APPENDIX B

CALCULATIONS

MT13.01 Small Watershed Runoff South Stormwater Pond Watershed

MT13.02 Small Watershed Runoff Ore Pad

MT13.03 Ore Pad Cushion Layer Thickness

MT13.04 Capacity of the Mine Water Treatment Ponds

MT13.05 North Waste Pile Areas and Volumes

CALCULATION #	MT13.01	PROJECT # MT13-AC	Page 1 of 2	REV	DATE
PROJECT:	MT TAYLOR MINE REACTIVATION			0	2/15/2013
CALCULATION NAME:	**Small Watershed Runoff**				
	South Stormwater Pond Watershed				
Originator	Alan Kuhn	Checker	Ed Loescher		

Objective: Calculate the estimated runoff parameters needed to design the capacity of culverts and the south storm water retention pond for events up to the 100 year storm.

Given: NPDES #NMR05GB27 requirements apply. Pond capacity must be sufficient to to contain design storm runoff. Existing diversions remain.

Assumptions:

1) Discharge of runoff crossing county road south to north will be redirected to south pond. Area north of county road will be drain naturally to Marquez Arroyo.
2) New culvert will be added around east and north side of old waste pile.
3) For conservatism, pond will be sized to contain all runoff from the 100 year storm, plus up to one additional 100 year storm.

References: NMSHTD Drainage Manual, 1995
NOAA Atlas 14, Vol 1, Version 5, San Mateo
Mt Taylor Mine topographic map 2012, by TJ Mann & Associates
South Stormwater Pond Watershed Parameters RGR-MT13.AC-CALC-04

CALCULATION

Simplified Peak Flow Method (NMSHTD Drainage Manual, 1995)

Time of Concentration, Tc

(NMSHTD Drainage Manual,1995, Vol. 1, eqn 3-18)
(South Stormwater Pond Watershed Parameters figure)

Tc= 0.0078*L^0.77*S^(-0.385)

Flow Path Segment #		length	slope	elev
	1	94	0.02	7500
	2	119	0.1591	
	3	162	0.1904	
	4	113	0.1005	
	5	65	0.0603	
	6	162	0.0768	
	7	113	0.1557	
	8	67	0.41	
	9	393	0.0032	
	10	251	0.123	
	11	439	0.0262	
	12	339	0.0308	
	13	389	0.012	
	14	551	0.005	
	15	131	0.005	
	16	394	0.005	7304.26
L, ft =	Sum	3782		
S=	Ave			0.05176
Tc=	13.87 minutes			

CALCULATION #	MT13.02	PROJECT # MT13-AC	Page 1 of 2	REV	DATE
PROJECT:	MT TAYLOR MINE REACTIVATION			0	2/15/2013
CALCULATION NAME:	Small Watershed Runoff	Ore Pad			
Originator	Alan Kuhn	Checker	Ed Loescher		

Objective: Calculate the estimated runoff parameters needed to design the capacity of culverts and the ore pad runoff retention pond for events up to the 100 year storm, plus antecedent runoff including truck wash.

Given: NPDES #NMR05GB27 requirements apply. Pond capacity must be sufficient to to contain design storm runoff. Zero discharge from pond required.

Assumptions:

1) All discharge of runoff from the ore pad north will be redirected to ore pad runoff retention pond, formerly the north retention pond.
2) Other runoff north of the county road will drain to Marquez Arroyo.
3) For conservatism, pond will be sized to contain all runoff from the 100 year storm, plus up to one additional 100 year storm.
4) Equal areas with equal slopes drain to each of two catch, then flows combine into pond.
5) No separate or added capacity beyond two 100 year storms needed for truck wash runoff.

References: NMSHTD Drainage Manual, 1995
NOAA Atlas 14, Vol 1, Version 5, San Mateo
Mt Taylor Mine topographic map 2012, by TJ Mann & Associates

CALCULATION

Simplified Peak Flow Method (NMSHTD Drainage Manual, 1995)

Time of Concentration, Tc (NMSHTD Drainage Manual,1995, Vol. 1, eqn 3-18)

Tc= 0.0078*L^0.77*S^(-0.385)

Flow Path		length	slope	elev
Segment #	1	440	0.01	7318.4
				7314
L, ft =	Sum	440		
S=	Ave			0.01

Tc= 4.98 minutes

Precipitation (NOAA Atlas 14, Vol 1, Version 5, San Mateo)

In Inches for:

	Recurrence Interval, years		
Duration	10	50	100
6 hr	1.36	1.84	2.06
24 hr	1.71	2.26	2.51

Area, A 10 acres

scaled from Mt Taylor Mine topographic map 2012

CALCULATION #	MT13.02	PROJECT # MT13-AC	Page 2 of 2	REV	DATE
PROJECT:	MT TAYLOR MINE REACTIVATION			0	2/15/2013
CALCULATION NAME:	Small Watershed Runoff		Ore Pad		

Runoff Curve Number, CN

(NMSHTD Drainage Manual,1995, Vol. 1, 3.3.1.3.1; Fig. 3-8, Table 3-1 and 3-4)

Soil Group		C
Vegetation type		none
Per cent cover		<30%
CN =	85 to 91, =	91

Unit Peak Discharge, qu (NMSHTD Drainage Manual,1995, Vol. 1, eqn 3-22)

qu = 0.543 Tc^-0.812= 0.147 cfs/ac-in

Direct runoff, Qd (NMSHTD Drainage Manual,1995, Vol. 1, eqn 3-23)

Qd= (P-(200/CN)+2)^2/(P+(800/CN)-8)

10 yr	Qd=	0.91 inches
50 yr	Qd=	1.39 inches
100 yr	Qd=	1.62 inches

Peak Discharge, Qp

Qp= A*qu*Qd to each catch basin

10 yr	Qp=	1.35 cfs
50 yr	Qp=	2.05 cfs
100 yr	Qp=	2.39 cfs

Runoff Volume, Qv

Qv= Qd*A/12 to each catch basin total

10 yr	Qv=	0.76 ac ft	1.52 ac ft
50 yr	Qv=	1.16 ac ft	2.32 ac ft
100 yr	Qv=	1.35 ac ft	2.70 ac ft

CALCULATION #	MT13.03		PROJECT # MT13-AC	Page: **2 of 2**	REV	DATE
PROJECT:	MT TAYLOR MINE REACTIVATION				0	2/19/2013
CALCULATION NAME:			Ore Pad Cushion Layer Thickness			

CALCULATION

Calculate the maximum load on the liner versus allowable load based on puncture resistance, using several cushion layer depths to find necessary depth

Load imposed by 988 loader

L, Load per tire =	28757	lbs.	Ref.1
A, Tire gross contact area =	652	in.^2	Ref.2
R, radius of contact area, inches =	14.4	in.	
P, Pressure applied on ground = L*A =	44.11	psi	
Tire width =	35.5	in.	Ref.2
Puncture Resistance of 60 mil HDPE, min. ave,	108	lbs	Ref.3

based on ASTM D6241 using 2.0 in. diameter probe, or 34.4 psi

Load at liner level

Ref. 4

1) For distributed load Bousinnesq eqn for load vertically below center of tire, S_z

S_z = P*(1-(1/(1+(1/(z/R)^2)))^1.5) Ref.4, eqn 40.3

z= depth below surface to liner, inches

z	S_z, psi
6	41.60
12	32.53
18	23.11
24	16.30
30	11.79

or:

2) Alternative Method per Ref. 5 with Froehlich concentration factor

S_z =P[1-(z/(R^2+z^2)^0.5)^v]

S_z =vertical stress at depth z, psi

P= vertical stress (pressure) at ground surface, psi = 44.11

z = vertical distance between point load and depth of interest, inches

R = radius of applied (assumed) circular loaded area, inches = 14.4

for equivalent circular area of contact for 988 loader

v = Froehlich concentration factor, for normal soil = 4

S_z =44.11*[1-(z/(14.4^2+z^2)^0.5)^4]

z, inches	$S_{z,\ psi}$
6	43.14
12	36.70
18	27.71
24	20.26
30	14.97

Results: Method 2 gives the more conservative results.

Load from equipment on liner <= 34.4 psi at 18 inches, so 2.5 ft (30 in.) of cushion layer+ 12 inches travel course allows for some additional load from soil weight and other unknowns.

CALCULATION #	MT13.03		PROJECT # MT13-AC	Page: **1 of 2**	REV	DATE
PROJECT:	**MT TAYLOR MINE REACTIVATION**				0	2/19/2013
CALCULATION NAME:		**Ore Pad Cushion Layer Thickness**				
Originator	Alan Kuhn		Checker	Ed Loescher		

Objective: Calculate the thickness of soil cushion layer required to protect the underlying HDPE membrane from puncture from equipment working on the pad surface.

Given: Location of the ore pad remains as previous. Cushioning material will be locally available SC, CL, SP, and SP-SM soils. A 1.0 ft travel/ drainage layer of gravel or crushed sandstone will overlie the cushion layer.

Assumptions:

1) Maximum load is from a CAT 988 loader
2) Cushion layer placed and compacted without specified density, so 85 pcf dry density assumed
3) 988 tires are 35/65-33 per CAT manual
4) Cushion soil mass is elastic, isotropic, homogeneous and semi-infinite.
5) Puncture is primary liner failure mode
6) Boussinesq pressure distribution through soil from tire load

References:

1) CAT Manual 2012
2) http://www.goodyearotr.com/cfmx/web/otr/tire-selector/detailresults.cfm?tireid=1557
3) GRI Test Method GM13* Standard Specification for "Test Methods, Test Properties and Testing Frequency forHigh Density Polyethylene (HDPE) Smooth and Textured Geomembranes"
4) Soil Mechanics in Engineering Practice, 3rd Ed. , 1996, K. Terzaghi, R.B.Pech, and G. Mesri
5) Estimating Vertical Stress on Soil subjected to Vehicular Loading, ERDC/CRREL TR-09-2 US Army Corps of Engineers, February 2009

CALCULATION #	MT13.04	PROJECT #	MT13-AC	REV	DATE
PROJECT:	MT TAYLOR MINE REACTIVATION			0	2/27/2013
CALCULATION NAME:	**Capacity of the Mine Water Treatment Ponds**				

Originator	Ed Loescher	Checker	Alan Kuhn

Objective: Calculate the volume capacity of the mine water treatment ponds. Compare these values with those shown in the 1981 mine water discharge drawings

Given: Data from the two referenced mine water flow drawings regarding the water operating levels and areas. The survey data for the levels of the weirs on the hydraulic structures that control the flow in the ponds. New topographic base map from 2012. Some differences are expected due to accumulation of sediments, change to NAD 83 coordinates, and more modern survey and imaging methods.

Assumptions:

1) The minimum water pool elevation (assumes 0 flow through) for the ponds is determined by the elevation of the outlet weirs.
2) The maximum pool elevation determined by assuming a 2' freeboard from the top of the pond berms.
3) Volumes for the *existing* (as-is) conditions (Table 1) before upgrades (slope regrade or deepening).
4) Volumes after design upgrades (Table 2) are achieved primarily by balanced cut and fill of the pond slopes.

References:

1) AutoCAD Civil 3d Volume Calculation tools
2) Autocad Drawing of Mt Taylor Mine topographic map 2012, by TJ Mann & Associates
3) Drawing # 0000-P-983 Titled -"Water Treatement System Flow Schematic Minewater Discharge (Figure lV)- Rev 5 - Dated 9/22/1981
4) Drawing # 0000-P-797 Titled -"Water Treatement System Flow Scheme - Rev 4 - Dated 3/06/1981

CALCULATION

Methods: Use Autocad Civil 3d (2013) volume analysis tools to calculate existing volumes, based on existing topography as provided by recent survey by Thomas Mann and Associates, 2012.

Table 1 ***Ponds in Existing Condition***

	Ref. 3		Ref 4
Pond Number	**Pond Water Level Elevation**	**Pond Area Sq Ft.**	**Volume Capacity (Acre Feet)**
1	7303.4	44600	8.36
2	7297.7	31550	5.88
3	7294.2	43100	8.45
4	7286.4	68750	13.77
5	7283.0	66000	13.22
6	7282.8	11100	1.72
7	7282.8	10700	1.72
8	7287.4	45250	9.1
TOTALS	AREA	321050	
	VOLUME		62.22

Table 2 Ponds With Design Upgrades

Based on 2012 Topography and AutoCAD (Ref. 2 and 1)

Pond Number	Operating Pool Elevation	OPL	Area , ft^2	Volume, cy	Volume (acre feet)
1	Min	7305	68938	32911.6	15.32
	Max	7308		24718	20.40
2	Min	7299.6	31655	5803	3.60
	Max	7301		7470	4.63
3	Min	7296.7	40373	12420	7.70
	Max	7300		18130	11.24
4	Min	7287.5	60195	12680.4	7.86
	Max	7291		14977.3	9.28
5	Min	7285	60218	11728.7	7.27
	Max	7286		14041	8.70
6	Min	7282.8	6636	698	0.43
	Max	7286		1622.8	1.01
7	Min	7282.8	6634	697.8	0.43
	Max	7286		1614.8	1.00
8	Min	7287.5	34105	4489.2	2.78
	Max	7291		9568.5	5.93
			308754		
		VOLUMES AT MIN			50.47
		VOLUMES AT MAX			57.11

CALCULATION #	MT13.05		PROJECT #	MT13-AC	REV	DATE
PROJECT:	MT TAYLOR MINE REACTIVATION				0	3/24/2013
CALCULATION NAME:	North Waste Pile Areas and Volumes					
Originator	Ed Loescher	Checker	Alan Kuhn			

Objective:

Calculate various earthwork quantities for the CCP for the future North Waste Rock Pile.

Given: The basic design of the north waste rock pile with connected runoff retention basin as shown in Drawing MT13-AC-10. Base topography from 2012 Thomas Mann survey.

Assumptions:

1) Quantities shown are for final build out
2) Retention basin and surrounding diversion channel earthwork are separate from the main pile and will be performed first.

References:

1) Drawing MT13-AC-10
2) AutoCAD Volume Calculation method

CALCULATION

AutoCAD Civil 3D 2012 used to find areas and volumes, applying base topography compared to the final topography at full buildout.

North Waste Rock Retention Runoff Basin

Basic design parameters — Reference #1

Top of basin berm	7284	feet
Bottom of basin excavation	7272	feet
Basin side slopes	4H: 1V	
High water elevation	7282	feet
Surface area for clay liner	80097	Sq ft
Volume of clay liner, 1 ft thick	2967	CY
Capacity at high water level	22.1	Acre Feet

Earthwork quantities

Cut for basin	18291	CY	Reference #2
Fill for basin embankment	4792	CY	
Net clean soil to be stockpiled for cover	13499	CY	

North Waste Rock Pile (at full buildout)

Dimensions (maximum) — Reference #1

Top of pile	7352	feet
Bottom of pile	existing grades	
Pile side slopes	5H: 1V	

Calculated Areas and Volumes — Reference #2

Total area of waste rock pile cover	805372	Sq Ft		
Total volume of waste rock pile cover	59,657	CY		
Total area of the top of the pile	274071	Sq Ft		
Total slope areas	531301	Sq Ft	12.20	Acres
Total disturbed area	1184398	Sq Ft	27.19	Acres

Earthwork quantities

Fill capacity for waste rock storage at full buildout	675525	CY
Cut for diversion channel around pile	8278	CY
Clean fill for containment berm around pile	13474	CY

CALCULATION #	MT13.06		PROJECT #	MT13-AC	Page	1 of 3	REV	DATE
PROJECT:	MT TAYLOR MINE REACTIVATION						0	3/25/2013
CALCULATION NAME:	South Waste Pile and Retention Pond Areas and Volumes							
Originator	Ed Loescher		Checker	Alan Kuhn				

Objective:

Calculate various earthwork quantities for the CCP for the South Waste Rock Pile and South Storm water retention pond.

Given:

The basic design of the south waste rock pile and south storm water retention pond as shown in Drawings MT13-AC-08 and MT13-AC-16. Base topography from 2012 Thomas Mann survey.

Assumptions:

1) Quantities shown are for final build out and for the initial reshaping of the pond and pile
2) Retention basin excavation and excavation of the SW Corner of the existing pile are primarily in clean soil deposits and will be treated separately.
3) The first phase of earthwork will occur as part of the mine reactivation. This will include excavation and expansion of the South Storm Water Retention Basin and Reshaping the slopes of the existing south Waste Rock pile. See Reference #1.
4) The final buildout will be placed on top of the phase 1 surface. This assumes a level surface at elevation 7347 ft. See Reference #1.

References:

1) Drawing MT13-AC-08 and MT13-AC-16
2) AutoCAD Volume Calculation method
3) Attached Drawing MT13-Calc-13.06

CALCULATION **Mine Reactivation**

AutoCAD Civil 3D 2012 used to find areas and volumes, applying base topography compared to the final topography at full buildout.

South Storm Water Retention Basin

Basic design parameters — Reference #1

Top of basin berm	7304	feet	Reference #3
Bottom of basin excavation	7290	feet	
Basin side slopes	4H: 1V		
High water elevation	7302	feet	
Surface area for clay liner	86660	Sq ft	
Volume of clay liner, 1 ft thick	3210	CY	
Capacity at high water level	15.4	Acre Feet	

Earthwork quantities

Cut for basin (Clean Soil)	22567	CY	Reference #2
Cut for basin (Pond Sediments)	6776	CY	reference #3
Fill for basin embankment	4792	CY	
Net clean soil to be stockpiled for cover	17775	CY	

CALCULATION #	MT13.06	PROJECT #	MT13-AC	Page	2 of 3	REV	DATE
PROJECT:	MT TAYLOR MINE REACTIVATION					0	3/25/2013
CALCULATION NAME:	South Waste Pile and Retention Pond Areas and Volumes						

Reshaping the South Waste Rock Pile (at first phase earthwork) See Assumption #3.

Elevations — Reference #1

Top of pile	7247	feet	reference #3
Bottom of pile	existing grades		
Pile side slopes	5H: 1V		

Calculated Areas and Volumes — Reference #2

Total area of waste rock pile cover	246240	Sq Ft		
Total volume of waste rock pile cover	18,240	CY		
Total slope areas (in waste rock area)	246240	Sq Ft	5.65	Acres
Revegetated Area (excludes the area of the pond with clay liner, and the top of the waste rock pile)	622569	Sq Ft	14.29	Acres

Earthwork quantities

Fill Deposited in Waste Rock Pile From Various Sources

Mine Water Treatment Pond Sediments (ponds 1-8, Area A, And Ore Pad Retention Basin)	18310	CY
Ore Pad Soil Cleanup	5000	CY
Sediments from South Storm Water Retention Basin	6776	CY
Waste Rock cut from re-shaped slopes	47490	CY
Total Fill Soils	77576	CY

Reshaping the SW Corner of the South Waste Rock Pile (at first phase earthwork) See Assumption #3.

Elevations — Reference #1

Top of pile	7247	feet	reference #3
Bottom of pile	existing grades		
Pile side slopes	5H: 1V		

Calculated Areas and Volumes — Reference #2

Total slope areas (in Clean Soil area)	55316	Sq Ft	1.27	Acres
Total slope areas (in New Clean Soil Stockpile)	38200	Sq Ft	0.88	Acres

Earthwork quantities

Cut soils in SW Corner of Waste Rock Pile (Clean Soils)

Total Cut soils from Clean Soil Area	48122	CY
Fill needed in SW Corner	3660	CY
Clean Cover Soils needed in Waste Rock Area	18240	CY
Net Clean soils to New Stockpile	26222	CY

CALCULATION #	MT13.06		PROJECT #	MT13-AC	Page	3 of 3	REV	DATE
PROJECT:	MT TAYLOR MINE REACTIVATION						0	3/25/2013
CALCULATION NAME:	South Waste Pile and Retention Pond Areas and Volumes							

CALCULATION Final Closeout

South Waste Rock Pile (at full buildout) Assumption #4 Reference #3

Elevations Reference #1

Top of pile elevation	7372	feet
Bottom of pile (top of Phase 1 pile)	7347	feet
Pile side slopes	5H: 1V	

Calculated Areas and Volumes Reference #2

Total new surface area	361386	Sq Ft	8.30	Acres
Total new top area	121860	Sq Ft	2.80	Acres
Total new slope areas (excludes the work done previously)	239526	Sq Ft	5.50	Acres

Earthwork quantities

Fill capacity for waste rock storage at full buildout	178760	CY
2 Feet of Clean Soil Cover	26770	CY

SEGMENT NUMBER	STARTING ELEVATION	SEGMENT LENGTH FEET	SLOPE PERCENT	SURFACE DESCRIPTION
1	7500	94.14	2.00%	Rocky Mountain side
2	7498	119.13	-15.91%	steep cliff
3	7479	161.5	-19.04%	steep cliff
4	7448	112.6	-10.05%	Arroyo
5	7437	64.5	-6.03%	Arroyo
6	7433	162.4	-7.68%	gravel road way
7	7421	113.1	-15.57%	gravel road way
8	7403	67	-41.00%	steep cliff
9	7376	393.3	-0.32%	gravel road way
10	7374	251	-12.30%	gravel road way
11	7344	438.6	-2.62%	gravel road way
12	7332	339	-3.08%	drainage ditch

WATER ENTERS STORM SYSTEM

13	7314.3	66.4	-1.20%	MH 5 - 48' CMP
14	7313.49	322.3	-1.20%	MH 4 - 48' CMP
15	7309.64	550.7	0.50%	MH 3 - 48' CMP
16	7306.88	130.7	0.50%	MH 2 - 48' CMP
17	7306.23	394.4	0.50%	MH 1 - 48' CMP

TOTAL AREA = 77.5 ACRES

CALCULATION PURPOSE: PROVIDE BACKGROUND DATA FOR SOUTH STORM WATER RETENTION POND DESIGN. DATA REQUIRED IS CONTRIBUTING AREAS IN ACRES AND LENGTHS WITH SLOPES FOR THE VARIOUS SEGMENTS OF THE FLOW PATH.

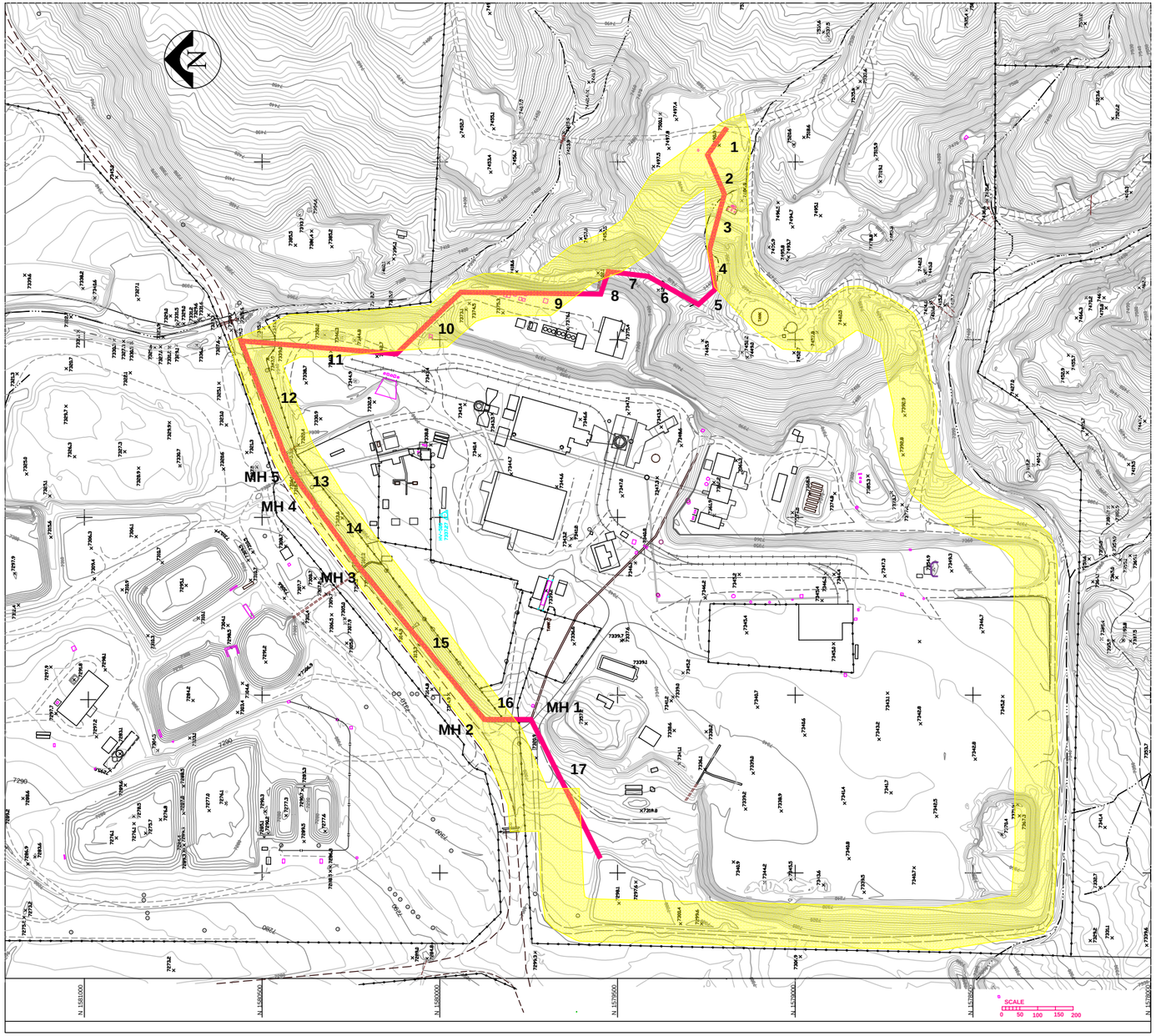
CALCULATION PROCEDURE: FROM AUTOCAD CIVIL 3D DETERMINE THE FLOW LINE FROM THE MOST UPSTREAM POINT TO THE POINT OF DISCHARGE AT THE POND. CREATE A FEATURE LINE FOLLOWING THE FLOW PATH. FIND THE LENGTHS AND SLOPES OF EACH SEGMENT BY LISTING THE SEGMENT LINE PROPERTIES IN AUTOCAD.

CALCULATION DOCUMENTS: 3D TOPOGRAPHY FROM AERIAL SURVEY DRAWING. THOMAS MANN, SURVEYOR 2012.

LEGEND

FLOW LINE

CONTRIBUTING AREA = 77.5 ACRES



REV	DESCRIPTION	DATE	DRAWN BY	ENGINEER	APPROVED
A	2013 CONTRIBUTING AREA	2/4/13	EL	AK	

RIO GRANDE RESOURCES CORPORATION
MOUNT TAYLOR MINE - Grants, NM 87020

Prepared By: Alan Kuhn Associates LLC

SIZE B | SCALE: AS NOTED | CALC NO. RGR-MT- AC-CALC 01

PROJECT TITLE: MT. TAYLOR MINE
MINE REACTIVATION PLAN

SHEET TITLE: SOUTH STORM WATER POND CALCULATION FIGURE 1

REV A