Hydrogeological Conditions

Redbank Copper:

Sandy Flat, Redbank, Azurite and Bluff

Issue No 1a

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Redbank Copper Limited

VDM CONSULTING

EcOz

Document Control

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Synopsis:	This document details the geological, hydrological and hydro-geological conditions at the Sandy Flat Pit, Redbank, Azurite and Bluff Oxide Deposits at Redbank Mines.

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1. Background

The Department of Primary Industry, Fisheries and Mines (DPIFM) in their Mine Water Quality Status Report on Sandy Flat Mine in July 2008 stated:

Over the nine year period from 1998 to 2006, seven of these years experienced higher wet season rainfall than the 30 year average annual rainfall. In response, the water inventory on site is at capacity and an average annual rainfall year results in overflow of highly contaminated water from Sandy Flat Pit into the receiving environment. The primary strategy of reducing the environmental risk will be achieved by a substantial reduction in pit water level. In addition to the excess water balance at this site, there is a highly transmissive paleo-drainage channel or strata beneath the operational area of the mine site, passing through the pit wall in the top 10m of its profile and continuing until intersecting Hanrahans Creek at Hanrahans Pool. The transmissive nature of this geology results in a continual seepage stream from Sandy Flat Pit into Hanrahans Creek. It is therefore essential the pit water level is reduced to below the level of the paleo-drainage channel to ensure seepage from the pit is minimised and overflow is impossible.

A survey conducted by DPIFM staff in 2004 identified that the water level in the pit was approximately seven metres above the channel base of Hanrahans Creek (Figure 5). The figure below is a conceptual diagram displaying the relationship between the paleo-drainage channel, the pit and Hanrahans Creek. Historic data suggests there is a high likelihood that much of the subsurface drainage on site reports either directly to the pit via the paleo-channel or via the Southern Low Flow Drain.

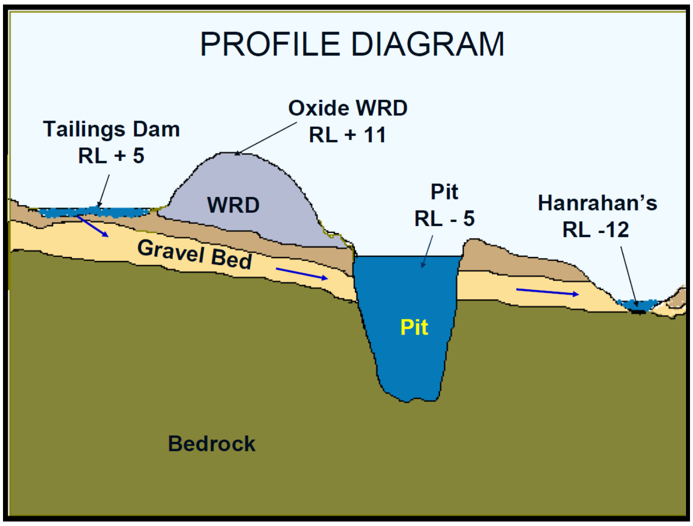


Figure 5: Conceptual diagram of subsurface drainage beneath Sandy Flat Mine.

(RL0 is arbitrarily taken from the top of a bore casing adjacent to the pit ramp) (DPIFM 2004)

In recent years the higher than average annual rainfalls have resulted in excessive seepage that has exceeded the capacity of the SLFD and breached the channel bund wall close to the overpass. A contributing factor to this is the high water level in the pit that is now continuous with water in the SLFD and now extends for at least two thirds of its length. This forces new flow in the SLFD to back-up and breach at a low point in the bund wall. The current water level in the pit is the most substantial contributing factor to off-site environmental contamination issues facing this site. The major challenge facing the operators is the lowering of the standing water level to approximately 10 metres below the current level. If this can be achieved and maintained it is likely the contaminated groundwater will also be collected in the pit with a resultant improvement in downstream water quality.

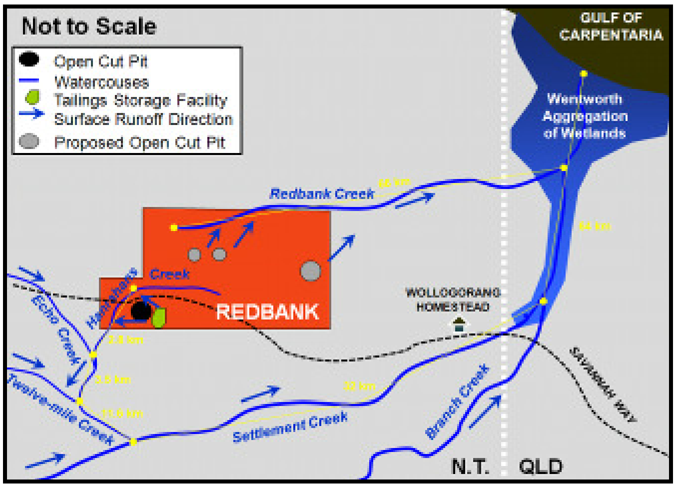
The current operators propose to address this critical issue by the installation of a resin column into their process circuit that will allow up to 99% of the copper to be removed from the pit water at a rate of approximately 2,400 m^3/day. The 'cleaned' water will then be either stored for later discharge and/or released during the wet season in accordance with a waste discharge licence. The company indicate currently that they aim to eventually empty the pit to enable an expansion of their mining operation. Measurable improvement in the water quality of Hanrahans Creek should be evident once the level of the pit is reduced below the paleo-drainage channel (approximately a 7m reduction in current water level).

2. Hydrology

2.1 Hydrological Setting

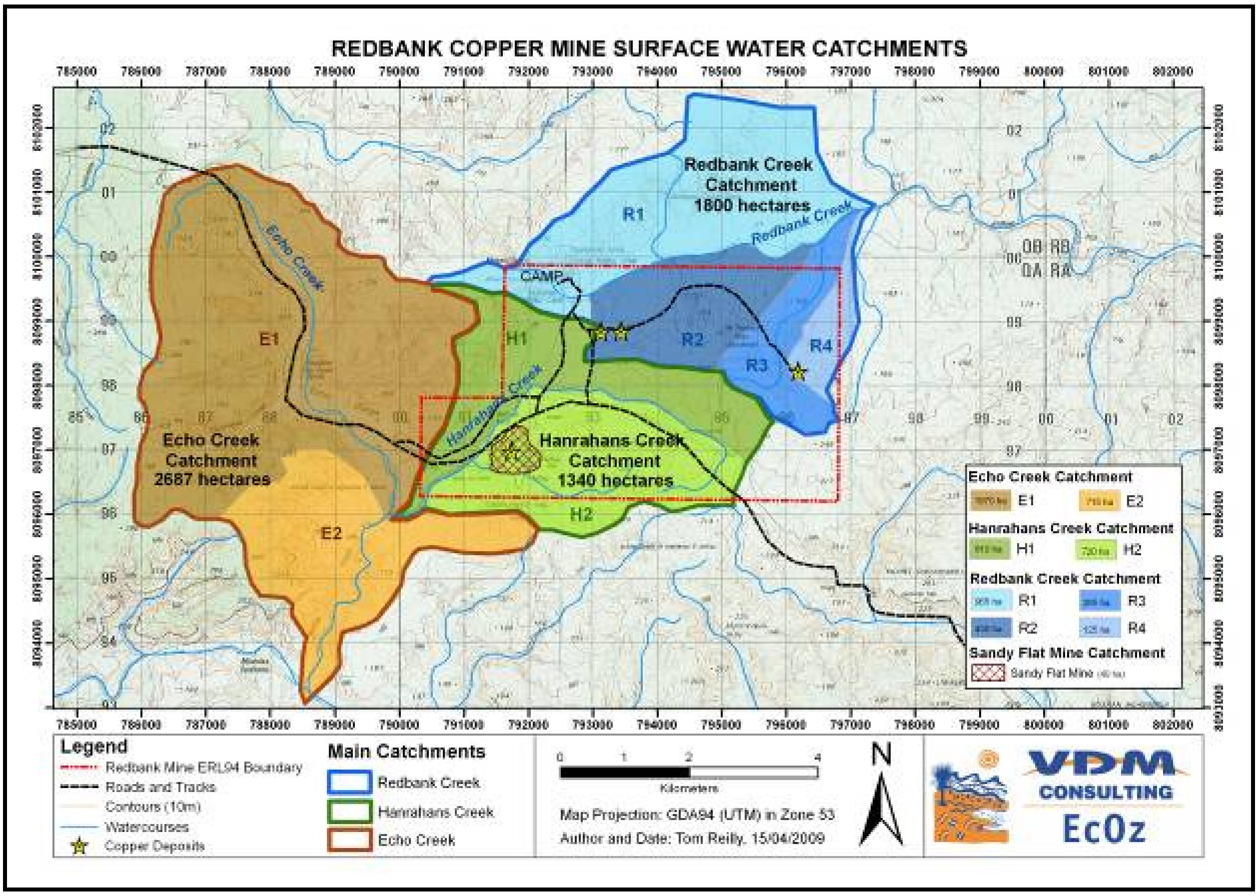
Redbank Mine (Figure 1) comprises the existing Sandy Flat Pit and Operations (SFP) and the Redbank (including Masterson's Open Pit some 10m deep), Azurite and Bluff deposits (from west to east). There is a distinct surface water divide between the SFP and other deposits although they are all located within the much larger Settlement Creek Catchment.

Figure 1: Schematic Diagram of Redbank ERL94 (in red).



The SFP is located on the eastern side of Hanrahan's Creek, a southerly draining ephemeral tributary of Settlement Creek (Figure 2) whilst the Redbank, Azurite and Bluff deposits are drained by the easterly draining Redbank Creek, also a tributary of Settlement Creek.

Figure 2: Surface Water Catchments.



Water from SFP enters Hanrahan's Creek which drains into Echo Creek some 2.8km downstream. Echo Creek drains into Twelve-Mile Creek and eventually Settlement Creek approximately 18 km downstream from SFP. The Wentworth Aggregation of Wetlands is the closest wetland and the only wetlands that might have been or may be impacted by mining activities in the Redbank area. These wetlands are 50km downstream of the SFP via Hanrahan's Creek or 66km downstream via Redbank Creek (Figure 1).

Settlement Creek is recognised in both the Northern Territory (NT) and Queensland as a healthy river that has environmental uses and values (Figure 3). The NT government has developed the Beneficial Use (water values) Declaration to assist in the protection and management of water resources under the *NT Water Act 1992* i.e. how a water body may be used is based upon the values placed on that water body. The beneficial uses for the NT portion of the Settlement Creek Catchment include Environmental, Riparian (or Agricultural) and Cultural (Table 1) and applies to all tributaries in respect of Settlement Creek (the waterway) that are situated within the Northern Territory. The Declaration of Beneficial Uses requires Waste Discharge Licenses (WDLs) for mining applications.

Figure 3: The Settlement Creek Catchment.

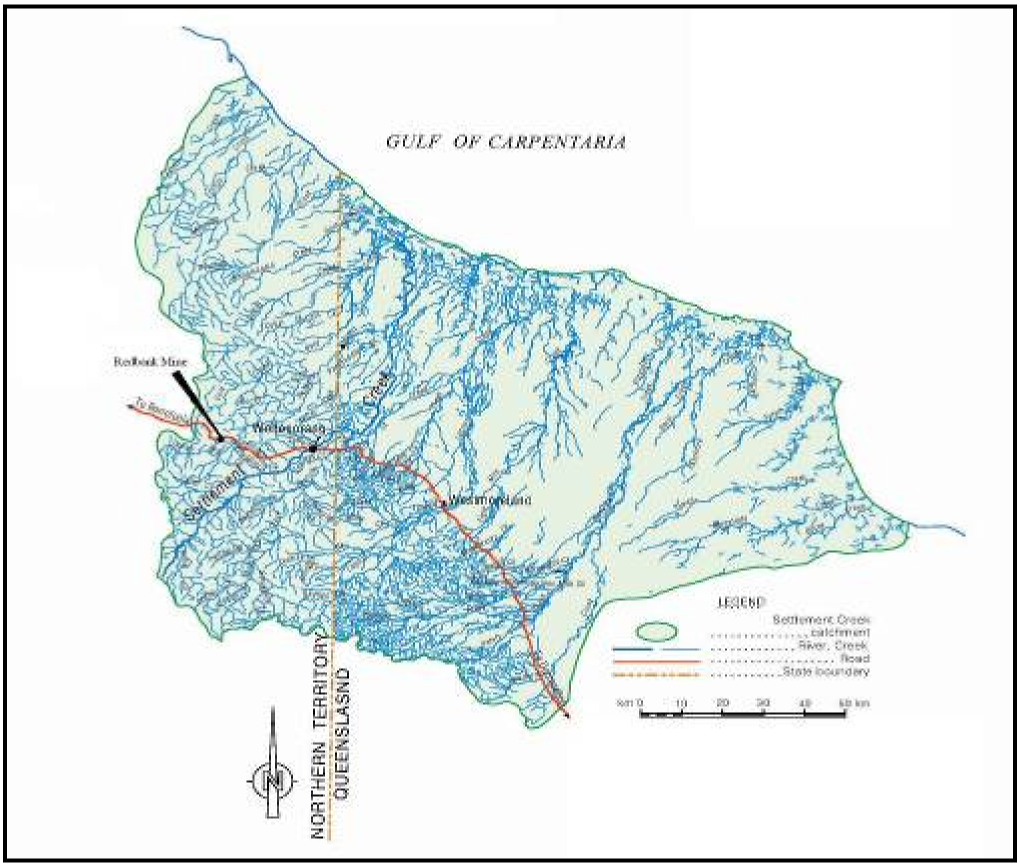


Table 1: Beneficial Uses of Settlement Creek.

Beneficial Use	Description
Environmental	To provide water to maintain the health of aquatic ecosystems.
Riparian (*now listed as Agricultural*)	Public rights and ownership rights to take water for domestic and/or stock purposes (*or provide water for primary production including related research*).
Cultural	To provide water to meet aesthetic, recreational and cultural needs.
The appropriate ANZECC Water Quality Guidelines to assess site environmental contamination are the 95% (for slightly to moderately disturbed ecosystems) and 80% (highly disturbed ecosystems) protection levels.	

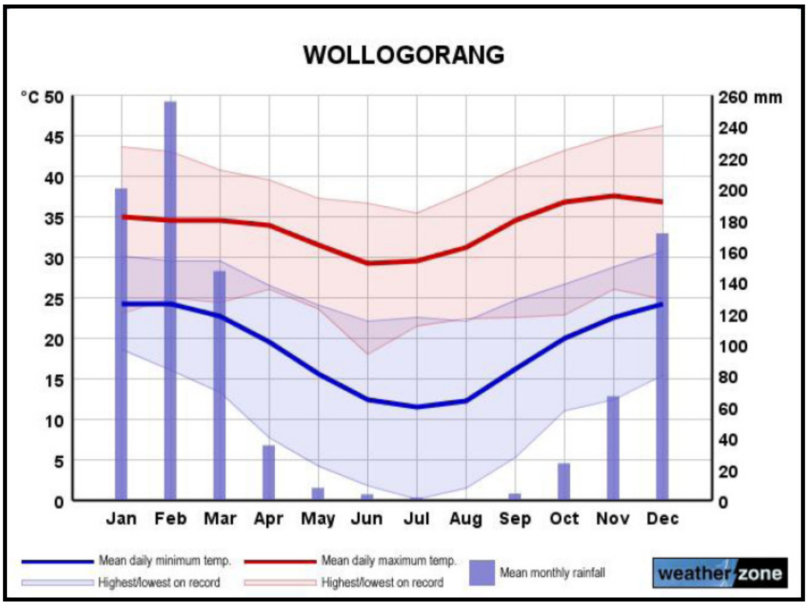
Queensland's *Settlement Wild River Declaration 2007* preserves the natural values of rivers that have not been significantly affected by development and thus have retained all, or almost all, of their natural values. Preservation is achieved though imposing development restrictions on the Wild River and its catchment area, and by regulating the taking of natural resources from the area. The Settlement Wild River Area includes both the Settlement River and the Wentworth Wetland Aggregation.

Since Redbank Mines lie within the Northern Territory it is subject to NT legislation only.

2.2 Surface Runoff

The climate at Redbank Mines is sub-tropical with well-defined wet and dry seasons:

Figure 4: Temperature and Rainfall Data for Wollogorang Station.



Most rain occurs in the months of October to April. The mean annual rainfall is 977mm (NT Bureau of Meteorology: Wollogorang Station, 32 year record up to 2009, some 30km east of SFP). The monthly rainfall data at Redbank appears in Table 2:

Table 2: Redbank Rainfall Data.

Year	Total	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wollogorang (Ave)	**979**	**1**	**1**	**4**	**23**	**67**	**164**	**223**	**249**	**161**	**38**	**7**	**3**
Evaporation (daily)	**2,237**	**5.3**	**5.3**	**5.7**	**6.3**	**5.6**	**4.8**	**5.4**	**6.4**	**7.6**	**7.8**	**7.2**	**6.1**
97/98	934	0	0	0	20	19	421	241	66	98	55	0	14
98/99	1,358	0	0	21	75	267	240	146	273	243	93	0	0
99/00	1,123	0	0	0	40	183	184	23	335	224	69	0	65
00/01	2,125	0	0	0	99	207	612	164	809	182	52	0	0
01/02	786	0	0	0	83	52	77	349	177	32	16	0	0
02/03	1,512	0	0	0	0	36	13	1,252	141	38	32	0	0
03/04	1,316	0	0	0	1	27	209	420	600	55	4	0	0
04/05	703	0	0	0	0	43	228	176	156	75	23	2	0
05/06	1,733	-	-	-	-	19	25	488	112	869	220	-	-
06/07	661	-	-	-	-	-	-	271	242	148	-	-	-
07/08	-	-	-	-	-	-	-	-	-	-	-	-	-
08/09	1,107	-	-	-	38	133	115	565	221	0	35	0	0
09/10	1,429*	0	0	0	0	74	160	768	527				
Average Redbank	**1,095**	**0**	**0**	**2**	**36**	**94**	**204**	**400**	**285**	**179**	**60**	**0**	**9**
All figures in mm. Highlighted values exceed average for Wollogorang Station.													

Table 2 illustrates that rainfall at Redbank exceeded the Wollogorang mean annual rainfall during 7 of the last 13 years.

The Settlement Creek catchment spans across the Northern Territory and Queensland border and covers an area of more than 15,000 km^2. The majority of the catchment lies within Queensland. Figure 2 illustrates the main sub-catchments of the Settlement Creek Catchment within the Redbank Exploration Retention License Number 94 (ERL 94). Table 3 tabulates the primary hydrological characteristics of the sub-catchments and indicates which catchments are, or will be, impacted upon by mining.

Table 3: Hydrologic Characteristics of the Sub-Catchments.

Catchment (Figure 2)	Sub Catchment	Area (ha)	Mean Annual Runoff (m^3/a)	Impacted Annual Runoff (m^3/a)
Redbank Creek	R1	905	442,998	
	R2 (Redbank and Azurite)	430	210,485	210,485
	R3	265	129,718	
	R4 (Bluff)	125	61,188	61,188
	Total (Redbank Creek)	**1,725**	**884,389**	**271,673 or 32%**
Hanrahans Creek	H1	610	298,595	
	H2	720	352,440	352,440
	Sandy Flat Mine	27	230,207	65% of H2 Runoff
Echo Creek	E1	1,970	964,315	
	E2 (downstream of H2)	715	349,993	
	Total (up to 12-Mile Creek)	**4,015**	**1,965,343**	**352,440 or 18%**
	Total	**5,740**	**2,809,730**	**624,113 or 22%**

The highlighted catchments are or may be impacted upon by mining.
Redbank Creek is currently undisturbed whilst SFP currently impacts upon Hanrahans Creek.
Runoff from natural catchments was estimated at 5% of mean annual rainfall (979mm) at Wollogorang.
Runoff from Sandy Flat Mine was estimated using runoff coefficients varying between 50% and 80% of mean annual rainfall (1,095mm) at Redbank.

The existing Sandy Flat Operations extend across some 27 ha within Catchment H2 and generates some 230,207m^3 surface runoff. A portion of this water has spilled into Hanrahans Creek in the past, particularly during high rainfall events and/or extremely wet years. The above estimations illustrate that the management of surface waters at Redbank is paramount if the impact of legacy issues are to be contained (medium term target) and/or reversed (long term target).

Surface water management entails two diversions drains (Southern, SLFD, and Northern, NLFD, Low Flow Drains) around the mine. These drains have low berms, approximately 100mm high, which diverts low flows (first flush) into the SFP whilst larger flows in the NLFD overflows into Hanrahans Creek.

2.3 Surface Water Quality

Settlement Creek has already been impacted upon by past mining activities at Redbank (Table 4). Acidic surface waters with elevated levels of copper and aluminium have been recorded in Settlement Creek since 1996.

Table 4: Average Water Quality in Settlement Creek.

Map Reference (Figure 2)	Distance Downstream (km)	pH	Al (µg/L)	Cu (µg/L)
	ANZECC Guidelines for Aquatic Ecosystems 95% species level	**6.5 - 8.5**	**55**	**1.4**
	ANZECC Guidelines for Aquatic Ecosystems 80% species level	**-**	**150**	**2.5**
17	SFP	**2.6**	**350,489**	**627,528**
24	0.5km Hanrahans Pool	**3.6**	**313,000**	**377,677**
6	3.3km confluence Echo Creek (2.8km)	**4.9**	**6,474**	**44,333**
9	6.8km confluence Twelve-Mile Creek (3.5km)	**6.0**	**190**	**1,588**
12	18.4km confluence Settlement Creek (11.6km)	7.9	50	**208**
13	37.1km Wollogorang Station (18.7km)	8.1	**213**	**25**
14	Reference Site (Branch Creek not affected by SFP)	8.7	126	2.2

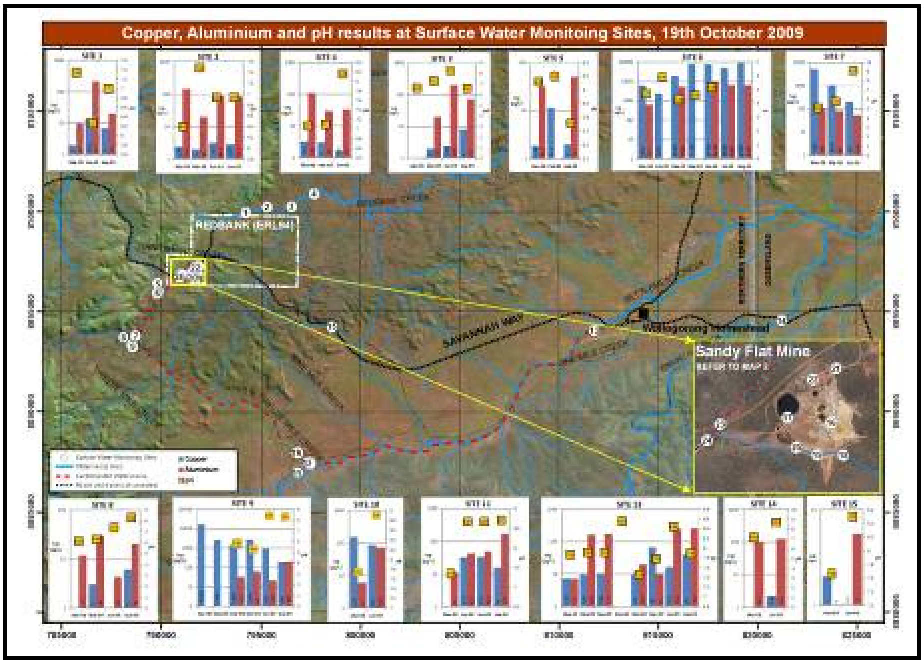
Averages for all monitoring records.
(2.8km) distance between sampling locations.
Highlighted concentrations exceed the 80% protection level.

It is apparent that none of the streams, including the reference site, meet the 95% protection level whilst Settlement Creek up to Wollogorang Station exceeds the 80% protection level.

Surface water sampling (Figure 5) has been undertaken at various locations across the sub catchments and along Settlement Creek. Small scale mining between 1916 and 1961 at the Redbank and Azurite deposits were regarded as insignificant with no detrimental effect on the quality of water in Redbank Creek. As such, Redbank Creek is deemed close to pristine and water sampling data gathered thus far will be used as a baseline against which future water qualities can be assessed.

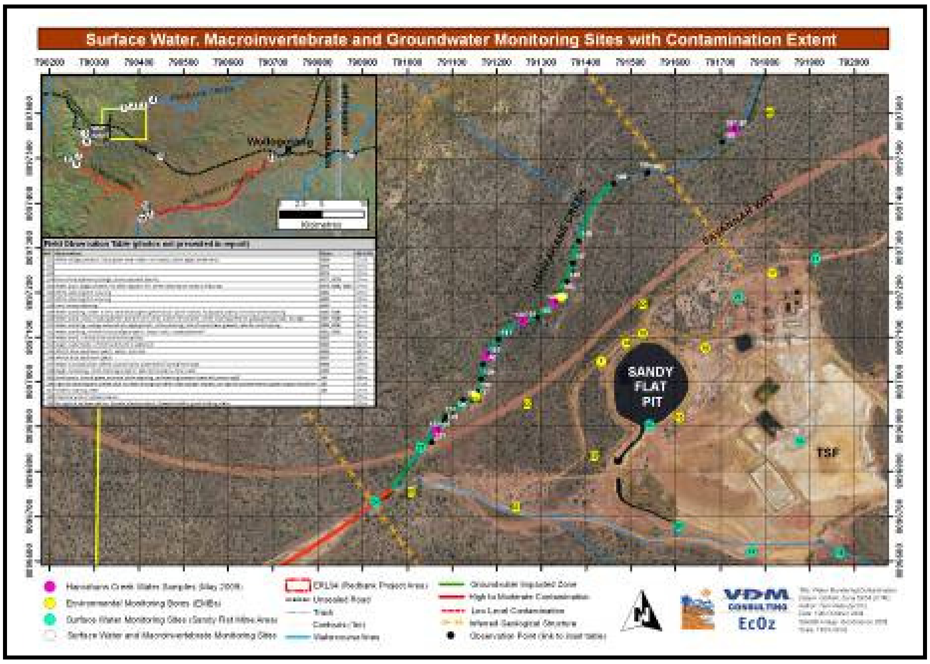
The Hanrahan's Creek Catchment is currently impacted by the legacy of past mining operations at ERL94 (Figure 5). It is evident that acidic metal laden waters from the Tailings Storage Facility (TSF), Waste Rock Dump (WRD) and Sandy Flat Open Pit (SFP) impacted upon Hanrahan's Creek through a combination of direct runoff and indirect ground water seepage emanating in Hanrahans Pool (DPIFM, 2008).

Figure 5: Surface Water Monitoring.



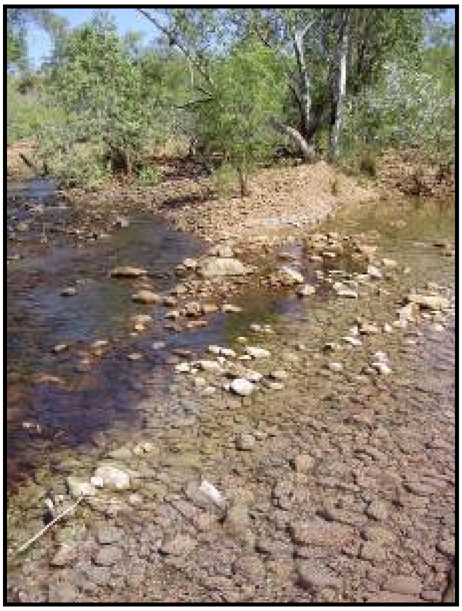
Extensive field surveys confirmed the extent of the impacted zone downstream of SFP (Figure 6) but it seems that an inferred geological structure downstream of Hanrahans Pool limits indirect discharges through ground water seepage to the creek downstream of the pool. However overflows from Hanrahans Pool impacts on the remaining downstream streambed of Hanrahans Creek to the confluence with Echo Creek and beyond due to the acidity and levels of concentrations of heavy metals in surface runoff from the pool.

Figure 6: Extent of Contamination along Hanrahans Creek.



Between 2002 and 2006 copper concentrations at Settlement Creek, 35 km downstream of SFP, exceeded the ANZECC 80% protection level guidelines for Aquatic Ecosystems. Recent 2008 sampling at the confluence of Settlement and 12 Mile Creek, 17 km downstream of SFP, measured concentrations of all major metal elements at concentrations markedly higher than the 80% protection levels. Visual observations along the streambeds of the various creeks confirmed contamination as pools are invariably clear, bluish (indicative of acidity and heavy metals) and the lack of aquatic life and stream vegetation (Figure 7):

Figure 7: Confluence of 12-Mile (left) and Echo (impacted – right).



Macro-invertebrate sampling has been undertaken since 2008 and is scheduled to be undertaken annually throughout the life of the proposed mining activities. Comparison between reference and contaminated sites reveal a significant reduction in macro-invertebrate diversity in waters downstream of the SFP. Earlier 2003/2004 macro-invertebrate data revealed that the more sensitive taxonomic orders e.g. mayflies were absent downstream of 12 Mile Creek (the closest study site to SFP and 17 km downstream). The total number of animals and number of taxa was reduced compared to reference sites which included those in Redbank Creek (Humphrey *et al.* 2008). These studies provide important baseline data against which improvements in water management at SFP and future expansions can be measured against. It seems that should the current water management measures at SFP improves water quality in Hanrahans Creek, that re-colonization from upstream assemblages is possible. There was a lack of discernable impact of historical mining activities on macro-invertebrates in Redbank Creek (Humphrey *et al.* 2008). This may be due to the fact that mining activities were limited in extent and depth and restricted to the oxide zone. Exploration soil surveys showed localised copper anomalies around the workings with no significant migration of metal down slope towards Redbank Creek.

2.4 Contaminant Ranges and Trigger Values

Monitoring in the Redbank Creek (Sample Locations 1 to 4) indicated the following concentrations and ranges for a selected number of hydro-chemical parameters (primary metals of concern or indicators of contamination):

Table 5: Water Quality in Redbank Creek.

Parameter	Min	Max	Ave	Std Dev	95%	80%
pH	**6.2**	8.3	6.6 – 7.9	0.0 – 0.8	6.5 – 8.5	
Copper	**11**	**42**	-	-	1.4	2.5
Aluminium	10	**360**	-	-	55	110
Note:	**Metal concentrations are in µg/L unless otherwise indicated. Highlighted concentrations exceed the ANZECC Guidelines.**					

Monitoring in Hanrahans Creek (Sample Location 23: Rock Bar at Hanrahans Pool) indicated the following concentrations and ranges for a selected number of hydro-chemical parameters (primary metals of concern or indicators of contamination):

Table 6: Water Quality in Hanrahans Creek (Rock Bar at Hanrahans Pool).

Parameter	Min	Max	Ave	Std Dev	95%	80%
pH	**3.3**	**4.6**	**3.9**	0.5	6.5 – 8.5	
Copper	**29,100**	**248,000**	**147,700**	110,591	1.4	2.5
Aluminium	**12,100**	**60,300**	**28,533**	27,516	55	110
Note:	**Metal concentrations are in µg/L unless otherwise indicated. Highlighted concentrations exceed the ANZECC Guidelines.**					

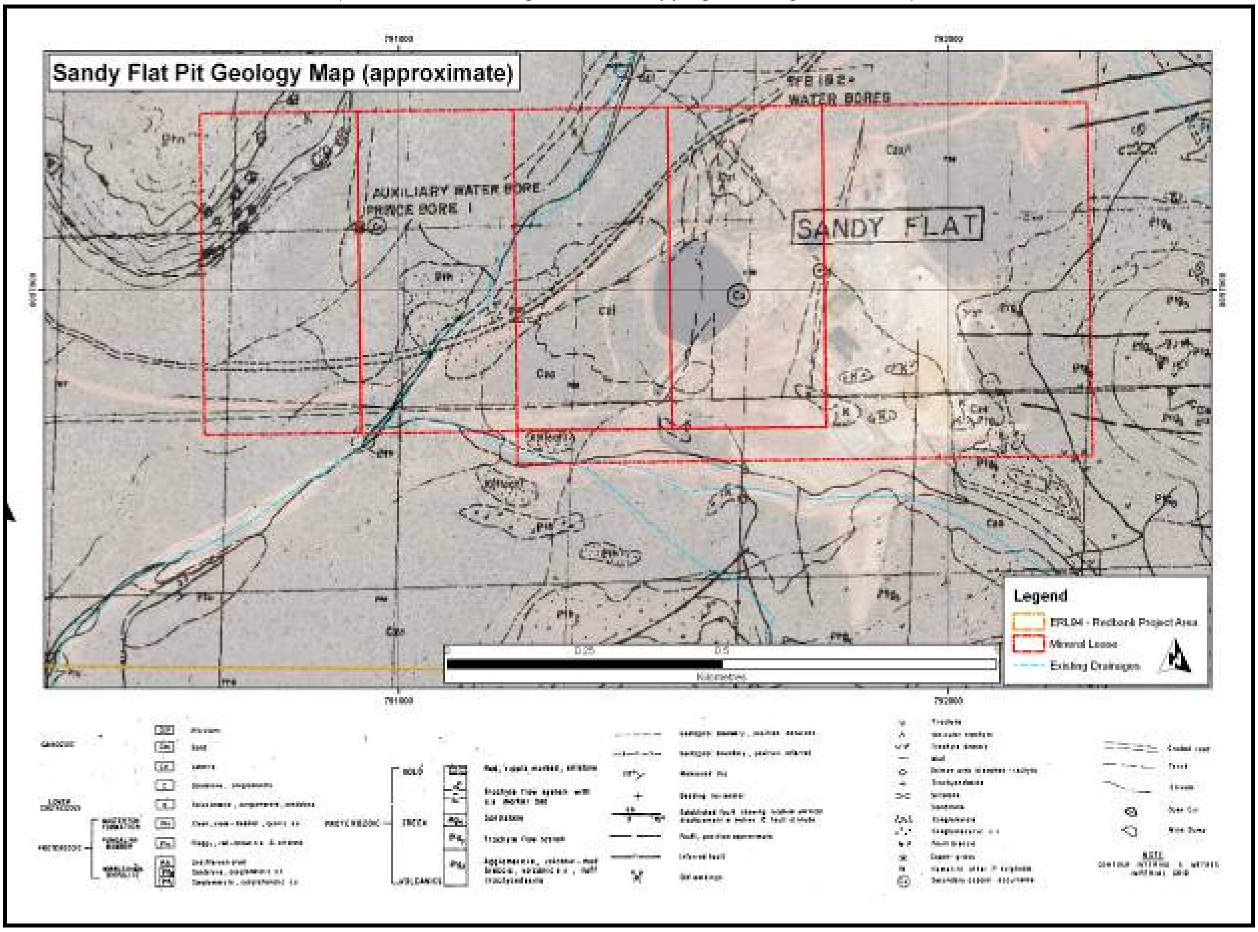
The maximum values are to be used as short term triggers whilst the long term triggers are to be set at the 80% protection level.

3.1 Geological Setting

DBG prepared a geological report for Redbank Mines in April 2009 (DBG, 2009). The primary objective was to review the mapping by AMDEX Mining Ltd (Figure 8) and examine outcrops in the mineralized zones. DBG regarded the AMDEX mapping *as quite accurate and of a high standard*.

Figure 8: Mapping at Sandy Flat.

(from AMDEX Mining 1:10,000 mapping, Fleming, et al, 1975)



The following observations are relevant to understanding the geological and structural controls that will influence the occurrence and movement of ground water across the SFP:

- The entire area is underlain predominantly by alluvium, sand and laterite.
- The immediate west and north-west of the SFP is underlain by laterite (C_{zl}), the south-west by alluvium (C_{za}) with rhyolite (P_{th}) along Hanrahans Creek and sandstone (P_{tn}) to the west forming the plateau.
- The TSF is underlain by alluvium with several floaters of breccias and conglomerates.
- Geological structures viz. fault zones and fracture systems strike predominantly east-west although there is also a dominant north-west strike outside the mining area. These structures are obscured by the alluvium across the mining area.
- There is a significant east-west striking fault zone through the TSF and south of Hanrahans Pool.

DBG indicated that the Redbank Copper Project *occurs within a 100km wide and 400km long north-west trending structural corridor that parallels the Calvert Fault* (Figure 9). *The copper mineralization is primarily hosted by breccia pipes (less than 75m in diameter) or vein-like zones of alteration. Disseminated and veinlet chalcopyrite is the primary copper ore. The upper 35m has been oxidized by surface weathering.*

The local basic geological setting across the Redbank Copper Project is depicted in Figure 10 overleaf.

Figure 9: Regional Mapping (DBG, 2009).

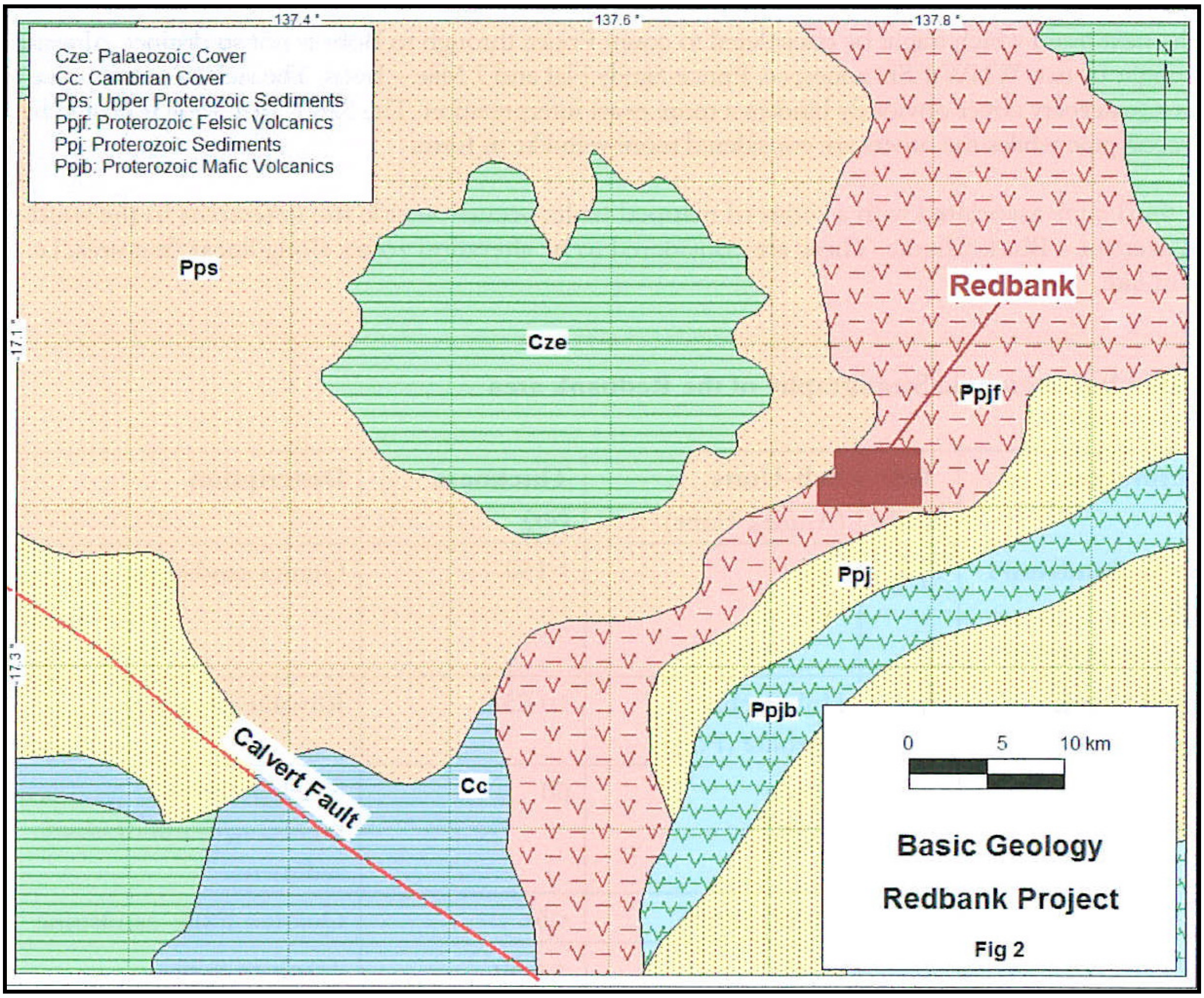
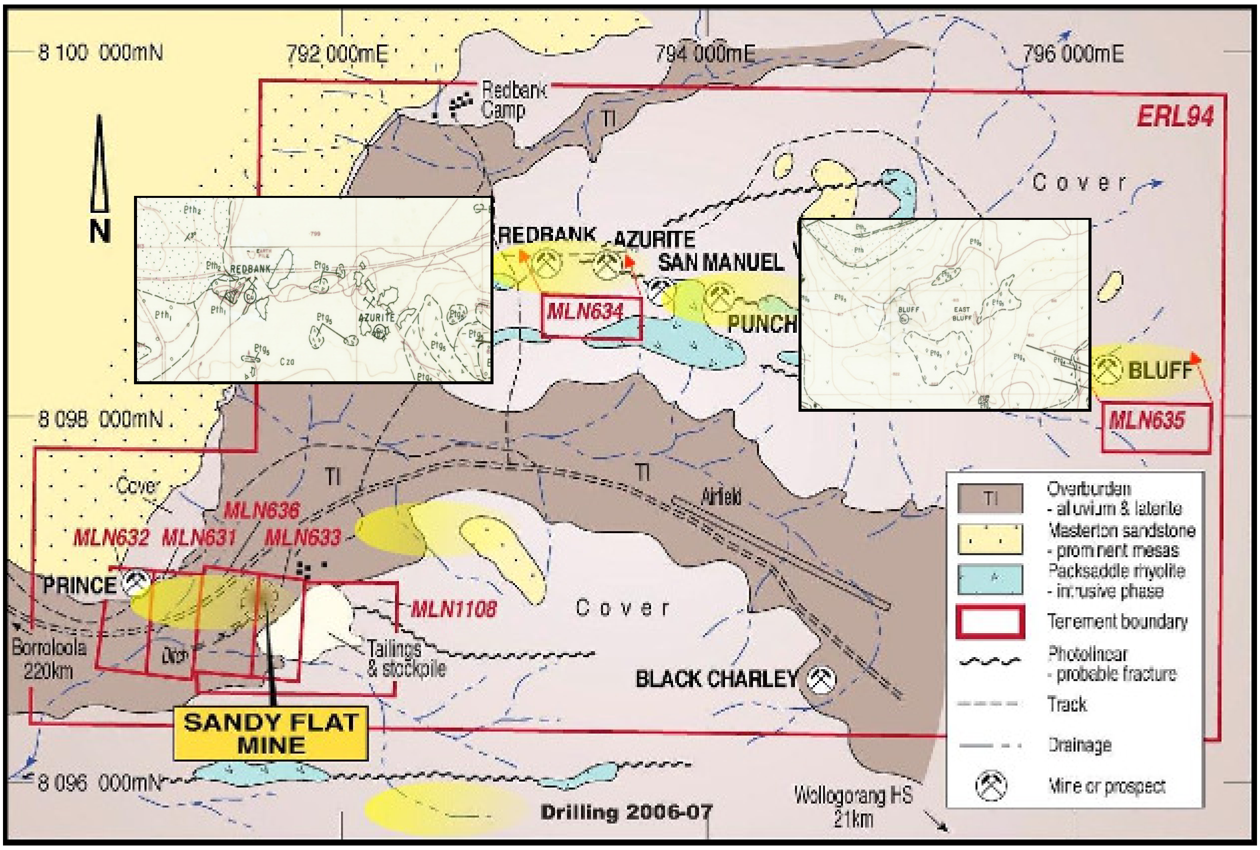
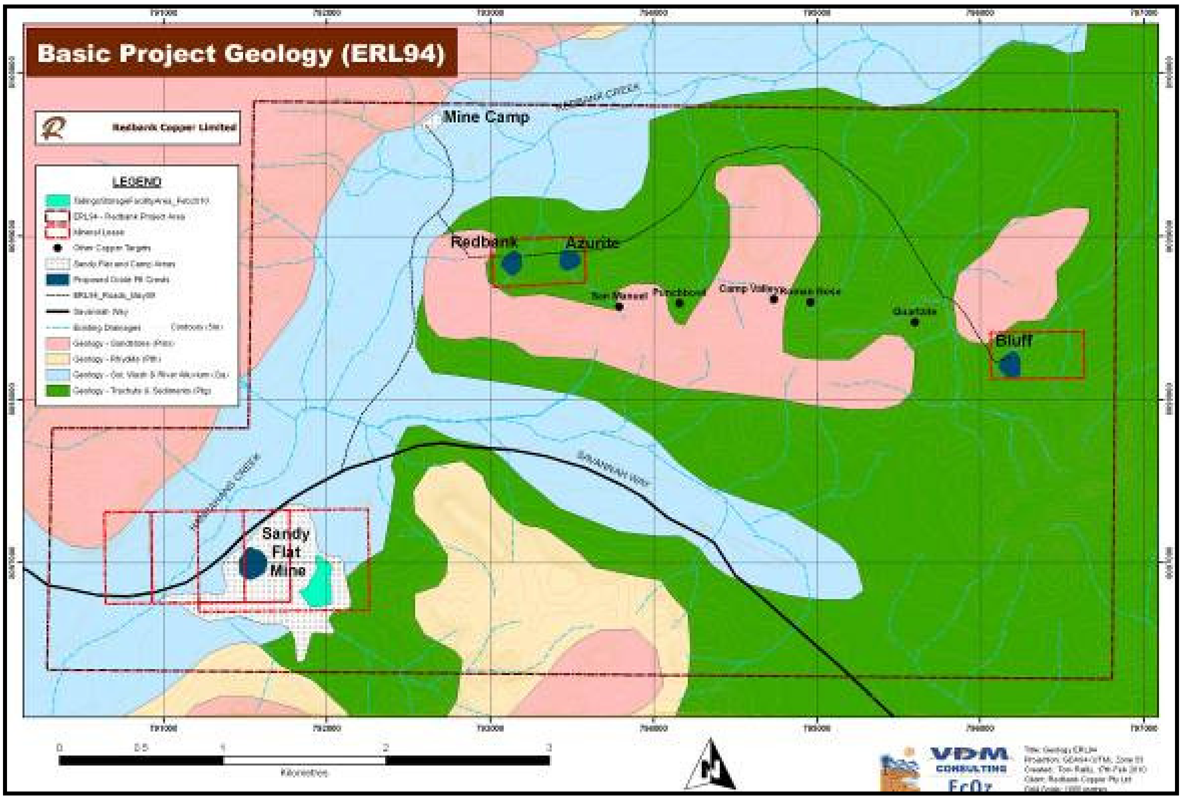


Figure 10: Redbank Basic Geological Setting.

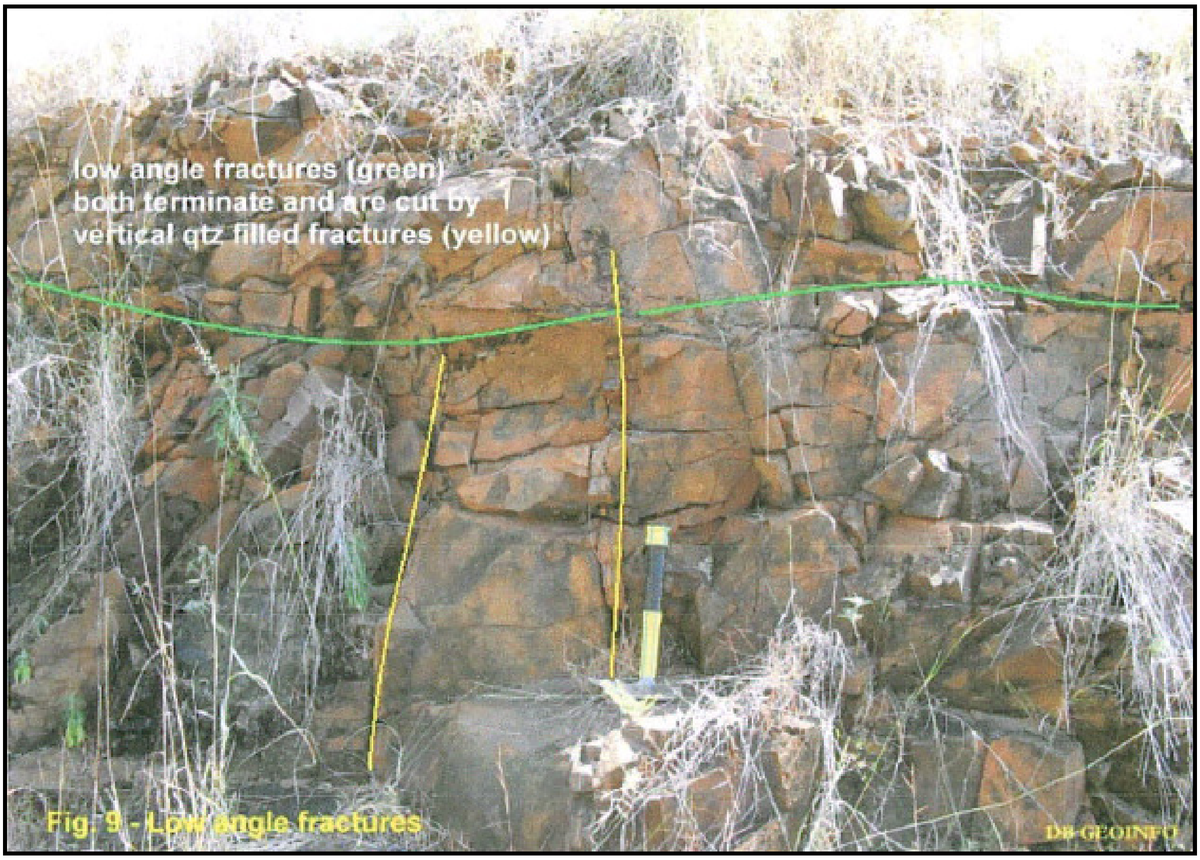


A similar basic geological map has been included in the EIS:



In contrast to the alluvial and lateritic cover at SFP, the Redbank, Azurite and Bluff deposits occur within hard outcropping fractured bedrock.

Figure 11: Geology at the Redbank Deposit (DBG, 2009; refer Figure 10).



The geological cross-sections and maps in Figures 12 and 13 overleaf further illustrate the geological setting and structure at Redbank Mines.

Figure 12: Geological Cross-Section.

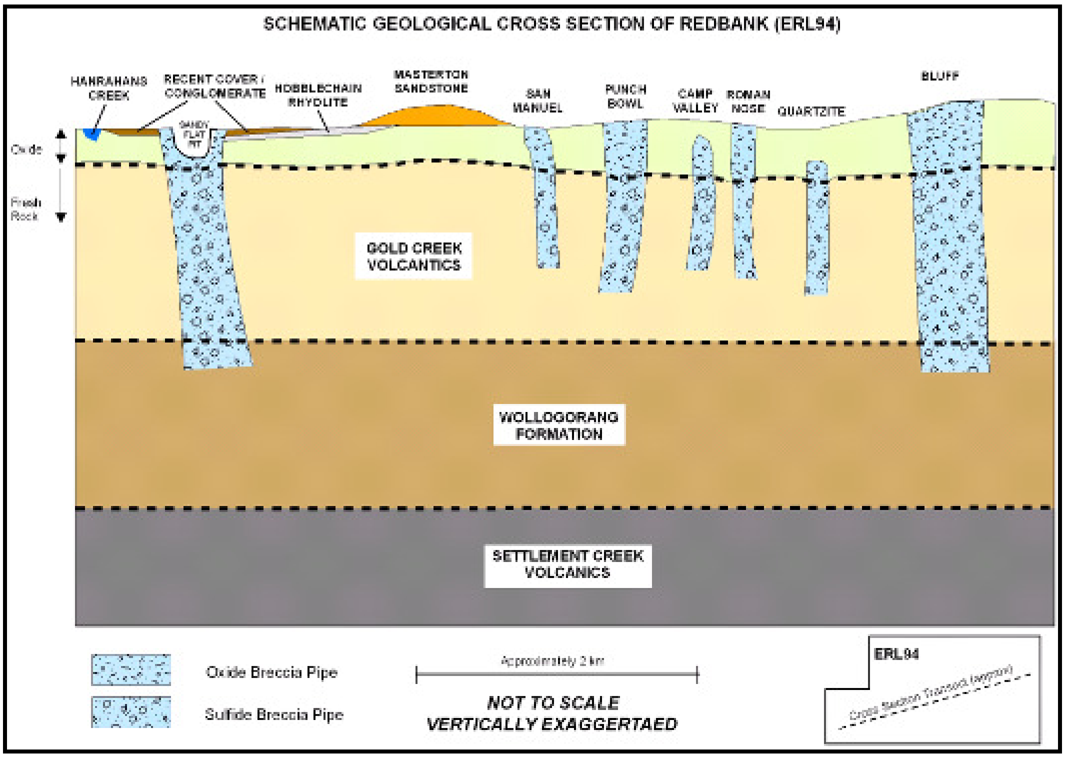
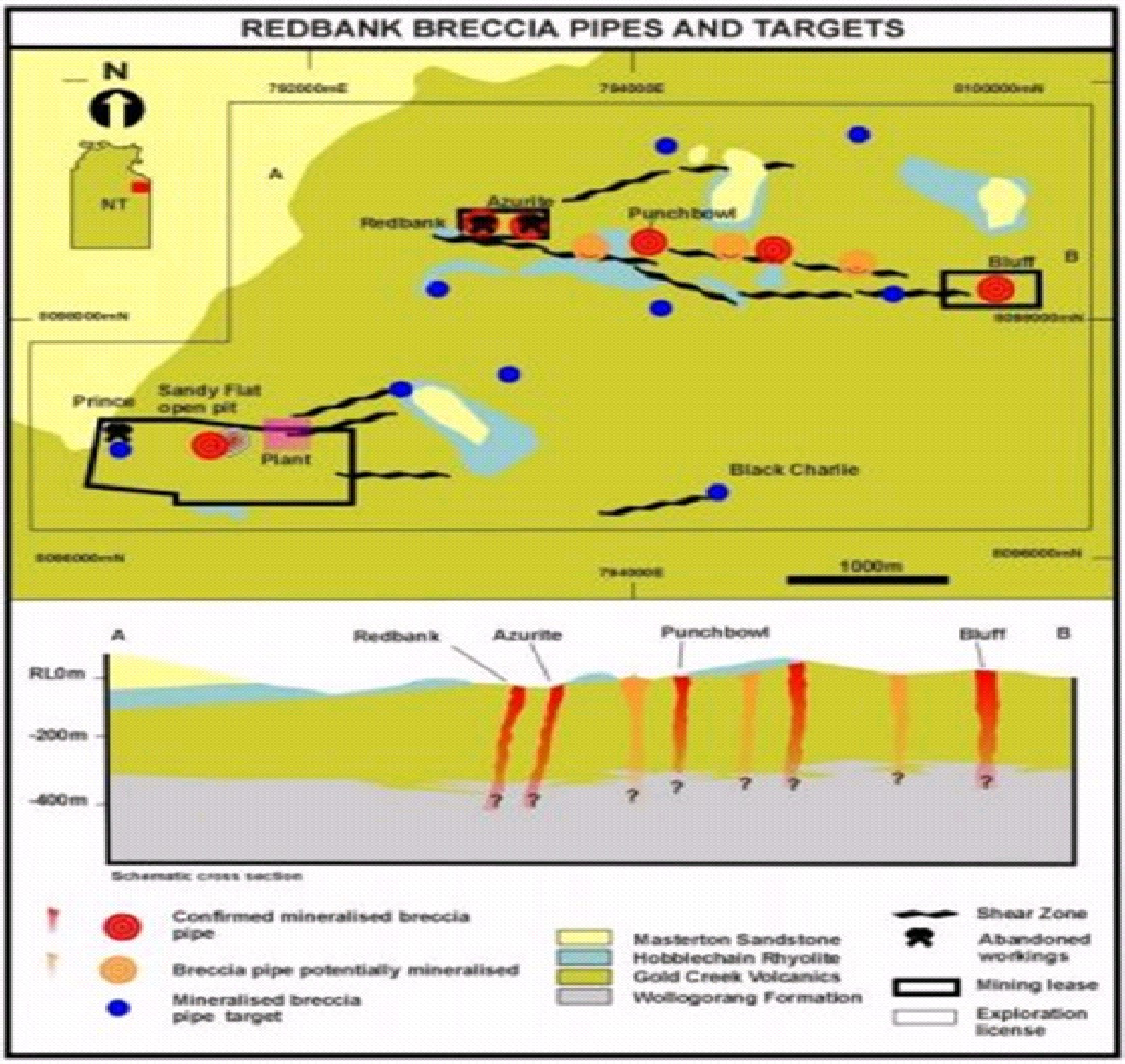


Figure 13: Redbank Breccia Pipes and Targets (source unknown).



4. Hydrogeology

4.1 Geophysical Investigations

Extensive geophysical investigations employing magnetic, gravimetric and Transient Electro Magnetic (TEM), primarily aiming at mineral exploration, were undertaken during 2009 by Alpha Geoscience. The TEM survey employed, after extensive testing of numerous loop sizes and configurations, a 50m by 50m transmitter loop with a centrally positioned roving receiver coil (RVR). This configuration was chosen in preference because of the presence of Super Parra-Magnetism (SPM) caused by the interaction of the primary field with iron minerals in the uppermost part of the regolith profile usually where laterite is present. The TEM data, due to loop configuration and geological setting, did not reflect fracturing and/or faulting to a scale that could assist in selecting drilling targets for ground water and/or contaminant investigations. Magnetic and gravimetric surveys were undertaken largely across exploration targets and therefore did not assist in the selection of ground water drilling targets between the ore body and downstream surface drainage features.

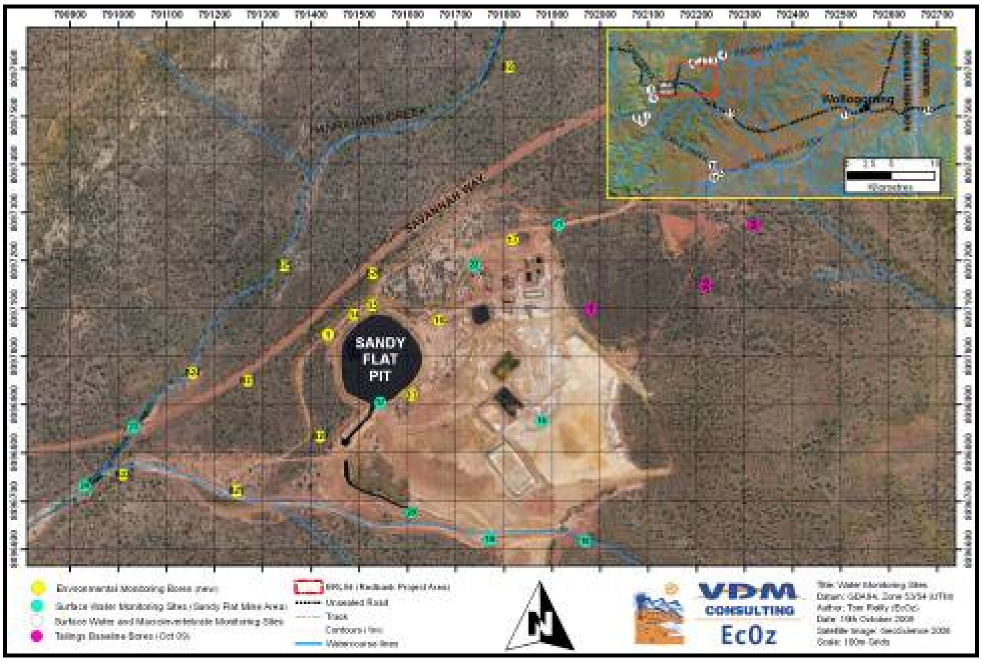
Nevertheless, a close inspection of the geophysical data revealed that the area between the SFP and Hanrahans Creek is largely devoid of any major significant structural features such as large-scale faulting/fracturing and/or broad zones of weathering which may have a bearing of the occurrence and movement of ground water. The Hanrahans Creek bed was subsequently surveyed (Figure 6) extensively to record seepage and other visual indicators to assist in mapping of the contaminated zone.

Further geophysical investigations are earmarked employing EM-34 and Geonics electro-magnetic systems.

4.2 Selection of Drilling Targets

Due cognisance was taken of observations during detailed site inspections of the existing infrastructure (open pit, heap leach pads, VATs, TSF, WRD, stockpiles and plant) and the area between the SFP and Hanrahans Creek, coupled with a detailed field traverse along Hanrahans Creek (Figure 6), and inspections of topographical, geological (the area is blanketed by a veneer of sand and cemented laterite) and bore data (existing bores 1, 13, 14, 15, 16 and 17 are indicated in yellow on Figure 14), aerial photos and drainage features in proximity to select drilling targets between the SFP and Hanrahans Creek. The primary aim of the drilling program was to facilitate a preliminary assessment and characterization of the ground water regime and seepage zone, including its possible extent, between the SFP and Hanrahans Creek, to provide suitable locations for ground water monitoring and to define future detailed drilling and bore testing programs employing slug and pump test methods.

Figure 14: Bore Locations at Redbank.



Bores 1, 2 and 3 (indicated in pink on Figure 14) were drilled to assess the geological and hydrogeological regimes underlying the area for the proposed new TSF.

The new investigative bores (indicated in yellow on Figure 14) were drilled between the SFP and adjacent to Hanrahans Creek:

- B27: upstream and outside the zone that may have been impacted upon by seepage from the SFP.
- B25: adjacent to Hanrahans Creek at the anticipated uppermost limit of contaminated seepage (expression of SFP water in Hanrahans Creek).
- B26: due north of the SFP to assess migration of contaminants in a northerly direction.
- B24: visible precipitation of salts in Hanrahans Creek and within the zone impacted upon by seepage from the SFP (expression of SFP water in Hanrahans Creek).
- B23: between the SFP and Hanrahans Creek.
- B20: downstream of the TSF and WRD.
- B21: downstream of the TSF and WRD - the anticipated downstream limit of the seepage zone (expression of SFP water in Hanrahans Creek), south and close to an interpreted east-west fault zone (Figure 8).
- B22: adjacent to and upstream of Hanrahans Pool an expression of SFP water in Hanrahans Creek.

4.3 Investigative Drilling

The information and data gathered during the investigative drilling program appear in Table 7. Detailed bore logs may be found in Appendix A.

Table 7: Investigative Drilling Data.

Bore Number Figure 14	Reference Number	Coordinates		Elevation	Depth	GW	GWL (Jan 10)	Lithology		
		N	E	(mAHD)	(mbgl)	(mbgl)	(mAHD)	Alluvium	Trachyte	Silt/Sand
Sandy Flat Pit (prefix SFMB09-)										
B27	008	7,603	1,811	175.5	48	8 & 16	170.8	4	44	-
B26	005	7,174	1,528	175.0	48	10	169.0	7	41	
B25	007	7,190	1,345	170.0	48	18(s)	168.5	-	48	-
B20	003	6,834	1,418	174.0	48	18(L)	169.0	4	-	44
B23	004	6,950	1,269	171.5	48	22-24	168.2	-	15	33
B24	006	6,966	1,154	168.0	48	24-42f	artesian	-	-	48
B21	002	6,721	1,244	170.5	48	11	169.2	-	9	39
B22	001	6,754	1,009	168.0	48	16	artesian	-	15	33
Tailings Storage Facility (prefix SI-)										
S1	S1	7,116	1,976	182.0	48	17.0	171.8	-	48	-
S2	S2	7,155	2,218	186.1	48	22.0	171.4	-	48	-
S3	S3	7,272	2,319	186.5	48	24.0	171.7	-	48	-
Bluff Deposit (prefix BLMB09-)										
B31	001	8,320	6,020	-	66	Dry	Dry	-	66	-
B32	002	8,340	6,300	-	96	Dry	Dry	-	96	-
Existing Bores										
Entrance (1.3kmS of Camp)		7,800	2,400	-	42	8.5–2.5L/s	8.0	-	18-42	0-18
Sandy Flat Pit Bore 1		6,900	1,300	-	42	8.5-2.0L/s	8.0	0-2	8-42	2-8
Sandy Flat Pit Bore 2		6,900	1,300	-	42	8.5-2.0L/s	8.0	0-2	8-42	2-8

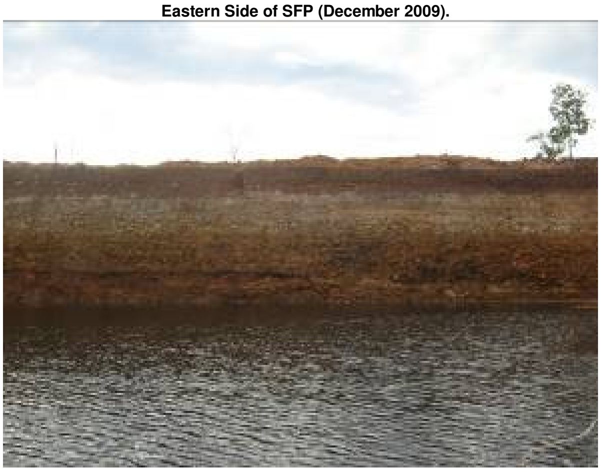
GW denotes ground water strike or depth at which ground water was encountered during drilling
GWL denotes ground water level
Silt/Sand hard rock siltstone and sandstone locally with overlying clay.
s: small and L: large quantities of ground water; f: large-scale fracturing.
Bores B22 and B24 are artesian flowing at <0.1L/s on 16 September 2009.
20 October 2009: SFP Water Level = 169.64mAHD (22 September = 169.96mAHD); Hanrahans Pool = 164.90mAHD.

From the observations made during the drilling program and data gathered it seems that ground water occurs predominantly in a fractured geological environment comprising medium to hard rock sandstone and siltstone overlain by trachytes and weathered strata comprising unconsolidated sand and laterite where present. It is evident that drilling did not encounter the highly permeable layer (paleo-channel) i.e. the layer is not continuous and/or is not as well developed between the SF Pit and Hanrahans Creek as previously postulated (DPIFM, 2004). The following photos confirm the above observation that the paleo-channel is less well developed at the downstream end of the SFP:

Aerial Photograph of SFP (February 2010).

Ramp into SFP (note: paleo-channel, February 2010).

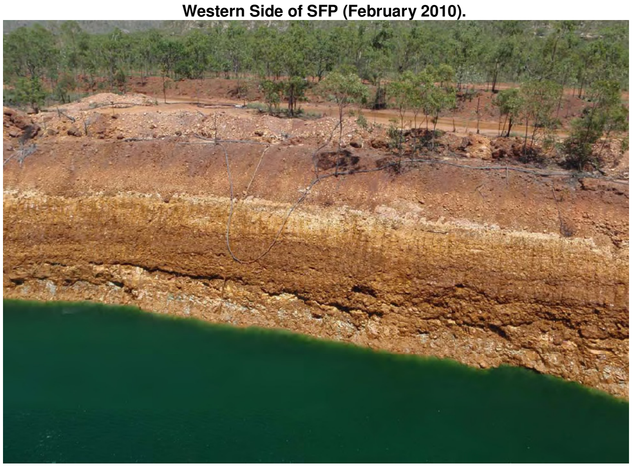
Eastern Side of SFP (December 2009).



North-Eastern Side of SFP (February 2010).

Western Side of SFP (December 2009).

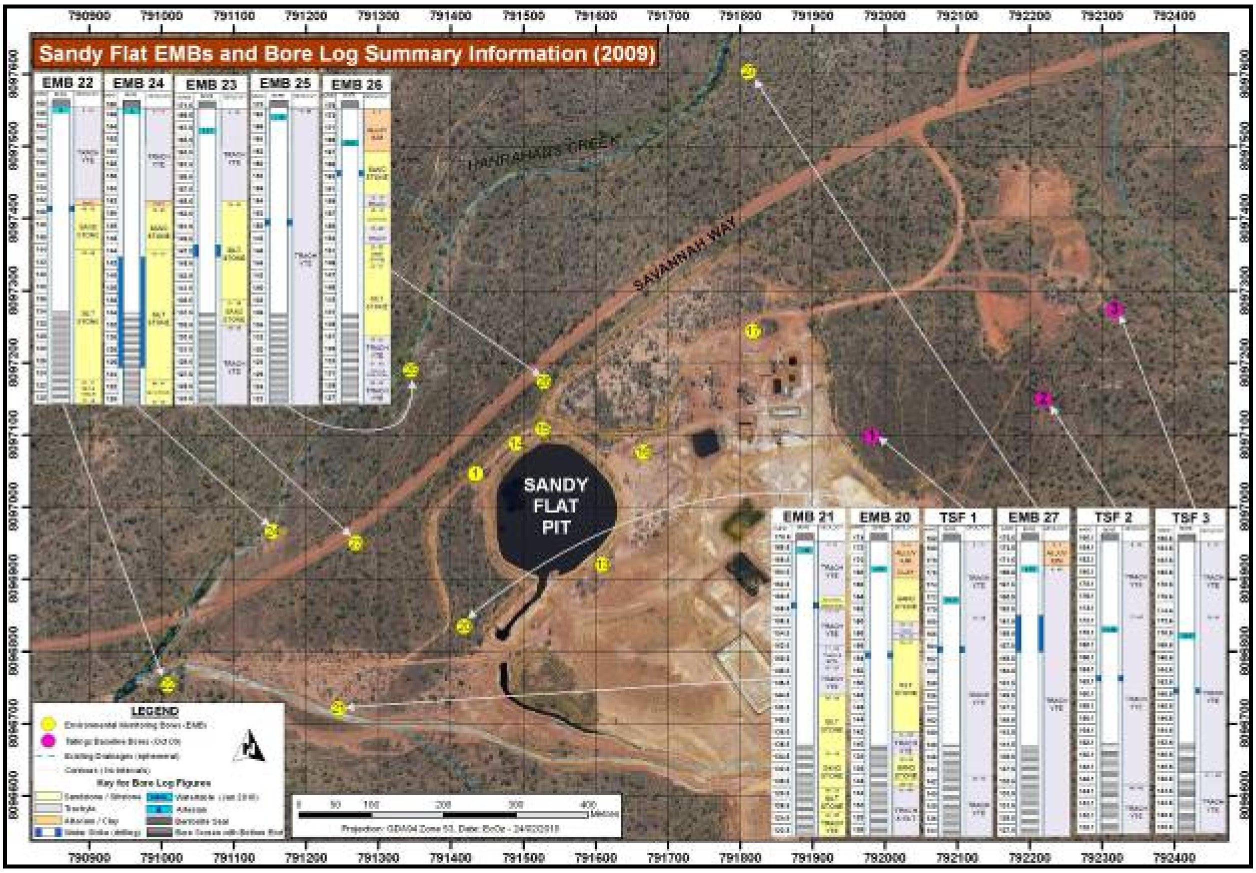
Western Side of SFP (February 2010).



There is no indication that a shallow and/or multiple aquifers exist between the SFP and Hanrahans Creek as ground water was encountered in fractures in sandstone whilst the overlying trachytes and weathering/shallow strata did not contain ground water (Figure 15). Locally artesian conditions may prevail where clays overly the fractured sandstone. Even if the permeable paleo-channel does exist in places, it seems that ground water flow behaviour is predominantly fractured rather than homogenous i.e. ground water flow will take place through smaller interconnected fractures and distinct zones rather than continuously throughout a permeable alluvial/sand bed. Detailed bore construction logs can be found in Appendix A.

The bores were completed in October 2009 and are currently being monitored for water levels and water quality on a monthly basis.

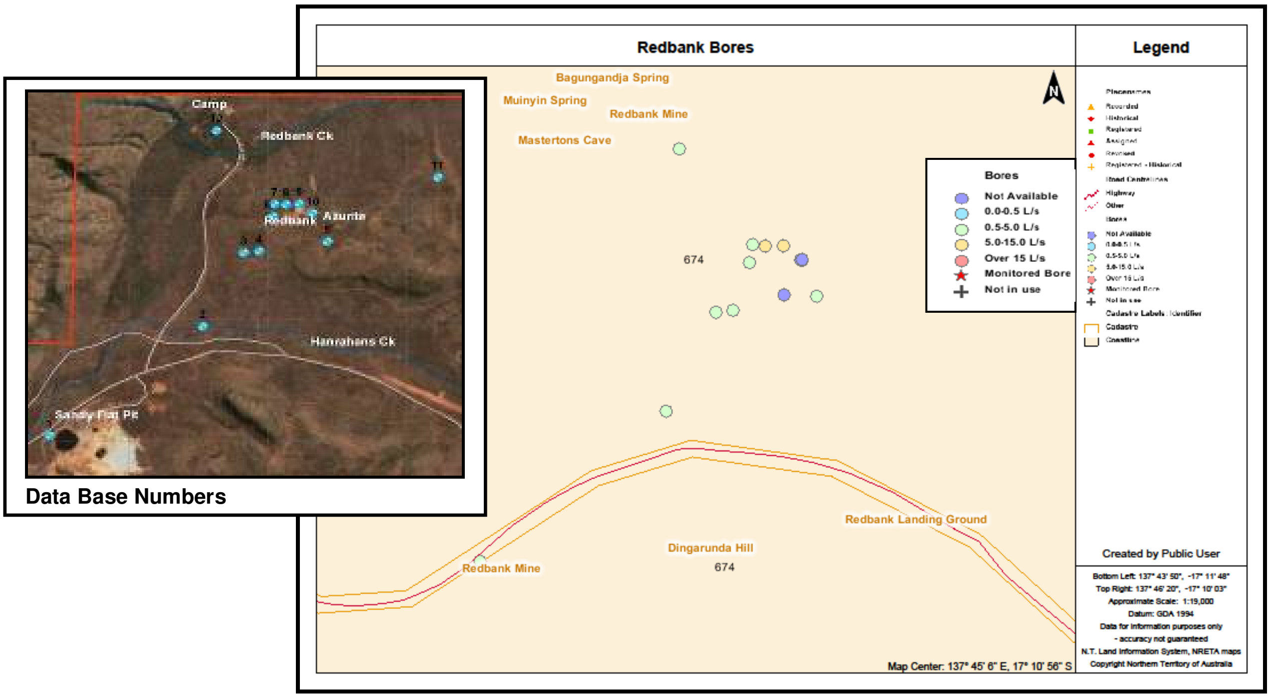
Figure 15: Bore Construction and Lithology (refer Appendix A: Detailed Bore Logs).



4.3.1 Ground Water Yields

Taking due cognisance of the yields of existing bores (Figure 16; these bores were re-numbered in the insert; numbers have a prefix EMB in the Ground Water Monitoring Database) and observations made during the drilling program, ground water yields are expected to be low i.e. in the range between 0.1L/s and 2.5L/s. A detailed bore testing program is yet to commence. This program will aim at determining the hydraulic parameters for the aquifer for detailed hydrogeological modelling employing flow and mass transport finite element techniques.

Figure 16: Existing Bores at Redbank.



4.3.2 Ground Water Levels and Flow Directions

Ground water levels are close to the surface (Figure 17): between 1.32m and 14.90m below ground level and resemble the local topography i.e. flow directions and hydraulic gradients are towards drainage features. There is a regional southerly and south-westerly gradient across Sandy Flats. Two bores i.e. 22 and 24 in close proximity to Hanrahans Creek are artesian; fracturing was encountered in sandstone underlying dense trachytes and clay. Currently (January 2010) there is a slight gradient towards the SFP due to dewatering and treatment of acidic pit waters to eliminate seepage from the TSF towards Hanrahans Creek.

Figure 17: Ground Water Level Contours (January 2010).

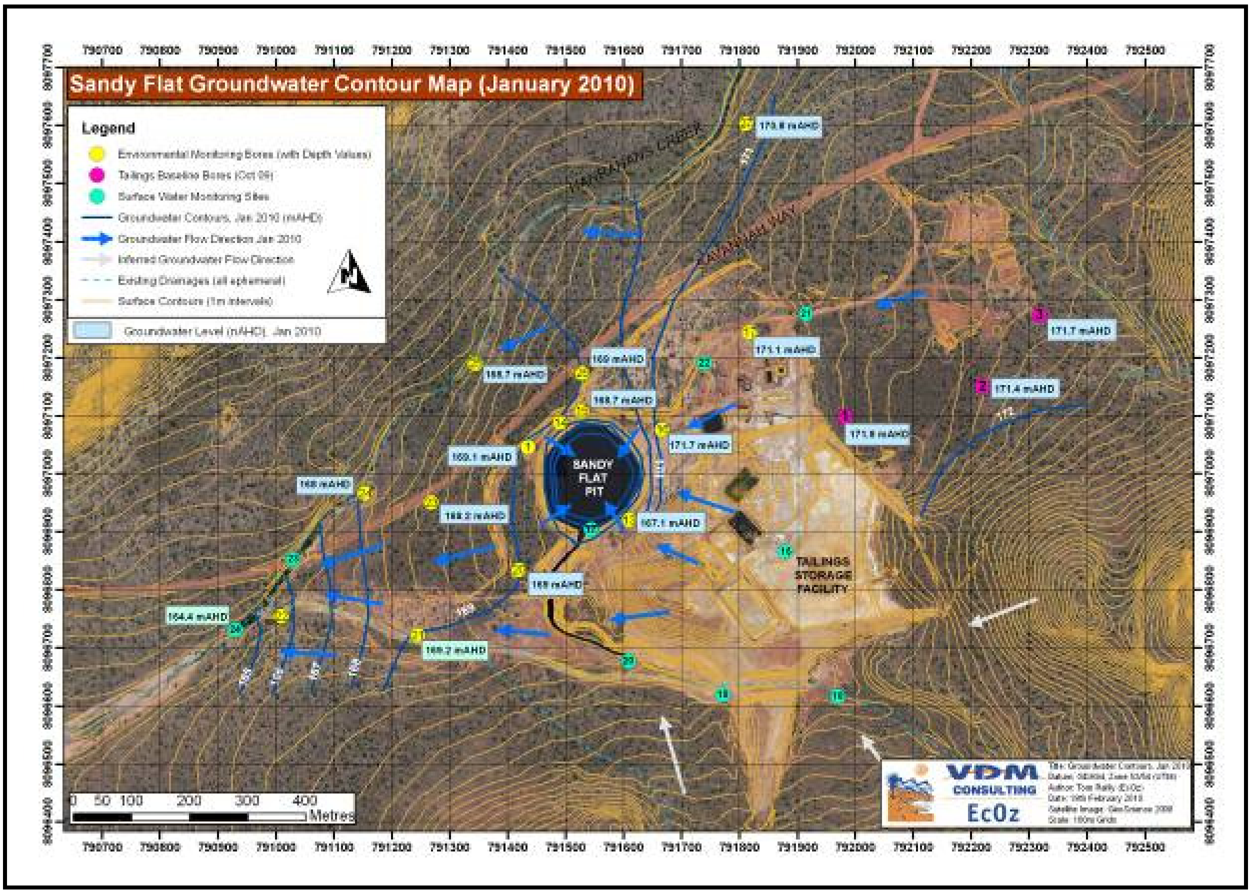


Table 8: Ground Water Level Fluctuations.

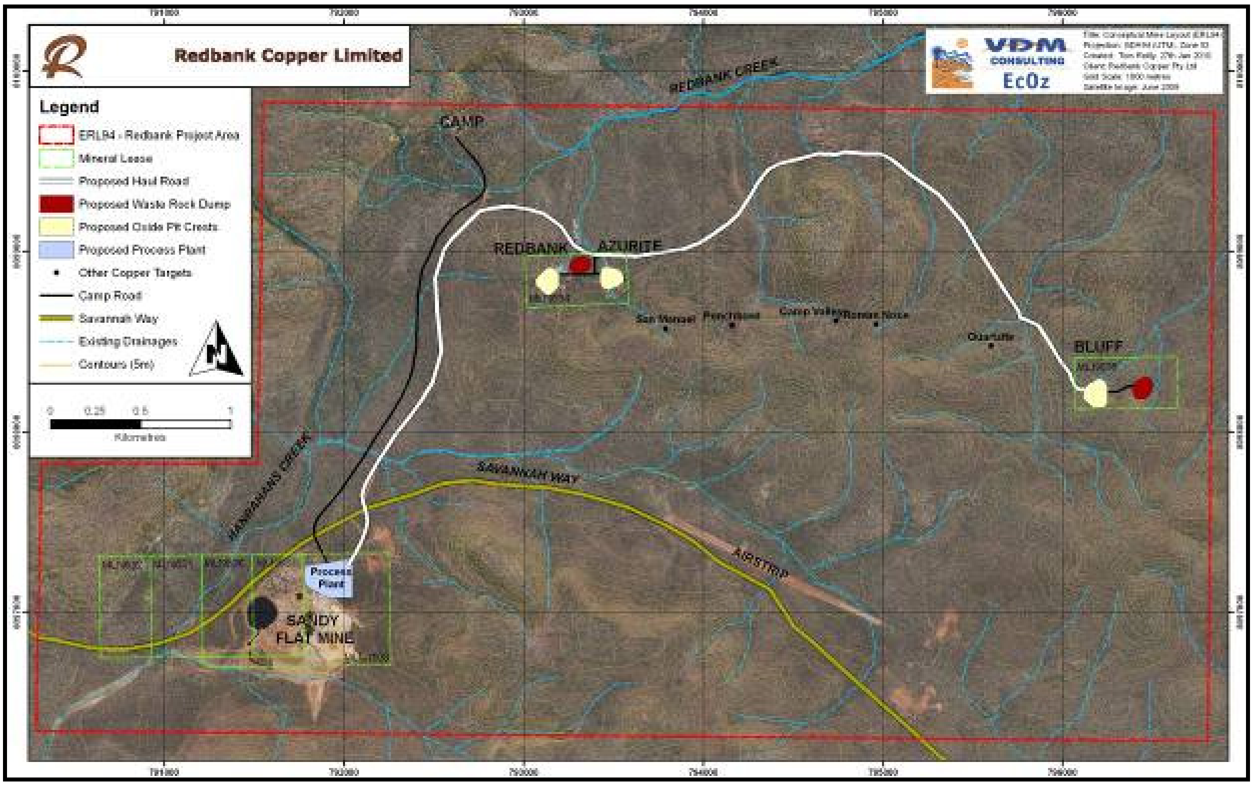
Bore	September 2009	November 2009	January 2010	Difference
SFP	170.00	168.20	165.30	-4.70[Note 1]
EMB 13	171.48	-	167.15	-4.33
EMB 15	168.67	-	168.72	0.05
EMB 17	171.71	-	171.11	-0.60
EMB 20	169.04	168.65	169.00	0.35
EMB 21	168.54	168.31	169.18	0.87
EMB 22 and 24	artesian			
EMB 23	167.99	167.73	168.19	0.46
EMB 25	168.81	168.61	168.53	-0.08
EMB 26	169.17	169.02	168.97	-0.05
EMB 27	170.57	170.55	170.80	0.25

Only those bores with more than one ground water level measurement are listed.
1) **SFP Difference between September 2009 and January 2010.**
2) **Bore Differences: January 2010 – November 2009. Negative differences indicate declining ground water levels.**

The large ground water level response and drawdown in bore 13 confirms that the paleo-channel is best developed on the eastern side of the SFP. There was no drawdown in bore 15 on the northern perimeter of the SFP where steep ground water level gradients prevail. Rising water levels at bores 21, 23 and 27 between November 2009 and January 2010 are to be monitored as they cannot be explained readily. Owing to ground water occurrences in confining or semi-confining fractured strata, it is unlikely that recharge has taken place albeit large rainfall (704mm) in January 2010.

Ground water levels at Redbank and Azurite are 20m below ground level and at the Bluff well below 95m below ground level (Figure 18).

Figure 18: Redbank, Azurite and Bluff – Conceptual Mine Layout.



Preliminary mining details of the Sand Flat Pit, Redbank, Azurite and Bluff deposits are tabulated below (Table 9). Although mineralization has been encountered below the oxide zone at Redbank and Azurite, there are a number of uncertainties that necessitate further investigation. Ground water levels and/or seepage from open pits and WRDs are anticipated to imitate the local topography.

Table 9: Mining and Ground Water Levels.

Parameter	Sandy Flat	Redbank	Azurite	Bluff
Pit Crest (ave. mAHD)	176	189	189	200
Oxide Pit Bottom (mAHD)	124	159	168	170
Area (m^2)	24,200	14,300	13,250	17,500
Depth of Oxide Pit (m)	52	30	21	30
Sulphide Pit Bottom (mAHD)	57	132	144	20
Area (m^2)	41,500	19,100	17,250	100,700
Depth of Sulphide Pit (m)	119	57[Note2]	45[Note2]	150
Ground Water Level (mAHD)	165[Note1]	169	169	104
Depth of Ground Water (mbgl)	9	20	20	96
Depth of Dewatering for Oxide Pit (m)	0	10	1	0
Depth of Dewatering for Sulphide Pit (m)	108	27	24	84
1) SFP current (February 2010) water level. **2) Ore reserves/mining to this depth has not been ascertained yet.**				

The Redbank and Azurite deposits will require little dewatering, if any, during mining of the oxide reserves. The ground water levels indicated in Table 10 are well above the depths at which ground water was encountered in fractured strata and may thus not be encountered during open pit mining.

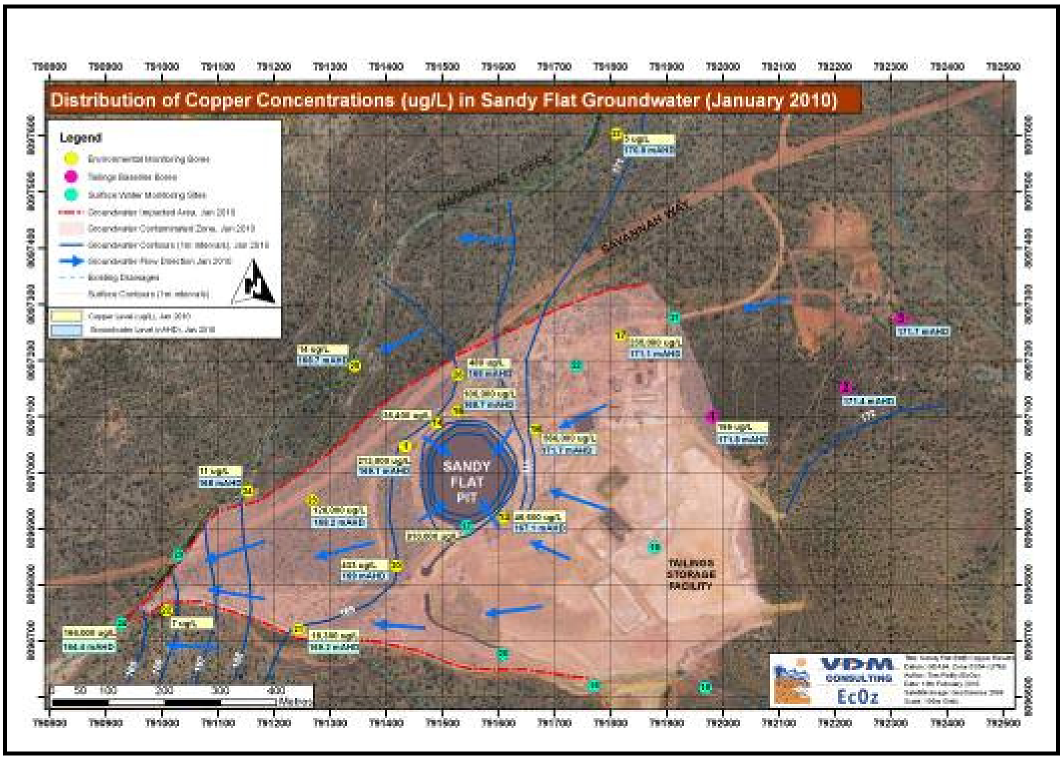
4.3.3 Ground Water Quality

The primary contaminant (pH, Copper and Aluminium) concentrations in ground water (Figure 19) are:

Table 10: Ground Water Quality (Jan 2010).

Bore Number Figure 17	Location	pH	Al (µg/L)	Cu (µg/L)
	ANZECC Guidelines for Aquatic Ecosystems 95% species level	6.5 - 8.5	55	1.4
	ANZECC Guidelines for Aquatic Ecosystems 80% species level	-	150	2.5
Along Hanrahans Creek from North to South				
B27	Upstream of SFP Hanrahans Creek	6.6	<10	**5**
B25	North-west adjacent to Hanrahans Creek	**6.4**	<10	**14**
B24	West of SFP upstream of Savannah Way (artesian)	**6.0**	10	**11**
24	Hanrahans Pool	**3.6**	**60,300**	**166,000**
B22	East of Hanrahans Pool (artesian)	**6.0**	<10	**7**
Between SFP and Hanrahans Creek				
17	SFP (open pit)	**2.4**	**453,000**	**910,000**
B26	North of SFP next to Savannah Way	**5.8**	<10	**480**
B23	Midway between SFP and Hanrahans Creek (B24)	**3.9**	**25,700**	**128,000**
EMB 15	Adjacent on north-side of SFP	**3.9**	**14,000**	**106,000**
EMB 14	Adjacent on north-side of SFP	**3.5**	**4,650**	**36,400**
EMB 1	Adjacent on west-side of SFP	**3.5**	**30,000**	**213,000**
B20	South of SFP downstream of WRD and TSF	**6.0**	<10	**443**
B21	South-west of SFP downstream of WRD and TSF	**5.6**	**280**	**18,300**
East and Upstream of SFP				
EMB 13	Between SFP and WRD downstream of TSF	**5.4**	**620**	**45,600**
EMB 16	Between SFP and Plant	**3.1**	**258,000**	**566,000**
EMB 17	North-east of SFP and north of Plant	**2.8**	**353,000**	**235,000**
Proposed New TSF				
T1	North-north-east of SFP upstream/adjacent of TSF	6.4	<10	**166**
pH, Al and Cu were used as the primary chemicals of concern (CoCs) due to their aquatic toxicity. Nevertheless, the concentrations of EC, major cations and anions and other heavy metals, included in the sampling regime, display trends similar to those of the primary CoCs. **Averages for all existing monitoring bore records.**				

Figure 19: Distribution of Copper Concentrations (µg/L) in Ground Water (January 2010).



It seems that the seepage zone is confined between Savannah Highway and the southern unnamed tributary of the Hanrahans Creek draining in a westerly direction into Hanrahans Pool.

Large concentrations of Copper in ground water at EMB 16 and 17 confirm that existing mine infrastructure leaks and/or facilitates seepage of acid metal laden waters into the underground.

Hydro-chemical trends, geochemical studies and further sampling will be undertaken together with further drilling and testing programmes.

4.3.4 Aquifer Hydraulic Parameters

In the absence of aquifer and pump testing, the hydraulic parameters of the aquifers are largely unknown. However, the drilling program undertaken in September/October 2009 indicated that the previously postulated permeable paleo-channel is absent in the seepage zone between the SF Pit and Hanrahans Creek. Assessment of the drilling and monitoring data to date suggests that the drilling program largely defined the lateral extent of the seepage zone. This complicates the mechanisms of seepage as it is currently interpreted that seepage is taking place through fractured rock. Further drilling and testing is scheduled for 2010 to coincide with geotechnical investigations for the proposed new TSF and WRDs. Data from these investigations together with water level and water quality data obtained since last year and during the current water treatment and associated pit water level reduction will be utilized to calibrate a finite element model which will be used for dewatering and seepage estimations and management.

For the purposes of this preliminary assessment the following hydraulic parameters were assumed based upon detailed physical descriptions and visual observations of drill cores and cuttings:

Table 11: Estimated Aquifer Hydraulic Parameters.

Aquifer/Layer	Hydraulic Conductivity (K) (m/s)	Transmissivity (T)[Note 1] (m^2/d)	Storativity (S) (dimensionless)
Alluvium[Note 2]	$>10^{-5}$	>50	$>10^{-3}$
Laterite[Note 3]	$<10^{-6}$	<1	$<10^{-5}$
Fractured Trachyte	$<10^{-5}$	<1	$<10^{-5}$
Fractured Sandstone	$<10^{-5}$	1 - 10	10^{-4} - 10^{-5}

Note 1: Unconsolidated; upstream of the Sandy Flat Pit.
2: T equals the thickness b of the layer multiplied by the hydraulic conductivity K.
3: Between Sandy Flat Pit and Hanrahans Creek.

The low permeabilities and transmissivities are confirmed by the steep gradients (Figure 16) in proximity to the SFP during dewatering between October 2009 and January 2010 particularly downstream of the pit. Upstream of the pit where the alluvium is well developed, ground water levels widen which suggest lower permeabilities across this area.

The above assessment indicates that groundwater seepage (quantity) from the SFP to Hanrahans Creek may not be as significant as previously thought. Nevertheless, it is evident from ground and surface water qualities that the SFP is impacting on Hanrahans Creek. Due cognizance must be taken that although seepage quantities could be much less, concentrations are at levels far exceeding the potential for dilution by upstream and downstream runoff. Furthermore, water quality in the contaminated zone (pools and sediments in Hanrahans Creek between immediately upstream of Savannah Highway and Hanrahans Pool) is further impacted upon by metallic salts accumulated in the streambed sediments over many years and evaporation (concentration) during the prolonged dry season.

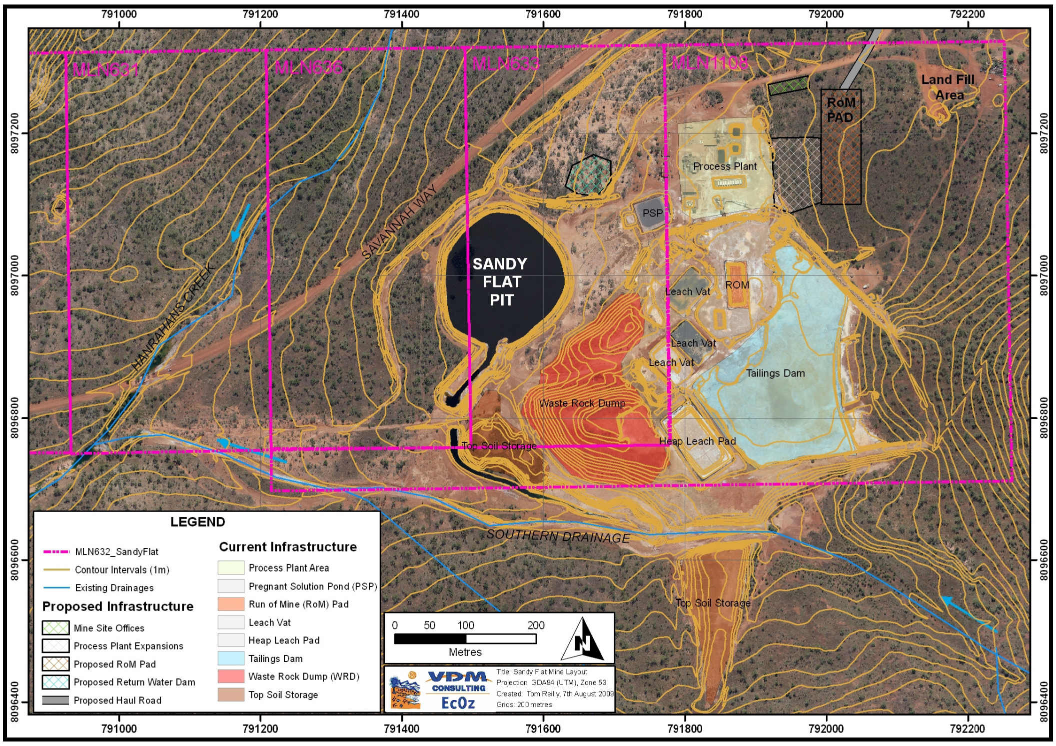
Preliminary estimates of seepage into Hanrahans Creek indicated that seepage may be far less than $100m^3$/day. This calculation, employing the Darcy Equation and the estimated hydraulic parameters indicated above, is based upon observations that seepage during dry weather (no flow during October and November 2009) equals evaporation from the impacted zone upstream of Hanrahans Pool. During the wet season seepage may increase substantially, up to $200m^3$/day or more, due to elevated levels at the SFP and across the TSF. These flows can be decreased substantially by dewatering of the SFP (October 2009 water level was at 170mAHD) to a level below that of Hanrahans Pool (164mAHD) which would create a local cone of dewatering (drawdown) and reverse gradients and ground water flow towards the SFP (Figure 17).

5. Sources of Contaminants

5.1 Existing Sources and Characteristics

The existing Sandy Flat mine layout and the potential sources of contamination are depicted in Figure 20.

Figure 20: Existing Mine Layout at Sandy Flat.

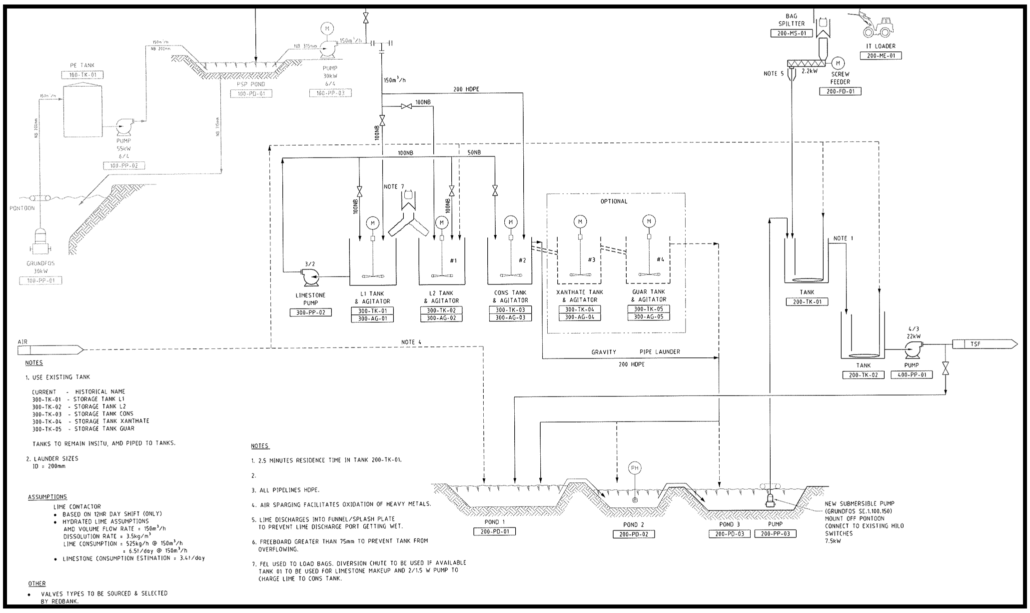


5.1.1 Existing TSF

The previous operators claim that the tailings deposited into the TSF were neutralized. However, acidic and metal laden SFP waters were pumped to the TSF during the past 10 plus years prior to the current proponent taking on the site, in an attempt to control spillages into and/or seepage from the SFP towards Hanrahans Creek.

Currently, SFP waters are pumped to a lime treatment plant (Figure 21 overleaf) from where effluent is pumped and retained on the TSF (see photo below). The deposition of neutralized SFP waters (with low metal concentrations) and lime sludges seem to have caused sealing of the upper layers of the TSF. Recent observations suggest that the treated effluent is largely contained on the TSF from where it is evaporated whilst seepage into the SLFD from the TSF has ceased or reduced.

Figure 21: Lime Treatment Process.



Sampling (42 samples between the surface and 1.5m deep) for acid base accounting and acetic acid leach testing confirmed the presence of acid producing materials and metals:

- Total Sulphur (S): vary between 0.5% and 1.7%
- Net Acid Producing Potential (NAPP): vary between -29.4kgH_2SO_4/t and 51.8kgH_2SO_4/t.
- Copper (Cu): vary between 29.9mg/L and 122.0mg/L.

The TSF is currently being treated with limed pit waters. However, further investigations are to be undertaken to ensure that the TSF will not be a source of contamination following completion of mining.

5.1.2 Existing WRD

Visual inspections of the WRD indicated the presence of reactive transition and possible sulphide waste rocks and ores. Subsequent, preliminary sampling (5 samples) for acid base accounting and acetic acid leach testing confirmed the presence of acid producing materials and metals:

- Total Sulphur (S): vary between 0.2% and 2.4%
- Net Acid Producing Potential (NAPP): vary between 1.7kgH_2SO_4/t and 59.0kgH_2SO_4/t.
- Copper (Cu): vary between 1.5mg/L and 500.0mg/L.

The WRD is to be re-processed in future and remaining wastes are to be encapsulated in either the proposed new TSF and/or WRD.

5.1.3 Existing ROM, VAT Leaches, PSP and Process Plant

The current degraded situation results from the legacy of a mine placed into long term maintenance rather than long term containment. The highly reactive transition and sulphide ores that remained on the ROM pad were not managed or treated; rather, a rainfall catchment system was provided to ensure that stormwater runoff is directed into the SFP. The runoff containment measures were insufficient to contain rain from large events and/or prolonged rain well above the average and resulted in spills (overflows) to Hanrahans Creek coupled with increased seepage from the SFP.

Sampling (4 samples) for acid base accounting and acetic acid leach testing confirmed the presence of acid producing materials and metals:

- Total Sulphur (S): vary between 2.0% and 4.2%
- Net Acid Producing Potential (NAPP): vary between 60.9kgH_2SO_4/t and 128.0kgH_2SO_4/t.
- Copper (Cu): vary between 111mg/L and 896mg/L.

In addition, large concentrations of copper in ground water in bores 16 and 17 (Figure 19) confirm that existing infrastructure is leaking and/or facilitating seepage of acidic metal laden waters into the underground.

These structures are under investigation to ascertain their integrity and are to be replaced by new appropriately designed and constructed facilities.

5.1.4 Sandy Flat Pit

The SFP contains low (2.4) pH water with high concentrations of metals (Figure 19) such as Aluminium (453,000µg/L) and Copper (910,000µg/L).

Up to October 2009, SFP water reduction strategies entailed pumping pit water to the TSF for evaporation.

The current strategy entails dewatering of the SFP by pumping pit water to a lime treatment plant from where the water is pumped to the TSF. This strategy aims at providing capacity to contain all site runoff and to maintain a pit water level below the level of Hanrahans Creek to prevent seepages from the SFP to Hanrahans Pool (Table 12). Redbank obtained a Waste Discharge Licence (WDL No 175) to discharge treated SFP waters to Hanrahans Creek. However, to date, no water has been discharged to Hanrahans Creek (Table 13).

Table 12: SFP Depth-Volume-Levels.

Elevation		Depth	Volume	Cumulative Pit Volume	Volume of Pit Water	Comment
Ref.	(mAHD)	(m)	(m^3)	(m^3)	(m^3)	
780	170.0	-8	43,482	535,759	0	Pit Water Level: September 2009.
778	168.0	-10	41,665	492,277	43,482	Base of paleo-channel: NT DPI?
	167.0	-11				Base of paleo-channel (geological interpretation).
	165.3				99,139	Pit Water Level: 30 January 2010.
	164.9				105,445	Hanrahans Creek.
	164.4				115,439	Hanrahans Pool.
770	160.0	-18	33,416	335,972	191,538	Base of paleo-channel at RL161?
768	158.0	-20	31,320	302,556	222,858	Target for dewatering: 6.4m below Hanrahans Creek to contain runoff from 979mm rain (average season).
760	150.0	-28	27,839	183,167	338,766	Target for dewatering: 14.4m below Hanrahans Creek to contain runoff from 1,162mm rain (wet season average).
750	140.0	-38	18,689	51,618	461,165	Oxide/Sulphide Contact.
734	124.0	-54	0	0	494,094	Base of SFP.

Table 13: SFP Water Balance October 2009 to January 2010.

Pit Dewatering Balance					
Month	**Rain (m^3)**	**Abstraction (m^3)**	**Evaporation (m^3)**	**dVolume (m^3)**	**Difference with $dVolume^{Pit}$ (m^3)**
31-October-2009	0	7,198	5,610	-12,808	-2,411
30-November-2009	1,234	27,432	5,178	-31,376	7,461
31-December-2009	2,700	32,424	4,198	-33,923	14,992
31-January-2010	15,622	52,229	3,647	-40,254	-820
Total	**19,556**	**119,283**	**18,633**	**-118,361**	**19,222**
Quantities in kL/a; levels in RL mAHD; drawdown in m. dVolume = Rain – Abstraction – Evaporation.					
Sandy Flat Open Pit (Pit Crest Level: 170.0mAHD, Area: 2.42ha)					
Month	**Level (mAHD)**	**$dVolume^{Pit}$ (m^3)**	**Cumulative $dVolume^{Pit}$**	**Drawdown (m)**	**Cumulative Drawdown (m)**
31-October-2009	169.30	15,219	15,219	0.70	0.70
30-November-2009	168.20	23,915	39,134	1.10	1.80
31-December-2009	167.30	18,931	58,065	0.90	2.70
31-January-2010	165.30	41,074	99,139	2.00	4.70
Total	**-**	**99,139**	**-**	**4.70**	**-**

The above water balance shows that some 19,222m^3 more water was treated than storage in the SFP. This is attributed to ground water influx into the SFP.

The current pit water level, albeit about 1.3m above the level of Hanrahans Pool, induces flow towards the SFP (Figure 17). The current strategy will curtail spillages of contaminated runoff and seepage from the TSF whilst the future mining of the sulphide ores beneath the bottom of the SFP will provide an opportunity to drain contaminated ground water from the surrounding rocks. The quality of ground water and water in the Hanrahans Creek are therefore likely to improve over the medium to long term.

Redbank Mines will treat any water that is to be discharged into the environment. However, current process water balances indicate that there will be a shortage of water during sulphide mining. Plans are underway to address these shortages by providing storage facilities and importing dewatering effluent from Bluff and/or suitably and appropriately located well fields.

5.2 Future Sources and Characteristics

Due cognisance must be taken of the characteristics of the ore body:

- Most of the ore body (breccia pipe) contains oxidized ores to a depth of between 30m and 35m below surface with sulphide ores beneath to a depth of about 200m below surface.
- Surrounding the ore body is a transition zone containing low grade ores.
- The breccia body is surrounded by host bedrocks comprising trachytes (Figures 12 and 13).

Mining will entail:

- Removal of the ore body and placing the ore on a ROM pad at the Sandy Flat Processing Plant.

  2010 onwards: the oxide ores will be processed and the resulting tailings, neutralized with lime, will be placed as dry stack tailings on the existing TSF.

  2012 onwards: the sulphide ores, current proven reserves at SF and Bluff only, will be processed and the resulting tailings, neutralized with lime, will be placed in a new TSF.(approvals not yet sought)
- The transition zone low grade ores and mineralized wastes will be placed in a separate stockpile for processing at a later stage.
- Most waste rock will be generated from removing the surrounding fresh host rocks. This rock will be used in the construction of haul roads and WRDs.

Table 14: Waste Rock Volumes.

Proposed Voids	Total Volume Oxide Waste Rock	Construction			WRDs
		Haul Road (SFP to Azurite)	Haul Road (Azurite to Bluff)	Pit Safety Bunding	
Redbank	104,000	70,000	0	1,800	32,200
Azurite	70,000	25,000	25,000	1,600	18,400
Bluff	117,000	0	75,000	1,600	40,400
Total	**291,000**	**95,000**	**100,000**	**5,000**	**91,000**
Units are in m^3. *In-situ* density: $2.2t/m^3$. Swell: 30%.					

Monitoring and assessment of the legacy issues at SF clearly illustrates the existing and potential future impacts of mining at Redbank. Current contamination issues indicate that the design and construction of all new mining infrastructure (pits, WRDs, processing plants and TSFR) with the view to minimize disturbance and wastes, contained in appropriate structures with suitable water management infrastructure and practices, are paramount.

Redbank Mines indicated that they will not establish any new mining infrastructure without appropriate and sufficient testing, results of which will be incorporated in the detailed design for construction of such infrastructure. Characterization of ores and wastes (rock and tailings) are therefore on-going.

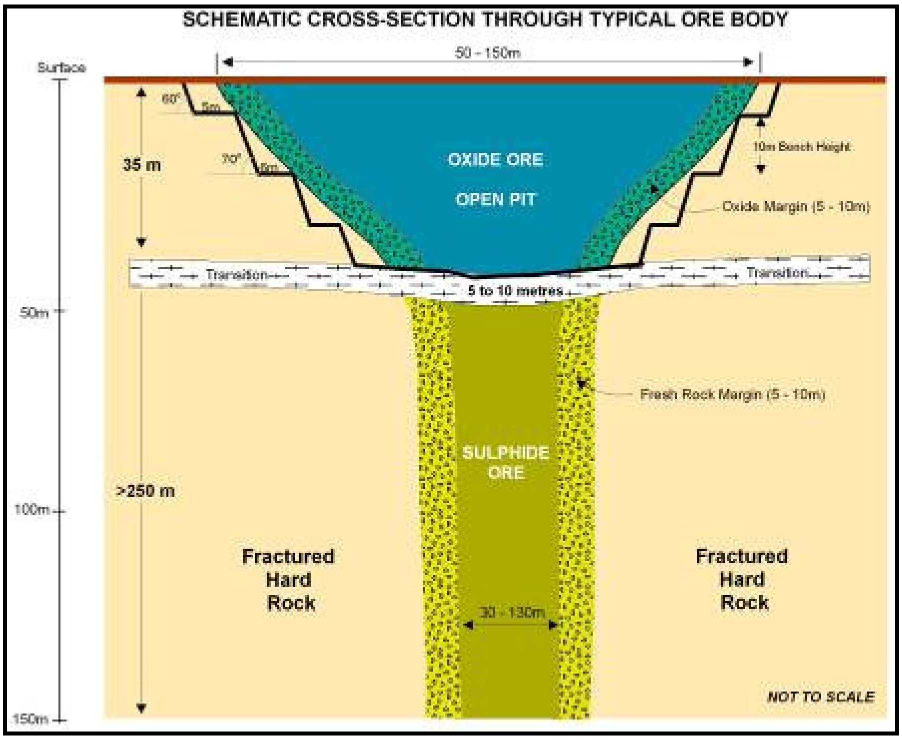
5.2.1 New WRDs

Owing to contamination from the existing WRD and TSF (where acidic metal laden pit waters were pumped in recent years), there is concern that the oxide wastes may contain potentially acid forming materials. This assumption has been discounted by the project geologist and proven by his 2500 xrf samples that indicate that there is no residual sulphur in the oxidised zone. The requested ARD lab testing then resulted in a focus on potentially acid forming material and hence only one single sample of waste material from the oxide zone was dispatched for testing along with the numerous samples from the sulphide zone.

XRF and Laboratory testing on samples from the existing TSF, WRD and ROM pads indicated the strong presence of sulphide materials, from earlier mining operations and processing, having a significant Sulphur and metal content. These materials can be confidently attributed to being derived from the sulphide zone and the previous operators of the mine have verified this during a recent site visit, where they were invited to site to offer first hand experience of previous activities.

Figure 22 illustrates a schematic cross section through the copper ore body:

Figure 22: Cross-Section of the Copper Ore Body.



The oxide zone at Sandy Flats has been mined out. The new oxide open pits at Redbank, Azurite and Bluff will extend down to the transition zone. Rock from the oxidized zones and oxide margins will be placed in new WRDs between Redbank and Azurite and at Bluff whilst tailings from processing will be placed as dry stack tailings on the existing TSF at Sandy Flats.

Mineralogical studies (RTA, 2007) on the oxide ore indicated that:

- The oxides are dominated by various forms of goethite and significant quantities of titanium oxides (leucoxene) and some manganese oxides.
- Copper mineralization is oxidized and dominated by malachite and pseudomalachite.
- Sulphides in the form of arsenopyrite and chalcopyrite are present in trace amounts.

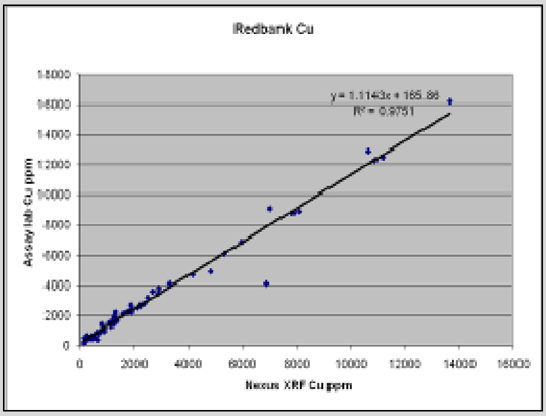
Redbank Copper has undertaken XRF analysis on samples from the entire oxidized zone, down to 35m below ground surface, across the ore bodies at Redbank, Azurite and Bluff. The ore, oxide margin and waste rock zones (Figure 22) were distinguished based upon their copper content:

Table 15: Number of XRF Analysis and Copper and Sulphur Concentrations.

Open Pit	Number of Analysis		
	Ore (Cu > 0.8%)	Oxide Margin (0.2% < Cu < 0.8%)	Oxidized Rock (Cu < 0.4%)
Redbank	170	58	196
Azurite	52	54	537
Bluff	115	118	367
Total	337	230	1,100
Ore	**Average Metal Concentration (%)**		
	Copper (Cu)	**Iron (Fe)**	**Sulphur (S)**
Redbank	4.17	2.45	0.21
Azurite	3.77	4.12	0.23
Bluff	2.14	5.28	0.08
Error (%)	**0.03 – 0.04**	**0.05 – 0.08**	**0.13 – 0.18**
Oxide Margin	**Copper (Cu)**	**Iron (Fe)**	**Sulphur (S)**
Redbank	0.60	2.78	0.20 (0.13)
Azurite	0.53	5.43	0.13 (0.18)

Bluff	0.55	4.17	0.07 (0.17)
Error (%)	**0.03 – 0.04**	**0.05 – 0.08**	**0.13 – 0.18**
Oxidized Rock	**Copper (Cu)**	**Iron (Fe)**	**Sulphur (S)**
Redbank	0.11	3.32	0.21 (0.15)
Azurite	0.11	7.25	0.11 (0.21)
Bluff	0.13	5.31	0.05 (0.19)
Error (%)	**0.01**	**0.06 – 0.09**	**0.15 – 0.21**

QA/QC: Comparison between Laboratory and XRF data.



From Table 22 it is evident that:

- Large Iron and small Sulphur concentrations seem to confirm that the oxidation process is almost, if not entirely, complete and consequently the absence of acid forming materials in the oxide zone.
- There is little difference in Sulphur concentrations across the ore body and surrounding bedrock.
- The error bands suggest that Redbank is more likely to contain Sulphur, if any. The error bands at Azurite and Bluff are at least twice the Sulphur concentration.

The Redbank deposit has undergone small scale mining for almost 1 century and a large area surrounding the remains of the open pit and adits is covered with waste material from a period when only very high grade material was selected for sale. Water quality monitoring of the nearby Redbank Creek displays no evidence of acid generation from this area of exposed waste.

Most waste will be generated from removing the oxide margin and surrounding hard fractured bedrock particularly when the sulphide ores will be mined.

The results of preliminary acid base accounting (ABA) and metals leach testing appear in Table 16. This testing program seems to confirm the XRF results. Owing to the mineralogical test program, samples for further ABA testing are not available. Additional testing has been scheduled for April and May 2010 when drilling programs re-commence. The XRF and ABA test data are to be used to establish a relationship that can be used to direct future disposal of waste rock to the appropriate facility and/or area for disposal, particularly wastes that may contain sulphides. XRF data are to be utilized, and complemented by detailed laboratory testing, to determine the perimeters of the ore, transition and waste rock zones. This information together with the relationship between XRF and ABA data is to be used to ensure that oxide margin materials and waste are appropriately handled and treated based upon XRF on-site analysis.

Table 16: Acid Base Accounting and Metals Leach Testing.

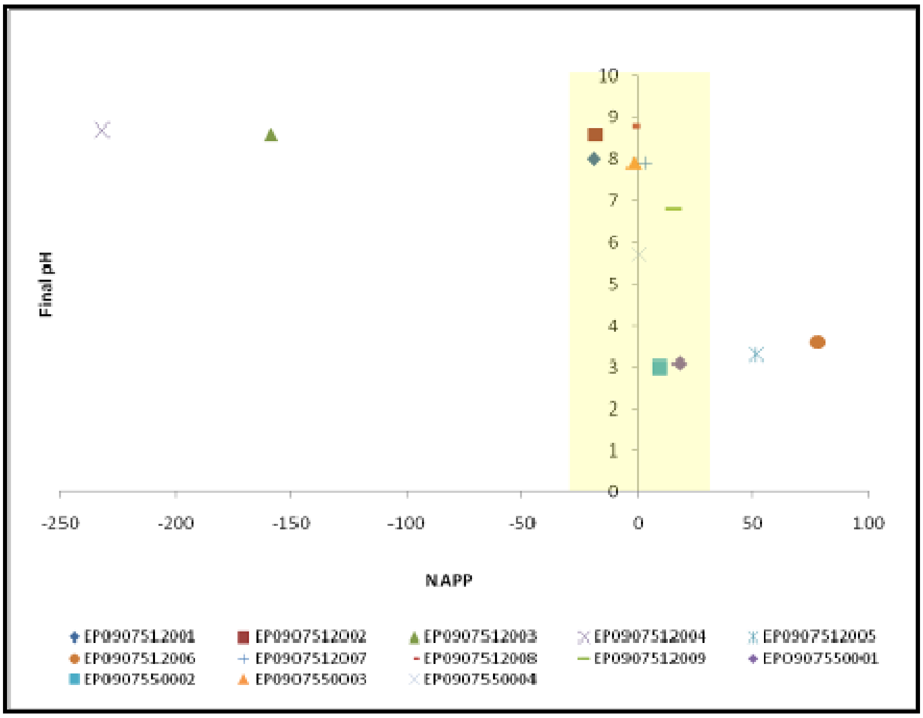
Material Type	**Concentrations**		
	Sulphur (S) (%)	**Net Acid Producing Potential (NAPP) (kgH_2SO_4/t)**	**Copper (Cu) (mg/L)**
Oxidized Rock (<30m depth; 2[Note 1])	<0.01	-19.0 to -18.5	<0.01
Oxide Tailings (4)	0.02 to 0.59	-1.7 to 18.0	0.2 to 59.7
Rock below Transition Zone (62m-222m depth; 7)	0.02 to 2.90	-232 to 77.9	<0.01 to 0.88
Note 1: Number of samples tested appears in brackets.			

Albeit that wastes may be considered non-acid forming as WRDs will only contain waste rock from above the zone of known acid forming potential, it is paramount that the detailed design and construction of

these facilities consider AMD and include management measures to contain seepage and runoff from these facilities.
The test results also indicate that tailings will require neutralization prior to placement into the TSF and/or are to be placed in a facility that contains and manages seepage and surface runoff.

A plot (Figure 23) of the net acid production potential (NAPP) versus the final pH of samples from the oxide (EP0907152001 and 2), transition (EP0907152005 and 6) and sulphide (EP0907152003, 4, 7, 8 and 9) zones clearly indicates three possible groupings. The EP0907550001 to 4 samples were obtained from tailings wastes (to be placed as dry stack tailings on the existing TSF) from the oxide process. Values less than -20 on the NAPP scale indicate a low probability of ARD, while values which exceed 20 on the NAPP axis most likely will cause ARD. The third group lies between these two values and further analysis is required to determine if these samples are possible candidates for ARD generation.

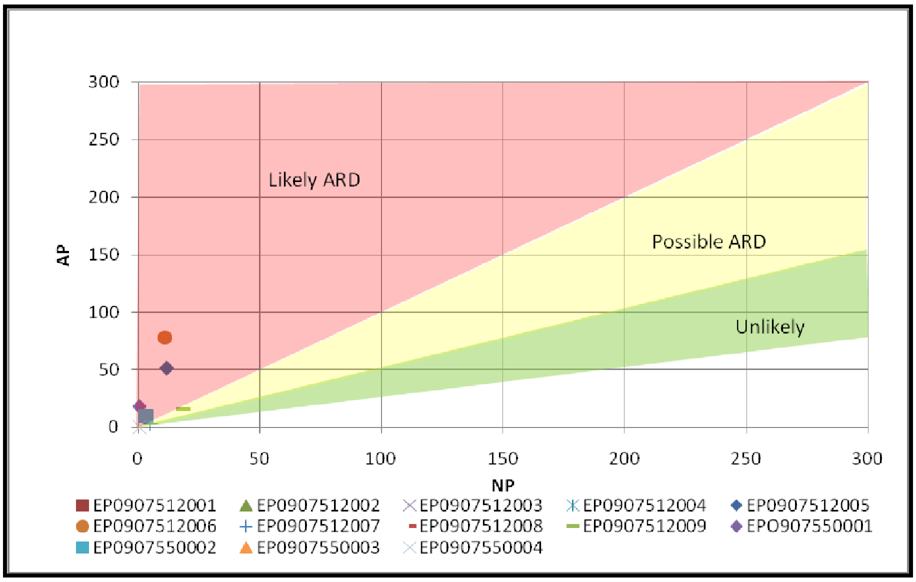
Figure 23: NAPP versus Final pH.



Samples EP0907512001 and EP0907512002 were collected from the oxide zone at the Bluff at depths of 13.75 and 29.55 metres respectively. The former was from within the waste zone identified as trachyte and the latter from the waste zone identified a mudstone.

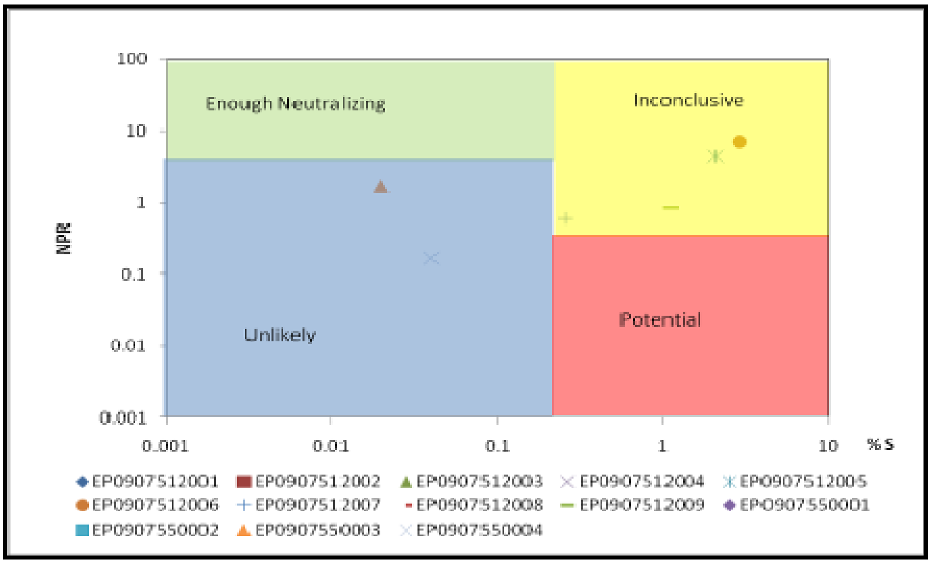
In Figure 24 five samples fall within the likely ARD area while two samples are possible ARD generation points. These samples were from wastes associated with the sulphide zone and oxide tailings.

Figure 24: AP versus NP.



In Figure 25 the presence of sulphur in the samples is correlated with the neutralizing potential ratio, and a significant number falls within the inconclusive group. To aid in the determination of the most probable points of ARD in the waste rock, a risk matrix was constructed (Table 14).

Figure 25: NPR.



Samples shown in red (Risk Values > 4) in the Risk Column will produce ARD while a Risk which ranges from 3 to 4 would be likely candidates to consider for kinetic testing. Risk values lower than 3 indicate a low probability for ARD.

Table 17: ARD Risk Matrix.

Sample Number	Figure 1	Figure 2	Figure 3	Risk
EP0907512001: oxide zone	1	0	0	1
EP0907512002: oxide zone	1	0	0	1
EP0907512003: sulphide zone	0	0	0	0
EP0907512004: sulphide zone	0	0	0	0
EP0907512005: transition zone	2	2	1	5
EP0907512006: transition zone	2	2	1	5
EP0907512007: sulphide zone	1	1	1	3
EP0907512008: sulphide zone	1	0	1	2
EP0907512009: sulphide zone	1	1	1	3
EPO907550001: oxide tailings	1	2	1	4

EP0907550002: oxide tailings	1	2	1	4
EP0907550003: oxide tailings	1	0	0	1
EP0907550004: oxide tailings	1	1	0	2

These test results would indicate that the tailings require neutralization prior to placement and/or are to be placed in a facility that contains seepage from the tailings.

5.2.2 Proposed TSF

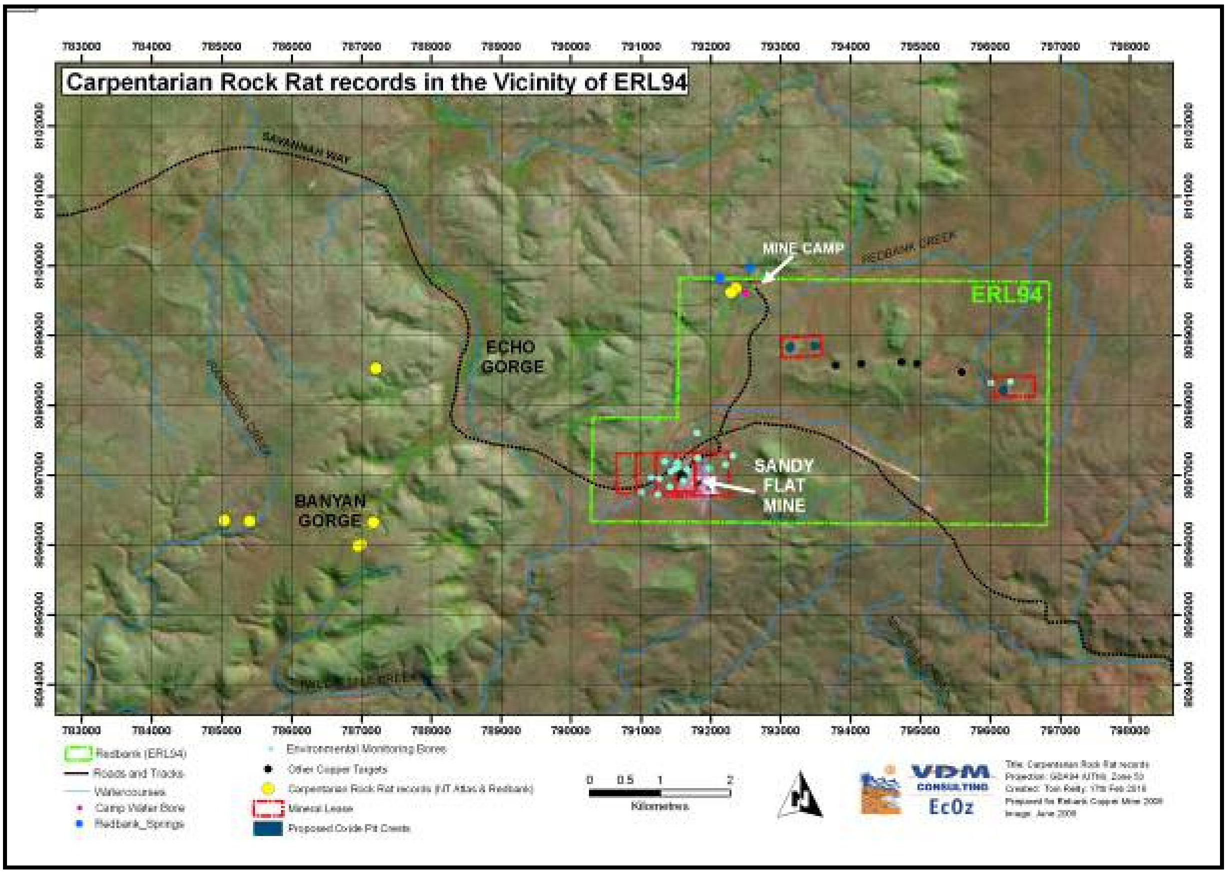
Whilst tailings from mining of the oxide ores at Redbank, Azurite and Bluff will be placed as dry stack tailings on the existing TSF, a new TSF is to be designed and constructed for mining and processing the sulphide ores. Tailings from the sulphide process for acid base accounting and metal leach testing are not yet available as the process is currently being developed and tested. However, the design and construction of the new TSF and WRDs will take due cognisance of AMD issues.

5.2.3 Dewatering

Future dewatering for oxide mining may impacts on:

- Water quality in streambeds if excess waters (unlikely in view of anticipated shortages in the sulphide process) are to be discharged. This impact can be mitigated by treating waters prior to discharge.
- Dewatering of surrounding bedrock and consequently flora and fauna particularly the Carpentarian Rock Rat (Figure 26). This impact is considered negligible since ground water was encountered in gravel and fractured sandstone bedrock at a depth between 15m and 24m in formations underlying the Masterson Sandstone in which the springs are located (Figure 27 and estimations below).

Figure 26: Carpentarian Rock Rat Populations.



The Carpentarian Rock Rat populations are:

- o About 154m from the Redbank Camp bore water supply and about 1,000m north-west of the Redbank and Azurite open pits.
- o About 2,800m north-north-east and 4,500m west of Sandy Flat.

Due cognisance must be taken of the surface water catchments at these locations:

- Redbank Camp bore water supply is downstream of the populations.
- Redbank and Azurite open pits are located in the Redbank Creek catchment draining into the easterly flowing creek at a location downstream of the populations.
- Sandy Flat is located in the southerly draining Hanrahans Creek which will not impact on the Redbank Creek catchment.

The camp water supply bore is about 440m downstream and at an elevation 185mAHD some 72m below the elevation of the Muinyin Springs at 242mAHD.

When the camp is fully occupied (40 persons for 12 months of the year; an extra 20 persons for 8 months) at a consumption of 100L/p/day for potable water and ablution and cooking purposes, some 2,105kL/a (or 6m^3/day on average) will be abstracted from the bore.

The construction log of the bore indicated that the bore:

- Encountered river gravel between 15m and 18m depth and sandstone between 18m and 30m.
- Has a 203mm DIA screened between 18m and 24m with a 150mm DIA PVC screen with 8mm apertures and a yield of 2.0L/s.
- The static water level was at 5.1m below ground level.
- Ground water has a pH of 5.4 and an Electrical Conductivity of 23µS/cm.

By using the Jacob Equation: $s = (2.3*Q)/(4* \pi*T)*\log(2.25*T*t/(r^2*S))$

where: s = drawdown (m).

Q = discharge rate (6m^3/day).

T = aquifer transmissivity (100m^2/day).

t = time (180days; maximum time without rain recharge).

r = radius of drawdown (m).

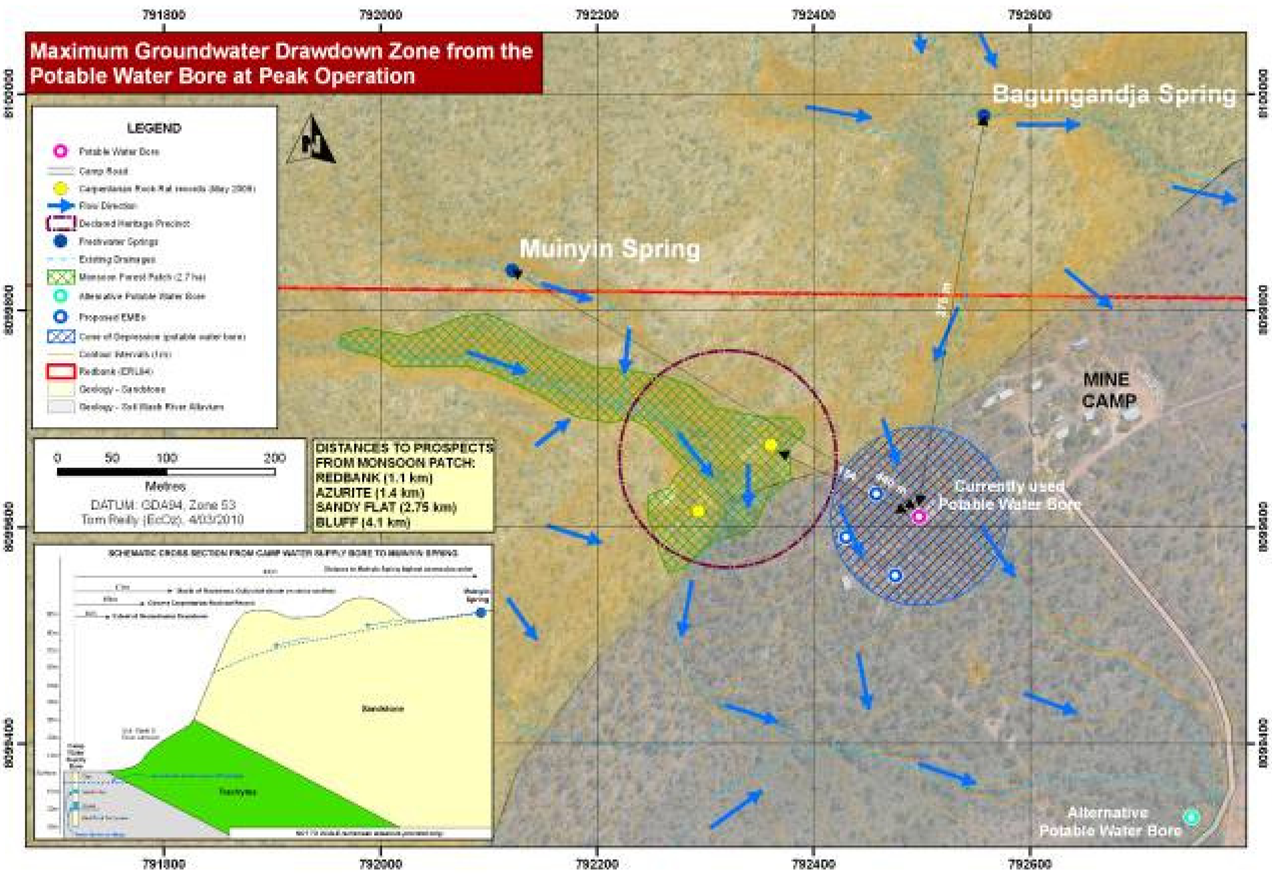
S = aquifer storativity (10^{-3}, dimensionless).

The drawdown after 180 days can be calculated at the locations of interest (radii of drawdown):

- Drawdown at the bore: 0.08m
- Drawdown at the rock rat populations: 0.04m.
- Drawdown at the springs: 0.03m.

The daily water requirement implies that the bore is utilised for about 1hr. There is no drawdown after 1hr at the rock rat population as the distance of zero drawdown after 1hour is estimated at 82m. In addition, it is expected that there is no hydraulic connection between the different geological formations (Figure 27) based upon the findings of the 2009 drilling program at Sandy Flat Pit.

Figure 27 and 28: Locations of the Camp Bore, Springs and Carpentarian Rock Rats with Geological Cross-Section.



Ground water qualities at the springs and the bore appear below:

Table 18: Spring and Camp Bore Water Quality.

Parameter	Springs (range)	Bore (average)
pH	4.1 – 4.9	4.7
Electrical Conductivity (µS/cm)	0.01 – 0.02	21.4
Calcium (Ca), Magnesium (Mg) and Potassium (K)	<1	<1
Sodium (Na)	2 – 3	2
Sulphate (SO_4)	1 – 2	20
Total Aluminium (Al)	0.060 – 0.130	0.05
Total Copper (Cu)	0.003 – 0.028	0.25
Units are mg/L unless stated otherwise.		

The strategy to monitor potential impacts on the springs and consequently the Carpentarian Rock Rat are detailed below and is illustrated in Figure 27.

Spring flow measurements with calibrated V-notches at suitable locations (narrow part of stream where most flow can be captured) are to be implemented immediately. The V-notch is to be installed outside the Declared Heritage Precinct in the western tributary. Samples of water for analysis of pH, Electrical Conductivity, major cations and anions and dissolved metals are to be taken at these locations. The flow data and selected hydro-chemical parameters are to be graphically presented and correlated with rainfall.

Drilling of two bores (actual number will be determined after geophysical traversing at the indicated locations) 75m from the camp bore at the suggested locations. Should any drawdown be detected following 72-hr pump testing, a new water supply bore is to be drilled further afield towards the south-east along the access road to the camp. Consideration should be given to installation of this bore during the next drilling program.

6. Conceptual Models

6.1 Conceptual Models

The conceptual models for the existing and future scenarios at Sandy Flat are depicted in the following figures:

Figure 28: Conceptual Model Sandy Flat (Existing Scenario).

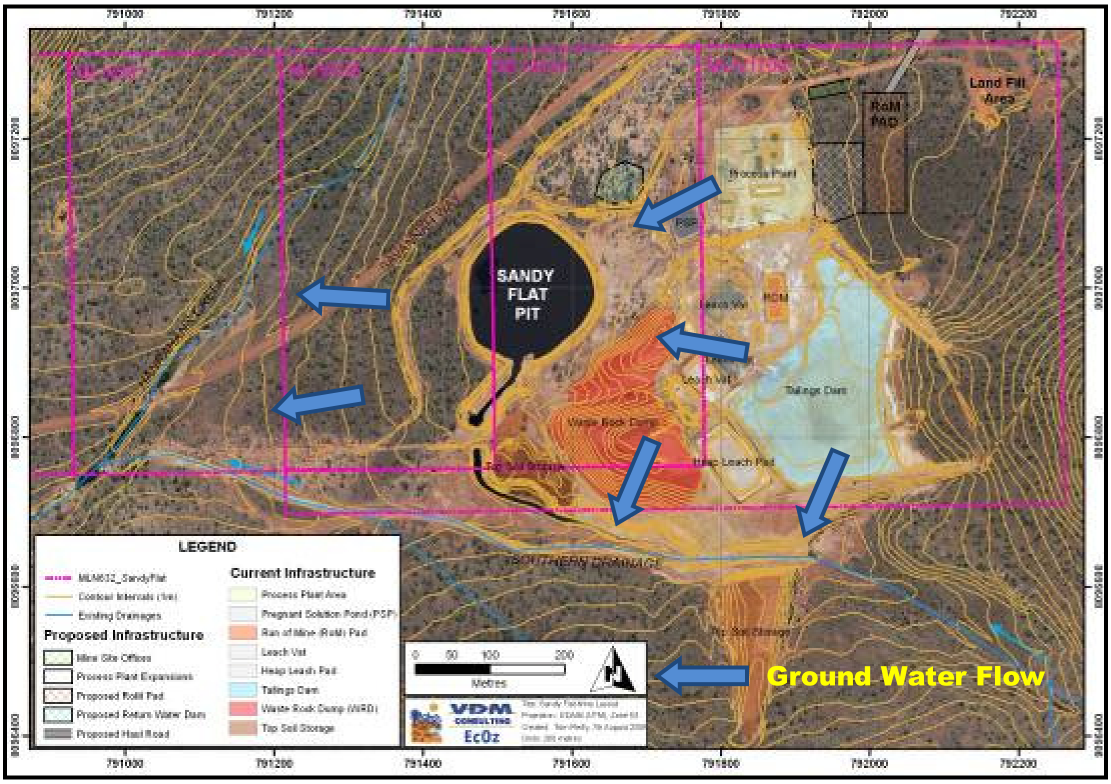
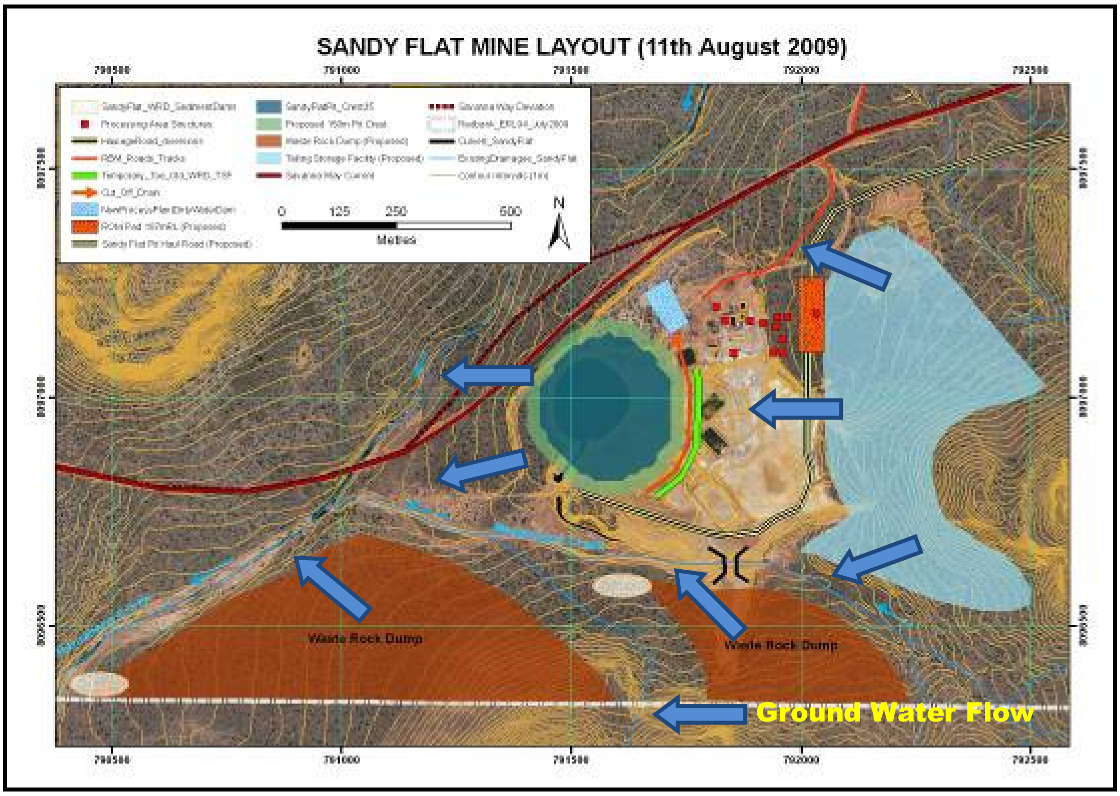
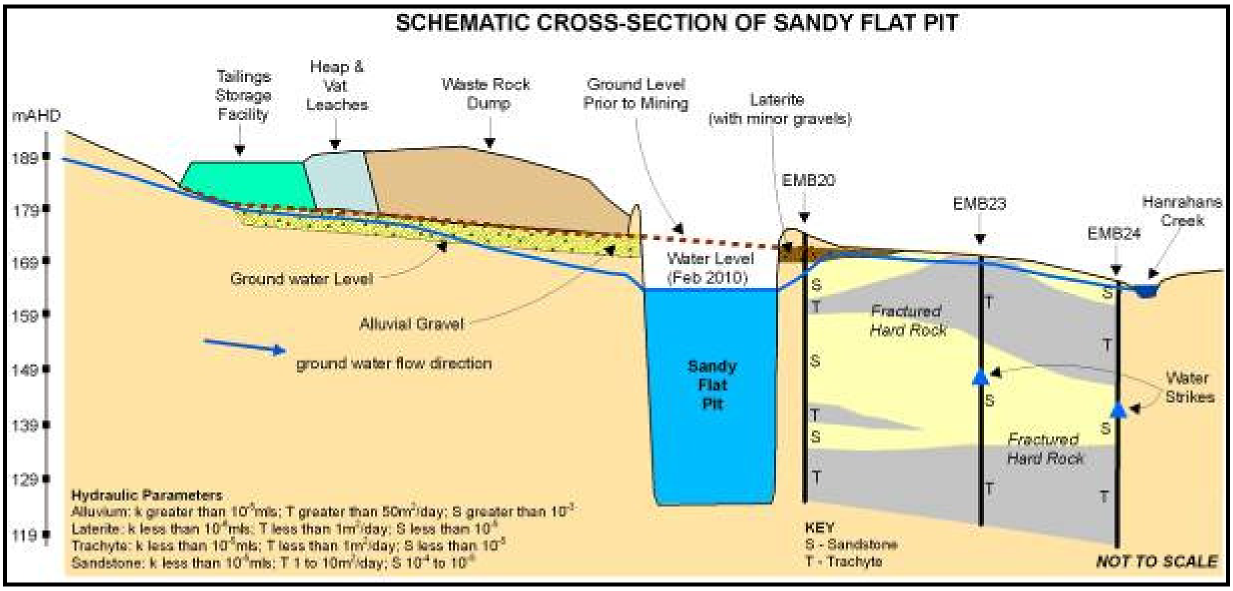


Figure 29: Conceptual Model Sandy Flat (Future Scenario).



A typical cross-section appears in Figure 31.

Figure 30: Typical Cross-Section.

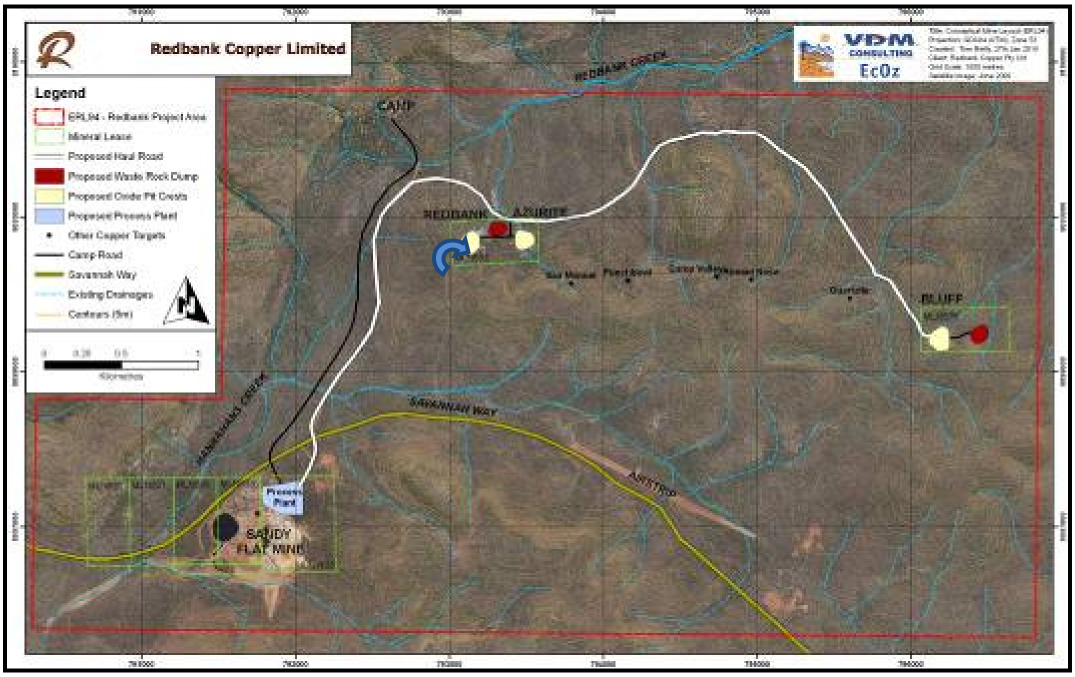


Location	Location	pH	Al (µg/L)	Cu (µg/L)
17	SFP (open pit)	2.4	453,000	910,000
EMB23	Midway between SFP and Hanrahans Creek (B24)	3.9	25,700	128,000
EMB24	West of SFP upstream of Savannah Way (artesian)	6.0	10	11
24	Hanrahans Pool	3.6	313,000	377,677

Figure 31 illustrates relatively large ground water flows through alluvium into the SFP from where slower migration towards Hanrahans Creek takes place as the well developed alluvial layer is replaced by laterite having significantly lower permeabilities and consequently lesser flows. Most ground water occurs in the fractured sandstone underlying hard rock trachytes well below the level of the creek. Owing to the relatively higher permeability of the alluvium, ground water level gradients are markedly shallower than downstream of the SFP where steep gradients prevail in semi-confined to confined aquifer conditions. Ground water quality in the aquifer changes markedly between the SFP and Hanrahans Creek.

Similarly, conceptual models at Redbank, Azurite and Bluff are:

Figure 31: Redbank, Azurite and Bluff Layout.



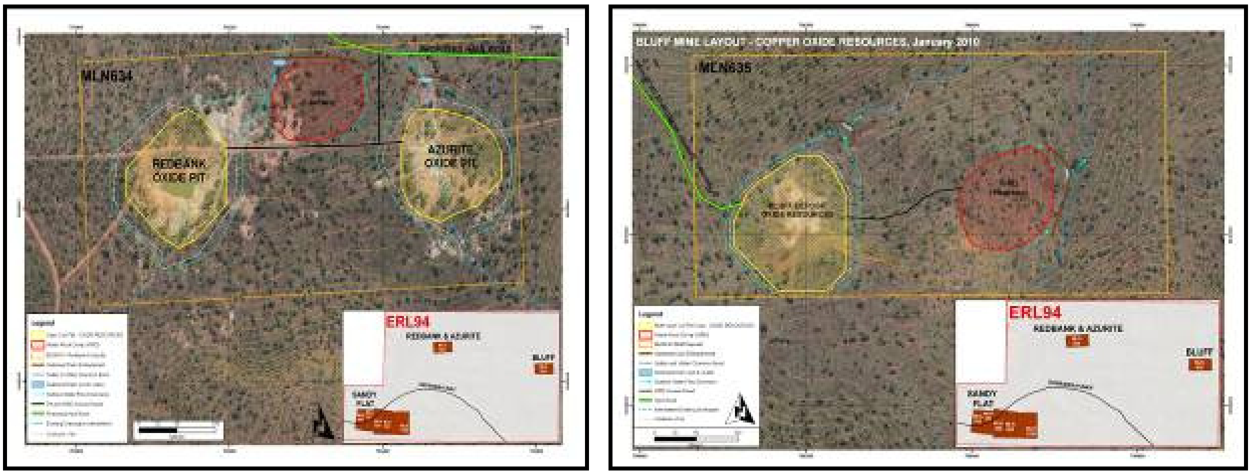
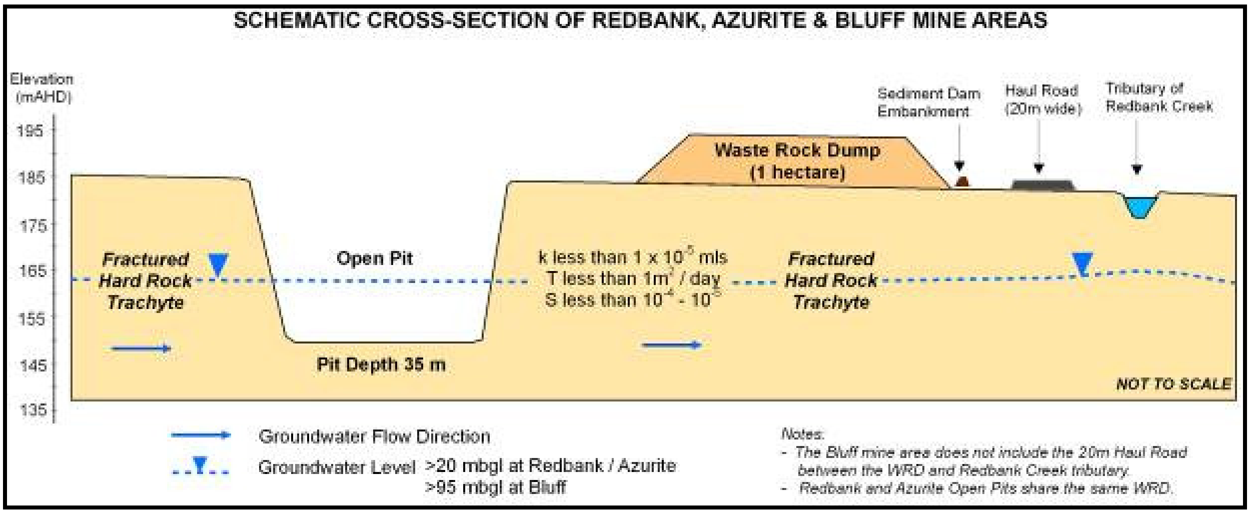


Figure 32: Typical Cross-Section.



It seems that where hard fractured bedrock conditions prevail, ground water levels may be significantly below streambeds. It is therefore unlikely that seepage from the pits would enter downstream surface drainage features and thus the Redbank Creek.

6.2 Design Considerations for New Mining Infrastructure

6.2.1 Dewatering Systems

Where required dewatering bores are to be located around the proposed open pit mining operations. Dewatering effluent is to be pumped to the Sandy Flat Plant. Excess water may be used for dust suppression and/or discharge to the nearest stream provided water qualities meet discharge criteria (pH > 6.5 and Dissolved Aluminium and Copper concentration less than 55µg/L and 150µg/L respectively). Dewatering bores are to be complemented by pit dewatering sumps. Pit waters are to be settled and may be used for dust suppression and/or discharge to the nearest stream provided water qualities meet discharge criteria.

Subsequent to mining, upstream diversion berms and channels are to be breached to flood the mined out pits to a level of the pre-mining ground water level. Once the pits have been filled, diversion structures are to be repaired.

Where discharge is required, applications should be made to obtain Waste Discharge Licences. The primary principle to be adopted entails discharge of clean water and retention and re-use of dirtiest waters after treatment, if required.

6.2.2 WRDs

The final locations and designs are to be ascertained following geophysical and geotechnical investigations complemented by investigative drilling and testing programs taking due consideration of hydrological and ecological features and design and life of mine requirements. The primary objective is to minimize on site impacts (water quantity and quality) to prevent off-site environmental risk and to create a long term sustainable land form.

Preliminary design features include placing non acid forming materials in a land form according to the surrounding topography and landscape with a height of approximately 10m and batter slopes less than 20°. The base of the WRD will be graded and compacted at a gradient that directs surface water flow and seepage to the toe of the facility where a swale/sediment dam will be constructed subsequent to removal of soil to a depth of 300mm. The top 50mm should be stored separately to maintain the seed bank for re-vegetation during rehabilitation.

Surface water management controls i.e. diversion of clean runoff by means of shallow berms and trenches are to be provided. Runoff and seepage from WRDs are to be captured in settling ponds and/or swales at the downstream lowest point of the WRD.

Monitoring (surface and ground water quality and erosion), including downstream bores (ground water levels), is to be undertaken at the surface water management controls and drainage features downstream of the WRD.

6.2.3 Plant and TSF

New surface water management controls should be established at the SFP processing plant area to ensure that all potentially contaminated storm water is captured for treatment and re-use. Initially, until sulphide mining and processing commences, the pit and TSF (dry stack tailings) should be utilized.

A new TSF and return water dam (RWD) are proposed to be constructed during 2011. The final locations and designs are to be ascertained following detailed investigations, including geotechnical and geophysical surveys, and assessments taking due consideration of hydrological features and design and life of mine requirements. The primary objective remains to minimize on site impacts (water quantity and quality) to prevent off-site environmental risk and to create a long term sustainable land form. These facilities should therefore be located on relatively impermeable soils (may require treatment and/or liners) coupled with treatment of the tailings and water to ensure long term sustainability.

All dirty storm and process waters are to be treated for re-use as a first source of water. Clean water should only be used in those processes requiring a good quality of water.

The capacity of the RWD should include capturing of rain from a 50-year ARI event plus 0.5m freeboard in addition to provisions for operating requirements. The RWD should be operated to attain a minimum operating level at the start of the rainy season.

Monitoring (surface and ground water quality and erosion), including downstream bores (ground water levels), is to be undertaken at the surface water management controls and downstream drainage features.

7. Further Work and Commitments

7.1 Mining Schedule and Further Work

The intended mining and detailed investigation schedule is:

Table 19: Project Time Table.

Activity	2010	2011	2012	2013 onwards
Oxide Mining and Processing: ▪ Sandy Flat Pit (none) ▪ Redbank ▪ Azurite ▪ Bluff	165,000tpa	220,000tpa	220,000tpa	220,000tpa
Oxide Plant Construction (Sandy Flat)	Construct/Operate	Existing TSF: Dry Stack Tailings		Rehabilitate WRD and TSF
April to June 2010 Investigative Program: **Continued surface and ground water quality monitoring coupled with pit and ground water level surveys.** **Geotechnical and geophysical (EM-34) investigations and further drilling (the number and locations will be determined after the geophysical investigations) at Redbank, Azurite, Bluff and Sandy Flat Pit.** **Aquifer and bore pump testing employing step-drawdown and constant-rate discharge tests (>24hrs) with recovery.** **AMD testing employing static and kinetic methods complimented by metal leach and mineralogical tests.** **Finalize conceptual ground water model and complete integrated surface water and ground water modelling.**				
Excluded from the current assessment:				
Sulphide Mining and Processing: ▪ Sandy Flat Pit ▪ Redbank ▪ Azurite ▪ Bluff			300,000tpa	500,000tpa
Sulphide Plant Refurbishment/Expansion		Refurnish	Expand	
New Tailings Storage Facility		Construct	Operate	
Data requirements: further investigation, drilling, testing and modelling.				

Current research and investigative projects include:

- Integrated surface and ground water management.
- Continue to develop water balances.
- The existing sources of contamination and the extent of ground water contamination including:
  - Continued sampling and measurement of the hydrological and hydrogeological regimes.
  - Geotechnical and geophysical investigations to demarcate preferential flow paths followed by further investigative drilling at existing and future open pits, WRDs and TSFs (April and May 2010).
  - Aquifer and bore pump testing (May and June 2010).
  - AMD and metal leach testing and waste characterization including establishing a relationship between XRF and laboratory data (April and May 2010).
  - Ground water and mass transport modelling (May and June 2010) including impact and risk assessments (current, future and residual).
- Remediation requirements for existing processing facilities, the WRD and TSF.
- Identify and set requirements for optimizing detailed design and construction of new mining infrastructure based upon detailed investigations.
- Obtain approvals for construction of new mining infrastructure.

7.2 Commitment

Redbank Mines remain committed to ensure that legacy issues do not recur and therefore commit to progressive investigations, and a mining and rehabilitation plan that will employ best practice adaptive management strategies.

Geological information along with the XRF and test data presented here provide confidence that the oxide mining and waste rock storage facilities will not be acid producers, however further testing will be performed prior to and progressively during the mining phase to ensure this remains the case. Receipt of test results prior to mining will allow for the correct decision making regarding the fate of those materials prior to their disturbance.

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