Appendix A ..... NRC Technical Evaluation Reports

United States Nuclear Regulatory Commission

Technical Evaluation Report
Evaluation of Erosion Protection for Ponds 1 and 3
At the Ambrosia Lake Mill site
Source Materials License, SUA-1473
Docket 40-8905
TAC No. L 52431
November 27, 2002

Technical Evaluation Report
Migration of the Arroyo del Puerto
At the Ambrosia Lake Uranium Mill Tailings Facility
Source Materials License, SUA-1473
Docket 40-8905
TAC No. LU 0056
October 5, 2004

Appendix A

NRC Technical Evaluation Reports

United States Nuclear Regulatory Commission

Technical Evaluation Report
Evaluation of Erosion Protection for Ponds 1 and 3
At the Ambrosia Lake Mill site
Source Materials License, SUA-1473
Docket 40-8905
TAC No. L 52431
November 27, 2002

Technical Evaluation Report
Migration of the Arroyo del Puerto
At the Ambrosia Lake Uranium Mill Tailings Facility
Source Materials License, SUA-1473
Docket 40-8905
TAC No. LU 0056
October 5, 2004

NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 27, 2002

Mr. William Paul Goranson, Manager
Radiation Safety, Licensing and
Regulatory Compliance
Rio Algom Mining LLC
6305 Waterford Blvd., Suite 400
Oklahoma City, OK 73118

SUBJECT: EROSION PROTECTION DESIGN FOR PONDS 1 AND 3 FOR THE AMBROSIA LAKE MILL TAILINGS SITE - LICENSE AMENDMENT 51, SUA -1473 (TAC NO. L52431)

Dear Mr. Goranson:

The U.S. Nuclear Regulatory Commission (NRC) staff has completed its review of the design of erosion protection for Ponds 1 and 3 at the Ambrosia Lake mill site. You submitted four separate designs and analysis under cover letters dated May 16, 2002, and September 26, 2002. Based on our review of the information submitted by you and on independent calculations, NRC staff concludes that the designs you have submitted have appropriately addressed the erosion protection along Ponds 1 and 3. Accordingly, Amendment 51 updates License Condition 37 of Source Materials License, SUA-1473 to reference these submittals. A detailed Technical Evaluation Report as well as the updated license is enclosed.

In many of the designs, especially for Pond 3, the design is dependent on an assumed final elevation and grade. Please be aware that the design is not valid if the final grade differs from that which you have assumed. In addition, you have not provided any information regarding the durability of the rock to be used in the erosion protection design. The rock should be good quality to meet the design which has been approved and rock durability information should be provided to NRC prior to placement. Finally, the design of the toe of Pond 3 (at Section 3) should be revisited to determine if the toe adequately protects against undercutting by the Arroyo del Puerto.

Other than the items stated above, the erosion protection design appears to be adequate to provide reasonable assurance of protection for 1000 years, as required in Criterion 6 of 10 CFR Part 40, Appendix A.

In accordance with 10 CFR 2.790 of NRC's "Rules of Practice for Domestic Licensing Proceedings and Issuance of Orders," a copy of this letter will be available electronically for

public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Should you have questions regarding this matter, please contact the NRC project manager, Jill Caverly, at 301-415-6699 or by e-mail to JSC1@nrc.gov.

Sincerely,

Daniel M. Gillen, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Docket No. 40-8905
SUA-1473

Enclosure: Technical Evaluation Report
Source Materials License, SUA-1473

cc: Art Kleinrath, DOE-GJ

TECHNICAL EVALUATION REPORT
EVALUATION OF EROSION PROTECTION FOR PONDS 1 AND 3
AT THE AMBROSIA LAKE MILL SITE
DOCKET 40-8905
NOVEMBER 2002

SUMMARY:

During a 2001 inspection of the Rio Algom Mining LLC (RAM) Ambrosia Lake facility, a U.S. Nuclear Regulatory Commission (NRC) inspector observed rilling of the soil along the southern toe trench of the Pond #1 tailings impoundment. A follow-up visit identified additional areas of concern, including excessive rilling along the northern Pond 1 toe trench and the potential for head-cutting along the drainage area north of Pond 1 and Pond 3. In a letter dated May 16, 2002, RAM submitted for NRC review, a report that provides the design of head-cutting control and toe protection facilities to be constructed along the northern edge of Pond 1. Staff reviewed this report and met with representatives of RAM on August 28, 2002. As a result of concerns raised at this meeting, RAM submitted a report entitled, "Responses to Staff Questions on Erosion Protection Design for Pond #3 and Additional Arroyo del Puerto Investigations." This report responded to staff concerns about the determination of the probable maximum flood and possible erosion for the nearby arroyo. The final aspect of the design, which addresses the erosion protection for Pond 3, was submitted under cover letter dated September 26, 2002, "Design Report: Pond 1 South Embankment Toe Erosion Protection, Ambrosia Lake New Mexico." This Technical Evaluation Report documents the staff's review of RAM's proposed designs and provides the technical basis for the acceptability of the licensee's design.

INTRODUCTION

The first proposed design addresses rilling along the northern embankment of Pond 1. An apron is provided to mitigate the effects of a hydraulic jump formed as flow transitions from the steeper embankment slope to the flat toe surface. Additionally, the channel is designed to withstand longitudinal flow forces that are anticipated along the embankment toe. The second design addresses potential erosion on approximately 20 acres north of the north embankment of Pond 1 and potential erosion for the surface of Pond 3. The third report is the response to staff questions regarding erosion protection for Pond 3, determination of the probable maximum flood (PMF) and the effects of a local stream, the Arroyo del Puerto. The final report addresses erosion protection for the south embankment of Pond 1.

In general, criterion 6 of 10 CFR 40, Appendix A, requires stability of the tailings for 1000 years to the extent reasonably achievable and in any case for 200 years. Because the design storm is difficult to quantify for 1000 year design period, NRC guidance suggests using the probable maximum precipitation (PMP) and PMF for the design basis of erosion control features at mill tailings sites. The licensee has proposed that the design storm for the entire site will be the probable maximum precipitation event.

Enclosure

REPORT 1: DESIGN REPORT: POND 1 NORTH EMBANKMENT TOE EROSION PROTECTION - AMBROSIA LAKE MILL, NEW MEXICO

Pond 1 is a reclaimed tailings disposal site and was previously used for burial of byproduct material produced at the mill. During a May 2001 inspection, NRC staff observed rilling along the northern embankment of Pond 1. In addition, the inspectors noted concerns with the current design of the apron and identified the potential for head-cutting along the toe from flow along the planned diversion channel. The embankment of Pond 1 includes a radon barrier and an overlying rock cover that provides erosion protection. The proposed erosion protection system for the north embankment toe of Pond 1 involves an apron, which is designed to withstand a hydraulic jump that occurs as flow transitions from the steeper embankment slope to the flat toe surface, and a channel design that will withstand the effects of longitudinal flow that is anticipated adjacent to the embankment toe.

Design parameters and assumptions

The PMP was determined using methodology outlined in the U.S. Department of Commerce's Hydrometeorological Report No. 55A (HMR-55A). The 1-hour 1 square mile event is estimated to be 10.5 inches but is adjusted for elevation and duration. The final value was determined to be 9.5 inches for the 1-hour, 1-square mile local storm. However, an earlier prediction of the PMP, based on calculations for this site's reclamation plan, estimates the precipitation to be 9.6 inches for the same storm. In order to maintain consistency, the licensee chose to use the 9.6 inch value for the remainder of the design.

Erosion Protection Design

The north toe of the Pond 1 embankment requires an erosion protection apron for runoff from the pile as well as erosion protection for the longitudinal flow along the toe due to the moderate slope. The licensee determined the apron characteristics based on methods recommended in NUREG-1623, Appendix D, Section 6. The open channel flow requirements to control the runoff and longitudinal flow were computed in accordance with NUREG-1623, Appendix D, Sections 2 and 3.

The north apron drains a 13.4 acre catchment on the top of Pond 1. A slope of 5H:1V exists along the entire Pond 1 embankment toe. The current apron has experienced minor erosion indicating that a redesign of the apron is appropriate. For the catchment area, a time of concentration was calculated for each of two slopes, with respective slope lengths of 350 feet and 575 feet. These are the longest and shortest slope length for the north toe of Pond 1. Times of concentration of 1.5 minutes and 2.5 minutes were calculated for the short and long slope, respectively. A shortest incremental rainfall duration of 2.5 minutes was used for both slope lengths. This assumption is in accordance with NRC guidance put forth in NUREG/CR-4630. The Rational Method was used to determine the runoff volume for both slopes. Given the computed flow rate and assuming a concentration factor of 2.5, the design calls for the placement of rock with a d_{50} of 6.0 inches on slopes shorter than 350 feet and a d_{50} of 7.8 inches is called for on slopes with lengths between 350 feet and 575feet.

The area along the toe at the northern end of Pond 1 is moderately sloped and could produce erosive longitudinal flows. The licensee proposes an open channel that will collect and convey

the precipitation that falls on the embankment slope. The design makes use of methods presented in NUREG-1623, Appendix D, Sections 2 and 3.

The design subdivides the channel into two sections. The first, consisting of the upper 5.1 acres, is segregated due to its location and slopes. The time of concentration, developed using the maximum calculated flow length of 1195 feet, was determined to be 7.0 minutes. The 7.0 minute PMP is 5.09 inches according to the method by Nelson et al in NUREG-1623. The resulting peak flow for the upper section is 221cfs.

The remaining 8.3 acres of the embankment are included in a second subdivision. The time of concentration for this area, which was based on a maximum flow length of 2100 feet and takes into account the flow length from the upper section, was determined to be 9.5 minutes. The 10 minute PMP according to Nelson et al in NUREG-1623 is 5.95 inches. The rational method yields a peak flow of 480cfs for the entire system.

The channel/apron configurations were developed using flow calculations and methods discussed in NUREG-1623. The more protective method between the apron and channel were chosen to maintain the channel integrity during both flow scenarios. A Manning's roughness coefficient was developed using the procedures of Section 3 of NUREG-1623 and entered into the hydraulic design software, Flow Pro 2.0. Estimated channel widths of 8 feet (upper channel) and 20 feet (lower channel) were included as program input data. The guidance recommends that channel widths be greater than 15 times the d_{50} diameter. The corresponding D_{50} diameters were also included in the program. The program calculates the depth of flow in the channel while the remaining channel cross-section can be determined based on a typical trapezoidal cross section with a 2H:1V side slope. For this case, a channel depth of 3 feet was determined.

The existing erosion control apron will be removed and the sub-grade properly re-graded to ensure that embankment run-off flows into the proposed channel/apron.

Conclusion

Given the assumptions stated in the referenced report, staff concludes that the proposed design for the northern embankment toe of Pond 1 and the channel/apron is appropriate.

REPORT 2: DESIGN REPORT - POND 3 EROSION PROTECTION AND EROSION PROTECTION FOR THE AREA NORTH OF POND 1- AMBROSIA LAKE MILL, NEW MEXICO

This design report address three areas of the site that include potential erosion on approximately 20 acres north of the north embankment, the extension of the Pond 1 channel/apron, and the runoff area for Pond 3. Seven specific areas for erosion protection have been identified.

1. Toe erosion protection apron at the interface of Pond 1 and Pond 3;
2. Surface erosion protection for Pond 3;
3. Erosion protection for the east embankment of Pond 3;
4. Toe erosion protection of the area north of Pond 1;
5. Surface run-off protection for the area north of Pond 1;

6. Diversion channel construction along the northern limit of the area north of Pond 1; and
7. Discharge channel construction from the end of the Pond 1 north embankment channel/apron to the Arroyo del Puerto basin.

Method of analysis

The analysis in this report determined that the erosion protection should be based on runoff analysis for sheet flow down slopes and across pond surfaces in accordance with NRC guidance in NUREG-1623. The longitudinal flow requirements for the open channel were used to calculate the toe requirements for the control of runoff during a PMF event.

In order to estimate the PMF for the Arroyo del Puerto, a natural channel, the basin area was first calculated to be 57.6 square miles at the Ambrosia Lake mill. Next, the Soil Conservation Service's curve number for the Montanosa Mesa drainage basin, 73.4, was chosen due to this basins similarities to the Arroyo del Puerto basin. A lag time of 1.83 hours was chosen corresponding to 60 percent of the time of concentration. Several storms were investigated, including the 1-hour and 6-hour local storms and the 6-hour, 24-hour and 72-hour general storms. Analysis of the results showed that the largest PMF was produced during the 6-hour local storm that produced a peak flow of 75,200 cfs. Since earlier designs used a peak flow of 78,000 cfs, the licensee opted to use the higher value.

Using the storm value of 78,000 cfs, the licensee constructed a hydraulic model of the Arroyo del Puerto in the vicinity of the Ambrosia Lake mill. The purpose of the model was to determine the flood water elevation in the vicinity of Pond 3. The following assumptions were used:

1. Arroyo del Puerto was rerouted to a new alignment east of its existing position in the vicinity of the mill. The new channel rejoins the original channel near the north-east corner of Pond 9.
2. The Pond 3 embankment will be constructed to a final elevation of 6935 feet.
3. The existing groundwater trench is backfilled.
4. Pond 9 is assumed to be removed and regarded to a final elevation of 6917 feet.

Using the assumptions stated above and the calculated PMP and PMF, the main aspects of the erosion protection were analyzed. A brief description of each follows.

Toe erosion protection apron at the interface of Pond 1 and Pond 3

For the 31 acre catchment with a slope length of 520 feet, a time of concentration was calculated to be 1.92 minutes. A corresponding incremental PMP distribution of 2.5 minutes was used to calculate the corresponding PMP depth of 2.64 inches. Based on this flow, the methods of NUREG-1623 yield a d_{50} of 7.5 inches. Because the licensee has stone of larger diameter available, the final d_{50} was increased to 9.4 inches. Consistent with NRC guidance established in NUREG-1623, apron width is set at 15 times d_{50}, while depth is set at six times d_{50}.

Surface erosion protection for Pond 3

Because Pond 3 is not yet complete, the design is based on several assumptions. The licensee anticipated that the 33 acre area will have a 12-inch thick rock cover resulting in a final elevation of 6938 feet. A surface grade of 0.3 percent will prevent ponding of water and the maximum surface length is assumed to be 7000 feet. The modeling of the PMF in the Arroyo del Puerto shows the flow elevation to be 1 foot less than the top of the embankment. A time of concentration of 11.6 minutes was determined. Pond 1 embankment flows will be discharged onto the Pond 3 surface, therefore, the time of concentration for Pond 3 was calculated to be 13.52 minutes. The incremental rainfall duration was used to determine the PMP depth of 6.72 inches. The method of Abt et al from NUREG-1623 predicts a rock d_{50} of 0.4 inches and the licensee proposed a rock size d_{50} of 1.0 inches since it is easier to obtain.

Erosion protection for the east embankment toe of Pond 3

Assumptions were made about the location of the east embankment toe of Pond 3 because of the ongoing reclamation work at Pond 3. The elevation was assumed to be 6923 feet. The apron will dissipate energy from the 65 feet slope. Two precipitation events were analyzed to determine which event would produce the largest run-off at the site. The controlling forces came from the PMF in the Arroyo del Puerto. Because the flow was greater in the open channel, the Army Corps of Engineers method was used to determine the d_{50} of 12 inches. This method is consistent with NRC guidance.

Surface run-off protection of the area north of Pond 1

The 20 acres of undeveloped land adjacent to the north embankment of Pond 1 was investigated for the need of an erosion protection layer. Analysis of the PMP determined that an erosion protection rock layer was necessary to prevent head-cutting due to local rain events. The licensee proposes to re-contour the area to prevent erosion and provide effective rock cover. To achieve this, slopes of greater than 7.5 percent will be regraded to slopes equal to or less than 7.5%. A rock size of d_{50} equal to 2.2 inches was based on flow volume calculated from the rational method of 1.6 cfs/ft, incremental rainfall duration of 7.82 minutes and a PMP depth of 5.2 inches.

Diversion channel construction along the northern limit of the area north of Pond 1

Rainfall that falls on the area north of Pond 1 flows toward the Arroyo Del Puerto producing head-cut erosion that is directed west toward the mill site. The licensee proposes an engineered diversion channel be placed at the erosion location to prevent further degradation. The design segmented the channel into three sections to account for flows, slopes and terrains. The following is a summary channel segment characteristics.

Channel Segment	Time of Concentration (minutes)	Local Increment al Rainfall (in)	Basin Size (acres)	Segment Flow Rate (cfs)	Rock Size, d_{50} (in)	Bottom Width of Channel (ft)
0+00-9+00	6.6	4.8	2.2	97	9.2	3
9+00-17+00	8.3	5.4	7.4	288	9.2	20
17+00-27+01	13.2	6.7	16.3	497	9.2	28

The hydraulic model developed for the channel indicated that a hydraulic jump develops between the steep second segment and the flatter third segment. It was then concluded that the channel would require additional height to contain the jump for a distance of 25 feet at the jump location. Additionally, the apron requires that rock with a d_{50} = 17 inches be placed to a depth of 4.3 feet to accommodate forces associated with the hydraulic jump.

Discharge channel construction from the end of Pond 1 north embankment channel/apron to the Arroyo del Puerto basin.

Runoff from the north embankment of Pond 1 collects in an apron/channel that runs east toward the Arroyo del Puerto. The discharge channel transitions back to the arroyo with a transition section 25 feet long to convert the apron/channel to a normal channel with 2:1 side slopes. The next 25 feet, the channel rock size is increased to accommodate an expected hydraulic jump. The time of concentration was calculated to be 12.2 minutes and the incremental PMP depth is 6.5 inches. The catchment area is 15.7 acres, resulting in a discharge (using the rational equation) of 498 cfs. A rock d_{50}=9.2 provides adequate protection for the channel under the design conditions.

The purpose of the apron will be to slow the flow of the water before it reaches the native vegetation of the Arroyo del Puerto, thereby preventing scour of the native silty clays. The apron also handles discharges from the arroyo. Accordingly, the design flow is a sum of the discharge channel and that from the arroyo basin (995 cfs). A slope of 0.5 percent and width of 80 feet should adequately slow the flow to less than 4ft/sec. The scour depth of 6 feet has been included in the toe design as well as 25 foot wing walls.

Conclusion

The staff concludes that the designs proposed for the apron along Pond 1 and Pond 3 interface and the Pond 3 embankment, toe and surface and the north erosion protection areas are appropriate given the assumptions stated in the referenced report. Staff notes that the assumptions of final grade should be reviewed at the time of construction and that changes may require re-evaluation of the proposed design.

REPORT 3: RESPONSES TO STAFF QUESTIONS ON EROSION PROTECTION DESIGN FOR POND #3 AND ADDITIONAL ARROYO DEL PUERTO INVESTIGATIONS

In August of 2002, NRC staff raised their concern to the licensee that the estimated PMF of 78,000 cfs for the Ambrosia Lake mill site may be too low. Additionally, the staff noted that the Arroyo del Puerto may be subject to migration over the design period and its flows should be accounted for when sizing rock. In response to the first concern, that the PMF was underestimated, the licensee performed a sensitivity analysis in order to determine which variable may have a dramatic effect on the calculation of the PMF.

The calculation of the PMF from the PMP requires many parameters including type of storm, the geometry of the basin, the infiltration properties of the basin, as well as assumptions about the behavior of the flood peak as it travels through the basin. A sensitivity analysis was performed using the hydrologic model HEC-1. The three variables that would affect the peak flow significantly were reviewed. The variables included curve number, lag time and rainfall sequence. The licensee applied the most conservative bounds on the parameters and the results showed that the PMF could be as high as 126,000 cfs. However, the circumstances for this to occur were so unlikely that the value simply provided a high bound for the PMF.

The one variable which appeared to have an influence within a reasonable range was the lag time calculation. The lag time was adjusted based on a New Mexico method developed by the U.S. Geological Survey (USGS) which increased the calculated PMF. However, the methodology for USGS which lowered the lag time does not directly transfer to the current situation. The methodology was based on floods in smaller basins. Therefore, the licensee's conclusion was that the current estimate for the PMF is reasonable.

In addition to considering the PMF calculation, the licensee was also asked to review the possibility for lateral migration of the Arroyo del Puerto. The concern of staff was that the arroyo would migrate over time and eventually be located at the toe of the tailings impoundment. If that occurred, the erosive forces of the arroyo could undermine the toe of the tailings impoundment causing a failure. The licensee performed an analysis which determined that the maximum lateral migration of the outside banks would be approximately 3 feet per year.

Conclusion

Staff concludes that the PMF is within a reasonable range and has been appropriately used in the design of Ponds 1 and 3 erosion protection. However, the lateral migration of the Arroyo del Puerto at Section 3 should be re-evaluated for the possibility of undercutting of the Pond 3 toe. The toe may be sufficient to resist any erosion to the migrating stream but the licensee should revisit this matter prior to construction and should verify this with staff.

REPORT 4: DESIGN REPORT: POND 1 SOUTH EMBANKMENT TOE EROSION PROTECTION, AMBROSIA LAKE, NEW MEXICO.

The report was written in response to an NRC inspection in 2000 where concerns were raised about erosion and rock displacement on the south side of Pond 1. The assumption of the PMP as discussed in Reports 1 and 2 is the same for this report and design. This report analyzes the apron requirements based on run-off analysis for the south embankment of Pond 1 and determined the open channel requirements to control the run-off and longitudinal flow from the south embankment.

A 19-acre catchment that discharges along the southern end of Pond 2 had a corresponding time of concentration of 1.64 minutes and a PMP depth for a local storm of 2.64 inches. The Rational Method calculated the unit discharge to be 0.63cfs/ft for the 452 feet slope length. Assuming a maximum embankment slope of 20 percent and a concentration factor or 2.5, the rock d_{50} requirement is 6.7 inches.

The slope at the toe of the south embankment of Pond 1 may induce moderate flows along the toe. This condition was evaluated by placing an open channel/apron at the base of the slope that will catch the precipitation that falls on the embankment slope and runs off. Methods from NUREG-1623 were used to develop the characteristics of the channel. The channel configuration is based on a time of concentration of 11.4 minutes, the incremental storm depth of 6.3 inches, a peak flow of 579 cfs and a bottom width of 12 feet. The average existing slope of 2.3 percent requires a rock d_{50} of 7.5 inches and a depth of 4.5 feet.

A discharge apron is required where the flow runs onto native ground downstream from the pond. A toe will be constructed at the edge of the discharge apron to prevent scour. Wingwalls will extend for an additional 25 feet beyond the apron and are constructed with a rock toe keyed into bedrock. A filter rock should also be placed. The existing erosion control apron must be removed and the subgrade properly re-graded such that run-off from the embankment flow into the proposed channel/apron and toe apron.

Conclusion

The staff concludes that the design proposed for the south embankment of Pond 1 is appropriate given the assumptions stated in the referenced report.

CONCLUSION

Based on the review of the information submitted by the licensee and on independent calculations, the NRC staff concludes that the licensee has identified the appropriate floods for the design of erosion protection features at the site. However, staff notes that the assumptions, especially final grade assumptions, should be closely monitored during construction and if any changes occur then the design should be revisited for potential impacts to the initial designs. In addition, these designs are based on durable rock that should be verified prior to placement. If suitable rock is not available and oversizing is requested, it may be possible that the revised rock size will affect the performance of the design. The licensee will be responsible for providing updated calculations and redesigns accounting for the new rock size. Finally, the toe of Pond 3 (at Section 3) should be reviewed for the possibility of undercutting by the Arroyo del Puerto in the event the arroyo migrates to the toe of the pond.

Other than the items stated above, the erosion protection design appears to be adequate and to provide reasonable assurance of protection for 1000 years, as required in Criterion 6 of 10 CFR Part 40, Appendix A.

Source Material License, SUA-1473, has been updated in Amendment 51 to reference the submittals dated May 16, 2002 and September 26, 2002. The designs included in these submittals for specific areas of Ponds 1 and 3 supercede any other designs previously approved.

ENVIRONMENTAL IMPACT EVALUATION

An environmental assessment for this action is not required, since this action is categorically excluded under 10 CFR 51.22(c)(3)(i), and an environmental report from the licensee is not required by 10 CFR 51.60(b)(2).

REFERENCES

Goranson, W.P., Rio Algom Mining LLC, letter to NRC dated May 16, 2002, "Design Report for Pond 1 North Embankment Erosion Protection, Pond 3 Erosion Protection and Erosion Protection for the Area North of Pond 1" License No.: SUA-1473, Docket No.: 40-8905.

Goranson, W.P., Rio Algom Mining LLC, letter to NRC dated September 26, 2002, "Responses to Staff Question On Erosion Protection Design for Pond #3 and Additional Arroyo del Puerto Investigation" License No.: SUA-1473, Docket No.: 40-8905.

Goranson, W.P., Rio Algom Mining LLC, letter to NRC dated September 26, 2002, "Design Report; Pond 1 South Embankment Toe Erosion Protection" License No.: SUA-1473, Docket No.: 40-8905.

Johnson, T.L., 2002, Design of Erosion Protection for Long-Term Stabilization. Final Report, NUREG-1623, U.S. Nuclear Regulatory Commission, Washington, DC.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 5, 2004

Mr. Peter Luthiger
Manager, Radiation Safety
and Environmental Affairs
Rio Algom Mining LLC
P.O. Box 218
Grants, NM 87020

SUBJECT: REVIEW OF RIO ALGOM MINING LLC's LATERAL MIGRATION EVALUATION FOR ARROYO DEL PUERTO (TAC NO. LU0056)

Dear Mr. Luthiger:

In a letter dated June 22, 2004, Mr. Paul Goranson of Rio Algom Mining LLC (Rio Algom) submitted to the U.S. Nuclear Regulatory Commission (NRC) a report assessing the potential for migration of the Arroyo del Puerto at the Ambrosia Lake uranium mill tailing site. This analysis was requested by the NRC during its review of erosion control facility design for Amendment 51 of Source Materials License SUA-1473.

An evaluation of Rio Algom's analysis is included in NRC's Technical Evaluation Report and has been enclosed for your information. Based on the conclusion that the maximum differential between the toe of the impoundment (Pond 3) and the channel bed is approximately 10 feet, we request Rio Algom address the potential undercutting of the impoundment due to the vertical down-cutting by the Arroyo in its design of erosion protection at the toe of Pond 3.

Should you have any questions regarding this letter, please feel free to contact me or Ms. Jill Caverly, the NRC project manager, at (301) 415-6699 or via email to jsc1@nrc.gov.

In accordance with 10 CFR 2.390 of the NRC's Rules of Practice, a copy of this letter will be available electronically from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

Sincerely,

Gary S. Janosko, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Docket No.: 40-8905
License No.: SUA-1473

Enclosure: Technical Evaluation Report

cc: B. Law, Rio Algom

Technical Evaluation Report
Migration of the
Arroyo del Puerto at the
Ambrosia Lake Uranium Mill Tailings Facility

BACKGROUND:

In 2002, Rio Algom Mining LLC (Rio Algom) submitted to the U.S. Nuclear Regulatory Commission (NRC) updated designs for erosion control at the uranium mill tailings impoundments at the Ambrosia, New Mexico facility. The designs were intended to update an earlier reclamation design that was approved by the NRC but with the requirements that additional analysis be performed. The erosion control designs were approved in an amendment (Amendment No. 51) to Source Materials License, SUA-1473. However, the NRC noted that geomorphic stability of the stream adjacent to the tailings impoundment should be verified.

The Arroyo del Puerto is a small meandering stream that crosses the Ambrosia Lake site at the northeast corner. The stream was realigned after the construction of the mill and other facilities. The revised alignment diverted the stream from its natural southeasterly course to one that goes directly east then turns approximately 90 degrees to the south eventually returning to the original channel. Included in the reclamation of the site was the re-establishment of the natural channel that will bring it within 300 feet of the toe of the tailings impoundment.

EVALUATION:

In NRC's review of Amendment No. 51, the staff noted its concern that the stream would migrate toward the toe of the Pond 3 impoundment and stated this in its Technical Evaluation Report dated November 27, 2002. Rio Algom discussed the migration of the Arroyo del Puerto in its original Ponds 1 and 3 erosion protection design submittal, stating that considering the most conservative assumptions the stream would migrate approximately 3 feet a year. Given the 300 feet distance between the pond and the stream, there is a possibility that the stream could migrate toward the tailings within the 1000 year design criteria. The NRC asked that further analysis be performed to evaluate the possibility of undercutting the Pond 3 toe and to assure that the impoundment would not be compromised. Rio Algom submitted an analysis for review by letter dated June 22, 2004.

Rio Algom evaluated the potential migration of the Arroyo del Puerto by considering the geologic characteristic of the site and the historical migration of the stream. The geologic analysis used information from mapping in an earlier submittal dealing with groundwater alternate concentration limits. The second method of evaluating the stream migration was based on arial photographs.

The geologic information shows that an outcropping of the Mancos Formation is at the surface in the vicinity of the tailings impoundment. The Mancos formation is comprised of cretaceous age shales interbedded with sandstone. The formation brackets the tailings impoundment on the north and south. The tailings impoundment is essentially located in a drainage between the two areas where Mancos outcrops. The channel of the stream abuts the outcrop of the Mancos at the north end and the southeast segment of the channel. Rio Algom stated that because Mancos is a competent rock and brackets the tailings impoundment that it is a limiting factor for the migration of the Arroyo del Puerto.

In addition to the geologic analysis, Rio Algom studied arial photographs of the Ambrosia Lake site dating 1935, 1952 and 1996 that viewed the area of Ambrosia Lake both pre- and post-milling activities. Migration of the Arroyo has been minimal based on the analysis of the photographs. Rio Algom concluded that the Arroyo has not significantly migrated over the past 70 years. However, Rio Algom noted that the bed elevation for the reconstructed Arroyo channel will be approximately 6 to 10 feet below the toe of the impoundment.

SUMMARY AND CONCLUSION:

The staff has reviewed the information submitted by Rio Algom and concludes that the geologic and historic information does provide a level of assurance that migration of the Arroyo del Puerto will not be significant. However, the east side of the impoundment (along Pond 3) will not be protected by the Mancos shale outcropping. Therefore, a possibility exists that migration of the Arroyo could affect the tailings impoundment by undercutting the toe of the impoundment by 6 to 10 feet.

Because parts of the Pond 3 impoundment can be compromised by undercutting from the Arroyo, Rio Algom should update the Ambrosia Lake erosion protection design to account for the migration of the Arroyo. Some suggested methods include stabilizing the stream at its reconstructed location or providing additional protection against undercutting at the Pond 3 toe.

REFERENCES:

U.S. Nuclear Regulatory Commission, November 27, 2002, "Erosion Protection Design for Ponds 1 and 3 for the Ambrosia Lake Mill Tailings Site - License Amendment 51" [ADAMS Accession No. ML023370493]

Rio Algom Mining LLC, May 16, 2002, "Design Report for Pond 1 North Embankment Erosion Protection, Pond 3 Erosion Protection and Erosion Protection for Area North of Pond 1" [ADAMS Accession No. ML021480047]

Rio Algom Mining LLC, June 22, 2004, "Lateral Migration for Arroyo del Puerto" [ADAMS Accession No. ML041970652]

In accordance with 10 CFR 2.390 of the NRC's Rules of Practice, a copy of this letter will be available electronically from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

Sincerely,

Gary S. Janosko, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Docket No.: 40-8905
License No.: SUA-1473

Enclosure: Technical Evaluation Report

CLOSES TAC LU0056

DISTRIBUTION:
FCFB r/f

G:\FCSS\FCLB\Uranium Recovery Section\Rio Algom\Arroyo Migration Evaluation Letter.wpd
ML

OFC	FCFB		FCFB		FCFB		FCFB	
NAME	J. Caverly		B. Garrett		B. von Till, Acting SC		G. Janosko	
DATE	10/06/04		10/01/04		10/5/04 Vacc. 10/5		10/5/04	

OFFICIAL RECORD COPY September 30, 2004 #1

Appendix B ..... Lateral Migration Evaluation for Arroyo del Puerto

Memorandum by Maxim Technologies
November 5, 2003

Appendix B

Lateral Migration Evaluation for Arroyo del Puerto

Memorandum by Maxim Technologies
November 5, 2003

MAYTAS

10601 Lomas NE, Suite 106
Albuquerque, NM 87112
(505) 237-8440

MEMORANDUM

DATE: November 5, 2003

TO: Paul Goranson, Rio Algom Mining Corporation

FROM: John M. McBee, P.E.

SUBJECT: Lateral Migration Evaluation for Arroyo del Puerto

PURPOSE AND SCOPE OF STUDY

This memorandum presents the results of a study to assess the potential migration of Arroyo del Puerto in the vicinity of the Ambrosia Lake Mill. Specifically, this study was in response to concerns presented in a letter from the Nuclear Regulatory Commission (NRC) dated November 27, 2002, which was a review of design submittal "Erosion Protection Design for Ponds 1 and 3 for the Ambrosia Lake Mill Tailings Site – License Amendment 51, SUA – 1473 (TAC no. L51431). On pages 7 and 8 of the letter, the NRC states in the conclusions that "the toe of Pond 3 (at Section 3) should be reviewed for the possibility of undercutting by the Arroyo del Puerto in the event the arroyo migrates to the toe of the pond". Section 3 of Pond 3 is through the northeast portion of the pond embankment closest to the arroyo.

PREVIOUS EVALUATION

A memorandum dated September 6, 2002, "Ambrosia Lake Mill – Arroyo del Puerto Investigations" by Maxim Technologies focused on issues raised in discussions with the NRC concerning calculation of the probable maximum flood (PMF). However, the memo also included a potential lateral migration rate of the arroyo to provide an assessment that the location of the channel (300 feet from the toe of Pond 3) used in the PMF calculations was adequate for the PMF erosion protection design. As stated in the memorandum, conservative assumptions were used in the calculation and were based on studies completed in western Canada. No historical site area records were available.

SITE ASSESSMENT

Two different lines of information were used to assess the potential migration of the arroyo. First, a bedrock outcrop map of the site area which had been compiled previously and included as Figure 2.3 in "Application for Alternate Concentration Limits (ACLs) in the Alluvial Materials at the Quivira Mill Facility Ambrosia Lake, New Mexico." Grants, New Mexico: Quivira Mining Company. 2001 was reviewed. Also, aerial photographs from as wide a time span as possible were collected and evaluated. Photographs of the site vicinity dated from 1935, 1952, and 1996; the first two photographs pre-dated mining and milling operations.

PURPOSE AND SCOPE OF STUDY

This report presents the results of a study to assess the potential migration of Arroyo del Puerto in the vicinity of the Ambrosia Lake Mill. Specifically, this study was in response to concerns presented in a letter from the Nuclear Regulatory Commission (NRC) dated November 27, 2002, which was a review of design submittal "Erosion Protection Design for Ponds 1 and 3 for the Ambrosia Lake Mill Tailings Site – License Amendment 51, SUA – 1473 (TAC no. L51431). On pages 7 and 8 of the letter, the NRC states in the conclusions that "the toe of Pond 3 (at Section 3) should be reviewed for the possibility of undercutting by the Arroyo del Puerto in the event the arroyo migrates to the toe of the pond". Section 3 of Pond 3 is through the northeast portion of the pond embankment closest to the arroyo.

PREVIOUS EVALUATION

A memorandum dated September 6, 2002, "Ambrosia Lake Mill – Arroyo del Puerto Investigations" by Maxim Technologies focused on issues raised in discussions with the NRC concerning calculation of the probable maximum flood (PMF). However, the memo also included a potential lateral migration rate of the arroyo to provide an assessment that the location of the channel (300 feet from the toe of Pond 3) used in the PMF calculations was adequate for the PMF erosion protection design. As stated in the memorandum, conservative assumptions were used in the calculation and were based on studies completed in western Canada. There was no historical review of site specific records.

SITE ASSESSMENT

Two different lines of information were used to assess the potential migration of the arroyo. First, a bedrock outcrop map of the site area which had been compiled previously and included as Figure 2.3 in "Application for Alternate Concentration Limits in the Alluvial Materials at the Quivira Mill Facility Ambrosia Lake, New Mexico." Grants, New Mexico: Quivira Mining Company. 2001 was reviewed. Also, aerial photographs from as wide a time span as possible were collected and evaluated. Photographs of the site vicinity dated from 1935, 1952, and 1996; the first two photographs pre-dated mining and milling operations.

Implications of the outcropping of the Mancos Formation at the ground surface in the vicinity of the site reveal that it in part controls the location of the channel of Arroyo del Puerto. Figure 1 shows the surface geologic map of the site vicinity with two units exposed at the surface, Quaternary Alluvium and the Mancos Formation, which is comprised of Cretaceous age shales interbedded with some sandstone. North of the tailings impoundment (primarily Ponds 1and 3) the channel of the arroyo abuts the outcrop of the Mancos Formation. Also, southeast of the impoundment the channel of the arroyo is adjacent to the Mancos in certain areas or has migrated to the east away from the Mancos Formation at the surface. As can be seen from the figure, the tailings impoundment was primarily located on an un-named drainage between the two outcroppings of the Mancos Formation. Since the Mancos is a competent rock unit and it essentially "brackets" the disposal cell, it will be a limiting factor of the migration of Arroyo del Puerto to the west for the two hundred to 1,000 design life of the disposal cell. Therefore, if migration of the arroyo both north and southeast of the disposal is limited by the bedrock outcrop, then the potential for migration of the arroyo immediately east of the cell will be limited.

Aerial photographs of the site vicinity, which covered a 61 year period of time, were reviewed to determine whether there were measureable changes in the location of the arroyo. Figures 2 through 5 show the overall location of the arroyo at the three time periods (1935, 1952, and 1996). Insets in the photographs were an attempt to highlight the same portion of the arroyo channel at a higher scale. But because of limitations of the resolution of the photographs and differences do the slight distortion of altitude and flight path of the aircraft, measurements to quantify migration distances could not be made. However, it can be seen from reviewing the photographs that migration of the channel of Arroyo del Puerto has been minimal, if any, since 1935.

The impacts of the mining operations can be seen in the 1996 photograph. The area of the arroyo southeast to north of the final disposal cell shows evidence of manmade changes, i.e., reworked, regraded, construction of ponds, etc. The natural, pre-mining conditions have been disturbed and will be remediated before site closure. However, there will be only about 6 feet difference in elevation of the reconstructed arroyo channel and the base of the disposal cell apron on the north end of the Pond 3 area to about 10 feet where the channel will discharge to the east of Pond 3. The potential of the arroyo under-cutting backfilled areas on the northeast section of Pond 3 will be limited to these depths.

No data from historical storm events in the vicinity of the site could be obtained. However, only since mining dewatering of underground operations has there been continuous discharge to the arroyo. All but one mine dewatering operation has stopped (Quivira Mining Company), which will also be stopped once approved. Therefore, flows in the arroyo will revert to only large natural storm events.

In summary, based on observation of aerial photographs, migration of the channel of Arroyo del Puerto has been minimal, if any, since 1935. Also, the bedrock outcrop of the Mancos Formation north and southeast of the tailings impoundment will limit potential westward migration of Arroyo del Puerto. Vertical down-cutting of the arroyo in the vicinity of Pond 3 will be limited to approximately 6 to 10 feet below the toe of the Pond 3 Apron.

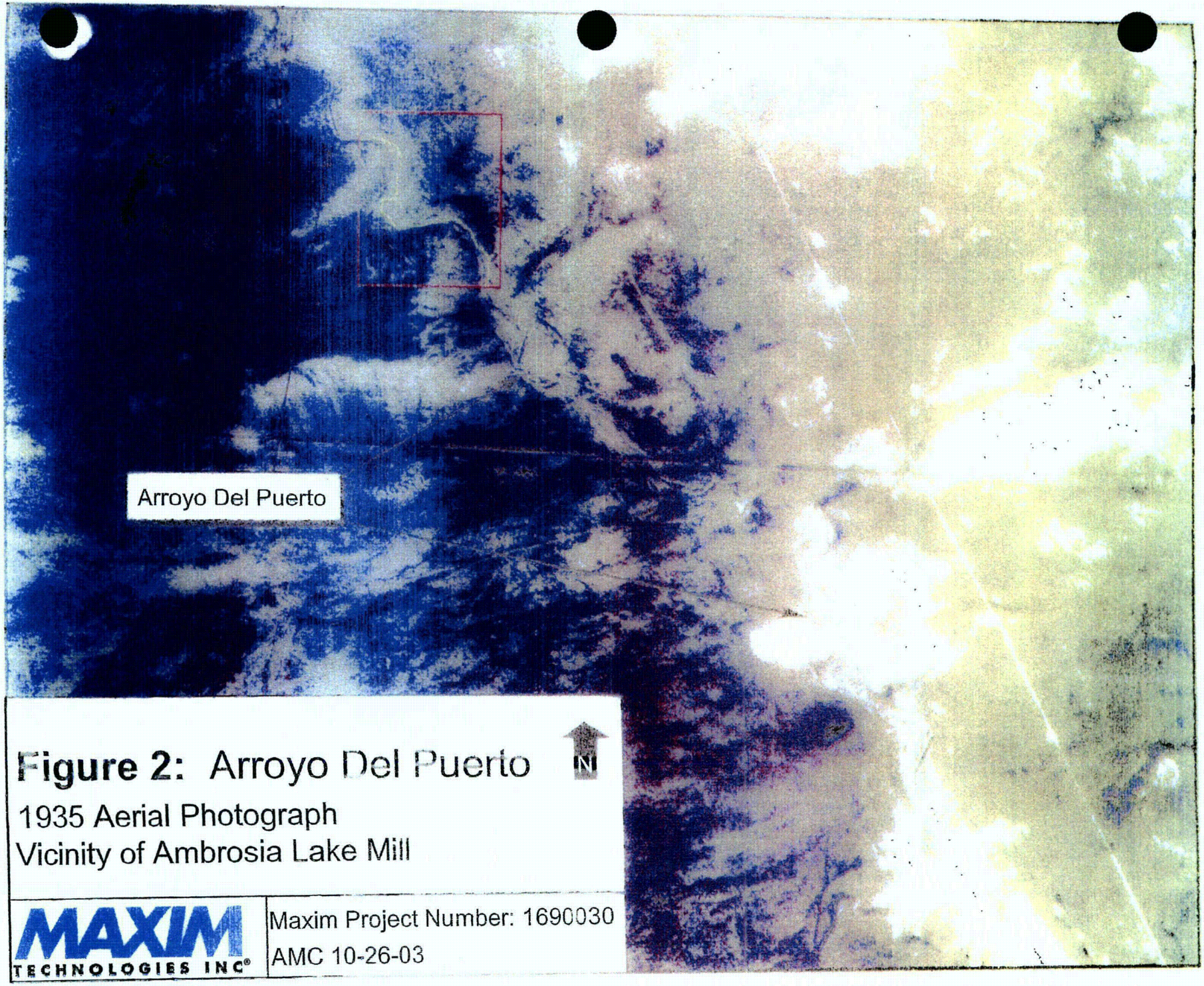


Figure 2: Arroyo Del Puerto

1935 Aerial Photograph
Vicinity of Ambrosia Lake Mill

MAXIM TECHNOLOGIES INC®

Maxim Project Number: 1690030
AMC 10-26-03

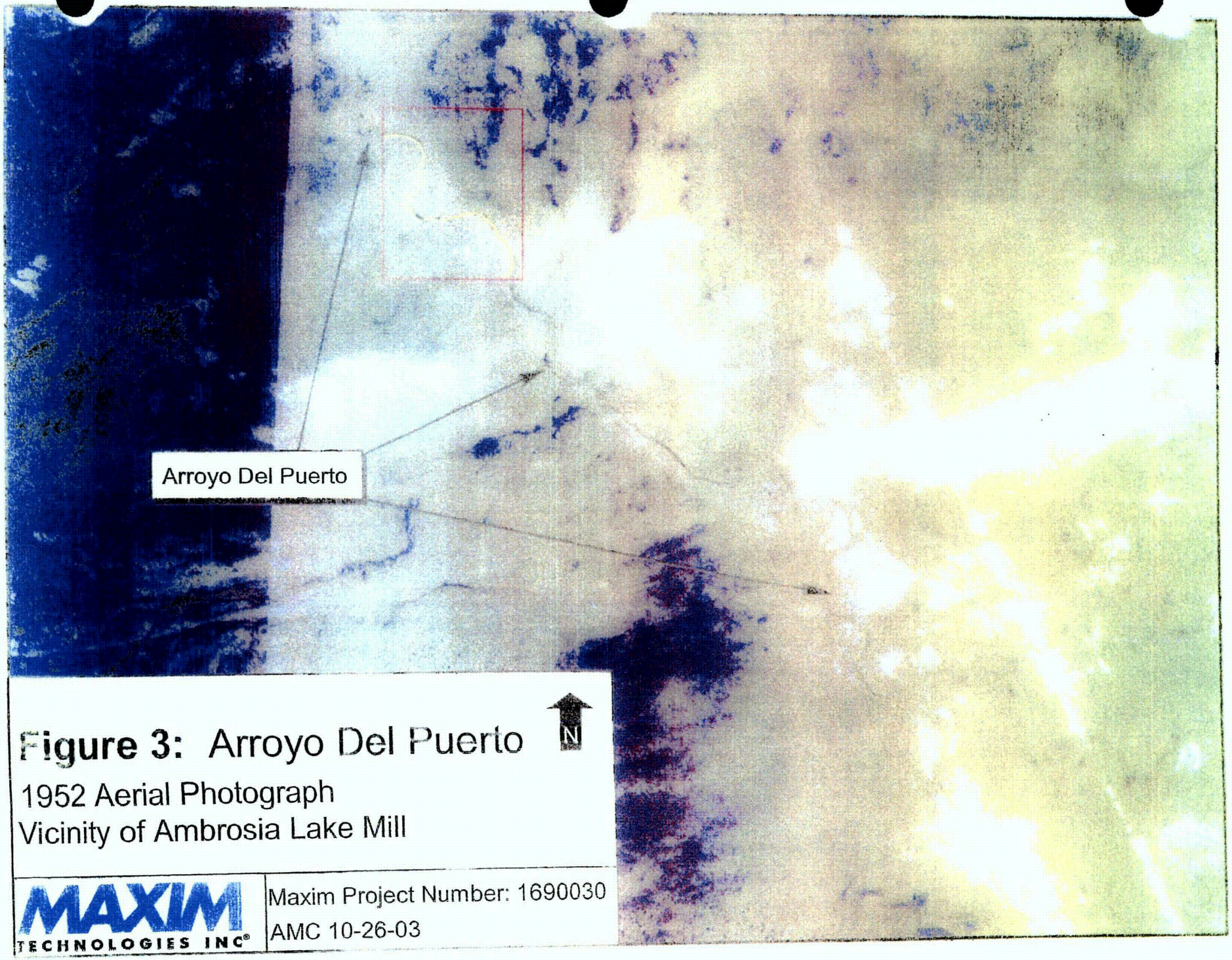


Figure 3: Arroyo Del Puerto

1952 Aerial Photograph
Vicinity of Ambrosia Lake Mill

MAXIM TECHNOLOGIES INC®

Maxim Project Number: 1690030
AMC 10-26-03

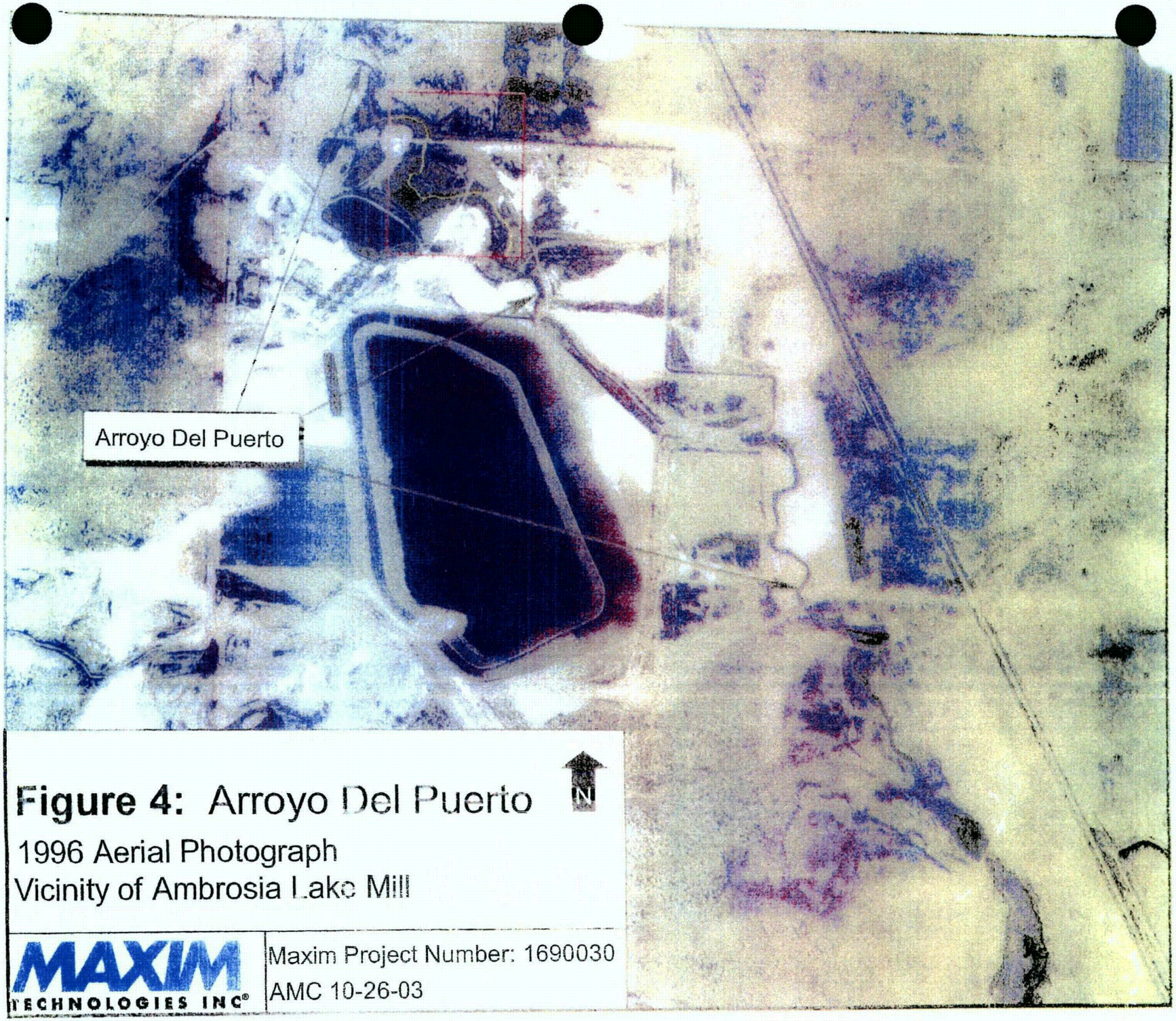
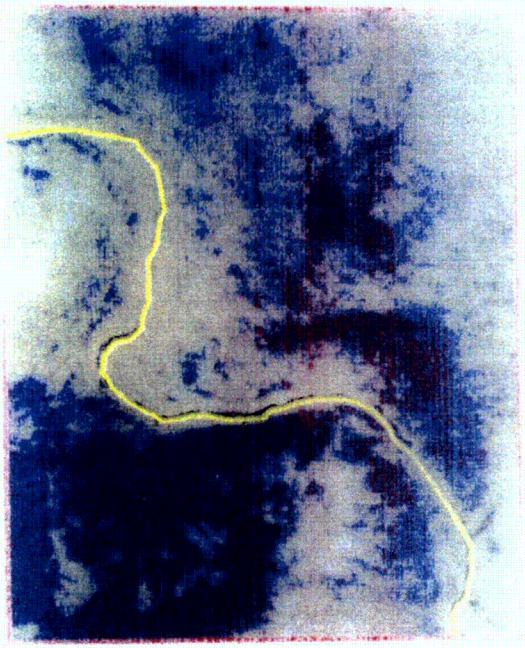


Figure 4: Arroyo Del Puerto

1996 Aerial Photograph
Vicinity of Ambrosia Lake Mill

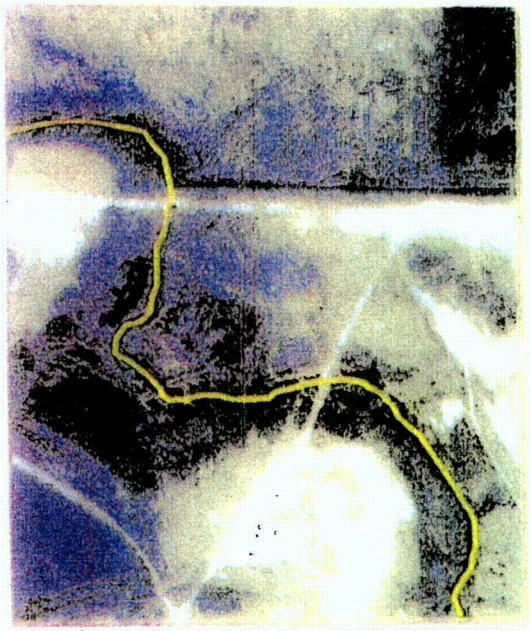
MAXIM TECHNOLOGIES INC®

Maxim Project Number: 1690030
AMC 10-26-03



1935

1952



1996

Figure 5: Detail of Arroyo Del Puerto

N

1935, 1952, and 1996 Aerial Photographs
Vicinity of Ambrosia Lake Mill

MAXIM TECHNOLOGIES INC®

Maxim Project Number: 1690030
AMC 10-26-03

Appendix C .....Interior Site Drainage Calculations

Calculation C.1 PMP Calculation – Local Storm
Calculation C.2 Design Flowrates and Erosion Protection

Appendix C.1 .....Calculation C.1 PMP Calculation – Local Storm

Calculation C.1
Rio Algom Mining LLC
Ambrosia Lake, New Mexico
Arroyo Del Puerto
Interior Site Drainage Calculations
PMP Calculation - Local Storm

1. PMP Calculation - Local Storm

Previous calculation performed in the design report titled:
Reclamation Plan for the Disposal of Pond Sediments and ancillary Materials
Tailings Cell 2 Expansion
Rio Algom Mining LLC, Ambrosia Lake, New Mexico
31-May-07

From that Design Report: 1hr-1mi2 PMP (Local) = 9.6 inches

2. Recalculation

See Figure 1.1 - Regions Covered by Generalized PMP Studies (see Sheet 2 of 16)
Reference: Reference: Hydrometeorological Report No. 55A (HMR 55A)
U.S. Dept of Commerce
NOAA, June 1988

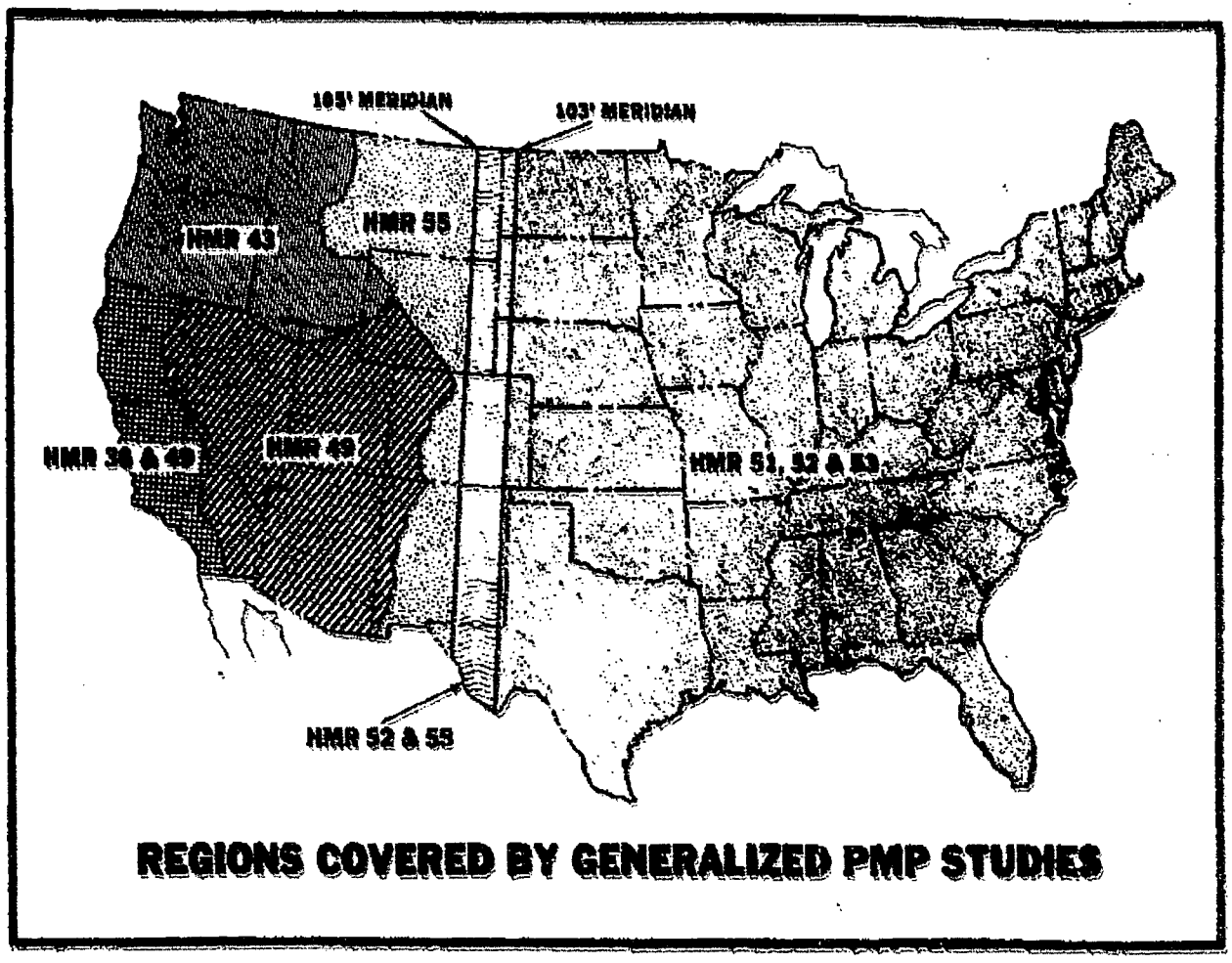


Figure 1.1.—Regions of the conterminous United States for which PMP estimates are provided in indicated Hydrometeorological Reports. See Appendix A for description of geographical region covered and scope of each report.

See the following table indicating the Stepwise Procedure Steps for a Local Storm taken from Section 14.3 of HMR 55A, (as shown on Sheets 4, 5, & 6)

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO EROSION PROTECTION MEASURES
HMR 55A[1] PMP LOCAL STORM CALCULATION
STEPWISE PROCEDURE, LOCAL STORM

Procedure Step #	Item Description	Units	Reference	Results
1	Index 1-hr 1-mi^2 PMP Estimate at 5000 ft elevation	inches	See Plate VI c (HMR 55A)(Sheet 7 of 16)	10.6
2	Maximum persisting 12-hr 1000-mb dew points for July	°F	See Fig 4.11 (Sheet 8 of 16) (HMR 55A)	76.6
	Mean elevation of drainage area	feet	See Design Report Sheet 2 and Worksheet "Drawing Sheet 2" (shown as Calculation Sheet 12 of 16)	7000
	Adjustment for Mean Elevation of Drainage	%	See Fig. 14.3 (Sheet 5 of 16) (HMR 55A)	90%
3	Index 1-hr 1-mi2 PMP Estimate at 7000 ft elevation of Site	inches	Step #1 times Step #2	9.60
4	Depth-Duration Curve for 1 mi^2	inches	From Table 12.4 (Sheet 9 of 16) (HMR 55A)	See Worksheet "PMP Indexes-55", (calc. Sheets 13 & 14 of 16)
5	Areal Reduction Factors	%	From Table 12.12 (Sheet 10 of 16) (HMR 55A)	100%
6	PMP Estimates for Basin	inches	Step #4 times Step #5	No reduction to Step 4 values
7	Incremental PMP Amounts	see temporal sequence	See Tables 12.5 & 12.6 (Sheet 11 of 16) (HMR 55A)	See Worksheet "Incremental PMP" for chronological distributions, (Calc Sheets 15 & 16)

[1] Hydrometeorological Report No. 55A, U.S. Dept. of Commerce, NOAA, June 1988

14.3 Stepwise Procedure, Local Storm

1. Index 1-hr 1-mi^2 PMP estimate at 5,000-ft elevation

Locate the drainage in Plate VI a-c, and determine the drainage average index 1-mi^2 1-hr PMP in inches at 5,000 ft. This is readily accomplished by eye because of the smooth gradient, and linear interpolation is assumed to apply.

2. Adjustment for mean elevation of drainage

Determine the mean drainage elevation to the nearest 100 ft. An adjustment needs to be determined and applied to the depth from step 1 if this elevation differs from 5,000 ft by more than 1,000 ft. If the mean terrain elevation of the drainage is greater than 6,000 ft or less than 4,000 ft, the correct vertical adjustment factor can be obtained by reference to figure 14.3. This is a nomogram of vertical elevation adjustments as discussed in section 12.3.2.4. To use the nomogram, enter the horizontal scale (abscissa) at the maximum persisting 12-hr 1000-mb dew point obtained from figure 4.11 for the location of the drainage. Move vertically to the figure to intersect the mean elevation of the drainage (to the nearest 100 ft) and read off the adjustment factor on the vertical scale (ordinate).

As an example of this determination, take a drainage that has a mean elevation of 7,800 ft and a maximum persisting 12-hr dew point of 70°F. Entering figure 14.3 at 70° on the abscissa and moving vertically to 7,800 ft, an adjustment factor of 0.82 is read from the ordinate.

3. Index 1-hr 1-mi^2 PMP estimate at mean elevation of drainage

Multiply the adjustment factor determined in step 2, if needed, by the index 1-mi^2 1-hr depth from step 1 to obtain a representative surface adjusted index PMP estimate.

4. Depth-duration curve for 1 mi^2

Refer to table 12.4 to obtain the 1-mi^2 factors for durations up to 6 hr. Multiply these factors by the estimate from step 3. These can be plotted on linear graph paper and a smooth curve drawn to obtain intermediate durational amounts if these are needed for the 1-mi^2 area.

5. Areal reduction factors

To obtain areal reduction factors, use the relations provided in figure 12.20. Find the drainage area on the abscissa and read the corresponding reduction factors as percent of the 1-mi^2 PMP.

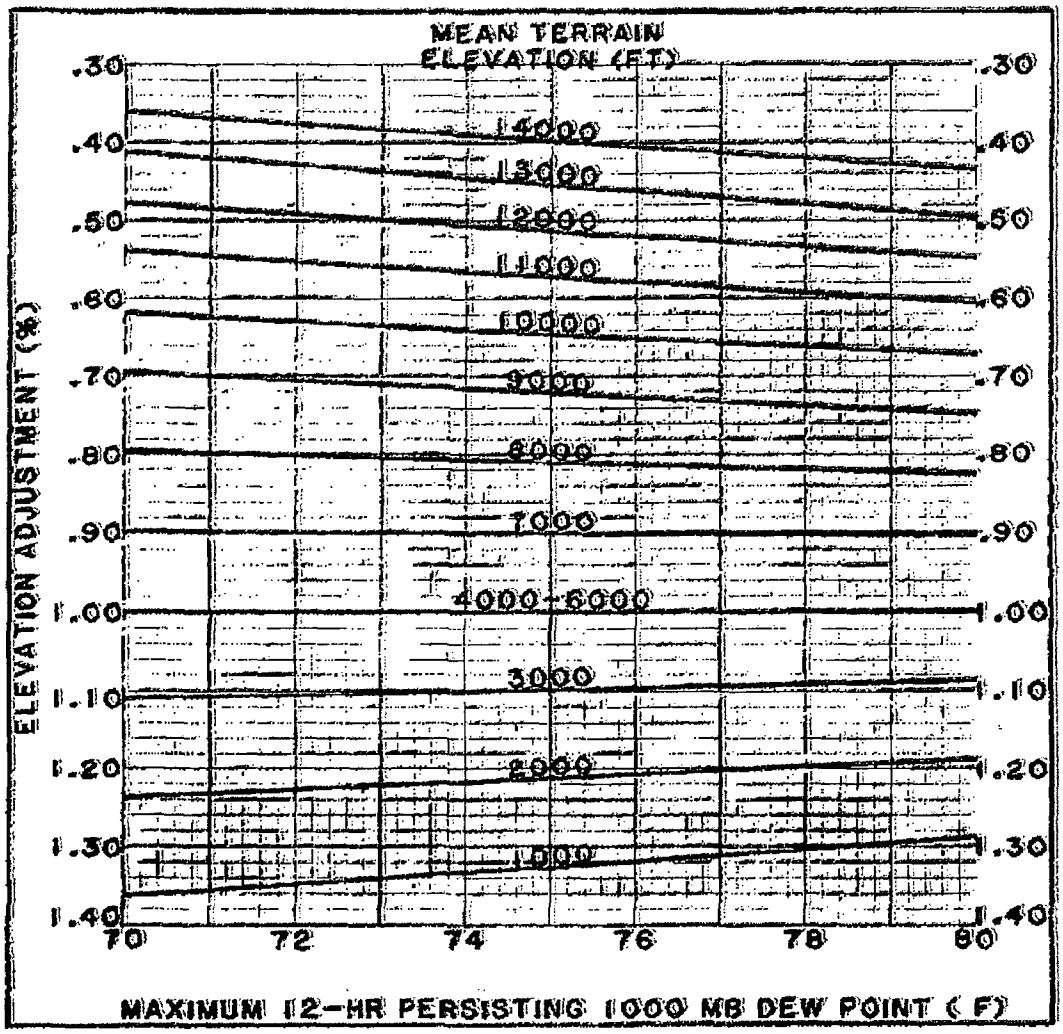


Figure 14.3.—Adjustment for elevation for local-storm PMP based on procedures developed in the report and maximum persisting 12-hr 1000-mb dew point (°F).

6. PMP estimates for basin

Multiply percentages of step 5 by the index PMP amounts from step 4. These values should be plotted on linear graph paper and a smooth curve drawn through the points. Values for the intermediate durations may be determined from this curve.

7. Incremental PMP amounts

If needed, local-storm PMP incremental amounts obtained through subtraction of adjacent amounts in step 6 may be arranged in temporal sequences recommended in tables 12.5 and 12.6.

No example is believed necessary for local-storm PMP determination, as the adjustment for elevation is the only complex element in the determination, and an example calculation of this factor is given in step 2.

15. FUTURE STUDIES

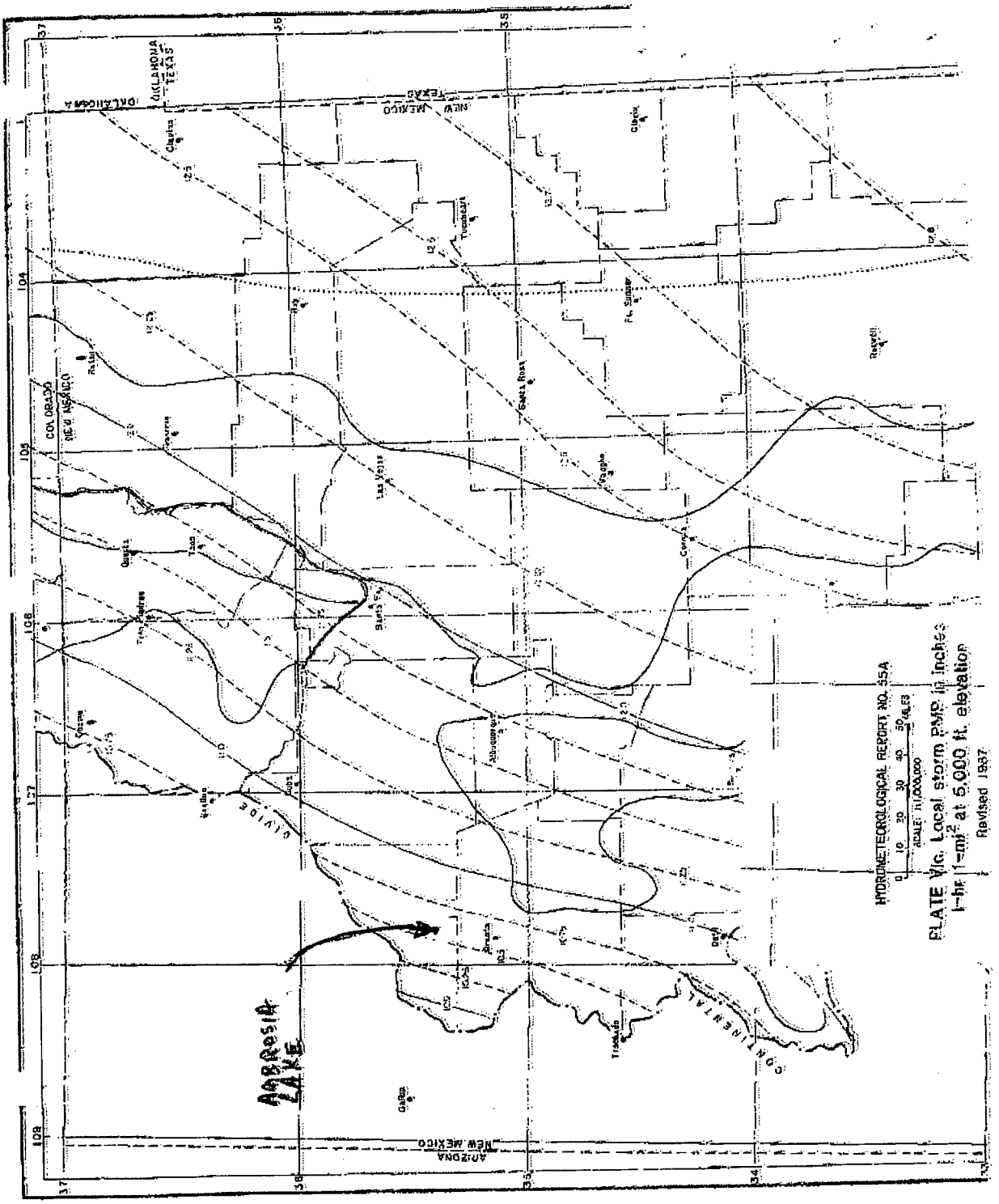
There are several problems involved in the development of design estimates that should be resolved. The purpose of this chapter is to briefly discuss these needed future studies.

15.1 Seasonal Variation

In the present study, it has been possible to develop only all-season PMP estimates. Although no attempt has been made to define the season of occurrence, some observations are possible. In the northern portion of the study region among the more important storms are Gibson Dam, MT (75), June 6-8, 1964; Warrick, MT (10), June 6-8, 1906; Springbrook, MT (32), June 17-21, 1921; and Savageton, WY (38), September 27-October 1, 1923. Through the central portion of the study region, Cherry Creek (47) and Hale (101), CO, May 30-31, 1935, Plum Creek (76), CO, June 13-20, 1965, Big Elk Meadow (77), CO May 4-8, 1969, and Big Thompson, July 31, 1976 are important in determining PMP estimates. In the extreme southern part of the study region, tropical storms or their remnants will be the causative mechanism for the longer duration PMP event. Such storms as Rancho Grande (60), NM, August 26-September 1, 1942, and Meek (27), NM, September 15-17, 1919 are typical of these events. Shorter duration storms similar to that at White Sands, NM, August 19, 1978 are important in this region. These storm dates suggest that the all-season PMP event will occur from early summer through fall. In those portions of the study region where snowmelt can be a critical factor, the probable maximum flood (PMF) may be the result of the lesser magnitude spring PMP event and accompanying snowmelt. The definition of the seasonal variation of PMP is, therefore, a necessary addition to the present report.

15.2 Permissible Snowpack With PMP and Snowmelt Criteria

To adequately evaluate the spring PMF, two additional factors are required. The first is an evaluation of the snowpack that could exist prior to the PMP event. The question to be answered is the depth and extent of the snow cover. Could, for example, the probable maximum snowpack (PMSP) occur just prior to the


HYDROMETEOROLOGICAL REPORT NO. 55A
PLATE VIc. Local storm PMP in inches
1-hr 1-mi² at 5,000 ft. elevation
Revised 1987
ARROYO LAKE
COLORADO
NEW MEXICO
ARIZONA
TEXAS
OKLAHOMA
DIVIDE
CONTINENTAL

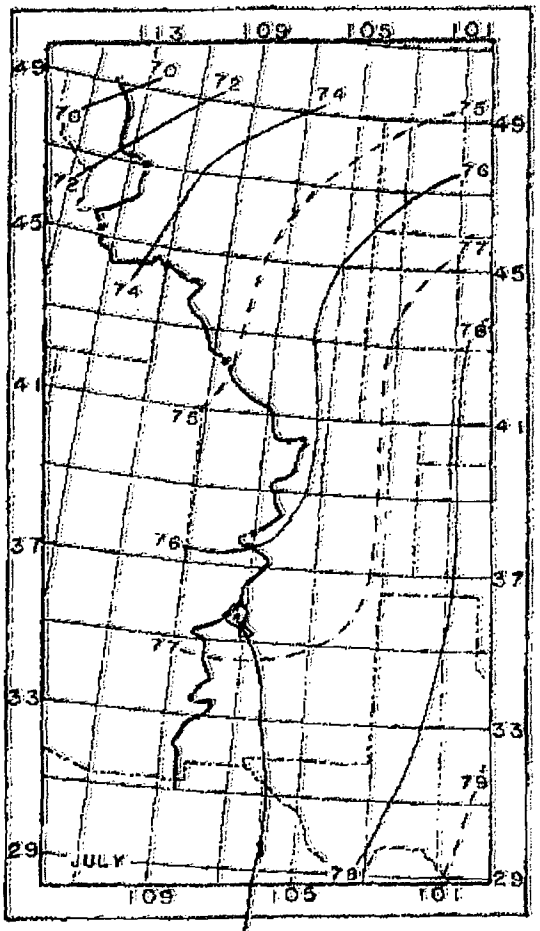


Figure 4.11.—Maximum persisting 12-hr 1000-mb dew points (°F) for July.

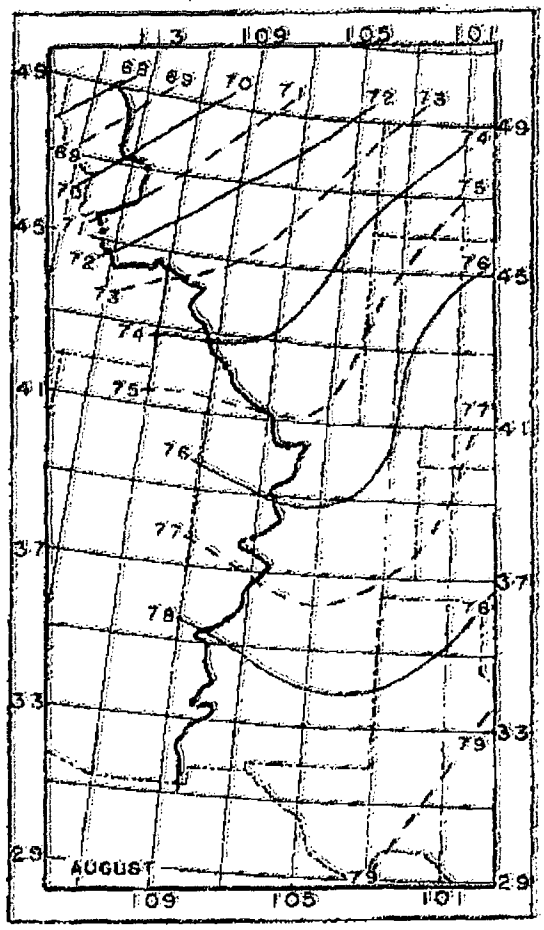


Figure 4.12.—Maximum persisting 12-hr 1000-mb dew points (°F) for August.

AMBROSIA LAKE

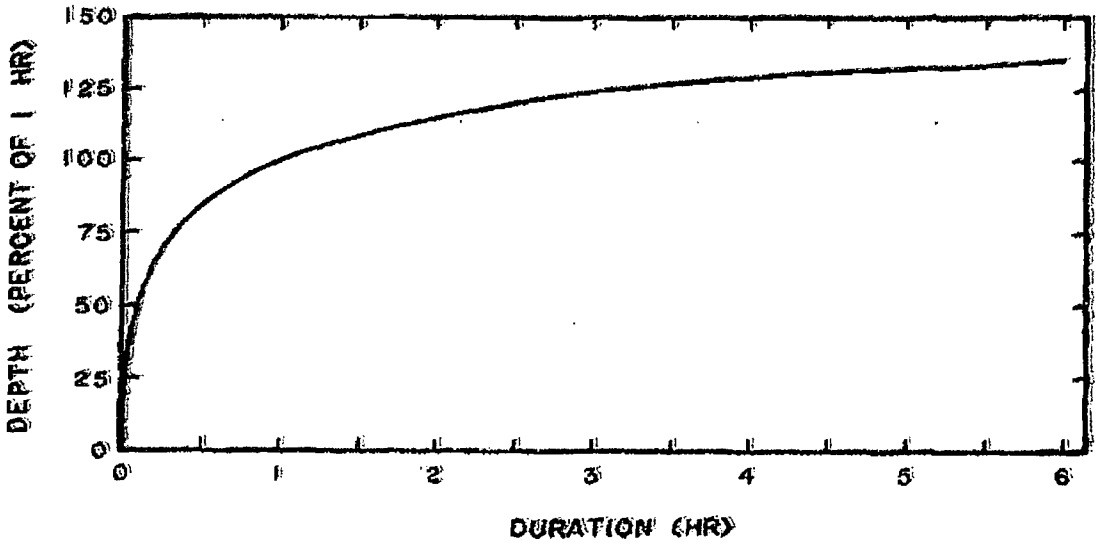


Figure 12.10.—Depth-duration curve for 6-/1-hr ratio of 1.35.

Table 12.A.—Percent of 1-hr local-storm PMP for selected durations for 6-/1-hr ratio of 1.35 (HMR No. 49)

Duration (hr)	Percent of 1 hr
1/4	.68
1/2	.86
3/4	.94
1	1.00
2	1.16
3	1.23
4	1.28
5	1.32
6	1.35

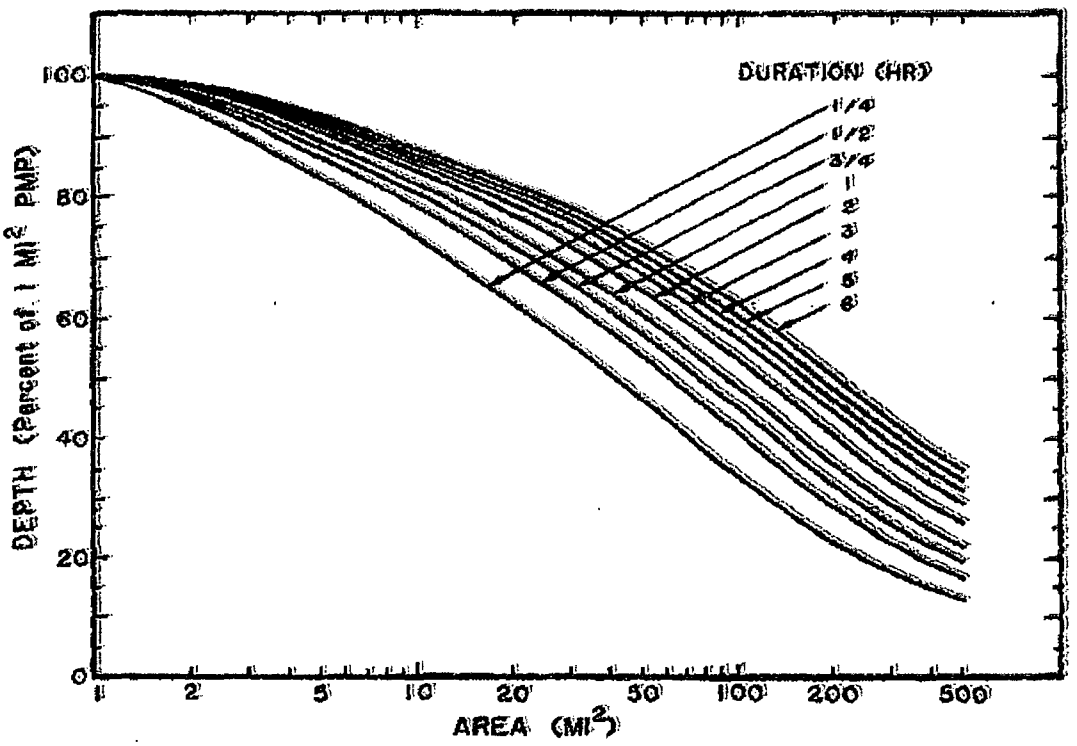


Figure 12.12.—Depth-area relations adopted for local-storm PMP in the CD-103 region (Hansen et al. 1977).

the storm in figure 12.9 that was constructed from a written account of the storm. The sequence of the hourly incremental rainfall for the storm shows that the storm decreased each succeeding hour after the first hour. However, meaningful conclusions cannot be drawn from this one example.

To supplement the lack of available data in the CD-103 region, data from HMR No. 49 was utilized. These data are presented in table 12.5 and include time distribution measurements from 6-hr storms, as utilized by the U.S. Weather Bureau (1947) and by the U.S. Army Corps of Engineers (1965). The choice of which of the two to apply is left to the user, as one sequence may be more critical than the other in a specific case.

There were no data available for the extreme local storms in the CD-103 region from which to determine the sequence of 15-min increments in the 1-hr storm. The 15-min incremental sequence taken from HMR No. 49 is, therefore, recommended. This incremental sequence appears in table 12.6. It is the result of percentages of total rainfall for thunderstorm rainfall determined by the U.S. Weather Bureau (1947).

Table 12.5.—Recommended chronological distribution of 1-hr incremental rainfall amounts for 6-hr local-storm PMP (Hansen et al. 1977)

Increment	Sequence position	
	HMR No. 5*	EM1110-2-1411#
Largest hourly increment	third	fourth
Second largest	fourth	third
Third largest	second	fifth
Fourth largest	fifth	second
Fifth largest	last	last
Least	first	first

* U.S. Weather Bureau 1947
\# U.S. Corps of Engineers, Standard Project Flood Determinations, March 1952, revised March 1965

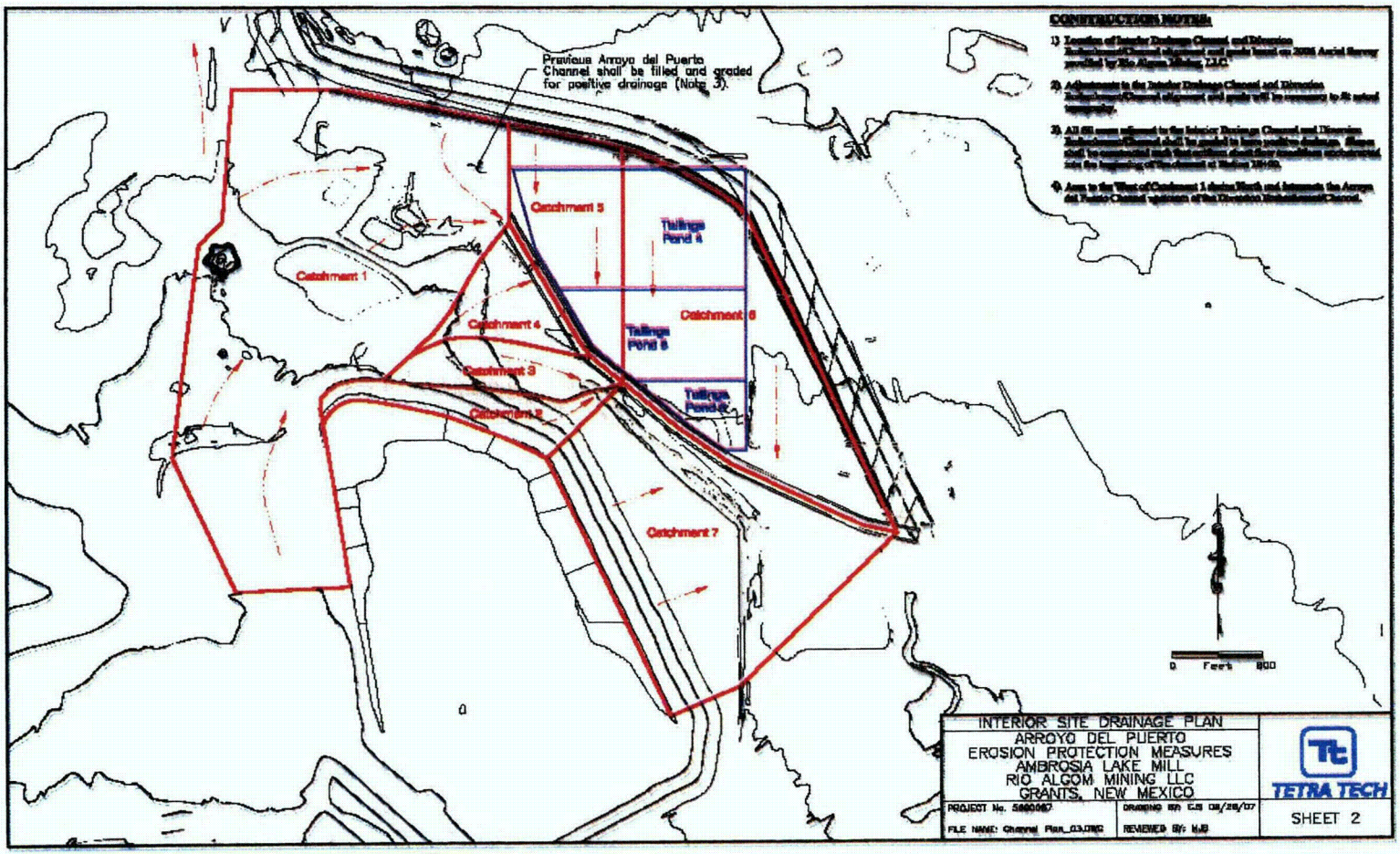
12.8 Seasonal Distribution

A brief analysis was undertaken to determine the season of occurrence of the local storm in the CD-103 region. The analysis took the form of recording the maximum 1-hr event at recorder stations throughout the CD-103 region (sec. 12.5.1). The period of record totaled 31 years (1948-78); however, many stations had fewer years than this maximum period of record. It was decided to use only stations that had 20 or more years of precipitation record. This removed stations whose data may not have been representative of the true conditions at the station because of an insufficient period of record.

Table 12.7 shows the seasonal distribution of the maximum 1-hr events at selected stations in the CD-103 region. Most of the maxima occur in the summer months of June, July, and August. These months represent the months of greatest potential moisture influx into the region, as shown by the maximum persisting 12-hr 1000-mb dew-point charts of chapter 4. The months of May and September show fewer recorded maximum 1-hr events, while April and October show the least. No other months in the year produced maximum 1-hr events of record for this period. These results are not unlike those found in HMR No. 49.

Table 12.6.—Recommended chronological distribution of 15-min incremental rainfall amounts for 1-hr local-storm PMP (Hansen et al. 1977)

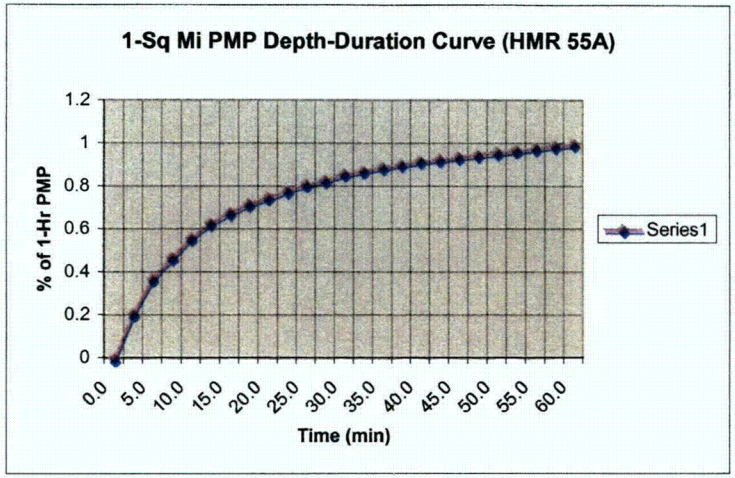
Increment	Sequence position
Largest 15-min increment	first
Second largest	second
Third largest	third
Fourth largest	fourth


Previous Arroyo del Puerto Channel shall be filled and graded for positive drainage (Note 3).
Catchment 1
Catchment 2
Catchment 3
Catchment 4
Catchment 5
Catchment 6
Catchment 7
Tailings Pond 4
Tailings Pond 5
Tailings Pond 6
0 Feet 800
INTERIOR SITE DRAINAGE PLAN
ARROYO DEL PUERTO
EROSION PROTECTION MEASURES
AMBROSIA LAKE MILL
RIO ALGOM MINING LLC
GRANTS, NEW MEXICO
TETRA TECH
SHEET 2

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO

1-HOUR PMP DEPTH-DURATION CURVE

Duration (min)	Percent of 1-hr PMP[1]	1-hr 1-mi^2 PMP (inches)	PMP 1-hr Indexes up to 6 hr
0.0	0	9.6	0.00
2.5	21.0%	9.6	2.02
5.0	37.0%	9.6	3.55
7.5	47.0%	9.6	4.51
10.0	56.0%	9.6	5.38
12.5	63.0%	9.6	6.05
15.0	68.0%	9.6	6.53
17.5	72.0%	9.6	6.91
20.0	75.0%	9.6	7.20
22.5	78.0%	9.6	7.49
25.0	81.0%	9.6	7.78
27.5	83.0%	9.6	7.97
30.0	86.0%	9.6	8.26
32.5	87.5%	9.6	8.40
35.0	89.0%	9.6	8.54
37.5	90.5%	9.6	8.69
40.0	92.0%	9.6	8.83
42.5	93.0%	9.6	8.93
45.0	94.0%	9.6	9.02
47.5	95.0%	9.6	9.12
50.0	96.0%	9.6	9.22
52.5	97.0%	9.6	9.31
55.0	98.0%	9.6	9.41
57.5	99.0%	9.6	9.50
60.0	100%	9.6	9.60

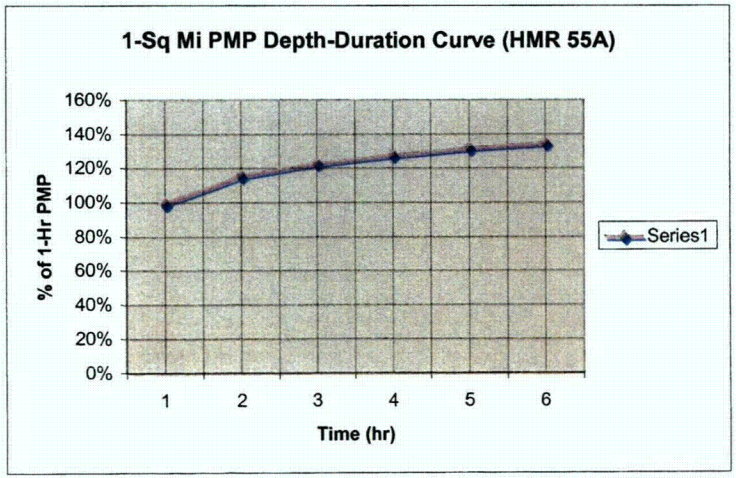


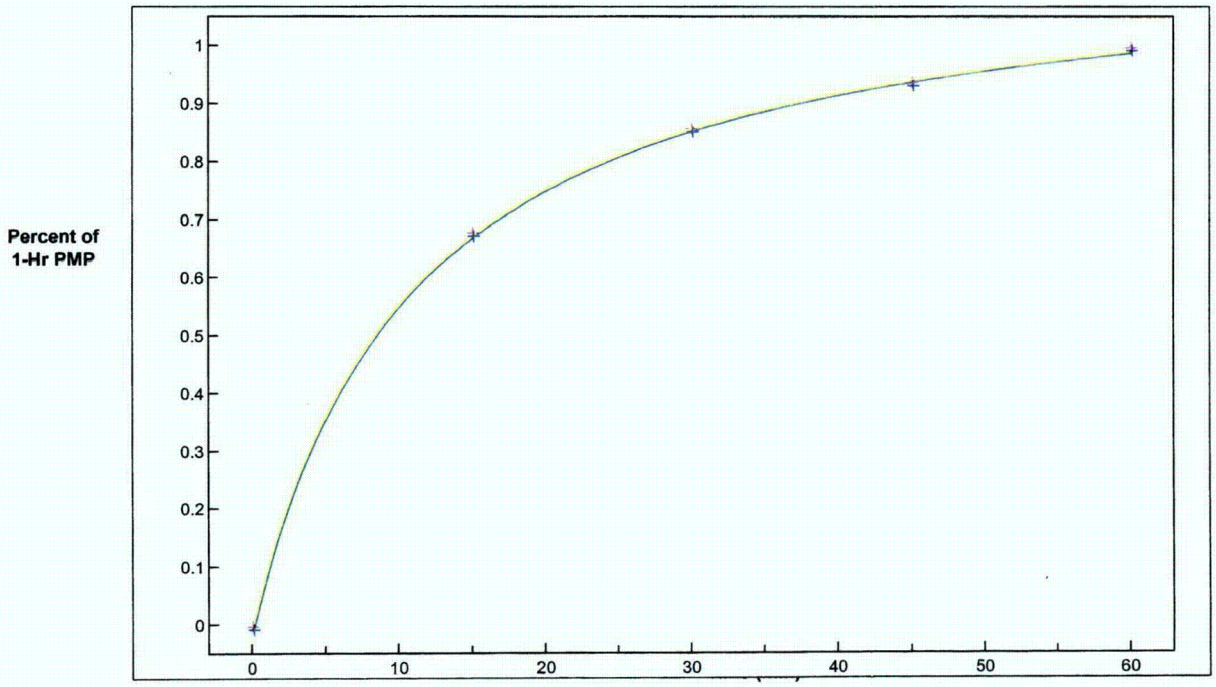
[1] Interpolated Values

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO

6-HOUR PMP DEPTH-DURATION CURVE

Duration (hr)	Percent of 1-hr PMP	1-hr 1-mi^2 PMP (inches)	PMP 1-hr Indexes up to 6 hr
1	100%	9.6	9.60
2	116%	9.6	11.14
3	123%	9.6	11.81
4	128%	9.6	12.29
5	132%	9.6	12.67
6	135%	9.6	12.96





1-Sq Mi PMP Depth-Duration Curve Up to 60 Minutes
Interpreted from HMR 55A Data from Table 12.4

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO

CHRONOLOGICAL DISTRIBUTION OF 15-MINUTE INCREMENTAL RAINFALL AMOUNTS FOR 1-HOUR LOCAL-STORM PMP

Duration (hr)	Percent of 1-hr PMP	1-hr 1-mi^2 PMP (inches)	PMP 1-hr Indexes	Incremental PMP Amounts (inches)	Size of Increment	HMR 5 & 49[1]	
0.00	0.00	9.60	0.00	0.00		Sequence Position	Increment Amount
15.00	0.68	9.60	6.53	6.53	Largest 15-min increment	First	6.53
30.00	0.86	9.60	8.26	1.73	2nd largest	Second	1.73
45.00	0.94	9.60	9.02	0.77	Third Largest	Third	0.77
60.00	1.00	9.60	9.60	0.58	Fourth Largest	Fourth	0.58

[1] HMR 5 (U.S. Weather Bureau, 1947); and HMR 49 (U.S. Weather Bureau, 1977, Reprinted 1984)

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO
CHRONOLOGICAL DISTRIBUTION OF 1-HOUR INCREMENTAL RAINFALL AMOUNTS FOR 6-HOUR LOCAL-STORM PMP

Duration (hr)	Percent of 1-hr PMP	1-hr 1-mi^2 PMP (inches)	PMP 1-hr Indexes up to 6 hr	Incremental PMP Amounts (inches)	Size of Increment	HMR 5 & 49[1]		EM1110-2-1411[2]	
0.00	0.00	9.60	0.00	0.00		Sequence Position	Increment Amount	Sequence Position	Increment Amount
1.00	1.00	9.60	9.60	9.60	Largest hourly increment	Third	0.67	Fourth	0.48
2.00	1.16	9.60	11.14	1.54	2nd largest	Fourth	0.48	Third	0.67
3.00	1.23	9.60	11.81	0.67	Third largest	Second	1.54	Fifth	0.38
4.00	1.28	9.60	12.29	0.48	Fourth largest	Fifth	0.38	Second	1.54
5.00	1.32	9.60	12.67	0.38	Fifth largest	Last	0.29	Last	0.29
6.00	1.35	9.60	12.96	0.29	Least	First	9.60	First	9.60

[1] HMR 5 (U.S. Weather Bureau, 1947); and HMR 49 (U.S. Weather Bureau, 1977, Reprinted 1984)
[2] EM1110-2-1411 (U.S. Corps of Engineers, Standard Project Flood Determinations, March 1952, revised March 1965

Appendix C.2 ..... Calculation C.2 Design Flowrates and Erosion Protection

Calculation C.2
Rio Algom Mining LLC
Ambrosia Lake, New Mexico
Arroyo Del Puerto
Interior Site Drainage Calculations
Design Flowrates and Erosion Protection

1. Determine Flowrates - Stepwise Procedure

See the following table indicating the Stepwise Procedure Steps to determine the design flowrates to be used to size erosion protection.

RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO EROSION PROTECTION MEASURES HYDROLOGY[1]				
STEPWISE PROCEDURE				
Procedure Step #	Item Description	Item Variable ID	Units	Results
1	Catchment Areas	A	acres	See Design Report Sheet 2 and Worksheet "Drawing Sheet 2" (calc. Sheet 3 of 23)
2	Maximum Flow Length	L	feet	See Design Report Sheet 2 and Worksheet "Drawing Sheet 2" (calc. Sheet 3 of 23)
3	Upper Elevation of Cell #2 Catchment Area	H_1	feet	See Design Report Sheet 2 and Worksheet "Drawing Sheet 2" (calc. Sheet 3 of 23)
4	Lower Elevation of Cell #2 Catchment Area	H_2	feet	See Design Report Sheet 2 and Worksheet "Drawing Sheet 2" (calc. Sheet 3 of 23)
5	Slope of Cell #2 Catchment Area	S	ft/ft	$(H_1 - H_2)/L$
6	Time of Concentration	T_c	min	NUREG/CR-4620, Equation 4.44
7	% PMP Values from Depth Duration Curve (HMR 55A)	% PMP	%	See curve developed in PMP Local Storm Calculation C.1 and shown again here in Worksheet "PMP Indexes-55" (calc. Sheets 4 & 5 of 23)
8	PMP Rainfall Depth	D	inches	% PMP x (PMP)
9	Rainfall Intensity	*i*	in/hr	$60D/T_c$
10	Maximum Design Flowrate	Q	cfs	Rational Method: Q = CiA
11	Runoff Coefficient	C	nt	(NUREG/CR-4620)
12	Unit Width Maximum Design Flowrate	q	cfs	$q = CiA_w = L \times (1 \text{ ft width})$

[1] NUREG/CR-4620, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June

2. Design Flowrate summary results

   See **Worksheet "Design Flowrates"** (calc. Sheets 6 & 7 of 23) for summary of catchment areas and applicable design flowrates. Stationing for interior channel shown on Design Report Sheet 4 and **Worksheet "Drawing Sheet 4"** (calc. Sheet 8 of 23), as well as Design Report Plan & Profile Sheets 12, 13, 14, and 15.

3. Catchment Area and Flowrate summary at Interior Channel Stationing

   See **Worksheet "Flow Summary"** (calc. Sheet 9 of 23) for specific flowrates at channel stationing

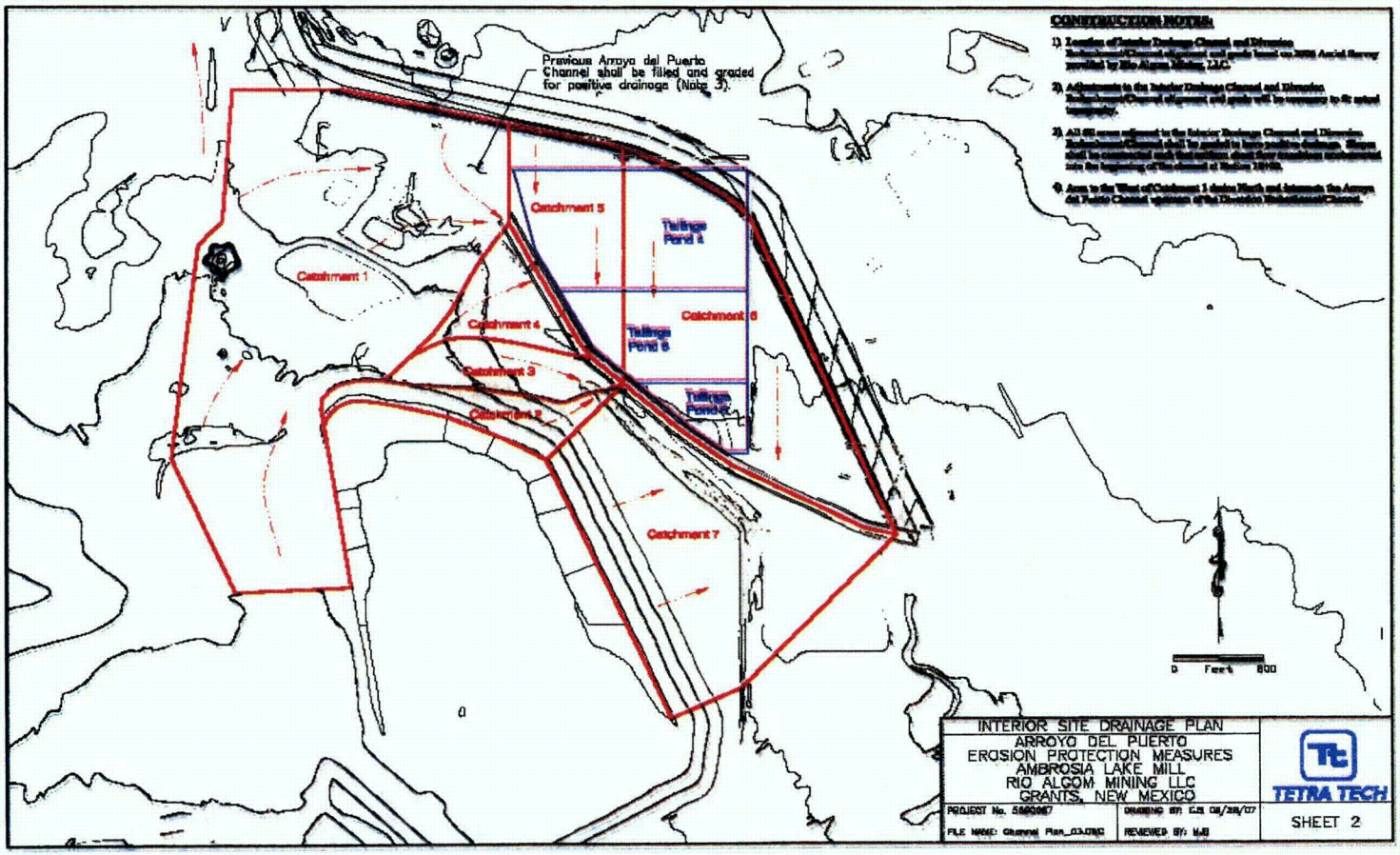
4. Rock Sizing Methods - see **Worksheet " Summary - Rock Methods"** (calc. Sheet 10 of 23)

5. Interior Drainage Channel Stationing and Elevation Summary - see **Worksheet "Elevation Summary"** (calc Sheets 11 & 12 of 23)

6. Interior Drainage Channel Erosion Protection Summary - see **Worksheet "Rock Summary"** (calc. Sheet 13 of 23)

7. Interior Drainage Channel Erosion Protection calculations at specific stationing:
   See remaining Worksheets for inlet, outlet, and channel stations:

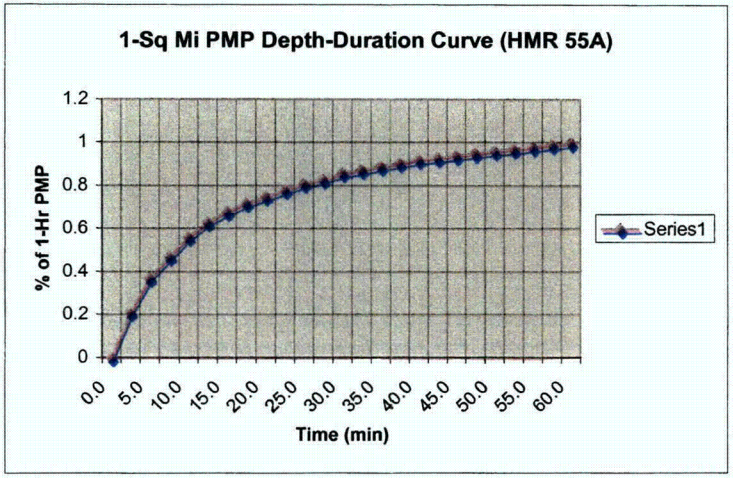
Inlet - Sta 8+00	0.5% slope	Calc. Sheet 14 of 23
Channel - Sta 8+00	4.0% slope	Calc. Sheet 15 of 23
Channel - Sta 10+25	4.0% slope	Calc. Sheet 16 of 23
Channel - Sta 10+25	0.5% slope	Calc. Sheet 17 of 23
Channel - Sta 24+00	0.5% slope	Calc. Sheet 18 of 23
Channel - Sta 27+50	0.5% slope	Calc. Sheet 19 of 23
Channel - Sta 43+00	0.5% slope	Calc. Sheet 20 of 23
Outlet - Sta 43+00	0.5% slope	Calc. Sheet 21 of 23
Channel - Sta 57+00	0.84% slope	Calc. Sheet 22 of 23
Outlet - Sta 57+00	0.84% slope	Calc. Sheet 23 of 23


Previous Arroyo del Puerto Channel shall be filled and graded for positive drainage (Note 3).
Catchment 1
Catchment 3
Catchment 4
Catchment 5
Catchment 6
Catchment 7
Tailings Pond 4
Tailings Pond 5
Tailings Pond 6
0 Feet 800
INTERIOR SITE DRAINAGE PLAN
ARROYO DEL PUERTO
EROSION PROTECTION MEASURES
AMBROSIA LAKE MILL
RIO ALGOM MINING LLC
GRANTS, NEW MEXICO
TETRA TECH
SHEET 2

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO

1-HOUR PMP DEPTH-DURATION CURVE

Duration (min)	Percent of 1-hr PMP	1-hr 1-mi^2 PMP (inches)	PMP 1-hr Indexes up to 6 hr
0.0	0	9.6	0.00
2.5	21.0%	9.6	2.02
5.0	37.0%	9.6	3.55
7.5	47.0%	9.6	4.51
10.0	56.0%	9.6	5.38
12.5	63.0%	9.6	6.05
15.0	68.0%	9.6	6.53
17.5	72.0%	9.6	6.91
20.0	75.0%	9.6	7.20
22.5	78.0%	9.6	7.49
25.0	81.0%	9.6	7.78
27.5	83.0%	9.6	7.97
30.0	86.0%	9.6	8.26
32.5	87.5%	9.6	8.40
35.0	89.0%	9.6	8.54
37.5	90.5%	9.6	8.69
40.0	92.0%	9.6	8.83
42.5	93.0%	9.6	8.93
45.0	94.0%	9.6	9.02
47.5	95.0%	9.6	9.12
50.0	96.0%	9.6	9.22
52.5	97.0%	9.6	9.31
55.0	98.0%	9.6	9.41
57.5	99.0%	9.6	9.50
60.0	100%	9.6	9.60

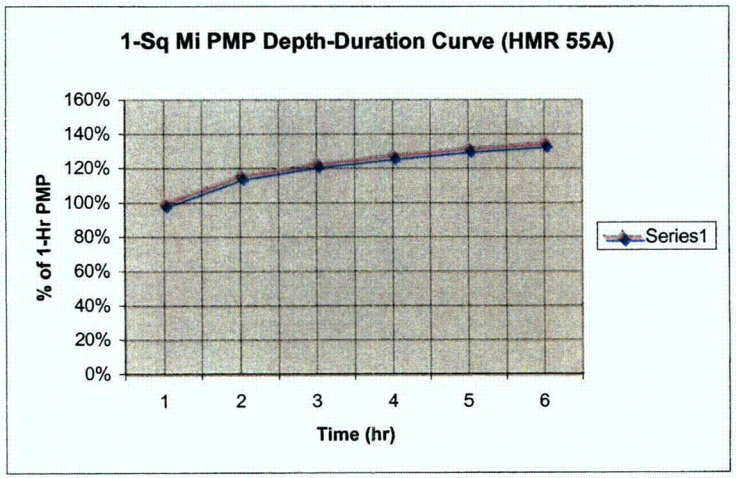


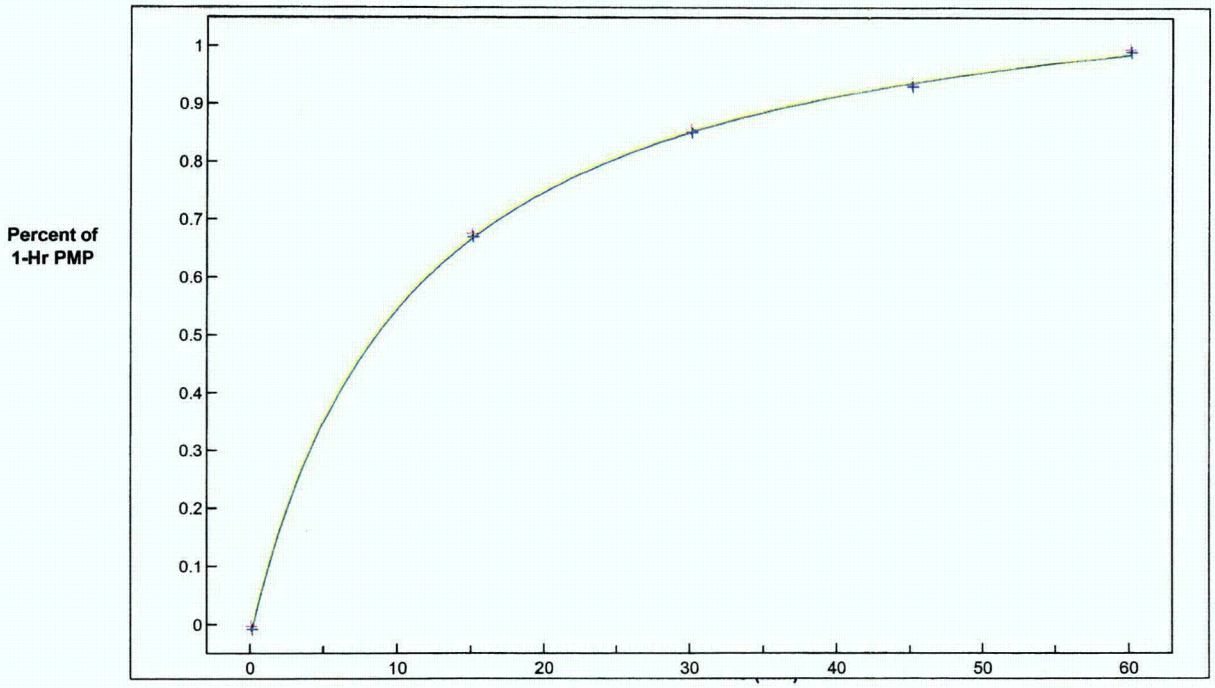
[1] Interpolated Values

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO

6-HOUR PMP DEPTH-DURATION CURVE

Duration (hr)	Percent of 1-hr PMP	1-hr 1-mi^2 PMP (inches)	PMP 1-hr Indexes up to 6 hr
1	100%	9.6	9.60
2	116%	9.6	11.14
3	123%	9.6	11.81
4	128%	9.6	12.29
5	132%	9.6	12.67
6	135%	9.6	12.96





1-Sq Mi PMP Depth-Duration Curve Up to 60 Minutes
Interpreted from HMR 55A Data from Table 12.4

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO
INTERIOR SITE DRAINAGE CALCULATIONS
DESIGN FLOWRATES - RATIONAL METHOD, AND ROCK SIZING [2, 3]

Catchment Drainage Area No.	A = Area [1] (acres)	PMP = Local 1-Hr 1-Mi^2 PMP Depth (inches)	H_1 = Higher Elevation (feet)	H_2 = Lower Elevation (feet)	H1 - H2	S = Slope (ft/ft)	L = Maximum Slope Length (feet)	A_W = Unit Width Area [1] (acres)	Specific Area Time of Concentration T_c= (0.0078 * ($L^{0.77}$)) / ($S^{0.385}$) (min)	% of PMP Index
1	180.2	9.60	7041	6930	111.00	0.022	5050.0		24.1	79.9%
2	15.7	9.60	7026	6926	100.00	0.037	2706.0		12.2	62.2%
3	16.3	9.60	7007	6926	81.00	0.030	2701.0		13.2	64.4%
4	29.8	9.60	7005	6926	79.00	0.029	2700.0		13.3	64.7%
5	34.4	9.60	6945	6925	20.00	0.008	2400.0		19.7	74.7%
5-Overland	0.046	9.60	6942	6925	17.00	0.009	2000.0	0.0458	17.0	71.2%
6	87.6	9.60	6942	6910	32.00	0.008	4000.0		29.7	85.7%
6-Overland	0.055	9.60	6940	6920	20.00	0.008	2400.0	0.0550	19.7	74.7%
7	107.4	9.60	7025	6910	115.00	0.048	2400.0		10.1	56.2%
Inside Sideslope of Diversion Berm	0.0010	9.60			15.00	0.333	45.0	0.0010	0.2	1.9%

[1] Sheet 2, Arroyo Del Puerto Erosion Protection Measures

[2] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[3] Abt, S.R., Johnson, T.L., Thornton, C.I. and Trabant, S.C., Riprap Sizing at the Toe of Embankment Slopes, J. of Hydr. Engr., ASCE, 1998.

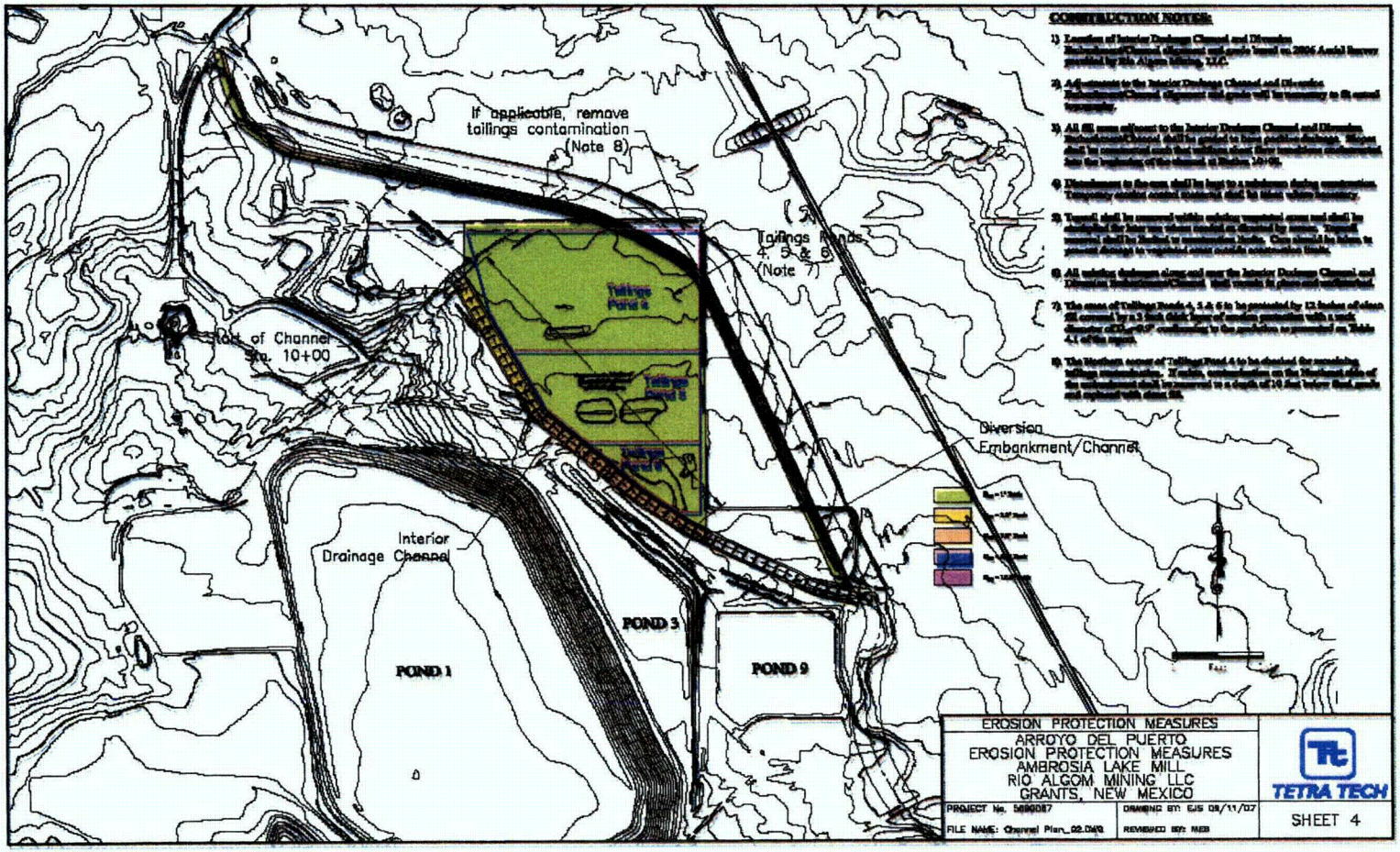
RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO EROSION PROTECTION MEASURES
INTERIOR SITE DRAINAGE CALCULATIONS
DESIGN FLOWRATES - RATIONAL METHOD, AND ROCK SIZING [2, 3]

Catchment Drainage Area No.	A = Area [1] (acres)	D = Rainfall Depth = %PMPxPMP (inches)	i = Rainfall Intensity = D*60/T_c = (inches/hr)	Q = Peak Discharge = CiA (cfs)	Station Location	Cumulative Q in Channel	q_d = Design Unit Width Peak Discharge = CiA_W (cfs/ft)	D_{50} Overland	Oversize 4%	D_{50} Summary Size to Use	
										Location	Size (inches)
1	180.2	7.67	19.10	570.11	0+00	570.11					
2	15.7	5.97	29.35	875.78	27+50	1445.90					
3	16.3	6.18	28.10	838.48	27+50	2284.38					
4	29.8	6.21	27.94	833.95	27+50	3118.33					
5	34.4	7.17	21.79	650.41	27+50	3768.73					
5-Overland	0.046	6.84	24.10				1.10	0.71	0.74	Overland	1.0
6	87.6	8.22	16.60	495.52	56+00	4264.25					
6-Overland	0.055	7.17	21.79				1.20	0.74	0.77	Overland	1.0
7	107.4	5.39	32.15	959.47	56+00	959.47					
Inside Sideslope of Diversion Berm	0.0010	0.18	48.38				0.05	0.61	0.63	Overland	1.0

[1] Sheet 2, Arroyo Del Puerto Erosion Protection Measures

[2] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[3] Abt, S.R., Johnson, T.L., Thornton, C.I. and Trabant, S.C., Riprap Sizing at the Toe of Embankment Slopes, J. of Hydr. Engr., ASCE, 1998.


If applicable, remove tailings contamination (Note 8)
Tailings Ponds 4, 5 & 6 (Note 7)
Tailings Pond 4
Tailings Pond 5
Tailings Pond 6
Start of Channel Sta. 10+00
Diversion Embankment/Channel
Interior Drainage Channel
POND 3
POND 1
POND 9
CONSTRUCTION NOTES:
EROSION PROTECTION MEASURES
ARROYO DEL PUERTO
EROSION PROTECTION MEASURES
AMBROSIA LAKE MILL
RIO ALGOM MINING LLC
GRANTS, NEW MEXICO
TETRA TECH
SHEET 4

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO
INTERIOR SITE DRAINAGE CALCULATIONS
SUMMARY: CATCHMENT AREAS & PEAK DISCHARGES

Catchment Drainage Area No.	A = Area [1] (acres)	Time of Concentration (min)	q_d = Design Unit Discharge (cfs/ft)	Q = Peak Discharge = CiA (cfs)
1	180.2	24.1		570.11
2	15.7	12.2		875.78
3	16.3	13.2		838.48
4	29.8	13.3		833.95
5	34.4	19.7		650.41
5 Overland[2]	0.0458	17.0	1.10	
6	87.6	29.7		495.52
6 Overland[2]	0.0550	19.7	1.20	
7	107.4	10.1		959.47
Inlet Channel at Sta 8+00 - 0.5% Slope	180.2			570.11
Channel at Sta 8+00 - 4% Slope	180.2			570.11
Channel at Sta 10+25 - 4% Slope	180.2			570.11
Channel at Sta 10+25 - 0.5% Slope	180.2			570.11
Channel at Sta 24+00 - 0.5% Slope	237.6			1924.39
Channel at Sta 27+50 - 0.5% Slope	276.5			3768.73
Channel at Sta 43+00 - 0.5% Slope	374.0			4496.23
Outlet Channel at Sta 43+00 - 0.5% Slope	374.0			4496.23
Channel at Sta 57+00 - 0.84% Slope	471.5			5223.73
Outlet Channel at Sta 57+00 - 0.84% Slope	471.5			5223.73

[1] Sheet 2, Arroyo Del Puerto Erosion Protection Measures
[2] Unit width

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO
INTERIOR SITE DRAINAGE CALCULATIONS
DESIGN OF EROSION PROTECTION SUMMARY OF METHODS PER NUREG-1623

NUREG-1623[1] Section #	Item Description	Depth of Flow, Rock Sizing, & Scour Depth Methods	Depth of Flow and Rock Sizing Methods	Equations	Reference
D.2	Overland Flow Slopes	Depth of Flow - Rational Method	Abt and Johnson Method	D_{50} Rock Size : $D_{50} = 5.23 (S)^{0.43} (q_d)^{0.56}$	NUREG-1623[1]
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for steep slope and flow depth small relative to the riprap size	Manning's n = $0.0456(D_{50} * S)^{0.159}$	NUREG/CR-4651[2]
			Manning's n for shallow slope and flow depth exceeding average size of riprap	Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[3]
			Manning's n for Open Channels	Manning's n = $R_h^{1/6}/(23.85+21.95Log_{10}(R/k))$	EM1110-2-1601[4]
			Manning's Equation to determine flow depth	Flow Depth: $Q = (1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[3]
D.3	Diversion Channels	Option 1 - Rock Sizing	Safety Factors Method (peak shear stress)	Actual Shear Stress: $t = W_w yS$	NUREG-1623[1]
				D_{50} Rock Size: $D_{50} = (t)/(a(W_s - W_w)) = t / 4.1$, where a = 0.04, W_s = 165 pcf, W_w = 62.4 pcf	NUREG-1623[1]
D.3	Diversion Channels	Option 2 - Rock Sizing	Abt and Johnson Method	D_{50} Rock Size: $D_{50} = 5.23 (S)^{0.43} (q_d)^{0.56}$, where q_d = Q/(bottom width of trapezoidal channel)	NUREG-1623[1]
D.4	Aprons and Diversion Channel Outlets	Option 2 - Rock Sizing	Abt and Johnson Method	$D_{50} = 5.23 (S)^{0.43} (q_d)^{0.56}$	NUREG-1623[1]
		Scour Depth - Discharge Apron Toe	USDOT HEC No. 14 Method	$d_s = R_h C_s(\alpha/\sigma^{1/3}) (Q/(g^{1/2}R_h^{5/2})^{\beta}(t/316)^{\theta}$	TRR No. 1523[6], & HEC No. 14[7]
D.6	Toe of Embankment Slopes	Rational Method	Abt and Johnson Method	$D_{50} = 10.46 (S)^{0.43} (C_f * q_d)^{0.56}$	Abt et al. (1998)[5]

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4651, U.S. Nuclear Regulatory Commission (NRC), Development of Riprap Design Criteria by Riprap Testing in Flumes: Phase II, September 1988.

[3] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[4] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

[5] Abt, S.R., Johnson, T.L., Thornton, C.I. and Trabant, S.C., Riprap Sizing at the Toe of Embankment Slopes, J. of Hydr. Engr., ASCE, 1998.

[6] Abt, S.R., Thompson, P.I., and Lewis, T.M., Enhancement of the Culvert Outlet Scour Estimation Equations, Geometric and Other General Design Issues, Transportation Research Record (TRR), No. 1523, pp. 178-184, 1996.

[7] U.S. Department of Transportation (USDOT), Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular (HEC) No. 14, 1983.

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO
INTERIOR SITE DRAINAGE CALCULATIONS
INTERIOR DRAINAGE CHANNEL STATIONING AND ELEVATION SUMMARY

Center Elev at Ending Station (ft)	Beginning Station (ft)	Ending Station (ft)	Reach Between Stations (ft)	Slope Between Previous Reach (ft/ft)	Channel Elev Drop Previous Reach (ft)	Channel Width Increase Previous Reach (ft)	Fixed design Channel Bottom Widths (ft)	Channel Bottom Width at Endin Station (ft)	Left Channel Elev at Ending Station (ft)	Center Elev at Ending Station (ft)	Right Channel Elev at Ending Station (ft)
6939.00		800					80.00				
6930.00	800.00	1025.00	225.00	4.00%	9.00	-40.00	40.00	40.00	6929.70	6930.00	6930.30
6929.63	1025.00	1100.00	75.00	0.50%	0.38	3.55	43.55	43.55	6929.30	6929.63	6929.95
6929.13	1100.00	1200.00	100.00	0.50%	0.50	4.73	48.27	48.27	6928.76	6929.13	6929.49
6928.63	1200.00	1300.00	100.00	0.50%	0.50	4.73	53.00	53.00	6928.23	6928.63	6929.02
6928.13	1300.00	1400.00	100.00	0.50%	0.50	4.73	57.73	57.73	6927.69	6928.13	6928.56
6927.63	1400.00	1500.00	100.00	0.50%	0.50	4.73	62.45	62.45	6927.16	6927.63	6928.09
6927.13	1500.00	1600.00	100.00	0.50%	0.50	4.73	67.18	67.18	6926.62	6927.13	6927.63
6926.63	1600.00	1700.00	100.00	0.50%	0.50	4.73	71.91	71.91	6926.09	6926.63	6927.16
6926.13	1700.00	1800.00	100.00	0.50%	0.50	4.73	76.64	76.64	6925.55	6926.13	6926.70
6925.63	1800.00	1900.00	100.00	0.50%	0.50	4.73	81.36	81.36	6925.01	6925.63	6926.24
6925.13	1900.00	2000.00	100.00	0.50%	0.50	4.73	86.09	86.09	6924.48	6925.13	6925.77
6924.63	2000.00	2100.00	100.00	0.50%	0.50	4.73	90.82	90.82	6923.94	6924.63	6925.31
6924.13	2100.00	2200.00	100.00	0.50%	0.50	4.73	95.55	95.55	6923.41	6924.13	6924.84
6923.63	2200.00	2300.00	100.00	0.50%	0.50	4.73	100.27	100.27	6922.87	6923.63	6924.38
6923.13	2300.00	2400.00	100.00	0.50%	0.50	4.73	105.00	105.00	6922.34	6923.13	6923.91
6922.63	2400.00	2500.00	100.00	0.50%	0.50	5.71	110.71	110.71	6921.79	6922.63	6923.46
6922.13	2500.00	2600.00	100.00	0.50%	0.50	5.71	116.43	116.43	6921.25	6922.13	6923.00
6921.63	2600.00	2700.00	100.00	0.50%	0.50	5.71	122.14	122.14	6920.71	6921.63	6922.54
6921.38	2700.00	2750.00	50.00	0.50%	0.25	2.86	125.00	125.00	6920.44	6921.38	6922.31
6921.13	2750.00	2800.00	50.00	0.50%	0.25	2.10	127.10	127.10	6920.17	6921.13	6922.08
6920.63	2800.00	2900.00	100.00	0.50%	0.50	4.19	131.29	131.29	6919.64	6920.63	6921.61
6920.13	2900.00	3000.00	100.00	0.50%	0.50	4.19	135.48	135.48	6919.11	6920.13	6921.14
6919.63	3000.00	3100.00	100.00	0.50%	0.50	4.19	139.68	139.68	6918.58	6919.63	6920.67

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO
INTERIOR SITE DRAINAGE CALCULATIONS
INTERIOR DRAINAGE CHANNEL STATIONING AND ELEVATION SUMMARY

Center Elev at Ending Station (ft)	Beginning Station (ft)	Ending Station (ft)	Reach Between Stations (ft)	Slope Between Previous Reach (ft/ft)	Channel Elev Drop Previous Reach (ft)	Channel Width Increase Previous Reach (ft)	Fixed design Channel Bottom Widths (ft)	Channel Bottom Width at Endin Station (ft)	Left Channel Elev at Ending Station (ft)	Center Elev at Ending Station (ft)	Right Channel Elev at Ending Station (ft)
6919.13	3100.00	3200.00	100.00	0.50%	0.50	4.19	143.87	143.87	6918.05	6919.13	6920.20
6918.63	3200.00	3300.00	100.00	0.50%	0.50	4.19	148.06	148.06	6917.51	6918.63	6919.74
6918.13	3300.00	3400.00	100.00	0.50%	0.50	4.19	152.26	152.26	6916.98	6918.13	6919.27
6917.63	3400.00	3500.00	100.00	0.50%	0.50	4.19	156.45	156.45	6916.45	6917.63	6918.80
6917.13	3500.00	3600.00	100.00	0.50%	0.50	4.19	160.65	160.65	6915.92	6917.13	6918.33
6916.63	3600.00	3700.00	100.00	0.50%	0.50	4.19	164.84	164.84	6915.39	6916.63	6917.86
6916.13	3700.00	3800.00	100.00	0.50%	0.50	4.19	169.03	169.03	6914.86	6916.13	6917.39
6915.63	3800.00	3900.00	100.00	0.50%	0.50	4.19	173.23	173.23	6914.33	6915.63	6916.92
6915.13	3900.00	4000.00	100.00	0.50%	0.50	4.19	177.42	177.42	6913.79	6915.13	6916.46
6914.63	4000.00	4100.00	100.00	0.50%	0.50	4.19	181.61	181.61	6913.26	6914.63	6915.99
6914.13	4100.00	4200.00	100.00	0.50%	0.50	4.19	185.81	185.81	6912.73	6914.13	6915.52
6913.63	4200.00	4300.00	100.00	0.50%	0.50	4.19	190.00	190.00	6912.20	6913.63	6915.05
6913.13	4300.00	4400.00	100.00	0.50%	0.50	0.00	190.00	190.00	6911.70	6913.13	6914.55
6912.63	4400.00	4500.00	100.00	0.50%	0.50	0.00	190.00	190.00	6911.20	6912.63	6914.05
6912.13	4500.00	4600.00	100.00	0.50%	0.50	0.00	190.00	190.00	6910.70	6912.13	6913.55
6911.63	4600.00	4700.00	100.00	0.50%	0.50	0.00	190.00	190.00	6910.20	6911.63	6913.05
6911.13	4700.00	4800.00	100.00	0.50%	0.50	0.00	190.00	190.00	6909.70	6911.13	6912.55
6910.63	4800.00	4900.00	100.00	0.50%	0.50	0.00	190.00	190.00	6909.20	6910.63	6912.05
6910.13	4900.00	5000.00	100.00	0.50%	0.50	0.00	190.00	190.00	6908.70	6910.13	6911.55
6909.63	5000.00	5100.00	100.00	0.50%	0.50	0.00	190.00	190.00	6908.20	6909.63	6911.05
6909.13	5100.00	5200.00	100.00	0.50%	0.50	0.00	190.00	190.00	6907.70	6909.13	6910.55
6908.28	5200.00	5300.00	100.00	0.84%	0.84	0.00	190.00	190.00	6906.86	6908.28	6909.71
6907.44	5300.00	5400.00	100.00	0.84%	0.84	0.00	190.00	190.00	6906.02	6907.44	6908.87
6906.60	5400.00	5500.00	100.00	0.84%	0.84	0.00	190.00	190.00	6905.18	6906.60	6908.03
6905.76	5500.00	5600.00	100.00	0.84%	0.84	0.00	190.00	190.00	6904.33	6905.76	6907.18
6904.92	5600.00	5700.00	100.00	0.84%	0.84	0.00	190.00	190.00	6903.49	6904.92	6906.34
6904.08	5700.00	5800.00	100.00	0.84%	0.84	0.00	190.00	190.00	6902.65	6904.08	6905.50

RIO ALGOM MINING , LLC
AMBROSIA LAKE, NEW MEXICO
ARROYO DEL PUERTO
INTERIOR SITE DRAINAGE CALCULATIONS
INTERIOR DRAINAGE CHANNEL EROSION PROTECTION SUMMARY

Rock Placement Area[1]	Q = Max Design Flow Rate (cfs)	q_d = Max Design Unit Width Flow Rate (cfs/ft)	Overland / Channel Slope (%)	Channel Bottom Width (ft)	Min D_{50} (in) Shear Stress Method	Min D_{50} (in) Abt and Johnson Method	Average of Methods Min D_{50} (in)	Oversize Min D_{50} 4% (in)	D_{50} Available to Use (in)	Min Thickness Ratio	Min Thickness to Use (in)	Min Apron Thickness = 3x D_{50} (in)	Apron Thickness to Use (in)	Min Apron Width = 15 x D_{50} (ft)	Apron Width to Use (ft)	Max Scour Depth (ft)
Catchment Area 5 Overland (Tailings Ponds 4 & 5)		1.10	0.85%			0.71	0.71	0.74	1.0	2	3					
Catchment Area 6 Overland (Tailings Ponds 4, 5, & 6)		1.20	0.83%			0.74	0.74	0.77	1.0	2	3					
Inlet Channel at Sta 8+00 - 0.5% Slope	570.11		0.50%	100.0		1.42	1.42	1.48	3.2	2	6	9.6	24	4.0	10.0	1.34
Channel at Sta 8+00 - 4% Slope	570.11		4.00%	100.0	5.40	3.47	4.44	4.61	7.8	2	16					
Channel at Sta 10+25 - 4% Slope	570.11		4.00%	60.0	7.23	4.62	5.92	6.16	7.8	2	16					
Channel at Sta 10+25 - 0.5% Slope	570.11		0.50%	60.0	1.66	1.89	1.78	1.85	3.2	2	6					
Channel at Sta 24+00 - 0.5% Slope	1924.39		0.50%	105.0	2.48	2.73	2.61	2.71	3.2	2	6					
Channel at Sta 27+50 - 0.5% Slope	3768.73		0.50%	125.0	3.62	3.61	3.62	3.76	7.8	2	16					
Channel at Sta 43+00 - 0.5% Slope	4496.23		0.50%	150.0	3.64	3.60	3.62	3.76	7.8	2	16					
Outlet Channel at Sta 43+00 - 0.5% Slope	4496.23		0.50%	150.0		3.60	3.60	3.74	7.8	2	16	23.4	36	9.8	15.0	2.65
Channel at Sta 57+00 - 0.84% Slope	5223.73		0.84%	190.0	5.01	4.28	4.65	4.83	7.8	2	16	23.4	36	9.8	15.0	2.65
Outlet Channel at Sta 57+00 - 0.84% Slope	5223.73		0.84%	190.0		4.28	4.28	4.46	12.0	2	24	36	36	15.0	30.0	2.55

[1] Sheet 2

Inlet Channel Station 8+00 at 0.5% Slope				RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO INTERIOR SITE DRAINAGE CALCULATIONS ROCK SIZING - INTERIOR CHANNEL											
NUREG-1623[1] Section #	Item Description	Sub-Item	Depth of Flow and Rock Sizing Methods	Method Equations	Reference	Summary of Results by Method		D_{50} rock size (in) to Use							
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for shallow slope and flow depth exceeding average size of riprap						Assume D_{50} rock size (ft)	coefficient	$(D_{50})^{1/6}$	Manning's n = $0.0395(D_{50})^{1/6}$			
				Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[2]	n =	0.0317		0.27	0.0395	0.8023	0.0317			
			Manning's n for Open Channels						R_h = hydraulic radius = depth of flow (ft)	$R_h^{1/6}$	k = equivalent roughness height = rock size (ft)	R/k	Manning's n = $R_h^{1/6}/(23.85+21.95Log_{10}(R/k))$		
				Manning's n = $R_h^{1/6}/(23.85+21.95Log_{10}(R/k))$	EM1110-2-1601[3]	n =	0.0371		0.82	0.9675	0.65	1.2615	0.0371		
			Manning's Equation to determine flow depth at Outlet						Q_d = Design Flowrate (cfs)	Assume y depth (ft)	1.486/n	b = bottom width (ft)	sideslope H/V ratio	S = channel slope (ft/ft)	Calculated Q (cfs)
				Flow Depth: $Q=(1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[2]	y =	0.82		570.11	0.82	40.03	100.0	2.0	0.040	577.0
D.4	Aprons and Diversion Channel Outlets	Option 2 - Rock Sizing	Abt and Johnson Method						Design Location	coefficient	S = channel slope (ft/ft)	$S^{0.43}$	b = bottom width (ft)	D_{50} (ft)	Oversize 4%
				$D_{50} = 5.23\ (S)^{0.43}\ (q)^{0.56}$	NUREG-1623[1]	D_{50} =	1.42	3.20	Inlet Shallow Apron	5.23	0.005	0.1025	100.0	0.12	1.48
D.4	Aprons and Diversion Channel Outlets	Downstream Scour Depth - Discharge Apron Toe	USDOT HEC No. 14 Method[5]						R_h = hydraulic radius = depth of flow (ft)	C_s = slope correction coeeficient (Table 5.2[5])	σ = coeeficient (Table 5.1[5])	σ = (D84/D16)0.5, material standard deviation	$\sigma^{1/3}$		
				$d_s = R_h C_s(\sigma/\sigma^{1/3})(Q/(g^{1/2}R_h^{5/2})^{\beta}(t/316)^{\theta}$	TRR No. 1523[4], & HEC No. 14[5]				0.82	1.0075	2.27	3.67	1.54		
									β = coeeficient (Table 5.1[5])	$(Q/g^{1/2}R_h^{5/2})^{\beta}$	t = time (min)	θ = coeeficient (Table 5.1[5])	$(t/316)^{\theta}$		
						$d_{s=}$	1.34		0.39	1.216	60	0.06	0.9051		

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[3] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

[4] Abt, S.R., Thompson, P.I., and Lewis, T.M., Enhancement of the Culvert Outlet Scour Estimation Equations, Geometric and Other General Design Issues, Transportation Research Record (TRR), No. 1523, pp. 178-184, 1996.

[5] U.S. Department of Transportation (USDOT), Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular (HEC) No. 14, 1983.

Channel Station 8+00 at 4% Slope				RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO INTERIOR SITE DRAINAGE CALCULATIONS ROCK SIZING - INTERIOR CHANNEL								
NUREG-1623[1] Section #	Item Description	Peak Flow Rate	Depth of Flow and Rock Sizing Methods	Method Equations	Reference	Summary of Results by Method						D_{50} rock size (in) to Use
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for shallow slope and flow depth exceeding average size of riprap					Assume D_{50} rock size (ft)	coefficient	Manning's n = $0.0395(D_{50})^{1/6}$		
				Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[2]	n =	0.0317	0.27	0.0395	0.0317		
			Manning's Equation to determine flow depth					Design Flowrate Q_d (cfs)	Assume y depth (ft)	b = bottom width (ft)	S = channel slope (ft/ft)	Calculated Q (cfs)
				Flow Depth: $Q=(1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[2]	y =	0.74	570.11	0.74	100.0	0.040	574.7
D.3	Diversion Channels	Option 1 - Rock Sizing	Safety Factors Method (peak shear stress)					W_w = unit weight of water (lb/ft^3)	y = depth (ft)	$t = W_w yS$ (shear sttres) (lb/ft^2)		
				Actual Shear Stress: $t = W_w yS$	NUREG-1623[1]	t =	1.85	62.4	0.74	1.8470		
								$t = W_w yS$ (shear sttres) (lb/ft^2)	a - coefficient	W_w = unit weight of water (lb/ft^3)		Oversize 4%
				D_{50} Rock Size: $D_{50} = (t)/(a(W_s - W_w)) = t / 4.1$, where a = 0.04, W_s = 165 pcf, W_w = 62.4 pcf	NUREG-1623[1]	D_{50} =	5.40	1.8470	0.04	62.4		5.62	7.8
D.3	Diversion Channels	Option 2 - Rock Sizing	Abt and Johnson Method					coefficient	S = channel slope (ft/ft)	b = bottom width (ft)		
				D_{50} Rock Size: $D_{50} = 5.23\ (S)^{0.43}\ (q_d)^{0.56}$, where q_d = Q/(bottom width of trapezoidal channel)	NUREG-1623[1]	D_{50} =	3.47	5.23	0.040	100.0		3.61	7.8

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[3] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

Channel Station 10+25 at 4% Slope				RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO INTERIOR SITE DRAINAGE CALCULATIONS ROCK SIZING - INTERIOR CHANNEL								
NUREG-1623[1] Section #	Item Description	Peak Flow Rate	Depth of Flow and Rock Sizing Methods	Method Equations	Reference	Summary of Results by Method						D_{50} rock size (in) to Use
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for shallow slope and flow depth exceeding average size of riprap					Assume D_{50} rock size (ft)	coefficient	Manning's n = $0.0395(D_{50})^{1/6}$		
				Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[2]	n =	0.0317	0.27	0.0395	0.0317		
			Manning's Equation to determine flow depth					Design Flowrate Q_d (cfs)	Assume y depth (ft)	b = bottom width (ft)	S = channel slope (ft/ft)	Calculated Q (cfs)
				Flow Depth: $Q=(1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[2]	y =	0.99	570.11	0.99	60.0	0.040	569.3
D.3	Diversion Channels	Option 1 - Rock Sizing	Safety Factors Method (peak shear stress)					W_w = unit weight of water (lb/ft^3)	y = depth (ft)	$t = W_w yS$ (shear sttres) (lb/ft^2)		
				Actual Shear Stress: $t = W_w yS$	NUREG-1623[1]	t =	2.47	62.4	0.99	2.4710		
								$t = W_w yS$ (shear sttres) (lb/ft^2)	a - coefficient	W_w = unit weight of water (lb/ft^3)		Oversize 4%
				D_{50} Rock Size: $D_{50} = (t)/(a(W_s - W_w)) = t / 4.1$, where a = 0.04, W_s = 165 pcf, W_w = 62.4 pcf	NUREG-1623[1]	D_{50} =	7.23	2.4710	0.04	62.4		7.51	7.8
D.3	Diversion Channels	Option 2 - Rock Sizing	Abt and Johnson Method					coefficient	S = channel slope (ft/ft)	b = bottom width (ft)		
				D_{50} Rock Size: $D_{50} = 5.23\,(S)^{0.43}\,(q_d)^{0.56}$, where q_d = Q/(bottom width of trapezoidal channel)	NUREG-1623[1]	D_{50} =	4.62	5.23	0.040	60.0		4.81	7.8

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[3] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

Channel Station 10+25 at 0.5% Slope				RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO INTERIOR SITE DRAINAGE CALCULATIONS ROCK SIZING - INTERIOR CHANNEL									
NUREG-1623[1] Section #	Item Description	Peak Flow Rate	Depth of Flow and Rock Sizing Methods	Method Equations	Reference	Summary of Results by Method							D_{50} rock size (in) to Use
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for shallow slope and flow depth exceeding average size of riprap					Assume D_{50} rock size (ft)	coefficient	Manning's n = $0.0395(D_{50})^{1/6}$			
				Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[2]	n =	0.0317	0.27	0.0395	0.0317			
			Manning's Equation to determine flow depth					Design Flowrate Q_d (cfs)	Assume y depth (ft)	b = bottom width (ft)	S = channel slope (ft/ft)	Calculated Q (cfs)	
				Flow Depth: $Q=(1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[2]	y =	1.82	570.11	1.82	60.0	0.005	570.6	
D.3	Diversion Channels	Option 1 -Rock Sizing	Safety Factors Method (peak shear stress)					W_w = unit weight of water (lb/ft^3)	5.00	$t = W_w yS$ (shear sttres) (lb/ft^2)			
				Actual Shear Stress: $t = W_w yS$	NUREG-1623[1]	t =	0.57	62.4	1.82	0.5678			
								$t = W_w yS$ (shear sttres) (lb/ft^2)	a - coefficient	W_w = unit weight of water (lb/ft^3)		Oversize 4%	
				D_{50} Rock Size: $D_{50} = (t)/(a(W_s - W_w)) = t / 4.1$, where a = 0.04, W_s = 165 pcf, W_w = 62.4 pcf	NUREG-1623[1]	D_{50} =	1.66	0.5678	0.04	62.4		1.73	3.2
D.3	Diversion Channels	Option 2 -Rock Sizing	Abt and Johnson Method					coefficient	S = channel slope (ft/ft)	b = bottom width (ft)			
				D_{50} Rock Size: $D_{50} = 5.23 (S)^{0.43} (q_d)^{0.56}$, where q_d = Q/(bottom width of trapezoidal channel)	NUREG-1623[1]	D_{50} =	1.89	5.23	0.005	60.0		1.97	3.2

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[3] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

Channel Station 24+00 at 0.5% Slope				RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO INTERIOR SITE DRAINAGE CALCULATIONS ROCK SIZING - INTERIOR CHANNEL								
NUREG-1623[1] Section #	Item Description	Peak Flow Rate	Depth of Flow and Rock Sizing Methods	Method Equations	Reference	Summary of Results by Method						D_{50} rock size (in) to Use
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for shallow slope and flow depth exceeding average size of riprap					Assume D_{50} rock size (ft)	coefficient	Manning's n = $0.0395(D_{50})^{1/6}$		
				Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[2]	n =	0.0317	0.27	0.0395	0.0317		
			Manning's Equation to determine flow depth					Design Flowrate Q_d (cfs)	Assume y depth (ft)	b = bottom width (ft)	S = channel slope (ft/ft)	Calculated Q (cfs)
				Flow Depth: $Q=(1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[2]	y =	2.72	1924.39	2.72	105.0	0.005	1933.5
D.3	Diversion Channels	Option 1 -Rock Sizing	Safety Factors Method (peak shear stress)					W_w = unit weight of water (lb/ft^3)	y = depth (ft)	$t = W_w yS$ (shear sttres) (lb/ft^2)		
				Actual Shear Stress: $t = W_w yS$	NUREG-1623[1]	t =	0.85	62.4	2.72	0.8486		
								$t = W_w yS$ (shear sttres) (lb/ft^2)	a - coefficient	W_w = unit weight of water (lb/ft^3)		Oversize 4%
				D_{50} Rock Size: $D_{50} = (t)/(a(W_s - W_w)) = t / 4.1$, where a = 0.04, W_s = 165 pcf, W_w = 62.4 pcf	NUREG-1623[1]	D_{50} =	2.48	0.8486	0.04	62.4		2.58	3.2
D.3	Diversion Channels	Option 2 -Rock Sizing	Abt and Johnson Method					coefficient	S = channel slope (ft/ft)	b = bottom width (ft)		
				D_{50} Rock Size: $D_{50} = 5.23\,(S)^{0.43}\,(q_d)^{0.56}$, where q_d = Q/(bottom width of trapezoidal channel)	NUREG-1623[1]	D_{50} =	2.73	5.23	0.005	105.0		2.84	3.2

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[3] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

Channel Station 27+50 at 0.5% Slope				RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO INTERIOR SITE DRAINAGE CALCULATIONS ROCK SIZING - INTERIOR CHANNEL									
NUREG-1623[1] Section #	Item Description	Peak Flow Rate	Depth of Flow and Rock Sizing Methods	Method Equations	Reference	Summary of Results by Method							D_{50} rock size (in) to Use
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for shallow slope and flow depth exceeding average size of riprap					Assume D_{50} rock size (ft)	coefficient	Manning's n = $0.0395(D_{50})^{1/6}$			
				Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[2]	n =	0.0368	0.65	0.0395	0.0368			
			Manning's Equation to determine flow depth					Design Flowrate Q_d (cfs)	Assume y depth (ft)	b = bottom width (ft)	S = channel slope (ft/ft)	Calculated Q (cfs)	
				Flow Depth: $Q=(1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[2]	y =	3.97	3768.73	3.97	125.0	0.005	3770.8	
D.3	Diversion Channels	Option 1 -Rock Sizing	Safety Factors Method (peak shear stress)					W_w = unit weight of water (lb/ft^3)	y = depth (ft)	$t = W_w yS$ (shear sttres) (lb/ft^2)			
				Actual Shear Stress: $t = W_w yS$	NUREG-1623[1]	t =	1.24	62.4	3.97	1.2386			
								$t = W_w yS$ (shear sttres) (lb/ft^2)	a - coefficient	W_w = unit weight of water (lb/ft^3)		Oversize 4%	
				D_{50} Rock Size: $D_{50} = (t)/(a(W_s - W_w)) = t / 4.1$, where a = 0.04, W_s = 165 pcf, W_w = 62.4 pcf	NUREG-1623[1]	D_{50} =	3.62	1.2386	0.04	62.4		3.77	7.8
D.3	Diversion Channels	Option 2 -Rock Sizing	Abt and Johnson Method					coefficient	S = channel slope (ft/ft)	b = bottom width (ft)			
				D_{50} Rock Size: $D_{50} = 5.23 (S)^{0.43} (q_d)^{0.56}$, where q_d = Q/(bottom width of trapezoidal channel)	NUREG-1623[1]	D_{50} =	3.61	5.23	0.005	125.0		3.75	7.8

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[3] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

Channel Station 43+00 at 0.5% Slope				RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO INTERIOR SITE DRAINAGE CALCULATIONS ROCK SIZING - INTERIOR CHANNEL									
NUREG-1623[1] Section #	Item Description	Peak Flow Rate	Depth of Flow and Rock Sizing Methods	Method Equations	Reference	Summary of Results by Method							D_{50} rock size (in) to Use
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for shallow slope and flow depth exceeding average size of riprap					Assume D_{50} rock size (ft)	coefficient	Manning's n = $0.0395(D_{50})^{1/6}$			
				Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[2]	n =	0.0368	0.65	0.0395	0.0368			
			Manning's Equation to determine flow depth					Design Flowrate Q_d (cfs)	Assume y depth (ft)	b = bottom width (ft)	S = channel slope (ft/ft)	Calculated Q (cfs)	
				Flow Depth: $Q=(1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[2]	y =	3.99	4496.23	3.99	150.0	0.005	4515.4	
D.3	Diversion Channels	Option 1 -Rock Sizing	Safety Factors Method (peak shear stress)					W_w = unit weight of water (lb/ft^3)	y = depth (ft)	$t = W_w yS$ (shear sttres) (lb/ft^2)			
				Actual Shear Stress: $t = W_w yS$	NUREG-1623[1]	t =	1.24	62.4	3.99	1.2449			
								$t = W_w yS$ (shear sttres) (lb/ft^2)	a - coefficient	W_w = unit weight of water (lb/ft^3)		Oversize 4%	
				D_{50} Rock Size: $D_{50} = (t)/(a(W_s - W_w)) = t / 4.1$, where a = 0.04, W_s = 165 pcf, W_w = 62.4 pcf	NUREG-1623[1]	D_{50} =	3.64	1.2449	0.04	62.4		3.79	7.8
D.3	Diversion Channels	Option 2 -Rock Sizing	Abt and Johnson Method					coefficient	S = channel slope (ft/ft)	b = bottom width (ft)			
				D_{50} Rock Size: $D_{50} = 5.23 (S)^{0.43} (q_d)^{0.56}$, where q_d = Q/(bottom width of trapezoidal channel)	NUREG-1623[1]	D_{50} =	3.60	5.23	0.005	150.0		3.74	7.8

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[3] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

Outlet Channel Station 43+00 at 0.5% Slope				RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO INTERIOR SITE DRAINAGE CALCULATIONS ROCK SIZING - INTERIOR CHANNEL											
NUREG-1623[1] Section #	Item Description	Sub-Item	Depth of Flow and Rock Sizing Methods	Method Equations	Reference	Summary of Results by Method		D_{50} rock size (in) to Use							
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for shallow slope and flow depth exceeding average size of riprap						Assume D_{50} rock size (ft)	coefficient	$(D_{50})^{1/6}$	Manning's n = $0.0395(D_{50})^{1/6}$			
				Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[2]	n =	0.0368		0.65	0.0395	0.9307	0.0368			
			Manning's n for Open Channels						R_h = hydraulic radius = depth of flow (ft)	$R_h^{1/6}$	k = equivalent roughness height = rock size (ft)	R/k	Manning's n = $R_h^{1/6}/(23.85+21.95Log_{10}(R/k))$		
				Manning's n = $R_h^{1/6}/(23.85+21.95Log_{10}(R/k))$	EM1110-2-1601[3]	n =	0.0308		3.66	1.2414	0.65	5.6308	0.0308		
			Manning's Equation to determine flow depth at Outlet						Q_d = Design Flowrate (cfs)	Assume y depth (ft)	1.486/n	b = bottom width (ft)	sideslope H/V ratio	S = channel slope (ft/ft)	Calculated Q (cfs)
				Flow Depth: $Q=(1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[2]	y =	3.66		4496.23	3.66	48.27	150.0	2.0	0.005	4496.7
D.4	Aprons and Diversion Channel Outlets	Option 2 - Rock Sizing	Abt and Johnson Method						Design Location	coefficient	S = channel slope (ft/ft)	$S^{0.43}$	b = bottom width (ft)	D_{50} (ft)	Oversize 4%
				$D_{50} = 5.23\ (S)^{0.43}\ (q)^{0.56}$	NUREG-1623[1]	D_{50} =	3.60	7.80	Discharge Channel	5.23	0.005	0.1025	150.0	0.30	3.74
D.4	Aprons and Diversion Channel Outlets	Downstream Scour Depth - Discharge Apron Toe	USDOT HEC No. 14 Method[5]						R_h = hydraulic radius = depth of flow (ft)	C_s = slope correction coeeficient (Table 5.2[5])	σ = coeeficient (Table 5.1[5])	σ = (D84/D16)0.5, material standard deviation	$\sigma^{1/3}$		
				$d_s = R_h C_s(\sigma/\sigma^{1/3})(Q/(g^{1/2}R_h^{5/2})^{\beta}(t/316)^{\theta}$	TRR No. 1523[4], & HEC No. 14[5]				3.66	1.0075	2.27	3.67	1.54		
									β = coeeficient (Table 5.1[5])	$(Q/g^{1/2}R_h^{5/2})^{\beta}$	t = time (min)	θ = coeeficient (Table 5.1[5])	$(t/316)^{\theta}$		
						d_s =	2.65		0.39	0.540	60	0.06	0.9051		

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[3] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

[4] Abt, S.R., Thompson, P.I., and Lewis, T.M., Enhancement of the Culvert Outlet Scour Estimation Equations, Geometric and Other General Design Issues, Transportation Research Record (TRR), No. 1523, pp. 178-184, 1996.

[5] U.S. Department of Transportation (USDOT), Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular (HEC) No. 14, 1983.

Channel Station 56+00 at 0.84% Slope				RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO INTERIOR SITE DRAINAGE CALCULTAIONS ROCK SIZING - INTERIOR CHANNEL								
NUREG-1623[1] Section #	Item Description	Peak Flow Rate	Depth of Flow and Rock Sizing Methods	Method Equations	Reference	Summary of Results by Method						D_{50} rock size (in) to Use
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for shallow slope and flow depth exceeding average size of riprap					Assume D_{50} rock size (ft)	coefficient	Manning's n = $0.0395(D_{50})^{1/6}$		
				Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[2]	n =	0.0368	0.65	0.0395	0.0368		
			Manning's Equation to determine flow depth					Design Flowrate Q_d (cfs)	Assume y depth (ft)	b = bottom width (ft)	S = channel slope (ft/ft)	Calculated Q (cfs)
				Flow Depth: $Q=(1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[2]	y =	3.27	5223.73	3.27	190.0	0.0084	5224.1
D.3	Diversion Channels	Option 1 -Rock Sizing	Safety Factors Method (peak shear stress)					W_w = unit weight of water (lb/ft^3)	y = depth (ft)	$t = W_w yS$ (shear sttres) (lb/ft^2)		
				Actual Shear Stress: $t = W_w yS$	NUREG-1623[1]	t =	1.71	62.4	3.27	1.7140		
								$t = W_w yS$ (shear sttres) (lb/ft^2)	a - coefficient	W_w = unit weight of water (lb/ft^3)		Oversize 4%
				D_{50} Rock Size: $D_{50} = (t)/(a(W_s - W_w)) = t / 4.1$, where a = 0.04, W_s = 165 pcf, W_w = 62.4 pcf	NUREG-1623[1]	D_{50} =	5.01	1.7140	0.04	62.4		5.21	7.8
D.3	Diversion Channels	Option 2 -Rock Sizing	Abt and Johnson Method					coefficient	S = channel slope (ft/ft)	b = bottom width (ft)		
				D_{50} Rock Size: $D_{50} = 5.23 (S)^{0.43} (q_d)^{0.56}$, where q_d = Q/(bottom width of trapezoidal channel)	NUREG-1623[1]	D_{50} =	4.28	5.23	0.008	190.0		4.46	7.8

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[3] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

Outlet Channel Station 43+00 at 0.84% Slope				RIO ALGOM MINING , LLC AMBROSIA LAKE, NEW MEXICO ARROYO DEL PUERTO INTERIOR SITE DRAINAGE CALCULTAIONS ROCK SIZING - INTERIOR CHANNEL											
NUREG-1623[1] Section #	Item Description	Sub-Item	Depth of Flow and Rock Sizing Methods	Method Equations	Reference	Summary of Results by Method		D_{50} rock size (in) to Use							
D.3	Diversion Channels	Depth of Flow - Rational Method	Manning's n for shallow slope and flow depth exceeding average size of riprap						Assume D_{50} rock size (ft)	coefficient	$(D_{50})^{1/6}$	Manning's n = $0.0395(D_{50})^{1/6}$			
				Manning's n = $0.0395(D_{50})^{1/6}$	NUREG/CR-4620[2]	n =	0.0368		0.65	0.0395	0.9307	0.0368			
			Manning's n for Open Channels						R_h = hydraulic radius = depth of flow (ft)	$R_h^{1/6}$	k = equivalent roughness height = rock size (ft)	R/k	Manning's n = $R_h^{1/6}/(23.85+21.95Log_{10}(R/k))$		
				Manning's n = $R_h^{1/6}/(23.85+21.95Log_{10}(R/k))$	EM1110-2-1601[3]	n =	0.0312		3.01	1.2016	0.65	4.6308	0.0312		
			Manning's Equation to determine flow depth at Outlet						Q_d = Design Flowrate (cfs)	Assume y depth (ft)	1.486/n	b = bottom width (ft)	sideslope H/V ratio	S = channel slope (ft/ft)	Calculated Q (cfs)
				Flow Depth: $Q=(1.486/n)AR^{2/3}S^{1/2}$	NUREG/CR-4620[2]	y =	3.01		5223.73	3.01	47.56	190.0	2.0	0.0084	5236.7
D.4	Aprons and Diversion Channel Outlets	Option 2 - Rock Sizing	Abt and Johnson Method						Design Location	coefficient	S = channel slope (ft/ft)	$S^{0.43}$	b = bottom width (ft)	D_{50} (ft)	Oversize 4%
				$D_{50} = 5.23\ (S)^{0.43}\ (q)^{0.56}$	NUREG-1623[1]	D_{50} =	4.28	7.80	Discharge Channel	5.23	0.0084	0.1281	190.0	0.36	4.46
D.4	Aprons and Diversion Channel Outlets	Downstream Scour Depth - Discharge Apron Toe	USDOT HEC No. 14 Method[5]						R_h = hydraulic radius = depth of flow (ft)	C_s = slope correction coeeficient (Table 5.2[5])	α = coeeficient (Table 5.1[5])	σ = (D84/D16)0.5, material standard deviation	$\sigma^{1/3}$		
					TRR No. 1523[4], & HEC No. 14[5]				3.01	1.0075	2.27	3.67	1.54		
									β = coeeficient (Table 5.1[5])	$(Q/g^{1/2}R_h^{5/2})^\beta$	t = time (min)	θ = coeeficient (Table 5.1[5])	$(t/316)^\theta$		
						d_{ss} =	2.55		0.39	0.632	60	0.06	0.9051		

[1] NUREG-1623, U.S. Nuclear Regulatory Commission (NRC), Design of Erosion Protection for Long-Term Stabilization, Final Report, September 2002.

[2] NUREG/CR-4620, U.S. Nuclear Regulatory Commission (NRC), Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, June 1986.

[3] EM1110-2-1601, U.S.Army Corps of Engineers (USACE), Hydraulic Design of Flood Control Channels, Office of the Chief of Engineers, Washington, DC, 1994

[4] Abt, S.R., Thompson, P.I., and Lewis, T.M., Enhancement of the Culvert Outlet Scour Estimation Equations, Geometric and Other General Design Issues, Transportation Research Record (TRR), No. 1523, pp. 178-184, 1996.

[5] U.S. Department of Transportation (USDOT), Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular (HEC) No. 14, 1983.

Appendix D .....Exterior Site Drainage Calculations

Calculation D.1 Design Flowrates and Erosion Protection

Appendix D.1 ..... Calculation D.1 Design Flowrates and Erosion Protection

Calculation D.1
Rio Algom Mining LLC
Ambrosia Lake, New Mexico
Arroyo Del Puerto
Exterior Site Drainage Calculations
Design Flowrates and Erosion Protection

1. Probable Maximum Flood (PMF) Magnitude Discussion

Calculation of a PMF from a probable maximum precipitation (PMP) event requires information on the type of storm, the geometry of the basin, the infiltration properties of the basin as well as assumptions about the behavior of the flood peak as it travels through the basin. The number and uncertainty of variables in the calculation can lead to greatly varying results in the magnitude of the PMF.

Previous consultants to Rio Algom Mining LLC on the project developed a PMF value of 78,000 cfs which was approved by the NRC inprevious design documents. It has later been suggested by the NRC that a much larger PMF value (200,000 cfs) should be used. For purposes of the present design the PMF value of 78,000 PMF will be used without adjustment.

In a previous Maxim (Tetra Tech) design report, "Pond 3 Erosion Protection and Erosion Protection for the Area North of Pond 1, Ambrosia Lake Mill, New Mexico (Maxim, 2002)", a PMF value of 75,200 cfs was calculated using the HEC-1 model (U.S. Army Corps of Engineers, 1990). The flood analysis was modeled with the following:

a) a 6-hr PMP, local storm with areal reduction - 9.2 inches
b) basin area = 57.6 square miles
c) The entire drainage area (57.6 sq. mi.) was input as one basin without subdividing into subbasins.
d) A curve number of 73.4 was used as a composite for the entire drainage basin.

The following items are noted that would suggest that the Maxim calculation of 75,200 cfs was performed on a conservative basis.

a) A drainage basin of 57.6 sq. mi. would have an areal reduction factor of ~40% when modeling with only one basin and at least ~80% when subbasins are modeled. A PMP value of 9.2 inches would indicate that a reduction factor of 96% was used which would be very conservative.
b) Modeling with only one basin instead of several subbasins would also produce a conservative result. A more appropriate depiction of the drainage area with delineated subbasins in shown in Worksheet "PMF Drainage Area", (calc. Sheet 3 of 37)
c) It is also noted in the delineated subbasin map that Subbasin 4D (comprising 11% of the drainage area) enters the site at Pond 9 which is below the present area of design and therefore would ot impact the design.
d) Also the Geomorphic Report by Jerry Lindsay, Appendix E, Design Report, would tend to suggest that due to high infiltration rates that a curve number of 73.4 might be on the conservative side.

2. Design Options

Given the location of comtaminated tailings materials located in Ponds 1, 3, 4, 5, & 6, three options for evaluated to provide protection measures for flood flows associated with the Arroyo Del Puerto.

These options were as follows:

Option 1 Relocate the Arroyo Del puerto to its historical alignment and provide erosion protection of the channel and the overbank areas for the PMF flood flows.

Option 2 Provide a diversion embankment/channel to route the PMF flood flows of the Arroyo del Puerto to the northeast side of Pond areas 4, 5, & 6. Interior site drainage would be provided by a channel located in the historical alignment of the Arroyo Del Puerto. The PMF flood flows of the Arroyo Del Puerto would not directly impact any of the contaminated areas.

Option 3 This option involved Option 1 with a weir embankment feature located on the downstream side of Pond Areas 4, 5, & 6. The purpose would be to back up flood flows within the comtaminated zones of Pond Areas 4, 5, & 6, thus reducing flow velocities and reducing rock protection sizes.

It was determined that Option 2 provided a better technical solution as well as a better economic solution.

3. Diversion Embankment/Channel Design Layout

An initial design used a 15 ft high embankment with 3:1 side slopes, and a channel width of 250 ft with the botom sloping 1 1/2% down and away from the berm. This is shown in the cross-section on Worksheet "Drawing Sheet 6", (calc. Sheet 4 of 37). The alignment is shown on Worksheet"Drawing Sheet 4", (calc. Sheet 5 of 37).

The layout of the diversion embankment/channel is driven primarily by balancing the cut and fill, and approximately matching the upstream and downstream existing elevations. Another consideration is matching the converging elevations of the interior and exterior channels as they come together at the northeast corner on Pond #9. The slope of the diversion channel was adjusted along its course so as to best balance the cut and fill. The geometric data and volume of cut and fill for the Diversion Embankment/Channel is shown on Worksheet "Option 2-Volumes", (calc. Sheets 6 thru 9 of 37). The approximate cut and fill estimate is in vicinity of 300,000 cy, with slightly more cut than fill to account for compaction volumes.

The geometric data along with additional topography data was utilized as input into the HEC-RAS Model (USACE, 2003) A summary of this input data is contained on Worksheet "Option 2-HEC Data", (calc. Sheets 10 thru 15 of 37)

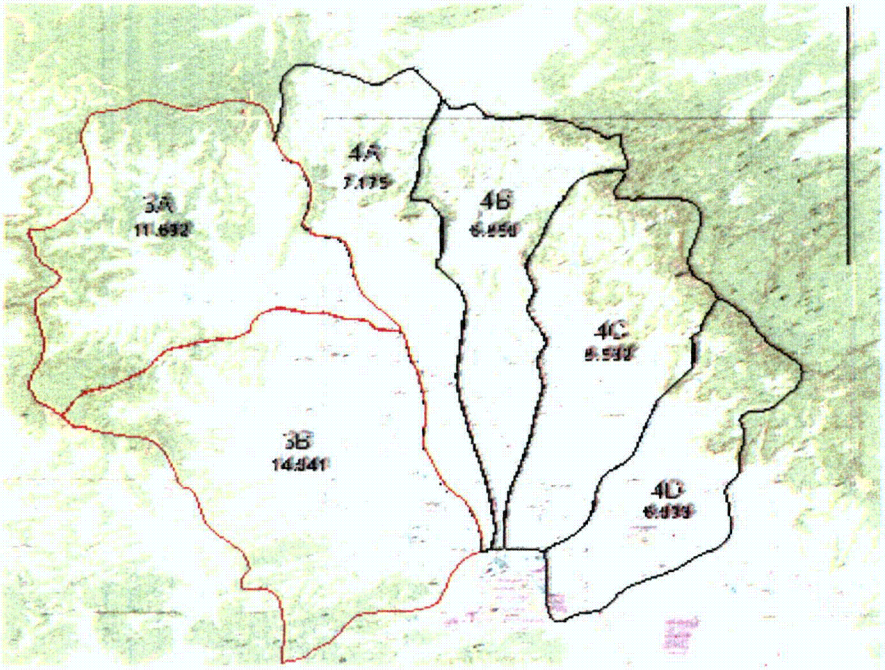
4. HEC-RAS Results

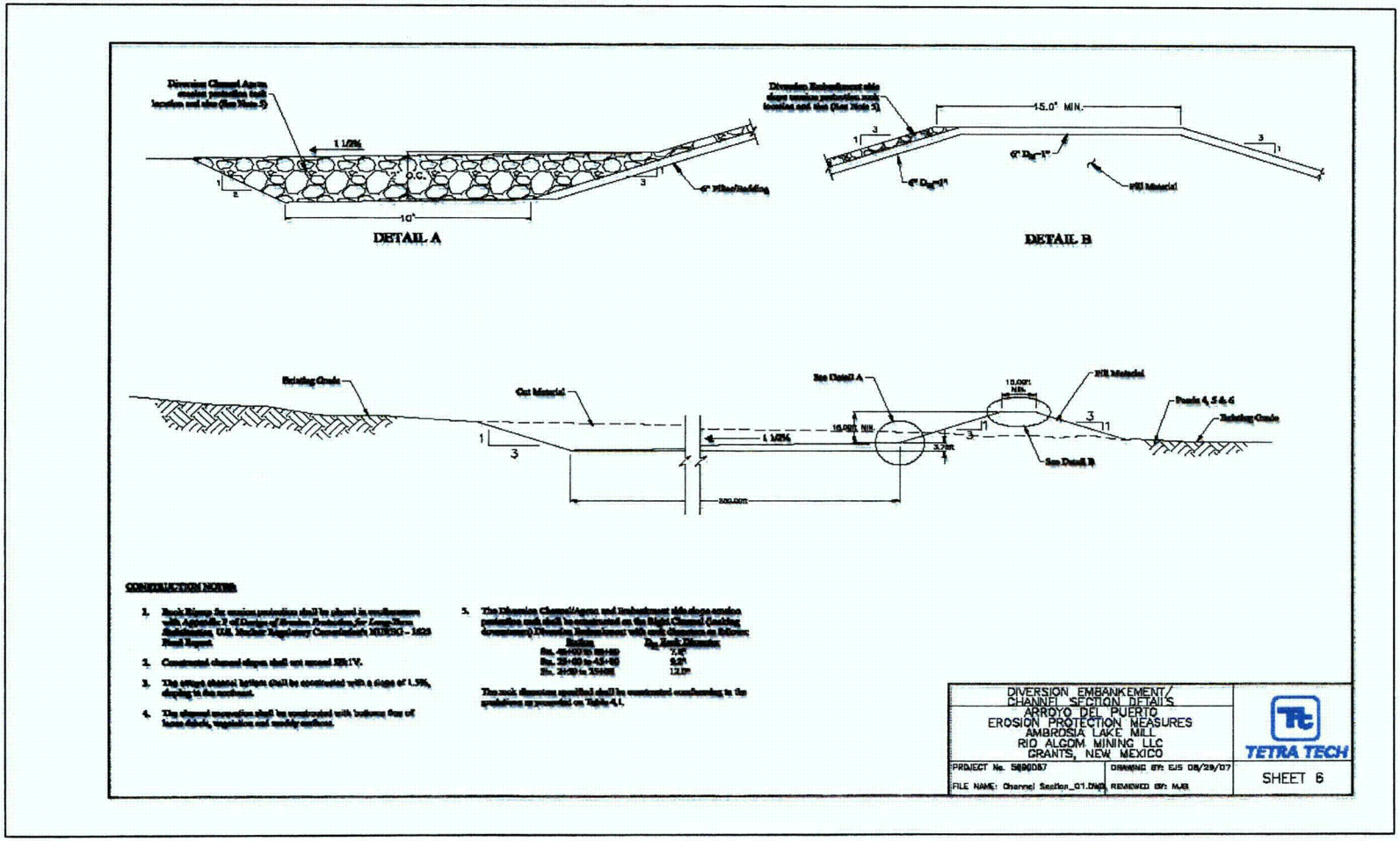
The results of the HEC-RAS analysis are summarized on the table of Worksheet "HEC-RAS Results", (calc. Sheets 16 thru 19 of 37). Erosion protection sizes have been estimated on this table by the Shear Stress Method; & the Abt and Johnson Method. An average of these 2 methods and then oversizing by 4% has been used to determine the D_{50} size rock protection to use. The scour depths along the diversion channel have also been estimated on this table. An additional summary table of estimated rock sizes to use on the Diversion Embankment/Channel is contained on Worksheet "Summary-Option 2", (calc. Sheet 20 of 37).

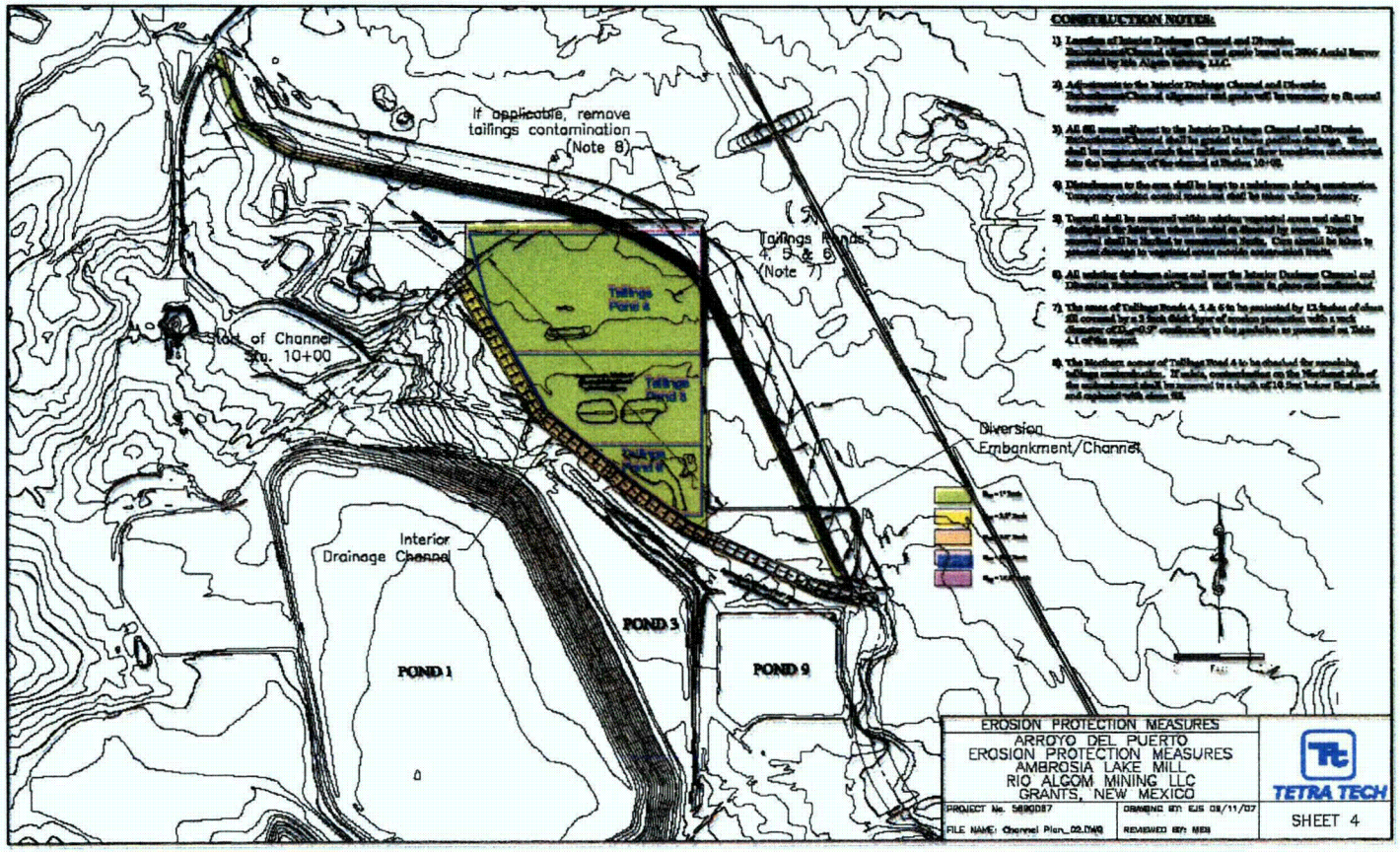
The extent of the PMF is illustrated on Worksheet "Drawing Sheet 3", (calc. Sheet 21 of 37). The extent of the PMF is also illustrated by the graphic cross-sections of the flood flow taken from the HEC-RAS Model and shown on Worksheet "PMF X-Sections", (calc. Sheets 22 thru 30 of 37).

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

Worksheet "Raw Data-Profile"	Calc. Sheet 31 of 37
Worksheet "Raw Data-Flow Dist"	Calc. Sheets 32, 33, & 34 of 37
Worksheet "Raw Data-Cross Sect"	Calc. Sheets 35, 36, & 37 of 37


4A
7.175
4B
4C
3A
3B
14.641
4D


DETAIL A
DETAIL B
15.0' MIN.
Existing Grade
Cut Material
Fill Material
See Detail A
See Detail B
Points 4, 5 & 6
CONSTRUCTION NOTES
DIVERSION EMBANKEMENT/
CHANNEL SECTION DETAILS
ARROYO DEL PUERTO
EROSION PROTECTION MEASURES
AMBROSIA LAKE MILL
RIO ALGOM MINING LLC
GRANTS, NEW MEXICO
TETRA TECH
SHEET 6


If applicable, remove tailings contamination (Note 8)
Tailings Ponds 4, 5 & 6 (Note 7)
Tailings Pond 4
Tailings Pond 5
Tailings Pond 6
Start of Channel Sta. 10+00
Diversion Embankment/Channel
Interior Drainage Channel
POND 1
POND 3
POND 9
EROSION PROTECTION MEASURES
ARROYO DEL PUERTO
EROSION PROTECTION MEASURES
AMBROSIA LAKE MILL
RIO ALGOM MINING LLC
GRANTS, NEW MEXICO
TETRA TECH
SHEET 4

	Reach Lengths			Other Embankment / Channel Data									
1	2	3	5	6	7	8	9	10	11	12	13	15	16
Section #	Left Channel	Main Channel	Right Channel	Existing Base Elev	Height Difference (Existing Elev - Proposed Elev)	Proposed Slope from previous Starting Station	Starting Station	End Station for Given Slope	Elevation at Base of Berm (Right Channel Bottom) at Beginning Station	Elevation at Center of Channel	Channel Bottom Width	Proposed Base of Berm (Right Channel Bottom) Elev	Proposed Top of Berm Elevation
21	500	500	500	6951.0	-1.0	0.0025	9675	9425	6952.0	6952.00	100	6952.00	
						0.0025	9425	9175	6951.38	6951.38	100		
20	500	500	500	6950.0	-0.8	0.0025	9175	8925	6950.77	6950.77	100	6950.77	
						0.0025	8925	8675	6950.15	6950.15	100		
19	350	325	275	6949.1	-0.4	0.0025	8675	8513	6949.53	6949.53	100	6949.53	
						0.0025	8513	8350	6949.13	6949.13	100	6970.00	6970.00
18	425	350	250	6948.5	-0.2	0.0025	8350	8175	6948.73	6946.85	250	6948.73	6965.00
						0.0025	8175	8000	6948.30	6946.42	250		
17	450	500	575	6947.80	-0.1	0.0025	8000	7750	6947.86	6945.99	250	6947.86	6962.86
						0.0025	7750	7500	6947.25	6945.37	250		
16	425	500	575	6947.0	0.0	0.0010	7500	7250	6947.00	6945.12	250	6947.00	6962.00
						0.0010	7250	7000	6946.75	6944.87	250		
15	500	500	500	6947.5	1.0	0.0010	7000	6750	6946.50	6944.62	250	6946.50	6961.50
						0.0010	6750	6500	6946.25	6944.37	250		
14	500	500	500	6949.0	3.0	0.0010	6500	6250	6946.00	6944.12	250	6946.00	6961.00
						0.0010	6250	6000	6945.75	6943.87	250		
13	500	500	500	6946.5	1.0	0.0010	6000	5750	6945.50	6943.62	250	6945.50	6959.87
						0.0010	5750	5500	6945.25	6943.37	250		
12	500	500	500	6946.5	1.5	0.0010	5500	5250	6945.00	6943.12	250	6945.00	6958.75
						0.0010	5250	5000	6944.75	6942.87	250		
11	525	500	475	6945.0	0.5	0.0010	5000	4750	6944.50	6942.62	250	6944.50	6957.62
						0.0010	4750	4500	6944.25	6942.37	250		
10	525	500	475	6944.0	0.0	0.0010	4500	4250	6944.00	6942.12	250	6944.00	6956.50
						0.0050	4250	4000	6942.75	6940.87	250		
9	525	500	475	6942.5	1.0	0.0050	4000	3750	6941.50	6939.62	250	6941.50	6954.00

	Reach Lengths			Other Embankment / Channel Data									
1	2	3	5	6	7	8	9	10	11	12	13	15	16
Section #	Left Channel	Main Channel	Right Channel	Existing Base Elev	Height Difference (Existing Elev - Proposed Elev)	Proposed Slope from previous Starting Station	Starting Station	End Station for Given Slope	Elevation at Base of Berm (Right Channel Bottom) at Beginning Station	Elevation at Center of Channel	Channel Bottom Width	Proposed Base of Berm (Right Channel Bottom) Elev	Proposed Top of Berm Elevation
						0.0050	3750	3500	6940.25	6938.37	250		
8	550	500	450	6938.0	-1.0	0.0050	3500	3250	6939.00	6937.12	250	6939.00	6951.50
						0.0050	3250	3000	6937.75	6935.87	250		
7	500	500	500	6933.3	-3.2	0.0050	3000	2750	6936.50	6934.62	250	6936.50	6949.62
						0.0100	2750	2500	6934.00	6932.12	250		
6	500	500	500	6930.0	-1.5	0.0100	2500	2250	6931.50	6929.62	250	6931.50	6945.25
						0.0100	2250	2000	6929.00	6927.12	250		
5	500	500	500	6927.0	0.5	0.0100	2000	1750	6926.50	6924.62	250	6926.50	6940.87
						0.0100	1750	1500	6924.00	6922.12	250		
4	500	500	500	6923.0	1.5	0.0100	1500	1250	6921.50	6919.62	250	6921.50	6936.50
						0.0100	1250	1000	6919.00	6917.12	250		
3	500	500	500	6921.0	4.5	0.0100	1000	750	6916.50	6914.62	250	6916.50	6931.50
						0.0100	750	500	6914.00	6912.12	250		
2	500	500	500	6915.0	3.5	0.0100	500	250	6911.50	6909.62	250	6911.50	6926.50
						0.0100	250	0	6909.00	6907.12	250		
1	100	100	100	6905.0	-1.5	0.0100	0	-50	6906.50	6904.62	250	6906.50	6921.50
						0.0100	-50	-100	6906.00	6904.12	250		
0	500	400	350	6903.0	-2.5	0.0100	-100	-300	6905.50	6903.62	250	6905.50	6909.50
						0.0090	-300	-500	6903.70	6901.82	250		
-1	500	500	525	6900.0	-1.9	0.0090	-500	-750	6901.90	6900.02	250	6901.90	6905.90
						0.0090	-750	-1000	6899.65	6897.77	250		
-2	475	500	525	6897.5	0.1	0.0090	-1000	-1250	6897.40	6895.52	250	6897.40	
						0.0090	-1250	-1500	6895.15	6893.27	250		
-3	475	500	525	6895.0	2.1	0.0090	-1500	-1750	6892.90	6891.02	250	6892.90	
						0.0090	-1750	-2000	6890.65	6888.77	250		
-4	200	200	200	6892.5	4.1	0.0090	-2000	-2100	6888.40	6886.52	250	6888.40	
						0.0090	-2100	-2200	6887.50	6885.62	250		
-5				6890.0	3.4	0.0090	-2200		6886.60	6884.72	250	6886.60	
	TOTALS	11875					11875						

Cut / Fill Berm & Channel Volumes

1	17	18	19	20	21	22	23	24	25	26	27	28	29	38	39
									Wet Slope Rock Cover (1 foot thick ratio) (previous reach)						
Section #	Relative Berm Height from Base of Right Channel Bottom	Avg Relative Berm Height from Base of Right Channel Bottom Between Reaches	Proposed Berm Fill Height at Station	Avg Berm Fill Height Between Reaches	Up Stream Reach	Berm X-Sect Area	Berm Fill Volume (cy)	Dry Slope Rock Cover (6 inches thick) (cy)	D50 to Use	Volume (cy)	ds = Scour Depth (ft)	Scour Volume Required (cy/lf)	Scour Volume Provided (cy/lf)	Channel Cut Volume	Channel Fill Volume
21											7.39				
20											8.49				
19									3.20		5.56	0.000			
	0.00		0.00												
18	16.27	8.14	16.50	8.25	1335.00	327.94	16214.69	645.0	3.2	1,272.0	6.8	0.5963	0.74		
17	15.00	15.64	15.06	15.78	350.00	983.88	12753.95	323.0	3.2	641.0	6.5	0.5695	0.74	6349.83	8.68
16	15.00	15.00	15.00	15.03	500.00	903.05	16723.10	440.0	3.2	878.0	7.1	0.6202	0.74	9071.18	0.50
15	15.00	15.00	14.00	14.50	500.00	847.77	15699.36	424.0	7.8	878.0	7.4	0.6464	0.74	11422.14	150.19
14	15.00	15.00	12.00	13.00	500.00	701.56	12991.82	381.0	7.8	878.0	7.7	1.8126	2.22	18575.71	2369.24
13	14.38	14.69	13.37	12.68	500.00	672.80	12459.22	371.0	7.8	860.0	7.4	1.7251	2.22	18575.71	2369.24
12	13.75	14.06	12.25	12.81	500.00	684.23	12670.96	375.0	7.8	824.0	8.0	1.8731	2.22	14967.67	928.12
11	13.13	13.44	12.62	12.43	500.00	650.21	12040.95	364.0	7.8	787.0	7.1	1.6588	2.22	13778.89	595.12
10	12.50	12.81	12.50	12.56	500.00	661.46	12249.21	368.0	7.8	750.0	6.9	1.6078	2.22	10254.18	38.26
9	12.50	12.50	11.50	12.00	500.00	611.59	11325.68	351.0	7.8	732.0	8.1	1.9010	2.22	11422.14	150.19

Cut / Fill Berm & Channel Volumes

1	17	18	19	20	21	22	23	24	25	26	27	28	29	38	39
									Wet Slope Rock Cover (1 foot thick ratio) (previous reach)						
Section #	Relative Berm Height from Base of Right Channel Bottom	Avg Relative Berm Height from Base of Right Channel Bottom Between Reaches	Proposed Berm Fill Height at Station	Avg Berm Fill Height Between Reaches	Up Stream Reach	Berm X-Sect Area	Berm Fill Volume (cy)	Dry Slope Rock Cover (6 inches thick) (cy)	D50 to Use	Volume (cy)	ds = Scour Depth (ft)	Scour Volume Required (cy/lf)	Scour Volume Provided (cy/lf)	Channel Cut Volume	Channel Fill Volume
8	12.50	12.50	13.50	12.50	500.00	655.82	12144.86	366.0	9.2	732.0	8.0	2.1060	2.78	9093.17	0.01
7	13.13	12.81	16.32	14.91	500.00	890.34	16487.76	437.0	9.2	750.0	8.1	2.1369	2.78	9071.18	2587.97
6	13.75	13.44	15.25	15.78	500.00	984.03	18222.72	462.0	9.2	787.0	8.3	2.1837	2.78	9071.18	3242.40
5	14.38	14.06	13.87	14.56	500.00	854.15	15817.60	426.0	9.2	824.0	8.8	2.3087	2.78	9071.18	144.59
4	15.00	14.69	13.50	13.68	500.00	766.89	14201.74	401.0	9.2	860.0	8.5	2.2416	2.78	13778.89	595.12
3	15.00	15.00	10.50	12.00	500.00	611.59	11325.68	351.0	9.2	878.0	8.9	2.3557	2.78	23483.64	5322.37
2	15.00	15.00	11.50	11.00	500.00	527.62	9770.65	322.0	9.2	878.0	9.3	2.4474	2.78	28502.69	9454.51
1	15.00	15.00	16.50	14.00	500.00	797.53	10338.35	287.0	9.2	615.0	9.2	2.4155	2.78	13778.89	595.12
0	4.00	9.50	6.50	11.50	100.00			0.0	12.0	0.0	9.2	3.2378		1814.24	469.37
-1	4.00	4.00	5.90	6.20	400.00			145.0	12.0	47.0	9.0	3.1557	3.33	7256.94	2272.72
-2					500.00			0.0		0.0	9.0			9071.18	472.47
-3					500.00			0.0		0.0	9.3			14253.57	719.48
-4					500.00			0.0		0.0	10.1			23980.55	5682.53
-5					200.00			0.0		0.0	9.8			10895.01	3324.38
							243438.31	7239.00						297539.76	41492.57
			Sta 1+50 to Sta 83+50 + 1335 up road		9535.00										

		Cut	Fill
SUMMARY	Berm Fill		243438
	Channel Cut	297540	
	Channel Fill		41493
	Total	297540	284931

	Reach Lengths			Other Embankment / Channel Data										
Section #	Left	Chan	Right	Existing Base Elev	Height Difference (Existing Elev - Proposed Elev)	Proposed Slope from previous Starting Station	Starting Station	End Station for Given Slope	Elevation at Base of Berm (Right Channel Bottom) at Beginning Station	Elevation at Center of Channel	Channel Bottom Width	Proposed Base of Berm (Right Channel Bottom) Elev	Proposed Top of Berm Elevation	Proposed Berm Fill Height
21	500	500	500	6951.0	-1.0	0.0025	9675	9425	6952.0	6952.00	100	6952.00		
						0.0025	9425	9175	6951.38	6951.38	100			
20	500	500	500	6950.0	-0.8	0.0025	9175	8925	6950.77	6950.77	100	6950.77		
						0.0025	8925	8675	6950.15	6950.15	100			
19	350	325	275	6949.1	-0.4	0.0025	8675	8513	6949.53	6949.53	100	6949.53		
						0.0025	8513	8350	6949.13	6949.13	100			
18	425	350	250	6948.5	-0.2	0.0025	8350	8175	6948.73	6946.85	250	6948.73	6965.00	16.50
						0.0025	8175	8000	6948.30	6946.42	250			
17	450	500	575	6947.80	-0.1	0.0025	8000	7750	6947.86	6945.99	250	6947.86	6962.86	15.06
						0.0025	7750	7500	6947.25	6945.37	250			
16	425	500	575	6947.0	0.0	0.0010	7500	7250	6947.00	6945.12	250	6947.00	6962.00	15.00
						0.0010	7250	7000	6946.75	6944.87	250			
15	500	500	500	6947.5	1.0	0.0010	7000	6750	6946.50	6944.62	250	6946.50	6961.50	14.00
						0.0010	6750	6500	6946.25	6944.37	250			
14	500	500	500	6949.0	3.0	0.0010	6500	6250	6946.00	6944.12	250	6946.00	6961.00	12.00
						0.0010	6250	6000	6945.75	6943.87	250			
13	500	500	500	6946.5	1.0	0.0010	6000	5750	6945.50	6943.62	250	6945.50	6960.50	14.00
						0.0010	5750	5500	6945.25	6943.37	250			
12	500	500	500	6946.5	1.5	0.0010	5500	5250	6945.00	6943.12	250	6945.00	6960.00	13.50
						0.0010	5250	5000	6944.75	6942.87	250			
11	525	500	475	6945.0	0.5	0.0010	5000	4750	6944.50	6942.62	250	6944.50	6959.50	14.50
						0.0010	4750	4500	6944.25	6942.37	250			
10	525	500	475	6944.0	0.0	0.0010	4500	4250	6944.00	6942.12	250	6944.00	6959.00	15.00
						0.0050	4250	4000	6942.75	6940.87	250			
9	525	500	475	6942.5	1.0	0.0050	4000	3750	6941.50	6939.62	250	6941.50	6956.50	14.00

	Reach Lengths			Other Embankment / Channel Data										
Section #	Left	Chan	Right	Existing Base Elev	Height Difference (Existing Elev - Proposed Elev)	Proposed Slope from previous Starting Station	Starting Station	End Station for Given Slope	Elevation at Base of Berm (Right Channel Bottom) at Beginning Station	Elevation at Center of Channel	Channel Bottom Width	Proposed Base of Berm (Right Channel Bottom) Elev	Proposed Top of Berm Elevation	Proposed Berm Fill Height
						0.0050	3750	3500	6940.25	6938.37	250			
8	550	500	450	6938.0	-1.0	0.0050	3500	3250	6939.00	6937.12	250	6939.00	6954.00	16.00
						0.0050	3250	3000	6937.75	6935.87	250			
7	500	500	500	6933.3	-3.2	0.0050	3000	2750	6936.50	6934.62	250	6936.50	6951.50	18.20
						0.0100	2750	2500	6934.00	6932.12	250			
6	500	500	500	6930.0	-1.5	0.0100	2500	2250	6931.50	6929.62	250	6931.50	6946.50	16.50
						0.0100	2250	2000	6929.00	6927.12	250			
5	500	500	500	6927.0	0.5	0.0100	2000	1750	6926.50	6924.62	250	6926.50	6941.50	14.50
						0.0100	1750	1500	6924.00	6922.12	250			
4	500	500	500	6923.0	1.5	0.0100	1500	1250	6921.50	6919.62	250	6921.50	6936.50	13.50
						0.0100	1250	1000	6919.00	6917.12	250			
3	500	500	500	6921.0	4.5	0.0100	1000	750	6916.50	6914.62	250	6916.50	6931.50	10.50
						0.0100	750	500	6914.00	6912.12	250			
2	500	500	500	6915.0	3.5	0.0100	500	250	6911.50	6909.62	250	6911.50	6926.50	11.50
						0.0100	250	0	6909.00	6907.12	250			
1	100	100	100	6905.0	-1.5	0.0100	0	-50	6906.50	6904.62	250	6906.50		
						0.0100	-50	-100	6906.00	6904.12	250			
0	500	400	350	6903.0	-2.5	0.0100	-100	-300	6905.50	6903.62	250	6905.50		
						0.0090	-300	-500	6903.70	6901.82	250			
-1	500	500	525	6900.0	-1.9	0.0090	-500	-750	6901.90	6900.02	250	6901.90		
						0.0090	-750	-1000	6899.65	6897.77	250			
-2	475	500	525	6897.5	0.1	0.0090	-1000	-1250	6897.40	6895.52	250	6897.40		
						0.0090	-1250	-1500	6895.15	6893.27	250			
-3	475	500	525	6895.0	2.1	0.0090	-1500	-1750	6892.90	6891.02	250	6892.90		
						0.0090	-1750	-2000	6890.65	6888.77	250			
-4	200	200	200	6892.5	4.1	0.0090	-2000	-2100	6888.40	6886.52	250	6888.40		
						0.0090	-2100	-2200	6887.50	6885.62	250			
-5				6890.0	3.4	0.0090	-2200		6886.60	6884.72	250	6886.60		
	Total Length	11875					11875							

HEC-RAS INPUT DATA

Section #	left overbank-6		left overbank-5		left overbank-4		left overbank-3		left overbank-2		left overbank-1		left overbank-1		left bank		left bottom	
	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation
21					1,200	6,970	1,850	6,965	2,335	6,965	2,825	6,965	3,310	6,960	3425	6955.00	3450	6951.50
20									1,035	6970.00	2,010	6,965	2,745	6,960	3425	6955.00	3450	6951.00
19					630	6970.00	1685	6965.00	2175	6965.00	2255	6,960	2500	6,960	2745	6955.00	3450	6950.00
18			1,100	6970.00	1,425	6965.00	1,625	6965.00	1,875	6960.00	2,375	6,955	2,775	6,950	3238.75	6948.73	3250	6944.98
17			130	6965.00	945	6960.00	1675	6960.00	1835	6955.00	2975	6950	3225	6950	3238.75	6947.86	3250	6944.11
16							1025	6965.00	1920	6960.00	2160	6955	2975	6950	3238.75	6947.00	3250	6943.25
15					1060.00	6965.00	1710.00	6960.00	2035.00	6955.00	2850	6952	3000	6950	3238.75	6946.50	3250	6942.75
14					1200.00	6965.00	2010.00	6960.00	2335.00	6955.00	2825	6950	3075	6950	3238.75	6946.00	3250	6942.25
13							1000	6965.00	1810	6960.00	2380	6955	2625	6950	3238.75	6945.50	3250	6941.75
12							1150	6965.00	1800	6960.00	2150	6955	2775	6950	3238.75	6945.00	3250	6941.25
11			970.00	6965.00	1705.00	6960.00	2110.00	6955.00	2235	6955.00	2435	6950	2975	6945	3238.75	6944.50	3250	6940.75
10					1660.00	6965.00	1985.00	6960.00	2070.00	6955.00	2150	6950	2975	6945	3238.75	6944.00	3250	6940.25
9			1180.00	6965.00	1750.00	6960.00	1910.00	6955.00	2075.00	6950.00	2875	6945	3200	6945	3238.75	6941.50	3250	6937.75

HEC-RAS INPUT DATA

Section #	left overbank-6		left overbank-5		left overbank-4		left overbank-3		left overbank-2		left overbank-1		left overbank-1		left bank		left bottom	
8							1675	6955.00	2225	6950.00	2625	6945	3075	6940	3238.75	6939.00	3250	6935.25
7					1125	6950.00	1575	6946.50	1975	6946.50	2075	6945	2975	6940	3238.75	6936.50	3250	6932.75
6					1325	6945.00	2225	6941.00	2275	6940.00	2975	6935	3125	6935	3238.75	6931.50	3250	6927.75
5	1225	6945.00	1475	6940.00	2175	6936.50	2225	6935.00	2275	6935.00	3200	6933	3228.25	6930	3238.75	6926.50	3250	6922.75
4							2075	6935.00	2275	6932.50	2400	6930	3150	6925	3238.75	6921.50	3250	6917.75
3	1175	6940.00	1775	6935.00	2175	6930.00	2375	6927.60	2675	6925.00	3075	6922	3228.25	6920	3238.75	6916.50	3250	6912.75
2	1375	6930.00	2150	6926.50	2175	6925.00	2750	6920.70	2950	6920.00	3225	6920	3228.25	6915	3238.75	6911.50	3250	6907.75
1							2100	6923.50	2200	6920.00	2750	6915	3318.24	6910	3328.75	6906.50	3340	6902.75
0					2100	6923.00	2175	6920.00	2750	6915.00	3000	6911.2	3165.00	6910	3238.75	6905.50	3250	6901.75
-1			1725.00	6920.00	2000.00	6915.00	2525.00	6910.00	2935.00	6910.00	3050	6910	3225	6905	3238.75	6901.90	3250	6898.15
-2							1725.00	6915.00	2210.00	6910.00	2335.00	6905	3215.94	6905	3238.75	6897.40	3250.00	6893.65
-3					2200.00	6910.00	2350.00	6905.00	2625.00	6905.00	3150.00	6900	3232.44	6895	3238.75	6892.90	3250.00	6889.15
-4					2150.00	6910.00	2475.00	6905.00	2850.00	6900.00	3025.00	6900	3218.94	6895	3238.75	6888.40	3250.00	6884.65
-5							2100.00	6910.00	2550.00	6905.00	2715.00	6900	3213.54	6895	3238.75	6886.60	3250.00	6882.85

HEC-RAS INPUT DATA

Section #	Center Channel		right bottom		right bank		right berm		right overbank-1		right overbank-2		right overbank-3		right overbank-4		right overbank-5	
	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation	Station	Elevation
21	3475	6951.50	3500	6952.00	3525	6955.00	4300	6960.00	5100	6960.00	5200	6965.00	5250	6970.00				
20	3475	6950.00	3500	6951.00	3525	6955.00	3875	6960.00	4250	6960.00	4900	6960.00	4950	6965.00	5000	6970.00		
19	3475	6948.50	3500	6950.00	4075	6950.00	4125	6955.00	4175	6960.00	4675	6963.00	4800	6965.00	4900.00	6970.00		
18	3375	6946.85	3500	6948.73	3548.8	6965.00	4725	6965.00	4,825	6,970								
17	3375	6945.99	3500	6947.86	3545	6962.86	3560	6962.86										
16	3375	6945.12	3500	6947.00	3545	6962.00	3560	6962.00										
15	3375	6944.62	3500	6946.50	3545	6961.50	3560	6961.50										
14	3375	6944.12	3500	6946.00	3545	6961.00	3560	6961.00										
13	3375	6943.62	3500	6945.50	3545	6960.50	3560	6960.50										
12	3375	6943.12	3500	6945.00	3545	6960.00	3560	6960.00										
11	3375	6942.62	3500	6944.50	3545	6959.50	3560	6959.50										
10	3375	6942.12	3500	6944.00	3545	6959.00	3560	6959.00										
9	3375	6939.62	3500	6941.50	3545	6956.50	3560	6956.50										

HEC-RAS INPUT DATA

Section #	Center Channel		right bottom		right bank		right berm		right overbank-1		right overbank-2		right overbank-3		right overbank-4		right overbank-5	
8	3375	6937.12	3500	6939.00	3545	6954.00	3560	6954.00										
7	3375	6934.62	3500	6936.50	3545	6951.50	3560	6951.50										
6	3375	6929.62	3500	6931.50	3545	6946.50	3560	6946.50										
5	3375	6924.62	3500	6926.50	3545	6941.50	3560	6941.50										
4	3375	6919.62	3500	6921.50	3545	6936.50	3560	6936.50										
3	3375	6914.62	3500	6916.50	3545	6931.50	3560	6931.50										
2	3375	6909.62	3500	6911.50	3545	6926.50	3560	6926.50										
1	3375	6904.62	3590	6906.50	3600.00	6910.00	3775.00	6915.00	3875.00	6920	4500.00	6924						
0	3375	6903.62	3500	6905.50	3513.5	6910.00	3640	6915.00	3665	6920	4475	6923.5						
-1	3375	6900.02	3500	6901.90	3509.6	6905.10	3685	6910.00	3715	6915	3750	6920	4525	6924				
-2	3375.00	6895.52	3500	6897.40	3522.8	6905.00	3525.00	6910.00	3550.00	6915	3585.00	6920	3875.00	6921				
-3	3375.00	6891.02	3500	6892.90	3551.3	6910.00	3785.00	6910.00	4100.00	6910	4600.00	6915						
-4	3375.00	6886.52	3500	6888.40	3519.8	6895.00	3575.00	6895.60	3675.00	6900	3865.00	6905	4215.00	6910	4315.00	6915	4475.00	6920
-5	3375.00	6884.72	3500	6886.60	3540.2	6900.00	3815.00	6905.00	4150.00	6910	4385.00	6915	4640.00	6920	4825.00	6925		

River Section	Station	Flow (cfs)	Water Surface Elevation (ft)	Proposed Top of Berm Elevation	Estimated Freeboard	E.G. Slope (ft/ft)	Position	Left Station (ft)	Right Station (ft)	Manning's n Value	Split Section Flow (cfs)
1	2	3	4	5	6	7	8	9	10	11	12
21	9675	78000	6964.46			0.001508	LOB	0	3425	0.028	7930.64
						0.001508	Chan	3425	3525	0.032	11244.63
						0.001508	ROB	3525	0	0.028	58824.74
20	9175	78000	6962.29			0.004821	LOB	0	3425	0.028	31421.83
						0.004821	Chan	3425	3525	0.032	16261.22
						0.004821	ROB	3525	0	0.028	30316.95
19	8675	78000	6960.14			0.001008	LOB	0	2745	0.028	1420.57
						0.001008	Chan	2745	4125	0.032	76243.74
						0.001008	ROB	4125	0	0.028	335.69
18	8350	78000	6959.76	6965.00	5.24	0.000957	LOB	0	3238.75	0.028	51258.27
						0.000957	Chan	3238.75	3548.8	0.032	26741.74
						0.000957		0	0		0
17	8000	78000	6959.58	6962.86	3.28	0.00064	LOB	0	3238.75	0.028	54135.96
						0.00064	Chan	3238.75	3545	0.032	23864.04
								0	0		0
16	7500	78000	6958.99	6962.00	3.01	0.000929	LOB	0	3238.75	0.028	48255.36
						0.000929	Chan	3238.75	3545	0.032	29744.64
								0	0		0
15	7000	78000	6958.39	6961.50	3.11	0.001178	LOB	0	3238.75	0.028	44942.24
						0.001178	Chan	3238.75	3545	0.032	33057.76
								0	0		0
14	6500	78000	6957.21	6961.00	3.79	0.001791	LOB	0	3238.75	0.028	40547.65
						0.001791	Chan	3238.75	3545	0.032	37452.35
								0	0		0
13	6000	78000	6956.56	6959.87	3.31	0.001443	LOB	0	3238.75	0.028	45039.13
						0.001443	Chan	3238.75	3545	0.032	32960.86
								0	0		0
12	5500	78000	6954.59	6958.75	4.16	0.003251	LOB	0	3238.75	0.028	37642.88
						0.003251	Chan	3238.75	3545	0.032	40357.12
								0	0		0
11	5000	78000	6953.87	6957.62	3.75	0.001859	LOB	0	3238.75	0.028	48481.38
						0.001859	Chan	3238.75	3545	0.032	29518.63
								0	0		0
10	4500	78000	6953.04	6956.50	3.46	0.001745	LOB	0	3238.75	0.028	50800.9
						0.001745	Chan	3238.75	3545	0.032	27199.1
								0	0		0
9	4000	78000	6950.4	6954.00	3.60	0.00429	LOB	0	3238.75	0.028	36237
						0.00429	Chan	3238.75	3545	0.032	41762.99
								0	0		0

River Section	Station	Flow (cfs)	Water Surface Elevation (ft)	Proposed Top of Berm Elevation	Estimated Freeboard	E.G. Slope (ft/ft)	Position	Left Station (ft)	Right Station (ft)	Manning's n Value	Split Section Flow (cfs)
1	2	3	4	5	6	7	8	9	10	11	12
8	3500	78000	6947.51	6951.50	3.99	0.004479	LOB	0	3238.75	0.028	37934.85
						0.004479	Chan	3238.75	3545	0.032	40065.15
								0	0		
7	3000	78000	6945.24	6949.62	4.38	0.004489	LOB	0	3238.75	0.028	36360.75
						0.004489	Chan	3238.75	3545	0.032	41639.25
								0	0		0
6	2500	78000	6940.6	6945.25	4.65	0.004498	LOB	0	3238.75	0.028	33895.03
						0.004498	Chan	3238.75	3545	0.032	44104.97
								0	0		0
5	2000	78000	6937.65	6940.87	3.22	0.003436	LOB	0	3238.75	0.028	26529.44
						0.003436	Chan	3238.75	3545	0.032	51470.57
								0	0		0
4	1500	78000	6931.23	6936.50	5.27	0.004298	LOB	0	3238.75	0.028	30678.78
						0.004298	Chan	3238.75	3545	0.032	47321.22
								0	0		0
3	1000	78000	6927.50	6931.50	4.00	0.00396	LOB	0	3238.75	0.028	23853.05
						0.00396	Chan	3238.75	3545	0.032	54146.95
								0	0		0
2	500	78000	6924.14	6926.50	2.36	0.003279	LOB	0	3238.75	0.028	17672.17
						0.003279	Chan	3238.75	3545	0.032	60327.83
								0	0		0
1	0	78000	6916.56	6921.50	4.94	0.005396	LOB	0	3238.75	0.028	608.75
						0.005396	Chan	3238.75	3600	0.032	70716.48
						0.005396	ROB	3600	0	0.028	6674.78
0	-100	78000	6916.12	6909.50	-6.62	0.004272	LOB	0	3238.75	0.028	19919.19
						0.004272	Chan	3238.75	3513.5	0.032	54409.64
						0.004272	ROB	3513.5	0	0.028	3671.17
-1	-500	78000	6912.93			0.003264	LOB	0	3238.75	0.028	19340.82
						0.003264	Chan	3238.75	3509.6	0.032	50057.55
						0.003264	ROB	3509.6	0	0.028	8601.63
-2	-1000	78000	6908.61			0.003436	LOB	0	3238.75	0.028	25277.71
						0.003436	Chan	3238.75	3522.8	0.032	52715.1
						0.003436	ROB	3522.8	0	0.028	7.19
-3	-1500	78000	6905.98			0.002942	LOB	0	3238.75	0.028	17856.17
						0.002942	Chan	3238.75	3551.3	0.032	60143.83
								0	0		0
-4	-2000	78000	6899.68			0.005868	LOB	0	3238.75	0.028	4788.86
						0.005868	Chan	3238.75	3519.8	0.032	69644.12
						0.005868	ROB	3519.8	0	0.028	3567.02
-5	-2200	78000	6899.78			0.003813	LOB	0	3238.75	0.028	8722.38
						0.003813	Chan	3238.75	3540.2	0.032	69277.62
								0	0		0

						D_{50} (inches)		D_{50} (inches)			
River Section	Flow Area (sq ft)	Wetted Perimeter (ft)	Percentage of Conveyance	Hydraulic Depth (ft)	Velocity (ft/s)	Shear Stress Method	Abt and Johnson Method	Average D50	Oversize 4%	D_{50} to Use	d_s = **Scour Depth (ft)**
1	13	14	15	16	17	18	19	20	21	22	23
21	1764.05	547.56	10.17	3.22	4.5	0.89	1.43				
	1195.8	100.43	14.42	11.96	9.4	3.29	4.49	3.89	4.05		7.4
	9157.6	1664.29	75.42	5.5	6.42	1.51	2.36				
20	3642.19	1016.59	40.28	3.58	8.63	3.15	3.60				
	1053.96	100.68	20.85	10.54	15.43	9.27	9.10	9.18	9.55		8.5
	4049.34	1398.05	38.87	2.9	7.49	2.55	2.95				
19	679.88	492.25	1.82	1.38	2.09	0.25	0.49				
	12139.35	1380.36	97.75	8.8	6.28	1.62	2.54	2.08	2.16		5.6
	133.43	73.12	0.43	1.83	2.52	0.34	0.63				
18	8862.49	1340.17	65.72	6.61	5.78	1.15	2.03				
	3555.58	296.77	34.28	12.08	7.52	2.11	3.27	2.69	2.80	3.2	6.8
	0	0	0	0	0						
17	`	1550.7	69.41	7.07	4.94	0.83	1.62				
	3758.43	298.96	30.59	12.68	6.35	1.48	2.57	2.03	2.11	3.2	6.5
	0	0	0	0	0						
16	8439.71	1270.4	61.87	6.64	5.72	1.13	1.99				
	3838.84	299.81	38.13	12.92	7.75	2.19	3.41	2.80	2.91	3.2	7.1
	0	0	0	0	0						
15	7884.99	1424.02	57.62	5.54	5.7	1.19	1.99				
	3808.09	299.48	42.38	12.83	8.68	2.76	4.01	3.38	3.52	7.8	7.4
	0	0	0	0	0						
14	5781.83	1047.78	51.98	5.52	7.01	1.80	2.67				
	3608.85	297.35	48.02	12.24	10.38	4.00	5.17	4.58	4.77	7.8	7.7
	0	0	0	0	0						
13	6543.15	1036.95	57.74	6.31	6.88	1.66	2.60				
	3564.1	296.87	42.26	12.1	9.25	3.19	4.39	3.79	3.94	7.8	7.4
	0	0	0	0	0						
12	4606.1	1037.71	48.26	4.44	8.17	2.63	3.33				
	3134.17	292.22	51.74	10.81	12.88	6.41	7.03	6.72	6.99	7.8	8.0
	0	0	0	0	0						
11	6141.57	958.49	62.16	6.41	7.89	2.17	3.15				
	3069.11	291.51	37.84	10.61	9.62	3.60	4.65	4.12	4.29	7.8	7.1
	0	0	0	0	0						
10	6894.13	1137.46	65.13	6.06	7.37	1.93	2.86				
	2974.04	290.47	34.87	10.31	9.15	3.28	4.33	3.81	3.96	7.8	6.9
	0	0	0	0	0						
9	4356.89	1177.19	46.46	3.7	8.32	2.90	3.42				
	2934.93	290.04	53.54	10.19	14.23	7.98	8.11	8.04	8.37	9.2	8.1
	0	0	0	0	0						

						D_{50} (inches)		D_{50} (inches)			
River Section	Flow Area (sq ft)	Wetted Perimeter (ft)	Percentage of Conveyance	Hydraulic Depth (ft)	Velocity (ft/s)	Shear Stress Method	Abt and Johnson Method	Average D50	Oversize 4%	D_{50} to Use	d_s = **Scour Depth (ft)**
1	13	14	15	16	17	18	19	20	21	22	23
8	3814.77	814.27	48.63	4.69	9.94	3.83	4.39				
	2821.13	288.78	51.37	9.84	14.2	8.04	8.09	8.07	8.39	9.2	8.0
7	4310.66	1179.74	46.62	3.65	8.44	2.99	3.49				
	2888.15	289.52	53.38	10.05	14.42	8.23	8.27	8.25	8.58	9.2	8.1
	0	0	0	0	0						
6	3856.62	993.91	43.46	3.88	8.79	3.18	3.70				
	2992.5	290.67	56.54	10.37	14.74	8.51	8.53	8.52	8.86	9.2	8.3
	0	0	0	0	0						
5	4012.73	1295.17	34.01	3.1	6.61	1.94	2.47				
	3590.85	297.16	65.99	12.18	14.33	7.64	8.18	7.91	8.22	9.2	8.8
	0	0	0	0	0						
4	3539.57	900.13	39.33	3.93	8.67	3.08	3.62				
	3173.14	292.64	60.67	10.93	14.91	8.57	8.66	8.62	8.96	9.2	8.5
	0	0	0	0	0						
3	3052.15	852.58	30.58	3.58	7.82	2.59	3.13				
	3545.13	296.67	69.42	12.05	15.27	8.71	8.95	8.83	9.18	9.2	8.9
	0	0	0	0	0						
2	2819.05	951.41	22.66	2.97	6.27	1.78	2.30				
	4030.89	301.84	77.34	13.47	14.97	8.06	8.68	8.37	8.71	9.2	9.3
	0	0	0	0	0						
1	61.77	15.37	0.78	5.37	9.86	5.29	4.35				
	4106.27	361.97	90.66	11.37	17.22	11.19	10.62	10.91	11.34	12	9.2
	734.34	206.26	8.56	3.56	9.09	3.50	3.88				
0	2353.44	617.4	25.54	3.81	8.46	2.97	3.50				
	3377.15	276.12	69.76	12.29	16.11	9.58	9.65	9.62	10.00	12	9.2
	460.69	132.3	4.71	3.49	7.97	2.72	3.22				
-1	3065.75	1021.44	24.8	3	6.31	1.79	2.32				
	3461.59	272.01	64.18	12.78	14.46	7.61	8.27				9.0
	968.68	193.27	11.03	5.02	8.88	2.99	3.74				
-2	3508.1	995.2	32.41	3.53	7.21	2.21	2.79				
	3586.89	285.92	67.58	12.63	14.7	7.92	8.47				9.0
	2.86	3.94	0.01	1.8	2.51	1.13	0.64				
-3	2883.49	913.78	22.89	3.16	6.19	1.70	2.25				
	4164.26	303.25	77.11	13.86	14.44	7.44	8.25				9.3
	0	0	0	0	0						
-4	582.31	202.36	6.14	2.89	8.22	3.09	3.38				
	3594.61	282.76	89.29	12.79	19.37	13.69	12.54				10.1
	430.52	147.96	4.57	2.91	8.29	3.12	3.41				
-5	1367.57	503.62	11.18	2.72	6.38	1.89	2.36				
	4195.53	303.58	88.82	13.95	16.51	9.71	9.98				9.8
	0	0	0	0	0						

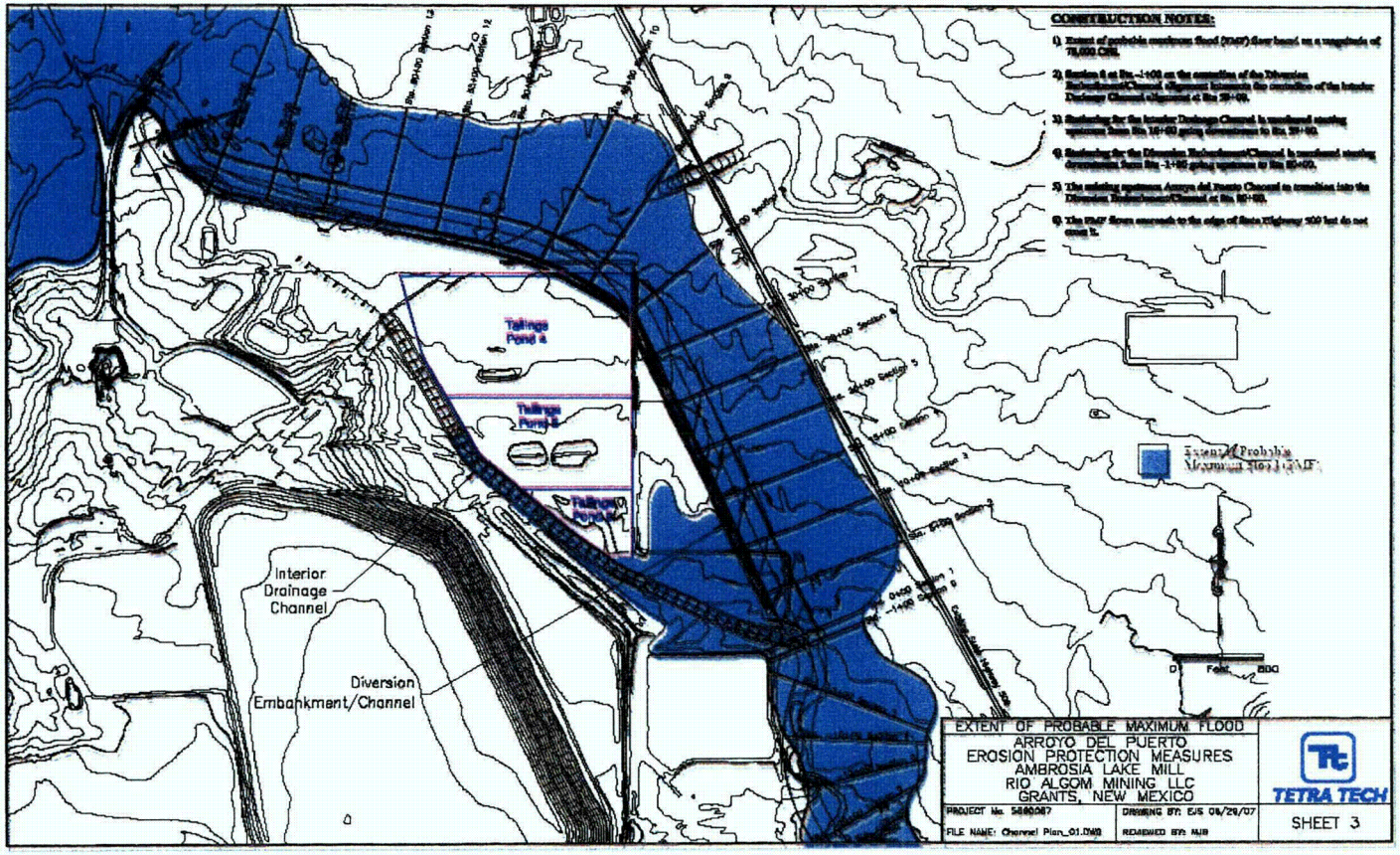
		Channel				Embankment Slope / Apron D_{50} (inches)		
1	2	5	6	7	8	9		10
River Section	Station	D_{50} - Shear Stress Method (inches)	Add 4% Oversize (inches	D_{50} - Abt and Johnson Method (inches)	Add 4% Oversize (inches	Average Size (inches)	Add 4% Oversize (inches	D50 to Use
21	9675							
20	9175							
19	8675							
18	8350	2.11	2.19	3.27	3.40	2.69	2.80	3.2
17	8000	1.48	1.54	2.57	2.68	2.03	2.11	3.2
16	7500	2.19	2.28	3.41	3.55	2.80	2.91	3.2
15	7000	2.76	2.87	4.01	4.17	3.38	3.52	7.8
14	6500	4.00	4.16	5.17	5.38	4.58	4.77	7.8
13	6000	3.19	3.31	4.39	4.57	3.79	3.94	7.8
12	5500	6.41	6.67	7.03	7.32	6.72	6.99	7.8
11	5000	3.60	3.74	4.65	4.83	4.12	4.29	7.8
10	4500	3.28	3.41	4.33	4.50	3.81	3.96	7.8
9	4000	7.98	8.30	8.11	8.44	8.04	8.37	9.2
8	3500	8.04	8.36	8.09	8.42	8.07	8.39	9.2
7	3000	8.23	8.56	8.27	8.60	8.25	8.58	9.2
6	2500	8.51	8.85	8.53	8.87	8.52	8.86	9.2
5	2000	7.64	7.94	8.18	8.50	7.91	8.22	9.2
4	1500	8.57	8.91	8.66	9.01	8.62	8.96	9.2
3	1000	8.71	9.05	8.95	9.31	8.83	9.18	9.2
2	500	8.06	8.38	8.68	9.03	8.37	8.71	9.2
1.3	150	8.06	8.38	8.68	9.03	8.37	8.71	9.2
1	0	11.19	11.64	10.62	11.05			
0	-100	9.58	9.96	9.65	10.04	9.62	10.00	12
-1	-500	7.61	7.92	8.27	8.61			
-2	-1000	7.92	8.23	8.47	8.81			
-3	-1500	7.44	7.74	8.25	8.58			
-4	-2000	13.69	14.24	12.54	13.04			
-5	-2200	9.71	10.09	9.98	10.38			

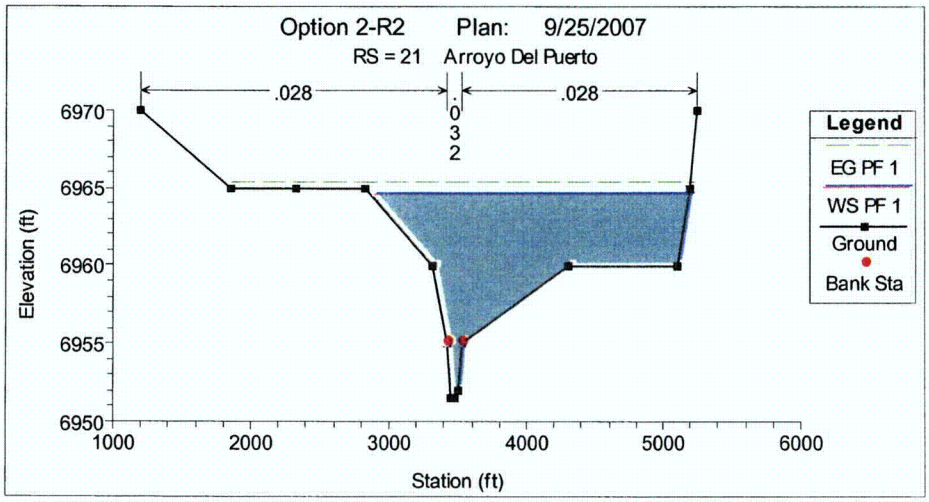
D_{50} = 7.8 inch rock

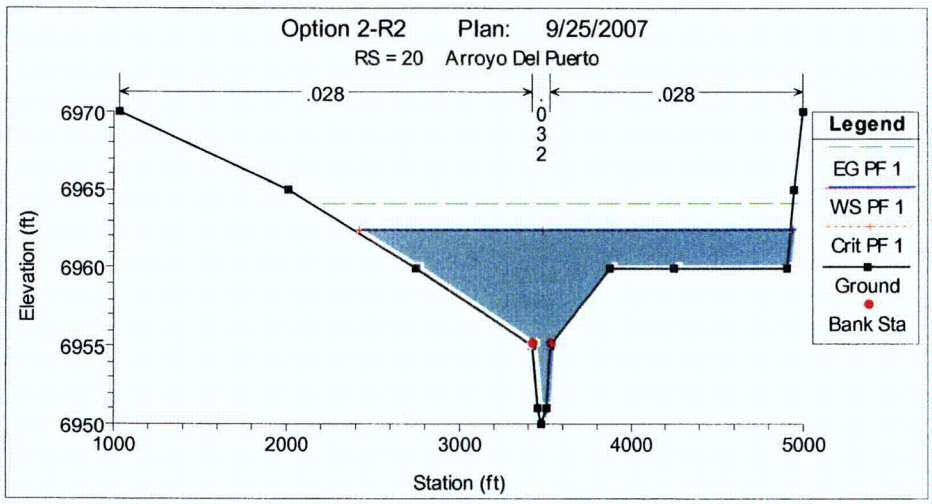
D_{50} = 12 inch rock

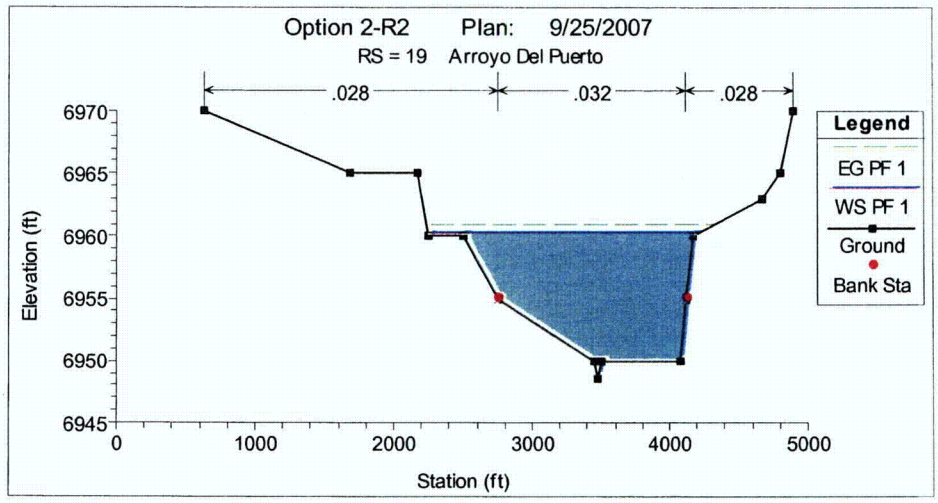
D_{50} = 9.2 inch rock

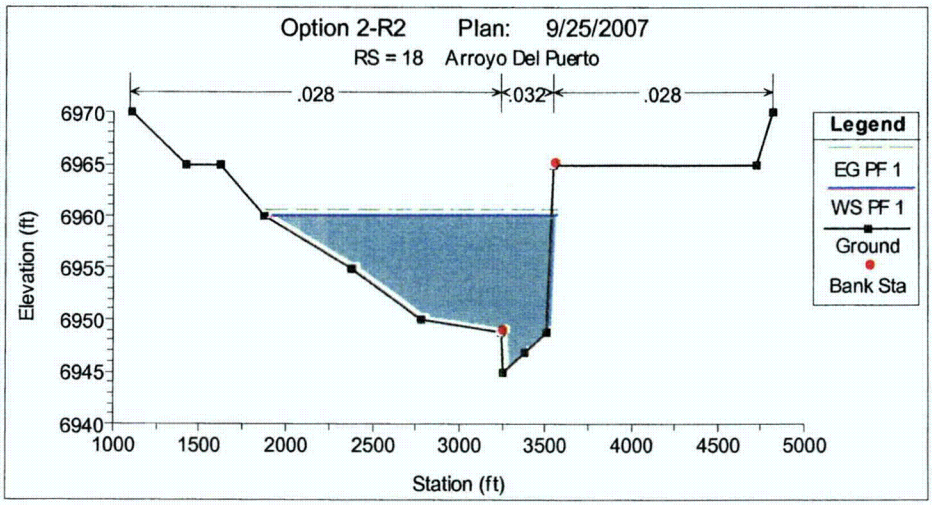
D_{50} = 3.2 inch rock

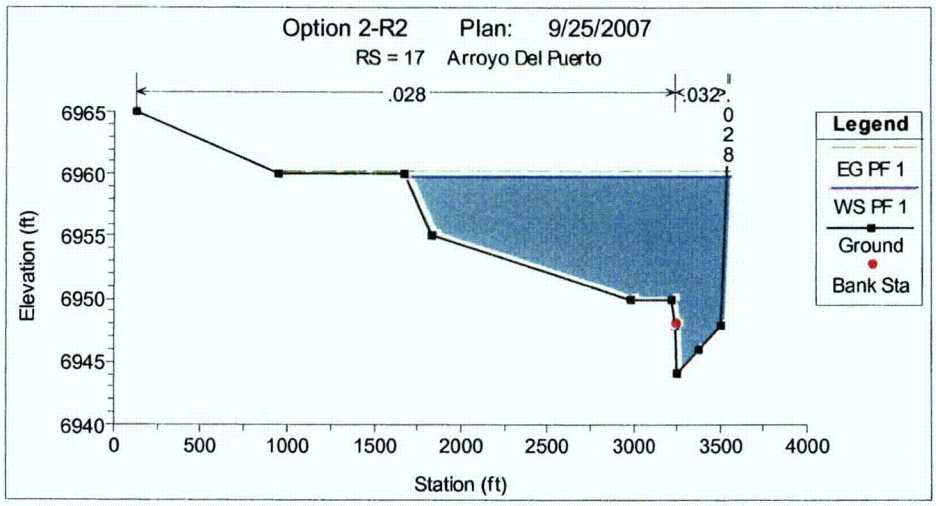

CONSTRUCTION NOTES:
Tailings Pond A
Tailings Pond B
Tailings Pond C
Interior Drainage Channel
Diversion Embankment/Channel
Extent of Probable Maximum Flood (PMF)
Feet
200
EXTENT OF PROBABLE MAXIMUM FLOOD
ARROYO DEL PUERTO
EROSION PROTECTION MEASURES
AMBROSIA LAKE MILL
RIO ALGOM MINING LLC
GRANTS, NEW MEXICO
TETRA TECH
SHEET 3

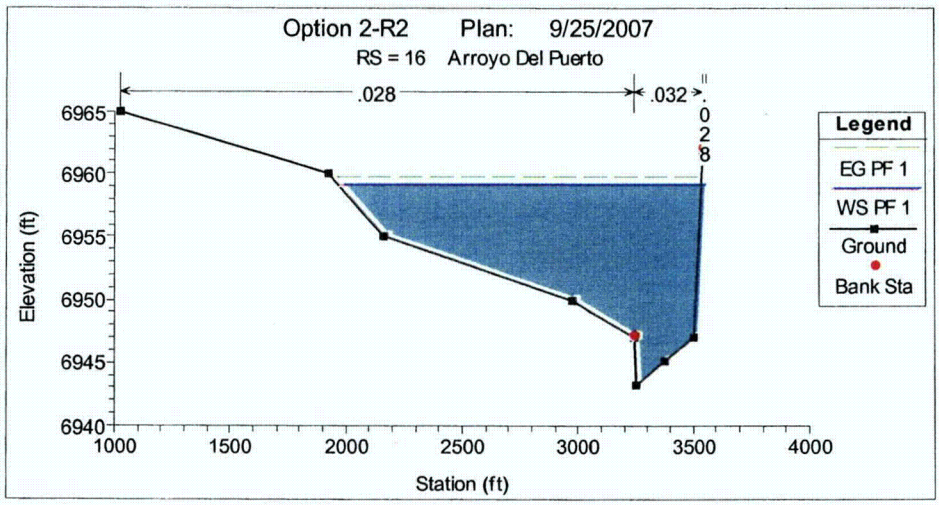

Option 2-R2 Plan: 9/25/2007
RS = 21 Arroyo Del Puerto
.028
.032
.028
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
6970
6965
6960
6955
6950
1000
2000
3000
4000
5000
6000
Station (ft)

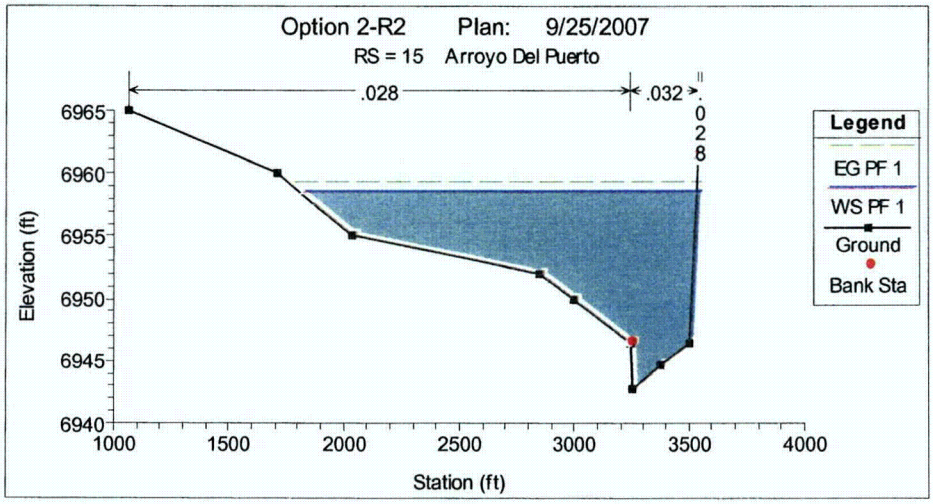

Option 2-R2 Plan: 9/25/2007
RS = 20 Arroyo Del Puerto
.028
.032
.028
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
6970
6965
6960
6955
6950
1000
2000
3000
4000
5000
Station (ft)

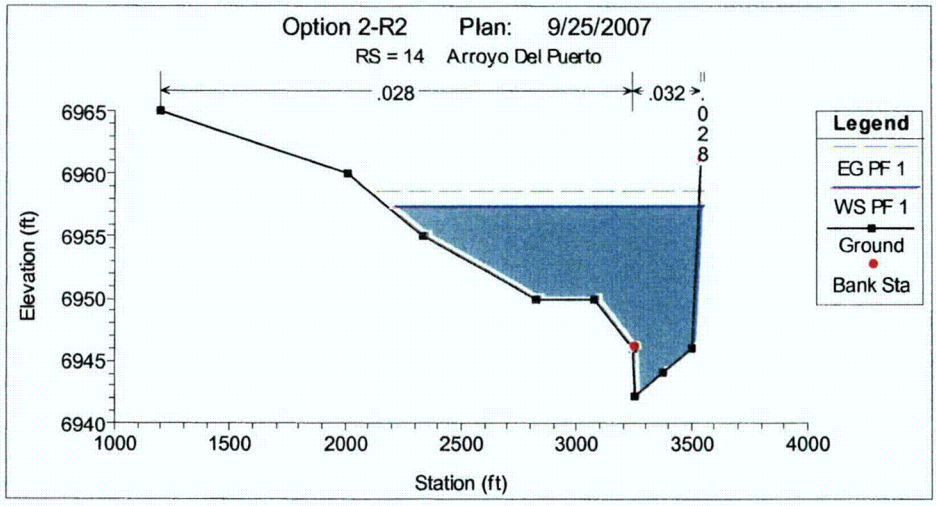

Option 2-R2 Plan: 9/25/2007
RS = 19 Arroyo Del Puerto
.028
.032
.028
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
6970
6965
6960
6955
6950
6945
0
1000
2000
3000
4000
5000
Station (ft)

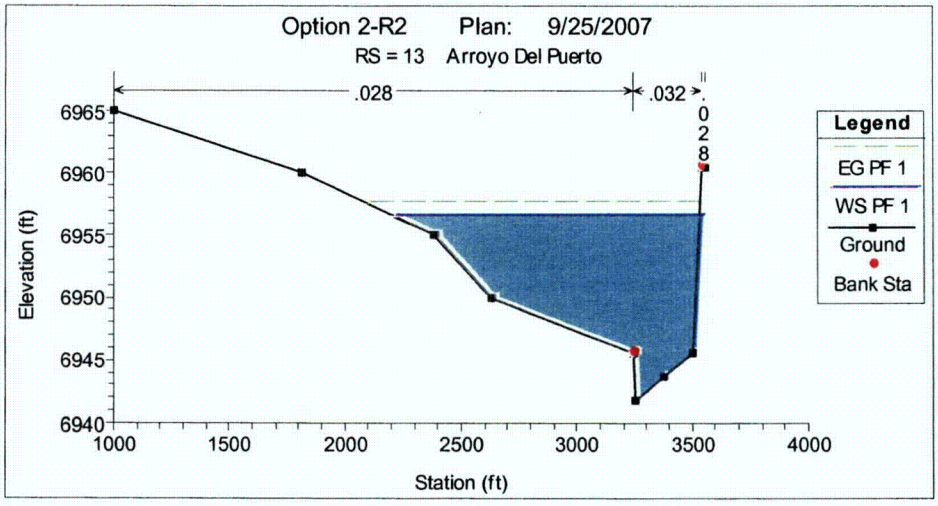

Option 2-R2 Plan: 9/25/2007
RS = 18 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

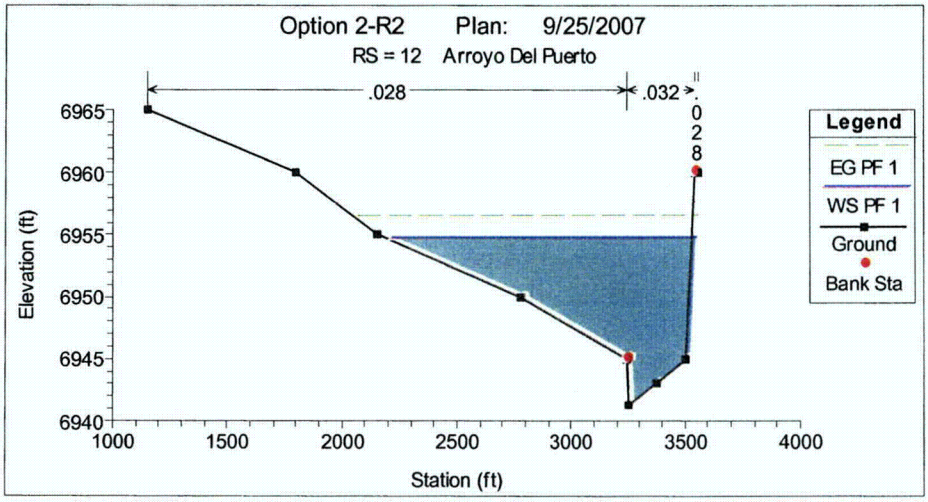

Option 2-R2 Plan: 9/25/2007
RS = 17 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

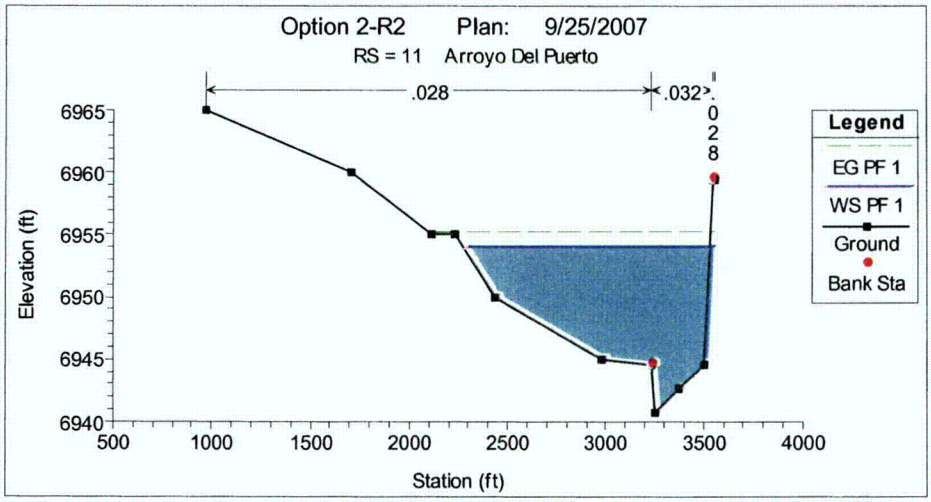

Option 2-R2 Plan: 9/25/2007
RS = 16 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

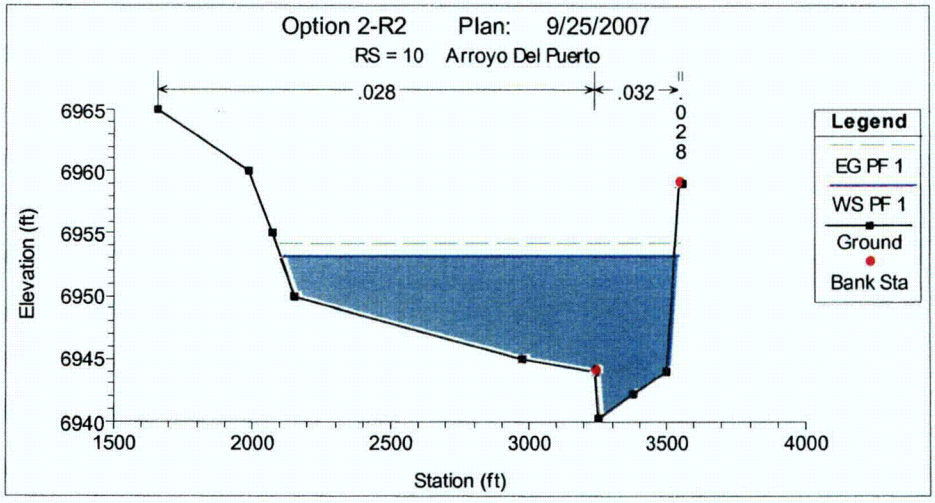

Option 2-R2 Plan: 9/25/2007
RS = 15 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
6965
6960
6955
6950
6945
6940
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

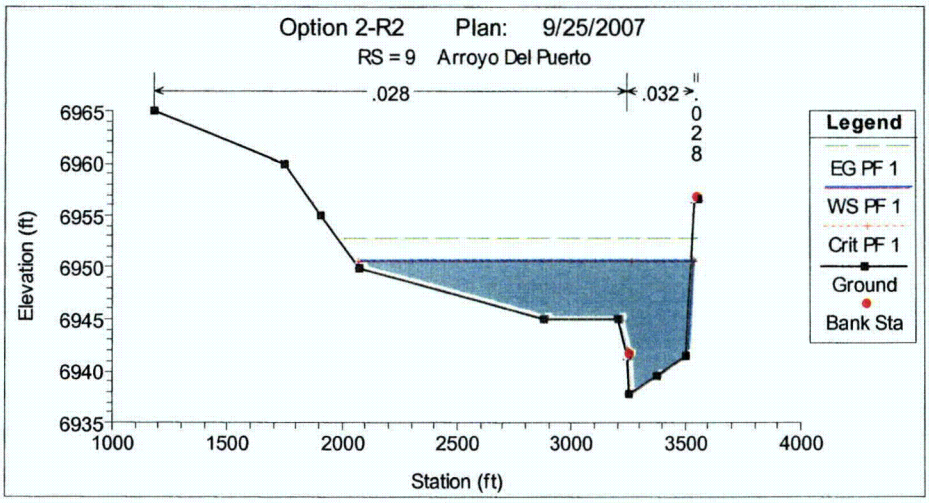

Option 2-R2 Plan: 9/25/2007
RS = 14 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
6965
6960
6955
6950
6945
6940
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

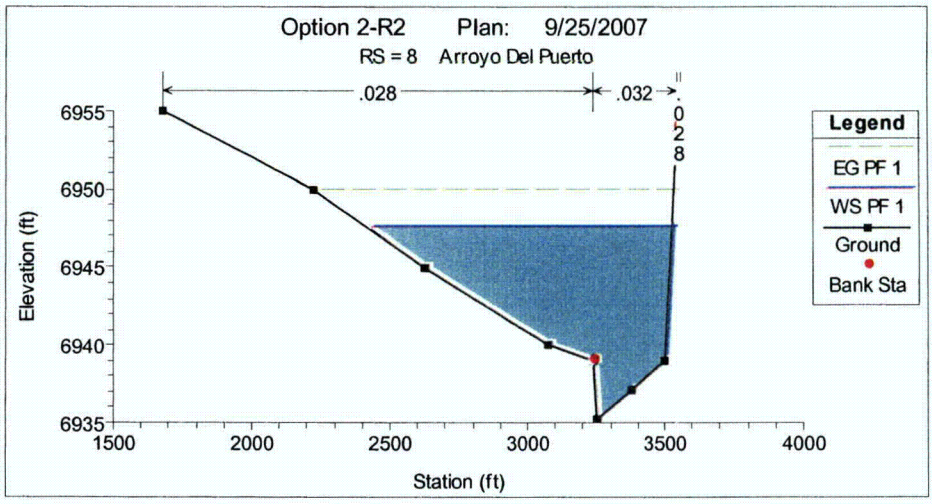

Option 2-R2 Plan: 9/25/2007
RS = 13 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
6965
6960
6955
6950
6945
6940
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

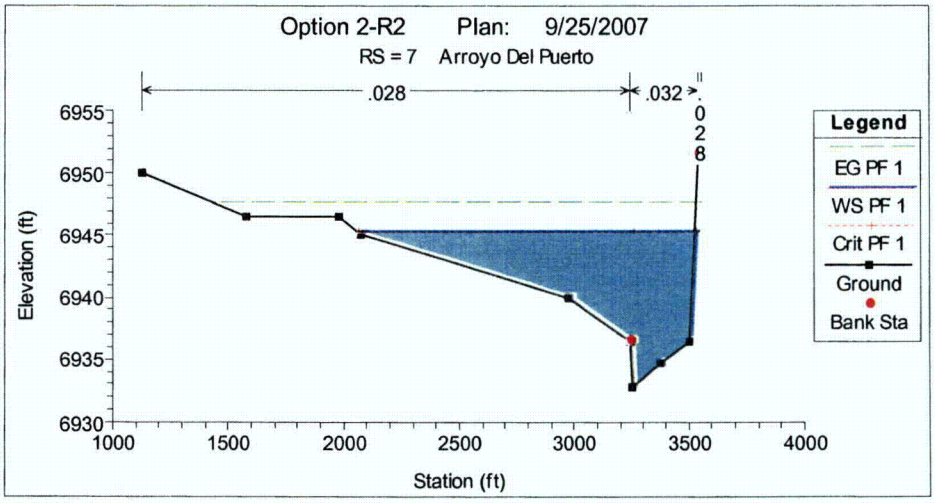

Option 2-R2 Plan: 9/25/2007
RS = 12 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
6965
6960
6955
6950
6945
6940
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

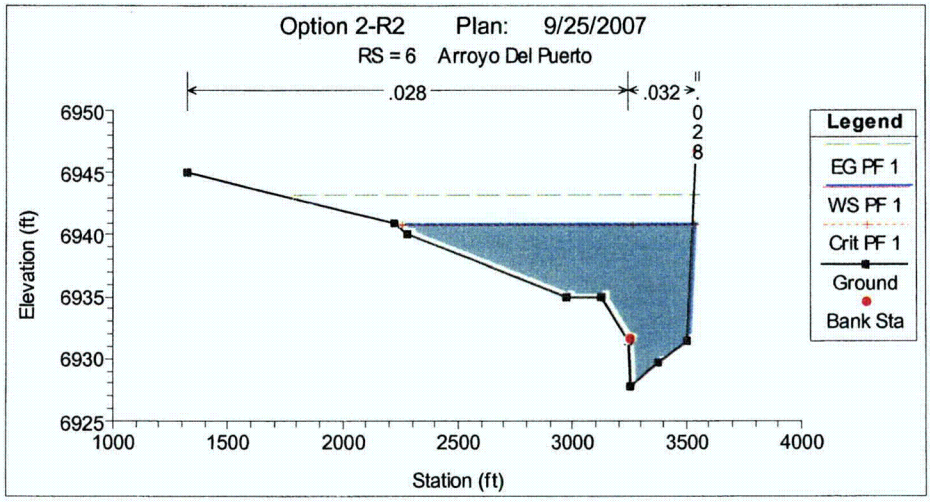

Option 2-R2 Plan: 9/25/2007
RS = 11 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
6965
6960
6955
6950
6945
6940
500
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

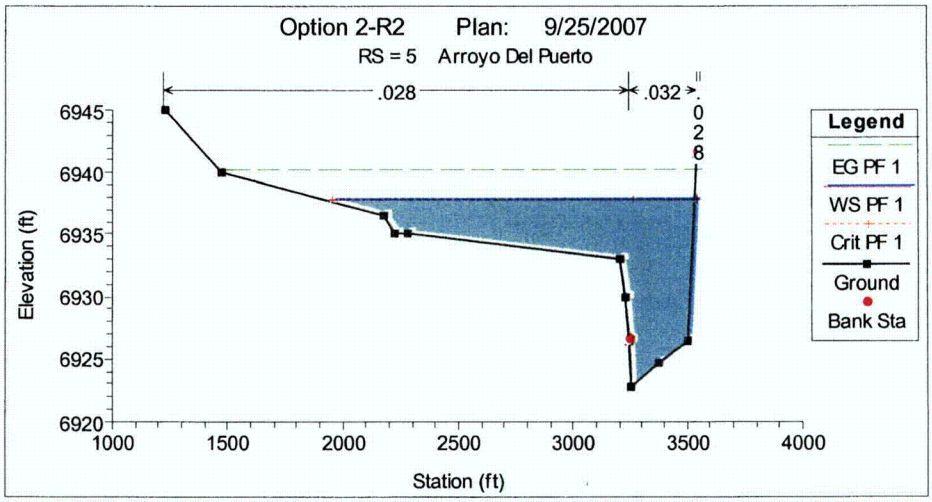

Option 2-R2 Plan: 9/25/2007
RS = 10 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
6965
6960
6955
6950
6945
6940
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

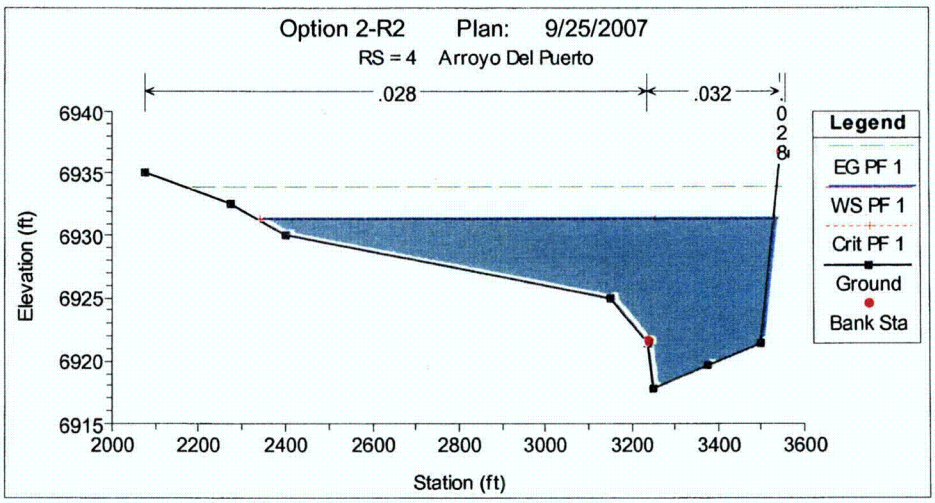

Option 2-R2 Plan: 9/25/2007
RS = 9 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
6965
6960
6955
6950
6945
6940
6935
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

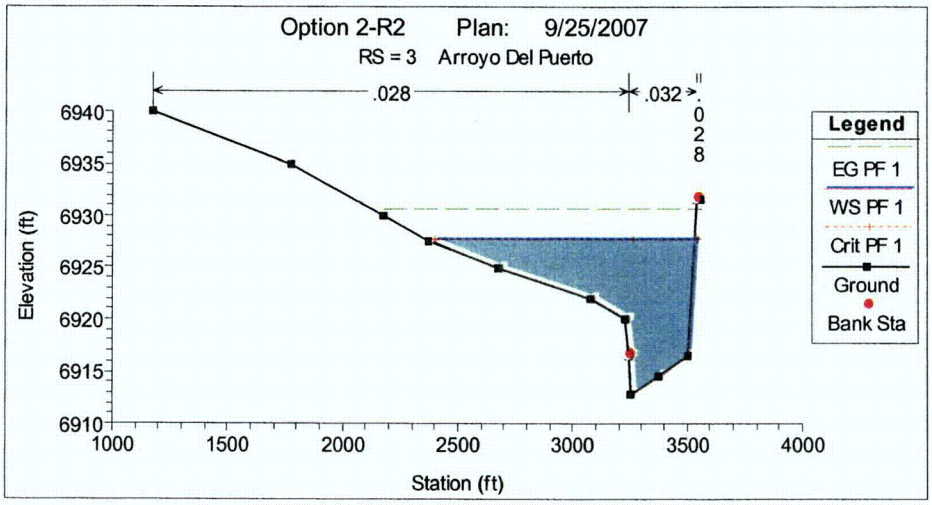

Option 2-R2 Plan: 9/25/2007
RS = 8 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
6955
6950
6945
6940
6935
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

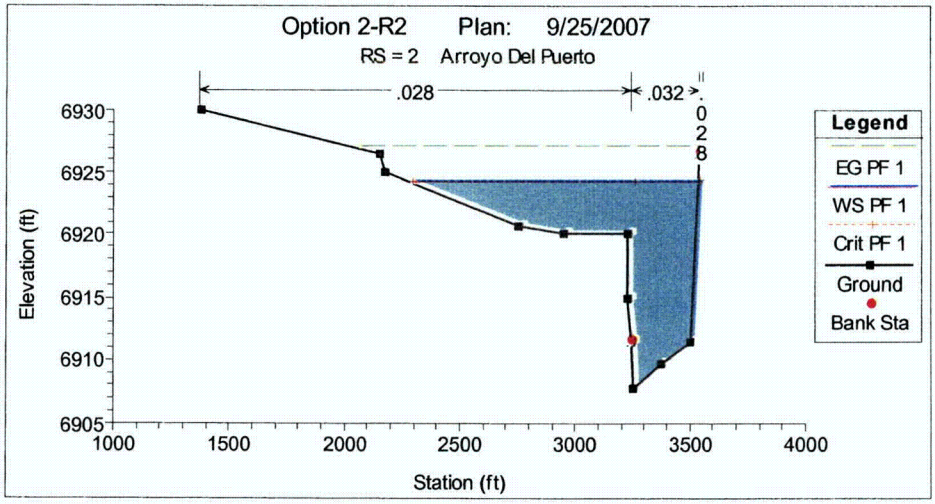

Option 2-R2 Plan: 9/25/2007
RS = 7 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
6955
6950
6945
6940
6935
6930
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

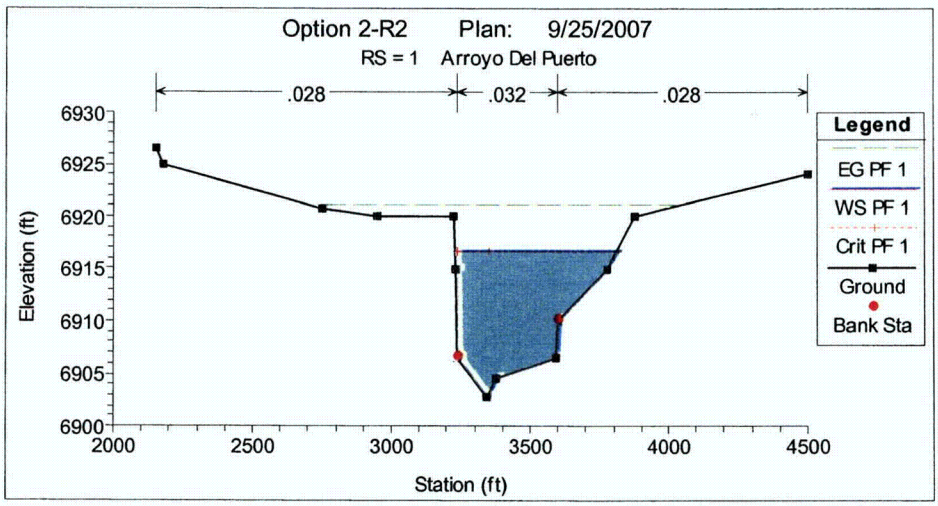

Option 2-R2 Plan: 9/25/2007
RS = 6 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

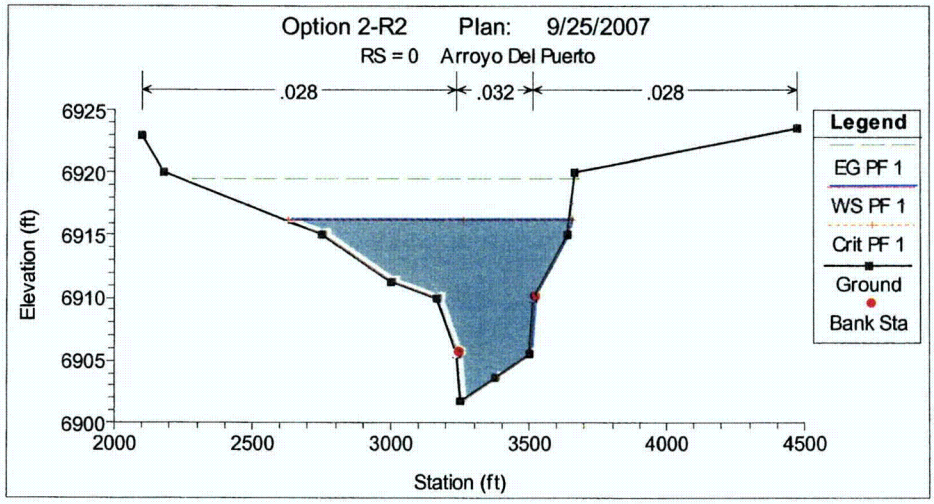

Option 2-R2 Plan: 9/25/2007
RS = 5 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

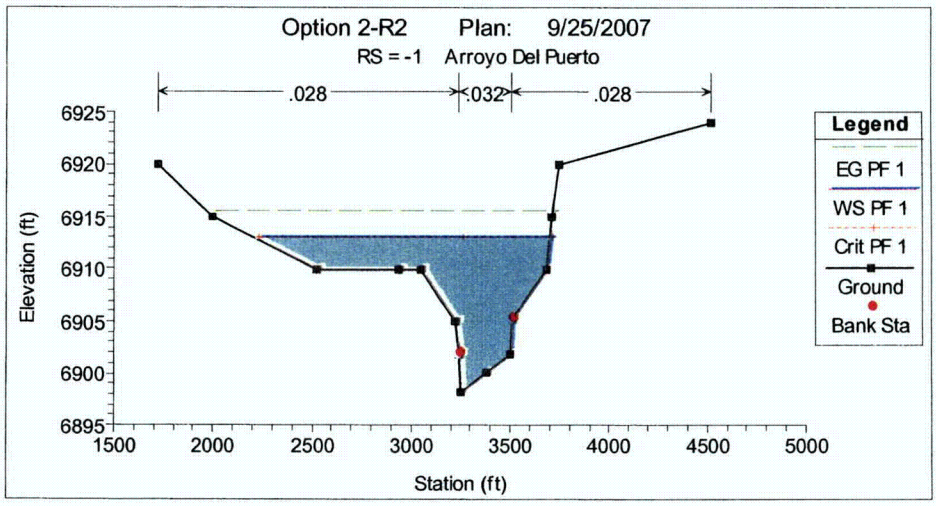

Option 2-R2 Plan: 9/25/2007
RS = 4 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

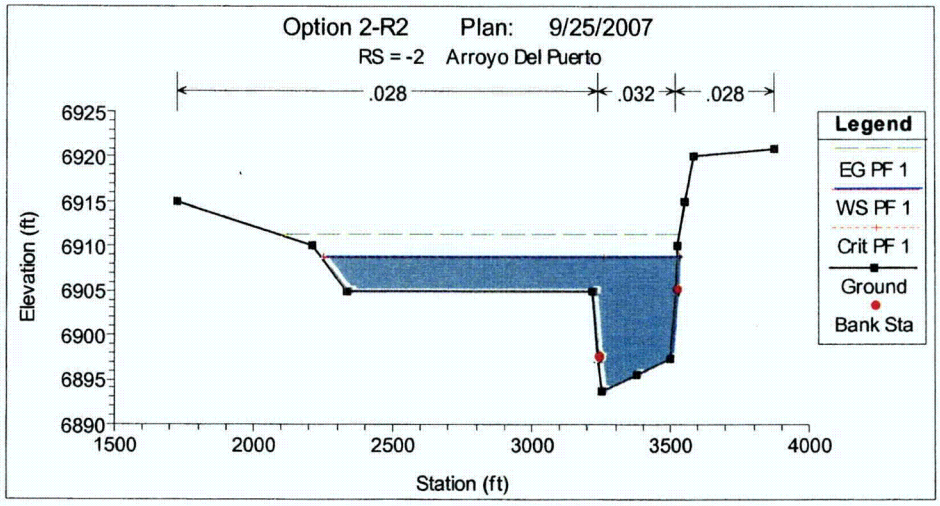

Option 2-R2 Plan: 9/25/2007
RS = 3 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

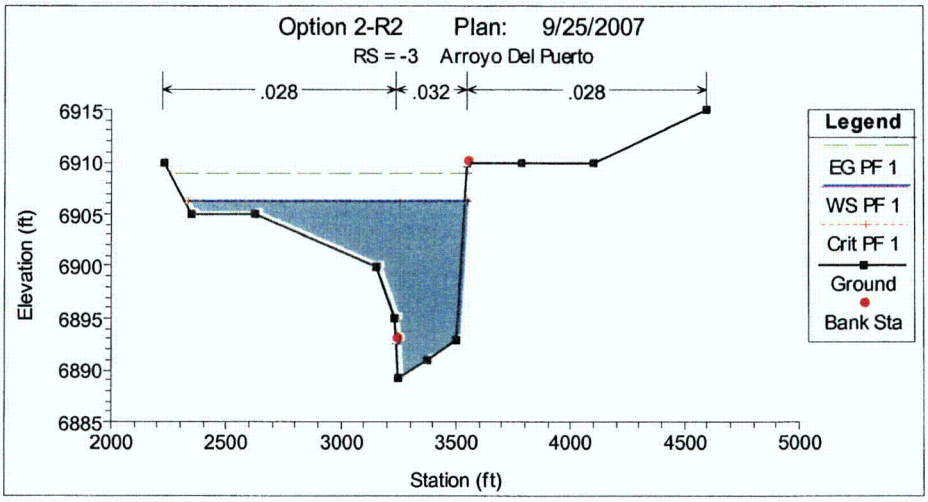

Option 2-R2 Plan: 9/25/2007
RS = 2 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

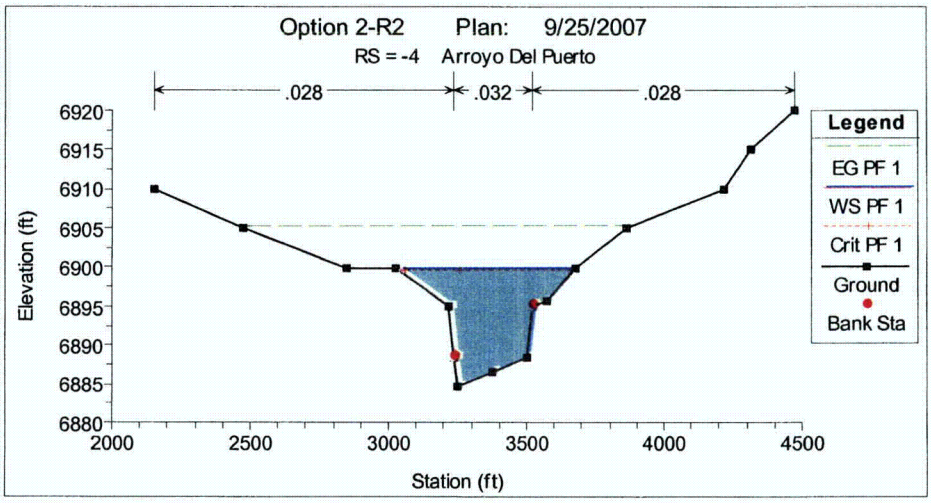

Option 2-R2 Plan: 9/25/2007
RS = 1 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

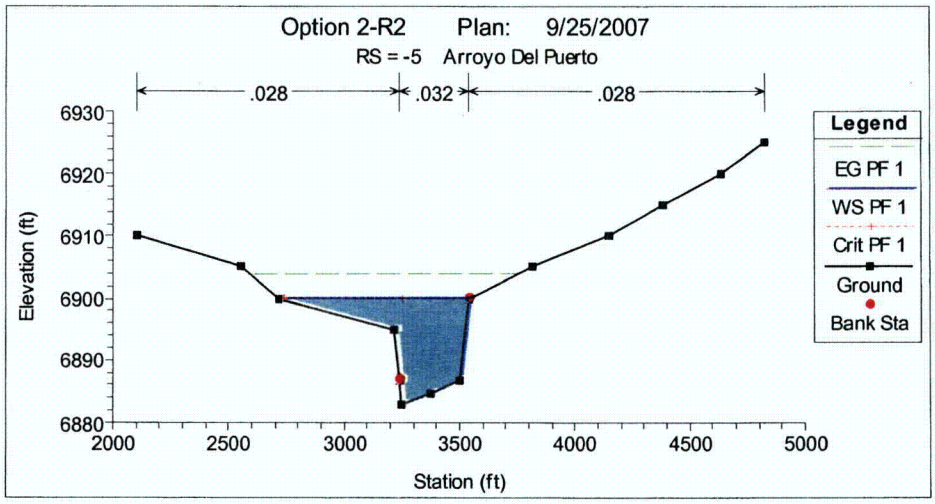

Option 2-R2 Plan: 9/25/2007
RS = 0 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta


Option 2-R2 Plan: 9/25/2007
RS = -1 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta


Option 2-R2 Plan: 9/25/2007
RS = -2 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta


Option 2-R2 Plan: 9/25/2007
RS = -3 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta


Option 2-R2 Plan: 9/25/2007
RS = -4 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta


Option 2-R2 Plan: 9/25/2007
RS = -5 Arroyo Del Puerto
.028
.032
.028
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta

	Reach	River Section	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	Top of Berm Elev	Free Board	Elevation at Base of Berm at Beginning Station	Depth
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)					(ft)
1	Reach #1	21	PF 1	78000	6951.50	6964.46		6965.17	0.001508	9.4	12117.45	2311.59	0.48			6952.00	
2	Reach #1	20	PF 1	78000	6950.00	6962.29	6962.29	6963.86	0.004821	15.43	8745.48	2514.46	0.84			6950.77	
3	Reach #1	19	PF 1	78000	6948.50	6960.14		6960.74	0.001008	6.28	12952.66	1945.06	0.37			6949.53	
4	Reach #1	18	PF 1	78000	6944.98	6959.76		6960.41	0.000957	7.52	12418.07	1634.46	0.38	6965.00	5.24	6948.73	11.03
5	Reach #1	17	PF 1	78000	6944.11	6959.58		6960.04	0.00064	6.35	14713.62	1846.88	0.31	6962.86	3.28	6947.86	11.72
6	Reach #1	16	PF 1	78000	6943.25	6958.99		6959.66	0.000929	7.75	12278.55	1567.55	0.38	6962.00	3.01	6947.00	11.99
7	Reach #1	15	PF 1	78000	6942.75	6958.39		6959.17	0.001178	8.68	11693.08	1720.86	0.43	6961.50	3.11	6946.50	11.89
8	Reach #1	14	PF 1	78000	6942.25	6957.21		6958.42	0.001791	10.38	9390.68	1342.58	0.52	6961.00	3.79	6946.00	11.21
9	Reach #1	13	PF 1	78000	6941.75	6956.56		6957.55	0.001443	9.25	10107.25	1331.31	0.47	6960.50	3.94	6945.50	11.06
10	Reach #1	12	PF 1	78000	6941.25	6954.59		6956.42	0.003251	12.88	7740.28	1327.69	0.69	6960.00	5.41	6945.00	9.59
11	Reach #1	11	PF 1	78000	6940.75	6953.87		6955.01	0.001859	9.62	9210.68	1247.77	0.52	6959.50	5.63	6944.50	9.37
12	Reach #1	10	PF 1	78000	6940.25	6953.04		6954.04	0.001745	9.15	9868.17	1425.71	0.5	6959.00	5.96	6944.00	9.04
13	Reach #1	9	PF 1	78000	6937.75	6950.40	6950.4	6952.58	0.00429	14.23	7291.81	1464.97	0.79	6956.50	6.10	6941.50	8.90
14	Reach #1	8	PF 1	78000	6935.25	6947.51		6949.86	0.004479	14.2	6635.9		0.8	6954.00	6.49	6939.00	8.51
15	Reach #1	7	PF 1	78000	6932.75	6945.24	6945.24	6947.48	0.004489	14.42	7198.81	1467.17	0.8	6951.50	6.26	6936.50	8.74
16	Reach #1	6	PF 1	78000	6927.75	6940.60	6940.6	6943.03	0.004498	14.74	6849.11	1282.38	0.81	6946.50	5.90	6931.50	9.10
17	Reach #1	5	PF 1	78000	6922.75	6937.65	6937.65	6939.99	0.003436	14.33	7603.59	1589.12	0.72	6941.50	3.85	6926.50	11.15
18	Reach #1	4	PF 1	78000	6917.75	6931.23	6931.23	6933.78	0.004298	14.91	6712.72	1190.46	0.8	6936.50	5.27	6921.50	9.73
19	Reach #1	3	PF 1	78000	6912.75	6927.50	6927.5	6930.3	0.00396	15.27	6597.28	1146.22	0.78	6931.50	4.00	6916.50	11.00
20	Reach #1	2	PF 1	78000	6907.75	6924.14	6924.14	6926.96	0.003279	14.97	6849.94	1247.27	0.72	6926.50	2.36	6911.50	12.64
21	Reach #1	1	PF 1	78000	6902.75	6916.56	6916.56	6920.85	0.005396	17.22	4902.38	578.91	0.9	6921.50	4.94	6906.50	10.06
22	Reach #1	0	PF 1	78000	6901.75	6916.12	6916.12	6919.26	0.004272	16.11	6191.28	1024.06	0.81	6920.50	4.38	6905.50	
23	Reach #1	-1	PF 1	78000	6898.15	6912.93	6912.93	6915.3	0.003264	14.46	7496.01	1484.82	0.71	6916.90	3.97	6901.90	
24	Reach #1	-2	PF 1	78000	6893.65	6908.61	6908.61	6911.13	0.003436	14.7	7097.85	1279.54	0.73	6912.40	3.79	6897.40	
25	Reach #1	-3	PF 1	78000	6889.15	6905.98	6905.98	6908.61	0.002942	14.44	7047.74	1213.74	0.68	6907.90	1.92	6892.90	
26	Reach #1	-4	PF 1	78000	6884.65	6899.68	6899.32	6905	0.005868	19.37	4607.44	630.15	0.95	6903.40	3.72	6888.40	
27	Reach #1	-5	PF 1	78000	6882.85	6899.78	6899.78	6903.62	0.003813	16.51	5563.09	803.03	0.78	6901.60	1.82	6886.60	

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		3425	7930.64	1764.05	547.56	10.17	3.22	4.5
2	Chan	3425	3525	11244.63	1195.8	100.43	14.42	11.96	9.4
3	ROB	3525		58824.74	9157.6	1664.29	75.42	5.5	6.42
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		3425	31421.83	3642.19	1016.59	40.28	3.58	8.63
2	Chan	3425	3525	16261.22	1053.96	100.68	20.85	10.54	15.43
3	ROB	3525		30316.95	4049.34	1398.05	38.87	2.9	7.49
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		2745	1420.57	679.88	492.25	1.82	1.38	2.09
2	Chan	2745	4125	76243.74	12139.35	1380.36	97.75	8.8	6.28
3	ROB	4125		335.69	133.43	73.12	0.43	1.83	2.52
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)
1	LOB		3238.75	51258.27	8862.49	1340.17	65.72	6.61	5.78
2	Chan	3238.75	3548.8	26741.74	3555.58	296.77	34.28	12.08	7.52
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)
1	LOB		3238.75	54135.96	10955.2	1550.7	69.41	7.07	4.94
2	Chan	3238.75	3545	23864.04	3758.43	298.96	30.59	12.68	6.35
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)
1	LOB		3238.75	48255.36	8439.71	1270.4	61.87	6.64	5.72
2	Chan	3238.75	3545	29744.64	3838.84	299.81	38.13	12.92	7.75
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)
1	LOB		3238.75	44942.24	7884.99	1424.02	57.62	5.54	5.7
2	Chan	3238.75	3545	33057.76	3808.09	299.48	42.38	12.83	8.68
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)
1	LOB		3238.75	40547.65	5781.83	1047.78	51.98	5.52	7.01
2	Chan	3238.75	3545	37452.35	3608.85	297.35	48.02	12.24	10.38
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)
1	LOB		3238.75	45039.13	6543.15	1036.95	57.74	6.31	6.88
2	Chan	3238.75	3545	32960.86	3564.1	296.87	42.26	12.1	9.25

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)
1	LOB		3238.75	37642.88	4606.1	1037.71	48.26	4.44	8.17
2	Chan	3238.75	3545	40357.12	3134.17	292.22	51.74	10.81	12.88
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)
1	LOB		3238.75	48481.38	6141.57	958.49	62.16	6.41	7.89
2	Chan	3238.75	3545	29518.63	3069.11	291.51	37.84	10.61	9.62
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)
1	LOB		3238.75	50800.9	6894.13	1137.46	65.13	6.06	7.37
2	Chan	3238.75	3545	27199.1	2974.04	290.47	34.87	10.31	9.15
Plan:	Reach #1	Reach #1 RS: 9		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		3238.75	36237	4356.89	1177.19	46.46	3.7	8.32
2	Chan	3238.75	3545	41762.99	2934.93	290.04	53.54	10.19	14.23
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)
1	LOB		3238.75	37934.85	3814.77	814.27	48.63	4.69	9.94
2	Chan	3238.75	3545	40065.15	2821.13	288.78	51.37	9.84	14.2
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)
1	LOB		3238.75	36360.75	4310.66	1179.74	46.62	3.65	8.44
2	Chan	3238.75	3545	41639.25	2888.15	289.52	53.38	10.05	14.42
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)
1	LOB		3238.75	33895.03	3856.62	993.91	43.46	3.88	8.79
2	Chan	3238.75	3545	44104.97	2992.5	290.67	56.54	10.37	14.74
Plan:	Reach #1	Reach #1 RS: 5		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		3238.75	26529.44	4012.73	1295.17	34.01	3.1	6.61
2	Chan	3238.75	3545	51470.57	3590.85	297.16	65.99	12.18	14.33
Plan:	Reach #1	Reach #1 RS: 4		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		3238.75	30678.78	3539.57	900.13	39.33	3.93	8.67
2	Chan	3238.75	3545	47321.22	3173.14	292.64	60.67	10.93	14.91

Plan:	Reach #1	Reach #1 RS: 3		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		3238.75	23853.05	3052.15	852.58	30.58	3.58	7.82
2	Chan	3238.75	3545	54146.95	3545.13	296.67	69.42	12.05	15.27
Plan:	Reach #1	Reach #1 RS: 2		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		3238.75	17672.17	2819.05	951.41	22.66	2.97	6.27
2	Chan	3238.75	3545	60327.83	4030.89	301.84	77.34	13.47	14.97
Plan:	Reach #1	Reach #1 RS: 1		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		3238.75	608.75	61.77	15.37	0.78	5.37	9.86
2	Chan	3238.75	3600	70716.48	4106.27	361.97	90.66	11.37	17.22
3	ROB	3600		6674.78	734.34	206.26	8.56	3.56	9.09
Plan:	Reach #1	Reach #1 RS: 0		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		3238.75	19919.19	2353.44	617.4	25.54	3.81	8.46
2	Chan	3238.75	3513.5	54409.64	3377.15	276.12	69.76	12.29	16.11
3	ROB	3513.5		3671.17	460.69	132.3	4.71	3.49	7.97
Plan:	Reach #1	Reach #1 RS: -1		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		3238.75	19340.82	3065.75	1021.44	24.8	3	6.31
2	Chan	3238.75	3509.6	50057.55	3461.59	272.01	64.18	12.78	14.46
3	ROB	3509.6		8601.63	968.68	193.27	11.03	5.02	8.88
Plan:	Reach #1	Reach #1 RS: -2		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		3238.75	25277.71	3508.1	995.2	32.41	3.53	7.21
2	Chan	3238.75	3522.8	52715.1	3586.89	285.92	67.58	12.63	14.7
3	ROB	3522.8		7.19	2.86	3.94	0.01	1.8	2.51
Plan:	Reach #1	Reach #1 RS: -3		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		3238.75	17856.17	2883.49	913.78	22.89	3.16	6.19
2	Chan	3238.75	3551.3	60143.83	4164.26	303.25	77.11	13.86	14.44
Plan:	Reach #1	Reach #1 RS: -4		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		3238.75	4788.86	582.31	202.36	6.14	2.89	8.22
2	Chan	3238.75	3519.8	69644.12	3594.61	282.76	89.29	12.79	19.37
3	ROB	3519.8		3567.02	430.52	147.96	4.57	2.91	8.29
Plan:	Reach #1	Reach #1 RS: -5		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		3238.75	8722.38	1367.57	503.62	11.18	2.72	6.38
2	Chan	3238.75	3540.2	69277.62	4195.53	303.58	88.82	13.95	16.51

Plan: Reach #1	Reach #1 RS: 21	Profile: PF 1			
E.G. Elev (ft)	6965.17	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.71	Wt. n-Val.	0.028	0.032	0.028
W.S. Elev (ft)	6964.46	Reach Len. (ft)	525	500	475
Crit W.S. (ft)		Flow Area (sq ft)	1764.05	1195.8	9157.6
E.G. Slope (ft/ft)	0.001508	Area (sq ft)	1764.05	1195.8	9157.6
Q Total (cfs)	78000	Flow (cfs)	7930.64	11244.63	58824.74
Top Width (ft)	2311.59	Top Width (ft)	547.43	100	1664.16
Vel Total (ft/s)	6.44	Avg. Vel. (ft/s)	4.5	9.4	6.42
Max Chl Dpth (ft)	12.96	Hydr. Depth (ft)	3.22	11.96	5.5
Conv. Total (cfs)	2008425	Conv. (cfs)	204206.2	289538.4	1514681
Length Wtd. (ft)	492.02	Wetted Per. (ft)	547.56	100.43	1664.29
Min Ch El (ft)	6951.5	Shear (lb/sq ft)	0.3	1.12	0.52
Alpha	1.11	Stream Power (lb/ft s)	1.36	10.54	3.33
Frctn Loss (ft)	1.22	Cum Volume (acre-ft)	1248.46	982.66	116.02
C & E Loss (ft)	0.09	Cum SA (acres)	272.24	86.76	30.23

Plan: Reach #1	Reach #1 RS: 20	Profile: PF 1			
E.G. Elev (ft)	6963.86	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.57	Wt. n-Val.	0.028	0.032	0.028
W.S. Elev (ft)	6962.29	Reach Len. (ft)	525	500	475
Crit W.S. (ft)	6962.29	Flow Area (sq ft)	3642.19	1053.96	4049.34
E.G. Slope (ft/ft)	0.004821	Area (sq ft)	3642.19	1053.96	4049.34
Q Total (cfs)	78000	Flow (cfs)	31421.83	16261.22	30316.95
Top Width (ft)	2514.46	Top Width (ft)	1016.56	100	1397.9
Vel Total (ft/s)	8.92	Avg. Vel. (ft/s)	8.63	15.43	7.49
Max Chl Dpth (ft)	12.29	Hydr. Depth (ft)	3.58	10.54	2.9
Conv. Total (cfs)	1123413	Conv. (cfs)	452560.3	234206.1	436647
Length Wtd. (ft)	500.35	Wetted Per. (ft)	1016.59	100.68	1398.05
Min Ch El (ft)	6950	Shear (lb/sq ft)	1.08	3.15	0.87
Alpha	1.27	Stream Power (lb/ft s)	9.3	48.61	6.53
Frctn Loss (ft)	0.95	Cum Volume (acre-ft)	1215.88	969.75	44.01
C & E Loss (ft)	0.29	Cum SA (acres)	262.82	85.62	13.54

Plan: Reach #1	Reach #1 RS: 19	Profile: PF 1			
E.G. Elev (ft)	6960.74	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.6	Wt. n-Val.	0.028	0.032	0.028
W.S. Elev (ft)	6960.14	Reach Len. (ft)	350	325	275
Crit W.S. (ft)		Flow Area (sq ft)	679.88	12139.35	133.43
E.G. Slope (ft/ft)	0.001008	Area (sq ft)	679.88	12139.35	133.43
Q Total (cfs)	78000	Flow (cfs)	1420.57	76243.74	335.69
Top Width (ft)	1945.06	Top Width (ft)	492.2	1380	72.87
Vel Total (ft/s)	6.02	Avg. Vel. (ft/s)	2.09	6.28	2.52
Max Chl Dpth (ft)	11.64	Hydr. Depth (ft)	1.38	8.8	1.83
Conv. Total (cfs)	2456971	Conv. (cfs)	44747.5	2401650	10574
Length Wtd. (ft)	333.33	Wetted Per. (ft)	492.25	1380.36	73.12
Min Ch El (ft)	6948.5	Shear (lb/sq ft)	0.09	0.55	0.11
Alpha	1.07	Stream Power (lb/ft s)	0.18	3.48	0.29
Frctn Loss (ft)	0.33	Cum Volume (acre-ft)	1189.84	894.03	21.2
C & E Loss (ft)	0	Cum SA (acres)	253.72	77.12	5.52

Plan: Reach #1	Reach #1 RS: 12	Profile: PF 1			
E.G. Elev (ft)	6956.42	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.83	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6954.59	Reach Len. (ft)	500	500	500
Crit W.S. (ft)		Flow Area (sq ft)	4606.1	3134.17	
E.G. Slope (ft/ft)	0.003251	Area (sq ft)	4606.1	3134.17	
Q Total (cfs)	78000	Flow (cfs)	37642.88	40357.12	
Top Width (ft)	1327.69	Top Width (ft)	1037.66	290.02	
Vel Total (ft/s)	10.08	Avg. Vel. (ft/s)	8.17	12.88	
Max Chl Dpth (ft)	13.34	Hydr. Depth (ft)	4.44	10.81	
Conv. Total (cfs)	1368005	Conv. (cfs)	660200.6	707804.3	
Length Wtd. (ft)	500	Wetted Per. (ft)	1037.71	292.22	
Min Ch El (ft)	6941.25	Shear (lb/sq ft)	0.9	2.18	
Alpha	1.16	Stream Power (lb/ft s)	7.36	28.03	
Frctn Loss (ft)	1.21	Cum Volume (acre-ft)	661.85	596.43	20.78
C & E Loss (ft)	0.21	Cum SA (acres)	166.49	51.55	5.29

Plan: Reach #1	Reach #1 RS: 11	Profile: PF 1			
E.G. Elev (ft)	6955.01	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.15	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6953.87	Reach Len. (ft)	525	500	475
Crit W.S. (ft)		Flow Area (sq ft)	6141.57	3069.11	
E.G. Slope (ft/ft)	0.001859	Area (sq ft)	6141.57	3069.11	
Q Total (cfs)	78000	Flow (cfs)	48481.38	29518.63	
Top Width (ft)	1247.77	Top Width (ft)	958.42	289.35	
Vel Total (ft/s)	8.47	Avg. Vel. (ft/s)	7.89	9.62	
Max Chl Dpth (ft)	13.12	Hydr. Depth (ft)	6.41	10.61	
Conv. Total (cfs)	1808970	Conv. (cfs)	1124376	684593.5	
Length Wtd. (ft)	515.91	Wetted Per. (ft)	958.49	291.51	
Min Ch El (ft)	6940.75	Shear (lb/sq ft)	0.74	1.22	
Alpha	1.03	Stream Power (lb/ft s)	5.87	11.75	
Frctn Loss (ft)	0.93	Cum Volume (acre-ft)	600.16	560.83	20.78
C & E Loss (ft)	0.04	Cum SA (acres)	155.04	48.23	5.29

Plan: Reach #1	Reach #1 RS: 10	Profile: PF 1			
E.G. Elev (ft)	6954.04	Element	Left OB	Channel	Right OB
Vel Head (ft)	1	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6953.04	Reach Len. (ft)	525	500	475
Crit W.S. (ft)		Flow Area (sq ft)	6894.13	2974.04	
E.G. Slope (ft/ft)	0.001745	Area (sq ft)	6894.13	2974.04	
Q Total (cfs)	78000	Flow (cfs)	50800.9	27199.1	
Top Width (ft)	1425.71	Top Width (ft)	1137.35	288.36	
Vel Total (ft/s)	7.9	Avg. Vel. (ft/s)	7.37	9.15	
Max Chl Dpth (ft)	12.79	Hydr. Depth (ft)	6.06	10.31	
Conv. Total (cfs)	1867385	Conv. (cfs)	1216216	651169.1	
Length Wtd. (ft)	513.95	Wetted Per. (ft)	1137.46	290.47	
Min Ch El (ft)	6940.25	Shear (lb/sq ft)	0.66	1.12	
Alpha	1.03	Stream Power (lb/ft s)	4.86	10.2	
Frctn Loss (ft)	1.34	Cum Volume (acre-ft)	521.61	526.15	20.78
C & E Loss (ft)	0.12	Cum SA (acres)	142.41	44.91	5.29

Plan: Reach #1	Reach #1 RS: 3	Profile: PF 1			
E.G. Elev (ft)	6930.3	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.8	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6927.5	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6927.5	Flow Area (sq ft)	3052.15	3545.13	
E.G. Slope (ft/ft)	0.00396	Area (sq ft)	3052.15	3545.13	
Q Total (cfs)	78000	Flow (cfs)	23853.05	54146.95	
Top Width (ft)	1146.22	Top Width (ft)	851.98	294.24	
Vel Total (ft/s)	11.82	Avg. Vel. (ft/s)	7.82	15.27	
Max Chl Dpth (ft)	14.75	Hydr. Depth (ft)	3.58	12.05	
Conv. Total (cfs)	1239485	Conv. (cfs)	379044.7	860440	
Length Wtd. (ft)	500	Wetted Per. (ft)	852.58	296.67	
Min Ch El (ft)	6912.75	Shear (lb/sq ft)	0.89	2.95	
Alpha	1.29	Stream Power (lb/ft s)	6.92	45.12	
Frctn Loss (ft)	1.8	Cum Volume (acre-ft)	180.05	277.52	20.78
C & E Loss (ft)	0	Cum SA (acres)	55.62	21.64	5.29

Plan: Reach #1	Reach #1 RS: 2	Profile: PF 1			
E.G. Elev (ft)	6926.96	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.83	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6924.14	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6924.14	Flow Area (sq ft)	2819.05	4030.89	
E.G. Slope (ft/ft)	0.003279	Area (sq ft)	2819.05	4030.89	
Q Total (cfs)	78000	Flow (cfs)	17672.17	60327.83	
Top Width (ft)	1247.27	Top Width (ft)	948.11	299.16	
Vel Total (ft/s)	11.39	Avg. Vel. (ft/s)	6.27	14.97	
Max Chl Dpth (ft)	16.39	Hydr. Depth (ft)	2.97	13.47	
Conv. Total (cfs)	1362185	Conv. (cfs)	308625.1	1053560	
Length Wtd. (ft)	500	Wetted Per. (ft)	951.41	301.84	
Min Ch El (ft)	6907.75	Shear (lb/sq ft)	0.61	2.73	
Alpha	1.4	Stream Power (lb/ft s)	3.8	40.91	
Frctn Loss (ft)	2.07	Cum Volume (acre-ft)	146.36	234.04	20.78
C & E Loss (ft)	0.15	Cum SA (acres)	45.28	18.24	5.29

Plan: Reach #1	Reach #1 RS: 1	Profile: PF 1			
E.G. Elev (ft)	6920.85	Element	Left OB	Channel	Right OB
Vel Head (ft)	4.3	Wt. n-Val.	0.028	0.032	0.028
W.S. Elev (ft)	6916.56	Reach Len. (ft)	100	100	100
Crit W.S. (ft)	6916.56	Flow Area (sq ft)	61.77	4106.27	734.34
E.G. Slope (ft/ft)	0.005396	Area (sq ft)	61.77	4106.27	734.34
Q Total (cfs)	78000	Flow (cfs)	608.75	70716.48	6674.78
Top Width (ft)	578.91	Top Width (ft)	11.51	361.25	206.15
Vel Total (ft/s)	15.91	Avg. Vel. (ft/s)	9.88	17.22	9.09
Max Chl Dpth (ft)	13.81	Hydr. Depth (ft)	5.37	11.37	3.56
Conv. Total (cfs)	1061812	Conv. (cfs)	8286.8	962661.9	90863.6
Length Wtd. (ft)	100	Wetted Per. (ft)	15.37	361.97	206.26
Min Ch El (ft)	6902.75	Shear (lb/sq ft)	1.35	3.82	1.2
Alpha	1.09	Stream Power (lb/ft s)	13.35	65.82	10.9
Frctn Loss (ft)	0.48	Cum Volume (acre-ft)	129.82	187.34	16.57
C & E Loss (ft)	0.35	Cum SA (acres)	39.78	14.45	4.11

Plan: Reach #1	Reach #1 RS: 18	Profile: PF 1			
E.G. Elev (ft)	6960.41	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.64	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6959.76	Reach Len. (ft)	425	350	250
Crit W.S. (ft)		Flow Area (sq ft)	8862.49	3555.58	
E.G. Slope (ft/ft)	0.000957	Area (sq ft)	8862.49	3555.58	
Q Total (cfs)	78000	Flow (cfs)	51258.27	26741.74	
Top Width (ft)	1634.46	Top Width (ft)	1340.12	294.34	
Vel Total (ft/s)	6.28	Avg. Vel. (ft/s)	5.78	7.52	
Max Chl Dpth (ft)	14.78	Hydr. Depth (ft)	6.61	12.08	
Conv. Total (cfs)	2521465	Conv. (cfs)	1656999	864465.9	
Length Wtd. (ft)	400.67	Wetted Per. (ft)	1340.17	296.77	
Min Ch El (ft)	6944.98	Shear (lb/sq ft)	0.4	0.72	
Alpha	1.05	Stream Power (lb/ft s)	2.28	5.38	
Frctn Loss (ft)	0.31	Cum Volume (acre-ft)	1151.5	835.48	20.78
C & E Loss (ft)	0.06	Cum SA (acres)	246.36	70.88	5.29

Plan: Reach #1	Reach #1 RS: 17	Profile: PF 1			
E.G. Elev (ft)	6960.04	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.45	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6959.58	Reach Len. (ft)	450	500	575
Crit W.S. (ft)		Flow Area (sq ft)	10955.2	3758.43	
E.G. Slope (ft/ft)	0.00064	Area (sq ft)	10955.2	3758.43	
Q Total (cfs)	78000	Flow (cfs)	54135.96	23864.04	
Top Width (ft)	1846.88	Top Width (ft)	1550.45	296.42	
Vel Total (ft/s)	5.3	Avg. Vel. (ft/s)	4.94	6.35	
Max Chl Dpth (ft)	15.47	Hydr. Depth (ft)	7.07	12.68	
Conv. Total (cfs)	3084092	Conv. (cfs)	2140517	943575.8	
Length Wtd. (ft)	467.18	Wetted Per. (ft)	1550.7	298.96	
Min Ch El (ft)	6944.11	Shear (lb/sq ft)	0.28	0.5	
Alpha	1.04	Stream Power (lb/ft s)	1.39	3.19	
Frctn Loss (ft)	0.36	Cum Volume (acre-ft)	1054.82	806.1	20.78
C & E Loss (ft)	0.02	Cum SA (acres)	232.26	68.5	5.29

Plan: Reach #1	Reach #1 RS: 16	Profile: PF 1			
E.G. Elev (ft)	6959.66	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.67	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6958.99	Reach Len. (ft)	425	500	575
Crit W.S. (ft)		Flow Area (sq ft)	8439.71	3838.84	
E.G. Slope (ft/ft)	0.000929	Area (sq ft)	8439.71	3838.84	
Q Total (cfs)	78000	Flow (cfs)	48255.36	29744.64	
Top Width (ft)	1567.55	Top Width (ft)	1270.33	297.22	
Vel Total (ft/s)	6.35	Avg. Vel. (ft/s)	5.72	7.75	
Max Chl Dpth (ft)	15.74	Hydr. Depth (ft)	6.64	12.92	
Conv. Total (cfs)	2558415	Conv. (cfs)	1582785	975629.9	
Length Wtd. (ft)	455.19	Wetted Per. (ft)	1270.4	299.81	
Min Ch El (ft)	6943.25	Shear (lb/sq ft)	0.39	0.74	
Alpha	1.07	Stream Power (lb/ft s)	2.2	5.76	
Frctn Loss (ft)	0.47	Cum Volume (acre-ft)	954.64	762.5	20.78
C & E Loss (ft)	0.01	Cum SA (acres)	217.69	65.1	5.29

Plan: Reach #1	Reach #1 RS: 9	Profile: PF 1			
E.G. Elev (ft)	6952.58	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.18	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6950.4	Reach Len. (ft)	525	500	475
Crit W.S. (ft)	6950.4	Flow Area (sq ft)	4356.89	2934.93	
E.G. Slope (ft/ft)	0.00429	Area (sq ft)	4356.89	2934.93	
Q Total (cfs)	78000	Flow (cfs)	36237	41762.99	
Top Width (ft)	1464.97	Top Width (ft)	1177.01	287.96	
Vel Total (ft/s)	10.7	Avg. Vel. (ft/s)	8.32	14.23	
Max Chl Dpth (ft)	12.65	Hydr. Depth (ft)	3.7	10.19	
Conv. Total (cfs)	1190809	Conv. (cfs)	553222.2	637586.3	
Length Wtd. (ft)	511.89	Wetted Per. (ft)	1177.19	290.04	
Min Ch El (ft)	6937.75	Shear (lb/sq ft)	0.99	2.71	
Alpha	1.23	Stream Power (lb/ft s)	8.25	38.57	
Frctn Loss (ft)	2.24	Cum Volume (acre-ft)	453.81	492.23	20.78
C & E Loss (ft)	0.02	Cum SA (acres)	128.46	41.61	5.29

Plan: Reach #1	Reach #1 RS: 8	Profile: PF 1			
E.G. Elev (ft)	6949.86	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.36	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6947.51	Reach Len. (ft)	550	500	450
Crit W.S. (ft)		Flow Area (sq ft)	3814.77	2821.13	
E.G. Slope (ft/ft)	0.004479	Area (sq ft)	3814.77	2821.13	
Q Total (cfs)	78000	Flow (cfs)	37934.85	40065.15	
Top Width (ft)	1100.99	Top Width (ft)	814.22	286.77	
Vel Total (ft/s)	11.75	Avg. Vel. (ft/s)	9.94	14.2	
Max Chl Dpth (ft)	12.26	Hydr. Depth (ft)	4.69	9.84	
Conv. Total (cfs)	1165458	Conv. (cfs)	566813.7	598644.2	
Length Wtd. (ft)	523.81	Wetted Per. (ft)	814.27	288.78	
Min Ch El (ft)	6935.25	Shear (lb/sq ft)	1.31	2.73	
Alpha	1.1	Stream Power (lb/ft s)	13.03	38.8	
Frctn Loss (ft)	2.35	Cum Volume (acre-ft)	404.56	459.2	20.78
C & E Loss (ft)	0.04	Cum SA (acres)	116.46	38.31	5.29

Plan: Reach #1	Reach #1 RS: 7	Profile: PF 1			
E.G. Elev (ft)	6947.48	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.24	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6945.24	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6945.24	Flow Area (sq ft)	4310.66	2888.15	
E.G. Slope (ft/ft)	0.004489	Area (sq ft)	4310.66	2888.15	
Q Total (cfs)	78000	Flow (cfs)	36360.75	41639.25	
Top Width (ft)	1467.17	Top Width (ft)	1179.7	287.47	
Vel Total (ft/s)	10.84	Avg. Vel. (ft/s)	8.44	14.42	
Max Chl Dpth (ft)	12.49	Hydr. Depth (ft)	3.65	10.05	
Conv. Total (cfs)	1164164	Conv. (cfs)	542690.5	621473.1	
Length Wtd. (ft)	500	Wetted Per. (ft)	1179.74	289.62	
Min Ch El (ft)	6932.75	Shear (lb/sq ft)	1.02	2.8	
Alpha	1.23	Stream Power (lb/ft s)	8.64	40.31	
Frctn Loss (ft)	2.25	Cum Volume (acre-ft)	353.27	426.43	20.78
C & E Loss (ft)	0.02	Cum SA (acres)	103.87	35.01	5.29

Plan: Reach #1	Reach #1 RS: 0	Profile: PF 1			
E.G. Elev (ft)	6919.26	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.14	Wt. n-Val.	0.028	0.032	0.028
W.S. Elev (ft)	6916.12	Reach Len. (ft)	500	400	350
Crit W.S. (ft)	6916.12	Flow Area (sq ft)	2353.44	3377.15	460.69
E.G. Slope (ft/ft)	0.004272	Area (sq ft)	2353.44	3377.15	460.69
Q Total (cfs)	78000	Flow (cfs)	19919.19	54409.64	3671.17
Top Width (ft)	1024.06	Top Width (ft)	617.23	274.75	132.09
Vel Total (ft/s)	12.6	Avg. Vel. (ft/s)	8.46	16.11	7.97
Max Chl Dpth (ft)	14.37	Hydr. Depth (ft)	3.81	12.29	3.49
Conv. Total (cfs)	1193400	Conv. (cfs)	304763.7	832467.6	56168.9
Length Wtd. (ft)	421.23	Wetted Per. (ft)	617.4	276.12	132.3
Min Ch El (ft)	6901.75	Shear (lb/sq ft)	1.02	3.26	0.93
Alpha	1.27	Stream Power (lb/ft s)	8.6	52.55	7.4
Frctn Loss (ft)	1.57	Cum Volume (acre-ft)	127.05	178.75	15.2
C & E Loss (ft)	0.23	Cum SA (acres)	39.06	13.72	3.72

Plan: Reach #1	Reach #1 RS: -1	Profile: PF 1			
E.G. Elev (ft)	6915.3	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.37	Wt. n-Val.	0.028	0.032	0.028
W.S. Elev (ft)	6912.93	Reach Len. (ft)	500	500	525
Crit W.S. (ft)	6912.93	Flow Area (sq ft)	3065.75	3461.59	968.68
E.G. Slope (ft/ft)	0.003264	Area (sq ft)	3065.75	3461.59	968.68
Q Total (cfs)	78000	Flow (cfs)	19340.82	50057.55	8801.63
Top Width (ft)	1484.82	Top Width (ft)	1021.01	270.85	192.96
Vel Total (ft/s)	10.41	Avg. Vel. (ft/s)	6.31	14.46	8.88
Max Chl Dpth (ft)	14.78	Hydr. Depth (ft)	3	12.78	5.02
Conv. Total (cfs)	1365242	Conv. (cfs)	338524.2	876162.3	150555.2
Length Wtd. (ft)	501.38	Wetted Per. (ft)	1021.44	272.01	193.27
Min Ch El (ft)	6898.15	Shear (lb/sq ft)	0.61	2.59	1.02
Alpha	1.41	Stream Power (lb/ft s)	3.86	37.5	9.07
Frctn Loss (ft)	1.68	Cum Volume (acre-ft)	95.95	147.35	9.45
C & E Loss (ft)	0.02	Cum SA (acres)	29.65	11.21	2.41

Plan: Reach #1	Reach #1 RS: -2	Profile: PF 1			
E.G. Elev (ft)	6911.13	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.53	Wt. n-Val.	0.028	0.032	0.028
W.S. Elev (ft)	6908.61	Reach Len. (ft)	475	500	525
Crit W.S. (ft)	6908.61	Flow Area (sq ft)	3508.1	3586.89	2.86
E.G. Slope (ft/ft)	0.003436	Area (sq ft)	3508.1	3586.89	2.86
Q Total (cfs)	78000	Flow (cfs)	25277.71	52715.1	7.19
Top Width (ft)	1279.54	Top Width (ft)	993.9	284.05	1.59
Vel Total (ft/s)	10.99	Avg. Vel. (ft/s)	7.21	14.7	2.51
Max Chl Dpth (ft)	14.96	Hydr. Depth (ft)	3.53	12.63	1.8
Conv. Total (cfs)	1330574	Conv. (cfs)	431203.5	899248	122.6
Length Wtd. (ft)	493.09	Wetted Per. (ft)	995.2	285.92	3.94
Min Ch El (ft)	6893.65	Shear (lb/sq ft)	0.76	2.69	0.16
Alpha	1.35	Stream Power (lb/ft s)	5.45	39.55	0.39
Frctn Loss (ft)	1.57	Cum Volume (acre-ft)	58.22	106.9	3.6
C & E Loss (ft)	0.01	Cum SA (acres)	18.09	8.03	1.24

Plan: Reach #1	Reach #1 RS: 15	Profile: PF 1			
E.G. Elev (ft)	6959.17	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.79	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6958.39	Reach Len. (ft)	500	500	500
Crit W.S. (ft)		Flow Area (sq ft)	7884.99	3808.09	
E.G. Slope (ft/ft)	0.001178	Area (sq ft)	7884.99	3808.09	
Q Total (cfs)	78000	Flow (cfs)	44942.24	33057.76	
Top Width (ft)	1720.86	Top Width (ft)	1423.95	296.91	
Vel Total (ft/s)	6.67	Avg. Vel. (ft/s)	5.7	8.68	
Max Chl Dpth (ft)	15.64	Hydr. Depth (ft)	5.54	12.83	
Conv. Total (cfs)	2273008	Conv. (cfs)	1309668	963340.4	
Length Wtd. (ft)	500	Wetted Per. (ft)	1424.02	299.48	
Min Ch El (ft)	6942.75	Shear (lb/sq ft)	0.41	0.93	
Alpha	1.14	Stream Power (lb/ft s)	2.32	8.11	
Frctn Loss (ft)	0.72	Cum Volume (acre-ft)	875.01	718.61	20.78
C & E Loss (ft)	0.04	Cum SA (acres)	204.55	61.69	5.29

Plan: Reach #1	Reach #1 RS: 14	Profile: PF 1			
E.G. Elev (ft)	6958.42	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.2	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6957.21	Reach Len. (ft)	500	500	500
Crit W.S. (ft)		Flow Area (sq ft)	5781.83	3608.85	
E.G. Slope (ft/ft)	0.001791	Area (sq ft)	5781.83	3608.85	
Q Total (cfs)	78000	Flow (cfs)	40547.65	37452.35	
Top Width (ft)	1342.58	Top Width (ft)	1047.68	294.89	
Vel Total (ft/s)	8.31	Avg. Vel. (ft/s)	7.01	10.38	
Max Chl Dpth (ft)	14.96	Hydr. Depth (ft)	5.52	12.24	
Conv. Total (cfs)	1843161	Conv. (cfs)	958152.1	885009.2	
Length Wtd. (ft)	500	Wetted Per. (ft)	1047.78	297.35	
Min Ch El (ft)	6942.25	Shear (lb/sq ft)	0.62	1.36	
Alpha	1.12	Stream Power (lb/ft s)	4.33	14.08	
Frctn Loss (ft)	0.8	Cum Volume (acre-ft)	796.57	676.04	20.78
C & E Loss (ft)	0.06	Cum SA (acres)	190.36	58.29	5.29

Plan: Reach #1	Reach #1 RS: 13	Profile: PF 1			
E.G. Elev (ft)	6957.55	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.99	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6956.56	Reach Len. (ft)	500	500	500
Crit W.S. (ft)		Flow Area (sq ft)	6543.15	3564.1	
E.G. Slope (ft/ft)	0.001443	Area (sq ft)	6543.15	3564.1	
Q Total (cfs)	78000	Flow (cfs)	45039.13	32960.86	
Top Width (ft)	1331.31	Top Width (ft)	1036.88	294.44	
Vel Total (ft/s)	7.72	Avg. Vel. (ft/s)	6.88	9.25	
Max Chl Dpth (ft)	14.81	Hydr. Depth (ft)	6.31	12.1	
Conv. Total (cfs)	2053435	Conv. (cfs)	1185704	867730.4	
Length Wtd. (ft)	500	Wetted Per. (ft)	1036.95	296.87	
Min Ch El (ft)	6941.75	Shear (lb/sq ft)	0.57	1.08	
Alpha	1.07	Stream Power (lb/ft s)	3.91	10	
Frctn Loss (ft)	1.04	Cum Volume (acre-ft)	725.83	634.88	20.78
C & E Loss (ft)	0.08	Cum SA (acres)	178.4	54.91	5.29

Plan: Reach #1	Reach #1 RS: 6	Profile: PF 1			
E.G. Elev (ft)	6943.03	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.43	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6940.6	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6940.6	Flow Area (sq ft)	3856.62	2992.5	
E.G. Slope (ft/ft)	0.004498	Area (sq ft)	3856.62	2992.5	
Q Total (cfs)	78000	Flow (cfs)	33895.03	44104.97	
Top Width (ft)	1282.38	Top Width (ft)	993.83	288.55	
Vel Total (ft/s)	11.39	Avg. Vel. (ft/s)	8.79	14.74	
Max Chl Dpth (ft)	12.85	Hydr. Depth (ft)	3.88	10.37	
Conv. Total (cfs)	1162990	Conv. (cfs)	505379.3	657610.9	
Length Wtd. (ft)	500	Wetted Per. (ft)	993.91	290.67	
Min Ch El (ft)	6927.75	Shear (lb/sq ft)	1.09	2.89	
Alpha	1.21	Stream Power (lb/ft s)	9.58	42.61	
Frctn Loss (ft)	1.96	Cum Volume (acre-ft)	306.39	392.68	20.78
C & E Loss (ft)	0.03	Cum SA (acres)	91.4	31.71	5.29

Plan: Reach #1	Reach #1 RS: 5	Profile: PF 1			
E.G. Elev (ft)	6939.99	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.34	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6937.65	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6937.65	Flow Area (sq ft)	4012.73	3590.85	
E.G. Slope (ft/ft)	0.003436	Area (sq ft)	4012.73	3590.85	
Q Total (cfs)	78000	Flow (cfs)	26529.44	51470.57	
Top Width (ft)	1589.12	Top Width (ft)	1294.41	294.71	
Vel Total (ft/s)	10.26	Avg. Vel. (ft/s)	6.61	14.33	
Max Chl Dpth (ft)	14.9	Hydr. Depth (ft)	3.1	12.18	
Conv. Total (cfs)	1330618	Conv. (cfs)	452571.2	878047.1	
Length Wtd. (ft)	500	Wetted Per. (ft)	1295.17	297.16	
Min Ch El (ft)	6922.75	Shear (lb/sq ft)	0.66	2.59	
Alpha	1.43	Stream Power (lb/ft s)	4.39	37.16	
Frctn Loss (ft)	1.92	Cum Volume (acre-ft)	261.23	354.9	20.78
C & E Loss (ft)	0.02	Cum SA (acres)	78.27	28.36	5.29

Plan: Reach #1	Reach #1 RS: 4	Profile: PF 1			
E.G. Elev (ft)	6933.78	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.55	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6931.23	Reach Len. (ft)	500	500	500
Crit W.S. (ft)	6931.23	Flow Area (sq ft)	3539.57	3173.14	
E.G. Slope (ft/ft)	0.004298	Area (sq ft)	3539.57	3173.14	
Q Total (cfs)	78000	Flow (cfs)	30678.78	47321.22	
Top Width (ft)	1190.46	Top Width (ft)	900.03	290.43	
Vel Total (ft/s)	11.62	Avg. Vel. (ft/s)	8.67	14.91	
Max Chl Dpth (ft)	13.48	Hydr. Depth (ft)	3.93	10.93	
Conv. Total (cfs)	1189806	Conv. (cfs)	467971.7	721834.1	
Length Wtd. (ft)	500	Wetted Per. (ft)	900.13	292.64	
Min Ch El (ft)	6917.75	Shear (lb/sq ft)	1.06	2.91	
Alpha	1.22	Stream Power (lb/ft s)	9.14	43.39	
Frctn Loss (ft)	2.06	Cum Volume (acre-ft)	217.89	316.08	20.78
C & E Loss (ft)	0.03	Cum SA (acres)	65.67	25	5.29

Plan: Reach #1	Reach #1 RS: -3	Profile: PF 1			
E.G. Elev (ft)	6908.61	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.63	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6905.98	Reach Len. (ft)	475	500	525
Crit W.S. (ft)	6905.98	Flow Area (sq ft)	2883.49	4164.26	
E.G. Slope (ft/ft)	0.002942	Area (sq ft)	2883.49	4164.26	
Q Total (cfs)	78000	Flow (cfs)	17856.17	60143.83	
Top Width (ft)	1213.74	Top Width (ft)	913.25	300.49	
Vel Total (ft/s)	11.07	Avg. Vel. (ft/s)	6.19	14.44	
Max Chl Dpth (ft)	16.83	Hydr. Depth (ft)	3.16	13.86	
Conv. Total (cfs)	1438063	Conv. (cfs)	329208.8	1108854	
Length Wtd. (ft)	496.94	Wetted Per. (ft)	913.78	303.25	
Min Ch El (ft)	6889.15	Shear (lb/sq ft)	0.58	2.52	
Alpha	1.38	Stream Power (lb/ft s)	3.59	36.43	
Frctn Loss (ft)	2	Cum Volume (acre-ft)	23.37	62.41	3.58
C & E Loss (ft)	0.27	Cum SA (acres)	7.69	4.67	1.23

Plan: Reach #1	Reach #1 RS: -4	Profile: PF 1			
E.G. Elev (ft)	6905	Element	Left OB	Channel	Right OB
Vel Head (ft)	5.32	Wt. n-Val.	0.028	0.032	0.028
W.S. Elev (ft)	6899.68	Reach Len. (ft)	200	200	200
Crit W.S. (ft)	6899.32	Flow Area (sq ft)	582.31	3594.61	430.52
E.G. Slope (ft/ft)	0.005868	Area (sq ft)	582.31	3594.61	430.52
Q Total (cfs)	78000	Flow (cfs)	4788.86	69644.12	3567.02
Top Width (ft)	630.15	Top Width (ft)	201.23	281.05	147.86
Vel Total (ft/s)	16.93	Avg. Vel. (ft/s)	8.22	19.37	8.29
Max Chl Dpth (ft)	15.03	Hydr. Depth (ft)	2.89	12.79	2.91
Conv. Total (cfs)	1018276	Conv. (cfs)	62517.7	909191.4	46566.8
Length Wtd. (ft)	200	Wetted Per. (ft)	202.36	282.76	147.96
Min Ch El (ft)	6884.65	Shear (lb/sq ft)	1.05	4.66	1.07
Alpha	1.19	Stream Power (lb/ft s)	8.67	90.22	8.83
Frctn Loss (ft)	0.94	Cum Volume (acre-ft)	4.48	17.88	0.99
C & E Loss (ft)	0.45	Cum SA (acres)	1.61	1.34	0.34

Plan: Reach #1	Reach #1 RS: -5	Profile: PF 1			
E.G. Elev (ft)	6903.62	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.83	Wt. n-Val.	0.028	0.032	
W.S. Elev (ft)	6899.78	Reach Len. (ft)			
Crit W.S. (ft)	6899.78	Flow Area (sq ft)	1367.57	4195.53	
E.G. Slope (ft/ft)	0.003813	Area (sq ft)	1367.57	4195.53	
Q Total (cfs)	78000	Flow (cfs)	8722.38	69277.62	
Top Width (ft)	803.03	Top Width (ft)	502.23	300.8	
Vel Total (ft/s)	14.02	Avg. Vel. (ft/s)	6.38	16.51	
Max Chl Dpth (ft)	16.93	Hydr. Depth (ft)	2.72	13.95	
Conv. Total (cfs)	1263214	Conv. (cfs)	141259.4	1121954	
Length Wtd. (ft)		Wetted Per. (ft)	503.62	303.58	
Min Ch El (ft)	6882.85	Shear (lb/sq ft)	0.65	3.29	
Alpha	1.25	Stream Power (lb/ft s)	4.12	54.32	
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			