Appendix E..... Geomorphic Evaluation

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Appendix E.1 ..... **Geomorphic Technical Evaluation Report**

Geomorphic Evaluation of Arroyo del Puerto Drainage Ambrosia Lake Area

Prepared by Jerry Lindsey
AMEC

July 2007

Geomorphic Analysis of Arroyo Del Puerto Drainage
Ambrosia Lake Area

Geomorphic Setting

The Rio Algom Mining LLC Ambrosia Lake site is located in Section 31, T 13N, R9W in Ambrosia Lake valley, New Mexico. The valley trends with the strike of the Cretaceous formations at the south edge of the San Juan Basin with strata dipping about 2 degrees northeast into the basin. Resistant strata of the Mesa Verde Group forms a high cuesta, called San Mateo Mesa, on the northeast side of the valley and lower Cretaceous strata of the Dakota and resistant sandstone members of the Mancos Shale form a similar cuesta, Mesa Montanosa, on the southwest side to bracket the valley. The valley has a width of about 7 km (4.3 miles wide) and slopes to the southwest at 1.1 degrees, the opposite direction of the dip of the strata. The Arroyo Del Puerto follows the southwest side of the valley, and trends southeast toward the confluence with San Mateo Creek at the southeast end of the valley eventually converging with the Rio Puerco about 65 km (40 Miles) southeast of the site. The San Mateo Creek flows south across a broad valley through the Homestake uranium mill and tailings site where the slope of the drainage ranges from .005 to .003 in near playa conditions. Protection against erosion there would prevent migration of nick points upsteam that might destabilize the Arroyo Del Puerto.

Mining and milling of uranium ores began in the late 1950's and early 60's resulting in some diversion of local drainage to protect tailings piles and mine. As many as 24 mines were operating in the valley at one time operating at depths from 170 to 450 m (560 to 1500 feet) depths (DOE, UMTRA, 1990). The Phillips-United mill and tailing site in section 28 has been remediated (DOE UMTRA -1990) and the Rio Algom milling site is in closure action in accordance with Nuclear Regulatory Commission criteria. All the underground mines have been filled and stabilized.

The valley has no native trees and presently has a moderate cover of native grass. Cattle grazing is the main use of the land in the upland part of the basin. There is no agricultural use of the land. As a policy, the USDA and State Soil Conservation has not made soil maps of the valley because of its previous use for mining and milling of uranium (USDA web site). Regionally, the age of deposition of the oldest Holocene alluvial and eolian units has been estimated to be between 2,500 to 7,000 years old and the youngest developed soils are estimated are no greater than 2,300 years based on soil development and radiocarbon dates (Wells et al, 1983). A map of the valley and location of the Rio Algom site is shown in Figure 1. The map shows 1957 drainage with mines and mill locations photo-revised to 1980.

The geomorphic processes upgradient from the site consist of sheet flow and ephemeral channel flow, and wind erosion and eolian deposition. Mine dewatering has occurred as recently as 2005 utilizing pipelines, treatment ponds and infiltration system rather than overland flow. A secondary process is the high infiltration rate of the thick surficial alluvial deposits that significantly reduces the potential for gullying. The drainages throughout the lower valley are poorly defined however one area in the upper portion of the drainage basin shows severe gullying of playa type soils, with piping and caving of banks. The incised drainage was down stream from a breached cattle pond with slopes

ranging from 0.02 to .04 ft/ft. This area is in section 18, 4 - km (2.5 miles) north of the project site. This condition was also observed during restoration of the Phillips-United mill and tailing site (DOE, UMTRA, 1990).

Valley alluvium and basin slopes

The lack of gullying in the lower Ambrosia Lake valley has been described in the remediation of the nearby Phillips-United tailings pile in Section 28 (DOE, UMTRA, 1990), which observed that highly permeable surface materials have resulted in rapid infiltration rates with very little surface runoff. Directly upslope from the Arroyo Del Puerto drainage in the northeast quarter of section 31 where the diversion channel is proposed the slope progressively decreases from .0175 to .0155, to .010 ft/ft over a distance of one mile. The high Infiltration rate should be considered in the channel design for PMF storm event.

The Arroyo Del Puerto is the only well defined channel in the lower part of the basin. Tributary channels are poorly defined as a result of a lack of flow concentration caused by infiltration and dissipation of runoff. Encroachment of the arroyo against the resistant bedrock outcrops is the cause of flow concentration and channel development along the course of the drainage.

The soil associations mapped by the Soil Conservation Service (1967) indicates that the lower part of the valley adjacent to the Arroyo Del Puerto is the Lohmiller-San Mateo soil association. This map, presented in DOE, UMTRA (1990), is shown in Figure 4. The soil is described as derived from sandstone and shale bedrock, about 60- inches (150- cm) deep and consists of loam, clay loam, sandy loam and clay and is often stratified. This soil series is not defined in nearby basins by more recent Soil Conservation soil map (USDA website). Observation of this mapped area indicates that it was intended for basin fill slopes of 0.015 ft/ft or less in the lowest part of the valley bordering Arroyo Del Puerto, and has very little clay content. An example of this slope under relatively undisturbed conditions is shown in Figure 5 (Photo No. 5). There is no apparent development of clay crusts that would promote runoff as consequence of lack of intense rainfall to develop the crust, and perhaps lack of available clay in the upper 2-cm as indicated by Duffy and Gardner (1983). Impact of rainfall may be inhibited by moderate to sparse vegetation cover.

The orientation of Ambrosia Lake valley, northwest to southeast, is considered favorable for deposition of windblown dust from prevailing southwest and westerly winds, as a result of its high cliff faces on the southwesterly cuesta escarpment. A high percentage of reworked eolian material would explain why the alluvium has a higher permeability rate than would occur by sediment derived from bedrock highlands alone.

In the adjacent Chaco Canyon basin, Duffy and Gardner (1983) observed that typically deep and well vegetated eolian deposits which blanket the bedrock and uplands surfaces are less prone to erosion. Studies have shown a strong correlation between less permeable soils and increased ephemeral discharge and the relevance of infiltration behavior in examination of the overland flow process. Rapid incision is predominantly associated in Chaco Canyon with valley fill deposits where valleys are drained by a central channel. Such erosion can be the result of: man induced changes, primarily mining and overgrazing; secular climatic variations in rainfall; and changes in rainfall distribution. In San Juan basin the impact of these factors is seen as reduced infiltration

where channeled flow predominates. Recent studies of soils in a semi-arid climate conclude that porosity, texture of top 7 centimeters, the percent of bare surface, and the percent of crown cover are the predominant factors influencing infiltration characteristics. (Duffy and Gardner, 1983).

A map of the drainage basins, provided by Tetra Tech, shows that the slopes in subbasin 4B directly upslope north of Pond No. 1, are less than .010 ft/ft (1.0 percent) over a linear distance of 4,570 m (14, 990 feet), and 4,865 (15,964 feet) measured along the thalweg center of drainage. The lowest slope measured is 0.005 or ½ percent grade. This area of 1.0 percent (or less) slope provides a buffer area around the north side slope where drainages are poorly defined and infiltration is most likely to occur before entering the flow concentration of the diversion channel. The slopes on the north 60 percent of the basin reach gradually increases to a maximum of 0.032 near the drainage divide a distance of 10.2 km (6.3 miles) from the diversion channel at the north site boundary of Section 31. Sub-basins 4C and 4D are shorter and have higher slopes on the flanks of San Mateo Mesa but the "buffer" zone near the site shows similar low slopes. This zone, directly upslope of the proposed Option 2 diversion ditch that delineates an area where the slopes are less than 0.013 is shown on Figure 6. The area is characterized by poorly defined channels, deposition exceeds erosion, and infiltration is expected to have a substantial influence on runoff contributions to Arroyo Del Puerto. The channel of Arroyo Del Puerto becomes recognizable only where it is adjacent to bedrock outcrops or where the runoff from bedrock is more appreciable than in the valley basin areas.

Rio Algom Site Area

The area around the Rio Algom site is shown in Figure 2. The original channel of Arroyo Del Puerto (blue) goes across the site from northwest to southeast with the lower portion of the channel offset by construction of Tailings Impoundments 1 and 3. The original channel was essentially the boundary between bedrock (southwest) and alluvium (northeast), except where lateral drainages joined the arroyo. A mine water discharge ditch was constructed which was also used to divert potential flows in the arroyo around the site (green). Under Option 2, potential flows in the Arroyo Del Puerto would be diverted by placing a diversion channel with the berm upslope of former waste ponds 4, 5, and 6 starting at the northwest approach of the original channel to the site. The outlet of the diversion channel would be to the Arroyo Del Puerto channel adjacent to Pond 9 (just off of Figure 2 to the south). The approximate berm location is shown by cross-hatching; its channel will have an approximate average slope of 0.05 ft/ft.

Arroyo Del Puerto enters the site from the west where it crosses the Rio Algom Access Road. Figure 3 (Photo No. 1) shows the down stream channel and the pipeline that was apparently used to import mine water to the treatment ponds prior to being discharged in the infiltration ditch. Immediately west of that crossing, two shallow tributaries are indicated on the topography map from the north and south to converge on the main drainage. There is little evidence of these tributaries today. The channel of Arroyo del Puerto is a vegetated swale about 3 feet deep and is free from gully incision. The lower reach of this drainage has been diverted from its original course by the construction of the infiltration ditch. The original drainage meandered between the two largest waste piles and cut off the northeast 1/4 of section 31.

Mine water discharge was a factor in creating bank erosion of channels in adjacent basins as reported by Mills and Gardner (1983). The history of dewatering of the mines is not well known across the valley here but the mine water discharge upstream from the site has evidence the water was piped to treatment ponds rather than being released into drainages.

Mine Water Discharge Ditch

In order to restrict the ground water contaminants from migrating north and east of section 31, a ditch was dug on the north and east boundaries of section 31 to maintain a "water mound" of perched contaminants towards the interceptor trench at the toe of Pond 3. The ditch is indicated in Figure 2 showing the point of discharge. The mine pumping at section 30 West stopped in December 2005, and the ditch pumping stopped in early 2006 with intermittent pumping through 2006. On the north side near the discharge the water level was within 5 feet of the surface. The water level declined to a current depth of 36 feet in well 31-05 when pumping ceased at the end of 2006.

A footprint of the recharge mound indicated that the mound was spread around the north side ditch as far as 520 m (1700 feet) but dissipated rapidly on the southward leg. (Maxim, 2001). This methodology illustrates both the infiltration capacity of the alluvium and the storage capacity of an underlying paleochannel to handle large quantities of surface water infiltration.

The infiltration ditch along the north side section line is about 3 feet deep and is shown in Figure 7 (Photo No. 3). The ditch on northeast section line was dug to about 8 feet below natural grade. Presently a portion of the original arroyo channel is being excavated to remove contaminated soils and the excavation reveals the sandy silt, as shown in Figure 8 (Photo No. 2) that is typical of the upper 37 feet of this alluvial deposit. A grain size analysis shows 100 % passing the No. 40 sieve and 51 to 67% passing the No 200 sieve resulting in a soil classification as a fine sandy silt. A borehole log of well no. 31-05 at the northeast corner section 31 shows 37 feet of this sandy silt, called "blow sand" underlain by another 41 feet of mostly sand and fine gravel with minor lenses of sandy clay. The gravelly alluvium is not locally seen but was noted in some terrace deposits in Section 28 near an older channel (DOE, UMTRA, 1990) and was thought to be derived from the Gallup Sandstone that outcrops in San Mateo Mesa to the northwest. In the Groundwater ACL Application for Rio Algom (Maxim, 2001), approved by the NRC, the alluvium was modeled using a hydraulic conductivity of 18 ft/day (or approximately 1 X 10^{-2} cm/sec).

Arroyo Del Puerto Paleochannel

The existence of the paleochannel in the valley alluvium is apparent from the migration of drainage down slope toward the southwest impinging against the resistant bedrock benches that underlie the main waste pile and Rio Algom facilities. This was also documented by Kerr-McGee Nuclear Corp (1980) and referenced by DOE UMTRA (1990) as shown in the cross section in Figure 9. This paleochannel is an ancestral drainage of the Arroyo Del Puerto. An isopach map that defines a paleochannel in the Phillips/United mill tailings pile (DOE, UMTRA, 1990) in section 28, shown as Figure 10, upslope from the Rio Algom main pile, indicates a channel incised in the bedrock trending southwest. The trend would make it a tributary to the main southeast trending paleochannel in south ½ of section 32. This suggests that it is likely there are other

lateral tributaries incised in the Mancos Shale bedrock surface to form an under drain for the valley. One account reported an alluvial thickness of 100 feet near the Arroyo Del Puerto (Purtymun et al, 1977).

Bedrock Outcrops

The bedrock benches on the high ground immediately bordering the south side of Arroyo Del Puerto as defined by topographic contours shown in Figure 2, form the foundations for Pond 9 and the former Rio Algom facilities. Figure 9, cross section shows the resistant sandstone members of the Mancos Shale called Tres Hermanos (C) and Tres Hermanos (B) with interbedded shale forming the outcrops. The upper portion of Figure 9 shows the outcrops with respect to outline of Tailings Impoundments 1 and 3. A photograph of typical bedrock outcropping, in the south half of section 31 (north of Tailings Pond 1) is shown in Figure 11 (Photo No 4). This high ground is an erosional feature resulting from channel development of the ancestral arroyo that formed the paleochannel and the present day drainage impinging against the resistant outcrops.

Conclusions

The geomorphic processes that most affect the Option 2 plan appear to be mitigating factors for supporting the stability of the proposed diversion channel. The lack of gullying in the most prominent drainages is a result of a high infiltration rate because of low slope gradients and deep permeable soils. The potential for infiltration is matched by a high capacity of storage evident by the granular fill in the underlying broad paleochannel. It is expected that infiltration could result in a substantial loss of runoff for a PMF.

The fine grained, low plasticity soils in which the channel is founded may result in local minor sedimentation that could mostly fill the interstices of the rock erosion protection but as a consequence of its fine grain and lack of cohesion/cementation should be of negligible consequence to any significant run-off event. It is unlikely that sedimentation of native coarse sand or gravel that might form deposits resistant to runoff will occur since there are no sources for such material.

Sedimentation of Arroyo Del Puerto valley has been in progress for at least 2500 years. Long term geomorphic stability of the valley is dependent on the stability of San Mateo Creek down stream from the site, is in near playa conditions. The stability of that valley has an added protection with the clean-up conditions of the Homestake mill and tailings site.

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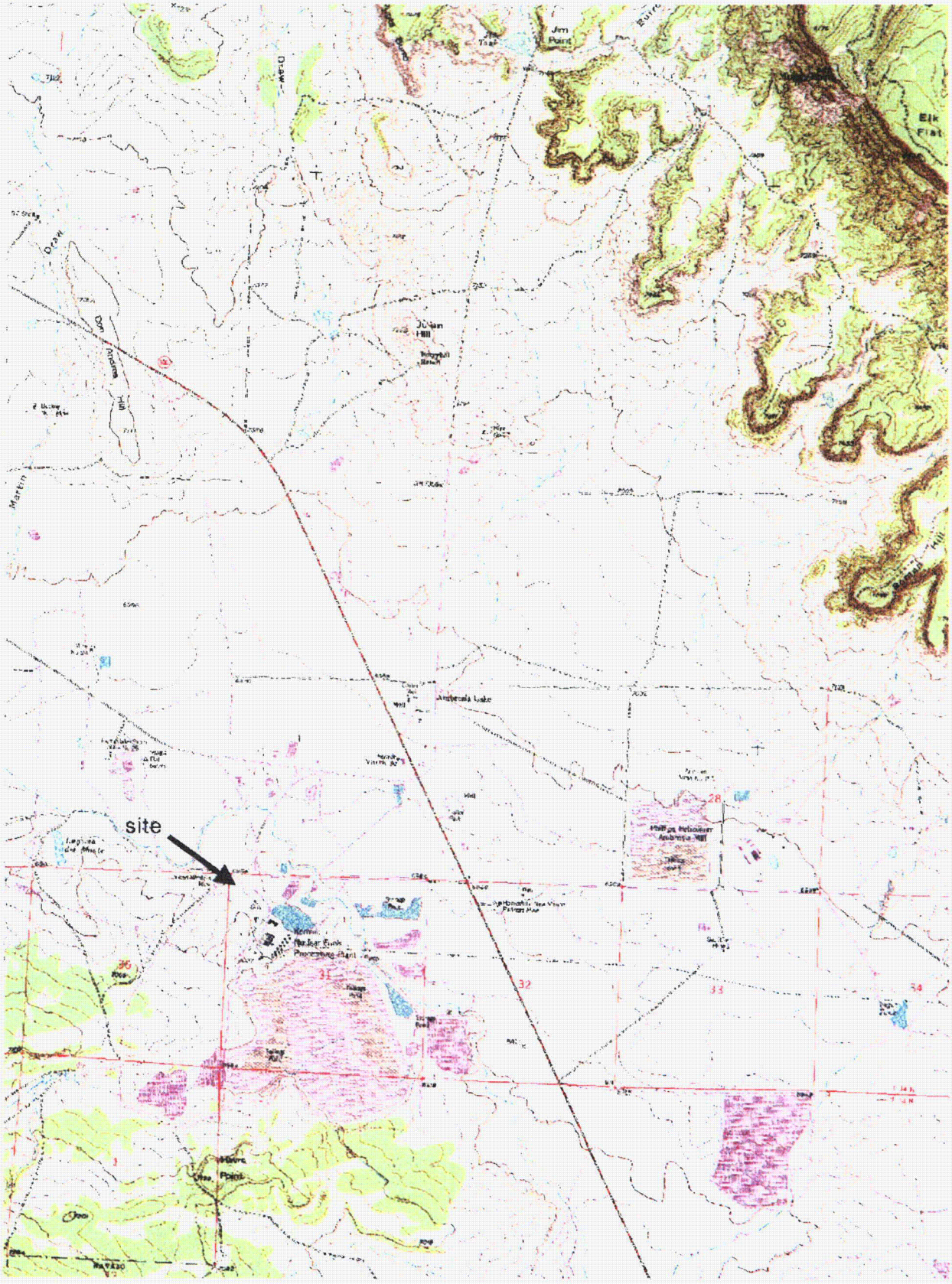
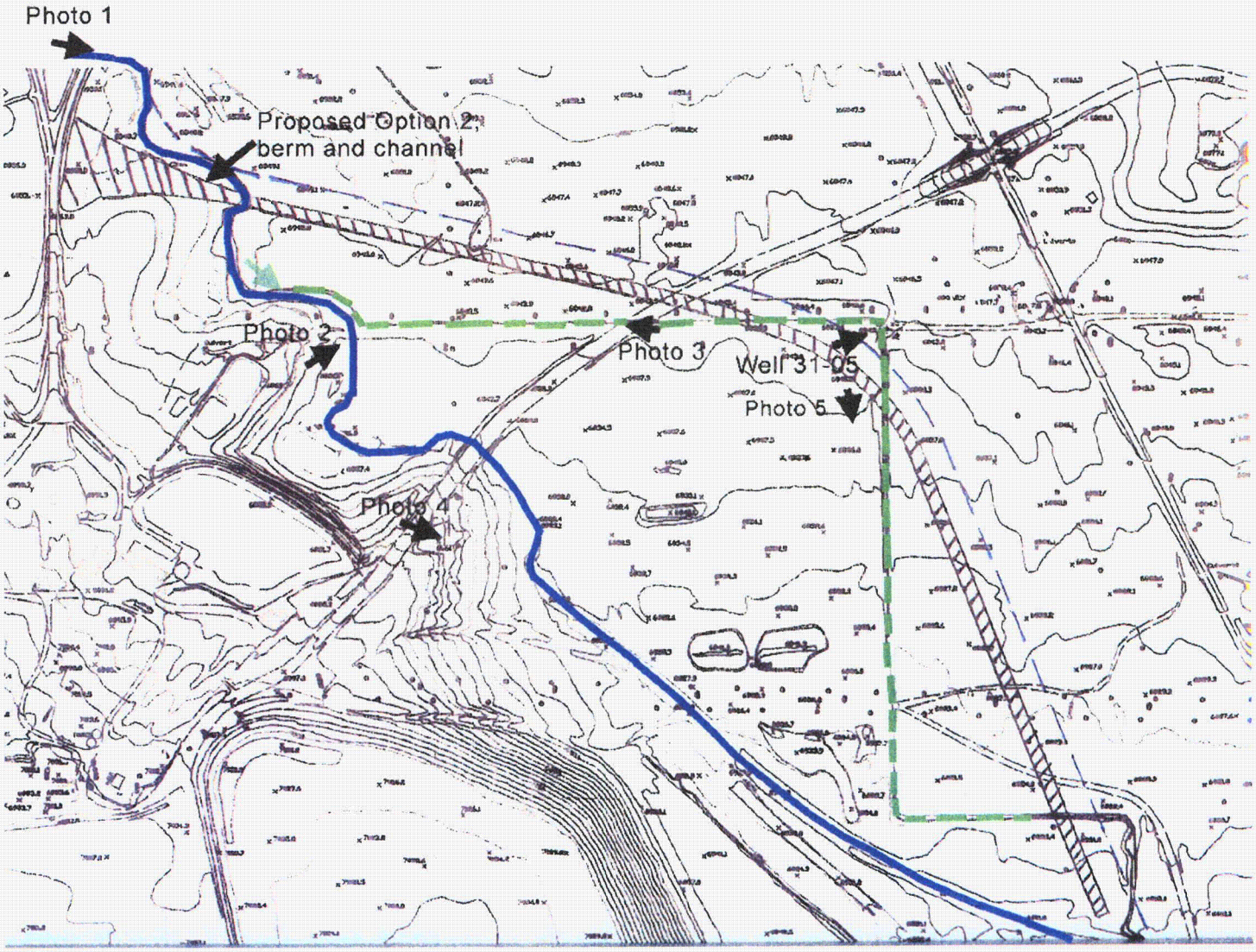


Reference: USGS topographic map, Ambrosia Lake Quad.
1957, photo enhanced 1980.

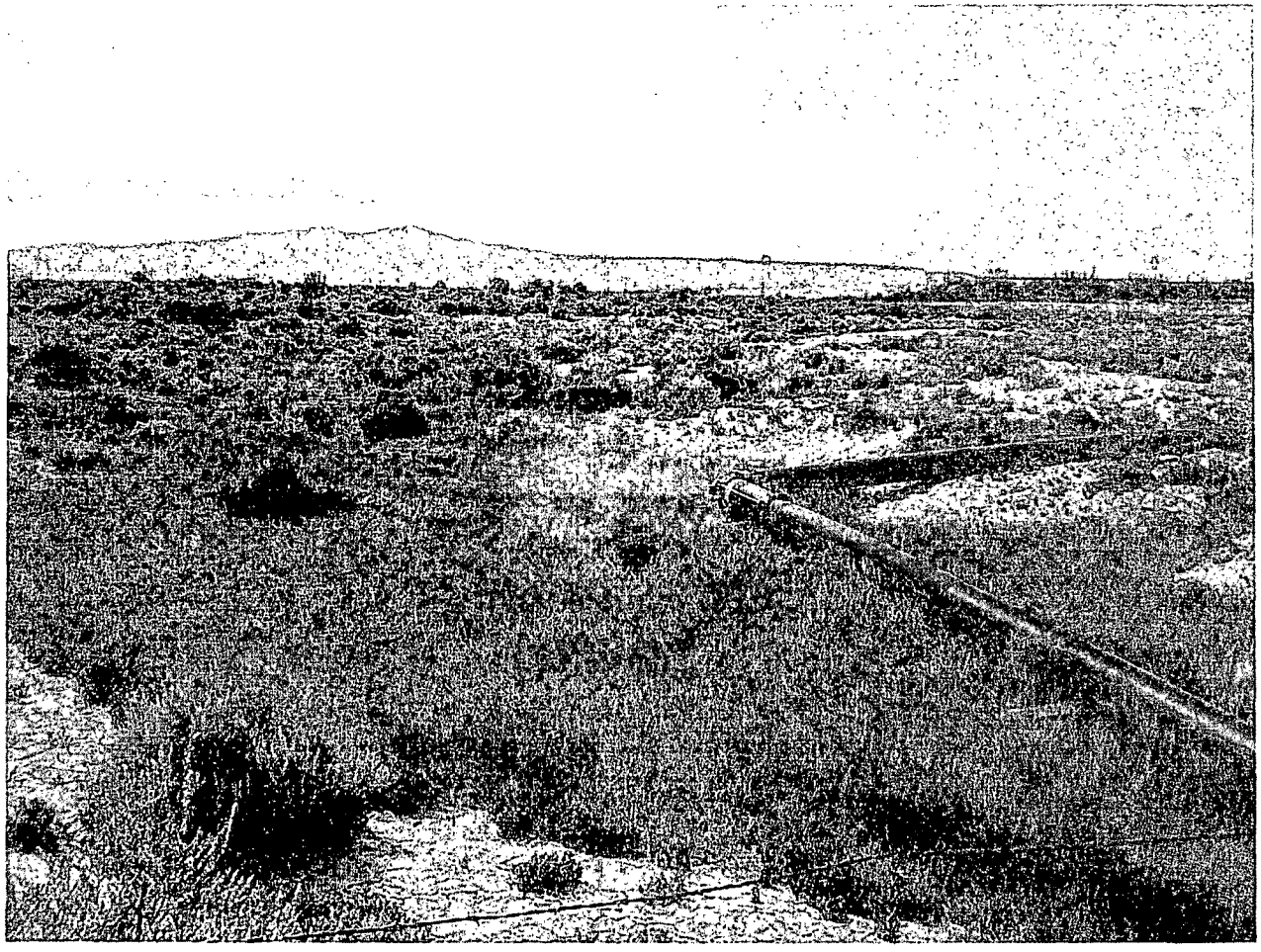
FIGURE 1 RIO ALGOM SITE IN AMBROSIA LAKE VALLEY, NEW MEXICO



Arroyo del Puerco
infiltration ditch for water mounding

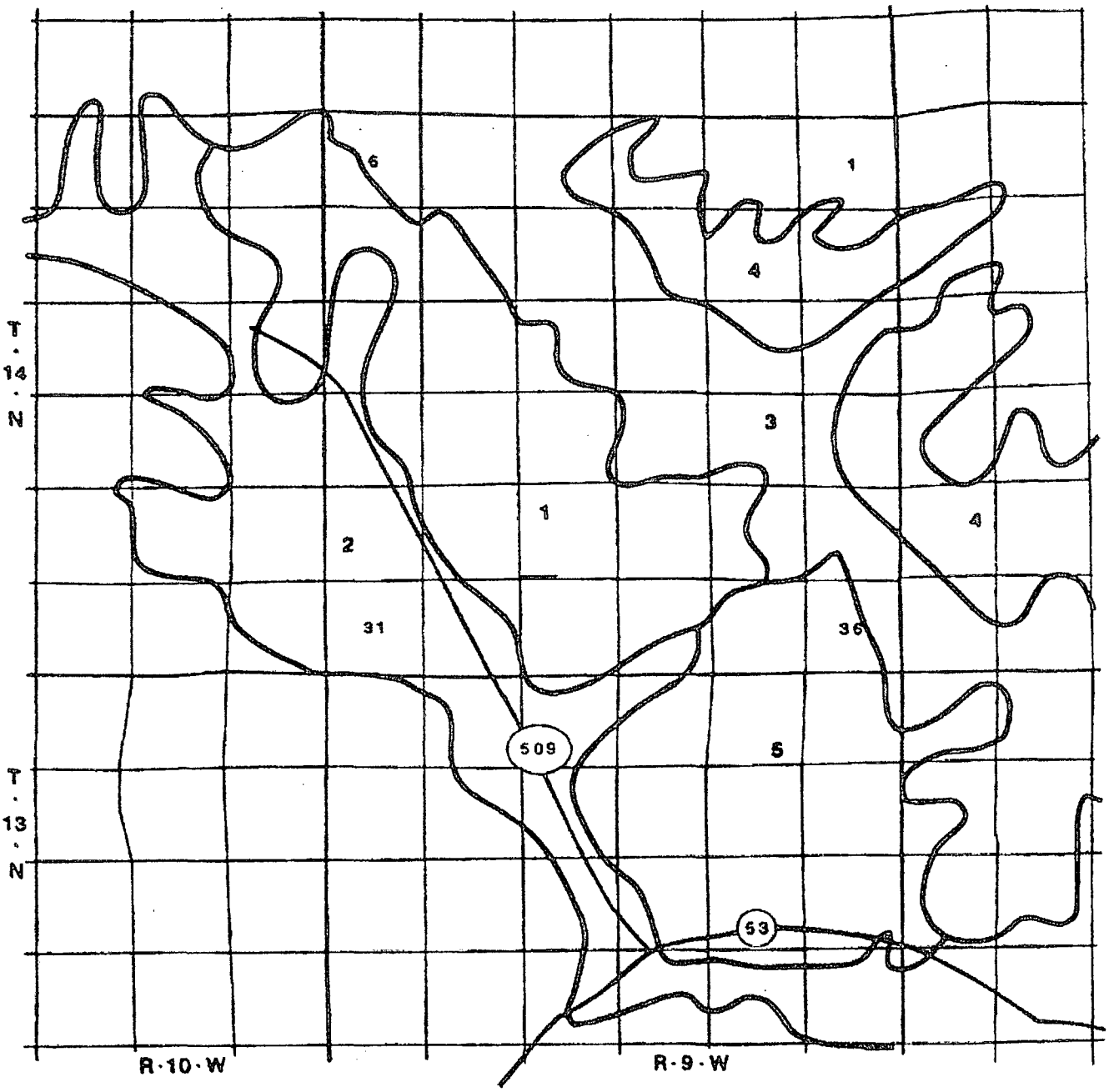
Note: locations of photographs are indicated by arrows
Note: The lower reach of Arroyo Del Puerto as shown has been straightened and moved east from bedrock encroachment.

FIGURE 2 SITE PLAN SHOWING PROPOSED OPTION 2 DIVERSION CHANNEL



(PHOTO NO 1)

FIGURE 3 VIEW OF ARROYO DEL PUERTO LOOKING EAST FROM RIO ALGOM ACCESS ROAD



SOIL ASSOCIATIONS

1 LAS LUCAS-LITLE-PERSAYO

2 LOHMILLER-SAN MATEO

3 ROCK LAND-TRAVESSILLA

4 ROCK LAND-BOND

5 HAGERMAN-TRAVESSILLA

Reference: U. S. Soil Conservation Corp.

2 0 2 4

SCALE IN KILOMETERS

FIGURE 4 SOIL MAP OF AMBROSIA LAKE VALLEY, NEW MEXICO

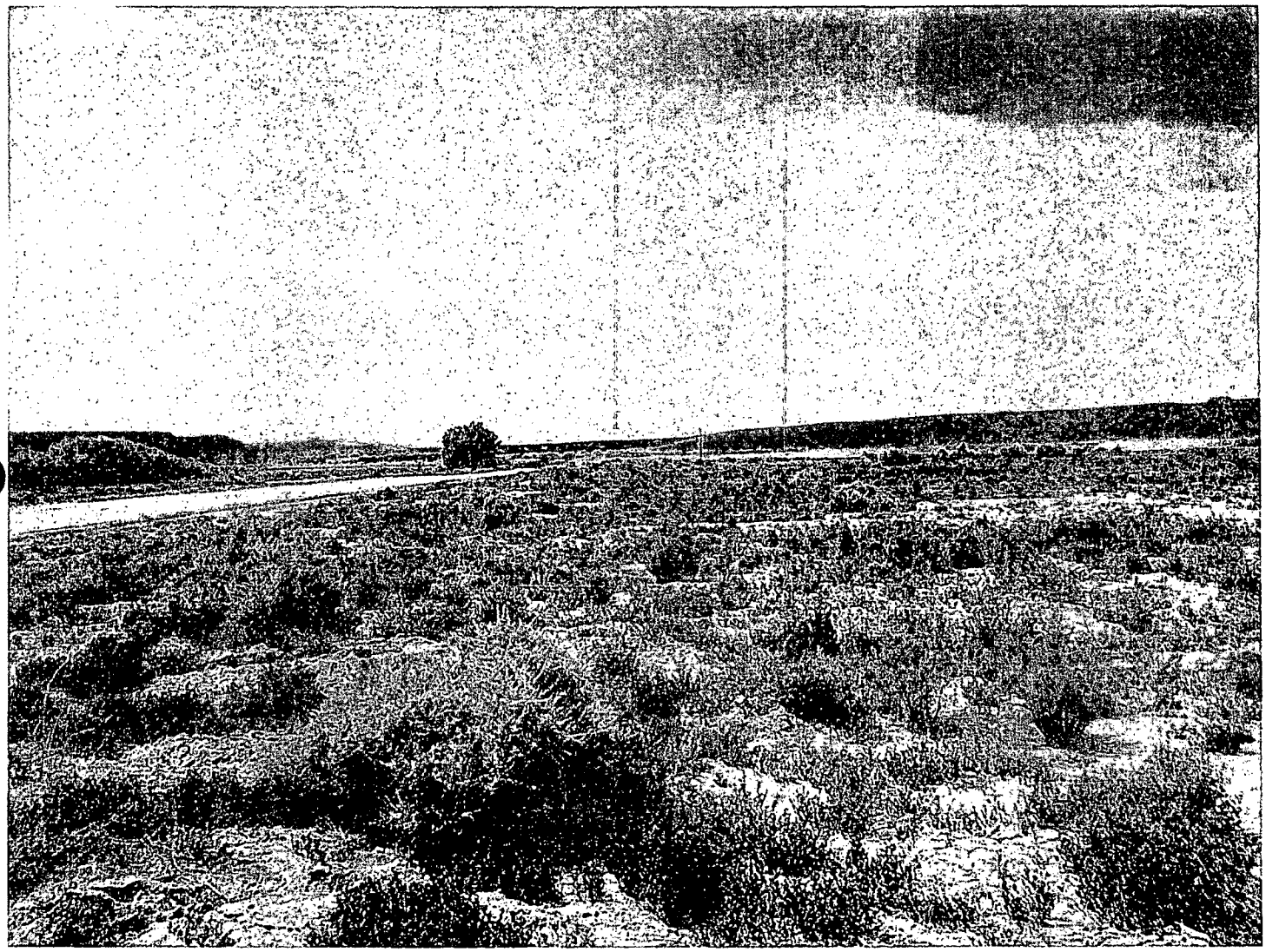
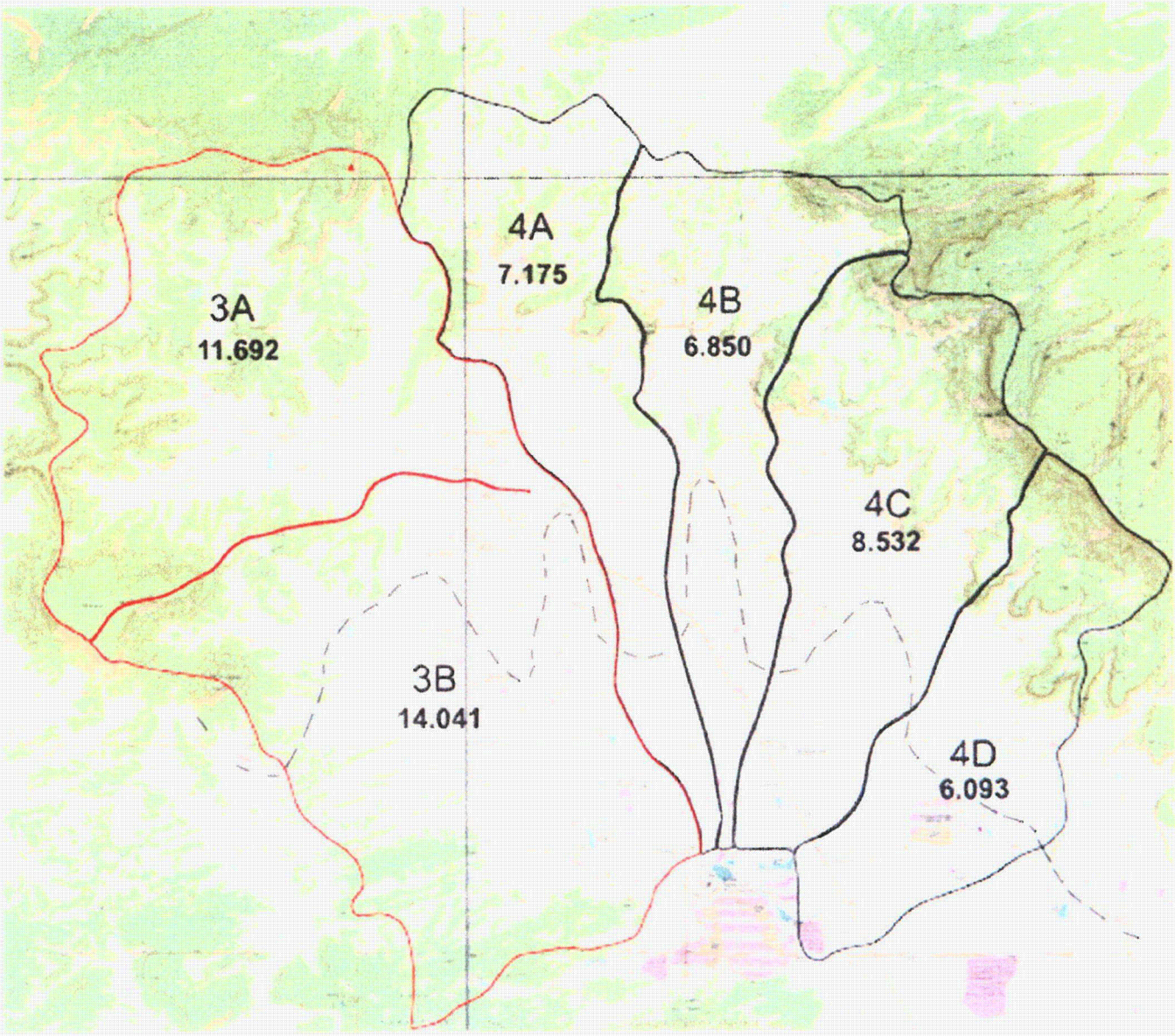


Photo no. 5, looking south toward Arroyo Del Puerto drainage
Slope is 0.010 ft/ft (1.0 Percent).

FIGURE 5 TYPICAL SHEET FLOW SLOPE UPGRADIENT FROM PROPOSED DIVERSION CHANNEL



Numbers indicate area size in square miles

= approximate boundary where slope is less than .013 approaching intercept diversion channel. This defines an area where drainage is poorly defined and infiltration into deep alluvial deposits is at a maximum.

FIGURE 6 DRAINAGE BASINS FOR RIO ALGOM SITE

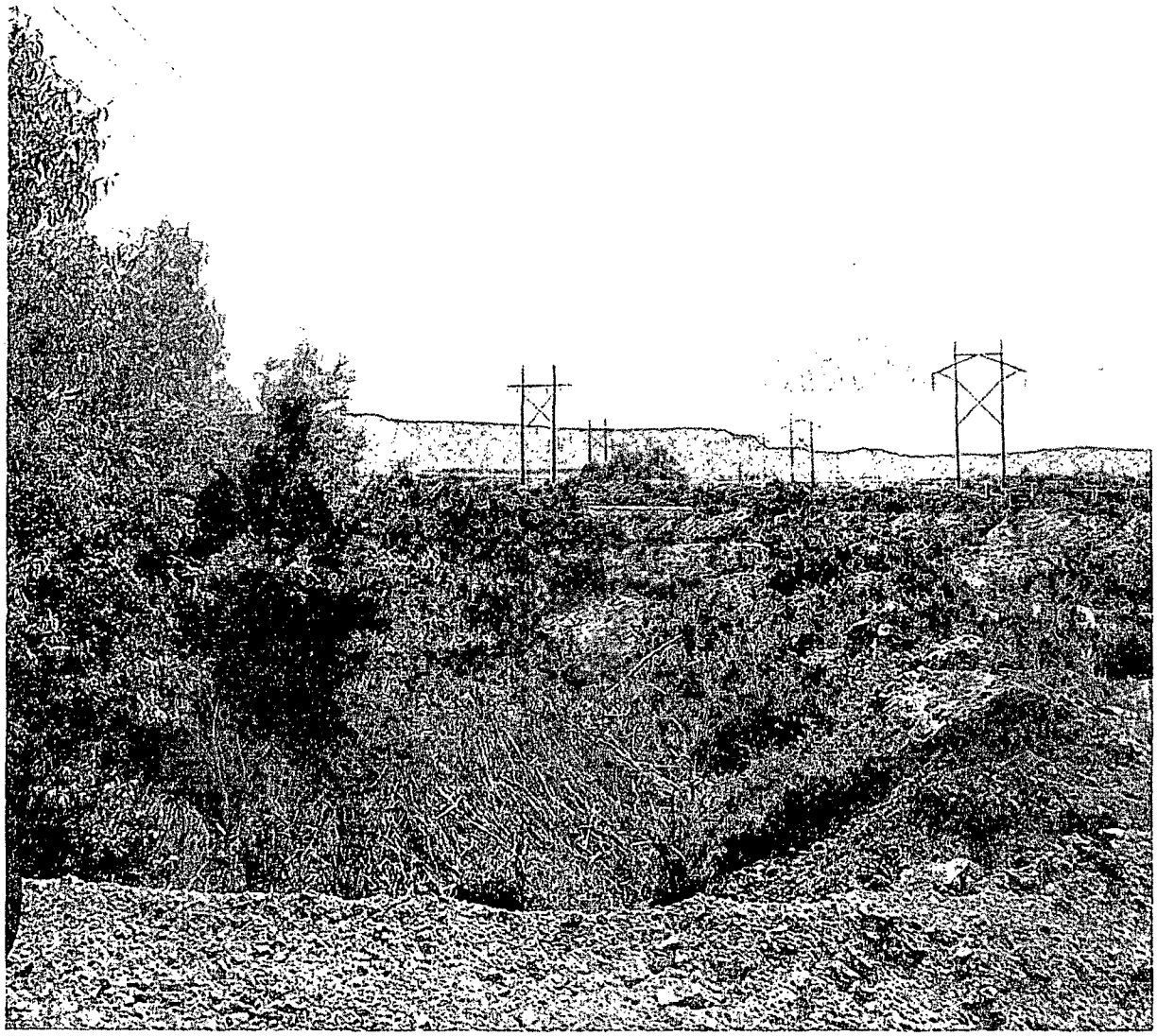


Photo No. 3 Looking east from haul road, north boundary line Section 31

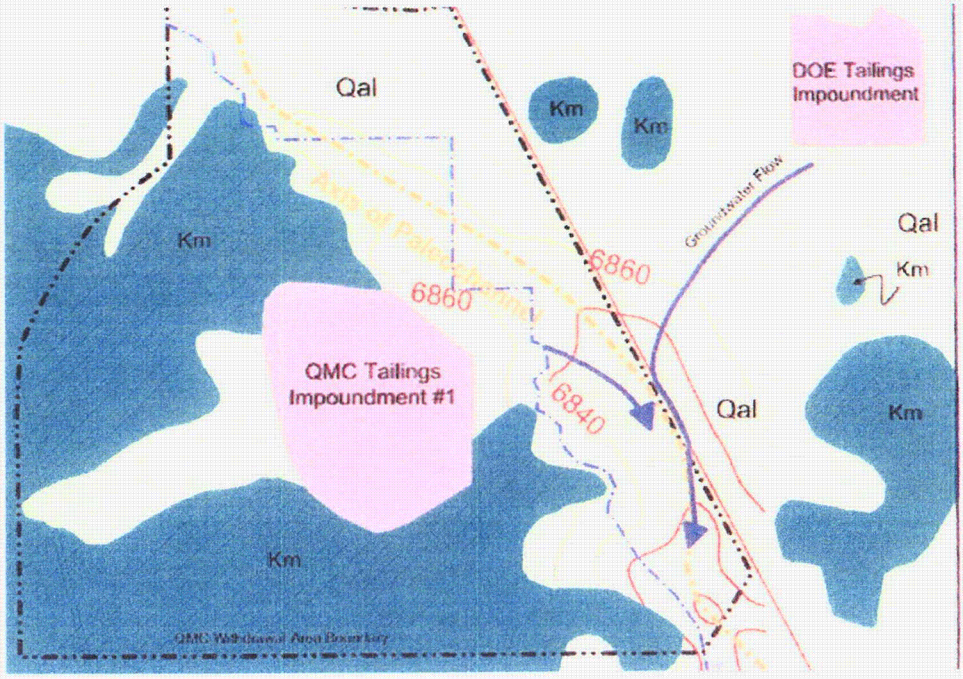
FIGURE 7 INFILTRATION DITCH USED FOR WATER MOUNDING

Photo No. 2, looking northeast

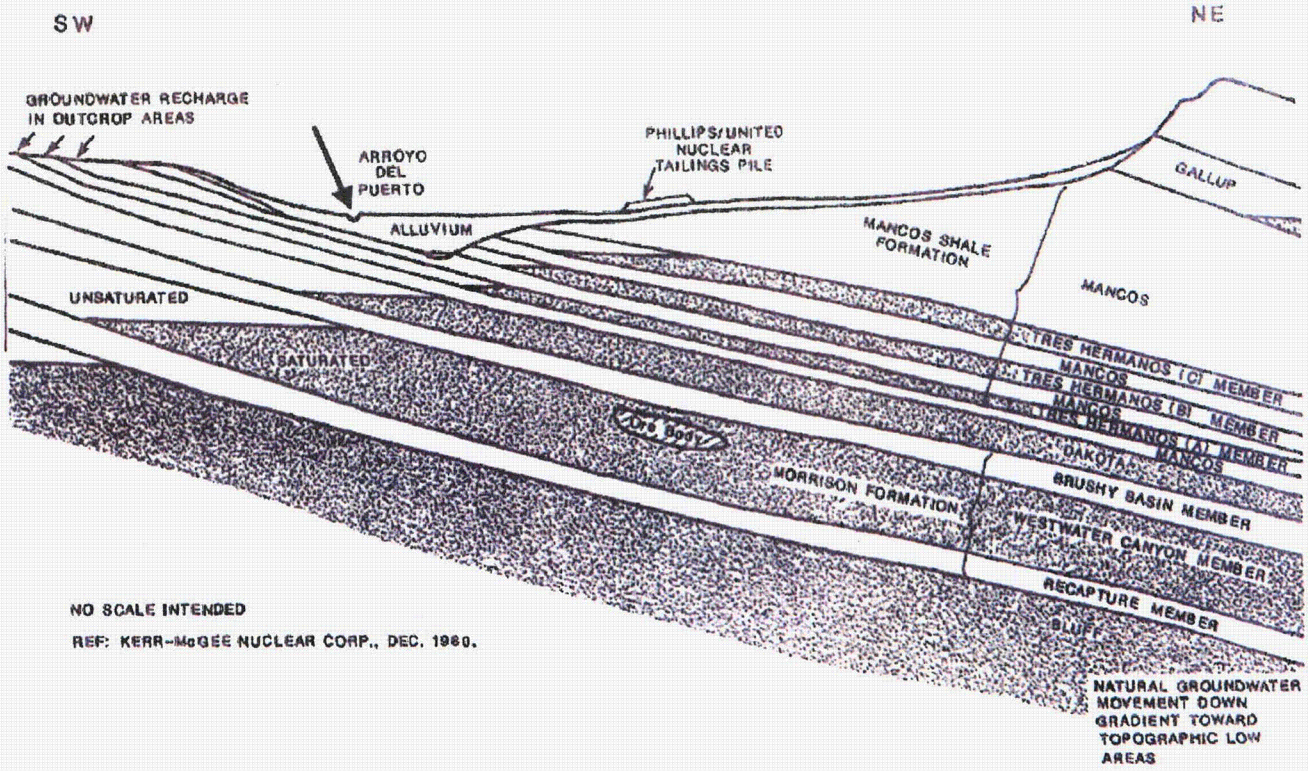
FIGURE 8 EXCAVATION OF CHANNEL OF ARROYO DEL PUERTO SHOWING SANDY SILT ALLUVIUM

Modified from: Maxim

Simplified geologic map of QMC Site showing contours of paleochannel



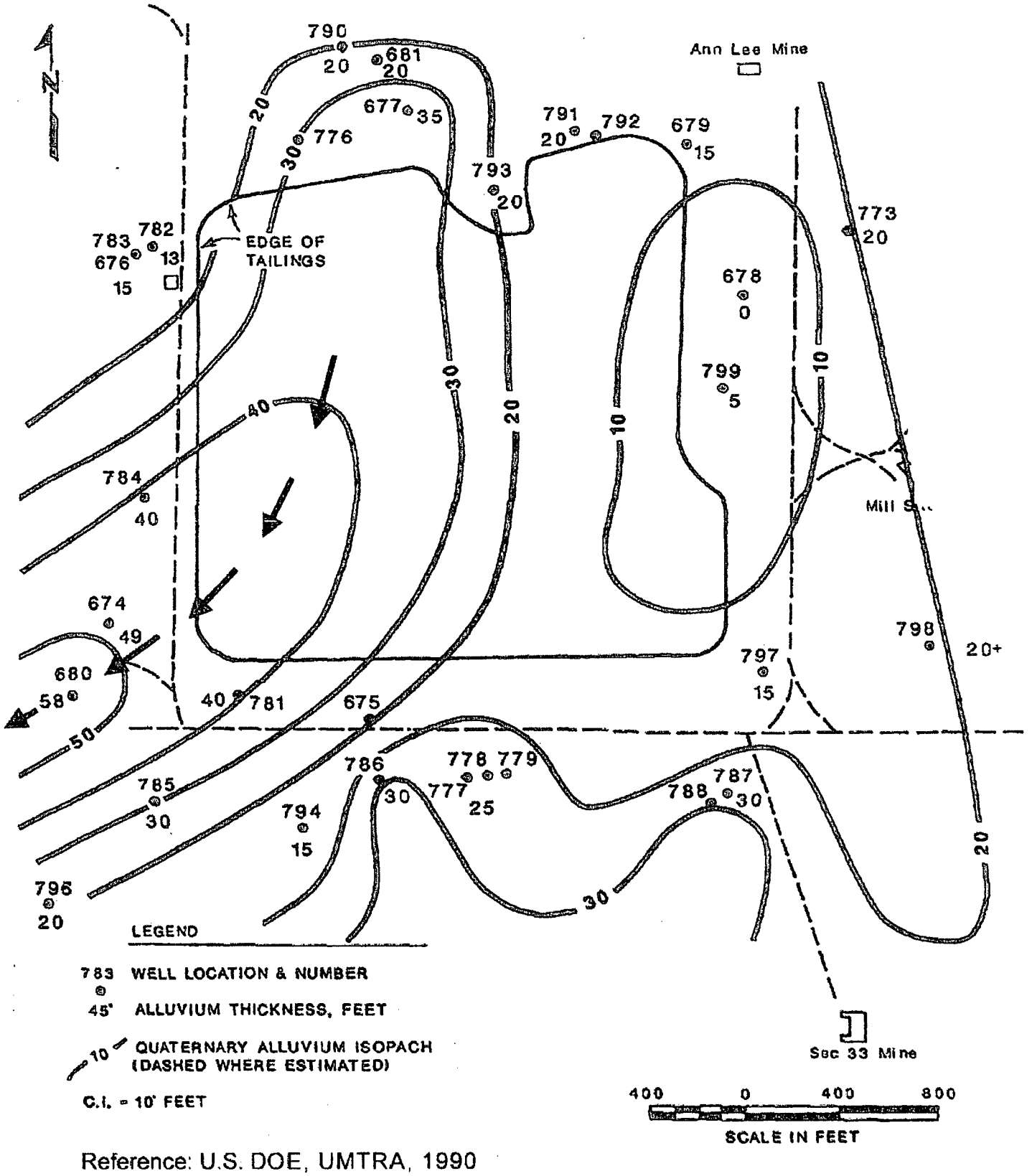
0 1/2 mile



FROM: DOE, UMTRA, 1990

This section shows strata underlying the Rio Algom site and the paleochannel that underlies the Arroyo Del Puerto

FIGURE 9 GEOLOGY MAP OF SITE AREA AND CROSS SECTION OF VALLEY



Reference: U.S. DOE, UMTRA, 1990

FIGURE 10 ISOPACH MAP OF PALEOCHANNEL INCISED IN MANCOS SHALE

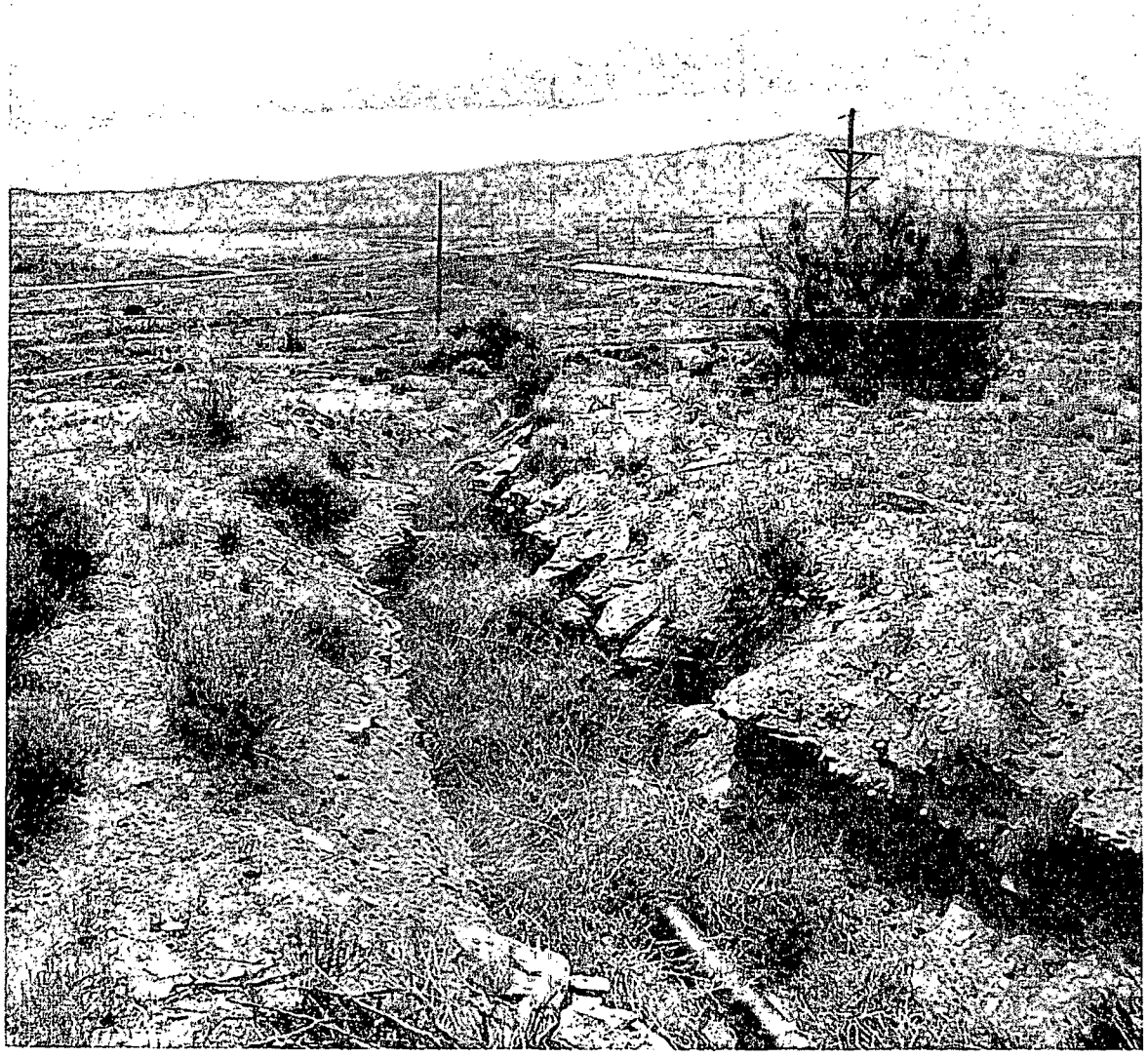


Photo No 4, looking east

FIGURE 11 SANDSTONE-SHALE BEDROCK ON HIGH GROUND ABOVE ARROYO DEL PUERTO

Appendix E.2..... Calculation E.1 Sedimentation Yield
Arroyo Del Puerto – NUREG-1623

Calculation E.1
Rio Algom Mining LLC
Ambrosia Lake, New Mexico
Arroyo Del Puerto
Exterior Site Drainage Calculations
Sedimentation Yield

1. Purpose:

The purpose of this calculation is to evaluate whether sedimentation will be a problem in the long-term for the Diversion Embankment/Channel of the Arroyo del Puerto at Ambrosia Lake, New Mexico. The methods contained in Appendix E of NUREG-1623 are used as a basis for this evaluation.

A summary of the results is shown on Worksheet Tab "Sediment Summary", (Calc. Sheet 3 of 17)

2. HEC-RAS Results

The results of the HEC-RAS modeling contained in Calculation D.1 indicated a region that had a higher potential for sediment buildup due to lower velocities. This region comprises the following locations:

Section 13 - Station 60+00
Section 12 - Station 55+00
Section 11 - Station 50+00

In order to evaluate lower storm events in addition to the PMF of 78,000 cfs, the PMF was divided evenly into lower flow amounts and the HEC-RAS Model was run for each flow amount.

The raw data taken directly from the HEC-RAS models are contained on the following worksheet:

Worksheet Tab "HEC-RAS Output Data" Calc. Sheets 15 thru 17 of 17

A summary of the flow data is contained in Worksheet Tab "Flow Summaries", (Calc. Sheet 4 of 17)

3. Sheet and Rill Erosion

The Modified Universal Soil-Loss Equation (USLE) was used according to the following equation:

A = RKLSVM (tons per acre)

This equation was previously discussed in the following paper:

Prediction of Erosional Soil Loss and Land Surface Protection Measures
Ambrosia Lake Facility
Rio Algom Mining LLC
Grants, New Mexico
Prepared by Curtis O. Sealy
Maxim Technologies
Albuquerque, NM
July 2005

This document is contained in Appendix E.3.

See Worksheet Tab "Sheet & Rill", (Calc. Sheet 10 of 17) for summary of results. The PMF Drainage area to the Diversion Embankment/Channel is shown on Worksheet Tab "PMF Drainage Area", (Calc. Sheet 11 of 17)

R = rainfall erodibility factor = 30
see figure of average annual values of rainfall erosion index (Calc. Sheet of 5 of 17)
K = soil erodibility factor = .55
see nomograph figure (Calc. Sheet 6 of 17) and utilize the size fractions contained on Worksheet Tab "Native Soils", (Calc. Sheet 12 of 17)
LS = slope steepness and length factor
LS = l1/2*(0.0076+0.53s+7.6s2)
Typically this factor is applicable to small drainages and not the long lengths and large basins of the Arroyo del Puerto. To do so does not recognize other factors within the larger basins that trap sediments. Therefore, to use it for larger basins will result in conservative yields.
VM = erosion control factor
Undisturbed Bare Soil Conditions: VM = 0.66 to 1.30 (see Calc. Sheet 7 of 17)
Apply cover factor with grass > 80% = 0.02 (see Calc. Sheet 8 of 17)

VM = 0.66*0.02 = 0.013
Considering the high infiltration rates (Appendix E.1) use VM = 0.005

The modified USLE produces a gross soil erosion rate. The Sediment Delivery Ratio (SDR) is applied to determine the actual sediment yield. For watersheds of 3200 and 64,000 acres, ratios of 0.22 and 0.10 are suggected accorded to Calc. Sheet 9 of 17
For the Arroyo del Puerto this results in SDR ratios of 0.21 to 0.22.

The resulting sheet & rill erosion sediment yield is approximately 3200 tons per year.

4. Gully Erosion

According to Appendix E.1, gully erosion is minimal and will be neglected for this evaluation.

5. Trap Efficiency

The trap efficiency equation is a relationship of reach length, settling velocity for each sediment fraction, mean flow depth, and mean flow velocity.

The results are shown on Worksheet Tab "Trap Efficiency", (Calc. Sheet 13 of 17)

6. Sediment Transport Capacity

This calculation made use of the flow-duration sediment -rating curve of Table E-1 of NUREG-1623 and applied it to the PMF value of 78,000 cfs. The results are shown on Worksheet Tab "Sediment Transport", (Calc. Sheet 14 of 17).

7. Conclusion:

Based on the summary of the results ass shown on Worksheet Tab "Sediment Summary", (Calc. Sheet 3 of 17), it is dramatically obvious that due to the fine sandy silty fraction of the native soil materials, that the any sediments dropped out are more than offset by the ability of the system to transport these fine sediments.

Rio Algom Mining LLC
Ambrosia Lake, New Mexico
Arroyo Del Puerto
Sediment Yield Summary

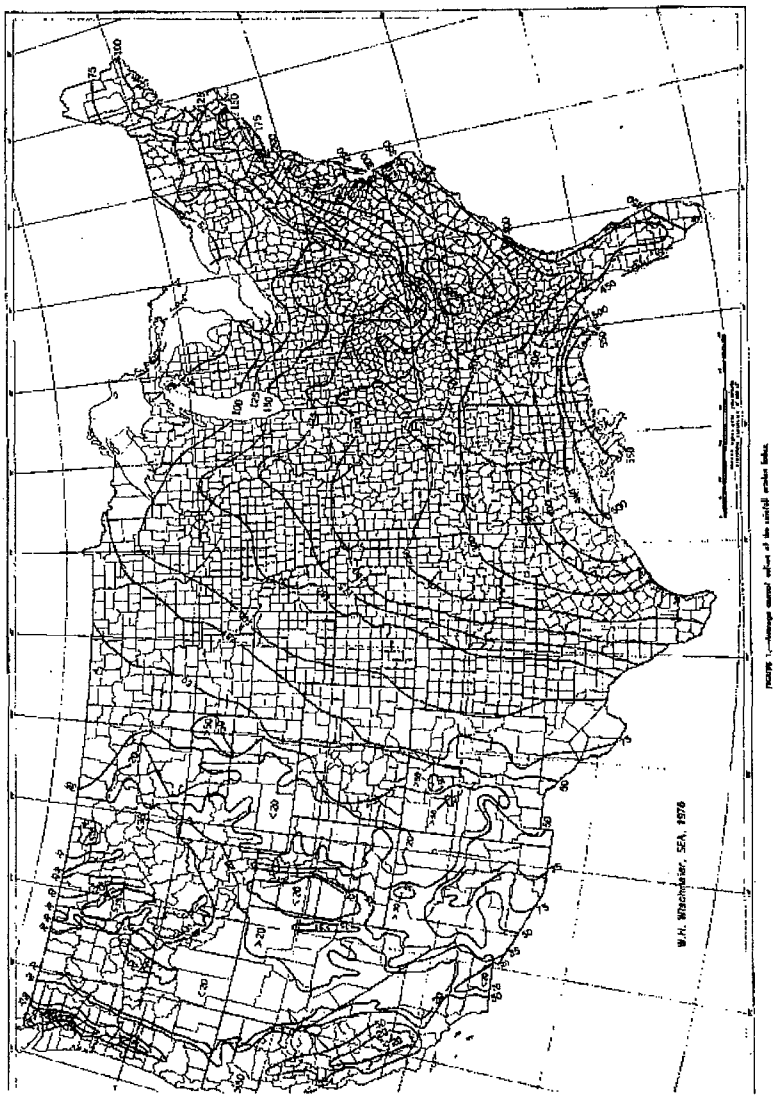
Flow Parameters				Section 13 - Sta 60+00 Annual Basis (tons/yr)		
Flow Rate (cfs)	X = Reach Length (ft)	h = Mean Flow Depth (ft)	V = Mean Flow Velocity (ft/sec)	Incoming Sediment Yield	Sediment Load that Settles	Outgoing Sediment Transport Yield
7800	500	5.15	4.96	3183	505	1,503,758
15600	500	6.94	6.29	3183	335	4,495,787
23400	500	8.15	7.11	3183	266	5,230,651
31200	500	9.81	8.46	3183	197	5,215,491
39000	500	9.45	6.98	3183	239	2,551,494
46800	500	10.47	9.04	3183	176	2,625,742
54600	500	11.04	9.59	3183	160	2,108,847
62400	500	11.56	10.09	3183	147	1,371,704
70200	500	12.05	10.57	3183	136	474,664
78000	500	12.50	11.11	3183	126	150,073

Flow Parameters				Section 12 - Sta 55+00 Annual Basis (tons/yr)		
Flow Rate (cfs)	X = Reach Length (ft)	h = Mean Flow Depth (ft)	V = Mean Flow Velocity (ft/sec)	Incoming Sediment Yield	Sediment Load that Settles	Outgoing Sediment Transport Yield
7800	500	5.01	5.11	3183	505	1,623,407
15600	500	6.75	6.44	3183	336	4,780,594
23400	500	7.92	7.34	3183	265	5,674,948
31200	500	9.56	8.56	3183	199	5,400,847
39000	500	8.38	7.32	3183	254	2,944,852
46800	500	10.20	9.10	3183	179	2,687,220
54600	500	10.75	9.62	3183	163	2,141,343
62400	500	11.25	10.09	3183	151	1,383,294
70200	500	11.72	10.51	3183	140	472,169
78000	500	12.16	10.89	3183	131	144,452

Flow Parameters				Section 11 - Sta 50+00 Annual Basis (tons/yr)		
Flow Rate (cfs)	X = Reach Length (ft)	h = Mean Flow Depth (ft)	V = Mean Flow Velocity (ft/sec)	Incoming Sediment Yield	Sediment Load that Settles	Outgoing Sediment Transport Yield
7800	500	4.85	5.15	3183	514	1,672,335
15600	500	6.58	6.34	3183	347	4,648,815
23400	500	7.70	7.27	3183	274	5,595,270
31200	500	9.28	8.58	3183	204	5,478,286
39000	500	8.12	7.54	3183	254	3,181,384
46800	500	9.87	9.15	3183	183	2,745,170
54600	500	10.35	9.76	3183	167	2,235,729
62400	500	10.79	10.33	3183	153	1,476,948
70200	500	11.19	10.86	3183	142	515,660
78000	500	11.57	11.35	3183	132	161,137

Rio Algom Mining LLC
Ambrosia Lake, New Mexico
Arroyo Del Puerto
Channel Station Flow PMF Parameters

	Section 13 - Sta 60+00					
Flow Rate (cfs)	Reach Length (ft)	h = Mean Flow Depth (ft)	V = Mean Flow Velocity (ft/sec)	$Q_{channel}$ (cfs)	W.P. (ft)	q = Unit Discharge (ft^2/s)
7800	500	5.15	4.96	6990.53	274.62	25.5
15600	500	6.94	6.29	12175.25	280.67	43.4
23400	500	8.15	7.11	16407.06	284.83	57.6
31200	500	9.81	8.46	23961.75	290.63	82.4
39000	500	9.45	6.98	18829.13	287.41	65.5
46800	500	10.47	9.04	27518.66	292.95	93.9
54600	500	11.04	9.59	30985.22	294.99	105.0
62400	500	11.56	10.09	34355.90	296.86	115.7
70200	500	12.05	10.57	37704.73	298.60	126.3
78000	500	12.50	11.11	41338.53	300.23	137.7
	Section 12 - Sta 55+00					
Flow Rate (cfs)	Reach Length (ft)	h = Mean Flow Depth (ft)	V = Mean Flow Velocity (ft/sec)	$Q_{channel}$ (cfs)	W.P. (ft)	q = Unit Discharge (ft^2/s)
7800	500	5.01	5.11	6994.16	274.16	25.5
15600	500	6.75	6.44	12107.42	280.05	43.2
23400	500	7.92	7.34	16415.96	284.07	57.8
31200	500	9.56	8.56	23548.22	289.79	81.3
39000	500	8.38	7.32	17294.75	283.69	61.0
46800	500	10.20	9.10	26891.22	292.03	92.1
54600	500	10.75	9.62	30147.30	293.97	102.6
62400	500	11.25	10.09	33290.46	295.76	112.6
70200	500	11.72	10.51	36327.31	297.44	122.1
78000	500	12.16	10.89	39264.45	299.05	131.3
	Section 11 - Sta 50+00					
Flow Rate (cfs)	Flow Rate (cfs)	h = Mean Flow Depth (ft)	V = Mean Flow Velocity (ft/sec)	$Q_{channel}$ (cfs)	W.P. (ft)	q = Unit Discharge (ft^2/s)
7800	500	4.85	5.15	6793.68	273.61	24.8
15600	500	6.58	6.34	11585.54	279.45	41.5
23400	500	7.70	7.27	15768.06	283.31	55.7
31200	500	9.28	8.58	22826.23	288.80	79.0
39000	500	8.12	7.54	17206.10	282.78	60.8
46800	500	9.87	9.15	26079.22	290.87	89.7
54600	500	10.35	9.76	29338.83	292.58	100.3
62400	500	10.79	10.33	32527.40	294.12	110.6
70200	500	11.19	10.86	35635.13	295.56	120.6
78000	500	11.57	11.35	38671.05	296.93	130.2


W.H. Wischmeier, SEA, 1976

PREDICTING RAINFALL EROSION LOSSES—A GUIDE TO CONSERVATION PLANNING 11

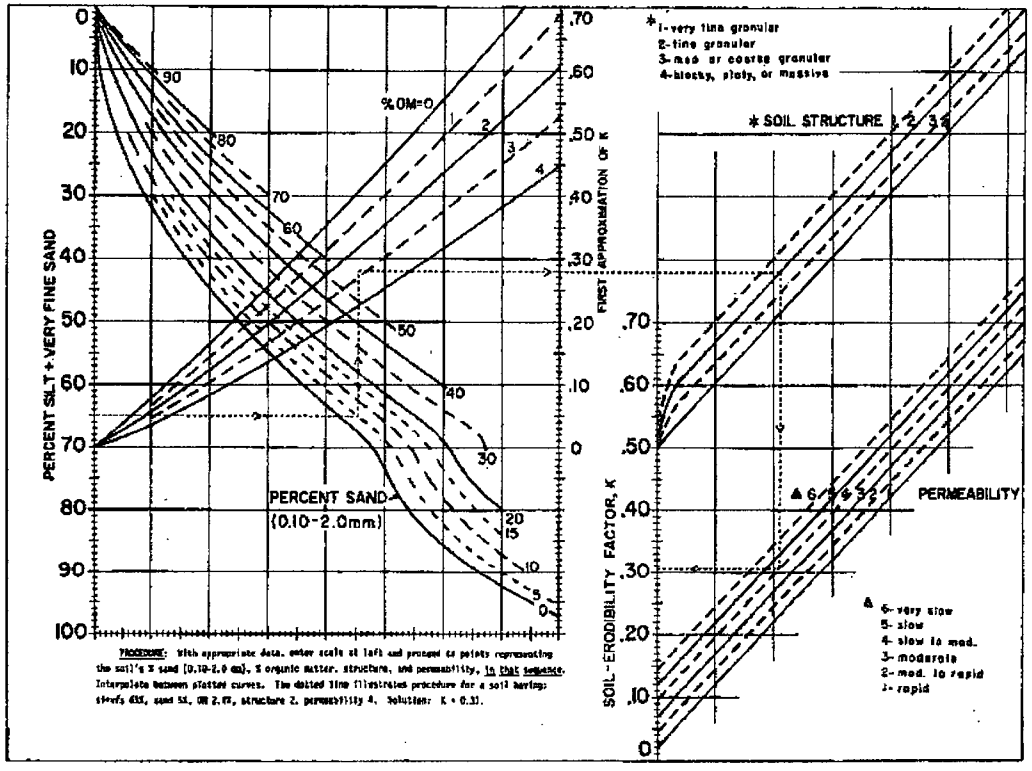


FIGURE 3.—The soil-erodibility nomograph. Where the silt fraction does not exceed 70 percent, the equation is $100\,K = 2.1\,M^{1.14}\,(10^{-4})\,(12 - a) + 3.25\,(b - 2) + 2.5\,(c - 3)$ where M = (percent si + vfs) (100 − percent c), a = percent organic matter, b = structure code, and c = profile permeability class.

The graph in Figure 3.2 was developed to solve Equation 3 and is used as follows:

1. Locate the slope length on the bottom.
2. Follow vertically to the correct slope gradient curve.
3. The corresponding LS value can be read from the left side.

The amount of erosion is very sensitive to the length and slope factors (e.g. cutting the slope length in half will cut the erosion by approximately one-third).

Erosion Control Factor (VM): The erosion control factor is applied to account for the effects of erosion control measures and devices used on a construction site. The lower the VM factor the more effective the device or control measure is in controlling erosion. Table 3.1 includes typical values based on the control device or measure utilized:

Table 3.1 - Erosion Control Factors (VM) for Various Erosion Control BMPs

Vegetative Management Practice	VM Value
Bare Soil – freshly disked to 6-8 inches	1.00
Bare Soil – after one rain	0.89
Compacted Fill	1.24-1.71
Undisturbed Soil – except for scraped	0.66-1.30
Soil Retention Blankets	0.015
Mulching (depends on application rate)	0.01-0.05
Hydromulch	0.05-0.10
Asphalt Emulsion (depends on application rate)	0.01-0.57
Silt Fence	0.25
Hay Bale	0.33
Triangular Sediment Dike	0.25
Inlet Protection	0.25-0.33*
Sediment Trap – Stone Outlet	0.15-0.30*
Sediment Basin	0.10*
Sandbag Berm	0.30*
Rock Berm	0.30*

*The VM values for structural controls listed must be adjusted for the type of cover that lies within the watershed for which they are treating runoff. Table 3.2 indicates the correction factors to use depending on the percent grass and canopy cover.

Equation 4

$$VM = VM_{Practice} \times Cover\ Factor$$

TxDOT (7/2002) 3.0 Design of Control Measures (BMPs)

The cover factor considers the protection of natural ground cover in preventing soil erosion. The factor is dependent on the type of vegetation (grasses or trees) and the density of the vegetation. The canopy cover is the percent of ground cover from the trees, brush or tall weeds. For construction sites stripped of natural vegetation, a cover factor of 1.0 should be used. Note: The table will produce a cover factor of 0.45 for an area with 0% canopy and 0% cover of grass. This value represents undisturbed bare soil. On construction sites the bare soils are typically disturbed and/or compacted or otherwise altered. A value of 1.0 is recommended in the areas of disturbed bare soil.

Table 3.2 - Watershed Cover Factors

Canopy Cover, %	Undisturbed Soil Percent Ground Cover of Grass				
	0	20	40	60	>80
0	0.45	0.20	0.10	0.04	0.02
25	0.36	0.17	0.08	0.04	0.02
50	0.26	0.13	0.07	0.03	0.02
75	0.17	0.10	0.06	0.03	0.02

Environmental Hydrology Chapter 9 Equations:

The Universal Soil Loss Equation, Downstream Sediment Yields, Single Event Sediment Yields

Yields, Single Event Sediment Yields

The Universal Soil Loss Equation

The USLE continues to be a widely accepted method of estimating sediment loss despite its simplification of the many variables involved in soil loss prediction. It is useful for determining the adequacy of conservation measures in resource planning, and for predicting nonpoint sediment losses in pollution control programs. The average annual soil loss, as determined by Wischmeier and Smith (1978) can be estimated from the equation

$$A = R\,K\,LS\,C\,P \tag{9.1}$$

where A = average annual soil loss in tons/acre,
R = rainfall and runoff erosivity index for a geographic location,
K = soil-erodibility factor,
LS = slope steepness and length factor,
C = cover management factor,
P = conservation practice factor.

In this text, English units are used for *A*, *R*, and *K*. Readers should ensure that if using other sources of information for the USLE, that units are consistent (Foster et al., 1981). Although developed for use in the United States, the procedure is used in many countries and has been the focus of considerable study during the past 30 years. Methods for determining each of the input parameters for the USLE and examples of their use follow.

Downstream Sediment Yields

Sediment delivery ratio (SDR). The USLE estimates gross sheet and rill erosion, but does not account for sediment deposited enroute to the place of measurement, nor for gully or channel erosion downstream. The sediment delivery ratio is defined as the ratio of sediment delivered at a location in the stream system to the gross erosion from the drainage area above that point. This ratio varies widely with size of area, steepness, density of drainage network, and many other factors. For watersheds of 6.4, 320, 3200, and 64,000 acres, ratios of 0.65, 0.33, 0.22, and 0.10, respectively, were suggested as average values by Roehl (1962). The development of new process-based erosion models in GIS environments will enhance the prediction of sediment delivery from watersheds.

Renfro (1975), for the Blackland Prairie Area in Texas, developed the SDR equation:

$$\log_{10} SDR = 1.8768 - 0.14191 \log_{10} 10A \tag{9.2}$$

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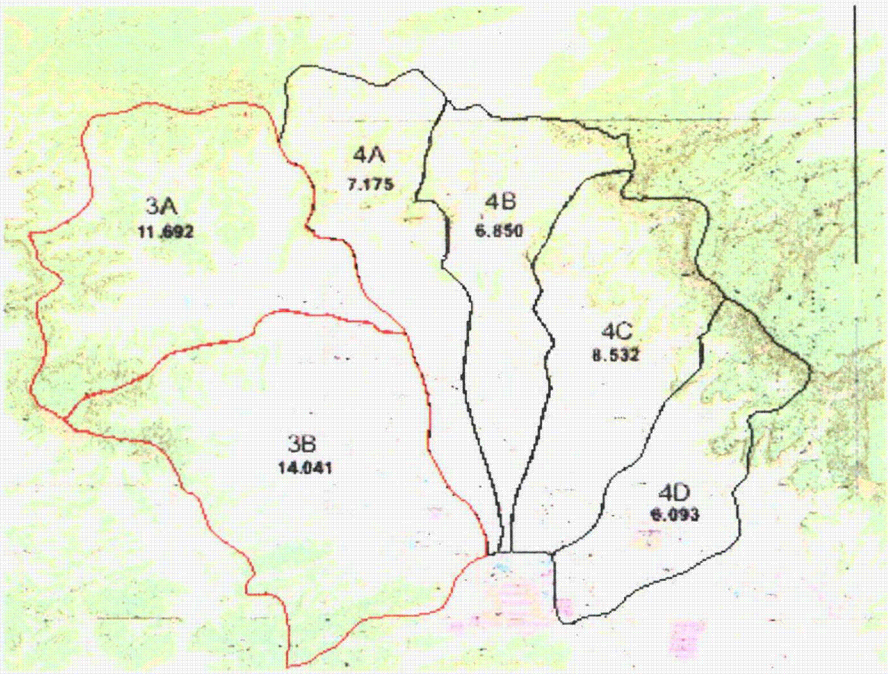
Arroyo Del Puerto
Sheet and Rill Erosion : Universal Soil-Loss Equation

Upstream Catchment Drainage Area No [1]	A = Area [1] (sq. mi.)	A = Area [1] (acres)	H_1 = Higher Elevation (feet)	H_2 = Lower Elevation (feet)	H1 - H2	S = Slope (ft/ft)	L = Maximum Slope Length (feet)	R = Rainfall Erodibility Factor	K = Soil Erodibility Factor	LS = Slope Length - Steepness Factor	VM = Erosion Control Factor	A = Soil Loss per Unit Area per year (tons/Ac/yr)	Gross Soil Loss (tons/yr)	Millenium Gross Erosion (tons)	SDR	Millenium Sediment Yield (tons)	Millenium Sediment Yield (cf)
3A	12.38	7926	8182.00	6950.00	1232.00	0.021	60000.00	30	0.55	5.31	0.005	0.44	3473	3,473,413	0.21	731,755	14,635,107
3B	14.87	9518	7848.00	6950.00	898.00	0.035	26000.00	30	0.55	5.64	0.005	0.47	4428	4,427,839	0.21	918,912	18,378,242
4A	7.60	4864	7600.00	6950.00	650.00	0.015	42000.00	30	0.55	3.61	0.005	0.30	1449	1,449,144	0.22	314,053	6,281,070
4B	7.26	4643	8054.00	6950.00	1104.00	0.029	38000.00	30	0.55	5.73	0.005	0.47	2196	2,196,396	0.22	476,950	9,539,008
4C	9.04	5783	8170.00	6950.00	1220.00	0.041	30000.00	30	0.55	7.23	0.005	0.60	3448	3,448,024	0.21	740,984	14,819,677
4D	6.45	4130	Not Included[2]													3,182,655	63,653,104
Total	57.60	36864															

[1] PMF Basin Area Figure

[2] Drainage Area 4D does not enter the Arroyo del Puerto channel until Tailings Pond 9.


4A
7.175
3A
11.692
4B
6.850
4C
8.532
3B
14.041
4D
6.093

Rio Algom Mining LLC
Ambrosia Lake, New Mexico
Arroyo Del Puerto
Native Soils : Grain Sizes

Size			Class Name	Settling Velocities		Percent Passing for Sample Areas of Site				Average Percent Passing	Size Fraction %
Mesh	mm	inches		ω_0 at 10° C (mm/sec)[1]	ω_0 at 10° C (ft/sec)	SE of Pond 6	Sec. 32 - No. 1	Sec. 32 - No. 2	Interceptor Trench Area		
No. 4	4.760	0.1874	fine gravel	237.0	0.778				100	100	
No. 10	2.000	0.0787	very coarse sand to very fine gravel	136.5	0.448				99	99	
No. 16	1.190	0.0469	very coarse sand	109.0	0.358				99	99	
No. 30	0.595	0.0234	coarse sand	66.4	0.218	100			99	99.5	
No. 40	0.420	0.0165	medium sand	31.3	0.103	99	100	100	98	99.25	1%
No. 50	0.297	0.0117	medium sand	31.3	0.103	98	98	98	98	98	1%
No. 100	0.149	0.0059	fine sand	10.1	0.033	86	76	80	81	80.75	17%
No. 200	0.074	0.0029	very fine sand	2.66	0.0087	67	54	51	65	59.25	22%
No. 400	0.037	0.0015	coarse silt	0.67	0.0022						59%

[1] NUREG-1623, Table E-4

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Arroyo Del Puerto
Trap Efficiency

Flow Parameters							Trap Efficiency = $T_{ei} = 1 - e^{(-X\omega_i/hV)}$									Composite Trap Efficiency	Incoming Millenium Sediment Yield (tons)	Millenium Sediment Load that Settles (tons
							Mesh Size	No. 10	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200	No. 400			
							mm Size	2.000	1.190	0.595	0.420	0.297	0.149	0.074	0.037			
							percent of sediment volume	1%				1%	17%	22%	59%			
							ω_0 at 10° C (mm/sec)[1]	136.5	109	66.4	31.3	31.3	10.1	2.66	0.67			
Flow Rate (cfs)	X = Reach Length (ft)	h = Mean Flow Depth (ft)	V = Mean Flow Velocity (ft/sec)	$Q_{channel}$ (cfs)	W.P. (ft)	q = Unit Discharge (ft^2/s)	ω_i at 10° C (ft/sec)	0.448	0.358	0.218	0.103	0.103	0.033	0.0087	0.0022			
	Section 13 - Sta 60+00																	
7800	500	5.15	4.96	6990.53	274.62	25.5		0.9998	0.9991	0.9859	0.8660	0.8660	0.4772	0.1570	0.0421	0.1588	3,182,655	505,440
15600	500	6.94	6.29	12175.25	280.67	43.4		0.9941	0.9834	0.9175	0.6916	0.6916	0.3158	0.0951	0.0249	0.1052	3,182,655	334,720
23400	500	8.15	7.11	16407.06	284.83	57.6		0.9790	0.9543	0.8474	0.5877	0.5877	0.2487	0.0725	0.0188	0.0836	3,182,655	266,125
31200	500	9.81	8.46	23961.75	290.63	82.4		0.9327	0.8840	0.7308	0.4613	0.4613	0.1810	0.0512	0.0132	0.0619	3,182,655	197,104
39000	500	9.45	6.98	18829.13	287.41	65.5		0.9664	0.9335	0.8082	0.5409	0.5409	0.2221	0.0640	0.0165	0.0751	3,182,655	239,093
46800	500	10.47	9.04	27518.66	292.95	93.9		0.9061	0.8488	0.6836	0.4187	0.4187	0.1606	0.0451	0.0115	0.0554	3,182,655	176,170
54600	500	11.04	9.59	30985.22	294.99	105.0		0.8794	0.8153	0.6426	0.3843	0.3843	0.1449	0.0404	0.0103	0.0502	3,182,655	159,925
62400	500	11.56	10.09	34355.90	296.86	115.7		0.8534	0.7841	0.6070	0.3561	0.3561	0.1324	0.0367	0.0094	0.0462	3,182,655	146,990
70200	500	12.05	10.57	37704.73	298.60	126.3		0.8276	0.7543	0.5748	0.3318	0.3318	0.1220	0.0337	0.0086	0.0428	3,182,655	136,070
78000	500	12.50	11.11	41338.53	300.23	137.7		0.8006	0.7240	0.5436	0.3091	0.3091	0.1125	0.0309	0.0079	0.0396	3,182,655	126,060
	Section 12 - Sta 55+00																	
7800	500	5.01	5.11	6994.16	274.16	25.5		0.9998	0.9991	0.9858	0.8654	0.8654	0.4765	0.1567	0.0420	0.1585	3,182,655	504,608
15600	500	6.75	6.44	12107.42	280.05	43.2		0.9942	0.9836	0.9184	0.6931	0.6931	0.3169	0.0955	0.0250	0.1055	3,182,655	335,840
23400	500	7.92	7.34	16415.96	284.07	57.8		0.9788	0.9538	0.8464	0.5866	0.5866	0.2480	0.0723	0.0187	0.0834	3,182,655	265,424
31200	500	9.56	8.56	23548.22	289.79	81.3		0.9352	0.8875	0.7358	0.4660	0.4660	0.1833	0.0519	0.0133	0.0627	3,182,655	199,471
39000	500	8.38	7.32	17294.75	283.69	61.0		0.9740	0.9458	0.8306	0.5670	0.5670	0.2367	0.0687	0.0178	0.0798	3,182,655	253,928
46800	500	10.20	9.10	26891.22	292.03	92.1		0.9104	0.8543	0.6907	0.4249	0.4249	0.1635	0.0459	0.0118	0.0563	3,182,655	179,146
54600	500	10.75	9.62	30147.30	293.97	102.6		0.8853	0.8225	0.6512	0.3913	0.3913	0.1480	0.0413	0.0106	0.0513	3,182,655	163,214
62400	500	11.25	10.09	33290.46	295.76	112.6		0.8609	0.7930	0.6169	0.3639	0.3639	0.1358	0.0377	0.0096	0.0473	3,182,655	150,521
70200	500	11.72	10.51	36327.31	297.44	122.1		0.8376	0.7658	0.5870	0.3409	0.3409	0.1259	0.0348	0.0089	0.0440	3,182,655	140,133
78000	500	12.16	10.89	39264.45	299.05	131.3		0.8157	0.7408	0.5607	0.3214	0.3214	0.1176	0.0324	0.0083	0.0413	3,182,655	131,480
	Section 11 - Sta 50+00																	
7800	500	4.85	5.15	6793.68	273.61	24.8		0.9999	0.9992	0.9872	0.8720	0.8720	0.4849	0.1603	0.0430	0.1615	3182655	513,856
15600	500	6.58	6.34	11585.54	279.45	41.5		0.9953	0.9862	0.9265	0.7079	0.7079	0.3278	0.0993	0.0260	0.1090	3182655	347,007
23400	500	7.70	7.27	15768.06	283.31	55.7		0.9817	0.9590	0.8571	0.6004	0.6004	0.2562	0.0750	0.0194	0.0860	3182655	273,773
31200	500	9.28	8.58	22826.23	288.80	79.0		0.9399	0.8941	0.7454	0.4753	0.4753	0.1879	0.0533	0.0137	0.0641	3182655	204,156
39000	500	8.12	7.54	17206.10	282.78	60.8		0.9742	0.9461	0.8312	0.5677	0.5677	0.2371	0.0688	0.0178	0.0799	3182655	254,328
46800	500	9.87	9.15	26079.22	290.87	89.7		0.9162	0.8619	0.7006	0.4336	0.4336	0.1676	0.0472	0.0121	0.0576	3182655	183,403
54600	500	10.35	9.76	29338.83	292.58	100.3		0.8910	0.8297	0.6598	0.3985	0.3985	0.1513	0.0423	0.0108	0.0523	3182655	166,561
62400	500	10.79	10.33	32527.40	294.12	110.6		0.8659	0.7990	0.6237	0.3691	0.3691	0.1381	0.0384	0.0098	0.0481	3182655	152,934
70200	500	11.19	10.86	35635.13	295.56	120.6		0.8416	0.7704	0.5919	0.3446	0.3446	0.1275	0.0353	0.0090	0.0446	3182655	141,805
78000	500	11.57	11.35	38671.05	296.93	130.2		0.8183	0.7438	0.5637	0.3236	0.3236	0.1185	0.0327	0.0083	0.0416	3182655	132,454

Rio Algom Mining LLC
Ambrosia Lake, New Mexico
Arroyo Del Puerto
Sediment Transport

Flow Parameters							Sediment Transport Discharge = $q_s = c_{s1} h^{cs2} V^{cs3}$ (cfs/ft)									q_s = Composite Sediment Transport (cfs/ft)	$C_{mg/l}$ = Sediment Concentration (mg/l)	Assumed Duration Δp (%)	Outgoing Sediment Transport Yield = Q_sxΔp (tons/yr)
							Mesh Size	No. 10	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200	No. 400				
							mm Size	2.000	1.190	0.595	0.420	0.297	0.149	0.074	0.037				
							percent of sediment volume	1%				1%	17%	22%	59%				
							c_{s1} at Gr=1.0	5.64E-06	5.62E-06	7.60E-06	7.60E-06	1.42E-05	3.30E-05	3.30E-05	3.30E-05				
							c_{s2} at Gr=1.0	-0.14	0.06	0.28	0.28	0.495	0.715	0.715	0.715				
Flow Rate (cfs)	X = Reach Length (ft)	h = Mean Flow Depth (ft)	V = Mean Flow Velocity (ft/sec)	$Q_{channel}$ (cfs)	W.P. (ft)	q = Unit Discharge (ft^2/s)	c_{s3} at Gr=1.0	3.950	3.930	3.820	3.820	3.610	3.300	3.300	3.300				
	Section 13 - Sta 60+00																		
7800	500	5.15	4.96	6990.53	274.62	25.5		0.0025	0.0034	0.0055	0.0055	0.0104	0.0210	0.0210	0.0210	0.0207	2,159	10.00	1,503,758
15600	500	6.94	6.29	12175.25	280.67	43.4		0.0061	0.0087	0.0147	0.0147	0.0283	0.0570	0.0570	0.0570	0.0562	3,435	9.40	4,495,787
23400	500	8.15	7.11	16407.06	284.83	57.6		0.0097	0.0142	0.0246	0.0246	0.0477	0.0958	0.0958	0.0958	0.0945	4,347	5.76	5,230,651
31200	500	9.81	8.46	23961.75	290.63	82.4		0.0189	0.0284	0.0502	0.0502	0.0979	0.1940	0.1940	0.1940	0.1915	6,155	3.04	5,215,491
39000	500	9.45	6.98	18829.13	287.41	65.5		0.0089	0.0133	0.0238	0.0238	0.0480	0.1002	0.1002	0.1002	0.0988	3,997	1.83	2,551,494
46800	500	10.47	9.04	27518.66	292.95	93.9		0.0243	0.0370	0.0659	0.0659	0.1285	0.2530	0.2530	0.2530	0.2497	7,045	0.89	2,625,742
54600	500	11.04	9.59	30985.22	294.99	105.0		0.0304	0.0469	0.0838	0.0838	0.1633	0.3193	0.3193	0.3193	0.3152	7,952	0.54	2,108,847
62400	500	11.56	10.09	34355.90	296.86	115.7		0.0370	0.0574	0.1031	0.1031	0.2007	0.3903	0.3903	0.3903	0.3852	8,821	0.28	1,371,704
70200	500	12.05	10.57	37704.73	298.60	126.3		0.0442	0.0691	0.1246	0.1246	0.2423	0.4687	0.4687	0.4687	0.4626	9,709	0.08	474,664
78000	500	12.50	11.11	41338.53	300.23	137.7		0.0535	0.0842	0.1523	0.1523	0.2953	0.5671	0.5671	0.5671	0.5598	10,774	0.02	150,073
	Section 12 - Sta 55+00															Total Annual Sediment Yield			25,728,211
7800	500	5.01	5.11	6994.16	274.16	25.5		0.0028	0.0038	0.0061	0.0061	0.0114	0.0227	0.0227	0.0227	0.0224	2,331	10.00	1,623,407
15600	500	6.75	6.44	12107.42	280.05	43.2		0.0068	0.0095	0.0160	0.0160	0.0304	0.0604	0.0604	0.0604	0.0596	3,652	9.40	4,780,594
23400	500	7.92	7.34	16415.96	284.07	57.8		0.0111	0.0161	0.0275	0.0275	0.0528	0.1042	0.1042	0.1042	0.1029	4,717	5.76	5,674,948
31200	500	9.56	8.56	23548.22	289.79	81.3		0.0198	0.0297	0.0522	0.0522	0.1009	0.1980	0.1980	0.1980	0.1955	6,374	3.04	5,400,847
39000	500	8.38	7.32	17294.75	283.69	61.0		0.0109	0.0159	0.0277	0.0277	0.0537	0.1075	0.1075	0.1075	0.1061	4,613	1.83	2,944,852
46800	500	10.20	9.10	26891.22	292.03	92.1		0.0250	0.0380	0.0671	0.0671	0.1299	0.2538	0.2538	0.2538	0.2505	7,210	0.89	2,687,220
54600	500	10.75	9.62	30147.30	293.97	102.6		0.0309	0.0474	0.0842	0.0842	0.1630	0.3166	0.3166	0.3166	0.3125	8,074	0.54	2,141,343
62400	500	11.25	10.09	33290.46	295.76	112.6		0.0371	0.0573	0.1023	0.1023	0.1980	0.3828	0.3828	0.3828	0.3778	8,895	0.28	1,383,294
70200	500	11.72	10.51	36327.31	297.44	122.1		0.0433	0.0674	0.1210	0.1210	0.2341	0.4509	0.4509	0.4509	0.4451	9,658	0.08	472,169
78000	500	12.16	10.89	39264.45	299.05	131.3		0.0496	0.0777	0.1400	0.1400	0.2710	0.5205	0.5205	0.5205	0.5138	10,371	0.02	144,452
	Section 11 - Sta 50+00															Total Annual Sediment Yield			27,253,126
7800	500	4.85	5.15	6793.68	273.61	24.8		0.0029	0.0039	0.0062	0.0062	0.0115	0.0228	0.0228	0.0228	0.0225	2,401	10.00	1,672,335
15600	500	6.58	6.34	11585.54	279.45	41.5		0.0064	0.0089	0.0149	0.0149	0.0284	0.0563	0.0563	0.0563	0.0556	3,551	9.40	4,648,815
23400	500	7.70	7.27	15768.06	283.31	55.7		0.0107	0.0154	0.0263	0.0263	0.0503	0.0990	0.0990	0.0990	0.0977	4,650	5.76	5,595,270
31200	500	9.28	8.58	22826.23	288.80	79.0		0.0201	0.0299	0.0522	0.0522	0.1003	0.1954	0.1954	0.1954	0.1928	6,465	3.04	5,478,286
39000	500	8.12	7.54	17206.10	282.78	60.8		0.0123	0.0179	0.0307	0.0307	0.0589	0.1159	0.1159	0.1159	0.1144	4,983	1.83	3,181,384
46800	500	9.87	9.15	26079.22	290.87	89.7		0.0257	0.0387	0.0679	0.0679	0.1304	0.2524	0.2524	0.2524	0.2492	7,365	0.89	2,745,170
54600	500	10.35	9.76	29338.83	292.58	100.3		0.0329	0.0500	0.0880	0.0880	0.1685	0.3231	0.3231	0.3231	0.3190	8,430	0.54	2,235,729
62400	500	10.79	10.33	32527.40	294.12	110.6		0.0410	0.0627	0.1106	0.1106	0.2111	0.4015	0.4015	0.4015	0.3964	9,498	0.28	1,476,948
70200	500	11.19	10.86	35635.13	295.56	120.6		0.0497	0.0765	0.1353	0.1353	0.2575	0.4860	0.4860	0.4860	0.4799	10,547	0.08	515,660
78000	500	11.57	11.35	38671.05	296.93	130.2		0.0588	0.0911	0.1617	0.1617	0.3070	0.5758	0.5758	0.5758	0.5686	11,569	0.02	161,137
																Total Annual Sediment Yield			27,710,734

7800 Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	809.47	443.72	320.22	10.38	1.39	1.82
2 Chan	3235	3543.1	6990.53	1408.47	274.62	89.62	5.15	4.96

15600 Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	3424.75	1267.46	541.2	21.95	2.34	2.7
2 Chan	3235	3543.1	12175.25	1936.7	280.67	78.05	6.94	6.29

23400 Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	6992.94	2062.37	645.32	29.88	3.2	3.39
2 Chan	3235	3543.1	16407.06	2306.5	284.83	70.12	8.15	7.11

31200 Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	15038.25	3328.95	735.25	38.56	4.53	4.52
2 Chan	3235	3543.1	23961.75	2830.84	290.63	61.44	9.81	8.46

39000 Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3238.75	20170.88	3884.14	788.72	51.72	4.92	5.19
2 Chan	3238.75	3545	18829.13	2696.38	287.41	48.28	9.45	6.98

46800 Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	19281.33	3880.57	771.15	41.2	5.03	4.97
2 Chan	3235	3543.1	27518.66	3042.94	292.95	58.8	10.47	9.04

54600 Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	23614.78	4388.53	802.79	43.25	5.47	5.38
2 Chan	3235	3543.1	30985.22	3231.22	294.99	56.75	11.04	9.59

62400 Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	28044.1	4871.75	831.77	44.94	5.86	5.76
2 Chan	3235	3543.1	34355.9	3404.78	296.86	55.06	11.56	10.09

70200 Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	32495.27	5337.45	863.65	46.29	6.18	6.09
2 Chan	3235	3543.1	37704.73	3567.39	298.6	53.71	12.05	10.57

78000 Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	36661.47	5797.88	922.43	47	6.29	6.32
2 Chan	3235	3543.1	41338.53	3720.44	300.23	53	12.5	11.11

Plan: Reach #1 Reach #1 RS: 12 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	805.84	436.83	333.33	10.33	1.31	1.84
2 Chan	3235	3541.3	6994.16	1367.42	274.16	89.67	5.01	5.11

Plan: Reach #1 Reach #1 RS: 12 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	3492.58	1276.7	569.85	22.39	2.24	2.74
2 Chan	3235	3541.3	12107.42	1880.12	280.05	77.61	6.75	6.44

Plan: Reach #1 Reach #1 RS: 12 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	6984.04	2102.59	731.3	29.85	2.88	3.32
2 Chan	3235	3541.3	16415.96	2236.05	284.07	70.15	7.92	7.34

Plan: Reach #1 Reach #1 RS: 12 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	15451.78	3543.08	859.62	39.62	4.12	4.36
2 Chan	3235	3541.3	23548.22	2751.62	289.79	60.38	9.56	8.56

Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3238.75	21705.25	3894.02	859.55	55.65	4.53	5.57
2 Chan	3238.75	3545	17294.75	2362.82	283.69	44.35	8.38	7.32

Plan: Reach #1 Reach #1 RS: 12 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	19908.78	4167.44	909.05	42.54	4.58	4.78
2 Chan	3235	3541.3	26891.22	2955.51	292.03	57.46	10.2	9.1

Plan: Reach #1 Reach #1 RS: 12 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	24452.7	4739.01	952.05	44.79	4.98	5.16
2 Chan	3235	3541.3	30147.3	3134.1	293.97	55.21	10.75	9.62

Plan: Reach #1 Reach #1 RS: 12 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	29109.54	5288.5	991.64	46.65	5.33	5.5
2 Chan	3235	3541.3	33290.46	3299.5	295.76	53.35	11.25	10.09

Plan: Reach #1 Reach #1 RS: 12 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	33872.68	5825.16	1028.83	48.25	5.66	5.81
2 Chan	3235	3541.3	36327.31	3455.78	297.44	51.75	11.72	10.51

Plan: Reach #1 Reach #1 RS: 12 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	38735.55	6355.05	1064.28	49.66	5.97	6.1
2 Chan	3235	3541.3	39264.45	3605.52	299.05	50.34	12.16	10.89

Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	1006.32	515	375.91	12.9	1.37	1.95
2 Chan	3235	3539.4	6793.68	1320.03	273.61	87.1	4.85	5.15

Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	4014.46	1396.71	580.05	25.73	2.41	2.87
2 Chan	3235	3539.4	11585.54	1827.55	279.45	74.27	6.58	6.34

Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	7631.94	2186.86	715.08	32.62	3.06	3.49
2 Chan	3235	3539.4	15768.06	2168.87	283.31	67.38	7.7	7.27

Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	16173.77	3559.64	838.67	41.47	4.24	4.54
2 Chan	3235	3539.4	22826.23	2661.43	288.8	58.53	9.28	8.58

Plan: Reach #1 Reach #1 RS: 10 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3238.75	21793.9	4176.87	1098.5	55.88	3.8	5.22
2 Chan	3238.75	3545	17206.1	2281.99	282.78	44.12	8.12	7.54

Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	20720.78	4119.03	864.95	44.28	4.76	5.03
2 Chan	3235	3539.4	26079.22	2850.4	290.87	55.72	9.87	9.15

Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	25261.17	4589.78	886.46	46.27	5.18	5.5
2 Chan	3235	3539.4	29338.83	3006.05	292.58	53.73	10.35	9.76

Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	29872.6	5025.59	905.92	47.87	5.55	5.94
2 Chan	3235	3539.4	32527.4	3147.61	294.12	52.13	10.79	10.33

Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	34564.87	5442.87	924.17	49.24	5.89	6.35
2 Chan	3235	3539.4	35635.13	3281.01	295.56	50.76	11.19	10.86

Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1

Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1 LOB		3235	39328.95	5845.94	941.46	50.42	6.21	6.73
2 Chan	3235	3539.4	38671.05	3407.98	296.93	49.58	11.57	11.35

Appendix E.3.....**Calculation E.2 Sedimentation 4.00-Foot Depth**
Arroyo Del Puerto

Calculation E.2
Rio Algom Mining LLC
Ambrosia Lake, New Mexico
Arroyo Del Puerto
Exterior Site Drainage Calculations
Sedimentation - 4.00-Foot Depth

1. Diversion Embankment/Channel Design Layout

The same geometry used in Calculation D.1 was also used for this sedimentation evaluation. The only change was that 4.00 feet of sediment was applied in the channel to evaluate critical changes that might effect rock erosion protection sizing and scour depth; and water level depth that might impact freeboard thus increasing the risk of overtopping. 4.00 feet was used because that is th relative height difference between the right and left channel bottoms for 2% slope across the 250-foot wide channel.

2. HEC-RAS Results

The summary results of the HEC-RAS analysis, rock size calculations, and depth scour calculations for the Diversion Embankment/Channel are contained on Worksheet Tab "Rock-Scour Depth Summary", (calc. Sheets 2 thru 3 of 48). The detailed results of the HEC-RAS analysis and subsequent calculations are summarized on the table of Worksheet Tab "HEC-RAS Results", (calc. Sheets 4 thru 31 of 48). Erosion protection sizes have been estimated on this table by the Abt and Johnson Method and then oversizing by 4% to determine the D_{50} size rock before applying slope correction factors. The size of rock after applying the slope factors and the scour depths are then compared to determine if the existing design is exceeded under this extreme silt condition.

The extent of the changes to the PMF channel flow is illustrated by the graphic cross-sections of the flood flow taken from the HEC-RAS Model and shown on Worksheet Tab "PMF Silt+4.00", (calc. Sheets 32 thru 40 of 48).

The raw data taken directly from the HEC-RAS model are contained on the following worksheets:

Worksheet Tab "HEC-RAS Profile Output"	Calc. Sheet 41 of 48
Worksheet Tab "HEC-RAS Flow Dist Output"	Calc. Sheets 42 thru 45 of 48
Worksheet Tab "HEC-RAS Cross-Sect Output"	Calc. Sheets 46 thru 48 of 48

3. Conclusion:

It is noted that the added 4.00 feet of silt to the channel bottom did not impact the rock sizing performed in Calculation D.1. Also, as the bottom is filled with silt, the channel flow begins to spread out into the left overbank area. Thus the impact to velocities and to the water surfac elevation is minimal.

		Embankment Slope / Apron D_{50} (inches)					
1	2	3	4	5	6	7	8
			D_{50} ROCK SIZE CALCULATION w/ SLOPE CORRECTION FACTORS (inches)				
River Section	Station	Channel X-Section Position	Abt and Johnson Method (inches)	Add Riprap Oversize 4%	2H:1V Apron Slope: Abt and Johnson D_{50} / Slope Factor (0.72)	3H:1V Slope: Abt and Johnson D_{50} / Slope Factor (0.88)	4H:1V Slope: Abt and Johnson D_{50} / Slope Factor (1.00)
21	9675						
20	9175						
19	8675	R. Chan. Apron	2.22	2.31	3.20	2.62	2.31
18	8350	R. Chan. C3	3.65	3.80	5.28	4.32	3.80
		R. Chan. C1 (Apron)	3.24	3.37	4.67	3.82	3.37
17	8000	R. Chan. C3	2.98	3.10	4.30	3.52	3.10
		R. Chan. C1 (Apron)	2.64	2.75	3.82	3.12	2.75
16	7500	R. Chan. C3	3.90	4.05	5.63	4.61	4.05
		R. Chan. C1 (Apron)	3.46	3.60	5.00	4.09	3.60
15	7000	R. Chan. C3	4.83	5.02	6.97	5.70	5.02
		R. Chan. C1 (Apron)	4.28	4.45	6.18	5.06	4.45
14	6500	R. Chan. C3	5.38	5.60	7.77	6.36	5.60
		R. Chan. C1 (Apron)	4.77	4.96	6.89	5.64	4.96
13	6000	R. Chan. C3	5.23	5.43	7.55	6.18	5.43
		R. Chan. C1 (Apron)	4.63	4.81	6.68	5.47	4.81
12	5500	R. Chan. C3	4.97	5.17	7.18	5.87	5.17
		R. Chan. C1 (Apron)	4.40	4.57	6.35	5.20	4.57
11	5000	R. Chan. C3	5.28	5.49	7.62	6.24	5.49
		R. Chan. C1 (Apron)	4.66	4.85	6.73	5.51	4.85
10	4500	R. Chan. C3	5.47	5.69	7.90	6.47	5.69
		R. Chan. C1 (Apron)	4.82	5.02	6.97	5.70	5.02
9	4000	R. Chan. C3	6.86	7.14	9.92	8.11	7.14
		R. Chan. C1 (Apron)	6.06	6.30	8.75	7.16	6.30
8	3500	R. Chan. C3	7.31	7.61	10.56	8.64	7.61
		R. Chan. C1 (Apron)	6.46	6.72	9.33	7.63	6.72
7	3000	R. Chan. C3	8.25	8.57	11.91	9.74	8.57
		R. Chan. C1 (Apron)	6.70	6.97	9.68	7.92	6.97
6	2500	R. Chan. C7	10.95	11.39	15.82	12.94	11.39
		R. Chan. C1 (Slope)	9.07	9.43	13.10	10.72	9.43
5	2000	R. Chan. C7	11.69	12.16	16.89	13.82	12.16
		R. Chan. C1 (Slope)	10.77	11.20	15.55	12.73	11.20
4	1500	R. Chan. C7	12.45	12.95	17.98	14.71	12.95
		R. Chan. C1 (Slope)	11.56	12.02	16.69	13.66	12.02
3	1000	R. Chan. C7	12.44	12.93	17.96	14.70	12.93
		R. Chan. C1 (Slope)	11.62	12.08	16.78	13.73	12.08
2	500	R. Chan. C7	12.37	12.87	17.87	14.62	12.87
		R. Chan. C1 (Slope)	11.52	11.98	16.64	13.62	11.98
1	0	R. Chan. C2	12.14	12.63	17.54	14.35	12.63
		R. Chan. C1 (Slope)	10.80	11.23	15.59	12.76	11.23
0	-100	R. Chan. C2	12.02	12.50	17.36	14.20	12.50
		R. Chan. C1 (Slope)	10.12	10.52	14.61	11.95	10.52
-1	-500						
-2	-1000						
-3	-1500						
-4	-2000						

D_{50} = 3.2 inch rock nominal (3.24 inch actual)

D_{50} = 7.8 inch rock nominal (7.95 inch actual)

D_{50} = 9.2 inch rock nominal (9.33 inch actual)

D_{50} = 12 inch rock nominal (12.97 inch actual)

D_{50} > 12.97 inch rock

		Embankment Slope / Apron D_{50} (inches)								
1	2	9	10	11	12	13	14	15	16	17
		D50 ROCK SIZE FOR BERM ABOVE GRADE SLOPES		D50 ROCK SIZE FOR BERM APRONS or BURIED SLOPES		DEPTH SCOUR (FT)				
River Section	Station	Minimum Required D_{50} to Use	Proposed D_{50} to Use for Slope	Minimum Required D_{50} to Use	Proposed D_{50} to Use for Apron/ Buried Slope	USDOT HEC-14 Scour Depth	USACE Equilibrium Scour Depth	CSU Equation for Piers	USDOT HEC-18 Froelich Equation for Live Bed Scour	Average Scour Depth
21	9675									
20	9175									
19	8675	3.20	3.24	3.20	3.24	3.6	2.5	5.003	6.081	4.3
18	8350			7.80	12.97	5.1	5.5	5.585	5.581	5.4
		7.80	7.95							
17	8000			7.80	12.97	5.0	5.1	5.301	5.308	5.2
		3.20	7.95							
16	7500			7.80	12.97	5.4	6.2	5.771	5.462	5.7
		7.80	7.95							
15	7000			7.80	12.97	5.7	6.9	6.127	5.688	6.1
		7.80	7.95							
14	6500			7.80	12.97	5.7	7.0	6.286	5.887	6.2
		7.80	7.95							
13	6000			7.80	12.97	5.6	6.6	6.196	5.941	6.1
		7.80	7.95							
12	5500			7.80	12.97	5.4	6.2	6.074	5.968	5.9
		7.80	7.95							
11	5000			7.80	12.97	5.4	6.1	6.127	6.173	5.9
		7.80	7.95							
10	4500			7.90	12.97	5.3	5.8	6.127	6.400	5.9
		7.80	7.95							
9	4000			12.00	12.97	5.7	6.9	6.594	6.560	6.4
		7.80	7.95							
8	3500			12.00	12.97	5.8	7.4	6.748	6.555	6.6
		7.80	7.95							
7	3000			12.00	12.97	6.1	7.9	6.980	6.694	6.9
		7.92	7.95							
6	2500			12.00	12.97	6.7	9.9	7.830	6.793	7.8
		12.00	12.97							
5	2000			12.16	12.97	6.5	9.2	8.216	7.043	7.8
		12.00	12.97							
4	1500			12.95	12.97	6.5	9.1	8.308	7.506	7.9
		12.02	12.97							
3	1000			12.93	12.97	6.6	9.6	8.408	7.108	7.9
		12.08	12.97							
2	500			12.87	12.97	6.8	10.0	8.452	6.955	8.0
		11.98	12.97							
1	0			12.63	12.97	4.1	3.4	7.738	6.672	5.5
		12.00	12.97							
0	-100			12.50	12.97	5.4	6.3	7.356	5.646	6.2
		12.00	12.97							
-1	-500									
-2	-1000									
-3	-1500									
-4	-2000									

D_{50} = 3.2 inch rock nominal (3.24 inch actual)

D_{50} = 7.8 inch rock nominal (7.95 inch actual)

D_{50} = 9.2 inch rock nominal (9.33 inch actual)

D_{50} = 12 inch rock nominal (12.97 inch actual)

D_{50} > 12.97 inch rock

INPUT DATA VALUES TO HEC-RAS

River Section	Station	Flow (cfs)	Proposed Top of Berm Elevation	Estimated Freeboard on Diversion Berm	Elevation at Base of Right Berm	Depth of Flow at Base of Right Berm	Channel Slope (ft/ft)	Right Bank & Apron Rock Sizes	Right Bank & Buried Slope Rock Sizes	Channel X-Section Position	Manning's n Value
1	2	3	4	5	6	7	8	9	10	11	12
21	9675	78000	No Berm	N/A	N/A	N/A	0.0032			LOB	0.0350
										L. Channel	0.0300
										Main Channel	0.0300
										R. Channel	0.0300
										ROB	0.0350
20	9175	78000	No Berm	N/A	N/A	N/A	0.0032			LOB	0.0350
										L. Channel	0.0300
										Main Channel	0.0300
										R. Channel	0.0300
										ROB	0.0350
19	8675	78000	No Berm	N/A	N/A	N/A	0.0032			LOB	0.0300
										L. Channel	0.0300
										Main Channel	0.0300
								3.2		R. Chan. Apron	0.0317
								3.2		R. Bank Slope	0.0317
18	8350	78000	6965.00	5.01	6948.39	11.61	0.0032			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368
17	8000	78000	6962.27	2.50	6947.27	12.50	0.0032			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368
16	7500	78000	6961.22	2.20	6946.22	12.80	0.001			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368
15	7000	78000	6960.47	2.38	6945.72	12.37	0.001			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368

INPUT DATA VALUES TO HEC-RAS

River Section	Station	Flow (cfs)	Proposed Top of Berm Elevation	Estimated Freeboard on Diversion Berm	Elevation at Base of Right Berm	Depth of Flow at Base of Right Berm	Channel Slope (ft/ft)	Right Bank & Apron Rock Sizes	Right Bank & Buried Slope Rock Sizes	Channel X-Section Position	Manning's n Value
1	2	3	4	5	6	7	8	9	10	11	12
14	6500	78000	6959.72	2.80	6945.22	11.70	0.001			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368
13	6000	78000	6958.97	3.01	6944.72	11.24	0.001			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368
12	5500	78000	6958.22	3.15	6944.22	10.85	0.001			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368
11	5000	78000	6957.47	3.62	6943.72	10.13	0.001			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368
10	4500	78000	6956.72	4.17	6943.22	9.33	0.005			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368
9	4000	78000	6953.72	3.35	6940.72	9.65	0.005			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368
8	3500	78000	6951.22	3.06	6938.22	9.94	0.005			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368

INPUT DATA VALUES TO HEC-RAS

River Section	Station	Flow (cfs)	Proposed Top of Berm Elevation	Estimated Freeboard on Diversion Berm	Elevation at Base of Right Berm	Depth of Flow at Base of Right Berm	Channel Slope (ft/ft)	Right Bank & Apron Rock Sizes	Right Bank & Buried Slope Rock Sizes	Channel X-Section Position	Manning's n Value
1	2	3	4	5	6	7	8	9	10	11	12
7	3000	78000	6948.72	3.09	6935.72	9.91	0.010			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
								12		R. Chan. C2 (Apron)	0.0395
								12		R. Chan. C1 (Apron)	0.0395
								7.8		R. Bank Slope	0.0368
6	2500	78000	6943.72	2.46	6930.72	10.54	0.010			R. Chan. C7	0.0300
									12	R. Chan. C6 (Slope)	0.0395
									12	R. Chan. C5 (Slope)	0.0395
									12	R. Chan. C4 (Slope)	0.0395
									12	R. Chan. C3 (Slope)	0.0395
									12	R. Chan. C2 (Slope)	0.0395
									12	R. Chan. C1 (Slope)	0.0395
									12	R. Bank Slope	0.0395
5	2000	78000	6938.72	2.65	6925.72	10.35	0.010			R. Chan. C7	0.0300
									12	R. Chan. C6 (Slope)	0.0395
									12	R. Chan. C5 (Slope)	0.0395
									12	R. Chan. C4 (Slope)	0.0395
									12	R. Chan. C3 (Slope)	0.0395
									12	R. Chan. C2 (Slope)	0.0395
									12	R. Chan. C1 (Slope)	0.0395
									12	R. Bank Slope	0.0395
4	1500	78000	6933.22	2.48	6920.72	10.02	0.010			R. Chan. C7	0.0300
									12	R. Chan. C6 (Slope)	0.0395
									12	R. Chan. C5 (Slope)	0.0395
									12	R. Chan. C4 (Slope)	0.0395
									12	R. Chan. C3 (Slope)	0.0395
									12	R. Chan. C2 (Slope)	0.0395
									12	R. Chan. C1 (Slope)	0.0395
									12	R. Bank Slope	0.0395
3	1000	78000	6928.22	2.05	6915.72	10.45	0.010			R. Chan. C7	0.0300
									12	R. Chan. C6 (Slope)	0.0395
									12	R. Chan. C5 (Slope)	0.0395
									12	R. Chan. C4 (Slope)	0.0395
									12	R. Chan. C3 (Slope)	0.0395
									12	R. Chan. C2 (Slope)	0.0395
									12	R. Chan. C1 (Slope)	0.0395
									12	R. Bank Slope	0.0395

INPUT DATA VALUES TO HEC-RAS

River Section	Station	Flow (cfs)	Proposed Top of Berm Elevation	Estimated Freeboard on Diversion Berm	Elevation at Base of Right Berm	Depth of Flow at Base of Right Berm	Channel Slope (ft/ft)	Right Bank & Apron Rock Sizes	Right Bank & Buried Slope Rock Sizes	Channel X-Section Position	Manning's n Value
1	2	3	4	5	6	7	8	9	10	11	12
2	500	78000	6923.22	1.48	6910.72	11.02	0.010			R. Chan. C7	0.0300
									12	R. Chan. C6 (Slope)	0.0395
									12	R. Chan. C5 (Slope)	0.0395
									12	R. Chan. C4 (Slope)	0.0395
									12	R. Chan. C3 (Slope)	0.0395
									12	R. Chan. C2 (Slope)	0.0395
									12	R. Chan. C1 (Slope)	0.0395
									12	R. Bank Slope	0.0395
1	0	78000	No Berm	N/A	N/A	N/A	0.009			R. Chan. C2	0.0300
									12	R. Chan. C1 (Slope)	0.0395
									12	R. Bank Slope	0.0395
0	-100	78000	No Berm	N/A	N/A	N/A	0.009			R. Chan. C2	0.0300
									12	R. Chan. C1 (Slope)	0.0395
									12	R. Bank Slope	0.0395
-1	-500	78000	No Berm	N/A	N/A	N/A	0.009			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
										R. Chan. C2	0.0300
										R. Chan. C1	0.0300
										R. Bank Slope	0.0350
-2	-1000	78000	No Berm	N/A	N/A	N/A	0.009			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
										R. Chan. C2	0.0300
										R. Chan. C1	0.0300
										R. Bank Slope	0.0350
-3	-1500	78000	No Berm	N/A	N/A	N/A	0.009			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
										R. Chan. C2	0.0300
										R. Chan. C1	0.0300
										R. Bank Slope	0.0350
-4	-2000	78000	No Berm	N/A	N/A	N/A	0.009			R. Chan. C5	0.0300
										R. Chan. C4	0.0300
										R. Chan. C3	0.0300
										R. Chan. C2	0.0300
										R. Chan. C1	0.0300
										R. Bank Slope	0.0350

HEC-RAS DATA RESULTS

River Section	Water Surface Elevation (ft)	E.G. Slope (ft/ft)	Position	Left Station (ft)	Right Station (ft)	Split Section Flow (cfs)	Flow Area (sq ft)	Wetted Perimeter (ft)	Percentage of Conveyance	Hydraulic Depth (ft)	Velocity (ft/s)
1	13	14	15	16	17	18	19	20	21	22	23
21	6964.88	0.001678	LOB	1175	3350	5957.83	1634.37	538.52	7.64	3.04	3.65
		0.001678	Chan	3350	3416.67	6152.39	658.63	66.67	7.89	9.88	9.34
		0.001678	Chan	3416.67	3483.33	6152.36	658.62	66.67	7.89	9.88	9.34
		0.001678	Chan	3483.33	3550	6152.38	658.63	66.67	7.89	9.88	9.34
		0.001678	ROB	3550	5225	53585.04	9491.66	1622.73	68.7	5.85	5.65
20	6962.53	0.005135	LOB	1010	3350	26117.83	3634.75	1001.26	33.48	3.63	7.19
		0.005135	Chan	3350	3416.67	8431.73	569.1	66.72	10.81	8.54	14.82
		0.005135	Chan	3416.67	3483.33	8583.5	575.03	66.67	11	8.63	14.93
		0.005135	Chan	3483.33	3550	8416.28	568.46	66.72	10.79	8.53	14.81
		0.005135	ROB	3550	4975	26450.66	4128.03	1350.42	33.91	3.06	6.41
19	6960.41	0.001115	LOB	605	2720	1612.59	816.52	496.68	2.07	1.64	1.97
		0.001115	Chan	2720	3180	21741.39	3442.64	460.02	27.87	7.48	6.32
		0.001115	Chan	3180	3640	35982.88	3962.33	460	35.23	8.61	6.94
		0.001115	Chan	3640	4100	18387.26	3911.13	460.16	34.47	8.5	6.87
		0.001115	ROB	4100	4875	275.88	159.93	119.18	0.35	1.34	1.72
18	6959.99	0.001152	Chan	3468.45	3474.76	682.82	76.79	6.31	0.88	12.17	8.89
		0.001152	Chan	3474.76	3481.07	671.07	76	6.31	0.86	12.04	8.83
		0.001152	Chan	3481.07	3487.38	599.86	75.2	6.31	0.77	11.92	7.98
		0.001152	Chan	3487.38	3493.69	492	74.4	6.31	0.63	11.79	6.61
		0.001152	Chan	3493.69	3500	483.25	73.61	6.31	0.62	11.67	6.57
		0.001152	ROB	3500	4825	861.97	201.81	36.67	1.11	5.8	4.27
17	6959.76	0.000786	Chan	3468.45	3474.76	634.32	82.4	6.31	0.81	13.06	7.7
		0.000786	Chan	3474.76	3481.07	624.13	81.6	6.31	0.8	12.93	7.65
		0.000786	Chan	3481.07	3487.38	558.55	80.8	6.31	0.72	12.81	6.91
		0.000786	Chan	3487.38	3493.69	458.7	80.01	6.31	0.59	12.68	5.73
		0.000786	Chan	3493.69	3500	451.12	79.21	6.31	0.58	12.55	5.7
		0.000786	ROB	3500	3560	867.42	234.05	39.5	1.11	6.25	3.71
16	6959.01	0.001114	Chan	3468.45	3474.76	784.05	84.27	6.31	1.01	13.36	9.3
		0.001114	Chan	3474.76	3481.07	771.76	83.47	6.31	0.99	13.23	9.25
		0.001114	Chan	3481.07	3487.38	690.92	82.67	6.31	0.89	13.1	8.36
		0.001114	Chan	3487.38	3493.69	567.62	81.88	6.31	0.73	12.98	6.93
		0.001114	Chan	3493.69	3500	558.45	81.08	6.31	0.72	12.85	6.89
		0.001114	ROB	3500	3560	1099.45	245.28	40.44	1.41	6.39	4.48
15	6958.08	0.001573	Chan	3468.45	3474.76	881.98	81.53	6.31	1.13	12.92	10.82
		0.001573	Chan	3474.76	3481.07	867.69	80.74	6.31	1.11	12.8	10.75
		0.001573	Chan	3481.07	3487.38	776.39	79.94	6.31	1	12.67	9.71
		0.001573	Chan	3487.38	3493.69	637.48	79.15	6.31	0.82	12.54	8.05
		0.001573	Chan	3493.69	3500	626.83	78.35	6.31	0.8	12.42	8
		0.001573	ROB	3500	3560	1191.93	228.95	39.07	1.53	6.18	5.21

HEC-RAS DATA RESULTS

River Section	Water Surface Elevation (ft)	E.G. Slope (ft/ft)	Position	Left Station (ft)	Right Station (ft)	Split Section Flow (cfs)	Flow Area (sq ft)	Wetted Perimeter (ft)	Percentage of Conveyance	Hydraulic Depth (ft)	Velocity (ft/s)
1	13	14	15	16	17	18	19	20	21	22	23
14	6956.91	0.00197	Chan	3468.45	3474.76	903.42	77.33	6.31	1.16	12.26	11.68
		0.00197	Chan	3474.76	3481.07	887.99	76.53	6.31	1.14	12.13	11.6
		0.00197	Chan	3481.07	3487.38	793.86	75.74	6.31	1.02	12	10.48
		0.00197	Chan	3487.38	3493.69	651.19	74.94	6.31	0.83	11.88	8.69
		0.00197	Chan	3493.69	3500	639.7	74.15	6.31	0.82	11.75	8.63
		0.00197	ROB	3500	3560	1150.24	204.91	36.96	1.47	5.84	5.61
13	6955.95	0.001988	Chan	3468.45	3474.76	852.16	74.46	6.31	1.09	11.8	11.44
		0.001988	Chan	3474.76	3481.07	837.05	73.66	6.31	1.07	11.67	11.36
		0.001988	Chan	3481.07	3487.38	747.82	72.86	6.31	0.96	11.55	10.26
		0.001988	Chan	3487.38	3493.69	612.99	72.07	6.31	0.79	11.42	8.51
		0.001988	Chan	3493.69	3500	601.74	71.27	6.31	0.77	11.3	8.44
		0.001988	ROB	3500	3558.1	1039.25	189.23	35.52	1.33	5.62	5.49
12	6955.06	0.001938	Chan	3468.45	3474.76	795.29	71.98	6.31	1.02	11.41	11.05
		0.001938	Chan	3474.76	3481.07	780.7	71.19	6.31	1	11.28	10.97
		0.001938	Chan	3481.07	3487.38	697.05	70.39	6.31	0.89	11.16	9.9
		0.001938	Chan	3487.38	3493.69	570.99	69.59	6.31	0.73	11.03	8.2
		0.001938	Chan	3493.69	3500	560.14	68.8	6.31	0.72	10.9	8.14
		0.001938	ROB	3500	3556.3	934.7	176.48	34.32	1.2	5.42	5.3
11	6953.84	0.002303	Chan	3468.45	3474.76	777.3	67.42	6.31	1	10.69	11.53
		0.002303	Chan	3474.76	3481.07	762.08	66.63	6.31	0.98	10.56	11.44
		0.002303	Chan	3481.07	3487.38	679.58	65.83	6.31	0.87	10.43	10.32
		0.002303	Chan	3487.38	3493.69	555.92	65.03	6.31	0.71	10.31	8.55
		0.002303	Chan	3493.69	3500	544.62	64.24	6.31	0.7	10.18	8.48
		0.002303	ROB	3500	3554.4	847.48	153.71	32.03	1.09	5.06	5.51
10	6952.54	0.002692	Chan	3468.45	3474.76	738.21	62.38	6.31	0.95	9.89	11.84
		0.002692	Chan	3474.76	3481.07	722.59	61.58	6.31	0.93	9.76	11.73
		0.002692	Chan	3481.07	3487.38	643.34	60.78	6.31	0.82	9.63	10.58
		0.002692	Chan	3487.38	3493.69	525.35	59.99	6.31	0.67	9.51	8.76
		0.002692	Chan	3493.69	3500	513.78	59.19	6.31	0.66	9.38	8.68
		0.002692	ROB	3500	3552.5	734.82	130.23	29.47	0.94	4.66	5.64
9	6950.36	0.003547	Chan	3468.45	3474.76	894.23	64.42	6.31	1.15	10.21	13.88
		0.003547	Chan	3474.76	3481.07	875.91	63.63	6.31	1.12	10.08	13.77
		0.003547	Chan	3481.07	3487.38	780.36	62.83	6.31	1	9.96	12.42
		0.003547	Chan	3487.38	3493.69	637.72	62.04	6.31	0.82	9.83	10.28
		0.003547	Chan	3493.69	3500	624.14	61.24	6.31	0.8	9.71	10.19
		0.003547	ROB	3500	3552.5	924.11	139.47	30.49	1.18	4.82	6.63
8	6948.15	0.003735	Chan	3468.45	3474.76	961.4	66.25	6.31	1.23	10.5	14.51
		0.003735	Chan	3474.76	3481.07	942.24	65.46	6.31	1.21	10.37	14.4
		0.003735	Chan	3481.07	3487.38	839.94	64.66	6.31	1.08	10.25	12.99
		0.003735	Chan	3487.38	3493.69	686.84	63.86	6.31	0.88	10.12	10.75
		0.003735	Chan	3493.69	3500	672.62	63.07	6.31	0.86	10	10.67
		0.003735	ROB	3500	3552.5	1026.12	147.97	31.41	1.32	4.97	6.93

HEC-RAS DATA RESULTS

River Section	Water Surface Elevation (ft)	E.G. Slope (ft/ft)	Position	Left Station (ft)	Right Station (ft)	Split Section Flow (cfs)	Flow Area (sq ft)	Wetted Perimeter (ft)	Percentage of Conveyance	Hydraulic Depth (ft)	Velocity (ft/s)
1	13	14	15	16	17	18	19	20	21	22	23
7	6945.62	0.004467	Chan	3468.45	3474.76	1038.06	66.02	6.31	1.33	10.46	15.72
		0.004467	Chan	3474.76	3481.07	1017.3	65.23	6.31	1.3	10.34	15.6
		0.004467	Chan	3481.07	3487.38	906.79	64.43	6.31	1.16	10.21	14.07
		0.004467	Chan	3487.38	3493.69	741.45	63.63	6.31	0.95	10.09	11.65
		0.004467	Chan	3493.69	3500	626.05	62.84	6.31	0.93	9.96	11.55
		0.004467	ROB	3500	3554.4	1112.63	147.05	31.32	1.43	4.95	7.57
6	6941.25	0.006179	Chan	3455.83	3462.14	1172.96	71.58	6.31	1.63	11.34	17.78
		0.006179	Chan	3462.14	3468.45	932.78	70.79	6.31	1.32	11.22	14.59
		0.006179	Chan	3468.45	3474.76	913.48	69.99	6.31	1.3	11.09	14.48
		0.006179	Chan	3474.76	3481.07	894.34	69.19	6.31	1.27	10.97	14.37
		0.006179	Chan	3481.07	3487.38	875.3	68.39	6.31	1.25	10.84	14.26
		0.006179	Chan	3487.38	3493.69	856.48	67.6	6.31	1.23	10.71	14.15
		0.006179	Chan	3493.69	3500	837.77	66.8	6.31	1.2	10.59	14.04
		0.006179	ROB	3500	3556.3	1436.97	166.35	33.32	1.84	5.26	8.64
5	6936.06	0.007986	Chan	3455.83	3462.14	1082.83	70.41	6.31	1.8	11.16	19.99
		0.007986	Chan	3462.14	3468.45	1041.83	69.61	6.31	1.46	11.03	16.4
		0.007986	Chan	3468.45	3474.76	1020.14	68.82	6.31	1.44	10.91	16.28
		0.007986	Chan	3474.76	3481.07	998.62	68.02	6.31	1.41	10.78	16.15
		0.007986	Chan	3481.07	3487.38	977.23	67.22	6.31	1.38	10.65	16.02
		0.007986	Chan	3487.38	3493.69	956.08	66.43	6.31	1.35	10.53	15.9
		0.007986	Chan	3493.69	3500	935.07	65.63	6.31	1.33	10.4	15.77
		0.007986	ROB	3500	3558.1	1555.54	160.31	32.69	1.99	5.17	9.7
4	6930.73	0.009374	Chan	3455.83	3462.14	1071.11	68.34	6.31	1.86	10.83	21.23
		0.009374	Chan	3462.14	3468.45	1051.24	67.54	6.31	1.51	10.71	17.41
		0.009374	Chan	3468.45	3474.76	1028.21	66.75	6.31	1.48	10.58	17.28
		0.009374	Chan	3474.76	3481.07	1005.37	65.95	6.31	1.45	10.45	17.14
		0.009374	Chan	3481.07	3487.38	982.67	65.15	6.31	1.42	10.33	17
		0.009374	Chan	3487.38	3493.69	960.24	64.36	6.31	1.39	10.2	16.86
		0.009374	Chan	3493.69	3500	937.95	63.56	6.31	1.36	10.07	16.72
		0.009374	ROB	3500	3560	1546.72	150.32	31.66	1.98	5.01	10.29
3	6926.16	0.008727	Chan	3455.83	3462.14	1129.74	71.07	6.31	1.92	11.26	21.03
		0.008727	Chan	3462.14	3468.45	1112.54	70.27	6.31	1.55	11.14	17.25
		0.008727	Chan	3468.45	3474.76	1089.73	69.48	6.31	1.53	11.01	17.12
		0.008727	Chan	3474.76	3481.07	1067.09	68.68	6.31	1.5	10.89	16.99
		0.008727	Chan	3481.07	3487.38	1044.57	67.88	6.31	1.47	10.76	16.86
		0.008727	Chan	3487.38	3493.69	1022.33	67.09	6.31	1.44	10.63	16.73
		0.008727	Chan	3493.69	3500	1000.21	66.29	6.31	1.41	10.51	16.6
		0.008727	ROB	3500	3560	1670.63	163.6	33.02	2.14	5.22	10.21

HEC-RAS DATA RESULTS

River Section	Water Surface Elevation (ft)	E.G. Slope (ft/ft)	Position	Left Station (ft)	Right Station (ft)	Split Section Flow (cfs)	Flow Area (sq ft)	Wetted Perimeter (ft)	Percentage of Conveyance	Hydraulic Depth (ft)	Velocity (ft/s)
1	13	14	15	16	17	18	19	20	21	22	23
2	6921.73	0.008114	Chan	3455.83	3462.14	1183.75	74.66	6.31	2.01	11.83	20.96
		0.008114	Chan	3462.14	3468.45	1154.52	73.86	6.31	1.63	11.71	17.2
		0.008114	Chan	3468.45	3474.76	1131.77	73.06	6.31	1.6	11.58	17.08
		0.008114	Chan	3474.76	3481.07	1109.19	72.27	6.31	1.57	11.45	16.95
		0.008114	Chan	3481.07	3487.38	1086.72	71.47	6.31	1.54	11.33	16.83
		0.008114	Chan	3487.38	3493.69	1064.51	70.67	6.31	1.51	11.2	16.7
		0.008114	Chan	3493.69	3500	1042.42	69.88	6.31	1.49	11.07	16.58
		0.008114	ROB	3500	3560	1855.44	181.89	34.82	2.38	5.51	10.2
1	6909.86	0.037263	Chan	3475	3487.5	703.13	53.31	12.5	1.61	4.27	23.51
		0.037263	Chan	3487.5	3500	570.26	50.19	12.5	1.18	4.01	18.34
		0.037263	ROB	3500	4502.11	2015.3	372.78	102.31	8.99	3.67	18.82
0	6910.56	0.014967	Chan	3473.1	3486.55	1498.04	79.28	13.46	1.92	5.89	18.89
		0.014967	Chan	3486.55	3500	1101.11	75.67	13.46	1.41	5.62	14.55
		0.014967	ROB	3500	4475	427.31	49.8	33.55	0.55	1.52	8.58
-1	6904.74	0.019846	Chan	3655.95	3679.76	1853.52	101.28	23.81	2.38	4.25	18.3
		0.019846	Chan	3679.76	3703.57	1721.08	96.88	23.81	2.21	4.07	17.77
		0.019846	Chan	3703.57	3727.38	1564.33	91.48	23.81	2.01	3.84	17.1
		0.019846	Chan	3727.38	3751.19	1413.62	86.09	23.81	1.81	3.62	16.42
		0.019846	Chan	3751.19	3775	1267.44	80.63	23.81	1.62	3.39	15.72
		0.019846	ROB	3775	5025	128.76	16.06	10.35	0.17	1.64	8.02
-2	6901.05	0.007763	Chan	3832.14	3860.71	1801.21	141.9	28.57	2.31	4.97	12.69
		0.007763	Chan	3860.71	3889.29	1683.83	136.28	28.57	2.16	4.77	12.36
		0.007763	Chan	3889.29	3917.86	1569.52	130.65	28.57	2.01	4.57	12.01
		0.007763	Chan	3917.86	3946.43	1458.4	125.02	28.57	1.87	4.38	11.67
		0.007763	Chan	3946.43	3975	1349.59	119.34	28.57	1.73	4.18	11.31
		0.007763	ROB	3975	5375	144.78	24.94	12.89	0.19	2.04	5.81
-3	6896.16	0.010188	Chan	3832.14	3860.71	1799.17	130.71	28.57	2.31	4.57	13.76
		0.010188	Chan	3860.71	3889.29	1672.03	125.09	28.57	2.14	4.38	13.37
		0.010188	Chan	3889.29	3917.86	1548.53	119.46	28.57	1.99	4.18	12.96
		0.010188	Chan	3917.86	3946.43	1428.8	113.83	28.57	1.83	3.98	12.55
		0.010188	Chan	3946.43	3975	1311.9	108.15	28.57	1.68	3.79	12.13
		0.010188	ROB	3975	5125	126.72	20.38	11.66	0.16	1.84	6.22
-4	6892.05	0.007753	Chan	3832.14	3860.71	1801.21	141.96	28.57	2.31	4.97	12.69
		0.007753	Chan	3860.71	3889.29	1683.88	136.33	28.57	2.16	4.77	12.35
		0.007753	Chan	3889.29	3917.86	1569.62	130.71	28.57	2.01	4.57	12.01
		0.007753	Chan	3917.86	3946.43	1458.54	125.07	28.57	1.87	4.38	11.66
		0.007753	Chan	3946.43	3975	1349.77	119.39	28.57	1.73	4.18	11.31
		0.007753	ROB	3975	5025	144.91	24.97	12.9	0.19	2.04	0

		D_{50} ROCK SIZE CALCULATION w/ SLOPE CORRECTION FACTORS (inches)					D50 ROCK SIZE FOR BERM ABOVE GRADE SLOPES		D50 ROCK SIZE FOR BERM APRONS or BURIED SLOPES	
River Section	Channel X-Section Position	Abt and Johnson Method (inches)	Add Riprap Oversize 4%	2H:1V Apron Slope: Abt and Johnson D_{50} / Slope Factor (0.72)	3H:1V Slope: Abt and Johnson D_{50} / Slope Factor (0.88)	4H:1V Slope: Abt and Johnson D_{50} / Slope Factor (1.00)	Minimum Required D_{50} to Use	Proposed D_{50} to Use for Slope	Minimum Required D_{50} to Use	Proposed D_{50} to Use for Apron/ Buried Slope
1	25	26	27	28	29	30	31	32	33	34
21	LOB									
	L. Channel									
	Main Channel									
	R. Channel									
	ROB	2.38	2.47	3.43	2.81	2.47				
20	LOB									
	L. Channel									
	Main Channel									
	R. Channel									
	ROB	2.87	2.98	4.14	3.39	2.98				
19	LOB									
	L. Channel									
	Main Channel									
	R. Chan. Apron	2.22	2.31	3.20	2.62	2.31	3.2	3.24	3.20	3.24
	R. Bank Slope	0.45	0.47	0.65	0.53	0.47				
18	R. Chan. C5	3.93	4.08	5.67	4.64	4.08				
	R. Chan. C4	3.89	4.05	5.62	4.60	4.05				
	R. Chan. C3	3.65	3.80	5.28	4.32	3.80			7.80	12.97
	R. Chan. C2 (Apron)	3.27	3.40	4.72	3.86	3.40				
	R. Chan. C1 (Apron)	3.24	3.37	4.67	3.82	3.37	7.8	7.95		
	R. Bank Slope	1.67	1.74	2.41	1.97	1.74				
17	R. Chan. C5	3.20	3.33	4.62	3.78	3.33				
	R. Chan. C4	3.17	3.30	4.58	3.74	3.30				
	R. Chan. C3	2.98	3.10	4.30	3.52	3.10			7.80	12.97
	R. Chan. C2 (Apron)	2.67	2.77	3.85	3.15	2.77				
	R. Chan. C1 (Apron)	2.64	2.75	3.82	3.12	2.75	3.2	7.95		
	R. Bank Slope	1.36	1.42	1.97	1.61	1.42				
16	R. Chan. C5	4.18	4.35	6.04	4.94	4.35				
	R. Chan. C4	4.15	4.31	5.99	4.90	4.31				
	R. Chan. C3	3.90	4.05	5.63	4.61	4.05			7.80	12.97
	R. Chan. C2 (Apron)	3.49	3.63	5.04	4.13	3.63				
	R. Chan. C1 (Apron)	3.46	3.60	5.00	4.09	3.60	7.8	7.95		
	R. Bank Slope	1.79	1.86	2.58	2.11	1.86				
15	R. Chan. C5	5.18	5.39	7.49	6.12	5.39				
	R. Chan. C4	5.14	5.34	7.42	6.07	5.34				
	R. Chan. C3	4.83	5.02	6.97	5.70	5.02			7.80	12.97
	R. Chan. C2 (Apron)	4.32	4.49	6.24	5.11	4.49				
	R. Chan. C1 (Apron)	4.28	4.45	6.18	5.06	4.45	7.8	7.95		
	R. Bank Slope	2.21	2.30	3.19	2.61	2.30				

		D_{50} ROCK SIZE CALCULATION w/ SLOPE CORRECTION FACTORS (inches)					D50 ROCK SIZE FOR BERM ABOVE GRADE SLOPES		D50 ROCK SIZE FOR BERM APRONS or BURIED SLOPES	
River Section	Channel X-Section Position	Abt and Johnson Method (inches)	Add Riprap Oversize 4%	2H:1V Apron Slope: Abt and Johnson D_{50} / Slope Factor (0.72)	3H:1V Slope: Abt and Johnson D_{50} / Slope Factor (0.88)	4H:1V Slope: Abt and Johnson D_{50} / Slope Factor (1.00)	Minimum Required D_{50} to Use	Proposed D_{50} to Use for Slope	Minimum Required D_{50} to Use	Proposed D_{50} to Use for Apron/ Buried Slope
1	25	26	27	28	29	30	31	32	33	34
14	R. Chan. C5	5.79	6.02	8.36	6.84	6.02				
	R. Chan. C4	5.73	5.96	8.28	6.77	5.96				
	R. Chan. C3	5.38	5.60	7.77	6.36	5.60			7.80	12.97
	R. Chan. C2 (Apron)	4.82	5.01	6.96	5.69	5.01				
	R. Chan. C1 (Apron)	4.77	4.96	6.89	5.64	4.96	7.8	7.95		
	R. Bank Slope	2.46	2.56	3.56	2.91	2.56				
13	R. Chan. C5	5.62	5.85	8.12	6.64	5.85				
	R. Chan. C4	5.57	5.79	8.04	6.58	5.79				
	R. Chan. C3	5.23	5.43	7.55	6.18	5.43			7.80	12.97
	R. Chan. C2 (Apron)	4.67	4.86	6.75	5.52	4.86				
	R. Chan. C1 (Apron)	4.63	4.81	6.68	5.47	4.81	7.8	7.95		
	R. Bank Slope	2.39	2.48	3.45	2.82	2.48				
12	R. Chan. C5	5.35	5.56	7.73	6.32	5.56				
	R. Chan. C4	5.29	5.51	7.65	6.26	5.51				
	R. Chan. C3	4.97	5.17	7.18	5.87	5.17			7.80	12.97
	R. Chan. C2 (Apron)	4.44	4.62	6.42	5.25	4.62				
	R. Chan. C1 (Apron)	4.40	4.57	6.35	5.20	4.57	7.8	7.95		
	R. Bank Slope	2.27	2.36	3.28	2.68	2.36				
11	R. Chan. C5	5.69	5.92	8.22	6.72	5.92				
	R. Chan. C4	5.63	5.85	8.13	6.65	5.85				
	R. Chan. C3	5.28	5.49	7.62	6.24	5.49			7.80	12.97
	R. Chan. C2 (Apron)	4.71	4.90	6.81	5.57	4.90				
	R. Chan. C1 (Apron)	4.66	4.85	6.73	5.51	4.85	7.8	7.95		
	R. Bank Slope	2.40	2.50	3.47	2.84	2.50				
10	R. Chan. C5	5.91	6.15	8.54	6.98	6.15				
	R. Chan. C4	5.84	6.07	8.44	6.90	6.07				
	R. Chan. C3	5.47	5.69	7.90	6.47	5.69			7.90	12.97
	R. Chan. C2 (Apron)	4.89	5.08	7.06	5.77	5.08				
	R. Chan. C1 (Apron)	4.82	5.02	6.97	5.70	5.02	7.8	7.95		
	R. Bank Slope	2.49	2.59	3.59	2.94	2.59				
9	R. Chan. C5	7.41	7.70	10.70	8.76	7.70				
	R. Chan. C4	7.32	7.62	10.58	8.65	7.62				
	R. Chan. C3	6.86	7.14	9.92	8.11	7.14			12.00	12.97
	R. Chan. C2 (Apron)	6.13	6.38	8.86	7.25	6.38				
	R. Chan. C1 (Apron)	6.06	6.30	8.75	7.16	6.30	7.8	7.95		
	R. Bank Slope	3.12	3.25	4.51	3.69	3.25				
8	R. Chan. C5	7.89	8.20	11.39	9.32	8.20				
	R. Chan. C4	7.80	8.11	11.27	9.22	8.11				
	R. Chan. C3	7.31	7.61	10.56	8.64	7.61			12.00	12.97
	R. Chan. C2 (Apron)	6.53	6.80	9.44	7.72	6.80				
	R. Chan. C1 (Apron)	6.46	6.72	9.33	7.63	6.72	7.8	7.95		
	R. Bank Slope	3.33	3.46	4.81	3.94	3.46				

		D_{50} ROCK SIZE CALCULATION w/ SLOPE CORRECTION FACTORS (inches)					D50 ROCK SIZE FOR BERM ABOVE GRADE SLOPES		D50 ROCK SIZE FOR BERM APRONS or BURIED SLOPES	
River Section	Channel X-Section Position	Abt and Johnson Method (inches)	Add Riprap Oversize 4%	2H:1V Apron Slope: Abt and Johnson D_{50} / Slope Factor (0.72)	3H:1V Slope: Abt and Johnson D_{50} / Slope Factor (0.88)	4H:1V Slope: Abt and Johnson D_{50} / Slope Factor (1.00)	Minimum Required D_{50} to Use	Proposed D_{50} to Use for Slope	Minimum Required D_{50} to Use	Proposed D_{50} to Use for Apron/ Buried Slope
1	25	26	27	28	29	30	31	32	33	34
7	R. Chan. C5	8.89	9.25	12.85	10.51	9.25				
	R. Chan. C4	8.79	9.15	12.70	10.39	9.15				
	R. Chan. C3	8.25	8.57	11.91	9.74	8.57			12.00	12.97
	R. Chan. C2 (Apron)	7.37	7.66	10.64	8.71	7.66				
	R. Chan. C1 (Apron)	6.70	6.97	9.68	7.92	6.97	7.9	7.95		
	R. Bank Slope	3.77	3.92	5.45	4.46	3.92				
6	R. Chan. C7	10.95	11.39	15.82	12.94	11.39			12.00	12.97
	R. Chan. C6 (Slope)	9.63	10.02	13.91	11.38	10.02				
	R. Chan. C5 (Slope)	9.52	9.90	13.75	11.25	9.90				
	R. Chan. C4 (Slope)	9.41	9.78	13.59	11.12	9.78				
	R. Chan. C3 (Slope)	9.29	9.67	13.42	10.98	9.67				
	R. Chan. C2 (Slope)	9.18	9.55	13.26	10.85	9.55				
	R. Chan. C1 (Slope)	9.07	9.43	13.10	10.72	9.43	12.0	12.97		
	R. Bank Slope	4.83	5.02	6.98	5.71	5.02				
5	R. Chan. C7	11.69	12.16	16.89	13.82	12.16			12.16	12.97
	R. Chan. C6 (Slope)	11.44	11.90	16.53	13.52	11.90				
	R. Chan. C5 (Slope)	11.31	11.76	16.33	13.36	11.76				
	R. Chan. C4 (Slope)	11.17	11.62	16.14	13.20	11.62				
	R. Chan. C3 (Slope)	11.04	11.48	15.94	13.04	11.48				
	R. Chan. C2 (Slope)	10.90	11.34	15.75	12.89	11.34				
	R. Chan. C1 (Slope)	10.77	11.20	15.55	12.73	11.20	12.0	12.97		
	R. Bank Slope	5.70	5.93	8.23	6.74	5.93				
4	R. Chan. C7	12.45	12.95	17.98	14.71	12.95			12.95	12.97
	R. Chan. C6 (Slope)	12.32	12.81	17.79	14.56	12.81				
	R. Chan. C5 (Slope)	12.17	12.65	17.57	14.38	12.65				
	R. Chan. C4 (Slope)	12.01	12.50	17.35	14.20	12.50				
	R. Chan. C3 (Slope)	11.86	12.34	17.13	14.02	12.34				
	R. Chan. C2 (Slope)	11.71	12.18	16.91	13.84	12.18				
	R. Chan. C1 (Slope)	11.56	12.02	16.69	13.66	12.02	12.0	12.97		
	R. Bank Slope	6.20	6.45	8.95	7.32	6.45				
3	R. Chan. C7	12.44	12.93	17.96	14.70	12.93			12.93	12.97
	R. Chan. C6 (Slope)	12.33	12.82	17.81	14.57	12.82				
	R. Chan. C5 (Slope)	12.19	12.68	17.61	14.40	12.68				
	R. Chan. C4 (Slope)	12.05	12.53	17.40	14.24	12.53				
	R. Chan. C3 (Slope)	11.90	12.38	17.19	14.07	12.38				
	R. Chan. C2 (Slope)	11.76	12.23	16.99	13.90	12.23				
	R. Chan. C1 (Slope)	11.62	12.08	16.78	13.73	12.08	12.1	12.97		
	R. Bank Slope	6.13	6.37	8.85	7.24	6.37				

		D_{50} ROCK SIZE CALCULATION w/ SLOPE CORRECTION FACTORS (inches)					D50 ROCK SIZE FOR BERM ABOVE GRADE SLOPES		D50 ROCK SIZE FOR BERM APRONS or BURIED SLOPES	
River Section	Channel X-Section Position	Abt and Johnson Method (inches)	Add Riprap Oversize 4%	2H:1V Apron Slope: Abt and Johnson D_{50} / Slope Factor (0.72)	3H:1V Slope: Abt and Johnson D_{50} / Slope Factor (0.88)	4H:1V Slope: Abt and Johnson D_{50} / Slope Factor (1.00)	Minimum Required D_{50} to Use	Proposed D_{50} to Use for Slope	Minimum Required D_{50} to Use	Proposed D_{50} to Use for Apron/ Buried Slope
1	25	26	27	28	29	30	31	32	33	34
2	R. Chan. C7	12.37	12.87	17.87	14.62	12.87			12.87	12.97
	R. Chan. C6 (Slope)	12.20	12.69	17.62	14.42	12.69				
	R. Chan. C5 (Slope)	12.07	12.55	17.43	14.26	12.55				
	R. Chan. C4 (Slope)	11.93	12.41	17.23	14.10	12.41				
	R. Chan. C3 (Slope)	11.79	12.27	17.04	13.94	12.27				
	R. Chan. C2 (Slope)	11.66	12.13	16.84	13.78	12.13				
	R. Chan. C1 (Slope)	11.52	11.98	16.64	13.62	11.98	12.0	12.97		
	R. Bank Slope	6.11	6.36	8.83	7.23	6.36				
1	R. Chan. C2	12.14	12.63	17.54	14.35	12.63			12.63	12.97
	R. Chan. C1 (Slope)	10.80	11.23	15.59	12.76	11.23	12.0	12.97		
	R. Bank Slope	6.75	7.02	9.74	7.97	7.02				
0	R. Chan. C2	12.02	12.50	17.36	14.20	12.50			12.50	12.97
	R. Chan. C1 (Slope)	10.12	10.52	14.61	11.95	10.52	12.0	12.97		
	R. Bank Slope	3.57	3.71	5.16	4.22	3.71				
-1	R. Chan. C5									
	R. Chan. C4									
	R. Chan. C3									
	R. Chan. C2									
	R. Chan. C1									
	R. Bank Slope									
-2	R. Chan. C5									
	R. Chan. C4									
	R. Chan. C3									
	R. Chan. C2									
	R. Chan. C1									
	R. Bank Slope									
-3	R. Chan. C5									
	R. Chan. C4									
	R. Chan. C3									
	R. Chan. C2									
	R. Chan. C1									
	R. Bank Slope									
-4	R. Chan. C5									
	R. Chan. C4									
	R. Chan. C3									
	R. Chan. C2									
	R. Chan. C1									
	R. Bank Slope									

USACE EQUILBRIUM SCOUR DEPTH

River Section	he = Equilibrium Scour Depth (ft)	qe = equilibrium discharge (cfs/ft)	g (ft/sec^2)	Ss = Sediment Specific Gravity	de = median grain-size diameter (mm)	$0.234*qe^{8/9}$	g(Ss-1)	$[g(Ss-1)]^{4/9}$	$de^{1/3}$
1	49	50	51	52	53	54	55	56	57
21									
20									
19									
	2.53	40.0	32.2	2.65	0.074	6.207	53.130	5.845	0.420
18									
	5.46	95.1	32.2	2.65	0.074	13.411	53.130	5.845	0.420
17									
	5.13	88.5	32.2	2.65	0.074	12.587	53.130	5.845	0.420
16									
	6.20	109.5	32.2	2.65	0.074	15.206	53.130	5.845	0.420
15									
	6.87	123.0	32.2	2.65	0.074	16.867	53.130	5.845	0.420

USACE EQUILBRIUM SCOUR DEPTH

River Section	he = Equilibrium Scour Depth (ft)	qe = equilibrium discharge (cfs/ft)	g (ft/sec^2)	Ss = Sediment Specific Gravity	de = median grain-size diameter (mm)	$0.234*qe^{8/9}$	g(Ss-1)	$[g(Ss-1)]^{4/9}$	$de^{1/3}$
1	49	50	51	52	53	54	55	56	57
14									
	7.01	125.8	32.2	2.65	0.074	17.204	53.130	5.845	0.420
13									
	6.65	118.5	32.2	2.65	0.074	16.314	53.130	5.845	0.420
12									
	6.24	110.5	32.2	2.65	0.074	15.326	53.130	5.845	0.420
11									
	6.11	107.7	32.2	2.65	0.074	14.984	53.130	5.845	0.420
10									
	5.82	102.0	32.2	2.65	0.074	14.272	53.130	5.845	0.420
9									
	6.90	123.7	32.2	2.65	0.074	16.944	53.130	5.845	0.420
8									
	7.37	133.1	32.2	2.65	0.074	18.089	53.130	5.845	0.420

USACE EQUILBRIUM SCOUR DEPTH

River Section	he = Equilibrium Scour Depth (ft)	qe = equilibrium discharge (cfs/ft)	g (ft/sec^2)	Ss = Sediment Specific Gravity	de = median grain-size diameter (mm)	$0.234*qe^{8/9}$	g(Ss-1)	$[g(Ss-1)]^{4/9}$	$de^{1/3}$
1	49	50	51	52	53	54	55	56	57
7									
	7.89	143.7	32.2	2.65	0.074	19.363	53.130	5.845	0.420
6	9.92	185.9	32.2	2.65	0.074	24.341	53.130	5.845	0.420
5	9.24	171.6	32.2	2.65	0.074	22.671	53.130	5.845	0.420
4	9.15	169.7	32.2	2.65	0.074	22.452	53.130	5.845	0.420
3	9.59	179.0	32.2	2.65	0.074	23.542	53.130	5.845	0.420

USACE EQUILBRIUM SCOUR DEPTH

River Section	he = Equilibrium Scour Depth (ft)	qe = equilibrium discharge (cfs/ft)	g (ft/sec^2)	Ss = Sediment Specific Gravity	de = median grain-size diameter (mm)	$0.234*qe^{8/9}$	g(Ss-1)	$[g(Ss-1)]^{4/9}$	$de^{1/3}$
1	49	50	51	52	53	54	55	56	57
2	10.00	187.6	32.2	2.65	0.074	24.539	53.130	5.845	0.420
1	3.43	56.3	32.2	2.65	0.074	8.412	53.130	5.845	0.420
0	6.29	111.3	32.2	2.65	0.074	15.428	53.130	5.845	0.420
-1									
-2									
-3									
-4									

USDOT HEC-14 DEPTH OF SCOUR

River Section	d_s = Scour Depth (ft)	R_h = hydraulic radius = depth of flow (ft)	C_s = slope correction coeeficient (Table 5.3[5])	α = coeeficient (Table 5.1[5])	σ = (D84/D16)0.5, material standard deviation (sand = 1.87)	$\sigma^{1/3}$	Q_d = Design Flowrate (cfs)	g (ft/sec^2)	$Q/g^{1/2}R_h^{5/2}$	β = coeeficient (Table 5.1[5])	$(Q/g^{1/2}R_h^{5/2})^{\beta}$	t = time (min)	θ = coeeficient (Table 5.1[5])	$(t/316)^{\theta}$
1	35	36	37	38	39	40	41	42	43	44	45	46	47	48
21														
20														
19														
	3.6	8.5	1.0048	2.27	1.87	1.23	40.0	32.2	0.033	0.39	0.265712	30	0.06	0.8683
18														
	5.1	11.92	1.0048	2.27	1.87	1.23	95.1	32.2	0.034	0.39	0.267933	30	0.06	0.8683
17														
	5.0	12.81	1.0048	2.27	1.87	1.23	88.5	32.2	0.027	0.39	0.242913	30	0.06	0.8683
16														
	5.4	13.1	1.0015	2.27	1.87	1.23	109.5	32.2	0.031	0.39	0.258222	30	0.06	0.8683
15														
	5.7	12.67	1.0015	2.27	1.87	1.23	123.0	32.2	0.038	0.39	0.279178	30	0.06	0.8683

USDOT HEC-14 DEPTH OF SCOUR

River Section	d_s = Scour Depth (ft)	R_h = hydraulic radius = depth of flow (ft)	C_s = slope correction coeeficient (Table 5.3[5])	α = coeeficient (Table 5.1[5])	σ = (D84/D16)0.5, material standard deviation (sand = 1.87)	$\sigma^{1/3}$	Q_d = Design Flowrate (cfs)	g (ft/sec^2)	$Q/g^{1/2}R_h^{5/2}$	β = coeeficient (Table 5.1[5])	$(Q/g^{1/2}R_h^{5/2})^{\beta}$	t = time (min)	θ = coeeficient (Table 5.1[5])	$(t/316)^{\theta}$
1	35	36	37	38	39	40	41	42	43	44	45	46	47	48
14														
	5.7	12	1.0015	2.27	1.87	1.23	125.8	32.2	0.044	0.39	0.296931	30	0.06	0.8683
13														
	5.6	11.55	1.0015	2.27	1.87	1.23	118.5	32.2	0.046	0.39	0.301106	30	0.06	0.8683
12														
	5.4	11.16	1.0015	2.27	1.87	1.23	110.5	32.2	0.047	0.39	0.30294	30	0.06	0.8683
11														
	5.4	10.43	1.0015	2.27	1.87	1.23	107.7	32.2	0.054	0.39	0.320408	30	0.06	0.8683
10														
	5.3	9.63	1.0075	2.27	1.87	1.23	102.0	32.2	0.062	0.39	0.33901	30	0.06	0.8683
9														
	5.7	9.96	1.0075	2.27	1.87	1.23	123.7	32.2	0.070	0.39	0.353711	30	0.06	0.8683
8														
	5.8	10.25	1.0075	2.27	1.87	1.23	133.1	32.2	0.070	0.39	0.353963	30	0.06	0.8683

USDOT HEC-14 DEPTH OF SCOUR

River Section	d_s = Scour Depth (ft)	R_h = hydraulic radius = depth of flow (ft)	C_s = slope correction coeeficient (Table 5.3[5])	α = coeeficient (Table 5.1[5])	σ = (D84/D16)0.5, material standard deviation (sand = 1.87)	$\sigma^{1/3}$	Q_d = Design Flowrate (cfs)	g (ft/sec^2)	$Q/g^{1/2}R_h^{5/2}$	β = coeeficient (Table 5.1[5])	$(Q/g^{1/2}R_h^{5/2})^{\beta}$	t = time (min)	θ = coeeficient (Table 5.1[5])	$(t/316)^{\theta}$
1	35	36	37	38	39	40	41	42	43	44	45	46	47	48
7														
	6.1	10.21	1.0150	2.27	1.87	1.23	143.7	32.2	0.076	0.39	0.366087	30	0.06	0.8683
6	6.7	11.34	1.0150	2.27	1.87	1.23	185.9	32.2	0.076	0.39	0.365367	30	0.06	0.8683
5	6.5	11.16	1.0150	2.27	1.87	1.23	171.6	32.2	0.073	0.39	0.359718	30	0.06	0.8683
4	6.5	10	1.0150	2.27	1.87	1.23	169.7	32.2	0.095	0.39	0.39865	30	0.06	0.8683
3	6.6	11.26	1.0150	2.27	1.87	1.23	179.0	32.2	0.074	0.39	0.36255	30	0.06	0.8683

USDOT HEC-14 DEPTH OF SCOUR

River Section	d_s = Scour Depth (ft)	R_h = hydraulic radius = depth of flow (ft)	C_s = slope correction coeeficient (Table 5.3[5])	α = coeeficient (Table 5.1[5])	σ = (D84/D16)0.5, material standard deviation (sand = 1.87)	$\sigma^{1/3}$	Q_d = Design Flowrate (cfs)	g (ft/sec^2)	$Q/g^{1/2}R_h^{5/2}$	β = coeeficient (Table 5.1[5])	$(Q/g^{1/2}R_h^{5/2})^{\beta}$	t = time (min)	θ = coeeficient (Table 5.1[5])	$(t/316)^{\theta}$
1	35	36	37	38	39	40	41	42	43	44	45	46	47	48
2	6.8	11.83	1.0150	2.27	1.87	1.23	187.6	32.2	0.069	0.39	0.351858	30	0.06	0.8683
1	4.1	4.27	1.0135	2.27	1.87	1.23	56.3	32.2	0.263	0.39	0.594087	30	0.06	0.8683
0	5.4	5.89	1.0135	2.27	1.87	1.23	111.3	32.2	0.233	0.39	0.566542	30	0.06	0.8683
-1														
-2														
-3														
-4														

CSU EQUATION FOR PIERS

River Section	d = depth of scour (ft)	Y1 = flow depth upstream (m)	K1	K2	K3	K4	b = pier width (m)	Fr = $V/(gy)^{0.5}$	V (mps)	g (m/sec^2)	$(b/Y1)^{0.65}$	$Fr^{0.43}$
1	58	59	60	61	62	63	64	65	66	67	68	69
21												
20												
19												
	5.003	2.591	1	1	1.1	1	0.6096	0.415	2.095	9.81	0.3904	0.6854
18												
	5.585	3.634	1	1	1.1	1	0.6096	0.407	2.433	9.81	0.3133	0.6797
17												
	5.301	3.905	1	1	1.1	1	0.6096	0.340	2.107	9.81	0.2990	0.6291
16												
	5.771	3.994	1	1	1.1	1	0.6096	0.407	2.549	9.81	0.2947	0.6795
15												
	6.127	3.863	1	1	1.1	1	0.6096	0.481	2.960	9.81	0.3012	0.7299

CSU EQUATION FOR PIERS

River Section	d = depth of scour (ft)	Y1 = flow depth upstream (m)	K1	K2	K3	K4	b = pier width (m)	Fr = $V/(gy)^{0.5}$	V (mps)	g (m/sec^2)	$(b/Y1)^{0.65}$	$Fr^{0.43}$
1	58	59	60	61	62	63	64	65	66	67	68	69
14												
	6.286	3.659	1	1	1.1	1	0.6096	0.533	3.195	9.81	0.3120	0.7631
13												
	6.196	3.521	1	1	1.1	1	0.6096	0.532	3.128	9.81	0.3198	0.7625
12												
	6.074	3.402	1	1	1.1	1	0.6096	0.522	3.018	9.81	0.3271	0.7564
11												
	6.127	3.180	1	1	1.1	1	0.6096	0.563	3.146	9.81	0.3418	0.7813
10												
	6.127	2.936	1	1	1.1	1	0.6096	0.601	3.226	9.81	0.3599	0.8034
9												
	6.594	3.037	1	1	1.1	1	0.6096	0.694	3.787	9.81	0.3522	0.8545
8												
	6.748	3.125	1	1	1.1	1	0.6096	0.715	3.960	9.81	0.3456	0.8658

CSU EQUATION FOR PIERS

River Section	d = depth of scour (ft)	Y1 = flow depth upstream (m)	K1	K2	K3	K4	b = pier width (m)	Fr = $V/(gy)^{0.5}$	V (mps)	g (m/sec^2)	$(b/Y1)^{0.65}$	$Fr^{0.43}$
1	58	59	60	61	62	63	64	65	66	67	68	69
7												
	6.980	3.113	1	1	1.1	1	0.6096	0.776	4.290	9.81	0.3465	0.8968
6	7.830	3.457	1	1	1.1	1	0.6096	0.931	5.421	9.81	0.3237	0.9696
5	8.216	3.402	1	1	1.1	1	0.6096	1.055	6.095	9.81	0.3271	1.0232
4	8.308	3.049	1.0	1.0	1.1	1.0	0.6096	1.184	6.473	9.81	0.3512	1.0751
3	8.408	3.433	1	1	1.1	1	0.6096	1.105	6.412	9.81	0.3252	1.0438

CSU EQUATION FOR PIERS

River Section	d = depth of scour (ft)	Y1 = flow depth upstream (m)	K1	K2	K3	K4	b = pier width (m)	Fr = $V/(gy)^{0.5}$	V (mps)	g (m/sec^2)	$(b/Y1)^{0.65}$	$Fr^{0.43}$
1	58	59	60	61	62	63	64	65	66	67	68	69
2	8.452	3.607	1	1	1.1	1	0.6096	1.074	6.390	9.81	0.3149	1.0313
1	7.738	1.302	1	1	1.1	1	0.6096	2.006	7.168	9.81	0.6107	1.3489
0	7.356	1.796	1	1	1.1	1	0.6096	1.372	5.759	9.81	0.4955	1.1457
-1												
-2												
-3												
-4												

USDOT HEC-18 FROEHLICH EQUATION FOR LIVE BED SCOUR AT ABUTMENTS

River Section	d = depth of scour (ft)	K1	K2	Y = flow depth (m)	L' = A/Y	Fr = $V/(gy)^{0.5}$	V (fps)	g (m/sec^2)	A = flow area (m^2)	$(L'/Y)^{0.43}$	$Fr^{0.61}$
1	70	71	72	73	74	75	76	77	78	79	80
21											
20											
19											
	6.08	0.55	1.000	2.591	0.269	2.649	6.870	9.810	0.697	0.378	1.812
18											
	5.58	0.55	1.000	3.634	0.192	3.090	7.980	9.810	0.697	0.282	1.990
17											
	5.31	0.55	1.000	3.905	0.179	2.781	6.910	9.810	0.697	0.265	1.866
16											
	5.46	0.55	1.000	3.994	0.175	3.238	8.360	9.810	0.697	0.260	2.048
15											
	5.69	0.55	1.000	3.863	0.180	3.629	9.710	9.810	0.697	0.268	2.195

USDOT HEC-18 FROEHLICH EQUATION FOR LIVE BED SCOUR AT ABUTMENTS

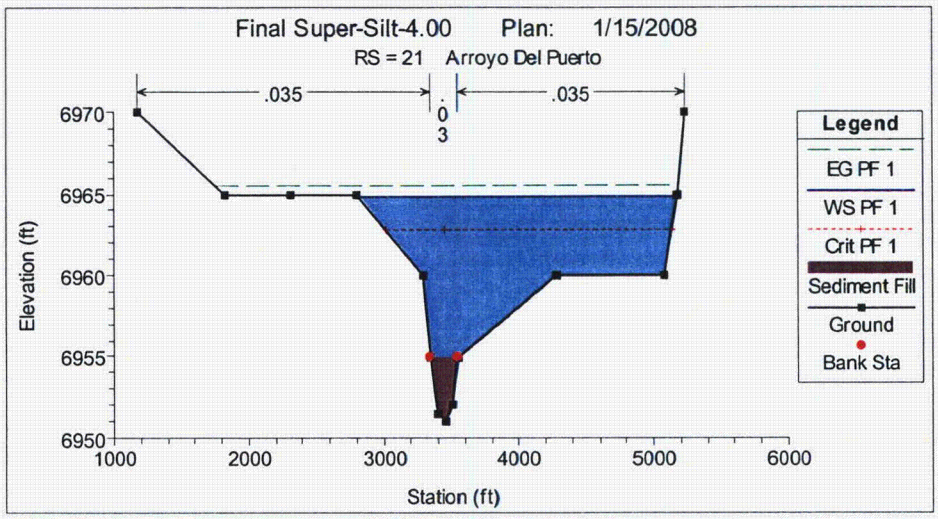
River Section	d = depth of scour (ft)	K1	K2	Y = flow depth (m)	L' = A/Y	Fr = $V/(gy)^{0.5}$	V (fps)	g (m/sec^2)	A = flow area (m^2)	$(L'/Y)^{0.43}$	$Fr^{0.61}$
1	70	71	72	73	74	75	76	77	78	79	80
14											
	5.89	0.55	1.000	3.659	0.191	3.830	10.480	9.810	0.697	0.281	2.269
13											
	5.94	0.55	1.000	3.521	0.198	3.751	10.260	9.810	0.697	0.290	2.240
12											
	5.97	0.55	1.000	3.402	0.205	3.634	9.900	9.810	0.697	0.299	2.197
11											
	6.17	0.55	1.000	3.180	0.219	3.728	10.320	9.810	0.697	0.317	2.231
10											
	6.40	0.55	1.000	2.936	0.237	3.769	10.580	9.810	0.697	0.339	2.246
9											
	6.56	0.55	1.000	3.037	0.230	4.290	12.420	9.810	0.697	0.329	2.431
8											
	6.56	0.55	1.000	3.125	0.223	4.457	12.990	9.810	0.697	0.321	2.488

USDOT HEC-18 FROEHLICH EQUATION FOR LIVE BED SCOUR AT ABUTMENTS

River Section	d = depth of scour (ft)	K1	K2	Y = flow depth (m)	L' = A/Y	Fr = $V/(gy)^{0.5}$	V (fps)	g (m/sec^2)	A = flow area (m^2)	$(L'/Y)^{0.43}$	$Fr^{0.61}$
1	70	71	72	73	74	75	76	77	78	79	80
7											
	6.69	0.55	1.000	3.113	0.224	4.744	14.070	9.810	0.697	0.322	2.585
6	6.79	0.55	1.000	3.457	0.202	5.765	17.780	9.810	0.697	0.295	2.911
5	7.04	0.55	1.000	3.402	0.205	6.309	19.990	9.810	0.697	0.299	3.076
4	7.51	0.55	1.000	3.049	0.229	6.537	21.230	9.810	0.697	0.328	3.143
3	7.11	0.55	1.000	3.433	0.203	6.572	21.030	9.810	0.697	0.296	3.154

USDOT HEC-18 FROEHLICH EQUATION FOR LIVE BED SCOUR AT ABUTMENTS

River Section	d = depth of scour (ft)	K1	K2	Y = flow depth (m)	L' = A/Y	Fr = $V/(gy)^{0.5}$	V (fps)	g (m/sec^2)	A = flow area (m^2)	$(L'/Y)^{0.43}$	$Fr^{0.61}$
1	70	71	72	73	74	75	76	77	78	79	80
2	6.96	0.55	1.000	3.607	0.193	6.590	20.960	9.810	0.697	0.284	3.159
1	6.67	0.55	1.000	3.905	0.179	6.463	23.510	9.810	0.697	0.265	3.121
0	5.65	0.55	1.000	5.387	0.129	5.635	18.890	9.810	0.697	0.201	2.871
-1											
-2											
-3											
-4											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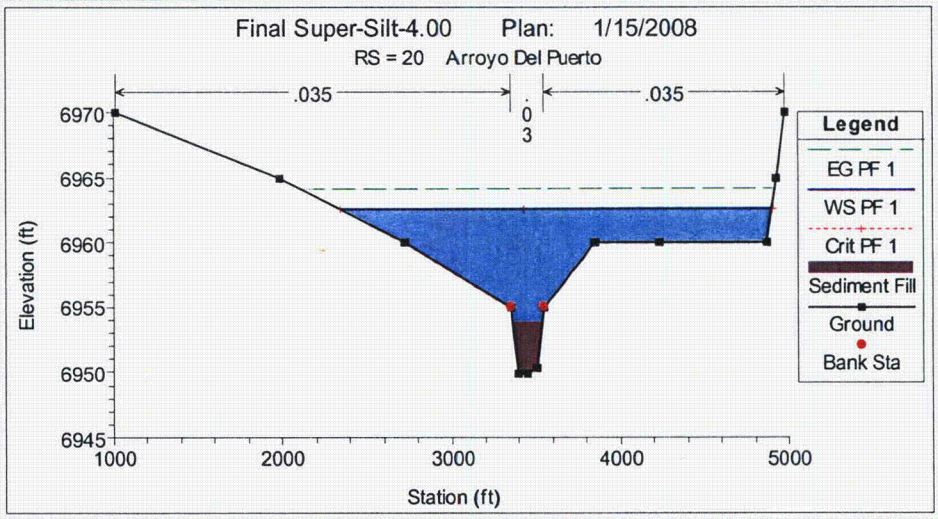
RS = 21 Arroyo Del Puerto
.035
.03
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Sediment Fill
Ground
Bank Sta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.035
.03
.035
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Station (ft)
Legend
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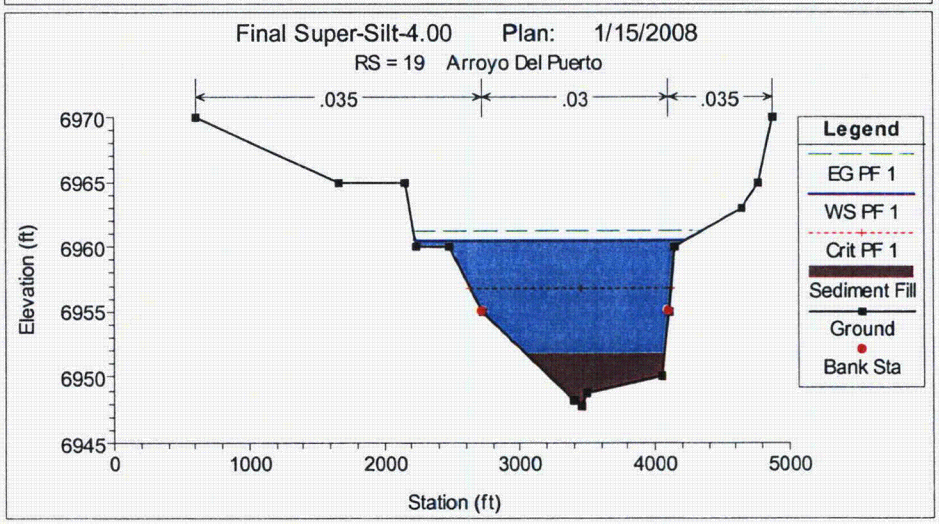
WS PF 1
Crit PF 1
Sediment Fill
Ground
Bank Sta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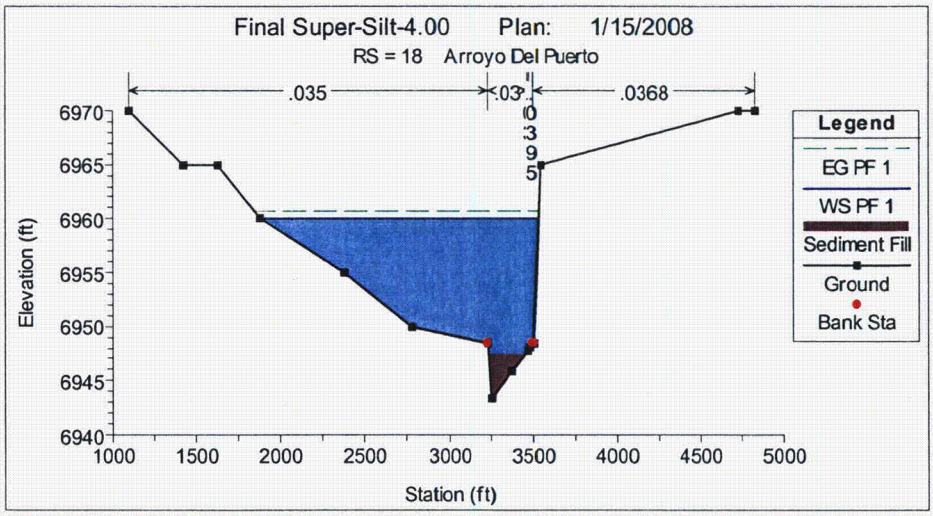
.035
.03
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Sediment Fill
Ground
Bank Sta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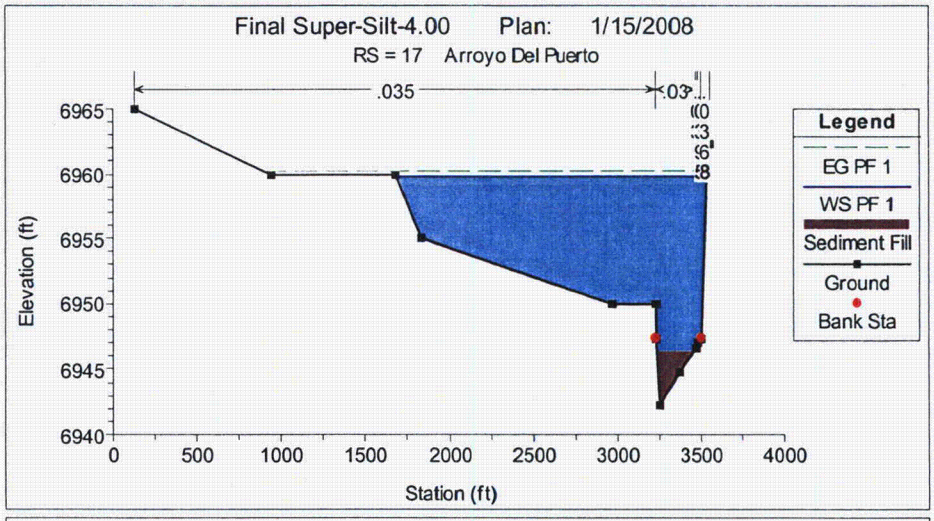
.03
.0368
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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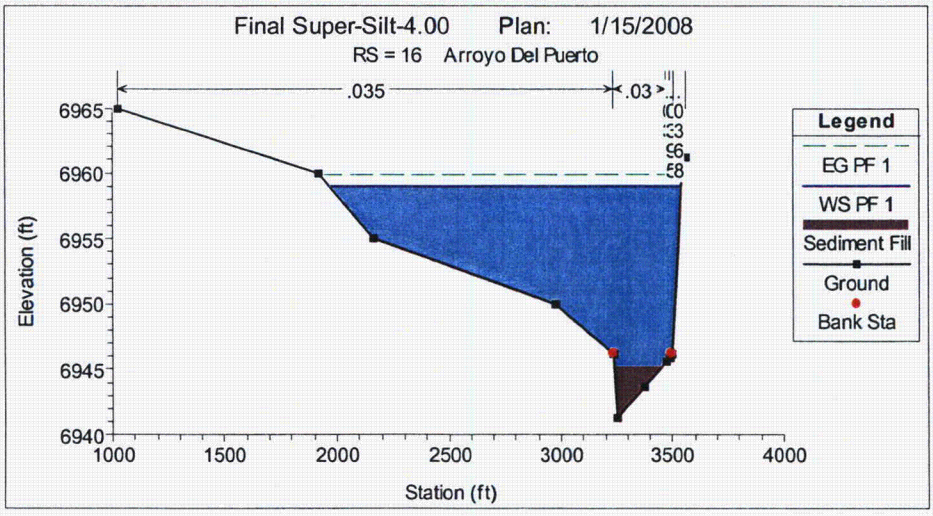
.035
.03
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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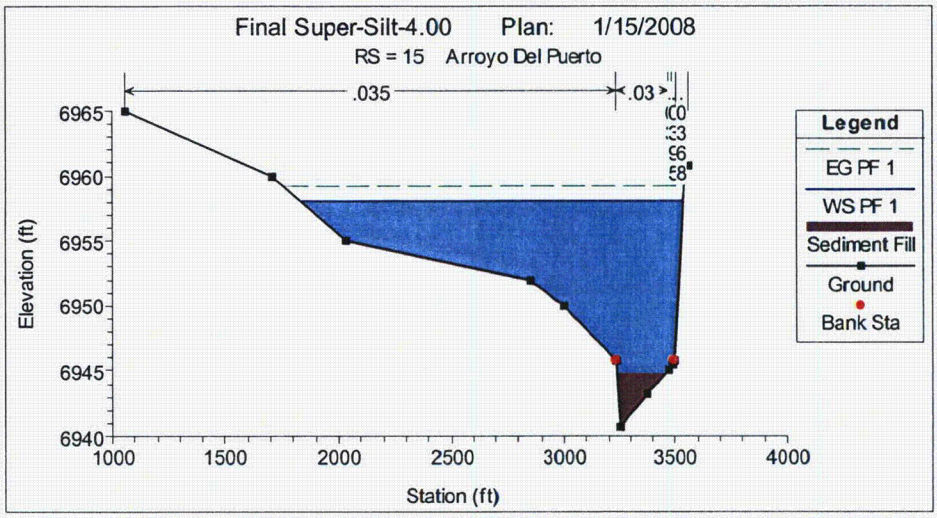
.03
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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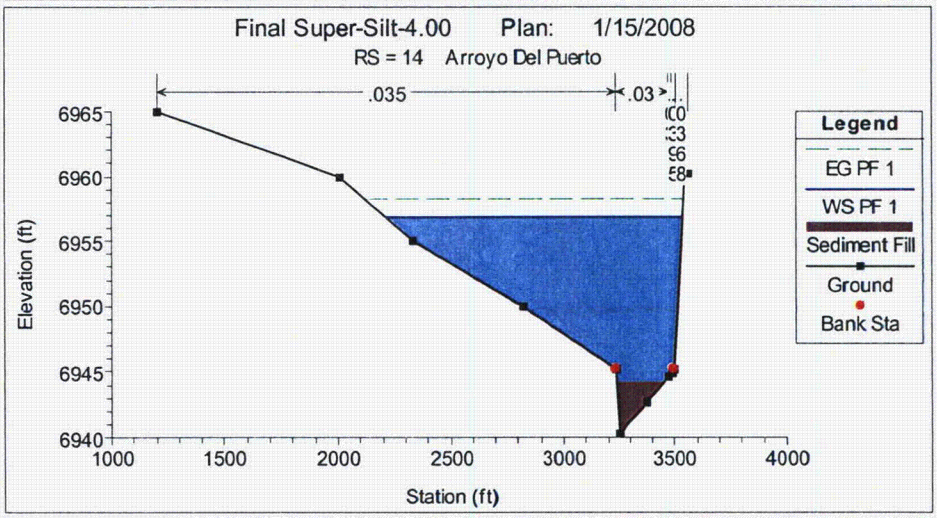
.035
.03
Elevation (ft)
6965
6960
6955
6950
6945
6940
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta


Final Super-Silt-4.00 Plan: 1/15/2008
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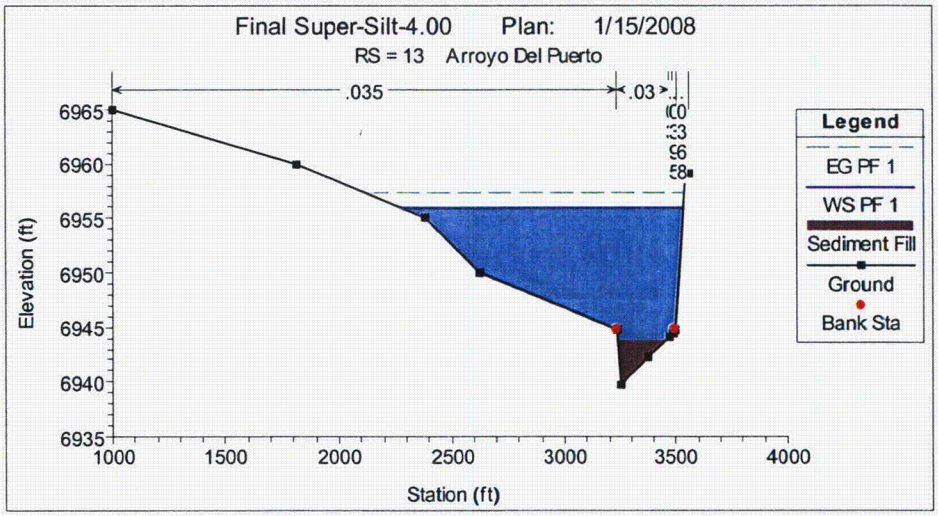
.035
.03
Elevation (ft)
6965
6960
6955
6950
6945
6940
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta


Final Super-Silt-4.00 Plan: 1/15/2008
RS = 13 Arroyo Del Puerto
.035
.03
Elevation (ft)
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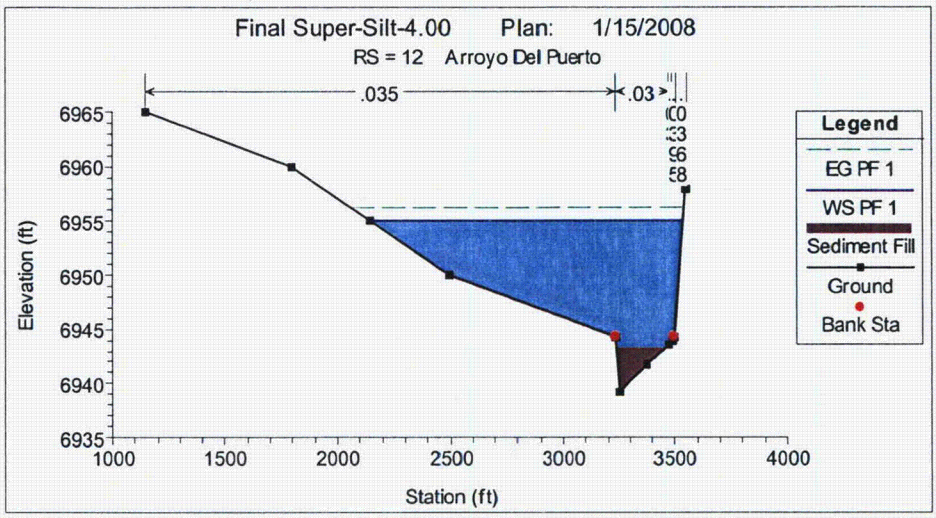
6960
6955
6950
6945
6940
6935
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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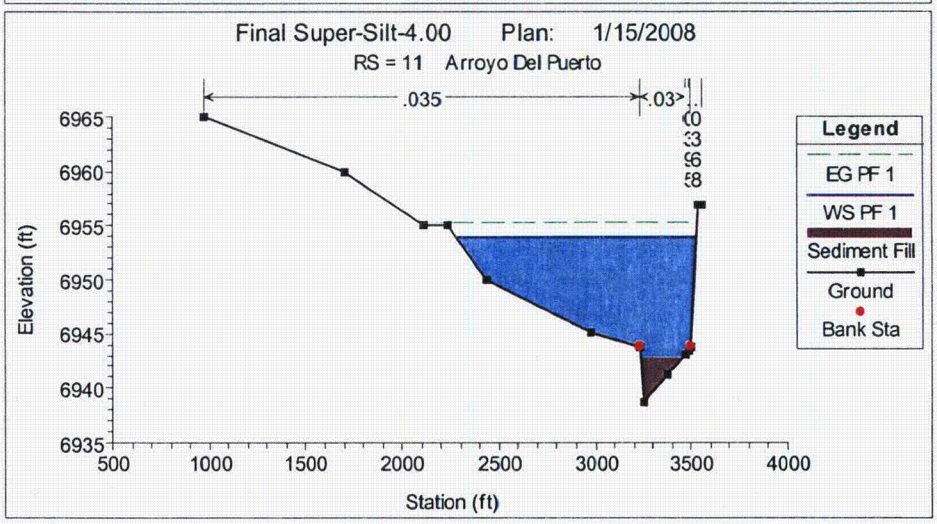
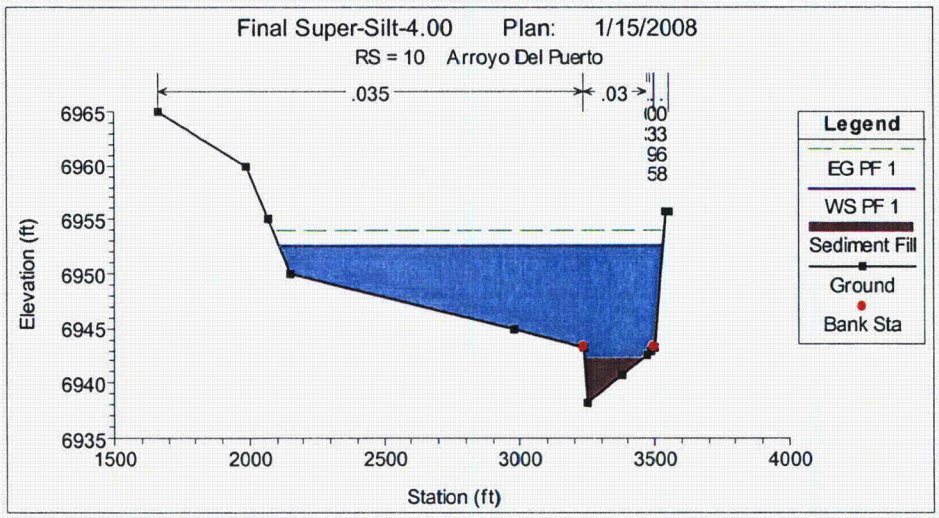
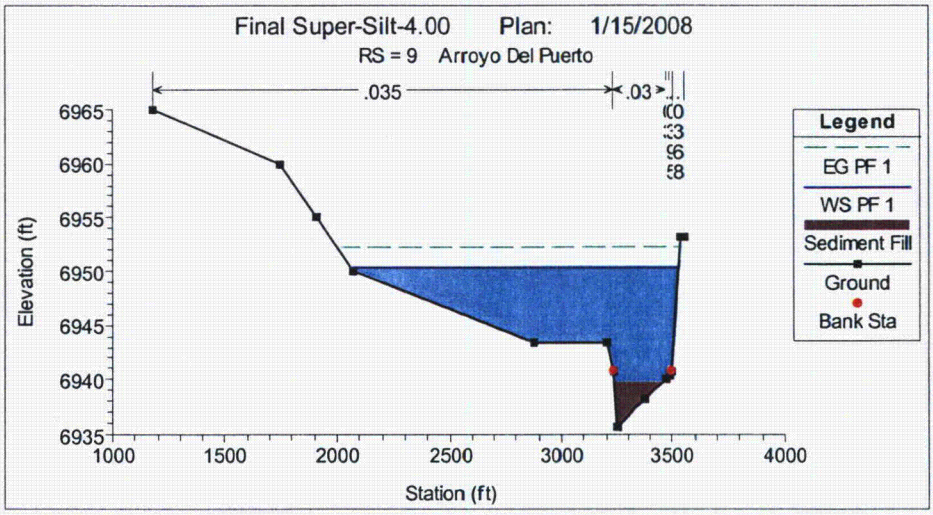
.035
.03
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta


Final Super-Silt-4.00 Plan: 1/15/2008
RS = 11 Arroyo Del Puerto
.035
.03
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta


Final Super-Silt-4.00 Plan: 1/15/2008
RS = 10 Arroyo Del Puerto
.035
.03
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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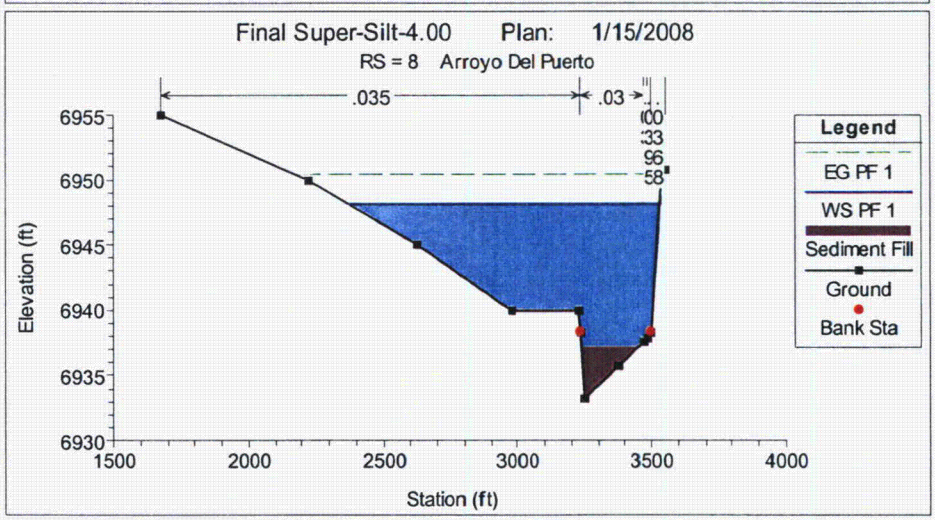
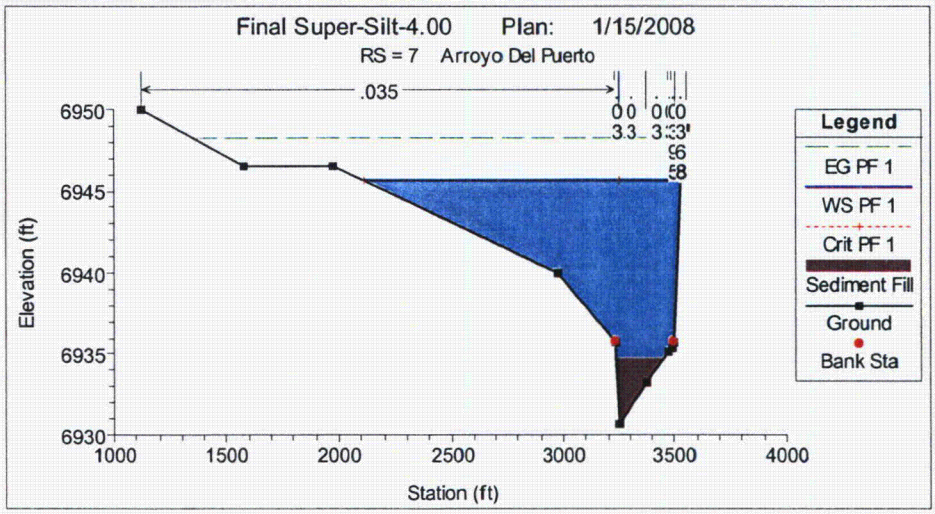
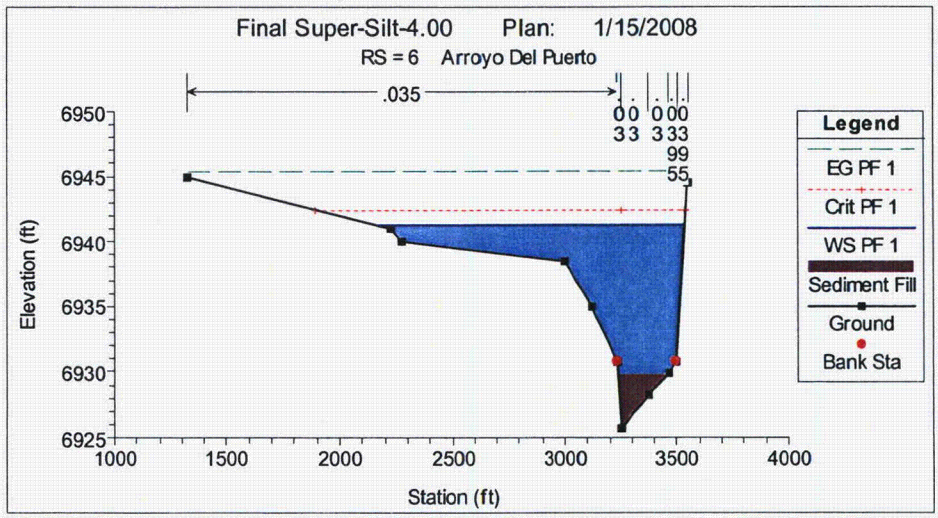
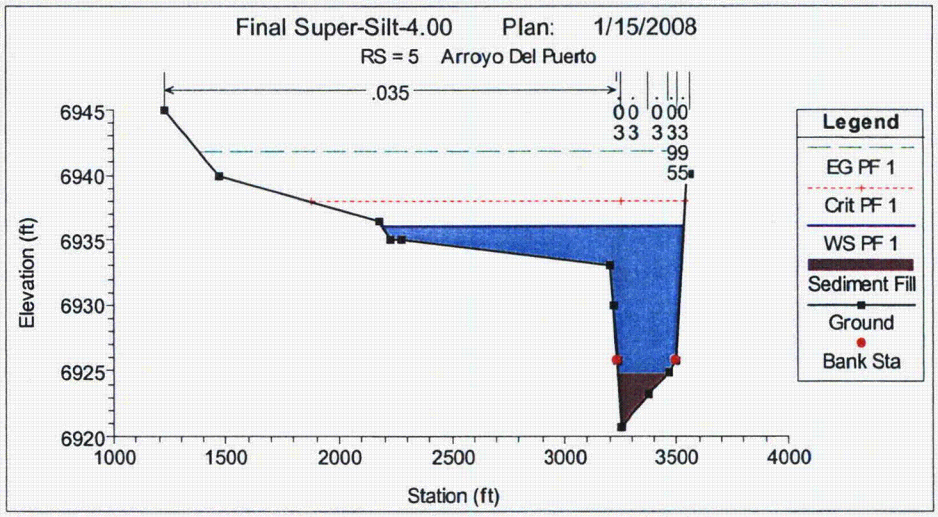
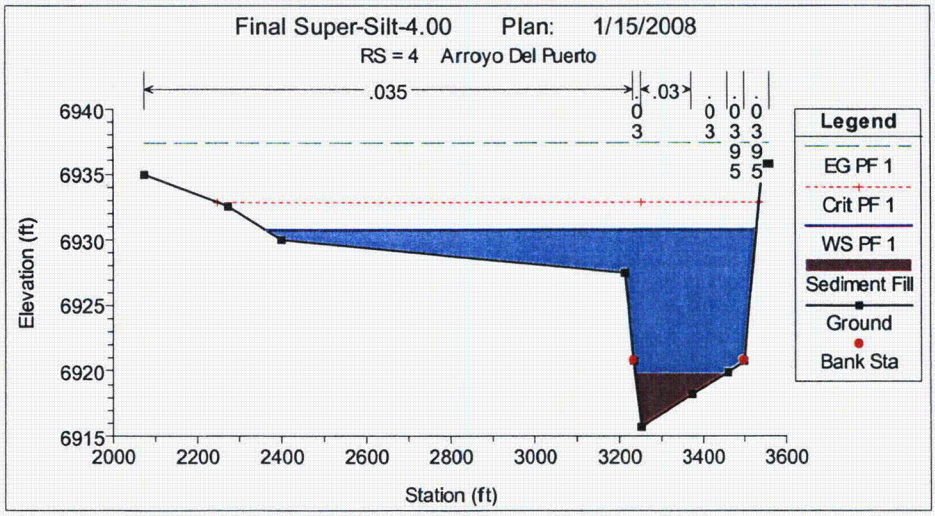
RS = 9 Arroyo Del Puerto
.035
.03
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta


Final Super-Silt-4.00 Plan: 1/15/2008
RS = 8 Arroyo Del Puerto
.035
.03
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta


Final Super-Silt-4.00 Plan: 1/15/2008
RS = 7 Arroyo Del Puerto
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Sediment Fill
Ground
Bank Sta


Final Super-Silt-4.00 Plan: 1/15/2008
RS = 6 Arroyo Del Puerto
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta


Final Super-Silt-4.00 Plan: 1/15/2008
RS = 5 Arroyo Del Puerto
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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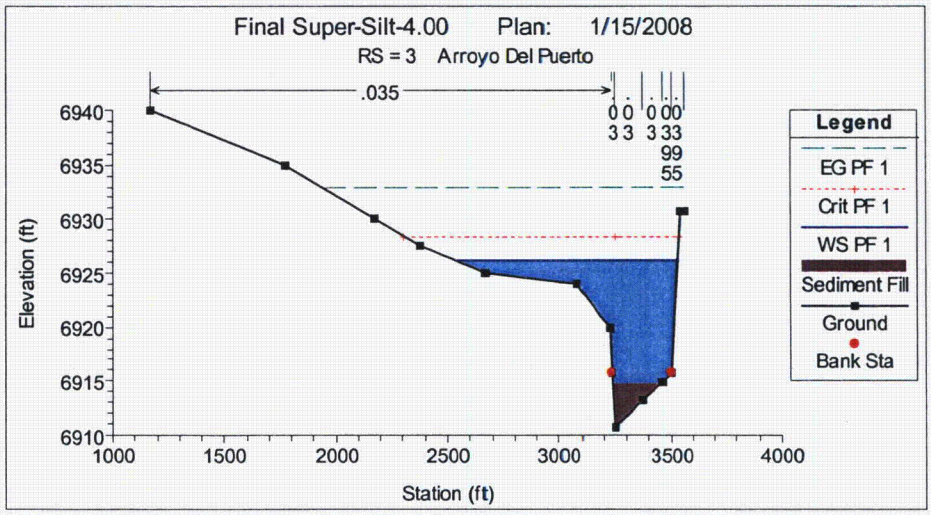
RS = 4 Arroyo Del Puerto
.035
.03
Elevation (ft)
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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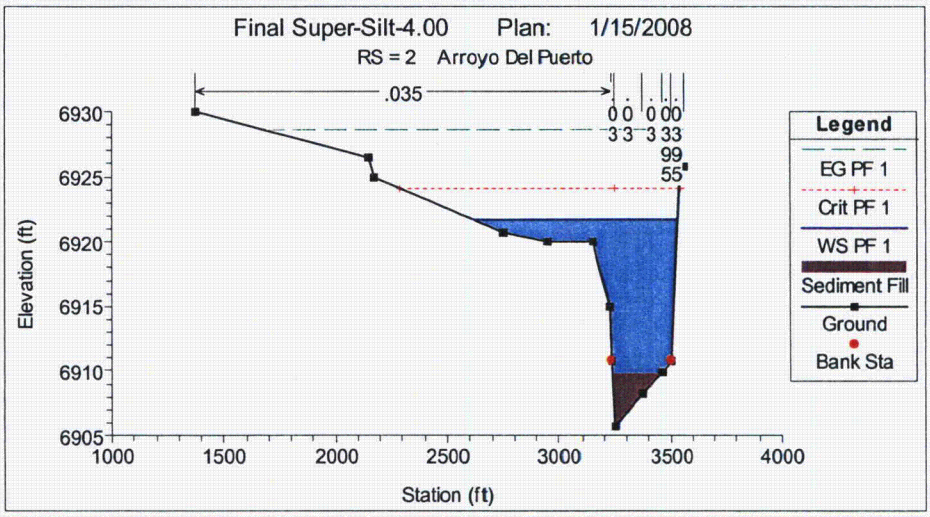
RS = 3 Arroyo Del Puerto
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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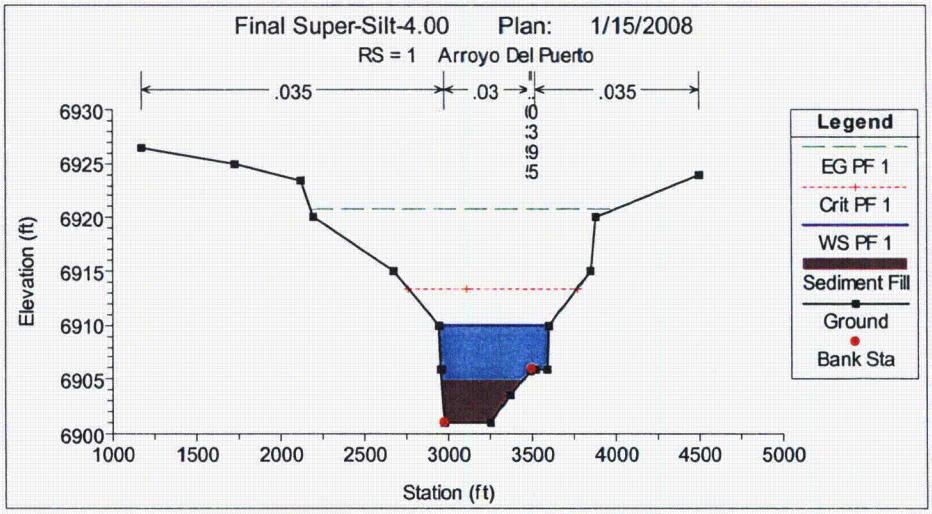
RS = 2 Arroyo Del Puerto
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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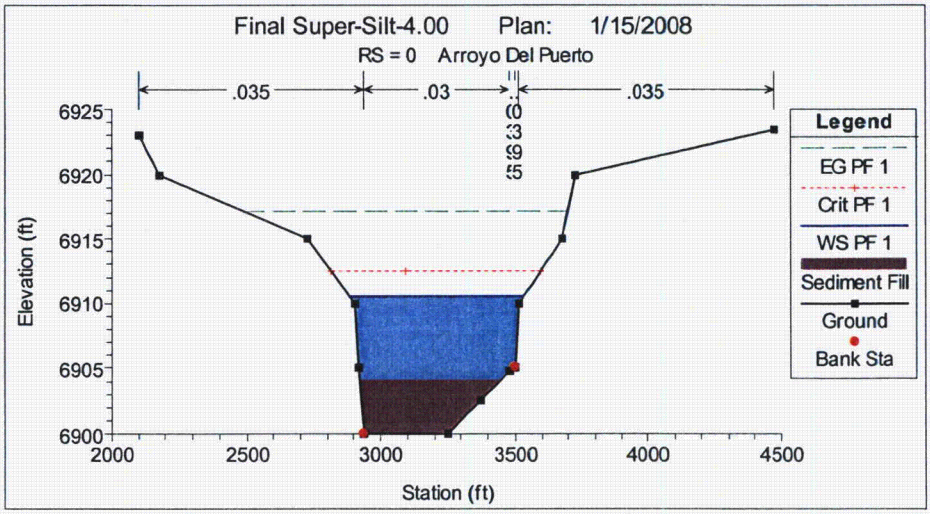
RS = 1 Arroyo Del Puerto
.035
.03
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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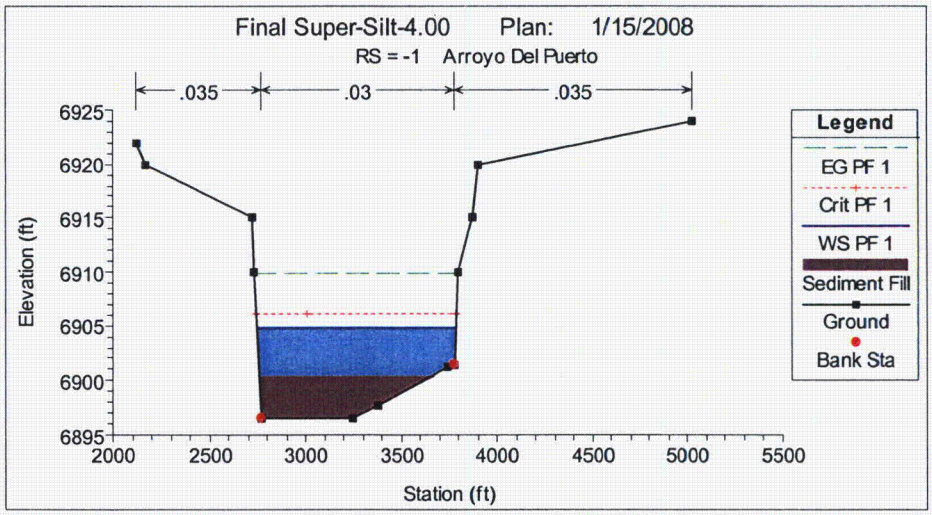
RS = 0 Arroyo Del Puerto
.035
.03
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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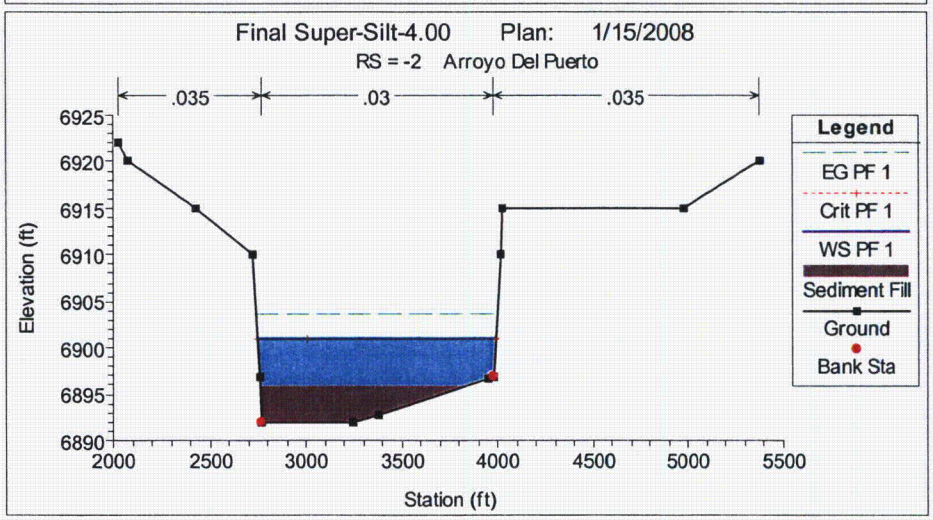
RS = -1 Arroyo Del Puerto
.035
.03
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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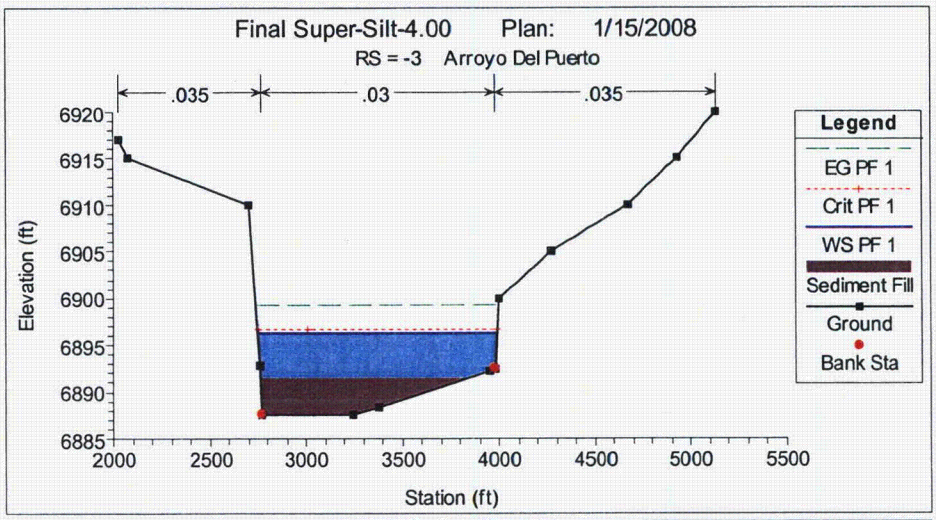
RS = -2 Arroyo Del Puerto
.035
.03
.035
Elevation (ft)
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta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.035
.03
.035
Elevation (ft)
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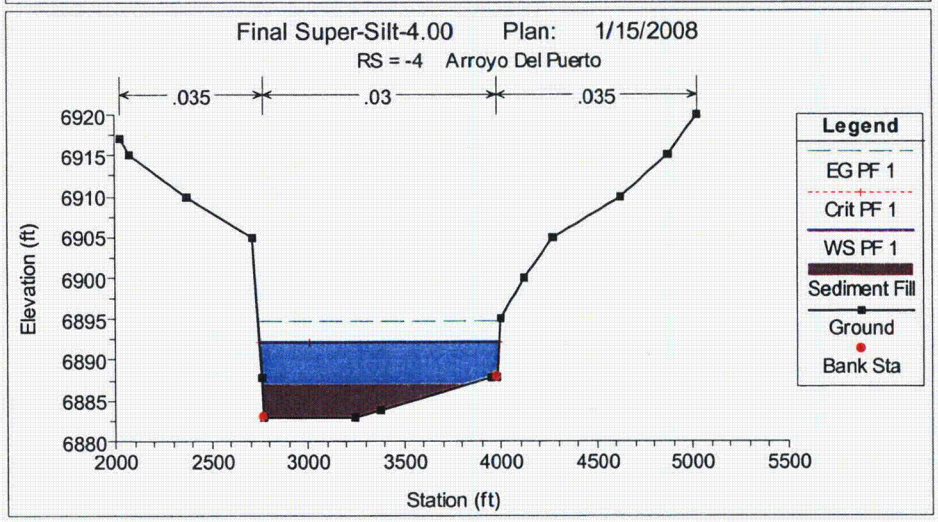
6885
2000
2500
3000
3500
4000
4500
5000
5500
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta


Final Super-Silt-4.00 Plan: 1/15/2008
RS = -4 Arroyo Del Puerto
.035
.03
.035
Elevation (ft)
6920
6915
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6905
6900
6895
6890
6885
6880
2000
2500
3000
3500
4000
4500
5000
5500
Station (ft)
Legend
EG PF 1
Crit PF 1
WS PF 1
Sediment Fill
Ground
Bank Sta

	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	Reach #1	21	PF 1	78000	6955.00	6964.88	6962.79	6965.56	0.001678	9.34	13101.91	2360.89	0.52
2	Reach #1	20	PF 1	78000	6953.90	6962.53	6962.53	6964.13	0.005135	14.85	9475.37	2551.49	0.89
3	Reach #1	19	PF 1	78000	6951.80	6960.41	6956.85	6961.1	0.001115	6.73	12292.56	1995.55	0.41
4	Reach #1	18	PF 1	78000	6947.39	6959.99		6960.72	0.001152	8.94	12725.3	1659.05	0.45
5	Reach #1	17	PF 1	78000	6946.27	6959.76		6960.29	0.000786	7.73	14974.8	1854.83	0.37
6	Reach #1	16	PF 1	78000	6945.22	6959.01		6959.82	0.001114	9.34	12395.28	1570.74	0.44
7	Reach #1	15	PF 1	78000	6944.72	6958.08		6959.18	0.001573	10.86	11238.67	1701.92	0.53
8	Reach #1	14	PF 1	78000	6944.22	6956.91		6958.28	0.00197	11.75	9631.32	1324.1	0.58
9	Reach #1	13	PF 1	78000	6943.72	6955.95		6957.27	0.001988	11.51	9544	1262.35	0.58
10	Reach #1	12	PF 1	78000	6943.22	6955.06		6956.25	0.001938	11.12	10027.57	1386.8	0.57
11	Reach #1	11	PF 1	78000	6942.72	6953.84		6955.18	0.002303	11.62	9206.63	1248.9	0.62
12	Reach #1	10	PF 1	78000	6942.22	6952.54		6953.9	0.002692	11.95	9237.21	1418.56	0.66
13	Reach #1	9	PF 1	78000	6939.72	6950.36		6952.27	0.003547	14.01	8344.92	1465.9	0.76
14	Reach #1	8	PF 1	78000	6937.22	6948.15		6950.38	0.003735	14.64	7506.16	1156.98	0.78
15	Reach #1	7	PF 1	78000	6934.72	6945.62	6945.62	6948.22	0.004467	15.86	7450.88	1418.75	0.85
16	Reach #1	6	PF 1	78000	6929.72	6941.25	6942.48	6945.44	0.006179	18.79	6168.02	1361.65	0.98
17	Reach #1	5	PF 1	78000	6924.72	6936.06	6937.97	6941.78	0.007986	21.13	5321.44	1341.31	1.11
18	Reach #1	4	PF 1	78000	6919.72	6930.73	6932.82	6937.37	0.009374	22.44	4803.51	1166.58	1.2
19	Reach #1	3	PF 1	78000	6914.72	6926.16	6928.44	6932.85	0.008727	22.22	4632.71	990.58	1.16
20	Reach #1	2	PF 1	78000	6909.72	6921.73	6924.13	6928.63	0.008114	22.14	4452	921.01	1.13
21	Reach #1	1	PF 1	78000	6904.97	6909.86	6913.37	6920.69	0.037263	27.23	3009.44	653.37	2.18
22	Reach #1	0	PF 1	78000	6904.07	6910.56	6912.56	6917.2	0.014967	20.88	3838.08	647.74	1.45
23	Reach #1	-1	PF 1	78000	6900.47	6904.74	6906.18	6909.86	0.019846	18.22	4314.05	1034.64	1.56
24	Reach #1	-2	PF 1	78000	6895.97	6901.05	6901.07	6903.57	0.007763	12.79	6144.47	1239.47	1.01
25	Reach #1	-3	PF 1	78000	6891.47	6896.16	6896.55	6899.13	0.010188	13.88	5659.59	1237.13	1.14
26	Reach #1	-4	PF 1	78000	6886.97	6892.05	6892.06	6894.57	0.007753	12.78	6146.89	1239.48	1.01

Plan: Reach #1 Reach #1 RS: 21 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	1175	3350	5957.83	1634.37	538.52	7.64	3.04	3.65
2	Chan	3350	3416.67	6152.39	658.63	66.67	7.89	9.88	9.34
3	Chan	3416.67	3483.33	6152.36	658.62	66.67	7.89	9.88	9.34
4	Chan	3483.33	3550	6152.38	658.63	66.67	7.89	9.88	9.34
5	ROB	3550	5225	53585.04	9491.66	1622.73	68.7	5.85	5.65
Plan: Reach #1 Reach #1 RS: 20 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	1010	3350	26117.83	3634.75	1001.26	33.48	3.63	7.19
2	Chan	3350	3416.67	8431.73	569.1	66.72	10.81	8.54	14.82
3	Chan	3416.67	3483.33	8583.5	575.03	66.67	11	8.63	14.93
4	Chan	3483.33	3550	8416.28	568.46	66.72	10.79	8.53	14.81
5	ROB	3550	4975	26450.66	4128.03	1350.42	33.91	3.06	6.41
Plan: Reach #1 Reach #1 RS: 19 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	605	2720	1612.59	816.52	496.68	2.07	1.64	1.97
2	Chan	2720	3180	21741.39	3442.64	460.02	27.87	7.48	6.32
3	Chan	3180	3640	35982.88	3962.33	460	35.23	8.61	6.94
4	Chan	3640	4100	18387.26	3911.13	460.16	34.47	8.5	6.87
5	ROB	4100	4875	275.88	159.93	119.18	0.35	1.34	1.72
Plan: Reach #1 Reach #1 RS: 18 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	682.82	76.79	6.31	0.88	12.17	8.89
40	Chan	3474.76	3481.07	671.07	76	6.31	0.86	12.04	8.83
41	Chan	3481.07	3487.38	599.86	75.2	6.31	0.77	11.92	7.98
42	Chan	3487.38	3493.69	492	74.4	6.31	0.63	11.79	6.61
43	Chan	3493.69	3500	483.25	73.61	6.31	0.62	11.67	6.57
44	ROB	3500	4825	861.97	201.81	36.67	1.11	5.8	4.27
Plan: Reach #1 Reach #1 RS: 17 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	634.32	82.4	6.31	0.81	13.06	7.7
40	Chan	3474.76	3481.07	624.13	81.6	6.31	0.8	12.93	7.65
41	Chan	3481.07	3487.38	558.55	80.8	6.31	0.72	12.81	6.91
42	Chan	3487.38	3493.69	458.7	80.01	6.31	0.59	12.68	5.73
43	Chan	3493.69	3500	451.12	79.21	6.31	0.58	12.55	5.7
44	ROB	3500	3560	867.42	234.05	39.5	1.11	6.25	3.71
Plan: Reach #1 Reach #1 RS: 16 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	784.05	84.27	6.31	1.01	13.36	9.3
40	Chan	3474.76	3481.07	771.76	83.47	6.31	0.99	13.23	9.25
41	Chan	3481.07	3487.38	690.92	82.67	6.31	0.89	13.1	8.36
42	Chan	3487.38	3493.69	567.62	81.88	6.31	0.73	12.98	6.93
43	Chan	3493.69	3500	558.45	81.08	6.31	0.72	12.85	6.89
44	ROB	3500	3560	1099.45	245.28	40.44	1.41	6.39	4.48
Plan: Reach #1 Reach #1 RS: 15 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	881.98	81.53	6.31	1.13	12.92	10.82
40	Chan	3474.76	3481.07	867.69	80.74	6.31	1.11	12.8	10.75
41	Chan	3481.07	3487.38	776.39	79.94	6.31	1	12.67	9.71
42	Chan	3487.38	3493.69	637.48	79.15	6.31	0.82	12.54	8.05
43	Chan	3493.69	3500	626.83	78.35	6.31	0.8	12.42	8
44	ROB	3500	3560	1191.93	228.95	39.07	1.53	6.18	5.21

Plan: Reach #1 Reach #1 RS: 14 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	903.42	77.33	6.31	1.16	12.26	11.68
40	Chan	3474.76	3481.07	887.99	76.53	6.31	1.14	12.13	11.6
41	Chan	3481.07	3487.38	793.86	75.74	6.31	1.02	12	10.48
42	Chan	3487.38	3493.69	651.19	74.94	6.31	0.83	11.88	8.69
43	Chan	3493.69	3500	639.7	74.15	6.31	0.82	11.75	8.63
44	ROB	3500	3560	1150.24	204.91	36.96	1.47	5.84	5.61
Plan: Reach #1 Reach #1 RS: 13 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	852.16	74.46	6.31	1.09	11.8	11.44
40	Chan	3474.76	3481.07	837.05	73.66	6.31	1.07	11.67	11.36
41	Chan	3481.07	3487.38	747.82	72.86	6.31	0.96	11.55	10.26
42	Chan	3487.38	3493.69	612.99	72.07	6.31	0.79	11.42	8.51
43	Chan	3493.69	3500	601.74	71.27	6.31	0.77	11.3	8.44
44	ROB	3500	3558.1	1039.25	189.23	35.52	1.33	5.62	5.49
Plan: Reach #1 Reach #1 RS: 12 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	795.29	71.98	6.31	1.02	11.41	11.05
40	Chan	3474.76	3481.07	780.7	71.19	6.31	1	11.28	10.97
41	Chan	3481.07	3487.38	697.05	70.39	6.31	0.89	11.16	9.9
42	Chan	3487.38	3493.69	570.99	69.59	6.31	0.73	11.03	8.2
43	Chan	3493.69	3500	560.14	68.8	6.31	0.72	10.9	8.14
44	ROB	3500	3556.3	934.7	176.48	34.32	1.2	5.42	5.3
Plan: Reach #1 Reach #1 RS: 11 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	777.3	67.42	6.31	1	10.69	11.53
40	Chan	3474.76	3481.07	762.08	66.63	6.31	0.98	10.56	11.44
41	Chan	3481.07	3487.38	679.58	65.83	6.31	0.87	10.43	10.32
42	Chan	3487.38	3493.69	555.92	65.03	6.31	0.71	10.31	8.55
43	Chan	3493.69	3500	544.62	64.24	6.31	0.7	10.18	8.48
44	ROB	3500	3554.4	847.48	153.71	32.03	1.09	5.06	5.51
Plan: Reach #1 Reach #1 RS: 10 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	738.21	62.38	6.31	0.95	9.89	11.84
40	Chan	3474.76	3481.07	722.59	61.58	6.31	0.93	9.76	11.73
41	Chan	3481.07	3487.38	643.34	60.78	6.31	0.82	9.63	10.58
42	Chan	3487.38	3493.69	525.35	59.99	6.31	0.67	9.51	8.76
43	Chan	3493.69	3500	513.78	59.19	6.31	0.66	9.38	8.68
44	ROB	3500	3552.5	734.82	130.23	29.47	0.94	4.66	5.64
Plan: Reach #1 Reach #1 RS: 9 Profile: PF 1									0
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	894.23	64.42	6.31	1.15	10.21	13.88
40	Chan	3474.76	3481.07	875.91	63.63	6.31	1.12	10.08	13.77
41	Chan	3481.07	3487.38	780.36	62.83	6.31	1	9.96	12.42
42	Chan	3487.38	3493.69	637.72	62.04	6.31	0.82	9.83	10.28
43	Chan	3493.69	3500	624.14	61.24	6.31	0.8	9.71	10.19
44	ROB	3500	3552.5	924.11	139.47	30.49	1.18	4.82	6.63
Plan: Reach #1 Reach #1 RS: 8 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	961.4	66.25	6.31	1.23	10.5	14.51
40	Chan	3474.76	3481.07	942.24	65.46	6.31	1.21	10.37	14.4
41	Chan	3481.07	3487.38	839.94	64.66	6.31	1.08	10.25	12.99
42	Chan	3487.38	3493.69	686.84	63.86	6.31	0.88	10.12	10.75
43	Chan	3493.69	3500	672.62	63.07	6.31	0.86	10	10.67
44	ROB	3500	3552.5	1026.12	147.97	31.41	1.32	4.97	6.93

Plan: Reach #1 Reach #1 RS: 7 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
39	Chan	3468.45	3474.76	1038.06	66.02	6.31	1.33	10.46	15.72
40	Chan	3474.76	3481.07	1017.3	65.23	6.31	1.3	10.34	15.6
41	Chan	3481.07	3487.38	906.79	64.43	6.31	1.16	10.21	14.07
42	Chan	3487.38	3493.69	741.45	63.63	6.31	0.95	10.09	11.65
43	Chan	3493.69	3500	626.05	62.84	6.31	0.93	9.96	11.55
44	ROB	3500	3554.4	1112.63	147.05	31.32	1.43	4.95	7.57
Plan: Reach #1 Reach #1 RS: 6 Profile: PF 1									
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
37	Chan	3455.83	3462.14	1172.96	71.58	6.31	1.63	11.34	19.5
38	Chan	3462.14	3468.45	932.78	70.79	6.31	1.32	11.22	17.78
39	Chan	3468.45	3474.76	913.48	69.99	6.31	1.3	11.09	14.59
40	Chan	3474.76	3481.07	894.34	69.19	6.31	1.27	10.97	14.48
41	Chan	3481.07	3487.38	875.3	68.39	6.31	1.25	10.84	14.37
42	Chan	3487.38	3493.69	856.48	67.6	6.31	1.23	10.71	14.26
43	Chan	3493.69	3500	837.77	66.8	6.31	1.2	10.59	14.15
44	ROB	3500	3556.3	1436.97	166.35	33.32	1.84	5.26	14.04
Plan: Reach #1 Reach #1 RS: 5 Profile: PF 1									8.64
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	Velocity
37	Chan	3455.83	3462.14	1082.83	70.41	6.31	1.8	11.16	21.92
38	Chan	3462.14	3468.45	1041.83	69.61	6.31	1.46	11.03	19.99
39	Chan	3468.45	3474.76	1020.14	68.82	6.31	1.44	10.91	16.4
40	Chan	3474.76	3481.07	998.62	68.02	6.31	1.41	10.78	16.28
41	Chan	3481.07	3487.38	977.23	67.22	6.31	1.38	10.65	16.15
42	Chan	3487.38	3493.69	956.08	66.43	6.31	1.35	10.53	16.02
43	Chan	3493.69	3500	935.07	65.63	6.31	1.33	10.4	15.9
44	ROB	3500	3558.1	1555.54	160.31	32.69	1.99	5.17	15.77
Plan: Reach #1 Reach #1 RS: 4 Profile: PF 1									9.7
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	Velocity
37	Chan	3455.83	3462.14	1071.11	68.34	6.31	1.86	10.83	23.29
38	Chan	3462.14	3468.45	1051.24	67.54	6.31	1.51	10.71	21.23
39	Chan	3468.45	3474.76	1028.21	66.75	6.31	1.48	10.58	17.41
40	Chan	3474.76	3481.07	1005.37	65.95	6.31	1.45	10.45	17.28
41	Chan	3481.07	3487.38	982.67	65.15	6.31	1.42	10.33	17.14
42	Chan	3487.38	3493.69	960.24	64.36	6.31	1.39	10.2	17
43	Chan	3493.69	3500	937.95	63.56	6.31	1.36	10.07	16.86
44	ROB	3500	3560	1546.72	150.32	31.66	1.98	5.01	16.72
Plan: Reach #1 Reach #1 RS: 3 Profile: PF 1									10.29
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	Velocity
37	Chan	3455.83	3462.14	1129.74	71.07	6.31	1.92	11.26	23.06
38	Chan	3462.14	3468.45	1112.54	70.27	6.31	1.55	11.14	21.03
39	Chan	3468.45	3474.76	1089.73	69.48	6.31	1.53	11.01	17.25
40	Chan	3474.76	3481.07	1067.09	68.68	6.31	1.5	10.89	17.12
41	Chan	3481.07	3487.38	1044.57	67.88	6.31	1.47	10.76	16.99
42	Chan	3487.38	3493.69	1022.33	67.09	6.31	1.44	10.63	16.86
43	Chan	3493.69	3500	1000.21	66.29	6.31	1.41	10.51	16.73
44	ROB	3500	3560	1670.63	163.6	33.02	2.14	5.22	16.6
Plan: Reach #1 Reach #1 RS: 2 Profile: PF 1									10.21
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	Velocity
37	Chan	3455.83	3462.14	1183.75	74.66	6.31	2.01	11.83	22.97
38	Chan	3462.14	3468.45	1154.52	73.86	6.31	1.63	11.71	20.96
39	Chan	3468.45	3474.76	1131.77	73.06	6.31	1.6	11.58	17.2
40	Chan	3474.76	3481.07	1109.19	72.27	6.31	1.57	11.45	17.08
41	Chan	3481.07	3487.38	1086.72	71.47	6.31	1.54	11.33	16.95
42	Chan	3487.38	3493.69	1064.51	70.67	6.31	1.51	11.2	16.83
43	Chan	3493.69	3500	1042.42	69.88	6.31	1.49	11.07	16.7
44	ROB	3500	3560	1855.44	181.89	34.82	2.38	5.51	16.58

Plan:	Reach #1	Reach #1 RS: 1	Profile: PF 1						10.2
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	Velocity
38	Chan	3425	3437.5	1683.13	61.12	12.5	2.16	4.89	27.54
39	Chan	3437.5	3450	1683.13	61.12	12.5	2.16	4.89	27.54
40	Chan	3450	3462.5	1612.01	59.56	12.5	2.07	4.77	27.54
41	Chan	3462.5	3475	1473.61	56.44	12.5	1.89	4.52	27.06
42	Chan	3475	3487.5	703.13	53.31	12.5	1.61	4.27	26.11
43	Chan	3487.5	3500	570.26	50.19	12.5	1.18	4.01	23.51
44	ROB	3500	4502.11	4515.3	372.78	102.31	8.99	3.67	18.34
Plan:	Reach #1	Reach #1 RS: 0	Profile: PF 1						18.82
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	Velocity
38	Chan	3419.29	3432.74	1840.59	87.31	13.45	2.36	6.49	21.08
39	Chan	3432.74	3446.19	1840.59	87.31	13.45	2.36	6.49	21.08
40	Chan	3446.19	3459.64	1807.84	86.38	13.45	2.32	6.42	21.08
41	Chan	3459.64	3473.1	1688.24	82.9	13.46	2.16	6.16	20.93
42	Chan	3473.1	3486.55	1498.04	79.28	13.46	1.92	5.89	20.36
43	Chan	3486.55	3500	1101.11	75.67	13.46	1.41	5.62	18.89
44	ROB	3500	4475	427.31	49.8	33.55	0.55	1.52	14.55
Plan:	Reach #1	Reach #1 RS: -1	Profile: PF 1						8.58
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	Velocity
39	Chan	3655.95	3679.76	1853.52	101.28	23.81	2.38	4.25	(ft/s)
40	Chan	3679.76	3703.57	1721.08	96.88	23.81	2.21	4.07	18.3
41	Chan	3703.57	3727.38	1564.33	91.48	23.81	2.01	3.84	17.77
42	Chan	3727.38	3751.19	1413.62	86.09	23.81	1.81	3.62	17.1
43	Chan	3751.19	3775	1267.44	80.63	23.81	1.62	3.39	16.42
44	ROB	3775	5025	128.76	16.06	10.35	0.17	1.64	15.72
Plan:	Reach #1	Reach #1 RS: -2	Profile: PF 1						8.02
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	Velocity
39	Chan	3832.14	3860.71	1801.21	141.9	28.57	2.31	4.97	(ft/s)
40	Chan	3860.71	3889.29	1683.83	136.28	28.57	2.16	4.77	12.69
41	Chan	3889.29	3917.86	1569.52	130.65	28.57	2.01	4.57	12.36
42	Chan	3917.86	3946.43	1458.4	125.02	28.57	1.87	4.38	12.01
43	Chan	3946.43	3975	1349.59	119.34	28.57	1.73	4.18	11.67
44	ROB	3975	5375	144.78	24.94	12.89	0.19	2.04	11.31
Plan:	Reach #1	Reach #1 RS: -3	Profile: PF 1						5.81
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	Velocity
39	Chan	3832.14	3860.71	1799.17	130.71	28.57	2.31	4.57	(ft/s)
40	Chan	3860.71	3889.29	1672.03	125.09	28.57	2.14	4.38	13.76
41	Chan	3889.29	3917.86	1548.53	119.46	28.57	1.99	4.18	13.37
42	Chan	3917.86	3946.43	1428.8	113.83	28.57	1.83	3.98	12.96
43	Chan	3946.43	3975	1311.9	108.15	28.57	1.68	3.79	12.55
44	ROB	3975	5125	126.72	20.38	11.66	0.16	1.84	12.13
Plan:	Reach #1	Reach #1 RS: -4	Profile: PF 1						6.22
	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	Velocity
39	Chan	3832.14	3860.71	1801.21	141.96	28.57	2.31	4.97	(ft/s)
40	Chan	3860.71	3889.29	1683.88	136.33	28.57	2.16	4.77	12.69
41	Chan	3889.29	3917.86	1569.62	130.71	28.57	2.01	4.57	12.35
42	Chan	3917.86	3946.43	1458.54	125.07	28.57	1.87	4.38	12.01
43	Chan	3946.43	3975	1349.77	119.39	28.57	1.73	4.18	11.66
44	ROB	3975	5025	144.91	24.97	12.9	0.19	2.04	11.31

Plan: Reach #1	Reach #1 RS: 21	Profile: PF 1			
E.G. Elev (ft)	6965.56	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.68	Wt. n-Val.	0.035	0.03	0.035
W.S. Elev (ft)	6964.88	Reach Len. (ft)	525	500	475
Crit W.S. (ft)	6962.79	Flow Area (sq ft)	1634.37	1975.88	9491.66
E.G. Slope (ft/ft)	0.001678	Area (sq ft)	1634.37	1975.88	9491.66
Q Total (cfs)	78000	Flow (cfs)	5957.83	18457.13	53585.04
Top Width (ft)	2360.89	Top Width (ft)	538.3	200	1622.59
Vel Total (ft/s)	5.95	Avg. Vel. (ft/s)	3.65	9.34	5.65
Max Chl Dpth (ft)	9.88	Hydr. Depth (ft)	3.04	9.88	5.85
Conv. Total (cfs)	1904225	Conv. (cfs)	145449.3	450596.5	1308179
Length Wtd. (ft)	492.31	Wetted Per. (ft)	538.52	200	1622.73
Min Ch El (ft)	6955	Shear (lb/sq ft)	0.32	1.03	0.61
Alpha	1.23	Stream Power (lb/ft s)	1.16	9.67	3.46
Frctn Loss (ft)	1.34	Cum Volume (acre-ft)	1076.87	975.99	135.11
C & E Loss (ft)	0.09	Cum SA (acres)	224.92	118.4	31.99

Plan: Reach #1	Reach #1 RS: 20	Profile: PF 1			
E.G. Elev (ft)	6964.13	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.6	Wt. n-Val.	0.035	0.03	0.035
W.S. Elev (ft)	6962.53	Reach Len. (ft)	525	500	475
Crit W.S. (ft)	6962.53	Flow Area (sq ft)	3634.75	1712.59	4128.03
E.G. Slope (ft/ft)	0.005135	Area (sq ft)	3634.75	1712.59	4128.03
Q Total (cfs)	78000	Flow (cfs)	26117.83	25431.51	26450.66
Top Width (ft)	2551.49	Top Width (ft)	1001.23	200	1350.25
Vel Total (ft/s)	8.23	Avg. Vel. (ft/s)	7.19	14.85	6.41
Max Chl Dpth (ft)	8.63	Hydr. Depth (ft)	3.63	8.56	3.06
Conv. Total (cfs)	1088539	Conv. (cfs)	364490.7	354912.6	369135.4
Length Wtd. (ft)	500.16	Wetted Per. (ft)	1001.26	200.11	1350.42
Min Ch El (ft)	6953.9	Shear (lb/sq ft)	1.16	2.74	0.98
Alpha	1.52	Stream Power (lb/ft s)	8.36	40.74	6.28
Frctn Loss (ft)	1.04	Cum Volume (acre-ft)	1045.12	954.82	60.85
C & E Loss (ft)	0.27	Cum SA (acres)	215.64	116.11	15.78

Plan: Reach #1	Reach #1 RS: 19	Profile: PF 1			
E.G. Elev (ft)	6961.1	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.69	Wt. n-Val.	0.035	0.03	0.035
W.S. Elev (ft)	6960.41	Reach Len. (ft)	350	325	275
Crit W.S. (ft)	6956.85	Flow Area (sq ft)	816.52	11316.11	159.93
E.G. Slope (ft/ft)	0.001115	Area (sq ft)	816.52	11316.11	159.93
Q Total (cfs)	78000	Flow (cfs)	1612.59	76111.53	275.88
Top Width (ft)	1995.55	Top Width (ft)	496.62	1380	118.93
Vel Total (ft/s)	6.35	Avg. Vel. (ft/s)	1.97	6.73	1.72
Max Chl Dpth (ft)	8.61	Hydr. Depth (ft)	1.64	8.2	1.34
Conv. Total (cfs)	2335556	Conv. (cfs)	48285.8	2279009	8260.7
Length Wtd. (ft)	332.51	Wetted Per. (ft)	496.68	1380.18	119.18
Min Ch El (ft)	6951.8	Shear (lb/sq ft)	0.11	0.57	0.09
Alpha	1.1	Stream Power (lb/ft s)	0.23	3.84	0.16
Frctn Loss (ft)	0.38	Cum Volume (acre-ft)	1018.29	880.05	37.47
C & E Loss (ft)	0	Cum SA (acres)	206.61	107.04	7.77

Plan: Reach #1	Reach #1 RS: 12	Profile: PF 1			
E.G. Elev (ft)	6956.25	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.19	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6955.06	Reach Len. (ft)	500	500	500
Crit W.S. (ft)		Flow Area (sq ft)	6739.89	3111.2	176.48
E.G. Slope (ft/ft)	0.001938	Area (sq ft)	6739.89	3111.2	176.48
Q Total (cfs)	78000	Flow (cfs)	42456.73	34608.57	934.7
Top Width (ft)	1386.8	Top Width (ft)	1089.24	265	32.56
Vel Total (ft/s)	7.78	Avg. Vel. (ft/s)	6.3	11.12	5.3
Max Chl Dpth (ft)	11.84	Hydr. Depth (ft)	6.19	11.74	5.42
Conv. Total (cfs)	1771737	Conv. (cfs)	964386.6	786118.9	21231.3
Length Wtd. (ft)	500	Wetted Per. (ft)	1089.3	265.17	34.32
Min Ch El (ft)	6943.22	Shear (lb/sq ft)	0.75	1.42	0.62
Alpha	1.27	Stream Power (lb/ft s)	4.72	15.79	3.3
Frctn Loss (ft)	1.05	Cum Volume (acre-ft)	476.41	602.53	21.93
C & E Loss (ft)	0.02	Cum SA (acres)	120.28	83.56	4.89

Plan: Reach #1	Reach #1 RS: 11	Profile: PF 1			
E.G. Elev (ft)	6955.18	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.35	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6953.84	Reach Len. (ft)	525	500	475
Crit W.S. (ft)		Flow Area (sq ft)	6133.23	2919.69	153.71
E.G. Slope (ft/ft)	0.002303	Area (sq ft)	6133.23	2919.69	153.71
Q Total (cfs)	78000	Flow (cfs)	43214.59	33937.93	847.48
Top Width (ft)	1248.9	Top Width (ft)	953.52	265	30.38
Vel Total (ft/s)	8.47	Avg. Vel. (ft/s)	7.05	11.62	5.51
Max Chl Dpth (ft)	11.12	Hydr. Depth (ft)	6.43	11.02	5.06
Conv. Total (cfs)	1625419	Conv. (cfs)	900535.9	707222.3	17660.3
Length Wtd. (ft)	513.87	Wetted Per. (ft)	953.59	265.17	32.03
Min Ch El (ft)	6942.72	Shear (lb/sq ft)	0.92	1.58	0.69
Alpha	1.21	Stream Power (lb/ft s)	6.52	18.4	3.8
Frctn Loss (ft)	1.28	Cum Volume (acre-ft)	402.52	567.92	20.04
C & E Loss (ft)	0	Cum SA (acres)	108.55	80.52	4.53

Plan: Reach #1	Reach #1 RS: 10	Profile: PF 1			
E.G. Elev (ft)	6953.9	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.37	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6952.54	Reach Len. (ft)	525	500	475
Crit W.S. (ft)		Flow Area (sq ft)	6399.23	2707.74	130.23
E.G. Slope (ft/ft)	0.002692	Area (sq ft)	6399.23	2707.74	130.23
Q Total (cfs)	78000	Flow (cfs)	44897.73	32367.46	734.82
Top Width (ft)	1418.56	Top Width (ft)	1125.61	265	27.95
Vel Total (ft/s)	8.44	Avg. Vel. (ft/s)	7.02	11.95	5.64
Max Chl Dpth (ft)	10.32	Hydr. Depth (ft)	5.69	10.22	4.66
Conv. Total (cfs)	1503347	Conv. (cfs)	865344.5	623840.1	14162.6
Length Wtd. (ft)	513.01	Wetted Per. (ft)	1125.71	265.17	29.47
Min Ch El (ft)	6942.22	Shear (lb/sq ft)	0.96	1.72	0.74
Alpha	1.23	Stream Power (lb/ft s)	6.7	20.51	4.19
Frctn Loss (ft)	1.58	Cum Volume (acre-ft)	327	535.62	18.49
C & E Loss (ft)	0.05	Cum SA (acres)	96.02	77.48	4.21

Plan: Reach #1	Reach #1 RS: 3	Profile: PF 1			
E.G. Elev (ft)	6932.85	Element	Left OB	Channel	Right OB
Vel Head (ft)	6.68	Wt. n-Val.	0.035	0.032	0.039
W.S. Elev (ft)	6926.16	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6928.44	Flow Area (sq ft)	1463.11	3006	163.6
E.G. Slope (ft/ft)	0.008727	Area (sq ft)	1463.11	3006	163.6
Q Total (cfs)	78000	Flow (cfs)	9531.35	66798.02	1670.63
Top Width (ft)	990.58	Top Width (ft)	694.25	265	31.33
Vel Total (ft/s)	16.84	Avg. Vel. (ft/s)	6.51	22.22	10.21
Max Chl Dpth (ft)	11.44	Hydr. Depth (ft)	2.11	11.34	5.22
Conv. Total (cfs)	834971	Conv. (cfs)	102030.8	715056.5	17883.7
Length Wtd. (ft)	500	Wetted Per. (ft)	695.01	265.17	33.02
Min Ch El (ft)	6914.72	Shear (lb/sq ft)	1.15	6.18	2.7
Alpha	1.52	Stream Power (lb/ft s)	7.47	137.24	27.56
Frctn Loss (ft)	4.52	Cum Volume (acre-ft)	26.48	302.85	6.67
C & E Loss (ft)	0	Cum SA (acres)	12.72	56.19	1.86

Plan: Reach #1	Reach #1 RS: 2	Profile: PF 1			
E.G. Elev (ft)	6928.63	Element	Left OB	Channel	Right OB
Vel Head (ft)	6.9	Wt. n-Val.	0.035	0.032	0.039
W.S. Elev (ft)	6921.73	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6924.13	Flow Area (sq ft)	1113.5	3156.61	181.89
E.G. Slope (ft/ft)	0.008114	Area (sq ft)	1113.5	3156.61	181.89
Q Total (cfs)	78000	Flow (cfs)	6265.81	69878.75	1855.44
Top Width (ft)	921.01	Top Width (ft)	622.97	265	33.04
Vel Total (ft/s)	17.52	Avg. Vel. (ft/s)	5.63	22.14	10.2
Max Chl Dpth (ft)	12.01	Hydr. Depth (ft)	1.79	11.91	5.51
Conv. Total (cfs)	865919.7	Conv. (cfs)	69560.1	775761.4	20598.3
Length Wtd. (ft)	500	Wetted Per. (ft)	623.84	265.17	34.82
Min Ch El (ft)	6909.72	Shear (lb/sq ft)	0.9	8.03	2.65
Alpha	1.45	Stream Power (lb/ft s)	5.09	133.49	26.99
Frctn Loss (ft)	4.21	Cum Volume (acre-ft)	11.69	267.48	4.69
C & E Loss (ft)	0.02	Cum SA (acres)	5.16	53.15	1.49

Plan: Reach #1	Reach #1 RS: 1	Profile: PF 1			
E.G. Elev (ft)	6920.69	Element	Left OB	Channel	Right OB
Vel Head (ft)	10.83	Wt. n-Val.	0.035	0.03	0.036
W.S. Elev (ft)	6909.86	Reach Len. (ft)	100	100	100
Crit W.S. (ft)	6913.37	Flow Area (sq ft)	94.58	2542.08	372.78
E.G. Slope (ft/ft)	0.037263	Area (sq ft)	94.58	2542.08	372.78
Q Total (cfs)	78000	Flow (cfs)	1766.79	71717.88	4515.3
Top Width (ft)	653.37	Top Width (ft)	26.69	525	101.68
Vel Total (ft/s)	25.92	Avg. Vel. (ft/s)	18.68	27.23	18.82
Max Chl Dpth (ft)	4.89	Hydr. Depth (ft)	3.54	4.84	3.67
Conv. Total (cfs)	404071.6	Conv. (cfs)	9152.7	358576.7	36342.2
Length Wtd. (ft)	100	Wetted Per. (ft)	27.48	525.01	102.31
Min Ch El (ft)	6904.97	Shear (lb/sq ft)	8.01	11.26	8.48
Alpha	1.04	Stream Power (lb/ft s)	149.56	306.7	159.51
Frctn Loss (ft)	7.54	Cum Volume (acre-ft)	4.76	234.78	1.51
C & E Loss (ft)	0.39	Cum SA (acres)	1.43	48.61	0.72

Plan: Reach #1	Reach #1 RS: 18	Profile: PF 1			
E.G. Elev (ft)	6960.72	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.73	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6959.99	Reach Len. (ft)	425	350	250
Crit W.S. (ft)		Flow Area (sq ft)	9210.31	3313.18	201.81
E.G. Slope (ft/ft)	0.001152	Area (sq ft)	9210.31	3313.18	201.81
Q Total (cfs)	78000	Flow (cfs)	47514.85	29623.18	861.97
Top Width (ft)	1659.05	Top Width (ft)	1359.27	265	34.79
Vel Total (ft/s)	6.13	Avg. Vel. (ft/s)	5.16	8.94	4.27
Max Chl Dpth (ft)	12.8	Hydr. Depth (ft)	6.78	12.5	5.8
Conv. Total (cfs)	2298442	Conv. (cfs)	1400130	872912.2	25399.9
Length Wtd. (ft)	395.63	Wetted Per. (ft)	1359.33	265.17	36.67
Min Ch El (ft)	6947.39	Shear (lb/sq ft)	0.49	0.9	0.4
Alpha	1.24	Stream Power (lb/ft s)	2.51	8.03	1.69
Frctn Loss (ft)	0.37	Cum Volume (acre-ft)	978.01	825.47	36.33
C & E Loss (ft)	0.06	Cum SA (acres)	199.16	100.9	7.29

Plan: Reach #1	Reach #1 RS: 17	Profile: PF 1			
E.G. Elev (ft)	6960.29	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.52	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6959.76	Reach Len. (ft)	450	500	575
Crit W.S. (ft)		Flow Area (sq ft)	11192.08	3548.67	234.05
E.G. Slope (ft/ft)	0.000786	Area (sq ft)	11192.08	3548.67	234.05
Q Total (cfs)	78000	Flow (cfs)	49699.43	27433.15	867.42
Top Width (ft)	1854.83	Top Width (ft)	1552.36	265	37.47
Vel Total (ft/s)	5.21	Avg. Vel. (ft/s)	4.44	7.73	3.71
Max Chl Dpth (ft)	13.49	Hydr. Depth (ft)	7.21	13.39	6.25
Conv. Total (cfs)	2782549	Conv. (cfs)	1772963	978642.3	30944.1
Length Wtd. (ft)	471.23	Wetted Per. (ft)	1552.81	265.17	39.5
Min Ch El (ft)	6946.27	Shear (lb/sq ft)	0.35	0.66	0.29
Alpha	1.24	Stream Power (lb/ft s)	1.57	5.08	1.08
Frctn Loss (ft)	0.44	Cum Volume (acre-ft)	878.48	797.9	35.08
C & E Loss (ft)	0.03	Cum SA (acres)	184.95	98.77	7.08

Plan: Reach #1	Reach #1 RS: 16	Profile: PF 1			
E.G. Elev (ft)	6959.82	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.81	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6959.01	Reach Len. (ft)	425	500	575
Crit W.S. (ft)		Flow Area (sq ft)	8522.77	3627.22	245.28
E.G. Slope (ft/ft)	0.001114	Area (sq ft)	8522.77	3627.22	245.28
Q Total (cfs)	78000	Flow (cfs)	43024.19	33876.36	1099.45
Top Width (ft)	1570.74	Top Width (ft)	1267.38	265	38.36
Vel Total (ft/s)	6.29	Avg. Vel. (ft/s)	5.05	9.34	4.48
Max Chl Dpth (ft)	13.79	Hydr. Depth (ft)	6.72	13.69	6.39
Conv. Total (cfs)	2336977	Conv. (cfs)	1289058	1014978	32941
Length Wtd. (ft)	461.84	Wetted Per. (ft)	1267.46	265.17	40.44
Min Ch El (ft)	6945.22	Shear (lb/sq ft)	0.47	0.95	0.42
Alpha	1.32	Stream Power (lb/ft s)	2.36	8.88	1.89
Frctn Loss (ft)	0.61	Cum Volume (acre-ft)	776.65	756.72	31.91
C & E Loss (ft)	0.03	Cum SA (acres)	170.39	95.73	6.58

Plan: Reach #1	Reach #1 RS: 9	Profile: PF 1			
E.G. Elev (ft)	6952.27	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.91	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6950.36	Reach Len. (ft)	525	500	475
Crit W.S. (ft)		Flow Area (sq ft)	5411.66	2793.79	139.47
E.G. Slope (ft/ft)	0.003547	Area (sq ft)	5411.66	2793.79	139.47
Q Total (cfs)	78000	Flow (cfs)	37937.93	39137.97	924.11
Top Width (ft)	1465.9	Top Width (ft)	1171.97	265	28.93
Vel Total (ft/s)	9.35	Avg. Vel. (ft/s)	7.01	14.01	6.63
Max Chl Dpth (ft)	10.64	Hydr. Depth (ft)	4.62	10.54	4.82
Conv. Total (cfs)	1309741	Conv. (cfs)	637036.4	657186.9	15517.2
Length Wtd. (ft)	511.37	Wetted Per. (ft)	1172.11	265.17	30.49
Min Ch El (ft)	6939.72	Shear (lb/sq ft)	1.02	2.33	1.01
Alpha	1.41	Stream Power (lb/ft s)	7.17	32.68	6.71
Frctn Loss (ft)	1.86	Cum Volume (acre-ft)	255.83	504.05	17.02
C & E Loss (ft)	0.03	Cum SA (acres)	82.18	74.44	3.9

Plan: Reach #1	Reach #1 RS: 8	Profile: PF 1			
E.G. Elev (ft)	6950.38	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.22	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6948.15	Reach Len. (ft)	550	500	450
Crit W.S. (ft)		Flow Area (sq ft)	4487.67	2870.52	147.97
E.G. Slope (ft/ft)	0.003735	Area (sq ft)	4487.67	2870.52	147.97
Q Total (cfs)	78000	Flow (cfs)	34959.57	42014.3	1026.12
Top Width (ft)	1156.98	Top Width (ft)	862.19	265	29.8
Vel Total (ft/s)	10.39	Avg. Vel. (ft/s)	7.79	14.64	6.93
Max Chl Dpth (ft)	10.93	Hydr. Depth (ft)	5.2	10.83	4.97
Conv. Total (cfs)	1276363	Conv. (cfs)	572065.6	687506.6	16791.1
Length Wtd. (ft)	520.62	Wetted Per. (ft)	862.53	265.17	31.41
Min Ch El (ft)	6937.22	Shear (lb/sq ft)	1.21	2.52	1.1
Alpha	1.33	Stream Power (lb/ft s)	9.45	36.94	7.62
Frctn Loss (ft)	2.12	Cum Volume (acre-ft)	196.17	471.54	15.45
C & E Loss (ft)	0.04	Cum SA (acres)	69.92	71.4	3.58

Plan: Reach #1	Reach #1 RS: 7	Profile: PF 1			
E.G. Elev (ft)	6948.22	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.6	Wt. n-Val.	0.035	0.031	0.037
W.S. Elev (ft)	6945.62	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6945.62	Flow Area (sq ft)	4442.88	2860.95	147.05
E.G. Slope (ft/ft)	0.004467	Area (sq ft)	4442.88	2860.95	147.05
Q Total (cfs)	78000	Flow (cfs)	31514.46	45372.91	1112.63
Top Width (ft)	1418.75	Top Width (ft)	1124.03	265	29.72
Vel Total (ft/s)	10.47	Avg. Vel. (ft/s)	7.09	15.88	7.57
Max Chl Dpth (ft)	10.9	Hydr. Depth (ft)	3.95	10.8	4.95
Conv. Total (cfs)	1167042	Conv. (cfs)	471521.9	678873.3	16647.2
Length Wtd. (ft)	500	Wetted Per. (ft)	1124.09	265.17	31.32
Min Ch El (ft)	6934.72	Shear (lb/sq ft)	1.1	3.01	1.31
Alpha	1.53	Stream Power (lb/ft s)	7.82	47.72	9.91
Frctn Loss (ft)	2	Cum Volume (acre-ft)	139.79	438.65	13.93
C & E Loss (ft)	0.01	Cum SA (acres)	57.38	68.35	3.28

Plan: Reach #1	Reach #1 RS: 0	Profile: PF 1			
E.G. Elev (ft)	6917.2	Element	Left OB	Channel	Right OB
Vel Head (ft)	6.64	Wt. n-Val.	0.035	0.03	0.039
W.S. Elev (ft)	6910.56	Reach Len. (ft)	500	400	350
Crit W.S. (ft)	6912.56	Flow Area (sq ft)	146.31	3641.98	49.8
E.G. Slope (ft/ft)	0.014967	Area (sq ft)	146.31	3641.98	49.8
Q Total (cfs)	78000	Flow (cfs)	1535	76037.69	427.31
Top Width (ft)	647.74	Top Width (ft)	49.99	565	32.74
Vel Total (ft/s)	20.32	Avg. Vel. (ft/s)	10.49	20.88	8.58
Max Chl Dpth (ft)	6.49	Hydr. Depth (ft)	2.93	6.45	1.52
Conv. Total (cfs)	637567.3	Conv. (cfs)	12547	621527.4	3492.8
Length Wtd. (ft)	401.44	Wetted Per. (ft)	50.96	565.01	33.55
Min Ch El (ft)	6904.07	Shear (lb/sq ft)	2.68	6.02	1.39
Alpha	1.04	Stream Power (lb/ft s)	28.14	125.75	11.9
Frctn Loss (ft)	2.24	Cum Volume (acre-ft)	4.48	227.68	1.02
C & E Loss (ft)	1.26	Cum SA (acres)	1.34	47.36	0.56

Plan: Reach #1	Reach #1 RS: -1	Profile: PF 1			
E.G. Elev (ft)	6909.86	Element	Left OB	Channel	Right OB
Vel Head (ft)	5.11	Wt. n-Val.	0.035	0.03	0.035
W.S. Elev (ft)	6904.74	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6906.18	Flow Area (sq ft)	78.65	4219.34	16.06
E.G. Slope (ft/ft)	0.019846	Area (sq ft)	78.65	4219.34	16.06
Q Total (cfs)	78000	Flow (cfs)	996.28	76874.96	128.76
Top Width (ft)	1034.64	Top Width (ft)	24.82	1000	9.82
Vel Total (ft/s)	18.08	Avg. Vel. (ft/s)	12.67	18.22	8.02
Max Chl Dpth (ft)	4.27	Hydr. Depth (ft)	3.17	4.22	1.64
Conv. Total (cfs)	553677.8	Conv. (cfs)	7072	545691.8	914
Length Wtd. (ft)	500	Wetted Per. (ft)	25.51	1000.01	10.35
Min Ch El (ft)	6900.47	Shear (lb/sq ft)	3.82	5.23	1.92
Alpha	1.01	Stream Power (lb/ft s)	48.38	95.25	15.41
Frctn Loss (ft)	6.88	Cum Volume (acre-ft)	3.19	191.58	0.76
C & E Loss (ft)	0.46	Cum SA (acres)	0.91	40.17	0.39

Plan: Reach #1	Reach #1 RS: -2	Profile: PF 1			
E.G. Elev (ft)	6903.57	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.52	Wt. n-Val.	0.035	0.03	0.035
W.S. Elev (ft)	6901.05	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6901.07	Flow Area (sq ft)	99.59	6019.94	24.94
E.G. Slope (ft/ft)	0.007763	Area (sq ft)	99.59	6019.94	24.94
Q Total (cfs)	78000	Flow (cfs)	866.82	76988.4	144.78
Top Width (ft)	1239.47	Top Width (ft)	27.24	1200	12.23
Vel Total (ft/s)	12.69	Avg. Vel. (ft/s)	8.7	12.79	5.81
Max Chl Dpth (ft)	5.08	Hydr. Depth (ft)	3.66	5.02	2.04
Conv. Total (cfs)	885268.2	Conv. (cfs)	9838.1	873786.9	1643.2
Length Wtd. (ft)	500	Wetted Per. (ft)	28.06	1200	12.89
Min Ch El (ft)	6895.97	Shear (lb/sq ft)	1.72	2.43	0.94
Alpha	1.01	Stream Power (lb/ft s)	14.97	31.09	5.44
Frctn Loss (ft)	3.87	Cum Volume (acre-ft)	2.17	132.82	0.52
C & E Loss (ft)	0	Cum SA (acres)	0.61	27.55	0.27

Plan: Reach #1	Reach #1 RS: 15	Profile: PF 1			
E.G. Elev (ft)	6959.18	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.11	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6958.08	Reach Len. (ft)	500	500	500
Crit W.S. (ft)		Flow Area (sq ft)	7497.27	3512.45	228.95
E.G. Slope (ft/ft)	0.001573	Area (sq ft)	7497.27	3512.45	228.95
Q Total (cfs)	78000	Flow (cfs)	38646.73	38161.34	1191.93
Top Width (ft)	1701.92	Top Width (ft)	1399.86	265	37.06
Vel Total (ft/s)	6.94	Avg. Vel. (ft/s)	5.15	10.86	5.21
Max Chl Dpth (ft)	13.35	Hydr. Depth (ft)	5.36	13.25	6.18
Conv. Total (cfs)	1966416	Conv. (cfs)	974301.8	962064.8	30049.2
Length Wtd. (ft)	500	Wetted Per. (ft)	1399.94	265.17	39.07
Min Ch El (ft)	6944.72	Shear (lb/sq ft)	0.53	1.3	0.58
Alpha	1.48	Stream Power (lb/ft s)	2.71	14.14	3
Frctn Loss (ft)	0.88	Cum Volume (acre-ft)	698.5	715.74	28.78
C & E Loss (ft)	0.03	Cum SA (acres)	157.38	92.69	6.08

Plan: Reach #1	Reach #1 RS: 14	Profile: PF 1			
E.G. Elev (ft)	6958.28	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.37	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6956.91	Reach Len. (ft)	500	500	500
Crit W.S. (ft)		Flow Area (sq ft)	6090.58	3335.82	204.91
E.G. Slope (ft/ft)	0.00197	Area (sq ft)	6090.58	3335.82	204.91
Q Total (cfs)	78000	Flow (cfs)	37668.52	39181.24	1150.24
Top Width (ft)	1324.1	Top Width (ft)	1024.03	265	35.06
Vel Total (ft/s)	8.1	Avg. Vel. (ft/s)	6.18	11.75	5.61
Max Chl Dpth (ft)	12.69	Hydr. Depth (ft)	5.95	12.59	5.84
Conv. Total (cfs)	1757568	Conv. (cfs)	848782	882868	25918.2
Length Wtd. (ft)	500	Wetted Per. (ft)	1024.1	265.17	36.96
Min Ch El (ft)	6944.22	Shear (lb/sq ft)	0.73	1.55	0.68
Alpha	1.35	Stream Power (lb/ft s)	4.52	18.17	3.83
Frctn Loss (ft)	0.99	Cum Volume (acre-ft)	620.51	676.44	26.29
C & E Loss (ft)	0.02	Cum SA (acres)	143.47	89.65	5.67

Plan: Reach #1	Reach #1 RS: 13	Profile: PF 1			
E.G. Elev (ft)	6957.27	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.32	Wt. n-Val.	0.035	0.03	0.037
W.S. Elev (ft)	6955.95	Reach Len. (ft)	500	500	500
Crit W.S. (ft)		Flow Area (sq ft)	6139.54	3215.23	189.23
E.G. Slope (ft/ft)	0.001988	Area (sq ft)	6139.54	3215.23	189.23
Q Total (cfs)	78000	Flow (cfs)	39937.71	37023.04	1039.25
Top Width (ft)	1262.35	Top Width (ft)	963.66	265	33.69
Vel Total (ft/s)	8.17	Avg. Vel. (ft/s)	6.51	11.51	5.49
Max Chl Dpth (ft)	12.23	Hydr. Depth (ft)	6.37	12.13	5.62
Conv. Total (cfs)	1749416	Conv. (cfs)	895739.5	830368.1	23308.7
Length Wtd. (ft)	500	Wetted Per. (ft)	963.73	265.17	35.52
Min Ch El (ft)	6943.72	Shear (lb/sq ft)	0.79	1.5	0.66
Alpha	1.27	Stream Power (lb/ft s)	5.14	17.33	3.63
Frctn Loss (ft)	0.98	Cum Volume (acre-ft)	550.32	638.84	24.03
C & E Loss (ft)	0.04	Cum SA (acres)	132.06	86.6	5.27

Plan: Reach #1	Reach #1 RS: 6	Profile: PF 1			
E.G. Elev (ft)	6945.44	Element	Left OB	Channel	Right OB
Vel Head (ft)	4.19	Wt. n-Val.	0.035	0.032	0.039
W.S. Elev (ft)	6941.25	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6942.48	Flow Area (sq ft)	2974.2	3027.48	166.35
E.G. Slope (ft/ft)	0.006179	Area (sq ft)	2974.2	3027.48	166.35
Q Total (cfs)	78000	Flow (cfs)	19681.9	56881.13	1436.97
Top Width (ft)	1361.65	Top Width (ft)	1065.04	265	31.61
Vel Total (ft/s)	12.65	Avg. Vel. (ft/s)	6.62	18.79	8.64
Max Chl Dpth (ft)	11.52	Hydr. Depth (ft)	2.79	11.42	5.26
Conv. Total (cfs)	992248.5	Conv. (cfs)	250376	723592.6	18279.9
Length Wtd. (ft)	500	Wetted Per. (ft)	1065.19	265.17	33.32
Min Ch El (ft)	6929.72	Shear (lb/sq ft)	1.08	4.4	1.93
Alpha	1.69	Stream Power (lb/ft s)	7.13	82.75	16.64
Frctn Loss (ft)	2.63	Cum Volume (acre-ft)	97.22	404.85	12.13
C & E Loss (ft)	0.16	Cum SA (acres)	44.82	65.31	2.92

Plan: Reach #1	Reach #1 RS: 5	Profile: PF 1			
E.G. Elev (ft)	6941.78	Element	Left OB	Channel	Right OB
Vel Head (ft)	5.72	Wt. n-Val.	0.035	0.032	0.039
W.S. Elev (ft)	6936.06	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6937.97	Flow Area (sq ft)	2182.82	2978.31	160.31
E.G. Slope (ft/ft)	0.007986	Area (sq ft)	2182.82	2978.31	160.31
Q Total (cfs)	78000	Flow (cfs)	13522	62922.46	1555.54
Top Width (ft)	1341.31	Top Width (ft)	1045.3	265	31.01
Vel Total (ft/s)	14.66	Avg. Vel. (ft/s)	6.19	21.13	9.7
Max Chl Dpth (ft)	11.34	Hydr. Depth (ft)	2.09	11.24	5.17
Conv. Total (cfs)	872832	Conv. (cfs)	151313.2	704112.1	17406.7
Length Wtd. (ft)	500	Wetted Per. (ft)	1046.22	265.17	32.69
Min Ch El (ft)	6924.72	Shear (lb/sq ft)	1.04	5.6	2.44
Alpha	1.72	Stream Power (lb/ft s)	6.44	118.3	23.73
Frctn Loss (ft)	3.5	Cum Volume (acre-ft)	67.63	370.38	10.26
C & E Loss (ft)	0.15	Cum SA (acres)	32.7	62.27	2.56

Plan: Reach #1	Reach #1 RS: 4	Profile: PF 1			
E.G. Elev (ft)	6937.37	Element	Left OB	Channel	Right OB
Vel Head (ft)	6.64	Wt. n-Val.	0.035	0.032	0.039
W.S. Elev (ft)	6930.73	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6932.82	Flow Area (sq ft)	1761.83	2891.36	150.32
E.G. Slope (ft/ft)	0.009374	Area (sq ft)	1761.83	2891.36	150.32
Q Total (cfs)	78000	Flow (cfs)	11567.96	64885.32	1546.72
Top Width (ft)	1166.58	Top Width (ft)	871.55	265	30.03
Vel Total (ft/s)	16.24	Avg. Vel. (ft/s)	6.57	22.44	10.29
Max Chl Dpth (ft)	11.01	Hydr. Depth (ft)	2.02	10.91	5.01
Conv. Total (cfs)	805643.5	Conv. (cfs)	119482.7	670185.1	15975.7
Length Wtd. (ft)	500	Wetted Per. (ft)	872.66	265.17	31.66
Min Ch El (ft)	6919.72	Shear (lb/sq ft)	1.18	6.38	2.78
Alpha	1.62	Stream Power (lb/ft s)	7.76	143.19	28.59
Frctn Loss (ft)	4.32	Cum Volume (acre-ft)	44.99	336.7	8.47
C & E Loss (ft)	0.09	Cum SA (acres)	21.7	59.23	2.21

Plan: Reach #1	Reach #1 RS: -3	Profile: PF 1			
E.G. Elev (ft)	6899.13	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.97	Wt. n-Val.	0.035	0.03	0.035
W.S. Elev (ft)	6896.16	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6896.55	Flow Area (sq ft)	89.2	5550.02	20.38
E.G. Slope (ft/ft)	0.010188	Area (sq ft)	89.2	5550.02	20.38
Q Total (cfs)	78000	Flow (cfs)	851.46	77021.81	126.72
Top Width (ft)	1237.13	Top Width (ft)	26.07	1200	11.06
Vel Total (ft/s)	13.78	Avg. Vel. (ft/s)	9.55	13.88	6.22
Max Chl Dpth (ft)	4.69	Hydr. Depth (ft)	3.42	4.63	1.84
Conv. Total (cfs)	772781.7	Conv. (cfs)	8435.8	763090.4	1255.5
Length Wtd. (ft)	500	Wetted Per. (ft)	26.83	1200	11.66
Min Ch El (ft)	6891.47	Shear (lb/sq ft)	2.11	2.94	1.11
Alpha	1.01	Stream Power (lb/ft s)	20.19	40.82	6.91
Frctn Loss (ft)	4.4	Cum Volume (acre-ft)	1.08	66.42	0.26
C & E Loss (ft)	0.05	Cum SA (acres)	0.31	13.77	0.13

Plan: Reach #1	Reach #1 RS: -4	Profile: PF 1			
E.G. Elev (ft)	6894.57	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.52	Wt. n-Val.	0.035	0.03	0.035
W.S. Elev (ft)	6892.05	Reach Len. (ft)			
Crit W.S. (ft)	6892.06	Flow Area (sq ft)	99.64	6022.28	24.97
E.G. Slope (ft/ft)	0.007753	Area (sq ft)	99.64	6022.28	24.97
Q Total (cfs)	78000	Flow (cfs)	866.88	76988.21	144.91
Top Width (ft)	1239.48	Top Width (ft)	27.24	1200	12.24
Vel Total (ft/s)	12.69	Avg. Vel. (ft/s)	8.7	12.78	5.8
Max Chl Dpth (ft)	5.08	Hydr. Depth (ft)	3.68	5.02	2.04
Conv. Total (cfs)	885844.9	Conv. (cfs)	9845.2	874354	1645.7
Length Wtd. (ft)		Wetted Per. (ft)	28.06	1200	12.9
Min Ch El (ft)	6888.97	Shear (lb/sq ft)	1.72	2.43	0.94
Alpha	1.01	Stream Power (lb/ft s)	14.95	31.05	5.44
Frctn Loss (ft)	4.42	Cum Volume (acre-ft)			
C & E Loss (ft)	0.14	Cum SA (acres)			

Appendix E.4..... Erosional Soil Loss Technical Evaluation Report

Prediction of Erosional Soil Loss and Land Surface Protection Measures

Ambrosia Lake Facility
Rio Algom Mining LLC
Grants, New Mexico

Prepared by Curtis O. Sealy
Maxim Technologies
Albuquerque, NM

July 2005

PREDICTION
OF
EROSIONAL SOIL LOSS
AND
LAND SURFACE PROTECTION MEASURES

Ambrosia Lake Facility

Rio Algom Mining Company, LLC

Grants, New Mexico

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July 2005

Introduction

This engineering report has been prepared by Maxim Technologies (Maxim) for Rio Algom Mining Company, LLC., to evaluate the long term erosion potential for general areas at the Ambrosia Lake facility near Grants, New Mexico. The purpose was to use standard methodologies to predict soil loss potential in reclaimed areas beyond the existing reclaimed tailing ponds that could be affected by runoff and run-on from periodic and long term storm events. In addition, the erosion potential of the land surface of reclaimed holding ponds 4, 5 and 6 were evaluated both for short term periodic storm events and from a PMP event.

The following paragraphs present the accepted methodologies for predicting soil loss and present recommendations for achieving stable reclamation covers and land surfaces at the facility.

Soil Loss Prediction Methodologies

Several methodologies exist that are useful to predict erosion potential of reclamation covers and surrounding land surfaces. Agricultural erosion has been studied for many years resulting in the development of prediction algorithms and control procedures. Because soil erosion and sedimentation from construction and mining activities are similar, the procedures and algorithms developed are useful in predicting soil erosion from these activities.

Maxim utilized two industry accepted methods for predicting soil erosion loss at the Ambrosia Lake Facility which are presented in NUREG Documents CR-3199, CR-4620 and 1623. The methods are described as follows:

Universal Soil Loss Equation

The principal controlling factors affecting the erosional processes in the Universal Soil Loss Equation model are:

- Soil particle size, density and moisture control
- Surface roughness
- Slope angle and slope length
- Vegetation/surface protection
- Climatic Variables

Both the short and long term erosional stability of slopes at this facility can be evaluated with respect to the aforementioned variables by use of the Universal Soil Loss Equation model.

The USLE was primarily developed for agricultural purposes but has been modified to accommodate mining and construction activities in the Western United States by the Utah Water Research Laboratory. The resulting modified method (MUSLE) is a mathematical model based on coefficients determined in the field and provides the most rational approach to evaluating the potential for long term erosion on bare or vegetated land surfaces.

The modified Universal Soil Loss Equation (MUSLE) is defined as follows:

$$A=R*K*(LS)*(VM) \qquad \text{Equation 1.1}$$

Where,

A = the computed loss per unit area in tons per calculated area units per year with the units selected for K and R properly selected:

R = the rainfall factor which is the number for rainfall erosion index units plus a factor for snowmelt, if applicable:

K = the soil erodibility factor, which is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot that is defined as a 72.6 ft length of uniform 9% slope continuously maintained as clean tilled fallow:

LS = the topographic factor, which is the ratio of soil loss from the field slope length to that from a 72.6 ft length under otherwise identical conditions:

VM = the dimensionless erosion control factor relating to vegetative and mechanical factors. This factor replaces the cover management factor (C) and the support factor (P) of the original USLE.

The Rainfall and Runoff Factor (R)

The R factor is described in terms of a rainfall storm energy (E) and the maximum 30-minute rainfall intensity (I_{30}). Generalized R factors applicable to the interior western United States are given in Table 1.1.

Table 1.1 Generalized Rainfall and Runoff (R) Values

State	Eastern Third	Central Third	Western Third
N. Dakota	50-75	40-50	40
S. Dakota	75-100	50	40
Montana	30-40	20	20-50
Wyoming	30-50	15-30	15-25
Colorado	75-100	40-50	20-40
Utah	20-30	20-50	15-40
New Mexico	75-100	40-50	20-40
Arizona	20-50	20-50	25-40

Source: NUREG CR-4620

The Soil Erodibility Factor (K)

The soil erodibility factor (K) recognized the fact that the erodibility potential of a given soil is dependent on its compositional makeup, which in turn reflects the grain size distribution of the soil. To predict soil erodibility, five soil characteristics that include the percent silt and fine sand, percent sand greater that 0.2 mm, percent organic material, general soil structure and general permeability are determined. The K factor is then found by using the Wischmeier nomograph presented in Figure 1.1.

The Topographic Factor (LS)

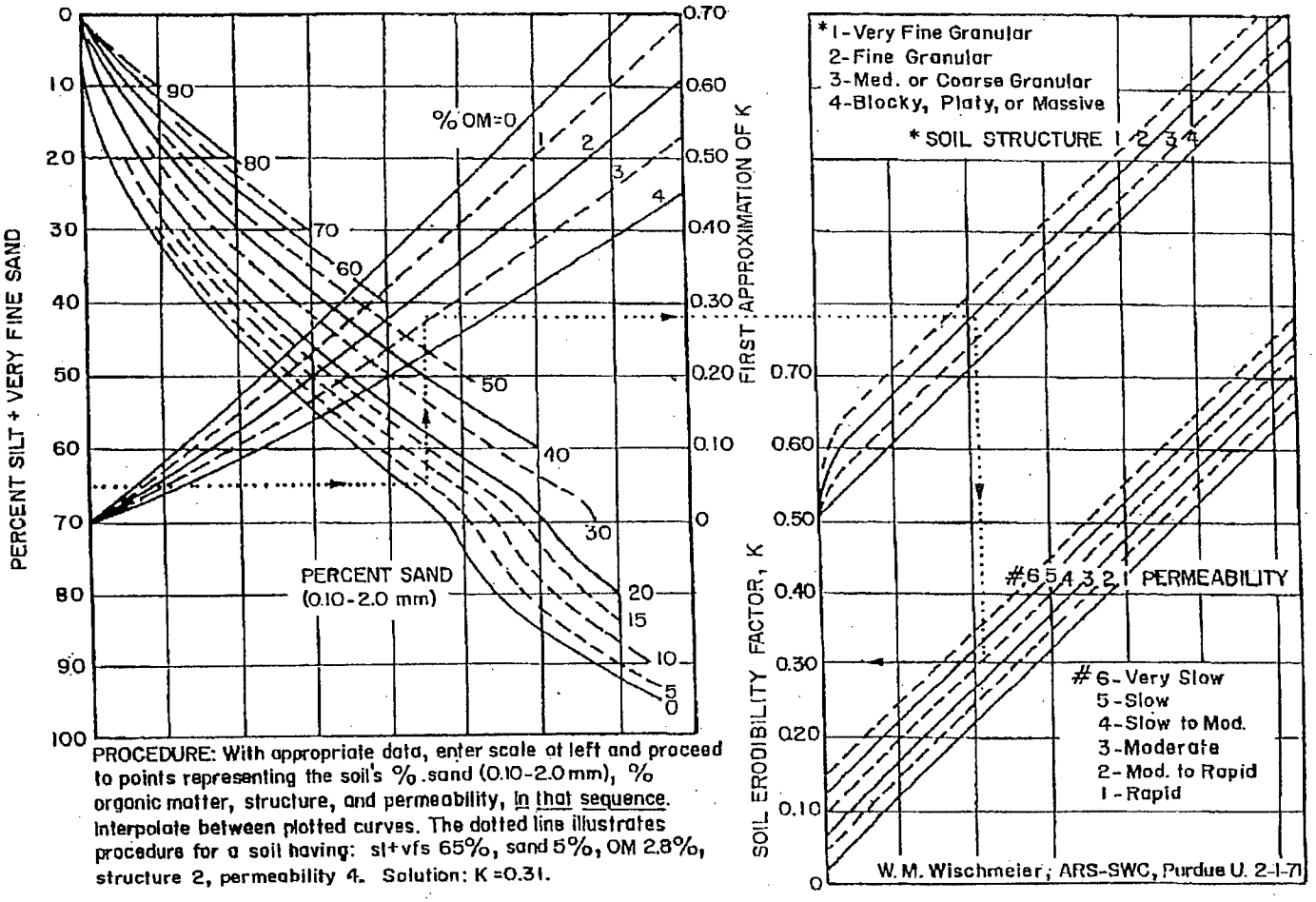
Although the effects of both length and steepness of slope have been investigated separately in different research efforts, it is more convenient for analytical purposes to combine the two into one topographic factor, LS. Wischmeier and Smith (1978) developed plots correlating the topographic factor for slopes up to 500 meters in length at slope inclinations from 0.5% to 50%.

The equation to determine the LS factor is as follows:

$$LS = \frac{650 + 450 + 65s2}{10{,}000 + s2} \quad \frac{L}{72.6} \quad M \qquad \text{Equation 1.2}$$

where LS = topographic factor

L = slope length in feet



PROCEDURE: With appropriate data, enter scale at left and proceed to points representing the soil's % sand (0.10-2.0 mm), % organic matter, structure, and permeability, in that sequence. Interpolate between plotted curves. The dotted line illustrates procedure for a soil having: si+vfs 65%, sand 5%, OM 2.8%, structure 2, permeability 4. Solution: K=0.31.

Fig. 1.1 Nomograph for determining soil erodibility factor *K*. *Source:* after Wischmeier et al., 1971.

S = slope steepness in percent

M = exponent dependent upon slope steepness

The slope dependent exponent m is presented in Table 1.2

Table 1.2 Slope Dependent Exponent

Slope	m
$s \leq 1.0$	0.2
$1.0 < s \leq 3.0$	0.3
$3.0 < s \leq 5.0$	0.4
$5.0 < s \leq 10.0$	0.5
$s > 10.0$	0.6

The VM Factor

The VM factor is the erosion control factor applied in place of the cover and erosion control factors found in the USLE. The erosion control factor accounts for measures implemented at the construction site to include vegetation, mulching, chemical treatments and sprayed emulsions to impede or reduce erosion due to the overland flow of water. Values of the VM factor relative to site-specific conditions are presented in Table 1.3 The VM factor is perhaps the most sensitive factor to effect the computed erosion loss for a given site. As shown by the values presented on Table 1.3, the development of a permanent vegetative cover can have a significant impact in reducing the computed erosion loss.

Permissible Velocity Approach

The erosion potential of a soil cover or land surface can be evaluated by determining the properties of the soils and specifying a velocity criterion that will not erode the cover or land surface and will prevent scour. Studies by the U.S. Army Corps of Engineers, Universities and other organizations have developed permissible velocities for various soil types obtained from experimental studies which provide a conservative estimate for evaluating erosion potential of soil for the long term. These permissible velocity values are summarized in NUREG CR-4620 and are presented in Tables 1.4 through 1.6.

Table 4.3 Typical VM Factor Values Reported in the Literature.[a]

Condition	VM Factor
1. Bare soil conditions	
freshly disked to 6-8 inches	1.00
after one rain	0.89
loose to 12 inches smooth	0.90
loose to 12 inches rough	0.80
compacted bulldozer scraped up and down	1.30
same except root raked	1.20
compacted bulldozer scraped across slope	1.20
same except root raked across	0.90
rough irregular tracked all directions	0.90
seed and fertilizer, fresh	0.64
same after six months	0.54
seed, fertilizer, and 12 months chemical	0.38
not tilled algae crusted	0.01
tilled algae crusted	0.02
compacted fill	1.24 - 1.71
undisturbed except scraped	0.66 - 1.30
scarified only	0.76 - 1.31
sawdust 2 inches deep, disked in	0.61
2. Asphalt emulsion on bare soil	
1250 gallons/acre	0.02
1210 gallons/acre	0.01 - 0.019
605 gallons/acre	0.14 - 0.57
302 gallons/acre	0.28 - 0.60
151 gallons/acre	0.65 - 0.70
3. Dust binder	
605 gallons/acre	1.05
1210 gallons/acre	0.29 - 0.78
4. Other chemicals	
1000 lb. fiber Glass Roving with 60-150 gallons asphalt emulsion/acre	0.01 - 0.05
Aquatain	0.68
Aerospray 70, 10 percent cover	0.94
Curasol AE	0.30 - 0.48
Petroset SB	0.40 - 0.66
PVA	0.71 - 0.90
Terra-Tack	0.66
Wood fiber slurry, 1000 lb/acre fresh[b]	0.05
Wood fiber slurry, 1400 lb/acre fresh[b]	0.01 - 0.02
Wood fiber slurry, 3500 lb/acre fresh[b]	0.10
5. Seedings	
temporary, 0 to 60 days	0.40
temporary, after 60 days	0.05
permanent, 0 to 60 days	0.40
permanent, 2 to 12 months	0.05
permanent, after 12 months	0.01
6. Brush	
7. Excelsior blanket with plastic net	0.04 - 0.10

[a]Note the variation in values of VM factors reported by different researchers for the same measures. References containing details of research which produced these VM values are included in NCHRP Project 16-3 report, "Erosion Control During Highway Construction. Vol. III. Bibliography of Water and Wind Erosion Control References," Transportation Research Board, 2101 Constitution Avenue, Washington, DC 20418.

[b]This material is commonly referred to as hydromulch.

Table 1.4 Maximum permissible velocities in erodible channels

Channel Material	Water Transporting Colloidal Silts Velocity v (ft/sec)
Fine sand, colloidal	2.50
Sandy loam, non-colloidal	2.50
Silty loam, non-colloidal	3.00
Alluvial silts, non-colloidal	3.50
Firm loam	3.50
Volcanic ash	3.50
Stiff clay, colloidal	5.00
Alluvial silts, colloidal	5.00
Shales and hardpans	6.00
Fine Gravel	5.00
Graded loam to cobbles, non-colloidal	5.00
Graded Silts to cobble, colloidal	5.50
Coarse gravel, non-colloidal	6.00
Cobbles and shingles	5.50

Source: NUREG CR-4620

Table 1.5 Maximum allowable velocities in sand-based material

	Velocity (ft/sec)
Very light sand of quicksand character	0.75 to 1.00
Very light loose sand	1.00 to 1.50
Coarse sand to light sandy soil	1.50 to 2.00
Sandy soil	2.00 to 2.50
Sandy loam	2.50 to 2.75
Average loam, alluvial soil, volcanic ash	2.75 to 3.00
Firm loam, clay loam	3.00 to 3.75
Stiff clay soil, gravel soil	4.00 to 5.00
Coarse gravel, cobbles and shingles	5.00 to 6.00
Conglomerate, cemented gravel, soft slate, Tough hardpan, soft sedimentary rock	6.00 to 8.00

Source: NUREG CR-4620

Table 1.6 Limiting velocities in cohesive materials

	Compactness of Bed			
	Loose	Fairly Compact	Compact	Very Compact
Principle Cohesive Material	Velocity (ft/sec)	Velocity (ft/sec)	Velocity (ft/sec)	Velocity (ft/sec)
Sandy clay	1.48	2.95	4.26	5.90
Heavy clayey soils	1.31	2.79	4.10	5.58
Clays	1.15	2.62	3.94	5.41
Lean clayey soils	1.05	2.30	3.44	4.43

Source: NUREG CR-4620

Recommendations

General

The surface soils at the Ambrosia Lake facility consist of alluvium/colluvium which classify primarily as very silty sands to sandy silts in the Unified Soil Classification system. The types of soils are easily erodible under storm runoff events.

Prediction of soil loss by the Modified Universal Soil Loss equation shows that unvegetated soils at this site will be relatively stable for slopes generally less than one percent and not exceeding 200 feet. Predicted soil loss for this gradient and length is on the order of one foot per 1000 years. Unvegetated slopes steeper than one percent even for short distances will experience an unacceptable erosion rate. (See Results of MUSLE Analysis in Tables A-1 and A-2 in the appendix.)

Soil surfaces that are sparingly to moderately vegetated will be stable at slopes up to 3 percent. Vegetated slopes at 3 percent will generally be stable up to a distance approaching 1000 feet.

Using the "Allowable Velocity Approach" the surface soils at this facility will erode at runoff velocities approaching or exceeding 2.5 ft/sec. This criterion is more conservative than the MUSLE model and is recommended to evaluate surface stability in sensitive areas and from significant storm events.

Stability of Land Surface (Reclaimed Ponds 4, 5 & 6)

Ponds 4,5 & 6 are considered to be in a sensitive area because of the proximity to the Arroyo del Puerto, and the need to apply alternative release criteria to this area. The MUSLE model shows that a moderately vegetated surface will under go about 1/3 foot of soil loss over a 1000 year period. Calculations of runoff from a PMP event (see appendix) show that the runoff velocity will be on the order of 2.6 feet/sec and the flow depth will be on the order of 0.4 foot. Considering the above, it is recommended that a

rock mulch be placed over the existing reclaimed surface of Ponds 4, 5 & 6. The rock should have a median stone diameter D_{50} of 0.5 inch or larger. The stone should have a minimum thickness of 1.0 inch. This will more than adequately protect the land surface in this area from the runoff originating from a PMP event.

Stability of Land Surface (Ponds 7 & 8)

The area of encompassing Ponds 7 and 8 and surrounding land is sparsely to moderately vegetated. For this area it is recommended that a gravel mulch be placed on slopes exceeding one percent. The gravel should have a median stone diameter (D_{50}) of 0.5 inch. The gravel may be placed in a thin layer as practicably achievable. The stone may be placed directly on the established grasses and around shrubs. The placement of this gravel mulch will enhance soil moisture retention, further promote re-establishment of the vegetative cover and enhance infiltration. Runoff velocities from storm events will also be reduced, further enhancing the stability of the land surface.

Selected References

Johnson, T. L., 1998, Design of Erosion Protection for Long-Term Stabilization. Draft Report for Comment, NUREG-1623. U.S. Nuclear Regulatory Commission, Washington, D.C.

Nelson, J. D., S. R. Abt, R. L. Volpe, D. van Zyl, N. E. Hinkle, W. R. Staub, 1986, Methodologies for Evaluating Long-Term Stabilization Designs for Uranium Mill Tailings Impoundments. NUREG/CR-4620, U. S. Nuclear Regulatory Commission, Washington, D. C.

Voorhees, L. D., M. J. Sale, J. W. Webb, P. J. Mulholland, 1983, Guidance for Disposal of Uranium Mill Tailings: Long-Term Stabilization of Earthen Cover materials, NUREG/CR-3199, U. S. Nuclear Regulatory Commission, Washington, D. C.

Appendix

Calculations

Figure A-1 **MODIFIED UNIVERSAL SOIL LOSS EQUATION (MUSLE)**

INPUT		COMPUTED RESULTS	
SLOPE LENGTH (FEET)	200	TOPOGRAPHIC FACTOR	0.35
SLOPE (%)	3.00		
RAIN FALL EROSIVITY FACTOR-R	30	AVERAGE ANNUAL SOIL L	1.44
SOIL ERODIBILITY FACTOR-K	0.55	(TONS/ACRE/YEAR)	
VEG MANAGEMENT FACTOR-(VM)	0.25		
SOIL DENSITY (PCF)	105	LOSS IN DEPTH (FT/1000 YEARS)	0.63

REFERENCE NUREG/CR-4620

Table A-1
Results of MUSLE Analysis
Predicted Soil Loss Measured in Feet/1000 years
On
Bare Land Surfaces
Ambrosia Lake Facility
Rio Algom Company, LLC

Slope Length (feet)

Slope Percent	50	100	200	500	1000	2000
3	1.67	2.05	2.52	3.32	4.09	5.04
2	1.17	1.44	1.77	2.33	2.87	3.53
1	0.78	0.90	1.03	1.24	1.42	1.53

Note: All values reported in chart are in feet/1000 years

Table A-2
Results of MUSLE Analysis
Predicted Soil Loss Measured in Feet/1000 Years
On
Vegetated Land Surfaces
Ambrosia Lake Facility
Rio Algom Company, LLC

Slope Length (feet)

Slope Percent	50	100	200	500	1000	2000
3	0.42	0.51	0.63	0.83	1.02	1.26
2	0.29	0.36	0.44	0.58	0.72	0.88
1	0.19	0.22	0.26	0.31	0.35	0.41

MAXIM TECHNOLOGIES A DIVISION OF TETRA TECH, INC.

BY C SEALY DATE 7-5-05

JOB TITLE Rio Algom JOB NUMBER

SUBJECT PMP Hydrology - Ponds 4, 5 & 6 SHEET 1/2

FOR Drainage AREA

MAX Length = 1780

Avg Slope = 0.66% OR 0.006

DETERMINE T_c (Time of Conc)

$$T_c = 0.0013 \frac{L^{0.77}}{S^{0.385}}$$

$$T_c = 0.0013 \frac{(1780)^{0.77}}{(0.0066)^{0.385}} = 0.286 \text{ HRS OR } 17.15 \text{ MIN.}$$

Calculate % of 1-HR PMP

Table 2.1 NUREG 4620

DURATION (MIN)	% 1-HR PMP
15	74
17.15	? → 77.4 %
20	82

PMP RAINFALL Depth = (0.774)(9.4) = 7.3 inches

Rainfall Intensity

$$i = \frac{(7.3)(60)}{17.15} = 25.5 \text{ inches/HR}$$

Fig A-2

MAXIM TECHNOLOGIES
A DIVISION OF TETRA TECH, INC.

BY C. SEALY DATE 7-5-05

JOB TITLE Rio Algom JOB NUMBER

SUBJECT PMP Hydrology SHEET 2/2

Peak Sheet Flow Unit Discharge

Rational Formula $Q = CIA$

$q_{soil} = Q/ft = (1.0)(25.5)\left(\frac{1780}{43,560}\right) = 1.04$ cfs/ft

Calc Sheet Flow Velocity

$y = \text{Flow Depth} = \left[\frac{(1.04)(.025)}{(1.486)(0.0066)^{1/2}}\right]^{3/5} = 0.4$ foot

$V_{design\ (soil\ surface)} = Q/A = \frac{1.04}{0.4} = 2.6$ ft/sec > 2.5 ft/sec

∴ Surface Protection from Runoff Required

Safety Factors Method - See Attached Spreadsheet = Fig A-4

$D_{50} \sim 1/2$ inch S.F. = 1.16 ∴ OK

NUREG 1623 Sect D-8 Abt & Johnson Method

$Q_{Rock} = Q_{soil} \times 0.8 = 1.04 \times 0.8 = 0.83$ cfs

$D_{50} = (5.23)(0.0066)^{0.43}(0.83)^{.56}$

$D_{50} = (5.23)(.1155)(0.90) = 0.54$ inch

Use $D_{50} \sim 0.5$

Fig A-3

Figure A-2

Project: Rio Algom-Ambrosia Lake		Date	7/5/05
Location: Ponds 4,5,& 6			

RIPRAP DESIGN-SAFETY FACTORS METHOD
FLOW OVER A PLANE SLOPING BED

INPUT		**COMPUTED RESULTS**	
Median Rock Diameter-(D-50)-ft	0.04		
Flow Depth-Ft	0.40	**Design Shear-Psf**	**0.16**
Bed Slope- Ft/Ft	0.007		
Angle of repose-Rock-Degrees	40.00	**Safety Factor**	**1.16**
Unit Weight-Rock-Pcf	160.00		

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