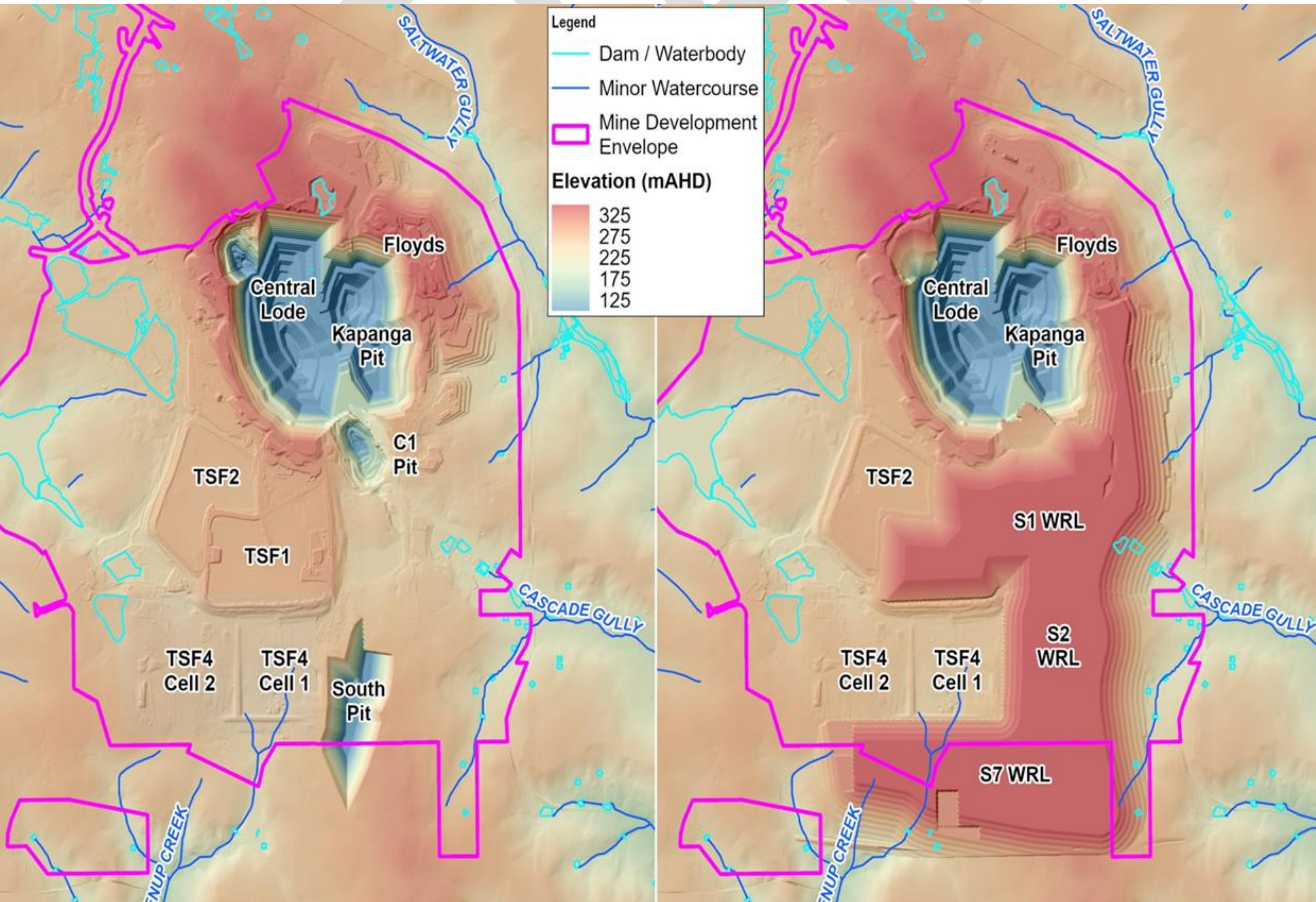
S2 and S7 Waste Rock Landforms Hydrology Study

Monitoring Plan

Talison Lithium Pty Ltd

8 January 2025

→ **The Power of Commitment**



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The Power of Commitment

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1. Introduction

1.1 Background

GHD Pty Ltd (GHD) was engaged by Talison Lithium Pty Ltd (Talison) to undertake a study (the Study) of additional proposed open pits and Waste Rock Landforms (WRLs). The Study includes hydrological and hydrogeological modelling of the proposed facilities and subsequent preliminary assessments of the environmental and human health risks arising from these facilities. The Study is focussed on the following facilities:

– Expansion of existing open cut pits and development of new open cut pits.
– Establishment of the new Floyds Stage 2 (S2) and Stage 7 (S7) WRLs.

The current planned landform of the proposed facilities at closure in circa 2052 is presented in **Figure 1.1.**

Assessments of the southern and eastern parts of the mine site and the receiving catchments have been undertaken through the *TSF4 Seepage Assessment* (Woljenup Creek) and *Eastern Catchments Hydrology Study* (Hester Brook and its tributaries Salt Water Gully and Cascades Creek). The following reports are therefore referred to in the Study:

– TSF4 Seepage Assessment: Conceptual Hydrogeological Model (GHD, 2023a).
– TSF4 Seepage Assessment: Groundwater Model Update and Site Assessment (GHD, 2023b).
– TSF4 Seepage Assessment: Human Health and Environmental Risk Assessment (GHD, 2023c).
– TSF4 Seepage Assessment: Seepage Monitoring and Management Plan (GHD, 2023d).
– TSF4 Seepage Assessment: Woljenup Creek Hydrological Assessment. (GHD, 2023e).
– Eastern Catchments Hydrological Study: Gap Analysis Report (GHD, 2023f).
– Eastern Catchments Hydrological Study: Conceptual Hydrogeological Model (GHD, 2023g).
– Eastern Catchments Hydrological Study: Surface Water and Mass Balance Modelling Report (GHD, 2023h).
– Eastern Catchments Hydrological Study: Groundwater Modelling Report (GHD, 2023i).
– Eastern Catchments Hydrological Study: Preliminary Risk Assessment Report (GHD, 2023j).
– Eastern Catchments Hydrological Study: Monitoring Plan (GHD, 2023k).
– TSF1 Seepage Assessment: Human Health and Environmental Risk Assessment (GHD, 2023l).

The purpose of this Study is to complete a baseline investigation and preliminary risk assessment of the proposed facilities to understand the efficacy of existing management and monitoring of the existing and approved facilities as well as the proposed S2 and S7 WRLs and expanded pits. The Study is also intended inform the need for management measures for incorporation into the proposed facility designs and the findings will be considered and incorporated into various Environmental Management Plans as appropriate. In doing so, the Study will support the applications for the various environmental approvals for the facilities.

The Study deliverables are:

– Gap Analysis (GHD, 2024a).
– Conceptual Hydrogeological Model (GHD, 2024b).
– Water Resources Monitoring Plan (this report).
– Groundwater Modelling (GHD, 2024c).
– Surface Water and Mass Balance Modelling (GHD, 2024d).
– Preliminary Risk Assessment (GHD, 2024e).

This report presents the water monitoring plan for the S2 and S7 WRLS and pit expansions.

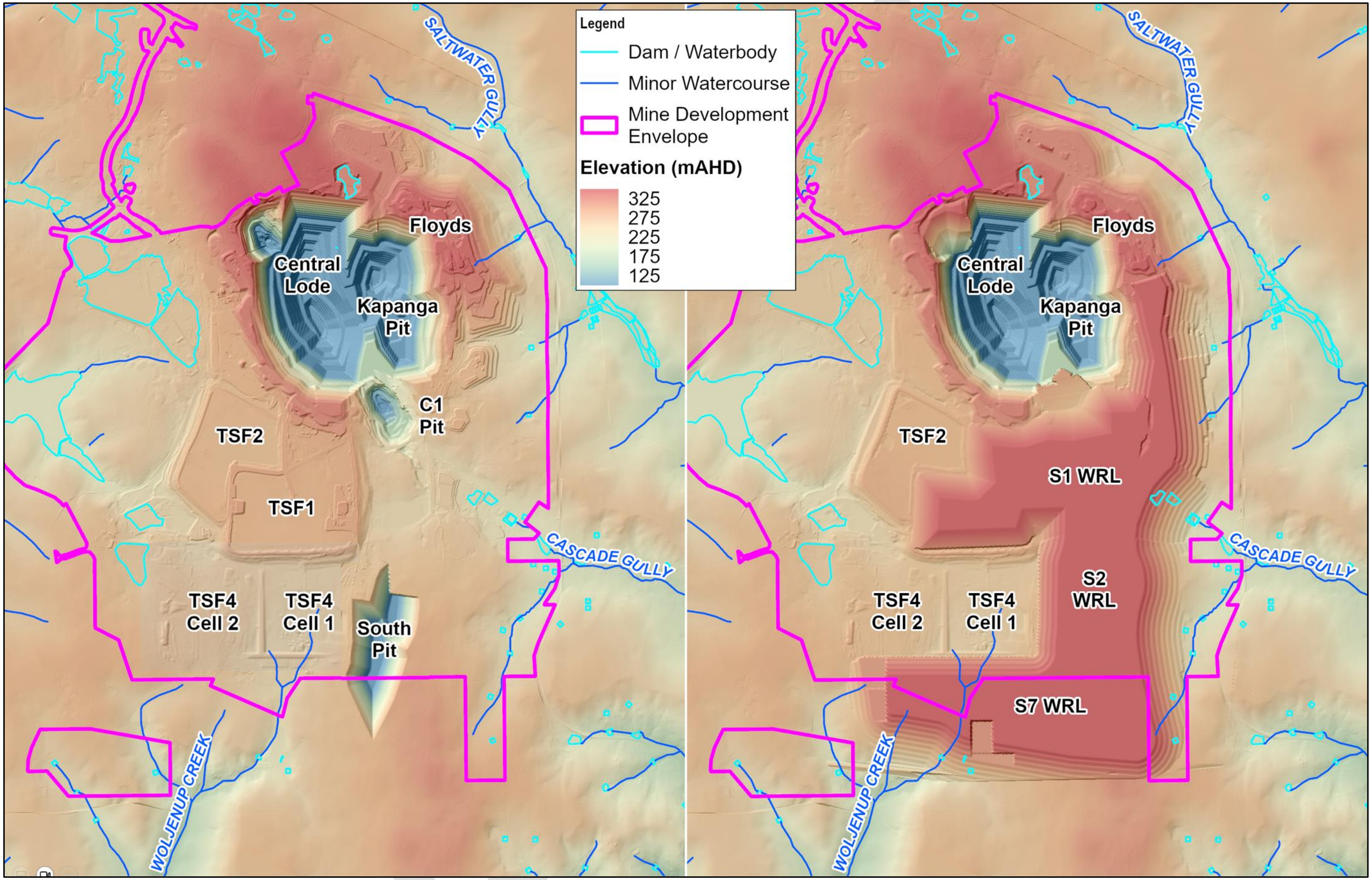


Figure 1.1: Proposed 2052 Landform

1.2 Study Area

The Study Area is defined by the proposed domains of the surface water and groundwater models:

- The surface water model domain encompasses the planned footprints of the expanded pits, the S2, S7 and Salt Water Gully (SWG) WRLs, the new SWG Dam, the various TSFs, the upstream contributing catchment areas and the downstream receiving environment. This includes Woljenup Creek and Hester Brook and its tributaries up to the confluence with Blackwood River. A plan of the surface water model domain is provided in Figure 1.1.
- The groundwater model domain matches the surface water domain, other than Hester Brook above Salt Water Gully, and accommodates the potential groundwater impact areas downgradient of the proposed activities (i.e., to the southeast). A plan of the groundwater model domain is provided in Figure 1.2.

1.3 Purpose of this Report

This report details the Monitoring Plan for the S2 and S7 WRLS and pit expansions, the purpose of which is to present a program for the establishment of baseline surface water and groundwater conditions within the likely impact footprints of the existing approved mine activities and the proposed new activities, including:

- A network of monitoring infrastructure and sampling locations; and
- Protocols and procedures for monitoring and sampling.

This report is intended for internal use by Talison to guide the implementation of the required monitoring activities to provide better definition of the geological and hydrogeological conditions in the vicinity the S2 and S7 WRLS and pit expansions and to establish the current surface and groundwater quality and flows in these areas. The program has also been designed to facilitate ongoing impact monitoring during construction and operation of these facilities should these proceed and following a review on completion of the baseline monitoring results.

1.4 Scope and Limitations

1.4.1 Scope

The scope covered by this report includes a review of existing and proposed monitoring and the development of surface water and groundwater monitoring programs to establish baseline conditions, which are informed by the site hydrology and hydrogeology, the Source-Pathway-Receptor (SPR) analysis, and Contaminants of Potential Concern (CoPCs) detailed in the *Preliminary Risk Assessment* (GHD, 2024e).

1.4.2 Limitations

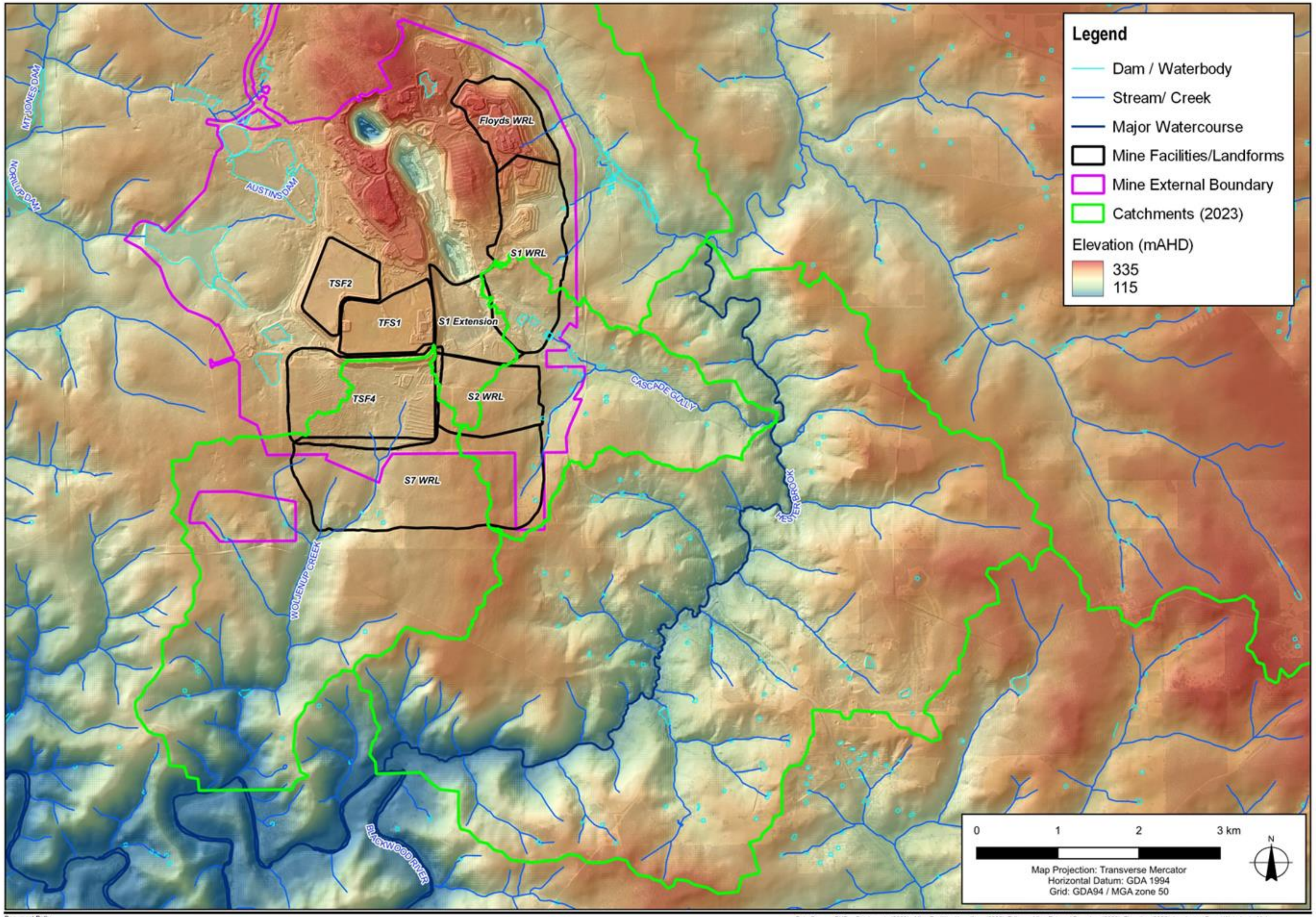
This report has been prepared by GHD for Talison and may only be used and relied on by Talison for the purpose agreed between GHD and Talison as set out in **Section 1.3** of this report.

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 in this report (refer Section 1.5 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.



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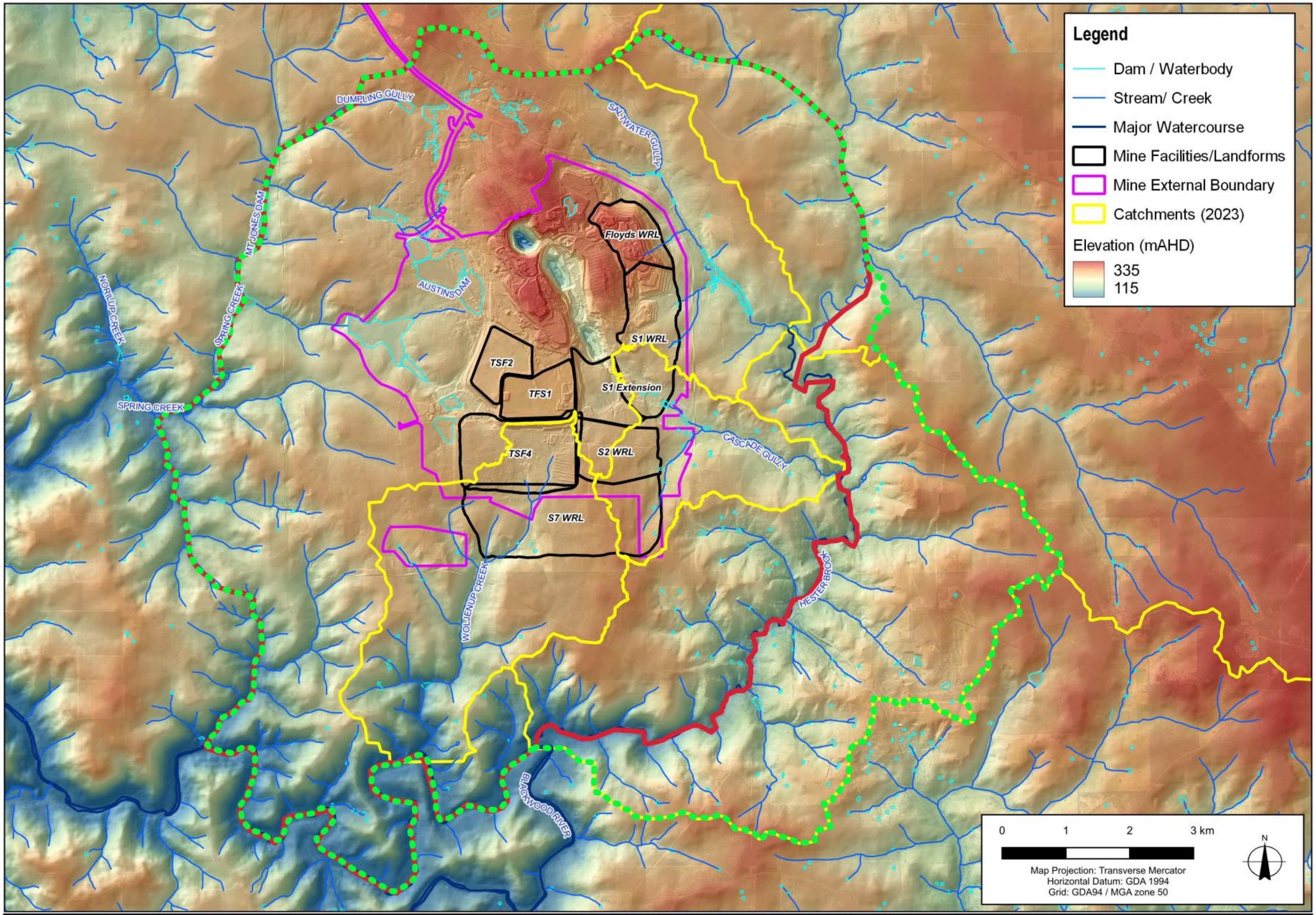
Data Source: GHD - Catchments (2023), Mine Facilities/ Landform (2022). Talison - Mine External Boundary (2023), Elevation (2022). Landgate - Dam / Waterbody, Major Watercourse, Minor Watercourse, Stream / Creek (2020), Elevation (2020).

Figure 1.2: Surface Water Model Domain.



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Data Source: GHD - Catchments (2023), Mine Facilities/ Landform (2022), Groundwater Model Domain. Talison - Mine External Boundary (2023), Elevation (2022). Landgate - Dam / Waterbody, Major Watercourse, Minor Watercourse, Stream / Creek (2020), Elevation (2020).

Figure 1.3: Groundwater model domain

GHD has prepared this report on the basis of information provided by Talison and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Surface Water Monitoring

2.1 Surface Water Monitoring Locations

Potential surface water monitoring locations for streamflow gauging and water quality sampling were selected based on the desktop assessment undertaken for the Gap Analysis (GHD, 2024a). This Plan has taken into considerations previous recommendations for monitoring provided in the *Eastern Catchments Hydrological Study: Monitoring Plan* (GHD, 2023k) and *TSF4 Seepage Assessment: Seepage Monitoring and Management Plan* (GHD, 2023d). Previously recommended monitoring sites have been included for completeness and it is assumed that these will be installed.

This assessment considered the current and approved mine operations (including S1 WRL, TSF1, and TSF4), the proposed new facilities (S2 and S7 WRLs), and available site characteristics. Such characteristics included surface water drainage channels, creeks, catchment areas, topography, site geomorphology, desirable cross-section characteristics for flow monitoring, accessibility and health and safety considerations.

Streamflow in Cascade Gully, lower Hester Brook, and Woljenup Creek (the receiving environments of S2 and S7 WRLs) is currently being monitored, or proposed to be monitored in the other plans mentioned above, at the locations detailed in **Table 2.1** and depicted in **Figure 2.1**.

Table 2.1: Existing and Proposed Streamflow Monitoring Sites from other Plans[1]

Functional Area	Site ID	Purpose	Easting (MGA94)	Northing (MGA94)
Cascade Gully	CEMETERY	Existing licenced discharge point, gauges runoff from approved S1 WRL.	415,347	6,250,952
	SW23-05	Proposed site by GHD (2023k) upstream of confluence of Hester Brook to monitor sub-catchment flows and for model calibration.	417,951	6,249,875
Lower Hester Brook	Hester Hill (609016)	Proposed site by GHD (2023k) which would entail reinstating recording of streamflow at mothballed DWER gauge to monitor discharges to Blackwood and for model calibration.[2]	416,590	6,246,550
Woljenup Creek	SW23-01	Proposed site by GHD (GHD, 2023d) on tributary discharging into the creek from mine camp to monitor sub-catchment flows and for model calibration.	412288	6248473
	SW23-02	Proposed site by GHD (GHD, 2023d) at large pool within Woljenup Creek downstream of TSF4 to monitor discharges to Blackwood and for model calibration.	411540	6246543
	SW24-01	Proposed site by GHD (GHD, 2023d) to replace SW20/02 (landowner denying access) to monitor discharges from TSF4 and for model calibration.	413180	6249160

1 It is recommended that Talison confirms the suitability of the proposed new gauging sites through field inspections.
2 It is recommended that Talison engages with DWER to establish the requirements to reinstate monitoring at Hester Hill.

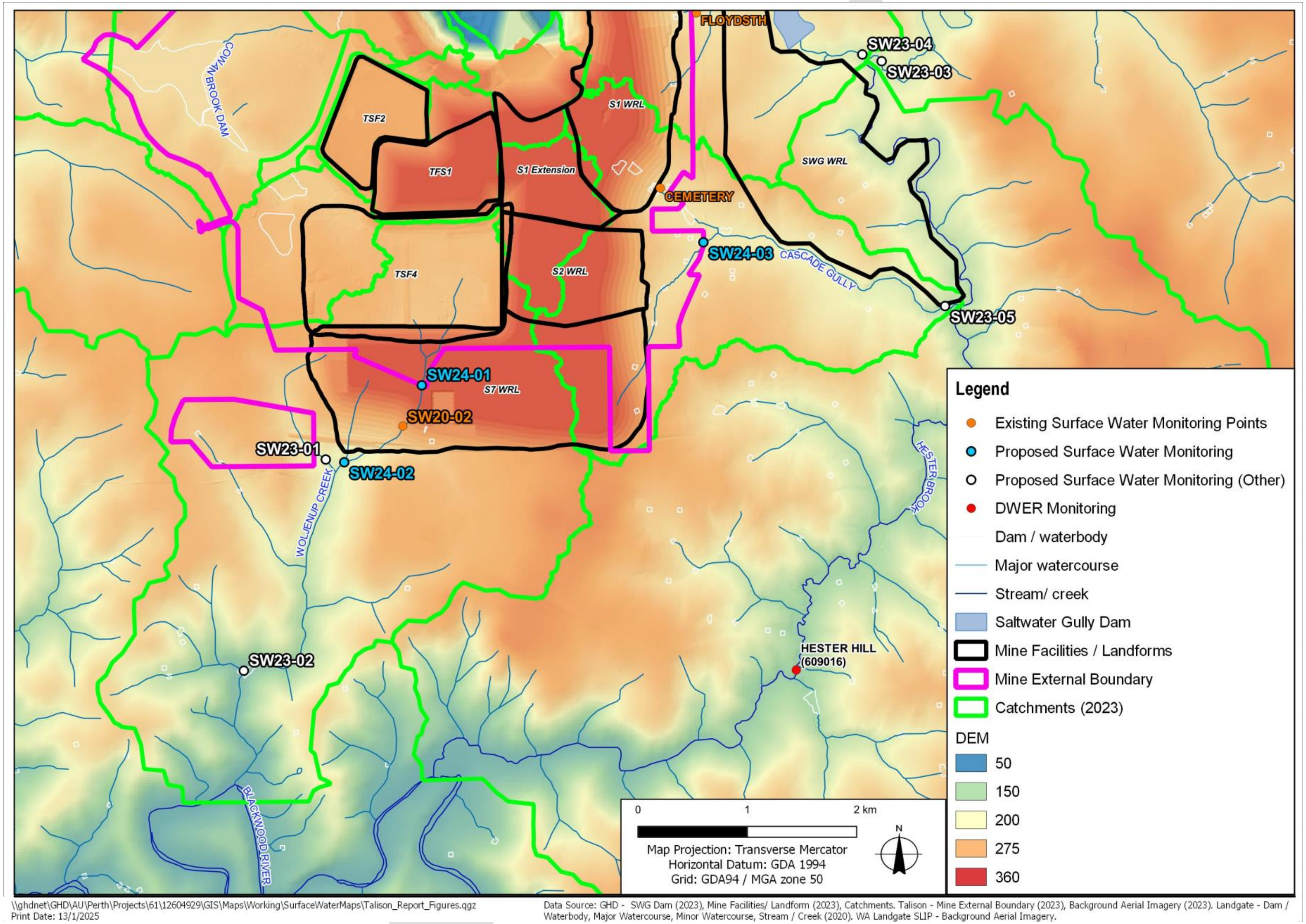

Figure 2.1: Surface Water Monitoring Locations.

It is noted in **Figure 2.1** that site SW24-01 is within the footprint of the S7 WRL and will no longer be available for monitoring once dumping in this area commences. To this end, a new site SW24-02 is proposed on Woljenup Creek downstream of the toe of the WRL. Installation of this site should be at least two years prior to dumping in the upper Woljenup Creek catchment to provide a reasonable baseline (albeit it may be impacted by discharges from TSF4). In addition to the above, monitoring of baseline and operational conditions in the unnamed north-westerly flowing tributary of Cascades Gully is recommended at site SW24-03 to identify impacts of the WRLs on this creek as well as the incremental impacts on Cascade Gully. Details of these proposed additional sites are provided in **Table 2.2**.

Table 2.2: Additional Proposed Streamflow Monitoring Sites for S2 and S7 WRLs

Waterway	Site ID	Purpose	Easting (MGA94)	Northing (MGA94)
Woljenup Creek	SW24-02	Monitor discharges from S7 WRL in Woljenup Creek and replace proposed streamflow gauge at SW20-02.	412,457	6,248,448
Cascade Gully tributary.	SW24-03	Monitor discharges from S2 and S7 WRLs in unnamed tributary of Cascades Gully.	415,741	6,250,457

2.2 Analytical Suite

Suites of water quality parameters have been identified for monitoring to provide a comprehensive characterisation of the background surface water quality as well the potential contaminants from the mine and proposed expansion activities. The analytes were derived from the SPR analysis and identification of CoPCs detailed in the *Preliminary Risk Assessment* (GHD, 2024e). The following analytical suite is recommended:

– **Physicochemical parameters:** pH, electrical conductivity (EC), total dissolved solids (TDS), oxidation-reduction potential (ORP), dissolved oxygen (DO), total suspended solids (TSS), turbidity.
– **Alkalinity:** Carbonate/bicarbonate/hydroxide (CO_3/HCO_3/OH), total as $CaCO_3$, hardness as $CaCO_3$
– **Major Anions:** Chloride (Cl), Sulphate (SO_4), Fluoride (F)
– **Major Cations:** Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K)
– **Nutrients:** Total Nitrogen (TN), Total Kjeldahl Nitrogen (TKN), nitrate and nitrite nitrogen (NO_x-N), ammonia (NH_4-N), Total Phosphorus (TP), Phosphate (PO_4)
– **Metals (dissolved and total):** Aluminium (Al), antimony (Sb), arsenic (As), cadmium (Cd), caesium (Cs), chromium (III +VI) (Cr), cobalt (Co), copper (Cu), iron (Fe), lithium (Li), manganese (Mn), molybdenum (Mo), nickel (Ni), rubidium (Rb), thallium (Tl), thorium (Th) uranium (U), vanadium (Va), zinc (Zn),
– **Hydrocarbons:** TRH; BTEX; PAHs

2.3 Surface Water Monitoring Program

A summary of the surface water monitoring program in the receiving creeks to establish the baseline conditions and for operational monitoring is presented in **Table 2.3** and the monitoring methods and procedures are presented in **Appendix A**.

Table 2.3: Summary of Surface Water Monitoring Program

Site ID	Frequency	Duration[3]	Parameters[4]	Reporting frequency
– CEMETERY – 609016 – SW23-01 – SW23-02 – SW23-05 – SW24-01 – SW24-02 – SW24-03	Monthly (when streamflow occurs)	Year 1 to Year 2 (baseline monitoring)	– Streamflow: Continuous logging of flows – Physicochemical parameters: pH, EC, TDS, ORP, DO, TSS, turbidity – Alkalinity: CO_3/HCO_3/OH, total as $CaCO_3$, hardness as $CaCO_3$ – Major Anions: Cl, SO_4, F – Major Cations: Ca, Mg, Na, K – Nutrients: TN, TKN, NO_2-N, NO_3-N, NH_4-N, TP, PO_4 – Metals: Al, Sb, As, Cd, Cs, Cr_{III}, Cr_{IV}, Co, Cu, Fe, Li, Mn, Mo, Ni, Rb, Tl, Th, U, Va, Zn – Hydrocarbons: TRH; BTEX; PAHs	Internal monthly surface water monitoring report for sites, Internal annual: surface water monitoring review for all sites. Annual Environmental Report for licenced sites.
	Bimonthly (when streamflow occurs)	Year 3 onwards (operational monitoring)		Internal bimonthly surface water monitoring report for sites. As above for annual reports.

2.4 Reporting and Evaluation

The evaluation of surface water monitoring data should include the assessment and reporting of the following:

– Presentation of the baseline surface water flows and quality at the licenced discharge points and within the various downstream creeks (with which to compare any future impacts).

– Assessment of concentrations of CoPCs and major ions and loads of CoCPs in the various creeks over time (graphs with trend analysis).

– Summary of quality control and sampling methods (QA/QC).

The above data and information should be included in a baseline monitoring report. Identification of baseline CoPC concentrations in the receiving creeks should be considered as the seasonally adjusted median concentrations following a minimum of two years of monitoring prior to construction.

Flow and quality trigger levels should be established following baseline monitoring and an adaptive management plan developed to manage flows and quality.

[3] Year 1 indicates start of monitoring period, nominally two years prior to dumping in the upstream catchment area. Note that other plans may require monitoring to commence earlier at sites nominated in such plans.

[4] Laboratory limits of reporting to below WQGs as follows:

< 1 mg/L: major ions/nutrients	< 0.1 mg/L: Mn	< 0.01 mg/L: Al, Cs, Mo, Ni
< 0.001 mg/L: Sb, As, Cs, Cr, Li, Rb	<0.0001 mg/L: Cd, Cu, U	<0.00001 mg/L: Tl, V

3. Groundwater Monitoring

3.1 Groundwater Monitoring Locations

Potential groundwater water monitoring locations were selected based on the desktop assessment undertaken for the Gap Analysis (GHD, 2024a). This Plan has taken into consideration existing monitoring plans within the Study Area as well as recommendations for monitoring provided in other plans.

Five nested shallow (S), intermediate (I), and deep (D) bores (targeting the surficial sands, the saprolite formation, and the base of the saprock layer respectively) have been installed along the eastern boundary of the existing Floyds WRL and approved S1 WRL extension to monitor seepage impacts from these WRLs. These are existing WRL compliance monitoring bores, a summary of which is provided in **Table 3.1** and the locations are depicted in green in **Figure 3.1**. Another bore (MB25) has been installed adjacent to Cascade Gully to monitor potential impacts at an existing groundwater user.

Existing groundwater monitoring of potential seepage impacts from TSF1 is documented in the *TSF1 Groundwater Monitoring Program December 2023 Summary Report* (GHD, 2023j). Seven sites comprising nested S, I, and D bores (also targeting the surficial sands, the saprolite formation, and the base of the saprock layer respectively) have been installed downgradient of TSF1 to monitor potential seepage impacts. A summary of the existing TSF1 monitoring bores is provided in **Table 3.1** and the locations are depicted dark blue in **Figure 3.1**. It should be noted that all these bores will be impacted by the development of the S2 and S7 WRLs. If possible, the standpipes should be extended and reinforced to facilitate ongoing monitoring of potential TSF1 seepage impacts.

Existing and proposed groundwater monitoring of baseline conditions and potential seepage impacts from TSF4 is documented in the *TSF4 Seepage Assessment: Seepage Monitoring and Management Plan* (GHD, 2023d), a summary of which is:

– Eight sites comprising nested S, I, and D bores have been installed downgradient of TSF4 to monitor the baseline and potential distal seepage impacts (depicted in light blue in **Figure 3.1**).
– A further eight sites comprising nested S, I, and D bores have been installed along the southern toe of theTSF4 embankment TSF4 to monitor baseline and operational seepage impacts (depicted in light pink in **Figure 3.1**).
– An additional six monitoring bores (also S, I, and D) are to be installed along the western and eastern toes of theTSF4 embankment following a preliminary period of operations and if the groundwater mounding beneath TSF4 produces an observable outwards radial groundwater flow pattern from TSF4 and a localised reversal of the dominant southerly groundwater flow direction (depicted in dark pink in **Figure 3.1**).

A summary of the existing and proposed TSF4 monitoring bores is provided in **Table 3.1**. It should be noted that all these bores will be impacted by the development of the S2 and S7 WRLs. If possible, the standpipes should be extended and reinforced to facilitate ongoing monitoring of potential TSF4 seepage impacts.

Thirteen nested S, I, and D bores are proposed to monitor the baseline conditions and potential seepage impacts from the proposed SWG WRL and SWG Dam, details of which are documented in the *Eastern Catchments Hydrological Study: Monitoring Plan* (GHD, 2023k). Talison has revised the locations of several of these bore sites to according to the current conceptual design of SWG WRL and full supply level of SWG Dam. A summary of the existing WRL monitoring bores is also provided in **Table 3.1** and the locations are depicted in yellow in **Figure 3.1**.

As noted above and in **Figure 3.1** that several existing monitoring bores fall within the footprint of the S1 extension, S2, and S7 WRLs (i.e. predominantly the TSF1 operational monitoring bores and TSF4 baseline monitoring bores). These bores are monitored regularly (quarterly to bi-annually) for water quality and water levels, and sufficient data are available to characterise the baseline conditions over that part of the footprint of the S2 and S7 WRLs. These bores also provide sufficient hydrogeological information in the respective parts of the footprint, including lithology, permeability, and water level information, that will be appropriate to develop the hydrogeological conceptual model. Further, bores MB21-1 and MB23-1 are positioned in locations which are suitable for future monitoring during operations and closure of S7 WRL.

Table 3.1: Summary of Existing Groundwater Monitoring Bores[5]

Functional Area	Site ID	Purpose [6]	Easting (MGA94)	Northing (MGA94)
Floyds and S1 WRLs (Cascade and Salt Water Gully)	MB WRD-N	Existing S, I, & D nested bores installed to east of Floyds and S1 WRLs to monitor potential seepage/seepage impacts.	414,639	6,254,177
	MB WRD-NE		415,371	6,253,583
	MB WRD-E		415,619	6,252,644
	MB WRD-SE		415,619	6,251,979
	MB20-04		415,333	6,250,845
	MB25		416,702	6,250,325
TSF1 (Cascade Gully, mine pit, S2 WRL) See *TSF1 Groundwater Monitoring Program December 2023 Summary Report* (GHD, 2023j).	MB22-26	Existing S, I, & D nested bores installed to east of TSF1 to monitor potential operational seepage impacts.	413,981	6,251,589
	MB22-27		414,048	6,251,412
	MB22-28		414,302	6,251,278
	MB22-29		414,050	6,251,231
	MB22-30		414,587	6,251,148
	MB22-31		414,331	6,250,989
	MB22-32		414,066	6,250,707
TSF4 (Woljenup Creek, S2 and S7 WRL) See *TSF4 Seepage Assessment: Seepage Monitoring and Management Plan* (GHD, 2023d) for further details.	MB01	Existing S, I, and D nested bores installed downgradient of TSF4 to monitor baseline and potential distal seepage impacts.	414,315	6,250,825
	MB08		414,226	6,250,272
	MB20-01		411,773	6,250,341
	MB20-03[7]		414,139	6,249,774
	MB21		411,979	6,249,499
	MB22		414,135	6,249,498
	MB23		411,943	6,248,885
	PB001		413,180	6,249,160
	MB24-01	Existing S, I, & D nested bores installed along toe of southern embankment of TSF4 to monitor baseline and potential seepage impacts.	412,225	6,249,573
	MB24-02		412,364	6,249,523
	MB24-03		412,700	6,249,511
	MB24-04		412,935	6,249,514
	MB24-05		413,074	6,249,455
	MB24-06		413,200	6,249,460
	MB24/07		413,460	6,249,525
	MB24-08		413,835	6,249,534
	MB24/08S/1		413,677	6,249,527
	MB24-09	Proposed S, I, & D nested bores to be installed along toe of western and eastern embankments of TSF4 to monitor baseline and potential seepage impacts. Only to be installed if groundwater mounding produces an observable outwards radial groundwater flow pattern from TSF4.	411,960	6,250,565
	MB24-10		411,960	6,250,200
	MB24-11		411,960	6,249,820
	MB24-12		414,015	6,250,615
	MB24-13		414,015	6,250,340

5 Blue highlighted bores - some or all of bores are dry.
Grey highlighted bores outside potential groundwater impact zone of S2 and S7 WRLs.
6 S – Shallow depth targeting the upper sands, laterite and upper clays.
I – Intermediate depth targeting the saprolite clays.
D – Deep bores targeting the weathered basement rocks.
7 Only I & D bores installed.

Functional Area	Site ID	Purpose [6]	Easting (MGA94)	Northing (MGA94)
	MB24-14		414,015	6,250,005
SWG WRL (Salt Water Gully and Cascade Gully). See *Eastern Catchments Hydrological Study: Monitoring Plan* (GHD, 2023k).	MB23-01	Proposed S, I, & D nested bores to be installed within the potential impact footprint of the proposed SWG WRL.	414,851	6,254,521
	MB23-02		415,629	6,253,650
	MB23-03		416,356	6,252,608
	MB23-04		416,445	6,252,266
	MB23-06		415,530	6,251,696
	MB23-07		417,041	6,252,094
	MB23-08		415,616	6,251,178
	MB23-09		417,043	6,251,291
	MB23-10		416,230	6,250,610
	MB23-11		417,668	6,250,678
	MB23-12		417,502	6,250,187
	MB23-13		417,970	6,250,013
	MB23-14		415,542	6,250,243

Additional monitoring bores will be required at the periphery and downgradient of the S2 and S7 WRLs to establish the requisite hydrogeological information in those areas not covered by the above-mentioned existing bores, for baseline monitoring, and for future operational and closure monitoring. Such bores should be located at the toes of the proposed WRLs, hydraulically downgradient, and at the groundwater discharge locations, such as where groundwater levels indicate groundwater may discharge may occur into the creek lines (receptor). It is also important to establish continuity of monitoring through the baseline, operational, and closure stages to compare and monitor any future seepage impacts.

The recommended network of groundwater monitoring sites for the S2 and S7 WRLs is presented in **Figure 3.1** (depicted in red) which satisfies the above gaps and aims (baseline conditions, conceptual model, and operations/closure monitoring). The coordinates are presented in **Table 3.2**. The locations are approximate and are subject to the final design of the landform and site access.

Table 3.2 Proposed monitoring bore locations

Functional areas	Site ID	Proposed location	Northing (MGA94)	Easting (MGA94)
Woljenup Creek	MB24-16	Southern toe of S7 WRL	413519	6248542
	MB24-17	Woljenup Creek tributary.	413181	6247471
	MB24-18	Southern toe of S7 WRL	414359	6248539
Cascade Gully	MB24-19	South-east toe of S7 WRL	415189	6248606
	MB24-20	Cascade Gully, west tributary.	415224	6249506
	MB24-21	Cascade Gully, west tributary.	415699	6250440

Bore depths are likely to be ~30 m to~50m, with S, I, and D piezometers installed at each site (nominally set at the base of surficial sands if present, the base of the saprolite layer, and in fractured bedrock in the more elevated areas. All bore drilling and construction activities should be conducted in accordance with the regulatory requirements set by DWER under the Minimum Construction Requirements for Water Bores in Australia developed by the National Uniform Drillers Licensing Committee (NUDLC, 2020).

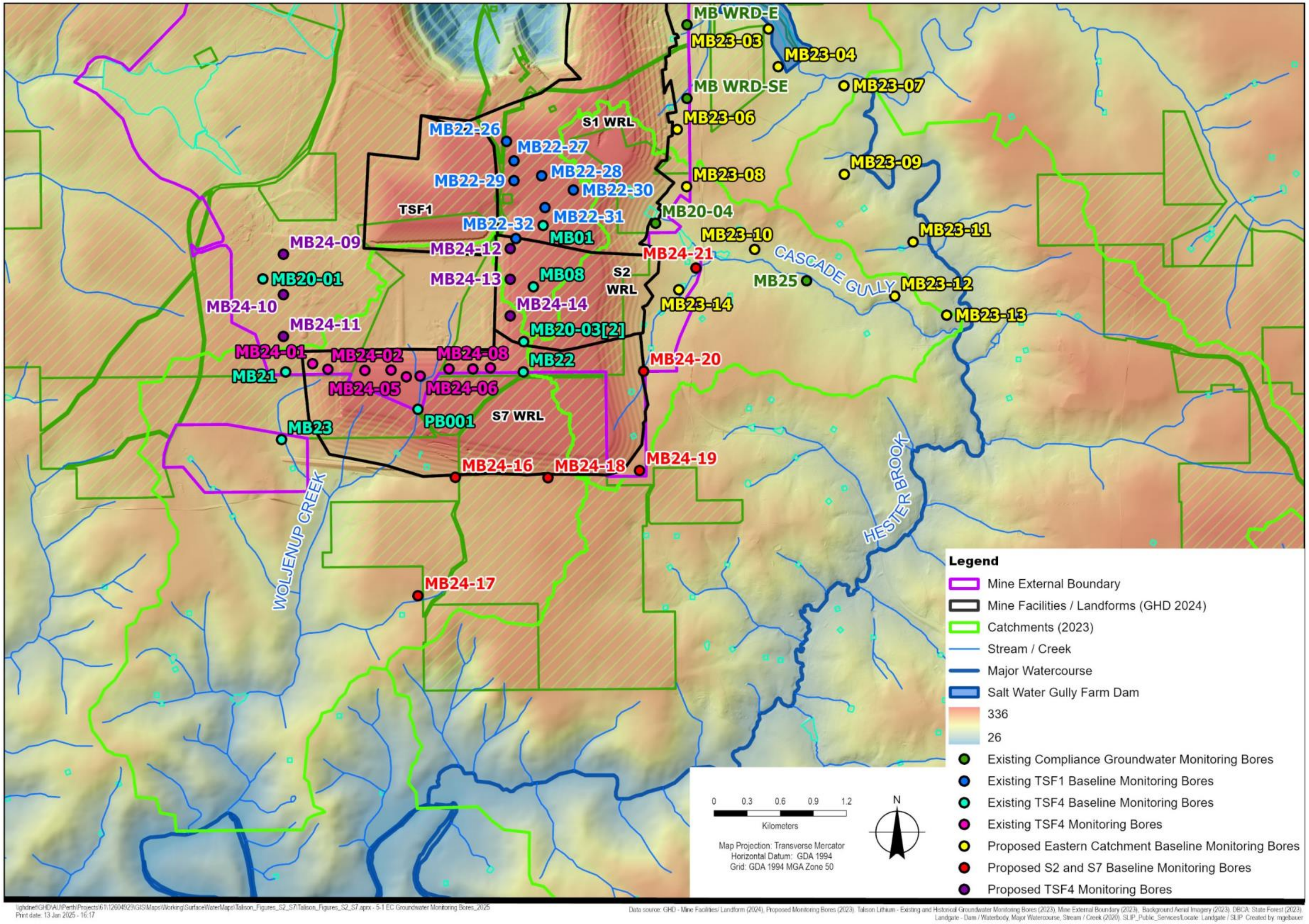

Figure 3.1: Locations of Groundwater Monitoring Bores.

3.2 Analytical Suite

The standing groundwater levels (SWLs) should be measured from the top of casing prior to sampling. Discharge at the wellhead should be monitored insitu for basic groundwater parameters (listed below as physicochemical parameters). Final readings should be recorded as per standard field observation procedures for purging and/or low-flow sampling techniques, with standard parameter stabilisation criteria applying (Sundaram, 2009). The analytes were derived from the SPR analysis and identification of CoPCs detailed in the *Preliminary Risk Assessment* (GHD, 2024e). The following analytical suite is recommended:

– **Physicochemical parameters:** pH, electrical conductivity (EC), total dissolved solids (TDS), oxidation-reduction potential (ORP), dissolved oxygen (DO), temperature.
– **Alkalinity:** Carbonate/bicarbonate/hydroxide (CO_3/HCO_3/OH), Total as $CaCO_3$, Hardness as $CaCO_3$
– **Major Anions:** Chloride (Cl), Sulfate (SO_4), Fluoride (F)
– **Major Cations:** Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K)
– **Nutrients:** Total Nitrogen (TN), Nitrate nitrogen (NO_3-N), Total Phosphorus (TP), Phosphate (PO_4).
– **Organic Indicators:** Sulfur as S
– **Dissolved Metals:** Aluminium (Al), antimony (Sb), arsenic (As), cadmium (Cd), caesium (Cs), chromium (III +VI) (Cr), cobalt (Co), copper (Cu), iron (Fe), lithium (Li), manganese (Mn), molybdenum (Mo), nickel (Ni), rubidium (Rb), thallium (Tl), thorium (Th) uranium (U), vanadium (V), zinc (Zn).

3.3 Groundwater Monitoring Program

A summary of the surface water monitoring program in the receiving creeks to establish the baseline conditions and for operational monitoring is presented in **Table 2.3** and the monitoring methods and procedures are presented in **Appendix A**.

Table 3.3: Summary of Groundwater Monitoring Program

Site ID	Frequency	Duration[8]	Parameters[9]	Reporting frequency
Floyds and S1 WRLs (MB20-04, and MB25	As required for existing WRL compliance monitoring.			
TSF1 (MB22-26 to MB22-32)	As required by the *TSF1 Groundwater Monitoring Program December 2023 Summary Report* (GHD, 2023j). If possible, extent and reinforce standpipes to facilitate ongoing monitoring of potential TSF1 seepage impacts when S2 WRL becomes operational.			
TSF4 (MB01, MB08, MB20-01, MB20-03, MB21 to MB23, PB001, MB24-01 to MB24-14)	As required by the *TSF4 Seepage Assessment: Seepage Monitoring and Management Plan* (GHD, 2023d). If possible, extent and reinforce standpipes to facilitate ongoing monitoring of potential TSF4 seepage impacts when S7 WRL becomes operational.			
SWG WRL and SWG Dam (MB23-01 to MB23-04, and MB23-06 to MB23-14)	As required by the *Eastern Catchments Hydrological Study: Monitoring Plan* (GHD, 2023k).			

8 Year 1 indicates start of monitoring period, nominally two years prior to dumping in the upstream catchment area. Note that other plans may require monitoring to commence earlier at sites nominated in such plans.
9 Laboratory limits of reporting to below WQGs as follows:
< 1 mg/L: major ions/nutrients | < 0.1 mg/L: Mn | < 0.01 mg/L: Al, Cs, Mo, Ni
< 0.001 mg/L: Sb, As, Cs, Cr, Li, Rb | <0.0001 mg/L: Cd, Cu, U | <0.00001 mg/L: Tl, V

Site ID	Frequency	Duration[8]	Parameters[9]	Reporting frequency
– MB24-16 – MB24-17 – MB24-18 – MB24-19 – MB24-20 – MB24-21	Bi-monthly (January, March, May, July, September, November)	Year 1 to Year 2 (baseline monitoring)	– Standing Water Level (m below top of casing) – Physicochemical parameters: pH, EC, TDS, ORP, DO, temperature. – Alkalinity: CO_3/HCO_3/OH, total as $CaCO_3$, Hardness as $CaCO_3$ – Major Anions: Cl, SO_4, F – Major Cations: Ca, Mg, Na, K – Nutrients: TN, NO_3-N, TP, PO_4. – Dissolved Metals: Al, Sb, As, Cd, Cs, Cr, Co, Cu, Fe, Li, Mn, Mo, Ni, Rb, Tl, Th, U, V, Zn.	Internal bimonthly groundwater monitoring report for all bores. Internal annual: groundwater monitoring review for all bores. Annual Environmental Report for licenced bores.
As above	Quarterly (March, June, September, December)	Year 3 onwards (operational monitoring)	As above	Internal quarterly groundwater monitoring report for sites. As above for annual reports.

3.4 Reporting and Evaluation

The evaluation of groundwater monitoring data should include the assessment and reporting of the following:

– Groundwater flow directions (contour plans and tables of groundwater level data).
– Presentation of baseline groundwater quality (with which to compare any future impacts).
– Identification of CoPC concentrations in groundwater which can be attributed to WRL leachate seepage, based on comparison of the groundwater laboratory results to the baseline groundwater quality.
– Graphs and trend analysis of CoPCs and major-ion concentrations against time.
– Map mine site impact signatures.
– Migration direction and rate of any impacts identified as derived from the existing mine site (MSA) including the and proposed reuse of TSF1 and, construction and operation of SWG Dam, and establishment of the SWG8 WRL
– Summary of quality control and sampling methods (QA/QC).

The above data and information should be included in an annual baseline monitoring report.

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Appendix A

Methods for Groundwater and Surface Water Monitoring

Monitoring Methods and Procedures

A-1 Groundwater Monitoring

A-1-1 Groundwater Level Monitoring

Groundwater levels should be measured using an electronic interface water level meter prior to collection of groundwater samples during all groundwater monitoring events. The water level meter should be cleaned and washed between sampling locations using Decon90 detergent, tap water and deionised water.

A-1-2 Groundwater Field Water Quality Parameters

Groundwater monitoring parameters should be recorded using a calibrated field water quality meter. The following parameters should be recorded during well purging:

– Temperature (^{o}C).
– pH (pH units).
– Electrical conductivity (EC; µS/cm).
– Dissolved oxygen (DO; mg/L).
– Oxidation-reduction potential (ORP).

Field measurements should be recorded on field sampling sheets. Field observations such as odours and colour should also be recorded on field sampling sheets.

For bores that are screened through entire saturated length, the water quality probe should be lowered into the column and a measurement taken one metre below the water surface and one metre above the base of the bore. For discretely screened bores, the measurements should be taken at the nominal centre of the screen intervals.

A-1-3 Groundwater Quality Sample Collection

Groundwater bores should be purged prior to collection of groundwater quality samples to provide representative samples of in-situ groundwater. The static water level should be measured allowing a water column depth and purge volume to be calculated, which is essential to evacuate stagnant water in the bore prior to sampling. Purging of groundwater monitoring bores should be based on AS/NSZ 5667.11-1998 (Standards Australia, 1998).

Groundwater monitoring bores should be purged until stabilisation of field parameters has occurred over three consecutive readings.

Groundwater monitoring bores should be sampled using low-density polyethylene tubing coupled to an electric pumping system. Depending on bore type (i.e., diameter), and bore yield the pump may be either a peristaltic or micro purge ('low flow') pump system.

A-1-4 Filtering of Groundwater Samples

Filtering is important process to remove suspended particulate that may affect sample results. Filtration of groundwater samples is generally limited to metal analysis.

Filtering can be completed in the field using in-line filters or a vacuum filter kit. Filtering of samples can also be completed by the laboratory, in which case, the samples should not be preserved and should be delivered to the laboratory within 24 hours of sample collection.

A-2 Surface Water Monitoring

Sample collection, processing, transportation, storage, preservation and labelling of surface water samples should be conducted in accordance with the appropriate industry standards and general surface water sampling guidance AS/NZS 5667.1:1998 (Standards Ausralia, 1998).

A-2-1 Field Parameters

Surface water monitoring parameters should be recorded using a calibrated field water quality meter. The following parameters should be recorded:

– Temperature (ºC).
– pH (pH units).
– Dissolved oxygen (DO; mg/L).
– Electrical conductivity (EC; µS/cm).
– Oxidation-reduction potential (ORP).
– Total dissolved solids (TDS).

Field measurements should be recorded on field sampling sheets. Field observations such as odours and colour should also be recorded on field sampling sheets.

A-2-2 Surface Water Grab Sample Collection

Where the embankment of the water body is stable and the water body can be safely accessed, surface water samples should be collected by hand. Where possible, samples should be collected directly into the laboratory supplied sample containers. For samples that have preservatives, samples should be decanted into the laboratory supplied sample containers.

Where depth permits, the sample container should be positioned at least 10 cm below the surface water level, above the sediment bed and oriented with the capped opening facing downwards to avoid the collection of surface films. Once in position, the container cap should be removed to allow sample collection. Where sampling points cannot be safely accessed, surface water samples should be collected using a long-handled sampler and decanted into the laboratory supplied sample containers.

A-3 Field Sampling Program

Field sampling should be completed in accordance with industry accepted standards (Standards Australia, 2005) using uniform and systematic methods to ensure collection of representative environmental samples. Key requirements of these procedures are as follows:

– Calibration of field equipment: The water quality meter should have calibration checks completed using appropriate calibration standards prior to use.
– Appropriately trained and experienced staff should conduct and document site activities. Field activities should be conducted in general accordance with based on accepted industry protocols for environmental sampling.
– Decontamination procedures: These include the use of new disposable gloves for the collection of each sample, decontamination of reusable sampling equipment between each sampling location, and the use of appropriate sampling containers provided by the primary laboratory.
– Sample identification procedures: Collected samples should be immediately transferred to sample containers of appropriate composition and preservation for the required laboratory analysis. All sample containers should be clearly labelled with a sample number, job number, sample depth and sample date. The sample containers should then be transferred to a chilled insulated container for sample preservation prior to and during shipment to the analytical laboratory.

– Chain of Custody (CoC) information requirements: A CoC form should be completed and forwarded to the testing laboratory with the samples. A CoC form should be used for every batch of samples submitted to the laboratory. Delivery and analysis of samples to the laboratory should comply with sample holding times.

– Duplicate and blank samples: As detailed in **Section A-4**.

– Decontamination methodology:

  - Where possible, single use sampling equipment which does not require decontamination should be utilised.
  - When needed, equipment should be cleaned and decontaminated using a triple rinse system.

– Logging procedures: All samples should be described using a recognised system.

Samples should be taken in accordance with the following guidelines:

- Australian Standard 5667.1998 Water Quality – Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (Standards Ausralia, 1998)
- Australian Standard 5667:1998 Water Quality – Sampling, Part 11: Guidance on the Sampling of Groundwaters (Standards Australia, 1998).
- Monitoring and Sampling Manual – Environmental Protection (Water) Policy, (Department of Environment and Science, 2018).

Samples should be taken in laboratory provided bottles and stored in a chilled container before being couriered to the NATA accredited laboratory.

A-4 Laboratory Analysis Program

A-4-1 Laboratory Analysis

Samples should be submitted for analysis at a National Association of Testing Authorities (NATA) accredited laboratory.

A-4-2 Sampling and Analysis Control

The quality assurance samples to be collected during the assessment are described below.

Field Blind Duplicate

Duplicate sample that is used to identify the variation in the analyte concentration between samples from the same sampling point. Field blind duplicates should generally be collected from a well-mixed sample of water. A stainless-steel bowl or bucket should be used for mixing water samples. Samples should be collected at a frequency of 1 in 20 samples. Typical nomenclature for field blind duplicates would be FD1, FD2 etc.

Field Split Duplicates

Field splits are duplicate samples that are sent to different laboratories for analysis to assess the analytical proficiency of the laboratories. These samples should be collected using the same procedures as for field duplicates. Typical nomenclature for field split duplicates would be FS1, FS2 etc.

Rinsate Blanks

Rinsate blank samples are used to estimate the amount of contamination introduced during the re-use of sampling equipment. Rinsate blanks should be collected when cross contamination of the samples is likely to impact on the validity of the analytical results, for example, where the investigation level for a contaminant is near the detection limit for the contaminant.

Rinsate blank samples should be obtained by pouring laboratory supplied deionised water over decontaminated sampling equipment (water quality meter) into laboratory supplied bottles. Rinsate blanks should then kept cool in insulated containers until delivery to the laboratory. Typical nomenclature for rinsate blanks would be RB1, RB2 etc.

Transport Blanks

No trip blank samples are required since no volatile contaminants are included in the analytical schedule.

Sampling Frequency

QA/QC sample type	Rate
Field Blind Duplicate	1 in 20 samples
Field Split Duplicate	1 per day
Rinsate Blank	1 per piece of reused equipment per day
Transport Blank	Not required

A-4-3 Laboratory QA/QC

Laboratory Procedures

Laboratory quality verification is necessary to assess the accuracy and precision of analytical results and to identify assignable causes for atypical analytical results. The internal quality verification checks should consist of field and laboratory duplicate, blank and spike samples to quantify accuracy and precision and identify any problems with the sample results.

Laboratory Duplicates

The variation between duplicate analyses should be recorded for each process batch to provide an estimate of the method precision and sample heterogeneity. There should be at least one duplicate per process batch, or two duplicates if the process batch exceeds 10 samples. If results show greater than 30% difference, the analyst should review the appropriateness of the method being used.

Laboratory Control Simple (LCS)

A Laboratory Control Sample (LCS) comprises a standard reference material, or a matrix of proven known concentration, or a control matrix spiked with all analytes representative of the analyte class. Representative samples of either material should be spiked at concentrations equivalent to the midpoint of the preceding linear calibration or continuing calibration check, upon which sample quantification will be based. In this way, the concentrations should be easily quantified and be within the range of concentrations expected for real samples.

The LCS should be from an independent source to the calibration standard, unless an ICV (independent calibration verification) is used to confirm the validity of the primary calibration.

There should be at least one LCS per process batch.

Matrix Spike Non-Compliances

A matrix is the component or substrate (e.g., water, soil) that contains the analyte of interest. A matrix spike is an aliquot of sample spiked with a known concentration of target analyte. A matrix spike documents the effect (bias) of matrix on method performance.

There should be one matrix spike per matrix (and soil type) per process batch.

Poor matrix spike recovery but an acceptable LCS results may indicate that it is the matrix, not the method, that may be the issue but it is not acceptable to assign poor recovery to matrix effects, without a reasonable investigation (NEPC, 1999)

Method Blank

Method blank data should be reported with the primary sample data, thus enabling the site assessor to assess potential method bias for the relevant analytes.

There should be at least one method blank per process batch.

Data Validation Procedures

Data validation is defined as a technical review of a set of analytical data using criteria for quality verification. Initially the reviewer should determine whether all analyses were performed as requested, whether holding times were met and whether all verification checks were reported with the data. The data should be assessed against the acceptance criteria using the procedures as described below. These criteria are estimates of the degree of uncertainty that is generally considered acceptable.

Data Quality Objectives (DQOs) should be established at the outset of the project to enable an appropriate level of comparison with the investigation objectives. Refer to Schedule B2 Appendix B of the NEPM (2013).

If the amount of data that does not conform to the acceptance criteria is significant, corrective action may be necessary. This could involve re-analysing the samples, re-sampling and analysing, altering the analysis method or detection limit, or accepting, explaining, and interpreting the data.

Accuracy

The accuracy of the data should be determined by analysis of spiked samples (LCS, field spikes, matrix spikes and surrogate spikes).

Accuracy is calculated by:

$$\text{Recovery} = \frac{c-a}{b} \times 100$$

Where:

– a = measured concentration of the unspiked sample aliquot.
– b = nominal (theoretical concentration increase that results from spiking the sample.
– c = measured concentration of the spiked sample aliquot.

The QC acceptance criteria for spikes are generally ± 30% recovery (NEPC 1999).

Precision

Precision of the data should be assessed by the RPD for field and laboratory duplicate samples. The RPD is a measure of the representativeness of duplicate samples and may be used to identify issues with laboratory analysis or field sampling methods.

The following equations are used:

$$\text{RDP} = \frac{X5-XD}{\frac{X5+XD}{2}} \times 100$$

Where:

– Xs = concentration obtained for the sample.
– XD = concentration obtained for the blind/split sample.

If the results show greater than 30% difference, a review should be conducted of the cause (e.g. instrument calibration, extraction efficiency, appropriateness of the methods being used).

Some common reasons for anomalies may be attributable to one or more of the following (but not limited to):

– Errors in duplicate sample collection (i.e., in appropriate mixing of sample before collected subsamples for sample analysis).
– Heterogeneity of sample providing inconsistent results (i.e., presence of ash/coal fragments of paint chips).

– Slight differences in sample analysis technique (i.e., mixing of sample in the laboratory by either shacking vigorously or tilting back and forth).

Limit of Reporting

The Limits of Reporting (LOR) should be at or below the adopted criteria and should be equal to the lowest calibration standard.

Holding Times

Holding times should be the recommended maximum times before sample extraction (NEPC, 1999). Recommended holding times for soil are listed in Table 1 AS/NZS 5667.1-1998 (Australian Sandard, 1998).

All tests should be carried out as soon as practicable after sampling, and according to any jurisdictional requirements.

Data Reporting

Reporting of the analysis and interpretation of surface and ground water chemistry should demonstrate compliance with agreed standards and criteria such as the Australian and New Zealand Environment and Conservation Council guidelines for the protection of fresh and marine aquatic ecosystems. Examples of information that should be included in water quality reporting include:

– Water quality data and interpretation of this data (i.e., comparison to triggers).
– Identification of any issues (e.g., degrading water quality in a specific site/area).
– Potential causes of issues.
– Details of any incidents potentially affecting water quality.
– Details of actions taken to address any water quality issues.
– Commitments to specific areas for improvement in the next reporting period.

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