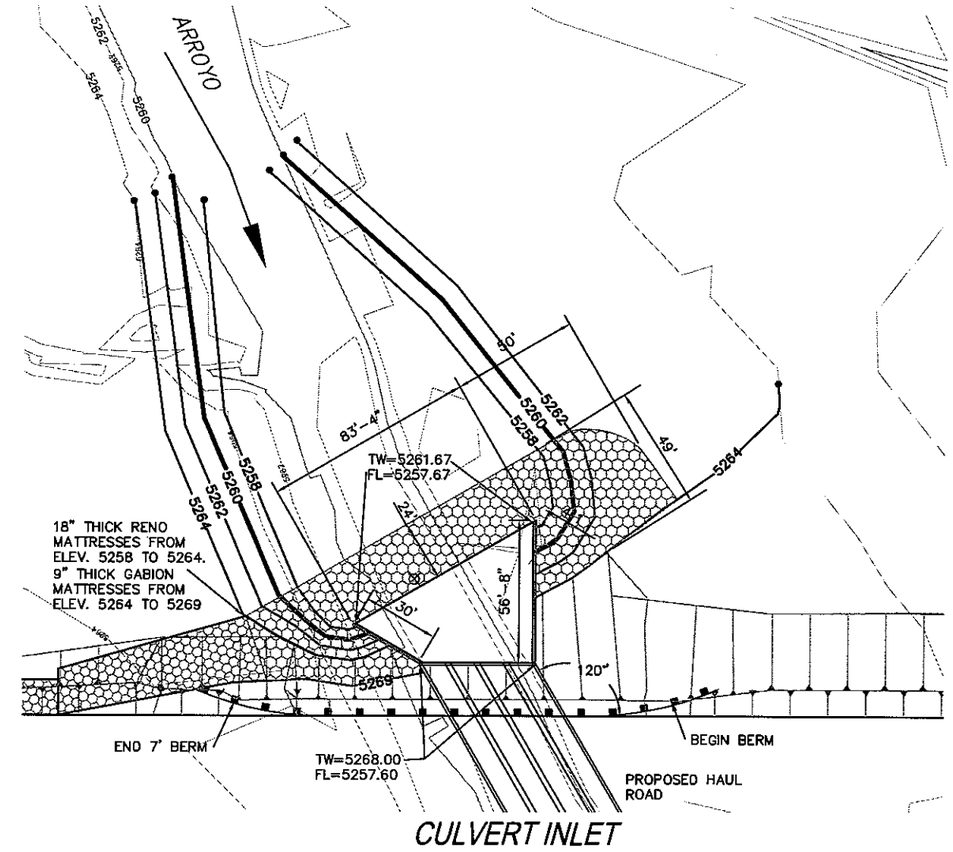
SCALE: AS NOTED

D-1

KENT N. WHITMAN NEW MEXICO 6170 REGISTERED PROFESSIONAL ENGINEER

FILE: D-1 Plan and Prof.dwg PROJECT NUMBER: 24342727





ABBREVIATIONS

TW TOP OF WALL
FL FLOWLINE ELEVATION

LEGEND

5250 EXISTING TOPOGRAPHY - IN FEET
5250 PROPOSED CONTOUR - IN FEET
GABION ARMORING

BOX CULVERT GRADING PLAN

NOTES:

1. EXISTING GROUND TOPOGRAPHY AND CONTOURS WITHIN SITE PLAN LIMITS SHOWN ON THIS DRAWING ARE BASED ON 2004 GROUND SURVEY PROVIDED BY BNCC. TOPOGRAPHY OUTSIDE THESE LIMITS ARE UNKNOWN.
2. COORDINATES AND ELEVATIONS FROM THE 2004 BNCC GROUND SURVEY ARE BASED ON BNCC MINE SURVEY CONTROL AND DATUM. THE CONTRACTOR SHALL CONFIRM ALL COORDINATES AND ELEVATIONS AND ENSURE TIE-IN OF THIS PROJECT WITH THE BNCC SURVEY CONTROL AND DATUM PRIOR TO CONSTRUCTION.

SCALE
30' 0 30' 60'
CONTOUR INTERVAL 2' FT.

KENT W. WHITMAN NEW MEXICO 6170 REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	RLR	JAK	KMW

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CULVERT GRADING PLAN

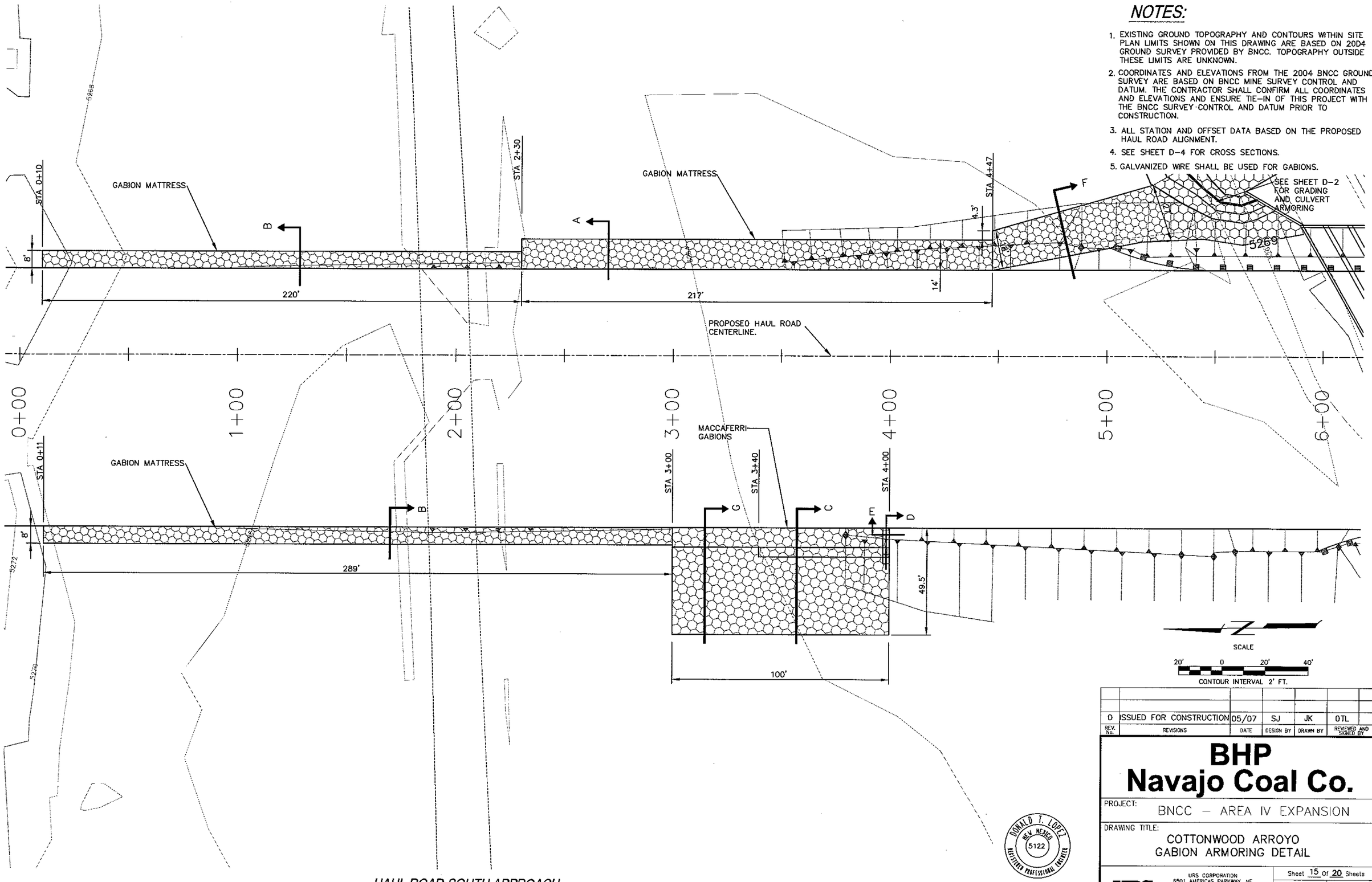
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 14 of 20 Sheets
SCALE: AS NOTED
D-2

FILE: D-2 GRADING.dwg PROJECT NUMBER: 24342727

NOTES:

1. EXISTING GROUND TOPOGRAPHY AND CONTOURS WITHIN SITE PLAN LIMITS SHOWN ON THIS DRAWING ARE BASED ON 2004 GROUND SURVEY PROVIDED BY BNCC. TOPOGRAPHY OUTSIDE THESE LIMITS ARE UNKNOWN.
2. COORDINATES AND ELEVATIONS FROM THE 2004 BNCC GROUND SURVEY ARE BASED ON BNCC MINE SURVEY CONTROL AND DATUM. THE CONTRACTOR SHALL CONFIRM ALL COORDINATES AND ELEVATIONS AND ENSURE TIE-IN OF THIS PROJECT WITH THE BNCC SURVEY CONTROL AND DATUM PRIOR TO CONSTRUCTION.
3. ALL STATION AND OFFSET DATA BASED ON THE PROPOSED HAUL ROAD ALIGNMENT.
4. SEE SHEET D-4 FOR CROSS SECTIONS.
5. GALVANIZED WIRE SHALL BE USED FOR GABIONS.



HAUL ROAD SOUTH APPROACH

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	SJ	JK	OTL

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO GABION ARMORING DETAIL

DONALD T. LOPEZ NEW MEXICO 5122 REGISTERED PROFESSIONAL ENGINEER

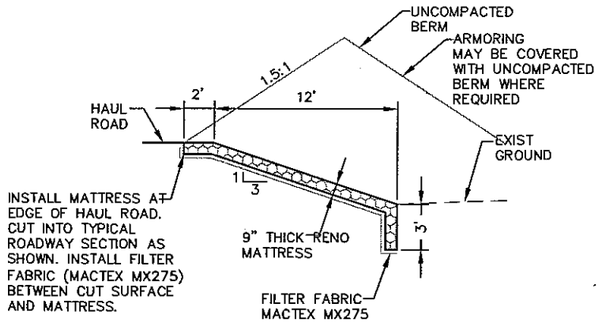
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 15 of 20 Sheets

SCALE: AS NOTED

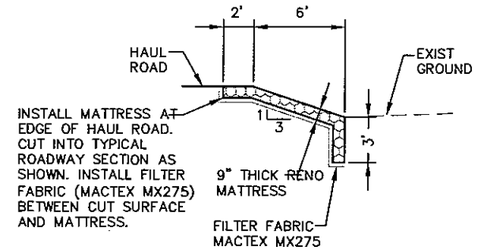
D-3

FILE: D-3 GABION detail sheet.dwg PROJECT NUMBER: 24342727



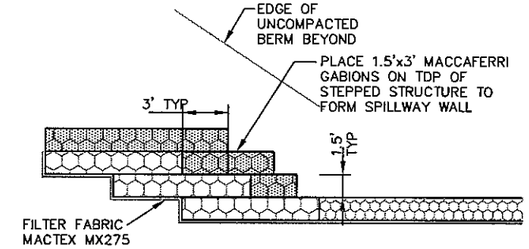
ARMORING SECTION A
STA 2+30 TO 4+47

SCALE:
HZ 1" = 5'
VT 1" = 5'



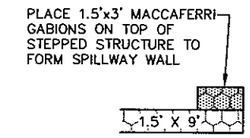
ARMORING SECTION B
STA. 0+10 TO 2+30 EAST
STA 0+11 TO 3+00 WEST

SCALE:
HZ 1" = 5'
VT 1" = 5'



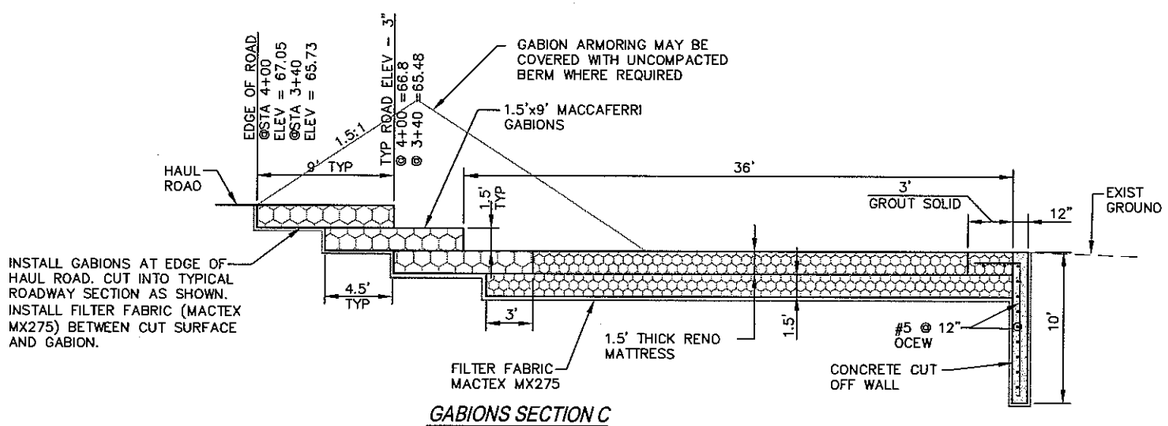
GABIONS SECTION D

SCALE:
HZ 1" = 5'
VT 1" = 5'



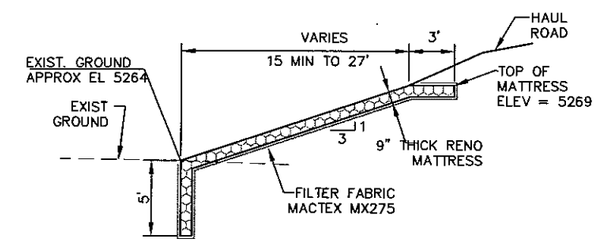
GABIONS SECTION E

SCALE:
HZ 1" = 5'
VT 1" = 5'



GABIONS SECTION C
STA 3+40 TO 4+00

SCALE:
HZ 1" = 5'
VT 1" = 5'

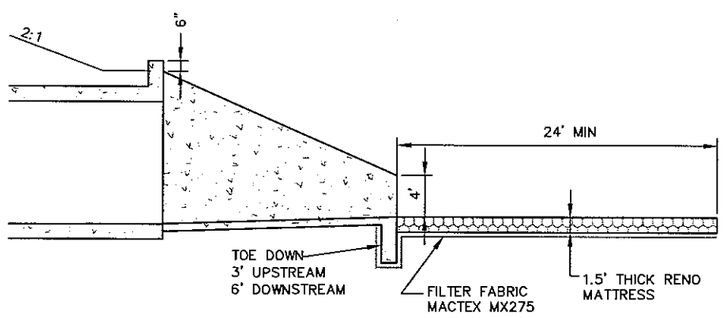


GABIONS SECTION F
STA 4+47 TO 5+62

SCALE:
HZ 1" = 5'
VT 1" = 5'

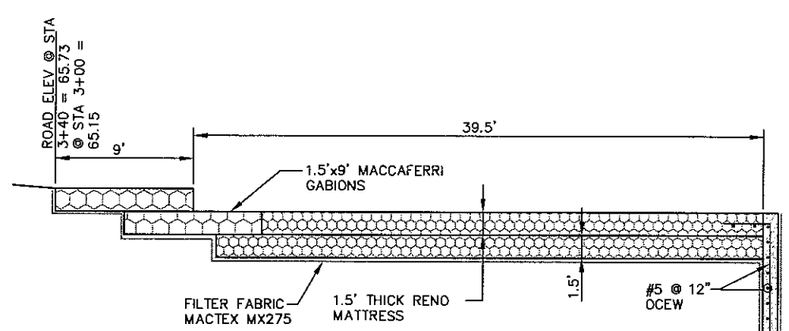
NOTES:

1. GALVANIZED WIRE SHALL BE USED FOR GABIONS.



BOX CULVERTS WITH APRONS SECTION

NTS



ARMORING SECTION G
STA 3+00 TO 3+40

SCALE:
HZ 1" = 5'
VT 1" = 5'

DONALD T. LOPEZ
NEW MEXICO
5122
REGISTERED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	SJ	JK	DTL

BHP Navajo Coal Co.

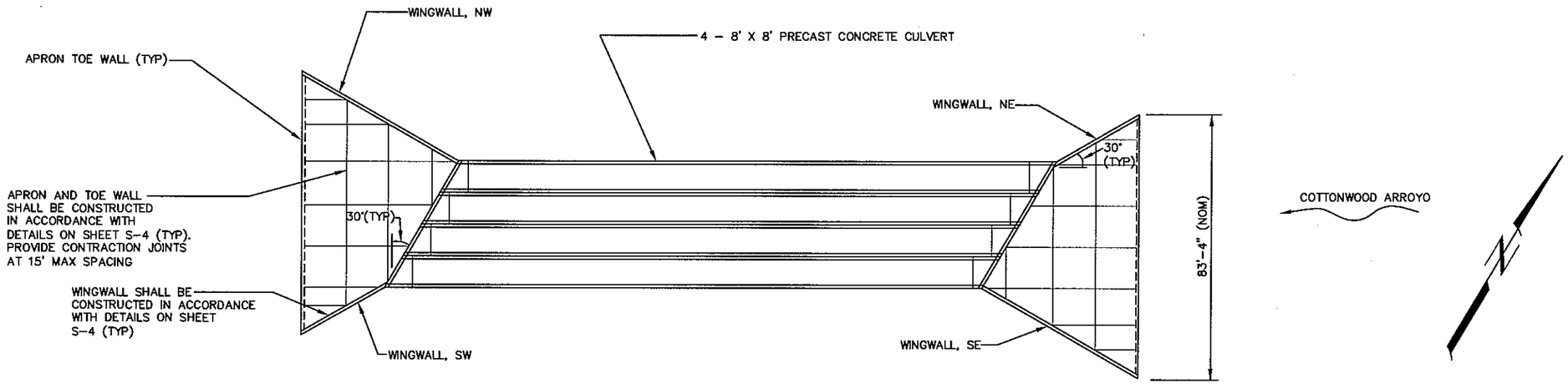
PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO GABION AND EROSION CONTROL DETAILS

URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 16 of 20 Sheets
SCALE: AS NOTED
D-4

FILE: D-4 EROSION AND GABION DETAILS.DWG
PROJECT NUMBER: 24342727



CULVERT STRUCTURAL PLAN

SCALE
20' 0 20' 40'

NOTES:

GENERAL

1. SEE SHT C–2 FOR GENERAL NOTES.
2. SEE SHT D–1 FOR HYDROLOGIC AND HYDRAULIC DATA AND SHT D–2 FOR ELEVATIONS.

DESIGN SPECIFICATIONS

1. DESIGN: AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, 17TH EDITION, 2002.
2. CONSTRUCTION: NEW MEXICO DEPARTMENT OF TRANSPORTATION 2005 INTERIM SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION.

GEOTECHNICAL DATA

1. FOR BORELOG AND TEST PIT GEOTECHNICAL INFORMATION REFER TO THE DESIGN REPORT.

REINFORCED CONCRETE

1. PROVIDE 3/4" CHAMFERS ON ALL EXPOSED EDGES, UNLESS NOTED OTHERWISE.
2. PROVIDE 2" MINIMUM COVER TO REINFORCING STEEL, UNLESS NOTED OTHERWISE.
3. CONSTRUCTION JOINTS SHALL BE MADE ONLY AT THE LOCATIONS SHOWN IN THE PLANS, UNLESS OTHERWISE APPROVED BY THE ENGINEER.
4. ALL CAST–IN–PLACE CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4000 PSI ($f'c$ = 4000 PSI).
5. ALL PRECAST CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 5000 PSI ($f'c$ = 5000 PSI).

REINFORCING STEEL

1. ALL REINFORCING STEEL SHALL CONFORM TO AASHTO M31 / ASTM A615 GRADE 60. DIMENSIONS TO REINFORCING STEEL LOCATIONS ARE TO CENTERLINE OF BARS UNLESS NOTED OTHERWISE.
2. WELDED WIRE FABRIC SHALL CONFORM TO ASTM A185, FLAT SHEETS, UNLESS NOTED OTHERWISE.
3. REINFORCING STEEL LAP SPLICES NOT SHOWN IN THE PLANS SHALL BE APPROVED BY THE ENGINEER.
4. MECHANICAL BAR SPLICES MAY BE USED AS SHOWN IN THE PLANS OR AS APPROVED BY THE ENGINEER IN LIEU OF LAP SPLICES. THE CONTRACTOR SHALL SUBMIT CERTIFIED TEST RESULTS FOR EACH BAR SIZE AND EACH MECHANICAL SPLICE TYPE, VERIFYING THAT THE MECHANICAL BAR SPLICE IS CAPABLE OF DEVELOPING AT LEAST 125% OF THE YIELD STRENGTH OF THE BARS BEING SPLICED.

FOR 28 DAY CONCRETE STRENGTH OF 4000 PSI AND GRADE 60 REINFORCING STEEL

BAR SIZE	#4	#5	#6	#7	#8	#9	#10
SPLICE LENGTH (FEET)	1'–9"	2'–3"	2'–7"	3'–3"	4'–3"	5'–5"	6'–10"

NOTE:
(A) FOR HORIZONTAL REINFORCING BARS WITH MORE THAN 12 INCHES OF CONCRETE CAST BELOW THE REINFORCEMENT, THE ABOVE VALUES SHALL BE MULTIPLIED BY 1.4

CULVERT DESIGN

1. DESIGN SHALL CONFORM TO CURRENT AASHTO STANDARD AND ASTM C1433.
2. DEAD LOADS
   NORMAL CONCRETE WEIGHT = 150 PCF
   SOIL WEIGHT = 120 PCF
3. SOIL LOADS
   LATERAL PRESSURE = 60 PCF (MAX) OR 30 PCF (MIN)
   ALLOWABLE BEARING PRESSURE = 5000 PSF
4. VEHICLE LOADS
   DRAGLINE:
   SURFACE LOAD = 5D98 PSF ON TWO 16' X 80' SHOES
   HAUL TRUCK:
   SURFACE LOAD = 14,700 PSF ON 12.54 SQ FT WHEEL CONTACT
5. THE CONTRACTOR SHALL SUBMIT DESIGN CALCULATIONS AND SHOP DRAWINGS FOR THE DESIGN OF THE BOX CULVERTS FOR APPROVAL. CALCULATIONS SHALL BE STAMPED AND SIGNED BY AN ENGINEER LICENSED IN THE STATE OF NEW MEXICO.
6. IN LIEU OF THE DESIGN SHOWN, THE CONTRACTOR MAY FURNISH AN ALTERNATIVE DESIGN THAT MEETS ALL THE DESIGN, LOAD AND HYDRAULIC CRITERIA. THE CONTRACTOR SHALL SUBMIT DESIGN CALCULATIONS AND SHOP DRAWINGS FOR THE ALTERNATIVE DESIGN FOR APPROVAL. CALCULATIONS SHALL BE STAMPED AND SIGNED BY AN ENGINEER LICENSED IN THE STATE OF NEW MEXICO.

CULVERT CONSTRUCTION

1. EXCAVATION AND BACKFILL SHALL BE IN ACCORDANCE WITH THE DETAILS SHOWN ON SHEET S–3.
2. WINGWALLS AND APRONS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE DETAILS SHOWN ON SHEET S–4.
3. LIFTING DEVICES SHALL BE THE SOLE RESPONSIBILITY OF THE MANUFACTURER. THEY SHALL BE LOCATED 1" BELOW THE TOP OF THE CONCRETE SURFACE AND SHALL BE FILLED WITH GROUT BEFORE BACKFILLING IS STARTED.

WINGWALL DESIGNATION	H	K	ℓ	M
NE	8'–0"	6"	30'–0"	9'–9"
SE	8'–0"	6"	56'–8"	9'–9"
NW	8'–0"	6"	56'–8"	9'–9"
SW	8'–0"	6"	30'–0"	9'–9"

WINGWALL TABLE

REFER TO SHEET S–4 FOR LOCATION OF WINGWALL TABLE VARIABLES H, K, ℓ, AND M.

BARRY T. CHUNG
NEW MEXICO
15471
LICENSED PROFESSIONAL ENGINEER

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	5/07	BTC	JAK	BTC

BHP Navajo Coal Co.

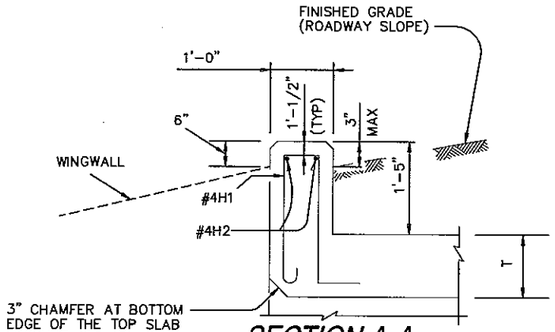
PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CROSSING BOX CULVERT STRUCTURAL PLAN

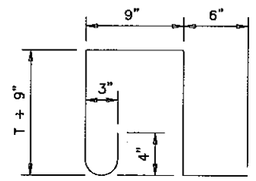
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 17 of 20 Sheets
SCALE: AS NOTED
S–1

FILE: S–1 Plan.dwg PROJECT NUMBER: 24342727

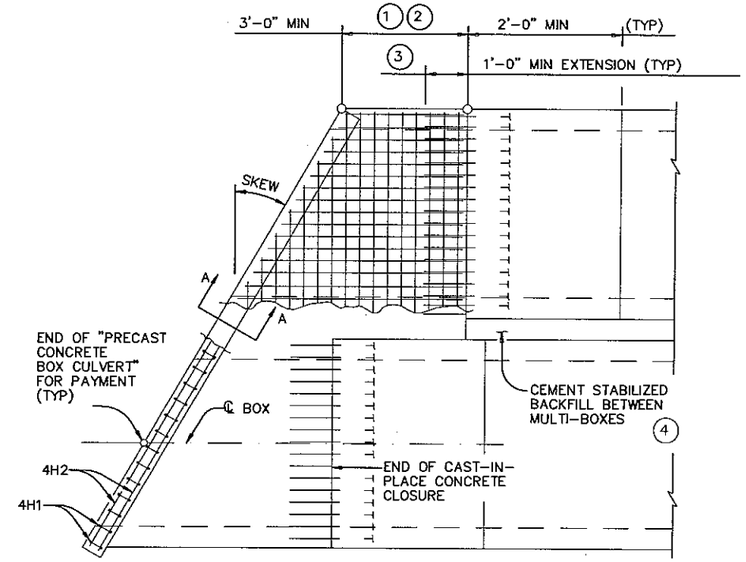


SECTION A-A



#4H1

(SPA = 1'-0" MAX)

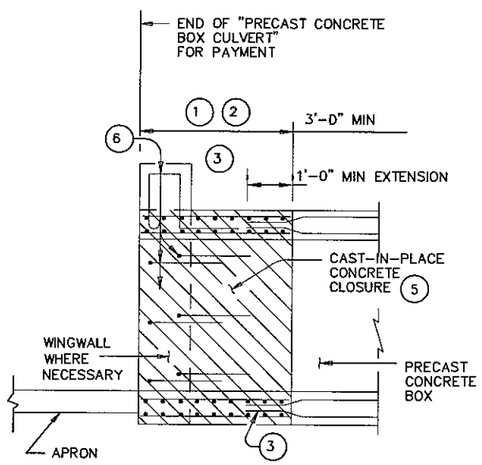


PLAN OF SKEWED ENDS

(SHOWING MULTI-BOX PLACEMENT)

KEYED NOTES:

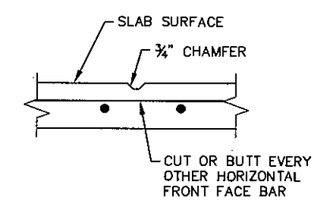
1. CAST-IN-PLACE CONCRETE CLOSURE SHALL BE 3'-0" MIN. BOXES SHALL BE CAST SHORT OR BROKEN BACK IN THE FIELD. ALL REINFORCING IN THE CLOSURE SHALL BE THE SAME SIZE AND SPACING AS IN THE PRECAST BOX SECTION. EXCEPT WHERE SHOWN OTHERWISE, THE CAST-IN-PLACE CLOSURE SHALL BE FLUSH WITH THE INSIDE AND OUTSIDE FACES OF THE PRECAST BOX SECTION.
2. FOR MULTIPLE UNIT PLACEMENTS THE LENGTH OF THE CLOSURE FOR THE INTERIOR WALLS MAY BE ADJUSTED AS NECESSARY. THE LENGTH OF THE TOP SLAB, BOTTOM SLAB, AND EXTERIOR WALL CLOSURE SHALL NOT BE LESS THAN 3'-0".
3. PRECAST BOX REINFORCING SHALL EXTEND A MINIMUM OF 1'-0" INTO CONCRETE CLOSURE (TYP).
4. CEMENT STABILIZED BACKFILL AND GROUT BETWEEN BOXES SHALL BE CONSIDERED INCIDENTAL TO THE BOX CULVERT.
5. ALL CAST IN PLACE CONCRETE AND REINFORCING SHALL BE CONSIDERED INCIDENTAL TO THE BOX CULVERT.
6. HEADWALL AND WINGWALL. REINFORCING SHALL EXTEND INTO CONCRETE CLOSURE. ANY REINFORCEMENT THAT DOES NOT FIT INTO THE CLOSURE SHALL BE BENT OR TRIMMED AS NECESSARY.



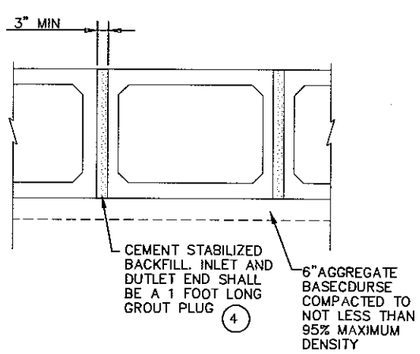
WALL CLOSURE

(AT ALL WALLS)

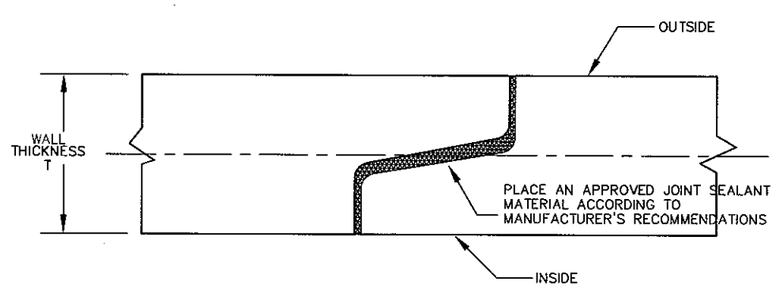
TYPICAL APRON CONSTRUCTION JOINT



TYPICAL APRON CONTRACTION JOINT



MULTIPLE UNIT PLACEMENT



TYPICAL BOX CULVERT TRANSVERSE JOINT

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	ISSUED FOR CONSTRUCTION	05/07	BTC	JAK	BTC

BHP Navajo Coal Co.

PROJECT: BNCC – AREA IV EXPANSION

DRAWING TITLE: COTTONWOOD ARROYO CROSSING BOX CULVERT DETAILS

BARRY T. CHUNG NEW MEXICO 15471 LICENSED PROFESSIONAL ENGINEER

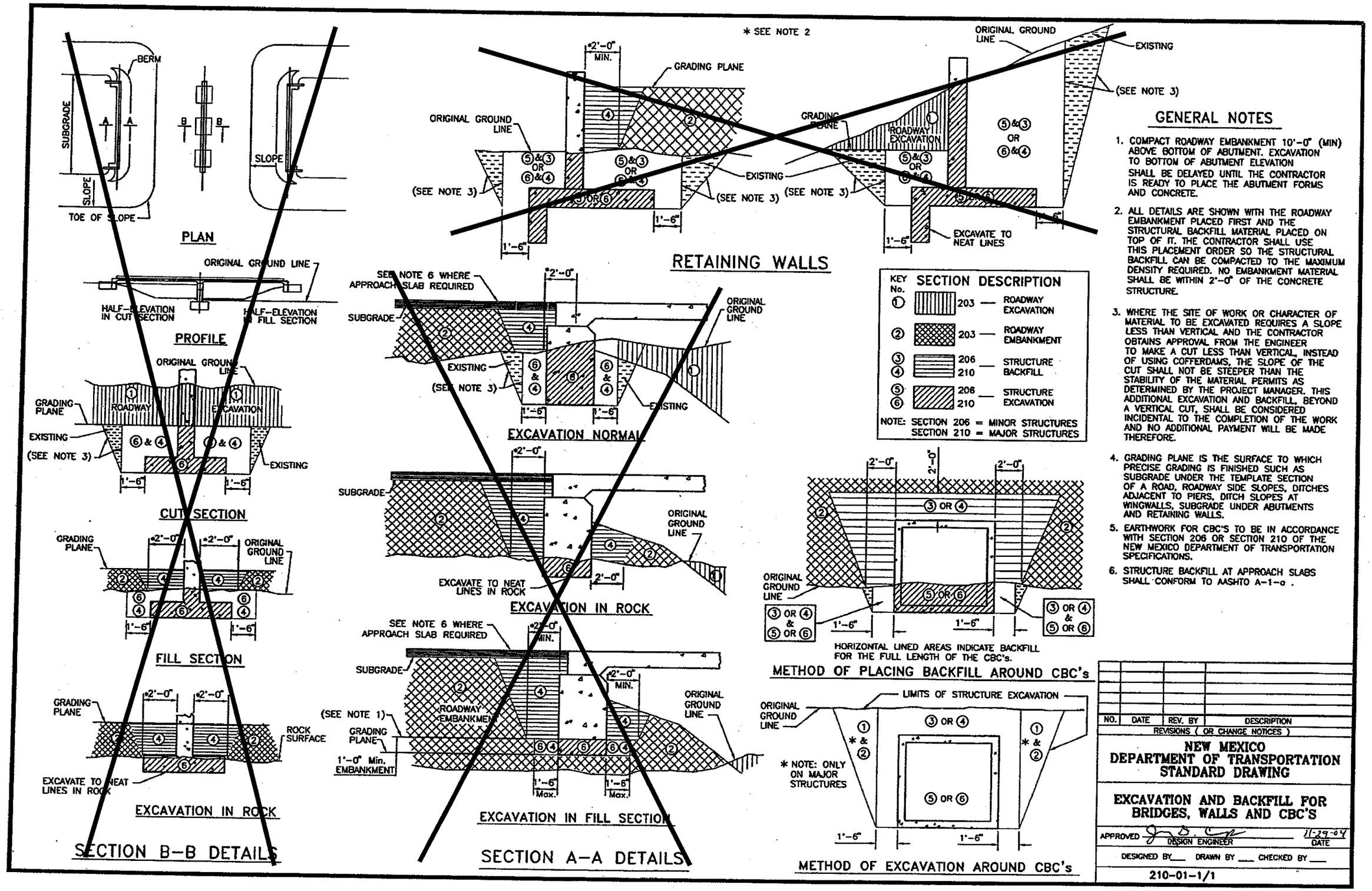
URS CORPORATION
6501 AMERICAS PARKWAY, NE
SUITE 900
ALBUQUERQUE, NEW MEXICO 87110

Sheet 18 Of 20 Sheets

SCALE: NTS

S-2

FILE: S-2 Culvert misc Details.dwg PROJECT NUMBER: 24342727



GENERAL NOTES

1. COMPACT ROADWAY EMBANKMENT 10'-0" (MIN) ABOVE BOTTOM OF ABUTMENT. EXCAVATION TO BOTTOM OF ABUTMENT ELEVATION SHALL BE DELAYED UNTIL THE CONTRACTOR IS READY TO PLACE THE ABUTMENT FORMS AND CONCRETE.
2. ALL DETAILS ARE SHOWN WITH THE ROADWAY EMBANKMENT PLACED FIRST AND THE STRUCTURAL BACKFILL MATERIAL PLACED ON TOP OF IT. THE CONTRACTOR SHALL USE THIS PLACEMENT ORDER SO THE STRUCTURAL BACKFILL CAN BE COMPACTED TO THE MAXIMUM DENSITY REQUIRED. NO EMBANKMENT MATERIAL SHALL BE WITHIN 2'-0" OF THE CONCRETE STRUCTURE.
3. WHERE THE SITE OF WORK OR CHARACTER OF MATERIAL TO BE EXCAVATED REQUIRES A SLOPE LESS THAN VERTICAL AND THE CONTRACTOR OBTAINS APPROVAL FROM THE ENGINEER TO MAKE A CUT LESS THAN VERTICAL, INSTEAD OF USING COFFERDAMS, THE SLOPE OF THE CUT SHALL NOT BE STEEPER THAN THE STABILITY OF THE MATERIAL PERMITS AS DETERMINED BY THE PROJECT MANAGER. THIS ADDITIONAL EXCAVATION AND BACKFILL, BEYOND A VERTICAL CUT, SHALL BE CONSIDERED INCIDENTAL TO THE COMPLETION OF THE WORK AND NO ADDITIONAL PAYMENT WILL BE MADE THEREFORE.
4. GRADING PLANE IS THE SURFACE TO WHICH PRECISE GRADING IS FINISHED SUCH AS SUBGRADE UNDER THE TEMPLATE SECTION OF A ROAD, ROADWAY SIDE SLOPES, DITCHES ADJACENT TO PIERS, DITCH SLOPES AT WINGWALLS, SUBGRADE UNDER ABUTMENTS AND RETAINING WALLS.
5. EARTHWORK FOR CBC'S TO BE IN ACCORDANCE WITH SECTION 206 OR SECTION 210 OF THE NEW MEXICO DEPARTMENT OF TRANSPORTATION SPECIFICATIONS.
6. STRUCTURE BACKFILL AT APPROACH SLABS SHALL CONFORM TO AASHTO A-1-a .

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS (OR CHANGE NOTICES)

NEW MEXICO DEPARTMENT OF TRANSPORTATION STANDARD DRAWING

EXCAVATION AND BACKFILL FOR BRIDGES, WALLS AND CBC'S

APPROVED DESIGN ENGINEER 11-29-04 DATE

DESIGNED BY___ DRAWN BY ___ CHECKED BY ___

210-01-1/1

24342727

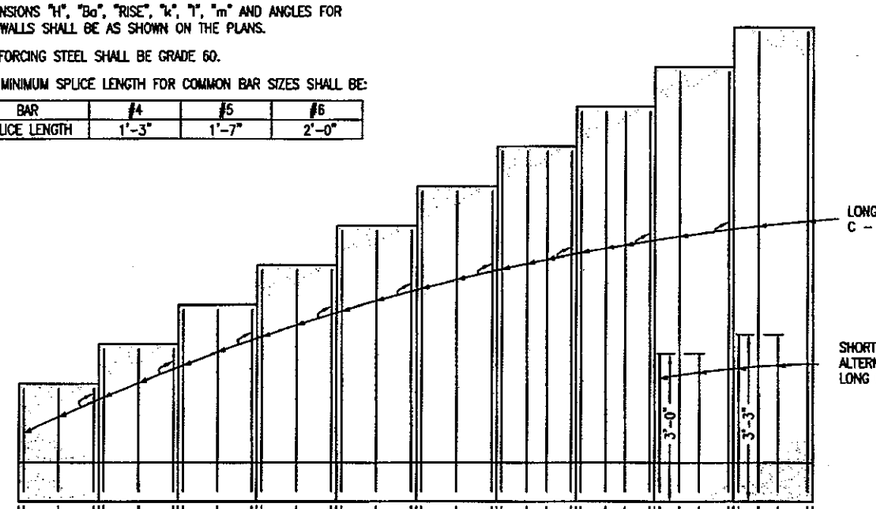
5-3 std details.dwg

S-3

GENERAL NOTES

1. ALL EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4".
2. WINGWALL FOOTINGS AND FLOOR OF BOX CULVERT SHALL BE PLACED MONOLITHICALLY.
3. DIMENSIONS "H", "Ba", "RISE", "k", "l", "m" AND ANGLES FOR WINGWALLS SHALL BE AS SHOWN ON THE PLANS.
4. REINFORCING STEEL SHALL BE GRADE 60.
5. THE MINIMUM SPLICE LENGTH FOR COMMON BAR SIZES SHALL BE:

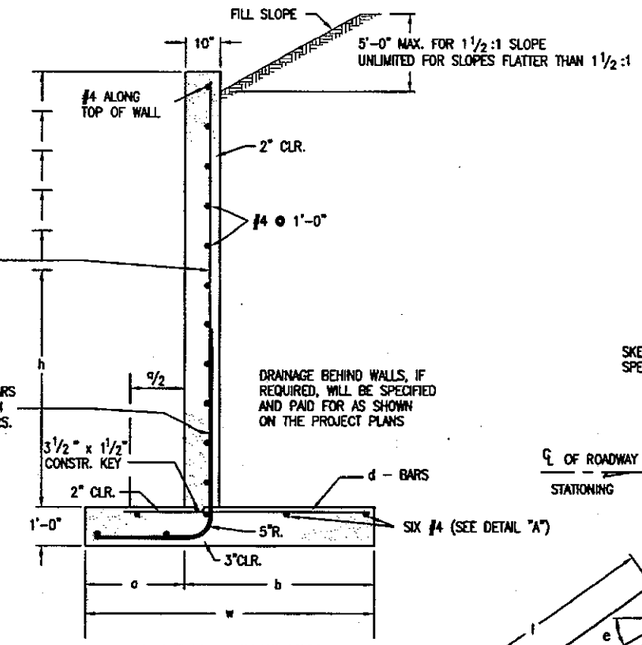
BAR	#4	#5	#6
SPLICE LENGTH	1'-3"	1'-7"	2'-0"



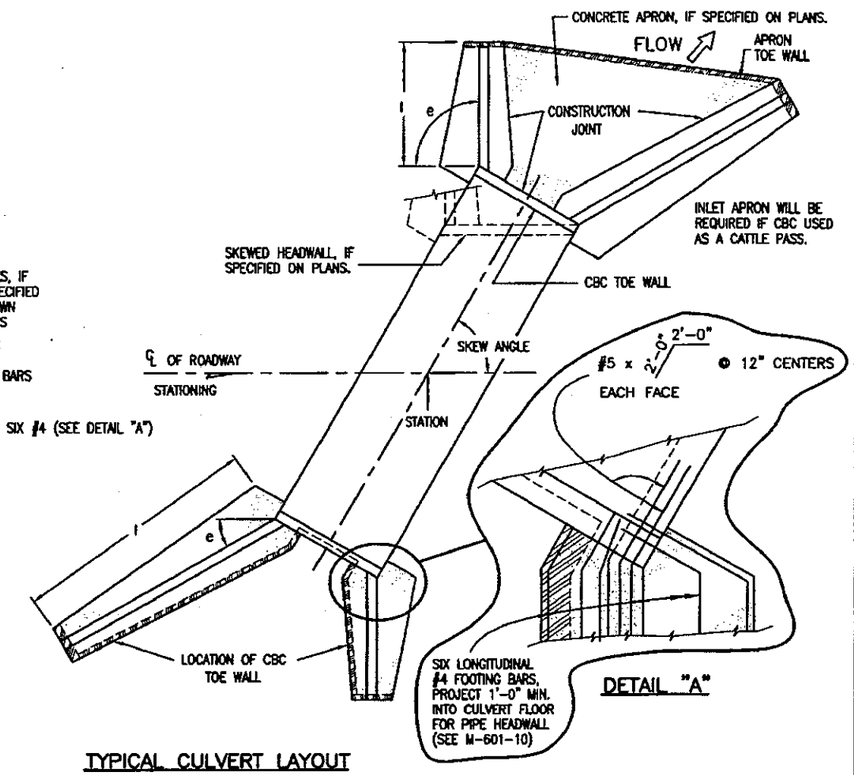
e =	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-4"	1'-3"	11'	9"	7" CTRS.
h =	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'
a =	1'-0"	1'-2"	1'-4"	1'-6"	1'-8"	1'-10"	2'-0"	2'-2"	2'-4"	2'-6"
b =	1'-8"	2'-0"	2'-4"	2'-8"	3'-0"	3'-4"	3'-8"	4'-0"	4'-4"	4'-8"
w =	2'-8"	3'-2"	3'-8"	4'-2"	4'-8"	5'-2"	5'-8"	6'-2"	6'-8"	7'-2"
c & d BARS	#4@1'-6"	#4@1'-6"	#4@1'-6"	#4@1'-6"	#4@1'-6"	#4@1'-4"	#5@1'-3"	#5@11"	#6@9"	#6@7" CTRS.
* CONC.CU.YD./L.F.	0.161	0.210	0.259	0.308	0.358	0.407	0.457	0.506	0.556	0.604
* REINF. LB./L.F.	8.0	9.3	10.7	12.1	14.3	16.4	23.0	28.6	41.8	54.6

* DOES NOT INCLUDE TOE WALL QUANTITIES

DESIGN TABLE

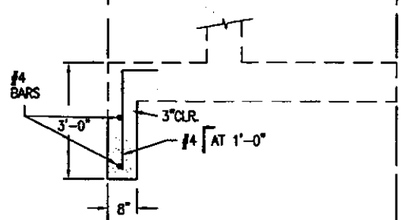


TYPICAL SECTION

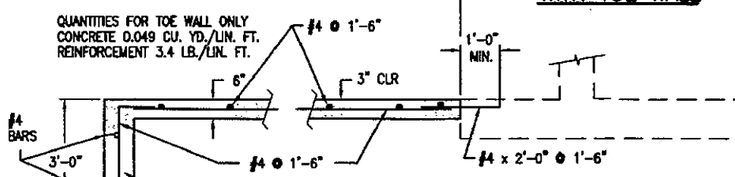


TYPICAL CULVERT LAYOUT

DETAIL "A"



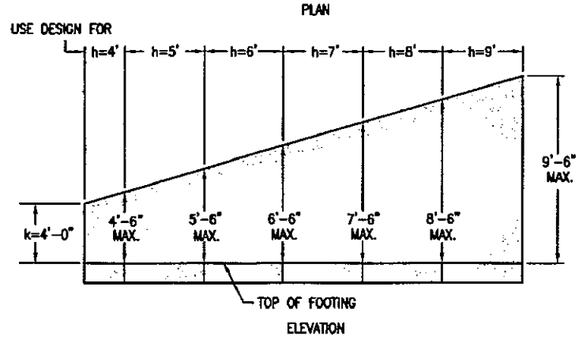
WITH TOE WALL



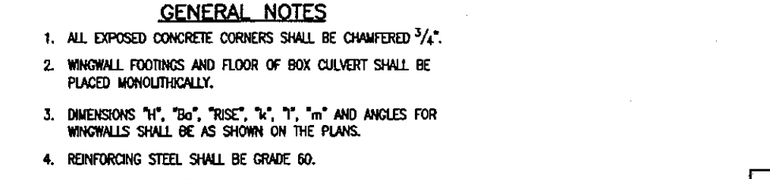
WITH CONCRETE APRON

REINFORCEMENT 0.89 LB./SQ. FT.

APRON TOE WALL



DESIGN EXAMPLE



PLAN

DESIGN DATA:
UNIT STRESSES: f_s = 24,000 PSI
f_c = 1,200 PSI
n = 9

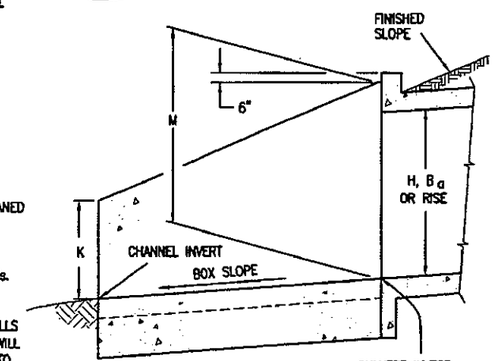
EQUIVALENT FLUID PRESSURE = 36 LBS./CU. FT.
MAXIMUM TOE PRESSURE = 1 TON/SQ. FT.

ALL CONSTRUCTION JOINTS SHALL BE THOROUGHLY CLEANED BEFORE CONCRETE IS POURED.

WINGWALL AND APRON CONCRETE SHALL BE:
CONCRETE CLASS B, OR D (BOX CULVERT) FOR CBC's.
CONCRETE CLASS B, OR D (WALL) FOR PIPES.

LIVE LOAD SURCHARGE HAS NOT BEEN CONSIDERED. WALLS WITHIN h/2 OF THE EDGE OF THE ROADWAY SHOULDER WILL REQUIRE A SPECIAL DESIGN IN ACCORDANCE WITH AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES.

APRON REQUIRED AT INLET OF THE CBC, IF USED FOR CATTLE PASSAGE.



BOX ELEVATION

M = H, Ba OR RISE + (1'-4") UNLESS OTHERWISE SHOWN ON PLANS.

Colorado Department of Transportation
DOT
4201 East Arkansas Avenue
Denver, Colorado 80222
Phone: (303) 757-9083 FAX: (303) 757-9820
Project Development Branch SD

Computer File Information	
Path: www.dot.state.co.us/DevelopProjects/DesignSupport/MStandards/	
Drawing File Name: 6010200101.dwg	
Acad Version: R14	Scale: NA Units: English

Standard Plan Revised	
Date:	Comments:

WINGWALLS FOR PIPE OR BOX CULVERTS

Issued By: Project Development Branch October 1, 2000

STANDARD PLAN NO.
M-601-20
Sheet No. 1 of 1

24342639
S-4 std details.dwg

Appendix 23.E

Stability Analyses

GEOMAT INC
2060 Afton Place ◆ Farmington, NM 87401 ◆ Tel (505) 327-7928 ◆ Fax (505) 326-5721

August 27, 2009

Ron C. Van Valkenburg, P.E.
BHP Billiton
BHP Navajo Coal Company
P.O. Box 1717
Fruitland, New Mexico 87416

RE: Proposed Area 4 North Coal Haulage/Small Vehicles Road
Pond Embankment Slope Stability Analysis
Ponds 401, 402, 403, 404, and 405
GEOMAT Project No. 92-0893

GEOMAT Inc. (GEOMAT) has completed geotechnical engineering analyses to evaluate the stability of the proposed roadway embankments which will form the dams of the Navajo Mine Area 4 North Ponds 401, 402, 403, 404, and 405 at the referenced project site. As shown on the Plan and Profile sheets (provided by BHP Billiton) in Appendix A, Ponds 401 through 405 will be located along the south side of Cottonwood Wash between Stations 157+00 and 108+00 on the south side of the proposed Area 4 North Road. The pond embankments will range from approximately 200 to 900 feet in length and 12 to 50 feet in height. We understand the embankments will be constructed of compacted materials obtained from two on-site borrow areas as shown on the Site Plan in Appendix A. The ponds will retain sediment from storm runoff. The maximum depth of water retained in the ponds will range from approximately eight feet in Ponds 401 and 405 to 18 feet in Pond 404. We also understand the topsoil present at the embankment sites will be removed and stockpiled prior to construction of the ponds.

Our scope of services for this project included a site reconnaissance by a geotechnical engineer, a subsurface exploration program, laboratory analyses, and slope stability analyses. Our services were performed in general accordance with our Proposal No. 92-08-04 dated August 5, 2009.

SITE RECONNAISSANCE

A geotechnical engineer from our office performed a site reconnaissance on August 6 and 10, 2009. Selected photographs taken during the reconnaissance trips are presented in Appendix B.

SUBSURFACE EXPLORATION

Subsurface conditions were explored on August 10, 2009 by drilling one exploratory boring at each of the five proposed pond embankment sites as shown on the Site Plan in Appendix C. The borings were advanced with a CME-45 truck-mounted drill using a combination of 4-inch O.D. solid stem and 7-inch O.D. hollow-stem augers. Each boring was advanced to a depth of approximately 20 feet below existing ground surface, with the exception of boring B-5, which was terminated at a depth of about 13 feet due to auger refusal on sandstone.

The borings were continuously monitored by a geologist from our office who examined and

classified the subsurface materials encountered, obtained representative samples, observed groundwater conditions, and maintained a continuous log of each boring. Soil samples were obtained from the borings using a combination of standard 2-inch O.D. split spoon and 3-inch O.D. modified California ring barrel samplers. The samplers were driven using a 140-pound hammer falling 30 inches. The standard penetration resistance was determined by recording the number of hammer blows required to advance the sampler in six-inch increments.

Groundwater evaluations were made in each boring at the time of site exploration. Soils were classified in accordance with the Unified Soil Classification System described in Appendix C. Boring logs were prepared and are presented in Appendix C.

In addition to the borings, an exploratory test pit was excavated at each of the two proposed borrow sites at the approximate locations shown on the Site Plan in Appendix C. The test pits were excavated using a rubber-tire backhoe with a 24-inch bucket. Logs of the test pits were prepared and are presented in Appendix C. Bulk samples of the materials were obtained for laboratory testing.

In borings B-1 and B-2 (Ponds 401 and 402, respectively), we encountered loose silty sand to the total depths explored. In borings B-3, B-4, and B-5 (Ponds 403, 404, and 405, respectively), we encountered approximately five feet of clayey sand overlying sandstone, shale, and coal.

Groundwater was encountered at a depth of approximately 20 feet in boring B-2. Groundwater was not observed in the other borings.

LABORATORY ANALYSIS

Laboratory analyses of representative samples indicate that the silty/clayey sand soils encountered in the borings have fines contents (silt- and/or clay-sized particles passing the U.S. No. 200 sieve) ranging from approximately 13 to 50 percent. The plasticity index of a sample of the clayey sand was 12. In-place dry densities of the sandy soils from the borings ranged from approximately 96 to 106 pounds per cubic foot (pcf), with natural moisture contents on the order of 2 to 7 percent.

Samples of the proposed borrow material from the test pits were analyzed for suitability as fill material. Fines contents of this material were on the order of 30 percent and the plasticity index was about 16. Laboratory maximum dry densities of two samples tested were approximately 108 and 112 pcf at optimum moisture contents of 18 and 16 percent, respectively (as determined by ASTM D 698, Standard Proctor).

Direct shear analyses were performed on undisturbed samples of the silty sand soils from borings B-1 and B-2 at depths of 10 feet below ground surface. The tests were conducted in accordance with ASTM D 3080-04. The phi angles of the samples were 33.9 and 33.0 degrees for the samples from B-1 and B-2, respectively. Both samples were cohesionless.

A summary of laboratory results is presented in Appendix C.

SLOPE STABILITY ANALYSIS

Both the pond side and the non-pond sides of the embankments at Ponds 401 through 405 were analyzed. The embankments were analyzed with the ponds full and empty and with and without pseudo-static earthquake forces of 0.1g. The configurations of the embankments, properties of the native soils/rock and imported soils that will be used to construct the embankments, and surcharge loading conditions which were used in the analyses are as follows:

- Slopes of both the pond and non-pond sides of the embankments were analyzed,
- Slopes of safety berms: 1.5:1 H:V,
- Elevations of the embankments were provided to us by BHP,
- Embankment material to be used: compacted on-site clayey sand and gravel: compacted density 130 pcf; cohesion 250 psf; angle of internal friction (phi) 35 degrees,
- Material type and strength data for the soil to be used in the embankments are based on information obtained by GEOMAT for this project from the exploratory borings and laboratory tests.
- The shoe ground pressure of 25.3 psi imposed by the Marion 7920 Dragline while traveling on the haul road was the design surcharge used for all the analyses.

The location and configuration of the embankments and ponds are depicted on the Plan and Profile sheets in Appendix A. Appendix A also contains a sheet (provided by BHP Billiton) showing the embankment cross-sections.

We understand that the ponds will be used to retain sediment from storm runoff water. The ponds are not expected to impound water for long periods of time.

The Galena Slope Stability Analysis System computer software, version 4.02 was used to analyze the stability of both sides (the pond-side and non-pond-side) of the embankments. It should be noted that due to requirements of the program, all the slopes are plotted ascending to the right. Both the pond-side and non-pond sides were analyzed with and without water. The analyses were also performed with and without a pseudo-static earthquake force of 0.1g. The analyses were performed using the soil strength/density parameters that were obtained by GEOMAT and that are presented in Appendix C of this report.

In our analysis, we assumed removal of the top five feet of soil (topsoil) before construction of the embankments. The underlying layers of sandstone were defined as having a cohesion ranging from about 100,000 to 200,000 psf and a phi angle of approximately 2 to 4 degrees. The coal seam was modeled with a unit weight of 80 pcf, a cohesion of 2,000 psf (approximately 14 psi) and a phi angle of 3 degrees. These values are estimates intended to be conservative for these material types.

Rapid drawdown conditions were not analyzed, since a phreatic surface should not develop during the short time the water is expected to be impounded.

The results of the analyses are shown in the following table. Individual sheets showing the details of the calculations and the configurations of the slopes used in the calculations are available upon request.

Pond Area	Side	Water Condition	Pseudo Static Earthquake (%g)	Calculated Factor of Safety
401	Pond	Reservoir empty	0.0	2.0
401	Pond	Reservoir empty	0.1	1.8
401	Pond	Reservoir full	0.1	1.7
401	Non-Pond	Reservoir empty	0.0	2.0
401	Non-Pond	Reservoir empty	0.1	1.6
401	Non-Pond	Reservoir full	0.1	1.4
402	Pond	Reservoir empty	0.0	2.1
402	Pond	Reservoir empty	0.1	1.7
402	Pond	Reservoir full	0.1	1.4
402	Non-Pond	Reservoir empty	0.0	2.0
402	Non-Pond	Reservoir empty	0.1	1.7
402	Non-Pond	Reservoir full	0.1	1.7
403	Pond	Reservoir empty	0.0	2.2
403	Pond	Reservoir empty	0.1	1.8
403	Pond	Reservoir full	0.1	1.6
403	Non-Pond	Reservoir empty	0.0	1.9
403	Non-Pond	Reservoir empty	0.1	1.6
403	Non-Pond	Reservoir full	0.1	1.3

Pond Area	Side	Water Condition	Pseudo Static Earthquake (%g)	Calculated Factor of Safety
404	Pond	Reservoir empty	0.0	2.1
404	Pond	Reservoir empty	0.1	1.7
404	Pond	Reservoir full	0.1	1.5
404	Non-Pond	Reservoir empty	0.0	1.7
404	Non-Pond	Reservoir empty	0.1	1.5
404	Non-Pond	Reservoir full	0.1	1.2
405	Pond	Reservoir empty	0.0	1.7
405	Pond	Reservoir empty	0.1	1.4
405	Pond	Reservoir full	0.1	1.3
405	Non-Pond	Reservoir empty	0.0	1.6
405	Non-Pond	Reservoir empty	0.1	1.4
405	Non-Pond	Reservoir full	0.1	1.2

As shown in the above table, the calculated factors of safety range from 1.2 to 2.2 for the 1.5:1 H:V embankment slope. All of the slopes and conditions met what we understand is the Office of Surface Mining (OSM) required factor of safety of 1.3, except for the non-pond side of 404 and the non-pond side of 405. The factors of safety for these two embankments were 1.2 under the conditions of the reservoirs being full at the time there was an earthquake. Since the conditions of the earthquake and high water occurring at the same time are unlikely and the factors of safety are within 0.1 of the 1.3 value, it is our opinion that the design conditions are adequate. If higher factors of safety are required, the slopes could be reduced from 1.5:1 H:V to 2:1 H:V.

The analysis and recommendations submitted in this report are contingent upon proper compaction of the fill material used to construct the embankments. Soils should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557 (modified proctor) at a moisture content between two (2.0) percent below and four (4.0) percent above the optimum moisture content. Fill should be placed in lift thicknesses that can be compacted to the required density by the type of compaction equipment being used.

The nature and variation of the native materials and the materials to be used to construct the embankment may not become evident until construction or until the final source location and type

of material to be used in the embankment is determined. If variations then appear, it will be necessary to reevaluate the recommendations of this report. Likewise, in the event that any changes in the nature, design, configuration or location of the embankment slopes are made, the recommendations contained in this report shall not be considered valid unless the changes are reviewed and the recommendations of this report modified or verified in writing by GEOMAT.

Thank you for the opportunity to work with you on this project. If you have any questions or need additional information, please let us know.

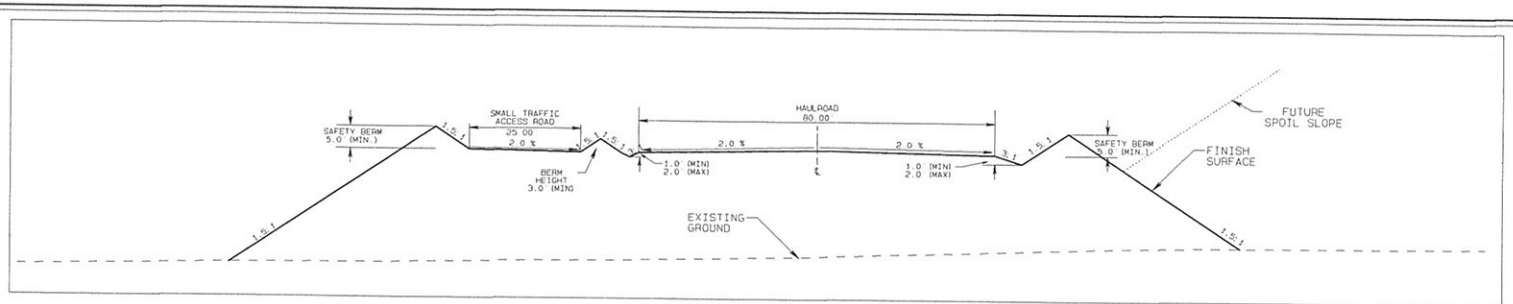
Sincerely yours,
GEOMAT Inc.

GEORGE A. MADRID
NEW MEXICO
9110
REGISTERED PROFESSIONAL ENGINEER

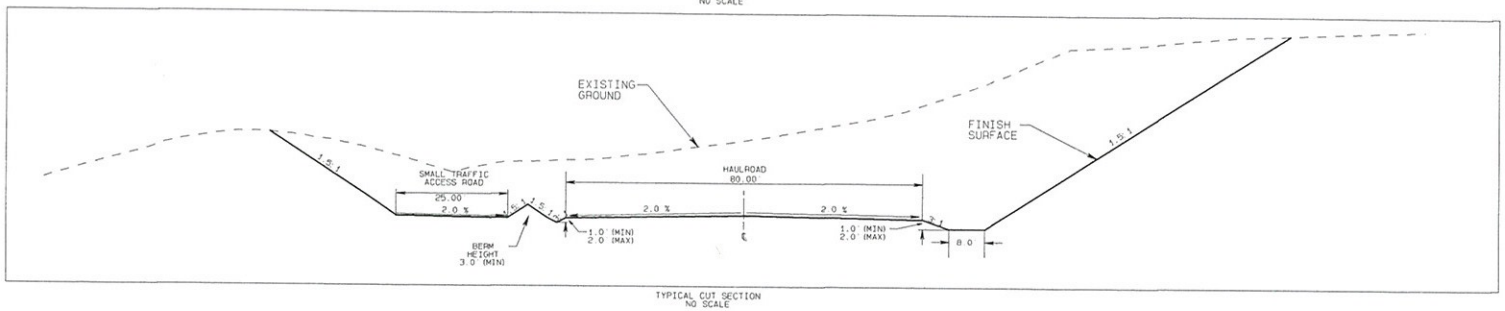
George A. Madrid, P.E. 8.27.09
President, Principal Engineer

Distribution: Addressee (1)

Appendix A

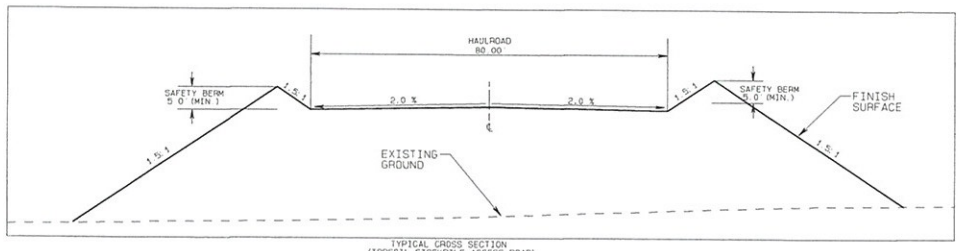


TYPICAL FILL SECTION
NO SCALE

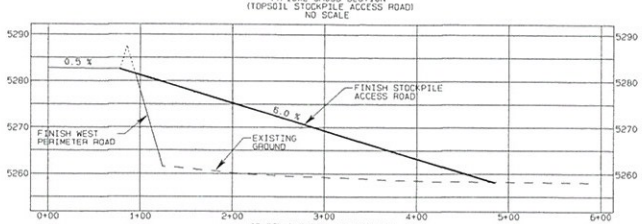


TYPICAL CUT SECTION
NO SCALE

ABOVE TYPICAL CUT AND FILL SECTIONS
EAST PERIMETER ROAD (VIEW LOOKING SE)
WEST PERIMETER ROAD (VIEW LOOKING NE)



TYPICAL CROSS SECTION
(TOPSOIL STOCKPILE ACCESS ROAD)
NO SCALE



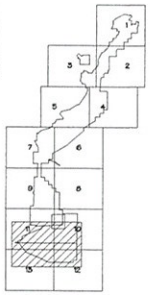
CENTERLINE OF ROAD PROFILE
(TOPSOIL STOCKPILE ACCESS ROAD)
Horizontal - 1"=60
Vertical - 1"=12

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45 LEASE CORNER
- L-30
- PERMIT/LEASE BOUNDARY

NOTES

1. For hydrology and design information refer to Appendix 11-2 in the approved PAP.



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Ron C. VAN VALKENBURG, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG
N.E.W. MEXICO
5263
LICENSED PROFESSIONAL ENGINEER

REVISION
SUBMITTED TO DOM FOR APPROVAL

DATE
12/17/04

PROJECT MANAGER: DK
PGR #: RCVAN LR
REV #: 5600
DRAWN BY: RCVAN
REV #: NL

bhpbilliton
BHP NAVAJO COAL CO.
N.M. Coal Mine Permit Area, Section 30-T19N-R17W, San Juan County, New Mexico

AUTOCAD:
DATE: October 13, 2004
DRAWN BY: RCVAN
CHECK BY: RCVAN
APPROVED BY: LR

PLAN, PROFILE AND SECTIONS

EXHIBIT 11-94C
AREA 4 NORTH
EAST & WEST PERIMETER ROAD
Design

DRAWING

SHEET 3 OF 3

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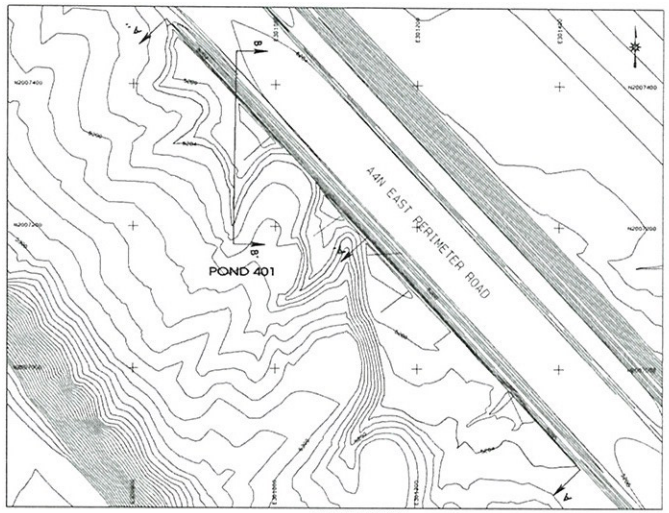

PLAN VIEW
CONTOUR INT. 2 FT
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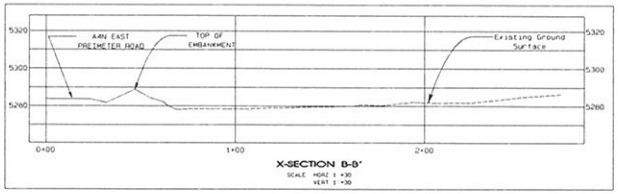

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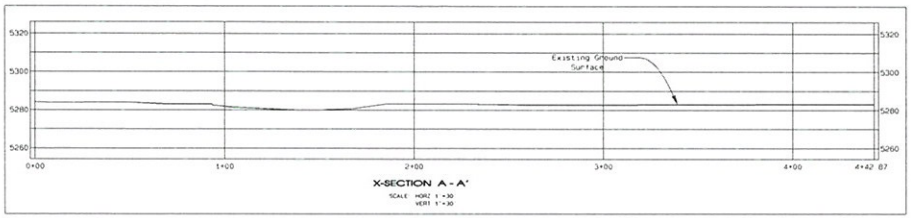

X-SECTION A - A'
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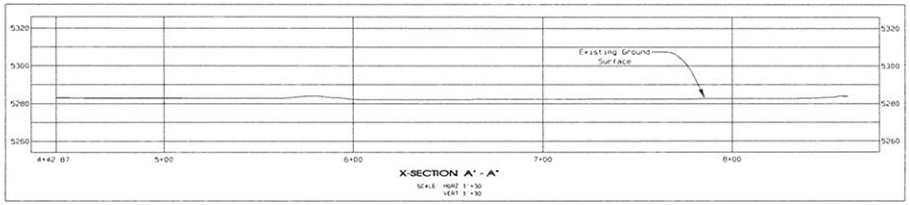


X-SECTION A' - A"
SCALE HORZ 1"=30
VERT 1"=30

LEGEND

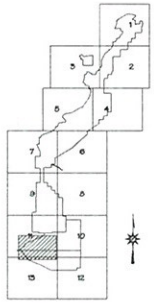
- ROAD
- BUILDING
- FENCE
- CULVERT
- DRAINAGE
- POWERLINE
- 5300 INDEX CONTOUR
- 5290 INTERMEDIATE CONTOUR
- PERMIT/LEASE BOUNDARY

NOTES

1. For location of drainage control structures and watersheds, refer to Exhibit 11-13F
2. The hydrology and supporting design data for the drainage control structures are referenced on Table 11-5AM of the NM PAP

STAGE STORAGE DATA

ELEV feet	AREA acres	VOLUME ac-ft	CUM VOLUME ac-ft
5274	0.046	0.00	0.00
5276	0.199	0.20	0.20
5278	0.471	0.70	0.90
5280	0.949	1.40	2.30
5282	1.237	2.20	4.50



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Ron C. Van Valkenburg, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG
NEW MEXICO
9263
LICENSED PROFESSIONAL ENGINEER

bhpbilliton
NAVAJO COAL COMPANY
NAVAJO MINE
PO BOX 1717 FRUITLAND NEW MEXICO 87416 PHONE 505-598-3305/FAX 505-598-3307

PROJECT ENGINEER: F. CORDOVA
PROJECT MANAGER: R. VAN VALKENBURG
DATE: AUG 27, 2009
DRAWN BY: RCRAMER
REV. NO.

REVISION | DATE
DESIGNED FOR REVIEW AND COMMENTS ON NM NOTICE | Aug 31 09

PROJECT: LAN
DATE: AUG 2009
DESIGNED BY: RCV
Drawn BY: RAPOLITER
CHECKED BY: RCV
APPROVED BY: RCV

PLAN, PROFILE AND SECTION

EXHIBIT 11-001
AREA 4 NORTH
POND 401
Design

DRAWING
SHEET
OF 0

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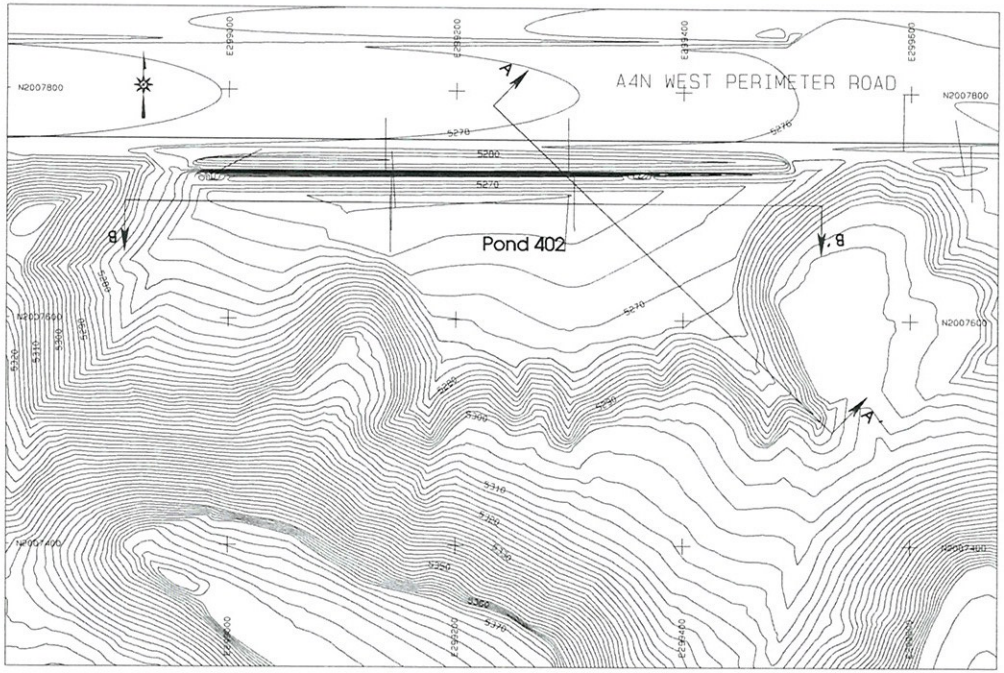

PLAN VIEW

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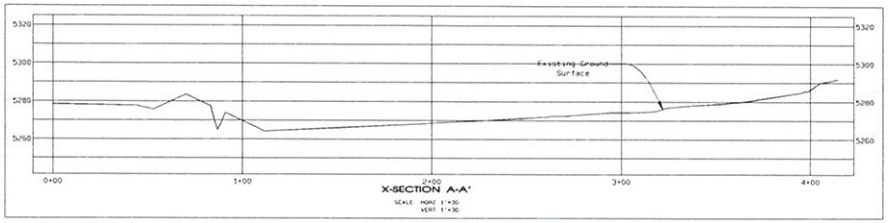

X-SECTION A-A'

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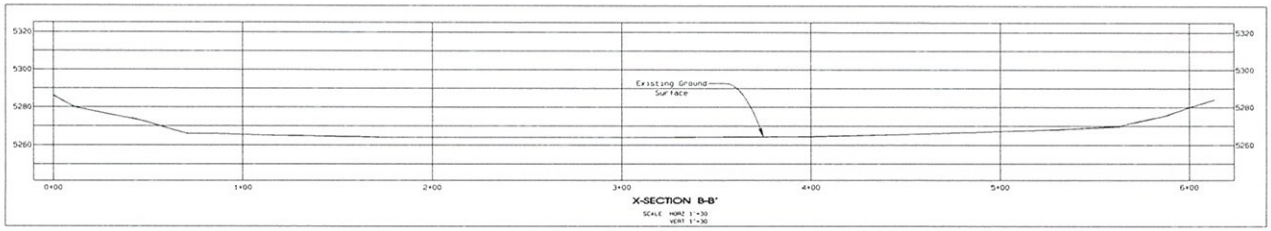
VERT 1"=30



X-SECTION B-B'

SCALE HORZ 1"=30
VERT 1"=30

LEGEND

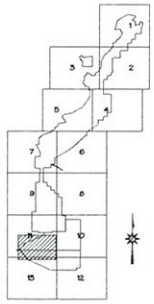
- ROAD
- BUILDING
- FENCE
- CULVERT
- DRAINAGE
- POWERLINE
- 5300 INDEX CONTOUR
- 5290 INTERMEDIATE CONTOUR
- PERMIT/LEASE BOUNDARY

NOTES

1. For location of drainage control structures and watersheds, refer to Exhibit 11-13W
2. The hydrology and supporting design data for the drainage control structures are referenced on Table 11-5AM of the NM PAP

STAGE STORAGE DATA

ELEV feet	AREA acres	VOLUME ac-ft	CUM VOLUME ac-ft
5260	0.09	0.00	0.00
5262	0.31	0.40	0.40
5264	0.49	0.80	1.20
5266	0.66	1.10	2.30
5268	0.84	1.50	3.80
5270	1.06	1.90	5.70
5272	1.31	2.40	8.10
5274	1.54	2.90	11.00
5276	1.75	3.30	14.30



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Ron C. Van Valkenburg, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG NEW MEXICO 9263 LICENSED PROFESSIONAL ENGINEER

REVISION	DATE
REVISED TO SHOW NEW PERIMETER ROAD	Aug 31, 09

PROJECT MANAGER: R. VAN VALKENBURG
FILE: 11-02_23-POND 402.DWG
DATE: AUG 13, 2009
DATE RECORD: NEG. NO. NM 9263
DATE OF RECORD: NEG. NO.

bhpbilliton
NAVAJO COAL COMPANY
NAVAJO MINE
PO BOX 1717 FRUITLAND NEW MEXICO 87416 PHONE 505-598-3208/241 505-598-3381

PROJECT: A4N
DATE: AUG 8, 2009
DESIGNED BY: RCV
DRAWN BY: D.PATTON
CHECKED BY: RCV
APPROVED BY: RCV

PLAN, PROFILE AND SECTION

EXHIBIT 11-02
AREA 4 NORTH
POND 402
Design

DRAWING

SHEET
OF 6

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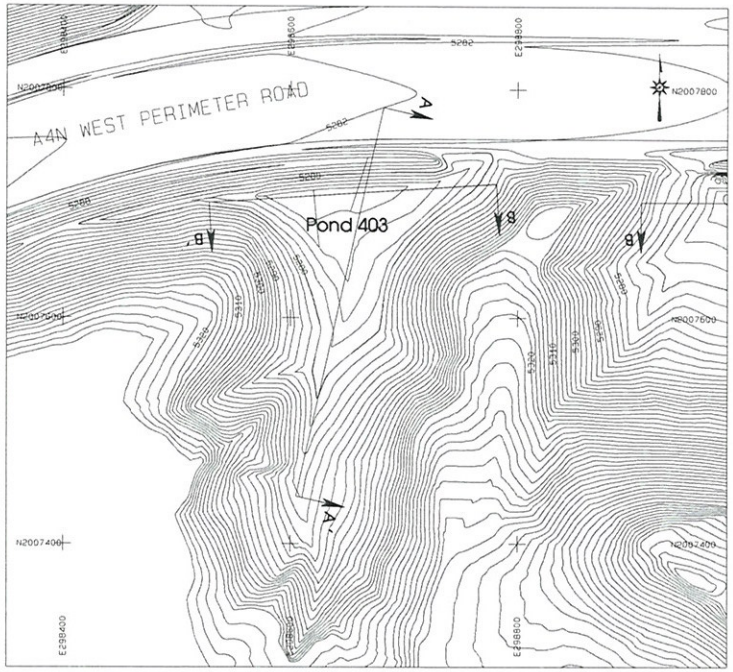

PLAN VIEW

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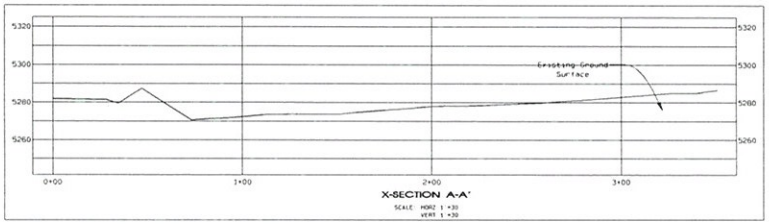

X-SECTION A-A'

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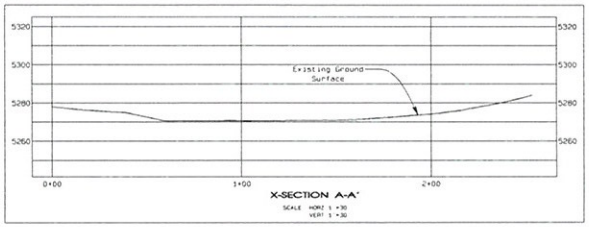
VERT 1"=30'



X-SECTION A-A'

SCALE HORZ 1"=30'
VERT 1"=30'

LEGEND

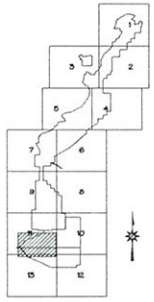
- ROAD
- BUILDING
- FENCE
- CULVERT
- DRAINAGE
- POWERLINE
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- PERMIT/LEASE BOUNDARY

NOTES

1. For location of drainage control structures and watersheds, refer to Exhibit 11-13F
2. The hydrology and supporting design data for the drainage control structures are referenced on Table 11-5AM of the NM PAP

STAGE STORAGE DATA

ELEV feet	AREA acres	VOLUME ac-ft	CUM VOLUME ac-ft
5266	0.00	0.00	0.00
5268	0.02	0.00	0.00
5270	0.05	0.10	0.10
5272	0.09	0.10	0.20
5274	0.15	0.20	0.50
5276	0.24	0.40	0.90
5278	0.33	0.60	1.40
5280	0.45	0.80	2.20



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Ron C. Van Valkenburg, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG NEW MEXICO 9263 REGISTERED PROFESSIONAL ENGINEER

bhpbilliton
NAVAJO COAL COMPANY
NAVAJO MINE
PO BOX 1717 FRUITLAND NEW MEXICO 87416 PHONE 505-598-3009 FAX 505-598-3381

PROJECT MANAGER: F. GERMAN
CHIEF ENGINEER: RON C. VAN VALKENBURG
DATE: AUG 13, 2009
DRAWN BY: RAYMOND
REVISION DATE

PROJECT: LAN
DATE: AUG 8, 2009
DESIGNED BY: RCV
DRAWN BY: RAYMOND
CHECKED BY: RCV
APPROVED BY: RCV

PLAN, PROFILE AND SECTION

EXHIBIT 11-03
AREA 4 NORTH
POND 403
Design

DRAWING

SHEET
OF 0

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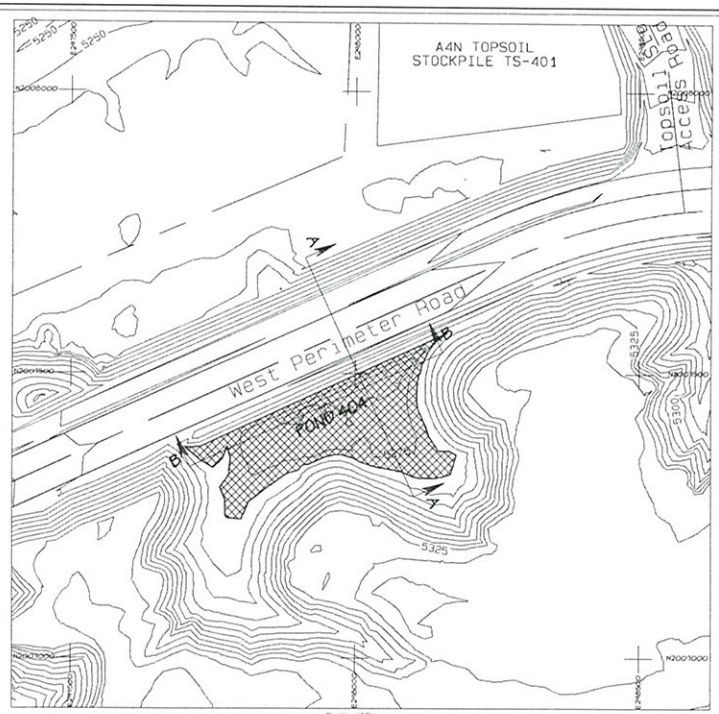
Raymond Thu Aug 13 08:33:11 2009



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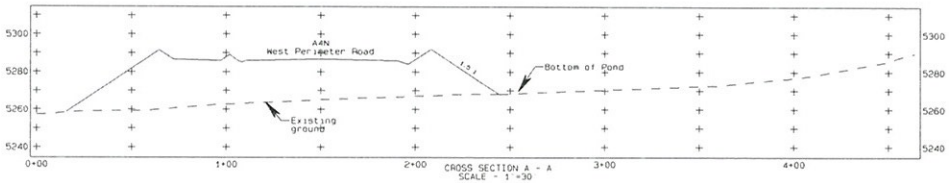

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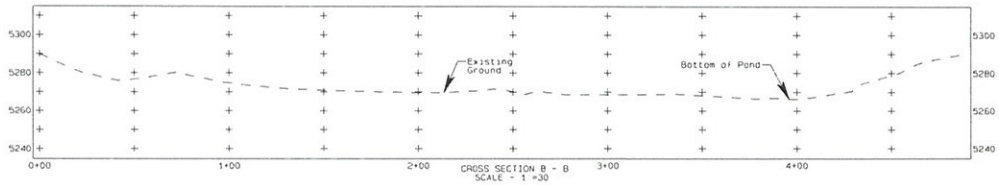

CROSS SECTION B - B
SCALE - 1 "=30

N
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LEGEND

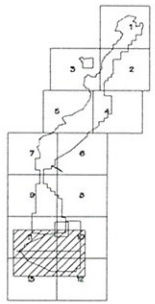
- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 218 5422.45
- L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY

NOTES

1. For hydrology and design information refer to Appendix 11-2 in the approved PAP
1. Refer to Exhibit 11-13F for watershed information and location of ponds

STAGE STORAGE DATA

ELEV feet	AREA acres	VOLUME ac-ft	CUM VOLUME ac-ft
5266	0.0	0.0	0.00
5268	0.03	0.0	0.0
5270	0.15	0.2	0.2
5272	0.45	0.6	0.8
5274	0.68	1.1	1.9
5276	0.87	1.5	3.5
5278	1.06	1.9	5.4
5280	1.32	2.4	7.8
5282	1.58	2.9	10.7
5284	1.83	3.4	14.1



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Ron C. VAN VALKENBURG, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG NEW MEXICO 9263 LICENSED PROFESSIONAL ENGINEER

REVISION	DATE
1 SUBMITTED TO OSM FOR APPROVAL	08.31.09
2	
3	
4	
5	

PROJECT NUMBER FG
PAGE of RECORD 10.5
SHEET of RECORD 10.5
SHEET of RECORD 40

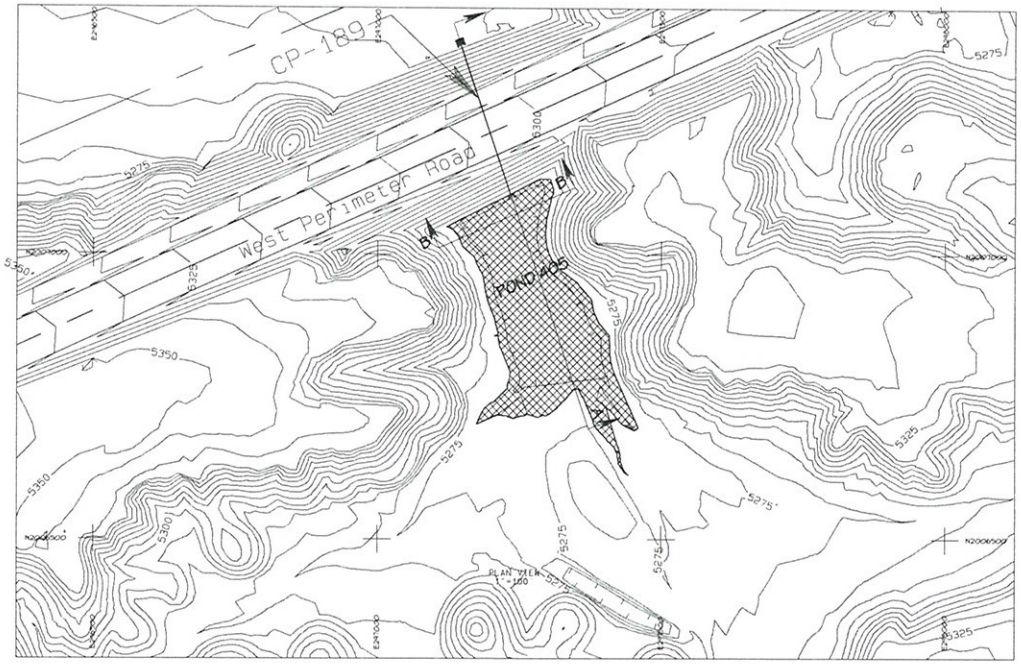
bhpBilliton
BHP NAVAJO COAL CO.
NAVAJO MINE

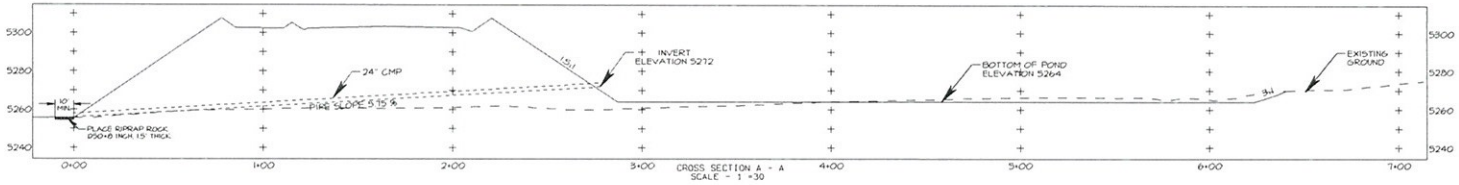
AUGUST 31, 2009
DRAWN BY: RCV
DESIGNED BY: RCV
CHECKED BY: RCV
APPROVED BY: RCV

PLAN, PROFILE AND SECTIONS

EXHIBIT 11-4
AREA 4 NORTH
POND 404
Design

DRAWING
SHEET 1 OF 1





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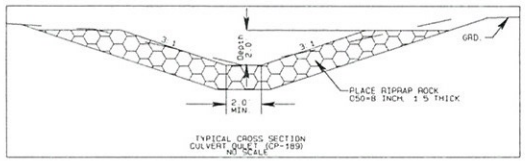
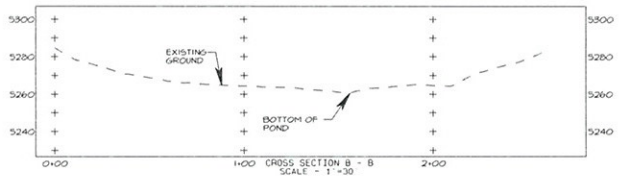


TYPICAL CROSS SECTION
CULVERT OULET (CP-189)
NO SCALE



CROSS SECTION B - B
SCALE - 1"=30

N
W E
S

STAGE STORAGE DATA

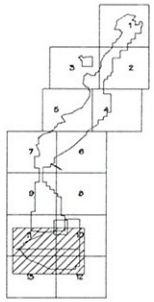
ELEV feet	AREA acres	VOLUME ac-ft	CUM VOLUME ac-ft
5264	0.93	0.0	0.00
5266	1.07	2.0	2.0
5268	1.24	2.3	4.3
5270	1.56	2.8	7.1
5272	2.12	3.7	10.8

LEGEND

- ROAD
- WATERSHED
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- 219 5422.45 L-30 LEASE CORNER
- PERMIT/LEASE BOUNDARY

NOTES

1. For hydrology and design information refer to appendix 11-2 in the approved PAP
2. The watershed areas for culverts are shown on Exhibit 11-12F
3. The watershed areas and location for Ponds are shown on Exhibit 11-13F



SCALE AS NOTED

CERTIFICATION STATEMENT

I, Ron C. VAN VALKENBURG, hereby certify that this drawing was reviewed by me and that the information shown is complete and accurate to the best of my knowledge.

RON C. VAN VALKENBURG NEW MEXICO 9263 LICENSED PROFESSIONAL ENGINEER

REVISION	DATE
1 SUBMITTED TO DOM FOR APPROVAL	08/31/09
2	
3	
4	

PROJECT MANAGER FG
PAGE of RECORD REV
REF NO 9263
SHEET of RECORD REV NO

bhpbilliton
BHP NAVAJO COAL CO.
PO BOX 1117 FARMINGTON NEW MEXICO 87499 TEL 505 598 3161 FAX 505 598 3163

ACCOUNT
DATE AUGUST 21, 2009
DRAWN BY EV
CHECKED BY RCVV
APPROVED BY MCF

PLAN, PROFILE AND SECTIONS

EXHIBIT 11-5
SPECIAL NORTH
POND #05
Design

DRAWING

SHEET 1
REV 1

Appendix B

SITE PHOTOGRAPHS

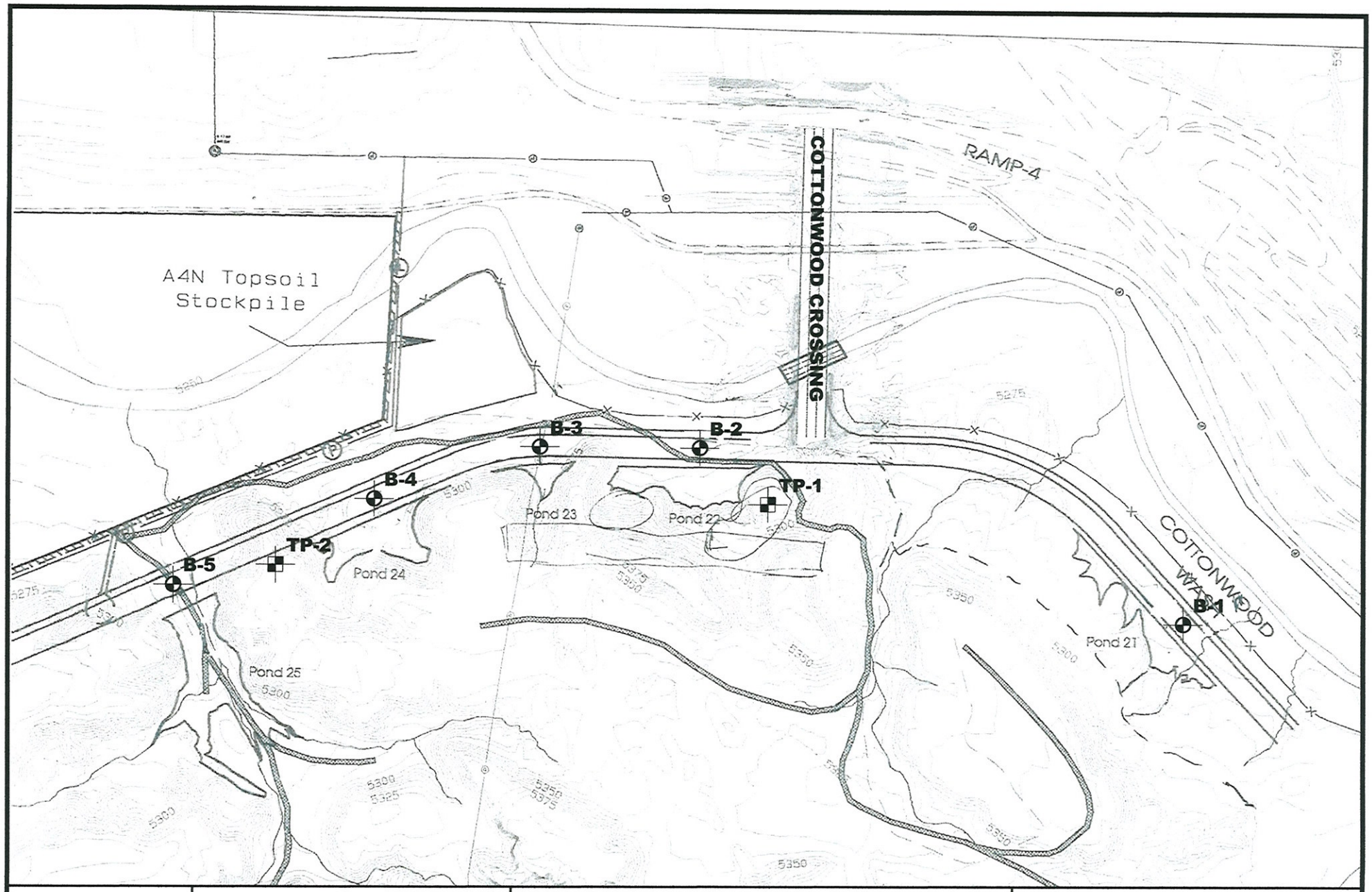
Test Pit TP-1 (Borrow Site)

Borrow Material from Test Pit TP-1

Drill Rig at Pond 405

Test Pit TP-2 (Borrow Site)

APPENDIX C



Approximate Not to Scale	SITE PLAN Boring Locations (approximate) GEOMAT Project No. 92-0893 Date Test Pits Excavated: 8-10-09 Date Borings Drilled: 8-10-09	PROJECT A4N Pond Embankment Stability Analysis Navajo Mine Area 4 North San Juan County, New Mexico

GEOMAT INC

Appendix 11-I

GEOMAT INC.
2060 Afton Place
Farmington, NM 87401
Tel (505) 327-7928
Fax (505) 326-5721

Borehole B-1

Project Name:	A4N Pond Embankment Stability	Date Drilled:	8/10/2009
Project Number:	92-0893	Latitude:	Not Determined
Client:	BHP Billiton	Longitude:	Not Determined
Site Location:	Navajo Mine Area 4 North	Elevation:	Not Determined
Rig Type:	CME-45	Boring Location:	See Site Plan
Drilling Method:	4" O.D. Solid Stem Auger	Groundwater Depth:	None Encountered
Sampling Method:	Ring and Split spoon samples	Logged By:	Don Baldwin
Hammer Weight:	140 lbs	Remarks:	Pond 401
Hammer Fall:	30 inches		

Laboratory Results: Dry Density (pcf)	% Passing #200 Sieve	Plasticity Index	Moisture Content (%)	Blows per 6"	Sample Type & Length (in)	Recovery	USCS	Soil Symbol	Depth (ft)	Soil Description
									1	SILTY SAND with trace gravel, gray, fine-grained, loose, dry to moist, weak cementation
									2	
									3	
									4	
106.4	24		2.9	3-7-10	MC 18				5	
									6	
									7	
									8	
									9	
				5-5-8	MC 18		SM		10	color change to dark gray
									11	trace of fine-grained organic material
									12	
									13	
									14	
				2-11-15	MC 18				15	
									16	becoming medium dense white salt stringers
									17	coal fragments
									18	
									19	
				3-6-8	SS 18				20	
									21	
									22	Total Depth 21.5 feet
									23	
									24	
									25	

A = Auger Cuttings GRAB = Hand Sample MC = Modified California (Ring Sample) SS = Split Spoon

GEOMAT 92-0893.GPJ GEOMAT.GDT 08/26/09

GEOMAT INC.
2060 Afton Place
Farmington, NM 87401
Tel (505) 327-7928
Fax (505) 326-5721

Borehole B-2

Project Name:	A4N Pond Embankment Stability	Date Drilled:	8/10/2009
Project Number:	92-0893	Latitude:	Not Determined
Client:	BHP Billiton	Longitude:	Not Determined
Site Location:	Navajo Mine Area 4 North	Elevation:	Not Determined
Rig Type:	CME-45	Boring Location:	See Site Plan
Drilling Method:	4" O.D. Solid Stem Auger	Groundwater Depth:	20.5 feet (approx) during drilling
Sampling Method:	Modified California with Rings	Logged By:	Don Baldwin
Hammer Weight:	140 lbs	Remarks:	Pond 402
Hammer Fall:	30 inches		

Laboratory Results: Dry Density (pcf)	% Passing #200 Sieve	Plasticity Index	Moisture Content (%)	Blows per 6"	Sample Type & Length (in)	Recovery	USCS	Soil Symbol	Depth (ft)	Soil Description
									1	SILTY SAND, brown, fine- to medium-grained, loose to medium dense, dry to moist, weak cementation
									2	
									3	
									4	
96.2	13		2.3	7-11-16	MC 18				5	
									6	
									7	
									8	
									9	
				2-4-10	MC 18		SM		10	
									11	
									12	
									13	
									14	
				2-5-12	MC 18				15	fine- to coarse-grained
									16	
									17	
									18	
									19	
				5-12-11	MC 18				20	
									21	▽ groundwater at approximately 20.5 foot depth during drilling
									22	Total Depth 21.5 feet
									23	
									24	
									25	

A = Auger Cuttings GRAB = Hand Sample MC = Modified California (Ring Sample) SS = Split Spoon

GEOMAT 92-0893.GPJ GEOMAT.GDT 08/26/09

GEOMAT INC.
2060 Afton Place
Farmington, NM 87401
Tel (505) 327-7928
Fax (505) 326-5721

Borehole B-3

Project Name:	A4N Pond Embankment Stability	Date Drilled:	8/10/2009
Project Number:	92-0893	Latitude:	Not Determined
Client:	BHP Billiton	Longitude:	Not Determined
Site Location:	Navajo Mine Area 4 North	Elevation:	Not Determined
Rig Type:	CME-45	Boring Location:	See Site Plan
Drilling Method:	4" O.D. Solid Stem Auger	Groundwater Depth:	None Encountered
Sampling Method:	Ring and Split spoon samples	Logged By:	Don Baldwin
Hammer Weight:	140 lbs	Remarks:	Pond 403
Hammer Fall:	30 inches		

Laboratory Results: Dry Density (pcf)	% Passing #200 Sieve	Plasticity Index	Moisture Content (%)	Blows per 6"	Sample Type & Length (in)	Recovery	USCS	Soil Symbol	Depth (ft)	Soil Description
97.2	50	12	6.7	4-8-14	MC 18		SC		1–6	CLAYEY SAND, gray, fine-grained, loose, dry to moist, no cementation
				50/5	MC 5		RK		7–13	SANDSTONE, gray, moderately weathered, moderately soft, weakly to moderately cemented; slightly weathered, moderately hard
				4-12-27	MC 18		RK		14–18	SHALE, dark gray to black, slightly weathered, moderately hard, weakly fissile, waxy
				32/6	SS 6		RK		19–20	COAL, black, fresh, moderately hard, fractured
									21–25	Total Depth 20.5 feet

A = Auger Cuttings GRAB = Hand Sample MC = Modified California (Ring Sample) SS = Split Spoon

GEOMAT 92-0893.GPJ GEOMAT.GDT 08/26/09

GEOMAT INC.
2060 Afton Place
Farmington, NM 87401
Tel (505) 327-7928
Fax (505) 326-5721

Borehole B-4

Project Name:	A4N Pond Embankment Stability	Date Drilled:	8/10/2009
Project Number:	92-0893	Latitude:	Not Determined
Client:	BHP Billiton	Longitude:	Not Determined
Site Location:	Navajo Mine Area 4 North	Elevation:	Not Determined
Rig Type:	CME-45	Boring Location:	See Site Plan
Drilling Method:	4" O.D. Solid Stem Auger	Groundwater Depth:	None Encountered
Sampling Method:	Modified California with Rings	Logged By:	Don Baldwin
Hammer Weight:	140 lbs	Remarks:	Pond 404
Hammer Fall:	30 inches		

Laboratory Results: Dry Density (pcf)	% Passing #200 Sieve	Plasticity Index	Moisture Content (%)	Blows per 6"	Sample Type & Length (in)	Recovery	USCS	Soil Symbol	Depth (ft)	Soil Description
							SC		1–5	CLAYEY SAND with gravel, gray, fine- to medium-grained, loose, dry to moist, no cementation
				4-9-15	MC 18					
							RK		6	SHALE, gray, moderately weathered, moderately soft
							RK		7–13	SANDSTONE, gray, fine- to coarse-grained, slightly weathered, moderately hard, moderately cemented
				9-29-50/5	MC 17					
							RK		14–18	COAL, black, fresh, moderately hard, fractured
				9-50/4	MC 10					
							RK		19–20	SILTSTONE grading to SHALE, gray, fresh, moderately hard
				19-50/2	MC 8					
									21–25	Total Depth 20.7 feet

A = Auger Cuttings GRAB = Hand Sample MC = Modified California (Ring Sample) SS = Split Spoon

GEOMAT 92-0893.GPJ GEOMAT.GDT 08/26/09

GEOMAT INC.
2060 Afton Place
Farmington, NM 87401
Tel (505) 327-7928
Fax (505) 326-5721

Borehole B-5

Project Name:	A4N Pond Embankment Stability	Date Drilled:	8/10/2009
Project Number:	92-0893	Latitude:	Not Determined
Client:	BHP Billiton	Longitude:	Not Determined
Site Location:	Navajo Mine Area 4 North	Elevation:	Not Determined
Rig Type:	CME-45	Boring Location:	See Site Plan
Drilling Method:	7" O.D. Hollow Stem Auger	Groundwater Depth:	None Encountered
Sampling Method:	Ring and Split spoon samples	Logged By:	Don Baldwin
Hammer Weight:	140 lbs	Remarks:	Pond 405
Hammer Fall:	30 inches		

Laboratory Results: Dry Density (pcf)	% Passing #200 Sieve	Plasticity Index	Moisture Content (%)	Blows per 6"	Sample Type & Length (in)	Recovery	USCS	Soil Symbol	Depth (ft)	Soil Description
							SC		1, 2, 3, 4	CLAYEY SAND with gravel, gray, fine- to medium-grained, loose, dry to moist, no cementation
				7-21-51	MC 18		RK		5	SANDSTONE, brown, fine-grained, highly weathered, soft, weakly cemented
							RK		6, 7, 8	COAL, black, fresh, moderately hard, fractured
				50/2	MC 2		RK		9, 10, 11, 12	SANDSTONE, gray, fine- to medium-grained, fresh, moderately hard, moderately cemented
				50/3	SS 3				13	auger refusal at 13 foot depth on sandstone
									14	Total Depth 13.3 feet
									15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25	

A = Auger Cuttings GRAB = Hand Sample MC = Modified California (Ring Sample) SS = Split Spoon

GEOMAT 92-0893.GPJ GEOMAT.GDT 08/26/09

PROJECT A4N Pond Embankment Stability
Navajo Mine Area 4 North

JOB NO. 92-0893 **DATE** 08/10/09

LOG OF TEST PIT NO. TP-1

LOGGED BY George Madrid
BACKHOE TYPE JD 310SJ
LOCATION See Site Plan
SURFACE ELEV. Not Determined **DATUM** N/A

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					SC		CLAYEY SAND, brown, fine- to medium-grained, loose, dry, no cementation
1			D				PI = 16 -200 = 30%
2							
					RK		SANDSTONE, brown, fine- to medium-grained, moderately weathered, moderately soft, moderate cementation, fractured
3							
					RK		SILTSTONE, gray, moderately weathered, moderately soft (PARTING)
4							
5							
6			D				PI = 15 -200 = 32
7							
8							
9							
10							Test pit completed at 10 foot depth No groundwater encountered

SAMPLE TYPE

B - Undisturbed Block Sample
D - Disturbed Bulk Sample
U - 3" O.D. 2.42" I.D. tube sample

GEOMAT INC.

GEOTECH TP2 92-0893 TP.GPJ AGRA ALB.GDT 08/26/09

PROJECT A4N Pond Embankment Stability
Navajo Mine Area 4 North

JOB NO. 92-0893 **DATE** 08/10/09

LOG OF TEST PIT NO. TP-2

LOGGED BY George Madrid
BACKHOE TYPE JD 310SJ
LOCATION See Site Plan
SURFACE ELEV. Not Determined **DATUM** N/A

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					SC		CLAYEY SAND, brown, fine- to medium-grained, loose, dry, no cementation
1							
2							
3					RK		SILTSTONE, gray, moderately weathered, moderately soft (PARTING)
4							
5							
6							
7							
8							
9							
10							Test pit completed at 10 foot depth No groundwater encountered

SAMPLE TYPE

B - Undisturbed Block Sample
D - Disturbed Bulk Sample
U - 3" O.D. 2.42" I.D. tube sample

GEOMAT INC.

GEOTECH TP2 92-0893 TP.GPJ AGRA ALB.GDT 08/26/09

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions			Group Symbols	Typical Names
Coarse-Grained Soils More than 50% retained on No. 200 sieve	**Gravels** 50% or more of coarse fraction retained on No. 4 sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils 50% or more passes No. 200 sieve	**Silts and Clays** Liquid Limit 50 or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays Liquid Limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous free sands or silts, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, mucic & other highly organic soils

CONSISTENCY OR RELATIVE DENSITY CRITERIA

Standard Penetration Test
Density of Granular Soils

Penetration Resistance, N (blows/ft.)	Relative Density
0-4	Very Loose
5-10	Loose
11-30	Medium Dense
31-50	Dense
>50	Very Dense

Standard Penetration Test
Density of Granular Soils

Penetration Resistance, N (blows/ft.)	Consistency	Unconfined Compressive Strength (Tons/ft2)
<2	Very Soft	<0.25
2-4	Soft	0.25-0.50
4-8	Firm	0.50-1.00
8-15	Stiff	1.00-2.00
15-30	Very Stiff	2.00-4.00
>30	Hard	>4.0

U.S. Standard Sieve Sizes	3"	3/4"	#4		#10		#40	#200
Unified Soil Classification	Cobbles	Gravel		Sand				Silt or Clay
		coarse	fine	coarse	medium	fine		

MOISTURE CONDITIONS

Dry	Absence of moist, dusty, dry to the touch
Slightly Damp	Below optimum moisture content for compaction
Moist	Near optimum moisture content, will moisten the hand
Very Moist	Above optimum moisture content
Wet	Visible free water, below water table

MATERIAL QUANTITY

trace	0-5%
few	5-10%
little	10-25%
some	25-45%
mostly	50-100%

OTHER SYMBOLS

R Ring Sample
S SPT Sample
B Bulk Sample
▼ Ground Water

BASIC LOG FORMAT:

Group name, Group symbol, (grain size), color, moisture, consistency or relative density. Additional comments: odor, presence of roots, mica, gypsum, coarse particles, etc.

EXAMPLE:

SILTY SAND w/trace silt (SM-SP), Brown, loose to med. Dense, fine to medium grained, damp

UNIFIED SOIL CLASSIFICATION SYSTEM

TEST DRILLING EQUIPMENT & PROCEDURES

Description of Subsurface Exploration Methods

Drilling Equipment – Truck-mounted drill rigs powered with gasoline or diesel engines are used in advancing test borings. Drilling through soil or softer rock is performed with hollow-stem auger or continuous flight auger. Carbide insert teeth are normally used on bits to penetrate soft rock or very strongly cemented soils which require blasting or very heavy equipment for excavation. Where refusal is experienced in auger drilling, the holes are sometimes advanced with tricone gear bits and NX rods using water or air as a drilling fluid.

Sampling Procedures - Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In most cases, 2" outside diameter, 1 3/8" inside diameter, samplers are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3" outside diameter samplers lined with 2.42" inside diameter brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samplers in 6-inch increments. These values are expressed in blows per foot on the boring logs. However, in stratified soils, driving resistance is sometimes recorded in 2- or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. "Undisturbed" sampling of softer soils is sometimes performed with thin-walled Shelby tubes (ASTM D1587). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Where samples of rock are required, they are obtained by NX diamond core drilling (ASTM D2113).

Boring Records - Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the logs.

LAB NO.	BORING NO.	SAMPLE DEPTH (ft)	ASTM D698		MOISTURE CONT. (%)	DENSITY		ATTERBERG LIMITS			SWELL (%)	PHI ANGLE (degrees)	% PASS #200 SIEVE	CLASSIFICATION	
			Density	Moisture		WET (pcf)	DRY (pcf)	LL	PL	PI					
7959	TP-1	0 - 2.5	111.8	15.9				34	18	16			30	SC	Clayey SAND w/ trace gravel
7960	TP-1	3.5 - 10.0	107.6	18.3				36	21	15			32	GC	Clayey GRAVEL w/ sand
7978	B-1	5.0			2.9	109.5	106.4						24	SM	Silty SAND
7979	B-1	10.0										33.9		SM	Silty SAND
7980	B-2	5.0			2.3	98.4	96.2	NLL	NPL	NP			13	SM	Silty SAND
7981	B-2	10.0										33.0		SM	Silty SAND
7982	B-3	5.0			6.7	103.7	97.2	29	17	12			50	SC/CL	Clayey SAND/Sandy CLAY

GEOMAT INC.

SUMMARY OF SOIL TESTS

Project	Area 4 North Pond Embankments
Job No.	92-0893
Location	BHP Navajo Mine
Date Drilled	8/10/2009

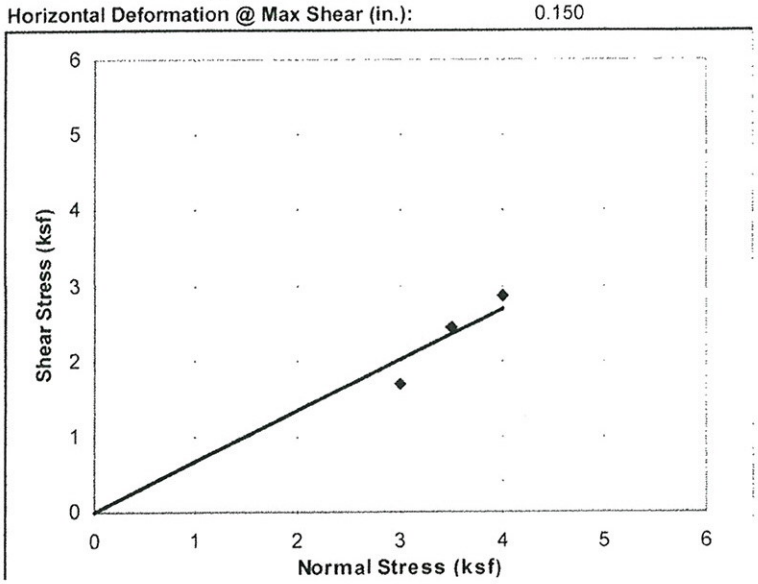
amec

Client:	Geomat, Inc. 2060 Afton Place Farmington, NM 87401-	**Report Date:**	August 21, 2009
		Project #:	8-519-005130
		Work Order #:	11
Attn:	George Madrid	**Lab #:**	9-0928-01
		Sampled By:	D. Baldwin
Project Name:	GeoMat 2008 Miscellaneous Testing Various Locations Farmington, NM	**Date Sampled:**	08/10/2009
		Visual Description of Material:	Geomat/Soil Sample #7979
		Sample Source:	Area 4 North Pond Embankments/ BH B-1 @ 10' Project #92-0893
Project Manager:	Robert Romero		

SOILS / AGGREGATES

Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D3080-04)

Direct Shear Point Number:	1	2	3
Initial Diameter of specimen (in.):	2.42	2.42	2.42
Initial Thickness of specimen (in.):	1.00	1.00	1.00
Dry Mass of Specimen (g):	97.5	104.8	108.5
Initial Moisture (%):	8.8%	9.2%	9.2%
Initial Wet Density (pcf):	88.1	94.8	98.1
Initial Dry Density (pcf):	81.0	86.8	89.8
Final Thickness of specimen (in.)::	0.98	0.99	0.99
Final Moisture (%):	7.6%	8.6%	7.2%
Final Wet Density (pcf):	88.8	95.3	97.4
Final Dry Density (pcf):	82.5	87.7	90.9
Normal Stress (ksf):	3.00	3.50	4.00
Maximum Shearing Stress (ksf):	1.7	2.4	2.9
Vertical Deformation @ Max Shear (in.):	-0.003	0.002	0.011
Horizontal Deformation @ Max Shear (in.):	0.150	0.155	0.170



Shearing Device Used:
Geomatic Direct Shear Apparatus, Model 8914

Rate of Deformation (in./min.):	0.015
Internal Friction Angle (deg.):	33.9
Cohesion (kips/sq.ft.):	0.0000

Reviewed By: for Bob R.
hg

Distribution: Client ✓ File: ✓ Supplier: ✓ Other: Addressee (1)
Email: George Madrid (email) (1)
(1)

AMEC Earth Environmental, Inc.
8519 Jefferson NE
Albuquerque, NM 87113
Tel 5058211801
Fax 5058217371
www.amec.com

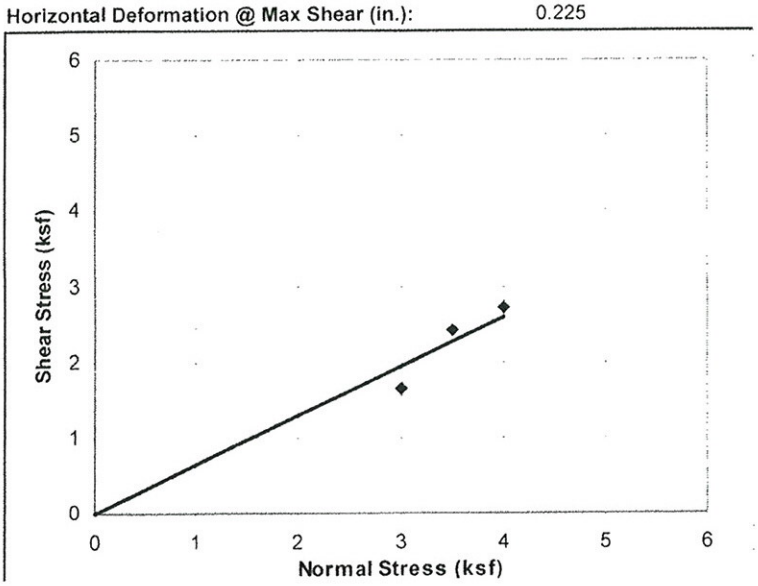
amec

Client:	Geomat, Inc. 2060 Afton Place Farmington, NM 87401-	**Report Date:**	August 21, 2009
		Project #:	8-519-005130
		Work Order #:	11
Attn:	George Madrid	**Lab #:**	9-0928-02
		Sampled By:	D. Baldwin
Project Name:	GeoMat 2008 Miscellaneous Testing Various Locations Farmington, NM	**Date Sampled:**	08/10/2009
		Visual Description of Material:	Geomat/Soil Sample #7981
		Sample Source:	Area 4 North Pond Embankments/ BH B-2 @ 10' Project #92-0893
Project Manager:	Robert Romero		

SOILS / AGGREGATES

Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D3080-04)

Direct Shear Point Number:	1	2	3
Initial Diameter of specimen (in.):	2.42	2.42	2.42
Initial Thickness of specimen (in.):	1.00	1.00	1.00
Dry Mass of Specimen (g):	132.7	129.2	129.3
Initial Moisture (%):	2.9%	3.0%	2.5%
Initial Wet Density (pcf):	113.5	110.7	110.2
Initial Dry Density (pcf):	110.3	107.4	107.5
Final Thickness of specimen (in.)::	0.99	1.00	0.99
Final Moisture (%):	2.0%	2.3%	1.9%
Final Wet Density (pcf):	113.8	110.2	110.3
Final Dry Density (pcf):	111.6	107.8	108.2
Normal Stress (ksf):	3.00	3.50	4.00
Maximum Shearing Stress (ksf):	1.6	2.4	2.7
Vertical Deformation @ Max Shear (in.):	0.001	0.007	0.013
Horizontal Deformation @ Max Shear (in.):	0.225	0.150	0.210



Shearing Device Used:
Geomatic Direct Shear Apparatus, Model 8914

Rate of Deformation (in./min.):	0.015
Internal Friction Angle (deg.):	33.0
Cohesion (kips/sq.ft.):	0.0000

Reviewed By: for Bob R.
hg

Distribution: Client ✓ File: ✓ Supplier: ✓ Other: Addressee (1)
Email: George Madrid (email) (1)
(1)

AMEC Earth Environmental, Inc.
8519 Jefferson NE
Albuquerque, NM 87113
Tel 5058211801
Fax 5058217371
www.amec.com

APPENDIX 23.E

SLOPE STABILITY SUMMARY

To demonstrate that all cut and fill slopes, regraded areas and embankments are stable, representative structures were selected on which to conduct stability analyses. Criteria for site selection included foundation material, embankment material, slope angle, safety and environmental concerns and use of the structure.

An inventory was made of all ponds, impoundments, embankments (cut and fill) and regrade areas. These structures were all examined in the field to determine their status. Notes were made as to the presence or absence of water, spillways, slope failures, seepage, and piping. The relative size of each structure was noted along with any potential safety or environmental hazards if the structure were to fail. Excessively steep slopes were also noted as were any conditions resulting from erosion. An assessment was made of the soil types forming both the structure itself and its foundation. All of this information, along with any unusual conditions seen during the field visits, was compiled to allow selection of representative structures for analysis.

It was originally thought that soil types would be useful in cataloging the structures. However, almost all of the structures were found to be composed of and sitting on a sandy clay type soil. Little difference is visible in the field from one structure to the next. Since this criteria is important, the soils section of the Permit Application Package (PAP) was examined to determine the soil types and their relative

proportions. This information was combined with data from "Soil Survey of San Juan County" by the Soil Conservation Service in which the various soils were evaluated as to their ability to form embankments, dikes and levees. Soils which received unfavorable comments as to their suitability for use as embankments, etc. were found to cover more than eighty percent of the permit area. A decision was made to treat all of the structures as if they were built on and of material which is not normally considered satisfactory. Hence, soil type was not used as a selection criterion. Selections were made based on size, steepness of slope, existence of seepage or other visible concerns and on potential safety and environmental problems. Ponds whose designs had already been examined and approved by OSMRE were eliminated. Totally incised structures were also eliminated as they have no dam or other structure to fail. A listing of the structures considered, their associated selection criteria and a brief description of why or why they were not selected for testing is given on TABLE 11-I-1. A steeply slope regrade area was selected as a worst case representative of the regraded spoils. The structures selected for stability analyses are listed below.

STRUCTURE AND REASON FOR SELECTION

Big Fill

Largest fill on permit area. Fill was not compacted and structure has had previous problem with piping and has had a small surficial slope failure. Drainage pipes were installed to keep water from ponding on and soaking into the structure.

Stub 17 Large Impoundment

Largest dam structure of the impoundments. Structure was not compacted.

Elms Embankment 2

Largest impounding haulroad embankment.

Area III Shop Pond

Dam has steep sides and has had significant erosional damage. The largest of the two sediment ponds which have not been previously approved.

Lowe Impoundment 13

Structure is representative of those built by Comstock and other pond-like impoundments and has the largest dam structure.

Lowe Railroad

Largest embankment (fill) on permit area Embankment 1 without a culvert. Water has previously impounded to a maximum depth of 5 feet. Embankment forms part of the railroad. Seepage from base occurs when water is present.

Barber Regrade

Steep regraded spoils with no compaction. Area is located by the railroad near North Barber.

Big Fill Stability Analysis

Two different stability analyses have been conducted on the Big Fill and are included in the permit package. The first is kept on file at the Environmental Quality Department of the Navajo Mine, and is a determination of static stability. The report indicates that the Big Fill would have a minimum static stability safety factor greater than 1.5 if certain remedial actions were taken. Those actions were all completed in 1985. The second stability analysis is kept on file at the Environmental Quality Department of the Navajo Mine and is a seismic stability analysis of the structure. The minimum seismic safety factor was found to be 1.2 under conservative assumptions.

The Big Fill stands alone and is not representative of any other structure on the mine. It was built using a dragline which excavated nearby material and placed it without compaction in the desired location. This construction method led to the problems experienced by the structure in subsequent years. The other fill structures associated with the railroad were compacted and have all retained their integrity over the years.

Stub 17 Large Impoundment

Stub 17 Large Impoundment was chosen for stability analysis because it is the largest of the impoundment structures constructed without compaction along the Barber highwall. Structures of like construction include Stub 17 small Impoundment and Stub 18 Impoundment. Results of the analysis, as detailed on file at the Environmental Quality Department of the Navajo Mine, indicate a minimum static factor of 1.2 and a minimum seismic factor of safety of 1.0.

No plans have been made to modify the structures to increase the safety factors as all of them will be mined through in the next few years.

Elms Embankment 2 (Standpipe)

Elms Embankment 2 (Standpipe) was selected for analysis because it is the largest of the impounding haulroad embankments. Other haulroad embankments also impound water along the same stretch of road. Results of the analysis, as detailed on file at the Environmental Quality Department of the Navajo Mine, shows a minimum static factor of safety of 1.2 and a minimum seismic factor of safety of 1.1.

The road has been modified since the analysis was made and is now approximately 70 feet wide at the crest. This widening also affected the other haulroad embankments which impound water.

Area III Shop Pond

Area III Shop Pond is representative of the sediment control ponds constructed when facilities were built for Area III development.

Those ponds include Area III Shop Pond, Area III Complex Pond and Lowe Stockpile Pond. Since Area III Shop Pond is the only one to have suffered any damage over the years it was analyzed for stability. Results of the analysis, as detailed on file at the Environmental Quality Department of the Navajo Mine, indicates that the structure has a minimum static factor of safety of 1.5 and a minimum seismic factor of safety of 3.7.

To control overtopping, an additional pond was constructed upstream of the structure to reduce runoff into the structure. The new pond is off the permit area and was built to Bureau of Indian Affairs specifications and now serves as a stock watering pond.

Lowe Impoundment 13

When Lowe pit was opened, five impoundments were constructed upstream of the workings to prevent water from flowing into the pit. The impoundment with the largest dam structure, Lowe Impoundment 13, was selected as a worst case representative of these impoundments and was subjected to stability analysis. Results of the analysis, as detailed on file at the Environmental Quality Department of the Navajo Mine, shows a minimum static factor of safety of 4.0 and a minimum seismic factor of safety of 2.9.

Lowe Railroad Embankment 1

Lowe Railroad Embankment 1 is directly representative of the two culvertless railroad embankments and is worse case representative of the embankments with culvert as they will not impound water. Unlike the Big Fill, these structures were compacted and the results of the stability analysis reflect the better construction practice. The stability analysis, as detailed on file at the Environmental Quality Department of the Navajo Mine, indicates that the embankment has a minimum static factor of safety of 3.4. Seismic stability was not determined.

North Barber Regrade

North Barber Regrade, a steep (4:1) regraded spoil slope, was selected as a worst case representative to determine static stability on regraded spoils. Results of the analysis, as detailed on file at the Environmental Quality Department of the Navajo Mine, shows that the slope is very stable with a minimum factor of safety of 9.7.

Table 11-I-1 (1 of 6)
SLOPE STABILITY STRUCTURES

NAME	SOIL TYPE SURROUNDING	FOUNDATION	SIZE	COMMENTS	TEST: REASONING
North Sewer Pond	Sandy Clay	Same	Medium	Lined, well engineered mostly incised pond	No. Previously approved.
Area III Sewer	Sandy clay	Same	Large	Lined, well engineered, mostly incised pond.	No, well engineered, lined, incised.
Barber Loadout Pond	Sandy clay	Same	Large	Pond is totally incised.	No, well engineered
Sediment Pond 1, Cell A	Sandy clay	Same	Medium	Design accepted by OSMRE.	No. Previously approved.
Sediment Pond 1, Cell B	Sandy clay	Same	Medium	Design accepted by OSMRE.	No. Previously approved.
Sediment Pond 1, Cell A	Sandy clay	Same	Large	Design accepted by OSMRE.	No. Previously approved.
Sediment Pond 5	Sandy clay	Same	Small	Design accepted by OSMRE.	No. Previously approved.
Emma's Pond	Sand with some clay	Same	Small	Standpipe type spillway behind small dam structure.	No. Previously approved.
Pinto Pond	Sand, sandstone	Same	Small	Pond is incised.	No. Previously approved.
Hosteen Stockpile	Sandy clay	Coal seam	Large	Dam is 4-5 times higher than on other sedimentation pond Pond is large and has some sandy clay soil. Design has already been accepted by OSMRE.	No. Previously approved

Table 11-I-1 (2 of 6)
SLOPE STABILITY STRUCTURES

NAME	SOIL TYPE SURROUNDING	FOUNDATION	SIZE	COMMENTS	TEST: REASONING
Barber Stock-pile Pond 1	Sandy Clay	Same	Medium	Incised pond with mild slopes.	No. Previously approved.
Barber Stock-pile Pond 2	Sandy clay	Same	Medium	Incised pond with mild slopes.	No. Previously approved.
Area III Shop Pond	Sandy clay	Same	Medium	Dam structure has steep Slopes.	Yes. Possible steep slope failure.
Area III Comples Pond	Sandy clay	Same	Small	Small dam with moderately steep slope.	No. Small incised.
Lowe Stock-pile Pond	Badlands	Same	Small	Partially incised, max height 6 feet slopes not excessively steep.	No. Small incised.
Stub 17 Impoundment	Sandy clay	Same	Small	Impounded only slight amounts of water in the past, dam is approximately 15' high with steep sides.	No. Small structure and drainage basin.
Stub 17 Large Impoundment	Sandy clay	Same	Large	Has failed to meet seismic stability requirements in the past. Slope will be modified.	Stability tested
Stub 18 Impoundment	Sandy clay	Same	Medium	Spillway has never passed any water.	No.
Lowe Impoundment 10	Sandy clay	Same	Medium	Largely incised, no water, small drainage basin.	No, Small drainage, engineered

Table 11-I-1 (3 of 6)

SLOPE STABILITY STRUCTURES

NAME	SOIL TYPE SURROUNDING	FOUNDATION	SIZE	COMMENTS	TEST: REASONING
Lowe Impoundment 11	Sandy Clay	Same	Medium	Totally incised, no failures of any type.	No. Totally incised, well engineered.
Lowe Impoundment 12	Sandy clay	Same	Medium	Totally incised, no failures of any type.	No. Totally incised well engineered
Lowe Impoundment 13	Sandy clay	Same	Medium	Maximum dam height of 7', no failures of any type.	Yes. Largest Lowe impoundment not incised.
Lowe Impoundment 14	Sandy clay	Same	Large	Totally incised, no failures of any type.	No. Totally incised well engineered
Area III Diversion Impoundment 1	Sand, Sandy clay	Shale, Sandy clay	Large	Structure has already been approved by OSMRE.	No. Previously approved.
Area III Diversion Impoundment 2	Sandy clay	Shale	Large	Structure has already been approved by OSMRE.	No. Previously approved.
Area III Diversion Impoundment 3	Sandy clay	Shale	Large	Structure has already been approved by OSMRE.	No. Previously approved.
Elms Embankment 1	Sandy clay	Same	Small	Embankment formed road, very wide. No culvert	No. Small

Table 11-I-1 (4 of 6)
SLOPE STABILITY STRUCTURES

NAME	SOIL TYPE SURROUNDING	FOUNDATION	SIZE	COMMENTS	TEST: REASONING
Elms Embankment 2	Sandy Clay	Same	Large	Has been analyzed for seismic stability. No culvert.	Stability tested.
Elms Embankment 3	Sandy clay	Same	Small	Embankment formed by road, very wide. No culvert.	No. Small
Elms Embankment 4	Sandy clay	Same	Small	Embankment formed by road, very wide. No culvert.	No. Small
Elms Embankment 5	Sandy clay	Same	Small	Embankment formed by road. No culvert.	No. Small
Elms Embankment 6	Sandy clay	Same	Small	Embankment formed by road. No culvert.	No. Small
Area III Embankment	Sandy clay	Same	Large	Embankment is 20' high and more than 170' wide. No culvert.	No. Very similar to Elms Embankment 2
Lowe Railroad Embankment 2	Sandy clay	Same with sandstone layers	Large	Large embankment, water seepage from base, small drainage area. No culvert.	No.
Lowe Railroad Embankment 1	Sandy clay	Same	Large	Large embankment, water seepage from base, small drainage area, no culvert.	Yes. Largest culvertless fill.
Neck Road Embankment 1	Sandy clay	Badlands	Large	Large, steep sided, 7' dia. culvert at base.	No. Compacted fill.

Table 11-I-1 (5 of 6)
SLOPE STABILITY STRUCTURES

NAME	SOIL TYPE SURROUNDING	FOUNDATION	SIZE	COMMENTS	TEST: REASONING
Neck Road Embankment 2	Sandy Clay	Badlands	Large	Large, steep sided, 30' dia. culvert at base.	No. Fill was compacted.
Pinto RR Embankment 1	Sandy clay	Same	Small	Two culvert; 4'drain and a 7' dia. livestock access.	No. Small
Pinto RR Embankment 2	Clayey sand	Sand, some sandstone	Medium	4' dia. drain culvert in excellent shape.	No. Small
Pinto RR Embankment 4	Sandy clay	Same	Small	Concrete drain culvert in excellent shape.	No. Small compacted fill.
Big Fill	Sandy clay	Same	Huge	Concrete drain culvert in excellent shape. Fill was not compacted.	Tested for static and seismic stability.
Hosteen RR Embankment	Sandy clay	Badlands	Large	Concrete drain culvert in excellent shape 5' diameter.	No. Compacted fill
Barber RR Embankment 1	Sandy clay	Same with sandstone	Small	Concrete drain culvert in excellent shape 4' diameter.	No. Compacted fill
Barber RR Embankment 2	Sandy clay	Same	Small	18" diameter culvert excellent shape.	No. Small
Updip Barber RR Embankment 1	Sandy clay	Same	Small	24" diameter culvert excellent shape.	No. Small
Updip Barber RR Embankment 2	Sand	Sandy clay	Small	30" diameter culvert excellent shape.	No. Small

Table 11-I-1 (6 of 6)
SLOPE STABILITY STRUCTURES

NAME	SOIL TYPE SURROUNDING	FOUNDATION	SIZE	COMMENTS	TEST: REASONING
Updip Barber RR Embankment 3	Sandy Clay Sandstone	Same	Small	30" diameter culvert excellent shape.	No. Small
Updip Barber RR Embankment 4	Sandy clay	Same	Small	24" diameter culvert excellent shape.	No. Small
Updip Barber RR Embankment 5	Sandy clay	Same	Large	Culvert exit end tends to silt in.	No. Compacted fill.
Neck RR Embankment 1	Sandy clay	Badlands	Large	10' diameter culvert in excellent condition.	No. Compacted fill.
Neck RR Embankment 2	Sandy clay	Badlands	Large	30' diameter culvert in excellent condition.	No. Compacted fill.

Appendix 23.F

Barber By-Pass Road

Roadway Side Ditch Design

November 2002

Barber By-pass Road

Roadway side ditch design. See attached Figure A for watershed area and Sedcad model.

LR

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87415

Phone: 505-598-5861

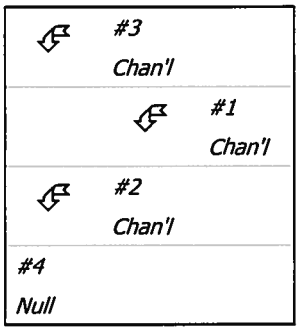
General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	5 yr - 6 hr
Rainfall Depth:	1.100 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#2	0.112	0.367	Rt side ditch @ 6% max
Channel	#2	==>	#4	0.000	0.000	Rt side ditch @ 1.6 %
Channel	#3	==>	#4	0.000	0.000	Lt side ditch @ 1.6 %
Null	#4	==>	End	0.000	0.000	



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	2.47	47.00	1,900.00	4.71	0.112
#1	**Muskingum K:**					**0.112**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#3	16.700	16.700	3.66	0.24
#1	9.500	9.500	7.25	0.28
#2	26.100	35.600	11.72	0.65
#4	0.000	52.300	15.39	0.90

Structure Detail:

Structure #3 (Erodible Channel)

Lt side ditch @ 1.6 %

Triangular Erodible Channel Inputs:

Material: Spoils w/sandstones cobbles

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	4.0:1	1.6	0.0290	1.00			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.66 cfs	
Depth:	0.64 ft	1.64 ft
Top Width:	3.86 ft	9.86 ft
Velocity:	2.95 fps	
X-Section Area:	1.24 sq ft	
Hydraulic Radius:	0.305	
Froude Number:	0.92	

Structure #1 (Riprap Channel)

Rt side ditch @ 6% max

Triangular Riprap Channel Inputs:

Material: Riprap

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.0:1	2.0:1	6.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	7.25 cfs	
Depth:	0.39 ft	1.39 ft
Top Width:	2.35 ft	8.35 ft

	w/o Freeboard	w/ Freeboard
Velocity*:		
X-Section Area:	0.46 sq ft	
Hydraulic Radius:	0.186	
Froude Number*:		
Manning's n*:		
Dmin:	4.00 in	
D50:	12.00 in	
Dmax:	15.00 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #2 (Erodible Channel)

Rt side ditch @ 1.6 %

Triangular Erodible Channel Inputs:

Material: Spoils w/sandstone cobbles

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.0:1	2.0:1	1.6	0.0290	1.00			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	11.72 cfs	
Depth:	1.00 ft	2.00 ft
Top Width:	5.97 ft	11.97 ft
Velocity:	3.94 fps	
X-Section Area:	2.97 sq ft	
Hydraulic Radius:	0.472	
Froude Number:	0.98	

Structure #4 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	16.700	0.159	0.000	0.000	83.000	M	3.66	0.242
	Σ	**16.700**						**3.66**	**0.242**
#1	1	9.500	0.055	0.000	0.000	89.000	M	7.25	0.276
	Σ	**9.500**						**7.25**	**0.276**
#2	1	26.100	0.194	0.000	0.000	83.000	M	5.38	0.379
	Σ	**35.600**						**11.72**	**0.654**
#4	Σ	**52.300**						**15.39**	**0.896**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	10.31	33.00	320.00	3.210	0.027
		8. Large gullies, diversions, and low flowing streams	5.21	37.00	710.00	6.840	0.028
#1	**1**	**Time of Concentration:**					**0.055**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	4.89	43.00	880.01	2.210	0.110
		8. Large gullies, diversions, and low flowing streams	1.39	15.00	1,080.00	3.530	0.084
#2	**1**	**Time of Concentration:**					**0.194**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	12.14	85.00	700.00	3.480	0.055
		8. Large gullies, diversions, and low flowing streams	1.61	23.00	1,430.00	3.800	0.104
#3	**1**	**Time of Concentration:**					**0.159**

General Information

Storm Information:

Storm Type:	NRCS Type II-60
Design Storm:	10 yr - 6 hr
Rainfall Depth:	1.300 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#3	16.700	16.700	5.80	0.38
#1	9.500	9.500	9.67	0.38
#2	26.100	35.600	17.05	0.97
#4	0.000	52.300	22.85	1.35

Structure Detail:

Structure #3 (Erodible Channel)

Lt side ditch @ 1.6 %

Triangular Erodible Channel Inputs:

Material: Spoils w/sandstones cobbles

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	4.0:1	1.6	0.0290	1.00			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	5.80 cfs	
Depth:	0.76 ft	1.76 ft
Top Width:	4.59 ft	10.59 ft
Velocity:	3.31 fps	
X-Section Area:	1.76 sq ft	
Hydraulic Radius:	0.363	
Froude Number:	0.94	

Structure #1 (Riprap Channel)

Rt side ditch @ 6% max

Triangular Riprap Channel Inputs:

Material: Riprap

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.0:1	2.0:1	6.0	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	9.67 cfs	
Depth:	0.43 ft	1.43 ft
Top Width:	2.57 ft	8.57 ft

	w/o Freeboard	w/ Freeboard
Velocity*:		
X-Section Area:	0.55 sq ft	
Hydraulic Radius:	0.203	
Froude Number*:		
Manning's n*:		
Dmin:	5.00 in	
D50:	15.00 in	
Dmax:	18.75 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #2 (Erodible Channel)

Rt side ditch @ 1.6 %

Triangular Erodible Channel Inputs:

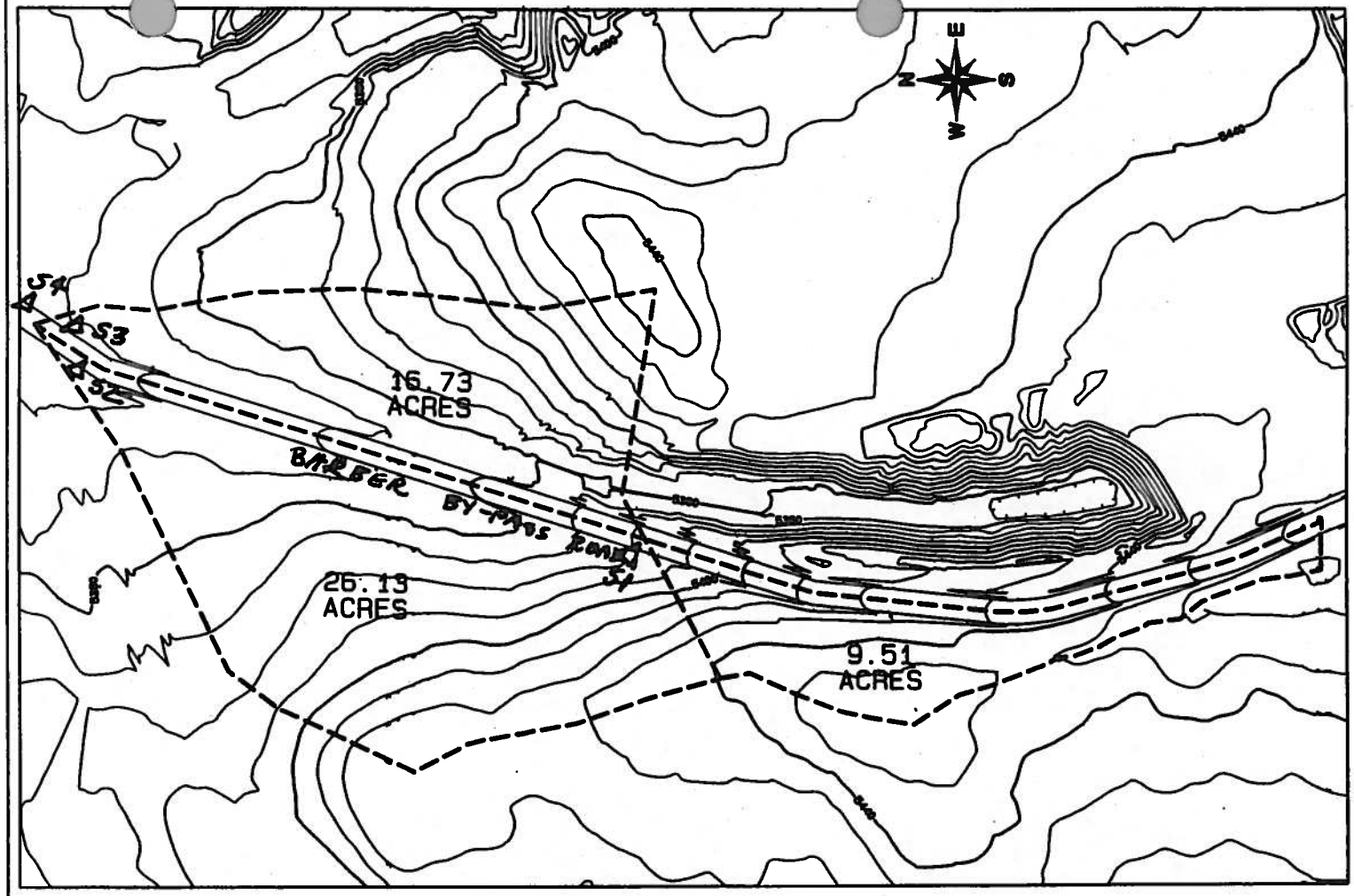
Material: Spoils w/sandstone cobbles

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.0:1	2.0:1	1.6	0.0290	1.00			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	17.05 cfs	
Depth:	1.15 ft	2.15 ft
Top Width:	6.87 ft	12.87 ft
Velocity:	4.33 fps	
X-Section Area:	3.94 sq ft	
Hydraulic Radius:	0.543	
Froude Number:	1.01	

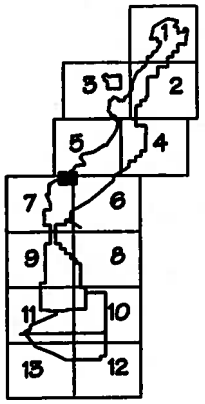
Structure #4 (Null)



SCALE: 1"=500'

LEGEND

- PAVED ROAD
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- RAILROAD
- TREES
- POWERLINE
- ×5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- 5298 INTERMEDIATE CONTOUR
- WATERSHED



REV. NO.	DATE	DRAWN BY	REVISION DESCRIPTION	DRN.	E.P.	P.E.	P.S.	APPROVED
A	04-15-02	RY	SUBMITTED TO OSM FOR APPROVAL		NC	LR	CN	SF

FIGURE A

NAVAJO COAL COMPANY

NAVAJO MINE

P.O. BOX 199 FRUITLAND, NEW MEXICO 87416

BARBER BYPASS ROAD SIDE DITCH WATERSHEDS

PREPARED BY RY	DRAWN BY RY	SCALE AS NOTED
APPROVED BY LR	DATE 11-19-02	REF DWG

DWG LOC C:\Ray\Terrasoft\Barber Bypass FIG A.pro

Appendix 23.G

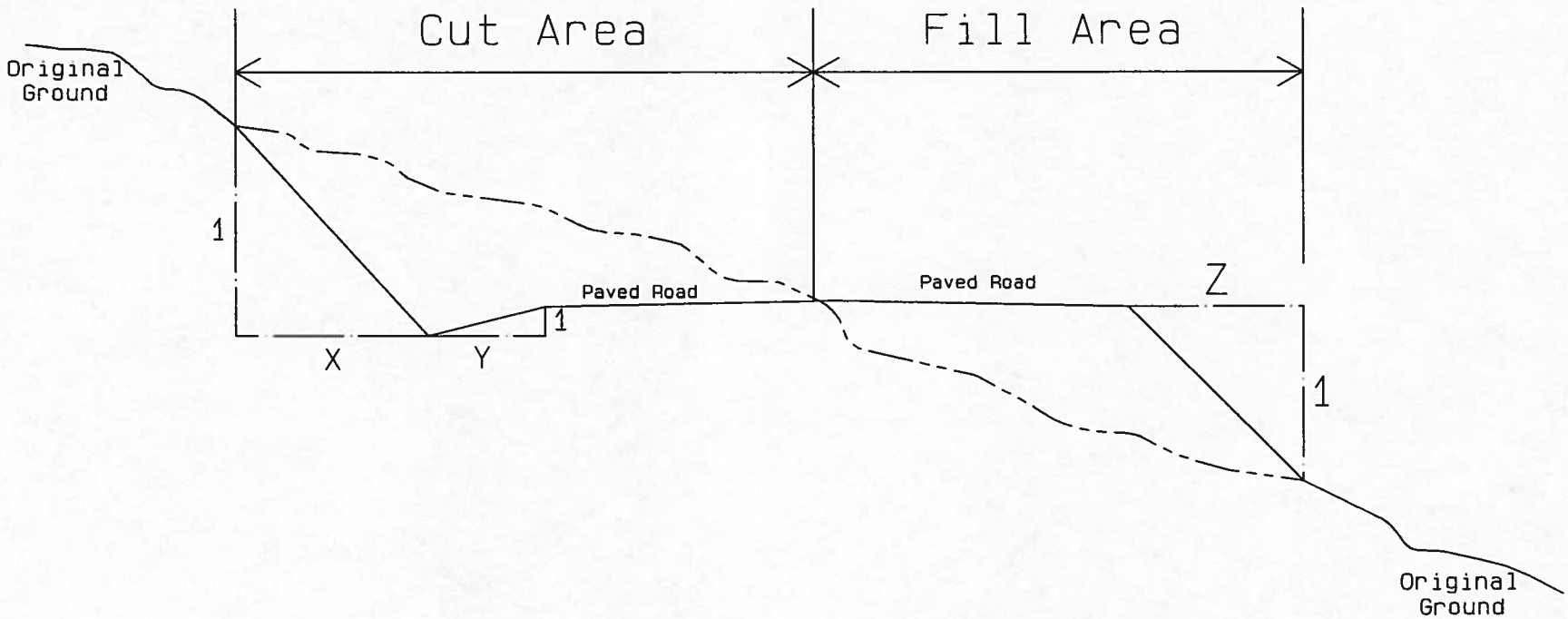
Area 3 Main Access Road

Verification of Adequacy of Side Ditch As-built

March 1996

Typical Side Ditch

"As Built"



	Minimum Slope	Maximum Slope
X	15.9	1.7
Y	13.9	2.1
Z	5.2	2.2

LEONARD RAYMOND
NEW MEXICO
6500
REGISTERED PROFESSIONAL ENGINEER
11-21-95

REV. NO.	DATE	DRAWN BY	REVISION DESCRIPTION	DWG.	E.A.	P.E.	R.A.	APPROVALS
1	11/95	BTS	Submitted for OSM Approval					

BHP MINERALS INTERNATIONAL INC.
NAVAJO MINE
P.O. BOX 155 FRUITLAND, NEW MEXICO 87416

Area III Main Access Road
Typical Side Ditch

PREPARED BY BTS	DRAWN BY BTS	SCALE NOT TO SCALE
APPROVED BY LR	DATE Nov. 10, 1995	DWG. LOC.
DWG. NO. Exhibit 11-??	REF. DWG.	

BHP MINERALS
NAVAJO MINE

09-Nov-95

PROJECT: Area 3 Access Rd. Side ditch
ENGINEER BTS
FILE NO :
DRWG NO :
MMD REF:

Channel Design

Precipitation Event:	10yr-6hr		
Design Flow	Q10	2.58	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	1.70	Maximum
(Z2:1)	Z2 =	2.10	Maximum
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.93	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.12	0.11	0.22	1.82
0.50	0.48	0.22	1.38	2.90
0.75	1.07	0.33	4.07	3.80
1.00	1.90	0.44	8.76	4.61
1.25	2.97	0.55	15.90	5.36
1.50	4.28	0.66	25.87	6.05
1.75	5.82	0.77	39.05	6.71
2.00	7.60	0.88	55.77	7.34
2.25	9.62	0.99	76.39	7.94
2.50	11.88	1.11	101.20	8.52
2.75	14.37	1.22	130.53	9.08
3.00	17.10	1.33	164.66	9.63
3.25	20.07	1.44	203.90	10.16
3.50	23.28	1.55	248.51	10.68
3.75	26.72	1.66	298.78	11.18
4.00	30.40	1.77	354.96	11.68
4.25	34.32	1.88	417.33	12.16

Flow Depth at Peak Discharge	0.64	Ft
Minimum Channel Depth Required	0.94	Ft
Critical Depth	0.65	Ft
Flow Type	Supercritical flow	
Froude Number	0.75	
Flow Velocity	3.42	fps
Soil Type:	Silty sand with vegetation	
Erosive Velocity	3.50	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

BHP MINERALS
NAVAJO MINE

09-Nov-95

PROJECT: Area 3 Access Rd. Side ditch
ENGINEER BTS
FILE NO :
DRWG NO :
MMD REF:

Channel Design

Precipitation Event:	10yr-6hr		
Design Flow	Q10	2.58	CFS
Bottom Channel Width	W =	0.00	Ft (min)
Side Slopes (Z1:1)	Z1 =	15.90	Minimum
(Z2:1)	Z2 =	13.90	Minimum
Manning's Roughness Coefficient	n =	0.032	
Channel Bed Slope	S =	2.93	%

STAGE FLOW

Flow Depth (Ft)	Area (Sq Ft)	Hydraulic Radius	Discharge Rate (CFS)	Velocity (FPS)
0.00	0.00	0.00	0.00	0.00
0.25	0.93	0.12	1.84	1.98
0.50	3.73	0.25	11.71	3.14
0.75	8.38	0.37	34.57	4.12
1.00	14.90	0.50	74.53	5.00
1.25	23.28	0.62	135.23	5.81
1.50	33.53	0.75	220.03	6.56
1.75	45.63	0.87	332.06	7.28
2.00	59.60	1.00	474.31	7.96
2.25	75.43	1.12	649.59	8.61
2.50	93.13	1.25	860.62	9.24
2.75	112.68	1.37	1110.01	9.85
3.00	134.10	1.50	1400.31	10.44
3.25	157.38	1.62	1733.96	11.02
3.50	182.53	1.75	2113.35	11.58
3.75	209.53	1.87	2540.81	12.13
4.00	238.40	2.00	3018.63	12.66
4.25	269.13	2.12	3549.02	13.19

Flow Depth at Peak Discharge	0.29	Ft
Minimum Channel Depth Required	0.59	Ft
Critical Depth	0.29	Ft
Flow Type	Supercritical flow	
Froude Number	0.71	
Flow Velocity	2.18	fps
Soil Type:	Silty sand with vegetation	
Erosive Velocity	3.50	fps

Flow Velocity is Less than Erosive Velocity, Therefore No Riprap Required

Reference: 1. Hydraulic Engineering Circular No. 15;
Federal Highway Administration
2. Applied Hydrology and Sedimentology for Disturbed Areas
Chapter 3; B.J. Barfield and R.C. Warner
University of Kentucky

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

HYDROLOGY CALCULATION FOR AREA III MAIN ACCESS ROAD

by

Name: Brian Sambirsky

Company Name: BHP MINERALS
File Name: B:\A3MAINRD

Date: 10-22-1995

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: BHP MINERALS
Filename: B:\A3MAINRD User: Brian Sambirsky
Date: 10-22-1995 Time: 16:47:14
Hydrology calculation for area III main access road
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	5.00	80	M	0.049	0.000	0.000	0.0	0.08	2.58
		Type: Null			Label: area III road					
111	Structure	5.00							0.08	
111	Total IN/OUT	5.00							0.08	2.58

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: BHP MINERALS
Filename: B:\A3MAINRD User: Brian Sambirsky
Date: 10-22-1995 Time: 16:47:14
Hydrology calculation for area III main access road
Storm: 1.30 inches, 10 year- 6 hour, type II-65
Hydrograph Convolution Interval: 0.1 hr

DETAILED SUBWATERSHED INPUT/OUTPUT TABLE

J	B	S	SWS	Seg. #	Land Flow Condition	Distance (ft)	Slope (%)	Velocity (fps)	Segment Time (hr)	Time Conc. (hr)	Muskingum K (hr)	Muskingum X
1	1	1	1	-a	5	250.00	2.00	1.41	0.05	0.049		