TETRA TECH

December 5, 2011
114-310979.203
SL# 40780

MEMORANDUM

TO: Ron Rimelman

FROM: David Hollinger

SUBJECT: Rock Creek Mine Closure Plan – Supplement to Phase 1 Construction

The purpose of this memo is to provide clarification and supplemental design information to the Area 3 Tailings Storage Facility (TSF) Dam breach concept described under Phase 1 closure construction activities. The plan to close the Rock Creek Mine has been developed by Tetra Tech (Tt) and submitted to the State of Alaska (State) for review on Oct. 24, 2011.

The State provided the following applicable questions regarding the breach by email dated Nov. 21, 2011:

1. How will the planned breach integrate with the foundation drains that are currently in place?
2. How will the breach affect local hydrology, i.e. channels (constructed or in place), natural channeling, surface flow, ground flow, aufeis?

Attached to this memo are three plan and profile sheets updating Figure 10 from the closure plan. Discussion below describes design intent and includes analysis for related aspects of the breach in order to fully coordinate the engineered design. The questions above are not directly answered herein by number, but the topics are addressed in multiple sections.

In planning a response to the above questions and others, the TSF area was resurveyed and the results incorporated into the terrain model. Analysis was given to alternative breach routes, boundary conditions, effects of drainage on constructed subsoils, as-built pipe networks, and both above- and below-grade hydrologic aspects. The result of this analysis will guide development of the final construction documents.

In general, the overall route of the drainage ditches and breach has been refined to accommodate complete drainage of all areas upstream of the dam, zero backfill of low spots, smoother overland flow characteristics, and avoid construction of the downstream ditch over and through backfill.

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SUPPLEMENTAL DESIGN AND ANALYSIS FOR TSF DAM BREACH

1. Breach Alignment

   The breach route has been refined beginning near the lowest point inside the TSF by turning it southward to avoid the main sump upon exit. In order to enhance stability of the downstream ditch over time, the breach exit and ditch route are now located south of the main sump and away from the eventual fill that will be placed in the sump.

2. Upstream Ditch around Tailings Pile

   The alignment for the upstream ditch has been refined to avoid contact with the tailings pile. It has also been deepened and lengthened slightly to ensure positive drainage from the area north of the pile. The route ensures the tailings may be covered independently of ditch construction. In addition, by locating the ditch away from the tailings, the expected stability and capacity of the constructed ditch will not be compromised over time as the tailings pile consolidates.

3. Tailings Cover – Materials and Methods

   NovaGold has determined that welded HDPE sheeting, at 1.53mm (60 mil) thick, will be used to cover the tailings. Hypalon will not be used.

4. Hydrologic Modeling

   A hydrologic (rainfall-runoff) and hydraulic analysis (open channel flow, water surface profiling) was conducted to evaluate the drainage conditions of the TSF and breach system and to confirm channel and breach design.

   A. Rainfall Runoff Modeling

   Rainfall-runoff modeling was conducted for the post-closure drainage associated with the TSF. All modeling was assumed to be after final closure and implementation of Phase II because that condition provides the largest drainage area and represents final grading and reclamation in the TSF area. The analysis was conducted to calculate the magnitude and timing of the peak discharge resulting from rainfall-runoff produced by two design storms. The SCS Curve Number approach was used to determine initial abstractions and excess precipitation, and the SCS unit hydrograph method was used to derive the peak flow and flow hydrograph resulting from excess rainfall. All modeling was conducted using the SCS Type I rainfall distribution (recommended for Alaska). Input parameters for the HEC-HMS model are provided in Table 1.

Table 1. HEC-HMS input parameters for the TSF Drainage and covered tailings					
Basin Area	Hydraulic Length (L)	Average Basin Slope (S)	Time of Concentration (Tc)	Lag Time (tp)	SCS Curve Number[1]
mi^2	ft	ft/ft	minutes	minutes	
0.38	1,312	0.12	17.3	10.4	78-90

[1] An SCS curve number of 95 was used for the covered tailings and 78 for other areas.

Estimated peak discharge and runoff volume to the TSF Diversion Channel and Breach were calculated for the 24-hour Probable Maximum Precipitation (PMP) storm event (10.6 inches)[1]. This design storm would allow an evaluation of the conveyance of a Probable Maximum Flood (PMF) through the breach by open channel flow (i.e. hydraulic) modeling. This design storm resulted in a peak discharge at the breach of 829 cubic feet per second (cfs) and a total volume of excess runoff of 97 acre-feet (ac-ft).

The runoff from the 10-year 24-hour storm event (2.3 inches)[1] and the 100-year 24-hour storm event (3.5 inches)[1] was used to evaluate the tailings diversion ditch, the flow channel invert through the breach and flows through DC-3. The resulting peak discharge at the breach for the 10-year 24-hour storm event was 61 cfs and a total volume of excess runoff of 8.7 ac-ft. The resulting peak discharge at that breach for the 100-year 24-hour storm event was 157 cfs and a total volume of excess runoff of 19 ac-ft. Table 2 summarizes results for the three design storms.

Table 2. Results from HEC-HMS Rainfall Runoff Modeling			
Design Storm	Precipitation (in)	Peak Discharge (cfs)	Total Runoff (ac-ft)
10-year 24-hour	2.3	61	8.7
100-year 24-hour	3.5	157	19
PMP 24-hour	10.6	829	164

B. Open Channel Flow Modeling

Using the inputs from the rainfall-runoff analysis, open channel flow modeling was conducted to evaluate the water surface profiles and hydraulics of the three design storms.

[1] NOAA Technical Paper No. 47. Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska for Areas to 400 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years.

The conveyance of the Probable Maximum Flood (PMF) was only evaluated through the breach section to determine if it could safely pass this storm event. The conveyance of flow from the 10-year, 24-hour and 100-year 24-hour events were modeled through the tailings diversion ditch, the breach invert channel, and DC-3. In DC-3, below the breach flows were combined with upper watershed runoff that would be flowing in DC-3 above the beach section making a combined flow of 280 cfs below the beach.

The hydraulics modeling shows that a PMF can safely convey through the breach section. Figure 1 shows a cross section and water surface profile of the PMF at Station 1620 in the middle of the breach. Table 3 shows tabular results for velocity, water surface grades, energy grades, and critical versus non-critical flow (i.e. Froude number). An evaluation of the Froude number for these stations show that flow ranges between non-critical and critical through this section, but flow is not substantially above 1.0 which is unity (i.e. Froude numbers less than 1 are non-critical flows, above 1 are critical flows). The maximum velocity at Station 1470 exiting the breach section is 11 feet per second (fps), acceptable for such a drastic event.

The hydraulics modeling for the 10-year 24-hour and 100-year 24-hour storm events show that flows adequately convey through the designed diversion channel around the covered tailings, through the breach channel invert, and through DC-3. Figure 2 and Figure 3 show water surface profiles for modeled stations in the tailings diversion ditch and in DC-3, respectively. While in some sections below the breach, DC-3 shows near bank-full conditions for the 100 year storm event, the channel appears to contain the combined flows from the breach and those occurring above DC-3. Table 4 shows tabular results for velocity, water surface grades, energy grades, and critical versus non-critical flow.

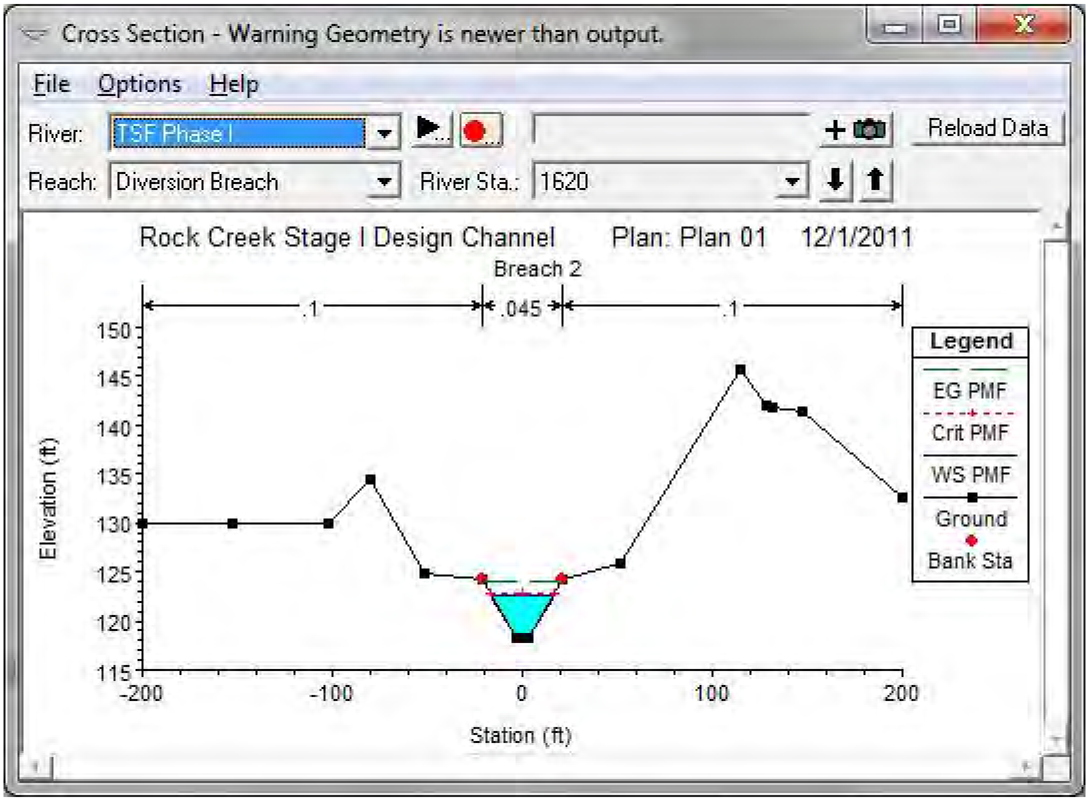

Figure 1. Water Surface Profile of PMF through the Breach at Station 1620.

Table 3. Tabular Output from HEC-RAS Hydraulics Modeling for the PMF through the Breach from up-gradient to down-gradient

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Diversion Breach	1670	PMF	829	119.7	124.2	124.2	125.5	0.023	9.3	88.96	33.52	1.01
Diversion Breach	1620	PMF	829	118.2	122.5	122.7	124.0	0.027	9.9	84.08	32.64	1.08
Diversion Breach	1570	PMF	829	116.6	121.0	121.0	122.4	0.023	9.3	89.59	33.69	1.00
Diversion Breach	1520	PMF	829	114.8	118.8	119.2	120.6	0.035	10.9	76.29	31.16	1.22
Diversion Breach	1470	PMF	829	113.0	116.9	117.4	118.8	0.036	11.0	75.31	31.01	1.24

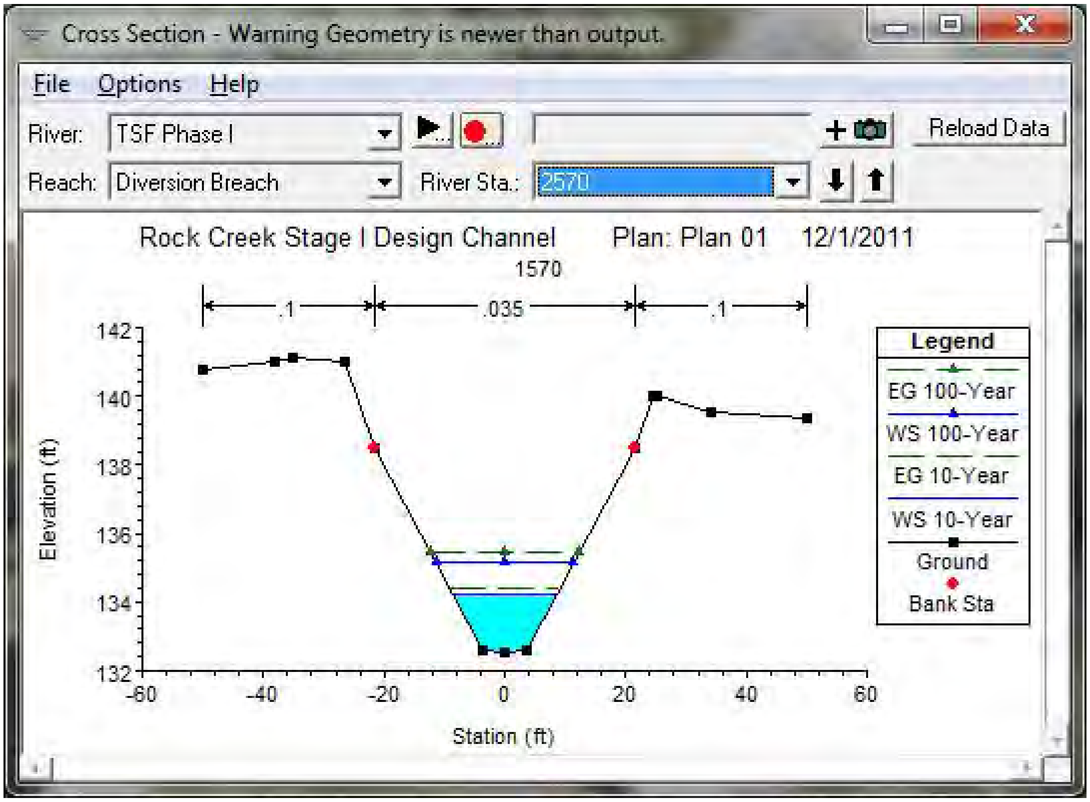

Figure 2. Water surface profiles in the tailings diversion ditch for the 10-year 24-hor and 100-year 24-hour storm events.

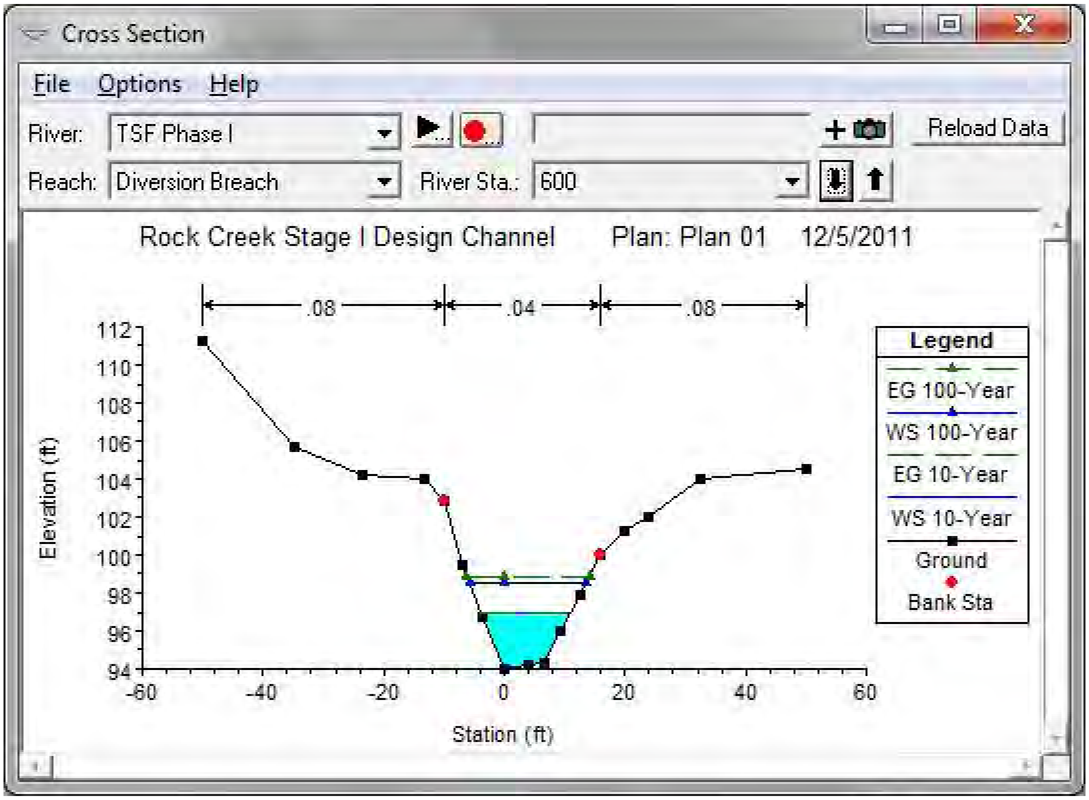

Figure 3. Water surface profiles for the 10-year 24-hour and 100-year 24-hour storm event in DC-3.

Table 4. Tabular Output from HEC-RAS Hydraulics Modeling for the 10-year and 100-year 24-hour storm events through the full conveyance from up-gradient to down-gradient.

River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2970	10-Year	61	133.2	135.1	134.3	135.2	0.0026	2.53	24.1	18.4	0.39
2970	100-Year	157	133.2	136.2	135.1	136.4	0.0026	3.25	48.3	25.2	0.41
2870	10-Year	61	132.9	134.9	134.0	135.0	0.0021	2.35	26.0	19.0	0.35
2870	100-Year	157	132.9	136.0	134.8	136.2	0.0023	3.1	50.7	25.7	0.39
2770	10-Year	61	132.5	134.7	133.7	134.8	0.0015	2.06	29.6	20.1	0.3
2770	100-Year	157	132.5	135.8	134.5	135.9	0.0018	2.87	54.7	26.6	0.35
2670	10-Year	61	132.4	134.6	133.6	134.6	0.0017	2.18	28.0	19.6	0.32
2670	100-Year	157	132.4	135.6	134.4	135.7	0.0022	3.07	51.2	25.8	0.38
2570	10-Year	61	132.5	134.3		134.4	0.0041	2.99	20.4	17.1	0.48
2570	100-Year	157	132.5	135.2		135.4	0.0046	4.02	39.0	22.8	0.54
2470	10-Year	61	132.2	133.5	133.4	133.8	0.0141	4.66	13.1	14.3	0.86
2470	100-Year	157	132.2	134.3	134.1	134.8	0.0140	6.05	26.0	19.0	0.91
2370	10-Year	61	130.8	132.1	132.0	132.4	0.0141	4.68	13.0	14.2	0.86
2370	100-Year	157	130.8	132.9	132.8	133.4	0.0142	6.09	25.8	18.8	0.92
2270	10-Year	61	129.4	130.7	130.6	131.0	0.0141	4.67	13.1	14.3	0.86
2270	100-Year	157	129.4	131.4	131.3	132.0	0.0140	6.06	25.9	19.0	0.91

Table 4. Tabular Output from HEC-RAS Hydraulics Modeling for the 10-year and 100-year 24-hour storm events through the full conveyance from up-gradient to down-gradient.

2170	10-Year	61	128.0	129.3		129.6	0.0119	4.39	13.9	14.7	0.79
2170	100-Year	157	128.0	130.1	130.0	130.6	0.0126	5.82	27.0	19.3	0.87
2070	10-Year	61	126.7	128.0		128.3	0.0120	4.39	13.9	14.8	0.8
2070	100-Year	157	126.7	128.7		129.2	0.0125	5.79	27.1	19.4	0.86
1970	10-Year	61	125.2	126.5		126.8	0.0142	4.68	13.0	14.3	0.86
1970	100-Year	157	125.2	127.2	127.1	127.8	0.0142	6.09	25.8	18.9	0.92
1870	10-Year	61	123.8	125.0	124.9	125.4	0.0153	4.8	12.7	14.1	0.89
1870	100-Year	157	123.8	125.8	125.7	126.4	0.0148	6.18	25.4	18.8	0.94
1770	10-Year	61	122.1	123.4	123.3	123.7	0.0240	4.71	13.0	14.3	0.87
1770	100-Year	157	122.1	124.1	124.0	124.7	0.0239	6.11	25.7	19.0	0.93
1670	10-Year	61	119.7	120.9	120.9	121.3	0.0295	5.08	12.0	13.8	0.96
1670	100-Year	157	119.7	121.7	121.7	122.3	0.0281	6.49	24.2	18.4	1
1620	10-Year	61	118.2	119.5	119.4	119.8	0.0280	4.98	12.3	14.0	0.94
1620	100-Year	157	118.2	120.2	120.2	120.8	0.0279	6.47	24.3	18.5	1
1570	10-Year	61	116.6	117.8	117.8	118.2	0.0322	5.21	11.7	13.8	1
1570	100-Year	157	116.6	118.5	118.5	119.2	0.0281	6.48	24.2	18.5	1
1520	10-Year	61	114.8	115.9	115.9	116.4	0.0405	5.68	10.7	13.3	1.11

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Table 4. Tabular Output from HEC-RAS Hydraulics Modeling for the 10-year and 100-year 24-hour storm events through the full conveyance from up-gradient to down-gradient.

1520	100-Year	157	114.8	116.6	116.7	117.4	0.0377	7.22	21.7	17.6	1.15
1470	10-Year	61	113.0	114.1	114.1	114.5	0.0384	5.55	11.0	13.5	1.08
1470	100-Year	157	113.0	114.7	114.9	115.6	0.0385	7.27	21.6	17.6	1.16
1370	10-Year	61	109.2	110.4	110.4	110.8	0.0372	5.51	11.1	13.4	1.07
1370	100-Year	157	109.2	111.2	111.2	111.8	0.0294	6.6	23.8	18.3	1.02
1270	10-Year	61	106.0	107.5	107.1	107.7	0.0123	3.7	16.5	15.7	0.64
1270	100-Year	157	106.0	108.4	107.9	108.7	0.0118	4.73	33.2	21.2	0.67
1170	10-Year	61	104.7	106.2	105.9	106.4	0.0120	3.67	16.6	15.7	0.63
1170	100-Year	157	104.7	107.2	106.7	107.5	0.0113	4.65	33.8	21.3	0.65
1070	10-Year	61	103.5	105.3	104.7	105.4	0.0062	2.9	21.0	17.4	0.46
1070	100-Year	157	103.5	106.3	105.5	106.5	0.0059	3.68	42.7	23.8	0.48
1000	10-Year	61	102.6	105.1	103.8	105.1	0.0015	1.73	35.4	21.8	0.24
1000	100-Year	157	102.6	106.1	104.5	106.2	0.0022	2.56	61.3	28.1	0.31
900	10-Year	61	103.7	104.9		105.1	0.0083	3.14	19.4	21.4	0.58
900	100-Year	157	103.7	106.0		106.2	0.0039	3.33	53.7	100.0	0.44
800	10-Year	61	101.9	103.7	102.9	103.8	0.0030	2.31	26.4	21.4	0.37
800	100-Year	280	101.9	105.6	104.3	105.8	0.0029	3.42	81.8	35.9	0.4

Table 4. Tabular Output from HEC-RAS Hydraulics Modeling for the 10-year and 100-year 24-hour storm events through the full conveyance from up-gradient to down-gradient.

700	10-Year	61	99.8	101.1		101.4	0.0166	4.47	13.7	14.7	0.82
700	100-Year	280	99.8	102.6	102.4	103.3	0.0158	6.74	41.5	22.9	0.88
600	10-Year	61	94.0	96.9		97.0	0.0014	2.08	29.4	14.8	0.26
600	100-Year	280	94.0	98.5		98.9	0.0050	4.93	56.9	19.3	0.51
500	10-Year	61	91.5	96.9		96.9	0.0001	0.74	82.3	24.3	0.07
500	100-Year	280	91.5	98.6		98.7	0.0006	2.2	128.3	34.0	0.19
400	10-Year	61	90.0	96.9		96.9	0.0000	0.29	210.0	43.5	0.02
400	100-Year	280	90.0	98.6		98.6	0.0001	0.97	291.5	58.5	0.07
300	10-Year	61	88.0	96.9		96.9	0.0000	0.19	322.6	55.1	0.01
300	100-Year	280	88.0	98.6		98.6	0.0000	0.67	420.6	62.1	0.05
200	10-Year	61	95.4	96.5	96.5	96.9	0.0425	4.79	12.7	18.3	1.01
200	100-Year	280	95.4	97.7	97.7	98.5	0.0333	7.05	39.7	26.2	1.01

5. Erosion Control

   It is planned that the residual pool remaining in the TSF will be pumped down to an approximate elevation between 132 and 134 feet prior to the breach being day-lighted. This is the lowest level at which water inside the TSF can be reliably pumped. A substantial amount of the remaining water volume will be frozen. Upon opening the breach any remaining free water will discharge through and down the design channel and become frozen above the sediment pond in DC-3. Sediment loads from this discharge would be controlled by the sediment control pond at the terminus pond of DC-3 during breakup. It is anticipated that this water would be as turbid as is normally encountered during breakup from this pond. Residual frozen water would slowly release over a period of weeks during breakup and discharge through the sediment pond at the terminus of DC-3. Once breakup has occurred in June, other standard sediment control measures and BMPs would be employed on the unvegetated portions of the TSF area, such as water bars or filter fencing to impede erosion until vegetation becomes better established.

6. Foundation Drain Intercepts and Hydraulics

   Collected underflow from all parts of the foundation drainage network cannot be routed by gravity to DC-3 or Rock Creek. The central portion adjacent to the main sump is too low.

   The foundation drains will be intercepted and decommissioned using a two-step schedule. The first step includes construction activities concurrent with the breach and the second focuses on backfilling remaining low areas and decommissioning the drains and gravel trench they are installed in. The primary drivers for a two-step schedule include winter construction feasibility and the need to control subsurface water flow and keep it in the ground.

   The south leg is currently drained by a lateral connection to the south sump. This pipe lateral will remain in place, but the sump pump will be removed and piping decommissioned. The south leg collection piping will be intercepted at the breach and diverted into the new drainage ditch between the dam and DC-3. The accompanying Figure 10A indicates that the toe drain flowline elevation at the center of the breach is 107.5 ft. The ditch intercept with DC-3 is approximately 102.6 ft, providing sufficient slope to daylight the pipe. These two outlets for the south leg will ensure gravity discharge both pre- and post-breach during the remaining winter months. The above-grade discharge from the drain intercept is expected to freeze up soon after the pipe construction is complete. However, the remaining drain to the south sump will provide a secondary route for collected water to be conveyed and remain below grade. The anticipated flow rate is expected to be low enough that the adjacent soils will allow infiltration without surface eruption and formation of aufeis.

The north leg of the drain collection system will continue to route water to the main sump until summer 2012. During breach construction, competent materials from the cut will be used to backfill the southern portion of the main sump near and around the sump riser. The sump pump will be removed and the sump riser pipe raised above the adjacent DC-3 elevation. A short gravity ditch will be constructed to link the riser and DC-3 as a backup discharge point for the sump. Approximately half of the main sump will not be backfilled during winter breach construction due to the potential for ice and snow inclusion in the backfill. See the discussion in Section 7. The remaining open main sump area will be allowed to accumulate water from the foundation drains as an open pond with frozen surface. Below-grade infiltration and dispersion will stabilize the pond elevation. Any surge or excess flow will be able to overtop the raised sump pipe and flow into DC-3. The objective of this approach over the winter is to continue collecting foundation drain water in the existing sump areas. In the spring, all water remaining in the open sump area will be pumped into DC-3 for disposal. The low area will be backfilled with competent material and the sump riser cut off and removed.

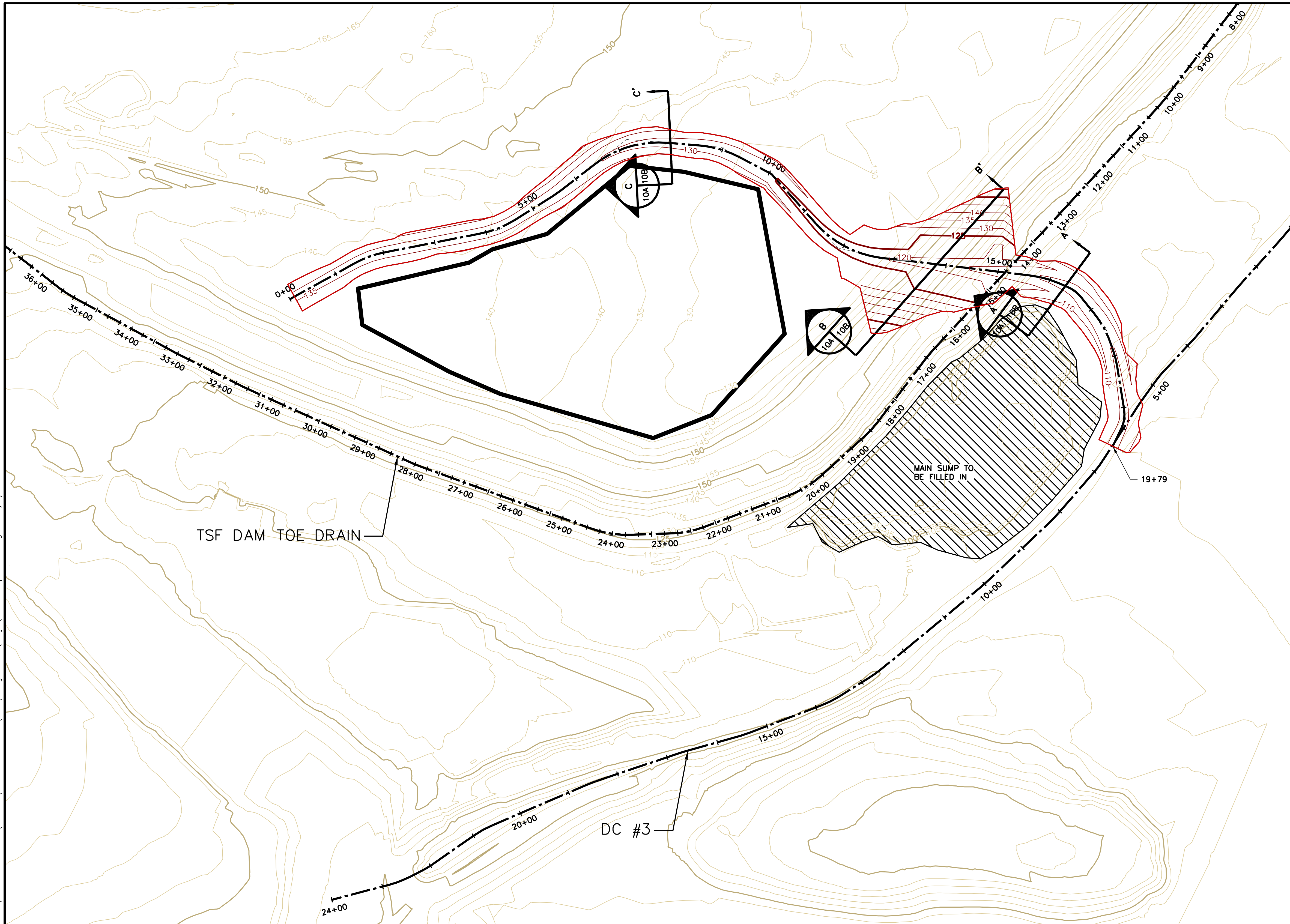
The foundation drains will be located, exposed, examined and filled with bentonite slurry or lean concrete after spring melt. The objective will be to impede as much subsurface flow as possible from shunting through the pipe or gravel trench to the main sump. Without the foundation drains available as a shunt, subterranean flownets will be forced to reestablish based on existing hydrogeology. The known up-gradient springs above and inside the TSF may or may not return to historical patterns. The potential for springs and seasonal aufeis is unknown but may be considered negligible based on existing conditions prior to original dam construction.

7. Sump Backfilling – Materials and Timing

Both the main and south sumps will be backfilled using appropriate material to prevent structural soil failure and formation of bogs. All material cut from the breach and upstream ditch will be used as backfill or screened for use as rip-rap. However, the earthwork design as shown in the accompanying figures will not produce sufficient quantity to fill both sumps. An additional borrow source from existing on-site materials will be identified at an appropriate time. Due to the breach construction being scheduled for late winter, there is a high potential for ice and snow inclusion in the cut/fill materials. In order to mitigate the potential for soil failure due to melt and resultant slumping, we intend to complete the sump backfill beginning in June 2012. To promote acceptable construction conditions for backfilling the remaining sump area, any standing water remaining from winter accumulation will be pumped to DC-3 as needed following spring melt.

END

DKH



LEGEND:

- 135 — EXISTING CONTOURS
- 140 — PROPOSED CONTOURS
- DRAINAGE CHANNEL
- TAILING LIMIT
- MAIN SUMP FILL

NOTE:

1. RIPRAP QUANTITIES ARE ESTIMATED FROM A D50 OF 12" AND A DEPTH OF 24". RIPRAP WILL BE INSTALLED ACROSS THE BASE OF THE PERMANENT PORTION (STATION 12+65 TO 20+29) OF THE CHANNEL AND 6' VERTICALLY UP THE 3H:1V SIDE SLOPES. THE TEMPORARY PORTION (STATION 0+00 TO 12+65) WILL RECEIVE RIPRAP WASTE FOR SEDIMENT CONTROL BUT IS NOT INCLUDED IN THE ESTIMATED QUANTITIES.
2. EXCESS CUT WILL BE PLACED WITHIN THE MAIN SUMP. NO FILL IS REQUIRED IN THE NORTHERN POOL SINCE THE INVERT OF THE START OF THE CHANNEL IS AT ELEVATION 132' AND THE LOW POINT OF THIS POOL IS 136'.
3. THE TOTAL FILL REQUIRED WITHIN THE MAIN SUMP TO CREATE POSITIVE DRAINAGE IS 55,300 C.Y.
4. THE TOPSOIL REQUIRED TO SATISFY THE BALANCE TO FILL THE MAIN SUMP IS 17,200 C.Y. AND WILL RESULT IN AN AVERAGE THICKNESS OF 3 FEET.

APPROXIMATE VOLUMES – TSF CLOSURE

MATERIAL	CUT (C.Y)	FILL (C.Y.)	NET (C.Y.)
DAM BREACH	41,000	2,900	38,100 (CUT)
RIPRAP	0	2,430	2,430 (FILL)
SUMP FILL	0	38,100	38,100 (FILL)
SUMP TOPSOIL	0	17,200	17,200 (FILL)

N

SCALE

100' 0 100' 200'

CONTOUR INTERVAL 5'

THE TOPO WAS PROVIDED BY NOVAGOLD AND IS ACCURATE AS OF THE DATE OF THE SURVEY FOR THE INDIVIDUAL DATA SETS. THE TOPO WAS COMPILED FROM SEVERAL SUB REGIONS INCLUDING THE RECONSTRUCTED GROUND TOPO, TSF EXCAVATION FOOTPRINT, TSF EMBANKMENT AND TSF BATHYMETRY.

REFERENCE

ENGINEER'S SEAL

Rev	Description	BY	Date
B	ISSUED FOR PERMIT	RJE	12/11
A	FOR BREACH LOCATION DISCUSSION	RJE	11/11

REVISIONS

Scale: As Shown
Designed by: RJE
Drawn by: RJE
Checked by:
Approved by:

Issued for:

Issued by:

TETRA TECH
350 Indiana Street, Suite 500
Golden, Colorado 80401
(303) 217-5700 (303) 217-5705 fax

Title: **BREACH ALIGNMENT PLAN VIEW**

B REVISION

Project: ROCK CREEK MINE TSF BREACH CLOSURE OPTIONS

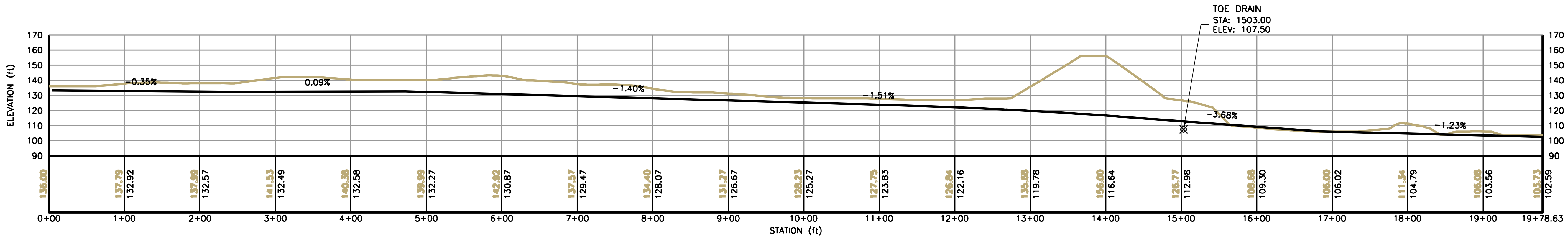
Project no.: 114-311186

FIGURE 10 A

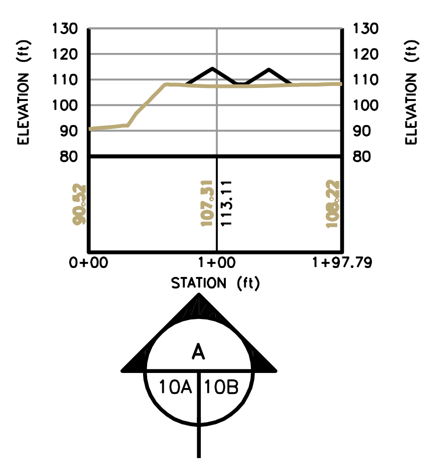
Location: NOME, ALASKA

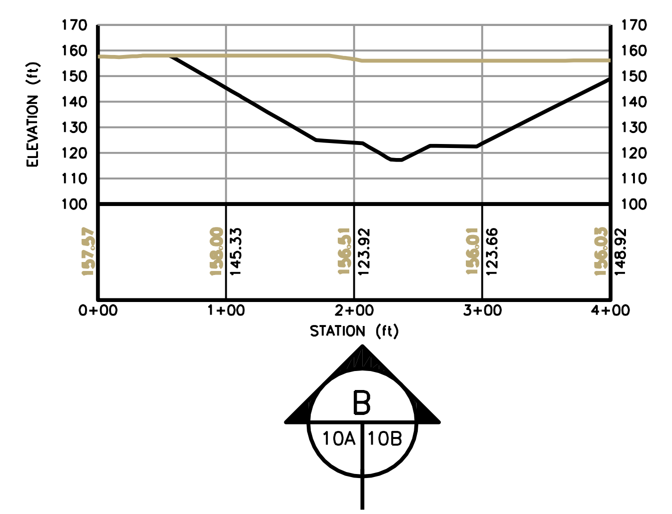
Date: 11/11

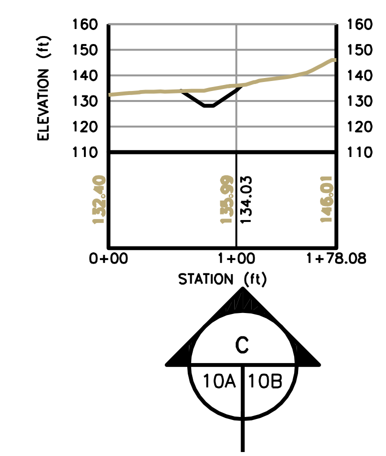
Ellis, Ryan – T:\Clients\Nova Gold\Rock Creek Mine\Closure\TSF Dam Breach\Cad\Design Work\Dwgs\Breach Option 4.dwg – 12/2/2011 10:17 AM



TSF DAM BREACH CHANNEL CENTERLINE PROFILE







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THE TOPO WAS PROVIDED BY NOVAGOLD AND IS ACCURATE AS OF THE DATE OF THE SURVEY FOR THE INDIVIDUAL DATA SETS. THE TOPO WAS COMPILED FROM SEVERAL SUB REGIONS INCLUDING THE RECONSTRUCTED GROUND TOPO, TSF EXCAVATION FOOTPRINT, TSF EMBANKMENT AND TSF BATHYMETRY.

REFERENCE

ENGINEER'S SEAL

Rev	Description	BY	Date
B	ISSUED FOR PERMIT	RJE	12/11
A	FOR BREACH LOCATION DISCUSSION	RJE	11/11

REVISIONS

Scale: As Shown
Designed by: RJE
Drawn by: RJE
Checked by:
Approved by:

Issued for:

Issued by:

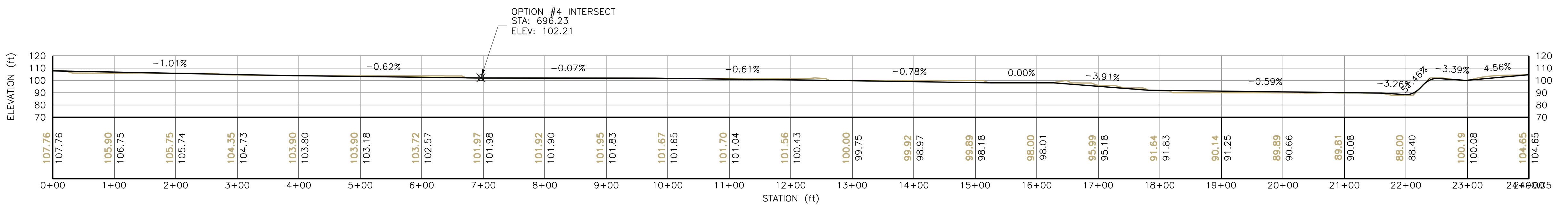
TETRA TECH
350 Indiana Street, Suite 500
Golden, Colorado 80401
(303) 217-5700 (303) 217-5705 fax

Title:
BREACH ALIGNMENT PROFILE AND CROSS SECTIONS

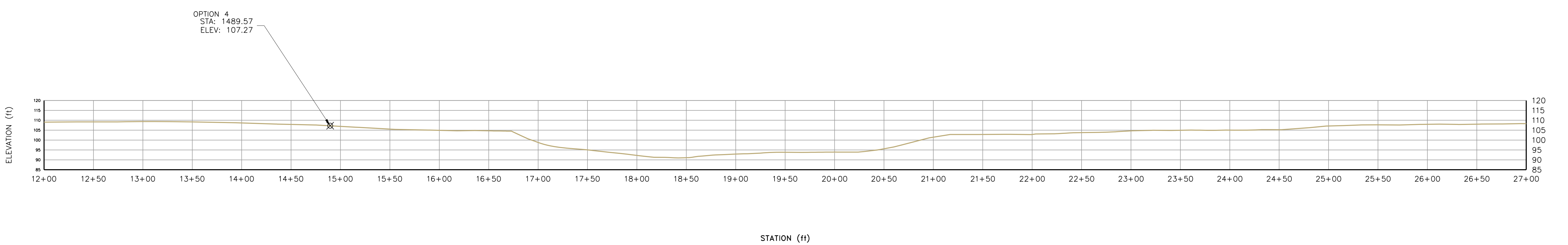
B
REVISION

Project: ROCK CREEK MINE TSF BREACH CLOSURE OPTIONS
Project no.: 114-311186
Location: NOME, ALASKA
Date: 11/11

FIGURE 10B



EXISTING DC #3 CENTERLINE PROFILE



TSF TOE DRAIN PROFILE

REFERENCE	ENGINEER'S SEAL
THE TOPO WAS PROVIDED BY NOVAGOLD AND IS ACCURATE AS OF THE DATE OF THE SURVEY FOR THE INDIVIDUAL DATA SETS. THE TOPO WAS COMPILED FROM SEVERAL SUB REGIONS INCLUDING THE RECONSTRUCTED GROUND TOPO, TSF EXCAVATION FOOTPRINT, TSF EMBANKMENT AND TSF BATHYMETRY.	

REVISIONS

Rev	Description	BY	Date
A	FOR BREACH LOCATION DISCUSSION	RJE	11/11

Scale: As Shown
Designed by: RJE
Drawn by: RJE
Checked by:
Approved by:

Issued for:

Issued by:

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Title: DC #3 AND TOE DRAIN PROFILE

REVISION B

Project: ROCK CREEK MINE TSF BREACH CLOSURE OPTIONS
Project no.: 114-311186
Location: NOME, ALASKA
Date: 11/11

FIGURE 10C