Klohn Crippen Berger

Resolution Copper Mining

Near West Tailings Management

Mine Plan of Operations Study

September 2014
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CANADA'S BEST MANAGED COMPANIES

Klohn Crippen Berger

September 5, 2014

Resolution Copper Mining
P.O. Box 1944
Superior, Arizona
85273

Mr. Frank Deal
Manager, Tailings

Dear Mr. Deal:

Near West Tailings Management
Mine Plan of Operations Study

We are pleased to submit this Mine Plan of Operations Study for the Near West Tailings Disposal Site.

Please contact us if you require any further assistance.

Yours truly,
KLOHN CRIPPEN BERGER LTD.

Howard D. Plewes, M.Sc., P.Eng.
Project Manager

HDP/KP:dl

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Resolution Copper Mining

Near West Tailings Management

Mine Plan of Operations Study

EXECUTIVE SUMMARY

This report presents the plan of operations level design of a Tailings Storage Facility (TSF) at the Near West site.

Previous Site Selection Study

KCB conducted an alternatives assessment for tailings disposal options in the Near West area in 2012 and 2013. The Near West area for this study was defined as the area located northwest of the town of Superior and south of the Superstition Wilderness area. Five locations in the Near West area were considered. Of the five locations, Whitford Canyon and Hewitt Canyon are located furthest north, close to the Superstition Wilderness. Silver King is a bowl canyon located directly north of Superior. Happy Camp East is located directly west of Superior in a flatter sloped area, between the washes of Whitford Canyon and Silver King Canyon. Happy Camp West is located further west than Happy Camp East, between the washes of Hewitt Canyon and Whitford Canyon.

The Happy Camp West (named the Near West site) is the tailings site described in this report).

Site Location and Geology

The Near West site is located 8 km *(4.97 mi)* west of the town of Superior and the proposed West Plant. It is located between two large drainages, Potts Canyon and Roblas Canyon, to protect these major drainages and reduce diversion requirements. The site is sloped from north to south with the south side near El. 700 m *(2,297 ft)* and the northern end as high as El. 860 m *(2,822 ft).*

Bedrock is exposed at surface over most of the site. Unconsolidated alluvial sediments are generally confined to ephemeral creek channels and valley bottoms, with the exception of "old alluvium" deposits at lower elevations at the south end of the site.

The bedrock is mainly Tertiary Gila Conglomerate, which forms north-south trending ridges and valleys. The north end of the site abuts early Proterozoic Pinal Schist, which is also exposed at the south end of site, between the TSF and Queen Creek. Older rock units of various origins are locally exposed over the western, northern and northeastern portions of the site.

The majority (60%) of the TSF is founded on the conglomerate and schist. The bulk permeability of these bedrock units should be low to very low according to surficial examination of the site and sub-surface data on these formations at other sites (M&A 2013). The conglomerate has local discontinuous fracturing but these areas are confined within the interior of the TSF basin. The other local bedrock units in the northwest may have somewhat higher permeability, and require further study to assess impacts.

Tailings Deposition Overview

The design basis for the tailing study is 1.5 billion tonnes (Bt) *(1.65 billion short tons (Btn)*) of ore produced over a 45 year mine life. Total tailings production is 1.44 Bt *(1.59 Btn),* comprising approximately 1.26 Bt *(1.39 Btn)* of scavenger tailings and 0.18 Bt *(0.20 Btn)* of cleaner tailings.

Scavenger and cleaner tailings will be thickened at the West Plant to 65% and 50% to 60% solids, respectively, before being pumped to the TSF.

The TSF is approximately 5 km *(3.1 mi)* by 3.5 km *(2.2 mi)* in size and covers 1,450 ha *(3,583 acres)*. An upstream raised embankment will contain the tailings on most of the perimeter. At the northwest corner of the site, a central core rockfill dam will contain the cleaner tailings and serves as a diversion structure at closure. A 5H:1V embankment slope was selected to meet static and seismic stability requirements during operations. Post-closure drain down of the TSF will further increase the long-term stability of the embankment.

During the early years of operation, the TSF consists of an east and west cell, separated by a bedrock ridge. At start-up, scavenger tailings will be deposited into the east cell from earthfill starter dams. Cleaner tailings will be spigotted onto low permeability Gila Conglomerate, from a separate starter dam inside the east cell. In Year 8, the cleaner starter dam will be overtopped by the scavenger tailings and sub-aqueous cleaner tailings deposition into the reclaim pond will continue thereafter from pipelines extending into the TSF from natural ridges to the north. All cleaner tailings will be founded mainly on Gila Conglomerate.

In Year 11, scavenger deposition into the west cell begins and both cells operate simultaneously. Free water in the west cell will be pumped to the east cell pond for reclaim. Between Years 11 and 18, the amount of scavenger tailings deposited in each cell is proportioned to raise the west cell and control the location of the reclaim pond in the east cell to ensure sub-aqueous deposition of the cleaner tailings. By Year 18, the perimeter crest of the west cell reaches the elevation of the east cell and thereafter the two cells are raised together. After Year 21, the reclaim ponds in the two cells coalesce and operate as a single pond.

The cleaner tailings will be deposited within the reclaim pond area, where they will be submerged and encapsulated in the slimes from the scavenger tailings. Advantages of this tailings deposition scheme include:

- The Potentially Acid General (PAG) cleaner tailings will be maintained in a saturated state during operations to prevent or reduce oxidation and potential acid generation.
- The cleaner tailings are deposited at the center of the facility where they will be progressively encapsulated by a thick sequence of scavenger tailings containing finer tailings slimes that segregate during deposition of the thickened scavenger tailings and collect in the reclaim pond. The very low permeability of the tailings scavenger slimes will reduce the rate of water infiltration into and out of the cleaner tailings during operations and closure. It will also reduce oxygen ingress into the cleaner tailings both during operations and post-closure.
- The cleaner tailings are deposited on Gila Conglomerate, which is expected to have low permeability and excess acid-neutralization potential.
- Closure capping of the cleaner tailings with an engineered cover.

Water will be continuously reclaimed from the TSF, keeping the pond between 2 million m^3 *(1620 acre-ft)* to 6 million m^3 *(4860 acre-ft)* for clarification of the water and to keep the cleaner tailings saturated.

Reclaimed water will be pumped back to the West Plant.

The flood storage capacity of the TSF is commensurably increased as the facility is raised in height. The initial scavenger starter dam is sized to store the first year of tailings plus an operating pond volume of 1 million m^3 *(810 acre-ft)* and the 100-year 24-hr flood from the local catchment. A temporary spillway will be provided to route the half 30-day Probable Maximum Flood (PMF) during the first year of operation. During this time, the cleaner tailings starter dam will store the half 30-day PMF. From Year 2 to 19, the TSF will be able to store a half 30-day PMF. After Year 19, the TSF will be able to store the full 30-day PMF.

Diversion channels will be excavated upstream of the TSF early in the mine life to divert non-contact runoff.

Rockfill underdrains will be constructed in creek channels below the embankment to depress the phreatic surface in the tailings to enhance embankment stability and aid in tailings consolidation. Seepage through the underdrains will report to the eleven seepage collection dams and be pumped back to the TSF. The seepage collection dams are sized to store an operating pond plus the runoff from a 200-year 24-hr storm.

Water balance calculations indicate the TSF will operate in a net water deficit. The total deficit[1] is 640 million m^3 *(5190 acre-ft)* over the 45 year operating life, equating to an average deficit of 490 L/s *(6470 USGPM),* or 0.44 m^3/tonne *(14 ft^3/tn)* of tailings.

Closure

The reclaim pond is expected to reduce in size after closure, to 2.5 Mm^3 *(2030 acre-ft)* or less. The storage capacity of the TSF exceeds that required to store the 30-day PMF event.

The embankment slopes will be armored and gradually reclaimed during operations to limit erosion. The tailings beaches will be covered with a minimum of 150 mm *(6")* of sand and gravel and re-vegetated to mimic natural ground conditions in the area. The area of the tailings beach above the cleaner tailings will be capped with an engineered cover.

The seepage collection dams will be maintained on closure and act as collection and evaporation ponds for seepage from the TSF. Diversion ditches will be built on the lower slope of the tailings embankment to reduce flow into the seepage collection ponds.

BADCT Compliance

Use of Best Available Demonstrated Control Technology (BADCT)[2] to minimize the impacts to groundwater is required by the Arizona Department of Environmental Quality (ADEQ) to obtain an

[1] Total deficit is the make-up water required to process the tailings at 30% solids density in the concentrator.
[2] Arizona Mining BADCT Guidance Manual published 1998 and revised 2005.

Aquifer Protection Permit (APP) for a tailings facility. The two general approaches to BADCT are prescriptive and individual:

- Prescriptive BADCT requires evaluating and selecting a pre-determined discharge control technology as the BADCT design.
- Individual BADCT establishes a Reference Design incorporating a combination of demonstrated control technologies, including site physical characteristics such as low permeability and geochemically reactive bedrock, which are appropriate for the site and then evaluating the aquifer loading potential for the Reference Design and alternative designs.

The Near West TSF will use the Individual BADCT approach. The following design elements, taken from the BADCT manual (the Individual BADCT base metals tailings impoundment section), will be used to demonstrate BADCT for the Near West TSF:

Individual BADCT Design Elements	Proposed Approach for Near West Site
▪ Interception of storm run-off and groundwater flow in shallow aquifers to minimize water inflow.	▪ Achieved by a combination of the low permeability Pinal Schist serving as a groundwater barrier between the TSF and the Queen Creek basin at the toe of the facility and dams or cutoff walls keyed into bedrock located around the facility to collect surface and seepage water.
▪ Natural geologic features and fine-grained tailings functioning as liners and/or discharge control.	▪ Gila Conglomerate and Pinal Schist have low to very low permeability, cover a majority of the TSF basin, and are expected (at least in the case of the Gila) to have excess neutralization capacity. ▪ A fine grained tailings “slime” with lower permeability will develop at the bottom of the tailings basin as a result of tailings consolidation.
▪ Provision of sub-drainage beneath the impoundment to minimize hydraulic head and promote dewatering after closure.	▪ Design includes extensive finger drains at the base of the embankment to facilitate collection of seepage, and minimize seepage losses to groundwater.
▪ Leachate collection systems consisting of granular finger or blanket drains and corrugated perforated HDPE pipes can be used to supplement natural sub-drainage (Brawner 1986).	▪ Design includes extensive finger drains at the base of the embankment to facilitate collection of seepage, and minimize seepage losses to groundwater.
▪ Drains and reclaim water pump back systems to lower or eliminate the phreatic surface in the embankment.	▪ Inclusion of drains, seepage dams and collection and pump-back systems.
▪ Channels and dikes or berms to collect run-off from downstream slopes.	▪ Toe ditches around embankment to facilitate drainage to the seepage collection dams. Additionally, up-gradient diversions will redirect storm water around the facility, reducing overall volume of run-off to be collected.

Future work

Additional baseline data is needed to complete a comprehensive hydrologic impact assessment of the Near West TSF facility including additional investigation of the subsurface conditions (bedrock shear wave velocity, bulk permeability, flow direction, neutralization capacity and refined volume and suitability of borrow material). The program will include drill holes with hydraulic packer testing and installation of piezometers, and test trenches with infiltration tests. Pump testing of major bedrock units and geologic structures will be required to identify permeability and hydraulic properties of the subsurface units.

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1 INTRODUCTION

1.1 General

Klohn Crippen Berger Ltd. (KCB) prepared this study in support of the Mine Plan of Operations (MPO) for disposal of tailings produced by the Resolution Mine at the Near West site (Figure 1.1). This design outlines the required civil and mechanical works for tailings disposal, water reclaim and surface water management for the MPO.

Previous Site Selection Study

KCB conducted an alternatives assessment for tailings disposal options in the Near West area in 2012. The Near West area for this study was defined as the area located northwest of the town of Superior and south of the Superstition Wilderness area. Five locations in the Near West area were considered. Of the five locations, Whitford Canyon and Hewitt Canyon are located furthest north, close to the Superstition Wilderness. Silver King is a bowl canyon located directly north of Superior. Happy Camp East is located directly west of Superior in a flatter sloped area, between the washes of Whitford Canyon and Silver King Canyon. Happy Camp West is located further west than Happy Camp East, between the washes of Hewitt Canyon and Whitford Canyon.

The Happy Camp West (named the Near West site) is the tailings site described in this report.

Scope of Work

The scope of this report includes:

- designs for storage of 1.44 billion tonnes *(1.59 billion short tons [tn]) of* tailings during a 45 year mine life;
- geotechnical, hydrogeological and hydrological characterization of the site based on the site reconnaissance conducted by KCB and others in early 2013;
- preparation of facility layouts and tailings staging;
- design of tailings embankment and associated seepage collection dams;
- design of catchment diversions;
- facility water balance;
- schedule of construction quantities; and
- conceptual closure plans.

1.2 Reference Information

Primary reference information for this study includes:

- Duke Hydrochem LLC. 2014. Geochemical Characterization of Resolution Tailings. July 21.

- KCB, 2011. Resolution Project, 2010 Geotechnical Testing of Tailings Samples. January.
- Montgomery and Associates, 2012. Draft Technical Memorandum, Hydrogeologic Data Submittal, Tailings Prefeasibility Study, Whitford, Silver King, and Happy Camp Sites. October.
- Montgomery and Associates, 2013. Draft Report Technical Memorandum, Phase I Hydrogeologic Field Investigations, Near West Tailings Site, Pinal County, Arizona. April.
- URS Corporation, 2013. Site-Specific Seismic Hazard Analyses for the Resolution Mining Company Tailings Storage Facilities, Southern Arizona. June 3.

2 DESIGN BASIS

2.1 Tailings Production Schedule

The tailings design capacity is 1.5 billion tonnes *(1.65 billion short tons (tn))* of ore, representing 45 years of mining at the phased-in and phased-out production rates presented in Table 2.1 and Table 2.2. Separate scavenger tailings and cleaner tailings will be produced: approximately 88% will be scavenger; 12% cleaner.

Figure 2.1 presents the hydrometer gradations for the scavenger and cleaner tailings produced from pilot scale metallurgical test work. For recovery purposes, the target gradation is tentatively set at $P_{80\%}$ = 160 microns *(6.3 mils)* for the scavenger tailings and $P_{80\%}$ = 40 to 80 microns *(1.6 mils to 3.1 mils)* for the cleaner tailings. The percentage of clay-sized particles less than 2 microns *(0.08 mils)* is nominally 7% for the scavenger tailings and 9% for the cleaner tailings.

Table 2.1 Ore and Tailings Production Schedule (Metric Units)

Year	Milled Ore (tonnes/year)	Cumulative Milled Ore (tonnes)	Scavenger Tailings (tonnes/year)	Cleaner Tailings (tonnes/year)
0	0	0	0	0
1	6,171,992	6,171,992	5,538,690	495,225
2	8,395,000	14,566,992	7,471,246	661,697
3	8,701,243	23,268,235	7,545,719	686,564
4	16,657,269	39,925,504	14,349,158	1,412,179
5	24,488,070	64,413,574	20,875,530	2,275,100
6	32,311,276	96,724,850	27,329,511	3,216,081
7	38,325,416	135,050,266	32,175,112	4,056,212
8	43,800,000	178,850,266	36,259,601	5,040,212
9	43,800,000	222,650,266	35,716,908	5,485,048
10	43,800,000	266,450,266	35,454,959	5,920,093
11	43,800,000	310,250,266	35,513,639	6,194,342
12	43,800,000	354,050,266	35,969,299	6,082,999
13	42,050,972	396,101,238	35,221,380	5,184,075
14	43,669,902	439,771,140	37,056,736	4,779,488
15	43,800,000	483,571,140	37,251,248	4,645,505
16	43,800,000	527,371,140	36,989,046	4,858,105
17	43,800,000	571,171,140	36,591,092	5,213,321
18	43,800,000	614,971,140	36,242,366	5,604,554
19	43,800,000	658,771,140	35,989,950	5,944,612
20	43,800,000	702,571,140	35,899,854	6,128,564
21	43,800,000	746,371,140	36,130,214	5,986,571
22	43,800,000	790,171,140	36,479,308	5,625,597
23	43,800,000	833,971,140	36,526,334	5,426,242
24	43,800,000	877,771,140	36,438,403	5,416,826
25	43,800,000	921,571,140	36,329,275	5,525,785
26	43,800,000	965,371,140	36,468,912	5,482,660
27	43,800,000	1,009,171,140	36,827,839	5,239,728
28	43,800,000	1,052,971,140	37,239,401	4,836,528
29	43,800,000	1,096,771,140	37,378,247	4,613,150
30	43,800,000	1,140,571,140	37,243,983	4,722,152

Year	Milled Ore (tonnes/year)	Cumulative Milled Ore (tonnes)	Scavenger Tailings (tonnes/year)	Cleaner Tailings (tonnes/year)
31	43,800,000	1,184,371,140	37,155,170	4,913,018
32	43,800,000	1,228,171,140	37,279,009	4,936,547
33	43,800,000	1,271,971,140	37,279,009	4,936,547
34	43,800,000	1,315,771,140	37,279,009	4,936,547
35	43,800,000	1,359,571,140	37,279,009	4,936,547
36	43,800,000	1,403,371,140	37,279,009	4,936,547
37	30,895,309	1,434,266,449	26,293,939	3,408,583
38	24,017,416	1,458,283,865	20,341,454	2,709,730
39	17,613,126	1,475,896,991	14,776,495	2,128,664
40	13,238,965	1,489,135,956	11,074,850	1,656,503
41	8,565,135	1,497,701,091	7,180,783	1,076,781
42	3,917,502	1,501,618,593	3,259,509	519,033
43	1,674,880	1,503,293,472	1,365,175	249,270
44	837,009	1,504,130,482	675,197	132,826
45	240,131	1,504,370,613	193,784	38,692
TOTAL	1,504,370,613	-	1,261,214,362	178,275,049

Notes: Supplied by Resolution Copper in an email dated March 4, 2013.

Table 2.2 Ore and Tailings Production Schedule (US Customary Units)

Year	Milled Ore (tn/year)	Cumulative Milled Ore (tn)	Scavenger Tailings (tn/year)	Cleaner Tailings (tn/year)
0	0	0	0	0
1	6,803,455	6,803,455	6,105,359	545,892
2	9,253,901	16,057,356	8,235,637	729,396
3	9,591,476	25,648,831	8,317,729	756,807
4	18,361,491	44,010,322	15,817,235	1,556,660
5	26,993,469	71,003,791	23,011,326	2,507,868
6	35,617,075	106,620,866	30,125,621	3,545,121
7	42,246,528	148,867,394	35,466,980	4,471,207
8	48,281,222	197,148,616	39,969,357	5,555,881
9	48,281,222	245,429,837	39,371,141	6,046,229
10	48,281,222	293,711,059	39,082,391	6,525,784
11	48,281,222	341,992,281	39,147,075	6,828,091
12	48,281,222	390,273,503	39,649,354	6,705,357
13	46,353,249	436,626,752	38,824,915	5,714,463
14	48,137,813	484,764,565	40,848,048	5,268,482
15	48,281,222	533,045,787	41,062,460	5,120,791
16	48,281,222	581,327,009	40,773,432	5,355,143
17	48,281,222	629,608,231	40,334,763	5,746,701
18	48,281,222	677,889,452	39,950,359	6,177,962
19	48,281,222	726,170,674	39,672,118	6,552,811
20	48,281,222	774,451,896	39,572,804	6,755,584
21	48,281,222	822,733,118	39,826,732	6,599,063
22	48,281,222	871,014,340	40,211,542	6,201,157
23	48,281,222	919,295,561	40,263,380	5,981,406
24	48,281,222	967,576,783	40,166,452	5,971,027
25	48,281,222	1,015,858,005	40,046,159	6,091,134

Year	Milled Ore (tn/year)	Cumulative Milled Ore (tn)	Scavenger Tailings (tn/year)	Cleaner Tailings (tn/year)
26	48,281,222	1,064,139,227	40,200,083	6,043,596
27	48,281,222	1,112,420,449	40,595,732	5,775,810
28	48,281,222	1,160,701,670	41,049,401	5,331,358
29	48,281,222	1,208,982,892	41,202,453	5,085,126
30	48,281,222	1,257,264,114	41,054,452	5,205,280
31	48,281,222	1,305,545,336	40,956,553	5,415,674
32	48,281,222	1,353,826,558	41,093,062	5,441,610
33	48,281,222	1,402,107,779	41,093,062	5,441,610
34	48,281,222	1,450,389,001	41,093,062	5,441,610
35	48,281,222	1,498,670,223	41,093,062	5,441,610
36	48,281,222	1,546,951,445	41,093,062	5,441,610
37	34,056,239	1,581,007,684	28,984,098	3,757,319
38	26,474,662	1,607,482,346	22,422,609	2,986,965
39	19,415,143	1,626,897,488	16,288,293	2,346,450
40	14,593,457	1,641,490,945	12,207,929	1,825,981
41	9,441,443	1,650,932,387	7,915,456	1,186,948
42	4,318,306	1,655,250,693	3,592,993	572,136
43	1,846,239	1,657,096,930	1,504,847	274,773
44	922,644	1,658,019,576	744,277	146,416
45	264,699	1,658,284,275	213,610	42,651
TOTAL	1,658,284,275	-	1,390,250,465	196,514,548

Notes: Supplied by Resolution Copper in an email dated March 4, 2013.

2.2 Tailings Properties

Properties used for the scavenger tailings and cleaner tailings are given in Table 2.3. Comments on the selection of the design parameters are provided below:

Scavenger and Cleaner Tailings:

- Specific gravity and particle size distributions are based on testing of scavenger and cleaner tailings by KCB (2011).
- Average consolidated tailings densities are estimated from previous studies and experience.
- Hydraulic conductivities are estimated from KCB experience on similar projects.
- Friction angles are estimated based on testing of similar tailings at other mines, including Kennecott Utah Copper and the nearby Pinto Valley Operations. The effect of stress level on friction angle was also considered.
- Geochemical assessment of the tailings streams shows that the scavenger tailings are largely non-acid-generating (NAG) and the high sulfide cleaner tailings and combined cleaner and scavenger are potentially-acid-generating (PAG). Based on kinetic humidity cell tests and field scale barrel tests, the lag time for unsaturated cleaner tailings to turn acid is about 3 months. During operations, prevention of acid generation in freshly placed cleaner tailings will be managed by continual wetting during deposition and submergence in the reclaim pond within a 3 month time period. After initial placement, acid generation will be managed by limiting

oxygen ingress as the cleaner tailings are progressively covered and encapsulated by scavenger tailings.

Tailings Beach Slopes:

- Thickened scavenger and cleaner tailings beach slopes are assumed to be 1% above water and 2% below water. These values are based on experience at other mines with similar beach lengths.

Table 2.3 Tailings Properties

Tailings Stream	Specific Gravity	Particle Size		Deposition Method	Final Average Consolidated Dry Density (t/m³)*(pcf)*	Static Friction Angle	Post-Earthquake Friction Angle	Average Hydraulic Conductivity (m/s) *(ft/s)*	Acid-generating Potential
		% fines < 74 microns	% clay < 2 microns						
Scavenger	2.67	50 - 65	< 7	Thickened deposition at 65% solids density	1.40 *(87)*	32°	Note 5	5×10^{-7} to 5×10^{-8} *(1.6×10^{-6} to 1.6×10^{-7})*	NAG
Cleaner	3.54	95 - 100	< 9	Subaerial or subaqueous deposition if thickened tailings at 60% solids density	1.70 *(106)*	32°	Note 5	1×10^{-8} to 1×10^{-9} *(3.3×10^{-8} to 3.3×10^{-9})*	PAG Lag time = 3 month

Notes:
1. PAG denotes potentially-acid-generating behavior.
2. NAG denotes non-acid-generating behavior, but material may be prone to neutral leaching.
3. Lag time is time for leachate to reach pH less than 5.
4. Where applicable, hydraulic conductivity represents range between void ratio of 1.0 near tailings surface and void ratio of 0.4 at base of tailings deposit.
5. Post-earthquake frictional strengths are based on liquefaction assessment, described in Appendix V.

Deposited Tailings Dry Densities:

The deposited tailings density is dependent upon the specific gravity of the particles and the void ratio of the resulting deposited tailings. Representative tailings densities deposited by different methods are given in Table 2.4.

Table 2.4 Representative Tailings Densities

Tailings	Specific Gravity	Void Ratio e	Tailings Dry Density[1] (t/m^3) *(pcf)*	
			Tailings Deposited Above Water	Tailings Deposited Below Water
Scavenger	2.67	0.80 – 1.00 (above water) 1.00 – 1.20 (below water)	1.34 – 1.48 *(84 – 92)*	1.21 – 1.34 *(76 – 84)*
Cleaner	3.54		1.77 – 1.97 *(110 – 123)*	1.61 – 1.77 *(101 – 110)*

1. Dry Density = γ_w = Gs/(1 + e) (in t/m^3)

Thickened scavenger tailings will be deposited in the tailings impoundment mostly above the pond surface, but some tailings deposition below the pond level will occur. An average deposited density of 1.40 t/m^3 *(87 pcf)* has been selected for design. Thickened cleaner tailings will be deposited in the tailings impoundment mostly below the pond surface. An average deposited density of 1.70 t/m^3 *(106 pcf)* has been selected for design.

2.3 Climate and Hydrology

The Near West site is located in a semi-arid climate zone, with an estimated average annual precipitation of 474 mm *(18.7”).* The climate and hydrological assumptions for this study are included in Appendix III.

The annual average temperature is about 21°C *(70°F),* and daily average temperatures typically range between 6°C *(43°F)* and 37°C *(99°F).* Precipitation occurs as frontal storms in winter and shorter, more intense convective storms in summer. Approximately 8% of precipitation falls as snow during December to April. The snow melts generally within a couple of days of falling.

The average annual pan evaporation rate is estimated to be 2451 mm *(96.5”).* To determine the monthly average free water surface (FWS) evaporation, the pan evaporation values were multiplied by a coefficient of 0.7.

The monthly distribution of precipitation and evaporation assumed for Near West is given in Table 2.5. A runoff coefficient of 0.3 was used for the monthly average water balance.

Table 2.5 Monthly Average Precipitation and Evaporation Rates

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Precipitation[1] (mm)	55	59	54	16	9	6	50	74	40	23	36	52	474
Pan Evaporation[2] (mm)	62	90	150	219	304	368	365	312	257	172	93	59	2,451
FWS Evaporation[3] (mm)	43	63	105	153	213	258	256	218	180	120	65	41	1,715
Precipitation[1] (inches)	*2.2*	*2.3*	*2.1*	*0.6*	*0.4*	*0.2*	*2.0*	*2.9*	*1.6*	*0.9*	*1.4*	*2.1*	*18.7*
Pan Evaporation[2] (inches)	*2.4*	*3.5*	*5.9*	*8.6*	*12.0*	*14.5*	*14.4*	*12.3*	*10.1*	*6.8*	*3.7*	*2.3*	*96.5*
FWS Evaporation[3] (inches)	*1.7*	*2.5*	*4.1*	*6.0*	*8.4*	*10.2*	*10.1*	*8.6*	*7.1*	*4.7*	*2.6*	*1.6*	*67.5*

Notes:
1. Average precipitation data obtained from Superior station Lat. 33.300 Long. -111.100 (1981-2010)
2. Average evaporation data obtained from Roosevelt 1 WNW station Lat. 33.667 Long. -111.150 (1905-2005)
3. A pan evaporation coefficient of 0.7 was used to estimate open water evaporation

The NOAA precipitation frequency estimates (NOAA, 2013) for the Near West site were determined for a point with coordinates Lat. 33.3176, Long. -111.1883, at an elevation of 745 m *(2444.2 ft),* and are given in Table 2.6.

Probable Maximum Precipitation (PMP) estimates for various durations for the Near West site are given in Table 2.7 and Table 2.8 for the local storm PMP and general storm PMP. Based on elevation and location, it was considered that the PMP values estimated for PVO could be applicable to the Near West site, but it is recognized that given the differences in elevation between PVO and Near West, the numbers are conservative and likely overestimate the PMP values for the Near West site. Site specific PMP values are likely lower for the Near West site.

For preliminary assessment of flood storage, a net runoff coefficient of 1.0 was assumed, making allowances for antecedent rainfall and soil moisture conditions. Again, since this estimate was based on the PVO numbers, this coefficient is likely conservative.

Table 2.6 Intensity-Duration-Frequency Relationship

Units	Average Recurrence Interval (years)	5 min	10 min	15 min	30 min	60 min	2 hr	3 hr	6 hr	12 hr	24 hr	2 day	3 day	4 day	7 day	10 day	20 day	30 day	45 day	60 day
mm	1	6	9	12	16	19	22	24	29	34	42	48	52	56	63	70	87	105	125	144
	2	8	12	15	20	25	29	30	36	43	53	60	65	71	80	88	111	133	158	182
	5	11	16	20	27	34	38	39	45	54	67	77	84	91	103	113	142	170	201	230
	10	13	19	24	33	40	45	46	53	62	78	90	99	107	123	134	167	199	235	267
	25	16	24	29	39	49	54	56	64	74	94	109	120	131	151	164	202	240	279	315
	50	18	27	33	45	55	62	64	72	83	106	123	137	150	174	188	229	272	315	351
	100	20	30	37	50	62	69	72	80	92	119	139	155	171	200	214	257	305	351	389
	200	22	33	41	56	69	76	81	89	101	132	155	174	193	228	242	287	338	386	424
	500	25	38	47	63	78	86	92	100	113	151	177	200	224	269	282	328	386	434	472
	1000	27	41	51	68	85	94	102	109	123	165	194	221	249	302	315	358	424	470	511
inches	*1*	*0.24*	*0.37*	*0.46*	*0.61*	*0.76*	*0.88*	*0.93*	*1.13*	*1.35*	*1.66*	*1.88*	*2.04*	*2.2*	*2.49*	*2.74*	*3.44*	*4.13*	*4.91*	*5.65*
	2	*0.32*	*0.48*	*0.59*	*0.8*	*0.99*	*1.13*	*1.19*	*1.42*	*1.69*	*2.09*	*2.37*	*2.57*	*2.78*	*3.14*	*3.46*	*4.36*	*5.22*	*6.21*	*7.15*
	5	*0.42*	*0.64*	*0.8*	*1.07*	*1.33*	*1.5*	*1.54*	*1.79*	*2.12*	*2.64*	*3.02*	*3.29*	*3.57*	*4.05*	*4.44*	*5.6*	*6.68*	*7.92*	*9.04*
	10	*0.5*	*0.77*	*0.95*	*1.28*	*1.58*	*1.77*	*1.82*	*2.09*	*2.45*	*3.08*	*3.55*	*3.89*	*4.22*	*4.83*	*5.26*	*6.59*	*7.83*	*9.23*	*10.47*
	25	*0.61*	*0.93*	*1.15*	*1.55*	*1.92*	*2.14*	*2.21*	*2.5*	*2.91*	*3.7*	*4.28*	*4.72*	*5.15*	*5.95*	*6.43*	*7.95*	*9.43*	*11.01*	*12.38*
	50	*0.69*	*1.06*	*1.31*	*1.76*	*2.18*	*2.43*	*2.52*	*2.82*	*3.26*	*4.18*	*4.86*	*5.38*	*5.91*	*6.87*	*7.39*	*9.02*	*10.68*	*12.37*	*13.82*
	100	*0.78*	*1.18*	*1.47*	*1.98*	*2.45*	*2.72*	*2.84*	*3.15*	*3.62*	*4.69*	*5.46*	*6.09*	*6.72*	*7.88*	*8.43*	*10.13*	*11.99*	*13.77*	*15.27*
	200	*0.86*	*1.31*	*1.62*	*2.19*	*2.71*	*3.01*	*3.17*	*3.49*	*3.97*	*5.21*	*6.09*	*6.84*	*7.58*	*8.97*	*9.53*	*11.28*	*13.34*	*15.18*	*16.72*
	500	*0.97*	*1.48*	*1.83*	*2.47*	*3.06*	*3.4*	*3.63*	*3.95*	*4.46*	*5.93*	*6.96*	*7.88*	*8.81*	*10.55*	*11.11*	*12.87*	*15.2*	*17.08*	*18.64*
	1000	*1.06*	*1.61*	*2*	*2.69*	*3.33*	*3.7*	*4*	*4.31*	*4.83*	*6.5*	*7.64*	*8.72*	*9.8*	*11.87*	*12.4*	*14.11*	*16.65*	*18.54*	*20.08*

Note:
From NOAA Atlas 14.

Table 2.7 Precipitation for Local PMP at PVO Site

Duration	Precipitation Depth mm *(inches)*
15 min	132 *(5.20")*
30 min	170 *(6.69")*
45 min	191*(7.52")*
1 hr	206 *(8.11")*
2 hr	244 *(9.61")*
3 hr	262 *(10.31")*
4 hr	277 *(10.91")*
5 hr	287 *(11.31")*
6 hr	295 *(11.61")*

Note: The PMP values have been obtained from the nearby Pinto Valley (PVO) site

Table 2.8 Precipitation for General Storm PMP at PVO Site

Duration	Precipitation Depth mm *(inches)*
6 hr	267 *(10.51")*
12 hr	366 *(14.41")*
18 hr	432 *(17.01")*
24 hr	480 *(18.90")*
48 hr	599 *(21.58")*
72 hr	653 *(25.71")*
30 day	1,575 *(62.01")*

Note: The PMP values have been obtained from the nearby Pinto Valley (PVO) site

2.4 Seismicity

URS Corporation (URS, 2013) conducted a site specific seismic hazard assessment and provided seismic design parameters and a suite of time histories representing design scenario earthquakes for the Near West site. Details on the seismic parameters used are given in Appendix V.

The 5,000 year return period ground motions (or probability of exceedance of 1% in 50 years) were taken as the maximum design earthquake ground motions for the tailings embankment at the Near West. URS (2013) provided the following site specific seismic design parameters:

a) 5,000 year return period Peak Ground Acceleration (PGA) and spectral accelerations (Sa) at 0.2 second and 1 second periods uniform hazard response spectra (UHRS):
   - PGA=0.107 g, Sa(T=0.2 s)=0.26 g and Sa(T=1 s)=0.15 g

b) PGAs corresponding to 5,000 year return period conditional mean spectra (CMS) at short period (0.2 s) and long period (1 s) are:
   - PGA=0.0987 g for CMS at 0.2 s
   - PGA=0.014 g for CMS at 1 s

c) Controlling or Scenario Earthquakes corresponding to ground motions at the PGA is a lower magnitude local earthquake. At the period of the proposed tailings embankment, the controlling earthquake is a long distance large magnitude earthquake occurring near the San Andreas Fault. The representative local and long distance earthquake magnitudes and distances are:

- For PGA, Earthquake Magnitude, M=5.4 and Distance, D=38 km *(24 mi)*
- For Sa(T=1), Earthquake Magnitude, M=7.7 and Distance, D=373 km *(232 mi)*

Both earthquake scenarios were considered in design.

2.5 Best Available Demonstrated Control Technology (BADCT)

2.5.1 Prescriptive and Individual BADCT

Use of Best Available Demonstrated Control Technology (BADCT)[3] to minimize the impacts to groundwater is required by the Arizona Department of Environmental Quality (ADEQ) to obtain an Aquifer Protection Permit (APP) for a tailings facility. BADCT is to be applied throughout the entire facility life cycle including design, construction, operation and closure. Two general approaches to demonstrate BADCT are possible:

- **Prescriptive BADCT:** requires evaluating and selecting a pre-determined discharge control technology as the BADCT design. Typically for precious metal tailings facilities, this requires a composite liner consisting of a single geomembrane underlain by a minimum of 300 mm *(12")* thickness of compacted soil with a saturated hydraulic conductivity less than 10^{-8} m/s *(3×10^{-8} ft/s).* The geomembrane is to be covered by a protective drainage layer with a minimum thickness of 450 mm *(18")* consisting of 19 mm *(0.75")* minus, well-draining material, and corrugated perforated HDPE pipe of 75 mm *(3")* or larger diameter at 6 m *(~20 ft)* spacing. The drainage layer should flow by gravity to a low point where the fluids can be removed, thereby minimizing the hydraulic head over the liner. See Table 2.9.
- Tailings disposal for base metal mines involves hydraulic deposition of large volumes of tailings slurries and application of prescriptive BADCT may be impractical and cost prohibitive. BADCT recognizes that adequate discharge control has been achieved in un-lined basins employing control techniques that take advantage of the arid and semi-arid climate in Arizona in conjunction with natural geologic controls including a low permeability foundation, geochemical reactivity of underlying bedrock, deep water table, special construction materials and high degree of hydrologic isolation. For these cases, individual BADCT is advocated.

[3] Arizona Mining BADCT Guidance Manual published 1998 and revised 2005.

Table 2.9 BADCT Prescriptive Liner Design Criteria (ADEQ, 2005)

TAILING IMPOUNDMENTS[(1)] Prescriptive BADCT		
Category	Element	Prescriptive Criteria
	2.5.2.4 Liner Specifications - Design and install impoundment components	1) Composite liner consisting of a single geomembrane of at least 30 mil thickness or 60 mil if proposing HDPE over, a minimum, twelve inches (placed in two-six inch lifts) of 3/8-inch minus native or natural materials compacted to achieve a saturated hydraulic conductivity of no greater than 10^{-6} cm/sec. Soil component surface to be smooth (e.g., rolled) and inspected prior to geomembrane installation. 2) Geomembrane material selected based on an evaluation of the liner composition and thickness, height of the tailing impoundment and foundation characteristics. 3) Geomembrane certified to be UV resistant for areas exposed to sunlight. 4) Geomembrane secured by an engineered trench. 5) Geomembrane will be covered by a protective/drainage layer of 3/4 inch minus, well draining material with a minimum thickness of 18 inches, and corrugated, perforated HDPE pipe of 3-inch or larger diameter at 20-foot spacing. Drainage layer must be designed to convey flow to a low point where fluids are removed by gravity flow or a dedicated pump in a manner that results in minimal hydraulic head over the liner. Materials used in the protective drainage layer shall not deteriorate when in contact with leachate solutions. 6) If tailing impoundment containment includes the use of a retention structure, the inner surface of the retention structure will be lined with a geomembrane (liner requirements as indicated above) in conjunction with the lining of the tailing impoundment area.

- **<u>Individual BADCT</u>:** establishes a Reference Design incorporating a combination of demonstrated control technologies which are appropriate for the site and then evaluating the aquifer loading potential for the Reference Design and alternative designs. The practical design resulting in the lowest significant pollutant load to the aquifer will be selected as the BADCT design. Individual BADCT may be developed based on considerations of waste characteristics, siting considerations (hydrology, hydrogeology [e.g., low permeability bedrock, geochemically reactive bedrock, etc.), design measures, operational features and closure methodology.

  The following design elements can be used as part of discharge control systems to achieve individual BADCT for base metal tailing impoundments. Because application of the design elements is site specific, all the design elements may not be a part of BADCT for all facilities.

- Interception of storm runoff and groundwater flow in shallow aquifers to minimize water inflow.
- Natural geologic features such as low hydraulic conductivity and geochemical reactivity (e.g., excess neutralization capacity).
- Localized lining with geosynthetic materials and/or clay.
- Slime sealing beneath the tailing pond. If properly done, this can produce an effective vertical hydraulic conductivity of 1×10^{-9} m/s *(3 x* 10^{-9} *ft/s)* or lower.
- Provision of subdrainage beneath the impoundment to minimize hydraulic head, promote dewatering, and minimize seepage losses to groundwater during operations and after closure.
- Leachate collection systems consisting of granular finger or blanket drains and corrugated perforated HDPE pipes can be used to supplement natural subdrainage.
- Lining beneath the main underdrains is sometimes done to further minimize seepage.
- Drains and reclaim water pump back systems to lower or eliminate the phreatic surface in the embankment.
- High-strength, free draining rockfill zones in the embankment.
- Channels and dikes or berms to collect run-off from downstream slopes.
- Engineered hydraulic barriers downstream of the embankment and above the natural regional ground water table. These may include soil-bentonite slurry walls with upstream pumpback wells, reclaim wells and trench drains with downstream clay or geomembrane barriers.

In line with the above listed individual BADCT design elements, Resolution Copper would take into account the following factors:

- The TSF founded on low to very low permeability bedrock.
- The local groundwater flow pathways and geology favorable to collecting seepage.
- The excess neutralization capacity of the carbonate-rich Gila Conglomerate which underlies most of the site.
- Submergence of cleaner tailings below water during operations.
- Segregation of PAG cleaner tailings and encapsulation within scavenger tailings.
- Capping of the cleaner tailings at closure using an engineered cover that helps minimize water and oxygen ingress into tailings.
- The NAG characteristics of the scavenger tailings deposited above the long-term closure water table.
- A hydraulic conductivity less than 1×10^{-8} m/s *(3 x* 10^{-8} *ft/s)* of the scavenger tailings deposited within the reclaim pond, which contributes to "slime sealing" below the tailings facility.

- Collection of leachate using drains or pumpback wells, as required. Drainage below the embankment to promote dewatering and enhance long-term stability.
- Engineered hydraulic barriers using cutoff walls and seepage collection dams keyed into bedrock and down gradient of the TSF
- Placement of tailings to avoid larger drainages and installation of up gradient storm water diversion channels to divert storm water around the facility.

The applicability of these assumptions for BADCT will need to be reviewed with ADEQ prior to submittal of a permit application during a pre-application meeting.

2.5.2 Hydrological Design Criteria

Under BADCT, the two design storm parameters of importance are: (1) peak flows that are used to size diversion structures such as ditches and spillways; and (2) storm volumes that are needed to size runoff containment ponds or other facilities such as tailings impoundments that collect storm precipitation and runoff. Each of these parameters needs to be established for a specified return period (or frequency), which reflects the level of risk that is incorporated into the design.

For the prescriptive BADCT, the appropriate design storm return period is 100 years unless another regulatory program requires a larger design storm or there is a threat to human life as discussed below. For the individual BADCT approach, a return period needs to be established. It typically ranges from a 25 year event to a 500 year event. If exceedance of the design peak flow or volume could result in failure that would pose an imminent risk to human life, then the Probable Maximum Flood (PMF) event should be used for both prescriptive and individual BADCT.

In establishing the appropriate design flood return period for individual BADCT, the following factors should be considered:

- potential threat to human life;
- potential threat to infrastructure such as bridges, roads, power lines, buildings and railroads;
- potential threat to the environment;
- facility life;
- potential future down-gradient property development; and
- requirements of any other agencies that may be relevant.

Table 2.10 summarizes the minimum storm design criteria selected for the Near West TSF.

Table 2.10 Hydrological Design Criteria

Facility	Design Storm
Scavenger Starter Dam	24 hr 100 yr
Scavenger Starter Dam Spillway	Half 30 day PMF
Cleaner Starter Dam	Half 30 day PMF
Tailings Embankment (up to Year 18)	Half 30 day PMF
Tailings Embankment (Year 19 onwards)	30 day PMF
Permanent Diversion Channel	6 hr PMF
Closure Diversion Channel	24 hr 1000 yr
Seepage Collection Dam	24 hr 200 yr
Seepage Collection Dam Spillway	24 hr 1000 yr

2.5.3 Geotechnical Design Criteria

BADCT provides geotechnical criteria for static and dynamic stability of a tailings embankment as summarized in Table 2.11 and Table 2.12.

The minimum design earthquake is the maximum probable earthquake (MPE) defined as the maximum earthquake that is likely to occur during a 100 year interval (80% probability of not being exceeded in 100 years[4]) and shall not be less than the maximum historical event. This design earthquake may apply to structures with a relatively short design life (e.g. 10 years) and minimum potential threat to human life or the environment. Where human life is potentially threatened, the Maximum Credible Earthquake (MCE) should be used. Judgment should be used to establish the appropriate design earthquake, which may range between the MPE and MCE, taking into account the following factors:

- potential threat to human life or the environment;
- facility life;
- potential future property development downstream of the embankment or earth structure; and
- seismic history in the area.

Geotechnical and seismic criteria selected for the TSF are summarized in Table 2.13.

[4] This is equivalent to 10% probability in 50 years, which equates to an earthquake with a 475-year return period.

Table 2.11 BADCT Static Stability Design Criteria (ADEQ, 2005)

TABLE E-1

Static Stability Design Criteria
(For Both Prescriptive and Individual Approaches)

Facility	Minimum Required Factor of Safety (FOS)
Heap Leach Pile	1.5 Without testing 1.3 With testing(1)
Tailing Impoundment Embankments	1.5 Without testing 1.3 With testing(1)
Embankments Constructed on Tailing or Constructed With Tailing	Final Construction Stage; 1.5 Without testing 1.3 With testing(1) Intermediate Construction Stage; 1.3 Without testing
Large(2) Embankments Associated with Ponds	1.5 Without testing 1.3 With testing(1)
Dump Leach Piles	1.5 Without testing 1.3 With testing(1)
Waste Rock Piles	The applicant is required to establish whether or not discharge can occur. If potential for discharge exists stability analyses should be performed and FOS should meet the same criteria as for Dump Leach Piles.

95-276 (8/10/96/dh)

(1) Refers to site specific testing of material shear strengths and/or liner interface strengths and quality control testing (e.g., moisture, density, grain size) during construction. The testing program should establish drained shear strength parameters for long-term (static) stability analyses and, where appropriate, undrained shear strength parameters for rapid loading conditions (e.g., earthquake or rapid drawdown).

(2) Embankments higher than 20 feet.

Table 2.12 BADCT Dynamic Stability Design Criteria (ADEQ, 2005)

TABLE E-2

<table>
<tr><th colspan="3">Dynamic Stability Design Criteria[1]</th></tr>
<tr><th>Facility</th><th>Prescriptive BADCT</th><th>Individual BADCT</th></tr>
<tr><td rowspan="3">• Heap Leach Piles
• Tailing Impoundment Embankments
• Embankments Constructed on Tailing or Constructed With Tailing
• Large[3] Embankments Associated with Ponds</td><td>• For final construction stages:
- Computed pseudostatic FOS 1.1[2] without testing.
- Computed pseudostatic FOS 1.0[2] with testing.
• For intermediate construction stages:
- Computed pseudostatic FOS 1.0[2] with or without testing.</td><td>• For final construction stages:
- Computed pseudostatic FOS 1.1[2] without testing.
- Computed pseudostatic FOS 1.0[2] with testing.
• For intermediate construction stages:
- Computed pseudostatic FOS 1.0[2] with or without testing.</td></tr>
<tr><td>and/or[4]</td><td>and/or[4]</td></tr>
<tr><td>• Liners and covers:
- Deformations 1 foot, without geomembranes.[5]
- Deformations 6 inches, with geomembranes.[5]
• Covers that are maintained:
- Deformations 1 foot.[5]</td><td>• Predicted deformations shall not jeopardize containment integrity.</td></tr>
<tr><td rowspan="3">• Dump Leach Piles</td><td rowspan="3">Not Applicable</td><td>• For final construction stages:
- Computed pseudostatic FOS 1.1[2] without testing.
- Computed pseudostatic FOS 1.0[2] with testing.[1]
• For intermediate construction stages:
- Computed pseudostatic FOS 1.0[2] with or without testing.</td></tr>
<tr><td>and/or[4]</td></tr>
<tr><td>• Predicted deformations shall not jeopardize containment integrity.</td></tr>
<tr><td>• Waste Rock Piles</td><td colspan="2">The applicant is required to establish whether or not discharge can occur. If potential for discharge exists stability analysis should be performed with FOS and deformation criteria the same as for dump leach piles under Individual BADCT.</td></tr>
</table>

95-276 (8/10/96/dh)

(1) Refer to Section E.2.4.3 for discussion of design earthquake selection.

(2) Applicable only when material types involved (e.g., clayey soils or large, coarse rock fragments) do not exhibit high potential for pore water pressure buildup and associated significant strength loss under loading.

(3) Embankments higher than 20 feet.

(4) For conditions with high potential for pore water pressure buildup and associated significant strength loss deformation analyses must be completed. Also, if loss of life or major environmental impacts are potentially imminent under failure conditions deformation analyses should be performed.

(5) Larger deformations may be acceptable if engineering evaluations are provided to demonstrate that they will not jeopardize containment integrity.

Table 2.13 Geotechnical Stability Criteria

Loading Condition	Design Standard	Design Criteria
1. Static	Two-Dimensional Limit-Equilibrium Factor of Safety with steady state operating pore pressures	FS ≥ 1.5
2. Seismic	Design Earthquake	5000-year return period
	Two-Dimensional Limit-Equilibrium Factor of Safety with operating pore pressures and horizontal seismic coefficient, a_h, equal to 67% of the PGA	FS ≥ 1.1 with a_h = 0.07
	Two-Dimensional Limit-Equilibrium Post-Earthquake Factor of Safety	FS ≥ 1.2 with cyclically induced pore pressures at end of earthquake shaking
	Seismic dam displacements during design earthquake	<1 m *(3.3 ft)* of embankment displacement <0.3 m *(1 ft)* of dam displacement for dams incorporating low permeability core or filter zone <0.15 m *(0.5 ft)* of displacement for slip planes through or on geomembrane/geotextile liners

2.6 Embankment Slopes

Conceptual design crest widths and side slopes adopted for various dams are given in Table 2.14. Slopes are based on stability analysis. Liquefaction and preliminary upstream embankment stability analysis are given in Appendix V. Seepage and static/pseudo-static stability analyses for the tailings embankment can be found in Appendix VI and Appendix VII, respectively, as well as Figure 5.4 to Figure 5.6.

Table 2.14 Design Crest Widths and Side Slopes

Embankment	Crest Width (m) *(ft)*	Upstream Slope	Downstream Slope
Rockfill Dams	10 *(33)*	2H:1V	2H:1V
Earthfill Dams	10 *(33)*	3H:1V	3H:1V
Starter Dams	15 *(49)*	3H:1V	3H:1V
Seepage Dams	8 *(33)*	3H:1V	3H:1V
Upstream Tailings Embankment Raises	18 *(59)*	N/A	5H:1V

2.7 Plant Location

The concentrator will be located at the proposed West Plant site north of Superior as shown in Figure 1.1. The approximate plant elevation is 930 m *(3,051 ft)*. Thickened tailings slurry will be fed by gravity from the West Plant to a tie-in location on the north side of the TSF site (El. 820 m *(2690 ft)* approx.). Figure 3.1 shows the approximate location of this tie-in.

2.8 Closure

Closure of the TSF is based on the following preliminary assumptions and design criteria:

- The surfaces underlain by thickened cleaner tailings will be covered with an engineered cover and vegetated with a native seed mix.
- The surfaces underlain by thickened scavenger tailings will be covered with an erosion resistant layer and vegetated with a native seed mix.
- The slopes of tailings embankment will be covered with rockfill armoring and vegetated with a native seed mix.
- The TSF will be capable of storing the entire 30-day PMF flood without discharge.
- The upstream diversions and containment dams (North Dams) will be maintained on closure to protect the TSF from floods and erosion.
- The seepage collection dams will be maintained on closure to passively manage seepage by evaporation.

The criteria listed above represent a typical closure scenario. The final closure plans will need to follow accepted design processes including laboratory testing, modeling and large scale field trials of cover designs. Importantly, field experience will also have been obtained from on-going closure of existing tailings impoundments in Arizona.

3 SITE CHARACTERIZATION

3.1 Location and Setting

The Near West site encompasses an area of approximately 16 square kilometers *(6 square miles)* west-northwest of the town of Superior, and north of Highway 60. The site includes all or portions of sections 18, 19, 30, and 31 of T.1 S., R.12 S., and sections 13, 22, 23, 24, 25, 26, 27, 34, 35, and 36 of T.1 S., R.11 S, in Pinal County, Arizona. The site plan is shown in Figure 3.1 and the divisional sections are shown in Figure 3.3.

The site is approximately 8 km *(5 mi)* from Superior and the West Plant. The site can be accessed from gravel roads off of Highway 60. The area is bordered on the north by a mountain range separating it from the Superstition Wilderness Area.

3.2 Land Use

The land management status for the Near West site is shown in Figure 3.3. The site is entirely on US Forest Services land. The Arizona Trail passes to the east of the site through Rice Water Canyon and Whitford Canyon (shown on Figure 3.1). The site is bordered on the south by a section of private land and a railroad.

The site is primarily used for livestock grazing, ranching and road access to recreational areas. Vegetation comprises mainly of desert shrubs and cacti.

3.3 Geomorphology

Near West is founded on a series of bedrock ridges and valleys running north-south. The main valleys from east to west are Benson Canyon, Bear Tank Canyon and East Fork Roblas Canyon. The base elevation of the TSF area is approximately at 700 m *(2,297 ft)*, and the northern extents rise up to 860 m *(2,822 ft)*. The site is bounded on the east and west by Potts Canyon and Roblas Canyon, respectively.

The valleys are ephemeral drainages, the bases of which are infilled with thin sand and gravel alluvial deposits. These streams flow north to south into the Queen Creek. The creek gradients range typically from 3% to 5%.

Geophysical surveys were done by hydroGEOPHYSICS, Inc. (HGI) in certain areas of the Near West site to determine depth of alluvium, depth of bedrock weathering and shear wave velocity of bedrock. The results suggest that the depth of alluvium in the creeks ranges from 2 m to 10 m *(6.6 ft to 33 ft)* maximum. The report discussing their results is included in Appendix II.

The regional catchment areas of these drainages are shown in Figure 3.1. The tailings facility was laid out to avoid the major drainages from Potts Canyon and Roblas Canyon (catchments 4 and 6).

3.4 Regional Geology and KCB 2013 Field Mapping

3.4.1 Regional Geology

Geology in the area was mapped and described previously by Spencer and Richard (1998) (Figure 3.4 and Appendix I). The oldest bedrock unit in the TSF area is the early-Proterozoic Pinal Schist which brackets the north end of the site and is exposed between the embankment and Queen Creek, in the south. As such, the Pinal schist is the dominant unit that will control any groundwater flow between the TSF and Queen Creek.

The schist is overlain by the middle Proterozoic aged Apache Group which consists of siltstone, quartzite, limestone and minor conglomerate and basalt. The Apache group is often intruded by similarly aged diabase. Younger, Paleozoic limestone and quartzite units overlie the Apache Group near the west edge and northwest corner of the site. Tertiary volcanic units include tuff, basalt, and perlitic rhyolite, the last of which forms steep cliffs and ridges at the northeast corner of site (the “Perlite Area”). The central and eastern portions of the TSF are dominated by Tertiary aged Gila Conglomerate which forms ridges oriented north to south, separated by creek channels. The conglomerate grades downslope into bedded sandstone in the southeast corner near Potts Canyon Bedrock is generally exposed at the surface, with the exception of alluvial sediments in stream channels, and “Old Alluvium” deposits concentrated at the south end of site at lower elevations.

Numerous faults were mapped by Spencer and Richard in the west and north “mixed” geology areas. Regional data suggests that the area has undergone significant extension, leading to normal faulting. The vast majority of the extensional displacement was accommodated by the Concentrator and Roblas Canyon faults, located northwest and northeast of the TSF, respectively (Spencer and Richard, p.1). According to Spencer and Richard, the “normal faulting and tilting ended after volcanism and during deposition of conglomerate and sandstone”. Thus, the Gila Conglomerate unit is largely undeformed by faulting.

3.4.2 2013 KCB Site Reconnaissance

KCB conducted a site reconnaissance in 2013. The purpose of the investigation was to:

- identify, describe and photograph soil and rock units exposed on site;
- visually assess the strength and permeability of the soil and rock units;
- assess the suitability of the Gila Conglomerate unit in preventing or minimizing seepage and estimate its acid neutralization potential; six exposures of the Gila conglomerate were mapped in greater detail in Bear Tank Canyon, where the cleaner tailings will be deposited;
- locate potential sites for seepage collection dams; and
- sample and test unconsolidated alluvial sediments to determine suitability as dam fill.

The investigation, field observations and laboratory data are provided in Appendix I. General geotechnical observations made of the different bedrock units are summarized in Table 3.1. Units are listed in order or age (youngest to oldest).

Table 3.1 Field Observations of Bedrock Units

Unit Symbol	Unit Name	Field Description
Tcg	Gila Conglomerate	Massive or sub-horizontally bedded conglomerate. Well graded with particle sizes ranging from fines to boulders, clast or matrix supported, differential weathering of beds common with finer, siltier beds weathering most readily, no acid reaction to strong acid reaction in matrix, unjointed with some small fractures typically terminating at bedding interfaces and open fractures caused by root penetration, weak to strong rock (R2 to R4), typically with strength loss on wetting.
Tss	Sandstone	Sub-horizontal parallel beds ranging from 20 cm to <1 mm *(8" to <0.04")* thick, grain size ranging from fines to cobbles, differential weathering of beds with finer, siltier beds weathering most readily, matrix reactive to acid, medium strong rock (cemented beds) to soil-like (weakly cemented to uncemented silty beds) (R3 to R0).
Tb	Basalt	Very blocky to disturbed, closed to open tightly spaced (avg. ~ 10 cm *(4")*) joints, planar to undulating joint surfaces, calcite infilling of joints and calcite mineralization on the rock surface observed in some outcrops, very strong to extremely strong rock (R5/R6).
Tp	Perlitic Aphyric Rhyolite	Variable unit which includes banded rhyolite, perlite and brecciated rhyolite. Weak, glassy perlite often interlayered with microcrystalline silica, parallel layers are randomly oriented regionally, material appears massive and unjointed in large cliff exposures, isolated sub-vertical fractures observed in some exposures, weak (glassy perlite, R2) to extremely strong (microcrystalline silica and rhyolite, R6) rock.
Tal	Apache Leap Tuff	Massive felsic tuff, often found with parallel vertical joints, strong to very strong rock (R4-R5).
Tt	Tuff (poorly welded)	Felsic tuff, massive or "bedded" with some exposures showing differential weathering of finer beds, jointed or intact, R2 to R4, less dense and tends to have a finer matrix than Tal.
Me	Escabrosa Limestone	One exposure observed on the west side of Roblas Canyon. Fine grained massive limestone, fractures well healed with calcite, reactive to acid, shallow discontinuous fractures and "pitting" on surface, very strong rock (R5).
Dm	Martin Formation	Variable unit that ranges from fine grained calcareous siltstone to coarse grained calcareous sandstone and conglomerate. Typically sub-horizontally bedded with differential erosion of finer beds noted, jointed or massive, joints/fractures on fresh surfaces observed to be well healed with calcite, reactive to acid, medium strong to very strong rock (R3 to R5).
Cb	Bolsa Quartzite	Coarse to fine grained quartz arenite/quartzite. Limited exposures, tends to be exposed as cobbles at surface, parallel to cross-bedded structure visible in cobbles, one brecciated outcrop observed, extremely strong rock (surface cobbles) (R6) to medium strong rock (exposure of fractured quartzite) (R3).
Yd	Diabase	Limited exposures, typically appears as weathered (oxidized) gravel and cobbles at surface. Outcrops are heavily fractured or show tightly spaced joints, fractures sometimes infilled with calcite, medium strong (fractured rock mass) to extremely strong (intact) rock (R3 to R6).
Ym	Mescal Limestone	Fine grained limestone. Bedded with differential weathering of fine soil-like silty beds between much more competent calcareous siltstone, tightly spaced joint sets and fractures commonly found cross cutting bedding planes, reactive to acid, medium strong to very strong rock (calcareous siltstone R3 to R5).

Unit Symbol	Unit Name	Field Description
Yds	Dripping Springs Quartzite, undivided	Fine grained quartz arenite. Alternating red and white quartz sand laminations, rock fractures preferentially along bedding planes, fractures and joints cross cut bedding planes, strong to extremely strong rock (R4 to R6).
Ydsu	Dripping Springs Quartzite, Upper Unit	Ranges from siltstone to fine grained quartz arenite, laminated, breaks preferentially along lamination planes, other joints and fractures typical cross cutting bedding laminations, some calcite infilling seen in fractures, strong to very strong rock (R4 to R5). Also exposed as a breccia which forms jagged outcrops with clasts of intact Ydsu in an oxidized siliceous matrix.
Yp	Pioneer Shale	Finely laminated quartz arenite and shale/siltstone, bedded with alternating shaley and sandy beds, fractures preferentially along bedding planes, other joints and fractures typical, cross cutting bedding planes, rock strength varies from weak rock (shale beds)(R2) up to extremely strong rock (quartz arenite beds)(R6).
Xpc	Pinal Schist, Calc-silicate Facies	One small exposure visited. Strongly foliated with mm spaced foliation cleavage planes, evidence of folding, quartz veining, undulating and smooth cleavage planes, strong rock (R4).
Xpm	Pinal Schist, Psammite Facies	Strongly foliated with preferential fracturing along foliation cleavage planes, dominant foliation cleavage spaced at cm to mm scale, undulating to planar, smooth foliation cleavage surfaces, some shear/fracture zones observed in outcrops, strong rock (R4). Foliation orientation highly variable regionally.
Xpp	Pinal Schist, Phyllite Facies	One exposure visited. Parallel foliation cleavage surfaces avg. 1 cm *(0.4")* apart, closed, some other randomly oriented fractures cross cutting foliation planes, one open vertical joint observed in exposure, foliation cleavage surfaces planar to undulating with "grainy" surface texture, very strong rock (R5).
Xps	Pinal Schist, Pelitic Schist	One exposure visited. Blocky with variable joint spacing (30 cm to mm *(12" to 0.04")* scale), wide to closed joints, one vertical shear zone observed in exposure.

General observations relevant to the design of the TSF, especially containment of the cleaner tailings, are:

a) The width of drainage channels and thickness of alluvial sediments decreases at higher elevations, where the channel gradients are steeper.

b) As evidenced by acid reaction tests, carbonate content in older alluvium sediments is variable from low to high, whereas carbonate content in active channel sediments is consistently very low to non-existent.

c) Discontinuities (joints, bedding, cleavage foliations) within any of the rock units are not oriented in such a way as to adversely affect embankment stability.

d) Gila Conglomerate:

- Sub-horizontal bedding is apparent, especially at lower elevations. At higher elevations, further upstream in the creek channels, the unit becomes more massive with larger clasts, less particle sorting and bedding is less apparent.
- Loss of strength is observed on wetting which may be due to loss of apparent cohesion between granular particles.
- Acid reaction occurs in the matrix of the rock and originates from the carbonate cementation. Bulk acid neutralization potential is therefore dependent on the amount of matrix present.
- Consistent bedding orientation was measured in outcrops and no vertical faulting or joint sets were observed indicating that the material hasn't undergone significant deformation. This is consistent with Spencer and Richard's comments above.
- Ponding water and moist sediments in creek channels indicate that the Gila is capable of holding water (i.e., is of low permeability and limits infiltration).

e) The Perlite Area:

- A general topographic sequence appears to exist in the unit. At lower elevations siliceous rhyolite and rhyolite breccia was observed which transitions into perlite with well developed "glassy" texture and silica inclusions. Harder perlite with less well developed "glassy" texture, typically banded with silica is generally exposed along ridges and topographic highs. Columnar jointing and "tilting" of layers was observed near the top of cliff faces.
- Perlite fractures preferentially along parallel banding and "layers". Regionally these layers have variable orientation.
- Ponding water on exposed perlite surfaces in drainage channels indicates that the unit is capable of holding water (i.e., is of low permeability and limits infiltration).
- Open, sub-vertical joints were observed in outcrops, however these joints were observed to close off quickly with depth. Few vertical discontinuities and no joint sets were

observed in large exposures which indicate the absence of large scale tectonic deformation.

f) The most suitable materials for embankment construction are alluvium and Gila Conglomerate. Active channel sediments may be suitable for use in embankment filters and/or drains and as a drainage medium in underdrains; however available volumes are likely small.

g) The Apache Leap Tuff (Tal) and Basalt (Tb) units are likely the best sources of riprap due to their relatively high strength and low friability.

h) Additional sub-surface investigation is required to determine the nature of the contacts between the Devonian, Cambrian and Proterozoic units in the “mixed” geology areas. Faults and shear zones may increase the bulk permeability of these rock units.

3.5 Hydrogeology

Montgomery and Associates conducted a preliminary hydrogeologic assessment (M&A, 2012) and site reconnaissance (M&A, 2013) at the Near West site. The following summaries are taken directly from the 2013 report.

From the Background Section (referring to the 2012 preliminary assessment): *Based on results of the hydrogeologic assessment, the following hydrogeologic units (in descending order) were inferred to occur in the subsurface at the Near West site:*

- *A thin veneer of unconsolidated active Quaternary alluvium and weakly consolidated older Quaternary alluvium on and adjacent to the floors of canyons and washes*
- *Tertiary conglomerate, sandstone, and volcanic rocks of relatively low permeability, except where fractured, which are exposed across most of the site*
- *Paleozoic sedimentary rocks including carbonates, siltstone, shale, and quartzite of relatively low permeability, except along bedding planes and where fractured, which are exposed in the western part of the site and underlies younger units in the remainder of the site*
- *Younger Precambrian sedimentary and igneous rocks including quartzite, shale, limestone, and diabase of low to very low permeability, except along bedding planes and where fractured, which are exposed in the northeastern, western and southwestern parts of the site and underlies younger units in the remainder of the site*
- *Older Precambrian crystalline metamorphic rocks (Pinal Schist) of low to very low permeability, except along relict bedding surfaces and where fractured, which is exposed in the northern, southern, and southwestern parts of the site and underlies younger units in the remainder of the site*

Hydraulic properties for these units at the Near West site are not available. However, based on data collected at the RCM West Plant site, hydraulic conductivities were estimated to be:

- *Alluvium – 3.4 x 10^{-5} centimeters per second (cm/sec) (1.3 x 10^{-5} inch/sec)*

- *Tertiary Gila Conglomerate – 6 x 10^{-9} to 1.1 x 10^{-5} cm/sec (2.4 x 10^{-9} to 4.3 x 10^{-6} inch/sec)*
- *Mudstone unit within the Gila Conglomerate – 1.3 x 10^{-9} cm/sec (5.1 x 10^{-10} inch/sec)*
- *Volcanic units interbedded with the Gila Conglomerate – 1 x 10^{-5} cm/sec (3.9 x 10^{-6} inch/sec)*
- *Younger Precambrian sedimentary rocks and diabase – 4 x 10^{-6} cm/sec (1.6 x 10^{-6} inch/sec)*

- *Data collected for Precambrian sedimentary rocks, diabase, and schist located in the Cross Canyon area southeast of Superior yielded an estimated hydraulic conductivity of 1 x 10^{-6} cm/sec (3.9 x 10^{-7} inch/sec)*

Data collected for the Tertiary Apache Leap Tuff in the Oak Flat area east of Superior yielded estimated hydraulic conductivities ranging from 2 x 10^{-7} to 6 x 10^{-3} cm/sec (7.9 x 10^{-8} to 2.4 x 10^{-3} inch/sec.

As part of the Queen Creek corridor survey, groundwater levels were measured in selected wells in the Superior basin during the period May to September 2012. For wells in the vicinity of the Near West site, depth to groundwater level was in the range of 3.2 m bls to 16.7 m bls (10.5 ft bls to 54.7 ft bls. Groundwater is believed to be moving generally from northeast to southwest (M&A 2012).

From the 2013 site reconnaissance:

The following conclusions are based on results of the Phase I Hydrogeologic Assessment of the Near West site:

- *Geologic mapping by Arizona Geological Survey (AZGS) appears to be generally accurate with some relatively minor exceptions at a local scale. Small-scale features were not always mapped locally, and small inconsistencies were noted along some of the traverses. Near the southwest corner of the proposed tailing impoundment, faulting was observed to be more complex than shown on the published geologic map.*
- *With the exception of Quaternary alluvium along ephemeral stream channels, permeability for all geologic units at the site would be low to very low except where fractured. Fracturing of rock units was most evident along and adjacent to mapped faults in the northern part of the proposed tailings impoundment. However, some evidence of fracturing was also observed in rock units in the western and southwestern parts of the proposed tailings impoundment.*
- *Three springs occur in the vicinity of the Near West site, including Happy Camp, Benson, and Bear Tank Canyon Springs. Discharge was observed at Happy Camp and Bear Tank Canyon Springs, but not at Benson Spring. Happy Camp and Bear Tank Canyon Springs occur within the Tertiary conglomerate. Benson Spring occurs near the contact between the Tertiary conglomerate and the Pinal Schist. A feature mapped as Perlite Spring was inspected. Three apparent surface water impoundments occur in the vicinity of the perlite quarries in the northern part of the site, but are not believed to be springs. Samples were*

collected for laboratory chemical analyses from Happy Camp and Bear Tank Canyon Springs.

- *Results of pilot infiltration testing indicate that the "bottomless bucket" method provided an appropriate means for measuring infiltration rates and field-saturated hydraulic conductivity (Ksat) of exposed bedrock surfaces. The generally very low Ksat values determined by these pilot tests are consistent with the general magnitude of Ksat values that would be expected for these bedrock units.*

4 TAILINGS MANAGEMENT OVERVIEW

4.1 General

This section provides an overview of the general tailings management plan for operation and closure of the TSF. Details of the embankment, impoundment water balance, water control structures, mechanical systems, and operating controls are provided in Sections 5 to 9. The preliminary closure plan is discussed in Section 10.

4.2 General Layout

Figure 4.1 and Figure 4.2 presents the modeling results for the TSF at major development stages throughout the mine life, and Figures 4.3 to 4.12 present the plan layout of the TSF at 5 year staged intervals. The ultimate TSF is approximately 5 km *(3.1 mi)* by 3.5 km *(2.2 mi)* in size and covers 1,450 ha. The site is strategically positioned between Potts Canyon and Roblas Canyon, avoiding those drainages and thereby allowing the larger storm water flows to pass by and minimizing upstream runoff and the size of diversion structures.

The thickened scavenger tailings will be deposited behind an upstream raised embankment on the east, south and west sides of the TSF. The North Dams confine the north side and comprise rockfill starter dams followed by upstream raised tailings embankments. They also provide security for diversion of upstream non-contact water during long-term closure.

For the initial ten years the tailings will be deposited into the east cell. From Year 10 to Year 18, the east cell and west cell will operate simultaneously. After Year 18, the cells merge and act as one TSF.

Cleaner tailings will be deposited behind a separate internal starter dam for the initial eight years and thereafter deposited in the reclaim pond. The cleaner tailings are strategically sited to minimize the potential for ARD. This includes placing the tailings on low permeability Gila Conglomerate, saturating the tailings in the reclaim pond during operations and encapsulating the tailings within low-permeability slimes segregated from the scavenger tailings for closure.

No large external borrow sources of fill will be required for construction since the embankment will be an upstream raise. General fill will be required for starter dams and seepage dams. Additional sources will be required to supply fill for engineered fill zones such as filters, drains and riprap armoring. These material requirements and estimated availability from within the impoundment footprint are given in Appendix XIII.

4.3 Tailings Staging Plan

Three-dimensional modeling of the tailings deposition and embankment raising was carried out using the computer software Muck 3D (Appendix IV). The results are summarized in Figure 4.1 and Figure 4.2 and layouts every five years are shown in Figures 4.3 to Figure 4.12.

Tailings deposition is developed in three major stages:

- Stage I – East cell development (Years 0 – 10):

  Scavenger tailings are initially placed behind a general fill starter dam. Thereafter, the scavenger tailings will be deposited from berms on the embankment crest. A minimum scavenger beach above water length of 150 m *(492 ft)* is required for embankment stability and flood storage.

  A separate starter dam is constructed from general fill for the cleaner tailings with a crest elevation of 768 m (43 m high) *(2,520 ft (141 ft high))*. Cleaner tailings are deposited sub-aqueously along the crest of the starter dam until the end of Year 8, at which point the tailings are discharged into the reclaim pond from pipelines extending into the TSF from the valley ridges. A 0.5 Mm^3 *(405 acre-ft)* cleaner tailings reclaim pond is maintained to keep the cleaner tailings saturated and to allow for clarification of the water in the reclaim pond.

- Stage II – East and west cell development (Years 11 – 18):

  In Year 11 of operation, scavenger tailings deposition in the west cell begins. Cleaner tailings continue to be deposited into the reclaim pond of the east cell. From Year 13 to the end of Year 18, scavenger tailings are typically distributed 20% and 80% between the east and west cells, respectively. To minimize the southern movement of cleaner tailings, the scavenger tailings is divided 40% and 60% respectively between the east and west cells in Year 15. In Year 18, 10% of the scavenger tailings are deposited from a pipeline along ridges within the extents of the north east crest of the east cell. This forces the east tailings pond towards the center of the east cell to decrease the length of the cleaner tailings beach.

- Stage III – Combined cell development (Years 19 – 45):

  At the end of Stage II, the east and west cells reach the same embankment elevation. In Year 19, the joined cells are raised together and in Year 21, the east and west cells coalesce with one reclaim pond. From Year 29 to Year 45, cleaner tailings are deposited from a pipeline along access berms constructed within the impoundment. This pipeline maintains the deposition of the cleaner tailings to the center of the TSF, generally above Gila Conglomerate.

The rate of embankment rise, above the initial starter dam crests, ranges between 1 m/yr and 8 m/yr *(3.3 ft/yr and 26.2 ft/yr)*.

4.4 Cleaner Tailings Placement Strategy

The cleaner tailings will initially (for the first eight years) be deposited behind an internal starter dam positioned 1.5 km *(0.9 mi)* upstream of the embankment toe. Thereafter, the cleaner will be deposited in the interior of the scavenger tailings pond from ridges and, ultimately, from access berms extending into the TSF from the North Dams. Figure 4.13 shows the location and typical section of the access berms. These berms will be approximately 10 m *(33 ft)* wide and raised incrementally 1 m to 3 m *(3.3 ft to 9.8 ft)* annually to keep above the rising tailings level. The berms will be constructed with rockfill borrow or segregated coarse tailings borrowed from the beach.

Some of the advantages of this tailings deposition scheme in mitigating potential geochemical impacts are:

- The PAG cleaner tailings will be maintained in a saturated state during active deposition during operations to prevent or reduce oxidation and potential acid generation until they can be covered and encapsulated with scavenger tailings.
- The cleaner tailings will be encapsulated and covered in the finer tailings slimes that segregate during deposition from the thickened scavenger tailings and collect in the reclaim pond. The low hydraulic conductivity of the tailings slimes will minimize infiltration into and out of the cleaner tailings. It will also reduce or prevent oxygen ingress.
- Any seepage pathway from the cleaner tailings to any environmental receptors is maximized, taking advantage of the long lag time for seepage to reach the receptors and attenuation of any constituents along the seepage pathways.
- Final capping of the cleaner tailings with an engineered cover provides a buffer between surface runoff and the cleaner tailings.
- The cleaner tailings are deposited on the Gila Conglomerate, which has a low to very low bulk permeability and excess neutralization potential.

4.5 Water Management

The upstream catchment will be diverted by diversion channels (Figure 7.2) designed to convey the peak PMF flow.

Water will be continuously reclaimed from the TSF, keeping the pond between 2 million m^3 to 6 million m^3 *(1620 acre-ft to 4860 acre-ft)* for clarification of the water and to keep the cleaner tailings saturated. The scavenger starter dam will be sized to contain the first year of tailings, an operating pond volume of 1 million m^3 *(810 acre-ft)* and the 100-year 24-hr flood from the local upstream catchment. A temporary spillway (to be designed in next design phase) will be provided to route the half 30-day PMF flood during the first year of operations from the total TSF catchment. During this time, the cleaner tailings starter dam will store the half 30-day PMF flood from the upstream catchment. From Year 2, the TSF will be able to contain a half 30-day PMF flood without overtopping up to Year 19. Thereafter, the TSF will be able to store the full 30-day PMF flood. Reclaimed water will be pumped back to the West Plant (system designed by others).

The average seepage rate from the TSF is predicted to be 0.3 m^3/day per meter *(10.6 ft^3/day per foot)* of crest width. Seepage from the toe of the embankment will be collected by eleven seepage collection dams (SCD). These ponds are sized for a normal operating pond depth of 3 m *(9.8 ft)* and to store the runoff from a 200-year 24-hour storm without discharge. The SCD water will be pumped back into the TSF.

Water balance calculations indicate the TSF will operate in a net water deficit. The total deficit[5] is 640 million m^3 *(5190 acre-ft)* over the 45 year operating life, equating to an average deficit of 490 L/s *(6470 USGPM)*, or 0.44 m^3/tonne *(14 ft^3/tn)* of tailings.

4.6 Upstream Embankment

The main tailings embankment will be an upstream constructed scavenger tailings embankment with an 18 m wide *(60 ft)* (average width) trafficable zone on the outer slope and downstream slope of 5H:1V. At the ultimate crest elevation of 855 m *(2,805 ft)*, the maximum embankment height is 175 m *(574 ft)* and the final crest length is about 9800 m *(32,150 ft)*.

Starter dams of compacted general fill will be constructed in the valleys bottoms for initial tailings deposition. Subsequent upstream berm raises will be constructed from compacted tailings locally borrowed from the upstream beach deposits.

A network of underdrains in the existing drainage pathways will be installed under the embankment to keep the water level in the embankment depressed. The details of the tailings embankment and the underdrain system are shown on Figure 5.1 to Figure 5.3 and Figure 5.7.

4.7 Dam Structures

The North Dams will contain the tailings and encroaching reclaim pond at the north end of the site, as well as protect the TSF from floods from the upstream catchment on closure. The base case design of the Northeast Dam comprises a 15 m high starter dam followed by an upstream raised tailings embankment. The Northwest Dam comprises a 30 m *(98 ft)* central core[6] rockfill dam, followed by a raised tailings embankment. This design optimizes borrow requirements and construction costs for the North Dams from the alternative design. Details of the base case design are shown on Figure 5.10.

An alternative design for the North Dams is shown on Figure 5.11. Both the Northeast and Northwest Dams are central core rockfill dams with crest widths of 10 m *(33 ft)*, and upstream and downstream slopes of 3H:1V. This alterative design was used for deposition modeling, seepage reclaim design and all designs shown in the figures of this report. The base case configuration shown in Figure 5.10 was optimized later in the design.

The seepage collection dams (SCDs) will contain the seepage from the TSF as well as surface runoff from the tailings embankment slopes. Similarly to the North Dams, the dams will be a zoned earth and rockfill structure with an impermeable asphalt core. The crest widths are 8 m *(26 ft)*, with upstream and downstream slopes of 3H:1V. Typical details of the dams are shown on Figure 5.7 and Figure 5.8.

[5] Total deficit is the make-up water required to process the tailings at 30% solids density in the concentrator.
[6] Asphalt core proposed for the Mine Plan of Operations Study and cost estimating.

4.8 Monitoring and Operating Controls

Groundwater monitoring wells located downstream of the facility and piezometers set below the embankment will be used to monitor the performance of the SCDs. Water from the reclaim pond and SCDs will also be sampled and tested regularly for quality.

The stability of the tailings embankment and North Dams during construction and operations will be monitored by piezometers installed in the dam and the foundation, and by survey monuments on the dam crest and slopes. These instruments will be observed and reported on a regular basis with recommended contingency measures for reducing seepage or increasing stability, if required.

Dust from the TSF will be monitored and actively managed with sprinklers and dust suppressants if necessary.

4.9 Closure

The configuration of the TSF at closure is shown on Figure 9.1 and Figure 9.2. The reclaim pond is expected to diminish in size after closure to 2.5 million m^3 *(2030 acre-ft)* or less. The storage capacity of the TSF exceeds that required to store the 30-day PMF flood.

The embankment slopes will be armored with a riprap layer to prevent erosion. The scavenger tailings beach will be covered with a minimum of 150 mm *(6")* of sand and gravel, and re-vegetated to mimic natural ground conditions in the area. The area above the cleaner tailings will be capped with an engineered cover to prevent and minimize ARD and seepage.

4.10 BADCT Compliance

The Near West TSF will use the Individual BADCT approach. The following design elements, taken from the BADCT manual (the Individual BADCT base metals tailings impoundment section), will be used to demonstrate BADCT for the Near West TSF:

Individual BADCT Design Elements	Proposed Approach for Near West Site
▪ Interception of storm run-off and groundwater flow in shallow aquifers to minimize water inflow.	▪ Achieved by a combination of the low permeability Pinal Schist serving as a groundwater barrier between the TSF and the Queen Creek basin at the toe of the facility and dams or cutoff walls keyed into bedrock located around the facility to collect surface and seepage water.
▪ Natural geologic features functioning as liners and/or discharge control.	▪ Gila Conglomerate and Pinal Schist have low to very low permeability, cover a majority of the TSF basin, and are expected (at least in the case of the Gila Conglomerate) to have excess neutralization capacity.
▪ Provision of sub-drainage beneath the impoundment to minimize hydraulic head and promote dewatering after closure.	▪ Design includes extensive finger drains at the base of the embankment to facilitate collection of seepage, and minimize seepage losses to groundwater.
▪ Leachate collection systems consisting of granular finger or blanket drains and corrugated perforated HDPE pipes can be used to supplement natural sub-drainage (Brawner, 1986).	▪ Design includes extensive finger drains at the base of the embankment to facilitate collection of seepage, and minimize seepage losses to groundwater.

Individual BADCT Design Elements	Proposed Approach for Near West Site
- Drains and reclaim water pump back systems to lower or eliminate the phreatic surface in the embankment.	- Inclusion of drains, seepage dams and collection and pump back systems.
- Channels and dikes or berms to collect run-off from downstream slopes.	- Toe ditches around embankment to facilitate drainage to the seepage collection dams. Additionally, up-gradient diversions will redirect storm water around the facility, reducing overall volume of run-off to be collected.

5 TAILINGS EMBANKMENT DESIGN

5.1 Upstream Embankment Design

Figure 5.1 to Figure 5.3 present the design layout and sections of the upstream tailings embankment. Initial starter dams for scavenger deposition will be built of locally borrowed Gila Conglomerate in valley bottoms. Where starter dams are not present, low “deposition berms” will be built along the ultimate toe of the embankment to support the tailings pipelines for initial deposition. The embankment will be raised upstream by constructing berms from tailings locally borrowed on the upstream tailings beach. The crest width is nominally 10 m *(33 ft)* to provide room for tailings pipelines and vehicle traffic.

An underdrain system is provided to depress the phreatic surface in the tailings embankment and aid in tailings consolidation, improve embankment stability, minimize seepage losses, and convey seepage water to the SCDs. The underdrains will be constructed in existing drainage channels and consist of a high capacity rockfill core encapsulated in a sand and gravel filter to prevent tailings and other fine material from entering the drain core. The drain layouts are shown on Figure 5.7. There will be two drain sizes, primary underdrains and secondary underdrains. The drains are sized to convey at least 20 times the estimated design flows.

Portions of the east side of the facility abut directly against a ridge and will require a 20 m *(66 ft)* wide local blanket drain upstream of the initial deposition berms to depress the phreatic surface for stability. Details of the local blanket drain are shown on Figure 5.7.

5.2 Stability and Operational Seepage Analysis

The stability of the tailings embankment was analyzed for typical sections. The plan is shown on Figure 5.4 and sections are shown in Figure 5.5 and Figure 5.6.

5.2.1 Operational Seepage Analysis

Seepage analysis was performed to determine the phreatic surface in the embankment for stability analysis during operations. The seepage performance of the tailings embankment was assessed using the two-dimensional finite element software SEEP/W, details of the analyses are given in Appendix VI. The model assumed embankment cross-sections with 5H:1V outer slope constructed of 18 m *(59 ft)* of freely draining compacted material, and 1% slope of “wetted” tailings beach, with “wetted” tailings beach starting 100 m *(328 ft)* from the embankment crest. Results of the operational seepage analyses are given in Figure 5.5 and are summarized below.

- The phreatic surface is generally a minimum of 5 m *(16 ft)* below the tailings surface.
- The permeable starter dams are effective at drawing the phreatic surface down in the tailings and preventing a seepage face from developing on the embankment slope; provided the permeability of the dam fill is relatively high (5×10^{-5} m/s *(1.6×10^{-4} ft/s)* was used in analysis).
- At Section E, the starter dam must be augmented with a 20 m *(66 ft)* wide blanket drain to achieve acceptable drawdown of the phreatic surface. The area that requires blanket drains are shown in Figure 5.7.

- Seepage rates during operation range from 0.19 m^3/day *(0.25 yd^3/day)* to 0.36 m^3/day *(0.47 yd^3/day)* per meter of embankment crest. An average seepage rate of 0.3 m^3/day *(0.4 yd^3/day)* per meter of embankment crest was assumed for design of seepage dams, size underdrains and input into the water balance.

5.2.2 Stability Analysis

Post-Earthquake Analyses

Liquefaction and post-earthquake stability analyses were carried out and results of the analysis are given in Appendix V.

The analysis was based on the seismic design parameters from the site specific seismic hazard assessment by URS (2013). 5,000 year return period ground motions (or probability of exceedance of 1% in 50 years) were taken as the maximum design earthquake ground motions for the tailings embankments at the Near West site.

A M5.4 earthquake at 40 km distance and M7.7 earthquake at 375 km *(233 mi)* distance were identified by URS (2013) as controlling or scenario earthquakes corresponding to short period (0.2 s) and long period (1 s) ground motions. It was found that the critical earthquakes were the magnitude M7.7 earthquakes originating at the San Andreas Fault. Although the peak ground acceleration is less than that for the local earthquake, the conditional mean spectrum (CMS) of 1.0 s for the more distant earthquakes is nearer to the natural frequency of the embankment, and thus results in greater cyclic stress ratios (CSRs) due to amplification effects.

Ground response analyses were conducted for 1-D soil columns representing the proposed tailings embankment to determine the susceptibility of tailings to liquefaction using the program PROSHAKE (Edupro 2005) for different tailings thicknesses, depths to water table and with and without a free draining material cover. A Standard Penetration Test $(N_1)_{60}$ value of 7 was adopted for the tailings based on experience at similar facilities. The liquefaction assessment of granular soils was carried out in general accordance with Seed’s simplified approach recommended by Idriss and Boulanger (2008).

Based on the results, liquefaction is unlikely to occur for any of the scenarios analyzed. Some buildup of pore water pressure during shaking will occur, which is taken into account for stability analysis. For the stability analysis, the reduced tailings friction angles were reduced based on the Ru values calculated from the PROSHAKE analyses.

Stability analyses yielded post-earthquake factor of safety target between a minimum of 1.2 to 1.5. The post-earthquake stability of the embankment meets the target factor of safety.

Static and Pseudo-Static Analyses

Static and pseudo-static stability analyses in Appendix VII indicate that the tailings embankment with 5H:1V slopes meets and exceeds all factor of safety criteria for static and pseudo-static dynamic loading. Results are given in Figure 5.6.

5.3 Seepage Collection Dams

The eleven seepage collection dams (SCDs) will be built early in construction to act as sediment ponds for starter dam construction and to capture seepage. They are shown on Figure 5.8, with a typical SCD shown on Figure 5.8 and a section is shown on Figure 5.9. The SCDs will have a minimum crest width of 8 m *(26 ft)* and 3H:1V side slopes. The upstream slope will be armored to protect against wave action. The SCDs will be rockfill dams with an impermeable core.

5.4 North Dam Design

There are two design options for the North Dams. The alternative North Dams (Figure 5.11) were used for tailings deposition plans and are shown in the designs on the figures. The base case (Figure 5.10) is an optimization of the alternative design.

5.4.1 Base Case North Dams

The optimization is the base case North Dams and the layouts and sections are shown on Figure 5.10.

The Northeast Dam was optimized with a starter dam built to El. 825 m *(2,707 ft)* by Year 20 followed by an upstream raised tailings embankment to El. 855 m *(2,805 ft)*. The starter dam is built to an elevation that would allow for redundant passage of an extreme flood through the diversion invert before it inundates the upstream raised embankment. Seepage will be collected at the toe of the starter dam and pumped back to the TSF reclaim pond.

The Northwest Dam will be reduced in height to the elevation 835 m *(2,739 ft)*, which is 5 m *(16 ft)* above the upstream diversion channel outlet invert of El. 830 m *(2,723 ft)* and allows for redundant passage of an extreme flood in the event the diversion channel fails. When the tailings reach elevation 827 m *(2,713 ft)* on the Northwest Dam, a starter berm and local drain will be built to facilitate the upstream embankment raise to the ultimate elevation of 855 m *(2,805 ft)*. The initial dam will be made of rockfill with an impermeable asphalt core or equivalent. The dam will have a minimum crest width of 10 m *(33 ft)* and 2H:1V side slopes.

5.4.2 Alternative North Dams

The alternative North Dams were used for tailings deposition, mechanical designs and designs shown in the figures. The dams will be full-height conventional embankments with a minimum crest width of 10 m *(33 ft)* and 3H:1V side slopes. The dams will be made of rock or earthfill with an impermeable central core, made of asphalt or equivalent. The alternative North Dams layouts and sections are shown on Figure 5.11.

The North Dams will initially be built to contain the cleaner tailings and the reclaim pond. Construction of the North Dams will begin in Year 17. Thereafter they will be raised to the elevation required to store the 30-day PMF within the TSF.

6 BORROW ESTIMATES

Borrow is required for general fill, drains and filters, and riprap for the TSF. The following rock types were assumed to be suitable for the borrow requirements:

- General Fill will be taken from Gila Conglomerate.
- Drains and Filters will be taken from active channel alluvium, processed Gila Conglomerate or processed Apache Leap Tuff.
- Riprap will be taken from Apache Leap Tuff or Pinal Schist.

Starter and early mine life operational borrow requirements will be taken from within the impoundment footprint. Later mine life operational and closure borrow requirements will be excavated from nearby sources. The borrow areas identified are shown in Figure 6.1 and are as follows:

- Borrow area B1 is in Gila Conglomerate and has the capacity to supply the starter dams, North Dams, SCDs, and the embankment drains and filters.
- Borrow area B2 is in Apache Leap Tuff and can supply the starter riprap quantities.
- Borrow area B3 and B4 are in Gila Conglomerate east of the site and each have the capacity for tailings beach cover and general fill for the North Dam later in mine life.
- Borrow area B5 and B6 are in Pinal Schist north and south of the site and each has the capacity for closure riprap requirements.

Appendix XIII discusses the borrow material requirements and available borrow in more detail.

7 WATER MANAGEMENT PLAN

7.1 General

This section presents the operational water management plan for the TSF. The purpose of the water management plan is to:

- divert non-contact water around the facility;
- collect and reclaim toe seepage and surface runoff from the tailings facility;
- provide storage for the design storm events without discharge; and
- protect the tailings facility and diversion structures from erosion from flood events.

The water management structures are shown on Figure 7.1 and the TSF water balance is schematically represented in Figure 7.4. The upstream catchment will be diverted as much as practical with the use of diversion channels and dams. Water from the tailings beach and the undiverted catchment will collect in the reclaim pond, which is ultimately formed in the center of the facility. Water from the reclaim pond will be sent back to the West Plant for re-use. SCDs will collect seepage and embankment runoff. Water from the SCDs will be pumped back to the TSF reclaim pond.

7.2 Upstream Water Diversions

Three diversion channels will be constructed north of the TSF to route the upstream catchment around the facility. The diversion channel general layouts are shown in the staging figures, Figure 4.3 to Figure 4.12. Design of the diversion channels are described in Appendix VIII and shown in Figure 7.2 and Figure 7.3.

The diversion channels will be sized to convey the peak probably maximum flood (PMF) flow, which is the greater peak flow of the general PMF 72-hr or local PMF 6-hr storms. The diversion design flows range from 100 m^3/s to 340 m^3/s *(3,500 ft^3/s to 12,000 ft^3/s)*. The diversion base widths range from 5 m to 15 m *(16 ft to 49 ft)* and have side slopes of 1H:2V. The slopes of the diversion channels will be 1%. Riprap is not required due the assumption of the diversions being fully excavated in competent bedrock.

7.3 Surface Water Controls

Eleven SCDs will be built to collect seepage water from the tailings embankment underdrain system and surface runoff from the embankment slope. The seepage dams are shown in Figure 5.4 and a typical section is given in Figure 5.5. Design details are given in Appendix IX.

Water from the SCDs will be pumped back into the TSF. The ponds have an allowance of a 3.0 m *(9.8 ft)* for operating pond, and are designed to store the 200-year 24-hour storm volume, without discharge, and 2.0 m *(6.6 ft)* of freeboard. The dams will have an impermeable asphalt core and grout curtain to limit seepage to the environment.

The toe of the embankment will be armored to convey seepage that daylights along ridges to the SCDs.

7.4 Reclaim Pond

The TSF reclaim pond is sized for a 20 day retention period of the tailings slurry water to allow for water clarification. Water will be reclaimed from the pond using a floating pump barge (designed by others).

For the first eight years, the scavenger and cleaner reclaim ponds will be separate. Water from the scavenger reclaim pond will be pumped into the cleaner reclaim pond, where the reclaim barge will pump back to the West Plant.

From Years 11 to 20, there will also be separate reclaim ponds in the east cell and the west cell. Water will be pumped from the west cell into the east cell where it will be reclaimed back to the West Plant.

7.5 Water Balance

The TSF system water balance is schematically represented in Figure 7.4. The water balance was modeled in the software program GoldSim. The model considered the entire tailings distribution system downstream of the West Plant. Model parameters, assumptions and results are given in Appendix XI.

The water balance was modeled as four facilities, each facility containing its own water balance calculation:

1. West Plant
2. East Cell TSF
3. West Cell TSF
4. Seepage Collection Dam (SCD) (Note: all seepage collection dams are assumed to act as one large pond for the purposes of the water balance)

Results of the water balance are shown in Figure 7.5.

The predicted required makeup water is 640 million m^3 *(5190 acre-ft)* over the 45 year operating life. The breakdown of makeup water requirement at the West Plant and at the TSF for later years to maintain cleaner saturation, are listed below:

- West Plant – 620 million m^3 *(5,030 acre-ft)* (97% of total makeup water).
- TSF (maintain cleaner saturation) – 20 million m^3 *(160 acre-ft)* (3% of total makeup water).

Water requirements for dust management have not been incorporated into the water balance at this stage of design. The dust management plan is shown in Figure 9.3 and discussed in Section 9.5. The plan will limit the use of water as a dust suppressant as much as possible. Water use for dust management is expected to be less than 5% of the total make-up water requirements.

8 TAILINGS DELIVERY AND RECLAIM PIPELINES

8.1 Tailings Delivery and Distribution

The TSF is designed for a plant capacity of 120,000 tpd *(134,400 tnpd)*. Scavenger and cleaner tailings will be delivered to the northeast corner of the TSF from the West Plant. These delivery pipelines from the West Plant are designed by others, whereas KCB's scope starts at the tie-in point at the northeast corner of the TSF.

From this point the scavenger tailings will be distributed along the embankment crest for deposition. Where possible, the pipelines have been routed to stay 10 m *(33 ft)* below the ridge crests and within the ridge lines of the TSF, such that any pipe breakage or leakage will drain into the TSF.

The cleaner tailings line will run along a center ridge for deposition.

Conditions at Year 2, Year 10, Year 25 and Year 45 (ultimate configuration) were considered when designing the pipeline. The details of the pipeline designs are given in Appendix XII.

The pipeline sizes are summarized in Table 8.1 and described below.

Table 8.1 Pipeline Sizes

Tailings Type	Steel Pipe Diameter inch	Steel Pipe Length m *(ft)*	HDPE Pipe Diameter inch	HDPE Pipe Length m *(ft)*
Scavenger	26	1,200 (2 pipes) *(3,940)*	32	13,820 (2 pipes) *(45,340)*
Cleaner	N/A	N/A	18	7,540 (2 pipe) *(24,740)*

Notes:

1. Pipeline lengths are the maximum lengths over the mine life.
2. Scavenger HDPE pipe is DR9 IPS PE4710 [250 PSI] and Steel pipe is SCH 20
3. Cleaner HDPE pipe is DR6.3 PE4710 [380 PSI]

8.1.1 Scavenger Tailings

The scavenger tailings will be typically delivered at 58% to 65% solids. The flow will be split at the northeast tie-in point.

For the ultimate configuration, the split flow will be directed in two 26-inch steel pipelines that extend from the tie-in point up the face of the embankment and then transition into 32-inch HDPE pipelines, extending along the crest of the impoundment.

8.1.2 Cleaner Tailings

The cleaner tailings are delivered to the tie-in point at 50% to 60% solids. The tailings will be conveyed in two primary 18-inch HDPE pipe which will split into additional pipe segments to allow the deposition point to be shifted around as required by the deposition plan. The additional pipes are not designed for this report.

The initial pipeline lengths will be selected for start-up and will be adjusted as required to account for the movement of the tailings pond. In later years of the mine life, cleaner tailings deposition berms will be built into the tailings pond to allow the tailings to discharge in the desired areas (Figure 4.13).

8.2 Seepage Reclaim

A typical seepage reclaim system was conceptually designed for the SCD S2 during operations. The seepage and dam runoff stored in the SCD will be pumped up the embankment slope and discharged into the TSF, as shown on Figure 7.1. Details and layout of the seepage reclaim pipeline and pumps are given in Appendix XII.

The design flow rate for the seepage reclaim system is 324 m^3/hr *(1427 USGPM)* of water during operations, which is based on a conservative estimate of average seepage and runoff rates plus an assumed requirement to draw down the contained 100-year 24-hr storm over a period of 14 days. Due to the low system pressures, the entire length of pipe will be 12-inch DR6.3 HDPE; steel is not required.

9 OPERATING AND MONITORING CONTROLS

9.1 General

Performance of the TSF and the operation of the water control structures will be monitored and inspected on a regular basis. This section outlines the proposed monitoring and operational controls.

9.2 Instrumentation

The tailings embankment will be monitored during operations by piezometers and settlement pins to measure phreatic levels in the embankments and foundation soils where possible, and to measure deformation of the structures. The monitoring instruments will be installed on the representative sections of the dams shown in Figure 9.1 and Figure 9.2. Table 9.1 summarizes the minimum number of sections and instruments that would be installed. The final locations of the sections and instruments will be determined in the field.

Table 9.1 Summary of Dam Instrumentation

Dam	Number of Instrumented Sections	Total Number of Piezometers		Displacement Survey Pins
		Embankment	Foundation	
Upstream Raise	12	63	33	32
North Dam	4	4	4	8
SCD (per dam)	1	1	1	2

In addition to the above instruments, seepage from the embankment will be monitored by pumping rates from the SCDs.

The instruments will be read regularly during normal operating conditions. Maximum or minimum warning threshold values will be identified for each instrument. Corrective action will be undertaken if the readings exceed the threshold values. An overall review and evaluation of the monitoring data will be carried out annually.

9.3 Pond Operation

Pond levels will be recorded monthly and used, in conjunction with pond filling curves, to plan the tailings discharge and the operation of the reclaim pond. Records of pumping from the TSF reclaim pond and SCDs will be kept to assess the site wide water balance and to assess the seepage rate from the tailings embankment.

A weather station will be established close to the TSF during operations. This station will provide daily records of precipitation, evaporation and other climate parameters required to assess the performance and water balance for the tailings facility.

9.4 Water Quality

Surface water sampling and flow quantities will be monitored at various points through the TSF area to evaluate water quality and maintain a site wide water and solute balance. These sites include:

- Tailings Reclaim Pond
- Seepage Collection Dams
- Diversion Channels
- Tailings Delivery Pipelines

Groundwater quality and levels will be monitored at designated compliance monitoring wells located downstream of the seepage recovery dams per the requirements of the Aquifer Protection Permit (APP) program administered by ADEQ.

9.5 Dust Mitigation

Figure 9.3 presents the dust management plan for the operating facilities. Key elements of the plan include:

- Dust emissions from the embankment slopes and tailings beaches will be managed by continuous wetting of the tailings during active deposition. This includes actively pumping collected seepage to the top of the embankment and allowing the water to flow over the beach, maintaining a wetted surface as the water flows towards the reclaim pond.
- Dry surfaces of the exterior embankment will be susceptible to wind erosion during non-active periods. Dust emissions will be actively managed by a number of measures including:
    - Progressive reclamation of the outer slopes.
    - Establishment of a faster growing native vegetation crop on construction areas that will be inactive and exposed for longer than 12 months.
    - Wetting of inactive beaches and dam surfaces with irrigation from sprinkler systems only as a contingency if needed during dry months of the year (May, June, September, and October) when no winter or summer monsoon rains are occurring. Other tailings facilities have shown that adequate dust control can be accomplished by application of 2 mm to 5 mm *(0.1" to 0.2")* of water over an 8-hour period preceding a windstorm. Water would be obtained from the reclaim pond.
    - Treatment with chemical or polymer dust suppressants on local areas with higher exposure to wind.

Regular watering would be conducted on service roads, supplemented with application of dust suppressants as required.

10 PRELIMINARY CLOSURE PLAN

10.1 Facility Closure Covers

The conceptual closure and reclamation plans for the TSF is shown in Figure 10.1 and Figure 10.2.

The closure covers are shown in Figure 10.2 and are as follows:

- Scavenger tailings beaches will be covered with a minimum 150 mm *(6")* thick erosion resistant layer and vegetated with a native seed mix. The cover will mimic the pre-existing natural ground surface.
- The bulk of the cleaner tailings would be covered and encapsulated in a thick sequence of scavenger tailings, which will limit oxygen ingress and prevent or minimize acid generation.
- Where a thinner layer of scavenger tailings beaches are underlain by cleaner tailings or there are exposed cleaner tailings beaches, these areas will be covered with an engineered cover, most likely a "store and release" evaporative cover to minimize surface infiltration and oxygen ingress. It will comprise of a minimum 300 mm *(12")* layer of compacted fill overlain by 700 mm *(28")* of uncompacted fill, overlain by a minimum 150 mm *(6")* thick erosion resistant layer and vegetated with a native seed mix.
- The 5H:1V outer slopes of the tailings embankment will be covered by a minimum 200 mm *(8")* layer of rockfill armoring to prevent erosion. The required D_{50} of the rockfill armoring is 100 mm *(4")*.

Vadose modeling (Appendix XV) indicates that a "store and release" cover could limit percolation into the cleaner tailings to less than 1% of annual precipitation for both the "average" and the "wet" climate years. For the scavenger tailings, where only the simple erosion cover is provided, percolation ranged from 2% of the annual precipitation for the average climate year and 7% for the wet climate year.

10.2 Closure Water Management

The ultimate closure water management plan is shown in Figure 10.1 and Figure 10.2. Key aspects of the plan include:

- The diversion channels upstream of the North Dams will be maintained on closure to direct water around the TSF.
- The average closure monthly water balance for the tailings impoundment predicts a permanent closure pond will be formed with an approximate average volume of 2.5 million m^3 *(2030 acre-ft)* and average elevation of 845 m *(2,772 ft)*. Final size of the pond is determined by the surface area required to evaporate the net runoff into the tailings facility.
- The tailings facility will have sufficient capacity to safely store the 30-day PMF flood. However, the benefits of excavating a spillway should be reviewed at the next stage of design.

- Closure diversion channels will be built to divert local embankment surface water runoff around the SCDs.
- The SCDs will be maintained on closure and act as evaporation ponds for seepage collected from the TSF.

10.3 Closure Considerations

The design explained in this section represents a typical closure scenario. It is recognized that through the NEPA and permitting process, plans will become further refined and prior to final closure additional laboratory testing, modeling and field data may be required.

11 ESTIMATED QUANTITIES AND SCHEDULE

The material quantities for start-up construction, operation and closure of the tailings management plan were estimate by KCB and provided in Appendix XIV. Quantities for both the base case and alternative North Dam options have been estimated. Mechanical components are not included in Appendix XIV. The mechanical material take-offs can be found in Appendix XII. The quantities are identified according to each stage of facility development, which are categorized as follows:

- Pre-production: Pre-production start-up occurring in Years -3 to -1 to store tailings for the first 24 months.
- Operations: Years 1 to 45.
- Closure: Permanent facility closure implemented after Year 45.

The preliminary implementation schedule of the TSF through pre-production to closure is given in Figure 11.1.

12 FUTURE WORK

Additional baseline and site characterization data is needed to complete a comprehensive hydrologic impact assessment of the Near West TSF facility including additional investigation of the subsurface conditions (bedrock shear wave velocity, bulk permeability, groundwater flow direction, neutralization capacity and refined volume and suitability of borrow material). The program will include drill holes with hydraulic packer testing and installation of piezometers, and test trenches with infiltration tests. Pump testing of major bedrock units and geologic structures will be required to identify permeability and hydraulic properties of the subsurface units.

13 CLARIFICATIONS REGARDING THIS REPORT

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Resolution Copper Mining for the specific application to the Mine Plan of Operations and Tailings study work. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavored to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

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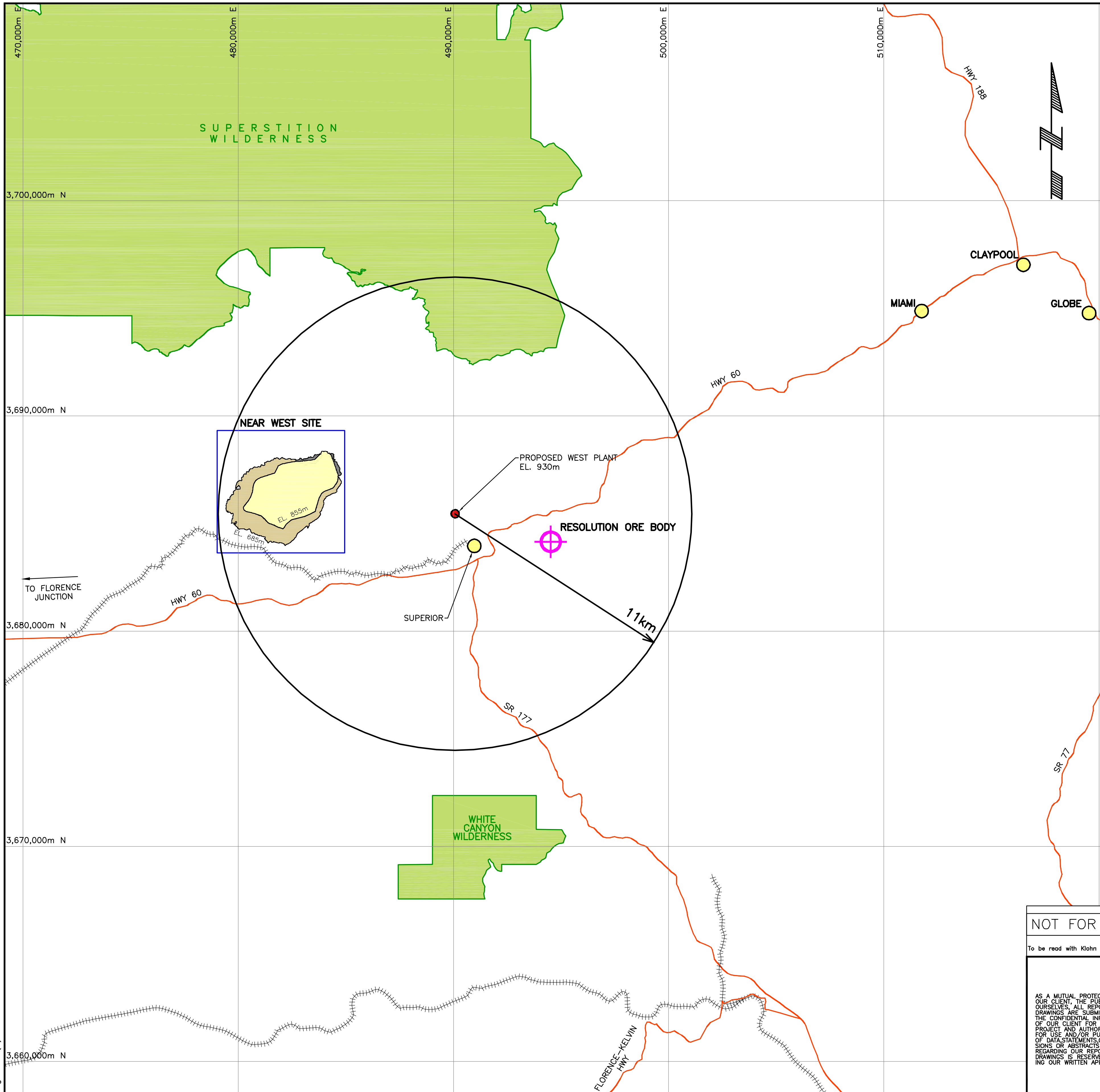
FIGURES



ARIZONA STATE
SCALE: NTS

LEGEND

- STUDY AREAS
- WILDERNESS AREAS
- HIGHWAY
- RAILWAY

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD27

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 5km

CLIENT
Resolution Copper Mining

Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE
REGIONAL PLAN OF NEAR WEST SITE

PROJECT No.	FIG. No.
M09441A14	1.1

KCB–R–MLB

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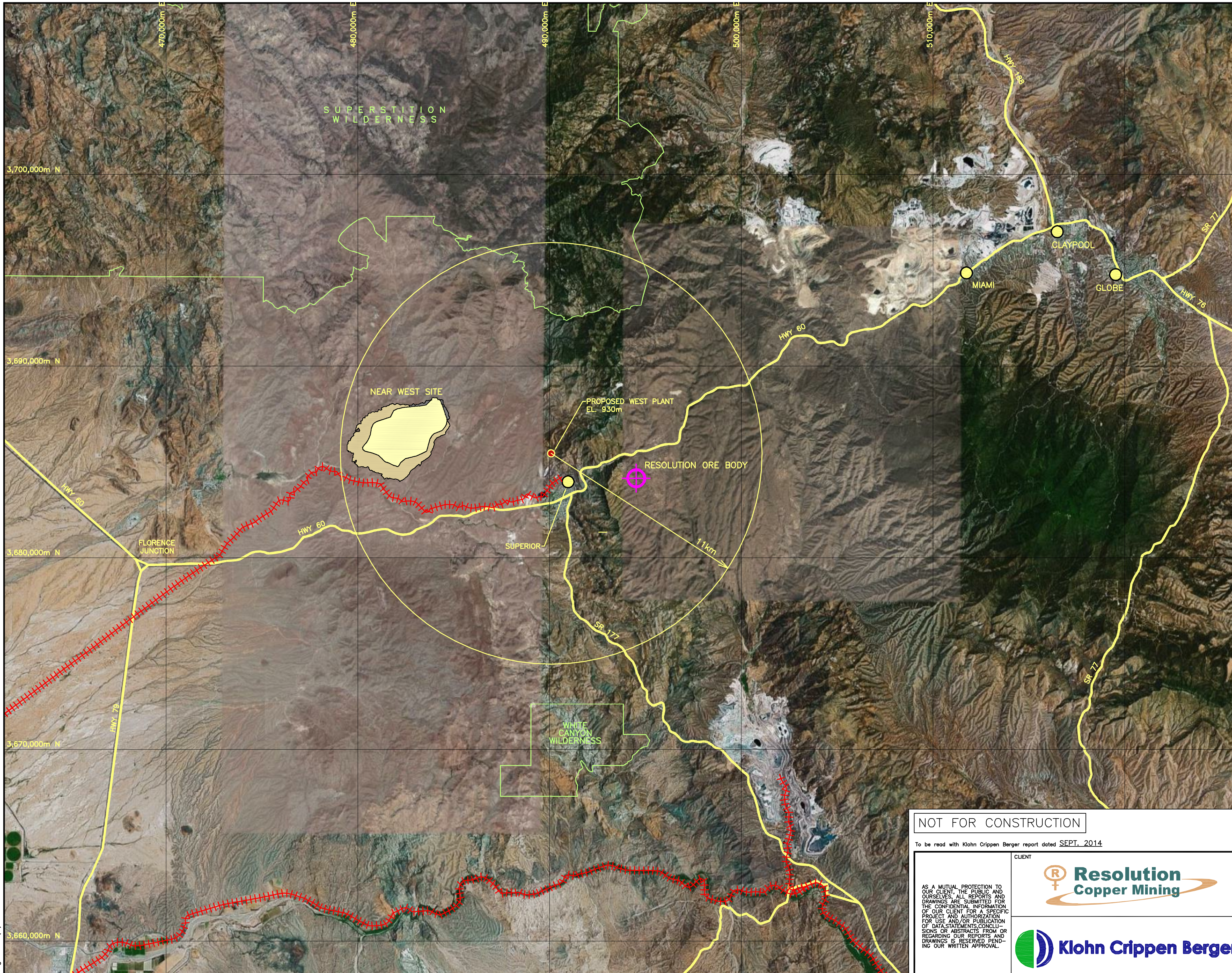

LEGEND

- STUDY AREAS
- WILDERNESS AREAS
- HIGHWAY
- RAILWAY

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD27

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SCALE 0 5 km

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Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: AERIAL VIEW OF NEAR WEST SITE

PROJECT No. M09441A14

FIG. No. 1.2

KCB-R-MLB

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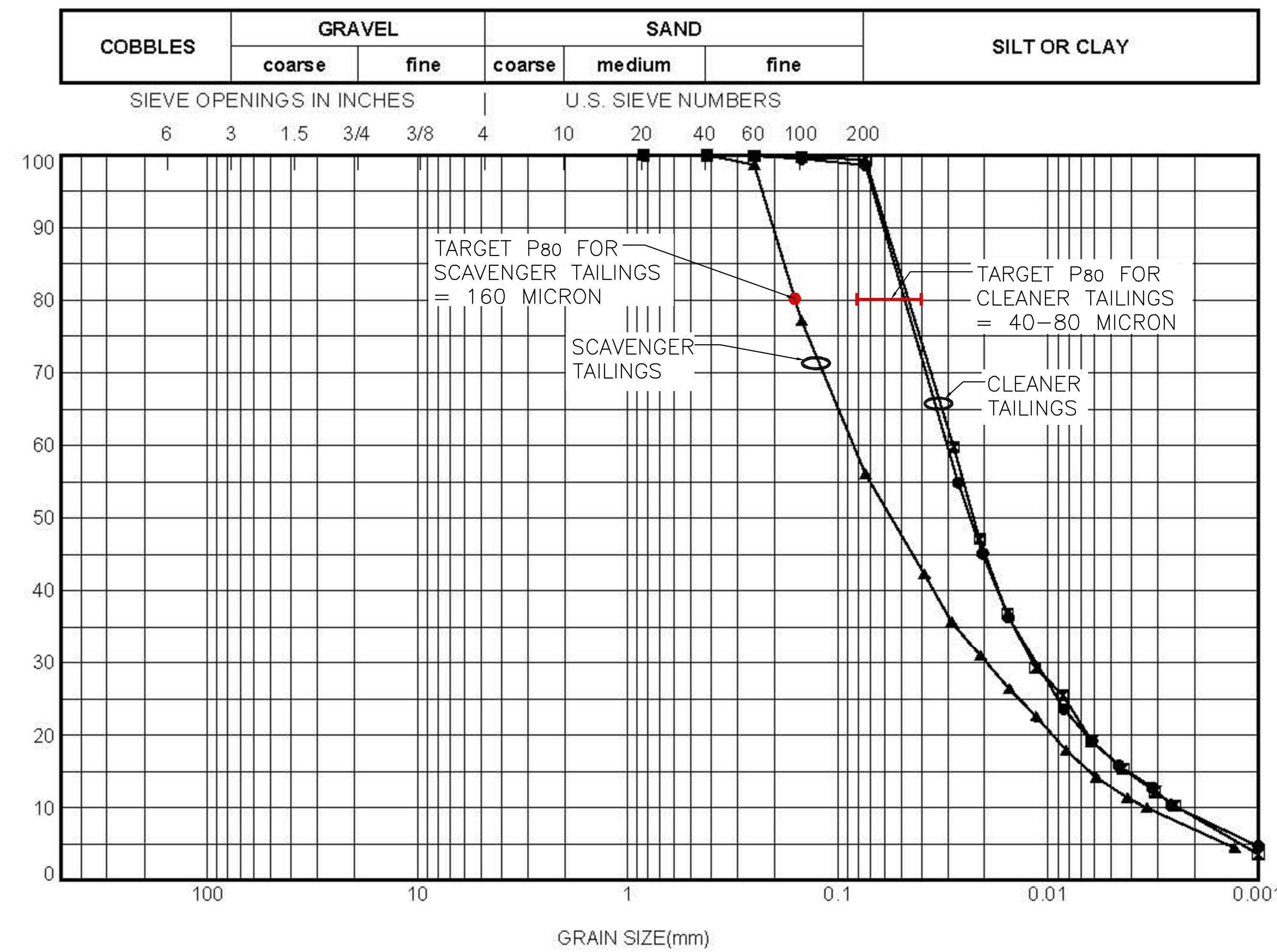

NOTES

1. CYCLONE UNDERFLOW SAND GRADATION PREDICTED BY NUMERICAL SIMULATIONS BY KREBS ENGINEERS INC. (KCB, 2008).

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SCALE NTS

CLIENT
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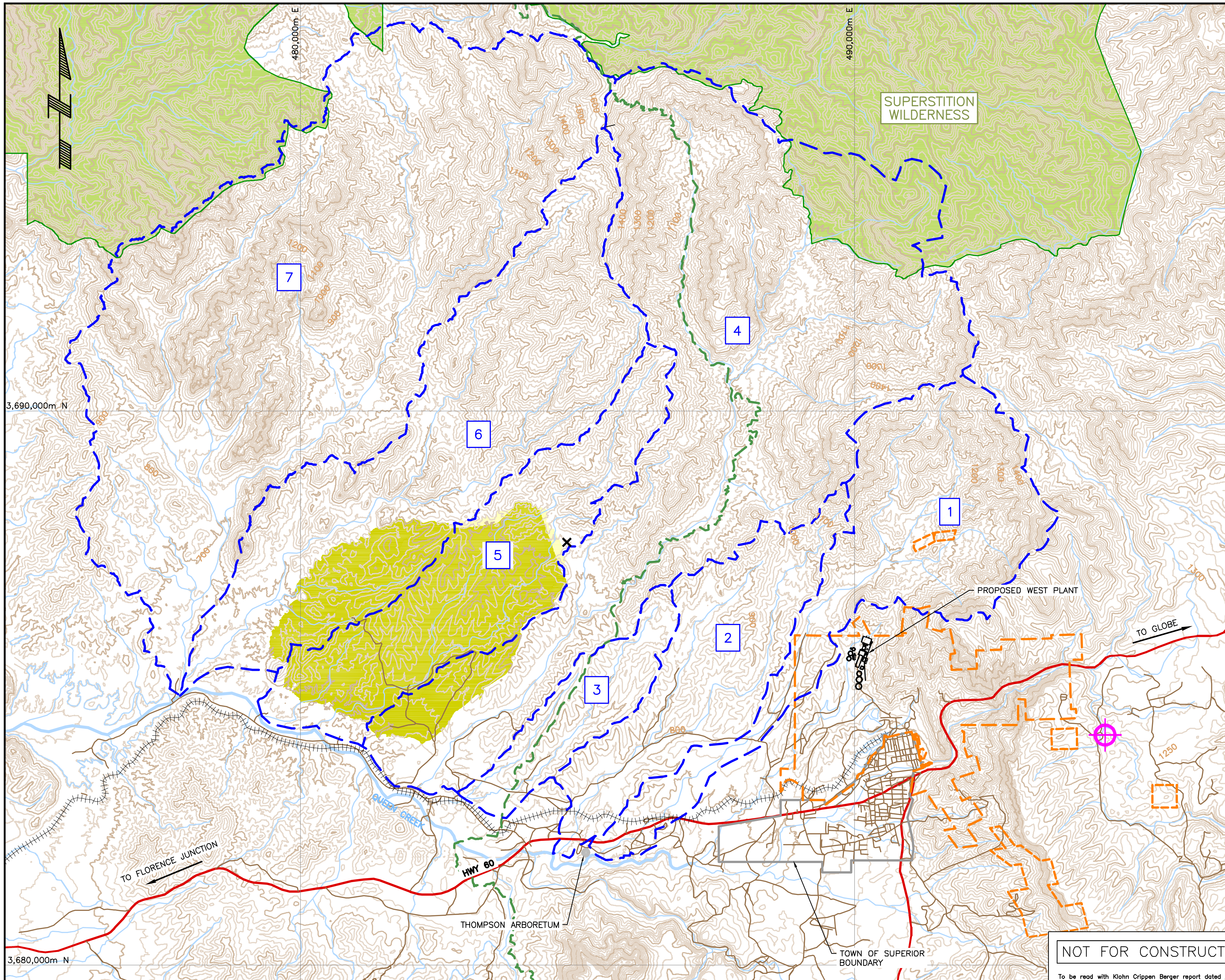
PROJECT
RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE
GRADATION OF SCAVENGER AND CLEANER TAILINGS

PROJECT No. M09441A14

FIG. No. 2.1

Time: 14:56:06
Date: 9/2/2014
Scale: 1:2.5849(PS)
Drawing File: Z:\M\VCR\M09441A14 – RES–Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig2.1_rA – Tailings Gradation.dwg (dhu)
Xref File(s):
Image File(s): 01 resolution sieve sep 07 figA figB figC
KCB–R–MLD



PLAN

WATERSHEDS		AREA (km²)
1	SILVER KING CANYON	17
2	HAPPY CAMP CANYON	12
3	RICE WATER CANYON	5
4	POTTS CANYON	49
5	BEAR TANK CANYON	15
6	ROBLAS CANYON	27
7	HEWITT CANYON	54

NOTE: NEAR WEST IS LOCATED IN PORTIONS OF WATERSHED 4, 5 AND 6

LEGEND

- WATERSHED BOUNDARY
- RESOLUTION OWNERSHIP BOUNDARY
- HIGHWAY
- RAILWAY
- EXISTING ROAD
- ARIZONA TRAIL
- WILDERNESS AREA
- TSF FOOTPRINT
- APPROXIMATE CENTER OF RESOLUTION ORE BODY
- PIPELINE TIE-IN LOCATION

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD27
2. FULL EXTENTS OF POWER LINES ARE NOT SHOWN. FIGURE SHOWS ONLY POWER LINES IN SILVER KING AND HAPPY CAMP AREA.

SCALE 0 2 km

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

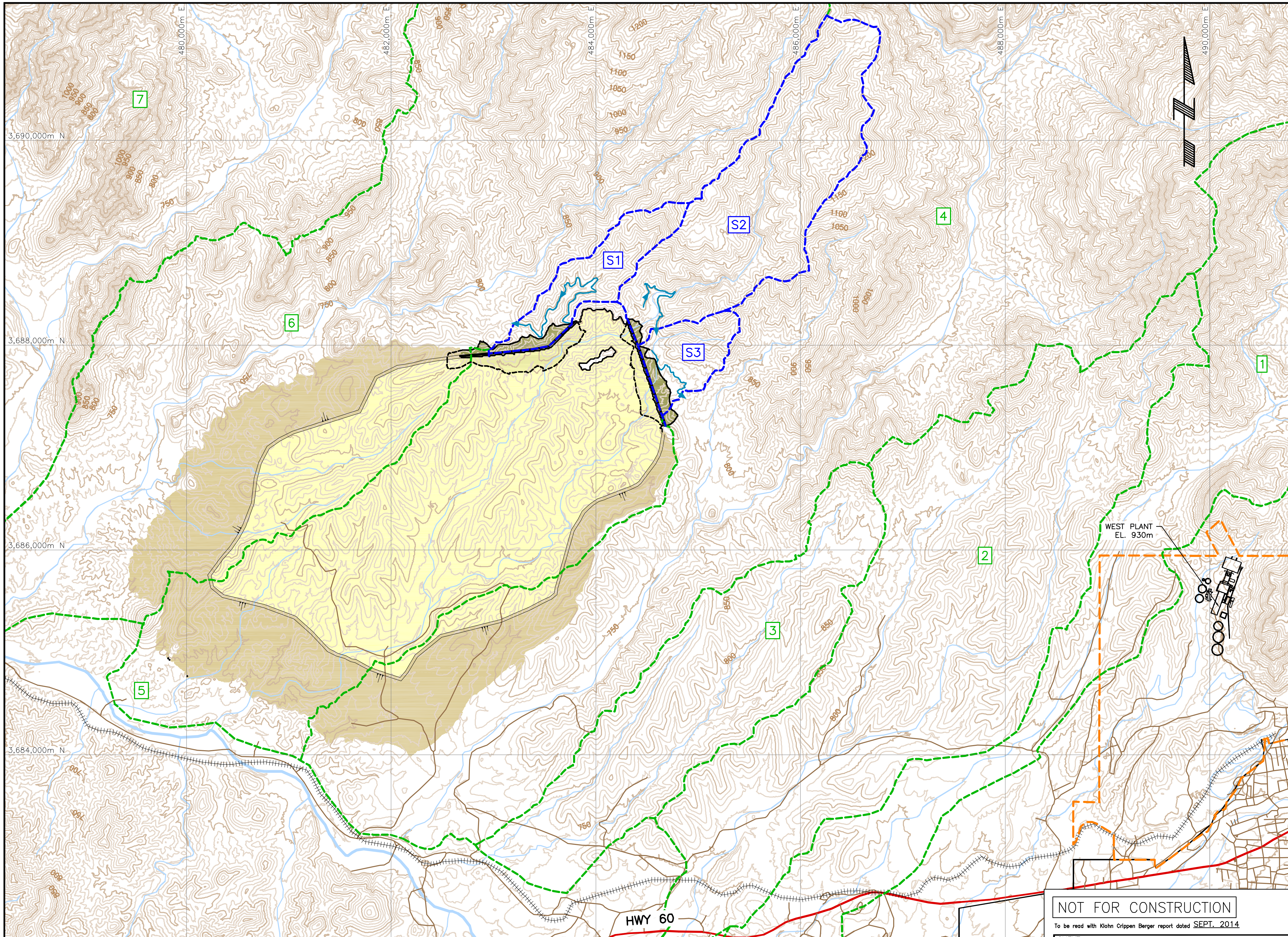
TITLE: REGIONAL CATCHMENT AREAS

PROJECT No. M09441A14

FIG. No. 3.1

KCB-R-MLB

Time: 15:01:03
Date: 9/2/2014
Scale: 1:2.5849(PS)
Drawing File: Z:\M\VCR\M09441A14 – RES–Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig3.1_rA – Regional Catchment Areas.dwg (dhu)
Xref File(s): Happy_Camp_Contours_MIXED; FOR INSERT_UTMNAD27_TELEGRAPH_CANYON_GENERAL_2011; Happy_Camp_Streams_Sep2012; Happy_Camp_Facilities_Sep2012
Image File(s): Phoenix



SUB–CATCHMENTS	AREA (km²)
S1	0.84
S2	3.28
S3	0.68

LEGEND

- DIVERSION CHANNEL
- RAILWAY
- EXISTING ROAD
- STREAM
- CATCHMENT BOUNDARY
- SUB–CATCHMENT BOUNDARY
- RESOLUTION OWNERSHIP BOUNDARY

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 800m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: LOCAL SUB–CATCHMENT AREAS

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	3.2

KCB-FIG-D-L

Date: 9/2/2014 Time: 15:15:10 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 – RES–Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig3.2_rA – Site Plan.DWG (dhu)
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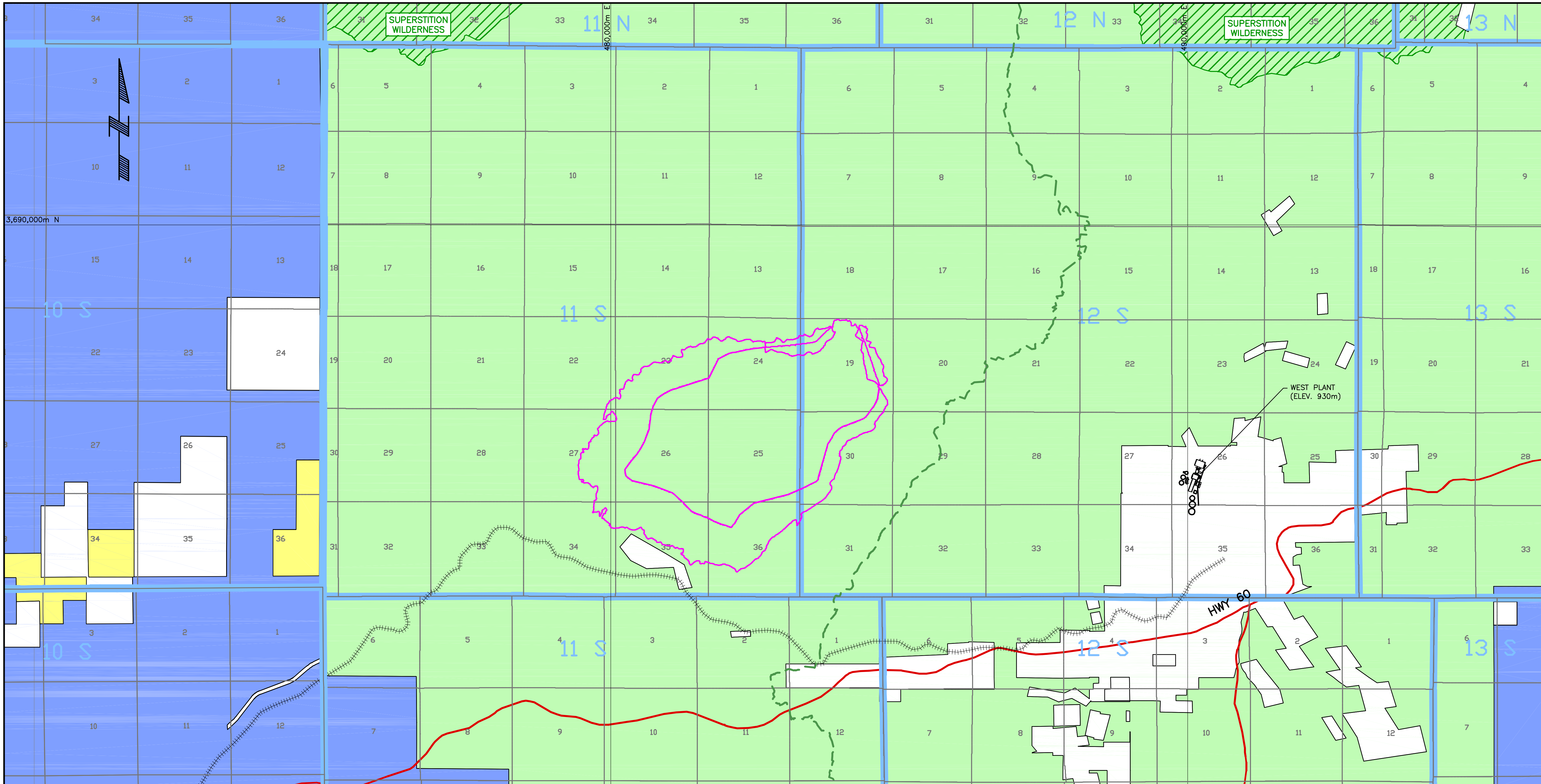


LEGEND

- BLM
- USFS
- STATE
- PRIVATE
- WILDERNESS AREA
- NEAR WEST TAILINGS FACILITY
- 11 N RANGE
- 1 SECTION
- RAILWAY
- ARIZONA TRAIL

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD27

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 – 1mi; 0 – 2km

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

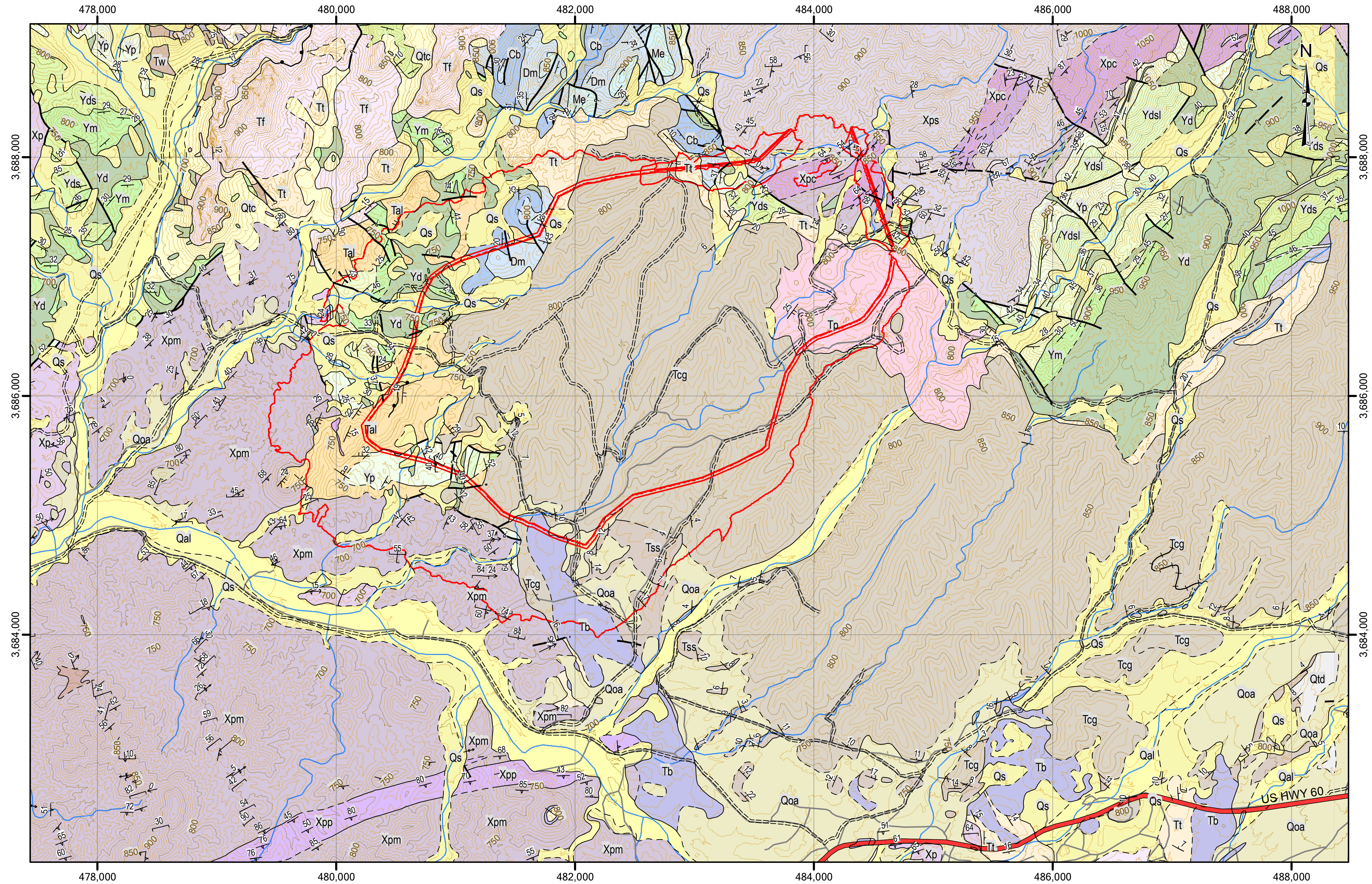
TITLE: LAND STATUS

PROJECT No. M09441A14

FIG. No. 3.3

KCB-R-MLB

Time: 15:18:06
Date: 9/2/2014
Scale: 1:2.5849(PS)
Drawing File: Z:\M\VCR\M09441A14 – RES–Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig3.3_rA – Land Status.dwg (dhu)
Xref File(s): Happy_Camp_Contours_Sep2012.v2; FOR INSERT_UTMNAD27_TELEGRAPH_CANYON_GENERAL_2011; Happy_Camp_Streams_Sep2012
Image File(s): Phoenix



Qs	Undivided Surficial Deposits (Quaternary)
Qtd	Disturbed Surficial Deposits (Holocene)
Qtc	Talus and Colluvium (Quaternary)
Qal	Unconsolidated Alluvium (Quaternary)
Qoa	Old Alluvium (Quaternary)
QTs	Older Alluvium (Early Quaternary to Late Tertiary)
Tcg	Conglomerate (Pliocene to Late Miocene)
Tss	Sandstone (Pliocene to late Miocene)
Tb	Basalt (Mid-Miocene to Early Miocene)
Tp	Perlitic Aphyric Rhyolite (Middle Tertiary)
Tal	Apache Leap Tuff (Early Miocene)
Tt	Tuff (poorly welded) (Miocene)
Tf	Felsic Volcanic Rocks, undivided (Middle Tertiary)
Tbl	Lower Basalt (Middle Tertiary)
Tx	Rock Avalanche or Talus Breccia (Middle Tertiary)
Tw	Whitetail Conglomerate
Tdb	Basaltic Dikes (Middle Tertiary)
Kd	Quartz Diorite (Latest Cretaceous)
Me	Escabrosa Limestone (Mississippian)
Dm	Martin Limestone (Devonian)
Cb	Bolsa Quartzite (Cambrian)
Yd	Diabase (Middle Proterozoic)
Ym	Mescal Limestone (Middle Proterozoic)
Yds	Dripping Spring Quartzite, undivided (Middle Proterozoic)
Ydsu	Dripping Spring Quartzite, Upper Unit (Middle Proterozoic)
Ydsl	Dripping Spring Quartzite, Lower Unit (Middle Proterozoic)
Yp	Pioneer Shale (Middle Proterozoic)
Ypt	Pioneer Shale, Tuff Unit (Middle Proterozoic)
YXd	Diorite (Early or Middle Proterozoic)
Xp	Pinal Schist, undivided (Early Proterozoic)
Xpc	Pinal Schist, Calc-silicate Facies (Early Proterozoic)
Xpcs	Pinal Schist, Calc-silicate and Schist Facies (Early Proterozoic)
Xpm	Pinal Schist, Psammite Facies (Early Proterozoic)
Xpp	Pinal Sctist, Phyllite Facies (Early Proterozoic)
Xpq	Pinal Schist, Quartzite Layers (Early Proterozoic)
Xps	Pinal Schist, Pelitic Schist (Early Proterozoic)

LEGEND

- NEAR WEST TAILINGS SITE
- HIGHWAY
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- MARKER HORIZON (LOCAL)
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST
  CLAST-RICH CONGOMERATE BELOW
  AND DRIPPING SPRING QUARTZITE
  CLAST-RICH CONGLOMERATE ABOVE

Notes:
1. NAD27 UTM12N
2. Refer to main report for source of geologic data.

0 1,000 m

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED SEPT 2014

CLIENT
Resolution Copper Mining

Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OPERATIONS STUDY

TITLE
SITE GEOLOGY

PROJECT No. M09441A14

FIG No. 3.4

CB
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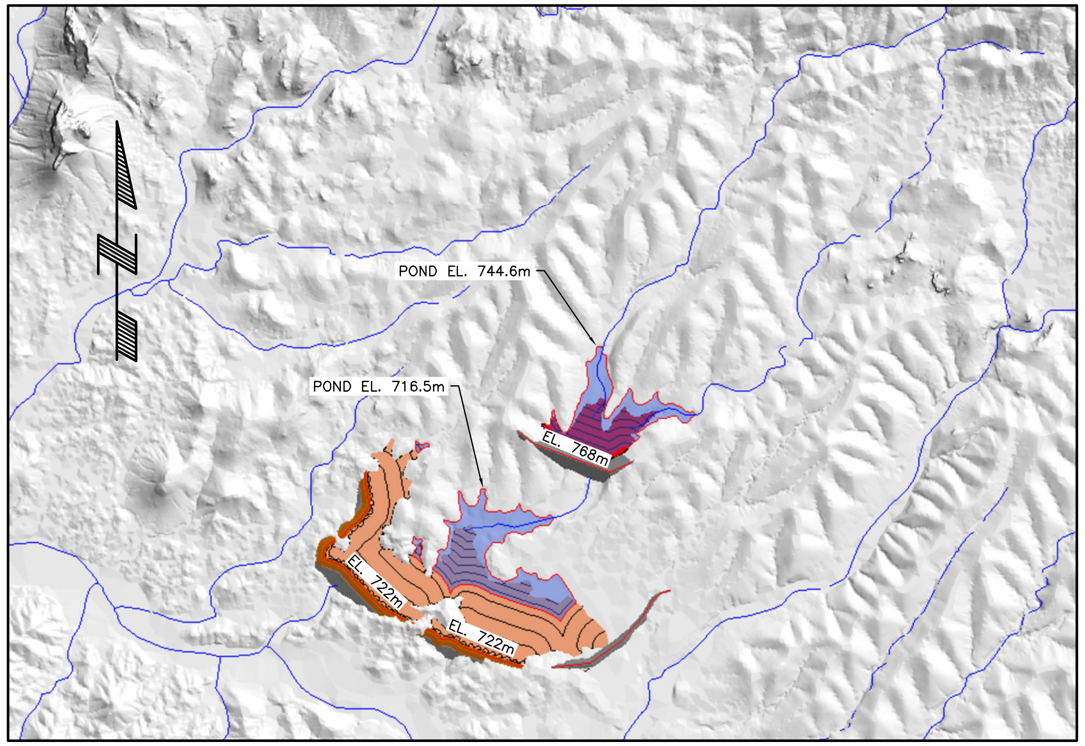
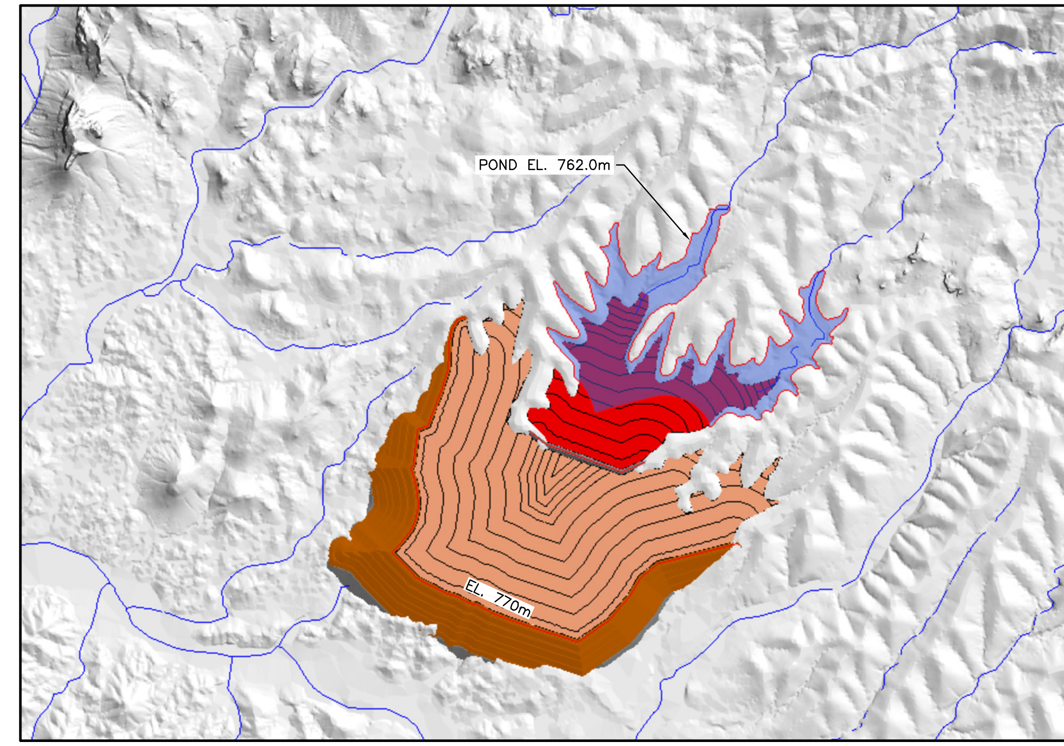
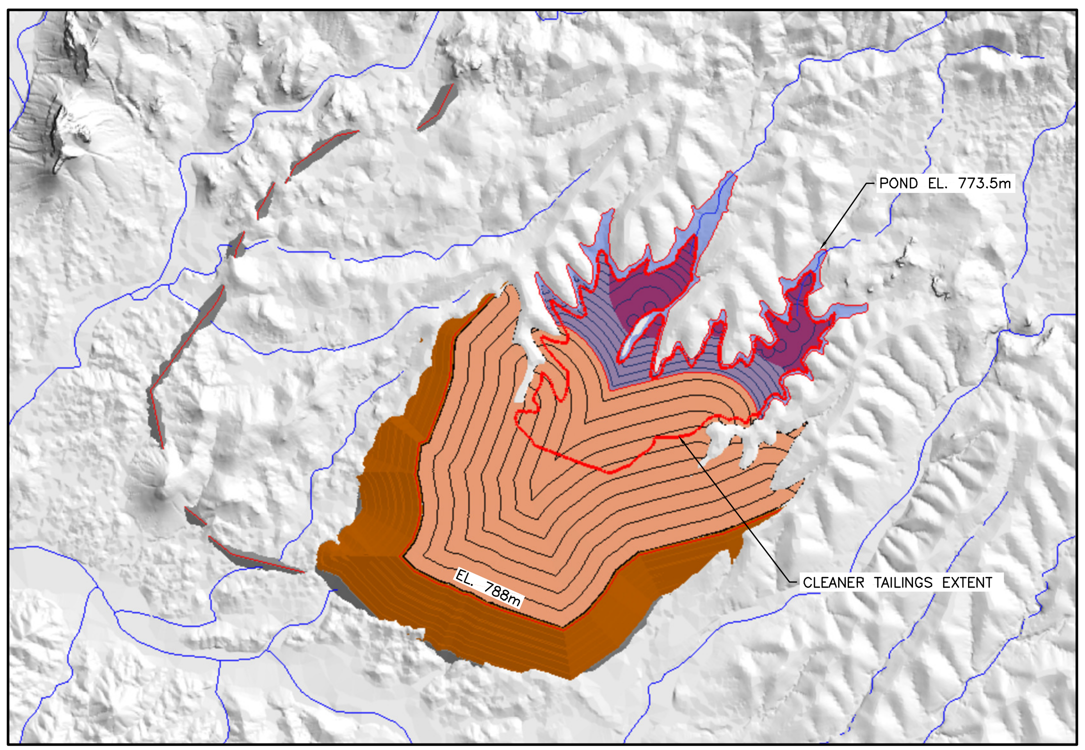


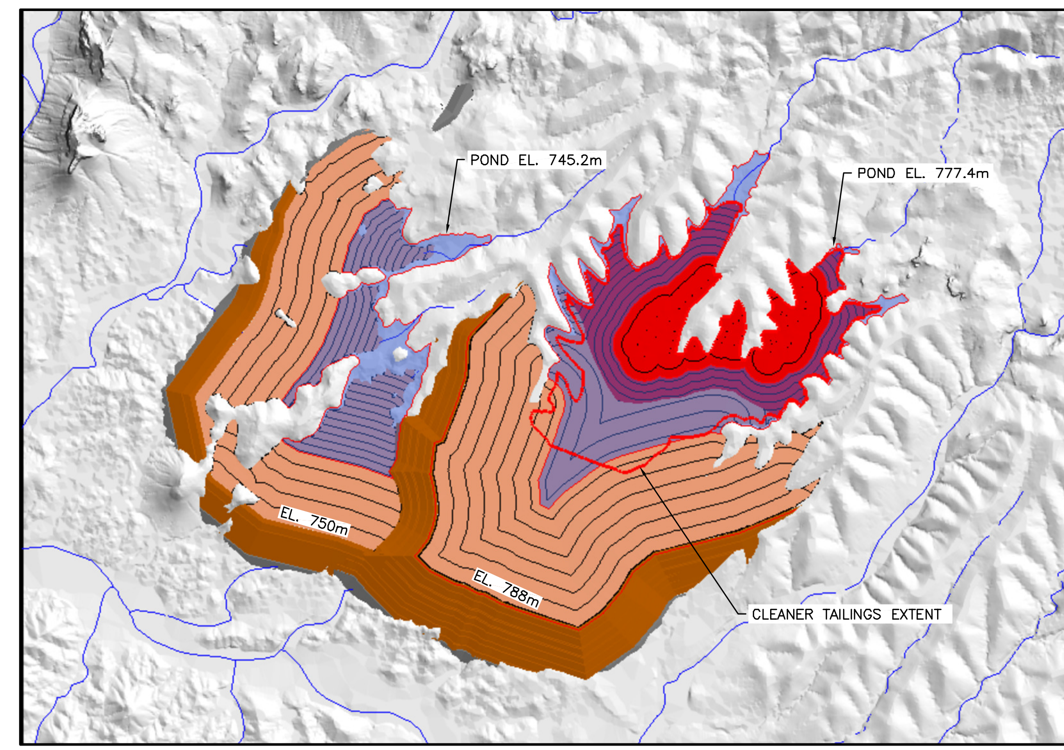
YEAR 2



YEAR 8



YEAR 10



YEAR 12

NOT FOR CONSTRUCTION

LEGEND

- SCAVENGER TAILINGS
- CLEANER TAILINGS
- POND OVER CLEANER TAILINGS
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAMS
- TSF RECLAIM POND
- STREAMS

NOTES

1. BASED ON TOPOGRAPHY PROVIDED BY RESOLUTION IN UTM ZONE 12N NAD 27 – AUGUST, 2012.
2. ASSUMED 1% SLOPE FOR SCAVENGER AND CLEANER TAILINGS SURFACE ABOVE POND LEVEL; 2% SLOPE FOR SCAVENGER AND CLEANER TAILINGS SURFACE BELOW POND LEVEL.
3. 5H:1V EMBANKMENT SLOPE.

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE NTS

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: TAILINGS DEPOSITION MODELING
SHEET 1 OF 2

PROJECT No. M09441A14

FIG. No. 4.1

KCB-R-MLD

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Date: 9/2/2014
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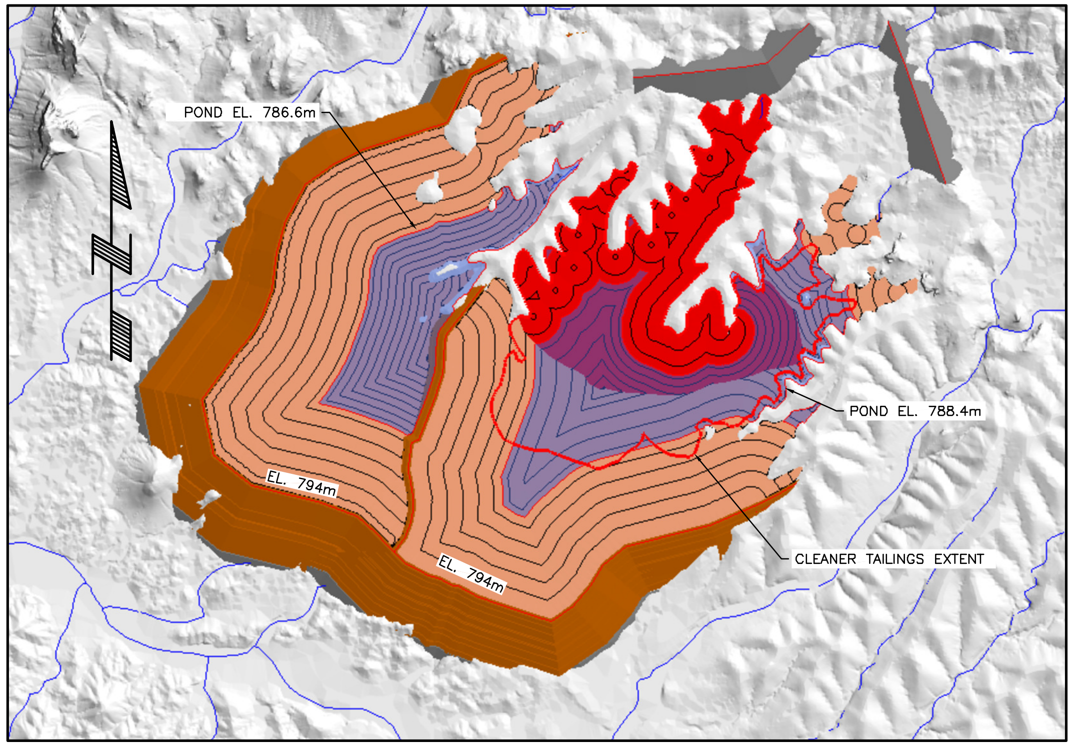
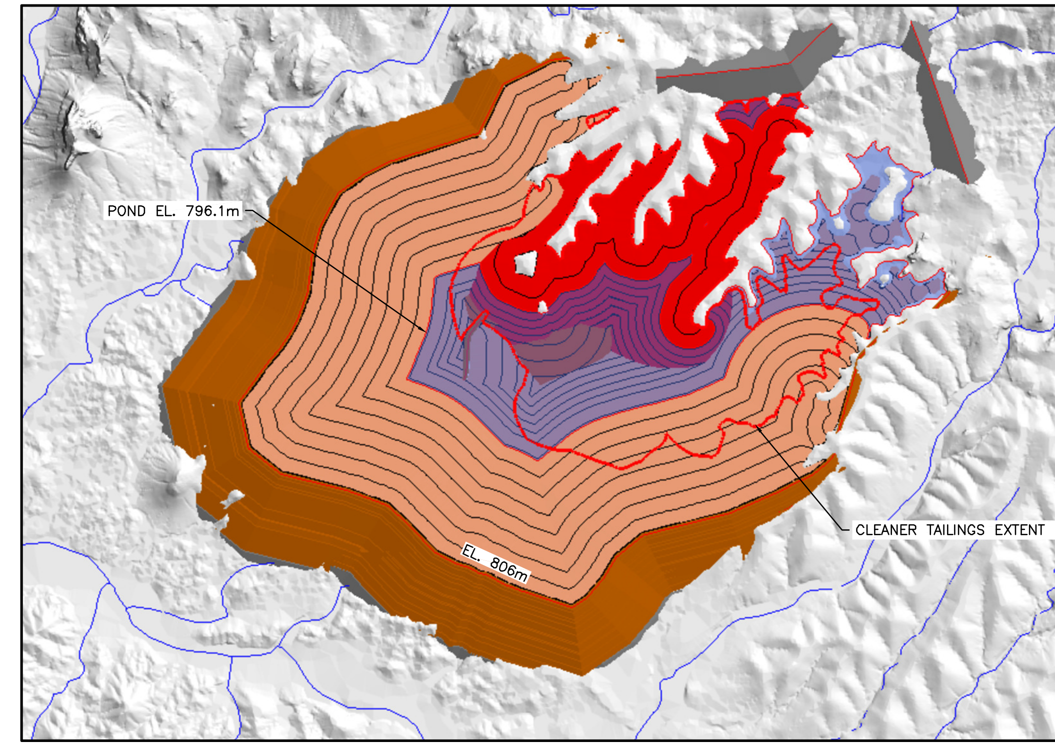
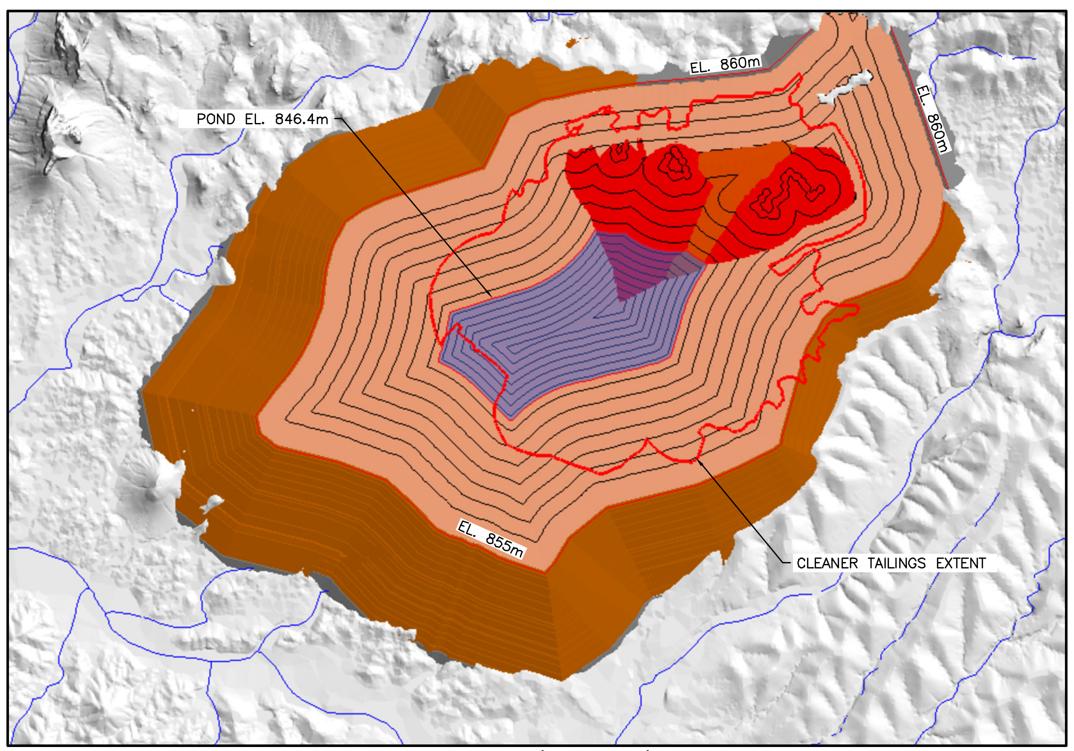


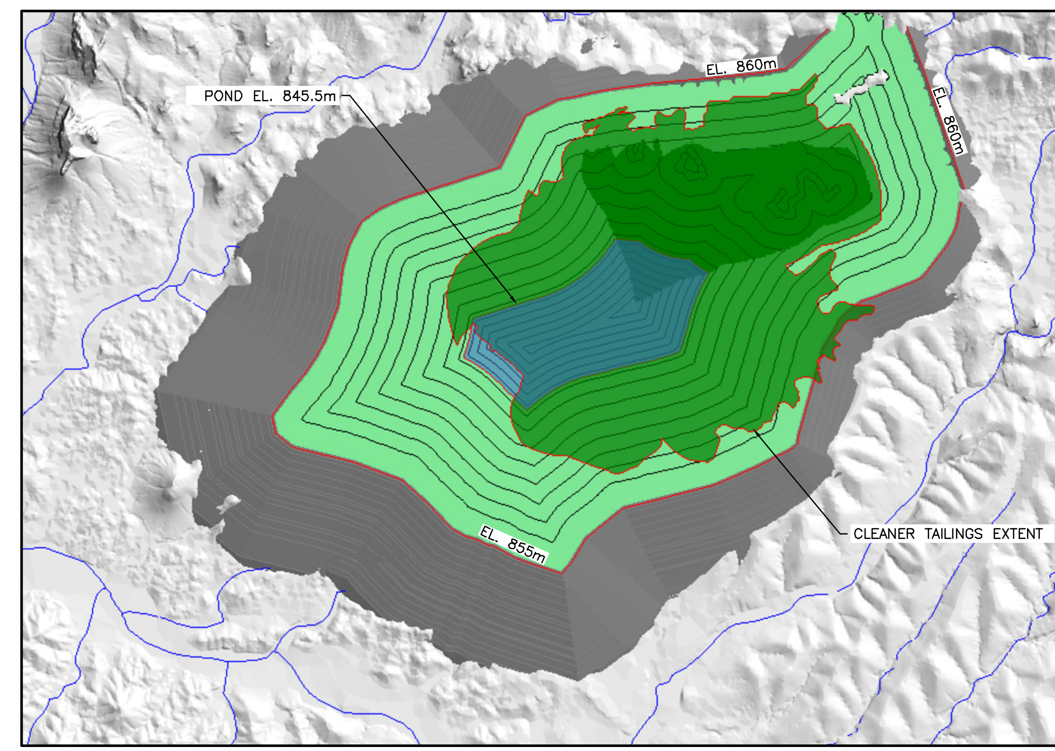
YEAR 18



YEAR 21



YEAR 45 (ULTIMATE)



CLOSURE

NOT FOR CONSTRUCTION

LEGEND

- SCAVENGER TAILINGS
- CLEANER TAILINGS
- POND OVER CLEANER TAILINGS
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAMS
- TSF RECLAIM POND
- RECLAIMED CLEANER TAILINGS
- RECLAIMED SCAVENGER TAILINGS
- RECLAIMED EMBANKMENT SLOPE
- STREAMS

NOTES

1. BASED ON TOPOGRAPHY PROVIDED BY RESOLUTION IN UTM ZONE 12N NAD 27 – AUGUST, 2012.
2. ASSUMED 1% SLOPE FOR SCAVENGER AND CLEANER TAILINGS SURFACE ABOVE POND LEVEL; 2% SLOPE FOR SCAVENGER AND CLEANER TAILINGS SURFACE BELOW POND LEVEL.
3. 5H:1V EMBANKMENT SLOPE.

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE NTS

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: TAILINGS DEPOSITION MODELING
SHEET 2 OF 2

PROJECT No. M09441A14

FIG. No. 4.2

KCB-R-MLD

Time: 15:22:56
Date: 9/2/2014
Scale: 1:2.5849(PS)
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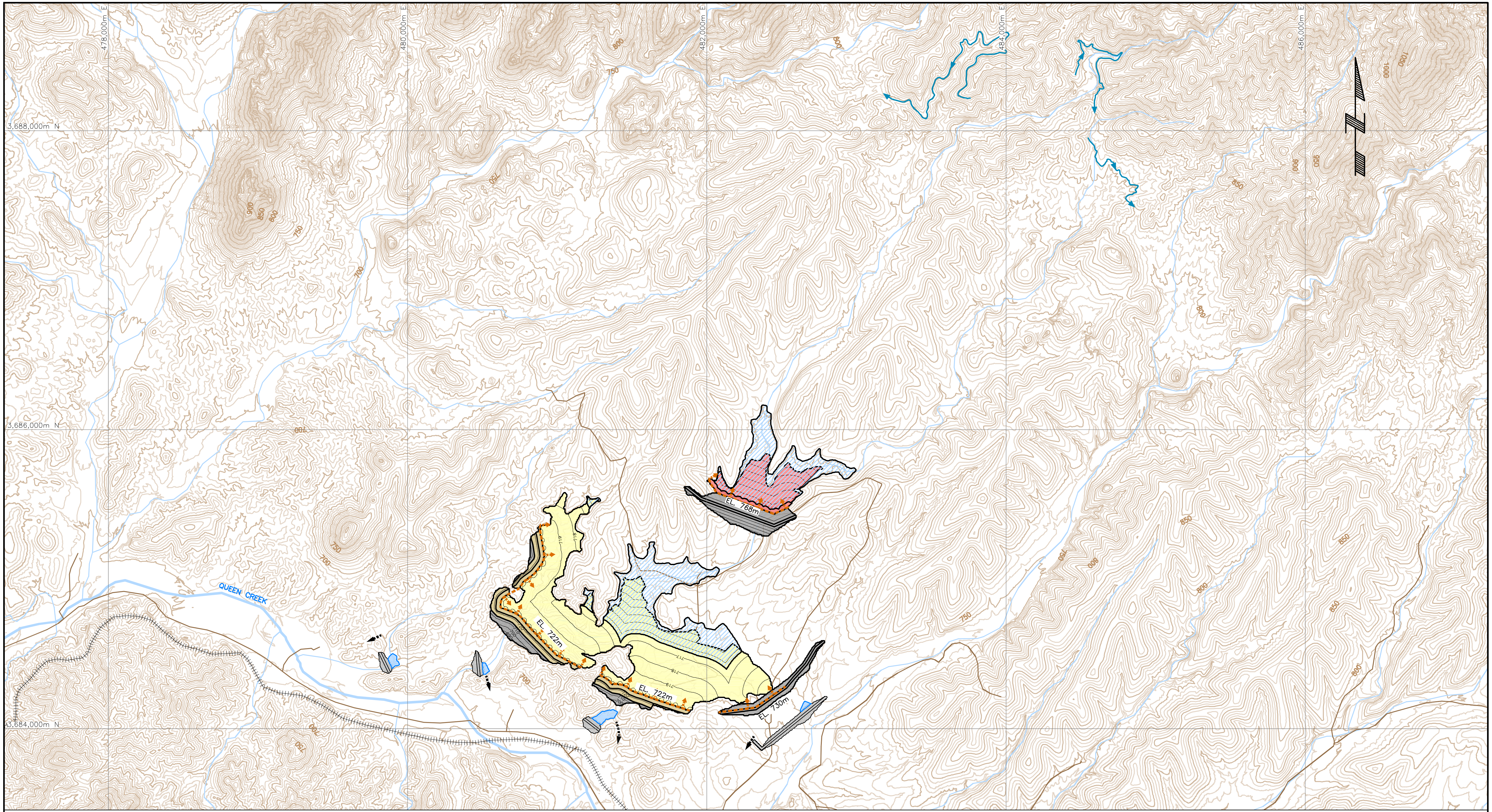
Image File(s): 130508–Closure 130502–Year18 130502–Year21 130502–Year45 130502–Year10 130502–Year12 130502–Year2 130502–Year8



LEGEND

- DIVERSION CHANNEL
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- TAILINGS DISCHARGE
- SPILLWAY
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- TSF RECLAIM POND
- SCD POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: TAILINGS LAYOUT
YEAR 2 (START-UP)

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	4.3

KCB-FIG-D-L

Date: 9/2/2014 Time: 15:33:14 Scale: 1:2.585(PS)
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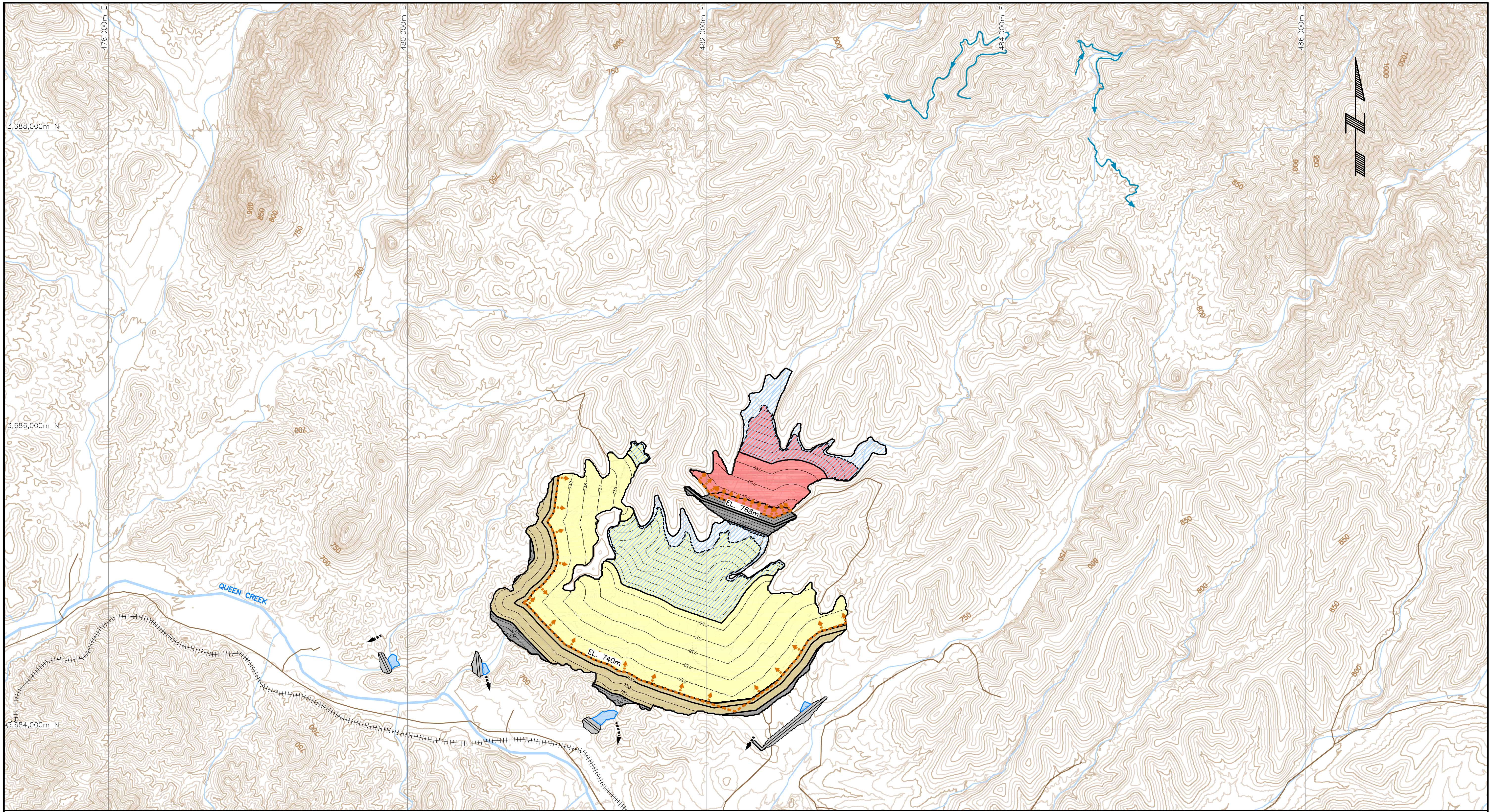

LEGEND

- DIVERSION CHANNEL
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- TAILINGS DISCHARGE
- SPILLWAY
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- TSF RECLAIM POND
- SCD POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: TAILINGS LAYOUT YEAR 5

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	4.4

KCB-FIG-D-L

Date: 9/2/2014 Time: 15:37:33 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near West\Geotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig4.4_rA - Year 5 Plan.dwg (dhu)
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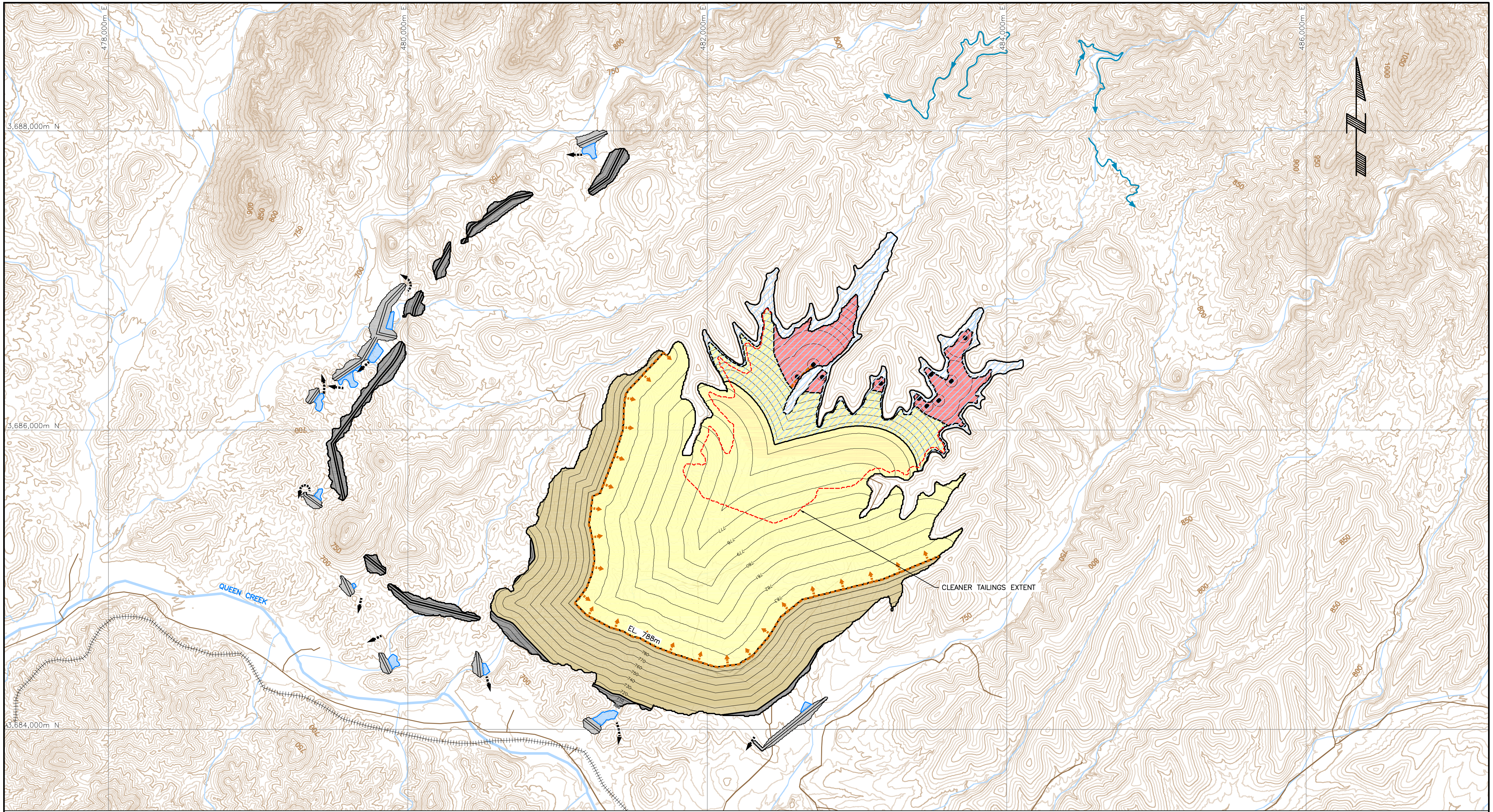

LEGEND

	DIVERSION CHANNEL		UPSTREAM EMBANKMENT RAISE FILL
	RAILWAY		STARTER DAM
	ROAD		THICKENED SCAVENGER TAILINGS
	STREAM		THICKENED CLEANER TAILINGS
	SEEPAGE COLLECTION DAM (SCD)		TSF RECLAIM POND
	SCAVENGER TAILINGS DISCHARGE		SCD POND
	CLEANER TAILINGS SPIGOT		
	SPILLWAY		

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: TAILINGS LAYOUT
YEAR 10

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	4.5

KCB-FIG-D-L

Date: 9/2/2014 Time: 15:47:23 Scale: 1:2,585(FS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig4.5_rA - Year 10 Plan.dwg (dhu)
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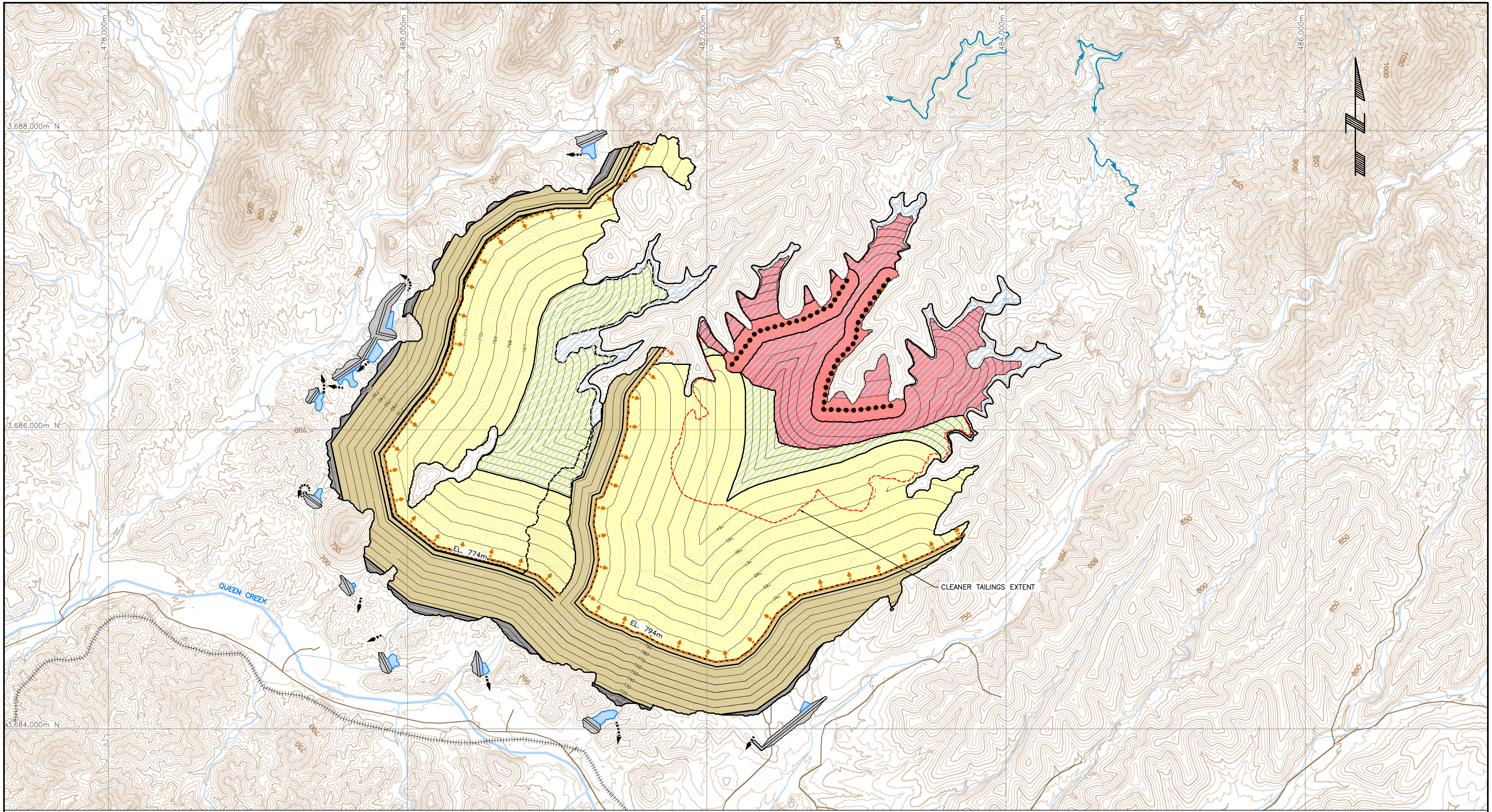

LEGEND

- DIVERSION CHANNEL
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- SCAVENGER TAILINGS DISCHARGE
- CLEANER TAILINGS SPIGOT
- SPILLWAY
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- TSF RECLAIM POND
- SCD POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERTIONS STUDY

TITLE: TAILINGS LAYOUT
YEAR 15

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	4.6

KCB-FIG-D-L

Date: 9/2/2014 Time: 15:51:39 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 – RES–Near West\Geotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig4.6_rA – Year 15 Plan.dwg (dhu)
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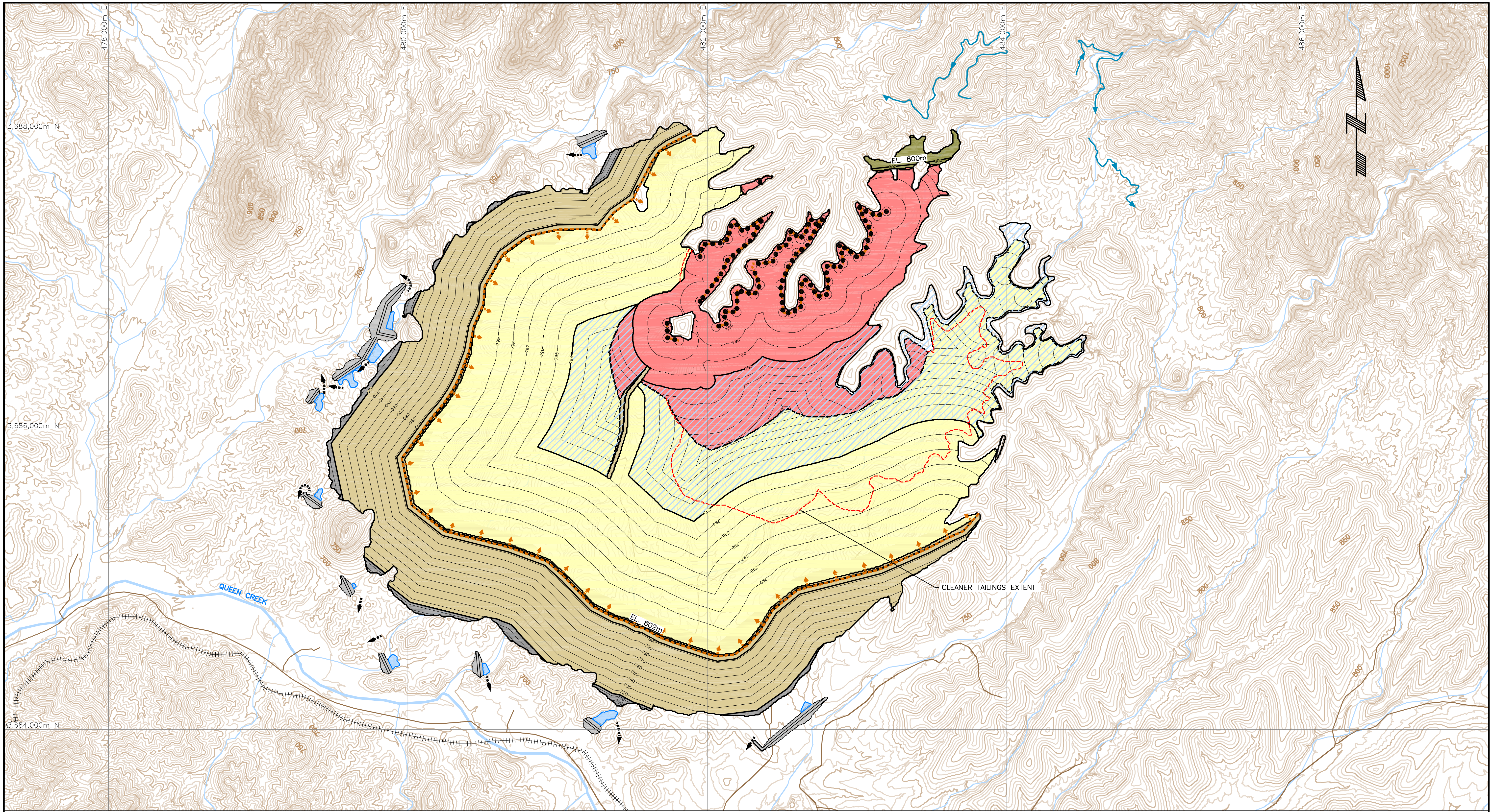
Image File(s):



LEGEND

- DIVERSION CHANNEL
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- SCAVENGER TAILINGS DISCHARGE
- CLEANER TAILINGS SPIGOT
- SPILLWAY
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAMS
- TSF RECLAIM POND
- SCD POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MINE PLAN OF OPERATIONS STUDY

TITLE: TAILINGS LAYOUT
YEAR 20

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	4.7

KCB-FIG-D-L

Date: 9/2/2014 Time: 15:53:33 Scale: 1:2.585(PS)
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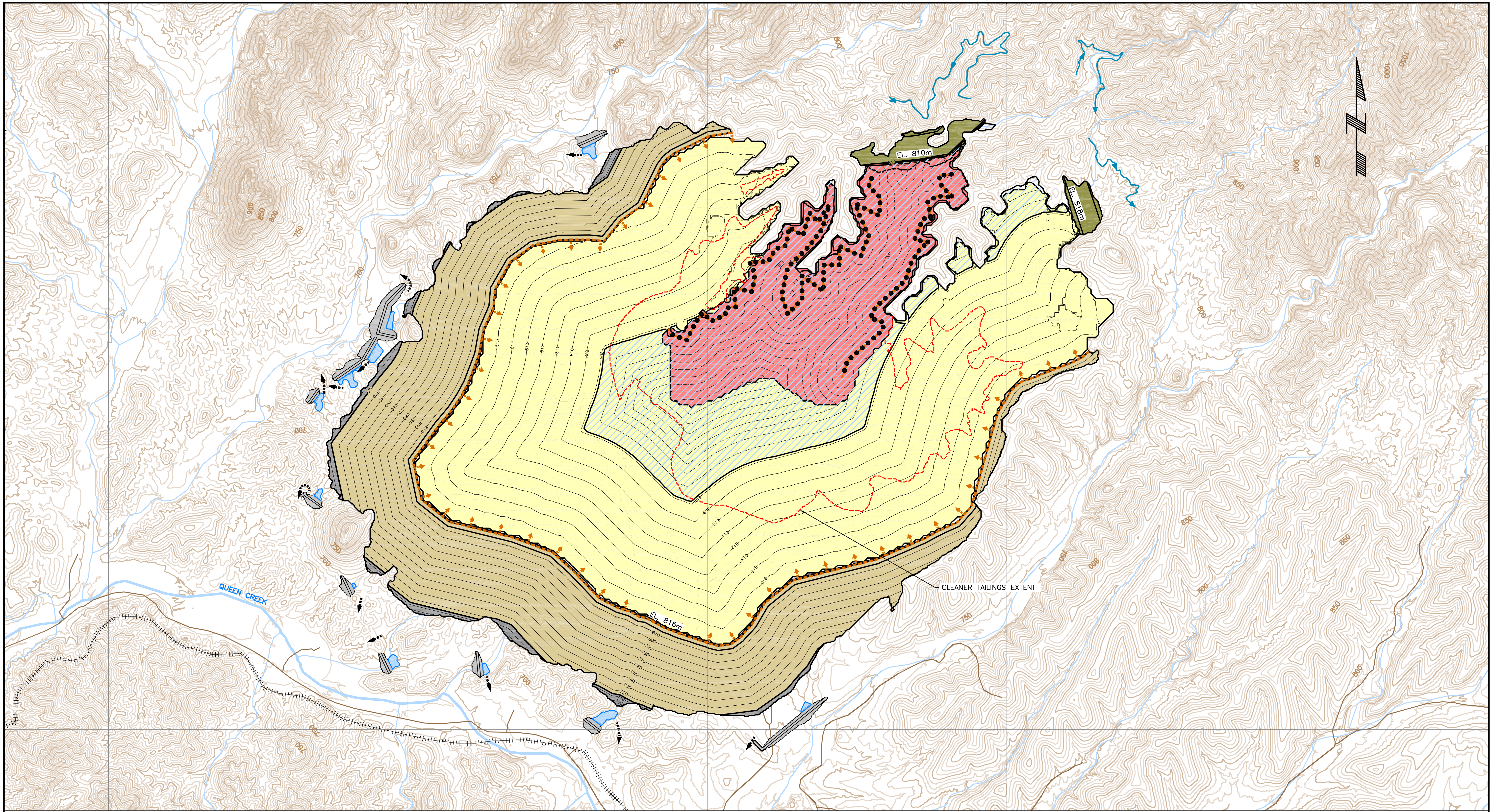
Image File(s):



LEGEND

DIVERSION CHANNEL	UPSTREAM EMBANKMENT RAISE FILL
RAILWAY	STARTER DAM
ROAD	THICKENED SCAVENGER TAILINGS
STREAM	THICKENED CLEANER TAILINGS
SEEPAGE COLLECTION DAM (SCD)	NORTH DAMS
SCAVENGER TAILINGS DISCHARGE	TSF RECLAIM POND
CLEANER TAILINGS SPIGOT	SCD POND
SPILLWAY	

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

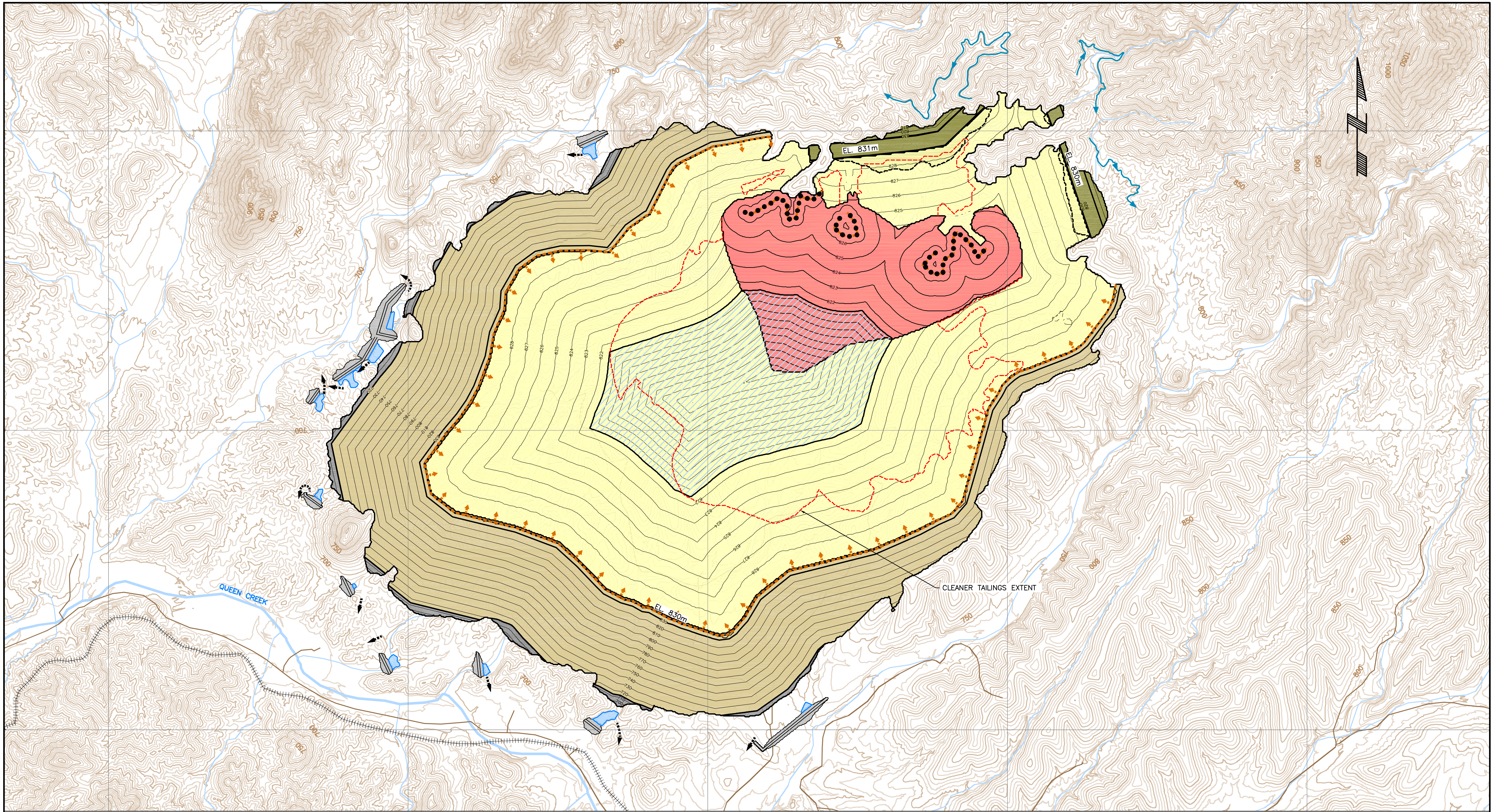
PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: TAILINGS LAYOUT
YEAR 25

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	4.8

KCB-FIG-D-L

Date: 7/19/2013 Time: 16:26:31 Scale: 1:2,585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig4.8_rA - Year 25 Plan.dwg (olacson)
Xref File(s): FOR INSERT_NEAR WEST - APRIL 2013; Happy_Camp_Facilities_Sep2012; bm-near west-5mtopo; Happy_Camp_Streams_Sep2012
Image File(s):



LEGEND

- DIVERSION CHANNEL
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- SCAVENGER TAILINGS DISCHARGE
- CLEANER TAILINGS SPIGOT
- SPILLWAY
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAMS
- TSF RECLAIM POND
- SCD POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT

Resolution Copper Mining

Klohn Crippen Berger

PROJECT

RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE

TAILINGS LAYOUT
YEAR 30

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	4.9

KCB-FIG-D-L

Date: 9/2/2014 Time: 16:01:34 Scale: 1:2,585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig4.9_rA - Year 30 Plan.dwg (dhu)
Xref File(s): FOR INSERT_NEAR WEST - APRIL 2013; Happy_Camp_Facilities_Sep2012; bm-near west-5mtopo; Happy_Camp_Streams_Sep2012
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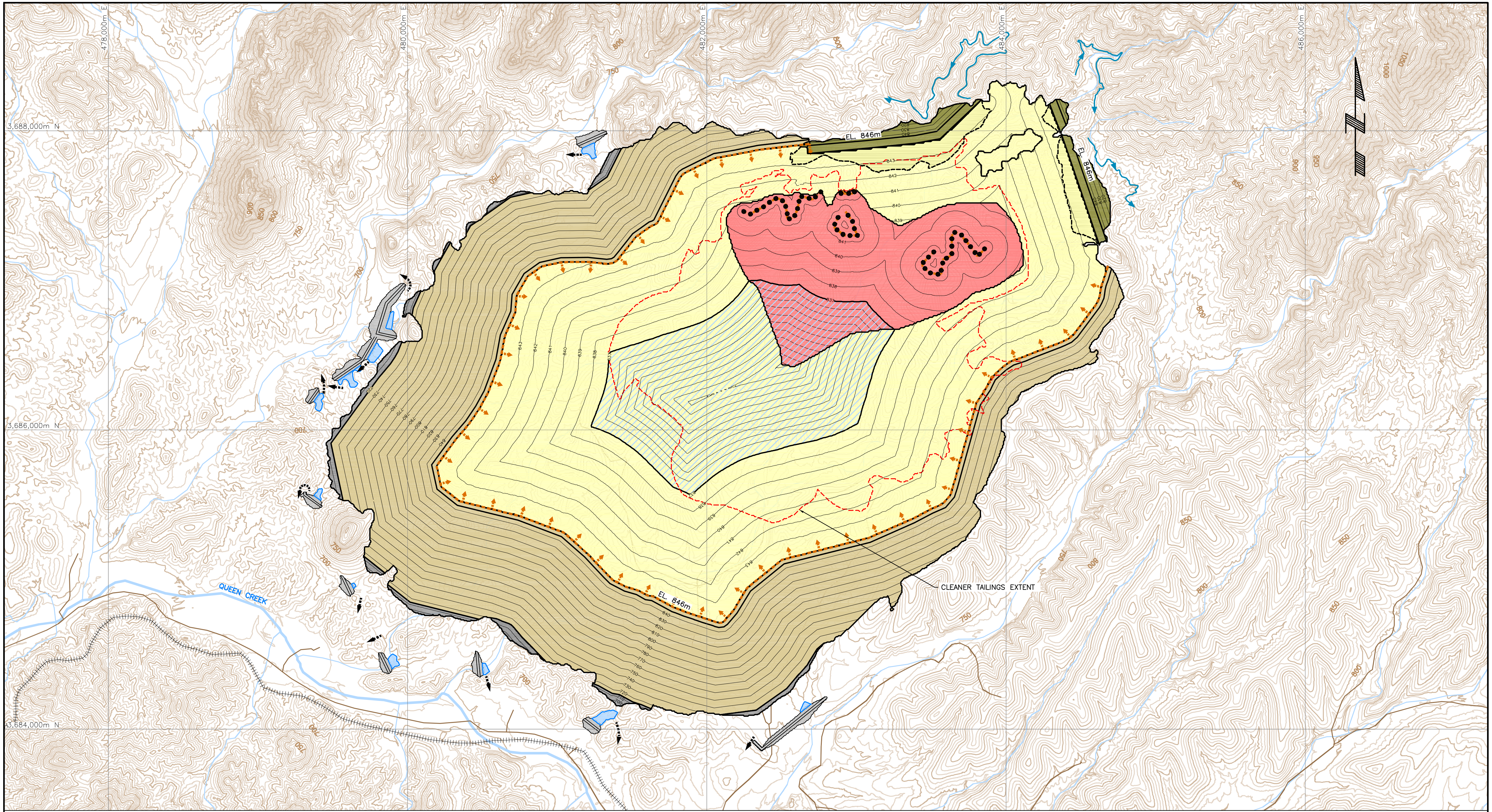

LEGEND

DIVERSION CHANNEL	UPSTREAM EMBANKMENT RAISE FILL
RAILWAY	STARTER DAM
ROAD	THICKENED SCAVENGER TAILINGS
STREAM	THICKENED CLEANER TAILINGS
SEEPAGE COLLECTION DAM (SCD)	NORTH DAMS
SCAVENGER TAILINGS DISCHARGE	TSF RECLAIM POND
CLEANER TAILINGS SPIGOT	SCD POND
SPILLWAY	

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: TAILINGS LAYOUT YEAR 35

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	4.10

KCB-FIG-D-L

Date: 9/2/2014 Time: 16:03:46 Scale: 1:2,585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near West\Geotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig4.10_rA - Year 35 Plan.dwg (dhu)
Xref File(s): FOR INSERT_NEAR WEST - APRIL 2013; bm-near west-5mtopo; Happy_Camp_Facilities_Sep2012; bm-near west-5mtopo; Happy_Camp_Streams_Sep2012
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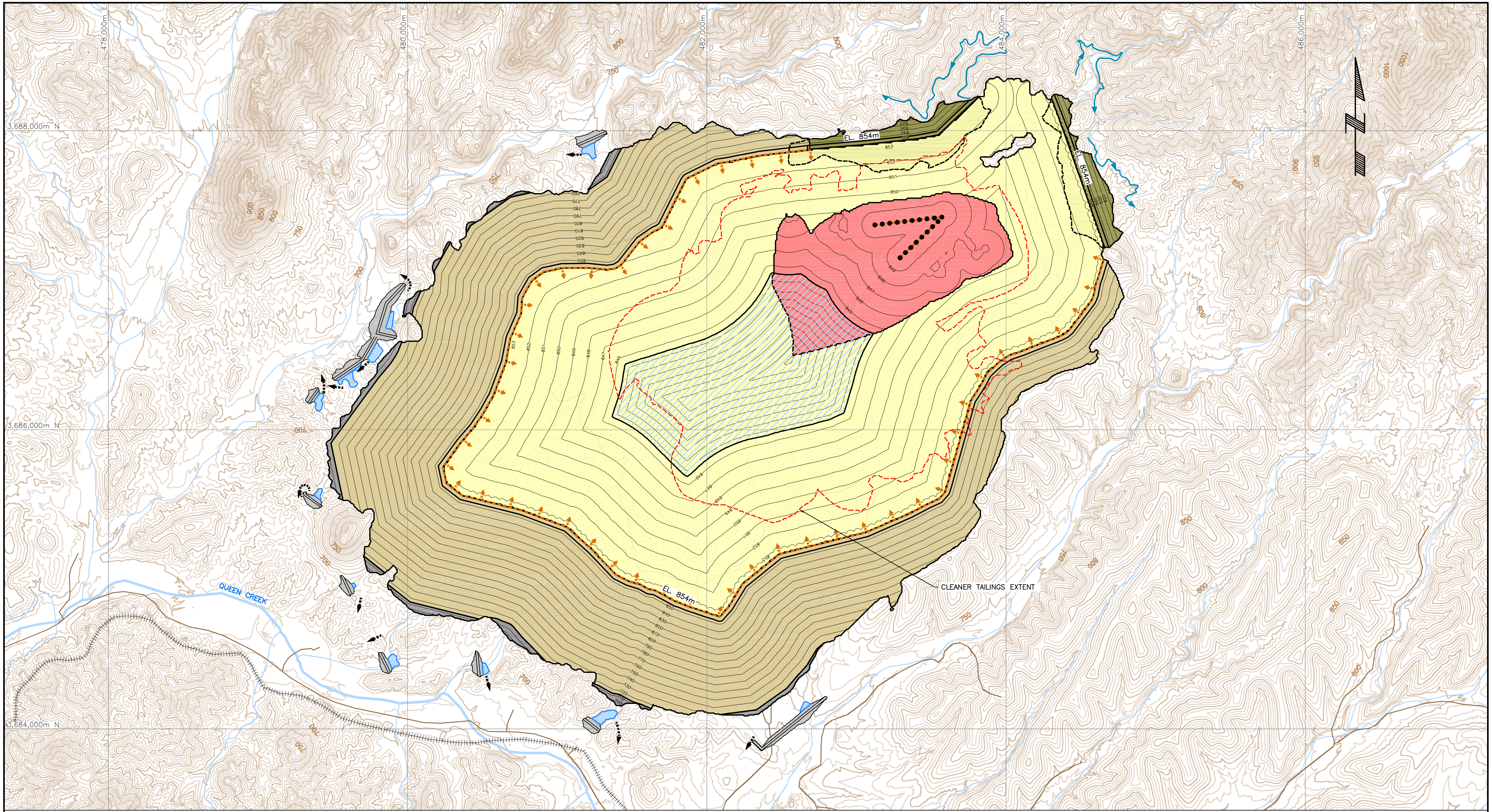

LEGEND

- DIVERSION CHANNEL
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- SCAVENGER TAILINGS DISCHARGE
- CLEANER TAILINGS SPIGOT
- SPILLWAY
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAMS
- TSF RECLAIM POND
- SCD POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: TAILINGS LAYOUT
YEAR 40

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	4.11

KCB-FIG-D-L

Date: 9/2/2014 Time: 16:06:35 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near West Geotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig4.11_rA - Year 40 Plan.dwg (dhu)
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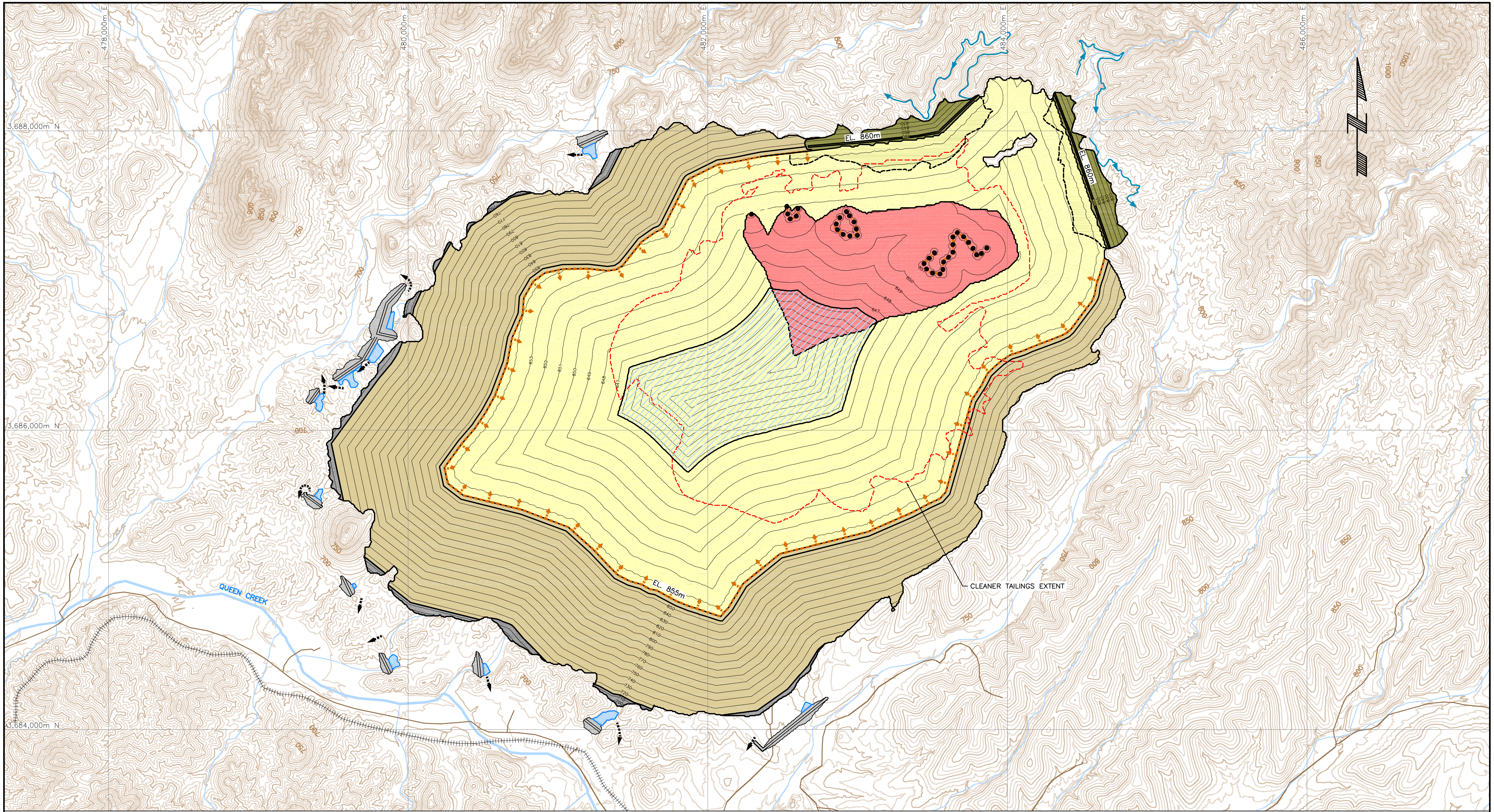


LEGEND

(symbol)	DIVERSION CHANNEL	(fill)	UPSTREAM EMBANKMENT RAISE FILL
(symbol)	RAILWAY	(fill)	STARTER DAM
(symbol)	ROAD	(fill)	THICKENED SCAVENGER TAILINGS
(symbol)	STREAM	(fill)	THICKENED CLEANER TAILINGS
(symbol)	SEEPAGE COLLECTION DAM (SCD)	(fill)	NORTH DAMS
(symbol)	SCAVENGER TAILINGS DISCHARGE	(fill)	TSF RECLAIM POND
(symbol)	CLEANER TAILINGS SPIGOT	(fill)	SCD POND
(symbol)	SPILLWAY		

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

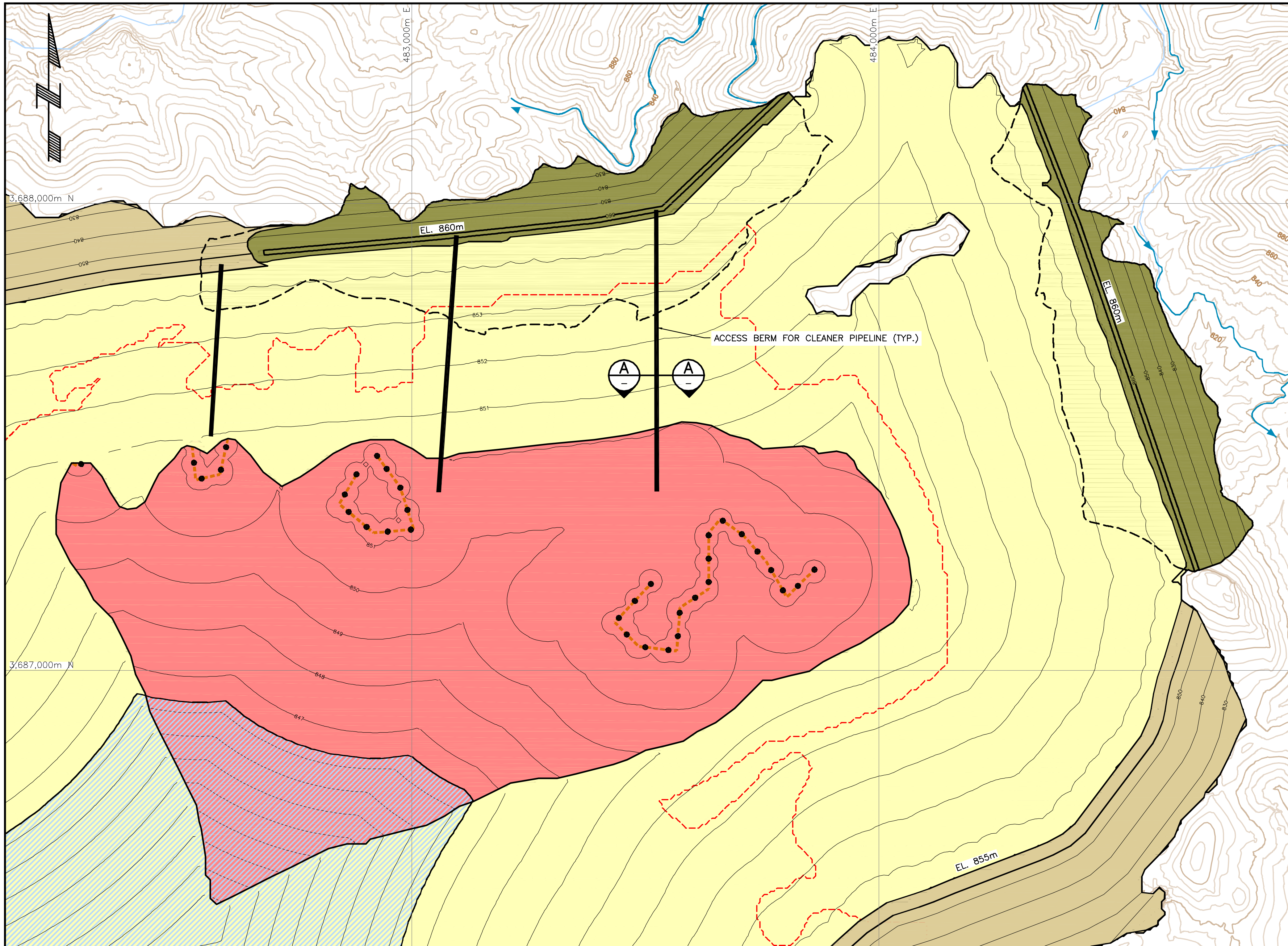
PROJECT: RESOLUTION PROJECT — NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: TAILINGS LAYOUT YEAR 45 (ULTIMATE)

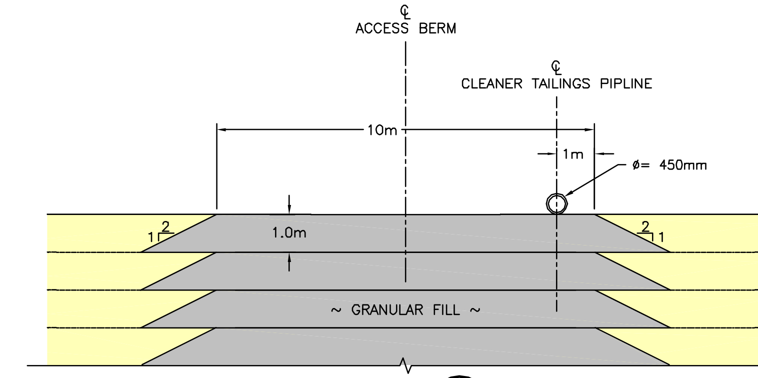
SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	4.12

KCB-FIG-D-L

Date: 9/2/2014 Time: 16:09:52 Scale: 1:2,585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near West\Geotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig4.12_rA - Ultimate Plan.dwg (dhu)
Xref File(s): FOR INSERT_NEAR WEST - APRIL 2013; Happy_Camp_Facilities_Sep2012; bm-near west-5mtopo; Happy_Camp_Streams_Sep2012
Image File(s):



PLAN
SCALE A



SECTION A
NTS

LEGEND

- UPSTREAM EMBANKMENT RAISE FILL
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAMS
- TSF RECLAIM POND
- CLEANER TAILINGS SPIGOT

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 250m

CLIENT: Resolution Copper Mining	PROJECT: RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY
Klohn Crippen Berger	TITLE: CLEANER DEPOSITION ACCESS BERMS
SCALE: AS SHOWN	PROJECT No. M09441A14
FIG. No. 4.13	

KCB-FIG-D-L

Date: 9/2/2014 Time: 16:12:34 Scale: 1:2,585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig4.13_rA - Cleaner Deposition.dwg (dhu)
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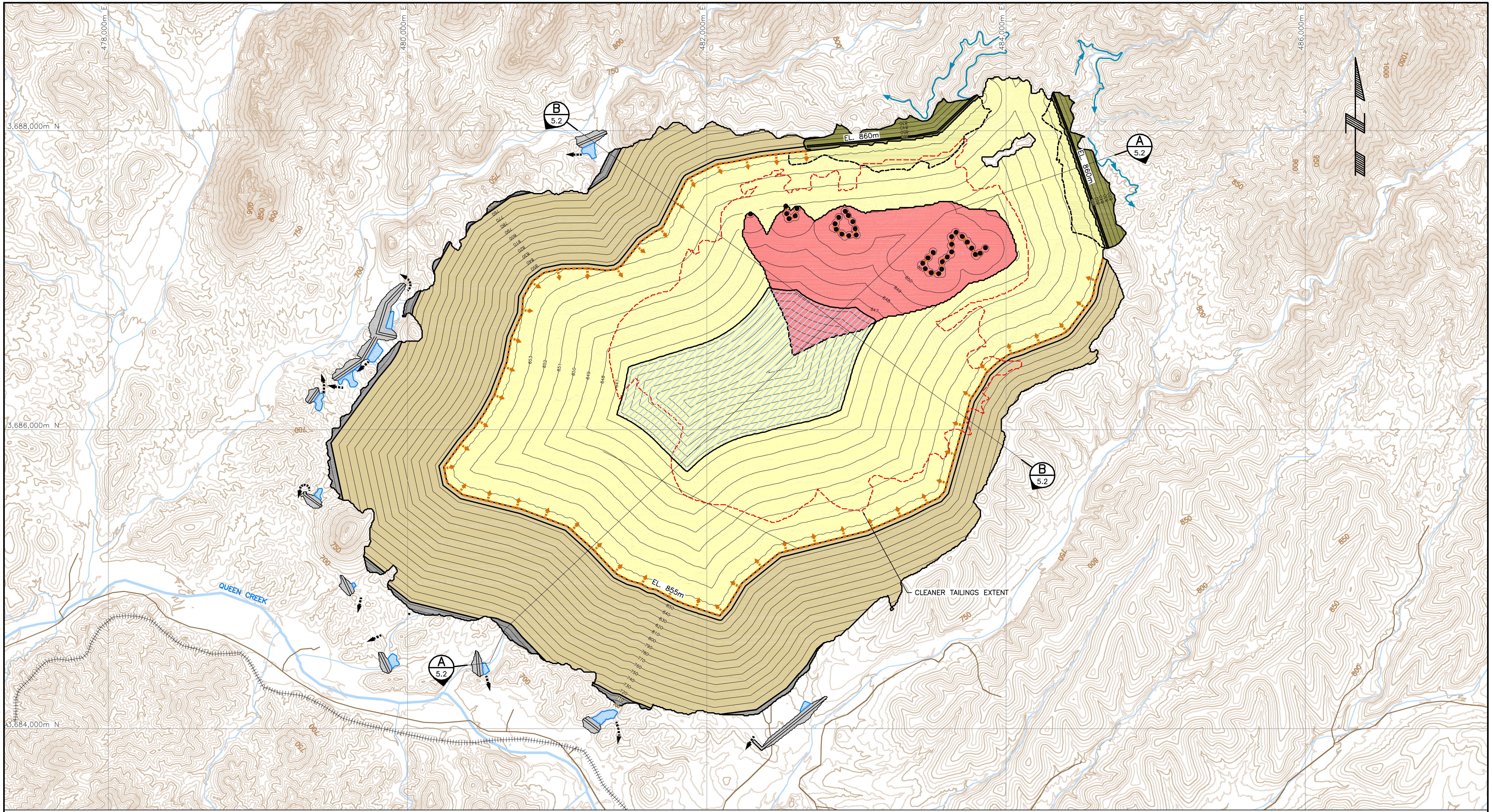

LEGEND

DIVERSION CHANNEL		UPSTREAM EMBANKMENT RAISE FILL	
RAILWAY		STARTER DAM	
ROAD		THICKENED SCAVENGER TAILINGS	
STREAM		THICKENED CLEANER TAILINGS	
SEEPAGE COLLECTION DAM (SCD)		NORTH DAMS	
SCAVENGER TAILINGS DISCHARGE		TSF RECLAIM POND	
CLEANER TAILINGS SPIGOT		SCD POND	
SPILLWAY			

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT

Resolution Copper Mining

Klohn Crippen Berger

PROJECT

RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE

ULTIMATE EMBANKMENT LAYOUT

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	5.1

KCB-FIG-D-L

Date: 9/2/2014 Time: 16:14:08 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig5.1_rA - Embankment Layout.dwg (dhu)
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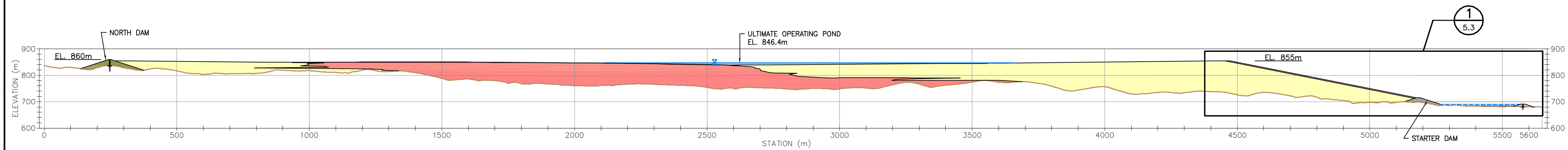
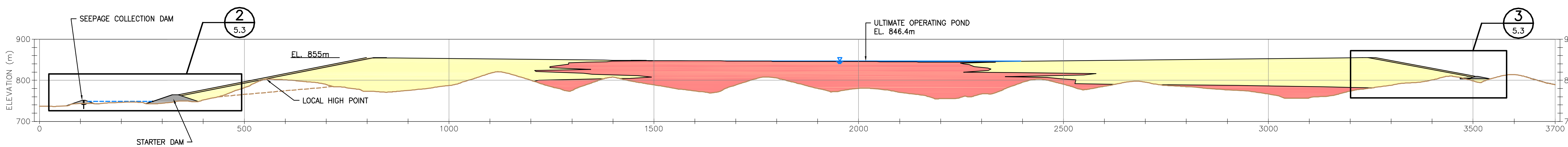


SECTION A
SCALE A
5.1



SECTION B
SCALE B
5.1

LEGEND

- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- SEEPAGE COLLECTION DAM (SCD)
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAM

SCALE B 0 250m
SCALE A 0 300m

NOT FOR CONSTRUCTION

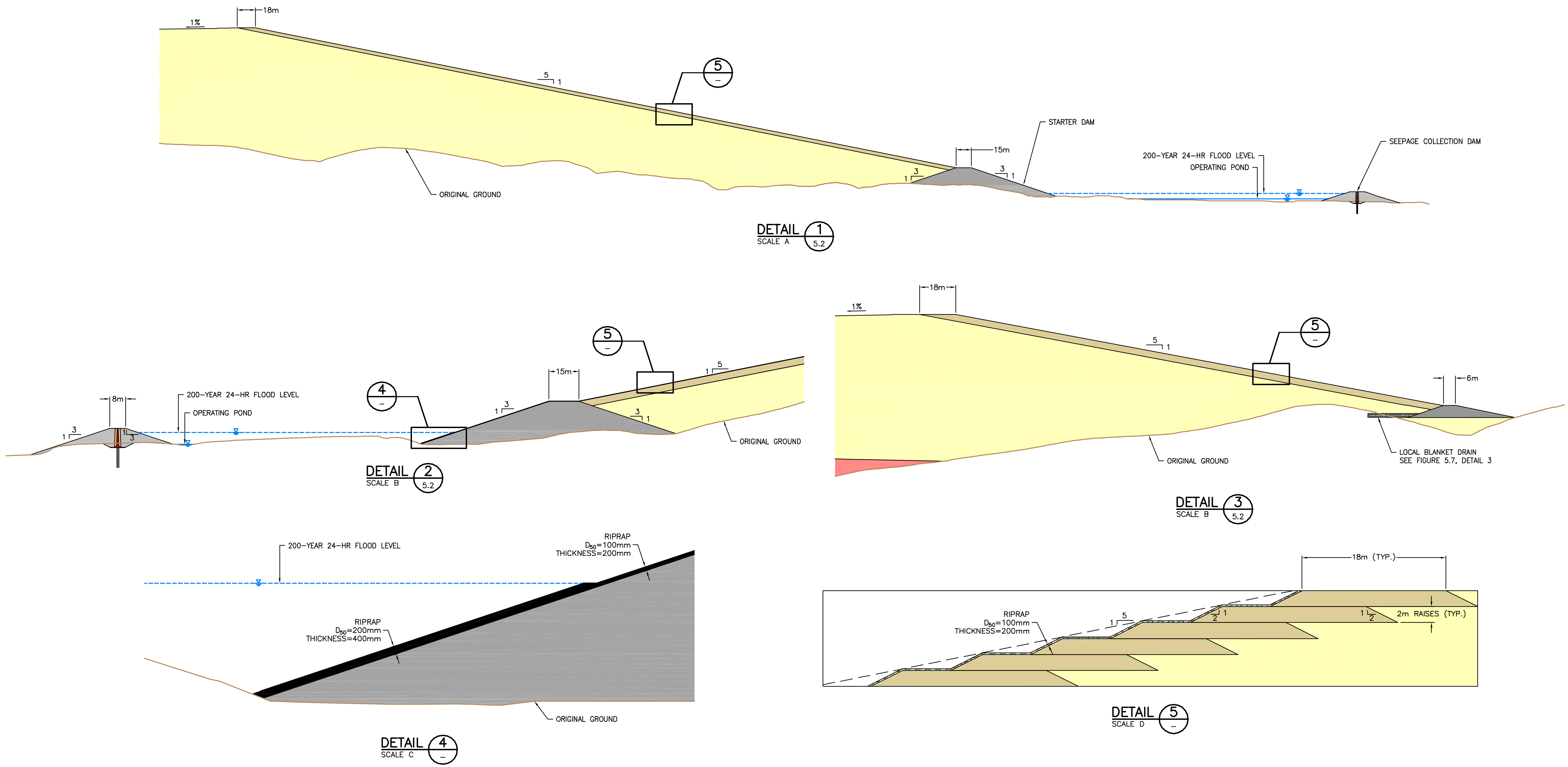
To be read with Klohn Crippen Berger report dated SEPT. 2014

CLIENT	PROJECT
Resolution Copper Mining	RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY
Klohn Crippen Berger	TITLE EMBANKMENT SECTIONS

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	5.2

Date: 9/2/2014 Time: 16:19:06 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 – RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig5.2-5.3_r0 – Embankment Sections and Details.dwg (dhu)
Xref File(s):
Image File(s):

KCB-FIG-D-L



LEGEND

- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- SEEPAGE COLLECTION DAM (SCD)
- THICKENED SCAVENGER TAILINGS

NOT FOR CONSTRUCTION

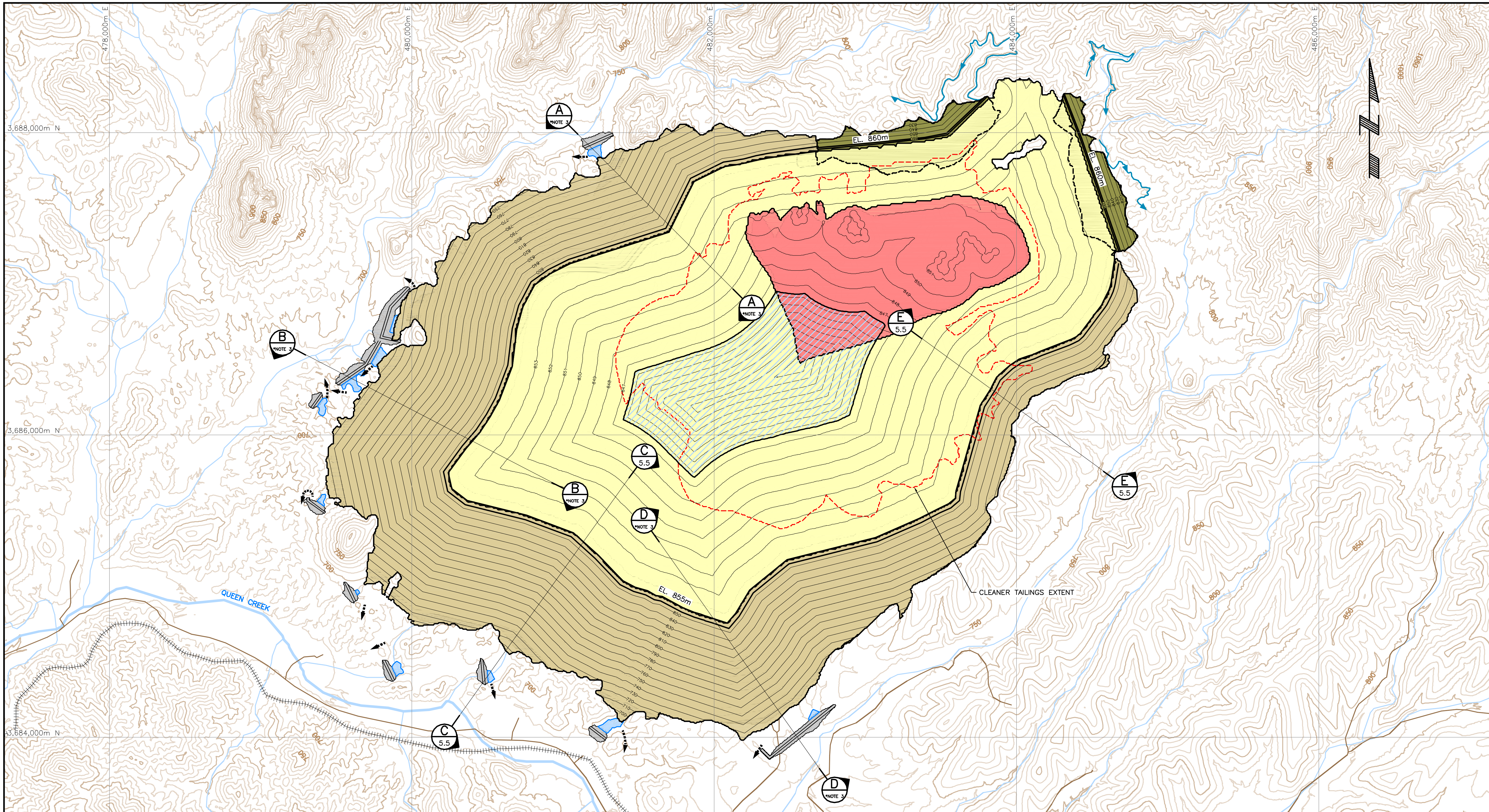
To be read with Klohn Crippen Berger report dated SEPT. 2014

CLIENT	PROJECT
Resolution Copper Mining	RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY
Klohn Crippen Berger	TITLE EMBANKMENT DETAILS

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A12	5.3

Date: 9/2/2014 Time: 16:19:06 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 – RES–Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig5.2–5.3_r0 – Embankment Sections and Details.dwg (dhu)
Xref File(s):
Image File(s):

KCB-FIG-D-L



LEGEND

- DIVERSION CHANNEL
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- SPILLWAY
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAMS
- TSF RECLAIM POND
- SCD POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.
3. REFER TO APPENDIX VI FOR ALL SEEPAGE SECTIONS.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

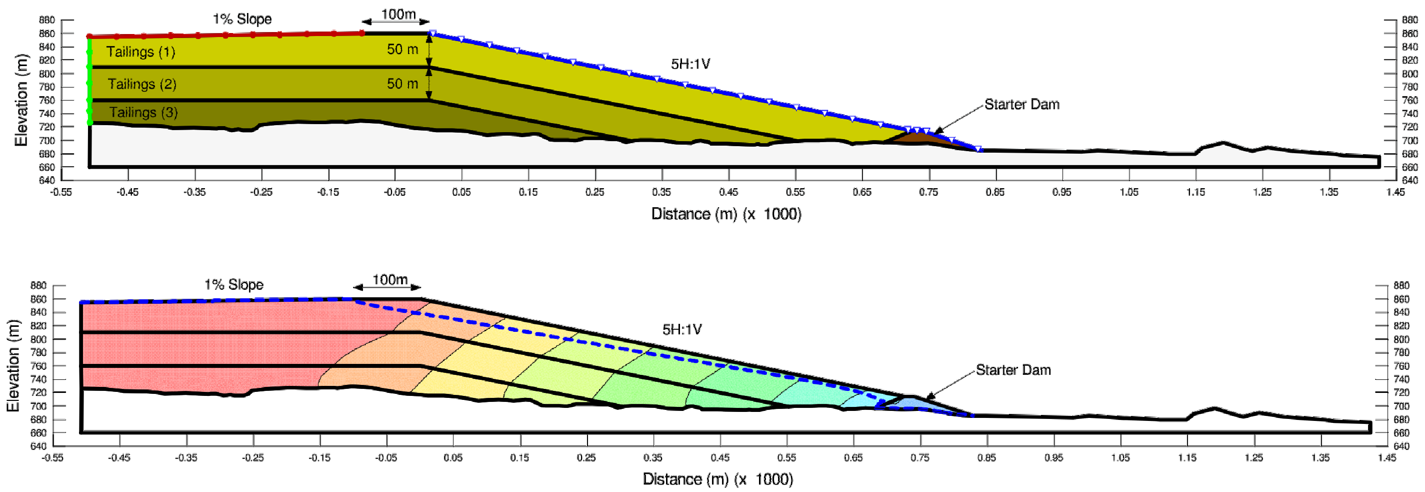
PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: SEEPAGE AND STABILITY DESIGN SECTIONS

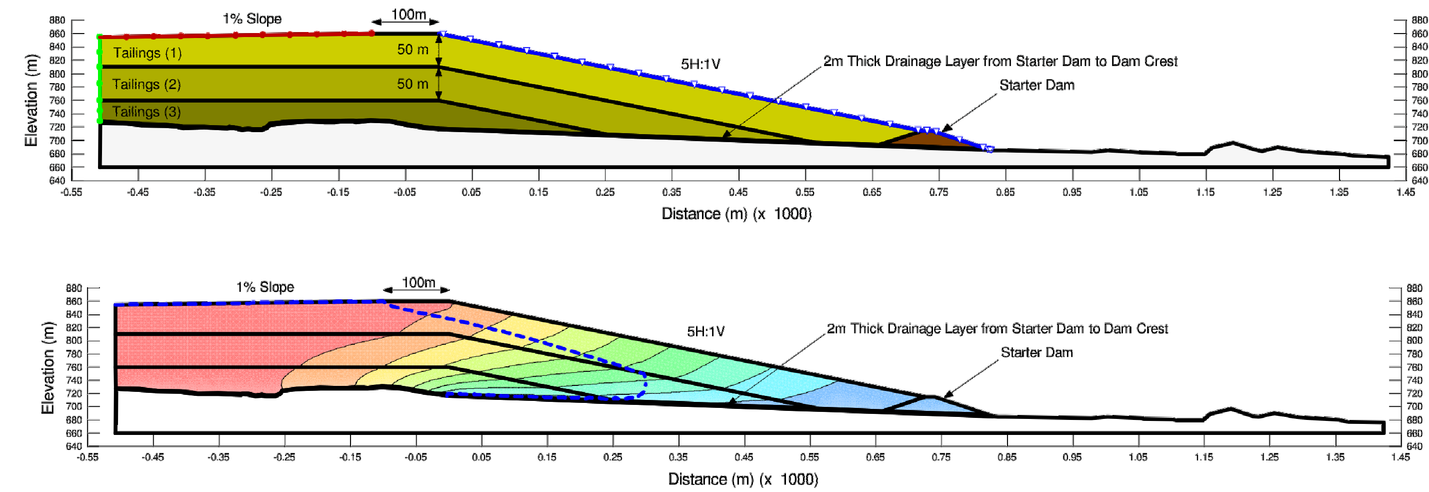
SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	5.4

KCB-FIG-D-L

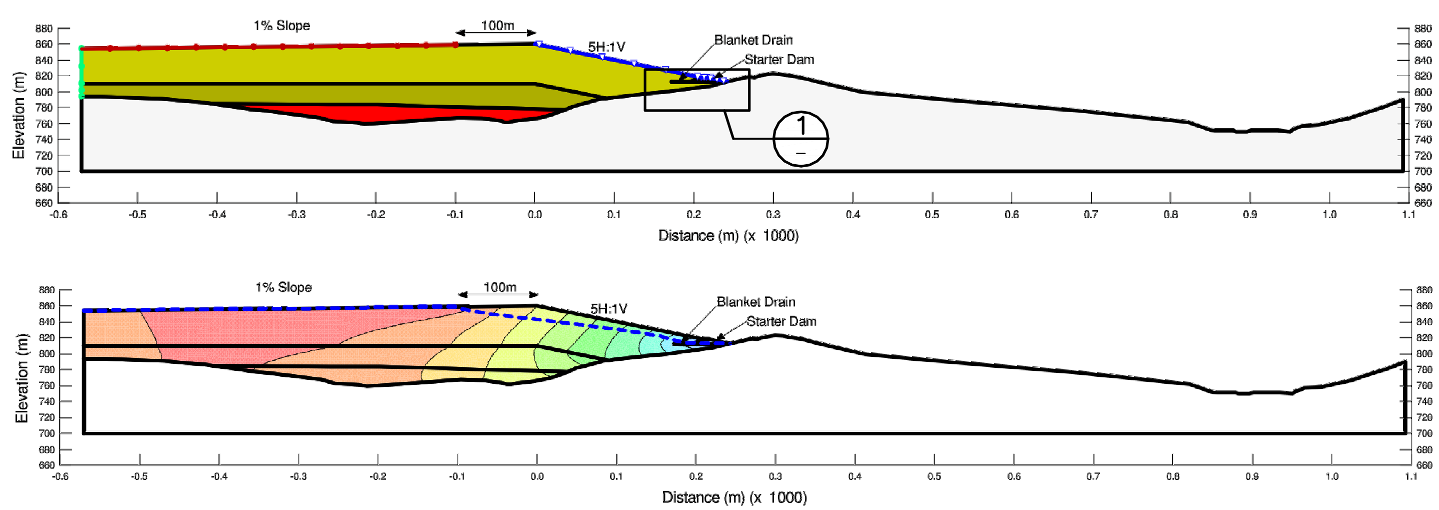
Date: 9/2/2014 Time: 16:26:40 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig5.4_rA - Seepage and Stability Plan.dwg (dhu)
Xref File(s): FOR INSERT_NEAR WEST - APRIL 2013; Happy_Comp_Facilities_Sep2012; bm-near west-5mtopo; Happy_Comp_Streams_Sep2012
Image File(s):



SECTION (C / 5.4)
NTS



SECTION (C / 5.4) WITH UNDERDRAIN
NTS



SECTION (E / 5.4) WITH BLANKET DRAIN
NTS

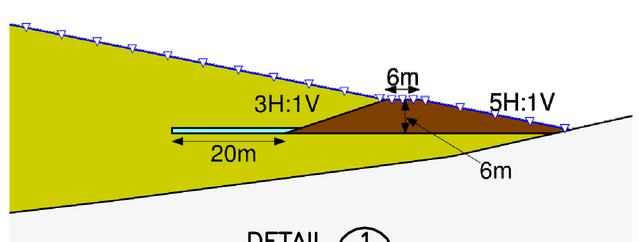
HYDRAULIC CONDUCTIVITIES USED IN SEEPAGE ANALYSIS

Material		Saturated K_h (m/s)	K_v/K_h
Scavenger Tailings (1) (Least Consolidation)		5×10^{-7}	0.11
Scavenger Tailings (2) (Intermediate Consolidation)		1×10^{-7}	0.11
Scavenger Tailings (3) (Most Consolidation)		5×10^{-8}	0.11
Cleaner Tailings		5×10^{-8}	0.11
Starter Dam Fill		5×10^{-5}	1.0
Drains		1×10^{-1}	1.0

Note: Bedrock treated as impermeable.

SEEPAGE RATES

Seepage Section	Seepage Rate at Toe of Dam Slope (m^3/day/m)	Seepage Rate at Toe of Dam Slope (L/s/m)
A	0.22	2.5E-03
B	0.27	3.1E-03
C	0.28	3.3E-03
C (with underdrain)	0.36	4.2E-03
D	0.28	3.2E-03
E	0.20	2.3E-03
E (with blanket drain)	0.19	2.2E-03



DETAIL (1 / –)
NTS

NOTES
1. REFER TO APPENDIX VI FOR ALL SEEPAGE SECTIONS.

NOT FOR CONSTRUCTION
To be read with Klohn Crippen Berger report dated SEPT. 2014

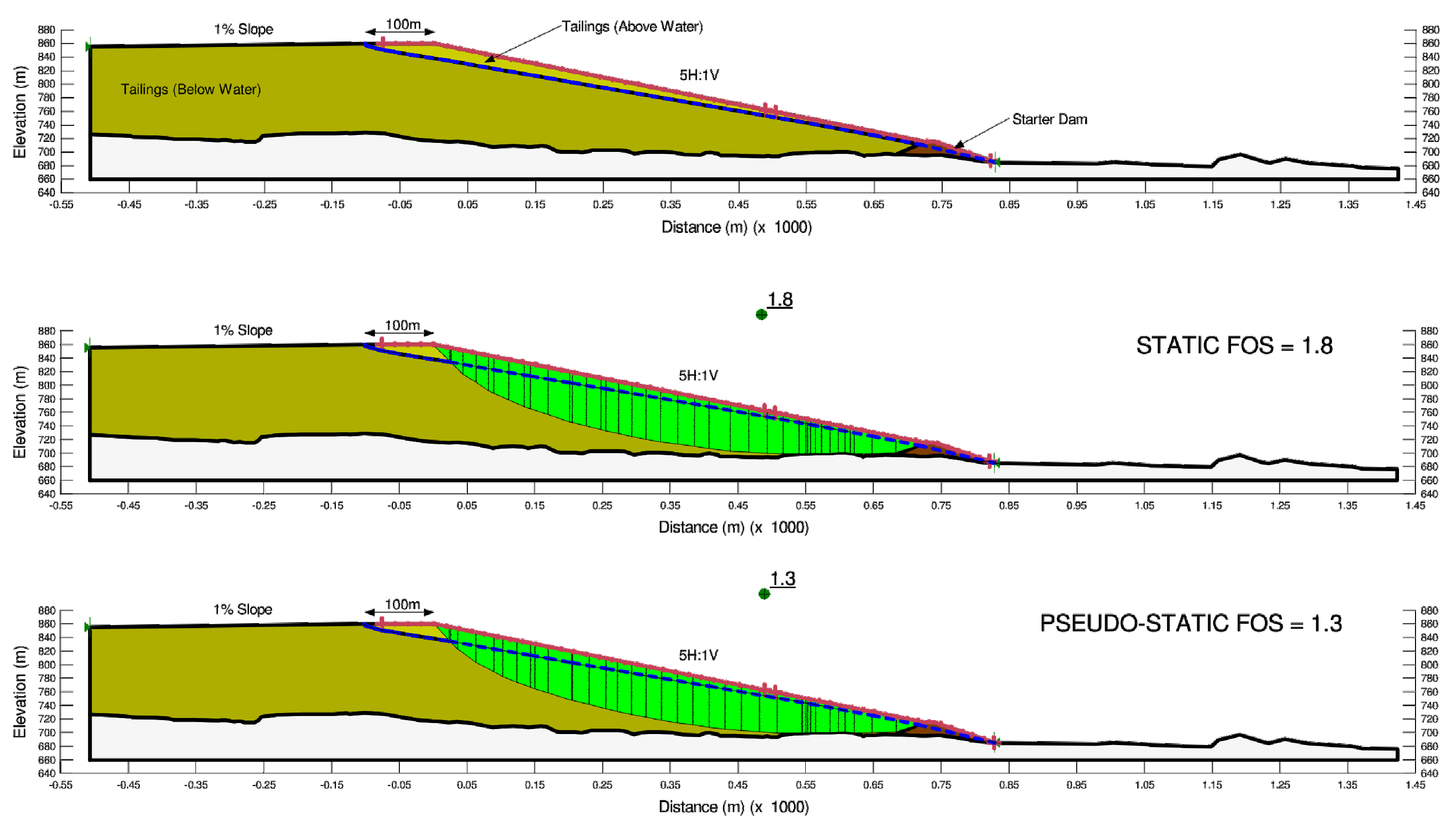
CLIENT: Resolution Copper Mining

Klohn Crippen Berger

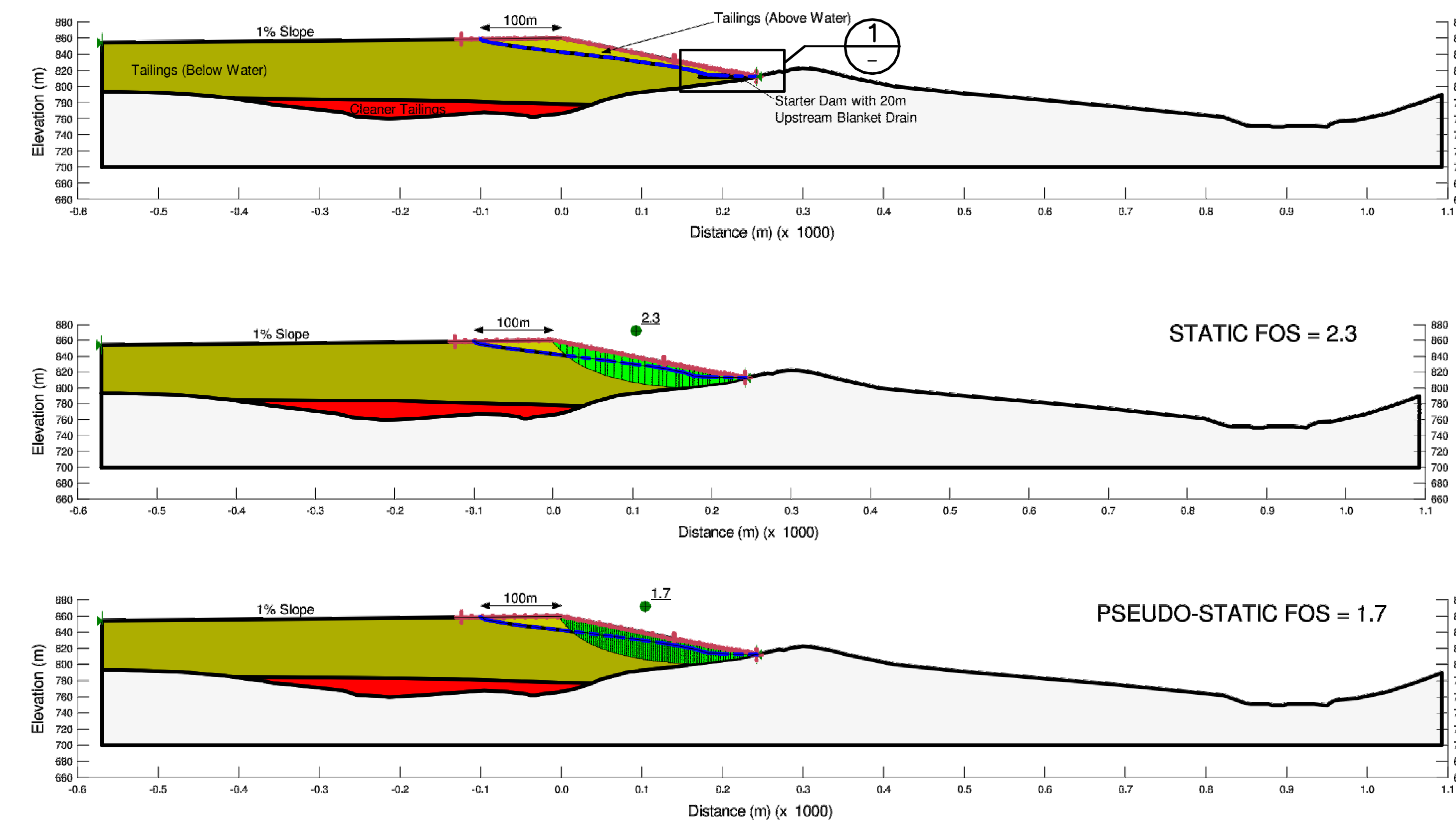
PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: TYPICAL SEEPAGE ANALYSIS SECTIONS

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	5.5



SECTION C
NTS 5.4

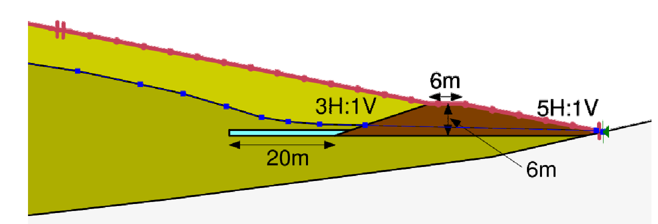


SECTION E
NTS 5.4

SOIL PROPERTIES

Material	Bulk Unit Weight (kN/m^3)	Friction Angle (degrees)
Tailings (Above Water)	15	32°
Tailings (Below Water)	18	32°
Cleaner Tailings	18	32°
Starter Dam Fill	19	36°
Drain	22	35°

Note:
1. Cleaner tailings are only intersected along Section E.
2. Local blanket drain only included in Section E.



DETAIL 1
NTS

FACTORS OF SAFETY

Stability Section	Case	Target FOS	Calculated FOS
C	Static	1.5	1.8
	Pseudo-Static	1.1	1.3
E	Static	1.5	2.3
	Pseudo-Static	1.1	1.7

Note:
1. Horizontal seismic coefficient equal to 2/3 of the PGA was used in pseudo-static analysis.
2. The calculated FOS corresponds to the critical slip surface determind by Slope/W.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

CLIENT
Resolution Copper Mining
Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE
TYPICAL STABILITY ANALYSIS SECTIONS

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	5.6

KCB-FIG-D-L

Date: 9/2/2014 Time: 16:32:42 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig5.6_rA - Stability Analysis Sections.dwg (dhu)
Xref File(s):
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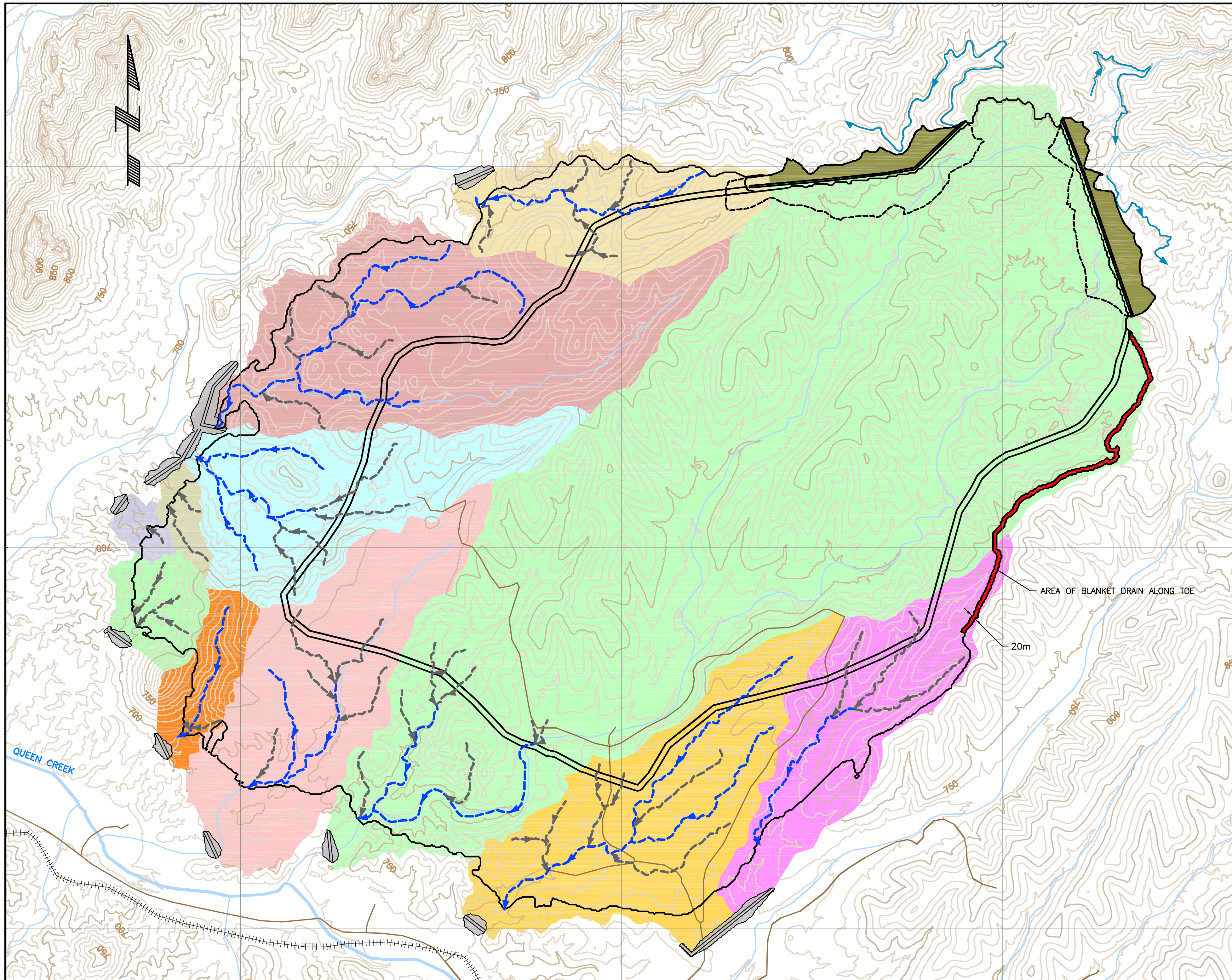
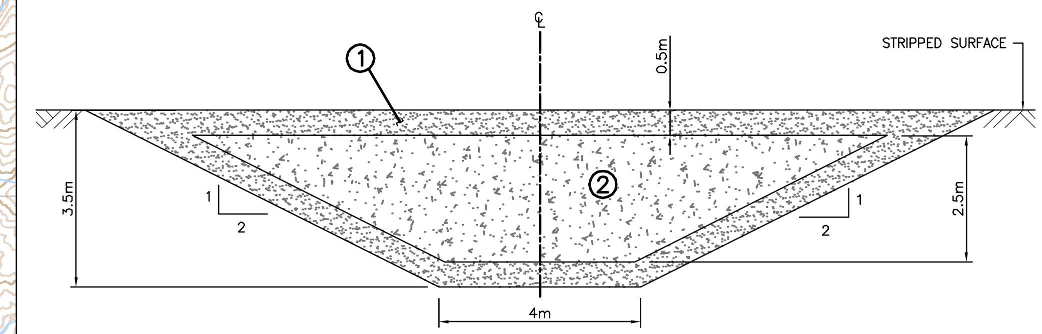
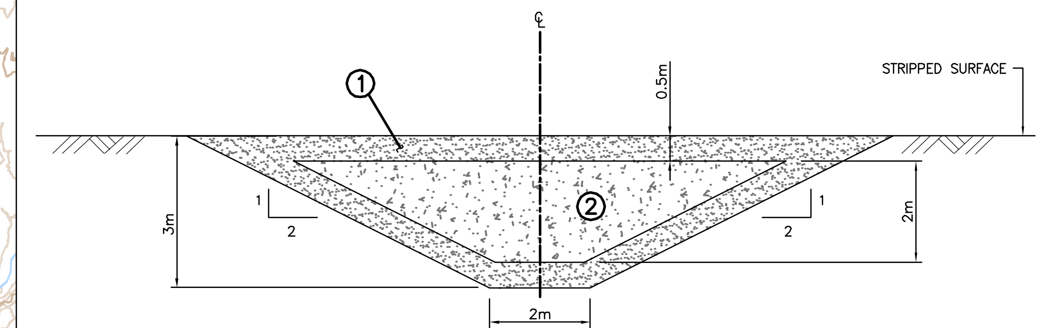


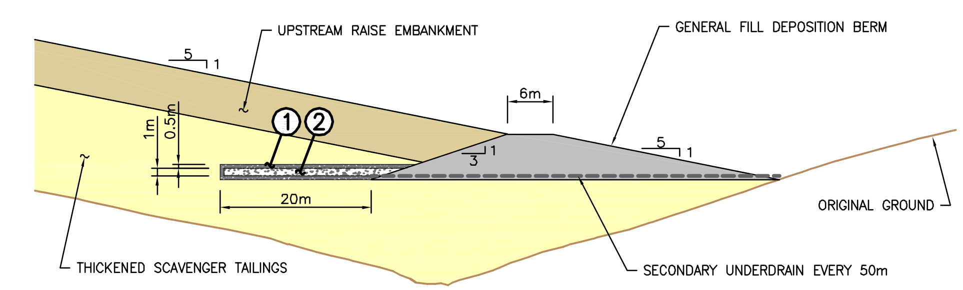
PLAN
SCALE A



DETAIL 1 PRIMARY UNDERDRAIN
SCALE B



DETAIL 2 SECONDARY UNDERDRAIN
SCALE B



DETAIL 3 LOCAL BLANKET DRAIN
SCALE C

LEGEND

- DIVERSION CHANNEL
- PRIMARY UNDERDRAIN
- SECONDARY UNDERDRAIN
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- NORTH DAMS
- AREA OF LOCAL BLANKET DRAIN

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.
3. DRAINAGE AREAS ARE INDICATED BY SHADED AREAS.

MATERIAL ZONES	
ZONE	MATERIAL TYPE
①	19mm MINUS SAND AND GRAVEL WITH D_{15} BETWEEN 0.6mm AND 0.2mm. 5% MAXIMUM FINES CONTENT.
②	100mm–20mm DRAIN ROCK

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE C 0 20m
SCALE B 0 3m
SCALE A 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

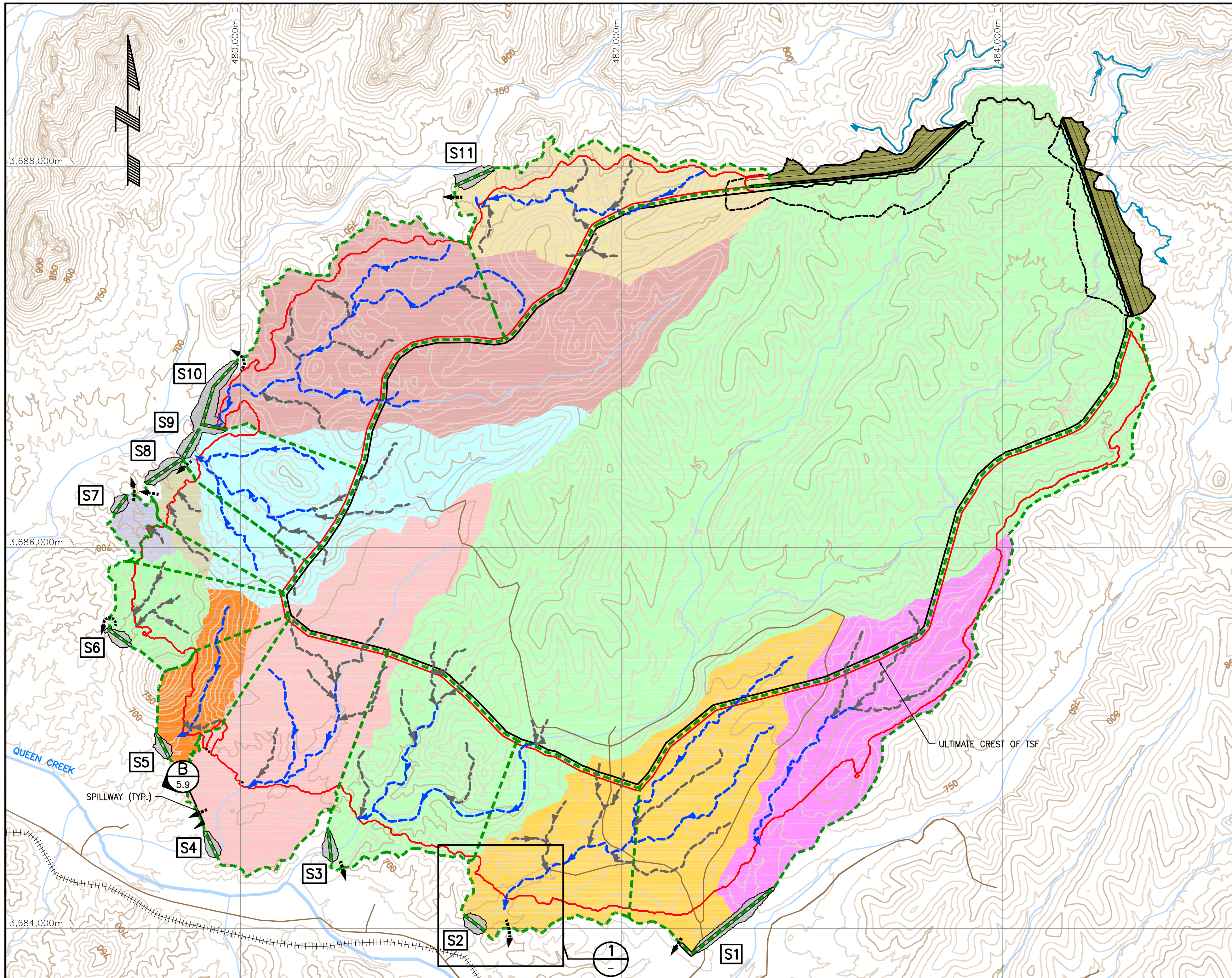
PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: UNDERDRAIN DESIGN

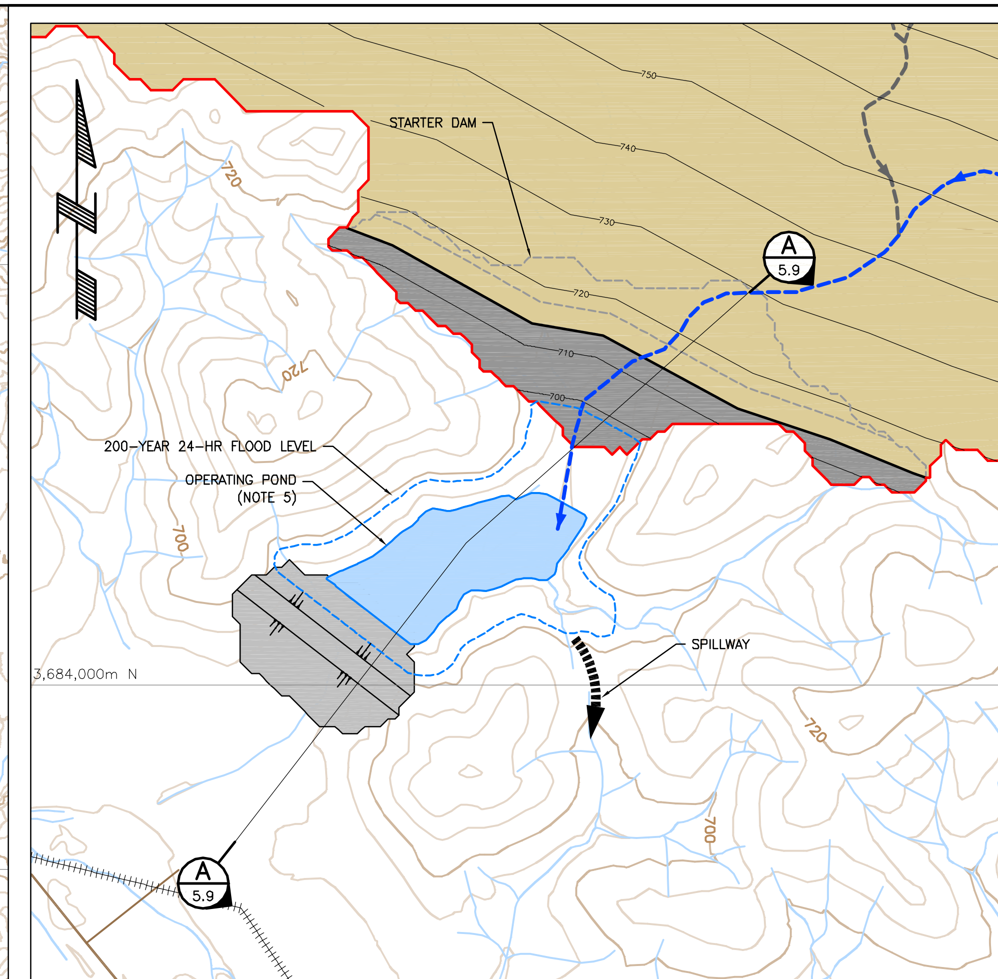
SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	5.7

KCB–FIG–D–L

Date: 7/19/2013 Time: 16:56:14 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 – RES–Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig5.7_rA – Underdrains.dwg (olacson)
Xref File(s): FOR INSERT_NEAR WEST – APRIL 2013; Happy_Camp_Facilities_Sep2012; bm–near west–5mtopo; Happy_Camp_Streams_Sep2012
Image File(s):



PLAN
SCALE A



DETAIL 1 TYPICAL SEEPAGE DAM
SCALE B

SEEPAGE COLLECTION DAM	CATCHMENT AREA (km²) (NOTE 3)	DRAINAGE AREA (km²) (NOTE 4)
S1	1.94	0.96
S2	0.67	1.45
S3	0.74	7.91
S4	0.83	1.36
S5	0.25	0.26
S6	0.32	0.24
S7	0.15	0.07
S8	0.22	0.10
S9	0.38	1.11
S10	1.03	1.99
S11	0.65	0.81

LEGEND

- DIVERSION CHANNEL
- PRIMARY UNDERDRAIN
- SECONDARY UNDERDRAIN
- SPILLWAY
- CATCHMENT BOUNDARY
- RAILWAY
- ROAD
- STREAM
- S1 SEEPAGE COLLECTION DAM (SCD)
- NORTH DAMS

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.
3. CATCHMENT AREAS ARE INDICATED BY DASHED GREEN LINES.
4. DRAINAGE AREAS ARE INDICATED BY SHADED AREAS.
5. OPERATING POND BASED ON 3m WATER DEPTH FOR PUMPING.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE B 0 100m
SCALE A 0 500m

CLIENT
Resolution Copper Mining

Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE
SEEPAGE COLLECTION DAMS
PLAN

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	5.8

KCB-FIG-D-L

Date: 9/2/2014 Time: 16:43:01 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig5.8_rA - Seepage Dams.dwg (dhu)
Xref File(s): FOR INSERT_NEAR WEST - APRIL 2013; Happy_Camp_Facilities_Sep2012; bm-near west-5mtopo; Happy_Camp_Streams_Sep2012
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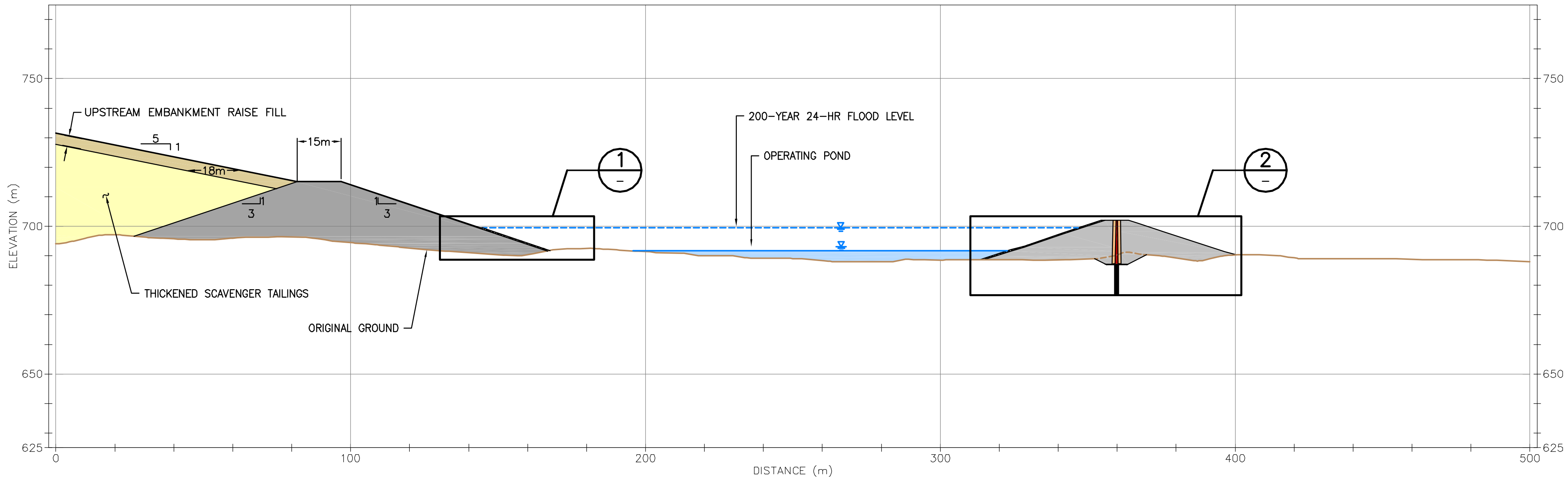
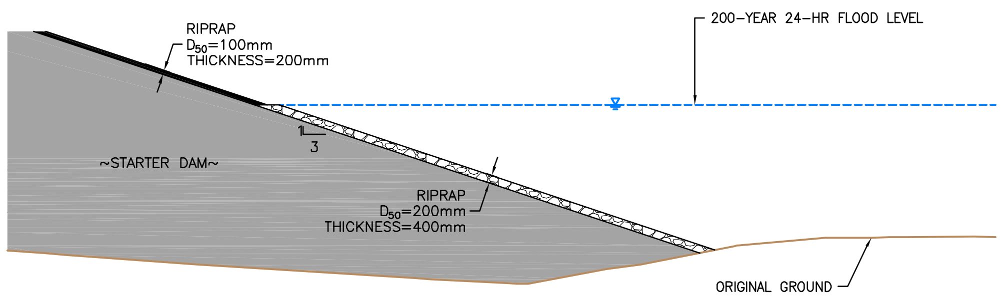
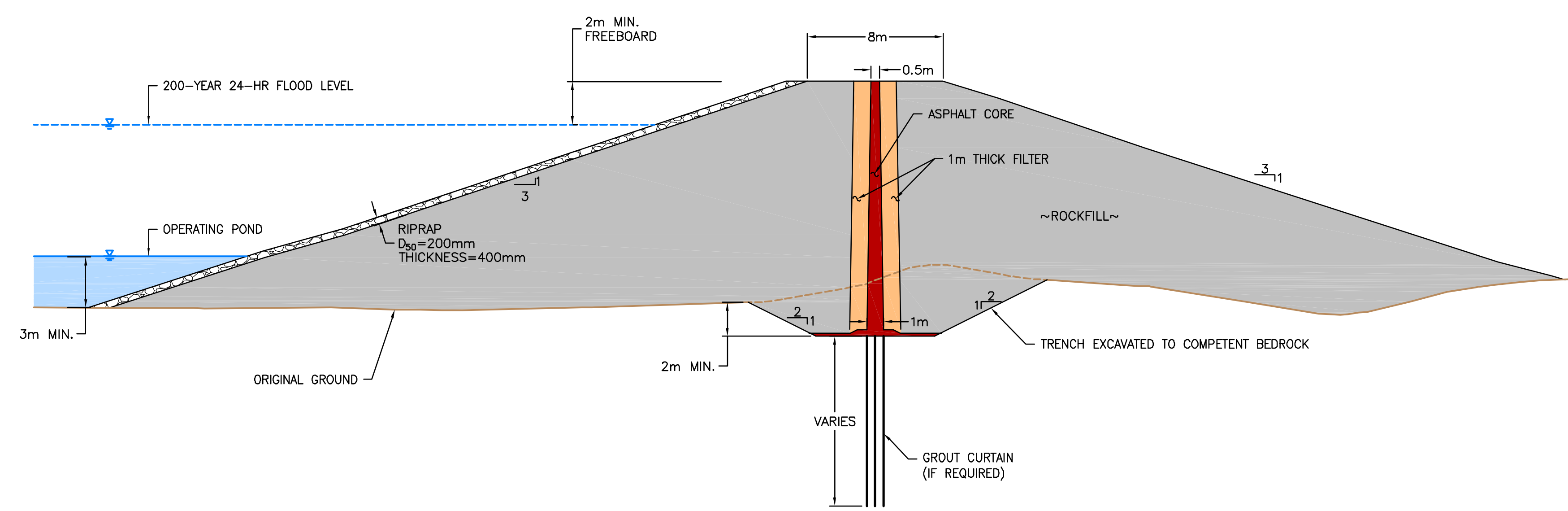


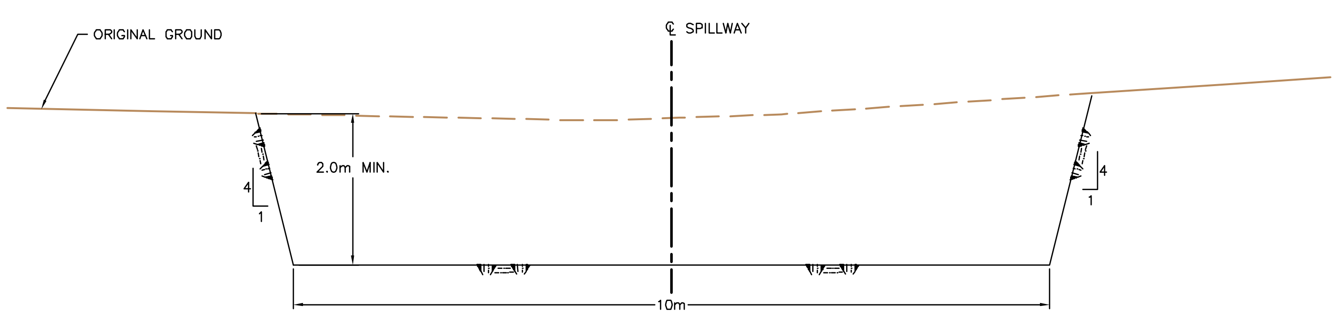
SECTION A
SCALE A 5.8



DETAIL 1 TYPICAL STARTER DAM ARMOURING
SCALE B



DETAIL 2 TYPICAL SEEPAGE DAM
SCALE B



SECTION B TYPICAL SPILLWAY SECTION
SCALE C 5.8

SCALE C 0 2.5 m
SCALE B 0 10 m
SCALE A 0 50 m

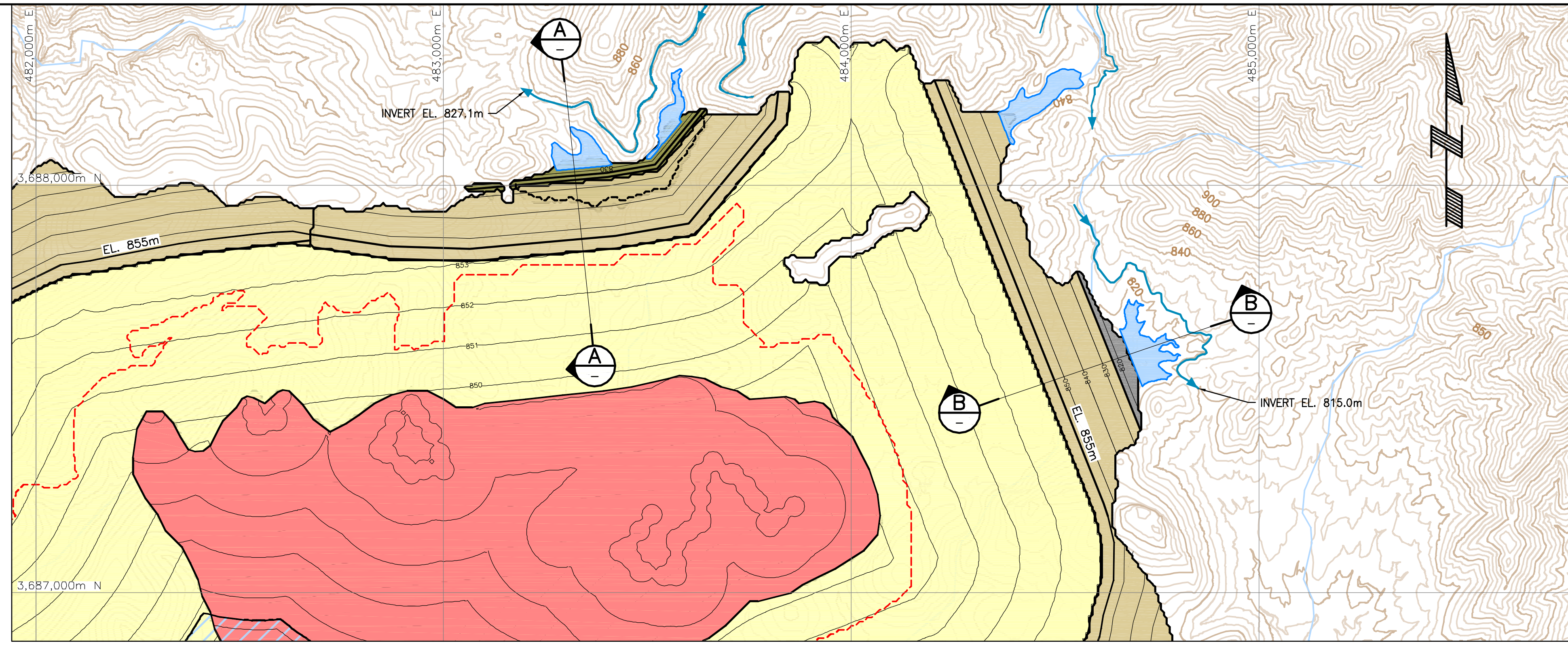
NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

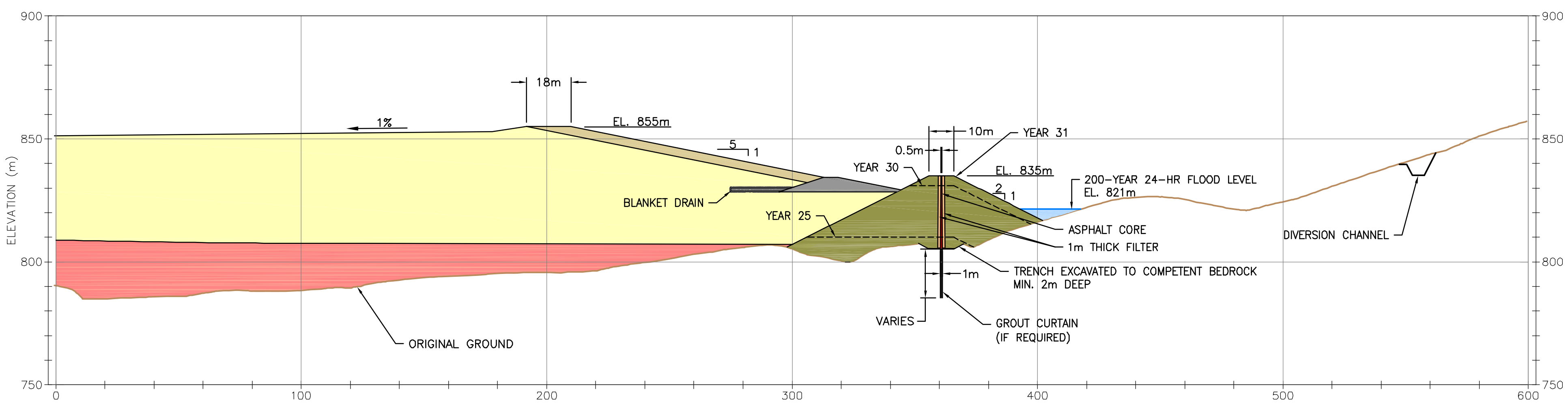
CLIENT	PROJECT
Resolution Copper Mining	RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY
Klohn Crippen Berger	TITLE SEEPAGE COLLECTION DAM TYPICAL CROSS-SECTION

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	5.9

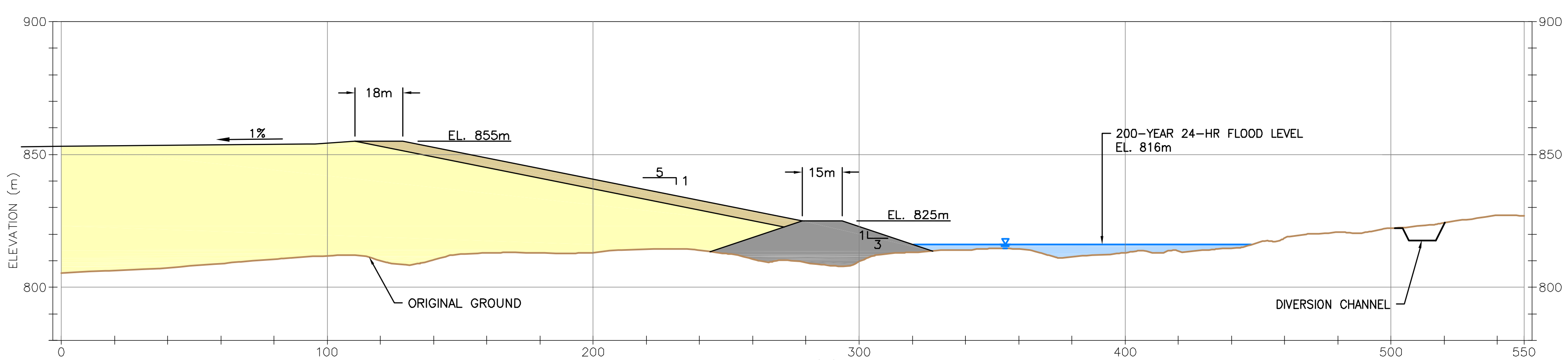
KCB-FIG-D-L



PLAN
SCALE A



SECTION A NORTHWEST DAM
SCALE B



SECTION B NORTHEAST DAM
SCALE B

LEGEND

- UPSTREAM EMBANKMENT RAISE FILL
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAMS
- STARTER DAM

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

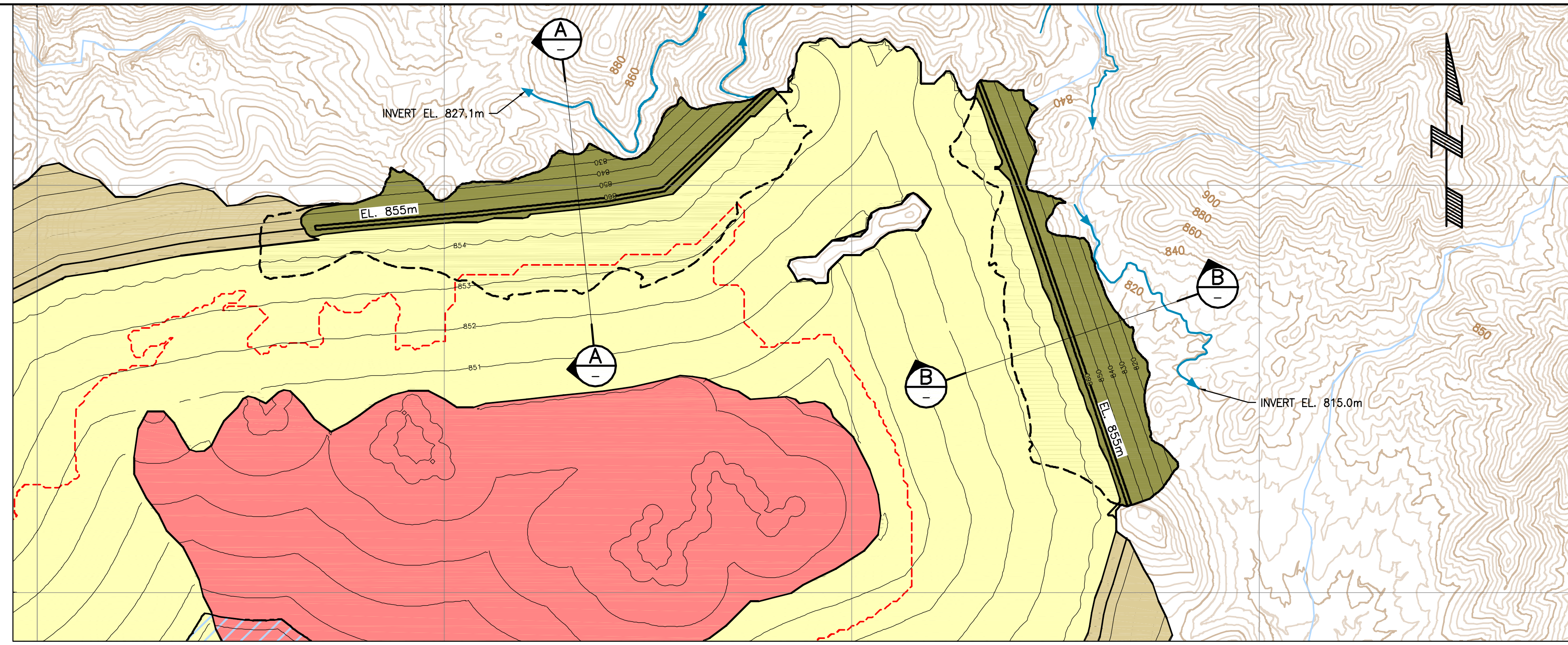
To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE B 0 50m
SCALE A 0 300m

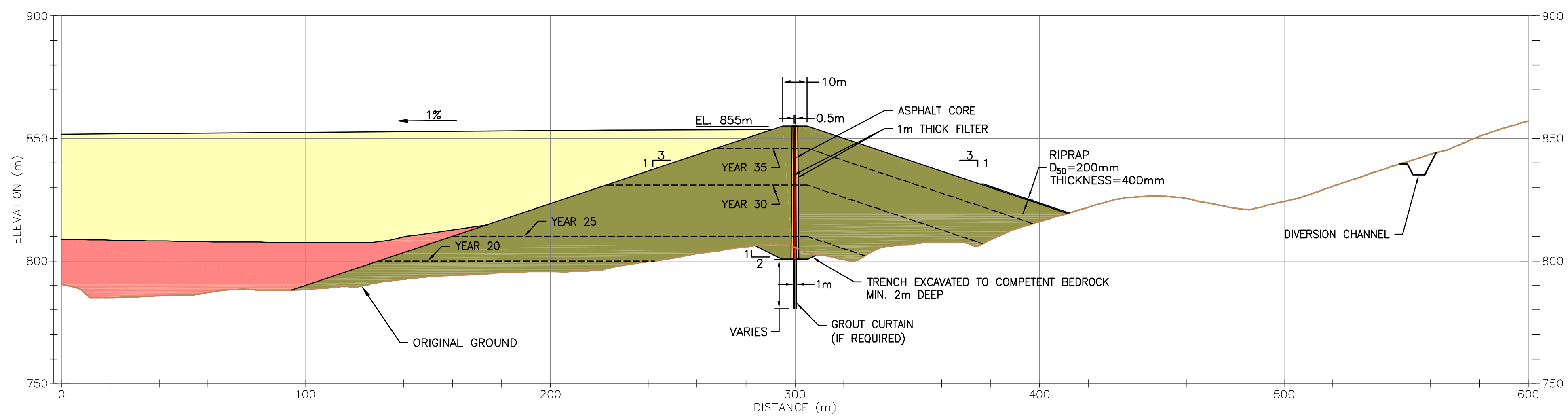
CLIENT: Resolution Copper Mining	PROJECT: RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERTIONS STUDY
Klohn Crippen Berger	TITLE: NORTH DAMS
SCALE: AS SHOWN	PROJECT No. M09441A14
FIG. No. 5.10	

Date: 9/2/2014 Time: 16:47:30 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig5.10_rA - North Dams Base.dwg (dhu)
Xref File(s): FOR INSERT_NEAR WEST - APRIL 2013; Happy_Camp_Facilities_Sep2012; bm-near west-5mtopo; Happy_Camp_Streams_Sep2012
Image File(s):

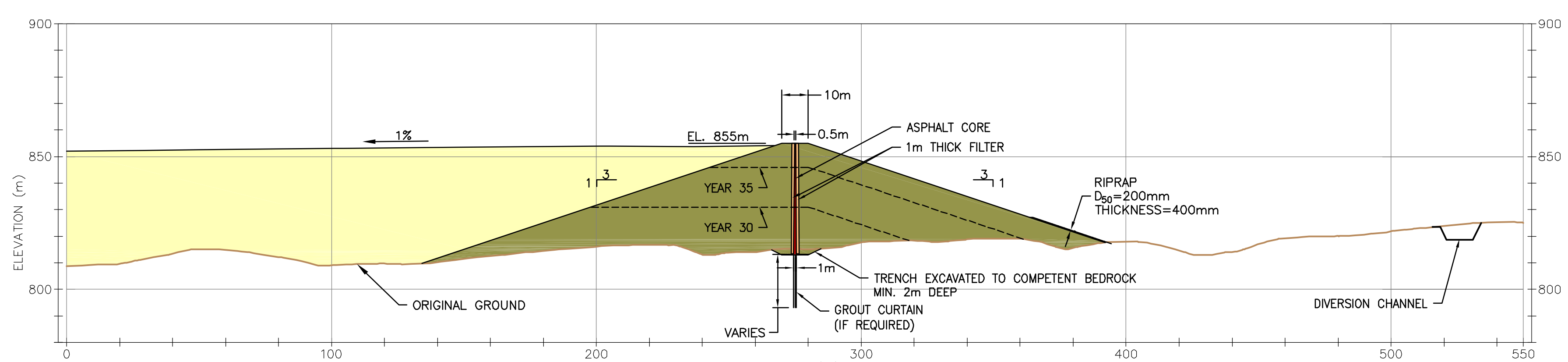
KCB-FIG-D-L



PLAN
SCALE A



SECTION A NORTHWEST DAM
SCALE B



SECTION B NORTHEAST DAM
SCALE B

LEGEND

- UPSTREAM EMBANKMENT RAISE FILL
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAMS

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE B 0 50m

SCALE A 0 300m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: NORTH DAM ALTERNATIVE

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	5.11

KCB-FIG-D-L

Date: 9/2/2014 Time: 16:52:43 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig5.11_rA - North Dams Alternative.dwg (dhu)
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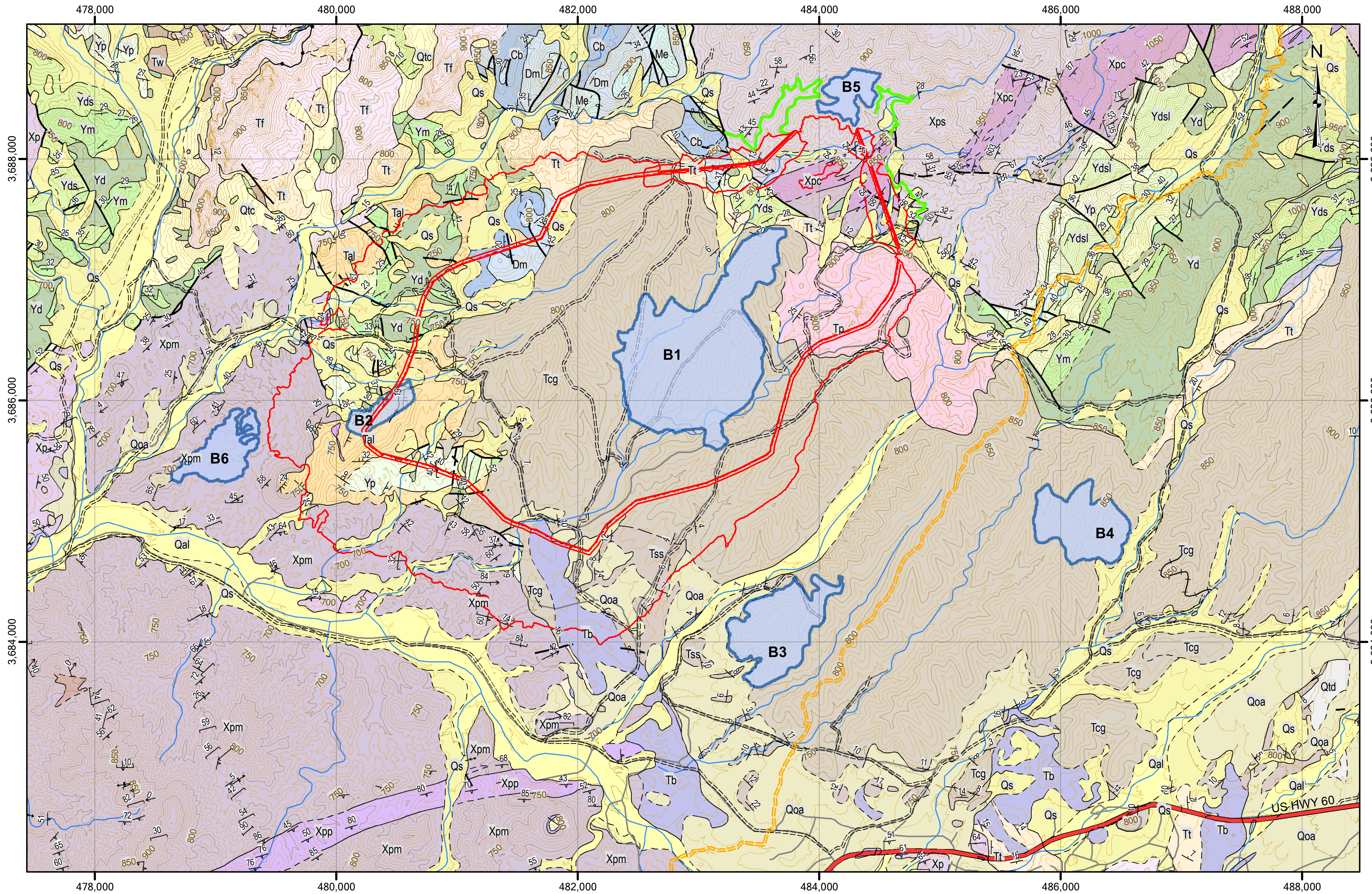
Image File(s):



Qs	Undivided Surficial Deposits (Quaternary)
Qtd	Disturbed Surficial Deposits (Holocene)
Qtc	Talus and Colluvium (Quaternary)
Qal	Unconsolidated Alluvium (Quaternary)
Qoa	Old Alluvium (Quaternary)
QTs	Older Alluvium (Early Quaternary to Late Tertiary)
Tcg	Conglomerate (Pliocene to Late Miocene)
Tss	Sandstone (Pliocene to late Miocene)
Tb	Basalt (Mid-Miocene to Early Miocene)
Tp	Perlitic Aphyric Rhyolite (Middle Tertiary)
Tal	Apache Leap Tuff (Early Miocene)
Tt	Tuff (poorly welded) (Miocene)
Tf	Felsic Volcanic Rocks, undivided (Middle Tertiary)
Tbl	Lower Basalt (Middle Tertiary)
Tx	Rock Avalanche or Talus Brecchia (Middle Tertiary)
Tw	Whitetail Conglomerate
Tdb	Basaltic Dikes (Middle Tertiary)
Kd	Quartz Diorite (Latest Cretaceous)
Me	Escabrosa Limestone (Mississippian)
Dm	Martin Limestone (Devonian)
Cb	Bolsa Quartzite (Cambrian)
Yd	Diabase (Middle Proterozoic)
Ym	Mescal Limestone (Middle Proterozoic)
Yds	Dripping Spring Quartzite, undivided (Middle Proterozoic)
Ydsu	Dripping Spring Quartzite, Upper Unit (Middle Proterozoic)
Ydsl	Dripping Spring Quartzite, Lower Unit (Middle Proterozoic)
Yp	Pioneer Shale (Middle Proterozoic)
Ypt	Pioneer Shale, Tuff Unit (Middle Proterozoic)
YXd	Diorite (Early or Middle Proterozoic)
Xp	Pinal Schist, undivided (Early Proterozoic)
Xpc	Pinal Schist, Calc-silicate Facies (Early Proterozoic)
Xpcs	Pinal Schist, Calc-silicate and Schist Facies (Early Proterozoic)
Xpm	Pinal Schist, Psammite Facies (Early Proterozoic)
Xpp	Pinal Sctist, Phyllite Facies (Early Proterozoic)
Xpq	Pinal Schist, Quartzite Layers (Early Proterozoic)
Xps	Pinal Schist, Pelitic Schist (Early Proterozoic)

LEGEND

- DIVERSION
- NEAR WEST TAILINGS SITE
- ARIZONA TRAIL
- HIGHWAY
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- MARKER HORIZON (LOCAL)
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST
  CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE
- BORROW AREA

Notes:
1. NAD27 UTM12N
2. Refer to main report for source of geologic data.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED SEPT 2014

0 1,000 m

CLIENT
Resolution Copper Mining

Klohn Crippen Berger

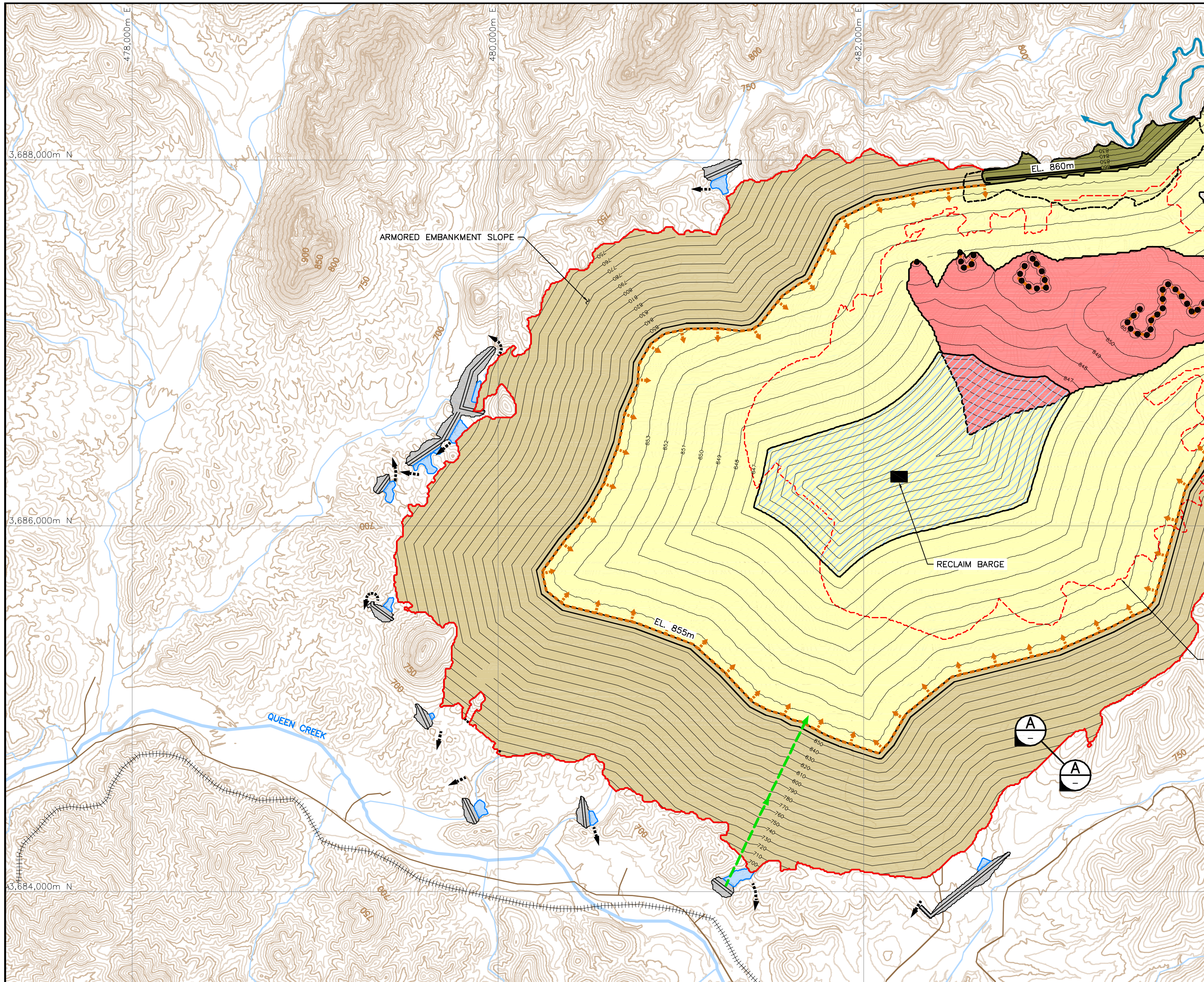
PROJECT
RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

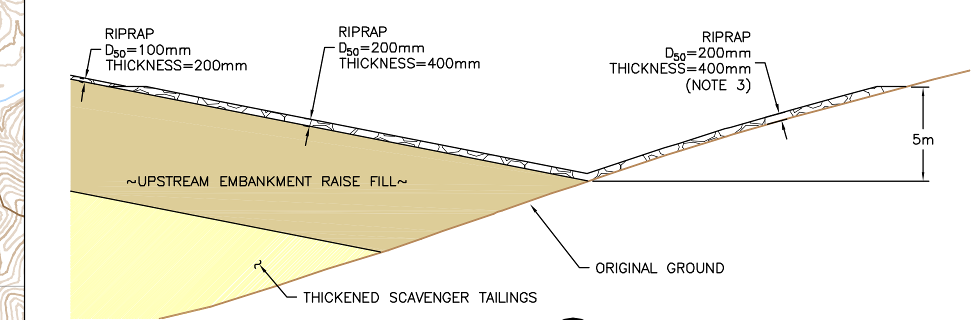
TITLE
BORROW LOCATIONS

PROJECT No. M09441A14

FIG No. 6.1

CB
Z:\MIVCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\MXD\Mine_Plan_Operations_Study\Borrow_Locations.mxd 02/09/2014 11:29:23 AM





SECTION A
SCALE B

LEGEND

- DIVERSION CHANNEL
- SEEPAGE WATER RETURN PIPELINE
- PERIMETER SEEPAGE COLLECTION DITCH AND TOE ARMORING
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- SCAVENGER TAILINGS DISCHARGE
- CLEANER TAILINGS SPIGOT
- SPILLWAY
- RECLAIM BARGE
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- RECLAIM POND
- SCD POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.
3. ADDITIONAL RIPRAP ON NATURAL GROUND REQUIRED WHERE EMBANKMENT ABUTS INTO A RIDGE AND WATER FLOWS ALONG THE TOE.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE B 0 8m
SCALE A 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: WATER MANAGEMENT STRUCTURES

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	7.1

KCB-FIG-D-L

Date: 9/2/2014 Time: 16:55:17 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig7.1_rA - Water Management Plan.dwg (dhu)
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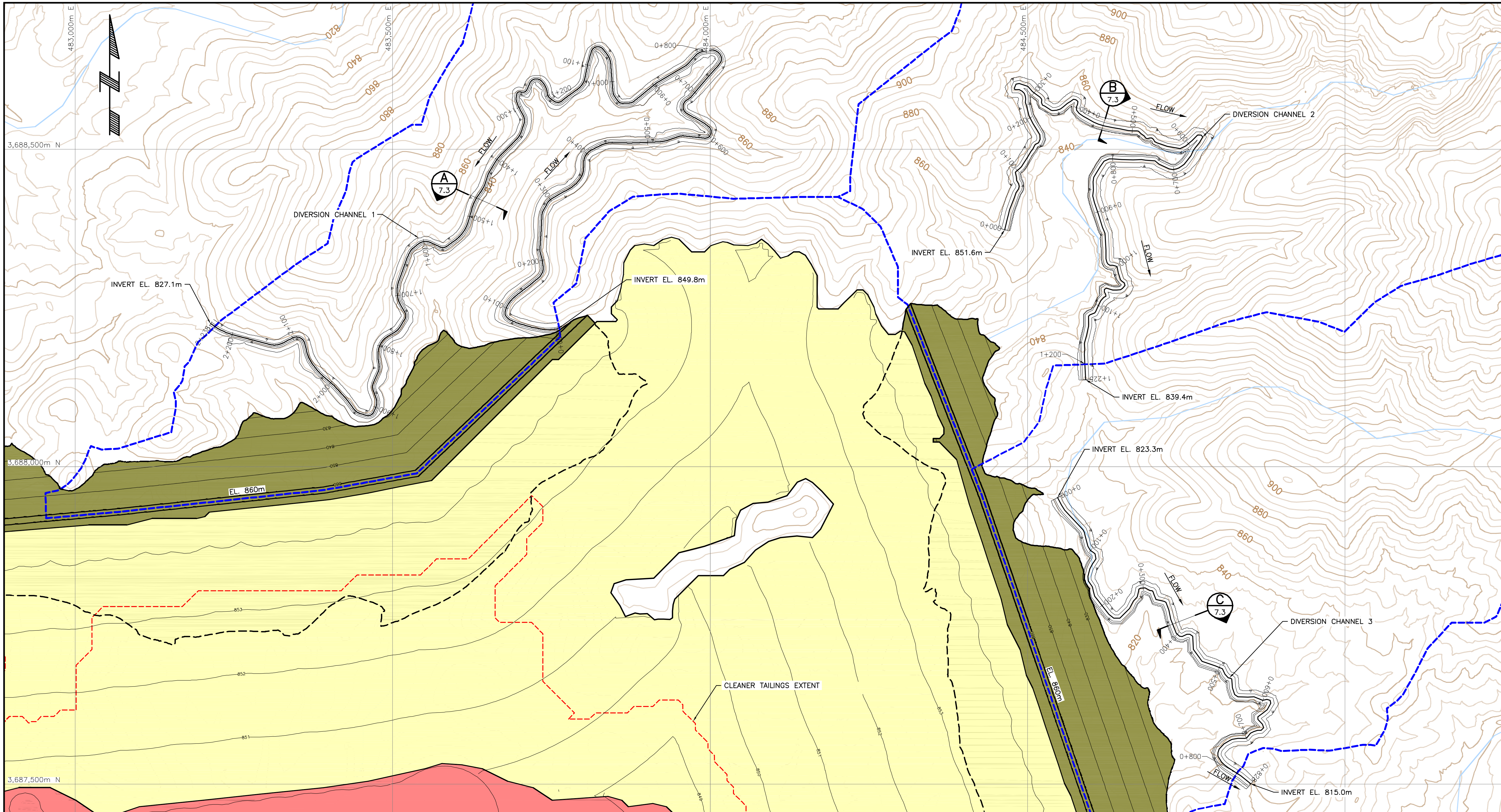


PLAN

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE A 0 150m

LEGEND

- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAMS

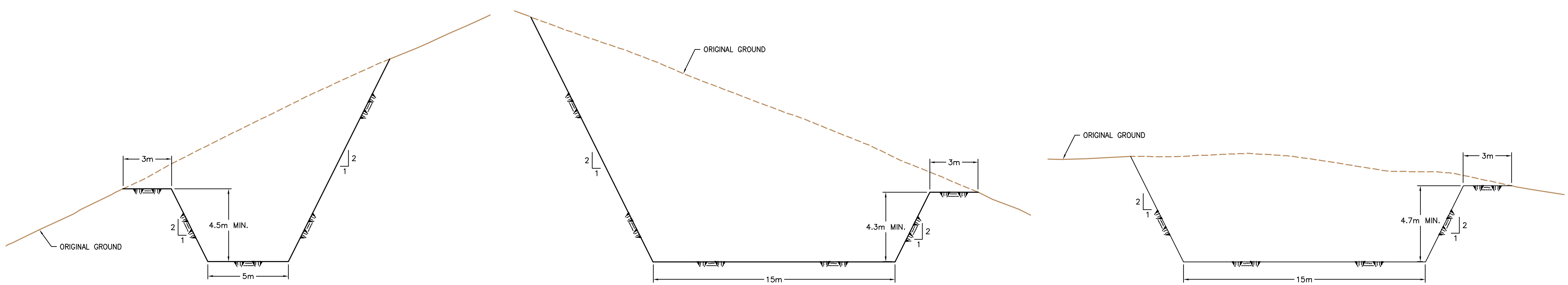
NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

CLIENT: Resolution Copper Mining	PROJECT: RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY
Klohn Crippen Berger	TITLE: DIVERSION CHANNEL LAYOUTS
SCALE: AS SHOWN	PROJECT No. M09441A14 — FIG. No. 7.2

Date: 9/3/2014 Time: 08:14:01 Scale: 1:2,585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near West\Geotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig7.2-7.3_rA - Diversion Channel Plan and Sections.dwg (dhu)
Xref File(s): FOR INSERT_NEAR WEST - APRIL 2013; Happy_Comp_Facilities_Sep2012; bm-near west-5mtopo; Happy_Comp_Streams_Sep2012
Image File(s):

KCB-FIG-D-L



SECTION A/7.2 DIVERSION CHANNEL 1 TYPICAL SECTION

SECTION B/7.2 DIVERSION CHANNEL 2 TYPICAL SECTION

SECTION C/7.2 DIVERSION CHANNEL 3 TYPICAL SECTION

LEGEND

BEDROCK

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 5m

CLIENT	PROJECT
Resolution Copper Mining	RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY
Klohn Crippen Berger	TITLE DIVERSION CHANNEL TYPICAL CROSS-SECTIONS
	SCALE AS SHOWN · PROJECT No. M09441A14 · FIG. No. 7.3

KCB-FIG-D-L

Date: 9/3/2014 Time: 08:14:01 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near West\Geotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig7.2-7.3_rA - Diversion Channel Plan and Sections.dwg (dhu)
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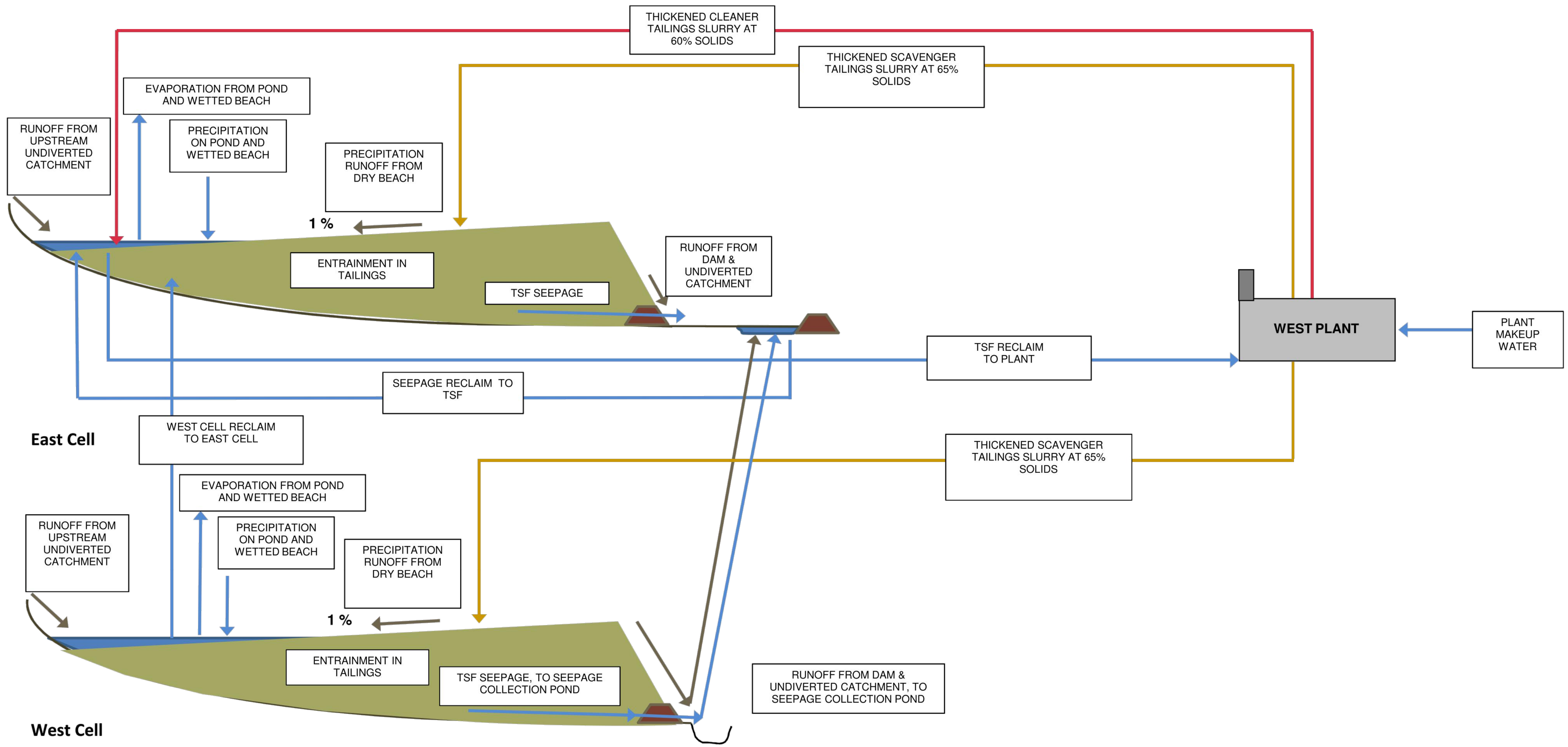


East and West Cells Tailings Storage Facility (TSF)
Water Balance

Input

Precipitation over pond area
Precipitation over wetted tailings beach (25% of tailings beach)
Precipitation runoff over dry tailings beach (0.3 runoff coefficient on 75% of tailings beach)
Runoff from upstream undiverted catchment (0.3 runoff coefficient)
Thickened scavenger tailings slurry water
Thickened cleaner tailings slurry water
Seepage reclaim to TSF

Output

Evaporation over pond area
Evaporation over wetted tailings beach (25% of tailings beach)
Entrainment in scavenger tailings
Entrainment in cleaner tailings
TSF reclaim to West Plant
TSF seepage (max 34 L/s, collected at seepage collection pond)

Seepage Collection Pond (Note 1)
Water Balance

Input

TSF Seepage (max 34 L/s)
Runoff from dam and undiverted catchment

Output

Seepage reclaim to TSF

West Plant
Water Balance

Input

TSF reclaim to West Plant
Plant makeup water

Output

Thickened scavenger tailings slurry to East and West Cells (at 65% solids)
Thickened cleaner tailings slurry to East Cell (at 60% solids)

NOTES

1. ASSUME PRECIPITATION RETAINED ON DRY BEACH IS EVAPORATED.

NOT FOR CONSTRUCTION

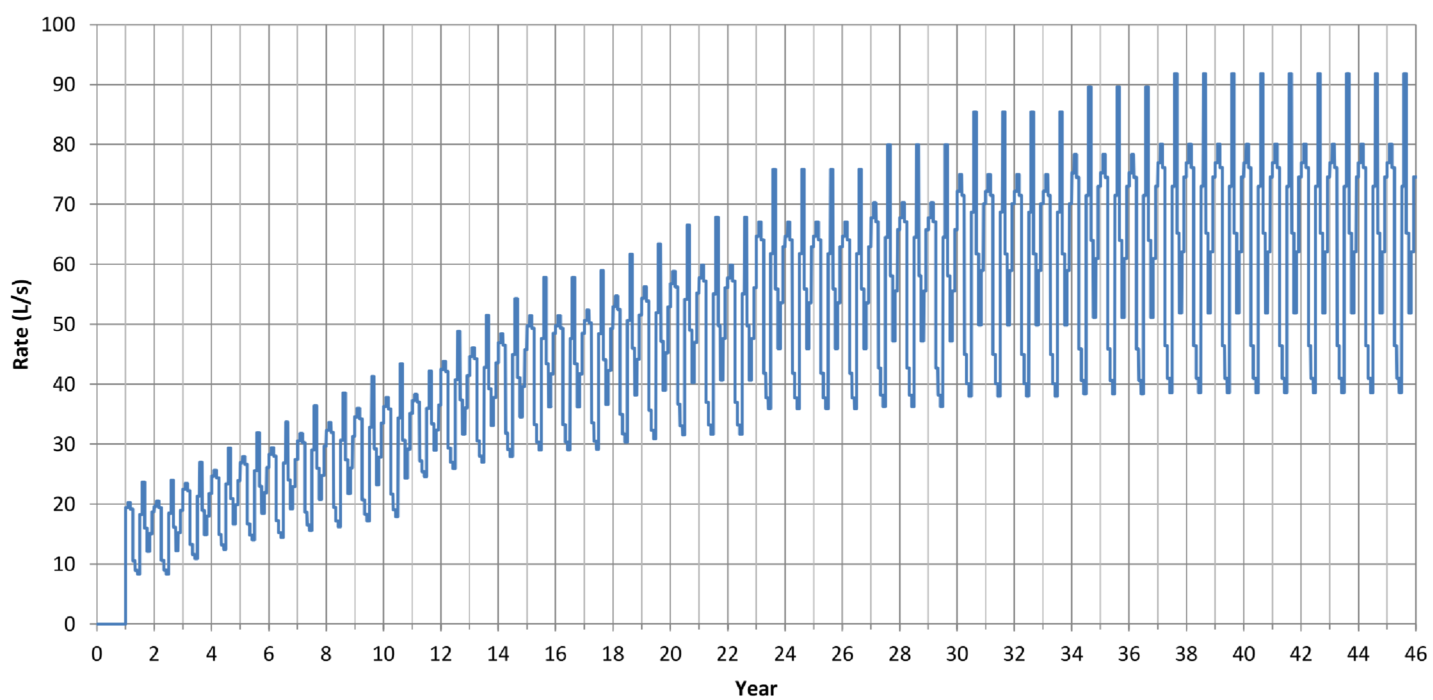
To be read with Klohn Crippen Berger report dated SEPT. 2014

CLIENT	PROJECT
Resolution Copper Mining	RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY
Klohn Crippen Berger	TITLE: WATER BALANCE SCHEMATIC
SCALE: AS SHOWN	PROJECT No. M09441A14 / FIG. No. 7.4

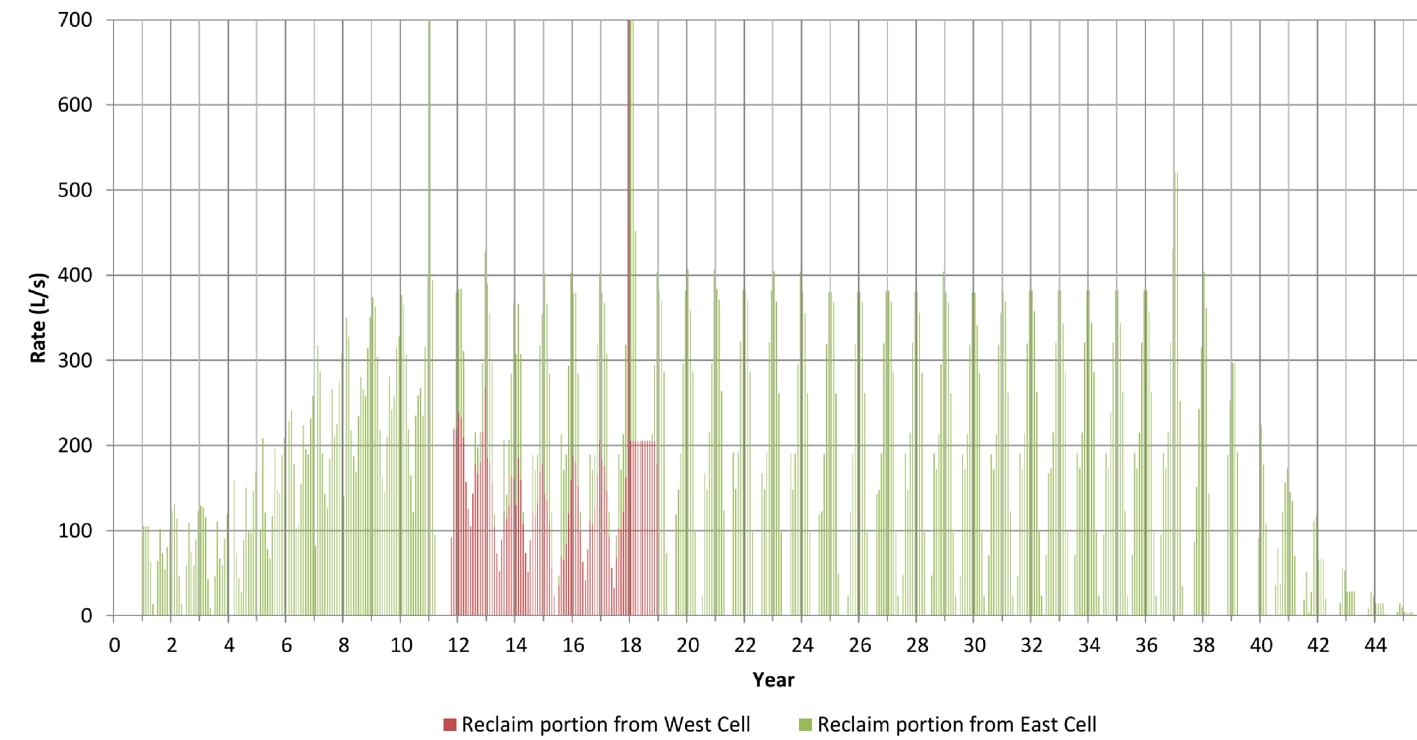
KCB-FIG-D-L

Date: 9/3/2014 Time: 09:14:22 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig7.4_rA - Water Balance Schematic.dwg (dhu)
Xref File(s):
Image File(s):

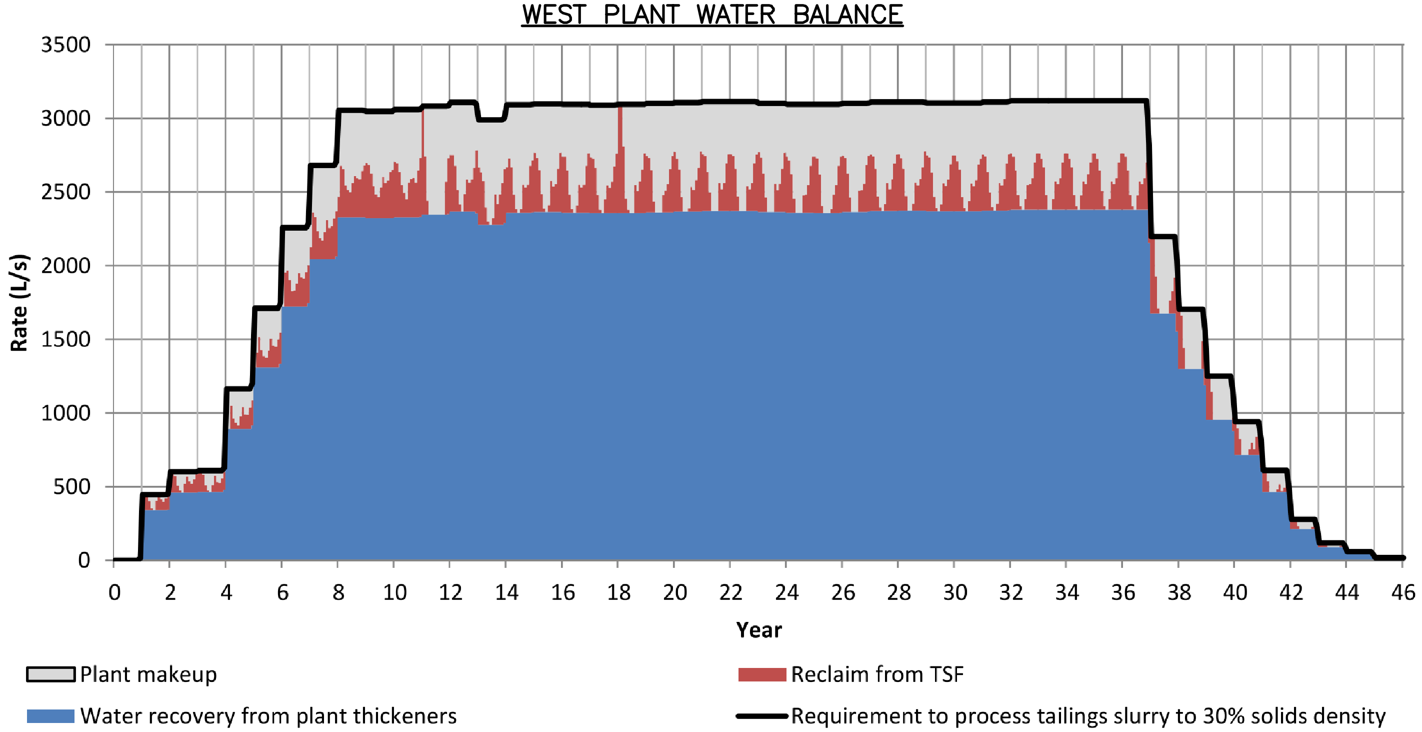
SEEPAGE COLLECTION POND RECLAIM TO EAST CELL



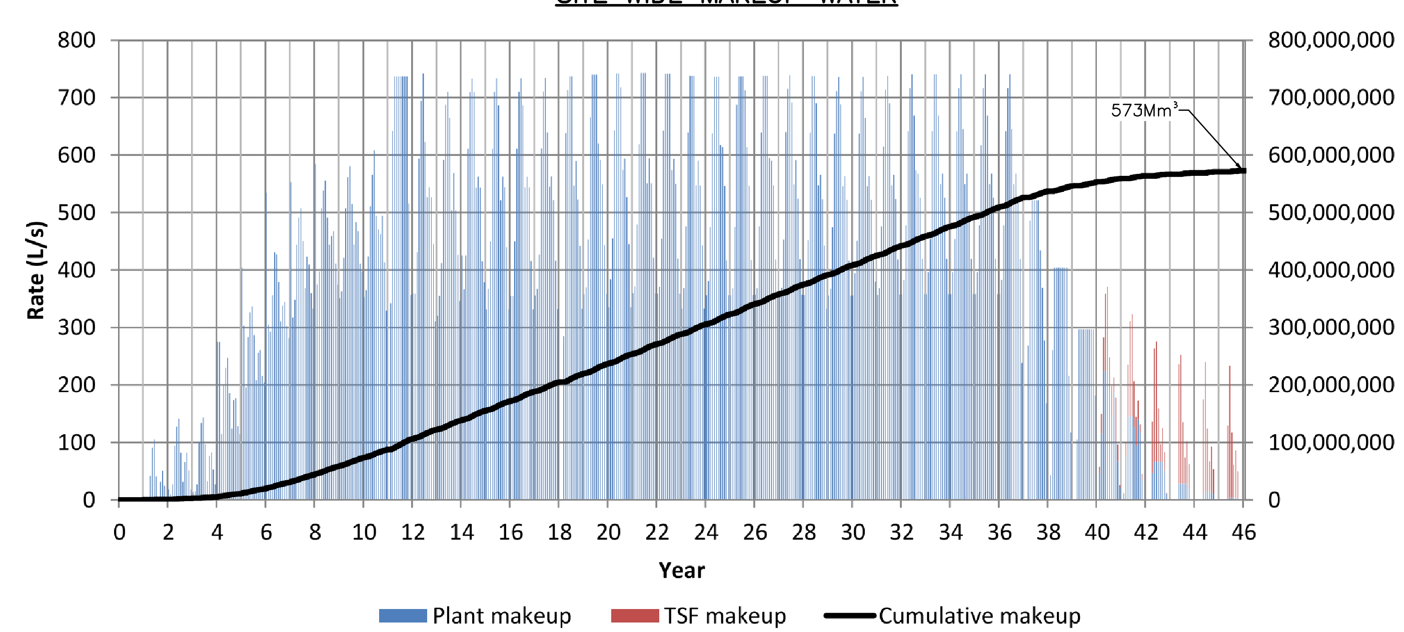
TSF RECLAIM TO WEST PLANT



WEST PLANT WATER BALANCE



SITE WIDE MAKEUP WATER



NOTES

1. WATER BALANCE RESULTS ARE MONTHLY FOR AVERAGE CLIMATIC CONDITIONS.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

CLIENT: Resolution Copper Mining	PROJECT: RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY
Klohn Crippen Berger	TITLE: WATER BALANCE RESULTS
	SCALE: AS SHOWN · PROJECT No.: M09441A14 · FIG. No.: 7.5

KCB-FIG-D-L

Date: 9/3/2014 Time: 08:24:17 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig7.5_rA - Water Balance Results.dwg (dhu)
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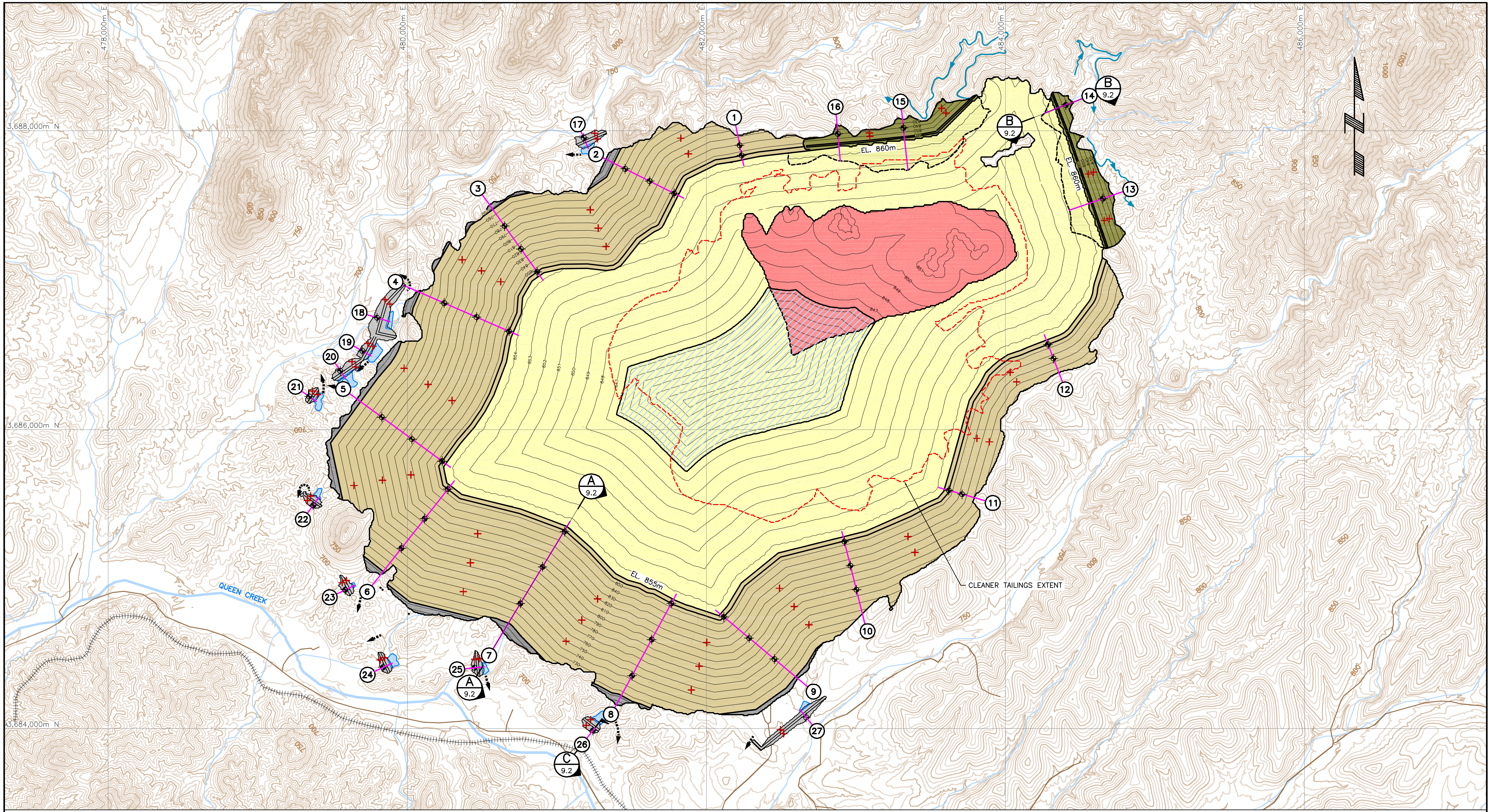

LEGEND

- PIEZOMETERS
- DISPLACEMENT SURVEY PINS
- GEOTECHNICAL INSTRUMENTATION LINE
- DIVERSION CHANNEL
- SPILLWAY
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- UPSTREAM EMBANKMENT RAISE FILL
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAMS
- STARTER DAMS
- TSF RECLAIM POND
- SCD POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: INSTRUMENTATION PLAN YEAR 45

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	9.1

KCB-FIG-D-L

Date: 9/3/2014 Time: 08:25:27 Scale: 1:2,585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig9.1_rA - Instrumentation Plan.dwg (dhu)
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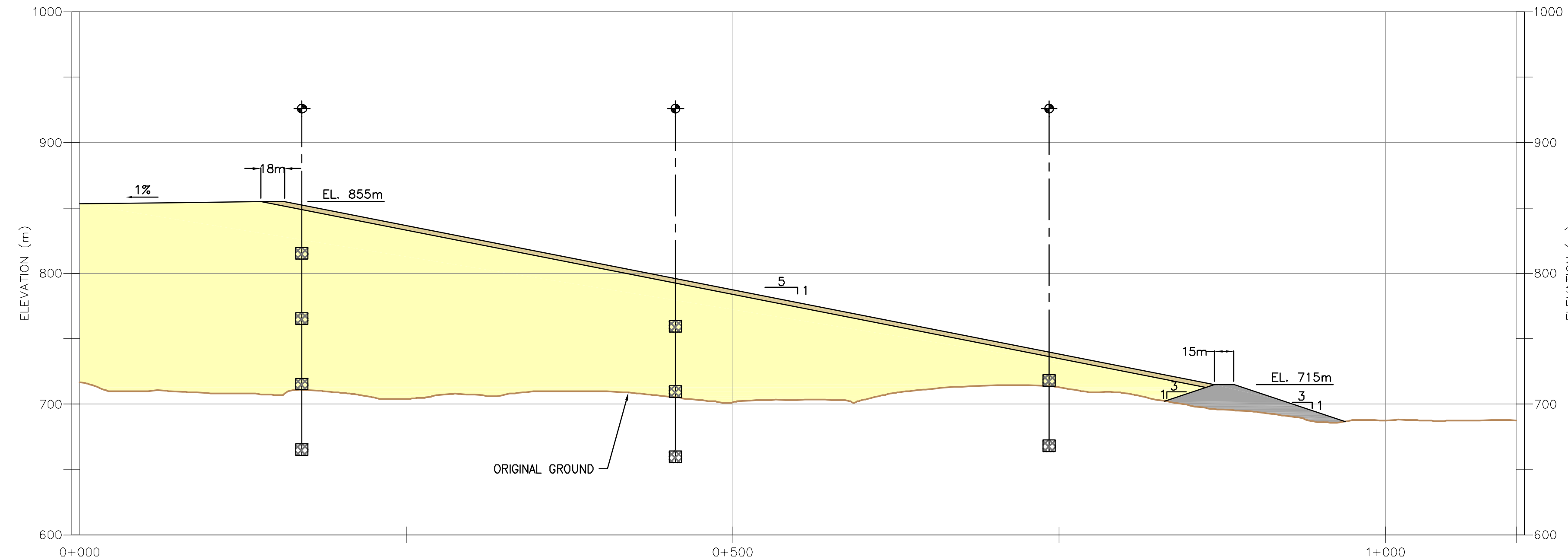
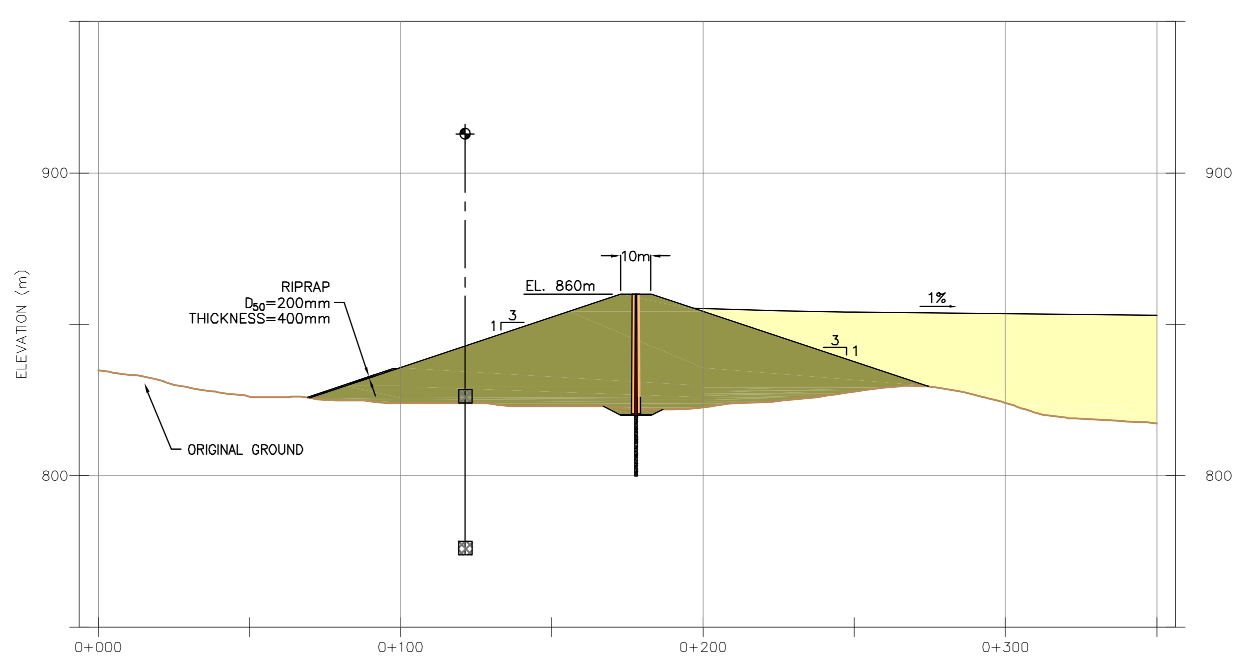
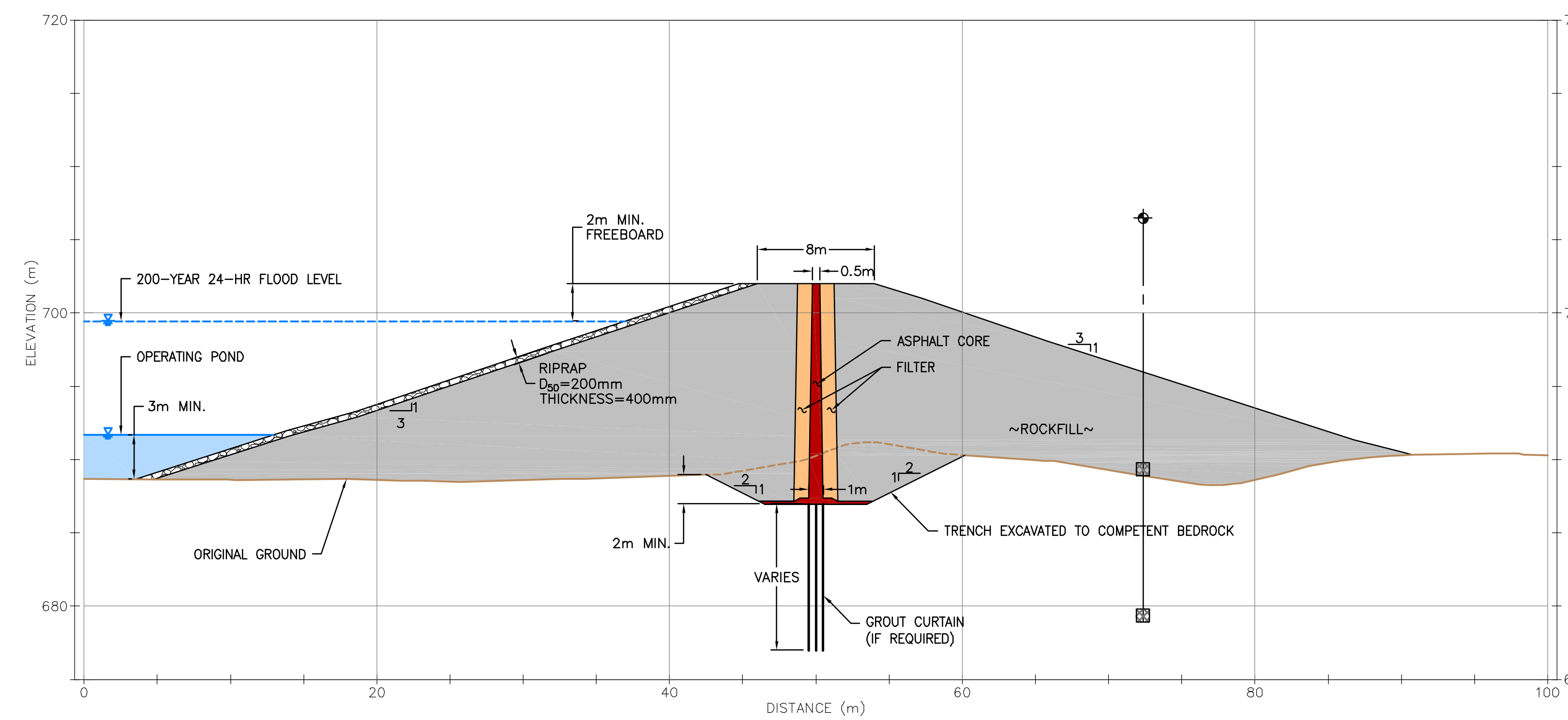


SECTION (A / 9.1) TYPICAL EMBANKMENT SECTION
SCALE A



SECTION (B / 9.1) TYPICAL NORTH DAM SECTION
SCALE B



SECTION (C / 9.1) TYPICAL SEEPAGE COLLECTION DAM SECTION
SCALE C

SCALE C 0 10m
SCALE B 0 50m
SCALE A 0 100m

LEGEND

- PIEZOMETER
- PIEZOMETER WELL SCREEN
- UPSTREAM EMBANKMENT RAISE FILL
- STARTER DAM
- THICKENED SCAVENGER TAILINGS
- NORTH DAM

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

CLIENT	PROJECT		
Resolution Copper Mining	RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY		
Klohn Crippen Berger	TITLE: INSTRUMENTATION TYPICAL SECTIONS		
	SCALE: AS SHOWN	PROJECT No.: M09441A14	FIG. No.: 9.2

KCB-FIG-D-L

Date: 9/3/2014 Time: 08:30:00 Scale: 1:2.585(PS)
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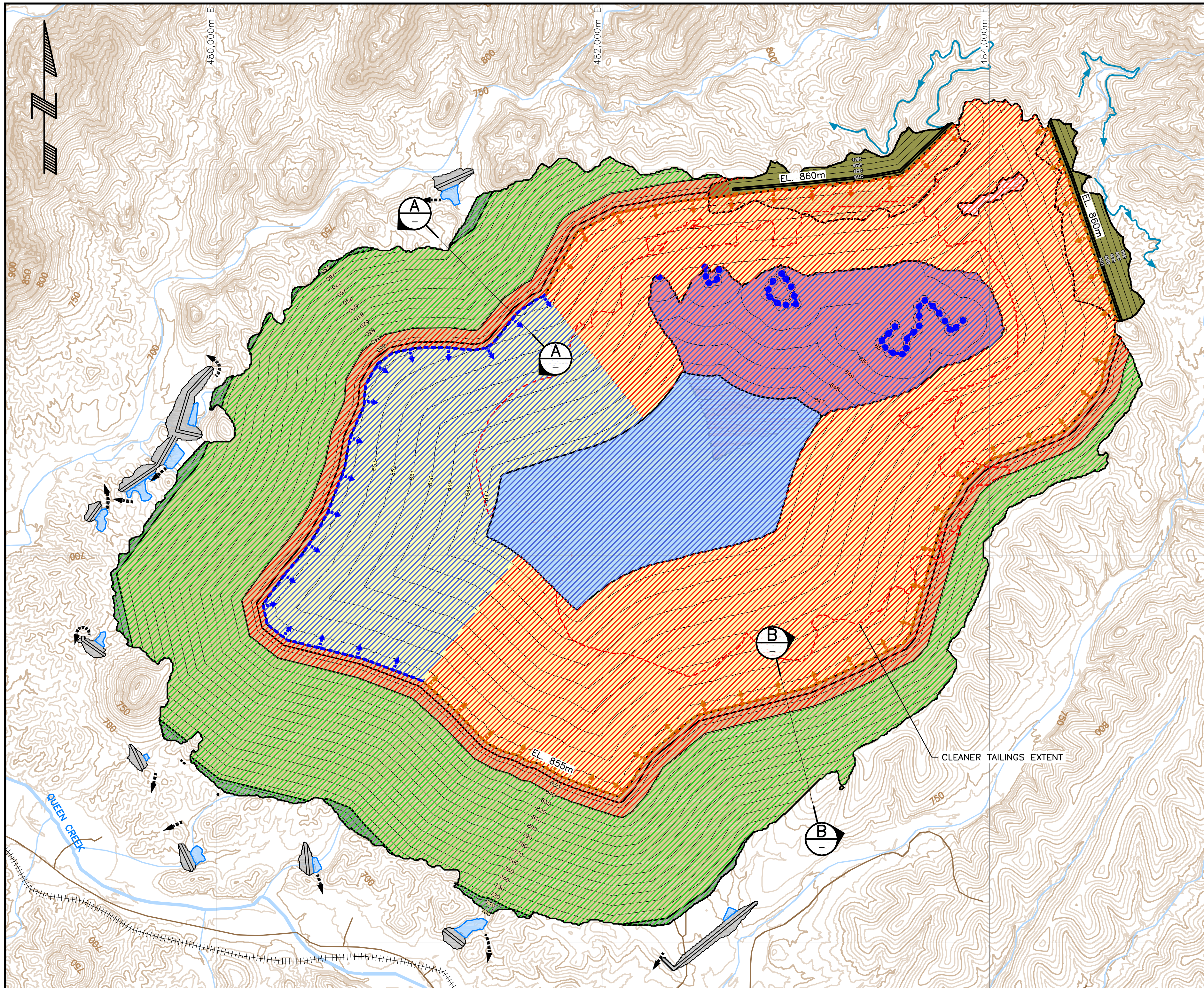
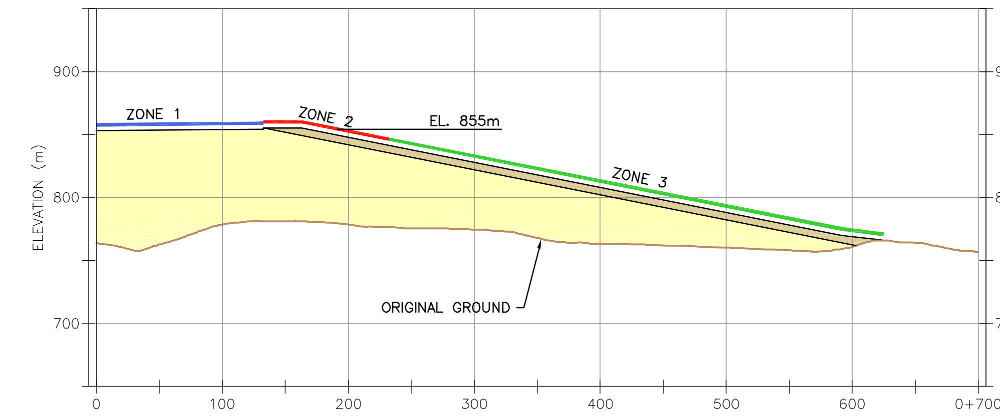
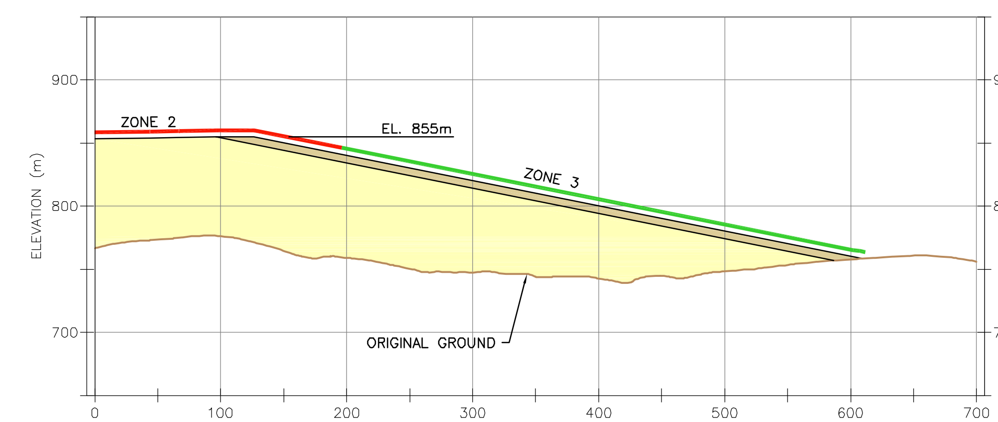
Xref File(s):
Image File(s):



PLAN
SCALE A



SECTION A
SCALE B



SECTION B
SCALE B

ZONE 1	WETTED TAILINGS SURFACE/RECLAIM POND
ZONE 2	ACTIVE SPRINKLER MANAGEMENT
ZONE 3	RECLAIMED SURFACE (COMPACTED SOIL OR GRADED ROCK ARMOURING AND VEGETATION)

LEGEND

- DIVERSION CHANNEL
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- ACTIVE SPIGOT
- INACTIVE SPIGOT
- SPILLWAY
- UPSTREAM EMBANKMENT RAISE FILL
- THICKENED SCAVENGER TAILINGS
- THICKENED CLEANER TAILINGS
- NORTH DAMS
- STARTER DAMS
- TSF RECLAIM POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE B 0 100m

SCALE A 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: DUST MANAGEMENT PLAN

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	9.3

KCB-FIG-D-L

Date: 9/3/2014 Time: 08:31:56 Scale: 1:2,585(PS)
Drawing File: Z:\M\VCR\M09441A14 – RES–Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig9.3_rA – Dust Management Plan.dwg (dhu)
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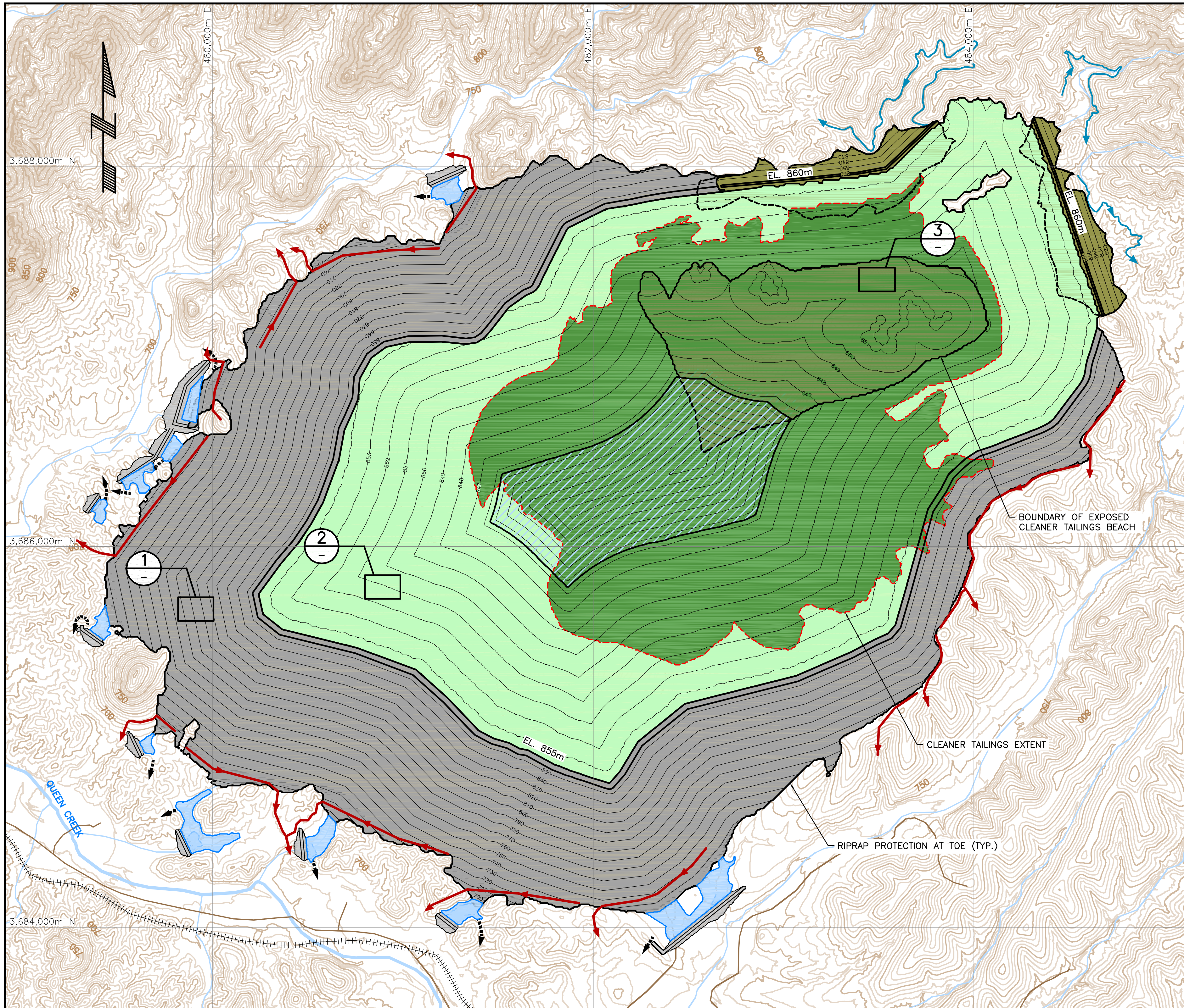
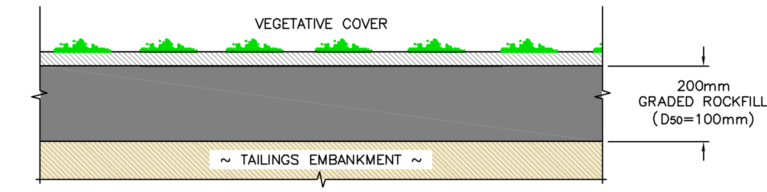
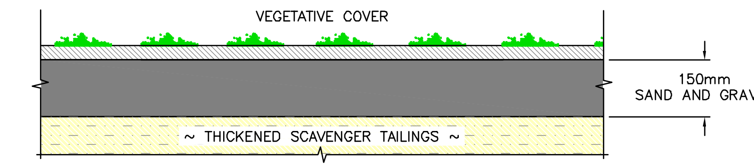


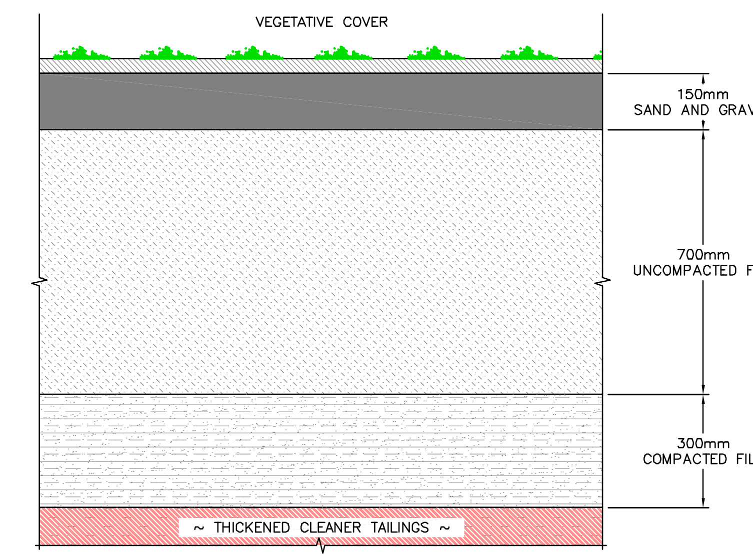
PLAN



DETAIL 1 EMBANKMENT CLOSURE COVER DETAIL
NTS



DETAIL 2 SCAVENGER TAILINGS CLOSURE COVER DETAIL
NTS



DETAIL 3 CLEANER TAILINGS CLOSURE COVER DETAIL
NTS

LEGEND

- DIVERSION CHANNEL
- SLOPE RUNOFF DIVERSION CHANNEL
- SPILLWAY
- RAILWAY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- RECLAIMED UPSTREAM EMBANKMENT RAISE FILL
- RECLAIMED SCAVENGER TAILINGS
- RECLAIMED CLEANER TAILINGS
- NORTH DAMS
- TSF CLOSURE POND
- SCD CLOSURE POND

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE 0 500m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: CLOSURE PLAN

SCALE	PROJECT No.	FIG. No.
AS SHOWN	M09441A14	10.1

KCB-FIG-D-L

Date: 9/3/2014 Time: 08:35:32 Scale: 1:2,585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig10.1_rA - Closure Plan.dwg (dhu)
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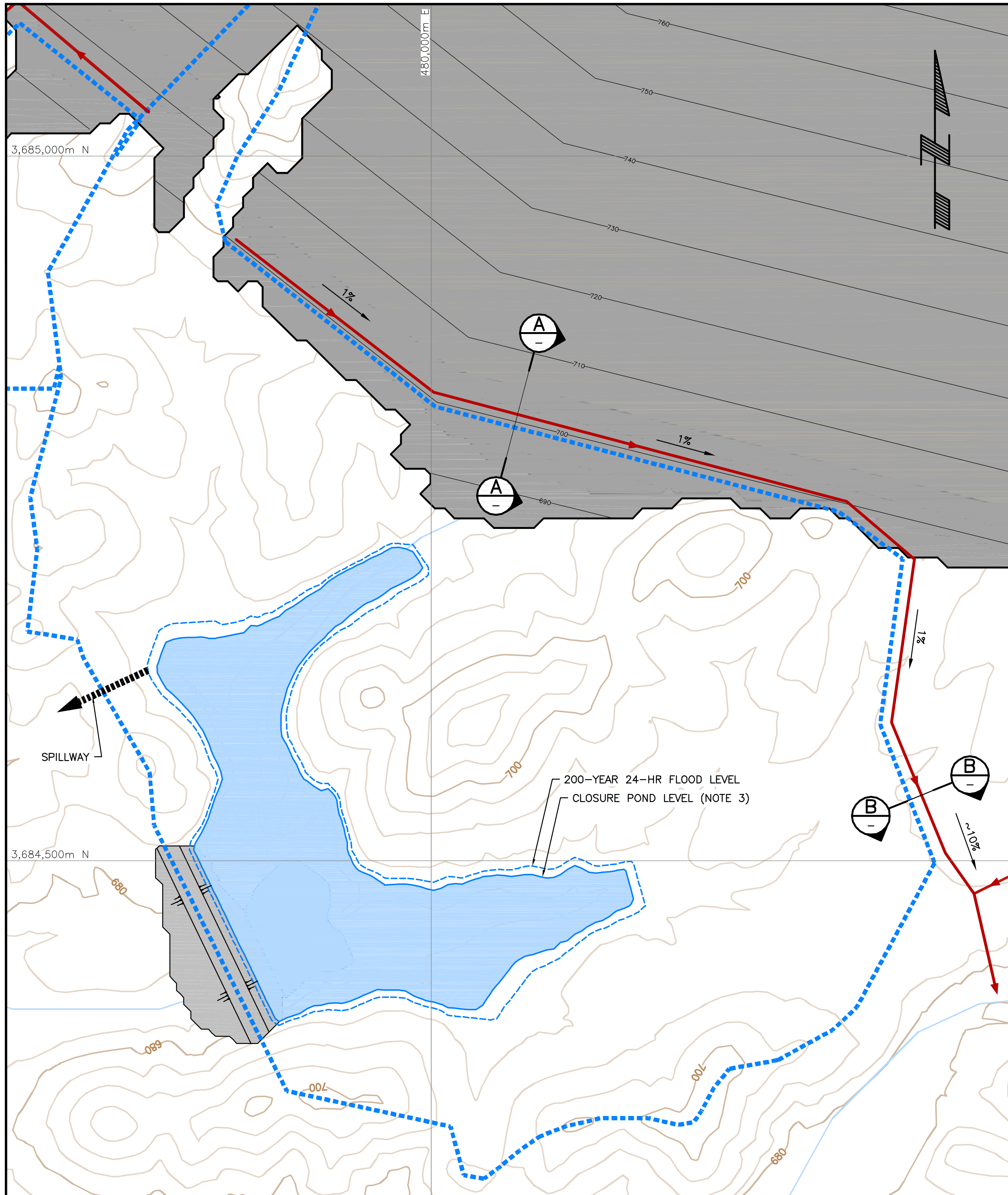
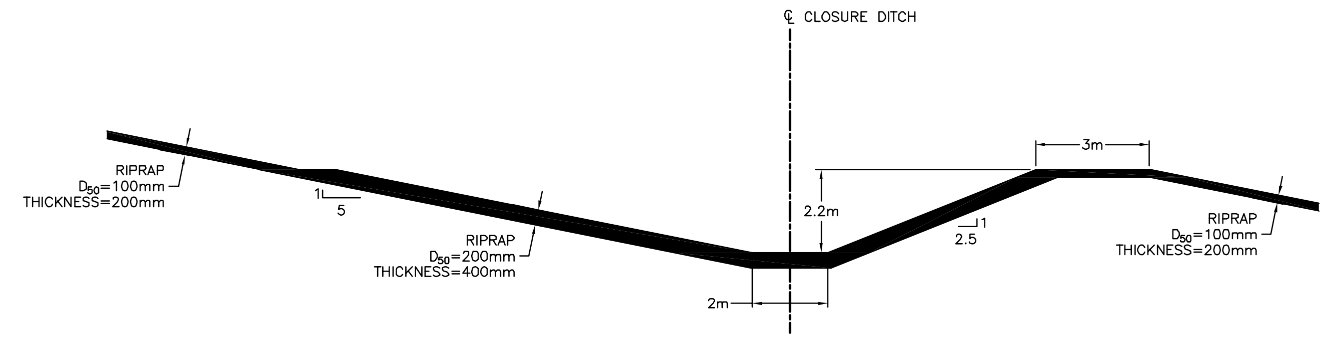
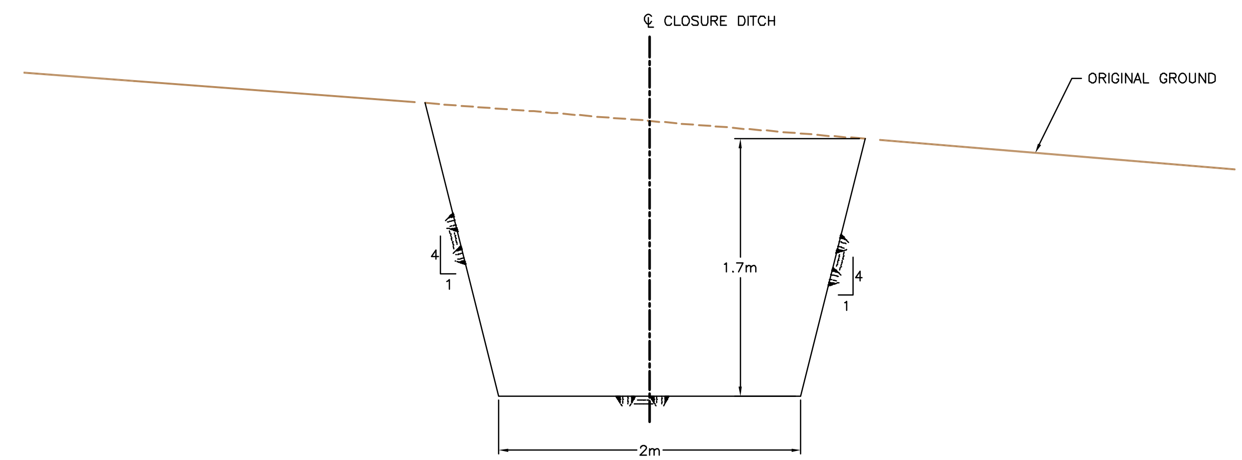
Image File(s):



PLAN
SCALE A



SECTION A TYPICAL CLOSURE DIVERSION CHANNEL ON EMBANKMENT SLOPE CROSS-SECTION
SCALE B



SECTION B TYPICAL CLOSURE DIVERSION CHANNEL ON BEDROCK CROSS-SECTION
SCALE C

LEGEND

- CLOSURE DIVERSION CHANNEL
- UNDIVERTED CATCHMENT BOUNDARY
- ROAD
- STREAM
- SEEPAGE COLLECTION DAM (SCD)
- RECLAIMED UPSTREAM EMBANKMENT RAISE FILL
- SCD CLOSURE POND
- BEDROCK

NOTES

1. PROJECTION AND DATUM: UTM ZONE 12N, NAD 27
2. TOPOGRAPHY BASED ON 1m INTERVAL CONTOURS RECEIVED FROM RESOLUTION JANUARY, 2013.
3. CLOSURE POND LEVEL DETERMINED BY WATER SURFACE AREA TO EVAPORATE LONG TERM SEEPAGE FROM EMBANKMENT TOE AND RUNOFF FROM AVERAGE CLIMATIC YEAR.

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

SCALE C 0 1m
SCALE B 0 4m
SCALE A 0 80m

CLIENT: Resolution Copper Mining	PROJECT: RESOLUTION PROJECT NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY
Klohn Crippen Berger	TITLE: SEEPAGE COLLECTION DAM TYPICAL CLOSURE PLAN
SCALE: AS SHOWN	PROJECT No. M09441A14
FIG. No. 10.2	

KCB-FIG-D-L

Date: 9/3/2014 Time: 08:38:06 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig10.2_rA - Closure Seepage Dam.dwg (dhu)
Xref File(s): FOR INSERT_NEAR WEST - APRIL 2013; Happy_Camp_Facilities_Sep2012; bm-near west-5mtopo; Happy_Camp_Streams_Sep2012
Image File(s):

Item		Units	Figure Reference	Year -3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
				Pre-Production			Operations																					
Scavenger Starter Dams	Clear and Grub	m^2	4.1, 4.3, 4.6, 5.1 - 5.3			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	■	■		■
	Foundation Preparation	m^2				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	■	■		■
	General Fill for Starter Dams	m^3				■	■									■		■										
	General Fill for Deposition Berms	m^3					■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	■	■		■
Cleaner Starter Dam	Clear and Grub	m^2	4.1, 4.3			■																						
	Foundation Preparation	m^2				■																						
	General Fill	m^3				■																						
Upstream Diversion Channels	Clear and Grub	m^2	7.1 - 7.3	■																								
	Excavation	m^3		■																								
Seepage Collection Dams	Clear and Grub	m^2	5.8 - 5.9		■											■		■										
	Foundation Preparation	m^2			■											■		■										
	Grout Curtain	m			■											■		■										
	Excavation	m^3			■											■		■										
	Asphalt Core	m^3			■											■		■										
	Core Filter	m^3			■											■		■										
	General Fill	m^3			■											■		■										
	Riprap	m^3			■											■		■										
	Excavation	m^3			■											■		■										
Embankment Underdrains	Drain Rock for Underdrains	m^3	5.7			■										■									■			■
	Filter for Underdrains	m^3				■										■									■			■
	Drain Rock for Local Blanket Drains	m^3																								■		■
	Filter for Local Blanket Drains	m^3																								■		■
Embankment Raises	Compacted Zone	m^3	5.1-5.3, 9.1				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Riprap for Embankment Slope Armouring	m^3					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
	Riprap for Embankment Toe Armouring	m^3					■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■
Cleaner Tailings Deposition Access Berms	General Fill	m^3	4.13																									
North Dams	Clear and Grub	m^2	4.7 - 4.12, 5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	■	0.00	■
	Foundation Preparation	m^2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	■	0.00	■
	Grout Curtain	m^3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	■	0.00	■
	Excavation	m^3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	■	0.00	■
	Asphalt Core	m^3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	■	0.00	■
	Core Filter	m^3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	■	0.00	■
	General Fill	m^3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	■	0.00	■
	Riprap	m^3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closure of Embankment Slope	Riprap for Diversion Channels	m^3	10.1 - 10.2																									
	Excavation of Diversion Channels (in natural ground)	m^3																										
	Re-vegetation	m^2																										
Closure of Tailings Beaches	Uncompacted Fill	m^3	10.1																									
	Compacted General Fill	m^3																										
	Armouring	m^3																										
	Re-vegetation	m^2																										

Item		23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Year 50+
		Operations																							Closure					Post-Closure
Scavenger Starter Dams	Clear and Grub		■		■			■	■			■			■	■				■			■							
	Foundation Preparation		■		■			■	■			■			■	■				■			■							
	General Fill for Starter Dams		■																											
	General Fill for Deposition Berms				■			■	■	■		■			■	■				■			■							
Cleaner Starter Dam	Clear and Grub																													
	Foundation Preparation																													
	General Fill																													
Upstream Diversion Channels	Clear and Grub																													
	Excavation																													
Seepage Collection Dams	Clear and Grub																													
	Foundation Preparation																													
	Grout Curtain																													
	Excavation																													
	Asphalt Core																													
	Core Filter																													
	General Fill																													
	Riprap																													
	Excavation																													
Embankment Underdrains	Drain Rock for Underdrains				■					■																				
	Filter for Underdrains				■					■																				
	Drain Rock for Local Blanket Drains				■																									
	Filter for Local Blanket Drains				■																									
Embankment Raises	Compacted Zone	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
	Riprap for Embankment Slope Armouring	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
	Riprap for Embankment Toe Armouring	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
Cleaner Tailings Deposition Access Berms	General Fill					■	■	■	■	■	■	■	■	■	■	■	■	■	■			■								
North Dams	Clear and Grub	■	■	■	■	■	■	■	■	■	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Foundation Preparation	■	■	■	■	■	■	■	■	■	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Grout Curtain	■	■	■	■	■	■	■	■	■	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Excavation	■	■	■	■	■	■	■	■	■	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Asphalt Core	■	■	■	■	■	■	■	■	■	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Core Filter	■	■	■	■	■	■	■	■	■	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	General Fill	■	■	■	■	■	■	■	■	■	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Riprap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	■	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closure of Embankment Slope	Riprap for Diversion Channels																								■					
	Excavation of Diversion Channels (in natural ground)																								■					
	Re-vegetation																								■					
Closure of Tailings Beaches	Uncompacted Fill																								■	■	■			
	Compacted General Fill																								■	■	■			
	Armouring																								■	■	■			
	Re-vegetation																								■	■	■			

Note: Schedule is based on the North Dam base case design

NOT FOR CONSTRUCTION

To be read with Klohn Crippen Berger report dated SEPT. 2014

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
NEAR WEST TAILINGS MANAGEMENT MINE PLAN OF OPERATIONS STUDY

TITLE: PROJECT SCHEDULE

SCALE: AS SHOWN | PROJECT No. M09441A14 | FIG. No. 11.1

KCB-FIG-D-L

Date: 9/3/2014 Time: 08:41:19 Scale: 1:2.585(PS)
Drawing File: Z:\M\VCR\M09441A14 – RES–Near WestGeotech Study\400 Drawings\CAD\Order of Magnitude Study\FINAL\Fig11.1_rA – Project Schedule.dwg (dhu)
Xref File(s):
Image File(s):

APPENDIX I

Near West Field Mapping

MEMORANDUM

TO:	File	**DATE:**	July 26, 2013
FROM:	Jim Casey	**FILE NO:**	M09441A14.730
SUBJECT:	Appendix I - Near West Field Mapping		

1 INTRODUCTION

Klohn Crippen Berger Ltd. (KCB) conducted field reconnaissance and surface mapping of the proposed Near West Tailings Management site between February 14 and March 9, 2013. The purpose of the mapping was to:

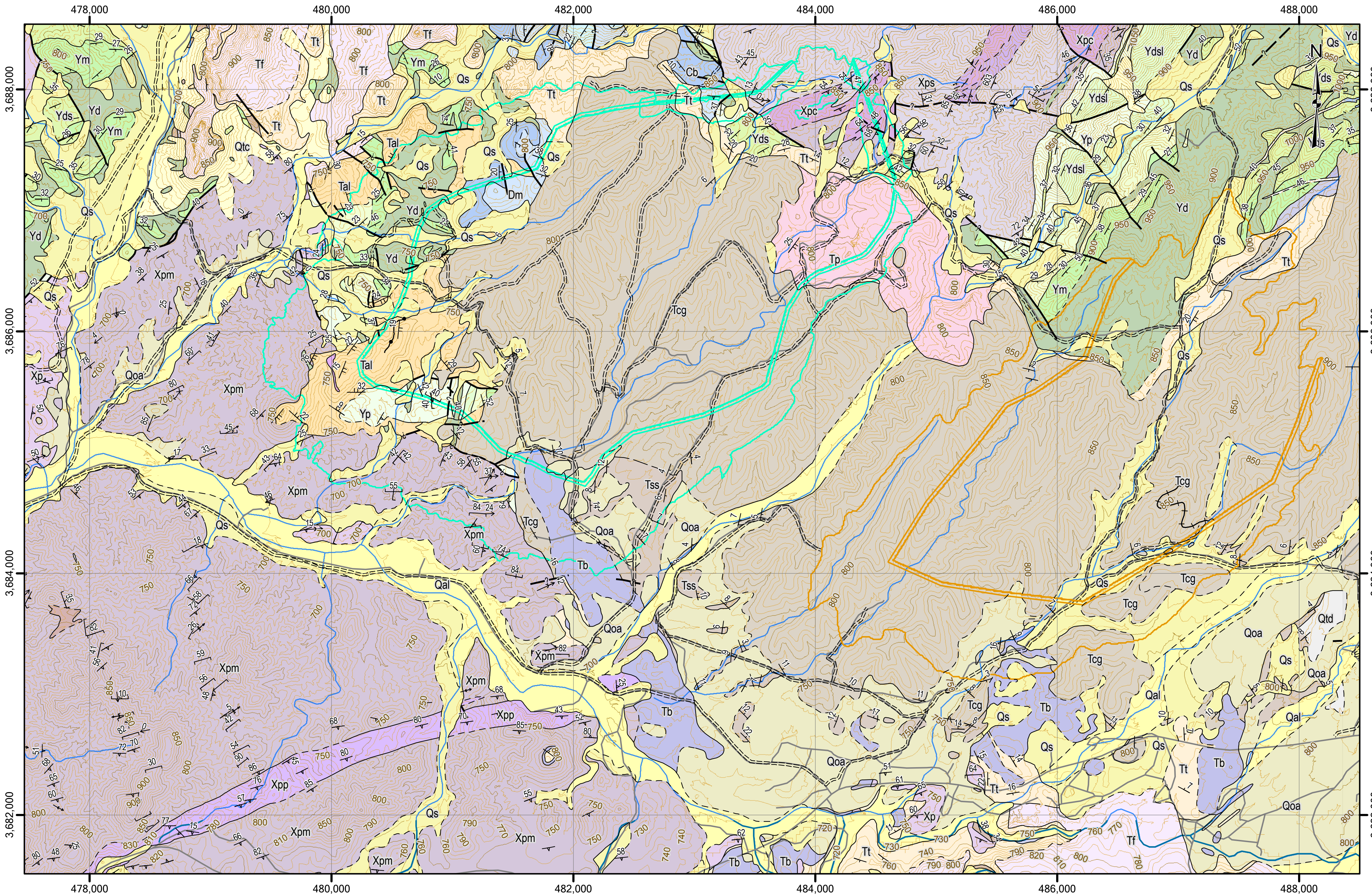
- identify, describe and photograph soil and rock units exposed on site;
- visually assess the strength and permeability of the soil and rock units;
- assess the suitability of the Gila Conglomerate unit as a barrier to seepage and estimate its acid neutralization potential;
- locate potential sites for seepage control structures; and
- sample and test unconsolidated alluvial sediments to determine suitability as dam fill.

The mapping program was divided into three main activities:

- Creek Traverses – active drainages were traversed to characterize the active channels, alluvium deposits and bedrock outcrops.
- Gila Conglomerate Detailed Mapping – Gila Conglomerate exposures were visited along Creek Traverse #4 (Bear Tank Canyon), logged in detail and sampled for geotechnical and geochemical testing.
- Bedrock Geology Mapping – Areas of the site with “mixed” geology were visited to identify and characterize the rock units.

Each activity is described in greater detail in Section 2.

A site geology map (Figure 1.1) (Spencer and Richard) was provided to KCB by Montgomery & Associates. The map was used to plan traverses and served as a reference during the site investigation. Geology shown in figures throughout this report was derived from this map.



Qs	Undivided Surficial Deposits (Quaternary)
Qtd	Disturbed Surficial Deposits (Holocene)
Qtc	Talus and Colluvium (Quaternary)
Qal	Unconsolidated Alluvium (Quaternary)
Qoa	Old Alluvium (Quaternary)
QTs	Older Alluvium (Early Quaternary to Late Tertiary)
Tcg	Conglomerate (Pliocene to Late Miocene)
Tss	Sandstone (Pliocene to late Miocene)
Tb	Basalt (Mid-Miocene to Early Miocene)
Tp	Perlitic Aphyric Rhyolite (Middle Tertiary)
Tal	Apache Leap Tuff (Early Miocene)
Tt	Tuff (poorly welded) (Miocene)
Tf	Felsic Volcanic Rocks, undivided (Middle Tertiary)
Tbl	Lower Basalt (Middle Tertiary)
Tx	Rock Avalanche or Talus Brecchia (Middle Tertiary)
Tw	Whitetail Conglomerate
Tdb	Basaltic Dikes (Middle Tertiary)
Kd	Quartz Diorite (Latest Cretaceous)
Me	Escabrosa Limestone (Mississippian)
Dm	Martin Limestone (Devonian)
Cb	Bolsa Quartzite (Cambrian)
Yd	Diabase (Middle Proterozoic)
Ym	Mescal Limestone (Middle Proterozoic)
Yds	Dripping Spring Quartzite, undivided (Middle Proterozoic)
Ydsu	Dripping Spring Quartzite, Upper Unit (Middle Proterozoic)
Ydsl	Dripping Spring Quartzite, Lower Unit (Middle Proterozoic)
Yp	Pioneer Shale (Middle Proterozoic)
Ypt	Pioneer Shale, Tuff Unit (Middle Proterozoic)
YXd	Diorite (Early or Middle Proterozoic)
Xp	Pinal Schist, undivided (Early Proterozoic)
Xpc	Pinal Schist, Calc-silicate Facies (Early Proterozoic)
Xpcs	Pinal Schist, Calc-silicate and Schist Facies (Early Proterozoic)
Xpm	Pinal Schist, Psammite Facies (Early Proterozoic)
Xpp	Pinal Sctist, Phyllite Facies (Early Proterozoic)
Xpq	Pinal Schist, Quartzite Layers (Early Proterozoic)
Xps	Pinal Schist, Pelitic Schist (Early Proterozoic)

LEGEND

- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST

CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE

Notes:
1. NAD27 UTM12
2. Refer to main report for source of geologic data.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

0 1,000 m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT 2013 NEAR WEST SITE INVESTIGATION

TITLE: SITE GEOLOGY

PROJECT No. M09441A14

FIG No. 1.1

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2 TRAVERSE TYPES AND METHODOLOGY

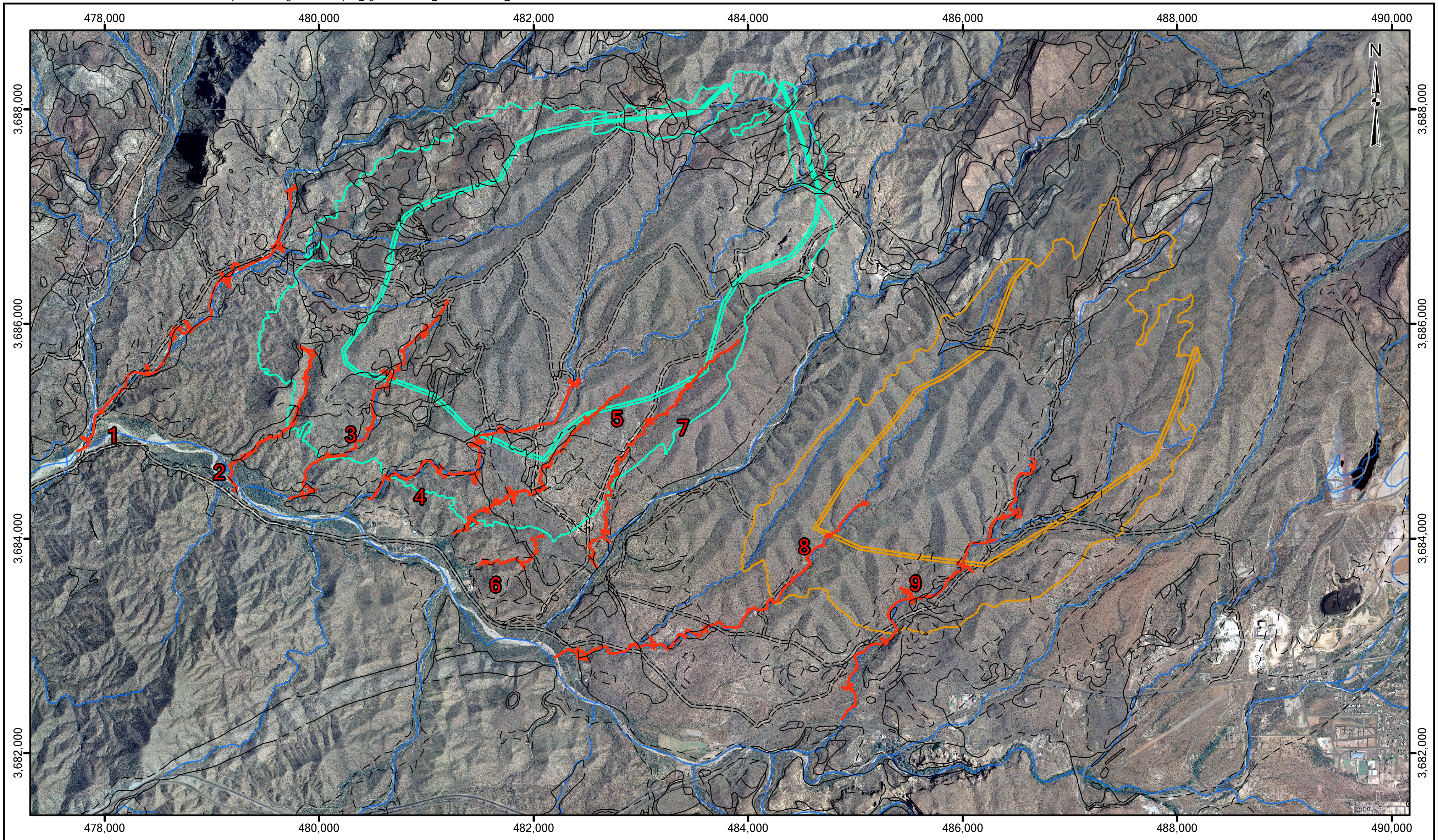
2.1 Creek Traverses

A total of 9 drainage channels were mapped. The traverses are shown over an aerial image in Figure 2.1 and over the geology map in Figure 2.2. Each traverse generally began near the confluence between the channel and Queen Creek. Creek traverse mapping stations were chosen roughly every 500 m *(1640.4 ft)* along the channel. At each mapping station, the creek cross section was described from left to right (looking upstream) and the following was documented:

- width of the channel, including the width of both active channel sediments and unconsolidated older alluvium deposits;
- rock type and geotechnical properties of bedrock exposed on either side of the creek section;
- soil and rock units exposed in the base of the creek channel and channel banks. Soils were excavated by hand (to a maximum depth of 40 cm *(15.7 inches)*), screened across a 5/8” sieve, photographed and geotechnically described;
- the maximum particle size in the active channel; and
- amount of vegetation in the active channel.

Locations of the mapping stations, detailed logs, photographs and creek cross section sketches are provided in Appendix I.

In addition to creek traverse mapping stations, observations were made at points of interest. Locations, photographs and descriptions of the observation stations are also included in Appendix I.



LEGEND

- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- STREAM
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Orthophoto from USDA

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TITLE: LOCATIONS OF CREEK TRAVERSES

PROJECT No. M09441A14

FIG No. 2.1

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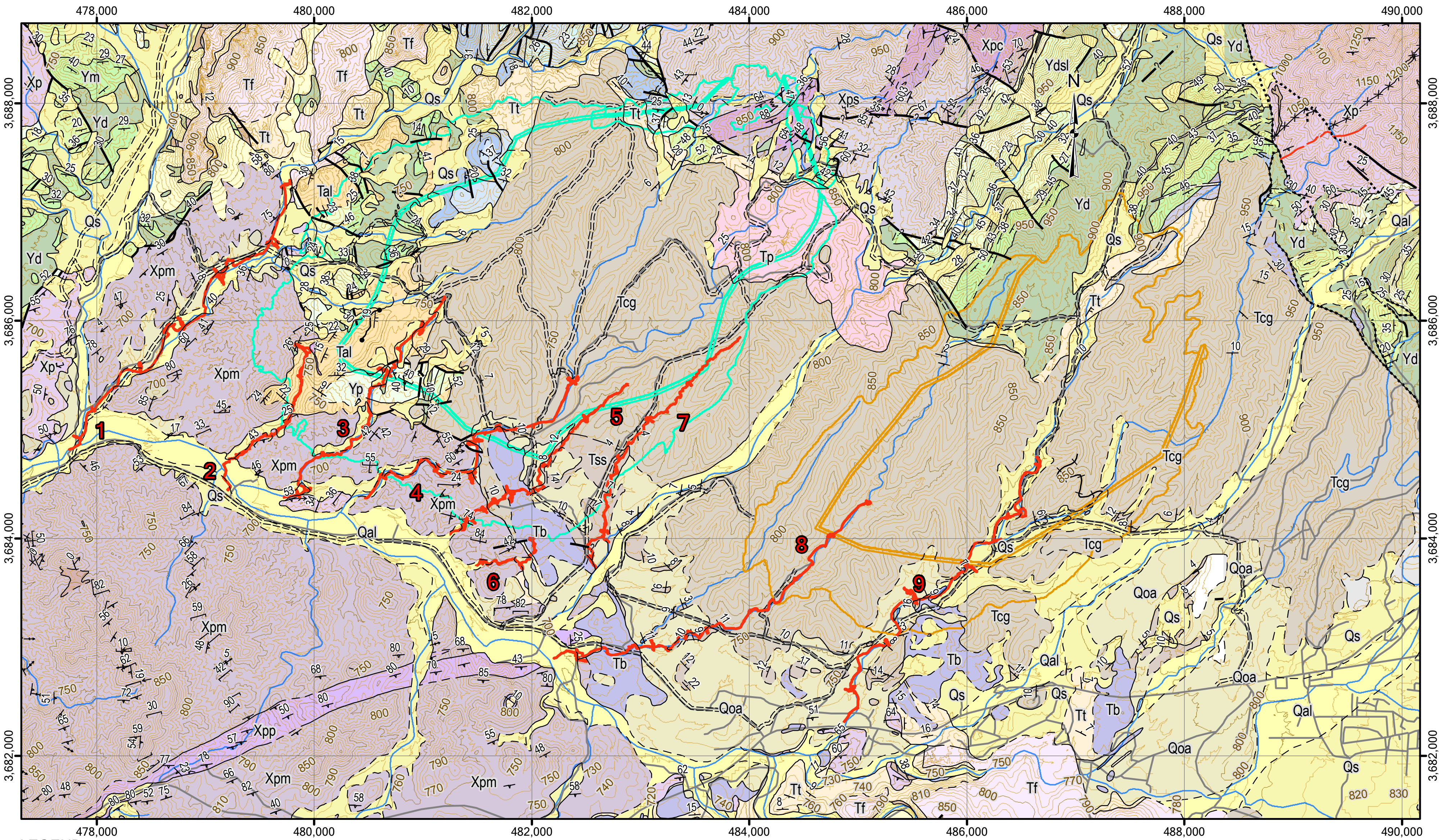

LEGEND

- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
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- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)

Notes:
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2. Refer to main report for descriptions of geologic units.

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TITLE: LOCATIONS OF CREEK TRAVERSES AND GEOLOGY

PROJECT No. M09441A14

FIG No. 2.2

2.2 Detailed Gila Observations and Sampling

Six exposures of Gila Conglomerate were visited in Bear Tank Canyon (Creek Traverse #4) for detailed logging and sampling. The names and locations of the mapping stations are shown on Figure 2.3 and Figure 2.4. General observations are discussed in Section 4.2. Photos, detailed descriptions of the conglomerate outcrops and laboratory test results are provided in Appendix II. X-ray diffraction (XRD) testing was still in progress at the time of writing and results will be submitted in an addendum to this report once testing is complete.

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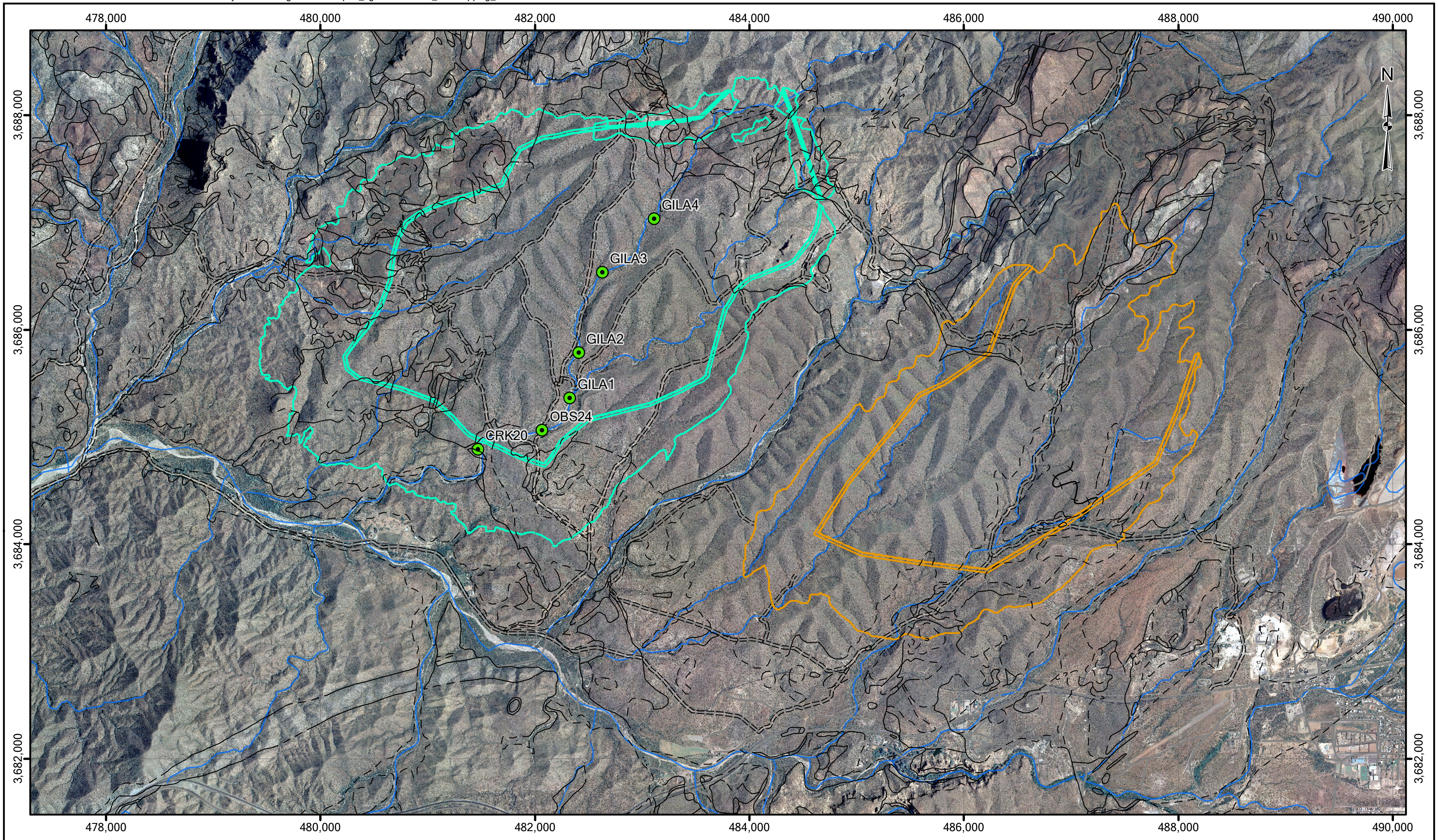

LEGEND

- GILA CONGLOMERATE MAPPING STATION
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Orthophoto from USDA

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0 1,000 m

CLIENT: Resolution Copper Mining	PROJECT: RESOLUTION PROJECT 2013 NEAR WEST SITE INVESTIGATION
Klohn Crippen Berger	TITLE: LOCATIONS OF GILA CONGLOMERATE MAPPING STATIONS
	PROJECT No. M09441A14 / FIG No. 2.3

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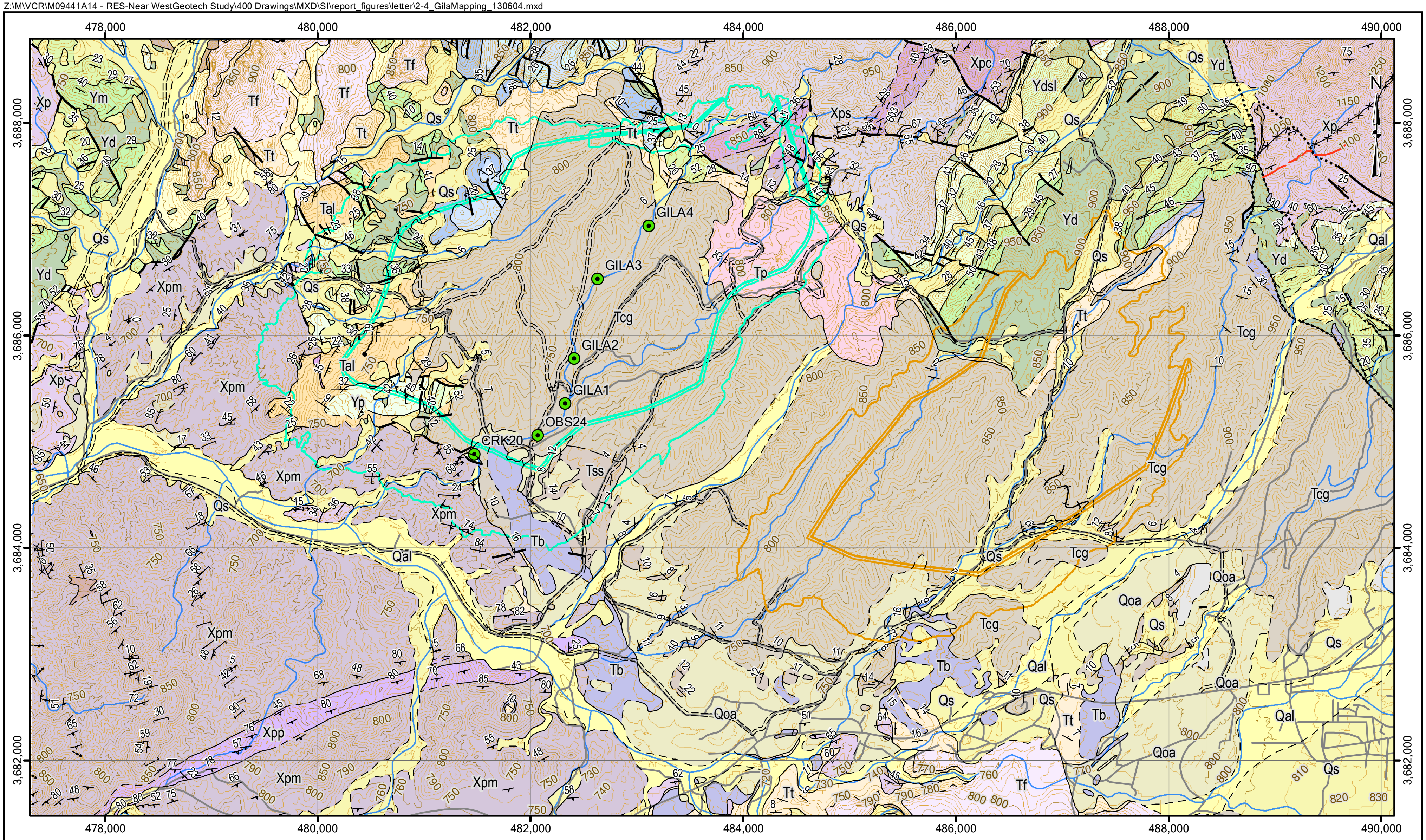

LEGEND

- GILA CONGLOMERATE MAPPING STATION
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
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- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)

Notes:
1. NAD27 UTM12
2. Refer to main report for descriptions of geologic units.

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2013 NEAR WEST SITE INVESTIGATION

TITLE: LOCATIONS OF GILA CONGLOMERATE MAPPING STATIONS AND GEOLOGY

PROJECT No.	FIG No.
M09441A14	2.4

2.3 Bedrock Geology Mapping

Special attention was paid to three areas of the site where Gila Conglomerate is not exposed at surface. These were the Northern Mixed Geology Area, the Western Mixed Geology Area and the Perlite Area as shown on Figure 2.5 and Figure 2.6. Traverses in these areas were carried out to identify and describe the exposures of different rock units. General observations are summarized in Section 4.2. Photos and detailed observations made at each outcrop and locations of the observation points are provided in Appendix III.

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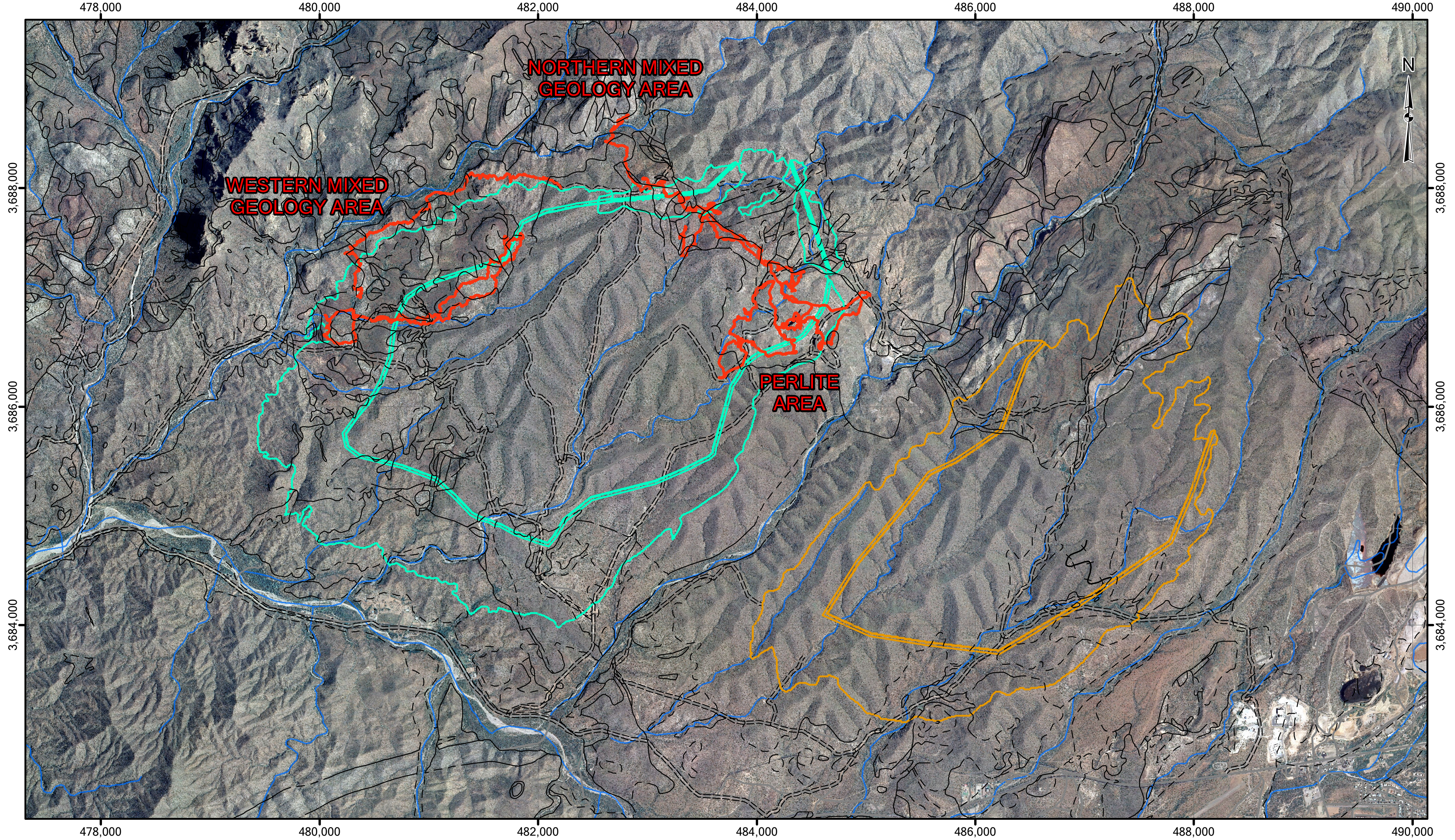

LEGEND

- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
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2. Orthophoto from USDA

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RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE
LOCATIONS OF BEDROCK GEOLOGY MAPPING AREAS

PROJECT No. M09441A14

FIG No. 2.5

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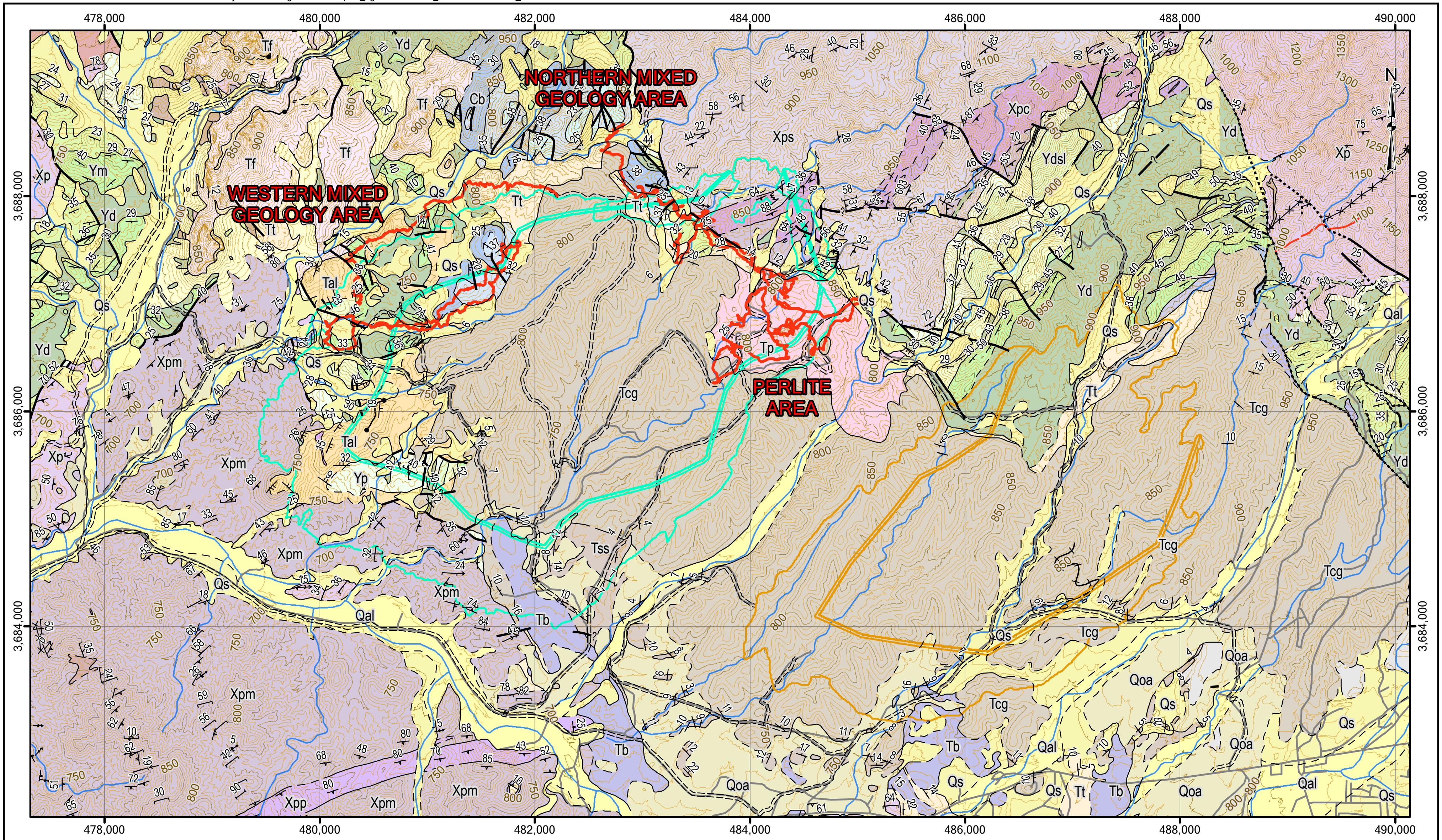

LEGEND

- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
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TITLE: LOCATIONS OF BEDROCK GEOLOGY MAPPING AREAS AND GEOLOGY

PROJECT No. M09441A14

FIG No. 2.6

3 SOIL SAMPLING

Alluvium was sampled along Creek Traverses #1 (Roblas Canyon), #4 (Bear Tank Canyon) and #9 (Happy Camp Canyon) and from Old Alluvium deposits near the south end of Pott's Canyon. Sampling locations are shown on Figure 3.1 and Figure 3.2. The samples were sent for geotechnical testing to assess suitability for dam fill and filters/drains. Field descriptions of the samples, sampling methodology and laboratory test results are included in Appendix IV.

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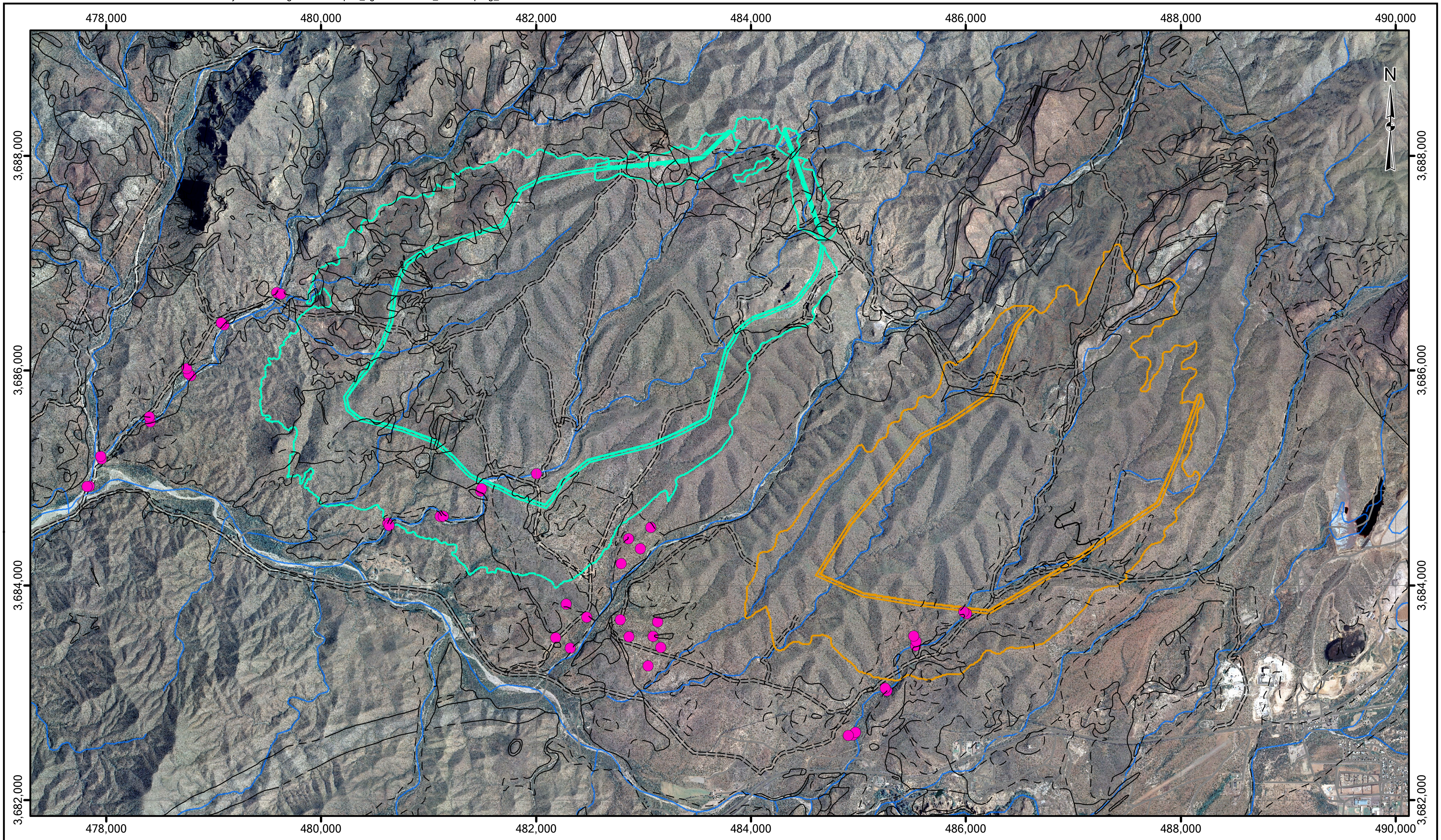

LEGEND

- SOIL SAMPLING LOCATION
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
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2013 NEAR WEST SITE INVESTIGATION

TITLE
SOIL SAMPLING LOCATIONS

PROJECT No. M09441A14

FIG No. 3.1

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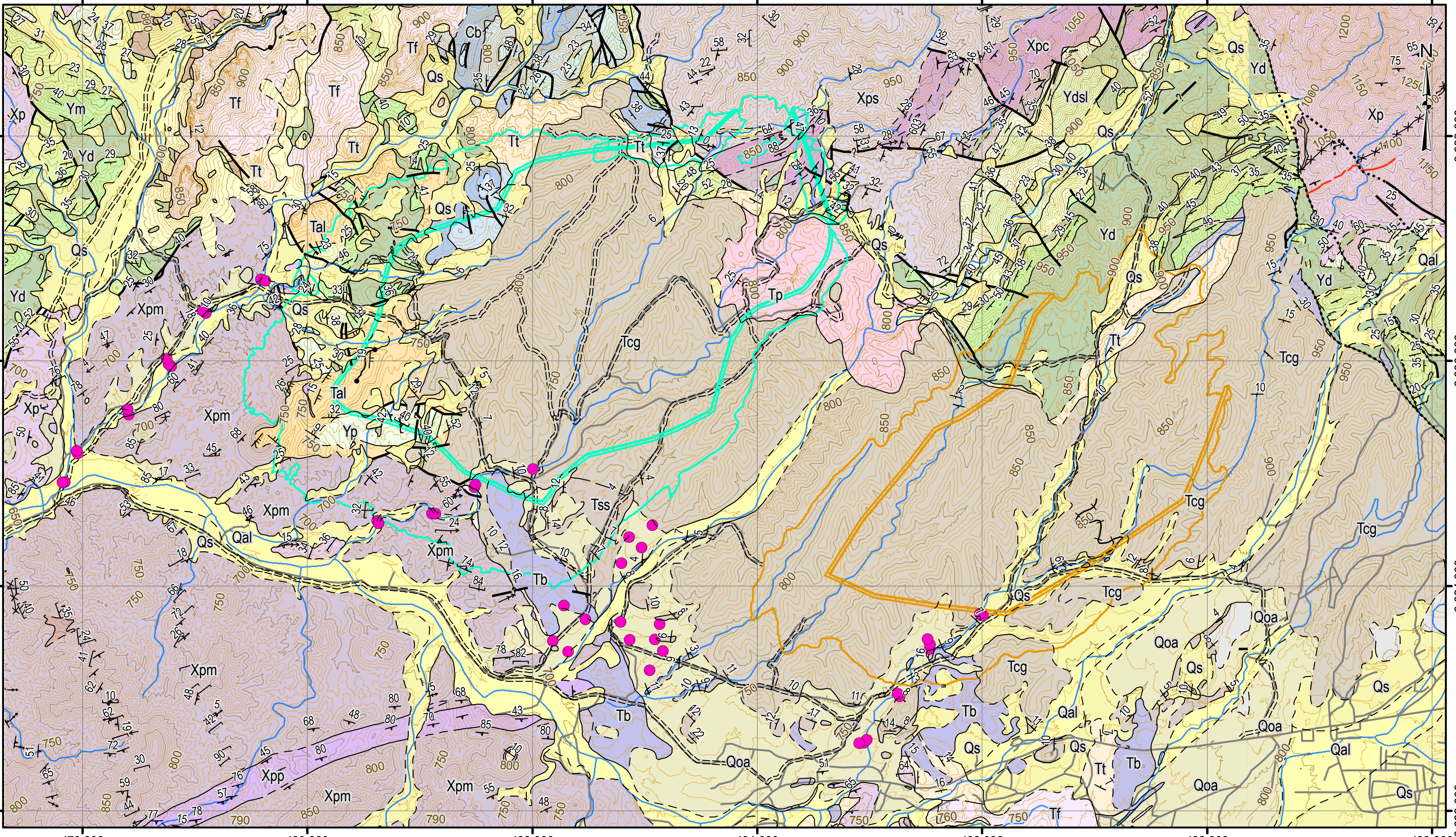

LEGEND

- SOIL SAMPLING LOCATION
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
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- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*
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- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)

Notes:
1. NAD27 UTM12
2. Refer to main repor tfor descriptions of geologic units.

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PROJECT No. M09441A14

FIG No. 3.2

4 GENERAL OBSERVATIONS

4.1 Alluvium

Alluvial sediments observed along the creek traverses consisted of two types: old alluvium and active channel sediments. Active channel sediments are clean, well graded sand, gravel and cobbles (typically) with occasional boulders. Acid reaction was mild to non-existent and occurs on the grain surfaces. Vegetation in the active channels was generally concentrated on elevated channel bars.

Old alluvium deposits form flat, elevated and vegetated areas adjacent to active channels. Sediments observed in shallow exploration holes ranged from fine, poorly graded silty sand to well graded sand, gravel and cobbles. Exposures of old alluvium in eroded channel banks indicate that the material gradation is similar to the active channel sediments although with higher fines content. Old alluvium sampled near the south end of Pott's Canyon typically contained a higher percentage of clay than was found along the creek traverses. Acid reaction was much more variable in old alluvium deposits than the active channels and ranged from strong to no reaction.

Typical active channel and old alluvium sediments are shown in Figure 4.1. Detailed geotechnical descriptions of the soils were made at each creek traverse mapping station, and are provided in Appendix I.

Figure 4.1 Old Alluvium Exposed in Cut Bank (left), Typical Active Channel (top right) and Typical Active Channel Sediments (bottom right)

4.2 Bedrock

General observations of the different rock units exposed on site are summarized in this section. Rock units are listed in order of age (youngest to oldest). Observations made of each outcrop, and locations of the observation points, are provided in Appendix III.

Gila Conglomerate (Tcg)

Massive or sub-horizontally bedded conglomerate. Well graded with particle sizes ranging from fines to boulders, clast or matrix supported, differential weathering of beds common with finer, siltier beds weathering most readily, no acid reaction to strong acid reaction in matrix, various clast lithology, unjointed with some small fractures typically terminating at bedding interfaces and open fractures caused by root penetration, weak to strong rock (R2 to R4), typically with strength loss on wetting.

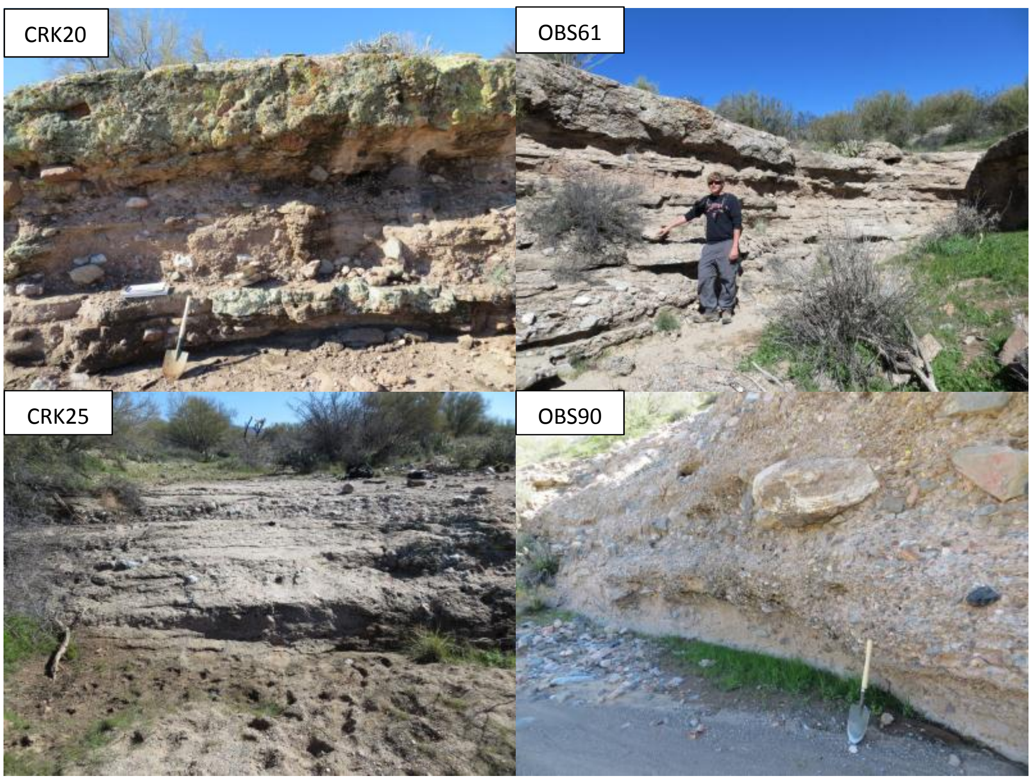


Figure 4.2 Typical "Tcg" Outcrops

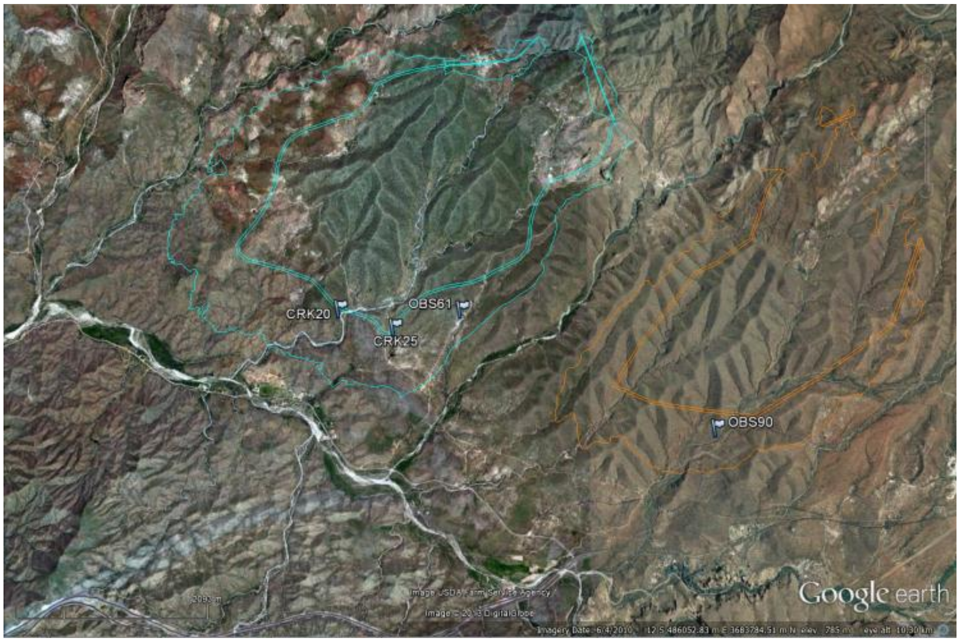


Figure 4.3 Locations of Typical "Tcg" Outcrop Photos

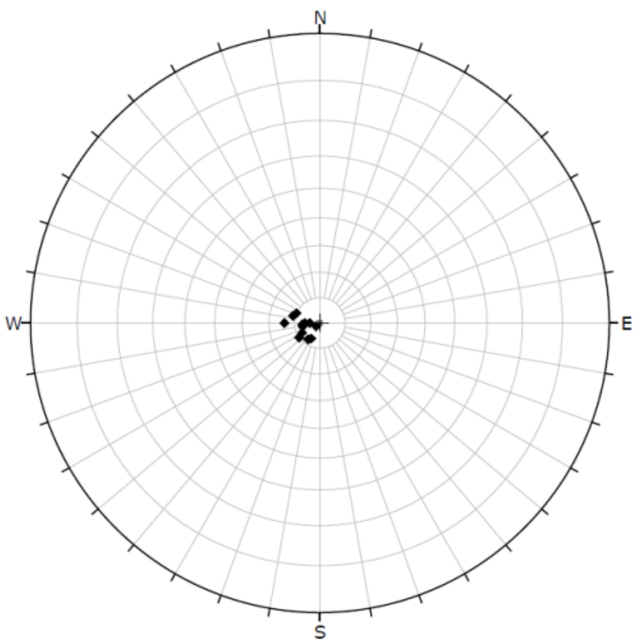


Figure 4.4 Poles to Bedding Planes in "Tcg" Unit

Sandstone (Tss)

Found downslope of the Gila conglomerate. Sub-horizontal parallel beds ranging from 20 cm to <1 mm *(8 inches to <0.04 inches)* thick, grain size ranging from fines to cobbles, differential weathering of beds with finer, siltier beds weathering most readily, matrix reactive to acid, medium strong rock (cemented beds) to soil-like (weakly cemented to uncemented silty beds) (R3 to R0).

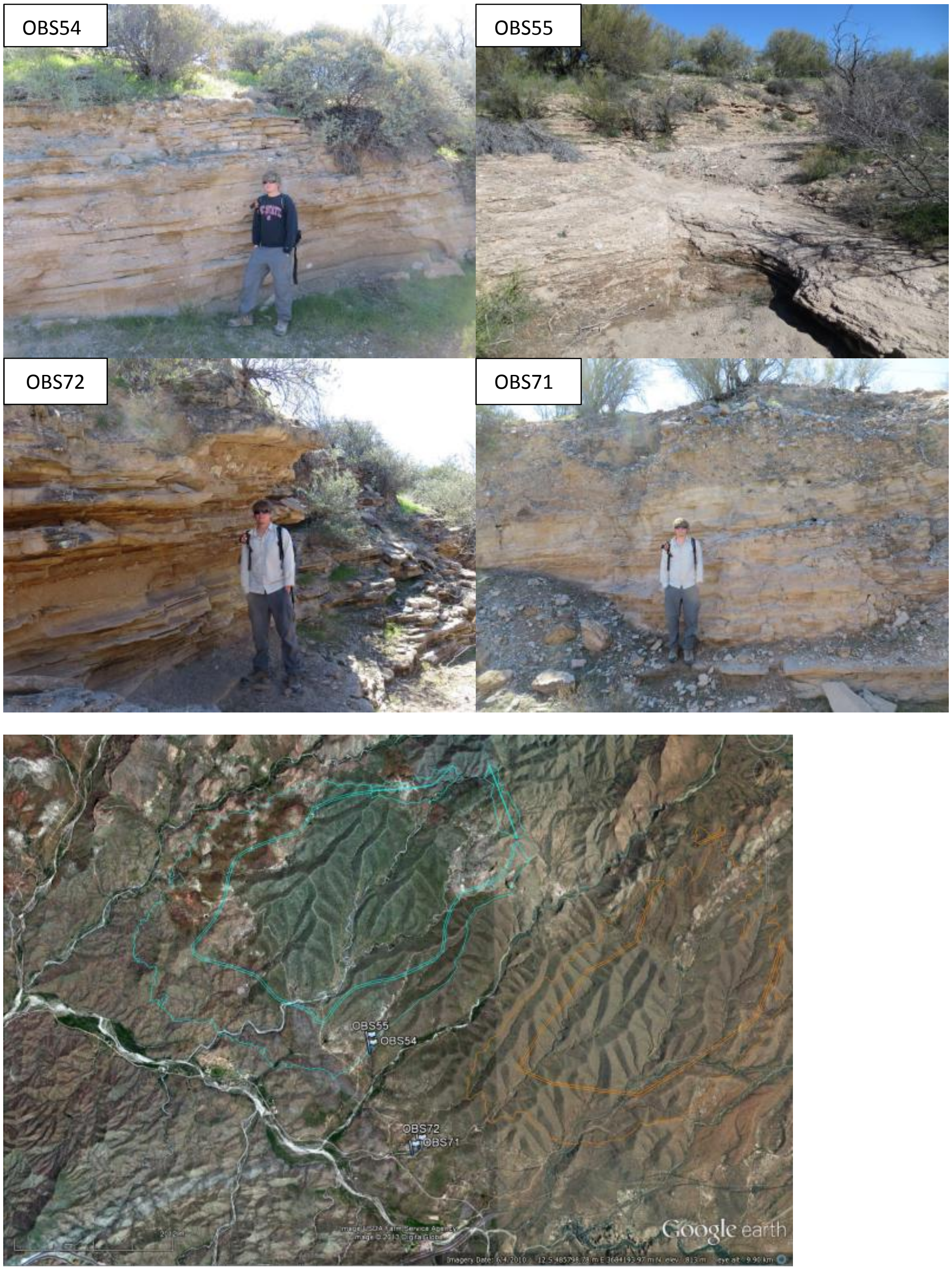


Figure 4.5 Typical "Tss" Outcrops (top tiles) and Photo Locations (bottom)

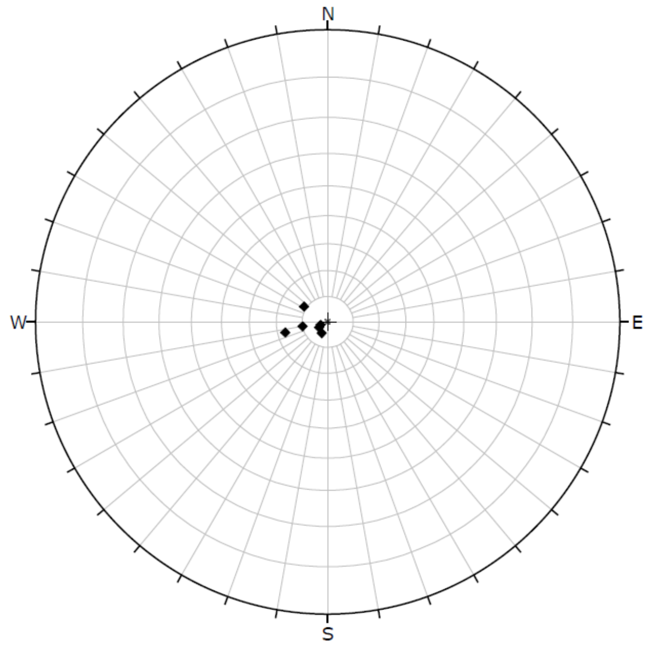


Figure 4.6 Poles to Bedding Planes in "Tss" Unit

Basalt (Tb)

Very blocky to disturbed, closed to open tightly spaced (avg. ~ 10 cm *(3.9 inches)*) joints, planar to undulating joint surfaces, calcite infilling of joints and calcite mineralization on the rock surface observed in some outcrops, very strong to extremely strong rock (R5/R6).

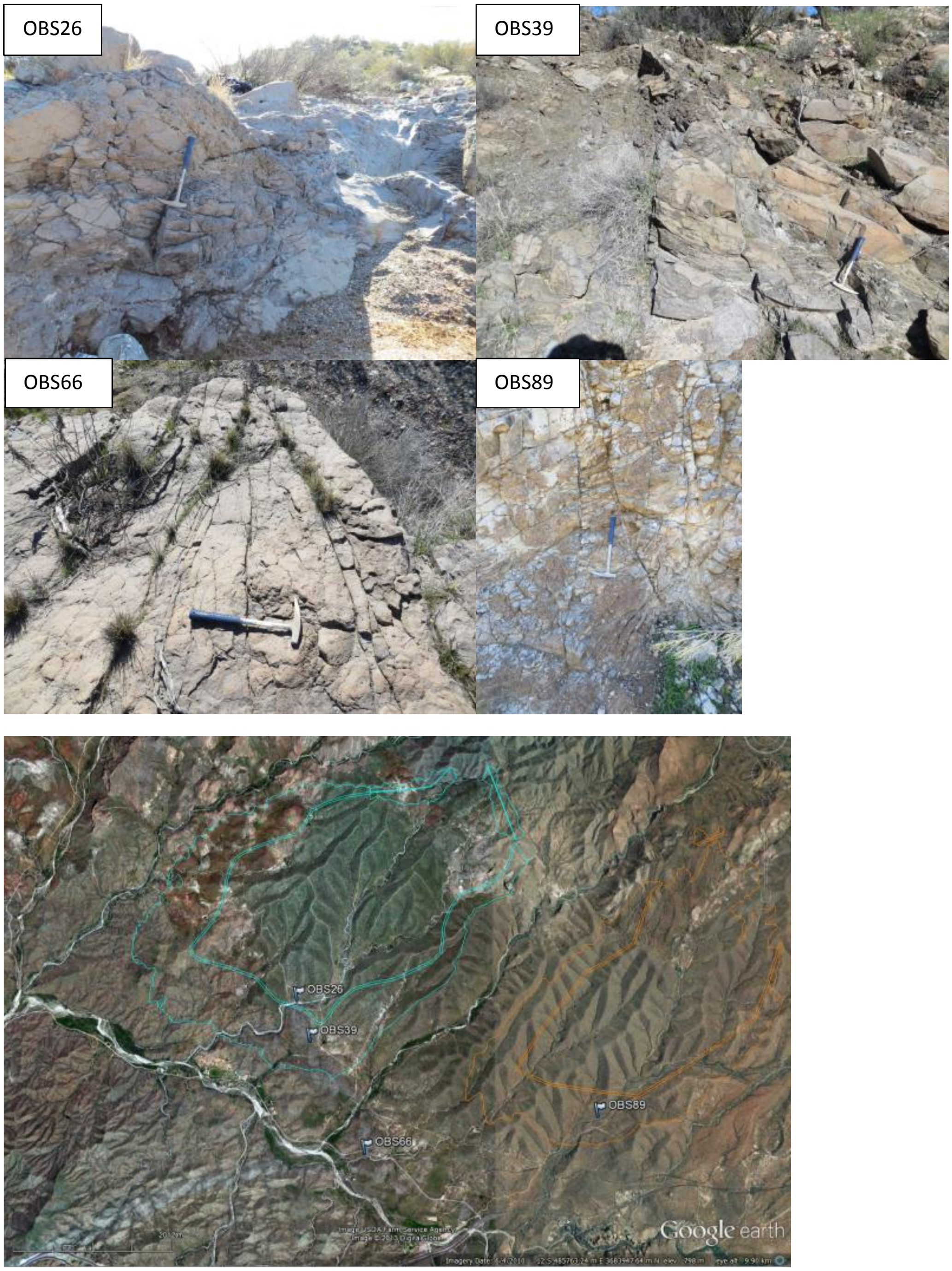


Figure 4.7 Typical "Tb" Outcrops (top tiles) and Photo Locations (bottom)

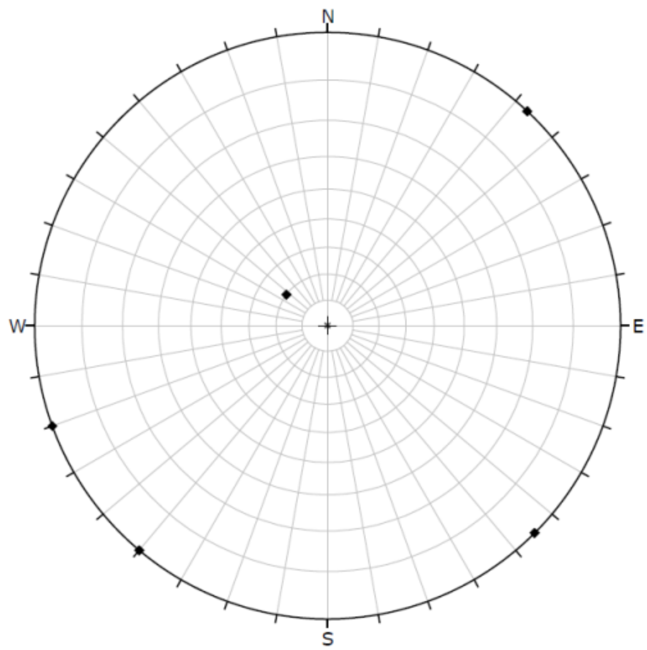


Figure 4.8 Poles to Joints in "Tb" Unit

Perlitic Aphyric Rhyolite (Perlite) (Tp)

Variable unit which includes banded rhyolite, perlite and brecciated rhyolite. Weak, glassy perlite often interlayered with microcrystalline silica, silica often occurs as spherical geodes within glassy perlite, parallel layers are randomly oriented regionally, material appears massive and unjointed in large cliff exposures, isolated sub-vertical fractures observed in some exposures, weak (glassy perlite, R2) to extremely strong (microcrystalline silica and rhyolite, R6) rock.

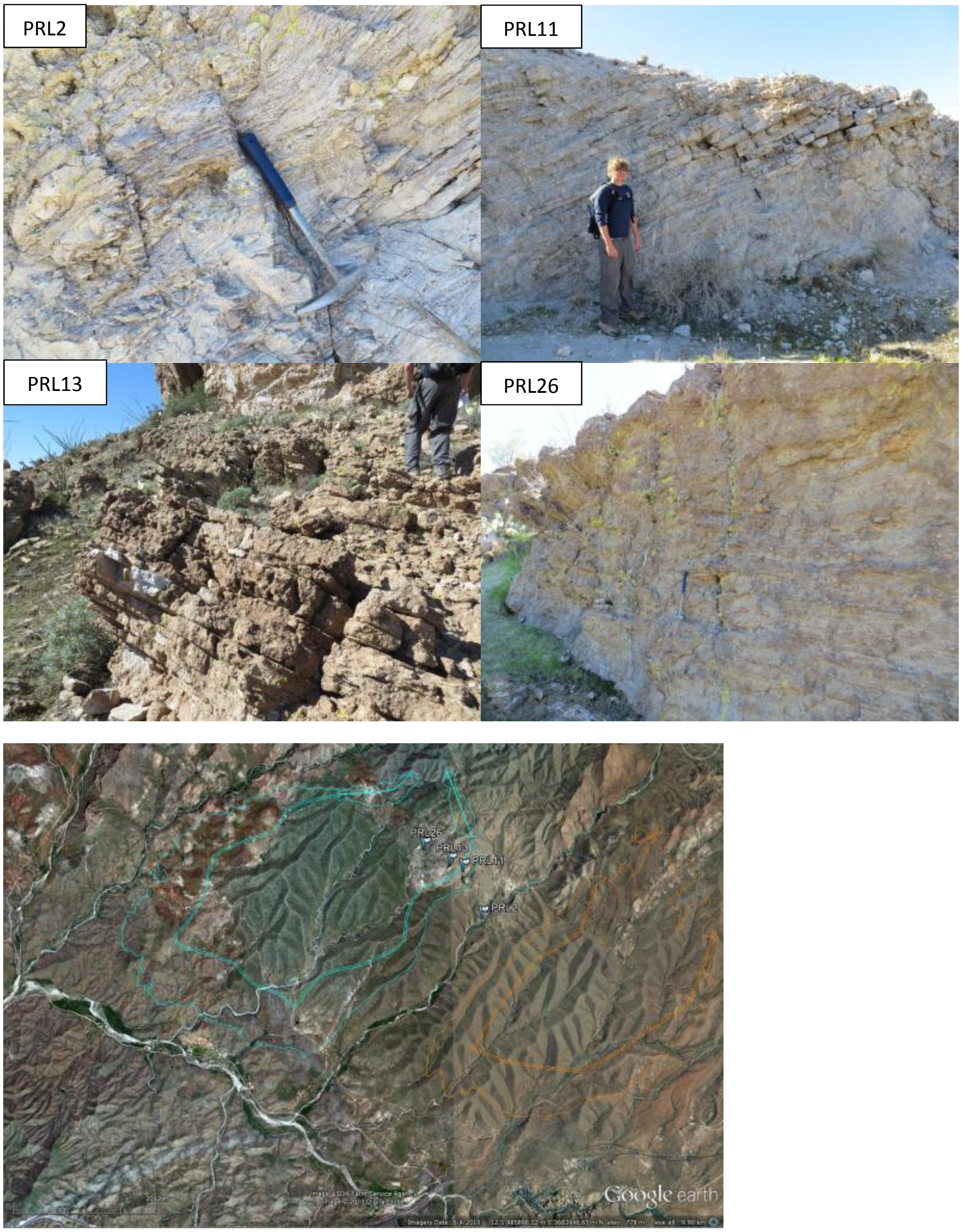


Figure 4.9 Typical "Tp" Outcrops (top tiles) and Photo Locations (bottom)

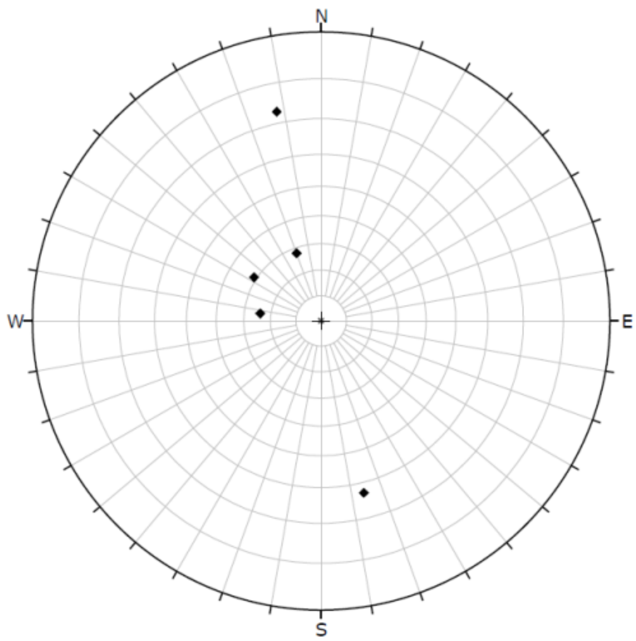


Figure 4.10 Poles to Parallel "Layering" in "Tp" Unit

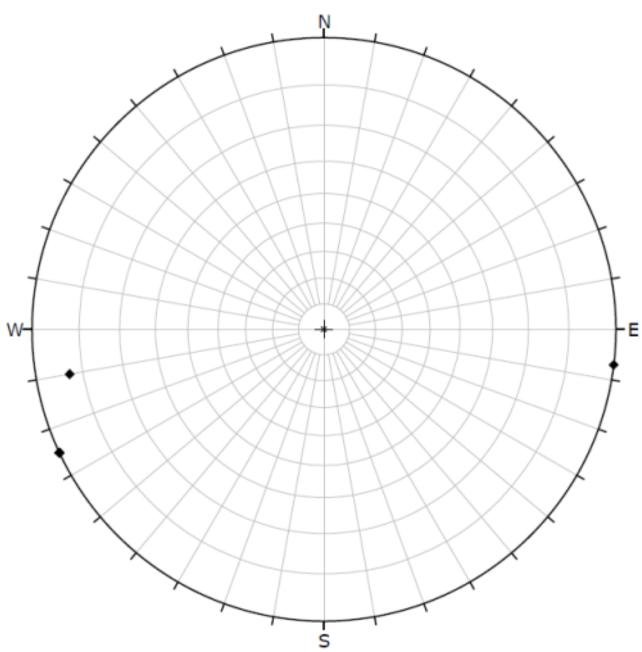


Figure 4.11 Poles to Joints in "Tp" Unit

Apache Leap Tuff (Tal):

Massive felsic tuff, often found with parallel vertical joints, strong to very strong rock (R4-R5).

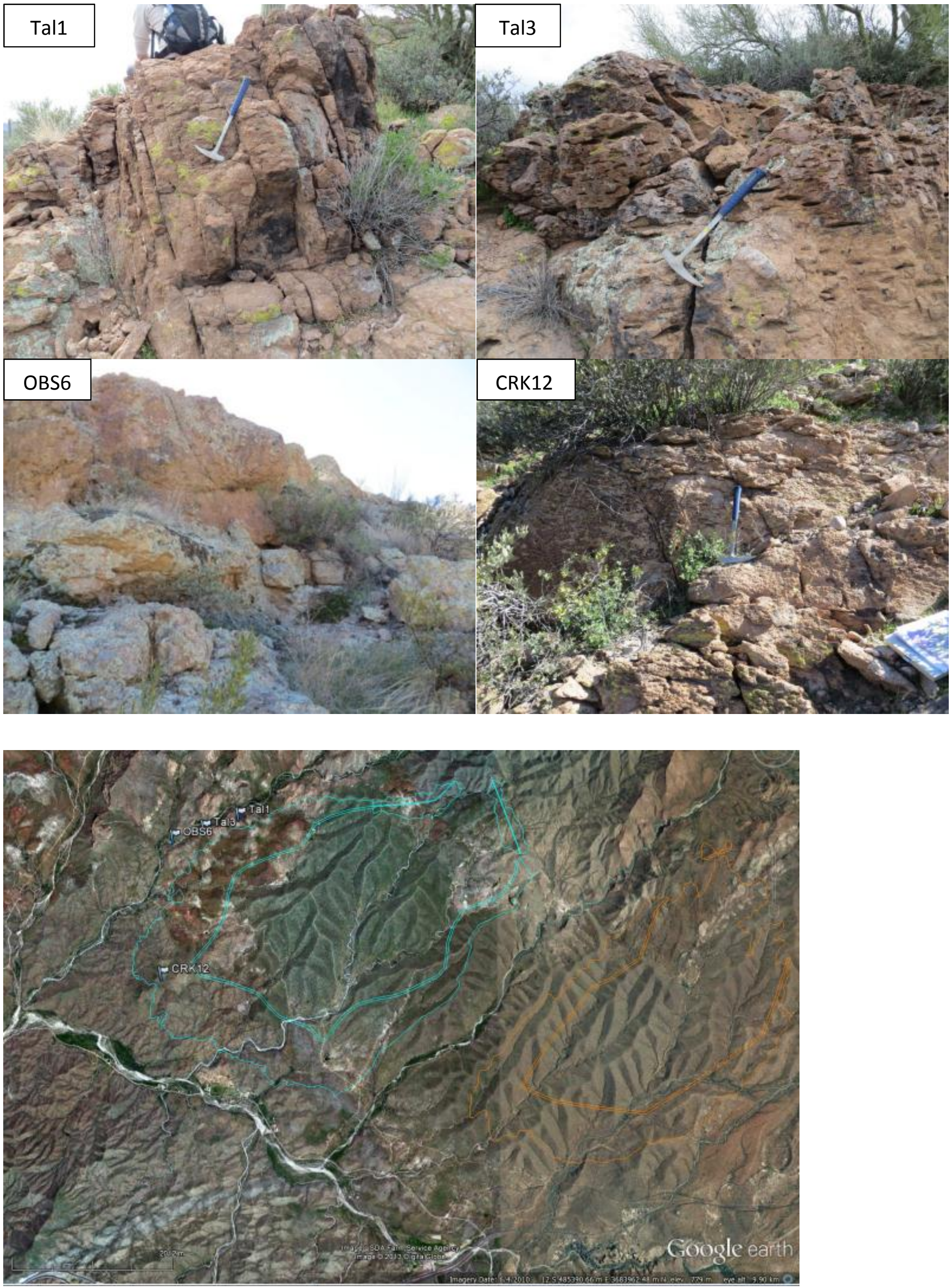


Figure 4.12 Typical "Tal" Outcrops (top tiles) and Photo Locations (bottom)

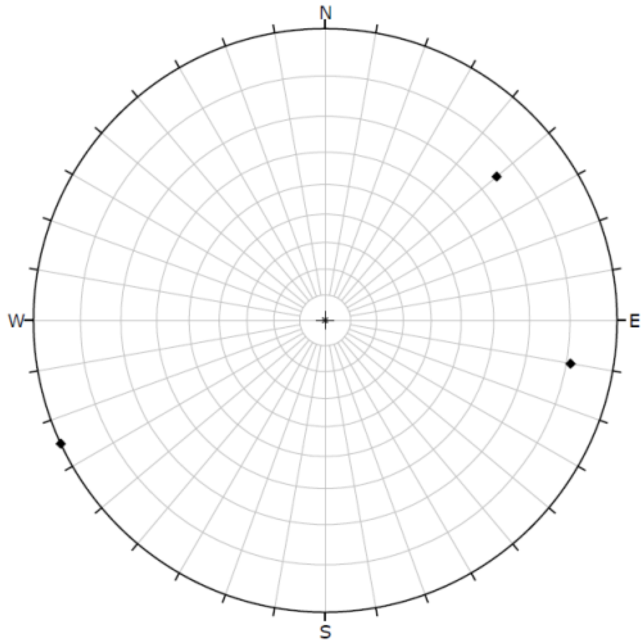
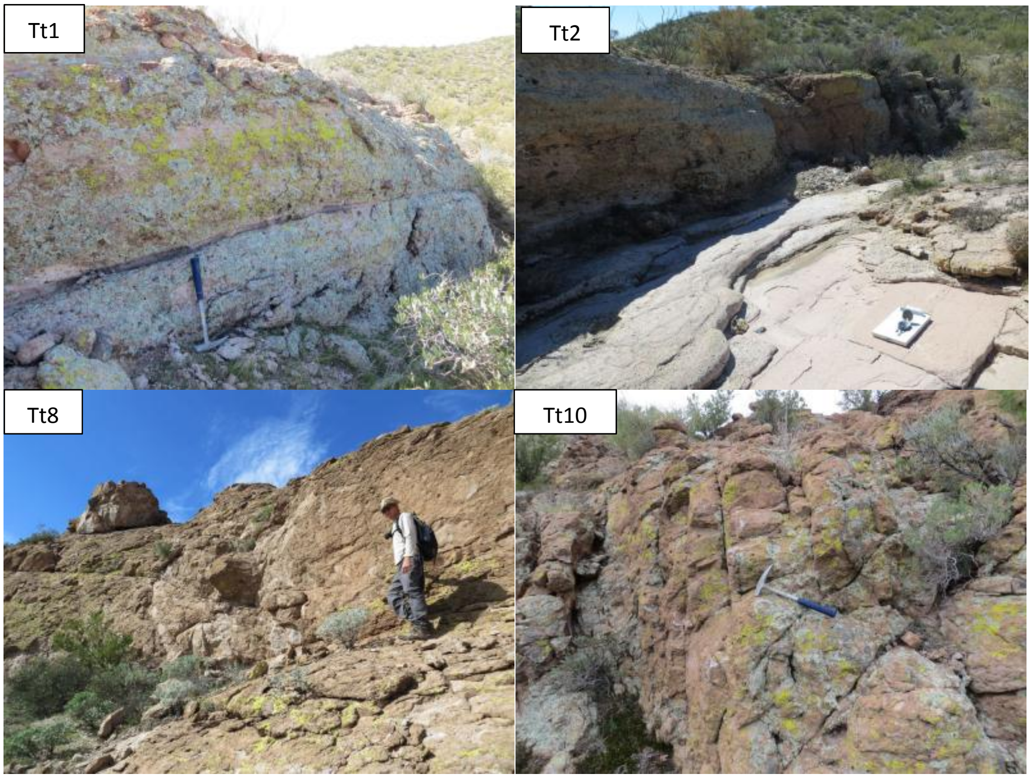


Figure 4.13 Poles to Joints in "Tal" Unit

Poorly Welded Tuff (Tt)

Felsic tuff, massive or “bedded” with some exposures showing differential weathering of finer beds, jointed or intact, R2 to R4, less dense and tends to have a finer matrix than Tal.



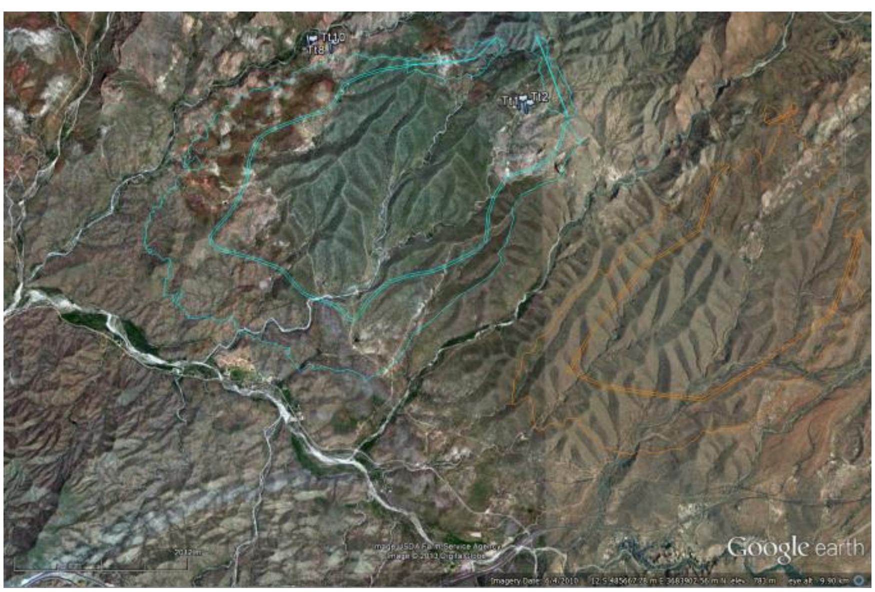


Figure 4.14 Typical “Tt” Outcrops (top tiles) and Photo Locations (bottom)

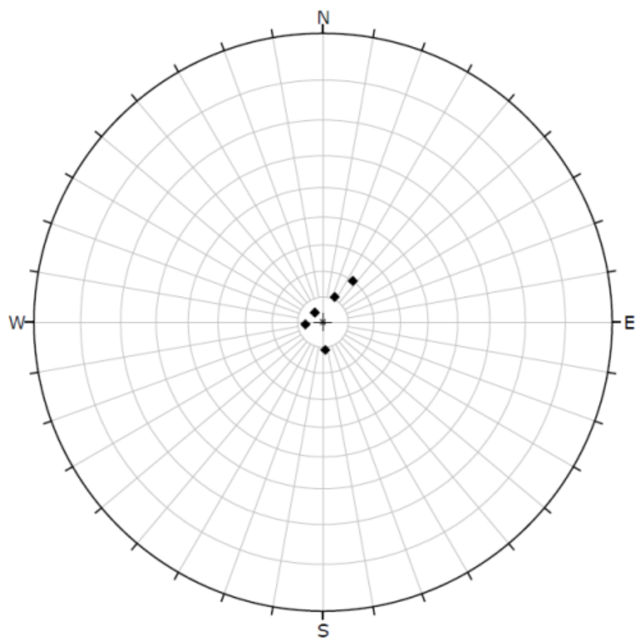


Figure 4.15 Poles to "Bedding" Planes in "Tt" Unit

Escabrosa Limestone (Me)

One exposure observed on the west side of Roblas Canyon. Fine grained massive limestone, fractures well healed with calcite, reactive to acid, shallow discontinuous fractures and “pitting” on surface, very strong rock (R5).

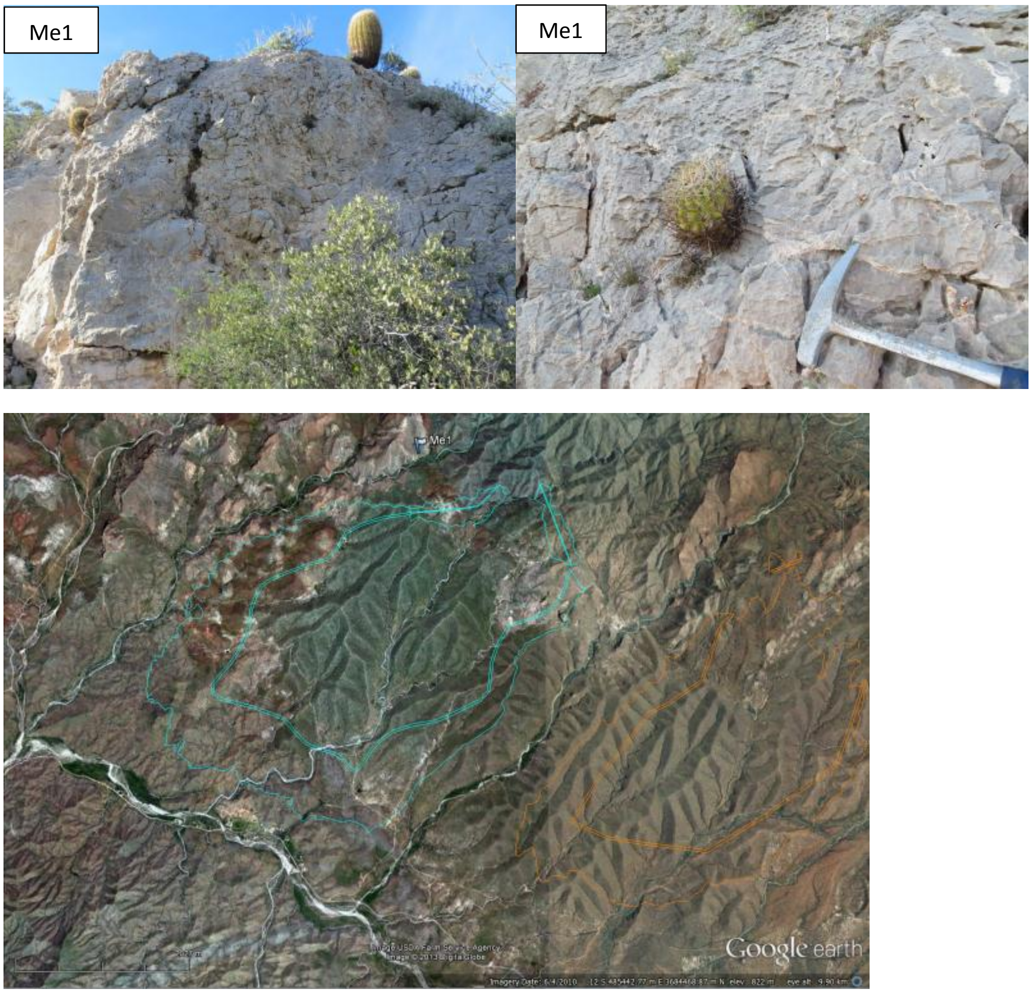


Figure 4.16 “Me” Outcrop (top tiles) and Photo Locations (bottom)

Martin Formation (Dm)

Variable limestone unit that ranges from fine grained calcareous siltstone to coarse grained calcareous sandstone and conglomerate. Typically sub-horizontally bedded with differential erosion of finer beds noted, jointed or massive, joints/fractures on fresh surfaces observed to be well healed with calcite, reactive to acid, medium strong to very strong rock (R3 to R5), often fossiliferous.

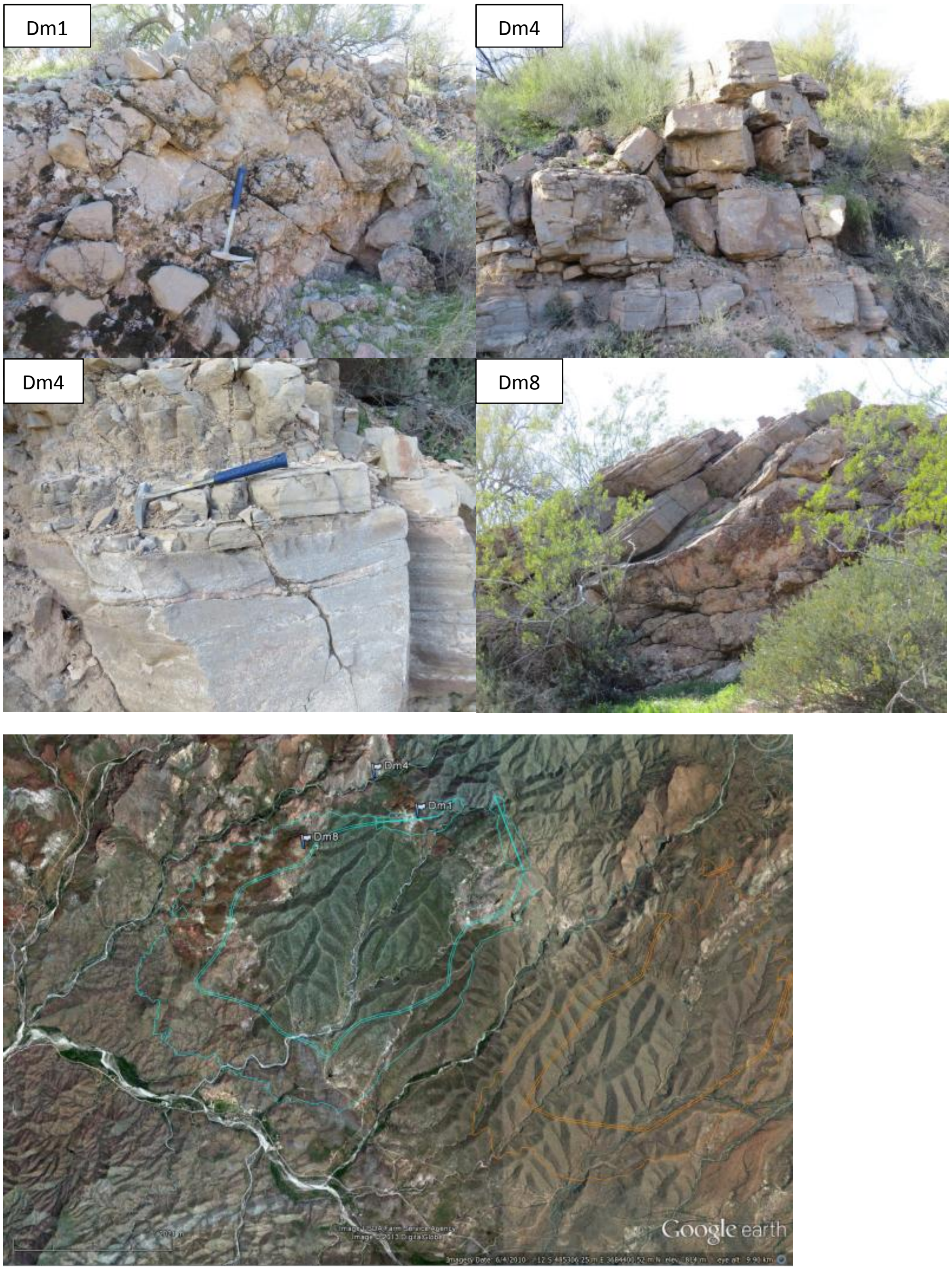


Figure 4.17 Typical "Dm" Outcrops (top tiles) and Photo Locations

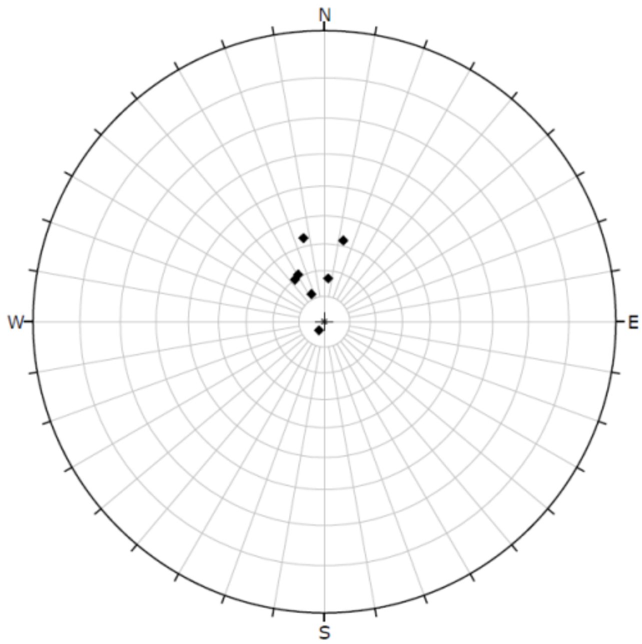


Figure 4.18 Poles to Bedding Planes in "Dm" Unit

Bolsa Quartzite (Cb)

Coarse to fine grained quartz arenite/quartzite. Limited exposures, tends to be exposed as cobbles at surface, parallel to cross-bedded structure visible in cobbles, one brecciated outcrop observed, extremely strong rock (surface cobbles) (R6) to medium strong rock (exposure of fractured quartzite) (R3).

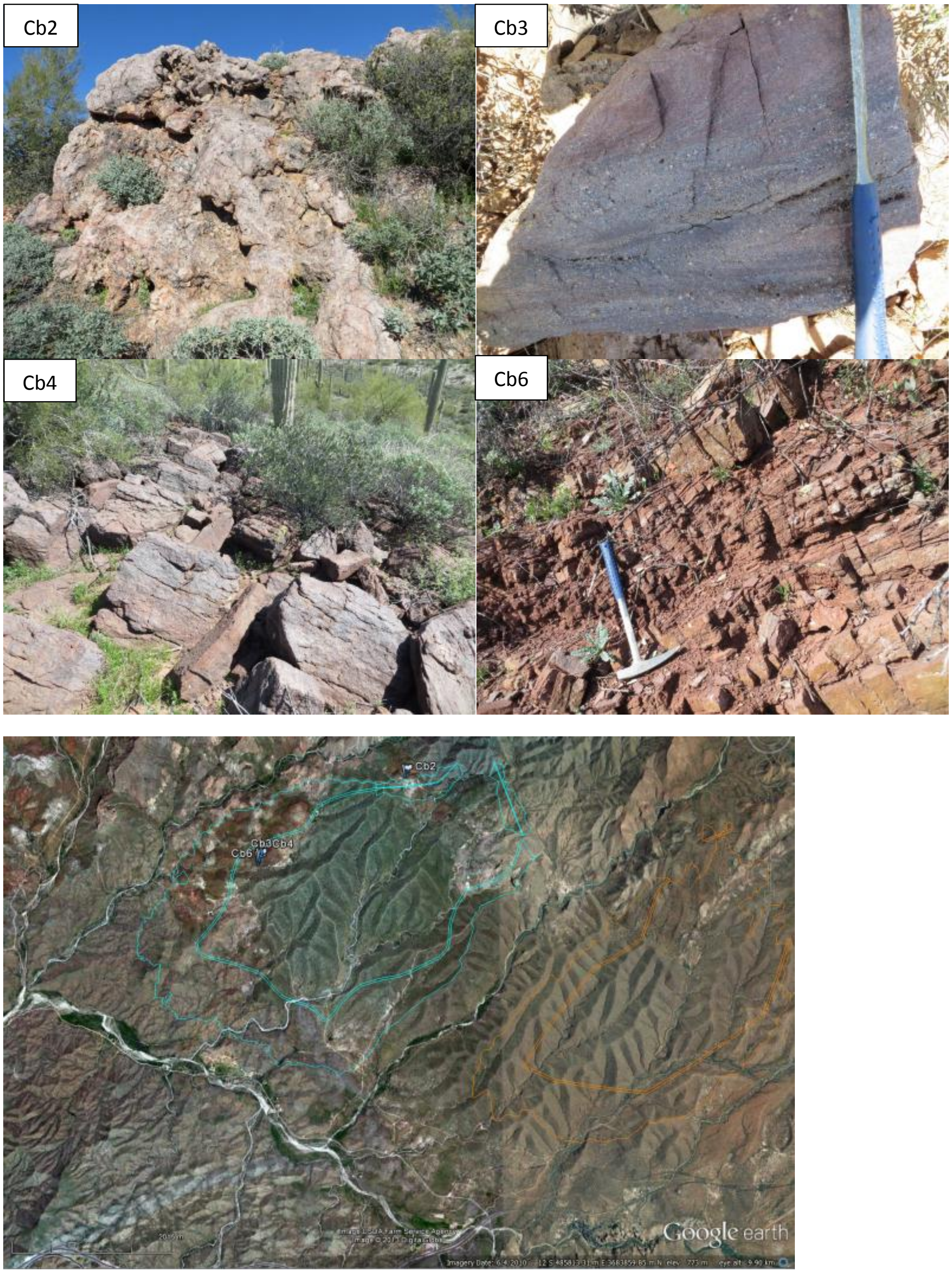


Figure 4.19 Typical "Cb" Outcrops (top tiles) and Photo Locations (bottom)

Diabase (Yd)

Limited exposures, typically appears as weathered (oxidized) gravel and cobbles at surface. Outcrops are heavily fractured or show tightly spaced joints, fractures sometimes infilled with calcite, medium strong (fractured rock mass) to extremely strong (intact) rock (R3 to R6).

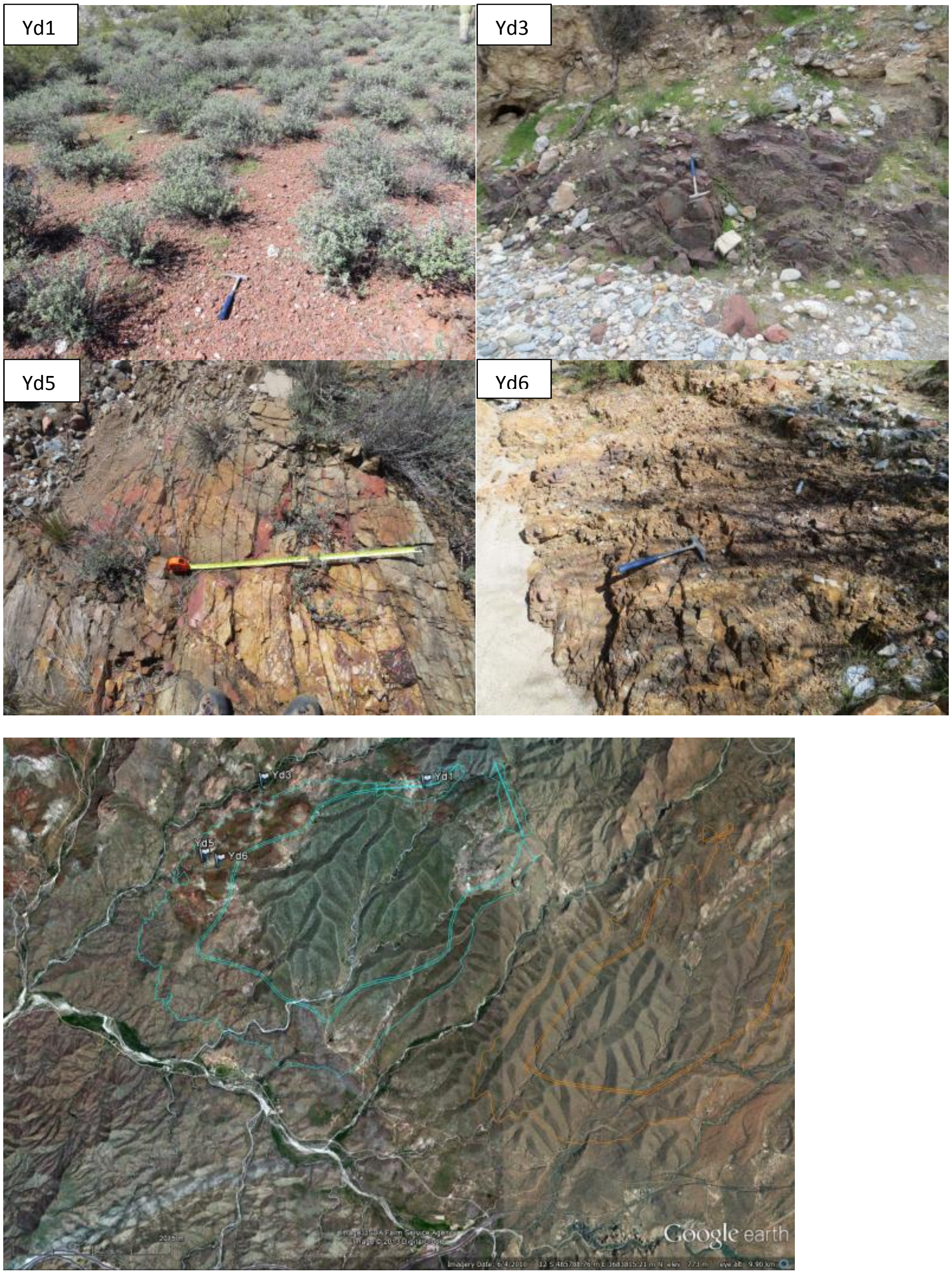


Figure 4.20 Typical "Yd" Outcrops (top tiles) and Photo Locations (bottom)

Mescal Limestone (Ym)

Fine grained limestone. Bedded with differential weathering of fine soil-like silty beds between much more competent calcareous siltstone, tightly spaced joint sets and fractures commonly found cross cutting bedding planes, reactive to acid, medium strong to very strong rock (calcareous siltstone R3 to R5).

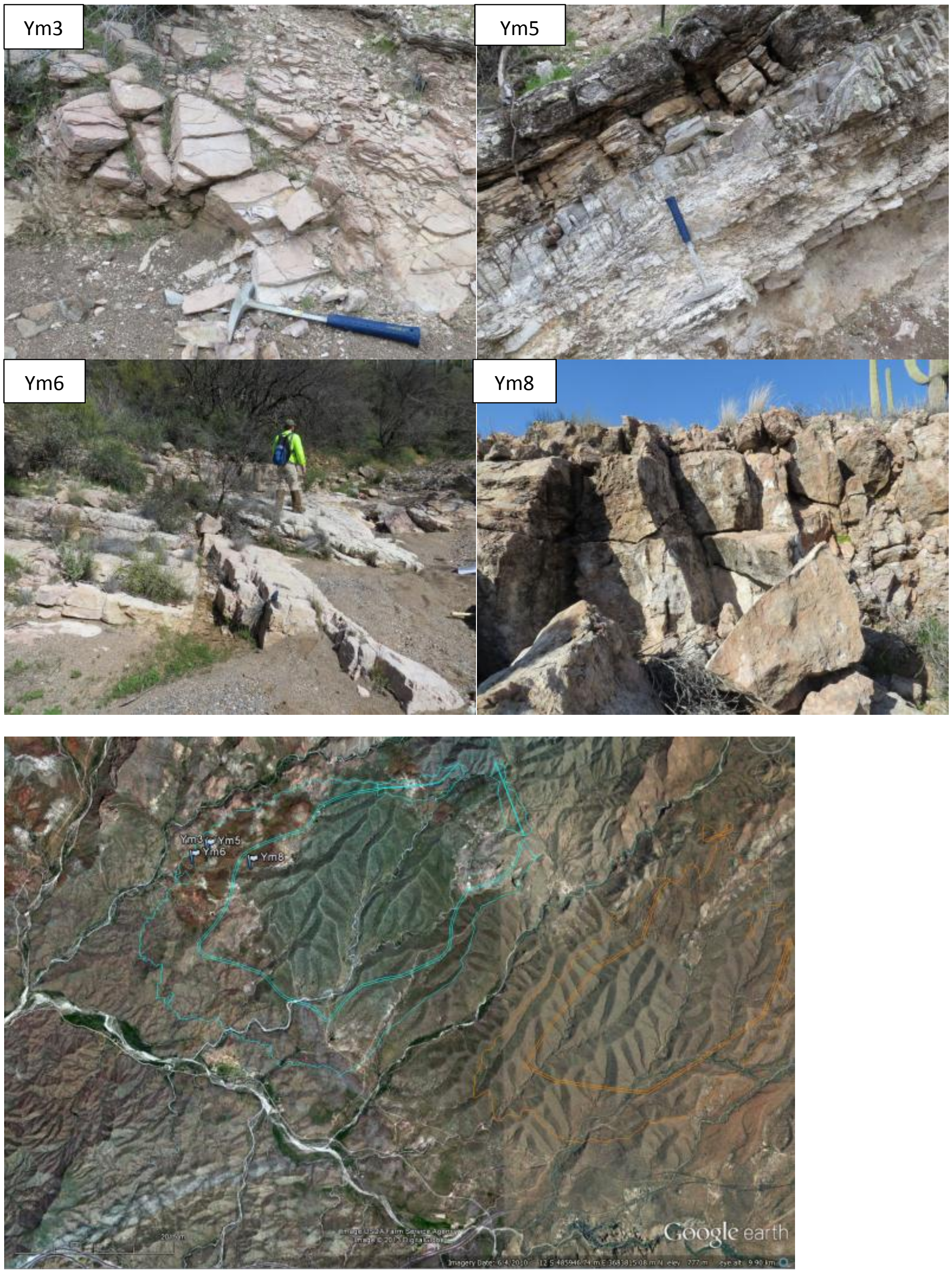


Figure 4.21 Typical "Ym" Outcrops (top tiles) and Photo Locations (bottom)

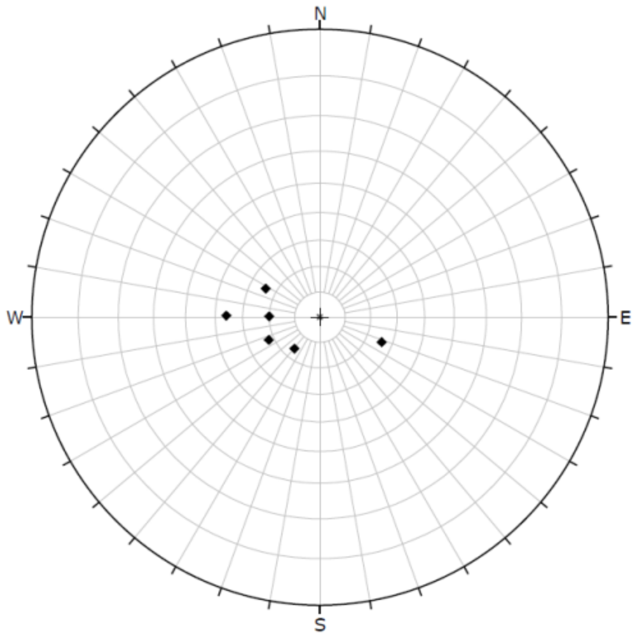


Figure 4.22 Poles to Bedding Planes in "Ym" Unit

Dripping Springs Quartzite (Undivided) (Yds)

Fine grained quartz arenite. Alternating red and white quartz sand laminations, rock fractures preferentially along bedding planes, fractures and joints cross cut bedding planes, strong to extremely strong rock (R4 to R6). One shear zone with heavily fractured rock observed at the contact with Pioneer Shale (Yp) (see Yds5).

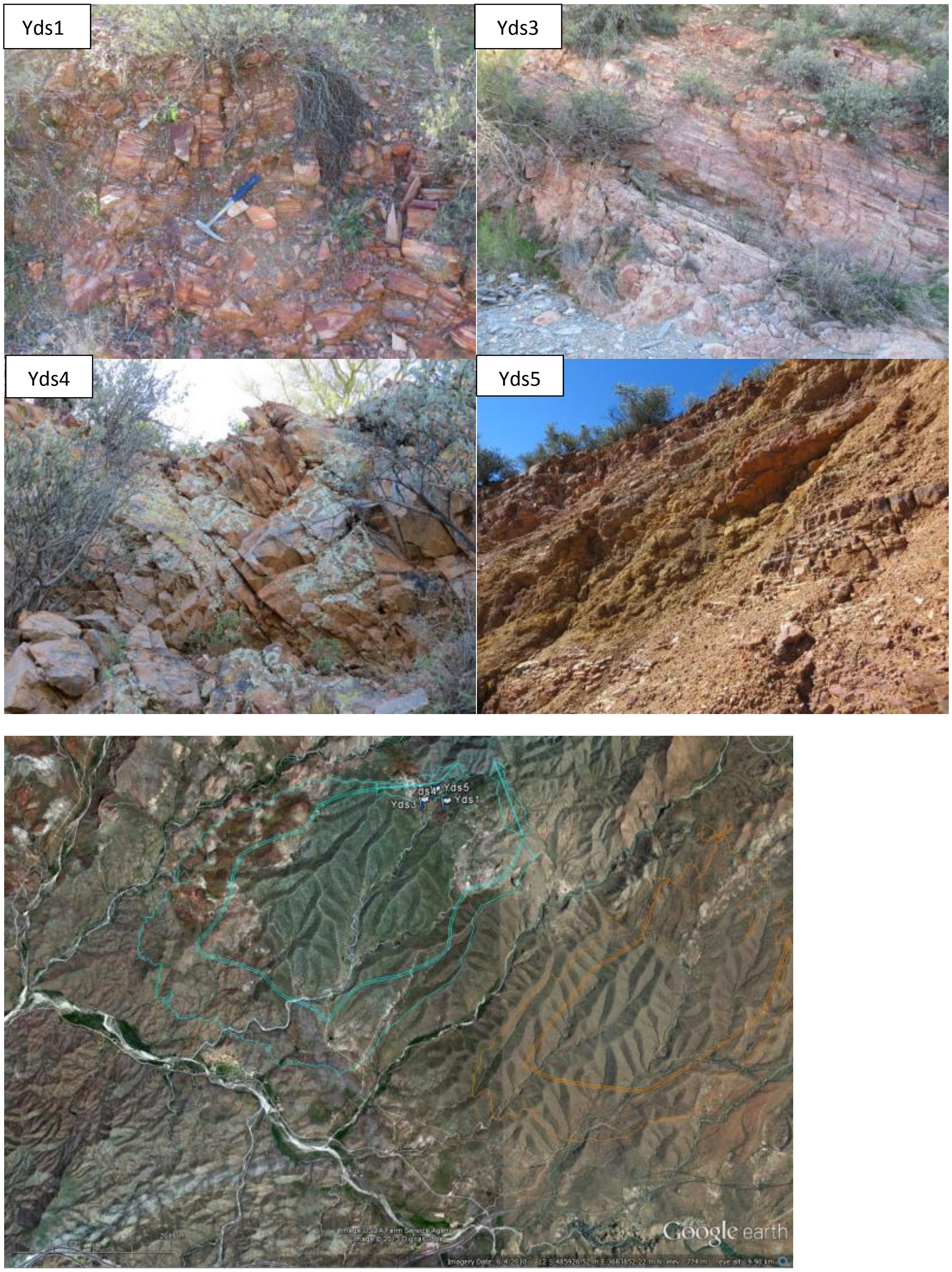


Figure 4.23 Typical "Yds" Outcrops (top tiles) and Photo Locations (bottom)

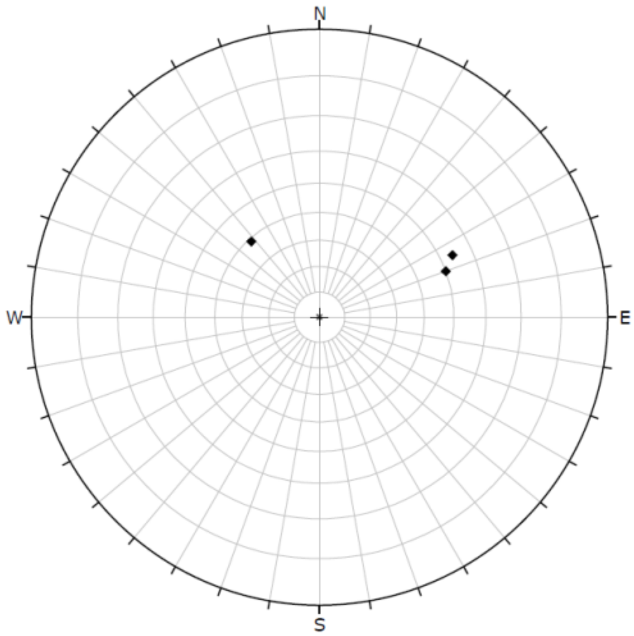


Figure 4.24 Poles to Joints in "Yds" Unit

Dripping Springs Quartzite (Upper Unit) Ydsu

Ranges from siltstone to fine grained quartz arenite, laminated, breaks preferentially along lamination planes, other joints and fractures typical cross cutting bedding laminations, some calcite infilling seen in fractures, strong to very strong rock (R4 to R5). Also exposed as a breccia which forms jagged outcrops with clasts of laminated Ydsu in an oxidized siliceous matrix.

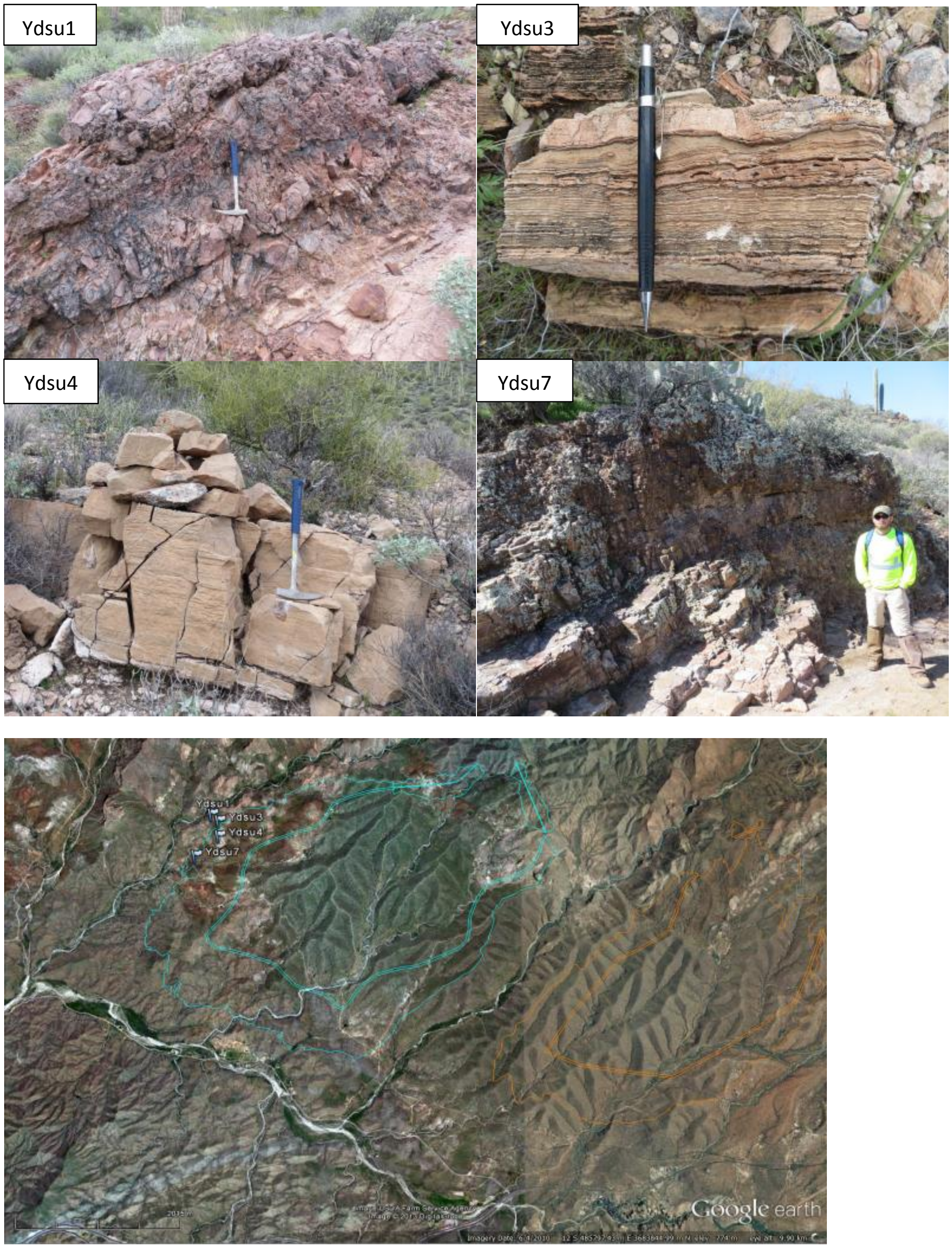


Figure 4.25 Typical "Ydsu" Outcrops (top tiles) and Photo Locations (bottom)

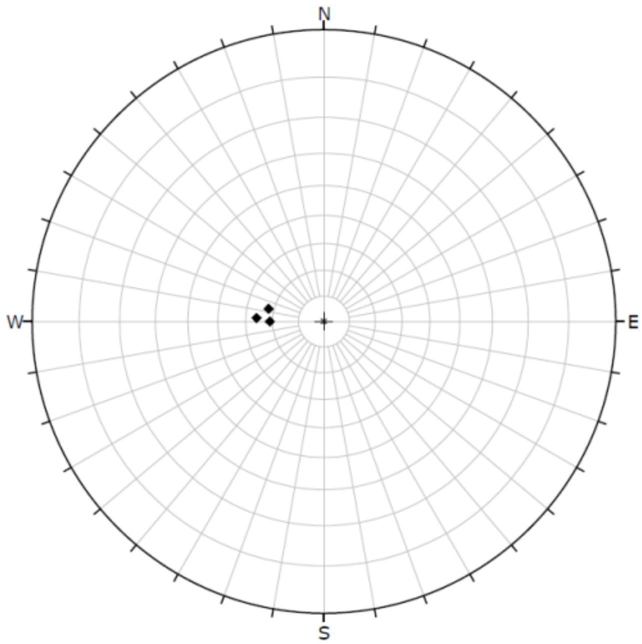


Figure 4.26 Poles to Bedding Planes in "Ydsu" Unit

Pioneer Shale (Yp)

Finely laminated quartz arenite and shale/siltstone, bedded with alternating shaley (darker colored) and sandy (lighter colored) beds, fractures preferentially along bedding planes, other joints and fractures typical, cross cutting bedding planes, rock strength varies from weak rock (shale beds) up to extremely strong rock (quartz arenite beds).

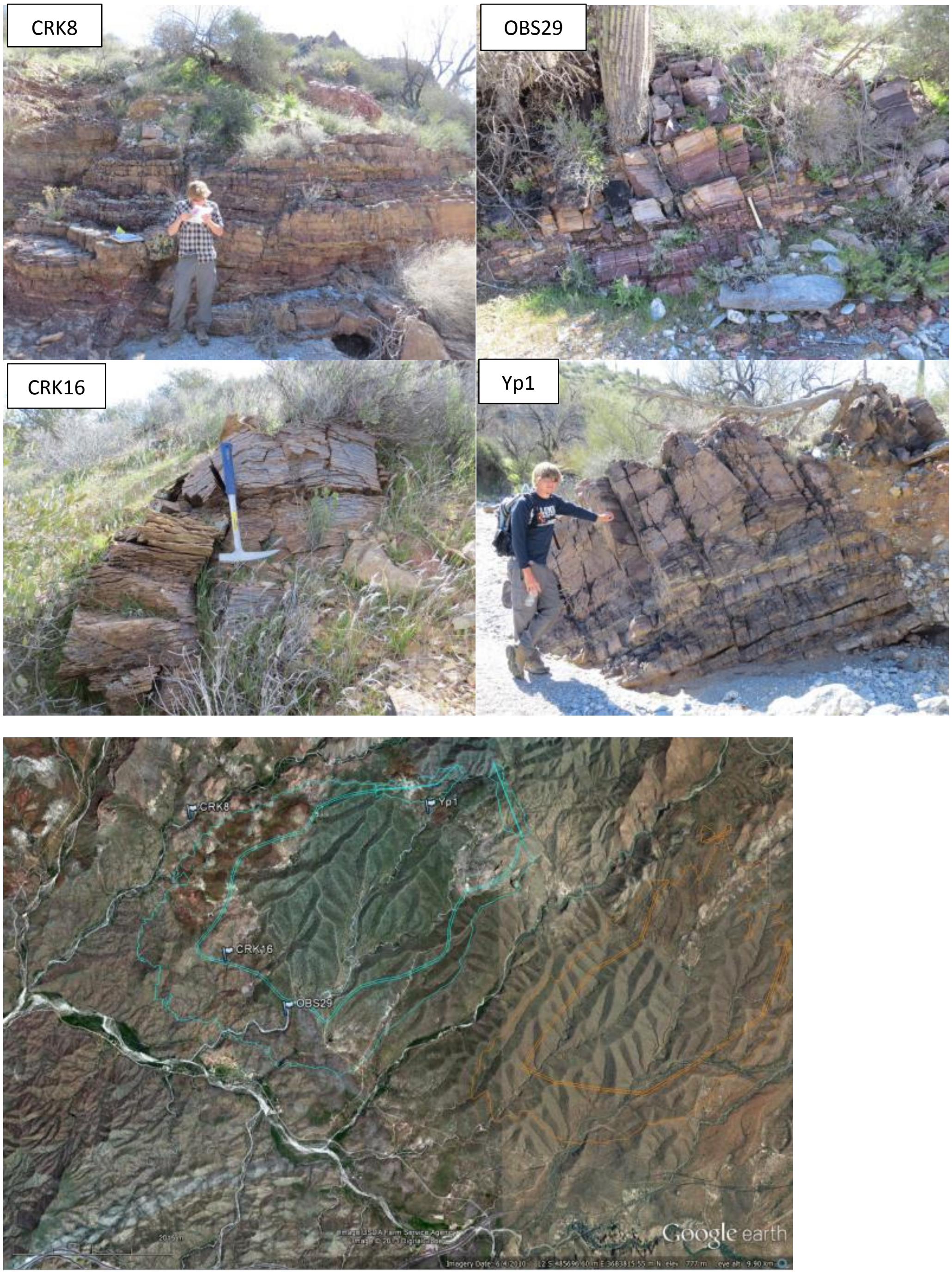


Figure 4.27 Typical "Yp" Outcrops (top tiles) and Photo Locations (bottom)

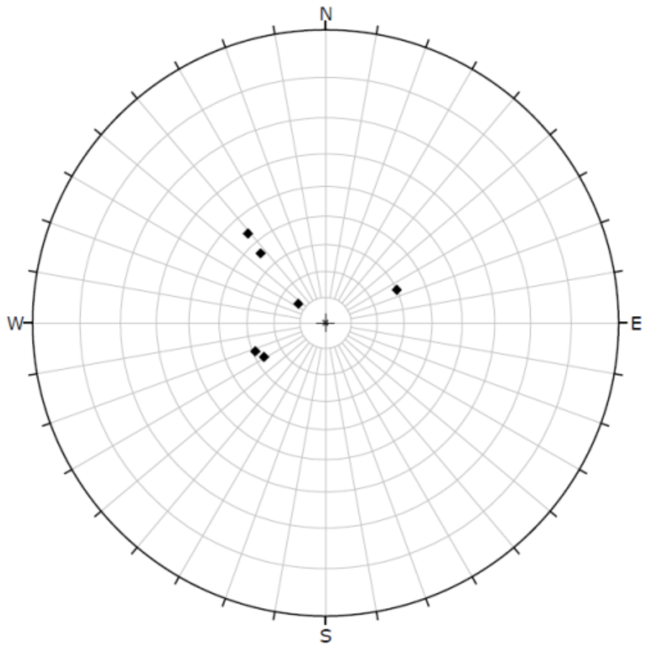


Figure 4.28 Poles to Bedding Planes in "Yp" Unit

Pinal Schist (Calc-Silicate Facies) (Xpc)

One small exposure visited. Strongly foliated with mm spaced foliation cleavage planes, evidence of folding, quartz veining, undulating and smooth cleavage planes, strong rock (R4).

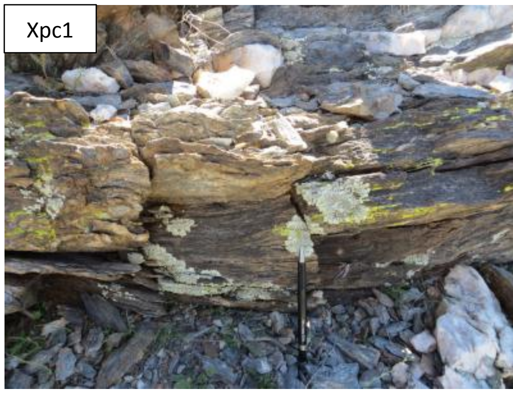


Figure 4.29 “Xpc” Outcrop (top tiles) and Photo Locations (bottom)

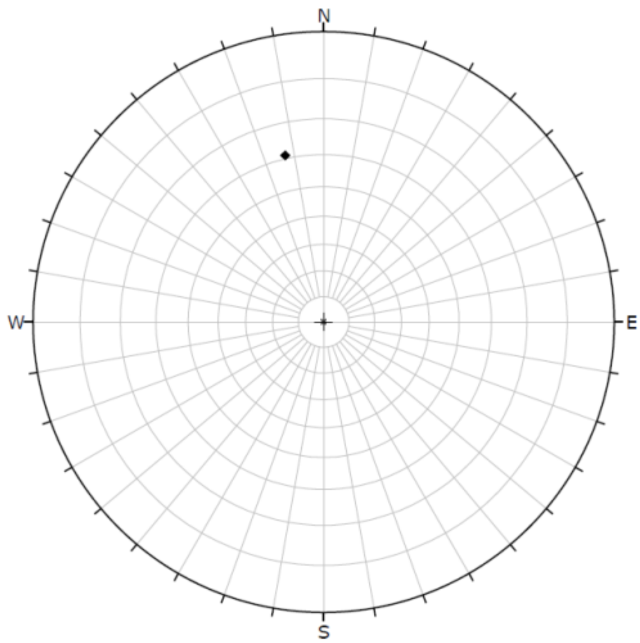


Figure 4.30 Poles to Foliation Cleavage Planes in "Xpc" Unit

Pinal Schist (Psammite Facies) (Xpm)

Strongly foliated with preferential fracturing along foliation cleavage planes, dominant foliation cleavage spaced at cm to mm scale, undulating to planar, smooth foliation cleavage surfaces, some shear/fracture zones observed in outcrops, strong rock (R4).

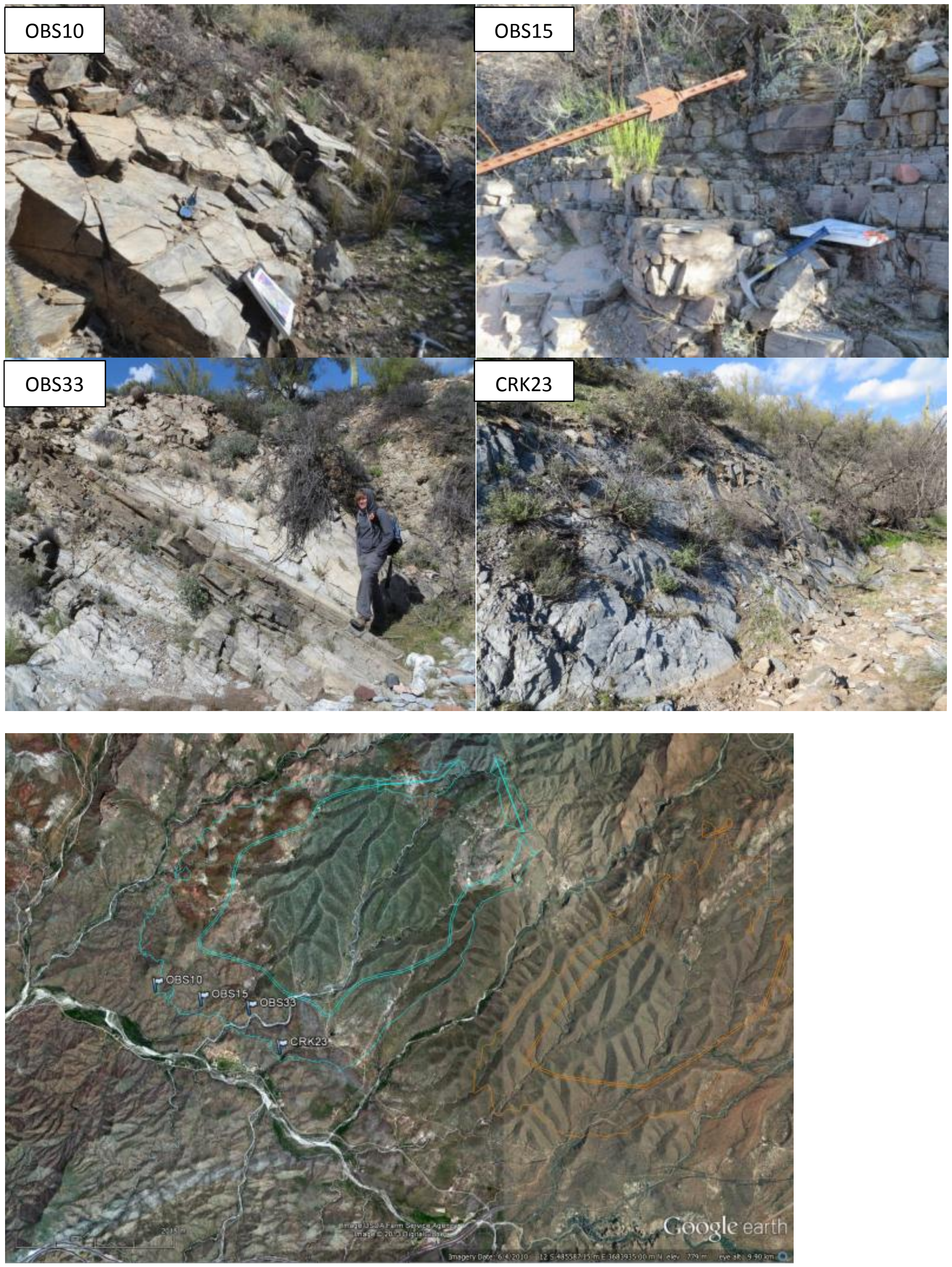


Figure 4.31 Typical "Xpm" Outcrops (top tiles) and Photo Locations (bottom)

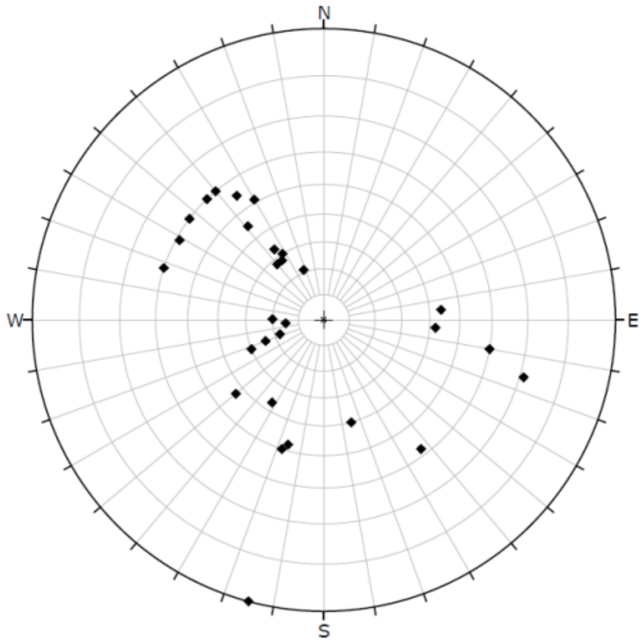


Figure 4.32 Poles to Foliation Cleavage Planes in "Xpm" Unit

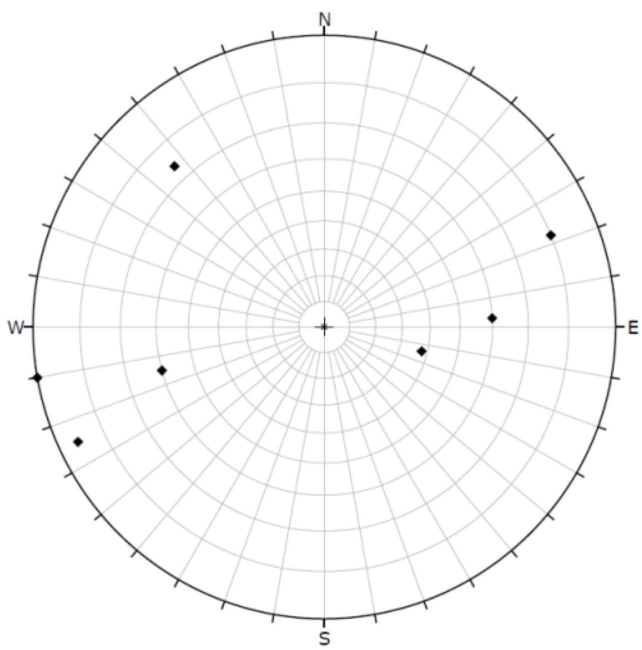


Figure 4.33 Poles to Joints in "Xpm" Unit

Pinal Schist (Phyllite Facies) (Xpp)

One exposure visited. Parallel foliation cleavage surfaces avg. 1 cm *(0.4 inches)* apart, closed, some other randomly oriented fractures cross cutting foliation planes, one open vertical joint observed in exposure, foliation cleavage surfaces planar to undulating with “grainy” surface texture, very strong rock (R5).

Figure 4.34 “Xpp” Outcrop (top tiles) and Photo Locations (bottom)

Pinal Schist (Pelitic Schist) (Xps)

One exposure visited. Blocky with variable joint spacing (30 cm *(12 inches)* to mm scale), wide to closed joints, one vertical shear zone observed in exposure.

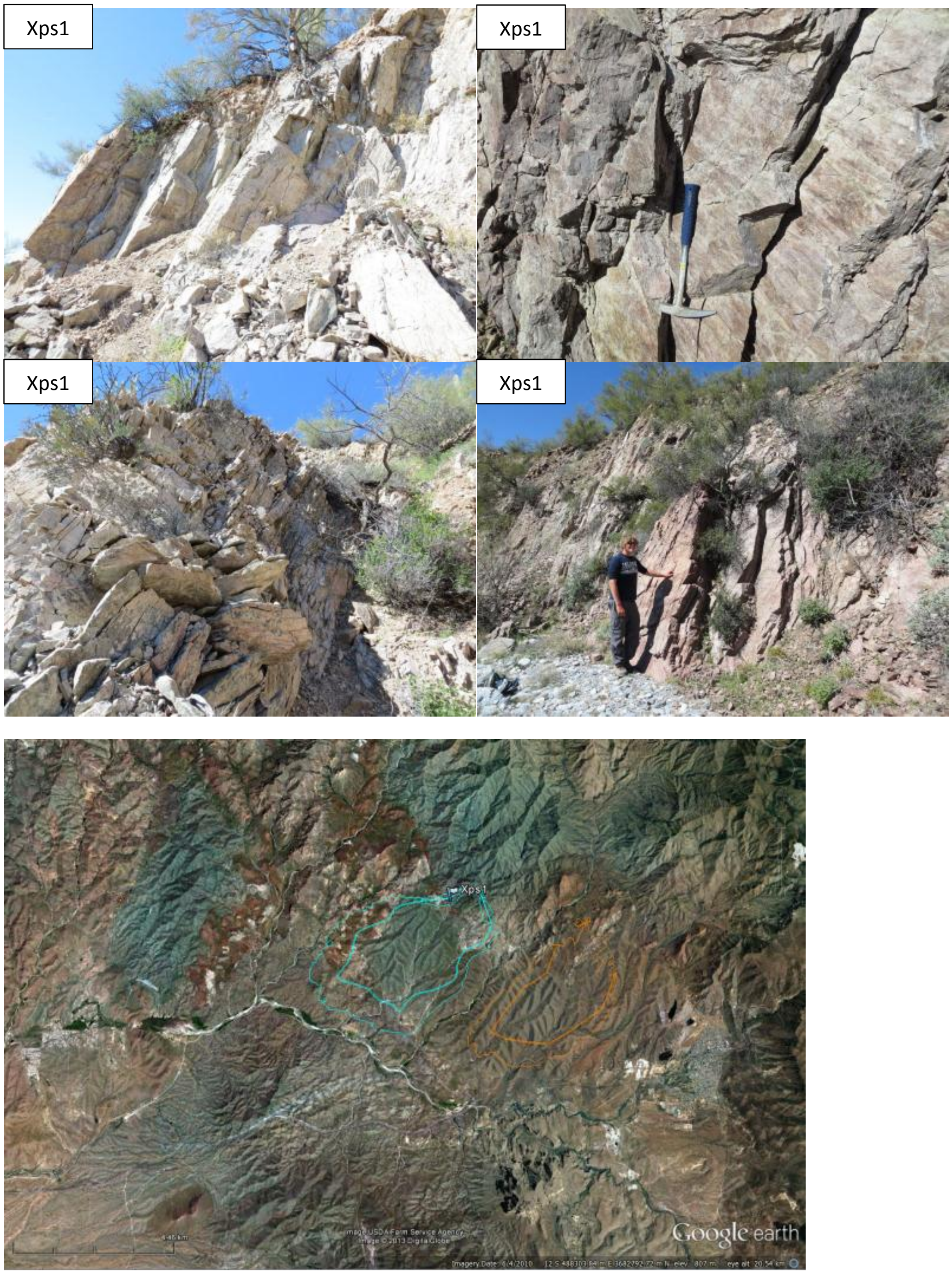


Figure 4.35 "Xps" Ouctrop (top tiles) and Photo Locations (bottom)

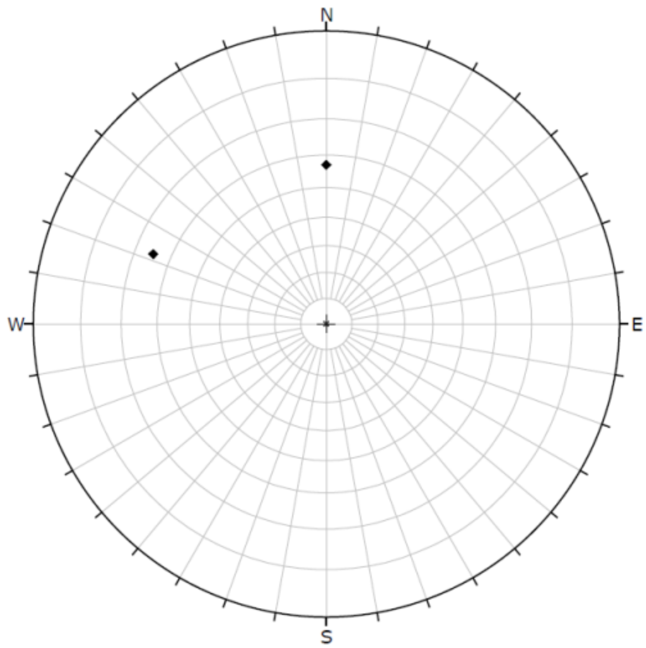


Figure 4.36 Poles to Joints in "Xps" Unit

5 CONCLUSIONS

The primary findings of the site investigation relevant to the design and construction of the tailings facility are as follows:

- Bedrock is exposed at or very close to surface across most areas of the site.
- The width of drainage channels and presence of older alluvium sediments decreases at higher elevations.
- Carbonate content in older alluvium sediments is highly variable whereas carbonate content in active channel sediments is consistently very low to non-existent, as evidenced by acid reaction tests.
- Discontinuities (joints, bedding, cleavage foliations) of any of the rock units are not oriented in such a way as to adversely affect embankment stability.
- General conclusions made on the Gila Conglomerate:
  - The unit ranges from sub-horizontally bedded to massive.
  - No evidence suggests that the conglomerate has undergone significant deformation as joint sets were not observed in outcrop and consistency was found in bedding orientation.
  - Loss of strength is observed through wetting, both in outcrop and hand sample. Visible “bubbling” was commonly observed upon submersion of samples indicating that there is connected void space in the material and strength loss may be due to loss of apparent cohesion.
  - Acid reaction occurs in the matrix of the material and clasts are generally non-reactive, with the exception of rare limestone clasts. Acid neutralization potential is therefore dependent on the amount of matrix present.
  - Increasing maximum particle size, reduced particle sorting and thicker or non-existent beds indicates that depositional energy increased at higher elevations, closer to the sediment source.
  - Ponding water and moist sediments on the conglomerate surface indicate that the unit is capable of holding water.
  - Differential erosion of beds was commonly observed with fine, silty beds weathering most readily and beds formed primarily by well graded sand generally the most competent.
- General conclusions made on the Perlite Area:
  - A general topographic sequence appears to exist in the unit. At lower elevations siliceous rhyolite and rhyolite breccia was observed which transitions into perlite with well developed “glassy” texture and silica inclusions. Harder perlite with less well developed “glassy” texture, typically banded with silica is generally exposed along ridges and topographic highs. Columnar jointing and “tilting” of layers was observed near the top of cliff faces.

    - Perlite fractures preferentially along parallel banding and "layers". Regionally these layers have variable orientation.
    - Ponding water on exposed perlite surfaces in drainage channels indicates that the unit is capable of holding water.
    - Open, sub-vertical joints were observed in outcrops, however these joints were observed to close off quickly with depth. Few vertical discontinuities and no joint sets were observed in large exposures which indicate that large scale deformation has not occurred.
- The most suitable materials for embankment construction are alluvium and Gila Conglomerate. Active channel sediments may be suitable for use in embankment filters and/or drains and as a drainage medium in underdrains; however available volumes are likely small.
- The Apache Leap Tuff (Tal) and Basalt (Tb) units are likely the best sources of riprap due to their relatively high strength and low friability.
- Additional sub-surface investigation is required to determine the nature of the contacts between the Devonian, Cambrian and Proterozoic units in the "mixed" geology areas. Faults and shear zones may increase the bulk permeability of these rock units.

Attachments:

Appendix I – Creek Traverse Logs and Observations
Appendix II – Detailed Gila Mapping
Appendix III – Bedrock Geology Mapping
Appendix IV – Laboratory Testing of Alluvium

REFERENCES

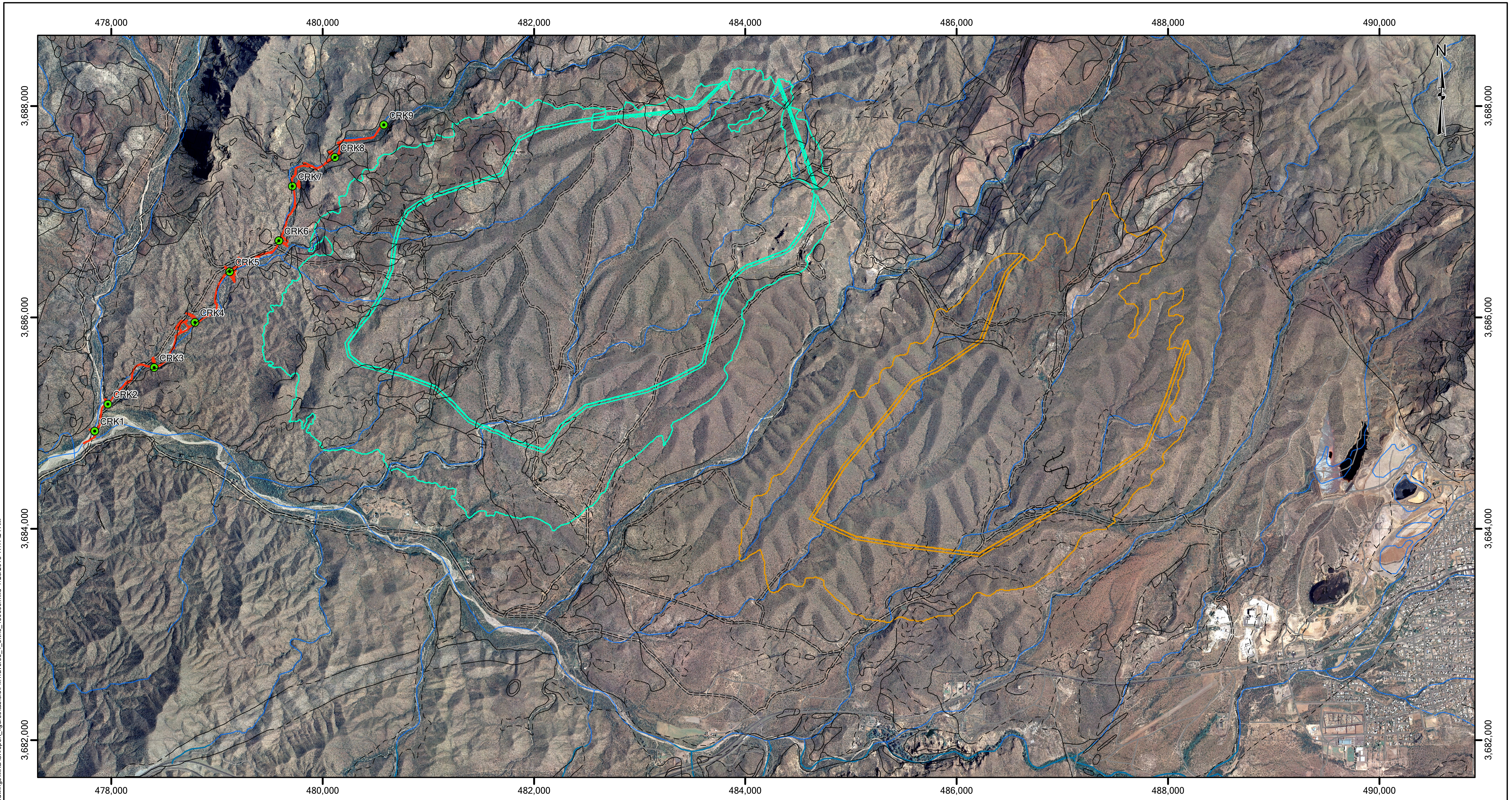
Spencer, J.E., and Richard, S.M. 1995. Geology of the Picketpost Mountain and the southern part of the Iron Mountain 7 1/2' quadrangles, Pinal County, Arizona: Arizona Geological Survey Open File Report 95-15, September 1995, 12 p., 1 sheet, scale 1:24,000.

APPENDIX I

Creek Traverse Logs and Observations

APPENDIX I-A

Traverse #1



LEGEND

- CREEK TRAVERSE MAPPING STATION
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- STREAM
- ROAD (FROM STATE)
- ROAD (FROM RESOLUTION)
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Orthophoto from USDA

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

0 1,000 m

CLIENT

Resolution Copper Mining

Klohn Crippen Berger

PROJECT

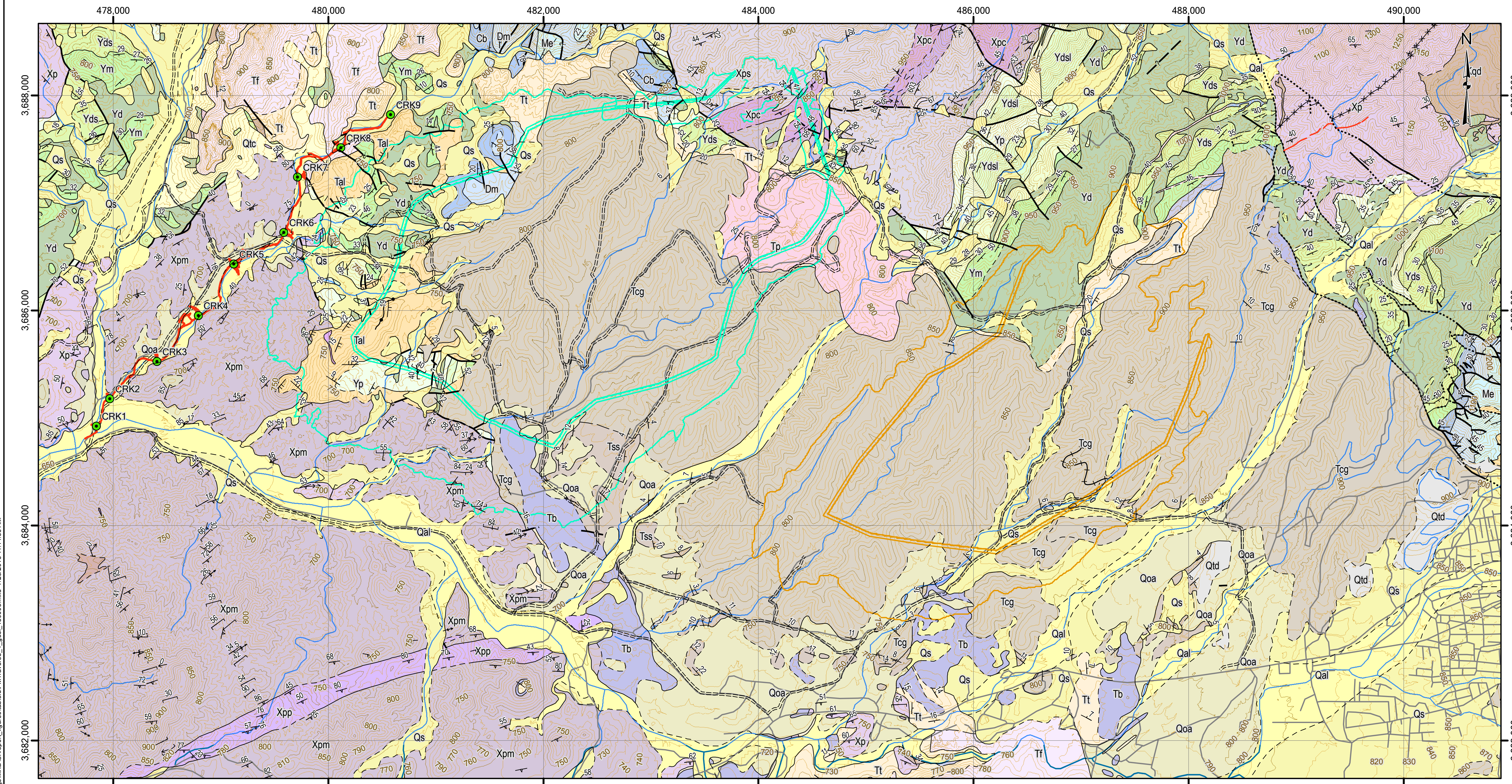
RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE

CREEK TRAVERSE #1

PROJECT No.	FIG No.
M09441A14	I-A.1

CB
Z:\M\VCRM09441A14 - RES-Near West\Geotech Study\400 Drawings\MXD\3\report_figures\tablod\FMTraverse_1_ortho_130603.mxd 7/23/2013 11:17:24 AM



LEGEND

- CREEK TRAVERSE MAPPING STATION
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- STREAM
- ROAD (FROM STATE)
- ROAD (FROM RESOLUTION)
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Refer to main report for descriptions of geologic units.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

0 1,000 m

CLIENT
Resolution Copper Mining
Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE
CREEK TRAVERSE #1
AND GEOLOGY

PROJECT No.	FIG No.
M09441A14	I-A.2

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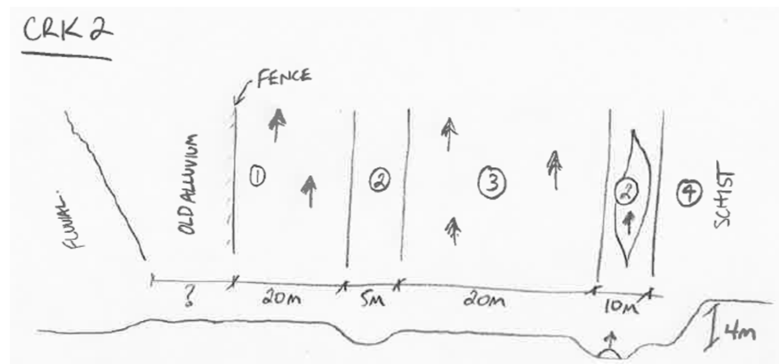
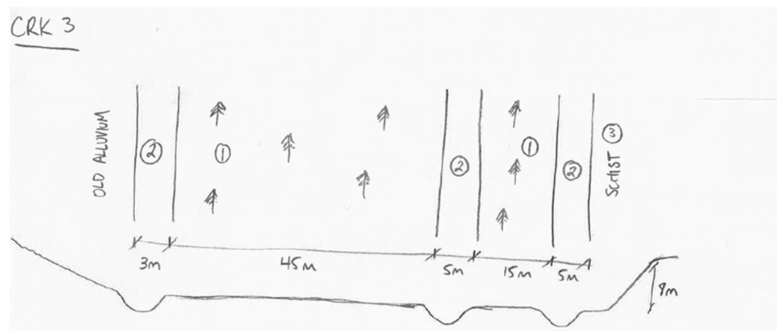
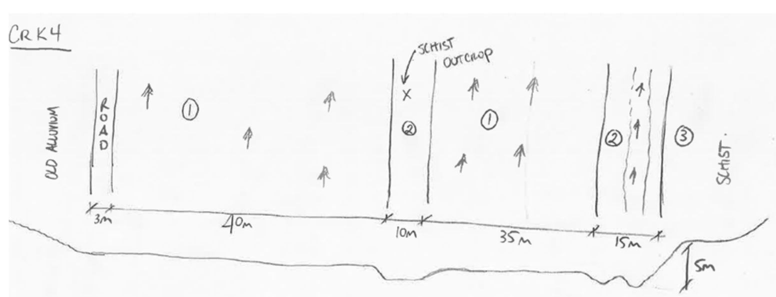
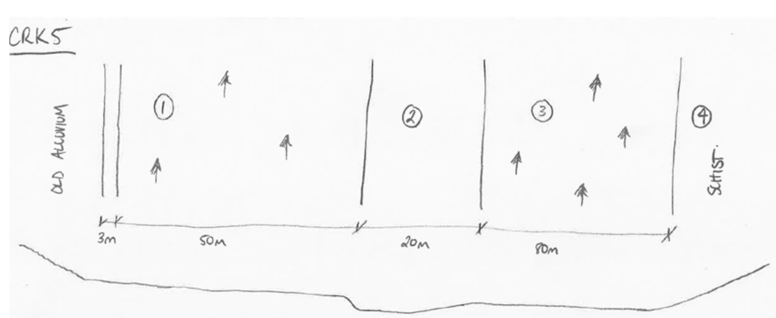
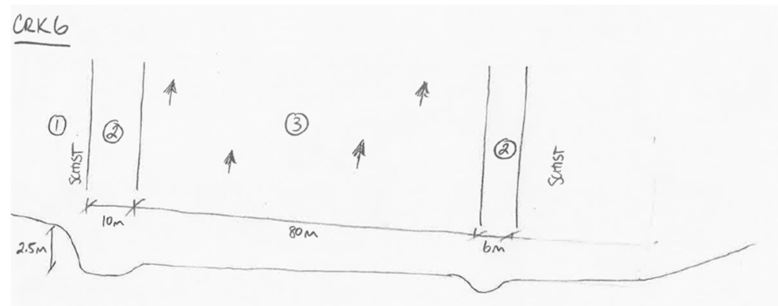
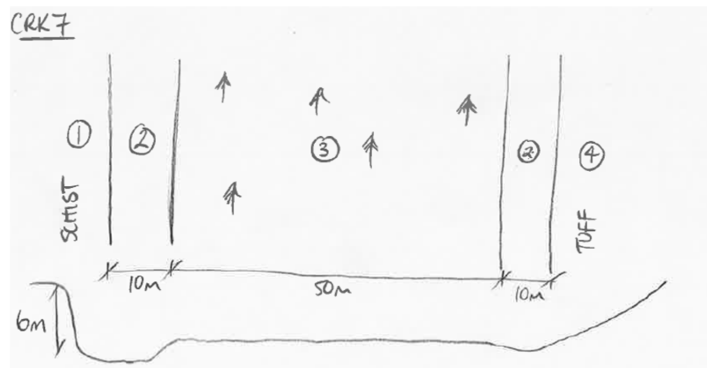
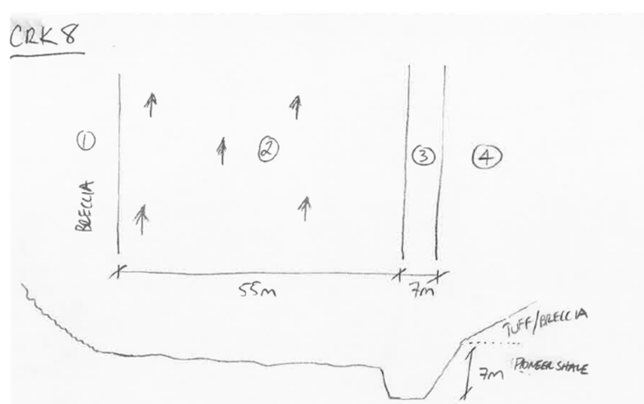
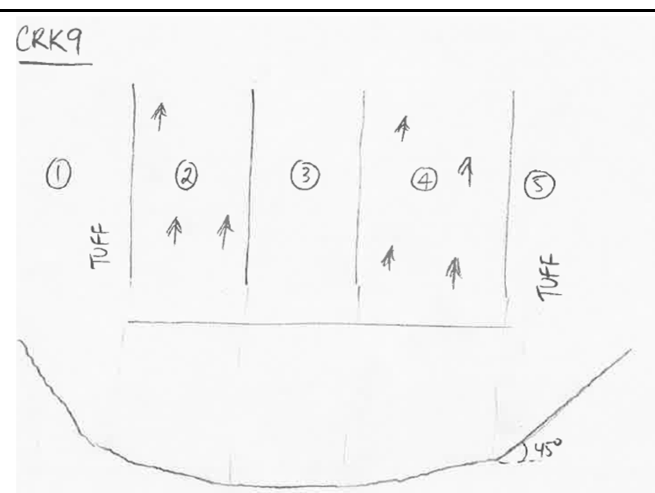
Z:\M\VCR\M09441A14 - RES-Near West\Geotech Study\400 Drawings\MXD\SI\report_figures\tab\io\FMTraverse_1_geol_130603.mxd 7/23/2013 11:14:35 AM

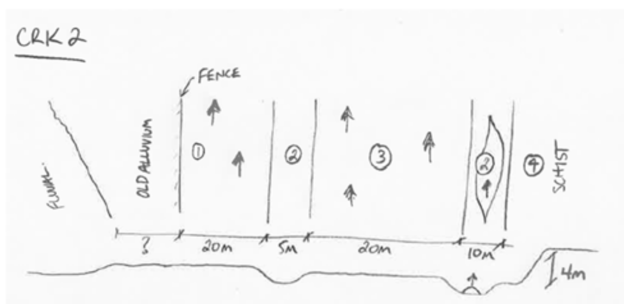
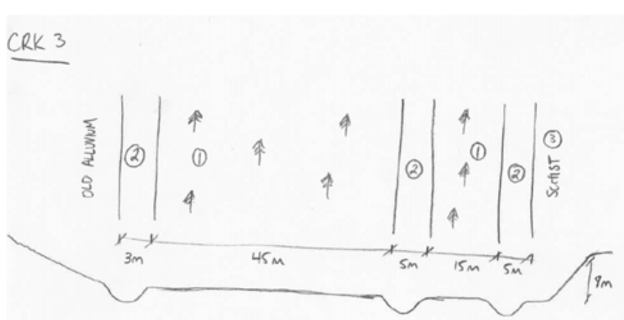
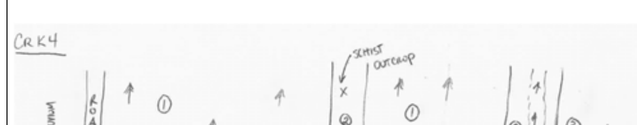
TRAVERSE 1

Date Mapped	Traverse Type	Mapping Point	Northing* (m)	Easting* (m)	Total Channel Width (m)** *(ft)*	Field Sketch	Unit Described	Description (From Left to Right Across Channel Looking Upstream)	Geologic Unit	Maximum Particle Size in Channel (cm) *(inches)*	Rock Strength	Notes
14-Feb-13	Creek	CRK1	3684921	477845			1	SAND and GRAVEL (SW-GW) fine to coarse, well graded,max. particle size = 30 cm, avg. particle size = 2 cm, sub-rounded to angular, moist ~6" below surface, various lithology.	Qal	30 *(11.8)*		Fluvial deposits described at the channel centre in Queen Creek.
14-Feb-13	Creek	CRK2	3685175	477970	>55 *(>180)*		1	Gravelly SAND (SP), fine, poorly graded, max. particle size = 2 cm (in sample), sub-angular to sub-rounded, brown, moist, range of gravel lithologies, some organics	Qoa			
							2	SAND and GRAVEL (SW-GW) fine to coarse, well graded, max. particle size = 20 cm, avg. particle size = 1 cm, sub-rounded to angular, moist just below surface, various lithology	Qal	20 *(7.9)*		
							3	Gravelly SAND (SW), fine to coarse, well graded, sub-angular to sub-rounded, max. particle size = 10 cm (in sample), moist, range of gravel lithologies, some organics	Qoa			
							4	SCHIST, fresh, R4, joints perpendicular to foliations, variable spacing, very wide to very tight (maximum aperture = 5 cm), undulating to planar, no infilling or loose sand infilling wider joints dominant foliation orientation (288/50) dominant joint orientation (177/60)	Xpm		R4	
14-Feb-13	Creek	CRK3	3685522	478407	73 *(240)*		1	SAND (SP), fine, some gravel, some cobbles, poorly graded, brown, moist, range of gravel lithology, some organics, becomes coarser (sand, gravel and cobbles) at 30 cm depth	Qoa			
							2	SAND and GRAVEL (SW-GW) fine to coarse, some cobbles, well graded, max. particle size = 30 cm, avg. particle size = 1 cm, sub-rounded to sub-angular, moist below surface, various lithology	Qal	30 *(11.8)*		
							3	SCHIST, fresh, R4, variable spacing, very wide to very tight (maximum aperture = 5 cm), undulating to planar, sand and loose material infilling wider joints dominant joint orientation 345/60	Xpm		R4	
14-Feb-13	Creek	CRK4	3685949	478792	60 *(197)*		1	SAND (SP), fine, some silt to silty, some to trace gravel, trace cobbles, poorly graded, max. particle size = 5 cm, angular to sub-angular, brown, moist	Qoa			
							2	SAND, GRAVEL and COBBLES (SW-GW), well graded, max. particle size = 60 cm, avg. particle size = 1 cm, sub-rounded to sub-angular, moist below surface, various lithology	Qal	60 *(23.6)*		
							3	SCHIST, fresh, R4, variable spacing, joints tight to very tight, undulating to planar, no infilling or loose sand infilling, thin soil horizon overtop of unit (<30 cm) foliation orientations (029/59) and (196/71)	Xpm		R4	
14-Feb-13	Creek	CRK5	3686431	479121	150 *(492)*		1	SAND (SP), fine, some silt to silty, trace gravel, poorly graded, max. particle size = 2 cm in sample, brown, moist, some organics, hole excavated to ~ 40 cm depth	Qoa			
							2	SAND, GRAVEL and COBBLES (SW-GW), well graded, max. particle size = 60 cm, avg. particle size = 1 cm, sub-rounded to sub-angular, moist below surface, various lithology	Qal	60 *(23.6)*		
							3	Gravelly SAND (SP-SW), fine to coarse, some silt, gap graded, sub-angular to angular coarse particles, max. particle size = 4 cm, coarse particles all schist	Xpm (?)			
							4	SCHIST, no outcrops visible to log structure	Xpm		R4	

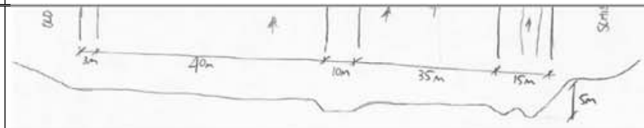
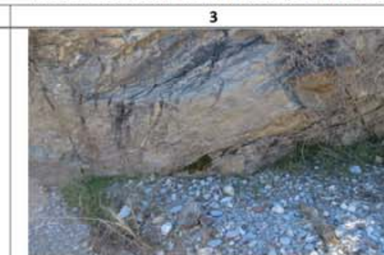
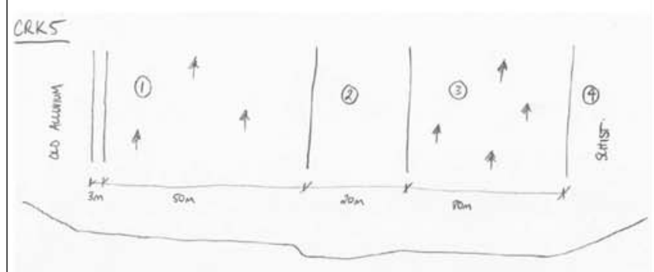
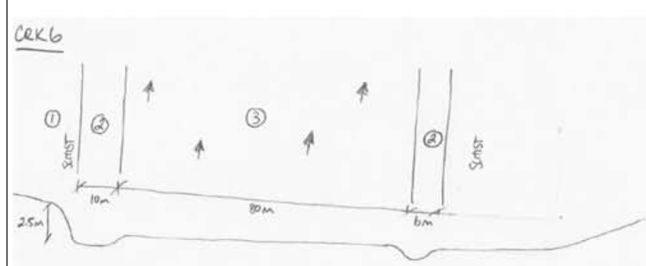
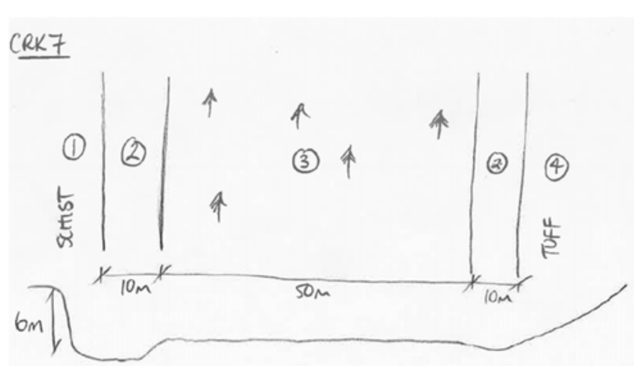
Date Mapped	Traverse Type	Mapping Point	Northing* (m)	Easting* (m)	Total Channel Width (m)** *(ft)*	Field Sketch	Unit Described	Description (From Left to Right Across Channel Looking Upstream)	Geologic Unit	Maximum Particle Size in Channel (cm) *(inches)*	Rock Strength	Notes
14-Feb-13	Creek	CRK6	3686721	479586	96 *(315)*		1	SCHIST, fresh, R4, typical joint spacing = 30 cm, joints very wide to very tight (max. aperture = 4cm), unduating to planar, loose sand or no infilling foliation orientations (001/20) and (055/33) dominant joint orientation (158/80)	Xpm		R4	
							2	SAND, GRAVEL and COBBLES (SW-GW), well graded, max. particle size = 45 cm, avg. particle size = 1 cm, sub-rounded to sub-angular, moist below surface, range of lithologies	Qal	45 *(17.7)*		
							3	SAND (SP), fine, some silt to silty, trace gravel, brown, moist, some organics. Hole excavated to 30 cm depth	Qoa			
14-Feb-13	Creek	CRK7	3687239	479715	70 *(230)*		1	SCHIST, fresh, R4, foliation cleavage throughout, typical joint spacing = 15 cm, very tight to closed, no infilling foliation orientations (338/30) and (190/60)	Xpm		R4	
							2	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, well graded, rounded to angular, max. particle size = 5 cm (sample); 45 cm (channel), various lithology	Qal	45 *(17.7)*		
							3	Silty SAND (SM), fine, gravelly, poorly graded, sub-rounded gravel particles, brown, moist, coarse particles schist, tuff and quartz	Qoa			
							4	TUFF, fresh, R5, massive	Tal		R5	
16-Feb-13	Creek	CRK8	3687511	480118	62 *(203)*		1	BRECCIA, slightly weathered (oxidized) to fresh, R5, no apparent jointing, felsic volcanic fragments in fine grained matrix	Tvx (?)		R5	
							2	Gravelly SAND (SW) fine to medium, some silt, some cobbles, well graded, max. particle size = 20 cm, sub-rounded to sub-angular, brown, moist, most coarse particles schist, some organics	Qoa			
							3	SAND and GRAVEL (SW-GW) fine to coarse, some cobbles, well graded, max. particle size = 3 cm (sample); 60 cm (channel), avg. particle size = 1 cm, sub-angular to rounded, dry, dominated by schist particles	Qal	60 *(23.6)*		
							4	SHALE, interbedded with hard siliceous material (quartzite or quartz arenite?), fresh to slightly weathered, R2 (red, shaley beds) to R4/R5 (grey, siliceous beds), heavily fractured with fractures occuring perpendicular to bedding planes, beds are dominantly sub-horizontal with some gentle folding orientation of dipping bed (155/30)	Yp		R2 to R4/R5	Vertical Yp exposure is overlain by Apache Leap Tuff and brecciated tuff
16-Feb-13	Creek	CRK9	3687820	480581	60 *(197)*		1	TUFF, fresh, R5, spacing ~15 cm between some major joints, randomly oriented, very wide to closed (max. aperture = 3 cm), undulating to rough, no infilling	Tt		R5	
							2	TALUS, tuff boulders with sand and organic infilling	Tt			
							3	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, well graded, rounded to sub-angular, max. particle size = 7 cm (sample); 60 cm (channel), avg. particle size = 1-2 cm, moist just below surface, sparse vegetation in channel center, coarse particles dominantly schist and quartz	Qal	60 *(23.6)*		
							4	Silty SAND (SM) with some organics overlying fluvial channel deposits (as above)	Qoa			
							5	TUFF, fresh, R5, talus and shallow outcrops on surface of slope, no mappable outcrops	Tal		R5	

* Coordinates measured with handheld GPS unit. Coordinate System: UTM NAD27 CONUS
** Total Channel Width includes the width of active channels as well as Old Alluvium deposits

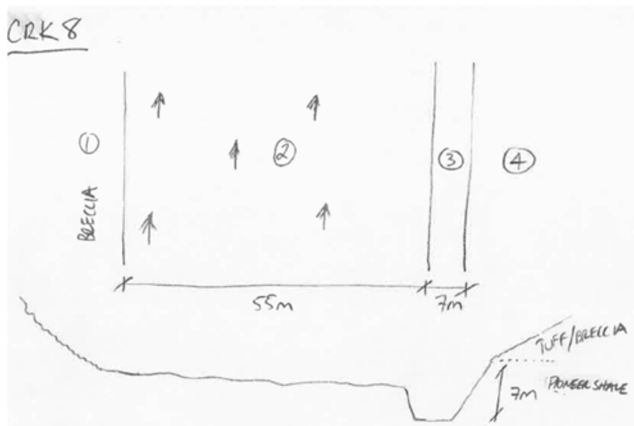
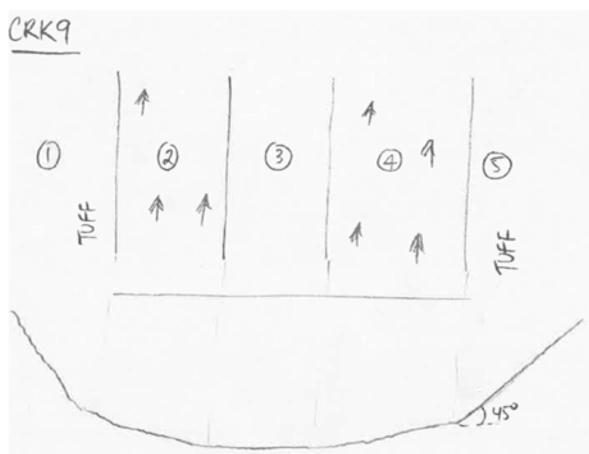
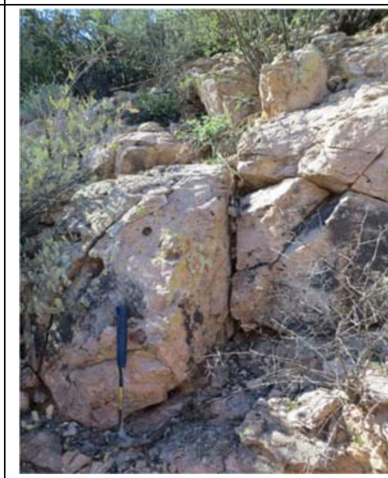
TRAVERSE 1

Date Mapped	Traverse Type	Mapping Point	Field Sketch	Traverse Observation Point Photos (See Field Sketch)				
				1	2	3	4	5
14-Feb-13	Creek	CRK1		 				
14-Feb-13	Creek	CRK2			 			
14-Feb-13	Creek	CRK3		 	 			
14-Feb-13	Creek	CRK4						

TRAVERSE 1

Date Mapped	Traverse Type	Mapping Point	Field Sketch	Traverse Observation Point Photos (See Field Sketch) 1	2	3	4	5
14-Feb-13	Creek	CRK4						
14-Feb-13	Creek	CRK5		 	 	 		
14-Feb-13	Creek	CRK6			 	 	 	
14-Feb-13	Creek	CRK7			 	 		

TRAVERSE 1

Date Mapped	Traverse Type	Mapping Point	Field Sketch	Traverse Observation Point Photos (See Field Sketch)				
				1	2	3	4	5
16-Feb-13	Creek	CRK8			 	 		
16-Feb-13	Creek	CRK9				 	 	 

Creek Traverse #1 Observations

Observation Station	Coordinates[1]	
	Easting (m)	Northing (m)
OBS1	478030	3685258
OBS2	478170	3685388
CRK3	478407	3685522
OBS3	478589	3685708
OBS4	478983	3686137
OBS5	479367	3686563
OBS6	479946	3687399
OBS7	480037	3687462
OBS8	480148	3687542

1 – Coordinates measured with handheld GPS unit. Coordinate system: UTM NAD27 CONUS

cbeasy
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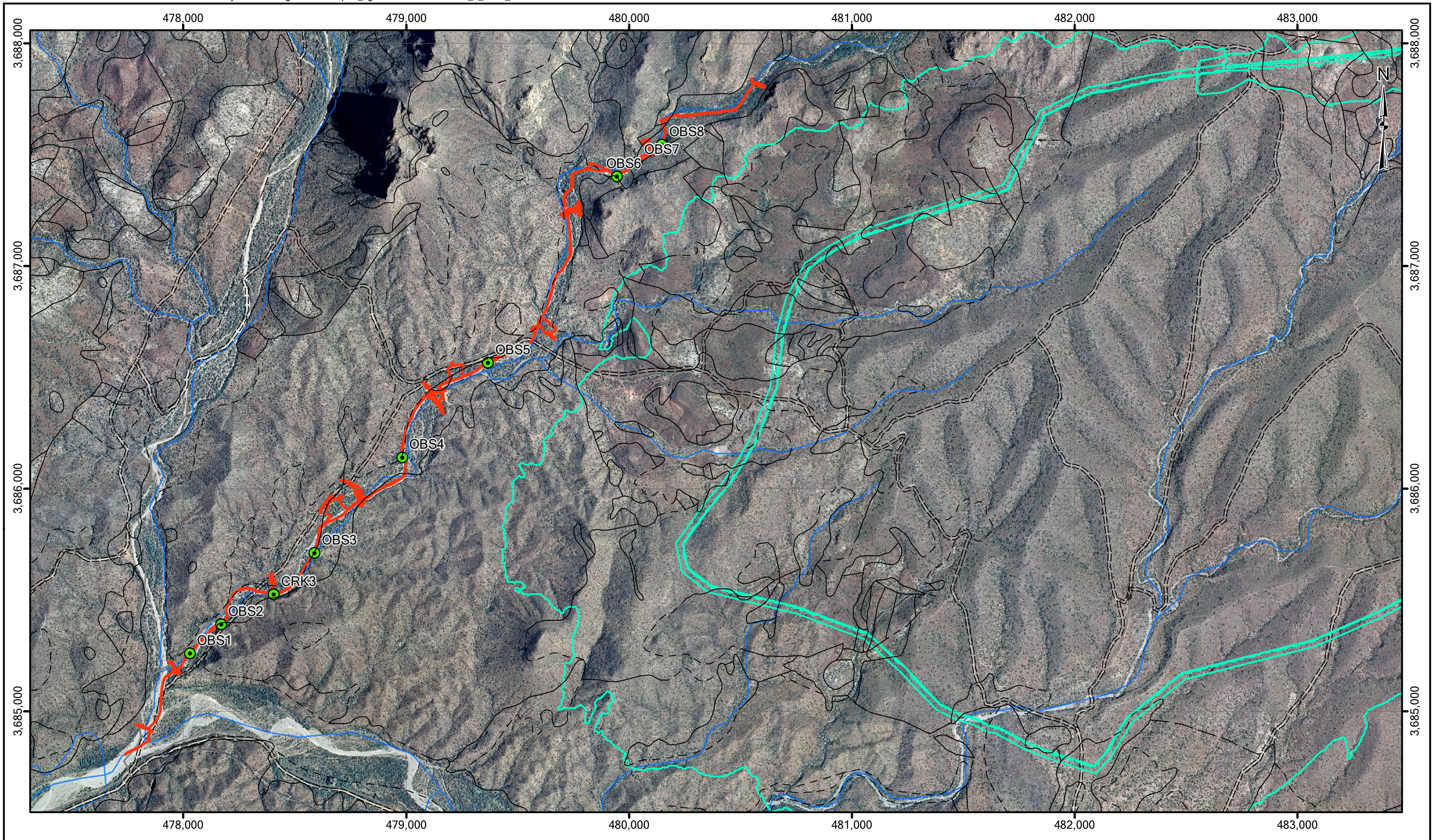

LEGEND

- CREEK TRAVERSE OBSERVATION POINT
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Orthophoto from USDA

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0 500 m

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CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT 2013 NEAR WEST SITE INVESTIGATION

TITLE: CREEK TRAVERSE #1 OBSERVATIONS

PROJECT No. M09441A14

FIG No. I-A.3

cbeasy
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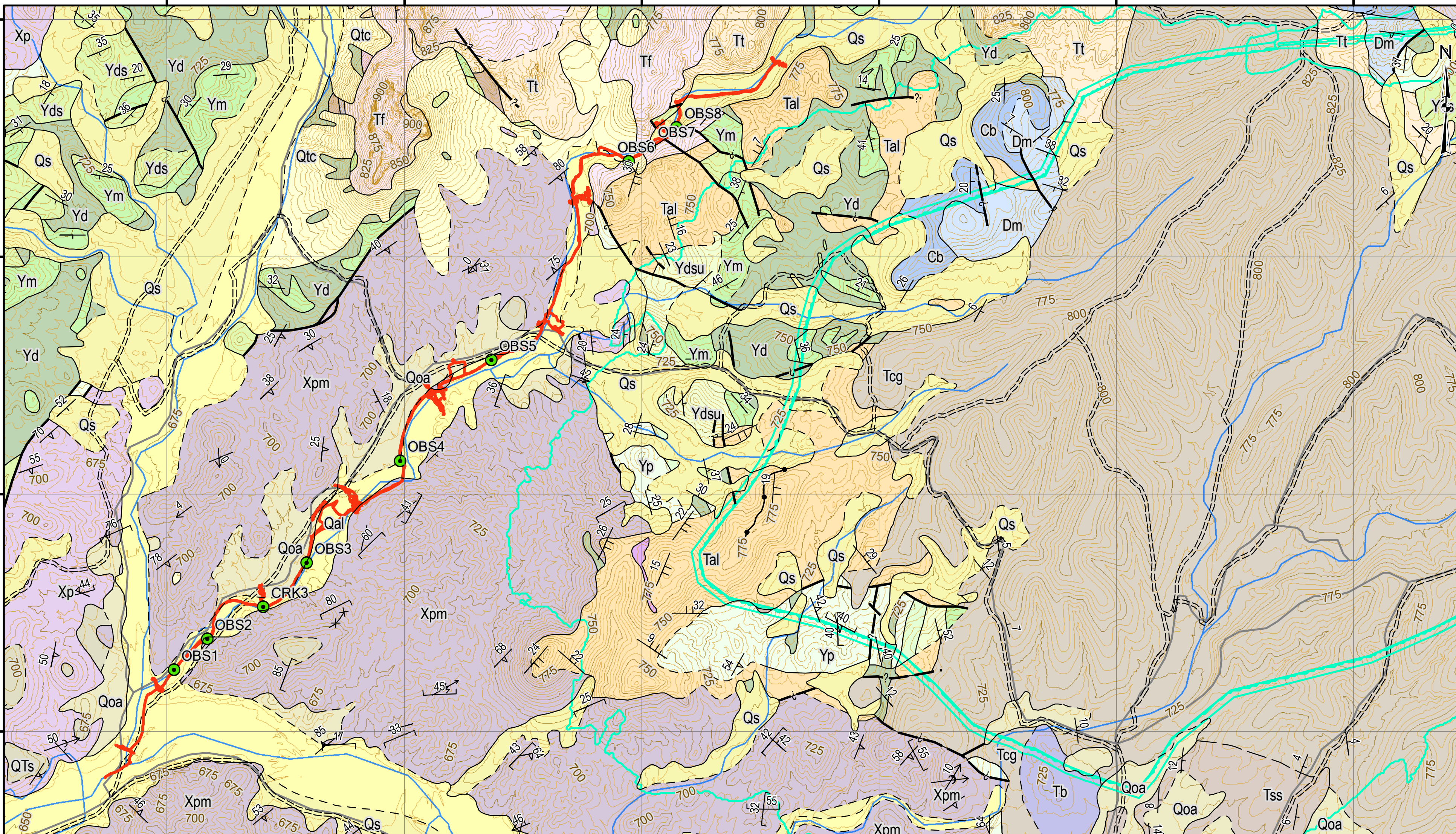

LEGEND

- CREEK TRAVERSE OBSERVATION POINT
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)

Notes:
1. NAD27 UTM12
2. Refer to main report for descriptions of geologic units.

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0 500 m

CLIENT
Resolution Copper Mining

Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE
CREEK TRAVERSE #1
OBSERVATIONS AND GEOLOGY

PROJECT No. M09441A14

FIG No. I-A.4

OBS1

Exposure of Old Alluvium next to schist outcrop on the outside of small channel bend.

OBS2

"Blocky" schist displaying distinct foliation cleavage (discontinuities along cleavage planes)

Orientation of dominant cleavage foliation: **340/24**

Orientation of dominant cleavage foliation: **184/42**

CRK3

Zone of weathered schist contained on either side by blocky, intact schist outcrops

OBS3

~30 cm to 15 cm *(11.8 inches to 5.9 inches)* of soil horizon observed overtop of fresh schist.

Orientation of dominant foliation in schist outcrop: **233/58**

OBS4

Vertical exposure of unlithified Old Alluvium, ~3 m (9.84 ft) high.

OBS5

Steeply dipping schist exposed on west bank of channel and in channel invert. **037/60**

OBS6

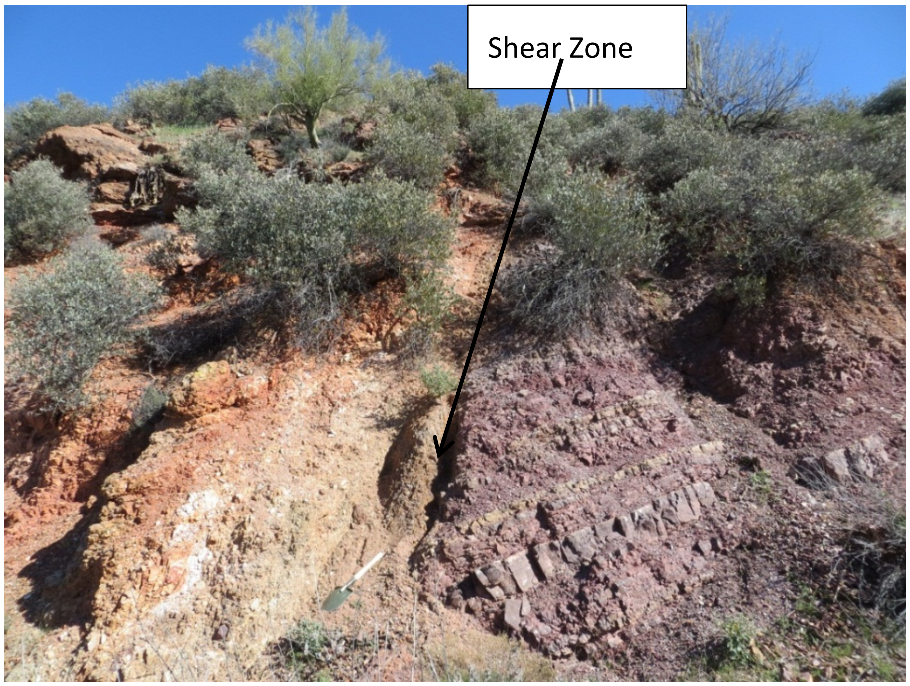
Large tuff outcrop in south bank. Fresh, R5, intact/massive with few fractures, no joint sets apparent in outcrop, fractures very tight to closed.

OBS7

Tuff (Tal) exposed in creek bottom.

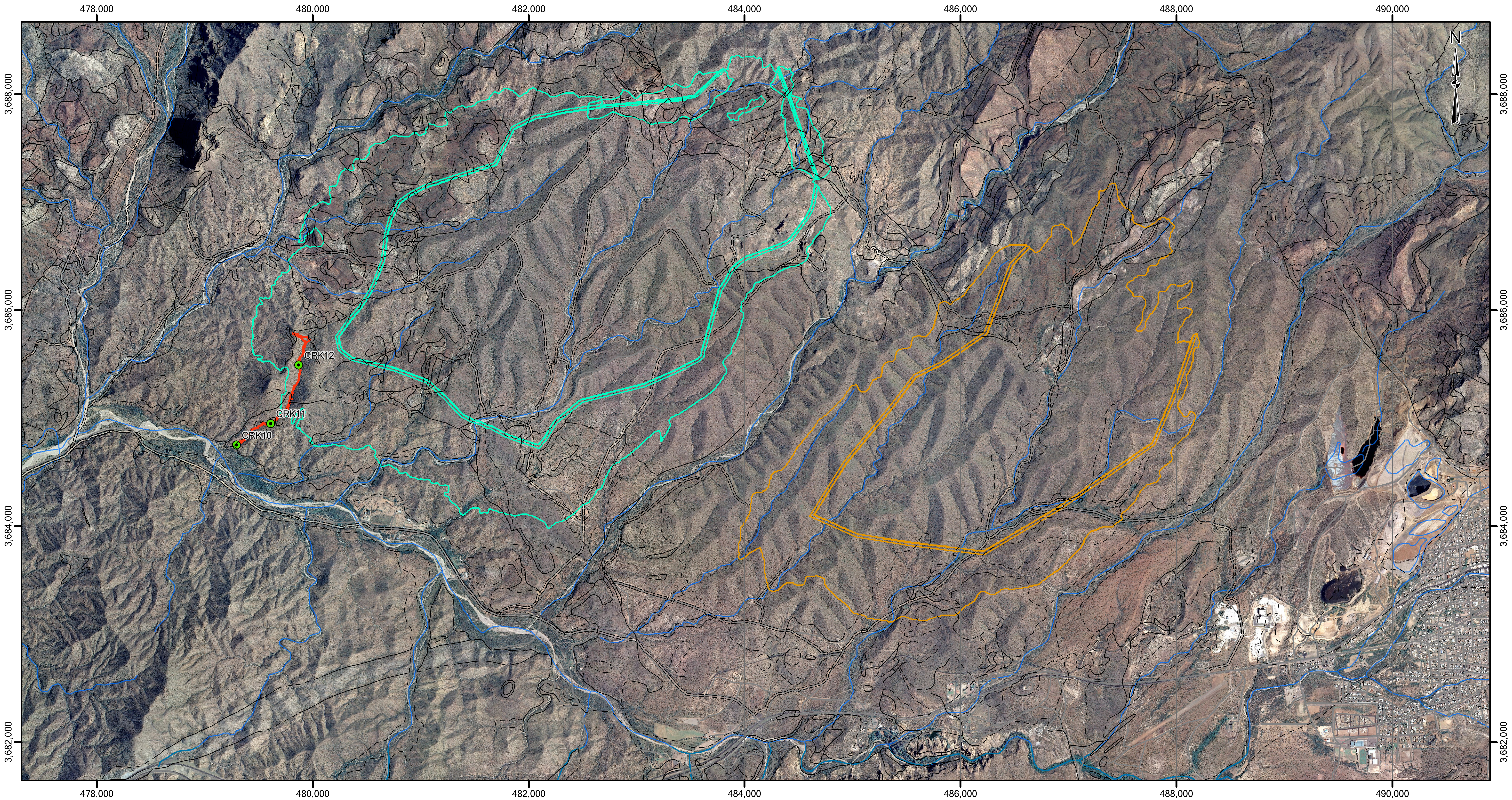
OBS8

Near vertical shear zone infilled with gouge. Pioneer shale folds gently into shear zone. Rock type on both sides of the shear zone appear to be similar but are much different in colour (weathering minerals different?)



APPENDIX I-B

Traverse #2



LEGEND

CREEK TRAVERSE MAPPING STATION	STREAM	CONTACT (BETWEEN GEOLOGIC UNITS)
TRAVERSE	ROAD (FROM STATE)	CONTACT - APPROXIMATE
NEAR WEST TAILINGS SITE	ROAD (FROM RESOLUTION)	CONTACT - INFERRED
HAPPY CAMP OPTION		CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Orthophoto from USDA

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0 1,000 m

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CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE: CREEK TRAVERSE #2

PROJECT No. M09441A14

FIG No. I-B.1

CB
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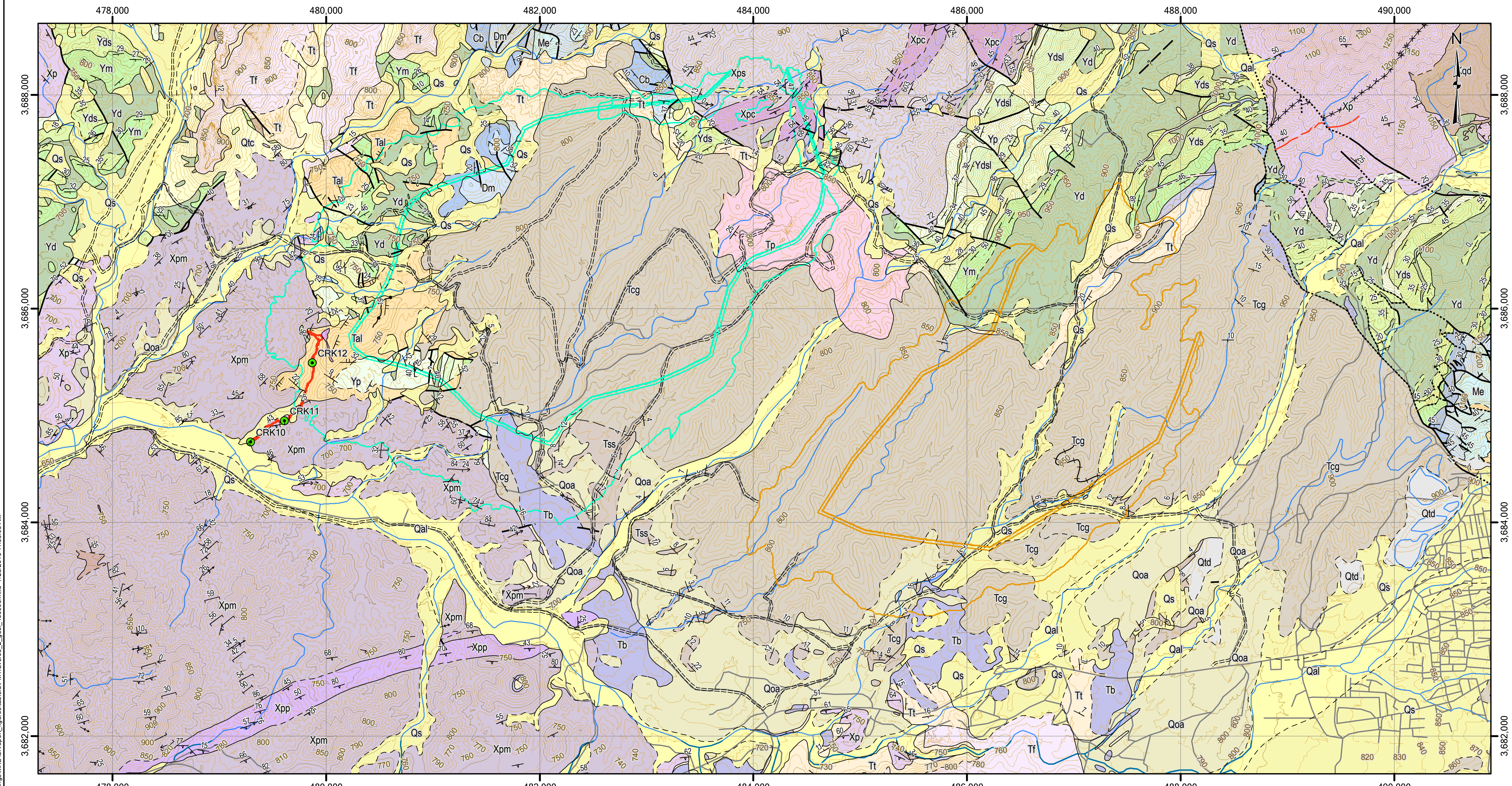

LEGEND

- CREEK TRAVERSE MAPPING STATION
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- STREAM
- ROAD (FROM STATE)
- ROAD (FROM RESOLUTION)
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)
- CONTACT
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Refer to main report for descriptions of geologic units.

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TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

0 1,000 m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT 2013 NEAR WEST SITE INVESTIGATION

TITLE: CREEK TRAVERSE #2 AND GEOLOGY

PROJECT No.	FIG No.
M09441A14	I-B.2

CB
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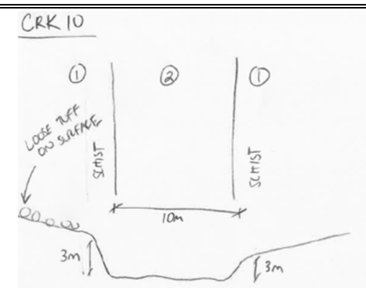
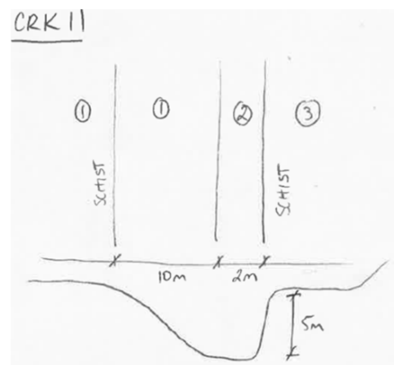
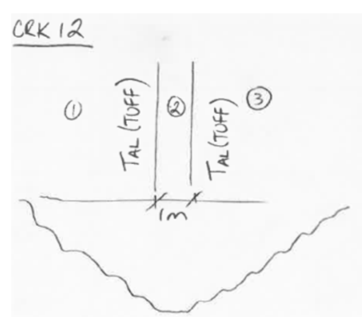
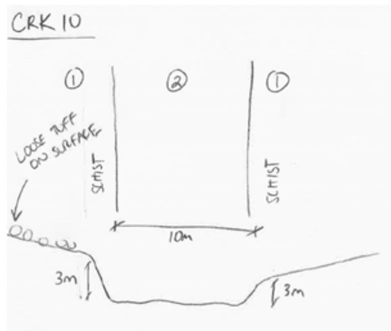
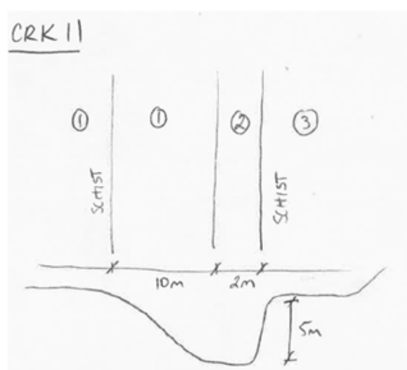
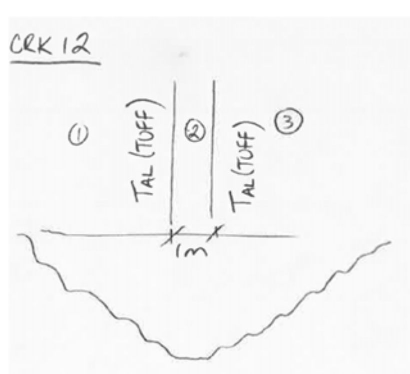
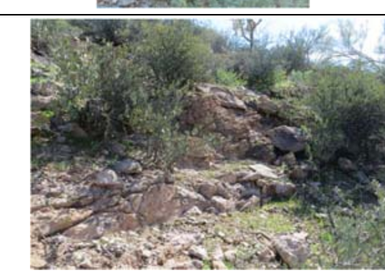
TRAVERSE 2

Date Mapped	Traverse Type	Mapping Point	Northing* (m)	Easting* (m)	Total Channel Width (m)** *(ft)*	Field Sketch	Unit Described	Description (From Left to Right Across Channel Looking Upstream)	Maximum Particle Size in Channel (cm) *(inches)*	Rock Strength	Geologic Unit	Notes
16-Feb-13	Creek	CRK10	3684748	479294	10 *(33)*		1	SCHIST, fresh, R4, steeply dipping foliation cleavage dominate, cleavage planes can be <1 cm apart, ~40 cm apart for other sub-horizontal discontinuities, joints closed to very tight, one vertical shear zone or zone of intense weathering ~1.2 m wide		R4	Xpm	
							2	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, trace silt, well graded, max. particle size = 8 cm (sample); 30 cm (channel), avg. particle size = 0.5 cm, angular to sub-rounded, moist just below surface, particle lithology dominated by schist and tuff, vegetation in channel - concentrated in the channel centre	30 *(11.8)*		Qs	
18-Feb-13	Creek	CRK11	3684946	479612	2 *(7)*		1	Shallow Schist outcrops and schist, tuff and quartz gravel and cobbles at surface			Xpm	
							2	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, trace silt, well graded, max. particle size = 10 cm (sample); 45 cm (channel), avg. particle size = 0.5 cm, angular to sub-rounded, moist just below surface, particle lithology dominated by schist, quartz and tuff	45 *(17.7)*		Qs	
							3	SCHIST, fresh, R3 (R6 above foliation cleavage in more massive rock), sub-horizontal planar foliation cleavage , spacing =~ 1/2 cm, cleavage planes closed to partly open, overlain by more massive rock that does not display the same degree of foliation of cleavage, joints in the more massive rock infilled with quartz foliation cleavage orientation (068/21) large exposed face (see photo) (286/48) large near-vertical joint (see photo) (335/86)		R3 to R6	Xpm	
18-Feb-13	Creek	CRK12	3685490	479872	1 *(3)*		1	TUFF, fresh, R5/R6, joints spaced 20 - 30 cm apart, some closed joints, max. joint aperture = 3 cm, planar and rough joint surfaces, loose sand/vegetation or no infilling wide joint (335/90)		R5/R6	Tal	
							2	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, trace silt, well graded, max. particle size = 7 cm (sample); 60 cm (channel), sub-rounded to sub-angular, dry, coarse particles in the fluvial channel deposit dominated by basalt, larger particles in and around the fluvial sediments are tuff	60 *(23.6)*		Qs	
							3	TUFF, fresh, R6, joint spacing = 50 cm, partly open to closed, no infilling		R6	Tal	

* Coordinates measured with handheld GPS unit. Coordinate System: UTM NAD27 CONUS
**Total Channel Width includes the width of active channels as well as Old Alluvium deposits

TRAVERSE 2

Date Mapped	Traverse Type	Mapping Point	Field Sketch	Traverse Observation Point Photos (See Field Sketch)		
				1	2	3
16-Feb-13	Creek	CRK10			 	
18-Feb-13	Creek	CRK11			 	 
18-Feb-13	Creek	CRK12		 	 	 

Creek Traverse #2 Observations

Observation Station	Coordinates[1]	
	Easting (m)	Northing (m)
OBS9	479536	3684955
OBS10	479704	3685023
OBS11	479785	3685137
CONTACT	479796	3685173
OBS12	479973	3685720

1 – Coordinates measured with handheld GPS unit. Coordinate system: UTM NAD27 CONUS

cbeasy
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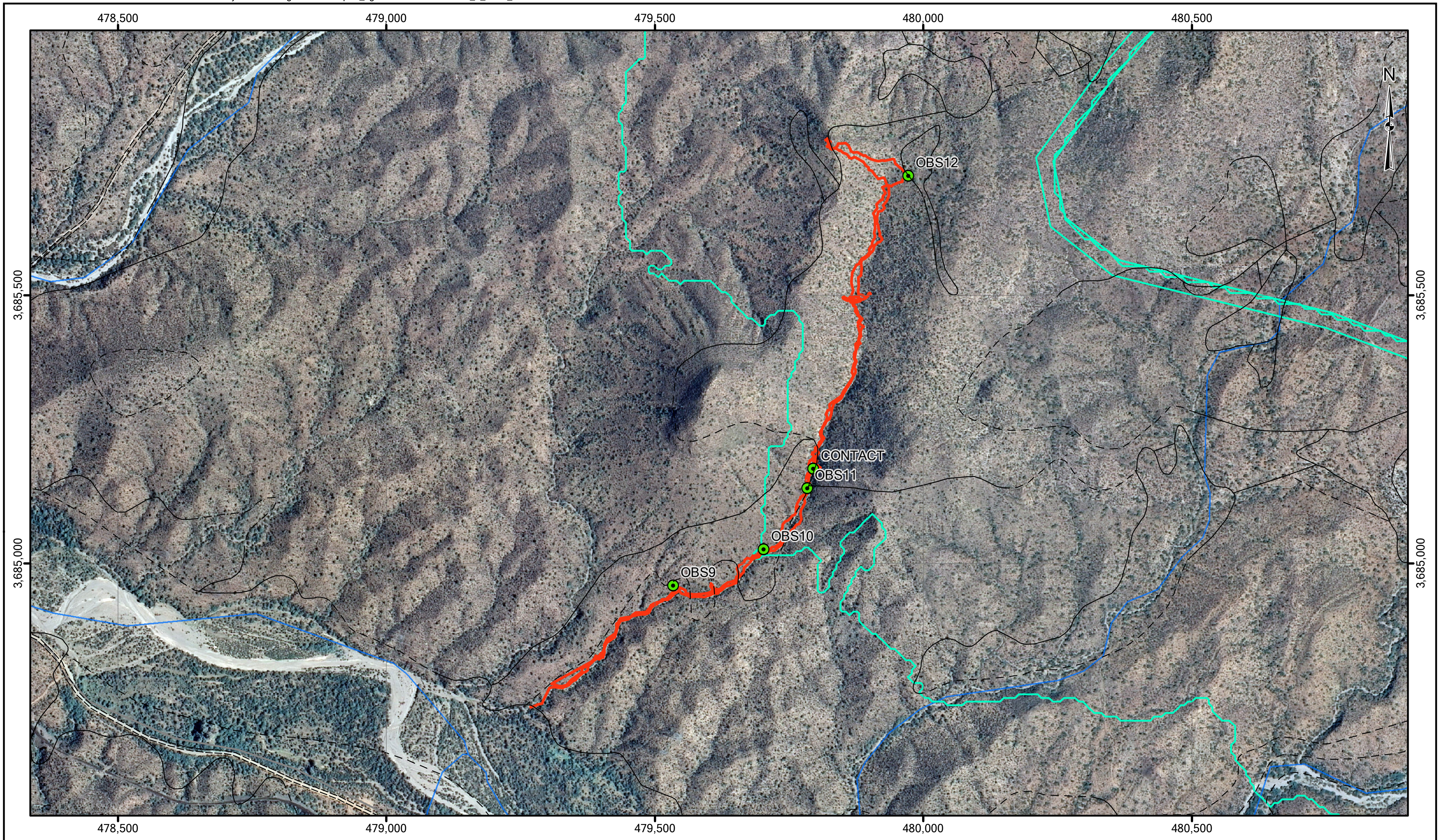

LEGEND

- CREEK TRAVERSE OBSERVATION POINT
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Orthophoto from USDA

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0 250 m

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Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT 2013 NEAR WEST SITE INVESTIGATION

TITLE: CREEK TRAVERSE #2 OBSERVATIONS

PROJECT No. M09441A14

FIG No. I-B.3

cbeasy
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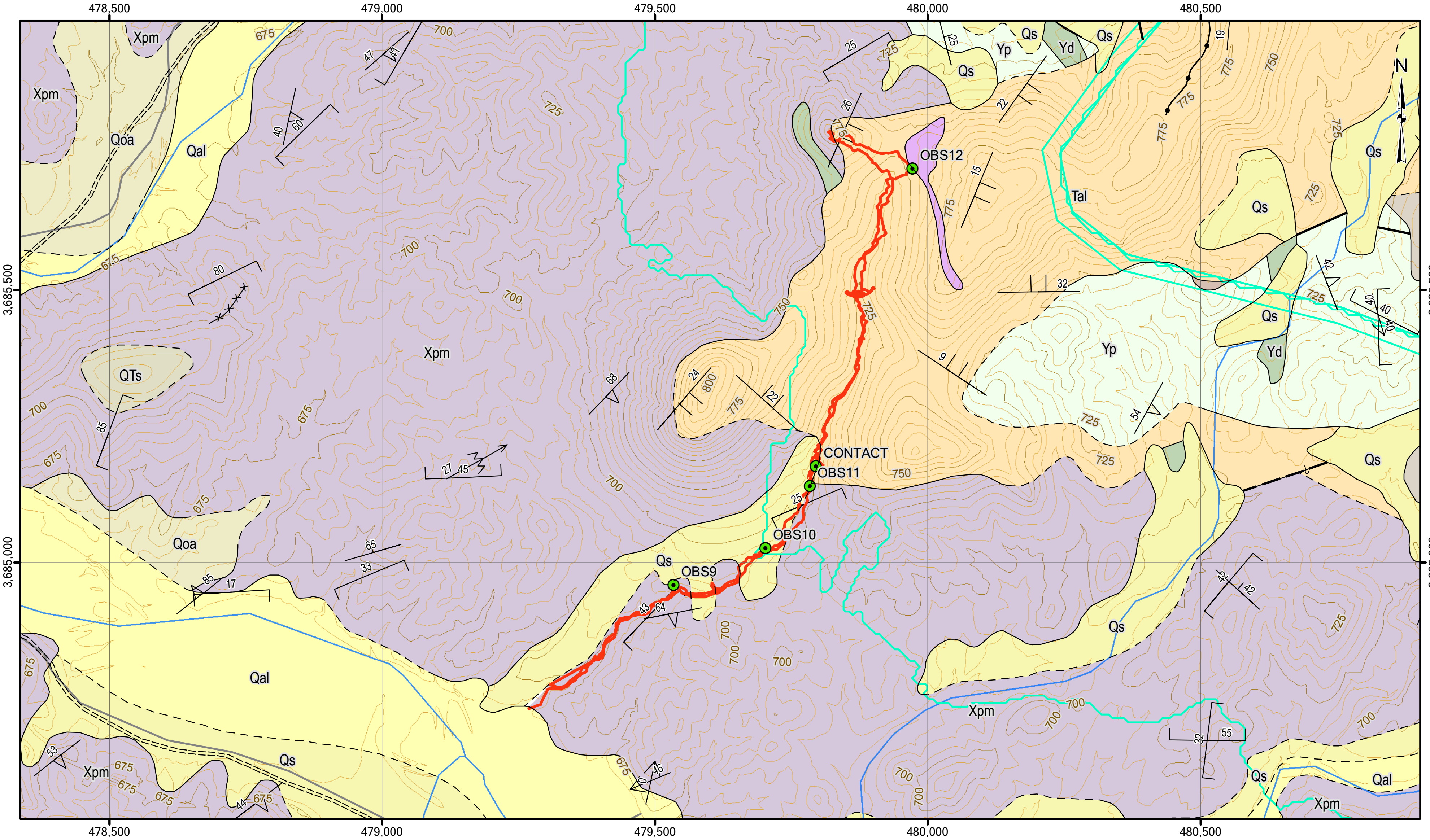


LEGEND

- CREEK TRAVERSE OBSERVATION POINT
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)

Notes:
1. NAD27 UTM12
2. Refer to main report for descriptions of geologic units.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

0 250 m

CLIENT
Resolution Copper Mining

Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE
CREEK TRAVERSE #2
OBSERVATIONS AND GEOLOGY

PROJECT No. M09441A14

FIG No. I-B.4

OBS9

Schist/Tuff boulder deposit on outside edge of channel bend, ~0.5 m *(1.64 ft)* thick; cut down to bedrock on inside of bend.

OBS10

Schist exposure with strong preferential foliation cleavage. Cleavage planes dipping into channel.

Orientation of foliation cleavage: **058/30**

OBS11

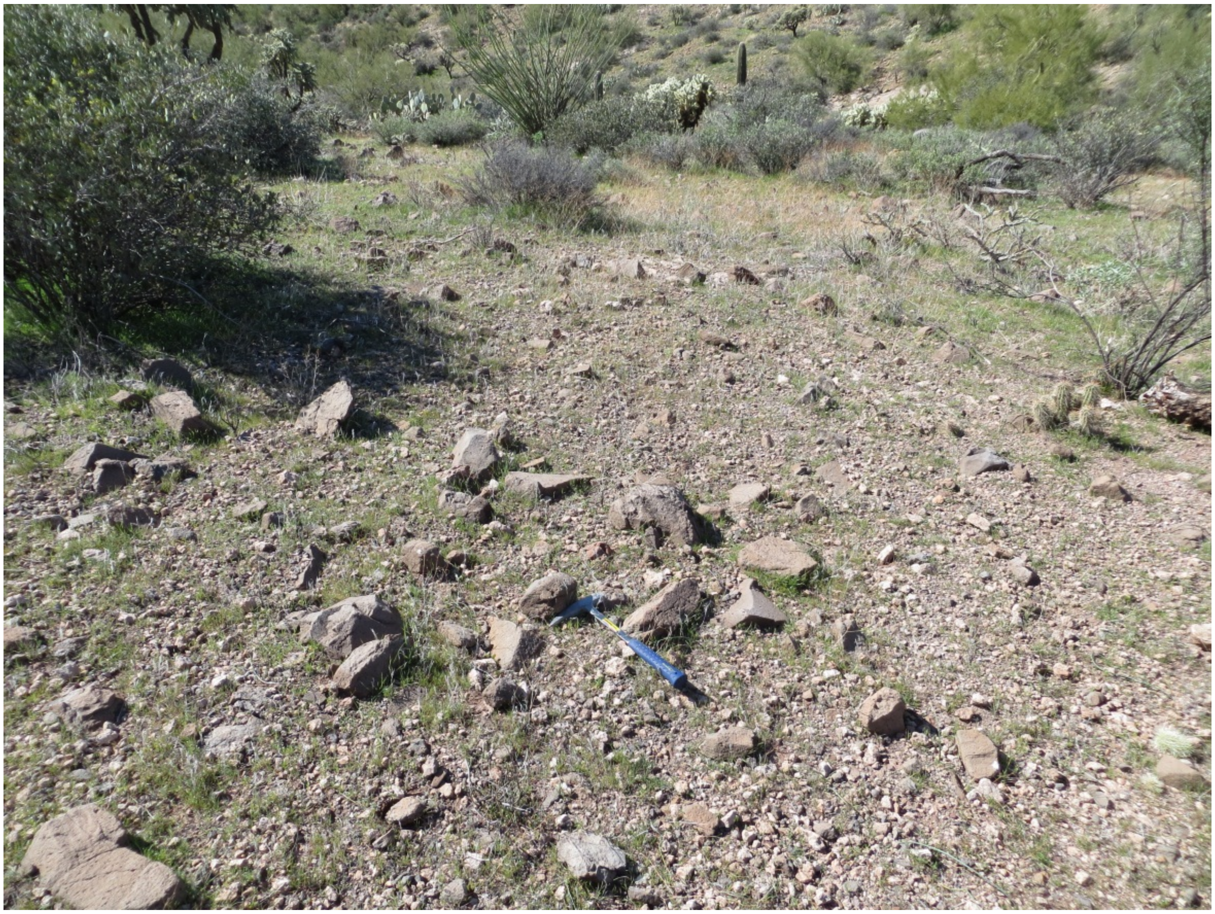
Bedded colluvium or alluvium with cobbles. Just beyond this observation point Apache Leap Tuff is exposed on both sides of channel.

CONTACT

Approximate location where Pinal Schist is no longer present on the channel sides. - **Not photographed.**

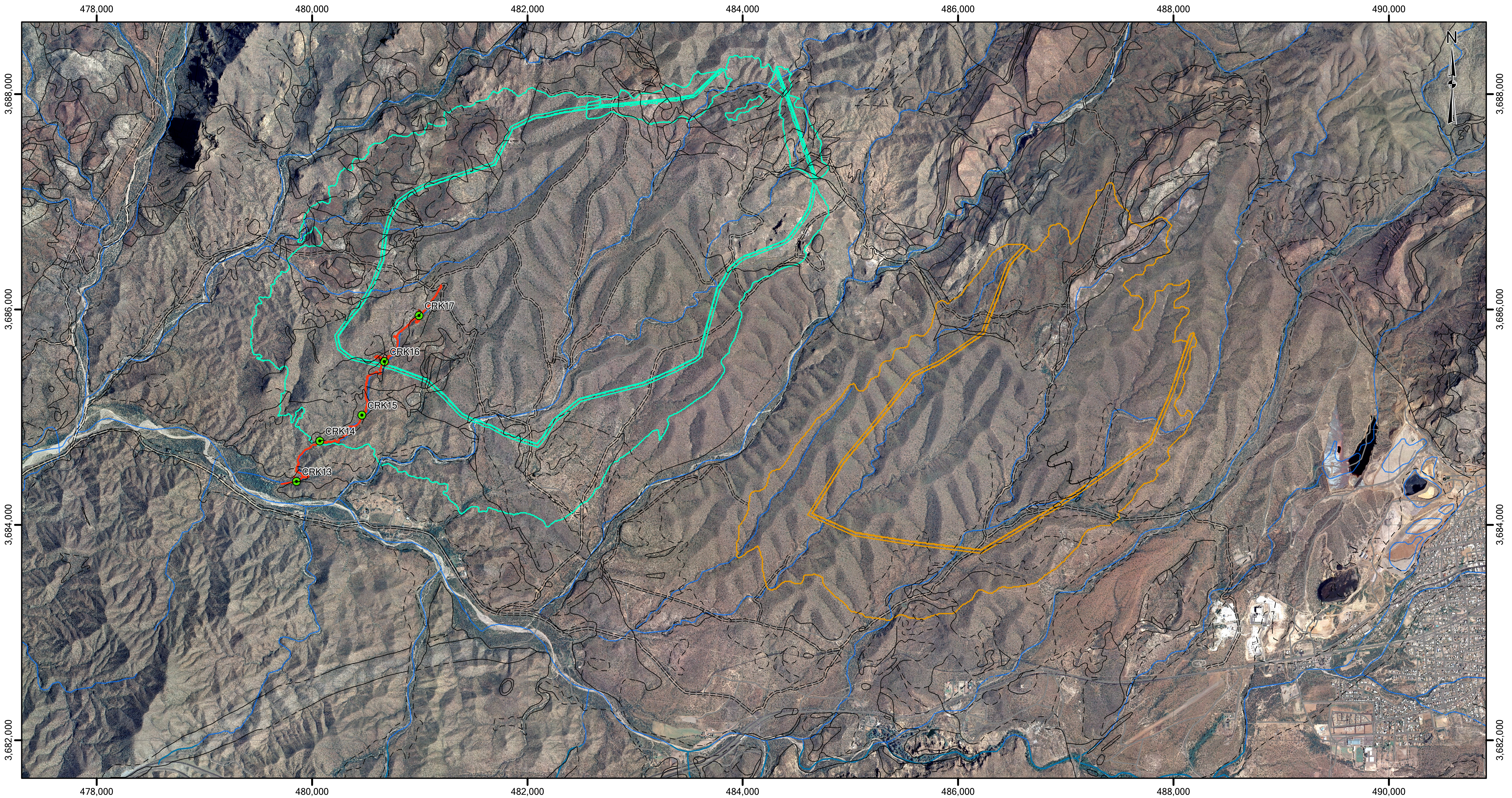
OBS12

Basalt cobbles and boulders on surface. Likely surface exposure of Tdb (Basaltic Dykes) unit.



APPENDIX I-C

Traverse #3



LEGEND

- CREEK TRAVERSE MAPPING STATION
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- STREAM
- ROAD (FROM STATE)
- ==== ROAD (FROM RESOLUTION)
- CONTACT (BETWEEN GEOLOGIC UNITS
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST
  CLAST-RICH CONGOMERATE BELOW
  AND DRIPPING SPRING QUARTZITE
  CLAST-RICH CONGLOMERATE ABOVE

Notes:
1. NAD27 UTM12
2. Orthophoto from USDA

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

0 1,000 m

CLIENT
Resolution Copper Mining

Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE
CREEK TRAVERSE #3

PROJECT No.	FIG No.
M09441A14	I-C.1

CB
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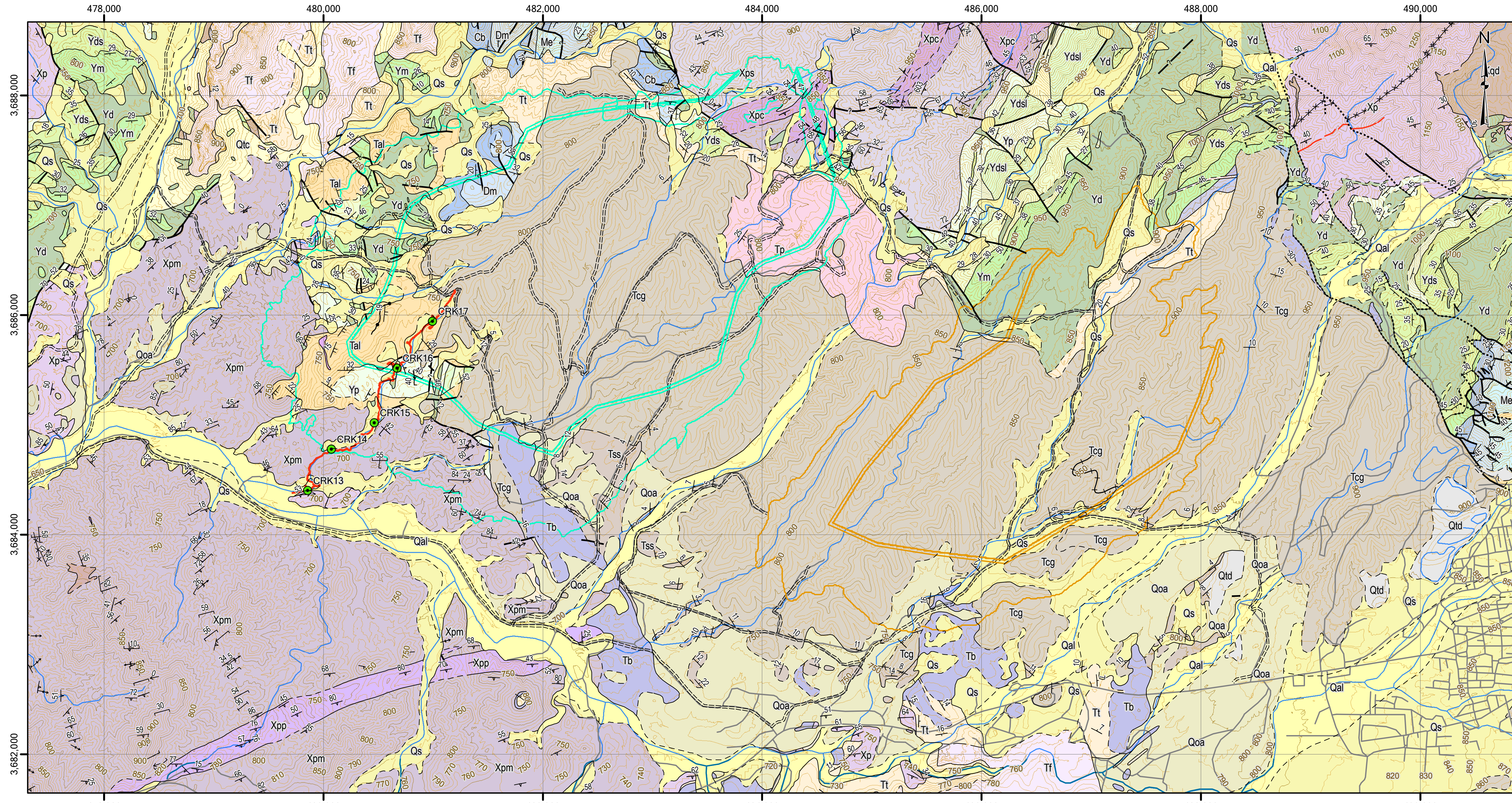


LEGEND

- CREEK TRAVERSE MAPPING STATION
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- STREAM
- ROAD (FROM STATE)
- ROAD (FROM RESOLUTION)
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)
- CONTACT (BETWEEN GEOLOGIC UNITS
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Refer to main report for descriptions of geologic units.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

0 1,000 m

CLIENT

Resolution Copper Mining

Klohn Crippen Berger

PROJECT

RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

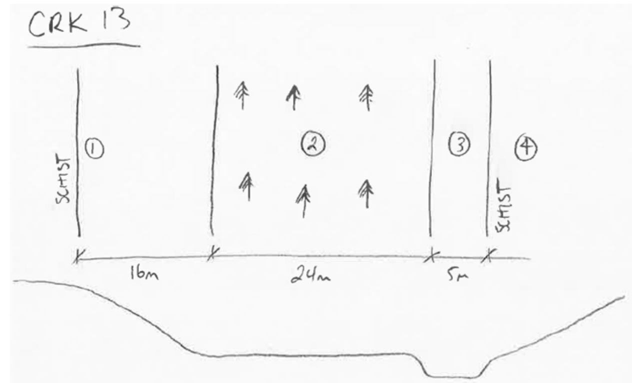
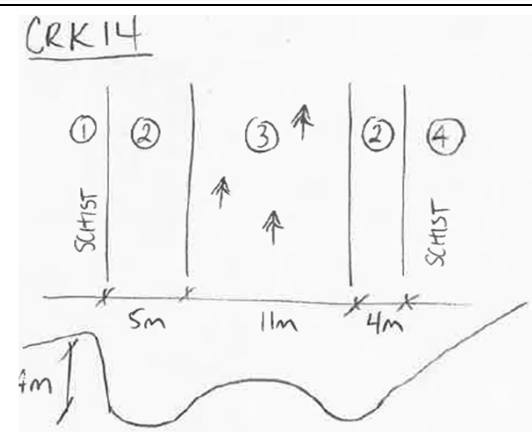
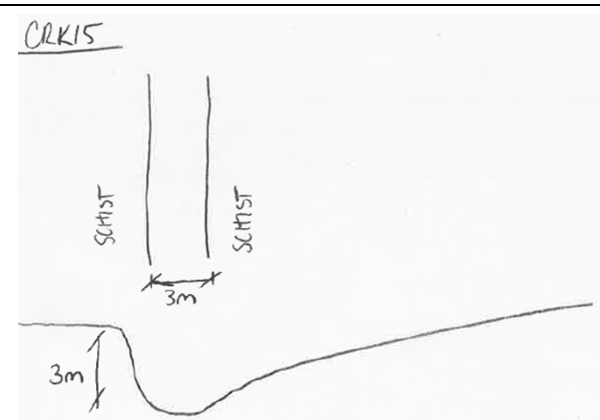
TITLE

CREEK TRAVERSE #3
AND GEOLOGY

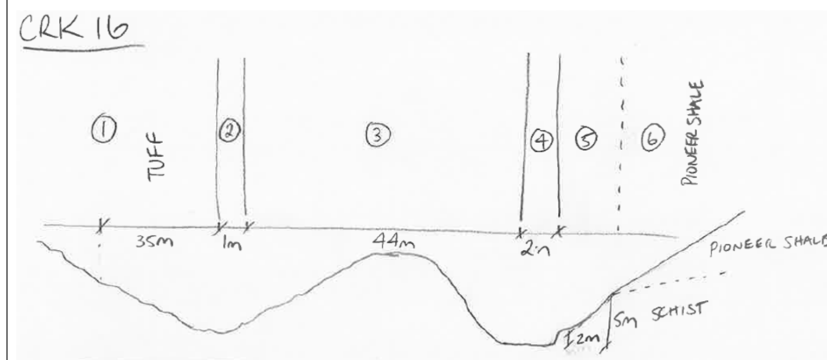
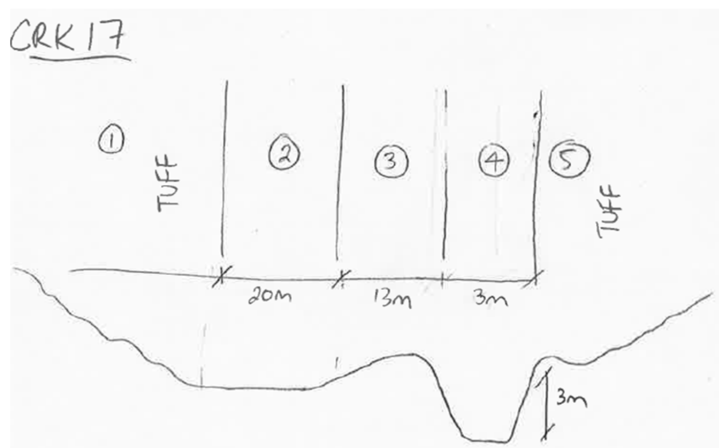
PROJECT No. M09441A14

FIG No. I-C.2

TRAVERSE 3

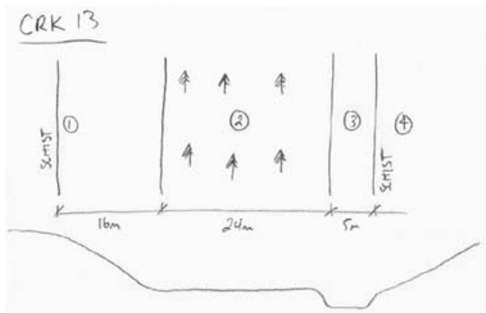
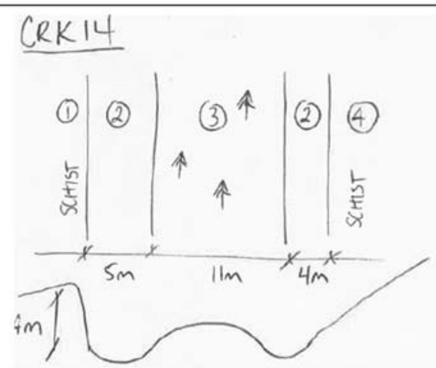
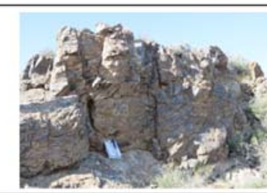
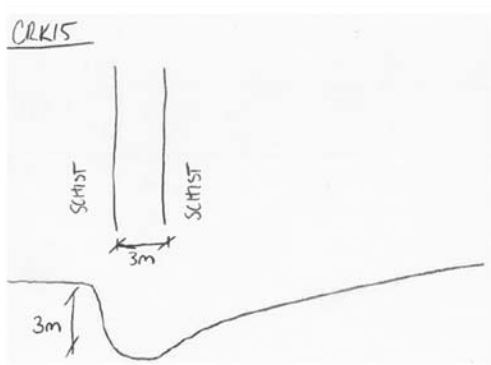
Date Mapped	Traverse Type	Mapping Point	Northing* (m)	Easting* (m)	Total Channel Width (m)** *(ft)*	Field Sketch	Unit Described	Description (From Left to Right Across Channel Looking Upstream)	Maximum Particle Size in Channel (cm) *(inches)*	Rock Strength	Geologic Unit	Notes
18-Feb-13	Creek	CRK13	3684398.16	479855.86	29 *(95)*		1	SCHIST, schist and quartz cobbles and gravel exposed at surface, angular particles			Xpm	
							2	SAND (SP) fine to medium, some gravel, some silt, trace cobbles, poorly graded, max. particle size = 10 cm, sub-rounded to sub-angular, brown, moist, hole excavated to 40 cm depth			Qoa	
							3	SAND and GRAVEL (SW-GW) fine to coarse, no cobbles in sample but in surrounding area, well graded, max. particle size = 7 cm (sample); 40 cm (channel), avg. particle size = 0.5 cm, angular to sub-angular with elongated schist particles, moist just below surface, litholoy dominated by schist and quartz	40 *(15.7)*		Qs	
							4	SCHIST, schist and quartz cobbles and gravel exposed at surface, angular particles			Xpm	
18-Feb-13	Creek	CRK14	3684775.77	480073.09	20 *(66)*		1	SCHIST, fresh, R4, folded with some planar foliation cleavage in outcrop, vertical joint spacing ~10 cm, open to closed, no infilling in vertical joints, quartz infilling in some folded foliations dominant cleavage planes dipping towards stream channel (050/60)		R4	Xpm	
							2	SAND and GRAVEL (SW-GW) fine to coarse, some cobbles, well graded, max. particle size = 20 cm (sample) with large boulders and outcrops in channel , sub-rounded to angular, moist just below surface, lithology dominated by schist and quartz	>60 *(>23.6)*		Qs	
							3	Outcropping schist with vegetation			Xpm	
							4	SCHIST, schist and quartz cobbles and gravel exposed at surface, angular clasts, cannot free dig			Xpm	
18-Feb-13	Creek	CRK15	3685015.33	480464.95	3 *(10)*		1	SCHIST, weathered, silty sand with schist gravel and cobbles, angular particles, difficult to dig past 15 cm			Xpm	
							2	SCHIST, fresh, R3, heavily foliated with foliation cleavage planes dipping into channel, random fracturing without apparent joint sets, fracture aperture variable (closed to wide open) orientation of cleavage planes (051/45)		R3	Xpm	
							3	SAND and GRAVEL (SW-GW), fine to coarse, some cobbles, well graded, max. particle size = 12 cm (sample); 40 cm (channel), avg. = 0.5 cm, angular to sub-rounded, moist right below surface, various lithology	40 *(15.7)*		Qs	
							4	SCHIST, weathered, silty sand with schist gravel, angular particles, hole excavated to 30 cm depth, increasing coarse particle content with depth			Xpm	

TRAVERSE 3

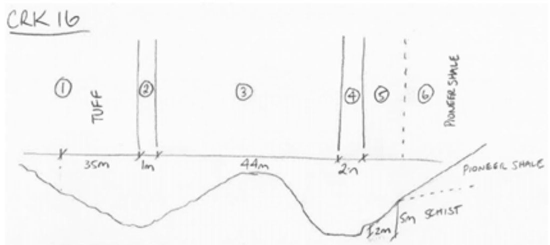
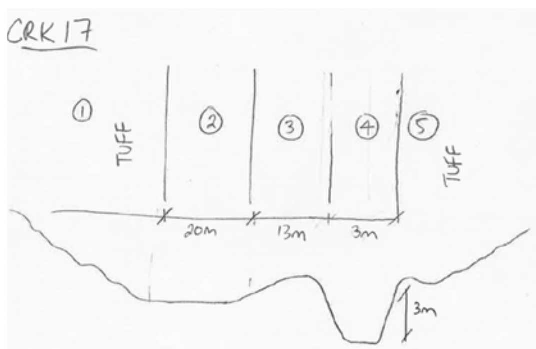
Date Mapped	Traverse Type	Mapping Point	Northing* (m)	Easting* (m)	Total Channel Width (m)** *(ft)*	Field Sketch	Unit Described	Description (From Left to Right Across Channel Looking Upstream)	Maximum Particle Size in Channel (cm) *(inches)*	Rock Strength	Geologic Unit	Notes
19-Feb-13	Creek	CRK16	3685514.69	480673.17	1 + 2 *(3 + 7)*		1	TUFF, loose boulders, cobbles and gravel exposed at surface of slope with shallow bedrock outcrops. Unable to free dig			Tal	
							2	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, max. particle size = 8 cm (sample); 20 cm (channel), sub-angular to sub-rounded, brownish grey, moist ~8cm below surface, almost all coarse grains tuff	20 *(7.9)*		Qs	
							3	SCHIST, loose boulders, cobbles and gravel exposed at surface with shallow outcrops			Xpm	
							4	SAND, GRAVEL and COBBLES, (SW-GW) fine to coarse, max. particle size = 8 cm (sample) and 40 cm (channel), avg. = 0.5 cm, sub-angular to angular, moist just below surface, quartz, schist and tuff lithology	40 *(15.7)*		Qs	
							5	SCHIST, fresh to slightly weathered, R4, foliation cleavage dipping away from channel, cleavage planes typically parallel and spaced 2 - 3cm apart, other fractures randomly oriented with no joint sets apparent orientation of cleavage planes (342/18)		R4	Xpm	
							6	SHALE, fresh, R5, beds typically 0.5 cm to 1 cm apart, some discontinuities along bedding planes, planar dominant bedding orientation (338/29)			Yp	
19-Feb-13	Creek	CRK17	3685939.45	480994.41	3 *(10)*		1	TUFF, fresh, R5/R6, loose boulders and cobbles on surface with shallow massive outcrops		R5/R6	Tal	
							2	Extremely weak rock or soil (can be broken apart with hand), mica, quartz and calcite grains, white and grey, reacts vigorously to acid, surface of material ~ 15 cm below surface. Hole excavated to 30 cm depth.			?	Surface sediments are white overtop of this unit and react to acid
							3	Loose schist, basalt, quartz and tuff cobbles at surface. Unable to free dig			?	
							4	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, trace silt, well graded, max. particle size = 12 cm (sample); 20 cm (channel), avg. 0.5 cm, sub-angular to angular, dominantly schist and tuff particles, vegetation in channel	20 *(7.9)*		Qs	
							5	TUFF, fresh, R6, near vertical joints spaced 30 cm apart (avg.), joints open at surface (max. 5 cm aperture), max. depth of joint penetration into outcrop ~40 cm, planar and rough joint surfaces joint orientation (140/75)		R6	Tal	

* Coordinates measured with handheld GPS unit. Coordinate System: UTM NAD27 CONUS
** Total Channel Width includes the width of active channels and Old Alluvium deposits

TRAVERSE 3

Date Mapped	Traverse Type	Mapping Point	Field Sketch	Traverse Observation Point Photos (See Field Sketch)					
				1	2	3	4	5	6
18-Feb-13	Creek	CRK13		 	 	 	 		
18-Feb-13	Creek	CRK14		 	 				
18-Feb-13	Creek	CRK15		 	 	 			

TRAVERSE 3

Date Mapped	Traverse Type	Mapping Point	Field Sketch	Traverse Observation Point Photos (See Field Sketch) 1	2	3	4	5	6
19-Feb-13	Creek	CRK16		 	 	 	 	 	 
19-Feb-13	Creek	CRK17		 	 	 	 	 	

Creek Traverse #3 Observations

Observation Station	Coordinates[1]	
	Easting (m)	Northing (m)
OBS13	479860	3684490
OBS14	479872	3684547
OBS15	480329	3684832
OBS16	480177	3684764
OBS17	480525	3685128
OBS18	480504	3685305
OBS19	480728	3685603
OBS20	480768	3685749
OBS21	481197	3686211

1 – Coordinates measured with handheld GPS unit. Coordinate system: UTM NAD27 CONUS

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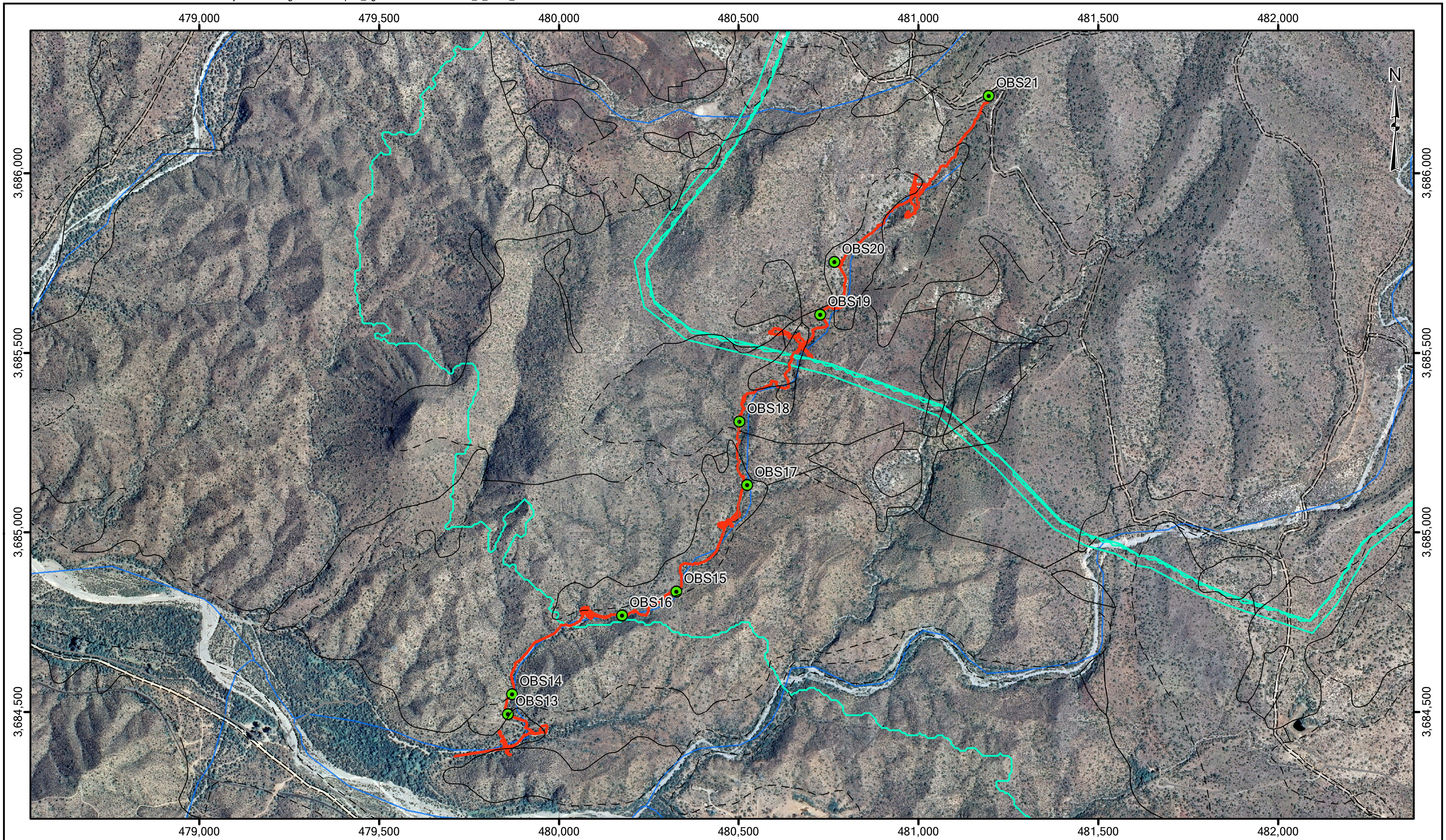

LEGEND

- CREEK TRAVERSE OBSERVATION POINT
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Orthophoto from USDA

NOT FOR CONSTRUCTION

0 500 m

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

CLIENT
Resolution Copper Mining

Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE
CREEK TRAVERSE #3
OBSERVATIONS

PROJECT No. M09441A14

FIG No. I-C.3

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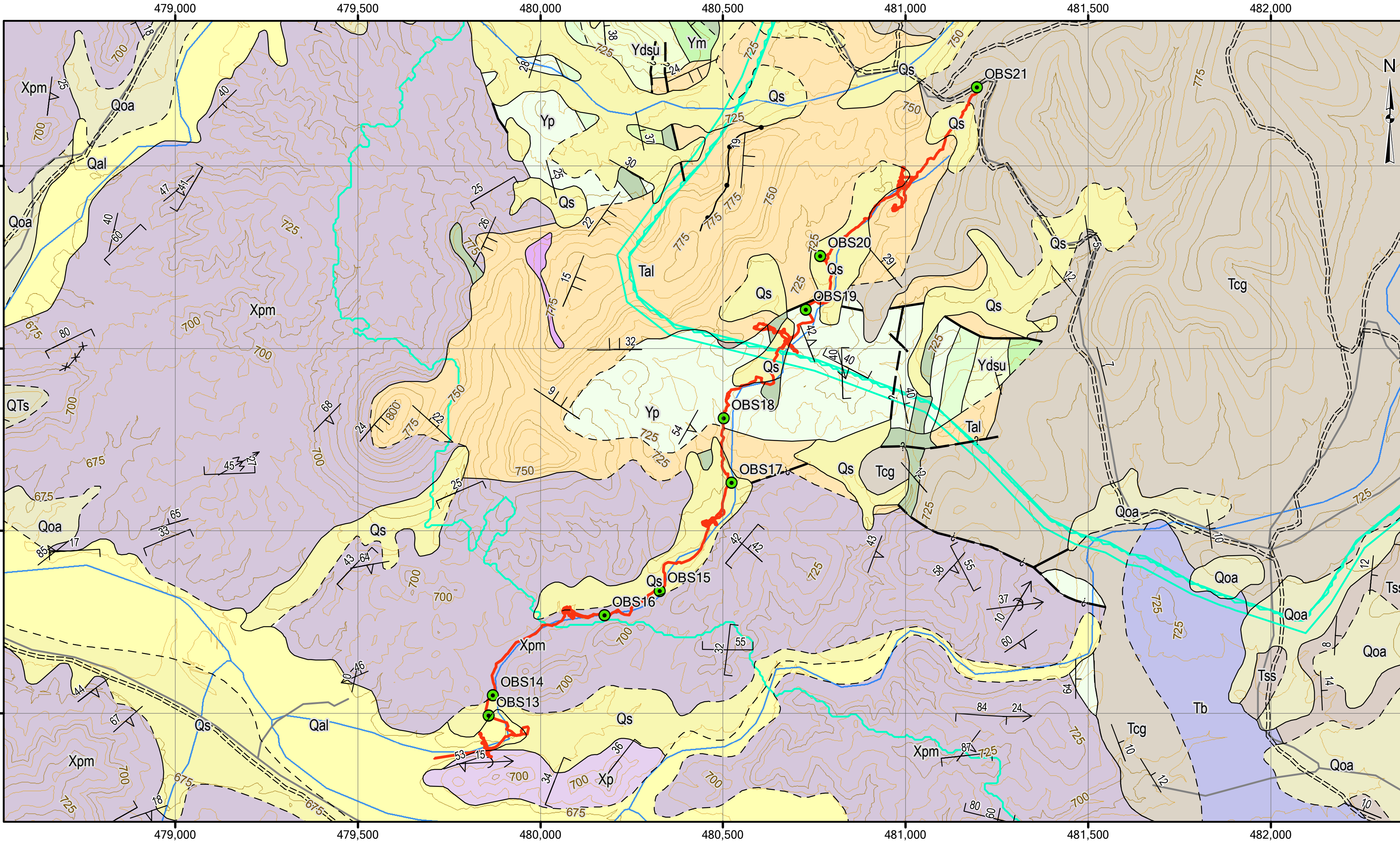

LEGEND

- CREEK TRAVERSE OBSERVATION POINT
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)

Notes:
1. NAD27 UTM12
2. Refer to main report for descriptions of geologic units.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

0 500 m

CLIENT
Resolution Copper Mining

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PROJECT
RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE
CREEK TRAVERSE #3
OBSERVATIONS AND GEOLOGY

PROJECT No. M09441A14

FIG No. I-C.4

OBS13

Schist outcrop with strong foliation cleavage, outcrop ~4 m *(13.1 ft)* high on the left channel bank.

Orientation of foliation cleavage: **320/43**

OBS14

Seepage daylighting from fluvial channel deposits, near where schist is outcropping in channel invert.

OBS15

Parallel foliation cleavage in schist outcrop dipping away from the channel.

Orientation of foliation cleavage: 050/28

OBS16

Dipping, parallel foliation cleavage in schist exposure.

Orientation of foliation cleavage: **055/28**

OBS17

First appearance of Apache Leap Tuff in channel. Tuff outcrops visible on both sides of channel.

OBS18

Orientation of schist foliation cleavage in channel invert: **018/60**

OBS19

Apache Leap Tuff now exposed consistently in the left channel bank.

OBS20

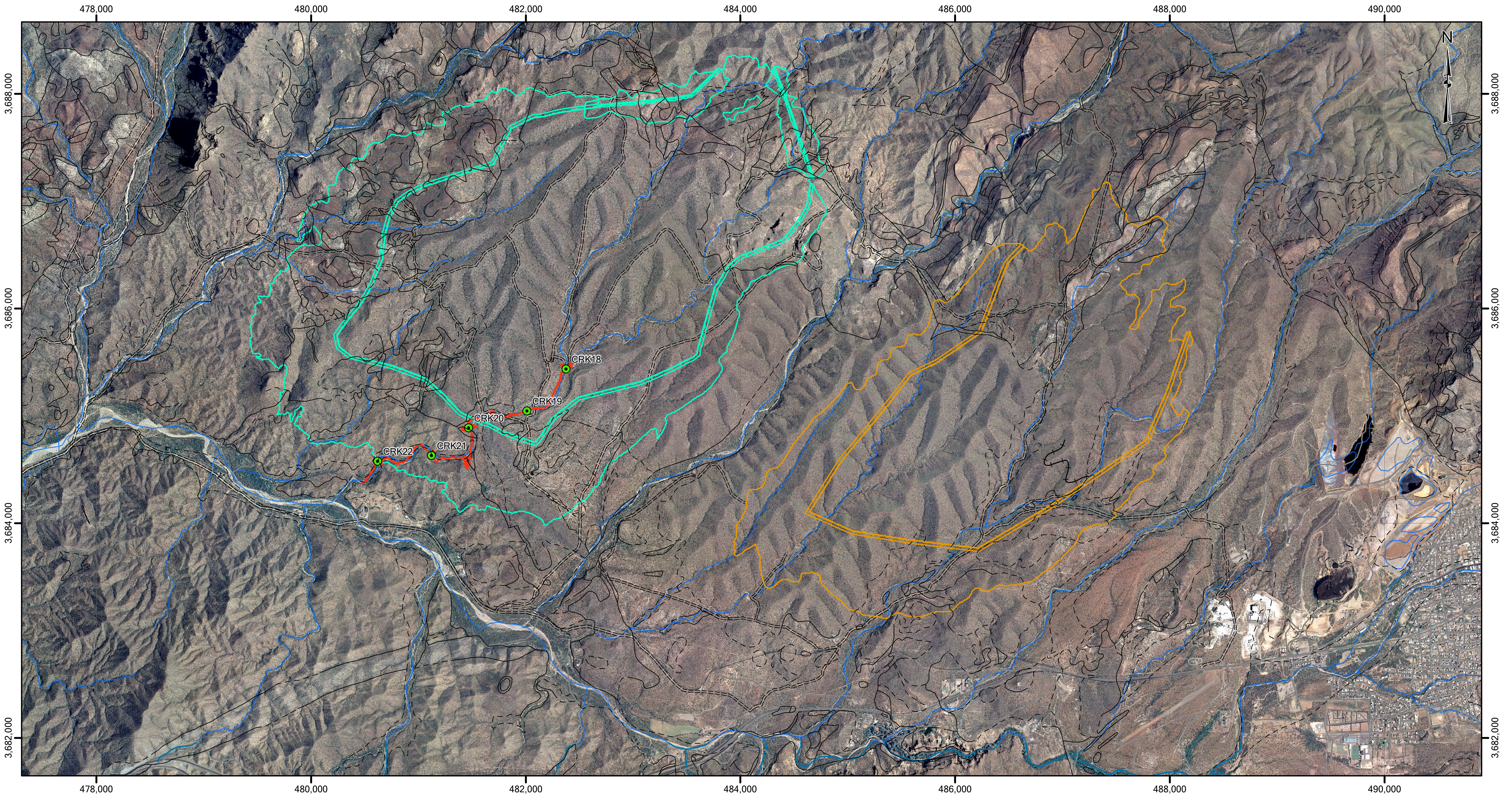
Outcrop of massive Apache Leap Tuff.

OBS21

Gila conglomerate outcropping on both sides of the channel.

APPENDIX I-D

Traverse #4



LEGEND

- CREEK TRAVERSE MAPPING STATION
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- STREAM
- ROAD (FROM STATE)
- ROAD (FROM RESOLUTION)
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Refer to main report for descriptions of geologic units.

NOT FOR CONSTRUCTION

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0 1,000 m

CLIENT: Resolution Copper Mining

Klohn Crippen Berger

PROJECT: RESOLUTION PROJECT 2013 NEAR WEST SITE INVESTIGATION

TITLE: CREEK TRAVERSE #4

PROJECT No. M09441A14

FIG No. I-D.1

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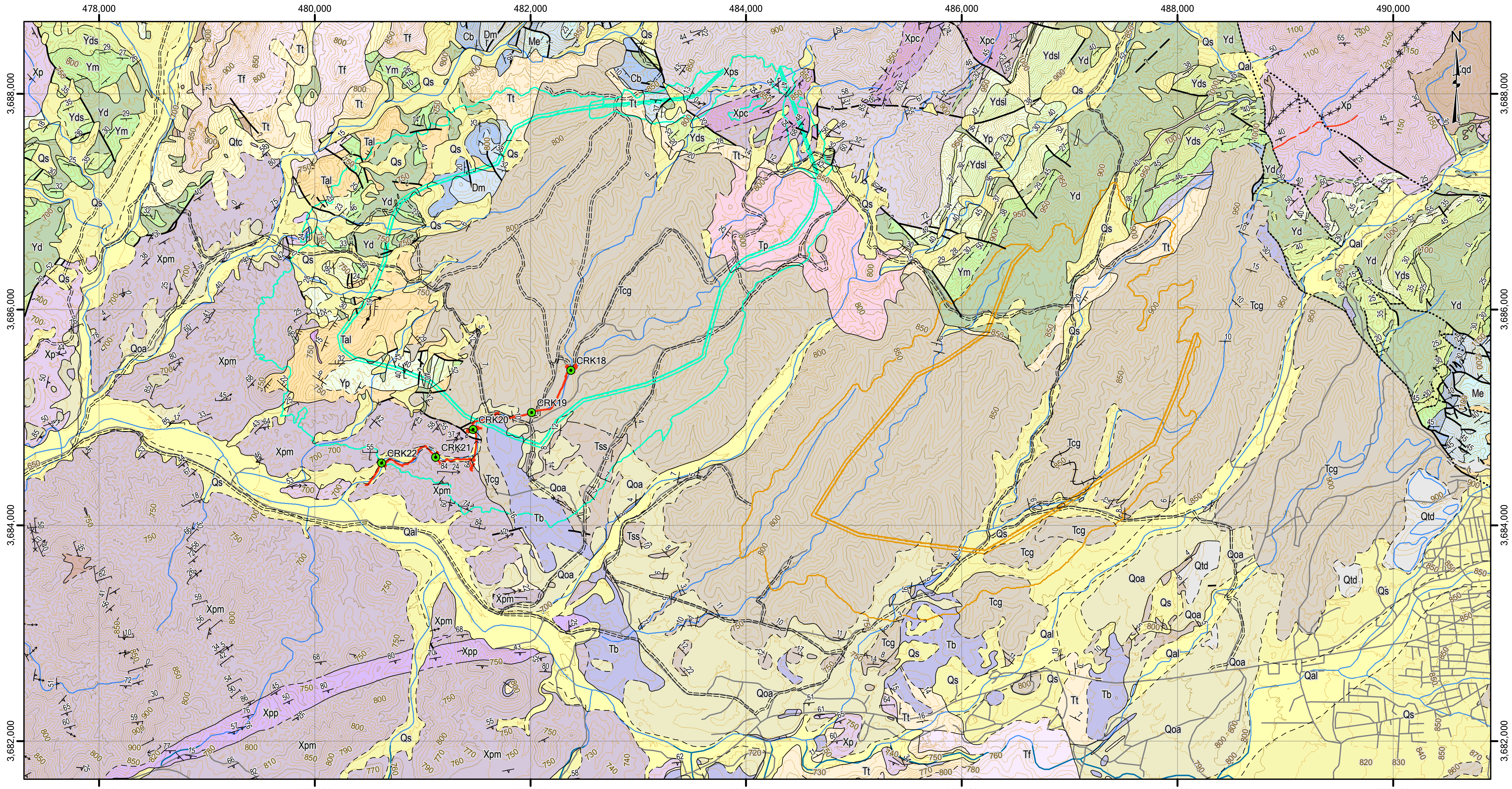

LEGEND

- CREEK TRAVERSE MAPPING STATION
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- STREAM
- ROAD (FROM STATE)
- ROAD (FROM RESOLUTION)
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST
  CLAST-RICH CONGOMERATE BELOW
  AND DRIPPING SPRING QUARTZITE
  CLAST-RICH CONGLOMERATE ABOVE

Notes:
1. NAD27 UTM12
2. Refer to main report for descriptions of geologic units.

NOT FOR CONSTRUCTION

0 1,000 m

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CLIENT
Resolution Copper Mining

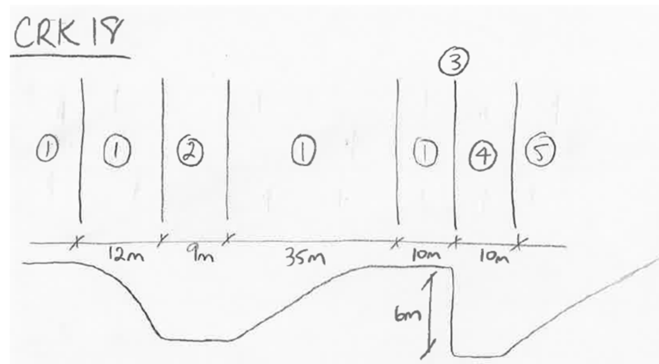
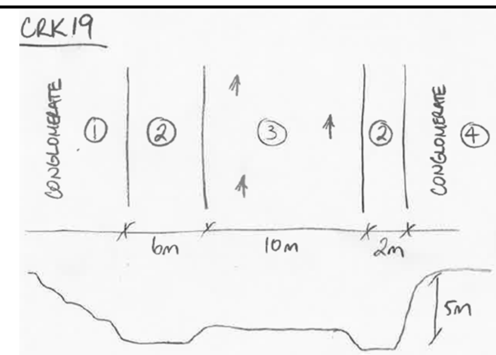
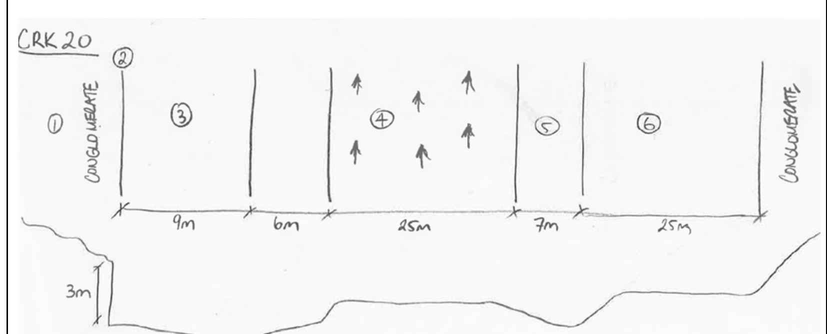
Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

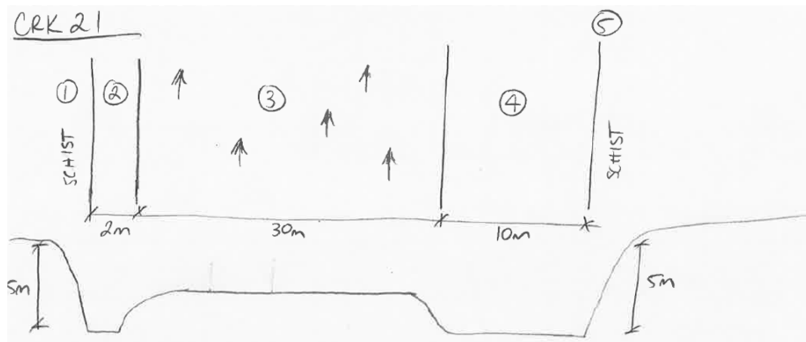
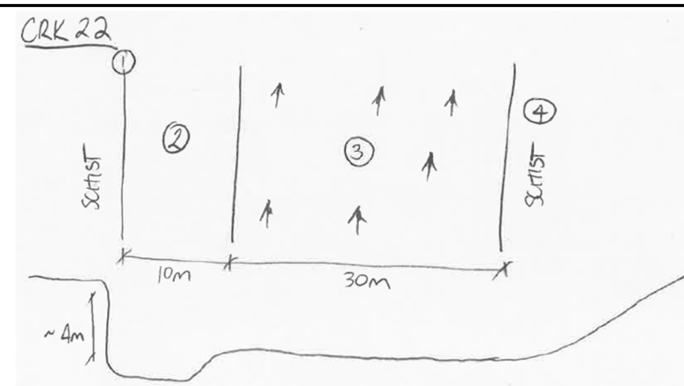
TITLE
CREEK TRAVERSE #4
AND GEOLOGY

PROJECT No.	FIG No.
M09441A14	I-D.2

TRAVERSE 4

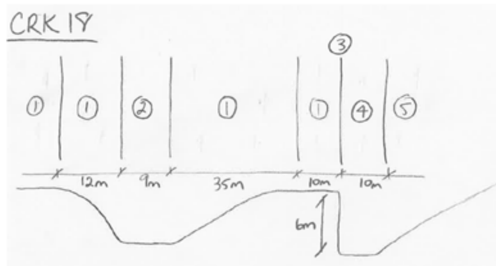
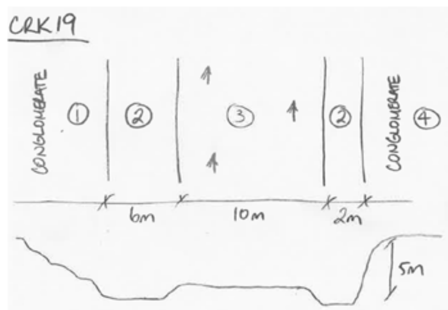
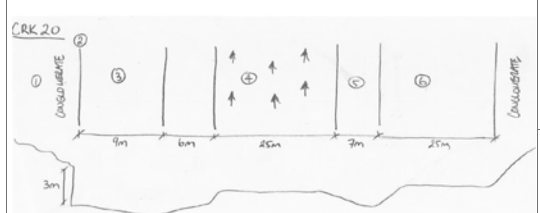
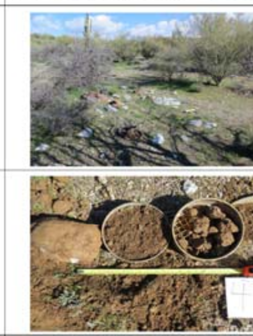
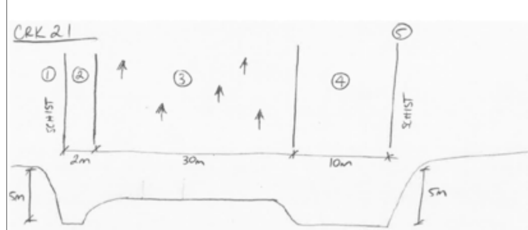
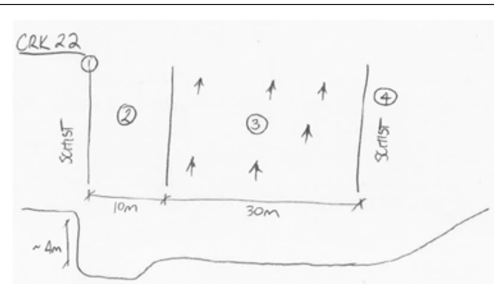
Date Mapped	Traverse Type	Mapping Point	Northing * (m)	Easting* (m)	Total Channel Width (m)** *(ft)*	Field Sketch	Unit Described	Description (From Left to Right Across Channel Looking Upstream)	Maximum Particle Size in Channel (cm) *(inches)*	Rock Strength	Geologic Unit	Notes
19-Feb-13	Creek	CRK18	3685432.61	482376.71	9 + 10 *(30 +33)*		1	CONGLOMERATE, surface exposure, silty sand and gravel/cobble particles, dominantly schist and quartz			Tcg	
							2	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, trace silt, well graded, max. particle size = 8 cm(sample); 100 cm (channel), sub-angular to rounded with elongated schist particles, moist just below surface, dominantly schist and quartz particles, finer fraction reactive to acid	100 *(39.4)*		Qs	
							3	CONGLOMERATE, fresh, R4, sub-horizontal bedding planes with variable bed thickness, no joint sets cross-cutting bedding planes, matric around clasts reactive to acid		R4	Tcg	
							4	Shallow dipping conglomerate beds outcropping in channel invert. Water daylighting and ponding on outcrops.			Tcg / Qs	
							5	Silty SAND (SM), fine to medium, some gravel, trace cobbles in top 20 cm, well graded, max. particle size = 2 cm, angular to sub-angular, brown, moist, some organics, various lithology, reacts to acid, difficult to dig >20 cm (more coarse particles)			Tcg	
20-Feb-13	Creek	CRK19	3685042.37	482013.03	18 *(59)*		1	Silty SAND (SM), fine to medium, some gravel, well graded, max. particle size = 5 cm, sub-rounded to angular, brown, moist, some organics, various lithology, fine fraction reacts to acid, increasing coarse particle content with depth, hole excavated to 35 cm			Tcg	
							2	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, well graded, max. particle size = 8 cm (sample); 40 cm (channel), sub-angular to sub-rounded, moist (but could be due to recent precip), various lithology	40 *(15.8)*		Qs	
							3	Gravel, cobbles and boulders exposed on channel bar, vegetated			Qs	
							4	CONGLOMERATE, bedded (thickness ranging from ~ 10 cm to 40 cm), sub-horizontal beds, max. particle size = 40cm, differential weathering of finer, siltier beds, reactive to acid		R4	Tcg	
22-Feb-13	Creek	CRK20	3684885.52	481468.7	47 *(154)*		1	SAND, CLAY and COBBLES, fine to coarse, well graded, max. particle size = 15 cm, angular to sub-rounded, brown, moist, all particles very hard silica rich rock (quartzite, Tds?), some organics, refusal in cobbly material at 15 cm depth			Tcg	
							2	CONGLOMERATE, fresh, R4, three dominant sub-horizontal beds (80 cm, 90 cm and 50 cm thick), differential weathering of the finest bed (middle), max. particle size = 30 cm, clasts rounded to angular, clast litholohy dominated by quartzite and limestone, cementation between particles reactive to acid		R4	Tcg	
							3	SAND and GRAVEL (SW-GW) fine to coarse, some cobbles, well graded, max. size = 8 cm (sample); 30 cm (channel), rounded to sub-angular, mild acid reaction, coarse particles dominantly schist and quartz, some grass growing in channel center	30 *(11.8)*		Qs	
							4	Silty SAND and GRAVEL (SM-GW), fine to coarse, some cobbles, well graded, max. particle size = 20 cm, brown, moist, angular to sub-rounded, schist quartz and conglomerate (reactive to acid) particles			Qoa	
							5	Exposed flatly dipping Gila conglomerate surface in small channel			Tcg	
							6	Silty SAND (SM), fine to coarse, some gravel, well graded, max. particle size = 3 cm, angular to sub-rounded, strong acid reaction in finer fraction, schist/quartz coarse particles			Tcg	

TRAVERSE 4

Date Mapped	Traverse Type	Mapping Point	Northing * (m)	Easting* (m)	Total Channel Width (m)** *(ft)*	Field Sketch	Unit Described	Description (From Left to Right Across Channel Looking Upstream)	Maximum Particle Size in Channel (cm) *(inches)*	Rock Strength	Geologic Unit	Notes
22-Feb-13	Creek	CRK21	3684627.77	481121.33	42 *(13)*		1	SCHIST, fresh to slightly weathered, R5 (breaks along foliation cleavage), strong foliation cleavage foliation cleavage orientation (060/51)		R5	Xpm	
							2	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, well graded, max. particle size = 15 cm (sample); 30 cm (channel), sub-rounded to angular, moist right below surface, schist and quartz coarse particle dominate, minor vegetation in channel area (grasses)	30 *(11.8)*		Qs	
							3	Gravelly SAND (SW), fine to coarse, trace silt, well graded, max. particle size = 7 cm, sub-angular to sub-rounded, brown, moist, schist quartz and quartz rich sandstone particles, trace organics, hole excavated to 40 cm depth without refusal			Qoa	
							4	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, well graded, max. particle size = 10 cm(sample); 25 cm (channel), sub-rounded to sub-angular, moist just below surface, mild acid reaction, schist quartz and quartz sandstone particles	25 *(9.8)*		Qs	
							5	SCHIST, fresh, R3 (when striking perpendicular to foliation cleavage), R4 (in more massive rock), foliations gently folded and overturned (dipping ~70 deg.) without clear orientation, random fracturing cross cutting foliations, outcrop overlain by 50 cm of schist particles and sand		R3/R4	Xpm	
22-Feb-13	Creek	CRK22	3684574.65	480621.58	40 *(12)*		1	SCHIST, fresh rock cross-cut by cemented fracture zones. Fresh Rock: R4/R5, gently folded near-vertical fractures with 1-5cm spacing, closed, other gently dipping (30 deg.) foliation cleavage dipping towards channel Fractured Rock: disturbed and fractured rock mass with carbonate cement infilling in some fractures		R4	Xpm	
							2	SAND, GRAVEL and COBBLES (SW-GW), fine to coarse, well graded, max. particle size = 10 cm (sample); 30 cm (channel), sub-rounded to sub-angular, moist just below surface, mild acid reaction in finer fraction, schist quartz and quartz rich sandstone particles	30 *(11.8)*		Qs	
							3	SAND (SP), fine to medium, some silt, some gravel, poorly graded, max. particle size = 4 cm, sub-rounded, brown, moist, trace organics, hole excavated to 30 cm without refusal			Qoa	
							4	Shallow schist outcrops and loose schist at surface, R4, tightly folded foliation cleavage		R4	Xpm	

* Coordinates measured with handheld GPS unit. Coordinate System: UTM NAD27 CONUS
** Total Channel Width includes the width of active channels and Old Alluvium deposits

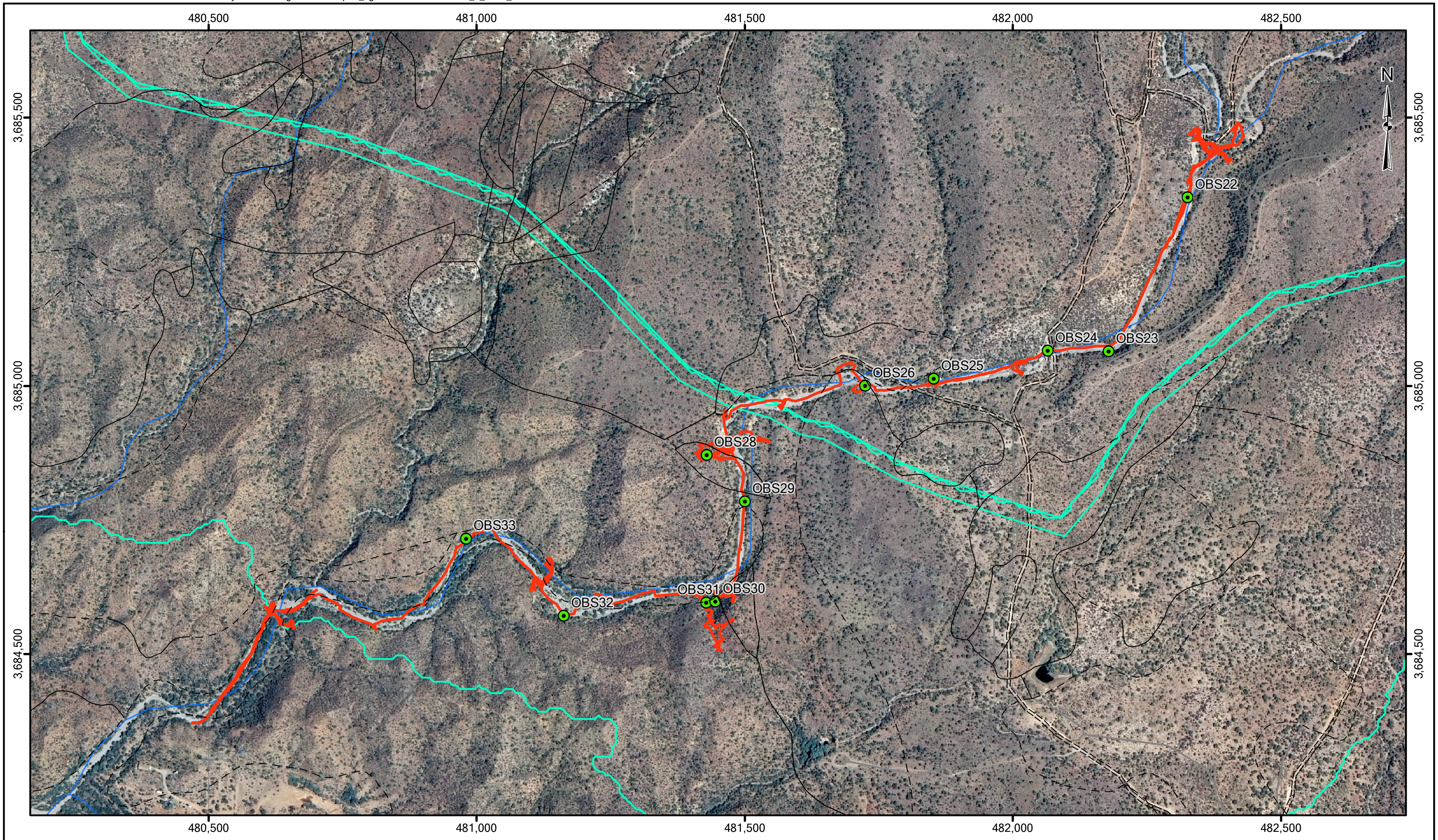
TRAVERSE 4

Date Mapped	Traverse Type	Mapping Point	Field Sketch	Traverse Observation Point Photos (See Field Sketch) 1	2	3	4	5	6
19-Feb-13	Creek	CRK18							
20-Feb-13	Creek	CRK19							
22-Feb-13	Creek	CRK20							
trav44	Creek	CRK21							
22-Feb-13	Creek	CRK22							

Creek Traverse #4 Observations

Observation Station	Coordinates[1]	
	Easting (m)	Northing (m)
OBS22	482327	3685348
OBS23	482180	3685061
OBS24	482066	3685062
OBS25	481854	3685010
OBS26	481726	3684997
OBS27	Not Tagged	Not Tagged
OBS28	481430	3684868
OBS29	481502	3684781
OBS30	481446	3684594
OBS31	481429	3684592
OBS32	481164	3684568
OBS33	480982	3684712

1 – Coordinates measured with handheld GPS unit. Coordinate system: UTM NAD27 CONUS



LEGEND

- CREEK TRAVERSE OBSERVATION POINT
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*

Notes:
1. NAD27 UTM12
2. Orthophoto from USDA

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

0 250 m

CLIENT
Resolution Copper Mining
Klohn Crippen Berger

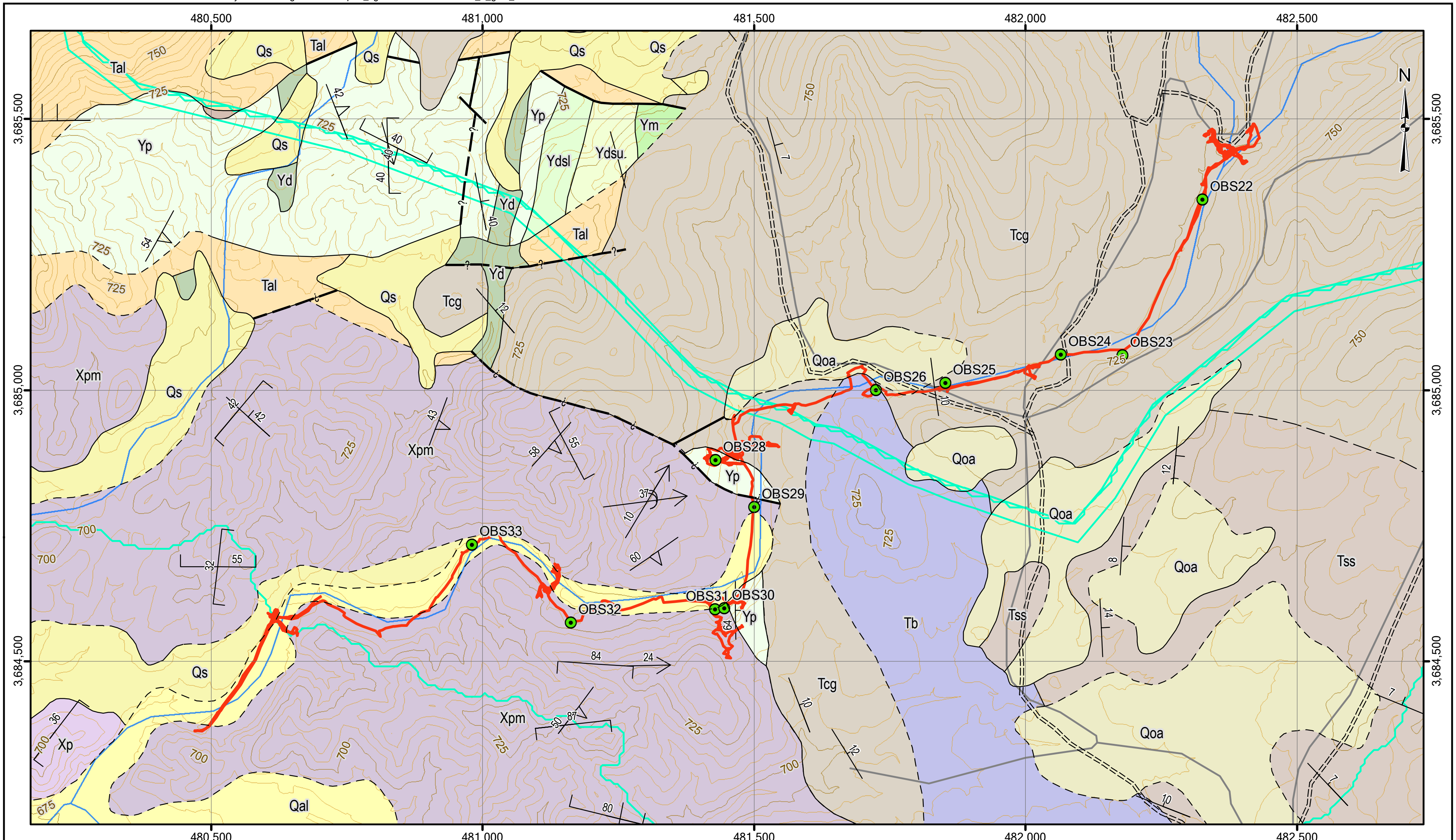
PROJECT
RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE
CREEK TRAVERSE #4
OBSERVATIONS

PROJECT No. M09441A14

FIG No. I-D.3

cbeasy
Z:\M\VCR\M09441A14 - RES-Near WestGeotech Study\400 Drawings\MXD\SI\report_figures\letter\FMTraverse_4_geol_130605.mxd



LEGEND

- CREEK TRAVERSE OBSERVATION POINT
- TRAVERSE
- NEAR WEST TAILINGS SITE
- HAPPY CAMP OPTION
- ROAD (FROM RESOLUTION)
- ROAD (FROM STATE)
- STREAM
- CONTACT (BETWEEN GEOLOGIC UNITS)
- CONTACT - APPROXIMATE
- CONTACT - INFERRED
- CONTACT BETWEEN PINAL SCHIST *CLAST-RICH CONGOMERATE BELOW AND DRIPPING SPRING QUARTZITE CLAST-RICH CONGLOMERATE ABOVE*
- FELSIC DYKE
- FAULT
- FAULT - APPROXIMATE
- FAULT - CONCEALED
- QUARTZ VEIN
- MARKER HORIZON (LOCAL)

Notes:
1. NAD27 UTM12
2. Refer to main report for descriptions of geologic units.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JULY 2013

0 250 m

CLIENT
Resolution Copper Mining
Klohn Crippen Berger

PROJECT
RESOLUTION PROJECT
2013 NEAR WEST SITE INVESTIGATION

TITLE
CREEK TRAVERSE #4
OBSERVATIONS AND GEOLOGY

PROJECT No. M09441A14

FIG No. I-D.4

OBS22

Sub-horizontal conglomerate beds.

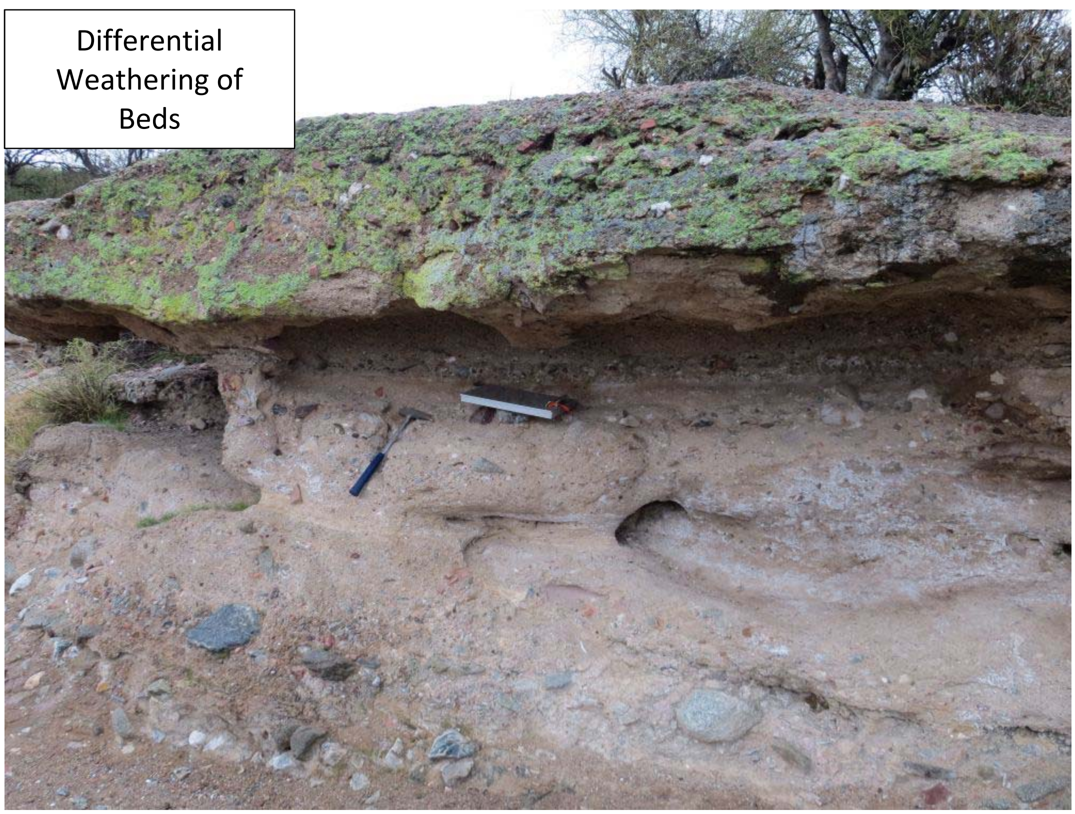
Orientation of bedding structure: **000/04**

OBS23

Large conglomerate outcrop (~10 m high), sub-horizontal beds with variable thickness, max. particle size = ~1 m, various lithology, water ponding at base of flat exposed beds.

OBS24

Elevation drop in channel invert over conglomerate exposure. Bedded with differential weathering of finer beds. Upper bed (~ 40 cm thick) is more competent than the finer, siltier bed below (max. particle size = 10 cm). **See Gila Mapping Station OBS24 for details.**


Differential Weathering of Beds

OBS25

Active channel width = 15m.

OSB26

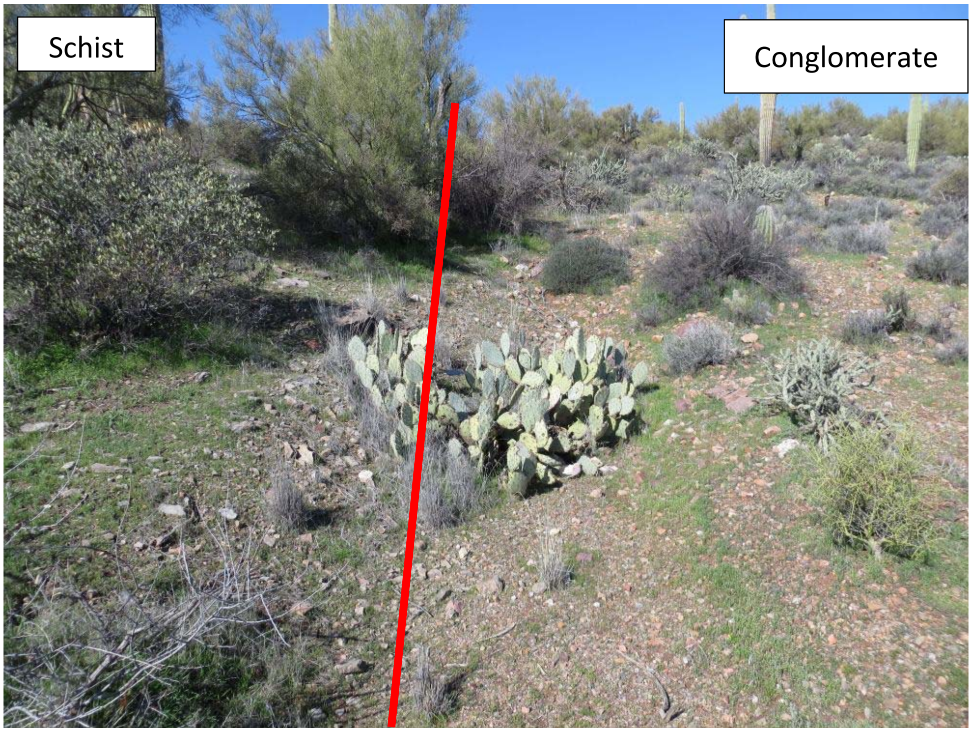
Basalt outcrops in channel bank and invert. Massive with no preferential joint orientation or joint sets. Basalt outcrops coincide with channel invert elevation change of approximately 4 m.

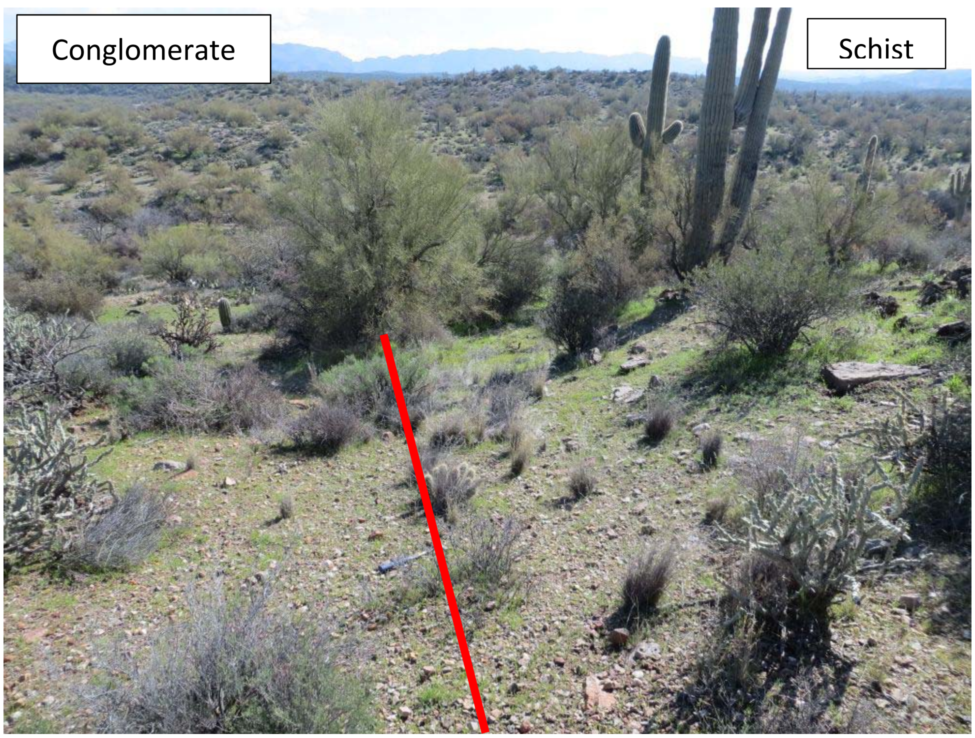
OBS27

70 cm channel invert elevation drop over sub-horizontal conglomerate “ledge”. Water ponding at bottom of drop.

OBS28

Contact between schist and conglomerate on left channel bank. >30 cm of silty sand along line of contact.





OBS29

Pioneer shale outcrop in right channel bank. Laminated red shale interbedded with more massive quartz arenite beds. Shale cleavage planes are planar with a “grainy” texture. Shale bed rock strength = R2/R3; quartz arenite strength = R6.

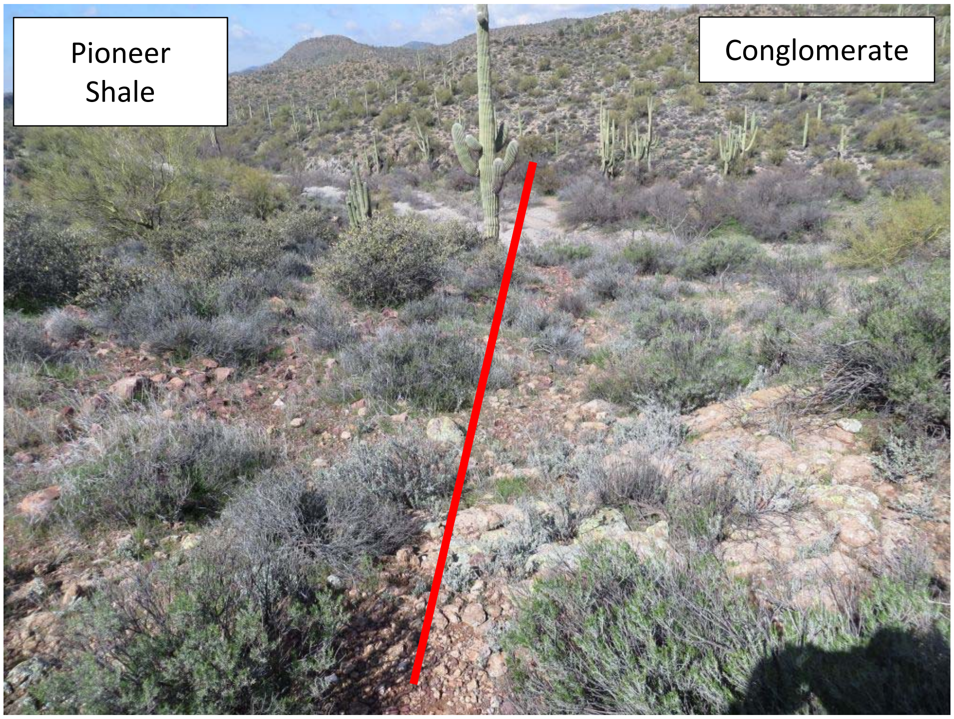
Orientation of bedding structure: **331/27**

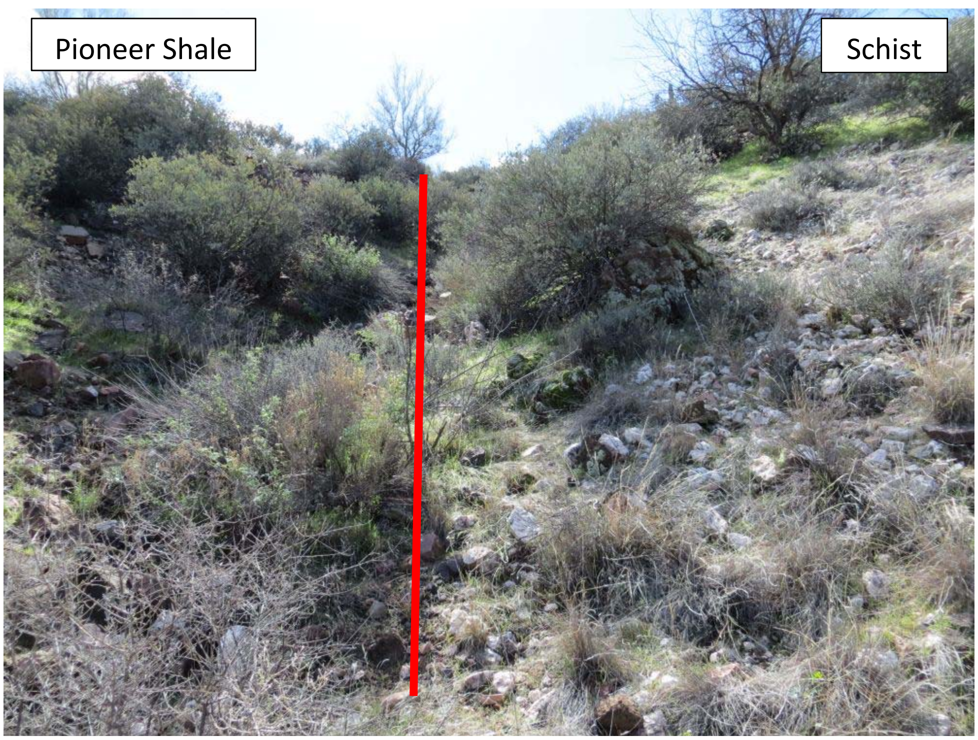
OBS30

Steep tuffaceous unit outcropped on right channel bank with widely spaced near-vertical joints. Interbedded with conglomerate.

OBS31

Contact between Gila conglomerate, Pinal schist and Pioneer shale on the right channel bank. 2 m deep silty sand filled gully formed at the contact between schist and Pioneer shale. A large amount of quartz gravel and cobbles are visible on the surface of schist adjacent to the contact.





OBS32

1.4 m of Older Alluvium exposed at the foot of a schist outcrop.

OBS33

Schist exposure with strong foliation cleavage.

Orientation of shallow dipping foliation cleavage: 302/37

Orientation of steeply dipping foliation cleavage: 055/55