F4 Seepage Assessment

Conceptual Hydrogeological Model

Talison Lithium Pty Ltd

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→ The Power of Commitment

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Executive Summary

Talison Lithium Pty Ltd (Talison) intends to construct Tailings Storage Facility No. 4 (TSF4) to facilitate ongoing operation of their Greenbushes Mine in Western Australia. GHD Pty Ltd (GHD) was appointed by Talison to investigate, model and assess potential seepage from TSF4 to address the various conditions and requests for information arising from the respective Mining Proposal and Works Approval. A key focus of the study was to further develop the conceptual hydrogeological model of the mine site in the vicinity of TSF4 to better understand the potential seepage pathways for migration of the Contaminants of Potential Concern (CoPC) to the downgradient receptors and endpoints.

This report details the interpreted conceptual hydrogeological model through the collation of drilling, hydraulic and monitoring data, and information, to present the continuity of aquifers and clays across the site as well as groundwater flow directions and groundwater discharge locations and surface water flows.

Physical Setting

The hydrogeological profile in area where TSF4 is to be constructed comprises:

- A discontinuous surface layer of sands and lesser lateritic/ferricrete loams, ~1 m to ~3 m thick. Within the footprint of the footprint of the TSF4, the sands have been excavated and removed, but remain in areas outside the TSF4 footprint.
- Low permeability saprolitic clays (highly oxidised bedrock) with an average thickness of ~20 m and which are deemed as continuous beneath the TSF4 footprint and the wider mine-site area, underlain by;
- A low/moderate permeability “saprock” transitional zone of weathered bedrock of ~2 m to ~4 m thickness, underlain by;
- Very low permeability fresh bedrock (not oxidised).

Talison drilled approximately 400 sterilisation boreholes within and adjacent to the TSF4 footprint to the bedrock to confirm that there is no lithium bearing ore underlying this future facility. It is understood that the boreholes were subsequently backfilled with the cuttings from the drill holes (the influence of the holes was assessed via groundwater modelling (see the following discussion under heading **TSF4 seepage migration and discharge**).

Groundwater Levels and Migration Direction

The groundwater levels within the saprolitic profile below the TSF4 area are on average ~7 m below ground level. Where sands remain (i.e., outside the TSF4 footprint), shallow perched groundwater levels may prevail following winter rains.

Groundwater flow directions indicate that any TSF4 derived seepage which migrates through the engineered clay liner beneath the TSF footprint into the underlying hydrogeological profile should migrate in two directions, primarily southwards into the Woljenup catchment (~80% of the seepage), with lesser flow towards the northwest and into the Cowan Brook Dam catchment (~20% of the seepage).

The observed groundwater levels indicate that a downwards hydraulic head potential (up to 10 m) exists over the natural topographically elevated areas on the western flank of the TSF4 footprint. The elevated hydraulic head potential should promote groundwater migration into the deeper geological profile and migration towards the remaining central and eastern areas of the TSF4 footprint where relatively neutral potential hydraulic head is indicated. Importantly, an upwards hydraulic head potential is indicated ~750 m to the south of the toe of the TSF4, where artesian flow is observed in nested monitoring bores.

TSF4 Seepage Migration and Discharge

Impacted seepage which migrates through the engineered clay liner will seep into the underlying saprolitic profile. The presence of backfilled sterilisation boreholes beneath TSF4 (approximately 400 holes) potentially provides a preferential pathway for a TSF4 derived seepage, to migrate through the saprolitic clays into the underlying saprock layer. The local-scale flow and transport modelling indicates that the small increases in metal concentrations will be transmitted by a small increase in flow (2.5% of TSF4 seepage captured and transmitted by borehole), and consequently the increase in mass and flux of metals into the aquifer is considered negligible.

Calculated groundwater velocities indicate that the groundwater flow will move slowly through the saprolitic clays (0.5 m/year), slightly quicker in the underlying saprock horizon (3 m/year), with low groundwater velocities inferred to flow through the bedrock (0.02 to 0.4 m/year).

Where seepage migrates through the saprolitic clays, the long residence time provides the opportunity for attenuation of metals derived from TSF4 seepage, through adsorption and ion-exchange reactions prior to groundwater discharge. Where seepage migrates through the saprock, the shorter residence times, and lower clay component indicates the unit will have less opportunity to attenuate metals.

The southerly groundwater flow path (80% of flow beneath TSF4 footprint) indicates that any TSF4 seepage impacts, will migrate for a distance of ~750 m downgradient of TSF4, where the observed artesian groundwater levels (MB23, S,I, D) support that groundwater and any seepage impacts that are not attenuated along the groundwater flow path, may discharge into the receiving environment of the Woljenup Creek line.

The north-westerly groundwater flow path (20% of flow beneath TSF4 footprint) indicates that any TSF4 seepage impacts will migrate for a distance of 100 to 200 m downgradient of TSF4, where the any seepage impacts that are not attenuated along the groundwater flow path, may discharge into the drainage line associated with Tin Shed Dam (upper catchment of the Cowan Brook dam).

Baseline Groundwater Monitoring (ongoing)

The laboratory analysis of groundwater samples from five monitoring bores in and around the TFS4 footprint indicates that metal concentrations were identified in two of the monitoring locations that were relatively elevated (e.g., arsenic, ~0.04 mg/L, and lithium, up to ~ 2 mg/L). These two bore locations are remote from any influence of mining impacts and given that the bores exhibit a water quality signature differing from the mine-seepage impacts (major-ion signature), the elevated metal concentrations are considered to reflect the background groundwater quality associated with the mineralised geological setting. These background metal concentrations will be considered in context with the TSF4 Human Health and Environmental Risk Assessment.

Qualifications

This report is subject to, and must be read in conjunction with, the limitations, assumptions and qualifications contained throughout this report.

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1 Introduction

1.1 Background

Talison Lithium Pty Ltd (Talison) intends to construct Tailings Storage Facility No. 4 (TSF4) to facilitate ongoing operation of their Greenbushes Mine in Western Australia. The Department of Mines, Industry Regulation and Safety (DMIRS) and the Department of Environment and Regulation (DWER) have approved the respective Mining Proposal (MP)[1] and Works Approval (WA)[2] subject to certain conditions and requests for information, a list of which is presented in **Table 1**.

Table 1: Issues Raised by DMIRS and DWER

GHD Item	Source of request	Agency	Request and information required
1A	Schedule 1: Areas of the Mine Closure Plan that require further development in the next revision.	DMIRS	Update the MCP with the hydrogeological information gained from the non-standard tenement condition requiring an assessment of water recharge to stock water dams 1 and 2 south of TSF4
1B			The MCP is to provide updated information on the expected timeframe for seepage water from TSF4 to reach an acceptable quality such that active management of seepage is no longer required post closure of the facility. This should include details of the test work completed to date, to determine the changes in seepage water quality over time.
2	Schedule 2: Recommended further conditions	DMIRS	Prior to 1 December 2022, the tenement holder shall undertake a hydrological and hydrogeological assessment to confirm there will be no significant reduction in the quantity of water recharge to stock water dams 1 and 2 south of the TSF4.
3A	Schedule 3: Table 11-8: Baseline Environmental Data Gaps	DMIRS	A subset of the recently identified (GHD 2020f) CoPC were analysed for the first time in 2020 and do not have published guidelines (antimony, caesium, rubidium, thallium)
3B			Time for TSF4 to drain and seepage to cease after tailings deposition ceases has not yet been modelled.
3C			Further information is needed on the tailings slurry water quality during operations.
4A	TSF4 Works Approval Condition 4(f)	DWER	Updated hydrogeological conceptual model incorporating: i) additional permeability testing of the saprolitic profile beneath the TSF4 footprint
4B	TSF4 Works Approval Condition 4(f)	DWER	Updated hydrogeological conceptual model incorporating: ii) confirmation of the permeability, lateral continuity and expected seepage and migration rates from TSF4
5A	TSF4 Works Approval Condition 16(e)	DWER	(i) updated seepage management plan, including an updated seepage model reflecting actual data collected from additional hydrogeological studies and actual tailings characteristics
5B			(ii) Trigger values for groundwater and surface water monitoring to identify potential impacts from seepage from TSF4, and actions undertaken to respond to potential seepage impacts
6	TSF4 Works Approval Condition 16(h)	DWER	(h) a groundwater monitoring report demonstrating their compliance with conditions 10, 11 and 12 for the time limited operations period….”

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[1] MP102901

[2] W6618-2021-1

GHD Pty Ltd (GHD) was appointed by Talison to assess the seepage from TSF4 (the Study) in response to the issues raised. The scope of the Study will culminate in a suite of reports that will be submitted to DMIRS and/or DWER in response to the various conditions and requests. Given the nature of these conditions and requests, some have been addressed across several reports detailing separate, but related, subject matter, and others have been addressed within a single report. A summary of the Study reporting structure is provided in **Table 2** and is depicted schematically in **Figure 1**.

Table 2: Reporting Structure to Address the DMIRS and DWER Requests and Conditions

Task	Description	Cross Reference to GHD Item(s) Listed in Table 1
Tailings Leach Testing (GHD, 2023a).	The testing of the tailings material further characterises the leaching of Contaminants of Potential Concern (CoPCs) from tailings material for the modelling work and risk assessment.	1B, 3B
Sub-surface Clays Attenuation Capacity Testing (GHD, 2023b).	The testing of the clays beneath TSF4 derived the attenuation factors for key CoPCs within clays for the the seepage modelling and risk assessment.	1A, 2
Baseline Monitoring Report (GHD, 2023c).	The report summarises the quarterly sampling and monitoring of the surface and groundwater monitoring of quality, levels and reporting to provide a pre-construction baseline.	6
Conceptual Hydrogeological Model of TSF4 (GHD, 2023d, this report).	The conceptual model is a collation of drilling, hydraulic and monitoring information, to present aquifer and clays continuity, groundwater flow directions and groundwater discharge locations and surface water flows.	2, 4A, 4B
Site-Specific Water Quality Criteria (GHD, 2023e).	The criteria have been derived for site specific conditions and form the basis for tolerable mine discharges to off-site environments. A summary of all previous guideline derivation work is included.	1B, 3A, 3B, 4B
Preliminary TSF4 Drainage Modelling (GHD, 2022a).	The modelling provides preliminary predictions of the timeframe for TSF4 to drain, the quality of the drainage waters, and an indication of how long drainage will continue after closure of TSF4.	1B, 3B, 3C
Woljenup Creek Hydrological Assessment (GHD, 2023f).	The assessment involves the determination of the dilution effect on any released CoCPs in the downstream creeks and estimates the total load on the Blackwood River.	Required for Risk Assessment
Site Wide Seepage Modelling (GHD, 2023g).	The modelling provides predictions for the fate and transport of impacted seepage within the groundwater system from facilities, including TSF1, TSF2, TSF4 and Floyds and WRD (cumulative impacts for TSF4).	1A, 2, 4A, 4B
Risk Assessment (GHD, 2023h).	The assessment demonstrates the risks to human health and the environment from mine site seepage and discharge and is supported by the various supporting technical studies (herein).	-
Seepage Management Plan (GHD, 2023i).	The plan details a monitoring plan and schedule for surface and groundwater, associated trigger criteria, and actions that should be undertaken should seepage be detected above the trigger levels.	5A and 5B

This report details the interpreted conceptual hydrogeological model through the collation of drilling, hydraulic and monitoring data and information, to present the continuity of aquifers and clays across the site as well as groundwater flow directions and groundwater discharge locations and surface water flows. This conceptual model feeds into the broader Study of understanding and demonstrating the seepage risks associated with the TSF4. This report represents one component of the overall Study as is highlighted in **Table 2** and in **Figure 1**.

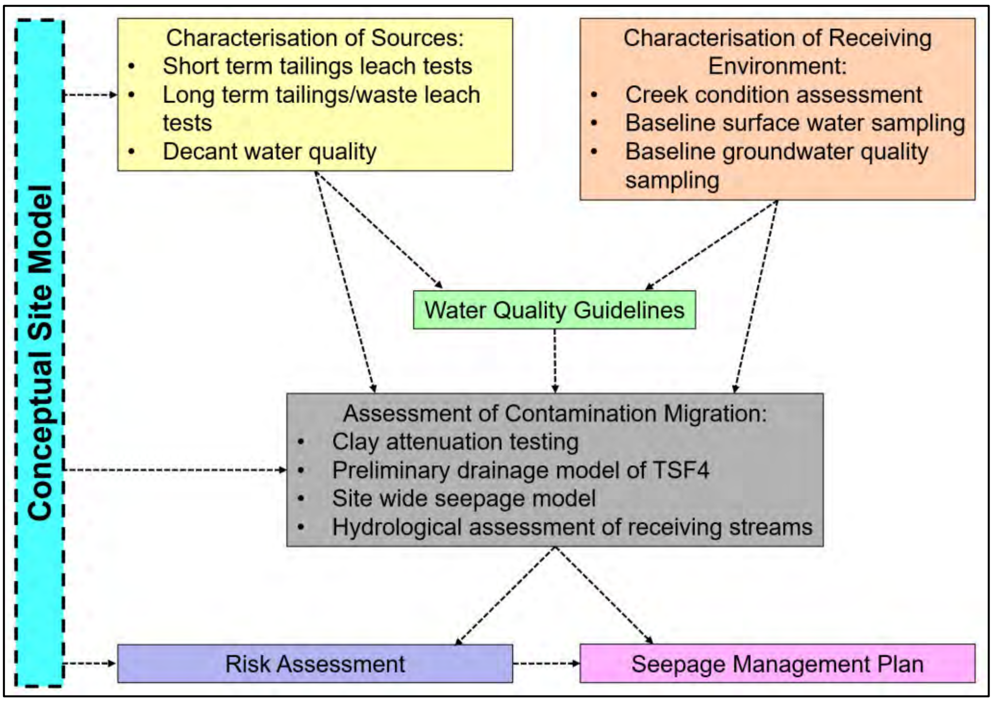

Figure 1: Reporting Structure for TSF4 Seepage Assessment

1.2 Overview of TSF4

TSF4 will be constructed immediately south of, and adjacent to the existing TSF1, and will use part of the TSF1 south wall as containment. The general location and layout of the mine site and TSF4 is depicted in **Figure 2** along with the surface water drainage lines. The downstream waterways that will receive discharge from TSF4 are Woljenup Creek and the Blackwood River, also depicted in **Figure 2**.

The design of TSF4 prepared by GHD (2021) specifies that, during operation, decant waters/seepage waters derived from TSF4 tailings will be directed by internal and external drainage lines to sumps for recirculation back into the water circuit (e.g.: Clear Water Dam). Collection and storage of seepage will continue following closure of the facility until such time that the quality and quantity are suitable for discharge to the downstream receiving environments.

1.3 Purpose and Objectives

The aims of preparing the conceptual hydrogeological model are to:

- Provide a basis from which to define and characterise the human health and environmental risks from water quality impacts derived from any seepage from TSF4.
- Directly satisfy the Condition F (i) of W6618-2021-1 for TSF4, which requires the model to be updated to reflect the permeability testing that was undertaken on the saprolitic profile beneath TSF4.
- Directly satisfy the Condition F (ii) of W6618-2021-1 for TSF4, which requires the model to confirm the permeability, lateral continuity and expected seepage and migration rates from TSF4.
- Indirectly satisfy one of the recommended further conditions in MP102901 (Schedule 2) pertaining to the hydrological and hydrogeological assessments to confirm there will be no significant reduction in the quantity of water recharge to the various stock water dams downgradient of TSF4, the numerical models for which will be based on the conceptual model.

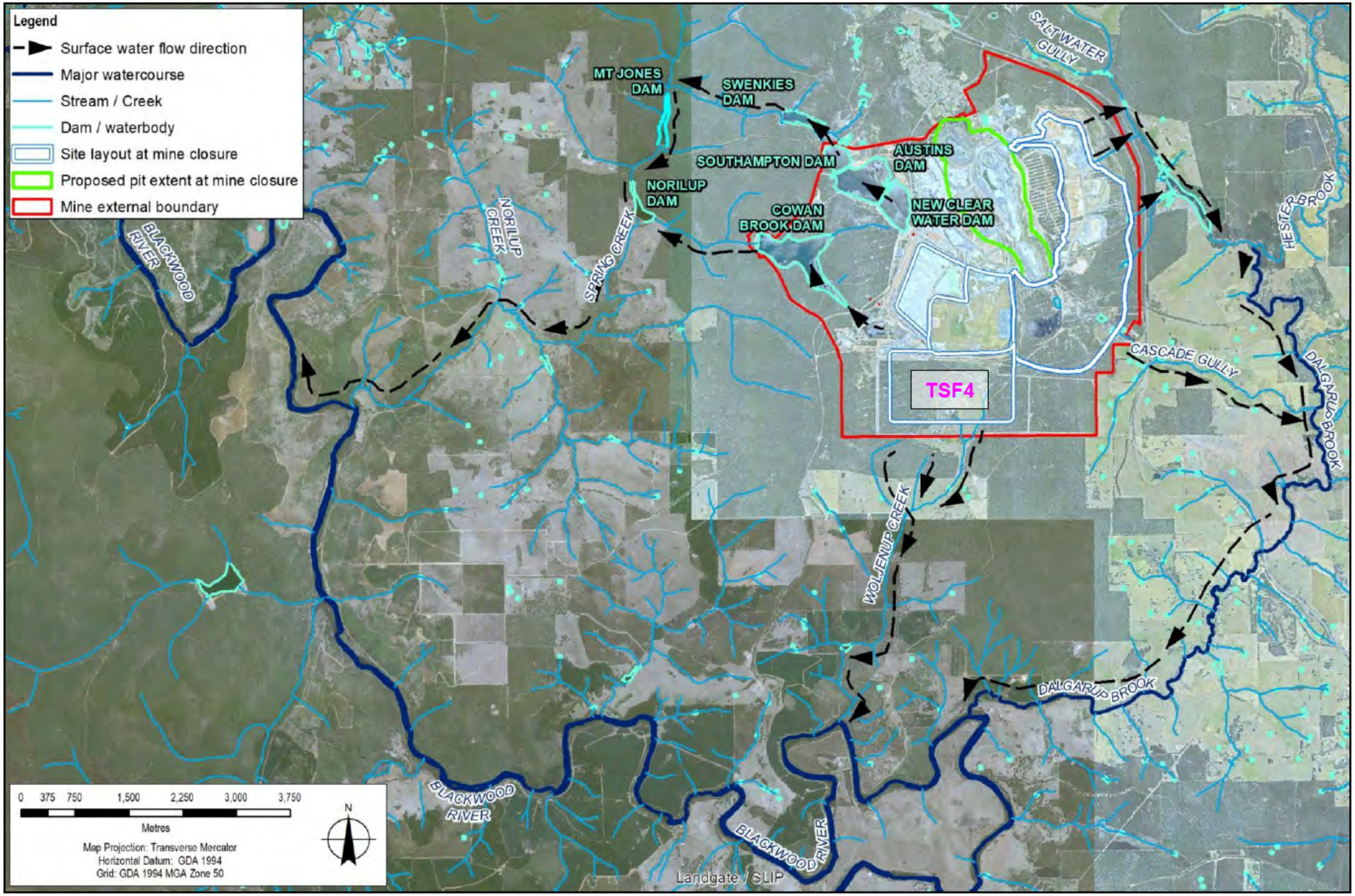

Figure 2: Mine Site Locality Plan Indicating Surface Water Discharges from the Mine Site

1.4 Scope of Work

The conceptual hydrogeological model documented in this report describes the hydrogeological setting and expected seepage from TSF4, the subsurface migration of this seepage (pathways) and the potential discharge location of any seepage impacted water to the downgradient environment (receptors).

The conceptual model has been derived from the collation and interpretation of the following information and data:

- Borehole and drilling records, to show geology including thickness of shallow sands, saprolitic clays, depth to bedrock and continuity and extent of geological layers (plans and cross sections).
- Hydraulic test results from bore holes / geotechnical investigations, to present permeability of geological/hydrogeological units (saprolitic clays), spatially and vertically (plans and cross sections).
- Groundwater and surface water quality monitoring results, to assess baseline water quality conditions.
- Groundwater level information, to infer groundwater and seepage flow directions, upward-downward hydraulic head potential, and seepage rates, based on permeability information.

1.5 Limitations

This report has been prepared by GHD for Talison and may only be used and relied on by Talison for the purpose agreed between GHD and Talison as set out in **Section 1.3** of this report.

GHD otherwise disclaims responsibility to any person other than Talison arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described throughout this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2 Mine Site Hydrological Setting

The mine site and operations are located on a north to north-west trending ridge, with surface water flow and tributaries discharging to the east, west and southerly directions, where the eventual receiving environment is identified as the Blackwood River (see **Figure 2**). The TSF4 Study Area is located to the south of the current mining operations, where surface water and topography flows in the southerly direction into Woljenup Creek.

The site wide and regional groundwater contours are presented in **Figure 3**, which were derived from the calibration of the groundwater modelling (GHD 2019), which included calibration to the open pit dewatering volumes and the availble groundwater monitoring bores (**Figure 3**). Excluding the open pits area, the groundwater contours indicate that groundwater flows is inferred to migrate radially outwards from the mining area (topographical high) towards the creeks and tributries, which are inferred as groundwater discharge boundaries (groundwater seepage into creeks).

The Archean host rocks underly the region (and mining area) and are generally considered as relativity low yielding groundwater sources, as evidenced locally from low open-pit inflows and via calibration of the groundwater model (GHD 2019). Although not evident at the mine site, localised faults and fractures can cause increased groundwater yields if connected with a more extensive deformation zone.

Collated drilling information throughout the mining area indicates that weathering of the Archean basement rocks occurs from surface to a depth of between ~20 m and ~50 m below ground level, with the profile comprising clays (“saprolite”) which are generally considered of low permeability and low groundwater yields (GHD 2018). The drilling information also indicates increased groundwater flows occur in some areas at the transition zone between the clays and basement (“saprock”).

Paleo-drainages occur in the mining area which have been mined historically for tin using sluicing/dredge methods. The lithology of the paleo- units comprises sands intermingled with historic sluicing/dredge deposits (sands and clay material).

In areas beneath the footprint of TSF4, the paleo-drainage comprises a shallow surficial sand unit of between ~1 m and ~3 m thick (depicted on the monitoring bore location plan in **Figure 4**), and which does not appear to have been historically mined. This shallow sandy unit beneath the TSF4 footprint is currently being excavated and removed. In addition, the clay core TSF4 embankments are to be keyed into the saprolitic clays. Sands will remain in areas outside the TSF4 footprint and embankments.

Seasonal water occurs in the surficial sands in the vicinity of the TSF4 footprint, which appears to be perched above the groundwater levels in the basement and saprolitic clay profile, which are typically from ~5 m to ~10 m below ground level (GHD 2018).

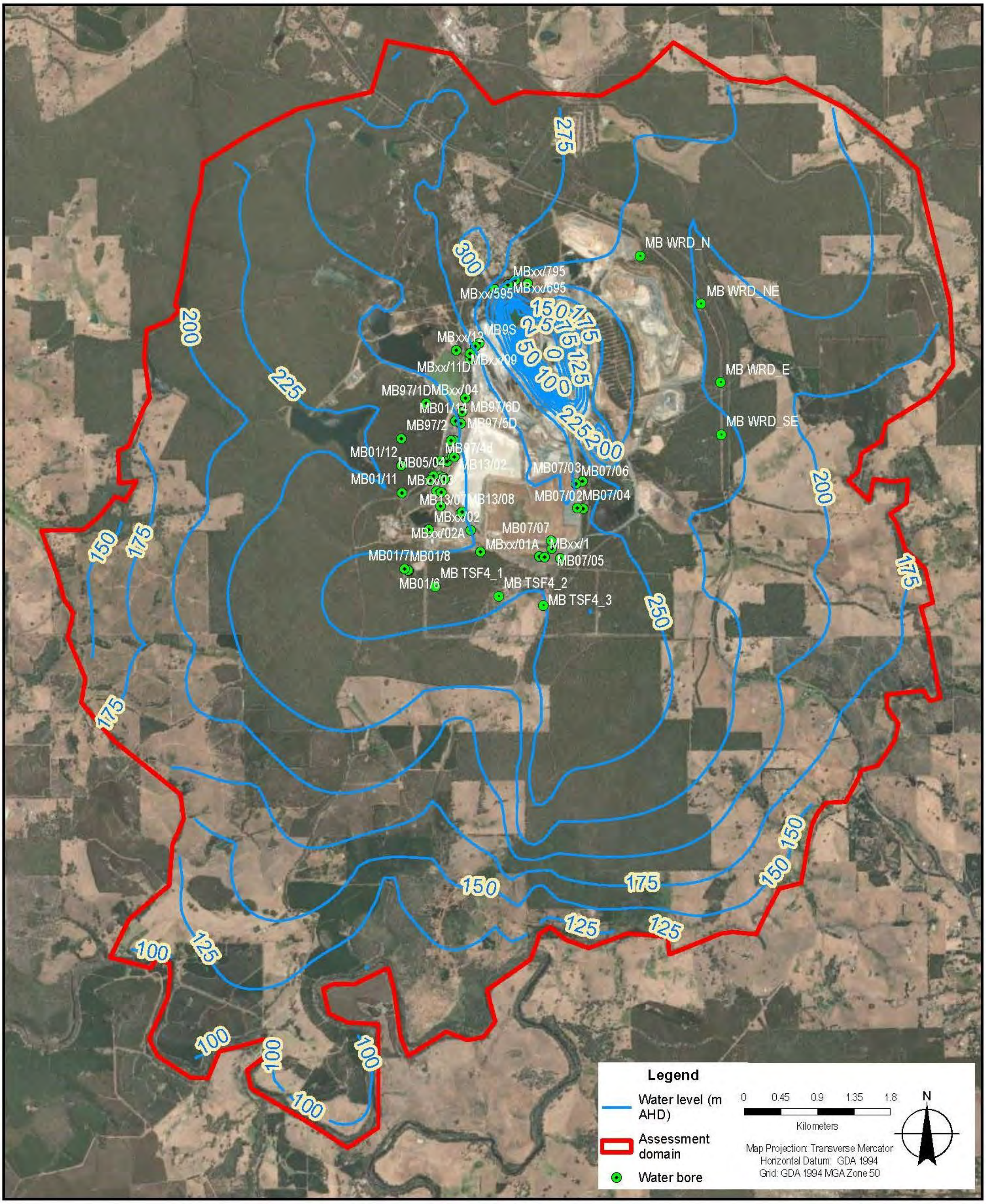

Figure 3: Interpreted Regional Groundwater Contours (Groundwater Modelling GHD 2019)

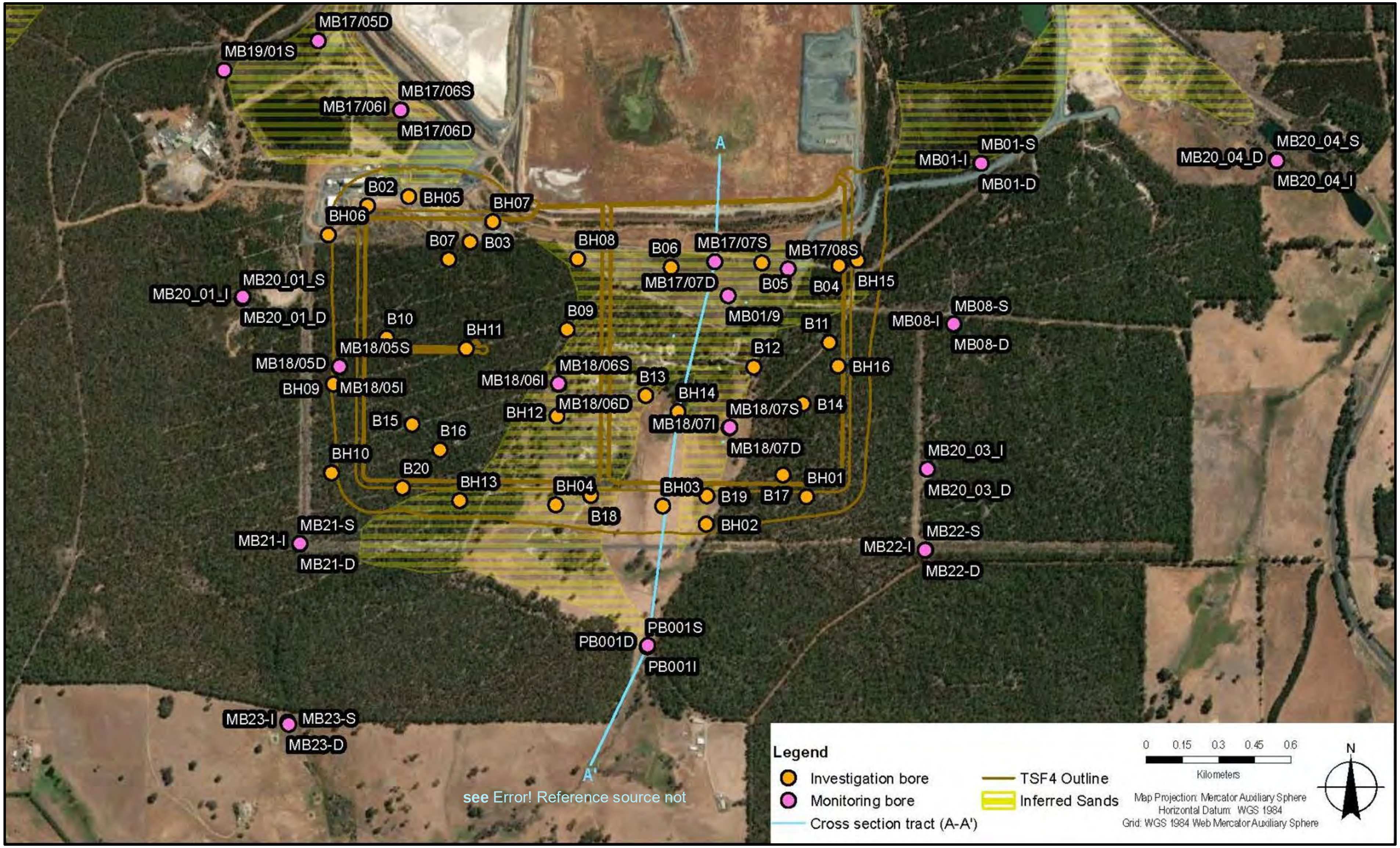

Figure 4: TSF4 Monitoring Bore Location Plan

3 TSF4 Hydrogeological Setting

3.1 Source Data and Information

The hydrogeological setting of TSF4 was derived from the logs for the drilling and installation of monitoring wells and investigation bores and from the monitoring of the water levels and groundwater quality. These data and information are provided as follows:

- The locations of the various monitoring wells and investigation bores are depicted in **Figure 4**.
- The coordinates and screened intervals of the monitoring wells and investigation bores are detailed in **Table A1** in **Appendix A**.
- The groundwater level data for the groundwater monitoring bores are provided in **Table A2** in **Appendix A**.
- The hydraulic testing results reported by GHD (2022b) are reproduced in **Table A3** in **Appendix A.**
- The baseline groundwater and surface water quality monitoring reported by GHD (2022c) are reproduced and tabulated in **Table B1** in **Appendix B**.
- The geological logs for the monitoring bores (MB prefix) and the hydraulic testing bores (B prefix) are presented in **Appendix D**.

3.2 Hydrogeological Units

Drilling investigations in the TSF4 area indicate the following generalised geological profile from shallow to deep as follows:

Surficial/shallow unit:

- fine to medium grained quartzo/feldpathic sands with a thickness of ~1 to ~3 meters (see **Figure 4** for distribution);
- Surficial lateritic/ferrierite which is laterally discontinuous and is ~1 m to ~2 m thickness;

Intermediate unit:

- saprolitic clays (highly oxidised bedrock), low permeability with an average of ~20 m of which are typically pale and leached in the upper ~5 m to ~10 m and which grade into darker clays, underlain by;

Deep unit:

- saprock (moderately oxidised bedrock), ~2 m to ~4 m of which has low/moderate permeability, transitional zone into and underlain by;

Basement unit:

  - fresh bedrock (not oxidised) which exhibits a low permeability (fractured bedrock).

The upper unit of surficial sands are in the process of being excavated and removed from the footprint of TSF4 and in areas beneath the TSF4 embankments/clay core. The surficial sands will remain in the areas outside the footprint of the TSF4. Evidence from surface mapping and test-pitting (GHD, 2017) indicates that the surficial sands are saturated in winter (deemed perched rainfall ~50 mg/L chloride), with groundwater levels close to ~1 meter below the ground surface.

The saprolitic profile thickness, derived from sterilisation drilling beneath the TSF4 footprint (see **Figure 5**) shows that the depth to bedrock is typically greater than ~15 m, with some minor expression of basement rock highs. The permeability of the saprolitic clays is low (see **Section 3.3**), and therefore is not considered to comprise exploitable groundwater resources.

During installation of the monitoring bores, water strikes typically occurred co-incident within the weathered bedrock (saprock), within the bottom few metres of the saprolite profile overlying the unoxidised bedrock. The unit is deemed as laterally continuous, given the common occurrence of water strikes during drilling. With a moderate/low hydraulic conductivity (See **Section 3.3**) and, given that the unit is relatively thin (~2 m to ~4 m thick), the unit is unlikely to comprise an exploitable groundwater resource.

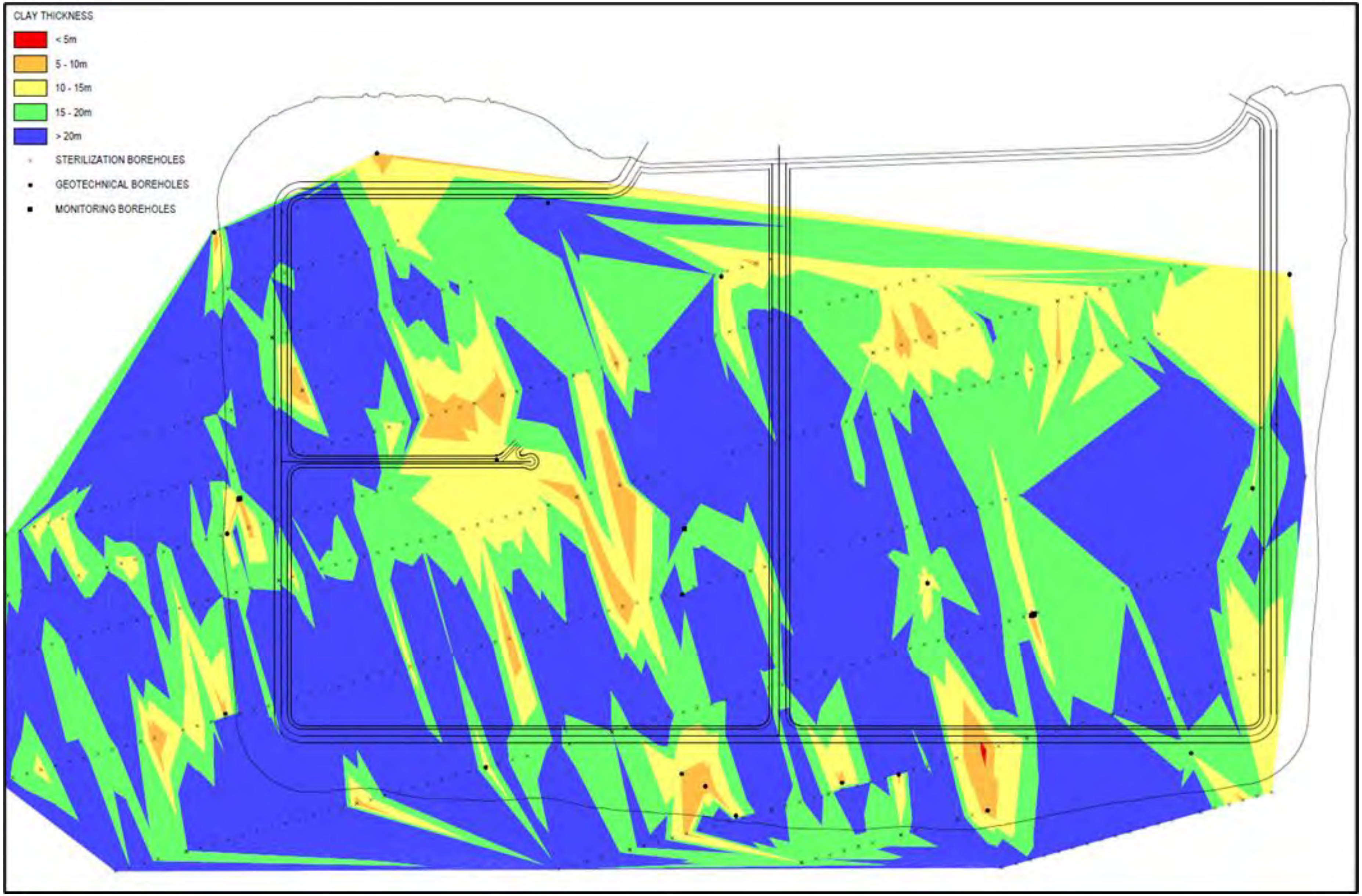

Figure 5: Thickness of Clay Underlying TSF4 and Locations of Sterilisation Boreholes

The bedrock has not been extensively tested via monitoring well drilling in the vicinity of TSF4, but where the monitoring wells have been installed, the bedrock appears to be competent with a sharp contact between the weathered bedrock and unoxidised bedrock. Where intersected, the bedrock generally exhibits little secondary joints/foliations/open fractures, which indicates that that the permeability is low. In addition, the open-pit groundwater inflows are minor and indicate that the bedrock permeability is low/very low, supported by calibration of the computer model using measured pit inflows (GHD, 2019).

3.3 Hydraulic Conductivity

Hydraulic conductivity tests were conducted on the geological profile (e.g., shallow/intermediate/deep) within the saprolitic clay and weathered bedrock profile in areas beneath, and close to, the footprint of TSF4. The hydraulic tests (falling/rising head "slug" tests) were conducted on the following bores:

- 18 locations comprising temporary hydraulic testing bores (prefix "B" in **Appendix A**).
- 6 permanent monitoring bore locations (prefix "MB" in **Appendix A**).

The locations of the hydraulic testing bores and monitoring wells are presented in **Figure 4**.

The hydraulic testing methods included rising/falling head tests at each interval (logger data processed using AQUSOLV) with selected cored intervals submitted to the laboratory for permeability tests.

The drilling, methods and hydraulic testing results are presented by GHD (2022b), the results of which has been reproduced in **Table A3** in **Appendix A**. The hydraulic testing results for the rising/falling head-tests have also been summarised and presented in **Table 3**. These values have been adopted in the groundwater modelling of the TSF4 seepage (GHD 2023g), together with appropriate margins to accommodate a range in values.

Table 3: Hydraulic Conductivity of Saprolitic Profile in Vicinity of TSF4

Profile	Median (m/day)	Geometric mean (m/day)	Number of results
Upper saprolitic clay	8.5×10^{-3}	$5.7. \times 10^{-2}$	29
Lower saprolitic clays	6.3×10^{-3}	5.7×10^{-3}	38
Saprock	0.13×10^{-2}	6.6×10^{-2}	14

To reflect the bulk hydraulic properties of the material, the hydraulic conductivity values were calculated using methods based on a central tendency of the data (the mean/average can skew the values based on data outliers).

The results (**Table 3**) indicate that the upper and lower saprolitic clay horizons have similar hydraulic conductivity (10^{-2} m/day). The values are consistent within published text values for clays (10^{-2} to 10^{-8} m/day), but indicate a "permeable" clay, considered due to the presence of residual primary feature (rock and grain textures) and secondary features (mineral dissolution and roots/organics). The results indicate that the saprock unit (typically ~2 to ~3 meters of weathered bedrock) exhibits higher hydraulic conductivity, close to10^{-2} m/day, likely due to lower clay composition and residual rock features.

3.4 Groundwater Levels and Flow Direction

Monitoring bores are not installed in the surficial sands as these sands are in the process of being excavated beneath the footprint of TSF4. The seasonal ground water levels in this surficial unit will follow the southwards fall of the topographical slope.

The groundwater level data presented in **Table A2** in **Appendix A** were used to develop groundwater contours and inferred groundwater flow directions. **Figure 6** shows the groundwater levels associated with the upper saprolitic horizon, and **Figure 7** shows the groundwater levels associated with the saprock (weathered bedrock). The hydraulic head potentials between the shallow saprolitic horizons and the saprock, as recorded in the monitoring wells screened in these separate horizons, are presented in **Table 4**.

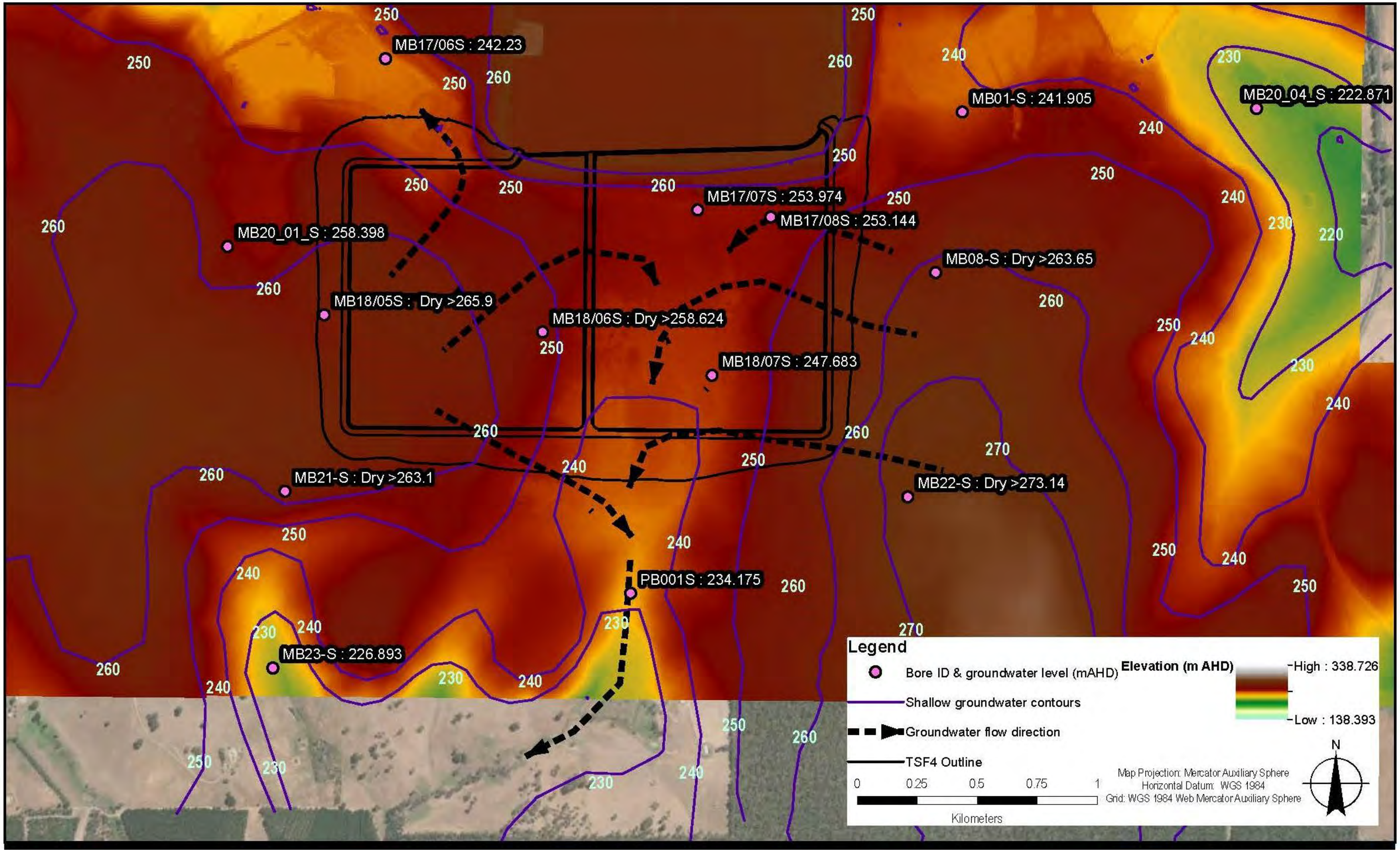

Figure 6: Interpretted upper saprolitic groundwater contours in the vicinity of TSF4 (shallow)

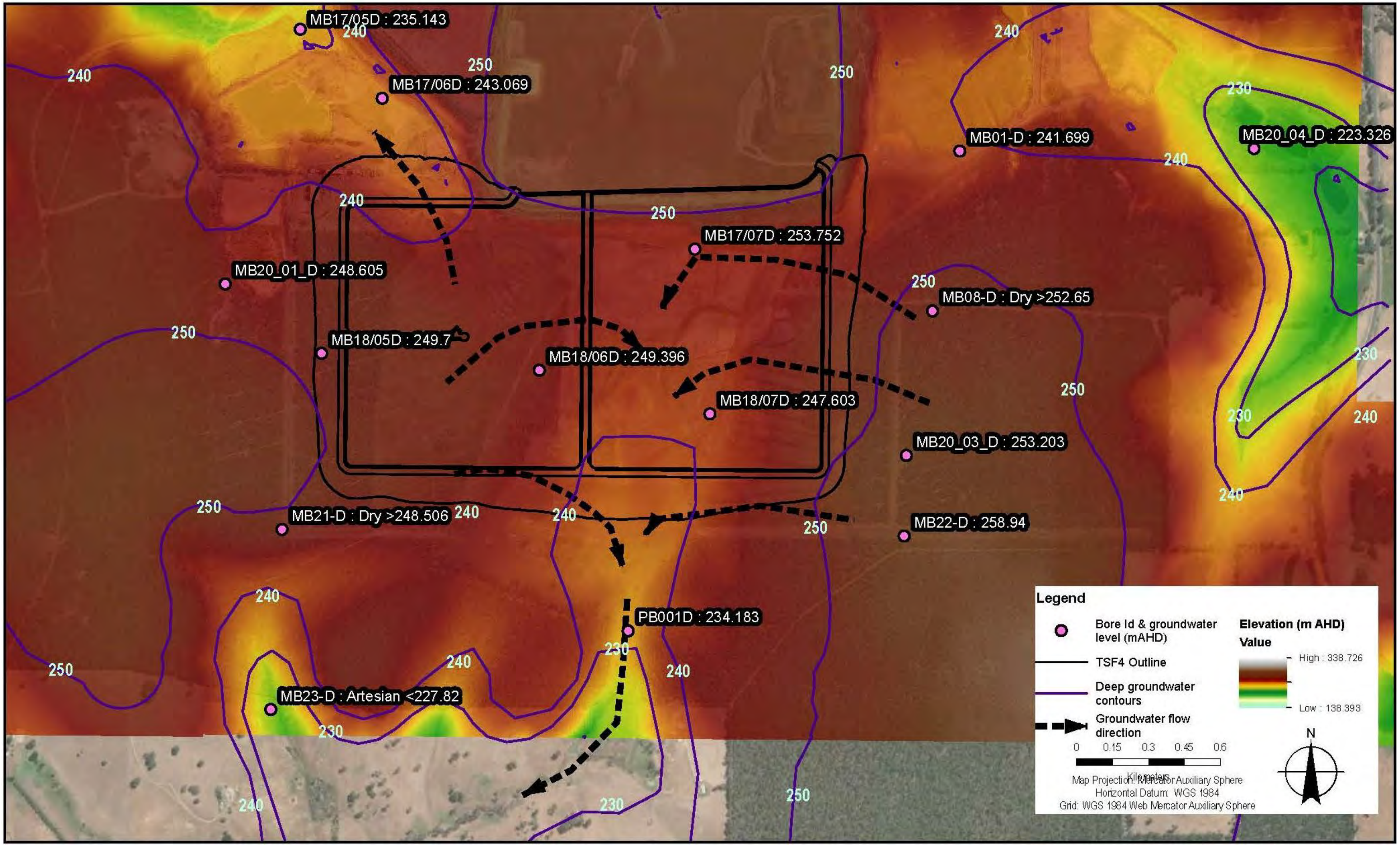

Figure 7: Interpretted saprock groundwater contours in the vicinity of TSF4 (deep)

Table 4: Hydraulic Head Potential Measured in Nested Bores[3]

Nested Monitoring Bore Location Identity Number	Hydraulic head potential (m)	Nested Monitoring Bore Location Identity Number	Hydraulic head potential (m)
PB001	-0.008	MB17/06	-0.839
MB23	- 1 to 5 (artesian)	MB08	Unknown (dry)
MB22	Unknown (dry)	MB01	+0.206
MB21	Unknown (dry)	MB18/07	+0.08
MB20_04	-0.455	MB18/06	Unknown (dry)
MB20_01	+9.793	MB18/05	Unknown (dry)
MB17/07	+0.222	MB21	Unknown (dry)

Figure 6 shows that approximately 80% of the area of shallow groundwater beneath the footprint of TSF4 is inferred to migrate from the topographical highs on the east and west flanks of the TSF, towards the centreline of the TSF, where groundwater then migrates in southerly direction with the topographical slope. **Figure 6** also shows that approximately 20% of the area of shallow groundwater beneath the footprint of the TSF4 is inferred to migrate towards the north-west.

The limited data in **Table 4** (some shallow bores dry) indicates that over the naturally topographically elevated areas on the west flanks of the TSF4 footprint, downwards hydraulic head potential appears to exists (see MB20-01 in **Table 4**). In other areas the hydraulic potential is relatively neutral, but a moderate upward hydraulic head potential is observed in monitoring well MB20-04 (artesian flow observed), which is in a topographical low ~40 m below the natural elevation of the TSF4 footprint.

The deeper groundwater flow directions depicted in **Figure 7** are similar to the shallow groundwater flow directions in **Figure 6** in that approximately 80% of the area of deep groundwater beneath the footprint of the TSF4 is inferred to migrate from the topographical highs and eventually discharge in southerly direction. The remining 20% of the area of deeper groundwater beneath the footprint of the TSF4 is inferred to migrate towards the north-west.

3.5 Baseline Groundwater Conditions

The results and key findings of the baseline groundwater and surface water monitoring reported by GHD (2022c) are summarised herein. The laboratory analysis results are reproduced and tabulated in **Table B1** in **Appendix B**, the sampling locations of which are depicted in **Figure 8**.

The baseline groundwater and surface water quality was previously compared against the geochemical signature of the mine-derived process water and TSF seepage to identify any mine derived seepage impacts (GHD, 2018). This assessment indicated that the tailings seepage water (used to slurry/deposit the tailings) has elevated added compounds (acid and buffering agent) and other elements which are released during ore processing and which can be used as tracers to distinguish the tailings seepage water impacts against the natural/background groundwater and surface water quality.

The geochemical signature of the tailings seepage water (process water) is presented in **Table 5**, and a description of the characterisation of the mine-site tracers provided by GHD (2018) is presented in **Appendix B**

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[3] Green is downwards hydraulic head potential, red is upwards hydraulic head potential. Head potential calculated as difference between groundwater level in shallow saprolite and deep bores installed into saprock (weathered basement).

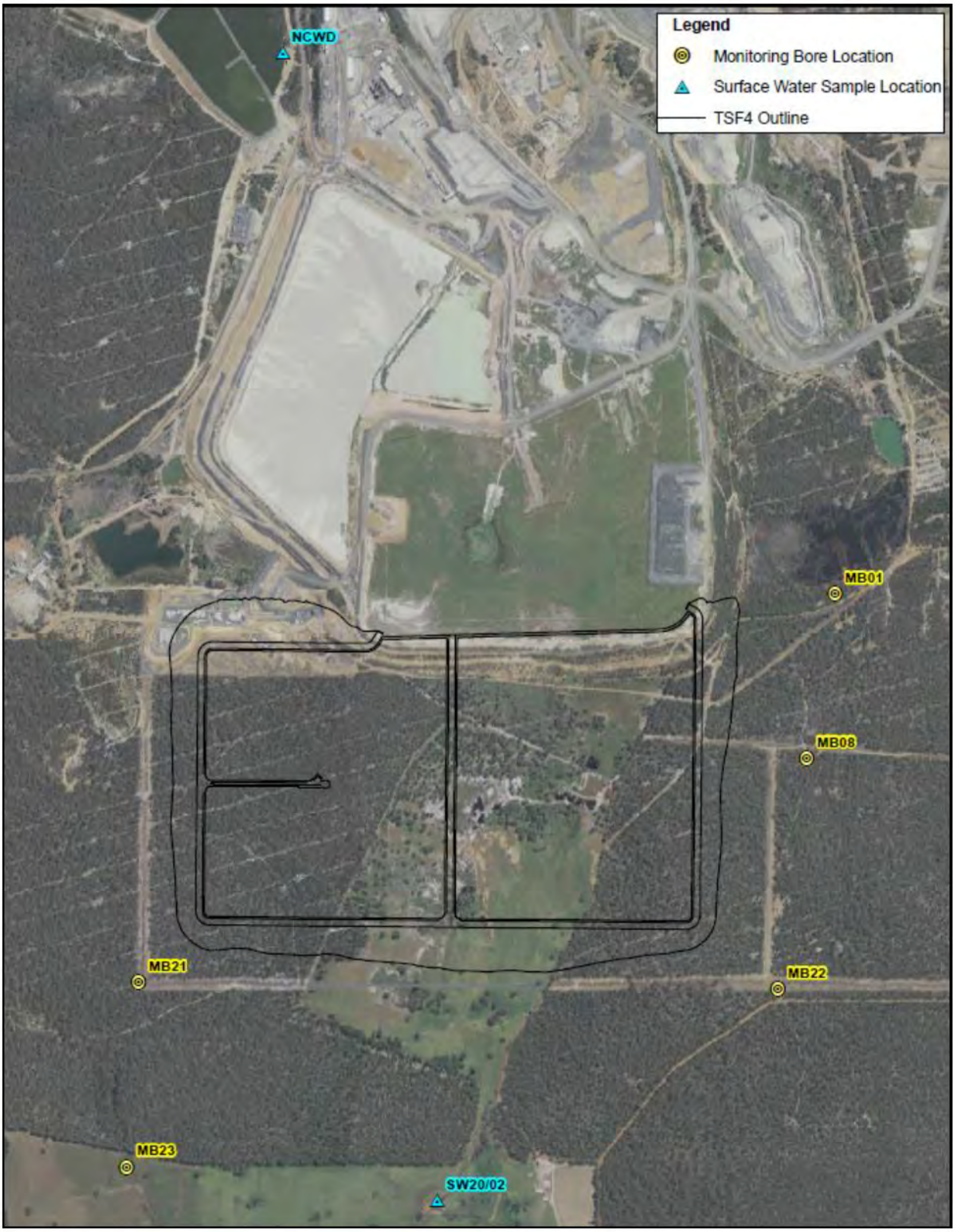

Figure 8: Plan of Water Monitoring Locations

Table 5: Comparison of Water Sample Concentrations Against Geochemical Signature of Tailings Water[4]

Bore ID	Sample concentration (mg/L)				
	Chloride	Li (dissolved)	SO4:Cl ratio	CO3:Cl ratio	Mg:Na ratio
Tailings/circuit water geochemical signature (GHD 2018)	~200 - 500	~6.0 – 18.0	~0.4 – 1.2	~0.3 – 0.6	~< 0.2
On-site Talison mining area:					
MB01-D	1,250	0.926	0.60	0.28	0.18
MB01-I	327	0.267	0.86	0.56	0.17
MB01-S	495	0.437	0.13	0.35	0.06
MB22-D	207	1.74	1.55	1.36	0.12
MB23-D	596	0.03	0.03	0.08	0.35
MB23-I	918	0.017	0.02	0.01	0.36
MB23-S	859	0.101	0.07	0.01	0.11
SW20/02	126	0.005	0.19	0.40	0.23
CWD (circuit water)	256	14.1	0.74	0.86	0.07

The groundwater and surface water results presented in **Table B1** in **Appendix B** and in **Table 5** above indicate the following key observations:

- As part of the process water circuit, the water quality in Clear Water Dam (CWD in **Figure 8**) indicates elevated concentrations of Contaminants of Potential Concern (CoPCs), including antimony, arsenic, caesium, lithium, rubidium, uranium (see **Table B1** in **Appendix B**).
- The water quality signature in monitoring bore MB01 is more consistent with that derived from the mine impacts, which reflects the position of MB01 being within the seepage pathway of TSF1 (**Table 5** and **Figure 8**). Consequently, the occurrence of elevated lithium (~0.5 to ~1 mg/L) and other metals are deemed to reflect TSF1 seepage impacts to groundwater.
- Monitoring bore MB22 is located upgradient of TSF4 and monitoring bore MB23 is located ~2 km from the current mining operations, so both should exclude the influence of the mining operations. These bores have a water quality signature that is not consistent with the derived mine impacts (see **Table B1** in **Appendix B**), therefore, the occurrence of elevated metals (e.g., arsenic, ~0.04 mg/L and lithium, up to ~ 2 mg/L) and other metals are considered to reflect background groundwater quality associated with the mineralised geological setting.

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[4] Red numbers indicate water quality within that observed as tailings seepage and circuit waters (GHD 2018).

4 TSF4 Seepage Migration and Discharge

4.1 Seepage into TSF4 Footprint

Although much of the TSF4 decant will be collected by the internal drainage network, the positive hydraulic head potential of the tailings decant (within the TSF4 tailings mass) will promote downwards seepage through the clay liner into the underlying saprolitic profile. Any seepage derived from TSF4 will migrate downwards to the water table, which is generally ~2 m to ~7 m below ground level in the vicinity of the TSF4 footprint.

Talison drilled approximately 400 sterilisation boreholes within and adjacent to the TSF4 footprint to confirm that there is no ore underlying this future facility. The drill holes (100 mm diameter) are presented conceptually in **Figure 9**, which illustrates the hydrogeological cross section through TSF4 along a short section of the alignment of section (See Section B to B’ on **Figure 10**). The cross section indicates that the boreholes were drilled through the saprolitic profile to intersect the weathered bedrock (saprock) and terminate at relatively unoxidised bedrock.

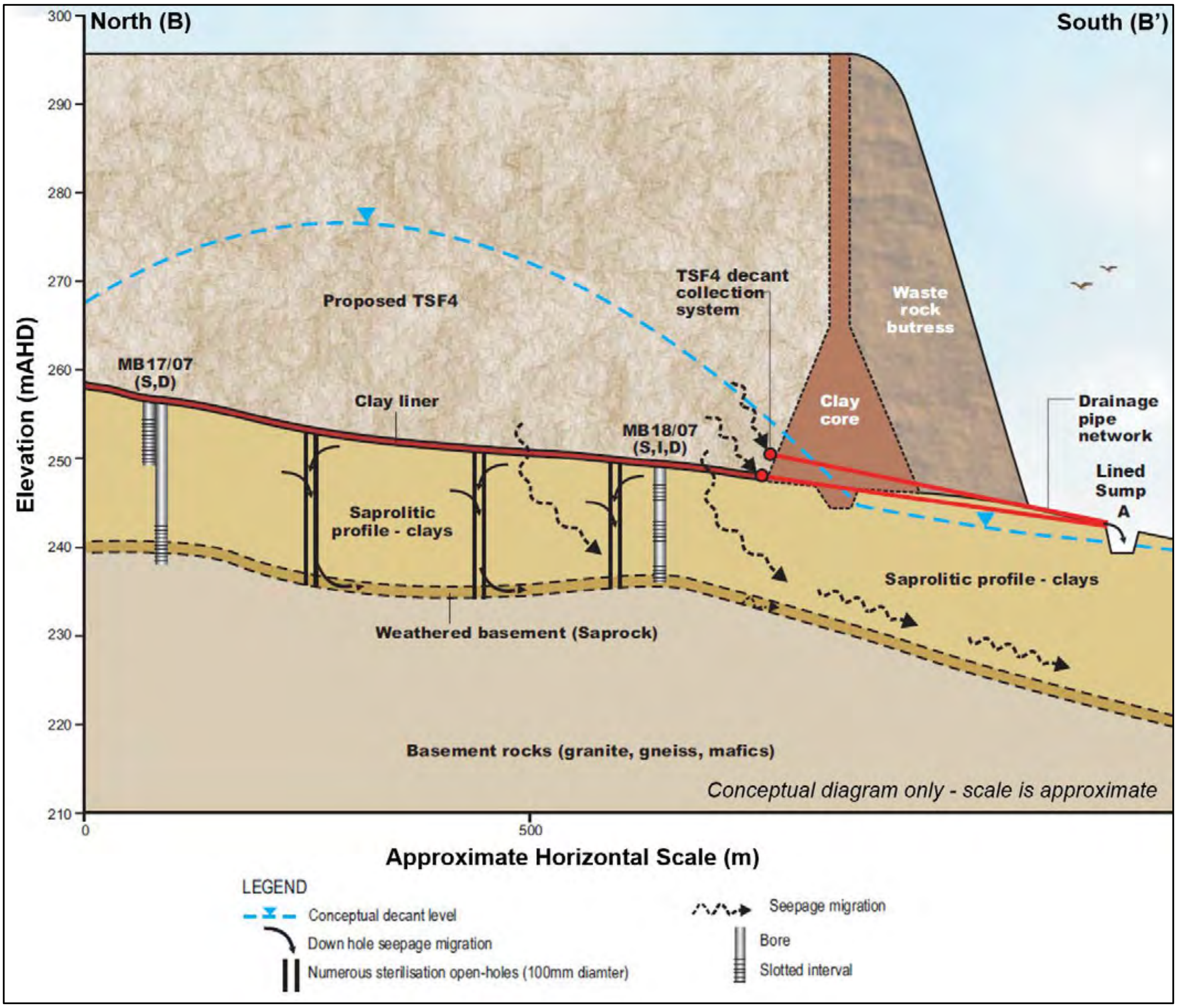

Figure 9: Hydrogeological Cross Section Through TSF4 Section B-B’ Depicting Localised Drainage and Seepage Pathways

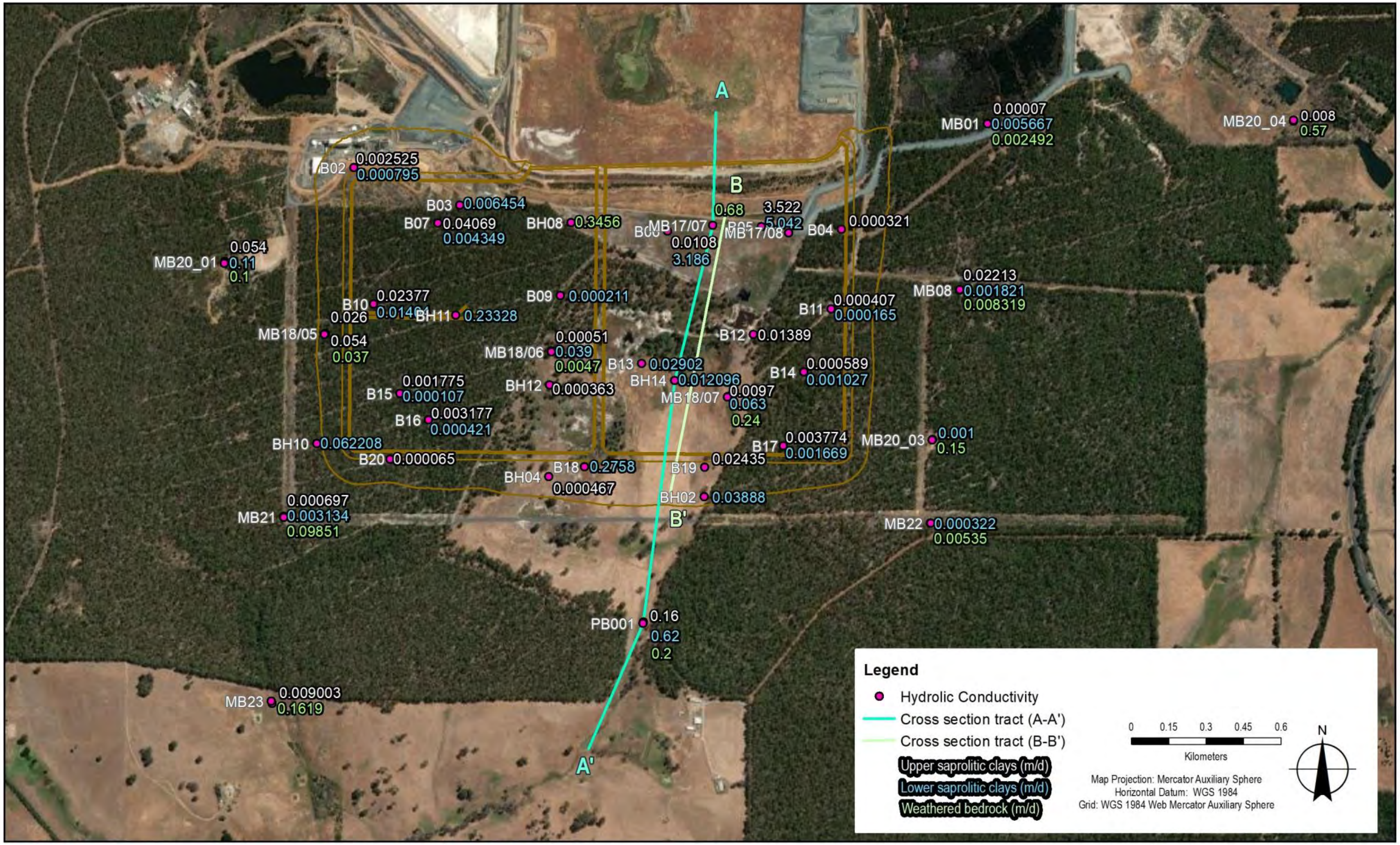

Figure 10: Hydraulic Conductivities of Saprolitic Profile (m/day), from field testing (rising/falling head tests)

It is understood that the sterilisation boreholes were backfilled with the cuttings from the drill holes. Although the boreholes have been backfilled, these may still present a preferential flow path for water seeping through the TSF4 clay liner, albeit the rate is likely to be low. A relatively small proportion of the TSF4 derived seepage may migrate downwards through the open bore holes into weathered bedrock horizon (saprock), which is characterised via hydraulic testing as being close to five times more permeable. A summary of the hydraulic test results of the various units is provided in **Table 6** and the calculated hydraulic conductivities are presented spatially in **Figure 10.**

Table 6: Hydraulic Parameters and Groundwater Velocity in Hydrogeological Profile

Groundwater unit	Hydraulic conductivity (m/d)*[5]	Effective Porosity (estimated)	Hydraulic gradient (m/m)	Groundwater flow velocity (m/year)
Upper saprolitic clay	7.0×10^{-3}	0.1	0.02	0.6
Lower saprolitic clays	6.0×10^{-3}	0.1	0.02	0.5
Weathered bedrock (Saprock)	3×10^{-2}	0.2	0.02	2.7
Fresh bedrock[6]	6×10^{-3} to 3×10^{-4}	0.1	0.02	0.02 to 0.4

Local-scale flow and transport modelling was undertaken to assess the potential effects of an individual backfilled sterilisation borehole underlying TSF4, the report on which is presented in **Appendix C**. The modelling focussed on assessing the potential for the borehole to provide a preferential pathway that could capture and direct a portion of TSF4 leakage through the relatively impermeable saprolite clay layer underlying the TSF to the more permeable saprock horizon at the bedrock interface.

The modelling (reported in **Appendix C**) shows that mixing of the low concentration of metals together with low volumetric flow (low flux), with the background groundwater within the saprock layer results in a negligible increase in the concentration of metals discharging from the model boundary (50 m from the borehole), equating to less than 1 % of the background concentration with respect to lithium (and even a smaller percentage for arsenic).

4.2 Migration of TSF4 Seepage

The shallow and deep groundwater flow directions depicted in **Figure 6** and **Figure 7** respectively indicate that much of the seepage derived from TSF4, which migrates into the geological profile, will migrate in a southwards direction, with a lesser component of flow migration in a northwest direction.

The hydraulic conductivities of the various units presented in **Table 6** support that the southwards groundwater flow will predominantly move through the saprolitic clays and underlying weathered bedrock horizon, with negligible groundwater flow inferred to flow through the bedrock. The groundwater levels, flow plans and head potential presented in **Section 3.4** indicate that the southerly groundwater flow will migrate for a distance of ~750 m downgradient of TSF4, where the observed artesian groundwater conditions at monitoring bore MB23 indicates that the groundwater may discharge into Woljenup Creek line.

The inferred hydrogeological cross section through TSF4 along the entire alignment of section A-A' as depicted in **Figure 10** is provided in **Figure 11**, which indicates the conceptual understanding of this dominant off site seepage pathway.

Seepage from TSF4 is also inferred to occur in the northwest direction within the saprolitic and weathered bedrock profile towards the drainage lines and dams/sumps associated with Tin Shed Dam and the catchment of the Cowan Brook dam, where the groundwater is likely to eventually discharge.

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[5] median and geometric mean value from hydraulic testing (Table 3).

[6] Bedrock hydraulic conductivity based on computer model calibration using measured pit inflows (GHD 2019).

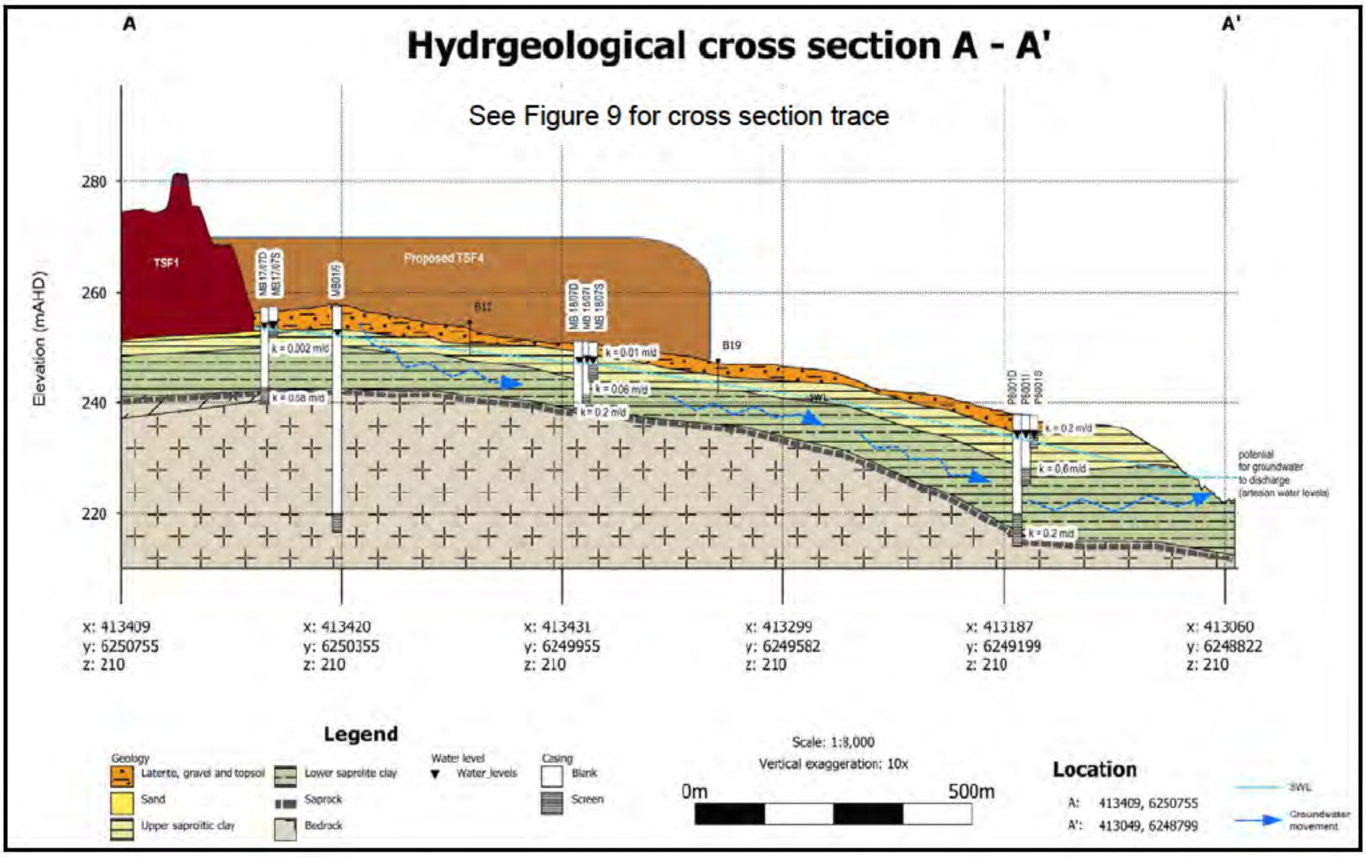

Figure 11: Hydrogeological Cross Section Through TSF4 Section A-A' Depicting off-site Seepage Pathways.

4.3 Seepage Migration Rates

The groundwater seepage rates in the geological profile beneath and within the TSF4 surrounding area was calculated based on the aquifer parameters (porosity, hydraulic gradient and measured hydraulic conductivity), and are presented in **Table 6**. These calculations indicate that the groundwater flow velocities are relatively slow in the saprolitic clays at 0.5 m/yr and increase to close to 3 m/year in the underlying weathered bedrock horizon (saprock). The unoxidised bedrock is inferred to have low seepage rates at 0.02 m/yr to 0.4 m/year.

Where TSF4 seepage migrates downwards in to the saprolitic clay profile and travels through the saprolite clays along the southern flow path, such seepage will be subject to long residence times (>1,000 years) due to the long distance to the potential groundwater discharge area (~750 m) and the slow migration rates (0.5 m/yr). The long residence time provides the opportunity to attenuate any CoPCs (dissolved metals) through adsorption and ion-exchange reactions with the saprolitic clay matrix prior to groundwater discharge. Where seepage migrates through the weathered bedrock horizon (saprock), the lower residence times (~250 years) and lower clay component, indicates that any TSF4 seepage within this unit will have less opportunity to attenuate metals through adsorption and ion-exchange reactions with the saprolitic clay matrix.

Potentially impacted TSF4 seepage, which migrates along the northwest flow path, is similar in that the long groundwater residence time provides the opportunity for the aquifer clay matrix to attenuate metals, prior to discharge of the groundwater (discharge inferred to occurs within the Cowan Brook dam catchment).

5 References

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Appendices

Appendix A

Data Tables (A1, A2 and A3)

Appendix B

Baseline Monitoring Results

Appendix C

Numerical Flow and Transport Modelling of TSF Leakage and Sterilisation Borehole

Appendix D

Bore Logs