Memo

North Star Extension Proposed Groundwater Management

OUR REF	NS-16018-RP-WM-0003_Rev 0	**DATE**	9/04/2025
TO	Vladimir Rios Vera; Matthew Dowling; Jacob Azzarello; Natasha Sanders	**CC**	Jordin Barclay; Ying Yu
FROM	Michael Carroll; Aline Barrabes		

This memorandum provides detail regarding the proposed groundwater management approved under the *Rights in Water and Irrigation (*RIWI) Act, to mitigate potential impacts associated with groundwater abstraction for the current approved North Star Project extent and, in future, with the North Star Extension (NSE) referral.

MANAGEMENT DOCUMENTATION

Fortescue manages the potential impacts associated with groundwater abstraction at North Star through the *RIWI* Act. More specifically, a Groundwater Operating Strategy document is submitted as part of an application for a groundwater abstraction licence (5C), alongside a hydrogeological impact assessment document. Both documents are written in accordance with DWER policies, particularly:

a. Operational policy no. 5.12 – Hydrogeological reporting associated with a groundwater well licence (https://www.water.wa.gov.au/__data/assets/pdf_file/0003/1659/89953.pdf)

b. Use of operating strategies in the water licensing process (https://www.water.wa.gov.au/__data/assets/pdf_file/0008/10061/Use-of-operating-strategies-prev-5.08.pdf)

ASSESSMENT OF UNMITIGATED RISKS

A reassessment of Iron Bridge's current project was completed to support an application for increased groundwater abstraction from the mine's water supply borefield, and the licensing of future dewatering. A hydrogeological impact assessment (Iron Bridge, 2023a) and revised groundwater operating strategy (GWOS) were supplied to DWER as part of this application, with the licence and associated GWOS (Iron Bridge, 2024) approved on 28 June 2024.

Impact assessments undertaken for the current project extent (Iron Bridge, 2023a), with reference to recent studies (CDM Smith (2025) and Hydrobiology (2025)) summarises potential risks to receptors associated with groundwater abstraction as highlighted in Table 1 below. The additional impact from NSE, associated with dewatering of the NSE pits (presented in the referral document 662NS-0000-AE-EN-0001 Rev 0) will not alter the risks highlighted below. The change to predicted drawdown between the current project and the NSE referral (for the 'base case' scenario) is illustrated in Map 1 and Map 2.

The risk assessment completed in Iron Bridge (2023a) acknowledged the potential source of drawdown at Mundagoora Pool as abstraction from the water supply borefield to the west of the pool, as dewatering of NSE Pits was not within the scope of the assessment. Conceptually, as indicated in Table 4, drawdown from either upstream (NSE dewatering) or downstream (water supply borefield) could impact the pool water balance. However, the risk ranking is very high regardless of whether it is only one or both sources of drawdown considered.

Map 3 illustrates the drawdown induced by the proposed NSE pit dewatering alone, reflecting the low permeability geology's effect on elongating the cone of depression along the strike of the north-south oriented ridge. While this drawdown does not reach Mundagoora Pool directly, the risk assessment considers the potential for the drawdown to affect the upstream catchment feeding the pool, reducing inflow volumes.

Table 1: Summary of potential unmitigated impacts to environmental and cultural groundwater dependent receptors (Risk assessment as per procedure 100-PR-RK-0006).

Receptor	Sensitivity to Groundwater Level Change	Risk of Impacts
Stygofauna	Potentially sensitive. Drawdown will deplete approximately 50% of the habitat (based on volume) within the study area but: • large size of the borefields means they may encompass whole ranges of some species; and • all areas with >2-5 m# drawdown should be treated as total loss of habitat, Therefore, greater than 50% of habitat is highly likely to be impacted.	Extreme
Western borefield potentially groundwater dependent vegetation	Moderate to low sensitivity. Vegetation community unlikely to be dependent on groundwater, with high resilience to change.	A high risk has been calculated, although the actual impact level to the vegetation communities has been assigned as negligible (CDM Smith, 2025)
Southern borefield potentially groundwater vegetation		
Mundagoora Pool and associated vegetation	Moderate to high sensitivity. Pool is groundwater dependent but also has surface water contribution. Baseline suggests pool is permanent	Very High
Site 12 Pool	Moderate. Pool is known to dry out and has contribution from surface water. A drop in upstream catchment bore NS-0664 groundwater level beyond 279.25 mAHD is associated with a drop in pool levels (Iron Bridge, 2021).	Medium

Other pools identified as commonly wet or permanent in Hydrobiology (2025)	High. However, whilst these pools may have elements of groundwater dependency, pools are generally conceptualised as receiving groundwater inflow from local fracture networks, not the targeted aquifer for North Star abstraction.	Low

PROPOSED MANAGEMENT

As indicated above, the details regarding the management of groundwater drawdown from dewatering and/or water supply abstraction, will be documented within a hydrogeological impact assessment and supporting groundwater operating strategy. The nature of hydrogeological uncertainty generally supports an adaptive management process, developed in consultation with DWER and other appropriate stakeholders, particularly Traditional Owners. Consultation on the management of impacts to sites of cultural value, which includes pools, is a requirement of the Social Cultural Heritage Management Plan (Iron Bridge, 2023b)

Adaptive Management Structure

Fortescue adopts a tiered trigger level strategy in groundwater management, with one or more quantifiable tiers providing an increasing scale of response, followed by a limit or threshold trigger, which denotes the environmental objective is under threat and that the highest level of management response is required. This process is illustrated in Figure 1 below.

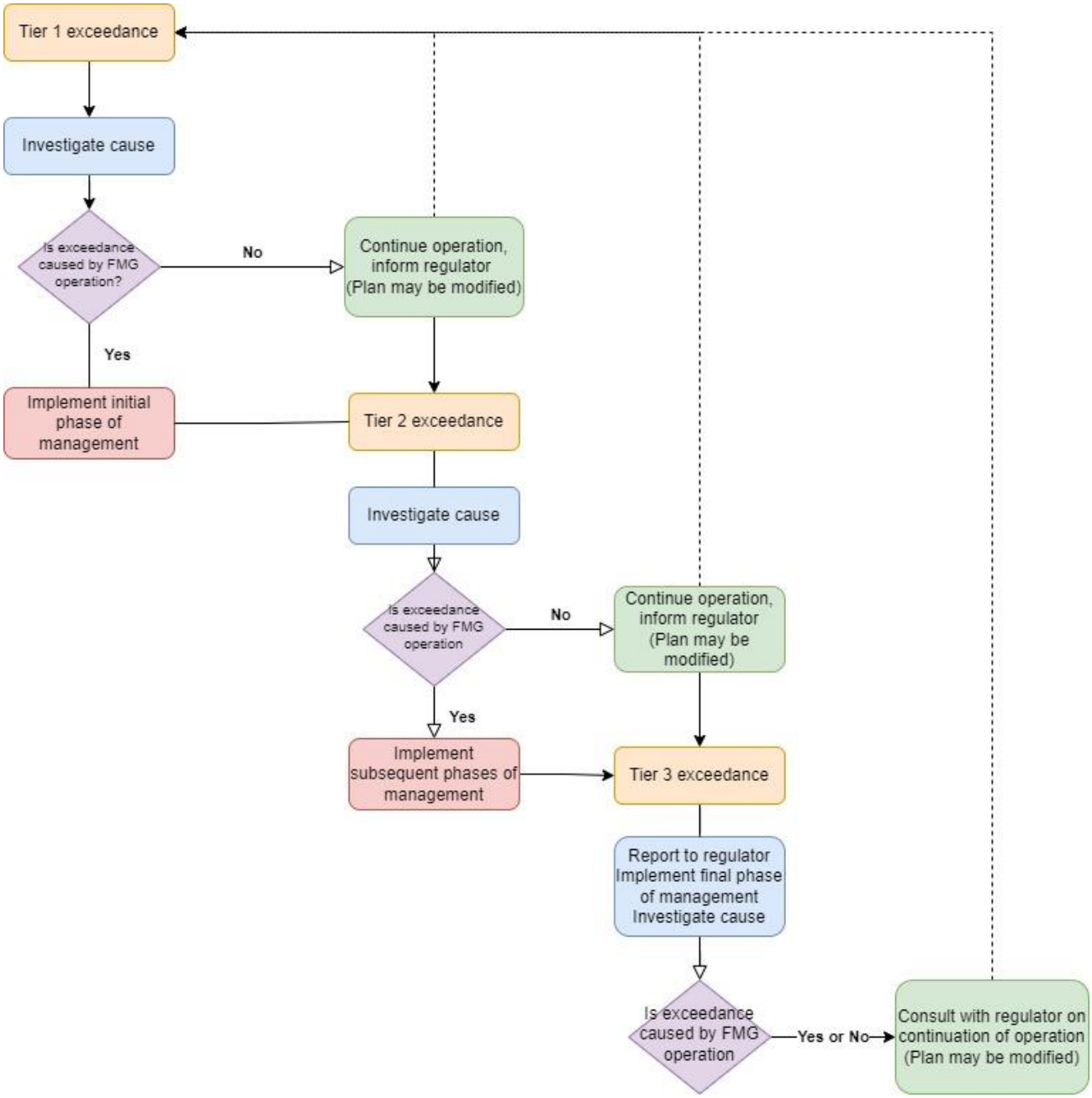


Figure 1: Example of adaptive management flowchart for groundwater management

Potential Management Strategies

The groundwater management strategies listed in Table 2 will be considered, and are appropriate to both vegetation and pool receptors, in the context of groundwater level and quality management. Adoption of management methods will be subject to consultation with Traditional Owner(s) and referenced in the North Star Extension Bridge Social Cultural Heritage Management Plan (Iron Bridge, 2023b).

Table 2: Summary of strategies which may be employed in the GWOS, to manage risks to environmental and cultural groundwater dependent receptors.

Strategy	Objective	Description
Direct Supplementation – surface	Manage soil moisture. Manage groundwater levels.	Adding water directly at surface at one or more locations, from a raw water source of similar quality. Water is distributed to the area via a pipeline (size depends on amount of water required) and flows out of an open end (called a spigot). This method delivers water quickly on surface to a specific location, which can include a creek or a pool. The movement of this water downstream depends on the creek environment. More water lost to evaporation.
Direct Supplementation – buried	Manage groundwater levels	Adding water via buried slotted pipe into the ground. A trench will be dug, and the slotted pipe will be buried into this trench. Water will be distributed via a pipeline (size depends on amount of water required) and allowed to flow into the aquifer from the slots in the buried pipe. Water will be sourced from a raw water source of similar quality. This method delivers water to the shallow subsurface across a longer, narrow area. It requires more ground disturbance but can better mimic naturally high

		groundwater levels without excessive ponding of water. Evaporation is also reduced.
Injection	Manage groundwater levels.	Adding water, from a raw water source of similar quality, via one or more injection bores. Injection bores are usually 8 – 14" holes in the ground, drilled into the aquifer that needs supplementation and cased with PVC. Water will be distributed to the bore(s) via a pipeline (size depends on amount of water required) and allowed to flow into the aquifer from the slots in PVC casing. This method works where supplementation is required for deeper aquifers that cannot be supplemented from surface or via a trench. It can also be managed to prevent water levels from rising to surface.
Alternation or reduction in abstraction (discrete bores)	Remove abstraction stress. Allow existing management to better/faster recover groundwater levels	This method is best used where unexpected drawdown (most likely associated with a structural connection) requires immediate mitigation. It can be targeted to specific bores; usually those closest to the receptor, or where a bore or bores is structurally connected to the receptor. Reduction in abstraction is best used in conjunction with methods above where propagation of drawdown water levels recovery takes time.
Physical flow barriers	Alter groundwater aquifer properties to reduce connection between receptor and cause of drawdown	The cost of these barriers compared to the volumes of water being abstracted will likely render this strategy least favoured compared to those above.

ASSESSMENT OF ADAPTIVELY MANAGED RISKS

The impact assessment for the current project extent (Iron Bridge, 2023a) also includes a risk assessment of the managed, or residual risks, associated with implementation of the current project extent, the NSE project and the proposed adaptive management strategies (Table 3 below).

Table 3: Summary of mitigated / managed risk assessment for environmental and cultural groundwater dependent receptors.

Receptor	Risk Scenario	Adaptive Management Strategy	Residual Risk	Further Actions
Stygofauna	Groundwater drawdown from water supply or dewatering reduces available habitat and/or connectivity for Stygofauna species, particularly those within limited known range, but also in areas without survey where species assemblage is unknown	a. Undertake additional regional surveys to better understand species occurrence; and b. Adopt adaptive management, with strategies as follows: bi. Alteration of abstraction regime from nearest bores bii. Groundwater injection to mitigate localised drawdown and increase groundwater availability biii. Reduced abstraction from borefield	Medium	• Commit to additional surveys to better understand stygofauna throughout borefield drawdown extent • Update impact assessment and GWOS with uplifted stygofauna study outcomes
Groundwater Dependent Vegetation (both Southern and Western Borefields)	Groundwater abstraction from Water Supply borefield reduces groundwater availability for mapped GDE or pGDE	a. Alteration of abstraction regime from nearest bores b. Direct supplementation to creekline to increase soil moisture availability	Low	• Progress approvals to allow supplementation to creekline so that this can commence if required, with minimal delay.

		c. Groundwater injection to mitigate localised drawdown and increase groundwater availability d. Reduced abstraction from borefield		
Mundagoora Pool and associated vegetation	Groundwater abstraction from Water Supply or Dewatering reduces groundwater levels below baseline.	a. Alteration of abstraction regime from nearest bores b. Direct supplementation to pool c. Groundwater injection to mitigate localised drawdown d. Reduced abstraction from borefield	Medium	• Further analysis of baseline water levels from pool and bores. • Investigate potential for structural geology assessment of the pool's setting, supported by non-destructive geophysical surveys. • Progress approvals to allow for supplementation infrastructure to be constructed if required, with no further delay.
Fig Pool and Cow Springs Pool	Groundwater abstraction from Water Supply or Dewatering dries out pools.	a. Alteration of abstraction regime from nearest bores b. Direct supplementation to pool	Low	• Progress approvals to allow for supplementation infrastructure to be constructed if required, with no further delay.

Other pools identified as commonly wet or permanent in Hydrobiology (2025)	Groundwater abstraction from Water Supply dries out pools.	a. Alteration of abstraction regime from nearest bores b. Direct supplementation to pool	Low	• If analysis of Cow Springs Pool indicates an impacts, commence investigation of these pools
Site 12 Pool	Groundwater abstraction from Dewatering leads to long term drying of pool (beyond the period of drying observed in baseline).	a. Alteration of abstraction regime from nearest dewatering bores b. Direct supplementation to pool c. Groundwater injection to mitigate localised drawdown d. Reduced abstraction from dewatering borefield	Low	• Progress approvals to allow for supplementation infrastructure to be constructed if required, with no further delay.

TRIGGER LEVELS

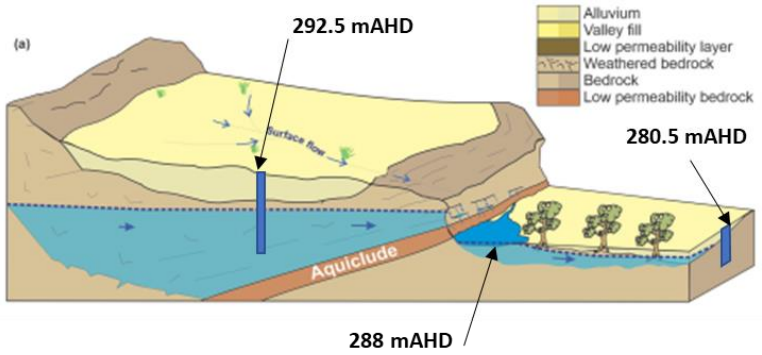
The setting of appropriate triggers can be complex, however the critical elements are:

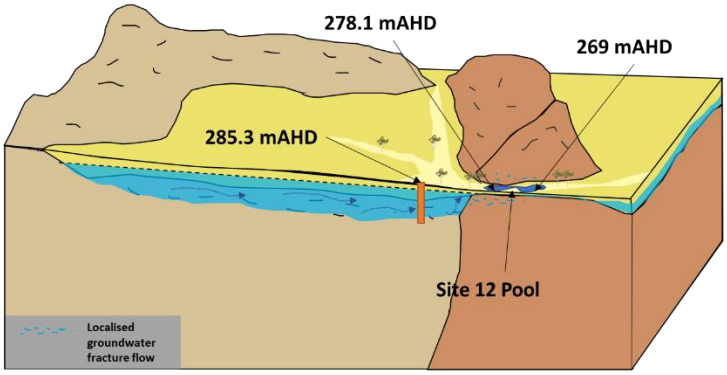
- Trigger value or values that relate to the risk to the receptor and also Fortescue's influence(s). This is most commonly a groundwater or pool water level.
- A simple series of metrics that can be adopted into the alerting system of our Environmental Management System. Whilst trends might form a part of the investigative process, a single value (perhaps across multiple consecutive measurements) is less prone to error.

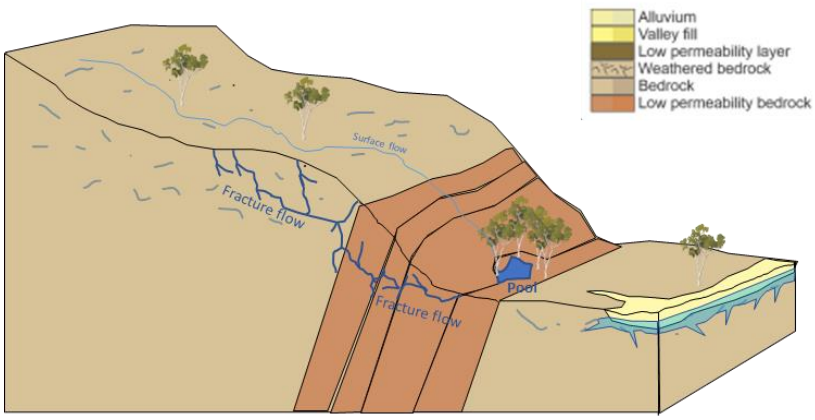
Table 4 outlines the trigger level approach implement at Iron Bridge, as approved through the RIWI Act process (via the GWOS) and revision of the Iron Bridge Vegetation Health Management Plan (662NS-0000-PL-EN-0004) to include provision for the management and monitoring of riparian vegetation (inclusive of GDV/PGDV) within the western and southern borefields.

Table 4: Summary of approach for setting of receptor trigger levels

Receptor	Appropriate Trigger Metrics	Rationale for Approach
Stygofauna	Groundwater level trigger(s) within habitat of any restricted species	Where a species has only been found within a limited range, groundwater levels will need to be managed to maintain saturated habitat.
Western borefield potentially groundwater dependent vegetation Southern borefield potentially groundwater vegetation	Vegetation and tree health metrics Vegetation Condition (per site) Visual Tree Health Assessment (10 trees per site) Leaf Water Potential (3 samples per	Monitoring of riparian vegetation (PGDV/GDV) within the western and southern borefields will be undertaken consistent with the provisions and approach outlined in the Iron Bridge Vegetation Health Management Plan (662NS-0000-PL-EN-0004). A minimum of six monitoring sites (three impact and three reference) will be monitored annually during the dry season with contingency actions initiated based on the below trigger and threshold criteria: **Trigger Criteria**: A statistically significant ($p<0.05$) decline in primary parameter trends at predicted impact areas in comparison to baseline monitoring values over two consecutive monitoring events.

	tree, 10 trees per site) Bore levels to be used as supporting information in trigger investigations	**Threshold Criteria**: A statistically significant difference ($p<0.05$) in the primary parameter trends between impact sites and baseline monitoring values. AND The decline is detected over four consecutive monitoring events and is associated with a decline in vegetation health condition in comparison to the reference sites. AND Subsequent investigation determine that the impacts are probably a result of the implementation of the proposal.
Mundagoora Pool and associated vegetation	Groundwater level triggers upstream and downstream of the pool; pool level	As indicated in the schematic below, and through analysis by Hydrobiology (2023), Mundagoora Pool's levels are sustained by groundwater. A reduction in either upstream or downstream groundwater levels is likely to impact the pool water balance and hence the pool level itself. This can only be validated through operational monitoring; hence the pool level is a metric to assess the connection between changing groundwater and pool levels. A tier 1 trigger, based on either groundwater or pool levels, will initiate investigation of an unexpected water level response. A tier 2 and 3 trigger, based on pool levels, will initiate subsequent, escalating phases of response (i.e. altered abstraction; supplementation) 

		Note that elevations above are reflective of late 2022 values; trigger levels are documented in the GWOS and will be further developed from a longer period of baseline monitoring.
Site 12 Pool	Groundwater level triggers upstream of the pool; pool level	Site 12 has been demonstrated to have a connection to groundwater levels via analysis of upstream bore NS-0664. Groundwater levels from this bore will be implemented into a 3-tiered trigger approach to drive investigation and escalating phases of active management. Downstream water levels are not considered to influence the pool level. Additional bores may be required upstream to determine the relative influence of subcatchments and/or different aquifer horizons that may support the pool water balance.  Note that elevations above are reflective of late 2022 values; trigger levels are documented in the GWOS and will be further developed from a longer period of baseline monitoring.
Fig Pool and Cow Spring	Pool levels	Analysis of data for Fig Pool and Cow Spring suggests these small pools are sustained by fractured groundwater inflow separate to that of the regional aquifer resource (FMG 2023 – *in prep*). The schematic below reflects this and suggests that monitoring of pool levels is appropriate to track deviation from the period of baseline. It is proposed that a three-tier trigger approach will be developed from pool levels, to initiate the adaptive management strategies identified.

CLOSING

Risks to groundwater levels and groundwater quality from the implementation of the North Star and North Star Extension have been identified. The primary source of risk is groundwater abstraction associated with the water supply borefield for the Mine; the dewatering of North Star Extension pits does not impact the risk profile. Without management, impacts to environmental and cultural receptors are unacceptable. Adaptive management, regulated through the RIWI Act process, is proposed to reduce the risk to acceptable levels.

The final details of the trigger and contingency actions under the proposed adaptive management strategy will be detailed in a Groundwater Operating Strategy being developed for DWER under an existing application to amend the North Star Mine's groundwater abstraction licence.

Michael Carroll

Principal Hydrogeologist, Water Planning

References

CDM Smith. (2025). *North Star Magnetite Project Extension – Phase 2 Terrestrial GDV Risk Assessment.* Unpublished report prepared for Fortescue Ltd.

Hydrobiology. (2022). *Iron Bridge: Surface Water Monitoring & Aquatic Ecology Baseline Report - Late Wet 2019 to Late Dry 2021. Report prepared for FMG Iron Bridge (Aust) Pty Ltd.*

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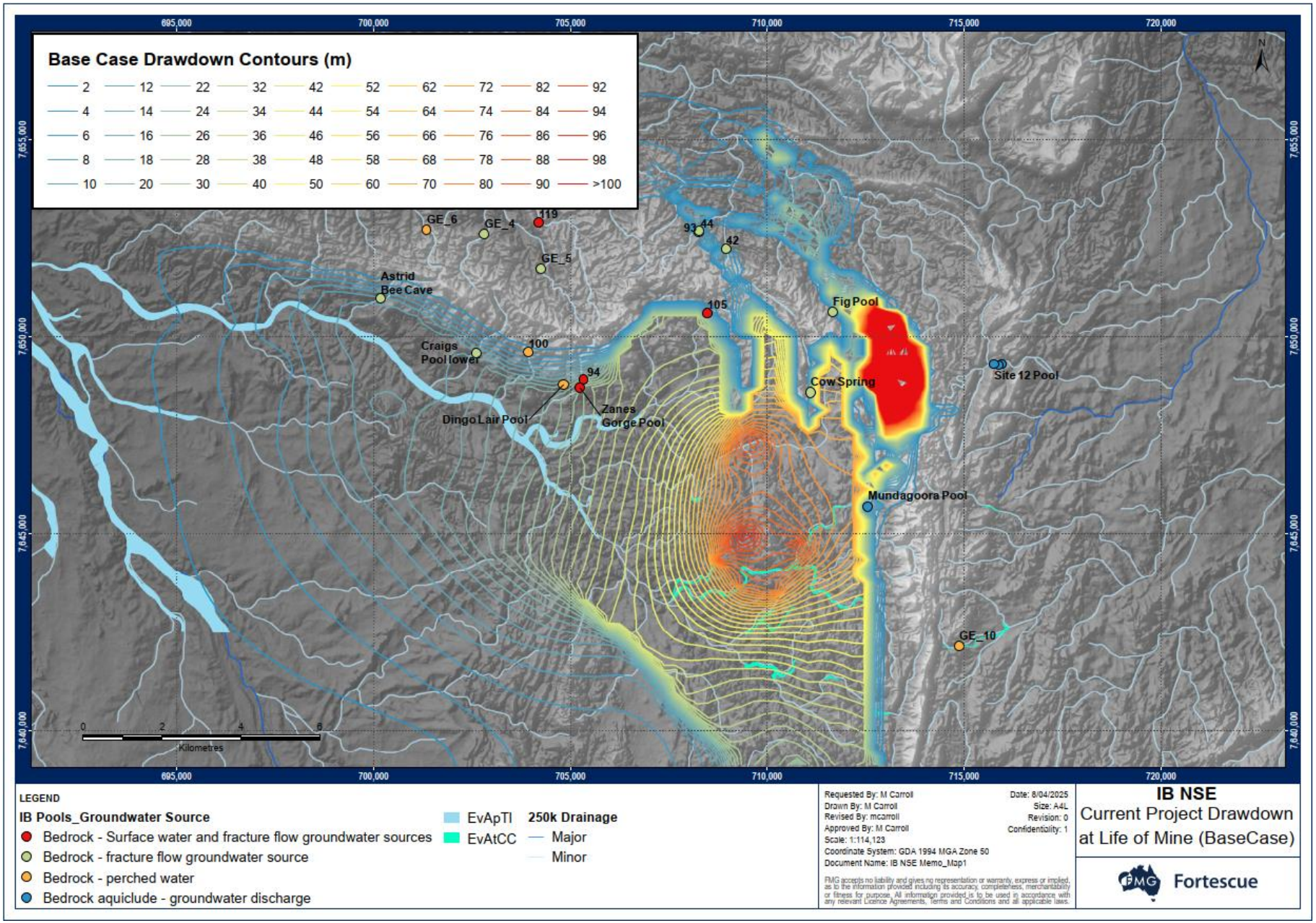
Hydrobiology. (2025). *NSE PER Inland Waters - Pool Characterisation.* Unpublished report prepared for Fortescue Ltd.

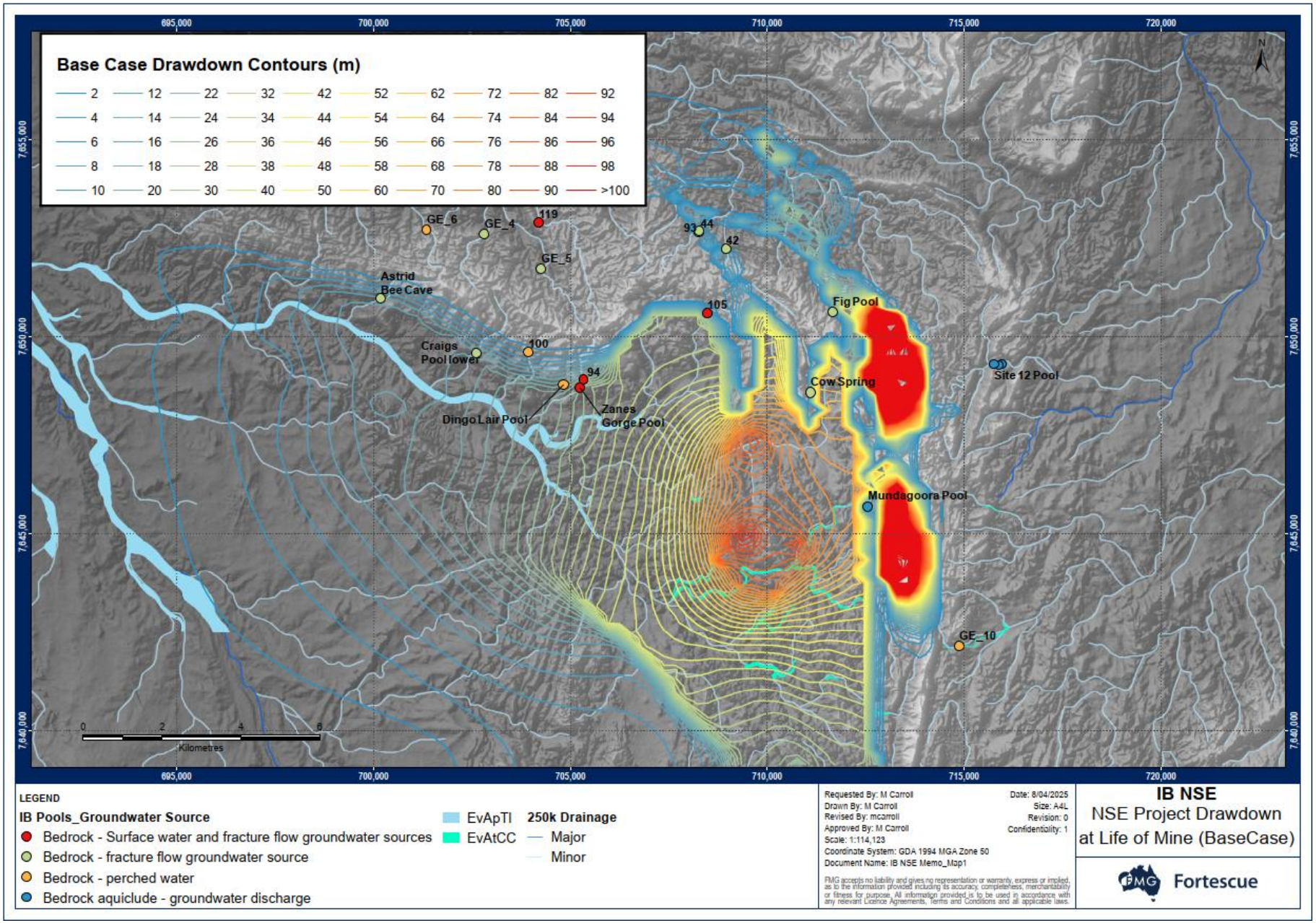
Iron Bridge. (2021). *Site 12 Pool Water Quality and Quantity Monitoring Plan. 662MI-5700-PL-WM-0001.*

Iron Bridge. (2023a). *Iron Bridge Mine Area Hydrogeological Assessment, IB-5700-RP-WM-0002.* Fortescue Metals Group.

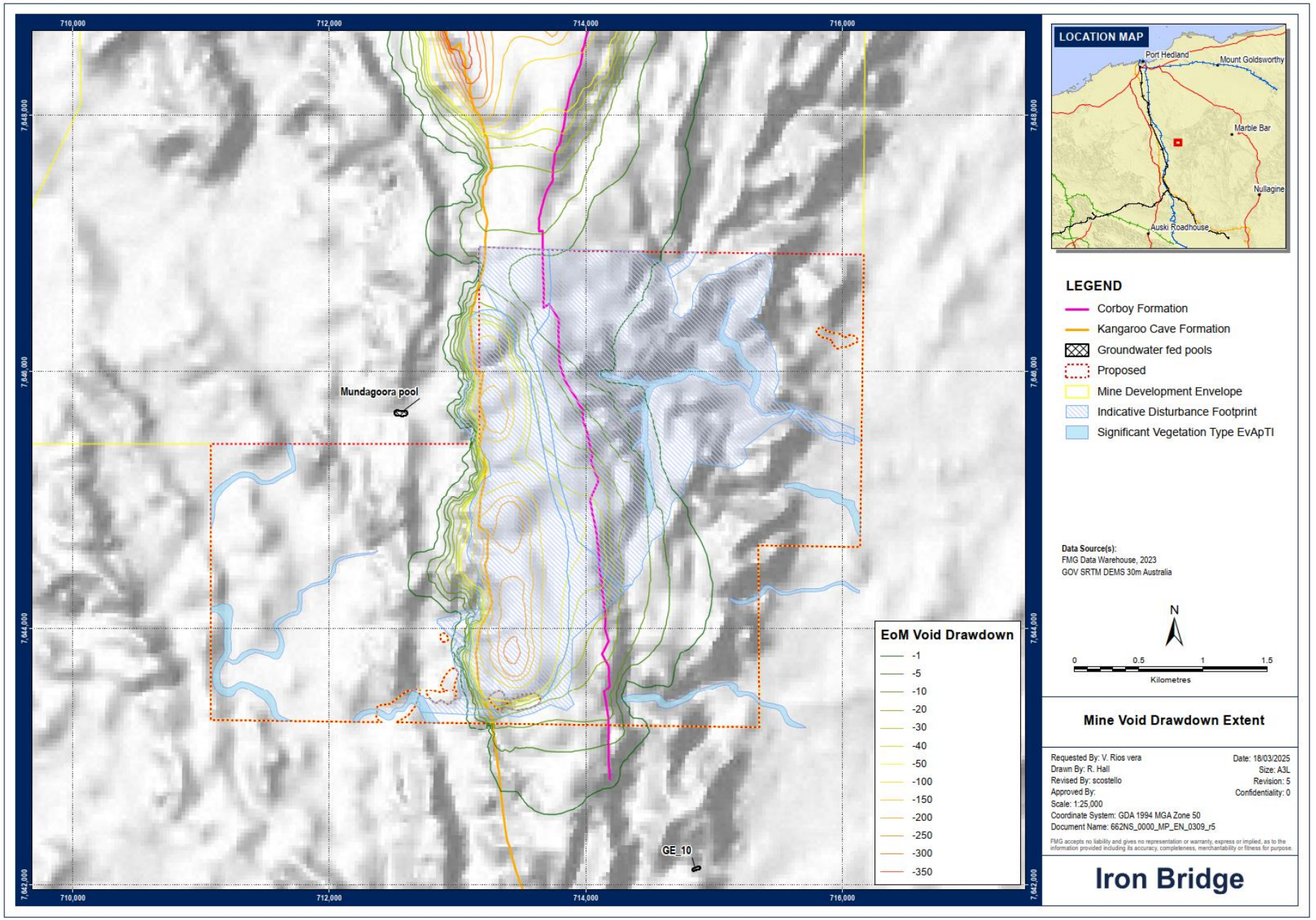
Iron Bridge. (2023b). *North Star Extension Social Cultural Heritage Management Plan, NS-0000-PL-HE-0001.* Fortescue Metals Group.



Map 1: End of LOM Drawdown for Current Iron Bridge Mining Project



Map 2: End of LOM Drawdown for NSE, Showing the Additional Drawdown Associated with Dewatering of the NSE Pits



Map 3: NSE Mine Dewatering drawdown in proximity to Mundagoora Pool