

**DESIGN REPORT  
POND 1 SOUTH EMBANKMENT  
TOE EROSION PROTECTION  
AMBROSIA LAKE MILL, NEW MEXICO**

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POND 1 SOUTH EMBANKMENT TOE EROSION PROTECTION  
AMBROSIA LAKE MILL, NEW MEXICO**

Prepared for:

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## INTRODUCTION

This design report was prepared by Maxim Technologies, Inc. (Maxim) for Rio Algom Mining Company, LLC. (Rio Algom) as part of their agreement for engineering services dated July 2001. Maxim has been retained to evaluate flood and long-term erosion conditions at the Ambrosia Lake Facility near Grants, New Mexico and to prepare designs for the long-term stability of tailings and evaporation ponds at this uranium mill tailings disposal site. This report provides the basis for the design required under Task 5. Task Five addresses erosion concerns at the toe of the south embankment of Pond 1, a reclaimed tailings pond, and consists of designing a channel/run-off apron for the south embankment of Pond 1. Figure 1 is a schematic representation of the area of concern in the current study.

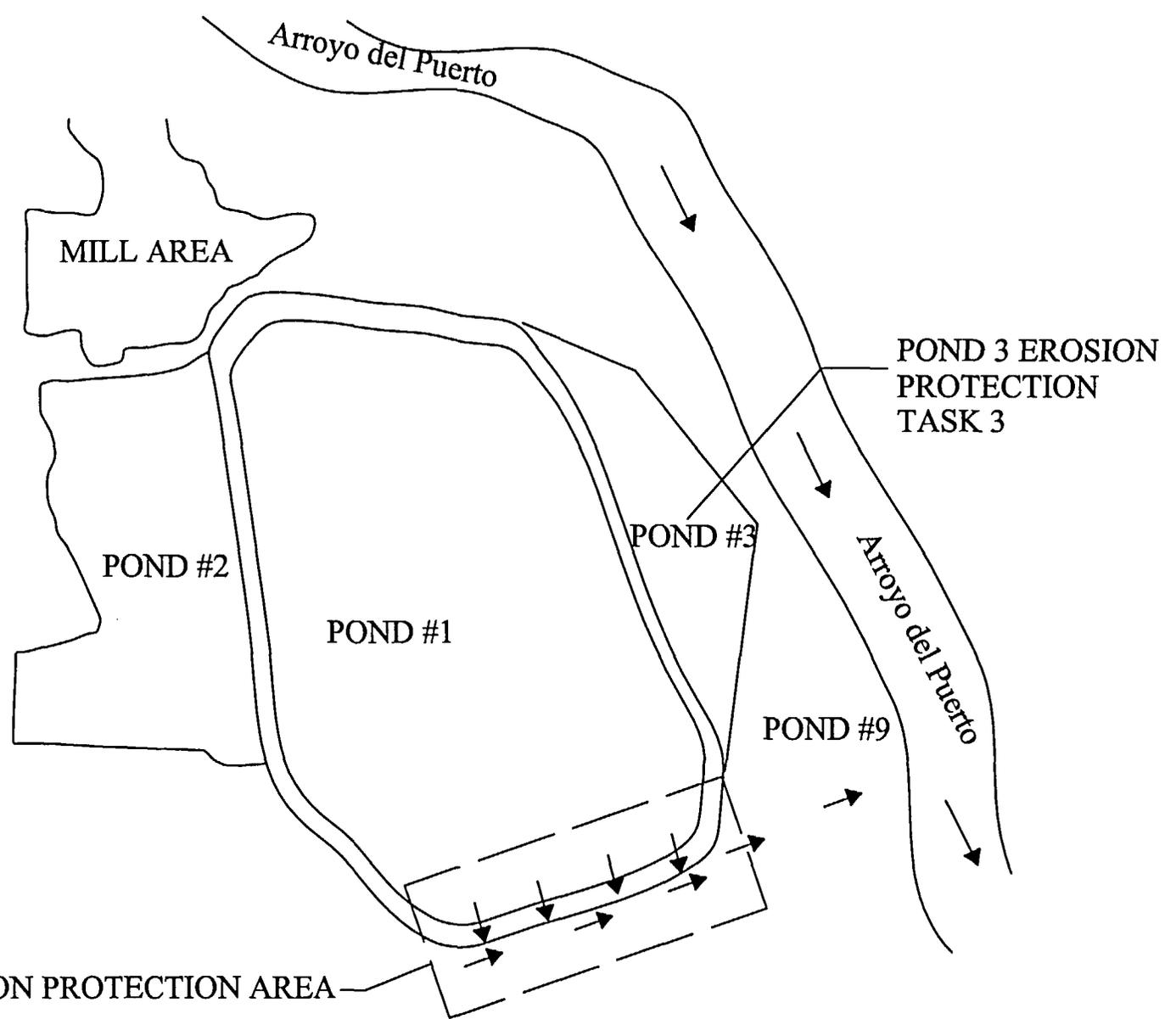
Pond 1 is a reclaimed tailings disposal site and was used for burial of byproducts produced at the mill. The embankment of Pond 1 is constructed with a radon barrier and overlying rock cover serving as erosion protection. The following report provides a design to prevent erosion of the embankment toe from run-off from the south embankment slope. For purposes of this design effort, it has been assumed that the erosion protection channel/apron shall only handle precipitation that falls on the south embankment slope or within the channel/apron limits. Local topographic information supplied by Rio Algom indicates precipitation that falls on the Pond top surface will run-off to the northwest and drain into the south diversion channel and then into the Arroyo del Puerto, which is hydrologically separate from the south embankment of Pond 1 and our proposed erosion protection system. The area south of the proposed erosion protection system drains to the south or east and away from the site on generally moderate slopes. Therefore, no other significant flows are anticipated to enter the channel/apron. The proposed erosion protection system for the south embankment toe of Pond 1 is a combination of an apron designed to withstand the hydraulic jump of the flow running of the steeper embankment slope onto the flat toe surface and a channel design that will withstand that longitudinal flow that is anticipated to run adjacent to the embankment toe. The greater design requirements for developing apron protection and channel protection were used to develop the design configurations that follow.

The analysis conducted for this design is consistent with Nuclear Regulatory Commission (NRC) guidance, particularly, *Design of Erosion Protection for Long-Term Stabilization* (Johnson 1999). This guidance, referred to as NUREG-1623 in this report, requires, in most cases, that erosion protection be designed for a 1,000-year life to minimize future maintenance issues. Because flood events with a 1,000 year recurrence interval are difficult to quantify, the guidance recommends use of the probable maximum precipitation event (PMP) for design purposes. PMPs can be derived for various parts of the United States using appropriate hydrometeorological reports. The report that addresses New Mexico east of the continental divide is *Hydrometeorological Report No. 55A, Probable Maximum Precipitation Estimates – United States between the Continental Divide and the 103<sup>rd</sup> Meridian* (Hansen et al. 1988). Appropriate PMPs are used to develop runoff hydrographs and determine the probable maximum flood (PMF) for an area of concern. The final step in the design process is to apply the PMF to the appropriate erosion control design method. Guidance for design of riprap erosion protection is found in Appendix D of NUREG-1623.

This design report is limited to those items affecting design of the south embankment of Pond 1 erosion protection, namely, the run-off issues mentioned previously. Methods of analysis are described for design issues including derivation of the PMP and calculation of the appropriate PMFs. The calculation of the riprap sizing is then described, and the report concludes with a discussion of other issues that affect the design.

### 1.0 PMP CALCULATION

Maxim verified the PMP calculation performed by others following the methods outlined in *Hydrometeorological Report No. 55A* (Hansen et al. 1988). The PMP rainfall depth calculated previously for the 1-hour local storm was 9.6 inches with no areal reduction. Maxim's calculation of the PMP depth



Legend:

→ Local Flow Direction

AMBROSIA LAKE MILL RIO ALGOM MINING COMPANY, LLC. GRANTS, NEW MEXICO		<b>MAXIM</b> TECHNOLOGIES INC
GENERAL OVERVIEW OF TASK	DRAWING BY: RLH 6/25/02	
PROJECT No. 1690030-500 FILE NAME: 1690030T5Fig1.DWG	REVIEWED BY: WHB	FIGURE 1

arrived at a 9.5 inch value for the 1-hour, 1-square mile local storm, slightly less than the previously calculated value of 9.6 inches. Because the values are so similar, we used the slightly higher, previously determined values in our calculations. Calculation sheets are attached in Appendix A.

## 2.0 DESIGN BASIS

A run-off erosion protection channel/apron is needed along the south toe of the Pond 1 embankment to prevent scour from undercutting the tailings rock cover during extreme run-off events. Another erosion concern at the toe of the embankment is the potential for longitudinal flow along the toe due to moderate slopes adjacent to the toe. Therefore, the general approach for this analysis consisted of two tasks with the greater design requirements controlling the final design configurations.

- 1) Determining the apron requirements based on run-off analysis for the south embankment of Pond 1 in accordance with NUREG-1623, Appendix D, Section 6; and
- 2) Determining open channel requirements to control the run-off and longitudinal flow from the south embankment by an open channel in accordance with NUREG-1623, Appendix D, Sections 2 and 3.

Each of these analyses is described separately in this section of the report.

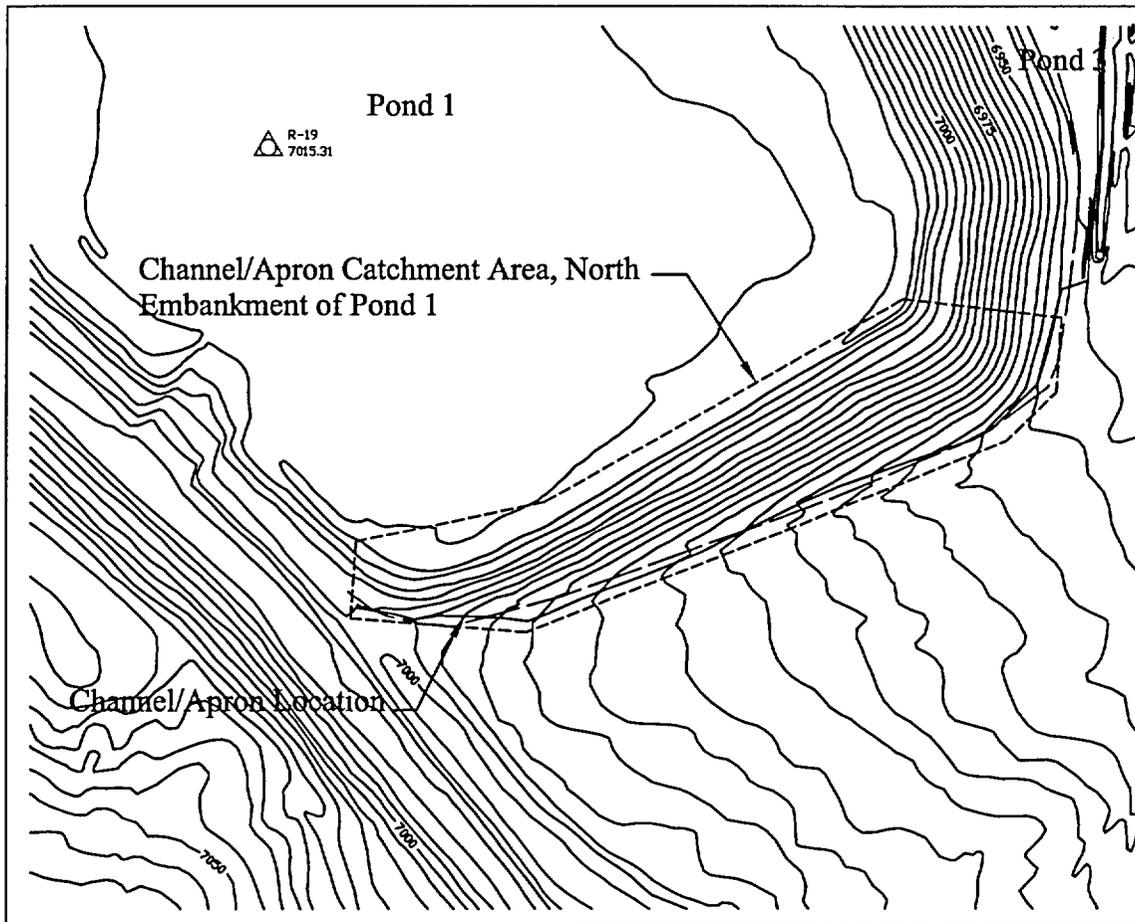
The development of this design is based on the 1 hr. local PMP depth for Pond 1 of 9.6 inches. The 19-acre catchment area includes essentially impervious covered tailings of the south embankment slope. In these calculations it is assumed that the entire catchment area is capped with a rock cover and is impervious. This catchment drains to the south, down the 5H:1V embankment slopes and exits in an existing internal apron that is constructed along the entire Pond 1 embankment toe. Visual observations during site visits have indicated that minor erosion has occurred outside the internal apron on the adjacent unprotected natural soils; therefore, redesign and replacement of the existing apron is necessary. Replacement of the existing apron will be required in order to install the new channel/apron. The proposed design is an external channel/apron that will replace the current internal apron. The catchment area is shown on Figure 2.

### 2.1 EROSION PROTECTION APRON FLOW

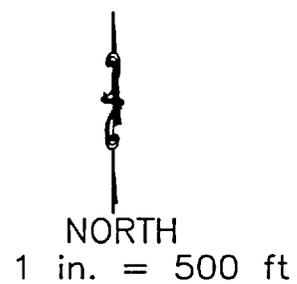
For the 19-acre catchment, a time of concentration was calculated using the longest embankment slope achievable to evaluate rock sizes in the erosion protection apron design. The slope length used for this calculation is 452 ft in length, producing a time of concentrations of 1.65 minutes. This time of concentration is below the smallest incremental rain duration provided by Nelson et al (1986) for developing a PMF depth. Therefore the shortest increment rainfall duration of 2.5 minutes was used in developing the 2.5 minute PMP depth. The 2.5 minute PMP depth for a local storm of 9.6 inches is 2.64 inches. Using a runoff coefficient of 1.0, the Rational Method gives a unit peak flow of 0.63 cfs/ft for this catchment with the slope length of 452 ft. Using a maximum embankment slope of 20 percent and a flow concentration factor of 2.5, the method of Abt *et al.* (1998) predicts a rock  $d_{50}$  of 6.7 inches for the toe apron at the base of the slope. Calculations are provided in Appendix B.

### 2.2 EROSION PROTECTION CHANNEL/APRON FLOW

Due to the moderate longitudinal slopes at the toe of the south embankment of Pond 1, a second design approach was evaluated for providing erosion protection at the toe of the south embankment of Pond 1. The moderate slopes will induce longitudinal flows along the embankment toe, which could cause instability of the embankment by erosion. This approach places an open channel/apron at the base of the slope that will catch the precipitation that falls on the embankment slope and runs off. The Figure 2



**NOTE:** The channel/apron will capture the run-off from the south embankment of Pond 1 and route it to the east where it will be discharged into the Arroyo del Puerto.



AMBROSIA LAKE MILL  
 RIO ALGOM MINING COMPANY, LLC  
 GRANTS, NEW MEXICO  
 TASK 5 EROSION PROTECTION

**MAXIM**  
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CATCHMENT AREA

DRAWING BY: RLH 6/24/01

PROJECT No. 1690030-500  
 FILE NAME: 1690030T5Fig2.DWG

REVIEWED BY: WHB

FIGURE 2

open channel/apron approach takes into consideration NUREG-1623 erosion control apron parameters as well as NUREG-1623 channel parameters and the Army Corp of Engineers, *Hydraulic Design of Flood Control Channels*, design methods (ASCE 1995). According to previous phone discussions with Mr. Ted Johnson of the Nuclear Regulatory Commission (NRC), the parameters provided within the NUREG-1623 shall be adequate for design of open channels, using Sections 2 and 3 of Appendix D, the Abt and Johnson Method. The open channel terminates at a discharge apron in the Arroyo del Puerto Basin.

The channel/apron separates from the embankment near channel stationing 21+75, at which point the channel/apron becomes a discharge channel (See Sheet 1 for general layout, Appendix D). The southeast portion of the embankment toe that requires erosion protection will be protected by a toe apron system. The southeast toe of the embankment is generally flat and longitudinal flows are not anticipated thus no channel has been incorporated in this portion of the apron design. See Section 2.5 for development of the toe design for the southeast apron.

The flow for the channel/apron originates on a 19 acre area. A time of concentration was developed using the maximum flow length on three sections of the channel/apron. The channel/apron was broken into three sections to maintain a designated rock size by altering each of the channel/apron configurations. The time of concentration for each section included the length of run-off from the embankment slope at station 0+00 of 200 ft. The starting elevation of 7,020 ft with an ending elevation of; 6,959 ft for the first section, 6,941 ft for the second section, and 6,910 ft for the third section and discharge apron was used to develop the time of concentrations for these sections. The flow lengths of these three sections are 1,600 ft, 2,350 ft, and 3,500 ft, respectively. With these parameters, the time of concentration was calculated for each section, 8.1 minutes, 11.4 minutes, and 15.9 minutes, respectively. From Nelson et al (1986), an 8.2 minute, 11.4 minute, and 15.9 minute PMP depth for a local storm of 9.6 inches was determined to be 5.3 inches, 6.1 inches, and 7.3 inches, respectively. The Rational Method gives a peak flow of 328 cfs, 443 cfs, and 543 cfs, respectively, at the end of each section. Calculations are found in Appendix C.

### 2.3 CHANNEL/APRON CONFIGURATION

The channel/apron configuration was developed using the results of the flow calculations noted above in conjunction with NUREG-1623 Sections 2 and 3 and Flow Pro 2.0, a hydraulic design software for steady-state open channel flow. The software was used to develop a flow depth in the proposed channel/apron sections. All other channel/apron dimensions were developed using recommendations from the NUREG-1623 and relations established by Abt *et al.* (1998). The more protective of the requirements for developing a channel configuration between channel design and apron design was chosen for the channel/apron development. Manning's roughness value was developed using equation 3-2 of Section 3, Army Corps of Engineers, (ASCE, 1995). The roughness value was then entered into the open channel modeling software with an estimated channel width greater than or equal to the D50 of the calculated apron rock size times 15 (the requirement for apron width from Section 6 of the NUREG), and the calculated flows noted above for the channel/apron. The sideslope rock size was sized 1.2 times larger according to the methods of ASCE (1995) with the expectation that D50 not exceed 7.5 inches. If the rock size exceeded D50 = 7.5 inches, a wider channel width was selected to reduce the rock size.

The channel slope of 2.3 % is an average slope of the existing grades for the length of the channel/apron and is based on the survey information provided by Rio Algom. With the times of concentration, the incremental storm depths, the peak flows, and the bottom widths determined using the Flow Pro software, a rock size of D50 = 7.5 inches was not exceeded for this erosion protection design using a channel bottom width of 14 ft from STA 0+00 to STA 14+00, a bottom width of 18 ft from STA 14+00 to STA 21+75, and a bottom width of 22 ft from STA 21+75 to the channel/apron end, STA 33+00. A minimum channel depth of 3.7 feet will be necessary to control the longitudinal flows as well as protect the toe from erosion through the channel/apron.

The channel bottom widths for longitudinal flow along the channel/apron is also adequate using the design criteria found in NUREG-1623, Section 6 for apron design. The rock size of D50 = 6.7 inches

determined in Section 2.1 would require an apron width of 8.4 feet, which is exceeded by the longitudinal flow requirements for bottom width in each section.

Existing longitudinal grades at the embankment toe from STA 0+00 to STA 5+00 range from 2.3% to 5.5% for short distances as determined from the survey information provided by Rio Algom. A rock size verification for the channel/apron grades between STA 0+00 and STA 5+00 was performed using the steeper grades. The results indicated that a rock size of  $D_{50} = 5.3$  inches would be required to prevent erosion during a storm event, therefore, the selected rock size from STA 0+00 to STA 14+00 of  $D_{50} = 7.5$  inches is adequate. The verification calculations are shown in Appendix C.

The calculations for this section of the report are shown in Appendix C. The open channel modeling software outputs of the depth of flow in the channel with the above noted input parameters are also included within the calculation section. The channel/apron configuration and location are shown on the design drawings in Appendix D.

#### 2.4 DISCHARGE APRON CONFIGURATION

Run-off from the south embankment of Pond 1 collects in a channel/apron along the toe and is then directed easterly along the toe to approximately station 21+75 where it is routed away from the embankment toe to a discharge apron. The intent of the discharge apron is to spread water on the native ground downstream of the pond. A maximum velocity of 4 ft/sec was chosen as the design criteria for allowing water to disperse on the native material. A toe is constructed at the edge of the discharge apron to prevent scour beneath the apron. The scour method of Abt *et al* (1996) was used to determine the depth of scour for the PMP. The downstream toe as well as the training wall and wingwall toes are designed to this scour depth. Calculations are found in Appendix C.

Wingwalls extend for an additional 25 feet beyond the apron to protect the corners of the apron. The wingwalls are constructed with a rock toe extended to the scour depth with 2H:1V side slopes. Before covering the rock toes of the apron and wing walls with compacted native materials, the contractor should work filter rock into the upper portion of the rock to prevent the loss of native materials in voids.

#### 2.5 EROSION PROTECTION APRON – SOUTHEAST PORTION OF POND 1

For the southeast portion of Pond 1 embankment, more specifically, west of Pond 3 and north of the southeast corner of Pond 1, we used an erosion protection toe apron design, which prevents scour at the base of the embankment slope. The topographic information provided by Rio Algom indicates that longitudinal flows are not expected in this general area; therefore, a channel/apron type erosion protection system is not necessary. The design grade of the embankment is 20%, according to Rio Algom. This value was verified to be between 17% and 20% by the topographic information supplied by Rio Algom. For this portion of the Pond 1 embankment erosion protection plan, a time of concentration and unit peak flow discussed in Section 2.1 were used in conjunction with a 20% embankment slope, a run-off coefficient of 1.0 (rock covered surface with no infiltration), and the method of Abt *et al*. (1998) to predict a rock  $D_{50}=6.7$  inches for erosion protection at the interface of the embankment toe and the native soil in this area.

In an effort to reduce the number of rock gradations used to complete several design tasks for erosion control at the mill site, the apron configurations were adjusted appropriately to fit a common rock size of other design tasks. A rock of  $D_{50} = 7.5$  inches was previously selected for use in an erosion control design at the mill site, the same rock size has been selected for use in this erosion control apron.

### 3.0 OTHER DESIGN/CONSTRUCTION CONSIDERATIONS

As part of this erosion protection design, the existing erosion control apron must be removed and the subgrade properly re-graded such that run-off from the embankment flows into the proposed

channel/apron and toe apron. It is recommended that the entire existing apron be removed as part of the proposed construction and replaced with this proposed channel/apron. Because the channel/apron should fit the topography at the toe of the embankment, some variation from the design grade will be required during construction. Any deviations outside the range 1.5 % to 3.5 % should be evaluated hydraulically to ensure adequate performance of the channel/apron.

The suitability of rock to be used as erosion protection at the Ambrosia Lake Mill was assessed by Rio Algom and from the laboratory test results of the physical characteristics of the rock source; an oversizing of the rock was required. Oversizing for the rock was based on a placement location for critical areas as outlined in Section 7.2.2 of NUREG-1623. The NUREG scoring criteria used on four laboratory samples submitted by Rio Algom resulted in an average rock grading of 76%. In accordance with NUREG and Critical Areas the rock in this design report was oversized by 4%. The design calculations were based on the expectations to not exceed a 7.5 inch nominal rock size. With the oversizing factor of 4%, a 7.8 inch nominal rock size was incorporated into the channel/apron, discharge apron, and toe apron design configurations.

#### 4.0 REFERENCES

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- Nelson, J. D., S. R. Abt, R. L. Volpe, D. van Zyl, N. E. Hinkle, W. R. Staub, 1986. *Methodologies for Evaluating Long-Term Stabilization Designs for Uranium Mill Tailings Impoundments*. NUREG/CR-4620, U. S. Nuclear Regulatory Commission, Washington, D.C.
- United States Army Corps of Engineers, 1995, *Hydraulic Design of Flood Control Channels*. Change 1. Hydrologic Engineering Center, Davis, California

## APPENDIX A

### PMP/Local Storm Calculation

Reference: Hydrometeorological Report No. 55A  
U.S. Dept of Commerce, NOAA, June 1988

Calculate local storm PMP for mine site

following method in Section 14.3.

1. 1-hr  $1 \text{ mi}^2$  PMP at 5000 ft el. from Plate VIc  
10.5 in.

2. Elevation adjustment - use 7,000 ft site elevation

Maximum 12-hr persistent 1000 MB Dew Point =

76.6°F from Figure 4.11

From Figure 14.3 - Elevation adjustment = 0.90

3.  $0.90 \times 10.5 \text{ in} = \underline{9.5 \text{ in}}$   $1 \text{ mi}^2 - 1 \text{ hr}$ .

4. From Table 12.4, 6 hr storm is 1.35 x 1 hr storm

$$9.5 \times 1.35 = \underline{12.8 \text{ in}}$$

5. Areal reduction factors will depend on basin.

For Arroyo del Puerto Basin

1. 1 hr -  $1 \text{ mi}^2$  PMP at 5000' El = 10.4" from Plate VIc

2. Assume average basin el of 7500'; max 12 hr persistent 1000 MB dew point = 76.6°F

Elevation adjustment = 0.86

3.  $0.86 \times 10.4 = \underline{8.9 \text{ ''}}$  1 hr -  $1 \text{ mi}^2$  PMP

5. For 1 hr storm areal reduction factor is .58

Basin Area = 57  $\text{mi}^2$

$$0.58 \times 8.9 = \underline{\underline{5.2 \text{ ''}}}$$

**APPENDIX B**

**CALCULATIONS FOR POND 1  
EROSION PROTECTION APRON  
SOUTH EAST CORNER**

Apron Calculations:

Using Method of NUREG CR-1623 Appendix D.  
Section 6 - Rip Rap Sizing

1.) Slope Length:

Longest 452.3 ft. (Using Aerial Survey)

2.) Pond 1 Embankment Slope:

Embankment Design Slope = 20%

3.) Time of Concentration:

$$t_c = (11.9 L^3 / H)^{0.385}$$

$$= (11.9 \times \frac{452^3}{3280} / (7025 - 6940))^{0.385}$$

$$t_c = 0.027 \text{ hr} = 1.65 \text{ min.}$$

4.) \*Using 2.5 min rainfall increment from  
Nelson et al (1986)

\* (Shortest Increment Available)

$$2.5 \text{ min PMP} = 0.275 \times 9.6'' = 2.64''$$

(Using 9.6'' PMP for Local Storm)

5.) Using Rational Method for Unit Flow/Width

$$L = 452 \quad \text{Area} = 452' \times 1 \text{ ft} = 452 \text{ Ft}^2$$

$$= 0.010 \text{ acres}$$

$$\text{Intensity, } i = \frac{60 \times 2.64}{2.5} = 63 \text{ in/hr}$$

(continued)

6.) Flow,  $q_u$  (Unit Flow)

$$q_u = C i a = 1.0 \times 63 \times 0.010$$

$$q_u = 0.63 \text{ cfs/ft}$$

$$C = 1.0 \text{ (Rock Covered Embankment Slope)}$$

7.) Using Equation D-18 From NUREG 1623  
Appendix D - Rock Sizing:

$$\text{Concentration Factor, } C_F = 2.5$$

$$D_{50} = 10.46 \times S^{0.43} (C_F \times q_u)^{0.56}$$

$$D_{50} = 10.46 \times (0.20)^{0.43} (2.5 \times 0.63)^{0.56}$$

$$D_{50} = 6.7 \text{ inches } \boxed{\text{Minimum}}$$

8.) Apron Configurations:

Using NUREG 1623 - Apron Configurations

1.) Minimum Depth of Rock Apron @ 6.7"

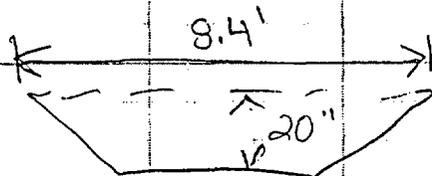
$$\text{Depth} = 3 \times D_{50}$$

$$D = \underline{\underline{20.1}} \text{ inches}$$

2.) Minimum Width

$$\text{Width} = D_{50} \times 15$$

$$W = 100.5 \text{ inches} = \underline{\underline{8.4'}} = W$$



Notes For Consistency w/ Project Results  $D_{50} = 7.8''$  will be Used (oversized)

**APPENDIX C**

**CALCULATIONS FOR POND 1  
EROSION PROTECTION CHANNEL/APRON AND DISCHARGE APRON**

JOB NO. 1690030-500 JOB TITLE Rio Algom DATE 2/21/03 BY RLH  
 SUBJECT Channel Section Size/Rock Sizing CHECKED \_\_\_\_\_ SHEET 1 OF 5

Channel Sizing w/ Rock Sizing  
I. By Section

Methods Calculate Flows For 3 Sections  
 Using MUREG 1623 Guidance Appendix D

1.) Sections

Sec 1 STA 0+00 to STA 14+00

Sec 2 STA 14+00 to STA 21+50

Sec 3 STA 21+50 to STA 33+00 (End)

2.) Channel Sizing and Rock Sizing Sec 1

Parameters

Channel Length = 1400 ft + 200 ft for  $t_c$

\* 200 ft is embankment slope length start  
 Area of Drainage = 8.4 acres

Change in elevation is  
 7020 ft to 6959 = 61 ft

Slope (Average slope for Rock Size) = 2.3%

2.1) Time of Concentration:  $t_c$

$$t_c = \left[ 11.9 \cdot \left( \frac{1600}{5000} \right)^3 / 61 \text{ ft} \right]^{0.385}$$

$$t_c = 0.134 \text{ hrs} = \underline{\underline{8.1 \text{ min}}}$$

2.2) Intensity:  $i$

From Table 2.1 (Nelson, 1986)

$$8.1 \text{ min PMP} = 55\% (9.6") = 5.3"$$

$$i = 60 \times \frac{5.3}{8.1} = \underline{\underline{39.1 \text{ in/hr}}}$$

JOB NO. 1690030-500 JOB TITLE Rio Algom DATE 2/21/03 BY RLH

SUBJECT Channel Section Size / Rock Sizing CHECKED \_\_\_\_\_ SHEET 2 OF 5

2.3) Flow, Q &

$$Q = C \cdot i \cdot A = 1.0 \times 39.1 \times 8.4 \text{ Acres} \cdot \frac{1 \text{ in}}{12 \text{ in}} \cdot \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$Q = \underline{\underline{328 \text{ cfs}}}$$

2.4) Channel Configurations:

- 14 ft wide Bottom
- 2H:1V Slopes
- Average Slope = 2.3%
- PMP = 9.6" / hr - mi<sup>2</sup>
- Flow = 328 cfs

2.5) Rock Sizing:

$$D_{50} = 5.23 \times q^{0.56} \times 0.023^{0.43}$$

$$D_{50} = 5.23 \times (328/14)^{0.56} \times (0.023)^{0.43}$$

$$D_{50} = 6.0 \text{ inches Bottom Rock}$$

Per ACE For Channel Side Slopes

$$D_{50} = 6.0" \times 1.2 = 7.2"$$

$$\underline{\underline{D_{50} = 7.2"}}$$

2.6) Oversizing:

Due to selected rock source selected rock requires a 1.04 (4%) oversizing

$$D_{50} = 7.2" \times 1.04 = 7.5"$$

$$D_{50} = 7.5" \text{ Minimum}$$

$$\underline{\underline{D_{50} = 7.8" \text{ From Other Tasks}}}$$

3) Channel Sizing & Rock Sizing Section 2%

Parameters

Channel Length = 21750 + 200 for  $t_c$

Area of Drainage = 13.7 acres

Change In Elevations  
7020 to 6941 = 79 Ft

Slope (Average Slope For Rock Size) = 2.3%

3.1) Time of Concentration  $t_c$ :

$$t_c = \left[ 11.9 \times \left( \frac{2350 \times 5280}{79} \right)^3 \right]^{0.385}$$

$$t_c = 0.189 \text{ hrs} = \underline{\underline{11.4 \text{ min}}}$$

3.2) Intensity  $i$ :

From Table 2.1 (Nelson, 1986)

$$11.4 \text{ min PMP} = 64\% (9.6") = 6.1"$$

$$i = 60 \times \frac{73}{11.4} = \underline{\underline{38.3 \text{ in/hr}}}$$

3.3) Flow,  $Q$ :

$$Q = 10 \times 38.3 \text{ in/hr} \times 13.7 \text{ acres}$$

$$Q = \underline{\underline{443 \text{ cfs}}}$$

3.4) Channel Configuration:

- 22" wide Bottom
- 2H:1V Side Slopes
- Average Slope = 2.3%
- PMP = 96" 11 hr - m, 2
- Flow = 443 cfs

JOB NO. 1690030-500 JOB TITLE Rio Algom DATE 2/21/03 BY RLH

SUBJECT Channel Section Size/Rock Sizing CHECKED \_\_\_\_\_ SHEET 4 OF 5

3.5) Rock Sizing:

$$D_{50} = 5.23 \times (44 \frac{3}{22})^{0.56} \times (0.023)^{0.43}$$

$$D_{50} = 5.6'' \text{ Bottom}$$

$$D_{50} = 5.6'' \times 1.2 = 6.7'' \text{ Side Slope}$$

$$D_{50} = 6.7''$$

3.6) Oversizing:

$$\text{Oversize Factor} = 1.04, (4\%)$$

$$D_{50} = 6.7 \times 1.04$$

$$D_{50} = 7.0''$$

$$\underline{D_{50} = 7.8''} \text{ From other Tasks}$$

4) Channel Size and Rock Sizing Section 3:

Parameters:

$$\text{Channel Length} = 3300 + 200 \text{ feet}$$

$$\text{Area of Drainage} = 198 \text{ acres}$$

Change in Elevation:

$$7020 - 6910 = 110 \text{ ft}$$

$$\text{Slope (Average Slope For Rock Size)} = 2.7\%$$

4.1) Time of Concentration

$$t_c = \left[ 11.9 \left( \frac{3500}{5200} \right)^{1.3} \right]^{0.385}$$

$$t_c = 0.264 \times 15.9 \text{ min}$$

JOB NO. 1690030-500 JOB TITLE Rio Algom DATE 1/22/03 BY RLH  
 SUBJECT Channel Section Size/Rock Sizing CHECKED \_\_\_\_\_ SHEET 5 OF 5

4.2) Intensity,  $i$  %

From Table 2.1 (Nelson, 1986)

$$15.9 \text{ min PMP} = 75.6\% (9.6'') = 7.3''$$

$$i = 60 \times \frac{7.3}{15.9} = \underline{\underline{27.4 \text{ in/hr}}}$$

4.3) Flow,  $Q$  %

$$Q = 1.0 \times 27.4 \text{ in/hr} \times 19.8 \text{ acres}$$

$$\underline{\underline{Q = 543 \text{ cfs}}}$$

4.4) Channel Configurations:

- 22 ft wide Bottom
- 24:1V slope of sides
- Average slope = 2.3 %
- PMP = 9.6" / hr - mid
- Flow = 543 cfs

4.5) Rock Sizing:

$$D_{50} = 5.23 \times \left( \frac{543}{22} \right)^{0.56} \times (0.023)^{6.43}$$

$$D_{50} = 6.2'' \text{ Bottom}$$

$$D_{50} = 6.2 \times 1.2 \text{ Side Slopes}$$

$$D_{50} = 7.4 \text{ inches Side Slopes}$$

4.6) Oversizing:

$$\text{Oversizing Factor} = 1.04, (4\%)$$

$$D_{50} = 7.4 \times 1.04$$

$$D_{50} = 7.7''$$

$$\underline{\underline{D_{50} = 7.8''}} \text{ From other tasks}$$

Task 5 Channel Design - Channel - Inputs to get channel Depth  
DISCHARGE CHANNEL

1. MANNING OUTPUT

SECTION 1

OPEN CHANNEL DESIGN - STRICKLER'S EQUATION					
ASSUMPTIONS & EQUATIONS			Where K=Ave Flume Data (ACE 1994)		
Mannings Value, $n \sim K(D90)^{0.16667}$					
D90 of D50 = 7.8 inch Rock Particle Distribution = 12" (See Design Report For Gradation)					
Note: Army Corp. of Engineers - Hydraulic Design of Flood Control Channels (1991)					
CALCULATION: Using Army Corp. Of Engineers (ACE) Method (ACE, 1991)					
Inputs	Value	Units	Output	Value	Units
D50	7.8	inches	n	0.0507	

2. CHANNEL DEPTH OUTPUT

**Depth, Flowrate, Slope, and Roughness** [X]

Flow Pro will compute the depth, flowrate, slope or roughness for the channel type of your choice. It will also compute the velocity, area, wetted perimeter, and hydraulic radius.

Depth | Flowrate | Slope | Roughness

Select the channel type:

Trapezoidal  
  Circular  
  Ushaped  
  Elongated circular

Flowrate: ft <sup>3</sup> /s:	328	Depth: ft:	2.524
Width: ft:	14	Velocity: ft/s:	6.821
Manning's N:	.0507	Area: ft <sup>2</sup> :	48.084
Bottom slope:	.023	Wetted perimeter: ft:	25.289
Side slope:	2	Hydraulic radius: ft:	1.901

**Task 5 Channel Design - Channel - Inputs to get channel Depth**  
**DISCHARGE CHANNEL**

**1. MANNING OUTPUT**

**SECTION 2**

**OPEN CHANNEL DESIGN - STRICKLER'S EQUATION**

**ASSUMPTIONS & EQUATIONS**

Where K=Ave Flume Data (ACE 1994)

Mannings Value,  $n \sim K(D90)^{0.16667}$

D90 of D50 = 7.8 inch Rock Particle Distribution = 12" (See Design Report For Gradation)

Note: Army Corp. of Engineers - Hydraulic Design of Flood Control Channels (1991)

**CALCULATION: Using Army Corp. Of Engineers (ACE) Method (ACE, 1991)**

Inputs	Value	Units
D50	7.8	inches

Output	Value	Units
n	0.0507	

**2. CHANNEL DEPTH OUTPUT**

**Depth, Flowrate, Slope, and Roughness**

Flow Pro will compute the depth, flowrate, slope or roughness for the channel type of your choice. It will also compute the velocity, area, wetted perimeter, and hydraulic radius.

Depth | Flowrate | Slope | Roughness

Select the channel type

Trapezoidal    Circular    Ushaped    Elongated circular

Flowrate, ft <sup>3</sup> /s	443	Depth, ft	2.642
Width, ft	18	Velocity, ft/s	7.203
Manning's N	.0507	Area, ft <sup>2</sup>	61.506
Bottom slope	.023	Wetted perimeter, ft	29.814
Side slope	2	Hydraulic radius, ft	2.063

Compute   Close

# Task 5 Channel Design - Channel - Inputs to get channel Depth

## DISCHARGE CHANNEL

### 1. MANNING OUTPUT

### SECTION 3

## OPEN CHANNEL DESIGN - STRICKLER'S EQUATION

### ASSUMPTIONS & EQUATIONS

Where K=Ave Flume Data (ACE 1994)

Mannings Value,  $n \sim K(D90)^{0.16667}$

D90 of D50 = 7.8 inch Rock Particle Distribution = 12" (See Design Report For Gradation)

Note: Army Corp. of Engineers - Hydraulic Design of Flood Control Channels (1991)

### CALCULATION: Using Army Corp. Of Engineers (ACE) Method (ACE, 1991)

Inputs	Value	Units
D50	7.8	inches

Output	Value	Units
n	0.0507	

### 2. CHANNEL DEPTH OUTPUT

**Depth, Flowrate, Slope, and Roughness** ✕

Flow Pro will compute the depth, flowrate, slope or roughness for the channel type of your choice. It will also compute the velocity, area, wetted perimeter, and hydraulic radius.

Depth
  Flowrate
  Slope
  Roughness

Select the channel type:

Trapezoidal
  Circular
  Ushaped
  Elongated circular

Flowrate: ft <sup>3</sup> /s:	543	Depth: ft:	2.677
Width: ft:	22	Velocity: ft/s:	7.416
Manning's N:	.0507	Area: ft <sup>2</sup> :	73.220
Bottom slope:	.023	Wetted perimeter: ft:	33.971
Side slope:	2	Hydraulic radius: ft:	2.155

JOB NO. 1690030-500 JOB TITLE Rio Algom DATE 7/8/02 BY RLH  
 SUBJECT Channel Rock Sizing CHECKED \_\_\_\_\_ SHEET 1 OF 2

Rock Sizing Verification Using Steeper Slope / Smaller Flows  
 Channel Rock Size Calculations: (VERIFICATION)

STA 0+00 - 5+00 - For Check of Rock Size  
 Determined w/ longer channel  
 length: large Flows

Method: NUREG 1623

Flow Calcs:

1) Parameters:

- Channel Length = 500 ft + 200 ft of Slope  
 = 700 ft for  $t_c$  calcs
- Area To Drain Into Channel = 1.8 acres
- Change Elev. Del = 7020 - 6981 = 39 ft
- Design Slopes (For Rock Sizing)

5.5%

Note: Steeper Slope Used For Rock Sizing  
 Channel Configuration developed for  
 using flatter slope

2.) Time of Concentration:

$$t_c = \left[ (11.9 \cdot \frac{1700}{5280})^3 \right]^{0.385}$$

$$t_c = 0.06 \text{ hrs} = \underline{2.5 \text{ min}}$$

3.) Intensity,  $i$

Incremental Rainfall (Table 21, Nelson, 1986)

27.5%

$$i = 2.5 \text{ min PMP} = (27.5\%) \times 9.6" = 2.64 \text{ in.}$$

$$i = 60 \times \frac{2.64}{2.5} = \underline{63.4} \text{ in/hr.}$$

4.) Flow  $Q$ :

$$Q = C_i A \quad (C = 1.0, \text{Rock Covered Surface})$$

$$Q = 1.0 \times 63.4 \times 1.8 = 114 \text{ cfs}$$

$$Q = 114 \text{ cfs}$$

5.) Rock Sizing

Using Johnson & Alt et al (1993)

$$D_{50} = 5.23 \times q_{pu}^{0.56} \times S^{0.43}$$

$$q_{pu} = Q/\text{width} = 114/12 = 9.5 \text{ cfs/ft}$$

$$S = 5.5\%$$

$$D_{50} = 5.23 \times (9.5)^{0.56} \times (0.055)^{0.43}$$

$$D_{50} = \underline{5.3 \text{ inches}}$$

6.) Note: The  $D_{50} = 5.3$  inch requirement is met for this section through the use of 7.5 in  $D_{50}$  Rock determined in "Channel Calculation" attached previous to this section. The Rock Size results in the previous section,  $D_{50} = 7.5$ , exceeds the rock size required using the steeper slope of 5.5% through this section, due to the large flow quantity calculated in the previous section. Current channel config. is also adequate.

JOB NO. 1690030 JOB TITLE Rio Algom DATE 12/5/02 BY RLH  
 SUBJECT Riprap Size For  $D_{50}=7.5"$  CHECKED \_\_\_\_\_ SHEET 1 OF 1

Gradation Development of  $D_{50} = 7.8"$  (7.5" w/ oversize)  
 Use ACE, 1995 (Hydraulic Design of Flood Control Channels)  
 Table 3-1 Gradation For Riprap

$D_{50} = 7.5"$  For Engineering Design.

Rock Source Grading Per Rio Algom  
 Samples =  $\approx 76\%$

\* Per NRC Appx. D Sect. 7 Oversizing of  
 Marginal Quality Rock

$D_{50} = 7.5" \times$  Oversize Factor

Oversize Factor =  $80\% - 76\% = 4\%$   
 (Per Section 7.2.2-Oversize criteria)

$D_{50} = 7.5" \times (1.04) = 7.8"$

Riprap Gradation Specification For  $D_{50} = 7.8"$

Sieve Size

% Passing

12"

100

9"

60 - 85

6"

5 - 30

4"

0 - 5

WMB  
2/27/03

Rio Algom-Task 5, Scour Depth at Discharge.  
Apron Outlet

For 1-hr. 10cl storm, PMP = 9.6"  
Runoff Area = 19.8 Acres. Assume impermeable surface.

$$\text{Discharge} = \frac{9.6}{12} \times 19.8 \times 43560 = 690,000 \text{ ft}^3$$

Runoff in 1 hr.,  $Q_{\text{AVE}} = \frac{690,000}{3600 \text{ sec}} = 192 \text{ cfs ave. flow}$

Use Abt et al (1996) scour equation to estimate scour depth:

$$d_s = R_h C_s \frac{\alpha}{G^{1/3}} \left( \frac{Q}{g^{1/2} R_h^{5/2}} \right)^B \left( \frac{t}{316} \right)^{\theta}$$

where:

$d_s$  = scour depth (ft)

$R_h$  = hydraulic radius = 1.69 ft (see worksheet)

$C_s$  = slope coefficient = 1.01 for 1% slope

$\alpha = 2.27$

$B = 0.34$

$\theta = 0.06$

$G$  = coefficient of uniformity = 2.8

$g = 32.2 \frac{\text{ft}}{\text{sec}^2}$

$Q = 192 \text{ cfs ave. flow}$

$t = 1 \text{ hr.}$

$$d_s = 1.69 \times 1.01 \frac{2.27}{2.8^{1/3}} \left( \frac{192}{32.2^{1/2} \times 1.69^{5/2}} \right)^{0.34} \left( \frac{1}{316} \right)^{0.06}$$
$$= \underline{4.6 \text{ ft.}}$$

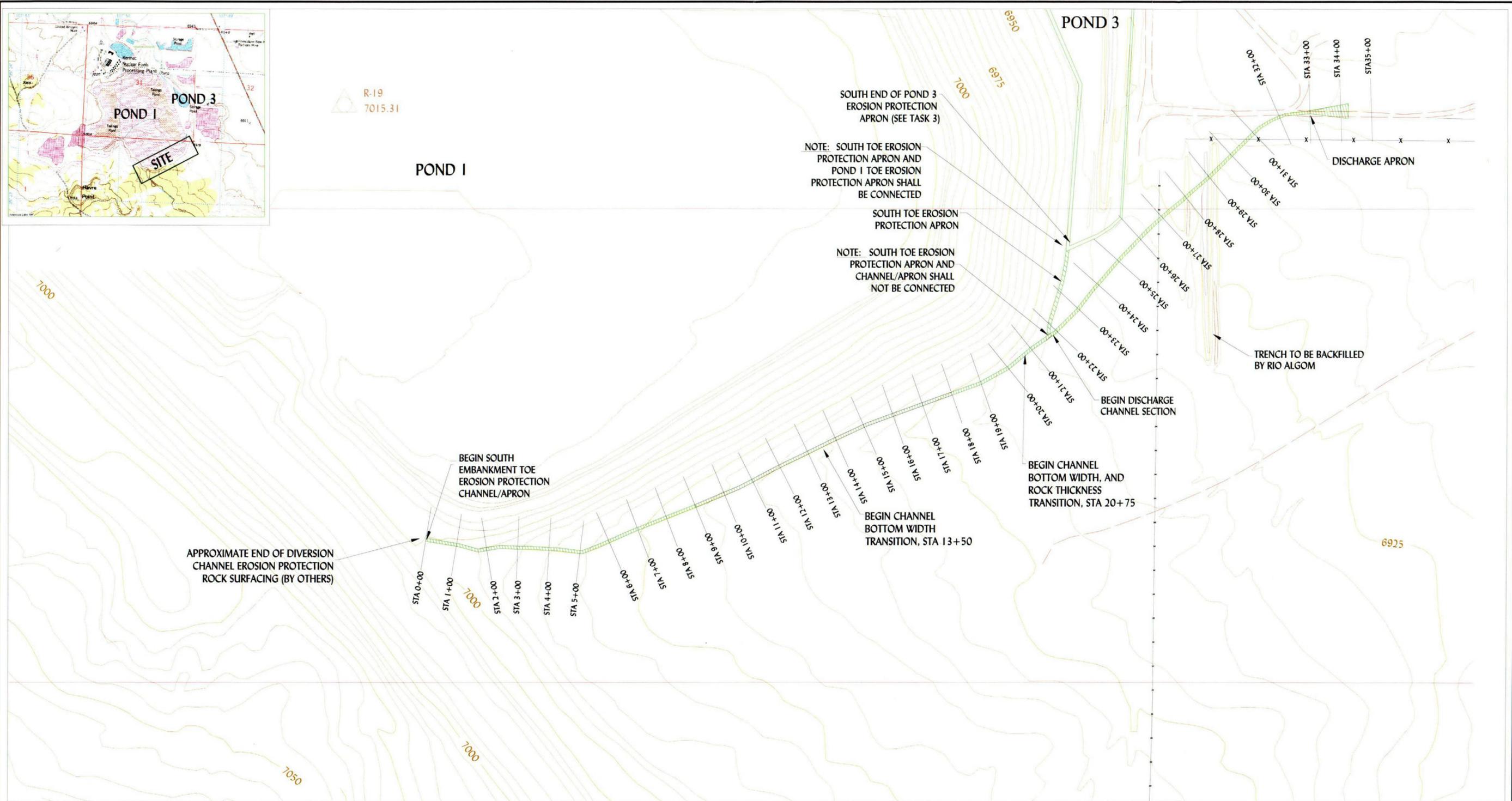
## Discharge Apron Outlet Condition Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\quivira.fm2
Worksheet	Quivira
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.051
Channel Slope	0.010000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Bottom Width	77.00 ft
Discharge	543.00 cfs

Results	
Depth	1.69 ft
Flow Area	135.86 ft <sup>2</sup>
Wetted Perimeter	84.56 ft
Top Width	83.76 ft
Critical Depth	1.14 ft
Critical Slope	0.036902 ft/ft
Velocity	4.00 ft/s
Velocity Head	0.25 ft
Specific Energy	1.94 ft
Froude Number	0.55
Flow is subcritical.	

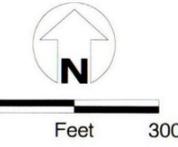
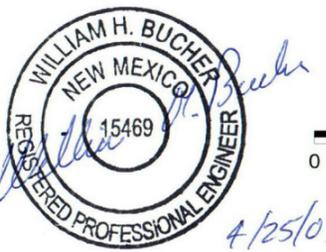
**APPENDIX D**  
**DESIGN DRAWINGS**



Notes: 1. Task 5 Consists of Three (3) Design Items; (See Item Areas Located On This Drawing)

- A. An Erosion Protection Channel/Apron Constructed Along The Pond 1 South Embankment Toe (See Sheets 2, 3, 4 and 5)
  - B. A Discharge Channel At The End of The Channel/Apron Section With A Discharge Apron Constructed At The End of The Discharge Channel For Energy Dissipation In The Arroyo del Puerto Basin (See Sheets 6, 7 and 8).
  - C. An Erosion Protection Apron Along The Pond 1 Southern Portion of the East Embankment Toe (See Sheet 9 of 9)
2. The Erosion Protection Apron And the Erosion Protection Channel/Apron Shall Not Be Connected. The Apron Shall End At The Crest Of The Interior Embankment Slope Of The Erosion Protection Channel/Apron Near Station 21+75.

- 3. The Pond 1 Toe Erosion Protection Apron (Task 3 Apron) And The South Embankment Toe Erosion Protection Apron Shall be Connected.
- 4. The Horizontal Location Of The Above Noted Items For Erosion Protection Are Approximate. Field Adjustment To The Horizontal Location Of the Erosion Protection Channel/Apron, Toe Apron, And Discharge Apron May Be Necessary. The Erosion Protection Channel/Apron And Toe Apron Shall be Placed At The Existing Toe Of Pond 1.



**AMBROSIA LAKE MILL  
RIO ALGOM MINING COMPANY, LLC.  
GRANTS, NEW MEXICO  
TASK 5 - EROSION PROTECTION  
GENERAL EROSION PROTECTION PLAN**



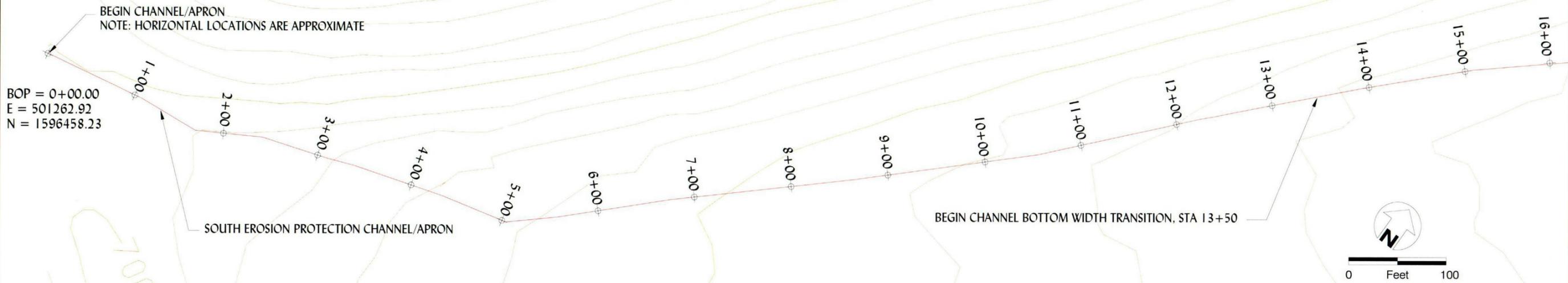
PROJECT No. 1690030-500  
FILE NAME: 1690030T5S1.DWG

DRAWING BY: RLH 5/28/02  
REVISION BY: RLH 2/21/03  
REVIEWED BY: WHB

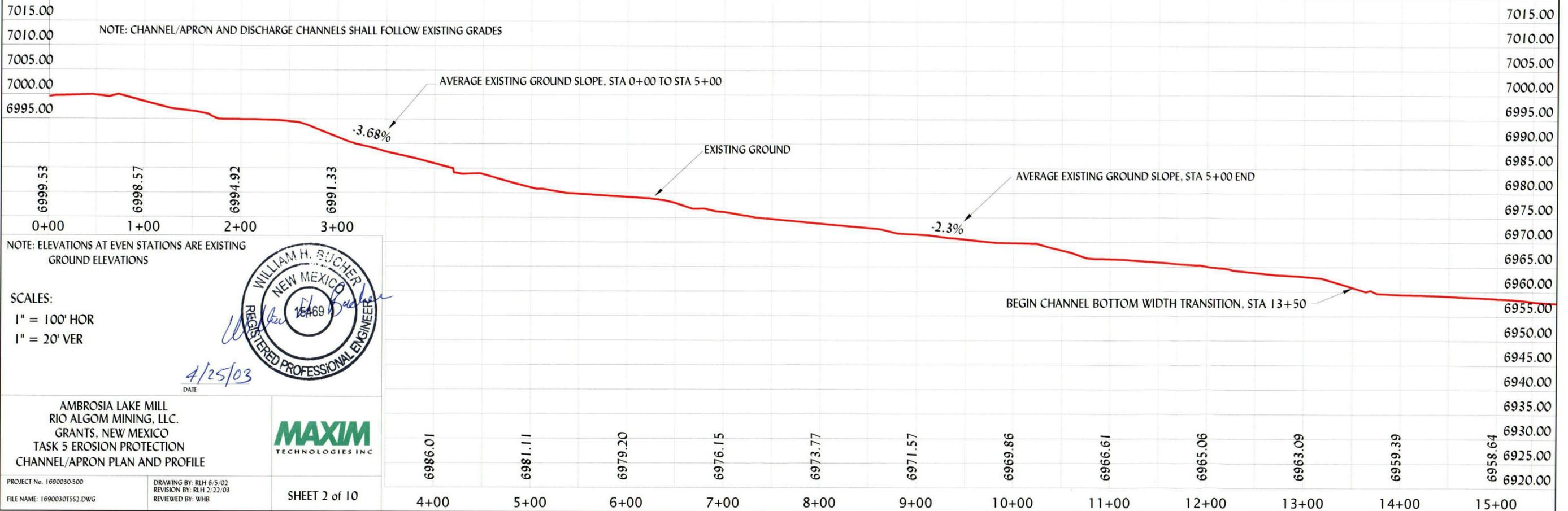
SHEET 1 of 10

C01

# POND I



PLAN & PROFILE DEVELOPED FROM AERIAL SURVEY PROVIDED BY RIO ALGOM MINING COMPANY, LLC.



NOTE: ELEVATIONS AT EVEN STATIONS ARE EXISTING GROUND ELEVATIONS

SCALES:  
 1" = 100' HOR  
 1" = 20' VER

DATE: 4/25/03

Professional Engineer Seal: WILLIAM H. BUCHER, NEW MEXICO, REGISTERED PROFESSIONAL ENGINEER, No. 15469.

AMBROSIA LAKE MILL  
 RIO ALGOM MINING, LLC.  
 GRANTS, NEW MEXICO  
 TASK 5 EROSION PROTECTION  
 CHANNEL/APRON PLAN AND PROFILE



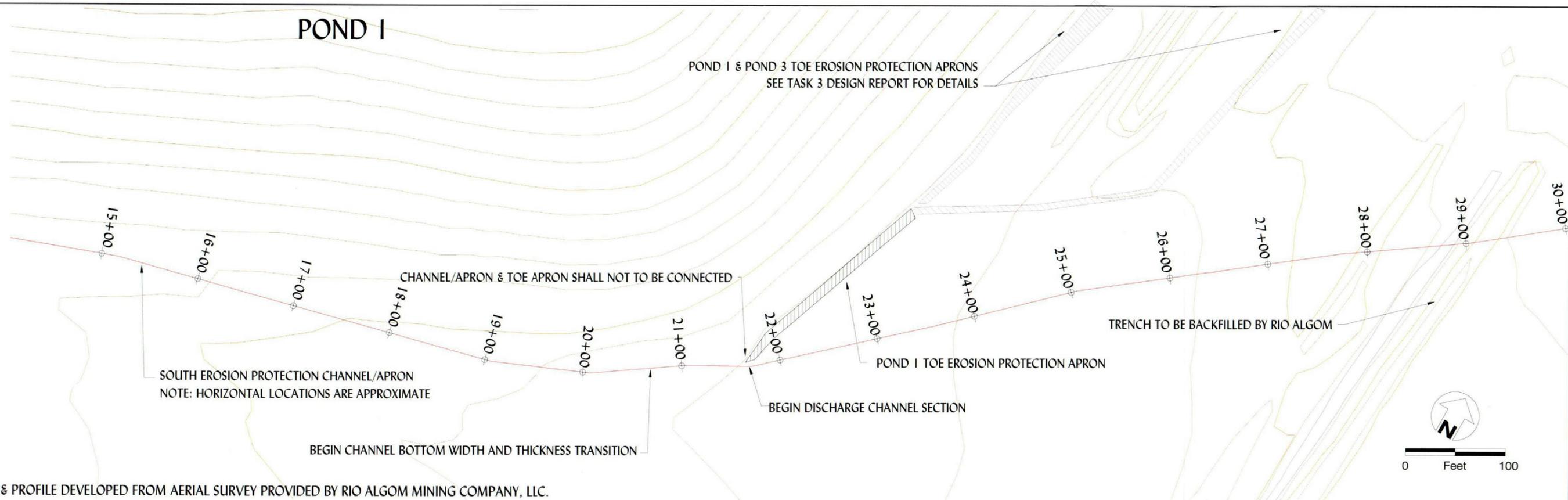
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 DRAWING BY: RLH 6/5/02  
 REVISION BY: RLH 2/22/03  
 REVIEWED BY: WHB

SHEET 2 of 10

C02

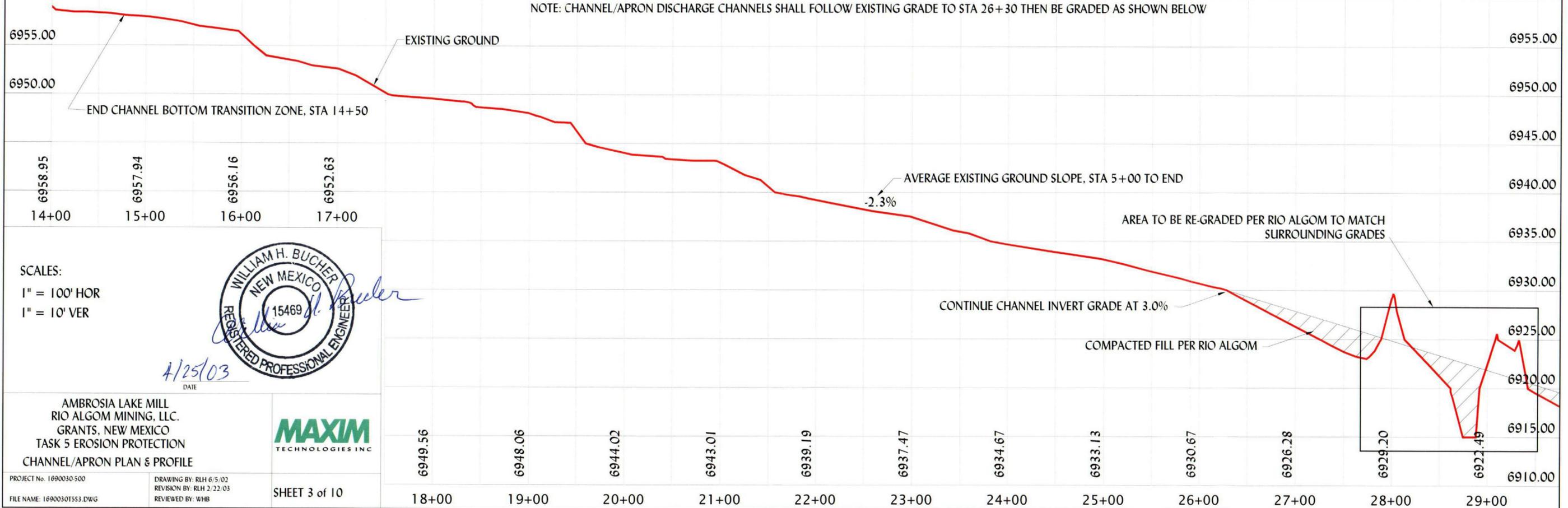
# POND 1

POND 1 & POND 3 TOE EROSION PROTECTION APRONS  
SEE TASK 3 DESIGN REPORT FOR DETAILS



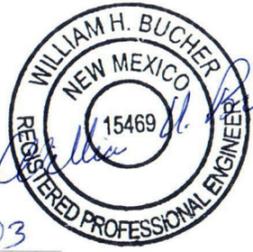
PLAN & PROFILE DEVELOPED FROM AERIAL SURVEY PROVIDED BY RIO ALGOM MINING COMPANY, LLC.

NOTE: CHANNEL/APRON DISCHARGE CHANNELS SHALL FOLLOW EXISTING GRADE TO STA 26+30 THEN BE GRADED AS SHOWN BELOW



SCALES:

1" = 100' HOR  
1" = 10' VER



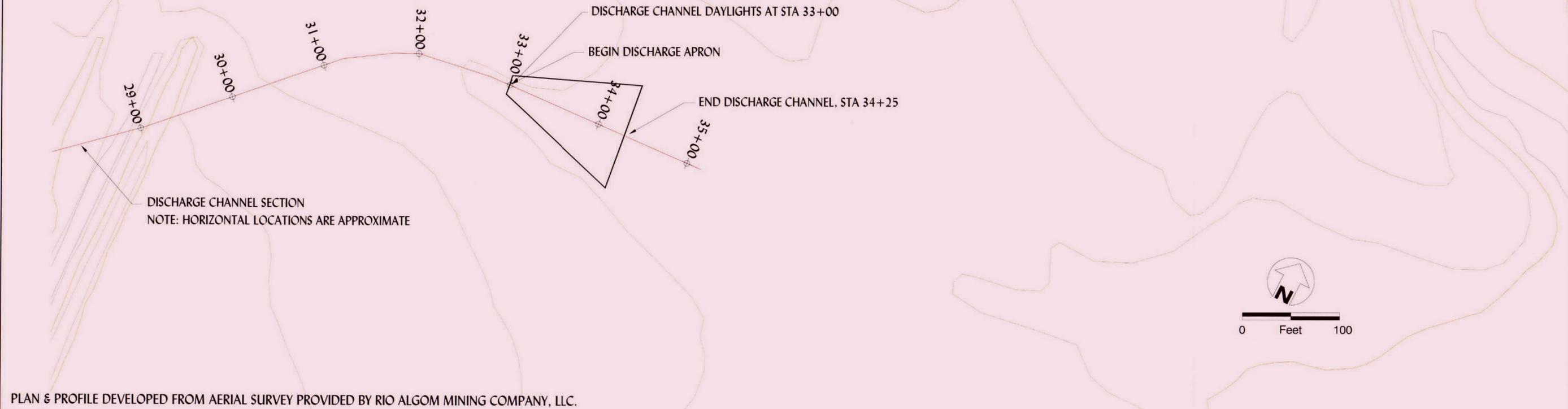
AMBROSIA LAKE MILL  
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GRANTS, NEW MEXICO  
TASK 5 EROSION PROTECTION  
CHANNEL/APRON PLAN & PROFILE



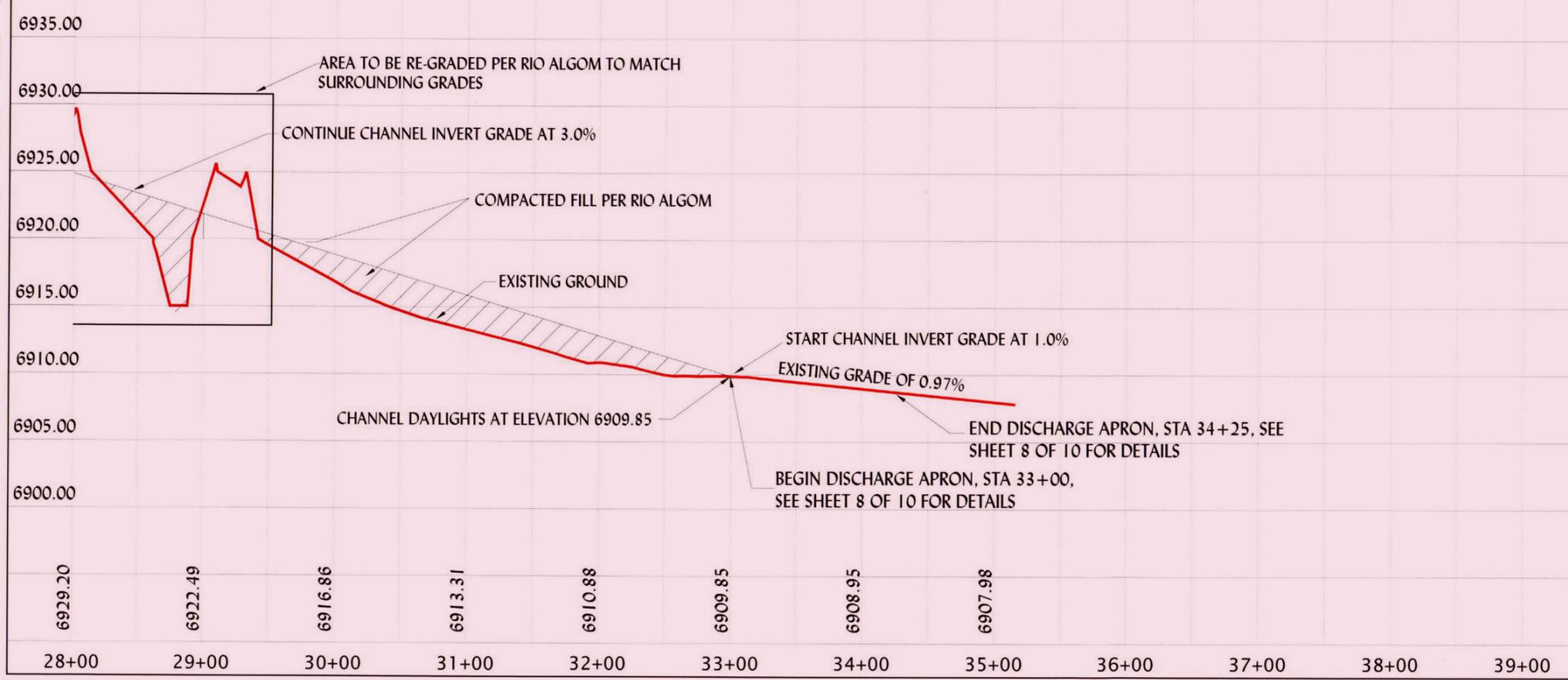
PROJECT No. 1690030-500  
DRAWING BY: RLH 6/5/02  
REVISION BY: RLH 2/22/03  
REVIEWED BY: WHB

SHEET 3 of 10

# ARROYO DEL PUERTO BASIN



PLAN & PROFILE DEVELOPED FROM AERIAL SURVEY PROVIDED BY RIO ALGOM MINING COMPANY, LLC.



NOTE: ELEVATIONS AT EVEN STATIONS ARE EXISTING GROUND ELEVATIONS

SCALES:  
1" = 100' HOR  
1" = 10' VER

4/25/03  
DATE

WILLIAM H. BUCHER  
NEW MEXICO  
REGISTERED PROFESSIONAL ENGINEER  
15469

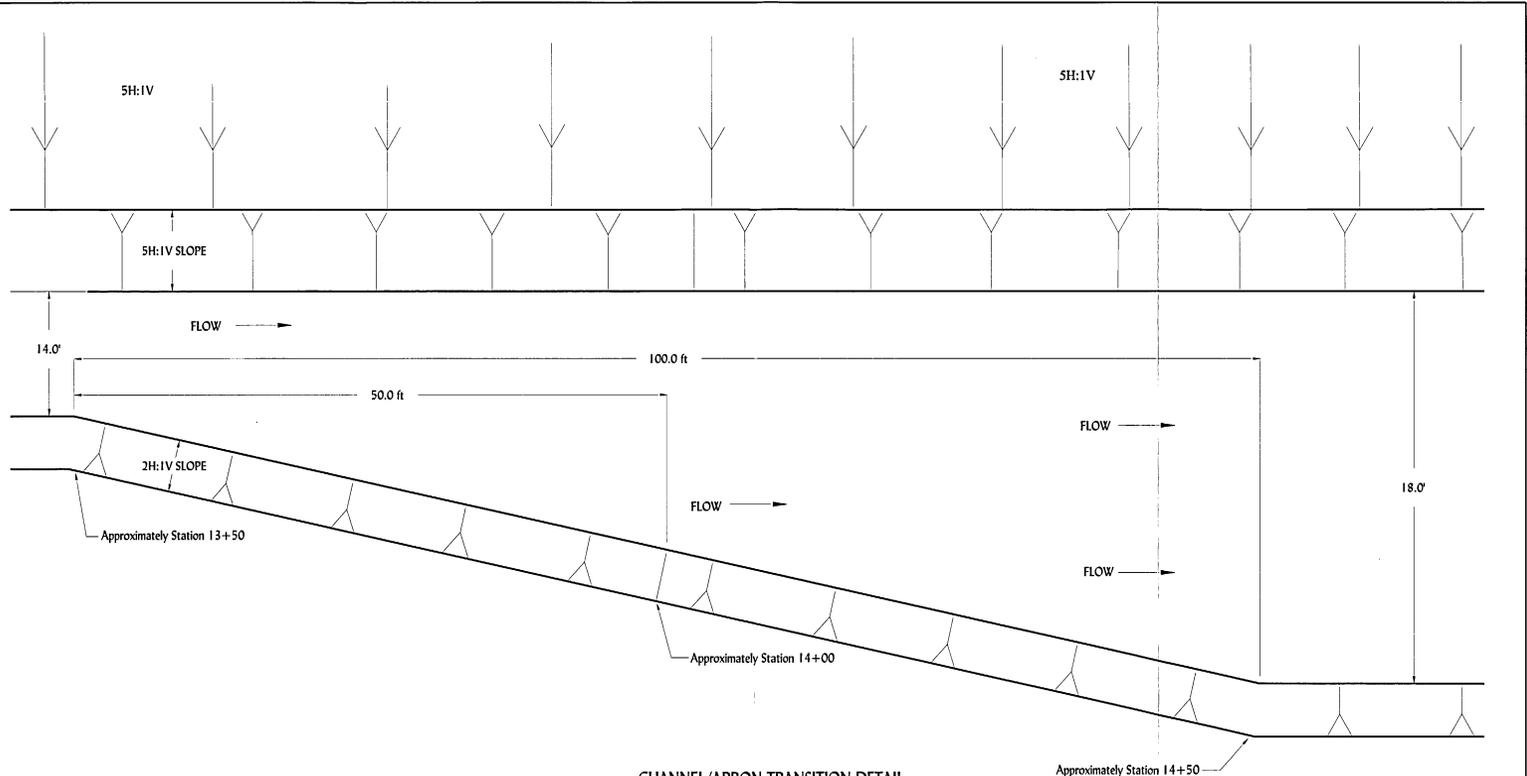
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GRANTS, NEW MEXICO  
TASK 5 EROSION PROTECTION  
CHANNEL/APRON PLAN & PROFILE



PROJECT No. 1690030-500	DRAWING BY: RLH 6/5/02	SHEET 4 of 10
FILE NAME: 1690030TSS4.DWG	REVISION BY: RLH 2/22/03 REVIEWED BY: WHR	

C04





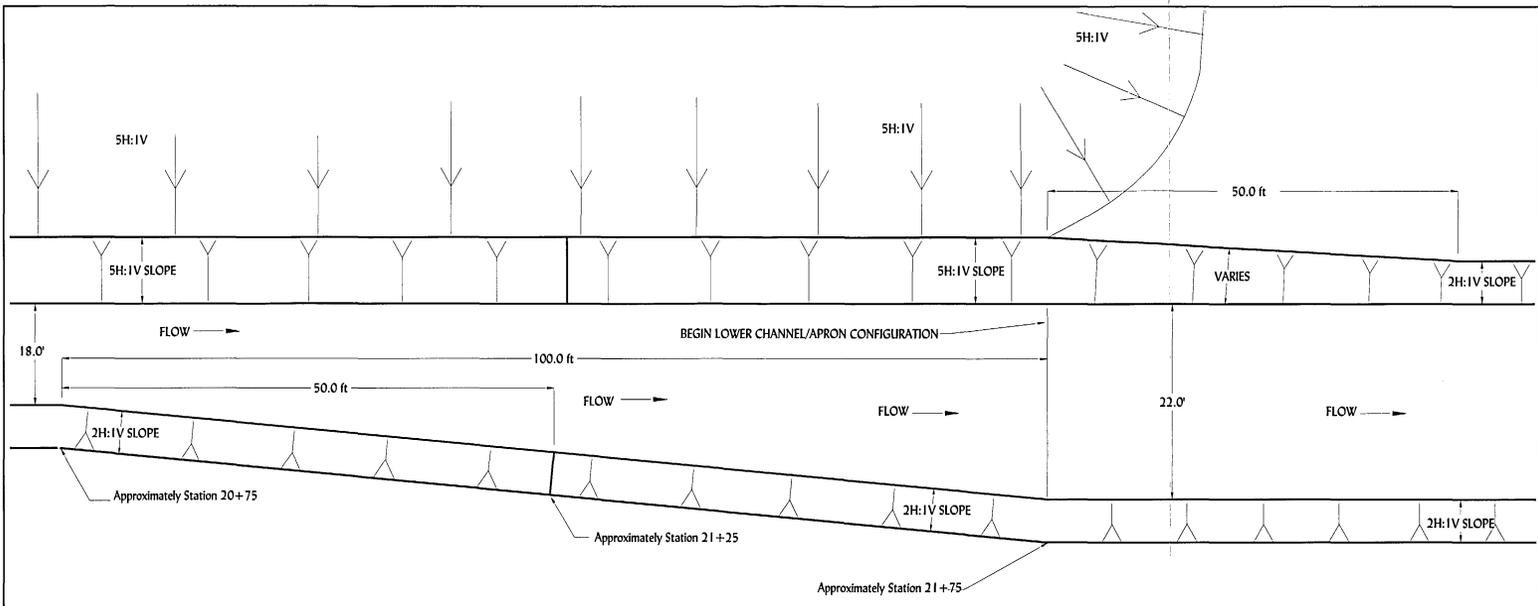
**CHANNEL/APRON TRANSITION DETAIL**  
Not To Scale

**CONSTRUCTION NOTES:**

1. The upper channel/apron configuration shall transition to the lower channel/apron configuration in 100.0 ft.
2. The channel/apron bottom shall be constructed flat such that flow is evenly distributed across the channel bottom.



AMBROSIA LAKE MILL RIO ALGOM MINING, LLC GRANTS, NEW MEXICO TASK 5 EROSION PROTECTION TRANSITION SECTION, STA 13+50 to STA 14+50		
PROJECT No. 1690030 500 FILE NAME: 1690030T556.DWG	DRAWING BY: RLH 2/27/03 REVIEWED BY: WHB	
		SHEET 6 of 10



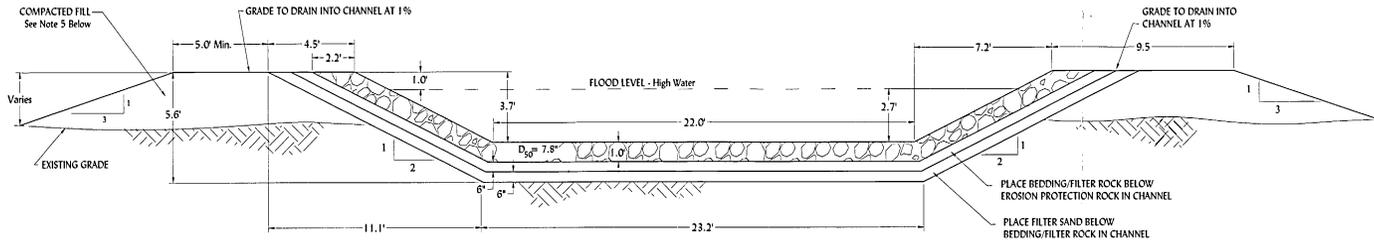
**CHANNEL/APRON TRANSITION DETAIL**  
Not To Scale

**CONSTRUCTION NOTES:**

1. The upper channel/apron configuration shall transition to the lower channel/apron configuration in 100.0 ft. The rip rap thickness design shall conform to the lower channel apron design at STA 21+75 of the transition section.
2. The channel/apron bottom shall be constructed flat such that flow is evenly distributed across the channel bottom.
3. The left side channel/apron slope shall transition from the 5H:1V slope to the 2H:1V slope in 50 ft starting at the point where the embankment toe separates from the channel/apron, approximately STA 21+75.



<b>AMBROSIA LAKE MILL</b> <b>RIO ALGOM MINING, LLC</b> <b>GRANTS, NEW MEXICO</b> <b>TASK 5 EROSION PROTECTION</b> TRANSITION SECTION: STA 20+75 to STA 22+25		
PROJECT No. 1690030500	DRAWING BY: RLH 2/27/03	
FILE NAME: 1690030T557.DWG	REVIEWED BY: WHB	SHEET 7 of 10



DISCHARGE CHANNEL TYPICAL SECTION

STA 21+75 TO STA 33+00

SCALE: 1 in = 5 ft



NOTES:

- Rock Riprap for erosion protection shall be placed in conformance with Appendix F of Design of Erosion Protection for Long-Term Stabilization, U.S. Nuclear Regulatory Commission's NUREG-CR1623 Draft Report unless otherwise specified in the TASK 5 Erosion Protection Report or the included Design Drawings.
- The bottom of the channel shall be constructed flat from side slope to side slope to prevent concentrated flows.
- The channel excavation shall be constructed with bottoms free of loose debris, vegetation and muddy surfaces.
- Areas disturbed during construction of the channel, shall be revegetated.
- Where applicable, compacted fill may be placed on the exterior to construct an embankment that will provide the minimum channel depth. The fill required to construct the embankment shall consist of material excavated from within the channel/apron trench or on-site borrow areas. The fill shall be compacted to a minimum of 95% of maximum density as determined by ASTM D-698 and within +/- 2% of optimum moisture content. Each lift of fill shall not exceed a loose thickness of 10 inches. The embankment shall maintain the 2H:1V slope on its interior and a 3H:1V or flatter slope on the exterior. The embankment shall have a crest width of not less than 5 ft.
- The erosion protection bedding/filter material shall be placed at a minimum thickness of 6" along the length of the channel. The bedding/filter material shall extend up the 2H:1V side slopes to the existing grade or berm crest, which ever is greater. Bedding/filter materials shall be spread and compacted in one layer.
- The channel shall be constructed with a minimum of 12" of  $d_{50} = 7.8"$  rock. The rock shall be extended up the side slopes to the existing grade on the exterior and interlocked with the existing rock placed for surface erosion protection on the south side of the diversion channel.
- The channel erosion protection rock shall be constructed of a rock diameter  $d = 7.8"$  conforming to the following gradation:

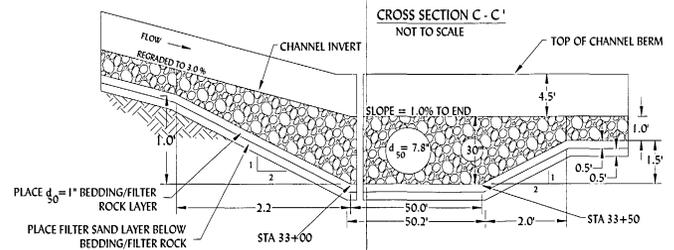
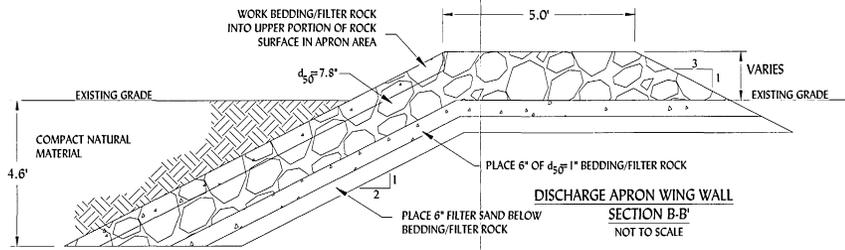
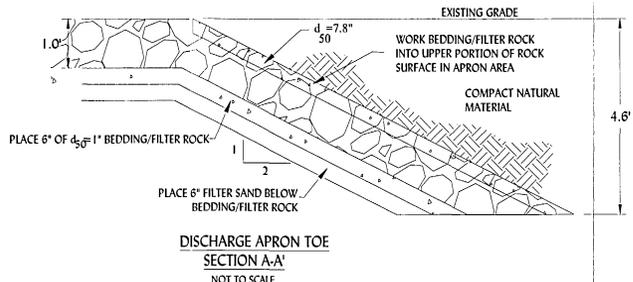
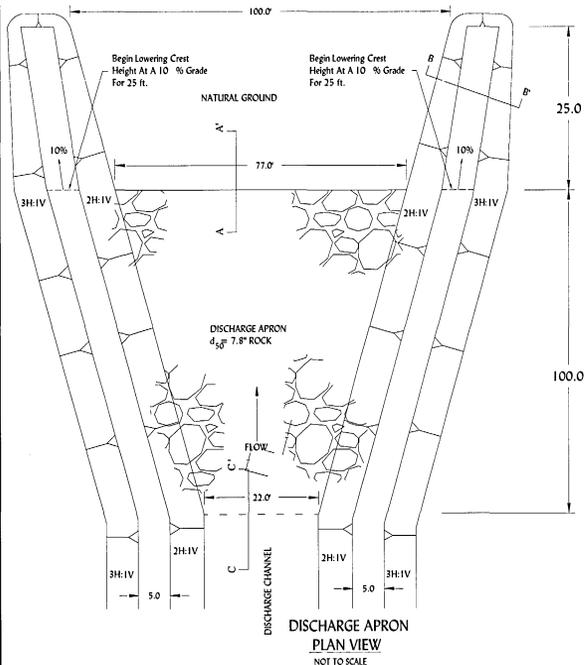
Sieve Designation	Percent Passing
12"	100
9"	60 - 85
6"	5 - 30
4"	0 - 5

- The channel/apron erosion protection rock shall be constructed on 6" of bedding/filter rock and 6" of filter sand conforming to the following gradation:

Bedding/Filter Gravel ( $d_{50} = 1.0"$ )		Filter Sand	
Sieve Designation	Percent Passing	Sieve Designation	Percent Passing
3"	100	No. 4	100
2"	80 - 90	No. 10	80 - 100
3/4"	20 - 70	No. 20	36 - 76
3/8"	10 - 30	No. 40	10 - 20
No. 4	0 - 10	No. 100	0 - 10



AMBROSIA LAKE MILL RIO ALGOM MINING COMPANY, LLC. GRANTS, NEW MEXICO TASK 5 EROSION PROTECTION DISCHARGE CHANNEL SECTION		
PROJECT No. 1690030 500 FILE NAME: 16900301558.DWG	DRAWING BY: RLH 2/27/03 REVIEWED BY: WHB	
SHEET 8 of 10		



**NOTES:**

1. Rock Riprap for erosion protection shall be placed in conformance with Appendix F of Design of Erosion Protection for Long-Term Stabilization, U.S. Nuclear Regulatory Commission's NUREG-CR1623 Draft Report unless otherwise specified in the TASK 5 Erosion Protection Report or the included Design Drawings.
2. The bottom of the channel shall be constructed flat from side slope to side slope to prevent concentrated flows.
3. The channel excavation shall be constructed with bottoms free of loose debris, vegetation and muddy surfaces.
4. Apron erosion protection rock shall be tied into the discharge channel rock. Areas disturbed during construction of the apron shall be revegetated.
5. The erosion protection bedding/filter material shall be placed at a minimum thickness of 6" along the length of the apron. The bedding/filter material shall extend up the 2H-IV side slopes to the existing grade and end below the erosion protection rock layer on the side slopes and ends as shown above. Bedding/filter materials shall be spread and compacted in one layer.

6. The apron shall be constructed with a minimum of 12" of  $d_{50} = 7.8"$  rock.
7. The height of the wing wall varies from 3.7 ft at the end of the rock apron to approximately 2 ft at the end of the wing wall.

8. The channel erosion protection rock shall be constructed of a rock diameter  $d_{50} = 7.8"$  conforming to the following gradation:

Sieve Designation	Percent Passing
12"	100
9"	60 - 85
6"	5 - 30
4"	0 - 5

9. The apron erosion protection rock shall be constructed on 6" of bedding/filter rock and 6" of filter sand conforming to the following gradation:

Bedding/Filter Gravel ( $d_{50} = 1.0"$ )		Filter Sand	
Sieve Designation	Percent Passing	Sieve Designation	Percent Passing
3"	100	No. 4	100
2"	80 - 90	No. 10	80 - 100
3/4"	20 - 70	No. 20	36 - 76
3/8"	10 - 30	No. 40	10 - 20
No. 4	0 - 10	No. 100	0 - 10

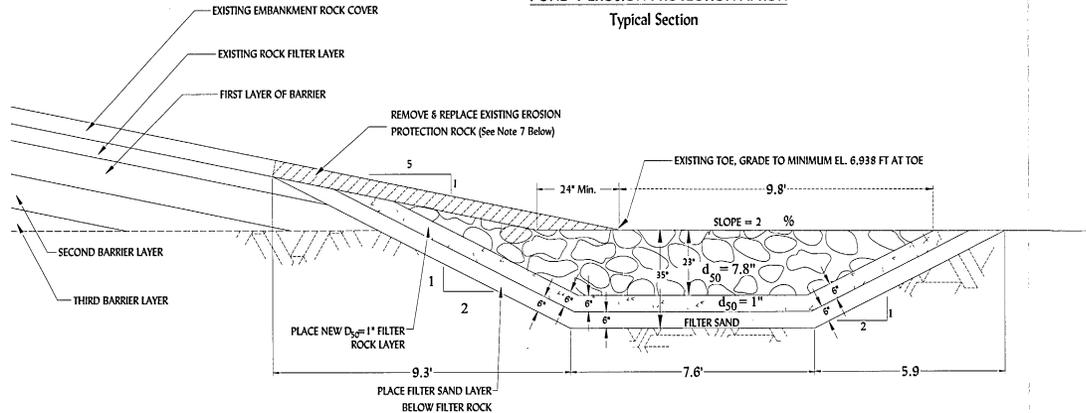


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AMBROSIA LAKE MILL RIO ALGOMINING COMPANY, LLC. GRANTS, NEW MEXICO TASK 5 EROSION PROTECTION DISCHARGE APRON		
PROJECT No. 1690030500	DRAWING BY: RLH 6/1/02	
FILE NAME: 16900301558.DWG	REVISION BY: RLH 2/22/03 REVIEWED BY: WHB	
SHEET 9 of 10		

## POND 1 EROSION PROTECTION APRON

### Typical Section



### NOTES:

- Rock Riprap for erosion protection aprons shall be placed in conformance with Appendix F of Design of Erosion Protection for Long-Term Stabilization, U.S. Nuclear Regulatory Commission's NUREG-1633 Draft Report unless otherwise specified in the Task 5 Erosion Control Design Report or the Design Drawings.
- Erosion protection aprons shall be sloped to the downstream edge with a minimum slope of two percent or at a slope that matches the slope of the natural ground, should it be steeper than two percent.
- Erosion protection apron excavations shall be constructed with 2H:1V slopes to permit placement of the filter materials as shown above.
- The erosion protection apron shall be constructed of a rock diameter  $d_{50} = 7.8"$  conforming to the following gradation:
 

Sieve Designation	Percent Passing
12"	100
9"	60 - 85
6"	5 - 30
4"	0 - 5
- Each layer of erosion protection bedding/filter material shall be placed at a minimum thickness of 6" along the length of the apron. The bedding/filter material shall extend up the 2V:1H sides and end below the Pond 3 erosion protection rock. Bedding/filter material shall be spread and compacted in one layer.
- Erosion protection apron riprap bedding/filter material shall meet the following gradation:
 

Filter Gravel		Filter Sand	
Sieve Designation	Percent Passing	Sieve Designation	Percent Passing
3"	100	No. 4	100
2"	80 - 100	No. 10	60 - 100
3/4"	20 - 70	No. 20	36 - 76
3/8"	10 - 30	No. 40	10 - 20
No. 4	0 - 10	No. 100	0 - 10
- Existing erosion protection disturbed during construction of the erosion protection aprons shall be replaced in a manner that maintains existing slopes and riprap conditions as approved previously by the U.S. Nuclear Regulatory Commission. Care shall be taken in removing and stockpiling the riprap such that the material is not degraded or otherwise damaged. Rock degraded or otherwise out of conformance with the NUREG 1623 due to removal and replacement methods shall be replaced with similar approved materials. Care should be taken so that existing tailings are not disturbed during erosion protection apron construction.
- The erosion protection apron shall be constructed continuously from the south embankment erosion protection channel/apron (southeast corner of Pond 1) to the southwest limits of Pond 3. The erosion protection apron shall be connected at the north end to the proposed Pond 1 to Pond 3 erosion protection apron. The south end of the erosion protection apron shall NOT be connected to the south embankment erosion protection channel/apron. The apron shall end at the crest of the interior slope of the south embankment erosion protection channel/apron.
- The erosion protection apron shall be constructed level from the north end to the south end to prevent longitudinal flows within the apron. The erosion protection apron shall be constructed such that flow from the embankment will flow perpendicular to the apron and onto the downstream side where it will drain away from the erosion protection apron.



William H. Bucher, P.E.

1/25/03  
DATE

<b>AMBROSIA LAKE MILL</b> <b>RIO ALGOM MINING COMPANY, LLC.</b> <b>GRANTS, NEW MEXICO</b> <b>TASK 5 EROSION PROTECTION</b> <b>POND 1 TO EROSION PROTECTION APRON</b>		
PROJECT No. 1690030-500 FILE NAME: 1690030T510.DWG	DRAWING BY: RHJ 2/28/02 REVISION BY: RHJ 2/27/03 REVIEWED BY: WHB	
SHEET 10 of 10		

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