Savannah Project
Stage 2 Tailings Storage Facility Amendment
Mining Leases 80/179, 80/180, 80/181, and Miscellaneous Licence 80/64

Mining Proposal

Prepared for:

PANORAMIC RESOURCES LTD

April 2012

Prepared by:
MBS Environmental

Martinick Bosch Sell Pty Ltd
ACN 102 814 479
MBS Environmental
environmental and water resource consultants

Savannah Nickel Mines Pty Ltd
Wholly Owned Subsidiary of Panoramic Resources Limited

SAVANNAH PROJECT
STAGE 2 TAILINGS STORAGE FACILITY AMENDMENT
MINING LEASES 80/179, 80/180, 80/181 AND MISCELLANEOUS LICENCE 80/64
MINING PROPOSAL

PREPARED FOR

PANORAMIC RESOURCES LTD

This report has been prepared for **Panoramic Resources Ltd** on the basis of instructions and information provided by **Panoramic Resources Ltd** and therefore may be subject to qualifications which are not expressed.

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This report has been checked and released for transmittal to **Panoramic Resources Ltd**.

PREPARED BY:
Siobhan Pelliccia
Senior Environmental Scientist

Signature: Date: 05/04/2012

CHECKED BY:
Lance Bosch
Managing Director

Signature: Date: 05/04/2012

MINING PROPOSAL CHECKLIST

Q No.	Mining Proposal Checklist	Y/N NA	Page No.	Comments
	Public Availability			
1	Are you aware that this mining proposal is publicly available?	Y	NA	
2	Is there any information in this mining proposal that should not be publicly available?	N	NA	
3	If 'No' to Q2, do you have any problems with the information contained within this mining proposal being publicly available?	N	NA	
4	If 'Yes' to Q2, has confidential information been submitted in a separate document / section?	NA	NA	
5	Has the mining proposal been endorsed? See last page Checklist.	Y	NA	
	Mining Proposal Details			
6	Have you included the tenement number(s), site name, proposal overview and date in the title page?	Y	NA	
7	Who authored the mining proposal?	MBS Environmental Panoramic Resources Limited		
8	State who to contact for enquires about the mining proposal?	David Swain Manager Environment & Heritage 08 9225 0999		
9	How many copies were submitted to DMP?	Hard copies = Two Executive Summaries.		
		Electronic = Online Submission		
10	Is this mining proposal to support lease application?	N	NA	
11	Has a geological resource statement been included (refer section 4.3.2 of mining proposal Guidelines)	Y	13	
12	Will more than 10 million tonnes of ore and waste be extracted per year? State total tonnage:	N	42	Ore: ~800 tonnes per annum
13	Will more than 2 million tonnes or ore be processed per year? State total throughput.	N	NA	750 tonnes per annum throughput
14	Is the mining proposal located on pre-1899 Crown Grant lands? (not subject to the Mining Act)	N	4	
15	Is the mining proposal located on reserve land? If 'Yes' state reserve types in space below:	N	NA	
16	Will the mining proposal occur within or affect a declared occupied townsite?	N	NA	
17	Is the mining proposal within 2 km of the coastline or a Private Conservation Reserve?	N	NA	
18	Is the mining proposal wholly or partially within a World Heritage Property, Biosphere Reserve, Heritage Site or Soil Reference Site?	N	NA	

Q No.	Mining Proposal Checklist	Y/N NA	Page No.	Comments
	Tenement Details			
19	Are all mining operations within granted or applied for tenement boundaries?	Y	4	
20	Are you the tenement holder of all tenements?	Y	4	
21	If 'No' at 20, do you have written authorisation from the tenement holder(s) to undertake the Mining proposal activities? (Refer to section 4.2.1 of the Mining Proposal Guidelines)	NA	NA	
22	If 'Yes' at 21, then is a copy of the authorisation contained within the mining proposal?	NA	NA	
23	Have you checked for compliance against tenement conditions?	Y	Appendix 1	
	Location and Site Layout Plans			
24	Have you included location plans showing tenement boundaries and mining operations?	Y	6	
25	Have you included site layout plans showing all mining operations and infrastructure in relation to tenement boundaries?	Y	9	
26	Have you included Area of Disturbance Tables for all tenements impacted by mining operations?	Y	41	
	Environmental Protection Act			
27	Does the mining proposal require referral under part four of the MOU? If 'Yes' describe why in space below:	N		
28	Has the EPA set a level of assessment? If yes state:	N		
29	Is a clearing permit required? If 'No' then explain why in space below?	N		Clearing less than 10 hectares per tenement
30	If 'Yes' at Q29 then has a permit been applied for?	NA	NA	
31	Is a Works Approval required by the DEC?	Y	53	
32	Has a Works Approval been submitted to the DEC?	N		
33	Stakeholder Consultation: Have the following stakeholders been consulted? (use NA if not relevant)			
	Shire?	NA		
	Pastoralist?	Y		
	DEC?	Y		
	Main Roads?	N		
	Others? (specify) Traditional Owners	Y		

Q No.	Mining Proposal Checklist	Y/N NA	Page No.	Comments
	Environmental Assessment and Management			
34	Is the mining proposal wholly or partially within DEC managed areas?	N		
35	If 'yes' at Q34 has DEC been consulted?	NA		
36	Is the mining proposal wholly or partially within a red book area or a bush forever site?	N		
37	Will the mining proposal impact upon a water resource area, water reserve, declared or proposed catchment, groundwater protection area, significant lake or wetland?	N		
38	Is a water or de-watering licence required?	N		
39	If 'Yes' at Q39 then has the licence(s) been applied for?	NA		
40	Does the mining proposal include a new tailings storage or changes to existing tailings storage?	Y	43	
41	Has AMD assessment been undertaken?	Y	13, 16	
42	Have flora and fauna checks been undertaken?	Y	34, 36	
43	Are any rare species present?	N		
44	Has preliminary closure plan has been included?	Y	Appendix 16	

I hereby certify that to the best of my knowledge the above checklist accurately reflects the information contained within this mining proposal.

Name: David Swain Signed:  Date: 5 April 2012

Position: Manager Environment and Heritage

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1. SUMMARY AND COMMITMENTS

The Savannah Project is located approximately 120 kilometres north of Halls Creek in the East Kimberley region of Western Australia (Figure 1). The Project is operated by Savannah Nickel Mines Pty Ltd (SNM), a wholly owned subsidiary of Panoramic Resources Limited (Panoramic). Operations commenced in 2004 and currently consist of a decommissioned pit, an operating underground mine, paste plant, processing plant with tailings and water storage facilities, supporting mine site infrastructure and an accommodation village.

Since Project approval in 2003, additional mineral resources have been identified within the Savannah orebody resulting in an extension of the operation's Life of Mine (LOM) beyond 2014.

To enable mining and processing of ore to continue beyond 2014, Panoramic require additional tailings storage capacity.

To accommodate additional tailings, Panoramic is seeking approval for an amended long-term tailings management strategy. Specifically, the Stage 2 TSF Amendment Proposal (this Proposal) requests approval for:

- Storage of additional tailings (974,000 cubic metres) within the existing valley-fill Tailing Storage Facility (TSF 1), through a series of upstream embankment raises.
- Tailings to be permanently stored *in-situ* within TSF 1 on completion of mining with an engineered cover.

Should additional tailings storage capacity be needed in the future (beyond the scope of this Proposal and as a result of defining additional reserves), a second TSF (TSF 2) will be required. This will include a review of options assessed at the 2011 Agency Workshop, including:

- Discharge of tailings to the decommissioned Savannah pit.
- Construction of an additional valley-fill or paddock TSF.

Approval of TSF 2 (if required) will be sought at a later stage.

Environmental impacts associated with the proposal are summarised in the Executive Summary (separate report) and in detail in Section 5 of this Mining Proposal. Impacts associated with the Proposal comprise:

- Increased seepage rates during operations with a steady decrease following the cessation of operations.
- Increased solute concentrations in groundwater and surface water during operations with a steady decrease during the closure phase.
- Temporary impacts to aquatic fauna in Mine Creek.

Table 1 of this Mining Proposal provides a series of commitments, all of which will become part of the conditions of approval by the Department of Mines and Petroleum (DMP) for proposal to expand the existing Savannah TSF and leave tailings *in-situ* at closure.

Table 1: Summary of Commitments

Commitment Number	Commitment
1	Relevant site procedures and management plans will be applied to all work undertaken as part of this Mining Proposal.
2	All available topsoil will be stripped from surfaces that will be disturbed and stored for rehabilitation. Wherever practicable, the duration that topsoil is stockpiled will be minimised to reduce the loss of seed viability and soil biota.
3	Vegetation will be established, where practicable, on disturbed areas following completion of mining activities.
4	Construction of the main and saddle embankments to standards required for the highest hazard rating (Category 1) facilities according to DMP criteria, with supervision by qualified person.
5	Design, construction and operation of TSF 1 with allowance of adequate freeboard to accommodate temporary storage of water on the facility during a 1 in 100 year average recurrence interval (ARI) 72 hour storm event with excess water removed from the facility via a weir during operations.
6	Design of the weir to accommodate surface water flow resulting from a probable maximum precipitation (PMP) event (i.e. greater than a 1:100 year ARI event).
7	Armouring the weir with suitable materials to reduce the development of erosion rills and gullies.
8	Locating the decant pond within the central layout of Cell 2 to reduce saturation of tailings and build-up of free standing water adjacent to the main and saddle embankments to enhance the structural integrity of the facility.
9	Regular monitoring of embankment prisms for movement and measurement of the decant water level.
10	Annual analysis of particle size distribution of tailings.
11	Continuation of the Annual Audit and Management Review of TSF 1.
12	Continuation of current tailings discharge methods which are effective in maintaining anoxic (reducing) conditions within the bulk tailings profile below the hardpan surface.
13	Continued operation of seepage recovery bores and sumps to retard the advance of the groundwater mound downstream during the operational phase.
14	Groundwater quality and levels will continue to be monitored in accordance with the Savannah Water Operating Strategy. Where an upward trend in solute concentrations is detected, this will result in a series of management responses which may include resampling and analysis of water quality, investigating the likely cause of the elevated concentrations and increasing seepage recovery operations.
15	Monitoring of surface water quality at locations along Mine Creek, Fletcher Creek and the Ord River.
16	Implementation of seasonal surface water trigger values at pre-determined locations.
17	Where surface water trigger values are exceeded, this will result in a series of management responses which may include resampling and analysis of water quality, investigating the likely cause of the elevated concentrations and increasing seepage recovery operations.
18	Continuation of aquatic fauna monitoring in Fletcher Creek.
19	Implementation of ecological trigger values at pre-determined locations.
20	Where ecological trigger values are exceeded, this will result in a series of management

Commitment Number	Commitment
	responses which may include resampling and analysis of water quality, sampling for aquatic fauna, investigating the likely cause of the elevated concentrations and increasing seepage recovery operations.
21	Continued periodic review and update of the Savannah Water Operating Strategy to reflect relevant changes.
22	Consultation with key stakeholders will continue throughout the LOM to ensure an inclusive approach to operations and mine closure.
23	All closure activities associated with the TSF 1 Closure Domain will be implemented in accordance with the Stage 2 TSF Amendment Mine Closure Plan.
24	Reducing the risk of material segregation during cover placement will be achieved by implementing a quality assurance and quality control (QA/QC) system during material selection and cover system construction in order to achieve the designed final landform.
25	A cover system field trial will be established in Cell 1 as TSF 1 is progressively closed. Performance of the field trial will be monitored for a minimum of three years before proceeding to cover system construction over the remaining TSF 1 footprint.
26	A weather station that meets Australian Standards (AS 2922-1987 & AS 2923-1987) for ambient air monitoring will be installed at the Savannah site in the third quarter of 2012.
27	A two phased approach to monitoring is proposed as follows: • Phase 1: Monitoring undertaken until completion criteria are achieved. • Phase 2: Continuation of monitoring for an agreed period to reinforce stability of the system.
28	In the event that Phase 1 and/or Phase 2 closure monitoring indicates that monitoring will be required beyond the current tenement expiry dates, Panoramic commits to seeking renewal of the relevant tenements one year prior to the expiry date.

2. BACKGROUND INFORMATION

2.1 OWNERSHIP

The Savannah Project is operated by Savannah Nickel Mines Pty Ltd (SNM), a wholly owned subsidiary of Panoramic Resources Limited (Panoramic).

All compliance and regulatory requirements regarding this assessment document should be forwarded by email, fax or post to the following address:

Contact: Mr David Swain, Manager Environment and Heritage
Postal address: PO Box Z5487
PERTH WA 6831
Telephone: 08 9225 0999
Facsimile: 08 9421 1008
Email: dswain@panres.com

2.2 PROJECT OBJECTIVES

The key objectives of the Stage 2 TSF Amendment Mining Proposal are to:

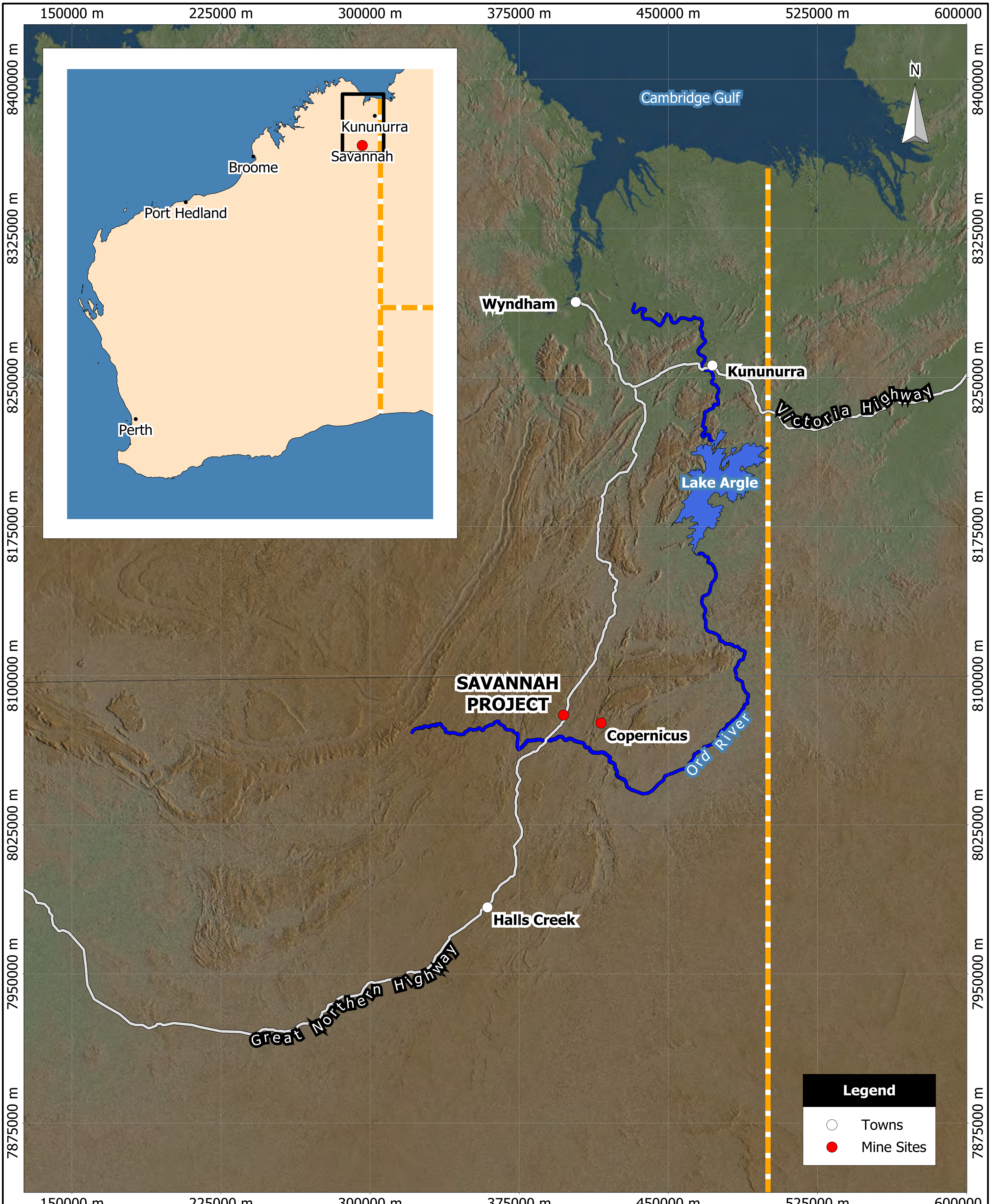
- Extend the Savannah Project LOM by obtaining approval for:
  - Storage of additional tailings within TSF 1 through a series of embankment raises.
  - The tailings to remain permanently *in-situ* within TSF 1 on completion of mining, with an engineered cover installed.
- Develop a Mine Closure Plan (MCP) that will deliver agreed environmental outcomes based on acceptable levels of risk without posing unacceptable liability to all stakeholders.

The specific objectives of the Mining Proposal are to:

- Describe the proposal and in particular, the proposed construction methods for the TSF 1 main and saddle embankment raises.
- Provide supporting documentation and justification for permanent *in-situ* storage of tailings within TSF 1.
- Appraise the environment of the area surrounding the Savannah Project and especially the areas that have the potential to be affected by the proposal.
- Identify potentially adverse environmental impacts and outline design and management procedures to avoid or minimise potentially adverse impacts.

2.3 LOCATION AND SITE LAYOUT PLANS

The Savannah Project is located approximately 40 kilometres south of Warmun and 120 kilometres north of Halls Creek in the East Kimberley region of Western Australia and is accessed via the Great Northern Highway (Figure 1). Infrastructure is located on Mining Leases M80/179, M80/180, M80/181 and Miscellaneous Lease L80/64. Tenement conditions are listed in Appendix 1. An overview of the Savannah Project layout, tenements and access is presented Figure 2.



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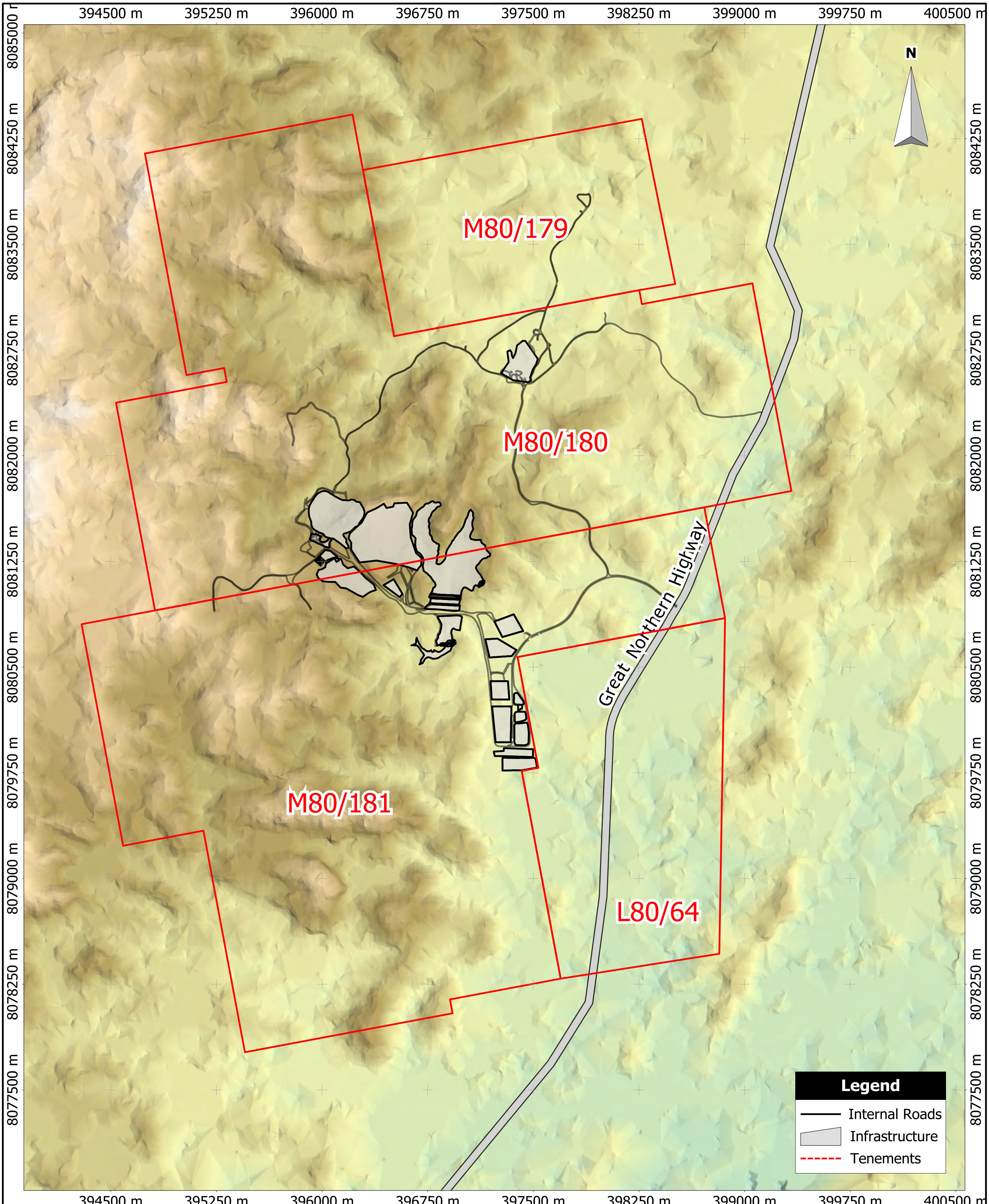
Scale: 1:2500000
Original Size: A4
Grid: Australia MGA94 (52)

0 100 km

Panoramic Resources Limited
Savannah Project

Location Plan

Figure 1



MBS ENVIRONMENTAL Environmental + Water Resource Consultants 4 Cook St West Perth WA 6005 Telephone: + 618 9226 3166 Facsimile: + 618 9226 3177 info@mbsenvironmental.com.au	Scale: 1:35000 Original Size: A4 Grid: MGA94(52) 0 — 1000 m	Panoramic Resources Limited Savannah Project	Overview of Savannah Project Layout, Tenements and Access Figure 2

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2.4 HISTORY

The Savannah Project was approved under Notice of Intent (NOI) 4099 in 2003 with a projected seven year LOM. Pre-strip mining of the pit commenced in February 2004 and full mining and processing operations commenced in August 2004. The first shipment of nickel/copper/cobalt concentrate departed the Wyndham Port on 5 September 2004. Open-cut mining ceased in January 2006, after 1,010,000 tonnes of ore from the pit had been mined and processed. Underground mining at Savannah commenced in late 2005.

Under NOI 4099, all tailings produced throughout the Life of Mine (LOM) are stored in the Tailing Storage Facility (TSF 1). Three options for closure were provided in NOI 4099 including:

- Relocation of tailings to an environmentally acceptable location.
- Installation of an engineered cover.
- Installation of a store-and-release (ecological) cover.

Based on the understanding of tailings geochemistry and hydrogeology at the time of the assessment, DMP in consultation with the Savannah Project determined that at closure, tailings should be returned to the completed mine workings (pit void and underground). The requirement to relocate tailings to the pit included a water cover to prevent oxidation of the tailings.

In 2007 an Addendum to NOI 4099 was granted allowing for tailings to be disposed underground as cement stabilised paste fill to the completed mine workings during operations. In July 2008, Panoramic announced an updated mineral resource that would extend the LOM to 2018. In June 2009 an Environmental Protection Statement (EPS) was submitted to the Office of the Environmental Protection Authority (OEPA) for assessment of a proposal to raise TSF 1 by nine metres and leave tailing *in-situ* at closure with an engineered cover.

In June 2010 it was communicated to Panoramic that key agencies had broad concerns regarding the proposal and that they would not support the proposal in its current form. Panoramic was asked to consider if there was an alternate interim option available to meet current operational needs while a long-term tailings management strategy was determined.

In August 2010, the Chairman of the EPA, Dr Paul Vogel, EPA Board Member, Dr Dennis Glennon, and OEPA Principal Environmental Officer, Mr Tim Gentle, visited the Savannah Project and following a tour of site, discussed the tailings storage options available to Panoramic. Following further consultation with the Department of Environment and Conservation (DEC), the Department of Water (DoW), the OEPA, DMP and EPA, it was agreed that the following revised two-staged tailings strategy would be an appropriate way forward:

- Stage 1 (approved in December 2010 and completed in 2011): Construction of a single, 3 metre embankment raise on TSF 1 and additional water storage facilities, to allow continuation of the Savannah operations, while Stage 2 is progressed.
- Stage 2 (TSF Options Assessment): Development of a long-term tailings storage strategy which may include a new lined TSF 2 or alternate tailings storage options.

The Stage 2 TSF Options Assessment involved a two day agency workshop that assessed environmental impacts associated with four tailings storage options. Based on the outcomes of the workshop Panoramic concluded that the best environmental outcome for tailings storage at Savannah would be achieved through raising TSF 1, with tailings to remain *in-situ* at closure, with an engineered cover.

2.5 EXISTING FACILITIES

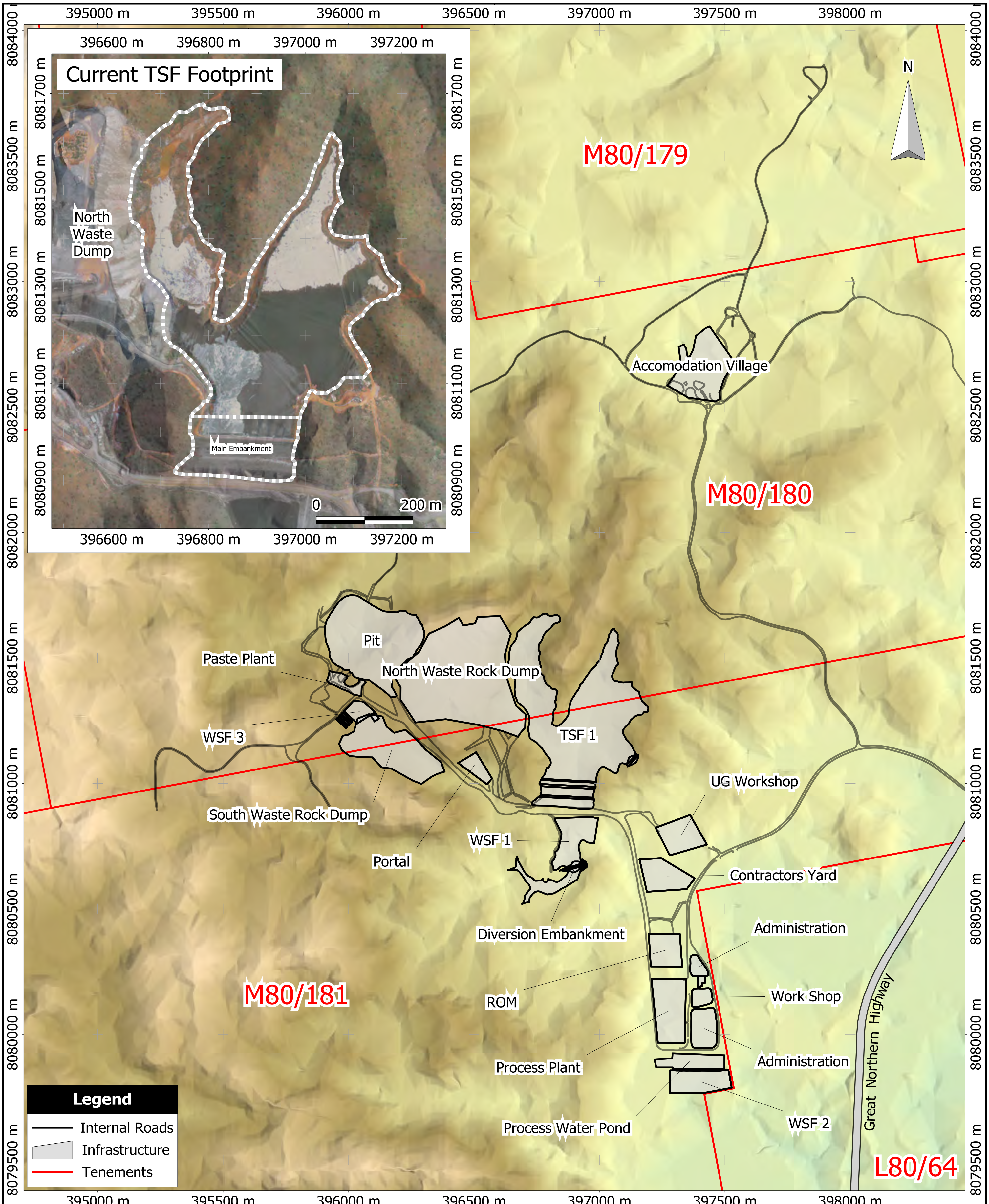
The Savannah Project is a fully operational mine and processing facility, with all supporting infrastructure currently in place. The main components of the project comprise:

- Decommissioned pit – mined to a final depth of approximately 100 metres.
- Underground mine.
- Run of Mine (ROM) pad.
- Topsoil stockpiles.
- Two waste rock dumps (North and South).
- Processing plant with crushing, grinding, flotation and filtering.
- Tailings paste plant.
- Power station and fuel farm.
- Process and raw water ponds.
- Tailings storage facility (TSF 1).
- Water storage facilities (WSF 1, WSF 2 and WSF 3).
- Process area runoff pond (PARP).
- Production borefield.
- Seepage recovery bore (SMPB03).
- Monitoring bores.
- Haul roads and other access roads.
- Laydown areas.
- Mine administration offices and contractor's workshops.
- Accommodation village.

The Savannah Project operates under Environmental Licence (7967/4) and Groundwater Licence (GWL153527(3)) which are presented in Appendix 2 and Appendix 3 respectively.

Annual environmental monitoring and reporting is conducted in accordance with the relevant site licences, tenement conditions and site policies. Annual reports are submitted to DMP, DEC and DoW.

Key infrastructure components are presented in Figure 3.



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Scale: 1:20000
Original Size: A4
Grid: MGA94(52)

0 400 m

Panoramic Resources Limited
Savannah Project

Site Infrastructure

Figure 3

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2.6 TAILINGS STORAGE

TSF 1 was constructed as a valley-fill style impoundment approximately one kilometre north of the Savannah processing plant. It was designed and construction supervised by Soil and Rock Engineering (now Coffey Mining) in 2004. Tailings in the form of slurry are discharged sub-aerially and spirally around the perimeter of the TSF in discrete layers from single point discharges. The supernatant water pond is maintained around the decant structure, which is located away from the main embankment. TSF 1 has been designed and constructed with factors of safety that exceed the corresponding recommended minimum factors of safety in the Australian National Committee on Large Dams (ANCOLD) Guidelines (1999) for operational and long-term (permanent) storage of tailings.

The main embankment has been constructed to a crest level of 372 mRL and currently has a maximum height of approximately 45 metres.

The proposal to increase the TSF 1 storage capacity requires construction of a six metre raise of the main embankment (in two by three metre staged raises) and construction of three additional saddle embankments.

At completion of mining, all tailings stored in TSF 1 will remain *in-situ* with installation of an engineered cover.

2.7 WATER STORAGE AND SEEPAGE RECOVERY

Three water storage facilities (WSF 1, WSF 2 and WSF 3) have been constructed at the Savannah Project to manage site water inputs and outputs.

WSF 1 is located at the downstream toe of TSF 1 main embankment and was constructed and located to receive any potential seepage from TSF 1 and act as a buffer/diluting body of water. The main embankment of WSF 1 was designed to allow leakage through the base thereby reducing pressure upstream of the embankment. This has resulted in elevated sulphate concentrations in downstream surface water and groundwater due predominantly to seepage. A series of seepage collection sumps and one seepage recovery bore (SMPB03) are located downstream of WSF 1 to capture seepage along this primary flow path. In 2009, a controlled release of water from WSF 1 via the existing emergency spillway occurred due to a series of high rainfall events which also contributed to elevated sulphate concentrations in downstream surface water. In 2011, a diversion embankment was constructed within the existing WSF 1 to allow upper catchment runoff to bypass WSF 1 via the existing spillway. The purpose of this was to:

- Reduce the chance of overflow into Mine Creek in extreme rainfall events.
- Reduce the hydraulic head in WSF 1 resulting in reduced seepage through the facility reporting to surface and groundwater.

WSF 2 is a lined facility, constructed in 2011 and located south of the PARP. Water stored in WSF 2 and used in the processing plant comprises:

- Seepage water pumped from SMPB03 and Mine Creek sumps.
- Water from WSF 1.
- Make-up water from the borefield.
- Supernatant water from TSF 1.

WSF 3 is a lined facility, constructed in 2011 and located south of the paste plant. Mine water to be temporarily stored in WSF 3 comprises:

- Water from the paste plant.
- Mine dewatering water.

3. EXISTING ENVIRONMENT

The existing environment is described in Section 2 of the original NOI 4099 (Appendix 4). As part of this Proposal, a number of additional studies have been commissioned to improve knowledge of the existing environment at the Savannah Project. The following sub-sections describe the existing environment of the Savannah Project, focusing on the most significant aspects associated with this proposal, namely, geochemistry of tailings and waste rock, hydrogeology, hydrology and aquatic ecology.

3.1 REGIONAL SETTING

The Savannah Project is located in the east Kimberley region of Western Australia. The topography of the site is dominated by a north-northeast trending ridge of steep low hills that cover approximately 80% of Mining Leases M80/179, M80/180 and M80/181. To the east and southeast of these hills, over Miscellaneous Licence 80/64, the area grades from rolling rises to undulating plains dissected by minor ephemeral drainage lines which drain gently eastwards to Stoney and Fletcher Creeks. An unnamed ephemeral drainage line referred to as Mine Creek, transverses the Savannah Project. The region is sparsely populated. The main economic activities occurring in the vicinity of the Savannah Project are pastoral activities and tourism.

3.2 GEOLOGY

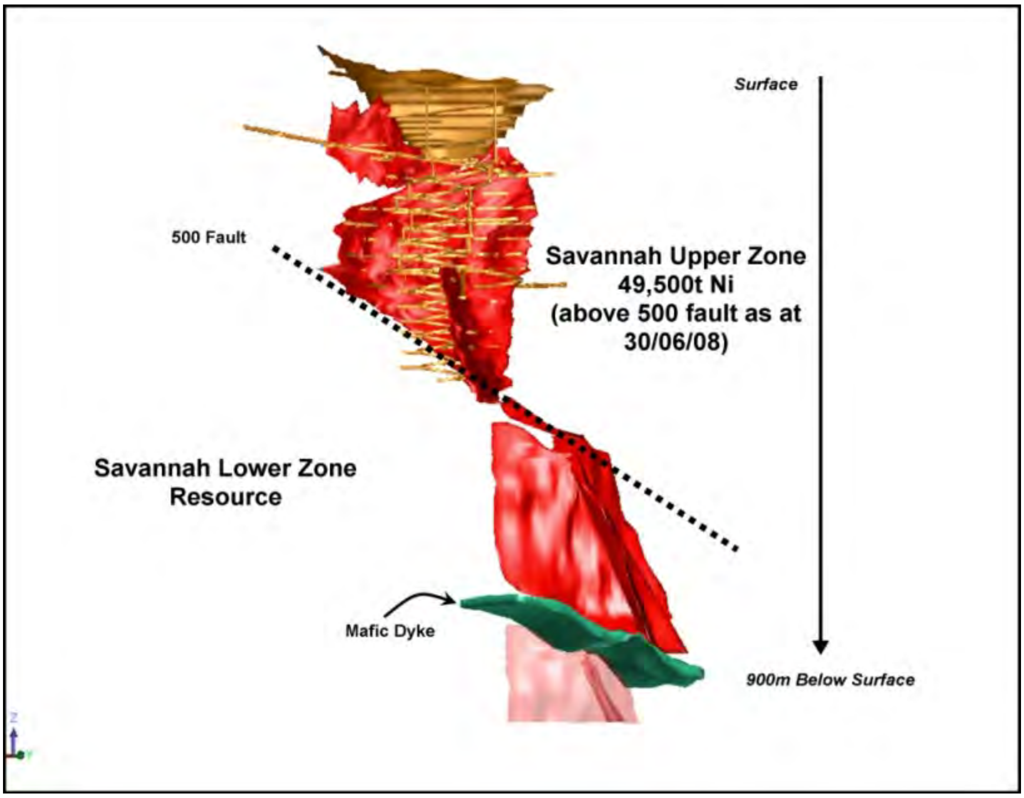
3.2.1 Local Geology

The geological bedrock within the Savannah Project area is Proterozoic in age and consists of the Sally Malay Layered Mafic Complex that hosts the sulphidic nickel orebody, and granulite facies, migmatitic gneisses of the Tickalara Metamorphics.

The Savannah orebody (sulphide nickel, copper and cobalt) is hosted by the layered mafic-ultramafic Savannah Intrusion, which is enveloped by aluminous metasediments and para-gneisses of the Tickalara Metamorphics. The orebody is mostly confined to a marginal norite unit up to about 40 metres in thickness that developed near the base of the intrusion. Areas of massive, matrix and disseminated sulphide mineralisation occur throughout the norite unit, dominated by pyrrhotite, chalcopyrite, pentlandite and minor pyrite.

Two significant faults truncate the Savannah deposit. The smaller 100 Fault truncates the orebody approximately 100 metres below the surface, displacing the mineralisation 20 to 25 metres towards the south-east. At approximately 500 metres below the surface a much larger fault (“500 fault”) truncates the orebody, displacing it in a north-westerly direction some 150 metres. A 3D view of the current Savannah Ni-Cu-Co deposit is shown in Figure 4. It shows the mineralisation in red, the pit and underground workings and the position of the 100 and 500 Faults. During 2007 an extension to the main ore zone along the western margin of the Savannah Ni-Cu-Co deposit was identified between the 100 and 500 Faults.

Figure 4: 3D View of the Savannah Nickel Deposit



3.2.2 Resource Details

At 30 June 2010, the combined Savannah and Copernicus Ore Reserves stood at 5.65 million tonnes producing 67,200 tonnes of nickel, 35,600 tonnes of copper and 3,300 tonnes of cobalt (Panoramic Resources 2010). This comprises:

- 20,200 tonnes contained nickel above the 500 Fault.
- 43,200 tonnes contained nickel below the 500 Fault.
- 3,800 tonnes contained nickel from Copernicus.

Mining of Savannah and Copernicus Ore Reserves will allow operations to continue to 2018/2019.

The reserve is compliant with Joint Ore Reserve Committee (JORC) guidelines.

3.3 WASTE ROCK CHARACTERISATION

3.3.1 Studies

A number of investigations have been undertaken to characterise the physical and chemical properties of Savannah Project waste rock, including:

- Pre-mining study of waste rock and regolith materials conducted by Graeme Campbell and Associates (GCA 2002a) as part of the original NOI.
- Soil and Rock Engineering Pty Ltd (2002) characterised the physical properties of waste rock for use in TSF construction.

- Further geochemical analysis of actual mine waste samples, undertaken by MBS Environmental (2008) (Appendix 5) and RGS (2009a).
- In 2009 a series of tests were completed on waste samples as part of the TSF 1 cover design investigations. This included testing of:
  - Erosion potential of subsoil and topsoil undertaken by Landloch Pty Ltd (Landloch) (2010).
  - Physical characterisation including particle size distribution, Atterberg limits, moisture retention characteristics and saturated hydraulic conductivity undertaken by O'Kane Consultants (2012).
  - Chemical analysis for plant-available nitrogen and phosphorus, organic carbon and water-soluble nutrients and metals undertaken by MBS.

3.3.2 Waste Rock Types

Based on geological information available at the time, GCA (2002a) identified four groups of Savannah waste rock, *viz*. gossan waste, oxidised waste, transition zone waste and bedrock waste. The oxidised, transition zone and bedrock waste can be divided into two geological categories. The first of these are the Tickalara Metamorphic rocks which are the regional metasedimentary rocks of the area. The other belongs to Sally Malay Intrusive (SMI) which hosts the nickel mineralisation.

Only the gossan waste rock was classified as Potentially Acid Forming (PAF) (GCA 2002a). All of the gossan waste rock has been removed by mining of the open pit and is encapsulated within the north waste rock dump (NWRD) at Savannah.

Apart from minor slightly weathered material from the top five to ten metres of the pit, all wastes are fresh, almost fracture-free impermeable and non-porous rock fragments virtually devoid of sulphide minerals.

3.3.2.1 Tickalara Metamorphics

The Tickalara Metamorphics comprise mostly felsic to intermediate metasediments and metasomatic pegmatoids in the pit area, often with joint fractures covered with golden biotite. Trace amounts of barite and various sulphide minerals, galena, sphalerite, chalcopyrite, pyrite are present in veins or in siliceous stratiform lenses. The content of the sulphide minerals is estimated to be less than one per cent. These rock types require no refinement and are estimated to contribute 60 to 65 per cent of the total waste rock.

3.3.2.2 Sally Malay Intrusive Rock Types

The samples described in the pre-mining study (GCA 2002a) included only one of the rock facies from the Sally Malay Intrusives (SMI) which are exposed within the pit, namely the peridotitic ultramafics. These form a narrow band of 8 to 12 metres thickness on the structural footwall of the sulphide mineralisation. Minor amounts of settled sulphides, up to about three per cent by volume but generally substantially less than one per cent by volume, were visible in the lowermost three metres of the pit. The dominant SMI rock type is a coarse grained noritic gabbro in which sulphide minerals appear to be absent.

3.3.3 Physical Properties

Particle size distribution measurements of 32 samples of Savannah waste rock show a range of 38 to 69 per cent gravel, 11 to 22 per cent sand, 3 to 7 per cent silt and clay.

The mean field saturated hydraulic conductivity value measured at the surface of the waste rock was approximately 4 x 10^{-7} metres per second. The majority of the measurements were conducted on the surface of the waste rock dump that had experienced light to heavy traffic. Subsequently, the mean hydraulic conductivity value for the surface of the trafficked waste rock represents the lower value expected for this material. The mean laboratory saturated hydraulic conductivity value was significantly higher at 4 x 10^{-5} metres per second.

Atterberg limit testing demonstrated that waste rock plots within the region of inorganic clays of low plasticity (O'Kane 2012).

Other physical characteristics relevant to use of waste rock as a cover material for TSF 1 are summarised below:

- Specific Gravity 2.74 to 2.95.
- Maximum dry density 2.16 tonnes per cubic metre.
- Optimum moisture content ten per cent.
- Porosity 0.34.
- Approximate air entry value five to ten kiloPascals.

3.3.4 Geochemical Properties

Static geochemical characterisation tests have been completed on waste rock materials from the Savannah Project focusing on acid generation potential, metal content, and potential for soluble metal mobilisation under various pH conditions. The geochemical test methods are based on industry recognised procedures for the geochemical characterisation of mine waste materials (AMIRA, 2002; DITR, 2007).

The majority of Savannah waste rock is characterised as Non Acid Forming (NAF). A small amount (less than five per cent) of waste rock is classified as PAF. These materials, located in close proximity to the orebody, are easily identifiable due to visible veins of sulphide minerals. They will contribute a very small proportion of all rock reporting as waste and so the potential for production of acid leachate from the waste rock dumps is negligible.

The pre-mining studies on Savannah waste rock (GCA, 2002) found some enrichment of "total" metals and metalloids (notably selenium) compared to unmineralised soils. Results from laboratory leaching studies suggested that these metals were unlikely to be mobilised under pH neutral conditions. Site data (MBS, 2008) indicates that initial leachate from Savannah waste rock exposed at the surface is likely to exhibit alkaline pH values and contain elevated concentrations of aluminium and silicon. The leachate pH is expected to drop as the leachate percolates through the waste rock materials, carbonate content decreases, and the effects of rainwater dilution become significant leading to precipitation of both aluminium and silicon. Water leachate characterisation results indicate that other metals are very slightly soluble at neutral pH and hence leachate is very unlikely to affect the groundwater quality. Trace metal analysis on surface and groundwater samples taken elsewhere on the mine site are well below appropriate guideline values.

Oxidation of residual sulphide minerals in waste rock produces a near-neutral, slightly saline leachate containing mainly calcium and magnesium sulphates.

3.4 TAILINGS CHARACTERISATION

3.4.1 Studies

Geotechnical studies undertaken on the Savannah tailings comprise:

- Soil & Rock Engineering (2002), *'Sally Malay Project, Geotechnical Investigation, Tailings and Water Storage Facilities'*, prepared for Sally Malay Mining Limited (prepared in conjunction with 2002 and 2003 design reports and 2003 NOI) – Original geotechnical investigation reporting on ground conditions, foundation materials (including hydraulic conductivity) and laboratory testing of both tailings and borrow materials.
- Tailings sampling and testing (including tri-axial testing) conducted as part of 2007 report by Coffey Mining (2007), *'Future Options Study, Tailings Storage, Sally Malay Mine',* prepared for Kimberley Nickel Mines.
- Coffey Mining (2008), *'Savannah Nickel Project, Tailings Storage Facility Raise, Geotechnical Investigation Factual Report*', letter to Panoramic Resources Limited – borrow and embankment material assessment.
- Coffey Mining (2009), *'Tailings Storage Facility, Additional Geotechnical Investigation, Savannah Mine'*, prepared for Panoramic Resources Limited – CPT testing, tailings strength evaluation, and consolidation and liquefaction assessment. This report has been updated as part of the revision of this design report.
- Coffey Mining (2010), 'Additional Geotechnical Investigation, Raising of TSF1, WSF1 Diversion, Construction of WSF2 and WSF3, Savannah Nickel Mine', letter to Panoramic Resources Limited.
- Rowe Cell testing was performed in 2011 to reconfirm tailings consolidation characteristics.
- Monthly tailings composite samples have been taken since 2004 and are analysed for key physical parameters.

All geotechnical studies listed above are included as appendices to the Coffey Mining (2012) TSF Design Report, provided in Appendix 6.

Studies undertaken on embankment stability are discussed in 4.6.

Geochemical studies conducted on Savannah tailings comprise:

- Initial geochemical tests were completed by GCA (2002b, 2002c) on simulated process tailings samples. This was peer reviewed by Environmental Geochemistry International.
- An investigation by MBS (2009) to geochemically characterise fresh Savannah tailings following commencement of mining in August 2004. Monthly tailings samples were collected by MBS and geochemically tested from July 2005 to January 2008. The third of a series of three tailings reports prepared by MBS Environmental (MBS 2009) is provided in Appendix 7.
- RGS was commissioned in 2008 to provide a third party peer review of the long-term tailings storage strategy at Savannah (RGS 2008). RGS reviewed the results and findings of the earlier GCA and MBS investigations and initiated additional testwork to refine predictions of the long-term geochemical nature of the Savannah tailings. The report is provided in Appendix 8 (RGS 2009a).
- In 2008 Levay & Co. Environmental Services (Levay & Co) and the Applied Centre for Structural and Synchrotron Studies (ACeSSS) at the University of South Australia were engaged to investigate the sulphide and silicate mineralogy of the Savannah tailings. Levay & Co defined the

reaction pathways taking place in the TSF1 tailings by identification of the reaction products. A peer review was also undertaken of earlier geochemical assessments completed by GCA, MBS, and RGS. The report is provided in Appendix 9 (Levay & Co 2009).

- RGS (2009b, 2010, 2012) commenced a series of kinetic leach column (KLC) tests of representative tailings samples from Savannah in 2009. These trials are on-going. A report of results to date is provided in Appendix 10.
- In October 2009, RGS analysed *in-situ* tailings samples taken at various depths (RGS 2009c) as part of a Coffey Mining geotechnical CPT drilling program. The aim of the RGS analysis was to further confirm the 2009 RGS findings and to provide information on the ongoing leachate quality trends from the tailings materials. The report is provided in Appendix 11.
- In 2011, Levay & Co undertook an analysis of three core samples drilled from the hardpan down to the original landform from beaches in the two northern fingers of the TSF. The analysis examined the rate of oxidation throughout the tailings profile and the capacity for acid neutralisation through the reaction with either lime or calcium and magnesium silicates. The report is provided in Appendix 12 (Levay & Co 2011).
- In 2011, RGS reviewed all of the available geochemical and other relevant (e.g. mineralogical) information on the Savannah tailings (RGS 2012). The report is provided in Appendix 13.

3.4.2 Geotechnical / Physical Properties

The geotechnical properties of Savannah tailings are summarised in Table 2.

Table 2: Geotechnical Properties of Savannah Tailings

Geotechnical Aspect	Savannah Tailings Properties
Average slurry density ex-plant	55 to 68% (av. 65%).
Final tailings density (average)	1.65 to 1.7 tonnes per cubic metre (dry density).
Angle of internal friction	33° (based on triaxial testing).
Particle size distribution	P80 passing 75 microns.
Hydraulic conductivity	10-7 to 10-9 metres per second (assumed).
Tailings beach slope	Approximately 2%.

Studies undertaken by Coffey Mining have found:

- There is limited segregation of the tailings down the tailings beach, as the tailings are thickened. The percentage fines results for samples obtained near the main embankment were 66% and 62% respectively, compared to the results for samples near the decant of 72% and 74%, respectively.
- CPT results indicate:
  - Relatively uniform strength profiles across the beach areas, with only minor reduction in strength away from the main embankment toward the centre of the TSF.
  - The inferred angle of internal friction of the tailings varied between 28° and 33°.
  - The estimated coefficient of consolidation was 105m^2/year, indicating that the tailings have good consolidation characteristics and are approaching 90% consolidation.

- Rowe Cell testing reconfirms consolidation predictions but with reduced consolidation times when compared with parameters interpreted from CPT testing.

Further details relating to tailings seepage, consolidation, settlement characteristics and liquefaction are provided in Section 4.6.

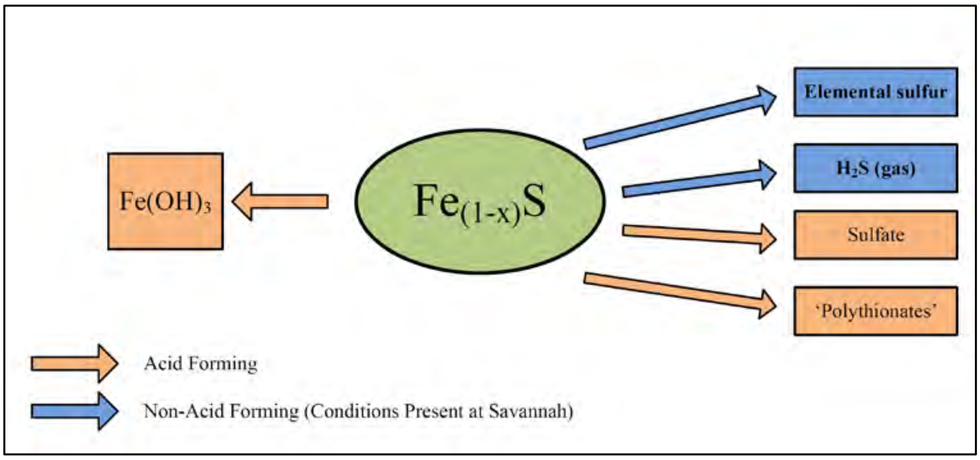
3.4.3 Geochemical Properties

The findings of multiple technical studies on Savannah tailings geochemistry can be summarised as follows:

- Tailings produced from processing of ore at the Savannah Project are classified by classical acid base accounting tests as Potentially Acid Forming (PAF).
- Bulk tailings stored at TSF1 are significantly less geochemically reactive than pre-mining simulated tailings and are unlikely to generate acid. Classical geochemical test measurements significantly overestimate the acid potential of the tailings.
- The tailings typically contain 8 – 9% total sulphur and mineralogical investigations indicate that most of the sulphur is present in the monosulphide form (i.e. pyrrhotite) in a gangue of mafic silicates.
- The dominant reaction product from oxidation of the tailings is elemental sulphur, via a reaction pathway that does not result in acid and metalliferous drainage (Figure 5).
- Tailings stored at TSF1 form a trafficable hardpan surface layer, which limit the rate of oxygen ingress and infiltration of precipitation into the bulk tailings materials.
- Bulk tailings below the hardpan surface of TSF1 generate pH neutral leachate containing excess alkalinity and low concentrations of soluble metals/metalloids. However, elevated salinity levels, mainly caused by sulphate, calcium and magnesium have occurred over time.
- Long-term KLC test leachate results obtained for tailings under anoxic conditions are consistent with those found for the *in-situ* tailings-at-depth geochemical assessment, groundwater monitoring data downstream of TSF1, and geochemical/mineralogical work completed by the University of South Australia.
- There is a lack of oxygen and subsequently reducing conditions below the TSF1 hardpan surface, which inhibits pyrrhotite oxidation.
- There is a lack of mobility of metal ions in TSF 1. Concentrations of ferrous iron and reduced sulphoxy species in the tailings below the hardpan are very low and therefore the likelihood of any later acid generation (latent acidity) through further oxidation of ferrous iron and/or reduced sulphur species in TSF seepage is also very low.
- Pyrrhotite oxidation in the hardpan is the main source of sulphate in the TSF. Elemental sulphur in the hardpan is the dominant secondary sulphur mineral phase consistent with non-acid producing oxidation of pyrrhotite to elemental sulphur as the main oxidative reaction.
- Savannah tailings contain enstatite, a magnesium silicate that has dissolution rate comparable to the measured oxidation rate of pyrrhotite in near saturated tailings and provides a source of alkalinity at a rate comparable to the acid generation rate from pyrrhotite oxidation. This results in pH neutral drainage with excess alkalinity and very low levels of dissolved metals and elevated salinity from sulphate, calcium and magnesium. These results are consistent with observations reported in the literature regarding other pyrrhotite-bearing tailings wastes.

- Where the tailings saturation level is greater than 75%, pyrrhotite oxidation is further inhibited and the downward movement of the oxidation front through the TSF is estimated to be less than 1 cm/year.
- Tailings with similar pyrrhotite concentrations to the Savannah Project, and stored with no cover under a similar groundwater regime for over 25 years at the Fault Lake site in Ontario, Canada showed a surface hardpan depth of 20 cm and the movement of the oxidation front a further 18 cm into the tailings. The decreases in the total porosity relative to the surrounding 'uncemented' tailings resulted in the cemented layers acts as a hydraulic and diffusive barrier towards the migration of infiltrating precipitation and atmospheric oxygen (RGS 2012).

Figure 5: Reaction Pathways



3.5 SOILS AND SOIL PROFILES

3.5.1 Studies

A number of investigations have been undertaken to characterise the physical and chemical properties of Savannah Project soils, including:

- Soil and Rock Engineering Pty Ltd (2002) dug a series of test pits as part of the TSF design report and characterised the physical properties of soils.
- Graeme Campbell and Associates (2002) undertook initial geochemical analysis of soil samples as part of the original NOI proposal.
- In 2009, Coffey Mining undertook further geotechnical analysis of soils as part of the proposal to raise TSF 1.
- In 2009 a series of tests were completed on soil samples as part of the cover design investigations. This included testing of:
  - Erosion potential of subsoil and topsoil.
  - Physical characterisation including particle size distribution, Atterberg limits, moisture retention characteristics and saturated hydraulic conductivity.
  - Chemical analysis of for plant-available nitrogen and phosphorus, organic carbon and water-soluble nutrients and metals

3.5.2 Physical Properties

Initial investigations indicated that topsoil and subsoil of the Savannah Project is of medium density (stiff to hard), brown to red brown, slightly moist to dry, low to intermediate plasticity, fine grained sandy silt, generally extending to depths of 0.2 to 0.8 metres overlying weathered rock.

Additional soil analysis completed in 2009 as part of cover design investigations found:

- Topsoil composed the upper 0.2 metre, with subsoil composing the rest of the 3.0 metre deep test pits.
- The topsoil samples ranged from 43 to 76% gravel, 27 to 46% sand, and 15 to 26% silt / clay falling in the intermediate to coarse texture category. The subsoil sample texture is similar to that of the topsoil at 32% gravel, 46% sand, and 22% silt / clay.
- The specific gravity of the topsoil ranged from 2.74 to 2.89, with a mean of 2.81. The subsoil sample specific gravity was 2.90.
- Atterberg limit testing demonstrated that topsoil and subsoil samples plot within the zone of inorganic clays of medium plasticity.
- The potential cover materials showed typical results for standard compaction tests with the finer textured topsoil having the lower maximum dry density and high optimum moisture content.

3.5.3 Geochemical Characteristics

Geochemical analyses indicate that the soils found at the Savannah Project have:

- Neutral pH and a low concentration of soluble salts.
- No sulphide minerals and a low capacity to consume acid.
- Low concentration of environmentally significant metals.

3.5.4 Plant Nutrition Characteristics

The results of analyses of plant nutrient characteristics indicate:

- The soils were typical of sub-tropical soils in Western Australia, with low organic matter and available phosphorus contents.
- Phosphorus and nitrogen are likely to be the limiting nutrients however local plants are adapted to low nutrient levels and it is therefore unlikely that fertiliser will be required.
- The soil fraction of the waste rock material evaluated for suitability as a growth medium contains moderate amounts of soluble salts, mainly as calcium, magnesium and sulphate ions. Sodicity is likely to be low, which will enable the reconstructed soil profile to develop good structural properties.
- A small amount of soluble nickel in the waste rock soil fraction is unlikely to be phytotoxic.

3.6 HYDROGEOLOGY

3.6.1 Studies

A number of hydrogeological studies have been completed for the Savannah Project including:

- An assessment on project impacts on local/regional hydrogeology, undertaken by Aquaterra (2002) as part of the original NOI submission.
- Annual aquifer reviews undertaken by URS and Aquaterra.
- Hydrogeological assessment of the Savannah Project undertaken by URS in 2009, 2010 and 2011.
- Ongoing groundwater quality and level monitoring in a number of monitoring bores on the Savannah Project tenements.

The most recent groundwater investigations undertaken by URS comprised:

- Electromagnetic survey to assist in refining the hydrogeological model.
- Two targeted drilling programmes around TSF 1 and within the inferred groundwater flow direction between TSF 1 and Fletcher Creek with subsequent establishment of groundwater monitoring piezometers.
- A complete review of the conceptual hydrogeological model based on the results of drilling programmes around WSF 1 and TSF 1.
- Refinement and simulation of Groundwater Seepage and Solute Transport Modelling.
- Calibration of the model through multiple phases using site-specific data acquired since 2003.

The URS (2012) report is provided in Appendix 14.

3.6.2 Hydrogeological Setting

Groundwater in the Savannah Project area primarily occurs in shallow weathered fractured rock, which responds rapidly to intensive rainfall and discharges to a network of surface drainages. Groundwater levels are closely related to the topographic elevations. Hydraulic conductivity of the thin layer of saturated weathered bedrock is generally low in the topographic high area and relatively high in thicker sequences in the topographic low area near Fletcher Creek. Groundwater from rainfall recharge events collects in aquifers along the valley floors after the wet season and flows down gradient to discharge either to the surface in local creeks (as springs) or superficial aquifers either in the alluvium or uppermost fractured rock interval where it is consumed by evapotranspiration (Figure 6).

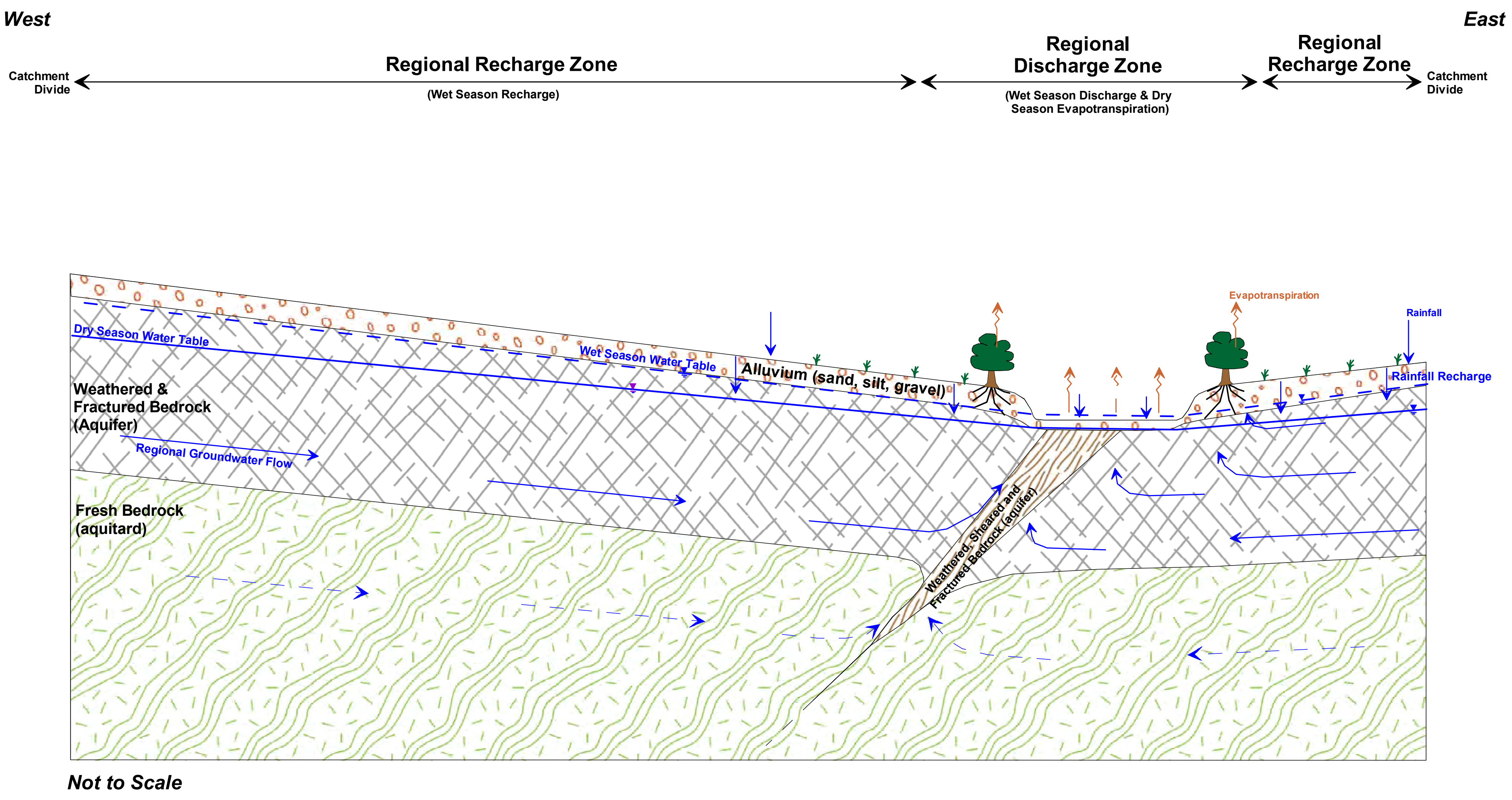


Figure 6: Conceptual Hydrogeological Model

URS

3.6.3 Baseline Groundwater Conditions

Natural groundwater within the Savannah Project area prior to mining was characterised as fresh and generally of near-neutral pH (Aquaterra, 2002). The baseline concentrations of salinity (using total dissolved solids [TDS] as an analogue) are generally in the order of 500 milligrams per litre (mg/L) indicating that the groundwater is naturally fresh. This is considered to be due to the influence of recharge in the wet season and minimal evapo-concentration effects during the dry season.

Baseline concentrations of sulphate are relatively low, being typically around 10 to 50 mg/L. The exception is in the upper catchment of Mine Creek. With the addition of background data collected since 2004, the baseline groundwater is now characterised as being neutral to slightly alkaline in pH. The baseline groundwater is of calcium (Ca)-magnesium (Mg)-bicarbonate (HCO_3) type. Calcium and magnesium as dominant cations are representative of groundwater sampled from gabbroic and norite geology. Bicarbonate-dominant groundwater is indicative of recharge being the main process that determines the baseline groundwater chemistry. Baseline concentrations of nickel range from <0.01 mg/L to 0.03 mg/L but are typically <0.01 mg/L. Similarly, concentrations of other metals were predominantly below detection limits.

3.6.4 Current Groundwater Conditions

The water table beneath TSF1 has been affected by seepage that has lifted (mounded) the level and altered the quality. Flow from this mound has affected natural groundwater nearby by increasing the salinity and sulphate concentrations and decreasing the seasonal depth to water. The low hydraulic conductivity of the fractured bedrock aquifer is sufficient to limit mounding to within about 200 to 300 metres of TSF1.

A preferential flowpath of seepage from TSF1 has been identified in the subsurface weathered zone of local drainages which sometimes discharges as surface water during the wet season when groundwater levels typically rise. Seepage emanating from TSF 1 is enriched in solutes such as sulphate and some metals and flows primarily towards the main embankment and then to Mine Creek, via WSF 1. The concentrations are decreasing along the primary flowpath towards Fletcher Creek as it mixes with natural groundwater. A seepage recovery bore (SMPB03) is located downstream of WSF 1.

A number of monitoring bores have been constructed since commencement of operations with regular sampling of groundwater in the vicinity of TSF 1 and along the seepage flowpath (Figure 7).

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Panoramic Resources Limited
Savannah Project

Seepage Recovery and Monitoring Bores

Figure 7

3.7 HYDROLOGY

3.7.1 Studies

URS completed a hydrological assessment of the Savannah Project area in 2012 comprising development of a regional baseline hydrological model using:

- Measured surface water flow and rainfall data collected on site.
- Development of a methodology for the assessment of the groundwater – surface water interactions within the Savannah Project creek system.
- Identification of potential changes to surface water quality downstream of the Project.

The URS (2012) report is provided in Appendix 14.

3.7.2 Hydrological Setting

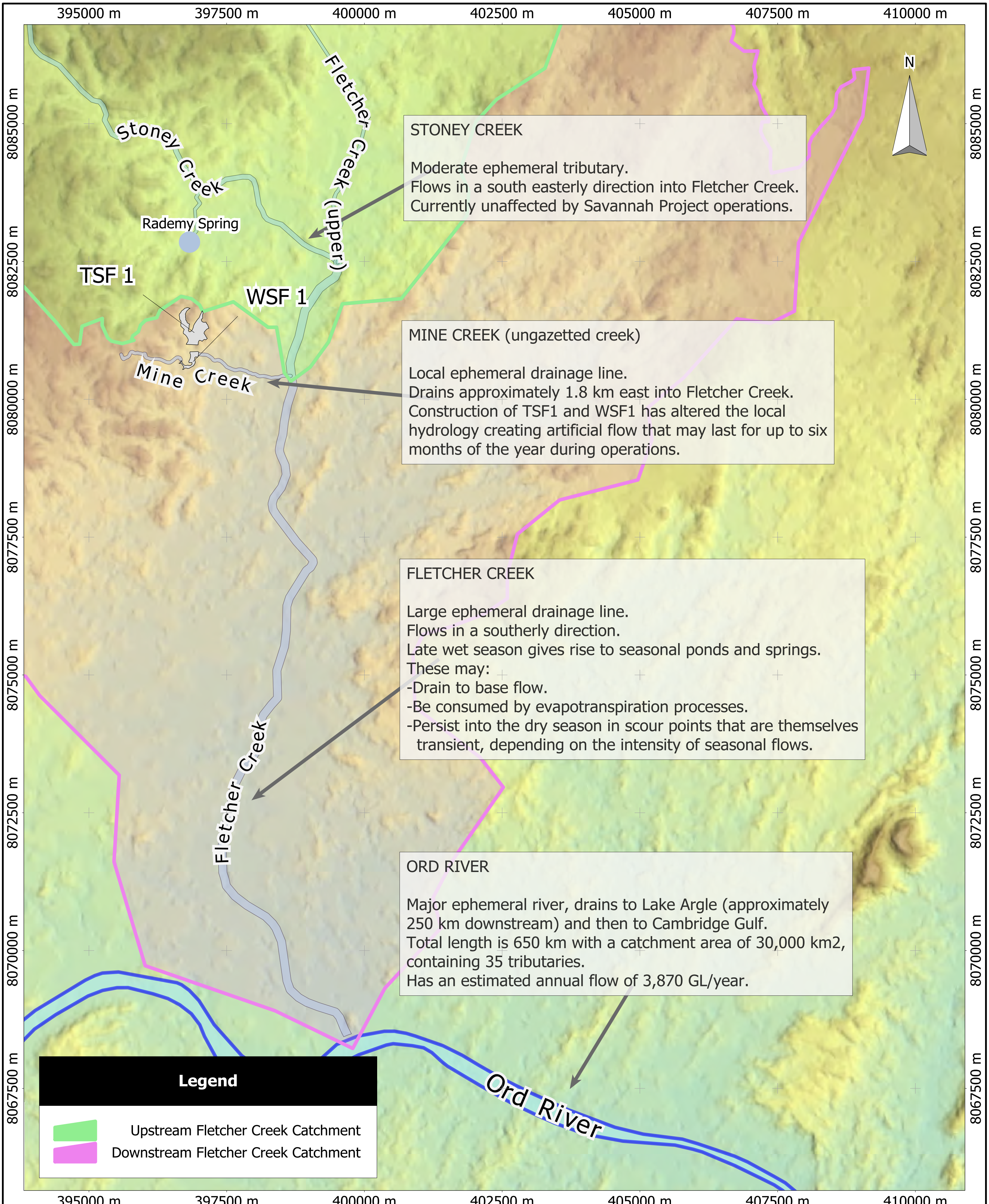
The Savannah Project is located within the Fletcher Creek catchment, part of the Ord River System, which also includes minor ephermeral creeks such as Stoney Creek and small drainage lines such as Mine Creek. Fletcher Creek catchment is divided into two sub-catchments, upstream and downstream of the confluence of Mine Creek. Hydrological features and catchments of the Savannah Project are presented in Figure 8.

On the north and western sides of the Project is a catchment drained by Stoney Creek and on the eastern side is a catchment drained by Fletcher Creek. The central area of the Project drains to Mine Creek which drains eastwards to Fletcher Creek. TSF 1 and WSF 1 are located within the Mine Creek catchment.

Fletcher Creek is a relatively large creek, with an overall width of about 80 metres and stretching approximately 33 kilometres in length. During the dry season, the creek is a dry channel with shallow intermittent pools. During the wet season, flood depths of three to four metres can be experienced.

Stoney Creek catchment has a surface area of about 135 square kilometres. The catchment is fed by numerous ephemeral creeks and is characterised by highly undulating terrain. Rademy Creek is a tributary of Stoney Creek. The Rademy Creek Catchment is characterised by a 200 m wide valley floor that is bordered by flat plateaux hills.

The Mine Creek catchment has a surface area of 3.7 square kilometres. The catchment consists of three upstream tributaries (with a combined catchment area of 2.1 square kilometres) that merge at the Savannah Project site. The remainder of the Mine Creek catchment area drains into Mine Creek downstream of the Savannah Project site.



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Panoramic Resources Limited
Savannah Project

Hydrological Features and Catchments

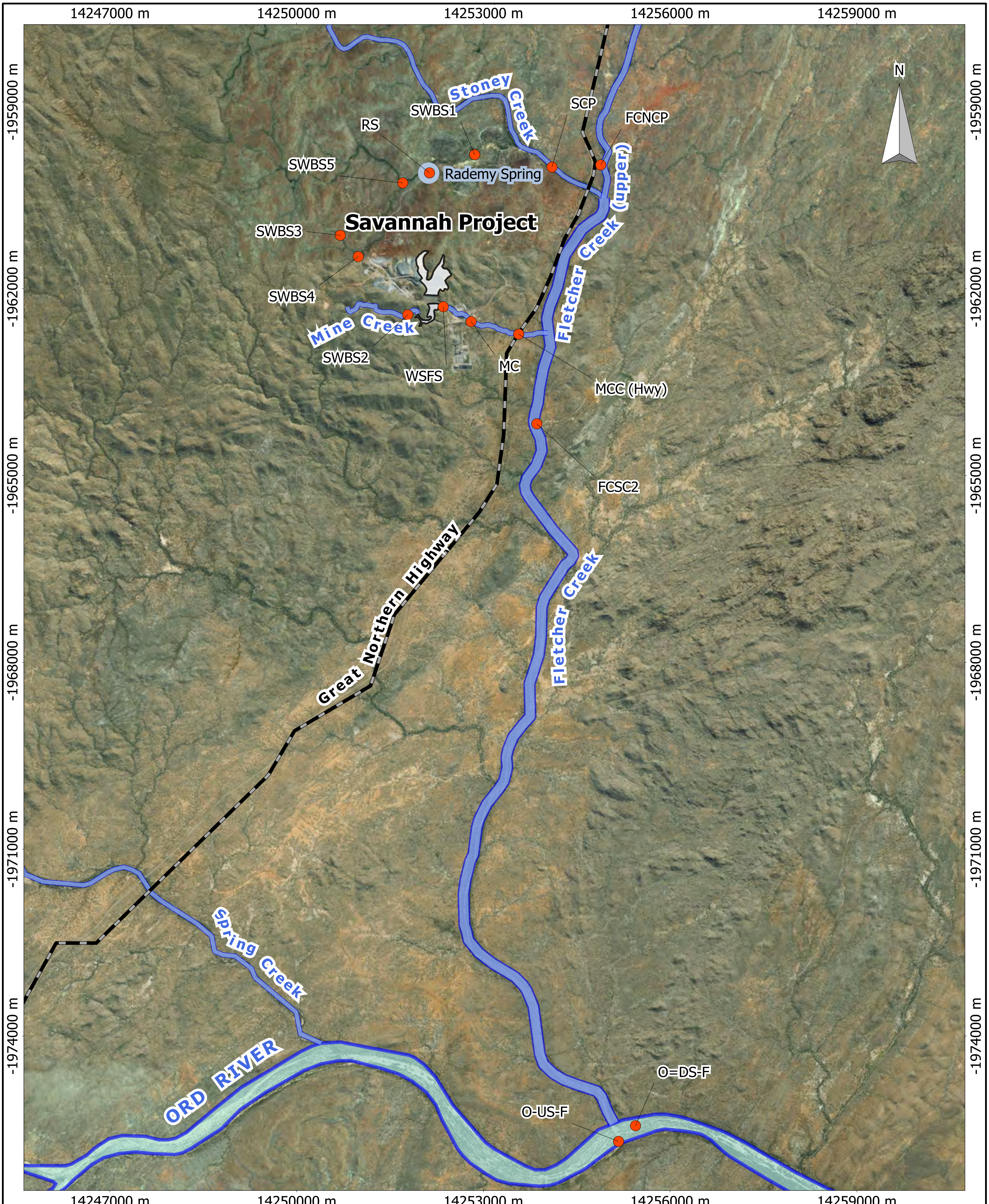
Figure 8

3.7.3 Baseline Surface Water Conditions

Baseline surface water is typically similar to baseline groundwater quality in the area. The quality varies seasonally, consistent with the hydraulic regime. Larger creeks exhibit larger ranges of the major ions than minor tributaries including bicarbonate and sulphate as a result of more persistent evapotranspiration effects. Minor metals are generally at or below the laboratory reporting. Copper and nickel occasionally occur just above these limits in Rademy Creek and Fletcher Creek.

Baseline surface water quality data collected prior to the operational phase are only available from Rademy Spring. Baseline conditions have however, been characterised by surface water that has not impacted by activities from the Savannah Project. Surface water quality data from non-impacted areas are available from seven sites as shown in Figure 9. A summary of the parameters of interest is provided in Table 3. The key characteristics of the baseline surface water quality are:

- The surface water is fresh and neutral to weakly alkaline.
- Larger creeks exhibit larger ranges of the major ions than minor tributaries including bicarbonate and sulphate as a result of more persistent evapotranspiration effects.
- Minor metals including arsenic, cobalt, copper and nickel are generally at or below the laboratory reporting limits of 0.01 or 0.001 mg/L as applicable. Copper and nickel occasionally occur just above these limits in Rademy Creek and Fletcher Creek.
- When detected, manganese is commonly at concentrations between 0.02 and 0.04 mg/L, but can reach concentrations of about 0.2 mg/L. Seasonal trends are not apparent in these data.
- Baseline surface water is characterised as being of the Ca-Mg-HCO3 type with larger proportions of calcium, magnesium and bicarbonate compared to sodium, potassium, chloride and sulphate. These characteristics reflect the dominance of rainfall runoff or the presence of recently recharged groundwater (as baseflow) with high proportions of bicarbonate. The predominance of ultramafic rock types in the catchments are responsible for higher proportions of calcium and magnesium compared to other cations. Surface water with longer residence times and subjected to stronger evapotranspiration effects would tend to be of the sodium-chloride type and be brackish to saline, particularly in the late dry season.



MBS ENVIRONMENTAL Environmental + Water Resource Consultants 4 Cook St West Perth WA 6005 Telephone: + 618 9226 3166 Facsimile: + 618 9226 3177 info@mbsenvironmental.com.au	Scale: 1:80000 Original Size: A4 Air Photo Date: 2011 Grid: Mercator 0 2000 m	Panoramic Resources Limited Savannah Project	Surface Water Monitoring Sites Figure 9

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Table 3: Summary of Key Baseline and Background Surface Water Quality Data

Parameter	Catchment	Mine Creek (upstream)	Fletcher Creek (upstream)	Fletcher Creek (down-stream)	Rademy Creek (upstream)	Rademy Creek (down-stream)	Stoney Creek	Ord River#
	Date	May 2011	2006-2010	2006-2010	May 2011	2006-2010	2006-2010	2011
	Sites	SWBS2	FCNCP	FCSC2	SWBS3, SWBS4	RS	SCP	O-US-F
pH (lab)	Min.	-	7.4	7.4	8.1	7.7	7.0	7.9
	Max.	-	8.7	8.6	8.4	8.4	8.7	8.6
	Average	8.1	8.1	8.1	8.3	8.0	7.9	8.3
Salinity (mg/L TDS)	Min.	-	200	210	460	340	150	76
	Max.	-	590	750	480	680	630	400
	Average	800	430	439	470	546	373	238
Alkalinity (mg/L HCO_3)	Min.	-	24	52	380	210	35	65
	Max.	-	490	450	390	530	490	365
	Average	490	277	222	385	420	225	215
Arsenic (mg/L)	Min.	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Max.	-	0.001	0.001	<0.001	0.001	0.001	<0.001
	Average	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (mg/L)	Min.	-	<0.0001	<0.001	<0.01	<0.01	<0.001	<0.0001
	Max.	-	0.04	<0.01	<0.01	<0.01	0.02	0.0001
	Average	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.0001
Copper (mg/L)	Min.	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.0006
	Max.	-	0.03	0.02	<0.01	0.03	0.01	0.002
	Average	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.001
Manganese (mg/L)	Min.	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.001
	Max.	-	0.27	0.22	0.23	0.15	0.07	0.005
	Average	0.2	0.04	0.04	0.12	0.03	0.02	0.003

Parameter	Catchment	Mine Creek (upstream)	Fletcher Creek (upstream)	Fletcher Creek (down-stream)	Rademy Creek (upstream)	Rademy Creek (down-stream)	Stoney Creek	Ord River#
	Date	May 2011	2006-2010	2006-2010	May 2011	2006-2010	2006-2010	2011
	Sites	SWBS2	FCNCP	FCSC2	SWBS3, SWBS4	RS	SCP	O-US-F
Nickel (mg/L)	Min.	-	<0.01	0.004	<0.01	<0.01	0.004	<0.001
	Max.	-	0.01	0.02	<0.01	<0.01	0.08	<0.001
	Average	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.001
Potassium (mg/L)	Min.	-	1.9	1.6	2.4	4.2	1.9	2.1
	Max.	-	5.9	5.9	2.9	5.6	6.2	3.1
	Average	6.7	4.1	3.3	2.7	4.8	3.8	2.6
Sulphate (mg/L)	Min.	-	<3	19	6	<3	9	1
	Max.	-	160	150	10	34	51	33
	Average	140	31	52	8	14	23	17
Selenium (mg/L)	Min.	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Max.	-	0.004	0.001	<0.001	0.007	0.002	<0.001
	Average	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001

Note: # - These data from ecological studies undertaken by Wetlands Research & Management, 2011.

3.7.4 Current Surface Water Conditions

The surface runoff pattern has been altered by the mining operation. TSF 1 and WSF 1 are located within the Mine Creek catchment. The major changes are the altered surface runoff characteristics due to the impoundment of runoff by TSF 1, WSF 1 and the pit, with changes in runoff coefficient and sediment load due to the changes in land use. The catchment boundaries have effectively remained unaltered.

Surface water quality is impacted by groundwater discharging into a section of Mine Creek (located between WSF 1 and SMMB01). Based on available surface water quality data, another minor discharge zone is apparent just downstream of the Mine Creek – Fletcher Creek confluence. The Mine Creek zone is already subjected to recovery of seepages from WSF 1 at the embankment toe and further downstream at SMPB03. Solute-enriched groundwater still however, discharges to Mine Creek, particularly during and shortly after the wet seasons due to seasonal rise in the water table. This pattern of release is expected to continue during the remaining years of operation.

A summary of current surface water quality is provided in Table 4. The key characteristics of the current surface water quality are:

- There is no evidence of contamination from the Savannah Project within Rademy Spring or Stoney Creek.
- Naturally elevated sulphate is present in surface water discharging into WSF 1.
- Mine Creek has received discharge of groundwater along the section between WSF 1 and bore SMMB01, and seasonally from the WSF 1 spillway that contains elevated solutes including sulphate, manganese and on occasion, nickel.
- Mixing of surface waters at the junction of Mine and Fletcher Creeks has typically produced fresh, near neutral to weakly alkaline chemistry that during some dry seasons is brackish. With the exception of nickel, the concentrations of all other metals of interest are within the background range.
- The elevated concentrations of sulphate measured in Fletcher Creek at surface water monitoring station FCSC1 appear to be related to the discharge of sulphate-enriched seepage. A comparison of sulphate concentrations at surface water monitoring station FCSC1 to rainfall, and other surface water monitoring locations (FCSC2 and along Mine Creek) indicates that the elevated concentrations of sulphate recorded at surface water monitoring station FCSC1 are not related to rainfall, evaporation or sulphate in surface water flows.
- Sulphate concentrations at surface water monitoring station FCSC2 are typically lower than at surface water monitoring station FCSC1, being similar, although typically slightly higher than at surface water monitoring station FCNCP.

Table 4: Current Surface Water Quality

Parameter	Catchment	Mine Creek (up-stream)	Mine Creek (down-stream)	Fletcher Creek (up-stream)	Fletcher-Mine Creek Junction	Fletcher Creek (down-stream)	Rademy Creek (up-stream)	Rademy Creek (down-stream)	Stoney Creek	Ord River#
	Date	May 2011	2011	2011	2011	2011	May 2011	May 2011	2011	2011
	Sites	SWBS2	WSFS, MC, MC(Hwy)	FCNCP	MCFC	FCSC1, FCSC2	SWBS3, SWBS4	SWBS1, SWBS5, RS	SCP	O-US-F, O-DS-F
pH (lab)	Min.	-	6.8	7.5	6.5	7.1	8.1	7.5	7.6	7.9
	Max.	-	9.7	8.5	8.5	8.7	8.4	8.8	8.6	8.6
	Average	8.1	7.9	8.1	7.9	8.1	8.3	8.2	8.0	8.2
Salinity (mg/L TDS)	Min.	-	120	45	170	50	460	260	50	75
	Max.	-	3300	540	2800	670	480	590	660	400
	Average	800	2219	380	689	428	470	499	320	238
Alkalinity (mg/L HCO_3)	Min.	-	46	34	39	31	380	170	32	60
	Max.	-	280	420	480	450	390	480	500	365
	Average	490	211	293	233	273	385	401	214	211
Arsenic (mg/L)	Min.	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Max.	-	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Average	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (mg/L)	Min.	-	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.0001
	Max.	-	0.02	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.0001
	Average	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.0001
Copper (mg/L)	Min.	-	<0.01	<0.001	<0.01	<0.001	<0.01	<0.01	<0.01	0.0006
	Max.	-	0.03	0.02	0.04	0.02	<0.01	<0.01	<0.01	0.002
	Average	0.005	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.001
Manganese (mg/L)	Min.	-	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.001
	Max.	-	2.90	0.12	0.32	0.34	0.23	0.13	0.50	0.01
	Average	0.2	0.33	0.03	0.06	0.04	0.12	0.03	0.09	0.00
Nickel (mg/L)	Min.	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.001
	Max.	-	0.87	<0.01	0.22	0.02	<0.01	0.02	<0.01	<0.001
	Average	<0.01	0.10	<0.01	0.04	0.01	<0.01	0.010	<0.01	<0.001
Potassium (mg/L)	Min.	-	5.1	1.8	2.2	2.0	2.4	3.1	1.9	2.1
	Max.	-	14.0	5.8	8.8	7.4	2.9	6.9	6.2	3.9
	Average	6.7	8.1	3.7	4.9	4.5	2.7	5.1	3.7	2.8
Sulphate (mg/L)	Min.	-	280	<3	7	<3	6	<3	<3	1
	Max.	-	2400	44	1900	190	10	29	61	79
	Average	140	1509	16	392	67	8	16	26	29
Selenium (mg/L)	Min.	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Max.	-	0.004	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Average	0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Note:# - These data from ecological studies undertaken by Wetlands Research & Management, 2011.

3.8 CLIMATE

3.8.1 Studies

A number of studies have been undertaken to characterise the climate of the Savannah Project including:

- URS (2012) undertook an analysis of all available climate data to characterise current and predicted site climate conditions.
- O'Kane Consultants (2012) developed a 100-year climate database of daily data between October 1908 and September 2008 from Hall's Creek and Warmun. One hundred years typically spans a sufficient time period to observe most types of weather patterns including drought and high precipitation conditions.

3.8.2 Savannah Climate

The climate of the Savannah area is sub-tropical and is characterised by humid summers and dry winters. The wet season occurs between December and March and brings frequent storms associated with the formation of the monsoonal depression over the northern Australian tropics. Severe weather associated with tropical cyclones or rain-bearing depressions (ex-tropical cyclones) occasionally bring intense rainfall and lead to flooding.

Daily rainfall data has been collected at Savannah (local readings) since November 2003. This data is comparable with rainfall and evaporation data from the closest Bureau of Meteorology (BOM) Stations located at Warmun (approximately 40 kilometres to the northeast) and Halls Creek Airport (approximately 110 kilometres to the southwest).

Meteorological data for Warmun and Halls Creek is presented in Chart 1.

Chart 1: Meteorological Data for Warmun and Halls Creek

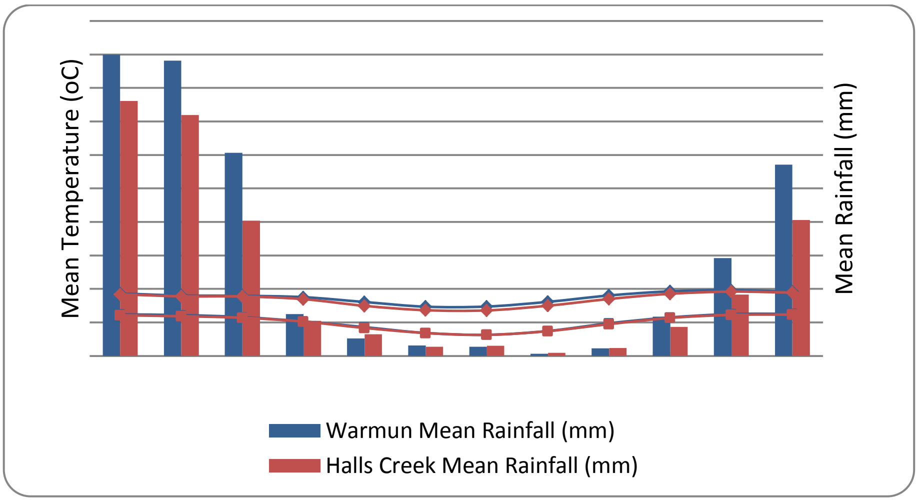


Table 5 summarises the average climate parameters for the 100-year climate database developed for the project. Annual rainfall varies greatly with the maximum rainfall year being double that of the average year, and the minimum rainfall year approximately one-third that of the average year.

Table 5: Average climate parameters for the 100-year climate database

Climate Parameter	Value
Mean Annual Rainfall.	636 mm
Maximum Rainfall Year.	1311 mm (1999-00)
Minimum Rainfall Year.	269 mm (1963-64)
Average Daily Maximum Temperature.	34.6°C
Average Daily Minimum Temperature.	20.2°C
Average Daily Maximum Relative Humidity.	58%
Average Daily Minimum Relative Humidity.	27%
Average Daily Wind Speed.	2.2 m/s
Average Daily Net Radiation.	9.4 $MJ/m^2/day$

To assist in gaining an improved understanding of the site-specific weather conditions at Savannah, a weather station will be installed on site in 2012.

3.9 FLORA AND VEGETATION

3.9.1 Studies

A number of flora and vegetation surveys have been completed for the Savannah Project, comprising:

- Baseline Vegetation and Habitat Survey (Dames and Moore 1992).
- Baseline Environmental Studies (Outback Ecology 2002).
- Wet Season Biological Survey (Outback Ecology 2003).
- Level 1 Flora and Vegetation Assessment of the Tailings Storage Options (Outback Ecology 2011).

In addition to this, vegetation health along creek lines and in the vicinity of production bores has been monitored annually since 2005 and reported in the SNM Annual Environmental Report submission. The most recent study by Outback Ecology included searches of relevant State and Federal databases.

3.9.2 Flora

The most recent survey undertaken by Outback Ecology (2011) recorded 100 taxa from 32 families and 72 genera, with the most dominant genera being *Acacia* (5 taxa), *Tephrosia* (5 taxa) and *Eucalyptus* (5 taxa).

One Priority flora taxon, *Sorghum plumosum* var. *teretifolium (*P1) was recorded and is noted to occur extensively across the wider Savannah Project area.

No Declared Rare Flora (DRF) listed under *Wildlife Conservation Act 1950* (WC Act 1950) or Threatened Flora listed under the Commonwealths *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) were recorded within the Study areas, and based on the survey undertaken and the habitat preferences of these species known to occur in the region, none are expected to occur in the Savannah Project area.

Six introduced species, **Aerva javanica, *Portulaca oleracea, *Vachellia farnesiana, Stylosanthes hamata,*Malvastrum americanum* and **Calotropis procera* were recorded within the Savannah Project area. Of these species, four are considered 'Environmental Weeds' by the Environmental Weed Strategy for Western Australia (DEC 1999). **Aerva javanica* and **Calotropis procera* are rated 'high', **Malvastrum americanum* is rated moderate and **Stylosanthes hamata* is rated 'mild'. None of the introduced species are considered 'Declared' plants within the Halls Creek area.

3.9.3 Land Units and Vegetation Communities

Three broad land units (Uplands, Plains and Riverine) were described by Outback Ecology (2003) in the Savannah Project area.

The Uplands Unit is characterised by predominantly hilly areas with relief up to 100 metres. Hills are steep (15º- 45º slopes) exhibiting flat upper surfaces. Valleys commonly form shallow, rocky creek lines that direct drainage to the main Riverine creek system. This is the dominant land unit of the Savannah Project area.

The Plains unit comprises low lying areas with slightly undulating landform located northeast and south east of the project area. The Plains unit is divided into two vegetation communities:

- <u>Plains Vegetation Community A</u> – Sparse open shrubland of *Acacia lysipholia* over a very sparse shrubland of *Hakea arborescens* with scattered *Aerva javanica* over mixed grasses of *Chrysopogon fallax* and *Heteropogon contortus*.
- <u>Plains Vegetation Community B –</u> Sparse woodland of *Eucalyptus tephrodes* with scattered *Bauhinia cunninghamii* over shrubland of *Carissa spinarum*, *Eremophila longifolia* over mixed grasses *Chrysopogon fallax* and *Heteropogon contortus.*

The Riverine unit includes main creeklines and drainage communities supporting emergent and riparian vegetation. This unit is characterised by a distinct dense strip of riparian vegetation along the creek lines and is generally flat with little relief. The Riverine land units are formed in the upper valleys opening out into the plain country to the east of the Savannah Project area.

The Riverine unit is divided into two vegetation communities:

- <u>Fletcher Creek Riverine Vegetation Community</u> - Open *Eucalyptus* forest to woodland with a sparse shrubland over open grassland.
- <u>Creekline Vegetation Community</u> - Open *Eucalyptus* forest with an open shrubland over closed grassland.

There are no Threatened Ecological Communities (TEC) or Priority Ecological Communities (PEC) under either the EPBC Act 1999 or the WC Act 1950 in the Savannah Project area.

Some plant species are known to be regionally restricted to the areas where the groundwater levels are within metres of the surface on a regular basis. These species include *Melaleuca leucadendra, Eucalyptus camaldulensis* and a range of sedges that prefer the seasonal flooding and water saturated soils (Mattiske Consulting, 2008). These species occur along Fletcher Creek but not within the vicinity of Mine Creek.

The vegetation within the Savannah Project area has been subjected to cattle grazing over a period of at least a century as well as fire events, which has resulted in degradation of vegetation.

3.10 TERRESTRIAL FAUNA AND HABITAT

3.10.1 Studies

As part of pre-mining baseline studies, a reconnaissance and detailed fauna survey of the Savannah Project area was undertaken by Outback Ecology in October 2001 and August 2002 respectively. Updated searches of State and Federal databases were undertaken in 2011.

3.10.2 Fauna

The detailed survey recorded two amphibians (frogs) from one species, 22 reptiles from nine species and 11 mammals from three species and 384 birds from 41 species. The results from the trapping program suggested that the Savannah Project area does not support an amphibian, reptile or mammal assemblage that differs in composition from that of the greater region.

3.10.3 Conservation Significant Species

Three species protected under Federal and State legislation, have been recorded in the Savannah Project area. These are the Gouldian Finch (*Erythrura gouldiae)*, Rainbow Bee-eater (*Merops ornatus*) and the Great Egret (*Ardea alba*).

Rainbow Bee-eater (Merops ornatus)
Two individuals of the Rainbow Bee-eater were sighted in the 2002 survey. One was at a site near Fletcher Creek and the other was within the Plains land unit near the main camp. The Rainbow Bee-eater is a widespread migratory species that breeds in tunnels dug into sandy banks. The species is evaluated as 'Least Concern' by the International Union for Conservation of Nature (IUCN) with an extremely large population size that appears stable.

The Rainbow Bee-eater has a diverse and widespread habitat preference that is well distributed in the region.

Great Egret (Ardea alba)
One individual of the Great Egret was recorded during the 2002 survey at a site along Fletcher Creek. The Great Egret is a migratory species that inhabits tidal mudflats and margins or shallows of watercourses, inland swamps or dams. It is evaluated as Least Concern by the IUCN and is described as having an extremely large range and very large population size, although population trends are unknown.

The Riverine land unit within the Savannah Project area provides potentially suitable habitat for the Great Egret. This land unit is well distributed in the wider region.

Gouldian Finch Habitat (Erythrura gouldiae)
Fauna and habitat surveys undertaken as part of the original Savannah NOI 4099 by Dames and Moore (1992) and Outback Ecology (2002), did not record the Gouldian Finch within the Savannah Project area, however the species has been observed by SNM personnel in the vicinity of the Savannah Project.

This species occurs on database searches as potentially present within the general area, with the Uplands and Riverine land units of the Savannah Project area potentially providing suitable habitat for the Gouldian Finch.

The Gouldian Finch was recorded during two fauna surveys in 2006 and 2007 adjacent to the Copernicus haul road, located approximately 70 kilometres south of the Savannah Project. The species has also been recorded in the nearby Purnululu National Park.

The Gouldian Finch is distributed across northern Australia and inhabits open forests and woodlands with a grassy understorey. These finches are often found near fresh water, particularly in the dry season. Breeding generally occurs in hilly or rocky areas with Snappy Gum (*Eucalyptus brevifolia)*, with the birds building nests in the *E. brevifolia* hollows. Gouldian Finches sometimes nest in small colonies and breeding occurs in winter (April to July). The decline in grass seed resources due to pastoral activities and altered fire regimes are thought to be the most likely causes of the decline in this species.

3.11 AQUATIC FAUNA AND ECOSYSTEM

3.11.1 Studies

Wetlands Research and Management (WRM) was commissioned to undertake an assessment of the current condition of aquatic fauna in the Fletcher Creek, Mine Creek and Stoney Creek system. This comprised:

- Sampling of aquatic fauna and water quality at sites along Fletcher Creek, Stoney Creek, Mine Creek and the Ord River in April 2009, January 2011, and June 2011.
- Assessment of spatial and/or temporal changes in biodiversity and conservation value of fish, macroinvertebrate and zooplankton assemblages of Fletcher Creek that may be related to tailings seepage.
- Characterisation of the seasonal and bi-annual variation in fauna-water quality relationships.
- Assessment of longitudinal changes in water quality as a function of tailings seepage and effects on aquatic fauna.

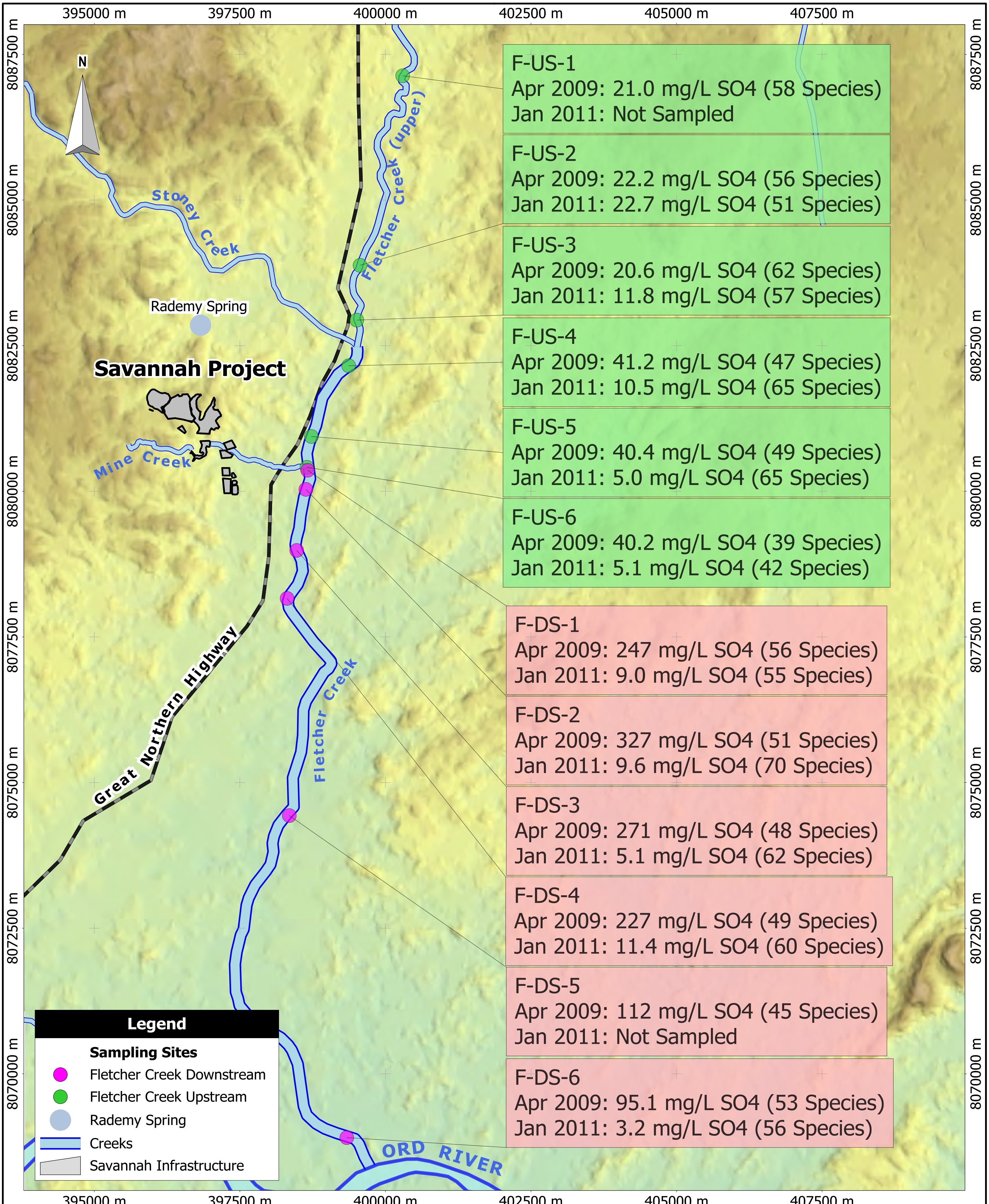
3.11.2 Survey Results

The surveys found:

- Significant analyte gradients for sulphate, calcium, potassium, magnesium, electrical conductivity (distinct from salinity), total dissolved solids and water hardness were recorded along Fletcher Creek in April 2009. This was largely attributed to a release of water from WSF 1 following a series of high rainfall events. These gradients were not present during sampling in January 2011. Despite elevated solute concentrations recorded in 2009, 95% protection of species was still maintained.
- A total of 129 microinvertebrate species with no obvious trends in taxa richness that could be related to mining activities. There was no significant difference in the number of microinvertebrate taxa recorded between systems or sampling events.(Figure 10)
- A total of 261 taxa of macroinvertebrates. The composition of macroinvertebrate taxa was typical of freshwater systems throughout the world (Hynes 1970), and was dominated by Insecta (94% of taxa). Of the insects, the majority were Coleoptera (34.5% of Insecta), closely followed by Diptera (25.5% of Insecta). There was no discernable difference in 'species'-level abundance data between reference and exposed sites within the study area.

- A total of 1,586 and 1,407 fish representing 12 species and 8 families were collected from the study area during April 2009 and January 2011 respectively. There were no species considered rare or restricted in distribution. Total fish species richness was not significantly different between systems or sampling events.

A report detailing the results of the April 2009 and June 2011 surveys is provided in Appendix 15. Species identification from the June 2011 sampling round is currently being finalised.



MBS ENVIRONMENTAL Environmental + Water Resource Consultants 4 Cook St West Perth WA 6005 Telephone: + 618 9226 3166 Facsimile: + 618 9226 3177 info@mbsenvironmental.com.au	Scale: 1:85000 Original Size: A4 Grid: MGA94(52) 0 2000 m	Panoramic Resources Limited Savannah Project	Sulphate (SO4) Concentrations and Aquatic Species Abundances Figure 10

W:\Panoramic\Savannah\TSF Amendment\Option B\Stage 2\Approvals\Drawings\Aquatic Fauna Sampling Locations.map 5/04/2012

3.12 SOCIAL ENVIRONMENT

The nearest communities to the Savannah Project are the Frog Hollow and Warmun Aboriginal Communities, which are 10 kilometres and 40 kilometres north of the project area respectively. Halls Creek is another local community that is located 120 kilometres south of Savannah Project. As part of the original approvals process, a search of the Department of Indigenous Affairs (DIA) Register database was undertaken and found that no known sites (both archaeological and ethnological) were registered within the Savannah Project area.

Separate archaeological surveys over the project area were completed in November 2001 and September 2002, with no sites of significance identified on or within close proximity to the mine and/or associated infrastructure areas to be disturbed.

Detailed heritage clearance surveys of the project area were undertaken in early April and August 2002. As a result of the two heritage clearance programs, the only identified site of significance was located approximately one kilometre west of the current exploration camp, well away from the Project activities and infrastructure.

In November 2007, the Kimberley Nickel Co-existence Agreement was signed between Panoramic and the registered native title parties for the area, namely the Purnululu and Malarngowem People. The Agreement provides the mechanisms for SNM to undertake all activities associated with Savannah, whilst ensuring the ongoing and future cultural heritage protection within the Savannah area.

In addition, the Agreement commits Panoramic to the ongoing maintenance of high standards of environmental planning and management and continued compliance with all relevant environmental laws and approvals. Commitments in the areas of training, employment, the provision of cultural awareness training, and associated mechanisms for ongoing consultation between all parties are also addressed.

Savannah Project is located on Mabel Downs Pastoral Lease, an active pastoral station. Panoramic has developed a strong relationship with the pastoral company and has also previously held preliminary discussions with the Pastoral Lands Board covering the post-closure status of the Project.

The Port of Wyndham is located 250 kilometres to the north, with the Savannah Project concentrate stockpiled and exported from the port. Panoramic is currently in the process of commissioning a purpose-built concentrate storage and handling shed at the Port of Wyndham.

4. PROJECT DESCRIPTION

4.1 KEY CHARACTERISTICS OF THE PROJECT

A summary of the current approved and proposed project characteristics is presented in Table 6.

Table 6: Key Project Characteristics

Parameters	Under Existing Approvals	Stage 2 TSF Amendment
Life of mine production	Approximately 10 years.	Approximately 14 years (cumulative).
Area of disturbance	Approximately 138 hectare.	Additional 10.5 hectares.
TSF height	372 mRL.	378 mRL.
TSF capacity	2.1 million Cubic metres (3.57 million tonnes)(current capacity).	3.1 million Cubic metres (5.27 million tonnes) (total capacity).
TSF closure strategy	Tailings relocated to underground and pit (with water cover).	Tailings to remain *in-situ* at closure with an engineered cover.

4.2 AREA OF DISTURBANCE

The Proposal will require an additional 10.5 hectares of clearing of native vegetation. Approximately 4.0 hectares of disturbance will occur on M80/180 and 6.5 hectares of disturbance on M80/181. Clearing is specifically required for the expanded TSF 1 surface area and access road, construction material borrow pits and topsoil stockpiles. The tailings surface will increase by approximately 5.1 hectares. No additional clearing is required on L80/64.

Details of previously approved disturbance areas and proposed disturbance areas for the Stage 2 TSF 1 expansion are provided in Table 7.

Table 7: Area of Disturbance Table (Hectares)

Description of Mining Disturbances	Previous Approved Area	Additional Disturbance	New Disturbance Area
M80/179			
Other Clearing	0.17	0	0.17
Road	1.97	0	1.97
Total	2.14	0	2.14
M80/180			
Built Infrastructure	0.69	0	0.69
Camp	6.2	0	6.2
Hardstand	0.07	0	0.07
Other Clearing (including fire breaks)	4.553	0	4.553
Pit	10.66	0	10.66
Pond (WSF 1)	0.02	0	0.02
Road	16.46	0	16.46

Description of Mining Disturbances	Previous Approved Area	Additional Disturbance	New Disturbance Area
Stockpile	1.29	0	1.29
Topsoil Stockpile	0.70	0	0.70
TSF 1 (including access track)	8.21	4.0	12.21
Waste Dump	18.71	0	18.71
WSF 3	0.97	0	0.97
Total Tenement Disturbance	**68.53**	**4.0**	**72.53**
M80/181			
Built Infrastructure	4.13	0	4.13
Camp	0.01	0	0.01
Hardstand	1.88	0	1.88
Other Clearing	7.02		7.02
Pit	0.56	0	0.56
Plant	3.62	0	3.62
Pond (WSF 1)	7.42	0	7.42
Road	14.41	0	14.41
ROM	2.43	0	2.43
Stockpile	0.12	0	0.12
TSF 1 (including access track)	12.38	2.5	14.88
Waste Dump	8.62	0	8.62
WSF 2	1.73	0	1.73
WSF 1 Diversion Embankment (and weir)	1.79	0	1.79
Borrow Pits	1	3	4
Topsoil Stockpile	0.1	1	1.1
Total Tenement Disturbance	**67.22**	**6.5**	**72.72**
Total Disturbance	**137.89**	**10.5**	**148.39**

4.3 MINING OPERATIONS AND SCHEDULE

Mining operations and ore processing are being conducted as detailed in NOI 4099, MP 19001 and MP 28210.

Additional mineral reserves defined below the 500 Fault will extend the Savannah Project LOM to 2018, subject to approval for additional tailings storage.

To enable mining and processing of ore to continue beyond 2014, Panoramic require additional above ground tailings storage capacity. The projected mining schedule is presented in Table 8 and summarises the following information:

- Ore mined to 2011 and tailings produced under NOI 4099, MP 19001 (Paste Disposal) and MP 19240 (Copernicus satellite pit).
- Ore mined and tailings produced from 2011 to 2014 under MP 28210 (Stage 1 TSF Amendment).

- Proposed ore to be mined and tailings produced from 2014 – 2018 based on expanded mineral resource estimate (Stage 2 TSF Amendment).

Table 8: Projected Mining Schedule (Tonnes)

Mining Schedule	To Date (as of 30 June 2011)	July 2011 – 2014 (Stage 1)	2014 – 2018 (Stage 2)
Ore Mined	5.29 million	1.7 million	3.20 million
Tailings Paste to UG	1.83 million	666,000	1.2 million
Tailings to TSF 1	2.76 million (1.63 million cubic metres)	830,000 (490,000 cubic metres)	1.65 million (974,000 cubic metres)

The production and storage of tailings is in balance with existing storage capacity to March 2014. The ability to mine and process further economic resources beyond March 2014 requires additional above ground tailings storage capacity.

4.4 PROPOSED LONG-TERM TAILINGS STORAGE STRATEGY

Panoramic is seeking approval for a new long-term tailings management strategy. The proposal involves storage of the additional tailings within the existing TSF 1 footprint through a series of embankment raises and the permanent *in-situ* containment of all tailings within this facility on completion of mining.

The Proposal to raise TSF 1 by six metres will allow additional storage capacity for 1.65 million tonnes. Based on a density of 1.7 this equates to 974,000 cubic metres of tailings to be deposited over four years. The raise will accommodate current known ore reserves at Savannah will allowance for maintenance of freeboard. Should additional tailings storage capacity be needed in the future (beyond the scope of this Proposal and as a result of defining additional reserves), a second TSF (TSF 2) will be required. This will include a review of options assessed at the 2011 Agency Workshop, including:

- Discharge of tailings to the decommissioned Savannah pit.
- Construction of an additional valley-fill or paddock TSF.

4.5 TSF DESIGN BACKGROUND

TSF 1 is a cross-valley facility located approximately one kilometre north of the processing plant and immediately upstream of the WSF 1. The main embankment has been constructed in three stages (note that construction stages do not correspond to the current Stage 1 and 2 TSF Amendments naming convention applied to approval documentation):

- Stage 1 Construction (under NOI 4099):
  - Construction of the embankment to a crest of 360 mRL with a maximum height of 33 metres.
- Stage 2 Construction (under NOI 4099):
  - Upstream raise of the main embankment a further nine metres from 360 mRL to a crest of 369 mRL with a maximum height of 42 metres.

- Stage 3 Construction (under MP 28210 and referred to as the Stage 1 TSF Amendment):
  - Upstream raise of main embankment by three metres from 369 mRL to a crest of 372 mRL, with a maximum height of 45 metres.
  - Construction of an eastern saddle embankment.

The main embankment comprises a zoned rockfill of 333,000 cubic metres of competent mine waste rock in the downstream zone and an upstream zone of 560,000 cubic metres of select crushed rock with a HDPE liner on the upstream face to 369 mRL. A geotextile layer is placed between the HDPE liner and the upstream select crushed rock zone in order to minimise the potential for damage to the liner. The embankment also incorporates a nominal one to two metre deep cut-off trench backfilled with low permeability material. The upstream liner is anchored within this cut-off trench.

TSF 1, as constructed to date, is shown in Figure 11.

4.6 PROPOSED TSF RAISE

The design of the proposed TSF 1 raise was undertaken by Coffey Mining (Coffey, 2012). The full report is provided in Appendix 6.

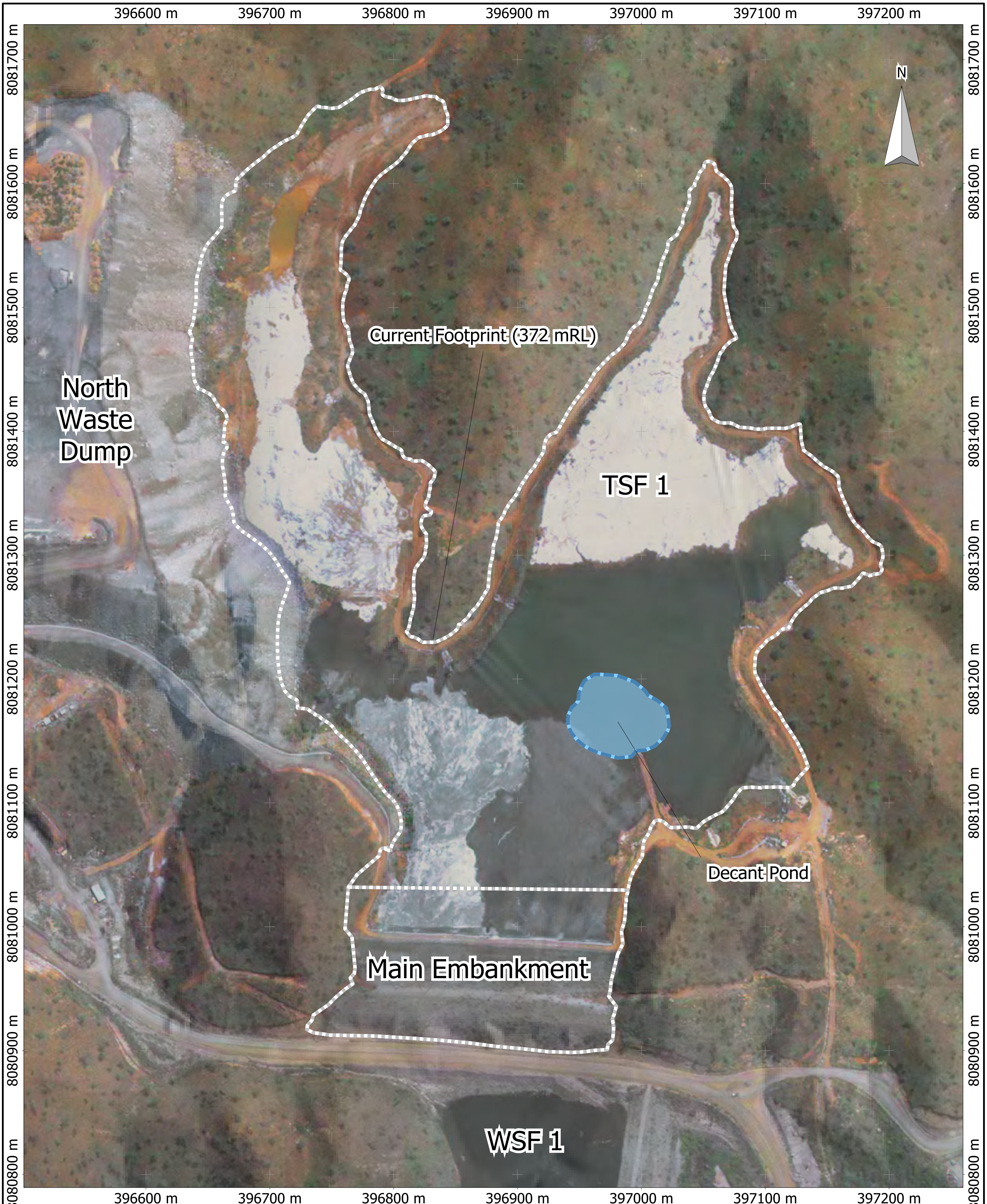
The objectives when designing the raise to TSF 1 were to:

- Optimise the containment and removal of surface water from the facility.
- Maximise the tailings density and storage capacity by alternating the discharge points.
- Provide tailings conditions and landforms suited to long-term closure objectives.
- Ensure a low level of risk to the surrounding environment with negligible impacts to ecological receptors.

The key components of the Stage 2 TSF Amendment design for the remaining operational phase of the Savannah Project comprise (Coffey, 2012):

- Stage 4 Construction:
  - Upstream raise of main embankment and existing eastern saddle embankment by three metres from 372 mRL to a crest of 375 mRL.
  - Construction of two additional saddle embankments (eastern side).
  - Extension of the decant structure.
  - Construction of an emergency weir in the north eastern saddle embankment.
- Stage 5 Construction:
  - Upstream raise of main embankment and eastern saddle embankments by three metres from 375 mRL to a crest of 378 mRL.
  - Construction of an internal wall to 378mRL to create two cells (Cell 1 and Cell 2).
  - Construction of a western saddle embankment to 378mRL.
  - Extension of the decant structure.

Each of these components is shown in Figure 12 and described in the following sub-sections.



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Savannah Project

Existing TSF 1

Figure 11

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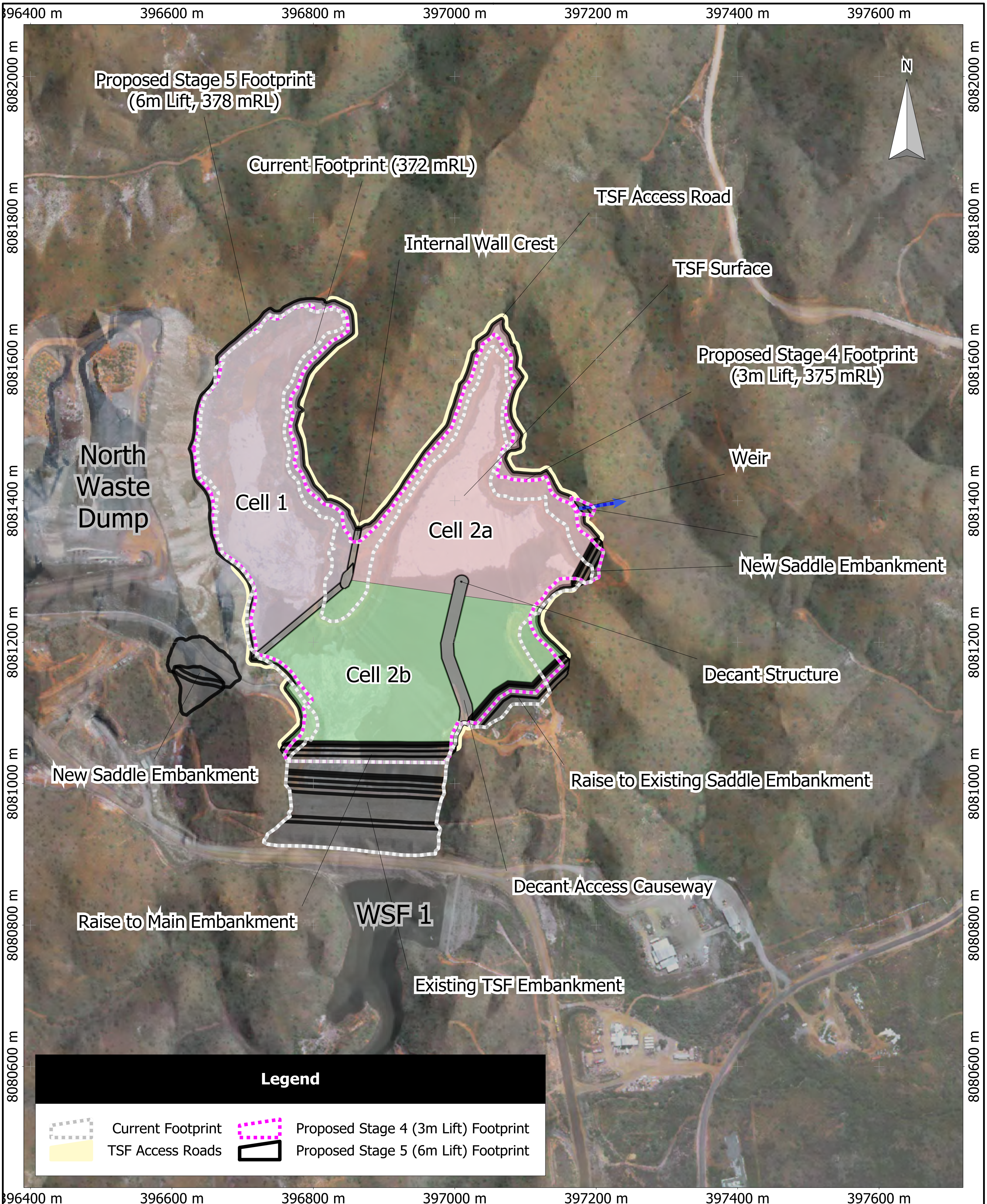

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Proposed Staged Raise Design & Catchments at Closure

Figure 12

4.6.1 Embankment Construction Details

The main embankment raise and eastern saddle embankments will be constructed using upstream raising techniques mostly over tailings beaches using roller compacted clayey borrow material. The downstream batters of both than main and saddle embankments will be covered with mine waste on the downstream face for erosion protection. The raises and saddle embankments will have design slopes of 1:2 (vertical to horizontal) upstream and slopes of 1:2.75 downstream.

Clayey fill material used in construction will be:

- Free of all organic and deleterious material.
- A minimum of 20% by weight of soil fractions finer than 0.075 mm and not more than 20% greater than 37.5 mm (maximum particle size of 150 mm).
- Have a plasticity index of 5% to 15%.

All waste rock utilised in construction will be:

- Non Acid Forming.
- Free of all organic and deleterious material.
- Competent with a maximum particle size not exceeding 100 millimetres.
- Well graded with less than 3% fines.

The design concept for the saddle embankment on the western side varies from the above concept. In lieu of a compacted clayey fill zone, an upstream liner will be utilised in this embankment to act as an upstream low permeability zone in order to reduce the potential for seepage (as the saddle is below 378mRL). A 'v' created between the waste dump and the saddle embankment will be backfilled with mine waste from the adjacent waste dump in order to protect the liner from UV light and provide for the final landform. A cushion layer of select fill will be required to protect the liner.

Cross-sections and construction details are provided in Appendix 6 (Coffey 2012). All embankments will be constructed to a hazard rating of 'High', based on classification criteria outlined in the 'Mining Environmental Management Guidelines, Safe Design and Operating Standards for Tailings Storage', (DoIR, 1999). Stability analysis of the main and saddle embankments is discussed in Section 4.7.2.

4.6.2 Internal Wall with Two-Cell Design

As part of the operation and closure of TSF 1, a two-cell configuration will be adopted by constructing an internal wall across the southern section of the western finger of the TSF during the final (Stage 5) raise. The internal wall will be constructed of competent waste rock over the tailings beach to a nominal height of three metres (378 mRL). Material will be placed and compacted to form a competent wall with slopes 1:1.5 (western side - Cell 1) and 1:2.5 (eastern side - Cell 2) and 10 metre wide crest.

The purpose of constructing two cells is to:

- Control surface water by reducing the catchment size and water volume.
- Maximise storage capacity.
- Allow tailings to be strategically deposited in two areas which could create opportunities for rehabilitation trialling.

As a component of the proposal, Cell 1 will be filled to maximum capacity prior to completion of Cell 2. Rehabilitation trials will be coordinated on a section of Cell 1 to allow an assessment of consolidation and settlement of tailings and analysis of the performance of the cover system. These trials will assist in refinement of the store-and-release cover design. Following the decommissioning of Cell 1, tailings deposition will continue to be directed into Cell 2.

Towards closure, tailings discharge will be managed to form three surface water catchment areas. Tailings will be discharged from the internal wall in Cell 1 to form a north draining tailings beach. Tailings within Cell 2 will be discharged to form a raised central landform (Eastern Cell) to sub-divide the cell such that two surface water catchments will be created for closure. The northern sub-catchment is identified as Cell 2a and the southern sub-catchment as Cell 2b (Figure 12).

4.6.3 Decant and Water Recycling

Tailings in the form of slurry will continue to be discharged sub aerially from a slurry ring main around the majority of the facility perimeter. Supernatant water liberated from the tailings slurry and incident rainfall within TSF 1 will be recovered from the impoundment area via a decant pump deployed within the 'permanent' decant structure. Return water will be pumped back to the processing plant and/or WSF 2 (as currently occurs). Once the internal wall is constructed, water recovered from Cell 1 will be pumped back to the main decant structure in Cell 2. The existing decant structure which comprises slotted concrete pipes stacked vertically on one another and surrounded by 'clean' rockfill, will be raised. The existing decant causeway will also be raised.

In order to ensure the decant location is 'centrally' located in Cell 2, the decant structure will be relocated northwards away from the main and eastern saddle embankments.

4.6.4 Water Balance

Coffey Mining undertook water balance analyses to provide a design value for the volume of accumulated water that the TSF 1 will be required to store during operations, in an above average rainfall year following the wet season. The water balance analyses were performed on the whole catchment of TSF 1 which includes Cell 1 and Cell 2 and assume that Cell 1 was full but not rehabilitated and Cell 2 is operating.

The amount of TSF1 water return as a percentage of slurry water inflow was estimated at 124% in 2011 (i.e. return water was stored or used in paste production). The 2011 Audit included an analysis of flows into and from TSF 1 using a mathematical simulation in order to examine the water balance for the facility during operation. Inflows and outflows for the facility were estimated on a monthly basis. Inflows include rainfall runoff into the TSF, slurry water and flows from other parts of the mine. Outflows comprise evaporation from the pond and wet beaches, evapo-transpiration from drying beaches, seepage losses, and water retained in the tailings (pore water).

The results of the water balance analyses indicates that, if a water return to the processing plant from TSF1 of 70% of slurry water inflow is assumed together with a 'worst' case wet season, approximately 125,000 cubic metres of water could potentially accumulate on the facility over the wet season. The commissioning of WSF 2 and WSF 3 during 2011 has provided additional storage capacity during high rainfall events.

The Savannah water balance is reviewed on an annual basis, using recorded figures, as part of the annual TSF and WSF audit, in order to assist in water and tailings management at the operation.

4.6.5 Design Floods

Based on the water balance analyses, TSF1 has been designed to temporarily store a 1 in 100 year ARI 72 hour storm event of 340 mm, with allowance for the catchment upslope of the impoundment area. The design assumes that the correct operational controls are adhered to and in particular that water is continually removed from the TSF, such that the decant water pond is positioned away from the main perimeter embankment at all times.

A minimum operational freeboard (vertical height between the tailings beach and embankment crest) of 0.3 metres is proposed, with a total freeboard of 1.5 metres.

4.6.6 Operational Weir and Closure Spillways

During operations, a temporary weir will be constructed utilising compacted clayey borrow material protected by geofabric and an HDPE Liner.

The 1 in 100 year 72-hour storm event will be stored within the TSF1 impoundment area below the operational weir level (i.e. above the 'normal' decant pond level) prior to discharge occurring over the weir crest.

The Cell 2 weir will remain operational until final capping works and surface water drainage infrastructure, including spillways, have been completed.

Further details on the closure spillways are provided in Section 7.1.

4.7 DESIGN CONSIDERATIONS

The following design considerations have been incorporated into the TSF 1 raise design.

4.7.1 Tailings Properties

A number of investigations have been undertaken by Coffey Mining to characterise the geotechnical properties of Savannah tailings, including:

- Shear vane testing of the tailings beaches immediately upstream of the TSF1 main embankment and laboratory testing (including tri-axial testing) of undisturbed tube samples of near surface tailing.
- CPT analyses across the tailings storage for the full depth of the tailings in August 2009.
- Rowe Cell testing was performed in 2011 to reconfirm tailings consolidation characteristics.

The results of these studies found:

- There is limited segregation of the tailings down the tailings beach, as the tailings are thickened. The percentage fines results for samples obtained near the main embankment were 66% and 62% respectively, compared to the results for samples near the decant of 72% and 74%, respectively.
- Relatively uniform strength profiles across the beach areas, with only minor reduction in strength away from the main embankment toward the centre of the TSF.
- The inferred angle of internal friction of the tailings varied between 28^{o} and 33^{o}.

- The estimated coefficient of consolidation of 105m²/year, indicating that the tailings have good consolidation characteristics and are approaching 90% consolidation.
- Reduced consolidation times from Rowe Cell testing when compared with parameters interpreted from CPT testing.

4.7.2 Stability Analysis

Stability analyses were undertaken by Coffey Mining as part of the design of the upstream raise to the main embankment and saddle embankments and to examine the construction of the internal embankment.

The parameters utilised in the analyses were based on the probing results of the existing tailings and those assumed in the original design for the existing TSF1 embankment. Strength parameters for the tailings were chosen based on the results of previous laboratory consolidated undrained triaxial testing and the recent CPT results. The phreatic surface adopted in the analyses was based on an assumed 'worst' case condition. The stability analyses were carried out using the computer program Slope/W, which models circular slip surfaces by Bishop's simplified method.

The stability analyses results indicate that all cases examined have factors of safety above the respective corresponding recommended minimum factors of safety in the ANCOLD (1999) Guidelines. The factor of safety for a deep seated failure through the embankments is mainly dependant on the position of the phreatic surface. To attain an acceptable factor of safety for deep seated failure, the TSF will be operated in such a manner as to ensure the phreatic surface adopted in the analyses is not exceeded. This will be best achieved by maintaining the water pond around the decant structure such that no water is allowed to pond against the main and saddle embankments (i.e. nominally 75 - 100 metres away from the embankment).

Stability results also concluded that under correct operational conditions, as documented in the TSF Operating Strategy, TSF 1 will have adequate factor of safety against failure. The results of the embankment stability assessments indicate under the Operating Basis Earthquake (OBE) and Maximum Credible Earthquake (MCE) conditions, the risk of embankment deformation is considered low and that the TSF design is of an acceptable standard for both operations and closure.

4.7.3 Liquefaction Assessment

A liquefaction assessment was undertaken based on the parameters assessed from the CPT results. The results of this assessment indicated that only liquefaction of the surficial tailings is possible for an OBE (1:500 year ARI) and hence any internal embankment slumping would be limited. For a MCE (1:10,000 year ARI) potential liquefaction at depth is possible however, post liquefaction stability assessments indicated that a failure of the main embankment, upstream raised section is unlikely as factor of safety requirements are satisfied (Coffey 2012).

It should be noted that liquefaction of tailings may only occur during an earthquake if the tailings are saturated. Therefore the decant pond will continue to be kept away from the main TSF perimeter embankment (as is the current operating strategy) and this will greatly reduce the risk of deformation of the main embankment during an OBE or MCE. The liquefaction assessment based on the probing results confirms the previous assessments presented in Appendix 6.

4.7.4 Borrow Material

Geotechnical investigations were undertaken to assess potential sources of clayey fill for embankment construction. The work comprised excavation of a series of test pits within the TSF 1 impoundment area, at an old borrow area near the camp and at an area south of the plant site. The borrow material investigation report is presented in Attachment 5 of Appendix 6.

Approximately 55,000 cubic metres of clayey borrow material is required for construction of the TSF 1 wall raises. Preferred borrow are located south of the processing plant. Borrow pits will be excavated to an average depth of two metres, depending on suitability of material at depth. All rocky material required for the embankment lifts will be sourced from mine waste rock. A breakdown of material volumes required for the TSF 1 expansion is provided in Table 9.

Table 9: Materials for TSF 1 Construction

Stage	Material (cubic metres)	
	Silty Sand/Clay fill*	Waste Rock**
4	24,000	12,200
5	31,000	28,800
Total	55,000	41,000

* Mainly sourced from borrow pits.
** Sourced from Waste Rock Dumps.

Based on the results of the geotechnical investigation it is concluded that sufficient borrow material is available to construct the planned embankment raises based on a minimum fines content of 15% being acceptable.

4.8 OPERATION AND MANAGEMENT

Tailings in the form of slurry will be discharged sub-aerially and spirally around the perimeter of TSF 1. Tailings will be deposited in discrete layers from single point discharges. The discharge point will be regularly moved to ensure an even development of the tailings beach. The preferred outcome is to achieve thin layers of tailings deposition which achieves improved settled densities while maintaining a moist environment to minimise oxidation. Tailings discharge or spigotting is to be carried out such that the supernatant water pond is maintained around the decant structure.

Seepage mitigation / recovery measures comprise use of thickened tailings in conjunction with ‘continuous’ water return to the processing plant in order to reduce potential water available to report as seepage.

4.9 REHABILITATION AND CLOSURE

The Stage 2 TSF Amendment proposal requests approval for tailings to remain *in-situ* at closure with construction of an engineered cover. O’Kane Consultants were commissioned to assess options for the final TSF 1 landform cover system design and the adjacent NWRD slope design.

Prior to closure, tailings discharge will be managed to form three surface water catchment areas comprising Cell 1 (western catchment) and two sub-catchments within Cell 2 consisting of Cell 2a (north-eastern catchment) and Cell 2b (southern catchment). Any surface water runoff from the rehabilitated

TSF 1 surfaces will be directed to engineered spillways within each of the sub-catchments thereby ensuring unrestricted drainage during heavy rainfall events.

The proposed cover system uses the moisture store-and-release concept, where incident rainfall is captured and stored within the cover system profile, with evapotranspiration releasing moisture back to the atmosphere. For high (and more intense) rainfall events, during which the cover system's moisture store-and-release capacity cannot accommodate the infiltration, the TSF 1 landform design facilitates surface water runoff.

The preferred cover design comprises a 0.3 metre non-compacted soil/waste rock mix overlaying two metres of waste rock sourced from the crest and eastern slope of the NWRD. The remaining NWRD will be reshaped with a concave eastern slope adjoining the rehabilitated tailings surface, with an engineered toe drain constructed at the base of the slope to capture and redirect runoff away from TSF 1.

Closure and Rehabilitation aspects of the proposal are summarised in Section 7 and in detail in the Mine Closure Plan (Appendix 16).

4.10 SUPPORT FACILITIES

Support facilities already exist as part of the current operations. Installation of additional standpipe piezometers in TSF 1 will be undertaken for monitoring of seepage and pore water pressure.

4.11 WORKFORCE

The proposal to increase the storage capacity of TSF 1 will require temporary employment of an earthworks contractor to undertake construction of the embankment raises and saddle embankment construction. All other aspects of this proposal can be managed by the current staff at SNM, comprising site personnel and the Perth based management team.

4.12 TRANSPORTATION AND INFRASTRUCTURE CORRIDORS

Existing roads and tracks will be used for general site access associated with the Savannah Project. As the existing perimeter access track around TSF 1 will be covered by the proposed raise (and tailings), a new track is required around the perimeter (as is shown in Figure 12).

Any additional or relocated tailings and water pipelines will be constructed in existing corridors. Tailings and seepage water pipelines will be bunded or sleeved where bunding is impractical (eg – drainage crossings).

4.13 RESOURCE REQUIREMENTS AND REGIONAL INFRASTRUCTURE

This proposal is a continuation of operations within an existing mining centre. It will not create any additional requirement for regional resources over the current operations.

4.14 COMPLIANCE WITH LEGISLATION AND OTHER APPROVALS

4.14.1 Mining Proposals

The Savannah Project operates in compliance with NOI 4099 (MP 17486), MP 19001 (Paste Disposal), MP 19240 (Copernicus) and MP 28210 (Stage 1 TSF Amendment).

4.14.2 Lease Conditions

Savannah Project is located on M80/179, M80/180, M80/181 and L80/64. These leases have a number of conditions dealing with a range of issues associated with the operation, reporting and closure.

Of specific relevance to this Mining Proposal is the condition applied to both M80/180 (Condition 24) and M80/181 (Condition 27), dealing with the relocation of tailings from the TSF to the completed mine workings at the conclusion of mining operations. Specifically, the condition applied on 27 August 2003 states:

> "*Tailings relocation from the TSF to the underground workings to commence within two weeks of cessation of underground and open pit mining operations unless prior approval is gained from the State Mining Engineer for an extension of this timeframe*."

Other conditions have been applied that also relate to the process of backfilling the mine workings with tailings. Specifically, a condition applied to M80/180 (Condition 25) on 27 August 2003 states:

> "*The maximum water level in the pit shall remain at least two metres below the natural surface of 2,364 mRL and not to exceed 2,362 mRL during the tailings infill operations*."

In summary, the above mentioned lease conditions require that:

- All tailings produced throughout LOM and stored in the TSF, be returned to the completed mine workings at the conclusion of the project.
- There is a restriction on the maximum allowable volume of tailings to be placed in the pit void.

This proposal seeks to amend these conditions according to the proposed long-term tailing management strategy described in this document. Lease conditions are provided in Appendix 1.

4.14.3 Works Approval

This Proposal will result in a change to the Prescribed Premise. This triggers the requirement for a Works Approval application to be made to DEC for approval of prescribed activities under Part V of the *Environmental Protection Act 1896.*

4.14.4 Clearing

The *Environmental Protection Act 1986* and *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* require all land clearing related to mining and mineral exploration activities to be approved by DMP.

Clearing required for this Proposal is less than 10 hectares per tenement, and will be cleared in accordance with the ten hectare per tenement per financial year exemption under the *Environmental*

Protection (Clearing of Native Vegetation) Regulations 2004 for activities authorised under the *Mining Act 1978*.

4.14.5 Licencing and Reporting

The Savannah Project operates under Environmental Licence (7967/4) and Groundwater Licence (GWL153527(3)) which are presented in Appendix 2 and Appendix 3 respectively.

Annual environmental monitoring and reporting is conducted in accordance with the relevant site licences, tenement conditions and site policies. Annual reports are submitted to DMP, DEC and DoW.

5. ENVIRONMENTAL IMPACTS AND MANAGEMENT

This section describes the operational impacts and management measures associated with this Proposal. Impacts and management associated with closure are described in Section 7 and Appendix 16.

Relevant site procedures and management plans will be applied to all work undertaken as part of this Mining Proposal (Commitment 1).

SNM prepares an annual environmental report in compliance with the tenement conditions of DMP and licence conditions of DEC pertaining to the Savannah Project. The report provides a detailed overview of the previous year's operations with particular emphasis on environmental impacts and management and likely developments in the next year. The report also serves the purpose of an internal environmental review.

5.1 LAND CLEARING

The proposal to expand TSF 1 is to be viewed in the context of an expansion to an existing TSF within an existing mining centre, with other mining, processing and infrastructure facilities already in place.

Approximately 10.5 hectares of native vegetation will be cleared to accommodate the increase in TSF 1 capacity (tailings footprint, embankments and access road), borrow pits and other minor supporting infrastructure. Vegetation units and habitats in the project area are well represented in the region and species protected by State or Federal legislation will not be adversely impacted. Clearing approval is not required as Panoramic will exercise the 10 hectare per tenement exemption as described in Section 4.14.4.

Minimisation of land degradation will be achieved by applying appropriate clearing and rehabilitation methods. Management strategies to achieve this include:

- The clearing of vegetation will be kept to the minimum required for the project.
- Vehicle movements will be confined to defined haul roads and tracks.
- All available topsoil will be stripped from surfaces that will be disturbed and stored for rehabilitation. Wherever practicable, the duration that topsoil is stockpiled will be minimised to reduce the loss of seed viability and soil biota (Commitment 2).
- Vegetation will be established, where practicable, on disturbed areas following completion of mining activities (Commitment 3).

5.2 GEOTECHNICAL STABILITY AND INTEGRITY OF TSF 1

5.2.1 Potential Impacts

Potential risks to the environment associated with storage of tailings in TSF 1 comprise:

- Structural breach of the TSF 1 main embankment and/or saddle embankments leading to release of tailings from the facility, with subsequent impacts to vegetation, fauna, surface water and groundwater.

- Structural breach of the internal embankment leading to release of tailings into Cell 2 and potentially resulting in overtopping of the main embankment, with subsequent impacts to vegetation, fauna, surface water and groundwater.
- Overtopping of main embankment and/or saddle embankments due to insufficient storage capacity in high rainfall events, with potential impacts to the environment and/or integrity of the embankments.
- Inadequate design of the operational weir resulting in erosion of the weir leading to increased sediment loading of downstream surface watercourses.

5.2.2 Management and Mitigation

The integrity of TSF 1 and containment of tailings will be managed by:

- Construction of the main and saddle embankments to standards required for the highest hazard rating (Category 1) facilities according to DMP criteria, with supervision by qualified personnel (Commitment 4).
- Design, construction and operation of TSF 1 with allowance of adequate freeboard to accommodate temporary storage of water on the facility during a 1 in 100 year average recurrence interval (ARI) 72 hour storm event with excess water removed from the facility via a weir during operations (Commitment 5).
- Design of the weir to accommodate surface water flow resulting from a probable maximum precipitation (PMP) event (i.e. greater than a 1:100 year ARI event) (Commitment 6).
- Armouring the weir with suitable materials to reduce the development of erosion rills and gullies (Commitment 7).
- Locating the decant pond within the central layout of Cell 2 to reduce saturation of tailings and build-up of free standing water adjacent to the main and saddle embankments to enhance the structural integrity of the facility (Commitment 8).
- Additional lined water storage facilities have been constructed to reduce water inputs to TSF 1 and ensure water ponding on TSF 1 surface is minimised.
- Ensuring operational personnel are familiar with TSF 1 operating procedures in the unlikely event of water release from TSF 1.
- Ensuring appropriate containment structures (e.g. – bunding) are maintained for all tailings lines and personnel are familiar with spill clean-up procedures.
- Regular monitoring of embankment prisms for movement and measurement of the decant water level (Commitment 9).
- Annual analysis of particle size distribution of tailings (Commitment 10).
- Continuation of the Annual Audit and Management Review of TSF 1 (Commitment 11).

Management of TSF 1 in closure is described in Section 7.

5.2.3 Impact Assessment

- Stability analyses confirm that the design of the existing TSF 1 main embankment and proposed upstream embankment raises have factor of safety that exceed the corresponding recommended minimum factor of safety in ANCOLD Guidelines (1999).

- Water mounding within TSF 1 will reduce over time (following completion of tailings deposition), with the lowering of the phreatic surface behind the TSF 1 embankments. This will further increase stability.
- There is adequate capacity in the TSF design to ensure that in extreme rainfall events, water accumulating on the TSF 1 surface can be stored and/or safely removed from the facility, ensuring embankment integrity.
- CPT analyses found that Savannah tailings are approaching 90% consolidation. Results of Rowe Cell testing re-confirm Savannah tailings to have very good consolidation characteristics and indicate reduced consolidation times when compared with parameters interpreted from CPT testing.
- Post liquefaction stability assessments indicate that the risk of failure of the main embankment and saddle embankments is low.
- The proposed design criteria will ensure that tailings are securely located to allow long-term (permanent) storage of tailings.

5.2.4 Predicted Outcome

All studies indicate that TSF1 meets design, construction and operational criteria for the safe and permanent storage of tailings. Based on these criteria and stability analyses, all identified hazards can be appropriately managed, with the risk of a breach and/or overtopping of the TSF1 embankments considered low.

5.3 TAILINGS MANAGEMENT

The Savannah Project generates pyrrhotite rich, sulphidic tailings, that, under reducing conditions, do not produce acid and metalliferous drainage. The risk of acid and metalliferous drainage (AMD) from the TSF 1 bulk tailings is low due to the hardpan layer formation, very slow moving oxidation front, high level of residual saturation of bulk tailings (following drain down of the water mound in the tailings profile) and inherent acid neutralising capacity. This is supported by nine years of downstream water quality monitoring, three years of KLC testing and *in-situ* tailings-at-depth analysis and a tailings mineralogy assessment, which have found that under anoxic conditions, which are the prevailing conditions at Savannah, no acid mine drainage occurs.

5.3.1 Potential Impacts

Potential risks associated with Savannah tailings include:

- Oxidisation of tailings via a reaction pathway that could result in the potential for AMD.
- Leachate from tailings resulting in seepage and potential impacts to groundwater and surface water.

5.3.2 Management and Mitigation

Potential impacts to the environment associated with storage of tailings at TSF1 will be managed by:

- During operations, tailings will be contained in TSF 1 in accordance with management measures described in Section 5.2.

- Continuation of current tailings discharge methods which are effective in maintaining anoxic (reducing) conditions within the bulk tailings profile below the hardpan surface (**Commitment 12**).
- At closure, tailings will remain *in-situ* (i.e. – under reducing conditions) which negates the risk associated with potential acid generation that is likely to occur if tailings were required to be relocated elsewhere.
- Construction of an engineered cover using the store-and-release concept to further enhance the long-term maintenance of anoxic conditions.

5.3.3 Impact Assessment

- Bulk tailings stored at TSF 1 are significantly less geochemically reactive than pre-mining simulated tailings and are unlikely to generate acid. Classical geochemical test measurements significantly overestimate the acid potential of the tailings.
- Pyrrhotite oxidation in the hardpan is the main source of sulphate in TSF1. Elemental sulphur in the hardpan is the dominant secondary sulphur mineral phase consistent with non-acid producing oxidation of pyrrhotite to elemental sulphur as the main oxidative reaction.
- Tailings stored at TSF 1 form a trafficable hardpan surface layer, which limit the rate of oxygen ingress and infiltration of precipitation into the bulk tailings materials.
- Bulk tailings below the hardpan surface of TSF 1 generate pH neutral leachate containing excess alkalinity and low concentrations of soluble metals/metalloids. However, elevated salinity levels, mainly caused by sulphate, calcium and magnesium have occurred over time.
- There is a lack of oxygen and subsequently reducing conditions prevail beneath the TSF 1 hardpan surface, which inhibits pyrrhotite oxidation.
- Savannah tailings contain enstatite, a magnesium silicate that has dissolution rate comparable to the measured oxidation rate of pyrrhotite in near saturated tailings and provides a source of alkalinity at a rate comparable to the acid generation rate from pyrrhotite oxidation. This results in pH neutral drainage with excess alkalinity and very low levels of dissolved metals and elevated salinity from sulphate, calcium and magnesium. These results are consistent with observations reported in the literature regarding other pyrrhotite-bearing tailings wastes.
- There is negligible reduced sulphur species present in tailings pore water and low iron concentrations at depth. Therefore, the risk of latent acidity being produced in seepage downstream of TSF 1 is low.
- Geochemical predictions from KLC tests are consistent with the *in-situ* tailings-at-depth assessment, mineralogical tests & groundwater monitoring data downstream of TSF 1.
- Where the tailings saturation level is more than 75%, pyrrhotite oxidation is inhibited and the downward movement of the oxidation front through TSF 1 is likely to be less than 1 cm per year.
- Soil-atmosphere modelling results associated with the proposed final cover design for TSF 1 demonstrate that a residual saturation level of 75 % in tailings is likely at depths of five metres or greater below the tailings-cover interface, with saturation levels increasing at depth. Hence this level of saturation, together with the surface hardpan, will serve to significantly slow the pyrrhotite oxidation rate at TSF1.

- Tailings with similar pyrrhotite concentrations to the Savannah Project, and stored with no cover under a similar groundwater regime for over 25 years at the Fault Lake site in Ontario, Canada showed a surface hardpan depth of 20 cm and the movement of the oxidation front a further 18 cm into the tailings. The decreases in the total porosity relative to the surrounding 'uncemented' tailings resulted in the cemented layers acts as a hydraulic and diffusive barrier towards the migration of infiltrating precipitation and atmospheric oxygen.

5.3.4 Predicted Outcome

Multiple technical studies provide a thorough understanding of the Savannah tailings geochemistry and confirm that the current and proposed method of tailings disposal and long-term management precludes the likelihood of oxidising conditions prevailing. This is due to natural formation of a trafficable hardpan layer and construction of a store-and-release cover that reduces oxygen ingress, very slow moving oxidation front, high level of saturation of bulk tailings and inherent acid neutralising capacity. The risk of AMD from the Savannah bulk tailings is therefore low.

5.4 GROUNDWATER

The water table beneath TSF 1 has been affected by seepage that has lifted (mounded) the groundwater level and altered the quality. Flow from this mound has affected natural groundwater nearby by increasing the salinity and sulphate concentrations and decreasing the seasonal depth to water. The low hydraulic conductivity of the fractured bedrock aquifer is sufficient to limit mounding to within about 200 to 300 metres of TSF 1.

A preferential flow path of seepage from TSF 1 has been identified in the subsurface weathered zone of local drainages which sometimes discharges as surface water during the wet season when groundwater levels normally rise. Seepage emanating from TSF 1 is enriched in solutes such as sulphate and some metals and flows primarily towards the main embankment and then to Mine Creek, via WSF 1. These concentrations within the solute plume decrease along the flow path towards Fletcher Creek as it mixes with natural groundwater.

5.4.1 Potential Impacts

Potential risks to groundwater comprise:

- Elevated groundwater levels associated with water mounding during the operational phase may result in the development of minor seasonal springs in low lying areas adjacent to TSF 1 and potential impacts to vegetation.
- Continuation of seepage containing elevated solute concentrations into groundwater and ultimately to surface water with potential impacts to ecological receptors.

5.4.2 Management and Mitigation

Impacts to groundwater quality and levels will be minimised through implementation of the following management and mitigation measures:

- Continued operation of seepage recovery bores and sumps to retard the advance of the groundwater mound and solute plume downstream during the operational phase (**Commitment 13**). Based on groundwater quality predictions at the time of closure, seepage recovery bores may continue to be operated for a period during the closure phase while the water mound drains down.
- If required, additional bores may be installed to improve seepage recovery and minimise closure-related impacts.
- Reducing water inputs to TSF 1 through operational measures thereby reducing the hydraulic head of the facility and subsequent seepage reporting to groundwater.
- Groundwater quality and levels will continue to be monitored in accordance with the Savannah Water Operating Strategy. Where an upward trend in solute concentrations is detected, this will result in a series of management responses which may include resampling and analysis of water quality, investigating the likely cause of the elevated concentrations and increasing seepage recovery operations (**Commitment 14**).
- Installation of an engineered cover at closure to control seepage rates and enhance maintenance of anoxic conditions in TSF 1.

5.4.3 Impact Assessment

5.4.3.1 Seepage Rate and Water Mound

Seepage with elevated solute concentrations is currently discharging to both Mine Creek and Fletcher Creek. Based on the results of numerical modelling, the average seepage rate from TSF 1 is predicted to:

- Increase from the current rate of 400 m^3/day to about 900 m^3/day during operations (2014 and 2018).
- Decrease from 900 to 50 m^3/day during the closure phase (2019 - 2028).
- Stabilise at about 35 m^3/day during the post-closure phase (2029 – 2048) which corresponds to the predicted recharge flux through the engineered cover.

During operations, groundwater discharges to Mine Creek are predicted to range from 450 m^3/day along the discharge zone between WSF1 and bore SMMB01, to 150 m^3/day between SMMB01 and Fletcher Creek. While the existing seepage recovery continues, these discharges only occur during the wet season when groundwater levels rise due to seasonal rainfall recharge.

The water mound beneath TSF 1 will begin to dissipate at the start of the closure phase (2019) when the decant pond will evaporate and the excess pore water will drain. Groundwater levels beneath TSF 1 are predicted to begin to stabilise about 10 years after closure.

The natural variation of ecosystems in the Kimberley as a result of extreme wet and dry fluctuations and subsequent adaptation of ecosystems to these conditions make it unlikely that the vegetation will be affected by predicted changes in groundwater levels (as is currently observed on site).

5.4.3.2 Solute Concentrations

During operations, elevated solute concentrations in groundwater will occur as a plume that extends primarily between TSF 1 and Fletcher Creek.

To provide a conservative assessment of seepage impacts, the modelling assumes that seepage recovery bore SMPB03 is turned off in 2018 (at closure), resulting in peak concentrations down gradient of TSF 1 in 2019.

Peak sulphate concentrations in groundwater in 2019 are predicted to be:

- Between 1,150 and 2,550 mg/L upstream of SMMB01. This assumes seepage recovery bores are switched off in 2018.
- Between 250 mg/L – 1250mg/L in discharged groundwater along the lower reaches of Mine Creek below SMMB01.
- Approximately 150 mg/L in discharged groundwater at Fletcher Creek.

Concentrations of metals in groundwater at Mine Creek (in seepage recovery bore SMPB03) in 2019 are estimated to be up to 0.015 mg/L copper, 0.009 mg/L nickel and 0.008 mg/L cobalt.

There are no identified sensitive groundwater receptors that will be impacted by elevated solute concentrations from tailings seepage. The only beneficial groundwater use in vicinity of the Savannah Project is livestock drinking water. With the exception of sulphate, all solute concentrations are below the corresponding ANZECC (2000) guideline values for livestock. The nearest groundwater fed stock watering point is located approximately six kilometres from the Project and will not be impacted by seepage.

The interaction of groundwater and surface water is identified as a key characteristic of the hydrogeological model. Concentrations of solutes of interest predicted to occur in surface water at 2019 (i.e. – peak concentrations assuming SMPB03 is turned off) and subsequent impacts on sensitive receptors is discussed in the Surface Water Section (Section 5.5).

5.4.4 Predicted Outcome

Groundwater quality will be temporarily altered from tailings seepage between TSF 1 and Fletcher Creek. There are no sensitive groundwater receptors that will be impacted by the temporary increase in solute concentrations in groundwater.

5.5 SURFACE WATER

Surface water quality is currently impacted by groundwater discharging into a section of Mine Creek (approximately located between WSF1 and SMMB01). Another minor discharge zone is apparent just downstream of the Mine Creek – Fletcher Creek confluence based on available surface water quality data. The Mine Creek zone is already subjected to recovery of seepages from WSF1 at the embankment toe and further downstream at recovery bore SMPB03.

5.5.1 Potential Impacts

Potential risks to surface water resulting from this Proposal include:

- Changes to surface water quality due to TSF 1 groundwater seepage expressing along part of Mine Creek and entering downstream watercourses with potential impacts to ecological receptors.
- Alteration to drainage lines and flow patterns from mine infrastructure during the operational phase and permanent redistribution of flows from the TSF 1 footprint to adjacent catchments.

- Erosion from high velocities where runoff is directed to local drainages through new spillways from the final TSF 1 landform and resulting increased sediment loads in the downstream watercourses arising from disturbed land and rehabilitated landforms.

5.5.2 Management and Mitigation

Impacts to surface water flows and quality will be minimised through implementation of the following management and mitigation measures:

- Continuing seepage minimisation activities below WSF 1 and along Mine Creek during the operational period.
- Seepage recovered during the operational period will continue to be recycled and used in the processing water circuit.
- Based on water quality predictions and analysis at the time of closure, seepage recovery bores may continue to be operated for a period during the closure phase while the water mound drains down.
- Seepage recovered during the closure phase will be discharged to the Savannah pit.
- Diversion of natural flows from the undisturbed upstream portion of the Mine Creek catchment into the lower section of Mine Creek to minimise solute concentrations in downstream surface water.
- Monitoring of surface water quality at locations along Mine Creek, Fletcher Creek and the Ord River (Commitment 15).
- Implementation of seasonal surface water trigger values at pre-determined locations (Commitment 16). Trigger values will be determined in consultation with DEC (Part V) as part of the Works Approval process.
- Where surface water trigger values are exceeded, this will result in a series of management responses which may include resampling and analysis of water quality, investigating the likely cause of the elevated concentrations and increasing seepage recovery operations (Commitment 17).
- Controlling the rate of runoff and erosion from the rehabilitated TSF 1 surface and spillways through appropriate design of a final landform with competent materials (refer to Section 7 for further details).

5.5.3 Impact Assessment

5.5.3.1 Surface Water Flows

TSF 1 retains all runoff captured within its catchment, while WSF 1 is retaining surface water runoff from the mine portal catchment. This is reducing the stream flows in Mine Creek downstream of WSF 1 as well as the duration of flood flows (hydroperiod) and flow velocities along a small section of Mine Creek. Construction in 2011 of the WSF 1 diversion embankment has directed surface water upstream of WSF1 to Mine Creek downstream of SMPB03 and further minimised the impact of the retained water.

No significant impacts to stream flow characteristics in Fletcher Creek downstream of its confluence with Mine Creek are expected. Diversion of a portion of the TSF 1 catchment (Cell1) to the north following closure will increase local flows and velocities in the local drainages, but should not result in any significant change to Stoney and Fletcher Creeks hydrology.

5.5.3.2 Surface Water Quality

Groundwater with elevated solute concentrations will continue to discharge to Mine Creek and Fletcher Creek during and shortly after the wet seasons due to seasonal rise in the water table. Surface water solute concentrations are predicted to increase slightly above existing levels due to higher rates of groundwater discharge as the water mound height beneath TSF 1 increases.

Table 10 provides a summary of predicted solute concentrations at different stages of the Savannah Project for current operations (year 2014), end of operations (year 2018), commencement of closure period (year 2019) and once steady-state conditions are predicted to prevail (2040). Surface water quality predictions are based on solutes that have accumulated in groundwater discharge zones during the dry season. The surface water concentrations are at their highest when the accumulated solutes are remobilised by the initial wet season runoff events, typically in October. Concentrations in surface water decrease as rainfall runoff continues to mix with, and remobilise residual solutes. By January, the majority of residual solutes are expected to have mixed with runoff, resulting in downstream concentrations that are close to background levels.

Table 10: Predicted Solute Concentrations in Surface Water

Year	Month	Peak Groundwater Discharge Zone in Mine Creek	Mine-Fletcher Creek Confluence	Groundwater Discharge Zone in Fletcher Creek	Fletcher Creek Above Ord River Confluence
Predicted Sulphate Concentrations (mg/L)					
2014	October	2,420	1,860	30	30
	January	170	160	30	30
2018	October	2,630	1,910	30	30
	January	170	160	30	30
2019	October	2,540	2,170	30	30
	January	170	170	30	30
2040	October	230	210	30	30
	January	140	140	30	30
Predicted Nickel Concentrations (mg/L)					
2018	October	0.015	0.011	<0.01	<0.01
	January	<0.01	<0.01	<0.01	<0.01
2019	October	0.014	0.013	<0.01	<0.01
	January	<0.01	<0.01	<0.01	<0.01
2040	October	<0.01	<0.01	<0.01	<0.01
	January	<0.01	<0.01	<0.01	<0.01
Predicted Copper Concentrations (mg/L)					
2018	October	0.025	0.018	<0.01	<0.01
	January	<0.01	<0.01	<0.01	<0.01
2019	October	0.024	0.021	<0.01	<0.01
	January	<0.01	<0.01	<0.01	<0.01
2040	October	<0.01	<0.01	<0.01	<0.01
	January	<0.01	<0.01	<0.01	<0.01

Note: Shaded cells equal to or below assumed baseline value

To provide a conservative assessment of seepage impacts to surface water, the modelling assumes that seepage recovery bore SMPB03 is turned off in 2018, resulting in peak concentrations in surface water in 2019.

Once surface water from Mine Creek joins with Fletcher Creek, concentrations are predicted to be reduced close to background levels within the mixing zone downstream of the confluence. Throughout the operational, closure and post-closure period, concentrations in Fletcher Creek (below the mixing zone) are predicted to remain within the natural variation of background levels. No measureable changes to Ord River water quality are expected to occur.

The most sensitive surface water receptor in the Savannah Project area is aquatic fauna. Potential impacts to aquatic fauna are discussed in Section 5.6. Other surface water receptors that have been identified in the Savannah Project area include vegetation, terrestrial fauna, avifauna and livestock. Studies undertaken as part of this Proposal have found that changes to surface water flows and quality will have a negligible effect on other receptors.

5.5.4 Predicted Outcome

The interaction between groundwater and surface water results in seasonal discharges of tailings seepage into surface water drainages downstream of the Savannah Project. Surface water solute concentrations in Mine Creek are predicted to increase slightly above existing levels. Concentrations in Fletcher Creek (below the mixing zone) are predicted to remain within the natural variation of background levels. No impacts to the Ord River are expected to occur. The risk to sensitive surface water receptors is considered low.

5.6 ECOLOGICAL RECEPTORS

Impacts to ecological receptors such as terrestrial and aquatic flora and fauna relate to surface water and groundwater impacts. Clearing of less than 10 hectares of vegetation will have negligible impacts on flora and fauna and does not warrant further assessment.

To assess potential ecological impacts associated with the Stage 2 TSF Amendment, MBS Environmental (2012) undertook an Ecological Assessment to identify the contaminants of concern, contaminant exposure pathways, contaminant toxicities and ecological receptors. This assessment is provided in Appendix 17 and incorporates the findings of URS (2012), RGS (2012) and WRM (2012).

Sulphate in seepage is the primary contaminant of concern under anoxic conditions (prevailing conditions in TSF 1). Nickel and other metals will not reach levels of toxicity that would be harmful to ecological receptors and as such, were assessed as secondary contaminants of concern.

Ecological receptors and values identified in the vicinity of the Savannah Project comprise:

- Cattle that access creek water or groundwater (bore water) for drinking.
- Aquatic fauna in creeklines.
- Riparian vegetation.
- Larger transient fauna such as birds and marsupials.
- Amphibious fauna such as frogs, turtles and freshwater crocodiles.
- Vegetation affected by impacted groundwater and surface water.
- Humans, heritage and social values.

Aquatic fauna are the most sensitive receptor group to elevated sulphate concentrations and are therefore used as the primary indicator of ecological impacts.

5.6.1 Potential Impacts

Potential impacts to ecological receptors comprise:

- Temporary loss or population reduction of some aquatic invertebrate species as a result of osmotic stress, due to increases in salinity (caused by soluble sulphate salts) and other changes in water quality.
- Localised mounding associated with a solute plume may result in inundation of plant roots in the vicinity of TSF 1.
- Ingestion of water sources contaminated with TSF 1 solute plume from groundwater/surface water interactions, or from contaminated surface waters.
- Dermal contact with water sources associated with the Savannah site. This pathway is most relevant to semi-aquatic species such as birds, reptiles and amphibians.
- Fauna may also be impacted indirectly if the health of vegetation providing habitat deteriorates.

5.6.2 Management and Mitigation

In addition to measures implemented to manage impacts to surface water and groundwater, the following management measures will be implemented to monitor ecosystem health:

- Continuation of aquatic fauna monitoring in Fletcher Creek (Commitment 18).
- Investigation of annual and seasonal variation in water quality and aquatic faunal communities and the consistency of any patterns observed.
- Implementation of ecological trigger values at pre-determined locations (Commitment 19). Trigger values will be determined in consultation with DEC (Part V) as part of the Works Approval process.
- Where ecological trigger values are exceeded, this will result in a series of management responses which may include resampling and analysis of water quality, sampling for aquatic fauna, investigating the likely cause of the elevated concentrations and increasing seepage recovery operations (Commitment 20).
- Continued periodic review and update of the Savannah Water Operating Strategy to reflect relevant changes (Commitment 21).

5.6.3 Impact Assessment

The Ecological Assessment and Aquatic Fauna studies (WRM 2012) concluded:

- Elevated sulphate concentrations recorded to date have not significantly affected the aquatic ecosystems of Fletcher Creek. Predicted solute concentrations and subsequent osmotic stress is not likely to adversely affect aquatic fauna species in the Fletcher Creek, allowing 95% protection of species to be maintained. Aquatic fauna in Mine Creek will be temporarily impacted by elevated solute concentrations.
- The majority of larger terrestrial fauna within the region are unlikely to be adversely affected by increased sulphate levels due to their body mass and range. However, smaller, more sensitive animal groups with a lower range, such as amphibians, are considered to be more susceptible.
- Vegetation is unlikely to be adversely affected by the concentration of sulphate as predicted to occur in the solute plume. Mounding associated with the solute plume may result in inundation of plant roots in the vicinity of the tailings storage facilities. The natural variation of ecosystems in

the Kimberley as a result of extreme wet and dry fluctuations and subsequent adaptation of ecosystems to these conditions, make it unlikely that the vegetation will be affected by predicted changes in groundwater levels (as is currently observed on site).

- Human, social and cultural values are unlikely to be adversely affected by sulphate seepage.
- Livestock are considered to be the least sensitive receptor group and are unlikely to be adversely affected by sulphate seepage.

5.6.4 Predicted Outcome

Aquatic fauna in Fletcher Creek have been identified as the most sensitive ecological receptor for the Savannah Project. Elevated sulphate concentrations in surface water recorded to date have not significantly affected the aquatic ecosystems of Fletcher Creek. While elevated concentrations are predicted to occur in Mine Creek, sulphate values are predicted to remain low in Fletcher Creek due to the volume of wet season flows received annually in this system, with no predicted impacts on the Ord River. Predicted solute concentrations and subsequent osmotic stress is not likely to adversely affect aquatic fauna species, allowing 95% protection of species to be maintained in Fletcher Creek.

Any reduction in aquatic fauna diversity resulting from Savannah seepage and/or natural phenomenon (i.e. – a sequence of consecutive dry wet seasons) is mitigated by the presence of recruitment sources (i.e. downstream drift of invertebrates and upstream migration by fish), which allow populations of more 'sensitive' species in Fletcher Creek to recover seasonally. There will be low impacts to other less sensitive ecological receptors.

5.7 TOPSOIL AND SOIL PROFILES

5.7.1 Potential Impacts

Clearing of less than ten hectares of vegetated land requires disturbance to topsoil and soil profiles. Topsoil and soil profiles will also need to be stored for later use in rehabilitation. This can impact on seed viability and health of soil biota, and if incorrectly managed will inhibit rehabilitation and establishment of vegetation following cessation of mining.

5.7.2 Management Measures

All available topsoil will be stripped from all areas requiring clearing and stored locally in a designated area for later use in rehabilitation. Topsoil stockpiles will be limited to a maximum of two metres in height to minimise erosion and the deterioration of soil structure, valuable organic matter and seeds. Subsoils and topsoils will be stockpiled separately to ensure optimal use of the seed bank present in topsoil.

Cleared vegetation will also be stockpiled. Access to stockpiles will be restricted to minimise potential for contamination or introduction of weeds.

At the completion of mining activities, or where practical, progressively throughout mining activities, stockpiled topsoil and vegetation will be spread over disturbed areas to act as a seed source, mulch to protect the soil from erosion and habitat for fauna.

5.7.3 Predicted Outcome

This Proposal will result in minimal amounts of disturbance to soil profiles. It is anticipated that adequate volumes of soil will be available for rehabilitation of disturbed areas. Further information on rehabilitation material quantities is provided in the Mine Closure Plan (Appendix 16).

5.8 DOMESTIC AND INDUSTRIAL WASTE PRODUCTS

There are no new domestic or industrial waste products to be generated from this Proposal. Waste products will be disposed of as detailed in NOI 4099.

5.9 DANGEROUS GOODS AND HAZARDOUS SUBSTANCES

There are no new dangerous goods, hazardous substances or hydrocarbons associated with this Proposal. Fuel and other dangerous substances will be stored and used as detailed in NOI 4099.

5.10 ATMOSPHERIC POLLUTION AND NOISE

There are no new atmospheric pollution or noise issues associated with this Proposal. Dust or noise potentially generated during construction of the TSF 1 raise will be managed in accordance with existing site procedures.

5.11 SUMMARY OF MANAGEMENT COMMITMENTS

A number of commitments to prevent or minimise adverse environmental impacts have been made throughout this document. These are summarised below in Table 11.

Table 11: Summary of Environmental Management Measures and Commitments

Environmental Impact	Management Measure/Commitments	Implementation Timelines	Performance to Date*
TSF 1 Integrity			
• The Proposal will result in a six metre increase to the facilities main embankment and construction of three new saddle embankments. All studies indicate that TSF1 meets design, construction and operational criteria for the safe and permanent storage of tailings.	• Construction of the main and saddle embankments to standards required for the highest hazard rating (Category 1) facilities with supervision by qualified personnel. • Design, construction and operation of TSF 1 with allowance of adequate freeboard during a 1 in 100 year ARI 72 hour storm event with excess water removed from the facility via a weir during operations. • Design of the weir to accommodate surface water flow resulting from a PMP event. • Armouring the weir with suitable materials to reduce the development of erosion rills and gullies. • Locating the decant pond within the	Construction Design Design Construction Design/Operations	Described in the Annual Geotechnical Audit. Demonstrated stability of structure.

Environmental Impact	Management Measure/Commitments	Implementation Timelines	Performance to Date*
	central layout of Cell 2 to reduce saturation of tailings and build-up of free standing water adjacent to the main and saddle embankments. • Regular monitoring of embankment prisms for movement and measurement of the decant water level. • Annual analysis of particle size distribution of tailings. • Continuation of the Annual Audit and Management Review of TSF 1.	Operations Operations Operations/Closure	
Tailings Geochemistry			
• Savannah tailings produces seepage that is elevated in sulphate with low concentrations of soluble metals/metalloids.	• Continuation of current tailings discharge methods which are effective in maintaining anoxic (reducing) conditions within the bulk tailings profile below the hardpan surface. • Construction of an engineered cover using the store-and-release concept to further enhance the long-term maintenance of anoxic conditions.	Operations Closure	No AMD recorded in nine years of operating.
Groundwater			
The Proposal will result in the continuation of the groundwater conditions including elevated sulphate and nickel concentrations and water mounding in the vicinity of TSF 1.	• Continued operation of seepage recovery bores and sumps to retard the advance of the groundwater mound downstream during the operational phase. • Groundwater quality and levels will continue to be monitored in accordance with the Savannah Water Operating Strategy. Where an upward trend in solute concentrations is detected, this will trigger a management response which may include resampling and analysis of water quality, investigating the likely cause of the elevated concentrations and increasing seepage recovery operations.	Operations Operations	Groundwater impacted by tailings seepage, however, no sensitive groundwater receptors impacted.
Surface Water			
• The Proposal will result in the continuation of the elevated sulphate concentrations in surface water.	• Monitoring of surface water quality at locations along Mine Creek, Fletcher Creek and the Ord River. • Implementation of seasonal surface water trigger values at pre-determined locations. • Where trigger values are	Operations Prior to construction/implementation of this proposal.	Elevated sulphate concentrations recorded in Mine Creek.

Environmental Impact	Management Measure/Commitments	Implementation Timelines	Performance to Date*
	exceeded, this will result in a series of management responses which may include resampling and analysis of water quality, investigating the likely cause of the elevated concentrations and increasing seepage recovery operations.	Operations	
Ecological Receptors			
Predicted solute concentrations and subsequent osmotic stress is not likely to adversely affect aquatic fauna species, allowing 95% protection of species to be maintained in Fletcher Creek.	• Continuation of aquatic fauna monitoring in Fletcher Creek. • Implementation of ecological trigger values at pre-determined locations. • Where trigger values are exceeded, this will result in a series of management responses which may include resampling and analysis of water quality, sampling for aquatic fauna, investigating the likely cause of the elevated concentrations and increasing seepage recovery operations. • Continued periodic review and update of the Savannah Water Operating Strategy to reflect relevant changes.	Operations Prior to construction/implementation of this proposal. Operations Operations Operations	95% protection of species maintained in Fletcher Creek.
Clearing			
Clearing of 10.5 hectares of native vegetation.	• All available topsoil will be stripped from surfaces that will be disturbed and stored for rehabilitation. Wherever practicable, the duration that topsoil is stockpiled will be minimised to reduce the loss of seed viability and soil biota. • Vegetation will be established, where practicable, on disturbed areas following completion of mining activities.	Construction preparation Construction preparation Closure	Reported in AER.
Stakeholder Consultation			
The proposal does not present any negative impacts to surrounding land uses and community.	• Consultation with key stakeholders will continue throughout the LOM to ensure an inclusive approach to operations and mine closure.	LOM	Panoramic have demonstrated a strong commitment to stakeholder engagement.
Closure and Rehabilitation			
The Proposal will result in an amendment to the approved long-tern tailings storage strategy.	• All closure activities associated with the TSF 1 Closure Domain will be implemented in accordance with the Stage 2	Operations and Closure	Progress will be reported in the AER.

Environmental Impact	Management Measure/Commitments	Implementation Timelines	Performance to Date*
	TSF Amendment Mine Closure Plan.		
	• Reducing the risk of material segregation during cover placement will be achieved by implementing a quality assurance and quality control (QA/QC) system during material selection and cover system construction in order to achieve the designed final landform.	Rehabilitation earthworks	
	• A cover system field trial will be established in Cell 1 as TSF 1 is progressively closed. Performance of the field trial will be monitored for a minimum of three years before proceeding to cover system construction over the remaining TSF 1 footprint.	Operations	
	• A weather station that meets Australian Standards (AS 2922-1987 & AS 2923-1987) for ambient air monitoring will be installed at the Savannah site in 2012.	Operations	
	• A two phased approach to monitoring is proposed as follows: – Phase 1: Monitoring undertaken until completion criteria are achieved. – Phase 2: Continuation of monitoring for an agreed period to reinforce stability of the system	Closure	
	• In the event that Phase 1 and/or Phase 2 closure monitoring indicates that monitoring will be required beyond the current tenement expiry dates, Panoramic commits to seeking renewal of the relevant tenements one year prior to the expiry date.	Closure	

* to be completed as a component of the AER compliance review

6. SOCIAL IMPACTS

6.1 HERITAGE

In consultation with the Kimberley Land Council, the Savannah Co-existence Agreement was signed with the Project's Traditional Owners in November 2007. The Co-existence Agreement was established to set up a long-term, mutually beneficial way forward by providing recognition and continued protection of cultural heritage sites of significance as well as procedures and mechanisms for ongoing consultation between parties. The consultative process undertaken during the work on this Agreement has established a vital partnership between SNM, the Projects Traditional Owners and the Kimberley Land Council.

This Proposal does not raise any issues relating to Native Title or Aboriginal Heritage.

6.2 LAND USE AND COMMUNITY

The Savannah Project is located on Mabel Downs Pastoral Lease, an active pastoral station, which is operated by Yeeda Pastoral Company. SNM has developed a strong relationship with the pastoral company and has also previously held discussions with the Pastoral Lands Board covering the post-closure status of the Project.

A Travellers and Stock Reserve (No.2263) vested in the Department of Lands encompassing an area of 2,424 hectares underlies M80/179 and the northern part of M80/180. The reserve is a resting place for travellers and stock. The reserve was gazetted in 1901, is unfenced and is integrated within the pastoral area of Mabel Downs Station.

This Proposal presents changes to the site water management which is designed to result in an overall improvement to the post-closure land use.

Consultation with key stakeholders will continue throughout the LOM to ensure an inclusive approach to operations and mine closure (Commitment 22).

Based on assessment of potential impacts and consideration of mitigation measures to control impacts, this Proposal does not present any negative impacts to surrounding land uses and community.

Implementation of this Proposal will allow continuation of the Savannah Mining operation beyond 2012, which has a current workforce of approximately 165 people on site and additional support staff (approximately 30 employees) in the Panoramic Perth office.

6.3 STAKEHOLDER CONSULTATION

Extensive stakeholder consultation associated with this Proposal has been undertaken since 2008. A list of all meetings held are provided in Table 12.

Table 12: Summary of Meetings and Site Visits Held

Date	Present	General Comments
28 May 08	• DoW. • DMP. • Panoramic.	• A referral to the EPA would be needed to determine level of assessment. • An amendment to current Mining Proposal would be required.
27 August 08	• EPA Chairman. • EPA Manager of Mining and Industrial. • MBS. • Panoramic.	• Introduction of the project. • Signal the company's intention for a long-term presence in the Kimberley.
1 September 08	• DEC Industry Regulation Regional Leader - Kimberley. • Panoramic.	• Introduction of the project. • Signal the company's intention for a long-term presence in the Kimberley.
14 October 08	• DoW - Kununurra. • URS - Senior Hydrogeologist. • MBS. • Panoramic.	• Introduction to project. • Panoramic requested feedback on referral. • Offered site visit.
20 October 08	• SNM Implementation and Review Committee (IRC). • Traditional Owners. • Panoramic.	• SNM IRC's role is to oversee the Savannah Co-existence Agreement. • Background on proposal. • Information on consultation process.
13 November 08	• DoW - Kununurra. • Panoramic.	• DoW provided feedback on EPA referral and will provide written documents.
17 November 08	• EPA Manager of Mining and Industrial. • MBS. • Panoramic.	• Discussion on EPS process. • Assessment must be "risk based". • Main report to be short, detail to be in appendices. • Peer reviews where appropriate.
19 November 08	• Hon Norman Moore - Minister for Mines and Petroleum. • Panoramic.	• Presentation on Panoramic Resources. • Overview of Panoramic and the TSF proposal.
20 November 08	• Conservation Council of WA. • Panoramic.	• Overview of Panoramic and the TSF proposal. • Offered site visit.
26 November 08	• Hon. Dr Kim Hames - Minister for Indigenous Affairs. • Mrs Carol Anne Martin MLA - Member for Kimberley. • Panoramic.	• Presentation on Panoramic Resources. • Overview of Panoramic and the TSF proposal.

Date	Present	General Comments
8 December 08	• Kimberley Land Council. • Panoramic.	• Presentation on Panoramic Resources. • Overview of Panoramic and the TSF.
9 December 08	• Environs Kimberley (Broome). • Panoramic.	• Presentation on Panoramic Resources. • Overview of Panoramic and the TSF. • Offered site visit.
17 February 09	• Environs Kimberley (Savannah site visit). • Panoramic.	• Queries on topsoil for final landform. • Water quality sample collection timetable. • Feasibility of artificial wetlands. • Cross-catchment effects of TSF.
1 July 09	• OEPA. • Panoramic.	• Meeting to discuss the EPS assessment process and associated timeframes moving forward.
15 January 10	• OEPA. • DMP. • DoW. • Panoramic. • MBS. • O'Kane Consults and RGS (Conference call).	• Queries regarding long-term stability of TSF cover and potential for long-term leakage emanating from the TSF. • Request for post-closure contingencies to be developed. • Queries relating to the TSF field based monitoring trial.
3 February 10	• EPA Chairman. • Panoramic. • MBS.	• Summarised overview and update of the TSF amendment proposal, key characteristics and environmental outcomes.
7 April 10	• DMP. • Panoramic. • MBS.	• Queries on the Risk Assessment process. • Heavy metal leachate validation. • Post-closure management (up to relinquishment).
8 April 10	• DMP – Resource Safety Branch. • Panoramic. • MBS.	• Queries relating to geotechnical designs. • Details provided on spillway design.
16 June 2010	• Acting EPA Chairman. • OEPA. • Panoramic.	• Request that an alternate tailings management strategy be developed due to DMA concerns regarding the TSF Amendment Proposal.
18 June 2010	• Acting EPA Chairman. • OEPA. • Panoramic. • MBS.	• Meeting to discuss DMA concerns, revised tailings strategy and requirement for a briefing document.

Date	Present	General Comments
13 July 2010	• OEPA. • DEC. • DMP. • DoW. • Panoramic. • MBS.	• Meeting to brief key agencies on a Stage 1 and Stage 2 tailings management strategy. Briefing document provided. • DMAs provided comments on proposed strategy and information that would be required for approval.
19 July 2010	• DEC. • Panoramic. • EPA.	• Meeting to discuss key issues to be addressed in DEC Works Approval, specifically: – Water management. – Seepage Control. – TSF 1 raise.
2 August 2010	• DMP. • Panoramic. • MBS.	• Meeting to discuss key issues to be addressed in DMP Mining Proposal, specifically:
11 – 12 August 2010	• EPA Chairman, Paul Vogel. • EPA board member, Dennis Glennon. • OEPA. • Panoramic. • MBS.	• Site visit to familiarise EPA with site and further discuss Stage 1 proposal and other long-term tailings options. • Presentation on Savannah tailings.
17 – 18 August 2010	• DEC (Part V). • DMP. • Panoramic.	• Site visit. • Discussion of Stage 1 proposal.
2 November	• DEC (Steve Appleyard).	• Discussion with Panoramic regarding geochemistry.
3 – 4 November 2011	• DEC (Part V). • DEC (Environmental Management Branch). • DMP (Safety Branch). • DMP (Environment Branch). • DoW. • OEPA. • Panoramic. • Panoramic specialist consultants.	• Regulator Workshop: Two day workshop assessing TSF options.
21 November 2011	• DMP. • Panoramic. • MBS.	• Meeting to discuss workshop outcomes and assessment pathway.
23 November 2011	• DEC (Part V). • Panoramic. • MBS.	• Meeting to discuss workshop outcomes and assessment pathway.

Date	Present	General Comments
16 December 2011	• EPA Chairman, Paul Vogel. • OEPA. • Panoramic. • MBS.	• Meeting to discuss assessment pathway.
21 March 2012	• SNM Co-Existence Agreement Implementation Review Committee.	• Meeting to present summary of Stage 2 Assessment proposal and discuss assessment pathway.
19 March	• DMP Safety Branch. • DMP (Environment Branch).	• Meeting to discuss geotechnical aspect of the TSF 1 Raise. • Conference call to discuss Project referral and agency issues.
30 March 2012	• DMP (Environment Branch).	• Meeting to present details on MCP Monitoring Program.
May 2012 (date to be finalised)	• Kimberley Land Council. • Environs Kimberley (Broome).	• Meeting to present summary of Stage 2 Assessment proposal and discuss assessment pathway.

6.4 KEY CONSULTATION ASSOCIATED WITH TSF 1

6.4.1 EPA Site Visit

In August 2010, the Chairman of the EPA, Dr Paul Vogel, EPA Board Member, Dr Dennis Glennon, and OEPA Principal Environmental Officer, Mr Tim Gentle, visited the Savannah Project and, following a tour of the site, discussed the tailings storage options available to. It was agreed that Panoramic would review all tailings storage options and present the findings at a combined agency and proponent workshop for further assessment. It was further suggested that Dr Roy Green (a former EPA Board member) act as an independent chair and provide an objective view of the outcomes of the workshop and process to the EPA.

6.4.2 Internal TSF Options Assessment Workshop

To assist in determining a suitable tailings storage solution, Panoramic undertook an internal TSF Options Assessment that relatively ranked 14 tailings storage options using a non-parametric (ranking) assessment process. The internal workshop was held over two days in August 2011 and facilitated by Donna Pershke (URS). As a component of the assessment process, consideration was given to the environmental and social impacts associated with each option in both the operational and closure phases. An independent review of this process was undertaken by Bill Biggs of Biggs and Associates. The report is provided in Appendix 18. The top four options ranked by this assessment process were the focus of further discussion at the Stage 2 Agency Workshop in November 2011.

6.4.3 Agency Workshop

A combined agency workshop was held over two days in November 2011, and was chaired by Dr Roy Green and facilitated by Donna Pershke (URS). The first part of the workshop entailed a series of technical presentations relevant to considering the TSF options. During the technical presentations, questions were raised and addressed through discussion with the relevant specialists. Bill Biggs, as the assessing officer of the original proposal (2003), provided a background summary of the decision-making process that occurred in relation to the agreed closure strategy for TSF 1.

The second part of the workshop entailed a session which asked the agency representatives to identify:

- Any remaining questions or points of clarification that needed to be addressed.
- Concerns regarding issues or risks associated with the tailings storage options presented for discussion.
- Any perceived data gaps.

A report detailing the findings of the Agency Workshop is provided in Appendix 19.

7. MINE CLOSURE

7.1 MINE CLOSURE PLAN

A Mine Closure Plan (MCP) has been prepared to support the Stage 2 TSF Amendment Mining Proposal and is provided in Appendix 16. The MCP was prepared to assist Panoramic in closing TSF 1 in a manner that meets statutory closure obligations such that there is no unacceptable liability to the State of Western Australia. It provides details of the activities and resources required for closure of the Savannah Project, with particular emphasis on closure associated with the TSF 1 Closure Domain which comprises TSF 1 and the eastern slope of the NWRD. A MCP for the whole of site will be submitted in October 2012 as part of the Annual Environmental Report (AER) submission.

The above approach was decided and agreed upon with DMP as a 'whole of site' MCP for the Savannah Project is required for submission in October 2012 as part of the Annual Environmental Report (AER) submission.

The scope and structure of the MCP is as follows:

Section 1: Outlines the scope and purpose of the MCP.

Section 2: Provides an overview of the history and status of the project, including land ownership, tenure, location, and an overview of the operations and main infrastructure components.

Section 3: Summarises the legal obligations and specific legally binding closure commitments relating to Savannah Project, with reference to the appended closure obligations register.

Section 4: Provides environmental data relevant to closure, including a summary of baseline studies completed prior to project commencement and throughout operations. This includes information on the climatic conditions, geology, soils, waste and tailings characterisation, hydrogeology, hydrology, flora and fauna, social environment, rehabilitation and closure studies and key knowledge gaps. A brief discussion of how these aspects impact on closure strategies is provided.

Section 5: Describes the process used to identify stakeholders relevant to mine closure, lists the stakeholders identified and provides a summary of how each has been, and will continue to be, consulted in relation to mine closure.

Section 6: Outlines the risk assessment process for identifying the key closure issues, and provides a summary of identified key risks and management measures.

Section 7: Identifies the post-mining land use and closure objectives based on the proposed land use.

Section 8: Describes the development of site-specific completion criteria by which success of closure will be measured.

Section 9: Describes the process, methodology and assumptions used to estimate the closure financial provision.

Section 10: Provides a closure implementation plan, that includes (i) high level planned, unplanned and care and maintenance closure scenarios, (ii) overview of Closure Domains, (iii) work programs for the TSF 1 Closure Domains (iv) high level closure milestones and schedules for research.

Section 11: Describes the proposed environmental monitoring program and maintenance response requirements.

Section 12: Provides a description of how closure relevant information and data will be managed during ongoing closure planning and implementation.

All closure activities associated with the TSF 1 Closure Domain will be implemented in accordance with the Stage 2 TSF Amendment Mine Closure Plan (**Commitment 23**). A summary of the key components of the MCP for the Stage 2 TSF Amendment is provided in the following sub-sections.

7.2 CURRENT CLOSURE STATUS

Under NOI 4099 all tailings produced throughout the LOM are to be stored in TSF 1. Three options for closure were provided in NOI 4099 including:

- Relocation of tailings to an environmentally acceptable location.
- Installation of an engineered cover.
- Installation of a store-and-release (ecological) cover.

Based on the understanding of tailings geochemistry and hydrogeology at the time of the assessment, DMP in consultation with Panoramic determined that at closure, tailings should be returned to the completed mine workings (pit void and underground). The requirement to relocate tailings to the pit included a water cover to prevent oxidation of the tailings.

Based on an improved understanding of the tailings geochemistry, hydrogeological characteristics of the site and resources available for use in rehabilitation, Panoramic propose to amend the long-term closure strategy at Savannah by leaving tailings in TSF 1 *in-situ* at closure, with installation of an engineered cover.

7.3 POTENTIAL CLOSURE RISKS

Potential risks to successful rehabilitation and closure of TSF 1, comprise:

- Failure of the engineered cover due to:
  - Excessive differential settlement and consolidation of the cover and/or tailings.
  - Impeded drainage on the rehabilitated TSF 1 surface.
  - Erosion of the cover.
  - Erosion of spillways.
  - Deep rooted vegetation/biological activity on the cover allowing increased infiltration of oxygen and water.
- Poor quality control during construction leading to segregation of cover materials.
- Increased sediment loads from the cover entering downstream surface waters.

- Erosion of the NWRD with potential siltation of the toe drain.
- Inadequate sizing of the spillways could result in restricted or impeded runoff with silting of flow paths. This could result in localised ponding on the rehabilitated TSF 1 surface adjacent to the spillways.

7.4 CLOSURE STUDIES

O'Kane Consultants was commissioned to assist in the development of a final landform design and closure plan for TSF 1. This study comprised:

- Materials Characterisation.
- Landform Design.
- Soil-Plant-Atmosphere Modelling.
- Seepage and Consolidation Modelling.
- Cover Failure Modes and Effects Analysis.
- Vegetation Literature Review.

The full report is provided in Appendix 20

Landloch was commissioned to assess the erosion and stability characteristics of the proposed store-and-release cover, including:

- The stability of various materials that could be used.
- The depth of material placement.
- Slope gradient responses.
- Slope length responses.
- Key drainage network features.

The full report is provided in Appendix 21.

7.5 MANAGEMENT OF CLOSURE ISSUES

7.5.1 Design

7.5.1.1 TSF 1

TSF 1 has been designed and constructed with factors of safety that exceed the corresponding recommended minimum factors of safety in ANCOLD long-term (permanent) storage of tailings.

7.5.1.2 TSF1 Cover

Reducing the risk of erosion of the TSF 1 cover material will be achieved through implementation of the following design considerations:

- Use of cover system based on the moisture store-and-release concept to capture and store incidental rainfall events, with runoff occurring during larger, high intensity wet season rainfall events. Soil atmosphere modelling determined the optimal design to comprise 0.3 metre non-compacted soil/waste rock mix overlaying two metres of non-compacted waste rock design (Figure 13).
- Adoption of a two-cell configuration (with three catchments) to reduce runoff flow path lengths and differential settlement through longer use of the decant structure currently in operation (Figure 14).
- Low surface flow gradients (taking into consideration the length of the flow path) for the final landform surface to reduce the flow energy of runoff.
- Identification of adequate sources of suitable materials during operations for use in the cover.
- Construction of an engineered toe-drain at the base of the NWRD slope to capture and redirect runoff away from the TSF 1 surface.
- Mixing growth medium (topsoil/subsoil) with benign waste rock to provide additional stability to the landform.

Figure 13: TSF 1 Cover Design

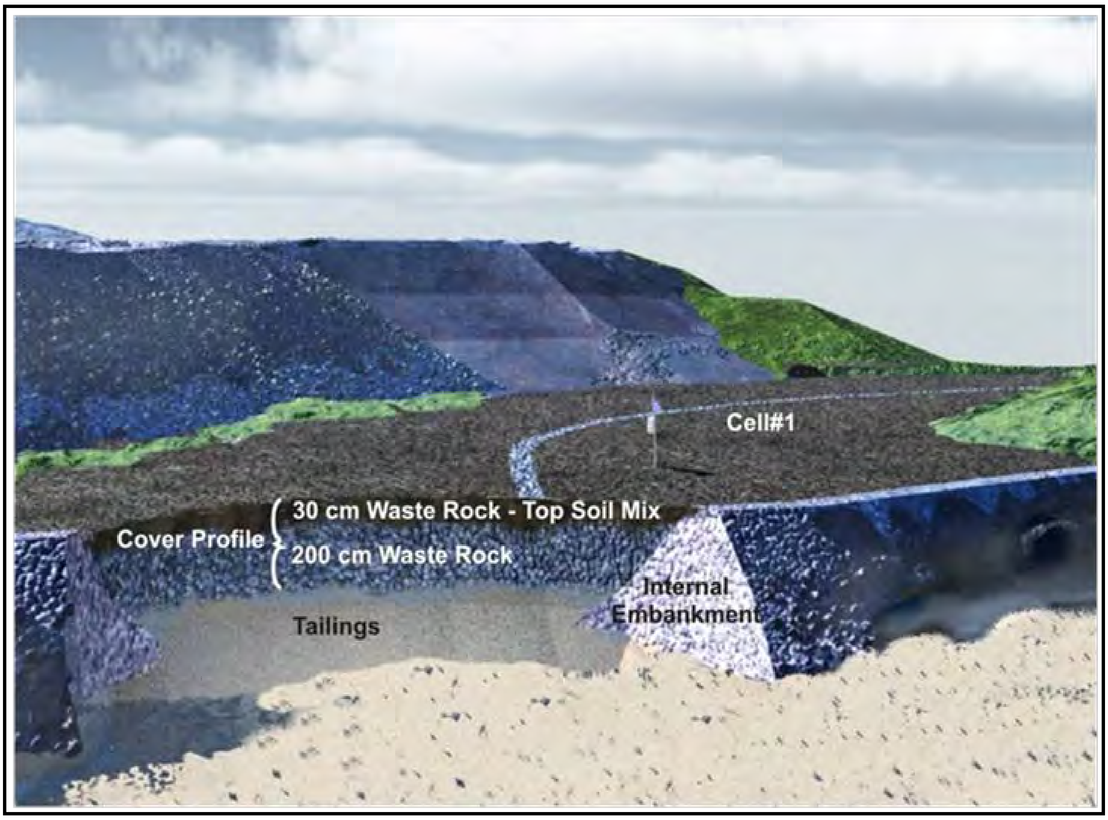
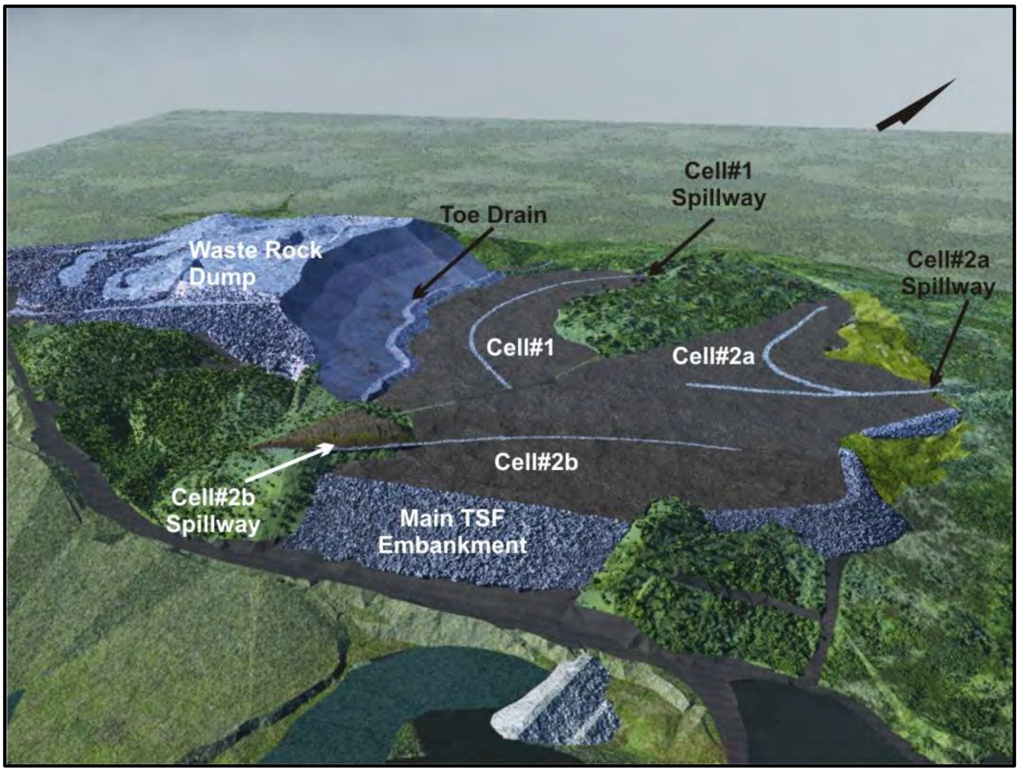


Figure 14: TSF 1 Closure Catchment Configuration



7.5.1.3 North Waste Rock Dump

Waste rock from the NWRD will be used to construct the TSF 1 cover. Following excavation of this material, the NWRD will be reshaped and rehabilitated. Reducing the risk of erosion of the NWRD and associated sediment deposition in the toe-drain will be achieved through implementation of the following design considerations:

- Developing a slope face based on modelled data such that erosion rates are low.
- Constructing an adequately sized toe-drain to accommodate predicted runoff and sediment from the NWRD slope.
- Armouring of the toe-drain with suitable material to minimise erosion.
- Incorporation of a north-south divide in the NWRD toe drain design, thus diverting flow to the north and to the south.

7.5.1.4 Spillways

The risk of erosion and siltation of spillways will be minimised by:

- Implementing design measures for the rehabilitated TSF 1 surface and adjacent NWRD slope landform to reduce the potential for erosion and the amount of sediment reporting to the spillways.
- Design of spillways to accommodate surface water flow from a probable maximum precipitation event (PMP) (i.e.: a minimum 1 in 100 year average recurrence (ARI) interval 72 hour duration (340 millimetres)) rainfall event.
- Locating spillways through natural, competent landforms that are resistant to water erosion and armouring, as necessary, with suitable materials to reduce the development of rills and gullies.

7.5.2 Construction

Reducing the risk of material segregation during cover placement will be achieved by implementing a quality assurance and quality control (QA/QC) system during material selection and cover system construction in order to achieve the designed final landform (Commitment 24). This will include frequent material sampling and *in-situ* field testing during the cover construction to ensure material heterogeneity is adequately constrained.

7.5.3 Research

7.5.3.1 Field Trial

A cover system field trial will be established in Cell 1 as TSF 1 is progressively closed. Performance of the field trial will be monitored for a minimum of three years before proceeding to cover system construction over the remaining TSF 1 footprint (Commitment 25). Field data obtained will also be used to:

- Calibrate the original numerical model developed in the design phase in order to improve the confidence in the predicted long-term average net percolation rate for the TSF 1 cover system.
- Assess consolidation and settlement of tailings, draindown rates, erosion, vegetation establishment and behaviour, catchment characteristics and seepage quality.
- Refine the cover system design, if required.

7.5.3.2 Weather Station

A weather station that meets Australian Standards (AS 2922-1987 & AS 2923-1987) for ambient air monitoring will be installed at the Savannah site in the third quarter of 2012 (Commitment 26). The weather station sensors will measure:

- Wind speed.
- Wind direction.
- Relative humidity (electronic).
- Air temperature.
- Rainfall.
- Solar radiation.
- Barometric pressure.

The selection of sensors will provide enough information to determine evaporation for the site.

This information will used to refine model predictions and design concepts.

7.5.4 Completion Criteria and Monitoring

Completion criteria will be developed to ensure closure objectives are met. These criteria will be refined over the remaining LOM. A closure monitoring program will be initiated to:

- Establish long-term rehabilitation success.
- Identify the need to amend rehabilitation procedures.

- Identify maintenance and remedial measures as required.
- Determine attainment of the completion criteria.

A two phased approach to monitoring is proposed as follows:

- Phase 1: Monitoring undertaken until completion criteria are achieved.
- Phase 2: Continuation of monitoring for an agreed period to reinforce stability of the system (Commitment 27).

The following post rehabilitation indicators will be monitored:

- Erosion and drainage characteristics of the rehabilitated TSF 1 and NWRD landforms.
- Consolidation and seepage rates.
- Vegetation establishment, diversity and survival.
- Surface water quality.
- Groundwater quality.
- Aquatic fauna health and diversity.

The Savannah Project tenement boundaries cover a large area and will facilitate closure monitoring under the *Mining Act 1978*. Table 13 lists the tenements and describes the key features covered in relation to planned closure monitoring associated with the TSF 1 Closure Domain as well as the respective tenement expiry dates.

Table 13: Tenement Details for Closure Monitoring

Tenement ID	Features Covered by Tenement	Expire Date
M80/179	• Stoney Creek	15 June 2029
M80/180	• Rademy Spring • Stoney Creek • Upper Fletcher Creek • TSF 1 • NWRD	15 June 2029
M80/181	• Upper Fletcher Creek • TSF 1 • NWRD • EFA Analogue Site	15 June 2029
L80/64	• Mine Creek • Fletcher Creek (extending approximately two kilometres downstream of the confluence of Mine Creek)	1 March 2033

In the event that Phase 1 and/or Phase 2 monitoring indicates that monitoring will be required beyond the current tenement expiry dates, Panoramic commits to seeking renewal of the relevant tenements one year prior to the expiry date (Commitment 28).

7.6 IMPACT ASSESSMENT

The proposed final landform design is based on site-specific climatic data and materials characterisation. Numerical modelling using the site-specific data for a final cover system design provides a basis for material selection and design features required for optimal surface water management. Consolidation and seepage analysis as well as landform evolution modelling validates the final landform design.

Soil-Plant-Atmosphere modelling of the cover system indicates that residual saturation of tailings will be maintained at levels that inhibit the speed of downward movement of the oxidation front through the TSF 1 profile, meaning that in the long-term, there is negligible chance of acid generation from the facility.

Landform and erosion modelling utilised for design of the cover was simulated for 1000 years "bare" surface conditions on the covered TSF (i.e. no vegetation, to be conservative), with predictions indicating that the cover remains intact and stable for that period with the maximum point of erosion anywhere on the structure significantly less than the depth of the cover during the simulation time frame (as demonstrated in Figure 15 and Figure 16).

Figure 15: Elevations of TSF 1 Landform and Surrounding Slopes Following Construction of Cover (2 Metre Contour Interval)

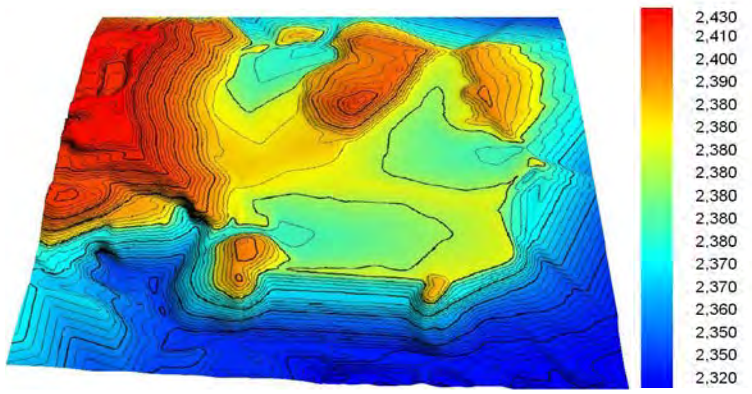
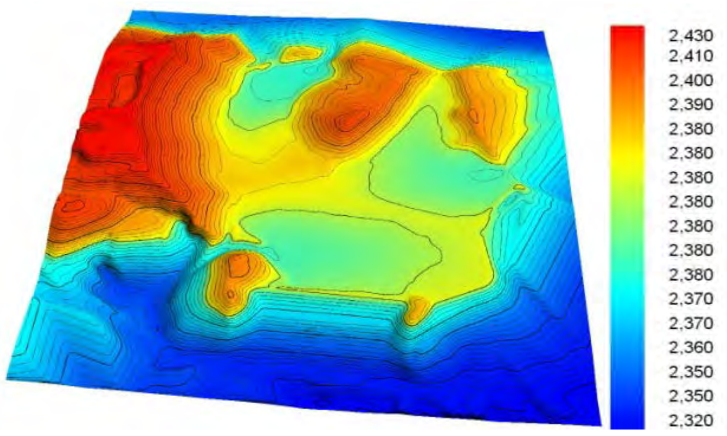


Figure 16: Evolved Elevations of TSF 1 Landform and Surrounding Slopes After 1000 Years (2 Metre Contour Interval)



The conservative nature of the design allows for variance in the performance of the cover such that the potential changes in net percolation, seepage water volume and quality remain within design tolerances and targets. Refinement of the cover design during operations (i.e. – from the TSF 1 trial) will ensure the optimal cover is constructed at closure.

7.7 PREDICTED OUTCOME

The closure plan for TSF 1 and supporting studies provides confidence that Panoramic will be able to close, decommission and rehabilitate TSF 1 in an ecologically sustainable manner, consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State of Western Australia.

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APPENDICES

APPENDIX 1:
TENEMENT CONDITIONS

(UPLOADED TO DMP ENVIRONMENTAL ASSESSMENT AND REGULATORY SYSTEM (EARS ONLINE)

APPENDIX 2:
ENVIRONMENTAL LICENCE

(UPLOADED TO DMP ENVIRONMENTAL ASSESSMENT AND REGULATORY SYSTEM (EARS ONLINE)

APPENDIX 3:
GROUNDWATER LICENCE

(UPLOADED TO DMP ENVIRONMENTAL ASSESSMENT AND REGULATORY SYSTEM (EARS ONLINE)

APPENDIX 4:
NOTICE OF INTENT 4099
(PROVIDED ON CD)

APPENDIX 5:
WASTE ROCK CHARACTERISATION STUDY
(MBS 2008)

(UPLOADED TO DMP ENVIRONMENTAL ASSESSMENT AND REGULATORY SYSTEM (EARS ONLINE)

APPENDIX 6:
RAISING OF TAILINGS STORAGE FACILITY RL 372M TO RL 378M
(COFFEY MINING 2012)

(PROVIDED ON CD)

Appendix 7:
Tailings Characterisation Report
Mining Leases 80/179, 80/180, 80/181
(MBS 2009)

(Uploaded to DMP Environmental Assessment and Regulatory System (EARS Online)

APPENDIX 8:
GEOCHEMICAL ASSESSMENT OF TAILINGS: PROPOSED AMENDMENT TO TAILINGS STORAGE FACILITY
(RGS 2009)

(UPLOADED TO DMP ENVIRONMENTAL ASSESSMENT AND REGULATORY SYSTEM (EARS ONLINE)

APPENDIX 9:
MINERALOGY OF REACTIONS OF TAILINGS AT THE SAVANNAH NICKEL MINE TAILINGS STORAGE FACILITY - STAGE 1
(LEVAY & CO AND UNIVERSITY OF SOUTH 2009)

(UPLOADED TO DMP ENVIRONMENTAL ASSESSMENT AND REGULATORY SYSTEM (EARS ONLINE)

APPENDIX 10:
KINETIC GEOCHEMICAL ASSESSMENT OF TAILINGS MATERIALS – SAVANNAH PROJECT: LETTER REVIEW REPORT
(RGS 2012)

(UPLOADED TO DMP ENVIRONMENTAL ASSESSMENT AND REGULATORY SYSTEM (EARS ONLINE)

APPENDIX 11:
GEOCHEMICAL ASSESSMENT OF TSF TAILINGS AT DEPTH SAVANNAH NICKEL PROJECT
(RGS 2009)

(UPLOADED TO DMP ENVIRONMENTAL ASSESSMENT AND REGULATORY SYSTEM (EARS ONLINE)

APPENDIX 12:
CHARACTERISATION OF GEOCHEMICAL REACTIONS WITHIN THE SAVANNAH NICKEL MINES' TAILINGS STORAGE FACILITY 1
(LEVAY & CO AND UNIVERSITY OF SOUTH AUSTRALIA 2011)

(UPLOADED TO DMP ENVIRONMENTAL ASSESSMENT AND REGULATORY SYSTEM (EARS ONLINE)

APPENDIX 13:
REVIEW OF GEOCHEMICAL CHARACTERISTICS OF TAILINGS AND WASTE ROCK MATERIALS: SAVANNAH PROJECT
(RGS 2012)

(UPLOADED TO DMP ENVIRONMENTAL ASSESSMENT AND REGULATORY SYSTEM (EARS ONLINE)

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