LAKE VERMONT MEADOWBROOK PROJECT ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 8 SURFACE WATER

Table of Contents

List of Figures

List of Tables

8 Surface Water

8.1 Environmental objectives and performance outcomes

This chapter has been prepared to assist in the assessment of the following relevant environmental objectives prescribed in the Project ToR.

Water quality

The activity will be operated in a way that:

- *protects environmental values of water;*
- *protects the environmental values of groundwater and any associated surface ecological systems; and*
- *prevents or minimises adverse effects on wetlands.*

Water resources

With regard to water resources, the proposed project should meet the following objectives:

- *equitable, sustainable, and efficient use of water resources;*
- *maintenance of environmental flows and water quality to support the long-term condition and viability of terrestrial, riverine, wetland, lacustrine, estuarine, coastal and marine ecosystems;*
- *maintenance of the stability of beds and banks of watercourses, and the shores of waterbodies, estuaries and the coast; and*
- *maintenance of supply to existing users of surface and groundwater resources.*

The assessment presented in this chapter along with the detailed assessments referenced in the relevant supporting appendices demonstrates that the Project will achieve the performance outcome for each surface water environmental objective, consistent with the Project ToR and Schedule 8, Part 3, Division 1 of the EP Regulation.

Specifically, the Project will achieve the performance outcome for each surface water environmental objective in satisfaction of section 2(4) of Schedule 8 to the EP Regulation, as follows:

- The water performance outcomes will be achieved because the Project will be operated in a way that achieves all of the following:
  - the storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks;
  - contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water;
  - the activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment;
  - acid producing rock will be managed to ensure that the production and release of acidic waste is prevented or minimised, including impacts during operation and after the environmental authority has been surrendered;
  - any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland; and

  - the activity will be managed so that adverse effects on environmental values are prevented or minimised.

The Project will achieve item 2 of the wetlands performance outcomes because it will be managed in a way that prevents or minimises adverse effects on wetlands.

8.2 Description of existing values

This section describes the baseline water quality data and the water quality of the local and regional surface water and groundwater resources to assist in describing the environmental values relating to water quality. Further details are provided in the following assessments:

- Geochemical Assessment (Appendix D);
- Surface Water Assessment (Appendix F); and
- Aquatic Ecology Assessment (Appendix H).

8.2.1 Environmental values

Environmental values (EVs) are defined as the qualities of water that make it suitable for supporting aquatic ecosystems and human water use (DES 2018). The Project is located within the Isaac-Connors sub-catchment of the greater Fitzroy Basin (Figure 3.4, Chapter 3, Project Description) and within the western upland tributaries of the Isaac River Sub-basin. The waterways in the vicinity of the Project (Phillips Creek, Boomerang Creek, One Mile Creek and Ripstone Creek) are located within the Isaac western upland tributaries region of the Isaac River Sub-Basin (WQ1301).

The Isaac River, and a small portion of the study area, lies within the Isaac and lower Connors River main channel sub catchment of the Isaac River Sub-basin.

The EV's selected for protection include:

- aquatic ecosystem protection (slightly to moderately disturbed ecosystems, QWQG 2009);
- irrigation, farm use and stock watering;
- aquaculture (upland tributaries only);
- human consumption;
- primary, secondary and visual recreation;
- drinking water;
- industrial use; and
- cultural and spiritual values.

In summary, the key environmental values for water that are to be protected are:

- physical, chemical and biological integrity of the watercourses within the catchment and their amenity as potential water sources for human use and to support aquatic ecosystems;
- the qualitive and quantitative integrity of local groundwater as a potential water source for agriculture or other suitable uses; and
- the integrity of raw water supplies and associated infrastructure in the region.

8.2.2 Regional hydrology

The Project is within the Isaac-Connors sub-catchment of the greater Fitzroy Basin. The Isaac River is the main watercourse in the vicinity and flows in a south-easterly direction to the east of the Project area.

The Isaac River catchment commences at the Denham Range approximately 97 km to the north of the Project. The Isaac River flows in a south-westerly direction through the Carborough and Kerlong Ranges before turning to a south-easterly direction near the Goonyella Riverside Mine. The Isaac River converges with the Connors River and then the Mackenzie River 150 km downstream of the Project. Ultimately, the Mackenzie River joins the Fitzroy River, which flows initially north and then east towards the east coast of Queensland before flowing into the Coral Sea south-east of Rockhampton, near Port Alma. Figure 3.4, Chapter 3, Project Description, shows the location of the Project and the Isaac-Connors sub-catchment.

The greater Isaac-Connors sub-catchment area is approximately 22,364 km^2 (to the Mackenzie River confluence), out of a total Fitzroy River catchment of 142,665 km^2; equivalent to approximately 15% of the overall Fitzroy River catchment.

The catchment area of the Isaac River upstream of the Project is approximately 410,000 ha. This represents 2.9% of the overall Fitzroy River catchment and 18.3% of the Isaac-Connors sub-catchment.

The maximum Project disturbance footprint is approximately 7000 ha and represents 0.05% and 0.3% of the overall Fitzroy River and Isaac-Connors sub-catchment areas, respectively.

The Isaac River is a seasonally flowing watercourse, typically with surface flows in the wetter months from November to March, reducing to little or no flow from about April to October. All waterways and drainage lines in the vicinity of the Project area are ephemeral and experience flow only after sustained or intense rainfall in the catchment. Stream flows are highly variable, with channels drying out during winter to early spring when rainfall and runoff is historically low, although some pools hold water for extended periods. Consequently, stream physical attributes, water quality and the composition of aquatic flora and fauna communities tend to be highly variable.

The Isaac River catchment upstream of the Project comprises mainly scattered to medium dense bushland and grazing land and includes the township of Moranbah. There are several existing coal mines in the Isaac River catchment, including:

- Burton;
- North Goonyella;
- Goonyella Riverside;
- Broadmeadow;
- Broadlea North;
- Isaac Plains;
- Moranbah North;
- Millennium;
- Daunia;
- Poitrel;
- Grosvenor;
- Peak Downs;
- Saraji;
- Norwich Park; and
- Lake Vermont.

In addition, Pembroke Resources' Olive Downs Project is an approved mine currently under construction to the north (Figure 3.1, Chapter 3, Project Description).

8.2.3 Local hydrology

Waterways within the Project area drain into the Isaac River *via* tributaries of Phillips Creek (to the south) and Boomerang Creek (the north), as shown on Figure 8.1.

The waterways passing through the Project area originate in the Harrow Range, where they are confined in narrow valleys by hillslopes and bedrock. Downstream of the range, they intersect the Saraji Mine, where they are diverted *via* narrow corridors between open-cut pits. A description of the various waterways in the vicinity of the Project is as follows:

- **Ripstone Creek** commences approximately 20 km to the north-west of the Project area and traverses in a south-easterly direction north of the Project area before draining into Boomerang Creek approximately 0.5 km to the east of the Project area. Ripstone Creek has a catchment area of approximately 30,300 km^2 to the confluence with Boomerang Creek, of which 12% is within the Project area. Ripstone creek will not be impacted by the Project.
- **Boomerang Creek catchment** begins approximately 21 km to the west of the Project area and discharges into the Isaac River approximately 4 km east of the Project area. The Boomerang Creek catchment to its confluence with Isaac River is approximately 79,600 ha and comprises the sub-catchments of Ripstone Creek, Plumtree Creek, East Creek, Hughes Creek, Barrett Creek, East Creek, One Mile Creek and Spring Creek. The Project area covers approximately 9550 ha, or 12% of the Boomerang Creek catchment.
- **Hughes Creek** commences approximately 25 km west of the Project area and drains in an easterly direction to its confluence with Boomerang Creek near the upstream boundary of the Project area. Hughes Creek has a catchment area of 17,500 ha, of which 0.2% is within the Project area. Barrett Creek drains into Hughes Creek upstream of Saraji Mine.
- **One Mile Creek** commences approximately 15 km south-west of the Project area and drains in a north-easterly direction through the Project area to Boomerang Creek. The channel and catchment of One Mile Creek have been significantly modified where it intersects the Saraji Mine. One Mile Creek has a catchment area of approximately 13,200 ha, of which 2.7% is within the Project area. Spring Creek drains into One Mile Creek approximately 0.6 km upstream of the Project area.
- **Phillips Creek** runs west to east into the Isaac River south of the Project area. It has a catchment area of approximately 51,400 ha to its confluence with the Isaac River. The Project area covers an area of approximately 2450 ha, or 4.8% of the Phillips Creek catchment. Phillips Creek will not be impacted by the Project.

The proposed underground mining operations underly sections of Boomerang Creek and One Mile Creek and parts of the floodplain of Phillips Creek. The proposed open-cut operations are between Phillips Creek and One Mile Creek. Phillips Creek and Hughes Creek/Boomerang Creek and One Mile Creek are defined watercourses under the *Water Act 2000* (Qld).

Land uses within these catchments include cattle grazing and open-cut mining. Mining activities upstream at Peak Downs and Saraji Mine have altered flow paths, with major diversions of Ripstone Creek, Boomerang Creek, East Creek, Hughes Creek, One Mile Creek, Spring Creek and Phillips Creek (Figure 8.2). Upstream tributaries have also been diverted (Figure 8.2). Lake Vermont Resources has approval for a proposed diversion of Phillips Creek adjacent to the Project area; Pembroke Resources has approval for a diversion of Ripstone Creek, neither of which has yet been constructed (Figure 8.2). Existing diversions upstream of the project extend 31 km.

8.2.4 Existing uses

There is currently minimal use of surface water from the Isaac River downstream of the Project, and water use is limited to mining, irrigation and stock watering. The Lower Fitzroy and Fitzroy Barrage Water Supply Schemes are located 250 km downstream of the confluence with the Isaac River.

A search of the Queensland Government Water Entitlement Viewer did not identify any surface water users on either One Mile Creek or Boomerang Creek downstream of the project.

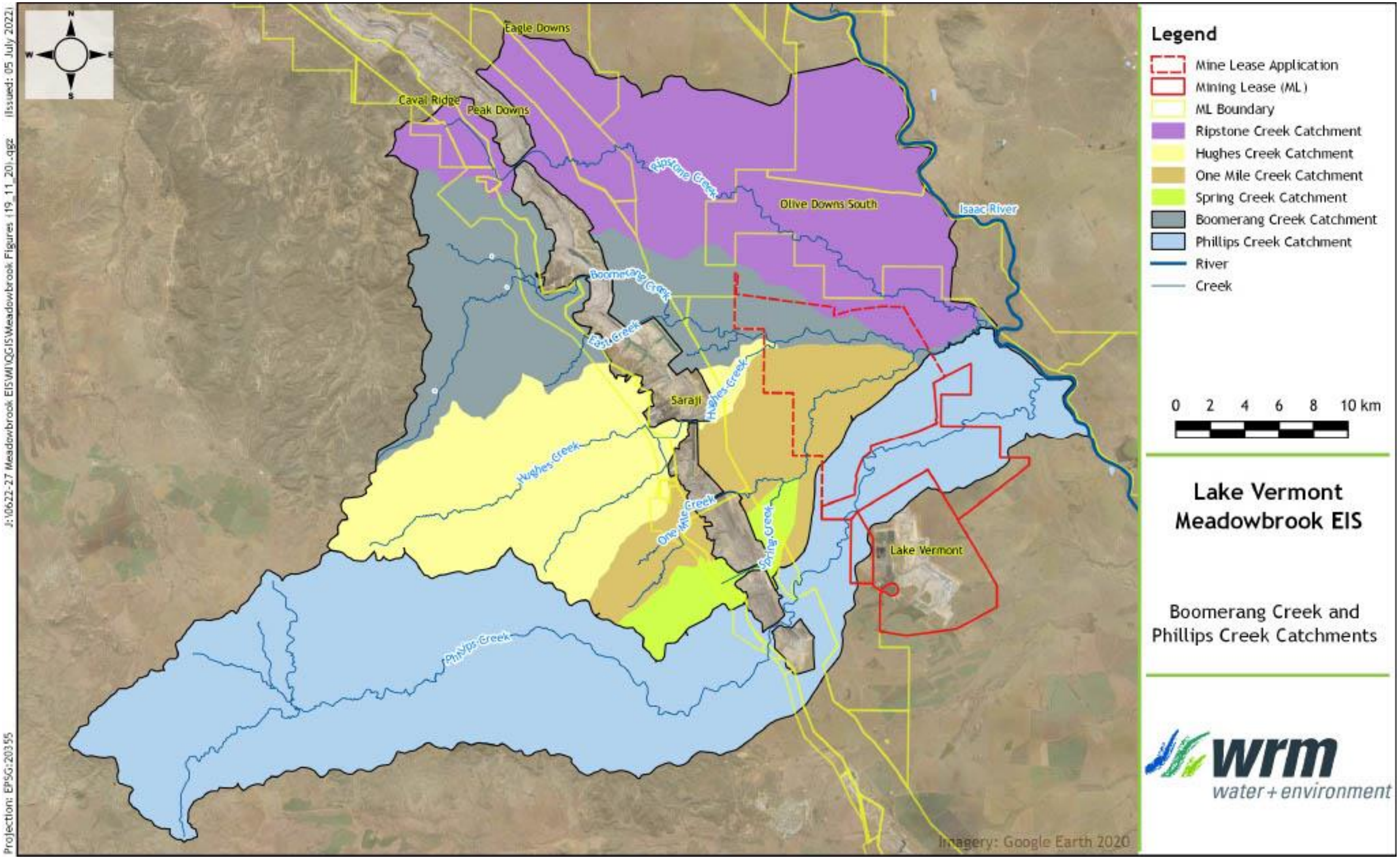

Figure 8.1: Catchments draining through the Project area

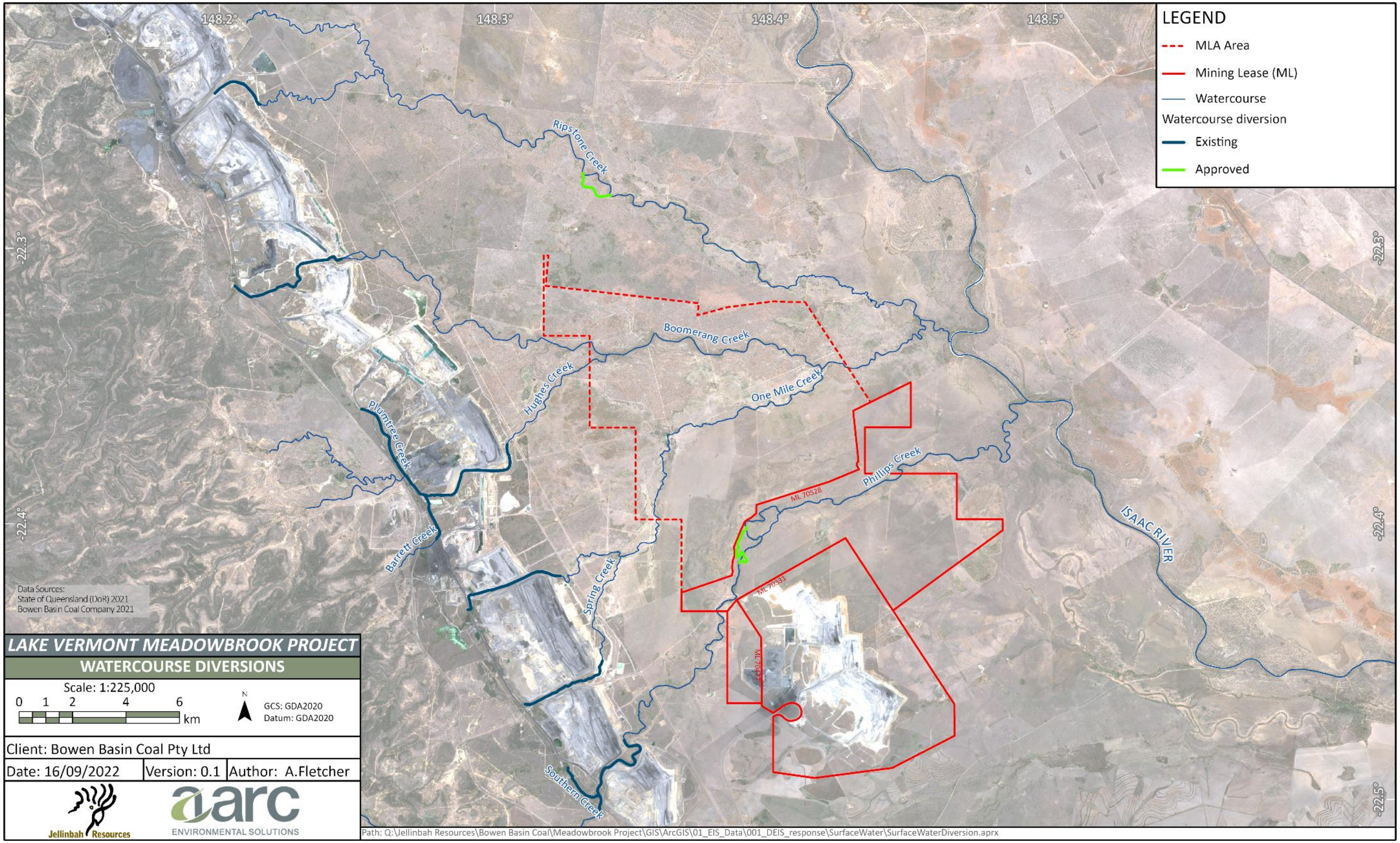

Figure 8.2: Existing and approved watercourse diversions in the vicinity of the Project.

There are five (5) licences to take water from the Isaac River downstream of the Project, which have been issued for mining, irrigation, stock watering, domestic supply and water harvesting. Detailed information regarding individual licences for Isaac River surface water users was obtained through analysis of water licence data provided by the Department of Resources. Some limitations in the dataset include the absence of names of water users, and in some cases, allocated volumes for water licenses due to privacy restrictions. The nearest downstream water entitlement is for a property located on the Isaac River approximately 25 km downstream of the Project.

There are also several historical riparian water access notifications along the Isaac River which authorise stock and domestic supplies only. Section 96 of the Water Act states that an owner of land adjoining a watercourse may take water for domestic and stock purposes without the need for a permit or licence. Details of the volume, source and purpose of the licences are included in Appendix F, Surface Water Assessment (Section 4.4).

8.2.5 Baseline surface water characteristics

8.2.5.1 Streamflow regime

The Queensland Government's Department of Regional Development, Manufacturing and Water operates a nearby surface water monitoring site on the Isaac River at Deverill (GS 130410). Water monitoring data is also available from Phillips Creek at the Tayglen gauge (GS 130409), which was operational from 1968 to 1988. The data available shows flows occur in Phillips Creek approximately 25% of the time. Daily flow records from the Tayglen gauge are shown in Figure 8.3. Surface water monitoring data is also available from monitoring stations on Phillips Creek, operated by Lake Vermont Resources; the locations of these monitoring stations are provided in Appendix F, Surface Water Assessment (Section 4.5).

The Tayglen gauge was at the upstream extent of the Phillips Creek Quaternary alluvium. While very low flows will be observed at that location, they will seep into the deep sandy bed of the downstream reaches of Phillips Creek and not reappear as surface flow. This is consistent with field observations during water sampling and post-flood water level measurements at Lake Vermont, which indicate Phillips Creek typically ceases to flow within 24 hours of the cessation of rainfall. The natural flow regime of One Mile Creek and Boomerang Creek will be similar to the characteristics of Phillips Creek. Flows in One Mile Creek are significantly affected by upstream mining activities.

8.2.5.2 Flood hydrology

Hydrological and hydraulic models of the Isaac River and local creek catchments have been developed, validated and calibrated to estimate the 50%, 10%, 2%, 1% and 0.1% AEP peak design discharges, as well as the PMF for a range of durations up to 48 hours. Rainfall data (rainfall depths, areal reduction factors and temporal patterns) have been applied in accordance with ensemble event procedures in Australian Rainfall & Runoff (Bell *et al.* 2019).

The existing-case flood model development and results are discussed in detail in Chapter 9, Flooding and Regulated Structures.

Further details regarding current flooding behaviour, flood mapping and flood model development are described in Appendix F, Surface Water Assessment (Section 4.7) and Appendix Z, Flood Modelling.

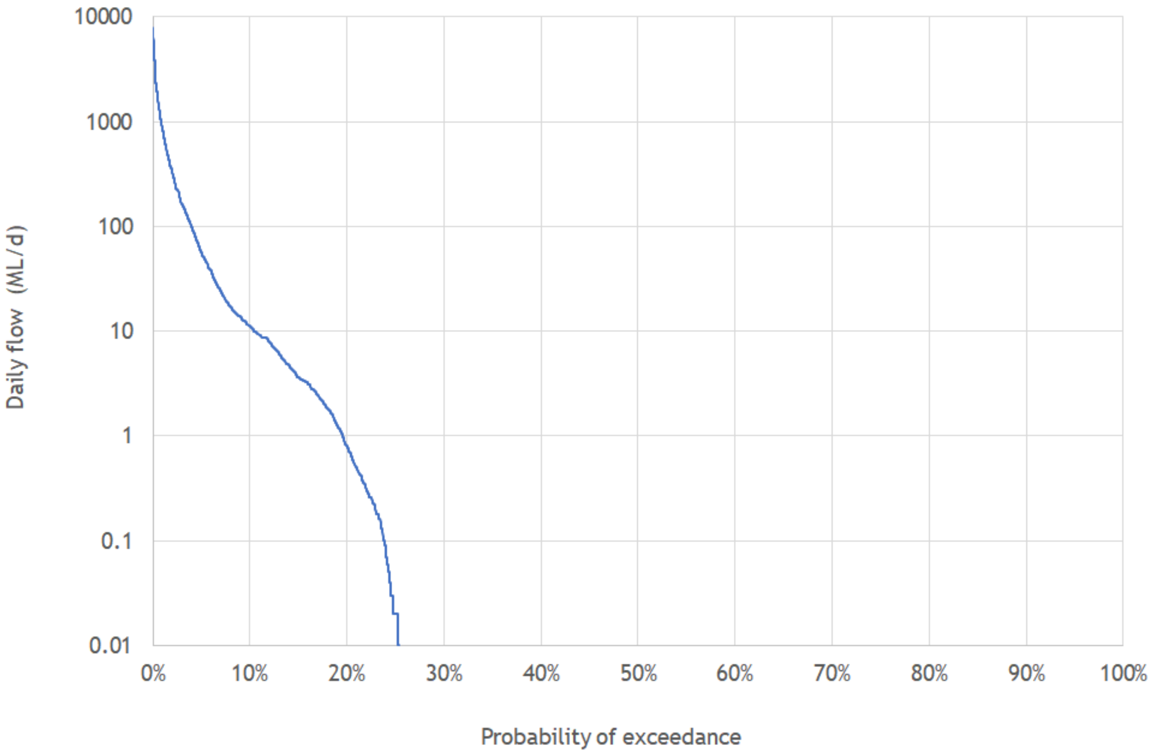

Figure 8.3: Frequency of daily flows recorded at Phillips Creek at Tayglen

8.2.6 Baseline water quality data

Surface water and stream sediment quality assessments, including physico-chemical sampling, have been conducted to characterise the baseline conditions of the Project and its receiving environment. To perform these assessments, water samples have been tested regularly since January 2021 at the locations shown in Figure 8.4. Figure 8.5 shows the locations where water monitoring is being undertaken for nearby projects, the data from which has been used to establish background water quality and to develop site-specific guidelines when sufficient suitable data is available. The methods and results of baseline monitoring are presented in full in Appendix F, Surface Water Assessment (Section 4.6) and discussed in Appendix H, Aquatic Ecology Assessment (Section 6.2). This assessment includes a comparison of WQOs for Upper Isaac River catchment waters published for the Isaac River Sub-basin (DEHP 2011) and ANZECC 'Guidelines for Freshwater and Marine Water Quality' (95% protection). Characterisation of the baseline water quality is as follows:

- Physico-chemical parameters:
  - Dissolved Oxygen (DO) values were outside the WQOs (85%–110%) at all sites except for MA1, MA5, MA8 and MA13 in 2020 and MA6 and MA11 in 2021.
  - Electrical conductivity (EC) values exceeded WQO (720 µS/cm) at sites MA3, MA5, MA6, MA12 and MA13 in 2020 and at site MA3 in 2021.
  - The waters of the study area are neutral to alkaline, with pH values outside the WQO range (6.5–8.5) at sites MA3 and MA4 in 2020.
  - Turbidity levels at each site exceeded the WQO for aquatic ecosystems (50 NTU) except for sites MA6 and MA8 in 2021.
  - Suspended solids (SS) exceeded the WQO value (55 mg/L) at sites MA3, MA5 and MA6 in 2020 and sites MA3 and MA12 in 2021.
  - Ammonia levels exceeded the WQO value (0.02 mg/L) at sites MA2, MA3, MA5, MA6 and MA12 in 2020 and sites MA6 and MA12 in 2021.

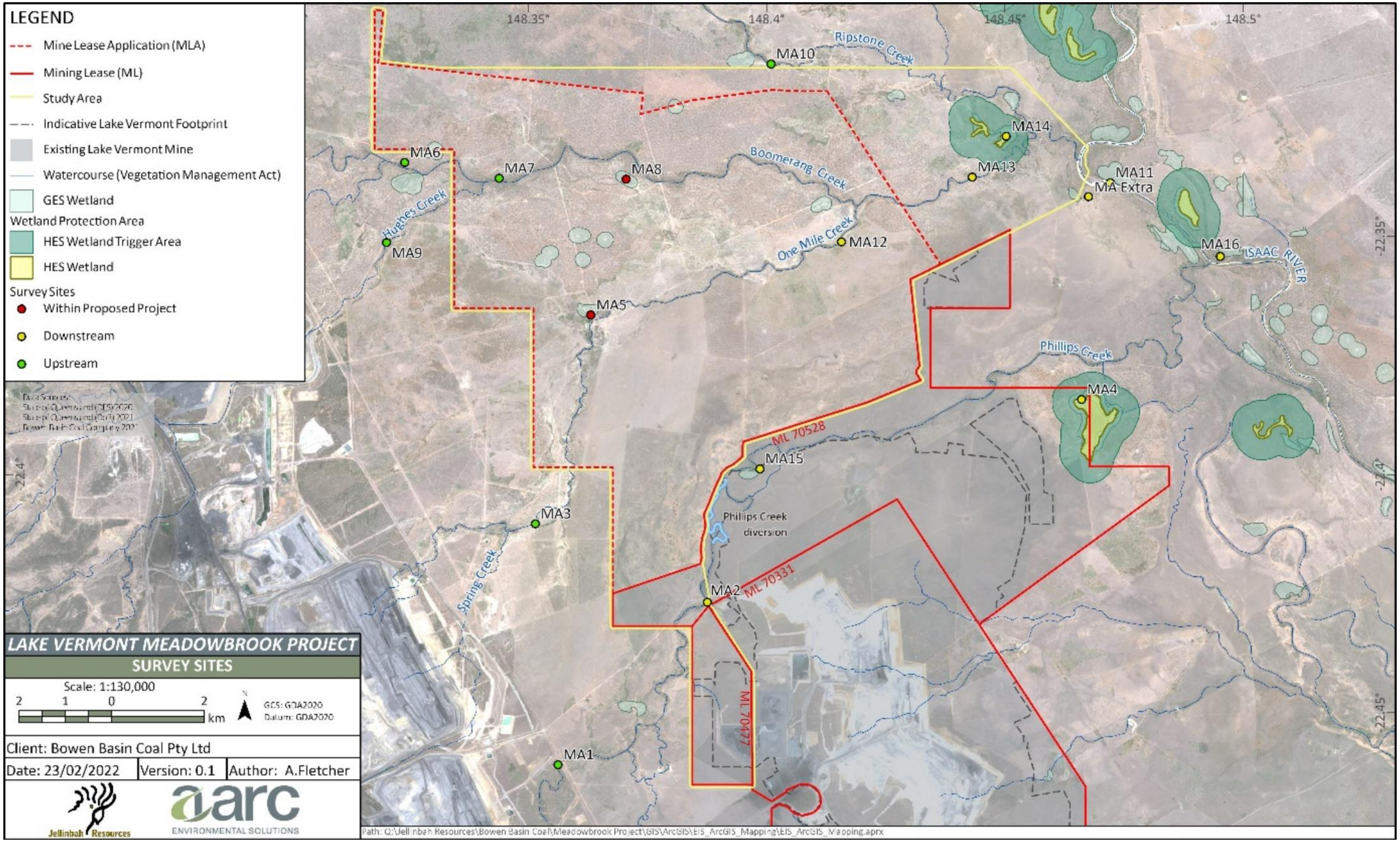

Figure 8.4 Baseline water quality monitoring sites

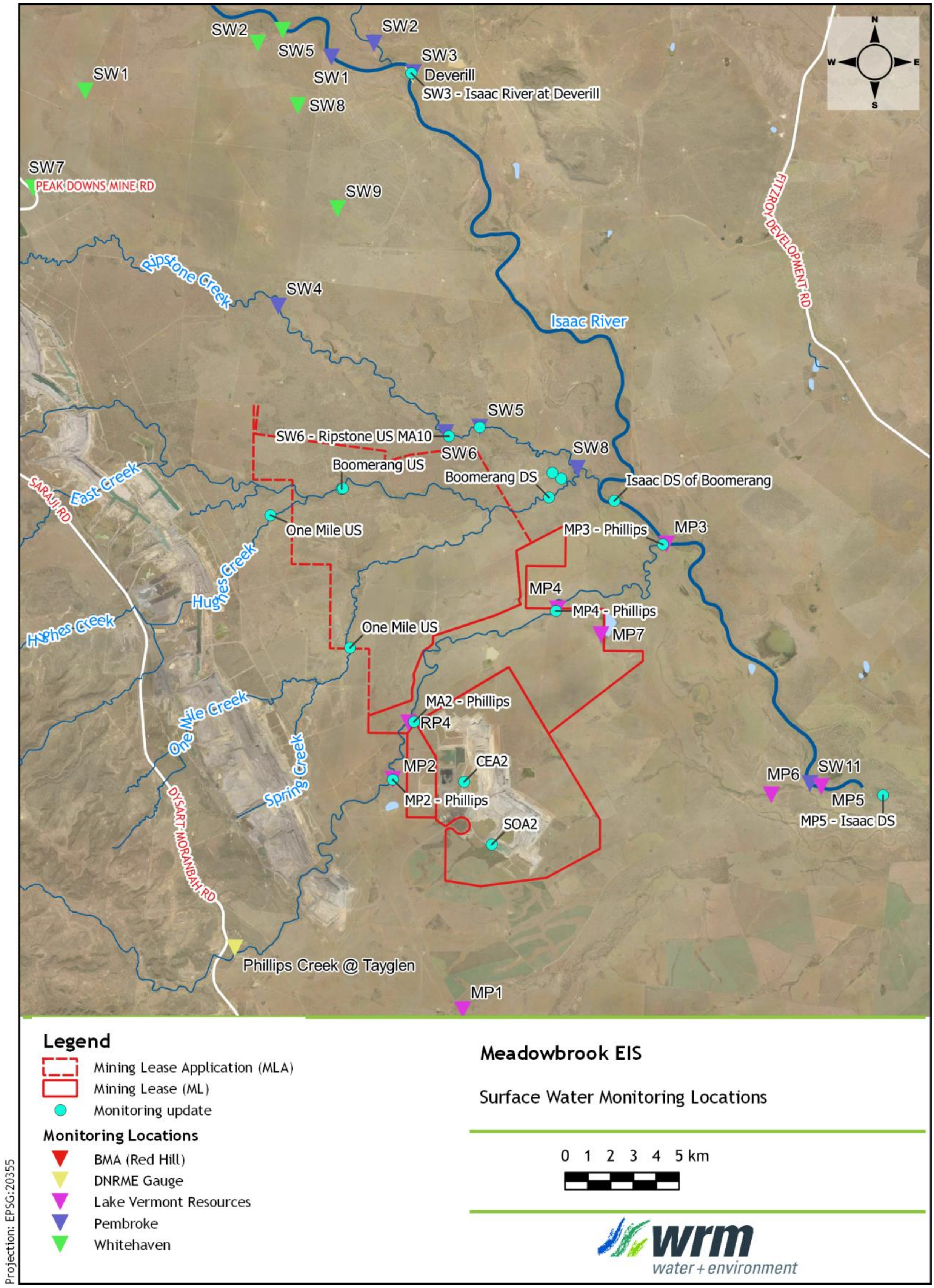

Figure 8.5: Map of monitoring locations used in collection of baseline data

- Total nitrogen WQO values were not exceeded in 2020; however, it should be noted the 2021 samples were not analysed for total nitrogen.
- Total phosphorus exceeded the WQO value (0.05 mg/L) at all sites except MA13 in 2020. The 2021 samples were not analysed for total phosphorus.
- Sulphate exceeded the WQO value (25 mg/L) at all sites except MA8 in 2020 and sites MA6, MA8 and MA11 in 2021.

- Dissolved metal values outside WQO or guideline values were infrequent across all sites. Only zinc exceeded the ANZECC value (0.008 mg/L) at sites MA6 and MA8 in 2020.
- Total metals outside WQO or guideline values have been recorded for several metals across various sites:
  - Aluminium exceeded the ANZECC value (0.055 mg/L) across all sites.
  - Cadmium exceeded the ANZECC value (0.002 mg/L) at site MA12 in 2021.
  - Copper exceeded the ANZECC value (0.0014 mg/L) across all sites. The WQO value (1 mg/L, cattle) was exceeded at sites MA3, MA6, MA8, MA11 and MA12 in 2021.
  - Lead exceeded the ANZECC value (0.0034 mg/L) at sites MA6 in 2020 and MA12 in 2021.
  - Nickel exceeded the ANZECC value (0.011 mg/L) at site MA12 in 2021.
  - Zinc exceeded the ANZECC value (0.008 mg/L) at sites MA3, MA5, MA6 and MA8 in 2020 and MA3, MA12 and MA13 in 2021.
- Petroleum hydrocarbon exceedances were infrequent across monitored sites:
  - C15–C28 fraction exceeded the ANZECC value (100 µg/L) at site MA8 in 2020.
  - C16–C34 fraction exceeded the ANZECC value (100 µg/L) at site MA8 in 2020.

Several factors, such as direct access of cattle to the watercourses and mining activities upstream of the Project (Saraji Mine and Saraji East Project) are likely to influence water quality results and may have resulted in a number of baseline water quality samples not meeting the default guideline values. Nevertheless, water quality in the Project area is considered typical of the slightly to moderately disturbed aquatic ecosystem in this region that this area represents.

Regional Isaac River water quality is presented in Appendix F, Surface Water Assessment (Section 4.6.1), noting that water quality is described to be at or above some regional default guidelines.

8.2.7 Controlled releases

The mine-affected water system, which will manage runoff and groundwater inflows from the underground, open-cut pit, ROM stockpile and MIA, is a closed system designed to prevent any releases of mine-affected water to the environment. No provision for controlled releases is included within the water management system.

8.2.8 Water quality objectives

Indicators and water quality guidelines relevant to each environmental value are described in the Queensland Water Quality Guidelines and ANZG (2018). The conditions of waterways located in the vicinity of the Project are classified as slightly to moderately disturbed ecosystems under the QWQG 2009.

The WQOs relevant to the identified EV's are provided in Table 8.1 and are generally based on the trigger values or Default Guideline Values nominated in the Queensland Water Quality Guidelines and the Australian and New Zealand 'Guidelines for Fresh and Marine Water' (ANZECC & ARMCANZ 2000). Where environmental values have multiple WQOs or default guideline value, the lowest value has been adopted.

Table 8.1: EPP (Water) guideline values adopted for the upper Isaac River catchment waters

Parameter	**Water Quality Objective**	**Relevant environmental value**
Ammonia N	< 0.02 mg/L	Aquatic ecosystem [b]
Oxidised N	< 0.06 mg/L	Aquatic ecosystem [b]
Organic N	< 0.42 mg/L	Aquatic ecosystem [b]
Total nitrogen	< 0.5 mg/L	Aquatic ecosystem [b]
Filterable Reactive Phosphorus (FRP)	< 0.02 mg/L	Aquatic ecosystem [b]
Total Phosphorus	< 0.05 mg/L	Aquatic ecosystem [b]
Chlorophyll a	< 0.005 mg/L	Aquatic ecosystem [b]
Dissolved oxygen	85-110% saturation > 4 mg/L at surface	Aquatic ecosystem [b] Drinking water [c]
Turbidity	< 50 NTU	Aquatic ecosystem [b]
Suspended solids	< 55 mg/L	Aquatic ecosystem [b]
pH	pH 6.5-8.5	Aquatic ecosystem [b]
Conductivity (EC) baseflow	< 720 µS/cm	Aquatic ecosystem [b]
Conductivity (EC) high flow	< 250 µS/cm	Aquatic ecosystem [b]
Sulphate	< 25 mg/L	Aquatic ecosystem [b]
Total Dissolved Solids	< 2000 mg/L	Stock watering [d]
Colour	50 Hazen Units	Drinking water [c]
Total Hardness	150 mg/L as CaCO3	Drinking water [c]
Sodium	< 30 mg/L	Drinking water [c]
Aluminium	< 20 mg/L < 5 mg/L < 0.055 mg/L (pH > 6.5)	Irrigation [g,e] Stock watering [f] Aquatic ecosystem [a]
Arsenic	2.0 mg/L 0.5 mg/L up to 5 mg/L < 0.013 mg/L	Irrigation [g,e] Stock watering [f] Aquatic ecosystem [b]
Beryllium	< 0.5 mg/L	Irrigation [g,e]
Boron	< 5 mg/L < 0.94 mg/L	Stock watering [f] Aquatic ecosystem [k]
Cadmium	< 0.01 mg/L < 0.0002 mg/L	Stock watering [f] Aquatic ecosystem [a]

Parameter	Water Quality Objective	Relevant environmental value
Chromium	< 1 mg/L < 1 mg/L < 0.001 mg/L	Irrigation [g,e] Stock watering [f] Aquatic ecosystem [a]
Cobalt	< 0.1 mg/L < 0.0014 mg/L	Irrigation [g,e] Aquatic ecosystem [h]
Copper	< 5 mg/L < 1 mg/L < 0.0014 mg/L	Irrigation [g,e] Stock watering (cattle) [f] Aquatic ecosystem [a]
Fluoride	< 2 mg/L	Irrigation [g,e]
Iron	< 10 mg/L < 0.18 mg/L	Irrigation [g,e] Aquatic ecosystem [l]
Lead	< 5 mg/L < 0.1 mg/L < 0.0034 mg/L	Irrigation [g,e] Stock watering [f] Aquatic ecosystem [a]
Lithium	< 2.5 mg/L	Irrigation [g]
Manganese	< 10 mg/L < 1.9 mg/L	Irrigation [g,e] Aquatic ecosystem [a]
Mercury	< 0.002 mg/L < 0.0006 mg/L	Irrigation [g] Aquatic ecosystem [a]
Molybdenum	< 0.05 mg/L < 0.034 mg/L	Irrigation [g,e] Aquatic ecosystem [h]
Nickel	< 2 mg/L < 1 mg/L < 0.011 mg/L	Irrigation [g,e] Stock watering [f] Aquatic ecosystem [a]
Selenium	< 0.05 mg/L < 0.02 mg/L < 0.005 mg/L	Irrigation [g,e] Stock watering [f] Aquatic ecosystem [a]
Silver	< 0.00005 mg/L	Aquatic ecosystem [a]
Uranium	< 0.1 mg/L < 0.0005 mg/L	Irrigation [g,e] Aquatic ecosystem [i]
Vanadium	< 0.5 mg/L < 0.006 mg/L	Irrigation [g,e] Aquatic ecosystem [i]
Zinc	< 5 mg/L < 0.008 mg/L	Irrigation [g,e] Aquatic ecosystem [a]
Nitrate as N	< 1.1 mg/L	Stock watering [j]

Parameter	Water Quality Objective	Relevant environmental value
Zinc	< 5 mg/L < 0.008 mg/L	Irrigation [g,e] Aquatic ecosystem [a]
Nitrate as N	< 1.1 mg/L	Stock watering [j]

[a] Table 3.4.1 of ANZECC & ARMCANZ (2000): trigger values for slightly-moderately disturbed systems (95% level of protection)
[b] Table 2 of Isaac River Sub-Basin EVs and WQOs: Aquatic ecosystem – moderately disturbed
[c] Table 4 of Isaac River Sub-Basin EVs and WQOs: Drinking water EV
[d] Table 10 of Isaac River Sub-Basin EVs and WQOs: Stock watering EV: salinity
[e] Short-term trigger value
[f] Table 11 of Isaac River Sub-Basin EVs and WQOs: Stock watering EV: heavy metals and metalloids
[g] Table 9 of Isaac River Sub-Basin EVs and WQOs: Irrigation EV: heavy metals and metalloids
[h] Section 8.3.7 of ANZECC & ARMCANZ (2000): low reliability guideline
[I] Based on Limit of Reporting (LOR) for ICPMS/CV FIMS analytical methods
[j] Based on ambient WQGs for total nitrogen –standard trigger value for contemporary environmental authorities in Bowen Basin
[k] Based on 95% level of protection in Toxicant default guideline values for aquatic ecosystem protection: Boron in fresh water (ANZG, 2018)
[l] Based on 95% level of protection in Toxicant default guideline values for aquatic ecosystem protection: Total iron in fresh water (ANZG, 2018), mg/L = milligrams per litre, NTU = Nephelometric Turbidity Units, µS/cm = microSiemens per centimetre
[m] Based on (ANZG, 2018) aquatic ecosystems
Note: All WQOs stated in this Table for metals are for dissolved metals

8.2.9 Sediment quality objectives

Baseline levels of metals in sediments are important to investigate for accrual of any pollutants. Stream sediment quality objectives for the Project are adopted from the' Interim Sediment Quality Guideline' (ISQG) values (ANZECC & ARMCANZ 2000), as shown in Table 8.2.

Table 8.2: ISQG Values adopted for the Meadowbrook Project (ANZECC & ARMCANZ 2000)

Contaminant	ISQG value—low (mg/kg)	ISQG value—high (mg/kg)
Arsenic	20	70
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Nickel	21	52
Mercury	0.15	1
Zinc	200	410

8.2.10 Site water balance numerical model

A GoldSim water balance model has been conducted and developed for the Project water management system and water balance for the rehabilitated pit depression. The model incorporates the Australian Water Balance Model to estimate daily runoff from daily rainfall, this model is a saturated overland flow model allowing for variable source areas of surface runoff. The potential effects of climate change were assessed using climate-change adjusted climate data developed as part of the Consistent Climate Scenarios. The model components described in section 8.3.6 and applied methods and model conditions supported by relevant research from comparable environments. Multiple model scenarios were modelled to account for uncertainty in model parameters and the methodology, configuration, operating parameters and modelled water balance results are presented in Appendix Y, Mine Water Balance (Section 5).

The water balance model predicts that the average annual demand for water is estimated to be up to approximately 1,390 ML/year.

The results of the water balance model show:

- The need for imported water from the raw water supply pipeline is expected to decrease from a peak of nearly 1,500 ML/year around Year 5 to less than 200 ML/year in the last 5 years of open cut operations. The available pipeline water allocation is sufficient to maintain supplies.
- The adopted MIA Dam storage capacity is sufficient to contain inflows throughout the Project life without overflow.
- In-pit water volumes would generally be maintained at relatively low volumes which would not interrupt mining operations. Pumping to the Dewatering Dam would ensure the pit is empty prior to the following wet season.
- During underground operations, the average annual quantity of water returned to the existing Lake Vermont operation would be approximately 1,000 ML/year (ranging from 518 ML/year to 1595 ML/year). During open cut operations, the average would reduce to approximately 404 ML/year (but could range from 0 ML/year to 3,078 ML/year depending on the prevailing weather conditions). Water delivered from Meadowbrook would offset Lake Vermont mine’s use of pipeline water, as this water will be used for processing activities. The Lake Vermont Mine water management system has significant potential storage capacity available (with careful planning, as much as 15 GL could be stored in part of the mine pits while maintaining mining in some areas). Water transferred from Meadowbrook following wet periods could therefore be accommodated within the existing capacity.
- The model results show sediment dam overflows would only be expected in the wettest 10% of historical climate periods. The largest modelled total sediment dam release during open cut operations was 1,038 ML from North Sediment Dam under very wet climate conditions. Median total project releases are expected to be much smaller – less than 140 ML from each dam over the total project life. The maximum modelled salinity of sediment dam releases was 691 mg/L at the North Sediment Dam..

8.3 Potential impacts

8.3.1 Surface water quality

The potential drivers of impacts on water quality due to the Project are as follows and detailed in Appendix H, Aquatic Ecology Assessment (Section 9.2):

- erosion and sedimentation (Chapter 5, Land Resources);
- uncontrolled water releases;
- mine drainage from waste rock emplacements (Chapter 6, Rehabilitation);
- final rehabilitated pit landform seepage and overflow (Chapter 7, Groundwater); and
- litter, waste and spills (Chapter 15, Waste Management).

Mine affected water generated by the Project will be pumped to the existing Lake Vermont Mine (via a pipeline located within the infrastructure corridor) for use in processing activities. This will work to reduce the volume of raw water taken from the Sunwater pipeline.

It is noted that significant mine affected water storage capacity exists at the Lake Vermont Mine. Mine water storage in existing environmental dams at the Lake Vermont Mine totals 4.9 GL. Following extreme wet periods, up to 200 GL of storage in the mine voids could potentially be used for emergency surface water storage - though this would be undesirable - as it would cause significant disruption to the open cut mining operations. The existing mine is therefore not dependent on making releases, with this strategy not expected to change as a result of Project inputs. It is noted that the Lake Vermont Mine has not released mine affected water since 2017. Further, this 2017 release event is noted as having been opportunistic, as opposed to necessary to manage site water inventories. The release history of the Lake Vermont Mine is provided through Figure 8.6 and Table 8.3 below.

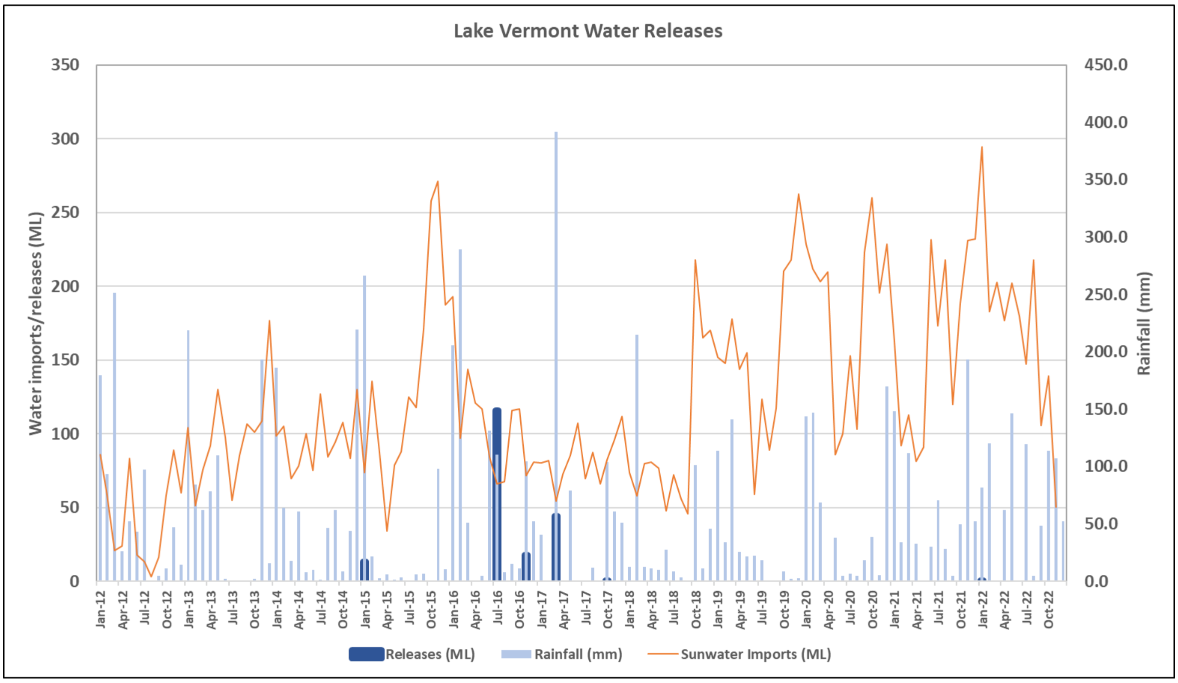

Figure 8.6: Mine affected water release history of Lake Vermont Mine

Table 8.3: Summary of event data from mine affected water releases (Lake Vermont Mine)

Release Dates		Release Point	Volume (ML)	Quality				Comment
Start Date	Stop Date			pH	EC (uS/cm)	Suspended Solids (mg/L)	SO4 (mg/L)	
28-Jan-15	28-Jan-15	RP4	13.6	8.2	696.0	43.0	7.0	
17-Jul-16	19-Jul-16	RP4	115.9	8.1	736.3	133.7	69.0	
4-Nov-16	5-Nov-16	RP4	18	7.9	286.0	116.0	8.0	
30-Mar-17	1-Apr-17	RP4	44.5	8.1	4475.0	394.0	856.5	
24-Oct-17	25-Oct-17	RP4	0.75	8.2	6370.0	8.0	992.0	Failed diversion valve. Two valves now in place to provide 100% redundency
9-Jan-22	9-Jan-22		0.7	8.1	366.0	88.0	39.0	Soil run off bund failure. Significant increases made to spoil run off bund construction.

Should any future releases of mine affected water occur from the existing Lake Vermont Mine, these releases would be from existing registered release points, in accordance with existing release conditions. Release conditions within the Lake Vermont Mine EA have been developed in accordance with the 'Fitzroy Model Mining Conditions', consistent with other Bowen Basin mining operations. These conditions are designed to manage potential impacts to the Great Barrier Reef catchment.

The water quality of mine affected water generated by the Project is expected to be consistent with the mine affected water of the existing operation, noting the same coal seams are being mined (dewatered). As such, impacts to receiving waters are not anticipated to occur as a result of the Project.

The impacts on water quality through failure to contain waters in the water management system are assessed through the preliminary consequence category assessment conducted within the site water balance model presented in section 8.3.6 and Appendix Y, Mine Water Balance (Section 6).

8.3.1.1 Dissolved inorganic nitrogen

Elevated 'dissolved inorganic nitrogen', which comprises nitrate, nitrite and ammonium, is a feature of the local surface water receiving environment and was one subject of the surface water monitoring program.

Nitrite, which is a short-term intermediate product from oxidative and reductive processes such as nitrification and denitrification, was below the limit of reporting in all samples.

All samples had total nitrate concentrations well below the default value in the Model Mining Conditions for Water (1.1 mg/L) - average nitrate was 0.05 mg/L in Boomerang Creek, 0.12 mg/L in One Mile Creek and only 0.07 mg/L in Ripstone Creek.

The default aquatic ecosystem guideline for total ammonia (0.02 mg/L) was exceeded in Boomerang Ck for five of the seven sampling events during 2021 (average 0.16 mg/L). In Ripstone Creek, the guideline was exceeded in 6 of 7 samples (average 0.16 mg/L). The highest concentration of 1.37 mg/L was recorded in Boomerang Creek in May 2021. Ammonia concentrations were lower in One Mile Creek - with all samples being at or below the guideline value.

Dissolved inorganic nitrogen is also occasionally measured within the existing Lake Vermont water management system (within site dams). Recent samples indicated nitrite concentrations below the default aquatic ecosystem guideline. Ammonia levels were below the limit of reporting in all dams tested except Environmental Dam 5 (0.22 mg/L), which stores water decanted from the co-disposal area and pumped from the mine pits. Total nitrate levels were also below the limit of reporting in all dams except ED3, where the concentration was 1.93 mg/L.

These results indicate overflows from the water management system would be unlikely to elevate dissolved inorganic nitrogen concentrations above background levels. Compared to other point and diffuse sources of DIN in the Great Barrier Reef catchments, the contribution of dam overflows to total nutrient loads in the Great Barrier Reef lagoon would be minimal and will not have a residual impact on DIN concentrations in the Great Barrier Reef catchment waters.

8.3.2 Sediment dams

Sediment dams will be designed to avoid releases and overflow events under most circumstances and in accordance with the Department of Environment and Heritage Protection Guideline - Stormwater and environmentally relevant activities (DEHP 2017). The likelihood and magnitude of sediment dam overflows, as well as the predicted salinity of sediment dam overflows, have been derived from a Project water balance model (Appendix Y, Mine Water Balance, Section 5.4). The water balance model has indicated that overflows from sediment dams will only be expected from 10th percentile wet conditions or greater. The median total overflow volumes have been modelled to be less than 140 ML from any sediment dam over the total Project life. Modelled maximum overflow salinities range from 518 mg/L to 691 mg/L, with maximum downstream salinities during sediment dam overflows of up to 377 mg/L in One Mile Creek and 253 mg/L in Phillips Creek. Increases of this magnitude will have minimal impact on downstream environmental values (Appendix Y, Mine Water Balance, Section 5.4).

8.3.3 Mine water dams

To manage any excess Project water, a return water pipeline will be utilised to transfer water to the mine water system at the existing Lake Vermont Mine. The return water pipeline will be located within the infrastructure corridor.

Predictions of the required stored water volume for the MIA Dam have been derived from the site water balance model (Appendix Y, Mine Water Balance Section 5.4.1). The MIA Dam adopted storage capacity has been sized to be sufficient to manage dewatering inflows and outflows to the return water pipeline without overflow throughout the Project life.

8.3.4 Open pit

Predictions of inundation of the open-cut pit have been derived from the site water balance model (Appendix Y, Mine Water Balance, Section 4.4). The 90th percentile in-pit inventory has been modelled to be always less than 365 ML. In very wet years, up to 1,063 ML of water could be stored in the open-cut pit at the 1% confidence level. Pit water will be managed by pumping it into the Dewatering Dam.

8.3.5 Rehabilitated pit landform

The open-cut pit will be progressively rehabilitated during operations and, on completion of mining, will be partially backfilled with spoil. The design of the final pit area landform is premised on achieving a final elevation above the anticipated recovered groundwater level. A water balance model was developed to assess the behaviour of the rehabilitated pit landform under various climate scenarios (Appendix X, Rehabilitated Pit Water Balance, Section 4).

Runoff from the surrounding out-of-pit waste rock emplacement areas post-closure will be directed away from the central pit area to limit the catchment area flowing into the depression to principally that of the depression itself (i.e., an area of approximately 185 ha). The modelled long-term behaviour in the Meadowbrook rehabilitated pit landform shows that due to the relatively large surface of the rehabilitated pit floor, water levels in the depression are expected to rapidly reach equilibrium level and fluctuate within a 1.2 m range above the floor level, well below the overflow level of the rehabilitated pit landform. All climate scenarios yield very similar water levels. The results of the modelling showed the modelled water levels were not sensitive to the seepage rate.

Salinity of water in the rehabilitated pit is modelled to result in fluctuating moderate salinity with median total dissolved solids salinity range of 270 (mg/L) to 465 (mg/L). The maximum salinity of water intermittently within and seeping from the rehabilitated pit landform is predicted to be less than 950 mg/L under the high salinity scenario modelled. This is below the low risk drinking water guideline for beef cattle (ANZG 2018). Further details of the modelled water quality of the rehabilitated pit landform is provided in Appendix X, Rehabilitated Pit Water Balance (Section 3.4).

8.3.6 Site water balance conceptual model

A conceptual model of water levels in the residual depression following pit rehabilitation is presented in Appendix X, Rehabilitated Pit Water Balance (Section 3.1). The assumptions, limitations and risks associated with this model and the numerical model are described at Section 7.2, Appendix F, Surface Water Assessment. The key components of the conceptual model are:

- rainfall;
- evaporation from the rehabilitated pit;
- evapotranspiration and runoff generation from catchments;
- outflows to regional groundwater; and
- salt fluxes in each flow component.

A diagrammatic representation of the conceptual model is provided through Figure 8.7.

It is noted that following rehabilitation, the landform would be configured to mostly shed water away from the depression, with some rainfall infiltrating through the in-pit waste rock. Infiltration through the waste rock would seep vertically until it reaches the underlying groundwater surface. Groundwater inflows to the backfilled pit were modelled separately as part of the groundwater impact assessment studies which included allowance for enhanced infiltration through the waste rock. The landform was designed on the basis of the groundwater modelling to ensure there would be no groundwater inflows to the residual depression after levels recover.

Outflows are limited to evaporation and seepage losses to the surrounding aquifer. Water accumulating in the pit depression would also infiltrate into the adjacent waste rock, creating additional water storage in this 'spoil aquifer'. The rehabilitated pit shell storage vs elevation curve was modified to include additional spoil storage based on a spoil storage vs elevation relationship for the pit shell provided by JBT consulting, assuming the porosity of the adjacent spoil would be 25%.

The focus of the water quality assessment is the potential for salt accumulation within the residual depression (or final pit landform). Sources of salt include catchment runoff. It is anticipated that excess water and dissolved salt would seep from the proposed landform into the spoil under and adjacent to the pit landform. Seepage to the groundwater results in the removal of salt from the surface water system, and thus, if seepage outflow rates are sufficiently high, salts would not accumulate in surface water over time.

In principle, for an initially empty depression, water is expected to accumulate until evaporative losses from the wetted surface area balance the combined influence of catchment runoff, rainfall and groundwater interception. Where catchment inflows are limited, over a sufficiently long timescale, water levels are expected to reach a nominal steady state, with some variation about the steady state level during prolonged periods of wet or dry climate bias. This principle works in reverse for any depression that is filled (e.g. by pumping) above the steady state level prior to relinquishment; water levels will reduce due to evaporation.

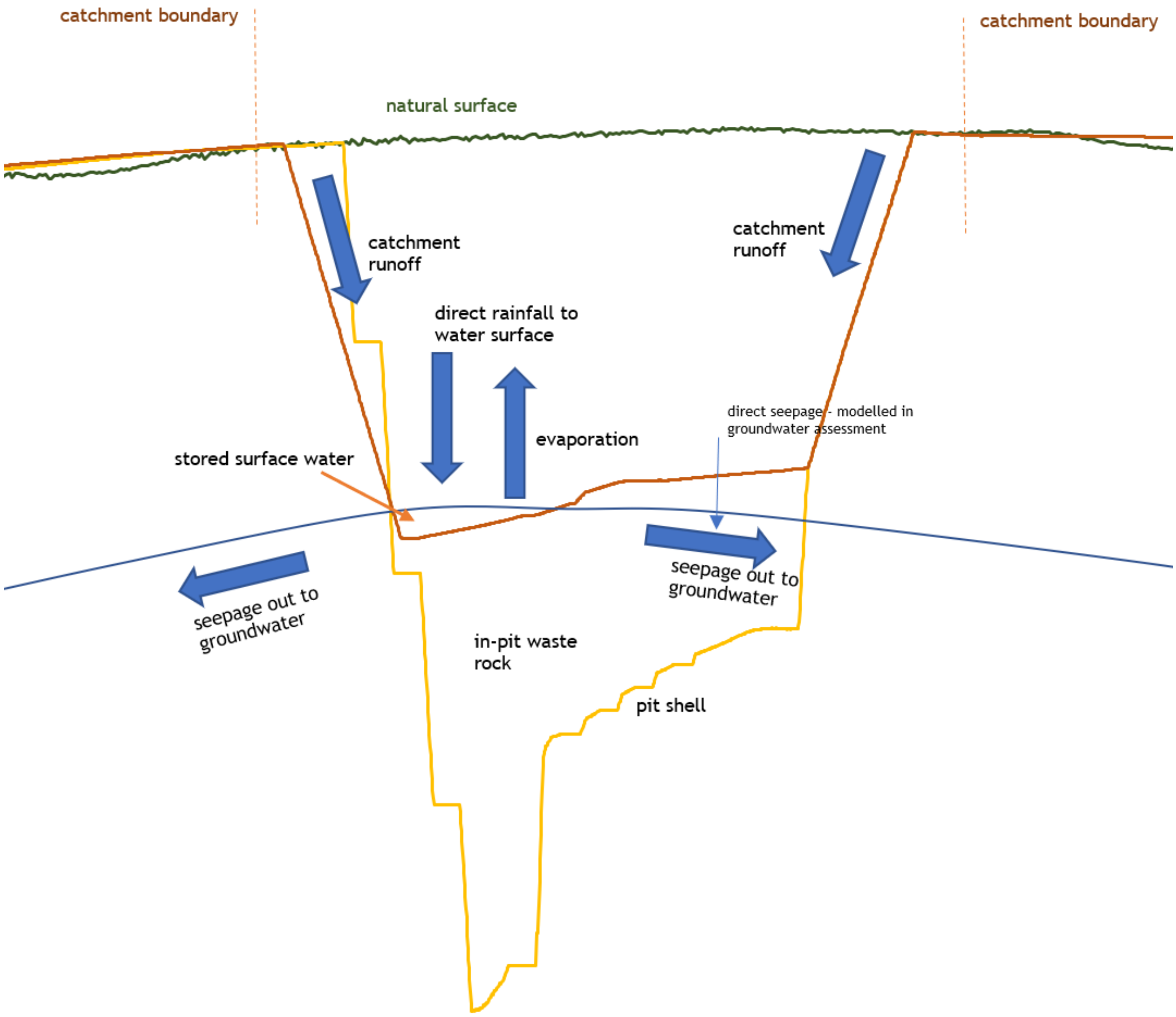

Figure 8.7: Diagrammatic representation of the conceptual surface water model of the rehabilitated pit landform

8.3.7 Geomorphology

The potential impacts of the Project on geomorphology of floodplains and streams of the Project area are described in detail in Appendix F, Surface Water Assessment (Section 7.4). The proposed longwall panels underly and will cause subsidence in Boomerang Creek, One Mile Creek and their floodplains, was well as part of the Phillips Creek floodplain to the south.

The channel and floodplain of Boomerang Creek would see a maximum subsidence depth of up to 4.0 m. Maximum subsidence depths in the floodplain between One Mile Creek and Boomerang would be over 4.5 m in localised areas. Maximum subsidence depths on the One Mile Creek channel and southern floodplain would be up to 3.0 m. Maximum subsidence depths on the Phillips Creek northern floodplain would be up to 3.0 m. The channel of Phillips Creek would not be directly affected by subsidence. Hydraulic models were used to assess the potential flood and geomorphic impacts of the Project.

Hydraulic models were used to assess the potential flood and geomorphic impacts of the Project.

8.3.7.1 Boomerang Creek

Due to the relatively flat natural ground slopes and the depth of the proposed subsidence, the extent and depth of undrained depressions in the floodplain would significantly increase. These depressions would partially fill with local rainfall and runoff and slowly evaporate or seep into the local soils. The duration of ponding in these depressions would depend on the depth and duration of rainfall, but based on water balance modelling, they would be unlikely to fill completely, and would be expected to store more than 1 m of water less than 10% of the time. However, based on modelling of the 50% AEP flood, the depressions would be expected to fill with Boomerang Creek floodwater at least every few years. The ponded water would then persist until it evaporated or seeped into the underlying soil. In the absence of seepage, depending on their depth, the ponds could then be expected to persist for several months post filling.

In small floods, the proposed subsidence would result in an increase in the amount of Boomerang Creek floodwater flowing towards One Mile Creek. Velocity increases of 0.25 m/s to 0.5 m/s are predicted over a broad area where Boomerang Creek floodwater approaches One Mile Creek. However, the increased velocities would be insufficient to erode the floodplain except in localised areas as it drains into subsidence troughs.

The proposed subsidence would result in a series of troughs in the channel bed due to the interaction of the differential settlement across the nine longwall panels and the intervening unmined pillars in each of the two overlying coal seams. These areas would see decreases in channel velocity, bed shear and stream power, causing reductions in sediment transport capacity in each trough, and promoting further aggradation of the bed (relative to the top of bank level) in these areas. The subsidence troughs in Boomerang Creek are expected to rapidly aggrade sediment during flow events from the abundant sediment present within the catchment. Notwithstanding the expected rapid in-filling of troughs, changes to stream morphology will be monitored according to the Subsidence Management Plan and include monitoring for erosion with demonstrable impact on channel form (refer Section 5.5.1 for further detail). Where these impacts occur, bank protection measures will be applied and are expected to be effective in securing stream banks and prevent the development of streambank erosion.

There would be increased channel velocity, bed shear and stream power as the channel drains into the mine subsidence zone at Ch 9,250. The deep bed sediments in these reaches are expected to erode relatively quickly as the channel morphology changes to reflect the higher bed grade. This may also lead to marginal increases in bank erosion as the channel capacity increases.

Channel velocity, bed shear and stream power would also increase as flow enters the second and fourth subsidence troughs (Ch 10,200, and Ch 11,700 to Ch 12,000). The bed sediments on the downstream side of these localised elevated sections of the stream bed are expected to scour and headward erosion may potentially occur to the extent that this elevated section of stream bed will be eroded down to the upstream and downstream bed levels (which will rise as the bed aggradation occurs). The expected aggradation relative to the bank levels could accelerate the potential abandonment of the existing Boomerang Creek channel. It should be emphasised that given the number of remnant channels and abundant sediment supplies in the catchment, a new Boomerang Creek channel could form in the absence of the proposed subsidence. Hydraulic modelling of earlier stages of underground operations indicated that the avulsion risk would be greatest in Year 17 prior to the development of the easternmost panels.

During initial flows, local incision and bank erosion can be expected over the pillars between subsidence troughs. However, given the abundant sediment supplies in Boomerang Creek, the sand bedload will infill the troughs such that the bed grade should revert to approaching the pre-mining grade over time. The expected aggradation relative to the bank levels could accelerate the potential abandonment of the existing Boomerang Creek channel. It should be emphasised that given the number of remnant channels and abundant sediment supplies in the catchment, a new Boomerang Creek channel could form in the absence of the proposed subsidence.

It should be noted that Alluvium (2019) found that depending on the timing of flows and mining and the infilling of subsidence at the proposed Saraji East underground mine through Hughes and Boomerang Creek would potentially cause downstream bedload starvation for a period and this could impact the timing of infilling of the bed at the Meadowbrook Project.

8.3.7.2 One Mile Creek

The proposed subsidence would result in a series of 8 main troughs in the channel bed due to the differential settlement across the longwall panels and the intervening unmined pillars in the one overlying coal seam which are aligned approximately perpendicular to the channel.

All troughs associated with the One Mile Creek floodplain would be directly connected to the main channel – and during flood flows, water would flow laterally into the subsidence areas. The north-flowing reaches of the One Mile Creek floodplain would also experience minor impact from the construction of the temporary levee proposed around the northern end of the open cut pit mining area. At the completion of open cut mining, the levee would be decommissioned, and the One Mile Creek floodplain would be restored to pre-mining levels through the placement of in-pit overburden in the final landform.

Within the subsidence zone, peak flood levels would be reduced by up to approximately 1.3 m and 1.5 m in the 50% AEP and 2% AEP floods respectively. In floods larger than the 2% AEP event, the impact of subsidence on downstream flows would be minimal.

Parts of the channel within subsidence troughs would see decreases in channel velocity, bed shear and stream power, causing reductions in sediment transport capacity in each trough, and promoting further aggradation of the bed (relative to the top of bank level) in these areas.

There would be increased channel velocity, bed shear and stream power as the channel drains into the mine subsidence zone. Velocities in this area would remain less than guidelines values but given the relatively fine sediment in this area and the apparent limitation in sediment supply, these reaches are expected to erode as the channel morphology changes to reflect the higher bed grade. This may also lead to increases in bank erosion as the channel capacity increases.

Channel velocity, bed shear and stream power also increase as flow enters the second to fifth subsidence troughs. The bed sediments on the downstream side of these localised elevated sections of the stream bed are expected to scour and headward erosion would occur through this elevated section of stream bed.

The subsidence troughs in Boomerang Creek are expected to rapidly aggrade sediment during flow events from the abundant sediment present within the catchment. Notwithstanding the expected rapid in-filling of troughs, changes to stream morphology will be monitored according to the Subsidence Management Plan and include monitoring for erosion with demonstrable impact on channel form (refer Section 5.5.1 for further detail). Where these impacts occur, bank protection measures will be applied and are expected to be effective in securing stream banks and prevent the development of streambank erosion.

For the subsidence impacted areas of the land adjacent to One Mile Creek, minor drainage channels are proposed to drain the subsidence panels where practicable, ponding of runoff captured in the floodplain between Boomerang and One Mile Creeks would effectively reduce the local catchment draining to One Mile Creek by approximately 900 ha (6.9%). During open-cut operations, water which would normally flow to One Mile Creek would be intercepted by the proposed mine water management system within the levees protecting the mine pit and sediment dams. During the period of peak open-cut mining disturbance, the temporary maximum additional reduction in catchment area to One Mile Creek would be approximately 300 ha (i.e. a total of 1,200 ha in catchment reduction). At the completion of mining and rehabilitation of the final landform, this would reduce by approximately 150 ha (i.e. a total catchment loss of 1,050 ha - 8%).

This catchment loss would impact the downstream 4 km to 6 km reach of One Mile Creek in minor runoff events, (which has been impacted by historical mining activities in the upper catchment) but would not significantly further alter the flow regime. The impacts of the catchment loss would be minimal downstream of the confluence, where it would make up 1.8% of the 48,900 ha total catchment.

8.3.7.3 Phillips Creek

The main channel of Phillips Creek will not be impacted by the proposed subsidence. However, four underground panels crossing the northern Phillips Creek floodplain would impact flooding and drainage. The proposed temporary levee around the south-eastern end of the open cut mining area would also impact flood flows until it was decommissioned, and pre-mining ground levels restored at the end of mining.

A minor drainage channel would be constructed around the toe of the levee to ensure the floodplain is free draining. Drainage channels would be cut through the pillars separating the subsidence troughs to allow free drainage of catchment runoff through the subsidence zone. Small embankments are also proposed across the subsidence panels to restrict the flow of water from Phillips Creek to One Mile Creek.

8.3.8 Reductions in streamflow

The Project has the potential to reduce streamflow in streams local to the Project area. Potential impacts to streamflow are discussed in Appendix W, Geomorphological Assessment Report, as well as summarised in sections 8.3.8.1 to 8.3.8.4.

8.3.8.1 Residual post-subsidence depressions

Ponding of runoff captured in the floodplain between Boomerang and One Mile Creeks will result in reductions in localised streamflow, that would otherwise be available to the downstream receiving environment.

It is estimated that subsidence depressions will reduce the local catchment draining to One Mile Creek by approximately 9 km^2 (or 6.9%). This catchment loss would impact the downstream 4 km reach of One Mile Creek in minor runoff events (which has been impacted by historical mining activities in the upper catchment) but would not significantly further alter the flow regime. The impact of this catchment loss would be minimal downstream of the confluence of One Mile Creek and Boomerang Creek, where it would make up 1.8% of the 489 km^2 total catchment. (Appendix W, Geomorphological Assessment Report, Section 3.3.4.1).

This catchment loss is noted as being an overestimate, as following prolonged rainfall, the volume of local overland flow would be sufficient to fill and overflow subsidence depressions. The volume of overland flow captured in the main floodplain depressions was estimated using a daily timestep surface water balance model (as per Appendix W, Geomorphological Assessment Report, Section 3.3.4.1).

Water balance modelling of the overland flow into the One Mile Creek depressions shows their median stored volume would total only 20 ML, but they could intercept approximately 283 ML/a of catchment runoff on average (median 96 ML/a). (Appendix W, Geomorphological Assessment Report, Section 5.3). As noted above, this is likely to be an overstatement of volumes due to limitations / challenges in modelling such scenarios.

Notwithstanding this, significant commitments have been made by the proponent to limit the volume of overland flow that may be trapped within subsidence depressions. These mitigations include the proposed construction of:

- mitigation bunds: to prevent surface water ingress into subsided areas; and
- mitigation drains: to facilitate water egress from subsided areas (where topography allows).

These mitigations are discussed in detail through Chapter 9, Flooding & Regulated Structures, Section 9.4.4.3.

Further, since the time of the public notification of the EIS, an additional commitment has now been made to limit the volume of water retained in subsided depressions (as part of the final submitted EIS). Specifically, the proponent proposes to use pumping equipment to further reduce the total volume of overland flow captured, by pumping water out of subsided depressions into downstream flow paths, when accumulated volumes become significant.

Pumps will be located at the deepest sections of each subsidence depression and deliver water to the pre-mining overland flow path. The effectiveness of pumping out each of the depressions at a nominal rate of 50 L/s (4.3 ML/d) when water depth exceeds 0.5 m above the lowest point, was tested using the water balance model. The results show that pumping reduces the volume captured in the depressions to 11% of the total runoff draining to the depressions (Appendix W, Geomorphological Assessment Report, Section 3.3.4.1).

It is noted that no works are proposed by the Project, for the purposes of capturing overland flow. Indeed, proposed works are only designed to limit the accumulation of overland flow. As such, a licencing requirement under the Fitzroy Water Plan is not considered to arise for the Project. Nonetheless, an assessment of impacts to overland flows has been provided as part of this EIS, to ensure consideration of the full range of potential impacts.

Post mining, it is expected that subsidence depressions will naturally refill with sediment. Based on estimated average sediment supply rates to the catchment, in the absence of significant depletion of sediment in the reach of Boomerang Creek between the two projects, it is expected to take 15 to 45 years for the Meadowbrook subsidence depressions to refill with sediment (post-mining). Complete replenishment of residual sediment loss attributable to the Saraji East project could take a similar time, however large floods occurring after the completion of mining could significantly reduce these timeframes. (Appendix W, Geomorphological Assessment Report, Section 3.3.4.1).

Mitigations such as the backfilling of subsidence depressions was considered as part of Project studies, however this option was discounted as a result of the more significant impact it presents to environmental values in these areas. Indeed, it is preferable to maintain ecosystem function within subsided areas, as opposed to presenting a greater impact within these footprints (resultant of building a new overlying landform). Further, there is also some argument that ponded areas arising as a result of subsidence will support increased habitat availability for some locally present threatened species (eg ornamental snake, squatter pigeon and greater glider).

Environmental impact assessment has not been reconsidered in respect of this new commitment, meaning ponding impacts are overstated. With catchment losses downstream of the Once Mile Creek and Boomerang Creek confluence representing just 1.8% of the 489 km^2 total catchment, minimal impact to streamflow is therefore expected as a result of subsidence depressions. Further, water retained in subsidence depressions will remain available to the environment, supporting local habitat value and providing a source of replenishment for localised alluvium.

8.3.8.2 Potential loss in the open cut mining area

During open cut operations, water which would normally flow to One Mile Creek and Phillips Creek would be intercepted by the proposed mine water management system within the levees protecting the mine pit and sediment dams. The construction of the sediment dams would be staged, and in large rainfall events they could overflow. However, during the period of peak open cut mining disturbance, the temporary maximum additional reduction in catchment area draining to the downstream 6 km reach of One Mile Creek would be approximately 300 ha. At the completion of mining and rehabilitation of the final landform, this would reduce to approximately 150 ha (i.e. a total catchment loss of 1,050 ha – 8%).

At Phillips Creek, there would be a corresponding 30 ha temporary loss of catchment during operations and a loss of 3 ha after rehabilitation of the final landform. These losses are insignificant in terms of impacts to the flow regime of Phillips Creek and its floodplain.

8.3.8.3 Potential loss to underground workings

Maximum depth of continuous subsurface subsidence cracking above the workings predicted from site conditions and observations at similar operations is predicted in Appendix A, Subsidence Assessment (Section 5.1.5). Cracking is not predicted to extend from the underground workings to ground surface and no potential loss of surface water to underground workings is predicted.

8.3.8.4 Potential loss to surface cracking

Surface subsidence cracks will develop in the proposed longwall mining areas and are predicted to extend to a maximum depth of 15 m, with the majority less than 1 m deep (Appendix A, Subsidence Assessment, Section 5.2.2.3). Cracks of this depth would not result in the loss of water from the alluvium associated with the watercourses overlying the underground workings and will not result in the loss of surface water to underground workings (Appendix F, Surface Water Assessment, Section 7.6.4). Indeed, there is no connectivity of cracking expected between the surface and the coal seams targeted for mining (Appendix A, Subsidence Assessment, Section 7.6).

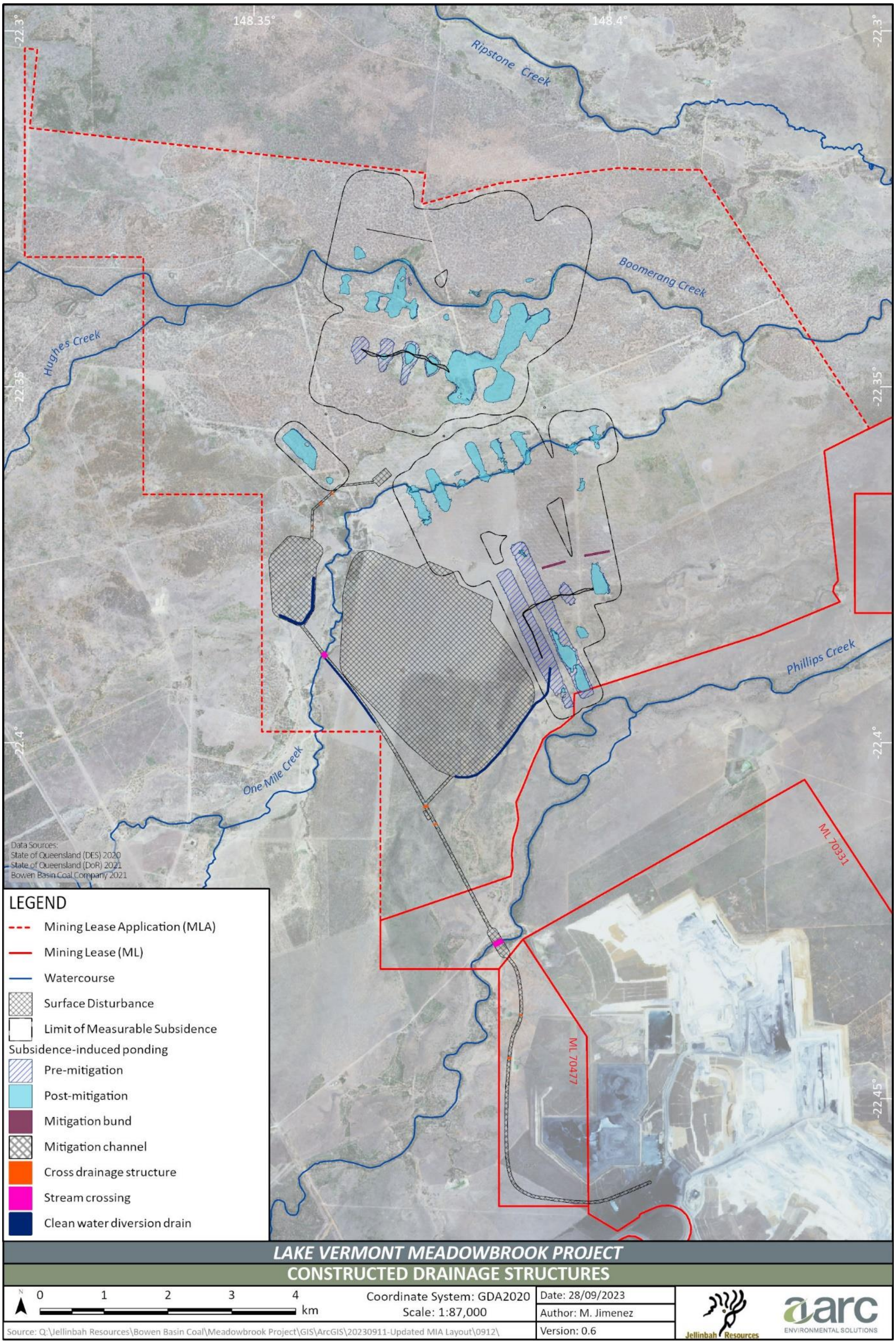

Figure 8.8: Indicative cross drainage and flow diversion drains.

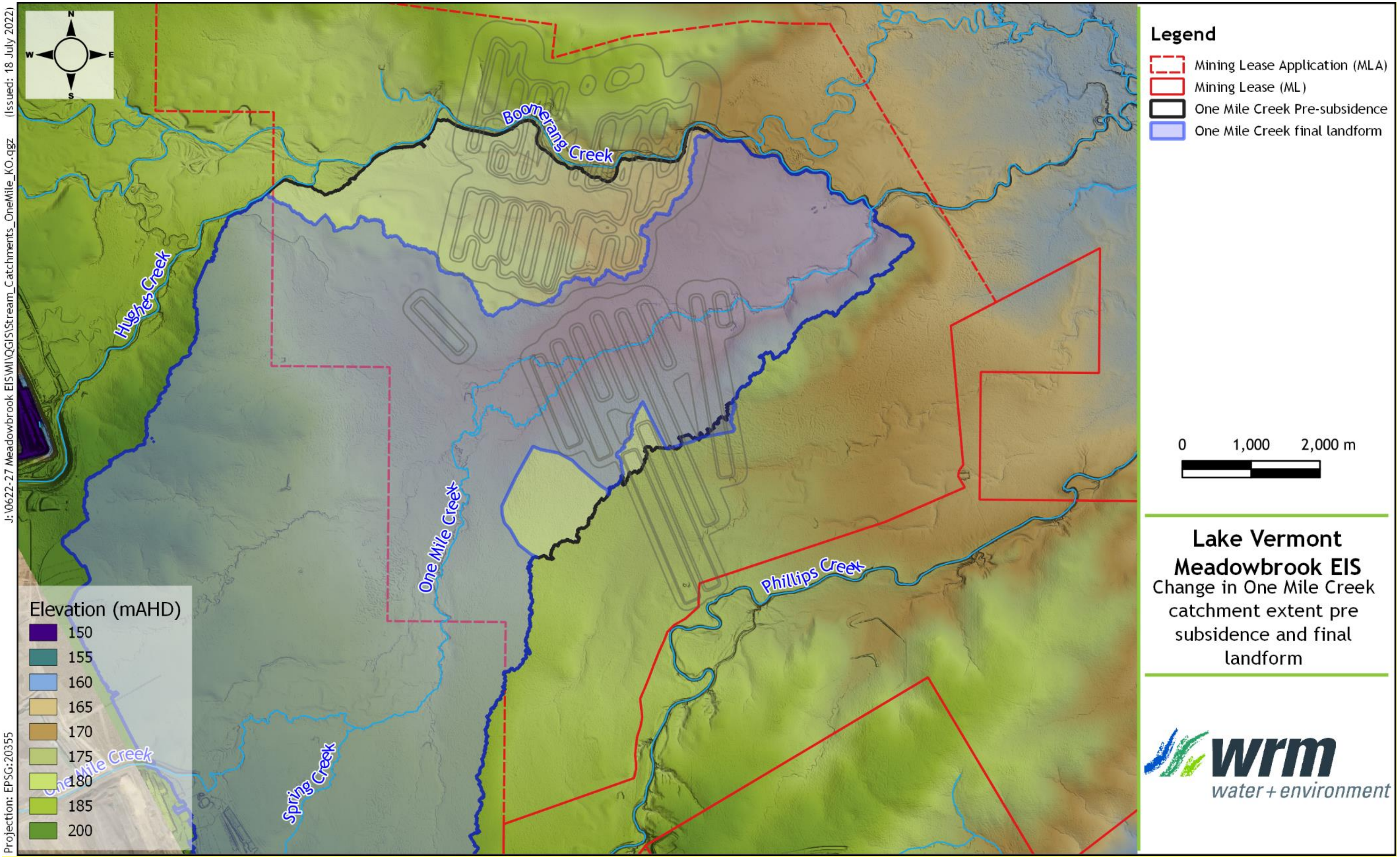

Figure 8.9: Changes in One Mile Creek catchment

8.3.9 Flooding impacts

Flood hydrology was modelled for the Project area in accordance with the most recent ensemble event procedures in Australian Rainfall & Runoff (Appendix F, Surface Water Assessment, Section 7.3 and Appendix Z, Flood Modelling, Section 1.1). The assumptions, limitations and risks associated with this model are described at Section 7.2, Appendix F, Surface Water Assessment. Potential flooding impacts associated with the Project are addressed in Chapter 9, Flooding and Regulated Structures.

8.3.10 Site water demand

During underground operations, the average annual demand for water is estimated to be up to approximately 1,390 ML/year. The principal water demand would be for raw water for underground operations which would become mine affected water after use in the underground operation. Minor quantities of water captured in the water management system would be used for washdown and dust suppression in the surface operations.

During open cut operations (and after the cessation of underground mining), the average annual water demand would be significantly reduced (to approximately 180 ML/year). While the infrastructure corridor linking the new MIA to the existing operation will include sealed access and coal haulage roads (which will not require watering for dust suppression during operations), water would be used for dust suppression on haul roads in the active mining area.

If on-site supplies are insufficient during dry periods, they would be supplemented with additional imported raw water. However, there will generally be sufficient water on-site, particularly during underground operations, and excess water would be returned to the existing Lake Vermont Mine for reuse within the site water management system via a pipeline along the infrastructure corridor.

8.3.10.1 Water pipeline supply and transfer volume

Predictions of water pipeline supply and transfer volumes have been derived from the site water balance model (Appendix Y, Mine Water Balance, Section 5.6). The need for raw water supply is expected to decrease from a peak of almost 1,500 ML per year to less than 200 ML per year in the last five years of operations. Mean transfer volume requirements are expected to peak at year 5 at 1,320 ML per year. Modelled very wet conditions (99th percentile) during open-cut pit mining predicts transfer volumes of 3,000 ML per year.

Mine water storage in existing environmental dams at the Lake Vermont Mine totals 4.9 GL. Following extreme wet periods, up to 200 GL of storage in the mine voids could potentially be used for emergency surface water storage - though this would be undesirable - as it would cause significant disruption to the open cut mining operations.

8.3.11 Regional water availability

The Project will source water from a raw water supply pipeline constructed within the infrastructure corridor. The raw water supply line will connect to the existing raw water supply pipeline at the Lake Vermont Mine that sources water from the Eungella Water Pipeline Southern Extension. Bowen Basin Coal holds a water supply agreement with Eungella Water Pipeline Pty Ltd for the supply of up to 1,500 ML of water per annum and an on--supply contract with Peabody to transfer 1,000 ML per year of their water allocation to the Lake Vermont Mine. There is sufficient capacity available from the current water supply agreements to meet the anticipated requirements of the Project. The Project will not require any licensed allocation of water from the Isaac River and will not impact existing licence allocation holders.

Water demands for construction will be met by the capture of incidental rainfall and runoff within the Project water management system, as well as water truck transfers from the existing Lake Vermont Mine. A diversion drain is proposed to be developed during the construction phase to divert clean water around the southern extent of the MIA levee. An additional diversion drain is also proposed to be constructed during the Project operational phase to divert clean water around the southern extent of the open-cut pit levee. Diversion drain design and construction is discussed in Chapter 9, Flooding and Regulated Structures.

8.3.12 Wetlands

No wetlands or watercourses identified as high ecological value waters are located within the study area or surrounds. The Project will not result in any direct disturbance to HES wetlands or HES wetland protection areas. However, HES wetlands could be impacted indirectly through changes to hydrogeological or hydrological flows.

The water management system has been designed to minimise potential impacts on HES wetlands. The Project will not result in a significant impact on prescribed wetlands. The assessment of potential impacts on prescribed wetlands, including HES wetlands, is detailed in Chapter 11, Aquatic Ecology and Chapter 10, Terrestrial Ecology.

8.3.13 Cumulative impacts

Assessments of impacts on water resources are detailed in:

- Appendix E, Groundwater Assessment;
- Appendix F, Surface Water Assessment;
- Appendix H, Aquatic Ecology Assessment; and
- Appendix Z, Flood Modelling Assessment Report.

No controlled releases of mine-affected waters are predicted to occur and no provision for an authorised release point is proposed. Consequently, no impacts to surface water quality or cumulative impacts to surface water quality as a result of mine-affected water releases are predicted to occur. Hydrological and hydrogeological modelling conducted to assess impacts on water resources has included all current and known future coal mining and gas extraction operations and no cumulative impacts to surface water environmental values were identified from geomorphology, reductions to streamflow or the rehabilitated pit landform.

Regional flood modelling has determined that cumulative flooding impacts of the Project and the approved Olive Downs project will extend onto the Isaac River floodplain downstream of the Project. However, the flooding impacts of the Project will be minor, and the cumulative impact of the Project and the Olive Downs project will also be minimal.

A full assessment of the cumulative impacts on surface water is provided at Appendix F, Section 7.7.3, an assessment of cumulative impacts on groundwater is detailed in Chapter 7, and Groundwater and the cumulative impact assessment of flood modelling is presented in Chapter 9, Flooding and Regulated Structures.

8.4 Mitigation and management measures

8.4.1 Water management system

The water management system for the Project has been developed to minimise potential water quality impacts on the receiving environment and achieve the environmental objectives for water quality that are to be met under the EP Act; namely, to protect the environmental values of waters, wetlands and GDE, groundwater and any associated surface ecological systems. Numerical modelling demonstrates the water management system would be adequate to minimise impacts on water resources and water dependent assets.

The water management system will be centred within the Project MIA shown in Figure 3.2, Chapter 3, Project Description. The infrastructure corridor linking the new MIA to the existing Lake Vermont Mine will include the water supply and return water pipelines, as shown in Figure 3.2, Chapter 3, Project Description.

The layout of the proposed water management system features within the MIA is shown in Figure 3.24, Chapter 3, Project Description.

8.4.1.1 Water management system water types

The water management system will manage water in separate types based on likely water quality characteristics, as described below.

Mine-affected water

The mine-affected water system will manage runoff from the open-cut pit, ROM stockpile and MIA, and groundwater inflows from the underground mine. It will be a closed system designed to prevent releases of mine-affected water to the environment.

Inflows to the mine-affected water system will be primarily from groundwater seepage into the underground mine and open-cut pit. Groundwater quality is described in Chapter 7, Groundwater. Water management system modelling has been based on an approximate equivalent representative TDS concentration of 17,000 mg/L for groundwater inflows (Appendix F, Surface Water Assessment, Section 5.2) and has included all waters defined as mine-affected water by DES (2017b).

The mine affected water system will manage runoff from the open-cut waste rock dumps, which is to be directed to sediment dams managed under a sediment and erosion control plan (section 8.4.2). Sediment dams have been sized to achieve a high-level of sediment containment. Stored water will be returned to the MIA Dam for blending with mine-affected water before reuse.

Clean catchment water

Clean water from undisturbed areas will be diverted around areas of disturbance by drains, which will include flow diversion drain proposed to be developed during the construction phase to support the diversion of clean water around the southern extent of the MIA levee (Figure 8.8). An additional flow diversion drain is proposed to be constructed during the Project operational phase to divert clean water around the southern extent of the open-cut pit levee (Figure 8.8). Flow diversion drain design and construction is discussed in Chapter 9, Flooding and Regulated Structures.

A program for the pumping of excess water captured within subsidence depressions to downstream flow paths, is also proposed to minimise the capture of overland flow resultant of the Project.

Watercourse diversions and crossings

The Project does not propose to divert the course of any Water Act 2000 (Qld) watercourses; or any watercourses identified as “yet to be mapped” on the Queensland ‘Watercourse Identification Mapping’.

Haul road crossings of Phillips Creek and One Mile Creek are proposed, with potential flooding impacts of these works discussed through Chapter 9 (Section 9.4.6); and potential aquatic ecology impacts discussed through Chapter 11 (Section 11.5.1).

It is noted that the Project haul road is proposed to be constructed above existing ground level to ensure all-weather access during mine operation. Therefore, the proposed haul road construction is anticipated to provide some obstruction to floodplain and channel flows, locally increasing upstream flood levels. These risks are proposed to be mitigated through the design of the road embankment and associated cross-drainage structures, as identified through Chapter 9 (Section 9.5.4). Locations of cross-drainage structures for the Project are shown in Figure 8.8. Stream crossings will be constructed as causeways with appropriately sized culverts to mitigate impacts to channel flows. Impacts to aquatic ecology values resultant of stream crossings is discussed through Chapter 11 (Section 11.5.1) while flooding impacts are considered within Chapter 9 (Section 9.4.6).

The electricity transmission line and light vehicle access to the substation and bore holes also transits channel flows at three locations with cross-drainage structures to mitigate upstream flood levels and downstream flow reductions (Figure 8.8).

Two flow diversion drains are proposed at the southern ends of the mine infrastructure area (1 km) and open cut (2.3 km) (Figure 8.8). Water diverted by these channels is returned to One Mile and Phillips Creeks respectively. The Stage 2 ponding mitigation channel returns almost all flow to the natural drainage line that joins Phillips Creek 6km east of the Project eastern boundary.

A small amount of overland flow (60 ha) will be redirected by the Project haul road to join One Mile Creek immediately upstream of the One Mile Creek crossing (Figure 8.8).

Raw water

The proposed infrastructure corridor will include a pipeline to deliver raw water *via* the Lake Vermont Mine, sourced from the Eungella Water Pipeline Southern Extension, as described in section 8.3.11. Raw water will be delivered to a dedicated Raw Water Dam at the Meadowbrook MIA, which will supply the mining operations and the potable water treatment plant (Figure 3.24, Chapter 3, Project Description).

Potable water and sewage water

Potable water and sewage water will be managed on-site within the MIA. A water treatment plant will be constructed within the MIA, as described in Chapter 3, Project Description. Treated water will be stored in 100 kl tanks adjacent to the plant, and effluent from the water treatment plant will be stored in the Mine Water Dam.

An STP will be constructed within the MIA to treat sewage generated during the operations phase. The STP will have secondary treatment capability and produce Class C effluent for land-based irrigation disposal (Chapter 3, Project Description). Effluent disposal using land irrigation is proposed based on the modelling of effluent disposal undertaken, as described in Chapter 15, Waste Management. The modelling has determined that an area of 3.6 ha will be sufficient for irrigation, given site characteristics and the proposed effluent irrigation areas are within the MIA contained catchment area. The sewage treatment system and management measures are addressed in Chapter 15, Waste Management.

8.4.1.2 Water management system components

The components of the water management system and their connectivity are presented in Figure 8.10, and the components located within the MIA are shown in Figure 3.24 Chapter 3, Project Description.

MIA and open-cut pit levees

The MIA and open-cut pit will be protected by levees and associated minor drainage systems to exclude clean water runoff from Phillips Creek and One Mile Creek and their minor tributaries in the 0.1% AEP design flood. The levees will be 'regulated structures' that will be designed, constructed, operated and decommissioned in accordance with the 'Manual for assessing consequence categories and hydraulic performance of structures' (DES 2016) and the guideline 'Structures which are dams or levees constructed as part of environmentally relevant activities' (DES 2022b).

The MIA levee structure will be developed during the initial Project construction phase and remain in place until mine closure. At this point, the levee will be removed, and the area rehabilitated. The open-cut pit levee structure will also be temporary, required only once open-cut mining commences in Project Year 20 (indicatively 2045) until the final overburden profile is achieved and the associated permanent landform is established. Details on the MIA levee and open-cut pit levee construction are provided in Chapter 3, Project Description.

Raw water supply pipeline

An extension to the existing raw water supply pipeline will be constructed within the infrastructure corridor. It will connect to the existing raw water supply pipeline at the Lake Vermont Mine (that sources water from the Eungella Water Pipeline Southern Extension) to the proposed MIA. The proposed 12 km raw water supply pipeline will transfer raw water to a Raw Water Dam at the MIA. Raw water will then be treated by a water treatment plant for ablutions use and use underground.

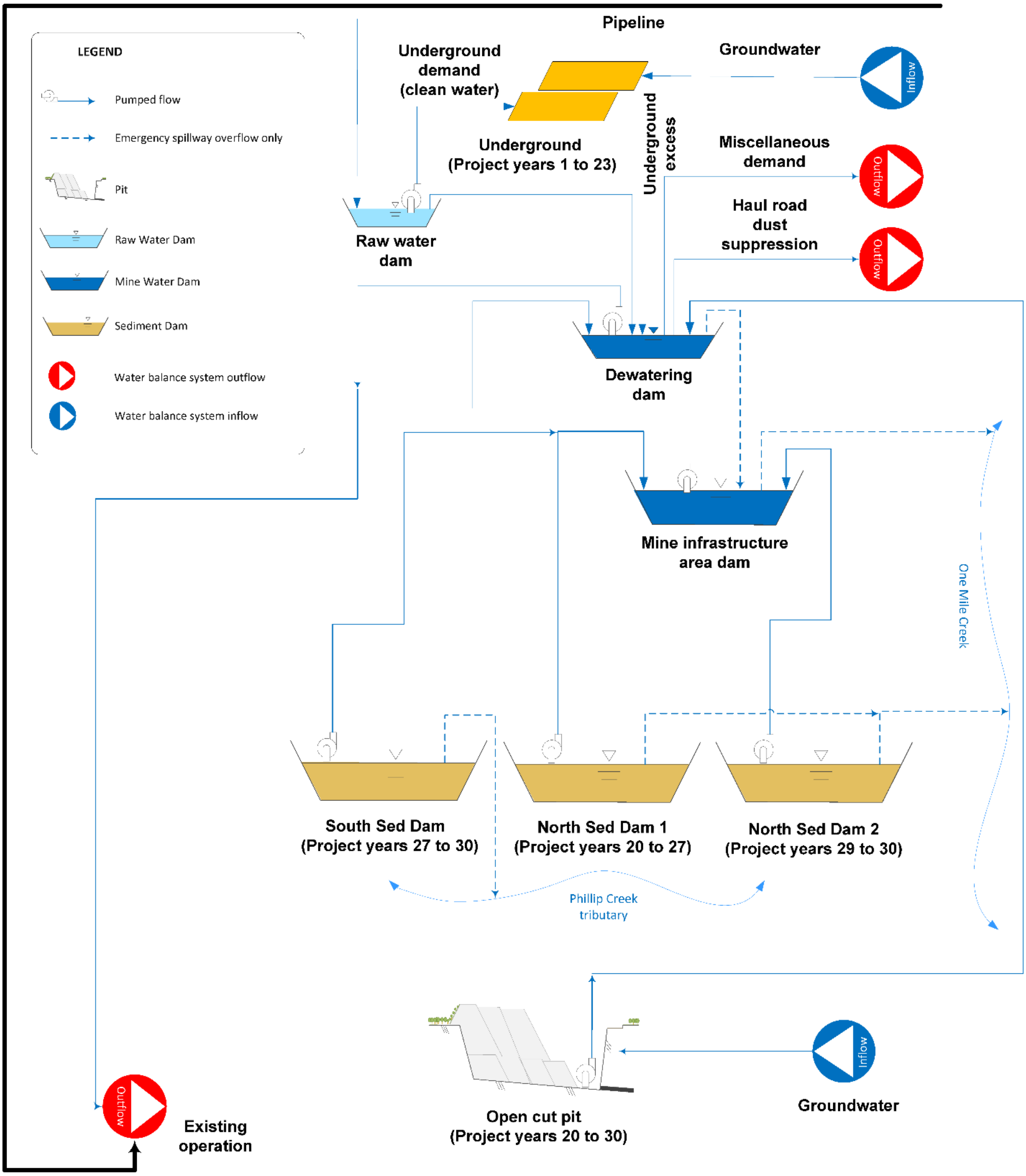

Figure 8.10: Water management system schematic

Underground mine dewatering system

Water accumulating within the underground workings (groundwater inflows, excess dust suppression water and washdown water) will be pumped to the surface to the Dewatering Dam to be located in the MIA. Underground dewatering is anticipated to cease at the completion of underground operations.

Open-cut mine dewatering

Local runoff and groundwater seepage accumulating within in-pit sumps in the open-cut mining pit will be pumped to the Dewatering Dam.

Return water pipeline

Inflows to the underground operations and associated water management system are expected to exceed demands for mine water within the Meadowbrook operation. The return water pipeline will be used to transfer excess mine-affected water *via* the infrastructure corridor to environmental dams at the existing Lake Vermont Mine. The return water pipeline will be located within the proposed infrastructure corridor for the Project.

Potable water supply

The water treatment plant will be located within the MIA and have the capacity to treat raw water from the Raw Water Dam and pipeline at a rate of up to 10 ML/year. Treated water will be stored in 180 kl capacity potable water tanks adjacent to the plant.

The minor volumes of effluent from the water treatment plant will be captured and stored within the mine-affected water system and used for dust suppression or returned to the Lake Vermont water management system.

Sewage treatment

Sewage generated at the MIA will be pumped to a package STP. The STP will have secondary treatment capability and the ability to produce Class C effluent for irrigation, as defined in the Queensland Public Health Regulation 2018. It is conservatively estimated that effluent will be produced at a rate of approximately 40 kl/day (based on 200 workers each generating 200 L/day of effluent on-site each day). Wet weather storage will be located adjacent to the plant. Irrigation of treated effluent is proposed to occur within the MIA. Details of the proposed effluent treatment and disposal system are provided in Appendix S, Land-Based Effluent Disposal Assessment (Section 3).

Raw Water Dam

The Raw Water Dam will be located within the MIA and will temporarily store raw water for use where relatively high-quality water is required—for example, within the underground operations, in equipment requiring clean water for cooling and feed water for the potable water treatment plant. The Raw Water Dam will be sized to provide continuity of supply in the event of reasonably foreseeable equipment failure (e.g. pump or pipeline failure).

Mine infrastructure area dam

Runoff from disturbed areas within the MIA will be contained within the catchment area and directed *via* a series of drains to the MIA Dam, which is proposed to be located in the low area to the north east of the ROM stockpile (Figure 3.24, Chapter 3, Project Description). Runoff captured in the MIA Dam will include runoff from the ROM stockpile, laydown areas and workshop areas. For the impact assessment, it has been assumed that the MIA Dam will capture runoff from the entire area within the MIA levee. In the detailed design, the site drainage system may be configured to minimise the catchment area and direct clean runoff from undisturbed parts of the MIA away from the dam.

Dewatering Dam

The Dewatering Dam will be located within the MIA and store water transferred from the underground and open-cut mining operations. Water stored in the Dewatering Dam will be reused for dust suppression of the surface operations.

Excess water will be transferred *via* the return water pipeline to the existing Lake Vermont Mine for reuse within the site water management system and to offset water otherwise imported *via* the raw water pipeline. The Dewatering Dam will be operated to avoid any overflows; however, emergency overflows *via* the spillway will be captured within the MIA Dam.

Sediment dams

During open-cut mining operations, catchment runoff from overburden dumps will be captured in three sediment dams (referred to as Southern Sediment Dam, Northern Sediment Dam 1 and Northern Sediment Dam 2, as shown in Figure 8.11 to Figure 8.13.

Sediment dams will be designed and operated in accordance with the 'Guideline–Stormwater and environmentally relevant activities' (DES 2021). This guideline states that:

> *For events up to and including a 24-hour storm event with an ARI of 1 in 10 years, the following must be achieved:*
>
> - *a sediment basin must be designed, constructed and operated to retain the runoff at the site(s) approved as part of the ERA application;*
> - *the release stormwater from these sediment basins must achieve a total suspended solids (TSS) concentration of no more than 50mg/L for events up to and including those mentioned above.*
>
> *For events larger than those stated above, all reasonable and practical measures must be taken to minimise the release of prescribed contaminants.*

Sediment dams will be constructed to contain a 1 in 10-year ARI 24-hour event and will be operated in accordance with 'Guideline – Stormwater and environmentally relevant activities' (DES 2021). Sediment dam catchment areas and proposed storage capacities are provided in Chapter 9, Flooding and Regulated Structures.

The Northern Sediment Dam 1 will be initially constructed by pre-excavating overburden material near the northern corner of the open-cut pit levee. Once the existing ground surface is mined out, sediment dams will be formed into localised depressions north and south of the open-cut pit.

8.4.2 Sediment and erosion control

The existing Lake Vermont Water Management Plan will be updated in accordance with erosion and stability management measures proposed in Chapter 5, Land Resources, Section 5.5.3. The Plan will be implemented during Project construction, operations and rehabilitation phases to minimise erosion and sediment generation from disturbed areas and maintain water quality in downstream water systems.

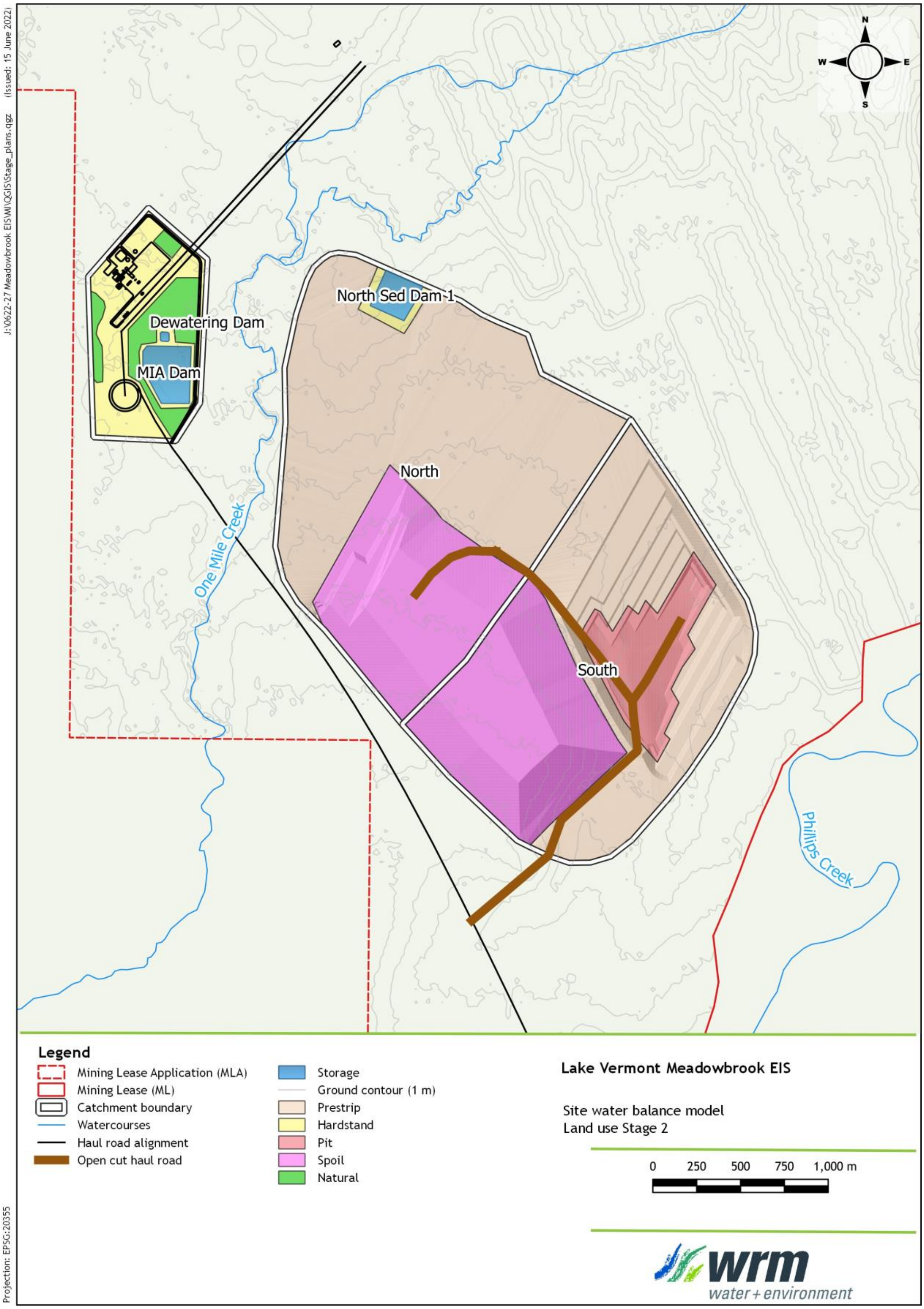

Figure 8.11: Proposed catchment and land use boundaries (Project Year 20–26)

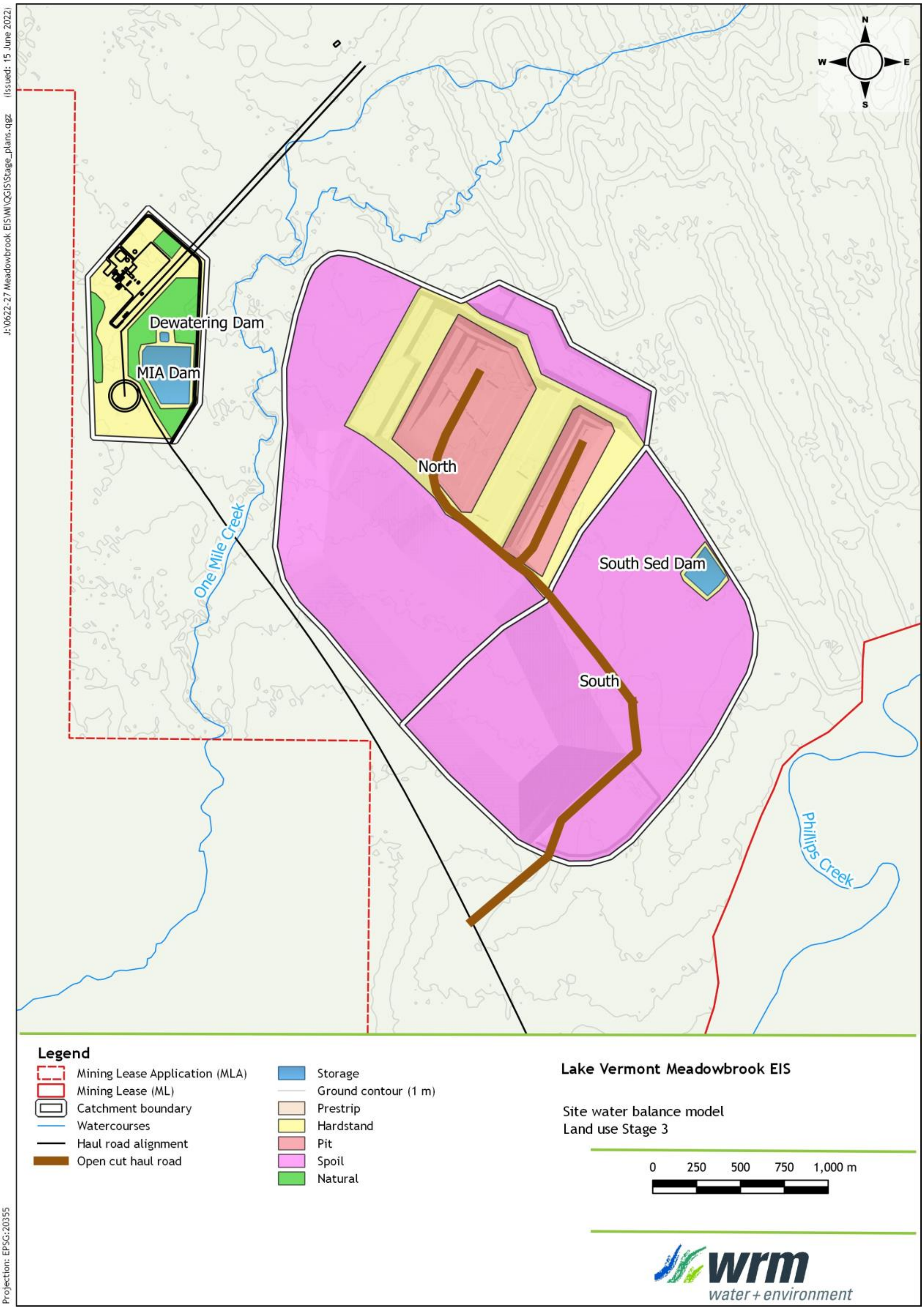

Figure 8.12: Proposed catchment and land use boundaries (Project Year 27–28)

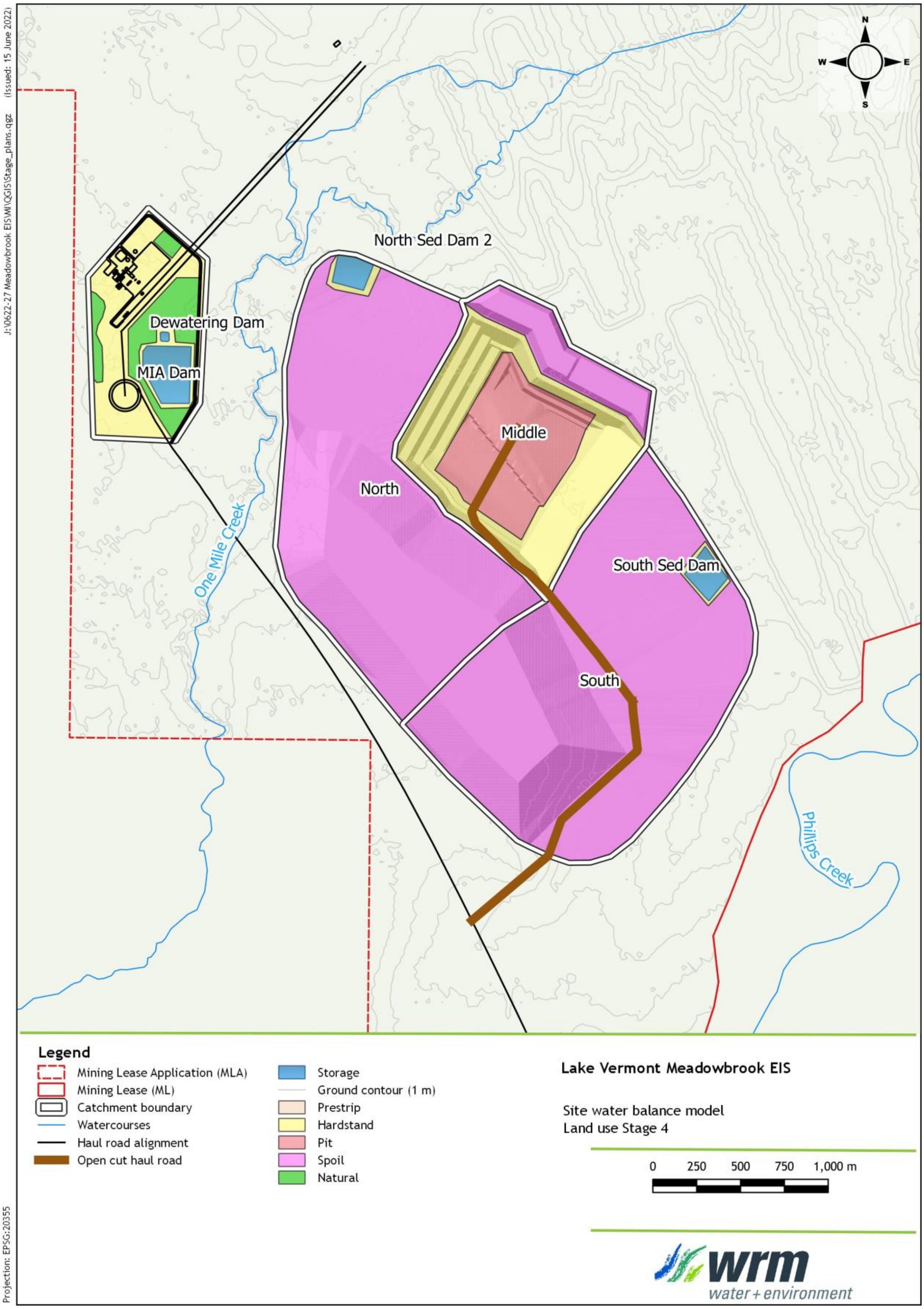

Figure 8.13: Proposed catchment and land use boundaries (Project Year 29–30)

8.4.3 Water Management Plan

The existing Lake Vermont Mine Water Management Plan will be updated to incorporate the management of water resources for the Project. It will include:

- a description of the potential sources of contaminants that could impact on water quality;
- a description of the water balance model;
- a description of the water management system;
- a program for the pumping of excess water captured within subsidence depressions (to minimise the capture of overland flow);
- a program for the monitoring and review of the Water Management Plan's effectiveness and adequacy of water mitigation measures; and
- corrective actions and contingency procedures for emergencies.

The Water Management Plan will be updated progressively to reflect changing water management requirements. The update process will identify risks associated with the water management system and enable feedback on infrastructure and operational management improvements. Once additional data is collected, site-specific water guidelines incorporating seasonal variation may be developed if necessary.

8.4.3.1 Emergency and contingency planning

The existing Lake Vermont Mine Water Management Plan will be updated to include proactive management measures for flood, drought and severe weather events, as they might apply to the Project. Emergency and contingency planning for the Project water management system will be designed to protect the values of receiving waters in accordance with the Project EA. Contingency planning and wet weather preparedness will include:

- managing water in accordance with this plan, including creating air space in storages ahead of each wet season;
- complying with the site's environmental authority;
- maintaining water management infrastructure, including ensuring dams, drains, pipes, pumps, monitoring equipment and other water management infrastructure are serviceable in advance of each wet season;
- reviewing the Water Management Plan and associated water management procedures annually and after each wet season to capture lessons learned from that wet season; and
- ensuring relevant personnel are trained in the Water Management Plan and associated procedures.

8.4.4 Water quality management and monitoring

8.4.4.1 Surface water quality monitoring program

There are no proposed release points for the Project and, therefore, no expected mine-affected water impacts to the sensitive receiving environment. Chapter 23, Proposed Environmental Authority Conditions provides the proposed water monitoring program for the Lake Vermont operation from Project commencement. The Lake Vermont Water Management Plan will be updated to include monitoring requirements for the Project. When water quality monitoring is undertaken, it will be by trained personnel and in accordance with the 'Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009' (DES 2018).

8.4.5 Receiving environment monitoring program

There are no proposed release points for the Project and, therefore, no sensitive receiving waters that will potentially be directly affected by an authorised release of mine-affected water. However, the overflow from sediment dams will have the potential to impact the sensitive receiving environment. The existing REMP design document will be updated to include monitoring of One Mile Creek to identify any potential impact of sediment dam overflow on ecotoxicological values, as outlined in Chapter 23, Proposed Environmental Authority Conditions. The location of REMP monitoring points on One Mile Creek will be determined subject to a REMP design process, however, are likely to be at the assessment monitoring locations MA3 and MA12 shown in Figure 11.3 (Chapter 11, Aquatic Ecology).

The REMP design document will also be updated to provide for monitoring of the receiving environment of Boomerang Creek, Phillips Creek and the Isaac River, such as to identify any potential impacts associated with subsidence induced geomorphological changes. As per proposed EA Condition C21 (Chapter 23, Proposed EA Conditions) the receiving environment for the Project is stated to include the waters of One Mile Creek, Boomerang Creek, Phillips Creek and the Isaac River.

The REMP design document that addresses the requirements of the REMP will be updated, and reports outlining the findings of the REMP (including all monitoring results and interpretations) will be prepared annually and made available to the administrating authority.

To ensure the ongoing adequacy of the water management system, reviews will include the Project water balance. The following data and information will be collected for the duration of the Project to inform regular updates and validation of the operational water balance model:

- water inventory of the mine water dams and sediment dams;
- water quality monitoring of the water storages and sediment dams;
- pumped flow water meter data for major transfer and water demand offtakes;
- aerial surveys of the mine topography to review catchment area and land use development; and
- daily rainfall.

The update and review of the model will be used to assess validity of the model inputs and assumptions.

8.4.6 Corrective actions

As described in Sections 8.4.1 to 8.4.3, water quality monitoring within the area of potential impact by the Project will be conducted in accordance with the Water Management Plan, and the REMP design document. The results of the water quality monitoring programs will:

- provide information on the performance of the water management system; and
- facilitate adaptive management through early detection of any impacts and the implementation of appropriate corrective actions.

When monitoring identifies a potential impact, further sampling and analysis may be undertaken and a direct toxicity assessment if required to verify and characterise the potential impact and identify feasible corrective actions. Potential corrective actions may include:

- maintaining and/or managing sediment and erosion controls when inspections indicate the controls are not operating effectively;
- implementing additional erosion control measures;
- implementing additional waste rock management measures;
- conducting water management system audits;
- modifying the water management system;
- increasing the frequency of monitoring or including additional sampling locations to inform the nature of the impacts and the effectiveness of the corrective actions implemented; and/or
- following up inspections and/or monitoring.

8.4.7 Annual review

An annual review of surface water quality trends and groundwater quality trends will be conducted by a suitably qualified person or persons. The review will assess the change in surface water quality and groundwater quality over time compared to historical trends and impact assessment predictions.