Iron Bridge

Site 12 Pool Water Quality and Quantity Monitoring Plan

IB Operations Pty Ltd

28 October 2021

662MI-5700-PL-WM-0001

	Site 12 Pool Water Management Plan		662MI-5700-PL-WM-0001
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Status	**DRAFT**		
Author	Sofie Springer	Signature	Click here to enter a date.
Checked	Belinda McCawley	Signature	Click here to enter a date.
Approved	Sean Mcgunnigle	Signature Sean McGunnigle Digitally signed by Sean McGunnigle Date: 2021.10.29 09:46:05 +08'00'	Click here to enter a date.
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Author	Checker	Approver	Rev No.	Status	Issued Date
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S.Springer	**B. McCawley**	**S. McGunnigle**	1	**IFR**	28/10/2021

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Table 1: Site 12 Pool WQQMP Executive Summary

Proposal name	North Star Magnetite Project
Proponent name	Iron Bridge Operations Pty Ltd
Ministerial Statement #	993
Purpose of the EMP	Provide management and monitoring actions for surface water in accordance with the objectives of condition 12-3 and 12-7 of MS 993
Key environmental factor/s, outcome/s and objective/s	**EPA Factor/s and objectives:** Inland Waters **Outcomes:** The Project does not have a detrimental impact on the water quality or hydrological regime of Site 12 Pool. **Key Environmental Values:** • Flora, fauna - To maintain the quality of groundwater and surface water so that environmental values are protected. • Hydrological processes – To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected **Key Impacts and Risks:** • Alteration of hydrological processes at Site 12 Pool that lead to degradation of flora and/or fauna habitat • Changes in water quality at Site 12 Pool due to sedimentation and WRD leachate that lead to degradation of flora and/or fauna habitat.
Condition clauses (if applicable)	The proponent shall ensure that the implementation of the proposal within the catchment of Site 12 Pool that is located within the Mine Development Envelope, as delineated in Figure 8 of Schedule 1 and defined by the geographic coordinates in Schedule 2, does not have a detrimental impact on the water quality or hydrological regime of Site 12 Pool, through the implementation of conditions 12-3 to 12-7.
Key components in the EMP (if applicable)	N/A
Proposed construction date	May 2021
EMP required pre-construction	Yes ✓ No ☐

1. CONTEXT, SCOPE AND RATIONALE

1.1 Proposal

The North Star Magnetite Project (the Project) was approved under Part IV of the *Environment Protection Act 1986* (EP Act) by Ministerial Statement 993 (MS) in January 2015. Condition 12 of the MS specifies that a Water Quality and Quantity Monitoring Plan (this Plan) is required to demonstrate that the implementation of the Project within the catchment of 'Site 12 Pool', located within the mine development envelope (MDE) as delineated in Figure 8 of Schedule 1, and defined by the geographic coordinates in Schedule 2, does not have a detrimental impact on the water quality or hydrological regime of 'Site 12 Pool'.

This Plan supersedes the Site 12 Pool Water Quality and Quantity Monitoring Plan (662MI-5700-PL-WM-0001 Rev 0).

The proponent for the North Star Magnetite Project is FMG Iron Bridge (Aust) Pty Ltd (FMG IB). The Project is a joint venture between FMGIB and Formosa Steel IB Pty Ltd (Formosa). The managing entity for the Project is IB Operations Pty Ltd (IBO), a joint venture company between FMG IB and Formosa.

650,000 700,000 750,000 800,000 850,000

7,800,000 7,750,000 7,700,000 7,650,000

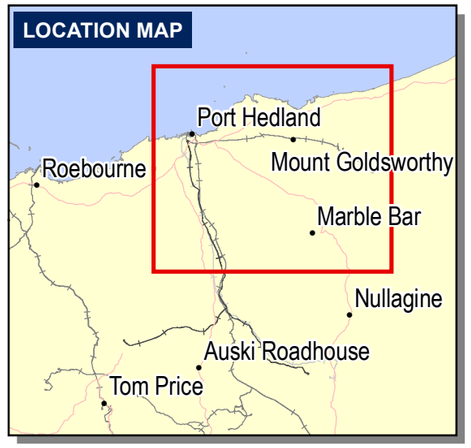
Port Hedland

Mount Goldsworthy

Marble Bar

Iron Bridge

LOCATION MAP



LEGEND

- Infrastructure Development Envelope
- Mining Area Development Envelope
- North Start Extension Disturbance Envelope
- Slurry Corridor Development Envelope
- Water Corridor Development Envelope
- FMG Managed Tenements
- Towns
- FMG Mines
- FMG Rail Alignments

Data Source(s):
Topo; Geoscience Australia
All other data; FMGL, 2020

N

0 10 20 30 40 50
Kilometres

Figure 1
Irgon Bridge Developement Envelopes

Requested By: A. Harris
Drawn By: B. Ralebala
Revised By: sanli
Approved By:
Scale: 1:750,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 662NS_0000_MP_EN_0158.003_r0

Date: 8/12/2020
Size: A3L
Revision: 0
Confidentiality: 0

Iron Bridge

1.2 Key Environmental Factors

The key environmental factor for Site 12 Pool is hydrological processes and water quality.

The Project activities in the MDE that have the potential to detrimentally impact the surface water quantity and the hydrological regime of Site 12 Pool (which contains habitat for the Pilbara Olive Python), include the following:

- Modification of the upper catchment resulting in decreased flow rates and deteriorating water quality
- Storage of waste material affecting the catchment's runoff characteristics. This can lead to decreased infiltration rates and volumes of runoff into Site 12 Pool. Site 12 Pool monitoring locations are provided in Table 3.

1.3 Condition Requirements

Water quality and quantity monitoring at Site 12 Pool will be undertaken to address the requirements of Condition 12 of MS 993 to ensure implementation of the proposal within the catchment of Site 12 Pool that is located within the MDE does not have a detrimental impact on the water quality of hydrological regime of Site 12 Pool.

To demonstrate this environmental outcome will be achieved, Condition 12-3 requires the following aspects to be included in the Plan:

(1) The location of monitoring sites for monitoring water quality and quantity within Site 12 Pool

(2) Baseline water quality and quantity survey data collected at monitoring sites identified pursuant to Condition 12-3 (i)

(3) Protocols, procedures and frequency for monitoring and evaluating water quality and quantity at monitoring sites required under Condition 12-3(i)

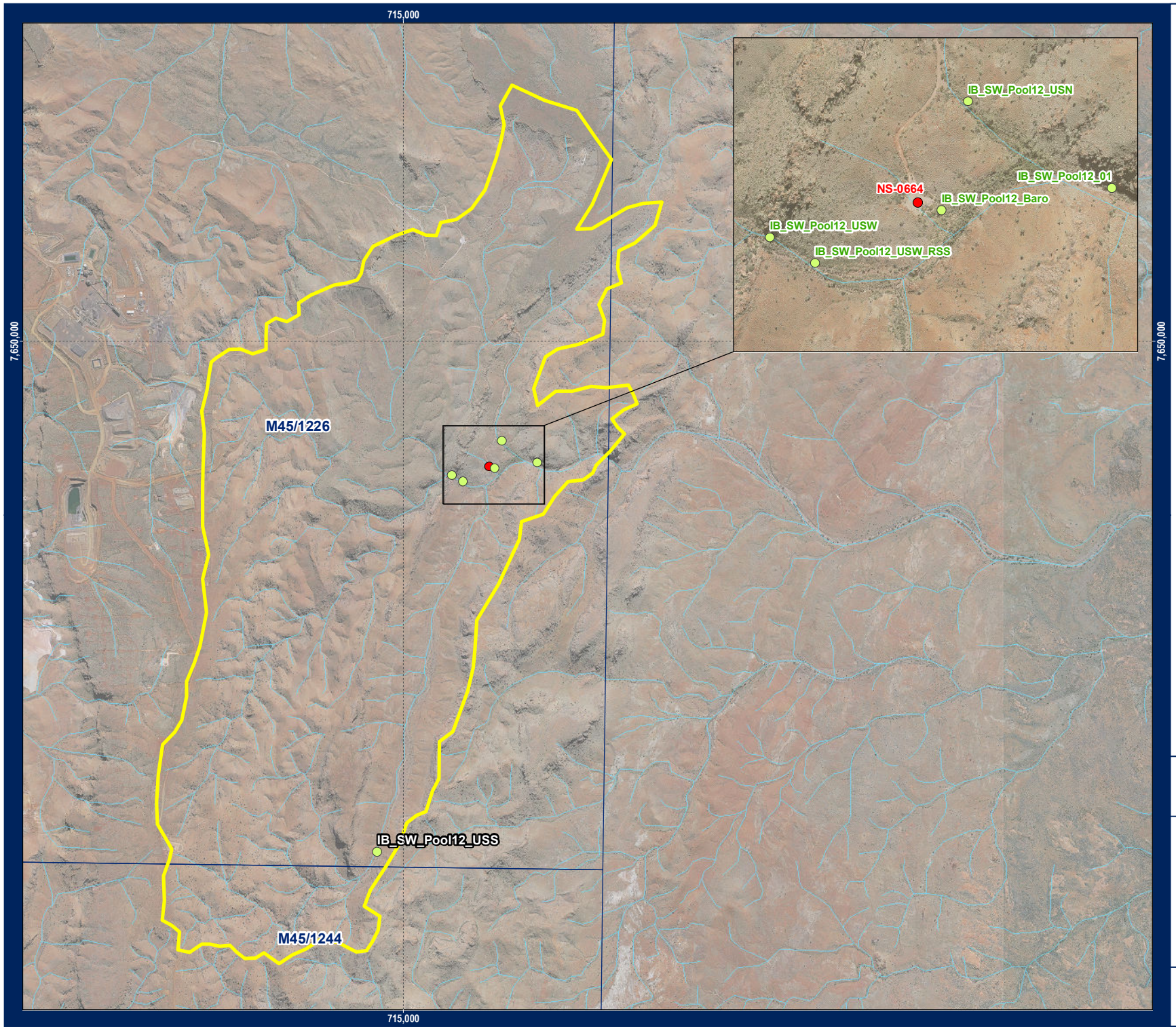
(4) Specified trigger levels for all run-off (including rainwater run-off) from the Mine Development envelope (including pH, total acidity, total alkalinity, dissolved iron), with reference to Managing Acid and metalliferous Drainage (DITR, 2007) and turbidity (including impacts related to increased sedimentation)

(5) A framework for development of management and contingency actions to be implemented for mitigating changes to the water quality and quantity in the event that any trigger levels referred to in condition 12-3 9(iv) are not met.

This Plan describes the environmental monitoring activities that are required of Iron Bridge Operations (IBO) in relation to surface water resources at Site 12 Pool. Table 2 outlines how this Plan meets the requirements of Condition 12 of MS 993, and where it is referenced throughout.

Table 2: Condition Requirement of MS 993

Conditions	Location in this Plan
12-1 *Prior to the commencement of ground disturbing activities within the catchment of Site 12 Pool that is located with the Mine Development Envelope, as delineated in Figure 8 of Schedule 1 and defined by the geographic coordinates in Schedule 2, the proponent shall prepare a Water Quality and Quantity Monitoring Plan in consultation with the Department of Water, to the requirements of the CEO, to demonstrate that Condition 12-2 has been met*	This Plan addresses these requirements and supersedes Site 12 Pool Water Quality and Quantity Monitoring Plan (662MI-5700-PL-WM-0001 Rev 0).
12-2 *The Proponent shall ensure that the implementation of the proposal within the catchment of Site 12 Pool that is located within the Mine Development Envelope, as delineated in Figure 8 of Schedule 1 and defined by the geographic coordinates in Schedule 2, does not have a detrimental impact on the water quality or hydrological regime of Site 12 Pool, through the implementation of conditions 12-3 to 12-7*	The implementation of this Plan will address the requirements of conditions 12-2 to 12-7.
i. The location of monitoring sites for monitoring water quality and quantity within Site 12 Pool.	i. Site 12 Pool monitoring locations are defined in Table 3 and Figure 2.
ii. Baseline water quality and quantity survey data collected at monitoring sites identified pursuant to condition 12-3(i).	ii. Baseline water quality and quantity data is discussed in Attachments 5 and 6.
iii. Protocols, procedures and frequency for monitoring sites required under condition 12-3(i);	iii. Monitoring procedures are provided in Attachment 4
iv. Specified trigger levels for all run-off (including rain water run-off) from the Mine Development Envelope (including pH, total acidity, total alkalinity, dissolved iron), with reference to Managing Acid and Metalliferous Drainage (DITR, 2007), and turbidity (including impacts related to increased sedimentation); and	iv. Trigger Levels are provided in Section 1.4.4.3
v. A framework for development of management and contingency actions to be implemented for mitigating changes to the water quality and quantity in the event that any trigger levels referred to in condition 12-3(iv) are not met.	v. Management and contingency actions are provided in Table 3
12-7 *In the event that monitoring required by Condition 12-3(iii), indicates that the trigger levels developed pursuant to Condition 12-3(iv), are exceeded or likely to be exceeded, due to surface or groundwater run-off from within the Mine Development Envelope, the proponent shall:*	
i. Investigate to determine the likely cause(s) of the trigger levels required by condition 12-3(iv) being exceeded; and	i. Table 3 outlines the investigations required where trigger levels are exceeded.
ii. If the exceedance is likely to be the result of activities undertaken in implementing the proposal, implement management and/or contingency measures required by condition 12-3(v) and continue implementation until trigger levels required by condition 12-3(iv) are met, or until otherwise agreed by the CEO, and	ii. Table 3 outlines what actions are required if exceedances are found to be caused by the Project.
iii. *Provide a report that describes the investigation required by condition 12-7(i) and measures required by condition 12-3(v) to the CEO within 21 days of identification that criteria required by 12-3(iv) has been exceeded.*	iii. Table 3 outlines the reporting requirements of a non-compliance



LOCATION MAP

LEGEND

- Site 12 Pool Catchment
- GOV 50k Drainage
- FMG Managed Tenements
- Site 12 Pool Surface Water Monitoring Locations
- Site 12 Pool Groundwater Bore Monitoring Location

N

0 0.5 1 1.5

Kilometres

Figure 2
Site 12 Pool Existing Monitoring Locations

Requested By: Jayden O'Brien
Drawn By: Sang Li
Revised By: sanli
Approved By: P. Mastalir
Scale: 1:30,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 662NS_0000_MP_EN_0158.002_r2

Date: 29/09/2021
Size: A4L
Revision: 0
Confidentiality: 0

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1.4 Rationale and Approach

Site 12 Pool is located on a small tributary downstream of a proposed Waste Rock Dump (WRD) at the Project. Condition 12 of MS 993 requires the preparation of a plan prior to the commencement of ground disturbing activities within the hydrological catchment of Site 12 Pool.

It is important to note that the proposed WRD and any potential runoffs will be contained in the upper part of the Site 12 Pool catchment and behind a north-south ridge line that sub-divides the upstream catchment of the Site 12 Pool in several sub-catchments (Plate 1).

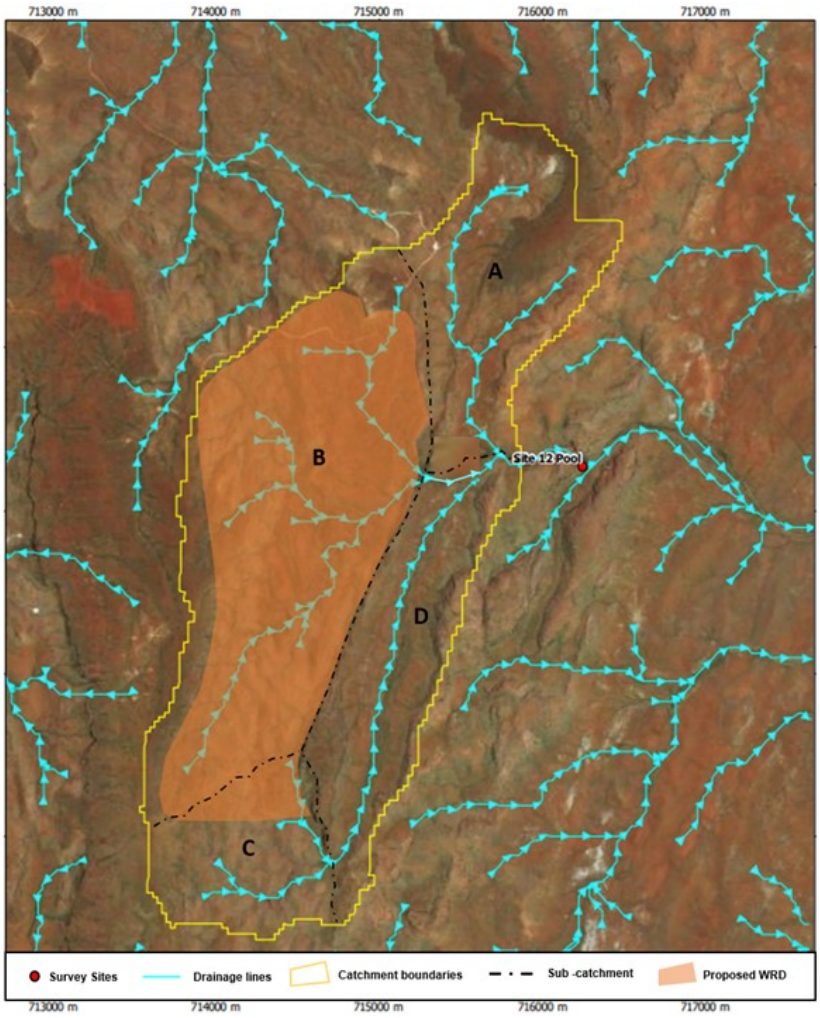


Plate 1: Site 12 Pool Sub-catchments and proposed WRD location (modified from Hydrobiology, 2021)The geological and hydrogeological settings of the Site 12 Pool catchment is summarised below. For further detail, please refer to the Site 12 Pool Hydrogeology Memorandum (FMG IB, 2021a) presented in Attachment 1.

The main geological units within the Site 12 Pool area are the Kangaroo Caves Formation, the Cardinal Formation, and the Corboy Formation comprised of metamorphosed sandstone,

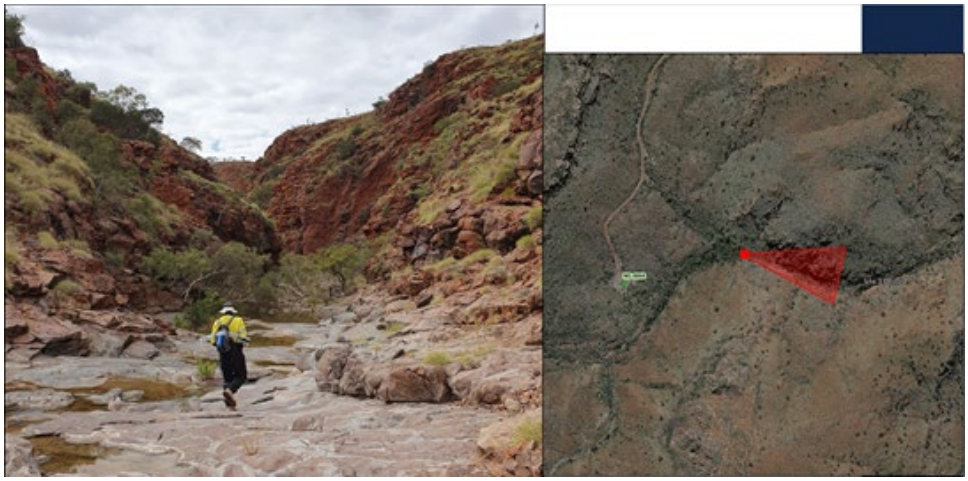
siltstone, and shale. These formations are considered sub-vertical as they are located on the eastern limb of the regional Pilgangoora Syncline.

All creek lines within the Site 12 Pool upper catchment and Site 12 Pool lay directly on the fractured bedrock Formations (Plate 2). Groundwater is only found within the weathered fractured bedrock (i.e., Corboy Formation and Kangaroo Caves Formation), and the groundwater levels mimic the local topography, naturally flowing from higher hill terrains (ridge area) to low-lying areas.

Groundwater levels within the Site 12 Pool upper catchment ranged from 340 m AHD at the watershed divide/ridge to 285 m AHD at the NS-0664 monitoring bore, and 279 m AHD further downstream at Site 12 Pool.

The main recharge processes to groundwater are infiltration of rainfall associated with cyclonic events due to the arid climate of the Pilbara region. An analysis of local monitoring bore hydrograph inclusive of daily rainfall records indicate that a minimum of 20 mm/day of rain is required before enough infiltration is generated to recharge the local fractured aquifers within the Site 12 Pool area.

During the dry season, local groundwater levels tend to decrease progressively due to groundwater discharge mechanisms such as seepage into creek beds/pools and evapotranspiration.



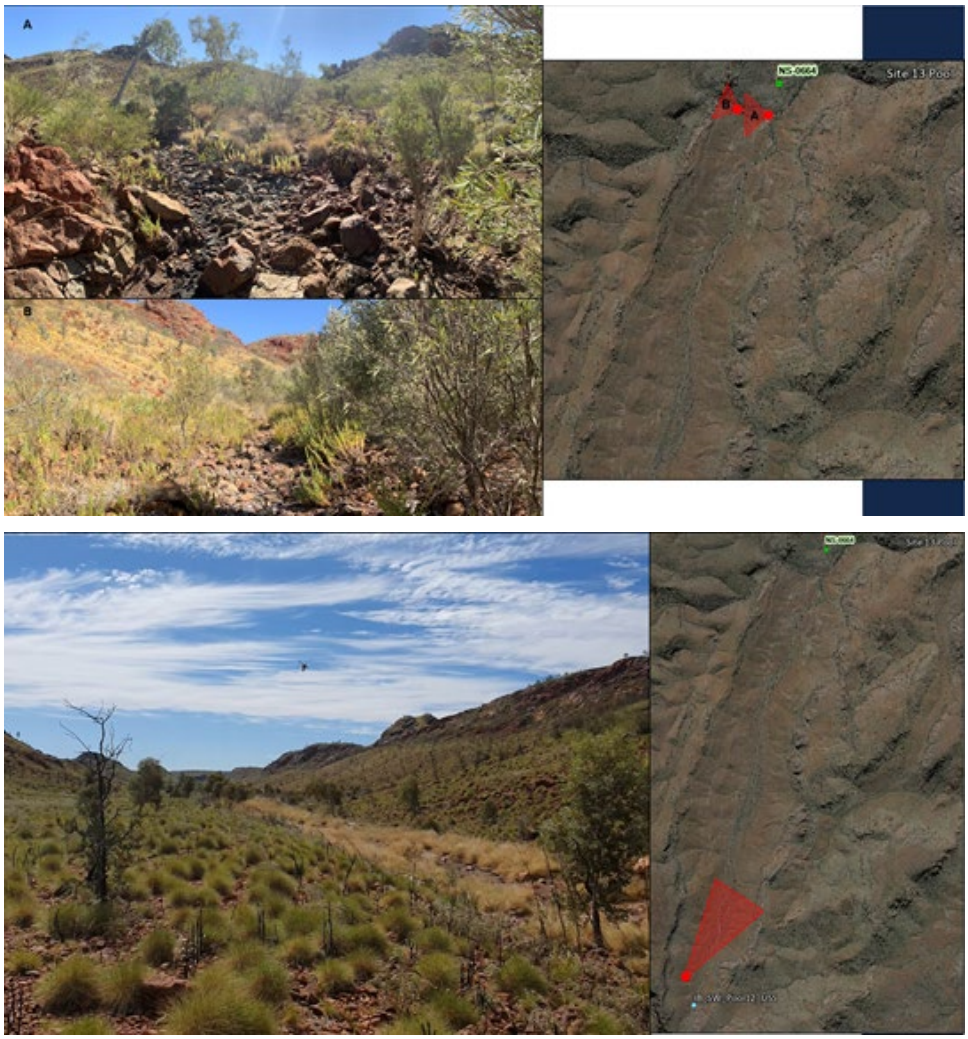


Plate 2: Photos of the upstream catchment of the Site 12 Pool (FMG, 2021)

The purpose of this Plan is to ensure the Project does not have a detrimental impact on the water quality or hydrological regime of Site 12 Pool. This Plan supersedes the WQQMP (662MI-5700-PL-WM-0001 Rev 0) approved by the EPA in October 2016.

In preparation of this Plan, monitoring was developed using water quality and hydrological regime investigations undertaken by Hydrobiology since December 2019. The monitoring approach applies a multiple line of evidence approach (ANZG 2018a) to assess whether management goals are achieved, or if a detrimental impact has occurred. In comparison to single line evaluation, this approach gives greater certainty to assessment conclusions, and subsequent management decisions aimed to meet water quality objectives.

Key indicators were selected across the following major groups:

1. Pressure (Drivers): External activities or status that affect water quality
2. Stressor (Direct Effects): Physical-chemical quality elements and non-water quality stressors
3. Ecosystem receptor (Indirect Effects): Biological elements.

Ecosystem receptors are an important line of evidence as they are used to classify the health status of the system, and ultimately determine whether a loss of environmental value/s has occurred.

Stressor lines of evidence (physical, chemical, and non-water quality) provide cause-effect linkages to validate ecological status, use quantitative measures obtained more frequently in an ongoing sampling program, and serve as early indicators to ecological impacts. Additionally, the selection of indicators across the surface water, sediment and biota systems of Site 12 Pool aims to provide a strong basis for meeting the EPA's (2018) objective of maintaining the water quality so that the environmental values are protected.

1.4.1 Environmental Outcomes

The implementation of the Project will not cause a detrimental impact on the water quality or hydrological regime within the catchment of Site 12 Pool located in the MDE.

1.4.2 Baseline Survey and Study Findings (Condition 12-3(ii))

Site 12 Pool is a gorge hosting a chain of small pools over a linear distance of approximately 650 m. Most pools are shallow, with the deepest pool at a maximum depth of approximately 2.5 m. Collectively, these pools are referred to as 'Site 12 Pool'.

Site 12 Pool is a fresh-brackish (<1500 uS/cm), clear (low turbidity), alkaline pool, and water levels and quality are highly seasonal. Site 12 Pool is a magnesium-bicarbonate (Mg-HCO_3) dominated water type with low sulphates (SO_4) (Hydrobiology, 2020, 2021).

Since 2013, monitoring data indicates that water levels in Site 12 Pool are primarily driven in response to rainfall, with pools initially filled by surface water runoff and sustained by groundwater for some time thereafter, before drying out later in the year. Following larger rainfall events, the local fractured rock aquifer can sustain pool water levels for the remainder of the wet season and into the dry season.

Once the local groundwater level drops below the pool elevation, groundwater discharge into Site 12 Pool ceases, and the pool water level will decrease with time due to evaporation until the pool becomes dry, or until a rainfall event replenishes the pool and/or recharges the local groundwater aquifers. Recent observations indicated that the pool completely dried out in 2020 (Hydrobiology, 2021a).

The potential impacts to Site 12 Pool have been informed through the following studies:

- Site 12 Pool Water Quality Monitoring & Hydrological Regime Investigation (Hydrobiology, 2021b)

- Surface Water Monitoring and Aquatic Ecology Survey Baseline Report – Late Wet 2019 /2020 (Hydrobiology, 2021a)
- Site 12 Pool Water Quantity Assessment and Management (662NS-5700-RP-WM-002) (FMG IB, 2021b)
- Site 12 Pool Hydrogeology (662MI-5700-RP-HY-0003) (FMG IB, 2021a).

1.4.2.1 Key Pool Features

The key features of Site 12 Pool were identified through the various baseline studies and were used in the preparation of this Plan to establish appropriate monitoring and management methods. The key features of Site 12 Pool are listed below:

- A bedrock supported natural habitat that lies in a small catchment with typically low rainfall and infrequent high rainfall events largely driven by storm and cyclonic activity.
- Water quality results demonstrate high seasonal variability due to the climatic conditions of the region and temporary nature of the waterbody. The greatest variability recorded occurs following rainfall events.
- Conductivity was typically slightly brackish (1,100-1,300 µS/cm) except during surface water flow events when it would become extremely fresh (<100 µS/cm).
- Predominantly clear (mean turbidity = 2.5 NTU), slightly alkaline (mean pH = 8.5) and a magnesium-bicarbonate (Ca/Mg-HCO_3) dominated water type with low sulphates (SO_4).
- Preliminary baseline data collected between December 2019 and June 2021 indicate that Site 12 Pool is sustained by the local fractured rock aquifers when the local groundwater levels are above the pool elevation and is periodically flushed with fresh surface water flows after rainfall events. The ratio of the Site 12 Pool volume against inflow volume is presented in Site 12 Pool Water Quantity Assessment and Management (FMG IB, 2021b). It takes approximately 2-3 weeks for the groundwater to displace the surface water flows once a flushing event has occurred.
- Represents a larger habitat area relative to other North Star pools, consisting of a series of isolated pools spanning a linear distance of 650 m, and a total estimated area of 1266m^2. Considered likely to have a greater downstream connectivity relative to other pools in the North Star area.
- Most pools are shallow, with the deepest being approximately 2.5 m. The total volume of Site 12 Pool is estimated to be 2,532 m^3 based on an average depth of 2 m. This is a small volume relative to the inflow volume; for example, the 1EY post development estimated inflow is substantially higher (54,198 m^3) (FMG IB, 2021b).

- Recorded water levels were a maximum of approximately 0.6 m above the overflow levels during high-flow events, which typically lasted less than 24 hours before flows receded.

Site 12 Pool is understood to be temporal, running dry for three to ten months of the year (based on a five-year monitoring period). Recent observations indicated Site 12 Pool did not completely dry out between December 2019 and October 2020, likely due to a high rainfall season and a large recharge (cyclonic) event.

Substantial decreases in water levels and the natural drying process of the pool are expected to impact significantly on the ecological health of Site 12 Pool due to evapo-concentration increasing environmental stressors (e.g., salinity) and lower water levels reducing available habitat. Visual observations in the late dry 2019 study indicated there were no fish in Site 12 Pool. However, after a drying event in mid-November 2020 (late dry), the pool retained all three fish species within several weeks of re-wetting in December 2020. These events indicated that the ecological response of Site 12 Pool to natural drying is variable depending on antecedent conditions.

1.4.3 Key Assumptions and Uncertainties

The key assumptions for this Plan include:

- Early Response Indicators adequately detect declining water quality that encompass the range of potential impact mechanisms.
- Ecological parameters adequately detect declining aquatic ecosystem functionality and thereby detect loss of environmental value.
- Seasonal and annual variability in water quality and quantity which result in non-project caused exceedances of Early Response Trigger Levels and Threshold Criteria, are identified by the Early Response Trigger Investigation and validation step of Threshold Criteria (Hydrobiology, 2021b).

The key uncertainties for this Plan are:

- Groundwater flow contribution is variable as the groundwater contribution is linked to the level of the groundwater local fractured rock aquifer. When the groundwater level is above the pool elevation, groundwater discharge will sustain the pool. When the local groundwater level drops below the pool elevation, no groundwater discharge will contribute to Site 12 Pool water levels.
- The baseline surveys provide a representative degree of variability (within and between seasons and years) in the natural system (Hydrobiology, 2021a).

1.4.4 Rationale for Indicators (Condition 12-3(iv)):

Site-specific indicators include water quality and ecological indicators. These are described further in the following sections.

1.4.4.1 Water Quality Indicators

The selected water quality indicators were developed into a monitoring program to use the stressors on the Site 12 Pool system (e.g., salinity, pH) as an early detection for potential detrimental impacts to the ecosystem receptors (e.g., macrophytes).

Water quality indicators were selected from those recommended by Managing Acid and Metalliferous Drainage (DITR 2007), as per MS 993 Condition 12 – 3 (iv), and from the Pressure-stressor-ecosystem Receptor (PSER) Causal Pathway as recommended by the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) (2018) to be informative of water quality changes that potentially impact environmental values. The selected indicators include conductivity, pH, turbidity, sulphate, total acidity, total alkalinity, dissolved iron, Nitrite & Nitrate (NOx as N).

Seasonal trigger levels for key water quality parameters were calculated from the baseline data to accommodate the high temporal variability anticipated in temporary water systems (ANZG 2018b).

1.4.4.2 Ecological Indicators

Threshold criteria are derived from monitoring ecosystem receptor indicators, identified through changes to water quality in the conceptual impact mechanisms and as indicators of the loss of environmental values. These indicators are diatom communities, macrophyte communities, macroinvertebrate communities and fish communities.

Criteria are qualitatively assessed to accommodate the high natural seasonal variability anticipated in temporary waters, which can impact abundance, and limits the applicability of quantitative assessment.

The rationale for the selected indicators is as follows:

- Algae (diatoms), macroinvertebrates, fish and macrophytes underpin the food web in temporary pools, providing habitat and/or food sources for a diversity of native species include terrestrial or semi-aquatic organisms that may use Site 12 Pool such as reptiles (e.g., Pilbara olive python), avian fauna and amphibians (Halse et al. 2001).
- The selection of these four communities spans multiple trophic levels and phyla which is recommended to capture the variable impact of ecosystems stressors, and detect for example, impacts of bioaccumulation and biomagnification.

- Diatom communities - single-celled algae are effective indicators of ecological change in freshwater systems (Gale 2015). Quantitative sampling using periphytometers placed *in situ* for a defined period measures the capacity for growth, reproduction, and colonisation under current conditions.
- Macroinvertebrate communities - highly studied worldwide as indicators of water quality using a variety of bioindices and predictive models (e.g., EPT, SIGNAL, AUSRIVAS). As for diatoms, the taxonomic groups sensitive or tolerant to declines in water quality is well known and the presence and abundance of these taxa are used to score the water condition of Site 12 Pool.
- Macrophyte communities - effective indicators of ecological change, including monitoring of physical parameter threshold targets (e.g., turbidity blocking photosynthesis of submerged macrophytes or impacts of sedimentation). They are useful indicators of heavy metal bioaccumulation in a waterbody due to immobility, and provide an important habitat and refuge for fauna, especially in shallow waterbodies such as Site 12 Pool.
- Fish communities - higher order organisms with relatively long-life spans. They are useful for visually assessing health including bioaccumulation effects, interannual survivability and reproduction. Evidence of reproduction is sought (i.e., presence of juveniles) to detect sub-lethal effects impacting reproduction or vulnerable size classes.

1.4.4.3 Trigger Level Derivation

The *Managing Acid and Metalliferous Drainage Guidance* (DITR 2007) states that mining activities should not lead to water quality degradation, such that the most conservative of environmental values defined for a water body is compromised. This does not mean that there must be no measurable impacts, but rather that impacts are minimised so that water quality is not degraded to the point where any existing environmental value is lost. Strategies in the *Managing Acid and Metalliferous Drainage Guidance* (DITR 2007) recommends demonstrating the retainment of environmental values by:

- Ensuring that relevant trigger values are not exceeded in receiving water bodies.
- Ensuring that discharge does not result in a statistically significant change in key water quality parameters (no change occurs that is outside the seasonally relevant background concentration plus (or minus) two standard deviations).
- Demonstrating that the discharge will not have ecological impacts on the basis of site-specific ecotoxicological studies.

This Plan presents a three-step trigger assessment approach to align with the relevant guidelines:

1. The **Early Response Trigger Levels**, while seasonal, are not yet refined to encompass the entire (site-specific) high variability in water quality associated with the hydrological cycle (such as first flush events and drying events). Therefore, they are intended to trigger further investigation and not to assess compliance.

2. The **Early Response Trigger Investigation** generated by exceedance of the Early Response Trigger Levels is supported by the *Temporary Waters Guidance* (ANZG 2018b) and involves assessing the water quality against the highly variable hydrological regime (Section 1.4.2). This may result in subsequent refinement of the trigger levels based on site-specific conditions. The outcome of the Early Response Trigger Investigation determines whether the Threshold Criteria is assessed.

3. **Threshold Criteria** is established from the exceedance of Early Response Trigger Levels, no natural hydrological cause identified by Early Response Trigger Investigation, and exceedance of Threshold Criteria. Criteria were developed with regard to the *Temporary Waters Guidance* (ANZG 2018b) and to align with *Managing Acid and Metalliferous Drainage* (DITR 2007). These criteria demonstrate whether the Project has had an ecological impact based on biological parameters reflecting toxicity. The Threshold Criteria are derived from the ecosystem receptor lines of evidence and assess the aquatic ecology. A 'traffic light system' of low, moderate and high-risk criteria is applied where an exceedance of a set number of validated moderate or high-risk criteria is defined as an exceedance and is reportable for purposes of further investigation and compliance monitoring.

Early Response Trigger Levels were developed for the receiving water body which ensures changes to key water quality parameters (as per MS 993 Condition 12) do not occur outside the relevant seasonal background concentration without triggering further investigation. To derive seasonal relevant site-specific trigger values, the median seasonal background concentration plus (and minus for pH) two standard deviations was applied as per the *Managing Acid and Metalliferous Drainage Guidance* (DITR 2007). These were determined to be the most protective compared to values, where available, provided by the *Water Quality Guidelines* (ANZG 2018a).

The trigger levels are interim values and will be reviewed at the completion of the baseline data collection phase. Supplementary monitoring parameters will be collected and analysed in the event of an exceedance of primary monitoring parameters. The supplementary monitoring parameters include:

- Groundwater water levels and quality upstream of Site 12 Pool in bore NS-0664
- Ecosystem health monitoring in Site 12 Pool.

1.4.4.4 Expected Changes in the Intensity, Duration, Magnitude or Geographic Footprint of the Impact.

The Project is expected to comprise approximately 40% of the Site 12 Pool catchment within a WRD, with a footprint of 3 km2. This has the potential to impact the downstream hydrology and water quality of the Site 12 Pool. Impacts to water quality and quantity, and consequently the ecology, may occur due to the following:

- Modification of the upper catchment resulting in decreased flow rates and deteriorating water quality.

- Storage of waste material affecting the catchment's runoff characteristics. This can lead to decreased infiltration rates and volumes of runoff into Site 12 Pool.

These impacts can cause direct or indirect effects which interlink with the natural variability and factors integral to water quality in temporary pools.

Despite the significant reduction in flow, the impact on the scouring ability and total inflow volume to the pools remain largely unchanged. This is due to the relatively small pool volume compared to the inflow volume of the reduced catchment, resulting in small and frequent rainfall events causing Site 12 Pool to fill and overflow, maintaining catchment connectivity.

1.4.4.5 Expected Changes and Rate of Changes at Site 12 Pool

Site 12 Pool hydrology is characterised by relatively large rainfall events at the beginning of the wet season and the associated flushing of water and sediment through the catchment. These highly variable conditions lead to fluctuations in water levels at Site 12 Pool.

Extended periods of little, to no rainfall, is likely to cause evaporation and reduced local groundwater levels, resulting in decreased surface water levels, increased electrical conductivity, increased sulphate, and lower pH levels.

In contrast, significant rainfall events may result in a decrease in electrical conductivity, increased turbidity, increased sulphate and increased dissolved iron. Note that the conductivity may have rebounded to pre-rainfall levels prior to other parameters stabilising.

Rainfall, and consequently run-off, has a varying impact on the water quality depending on when it occurs relative to the wet season and large rainfall events. Minor rainfall in the early or late wet season, infiltrates into the drier soil and has a relatively low impact to the water quality in comparison to similarly sized rainfall that occurs during the mid-wet season where the soil is more saturated. For example, a 21 mm rainfall event in May 2020 had a negligible impact to electrical conductivity, whereas a 31 mm rainfall event in March 2020 decreased the electrical conductivity by more than 60%.

Change in electrical conductivity can be used to guide the expected difference in other parameters. For example, where rainfall has occurred but has caused a small (<1%) change in electrical conductivity, it has likely infiltrated into soil and significant changes to other water quality parameters (e.g., SO_4, turbidity) are not expected to naturally occur. Likewise, where a significant change to electrical conductivity occurs (> 40%) during or following rainfall, significant changes to other parameters (e.g., turbidity) are expected as a result of substantial surface run-off and may be due to the natural seasonal variability.

1.4.4.6 Possible Effects of non-Project Activities

A small amount of disturbance occurred within the Site 12 Pool catchment during Stage 1 of the Project (haematite mining). A small amount of waste oxide material was placed at the top of the catchment, approximately 3.5 km upstream of the pools. Static and kinetic testing was

undertaken to determine the potential for waste oxide material to produce elevated levels of acid, salt and metals. These tests demonstrated that the waste from Stage 1 is benign and does not produce harmful leachates.

Given the small amount of waste that has been stored in the WRD (it occupies 2.5 ha in a catchment area upstream of the pools of 775 ha), the characteristics of the material and the distance from Site 12 Pool, it is unlikely that the elevated levels observed in the limited samples taken to date are caused by drainage from the Stage 1 WRD.

2. OUTCOME BASED MONITORING PLAN

This Plan is a requirement of Condition 12 in MS 993. Table 3 details how this Plan focuses on monitoring and evaluating measurable outcomes driven by trigger and threshold criteria, to meet the primary environmental outcome:

There shall be no detrimental impact on the water quality or hydrological regime of Site 12 Pool from implementation of the Project within the catchment of Site 12 Pool located in the Mine Development Envelope (MDE).

Table 3: Provisional Table

EPA Factor/s and objectives: Inland Waters
Outcomes: There shall be no detrimental impact on the water quality or hydrological regime of Site 12 Pool from implementation of the Project within the catchment of Site 12 Pool located in the Mine Development Envelope (MDE).
Key Environmental Values:

- Aquatic ecosystem

Key Impacts and Risks:

- Alteration of hydrological processes at Site 12 Pool that lead to degradation of the aquatic ecosystem;
- Changes in water quality at Site 12 Pool due to sedimentation and WRD leachate that lead to degradation of the aquatic ecosystem.

Outcomes-based provisions

Environmental criteria	Response actions	Monitoring	Reporting
Condition 12-2 The proponent shall ensure that the implementation of the proposal within the catchment of Site 12 Pool that is located within the Mine Development Envelope, as delineated in Figure 8 of Schedule 1 and defined by the geographic coordinates in Schedule 2, does not have a detrimental impact on the water quality or hydrological regime of Site 12 Pool, through the implementation of conditions 12-3 to 12-7.			
Trigger Criterion 1 An exceedance of Early Response Trigger Levels. The values for each parameter are presented in Table 4 of Section 3.1.3 **Trigger Criterion 2**: Early Response Trigger investigation determines the exceedance is due to Project and not natural causes **Trigger Criterion 3**: Ecological parameters meeting moderate or high-risk categories for indicating declining environmental value are validated by expert ecological assessment as not occurring due to natural causes. **Early Response Criteria:** An exceedance of Early Response Levels. The aquatic ecosystem is measured by a set of four ecological criteria (Refer to Table 5 of Section 3.1.3) that are assigned either low, moderate or high risk of indicating loss to the environmental value. **Threshold criteria:** When the designated number of moderate and/or high-risk criteria are met, the Threshold Criteria is determined to be exceeded. Detrimental impact or 'the loss of environmental value' is determined as where the Threshold Criteria is exceeded. The threshold is: • ≥2 High Risk Criteria; or • ≥2 Moderate Risk and ≥1 High Risk Criteria; or • ≥3 Moderate Risk Criteria. This approach uses the multiple lines of evidence approach to determine whether a Threshold exceedance has occurred.	**Trigger Contingency Actions in response to Early Response Trigger Level Exceedance** 1. Re-examine water quality results by checking the QA/QC sample result is consistent and ensuring correct calibration of sampling equipment. 2. Resample and reassess to confirm the exceedance. This will also help to establish if the parameter in exceedance is increasing or decreasing in the timeframe since previous sampling. 3. Check Project related operations that have the potential to impact the water quality. 4. Acquire and use current North Star rain gauge data to ensure that the water quality parameter results are being assessed against the correct seasons Early Response Trigger Level (i.e., wet or drying season). Note that seasons vary interannually and the water quality parameters should be compared to the most representative seasons. Early Response Trigger Levels based on rainfall events rather than sampling date. 5. Assess the Visual Inspection results recorded during sampling for indications of causes to changes in water quality and preliminary evidence of ecological impacts (See Appendix D for field datasheet template). For example, check if the *Visual Inspection* notes nearly dry water levels, flood conditions, evidence of increased sedimentation or records of fish death. 6. Acquire and record logger data from the Site 12 Pool water level and water quality data logger and the Site 12 Pool Barometer. Correct the water level for barometric pressure using the barometric data. Assess the water quality relative to the hydrological cycle by plotting the depth, temperature and specific conductivity over time and; a. Inspect the conductivity, depth and temperature data against the North Star rain gauge data and the sampled water quality parameters. Evaluate	**Method** / **Monitoring parameters** / **Frequency[1]** / **Location[5]** Water loggers — Pool water level & Upstream channel water level — Automatic logging 3 hour for pool and 15 minutes for watercourse. [6] — IB_SW_Pool12_01, IB_SW_Pool12_Baro, IB_SW_Pool12_USN, IB_SW_Pool12_USW [2], IB_SW_Pool12_USS Water loggers — Groundwater level — Automatic logging 3h — NS-0664 Field measurements — Dissolved Oxygen (DO), pH, Electrical Conductivity (EC), Turbidity, Temperature — Monthly from Nov to Apr, Quarterly from May to Oct, and/or event based[1] — IB_SW_Pool12_01, IB_SW_Pool12_USN, IB_SW_Pool12_USW _RSS [2], IB_SW_Pool12_USS Field measurements — Dissolved Oxygen (DO), pH, Electrical Conductivity (EC), Turbidity, Temperature — Monthly from Nov to Apr, Quarterly from May to Oct, and/or event based[1] — NS-0664 Grab water samples for laboratory analysis — TSS, TDS, TOC, DOC; Nutrients (Total Nitrogen, Total Phosphorus, Nitrate+Nitrite (NOx as N), Total Kjeldahl Nitrogen: TKN, Ammonia/Ammonium)[9]; Ions (Total Alkalinity, Cl, F, Sulphate, Bicarbonate/Carbonate, Ca, Mg, Na, K, Total Acidity SO_4, Hardness); total and dissolved metals (Al, As, Cd, Cr, Cu, Fe, Pb, Ni, Zn, Hg, B, Ba, Be, Co, Mn, Se, V) [7] — Monthly from Nov to Apr, Quarterly from May to Oct, and/or event based[1] — IB_SW_Pool12_01, IB_SW_Pool12_USN, IB_SW_Pool12_USW _RSS [2], IB_SW_Pool12_USS Grab water samples for laboratory analysis — Quarterly monitoring — NS-0664	Annual reporting will be undertaken in accordance with the OEPA's *Post Assessment Guideline for Preparing a Compliance Assessment Report (CAR), Post Assessment Guideline No. 3.* In the event that Trigger Criteria were exceeded during the reporting period, the CAR will include a description of the effectiveness of the Trigger Level Actions that have been implemented to manage the impact and any adaptive management measures applied as a result of the exceedance. When an exceedance of Threshold Criteria has occurred, Fortescue will: • Where the exceedance is attributable to surface run-off or groundwater seepage from the Project, report the exceedance to the CEO (of the OEPA) in accordance with condition 12-7 of MS 933. • Implement the Threshold Contingency Actions specified in this table as soon as practicable and continue to implement 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. • Investigate to determine the cause of the Threshold Criteria being exceeded. • Investigate to provide information for the OEPA to determine potential environmental harm or alteration of the environment that occurred due to Threshold Criteria being exceeded. • Provide a report to the OEPA within 21 days of the exceedance being reported. The report shall include: ○ Details of Threshold Contingency Actions implemented ○ The effectiveness of the Threshold Contingency Actions implemented, against the Threshold Criteria ○ The findings of the investigations ○ Measures to prevent the Threshold Criteria being exceeded in the future

EPA Factor/s and objectives: Inland Waters
Outcomes: There shall be no detrimental impact on the water quality or hydrological regime of Site 12 Pool from implementation of the Project within the catchment of Site 12 Pool located in the Mine Development Envelope (MDE).
Key Environmental Values:
- Aquatic ecosystem

Key Impacts and Risks:
- Alteration of hydrological processes at Site 12 Pool that lead to degradation of the aquatic ecosystem;
- Changes in water quality at Site 12 Pool due to sedimentation and WRD leachate that lead to degradation of the aquatic ecosystem.

whether there is evidence of a natural hydrological cause that could have resulted in the exceedance. b. Assess for evidence that groundwater connectivity is being maintained.		AMD suit (Ag, Bi, Ce, Cs, La, Mo, Rb, Sb, Sc, Sn, Sr, Th, Ti, Tl, U, W)[8]			○ Measures to prevent, control or abate the environmental harm which may have occurred ○ Justification of the threshold remaining, or being adjusted based on better understanding, demonstrating that outcomes will continue to be met.
7. Investigate spatial trends upstream of Site 12 Pool and across the surface water pools at Iron Bridge. This may include: a. Assess water level data from loggers located at Site 12 North Upstream, Site 12 West and Site 12 Downstream. b. Check Site 12 Pool water quality relative to water quality from recent and baseline concentrations at Site 12 North Upstream, Site 12 West and Site 12 Downstream. This may include water quality from first flush sampling collected using rising stage samplers. c. Review water quality and levels across Iron Bridge pools for evidence of a spatial trend across the region. 8. If there is an exceedance of Early Response Trigger levels and the investigation determines no natural hydrological cause for the exceedance, then ecological monitoring is implemented. **Overall Contingency Actions and the Adaptive Management Process** 1. Has an Early Response Trigger Level exceedance been recorded? a. NO - Resume standard monitoring frequency. b. YES - Proceed to Step 2. 2. Validate and investigate the cause for the exceedance as outlined in above contingency actions in response to Early Response Trigger Level Exceedance and proceed to Step 3. 3. Has a natural cause been identified by the Early Response Trigger Level Investigation as the cause of the Early Response Trigger Level exceedance?	Visual inspection and laboratory analysis for ecological monitoring	Ecological Monitoring Indicator - Parameters Diatom community - DSIAR scores and diversity Aquatic macroinvertebrate community - EPT abundance index Fish community - Presence/absence Size structure Sediment quality - Total Alkalinity, Total Acidity SO_4, TSS, Nutrients (Total Nitrogen, Total Phosphorus, Nitrate+Nitrite (NOx as N), Total Kjeldahl Nitrogen: TKN), Ions (Cl, F, Ca, Mg, Na, K), total metals (As, Cd, Cr, Cu, Fe, Pb, Ni, Zn, Hg, B, Ba, Be, Co, Mn, Se, V), TOC Habitat assessment - Wider habitat health Macrophyte diversity - Presence/absence	Biannual[3]	Site 12 Pool ecological sampling site including - Diatom periphytometers – within 2 m of data logger - Fyke net – downstream 3 m from data logger - Sediment – northern edge of data logger cross section - Macrophytes – 50 m reach - Habitat Assessment – upper pools to downstream pools prior to downstream junction - Macroinvertebrates – southern and northern edge of channel at gorge entrance	

[1] For the purpose of this Plan, 'event based' is defined as rainfall that has resulted in visual streamflow across a floodway or down a designated river/pool/creek/stream.
Monitoring following rainfall events will only be undertaken once it is considered safe to access monitoring sites.
[2] Water quality impacts are expected to be limited upstream of Site 12 Pool once the WRD access road is extended to block the stream flow from WRD.
[3] Biannual ecological surveys including water quality and sediment quality for laboratory analysis are conducted during the late-wet period (indicative February to April) and the dry periods (indicative September to November), only when water is present.
[4] Limit of Detection (LOD) on metals requested as meeting ANZG (2018) 99% EPL where applicable.

EPA Factor/s and objectives: Inland Waters
Outcomes: There shall be no detrimental impact on the water quality or hydrological regime of Site 12 Pool from implementation of the Project within the catchment of Site 12 Pool located in the Mine Development Envelope (MDE).
Key Environmental Values:

- Aquatic ecosystem

Key Impacts and Risks:

- Alteration of hydrological processes at Site 12 Pool that lead to degradation of the aquatic ecosystem;
- Changes in water quality at Site 12 Pool due to sedimentation and WRD leachate that lead to degradation of the aquatic ecosystem.

a. YES – Resume standard monitoring frequency.

b. NO – Proceed to Step 4.

4. Has a Threshold Criteria exceedance been recorded?

   a. NO - Conduct a follow-up visual inspection and re-sampling within two weeks. Record for the purposes of reassessing the trigger levels as part of an active management review.

   b. YES - Report trigger exceedance as per Reporting Requirement and proceed to Step 5.

5. Develop a case specific Site 12 Pool Recovery Plan and implement the contingency management measures as determined by the plan. A period of time or event (such as substantial rainfall) will likely be required to occur before an assessment of the effectiveness of the Site 12 Pool Recovery Plan can be made. Therefore, proceeding the agreed and case specific time after implementation of the Site 12 Pool Recovery Plan, proceed to Step 6.

6. Reassess from Step 1 following the implementation of the Site 12 Pool Recovery Plan. Depending on the contingency actions implemented, the monitoring parameters or frequency may require review. Where reassessment of Early Response trigger parameters (and any other parameters, if warranted) finds they are below trigger levels, standard monitoring (or the revised monitoring plan) is resumed. Where the reassessment records an exceedance of Threshold Criteria, proceed to step 7.

7. If monitoring indicates that implemented management measures are not mitigating impacts to Site 12 Pool, consider the following

   a. Review management measures with an adaptive management response. For example:

      (i) Re-evaluate trigger levels and threshold criteria.

      (ii) Measure other indicators to assess if Site 12 Pool environmental values have been detrimentally impacted by the guideline value exceedance event.

[5] Site 12 Pool is the primary monitoring location as the reporting location in accordance with MS993 Condition 12, the remaining monitoring sites are non-reporting locations as the supplementary information to support multiple lines of evidence

[6] Biannual data downloaded from data logger or when required.

[7] For sites in the waterways (IB_SW_Pool12_USN, IB_SW_Pool12_USW_RSS, IB_SW_Pool12_USS) while all dissolved metal parameters are required, total metal parameters only Cu, Hg, Zn are to be measured.

[8] AMD suits water quality analysis are applicable to the impacted waterways only (IB_SW_Pool12_USW_RSS, IB_SW_Pool12_USS)

[9] TP, TN and NOx have a 28 day holding time, phosphate, nitrate and nitrite individually have a 2 day holding time. The remoteness of the site location prevents reliable laboratory delivery and analysis within less than 5 days (the laboratory recommendation is for samples to arrive at the lab with half the holding time remaining to allow for lab scheduling and processing).

The locations of monitoring sites are provided in Figure 2.

EPA Factor/s and objectives: Inland Waters
Outcomes: There shall be no detrimental impact on the water quality or hydrological regime of Site 12 Pool from implementation of the Project within the catchment of Site 12 Pool located in the Mine Development Envelope (MDE).
Key Environmental Values:
- Aquatic ecosystem

Key Impacts and Risks:
- Alteration of hydrological processes at Site 12 Pool that lead to degradation of the aquatic ecosystem;
- Changes in water quality at Site 12 Pool due to sedimentation and WRD leachate that lead to degradation of the aquatic ecosystem.

	(iii) Workshop potential management measures with site (FMG) stakeholders (e.g., mining, environment, water departments) and potentially bring in expert/regulator advice. Implement appropriate measures. Carry on monthly monitoring frequency until water quality monitoring results do not exceed the Early Response Trigger Levels (see Table 5) for two consecutive sampling events, or as determined by the case specific Site 12 Pool Recovery Plan. Conduct sampling and analysis of biomarker lines of evidence to provide further evidence to establish cause and effect e.g., fish tissue analysis for heavy metal toxicity.		

3. ADAPTIVE MANAGEMENT AND REVIEW

This Plan is the outcome of the adaptive management approach for the preceding WQQMP. Condition 12-5 of MS 993 indicates that revisions to the WQQMP may be approved by the CEO.

Outcome based EMP:
Management of water quality and quantity at Site 12 Pool.

Outcome:
There shall be no detrimental impact on the water quality or hydrological regime of Site 12 Pool from the implementation of the Project within the catchment of Site 12 Pool located in the MDE. Using adaptive management, IBO identified the variability of ephemeral pools and adjusted the measures to meet the outcomes required of Condition 12. This was understood from the following:

- Evaluation of monitoring data and studies which identified that Site 12 Pool was highly variable and did not consider the seasonality of the pools and annual variations.
- Review of assumptions based on data collection undertaken since 2016.
- Re-evaluation of the monitoring triggers which previously assumed that it was a permanent water pool and not temporary, meaning that the ANZECC guidelines were no longer appropriate for use.
- Revision and submission of this Monitoring Plan.

Review of this Plan will be undertaken every three years.

3.1 Early Response Indicators, Criteria and Actions

3.1.1 Monitoring:

Water quality and water levels will be monitored at sites using pressure transducers, samplers and field samples at sites in, and upstream of Site 12 Pool. These sites will include:

- Site 12 Pool (within the pool) (Site name IB_SW_Pool12_01).
- Site 12 Pool_North Upstream (reference watercourse – unimpacted watercourse) (Site name IB_SW_Pool12_USN).
- Site 12 Pool_South Upstream (impacted watercourse) (Site name IB_SW_Pool12_USS).

- Site 12 Pool_West Upstream (impacted watercourse) (Site name IB_SW_Pool12_USW).
- Groundwater bore NS-0664.

The early response trigger and threshold criteria is only applicable for the monitoring of Site 12 Pool. The upstream impact and reference sites will be used to support the monitoring and studies of the Site 12 Pool water quality and quantity impact.

3.1.2 Indicators:

The selected indicators are conductivity, pH, turbidity, sulphate, total acidity, total alkalinity and dissolved iron for water quality. The Plan presents a three-step trigger assessment approach to align with the relevant guidelines.

Early Response Indicators:
Site 12 Pool water quality will assess the presence of stressors on Site 12 Pool as early detection for potential detrimental impacts to the ecosystem receptors.

Rationale for Choice of Early Response Indicators:
Site-specific indicators for water quality and ecological health are the key indicators in the monitoring program. Site-specific indicators of water quality were selected for Site 12 Pool for the relevant stressors and anticipated ecosystem receptors identified for the system in the conceptual model. Water quality indicators were selected from those recommended by *Managing Acid and Metalliferous Drainage Guidance* (DITR, 2017), as per MS 993 Condition 12 – 3 (iv) and from the PSER causal pathway as recommended by ANZG (2018) to be informative of water quality changes that potentially impact environmental values.

Refer to Section 1.4.4.2 for the rationale supporting the ecological indicators.

3.1.3 Trigger Criterium:

Trigger criteria for Early Response Trigger Levels for Site 12 Pool are provided in Table 4.

Table 4: Early Response Trigger Levels for Site 12 Pool

Parameter	Uni	Trigger Level (median seasonal baseline ± 2 SD)[5]	
		Wet season[1]	Dry season[1]
pH	-	<6.5[3] >9.0	<6.5[3] >9.0
Electrical conductivity (SPC)	µs/cm	>1854	>1517
Turbidity	NTU	>37	>1.6

Parameter	Uni	Trigger Level (median seasonal baseline ± 2 SD)[5]	
		Wet season[1]	Dry season[1]
Total alkalinity (as CaCO3)	mg/L	<82.2 >825.8	<364.1 >741.9
Total acidity (as CaCO3)	mg/L	>6.8	>5.5
Sulphate (SO4)	mg/L	>112.4	>65.0
Dissolved iron (Fe)	mg/L	>0.05[2]	>0.05[2]
Nitrite & Nitrate (NOx as N)[4]	mg/L	>0.6	>0.6

[1] Seasons vary interannually and are determined by the site-specific hydrological cycle. For guidance only, the dry season is typically from May – October and the wet season is typically from November - April.

[2] Dissolved Iron (Ferrous Iron mg/L) baseline concentrations consistently below LOD (0.05 mg/L), this LOD was applied as the trigger level as a reliable standard deviation could not be obtained.

[3] ANZG 2018 default pH guidelines

[4] TP, TN and NOx have a 28-day holding time, Phosphate, nitrate and nitrite individually have a 2-day holding time. The remoteness of the site location prevents reliable laboratory delivery and analysis within less than 5 days (the laboratory recommendation is for samples to arrive at the lab with half the holding time remaining to allow for lab scheduling and processing).

[5] The trigger levels are expected to be reviewed and updated as required upon the completion of baseline collection.

Early response criteria:

An exceedance of Early Response Trigger Levels. The aquatic ecosystem is measured by a set of four ecological criteria that are assigned either low, moderate or high risk, indicating loss to the environmental value.

Threshold criteria:

When the designated number of moderate and/or high-risk criteria are met, the Threshold Criteria is determined to be exceeded. Detrimental impact or 'the loss of environmental value' is determined where the Threshold Criteria is exceeded (Table 5). The threshold is as follows:

- ≥2 High Risk Criteria; or
- ≥2 Moderate Risk and ≥1 High Risk Criteria; or
- ≥3 Moderate Risk Criteria.

Table 5: Threshold Criteria

Environmental parameters	LOW RISK[1]	MODERATE RISK[1]	HIGH RISK[1]
Macroinvertebrate communities[2]	Presence of EPT taxa > 0.5*B*	EPT index < 0.5*B* OR SIGNAL2 score < the lower of 2 or *B*-1	No EPT taxa present
Fish communities	*Melanotaenia australis* present including small size classes (<60 mm)	*Melanotaenia australis* present and no small size classes present	No fish species present
Diatom communities[3]	DSIAR score > 0.5*B*	0.5*B* > DSIAR score > 0.2*B*	DSIAR score less than 0.2*B*
Macrophyte communities	Emergent (reed like and tussock/rush like species) present in ≥ isolated abundance	Emergent macrophytes present, with evidence of deteriorating health > *B* maximum	Emergent and submerged macrophytes absent

[1] *B*=Baseline seasonally relevant mean (i.e., wet or dry season ecological baseline values).

[2] The EPT Richness Index estimates water quality by the relative abundance of three major orders of stream insects that have low tolerance to water pollution: *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Tricoptera* (caddisflies). SIGNAL (Stream Invertebrate Grade Number – Average Level) is a scoring system for macro-invertebrate samples from Australian rivers that indicates water quality based on tolerance or sensitivity of macroinvertebrate families present to water quality.

[3] DSIAR score (Diatom Species Index for Australian Rivers score) estimates water quality by the relative abundance of diatom species sensitive to water quality stressors.

3.1.4 Response Actions

3.1.4.1 Trigger Criteria Action

This section provides guidance for assessment steps undertaken in response to an Early Response Trigger Level exceedance and can be adapted on a case-by-case basis.

1. Re-examine water quality results by checking the QA/QC sample result is consistent and ensuring correct calibration of sampling equipment.
2. Resample and reassess to confirm the exceedance. This will also help to establish if the parameter in exceedance is increasing or decreasing in the timeframe since previous sampling.
3. Check project related operations that have the potential to impact the water quality. For example, this may include structural failures or the overflow of a sediment pond during storm events.

4. Acquire and use current North Star rain gauge data to ensure that the water quality parameter results are being assessed against the correct seasons Early Response Trigger Level (i.e., wet or drying season). Note that seasons vary interannually and the water quality parameters should be compared to the most representative seasons Early Response Tigger Levels, based on rainfall events, rather than sampling date. For example, if the wet season has not started prior to sampling in November, the November sample should be evaluated against the drying season Early Response Trigger Levels. For guidance only, the dry season is typically from May – October and the wet season is typically from November – April.

5. Assess the Visual Inspection results recorded during sampling for indications of causes to changes in water quality and preliminary evidence of ecological impacts. For example, check if the Visual Inspection notes nearly dry water levels, flood conditions, evidence of increased sedimentation or records of fish death.

6. Acquire and record logger data from the Site 12 Pool water level and water quality data logger and the Site 12 Pool Barometer. Correct the water level for barometric pressure using the barometric data. Assess the water quality relative to the hydrological cycle by plotting the depth, temperature and specific conductivity over time and:

    a. Inspect the conductivity, depth and temperature data against the North Star rain gauge data and the sampled water quality parameters. Evaluate whether there is evidence of a natural hydrological cause that could have resulted in the exceedance.

    b. Assess for evidence that groundwater connectivity is being maintained. Baseline data shows the conductivity decline during a rainfall event, and subsequent increase to near pre-rainfall conductivity levels over a 2 to 3-week period (assuming no further significant rainfall). The lack of this pattern may be a preliminary indication that reduced groundwater inputs to Site 12 Pool are the cause of the Water Quality trigger exceedance. This may be further assessed by reviewing groundwater quality for changes in conductivity (similar surface water and groundwater levels may reduce the ability to discern connectivity through conductivity patterns) and check for declining groundwater levels in bore NS-0664.

7. Investigate spatial trends upstream of Site 12 Pool and across the surface water pools at Iron Bridge. Refer to Figure 2 for monitoring locations. This may include:

    a. Assess water level data from loggers located at Site 12 North Upstream, Site 12 West and Site 12 Downstream.

    b. Check Site 12 Pool water quality relative to water quality from recent and baseline concentrations at Site 12 North Upstream, Site 12 West and Site 12 Downstream. This may include water quality from first flush sampling collected using rising stage samplers.

    c. Review water quality and levels across Iron Bridge pools for evidence of a spatial trend across the region.

8. If there is an exceedance of Early Response Trigger levels and the investigation determines no natural hydrological cause for the exceedance, then ecological monitoring is implemented.

3.1.4.2 Early Response Actions

Validate and investigate the cause of the Early Response Trigger level exceedance. Where impacts may result from sedimentation, acid and/or metalliferous drainage, consider the following:

- Review the water quality at the groundwater monitoring bore
- Review the seepage management and minimisation control measures
- Review the management and minimisation control measures relating to acid and/or metalliferous drainage to reduce the transport of material from WRD to Site 12 Pool
- Review of erosion control management on WRD.

It is noted that a large toe bund will be constructed as part of the WRD development to minimise the sediment discharge from the WRD catchment to Site 12 Pool.

3.1.4.3 Threshold Criteria Action

Implement the Site 12 Pool Recovery Plan contingency management measures. If monitoring indicates that the measures are not mitigating impacts to Site 12 Pool, consider:

- Review of management measures with an adaptive management response. For example:
  - Re-evaluate trigger levels and threshold criteria.
  - Measure other indicators to assess if Site 12 Pool environmental values have been detrimentally impacted by the guideline value exceedance event.
  - Troubleshooting potential management measures with site stakeholders and potentially bring in expert/regulator advice. Implement appropriate measures.
- Increase the frequency of biannual monitoring to monthly until Water Quality monitoring results do not exceed the Early Response Trigger Levels (see Table 5) for two consecutive sampling events, or as determined by the case specific Site 12 Pool Recovery Plan.
- Conduct sampling and analysis of biomarker lines of evidence to provide further evidence to establish cause and effect (e.g., fish tissue analysis for heavy metal toxicity).

3.2 Review

Revisions of this Plan will be submitted to the relevant State and Commonwealth Governments for approval, in accordance with the applicable approval conditions. In accordance with Condition 12 of MS 993, IBO will continue to implement the latest revision of this Plan.

4. STAKEHOLDER CONSULTATION

The stakeholder engagement undertaken to date is summarised in Table 6. This is a live register and will be updated as required.

Table 6: Stakeholder Consultation

Stakeholder	Correspondence	Comments
DWER	18 January 2016	• Commitment to obtain at least 12 months of baseline water quality data as soon as possible • Inclusion of hydrogeology information upstream of Site 12 Pool Clarification regarding contingency actions and monitoring frequency where trigger levels are exceeded.
DWER	4 April 2016	EPA recommends the monitoring programme is extended to include groundwater levels and water quality at bore NS-0064, as water in this bore is likely to represent the alluvial sources of Site 12 Pool water. It is not necessary to develop triggers for this bore.

EPA	12 August 2016	• EPA requires the Plan to include locations of surface water/storm water monitoring sites within the proposal boundary, in particular in culverts, drainage basins and around the base of the waste rock dump to monitor any leachate discharged to the environment.
		• EPA considers the site-specific Trigger Values should be developed using the 80th percentile value of collected data.
		• Frequency of monitoring activities detailed in the plan will not provide sufficient early warning for potential breaches. The EPA requires the frequency in the plan to be amended to include the following:
		  ○ Monthly leachate monitoring from the waste rock dump
		  ○ Significant rainfall event monitoring following each event
		• Specified trigger levels should include a measure for total alkalinity given the current chemical composition of the Site 12 Pool water and the likely that buffering of some metals may occur. Parameters should also reflect the analytes that would likely to occur in the leachate from the proposed Waste Rock Dump
		• The information provided in the Site 12 Pool Water Quality and Quantity Monitoring Plan indicates that water quality is close to pristine. This indicates that any perceived impact on pool water quality from feral animal grazing is negligible. The Environmental Protection Authority Report 1514 determined that the Site 12 Pool was regionally significant and recommended that condition 12 be applied to maintain existing water quality and quantity in Site 12 Pool The EPA requires the protection level to be amended to 99% species protection level to adequately ensure condition 12-2 is met and the existing quality and quantity of the Site 12 Pool is maintained. Any change to this protection level should only occur where comprehensive biological effects and monitoring data show that biodiversity would not be altered.

Stakeholder	Correspondence	Comments
		• Plan is required to be amended to clearly detail that the monitoring frequency will be adjusted to monthly when an investigation determines that trigger exceedances are Project attributable. EPA requires the Plan to be amended to include threshold criteria and include threshold contingency actions.
EPA	26 October 2016	Approval of the Site 12 Pool Water Quality and Quantity Monitoring Plan.
	January 2018	North Star Stage 1 Project placed in care and maintenance
	June 2019	Project restarted in preparation for Stage 2.
DWER	29 January 2020	Meeting with DWER to discuss updated Site 12 Pool Water Quality and Quantity Monitoring Plan
DMIRS	13 March 2020	Feedback on Mine Proposal Stage 2A: **Section 6.3.1 – Environmental Management Plans**: The following additional plans are required, or, where FMG consider they are addressed in other existing documents, detail the name and scope of the management: • Surface Water Management Plan, with a brief summary of key surface water management during operations. DMIRS expect that this document will present locations of all surface water management controls and monitoring sites, detail the design criteria based on the critical duration rainfall event, specify maintenance and monitoring program (water quality, quantity, erosion and sedimentation, riparian vegetation health). Specific areas which need to be addressed are: o Turner River; o Central Creek Pool; o Fig Pool; o Pit Flood Response Pipeline (PFRP) discharge location, discharge water quality criteria and rate of discharge o RWP emergency spillway discharge location.
DWER	31 August 2021	Meeting with DWER to discuss DWER RFI on the groundwater items 1, 2, 3 and 5 of the Site 12 Pool Water Quality and Quantity Monitoring Plan received on 18 August 2021. Recommendation from DWER: • Update the conceptual hydrogeology in the Site 12 Pool Water Quality and Quantity Monitoring Plan – include photos from the

Stakeholder	Correspondence	Comments
		catchment and figure with proposed WRD development area within the catchment and proposed monitoring sites (SW and GW sites) • Update the conceptual hydrogeology in the Hydrobiology report (2020a) • Resubmit the plan to the EPA with the amendments.

REFERENCES

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Attachment 1: Site 12 Pool Hydrology Memorandum (FMG, 2021)

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Attachment 2: Site 12 Pool Water Quantity Assessment and Management

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Attachment 3: Visual Inspection Field Datasheet

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Site 12 Pool Visual Inspection Field Data Sheet

Date: / /
Name:

Undertake the following visual inspection during routine water quality monitoring at Site 12 Pool Water Quality Monitoring Site. This will form part of the site investigation assessment in the event of Primary Trigger Levels being exceeded. See below for visual guide for conducting inspection, and example of site photo. Coordinates for all monitoring locations are provided on the site photo using the coordinate system is GDA 1995 MGA Zone 50. The access to the specified location for the individual monitoring sites are subject to the safe access particularly during the wet season.

Record YES or NO below as an indication of observed status of the ecological health.

Habitat health parameter	**YES**	**NO**
Fish presence	☐	☐
Macrophyte presence	☐	☐
Recent sedimentation presence *(Provide additional details below)* *(Include photos with GPS coordinates for future reference)*	☐	☐

……

……

Observations of change ☐ ☐
(i.e. recent fire, nearly dry, flooding, cattle impact or dead animals)
(Provide additional details below)

……

……

Site photo taken ☐ ☐
(Details of type of camera type (i.e. digital vs 35mm etc)

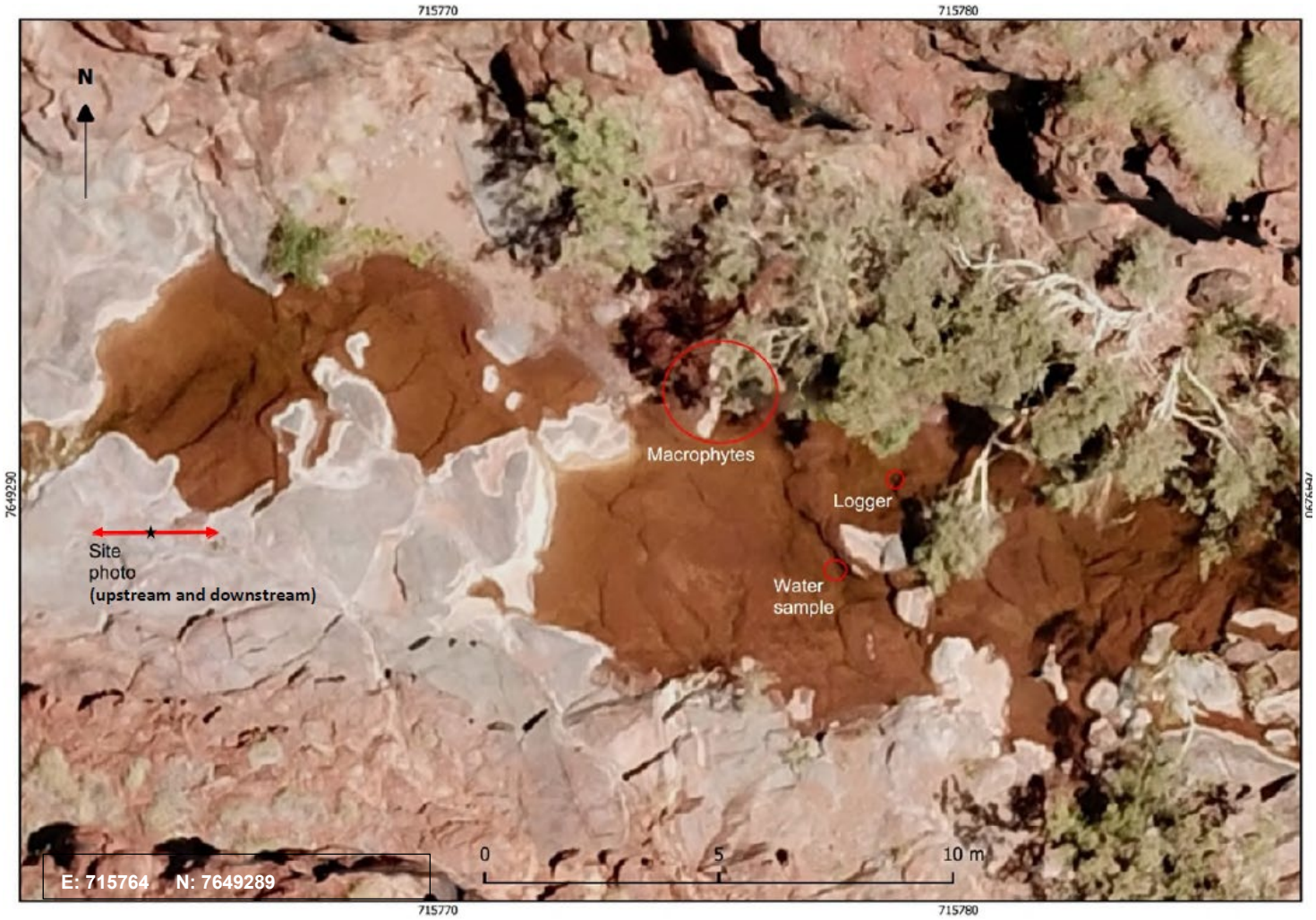
……

Any additional comments

……

……

……



Guide for conducting visual inspection at Site 12 Pool

Attachment 4: Surface Water Monitoring Procedures

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Attachment 5: Surface Water Monitoring and Aquatic Ecology Survey Baseline Report (Hydrobiology 2021)

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Attachment 6: Site 12 Pool Water Quality and Hydrological Regime Investigation (Hydrobiology, 2021)

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