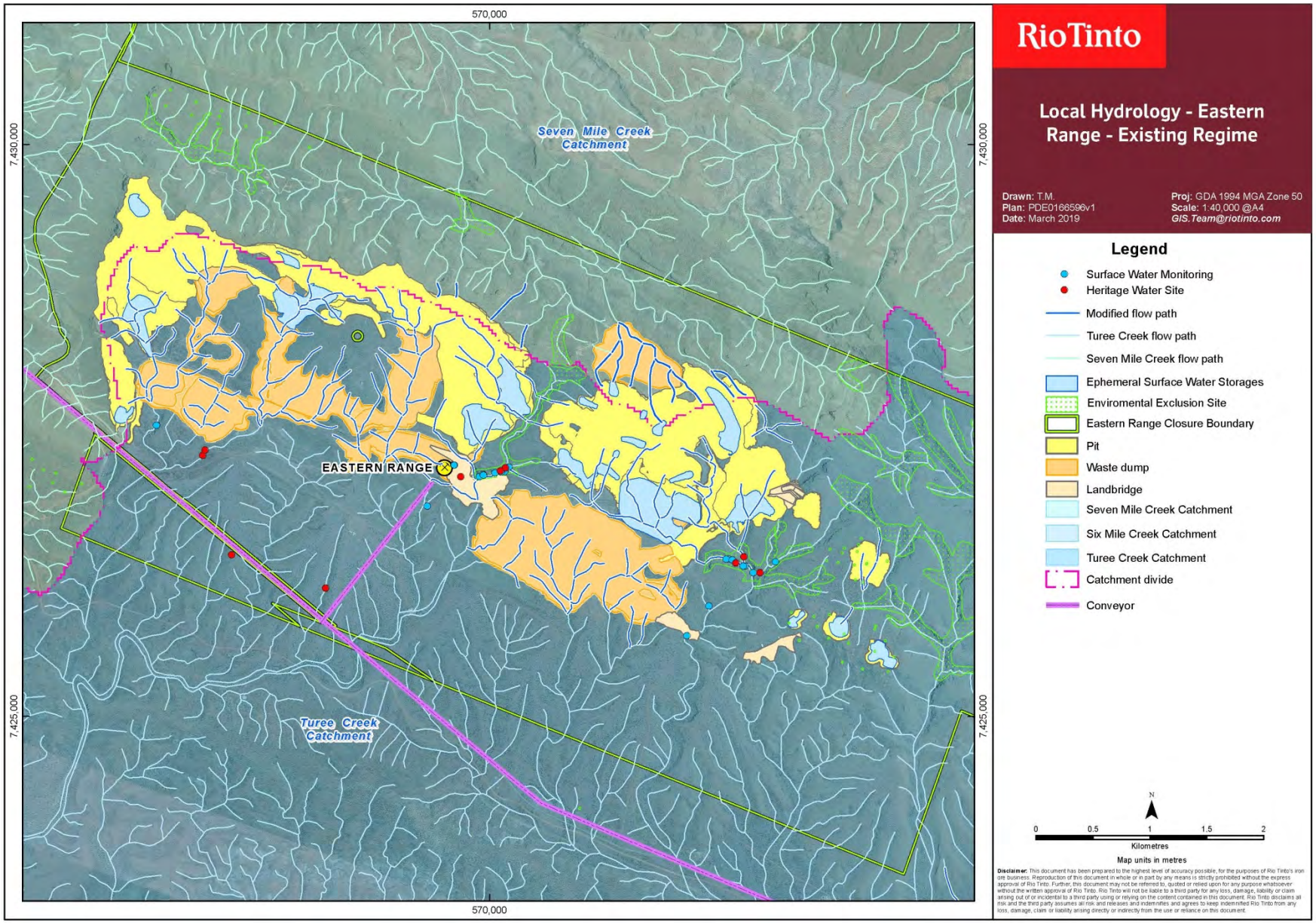

Figure 45: Post closure topography and impacted flow paths (red dotted lines)

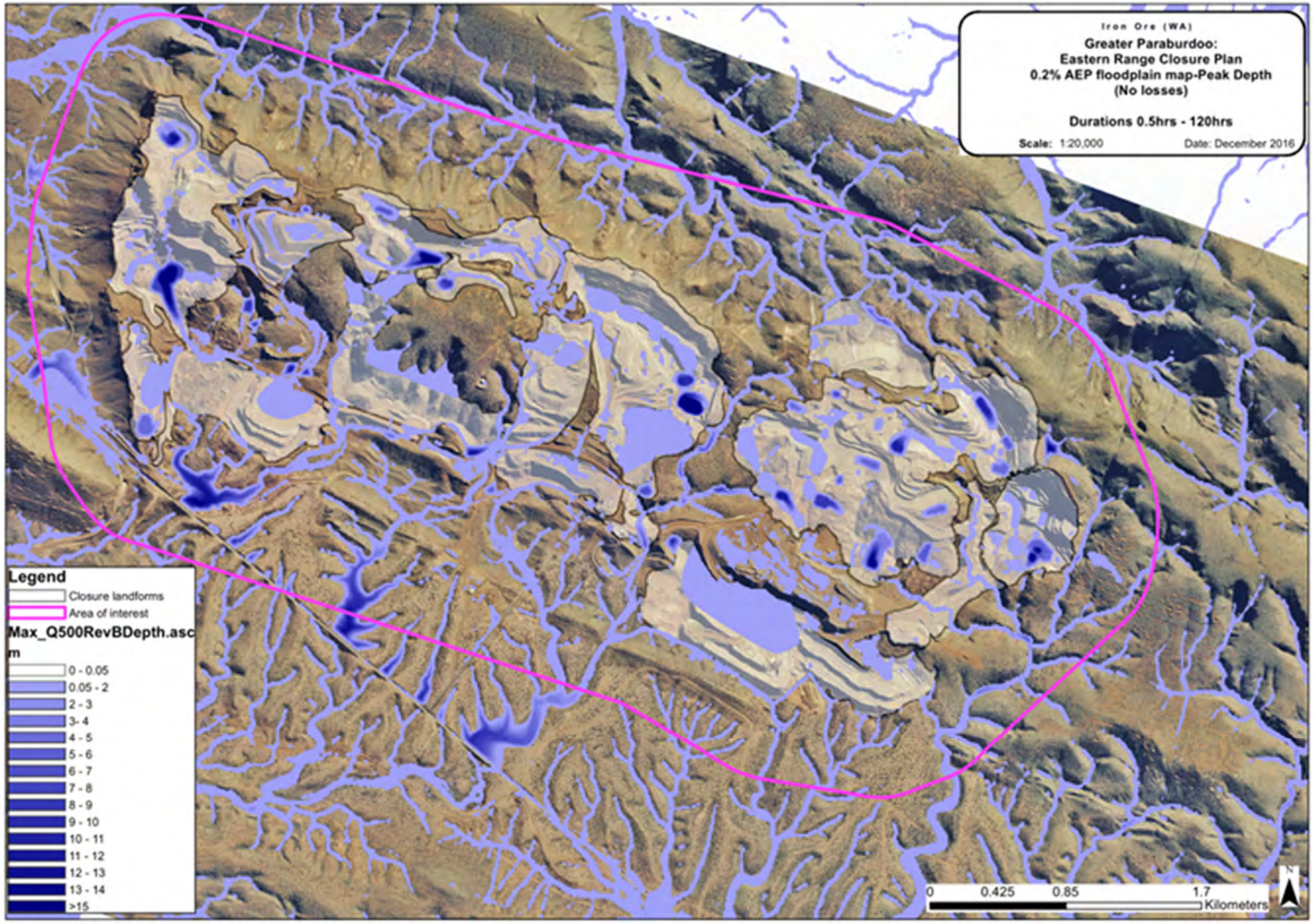

Figure 46: O.2% AEP peak flood depths (1 in 500 year average recurrence interval)

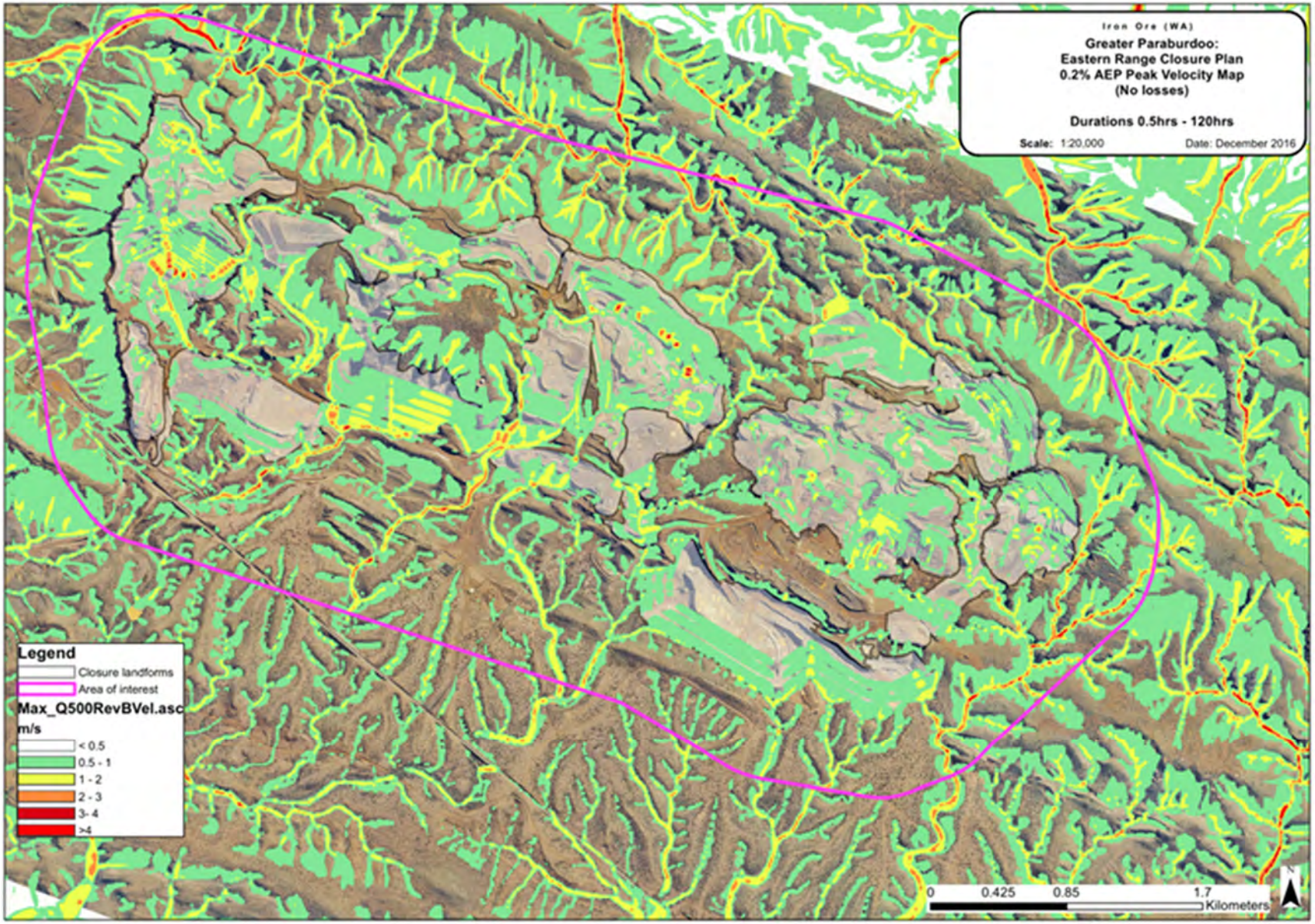

Figure 47: 0.2% AEP peak flood velocities (metres per second) (1 in 500 year average recurrence interval)

20. Research and investigation task list

Table 27 summarises the actions identified through the risk evaluation process (Section 18) that require research or form part of significant ongoing investigations. It is not expected that this list includes all of the mine activities undertaken that relate to closure, only the key activities that are necessary to either manage or prevent closure threats that exceed the risk acceptance threshold (Class III and IV threats) or ensure gaps in knowledge are addressed in a timely manner. A separate scope document has been prepared for the PFS stage of the closure study which details scope items relevant to each discipline as required to meet PFS stage requirements.

Table 27: Eastern Range closure task list.

Reference	Task	Indicative commencement	Notes/ changes since last closure plan
ER01	Review potential contaminating activities and areas of concern at Eastern Range to determine whether any require formal reporting.	During PFS	Previous closure plan listed task to commence within three years. Work was done in OoM to scope a Preliminary Sampling and Investigation Plan for implementation during PFS.
ER02	Undertake detailed site investigation prior to closure to identify, risk assess and classify potentially contaminated sites.	During PFS	Previous closure plan listed task to commence during final closure planning.
ER03	Ensure end land use planning considers the impacts of any known or suspected contaminated sites.	Commenced (ongoing)	Previous closure plan listed task to commence during final closure planning.
ER04	Review site groundwater models to confirm watertable level and to determine whether additional monitoring bores are required.	Commenced (ongoing)	Not listed in previous closure plan.
ER05	Monitoring of rock pools to capture ongoing information about hydrological regime.	Commenced (ongoing)	Previous closure plan listed task to commence within three years.
ER06	Review surface water impoundment and over topping risk of landforms, particularly landbridges prior to implementation of final closure strategies.	Commenced (ongoing)	Previous closure plan listed task to commence within three years.
ER07	Review geotechnical zones of instability around final pit crests prior to closure and undertake risk assessment to determine	Commenced and to be reviewed during	Previous closure plan listed task to commence during final closure planning.

Reference	Task	Indicative commencement	Notes/ changes since last closure plan
	which (if any) waste dumps and other structures need to be removed from within the zone.	PFS.	
ER08	Validate landform design assumptions and associated erosion modelling by determining field erosion rates from rehabilitated waste dumps.	During PFS	Previous closure plan listed task to commence within three years.
ER09	Review waste dumping strategies throughout life of operation to confirm final dump compositions at end of mine life (use data to inform final design criteria).	Commenced (ongoing)	Previous closure plan listed task to commence during operations.
ER10	Establish scree slope trial to validate closure methodology for landbridges.	During PFS	Previous closure plan listed task to commence within three years. Listed in previous closure plan as ER25 also. Duplicate retired. Planning commenced during the OoM study.
ER11	Confirm sufficient rock armour material can be sourced at site to implement scree slope strategy.	Commenced	Previous closure plan listed task to commence during operations. Preliminary assessment conducted in the OoM however this strategy will not form part of base case until trial outcomes are known.
ER13	Review surface water impoundment and overtopping potential of final landforms and associated geotechnical risks.	Commenced	Previous closure plan listed task to commence within three years.
ER14	Further material characterisation required to confirm erodibility of wastes and appropriate rehabilitation design parameters.	Ongoing, continue during PFS	Previous closure plan listed task to commence within three years.
ER15	Investigate optimal species selection for post-closure landforms.	Commenced	Previous closure plan listed task to commence during final closure planning.
ER16	Undertake field trials to validate the potential of identified alternative growth media as topsoil substitute during	Commenced	Previous closure plan listed task to commence within three years.

Reference	Task	Indicative commencement	Notes/ changes since last closure plan
	rehabilitation activities.		
ER17	Forecast closure seed requirements and reconcile against present stocks based on final landform knowledge. Develop strategy to address any predicted shortfall in seed availability.	Commenced	Previous closure plan listed task to commence within three years.
ER18	Ensure significant species locations/habitats are considered during any changes to final landform limits.	Commenced (ongoing)	Previous closure plan listed task to commence during operations.
ER19	Engage with stakeholders regarding post closure land use objectives and expectations.	Commenced (ongoing)	Previous closure plan listed task to commence within three years. Previous plan listed this same task multiple times as ER21 and ER23 also. Duplicate tasks retired. Initial engagements commenced during the OoM study.
ER20	Refine site closure objectives, completion criteria and measurement tools in consultation with key stakeholders.	Commenced (ongoing)	Previous closure plan listed task to commence within three years. Previous plan listed this same task multiple times as ER22 and ER24 also. Duplicate tasks retired. Limited work on this commenced in the OoM study.
ER30	Review and refine closure costs via closure studies process.	Commenced (ongoing)	Not listed in previous closure plan.
ER31	Incorporate learnings from rehabilitation and decommissioning projects into closure cost estimation process.	Commence in PFS	Not listed in previous closure plan.
ER32	Define and confirm final locations for abandonment bunding.	Commenced (ongoing)	Previous closure plan listed task to commence during final closure planning.
ER35	Determine construction methodology for abandonment bunds.	During PFS	Previous closure plan listed task to commence during final closure planning.

Reference	Task	Indicative commencement	Notes/ changes since last closure plan
ER36	Review the AMD risk assessment to ensure it remains appropriate.	Complete	Not listed in previous closure plan.
ER37	Confirm mine planning strategy in 32E6 pit regarding mining of PAF material.	Complete	Not listed in previous closure plan.
ER38	Seek advice from regulator on placement of bunds where topographical constrains exist.	During PFS	Not listed in previous closure plan.
ER39	Investigate reasons for poor rehabilitation performance in some existing areas and use knowledge to inform future rehabilitation activities.	Commence during PFS	Not listed in previous closure plan.
ER40	Heritage Specialist to confirm list of significant sites for review and consideration in final landform planning.	Commenced	Not listed in previous closure plan.
ER41	Agree completion criteria with appropriate regulators.	FS stage	Not listed in previous closure plan.
ER42	Develop stakeholder engagement plan and strategy.	Commenced.	Not listed in previous closure plan. Will be revised at each stage of study based on stakeholder feedback
ER43	Actively pursue development of Traditional Owner business development and growth opportunities.	Commenced (ongoing)	Not listed in previous closure plan.
ER44	Develop Human Resources Strategy for closure.	Commenced (ongoing)	Not listed in previous closure plan.
ER48	Refine closure plan at each stage of study to ensure it reflects changes in strategies and knowledge development.	Commenced (ongoing)	Not listed in previous closure plan.
ER49	Review and acceptance of abandonment bund placement and design by regulators.	Commence PFS	Not listed in previous closure plan.
ER50	Propose and agree safe access routes to traditional owner sites.	Commenced	Not listed in previous closure plan.

CLOSURE IMPLEMENTATION

Closure domains are used to group areas with common features, rehabilitation and decommissioning requirements at closure. Detailed closure strategies for the rehabilitation and decommissioning of individual closure domains, beyond those of current standard management practices, will be documented in the final closure plan as the site approaches closure.

21. Landform rehabilitation options assessment

As part of the OoM study, a rehabilitation landform options assessment was undertaken to assess the different ways in which individual domains could be rehabilitated. This process involved:

- a review of the final landform strategies presented in the 2016 Eastern Range Mine Closure Plan;
- a two day field trip to the site to visually evaluate individual landforms; and
- three separate multi-discipline final landform strategy workshop sessions focusing on landforms at an individual domain level.

The strategy sessions included representatives from mine planning, rehabilitation and closure, hydrology, geotechnical engineering, heritage, environmental approval and an external consulting closure expert. Each of the individual domain options were rated against various criteria as detailed in Table 28 including:

- safety;
- surface water flow impacts;
- landform stability;
- flora and fauna impacts;
- heritage impacts;
- ground disturbance outcome;
- potentially unstable pit edge zone impacts;
- practicality; and
- relative cost.

Each of these elements was assigned a numerical rating and the highest rated option for each landform was adopted as the central case. The least preferred option was adopted as the downside case and the upside case are those which require less material movement but are not currently proposed due to a range of limiting factors[27]. Design information presented in this closure plan is based on the central case only. As studies progress the appropriateness of the other options will continue to be investigated and therefore the central cases in Section 22 and Appendix E should be considered in this light.

[27] Some landforms have only a central case.

Table 28: Rehabilitation strategy by domain - evaluation criteria

Safety		**Water Surface Flow Impact**		**Landform Stability Outcome**		**Flora/Fauna Outcome**	
Cannot be managed safely	1	Negatively impacts surface water flow	1	Poor landform stability	1	Negatively impacts flora/fauna	1
Difficult to manage safely	2	Neutrally impacts surface water flow	2	neutrally impacts landform stability	2	Neutrally impacts flora/fauna	2
Can be managed safely with controls	3	Slightly improves surface water flow	3	Good landform stability	3	Improves flora/fauna outcome	3
Easy to manage safely	4	Greatly improves surface water flow	4	Greatly improves landform stability	4	Greatly improves flora/fauna outcome	4

Heritage Outcome		**Ground Disturbance Outcome**		**Zone Of Instability (ZOI) Outcome**		**Practicality/ Relative Cost**	
Significant heritage disturbance	1	Significant additional disturbance required	1	Within ZOI	1	Is difficult and expensive to achieve	1
Some heritage disturbance	2	Some additional disturbance required	2	Impacted by ZOI	2	Is not easy but can be achieved	2
No Heritage Disturbance	3	Minimal additional disturbance required	3	Slightly impacted by ZOI	3	Can practically be achieved with some effort	3
Protects Heritage site	4	No additional disturbance required	4	Is not restricted by ZOI	4	minimal effort required	4

22. Closure domains

Figure 48 illustrates the closure domains that have been established for Eastern Range based on the current life of mine plan. Eastern Range domains include:

- Pits: includes currently operating, developing or proposed pits associated with deposits 23E, 24E, 32E, 37E, 42E and 47E, including areas where waste material has been backfilled into pits for which no rehabilitation is required or planned;
- Inert waste dumps and ROM pad: Includes inert external waste dumps and long term low grade material stockpiles that are not currently planned to be utilised in processing and landbridges;
- Inert in-pit waste dumps: in-pit internally draining waste dumps for which no rehabilitation is proposed;
- Landbridges – rehabilitate: landbridges which will be rehabilitated in-situ as per waste dump parameters;
- Landbridges – remove: landbridges which will be removed and the footprint will be rehabilitated;
- Infrastructure: Refers to areas where items of infrastructure are located;
- Haul roads: Mine HV access roads;
- Other disturbed areas: All areas of disturbance that are not categorised by any of the above landform domain categories.

Proposed closure measures for each of the closure domains are included in Table 29. Designs and key criteria for all major landforms are included in Appendix E.

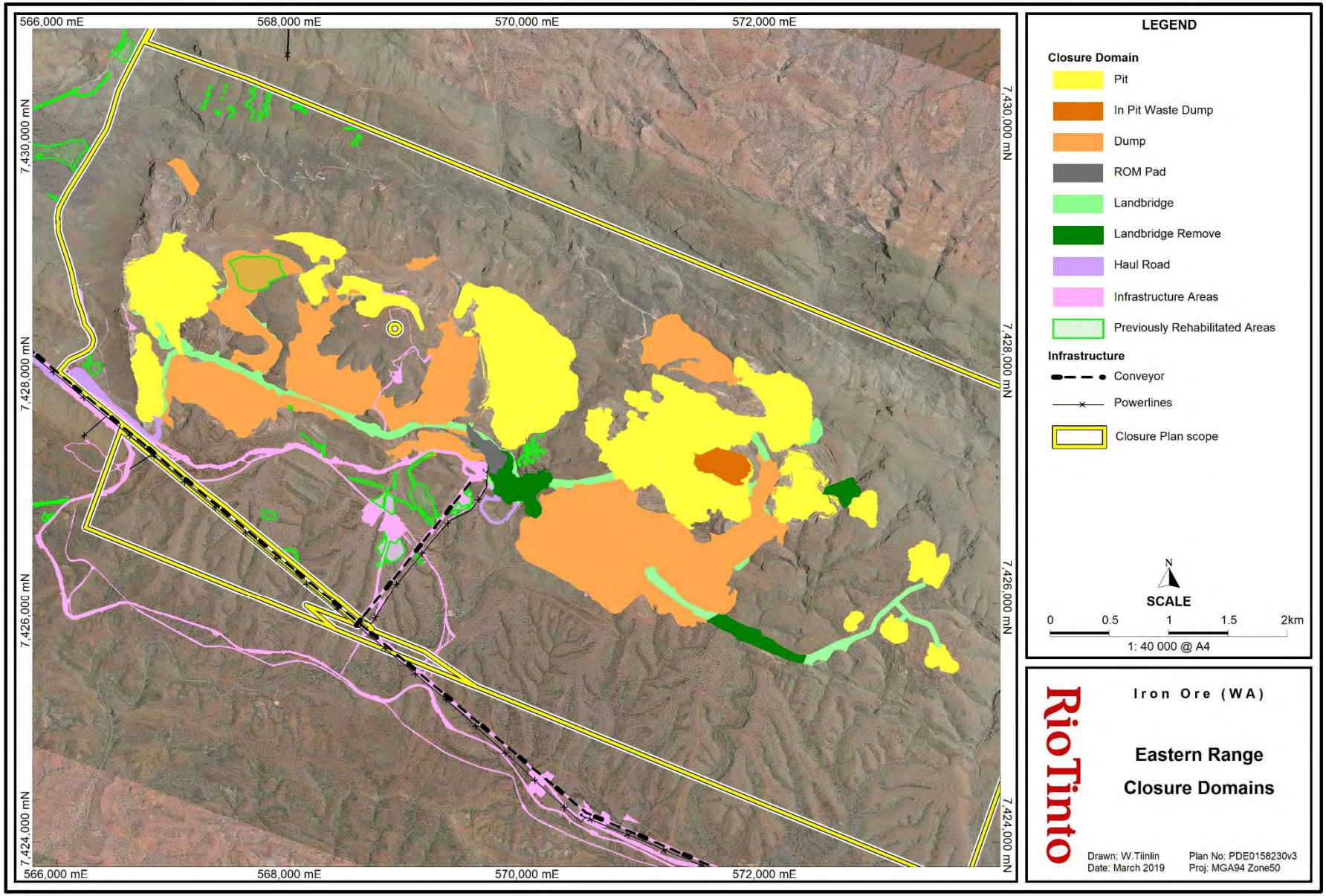

Figure 48: Eastern Range closure domains

Table 29: Eastern Range general area implementation strategies by closure domain.

Domain class	Rehabilitation proposed	Domains	Measures
Pits			
AWT pits	Bund to prevent inadvertent access where possible.	**23E/24E deposit:** 23E, 23E_S3 24E **32E deposit:** 32E 32E3 32E3_extn 32E4_extn 32E5 32E6 32E7 **37E deposit:** 37E1 37E2 37E4 37E5 37E6 **42E deposit:** 42E 42EE **47E deposit:** 47E 47E_series 1 47E_series 2 47E_series 4	• Pits may be partially backfilled where possible to minimise the volume of waste in out of pit waste landforms; • implementation of measures to restrict public access i.e. abandonment bunding; • no rehabilitation proposed within pit footprint; and • bare rock areas (pit walls and floors) will not be rehabilitated.
Waste dumps			
In-pit waste dumps (inert and internally draining)	No rehabilitation proposed.	37E6_BF	• N/A
In-pit waste dumps	Some rehabilitation proposed.	32E3_BF 37E1_BF	• Sections that are externally draining will be reshaped and rehabilitated appropriately. • Areas that are near pit crest will also be ripped and seeded.
Free standing inert waste dumps (including in pit dumps if externally	Reshape to safe and stable landform – batter and berm configuration.	23E_WD1 23E_WD3 24E_WD2 32E_WD4 32E6_WD	• Where practicable, construct dumps in accordance with criteria outlined in Section 19.3; • reshaping outer slopes to appropriate angles/profiles based on design criteria suitable for waste type;

Domain class	Rehabilitation proposed	Domains	Measures
draining)		37E_WD1 37E_WD2 42E_WD1	• application of subsoil/topsoil where available; and • rip and seed using appropriate native species.
Landbridges - retain and rehabilitate	Reshape to safe and stable landform -batter and berm configuration as per a waste dump.	23E_32E LB 23E_32E6 LB 24E_LB 32E_WD4 LB 37E_LB 42E2_LB	• Where practicable, rehabilitate dumps in accordance with criteria outlined in Section 19.2.1; • reshaping outer slopes to appropriate angles/profiles based on design criteria suitable for waste type; • application of subsoil/topsoil where available; and • rip and seed using appropriate native species.
Landbridges - remove	Drill and blast access ramp and remove valley fill sections of landbridge.	32E_37E LB 42EE_LB 47E_LB	• Excess cut material loaded and hauled to nearest pit as backfill; • mining via drill and blast of in-situ portion to allow minimum mining width access; • batter down residual sections of fill; • application of subsoil/topsoil where available; and • rip and seed using appropriate native species.
Other domains			
ROM pad	Reshape to safe and stable landform – batter and berm configuration.	32E ROM pad	• Reclaim any remaining ore; • remove infrastructure; and • rehabilitate as per a free standing inert waste dump.
Haul roads	Reshape to safe and stable landform – batter and berm configuration.	Haul roads	• Push slopes at either side of the haul road to a maximum gradient of 20 degrees with berms at 10m intervals; • install cross bunds where appropriate (at approximately 50m to intervals if the gradient of the reshaped road corridor is less than 10 degrees); • application of subsoil/topsoil where available; and • rip and seed using appropriate native species.
Infrastructure areas	Reshape (if required), rip and seed.	Plant Maintenance Buildings Roads	• Retain or remove infrastructure in accordance with NVCP and State Agreement requirements; • undertake contaminated sites evaluation and clean up if required;

Domain class	Rehabilitation proposed	Domains	Measures
		Tracks Laydown Conveyors (etc.)	• where infrastructure requires removal, remove all structures and footings that is above surface or within 1m of the final land surface; • drain pipelines and remove hazardous materials (from pipelines and elsewhere across the site) in accordance with Controlled Waste Regulations; • actively seek reuse and recycling opportunities for decommissioned infrastructure; • dispose of inert materials that are not retained, reused or recycled in an inert landfill area (may be a used pit area) and then cap with at least 2m of inert material; • where linear infrastructure is removed, reinstate drainage lines where appropriate; • rehabilitate final surface in accordance with standard procedures, which includes: • add a layer of topsoil where available and appropriate; • deep rip the surface where required to address compaction; and • revegetate with an appropriate mix of species of local provenance.
Previously rehabilitated areas	No further rehabilitation required at this stage.	Various. Includes light vehicle roads, construction camp, laydown, borrow pits, exploration disturbance and 23E waste dump.	Each individual landform will be assessed to ensure performance meets agreed completion criteria. If it is deemed they are not meeting requirements, they will be assessed for rehabilitation rework. Rework measures will be determined on a case by case basis.

23. Final landforms

The post mining landform is the landform that would be generated as a result of implementation of the mine plan. This assumes no progressive rehabilitation activities are conducted; however opportunities for progressive rehabilitation prior to closure are being reviewed on an ongoing basis. A conceptual image of the post mining landform is shown in Figure 49. The post closure landform is the final expected landform at the completion of the rehabilitation and closure measures outlined in Table 29 above. A conceptual image of this is shown in Figure 50.

24. Unexpected closure

The closure implementation schedule may be influenced by factors outside of the current mine plan. These factors include:

- suspension of operations under care and maintenance; this could occur if production costs exceed product value e.g. due to commodity price changes;
- unexpected closure; this could occur if there was major change in global demand for iron ore; and
- future proposals; these could occur if iron ore deposits of appropriate quality and quantity are identified adjacent to the existing deposits that are or can become legally accessible.

24.1 Temporary care and maintenance

In the event of temporary closure, measures will be undertaken to transfer the site from operations into a care and maintenance regime and relevant authorities notified. A Care and Maintenance Plan will be developed prior to the care and maintenance period which demonstrates how on-going environmental obligations associated with the site will continue to be met during the period of care and maintenance and submitted to regulatory agencies as required. Social obligations and responsibilities will also be addressed in this plan.

24.2 Early permanent closure

Whilst Rio Tinto considers the risk of unexpected closure to be minimal, there are numerous factors that could force early closure of one or several sites. Even if some level of contraction were to occur, it is reasonable to assume that the company would continue to operate in the Pilbara and continue to manage closure of its sites. It should be noted that the iron ore product group is one group within the global Rio Tinto group of companies, which further mitigates this risk.

As indicated in Section 3, this closure plan represents the outcomes of the OoM closure study for Eastern Range as the site has entered the closure studies phase and detailed plans for closure are in preparation. Closure implementation is currently expected to commence in approximately 2024; however if sudden and unexpected closure occurs, the site would be placed on a period of care and maintenance whilst studies and plans are completed to facilitate effective closure implementation. Final completion criteria would also be agreed with stakeholders during this period.

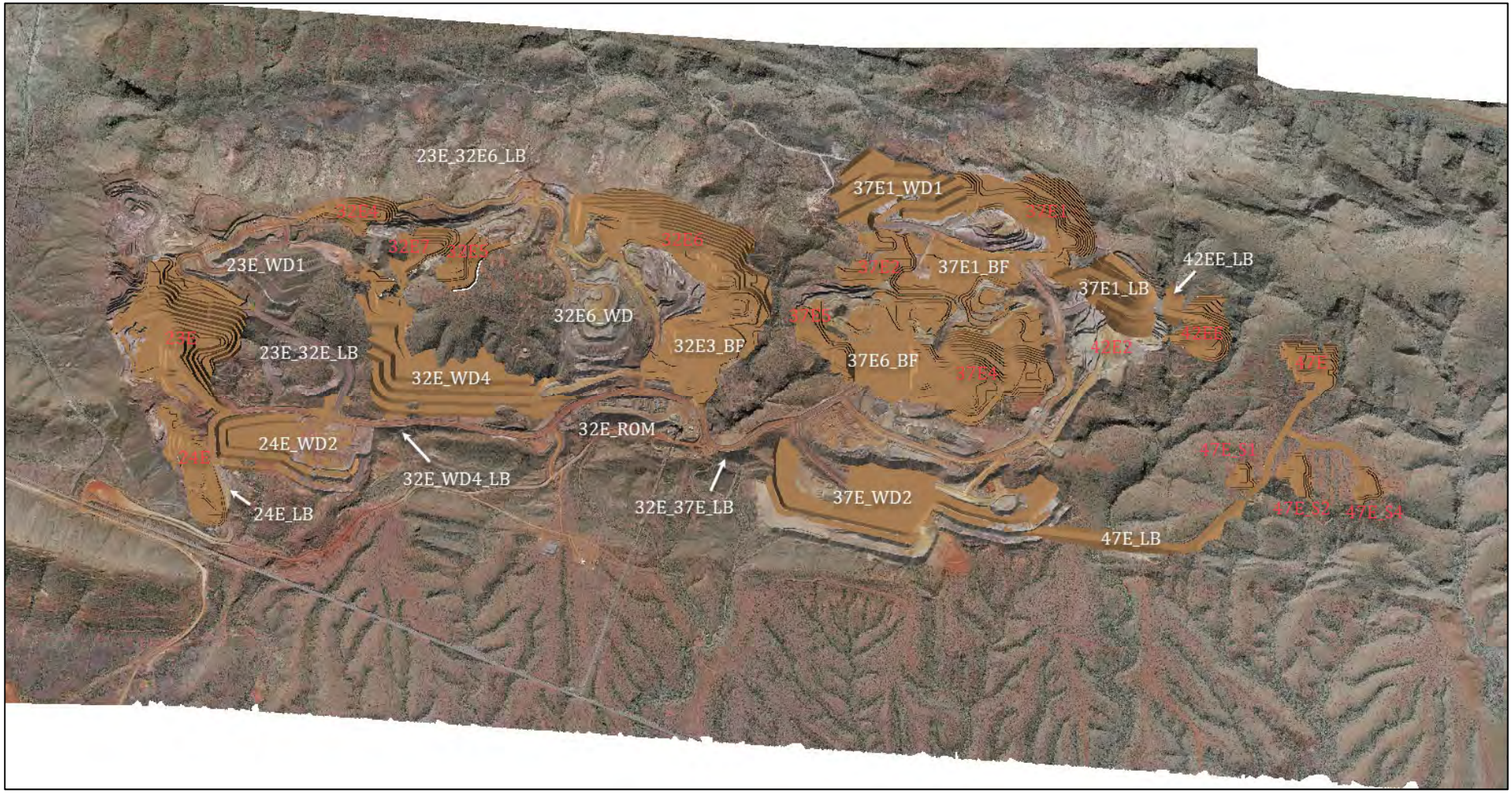

Figure 49: Eastern Range post mining landform

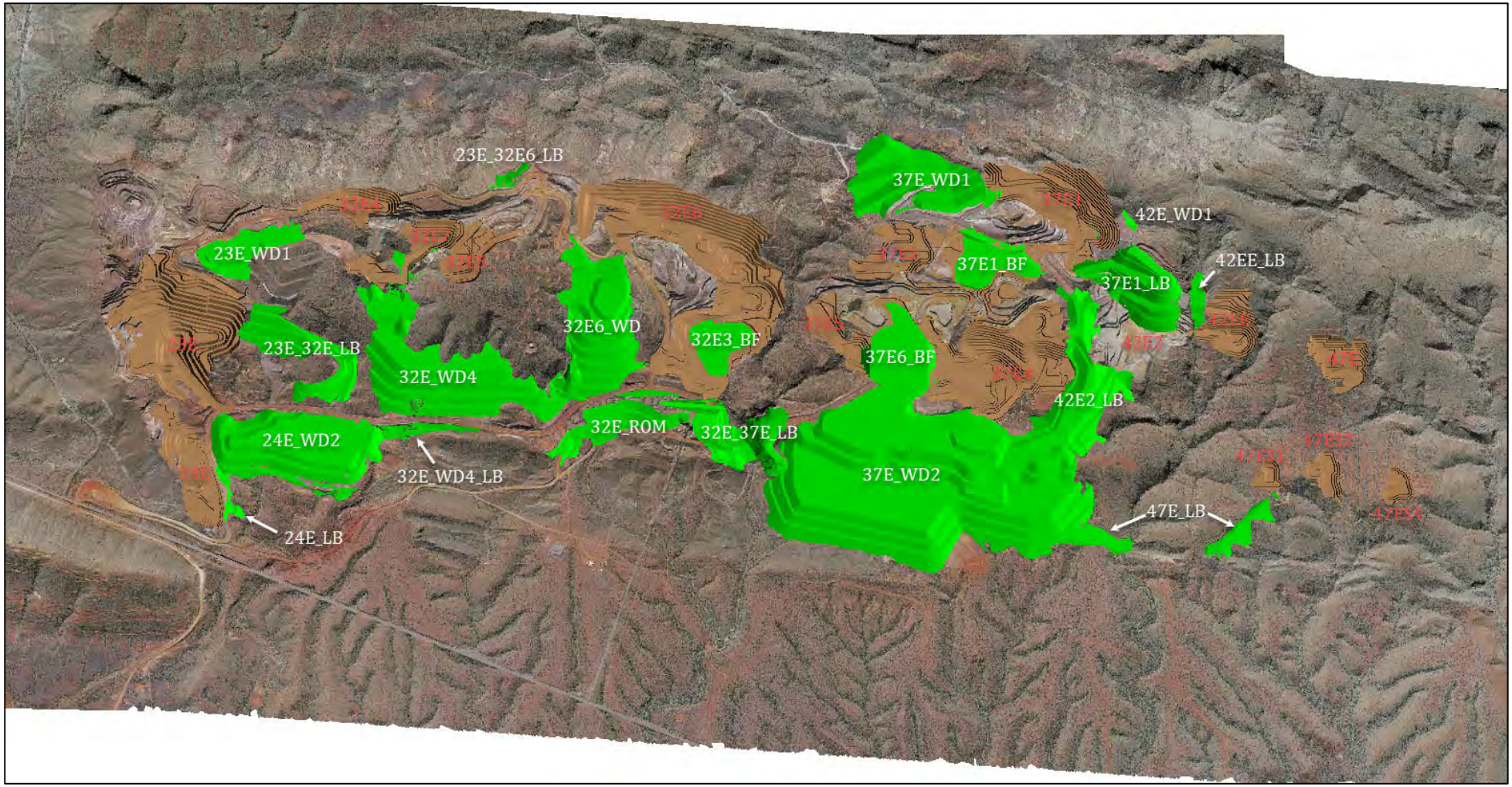

Figure 50: Eastern Range post closure landform

CLOSURE MONITORING AND MAINTENANCE

25. Closure monitoring program

The primary purpose of closure monitoring is to assess whether closure objectives have been met for Eastern Range. A more specific monitoring program will be drafted during the PFS and finalised in the FS.

25.1 Phases of monitoring

For the purposes of this plan, monitoring is assumed to be conducted in several phases including:

- Baseline monitoring, which is conducted as operations expand into new mining areas. Results that are relevant to closure are summarised in the environment knowledge base;
- Operational monitoring, which occurs throughout the life of the mine, in line with regulatory requirements and the Rio Tinto operational standards. Results that are relevant to closure are incorporated in the environment knowledge base when it is reviewed;
- Pre-closure monitoring, which occurs as the site approaches closure to underpin assessment of post-closure performance;
- Closure monitoring, which is conducted during the period of active site closure (approximately three years following the cessation of mining); and
- Post-closure monitoring, which is conducted on a regular basis, nominally for a period of 15 years, until either:
    - There is a demonstration that closure objectives have been met and that the site is able to be relinquished; or
    - Parameters being monitored reach a steady state.

25.2 Indicative monitoring program

The monitoring program will be refined in the PFS and finalised in the FS planning stages. Specific and appropriate monitoring will be conducted to ensure data is obtained to allow assessment of performance against completion criteria (Section 9). The monitoring programme is likely to contain specific monitoring of the following key areas, as a minimum.

25.2.1 Rehabilitation vegetation and fauna monitoring

Rehabilitation monitoring occurs on a scheduled basis, aimed at establishing trends for the return to self-sustaining status. The rehabilitation development is compared to the reference site values. Data analysis is undertaken to assess progress towards an acceptable outcome and a report produced to document findings. Where possible, monitoring is completed annually for the first three years following installation, then continues to be monitored based on risk (low risk areas are monitored less frequently, while higher risk areas such as waste dumps are monitored more frequently). The following parameters are measured during each monitoring event:

- flowering and fruiting native plant species;
- percentage of perennial cover;
- percentage of spinifex cover;
- percentage of grass cover;
- percentage of shrub cover (0.5 to 2m);
- estimated percentage of litter cover;
- estimated percentage of tree cover >2 m (irrelevant for first few years of monitoring);

- species richness (total number of species counted in the transect quadrats);
- total perennial density;
- presence of erosion gullies and if present these are measured; and
- evidence of fire.

Fauna monitoring is also conducted in conjunction with rehabilitation monitoring, on the same transects. The following information is recorded:

- number of logs (>10cm diameter and >30cm long);
- number of rocks (>15cm diameter);
- score of native animal scat prevalence;
- score of native ant species;
- general native animal sightings (including tracks, burrows and nests); and
- extent of grazing.

Weed monitoring is also conducted as part of vegetation monitoring, with the presence and abundance of weed species noted. This information is used to inform weed management programs.

25.2.2 Erosion monitoring

Erosion monitoring on rehabilitated areas involves the examination of transects for rills and gullies, recording their width and depth. This information is captured during vegetation monitoring events as part of the vegetation transects and also by a broader area walk around. These measurements are compared over time to determine if the landform has stabilised; for example, erosion rates are within the accepted completion criteria range or rill and gully geometry is similar to the surrounding landscape. If a landform fails to stabilise, further management / intervention will be applied.

As the site enters closure, aerial imagery analysis will also be utilised to support further qualitative assessment of landform stability.

25.2.3 Water monitoring

Water monitoring during closure will focus on water quality including contamination, sedimentation and water levels. A specific program of monitoring focusing on quality and levels in the rock pools and heritage related water source areas where safe access is available was drafted in the OoM and will be refined in the PFS and FS. Monitoring is expected to commence prior to closure in the operational or pre-closure phase. Monitoring will be conducted via a combination of depth gauges, EC loggers and cameras.

25.2.4 Heritage surveys

Heritage assessments (ethnographic and archaeological) will be undertaken prior to closure to ascertain potential cultural heritage impacts of closure implementation, and inform the development of alternative landform strategies if required. Assessments are also undertaken post-closure to confirm that implementation has been undertaken in an appropriate manner. Surveys are expected to commence in the PFS in conjunction with consultation with Yinhawangka representatives.

25.2.5 Visual impact assessment

Visual impact assessment is expected to be conducted, nominally two events. The first would be conducted in the PFS once final landform designs are advanced to a stage that enables a representative model to be developed. This information would be used to inform stakeholder consultations regarding final landform and

enable changes to designs where practical. The second visual impact assessment would be conducted post closure implementation once final landforms have been constructed.

25.2.6 Dust monitoring

Dust monitoring will continue to be conducted during the closure implementation phase, in accordance with operational Health, Safety and Environment (HSE) procedures to ensure safe working conditions during implementation.

26. Post-closure maintenance

Post closure, maintenance will be undertaken on an as needs basis during the post closure monitoring period where areas have been deemed to not adequately meeting agreed completion criteria. Maintenance will continue as required until it is determined that the closure objectives have been met or it is otherwise agreed with Government to allow relinquishment of the site.

FINANCIAL PROVISION FOR CLOSURE

Rio Tinto considers specifics of the closure cost estimate to be commercially sensitive information. This section outlines the general process used to develop the closure cost estimate.

27. Rio Tinto closure cost estimation

Closure cost estimates are determined based on methods outlined in the Rio Tinto Closure Standard and the Rio Tinto Accounting Policy. Closure costs are considered in two formats:

- a Present Closure Obligation (PCO) which is indicative of costs associated with closure of the mine given its current footprint. This estimate is updated on an annual basis to account for the progressive development of a site over time; and
- a Total Projected Closure (TPC) cost which predicts the cost (in current terms) associated with closure at the end of the life of the mine. The TPC includes areas that are not currently approved, but that feature within the life of mine plan and that are considered likely to be developed in the future. The TPC estimate is updated each time the closure plan is revised.

The cost estimates consider the following components[28]:

- pre-closure studies;
- decommissioning (i.e. demolition and removal of infrastructure)[29];
- earthworks associated with final landform shaping;
- rehabilitation and biodiversity management;
- heritage management;
- workforce management (i.e. training costs and redundancy payments)[30];
- monitoring costs;
- costs associated with the development of the final closure plan;
- costs associated with undertaking a final shutdown of operations;
- allowance for failed rehabilitation or pollution that may necessitate rework of rehabilitation areas;
- assignment of indirect costs in accordance with Rio Tinto Accounting Policy; and
- a contingency factor.

[28] Costs associated with decontamination are assessed during closure plan development but are costed separately as they are classified as operating costs, not closure costs.

[29] The decommissioning cost estimate assumes that infrastructure will be demolished and buried on site. The site is sufficiently remote that deconstruction for the purposes of materials salvage and recycling is likely to be cost prohibitive. However; opportunities for salvage and recycling will be sought as the site approaches closure.

[30] Workforce management costs are only been included in the TPC.

The estimates are generally undertaken by specialist external consultants and the level of accuracy increases as the site approaches closure[31]. As part of Rio Tinto assurance processes, cost estimates are audited by external financial auditors annually to ensure adequate closure provisions are maintained. Note that for commercial reasons the actual estimate is not documented in this closure plan.

[31] The level of accuracy applied to Rio Tinto iron ore estimates is as follows:

- greater than 10 years from closure: ±30%;
- between 10 years and 5 years from closure: ±20%; and
- Less than 5 years from closure: ±15%.

MANAGEMENT OF INFORMATION AND DATA

28. Data and information management

The following section outlines the systems the business currently uses to ensure appropriate document control and record keeping during operations. These same systems are intended to be utilised during closure and up to site relinquishment.

28.1 Document management system

Rio Tinto operates a comprehensive document management system, with electronic records of all key information and data. The document system, known as Iron Ore Document Management System (IODMS) is linked to other business units within the Rio Tinto group of companies, and processes are in place to ensure that the data contained within this system is appropriately backed up and protected. Each document stored within this system is given a unique document number which identifies the document and enables it to be accessed. This system will continue to operate following site closure, and all relevant data will be retained according to appropriate data retention requirements.

An audit will be conducted prior to closure to ascertain whether there is any additional information stored in hard copy form at the site. Such data will be scanned and entered into IODMS to ensure that it is appropriately retained post-closure.

28.2 Closure knowledge base

The closure knowledge database is a knowledge management process designed to bring closure related research and monitoring outcomes together into one searchable location. It uses a single entry form to capture where the report is stored, and how and where the research can be applied for all new ongoing and completed closure related studies. This information is then managed by the Closure team within a secure database. A summary of relevant reports from this database is appended to this closure plan (Appendix C).

28.3 EnviroSys

EnviroSys is an environmental database that is used by Rio Tinto to manage environmental and hydrogeological data. The tool is used to store, monitor and analyse those parameters and report trends on data collections. Data collected currently includes:

- groundwater – biological, chemical, field, levels, production;
- marine water – biological, chemical, field;
- rehabilitation monitoring information;
- soil chemistry;
- surface water – biological, chemical, field, levels, production;
- tonnes and moisture;
- water meters; and
- weather (rainfall, temperatures etc.).

EnviroSys is used to support the building of closure knowledge bases, as well as ensure compliance with operating licenses pertaining to data management. At closure this data would be appropriately stored to allow for review of post closure completion criteria.

APPENDIX A – REGISTER OF KEY CLOSURE OBLIGATIONS

Iron Ore (Hamersley Range) Agreement Act 1963-1968	
Clause No.	**Closure obligations**
	Nothing in this clause shall be construed to exempt the Company from complying with, or the application of, the other provisions of this Agreement including, without Limitation, clauses 11 and 20 and of relevant laws from time to time of the said State.
1. Interpretation	Nothing in this Agreement shall be construed: (a) to exempt the Company from compliance with any requirement in connection with the protection of the environment arising out of or incidental to its activities under this Agreement that may be made by or under the EP Act;
11(d)	**Effect of determination of Agreement** that on the cessation or determination of this Agreement (i) except as otherwise agreed by the Minister the rights of the Company to in or under this Agreement and the rights of the Company or of any assignee of the Company or any mortgagee to in or under the mineral lease and any other lease license easement or right granted hereunder or pursuant hereto shall thereupon cease and determine but without prejudice to the liability of either of the parties hereto in respect of any antecedent breach or default under this Agreement or in respect of any indemnity given hereunder AND the Company will without further consideration but otherwise at the request and cost of the State transfer or surrender to the State or the Crown all land the subject of any Crown Grant issued under the Land Act pursuant to this Agreement (ii) the Company shall forthwith pay to the State all moneys which may then have become payable or accrued due; (iii) the Company shall forthwith furnish to the State complete factual statements of the work research surveys and reconnaissances carried out pursuant to clause 4(1) hereof if and insofar as the statements may not have been so furnished save as aforesaid and as provided in clause 8(4) hereof and in the next following paragraph neither of the parties hereto shall have any claim against another of them with respect to any matter or thing in or arising out of this Agreement.
11(e)	**Effect of determination of lease** that on the cessation or determination of any lease license or easement granted hereunder or pursuant hereto by the State to the Company or (except as otherwise agreed by the Minister) to an associated company or other assignee of the Company under clause 20 hereof of land or held pursuant hereto for the Company's wharf for any installation within the harbour for the Company's railway or for housing at the port or port townsite the improvements and things erected on the relevant land and provided for in connection therewith shall remain or become the absolute property of the State without compensation and freed and discharged from all mortgages and encumbrances and the Company will do and execute such documents and things (including surrenders) as the State may reasonably require to give effect to this provision. In the event of the Company immediately prior to such expiration or determination or subsequent thereto deciding to remove its locomotives rolling stock plant equipment and removable buildings or any of them from any land it shall not do so without first notifying the State in writing of its decision and thereby granting to the State the right or option exercisable within three months thereafter to purchase at valuation in situ the said plant equipment and removable buildings or any of them. Such valuation shall be mutually agreed or in default of agreement shall be made by such competent valuer as the parties may appoint or falling agreement as to such appointment then by two competent valuers one to be appointed by each party or by an umpire appointed by such valuers should they fail to agree;
20 (1)	Subject to the provisions of this clause the Company may at any time - (a) assign mortgage charge sublet or dispose of to an associated company as of right and to any other company or person with the consent in writing of the Minister the whole or any part of the rights of the Company hereunder (including its rights to or as the holder of any lease license easement grant or other title) and of the obligations of the Company hereunder; and (b) appoint as of right an associated company or with the consent in writing of the Minister any other company or person to exercise all or any of the powers functions and authorities which are or may be conferred on the Company hereunder; subject however to the assignee or (as the case may be) the appointee executing in favour of the State a deed of covenant in a form to be approved by the Minister to comply with observe and perform the provisions hereof on the part of the Company to be complied with observed or performed in regard to the matter or matters so assigned or (as the case may be) the subject of the appointment (2) Notwithstanding anything contained in or anything done under or pursuant to subclause (1) of this clause the Company shall at all times during the currency of this Agreement be and remain liable for the due and punctual performance and observance of all the covenants and agreements on its part contained herein and in any lease license easement grant or other title the subject of an assignment under the said subclause (1).

Mining Act, 1978	
Mineral Lease 4SA	
Condition No.	**Closure conditions**
N/A	Nil
Mineral Lease 246SA	
Condition No.	**Closure conditions**
N/A	Nil

Environmental Protection Act, 1986	
Section 51 - Permit No. 4032/4 (mineral production)	
Condition No.	**Closure conditions**
1-2	**Purpose for which clearing may be done** Clearing for the purposes of mineral production and associated activities.
1 -3	**Area of Clearing** The Permit Holder must not clear more than 600 hectares of native vegetation. All clearing must be within the areas cross-hatched yellow or shaded red on attached plan 4032/4.
1 -4	**Purpose for which clearing may be done** The Permit Holder shall only clear native vegetation within the areas shaded red on attached plan 4032/4 for the purpose of light vehicle access tracks, maintaining existing tracks, monitoring activities, inadvertent fly rock, remedial and safety works and rehabilitation activities.
8	**Weed control** When undertaking any clearing or any other activity authorised under this permit, the Permit Holder must take the following steps to minimise the risk of introduction and spread of weeds: (i) clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared; (ii) ensure that no weed affected soil, mulch, fill or other material is brought to into the are to be cleared; and (iii) restrict the movement of machines and other vehicles to the limits of the areas to be cleared.
9	**Watercourse Management** (a) Where practicable the Permit Holder shall avoid clearing riparian vegetation; and (b) Where a watercourse is to be impacted by clearing, the Permit Holder shall maintain the existing surface flow where practicable.

10	**Retain and spread vegetative material and topsoil** The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following completion of clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) ripping the ground on the contour to remove soil compaction; and (ii) laying the vegetative material and topsoil retained under Condition 10(a) on the cleared area. (c) within four years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 10(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 10(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and denisty of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used. (d) where additional planting or direct seeding of native vegetation is undertaken in accordance with Condition 10(c)(ii) of this permit, the Permit Holder shall repeat the Condition 10(c)(i) and 10(c)(ii) within 24 months of undertaking the additional planting or direct seeding of native vegetation. (e) where a determination by an environmental specialist that the composition, structure and density within areas revegetated and rehabilitated will result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, as determined in Condition 10(c)(i) and (ii) of this permit, that determination shall be submitted for the CEO's consideration. If the CEO does not agree with the determination made under Condition 10(c)(ii), the CEO may require the Permit Holder to undertake additional planting and direct seeding in accordance with the requirements under Condition 10(c)(ii).
11	**Records to be kept** The Permit Holder must maintain the following records for activities done pursuant to this Permit: (a) In relation to the clearing of native vegetation authorised under this Permit: (i) the location where the clearing occurred, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) the date that the area was cleared; (iii) the size of the area cleared (in hectares); and (iv) purpose for which clearing was undertaken. (b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 10 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) the size of the area revegetated and rehabilitated (in hectares).
12	**Reporting** (a) The Permit Holder shall provide a report to the Director Operations, Environment, Department of Mines and Petroleum by 30 June each year for the life of this permit, demonstrating adherence to all conditions of this permit, and setting out the records required under Condition 11 of this permit in relation to clearing carried out between 1 January and 31 December of the previous calendar year. (b) Prior to 31 December 2029, the Permit Holder must provide to the Director Operations, Environment, Department of Mines and Petroleum a written report of records required under Condition 11 of this Permit where these records have not already been provided under Condition 12(a) of this Permit.
Definitions	The following meanings are given to terms used in this Permit: **CEO** means the Chief Executive Officer of the Department of Environment Regulation or an officer with delegated authority under Section 20 of the Environmental Protection Act 1986; **direct seeding** means a method of re-establishing vegetation through the establishment of a seed bed and the introduction of seeds of the desired plant species; **environmental specialist** means a person who holds a tertiary qualification in environmental science or equivalent, and has experience relevant to the type of environmental advice that an environmental specialist is required to provide under this Permit, or who is approved by the CEO as a suitable environmental specialist; **fill** means material used to increase the ground level, or fill a hollow; **local provenance** means native vegetation seeds and propagating material from natural sources within 200 kilometres and the same Interim Biogeographic Regionalisation for Australia (IBRA) subregion of the area cleared; **mulch** means the use of organic matter, wood chips or rocks to slow the movement of water across the soil surface and to reduce evaporation; **planting** means the re-establishment of vegetation by creating favourable soil conditions and planting seedlings of the desired species; **regenerate/ed/ion** means re-establishment of vegetation from in situ seed banks and propagating material (such as lignotubers, bulbs, rhizomes) contained either within the topsoil or seed-bearing mulch; **rehabilitate/ed/ion** means actively managing an area containing native vegetation in order to improve the ecological function of that area; **revegetate/ed/ion** means the re-establishment of a cover of local provenance native vegetation in an area using methods such as natural regeneration, direct seeding and/or planting, so that the species composition, structure and density is similar to pre-clearing vegetation types in that area; **riparian vegetation** has the meaning given to it in Regulation 3 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004; **temporary disturbance** means areas cleared for the purpose of borrow pits; infrastructure corridors; ancillary infrastructure; topsoil and subsoil stockpiles; lay down areas; mineral exploration; air strips; landfill sites; car parks and access roads; **rehabilitate/ed/ion** means actively managing an area containing native vegetation in order to improve the ecological function of that area; **revegetate/ed/ion** means the re-establishment of a cover of local provenance native vegetation in an area using methods such as natural regeneration, direct seeding and/or planting, so that the species composition, structure and density is similar to pre-clearing vegetation types in that area; **riparian vegetatio**n has the meaning given to it in Regulation 3 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004; **temporary disturbance** means areas cleared for the purpose of borrow pits; infrastructure corridors; ancillary infrastructure; topsoil and subsoil stockpiles; lay down areas; mineral exploration; air strips; landfill sites; car parks and access roads;
	watercourse has the meaning given to it in section 3 of the Rights in Water and Irrigation Act 1914; **weed/s** means any plant - (a) that is declared under the section 22 of the Biosecurity and Agriculture Management Act 2007; or (b) published in a Department of Parks and Wildlife Regional Weed Summary, regardless of ranking; or (c) not indigenous to the area concerned. Has the meaning given to it in section 3 of the Rights in Water and Irrigation Act 1914;

Part V Licence L5275/1972/12	
Condition No.	**Closure conditions**
15	The licensee shall ensure no waste is left within: (i) 100m of any surface water body at the site; and 3m of the highest level of the water table aquifer at the putrescible landfill site.
***Aboriginal Heritage Act, 1972* (section 18)**	
Condition No.	**Closure conditions**
15, H21	The proponent is urged to protect the three water sources identified (ERC02-01, ERC02-02, ERC02-03).
16, H09	Undisturbed areas of P05635-1b and P05635-2 to be fenced.
Note	Other operational related conditions are expected to govern closure implementation activities.

CLOSURE OBLIGATIONS REGISTER
Relevant Legislation

Closure planning and implementation requires consideration of general legislative requirements beyond those that apply to a specific site. A list of potentially relevant legislation is provided below, but is not necessarily exhaustive. A comprehensive legal review will be required as closure approaches to ensure that all relevant legislative requirements are identified.

Australian Commonwealth Legislation
Environmental Protection and Biodiversity Conservation Act 1999
Native Title Act 1993
Aboriginal and Torres Strait Islander Heritage Protection Act 1984
Workplace Relations Act 1996

Western Australian State Legislation
Environmental Protection Act 1986
Environmental Protection Regulations 1987
Environmental Protection (Controlled Waste) Regulations 2004
Environmental Protection (Unauthorised Discharges) Regulations 2004
Contaminated Sites Act 2003
Contaminated Sites Regulations 2006
Conservation and Land Management Act 1984
Mining Act 1978
Mining Regulations 1981
Parks and Reserves Act 1895
Rights in Water and Irrigation Act 1914
Wildlife Conservation Act 1950
Aboriginal Heritage Act 1972
Aboriginal Affairs Planning Authority Act 1972
Mines Safety and Inspection Act 1994
Mines Safety and Inspection Regulations 1995
Occupiers Liability Act 1985
Criminal Code Compilation Act 1913
Dangerous Goods Safety Act 2004
Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007
Health (Asbestos) Regulations 1992
Conservation and Land Management Act 1984
Land Administration Act 1997

CLOSURE OBLIGATIONS REGISTER
Relevant Guidelines and Standards

Closure planning and implementation requires consideration of relevant guidelines and standards, some of which may have regulatory consequence through being referenced in regulatory documents. A list of key guidelines and standards that are routinely considered is provided below, but is not exhaustive due to the breadth of the closure planning discipline. This closure plan has been prepared so as to be considered with relevant content of these guidelines and standards.

Guideline or Standard	**Author**
Guidelines for the Preparation of Mine Closure Plans (2015)	Western Australian Department of Mines and Petroleum and Environmental Protection Authority
Leading Practice Sustainable Development Program for the Mining Industry - Mine Closure and Completion (2006)	Commonwealth Department of Industry Trade and Resources
Mine Rehabilitation Handbook (1998)	Minerals Council of Australia
Guideline for the Assessment of Environmental Factors: Rehabilitation of Terrestrial Ecosystems (2006)	Western Australian Environmental Protection Authority
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)	Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council
Mine Void Water Resource Issues in Western Australia (2003)	Western Australian Water and Rivers Commission
Contaminated Sites guideline series	Western Australian Department of Environmental Regulation
Environmental Notes on Mining: Acid Mine Drainage (2009)	Western Australian Department of Mines and Petroleum
Environmental Notes on Mining: Waste Rock Dumps (2009)	Western Australian Department of Mines and Petroleum
Safety Bund Walls Around Abandoned Open Pit Mines (1997)	Western Australian Department of Industry and Resources
Global Acid Rock Drainage Guide (2014)	International Network for Acid Prevention
Australian Standard 2601: The Demolition of Structures (2001)	Standards Australia
Australian Standard 4976: The Removal of Underground Petroleum Storage Tanks (2008)	Standards Australia
Demolition Work Code of Practice (2015)	Safe Work Australia

APPENDIX B – COMMUNICATIONS REGISTER

Consultation Stage	Date	Stakeholder(s)	Summary of discussion relevant to closure	Response
Pre construction	29/4/1998	Department of Environmental Protection	Paraburdoo 23-42 East Environmental Commitments: Letter from Sam Walsh, Managing Director to the Department of Environmental Protection. Commitments relevant to closure included: 2. Before mining commences and thereafter at regular intervals, review the mine plan to ensure that, as far as practical, backfilling is maximised and waste rock dumps are minimised and to transmit the detail of these reviews to the Department of Environmental Protection and Department of Minerals & Energy. 4. Within 12 months of commencing mining, develop a rehabilitation plan, which covers ongoing rehabilitation, to the satisfaction of the Department of Environmental Protection on advice from the Department of Minerals & Energy. 5. At least 2 years before mining ceases, develop a site closure plan to the satisfaction of the Department of Environmental Protection on advice from the Department of Minerals & Energy and to implement that plan at closure.	Noted
Pre construction	16/01/2003	Department of Environmental Protection	Eastern Range Project Review of ERP Mine Plan (commitment 2) - outcome of 2002 review - Letter to Murray Hogarth from Jim Stoddart, Manager Environment Hamersely Iron Pty. Limited. In accordance with commitments made on 29th April 1998, Hamersley Iron Pty. Limited undertook to review the mine plan, before mining commences and thereafter at regular intervals, to ensure that as far as practical backfilling is maximised and waste rock dumps are minimised. This letter outlined the outcomes of a 2002 mine plan review. This letter included a commitment to further review opportunities for backfilling of voids and to regularly review the mine plan over the life of the mine. Future updates on reviews would be provided once mining had been underway for several years and through Annual Environmental Reports.	Noted
Pre construction	15/02/2005	Office of the Environmental Protection Authority	Public advice in relation to the proposal to extend the Paraburdoo 23-42E Eastern Ranges Iron project: The EPA notes that this proposal is for an extension of the existing Paraburdoo operation. The original 23E-42E Eastern Extension operation was to be developed as part of the original operation. The EPA expects therefore that this proposal to extend the operation will also be developed as an integral part of the existing operations. Referring to a letter dated 29th April 1998 from Hamersley Iron to the Department of Environmental Protection, the EPA notes that the proponent has committed to a Rehabilitation Plan and a Site Closure Plan for the original mining operation and that both plans are to the satisfaction of the Department, on advice from the Department of Minerals and Energy. The proposal to extend mining should integrate this portion of the operations with the existing operations.	Noted
Ongoing consultation with regulators	September 2013	Department of Mines and Petroleum	Requirement on native vegetation clearing permits (NVCP) to return site to pre-clearing vegetation level. RTIO expressed concerns around the expectation inherent in the wording of the condition that requires the proponent to return the area to 'pre-cleared' vegetation levels. RTIO indicated it was concerned by lack of definition of acceptable standard of rehabilitation, and would prefer clarity on the acceptable level of deviation from the 'pre-cleared' state. DMP stated that the intent of the condition is to provide regulatory bodies recourse to ensure rehabilitation is undertaken to a satisfactory standard, and that nothing 'unreasonable' would be expected. DMP stated that end land use form is taken into account and the DMP recognise that certain land forms cannot be expected to reach a level of the pre-cleared state. For the purposes of the NVCP rehab conditions a Waste Dump (for example) would be viewed as still required for the purpose for which it was cleared. NVCP Rehabilitation requirements would therefore not apply in the same way as they would for areas which are no longer required such as a temporary access roads or temporary stockpile areas for example. DMP stated that it is their view that an environmental specialist within the Company (RTIO) is able to determine what is considered a 'representative' area to monitor in order to determine rehabilitation success.	Noted
General correspondence from the OEPA regarding a joint BHP Billiton and Rio Tinto rehabilitation presentation held on 20th March 2014 (our reference RTIO-HSE-0229339).	May 2014	Office of the Environmental Protection Agency	Correspondence from OEPA commending BHP Billiton and Rio Tinto on their joint presentation on rehabilitation success in the Pilbara. In its letter OEPA recognised that mine closure and rehabilitation is an important strategic issue and recognised the significant challenges remaining in this area. The OEPA referred to the Department of Mines and Petroleum/EAP Joint Mine Closure Guidelines as the primary document guiding mine closure and rehabilitation across all land tenures and sought written confirmation from both companies that they would abide by any contemporary version of the guidelines, irrespective of what the current Ministerial Statement conditions required in regard to closure and rehabilitation, or similarly what State Agreement Act conditions require on the same matter. OEPA indicated its desire to discuss the updating of existing Ministerial Statements to ensure they are contemporary with respect to mine closure and rehabilitation with both parties in future.	Rio Tinto acknowledged the feedback form OEPA and indicated it looked forward to continued involvement with government and industry partners in developing sustainable, long term improvements for rehabilitation and closure in Western Australia. In response to the request for mine closure plans to conform to the contemporary version of the Department of Mines and Petroleum/EAP Joint Mine Closure Guidelines, it is noted that Rio Tinto iron ore closure plans drafted to support new proposals are prepared in accordance with the Guidelines. For existing Ministerial Statements, closure planning is undertaken in accordance with approval conditions and Rio Tinto standards. Of particular note, compliance to the Rio Tinto standard is required irrespective of what the current Ministerial Statement conditions and State Agreement requirements are on this matter. Rio Tinto's standards require the preparation of closure plans for each aspect of an iron ore operation, and plans are revised at a frequency that is appropriate to the life and scale of the operations, and take into consideration the objectives and intended outcomes of the contemporary Guideline. RTIO will continue to undertake closure planning in accordance with its approval conditions, and Rio Tinto standards. This process will ensure that plans are progressively updated to align with contemporary Guidelines. Rio Tinto iron ore considers this a practical approach which is consistent with requirements for closure planning in Western Australia (Our reference: RTIO-HSE-0229340).
Ongoing consultation with regulators	May 2014	Department of Mines and Petroleum	1. Rehabilitation within pit areas Rio Tinto has assumed that rehabilitation within pit areas will not be required except under specific scenarios. The scenarios where in-pit rehabilitation is appropriate are where: - geochemical risks need to be managed; - backfill is at ground level or close to it; - pits drain externally; - specific visual amenity concerns; - or any other scenario that may arise on a case by case basis. DMP expressed general support for this approach. 2. Landform stability The DMP recognised that historic construction of waste landforms can make it challenging to achieve stability objectives. Notwithstanding these challenges, the DMP indicated that it considers landform stability to be a critical element of rehabilitation design. It advocated that designs be based on consideration of the materials present with the landform.	1. This strategy has been applied by RTIO in the Eastern Range closure plan 2. Noted
Preliminary consultation on objectives and criteria applicable to the Channar closure plan	September 2014	Department of Mines and Petroleum	Preliminary consultation on objectives and criteria applicable to the Channar closure plan 1. Landform design needs to consider stability under maximum probable precipitation (PMP) and maximum probable flood (PMF) events 2. Consider the pit wall zone of instability and the impact that would have on waste dump placements within the final landform. 3. The DMP agreed that abandonment bunds around hill pits are not necessarily appropriate, and that other methods of access restriction (e.g. reducing exposure by removal of major access roads) should be considered. However, this would need to be assessed and endorsed on a case by case basis by the District Inspector.	1. Modelling of the PMP design flood event has been undertaken to predict impacts, but RTIO does not consider it feasible to design the landform to withstand such events. High levels of erosion are expected to occur in both natural and man-made landforms during such periods. The 1% Annual Exceedance Probability (AEP) event has been used as the basis for landform design in the Eastern Range closure plan. 2. Zones of instability (derived from the conservative methodology iterated in DMP's abandonment bund guidance material) have been considered in the Eastern Range plan. These will be reviewed throughout mine life and finalised once ultimate pit geometries and face geologies are known. 3. The Eastern Range closure plan has adopted this approach, on the assumption that endorsement can be achieved prior to closure.
Preliminary consultation on objectives and criteria applicable to the Channar Final Study	January 2015	OEPA Compliance Branch	The OEPA would defer to the DMP in relation to closure objectives and completion criteria, as the DMP is the lead agency in Western Australia. However, it committed to providing a joint response with the DMP in relation to proposed objectives and criteria.	Noted
Ongoing consultation with regulators	February 2014	Department of Mines and Petroleum	The DMP have noted that scree slopes are planned for closure at 94E and Channar Hill. Without the finer detail on area, slope length, angle, etc. the development of "scree slopes" as a final rehabilitated landform would not be supported by DMP. Site objectives are to leave the site in a safe, stable, non-polluting and self-sustaining state. The creation of scree slopes at certain parameters would not meet these criteria.	RTIO's objection for closure is to create rehabilitated landforms that are safe and stable. RTIO plans to trial scree slopes in 2018. Further information will be provided following the outcomes from this trial.

Consultation Stage	Date	Stakeholder(s)	Summary of discussion relevant to closure	Response
Correspondence from DMP Executive Director Environment to CMS (cc Manager OEPA Compliance Branch) regarding completion criteria proposed within Channar Final Study	February 2015	Department of Mines and Petroleum	1. The DMP supports the use of 'As Built Reports, audits, modelling and monitoring as proposed measurement tools 2. Completion criteria should refer to all weed species, and not just declared weeds 3. The scree slopes planned for areas at Channar could not be supported without further details. The DMP affirmed the requirement for safe, stable, non-polluting and self-sustaining landforms, and scree slopes may not achieve these basic objectives.	1. Noted 2. Noted 3. Noted. The Eastern Range closure plan proposes rock armouring for select areas of the site only where alternative strategies are either precluded or made extremely challenging to implement as a result of local topography and restricted access. RTIO plans to trial rock armouring (scree slopes) as a means of stabilising particular waste features to make them safe, stable and non-polluting. Further information will be provided following the outcomes from this trial.
RTIO presentation at Yinhawangka Local Implementation Committee (LIC) meeting	April 2015	Yinhawangka and Yinhawangka Aboriginal Corporation representatives	RTIO presented information on its mine closure planning process, general closure strategies for dumps and pits and the stages of mine closure.	
Presentation of final landform designs with a focus on scree slopes	May 2015	Department of Mines and Petroleum · District Inspector · Geotechnical Inspector · Environment	1. Concave slopes are preferred by the DMP over berm/batter designs 2. The safety risk profile of a rehabilitated slope may need to exceed that of the surrounding landscape if the latter is inherently unsafe, as it is concerned about the inheritance of public liability 3. The DMP requested further information in relation to the placement of abandonment bunds within the rehabilitation design. 4. The DMP requested further information on the geotechnical assessment of scree slopes	1 Concave slopes are utilised where possible in the landform design. However the larger footprint is not able to be accommodated in all areas. 2 RTIO considers it impossible to completely de-risk the rehabilitated landform. RTIO plans an approach that considers an appropriate level of risk mitigation, which is reduced as far as reasonably practicable without incurring excessive cost. 3 The purpose of abandonment bunding is to limit inadvertent access to pit voids. ER is comprised of hill pits, and RTIO considers that natural topography acts as a natural barrier to access. 4 Noted. A scree slope trial is planned for 2018.
AER Environment site inspection	August 2015	Department of Mines and Petroleum	1. Roly Poly *(Salsola australis)* was observed as being prolific within the rehabilitation on 23 East Waste Dump at Eastern Range however, a number of other native species were seen to be emerging. This should be monitored to ensure that succession is taking place and that Roly Poly is not inhibiting the emergence of other native species. Erosion was minimal on the slopes and generally the rehabilitated area appears to be going well. Large amounts of Ruby Dock were observed around the Eastern Range site and it will be important to ensure this species is well managed and does not become prevalent through the 23 East Waste Dump rehabilitation. 2. Given the difficulties in accessing the landbridge at 94E1 (Channar) and the environment below (a creekline), it is understood that there are numerous challenges to be faced at closure. In order to demonstrate that the proposed closure designs for the 94E1 landbridge will achieve DMPs closure objectives of leaving a safe and stable landform at closure, trials should be conducted over a period of several years. Alternatively, other measures to re-shape the land to a stable structure may be investigated.	1. Noted. Rehabilitation monitoring will continue at 23E WD. 2. Noted
Ongoing consultation with regulators	May 2016	Department of Mines and Petroleum	Public safety risk mitigation requirements for closed mine sites. Environmental inspectors regulate safety through Mining Regulations 1981 Regulation 28 "…all holes, pits, trenches and other disturbances to the surface of the land made whilst mining which in the opinion of an environmental officer are likely to endanger the safety of any person or animal will be filled in or otherwise made safe to the satisfaction of the environmental officer". The DMP advised it intends to revise its abandonment bund guidance to become less prescriptive and more outcomes focused. There would not be an expectation to batter down and rehabilitate large faces – abandonment bunds to prevent inadvertent access would be more appropriate. Vegetation on a slope would help prevent access, but should not be relied upon as a primary control as it could be lost to fire etc. Similarly, fences should not be considered a permanent control.	Noted. Placement and construction methodology for abandonment bunding will be refined as Eastern Range site approaches closure.
Ongoing consultation with regulators	June 2016	Department of Mines and Petroleum	Consultation with DMP on PMP/PMF modelling for closure planning. DMP acknowledged that achieving stability of large waste landforms is challenging, even under current seasonable climatic conditions. DMP has observed many cases across the Pilbara and the State more broadly where rehabilitation areas have performed poorly or failed, often over a reasonably short time frame. Guidance is expected to be risk based and not a 'one size fits all' approach. It was suggested that high risk dumps (e.g. those containing designated fibrous or PAF waste) may need to be designed to withstand larger or more intense rainfall events than small, inert, low risk waste dumps.	RTIO is awaiting further guidance from the DMP on requirement to design waste landforms to withstand PMP events.
Ongoing consultation with regulators	2016	Department of Mines and Petroleum	Public safety risk mitigation requirements for closed mine sites Environmental inspectors regulate safety through Mining Regulations 1981 Regulation 28 "…all holes, pits, trenches and other disturbances to the surface of the land made whilst mining which in the opinion of an environmental officer are likely to endanger the safety of any person or animal will be filled in or otherwise made safe to the satisfaction of the environmental officer"	The DMP intends to revise its abandonment bund guidance to become less prescriptive and more outcomes focused There would not be an expectation to batter down and rehabilitate large faces – abandonment bunds to prevent inadvertent access would be more appropriate. Vegetation on a slope would help prevent access, but should not be relied upon as a primary control as it could be lost to fire etc. Similarly, fences should not be considered a permanent control.
General mine closure plan discussions held with DSD.	11th July 2016	Department of State Development (Formal written communication from Rio Tinto to DSD).	DSD held discussions and sent various correspondence to Rio Tinto requesting that all State Agreement proponents: Prepare and submit mine closure plans in accordance with the Guidelines for Preparing Mine Closure Plans (compliant mine closure plans) for all mine operations, including those where there is no current legal obligation to do so; and Report land disturbance data consistent with Mining Rehabilitation Fund (MRF) categories in our State Agreement Annual Environmental Reports (AER).	In relation to mine closure plans Rio Tinto indicated that it was willing to voluntarily provide the State with the material requested on the following basis: • A timeframe of at least three years to progressively prepare and lodge compliant mine closure plans for operations where modern closure conditions do not currently apply. • Assurance that Mine Closure Plans will only be reviewed on a triennial basis by the Department of Mines and Petroleum (DMP) in accordance with the Guidelines; and • Confirmation that mine closure plans will not be connected in any formal way with the operation of our State Agreement mining approvals, such that changes to our mine plan will not mandate the need for revision of our mine closure plans, except at the regular triennial review period. As part of this Rio Tinto provided a suggested submission schedule which was subsequently agreed to by the DSD. The 2016 Eastern Range closure plan was planned for submission.
RTIO presentation at Yinhawangka Local Implementation Committee (LIC) meeting	March 22nd 2017	Yinhawangka and Yinhawangka Aboriginal Corporation representatives	The order of magnitude closure studies being undertaken this year for Eastern Range and Channar was introduced to the group. Indicated that this is the first type of these studies for Rio Tinto iron ore and it involved taking the closure plan to a greater level of detail as a mine approaches closure. An overview of the closure planning process was provided and it was indicated that mine closure is an expensive process with the amount of earthworks needed for reshaping the landscapes. Indicated that Rio Tinto are committed to monitoring closed mines to assure safety and stability into the future. Discussion in relation to the order of magnitude studies indicated that these will take a step back from standardised procedures and look at range of different options for closure, and while Rio Tinto Iron Ore (RTIO) haven't closed in mines in the Pilbara, we have done so in other countries, so we have a good resource of knowledge across the globe to support our efforts. Indicated that the Argyle diamond mine is going through a similar closure planning process and that we are in discussions with them about common issues. Discussed the process of consultation and the importance of the Yinhawangka People providing feedback. Indicated that at this stage useful information the group can communicate on could include: o feedback on closure strategies o visual amenity considerations – will landscape changes have cultural heritage implications? o whether closure objectives are culturally appropriate o flora species to be considered in seed mixes (i.e. bush foods) o expectations for management of salvaged artefacts o areas where post closure access is important Indicated that the business is keen to establish a plan to engage with the group about the current closure studies over the coming months. An alternate forum for this may be through the H&EC meetings.	Feedback from LIC representatives and RTIO responses included: • An enquiry about the economic viability of the work due to amount being spent on closure. RTIO indicated that other options (other than closure) are being explored for these areas such as tourism, training. • Statement from LIC that there a lot of examples across the globe of how not to do mine closure and the importance of learning from previous mistakes was expressed. • RTIO discussed progressive rehabilitation that has taken place at these sites already which included some black shale encapsulations. • An enquiry was raised as to whether the 100 year flood predictions are taken into account in design. RTIO indicated that yes they are as this can affect the stability of the landforms. • RTIO indicated that the landscape is not likely to be returned to its original state. • An enquiry was raised about the impacts to the landscape after mining and clarification was sought regarding what impacts are expected because Iron Ore mining doesn't use the same process of extraction as other mining like gold. RTIO discussed acid and metalliferous materials which can cause detrimental affects and our process for managing these.

Consultation Stage	Date	Stakeholder(s)	Summary of discussion relevant to closure	Response
Channar site inspection	11th September 2017	Department of Jobs, Tourism, Science and Innovation (JTSI) formerly the Department of State Development prior to July 1 2017. JTSI representatives included Paul Platt, Duane McDonnell, Leanne Spencer.	Presentation and site inspection at Channar. Discussed the following: Channar Closure Plan submitted to JTSI in May 2017. JTSI indicated that comments should be provided within 2-3 weeks. Noted that the most contentious issue in the review has been lost ordinates. Overview of the study process given from conceptual through to feasibility studies. PMP/PMF design considerations were discussed in the context that they are being raised in the regulatory space. Indicated that the closure planned use intended for Channar is safe, stable and self sustaining landscape, which will likely be reverted to Crown land, with a very small portion of pastoral. Indicated that landforms would be reviewed on an individual basis to determine suitable rehabilitation approach. Landbridges in particular were discussed, as were placement of abandonment bunds, in the context of how they are challenged by the topography. Various queries regarding rehabilitation technical aspects. Provided JTSI with an overview of the new 3D models now available, including highlighting the area where the scree slope trial is planned to be implemented. Provided overview of CHE3 rehabilitation completed in 2016.	N/A
RTIO presentation at Yinhawangka Local Implementation Committee (LIC) meeting	September 22nd 2017	Yinhawangka and Yinhawangka Aboriginal Corporation representatives	Reiterated that the order of magnitude closure studies were still underway for Channar and Eastern Range. Reassured the group that the Paraburdoo mine will continue well beyond the closure of Eastern Range and Channar and thus the future of the township of Paraburdoo is under no immediate threat. Rio Tinto representative (Pat Knott) informed the group that we have been working on an engagement strategy, and provided a copy to the group. Indicated that the company is seeking to arrange a day long closure consult with the group in October or November. Provided an overview of the items we would like to discuss and seek Yinhawangka input on. PK provided a draft agenda for this meeting. Discussion on importance of rehabilitation, and appropriate seed collection and soil preparation raised by Yinhawangka representative. Pk discussed that there may be business opportunities for Yinhawangka with rehabilitation and environmental site works. Also indicated that YAC are welcome to invite a technical consultant to attend the consultation when it occurs.	There were no objections or concerns raised relating to the proposed Channar and Eastern Range Order of Magnitude Closure studies consultation session with Yinhawangka representatives. A forum is to be organised ideally prior to the end of 2017, involving appropriate representation from RTIO, Yinhawangka People and YAC.
Environmental inspection Greater Paraburdoo	11th October 2017	Department of Mines, Industry regulation and Safety (DMIRS) formerly Department of Mines and Petroleum prior to July 1 2017. Representatives included Matt Boardman and Adam Ashby.	Presentation and site inspection given focussed on environmental management and rehabilitation as outlined below. 1. Rehabilitation Monitoring Programme: Copies of the Paraburdoo and Channar 2016 Rehabilitation Monitoring Reports were available and Rio Tinto took DMIRS through their monitoring techniques (transects and RQA). Overall they were very impressed with our monitoring programme, however mentioned that the detail we provide in the AER is very limited. Rio Tinto advised that once we have finished our Enviro Sys work (data cleanse), we will be in a position to consult with them further on the monitoring results. 2. Rehabilitation Quality: DMIRS were impressed with rehabilitation quality at CHE3, the CH Weather Station, 84E5 and the Truck Training Ground. They noted that we need to monitor and potentially undertake remedial works on the 4WN rehabilitation due to erosion gullies and minimal native vegetation establishment. 3. Patchy Rehabilitation: It was noted that the Truck Training Ground rehabilitation had some sparse patches. DMIRS were happy with that, as they know this happens naturally in undisturbed vegetation. 4. 84E5 gully repaired: DMIRS were happy to see that the 84E5 gully reported during their last inspection has been repaired. 5. Interface Between rehabilitation and natural ground: Whilst at the 84E5 waste dump rehabilitation they noted the erosion gullies at the point where the rehabilitation meets the natural hill side. DMIRS asked what the management strategies are for this zone. Rio Tinto responded that to date we have not implemented any, but dumping blocky waste in this area would be an appropriate future control. DMIRS advised that BHP have a project underway investigating appropriate controls/designs for this issue.	N/A
			6. Alternative Growth Media: DMIRS accompanied Rio Tinto to collect a sample of the CH 64E5 pit detritals which was to be tested as an alternative growth media. They also viewed the Sugar Dump (alternative growth media stockpile) and advised stockpiling this material is a good initiative. 7. Closure Planning: DMIRS emphasised the importance of detailed closure planning from studies phase all the way through to closure. 8. Landbridges and Channar Hill: DMIRS requested an update on these topics. Rio Tinto advised they have been worked on by the OoM closure studies and will be discussed during the DMIRS meeting scheduled for later this month. 9. Eastern Range Closure Plan Review Comments: Rio Tinto confirmed with Matt Boardman that the comment received from DMIRS in regard to wave action eroding a landbridge does refer to a body of water sitting against a landbridge and the impact of waves (caused by wind) to erode the landbridge, as opposed to a wave (rush of water) caused by a significant flood event. 10. Stakeholder Engagement: DMIRS emphasised the importance that we consult with our stakeholders. Rio Tinto advised that increased stakeholder engagement has commenced as part of the Eastern Range and Channar OoM Closure Studies. They advised that we must engage with the District Safety Inspector, particularly in regard to abandonment bunds. 11. Weed Management: DMIRS noted that weeds across the site are an issue and need to be managed. 12. Paraburdoo Pits and Creek Lines: DMIRS noted how close the 4W Pit crest is to the Pirraburdoo Creek and raised concerns about the pit intercepting the creek flows (refer attached photo). Rio Tinto advised this will be addressed in the closure plan update that is underway for Paraburdoo. 13. Progressive Rehabilitation: DMIRS mentioned in the close out meeting that it is evident that rehabilitation is now a focus, which is good to see. 14. Channar Closure Plan Comments: Have been completed by DMIRS and sent to JTSI (DSD) so should be with Rio Tinto in due course.	
General closure plan update provided as part of the EPA Services Monthly Meeting between DWER and Rio Tinto iron ore.	24th October 2017	Department of Water and Environmental Regulation (DWER) -EPA Services (formerly Office of the Environmental Protection Authority (OEPA) prior to July 1 2017)	Overview provided of closure plans that Rio Tinto (iron ore) is currently working on in 2017 and planning for 2018 to either support approvals in process, for compliance purposes or to meet commitments made to the Department of State Development in 2016 to submit closure plans for all operations over a three year period. These include: - Silvergrass East - Hope Downs 1 - Mesa A hub - Mesa J hub - Paraburdoo - Tom Price - Brockman 4 - Hope Downs 4 - Eastern Range - Channar Discussed the Order of Magnitude closure studies underway for Eastern Range and Channar operations and indicated that Rio Tinto would like to arrange targeted discussions with DWER on these projects. Discussed imminent submission of Silvergrass Closure Plan.	Rio Tinto will submit the Silvergrass Closure Plan in the near future for review and approval. Rio Tinto will seek to arrange a meeting to discuss Eastern Range and Channar closure studies with all relevant DWER stakeholders (including Department of Water, Environment Regulation and OEPA).

Consultation Stage	Date	Stakeholder(s)	Summary of discussion relevant to closure	Response
Consultation as part of OoM closure studies	25th October 2017	Department of Mines, Industry regulation and Safety (DMIRS) formerly Department of Mines and Petroleum prior to July 1 2017. Representatives included Danielle Risbey and Matt Boardman.	First official engagement with DMIRS as part of the Channar and Eastern Range closure studies. A copy of the Stakeholder Engagement Strategy had been provided ahead of the meeting. Topics discussed included: Introductions and overview of closure planning process from conceptual through to implementation. Overview of engagement strategy. DMIRS indicated they are happy to be part of cross regulatory engagements. Recommended Rio Tinto include the safety and geotechnical branches of DMIRS in our discussions particularly on potentially unstable pit edge zone and abandonment bunds. Provided update on completion criteria process. Provided overview of rock armouring trial planned for implementation at Channar in 2018. Discussed Rio Tinto draft responses to Eastern Range conceptual closure plan. Discussed landform design and PMP/PMF in relation to ongoing feedback from regulators. Rio Tinto keen to engage on this issue. DMIRS indicated that this would occur in the near future. Indicated that Rio Tinto would like to consult on these sites again before the end of the year and again in early 2018.	Next meeting to be arranged prior to the end of the year
Consultation as part of OoM closure studies	24th November 2017	Yinhawangka and Yinhawangka Aboriginal Corporation representatives, supported by Phil Haydock (external anthropologist)	Day long workshop held in Paraburdoo. Topics discussed included: -Production profile for eastern Range and Channar to current predicted end of mine life (subject to change each time mine plan is reviewed) -Overview of closure planning process -3D overview of the site -How community impacts are being considered and relation to Western Range project which is in planning -Overview of closure objectives and criteria -Rehabilitation seed mixes -Cultural heritage management during closure -Post closure access and landscape -Business opportunities for Yinhawangka in relation to rehabilitation and closure -Next steps in terms of next engagement and process from here	Key messages from this workshop were: -Yinhawangka are keen to be involved in the closure journey. -Would like access to baseline water, flora, fauna and heritage data where available, and would like to know in terms of heritage sites identified which have been cleared under S18 which ones still exist/haven't been disturbed to date. Would also like access to 3D models if possible. Rio Tinto to investigate. -In terms of whether any plants are important to them in the landscape, Yinhawangka requested a survey (i.e. ethno-botanic) to look at what is growing locally currently and also for analysis on a salvaged grinding stone to be undertaken to determine what plant species it was used for - this will help Yinhawangka to provide the company with guidance on what plants might be important to them in the landscape. -Questions raised around borefields and water sources. Access to water post closure is important. Yinhawangka commented that 'water is the lifeblood of Yinhawangka country and we need to respect this. Water is crucial to Aboriginal people'. Rio Tinto have been planning for a water presentation to the group and this should occur in the new year. -Yinhawangka committed to providing a document of what is important to them for the company to consider in closure planning. -In terms of business opportunities, the group is keen for women to be involved in seed collection - suggested as a possible women's ranger program. - Access to country post closure was discussed and preliminary abandonment bund locations demonstrated.
Eastern Range 2016 Closure Plan Regulatory Agency Review Comments	8th December 2017	Department of Jobs, Tourism, Science and Innovation (JTSI) and Department of Mines, Industry Regulation and Safety (DMIRS)	The 2016 closure plan was submitted voluntarily to JTSI in 2016. Comment on the plan was provided by DMIRS. Key areas of comment included: - A stakeholder engagement strategy should be included in the closure plan. - Closure objectives and completion criteria require refinement. - Clarity is required on management of potentially acid forming material (PAF) - Site specific soil sampling is required. - Further information requested on rehabilitation performance. - DMIRS requires closure landforms be designed for events far more extreme than a 1:100 year ARI event, with consideration given to a PMF event (and designed to a PMF event if reasonable). - DMIRS does not see the nature of Iron Ore mining as being a limiting factor for progressive rehabilitation. - Concern around leaving landbridges in -situ at closure. Investigation is required to understand whether removal or additional re-shaping is required.	- Stakeholder engagement strategy will be included in next closure plan update. - Closure objectives and completion criteria will commence review during the Order of Magnitude study. - The pit containing PAF material is planned for redesign to avoid intercepting this material. - Soil sampling will be conducted at Eastern Range. - DMIRS inspected this area on 11 October 2017 and feedback indicated they were happy with current rehabilitation progress. - RTIO currently designs final landforms to 1:100 year ARI events and considers more intense events including PMP / PMF. Where PMP / PMF risks are significant RTIO plan to implement appropriate controls where practicable. Further engagement is requested to understand the regulators direction and reach an agreed approach. - Rio Tinto considers many aspects prior to progressing areas for rehabilitation to ensure that scarce topsoil and seed resources are not squandered. - Landbridges are large structures, often located in inaccessible terrain, that are technically challenging to remove and/or rehabilitate. In assessing whether an individual landbridge should be removed or rehabilitated in-situ, many factors are considered.
Consultation as part of OoM closure studies	16th January 2018	Shire of Ashburton representatives (via Council meeting)	Introductory meeting to provide council representatives with an overview of the closure studies underway for Eastern Range and Channar. Discussed the following items: - Indicative closure timing for both sites, which have less than 10 years until the end of mine life based on the November 2016 life of mine plan (LoM). This may change when the next iteration of the LoM is released. - Provided an overview if the closure planning process from conceptual closure planning through to relinquishment. - Discussed how Paraburdoo town impacts are being considered and recognised that the town economy is dependent on the mining industry. - Sought guidance from the Shire on how often they would like us to engage with them on this topic and who are the appropriate representatives. - Indicated that in 2018 we will commence prefeasibility studies, with Eastern Range being the first one. Indicated that the company is committed to keeping the Shire informed as information becomes available.	Question from Council: How does this study line up with the Western Range development? Response: The Western Ranges study is at the same stage of investigation as these closure studies. The workforce demands for this study will be completed as it moves into the next stage of detail and this information will then inform closure strategies for Eastern Range and Channar in terms of workforce. Question: How is this going to effect the population of the town? Response: At this stage Rio Tinto is committed to Paraburdoo as a residential town, as evidenced by recent funding investment and the 90% occupancy rate in the town. Comment from Council: A context setting slide is missing from the pack, it was assumed that everyone present knew the sites and the fact that they are part of an operating hub. Response: This was acknowledged by Rio Tinto and commitment taken on board to keep this in mind for future engagement Question: Have other land use options been considered for the area once mining has finished? For example the area could be amenable to mountain biking. Response: The process of identifying and evaluating final land use options for the site during this first stage of study was discussed. Indicated that our standard option is to rehabilitate the landscape back to a native ecosystem which is safe, stable and non-polluting. However other options have been investigated. Comment: Council would like to understand these options and be given opportunity to comment on them in future engagements. Comment from Council: Pleasing to see the transparent manner of this engagement. Also appreciate early engagement on this.
Consultation as part of OoM closure studies	6th and 7th March 2018	Yinhawangka and Yinhawangka Aboriginal Corporation representatives	2 day meeting with Yinhawangka to provide an update on the Channar and Eastern Range order of magnitude closure studies, the Western Range prefeasibility study and provide an overview of hydrology and hydrogeology for Greater Paraburdoo. Included a site visit as part of the closure studies. Key discussion points of relevance to closure included closure objectives, post closure access and business opportunities presented by closure. Site visit included the 64E1 landbridge, Channar radio hill lookout, CHE3 in-pit PAF rehabilitation, 84E5 rehabilitated waste dump and 94E2 landbridge.	Key questions and responses are included below: Q: How do YAC find out about the process to establish a Pilbara Aboriginal Business? A: We have dedicated roles in the Perth team to support this. Q: There are two key bush medicines in the natural landscape. These are identified in Lola Young's Book. A: Noted, will bring book to next engagement. Q: In relation to visual impact assessment and access, access to Howie's Hole needs to be kept open from the north and south. A: Noted, will be included in site knowledge base to direct closure planning. Q: Is it possible when rehabilitation is being undertaken to have the access road to Doggers Gorge graded to make access easier? A: Yes this can be included. Q: Can we leave the access track in place up to Channar Radio Hill? It provides a good lookout point for tourism. A: At this stage we are leaving the tower in place and the access track would remain until the borefields are closed for maintenance i.e. when Paraburdoo closes and the radio tower is no longer needed. Q: Can we spend money that is planned to be spent on rehabilitation on investing in YAC instead? A: We have legal obligations to the regulators that we need to meet as part of our conditions.

Consultation Stage	Date	Stakeholder(s)	Summary of discussion relevant to closure	Response
				Q: Looking at water in the base of the CHE3 pit, one Yinhawangka member indicated he would be amenable to a pit lake as long as water quality is good. A: You will only get a lake developing if the pit has been mined below the water table and has not been backfilled. Above water table pits may hold water for a short period as it infiltrates and evaporates but this won't be permanent. The only potential area where we may still mine below the water table is at 64E5, however the business has not yet made a decision on this. If it is pursued, we still need to do studies to understand what the water quality would be before a pit lake strategy was progressed.Q: (In relation to 84E5 rehabilitation) – There are no trees in the rehabilitation. What species are these? They are not from here. A: Discussed provenance zones which allow seed to be collected from within a certain radius of the site. The seed is native. No trees are present as the rehabilitation is relatively young, and it is harder for us to get trees and spinifex (Triodia) growing in our rehabilitation. Over time a vegetation complex with an understorey and shrubs should develop. This area was rehabilitated with no topsoil.
Consultation as part of OoM closure studies	8/3/2018	Department of Water and Environmental Regulation	Meeting included representatives from the former Contaminated Sites Assessment branch, Department of Water and EPA Services. Meeting provided an overview of the closure studies underway for Eastern Range and Channar and sought feedback from representatives on the proposed engagement strategy. Key topics of discussion included: - Site location and context - Indicative timing for closure - Closure plan scope - Proposed engagement strategy - Closure objectives - Complex landform rehabilitation challenges - Contaminated sites investigation process - Hydrology and hydrogeology	Key questions and responses are included below: Q: Does Ministerial Statement 16 (Channar) have a clearing limit imposed? A: To be confirmed. NB: This has been clarified since the meeting, Channar is limited to 2500 hectares within the proposed disturbance boundary. Rio Tinto question: is appropriate to continue combined engagement or target specific areas of DWER based on the agenda of the discussion? DWER response: if it is a general presentation then combined engagement is preferred however for specific topics split these out to the target group. If a discussion is related to contaminated sites, include water team representatives also. Q: In relation to the landform criteria, when we say 'consider' hydrological factors' do we mean 'protect'? A: Agree that this could be refined. The completion criteria that support these objectives go into the detail of what will be measured. Q: Water could be split out into its own objective. The groundwater monitoring proposed in the Channar closure plan are not included in the completion criteria. A: The intent is to revise the criteria this year. Later in the year we intend to have these revised criteria available for formal comment. Q: Any Preliminary Site Investigation should include landfills and waste dumps where PAF has been stored? A: Noted. Q: Will the new mine plan extend the life of the mine? A: Potentially yes. However it normally is only by 1-2 years each time a plan is revised so we are still undertaking the closure studies at the appropriate time.
RTIO presentation at Yinhawangka Local Implementation Committee (LIC) meeting	12/4/2018	Yinhawangka and Yinhawangka Aboriginal Corporation representatives	Presentation as part of the Local Implementation Committee meeting. Update provided regarding status of closure studies indicating that the OoM studies were concluding and the Prefeasibility studies are expected to commence in the near future, pending review outcomes.	Discussion point: YAC needs to know when Eastern Range is actually going to close as this will impact YHW's mining benefit payments (MBP) and the Trust will need to adjust accordingly. Rio Tinto representatives explained that as soon as Eastern Range ceases production, Western Range will be required to start up in order to maintain the required level of tonnes produced from Greater Paraburdoo; therefore there the mining benefit payments should not be impacted. At this stage Western Range will commence production in 2023 and is expected to continue to run for 20 years. Discussion point: Follow up on a request that was made at the recent closure consultation meeting. Rio Tinto received a request from YAC to fund a dedicated Environmental Specialist position to interpret environmental reports associated with these projects. Rio Tinto indicated that it already provides the funding for the YAC Implementation Officer and therefore would not provide funding for another position. YAC will need to factor in the specific skill requirements in the future when recruiting for this position; Rio Tinto may be able to get the consultants to produce modified reports that don't require a high level of technical expertise to interpret, but cover the main points/results.
RTIO presentation at Yinhawangka Heritage and Environment Committee (LIC) meeting	26/10/2018	Yinhawangka and Yinhawangka Aboriginal Corporation representatives	Indicated that the Eastern Range and Channar Order of Magnitude closure studies had just been completed and the Eastern Range closure Prefeasibility study commenced in August. Discussed the Closure Paper that YAC have previously committed to preparing to provide guidance to Rio Tinto on Yinhawangka's wishes with respect to closure. One Yinhawangka member mentioned that the concept of pit lakes for potential tourism activities was very appealing and asked for this to remain part of the ongoing conversation about closure.	
Consultation as part of OoM closure studies	17/1/2019	Yinhawangka Aboriginal Corporation	Yinhawangka Liaison Officer contacted Rio Tinto to request copies/access to the latest closure plans for Eastern Range and Channar	Provided copies of the 2016 Eastern Range and 2017 Channar closure plans as requested.
Yinhawangka end of year LIC report	January 2019	Yinhawangka Aboriginal Corporation	Half yearly written summary provided to Yinhawangka in relation to Paraburdoo and West Angelas operations. In relation to Channar and Eastern Range, the report advised that the OoM closure studies have now been completed. The Pre-feasibility studies will commence in 2019 and we will continue to engage with Yinhawangka throughout the process.	N/A
Consultation as part of wrap up of the OoM closure studies	March 19th and 20th 2019	Yinhawangka Aboriginal Corporation	In two separate forums over two days, a 3D mapping model which covers the mine sites relevant to Yinhawangka lands; West Angelas, Western Range, Paraburdoo, Eastern Range and Channar was presented to Yinhawangka representatives. This model is a replica of the internal mapping software used by Rio Tinto and was being provided for external use by Yinhawangka in response to a request during earlier consultation for access to a tool such as this. Relevant closure related topics discussed during these forums included: - 3D model was very well received by the group who discussed multiple uses of the tool; - Strong desire for salvaged artefacts to be returned to country at closure, not necessarily in the locations it came from but using GPS locations as nearby as possible; - Discussed the remaining life of operations for Eastern Range and Channar and more broadly for Greater Paraburdoo; - Yinhawangka are keen to see Paraburdoo town have a life after mining. They have aspirations to build a cultural interpretive centre in Paraburdoo; - Desire by the group to use the land post closure where possible for beneficial uses such as intensive agriculture and request that operational bores are considered to be left for their access/use; - Request that environmental controls are put in place for sea containers being used for artefact storage; - In the PFS closure studies Yinhawangka representatives who haven't been previously would like to visit existing rehabilitation sites at Paraburdoo, Eastern Range and Channar; and - Yinhawangka would like access to the list of flora species used in rehabilitation.	N/A
Presentation of Greater Paraburdoo Iron Ore Hub closure overview	April 2019	Department of Water and Environmental Regulation (DWER); Department of Planning, Lands and Heritage (DPLH)	PowerPoint presentation on the Paraburdoo, Western Range and Eastern Range closure plan updates, which will be submitted as part of the Part IV approval for the Greater Paraburdoo Iron Ore Hub. Eastern Range closure plan was last submitted to JTSI in 2016. This 2019 update will include proposed new mining areas 42EE and 47E. Two new landbridges are proposed, and will be removed at closure to reinstate surface water flows. The next detailed closure planning stage (PFS) for ER is scheduled to commence in the near future. At this time engagement with Stakeholders will recommence.	Queries raised related to Western Range and Paraburdoo developments
Presentation of Greater Paraburdoo Iron Ore Hub closure overview	April 2019	Department of Mines, Industry, Regulation and Safety (DMIRS)	PowerPoint presentation on the Paraburdoo, Western Range and Eastern Range closure plan updates, which will be submitted as part of the Part IV approval for the Greater Paraburdoo Iron Ore Hub. Eastern Range closure plan was last submitted to JTSI in 2016. This 2019 update will include proposed new mining areas 42EE and 47E. Two new landbridges are proposed, and will be removed at closure to reinstate surface water flows. The next detailed closure planning stage (PFS) for ER is scheduled to commence in the near future. At this time engagement with Stakeholders will recommence.	Queries raised related to Western Range and Paraburdoo developments

APPENDIX C – CLOSURE KNOWLEDGE DATABASE

Rio Tinto Eastern Range closure knowledge database

The closure knowledge database is a summary of the technical reports that directly or indirectly contribute to the development of the closure plan. These documents do not form part of the report and are for indicative purposes only.

The knowledge and understanding of closure issues and management strategies evolve and improve over time, coincident with the development of the mining operation. As a result, some components of some reports and studies may be superseded by new research or studies. While the closure plan addresses the current state of understanding and strategy for closure, the closure knowledge database captures the historical development of closure knowledge, and demonstrates how experience and knowledge developed at other Rio Tinto sites has been considered during the development of the closure plan and across the life of the operation. Accordingly, some information presented in the closure knowledge database may be obsolete.

Technical reports supporting the closure of the operation will be presented as part of the last plan produced prior to the implementation of closure (also known as the Decommissioning Plan).

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Geochemical characterisation

Review of Waste Rock Geochemistry a) General Overview of Acid Base Accounting **2006**

Internal reference: RTIO-PDE-0021130

This report contains a general overview of acid base accounting and a summary of the geochemical test work that has been previously completed for various sites and lithologies.

There are large discrepancies in the total sulfur concentration measured using XRF and LECO machines. The XRF machine underestimates the sulfur concentration at values greater than 2%. Materials with total sulfur concentrations less than 0.1% can contain low capacity PAF material, however, it is considered only to be low additional acid and metalliferous risk if the boundary for inert material and potentially acid forming material is shifted from 0.02%S to 0.1%S. A paste pH result of less than 7 should be sent to the black shale dump and a paste pH result of greater than 7 can be sent to an inert material waste dump.

Mineralogical Analysis of Potentially Acid Forming Materials **2008**

Internal reference: RTIO-PDE-0053725

Quantitative mineralogy (QEM-Scan) for samples of rock collected from Tom Price, Channar, West Angelas, Brockman, Paraburdoo (4 East Extension), Western Turner Syncline and Hope Downs 1 North was undertaken. Comparisons were made between two methodologies use to characterise potentially acid forming materials; acid base accounting and mineralogical analysis.

All samples contained elevated total sulfur concentrations and the lithologies were either shale, banded iron formation or dolomite. Pyrite was the dominant mineral contributing to acidity and the dominant sulfate secondary mineralisation consisted of alunite and jarosite.

Determination of ARD potential of Rio Tinto Iron Ore (WA) Waste Rock Samples **2008**

Internal reference: RTIO-PDE-0051613

This report investigates the use of mineralogy to predict acid and metalliferous drainage potential. Analysis of numerous rocks was undertaken using QEM-SCAN.

Areas of waste rock which have underdone oxidation can be identified where sulfur-bearing minerals vary between samples in the form of pyrite, alunite and jarosite. The variability of gangue mineral phases suggest that some areas of composite waste rock pile may provide some neutralising potential while other areas will have no neutralising potential. Variable textural and mineralogical controls on sulfide mineral occurrence result in decreased accessibility of pyrite to oxidising fluids.

Contaminant Leaching from Non-Sulfidic Waste Material **2011**

Internal reference: RTIO-HSE-0145041

The available leach extract data and information pertaining to the distribution of metals and metalloids in non sulfur materials at neutral pH was reviewed. Based on this review conceptual models for controls on their leaching and mobility were developed.

The review found that contaminant leaching from non-sulfidic materials was generally very limited. Usually the pH in leach tests was near-neutral (pH 6 to 8), and dissolved contaminant concentration were at or below detection limits. It is believed that a primary leachable contaminant source is the oxidation of sulfide minerals. Release from oxidising sulfides leads to release of soluble reaction products. Under neutral pH conditions, there is the potential for release of these contaminants when those products dissolve.

Environmental Status of Selenium (Se) in the Pilbara Region of Western Australia – Potential Risk from Iron Ore Mining **2011**

Internal reference: RTIO-PDE-0103857

This report includes information about Selenium geochemistry, distribution in the environment, occurrence in rocks in the Pilbara and potential risks to the environment.

The Selenium (Se) content of shales containing significant pyrite should be recorded as part of the overall risk assessment for acid and metalliferous mine drainage. However, it should also be noted Se solubility is far less constrained by pH than in the case of metals and near neutral drainage may contain significant Se concentrations in solution. It would be most useful to study the Selenium budget of the wetlands in the Pilbara as, apart from the chance poisoning of livestock from the consumption of plants that have taken up high concentrations of Selenium, impacts are most likely to be felt in wetlands receiving mine site drainage.

Contaminant Leaching from Low-Sulphur Waste Minerals (Summary) **2011**

Internal reference: RTIO-PDE-0090689

RTIO's Geochemical Database was reviewed and based upon this data, conceptual models for controls on the leaching and mobility of a range of metals and metalloids were developed. This summary also describes potential controls on the amount of dissolved element that may be released. This is a summary of a comprehensive report RTIO-PDE-0100104.

For most contaminants, dissolved concentrations at circum neutral pH (pH 6 to 8) were very low, typically at or below detection limit. Geochemical modelling indicates that water-rock interactions are controlled by equilibrium, for salt, carbonates and sulphates this equilibrium is often source term limited whilst hydroxyl-sulphates and hydroxides are solubility controlled. Results also indicate that sorption plays an important role in solute concentration; weak (but detectable) sorption occurred for selenium and zinc whilst the strongest sorption was evident for cobalt. The review suggested that storage waste facilities containing low-sulfur materials pose a low level of environmental risk however, there is a small risk of increased in mobility of some contaminants if acidic conditions arise. Acidic conditions can sometimes arise from the interactions between iron and aluminium hydroxyl-sulphates and hydroxides.

Geochemical Characterisation of Samples from the Eastern Ranges Operation **2012**

Internal reference: RTIO-PDE-0102595

Acid-base accounting test work was completed on samples collected from the Eastern Ranges project area to assess the acid generation potential of the materials. Leach test work was also undertaken to give an indication of the propensity for contaminants to leach from the samples.

The samples were classed as either non acid forming (NAF) or of uncertain potential to generate acidity UC(NAF). Results suggest stored acidity is present in the samples in the form of the sulfate mineral alunite. The following minor and trace materials were enriched compared to average crustal abundances As, Bi, Sb and Se. Leach extractions were dominated by Ca, Na and Cl, though high concentrations of K, Mg, S, Si, N, B and Ba were also measured. Other minor and trace elements above detection limits included: F, Al, Cd, Mn, Ni and Zn. For samples with moderate levels of S, As, Co and Cu were detected in the extracts.

Geochemical Assessment of Tailings from Yandi, Paraburdoo, Tom Price, Brockman 4 and Mesa J **2014**

Internal reference: RTIO-PDE-0123030

This report presents the results from geochemical testing and saline solution extraction of tailings samples from Yandi, Paraburdoo, Tom Price, Brockman 4 and Mesa J deposits.

Overall the tailings from these operations are unlikely to generate acid and are not expected to leach significant levels of metals under oxidising or saline conditions.

Oxidation and solute accumulation in dewatered pit wall rocks **2014**

Internal reference: RTIO-PDE-0109045

Dewatering and removing the water table may result in de-saturation of sulphide-bearing lithologies. This study was undertaken to review how oxygen ingress and consequent sulphide oxidation of Mount McRae Shales could impact water quality when the groundwater table rebounds after mining.

Large Scale Column Construction Procedure and Initial Chemistry **2014**

Internal reference: RTIO-PDE-0123894

Large scale column experiments have been constructed to examine the reactivity of hot and cold black shale material in an operational environment. The memo describes the construction of the columns and the first geochemistry data collected after small rainfall events at Rhodes Ridge.

Initial results suggest that effluent water retains the chemistry of the incident rainfall. Constituents to note in the initial chemistry include nitrate and ammonia detected in the hot black shale effluent. This study provides an important comparison between laboratory characterisation studies and field reactivity of waste rock. Data from the large scale column tests can be applied to reactivity of in pit waste/talus as well as waste rock dumps. It can be used as an intermediate to predict long term reactivity of waste rock.

Tom Price – Historical black shale exposures in SEP Pit compared to expected black shale exposures at BS4 and HD4 **2017**

Internal reference: RTIO-PDE-0149285

The purpose of this study was to understand and compare potential surface water and groundwater quality risks from pits with areas of exposed Mount McRae Shale (MCS) at Tom Price, Brockman Syncline 4 and Hope Downs 4 operations.

The annual (approximate wet season) black MCS exposures in South East Prongs (SEP) pit at Tom Price have been modelled as part of this exercise. The maximum black MCS surface area within the SEP pit (from 2000-2010) is modelled to be 200,000 m2 (2010), representing approximately 9% of the SEP pit catchment area. It is noted that acid water was first observed in a SEP groundwater bore in 2001, when total black MCS surface areas were modelled to be 68,500 m2 (3% of total pit shell catchment area). Acidic water within groundwater was observed in 2001, approximately three years after dewatering of the SEP pit commenced in 1998 via a number of in-pit dewatering bores. It is possible that surface water may have been acidic earlier than 2001. The significant accumulation and pooling of water within the SEP pit during large successive rainfall events, particularly Cyclone Monty in 2004 (representing a 12 year ARI (average recurrence interval) at Tom Price), likely caused acidity within the in-pit groundwater bores. In subsequent years, the pH had an increasing trend in many of the bores, however groundwater remained acidic for at least four years following Cyclone Monty.

Geochemical Characterisation of mine waste from Tom Price, Hope Downs 1 and Hope Downs 4 **2018**

Internal reference:
RTIO-PDE-0159203

The purpose of this work was to investigate the leaching kinetics of six low-sulfur waste rock samples collected from Tom Price, Hope Downs 1 and Hope Downs 4. Static testing was conducted to provide a 'snapshot' of the geochemical characteristics of each waste rock sample. These tests were completed to screen all samples before commencing more detailed leach column tests. The geochemical test program was designed to assess the degree of risk from the presence of reactive sulfides, acid generation and leaching of soluble metals/metalloids and salts in accordance with relevant mine waste geochemistry and mine closure guidelines.

The results from the geochemical assessment indicate the samples have negligible to low-sulfur content, low but generally sufficient ANC and are generally classified as non-acid forming. The amount of potential acidity that could be generated from the samples is expected to be negligible to low, with all samples having low reactivity; there is a high factor of safety and low risk of any significant acid generation from these materials. Waste rock materials represented by these samples are likely to generate pH neutral surface runoff and seepage with low salinity and generally low concentrations of dissolved metals(loids) (excluding the Tom Price black MCS sample where elevated manganese was measured in the leachate).

Easter Range AMD Risk Assessment **2019**

Internal reference:
RTIO-PDE-0113738

The acid and metalliferous drainage (AMD) risk assessment for Eastern Range takes into account total sulfur content and logging data for drillhole samples, to indicate the presence of sulfide or sulfate minerals. The assessment also considers the measured acid neutralising capacity of rock types to assess the overall risk of acid generation from waste exposed in each area. The in-pit analysis of waste rock types (to be) mined from each area have been compiled; that data are used to validate the assessment of inherent acid drainage risk determined using all mining-area drillhole data. The potential exposure of black shale against the 32E final pit walls have also been examined, along with all geochemical data, to identify enriched concentrations of elements that may pose an environmental risk. This assessment supports the current Eastern Range Closure Plan (order of magnitude study) as well as the Eastern Range feasibility study, and should be used to focus future budget and resources into areas that are deemed to pose a greater relative risk of AMD during operations and upon closure.

Drillhole data have been divided into the following mining areas: 23e24e 32e, 37e42e and 42ee47e. The calculated Neutralisation Potential Ratio (NPR), which relates the neutralising capacity to the maximum potential acidity which could be generated, was used to assess the inherent risk of acid generation from waste rock associated with each mining area. All mining areas at Eastern Range are deemed to pose a low AMD risk (based on current final pit shell designs, specifically at 32e where the current design avoids the exposure of black shale).
With regards to chemical enrichment, the following elements have been identified as being enriched in various rock types across the Greater Paraburdoo mining areas (considered analogous to Eastern Range): As, Cl, Fe, Co, Cr, Cu, Mn, Pb, S, Sb, Se, Sn, V and Zn. Leach testing on low-sulfur drillhole samples generally resulted in leachates with most trace elements (including nitrate) measured at concentrations that were close to or below the limits of detection.

Physical characterisation

Net solute load response to the installation of infiltration limiting dry cover systems over acid forming waste piles **2014**

Internal reference:
RTIO-PDE-0128431

This work was conducted to verify the central design concept of store-and-release covers over sulfidic above water table waste dumps that is, whether limiting net percolation volume through the cover results in a lesser sulfate and acidity load being realised generated and passing through the dump.

The results from this thesis project confirm that the central aim of store-and-release covers to reduce net percolation volume is a valid measure for reducing the net loading of sulfate and acidity. The mechanism through which decreasing net percolation (applied water volume) results in a lesser sulfate and acidity load was identified, however further work in a site context is needed to assess how this relationship between percolation volume and loading persists in the real-world environment.

Growth Media Characterisation **2018**

Internal reference:
RTIO-HSE-0324326

This report provides an interpretation of material characterisation data for a total of 53 potential growth media samples made up of 34 samples for which data has been previously collected by Outback Ecology Services on behalf of Rio Tinto, 11 samples for which data has been previously collected by Landloch on behalf of Rio Tinto as part of previous erosion studies and 8 additional samples collected and analysed as part of this project. Based on this characterisation, each material was classified as either suitable or not suitable for use as a growth medium.

Properties tested for included pH1:5 (water), salinity (EC1:5, EC1:2), exchangeable cations (K+, Ca2+, Mg2+, Na+, Al3+), effective cation exchange capacity (ECEC), exchangeable sodium percentage (ESP), particle size distribution (fine fraction<2mm), coarse fraction (> 2mm), particle size distribution (all material), texture, emerson class, dispersion potential rating, rock particle density, rock water absorption and rock cover of rain-armoured surface. A classification scheme for key parameters was then developed to classify a material as suitable or unsuitable. Several materials have properties that were invariably suitable. In some cases, materials have some properties that are suitable and others unsuitable. In others, several of the properties are problematic. Suitable materials represent those that have base properties that are not likely to impede vegetation. Marginal materials are those that are likely to support vegetation but that have some properties that may limit establishment and growth. Unsuitable materials are those that have properties that are likely to significantly impact on vegetation growth either through being saline, prone to dispersion, and having pH values quite different to those typically observed. Of the 53 samples, 21 were recommended as suitable growth media, 25 were assessed as marginal growth media and 8 were not recommended as growth media. Samples which were recommended were sourced from Yandicoogina, Channar, Mesa J, Mesa K, Eastern Range, Paraburdoo and Parker Point. Marginal samples were sourced from Brockman 4, Brockman 2/Nammuldi, Mesa A, Mesa J, Channar, Eastern Range, Paraburdoo, Yandicoogina and Hope Downs 4. Samples which were not recommended were sourced from areas at Greater Paraburdoo (Paraburdoo and Eastern Range), West Angelas, Western Turner Syncline and Parker Point.

Surface water

2016 review of Existing Water Quality Data Greater Paraburdoo **2017**

Internal reference:
RTIO-PDE-0154092

This report evaluates historical and current geochemical data from surface water and groundwater monitoring locations in the Greater Paraburdoo region, including at the Paraburdoo, Eastern Ranges and Channar mine sites. The aim of the report is to monitor for signs of acid and metalliferous drainage (AMD) development or changes in water quality associated with dewatering or other mining activities. Groundwater quality has been reviewed from production and monitoring bores regionally and within the Paraburdoo and Channar mine sites, with a focus on areas with AMD risk. The Eastern Range mining area is AWT and there are no groundwater bores due to its high elevation. Surface water quality was evaluated from monitoring sites in pools and creeks, within the Seven Mile Creek and Turee Creek catchments. The previous water quality review for Greater Paraburdoo was conducted in 2011 and therefore, the focus is on water quality data between 2012 and 2016.

Groundwater at Greater Paraburdoo was circum-neutral in 2012-2016 and ranged from 7.3 to 8.6 pH. Excluding the groundwater surrounding the Paraburdoo tailings dam, groundwater was fresh and TDS ranged between 150 and 1800 mg/L, with a median of 870 mg/L. CHE3, 4E and 4W pits pose moderate to high potential AMD risk due to PAF exposures and PAF waste storage in-pit. Ratty Springs bores were monitored during 2011-2013 and displayed generally low salinity (median TDS = 680 mg/L). Regular monitoring is recommended across the site to make it easier to identify changes in water quality. Surface water within the Greater Paraburdoo region was fresh to brackish (TDS: 32 to 3900 mg/L) and neutral to mildly alkaline, with pH ranging from 6.8 to 9.2 for the 2012-2016 period. In general, surface water quality is relatively stable over time within the Greater Paraburdoo region, although there are some gaps in water quality data. This is partially due to the ephemeral nature of many of the water bodies, such as Howie's Hole and Python Pool, where the pools were dry when monitoring was undertaken.

Water interactions and pit lakes

Testing hay as an in situ remediation option for acidic pit lakes in the Pilbara **2017**

Internal reference:
RTIO-PDE-0159196

A field experiment was conducted at the Tom Price mine in two small temporary pit lakes ('West' and 'East' Lakes). Water-damaged hay produced by Rio Tinto Iron Ore in the Pilbara was used to treat the West Lake, with the East Lake kept untreated. A laboratory-based microcosm experiment was conducted in order to determine if bio-physical processes that occur in microcosms (a classic method in mine water treatment experiments) represent field conditions. A laboratory-based microcosm pilot experiment containing acidic lake water was conducted for 60 days. Results from the pilot demonstrated that (relative to controls) microcosms containing hay become more neutral to pH >6. Review of the pilot experiment resulted in a range of improvements in the design and execution of the microcosm experiment in order to better mimic conditions in the field trial.

The West Lake controls exhibited a slight improvement in pH over the course of the experiment, whereas the East Lake controls did not. The likely contamination of the water and sediment by hay prior to the experiment (due to collection of in situ water after the field experiment commenced) indicates that the carbon that leached from the hay may have been sufficient to increase pH in the microcosms. The main observable effect of lake water source appeared to be that chemical composition of West Lake was such that the hay - while effective at reducing dissolved oxygen concentrations - was not as effective in driving oxidation reduction potential to levels that classically are considered necessary to support sulphate reducing bacteria. A seasonal algal bloom in East Lake indicated that pit lakes are subject to the same processes as natural lakes; the specific cause of the bloom is currently unclear but likely seasonal. The main risk associated with the use of organic matter to treat acidity in pit lakes is the potential for release of problematic quantities of gases such as methane, carbon dioxide or hydrogen sulphide. Due to a lack of within-lake replication the effect of hay on microbial assemblages could not be determined for the field trial. Further research is needed on gas flux and the microbes responsible associated with organic matter treatments in pit lakes to better understand potential risks associated with gas flux on closure.

Flora

Flora, Vegetation and Vertebrate Fauna on 23E/42E Paraburdoo **1998**

Internal reference:
RTIO-HSE-0016081

This report provides a summary of flora, vegetation and vertebrate fauna on the 23E/42E mine area. The objectives were based on: vascular flora, rare or restricted species, plant communities with local or regional significance, vertebrate fauna (observed or likely to occur) and conservation status. Biological Survey IDs: 1998-1732; 1998-1737; 1998-1911

195 vascular plants species were located, with three introduced species. Higher species diversity is recorded in gullies and drainage areas. No Declared Rare Flora were located within the survey area. Seventeen plant communities were identified. 43 bird species sighted during site inspection. 11 species of birds, mammals and reptiles could occur in the area of conservation significance.

Eastern Ranges Rare Flora Surveys **2002**

Internal reference:
RTIO-HSE-0011111

This report provides a summary document of the Eastern Ranges rare flora surveys. Biological Survey ID: 2002-68

No Declared Rare Flora (DRF) were recorded. The two Pilbara DRF species (Lepidium catapycnon and Thryptomene wittweri) were not recorded in these surveys or previous consulting of the 1980s and 1990s. These species are not believed to be present in the area. One priority flora species was recorded: Eriachne tenuiculmis (P3). Other flora of interest was identified (Eremophila cryptothrix, Eremophila spp., Hibiscus sp., Peplidium sp., Sida spp., Rhodanthe spp., Taplinia saxatilis and Prostanthera campbellii).

Paraburdoo Gas Pipeline Rare Flora Survey **2003**

Internal reference:
RTIO-HSE-0011107

This report describes the flora of the Paraburdoo Gas Pipeline route from September 2003, with the focus to record locations of any rare or unknown flora specimens (and take voucher specimens). Biological Survey IDs: 2003-105 and 2003-540.

Nine general vegetation types identified. Over 150 taxa of vascular flora were recorded, but the focus of the study was on rare or unusual flora. No Declared Rare Flora (DRF) were recorded, including no evidence of Lepidium catapycnon. A single Priority flora species was recorded: Ptilotus trichocephalus (P1), which is a small annual herb found in small patches of up to 25 individuals. Six introduced weed species were recorded from the pipeline corridor: Acetosa vesicaria (Ruby Dock), Aerva javanica (Kapok), Cenchrus ciliaris (Buffel Grass), Cenchrus setigerus (Birdwood Grass), Malvastrum americanum (Spiked Malvastrum) and Solanum nigrum (Black Berry Nightshade).

Regional Survey for Ptilotus sp. Brockman, Aluta quadrata and Geijera aff.Salicifolia **2007**

Internal reference:
RTIO-HSE-0039999

A regional survey was conducted, targeting three flora species, namely Aluta quadrata, Ptilotus subspinescens (formerly Ptilotus sp. Brockman) and Geijera salicifolia (formerly Geijera aff. salicifolia).

The survey proved successful for two of the target species (Ptilotus sp. Brockman and Geijera aff. Salicifolia), as well as a number of other Priority
flora. In reference to Aluta quadrata, no new populations were identified and one erroneous species record was removed from the dataset – reducing its known range.

Eastern Ranges LoM Flora and Vegetation Report **2010**

This report provides a comprehensive flora and vegetation assessment of Eastern Range. Biological Survey ID: 2010-1309; 2010-1314.

Internal reference: RTIO-HSE-0100421

The area has a 'moderate level of floral species diversity' with 191 species of native vascular flora, most prolific genera are Acacia (20), Eremophila (19) and Senna (10). One Priority Flora species: Sida sp. (P3) was recorded from many locations. No Pilbara DRF, TECs or PECs were recorded, but there is potential for Lepidium catapycnon and other Priority species to occur. The area was relatively free of weeds. 52 intact vegetation types were recorded. Ecosystems at risk within the Hamersley IBRA subregion are: 'lower-slope mulga' and 'all major ephemeral water courses'.

Flora and Vegetation Surveys for the Paraburdoo Magazine and the Tom Price Powerline Infrastructure Areas **2011**

This report describes the flora and vegetation for the Paraburdoo Magazine, including the tailings dam stage 3 and the access track to Stony Creek . Biological Survey ID: 2011-1365

Internal reference: RTIO-HSE-0109585

144 taxa from 40 families were iedntified at Stony Creek, across seven vegetation types. No DRF or Priority Flora were identified. Four introduced weed species were identified.77 taxa from 27 families were identified ont eh access tract to Stony Creek, acorss eight vegetation types. No DRF or or Priority Flora were identified, although confirmation is required for a sighting of Eremophila coacta (P1). Four introduced weed species were identified.

Aluta quadrata (P1) Seed Phenology & Collection Program **2011**

Western Botanical implemented an Aluta quadrata seed collection program from August to October 2011. Primary objectives were to gain an understanding of the phenology and seed development of Aluta quadrata, to collect seed from known populations and to determine and implement a seed cleaning method.

Internal reference:

Conclusions recommended that initial seed collection should be undertaken from exposed, north-facing areas, as these plants were first to shed their fruit. The week up to the 30th September 2011 was an optimum time for seed collection at Howie's Hole. By the 4th October optimum seed collection time at Western Range appeared to have passed.

Paraburdoo Botanical & Vertebrate Fauna Survey (2012) **2012**

This survey, commissioned to support a new clearing permit, combined background research with a detailed field survey, provides: an inventory of species of biological and conservation significance, vegetation types and flora species, vertebrate fauna, vegetation types, fauna habitats and a review of previous surveys.

Internal reference: RTIO-HSE-0133972

Two priority flora species were recorded: Aluta quadrata (P1) and Ptilotus trichocephalus (P3). 22 vegetation units were described. 284 terrestrial vertebrate fauna species potentially occur area, including: 33 native and seven introduced mammal species, 140 bird species, 100 reptile species and four amphibian species. There are 23 fauna species of conservation significance. A roost cave for the Pilbara Leaf-nosed Bat was identified.

Flora and Vegetation Assessment - Turee Creek Water Pipeline Upgrade and Paraburdoo Town Feeder One Line Replacement **2012**

This flora and vegetation assessment was conducted for the Turee Creek pipeline upgrade (TCPU) and the town feeder one line (TFOR) locations near Paraburdoo. Biological Survey IDs: 2012-2061; 2012-2062

Internal reference: RTIO-HSE-0147662

The vegetation and flora of the study area is considered to be represented in nearby areas. There are no TECs within the study area. Families with the highest amount of taxa include Fabaceae, Poaceae, Malvaceae and Scrophulariaceae. No threatened species were recorded. Two species of priority flora were recorded from TCPU: Hibiscus sp. (P1) and Goodenia sp. (P3). Restriction zones will be placed around the location of these species. Five introduced (weed) species were recorded in TFOR; seven weeds in TCPU. Desktop assessment shows the study area may provide habitat to 15 conservation significant terrestrial vertebrate fauna species. The fauna habitats of TFOR are common and widespread and does not include significant fauna habitat (eg. caves, rock piles, waterholes, termite mounds, sandy banks or tree hollows). Whereas TCPU contains a water body likely to provide important habitat for native fauna, but there are no other significant fauna habitats.

Propagation of Aluta quadrata via cuttings **2012**

Nuts about Natives were commissioned to investigate propagation of Aluta quadrata via cuttings. Three separate trials were conducted, each employing standard nursery propagation techniques and prior learnings.

Internal reference:

Trials showed that propagation of Aluta quadrata via cuttings was possible using standard nursery techniques, but success rates were extremely low. Over the entire trial period only 6 out of the 896 (0.7%) cuttings showed positive root development. As a result, use and/or application of these propagation techniques in a field based capacity was not viewed as a viable option; and further small-scale laboratory trials would be required to develop/improve methodologies.

Seed testing of Aluta quadrata seed lots **2012**

Internal reference:

Western Botanical's SeedLab (WBSL) was engaged by Rio Tinto Iron Ore (RTIO) to investigate seed quality and germination biology of Aluta quadrata. Seed lots were collected in 2011, from the Howie's Hole, Western Range and Pirraburdoo Creek populations.

On the whole, all seed lots were considered to have a high purity, ranging 96.50% to 99.92% . Viability of seed lots ranged from 9% to 25% and results were considered to be within the expected range for this genus. Germination trials found that the application of certain pre-treatments can increase the germination of A. quadrata seeds. Maximum germination was recorded from manually excising seed out of the indehiscent fruit, though this treatment is not recommended due to the high labour intensity and abnormal seedlings with poor survival rates. The current recommended pre-treatment for germination of A. quadrata seeds is Smoke

Knowledge Review and Predictive Species Habitat Modelling **2012**

Internal reference:

To further the understanding of Aluta quadrata a literature review on the biology and distribution was conducted. The objective of this work was to enhance understanding of known and potential habitat distributions, with a view to utilising outcomes to guide future targeted survey efforts.

Outcomes of the predictive models identified the following potential relationships with known Aluta quadrata locations: mid to high elevations of moderately rugged terrain; low to mid topographic positions of gullies and mid-slopes; low average annual rainfall (approx. 270 mm); vegetation classified as Triodia open hummock grassland; and land system types of hills and ranges.

Eastern Ranges 23E rehabilitation **2013**

Internal reference:
RTIO-HSE-0273803

This project trial involved rehabilitation of the 23E waste dump using utilising fertiliser with the seeding. The lower slope area received Multicote 8 slow release fertilizer, while the upper slope did not. Rehabilitation monitoring took place on the 16-17 June 2015 (rehabilitated sites) and on the 20, 21 and 29 June 2015 (reference sites).

Analysis of the fertiliser trial shows that some differences have developed between the two sites, with perennial and spinifex cover appearing to be higher in the two upper transects (which were not fertilised) than in the lower transects (which were fertilised), and total perennial density significantly higher in the upper transects, reflecting good spinifex establishment. Soil analysis graphs show variability within sites for conductivity, but no consistent differences between the upper and lower transects, although total % carbon and % nitrogen tended to be higher in the upper transects. At this stage, it can be concluded that the presence (or absence) of fertiliser does not explain the difference between the upper and lower transects.

Flora and Vegetation Assessment of the Eastern Ranges Study Area **2014**

Internal reference:
RTIO-HSE-0241229

Vegetation, flora and fauna assessments of the remaining portion of Eastern Range proposal area, not surveyed as part of the 2010 study (hereafter the study area), were completed to address the 10 Clearing Principles as part of the Native Vegetation Clearing Permit (NVCP) Application process.

A total of 214 taxa (including five introduced species) from 100 genera belonging to 41 families were recorded from the study area. Families with the highest number of taxa recorded in the study area included Fabaceae, Malvaceae, Poaceae and Scrophulariaceae. Acacia, Eremophila, Sida, Hibiscus and Senna were the best represented genera within the study area. The study area is not considered to hold above average species richness. The relatively low degree of evenness combined with the areas richness suggests that it is not significantly diverse. The dominant plant groups are consistent with other surveys of the greater Paraburdoo locality. None of the three Threatened flora species known from the Pilbara region - Lepidium catapycnon, Thryptomene wittweri or Aluta quadrata were recorded during the survey. Five introduced (weed) species were recorded during the survey; however none are considered as Declared Pests under the Biosecurity and Agriculture Management Act 2007.

Marandoo Native Pivot Trial Harvesting and Monitoring 2015 **2016**

Internal reference:

The primary objective was to determine whether native plants required in mine site rehabilitation could be established and grown under large-scale irrigation pivots; for the purpose of producing harvestable quantities of seeds. Trials were located within two irrigation pivots at the Hamersley Agricultural Project (HAP) near Rio Tinto's Marandoo Mine.

Twelve native species were planted and grown in the pivot trials. Of these species, Aluta quadrata seedlings from the seed propagation trials were translocated and incorporated into the study in May 2013. Aluta quadrata showed low survival rates in the pivots, with only 10% remaining by the end of the first year's trial period. Low survival rates more than likely reflected atypical substrate conditions, competition from invasive species and accidental clearing by machinery. It is noted that seed for this translocation trial was collected prior to Aluta quadrata being listed as Declared Rare Flora; therefore no approved translocation program was required.

Greater Paraburdoo Detailed Flora and Vegetation Survey **2018**

Internal reference: RTIO-HSE-0330744

Astron Environmental Services were commissioned to undertake a detailed two phase flora and vegetation assessment of the Greater Paraburdoo Development Envelope, covering a survey area of 11,203 hectares.

Twenty-one vegetation units were recorded in the survey area, none of which represent a threatened ecological community or priority ecological community. All vegetation units are considered well represented beyond the survey area and do not support assemblages of species that are unique, located on restricted landforms, or of high conservation significance. Vegetation condition ranged from Excellent to Completely Degraded. An estimated 41.1% of the survey area was rated between Very Good and Excellent, 17.9% was rated as Good and 10.4% was rated between Poor and Degraded. An estimated 30.6% of the survey area was cleared and rated as Completely Degraded. When combined with the previous site data from within the survey area a total of 470 taxa have been recorded. Twenty-two introduced flora species (weeds) were recorded during the current survey, none of which are listed as Weeds of National Significance or as declared pests.

Fauna

Historical records of the Pilbara leaf-nosed bat at lease 23E – 42E **2009**

Internal reference: RTIO-HSE-0206240

To summarise historical survey work on the presence of Pilbara Leaf Nose Bats and an appropriate roosting site in the Eastern Range area (historical surveys conducted between 1998 - 1999).

No roost sites of either the Pilbara leaf-nosed bat or the ghost bat were found in the 23E – 42E lease area during the surveys, however a deep gorge with a semi-permanent pool was visited on a nightly basis by the Pilbara leaf-nosed bat. Two Pilbara Olive Pythons were also recorded in the pool near 42E. The location of previous records of the Pilbara leaf-nosed bat in a gorge near the crusher remains significant (32E pools).

Turee Syncline Bat Monitoring 2009 **2010**

Internal reference: RTIO-HSE-0206241

To collect data on presence and levels of activity of the two bat species in the Turee Syncline project area in order to define the type of usage of particular habitats, and from this make assumptions about the importance of such habitats to the species. The design approximates a Before–After–Control–Impact, and includes sites for comparison from the Eastern Ranges and near Channar where the Pilbara leaf-nosed bat has been recorded previously.

The Pilbara leaf-nosed bat was present at four sites in the Turee Syncline (TS) area and one site in the Eastern Ranges (ER) on the present survey. Activity levels were greatest at the two sites with pools of water: ER1 (32E pools) and TS5. The latter site was discovered and added during the present survey based on observations of activity over the pool of ER1 (32E Pools) part way through the survey. Pools of water, rather than roost sites, might be the most important resource to the Pilbara leaf-nosed bat in the Eastern Ranges, Channar, and Turee Syncline areas. This is supported by observations of the greatest activity over pools, and the virtual absence of activity at cave entrances and areas where pools have disappeared in the past few years (Channar, HH1). However, roost sites are likely to be somewhere within the range system. The presence of the Pilbara leaf-nosed bat consistently over two surveys in 2009 in a gorge in the Eastern Ranges was a significant observation given its close proximity to mining infrastructure since 2004.

Summary of Pilbara Leaf Nosed Bat occurances at Eastern Range and surrounds **2010**

Internal reference: RTIO-HSE-0206242

To summarise data on presence of the Pilbara Leaf Nosed Bat at Eastern Range and surrounds. Summary of efforts conducted to find the PLNB roost.

Area 1 (32E pools) appears to provide some kind of important, possibly limited resource to the PLNB. This site demonstrates the persistence of the species despite nearby mining and habitat degradation. Pools and suitable roost sites are important, and possibly limited resources in the area around Paraburdoo. The Eastern Ranges area has been searched extensively on several occasions for roosts of the Pilbara leaf-nosed bat and ghost bat between May 1997 and July 1999. None were found. Pilbara leaf-nosed bats have been noted as present in Area 1 (32E pools) during every visit made between June 1998 and November 2009.

Review of likelihood of fauna species of conservation significance utilising habitats at Eastern Range **2010**

Internal reference: RTIO-HSE-0300544

Review of previous studies and database searches to assess the likelihood of occurrence of fauna species of conservation significance utilising habitats on the Eastern Ranges near Paraburdoo, and the potential for significant impact on these species.

Three key fauna habitats are present at Eastern Range; Rocky hill tops and steep slopes, Breakaways and Creek lines in valleys and gorge. All of these habitats are widespread and not restricted to the Eastern Ranges, the latter is evident from the extensive mapping undertaken on the nearby Channar environments. The following vertebrate fauna species of conservation significance may require some further survey effort or management: Northern Quoll, Pilbara Leaf-nosed Bat, Ghost Bat, Rainbow Bee-eater, Peregrine Falcon,Australian Bustard, Bush Stone-curlew, Pilbara Olive Python. Liasis olivaceus barroni (Pilbara Olive Python) has a high potential for occurance at ER. The major impact of the proposed mine extension may be to the hydrology of the Eastern Ranges. Surface hydrology in areas where these pools exists should be maintained. Northern Quoll - Given the presence of rocky hills and breakaways in the Eastern Ranges, there could be some local impact on this mammal from loss of habitat if it is found to occur. However, given the lack of recent records of this species in the Paraburdoo area and the extent of suitable habitat in areas where it does occur, there will be no regional impact on the species. Ghost bat - While no roosts have been located within the Eastern Ranges it is likely that they forage for prey over a wide area including the Eastern Ranges. The loss of a small area of foraging habitat is unlikely to have a major impact on this bat. Pilbara Leaf nosed bat - this bat has been recorded at ER - although no roost has been found. The report recommends that the impact on drainage, pools and creeklines should be minimised.

Eastern Ranges LoM Flora and Vegetation Report (including Fauna) **2010**

Internal reference: RTIO-HSE-0100421

This report summarised nine existing Eastern Range fauna reports. No fauna surveys were undertaken for this study.

Three broad fauna habitats have been identified: 1) Rocky hill tops and steep screes; 2) breakaways; and 3) creek lines in valleys and gorges. These areas are strongly associated with the Newman Land System and are common and widespread across the greater Paraburdoo and the Hamersley IBRA subregion. The subcategorised microhabitats include: caves; rock outcrops and crevices; overhangs; ephemeral and permanent waterholes; hollow-bearing trees; termite mounds; and areas of dense scrub with well-developed litter layer. 21 species of conservation significance have been identified in the vicinity and three of these species have been recorded directly in the study area: 1) Orange Leaf-nosed Bat (Rhinonicteris aurantia); 2) Ghost Bat (Macroderma gigas); and 3) Pilbara Olive Python (Liasis olivaceous barroni).

Eastern Range Targeted Fauna Survey **2010**

Internal reference: RTIO-HSE-0107792

A site assessment to evaluate the potential for fauna of conservation significance to occur, and to identify any areas of core habitat suitable for these species. This report documents the methods and results relating to the field based habitat assessment and survey for evidence of fauna species of elevated conservation significance occurring within the Eastern Ranges Study area. Additionally, it discusses the potential impacts of the ongoing infrastructure development at Eastern Ranges on the habitats of fauna species of elevated conservation significance and significant fauna species potentially occurring in the Project area.

The ongoing occurrence of the species investigated indicates that the intact habitats found within the gorges at Eastern Range remain suitable, as they presumably were prior to mining. Central to this are the rock pools found in various locations, which represent primary habitat within the gorges as for the four species. It is possible that any deterioration of these rock pools may have a significant effect on individuals of each species present in the area. It appears that mining activities at Eastern Ranges over the past decade or more have not deleteriously affected the values of the intact core habitats for the target species within and adjacent to the current operations area. Despite the paucity of data prior to the development of the mine, the maintenance of these values can probably be attributed to a small number of factors including: • the relative lack of disturbance to those habitats that represent optimal areas for the species in question, namely the gorge habitats; • the availability of habitats that exhibit faunal values similar to those within the Project area in adjacent areas in the wider Study area to the north and east; and • the relatively small quantity of core habitat within the Project area in relation to the high degree of mobility of all species in question.

Presence and activity of Pilbara Leaf nosed bat at Eastern Ranges **2013**

Internal reference: RTIO-HSE-0206244

To determine whether the Pilbara leaf-nosed bat continues to use the Eastern Ranges project area during mining, and assess the level and types of mining activity that might have detectable effects on the species in comparison to natural environmental factors.

The continued presence of the species in the gorge within which 32E Site 3 ('ER1' on previous surveys) is located has been recorded. Access to this gorge is somewhat restricted by a rock face upstream and infill to create the haul roads downstream, and the pool was completely dry during the survey, however the Pilbara leaf-nosed bat was still present. No unambiguous calls of this species were detected. There have been no reliable records of the ghost bat in the Eastern Ranges and no roost sites have been located.

Greater Paraburdoo Operations Orange Leaf-nosed Bat Foraging Study **2014**

Internal reference: RTIO-HSE-0213593

In 2011, a significant maternity roost of the Orange Leaf-nosed Bat (OLNB) (Rhinonicteris aurantius) was recorded in the eastern Hamersley Range at an adit adjacent to the K75W deposit of the proposed Koodaideri mine, north of Newman. The OLNB is listed as a Vulnerable species under both State and Commonwealth legislation. As part of finalising its assessment of the Koodaideri project, the Environmental Protection Authority (EPA) has requested that Rio Tinto Pty Ltd (Rio Tinto) conduct further investigations into potential impacts on OLNB foraging behaviour patterns; specifically, the effect of disturbance generated by mine construction and operational activities. As these disturbance factors do not currently exist at Koodaideri, other operational mines where OLNB are known to occur were considered for further study. Eastern Range and Paraburdoo mines were chosen for this purpose. The intent of this was to allow inferences to be made regarding the Koodaideri OLNB colony. In this context, focus was applied to further investigation of the use of water sources (both anthropogenic and natural) by OLNB close to existing operational areas where the species is known to occur.

This study confirmed that OLNBs continue to utilise foraging areas in close proximity to the operational mine sites at Paraburdoo and Eastern Range. OLNB calls were detected at several localities in and around the active operations, including close to mine pits, rail, crushers and other infrastructure. This demonstrates that OLNB will continue to forage close to active mining operations where important foraging areas are present. OLNBs have been previously detected at site PARBAT84-04 at Eastern Range during studies undertaken in 2009. While fewer calls were detected during that earlier work, when combined with the current data, this demonstrates continued foraging by this species in areas of close proximity to ongoing mining impacts over a minimum five-year period. Levels of OLNB call activity at the sites near Western Range appeared consistent only with foraging behaviour and were not indicative of a nearby roost. It is possible that the roost is located further to the east of, or closer to, the Paraburdoo and Eastern Range mines, but this cannot be confirmed without further targeted work once access constraints are resolved.

Level 1 and targeted fauna Survey - Eastern Range **2014**

Internal reference: RTIO-HSE-0231213

Level 1 fauna assessment and targeted survey for species listed as Matters of National Environmental Significance (MNES); specifically Pilbara Leaf-nosed Bat (Rhinonicteris aurantia), Northern Quoll (Dasyurus hallucatus) and Pilbara Olive Python (Liasis olivaceus barroni).

40 bird species, six reptile species and 14 mammal species were recorded during the survey including the Ghost Bat and target MNES species, the Pilbara Leaf-nosed Bat. The target MNES species, the Pilbara Olive Python, was not recorded during the survey, despite active searching throughout highly suitable habitat within the survey area (i.e. gorge habitats that contained water pools), including the areas where individuals had previously been recorded. The low activity and locations of Pilbara Leaf-nosed Bat calls recorded during the survey, and previous surveys, suggest that the gorge habitats within the survey area are used for foraging and drinking, particularly at the permanent and semi-permanent pools. Analysis of call data suggests that a Pilbara Leaf-nosed Bat roost is likely to be present within a radius of approximately 10 kilometres of the eastern-most sites within the survey area. A small number of Ghost Bat calls were also recorded from a cave entrance on the small mesa in the north-west corner of the survey area during the current survey and Ghost Bats (calls and feeding debris) have previously been recorded within gorge habitats in the survey area.

OEPA Level 1 and Targeted Conservation Significant Fauna Assessment **2018**

Internal reference: RTIO-HSE-0326666

Astron Environmental Services were commissioned to undertake a Level 1 and targeted conservation significant fauna assessment of the Channar Development Envelope which is 7,305 hectares in size.

There were 74 vertebrate fauna species recorded within the survey area, comprising one amphibian, eight reptiles, 49 birds and 16 mammals (including three introduced species). The fauna species assemblage recorded during the survey was considered typical of the Hamersley Range subregion. One vertebrate species of conservation significance: the Pilbara Leaf-nosed Bat was recorded within the survey area during the current survey, with the majority of the survey area (65%) considered suitable foraging habitat. This species was recorded at five locations within the survey area, with one location Howie's Hole recording 'very high' activity (approximately 2,500 calls), which is expected given the presence of water. However, the timing of calls also indicated that at least one Pilbara Leaf-nosed Bat roosted overnight in a satellite cave close to Howie's Hole. An additional seven conservation significant fauna species have been assessed as highly likely to occur given previous records in the vicinity and suitable habitat within the survey area: Pilbara Olive Python, Grey Falcon (Falco hypoleucos) (Vulnerable), Peregrine Falcon (Falco peregrinus) (Other Specially Protected Fauna), Northern Quoll, Long-tailed Dunnart (Sminthopsis longicaudata) (Priority 4), Ghost Bat and Western Pebble-mound Mouse (Pseudomys chapmani) (Priority 4). The Night Parrot (Pezoporus occidentalis) (Endangered; Critically Endangered) was considered unlikely to occur within the survey area due to a lack of potential shelter and foraging habitat and no calls being recorded during the current survey.

Greater Paraburdoo Level 2 Fauna Survey April 2018 **2018**

Internal reference: RTIO-HSE-0328335

Astron Environmental Services were commissioned to undertake a Level 2 fauna and Short Range Endemic assessment of the Greater Paraburdoo Development Envelope which is 11,203.4 hectares in size.

Seven broad fauna habitat types were recorded in the survey area: Riverine, Drainage Line, Gorge, Breakaway, Rocky Hill, Low Hill, and Stony Plain. Areas of cleared habitat were prevalent throughout the central portion of the survey area where mining infrastructure and operations are concentrated. The Gorge, Riverine and Breakaway habitats in the survey area are considered important for fauna due to the microhabitats they provide such as caves and permanent water pools. The Gorges and Breakaways in particular contain a high diversity of microhabitats. There were 154 vertebrate fauna species recorded within the survey area, comprising two amphibians, 34 reptiles, 94 birds and 24 mammals (including four introduced species). The fauna species assemblage recorded during the survey is considered typical of the Hamersley Range subregion. Four of the seven recorded conservation listed species are classified under the Environment Protection and Biodiversity Act 1999 as 'Matters of National Environmental Significance' species: the Pilbara Olive Python, Northern Quoll, Ghost Bat and Pilbara Leaf-nosed Bat. The Pilbara Olive Python has been previously recorded in the Riverine habitat of the survey area at Seven Mile Creek. The Northern Quoll was recorded twice during the first phase of the current survey in the form of individual scats in the Breakaway and Gorge habitats. The Pilbara Leaf-nosed Bat was recorded at seven of the 16 bat detector locations; all were deemed to be at low activity levels. The Pilbara Leaf Nosed Bat records were from foraging individuals in Breakaway, Drainage Line and Riverine habitats. One previously identified roost within the survey area that is close to Ratty Springs is a confirmed permanent diurnal/maternal roost. The Ghost Bat was recorded once (two possible calls) during the current survey through an acoustic recording in the Breakaway habitat. A targeted fauna survey, specifically to assess the presence of the Northern Quoll, was undertaken within certain gorges in the Eastern Ranges portion of the survey area. No conservation significant fauna were recorded as part of this targeted fauna survey.

Eastern Range EPA Level 1 Targeted Fauna Survey June/July 2018 **2018**

Internal reference: RTIO-HSE-0328565

Astron Environmental Services were commissioned to undertake a targeted fauna survey of selected gorges in the Eastern Range area that had been previously identified as critical habitat for Matters of National Environmental Significance.

Twenty motion sensitive cameras were deployed in suitable microhabitats within the gorge habitats of the exclusion zones, such as overhangs and pools of water. The cameras were left in situ for between 30 to 31 days (towards the upper limit of battery duration) with a combined trapping effort of 618 trap nights. Despite the high level of survey effort undertaken in the appropriate time of the year, no Northern Quolls or other conservation significant fauna species were recorded in the survey area. In addition, searches throughout the survey area failed to detect secondary evidence of any conservation significant fauna (tracks, scats or remains), despite suitable habitat. A total of nine fauna species (five mammals and four birds) were recorded in the survey area from motion sensitive camera records, including two introduced species: Cat (Felis catus) and Dog/Dingo (Canis familiaris). The low species diversity and number of camera triggers suggests that this habitat does not support a large population of resident fauna. The low species diversity was not expected considering the quality of the habitat present. There were some impacts associated with the nearby mining activity including dust/sedimentation, weeds and rubbish that had been washed down into the gorge during localised flood events. However, the habitat continues to provide refuge for fauna and comprises a number of microhabitats that are restricted to this habitat type including overhangs, rock piles, crevices, tree hollows, thick undergrowth and semi-permanent pools. The caves of the survey area were relatively shallow and exposed, and lacked the deep, complex caves that constitute roosting habitat for bat species.

Greater Paraburdoo Subterranean Fauna Survey **2019**

Internal reference: RTIO-HSE-0334994

Biologic Environmental Survey Pty Ltd (Biologic) was commissioned to undertake a survey and assessment for subterranean fauna (troglofauna and stygofauna) throughout a Study Area encompassing the Greater Paraburdoo Iron Ore Hub.

The 2018 survey sampled a total of 312 bores and drill holes throughout the Study Area. A total of 1510 subterranean fauna specimens were recorded comprising 165 troglofauna and 1345 stygofauna specimens. In combination with previous records, a total of 171 troglofauna specimens representing 40 species/ species level taxa and nine higher level indeterminate taxa are known to occur within the Study Area. In combination with previous records, a total of 1355 stygofauna specimens representing 72 species/ morphospecies and nine higher level indeterminate taxa are known to occur within the Study Area.

Biodiversity improvement studies

Evaluation of mine waste materials as alternative rehabilitation growth medium **2010**

Internal reference: RTIO-HSE-0109961

This study reviewed the physical and chemical properties of soil, tailing and mineral waste from select Pilbara mining operations, to identify waste material and material combinations for use as a topsoil substitute or supplement.

The study showed plant-available nutrients held within the waste materials, although variable, was characteristically low and comparable to natural soils in the region. The majority of the waste materials had macro and micro nutrient concentrations within the range or above the levels measured in benchmark Pilbara topsoil and rehabilitated soils. The pH and phosphorus buffering index of most waste materials were also comparable to that of the benchmark topsoil materials. However, some of the waste types and tailings may need to be mixed with rocky material due to poor physical / erodibility characteristics.

Genetic diversity in Eucalyptus leucophloia across the Pilbara: Provenance zone implications **2011**

Internal reference: RTIO-HSE-0108843

This study was undertaken to define the provenance seed collection zones for a common species of the Pilbara, Eucalyptus leucophloia (Snappy Gum). This report details information on genetic analysis conducted on E. leucophloia. Collections of E. leucophloia were made from 20 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.

Genetic diversity in E. leucophloia was high and was typical of that found in other eucalypt species with wide spread distributions. Across the species the level of population differentiation was low and the majority of the diversity was maintained within populations with only 6% of variation partitioned between populations. Genetic variation in E. leucophloia showed little structure across the Pilbara with no clustering of populations based on any geographical proximity or in association with obvious topographical, physiogeographical or geological features such as the Hamersley or Chichester Ranges. Populations towards the edges of the species distribution within the Pilbara showed greater levels of differentiation from populations within the species main range. The high levels of genetic diversity and low levels of differentiation within E. leucophloia implies that seed resources for rehabilitation can be selected from a wide range within the Pilbara.

Genetic diversity in Acacia ancistrocarpa across the Pilbara: Provenance zone implications **2011**

Internal reference: RTIO-HSE-0119260

This study was undertaken to define the provenance seed collection zones for Acacia ancistrocarpa (Fitzroy Wattle). This report details information on genetic analysis conducted on Acacia ancistrocarpa. Collections were made from 24 populations across the Pilbara bioregion and genetic analysis was conducted on 16 populations using microsatellite markers.

Genetic diversity in A. ancistrocarpa was high but lower than that in E. leucophloia, another widespread species in the Pilbara. Across the species Pilbara range the level of population differentiation was low and the majority of the diversity was maintained within populations with only 3% of variation partitioned between populations. Genetic variation in A. ancistrocarpa showed little structure across the Pilbara with no clustering of populations based on geographical proximity or in association with obvious topographical, physiogeographical or geological features. Populations towards the edges of the species distribution within the Pilbara showed greater levels of differentiation from populations within the species main range. The high levels of genetic diversity and low levels of differentiation within A. ancistrocarpa implies that seed resources for land rehabilitation and mine-site revegetation programs can be selected from a wide range within the Pilbara

Root hydraulic conductance and aquaporin abundance respond rapidly to partial root-zone drying events in a riparian Melaleuca species **2011**

Internal reference: RTIO-HSE-0252171

This study examined partial root zone drying (PRD) responses of Melaleuca argentea.

The results demonstrate that PRD can induce rapid changes in root hydraulic conductance and aquaporin expression in roots, which may play a role in short-term water uptake adjustments, particularly in species adapted to heterogeneous water availability.

Baseline Terrestrial Fauna Assessment of Pilbara Rehabilitation Areas **2012**

Internal reference: RTIO-HSE-0134168

In 2011 a fauna survey was conducted within established rehabilitation areas at Brockman 2 and Tom Price mine sites, with the aim of identifying whether fauna is recolonising rehabilitation sites in assemblages comparable to reference sites.

The study found that at least 85 species of native vertebrate fauna, as well as representatives from each of six major groups of invertebrate fauna, are using rehabilitation areas at Brockman 2 and Tom Price, with species compositions that were broadly similar to reference sites. Ant collections were typical of the Pilbara bioregion, with an absence of invasive ant species. The study found greater data correlation between monitoring sites at a particular mine site (Tom Price or Brockman 2) than between rehabilitation and reference sites, indicating the importance of selecting local reference sites. The study concluded that the best candidates for bio-indicators are ants and reptiles.

Hay Project – Native Seed Orchard **2012**

Internal reference: RTIO-HSE-0141263

Commencing in 2011 (and still ongoing), a trial irrigated seed orchard was established at the Hamersley Agriculture Project (Marandoo). The purpose of the trial was to identify an alternate method of addressing seed deficits. If successful, the project may be implemented at other Rio Tinto operations, such as the Nammuldi agriculture project.

Genetic diversity in Aluta quadrata:Implication for management and provenance zone **2012**

Internal reference: RTIO-HSE-0156732

This study was undertaken to define the provenance seed collection zones for Aluta quadrata. This report details information on genetic analysis conducted on Aluta quadrata. Collections were made from 8 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.

Genetic diversity in A. quadrata was moderate and lower than in the other two more widespread Pilbara species, E. leucophloia and A. ancistrocarpa. The findings suggest that its populations may have fluctuated significantly in size over time with genetic drift and possibly inbreeding resulting in a reduction in genetic variability, particularly in rare alleles. Despite the narrow geographic range, the level of population differentiation in A.quadrata was relatively high with 25% of the genetic variation maintained between populations and 19% due to differences between the three different locations. This significant genetic structure indicates that A. quadrata consists of three conservation or management units, Western Ranges, Pirraburdoo and Howie's Hole.

Genetic diversity in Acacia atkinsiana across the Pilbara: Provenance zone implications **2012**

Internal reference: RTIO-HSE-0187256

This study was undertaken to define the provenance seed collection zones for Acacia atkinsiana (Atkins wattle). This report details information on genetic analysis conducted on Aluta quadrata. Collections were made from 16 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.

Genetic diversity in A. atkinsiana was low and lower than that observed in its congener Acacia ancistrocarpa, a widespread species across northern Australia. The level of population differentiation was high and 30% of the diversity was partitioned between populations across the range of A. atkinsiana. Genetic variation in A. atkinsiana showed some structure across the Pilbara with clustering of populations in the western part of the distribution and from the Hamersley Range, along with other populations that were divergent from these groups. The low levels of genetic diversity and high levels of differentiation within A. atkinsiana implies that seed for land rehabilitation and mine-site revegetation programs should be restricted to specific zones. For rehabilitation of sites within the Hamersley Range we recommend seed collections be restricted to that region. Similarly, for rehabilitation in the part of the distribution west of Pannawonica, seed collections should be restricted to that area.

Rehabilitation Quality Metric (RQM) Project **2012**

Internal reference: RTIO-HSE-0164020

Western Australia has no formal process to measure habitat quality and as such RTIO has needed to design its own customised metrics. Vegetation condition scoring has previously been developed by RTIO through a Biodiversity Net Positive Impact Assessment, but a more precise metric was needed. The Rehabilitation Quality Metric (RQM) project was developed to provide a repeatable method to assess rehabilitation quality against pre-determined reference sites, on a site by site basis, to predict rehabilitation ecosystem quality at the time of relinquishment.

The RQM methodology employs seventeen parameters to characterise the landscape, including vegetation, fauna habitat, fauna presence, erosion, and ecosystem function. Parameters are tailored to be an applicable measure for both rehabilitation and native vegetation (reference sites). Parameters are scored, based on measured or observed characteristics, with a value between 0 and 1, with 1 being functional (terrestrial ecosystem is functioning for the maintenance of biodiversity values at a local or property scale) and 0 being dysfunctional (terrestrial ecosystem is failing; indicators of ecosystem function have scored below acceptable levels). Both rehabilitation areas and reference sites are scored. Scores are subsequently determined for the entire mine lease, based on the condition of the land before mining (extrapolated from the reference sites, area weighted) and the likely post-mining conditions (extrapolated from the rehabilitation areas and expected closure domain distribution, area weighted, ie pits with no rehabilitation score 0). The difference between the pre-mining and post-mining scores represents the residual impact of mining.

Propagation of Pilbara spinifex (Triodia sp.) **2012**

Internal reference: RTIO-HSE-0169744

Triodia has often been observed to have very poor establishment from broadcast seed. This project investigated alternatives to growing Triodia (spinifex) from seed, focussing on ways to propagate seedlings from wild harvested material.

The project found the most successful propagating material was stolons. Greatest propagation success was achieved when Triodia were collected when semi to fully dormant (mid Winter-Spring). The 'Moist Root Induction Method' recommended by previous researchers was less successful than the standard propagation techniques employed in this project. Success varied notably between populations. Consequently, any future collections of propagating material should target multiple populations to maximise potential for success.

Pilbara Seed Science Project, Part 2 Final Report Jan 2012 **2013**

Internal reference: RTIO-HSE-0174944

Undertaken between 2009-2012, this seed research investigated germination, biology, dormancy classification and treatments for dormancy alleviation for a range of species from the Pilbara.

The *Acacia atkinsiana, Indigofera monophylla and Sida echinocarpa* seed lots have physical dormancy. Heat treatments and mechanical scarification improved germination on dormant seeds, however, heat treatments killed non-dormant seeds. The treatments used for *Goodenia stobbsiana* seeds failed to overcome dormancy, suggesting deep physiological dormancy. The *Hakea lorea/ chordophylla* seed lots were found to be non-dormant, with very high germination results in the controls. As such, they will not require any pre-treatments prior to direct seeding. The florets surrounding the *Triodia pungens* and *T. wiseana* seeds were found to restrict germination, however, many of the freshly extracted seeds out of the florets were found to be physiologically dormant. Treatments for dormancy include mechanical scarifier to rupture seed coat, hot water (noting potential damage to immature or non-dormant seeds) and increases to germination through wet / dry cycling and / or temperature cycling.

Morphological variation in the western rainbowfish (Melanotaenia australis) among habitats of the Pilbara region of northwest Australia. **2013**

Internal reference: RTIO-HSE-0252169

The aim of this honours thesis was to determine and quantify the extent of morphological variation present in M. australis and relate this to environmental variables, which will provide the first step to understanding how the species copes with environmental change.

This results of this thesis found that there was limited evidence that fish morphology correlated with environmental variables

Patterns of water use by the riparian tree Melaleuca argentea in semi-arid northwest Australia **2013**

Internal reference: RTIO-HSE-0249538

This thesis examines the water use physiology of the riparian tree Melaleuca argentea, and the ways in which this species may respond to anthropogenic disturbances to hydrologic processes.

M. argentea displays highly plastic root-level responses to heterogeneous water availability and to waterlogging, facilitating high rates of water use and growth in the riparian wetland habitats of the Pilbara. Mature M.argentea trees appear to tolerate groundwater drawdown of at least several metres, most likely by employing the same plastic root strategies to access deeper water. M.argentea can also withstand short periods of severe drought, by adopting a 'waiting' strategy of ceasing growth and shedding leaves to avoid moisture loss, a state from which they can then recover. M. argentea populations are unlikely to thrive under large and prolonged reductions in water availability.

Priority Species Seed Quality and Germination Final Report **2013**

Internal reference: RTIO-HSE-0207487

This study investigated the quality and germination biology of a range of priority and keystone (Triodia) plant species from the Pilbara.

Eremophila magnifica subsp. Magnifica has physical & physiological dormancy. Propagation methods other than seed may be more successful. Geijera salicifolia and Olearia mucronata has physiological dormancy. Temperature cycling may be required to stimulate germination. Indigofera ixiocarpa and Indigofera sp. Bungaroo Creek has physical dormancy or is non-dormant. Mechanical scarification may be required. Ptilotus subspinescens is non-dormant and will germinate easily without removal from the perianth sheath. However, seed is likely to lose viability with a few years. Sida echinocarpa and Sida sp. Barlee Range has physical dormancy. Seeds should be removed from the mericarp and then scarified in order to germinate. Triodia pungens has T. wiseana non-deeep or deep physiological dormancy. Germination of de-husked seeds can be improved by applying gibberellic acid or 1% smoke water and wet/dry cycling.

Early physiological flood-tolerance and extensive morphological changes are followed by slow post-flooding root recovery in the dryland tree Eucalyptus camaldulensis subsp. Refulgens **2014**

Internal reference: RTIO-HSE-0252170

This study investigated physiological and morphological response to flooding and recovery in Eucalyptus camaldulensis subsp. Refulgens, a riparian tree species from a dryland region prone to intense episodic flood events.

E. camaldulensis subsp. Refulgens underwent considerable morphological changes during flooding, including extensive adventitious root production, increased root porosity and stem hypertrophy. Physiologically, net photosynthesis and stomatal conductance were maintained for at least 2 weeks of flooding before declining gradually. Despite moderate flood-tolerance during flooding and presumably high environmental selection pressure, recovery of reduced root mass after flooding was poor.

Priority Species Project Progress Report 2013 **2014**

Internal reference: RTIO-HSE-0207486

The Priority Species Project, initiated in 2012, aims to improve knowledge of priority plant species and develop methods to successfully germinate and establish priority species, to enable priority plant species to be integrated into Rio Tinto rehabilitation programmes. This work is being undertaken in conjunction with the Department of Parks and Wildlife.

13 plant species were selected as being potentially suitable for establishment in rehabilitation: Eremophila magnifica subsp. magnifica, Indigofera sp. Bungaroo Creek, Indigofera sp. gilesii, Acacia bromilowiana, Sida sp. Barlee Range, Ptilotus subspinescens, Ptilotus mollis, Acacia subtiliformis, Isotropis parviflora, Grevillea sp. Turee, Hibiscus sp. Canga, Themeda sp. Hamersley Station, and Aluta quadrata. Indigofera sp. Bungaroo Creek and Ptilotus subspinescens were found to readily germinate in laboratory conditions, and a field trial was established at Brockman 4 late in 2013.

Regional Variation in Metal Concentrations of Pilbara Fish in Relation to Concentrations in Water and Sediments **2014**

Internal reference: RTIO-HSE-0216967

This study aimed to characterise and document natural, background metal concentrations in freshwater fishes from different locations across the Pilbara in order to understand how local geology may affect baseline metal levels in fish tissues and surface waters. Metal concentrations were analysed from water, sediment and muscle and liver tissues from fish collected from up to 13 sites as yet unimpacted by mining across the Pilbara during October (dry season) of 2012.

Levels of dissolved metals from water samples were generally low. However, some elevated concentrations of Boron, Copper and Zinc were recorded. Concentrations of heavy metals in sediments were variable across the Pilbara. Generally, sediment concentrations were well below the Interim Sediment Quality Guidelines (ISQG). However, metal concentrations in excess of ISQG TVs were recorded for Chromium and Copper at some sites. There was no relationship between metal concentrations in sediment and those in water. Metal concentrations in fish tissue (muscle and liver) varied between species with some significantly higher in some particular species. The study concluded that variation in metal concentrations in water, sediment and fish across pools in the Pilbara was likely to be mainly dictated by the local geological setting in which the pool occurs.

Progress Report 2014, Ecological responses of native fishes to dynamic water flows in northwest arid Australia **2014**

Internal reference: RTIO-HSE-0246021

This three year Australian Research Council linkage Project commenced in 2013 and aims to increase understanding of the effects of altered stream flows on the Pilbara freshwater aquatic environment. Project aims: 1. Quantifying fish biodiversity and population structure in relation to hydrological and environmental parameters to identify thresholds of ecological concern for water management; 2. Determine the fundamental physiological, morphological and behavioural adaptations of fishes to variations in water quality using experimental manipulations; and 3. Examine spatial scales of gene flow to determine if increased flows increase genetic connectivity relative to natural-flow sites.

To date work has focuses on characterisation of baseline physicochemical parameters across aquatic habitats within the Fortescue River catchment (Aim 1), analysis of variation in rainbow fish morphometrics and mechanosensory lateral line systems in response to geographic region and water management regime (Aim 2), and extraction of DNA samples from 17 populations across the Fortescue River catchment (Aim 3). The project will culminate in the development of a predictive model for stream restoration relevant to future closure scenarios for above and below-groundwater mines. Results from an honours thesis indicate that rainbow fish body shape varies according to geographic region but fish from a dewatered site (WW Ck) were more streamlined than other populations from the upper Fortescue catchment. This statement of results has been superseded by the results of the actual thesis report RTIO-HSE-0252169.

Rehabilitation Close Out Report: CHE3 AMD Encapsulation **2017**

Internal reference: RTIO-HSE-0315087

This report outlines the process followed to implement rehabilitation of potentially acid forming material at the Channar CHE3 pit at Greater Paraburdoo, which was identified as not meeting the SCARD Management Plan requirements. Natural occurring Black Shale (BS) exposures were identified in the floor of the pit and on areas of the wall. Also BS exposures were visible in the surface of the 'ready for rehabilitation' waste dumps, suggesting inadequate encapsulation during dump construction.

Rehabilitation earthworks took place between March and November 2016. The total footprint area rehabilitated was 33.75 Ha over the project, which includes the CHE3 dumps, inert areas and CHE1 rework area. The project was significant in scale; in order to achieve the required rehabilitation design that would leave an encapsulated, safe and stable landform, approximately 2.2 million cubic meters of material was moved by a load and haul operation. Topsoil (~63,000 m3) was hauled from CH64E5 stockpiles, but only applied to the encapsulated waste dumps, not inert areas. Two native seed mixes were created for the project; one for the encapsulation dumps which contained predominantly shallow rooted species, and a second mix for the inert areas which reflected a normal format seed mix. The seed was sown on the same pass as ripping using a mechanical seeder. The project involved an estimated 50,650 manhours with no recorded Lost Time Injuries. Instrumentation has been installed on the dumps containing encapsulated BS to monitor for any changes to water quality.

Landform design

Results of flume investigations of the stability of rock mulches **1998**

Internal reference: RTIO-HSE-0109221

This study assessed the potential for rock mulches to be stripped from the soil surface by overland flows.

Although 150-300mm diameter BIF was not removed by simulated overland flows, even for 100mm/hr simulated runoff on 55% gradients, considerable scour of the spoil between the rocks was observed, indicating potential for long-term development of rills or gullies if the level of rock cover was less than 100%. Large reductions in sediment concentrations were observed when finer rocks were mixed with BIF. The data indicate that it is crucial for any rock mulch to cover a wide range of particle diameters, including a component of finer rocks. The resulting mixed rock created a framework of large rocks that resist movement by flows, while the smaller rocks reduce erosion being anchored within the larger (framework) rock. For rock mulches with a mixture of rock diameters, 80% cover produced acceptable erosion rates. Sediment loads were slightly higher for 40% cover by rock of mixed diameters, and it was speculated that this may also achieve acceptable erosion rates with the addition of vegetation.

Final Landform Design Criteria for Use During Mine Planning **2012**

Internal reference: RTIO-PDE-0159989

Rio Tinto Iron Ore WA have historically designed closure landforms for waste materials with berms ~10 m, lifts ~20 m and ad hoc alterations to batter gradients where erosion rates have been perceived to be unacceptably high. This report integrates recent advances in characterisation and modelling of materials, climate and erosion processes to provide appropriate final landform batter characteristics for key Pilbara mineral wastes and soils.

Material properties of mineral wastes were assessed and classified for the range of mineral wastes found across Rio Tinto Pilbara sites. Climate sequences were used to model and test potential erosion rates for a range of batter configurations (shapes (linear, concave), heights, gradients, berm capacity) and validated against existing slopes for which material and climate data were available. This information was used to develop a searchable waste dump batter database for all major mineral wastes and soils, intended for use during mine planning design.

Assessment of 1000 and 2000 year return interval storms on a rehabilitated landform batter profile shape, berm size and crest size for Greater Paraburdoo materials **2018**

Internal reference: RTIO-HSE-0324327

This report details the results of the assessment of the impact of 1000 year and 2000 year return interval storms (24-hour duration) on rehabilitated landform batter profile shapes, berm sizes and crest bund sizes for materials at Greater Paraburdoo. The assessment involved creating 1000 and 2000 year water erosion prediction project (WEPP) climate sequences for Greater Paraburdoo and using this information to undertake erosion simulations and assessment of runoff predictions in order to develop landform design parameter recommendations for materials found at Greater Paraburdoo operations that would deliver an acceptable rate of erosion in these larger rainfall events.

Seven materials were included in the assessment including Dales Gorge, Joffre, Footwall Zone, Whaleback Shale, Hydrated Zone, Calcrete and McRae Shale. A range of design options were recommended. For low erodibility materials (Dales Gorge, Joffre and Footwall Zone) it was determined that the current parameters recommended for 1 in 100 year ARI events remain appropriate for these larger events due to conservancy built into the existing design tool.

Contamination

Impact of Nitrogen from Explosives on Mine Site Water Quality **2008**

Internal reference: RTIO-PDE-0054638

The likely issues associated with the use of nitrogen based explosives on mineral waste and any leachate water are explored in this report. The amounts of explosives used on site are described, along with nitrogen chemistry and toxicity. Nitrogen concentrations for various mine sites and specific lithologies are presented which includes concentration in rock assays and liquid extracts.

It was concluded that the largest risk of nitrogen contamination is likely to arise from the discharge of surface waters that have been in contact with blasted materials and are discharged off site into creeks or waterways. This becomes a more significant issue if the water is also acidic. Algae (ie cyanobacteria) plumes have been identified in acidic water at Tom Price

Control Measures for Potentially Acid Forming Pit Wall Rocks **2010**

Internal reference: RTIO-PDE-0079541

Desktop study of potential strategies to manage exposed sulfidic materials and find viable options for management was conducted with a focus on the Hope Downs 1 and Tom Price sites.

Chemical treatments have the potential to be effective only in the short-term and only for minor water quality issues. Grouting of the pit walls is expected to have limited applicability, although grout curtains behind the wall may have success (untested). Cover technologies have the greatest potential to be effective over the long term, but would need to be resistant to puncture by underlying rocks, resistant to weathering and UV damage ie shotcrete, geomembranes. For long term performance the exposed surface need to be as stable and free of loose material as possible. Treatment effectiveness will also depend on the site conditions, eg chemical less effective at Tom Price.

Paraburdoo and Channar Preliminary Site Investigation (PSI) & Sampling and Analysis Plan (SAP) 2010 **2010**

Internal reference: RTIO-HSE-0094695

This preliminary site investigation was conducted to identify potential sources of contamination from current and historical site activities.

The main sources of contamination from historical and current mining operations include hydrocarbon (mainly diesel) storage and handling associated underground pipework and fuel pumps. Other sources of contamination include vehicle washes and maintenance facilities, storage and handling of waste oils, liquid wastes and ammonium nitrate fuel oil, equipment laydown and spray painting areas, historical landfilling, wastewater treatment and transformer oils. A qualitative risk assessment highlighted that Area 20:Train Refuelling/Load Out Area poses a 'potentially high risk'. This was the highest ranked activity at the site.

Workshop Summary and Desktop Review: Dewatering and Sulfate Accumulation **2012**

Internal reference: RTIO-PDE-0101903

This is a summary of a workshop held to determine the risks of dewatering sulphides within the pit wall. The outcomes from this workshop will be used to develop models to estimate the mass of sulfate produced as a consequence of dewatering activities.

There are many processes that contribute to poor pit water quality. Most of these processes are known and accounted for in existing models. However, the science of fluid flow in fractured rock is not well developed and this lack of knowledge restricts the outcomes of studies on pit water quality. There is a general lack of empirical data for estimating parameters used in models, creating a large degree of uncertainty in predictive models. Sensitivity analysis can be used to overcome some of these challenges.

Development of a conceptual model: Sulfate accumulation as a consequence of pit dewatering activities, memo **2012**

Internal reference:
RTIO-PDE-0101903

Mine dewatering and the consequent lowering of the water table may result in desaturation of sulfide bearing lithologies. The objective of this work was to develop a conceptual model of the associated processes: where sulphide bearing rock intersects the pit walls, and where the sulphide bearing rock is located behind the pit walls but not directly exposed on the pit wall face.

The conceptual model developed estimates the mass of sulfate produced as a consequence of dewatering activities, considering processes during operations and after operations cease, and using sensitivity analysis where parameter inputs are uncertain. The model output provides the basis for an assessment of potential impacts on water quality for general risk assessment applications. Further work was identified to improve parameterisation of the model, including the collection of additional empirical data for pit wall fracturing, saturation of pit wall fractures and sulfide oxidation rates in talus and on pit walls.

Ethnographic or archaeological values

Water and Indigenous People in the Pilbara: A Preliminary Study, CSIRO: Water for a Healthy Country **2011**

Internal reference:
RTIO-HSE-0218222

Water resources are vital to Indigenous identities, beliefs, environmental philosophies and livelihoods. This report provides a broad-scale scoping study of Indigenous relationships to water in the Pilbara and considers the potential impacts of Indigenous water values.

Indigenous belief systems perceive water as an elemental part of the broader cultural landscape, held and managed under customary systems of law. Water sources were derived during the Dreaming and are the most important features in the Pilbara cultural landscape. Interviews raised issues of long term drying, obstruction of water flow, over-extraction, inappropriate discharge from de-watering and access restrictions.

APPENDIX D – CLOSURE RISK ASSESSMENT

Ref.				Risk Description					
Risk Type (T=Threat)	Category	Subcategory	Item	Evaluated of risks (0 Remaining) Threat Title	Potential causes (Triggers / Indicators)	Existing Controls and Commitments	Evaluation Rationale (Maximum reasonable consequence)	Risk Management Class -	Detailed Action Descriptions
T	**A**			**Planning and knowledge**					
T	**A**	**01**		**Contaminated sites**					
T	A	01	01	Contaminated sites (non-AMD) lead to an ongoing environmental or financial impact	• Use of chemicals and hydrocarbons during operations • Housekeeping practice and maintenance of work areas and equipment • Contaminated sites have not been identified • Inadequate cleanup of contaminated sites • Contamination source has not been appropriately addressed	• Regular maintenance / inspection / audit of work place procedures • Areas of potential environmental concern are captured on the RTIO Potentially Contaminated Sites Register, which represents potentially contaminating activities and sites, and will be assessed in time taking into account a risk based approach. • RTIO contaminated sites work practice and procedure is under development to guide the identification and reporting of contaminated sites • Potential contaminated sites are risk assessed and investigated • Appropriate waste disposal practices are maintained	A reportable contaminated site is found during the closure phase that requires remediation or management. Assumption: Clean up and low level ongoing management required (e.g. pumping bores).	**II**	**ER01** Review previously identified contaminating activities and areas of concern at ER to determine whether any require formal reporting **ER02** Undertake detailed site investigation prior to closure to identify, risk assess and classify potentially contaminated sites **ER03** Ensure end land use planning considers the impacts of any known or suspected contaminated sites
T	A	01	02	Acid and / or metalliferous drainage generation creates a contaminated site	• Interaction of water and mineral waste could generate acid / alkaline levels that leach metals / salts from the mineral waste or local environment • Presence of temporary or permanent open water bodies, enabling evapoconcentration to occur with creation of alkaline / hypersaline water quality • Ability of metals / salts to move through environment to impact a sensitive receptor, to meet definitions in Contaminated Sites Act 2003 • Poor management of PAF material and/or incomplete knowledge regarding location in waste dumps • Leaching from tailings facilities.	• Geochemical characterisation of waste material has been completed • Wet season management plans used to control run off. • Groundwater operating management plan to monitor groundwater quality • No tailings facility exists at ER Operations	An AMD plume develops, either during operations or at closure leading to corrective actions being required during the post-closure phase. Assumption: Acid water treatment plant required and operates for 10 years - Cost implications to be reviewed in PFS.	**III**	**ER04** Review site groundwater models to confirm watertable level and to determine whether additional monitoring bores are required **ER36** May 2017 - Review the AMD risk assessment to ensure it remains appropriate. **ER37** Confirm mine planning strategy in 32E6 pit and how PAF material mined will be managed.
T	A	01	03	Human health impacts from fibrous material exposures	• Hazardous fibres exposed in situ by mining, mined and moved to encapsulated areas or naturally present in soils disturbed by mining / rehabilitation activities • Erosion of materials containing hazardous fibres post-closure • Disposal of fibrous building materials	• Physical materials characterisation, some fibres present in mineral waste materials and associated with infrastructure • Fibrous materials management plan enacted	**Not evaluated - not considered a reasonable credible threat.**		
T	**A**	**02**		**Void management**					
T	A	02	01	Pit lake has undesirable impacts on local ecosystem function.	• Open water bodies in Pilbara naturally attract fauna (feral and native species) for food/ water/ refuge, safe access to water required • Evapoconcentration in open water bodies results in water quality degradation • Release of metals from natural geology or mineral waste into water (infiltration or groundwater flow) • Water provides opportunity for plant /weed growth, good and bad (toxic algal blooms, noxious weeds) • Certain plant / animal species bio-accumulate / magnify toxic metals • Instability associated with saturated, unconsolidated ground, can be increased by high trafficability Pit lake or individual landform strategies not acceptable to the regulator	• Void closure management guidance • Geochemical waste characterisation, good understanding of water chemistry / reaction chemistry • Physical waste characterisation • Rehabilitation handbook • Landform design guidance • Safe access to lake edges established via adjacent waste dumps • Aquatic fauna research underway to understand natural levels of toxic metal accumulation / impact on native species	**Not assessed - not considered a serious credible threat**		
T	A	02	02	Void has undesirable impacts on downstream ecosystem function	• Capture of surface water flows • Overtopping of pits causing unplanned discharges of poor quality water	• Multi-discipline review of new pit and dump designs (MDAS), includes review by surface water team • Approvals request process includes review and sign off by biodiversity/environmental disciplines	Pits intercept some minor surface water flows, thereby impacting downstream ecosystems and MNES habitat.	**II**	**ER05** Baseline monitoring of surface water pools to capture ongoing information about hydrological regime. **ER06** Review surface water impoundment and over topping risk of landforms, particularly landbridges prior to implementation of final closure strategies
T	A	02	03	Pit lake leads to degradation of regional groundwater quality or levels	• Groundwater flow through pit lake or mineral waste with connection to regional aquifer • Density driven saline groundwater flow from groundwater sink-style pit lakes • Downstream groundwater users (people, plants or animals)	• RTIO Void Closure Management Guidance. • Environmental surveys include regional groundwater dependent ecosystem. • Geochemical waste characterisation and column leach tests. • Preliminary integrated ground-surface water modelling (with recovery) completed.	**Not assessed - not considered a serious credible threat**		
T	A	02	04	Pit wall stability compromises closure outcomes	• Influence of erosion, subsidence, seismicity, wall slip • Influence of groundwater recovery and surface water flow on stability. • Creek system neighbouring or within potential unstable zone, potential stream capture • Geotechnical assessment incorrectly defines the potentially unstable zone	• Geotechnical assessments for wall stability and zone of collapse as part of mine design reviews, as required • New pit walls design factor of safety 1.2, geotechnical assessment show zone of collapse for high risk locations (near creeks, infrastructure etc.)	Pit wall collapses. Waste dump or other constructed feature, positioned inside the zone of instability, fails. Assumption: Any failures are contained in-pit (environmental impacts are minimal)	**II**	**ER07** Review potentially unstable zone around final pit crests prior to closure and undertake risk assessment to determine which .(if any) waste dumps and other structures need to be removed from within the zone. **ER38** New task May 2017 - Seek advice from regulator on placement of bunds where topographical constrains exist

Ref.				Risk Description				Risk Management Class -	
Risk Type (T=Threat)	Category	Subcategory	Item	Evaluated of risks (0 Remaining) Threat Title	Potential causes (Triggers / Indicators)	Existing Controls and Commitments	Evaluation Rationale (Maximum reasonable consequence)		Detailed Action Descriptions
T	**A**	**03**		**Closure landforms**					
T	A	3	01	Waste Fines Storage Facility is not closed effectively leading to downstream impacts.	Inappropriate design leads to wall failure Engineering solutions are not effective post-closure	• Specific closure design considerations built into the design of WFSFs. • Local hydrology management addressed in design and construction phases i.e. run on from adjacent natural landforms. • Landform design guidelines to implemented i.e. physical characterisation of the mineral waste on the outer surface. • Internal tailings closure guideline being	**Not assessed - not considered a serious credible threat**		
T	A	3	02	Landforms (excluding mine void areas) erode and / or collapse	Physical material properties not considered in design Poor drainage and erosion management Landforms not constructed to design requirements Current designs do not accommodate PMP/PMF events - regulator feedback in December 2017 recommends engineering design for large permanent mining related landforms should be based on Probable Maximum Precipitation / Probable Maximum Flood events (in excess 1:10,000,000). No rehab design for landforms	• Physical materials characterisation completed for common waste types • Backfill of some pits proposed • Multi-disciplinary pit and waste dump design sign-off process exists (MDAS), considers landform design guidelines and provides rehabilitation designs where appropriate • RTIO Rehabilitation handbook used for general rehabilitation activities • Rehabilitation designed to be stable without vegetation where practical to do so	Built landform/s fails due to erosion. Consider cost implications in PFS study.	**III**	**ER08** Validate landform design assumptions and associated erosion modelling by determining field erosion rates from rehabilitated waste dumps **ER09** Review waste dumping strategies throughout life of operation to confirm final dump compositions at end of mine life (use data to inform final design criteria) **ER10** Establish scree slope trial to validate closure methodology for landbridges **ER11** Confirm sufficient rock armour material can be sourced at site to implement scree slope strategy **ER07** Review potentially unstable zones around final pit crests prior to closure and undertake risk assessment to determine which (if any) waste dumps and other structures need to be removed from within the zone **ER06** Review surface water impoundment and overtopping potential of final landforms and associated geotechnical risks **ER14** Material characterisation required to confirm erodibility of ER wastes and appropriate rehab design parameters
T	A	3	03	Vegetation does not meet completion criteria	• Vegetation established, but does not re-seed in same abundance • Weed competition • Species selection / insufficient species diversity • Animal interference i.e. feral animals eating new growth • Changes to soil water conditions e.g. salinity, water logging etc. Vegetation is not self-sustaining Vegetation does not provide suitable habitat for local fauna • Availability of top soil stockpile soil / poor stockpile management e.g. soil washed away • Low moisture retention i.e. hydrophobic soils development, very rocky materials • Chemical properties of materials on waste dump / rehab surface e.g. salt circulation, alkalinity	• Rehabilitation handbook provides guidance on seed selection for appropriate diversity • Top soil stockpiles provide seed bank • Subsoil stockpiled to assist with deficits in topsoil • Seeds tested for germination as standard. Seeds sourced from reliable suppliers. • Seeds R&D programs carried out. • Rehabilitation monitoring carried out to determine progress of rehab towards completion criteria. • Allowance for rework as part of closure cost provision.	Vegetation fails to meet criteria at a site level (not at a single dump), requires remediation above what is allowed for in closure cost provision. Assumption: Lack of topsoil means that much of the rehabilitation is completed without growth media.	**III**	**ER15** Investigate optimal species selection for post-closure landforms **ER16** Undertake field trials to validate the potential of identified alternative growth media as topsoil substitute during rehabilitation activities **ER17** Forecast closure seed requirements and reconcile against present stocks based on final landform knowledge. Develop strategy to address any predicted shortfall in seed availability. **ER39** Investigate reasons for poor rehabilitation performance in some existing areas and use knowledge to inform future rehabilitation activities.
T	**A**	**04**		**Other regional considerations**					
T	A	04	02	Adverse impact to flora or fauna with conservation status or wider regional impact to high value environment	• Scheduled, listed or declared rare and / or threatened species of flora or fauna present in/adjacent to site • Downstream regional area of high value • Environmental conditions post-closure differ significantly from pre-mining conditions • Post-mining land use differs from pre-mining land use	• Baseline biological / ecosystem monitoring used to evaluate post-mining impacts • Many of the exclusions zones associate with NVCPs at ER contain areas of both significant habitat and heritage areas. - Areas of potential environmental concern are captured on the RTIO internal Potentially Contaminated Sites Register, which represents potentially contaminating activities and sites, and will be assessed in time taking into account a risk based approach.	Flora or fauna with conservation status or wider regional impact to high value environment suffers unforseen impact as a result of the closure strategy (e.g. via sedimentation or direct clearing) Assumption: Exclusion zone is impacted (habitat for MNES species)	**III**	**ER18** Ensure significant species locations/habitats are considered during any changes to final landform limits
T	A	04	03	Heritage site condition / cultural value is degraded as a result of implementing the closure plan	• Previously unidentified heritage sites or cultural heritage values, not considered in existing assessment, discussions, agreements or with authority to disturb • Changes to landforms on closure have potential to alter conditions at downstream sites, e.g. consider drainage, landform footprint, erosion implications • Cessation of maintenance of / to heritage site • Cultural values are not considered in rehabilitation strategies Inability to maintain access to heritage sites post closure.	• Internal ground disturbance approval request system • GIS system includes results from heritage surveys • Heritage sites within mine area, S18 application etc. prior to disturbance • Ongoing consultation with Traditional Owners • Cultural Heritage Management Plan	Landscape and ecosystem changes impact cultural heritage values in the area Cost to develop access routes to heritage sites.	**III**	**ER40:** Heritage Specialist to provide list of sites for review and consideration in final landform planning **ER19** Engage with stakeholders regarding post closure land use objectives and expectations

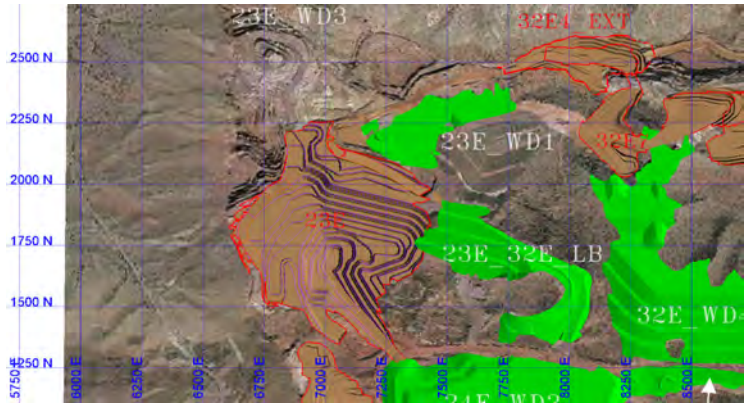
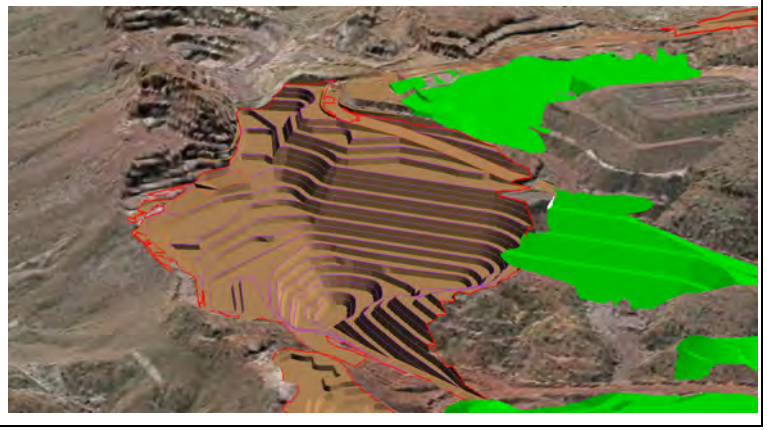
Ref.				Risk Description					
Risk Type (T=Threat)	Category	Subcategory	Item	Evaluated of risks (0 Remaining) Threat Title	Potential causes (Triggers / Indicators)	Existing Controls and Commitments	Evaluation Rationale (Maximum reasonable consequence)	Risk Management Class -	Detailed Action Descriptions
T	B			**Stakeholders**					
T	B	02		**Key stakeholder expectations**					
T	B	02	01	Closure outcomes do not meet stakeholder(s) / community expectations	•Fundamental opposition to planned retention of landbridges, regardless of trial outcomes, commitments Absence of rehabilitation trial or data to support predicted outcomes, closure activities fail to achieve completion criteria • Communication of anticipated closure outcomes and post-closure land use needs i.e. wrong plant species established • Unrealistic expectations for economic potential opportunities / post-closure land use capability • Consultation fails to identify stakeholder concerns • Large number of stakeholders in the project • Clarity of explanation / prediction of closure outcomes, communication styles, long term engagement of agreed outcomes through generational change. • Stakeholder expectations change over time, due to changing global benchmarks for mine rehabilitation success, intergenerational change, regulatory changes etc. • Stakeholders do not endorse site closure as their issues / concerns were not addressed A stakeholder's expectations do not align with that of another stakeholder, causing delays to plan approval and / or closure • Conflicting stakeholder expectations or areas of authority e.g. different regulators for environment, heritage, health, economic, tourism • Conflicting legal obligations e.g. State Agreement and EPA • Interactions between catchment land uses, including mining developments, at different points in time Perception or proven non-compliance with environmental commitments put forward during original approval process	• RTIO stakeholder engagement practice with key stakeholders • Monitoring established for rehabilitation areas Annual environmental reporting that has been undertaken	Relinquishment is delayed because agreed completion criteria no longer meet stakeholder expectations Assumption: Required to retain site for an additional 20 years, rework required to align with stakeholder expectations.	IV	**ER47:** Develop an evidence base of hydrological and mine planning impacts of PMP/PMF design criteria to support stakeholder discussions. **ER42:** Develop stakeholder engagement plan and strategy. **ER19** Engage with stakeholders regarding post closure land use objectives and expectations. Align objectives with these expectations. **ER20** Refine site closure objectives, completion criteria and measurement tools in consultation with key stakeholders **ER41:** Agree completion criteria with appropriate regulators. **ER43** Actively pursue development of TO business development and growth opportunities
T	B	02	02	Closure strategy prevents or limits future access to resources	• Backfill or waste dumping strategies sterilise ore reserves	• Economic review of ore reserves prior to backfill	Future resource is sterilised through pit backfill completed as part of closure works Assumption: Future change in grade cut-off or ore price results in some minor reserves being deemed economic, had backfill not occurred.	I	Class 1 do not require any specific actions but should be monitored for changes which result in change in rating of such risks.
T	B	03		**Other expectations**					
T	B	03	01	Mine closure has a significant, long-term detrimental impact on local communities	• Local communities receive direct support from operation for basic community services e.g. doctor • Significant proportion of community are directly or indirectly employed by operation		Reputational damage as a result of community outrage associated with impact to local business and services. Relationship damage with TO group and other key stakeholders. Issues with managing small residential workforce with a larger FIFO component.	III	**ER42** Develop Stakeholder Engagement Strategy **ER44** Develop Human Resources Strategy for closure **ER43:** Actively pursue development of TO business development and growth opportunities
T	C			**Obligations**					
T	C	01		**Agreements and commitments**					
T	C	01	01	Closure cannot be implemented in accordance with the approved closure plan	• Mine development changes prevent closure plan from being implemented as planned • Closure plan proves to be overly challenging to implement or implementation results in a different outcome than anticipated	• Integration of closure plan with LoM plan • Involvement of broad range of internal stakeholders in development of closure plan • May 2017 - RT Closure study process Opportunity to amend the closure plan at PFS and FS stages of the closure study.	Regulator identifies an inconsistency in closure implementation Assumption: Forced to retain site for an additional 10 years, rework required to align with stakeholder expectations.	II	**ER19** Engage with stakeholders regarding post closure land use objectives and expectations. **ER20** Refine site closure objectives, completion criteria and measurement tools in consultation with key stakeholders **ER10** Establish scree slope trial to validate closure methodology for landbridges **ER48** Refine closure plan at each stage of study to ensure it reflects changes in strategies and knowledge development
T	C	02		**Governance**					
T	C	02	01	Changes during planning and operations leads to increased closure complexity	• Unsafe working conditions evolve prior to rehabilitation e.g. reduce maintenance, pit / landform stability changes over time, groundwater recovery prior to completion of in pit closure activities, hazardous fibres exposed with erosion, sulphides gases • Lack of experience, i.e. staff skills or trial areas/activities, use of inefficient management processes / practice, high degree of re-work • Ambiguity of risk / issue / action ownership to appropriately resource & resolve prior to key mining decisions, increased cost & lost opportunities • Poor communication of closure strategies to site operations • Operational decisions influenced by short term economic/planning drivers possibly leading to sub-optimal closure outcomes	Via direction, initiatives & projects from: • Rehabilitation Working Group initiatives & projects • Rehabilitation and Closure Sub Committee• Closure Steering Committee Pit signoff for closure of the pit Dump signoff is for rehab • Closure Steering Committee	Mine planning decisions during life of operations lead to higher than predicted closure complexity and cost Assumption: Additional costs exceed 10% of estimate.	IV	**ER45** Communicate the results/findings of the outcomes of the ER OoM study to internal stakeholders.

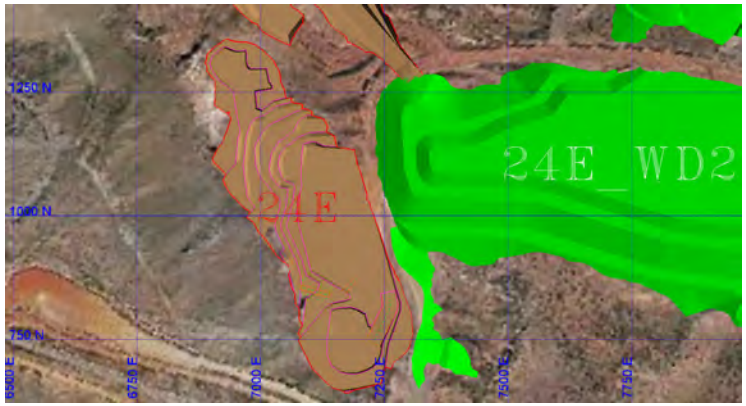
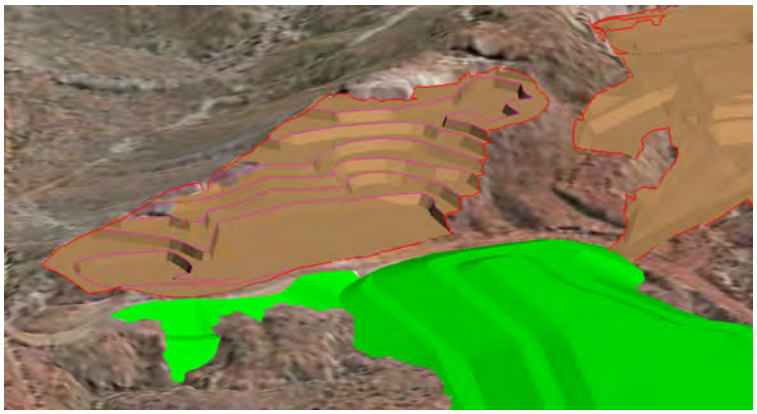
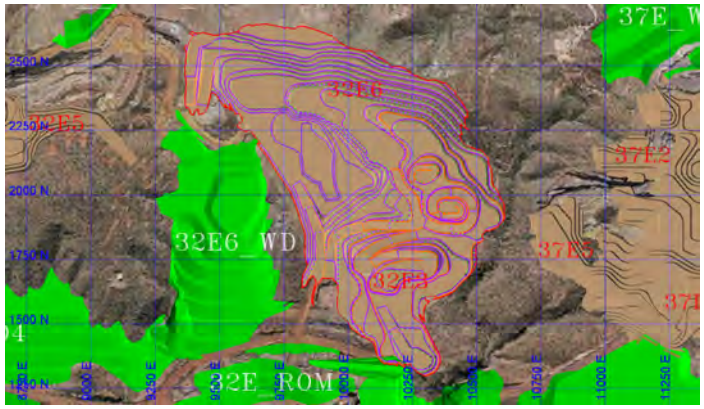
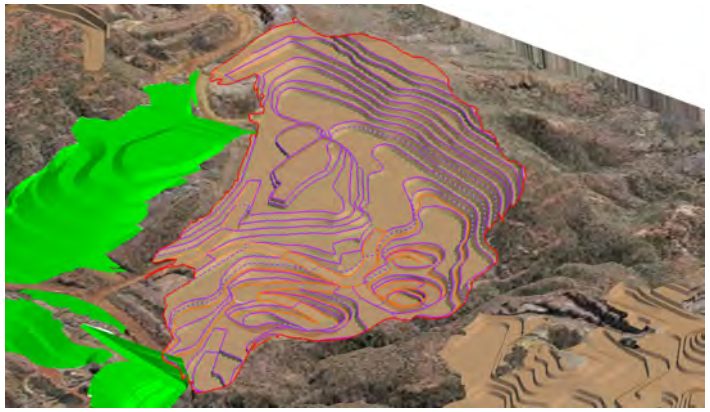
Ref.				Risk Description					
Risk Type (T=Threat)	Category	Subcategory	Item	Evaluated of risks (0 Remaining) Threat Title	Potential causes (Triggers / Indicators)	Existing Controls and Commitments	Evaluation Rationale (Maximum reasonable consequence)	Risk Management Class -	Detailed Action Descriptions
T	**D**			**Implementation - Land management**					
T	**D**	**01**		**Pre-closure care and maintenance**					
T	D	01	01	Closure costs are not effectively provisioned	• Costs are underestimated due to risks not being identified • Costs are underestimated because closure strategies fail and require rework • Assumptions around decommissioning prove incorrect e.g. asset such as rail or port facilities can not be handed to State or decommissioned structures can not be disposed of on site (no suitable disposal site exists) Landscape created through ongoing mining would be more expensive to rehab Regulator expectations increasing over time Approvals for projects / developments may have more onerous closure requirements. Federal enquiry into closure Improvements in the OBK Changes to broader business strategy JV withhold consent regarding an option.	• Annual PCO process for generation of provisions • Closure risk identification process (risk assessment) • Closure process within Rio Tinto calls for OoM/PFS/FS studies as the site approaches closure, which go to increasing levels of details and ensures confirmation that appropriate provisions are allowed for 3-yearly updates to the closure plan. Closure Steerco Internal mine design processes Investment approval processes	Closure costs exceed closure provisions Assumption: Additional costs exceed 10% of estimate.	**IV**	**ER30** Review and refine closure costs via closure studies process **ER31** Incorporate learnings from rehabilitation and decommissioning projects into closure cost estimation process **ER46** Ensure alignment between annual provisions reported to RT with the outcomes of the ER OoM study. **ER47:** Develop an evidence base of hydrological and mine planning impacts of PMP/PMF design criteria to support stakeholder discussions.
T	**F**	**01**		**Safety**					
T	F	01	01	Access to the area post-closure poses a public liability risk.	• Post-closure access / land-use requirements, e.g. for stock, people, heritage, environmental monitoring, adjacent mining activities etc. • Potential for general public to create their own access if appropriate access not provided. • Long term integrity of abandonment bunds. • Decommissioning of infrastructure not implemented effectively. • Some roads retained for post-closure access. • Water bores potentially retained.	* Site access currently controlled as it is an operating mine.	Closure fails to prevent inadvertent access to unstable or unsafe ground. Assumption: Single fatality or impairment	**III**	**ER32** Define & confirm final locations for abandonment bunding **ER07** Review geotechnical potentially unstable zones around final pit crests prior to closure and undertake risk assessment to determine which (if any) waste dumps and other structures need to be removed from within the zone **ER35** Determine construction methodology for abandonment bunds **ER49** Review and acceptance of abandonment bund placement and design by regulators **ER50** Propose and agree safe access routes to traditional owner sites
T	**D**	**05**		**Workforce & organisational design**					
T	D	05	02	Insufficient internal / external workforce to complete closure activities	Closure activities lengthy (3-5 years) Potentially parallel closure activities with ER/Channar (Argyle, BHP etc.) Other mining developments may put pressure on earth moving labour.	Channar and ER are relatively small sites.	Increased cost for closure labour or impact to schedule.	**II**	**ER44:** Develop Human Resources Strategy for closure
T	**F**	**05**		**Study Management**					
T	F	05	01	Stakeholder engagement inadequate to meet requirements of the study.	Engagement does not occur at right level Misaligned approach between business closure studies (Argyle, DSL, Channar / ER) sets divergent precendents Change of governments and associated closure expectations Federal Government override agreements RT makes with State Government. Limited understanding of the expectations, messaging, context of the engagement with key stakeholders. Limited TEG team engagement Loss of key study resources and study knowledge.	Comms of study outcomes coordinated through the Closure team. Stakeholder register Endorsed stakeholder engagement plan/strategy for the study. Coordination between Channar / ER and Argyle closure activities.	Uncoordinated approach to messaging of study outcomes leads to unrealistic expectations by the regulator or internal stakeholders. Potential delays to closure plan approval or a conservative position adopted by the regulator leading to additional costs to implement. Impacts to future approvals.	**III**	**ER50**. Ensure stakeholder expectations are understood and managed during the engagement process **ER51.** Implement knowledge management process for the study. **ER52**. Escalate regulatory engagement strategy to Closure Steerco
				End of record					

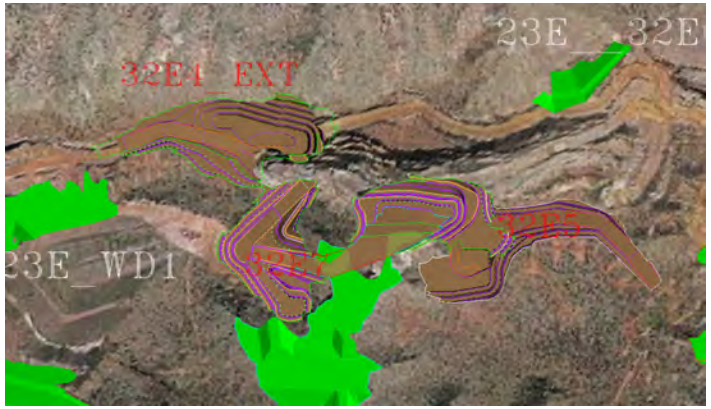
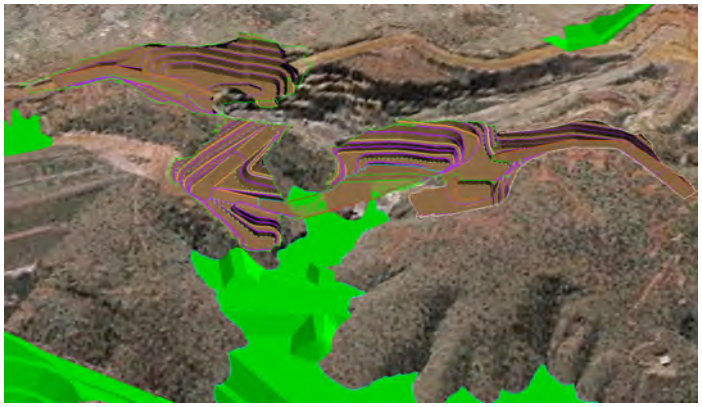
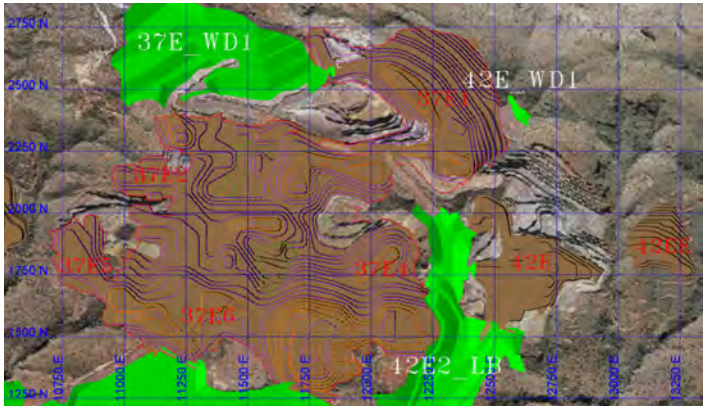
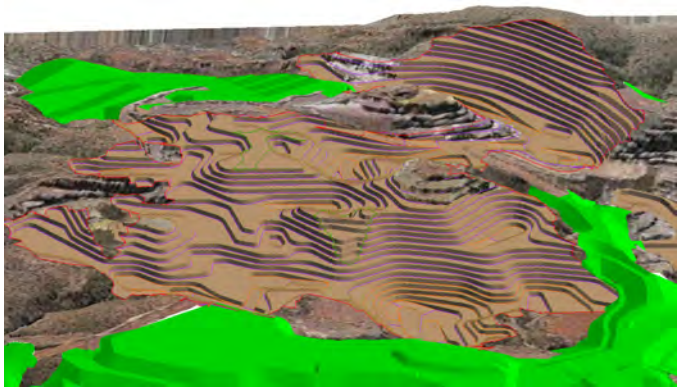
APPENDIX E - LANDFORM DESIGN CRITERIA

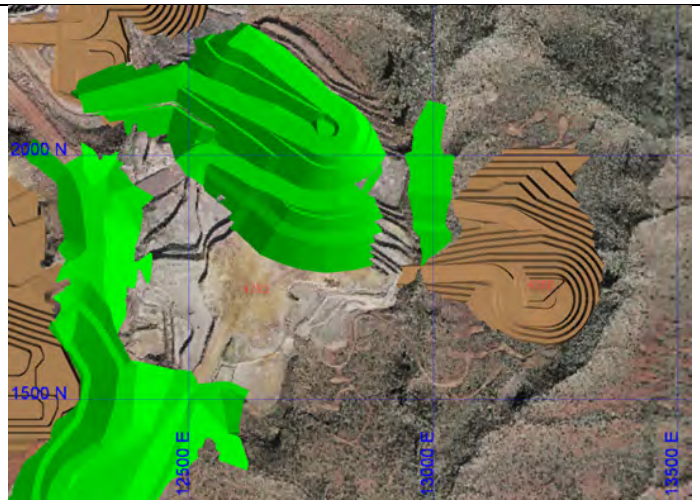
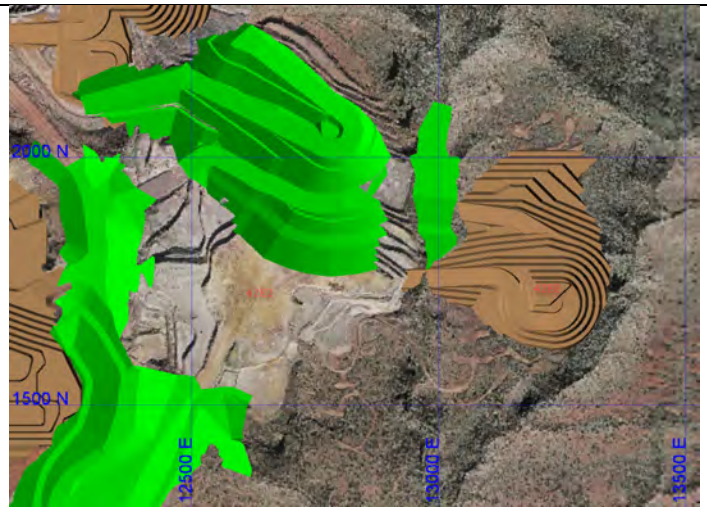
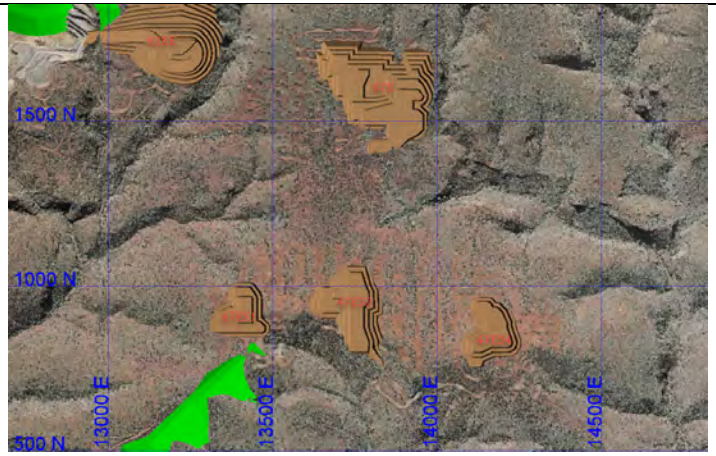
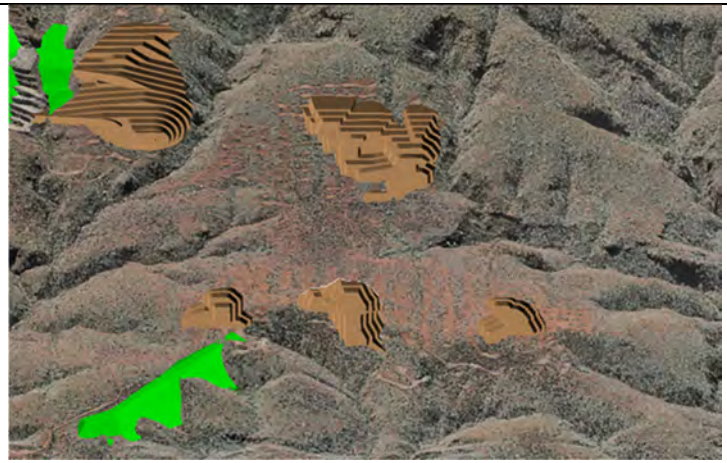
The following tables present the final pit shells across Eastern Range. Rehabilitation within pit boundaries is not proposed. Abandonment bunds will be placed as required to prevent inadvertent access to areas within the PUPEZ.

PITS

Deposit	Pit name	Final pit shell plan view	Final pit shell side view
23E	23E (including 23E_S3)		

Deposit	Pit name	Final pit shell plan view	Final pit shell side view
24E	24E		
32E	32E3 & 32E6		

Deposit	Pit name	Final pit shell plan view	Final pit shell side view
32E	32E4_Ext, 32E5 & 32E7		
37E	37E1, 37E2, 37E4, 37E5 & 37E6		

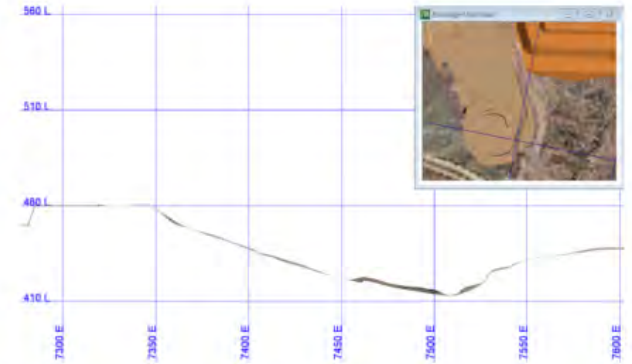
Deposit	Pit name	Final pit shell plan view	Final pit shell side view
42E	42E & 42EE		
47E	47E, 47ES1, 47ES2 & 47ES4		

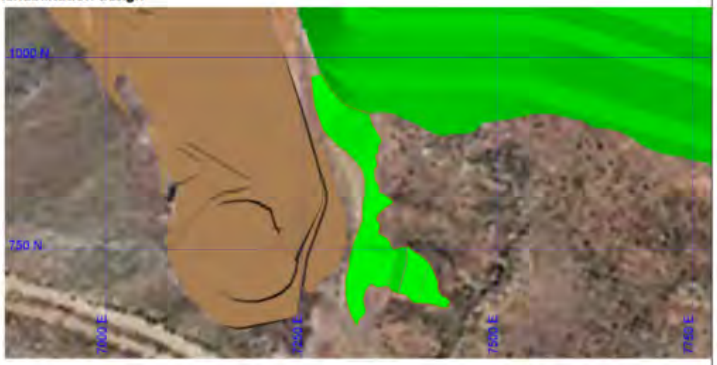
DUMPS AND LANDBRIDGES

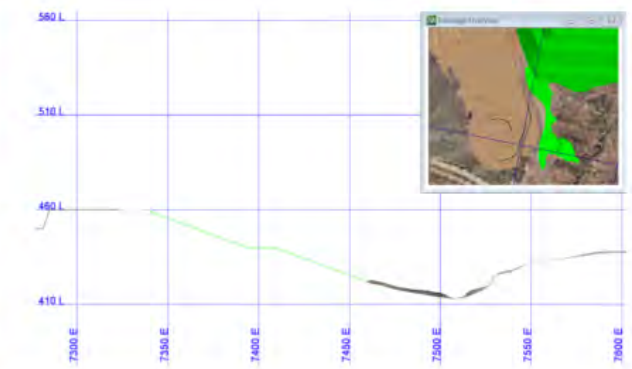
The following tables provide summaries of the key design criteria (where available) of the waste landforms associated with Eastern Range.

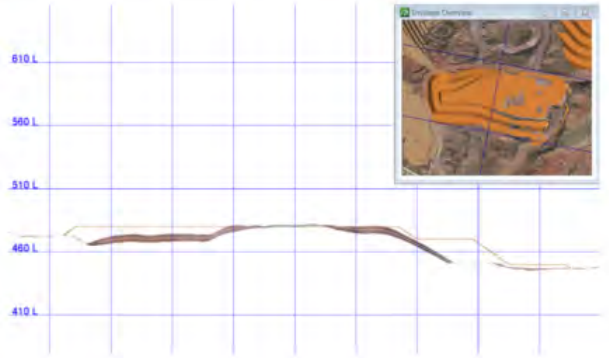
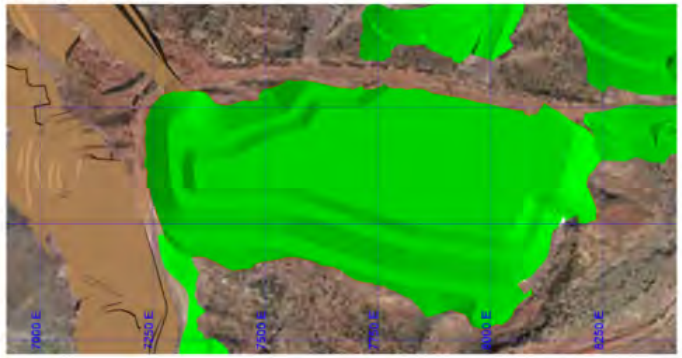
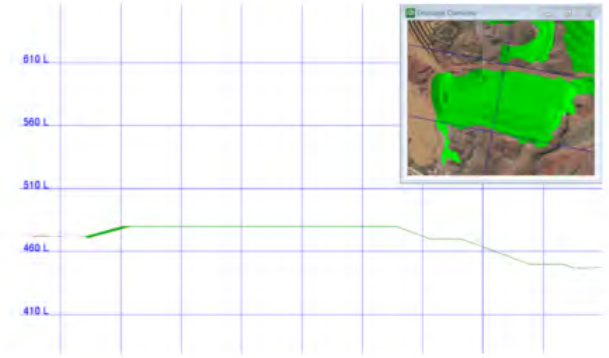
These rehabilitation designs have been refined to OoM level of detail and will continue to be refined during PFS stage. Alternatives to central case options will also continue to be investigated and may replace these designs as planning progresses. Note a rehabilitation design has not been completed for 23E_WD3 at this stage; however allowance has been included in the cost estimate for its rehabilitation requirements. This will be designed and included in the PFS.

Landform name			24E_LB
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view** / **Side view**
Erodibility Ranking		Low	Construction design
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	1.6	1.6	
Surface area (ha)		1.7	
Overall height (RL/m)	40	40	
Slope angle (degrees)	35	20	
Number of lifts	1	2	
Height of bottom lift 1 (m)		20	
Height of lift 2 (m)		20	
Height of lift 3 (m)			
Height of bottom lift 4 (m)			
Berm slope (degrees)		11	
Berm widths m		10	
Topsoil vol required m3		3,400	
Capping vol required t			
Toe bund distance m	N/A	250	Rehabilitation design
Crest bund distance m	N/A	350	
Comments:			



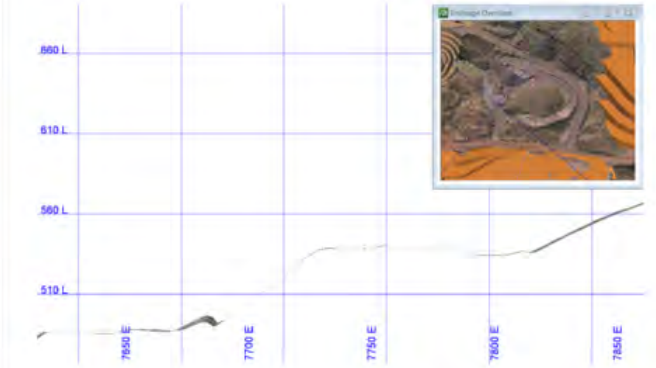


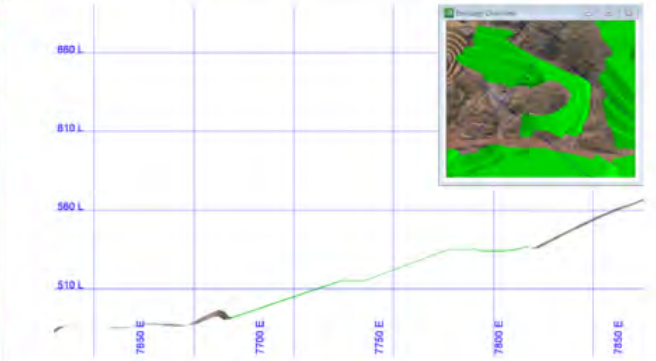


Landform name			24E_WD2	
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**	**Side view**
Erodibility Ranking		Low	**Construction design**	
Classification	Inert YES			
	PAF NO			
	Fibrous minerals NO			
Footprint (ha)	38	38		
Surface area (ha)		39		
Overall height (RL/m)	50	50		
Slope angle (degrees)	35	20		
Number of lifts	3	3		
Height of bottom lift 1 (m)	20	20		
Height of lift 2 (m)	20	20		
Height of lift 3 (m)	10	10		
Height of bottom lift 4 (m)	N/A	N/A		
Berm slope (degrees)	0	11		
Berm widths m	40	10		
Topsoil vol required m3		78,000		
Capping vol required t				
Toe bund distance m	N/A	2200	**Rehabilitation design**	
Crest bund distance m	N/A	1700		
Comments:				

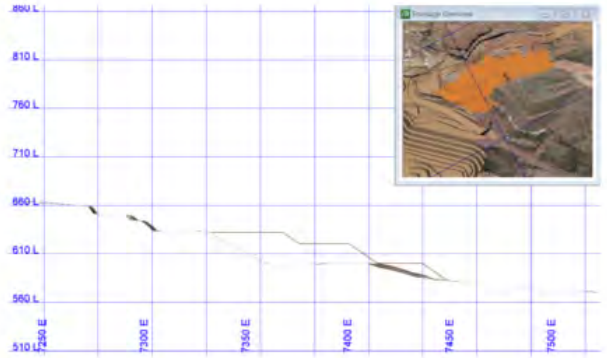
Landform name			23E_32E_LB
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	16.4	16.4	
Surface area (ha)		17.3	
Overall height (RL/m)	80	80	
Slope angle (degrees)	35	20	
Number of lifts	1	4	
Height of bottom lift 1 (m)	80	20	
Height of lift 2 (m)	N/A	20	
Height of lift 3 (m)	N/A	20	
Height of bottom lift 4 (m)	N/A	20	
Berm slope (degrees)	N/A	11	
Berm widths m	N/A	10	
Topsoil vol required m3		34,600	
Capping vol required t			
Toe bund distance m	N/A	600	**Rehabilitation design**
Crest bund distance m	N/A	1000	
Comments:			

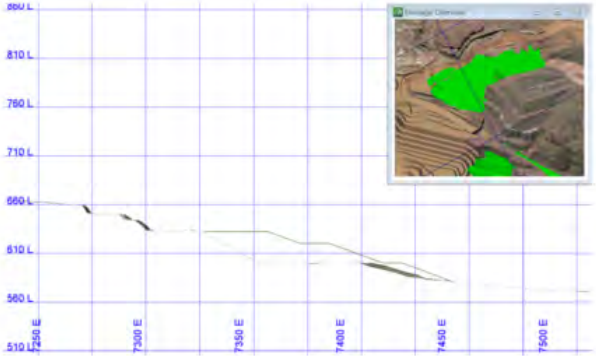
Side view



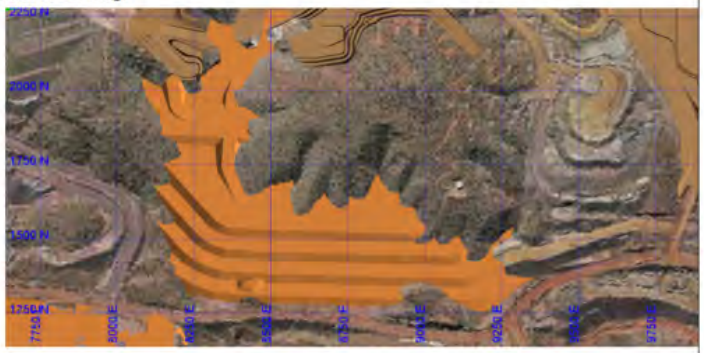


Landform name			23E_WD1	
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**	**Side view**
Erodibility Ranking		Low	**Construction design**	
Classification	Inert YES			
	PAF NO			
	Fibrous minerals NO			
Footprint (ha)		28.8		
Surface area (ha)		29.3		
Overall height (RL/m)	52	52		
Slope angle (degrees)	35	20		
Number of lifts	3	3		
Height of bottom lift 1 (m)	20	20		
Height of lift 2 (m)	20	20		
Height of lift 3 (m)	12	12		
Height of bottom lift 4 (m)	N/A			
Berm slope (degrees)	0	11		
Berm widths m	40	10		
Topsoil vol required m3		20,600		
Capping vol required t				
Toe bund distance m	N/A	200	**Rehabilitation design**	
Crest bund distance m	N/A	500		
Comments:				

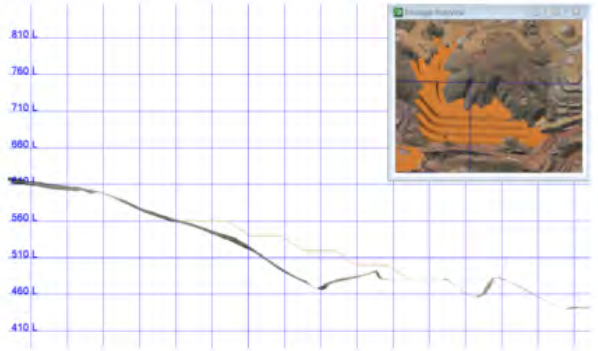


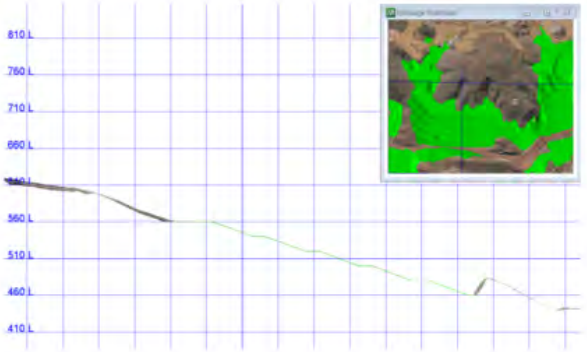


Landform name			32E_WD4
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	46.5	47.3	
Surface area (ha)		49	
Overall height (RL/m)		100	
Slope angle (degrees)	35	20	
Number of lifts	5	5	
Height of bottom lift 1 (m)	20	20	
Height of lift 2 (m)	20	20	
Height of lift 3 (m)	20	20	
Height of bottom lift 4 (m)	20	20	
Berm slope (degrees)	0	11	
Berm widths m	40	10	
Topsoil vol required m3		98,000	
Capping vol required t			
Toe bund distance m	N/A	1200	**Rehabilitation design**
Crest bund distance m	N/A	1200	
Comments:			

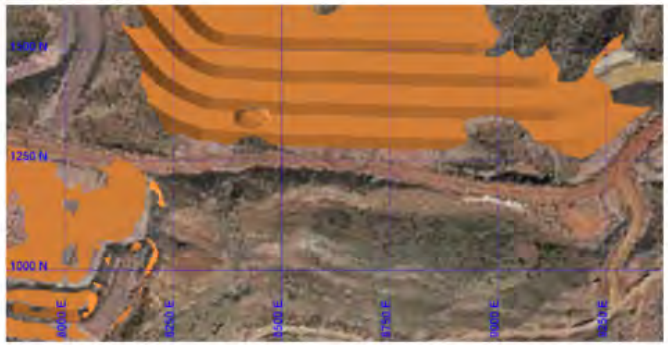


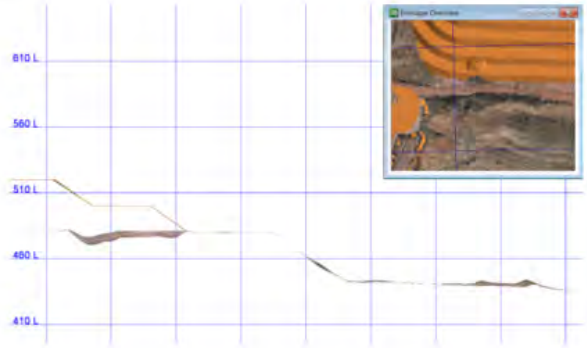
Side view

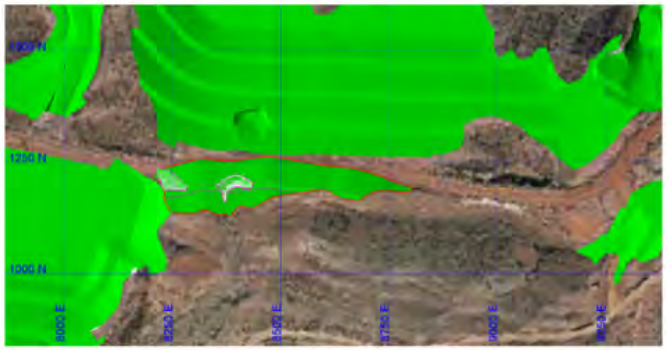


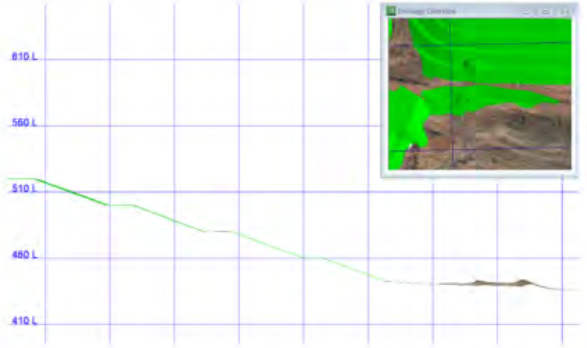


Landform name			32E_WD4_LB	
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**	**Side view**
Erodibility Ranking		Low	**Construction design**	
Classification	Inert YES			
	PAF NO			
	Fibrous minerals NO			
Footprint (ha)	4.7	4.7		
Surface area (ha)		5		
Overall height (RL/m)	40	40		
Slope angle (degrees)	35	20		
Number of lifts	1	2		
Height of bottom lift 1 (m)	40	20		
Height of lift 2 (m)	N/A	20		
Height of lift 3 (m)	N/A	N/A		
Height of bottom lift 4 (m)	N/A	N/A		
Berm slope (degrees)	N/A	11		
Berm widths m	N/A	10		
Topsoil vol required m3		10,000		
Capping vol required t				
Toe bund distance m	N/A	600	**Rehabilitation design**	
Crest bund distance m	N/A	600		
Comments:				

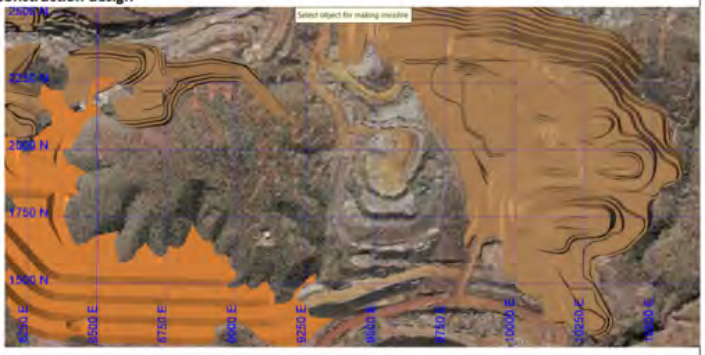


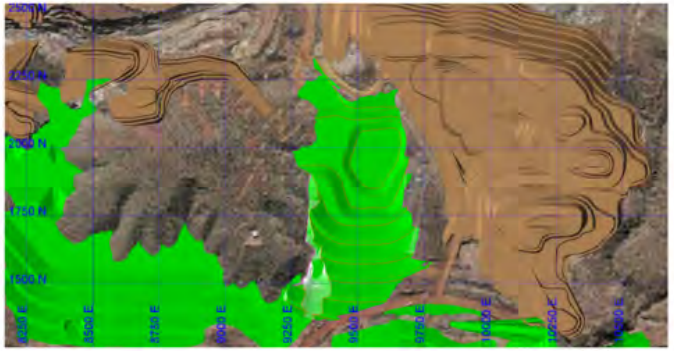


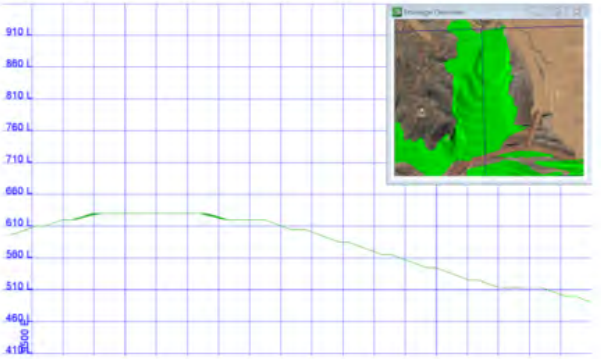




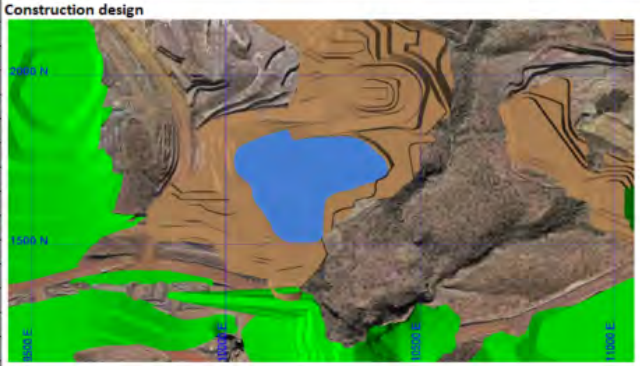
Landform name			32E6_WD
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view** / **Side view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	32.8	32.8	
Surface area (ha)		34.2	
Overall height (RL/m)	130	130	
Slope angle (degrees)	35	20	
Number of lifts	6	7	
Height of bottom lift 1 (m)	25	20	
Height of lift 2 (m)	25	20	
Height of lift 3 (m)	15	20	
Height of bottom lift 4 (m)	20	20	
Berm slope (degrees)	0	11	
Berm widths m	35	10	
Topsoil vol required m3		68,400	
Capping vol required t			
Toe bund distance m	N/A	1100	**Rehabilitation design**
Crest bund distance m	N/A	700	
Comments:			

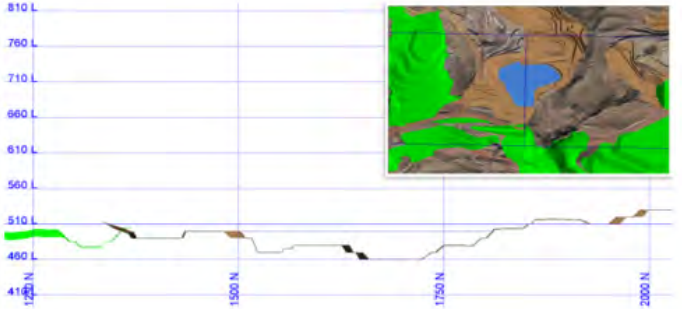


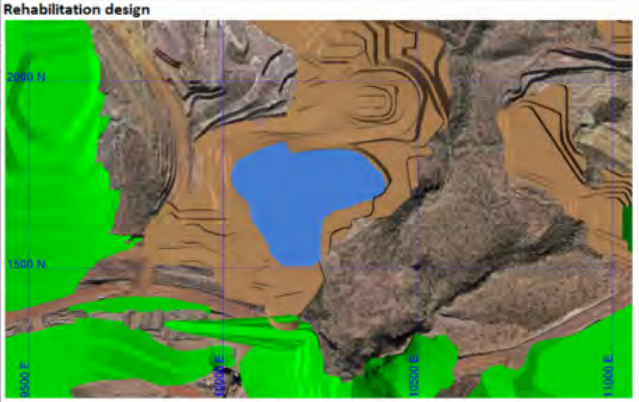


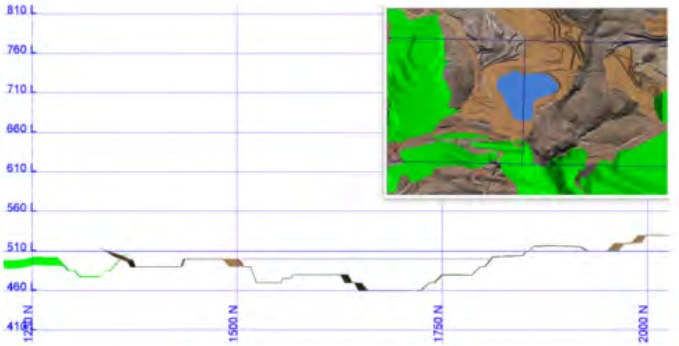


Landform name			32E3 BF	
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**	**Side view**
Erodibility Ranking	N/A	Low	**Construction design**	
Classification	Inert YES			
	PAF NO			
	Fibrous minerals NO			
Footprint (ha)	4.9	4.9		
Surface area (ha)	4.9	4.9		
Overall height (RL/m)	45	45		
Slope angle (degrees)	N/A	N/A		
Number of lifts	1	1		
Height of bottom lift 1 (m)	45	45		
Height of lift 2 (m)	N/A	N/A		
Height of lift 3 (m)	N/A	N/A		
Height of bottom lift 4 (m)	N/A	N/A		
Berm slope (degrees)	N/A	N/A		
Berm widths m	N/A	N/A		
Topsoil vol required m3	N/A	9700		
Capping vol required t	N/A	N/A		
Toe bund distance m	N/A	N/A	**Rehabilitation design**	
Crest bund distance m	N/A	N/A		
Comments:				
Backfill of pit to crest level (500RL). No reshaping required.				

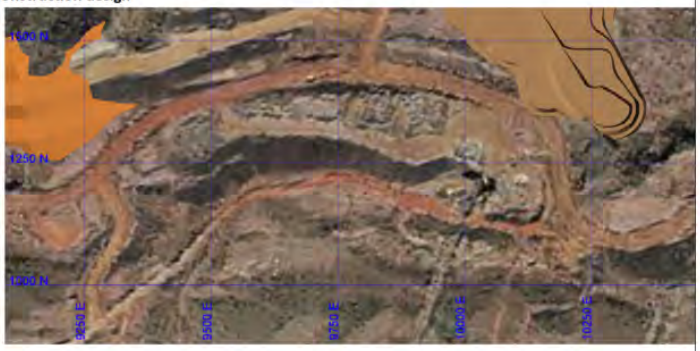


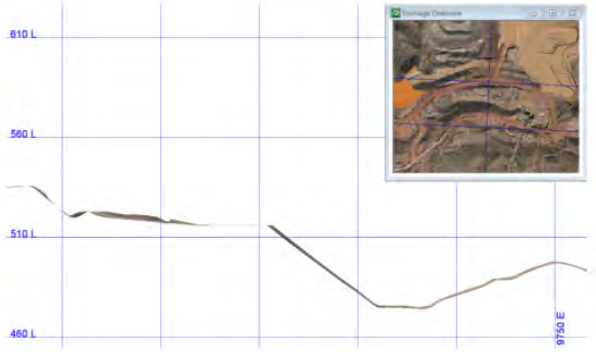


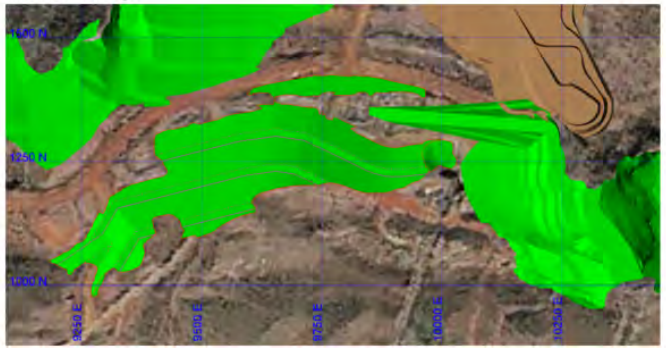


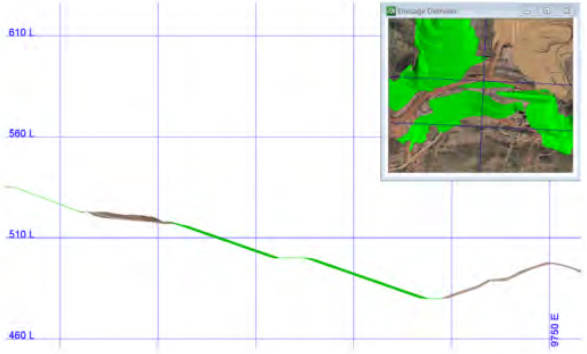


Landform name			32E_ROM	
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**	**Side view**
Erodibility Ranking		Low	**Construction design**	
Classification	Inert YES			
	PAF NO			
	Fibrous minerals NO			
Footprint (ha)		12.5		
Surface area (ha)		13.1		
Overall height (RL/m)	70	70		
Slope angle (degrees)	35	20		
Number of lifts	1	4		
Height of bottom lift 1 (m)		10		
Height of lift 2 (m)		20		
Height of lift 3 (m)		20		
Height of bottom lift 4 (m)		20		
Berm slope (degrees)		11		
Berm widths m		10		
Topsoil vol required m3		26,200		
Capping vol required t				
Toe bund distance m	N/A	900	**Rehabilitation design**	
Crest bund distance m	N/A	1000		
Comments:				

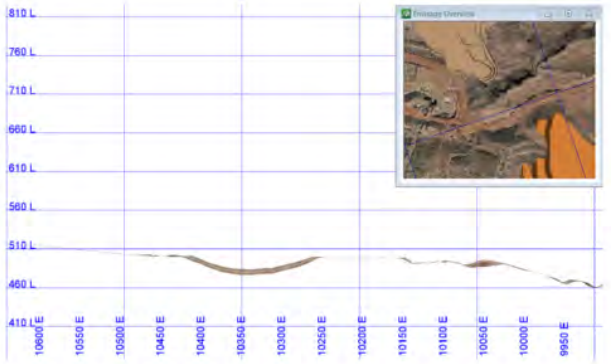


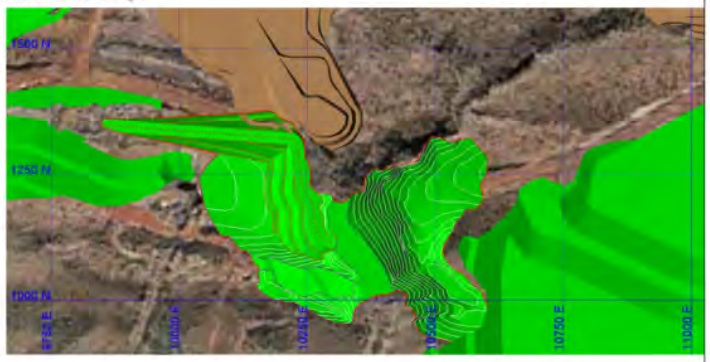


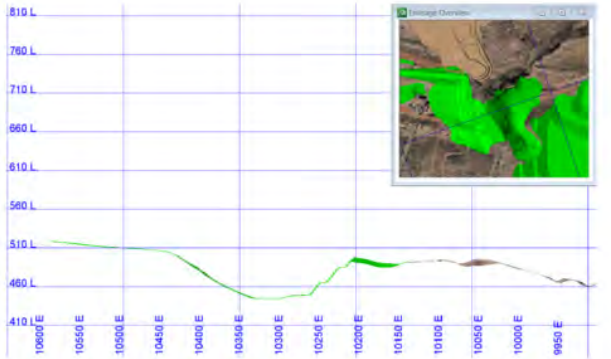




Landform name			32E_37E_LB
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view** / **Side view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)		16.6	
Surface area (ha)		18.8	
Overall height (RL/m)	80	80	
Slope angle (degrees)	35	20	
Number of lifts	1	4	
Height of bottom lift 1 (m)	80	20	
Height of lift 2 (m)	N/A	20	
Height of lift 3 (m)	N/A	20	
Height of bottom lift 4 (m)	N/A	20	
Berm slope (degrees)	N/A	8	
Berm widths m	N/A	8	
Topsoil vol required m3		37,600	
Capping vol required t			
Toe bund distance m	N/A	N/A	**Rehabilitation design**
Crest bund distance m	N/A	700	
Comments:			

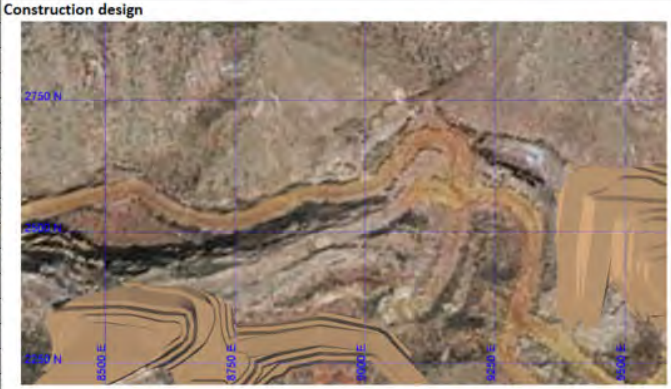


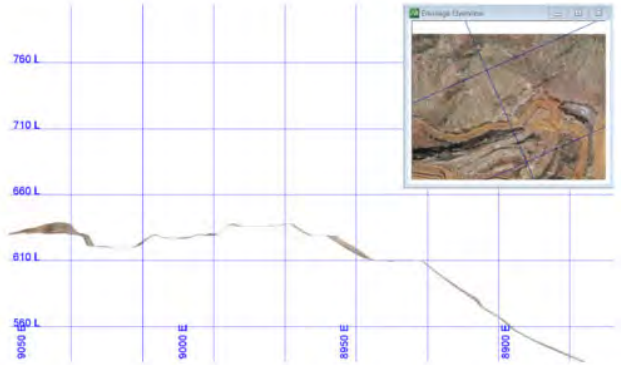




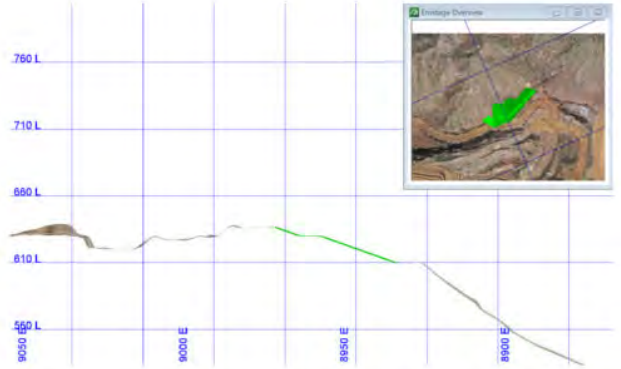
Landform name			23E_32E6_LB
Criteria	Construction specifications	Rehabilitation specifications	Plan view / Side view
Erodibility Ranking		Low	
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	1.9	1.9	
Surface area (ha)		1.9	
Overall height (RL/m)	35	35	
Slope angle (degrees)	35	20	
Number of lifts	1	2	
Height of bottom lift 1 (m)	35	20	
Height of lift 2 (m)	N/A	15	
Height of lift 3 (m)	N/A	N/A	
Height of bottom lift 4 (m)	N/A	N/A	
Berm slope (degrees)	N/A	N/A	
Berm widths m	N/A	N/A	
Topsoil vol required m3		3,736	
Capping vol required t			
Toe bund distance m	N/A	200	
Crest bund distance m	N/A	350	
Comments:			

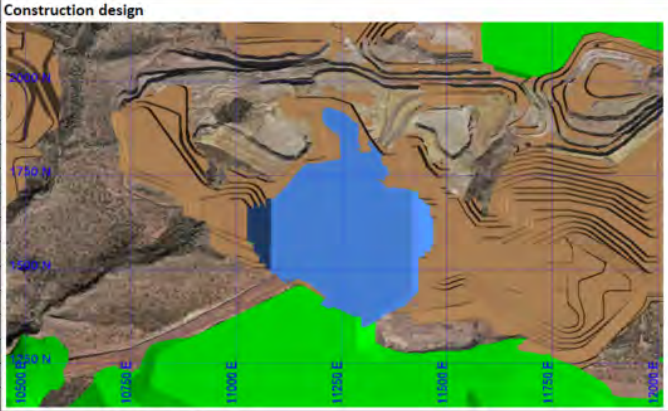
Construction design



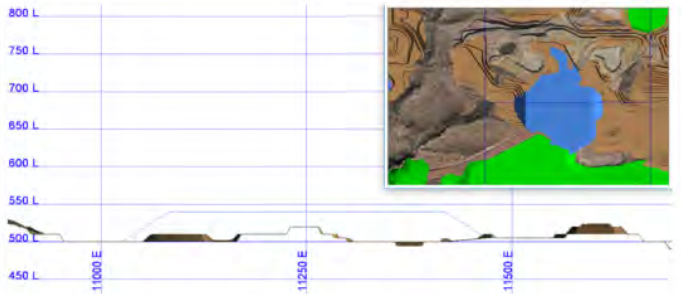


Rehabilitation design

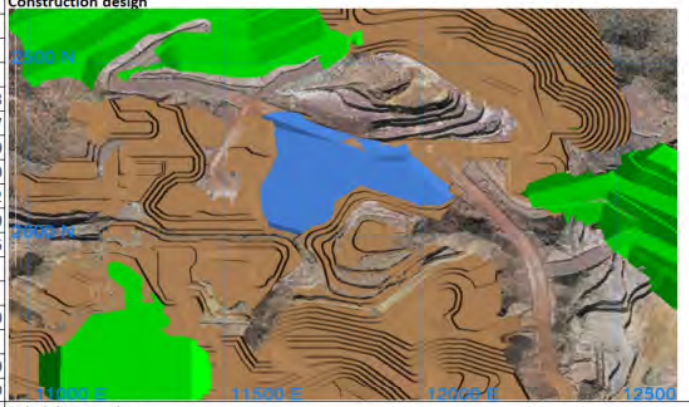


Landform name			37E6_BF
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	14.6	14.6	
Surface area (ha)	14.7	14.7	
Overall height (RL/m)	40	40	
Slope angle (degrees)	35	35	
Number of lifts	1	1	
Height of bottom lift 1 (m)	40	40	
Height of lift 2 (m)	n/a	n/a	
Height of lift 3 (m)	n/a	n/a	
Height of bottom lift 4 (m)	n/a	n/a	
Berm slope (degrees)	n/a	n/a	
Berm widths m	n/a	n/a	
Topsoil vol required m3	n/a	23,966	
Capping vol required t	n/a	n/a	
Toe bund distance m	n/a	n/a	**Rehabilitation design - N/A**
Crest bund distance m	n/a	415	
Comments:			
Backfill of 37E6 pit that is internally draining. This dump leaves capacity in 37E_WD2 for 47E waste, and reduces the clearing footprint of the 47E works. Internally draining so no rehabilitation required.			

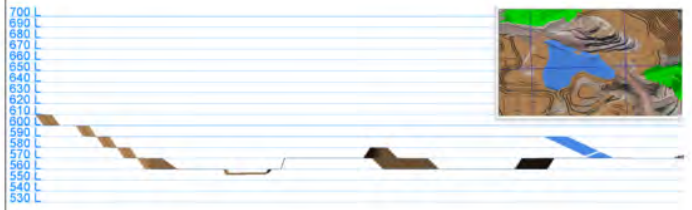
Side view

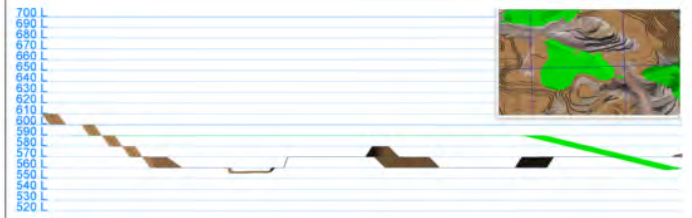


Landform name			37E1_BF
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	9.7	9.8	
Surface area (ha)	9.6	9.7	
Overall height (RL/m)	40	40	
Slope angle (degrees)	35	20	
Number of lifts	2	2	
Height of bottom lift 1 (m)	20	20	
Height of lift 2 (m)	16	16	
Height of lift 3 (m)			
Height of bottom lift 4 (m)			
Berm slope (degrees)	0	0	
Berm widths m	N/A	N/A	
Topsoil vol required m3		19000	
Capping vol required t		0	
Toe bund distance m		0	**Rehabilitation design**
Crest bund distance m		0	
Comments:			



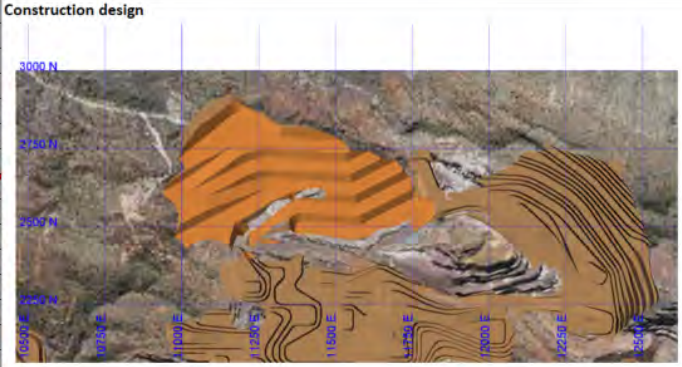
Side view

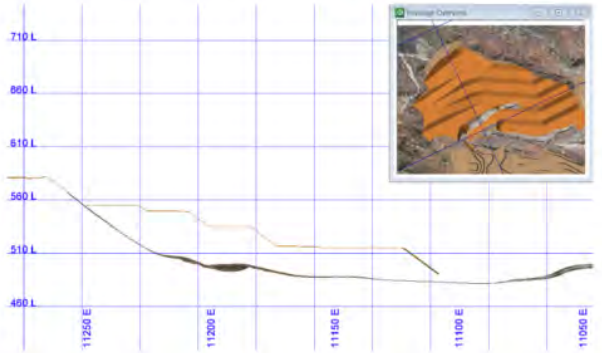


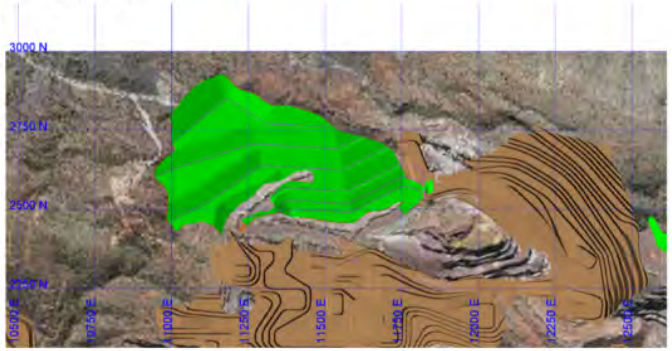


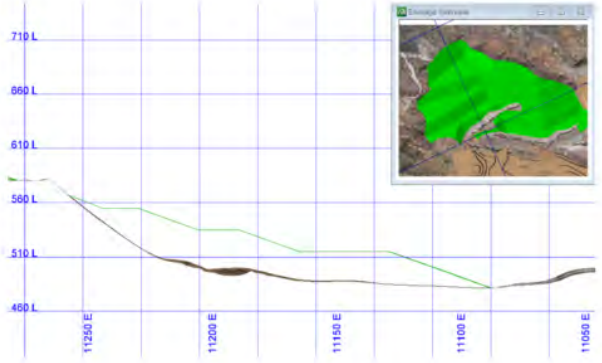
Backfill to the 590RL as a single lift (20m), with the second lift just being the ramp to 37E2. Rehabilitated area on the northern edge only where the ramp is externally draining to the east.

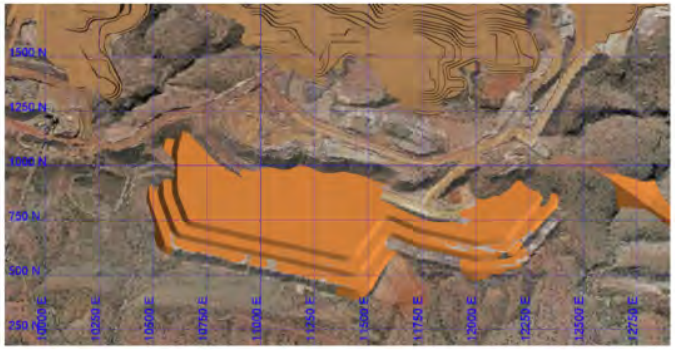
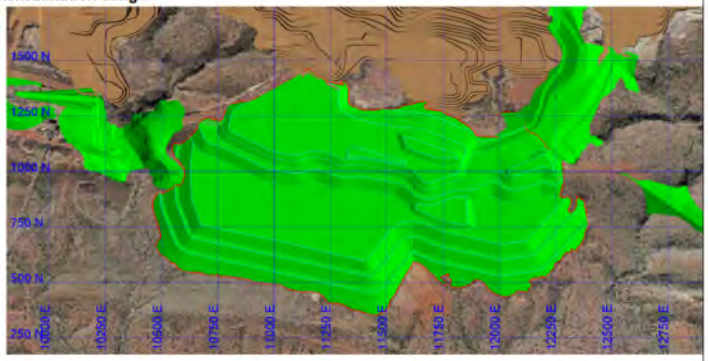
Landform name			37E_WD1	
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**	**Side view**
Erodibility Ranking		Low	**Construction design**	
Classification	Inert YES			
	PAF NO			
	Fibrous minerals NO			
Footprint (ha)	25.7	26		
Surface area (ha)		27.1		
Overall height (RL/m)	100	100		
Slope angle (degrees)	35	20		
Number of lifts	5	5		
Height of bottom lift 1 (m)	20	20		
Height of lift 2 (m)	20	20		
Height of lift 3 (m)	20	20		
Height of bottom lift 4 (m)	20	20		
Berm slope (degrees)	0	11		
Berm widths m	40	10		
Topsoil vol required m3		54,200		
Capping vol required t				
Toe bund distance m	N/A	600	**Rehabilitation design**	
Crest bund distance m	N/A	700		
Comments:				

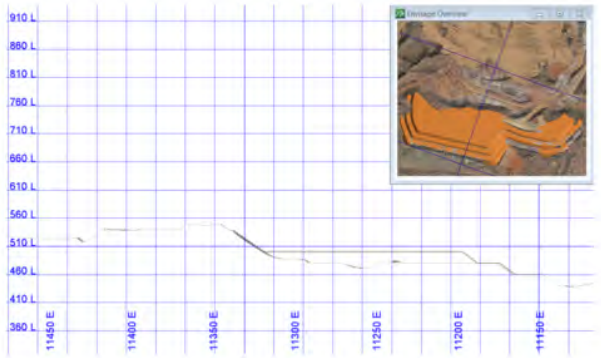
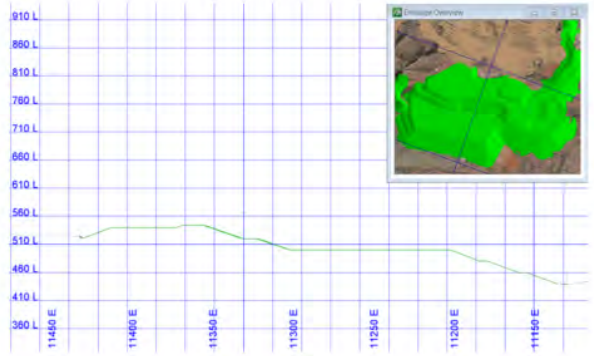


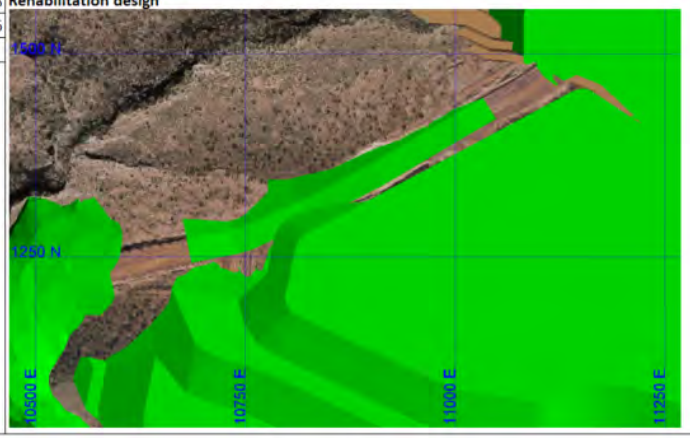




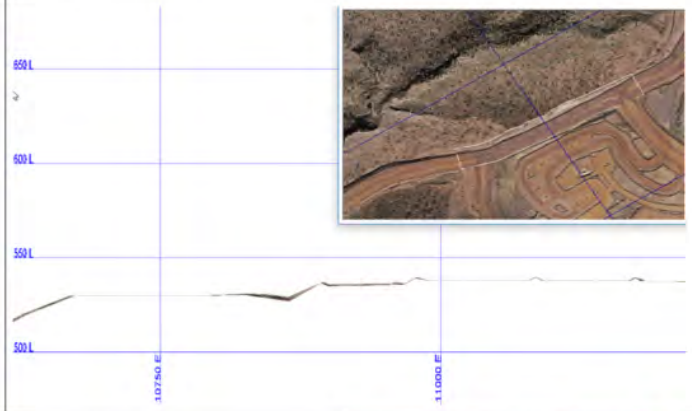


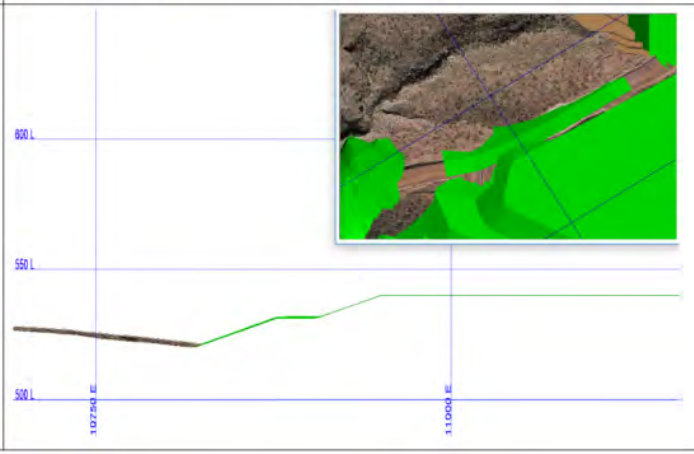
Landform name			37E_WD2
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	140.3	140.3	
Surface area (ha)		144.7	
Overall height (RL/m)	100	100	
Slope angle (degrees)	35	20	
Number of lifts	4	5	
Height of bottom lift 1 (m)	20	20	
Height of lift 2 (m)	20	20	
Height of lift 3 (m)	20	20	
Height of bottom lift 4 (m)	20	20	
Berm slope (degrees)	N/A	11	
Berm widths m	40	10	
Topsoil vol required m3		289,400	
Capping vol required t			
Toe bund distance m	N/A	2500	**Rehabilitation design**
Crest bund distance m	N/A	1700	
Comments:			

Side view



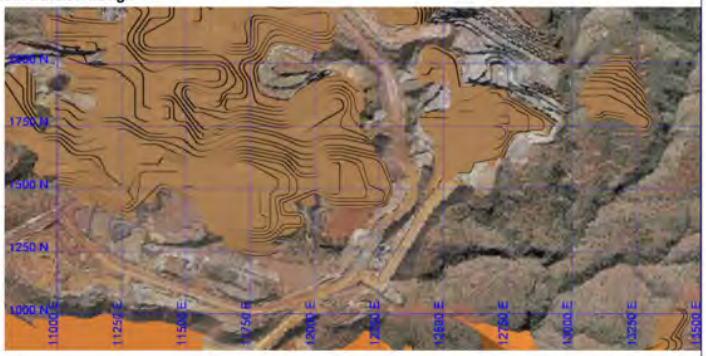
Landform name			37E_LB
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	2.0	1.7	
Surface area (ha)	2.1	1.7	
Overall height (RL/m)	10	10	
Slope angle (degrees)	35	20	
Number of lifts	1	1	
Height of bottom lift 1 (m)	10	10	
Height of lift 2 (m)	n/a	n/a	
Height of lift 3 (m)	n/a	n/a	
Height of bottom lift 4 (m)	n/a	n/a	
Berm slope (degrees)	n/a	n/a	
Berm widths m	n/a	n/a	
Topsoil vol required m3	n/a	3,475	
Capping vol required t	n/a	0	
Toe bund distance m	n/a	408	**Rehabilitation design**
Crest bund distance m	n/a	396	
Comments:			
Assume constructed from hydrated material from 32E pits.			

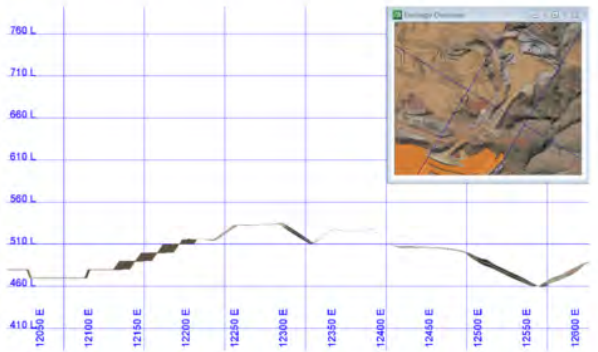
Side view

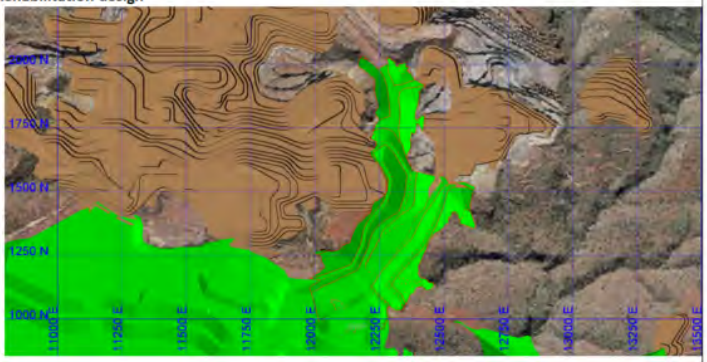


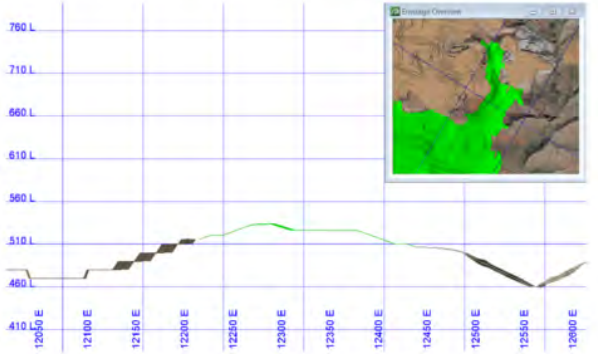


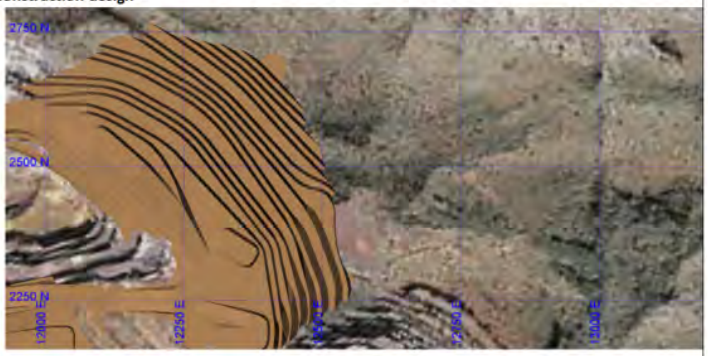
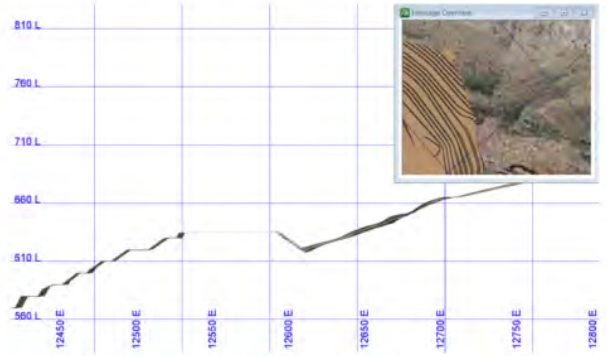
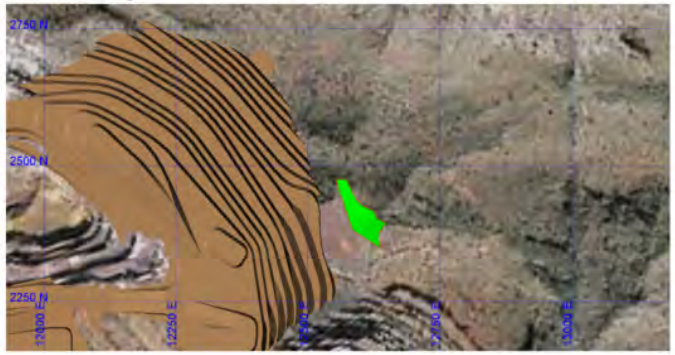
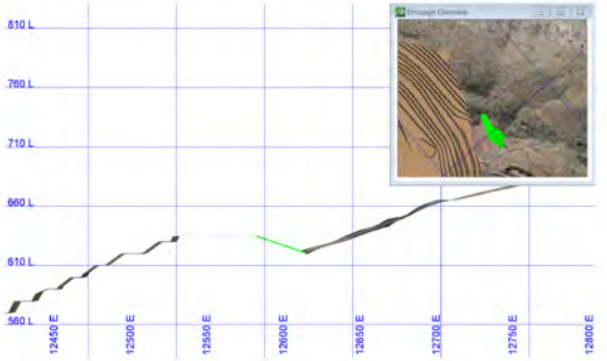
Landform name			42E2_LB
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)		28.5	
Surface area (ha)		29.6	
Overall height (RL/m)	60	60	
Slope angle (degrees)	35	20	
Number of lifts	1	4	
Height of bottom lift 1 (m)	60	20	
Height of lift 2 (m)	N/A	15	
Height of lift 3 (m)	N/A	15	
Height of bottom lift 4 (m)	N/A	10	
Berm slope (degrees)	N/A	11	
Berm widths m	N/A	10	
Topsoil vol required m3		59,200	
Capping vol required t			
Toe bund distance m	N/A	700	**Rehabilitation design**
Crest bund distance m	N/A	500	
Comments:			





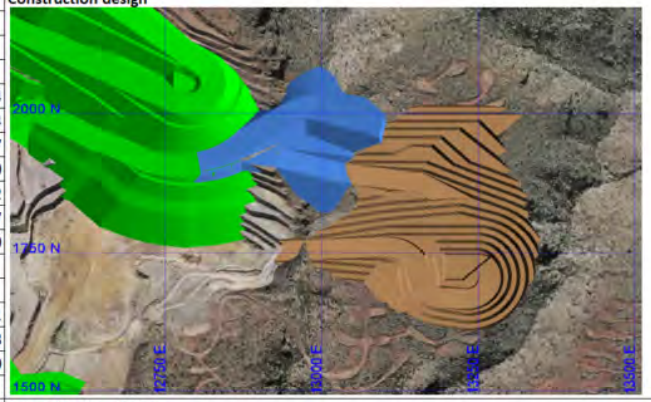




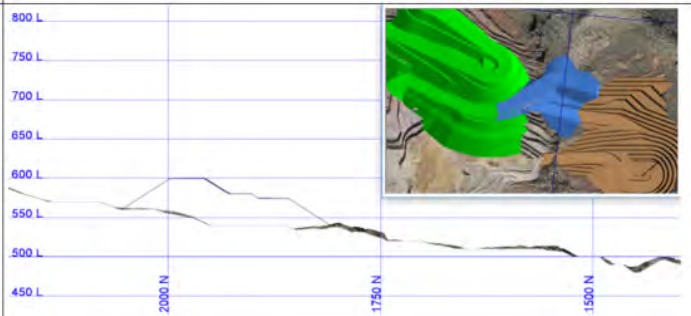
Landform name			42E_WD1	
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**	**Side view**
Erodibility Ranking		Low	**Construction design**	
Classification	Inert YES			
	PAF NO			
	Fibrous minerals NO			
Footprint (ha)	0.5	0.5		
Surface area (ha)		0.5		
Overall height (RL/m)	16	16		
Slope angle (degrees)	35	20		
Number of lifts	1	1		
Height of bottom lift 1 (m)	16	16		
Height of lift 2 (m)	N/A	N/A		
Height of lift 3 (m)	N/A	N/A		
Height of bottom lift 4 (m)	N/A	N/A		
Berm slope (degrees)	N/A	N/A		
Berm widths m	N/A	N/A		
Topsoil vol required m3		1,000		
Capping vol required t				
Toe bund distance m	N/A	100	**Rehabilitation design**	
Crest bund distance m	N/A	100		
Comments:				

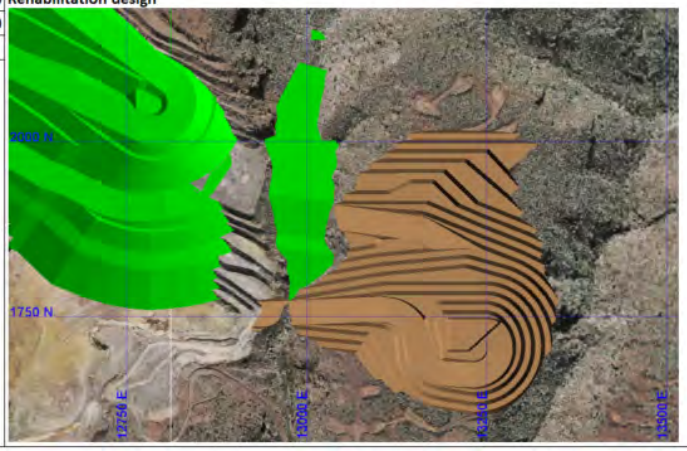
Landform name			42EE_LB
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	4.2	2.4	
Surface area (ha)	4.4	2.4	
Overall height (RL/m)	80	47	
Slope angle (degrees)	35	20	
Number of lifts	2	2	
Height of bottom lift 1 (m)	50	27	
Height of lift 2 (m)	30	20	
Height of lift 3 (m)	n/a	n/a	
Height of bottom lift 4 (m)	n/a	n/a	
Berm slope (degrees)	0	11	
Berm widths m	50	18	
Topsoil vol required m3	n/a	4,800	
Capping vol required t	n/a		
Toe bund distance m	n/a	0	**Rehabilitation design**
Crest bund distance m	n/a	90	
Comments:			

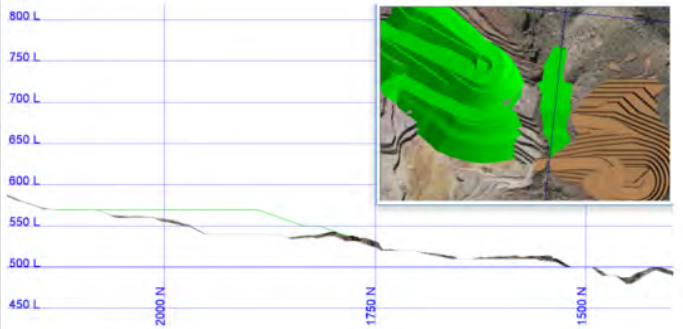
May need rip-rap for water course protection or some other form of water control. Will have to shed water. Most of the landbridge will be reclaimed during operations



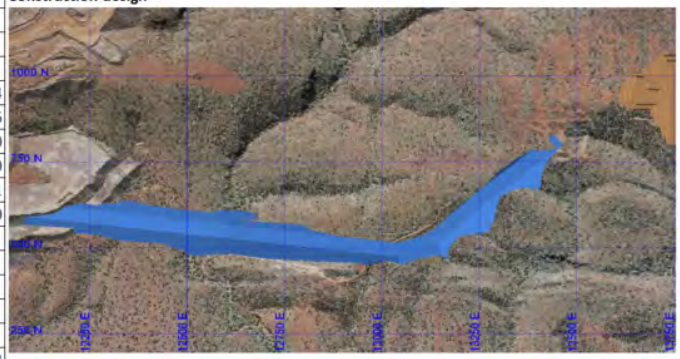
Side view



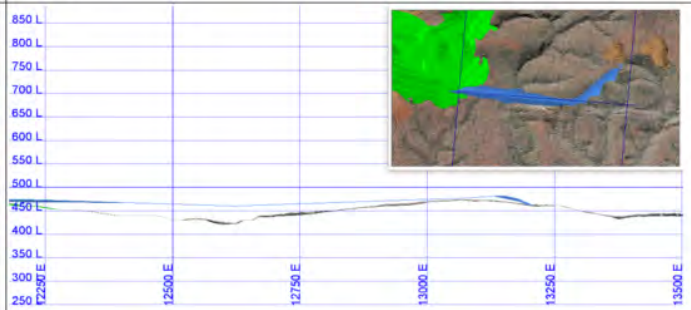




Landform name			47E LB
Criteria	**Construction specifications**	**Rehabilitation specifications**	**Plan view**
Erodibility Ranking		Low	**Construction design**
Classification	Inert YES		
	PAF NO		
	Fibrous minerals NO		
Footprint (ha)	13.3	9.4	
Surface area (ha)	14.4	9.6	
Overall height (RL/m)	50	40	
Slope angle (degrees)	35	20	
Number of lifts	1	1	
Height of bottom lift 1 (m)	50	40	
Height of lift 2 (m)	n/a	n/a	
Height of lift 3 (m)	n/a	n/a	
Height of bottom lift 4 (m)	n/a	n/a	
Berm slope (degrees)	n/a	n/a	
Berm widths m	n/a	n/a	
Topsoil vol required m3	n/a	19,242	
Capping vol required t	n/a	0	
Toe bund distance m	n/a	1740	**Rehabilitation design**
Crest bund distance m	n/a	1300	
Comments:			



Side view



Conceptual rehab design - no berms included in gullies, but will likely need to be in final design versions unless concave slopes can be used?