Environmental Management Plan

Yandicoogina Iron Ore Project

Ministerial Statement 1038

RTIO-HSE-0307300

Hamersley Iron – Yandi Pty Ltd

152-158 St Georges Terrace, Perth

GPO Box A42, Perth WA 6837

July 2021

Disclaimer and Limitation

This Environmental Management Plan has been prepared by Rio Tinto's Iron Ore group (Rio Tinto) on behalf of Hamersley Iron - Yandi Pty Ltd (the Proponent), specifically for the Yandicoogina Iron Ore Project – Revised Proposal. Neither the report nor its contents may be referred to without the express approval of Rio Tinto, unless the report has been released for referral and assessment of proposals.

Document Status					
Rev	Author	Reviewer/s	Date	Approved for Issue	
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1	Rio Tinto	Rio Tinto	Dec 2012	EPA Services	Dec 2012
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SUMMARY

This Environmental Management Plan (EMP) has been prepared by Rio Tinto on behalf of Hamersley Iron - Yandi Pty Ltd (the Proponent) in accordance with Condition 5 of Ministerial Statement (MS) 1038 for the Yandicoogina Iron Ore Project – Revised Proposal (the Project).

This Summary Table presents the conditioned environmental outcomes for each environmental factor that must be met through implementation of this EMP, as well as the environmental criteria to measure achievement of the associated environmental outcomes.

Summary Table: Environmental criteria to measure achievement of environmental outcomes

Proposal title	Yandicoogina Iron Ore Project - Revised Proposal
Proponent	Hamersley Iron - Yandi Pty Ltd
Purpose of this EMP	This EMP fulfils the requirements of Condition 5 of MS 1038
Condition environmental outcomes	• The implementation of the Proposal, including but not limited to land clearing, groundwater abstraction and surplus dewater discharge, does not cause long-term impacts to the environmental values of Weeli Wolli Creek, as defined in the Environmental Values Statement required by Condition 5-4 of MS 1038 • The implementation of the Proposal, including but not limited to land clearing, groundwater abstraction and surplus dewater discharge, does not cause long term impacts to the Aboriginal heritage values linked to the physical and/or biological surroundings of Weeli Wolli Creek • Groundwater abstraction and/or surplus dewater discharge from the implementation of the Proposal does not cause long term impacts on the health or cover of riparian vegetation outside the Management Zone as delineated in Figure 3 of Schedule 1 and defined by the geographic coordinates in Schedule 2
Key Environmental Factors: Inland Waters, Flora and Vegetation, Subterranean Fauna, Terrestrial Fauna **EPA Objective:** *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* *To protect flora and vegetation and terrestrial fauna so that biological diversity and ecological integrity are maintained* *To protect subterranean fauna so that biological diversity and ecological integrity are maintained*	
Early response criteria	1. Greater proportion of pheatophytic overstorey stands in Weeli Wolli Creek Reach or Marillana Creek Reach with declining trend in MSAVI since baseline and/or greater average decline in comparison to reference areas
Trigger criteria	1. Within any one riparian management zone, the area of phreatophytic overstorey canopy decline since baseline is 20% greater in Weeli Wolli Creek Reach or Marillana Creek Reach than in reference areas OR 2. Significant decline in number, and/or change in composition, of native perennial species in Weeli Wolli Reach or Marillana Creek Reach since baseline, in comparison to reference sites OR

	3. Establishment of a high priority weed species in Weeli Wolli Creek Reach or Marillana Creek Reach previously not detected within Weeli Wolli Creek or Marillana Creek OR 4. Increased extent of existing high priority weed species in Weeli Wolli Creek or Marillana Creek since baseline relative to reference sites
Threshold criteria	1. The area of phreatophytic overstorey canopy decline since baseline and attributable to implementation of the Project is over 50% of any riparian management zone in Weeli Wolli Creek Reach or Marillana Creek Reach and is greater than in reference areas, confirmed with ground-truthing; with no evidence of seasonal recovery over two consecutive (annual) monitoring events; and outside of historical baseline variation OR 2. Over 50% of Weeli Wolli Creek Reach or Marillana Creek Reach displays significant compositional change to riparian vegetation since baseline in comparison to reference areas attributable to implementation of the Project.
Key Environmental Factor: Inland Waters and Subterranean Fauna **EPA Objectives:** *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected*; and *To protect subterranean fauna so that biological diversity and ecological integrity are maintained*	
Early response criteria	1. Surface water discharge reaches the early response indicator site (Figure 3) located 9 km downstream from the Marillana Creek and Weeli Wolli Creek confluence under natural no-flow conditions OR 2. Exceedance of SSGV water quality criteria, taking into account baseline and regional reference data
Trigger criteria	1. Significant reduction in aquatic fauna diversity or change to assemblage structure (macroinvertebrates including hyporheic) within Weeli Wolli Creek Reach or Marillana Creek Reach relative to comparable seasonal baseline and reference locations, attributable to discharge water quality associated with the Project
Threshold criteria	1. Declining trend in aquatic fauna diversity or change to assemblage structure within Weeli Wolli Creek Reach or Marillana Creek Reach continues for two or more consecutive (annual) monitoring events, relative to comparable seasonal baseline and reference locations and evidence indicates a long-term loss of the ecological integrity of the creek attributable to discharge water quality associated with the Project

Corporate Endorsement

I hereby certify that to the best of my knowledge, the provisions within this EMP are true and correct and address the legal requirements of MS 1038.

Name: Ron Mutambiranwa **Signed:** 

Designation: Acting General Manager Yandicoogina **Date:** 14/7/2021

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1. CONTEXT, SCOPE AND RATIONALE

This EMP replaces the existing approved environmental management plan associated with the Project (Rio Tinto 2012a, RTIO-HSE-0171024) and has been developed to fulfil the requirements of Condition 5 of MS 1038 under Part IV of the *Environmental Protection Act 1986* (EP Act), in accordance with the following documents:

- *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016* (EPA 2016a);
- *Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual* (EPA 2018a); and
- *Instructions on How to Prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA 2018b).

This EMP is subject to approval by the Department of Water and Environmental Regulation (DWER) and will subsequently be implemented.

1.1. Yandi Project Overview

The Project is located in the central Pilbara region of Western Australia, approximately 90 kilometres north-west of Newman and approximately 40 kilometres south of Fortescue Marsh (Figure 1). Figure 2 presents the MS 1038 Development Envelope and the conceptual layout of the approved Project.

Yandicoogina operations commenced in 1998 and consist of the following:

- Above and below water table (AWT and BWT) mining;
- Development of the Junction Central (JC), Junction South East (JSE), Junction South West (JSW), Mungadoo (previously Oxbow), Pocket and Bina Bina South (BBS; previously Billiard South) deposits;
- Associated infrastructure including but not limited to processing facilities, temporary and permanent waste landforms and waste fines storage facilities;
- Surface water management infrastructure for groundwater abstraction and discharge of surplus water into Marillana and Weeli Wolli Creeks; and
- Flood protection structures and creek crossings.

Key approvals for the Project are as follows:

- Iron ore mining at the existing Yandi Operations is subject to the *Iron Ore (Yandicoogina) Agreement Act* 1996, which came into effect on 22 October 1996.
- Mining at the JC deposits received approval from the Minister for the Environment on 24 May 1996 (MS 417), with mining commencing in 1998. Ministerial Statement 417 was superseded by MS 523 on 1 October 1999.
- Expansion of the JSE deposits received approval from the Minister for the Environment on 22 October 2005 (MS 695), with mining activities commencing in 2006.
- Ministerial Statement 914 was issued on 18 October 2012 and amalgamated the existing MS 417 and MS 695 to a single set of contemporary conditions via Section 46B of the EP Act and included new pits JSW-A, JSW-C and Oxbow.

- The most recent approval (MS 1038) for expansion at Pocket and Billiard South was issued on 30 September 2016, superseding MS 914.

1.2. Key Environmental Factors

Management of the following key environmental factors for the Project are incorporated in this EMP:

- **Inland Waters, Flora and Vegetation, Subterranean Fauna and Terrestrial Fauna:**
    - Potential impacts to groundwater dependent riparian vegetation and subterranean fauna habitat of Marillana and Weeli Wolli Creeks due to dewatering;
    - Potential impacts to riparian vegetation (including potential for introduction of weeds) and water quality due to surplus water discharge; and
    - Potential indirect impact to habitat for conservation significant fauna species due to impact to riparian vegetation from dewatering and/or discharge.

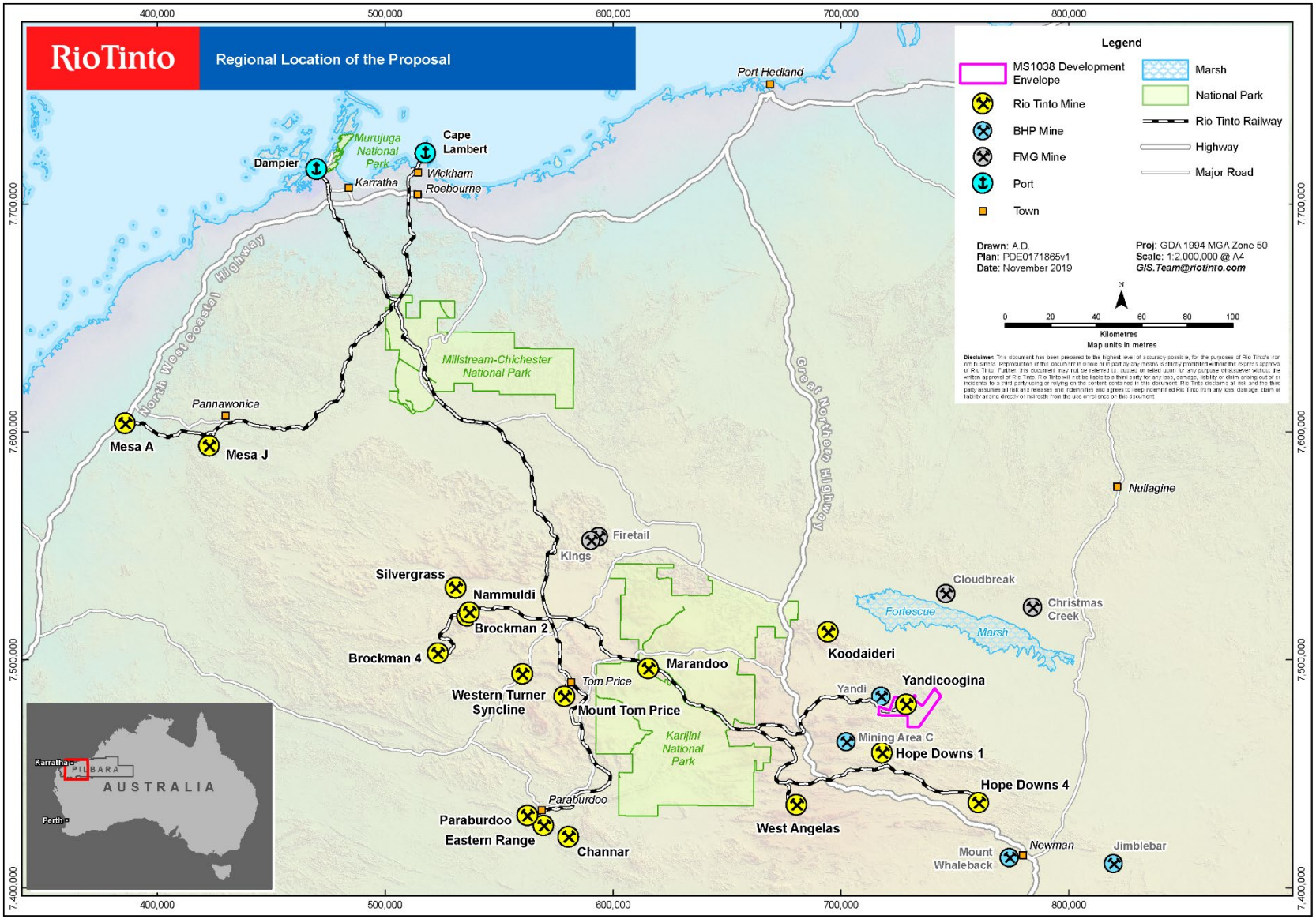

Figure 1: Regional Location of the Yandicoogina Project

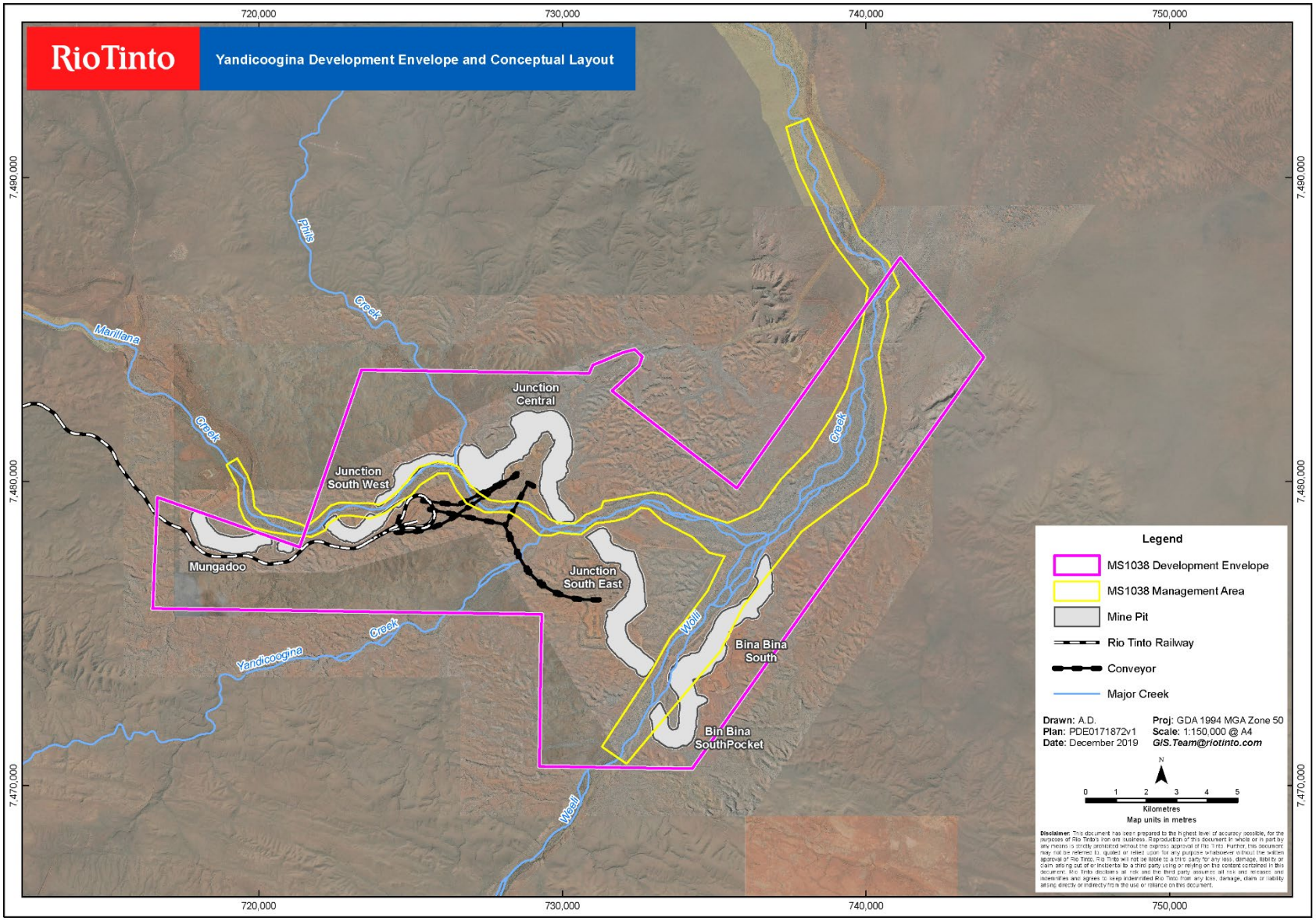

Figure 2: Yandicoogina Development Envelope and Conceptual Layout

1.3. Condition Requirements

Ministerial conditions for the Project as per MS 1038 are detailed in Table 1.

Table 1: Proponent Conditions for the Project

Condition	
5	**Hydrological Processes, Inland Waters Environmental Quality and Flora and Vegetation – dewatering, discharge of surplus dewater and riparian vegetation**
5-1	Within 6 months of issue of this Statement, the proponent shall prepare and submit a Condition Environmental Management Plan/s to the satisfaction of the CEO. These plan/s shall demonstrate that the following environmental outcome will be met: (1) the implementation of the Proposal, including but not limited to land clearing, groundwater abstraction and surplus dewater discharge, does not cause long term impacts to the environmental values of Weeli Wolli Creek, as defined in the Environmental Values Statement required by Condition 5-4; (2) the implementation of the Proposal, including but not limited to land clearing, groundwater abstraction and surplus dewater discharge, does not cause long term impacts to the Aboriginal heritage values linked to the physical and/or biological surroundings of Weeli Wolli Creek; and (3) groundwater abstraction and/or surplus dewater discharge from the implementation of the Proposal does not cause long term impacts on the health or cover of riparian vegetation outside the Management Zone as delineated in Figure 3 of Schedule 1 and defined by the geographic coordinates in Schedule 2.
5-2	The Condition Environmental Management Plan/s shall: (1) specify the environmental outcome to be achieved, as specified in Condition 5-1; (2) specify trigger criteria that must provide an early warning that the threshold criteria identified in Condition 5-2(3) may not be met; (3) specify threshold criteria to demonstrate compliance with the environmental outcome specified in Condition 5-1. Exceedance of the threshold criteria represents non-compliance with these Conditions; (4) specify monitoring to determine if trigger criteria and threshold criteria are exceeded; (5) specify trigger level actions to be implemented in the event that trigger criteria have been exceeded; (6) specify threshold contingency actions to be implemented in the event that threshold criteria are exceeded; and (7) provide the format and timing for the reporting of monitoring results against trigger criteria and threshold criteria to demonstrate that Condition 5-1 has been met over the reporting period in the Compliance Assessment Report required by Condition 3-6.
5-3	The plan/s required by Condition 5-1 shall include provisions required by Condition 5-2 to address impacts on riparian vegetation including from, but not limited to: changes to groundwater levels and groundwater quality; changes to surface water flows (including the location of the wetting front as depicted in Figure 3) and surface water quality, and weeds.
5-4	For the purpose of Condition 5-1(1), the plan/s required by Condition 5-1 shall include an Environmental Values Statement for Weeli Wolli Creek that defines the environmental values of Weeli Wolli Creek to the satisfaction of the CEO.
5-5	After receiving notice in the writing from the CEO that the Condition Environmental Management Plan/s satisfy the requirements of Condition 5-2 the proponent shall: (1) implement the provisions of the Condition Environmental Management Plan/s; and (2) continue to implement the Condition Environmental Management Plan/s until the CEO has confirmed by notice in writing that the proponent has demonstrated the outcomes specified in Condition 5-1 have been met.
5-6	In the event that monitoring indicates exceedance of the threshold criteria specified in the Condition Environmental Management Plan, the proponent shall: (1) report the exceedance in writing to the CEO within 7 days of the exceedance being identified; (2) implement the threshold contingency actions specified in the Condition Environmental Management Plan within 24 hours and continue implementation of those actions until the CEO has confirmed by notice in writing that it has been demonstrated that the threshold criteria are being met and the implementation of the threshold contingency actions is no longer required; (3) investigate to determine the cause of the threshold

Condition	
	criteria being exceeded; (4) investigate to provide information for the CEO to determine potential environmental harm or alteration of the environment that occurred due to the threshold criteria being exceeded; and (5) provide a report to the CEO within 21 days of the exceedance being reported as required by Condition 5-6(1). The report shall include: (a) details of threshold contingency actions implemented; (b) the effectiveness of the threshold contingency actions implemented, against the threshold criteria; (c) the findings of the investigations required by Condition 5-6(3) and 5-6(4); (d) measures to prevent the threshold criteria being exceeded in the future (e) measures to prevent, control or abate the environmental harm which may have occurred; and (f) justification of the threshold remaining, or being adjusted based on better understanding, demonstrating that outcomes would continue to be met.
5-7	The proponent: (1) may review and revise the Condition Environmental Management Plan/s, or (2) shall review and revise the Condition Environmental Management Plan/s as and when directed by the CEO.
5-8	The proponent shall implement the latest revision of the Condition Environmental Management Plan/s, which the CEO has confirmed by notice in writing, satisfies the requirements of Conditions 5-2, 5-3 and 5-4.
5-9	The proponent shall continue to implement the versions most recently approved by the CEO of the *Water and Discharge Monitoring and Management Plan* and *Vegetation and Groundwater Dependent Ecosystems Monitoring and Management Plan* (RTIO-HSE-165556) until the CEO has confirmed by notice in writing that the plan/s required by Condition 5-1 satisfies the requirements of Condition 5-2, 5-3 and 5-4 to meet the outcomes required by Condition 5-1.

1.4. High Level Environmental Values

Condition 5-4 of MS 1038 requires the development of an Environmental Values Statement (EVS) that defines the key environmental values of Weeli Wolli Creek, to the satisfaction of the CEO of the Office of the Environmental Protection Authority (OEPA). Appendix 1 provides an update to the EVS for the CEO's assessment. The refinements reflect learnings from extensive monitoring and consultation with environmental subject matter experts, including liaison with regulators and Traditional Owners.

The environmental values of Weeli Wolli Creek are summarised below:

Value 1 – Fortescue Marsh

The Fortescue Marsh is the largest ephemeral wetland in the Pilbara region, located in the Fortescue River Valley between the Chichester and Hamersley Ranges. The Fortescue Marsh is a Priority Ecological Community and listed on the Directory of Important Wetlands of Australia as a wetland of national significance.

The Yandicoogina Development Envelope is intersected by major ephemeral creeks that ultimately drain into the Fortescue Marsh and form part of its catchment. The Fortescue Marsh is episodically inundated, predominantly as a result of rainfall associated with tropical low-pressure cyclonic weather systems that generally occur between December and April.

The Fortescue Marsh has cultural and heritage significance to the region's traditional owners and supports a range of native plant and animal species, including a large and diverse number of migratory bird species.

Plant and animal species and communities of high conservation value occur in the Fortescue Marsh and in the surrounding areas. The diverse ecosystem includes endemic flora, fauna and supports a rich diversity of aquatic and terrestrial invertebrates.

Value 2 – Flora and Vegetation

The vegetation communities and fauna habitats within the Yandicoogina Development Envelope are relatively widespread and well-represented regionally. This includes local riparian vegetation communities and groundwater dependant ecosystems commonly associated with large ephemeral creek systems of the Pilbara region.

The riparian vegetation communities of Marillana and Weeli Wolli Creeks within the Development Envelope are similar to other large ephemeral systems of the Pilbara. Low flow pathways are populated with large open eucalpyt woodland, over eucalypt and acacia low woodland, largely flanked by tall, open acacia shrubland with **Cenchrus ciliaris* tussock grasslands.

One community, identified locally as the C1A riparian community, broadly comprises a eucalypt woodland containing a co-dominant *Melaleuca argentea* component and is considered to have local conservation significance due to its groundwater dependency, associated mesic habitat values, somewhat restricted distribution, and association with a major creekline in the area (predominantly Marillana Creek). This community is similar but of different structure and reduced significance in relation to the vegetation community of Weeli Wolli Spring (significant *Melaleuca argentea* woodlands).

Value 3 – Fauna

Weeli Wolli Creek provides habitat for a wide range of fauna. The alluvial aquifer system supports subterranean fauna (stygofauna), whilst the ephemeral seasonal surface expression of water supports fish and aquatic invertebrates (although the project area does not contain permanent pools). Weeli Wolli Creek also provides foraging habitat for an assemblage of various bat species and is the most northerly distribution of the Chocolate Wattle Bat (*Chalinobolus morio*). The Pilbara Olive Python (*Liasis olivaceus barroni*) has been recorded within Weeli Wolli Creek and the Development Envelope may contain habitat for the Northern Quoll (*Dasyurus hallucatus*).

Value 4 – Heritage

Aboriginal people are spiritually and physically connected to the landscape through Jukurppa (Dreaming) stories, ceremony, and physical places such as ethnographic and archaeological heritage sites. Weeli Wolli Creek holds special cultural and spiritual significance for the Traditional Owner groups of the region (*Nyiyarparli* and *Banjima* people) as a place where the rainbow serpent (*Yarduba*) resides. Weeli Wolli Creek hosts significant ethnographic and archaeological heritage sites which are associated with the water course. It is noteworthy that discharge of excess groundwater dewatered from nearby mining operations has created a temporary perennial source of water within parts of Weeli Wolli Creek, which is predicted to return to ephemeral patterns upon the cessation of discharge.

1.5. Management Approach and Rationale

1.5.1. Survey and Study Findings

Extensive vegetation mapping, baseline surveys and monitoring (vegetation, groundwater, surface water and stygofauna) have been undertaken along Marillana and Weeli Wolli Creeks. This has enabled a continued understanding of processes within the catchment to inform the selection of monitoring techniques and appropriate assessment criteria.

Rio Tinto has identified four riparian management zones within Weeli Wolli Creek Reach and Marillana Creek Reach (Figure 4), to focus environmental monitoring programs used to evaluate compliance with trigger and threshold criteria. The management zones have been designated based on observed and/or predicted dewatering drawdown and surface discharge extents from the Project and/or other mining operations within the catchment. Weeli Wolli Creek Reach and Marillana Creek Reach refer to

the areas of Weeli Wolli Creek and Marillana Creek within the MS 1038 Development Envelope (Figure 4).

Results of baseline surveys, environmental monitoring and a number of assumptions and uncertainties inform the management approach for meeting the condition environmental outcomes.

1.5.1.1. Inland Waters – Groundwater and Dewatering

The Project is located within the Weeli Wolli Creek catchment, with Weeli Wolli Creek flowing through and adjacent to the Project from south of the BBS and Pockets ore deposits.

The mine pits are all contained within a continuous Channel Iron Deposit (CID) orebody, which also forms a major aquifer in the area. Approximately 95 percent of the orebody is situated below the pre-mining water table and therefore dewatering is required. Schedule 1 of MS 1038 authorises a maximum abstraction limit of 83 GL/a and disposal of up to 78 GL/a dewater through controlled dewater discharge to Marillana and Weeli Wolli Creeks. A large portion of the dewatering from the Project is 're-dewatering' of water discharged from Rio Tinto's Hope Downs 1 and BHP's Yandi operations, upstream of the Project.

The degree of hydraulic connectivity between the near-surface alluvial aquifer and underlying strata (i.e. CID; Weeli Wolli Formation) influences recharge mechanisms and long-term drawdown. Weeli Wolli Creek and associated habitat including riparian vegetation is partially isolated from aquifer drawdown in the adjacent CID in the southern section of BBS due to the basement rocks acting as an aquiclude. Nonetheless, in some locations, seepage to BBS can still influence the lowering of groundwater levels in the vicinity of riparian vegetation depending on the water balance for the reach, upstream flow rates, and local aquifer transmissivity.

In the northern extent of BBS, the CID and alluvium are underlain by banded iron beds of the Weeli Wolli Formation. Fractures around fault zones interpreted from geotechnical drilling potentially provide increased connection to the overlying CID and alluvial aquifers. Following the commencement of BBS dewatering, this hydraulic connectivity resulted in a rapid response in the Weeli Wolli Creek alluvial aquifer. In this location decline in groundwater levels are influenced by the balance between abstraction at BBS and discharge to Marillana Creek, as well as a permeable fault system that extends south from Iron Valley's orebody aquifer and enters the Weeli Wolli Creek alluvial aquifer (BC Iron, 2016 and EPA, 2016b). The alluvium is also deeper and better connected to the CID at the confluence of these creeks, meaning that groundwater drawdown can more directly impact on streamflow. Any changes to surface water discharge to Marillana Creek are expected to alter groundwater levels and therefore flow rates downstream. A reduction in inflows is forecast from Hope Downs 1 and will result in lower dewatering volumes from BBS and a decrease in surplus dewater discharge to Marillana Creek.

1.5.1.2. Inland Waters – Surface Water and Discharge

The Weeli Wolli Creek catchment, including Marillana Creek, represents approximately ten percent of surface water flow into Fortescue Marsh (RTIO 2015). Before mining, the section of Weeli Wolli Creek within the MS 1038 Development Envelope (Figure 4) was an ephemeral watercourse, flowing only in response to rainfall events and supporting vegetation communities along its margins.

Discharge of surplus dewater into Marillana and Weeli Wolli Creeks from numerous mining projects has been occurring since the early 1990s, including discharge upstream of the Project from BHP's Yandi (1994), Rio Tinto's JC (1998), JSE (2006) and Hope Downs 1 (2007) projects, and downstream from Mineral Resources Limited's Iron Valley project (2016). This has transformed parts of Weeli Wolli Creek to a perennial flow regime and thereby influenced the adaptation of riparian vegetation to the new flow conditions.

Dewater from the Project is used onsite in the first instance to supply water for operational purposes, including potable supply, dust suppression and in ore processing facilities. All surplus dewater exceeding the operational requirement is discharged to either Marillana or Weeli Wolli Creek through controlled water discharge, with Marillana Creek receiving a large majority of discharge water. Discharge volumes into the creeks are influenced by water-supply demands (on-site or external) and will be reduced or eliminated during the life-of-mine as different demand requirements eventuate.

Flow regimes in the Weeli Wolli Creek system are influenced by historical and current water disposal activities associated with mining within the wider locality. Discharge from Hope Downs 1 is predominantly via a single gabion structure adjacent to Weeli Wolli Creek, however a system of spur lines deliver water via seepage flows to maintain phreatophytic trees and pools upstream of the gabion, in the area of historic springs and permanent pools. The purpose of the seepage through spurs at Hope Downs 1 is to maintain the groundwater levels around Weeli Wolli Spring as mitigation of any potential impact from dewatering Hope Downs 1 deposits.

The presence of permanent water within the Weeli Wolli Creek system as a result of surplus dewater discharge has led to the establishment of an ecosystem dominated by regional species tolerant of permanent water. In particular, increased water availability has contributed to increased recruitment of riparian plant species downstream of the discharge areas.

As discharge of surplus dewater ceases and following the completion of mining, the vegetation along the watercourse will eventually revert to a seasonally wet ecosystem, originally found in this area of the Weeli Wolli Creek system (EPA 1996). This involves a two-stage change, both after the commencement of dewatering when permanent water is first present, and as inflows reduce over time from both Rio Tinto and other mining operations, when the water regime reverts to being seasonally wet (EPA 1996).

Dewatering at BBS pits and associated surplus water discharge from Hope Downs 1 (and potentially other mines) are forecast to progressively reduce surface flows within the creeks, with a proportionate retraction of the wetting front into the future. As the extent of permanent surface water gradually moves southward along the creek line, it is likely that some plant species, particularly those that rely on immediate availability of water within the shallow root zones, will indicate increased signs of water stress (Mattiske 2019), as the creek gradually transitions from an altered perennial flow regime back to ephemeral conditions.

The ecosystem has naturally high variability across seasons and years and is further complicated by the occurrence of multiple changes at the same time, including drought, dewatering, discharge of surplus water and fire (EPA 2018c and Mattiske 2019). The emergence of altered riparian vegetation is a consequence of the interactions and relationships between multiple elements within the creek system.

In addition to a high level of natural variation in rainfall and surface water flow, the creeks are also influenced by dewatering, spur irrigation, discharge and the hydrogeology associated with mines operating in the catchment. Ecological changes are inherent where an ephemeral hydrological regime is altered to a perennial regime for a number of years. The current riparian monitoring program is designed to facilitate an assessment of indirect impacts on the environmental values of Weeli Wolli Creek in a dynamic system where multiple stressors overlap in time and space.

1.5.1.3. Flora and Vegetation

Riparian vegetation along Pilbara watercourses are often dominated by dense, tall, large trees of *Melaleuca argentea*, *Eucalyptus camaldulensis* and *E. victrix*. These species occur in an environment subject to ecological shifts that can be quite large and dynamic, with episodic occurrences of drought, defoliating wildfire, severe flood and stand replacement by degeneration, even when in a natural and

protected condition. Shifts in species composition and in tree health are inherent in the natural dynamics of the system.

The riparian vegetation communities of Marillana and Weeli Wolli Creeks are similar to other large ephemeral systems of the Pilbara. Low flow pathways are populated with large open *Eucalyptus* woodland, over *Eucalyptus* and *Acacia* low woodland, largely flanked by tall, open *Acacia* shrubland with introduced **Cenchrus ciliaris* tussock grasslands (Biota 2014). These creek communities are considered locally significant, as they tend to support riparian vegetation and species that are less widespread due to their site preferences for moister soils.

Riparian vegetation in the vicinity of the Project has been subjected to the effects of groundwater drawdown and discharge of surplus groundwater by existing approved mining activities within the catchments of Marillana Creek since the mid-1990s and Weeli Wolli since the mid-2000s. The presence of a permanent surface expression of discharge water in what was originally an ephemeral system has resulted in altered vegetation community structure, composition and health of the dominant riparian tree species *Eucalyptus victrix* and *Eucalyptus camaldulensis* (Mattiske 2019; Rio Tinto 2015a). This change has allowed increased recruitment, increased biomass and the establishment of riparian species. Limited baseline surveys were originally conducted in 1994, with several further surveys conducted to identify the abundance and diversity of flora and fauna likely to occur within the MS 1038 Development Envelope.

The vegetation communities recorded within the MS 1038 Development Envelope were found to be relatively widespread in the Pilbara region, with no Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs). A number of communities are considered to be locally significant due to their inherent ecological values and restricted distribution in the Hamersley sub-region.

One recorded species of flora, *Lepidium catapycnon*, was classified as Threatened (Declared Rare) by the WA State Government and Vulnerable under the *Environmental Protection and Biodiversity Conservation Act* 1999 (*EPBC Act*) at the time of the baseline surveys and assessment. However, in 2015 the WA State Government reclassified the conservation status of *Lepidium catapycnon* from Vulnerable to Priority 4 and is no longer listed under the *EPBC Act*. One Priority flora species, *Goodenia nuda* (Priority 4) was recorded in the Project area.

A total of 18 introduced taxa were recorded in the wet season survey conducted in 2013, with 25 recorded in the 2019 wet season survey, within Marillana and Weeli Wolli Creeks (Mattiske 2019). No weed species were classified as a Weed of National Significance or Declared Pest for the Pilbara region. The dominant species present is **Cenchrus ciliaris* (Buffel grass), which was introduced in pastoral stations as pasture grass that has become widespread.

1.5.1.4. Stygofauna

A total of 2761 specimens from 62 taxa of stygofauna have been recorded at Yandicoogina since 2003.The habitat (alluvial and CID aquifers) in which the stygofauna occur is broadly associated with the Weeli Wolli Creek system and extends north and south of the Yandicoogina Development Envelope. A portion of this would be affected by the drawdown for the mine pit, however the habitat extends beyond the area of impact. It is considered there will be limited regional impact on stygofauna as almost half of the recorded stygofauna specimens recorded at Yandicoogina have been found in the wider region.

Stygofauna in Western Australia often exhibit high levels of endemism and a number of species are known only from the Weeli Wolli catchment (RTIO 2015b). The potential impacts to stygofauna from the Project are direct mortality and loss of habitat through subsurface disturbance, and loss of habitat

through the increased abstraction of groundwater for dewatering. Conversely, elevated groundwater levels from surface water discharge into Marillana and Weeli Wolli Creeks may increase the areas of suitable habitat for stygofauna.

The alluvial and CID aquifer in which the stygofauna occur is associated with the Weeli Wolli Creek system and extends north and south of the Project, including northwards beyond the Marillana Creek confluence, which is further associated with alluvial units draining towards Fortescue Marsh. This extensive and hydrologically connected system of aquifers results in habitat that extends continuously beyond the predicted area of impact from pit excavation and groundwater drawdown. Seasonal flooding caused by cyclonic events may also assist in dispersing stygofauna taxa. This continuous aquifer linkage suggests that it is less likely that stygofauna species recorded in the proposed pit boundary and Project are restricted to this area (Biota 2015).

The majority of stygofauna recordings have been in sites that intersect the superficial floodplain aquifer (alluvial aquifer). This floodplain alluvium extends almost continuously along the length of Weeli Wolli Creek. The low flow channel of the creek is the primary mechanism by which the core stygofauna habitat of the superficial floodplain aquifer is recharged and kept saturated and is therefore important in maintaining habitat (RTIO 2015b). Discharge of surface water from other operations may also serve to minimise potential impacts from dewatering; while the peak dewatering periods may reduce the ability for stygofauna to move through the MS 1038 Development Envelope, restricting the ability for some dispersal through the groundwater system toward the Fortescue Marsh, natural seasonal flooding events are expected to largely reduce this impact.

Direct habitat removal via excavation will be managed by implementing the Project as described in Schedule 1 of MS 1038, whereby the extent of lateral habitat removal is clearly defined. Indirect impacts to stygofauna habitat (predominantly the alluvial aquifers) will be managed with the provisions for Inland Waters (surface water discharge, dewatering, riparian vegetation) in this EMP.

1.5.1.5. Aquatic Fauna

The Yandicoogina Development Envelope does not contain any natural permanent pools as refuge for aquatic fauna and, as a result, there is no elevated conservation significance for aquatic fauna in the Project footprint. Seasonal (naturally ephemeral but currently perennial due to dewatering discharge) surface expression of water supports fish and aquatic invertebrates. In consideration of the 12 known species of freshwater fish of the Fortescue River system, three were recorded in Weeli Wolli and Marillana Creeks; *Leiopotherapon unicolor* (Spangled Perch), *Neosilurus* sp. (Pilbara Tandan), and *Melanotaenia australis* (Western Rainbowfish), none of which are conservation-listed.

Minimal aquatic fauna habitat naturally associated with Weeli Wolli Creek will be lost as a result of the Project, and the opportunities for flooding of the adjacent riparian zone remains unchanged from baseline, which will sustain the connection upstream to Weeli Wolli Spring and downstream to Fortescue Marsh.

Although Marillana and lower Weeli Wolli Creeks are part of a naturally ephemeral system, discharge of surplus water has created sections of permanent flow. Increased water availability has augmented aquatic fauna and social values associated with permanent pools (such as fishing), and has value for local people, including the Aboriginal community (EPA 2016c). It is important to note that these values may change as the creek reverts from a perennial flow regime back to naturally ephemeral conditions.

1.5.1.6. Terrestrial Fauna and Short Range Endemic Invertebrates

The Project has restrictions on clearing of riparian vegetation that supports terrestrial fauna species.

Several vertebrate fauna species of conservation significance have been recorded within the Development Envelope, or have a high or medium probability of occurring within the Project area

based on known distribution in the locality (within 40 km of the Project) and availability of suitable habitat within the Project area (Rio Tinto 2015b), consisting of:

- Pilbara Olive Python (*Liasis olivaceus barroni*);
- Fork-tailed Swift (*Apus pacificus*);
- Eastern Great Egret (*Ardea modesta*);
- Rainbow Bee-eater (*Merops ornatus*);
- Western Pebble-mound Mouse (*Pseudomys chapmani*);
- Chocolate Wattled Bat (*Chalinolobus morio*);
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*);
- Common Greenshank (*Tringa nebularia*);
- Peregrine Falcon (*Falco peregrinus*);
- Blind Snake (*Anilios ganei*);
- Pilbara Barking Gecko (*Underwoodisaurus seorsus*);
- Brush-tailed Mulgara (*Dasycercus blythi*);
- Ghost Bat (*Macroderma gigas*);
- Northern Quoll (*Dasyurus hallucatus*);
- Grey Falcon (*Falco hypoleucos*);
- Australian Painted Snipe (*Rostratula australis*); and
- Cattle Egret (*Ardea ibis*).

The migratory birds recorded in the Project area are considered to be occasional visitors or wide-spread species whose core habitat is not within the Development Envelope. As the Project does not impact the Fortescue Marsh it is unlikely to have a significant impact on the migratory bird species.

In the wider catchment, the Weeli Wolli Spring (upstream from the Development Envelope) is known to support a significant microbat species assemblage, which includes the most northerly population of the Chocolate Wattle Bat (*Chalinobolus morio*).

The disturbance required for the Project includes potential habitat for short range endemic (SRE) invertebrate species. Potential SRE species recorded from the Project area comprise four species of mygalomorph spiders. All four of these species are known from outside the Development Envelope and have been recorded in multiple land systems and substrate types. Therefore, the SRE species are considered to have a wider distribution than the area of impact.

1.6. Key Assumptions and Uncertainties

The key limitations relating to the information used for this EMP include:

- Limited understanding of the response of ephemeral systems to multiple stressors such as groundwater abstraction, surplus water discharge and climate variability.
- Baseline weed surveys were not exhaustive across all of Marillana Creek and Weeli Wolli Creek therefore not all weed species present at baseline may have been detected.
- There is limited baseline data available, particularly for Marillana Creek, with dewatering and discharge associated with nearby mines occurring since the early 1990s.

The key assumptions relating to this EMP are:

- The hydrogeological modelling of groundwater abstraction from the orebody aquifer provides the best available estimates of the quantity of the abstracted water and of the extent and depth of groundwater drawdown, based on the hydrogeological conceptualisation using best available

knowledge to date. The hydrogeological models will be updated as additional data become available.

- The baseline period for remote sensing of groundwater dependent overstorey vegetation is designated as 2006 to 2008 (prior to significant discharge to Weeli Wolli Creek). This follows a decade of rainfall substantially above the long-term average and may therefore represent a period of peak water availability for biota that are not typical for the region.
- Baseline surveys provide a representative weed species inventory as well as abundance and distribution data and reflect sampling over variable seasonal conditions. The distribution and abundance of new and existing weeds across the Pilbara region are affected by multiple factors including land development, mining and agriculture.
- Due to the presence of dormant seeds, weeds are expected to persist over a number of years irrespective of control actions.

1.7. Rationale for Choice of Provisions

This EMP incorporates outcomes-based provisions to address the environmental factors which were assessed by the Department of Water and Environmental Regulation – EPA Services (EPA Services) as relevant to the potential impacts associated with the Project.

The specific early response, trigger and threshold criteria and associated response actions defined in Table 2 have been chosen as they provide a basis for detecting and avoiding or otherwise managing potential impacts, such that the condition environmental outcomes and objectives stated in Condition 5 of MS 1038 are achieved.

Early response and trigger criteria are set at a conservative level to ensure management actions are implemented well in advance of the environmental objective being compromised. Exceedance of a trigger criterion will therefore not be treated as a potential non-compliance.

Exceedance of a threshold criterion will be treated as a potential non-compliance against the environmental outcome if the exceedance is determined to be attributable to implementation of the Project. There is potential for criteria to be exceeded due to natural variability and stochastic factors, that must be accounted for in the management response.

The EMP provisions (Table 2) include monitoring to measure performance against the environmental outcome and to determine whether criteria have been exceeded, as well as contingency response actions.

The rationale for selection of provisions for each aspect is discussed below.

1.7.1. Inland Waters – Surface Water Discharge

Surface water quality and quantity have the potential to impact on the identified environmental values of Weeli Wolli Creek, including downstream impacts on Fortescue Marsh, flora and vegetation, stygofauna and aquatic fauna. Changes to surface water can also potentially affect beneficial uses within the catchment including recreation, cultural and aesthetic values, and the use of water for drinking, agricultural and industry (EPA 2018d).

Discharge of surplus dewater into Marillana and Weeli Wolli Creeks has been occurring since the early 1990s, including upstream of the Project from BHP's Yandi (1994) and Rio Tinto's Hope Downs 1 projects (2007), and downstream of the Project from Mineral Resources Limited's Iron Valley project (2016). Rio Tinto's historic Yandi operations have been discharging into Marillana and Weeli Wolli Creeks from the JC and JSE deposits since 1998 and 2006, respectively.

The extent of surplus water discharge under natural no-flow conditions is expected to be contained to within 17 km downstream from the confluence of Marillana and Weeli Wolli Creeks, as depicted in

Figure 3 of MS 1038. As this extent is downstream of the discharge outlet for Mineral Resources Limited's Iron Valley project, the provisions for surface water discharge include an early response indicator for surface discharge extent at a site 9 km downstream from the confluence, to allow time for management action, if required to limit the discharge extent to that specified in MS 1038 and so avoid any potential impacts from this Project on downstream receptors, including the Fortescue Marsh. The early response site 9 km downstream from the confluence is located upstream of the Iron Valley discharge location to ensure the Project does not cause long-term impacts on the health and cover of riparian vegetation outside the Management Zone, as per Condition 5-1(3) of MS 1038.

The monitoring of surface water quality is necessary to assess impacts on ecosystem integrity and to support and maintain designated water uses within the Weeli Wolli and Upper Fortescue River catchments. Extensive water quality monitoring within Marillana and Weeli Wolli Creeks, as well as surrounding reference creeks, has been undertaken since 2007. In addition, monitoring of aquatic ecosystem health (aquatic fauna and water quality) of Marillana and Weeli Wolli Creeks in response to dewatering discharge has been undertaken since October 2008.

Surface water quality results within the receiving environment are assessed against site-specific guideline values (SSGVs) for both Marillana and Weeli Wolli Creeks, that are based on either 80th percentile of background values or the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) default guideline values (DGVs) for protection of 95% of freshwater species ANZG (2018). In 2014, the suite of parameters for monitoring and interim SSGVs were revised as part of a post-discharge hazard analysis, which statistically compared all available water quality and aquatic fauna data for the receiving environment prior to dewatering discharge from DO9 in September 2013 (September 2007 to September 2013) against post-discharge monitoring data (September 2013 to February 2014) (WRM 2015). Available data used for the SSGVs were collected after the commencement of discharge from BHPs Yandi (1994) and Rio Tinto's JC (1998), JSE (2006) and Hope Downs 1 (2007), and as such represents a modified environment.

The suite of monitoring parameters and SSGVs were reviewed again in 2020 (WRM 2020a) and are included as Appendix 2. The monitoring suite covers pH, EC, turbidity, alkalinity, nutrients and metals, with the aim to assess i) any parameters with the potential to be elevated in discharge water, and ii) any influence on water quality from change in surface water flows as a result of infrastructure associated with the Project. Water quality will be assessed against SSGV criteria (as described in Appendix 2) at the compliance points, which occur close to the discharge outlet and infrastructure, to provide early response criteria designed to be protective of the downstream environment. As outlined in ANZG (2018), the SSGVs are not intended to be used as a pass/fail test, rather, an exceedance should trigger further investigation, noting that the SSGVs are conservative to allow investigation before any potential impacts on receptors are observed. If there is an exceedance of the early response criteria, water quality will be assessed at the downstream extent of the Development Envelope, to assess exposure to receptors within the Development Envelope and/or any potential risk to the downstream environment outside of the Management Zone. The modified groundwater table is connected to the low-flow channel of Marillana and Weeli Wolli Creeks for the majority of the length of the surface water wetting front (RTIO 2015) and provisions for surface water quality would therefore also address potential impacts to groundwater quality including stygofauna habitat.

The provisions for water quality will also take into account changes to observed aquatic fauna assemblages. Surveys of aquatic ecosystem health of Marillana Creek and lower Weeli Wolli Creeks have been undertaken since October 2008 (see WRM 2020b). The surveys include a comprehensive suite of water quality analytes, aquatic invertebrates (zooplankton, hyporheos including stygofauna, macroinvertebrates) and fish.

During the Yandicoogina aquatic fauna surveys, hyporheos including stygofauna are collected and identified using a similar approach and methodology to that used by government and universities for similar surveys, including the Pilbara Biological Survey (i.e. Pinder *et al*. 2010) and National Monitoring

River Health Initiative (Department of Environment Sport and Territories *et al*. 1994). Hyperheos are collected using the Karaman-Chappuis method (Delamare Deboutteville 1960). Consultant in-house expertise is used to identify invertebrate taxa using available published keys and through reference to the established voucher collections. Taxa recorded from hyporheic samples are classified stygobite, stygophile and stygoxene according to Boulton's (2001) categories. External specialist taxonomic expertise is sub-contracted as needed to assist with identification. Taxa that cannot be identified to species level are assigned a voucher number and lodged in the voucher collection. Molecular systematic analysis may be undertaken where considered appropriate for any potential short-range endemic species encountered with lack of taxonomic information.

The trigger criterion refers to change in macroinvertebrate diversity or assemblage structure, which provides a sensitive indicator of the impact of any changes in water quality to the receiving environment. This includes hyporheic fauna, thus providing an indication of any potential impacts from water quality to stygofauna communities. The threshold criterion refers to a significant decline in aquatic fauna diversity in Marillana and Weeli Wolli Creeks that is attributable to poor water quality from discharge related to the Project, continuing for two years. All trophic levels will be considered in the threshold criteria for a holistic assessment of the aquatic ecosystem function in comparison to the baseline condition and reference sites. Two years for the threshold criteria is considered a suitable time-frame to distinguish a potential impact from dewatering discharge from the inherent natural variability in aquatic fauna diversity.

As noted above, surplus discharge has increased aquatic fauna habitat and has increased diversity in some cases (WRM 2020b). Some changes to aquatic fauna diversity and composition are expected to occur as creek flows revert to ephemeral conditions. As the current aquatic fauna monitoring program did not commence until 2009, (after surplus discharge had already commenced), interpretation of the trigger and threshold criteria will involve separation of potential impacts from water quality from those due to changed flow regime. Assessing both impact and reference monitoring sites is an integral part of understanding the variation in water quality, hydrological, and ecological processes within the Weeli Wolli catchment. The broad dataset from reference sites are useful to contextualise observed variation in surface water quality of Weeli Wolli Creek. This helps understand how dewatering and discharge of surplus water, environmental factors such as the frequency and intensity of rainfall and runoff events, infiltration, temperature, evaporation and other factors within the catchment (e.g. pastoral land use) influence the results of water quality monitoring. Over the duration of dewatering discharge there have been periodic exceedances of nitrogen and nitrate SSGVs in Marillana and Weeli Wolli Creek, but no definitive evidence of this or any water quality parameter impacting aquatic fauna assemblages to date (WRM 2020b).

The structure of the environmental monitoring program including monitoring frequency and analytical suite is subject to change in accordance with adaptive management principles necessary to effectively meet the conditioned environmental outcomes.

1.7.2. Inland Waters and Flora and Vegetation – Dewatering and Discharge

Schedule 1 of MS 1038 authorises the clearing of no more than 7,400 ha of native vegetation within the 19,351 ha Mine Development Envelope (including no more than 129 ha of direct clearing within the Restricted Clearing Area) and the 607 ha Infrastructure Development Envelope. The annual clearing data is reconciled through survey pickup and/or aerial survey and reported as part of the Compliance Assessment Report for MS 1038; as such environmental criteria for clearing are not included in this EMP.

Riparian vegetation is identified as a sensitive receptor to dewatering and discharge activities, particularly in areas of strong connectivity between the alluvial aquifer and the target orebody. The discharge of surplus water from numerous projects has changed the riparian vegetation along sections

of Marillana and Weeli Wolli Creeks with increased recruitment of some species downstream of the discharge areas. As inflows reduce over time from both Rio Tinto and other mining operations, the vegetation along the watercourses will eventually revert to a seasonally wet ecosystem, originally found in this part of the Weeli Wolli and Marillana Creek system (EPA 1996). It is expected that some species that have established during dewatering will become stressed as the ecosystem adapts to the dynamic conditions and reverts to the pre-disturbance ephemeral regime.

To detect any long-term impacts to riparian vegetation, monitoring actions include:

- Vegetation community transects to track species composition (including weeds), community structure and qualitative condition of all understorey and overstorey riparian vegetation strata (completed in-field).
- Remote Sensing using multispectral imagery used to derive vegetation indices, as an indicator of riparian phreatophytic overstorey canopy cover and condition.

1) Vegetation Transects

A) Native Species

Annual vegetation surveys are conducted post-wet season as an optimal time to detect understorey species. The trigger and threshold criteria are designed to detect changes from dewatering and/or discharge that may affect native species composition and abundance. Monitoring shows variation in species richness through time across all reaches, including control areas (Mattiske 2019), indicating that this can be naturally variable depending on climatic conditions. Therefore, the trigger criterion will detect a significant decline in the number of native perennial species, in comparison to reference areas. The trigger criterion also includes a measure of compositional change, assessed with multivariate analysis, to determine any changes in the plant species assemblage over time and across treatment (potential impact versus reference). Recent analysis shows that the number of native perennial species has increased since baseline in both reference and potential impact zones (Appendix 3). Multi-dimensional analysis has shown there has been change in composition since the monitoring program was established but that change has occurred over all sections of creek, including reference areas (Mattiske 2019).

The threshold criterion would detect a further decline in the abundance of individual native species. The threshold criterion would be exceeded if 50% or more of Marillana or Weeli Wolli Creek Reach showed a loss of any dominant species. The threshold criterion is designed to prevent long-term impacts to riparian vegetation while acknowledging a certain level of change due to dewatering and discharge. While a proportion of the creek may be impacted, broad scale maintenance of species composition and structure in the remaining proportion would allow recolonization once dewatering and/or discharge ceases, thus preventing long term loss of function. Dominant species present in 2013 are presented in Appendix 4.

All Marillana transects were established in September 2012 and have been consistently surveyed since transect establishment. Weeli Wolli transects were established at various times during 2008-2011, however were not consistently surveyed until September 2012. Due to the inconsistency in transect assessments prior to 2012, post wet season 2013 is used as a baseline. It is likely that some changes to the riparian vegetation had already occurred by this time, due to dewatering and discharge; in particular, some vegetation may have been artificially augmented by discharge and its possible some species may decrease in extent as discharge is reduced in the future. For example, in 2013, *Melaleuca argentea* was recorded present in 14 transects combined across Marillana Creek Reach and Weeli Wolli Creek Reach (Mattiske 2019); however, investigations indicated that mature individuals likely to be present prior to commencement of discharge (Rio Tinto 2015a) coincided with only two of these transects. Therefore, investigation of potential exceedance of the trigger and threshold criteria will include review of historical data to determine the likelihood of species being present prior to discharge occurring

The trigger and threshold criteria for native vegetation could be exceeded due to waterlogging from discharge or drought due to dewatering, or could be influenced by augmentation of introduced weed or other species due to discharge. This would be investigated as part of the response actions to any exceedance, and also with the trigger criteria specifically for weeds below.

B) Introduced Weed Species

The EMP provisions include detection of new weed species and increased extent of existing weed species within Marillana and Weeli Wolli Creek, due to the Project. The provisions are intended to minimize impacts to riparian vegetation within Weeli Wolli Creek Reach and Marillana Creek Reach, as well as avoiding spread of weeds to the downstream environment, including habitat outside of the Yandicoogina Management Zone and the Fortescue Marsh.

All weed species will be assessed during the annual survey of transects in Marillana and Weeli Wolli Creek, as well as during targeted surveys associated with weed management events. Weed species for management will be prioritized following the DBCA's weed prioritization process for the Pilbara (DPaW 2013). Species rated as "Rapid invasiveness" and "High ecological impact" according to the "Pilbara Impact and Invasiveness Ratings", while taking into account feasibility of control, are rated high priority for control. Priority will also be determined by taking into account the Fortescue Marsh Management Strategy 2018-2024 (DBCA 2018) and relevant updates. High priority weed species currently present in Weeli Wolli Creek Reach or Marillana Creek Reach were also present at baseline (Appendix 5). However, since baseline, the extent of these high priority species has increased in some areas (see Appendix 6). These areas will be targeted for ongoing control as part of the wider site weed management program, particularly following optimal local environmental conditions e.g. following rainfall events.

2) Riparian Phreatophytic Overstorey Canopy

Previously, Digital Canopy Photography (DCP) was used to assess riparian phreatophytic (groundwater dependent) overstorey canopy condition. Remote sensing methods have since been implemented, to complement on-ground transect monitoring with a broader assessment of vegetation changes over time, across the entire riparian zone.

High resolution imagery has been captured annually at the end of the dry season (October to December), with baseline monitoring conducted from 2006 to 2008, and monitoring during the potential impact period conducted from 2009 to present. This timing of imagery capture during the dry season coincides with the period in which trees are under greatest stress and when the contrast between the greenness of the tree canopy and understorey canopy is more discernible. From 2006 to 2015 four-band digital multispectral imagery (DMSI) was captured and from 2016 onwards eight-band Worldview 2 and/or Worldview 3 satellite imagery has been collected. The DMSI and Worldview imagery is used to determine the area of phreatophytic overstorey canopy over time. The Worldview imagery is also used to calculate an index of vegetation health in the overstorey canopy; currently modified soil adjusted vegetation index (MSAVI) is used but an alternative index may be used in the future subject to improvements in methodology. MSAVI is a readily measurable indicator of the health of riparian vegetation for which reference sites can be established and regular monitoring undertaken. Measurement of MSAVI is also consistent with other Rio Tinto riparian vegetation monitoring programs. The MSAVI values are used to monitor the condition of riparian tree canopy over time since Worldview data has been collected. Due to inconsistencies with data calibration between this and the DMSI, comparisons in MSAVI will not be made between the two methods. However, the annual capture of high spatial resolution Worldview imagery will be complemented with more frequent but coarser resolution imagery to examine longer-term trends in vegetation condition (e.g. Landsat imagery) and seasonal variation (e.g. Sentinel imagery).

An early response criterion is designated that detects potential localised declining trends in MSAVI from baseline. This would be applied to the Weeli Wolli and Marillana Creek reaches segregated into

stands of trees (e.g. groups of at least 20 trees). The proportion of stands that show a declining trend in MSAVI with time that is significantly different from the baseline trend would be compared to reference zones to assess the early response criterion. Trends will be assessed with annual high-resolution imagery capture and/or available coarser resolution imagery to provide a more frequent assessment of change over time. Exceedance of the early response criterion would be investigated further, including comparison of magnitude of decline to baseline and reference variation, and ground truthing to assess if decline is associated with vegetation that has been previously augmented from dewatering discharge.

Trigger and threshold criteria are currently based on the area of phreatophytic overstorey canopy as determined from high resolution imagery across Weeli Wolli and Marillana Creek.

The trigger criterion for Weeli Wolli Creek and Marillana Creek has been specified as a 20% increase above reference areas in the area of canopy decline since baseline. The trigger criterion is applied to any one riparian management zone; these zones have been designated based on observed and/or predicted dewatering drawdown and surface discharge extents from the Project and/or other mining operations within the catchment. A 20% margin above reference is considered reasonable in order to detect a decline in canopy condition that may be beyond natural variation, while acknowledging that a certain level of impact to the groundwater dependent riparian vegetation is expected as a result of dewatering and/or discharge.

The threshold criterion of canopy health decline over a period of two consecutive years has been selected for any one riparian management zone within Weeli Wolli Creek and Marillana Creek. Given the natural variability of rainfall and streamflow, and the variability seen in the MSAVI of phreatophytic canopy even in reference areas (Appendix 7), two years has been selected as a suitable timeframe to assess whether the condition of upper canopy vegetation is under threat of long term impacts from the Project, and to differentiate natural variation from the potential impacts of groundwater abstraction and surplus water discharge. Decline over two consecutive dry season monitoring events is chosen for the threshold criterion as condition of the upper canopy is best measured from remote sensing in the dry season when there is less influence from the understorey. The baseline period was relatively short and coincided with a period of above average rainfall. Therefore, assessment of seasonal variation and comparison to long term and regional trends, including ground-truthing of any observed decline, will also be considered in the threshold criterion.

Following baseline, there was a period of increase in phreatophytic overstorey canopy area between 2006 and 2015 in Weeli Wolli and Marillana likely related to augmentation of vegetation from discharge. This has been more pronounced in Weeli Wolli Creek than in Marillana; by the time high resolution DMSI was collected in Marillana (2002), there was likely to have already been significant augmentation of the vegetation from discharge. An increase in phreatophytic overstorey canopy area over time has also occurred to some extent in reference areas indicating some influence of climate. Significant variability is also seen between years, for reference and potential impact areas. More recently, there has been decline in phreatophytic overstorey canopy area in both Weeli Wolli and Marillana Creek, which may reflect decreases in some discharge augmented vegetation (Appendix 7). Localised areas of decline are evident in central parts of Marillana Creek, particularly in riparian management zone MC1, an area historically receiving dewatering discharge from BHP's Yandi operation. There has also been some decline in phreatophytic overstorey canopy area in Weeli Wolli immediately upstream of the confluence with Marillana Creek and also further downstream of the confluence, both coinciding with areas of reduced surface discharge extent affecting vegetation that has been augmented by historical discharge from the Project and other mines in the catchment. Phreatophytic overstorey canopy area in Weeli Wolli Creek is currently still greater than at baseline. More broadly across the creek, trends over time are similar to reference areas which have also exhibited periods of decline, coinciding with lower than average rainfall; there were also fires during 2015, 2016 and 2017 in both potential impact and reference areas.

High resolution imagery was not captured for Marillana Creek until several years after dewatering and discharge had been occurring, so a true baseline record is not available. Similarly, the majority of the coarser resolution Landsat satellite imagery archive is during periods when Marillana Creek was potentially exposed to variable dewatering and discharge regimes associated with Rio Tinto's and other proponent's mining operations, complicating interpretation of any future changes from baseline condition, as significant augmentation of vegetation from discharge may have already occurred when imagery was first captured. Therefore, potential exceedance of the trigger or threshold criteria as assessed with remote sensing will be investigated further. This will include on-ground assessment to determine the likelihood that any impacted vegetation has been previously augmented from discharge, and the interaction with reduced discharge and/or dewatering associated with the Project and other mines in the catchment.

Remote sensing of vegetation is an evolving technology, so methods will be reviewed and revised as improvements become available and in accordance with adaptive management principles, in consultation with DWER and other stakeholders.

Riparian vegetation is identified as having high conservation value for terrestrial fauna habitat as well as aesthetic and cultural significance. The authorised clearing limits of MS 1038 and provisions for the health and cover of riparian zone vegetation will detect, avoid or otherwise manage the fragmentation of habitat or disruption to ecological linkages outside Weeli Wolli Creek Reach or Marillana Creek Reach as well as potential long-term impacts to Aboriginal heritage values linked to the physical and/or biological surroundings of Weeli Wolli Creek.

1.7.3. Social and Heritage

The impacts that the Project may have on the social and heritage values of Marillana and Weeli Wolli Creeks are associated with changes in hydrogeology, hydrology, flora and vegetation and fauna values (as identified and listed in the EVS – Appendix 1). The results of monitoring and performance assessment for the protection of those values, including the consultation with and feedback from Traditional Owners, inherently informs the success of the protection to social and heritage values from impacts related to the Project.

Any disturbance within the Weeli Wolli Creek heritage zone or of other archaeological/ethnographic sites are to be in accordance with the provisions of the *Aboriginal Heritage Act* 1972 (WA) and will require appropriate consultation with the relevant Traditional Owners.

The provisions for Inland Waters, Flora and Vegetation, Stygofauna and Terrestrial Fauna will therefore also ensure social and heritage values are not impacted in the long-term.

2. EMP PROVISIONS

This section identifies the provisions that the Proponent will implement to ensure the environmental outcomes of Condition 5 are met during implementation of the Project. Outcomes-based provisions are detailed in Table 2 and monitoring, response actions and reporting are further detailed in Sections 3.1, 3.2 and 3.3.

The EMP will be updated to align with the adaptive management approach (refer to Section 4).

Table 2: Yandicoogina EMP Provisions

Outcomes:

- The implementation of the Proposal, including but not limited to land clearing, groundwater abstraction and surplus dewater discharge, does not cause long-term impacts to the environmental values of Weeli Wolli Creek, as defined in the Environmental Values Statement required by Condition 5-4 of MS 1038
- The implementation of the Proposal, including but not limited to land clearing, groundwater abstraction and surplus dewater discharge, does not cause long term impacts to the Aboriginal heritage values linked to the physical and/or biological surroundings of Weeli Wolli Creek
- Groundwater abstraction and/or surplus dewater discharge from the implementation of the Proposal does not cause long term impacts on the health or cover of riparian vegetation outside the Management Zone as delineated in Figure 3 of Schedule 1 and defined by the geographic coordinates in Schedule 2

EPA Factors: Inland Waters, Flora and Vegetation, Subterranean Fauna, Terrestrial Fauna

EPA Objectives:

To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected

To protect flora and vegetation and terrestrial fauna so that biological diversity and ecological integrity are maintained

To protect subterranean fauna so that biological diversity and ecological integrity are maintained

Key Values: The Flora and Vegetation, Fauna, and Heritage and Social values associated with Weeli Wolli Creek and Marillana Creek; the Fortescue Marsh

Key Impacts and Risks: Potential adverse impacts on conservation significant vegetation, subterranean fauna and terrestrial fauna from dewatering, surplus water discharge and introduction of weeds

Environmental Criteria	Response Actions	Monitoring	Reporting
Early Response Criterion: 1. Greater proportion of phreatophytic overstorey stands in Weeli Wolli Creek Reach or Marillana Creek Reach with declining trend in MSAVI since baseline and/or greater average decline, in comparison to reference areas[1]	• Review trends in groundwater level in relation to baseline, local/regional reference data and climatic information • Review groundwater abstraction rate, bore location and pumping biases in relation to extent of the cone of depression compared to predicted impacts on riparian vegetation • Review discharge regime, frequency, extent and timing in relation to predicted surface water extent • Review surface and/or ground water quality as appropriate • Review local and regional reference data, including rainfall, temperature, flooding and fire regime • Visual census of remote sensing imagery to confirm areas of exceedance; comparison of magnitude of decline in comparison to baseline and reference variation • On-ground monitoring to investigate areas of exceedance if required.	• Annual (nominally end of dry season), or more frequent as appropriate, remote sensing monitoring in Weeli Wolli Creek Reach, Marillana Creek Reach and regional reference creeks **Supporting Monitoring:** • Groundwater level and quality monitoring as specified in the Yandicoogina Groundwater Operating Strategy as amended and approved for implementation from time to time (refer to Appendix 8 for details of the programme as at the date of this Plan) • Monthly inspections to confirm water flow/pooling extent in Weeli Wolli Creek (subject to safe access) • Local and regional rainfall, weather and fire events	• If the trigger and/or threshold criteria were exceeded during the reporting period, the ACAR will include review of early response actions, if relevant to the exceedance

[1] The proportion of stands (e.g. groups of at least 20 trees) that show a negative slope in trend of MSAVI with time that is significantly different (α=0.05) from the baseline trend, and/or greater average decline (i.e. more negative slope) compared to reference zones. The Proponent will update this criterion as knowledge develops based on empirical observations of tree health and/or improvements in monitoring methodology. MSAVI is the current index used, an alternative index may be used in the future subject to advances in remote sensing. Canopy decline evident from satellite imagery will be confirmed and further investigated with ground truthing

Trigger Criteria: **1.** Within any one riparian management zone the area of phreatophytic overstorey canopy decline[2] since baseline is 20% greater in Weeli Wolli Creek Reach or Marillana Creek Reach than in reference areas **OR** **2.** Significant decline[3] in number, and/or change in composition, of native perennial species in Weeli Wolli Creek Reach or Marillana Creek Reach since baseline, in comparison to reference sites **OR** **3.** Establishment[4] of a high priority weed species in Weeli Creek Reach or Marillana Creek Reach previously not detected within Weeli Wolli Creek or Marillana Creek **OR** **4.** Increased extent[5] of existing high priority weed species within the Weeli Wolli Creek Reach or Marillana Creek Reach since baseline relative to reference sites	**For all trigger criteria, review the early response actions and if warranted for:** **Trigger Criterion 1:** • Undertake visual census of remote sensing imagery and review on-ground monitoring to confirm areas of exceedance • Assess seasonal trends and/or longer term and regional trends (e.g. with Landsat imagery) • Assess if decline is occurring in vegetation previously augmented from discharge • Review current trigger levels according to result of above investigation if necessary **Trigger Criterion 2:** • Review data to determine if decline coincides with areas where introduced species have increased in extent, or proliferation of obligate phreatophytes are potentially excluding/outcompeting other native riparian species – both understorey and overstorey species • If data indicate decline is due to increased establishment of introduced or other mesophytic species, or changes in composition are due to increased establishment of obligate phreatophytes, analyse remote sensing to determine extent of increased vegetation cover **Trigger Criterion 3 and 4:** • Review introduced species' presence and abundance. Internally record, report, map and monitor. Investigate the risk of the introduced species becoming dominant • Review weed hygiene practices • Implement weed management controls where required, considering priority rating of species, size and location of target population and feasibility of control **Applicable for all trigger criteria** If investigations indicate that trigger exceedance is attributable to the Project and may continue to be exceeded with no indication of recovery: • Review contingency actions/strategy • Increase frequency and/or extent of on-ground monitoring if warranted Consider mitigation options, for example: • Temporarily change frequency/duration of discharge • Re-optimise the pumping operating strategy away from the impacted areas • If trigger 2 exceedance is due to competitive impacts from augmentation of some species, implement management controls (e.g. mechanical removal) as appropriate If assessments indicate threshold criteria are likely to be exceeded and are due to the Project, investigate contingency actions to be implemented should the threshold criteria be exceeded in consultation with DWER and other stakeholders	• Annual (nominally end of dry season), or more frequent as appropriate, remote sensing monitoring in Weeli Wolli Creek Reach, Marillana Creek Reach and regional reference creeks • Annual (wet season), or more frequent as triggered, monitoring of representative botanical transects on Weeli Wolli Creek Reach, Marillana Creek Reach and reference sites (Figure 4) **Supporting Monitoring:** • Groundwater level and quality monitoring as specified in the Yandicoogina Groundwater Operating Strategy • Monthly inspections to confirm water flow/pooling extent in Weeli Wolli Creek (subject to safe access) • Local and regional rainfall, weather and fire events	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR • If any trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions
Threshold Criteria: **1.** The area of phreatophytic overstorey canopy decline[2] since baseline and attributable to the implementation of the Project is over 50% of any riparian management zone in Weeli Wolli Creek Reach or Marillana Creek Reach and is greater than in reference areas, confirmed with ground-truthing; with no evidence of seasonal recovery over two consecutive (annual) monitoring events; and outside of historical baseline variation **OR**	**If investigations indicate threshold exceedance is attributable to the Project and may continue to be exceeded with no indication of recovery, implement threshold contingency actions as follows, or as discussed and agreed with DWER should more effective solutions be deemed appropriate for the specific circumstances:** • Use of alternative discharge location (subject to additional approval by DWER if required); • Passive recharge system • Sub surface, low permeability barrier/s to retain groundwater within the shallow alluvium that supports riparian vegetation • Provide temporary supplementary irrigation to high value stands of vegetation • If threshold exceedance is due to increased cover of weeds or other species augmented due to discharge, undertake additional control measures as warranted.	• Annual (nominally end of dry season), or more frequent as appropriate, remote sensing monitoring in Weeli Wolli Creek Reach, Marillana Creek Reach and regional reference creeks • Annual (wet season), or more frequent as triggered, monitoring of representative botanical transects on Weeli Wolli Creek Reach, Marillana Creek Reach and reference sites (Figure 4) **Supporting Monitoring:** • Groundwater level and quality monitoring as specified in the Yandicoogina Groundwater Operating Strategy	• The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency actions that have been implemented to manage the potential impact, as well as an analysis of trends • In the event that monitoring, tests, surveys or investigations indicate exceedance of threshold criteria, the exceedance will be reported in writing to

[2] Decline in phreatophytic canopy area. The Proponent will update this criterion as knowledge develops based on empirical observations of tree health and/or improvements in monitoring methodology. MSAVI is the current index used, an alternative index may be used in the future subject to advances in remote sensing. Canopy decline evident from satellite imagery will be confirmed and further investigated with ground-truthing

[3] Significant decline since baseline in number of species (α=0.05), and/or compositional change to species assemblage

[4] Establishment: a species which has grown into maturity and reproduced, producing a viable second generation of individual plants signifying persistence at a given location. Refer to Appendix 5 for a list of high priority weed species previously recorded in Weeli Wolli and Marillana Creeks at baseline

[5] Increase in the number of quadrats that weed species occur in.

2. Over 50% of Weeli Wolli Creek Reach or Marillana Creek Reach displays significant compositional change[6] to riparian vegetation since baseline in comparison to reference areas attributable to the implementation of the Project	Continue to implement threshold contingency actions until the CEO has confirmed by notice in writing that it has been demonstrated that the threshold criteria are being met. Monitor threshold contingency actions to validate success of mitigation strategy.	• Monthly inspections to confirm water flow/pooling extent in Weeli Wolli Creek (subject to safe access) • Local and regional rainfall, weather and fire events	the CEO within seven (7) days of the exceedance being identified • The Proponent will provide a report to the CEO within twenty-one (21) days of the exceedance being reported

EPA Factors: Inland Waters and Subterranean Fauna

EPA Objectives:

To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected

To protect subterranean fauna so that biological diversity and ecological integrity are maintained

Key Values: The Fauna and Heritage and Social values associated with Weeli Wolli Creek and Marillana Creek; the Fortescue Marsh.

Key Impacts and Risks: Potential adverse impacts on aquatic fauna community and subterranean fauna from surplus water discharge quality

Environmental criteria	Response actions	Monitoring	Reporting
Early Response Criteria: **1.** Surface water discharge reaches the early response indicator site (Figure 3) located 9 km downstream from the Marillana Creek and Weeli Wolli Creek confluence under natural no-flow conditions **OR** **2.** Exceedance of SSGV water quality criteria, taking into account baseline and regional reference data[7]	**If warranted for:** **Early Response Criterion 1:** • Review discharge regime, frequency, extent and timing in relation to predicted surface water extent • Review local and regional reference data, including rainfall and flooding • Review hydrological model If investigations indicate surface water discharge may exceed the wetting front extent specified in Figure 3 of MS 1038, implement contingency actions as warranted. **Early Response Criterion 2:** • Confirm exceedance with next monthly sampling • Investigate source of contamination by review of rainfall, flooding regime, groundwater quality from production borefield, geology of orebody being dewatered, discharge volumes or potential other sources (e.g. sedimentation from crossings, levees or other construction, livestock) • If warranted, increase downstream extent of monitoring to assess geographic extent of exceedance • Review available data to determine potential impacts, if any, on aquatic fauna assemblage If investigations indicate exceedance is a result of the Project and is a potential risk to environmental values undertake further investigation, for example: • Bioavailability of toxicant (e.g. metal speciation, interaction with water hardness and/or pH) • Evidence of eutrophication (e.g. phytotoxic algal accumulation) • Additional field monitoring if warranted	• Monthly inspections to confirm water flow/pooling extent in Weeli Wolli Creek (subject to safe access) • Monthly surface water quality monitoring at the compliance sites (depicted in Figure 3) when flowing and accessible, for the analytes listed in Appendix 2 • Biannual water quality monitoring of reference sites for the analytes listed in Appendix 2 **Supporting Monitoring:** • Continuous monitoring of discharge volumes from flow meters at all approved Yandicoogina Discharge outlets where operable • Local and regional rainfall, weather and fire events	• If the trigger and/or threshold criteria was exceeded during the reporting period, the ACAR will include review of early response actions, if relevant to the exceedance.

[6] Compositional change determined as loss of species listed as dominant at baseline within any of the upper, mid or ground vegetation strata (dominant species listed in Appendix 4)

[7] Exceedance of the SSGV water quality criteria will be assessed as per Appendix 2

Trigger Criterion: **1.** Significant reduction in aquatic fauna diversity or change to assemblage structure [8] (macroinvertebrates including hyporheic) within Marillana Creek Reach or Weeli Creek Reach relative to comparable seasonal baseline and reference locations, attributable to discharge water quality associated with the Project	**Review early response actions and if warranted:** • If sources of contamination additional to discharge identified, remove as appropriate • Review effectiveness of sedimentation controls for levees and creek crossings if appropriate • Undertake ecotoxicity assessment if deemed necessary • Review discharge extent and trends in water quality parameters to assess potential risk to downstream environmental values • Increase frequency of aquatic fauna monitoring if appropriate If evidence indicates that trigger exceedance is due to the Project, has the potential to affect environmental values and may continue to be exceeded with no indication of recovery, implement trigger level actions and monitor for effectiveness to bring back to below trigger, for example: • Temporarily change frequency and/or duration of discharge as warranted If assessments indicate threshold criteria are likely to be exceeded and are due to the Project, investigate contingency actions to be implemented should the threshold criteria be exceeded in consultation with DWER and other stakeholders	• Monthly surface water quality monitoring at the compliance sites (depicted in Figure 3) when flowing and accessible, for the analytes listed in Appendix 2. • Annual [9] (or more frequent as triggered) aquatic fauna (including aquatic invertebrates) and water quality surveys of Marillana Creek, Weeli Wolli Creek and reference creeks **Supporting Monitoring:** • Continuous monitoring of discharge volumes from flow meters at all approved Yandicoogina Discharge outlets where operable • Local and regional rainfall, weather and fire events	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR • If any trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions
Threshold Criterion: **1.** Declining trend in aquatic fauna diversity in Marillana Creek Reach and Weeli Creek Reach continues for two or more consecutive (annual) monitoring events, relative to comparable seasonal baseline and reference locations and evidence indicates a long-term loss of the ecological integrity of the creek attributable to discharge water quality associated with the Project.	**If investigations indicate that threshold exceedance is attributable to the Project and may continue to be exceeded with no indication of recovery, implement threshold contingency actions as follows, or as discussed and agreed with DWER should more effective solutions be deemed appropriate for the specific circumstances, for example**: • Use of alternative discharge location (subject to additional approval by DWER if required); • Passive recharge system Continue to implement threshold contingency actions until the CEO has confirmed by notice in writing that it has been demonstrated that the threshold criteria are being met Monitor threshold contingency actions to validate success of mitigation strategy	• Monthly surface water quality monitoring at the compliance sites (depicted in Figure 3) when flowing and accessible, for the analytes listed in Appendix 2. • Annual [14] (or more frequent as triggered) aquatic fauna and water quality surveys of Marillana Creek, Weeli Wolli Creek and reference creeks **Supporting Monitoring:** • Continuous monitoring of discharge volumes from flow meters at all approved Yandicoogina Discharge outlets where operable • Local and regional rainfall, weather and fire events	• The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency actions that have been implemented to manage the potential impact, as well as an analysis of trends • In the event that monitoring, tests, surveys or investigations indicate exceedance of threshold criteria, the exceedance will be reported in writing to the CEO within seven (7) days of the exceedance being identified • The Proponent will provide a report to the CEO within twenty-one (21) days of the exceedance being reported

[8] Significant decline since baseline in number of species (α=0.05), and/or compositional change to species assemblage

[9] As dewatering discharge and creek flows are expected to decrease during the life of the Project, annual and/or more frequent monitoring of aquatic fauna is dependent on sufficient surface water being present to allow sampling

2.1. Monitoring

The purpose of monitoring is to inform, through the environmental criteria, if the conditioned environmental outcome is being achieved and when trigger level actions or threshold contingency actions will be implemented.

Monitoring provisions for each environmental factor and how these will determine performance against the environmental criteria are presented in Table 2.

2.2. Reporting

The environmental outcome will be reported against trigger and threshold criteria (Table 2) for each calendar year in the Annual Compliance Assessment Report (ACAR) for the Project against MS1038.

The annual report will also include a summary of analysis of monitoring data to facilitate adaptive management.

In the event that trigger and threshold criteria are exceeded during the reporting period, the annual report will include a description of the effectiveness of any management contingency actions that have been implemented to manage the impact. In the event that monitoring, tests, surveys or investigations indicate exceedance of threshold criteria, notification of the exceedance will be reported to the Department of Water and Environmental Regulation (DWER) within seven days of the exceedance being identified, followed by a stand-alone report within 21 days of the exceedance being reported as per Condition 5-6.

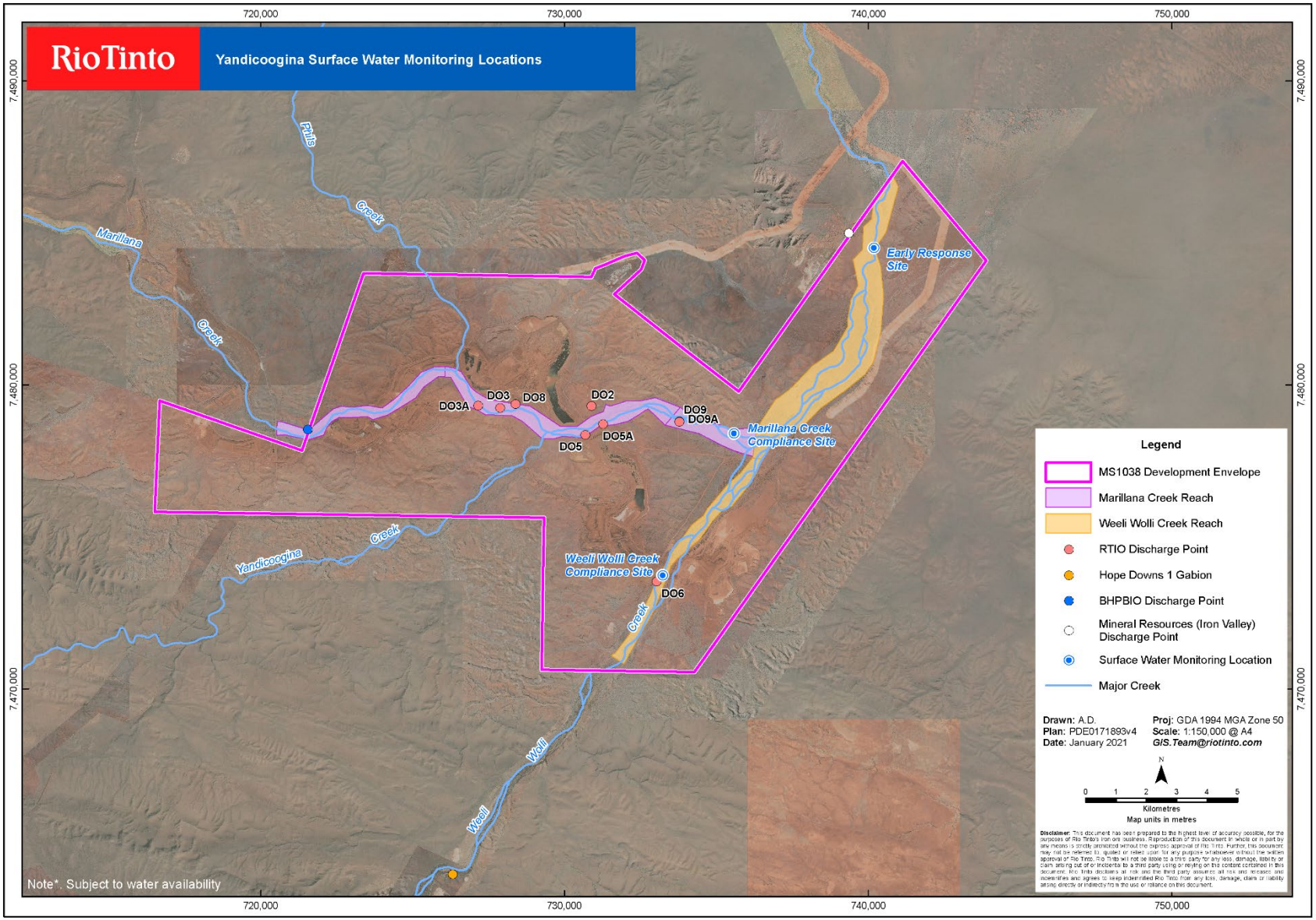

Figure 3: Yandicoogina Surface Water Monitoring Locations

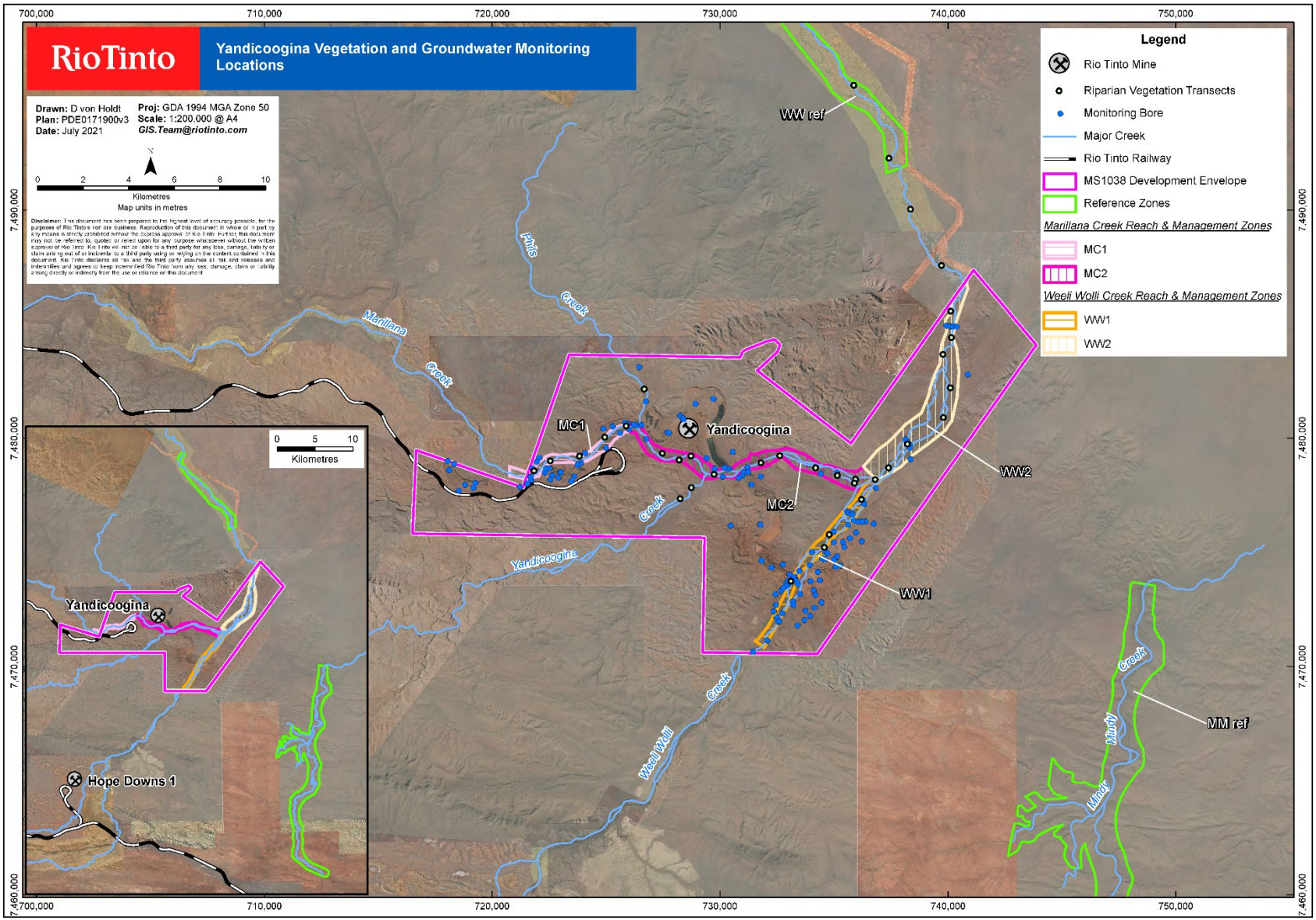

Figure 4: Yandicoogina Riparian Vegetation and Groundwater Monitoring Locations

Table 3: Yandicoogina Condition Environmental Management Plan Reporting Table

Key Environmental Factors: Inland Waters, Flora and Vegetation, Terrestrial Fauna and Subterranean Fauna **Key Values**: Fortescue Marsh, Flora and Vegetation, Fauna, Heritage and Social	
Condition Environmental Outcomes	**Reporting periods 1 January - 31 December** **Status report:** Environmental outcome achieved Environmental outcome not achieved
1. The implementation of the Proposal, including but not limited to land clearing, groundwater abstraction and surplus dewater discharge, does not cause long-term impacts to the environmental values of Weeli Wolli Creek, as defined in the Environmental Values Statement required by Condition 5-4 of MS 1038	
2. The implementation of the Proposal, including but not limited to land clearing, groundwater abstraction and surplus dewater discharge, does not cause long term impacts to the Aboriginal heritage values linked to the physical and/or biological surroundings of Weeli Wolli Creek	
3. Groundwater abstraction and/or surplus dewater discharge from the implementation of the Proposal does not cause long term impacts on the health or cover of riparian vegetation outside the Management Zone as delineated in Figure 3 of Schedule 1 and defined by the geographic coordinates in Schedule 2	
Trigger Criteria:	**Status report:** Criteria not exceeded Criteria exceeded
Inland Waters, Flora and Vegetation, Subterranean Fauna, Terrestrial Fauna	
1. Within any one riparian management zone, the area of phreatophytic overstorey canopy decline since baseline is 20% greater in Weeli Wolli Creek Reach or Marillana Creek Reach than in reference areas	
2. Significant decline in number, and/or change in composition, of native perennial species in Weeli Wolli Creek Reach or Marillana Creek Reach since baseline, in comparison to reference sites	

3. Establishment of a high priority weed species in Weeli Wolli Creek Reach or Marillana Creek Reach previously not detected within Weeli Wolli Creek or Marillana Creek	
4. Increased extent of existing high priority weed species in Weeli Wolli Creek Reach or Marillana Creek Reach since baseline relative to reference sites	
Inland Waters and Subterranean Fauna	
1. Significant reduction in aquatic fauna diversity or change to assemblage structure (macroinvertebrates including hyporheic) in Weeli Wolli Creek Reach or Marillana Creek Reach relative to comparable seasonal baseline and reference locations, attributable to discharge water quality associated with the Project	
Threshold Criteria:	**Status report:** Criteria not exceeded Criteria exceeded
Inland Waters, Flora and Vegetation, Subterranean Fauna and Terrestrial Fauna	
1. The area of phreatophytic overstorey canopy decline since baseline and attributable to the implementation of the Project is over 50% of any riparian management zone in Weeli Wolli Creek Reach or Marillana Creek Reach and is greater than in reference areas, confirmed with ground truthing; with no evidence of seasonal recovery over two consecutive (annual) monitoring events; and outside of historical baseline variation	
2. Over 50% of Weeli Wolli Creek Reach or Marillana Creek Reach displays significant compositional change to riparian vegetation since baseline in comparison to reference areas attributable to implementation of the Project	
Inland Waters and Subterranean Fauna	
1. Declining trend in aquatic fauna diversity or change to assemblage structure in Weeli Wolli Creek Reach or Marillana Creek Reach continues for two or more consecutive (annual) monitoring events, relative to comparable seasonal baseline and reference locations and evidence indicates a long-term loss of the ecological integrity of the creek attributable to discharge water quality associated with the Project	

3. ADAPTIVE MANAGEMENT AND REVIEW OF THIS EMP

The Proponent will implement adaptive management to learn from the implementation of mitigation measures, monitoring and evaluation against trigger and threshold criteria, to more effectively meet the conditioned environmental outcome.

The following approach will apply:

- Monitoring data will be systematically evaluated and compared to baseline and reference site data on a regular basis in a process of adaptive management to verify responses to the impact are the same or similar to predictions.
- The effectiveness and relevance of trigger level and threshold contingency actions will be evaluated on an annual basis to determine if any changes to management actions are required.

Increased understanding of the hydrological and eco-hydrological regimes based on additional internal and external studies will be incorporated into the monitoring and management approach when newer relevant information becomes available and where applicable.

4. STAKEHOLDER CONSULTATION

Consistent with the EPA's expectations for this EMP to align with the principles of EIA, the Proponent consulted with stakeholders, including but not limited to the Department of Biodiversity, Conservation and Attractions, Traditional Owners, EPA Services and the Department of Water and Environment Regulation during the Environmental Impact Assessment of the Yandicoogina Iron Ore Project – Revised Proposal and development of this EMP and has also considered feedback during the operation of the current EMP.

The EMP and Environmental Values Statement have been developed in consultation with relevant Traditional Owners and the Department of Water and Environmental Regulation, including the last iteration in 2017. The EMP has been substantially revised from the previous version in both format and content and previous stakeholder feedback has been considered.

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Appendix 1: Yandicoogina High Level Environmental Values Statement

High Level Values	Description
Fortescue Marsh	The Fortescue Marsh is the largest ephemeral wetland in the Pilbara region, located in the Fortescue River Valley between the Chichester and Hamersley Ranges. The Fortescue Marsh is a Priority Ecological Community and listed on the Directory of Important Wetlands of Australia as a wetland of national significance. The Yandicoogina Development Envelope is intersected by major ephemeral creeks that ultimately drain into the Fortescue Marsh and form part of its catchment. The Fortescue Marsh is episodically inundated, predominantly as a result of rainfall associated with tropical low-pressure cyclonic weather systems that generally occur between December and April. The Fortescue Marsh has cultural and heritage significance to the region's traditional owners and supports a range of native plant and animal species, including a large and diverse number of migratory bird species. Plant and animal species and communities of high conservation value occur in the Fortescue Marsh and in the surrounding areas. The diverse ecosystem includes endemic flora, fauna and supports a rich diversity of aquatic and terrestrial invertebrates.
Flora and Vegetation	The vegetation communities and fauna habitats within the Yandicoogina Development Envelope are relatively widespread and well-represented regionally. This includes local riparian vegetation communities and groundwater dependant ecosystems commonly associated with large ephemeral creek systems of the Pilbara region. The riparian vegetation communities of Marillana and Weeli Wolli Creeks within the Development Envelope are similar to other large ephemeral systems of the Pilbara. Low flow pathways are populated with large open Eucalpyt woodland, over eucalypt and acacia low woodland, largely flanked by tall, open acacia shrubland with **Cenchrus ciliaris* tussock grasslands. One community, identified locally as the C1A riparian community, broadly comprises a Eucalypt woodland containing a co-dominant *Melaleuca argentea* component and is considered to have local conservation significance due to its groundwater dependency, associated mesic habitat values, somewhat restricted distribution, and association with a major creekline in the area (predominantly Marillana Creek). This community is similar but of different structure and reduced significance in relation to the vegetation community of Weeli Wolli Spring (significant *Melaleuca argentea* woodlands).
Fauna	Weeli Wolli Creek provides habitat for a wide range of fauna. The alluvial aquifer system supports stygofauna, whilst the ephemeral seasonal surface expression of water supports fish and aquatic invertebrates (although the project area does not contain permanent pools). Weeli Wolli Creek also provides foraging habitat for an assemblage of various bat species and is the most northerly distribution of the Chocolate Wattle Bat (*Chalinobolus morio*). The Pilbara Olive Python (*Liasis olivaceus barroni*) has been recorded within Weeli Wolli Creek and the Development Envelope may contain habitat for the Northern Quoll (*Dasyurus hallucatus*).
Heritage	Aboriginal people are spiritually and physically connected to the landscape through Jukurppa (Dreaming) stories, ceremony, and physical places such as ethnographic and archaeological heritage sites. Weeli Wolli Creek holds special cultural and spiritual significance for the Traditional Owner groups of the region (*Nyiyarparli*, and *Banjima* people) as a place where the rainbow serpent (*Yarduba*) resides. Weeli Wolli Creek hosts significant ethnographic and archaeological heritage sites which are associated with the water course. It is noteworthy that discharge of excess groundwater dewatered from nearby mining operations has created a temporary perennial source of water within parts of Weeli Wolli Creek, which is predicted to return to ephemeral patterns upon the cessation of discharge.

Appendix 2: Yandi Surface Water Quality SSGVs for Marillana and Weeli Wolli Creek Compliance Sites

Chemical	Purpose	Marillana Creek Compliance Site SSGV	Weel Wolli Creek Compliance Site SSGV
Aluminium (Al)	T	0.055	0.055
Alkalinity-total (as $CaCO_3$)			
Arsenic (As-total)	T	0.013	0.013
Barium (Ba)	T	0.054	0.02
Boron (B)	T	0.37	0.37
Cadmium (Cd)	T, H	0.0002	0.0002
Calcium (Ca)			
Carbonate (CO3)			
Chloride (Cl)			
Chromium (Cr-total)	T, H	0.001	0.001
Cobalt (Co)	T	0.001	0.001
Copper (Cu)	T	0.0014	0.0014
Dissolved Oxygen (DO%)			
EC (µS/cm)		1010	880
Hardness (as $CaCO_3$)			
Hydrogen carbonate (HCO_3)			
Iron (Fe)	T	0.3	0.3
Lead (Pb)	T, H	0.0034	0.0034
Magnesium (Mg)			
Manganese (Mn)	T	1.9	1.9
Mercury-inorganic (Hg)	T	0.00006	0.00006
Molybdenum (Mo)	T	0.001	0.001
Nickel (Ni)	T, H	0.011	0.011
N-NH_3 (ammonia-nitrogen)	T	0.9	0.9
Nitrate (NO_3)	T	11	11
Nitrate-nitrogen (N-NO_3)	E	1.2	0.2
Nitrogen total (N-total)	E	1.2	0.3
pH (pH units)		6 – 8.5	7 – 8.5
Phosphorus (P-total)	E	0.02	0.02
Potassium (K)			
Selenium (Se-total)	T	0.011	0.011
Silicon (SiO_2)			
Sodium (Na)			
Sulphate (SO_4)			
Sulphur (S)			
Temperature (°C)			
Total Dissolved Solids (TDS)			
Total Suspended Solids (TSS)			
Turbidity (NTU)			
Uranium (U)	T	0.002	0.002
Vanadium (V)			
Zinc (Zn)	T	0.014	0.014

Notes:
E = SSGV is for protection against effects of eutrophication.
H = default guideline for freshwater ecosystems should be adjusted for site-specific water hardness using algorithms in Warne *et al*. (2018), as specified by ANZG (2018).
T = SSGV is for protection against effects of direct toxicity (either chronic or acute).

Parameters that can have either potential direct toxicity effects, lead to eutrophication or are a stressor are annotated in the table above and will be compared to SSGVs water quality criteria in order to assess exceedance of the early response criterion for discharge water quality in Table 2. Other parameters in the above table will be monitored to provide supporting information to aid interpretation of the provisions for discharge water quality in Table 2.

The process for comparing to the SSGV and/or ANZG default guidelines is as below.
Toxicant:

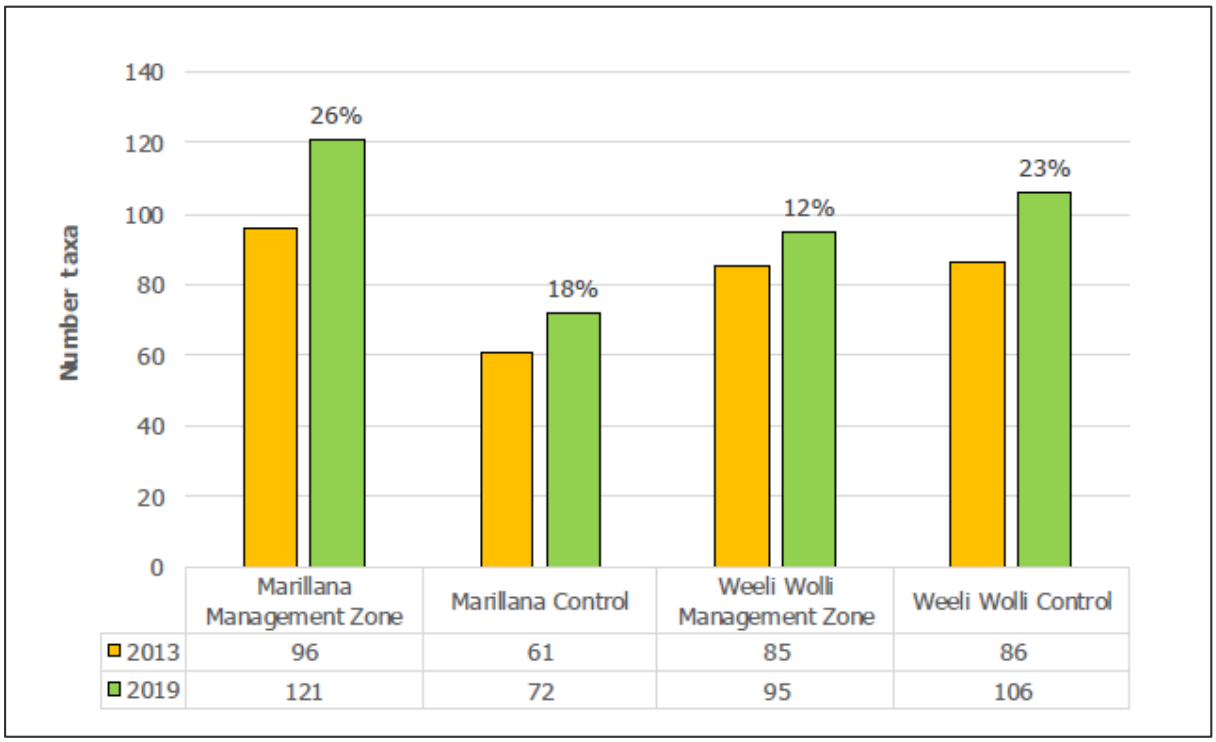
1. Assess single sample value each month and if greater than the SSGV then;
2. Compare to whichever is greater of baseline/reference maximum or ANZG default guideline for 90% species protection and if greater then;
3. Modify the SSGV for water hardness measured at the time of monthly sampling and if greater undertake investigation as per Table 2 response actions.

Eutrophication parameters and stressors:

1. Assess single sample value each month and if greater than the SSGV then;
2. Compare the 12-month rolling median to the SSGV and if greater then:
3. Test if the 12-month rolling median is statistically higher than the SSGV and if so then;
4. Compare to whichever is greater of baseline/reference maximum or ANZG default guideline for 90% species protection and if greater undertake investigation as per Table 2 response actions.

If investigations as described in Table 2 show no discernible impact of water quality exceedance for a particular parameter to aquatic fauna or other environmental values, then repeat investigations for similar exceedances of that same parameter should not be warranted. However, routine monitoring of water quality and aquatic fauna should continue, to confirm that environmental values are maintained. In addition, trends in parameters previously exceeded should be monitored, and if an increase in concentration is observed, then a repeat of previous or additional investigations should be instigate. SSGVs may be revised in the future as knowledge develops and in consultation with DWER.

Appendix 3: Number of native perennial species in Weeli Wolli Creek, Marillana Creek and reference areas in 2013 and 2019



Appendix 4: Dominant species present in 2013 within the Yandicoogina Management Zone and reference locations.

Species	Yandi Management Zone	Control Areas
**Cenchrus ciliaris*	Y	Y
Acacia bivenosa		Y
Acacia citrinoviridis	Y	Y
Acacia coriacea subsp. *pendens*	Y	Y
Acacia pyrifolia	Y	
Acacia tumida		Y
Androcalva luteiflora	Y	Y
Atalaya hemiglauca	Y	Y
Cleome viscosa	Y	Y
Corchorus crozophorifolius^	Y	
Corchorus lasiocarpus	Y	
Corchorus walcottii^	Y	Y
Cymbopogon ambiguus	Y	Y
Cyperus vaginatus	Y	Y
Dodonaea lanceolata var. *lanceolata*^		Y
Dodonaea viscosa subsp. *mucronata*		Y
Eriachne benthamii^	Y	Y
Eriachne mucronata^		Y
Eucalyptus camaldulensis	Y	Y
Eucalyptus victrix	Y	Y
Eulalia aurea	Y	Y
Glycine canescens	Y	
Gossypiumrobinsonii	Y	
Indigofera monophylla	Y	Y
Lobelia amhemiaca	Y	
Melaleuca argentea	Y	Y
Melaleuca bracteata		Y
Melaleuca lasiandra^	Y	Y
Melaleuca linophylla^		Y
Petalostyllis labicheoides R.Br.		Y
Phyllanthus maderaspatensis	Y	
Stemodia grossa	Y	
Tephrosia rosea var. *clementii*^	Y	Y
Themeda triandra	Y	Y
Typha domingensis	Y	Y

^ Some potential taxonomic inconsistencies have been identified with these species which are currently being investigated. Future changes in cover will be assessed in conjunction with cover of similar species, where mis-identifcation and/or taxonomic updates may have occurred.

Appendix 5: Weed species present in Marillana Creek and Weeli Wolli Creek during or prior to the wet season of 2013 and/or in the wet season of 2019

Species	Common Name	Priority Rating	Present 2013 or Prior	2019
* *Rumex vesicarius*	Ruby Dock	High	Y	Y
* *Cynodon dactylon*	Couch	High	Y	Y
* *Aerva javanica*	Kapok Bush	High	Y	Y
* *Chloris virgata*	Feathertop Rhodes Grass	High	Y	Y
* *Cenchrus ciliaris*	Buffel Grass	Medium	Y	Y
* *Cenchrus setiger*	Birdwood Grass	Medium	Y	Y
* *Echinochloa colona*	Awnless Barnyard Grass	Medium	N	Y
* *Malvastrum americanum*	Spiked Malvastrum	Medium	Y	Y
* *Setaria verticillata*	Whorled Pigeon Grass	Medium	Y	Y
* *Phoenix dactylifera*	Date Palm	Medium	Y	Y
* *Solanum nigrum*	Black Berry Nightshade	Medium	Y	Y
* *Euphorbia hirta*	Asthma Plant	Medium	N	Y
* *Lactuca serriola*		Medium	Y	Y
* *Argemone ochroleuca*	Mexican Poppy	Medium	Y	Y
* *Bidens bipinnata*	Bipinnate Begger's Tick	Medium	Y	Y
* *Sigesbeckia orientalis*	Indian Weed	Medium	N	Y
* *Conyza bonariensis*	Flaxleaf Fleabane	Medium	Y	Y
* *Flaveria trinervia*	Speedy Weed	Low	Y	Y
* *Symphyotrichum squamatum*	Bushy Starwort	Low	N	Y
* *Tridax procumbens*	Tridax	Low	Y	Y
* *Vachellia farnesiana*	Mimosa Bush	Low	Y	Y
* *Datura leichhardtii*	Native Thornapple	Low	Y	Y
* *Sonchus oleraceus*	Common Sowthistle		Y	Y
* *Sisymbrium orientale*	Indian Hedge Mustard		Y	Y
* *Citrullus amarus*			N	Y

Appendix 6: High priority weed species that have increased in extent Marillana Creek, Weeli Wolli Creek and/or control areas

Species	Common Name	Management Zone	# Quadrats	
			2013	2019
* *Aerva javanica*	Kapok bush	Marillana	0*	7
		Weeli Wolli	3	5
		Marillana Control	0	2
* *Chloris virgata*	Feathertop Rhodes Grass	Marillana	0*	8
* *Cynodon dactylon*	Couch	Marillana	2	11
* *Rumex vesicarius*	Ruby Dock	Marillana	1	6
		Marillana Control	0	3

* Weed species was present within Marillana and/or Weeli Wolli Creek prior to 2013

Appendix 7: Proportion (%) of baseline phreatophytic overstorey canopy area in Weeli Wolli and Marillana Creek[10] (baseline average between 2006-2008)

	MC1	MC2	Marillana Creek Reach	WW1	WW2	Weeli Wolli Creek Reach	Weeli Wolli reference WW ref	Mindy Mindy reference MM ref
2009	99	90	92	161	149	152	163	132
2010	142	115	122	235	185	196	136	158
2011	123	110	114	235	192	202	119	127
2012	156	115	125	242	188	200	180	189
2013	114	85	93	255	166	186	118	178
2014	126	97	104	259	198	212	144	169
2015	129	75	88	259	191	206	115	185
2016	51	23	30	233	118	144	125	166
2017	66	44	50	288	187	210	166	146
2018	43	84	74	291	162	191	119	174
2019	55	78	72	286	107	147	129	160
2020	98	80	85	237	112	140	183	175

[10] This data may be updated pending improvements in monitoring methodology, raw data availability and/or advances in technology, in consultation with DWER and other stakeholders.

Appendix 8: Yandicoogina Groundwater Level and Quality Monitoring Programme

Groundwater at Yandicoogina is abstracted in accordance with the conditions of Groundwater Licence GWL166205(7), issued under the *Rights in Water and Irrigation Act 1914* (RIWI) and administered by the Department of Water and Environment Regulation (DWER). The Groundwater Operating Strategy August 2017 (RTIO-HSE-0057642), as approved by the DWER on 31/08/2017, documents the compliance, monitoring and reporting requirements relating to the water scheme as specified by DWER (RIWI & Policy 5.08), and ensure monitoring and compliance requirements specified in Part IV and V approvals are addressed.

An overview of the groundwater level and quality monitoring programme as per the Groundwater Operating Strategy August 2017 (RTIO-HSE-0057642)[1] is detailed in Table 1 below. All data collected through the monitoring programme is included within the Annual and Triennial Aquifer Reviews.

Table 1 Yandicoogina Groundwater Monitoring Overview

Bore Type	Frequency[2]	Parameter	Monitoring Locations
Operating Production Bores	Monthly	Abstraction volume, Water level, EC, pH, Temperature	See EMP, Figure 4
	Annually	EC, pH, Temperature Major ions (CO3, HCO3, Ca, Na, K, Mg, SO4, Si, F, Fe, Al, Cl) Dissolved metals (Ag, As, B, Ba, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, Se, Sn, U, Zn) Nutrients (Total P, Total N, NO2, NO3, NH4)	
Monitoring Bores	Quarterly	Water level	

[1] Monitoring frequency to depend on accessibility of bores due to mining and weather events

[2] Management of operations will be based on the latest approved iteration of the Yandicoogina Groundwater Operating Strategy