

Appendix F

Water Quality Assessment



Acknowledgement of Country

The authors of this report pay our respects to the rich, long and ongoing history of the Traditional Owners and Custodians of the lands and waterways that we study. We acknowledge that the mountains, lakes and rivers that capture and channel water for hydropower are rich in Aboriginal history, culture, and tradition. We acknowledge ongoing Aboriginal connection to culture and custodianship of the lands and waters of places we share. We pay our respects to Elders past and present, and we extend that respect to all Aboriginal and Torres Strait Islander peoples today.

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Executive summary

Hydro Tasmania is proposing to redevelop the Tarraleah Hydropower Scheme which will include a new power station and associated infrastructure to convey water from Lake King William to the power station including a new pipeline, a tunnel and tunnel portals, surge tower and penstocks. Entura was engaged by Hydro Tasmania to undertake a surface water quality assessment that examines the impact of the construction of the redeveloped scheme on the water quality of receiving waters. The aim of the assessment was to provide a baseline understanding of the water quality of receiving waters and the potential impacts of the construction of the Project on the water quality of receiving waters. This is followed by the identification of mitigation measures to reduce the impact on water quality to the receiving waterways.

The potential impacts to water quality come from:

- Increases in erosion and sedimentation
- Hydrocarbons associated with construction
- Increases in pH from the use of concrete and grouting in tunnelling
- Metals associated with construction materials
- Nitrate and ammonium from explosive use

The Project is examined for its impact based on individual parts (sites) of the Project footprint. In summary, the assessment found:

- Most sites have a high potential for erosion and sedimentation impacting water quality on the basis of the high erodibility of soils and the slope of the sites.
- Most sites have a moderate potential for hydrocarbons to impact local water quality on the basis of the potential for spills and residues associated with the use of machinery.
- Most sites have either moderate or high potential to impact the pH of receiving waters, varying on the basis of the size of the potential waterway impacted and the ability to dilute to pH to close to background. Smaller receiving waterways have the highest potential to be impacted by discharges of water high in pH.
- All sites have low potential for impact by metals.
- For nitrate and ammonium, two sites drain to two small creeks that may result in periods of high concentration and have the high potential to significantly impact water quality. Other sites drain to large and/or fast flowing waterways with substantial dilution to reduce concentrations to acceptable levels, within background concentration ranges.

Analysis was undertaken to understand the potential generation of nitrate and ammonium across the whole project and its route and rate of transfer to waterways. A block model used a number of assumptions and was informed by data collected as part of the Tarraleah Intake Upgrade Project. The model provided an estimate of daily loads from each part of the project and was used to assess the potential use of dilution as a mitigation for nitrate.

Following the management measures and monitoring that will be put in place during construction, it is assessed that there will be no significant impacts to water quality from the construction sites. The mitigation measures to reduce the impacts on water quality include a water management plan which includes a series of measures to control water and potential contaminants, including the capture, storage, treatment and discharge of water on-site, specific spill response, hydrocarbon and concrete washout measures.

Important water management measures to be implemented include:

- Capture and storage of water on main work sites including below spoil emplacement locations and subsequent treatment of all water discharged from site to achieve pH and suspended sediment (turbidity) discharge performance criteria
- The use of dilution within the Tarraleah conveyances and the Nive River to achieve dilution of nitrate (as well as pH and sediment) in the discharge to comply with pH, suspended sediment (turbidity) and nitrate receiving environment performance criteria
- Contingency to store water on-site for a period of 72 hours in the event of brief and foreseeable outages of the Tarraleah conveyances where dilution cannot be assured. This will ensure compliance with receiving environment performance criteria

With the implementation of these mitigation measures, there will be no residual impacts on water quality that result in environmental harm. There will be an increase in the load of dissolved nitrogen, mostly in the form of nitrate, to the Derwent catchment for periods during and subsequent to blasting. However, the size of these loads relative to the greater catchment, their transient nature during the construction project and the significant dilution utilised to reduce their concentration are such that these loads are considered to have no residual impacts.

1. Introduction

Hydro Tasmania is proposing to redevelop the Tarraleah Hydropower Scheme in Tasmania's Central Highlands. The Tarraleah Redevelopment Project (**the Project**) proposes to increase the capacity of the existing Tarraleah Hydropower scheme from 90 megawatts (**MW**) to approximately 180 MW. The Project forms part of Hydro Tasmania's Major Projects Program (previously known as Battery of the Nation).

The Project will increase operational flexibility and efficiency by providing a direct pressurised connection between the scheme's headwaters at Lake King William and a new power station located adjacent to the existing Tarraleah Power Station on the Nive River. Part of the existing Number 2 water conveyance (**No. 2 Canal**) will be retained and water captured by Derwent Pumps, Horne's Dam and smaller water pick-ups will be transferred to the new pressurised conveyance. The Project will utilise the new intake on Lake King William and associated 950 m Lake King William tunnel that is currently being constructed as part of a program of upgrade works. A description of the Project is found in Section 2.

Entura was engaged by Hydro Tasmania to conduct a detailed surface water quality assessment for the Tarraleah Redevelopment Project in line with legislative and regulatory requirements (Section 3). This assessment included:

- Assessment of the broader catchment and existing condition of waterways associated with the Project (Sections 5 and 6).
- Modelling to describe nutrient loading (concentration and quantity) in discharge to waterways (Section 7.3).
- Impact assessment (Section 7) of construction and operation on the water quality of waterways associated with the Project taking into account legislative and regulatory requirements (Section 3).
- Management and monitoring measures (Section 8) to address potential impacts.

The Project area (including the disturbance footprint) comprises the pipeline alignment, tunnel portals and spoil dumps, a surge tower and 14-15 km of transmission line alignment. Associated waterbodies include rivers and storages that hydrological modelling indicates may be impacted by the Tarraleah Redevelopment Project, namely River Derwent from Clark Dam to Lake Catagunya, the Nive River from Tarraleah Power Station to Wayatinah Lagoon, Lake King William, Lake Liapootah, Wayatinah Lagoon, Mossy Marsh Pond, No. 1 Pond and No. 2 Pond). Mossy Marsh Pond, No. 1 Pond, No. 2 Pond, Lake Liapootah and Wayatinah Lagoon are all artificial water bodies.

2. Project Description

2.1 Project Description

Hydro Tasmania is proposing to redevelop the Tarraleah Hydropower Scheme to replace end of life assets and provide a more flexible and efficient scheme to ensure a reliable and safe renewable energy source into the future. The key permanent components of the Tarraleah Redevelopment Project are outlined below and shown in Figure 2.1:

- An approximately 4.2 km **headrace pipeline** and associated service roads connecting the Lake King William tunnel (under construction) to the headrace tunnel.
- An approximately 9.8 km low pressure **headrace tunnel**.
- An approximately 2.3 km long high pressure **power tunnel** that splits into two short penstocks before entering the power station.
- A partially underground **power station** with an installed capacity of approximately 180 MW and rated flow of 60 m³/s located adjacent to the existing Tarraleah Power Station.
- A **surge facility** consisting of a 70 m high (above ground level) surge tower and associated underground approximately 265 m high surge shaft to control water pressure in the headrace and power tunnels.
- An approximately 6 m³/s **pumping station** and approximately 0.8 km **rising main** to transfer water from the existing No. 2 Pond to the power and headrace tunnels via the surge tower.
- A **transformer yard** and **switchyard** located close to the power station connecting the power station to the proposed transmission line.
- A new 22 kV **power supply** from the existing 22 kV network to the western, mid access and Paddy's Quarry portals, pump station, surge tower and power station will provide power during construction and operation.
- A new 220 kV **transmission line**. There are currently two transmission line options being considered:
 - A 14 km double circuit line from the existing Tungatinah Switchyard to the existing Dee Lagoon Tee (northern option), or
 - A 15 km double circuit line from the proposed Tarraleah Switchyard to the existing Liapootah substation (southern option)
- **Access tunnels, tunnel portals** and **access roads** to provide access to the headrace and power tunnels. Excess spoil from tunnel, power station and portal excavations will be stored in one of three **permanent spoil emplacement areas** located at the western portal, mid tunnel access portal and Paddy's Quarry portals.

Construction of the Tarraleah Redevelopment Project underground works will be completed using drill and blast techniques and may be supported by a tunnel boring machine. Above ground works will be completed by conventional earth moving and mechanical excavation.

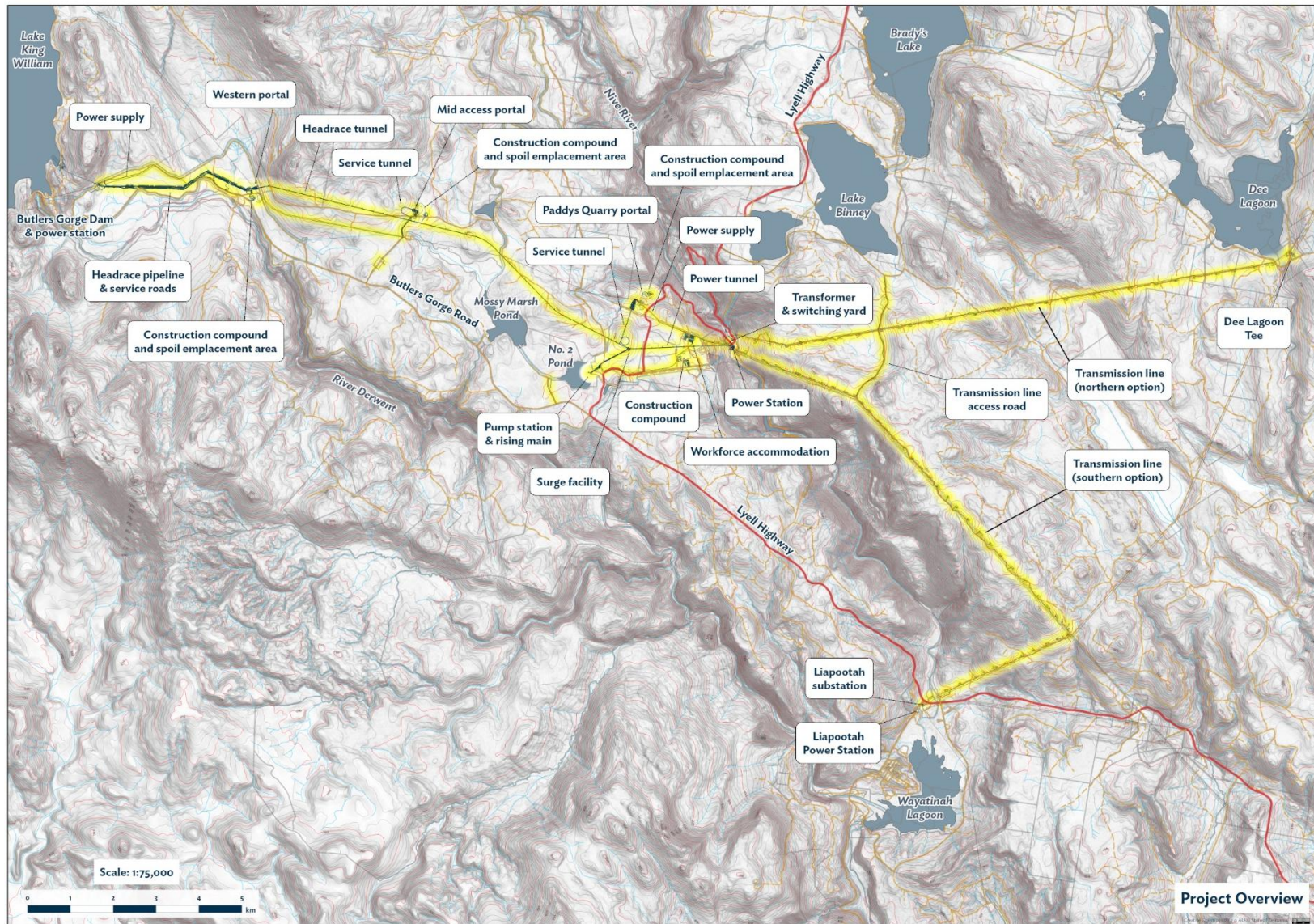


Figure 2.1: Overview of the Tarraleah Redevelopment Project and its key components

To support construction the following key temporary infrastructure is proposed:

- A **construction compound** at Tarraleah Village supported by smaller construction compounds located at each of the tunnel portals and the power station. Construction compounds will include site administration facilities and workshops, handle and store materials and equipment imported to site and concrete batching and crushing and screening plant.
- Explosives for excavation work are required to be stored in a dedicated facility. Two **explosive magazines** will be located off Butlers Gorge Road
- To facilitate construction of the power station a **temporary bridge** will be built over the Nive River.
- A **workforce accommodation facility** will be constructed at Tarraleah but is not included in the scope of this assessment.

Upon the completion of works, all temporary construction sites will be rehabilitated.

2.2 Construction requirements

The following Project construction methods and requirements have the potential to impact water quality:

- clearing of work sites
- excavation of tunnels, penstock, powerhouse including:
 - use of Ammonium Nitrate Emulsion explosives for drill and blasting methods
 - use of concrete and grouting to line tunnels and pipelines
 - transportation of excavated material to spoil emplacement areas
- use of concrete for hard stand areas and buildings
- use of construction machinery (hydrocarbon, fuels, oils)
- construction/upgrade of roads
- waste water and stormwater from Project work sites and its treatment/discharge
- waste management (leachates, spills)

3. Legislative and regulatory setting

The overarching principles and objectives for water quality management in Tasmania are provided in the State Policy on Water Quality Management 1997, with the main legislation controlling water quality in Tasmania being the Environmental Management and Pollution Control Act 1994. Further detail on legislation, policies, management plans and guidelines related to surface water and water quality that are relevant to the Project is provided below.

3.1 State Policy on Water Quality Management 1997

The State Policy on Water Quality Management (1997), also known as the Water Quality Policy, provides a framework for the development of ambient water quality objectives and the management and regulation of point and diffuse sources of emissions to surface waters (including coastal waters) and groundwater. The State Policy on Water Quality Management 1997 was established under the State Policies and Projects Act 1993. The policy provides a framework for the identification and management of Protected Environmental Values (PEVs). This is consistent with the National Water Quality Management Strategy (NWQMS) that seeks to maintain or improve water quality to meet the needs of PEVs such as the protection of aquatic ecosystems, drinking water supply, and industrial water use.

The identification of PEVs allows for the management and regulation of point and diffuse sources of emissions to surface waters – including coastal waters, and groundwaters in accordance with appropriate water quality objectives. The protection of aquatic ecosystems is a protected environmental value in common to all water types. On this basis, Default Guideline Values (DGVs) for aquatic ecosystems have been developed by the Environment Protection Authority (EPA) Tasmania in accordance with the NWQMS.

The setting of water quality objectives (WQOs) is a central component of the State Policy and WQOs provide the primary focus and reference point for the management of water quality and protecting the environmental values in Tasmania. The EPA's Technical Guidance for Water Quality Objectives (WQOs) Setting for Tasmania (EPA 2020) has been used to guide development of Project specific water quality objectives. These objectives are based on the DGVs for the Upper Derwent Catchment (EPA 2021) in which the project is situated, but take into account other lines of evidence and data (e.g. ANZG 2018, existing baseline water quality within the Project area) to provide water quality objectives relevant to the Project.

3.2 Environmental Management and Pollution Control Act 1994

The *Environmental Management and Pollution Control Act 1994* (Tas) (EMPC Act) is the primary environmental protection and pollution control legislation in Tasmania. The EMPC Act is a performance-based style of legislation, with the fundamental basis being the prevention, reduction and remediation of environmental harm. The focus of the Act is on preventing environmental harm from pollution and waste with objectives of the Act including to:

- protect and enhance the quality of the Tasmanian environment
- regulate, reduce or eliminate the discharge of pollutants and hazardous substances to air, land or water consistent with maintaining environmental quality
- provide for the monitoring and reporting of environmental quality on a regular basis
- adopt a precautionary approach when assessing environmental risk to ensure that all aspects of environmental quality, including ecosystem sustainability and integrity and beneficial uses of the environment, are considered in assessing, and making decisions in relation to, the environment.

Through assessment of potential water quality impacts and the development of practical and feasible management measures (including monitoring) to minimise any potential environmental risks to surface water quality, the Project looks to protect the quality of the Tasmanian environment by reducing impacts of the Project.

3.3 Water Management Act 1999

The *Water Management Act 1999* (Tas) (WM Act) provides for the use and management of fresh-water resources in Tasmania by:

- Promoting sustainable use and facilitating economic development of water resources;
- Recognising and fostering the significant social and economic benefits resulting from the sustainable use and development of water resources for the generation of hydro-electricity and for the supply of water for human consumption and commercial activities dependent on water;
- Maintaining ecological processes and genetic diversity for aquatic and riparian ecosystems;
- Providing for the fair, orderly and efficient allocation of water resources to meet the community's needs;
- Increasing the community's understanding of aquatic ecosystems and the need to use and manage water in a sustainable and cost-efficient manner; and
- Encouraging community involvement in water resources management.

Through looking to avoid or minimise any surface water quality impacts from the Project, the Project is consistent with the objectives and requirement of the WM Act.

3.4 Environment Protection and Biodiversity Conservation Act 1999 (Cth)

Matter of National Environmental Significance (MNES) are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Cth). The EPBC Act provides for Commonwealth involvement in development assessment and approval in circumstances where MNES could potentially be affected. MNES include:

- World Heritage properties
- National Heritage places
- Ramsar Wetlands
- Nationally threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear actions (including uranium mining)
- a water resource, in relation to coal seam gas development and large coal mining development.

A proponent who proposes to take an action that will have or is likely to have a significant impact on MNES must refer that action to the Federal Environment Minister for assessment. The Project has been referred to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) for assessment of impacts on nationally threatened species and the Tasmanian Wilderness World Heritage Area (TWWHA). Implementation of the proposed management and monitoring measures for surface water will ensure that the Project does not affect the surface water quality within the TWWHA, with subsequent impacts on natural and cultural values.

4. Methods

4.1 Baseline water quality monitoring

A total of 14 water quality sites between Lake King William and Wayatinah Lagoon, were used to provide baseline water quality data. Of these sites, monitoring commenced in April 2023 at six sites, December 2023 at one site and in June 2024 at the remaining sites. A full list of sites sampled, their locations and water quality parameters sampled is provided in Table 4.1, with their location shown in Figure 4.1. Photos of most sites are presented in Figure 4.2 to Figure 4.13.

Water quality monitoring has been undertaken at the eight new sites since June 2024 and is ongoing. At all sites, standard physico-chemical parameters (water temperature, electrical conductivity, pH, turbidity, dissolved oxygen) were measured at the surface using a WTW Multi 3630 IDS Multi-Parameter Portable Meter. Nutrient and metal water quality samples were collected in line with the Australian and New Zealand Water Quality sampling guidelines (AS 5667). When calculating the statistics, values below the laboratory limit of reporting are treated as the minimum reporting value (which leads to a slight over estimation of value).

Quality assurance and quality control (QAQC) for all field sampling, sample preservation and laboratory analysis was undertaken in alignment with national requirements for QAQC as outlined in the ANZG (2018).

Table 4.1: Baseline water quality monitoring sites

Site no(s).	Location	Waterway type	Data period	Frequency	Parameters sampled
Lake King William					
128.4	Lake King William at Clark Dam	Headwater lake	April 2023 to March 2025 (ongoing)	Variable: <i>Monthly:</i> Apr 2023-Apr 2024 <i>Weekly:</i> May 2024-Jul 2024 <i>Fortnightly:</i> Aug 2024-Dec 2024 <i>Monthly:</i> Jan 2025-Mar 2025	As per Wayatinah Lagoon sites
Vicinity of proposed headrace pipeline					
2621.1	Stream 1	Small stream tributary of River Derwent	December 2023 to March 2025 (ongoing)	Variable: <i>Sub-weekly/weekly:</i> Dec 2023 - Jun 2024 <i>Fortnightly:</i> Jul 2024-Jan 2025 <i>Monthly:</i> Jan 2025-Mar 2025	Field observations: Electrical conductivity, pH, dissolved oxygen, temperature, turbidity, Total solids: Total Dissolved Solids Total Suspended Solids

Site no(s).	Location	Waterway type	Data period	Frequency	Parameters sampled
No. 2 Canal upstream of Mossy Marsh to No. 2 Pond					Alkalinity: Total alkalinity, alkalinity CO ₃ , alkalinity HCO ₃ Dissolved Nutrients: nitrite, nitrate, ammonia, phosphorus dissolved reactive Total Nutrients: nitrogen and phosphorus Dissolved metals Chlorophyll-a (except sites 2621.1 and SW-P8)
SW-P1 (161.26)	No. 2 Canal below tunnel outlet	Exit point of No. 2 Canal from tunnel, before entering canal	June 2024 to March 2025 (ongoing)	Monthly	
SW-P2 (1433.1)	Mossy Marsh Pond at Dam	Shallow storage on No. 2 Canal	April 2023 to March 2025 (ongoing)	Variable: <i>Monthly:</i> Apr 2023-Jan 2024 <i>Sub-weekly/weekly:</i> Jan 2024 - Jun 2024 <i>Fortnightly:</i> Jul 2024-Jan 2025 <i>Monthly:</i> Jan 2025-Mar 2025	
SW-P3 (156.3)	No. 2 Canal below Mossy Marsh	Canal structure conveying water between Mossy Marsh Pond and No. 2 Pond	June 2024 to March 2025 (ongoing)	Monthly	
SW-P4 (553.1)	No. 2 Pond	Shallow final storage on No. 2. Canal	June 2024 to March 2025 (ongoing)	Monthly	
SW-P5 (2509.3)	Hornes Pond	Shallow storage diverting water to Mossy Marsh Pond	June 2024 to March 2025 (ongoing)	Monthly	
SW-P6 (257.2)	Overland flow between No. 2 Canal and Mossy Marsh	Braided overland channel – flow from No. 2 Canal	June 2024 to March 2025 (ongoing)	Monthly	
Tarraleah Village					
SW-P7 (1049.2)	Tarraleah Village – Poned Water	Pond in Tarraleah	June 2024 to March 2025 (ongoing)	Monthly	
SW-P8 (10172.2)	Tarraleah Penstock	Spring downslope from Tarraleah Village	June 2024 to March 2025 (ongoing)	Monthly	
Nive River downstream of Tarraleah Power Station					
98.1	Nive River below existing Tarraleah Power Station	Nive River	April 2023 to March 2025 (ongoing)	Variable <i>Monthly:</i> Apr 2023-Dec 2023 <i>Sub-weekly/weekly:</i> Jan 2024 - Jun 2024 <i>Fortnightly:</i> Jul 2024 – Nov 2024 <i>Monthly:</i> Dec 2024 – Mar 2025	Field observations: Electrical conductivity, pH, dissolved oxygen, temperature, turbidity, Dissolved Nutrients: nitrite, nitrate, ammonia, phosphorus dissolved reactive Total Nutrients: nitrogen and phosphorus

Site no(s).	Location	Waterway type	Data period	Frequency	Parameters sampled
Wayatinah Lagoon					Dissolved metals Chlorophyll-a
190.3	Wayatinah Lagoon at River Derwent inflow	Wayatinah Lagoon	April 2023 to March 2025 (ongoing)	Variable <i>Monthly:</i> Apr 2023-Jun 2024 <i>Quarterly:</i> Sep 2024-Mar 2025	
190.4	Wayatinah Lagoon at Wayatinah PS intake	Wayatinah Lagoon	April 2023 to March 2025 (ongoing)	Variable <i>Monthly:</i> Apr 2023-Jun 2024 <i>Quarterly:</i> Sep 2024-Mar 2025	
190.7	Wayatinah Lagoon at Liapootah PS Bay	Wayatinah Lagoon	April 2023 to March 2025 (ongoing)	Variable <i>Monthly:</i> Apr 2023-Jun 2024 <i>Quarterly:</i> Sep 2024-Mar 2025	

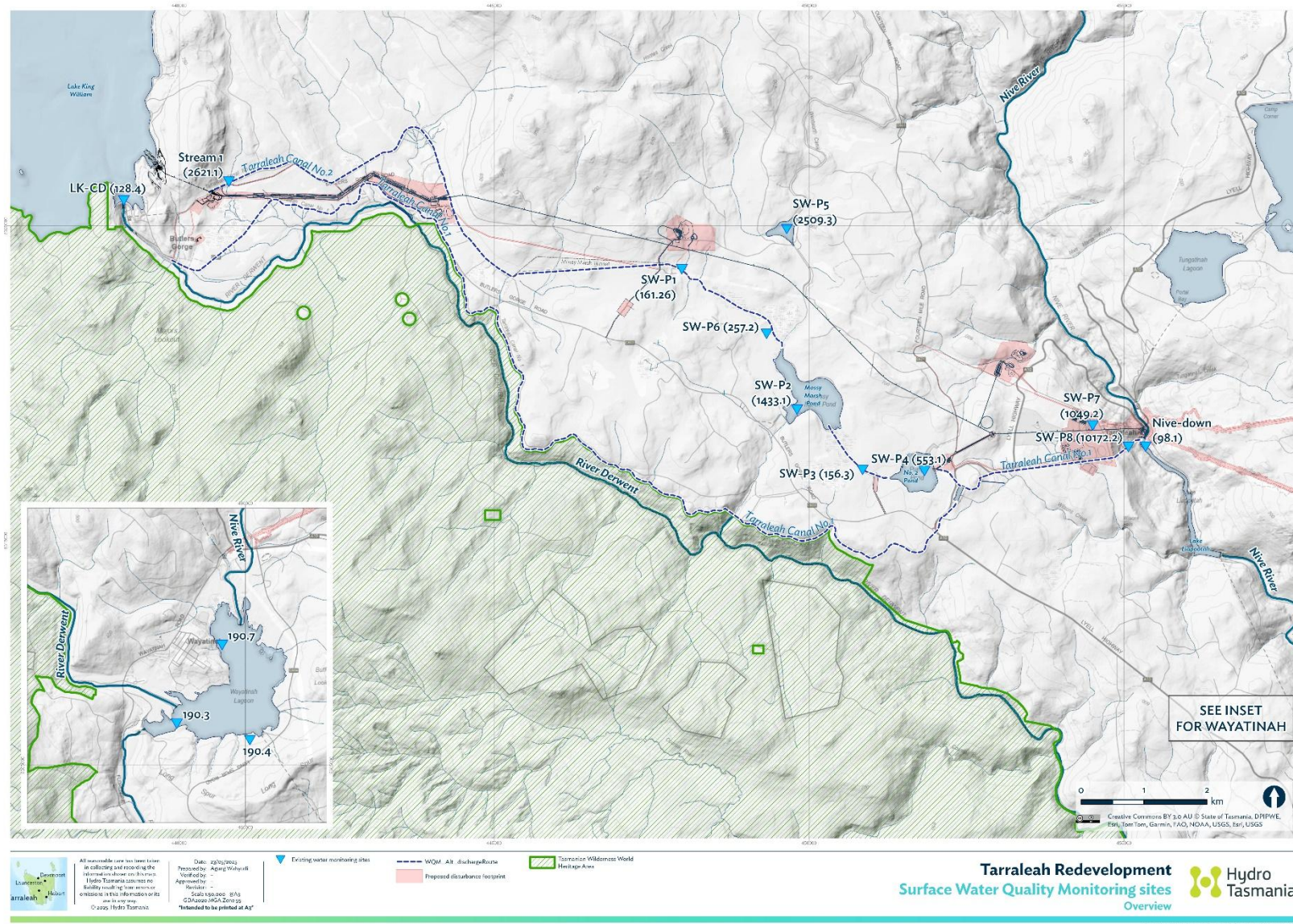


Figure 4.1: Project water quality baseline sampling sites in relation to the project disturbance footprint.



Figure 4.2: Water quality sampling site 128.4 located in Lake King William at Clark Dam



Figure 4.3: Water quality sampling site 2621.1 located in Stream 1



Figure 4.4: Water quality sampling site SW-P1 (161.26) located at the exit point of Canal No. 2 tunnel



Figure 4.5: Water quality sampling site SW-P6 (257.2) located in the overland flow that forms a section of No. 2 conveyance between the end of a section of Canal No. 2 and Mossy Marsh Pond.



Figure 4.6: Water quality sampling site SW-P5 (2509.1) located in Hornes Pond



Figure 4.7: Water quality sampling site SW-P2 (1433.1) located in Mossy Marsh Pond



Figure 4.8: Water quality sampling site SW-P3 (156.3) located in Canal No. 2 between Mossy Marsh Pond and No. 2 Pond looking upstream (top) and downstream (bottom).



Figure 4.9: Water quality sampling site SW-P4 (553.1) located in No. 2 Pond



Figure 4.10: Water quality sampling site SW-P7 (1049.2) located in Tarraleah Village Pond



Figure 4.11: Water quality sampling site 98.1 located in Nive River below Tarraleah Power Station



Figure 4.12: Water quality sampling site 190.3 located in Wayatinah Lagoon opposite River Derwent



Figure 4.13: Water quality sampling site 190.7 located in Wayatinah Lagoon at Power Station Bay

4.2 Block water quality model for nitrates and ammonium

The use of drill and blast explosives in the construction of the Project has the potential for the production of nitrate and ammonium that may be released to the environment. These are sourced from undetonated explosives and may end up in either spoil or in site wastewater. Understanding the potential amount of nitrate and ammonium (also referred to as TAN to refer to unionised (NH_4^+) and ionised (NH_3) forms) released to the environment and its location is required to assess the potential impact and to develop management measures.

A block model was developed for the Project with sub- models for each stockpile and access portal site to estimate on a daily time-step:

- the amount of nitrate generated from the explosive use
- the distribution of the nitrate generated between tunnel water and stockpile storage, noting that the timing of release of tunnel water will differ to that of spoil emplacement areas
- The combined discharge of nitrate to the environment.

Further detail on the block model and its assumptions can be found in Section 7.3.2

5. Existing environment

5.1 Catchment setting

The Project is located in the vicinity of Tarraleah in the Central Highlands, approximately 125 km north-west of Hobart, Tasmania (Figure 2.1). The Project area extends from Lake King William to Dee Lagoon or Liapootah via Tarraleah. The proposed project area covers approximately 4,800 ha however, the disturbance footprint is < 350 ha. The Project is located within the upper Derwent Valley within the catchments of the River Derwent and its tributary, the Nive River. The Project area is located north of the River Derwent and runs approximately parallel to the river between the location 1 km east of Lake King William to Tarraleah (Figure 2.1).

The Project area is located on the Tarraleah Plateau characterised by gently undulating slopes. Valleys containing the River Derwent and Nive River also exist in the landscape. The highest point within the Project area is approximately 814 m (AHD83) at the termination of the proposed northern transmission line option to the northeast of Dee Lagoon and the lowest is approximately 345 m (AHD83) at the site of the new power station. There is an approximately 315 m drop in elevation from the western end of the headrace pipeline to the power station.

The River Derwent is the second longest river in Tasmania, originating at Lake St Clair and flowing south-east over approximately 187 km to New Norfolk where it enters the Derwent Estuary. The River Derwent and a number of its main tributaries have been dammed by, or diverted to, 21 storages for the generation of hydro-electricity. The headwaters of the River Derwent begin at Lake St Clair, where the flow is regulated by St Clair Dam after which the river flows south-east for 5 km to the hydropower storage of Lake King William, formed by Clark Dam.

Lake King William is the storage for the Tarraleah Power Station where water is delivered via two canals, No. 1 Canal and No. 2 Canal. Butlers Gorge Power Station at the base of Clark Dam discharges into the River Derwent directly for approximately 350 m before the flow is diverted by Butlers Weir into No. 1 Canal, which has a capacity of 20 m³/s. Water spills back into the River Derwent when Butlers Gorge Power Station exceeds 20 m³/s (the maximum discharge of Butlers Gorge Power Station rarely exceeds 25 m³/s). No. 1 Canal is located close to and north of the River Derwent, carrying water to Tarraleah No. 1 Pond where it enters the headrace pipeline to the Tarraleah Power Station.

Derwent Pumps Weir and Derwent Pumps are located 6 km downstream of Clark Dam on the River Derwent. Water from the weir pool, derived from spills from Butlers Weir and tributary pickup, is transferred via the pumps at a rate of to 2.8 m³/s into No. 2 Canal which has a normal operating flow of approximately 10 m³/s. No. 2 Canal follows a route further north from No. 1 Canal and discharges overland through tea tree scrub, picking up water discharged from Wentworth Canal before flowing into Mossy Marsh Pond, a small (0.6 km²) shallow storage. Mossy Marsh Pond subsequently discharges to No. 2 Pond and No. 1 Pond and combining with flow from Tarraleah No. 1 Canal before entering the existing headrace pipeline and Tarraleah Power Station penstocks.

Water discharged from Tarraleah Power Station to the Nive River combines with flow in the Nive River and discharge from Tungatinah Power Station, which is located approximately 600 m upstream. The combined flows enter Lake Liapootah, a storage on the Nive River, with most flows entering the Liapootah Power Station headrace tunnel, to be discharged in Wayatinah Lagoon. Lake Liapootah occasionally spills to the Nive River which also flows into Wayatinah Lagoon and to the lower storages on the River Derwent.

Due to regulation of the River Derwent and Nive River, the aquatic environment from Lake King William and downstream of Tungatinah is highly modified from natural although water quality is generally good upstream of Wayatinah.

5.1.1 Surrounding land use

The Project area is largely vegetated by wet and dry eucalypt forests and woodlands, non-eucalypt forests and buttongrass moorlands, with land use dominated by forestry, hydroelectric generation and electricity transmission. The Project area is predominantly actively managed for forestry operations by Sustainable Timber Tasmania as per the provisions of the *Forestry Management Act 2013*. Forest operations include hardwood plantations dominated by *Eucalyptus nitens* and native forest dominated *Eucalyptus delegatensis*.

The Project area has also been modified overtime by hydroelectric generation and transmission, commencing in the 1930's when the original Tarraleah Hydropower Scheme was constructed and continuing through to the 1960's as the scheme was augmented. This has included the construction of dams, weirs, tunnels, pipelines, flumes, surface canals, penstocks, Tarraleah Power Station and the Tarraleah to New Norfolk 110 kV transmission line. Tungatinah Power Station and Tungatinah to Waddamana 110 kV transmission line are located immediately to the north of the Project area. The Project's transmission line will partly share an easement with one of the existing transmission lines.

The Project area is also located in close proximity to the Tasmanian Wilderness World Heritage Area (TWWHA, Figure 5.1), which is listed as a Matter of National Environmental Significance (MNES) under the EPBC Act. At its closest point at the proposed western portal, the Project area is approximately 50 m from the TWWHA boundary on the opposite side of No. 1 Canal.

Downstream of Wayatinah, land use along the River Derwent changes to agriculture (primarily sheep and cattle grazing) resulting in significantly more diffuse nutrient inputs (Proemse et al 2022).

5.2 Geology and soils

The Project design alignment traverses several geological units (Appendix A). Jurassic dolerite is the dominant rock type within the design alignment, including the power station, transmission line upgrades, the mid-access portal, pump station and rising main and some areas of the surge and western tunnel portals. Some exposure of Permian-Triassic sedimentary bedrock intersects the low-relief section of the headrace, and the majority of the area of the western tunnel portal, and Tertiary basalt flows intersect the majority of the surge tunnel portal, transmission line upgrades and the pump station.

A range of surficial Quaternary soils is expected to be encountered at all Project sites, including alluvial, colluvial, glacial and swamp deposits. A shallow water table may occur within bedrock hollows with wetlands, and local perched aquifers are possible within the Tertiary basalt flows; within the dolerite bedrock, there is likely a deeper, regional water table (PSM 2025). The Project construction activities within the disturbance footprint encompass some or all of the geological units

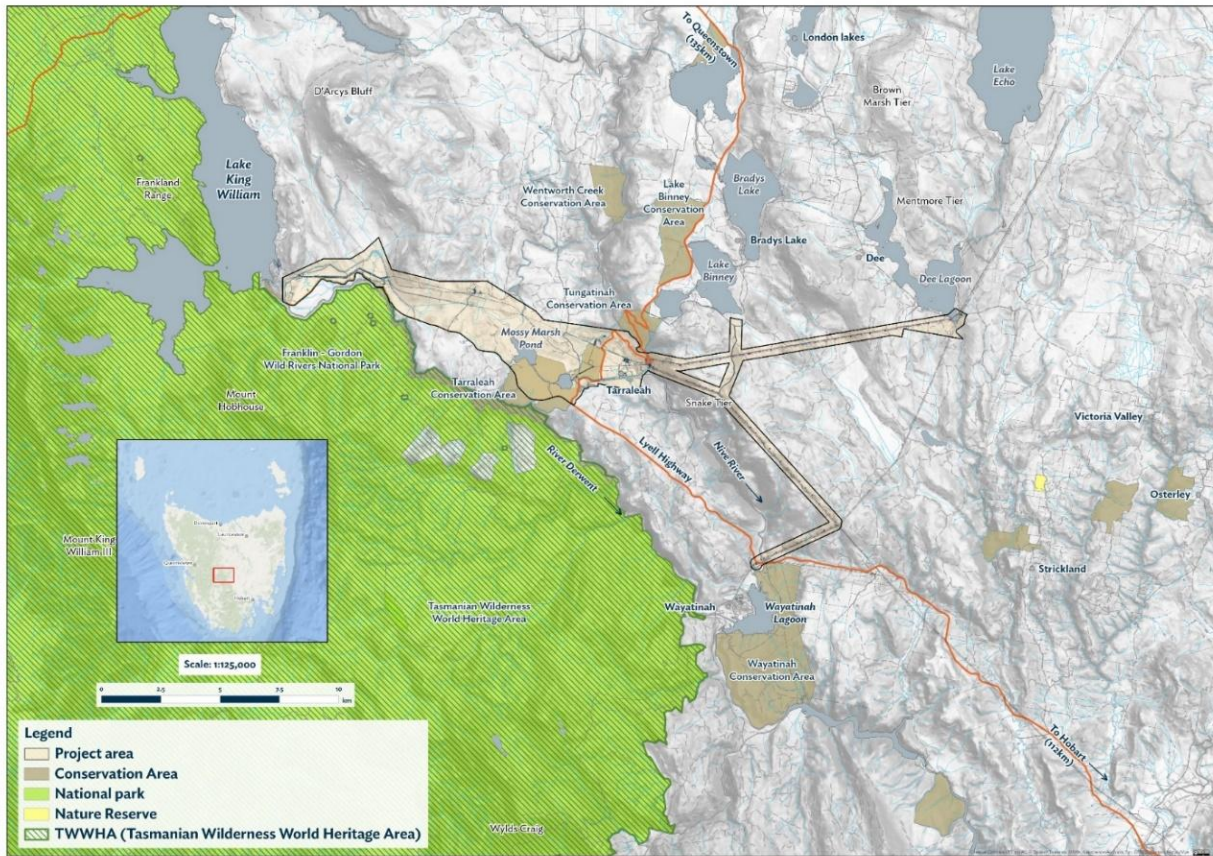


Figure 5.1: Location of Tasmanian Wilderness World Heritage Area relative to the Project area

5.2.1 Acid sulfate soils

The Tasmanian Acid Sulfate Soils Information (TASSI) program has mapped various areas within or within proximity to the Project disturbance footprint:

- Low relief, swampy area downstream of the western end of the pipeline on alluvial Dermosol soils as a location with a low probability of Acid Sulphate Soils occurring (6-70 % chance of occurrence within the mapping unit).
- South-eastern side of Butlers Gorge Road downstream from the pipeline on glacial Dermosol soils is a location with an extremely low probability of Acid Sulphate Soils occurring (1-5 % chance of occurrence within the mapping unit).
- Low relief area within the western tunnel portal disturbance footprint on glacial soils as a location with a low probability of Acid Sulphate Soils occurring (6-70 % chance of occurrence within the mapping unit).
- Low relief areas associated with Mossy Marsh Pond and No. 2 Pond and downstream from Mossy Marsh Pond is a location with an extremely low probability of Acid Sulphate Soils occurring (1-5 % chance of occurrence within the mapping unit).

Analysis of groundwater and surface water data by PSM (2025) characterised the Project area as having a low risk of the presence of Acid Mine Drainage (AMD) due to generally neutral pH, low levels of sulphate and low surface water electrical conductivity. PSM (2025) concluded that the risk of acid drainage from the oxidation of potentially acid-forming (PAF) material was low.

As the potential for acid sulfate soils to occur within the Project area is low, no AMD impacts are expected at any of the work sites.

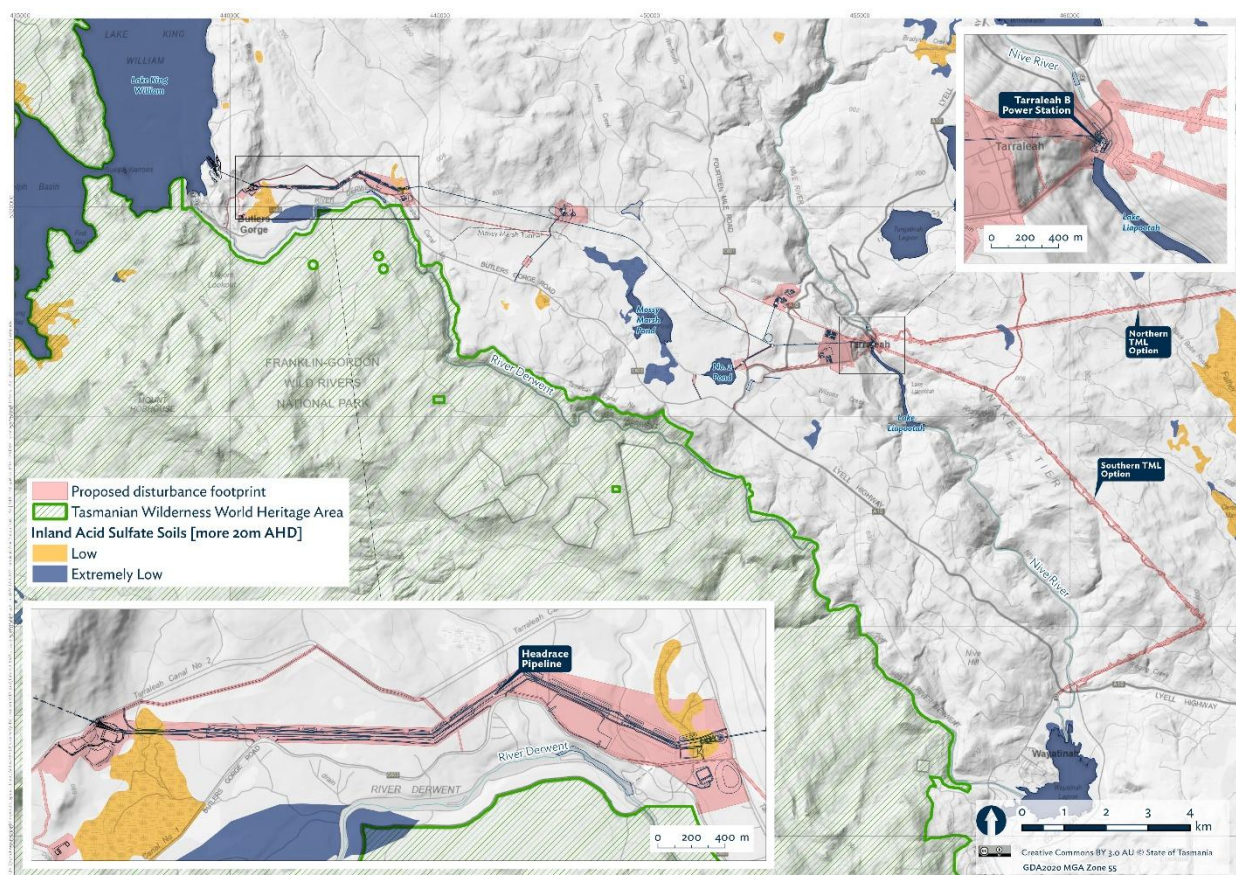


Figure 5.2: Tasmanian Acid Sulfate Soils Information (TASSI): Inland Areas of Tasmanian with potential to contain acid sulfate soils mapping for the Project area

5.3 Topography and slope

The pipeline and Tarraleah Village have the lowest relief of all the work sites (Appendix A). The eastern explosive magazine, Lyell Highway and Butlers Gorge Road intersection and western portal have low to moderate slope relief; however, the western portal has localised areas of steep to very steep slopes. Variable slopes were common to the construction sites, with localised steep areas common. A preliminary erosion risk rating based on monthly average rainfall depth shows that overall the disturbance footprint has a moderate erosion risk rating in January, February and March and a high erosion risk rating for all remaining months (Section 7.1.1).

5.4 Groundwater

A detailed hydrogeological interpretative report has been prepared by PSM (2025) which describes the hydrogeology (or groundwater) of the Project area including modelling of groundwater movement. The brief summary of groundwater recharge and discharge in the Project area provided below is sourced from the PSM (2025) report.

PSM (2025) assessed the Tarraleah Plateau topography, surface waters, and near surface geology to evaluate the capacity and distribution of recharge and discharge, with potential pathways summarised

in Figure 5.3. Potential recharge mechanisms to the groundwater system occur through direct rainfall infiltration and downward leakage of surface water atop the plateau. The aquifer system is full, with Mossy Marsh and numerous other wetlands and shallow water tables beneath adjoining hillocks. This reflects the net positive water balance at Tarraleah, with rainfall exceeding annual evapotranspiration by about 700 mm and the presence of anthropogenic (artificial) recharge supplied by surface flows from Mossy Marsh Canal. Recharge rates from rainfall infiltration are assumed to vary dependent on topographic elevation and slope, with steeper slopes providing lower local recharge and greater runoff potential.

Evidence of groundwater discharge is recorded on the Tarraleah Hillside, through ephemeral springs that are sourced from both the palaeo-valley and Mesozoic aquifers. Conceptually discharge is expected to arise from small springs in the headwater of the catchment, incised streams and from seepage faces at the base of outcropping permeable basalt horizons.

Downstream of Lake King William, the River Derwent forms a hydrogeological boundary condition to the southwest of the Project area. Being deeply incised into the surrounding topography, the river acts as a constant head discharge boundary where heads are equal to the elevation of the riverbed (Figure 5.3). As a result, the River Derwent hillside is considered a groundwater discharge zone, with the presence of small springs in gullies that bisect the hillside, and seepage faces on the lower slopes of the hillside. The same discharge conditions are observed for the Tarraleah Hillside which flanks the Nive River.

The Tarraleah Plateau at the base of the Wentworth Hills also behaves as a groundwater discharge location under fully saturated baseline conditions, supplying recharge to surface waters and swamps.

The baseline groundwater monitoring of up to 26 sites over 2024 (up to 8 sampling rounds) reported by PSM (2025) indicated fresh and circum-neutral groundwater quality, with typical low sulphate, nutrient, and metals concentrations.

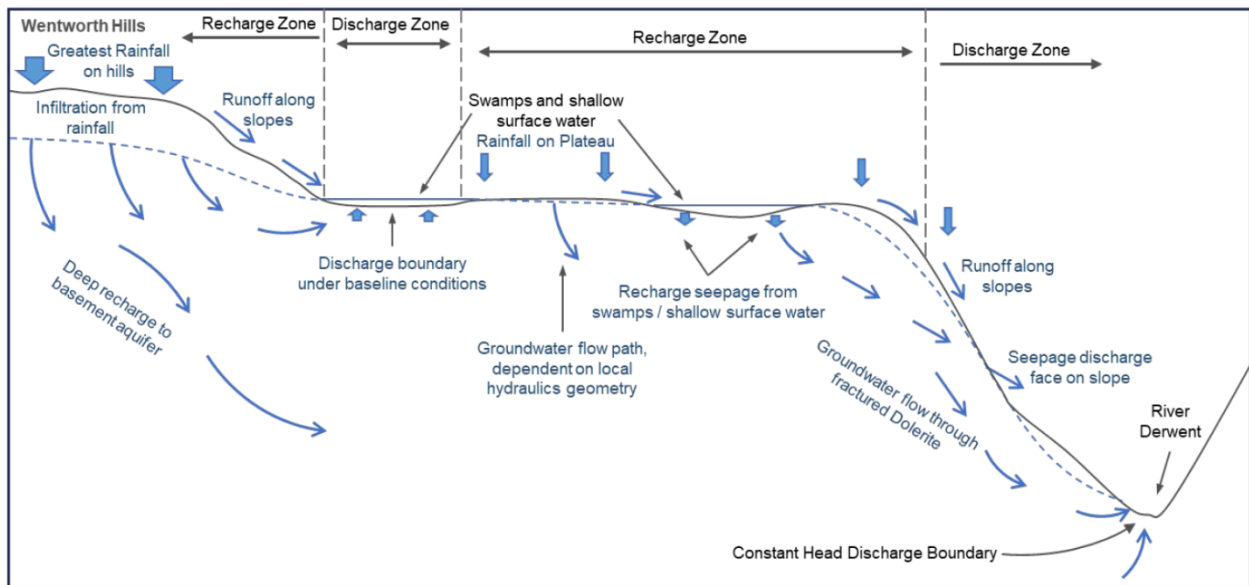


Figure 5.3: Schematic cross section of groundwater recharge and discharge concepts for the Project for the transect between the Wentworth Hills and the River Derwent.

5.5 Protected Environmental Values (PEVs)

The PEVs for the surface waters of the Derwent catchment were set in 2001-02 as a requirement of the *State Policy on Water Quality Management 1997*, and are published in DPIWE (2003). The Derwent catchment PEVs are summarised in Table 5.1 and include the different values identified in five categories, and on the land tenure within the catchment to which these apply. Sensitive uses within the immediate vicinity of the Project include raw water for drinking supply, agricultural water use and aquaculture. Of the five categories, the requirement for the maintenance of (modified) aquatic ecosystems is common across all catchments and the most stringent with respect to water quality requirements.

Default guideline values for water quality for the upper Derwent catchment have been derived by the EPA, with the aim of providing guidance as to the water quality required for maintenance of existing aquatic ecosystems. Further, as part of the baseline studies, water quality data has been collected as part of this assessment to establish the local baseline at those areas in the vicinity of the project (Section 5.6), and better assess the potential impacts from the Project.

Table 5.1: Summarised Protected Environmental Values for the Derwent catchment

Land tenure	A. Aquatic Ecosystems		B. Recreational Water Quality & Aesthetics			C. Raw Water for Drinking Water Supply	D. Agricultural Water Uses	E. Industrial Water Supply
	(i) Pristine	(ii) Modified	(i) Primary	(ii) Secondary	(iii) Aesthetic			
Private Land		✓	✓	✓	✓	Subject to coarse screening plus disinfection (town water intakes and Bryn Estyn)	Irrigation Stock watering	Aquaculture Pulp and paper mill Hydropower
Forest Reserves flowing from headwaters in Forest Reserves or National Parks	✓*		✓	✓	✓			Hydropower
Forest Reserves flowing from Private Land, State Forest, Unallocated Crown Land or HEC Land		✓*	✓	✓	✓			Hydropower
National Parks, State Reserves, Nature Reserves, Historic sites with headwaters within those reserves and parks.	✓*		✓	✓	✓	Subject to coarse screening plus disinfection (Lake Fenton catchment)		Hydropower
National Parks, State Reserves or Nature Reserves and Historic sites flowing from Private Land, State Forest, Unallocated Crown Land or HEC Land		✓	✓	✓	✓			Hydropower
Nature Recreation Areas and Reserves with headwaters in reserves or adjacent National Parks	✓		✓	✓	✓			Hydropower
Nature Recreation Areas and Reserves flowing from Private Land, State Forest, Unallocated Crown Land or HEC Land		✓	✓	✓	✓			Hydropower

Public Reserves flowing from Private Land, State Forest, Unallocated Crown Land or HEC Land		✓	✓	✓	✓			Hydropower
Unallocated Crown Land		✓	✓	✓	✓			Hydropower
Hydro Electric Corporation Land		✓	✓	✓	✓			Hydropower
Commonwealth Land		✓		✓	✓			
Within State Forests		✓	✓	✓	✓			Hydropower

5.6 Existing surface water quality

Baseline water quality data for the Project has been collected from 14 sites to characterise existing surface water quality conditions for the Project (Table 4.1 and Figure 4.1). These consist of a range of sites that represent the water quality between Lake King William and the Nive River, as well as further downstream at Wayatinah Lagoon. The monitoring sites were chosen to provide baseline water quality for representative locations where impacts to surface water quality are possible, thus not all work sites or potentially impacted creeks and streams have been sampled.

The following summarise the existing water quality of waterways associated with the Project. Site data is discussed with respect to six reaches/locations (total 14 sites):

- Lake King William (LKW (128.4))
- Vicinity of proposed headrace pipeline (Stream 1 (2621.1))
- No. 2 Canal upstream of Mossy Marsh to Pond No. 2:
 - SW-P1: No. 2 Canal
 - SW-P2: Mossy Marsh Pond
 - SW-P3: No. 2 Canal between Mossy Marsh Pond and No. 2 Pond
 - SW-P4: No. 2 Pond
 - SW-P5: Hornes Pond
 - SW-P6: No. 2 Canal overland flow upstream Mossy Marsh Pond
- Tarraleah Village: SW-P7 (pond in village) and SW-P8 (downslope from village sewage pond)
- Nive River downstream of Tarraleah Power Station (NR (98.1))
- Wayatinah Lagoon (WL (190.3), WL (190.4) and WL (190.7))

At each site a range of physiochemical (e.g. temperature, pH, turbidity, dissolved oxygen), nutrient and metal parameters were recorded (see submitted data for full data set). Site data for *in-situ* physicochemical parameters and nutrients has been compared to the annual Default Guideline Values (DGVs) for the Upper Derwent Catchment (EPA 2021, Table 5.2) using the Slightly to Moderately Disturbed (SMD) ecosystem category. The SMD ecosystem category has been chosen over High Ecological Value (HEV), as the aquatic environment from Lake King William to downstream of Tungatinah is highly modified due to regulation of the River Derwent and Nive River since the 1930-60s.

As monitoring commenced at a number of sites (SW-P1 - SW-P8) in June 2024, there is insufficient data at these sites to provide a seasonal assessment of water quality. Instead, annual statistics for each parameter have been provided in Figure 5.4 and Figure 5.5, and compared to the annual DGVs for the

upper Derwent catchment. The baseline monitoring is ongoing, and seasonal analysis will be undertaken once there is sufficient data at all sites.

Table 5.2: Default Guideline Values (DGVs) for the upper Derwent catchment (EPA 2021)

Parameter	units	Lower (20 th %ile)	Median	Upper (80 th %ile)
Temperature	°C	6.5	9	13.5
Turbidity	NTU [^]	-	2.6	8.3
Conductivity	µS/cm	-	75.5	123.4
pH-		6.2	6.7	7.4
Dissolved Oxygen	mg/L	9.4	10.6	11.8
Dissolved Oxygen	% Saturation	90.3	98.5	103.8
Chlorophyll a		-	NA	NA
Total Suspended Solids(1.5µm)	mg/L	-	5	5
Total Phosphorus	mg/L	-	0.01	0.022
Dissolved Reactive Phosphorus	mg/L	-	0.003	0.004
Total Nitrogen	mg/L	-	0.25	0.394
Nitrate	mg N/L	-	0.002	0.02
Nitrite	mg N/L	-	0.001	0.003
NO3 + NO2	mg N/L	-	NA	NA
TAN (Ammonia)	mg N/L	-	NA	NA

NA: no DGV defined

Generally, the *in-situ* physicochemical parameters and nutrients were within the annual SMD DGVs at all sites (Figure 5.4 and Figure 5.5) except for the sites at Tarraleah Village which appear to be impacted by proximity to the village or seepage from the village sewage pond, as discussed below:

- **Temperature:** The median water temperatures varied by over 5°C between sites, with smaller, slower flowing, waterbodies (i.e. SW-P2, SW-P4, SW-P5 and SW-P7) generally recording higher temperatures than larger or fastflowing sites. The maximum and 80th percentile temperature recorded generally increased with distance downstream, whereas the minimum temperatures did not. While only 2 out of the 14 sites (LKW and SW-P1) were outside (below) the lower DGV (20th percentile), only two sites (SW-P1 and SW-P8) were within (below) the upper DGV (80th percentile). In addition, five sites (SW-P2 to SW-P5 and SW-P7) recorded median water temperatures above the upper DGV, these sites being smaller, slower flowing, waterbodies.
- **Turbidity:** At all sites the 80th percentile values were within the DGV for turbidity. Five sites recorded maximum turbidities above the DGV, with three sites within 1 NTU of the DGV (Stream 1, SW-P8 and WL (190.3)) and one within 3 NTU (SW-P7). The maximum reading recorded was 37.0 NTU in No. 2 Canal between Mossy Marsh Pond and No. 2 Pond (SW-P3).
- **Conductivity:** All sites except SW-P8 (associated with Tarraleah Village) were within the DGV limit for conductivity (123.4 µS/cm), including maximum values, and reflective of freshwater conditions. At SW-P8, only the minimum conductivity (111 µS/cm) was below the DGV with all other metrics above (ranging from 132 to 163.9 µS/cm) indicating a higher but still low level of dissolved ions or salts in the water at this location which may be due to seepage from the village sewage pond which is located upslope from the sampling site.

- *pH*: pH was generally around neutral and within the DGVs for all sites, with little variance between sites. Only two sites had 80th percentile values slightly above the DGVs (within 0.5; SW-P2 and SW-P8). Minimum pH values below the DGVs were recorded at sites LKW, Stream 1, SW-P2, SW-P7, and NR. Acidic pH values are not uncommonly in Tasmanian waterways due to high organic inputs and low mineral inputs from the bedrock. Most sites recorded maximum pH values above the DGVs (all sites except SW-P1, SW-P4, SW-P5, SW-P6 and WL (190.4) with the maximum pH recorded at SW-P8 in Tarraleah Village (10.77). At site SW-P8, pH values were generally higher for all metrics than at all other sites and this may also be due to seepage from the village sewage pond.
- *Dissolved oxygen (DO)*: All sites recorded 80th percentile values within the upper DGVs, with most sites recording maximum levels within or just over the upper DGV (within 1 mg/L). Two sites recorded median values below the lower DGV (SW-P2 and SW-P5), and over half the sites recorded 20th percentile values below the lower DGV but still > 7 mg/L and >80 %; values that will typically maintain a healthy ecosystem. The site with the lowest DO levels (minimum value 2.82 mg/L and 27.6 %) was SW-P8. Such low values are usually indicative of the breakdown of organic matter, pollution and poor water quality. At SW-P8 the low DO levels are again most likely be linked to seepage from the village sewage pond.
- *Chlorophyll a*: Chlorophyll *a* records were generally relatively low across all sites and below the ANZG. (2018) default guideline for aquatic ecosystems (5 µg/L) with higher levels recorded associated with Tarraleah Village (SW-P7) and Wayatinah Lagoon (190.3) but still below recommended levels for recreational use (25 µg/L, ANZG 2018). The higher chlorophyll *a* levels in Wayatinah Lagoon is possibly a result of higher nutrients loadings from the fish hatchery located on the River Derwent at Wayatinah. Note, chlorophyll *a* was not sampled at Stream 1 or SW-P8.
- *Total Suspended Solids (TSS)*: TSS were below the DGV at all sites with little variability between sites and reflects the relatively low turbidity levels recorded at all sites.
- *Nutrients*: Nutrient levels at sites not associated with Tarraleah Village were generally low and within the DGVs. Site SW-P8 associated with Tarraleah Village consistently had high nutrient levels (i.e. high total phosphorus, dissolved reactive phosphorus, total nitrogen, nitrate, nitrate + nitrite and ammonia) and is most likely linked to seepage from the village sewage pond.

Dissolved reactive phosphorus, total nitrogen and ammonia were also higher associated with Wayatinah Lagoon, particular at site 190.3 which is located closest to the fish hatchery on the Derwent River at Wayatinah. Other sites within Wayatinah Lagoon that are further from the fish hatchery have lower nutrient and chlorophyll *a* levels.

Water quality in the River Derwent below Clark Dam is good in upper reaches and within the DGVs for the Upper Derwent Catchment, reflecting the water quality of Lake King William (Site 128.4). Below Derwent Pumps Weir and within the TWWHA, initial sampling (not presented here due to limited data) suggests a decline in some water quality parameters (i.e. higher concentration of nutrients) which is most probably the combined effects of low flow and surrounding land use (forestry). However, all physicochemical parameters (turbidity, dissolved oxygen, pH, conductivity, temperature) remained within the DGVs for the Upper Derwent Catchment.

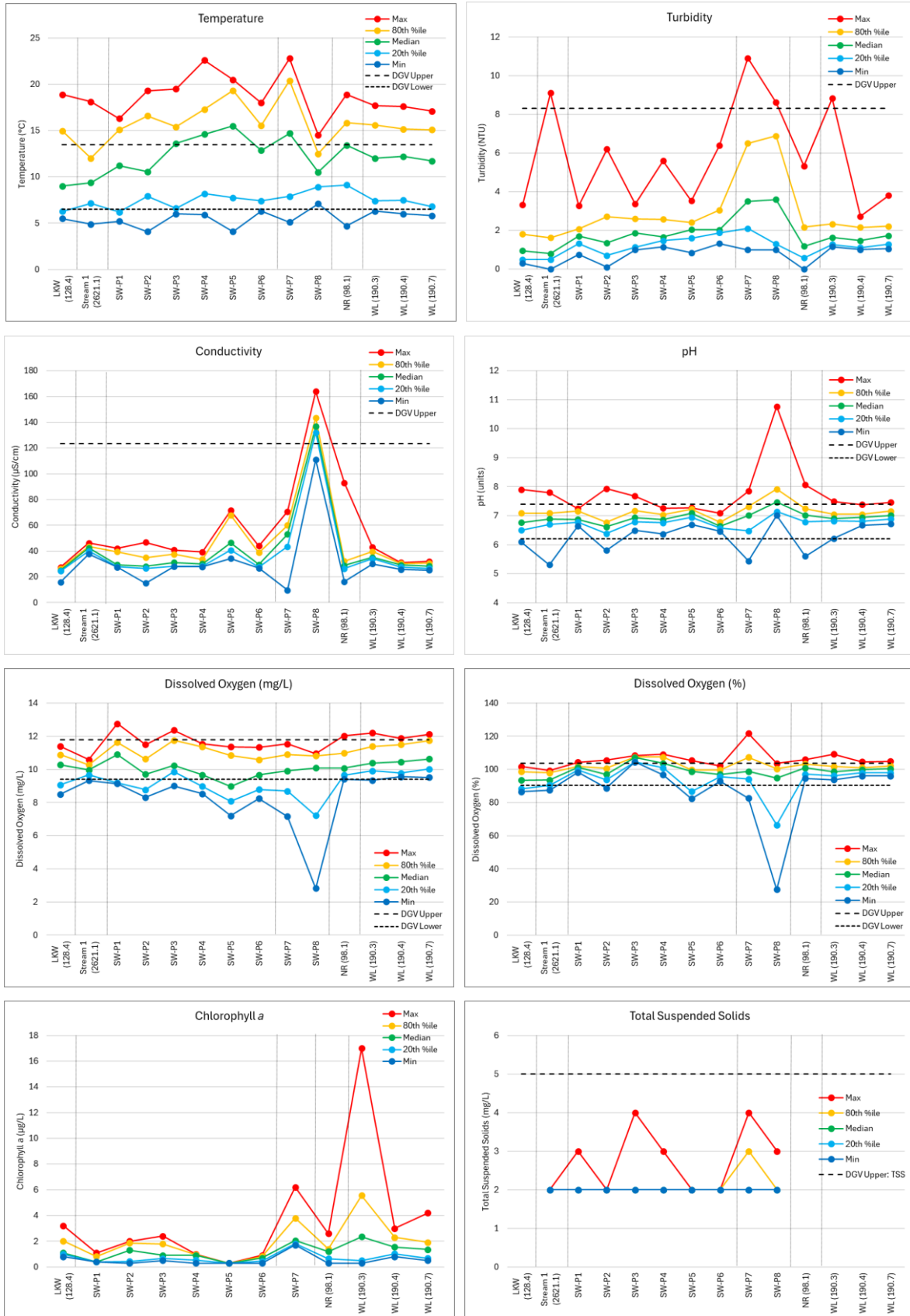


Figure 5.4: Surface *in-situ* physicochemical water quality, chlorophyll-a and total suspended solids (TSS)

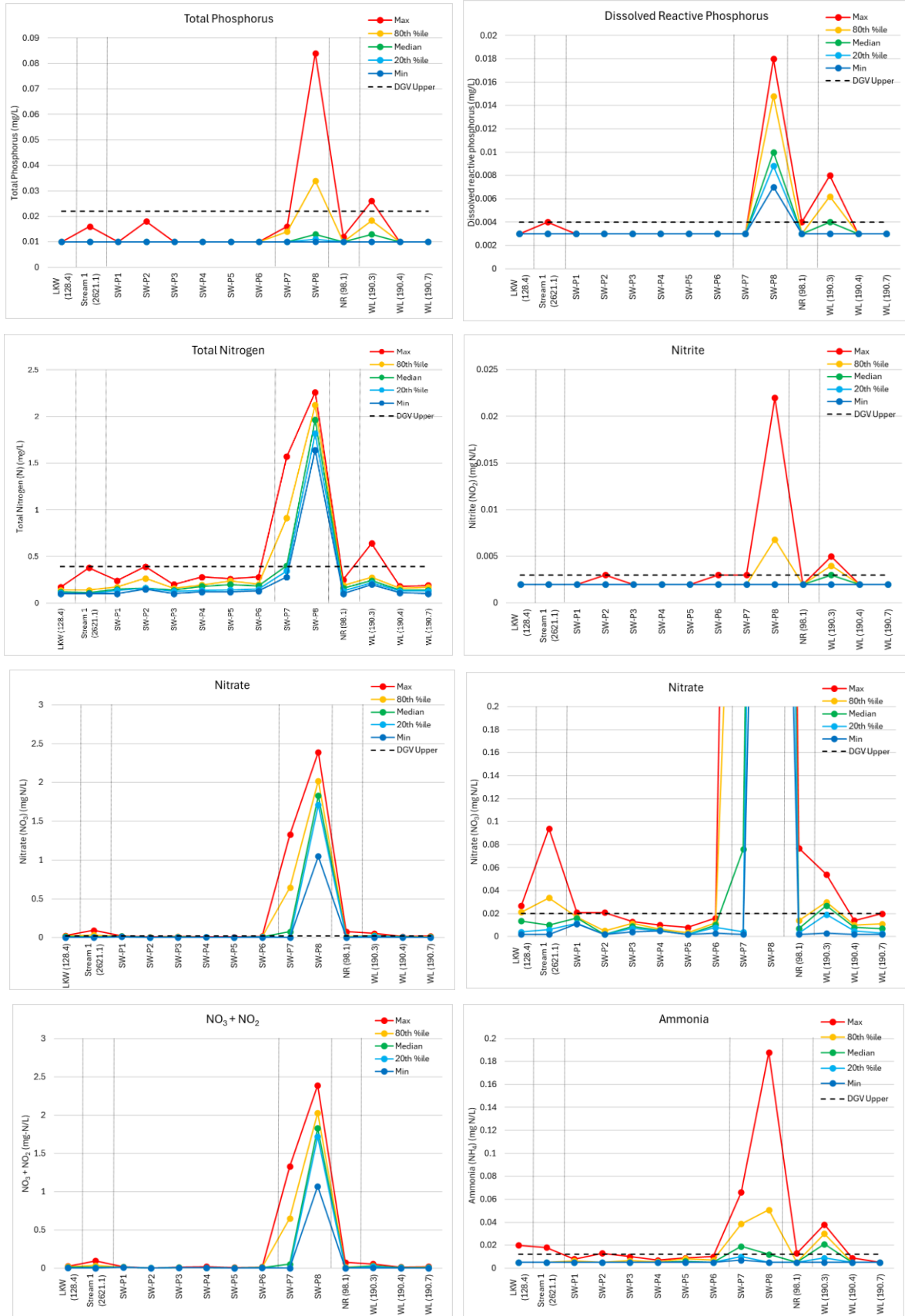


Figure 5.5: Surface water quality nutrient laboratory results

6. Project area

6.1 Main work sites

There are six main work sites that this water quality assessment focusses on. They are separated by their location and the construction activities that will take place. A brief summary of each work site is provided below.

6.1.1 Headrace pipeline

The headrace pipeline will be a continuation of the pressurised conveyance from Lake King William intake (constructed as part of the Tarraleah Upgrade Works). The pipeline will interface with the Lake King William tunnel approximated 100 m upstream from the downstream tunnel portal and terminate approximate 155 m into the headrace tunnel near the Western portal. The pipeline will be 4.2 km long and approximately 4 m diameter.

The pipeline will be above ground and will include the construction of access roads on either side of the pipeline. The main construction activities will include the clearing of vegetation, and civil works associated with the construction of the roads and pipeline.

The pipeline will cross 3 streams (Streams 1-3, Section 6.2.1), all of which flow to the River Derwent. It will also be necessary for the roads to cross these creeks and culverts will need to be constructed.

6.1.2 Western portal and headrace tunnel

The western portal work site is where the underground headrace tunnel construction will begin. It is located to the east of Derwent Weir/Derwent Pumps between No. 1 Canal and No. 2 Canal, approximately 300 m from the River Derwent. The Western Portal work site is dissected by Stream 4 that flow to the River Derwent (Section 6.2.1). Excavation of the portal will be undertaken using a combination of conventional earth moving techniques and drill and blast (where higher strength rock is encountered). Following completion of the portal the construction sites will be re-vegetated using a combination of topsoiling and hydro seeding (depending on the slope angles to be stabilised and the presence of shotcrete).

Approximately 12 km of pressurised water conveyance tunnels are proposed as part of the Project to link the headrace pipeline to the power station. The tunnels will be excavated using a combination of mechanised excavation and drill and blast techniques. A tunnel boring machine may also be utilised and if used, would excavate the majority of the headrace tunnel and approximately 75% of all tunnelling works. Construction of the Western Portal and headrace tunnel will utilise shotcrete, concrete and grout.

The tunnelling activities will create spoil, which will be placed on a stockpile at this site. All stockpiles are expected to be formed by placing and track rolling the spoil material to stable slope angles. Erosion and sediment controls will be in place for the duration of construction or until the stockpiles have been stabilised (whichever is the longest).

During tunnel construction, clean water and tunnel water will be separated with any wastewater being managed to meet discharge requirements. Groundwater inflow is expected to occur in all tunnel excavations. Where groundwater inflow occurs at higher rates, grouting will be undertaken ahead of the tunnel face until the groundwater inflow rate has reduced to an acceptable level. Construction groundwater will be managed within the tunnels by either a series of sumps and pumps that are progressively installed within the tunnel or by gravity flow. The collected water will be conveyed to treatment facilities at the portal

In addition to excavation and tunnelling, civil construction activities at this work site will include the clearing of vegetation, and civil works associated with the construction of the portal and laydown and associated areas.

6.1.3 Mid-access portal

The mid-access portal, 4 km to the east of the western portal, will allow tunnelling to occur from multiple concurrent headings and provide access to the headrace and power tunnels for future maintenance requirement. The portal will be located approximately 500 m to the north of Tarraleah No. 2 Canal upstream of Mossy Marsh Pond and 1.3 km to the west of Hornes Pond. Any water discharge from this site would enter the No. 2 conveyances, Mossy Marsh Pond and No. 2 Pond.

Excavation and construction of the portal and tunnels from this site will involve similar techniques as described above for the western portal/headrace tunnel, with groundwater to be managed in a similar manner also. As for the western portal/headrace tunnel civil construction activities at this work site will include the clearing of vegetation, and civil works associated with the construction of the portal and laydown and associated areas

6.1.4 Paddy's Quarry

Paddy's Quarry will be used as a portal, construction compound and spoil emplacement area for spoil generated at the power station work site as well as spoil generate at the portal. Spoil at this site will be managed as for the western portal work site. Stream 5 is a potential receptor for this site (Section 6.2.2).

6.1.5 Power station

The power station will be a multi-story building predominantly below ground level, located on the site of the existing Tarraleah Power Station switchyard on the western bank of the Nive River. A transformer yard and switchyard will be located next to the power station.

Excavation of the power station site will be via a combination of conventional excavation, rock hammering and drill and blast, subject to the quality and strength of the rock. Perimeter and base grouting may be required to reduce excavation dewatering requirements and provide a safe working environment. Spoil from the power station site will be taken by truck via the Lyell Highway to Paddy's Quarry.

The power station building will consist of a tanked reinforced concrete structure in which the power station will be located. As construction proceeds the surrounding excavated area will be progressively backfilled.

6.1.6 Tarraleah Village

An area has been set aside in Tarraleah Village for a Project office. This could involve the installation of a prefabricated building that will be removed and rehabilitated at the conclusion of the Project or use of existing buildings within the village.

Workshops and laydown areas at the Tarraleah Village may also be required to support construction activities. These will be constructed on land owned by Hydro Tasmania at the Tarraleah Village. Any workshops will include bunded areas where work on construction plant can be carried out with any potential spills appropriately contained. Construction will involve conventional earthworks activities to create a level area for the workshop. Following this access roads will be formed and utilities will be installed (power, water and sewer) as required. At the end of construction the workshop and laydown sites will be cleared and rehabilitated.

6.1.7 On-site water management

The Project will have a number of activities that both use water and generate water. The main sources of water use/generation during construction and which will be managed by the EPC Contractor are:

- **Water use:** Hydro Tasmania will provide access to existing dam storage and canals to provide a water source for use by the EPC Contractor.
- **Groundwater:** Excavation works are expected to generate water due to interaction with groundwater tables. The groundwater will typically be collected in sumps in the tunnels and surface excavations and then pumped to storage and treatment facilities at the portals.
- **Water treatment:** Water treatment will be carried out at each of the work sites using a combination of sediment retention basis and treatment.
- **Sewage:** Portable ablution facilities will be provided at each work site, with waste disposed of at an approved, licenced facility. At Tarraleah Village, the existing facilities will be upgraded to reduce seepage. A temporary water treatment plant will be required for the workforce accommodation facility (WAF) and will be included as part of the separate development plan and approvals for the WAF which will be assessed by Central Highlands Council.

6.2 Creeks and streams on-site

There are a number of surface waters where water quality has the potential to be impacted. These include six permanent and ephemeral streams with a total 11 crossings/tributaries within the Project work sites (Figure 6.6 to Figure 6.8). Their aquatic environmental values are described fully in Entura (2025). Entura (2025) also includes a description of the aquatic monitoring of creeks and streams to be undertaken pre construction (baseline) and during construction of the Project.

6.2.1 Streams 1-4: Headrace pipeline and western portal

Four streams flow from locations above No. 2 Canal and cross No. 2 Canal, Butlers Gorge Road and No. 1 Canal via culverts to the River Derwent. They cross the disturbance footprint in the vicinity of the headrace pipeline and the western portal. These four streams and their Project crossings are as follows:

- **Stream 1:** A permanent flowing stream which flows to the River Derwent. Three tributaries of this stream cross the disturbance footprint at locations immediately east of the current Downstream Portal construction (within 700 m) site at the start of the headrace pipeline (Crossings 1 – 3 or C1-C3; Figure 6.6). These crossings are within the disturbance footprint for the headrace pipeline and associated construction and maintenance access roads. The crossing furthest to the west (C1) is a permanently flowing 2nd order stream and a current water quality site is located on this stream that provides background (unimpacted) data for the Downstream Portal construction site which is part of the Lake King William Intake Upgrade Project. Crossing 2 is a similar 2nd order stream to the east and Crossing 3 is a smaller 1st order stream with lower flow.
- **Stream 2:** This stream enters the River Derwent 670 m upstream from Derwent Pumps Weir. It has two tributaries which both cross the disturbance footprint (Crossing 4 and Crossing 5; Figure 6.6) over 1 km west of the western portal. Crossing 4 is a small ephemeral 1st order stream, most of which falls within the Project disturbance footprint, while Crossing 5 is a larger 2nd order stream with permanent flow. These crossings are within the area proposed for the construction of the headrace pipeline and associated permanent access tracks.

- Stream 3: This is a larger 3rd order stream which enters the River Derwent just upstream from Derwent Pumps Weir. It crosses the disturbance footprint approximately 600 m from the headrace tunnel portal at the western portal construction site (Crossing 6; Figure 6.6) in areas proposed for the construction of the pipeline and associated construction and maintenance access roads.
- Stream 4: This is a small 2nd order stream that enters the River Derwent approximately 300 m downstream of Derwent Pumps Weir. There are three small tributaries (Crossings 7-9; Figure 6.6) that cross the disturbance footprint before converging and dissecting the proposed western portal work site and spoil emplacement area.



Figure 6.1: Stream 2, downstream of the disturbance footprint as it passes under Butlers Gorge Road and No. 1 Canal looking upstream (left) and looking downstream (right) .



Figure 6.2: Stream 3, downstream of the disturbance footprint as it passes under Butlers Gorge Road and No. 1 Canal.



Figure 6.3: Stream 4, immediately downstream of the disturbance footprint (top) and after it passes under Tarraleah No. 1 Canal (bottom).

6.2.2 Stream 5: Surge facility and Paddy's Quarry spoil emplacement area

There is one stream (Stream 5) that crosses the Project in the vicinity of the surge facility and spoil emplacement area near Paddy's Quarry (Figure 6.7). This stream intersects with the surge facility work site at the surge tunnel, dissecting the site, and the spoil emplacement area at Paddy's Quarry. This 3rd order stream flows into the Nive River approximately 2.2 km upstream of Tungatinah Power Station.



Figure 6.4: Stream 5, located in Paddy's Quarry.

6.2.3 Stream 6: Tarraleah Village

Tarraleah Village lies across the upper reaches of Stream 6 (Figure 6.8) which is a tributary of Wilsons Creek and the Nive River. The drainage line runs through a cleared paddock and provides no aquatic habitat. A small, piped culvert runs under Oldina Drive discharges into Stream 6 which flows for approximately 1.5 km before entering Wilsons Creek. Wilsons Creek flows for another 1.5 km before entering Lake Liapootah.

Stream 6 shows signs of eutrophication with an extensive biomass of filamentous algae. This is most likely due to seepage from the village sewage pond which is located upslope. Stream 6 becomes progressively steeper before entering Wilsons Creek which is very steep as it descends the valley towards Lake Liapootah.



Figure 6.5: Stream 6, located next to the existing sewage treatment pond (right) as it flows towards Wilson’s Creek .

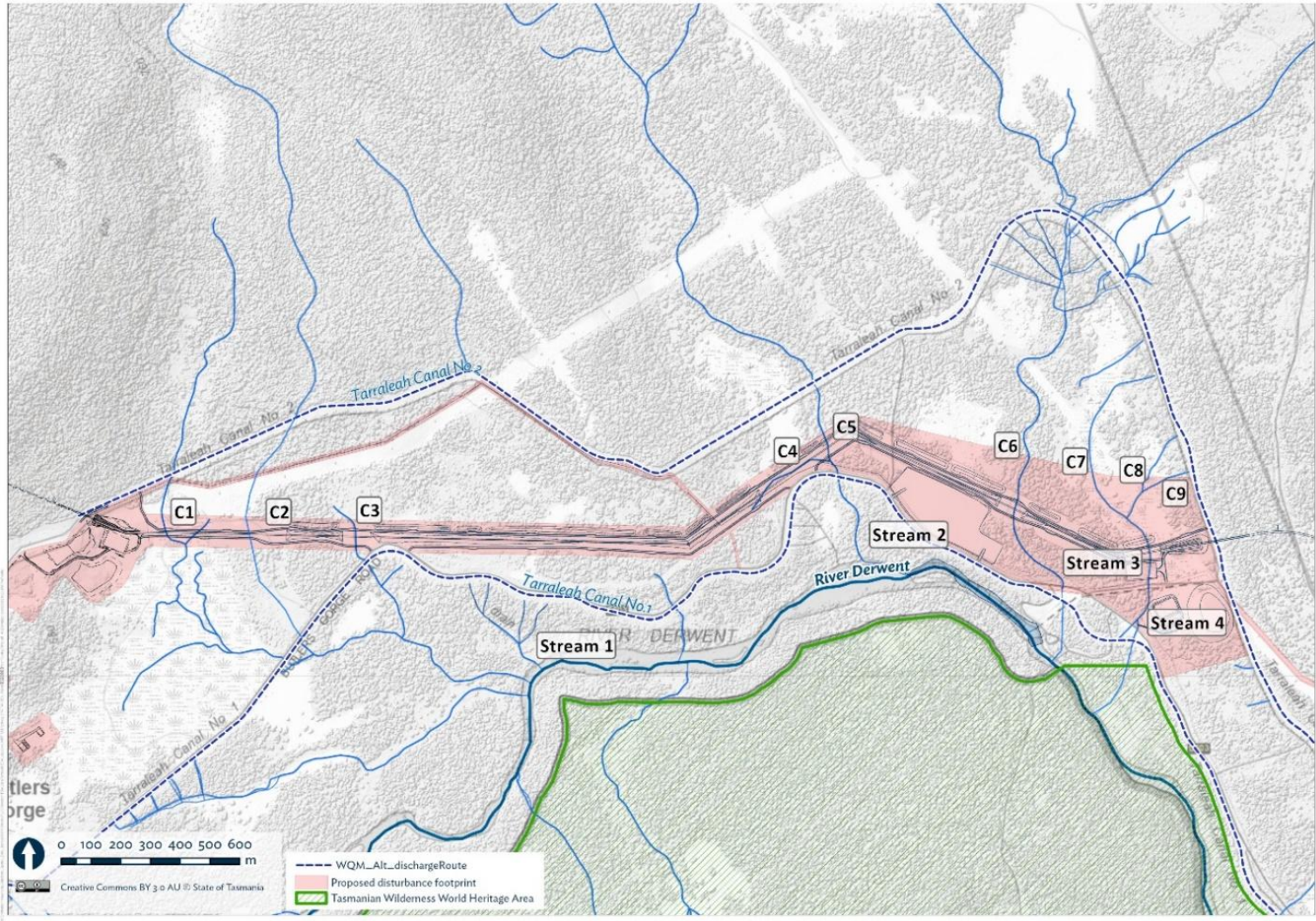


Figure 6.6: Location of Streams 1-4 in relation to the disturbance footprint of the headrace pipeline, with individual tributary crossings indicated (C1 to C9)

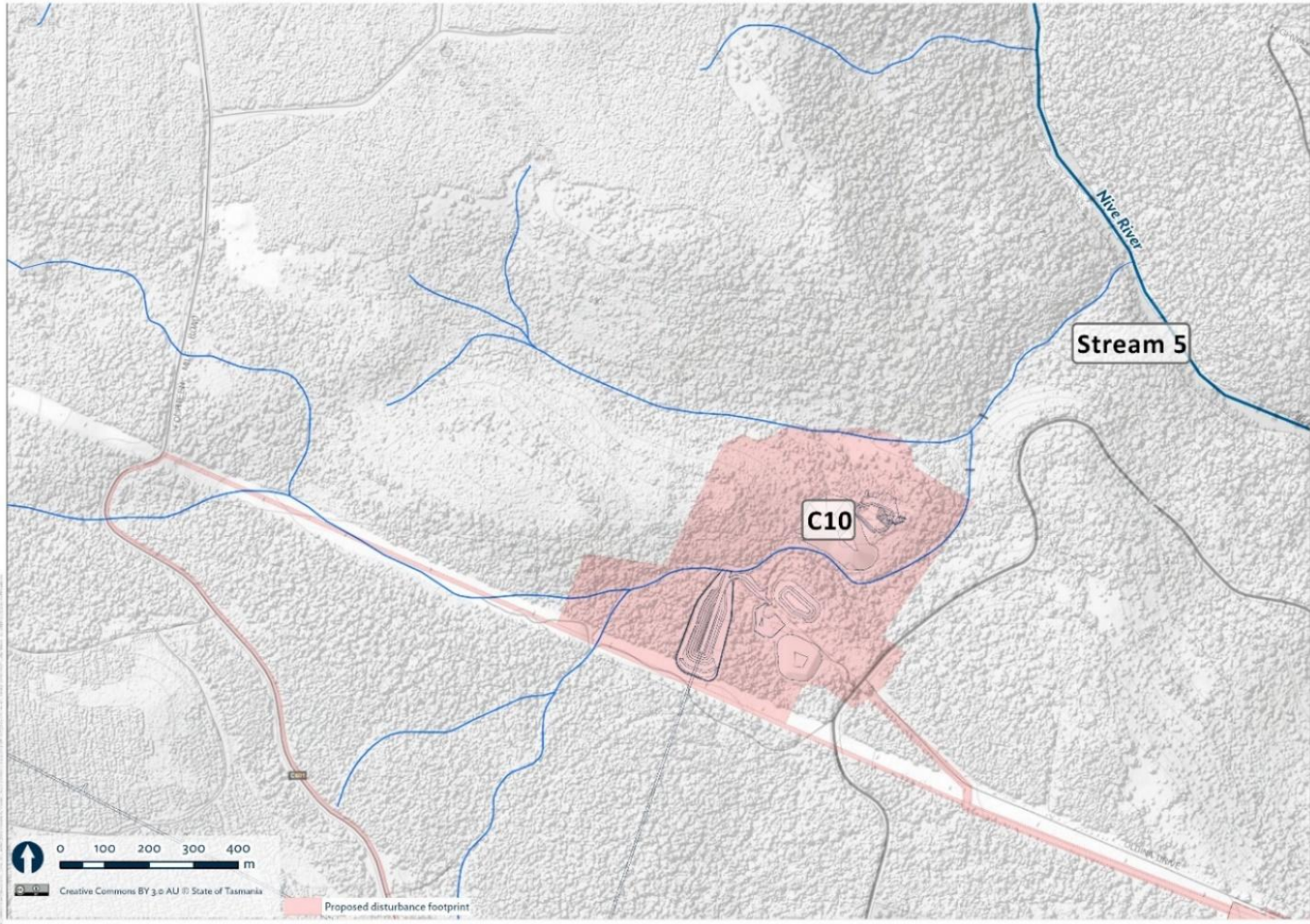


Figure 6.7: Location of Stream 5 in relation to the disturbance footprint at Paddy's Quarry, with the individual tributary crossing indicated (C10)

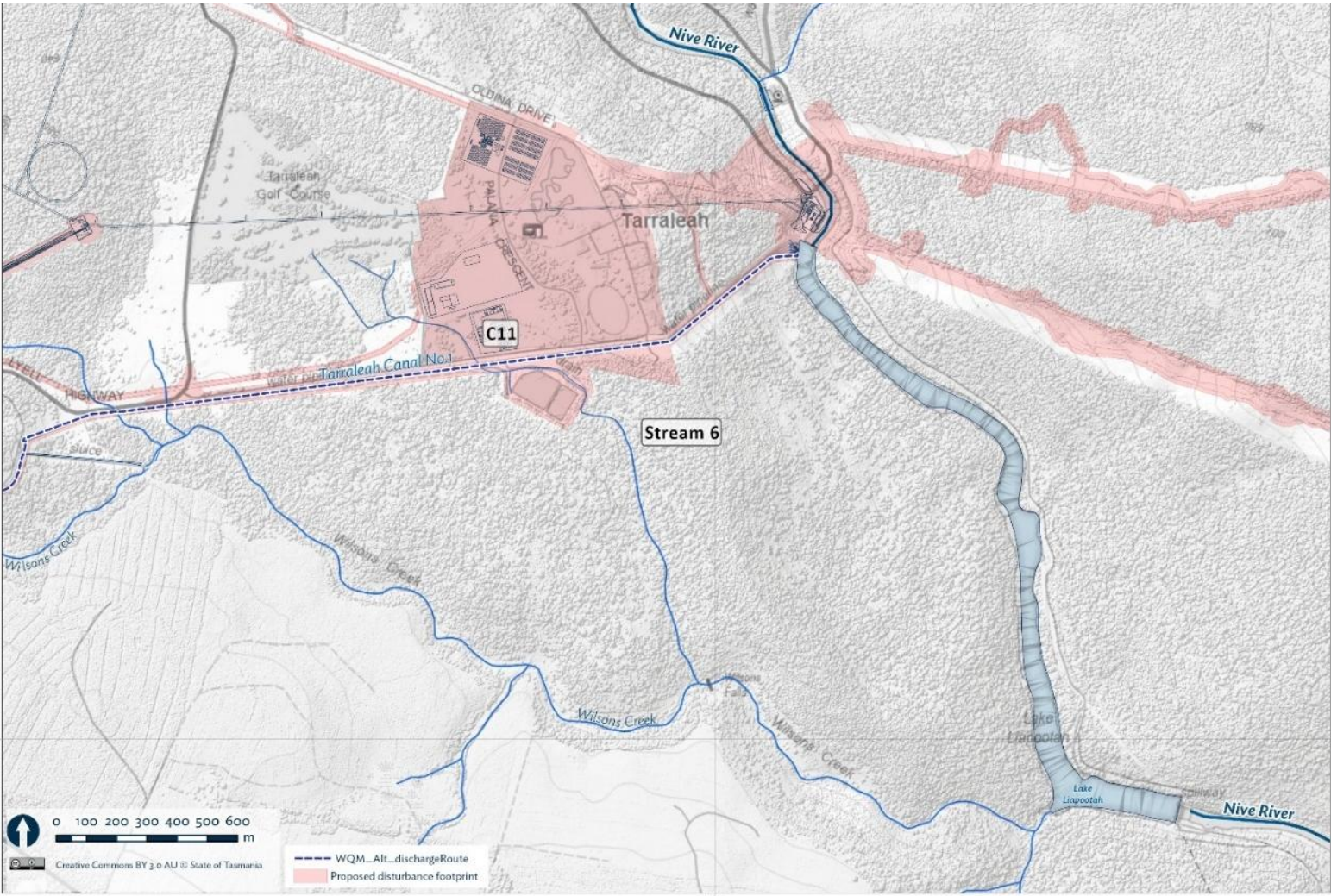


Figure 6.8: Location of Stream 6 in relation to the disturbance footprint at Tarraleah Village, with the individual tributary crossing indicated (C11)

6.3 Rivers and storages

There are a number of rivers and storages that the Project has the potential to impact which are described in more detail in Entura (2025) (Figure 6.9), including:

- River Derwent in the vicinity of the project.
- Mossy Marsh Pond and Pond No. 2 which are small storages that form part of the existing No. 2 conveyance between Lake King William and Tarraleah Power Station.
- Hornes Pond, a small diversion storage which provides additional water to Tarraleah Power station via Mossy Marsh Pond.
- Downstream receiving waters including the Nive River, Lake Liapootah (Nive River storage) and Wayatinah Lagoon (a River Derwent run-of-river storage) and eventually through to the lower Derwent including its further run of river storages and the Derwent estuary.

6.3.1 River Derwent

The River Derwent is south of and runs largely parallel to the Project, with each of the four streams (Streams 1-4) that cross the headrace pipeline flowing directly into the river. The River Derwent has a highly altered flow regime compared to natural as a result of hydropower development in the catchment. In addition to being impounded in Lake King William by Clark Dam, any water released from the dam is immediately diverted to No. 1 Canal at Butlers Weir. A further weir downstream (Derwent Weir) on the River Derwent picks up flow and pumps this to Tarraleah Canal No. 2 via the Derwent Pumps. Water is also diverted via an intake at Clark Dam to No. 2 Canal, following a different route to the Tarraleah Power Station.

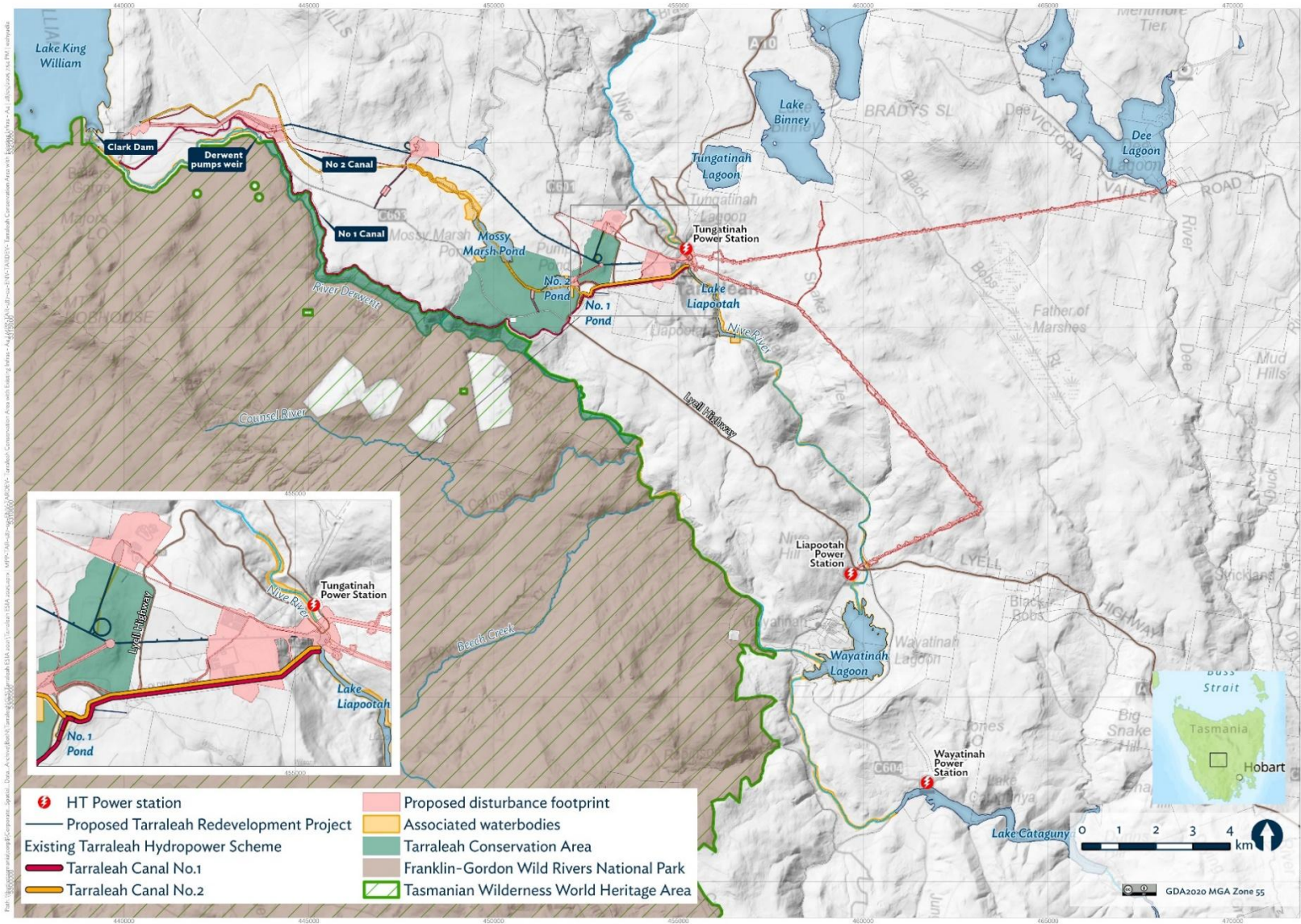


Figure 6.9: Associated waterbodies of the Project including existing water conveyance infrastructure, rivers and storages

Within the River Derwent, further water is picked up from inflows at Derwent Pumps Weir, 6 km downstream of Clark Dam, and pumped into No. 2 Canal. The River Derwent below Derwent Weir has a low flow down to the next hydro-power storage, Wayatinah Lagoon. This flow consists of catchment pick-up below Derwent Pumps Weir and occasional spills at Derwent Pumps Weir during periods of high inflow (for further detail see Entura 2025).



Figure 6.10: The impounded River Derwent at Derwent Pumps Weir, located 6 km downstream from Clark Dam. Pump infrastructure (at left) pumps water to No. 2 Canal via pipeline.



Figure 6.11: The River Derwent above Wayatinah Lagoon, where a small weir is used to provide for the fish hatchery at Wayatinah.

6.3.2 Mossy Marsh Pond, No. 2 Pond and Hornes Pond

No. 2 Canal currently discharges into Mossy Marsh Pond (normal operating flow of approximately 10 m³/s), a small (62 ha) shallow storage which then discharges to No. 2 Pond (31 ha) before entering the power station. These storages will be retained as part of the Project, with other existing water conveyance structures (No. 1 Canal, Tarraleah No. 1 Pond, part of No. 2 Canal) to be decommissioned post commissioning of the Project.

The main body of the Mossy Marsh Pond (62 ha) consists of shallow water up to approximately three metres depth, abundant submerged trees and deep layers of organic sediments. Inflows to Mossy Marsh Pond in the north-western corner of the pond produce a strong current. No. 2 Pond has less organic silt deposits and far fewer macrophyte beds than Mossy Marsh Pond. Water levels are relatively stable in both ponds and are not predicted to change during operation of the Project. A more detailed description of, Mossy Marsh and No. 2 ponds, is provided in Entura (2025).

Mossy Marsh Pond also receives water from Hornes Pond located to the north of Mossy Marsh Pond. Hornes Pond is supplied by Hornes Creek and Wentworth and Dunnys creeks via Wentworth and Dunnys canals.

6.3.3 Nive River and Lake Liapootah

The Nive River is one of the main tributaries of the River Derwent and originates from Lake Nive in the Walls of Jerusalem National Park. The unregulated portion of the Nive River flows southeast for approximately 25 km to Pine Tier Lagoon, which diverts all water except spills, from the Nive River to Tungatinah power station via Bronte and Tungatinah lagoons. Below Pine Tier Lagoon, the regulated channel of the Nive River runs south for approximately 31 km to the hydro storage of Lake Liapootah.

The existing Tarraleah and Tungatinah Power Stations discharge directly into the upstream end of Lake Liapootah. Lake Liapootah is a small hydropower storage located on the Nive River, formed by the Liapootah Dam. It is a narrow storage that follows the Nive River channel for approximately 2.5 km from just downstream of the Tarraleah Power Station discharge point to the Liapootah Dam. Apart from the occasional spill, all water in Lake Liapootah is diverted via the 6.5 km long Liapootah Tunnel to Liapootah Power Station. Below Lake Liapootah, the Nive River runs south for another 9 km before flowing into the hydropower storage of Wayatinah Lagoon. There are minimal tributary inflows within the narrow river valley; thus, most of the channel is dry.

7. Potential impacts

There are a number of Project activities including clearing, roadworks, civil excavation, drill and blast tunnelling operations and stockpiling, as well as additional road traffic on Butlers Gorge Road and the Lyell Highway, that have the potential to impact the water quality of local waterways.

Five key potential water quality impact types potentially arising from Project activities have been identified; erosion and sedimentation, hydrocarbons, pH, metals and nitrates. Each potential impact type is discussed below, followed by potential impacts by work sites. Many of the potential impact types are common to all work sites e.g. erosion and sedimentation, hydrocarbons and pH changes, whereas some are more particular to the type of work being undertaken at the work site i.e. blasting and release of nitrate and ammonium.

7.1 Impact types

7.1.1 Erosion and sedimentation

The clearing of work sites and construction activities have the potential to cause erosion and release sediments from work sites to local waterways and impact water quality. Potential sediment sources associated with construction include clearing, grubbing, earthworks and excavation of work sites and levelling of sites (which can also lead to erosion), spoil emplacement areas and laydown areas, vehicle washdown areas, road runoff and dust, site offices and buildings, and wastewater/sediment basin discharge. Areas with moderate to high slope, long slope length and erodible soils will be most susceptible to erosion. An increase in sediment release has the potential to impact on aquatic ecosystems either through the alteration of water quality and/or alteration of aquatic habitats via sedimentation e.g. smothering. The areas that could potentially impacted include local creeks within catchments of the construction areas, and to a lesser extent the River Derwent and Nive River. All of the Project worksites are considered to be high risk areas for erosion and sedimentation issues and is discussed further in Section 7.2.

7.1.1.1 Preliminary erosion risk rating

A preliminary erosion risk rating based on monthly average rainfall depth shows that overall the disturbance area footprint has a moderate erosion risk rating in January, February and March and a high erosion risk rating for all remaining months (Table 7.1).

Table 7.1: Average monthly rainfall at Butlers Gorge over the last ten years and associated IECA (2008) erosion risk rating

Monthly	Average monthly rainfall depth (mm)	Erosion risk rating
January	59.0	Moderate
February	76.7	Moderate
March	82.5	Moderate
April	106.1	High
May	169.7	High
June	158.1	High
July	172.2	High
August	203.0	High
September	180.4	High
October	134.7	High
November	126.7	High
December	114.9	High

7.1.2 Hydrocarbons

The use of heavy machinery and the need to store fuels, oils and other lubricants on site provides the potential for contamination of local waterways with hydrocarbons. Leakages and spills of fuel, oils and hydraulic fluids from storages and machinery, machinery breakages and the use of oil-based drilling lubricants are all potential sources of hydrocarbons.

Spills of hydrocarbons impact water quality and aquatic ecosystems. As oils and fuels float on water, the major impact of hydrocarbons is from shoreline smothering, unless it is first physically or chemically dispersed (ANZG 2018). In confined environments (e.g. small freshwater streams or lakes) biodegradation will result in reduction in dissolved oxygen when there is a localised build-up of toxic fractions (ANZG 2018).

The toxicity of oils to freshwater fish varies widely depending on oil type and the method of exposure, however diesel spillages into creeks can often kills the invertebrates, even if fish survive, resulting in indirect effects such as loss of fish food sources and an increase in algal growth (ANZG 2018).

Heavy machinery and fuels, oils, hydraulic fluids and lubricants will be associated with all Project worksites and a Hydrocarbon Management Plan will be included in the Project's Water Quality Management Plan prepared and implemented by the EPC Contractor.

7.1.3 pH

The use of concrete, shotcrete and grouting in the construction of the buildings, portals and tunnels will raise the pH of water used and discharged from site. Two temporary concrete batch plants are proposed for the Project and they will most likely be located at the western portal and Paddy's Quarry or Tarraleah Village. However, the final locations will be determined by the EPC Contractor.

The use of shotcrete in the portals, tunnels and power station excavation is likely to result in the production of alkaline site water requiring discharge. If construction site wastewater is discharged directly from site, elevated pH may impact local waterways, particularly in smaller creeks or rivers where flows are low and there is little dilution. Raised pH can impact the aquatic environment and in particular fish species, contributing to reduced condition, altered behaviour and increased susceptibility to other stressors in affected biota. High pH levels can also affect other stressors, for example increasing the proportion of ammonia in its unionized, toxic form. Very high pH (>10.5) is rapidly lethal to salmonids (e.g. brown trout), while longer term exposure to pH in the range of 9.0-9.5 is likely to be harmful to salmonids (Alabaster and Lloyd 1980).

Measures to manage wastewater (and associated changes in pH) will be included in the Project's Water Quality Management Plan prepared and implemented by the EPC Contractor.

7.1.4 Metals

There is a low potential for metal contamination although there is the potential for metals to enter water from some construction activities. Potential sources of aluminium include flocculants containing aluminium which may be used to remove sediment prior to discharge to the environment. Aluminium may also be used in products used in the production of shotcrete used for the acceleration of setting. Other metals such as chromium can be found in construction products and have the potential to be released into the environment.

Measures to manage wastewater (and metals) will be included in the Project's Water Quality Management Plan prepared and implemented by the EPC Contractor.

7.1.5 Nitrate and ammonium

The use of drill and blast techniques using ammonium nitrate explosives will be used to construct tunnel portals, to excavate the power station site and in tunnelling (depending on whether a TBM is used). It may also be used for sections of the headrace pipeline if hard rock is encountered. The use of ammonium nitrate explosive has the potential to release nitrate and ammonium into the surrounding environment primarily as the result of undetonated explosive remaining within the blast holes or spillage of explosive on site.

Understanding of the potential increases of nitrate and ammonium in the local aquatic environments as a result of the blasting has been informed by the work that has been undertaken by Hydro Tasmania on the Tarraleah Upgrade Works (see Section 7.3). These works have employed drill and blast techniques for the construction of a 950 m tunnel between Lake King William and the downstream portal at the start of the headrace pipeline. Intensive sampling of the aquatic environment has been undertaken as part of the works and used to develop a block model to estimate nitrate loads from this Project (see Section 7.3). For nitrates, the impact potential has been assessed against the 95th percentile DGV value of 0.073 mg/L. This has been chosen as variations in flow and discharge may result in higher concentrations than the 80th percentile DGV value of 0.02 mg/L (see Section 7.3) and toxicological impacts to aquatic biota tend to occur above this level. A maximum level of 2 mg/L is reported to protect the most sensitive freshwater species (Camargo et al 2005).

Nitrate and ammonium both have potential to exert toxicological impacts to aquatic organisms at high concentrations, with variation of the toxic impact influenced by different chemical conditions. In addition, both are biologically available sources of nitrogen with the capacity to increase the nutrient loading to the local waterways. The discharge of water containing nitrate and/or ammonium provides additional nutrients for the growth of phytoplankton or benthic algal species, as well as filamentous algae and macrophytes in the aquatic environment. If present in high enough concentrations, under the right light and flow condition, nitrate and ammonium can contribute to eutrophication.

The amount of ammonium nitrate remaining in blast holes and/or unexploded within rock spoil can be managed through the implementation of charging procedures that maximise the use of explosive and prevent spillage. A Nitrate Management Plan will be prepared and implemented by the EPC Contractor as part of the Project. The Nitrate Management Plan will include measures to limit the generation of nitrate (including blasting procedures) as well as management of wastewater and spoil containing nitrates.

7.2 Potential impacts by work site

The impact types described above (erosion/sedimentation, hydrocarbons, pH, metals, nitrate and ammonium) have different risk profiles depending on site specific characteristics of each work site and the activities that occur at each site. The type of impacts (and unmitigated risk) that are likely to occur at each work site described in Section 6.1 have been summarised in Table 7.2 and are discussed further below. Where risks are identified, management measures have been developed to ensure that water quality impacts to local waterways as a result of the Project are minimal as discussed in Section 8

Table 7.2: Project impacts (unmitigated) by work site

Work site	Waterway impacted	Impact type				
		Erosion/sedimentation	Hydrocarbons	pH	Metals	Nitrate/ammonia
Headrace pipeline	Stream 1-3 River Derwent	High	Low	Low	Low	Low
Western portal/ headrace tunnel	Stream 4 River Derwent	High	Moderate	High	Low	High
Mid-access portal	No. 2 Conveyances Nive River	High	Moderate	Moderate	Low	Low
Surge facility/ Paddy's Quarry	Stream 5 Nive River	High	Moderate	High	Low	High
Power station	Nive River	High	Moderate	Moderate	Low	Low
Tarraleah Village	Stream 6 Wilson's Creek Nive River	Low	Moderate	High	Low	None

7.2.1 Headrace pipeline

The headrace pipeline will be constructed within the catchments of Streams 1-3 (Figure 6.6). Potential water quality impacts associated with the headrace pipeline include:

- High potential for erosion and sedimentation from clearing of vegetation, use of temporary laydown areas, transport of fill and spoil, and civil works associated with the construction of the access tracks and headrace pipeline, in particular:
 - Site drainage during rainfall events has the potential to carry sediment from cleared areas, roads and associated laydown areas.
 - Construction of culverts over Streams 1-3 has the potential to increase erosion and deposition of sediment into the associated creeks.

The pipeline construction zone is a linear area with a greater perimeter-to-area ratio and intersects numerous watercourses and swamp areas associated with Streams 1-3, which flow into the River Derwent. The slope of the pipeline disturbance footprint is primarily <10 % (Appendix A.2). The soil types present at the pipeline are likely to be erodible and may produce turbid runoff and likely to require a Type-1 sediment basin. .

Measures to mitigate the erosion and sedimentation of the waterways along the headrace pipeline are discussed in Section 8.2.. Implementation of these measures will ensure that erosion and sediment impacts to local waterways as a result of the Project will be low such that the input of fine sediments is minimized.

- Low potential for the release of hydrocarbons into Streams 1-3 along the headrace pipeline as there will only be temporary laydown areas associated with the pipeline, with key laydown and workshop/refuelling areas located at the portals. Machinery associated with the headrace pipeline will include conventional earthworks plant and trucks

While there is a low potential for impacts to water quality from hydrocarbons along the pipeline, management measures developed for managing hydrocarbon impacts at other work sites which will be included in the Project's Water Quality Management Plan (Section 8.1) will applied to works along the pipeline. Thus, ensuring minimal water quality impacts as a result of hydrocarbons.

- Low potential for altered pH in Streams 1-3, as the headrace pipeline requires only limited use of concrete in the construction of the access roads (culverts) and pipeline. As concrete will not be mixed on site but rather at a batch facility associated with one of the portals, there is limited opportunity for high pH runoff from the use of concrete to impact local waterways along the headrace pipeline. If high pH runoff does occur, it is likely to be at a small scale and readily diluted, such that the impact to local waterways is limited.

While there is a low potential for impacts to water quality from high pH along the pipeline, management measures developed for managing pH impacts at other work sites (Sections 0: WQ4 and WQ5) which will be included in the Project's Water Quality Management Plan (Section 8.1) will applied to works along the pipeline. Thus, ensuring minimal water quality impacts as a result of changes to pH.

- Low potential for the release of metals into Streams 1-3 along the headrace pipeline as concrete will not be mixed on site and there are no major areas of concrete associated with the pipeline. In addition, as there will only be temporary laydown areas associated with the pipeline, with key laydown and workshop/refuelling areas located at the portals, there is limited potential for metals from laydown/workshop areas. While there is some potential for metals to be release from the worksite (i.e. from use of shotcrete, in flocculants containing aluminium used in sediment treatment), any concentrations will be low and rapidly diluted in the local waterways, such that the potential unmitigated impacts of metal is low.

As the potential impact from metals is low, no specific management measures are required. However, any potential impacts from metals will be mitigated through implementation of the Project's Water Quality Management Plan (Section 8.1).

- Low potential for high concentrations of nitrates and ammonia in Streams 1-3 as drill and blast techniques will only be used if hard rock is encountered along the pipeline route. Thus, any ammonium nitrate remaining in holes or spilt is expected to be extremely low and unlikely to have a significant impact on Streams 1-3 or the downstream River Derwent.

The potential impact from nitrates and ammonium is low, however, any potential impacts will be mitigated through implementation of the Project's Nitrate Management Plan (Section 8.3 and Section 0: WQ6 and WQ7).

7.2.2 Western portal and headrace tunnel

Due to the construction activities planned at the western portal including tunnelling of the headrace tunnel and spoil emplacement, there will be the potential to impact water quality in the local creek (Stream 4) and the River Derwent (Figure 6.6). Stream 4 is a small creek with generally low flows (Figure 7.1). This creek has a median flow of 20 L/s and a 30th percentile base flow (equivalent to the 70th % time exceeded flow) of 7 L/s. These low flows mean that this creek has low capacity for dilution and is susceptible to the discharges from the western portal site.

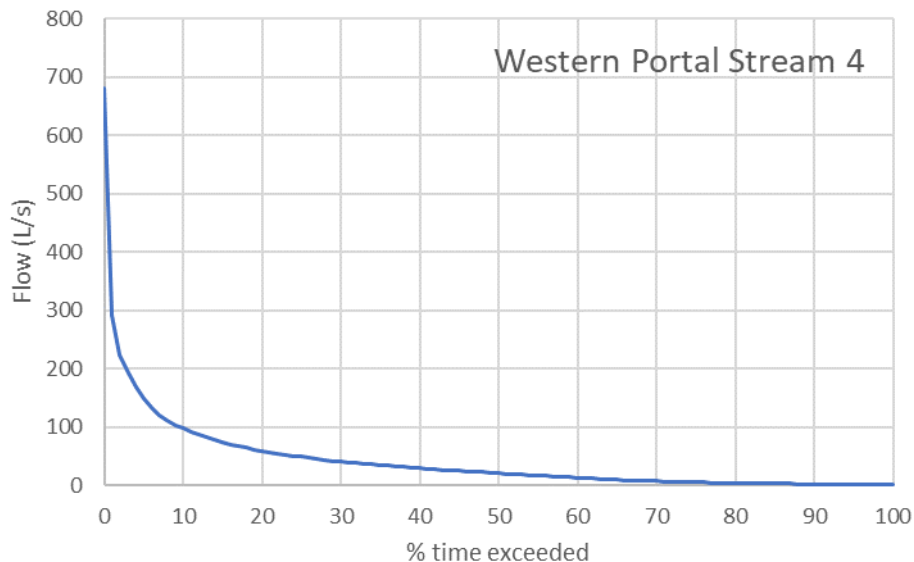


Figure 7.1: Flow duration curve of modelled flow data for Stream 4, located near the western portal.

For this site potential impacts to water quality include:

- High potential for erosion and sedimentation from clearing of vegetation, use of the spoil emplacement area and civil works associated with the construction of the portal and headrace tunnel. The potential risk will increase during rainfall events when site drainage has the potential to carry sediment from cleared areas, roads, spoil and associated laydown areas.

The western portal is a non-linear construction site. The slope is primarily <10 % gradient (Appendix A.2) and the soil types present at the western portal are likely to be erodible and may produce turbid runoff, and likely to require a Type 1 sediment control basin. The western portal also contains a large spoil emplacement area derived from tunnelling and other construction activities. The western portal intersects Stream 4 and associated creeks and swamp areas, which will require specific drainage controls.

Measures to mitigate the erosion and sedimentation risk on Stream 4 are discussed in Section 8.2.. Implementation of these measures will ensure that erosion and sediment impacts to Stream 4 as a result of the Project will be low.

- Moderate potential for the release of hydrocarbons into Stream 4 as there will be laydown and workshop/refuelling areas located at the western portal. In addition, a tunnel boring machine, if used, may operate from the western portal.

Measures to mitigate any release of hydrocarbons into Stream 4 are included in the Project's Water Quality Management Plan (Section 8.1) and include preparation and implementation of a

Hydrocarbon Management Plan. This plan will include appropriate transport, storage, handling and disposal of all hydrocarbons to limit potential for spills and if any spills do occur, ensure they are captured and disposed of at an accredited waste disposal facility. The plan will also include a spill response plan which specifies training requirements and equipment to be used in the event of a spill. These measures will ensure that there will be minimal water quality impacts as a result of hydrocarbons.

- High potential to increase the pH in Stream 4 due to the use of shotcrete and grout within the portal and headrace tunnel and the potential to discharge contaminated wastewater into local waterways. In addition, a concrete batch plant is likely to be located at the portal.

Measures to mitigate the potential for water with raised pH entering Stream 4 are included in the Project's Water Quality Management Plan (Section 8.1) and include discharge performance criteria for all water leaving the site (Section 0: WQ4), location of the concrete batching plants away from local waterways, including Stream 4, and capture of all washdown water (Section 0: WQ5). Captured water will be either treated onsite to achieve discharge performance criteria before discharged or removed and disposed of at an accredited waste disposal facility. These measures will ensure that there will be minimal water quality impacts as a result of changes to pH.

- Low potential for the release of metals into Stream 4 at the western portal. While there is some potential for metal to be released from the worksite (i.e. from use of shotcrete, workshops, laydown area, flocculants), any concentrations will be low and rapidly diluted in the local waterways, such that the potential unmitigated impact of metal is low.

As the potential impact from metals is low, no specific management measures are required. However, any potential impacts will be mitigated through implementation of the Project's Water Quality Management Plan (Section 8.1).

- High potential for high concentrations of nitrates and ammonia in Stream 4 due to the use of explosives in construction of the tunnel and western access portal. In order to understand the potential scale of impact from discharging of water with elevated nitrate levels into local waterways a block model analysis was undertaken which examined the potential generation of nitrates by construction and the means of discharging based on empirical observations and understanding from the current Tarraleah Upgrade Works. This analysis is described in Section 7.3.

Using this modelling, the predicted unmitigated impact of nitrate concentration on Stream 4, based on a 6 year construction period and 2 years post construction, is shown in Figure 7.2 and indicates the potential for high concentrations of nitrate, with peaks in excess of 20 mg/L in Years 2 and 3 and a median of approximately 3 mg/L in Year 3. The peak concentrations in Years 2 and 3 are at chronic toxicity levels for some freshwater aquatic species (NIWA 2013).

An estimate of nitrate concentrations in the River Derwent in the absence of mitigation as a result of construction activities at the western portal has been made. Based on a median flow of 20 L/s in Stream 4 and a conservative low base flow of 185 L/s for the River Derwent, peak nitrate concentrations in the River Derwent during Years 2 and 3 are estimated to be in excess of 2 mg/L with a median concentration of up to 0.29 mg/l. These values are greater than existing background nitrate concentrations in the River Derwent below Derwent Pumps (around 0.04 mg/L at Derwent above Wayatinah) and above the Upper Derwent SMD DGV 80th percentile (0.020 mg/L) and 95th percentile values (0.073 mg/L).

Modelling of potential nitrate and ammonia loads to groundwater was also made using the

block model. Estimates of loads to groundwater from spoil emplacement locations are minimal for the western portal site and are considered a low impact. Further discussion of these loadings and potential impact is found in Section 7.3.4.

Measures to mitigate the impact potential in Stream 4 are discussed in Section 8.3, and include development and implementation of a Nitrate Management Plan by the EPC Contractor. This plan will include blasting procedures to minimise the generation of nitrates (Section 0: WQ6), collection and storage of all on-site water and utilising existing conveyances (e.g. No. 1 Canal, No. 2 Canal and associated storages) and/or the Nive River as discharge locations to allow rapid dilution of nitrate concentrations to near background concentrations in the Nive River.

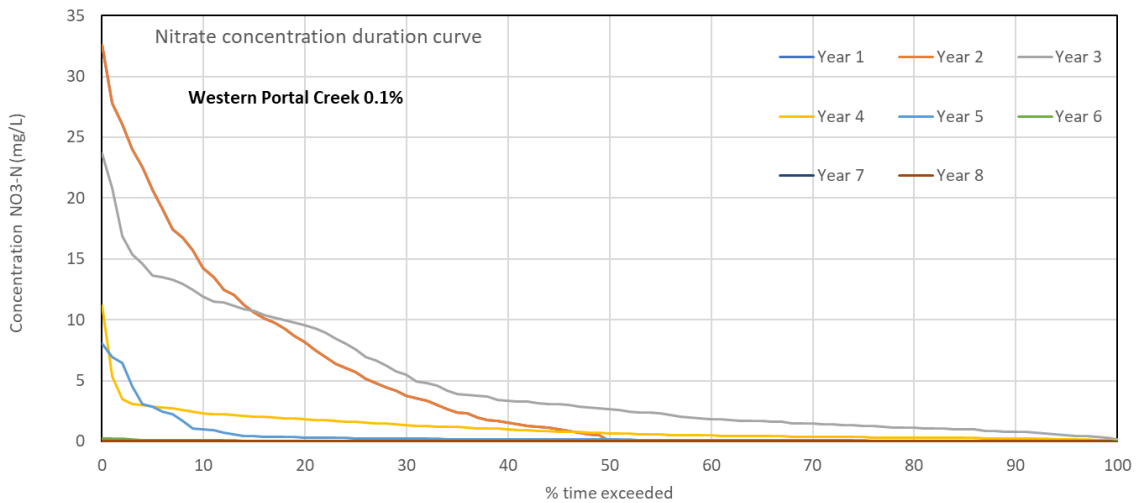


Figure 7.2: Estimated distribution of nitrate concentrations in Stream 4 in the absence of mitigations

7.2.3 Mid-access portal

Surface water quality impacts and proposed management measures for the mid-access portal are similar to those described for the western portal and headrace tunnel (Section 7.2.2) above). Discharge from the mid-access tunnel portal would affect the water quality of local receiving waters including No. 2 Canal, Mossy Marsh Pond and No. 2 Pond, and to a lesser extent Hornes Pond, Nive River and Lake Liapootah.

For this site potential impacts to water quality include:

- High potential for erosion and sedimentation from clearing of vegetation, use of the spoil emplacement area and civil works associated with the construction of the mid-access portal and headrace tunnel. The potential risk will increase during rainfall events when site drainage has the potential to carry sediment from cleared areas, roads, spoil and associated laydown areas.

The mid-access portal is a non-linear construction site. The mid-access portal site slope is variable (Appendix A.2) owing to being located on a catchment divide. The soil types present at the western portal are likely to be erodible and may produce turbid runoff, and likely to require a Type 1 sediment control basin. The western portal also contains a large spoil emplacement area derived from tunnelling and other construction activities. The mid-access portal into Mossy Marsh Pond and Hornes Dam from the catchment divide.

Measures to mitigate the erosion and sedimentation risks are discussed in Section 8.2.. Implementation of these measures will ensure that erosion and sediment impacts to local waterways as a result of the Project will be low.

- Moderate potential for the release of hydrocarbons into the No. 2 Canal, Mossy Marsh Pond and No. 2 Pond as there will be laydown and workshop/refuelling areas located at the western portal.

Measures to mitigate any release of hydrocarbons into the No. 2 conveyances and associated ponds are included in the Project's Water Quality Management Plan (Section 8.1) and include preparation and implementation of a Hydrocarbon Management Plan. This plan will include appropriate transport, storage, handling and disposal of all hydrocarbons to limit potential for spills and if any spills do occur, ensure they are captured and disposed of at an accredited waste disposal facility. The plan will also include a spill response plan which specifies training requirements and equipment to be used in the event of a spill. These measures will ensure that there will be minimal water quality impacts as a result of hydrocarbons.

- Moderate potential to increase the pH in No. 2 Canal, Mossy Marsh Pond and No. 2 Pond due to the use of shotcrete and grout within the portal and headrace tunnel and the potential to discharge contaminated wastewater into local waterways. A concrete batch plant is unlikely to be located at this portal.

Measures to mitigate the raised pH into Stream 4 are included in the Project's Water Quality Management Plan (Section 8.1) and include discharge performance criteria for all water leaving the site (Section 0: WQ4), location of the concrete batching plants away from local waterways and capture of all washdown water (Section 0: WQ5). Captured water will be either treated onsite to achieve discharge performance criteria before discharged or removed and disposed of at an accredited waste disposal facility. These measures will ensure that there will be minimal water quality impacts as a result of changes to pH.

- Low potential for the release of metals into No. 2 Canal, Mossy Marsh Pond and No. 2 Pond. While there is some potential for metal to be released from the worksite (i.e. from use of shotcrete, workshops, laydown area, flocculants), any concentrations will be low and rapidly diluted in the local waterways, such that the potential unmitigated impact of metal is low.

As the potential impact from metals is low, no specific management measures are required. However, any potential impacts from metals will be mitigated through implementation of the Project's Water Quality Management Plan (Section 8.1).

- Low potential for high concentrations of nitrates and ammonia in No. 2 Canal, Mossy Marsh Pond and No. 2 Pond due to the use of explosives in construction of the mid-access portal.

The local impacts to surface water are likely to be low due to the nature of the receiving waters having substantial flow and/or volume in the No. 2 conveyances (Mossy Marsh Pond, No. 2 Pond) and Hornes Pond. The high dilution in both the canal and the associated storages, and the low residence times (12 to 24 hours) in each of the storages that form part of the No. 2 conveyance also means there is only minor potential for a low impact. Such an impact may result in an increase in primary productivity in these locations, either as greater growth of macrophytes, benthic algae or phytoplankton (indicated by increased chlorophyll *a*).

Modelling of potential nitrate and ammonia loads to groundwater was also made using the block model. Estimates of loads to groundwater from spoil emplacement locations are estimated to be small and are considered a low impact. Further discussion of these loadings and impact is found in Section 7.3.4.

Blasting procedures to minimise the generation of nitrates and ensuring sufficient flows in the conveyances and Nive River for dilution (Section 8.3) will help mitigate any impacts to Mossy Marsh Pond and No. 2 Pond.

7.2.4 Paddy's Quarry

Due to the construction activities proposed at the surge facility and Paddy's Quarry including tunnelling of the surge tunnel access, surge tunnel and headrace tunnel, and spoil emplacement, there will be the potential to impact water quality in the local waterway (Stream 5) and the Nive River (Figure 6.7). Stream 5 is a moderately sized creek with a median flow of 35 L/s and a 30th percentile base flow (equivalent to the 70th % time exceeded flow) of 13 L/s. These flows are insufficient to provide rapid dilution to large discharges from the surge tunnel and Paddy's Quarry site.

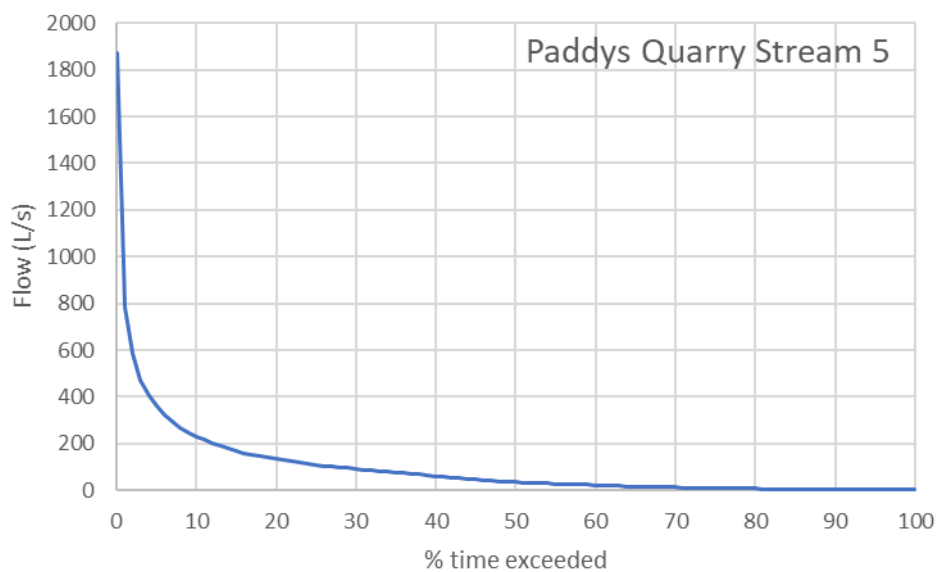


Figure 7.3: Flow duration curve of modelled flow data for Stream 5, located near the surge tunnel access and Paddy's Quarry site.

For this site potential impacts to water quality include:

- High potential for erosion and sedimentation from clearing of vegetation, use of the spoil emplacement area and civil works associated with the construction of the portal. With the risk increased during rainfall events when site drainage has the potential to carry sediment from cleared areas, roads, spoil and associated laydown areas.

Like the other portal sites, Paddy's Quarry is a non-linear construction zone. The slope is primarily <20 % gradient (Appendix A.2). The soil types present at Paddy's Quarry are likely to be erodible, especially where clay and silt soils are present, and may produce turbid runoff, and likely to require a Type 1 sediment control basin. Paddy's Quarry also contains a large spoil emplacement area derived from tunnelling and other construction activities. Paddy's Quarry intersects with Stream 4 and associated creeks and swamp areas, which will require specific drainage controls.

Measures to mitigate the erosion and sedimentation risk on Stream 5 are discussed in Section 8.2.. Implementation of these measures will ensure that erosion and sediment impacts to Stream 5 as a result of the Project will be low.

- Moderate potential for the release of hydrocarbons into Stream 5 as there will be laydown and workshop/refuelling areas located at the surge facility and/or Paddy's Quarry.

Measures to mitigate any release of hydrocarbons into Stream 5 are included in the Project's Water Quality Management Plan (Section 8.1) and include preparation and implementation of a Hydrocarbon Management Plan. This plan will include appropriate transport, storage, handling and disposal of all hydrocarbons to limit potential for spills and if any spills do occur, ensure they are captured and disposed of at an accredited waste disposal facility. The plan will also include a spill response plan which specifies training requirements and equipment to be used in the event of a spill. These measures will ensure that there will be minimal water quality impacts as a result of hydrocarbons.

- High potential to increase the pH in Stream 5 due to the use of shotcrete and grout within the portal and headrace tunnel and the potential to discharge contaminated wastewater into local waterways. In addition, a concrete batch plant is likely to be located at Paddy's Quarry.

Measures to mitigate the raised pH into Stream 5 are included in the Project's Water Quality Management Plan (Section 8.1) and include discharge performance criteria for all water leaving the site, location of the concrete batching plants away from local waterways, including Stream 5, and capture of all washdown water. Captured water will be either treated onsite to achieve discharge performance criteria before discharged or removed and disposed of at an accredited waste disposal facility. These measures will ensure that there will be minimal water quality impacts as a result of changes to pH.

- Low potential for the release of metals into Stream 5 at the surge facility or Paddy's Quarry. While there is some potential for metal to be released from the worksites (i.e. from use of shotcrete, workshops, laydown area, flocculants), any concentrations will be low and diluted in the local waterways, such that the potential unmitigated impact of metal is low.

As the potential impact from metals is low, no specific management measures are required. However, any potential impacts from metals will be mitigated through implementation of the Project's Water Quality Management Plan (Section 8.1).

- High potential for high concentrations of nitrates and ammonia in Stream 5 due to the use of explosives in construction of the surge facility and Paddy's Quarry portal and from the spoil emplacement area at Paddy's Quarry. In order to understand the potential scale of the impact of nitrate discharge on background concentration of local waterways, a block model analysis was undertaken which examined the potential generation of nitrates by construction and the means of discharging based on empirical observations and understanding from the current Tarraleah Upgrade Works. This analysis is described in Section 7.2.6.

As for the Western portal, modelling of nitrate concentrations in the local waterways (Stream 5) has been undertaken to show the potential impact over the construction period (Figure 7.4). This modelling indicates that high concentrations of nitrates may occur in the absence of mitigation, with peaks in excess of 25 - 30 mg/L in Year 2 and a median of approximately 3 mg/L. These concentrations are at chronic toxicity levels for some freshwater aquatic species (NIWA 2013).

An estimate of nitrate concentrations in the Nive River at the confluence with Stream 5 (approximated 2.2 km upstream from the Tungatinah tailrace) in the absence of mitigation as a result of construction activities at Paddy's Quarry has been made. Based on a median flow of 35 L/s in Stream 5 and a low base flow of 140 L/s for the Nive River, peak nitrate concentrations in the Nive River during Year 2 are estimated to be in excess of 2 mg/L, with a median

concentration of up to 0.75 mg/l. These values are greater than existing background nitrate concentrations in the Nive River (median around 0.009 mg/L) and above the Upper Derwent SMD DGV 80th percentile (0.020 mg/L) and 95th percentile values (0.073 mg/L). Background levels in the Nive River have been estimated based on data collected at the Nive River above Tarraleah site (downstream of the Tungatinah tailrace) during periods of no discharge from Tungatinah Power Station.

An estimate of increases in nitrate concentrations in the Nive River downstream of the Tarraleah tailrace in the absence of mitigation has also been made. This estimation was based on a median flow of 35 L/s in Stream 5 and a combined very low flow (i.e. one that occurs less than 2 % of the time) from Tungatinah Power Station, Tarraleah Power Station and the Nive River upstream Tungatinah Power Station of 20 m³/s. Based on this, the median nitrate concentration in the Nive River downstream of the Tarraleah tailrace in Year 2 as a result of works at Paddy’s Quarry is estimated to be below 0.005 mg/L ,98% of the time. This concentration is below the existing background nitrate concentration in the Nive River (median concentration 0.007 mg/L at Nive River downstream of Tarraleah Power Station) and the Upper Derwent SMD DGV 80th percentile and 95th percentile values. Peak values below the tailrace in Year 2 are estimated to be in excess of 0.04 mg/L, 2 % of the time and within the Upper Derwent SMD DGV 95th percentile value.

Measures to mitigate the impact potential to Stream 5 are discussed in Section 8.3, and include development and implementation of a Nitrate Management Plan by the EPC Contractor. This plan will include on blasting procedures to minimise the generation of nitrates and managing the discharge of water from work sites by utilising conveyances (e.g. canals) and/or the Nive River as discharge locations to provide rapid and high levels of mixing to reduce ambient concentrations (Section 0: WQ7).

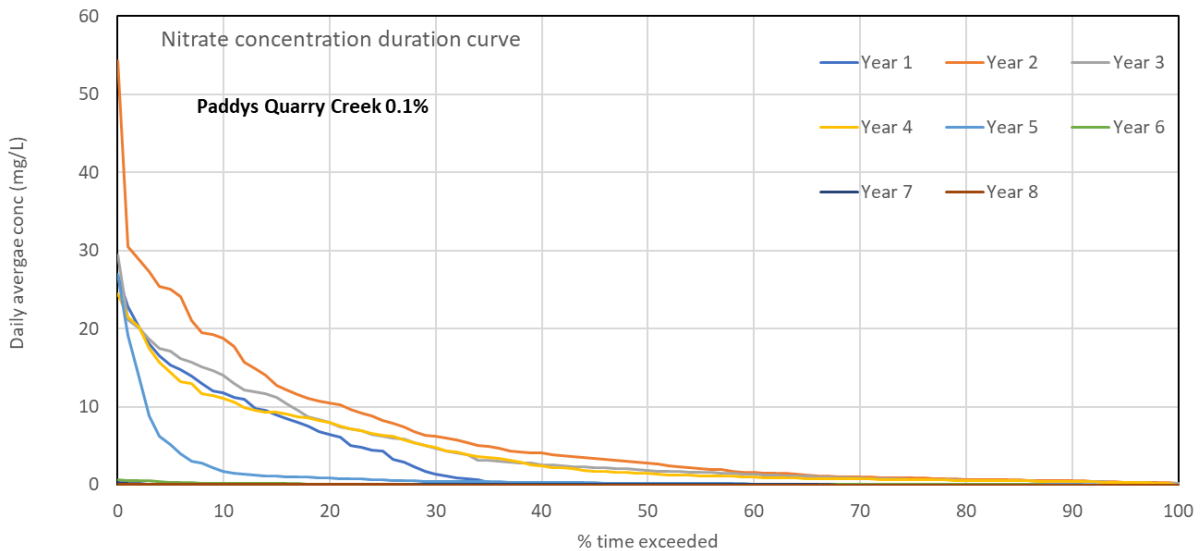


Figure 7.4: Estimated distribution of nitrate concentrations in Stream 5 in the absence of mitigation

7.2.5 Power station site

The activities for the construction of the power station that have potential to impact water quality include excavation of the power station site below water level as well as instream works within the Nive River. The power station site will be a source of potential water discharges to the Nive River from

groundwater ingress and tunnel wastewater as well as runoff from the site during rainfall events. The Nive River as a receiving environment, has a high flow most of the time from the combined discharges of Tungatinah Power Station and Tarraleah Power Station, as well as the flow present in the Nive River.

For this site potential impacts to water quality include:

- High potential for erosion and sedimentation from bank and instream works in the Nive River, and civil works associated with the construction of the power station and associated infrastructure. The risk of erosion and sediment runoff will increase during rainfall events when site drainage has the potential to carry sediment from exposed areas to the river.

The new power station site and associated hillslope and civil works laydown areas are located primarily within areas with steep slopes with >20 % gradient (except for the power station footprint, which is located on existing, levelled ground, Appendix A.2). The soil types are likely to be erodible and may produce turbid runoff, and likely to require a Type 1 sediment controls. In addition, the construction zone includes instream and riverbank works along the Nive River.

Measures to manage the erosion and sedimentation risk on the Nive River are discussed in Section 8.2. Implementation of these measures will ensure that erosion and sediment impacts to local waterways as a result of the Project will be low.

- Moderate potential for the release of hydrocarbons into the Nive River from conventional earthworks plant and trucks.

Measures to mitigate any release of hydrocarbons into Stream 4 are included in the Project's Water Quality Management Plan (Section 8.1) and include preparation and implementation of a Hydrocarbon Management Plan. This plan will include appropriate transport, storage, handling and disposal of all hydrocarbons to limit potential for spills and if any spills do occur, ensure they are captured and disposed of at an accredited waste disposal facility. The plan will also include a spill response plan which specifies training requirements and equipment to be used in the event of a spill. These measures will ensure that there will be minimal water quality impacts as a result of hydrocarbons.

- Moderate potential to increase the pH in local waterways due to the use of shotcrete and grout within the power station site and the potential to discharge contaminated wastewater into local waterways.

Measures to mitigate the raised pH into Nive River are included in the Project's Water Quality Management Plan (Section 8.1) and include management of wastewater to ensure that all wastewater is captured, discharge performance criteria for all water discharge to the Nive River (Section 0: WQ4) and removed and disposed of wastewater that does not meet the criteria at an accredited waste disposal facility. These measures will ensure that there will be minimal water quality impacts as a result of changes to pH.

- Low potential for the release of metals into the Nive River. While there is some potential for metal to be released from the worksite (i.e. from use of shotcrete, workshops, laydown area, flocculants), any concentrations will be low and rapidly diluted in the Nive River, such that the potential unmitigated impact of metal is low.

As the potential impact from metals is low, no specific management measures are required. However, any potential impacts from metals will be mitigated through implementation of the Project's Water Quality Management Plan (Section 8.1).

- Low potential for high concentrations of nitrates and TAN in the Nive River due to the use of explosives in construction of power station. In addition, there is a low potential if discharge from all work sites enters the Nive River at the power station. The potential to impact to the Nive River is reduced due to the substantial flow and/or volume of the receiving waters in the Nive River and Liapootah Pond downstream. The high dilution of nitrate or ammonia loads in any discharge means there is likely low impact in the Nive River and Lake Liapootah from the power station work site.

In order to understand the potential scale of the impact of nitrate and ammonia discharge on background concentration of local waterways, a block model analysis was undertaken which examined the potential generation of nitrates by construction and the means of discharging based on empirical observations and understanding from the current Tarraleah Upgrade Works. This analysis is described in Section 7.3.2).

Modelling of nitrate concentrations in the Nive River has been undertaken to show the potential impact over the construction period, and takes into consideration the inputs from all work sites that have been diverted via the canal to the Nive River. This modelling indicates that sufficient dilution is possible within the Nive River to maintain concentrations at levels within the 80th percentile DGV (0.020 mg/L) for the majority of time with only a minor (low) potential to exceed the 95th percentile concentration (0.073 mg/L) (see Section 7.3.6).

The year with the highest estimated daily loads and greatest potential to have high concentration of nitrate in the Nive River as a result of the Project is Year 3 (Section 7.3.3.2). A predicted < 0.4% of time or 1.5 days in Year 3 have the potential to exceed the Upper Derwent DGV 95th percentile value of 0.073 mg/L. On such days, the combined flows of Tungatinah, Tarraleah and the Nive River is not expected to be sufficient to dilute the nitrate load to < 0.073 mg/L in the Nive River (Figure 7.20).

As the potential impact from nitrates and ammonium is low, no specific management measures are required. However, measures have been included in the Project's Water Management Plan (Section 8.3) to ensure that potential impacts when there is insufficient flow in the Nive River are minimised (Section 8.1).

7.2.6 Tarraleah Village

Stream 6 which flows through the Tarraleah Village to Wilsons Creek and the Nive River has poor water quality (high, elevated conductivity, pH (slightly), nutrients and chlorophyll *a* and slightly reduced dissolve oxygen; Section 5.6), most likely due to seepage from the village sewage pond.

For this site potential impacts to water quality include:

- Low potential for erosion and sedimentation at Tarraleah Village as there will be limited clearing and no major civil works. Construction works will be limited to building laydown and workshop areas and the installation of prefabricated administration buildings.

The Tarraleah Village construction zones are primarily low relief and primarily <10 % gradient (Appendix A.2), except for the sewage treatment area, where some localised steep areas (including the pond batters) are present. The Tarraleah Village construction zones intersects numerous watercourses associated with Stream 6 which flows to the Wilson River and Lake Liapootah; however, some of the internal drainage within the Tarraleah Village is diverted to artificial ponds within the village. Whilst the soil type is unknown, the soil will likely be similar to

other Project areas within the disturbance footprint and could potentially erode easily and lead to turbid runoff.

As the potential impact from erosion and sediment is low, no specific management measures are required. However, any potential erosion and sediment impacts will be mitigated through implementation of the Project's Erosion and Sediment Control Plan (Section 8.2).

- Moderate potential for the release of hydrocarbons into Stream 6 as there will be laydown and workshop/refuelling areas located within the village.

Measures to mitigate any release of hydrocarbons into Stream 6 are included in the Project's Water Quality Management Plan (Section 8.1) and include preparation and implementation of a Hydrocarbon Management Plan. This plan will include appropriate transport, storage, handling and disposal of all hydrocarbons to limit potential for spills and if any spills do occur, ensure they are captured and disposed of at an accredited waste disposal facility. The plan will also include a spill response plan which specifies training requirements and equipment to be used in the event of a spill. These measures will ensure that there will be minimal water quality impacts as a result of hydrocarbons.

- High potential to increase the pH in Stream 6 due to the potential location of a concrete batch plant in the village and the use concrete for laydowns and workshop area, both of which could result in the discharge contaminated wastewater into local waterways.

Measures to mitigate the raised pH into Stream 5 are included in the Project's Water Quality Management Plan (Section 8.1) and include discharge performance criteria for all water leaving the site (Section 0: WQ4), location of the concrete batching plants away from local waterways and storages, including Stream 6, and capture of all washdown water (Section 0: WQ5). Captured water will be either treated onsite to achieve discharge performance criteria before discharged or removed and disposed of at an accredited waste disposal facility. These measures will ensure that there will be minimal water quality impacts as a result of changes to pH.

- Low potential for the release of metals into the waterways at Tarraleah Village. While there is some potential for metal to be release from the worksite (i.e. workshops, laydown areas), any concentrations will be low and rapidly diluted in the local waterways (Stream 6, Wilson Creek), such that the potential unmitigated impact of metal is low.

As the potential impact from metals is low, no specific management measures are required. However, any potential impacts from metals will be mitigated through implementation of the Project's Water Quality Management Plan (Section 8.1).

- No potential for the release of nitrates and ammonia as drill and blast construction techniques will not be used at Tarraleah Village.

7.2.7 Other work sites

In addition to the impacts at the main work sites, there may be the potential for construction impacts on water quality associated with other aspects of the Project, in particular erosion and sedimentation:

- The transmission line northern and southern options have the greatest area of potentially exposed soil and are also long, linear area areas with a greater perimeter length, where the slope length (and therefore, the chance of rill erosion developing) could be potentially long depending on whether the transmission line alignment is running along or down contours (Appendix A.2).. The slope is variable for the transmission line options; however, a high

proportion of these areas have a moderate to steep slope, which can enhance erosion by higher velocity runoff. Both transmission line options intersect stream/creeks and small swamps and drain downslope into major rivers and waterbodies, whilst the transmission line termination points are on the banks of the Nive River and therefore require specific drainage controls. Whilst the soil type is unknown, the soil will likely be similar to other project areas within the disturbance footprint and could potentially erode easily and lead to turbid runoff.

- The surge tower and rising main construction zones are primarily linear, with a high perimeter-to-area ratio and are intersected by creeks associated with Wilsons Creek that flows to the Nive River. The slope is variable; however, most of the area is <20 % gradient (Appendix A.2) and is located on a glacial quaternary surface, with soil types that are likely to be erodible and may produce turbid runoff.
- The pump station construction zones is primarily square, and drains to the Nive River via No. 2 Pond or waterways associated with Wilsons Creek that flows to the Nive River. The slope is variable; however, most of the area is <20 % gradient (Appendix A.2), with soil types that are likely to be erodible and may produce turbid runoff.
- The construction zone is smaller within the two explosive magazines, and the slope is variable, but primarily <10 % gradient (Appendix A.2). Both areas are located on a glacial quaternary surface, with soil types that are likely to be erodible and may produce turbid runoff. All three sites are intersected by watercourses, which flow to major rivers.
- The two road intersection upgrades have variable slopes where the Lyell Highway and Butlers Gorge Road intersection has a relatively low overall slope and currently already contains some roadside drainage, which flows to either the River Derwent or the Nive River. In contrast, the Lyell Highway and Oldina Drive intersection has variable slopes; however, this area is primarily a <20 % gradient (Appendix A.2). The intersections are located on a glacial quaternary surface, with soil types that are likely to be erodible and may produce turbid runoff.

Water quality impacts at these work sites will be managed in accordance with the Project's Water Quality Management Plan and Erosion and Sediment Control Plan. Implementation of these management measures will ensure that there will be minimal water quality impacts at work sites related to the Project.

7.2.8 Post mitigation

Implementation of the Project's Water Quality Management Plan (Section 8.1) including wastewater management controls (Section 8.1.1), Erosion and Sediment Control Plan (Section 8.2), Nitrate Management Plan (Section 8.3) will ensure that water quality impacts to local waterways and River Derwent and Nive River will be low, as outlined in Table 7.3.

Monitoring will be undertaken throughout the construction period to ensure that there are minimal water quality impacts to the local waterways or River Derwent (Section 8.4). Monitoring will include general water quality monitoring of all work sites as well as monitoring of any point source discharge (Section 8.4.2). The purpose of this monitoring will be to detect exceedances from guideline values and discharge performance criteria, as well as trends in data. In addition, there will be monitoring to ensure compliance with nitrate and turbidity discharge performance criteria in the Nive River and Lake Liapootah (Section 8.1). All monitoring will be reported on annually.

Other than the unknown impacts of temporary groundwater drawdown to the *Sphagnum* peatland community near Mossy Marsh Pond that will require precautionary offsetting, no other substantial residual impacts are anticipated if appropriate management measures are implemented.

Table 7.3: Project impacts (mitigated) by work site

Work site	Waterway impacted	Impact type				
		Erosion/ sedimentation	Hydrocarbons	pH	Metals	Nitrate/ ammonia
Headrace pipeline	Stream 1-3 River Derwent	Low	Low	Low	Low	Low
Western portal/ headrace tunnel	Stream 4 River Derwent	Low	Low	Low	Low	Low
Mid-access portal	No. 2 Conveyances Nive River	Low	Low	Low	Low	Low
Surge facility/ Paddy's Quarry	Stream 5 Nive River	Low	Low	Low	Low	Low
Power station	Nive River	Low	Low	Low	Low	Low
Tarraleah Village	Stream 6 Wilson's Creek Nive River	Low	Low	Low	Low	None

7.3 Nitrate and ammonia loading across the Project

Mitigating the potential water quality impacts of drill and blasting using ammonium nitrate requires both minimising the amount of undetonated ammonium nitrate and spillage, and managing discharge of impacted water to the environment. To manage the discharge, it is important to:

- Understand the potential for nitrate and ammonium to be mobilised into the environment, including what pathways (groundwater versus surface water).
- Quantify the potential loads
- Understand the flow regime of the receiving environment.

This then allows site specific assessments of the risk to waterways and the identification of any need for management measures. This section aims to explore these aspects for the Project, taking into account recent learnings from the Tarraleah Upgrade Works, to provide an understanding of the risk to receiving waters from ammonium nitrate used in drill and blasting. This section provides the worst case scenario for nitrate loading of local waterways and rivers, as it assumes that the entire Project will be undertaken using drill and blast and that a TBM will not be used for any tunnelling works.

Although some of the ammonium nitrate remaining after a blast will end up in spoil at the spoil emplacement areas (western portal, mid-access portal and Paddy's Quarry), a portion will directly enter the tunnel wastewater. Nitrate and ammonia in explosive residue is likely to be readily dissolved due to its high solubility and rapid release via site wastewater and/or groundwater seepage to the receiving environment. By comparison, nitrate and ammonia in spoil will only be mobilised following rain and released to the environment over an extended period, making its way into creeks via surface runoff and/or groundwater seepage.

7.3.1 Differences in nitrate and ammonium mobility

The understanding of the potential increases in nitrate and ammonium in the local aquatic environments as a result of the blasting has been informed by the work that has been undertaken on the Tarraleah Upgrade Works. These works have employed drill and blast techniques for the construction of a 950 m tunnel between Lake King William and the downstream portal at the start of the headrace pipeline. Intensive sampling of the aquatic environment has been undertaken as part of the works and used to develop a block model to estimate nitrate loads from this Project.

While the stoichiometric ratio of nitrate and ammonia in explosives is 1:1, their mobility varies and this affects their concentrations in the environment. Nitrate is highly mobile and can move rapidly through soil and rock spoil (Mahmood et al. 2017) while ammonium is relatively immobile. Differences in mobility between nitrate and ammonium have been observed at the Tarraleah Upgrade Works. The concentrations of ammonia relative to nitrate has differed between the two work sites:

- At the intake, water discharged from site has had a median concentration of ammonia that was 5 % of the nitrate concentration.
- At the tunnel, water discharged from tanks since the start of tunnelling at the site had a median concentration of ammonia that was 38 % of the nitrate concentration (Figure 7.5).

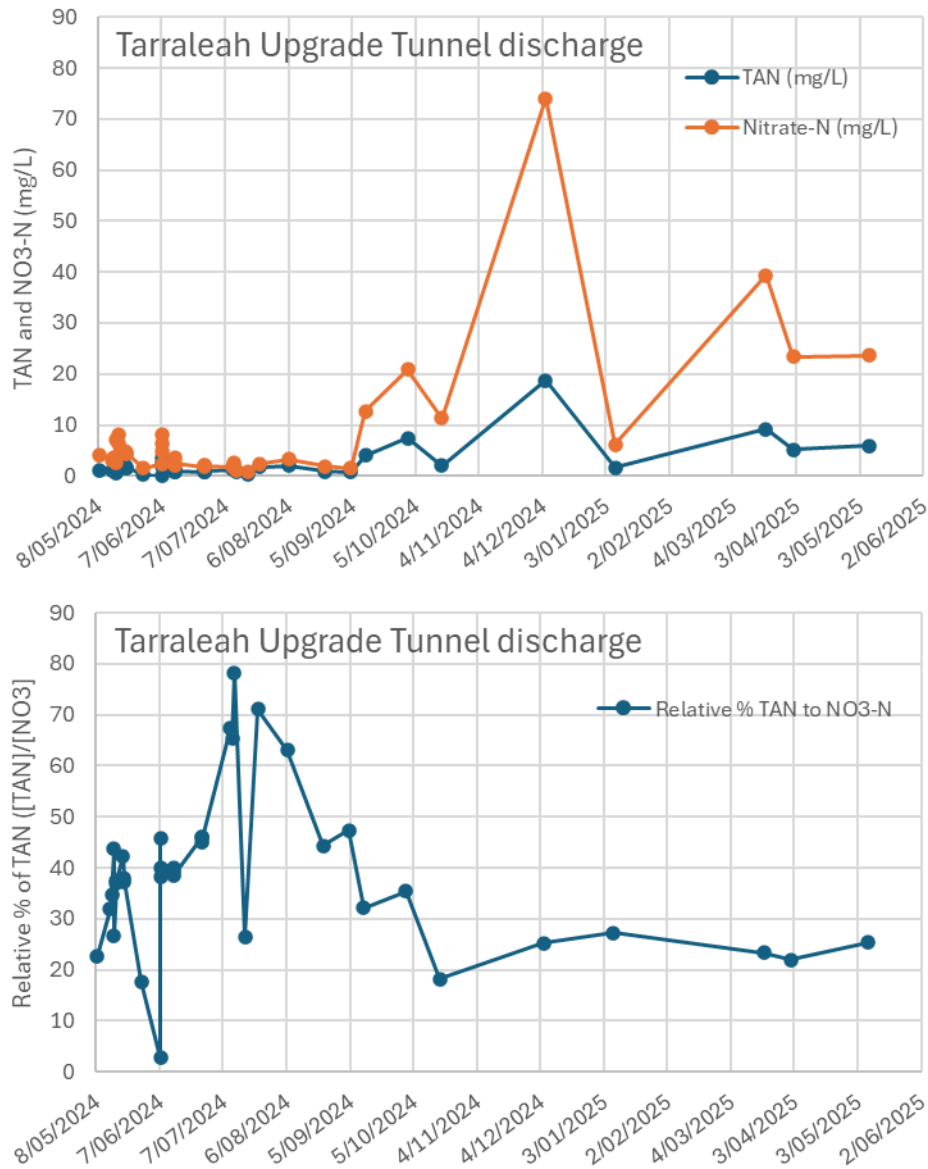


Figure 7.5: Concentration of nitrate and ammonia in water discharged from the Tarraleah Upgrade Tunnel site (top) and the relative percentage of concentration of ammonia to nitrate in each sample (bottom)

Our understanding of the discharge from the Tarraleah Upgrade Works is that nitrate is the dominant source of dissolved nitrogen and that ammonia will be observed at a lower concentration. However, the amount of ammonia contained in discharge water may be influenced by the route of the water to its discharge point. Water discharged at the intake site includes water that is draining accumulated spoil. Positively charged ammonium ions may be less mobile through spoil due to their capacity to bind readily to clay particles (Nieder et al 2011). In addition, oxidation of ammonium to nitrate (nitrification) may be occurring within the spoil, although this cannot be readily quantified. In contrast, water collected in the tunnel has a more direct route from the blast face to the storage tanks and less potential for interaction (binding or oxidation) with spoil, thus maintaining higher concentrations of ammonia in the tunnel wastewater.

Microbial processes within the spoil may influence potential transformations of nitrate to nitrogen gases (denitrification) and ammonium to nitrate (nitrification). There is significant uncertainty about whether this will occur or the potential rates at which it may occur in the spoil emplacement areas. Several physical, environmental and chemical factors, and complex interactions among them, influence nitrification in soils (Sahrawat 2008). Major factors influencing nitrification in soils include soil matrix, moisture status, aeration, pH and temperature (Sahrawat 2008). Factors correlated to nitrification include high soil water-filled pore space, high nitrate content and high soil temperature and low soil oxygen content (Pan et al 2022).

7.3.2 Block model

In order to estimate the potential impact of ammonium nitrate from drill and blast works, the potential load produced from the project and the rate at which it is likely to enter the environment has been estimated using a simple block model. A block model is a numerical model used to predict water quality parameters by breaking down waterbodies into discrete blocks or cells, each representing a specific location or volume. The block model established for the Project has used a sub-model for each stockpile and access portal to estimate each of the following on a daily time-step:

- The amount of nitrate and ammonia (i.e. TAN) generated from explosive use.
- The distribution of the nitrate and TAN between tunnel wastewater and stockpile storage, noting that:
 - Loads in tunnel wastewater were assumed to be discharged rapidly from site.
 - Loads in stockpiles were assumed to have nitrate and TAN removed over a longer period in response to rainfall.
- The discharge of nitrate from the spoil emplacement areas due to rainfall, with the load estimated as:
 - Controlled surface runoff for discharge from site.
 - Infiltration to groundwater through soil transmission.
- The combined surface discharge of nitrate or ammonia to the environment:
 - Comprised of loads from the tunnel wastewater and runoff from spoil emplacement areas.

Based on observations from the current Tarraleah Upgrade Works and using available literature, the following methods and assumptions were used to calculate the potential daily loads of nitrate and ammonia from the four tunnel construction site and associated spoil emplacement areas entering the environment.

7.3.2.1 Nitrate and ammonia generation

The 'generation' of nitrate and ammonia (i.e. nitrate and ammonia that is produced as waste either from failed detonation, spillage or other means) was estimated on a daily basis for the duration of the project. To do this, the following assumptions were made:

- An estimate of explosive used each day was made for each section of the Project based on:
 - predicted tunnelling progress estimates for each section of the Project
 - the current rate of explosive use for the tunnelling being undertaken for the Tarraleah Upgrade Works (85 kg per metre of tunnel).

- Using the above quantity of explosive, a conservative value of 15% nitrate and ammonia by mass remains in the undetonated explosive and is potentially available as a load (i.e. unexploded or spilt). The 15% value is a conservative over estimation of the amount undetonated. This percentage was adopted from literature values from large-scale experimental tests (Baekken 2014, Olssen et al 2019) which showed that total nitrogen (comprising nitrate and ammonia) equivalent to 8 - 10 % of the total explosive load was not detonated and recovered in leachate. Higher percentages than these, although rare, were observed in some of the trials, and as such a higher 15% value was adopted and should be considered as indicative of a worst case scenario.

7.3.2.2 Nitrate loading

Of the undetonated nitrate, it is assumed that 65% of this is lost (dissolved) immediately into the site water, either through the washing of the blast face or from the ingress of groundwater to the tunnel. The remaining 35 % of nitrate is assumed to remain in the spoil and is delivered to the spoil emplacement areas (stockpiles). The immediate loss rate has been derived on the basis that the measured nitrate load at the Tarraleah Upgrade Works is equivalent to approximately 65% of the nitrate in an assumed 15% of undetonated explosive. The justification for this is as follows and shown in Figure 7.6 which compares the modelled and measured nitrate loads for the Tarraleah intake upgrade tunnel site:

- the measured cumulative load of nitrate at the discharge from site was 600 kg over the four month period of November 2024 to March 2025. The measured load was derived based on continuous recording of nitrate concentrations at 15 minute intervals using an in-situ calibrated nitrate probe and continuous flow measurements aggregated by volume discharged over 15 minute periods.
- the modelled estimated nitrate load was around 920 kg for the same period, based on the blast records of explosive use and the assumption that 15% is undetonated explosive.
- the actual load (600 kg) was 65% of estimated nitrate load (920 kg) and is the basis of the application of this figure in the model.

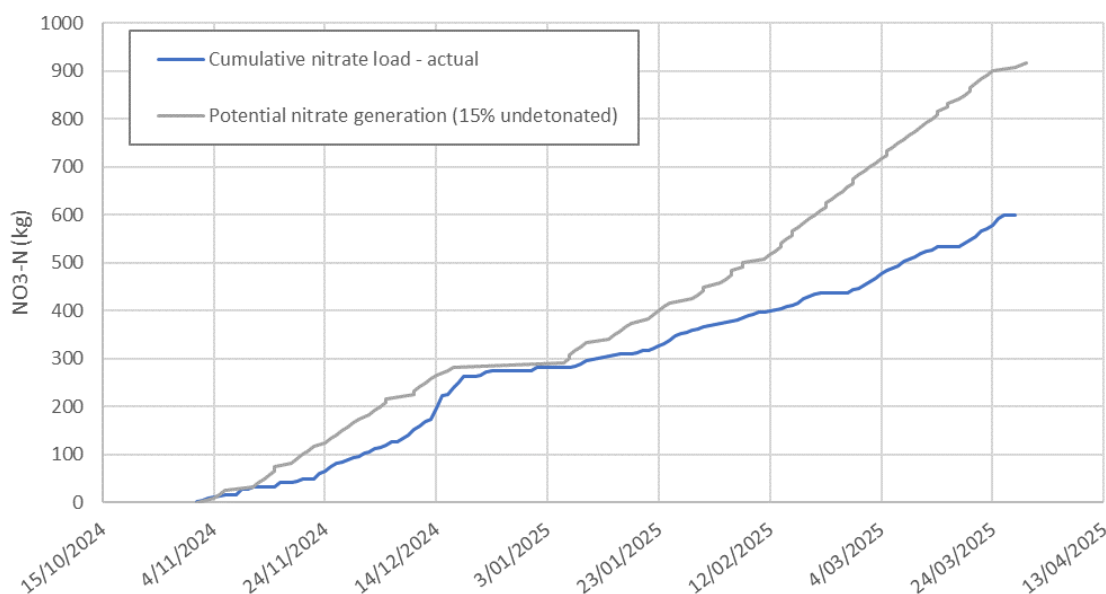


Figure 7.6: Comparison of actual nitrate load in water discharged from the Tarraleah intake tunnel excavation with the estimated quantity of nitrate generated from explosive use records assuming 15% undetonated explosive.

The delivery of nitrate onto the spoil emplacement areas was computed on a daily time step, based on the delivery of 35% of the nitrate in undetonated explosive. The rate at which this accumulated was based on the proposed rate of excavation.

The loading of nitrate from the spoil emplacement areas to surface waterways is assumed to occur in response to rainfall on site:

- Rainfall data for the period 2017-2020 was used for the block model.
- the stockpile flux rate was run at several different rates (0.04%, 0.07% and 0.1% loss of accumulated nitrate load per stockpile per mm of rain) to reflect that nitrate loading is sensitive to both rainfall and the amount of nitrate on the stockpile.

Figure 7.7 provides a comparison between actual and modelled data for nitrate loading of surface waters from spoil at the Tarraleah Upgrade Works. This comparison uses actual explosive use data and applies the parameters already derived:

- 15% undetonated explosive
- 65% nitrate directly to load in tunnel wastewater
- 35% nitrate delivered to spoil and delivered as load in response to rainfall at above flux rates. Rainfall data from Butlers Gorge (April 2017- March 2021 repeated) was applied to the stockpile load to simulate the typical precipitation.

The comparison demonstrates that daily loads estimated by the model show a reasonable correlation with actual daily load measurements. The model underestimated the daily loads at either end of the duration curve. This underestimation is likely the combined effects of the short period of data used (4 months) and events that the model is unable to capture, such as periods of greater discharge as a result of the on-site requirements. Given the short duration of data used, the comparison of daily duration curves indicates that the chosen percentages of undetonated explosive (15%), delivery to spoil (35%) and stockpile flux rates are likely to provide a good estimate of nitrate.

Though it is likely for uptake or denitrification (Hendry et al 2018) to occur within the spoil (microbial transformation of nitrate to nitrogen gases), no uptake or denitrification is assumed as part of this estimate. In addition nitrification of ammonia may also occur, resulting in greater amounts of N in the form of nitrate, but this too has not been estimated.

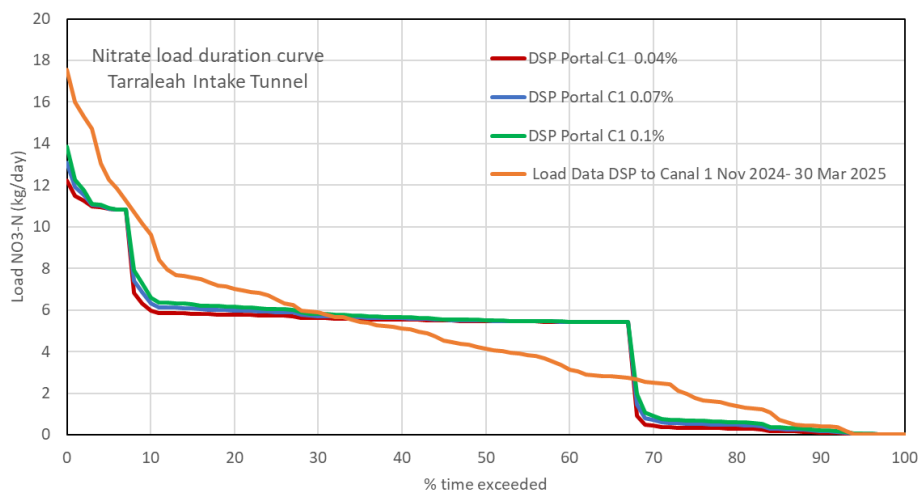


Figure 7.7: Duration curve of actual daily nitrate loads (kg/day) from the Tarraleah Upgrade Works downstream portal site to Canal No. 1 (Load Data DSP) compared to the block nitrate model for three stockpile nitrate flux rates (DSP Portal) to estimate daily loads from explosive use data.

7.3.2.3 Ammonia loading

Of the undetonated ammonia, it is assumed that 25% of this is lost (dissolved) immediately into the tunnel wastewater, either through the washing of the blast face or from the ingress of groundwater. This percentage has been determined on the basis that the observed concentration of ammonia at the Tarraleah Upgrade Works is a factor of 0.38 that of nitrate (38% - See Section 7.3.1). The remaining 75% of ammonia is assumed to remain and be delivered to the spoil emplacement areas (stockpiles) to be loaded to the environment over time in response to rainfall:

- Ammonia load from spoil during rainfall events is assumed in the model to occur at a rate of 38% of nitrate. This modelled loading is expected to be substantially higher than the actual rate at which ammonia will be released from the spoil and is considered a highly conservative over estimate. It is applied here using the empirical observations in the Tarraleah Upgrade Works discharge into the canal of tunnel ingress water. On this basis, a flux rate of 0.015%, 0.027% and 0.038% per mm of rain were assumed for the loading from spoil (i.e. 38% of the rates applied for nitrate – see Section 7.3.1).
- It is recognised that the uptake of ammonia and the microbial transformation of ammonia to nitrate through nitrification (to nitrate) is likely within the spoil emplacement area (Hendry et al 2018). However there has been no attempt to quantify this, owing to the complexity of these processes and lack of understanding of the rates at which they may occur within the spoil.

7.3.2.4 Surface and groundwater apportioning of loads from spoil

The derived rainfall-mediated loading of nitrate and ammonia from spoil emplacement areas (Section 7.3.2.2, Section 7.3.2.3) was apportioned to either surface water or groundwater. The base case groundwater recharge and runoff balances derived by PSM (2025) were utilised as the basis for the apportioning of loads. The water balance analysis considered the infiltration capacities, geological setting and water tables at these sites to determine a net groundwater recharge rate and surface runoff rate.

The vast majority of rainfall that is not lost to evapotranspiration (pink cells in Table 7.4) is calculated to be surface runoff or groundwater that surfaces as rejected recharge. Of this, rejected recharge is considered to be of small consequence during the construction of the tunnel, as the tunnel construction is estimated to lower the water table such that few groundwater inflows will not be re-entering the environment as surface flow (e.g. rejected recharge, PSM 2025). All surface runoff and rejected recharge was included as surface loading, with the small proportion of groundwater recharge determining the modelled loading to groundwater.

Table 7.4: Water balance for stockpiles as a percentage of rainfall (from PSM 2025). ETA = actual evapotranspiration.

Spoil emplacement area	Components	Proportional Water Balance (Per cent)		
		Base Case	Lower Bound	Upper Bound
Western portal	Rainfall	100		
	Actual ETA	44.4		
	Net Groundwater Recharge	1.0	0.2	4.1
	Runoff and Rejected Recharge	54.6	55.3	51.4
Mid-access	Rainfall	100		
	Actual ETA	44.4		
	Net Groundwater Recharge	2.6	1.5	4.3
	Runoff and Rejected Recharge	53.0	54.1	51.2
Paddy's Quarry	Rainfall	100		
	Actual ETA	44.4		
	Net Groundwater Recharge	6.5	3.2	12.3
	Runoff and Rejected Recharge	49.1	52.3	43.3

7.3.2.5 Assumptions and limitations

The previous sections have provided detail of the assumptions used within the model as summarised in Table 7.5. The main aim of the model is to produce an estimate of the quantum of dissolved nitrogen (ammonia and nitrate) that may enter the environment, so that an assessment of the impact of nitrate and ammonia loading can be made. While the use of available data and published values have been used to guide, the amount of explosive used and the potential amount of unexploded ammonium nitrate, there is a level of uncertainty in the model outputs. Where there is high to moderate levels of uncertainty, conservative estimates based on the literature or data from the Tarraleah Upgrade Works has been used to provide a worst case scenario of nitrate and ammonia loading of waterways during construction of the Project.

Table 7.5: Summary of assumptions included in the block model for estimating nitrate and ammonia loads

Factor	Value used	Basis of estimate	Uncertainty level/scenario	Notes
Construction				
Construction method for portals, tunnels and power station excavation	Drill and blast only	<ul style="list-style-type: none"> Modelled worst case tunnel construction scenario i.e. tunnel boring machine not used Highest use of explosives and greatest amount of new spoil predicted to occur during periods of active tunnel blasting 	Worst case scenario	Tunnel boring machine likely to be used, but will depend on final Project design and chosen construction methods of the EPC contractor
Residual explosive				
Quantity of explosive required	Rate of 85 kg per metre	<ul style="list-style-type: none"> Current rate of explosive use for the Tarraleah Upgrade Works Calculated rate for power station excavations 	Low	Greatest daily load at Paddy's Quarry (greatest use of explosive plus largest spoil emplacement area), followed by mid-access and western portal
Rate of construction progress	Construction schedule as per the Reference Design		Low	
Residual (undetonated) explosive	15% of explosive used	<ul style="list-style-type: none"> Value used by Swedish regulatory authorities (Olssen et al 2019) Published values (Baekken 2014, Olssen et al 2019) 	Moderate Indicative of worst case scenario	Undetonated values in literature usually less than 10%, with occasional higher value. The value is conservative and likely to overestimate the amount of residual explosive
Nitrate loading				
Proportion of nitrate in wastewater	65% of residual nitrate from explosive Only during construction	<ul style="list-style-type: none"> Measured nitrate load from tunnel at Tarraleah Upgrade Works is 65% of the residual nitrate load using the assumption that 15% of explosive is undetonated 	Moderate	Values are conservative as the estimate of residual explosives is conservative and the data from the Tarraleah Upgrade Works is from a limited period (4 months)
Proportion of nitrate in spoil	35% of residual nitrate from explosive	<ul style="list-style-type: none"> Remaining nitrate not lost (dissolved) immediately into the tunnel wastewater 	Moderate	

Factor	Value used	Basis of estimate	Uncertainty level/scenario	Notes
Spoil flux rates for nitrate (loss of accumulated nitrate load per stockpile per mm of rain)	0.04%, 0.07% and 0.1% per mm of rain Continues beyond construction period	<ul style="list-style-type: none"> When these values were used in a model for the Tarraleah Upgrade Works, they provided a reasonable estimate of the duration curve of actual daily loads using all of the spoil flux rates. 	Moderate	<p>Model underestimated the daily loads at either end of the duration curve compared to actual loads at Tarraleah Upgrade Works</p> <p>Model does not allow for uptake of nitrate or denitrification within the spoil</p>
Ammonia loading				
Proportion of ammonia relative to nitrate	38 % of nitrate concentration	<ul style="list-style-type: none"> Ammonia in water discharged from tanks since the start of tunnelling at Tarraleah Upgrade Works has a median concentration that was 38 % of the nitrate concentration 	Moderate	<p>Values are conservative as:</p> <ul style="list-style-type: none"> Estimate of residual explosives is conservative Data from the Tarraleah Upgrade Works is from a limited period Model does not allow for attenuation via uptake of ammonia or the microbial transformation of ammonia to nitrate through nitrification within the spoil. Observations suggest the load estimates of ammonia are overestimates.
Proportion of ammonia in wastewater from tunnel	25% of residual ammonia from explosive Only during construction	<ul style="list-style-type: none"> 38 % of the proportion of nitrate in tunnel wastewater 	Moderate	
Proportion of ammonia in spoil	75% of residual ammonia from explosive	<ul style="list-style-type: none"> Remaining ammonia not lost (dissolved) immediately into the tunnel wastewater 	Moderate	
Spoil flux rates for ammonia (loss of accumulated ammonia load per stockpile per mm of rain)	0.015%, 0.027% and 0.038% per mm of rain Continues beyond construction period	<ul style="list-style-type: none"> 38 % of the proportion of the spoil flux rates for nitrate 	High	
Surface and groundwater apportioning				
Western portal	Groundwater recharge – 1 % of rainfall Surface runoff – 54.6 % of rainfall	<ul style="list-style-type: none"> Base case groundwater recharge and runoff balances derived by PSM (2025) 44 % of rainfall lost to evapotranspiration Tunnel construction will lower the groundwater table such that there will be limited/no rejected recharge of groundwater. All surface runoff and rejected recharge from spoil emplacement areas is considered surface runoff 	Moderate	
Mid-access	Groundwater recharge – 2.6 % of rainfall Surface runoff – 53.0 % of rainfall		Moderate	
Paddy's Quarry	Groundwater recharge – 6.5 % of rainfall Surface runoff – 49.1 % of rainfall		Moderate	

7.3.3 Surface water loading analysis

7.3.3.1 Daily loading

Nitrate

The daily loading of nitrate to surface waters is comprised of (see Section 7.3.2.2):

- an immediate base loading of 65 % of material generated (from 15 % of explosive used) each day
- the amount leached from the spoil emplacement area in response to rainfall (spoil flux rates of 0.04%, 0.07% and 0.1% per mm of rain).

The modelling results for daily loading of nitrate for each site are shown in Figure 7.8 for a period of 10 years following the commencement of construction. These indicate:

- a constant daily discharge of water from the tunnel that persists for the proposed period of blasting,
- an additional variable component that represents the response to rainfall and continues after the completion of blasting, with smaller daily loads being seen as the amount remaining in the spoil is depleted.

The highest daily loads are predicted to occur during periods of active tunnel blasting, coincident with high rainfall and spoil emplacement areas with substantial stores of nitrate in them (i.e. greatest amount of new spoil). The greatest daily loads are predicted at Paddy's Quarry (including surge tunnel access) which has the greatest use of explosives. This site also has the largest spoil emplacement area, which includes the spoil from the power station and power tunnel excavations. The mid-access site has the next largest daily loads followed by the western portal due to the relative proportion of explosive to be used and the size of the spoil emplacement area. The power station site will not have a spoil emplacement area associated with it and as such nitrate discharge has been modelled to consist of only the discharge of dissolved nitrate from the tunnel water whilst blasting is undertaken.

The duration analysis for the combined load from the four sites site is presented in Figure 7.9, with results presented separately for each of the nitrate spoil flux rates. Only the first 8 years are presented, as following years are at similar low levels to Year 8. The greatest daily loads of nitrate are likely to be seen in Year 2 to Year 4 of construction. Maximum daily nitrate loads from the Project during these three years are predicted to be between 50 and 70 kg/day. The median daily loads in Year 2 to Year 4 are estimated to be between 12 and 20 kg/day. The following years have progressively lower estimated peak and median daily loads, as blasting ceases and nitrate from the spoil emplacement areas is leached. By Year 7 and Year 8 since the start of construction, the loads are predicted to be low, with maximum daily loads of 1-2 kg/day and median daily loads of 2 – 8 mg/s (0.2 - 0.7 kg/day).

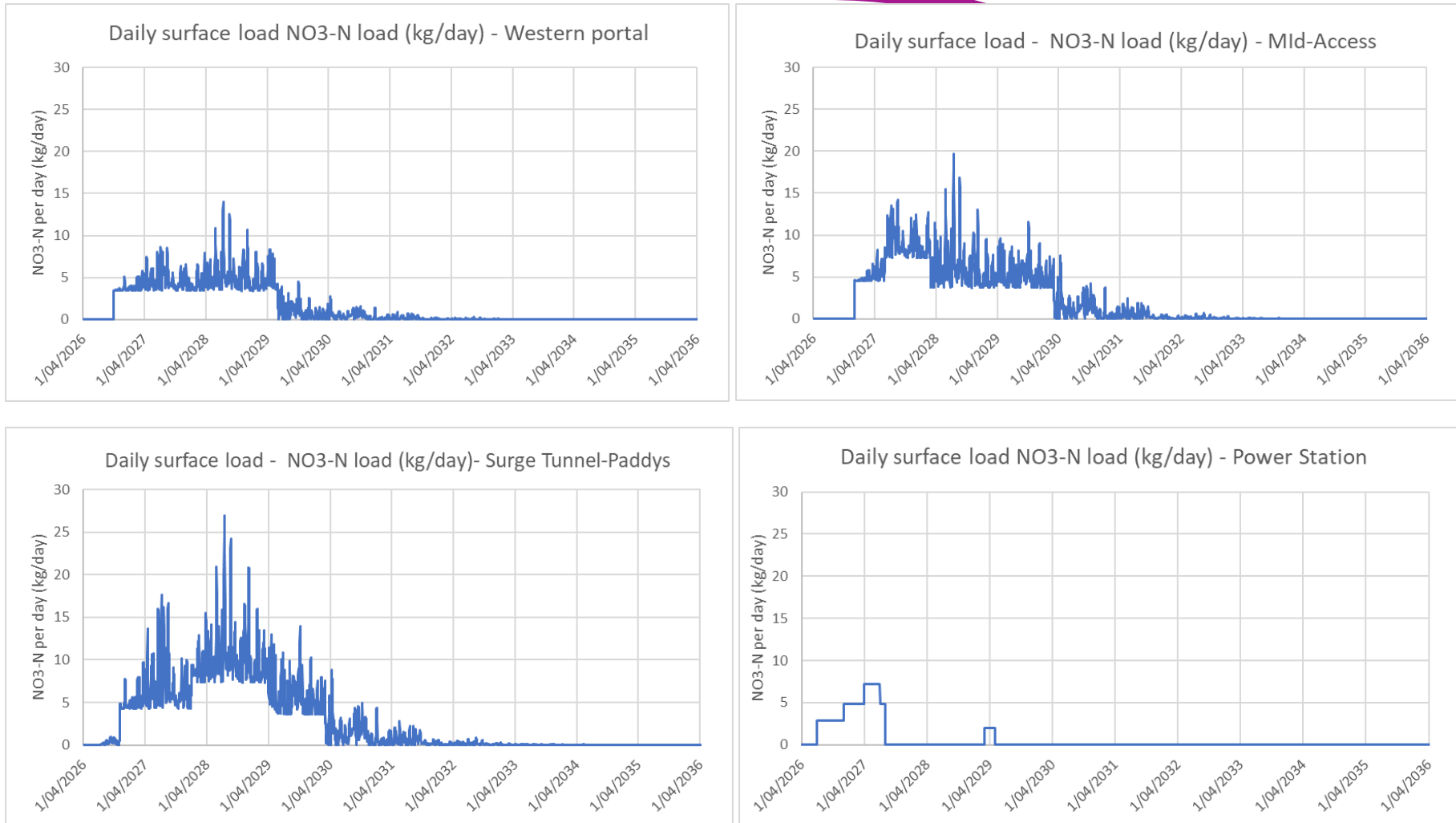


Figure 7.8: Time-series of daily predicted nitrate loads in kg/day generated by each of the Project sites (0.07 % per mm spoil flux rate) for a 10 year period from Project commencement, assuming a nominal start date in April 2026

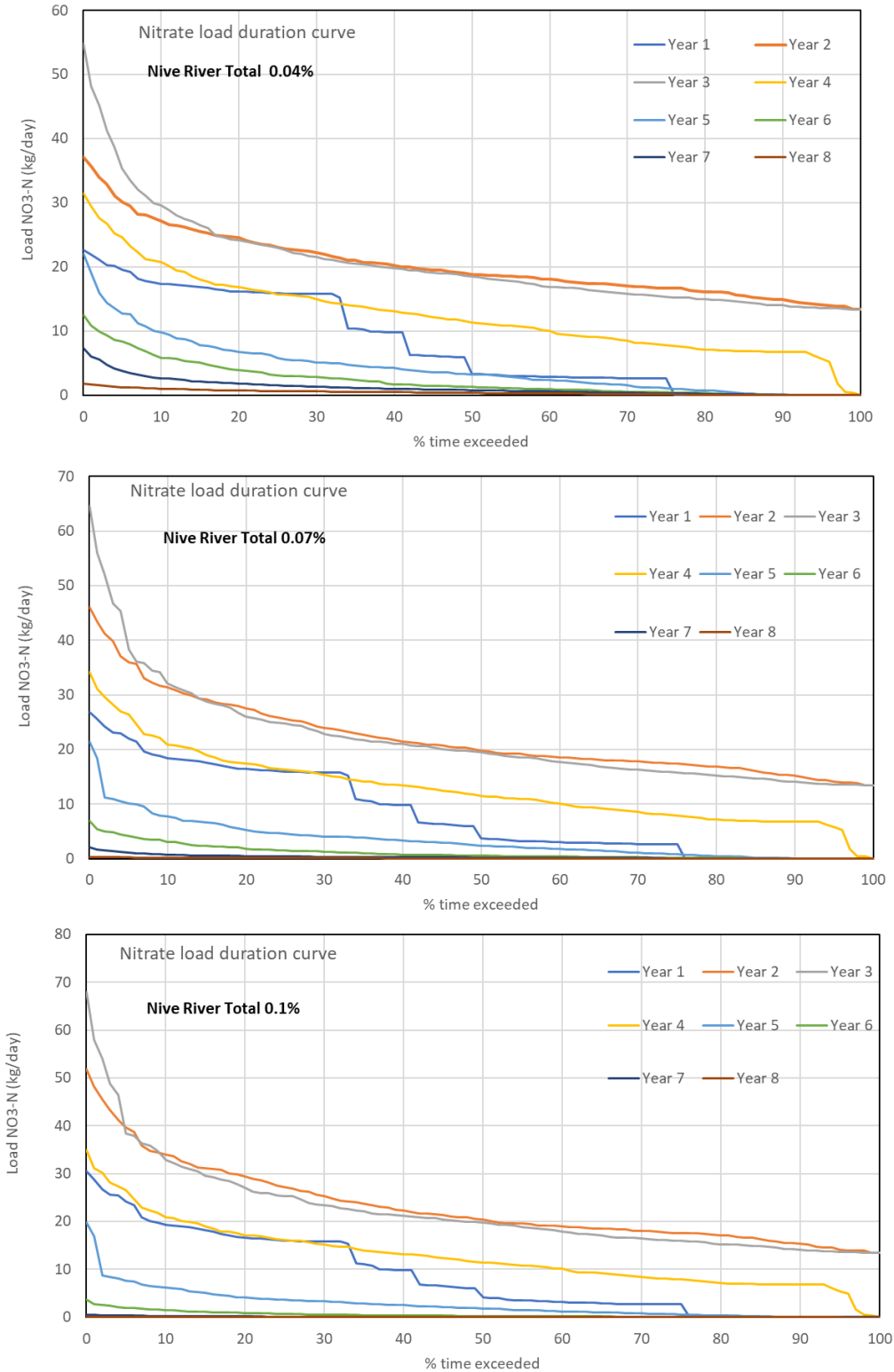


Figure 7.9: Duration curve of predicted combined nitrate-N daily surface loads from all sites, which represent the potential daily total that may be discharged to the Nive River for each of the first eight years following Project commencement, using each of the three spoil flux rates for nitrate.

Total ammoniacal nitrogen (TAN)

Total ammoniacal nitrogen (TAN) is the sum of nitrogen contained in unionised ammonia (NH_3) and ionised form ammonium (NH_4^+). The daily loading of TAN is modelled to comprise of (as per Section 7.3.2.3):

- an immediate base loading of 25 % of material generated (15 % of explosive used) each day whilst blasting is taking place
- the amount leached from the spoil emplacement area in response to rainfall (spoil flux rates of 0.015%, 0.027% and 0.038% per mm of rain).

The modelling results for daily loading of ammonia for each site are shown in Figure 7.10. As with nitrate, these indicate the modelling conditions of:

- a constant daily discharge of water from the tunnel that is seen during the proposed period of blasting. The load for TAN in this tunnel water fraction is lower than nitrate due to the lower base loading rate.
- an additional variable component that represents the response to the rainfall and continues after the completion of blasting, with smaller daily loads being seen over time as the amount remaining in the spoil declines.
- variability between the sites on the basis of the amount of material in the stockpile and the period of explosive use.

The duration analysis of the daily load time series applying each of the spoil flux rates is presented in Figure 7.11. These show that as the project progresses the load of TAN concentrations increase from Year 1 to Year 3, when the highest daily loads of TAN are modelled to be seen. Maximum daily loads during Year 3 are predicted to be between 50 and 90 kg/day, though the median loads are substantially lower at between 10 and 15 kg/day. From Year 4 onwards, the daily loads decline as the use of explosive ends and TAN from the spoil emplacement areas is leached. The rate at which loads decline is lower than for nitrate as a result of the modelled conditions of greater stockpile loads and a lower flux rate. By Year 7 and Year 8 post construction start, the daily loads are predicted to be substantially lower, with maximum daily loads of 3-12 kg/day and median daily loads of 1-2 kg/day. The absence of ammonia uptake and nitrification in the model means that these values are likely to be over-estimates.

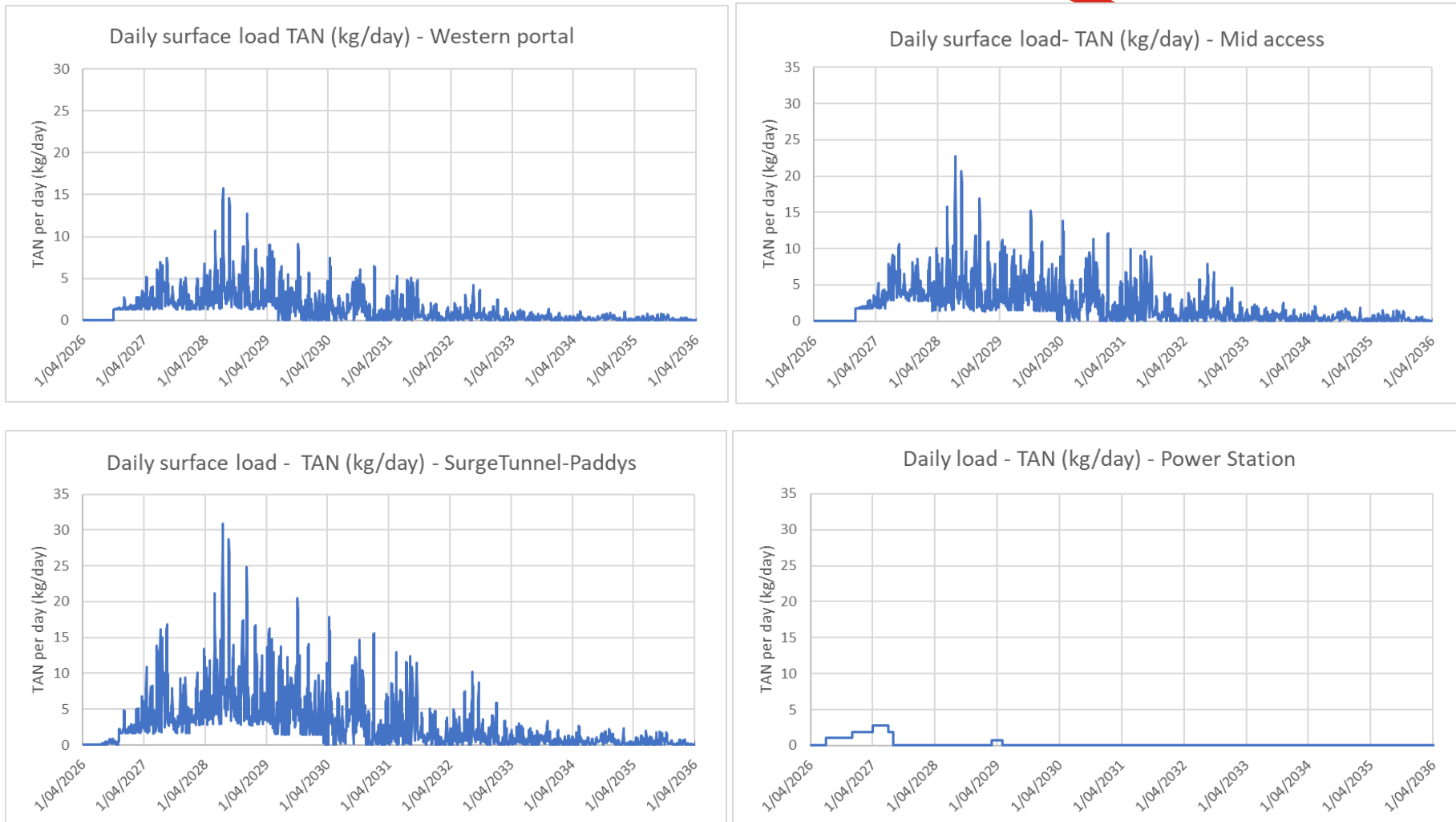


Figure 7.10: Time-series of daily predicted ammonia loads in kg/day generated by each of the Project sites (0.027 % per mm flux rate) for a 10 year period after Project commencement, assuming a nominal start date in April 2026

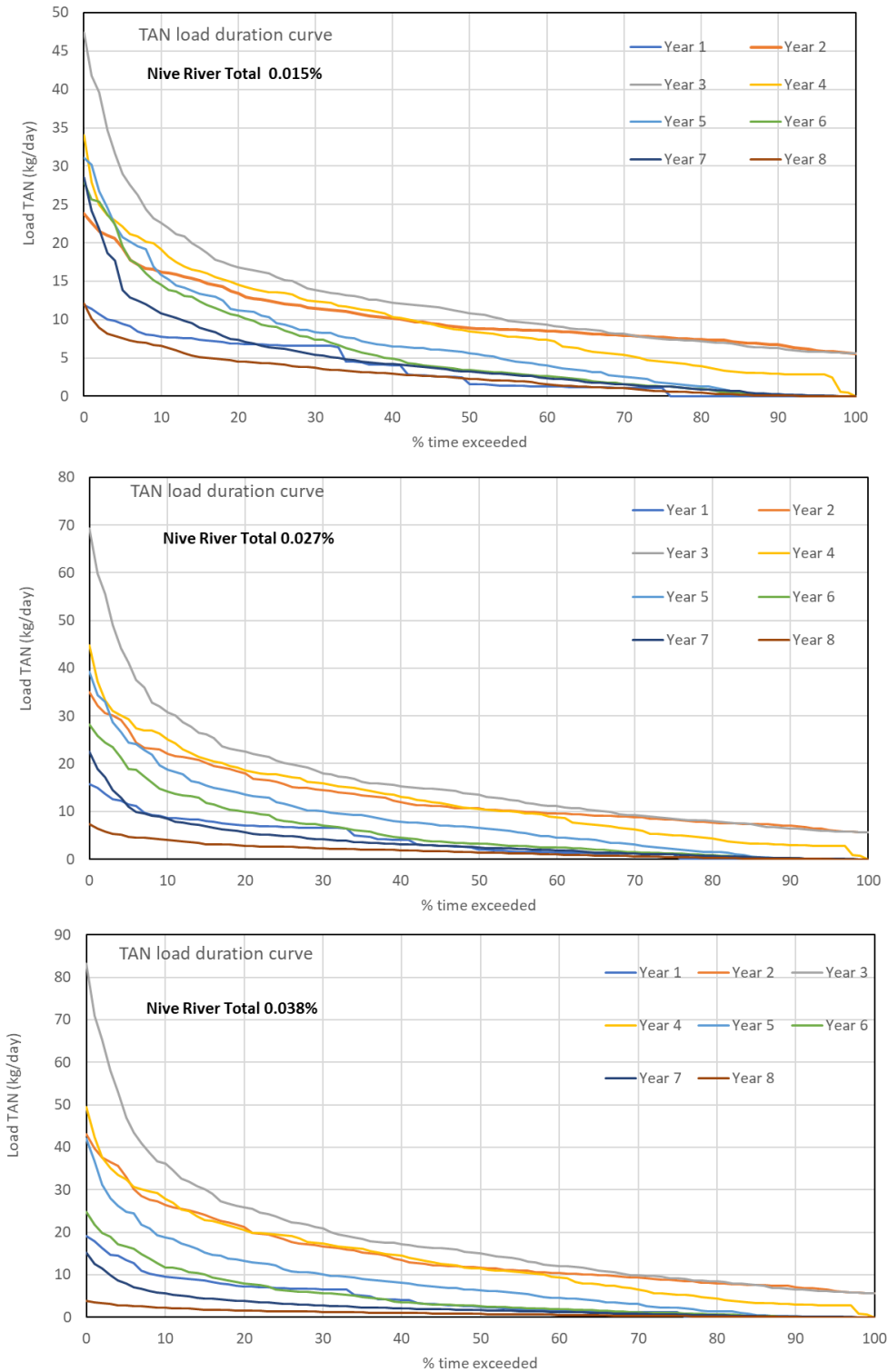


Figure 7.11: Duration curve of predicted ammonia daily loads that may be discharged to the Nive River for each of the first eight years following Project commencement, using each of the three spoil flux rates for ammonia.

7.3.3.2 Annual loading

The annual loading of nitrogen (either as nitrate or TAN) to the surface waters has been estimated on the basis of the loading quantities from each of the sites via the current conveyances (No. 1 and No. 2 Canals) to the Nive River within the Derwent catchment (Figure 7.12, Figure 7.13, Table 7.6). The annual loading trends are reflective of the trends in the daily loads (Section 7.3.3.1). Loading rates are shown up until Year 11, in order to represent the bulk of nitrogen leaving site in the years following completion.

The greatest nitrate loading of waterways in the Derwent catchment due to the Project occurs in Years 2 and 3, with loads of 7,000 to 8,000 kg predicted in both years, followed by Year 4 (approximately 4,500 kg - half the load of Years 2 and 3) and Year 1 (approximately 3,000kg – approximately one third of Years 2 and 3). Nitrate loads decrease quickly each year after Year 3, with only low residual levels post construction (Years 8 to 11). The rate at which loads decline to very low levels is dependent on the spoil flux rate, with a lower flux rate prolonging the loading. As the majority of nitrate (65 %) is assumed to rapidly leave the site in wastewater, the flux rate has only a minor influence as it acts on a relatively small pool of nitrate within the spoil emplacement area.

The loading of TAN to surface waters shows a slightly different pattern to nitrate with high loading in Years 2 to 4, followed by a more gradual decline in loading over the subsequent years, driven by the greater load from spoil emplacement areas and the lower spoil flux rate. The greatest estimated annual load of TAN is in Year 3: approximately 5,000 to 7,000 kg per annum. Given the modelling assumption of an ammonium load from spoil at 38% the rate of nitrate in combination with the higher spoil load and no estimates of denitrification or nitrification, the model estimates that TAN will remain in the spoil for longer and continue to discharge at low levels. By Year 8, the annual loads are estimated to be less than 1000 kg per annum for all flux rate scenarios.

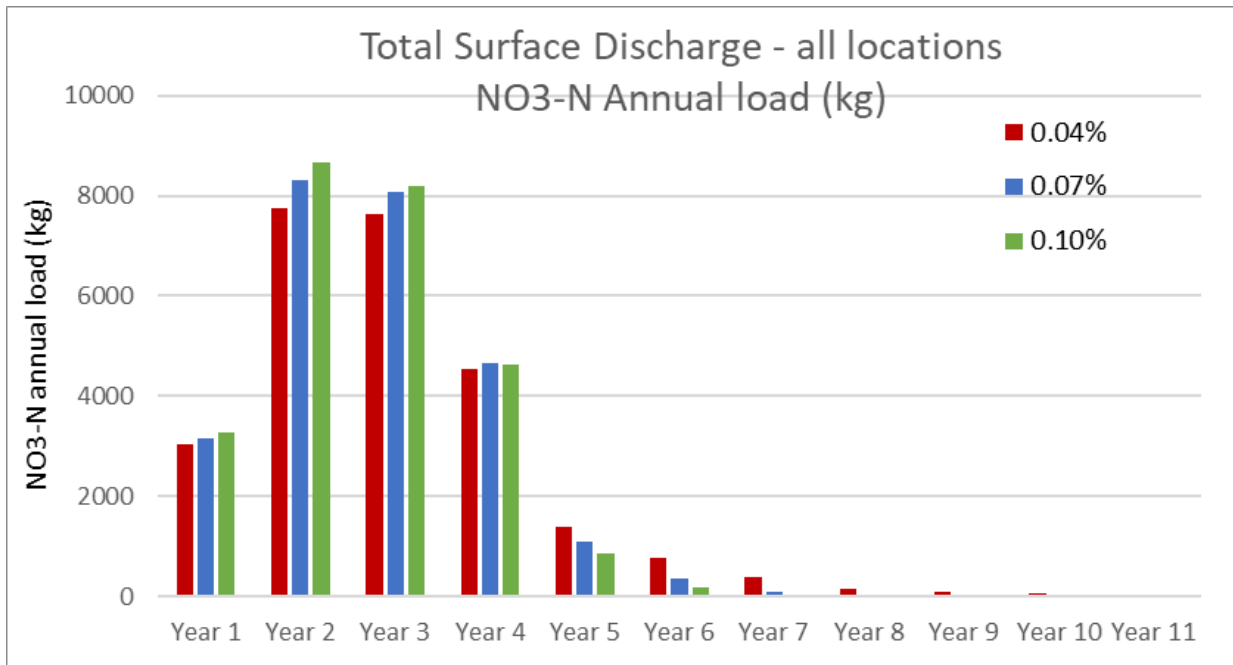


Figure 7.12: Annual nitrate surface loads of at different stockpile flux rates

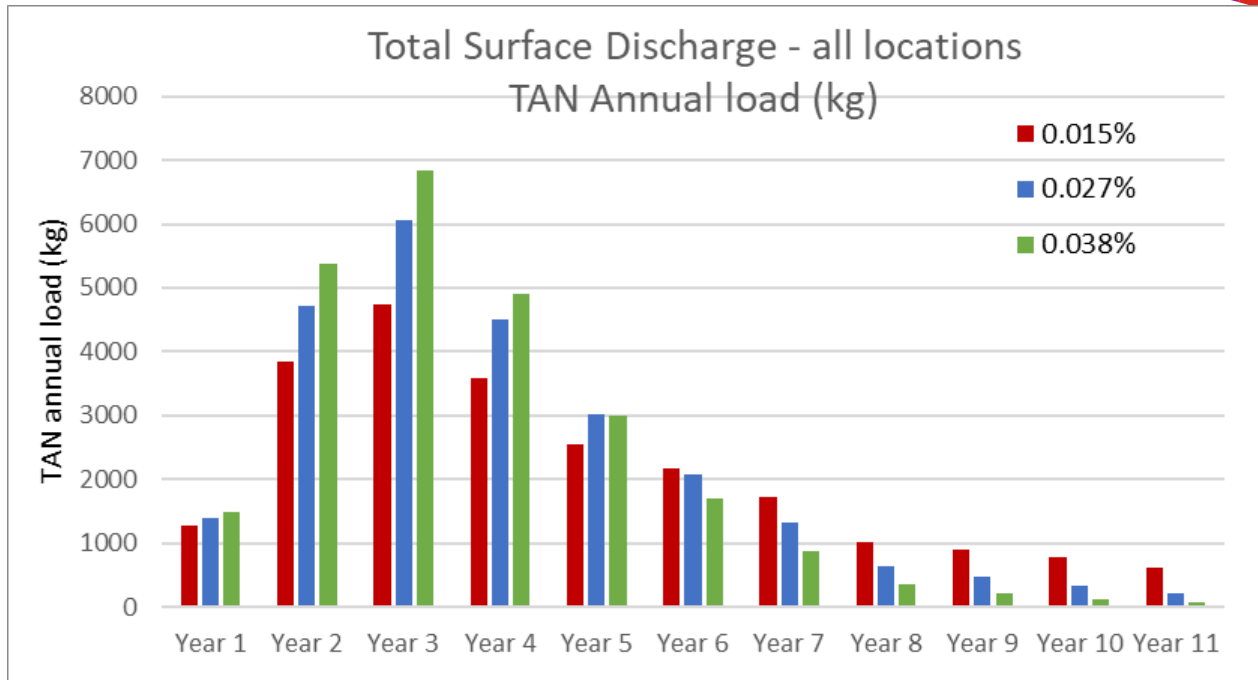


Figure 7.13: Annual estimated ammonia surface loads of at different stockpile flux rates

Cumulative impact

Table 7.6 compares the annual load estimates for nitrogen in the form of nitrate and ammonia from the Project with existing Derwent total nitrogen load estimates provided by Proemse et al (2022), as measured at Bryn Estyn. The estimated nitrogen load at Bryn Estyn is 881,000 kg. The maximum modelled combined loads of nitrate and ammonium from the Project, which occur in Years 2 and 3, are approximately 13,000-14,000 kg/annum or an additional 1.48 to 1.55 % of the total nitrogen catchment load. The transitory use of explosives by the Project ensures that loading at this rate will be limited to approximately two years, with subsequent years estimated to reduce to loads equivalent to around 1 % of the catchment total nitrogen (Year 4) and less than 0.5 % (Year 5), and halving every subsequent year

It is recognised that the nitrate load from the Project will enter the catchment in a short reach unlike the total catchment loads which include diffuse as well as point sources. However, the Project load will enter the Nive River and downstream River Derwent in areas in which there are very high flow rates, ensuring thorough and rapid mixing. On the basis of dilution calculation (Section 7.3.6), the assimilation zone where substantial dilution will have occurred is estimated at Liapootah Pond outlet.

Table 7.6: Model estimated annual loads of nitrate and ammonia to surface water using the mid-range flux rates for spoil loads

Year	Nitrate-N load Spoil flux rate 0.07 %/mm (NO ₃ -N kg/annum)	TAN load Spoil flux rate 0.027 %/mm (TAN-N kg/annum)	Total nitrogen load (TN kg/annum)	% of total N catchment load Derwent TN load at Bryn Estn (Proemse et al 2022)
Yr 1	3,161	1,386	4,574	0.66 %
Yr 2	8,310	4,710	13,020	1.48 %
Yr 3	8,075	6,048	14,123	1.55 %
Yr 4	4,648	4,498	9,146	1.04 %
Yr 5	1,098	3,015	4,201	0.48 %
Yr 6	358	2,074	2,492	0.28 %
Yr 7	101	1,317	1,734	0.20 %
Yr 8	22	629	791	0.09 %
Yr 9	8	461	560	0.06 %
Yr 10	3	330	389	0.04 %
Yr 11	1	213	207	0.03 %
Yr 1-11 TOTAL	25,785	24,681	50,466	-

In their study, Proemse et al (2022) also quantified the loads from a combination of diffuse and point sources, finding that major contributions come from diffuse inputs from forestry and agricultural industries as well as wilderness areas and national parks. The high diffuse contributions from forestry and agriculture are driven in large part by the application of fertilisers. The largest point sources to the Derwent catchment are five fish hatcheries.

Combining the project estimated maximum annual loads (Year 3) with the data presented by Proemse et al (2022) provides a comparison of the relative contribution of the project to other catchment nitrogen loads (Figure 7.14). In its approximately two year/s of greatest loading, the project is estimated to provide a 1.6% point source contribution to the total nitrogen in the Derwent catchment. This is small relative to the ongoing diffuse loads from land use activities of agriculture (17.6%) and forestry (38.9%), as well as loads from wilderness and national parks (34%). The largest nitrogen point source from fish hatcheries is 7.1 % of the catchment total.

In relation to the potential impact of the loading on downstream water quality, an example of a similar loading quantity is seen from water from the River Derwent (from upstream diffuse and point sources) into Wayatinah Lagoon. Water quality sampling within Wayatinah Lagoon has detected the signal from the inputs from the River Derwent where it enters Wayatinah Lagoon (at site 190.3); elevated nutrient (nitrate, TAN, dissolved phosphorus) and chlorophyll *a* concentrations (see Section 5.6). Other sites within Wayatinah Lagoon (sites 190.4 and 190.7) show substantially lower concentration of nutrients and chlorophyll *a*, at concentrations similar to those upstream in the Nive River (See Section 5.6). This suggests the impact from the upstream River Derwent is largely localised with generally undetectable impacts at other sites within Wayatinah Lagoon.

With respect to the potential loads discharged to the Nive River from the Project, these will be occurring at a relatively constant rate throughout the periods of blasting, and will be at their highest following

high rainfall when catchment inflows are also high in winter and spring when dilution is likely to be greatest. The high dilution and low water temperature at this time of year mean that, the susceptibility of the river to impacts are at their lowest.

The catchment as a whole, has a number of nutrient inputs that come from a large and complex array of diffuse sources and a number of large point sources. Due to the size and complexity of nutrient inputs to the catchment as a whole, it is difficult to quantify the potential impact of the loads from this Project on the downstream catchment. Proemse et al (2022) indicate that the River Derwent is potentially under stress from increased nutrient loads and that issues such as benthic cyanobacteria in the lower Derwent, which have been responsible for taste and odour issues in drinking water sourced at Bryn Estyn, are a symptom of high nutrient loads. The loads from the Project are estimated to be material for a period of 2 to 3 years, declining substantially in subsequent years, and during this time will add to the load of the Derwent catchment. The combination of high dilution in the immediate vicinity of the discharge (see Section 7.3.6.2) and the transitory nature of loading will see the impact minimised, with a short period of potential impact from a relatively small increase in total nitrogen to the catchment.

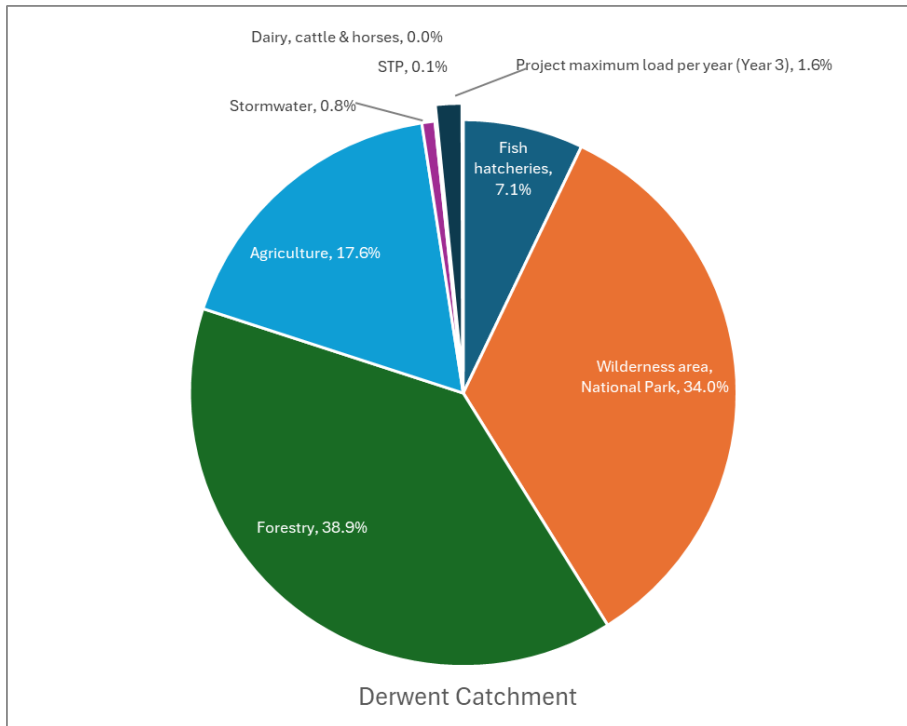


Figure 7.14: Total nitrogen contributions from individual industries and natural environments for the entire River Derwent catchment (from Proemse et al 2022).

7.3.4 Groundwater loading analysis

A nutrient loading analysis used the recharge boundary conditions of the 3D FEFLOW groundwater flow model (PSM 2025) to inform the hydrogeologic water balance analysis of the stockpile locations (PSM 2025) for each site over the course of the Project.

For each spoil emplacement area, there is the potential for groundwater recharge, mobilising dissolved nitrate and ammonia from spoil to groundwater. The total nitrate and ammonia loadings estimated to

recharge to groundwater were estimated to be affected by a combination of the amount of material (nitrate-N or TAN) in the spoil and the groundwater recharge rate for each spoil emplacement area.

The loadings of nitrate and ammonia to groundwaters is comprised of the amount mobilised from the spoil emplacement area in response to rainfall (see Sections 7.3.2.2 and 7.3.2.3), and apportioned this to groundwater according to the estimated groundwater recharge rates (see Section 7.3.2.4).

The site with the highest potential nitrate and ammonia loading impacts to groundwater is Paddy's Quarry (Table 7.7, Figure 7.15). Paddy's Quarry is expected to have the highest potential to discharge nitrate and ammonia to groundwater because it has both:

- The greatest quantity of spoil,
- The highest estimated groundwater recharge rate (PSM 2025, Table 7.4).

Using the mid-range base case for groundwater recharge (PSM 2025, Table 7.4), it is estimated that a total of 539 kg and 1,136 kg of nitrate and TAN respectively will leach to groundwater at Paddy's Quarry (Table 7.7) over an 11-year period. Around 80% of this amount is likely to leach to groundwater in the first 4 years, with the remaining 20% leaching in decreasing quantities each year. There is a small component of the nitrate and TAN load from the Paddys Quarry site. The majority of the load (96% of nitrate and 89% of TAN) is estimated to be discharged to surface waters. The mid-access site has approximately half the Paddy's Quarry groundwater load of nitrate and ammonia, while the western portal has less than one-tenth of the Paddy's Quarry load (Table 7.7).

The analysis indicates that all sites have approximately twice the amount of TAN than nitrate-N going to groundwater. This is related to the model estimate that approximately twice the amount of ammonia will end up in the spoil emplacement areas, where it may be leached from spoil at the applied flux rates. The application of the lower flux rate, due to the known slower movement of ammonia, results in the model estimate of a longer period of discharge of ammonia to groundwater (Figure 7.15). The potential for nitrate uptake, denitrification and nitrification has not been taken into account in the model. There is potential for all of these processes to occur, which in aggregate will reduce the loads to groundwater, meaning the model is a likely overestimate of loading.

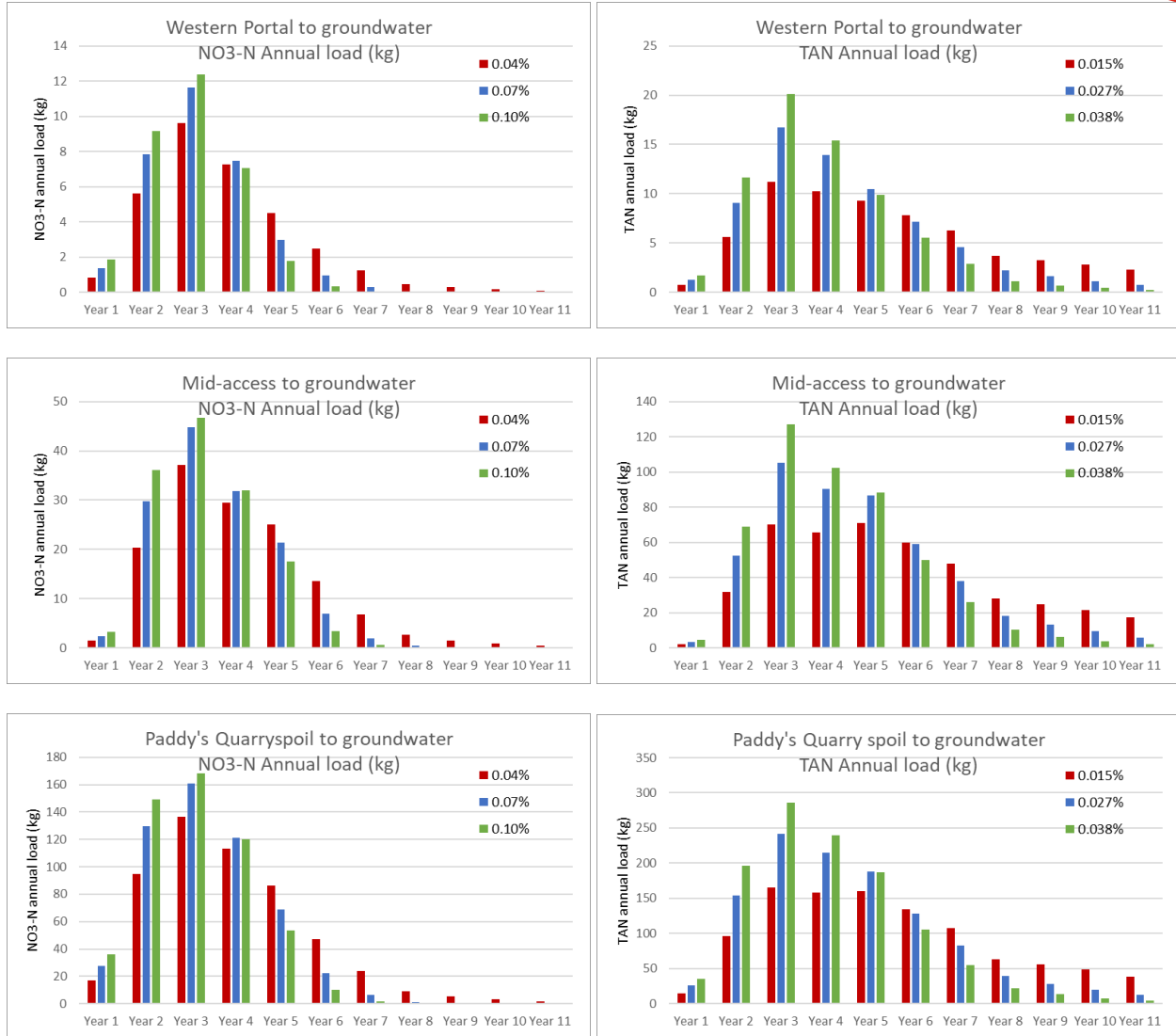


Figure 7.15: Estimated annual loads of nitrate and ammonia to groundwater from each stockpile location, using base case spoil emplacement water balance estimates and showing different flux rates.

Table 7.7: Estimated total nitrate-N and TAN leaching to groundwater from spoil emplacement areas over an 11 year period after the commencement of the Project. Estimates are made using the Base Case spoil emplacement water balance estimates of groundwater recharge, with the potential range using lower and upper recharge rate estimates in parentheses.

Site	Nitrate (kg)	TAN (kg)	Total dissolved N (kg)
Western portal	33 (7-134)	70 (14-283)	103 (21-417)
Mid-access	140 (80-229)	294 (169- 481)	434 (249-710)
Paddy's Quarry	539 (261- 988)	1,136 (549 – 2,084)	1,675 (810-3,072)

7.3.4.1 Groundwater-surface water nitrate and ammonia interactions

The three locations where there is potential for impact on groundwater due to spoil emplacement areas show differing potentials for loading of nitrate and ammonia to groundwater. For all sites, the expected changes in groundwater level as a result of the tunnel construction are likely to influence the expression of nitrate and ammonium in groundwater. The modelled behaviour of the groundwater is described in PSM (2025). The groundwater level is expected to drop in the vicinity of the spoil emplacement areas during construction, due to the groundwater inflows to the tunnel. Subsequently, at the end of construction, the pressurisation of the tunnel is expected to raise the water table.

Under a lowered water table, the nitrate and ammonia delivered to the groundwater is expected to enter flow fields towards the tunnels. It is expected that there will be an increase in concentrations of nitrate and ammonia in groundwater in close proximity to the spoil emplacement areas. Denitrification within groundwater may occur which results in the removal of nitrate from groundwater. Conditions amenable to denitrification include low dissolved oxygen and/or high dissolved organic carbon. Low dissolved oxygen is seen in many of the groundwater wells (PSM 2025). High levels of denitrification have been observed in shallow groundwater in studies in agricultural catchments in New Zealand (Collins et al 2016, Rivas et al 2017) which indicate the substantial potential for nitrate reduction in groundwaters, particularly those low in dissolved oxygen.

As the water table recovers post construction and the tunnels are pressurised, it is expected that there will be surface expression of groundwater containing nitrate and ammonia via springs and seeps. Empirical evidence from the Tarraleah Upgrade Works spoil emplacement area located in close proximity to a shallow groundwater table, a button grass plain and a receiving stream (Stream 1) has shown:

- High concentrations in some groundwater bores located immediately adjacent to the spoil emplacement area, but no increase in groundwater bores 100 m from the spoil emplacement area.
- A modest increase in the concentration of nitrate and ammonia in Stream 1
- No measurable increase in concentrations in the River Derwent.
- The potential factors contributing to the low concentrations of nitrate and ammonia in the Stream 1 and groundwater have been identified by Koehnken (2025) and include:
 - Dilution by surface water and recharge fluxes.
 - Transport in surface waters before infiltration.
 - Local plume development in groundwater beneath the spoil emplacement area and immediate surrounds.
 - Dilution within the groundwater and surface water on the button grass plain.
 - Likely uptake of nitrogen within the buttongrass community. Conservative estimates of the potential uptake come from uptake rates from a recent global analysis of nitrogen in grasslands and tussock communities (Liu et al 2024) combined with conservative root mat estimates (Ma et al 2025). In the buttongrass in the vicinity of the spoil emplacement area, conservative uptake estimates of 14.4 kg to 57 kg of nitrate-N per day indicate the significant potential of the buttongrass vegetation to remove dissolved nitrogen.
 - The potential denitrification within the groundwater of the buttongrass plain, driven by low dissolved oxygen or in waters with higher oxygen in the presence of suitable electron donors (including dissolved organic carbon, iron, manganese).

Similar factors are likely to reduce the impact of groundwater on surface waters at the three spoil emplacement areas associated with the Project. The following are likely to apply to the three Project spoil emplacement areas:

- Denitrification within the vadose zone and groundwater environment.
- Restoration of the water table and recharge fluxes will provide dilution of the concentrations within the groundwater, seeps and springs, as the water table rises and during slow velocity transport down-gradient.
- Uptake of nitrogen by terrestrial vegetation communities.

7.3.5 Project work sites and local waterways

For the purposes of assessing Project impacts on local waterways (including the Nive River and River Derwent) the impact potential of nitrate has been compared with the SMD 95th percentile DGV value of 0.073 mg/L. This has been chosen as variations in flow and discharge may result in higher concentrations than the 80th percentile DGV value of 0.02 mg/L and toxicological impacts to aquatic biota tend to occur above this level. A maximum level of 2 mg/L is reported to protect the most sensitive freshwater species (Camargo et al 2005). The level of risk above this level is dependent on the length of exposure and the tolerance of the species before chronic toxicity occurs. An assessment of nitrates on aquatic values of the catchment has been undertaken in Entura (2025).

7.3.5.1 Stream 4 (western portal)

Unmitigated discharge of surface wastewater from tunnelling at the western portal and runoff from the spoil emplacement area is modelled to result in nitrate concentrations in Stream 4 of up to 52 mg/L, with a median value of 0.01 mg/L (equivalent to current background levels). Nitrate concentrations are modelled to be above the Upper Derwent SMD DGV 95th percentile value of 0.073 mg/L for approximate 39 % of the time. Nitrate concentrations are predicted to be highest in Years 2 and 3 and lowest in Year 1 and Years 6-8 (Figure 7.16).

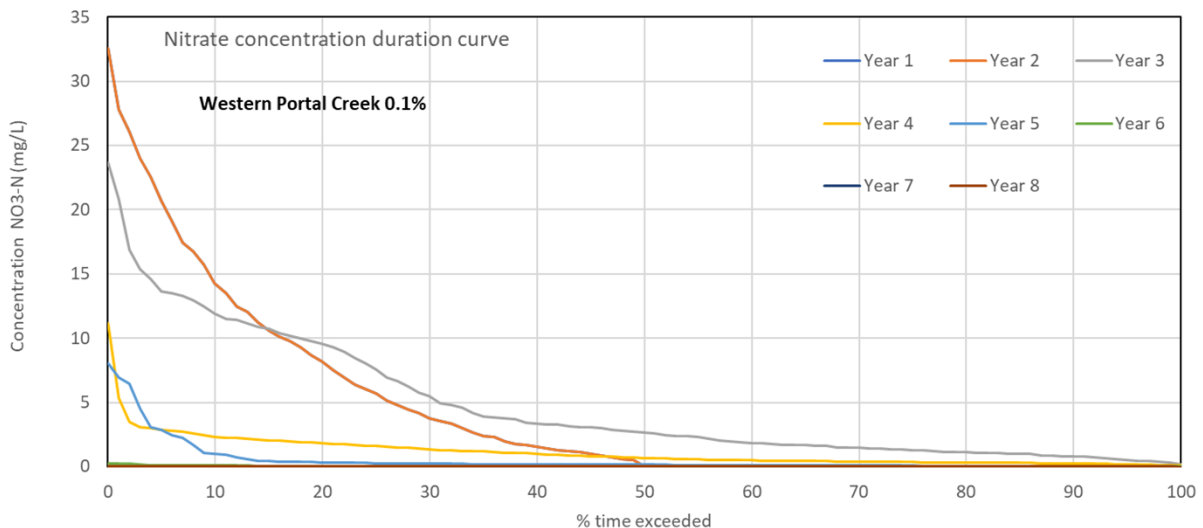


Figure 7.16: Concentration duration curve for unmitigated (direct to creek) nitrate in Stream 4 (western portal)

7.3.5.2 Stream 5 (Paddy’s Quarry)

Modelling of nitrate concentrations within Stream 5 associated with Paddy’s Quarry spoil emplacement area unmitigated (Figure 7.17) shows a similar result to that described for Stream 4, with the maximum concentration of 54 mg/L, and the percent of time exceeding the 95 percentile DGV being 41%.

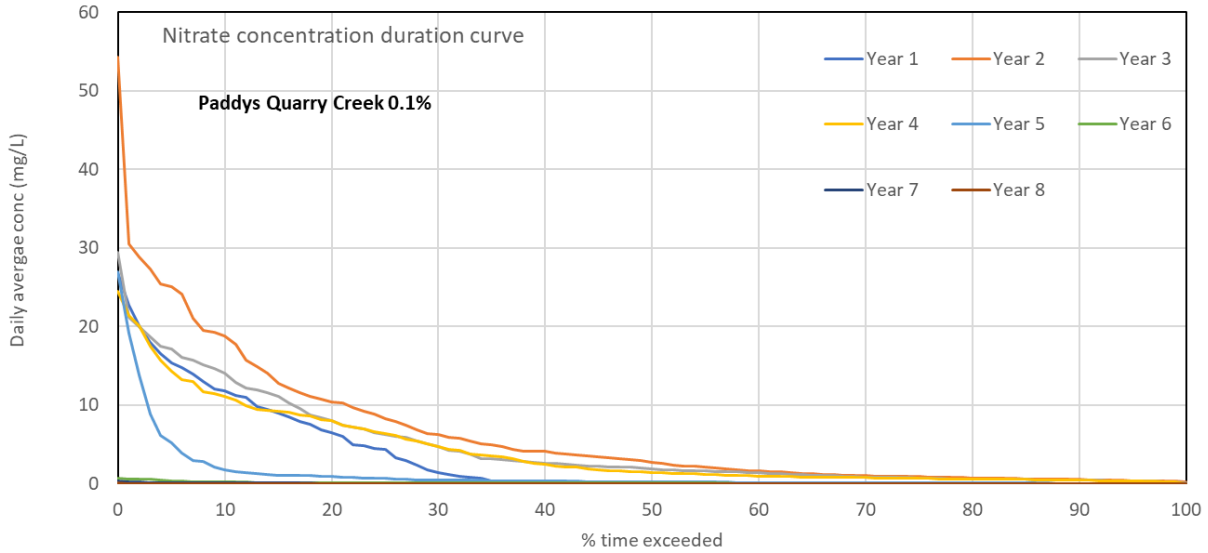


Figure 7.17: Concentration duration curve for nitrate in Stream 5 (Paddy’s Quarry) unmitigated (direct to creek)

7.3.5.3 Local waterways mitigations

To mitigate the impact of high nitrate concentrations, a Nitrate Management Plan (Section 8.3) will be developed and implemented for the Project that will include:

- Blasting procedures to minimise the generation of nitrates
- Collection and temporary storage of wastewater prior to rapid treatment and discharge to ensure adequate storage and to limit groundwater interactions (where storages are ponds)
- Utilising existing conveyances (e.g. No. 1 Conveyance, No. 2 Conveyance and storages) and/or the Nive River as discharge locations to allow dilution of nitrate concentration to near background concentrations in the Nive River.

Further detail on the planned management measures including proposed monitoring can be found in Section 8. These management measures and monitoring programs will be applied to all work sites that may be impacted by ammonium nitrate.

For Stream 4 and Stream 5, this plan will mean that site water from the western portal and Paddy’s Quarry worksites and spoil emplacement areas will be discharged into No. 1 and/or No. 2 Canal(s) unless there are insufficient flows for the dilution (e.g. when cleaning or maintenance of the canals and/or power stations is being undertaken and there is insufficient flows). In such cases, the water will be stored temporarily on-site until there is sufficient flow in the Nive River to dilute the nitrate concentrations to within 0.07 mg/L of background concentration (measured at a location on the Nive River upstream of the Tungatinah Power Station).

7.3.6 Nive River - Loads, flow and dilution

In the absence of treatment options for nitrate and ammonia, the discharge of wastewater to local streams at the western portal and Paddy's Quarry is likely to have elevated concentrations of nitrate and ammonia, with the potential to impact aquatic biota.

The option exists for discharge from these sites, in addition to the mid-access site, to be directed to the No. 1 and No. 2 Canals and associated storages (No. 1 and No. 2 Ponds, Mossy Marsh Pond). The canals and storages transport high volumes of water to the existing Tarraleah Power Station, which then discharges directly into the Nive River approximated 50 m upstream of Lake Liapootah.

The Nive River below Tarraleah consist of three major flow components, the Nive River flows, discharges from Tungatinah Power Station (located 600m upstream of Tarraleah Power Station) and discharges from Tarraleah Power Station. An analysis of flows in the Nive River has been undertaken and used to determine the potential impact of the combined discharge of nitrate from all Project work sites. The analysis consists of:

- Preparation of flow duration curves utilising 8 years data (2016-2024) at 6-hourly aggregated for:
 - Tarraleah Power Station
 - Tungatinah Power Station
 - Nive River u/s Tungatinah PS
 - The sum of all flows
- Estimation of the likelihood of there being no flow from either power stations
- Identification of any seasonal variation in discharge that might make some periods of higher risk than others for achieving adequate dilution.
- Estimation of the concentration of nitrate and ammonia in the Nive River below Tarraleah Power Station, using the daily load model outputs – pooled for all work sites. The estimated loads are presented in Section 7.3.3.

7.3.6.1 Flow

The flow duration analysis for Tarraleah Power Station, Tungatinah Power Station and the Nive River are shown in Figure 7.18. For Tarraleah Power Station, the duration curves indicate that Tarraleah Power Station had a relatively constant discharge of between 25 and 35 m³/s for more than 80% of the time. There is seasonal variation, with longer periods (90% of the time) of constant higher flow in summer, and slightly shorter periods in autumn, winter and to a lesser extent in spring. There were also periods of no discharge from Tarraleah Power Station to allow for cleaning of canals and maintenance: approximated 3% of the time or a total of 11 days per year. Summer and autumn were when most of the zero discharges days occurred.

For Tungatinah Power Station, the more variable operation of this power station means that, unlike Tarraleah, there is no one typical discharge. Tungatinah operates at a range of different discharges more frequently and this is seen in the duration curve. The period of time in which there was no discharge was 10%, with slightly lower periods of no discharge in winter and spring, and slightly higher periods of no discharge in summer and autumn.

The Nive River upstream of Tungatinah Power Station mostly had low flows, and reflects natural pickup downstream of Pine Tier Dam, with an annual median flow of 0.6 m³/s. There was substantial seasonal variation in flow, with very low flows in summer and autumn (median flow of 0.2 m³/s). Higher base flows were apparent in winter and spring with median flows of 2.5 m³/s and 1.7 m³/s, respectively. Flows in excess of 10 m³/s were rare in summer (< 1 % of flows) and autumn (3 % of flows) and uncommon in winter (25 % of flows) and spring (16 % of flows).

Whilst there are periods of low or no flow/discharge for Tarraleah Power Station, Tungatinah Power Station and Nive River, in order to estimate the potential impact of dilution in the Nive River, it is important to understand the combined flows (Figure 7.19). The combined flows indicate that over the most recent 8 years of the record, there have been few periods where there has been no discharge from both power stations, with combined flows being < 8 m³/s for 0.6 % of time. The occurrence of low or no flows was greatest in autumn and summer.

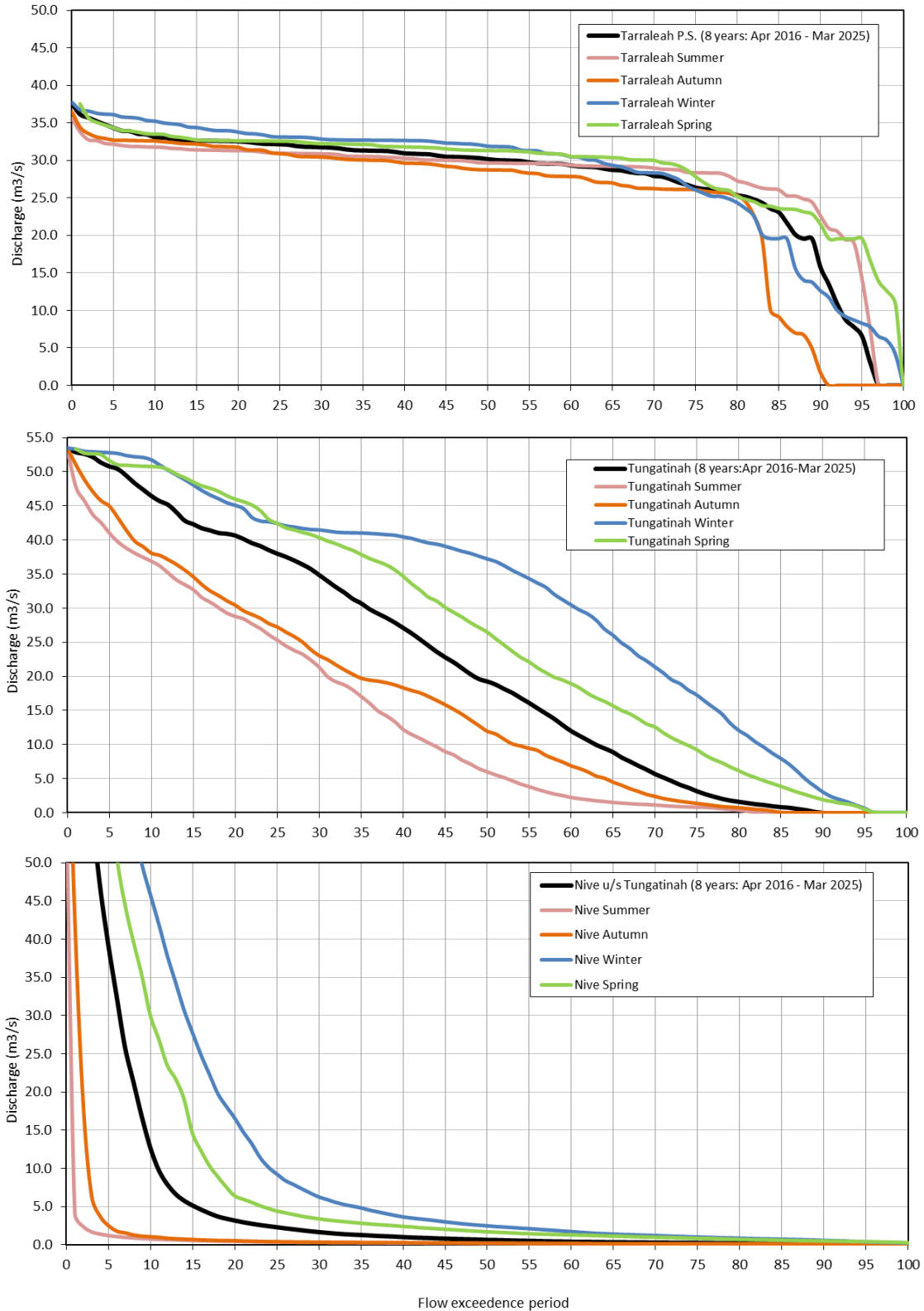


Figure 7.18: Flow duration curves for Tarraleah Power Station (top) , Tungatinah Power Station (middle) and Nive River upstream of Tungatinah Power Station (bottom) for the period 1 April 2016 to 31 March 2025 including seasonal curves

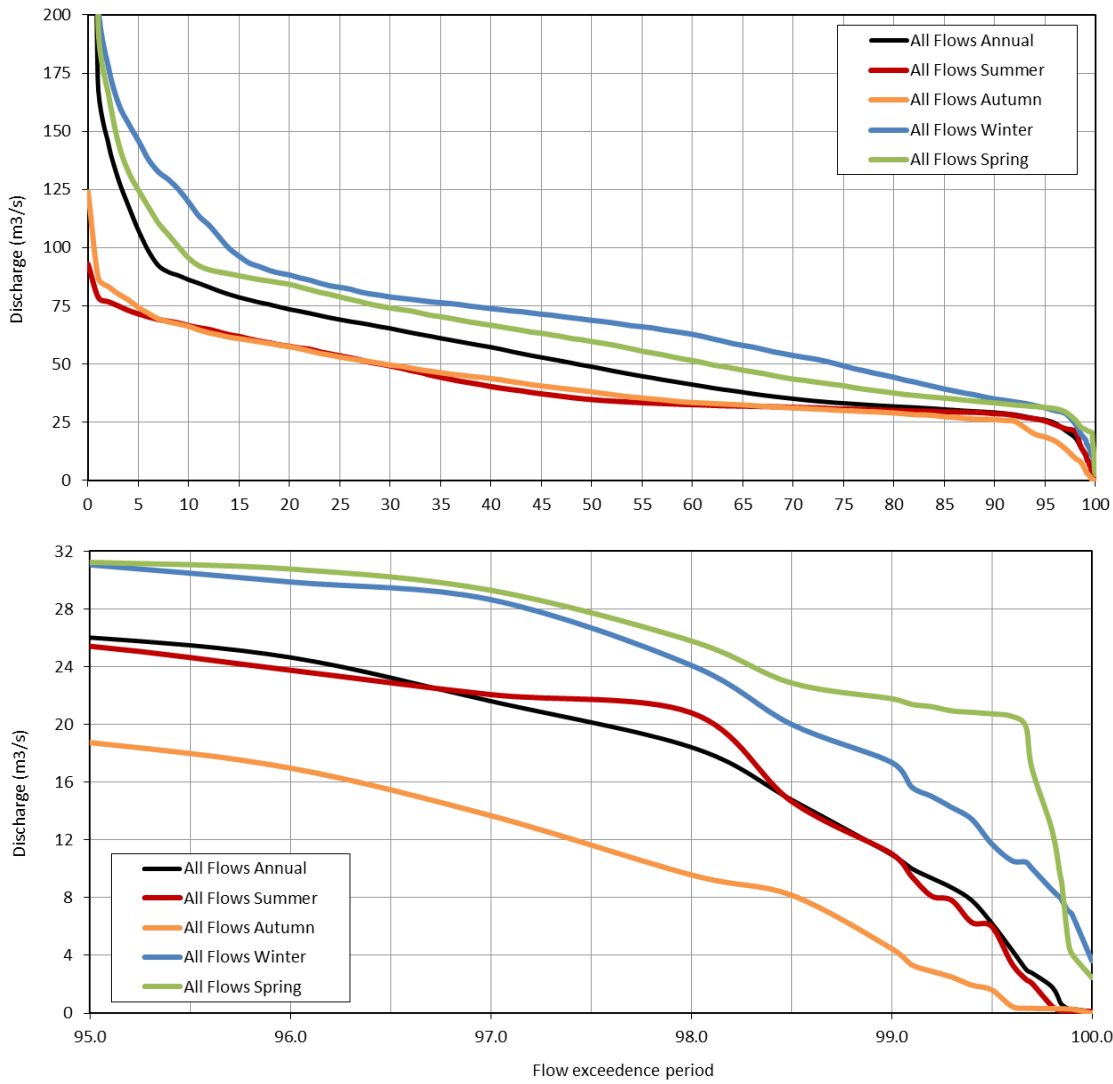


Figure 7.19: Sum of all flows to Nive River (Tungatinah Power Station, Tarraleah Power Station, Nive River upstream Tungatinah Power Station) flow duration curves 1 April 2016 to 31 March 2025 on annual and seasonal basis. Full duration curve (top) and duration curve with reduced x and y-axes (bottom) to differentiate variation in low flows

7.3.6.2 Dilution

Using the daily nitrate and ammonia load data calculated from the block model (as per Section 7.3.2.2), nitrate loads for the year with the highest expected load of nitrate-N and total ammonia nitrogen (TAN) i.e. Year 3 of construction (peak nitrate load) were applied to the flow duration data. This provided an estimate of the diluted concentration of nitrate and ammonia in the Nive River downstream from the existing Tarraleah Power Station for a range of flow scenarios based on the combined flows. The following points are important with regards to the flow, load and concentrations in the Nive River:

- On the basis of the assumptions used in the block model (Table 7.5) which estimates conservatively high load estimates, particularly for ammonia, the concentration estimates in the Nive River are also a likely over-estimate.
- The daily load data are those using a spoil flux rate of 0.07% per mm rainfall (nitrate) and 0.027% per mm rainfall (ammonia).

- A background nitrate and ammonia concentration has been assumed, based on the median concentration of existing surface water quality data at Nive River below Tarraleah. For nitrate, this concentration is 0.01 mg/L and for ammonia, it is 0.005 mg/L.
- The combined flow data from the most recent 8 years are used to predict the potential durations of concentration, and to demonstrate periods when concentration may increase to levels in excess of the 95th percentile DGVs. This assumes that discharge from power stations in the future will be similar to that of the most recent 8 years.

Figure 7.20 shows that in Year 3 – the year with the highest daily loads - dilution of nitrate loads to levels below the 95th percentile DGVs (0.073 mg/L) by flows in the Nive River will occur >99.6 % of the time over all seasons. That is, the combined flows of Tungatindah, Tarraleah and the Nive River will be insufficient to dilute nitrate loads to below the 95th percentile DGV, < 0.4 % of the time or 1.5 days in Year 3 (Figure 7.20). The lowest flows occurred in autumn and this season has the greatest potential for exceedances of the 95th percentile DGV, at 0.8% of the time. Winter and spring have the lowest potential for exceedence of the 95th percentile DGV (< 0.2 % of the time).

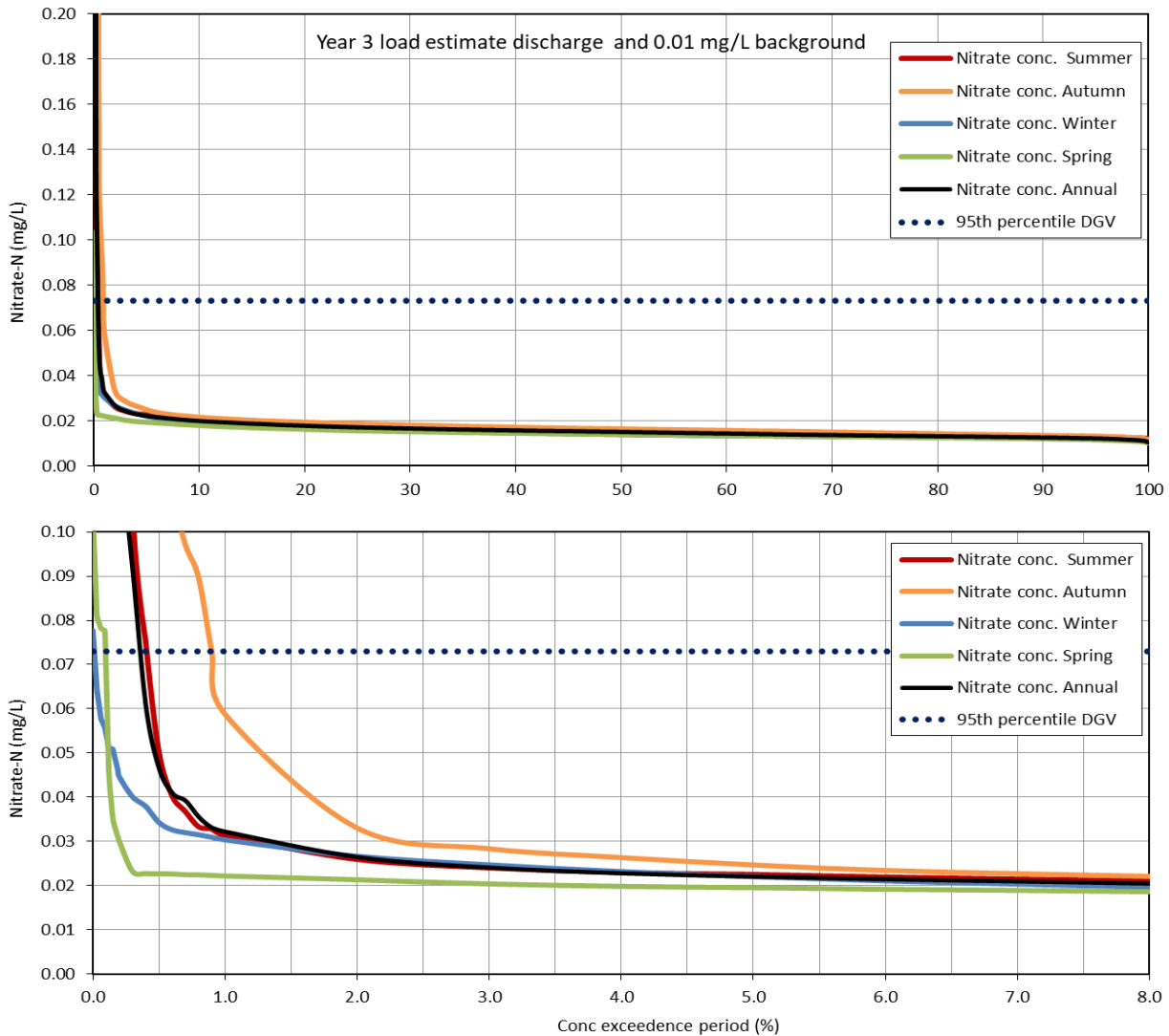


Figure 7.20: Estimated concentration of nitrate in the Nive River for different flow periods (seasons) assuming Year 3 load data

Figure 7.21 shows that dilution of ammonia loads to levels below the 95th percentile DGVs (0.018 mg/L) by flows in the Nive River will occur >96 % of the time over all seasons. That is, the combined flow in the Nive River will be insufficient to dilute ammonia loads to below the 95th percentile DGV < 4 % of the time or 15 days in Year 3. A similar potential for exceedance of the 95th percentile is seen for all seasons, with the exception of spring, which has the fewest periods with low flows. The potential for the highest concentrations is in autumn due to the lowest flows and periods of no flow from both power stations more likely.

In order to accommodate for periods when there is insufficient flow for dilution of discharges in the Nive River, from either the Tarraleah Power Station (via No. 1 or No. 2 Canals) or from Tungatimah Power Station, on-site storage will be provided to allow for the storage of water high in nitrates and to manage rates of discharge at appropriate loads for the available dilution as outline in Section 8.1.1.

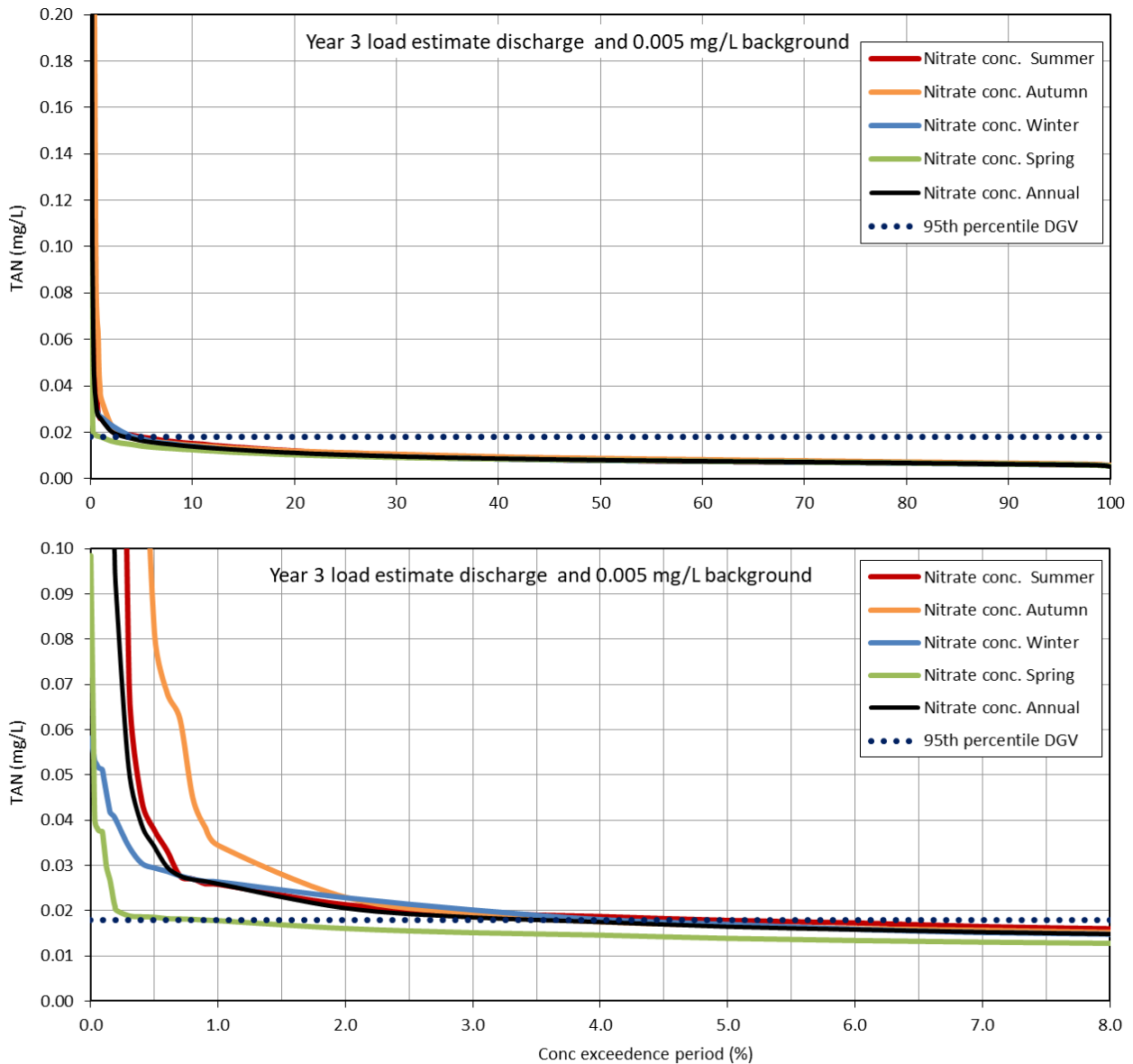
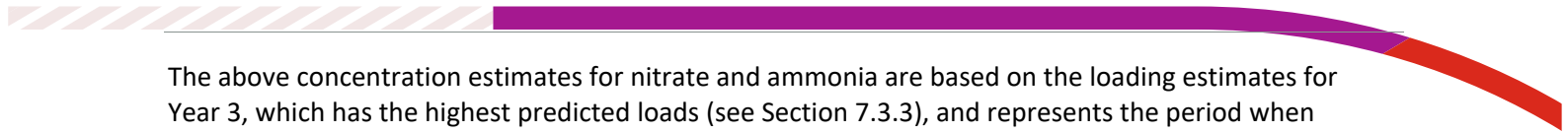


Figure 7.21: Estimated concentration of ammonia in the Nive River for different flow periods (seasons) for the highest year of surface loads.



The above concentration estimates for nitrate and ammonia are based on the loading estimates for Year 3, which has the highest predicted loads (see Section 7.3.3), and represents the period when concentrations will be highest. Prior and subsequent years will have decreased potential for high concentrations due to the lower loads expected in those years.

8. Management and monitoring

To protect the water quality within the Project area, the EPC Contractor will develop and implement EPA accepted management plans and monitoring programs that are consistent with the Sections 8.1 to 8.4.

Sections 8.1 to 8.3 outline the management measures to be implemented to ensure there will be no significant impacts to water quality as a result of the Project in local waterways. The management measures are consistent with avoiding impacts where possible (e.g. diversion of clean water around work sites, minimizing the impact area) and mitigating where necessary. Monitoring requirements to ensure compliance with the management measures and to ensure there are no unexpected or emerging water quality impacts as a result of the Project are outlined in Section 8.4.

Hydro Tasmania will conduct audits, have on-site representatives and receive environmental performance reports from the contractor to validate implementation of and compliance with the plans and programs.

8.1 Water Management Plan

A Water Management Plan (WMP) will be prepared for the construction of the Project by the EPC Contractor that reflects the final project design and construction methods. This plan will include (at a minimum) the following:

- Objectives and commitments, including water quality performance criteria designed to ensure impacts to the aquatic environment are minimised.
- Point Source Discharge Performance Criteria are to apply to each of the main work-sites where water will be collected and discharged. These work-site locations are:
 - Western Portal
 - Mid-access Portal
 - Paddys Quarry (including the Surge Tunnel Access Portal)
 - Power Station
- The water quality performance criteria applying to **point source discharges** from these sites are:
 - TSS of 50 mg/L (or a corresponding turbidity level)

This criterion is based on the erosion and sediment control construction guidelines published by the Tamar Estuary and Esk Rivers Program and the Derwent Estuary Program.

- pH of between 6.0 and 9.0

This criterion is determined through the understanding that where pH exceeds the upper DGV (up to pH 9.0), that significant dilution will ensure pH is within the EPA DGVs.

- Receiving environment Performance Criteria are to apply to the Liapootah Pond Outlet and are as follows:
 - Nitrate concentration, measured at the Liapootah Pond Outlet, is not to exceed background concentration (measured at a location on the Nive River upstream of the Tungatinah Power Station) plus 0.07 mg/L for more than two consecutive

measurements.

The EPA DGVs 95th percentile (0.073 mg/L) have been used as a guide for setting this criterion.

- Turbidity:
 - Nominally, turbidity at the Liapootah Pond Outlet **when in-stream works are being undertaken** is proposed to be no greater than upstream background turbidity plus 30 NTU on a 72 hour rolling average basis (final performance criteria to be based on the final Project design and construction method). This criteria acknowledges the potential for sediment resuspension from in-stream works and uses the EPA DGV 95th percentile (30.7 NTU) as a guide.

This criterion acknowledges the potential for sediment resuspension from in-stream works and uses the EPA DGV 95th percentile (30.7 NTU) as a guide.

- At all other times, **when there are no in-stream works**, turbidity downstream at the Liapootah Pond Outlet is to be no greater than background (in the Nive River upstream of the Tungatinah Power Station) plus 10 NTU (on a 72 hour rolling basis).

This criterion acknowledges the potential for sediment release and utilises the EPA DGV 80th percentile (8.3 NTU) as a guide.

- pH, measured at Liapootah Pond Outlet is not to exceed 8.1 for more than two consecutive measurements.
- Site water balance showing expected water sources (flows, groundwater, rainfall, wastewater) and discharge (groundwater, wastewater, clean water) at each work site over the construction period.
- Water and wastewater management (including management requirements outlined in Section 8.1.1):
 - Clean water diversion around work sites.
 - Capture, storage and treatment of wastewater.
- Performance criteria for wastewater discharge or requirements to remove and dispose of wastewater of at an accredited waste disposal facility (e.g. sewage)
- Concrete batching and washout area control measures:
 - Location away from drainage lines, storm water drains and waterbodies.
 - To be conveniently located for washing out equipment and clearly signposted.
 - Collection and/or treatment of all wastewater/washdown water within a designated impervious bund.
 - Performance criteria for pH for wastewater discharge
- Spoil emplacement management:
 - Drainage and erosion/sediment control measures (with cross references to Project's Erosion and Sediment Control Plan, Section 8.2).

- Capturing surface water drainage from the spoil emplacement sites to local waterways through use of bunds, drains/pipes, ponds and pumps (See Section 8.1.1.1) .
- Discharging captured drainage as per water and wastewater management measures.
- Hydrocarbon Management Plan:
 - Use of appropriate transport, storage, handling and disposal of all hydrocarbons to limit potential for spills and to reduce impact to waterways if spills occur.
 - Where/if appropriate, use of on-site treatment to separate hydrocarbons in site water.
 - Disposing of hydrocarbon waste through licensed waste management facilities
- Spill Response Plan
 - Spill prevention measures
 - Spill kit requirements
 - Equipment to be used in the event of a spill
 - Training requirements, including simulations.
- Nitrate Management Plan (see Section 8.3 for further detail of measures to be included):
 - Blasting procedures to minimise the generation of nitrates
 - Collection and storage of wastewater
 - Utilising existing conveyances (e.g. No. 1 Conveyance, No. 2 Conveyance and storages) and/or the Nive River as discharge locations to allow dilution of nitrate concentration to near background concentrations in the Nive River.
 - On-site storage for periods of low or no power station discharge (Section 8.1.1).
- Training and induction requirements, for all work site contractors, subcontractors and suppliers, including need for emergency response simulations and updates/refreshers.
- Incident response and reporting procedures.
- Water quality monitoring program for all work sites (see Section 8.5) including parameters sampled, method, frequency, responsibility, performance criteria/guideline values, and reporting requirements and frequency.
- Audit requirements, both internal and external, and frequency.

8.1.1 Wastewater management

Elevated pH, nitrate concentrations and sediment levels in wastewater (i.e. site water requiring discharge) from the construction sites will be managed through the collection, storage and discharge of wastewater as described below to ensure performance criteria are met.

8.1.1.1 Collection and storage of wastewater

In order to limit the risk of elevated concentrations of nitrate, sediments or elevated pH in local waterways the following shall be undertaken:

- Limiting water draining from site and reaching local waterways. This will include:

- Using methods to capture water on-site including drains, bunds, pipes, tanks or ponds. This will include the collection of surface water drainage below stockpiles, groundwater ingress from portals and tunnels and surface water drainage from other site locations
- Redirecting this water through temporary storage and site treatment processes prior to discharge to meet water quality discharge requirements e.g. sediment removal, pH adjustment
- Discharging to a location or locations that take advantage of dilution to maintain compliance with performance criteria, including:
 - No. 1 Canal (western portal)
 - No. 2 Canal and storages (mid-access portal and Paddy's Quarry)
 - Nive River (Power station).

An overview of the proposed discharge pathways is provided in Figure 8-2. It is assumed that the canals will be used for dilution/conveyance during construction (approximately 4 years) and for one year after blasting has ceased. It is expected that the existing Tarraleah Power Station would be operating for a likely period of 12 months following the cessation of blasting. In the event that the existing power station operates for less than 12 months, and that water quality is unacceptable for diffuse discharge from the site/s (e.g. nitrate is at potentially toxic concentrations in local streams), point source discharge water would be delivered from each discharge location to No. 2 Pond either directly or via No. 2 Canal and into the new scheme. The diffuse discharge could potentially be through passive wetlands, if appropriate.

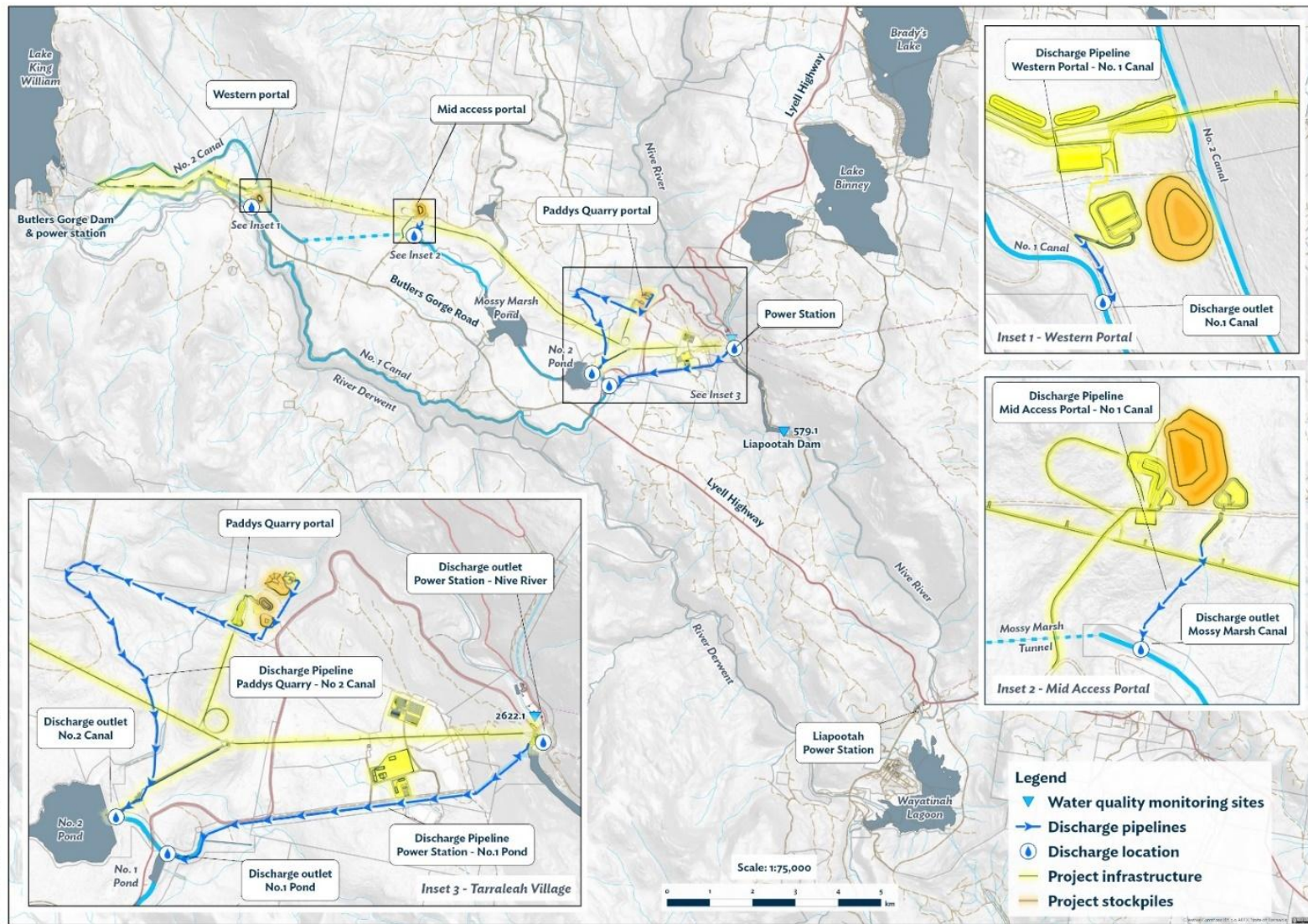


Figure 8.1: Proposed water management pathways

8.1.1.2 Periods of low or no power station discharge

On-site storage capacity will be provided in order to accommodate periods when there is low or no flow for dilution of discharges in the Nive River, from Tarraleah Power Station (via No. 1 or No. 2 Canals) and Tungatinah Power Station, including:

- Ensuring the on-site storage capacity at each portal locations is sufficient to hold water high in nitrate or for 72 hours without the need to discharge.
- Utilising No. 2 Pond as overflow storage capacity (in excess of the 72 hours on-site capacity)
- Prioritising the discharge of overflow storage following its use to ensure storage remains Available and to limit possible interactions with groundwater (where storage is in ponds). Managing subsequent discharges at a flow rate to remain below the nitrate performance criterion at Liapootah Outlet.

The measures described above will be used to manage occurrences of low or no flow planned by Hydro Tasmania (e.g. annual cleaning of No. 1 Canal). It is possible, though unlikely, that during construction there is an unplanned occurrence where discharge via No. 1 and No. 2 Canals or Tarraleah Power Station and Tungatinah Power Station is no longer possible for an extended period. If this were to occur, Hydro Tasmania would engage with EPA Tasmania to discuss alternative water management strategies.

8.2 Erosion and Sediment Control Plan

A detailed Erosion and Sediment Control Plan (ESCP) will be separately developed and implemented by the EPC Contractor for each work site. The ESCP will follow best practice IECA guidance and ESC management measures, and will take into account the available controls. The ESCP will be developed to mitigate erosion and sediment risks inherent in the Project works taking into consideration existing topography and drainage, vegetation, geology, soil types and climate. As a minimum the ESCP will include:

- Objectives and commitments relating to erosion and sediment management on site.
- General classification of erosion potential for each land type and topography likely to be disturbed by construction activities
- Preconstruction controls:
 - Determining specific erosion and sediment control management zones
 - Targeted soil testing and erosion hazard assessment
 - Management controls:
 - Timing of works
 - Defining work areas
 - Minimising clearing and retaining vegetation within work sites where possible
 - Physical controls:
 - Drainage controls within and around each work site including diversion of clean water around work sites and dirty water drainage
 - Sediment basins

- Vehicle washdown
- Concrete washout area
- Floating silt curtains
- Sediment controls for stockpiles, laydown and general work sites
- Controls for instream works in the Nive River
- Construction controls:
 - Maintenance of installed drainage to ensure functioning as designed
 - Road construction and maintenance drainage considerations
 - Dust control procedures to limit mobilisation of sediment
 - Contingency measures for events such as extreme rainfall, poor performance or operational changes
 - Progressive rehabilitation and revegetation of sites.
- Training and induction requirements, for all work site contractors, subcontractors and suppliers, including needs for updates/refreshers.
- Incident response and reporting procedures.
- Erosion and sediment monitoring program for all work sites requirements, including frequency, responsibility, performance criteria/guideline values, reporting requirements and frequency.
- Audit requirements, both internal and external, and frequency.

8.3 Nitrate Management Plan

A Nitrate Management Plan is also to be prepared and implemented for the Project by the EPC Contractor. This plan is to include as a minimum the requirements outlined below.

To manage nitrate generated from the use of explosives a Nitrate Management Plan will be developed and implemented in accordance with best practice blasting procedures. The Nitrate Management Plan will also include measures to manage wastewater with elevated nitrate concentrations. This plan will include (at a minimum):

- Objectives and commitments, including performance criteria designed to ensure impacts to the aquatic environment are minimised.
- Best practice blasting procedures to limit the generation of nitrate, including reducing the:
 - Generation of nitrate in the choice of explosive product, where practicable:
 - Where practical and cost effective, explosives with properties that reduce the generation of nitrate on-site will be selected
 - This may include choosing products for properties such as their composition of ammonium nitrate, their resistance to dissolving and their potential for the most complete detonation.
 - Spillage of explosive nitrate emulsion products, such as:
 - Careful handling of explosive emulsion and use of containment procedures such as bunding where spills may be more likely to occur

- Avoiding depositing excess explosive on the ground
- Collecting excess explosive emulsion remaining in hoses in a dedicated sealable explosive waste container
- Cleaning up spills of explosive emulsion
- Disposing of waste emulsion off-site at an appropriate waste management facility.
- Generation of nitrate in the setting of charges, such as:
 - Filling holes to an appropriate level that ensures there is little unexploded emulsion following each blast
 - Employing methods which minimise the occurrence of failed charges
 - Ensuring minimal wait time (sleep time) between setting charges and detonation
- As per the Water Management Plan:
 - All water exposed to blasted materials such as water from tunnel excavations and surface water draining from spoil emplacement areas will be collected and contained within the disturbance footprint prior to discharge (as per Section 8.1.1), to either:
 - No. 1 Canal
 - No. 2 Canal and storages
 - Nive River.
- On-site storage when there is low or no flow for dilution of discharges in the Nive River, from either the Tarraleah Power Station (via No. 1 or No. 2 Canals) or Tungatinah Power Station.
- To manage the rare occurrence when neither Tarraleah or Tungatinah Power stations are operating and there is reduced flow in the Nive River, and hence reduced dilution potential, storage will be provided with 72 hours detention time such that no discharge would be expected to occur during these conditions
- Training and induction requirements, for all work site contractors, subcontractors and suppliers, including need for updates/refreshers.
- Nitrate monitoring program for all work sites requirements (including that in Section 8.4), including frequency, responsibility, performance criteria/guideline values, and reporting requirements and frequency.
- Audit requirements, both internal and external, and frequency.

8.4 Monitoring

The following monitoring programs are to be implemented to ensure that the management measures are effective, with some monitoring to extend post construction (Section 8.4.3).

8.4.1 Baseline monitoring

Prior to the pre-construction and construction periods, baseline surface water quality monitoring will aim to extend the existing monitoring program to a total period of 2 years sampling. Monitoring of surface water quality will continue at 13 of the existing baseline water quality sites (Figure 4.1) along with new sites on Streams 1-6 and River Derwent. Sampling of site SW-P8 downslope from Tarraleah Village is already impacted, and not representative of surface water conditions and will be replaced by a

site on Stream 6. The potential location of the new baseline water quality sites is shown in Figure 8-2, with the location to be confirmed based on accessibility and safety requirements. Monitoring at new sites will occur monthly (for 12 months) and include *in-situ* physiochemical parameters (i.e. turbidity, electrical conductivity, pH, dissolved oxygen (mg/L and percent), chlorophyll *a*) along with laboratory analysis of dissolved and total nutrients, total suspended sediments and the standard metals suite. This monitoring will provide a water quality baseline, including seasonal data, for all Project work sites that have the potential to impact surface water quality during construction. In addition, two sites on the River Derwent will allow potential water quality impacts from the Project on the TWWHA to be monitored (Figure 8-2).

Subject to a periodic review of the monitoring results and project design development through the ECI process, the baseline monitoring program may be reviewed and updated to reflect current Project requirements.

8.4.2 Preconstruction and construction monitoring

The Water Management Plan will adapt the baseline surface water quality monitoring program and define the preconstruction and construction monitoring locations, frequency and parameters for surface water quality based on the final Project design and proposed construction methods. The design of the water quality monitoring program will be informed by analysis of all existing baseline data, including seasonal trends. The aim of the monitoring plan will be to establish:

- A pre-construction monitoring program based on the final Project design and construction method. The pre-construction baseline will aim to collect as long a record as possible of water quality data at all monitoring sites prior to the commencement of construction activities that may impact surface waters. Data may add to that which has already been collected as part of the baseline monitoring program if the same sites are used as part of the pre-construction monitoring program.
- A construction monitoring program that targets risks from potential surface water impacts during construction including:
 - Erosion and sedimentation
 - Hydrocarbons
 - Elevated pH
 - Metals
 - Nitrates from explosives

At a minimum construction monitoring will include monitoring of:

- Point source discharge locations at each work site
- Streams 1-5
- Mossy Marsh and No. 2 Pond
- River Derwent within and downstream of the TWWHA
- Upstream of the Tungatinah Power Station discharge (Nive River)
- Lake Liapootah outlet
- Monitoring will include in-situ physiochemical parameters (i.e. turbidity, electrical conductivity, pH, dissolved oxygen (mg/L and percent)) along with laboratory analysis of nitrate and

ammonia, total suspended sediments and any dissolved metals of concern. Chlorophyll a will also be monitored at Nive River upstream of Tungatinah Power Station and Lake Liapootah outlet only.

8.4.3 At a minimum monitoring will be completed at a frequency sufficient to demonstrate compliance with performance criteria. Post construction /operation monitoring

Post construction monitoring for nitrates at point source discharge monitoring locations from spoil emplacement areas will continue at the same frequency as during construction. This monitoring will continue until nitrate concentrations have returned to preconstruction levels or are showing evidence of attenuating towards a level that will not cause environmental harm of a slightly to moderately disturbed aquatic ecosystem.

8.5 Residual impacts summary

There is a risk to water quality of local waterways as a result of the construction of Tarraleah Redevelopment Project. Impacts to these small waterways from run-off from site include:

- the reduction in habitat quality through the release of sediment
- the increase in pH from the use of concrete
- the increase in the concentration of nitrate from the residues remaining following the use of explosives.

Management measures and monitoring will be put in place to ensure that there are no significant impacts to water quality from the construction sites. The mitigation measures to reduce the impacts of the work on water quality include a water management plan which includes a series of measures to control water and potential contaminants, including the capture, storage, treatment and discharge of water on-site, specific spill response, hydrocarbon and concrete washout measures. The implementation of an erosion and sediment control plan and a nitrate management plan will reduce the potential for generation and discharge of both sediment and nitrate. Important water management measures to be implemented include:

- Capture and storage of water on main work sites including below spoil emplacement locations and subsequent treatment of all water discharged from site to achieve pH and suspended sediment (turbidity) discharge performance criteria
- The use of dilution within the Tarraleah conveyances and the Nive River to achieve dilution of nitrate (as well as pH and sediment) in the discharge to comply with pH, suspended sediment (turbidity) and nitrate receiving environment performance criteria
- Contingency to store water on-site for a period of 72 hours in the event of brief and foreseeable outages of the Tarraleah conveyances where dilution cannot be assured. This will ensure compliance with receiving environment performance criteria

With the implementation of these mitigation measures, there will be no residual impacts on water quality that result in environmental harm. There will be an increase in the load of dissolved nitrogen mostly in the form of nitrate, to the Derwent catchment for periods during and subsequent to blasting. However, the size of these loads relative to the greater catchment, their transient nature during the construction project and the significant dilution utilised to reduce their concentration are such that these loads are considered to have no residual impacts.

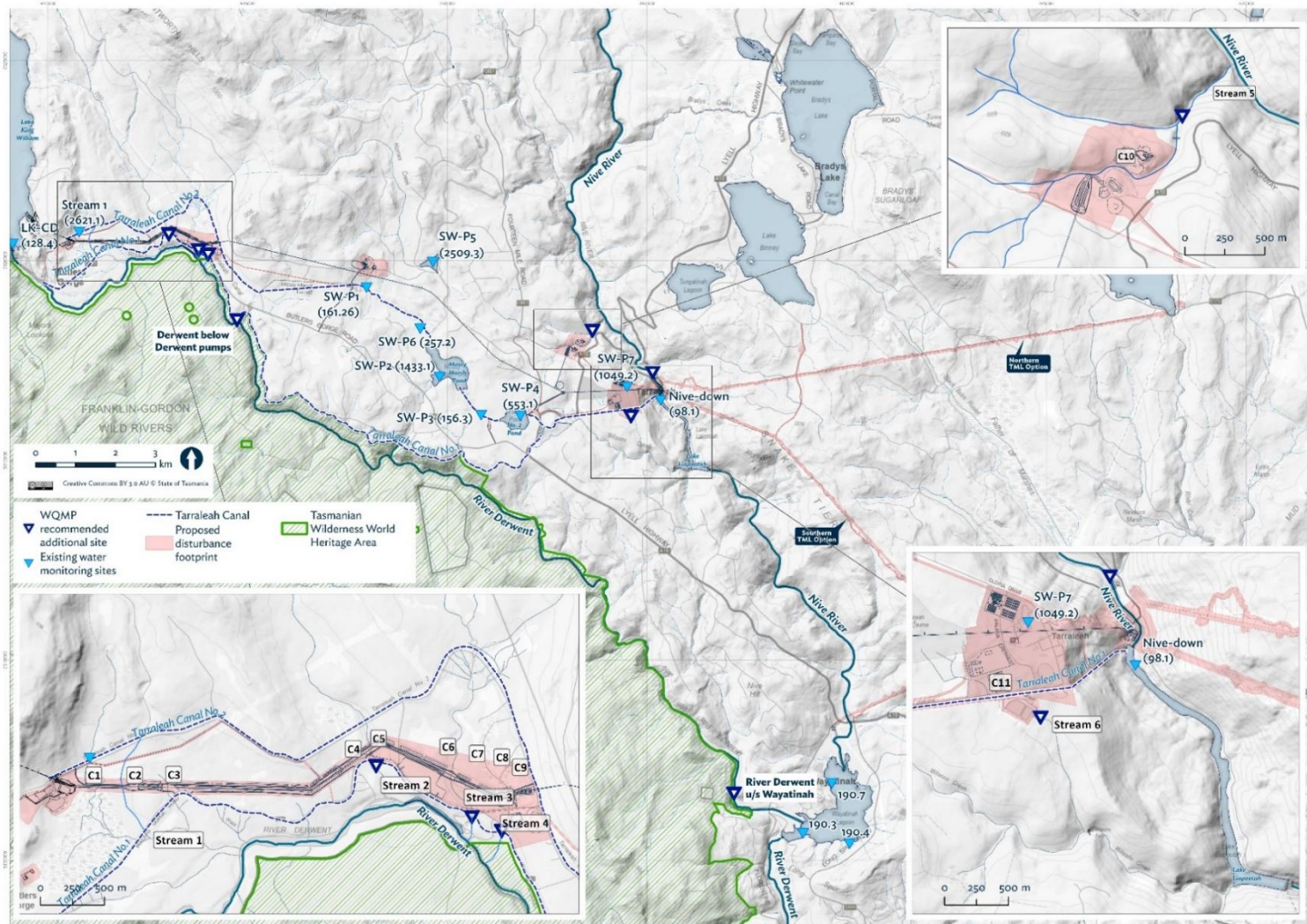


Figure 8-2: Overview of proposed additional surface water quality baseline monitoring sites

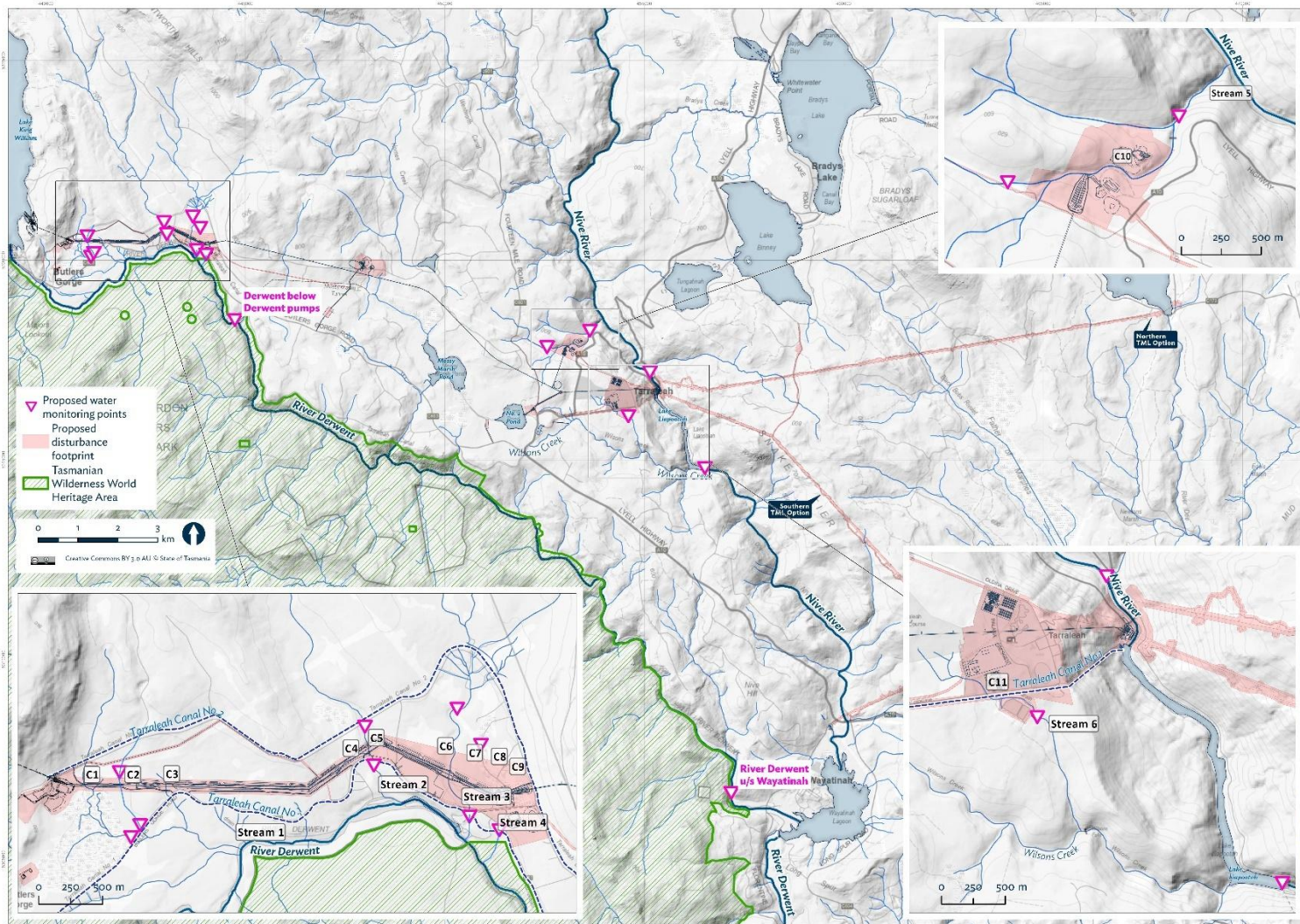


Figure 8-3: Overview of proposed additional surface water construction monitoring sites

9. References

- Alabaster, J.S. and Lloyd, R. (1980). *Water Quality Criteria of Freshwater Fish*. Butter Worth, London-Boston
- ANZG. (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments (ANZG) and Australian state and territory governments, Canberra ACT, Australia. www.waterquality.gov.au/anz-guidelines.
- Bækken, T. (2014) Nitrogen Runoff from Tunnel Blasted Rocks—a Large-Scale Test. *Water Environment Research* **86**(6): 573- 576.
- Camargo JA, Alonso A and Salamanca A. (2004) Nitrate toxicity to aquatic animals: a review with new data for freshwater invertebrates. *Chemosphere*. **58**(9):1255-67.
- Collins, S. B., Singh, R., Rivas, A., Palmer, A., Horne, D., Roygard, J. and Matthews, A. (2016). Assessment of nitrogen flow pathways and its potential attenuation in shallow groundwaters in the Lower Rangitikei catchment. In: *Integrated nutrient and water management for sustainable farming*. (Eds L. D. Currie and R. Singh). <http://flrc.massey.ac.nz/publications.html>.
- Entura (2025). *Tarraleah Redevelopment Project - Aquatic Ecology Assessment*. Report prepared for Hydro Tasmania, June 2025. Hobart, Tasmania.
- Environment Protection Authority (2020) *Technical Guidance for Water Quality Objectives (WQOs) Setting for Tasmania*, Environment Protection Authority, Hobart, Tasmania.
- Environment Protection Authority (2021) *Default Guideline Values (DGVs) for Aquatic Ecosystems of the Upper Derwent Catchment*, Environment Protection Authority, Hobart, Tasmania
- Hendry, J.M., Wassenaar, L.I., Barbour, S.L., Schabert, M.S., Birkham, T.K., Fedec, T., Schmeling, E.E. (2018) Assessing the fate of explosives derived nitrate in mine waste rock dumps using the stable isotopes of oxygen and nitrogen, *Science of The Total Environment*, **640-641**: 127-137.
- Koehnken (2025). *Nitrate at Tarraleah – a synthesis of information and conceptual model*. Report prepared for Hydro Tasmania, March 2025, Hobart, Tasmania.
- Liu, M., Xu, X., Wanek, W., Sun, J., Bardgett, R.D., Tian, Y., Cui, X., Jiang, L., Ma, Z., Kuzyakov, Y., Ouyang, H. and Wang, Y. (2025), Nitrogen availability in soil controls uptake of different nitrogen forms by plants. *New Phytol*, **245**: 1450-1467.
- Ma, T., Dai, G., Zhu, S., Chen, D., Chen, L., Lu, X., Wang, X., Zhu, J., Zhang, Y., He, J. Bai, Y., Han, X and Feng, X. (2020) Vertical variations in plant- and microbial-derived carbon components in grassland soils. *Plant Soil* **446**: 441–455.
- Mahmood, F.N, Lee Barbour, S.L, Kennedy, C , Hendry, M.J. (2017). Nitrate release from waste rock dumps in the Elk Valley, British Columbia, Canada. *Science of the Total Environment* **605–606**: 915-928.
- Nieder, R., Benbi, D.K. and Scherer, H.W. (2011). Fixation and defixation of ammonium in soils: a review. *Biol Fertil Soils* **47**, 1–14.

NIWA (2013) *Updating nitrate toxicity effects on freshwater aquatic species*. National Institute of Water and Atmospheric Research. Hamilton, New Zealand.

Olssen, M., Åkeson, U. and Niklasson, B. (2019) *Läkning av kväve i bergmassor från tunnlar (Leaching of nitrogen in rock masses from tunnels)*. Trafikverket, Borlänge. Publication number 2019:174. ISBN 978-91-7725-524-6

Pan, B., Xia, L., Lam, S-K, Wang, E., Zhang, Y, Mosier, A., Chen, D. (2022). A global synthesis of soil denitrification: Driving factors and mitigation strategies. *Agriculture, Ecosystems & Environment*, 327. <https://doi.org/10.1016/j.agee.2021.107850>

Proemse, B.C., Koolhof, I., White, R., Barmuta, L.A., Coughanow, C. (2022): Nutrient sources and loads in the River Derwent catchment, Tasmania, *Australasian Journal of Environmental Management*, DOI:10.1080/14486563.2022.2077847

PSM. (2025) *Tarraleah Redevelopment Project: Hydrogeological Interpretative Report*. Report prepared for Hydro Tasmania, June 2025.

Rivas, A., Singh, R., Horne, D., Roygard, J., Matthews, J, Hedley, M. (2017). Denitrification potential in the subsurface environment in the Manawatu River catchment, New Zealand: Indications from oxidation-reduction conditions, hydrogeological factors, and implications for nutrient management. *Journal of Environmental Management*, **197**: 476-489. <https://doi.org/10.1016/j.jenvman.2017.04.015>

Sahrawat, K. L. (2008). Factors Affecting Nitrification in Soils. *Communications in Soil Science and Plant Analysis*, 39(9–10), 1436–1446. <https://doi.org/10.1080/00103620802004235>

Tasmanian Acid Sulfate Soils Information (TASSI) (2009) *Inland areas of Tasmania with potential to contain Acid Sulfate Soils*. Accessed via http://maps.thelist.tas.gov.au/listmap/app/list/map?layout-options=LAYER_LIST_OPEN&cpoint=147.28,-42.72,10000&srs=EPSG:4283&bmlayer=3&layers=251.

Appendices

A Geology, soils and topography of the Project area

A.1 Geology and soils

The Project design alignment traverses several geological units. Jurassic dolerite is the dominant rock type within the design alignment, including the power station, transmission line upgrades, the mid-access portal, the No. 2 Pond pump station and rising main and some areas of the surge and western tunnel portals. Some exposure of Permian-Triassic sedimentary bedrock intersects the low-relief section of the headrace, and the majority of the area of the western tunnel portal, and Tertiary basalt flows intersect the majority of the surge tunnel portal, transmission line upgrades and the No. 2 pond pump house. A range of surficial Quaternary soils is expected to be encountered at all Project sites, including alluvial, colluvial, glacial and swamp deposits. A shallow water table may occur within bedrock hollows with wetlands, and local perched aquifers are possible within the Tertiary basalt flows; within the dolerite bedrock, there is likely a deeper, regional water table (PSM 2025a, www.thelist.tas.gov.au). The Project construction activities within the disturbance footprint encompass some or all of the geological units (Table A.1).

The soil stratigraphy within the Project disturbance footprint includes numerous geomorphological processes that contribute to soil formation and includes the following Quaternary aged mapping units, data and descriptions (Table A.1, PSM 2024, PSM 2025a, Stuart-Smith 2022, 2023):

- Alluvial deposits: gravels to boulders
 - Boulder deposits along the Derwent and Nive Rivers and associated tributaries. Fine to coarse soils, rounded gravels and cobbles with the potential for large boulders, sand and silt.
 - Summary of geotechnical data collected from the alluvial deposits mapping unit shows:
 - Emerson class 4 and pinhole dispersion ND1 from a single sample
 - USCS class CL-ML (inorganic clays and silts) from a single sample test pit. Inorganic silts and clays are potentially highly erodible, have a tendency for dispersion and may lead to turbid surface runoff (IECA 2018).
 - Plasticity index ranging from 6-16 %
 - Surface soil horizons from test pit and borehole logs include clayey silt, silt with fine sand and cobbles and boulders with a silt sand matrix.
 - Low proportion of clays and silts, with sand and gravels making up a larger percentage of soil samples. Very high percentage of sand at site TA-TP235 on the Nive River western bank, possibly on an instream bank-attached bar within the river margin (Table A.2).
- Colluvial deposits: rock fragments, boulders and clay
 - Encountered throughout the Project disturbance footprint and typically comprises low to medium plasticity, fine to coarse-grained gravelly sandy silt to silty sandy gravel with

weathered cobbles and boulders. The soil typically has a stiff matrix when dominated by fine-grained sediments.

- Summary of geotechnical data from the colluvial deposits mapping unit shows:
 - Soil dispersivity is unknown
 - USCS class CL-CH (inorganic clays of low and high plasticity) and CL at depth from a single borehole. Inorganic clays are potentially erodible (although variable for CH) and may lead to turbid surface runoff. In addition, CL soils also have a tendency for dispersion (IECA 2018).
 - Plasticity index 44 % from a single borehole sample.
 - No soil description is available.
 - Low proportion of clays and silts, with sand and gravels making up a larger percentage of soil samples. Very high percentage of sand at site TA-TP2351 on the Nive River western bank, possibly on an instream bank-attached bar within the river margin (Table A.2).
- Glacial moraine deposits: Soil with gravel to boulder rock fragments.
 - Quaternary glacial outwash soils are variable and include:
 - Gravelly, sandy SILT or silty, sandy GRAVEL with cobbles and boulders
 - A variably cemented layer of sandy CLAY with gravel, cobbles and boulders
 - Outwash deposits of Sandy CLAY to Clayey SAND with some gravel. Sand is typically fine to coarse-grained.
 - Summary of geotechnical data collected from the glacial deposits mapping unit:
 - Emerson class 4 from eight samples
 - Pinhole dispersion from ND1 to ND2 from five samples
 - USCS class is variable across samples, at depth and includes silty sands (SM), inorganic clays of low plasticity (CL), inorganic soils of high plasticity (CH), inorganic silts (MH), inorganic silts, clayey with low to medium plasticity (ML), clayey gravels (GC), Peat (Pt), organic silts and clays of high plasticity (OH), well graded gravels (GW) from 19 test pits and one borehole:
 - Highly erodible soils include clays and silts from USCS classes CL, CH, MH and ML. Silty sands (SM) have a medium erodibility, and gravels (GC and GW) have a medium to low erodibility (IECA 2018).
 - Clays, silts, silty sands and clayey gravels can potentially cause turbid runoff (SM, CL, CH, MH, ML, GC) (IECA 2018).
 - Silts and clays (CL and ML) have a tendency for dispersion (IECA 2018).
 - The Plasticity Index ranges from 3 to 49 % in eighteen samples. Non-plastic samples were also recorded.

¹ Site TA-TP235 was attributed to both Alluvial and Colluvial mapping units.

- Ten of the available eighteen surface horizon soil descriptions from test pit and borehole logs were clay and clayey silt. The remaining descriptions include sandy silt, silty sand, silty sandy peat, cobbles and boulders with a silt sand matrix. Gravels were recorded at three sites where the test pits were located on the existing Mossy Marsh dam wall.
- Particle size distribution from samples is variable at sites within the glacial moraine deposits mapping unit. Two sites have a low proportion of clays and silts, with sand and gravels making up a larger percentage of soil samples (Table A.2). Two sites have a very high proportion of silts and clays, possibly due to their location within previously disturbed locations (Table A.2). Site TA-TP224 has a very high proportion of sand, possibly due to the presence of Peat in the surface soil horizon over soil classified as SM (silty-sandy soil), associated with the drainage line downslope from a swamp deposit area (Table A.2).
- Swamp deposits: Developed in poorly drained areas.
 - Depositional sediments in water-logged, low relief areas that are poorly drained. The soils typically consist of soft to very soft silty-clayey black to brown peat with a low to medium plasticity.
 - Summary of geotechnical data collected from the swamp deposits mapping unit shows:
 - Pinhole dispersion ND1 and ND2 from two samples.
 - USCS class is variable across sites, at depth and includes inorganic clays of high (CH) and low to medium (CL) plasticity, silty gravels (GM), inorganic silts (MH), inorganic silts, clayey with low to medium plasticity (ML), Peat (Pt), Clayey sands (SC) and silty sands (SM from seven test pits and one borehole:
 - Highly erodible soils include clays and silts from USCS classes CL, CH, MH and ML; however, erodibility of CH and MH can be variable. Silty sands and clayey sands (SM and SC) have a medium erodibility and silty gravels (GM) have a low to medium erodibility (IECA 2018).
 - All soil types from samples within the swamp deposit mapping unit can potentially cause turbid runoff (IECA 2018).
 - Silts and clays (CL and ML) have a tendency for dispersion (IECA 2018).
 - The Plasticity Index ranges from 13 to 70 % in nine samples.
 - Surface soil horizons from test pit and borehole logs include clay, clayey silt, silty peat and sandy clayey peat.
 - High proportion of sand and silt at two sites, possibly due to the presence of Peat in the surface soil horizon over either a silty and sandy organic layer (OL and CL) or a silty-sandy soil (SM) (Table A.2). One site with a higher proportion of clay, possibly due to being located near the downstream outflow from a swamp deposit area, CH and CL (inorganic clay of either medium or high plasticity) soils and no peat/organic layer (Table A.2).
- A specific soil unit of displaced, “Disturbed dolerite” occurs on the lower Tarraleah hillside, consisting of dolerite cobbles and boulders with some clay.
- The soil surface horizon mapping units are not continuous, and therefore, some areas within the disturbance area are not mapped.

A.1.1 Acid sulfate soils

- The Tasmanian Acid Sulfate Soils Information (TASSI) program has mapped various areas within or within proximity to the Project disturbance footprint:
- Low relief, swampy area downstream of the western end of the pipeline on alluvial Dermosol soils as a location with a low probability of Acid Sulphate Soils occurring (6-70 % chance of occurrence within the mapping unit).
- South-eastern side of Butlers Gorge Road downstream from the pipeline on glacial Dermosol soils is a location with an extremely low probability of Acid Sulphate Soils occurring (1-5 % chance of occurrence within the mapping unit).
- Low relief area within the western tunnel portal disturbance footprint on glacial soils as a location with a low probability of Acid Sulphate Soils occurring (6-70 % chance of occurrence within the mapping unit).
- Low relief areas associated with Mossy Marsh Pond and No. 2 Pond and downstream from Mossy Marsh Pond is a location with an extremely low probability of Acid Sulphate Soils occurring (1-5 % chance of occurrence within the mapping unit).
- The mapping units provided by TASSI have not been field verified and are provisional (www.thelist.tas.gov.au, accessed 16 May 2025).
- Analysis of groundwater and surface water samples by PSM (2025b) characterised the Project area as having a low risk of the presence of Acid Mine Drainage (AMD) due to generally neutral pH, low levels of sulphate and low surface water electrical conductivity. PSM (2025b) concluded that the risk of acid drainage from the oxidation of potentially acid-forming (PAF) material was low; however, some residual risks from AMD include:
 - Runoff from waste rock landforms and stockpiles
 - Lowering the water table will increase the depth of the oxidation front and potentially expose trace quantities of AMD from Dolerite and Basalt.
- No mapping of Potential Acid Sulfate Soils (PASS) has been undertaken.

Table A.1: Geological and surface stratigraphy sediments present within the Project disturbance footprint (based on Stuart-Smith 2022, 2023)

Project disturbance footprint	Area within the disturbance footprint (ha)	Geology			Surface stratigraphy (Quaternary)				Unknown or not mapped
		Basalt (tholeiitic to alkalic) and related pyroclastic rocks.	Dolerite (tholeiitic) with locally developed granophyre.	Dominantly quartz sandstone.	Alluvial deposits: gravels to boulders.	Colluvial deposits: rock fragments, boulders and clay	Glacial moraine deposits: Soil with gravel to boulder rock fragments.	Swamp deposits: Poorly drained areas developed on glacial moraine deposits.	
Eastern explosive magazine and access track	2.4	✓					✓		
Lyell Hwy and Butlers Gorge Rd Intersection	0.6	✓					✓		
Main Distribution Lines	21.2	✓	✓	✓	✓	✓	✓		
Mid-Access Tunnel Portal with Access Track	35.2		✓				✓	✓	
Northern TML Option	112.9	✓	✓						✓
Paddy's Quarry	35.7	✓	✓						✓
Pipeline	36.3			✓	✓		✓	✓	
Southern TML Option	136.7		✓						✓
Surge Tower and Pump Station	12.8	✓	✓				✓		
Tarraleah Village	87.2	✓	✓	✓	✓	✓			
TML Options	2.5		✓		✓				
TML Options - Main Access Track	9.2		✓						✓
Upgrade work and magazine	16.0		✓	✓	✓		✓	✓	
Western explosive magazine and access track	5.3		✓				✓		
Western Portal and Pipeline	42.7		✓	✓	✓		✓	✓	

Table A.2: Sediment size class per cent from sites from natural inferred surface for each Quaternary surface mapping unit (based on PSM 2024)

Surface (Quaternary)	Sample ID	Gravel %	Sand %	Silt %	Clay %
Alluvial deposits: gravels to boulders.	TA-TP223	55.2	23.5	15	6.3
	TA06DC014 #1*	41.6	29.6	16.9	8.3
	TA06DC014 #2*	47.1	27.8	15.2	7.9
	TA-TP235	9	65.2	14.5	11.3
Colluvial deposits: rock fragments, boulders and clay	TA06DC014 #1*	41.6	29.6	16.9	8.3
	TA06DC014 #2*	47.1	27.8	15.2	7.9
	TA-DC215 #1*	40.3	26.1	16.1	13.3
	TA-DC215 #2*	41.9	27.3	15.6	12.4
	TA-TP235	9	65.2	14.5	11.3
Glacial moraine deposits: Soil with gravel to boulder rock fragments.	TA06TP013	1	11	44	44
	TA06TP009	10	19	36	35
	TA-DC215 #1*	40.3	26.1	16.1	13.3
	TA-DC215 #2*	41.9	27.3	15.6	12.4
	TA-TP210	71.8	13	4.3	2.9
	TA-TP224	0.3	82.6	12.5	4.6
Swamp deposits: Developed in poorly drained areas .	TA06TP012	36	28	15	21
	TA-TP206	2.2	49.8	30.1	17.9
	TA-TP209	10.9	47.8	24.6	14.6

- *Sites attributed with multiple Quaternary surface mapping units

A.2 Topography

The slope and drainage assessment is based on the state of the Project disturbance footprint during the first stages of construction work; for example, immediately following site clearing and before new surfaces or any significant change in site topography is established. The existing environment of topography and drainage is based on areas assumed to be locations of intensive construction zones (18 zones, Figure A.1 to Figure A.18), and excludes linear areas such as new and existing roads and also areas within Tarraleah Village, which may not be disturbed based on the reference design (Table A.3).

A.2.1 Slope

Slope categories are based on Tables E3 and F2 in IECA (2018) and summarised for each zone of intensive construction (Table A.3).

The pipeline and Tarraleah construction compound have the lowest relief of all the intensive construction zones. The eastern explosive magazine, Lyell Highway and Butlers Gorge Road intersection and western portal have low to moderate slope relief; however, the western portal has localised areas of steep to very steep slopes. Variable slopes were common to eleven intensive construction zones, with

localised steep areas common. The civil works laydown area, Paddy's quarry and Tarraleah hillside area are predominantly steep intensive construction zones (Table A.3).

A.2.2 Drainage

The middle access portal, TML quarry and TML southern option are primarily located on catchment divides within the watershed of various receiving waters, including Nive River, River Derwent, Lake Binney, Mossy Marsh, Hornes Dam and the lower Derwent catchment. The drainage pattern of the Lyell Highway and Butlers Gorge Road intersection and the power station is primarily via constructed drainage lines. The remaining fourteen intensive construction zones have inflows that vary from small headwaters to more significant watercourses, five of which also intersect swampy areas (Table A.3).

Drainage from the nineteen intensive construction zones flows within the Nive River and River Derwent catchments. Natural runoff from twelve of the nineteen intensive construction zones flows to the Nive River. Of these twelve zones, some of the zone within the Lyell Highway and Butlers Gorge Road intersection also flows the River Derwent and the TML quarry potentially to Lake Binney. The northern and southern TML options flow to the Lower Derwent Catchment. The pipeline, western explosives magazine, western tunnel portal and upgrade works explosives magazine flow to the River Derwent; however, some of the western portal tunnel zone may be intercepted by the Tarraleah No. 1 canal, which needs to be verified. The water quality management alignment and the middle access portal flow to Mossy Marsh Pond; however, some of the middle access portal zone may also flow to Hornes Dam. The eastern explosives magazine flows to the No. 2 pond. The TML northern and southern options, power station civil works laydown area and Tarraleah hillside intersect directly with the Nive River riverbank (Table A.3).

Table A.3: Slope and drainage for assumed zones of intensive construction work within the disturbance footprint

Assumed intensive construction zones	Associated disturbance footprint	Area (significant construction activity, ha)	Per cent area represented by slope category				Current slope description	Current drainage description	Map reference
			0-5 %	6-10 %	11-20 %	>20 %			
Civil works laydown area	Tarraleah Village	2.9	18.3	6.6	10.2	64.8	Steep valley margin of the Nive River and some level areas, including public space and power station switchyard	Intersects numerous natural inflows from the steep, upstream slope that flow into the Nive River, with some drainage control along existing roads. Also located on the bank of the Nive River	Figure A.1
Eastern explosive magazine	Eastern explosive magazine and access track	1.6	51.4	32.7	14.8	1.2	Low to moderate relief area located within natural vegetation	Intersects with a major inflow and numerous minor inflows within a natural headwater for No. 2 Pond	Figure A.2
Lyell Highway, Butlers Gorge Road Intersection	Lyell Hwy and Butlers Gorge Rd Intersection	0.6	46.5	34.7	14.3	4.5	Low to moderate relief area at the Highway intersection with	Local drainage lines diverted from the current intersection by road and canal drainage that flow into tributaries of the Nive River and the River Derwent	Figure A.3
Lyell Highway Oldina Drive Intersection	Tarraleah Village	1.6	33.8	35.4	25.2	5.6	Variable slope area at the Highway intersection	Intersects numerous natural inflows that flow into a tributary of the Nive River	Figure A.4
Middle access portal	Mid-Access Tunnel Portal with Access Track	35.2	23.2	26.2	29.7	20.9	Variable slope from a steep, eastern-facing slope with an area a lower relief downslope	On the catchment divide that intersects numerous watercourses that flow to Hornes Dam and Mossy Marsh Pond	Figure A.5
TML northern option	Northern TML Option	111.6	20.1	22.0	30.2	27.7	Variable slope along a long, narrow alignment, which includes the steep valley margin of the Nive River and the Dee Lagoon shoreline	Intersects numerous natural inflows and swampy areas across a wide geographical area. Intersected watercourses flow to the Nive River, Dee Lagoon and the lower Derwent catchment. Also intersects the bank of the Nive River	Figure A.6
Paddy's quarry	Main Distribution Lines, Paddy's Quarry	36.0	10.0	16.0	29.0	45.0	Steep valley margin of the Nive River	Intersects numerous natural inflows and swampy areas that flow directly to the Nive River	Figure A.7

Assumed intensive construction zones	Associated disturbance footprint	Area (significant construction activity, ha)	Per cent area represented by slope category					Current drainage description	Map reference
			0-5 %	6-10 %	11-20 %	>20 %	Current slope description		
Pipeline	Pipeline	25.6	64.7	26.5	7.4	1.4	Primarily low relief area located within natural vegetation	Intersects numerous natural inflows and swampy areas that flow to the River Derwent	Figure A.8
Power station	Main Distribution Lines, Tarraleah Village, TML Options	2.2	30.6	12.6	8.1	48.6	Variable slope , including steep, valley margin of the Nive River upslope from the low relief area of the current Tarraleah switchyard	Intersects with existing Lyell Highway and power station site drainage, which discharges to the Nive River. The power station is also located on the bank of the Nive River	Figure A.9
Sewage treatment ²	Tarraleah Village	7.0 (5.3)	50.1 (34.2)	22.7 (29.9)	16.1 (21.3)	11.1 (14.6)	Variable slope with localised steep areas, including the existing pond batters	Intersects numerous natural inflows that flow to the Nive River	Figure A.10
TML southern option	Southern TML Option	134.5	11.1	16.0	29.8	43.1	Variable slope along a long, narrow alignment, which includes the steep valley margin of the Nive River	Intersects numerous swampy areas and tributary headwaters of the Nive River along the valley margin across a wide geographical area. However, some locations along the alignment may flow into the lower Derwent catchment from the catchment divide. Also intersects the bank of the Nive River	Figure A.11
Surge tower	Surge Tower and Pump Station	10.8	30.2	28.7	28.1	13.0	Variable slope within a currently forested area with localised steep areas, including downslope from the proposed pump station and the No. 2 pond dam batter	Intersects numerous natural inflows that flow to the Nive River	Figure A.12

² Percent area of slope category presented in brackets represents the intensive construction zone minus the sewage basin (slope < 1 % excluded from the analysis)

Assumed intensive construction zones	Associated disturbance footprint	Area (significant construction activity, ha)	Per cent area represented by slope category				Current drainage description	Map reference	
			0-5 %	6-10 %	11-20 %	>20 %			Current slope description
Tarraleah hillside	Tarraleah Village	4.9	1.4	6.1	9.2	83.2	Steep valley margin of the Nive River	Intersects numerous natural inflows, which flow to with existing Lyell Highway and power station site drainage, which discharges to the Nive River. The hillside area extends to the bank of the Nive River	Figure A.13
Tarraleah construction compound	Tarraleah Village	11.3	65.9	25.4	8.5	0.1	Primarily low relief areas within the Tarraleah Village, with small areas of steep flow at the top of the Nive River valley margin	Intersects with numerous natural inflows that include: <ul style="list-style-type: none"> - A tributary of the Nive River that flows to ponds within the village. These ponds discharge to the Nive River during spill events - Other tributaries of the Nive River 	Figure A.14
TML quarry	TML Options	2.3	18.5	21.3	26.1	34.0	Variable slope with localised very steep areas, including upslope from the quarry, around the existing quarry pit margins and downstream watercourse	Located on the catchment divide between tributaries to the Nive River and Lake Binney	Figure A.15
UGW explosive magazine	Upgrade work and magazine	1.9	55.3	18.2	19.3	7.2	Variable slope with localised steep areas upslope of a low relief area. This area has already been cleared and the site prepared under the Tarraleah Upgrade project	Intersects numerous natural inflows that flow into a swampy area and then to the River Derwent	Figure A.16
Western explosive magazine	Western explosive magazine and access track	3.7	32.8	40.4	24.6	2.2	Variable slope area with some very localised steep areas within a current forested area.	Intersects numerous natural inflows that flow to the River Derwent	Figure A.17

Assumed intensive construction zones	Associated disturbance footprint	Area (significant construction activity, ha)	Per cent area represented by slope category					Current drainage description	Map reference
			0-5 %	6-10 %	11-20 %	>20 %	Current slope description		
Western portal	Main Distribution Lines, Pipeline, Water Quality Management, Western Portal and Pipeline	53.8	50.5	28.5	15.9	5.1	Low to moderate relief area with localised steep to very steep areas within a current area of natural vegetation.	Intersects numerous natural inflows and swampy areas that flow to the River Derwent and possibly Tarraleah Canal No. 1	Figure A.18

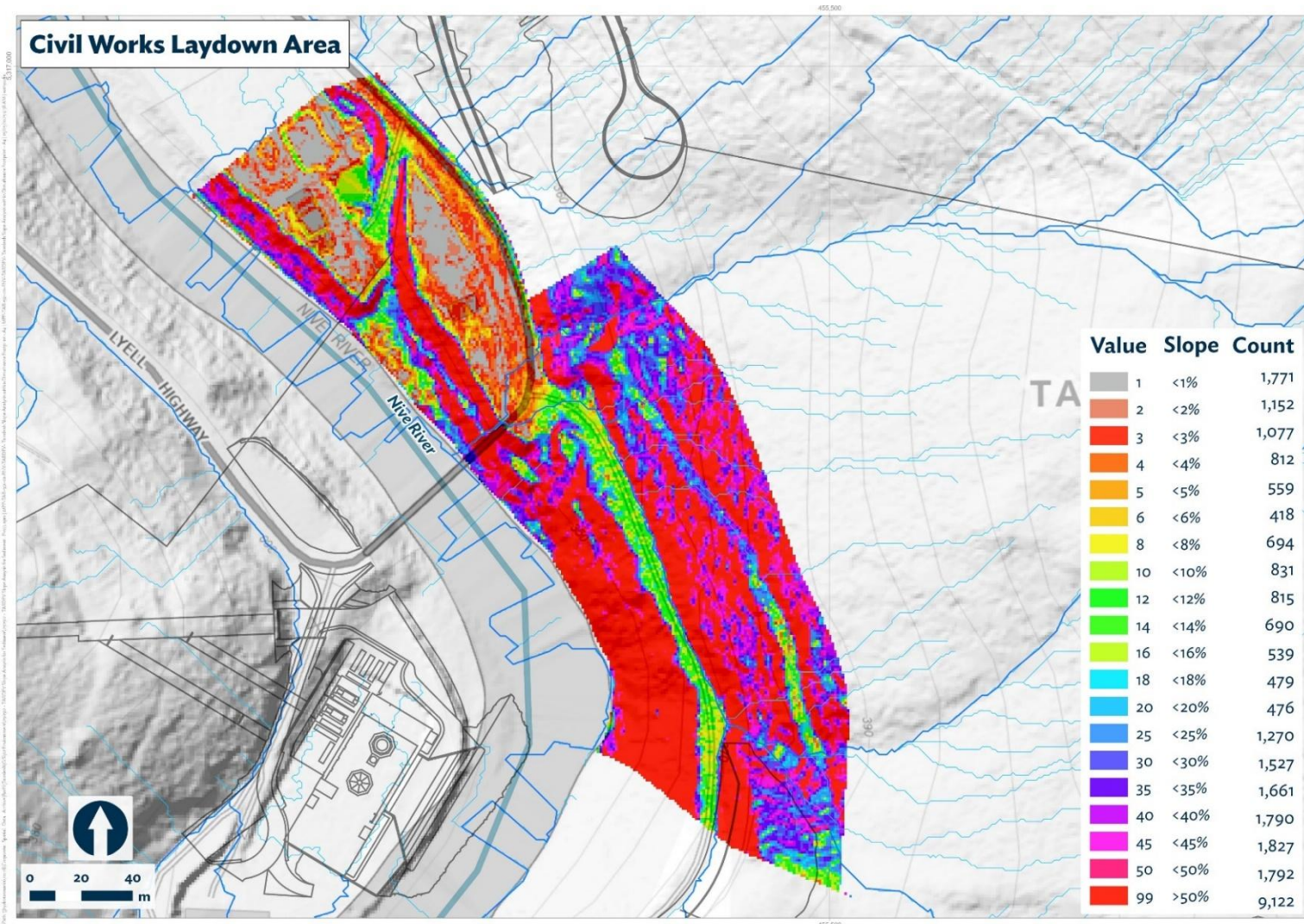


Figure A.1: Slope and drainage map for the civil works laydown area

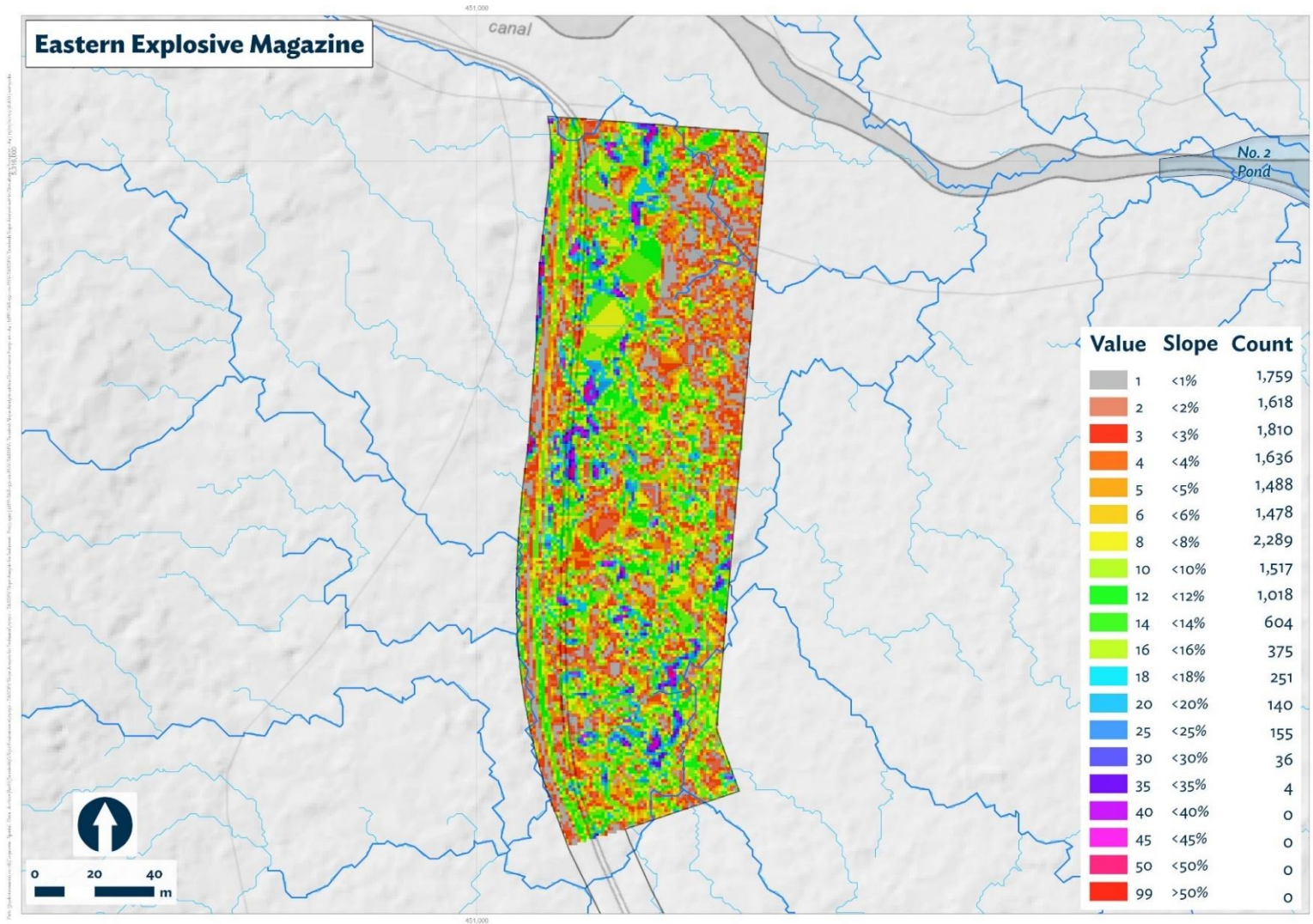


Figure A.2: Slope and drainage map for the eastern explosives magazine

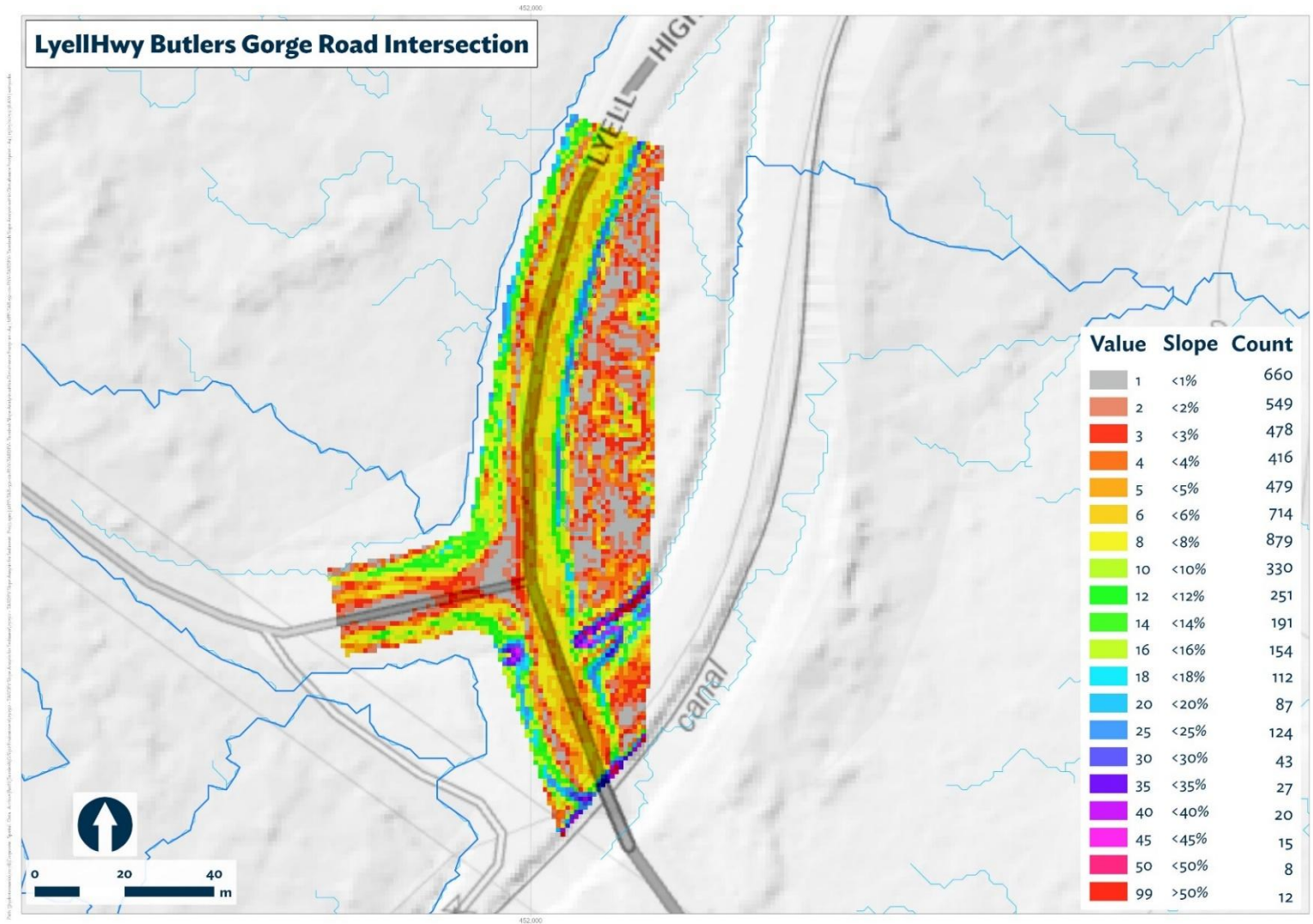


Figure A.3: Slope and drainage map for the Lyell Highway and Butlers Gorge Road intersection

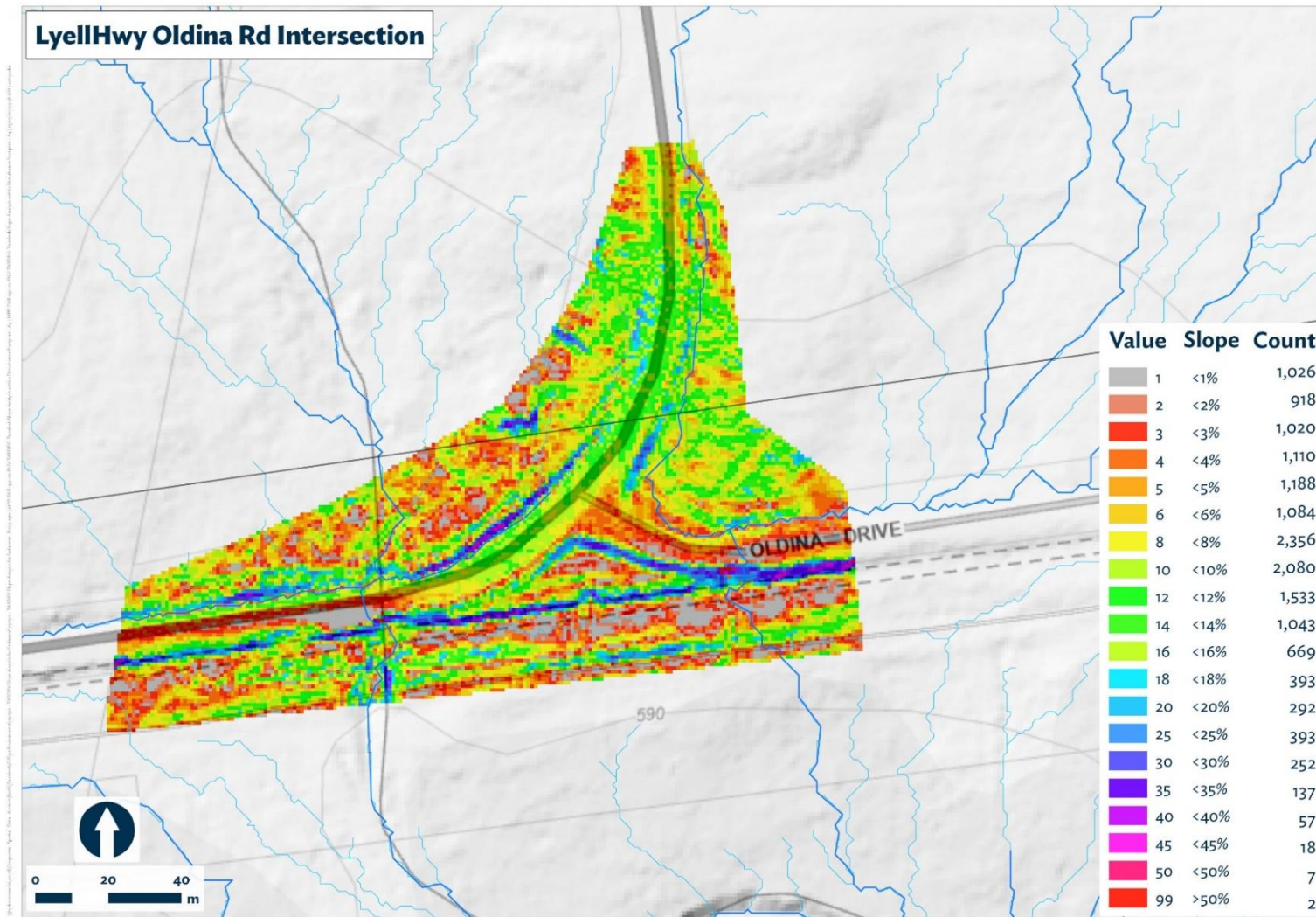


Figure A.4: Slope and drainage map for the Lyell Highway and Oldina Drive intersection

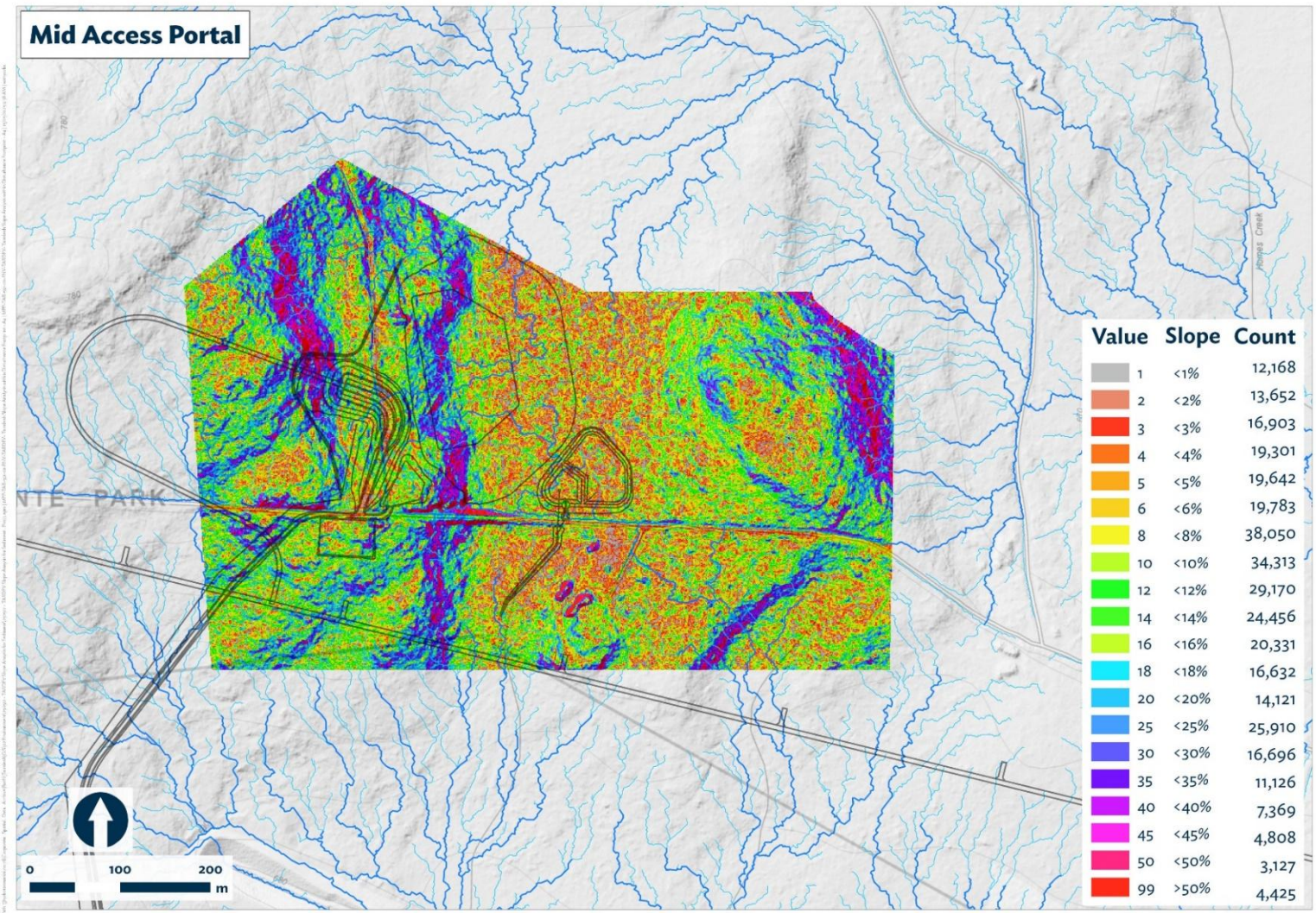


Figure A.5: Slope and drainage map for the middle access portal

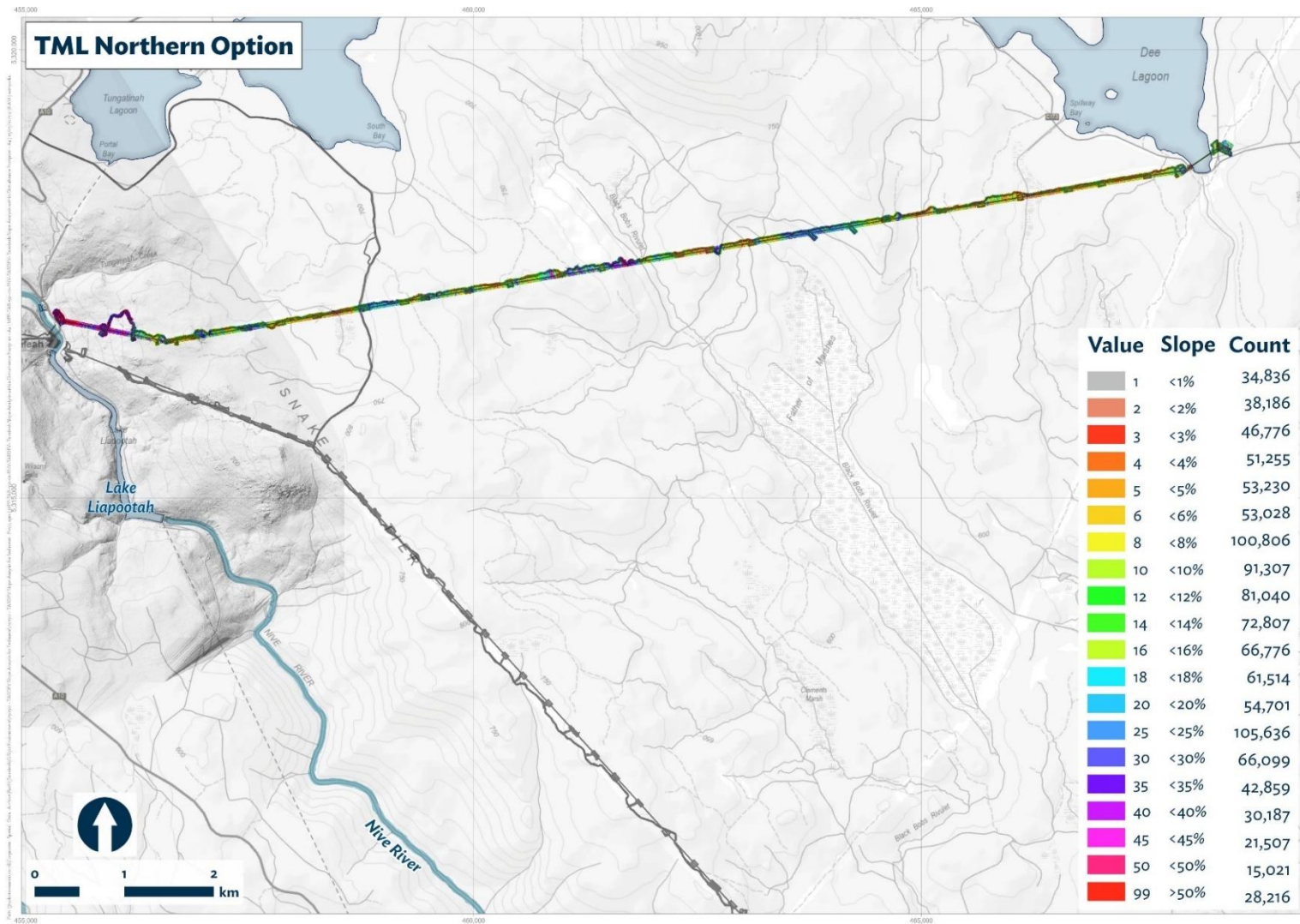


Figure A.6: Slope and drainage map for the northern transmission line option

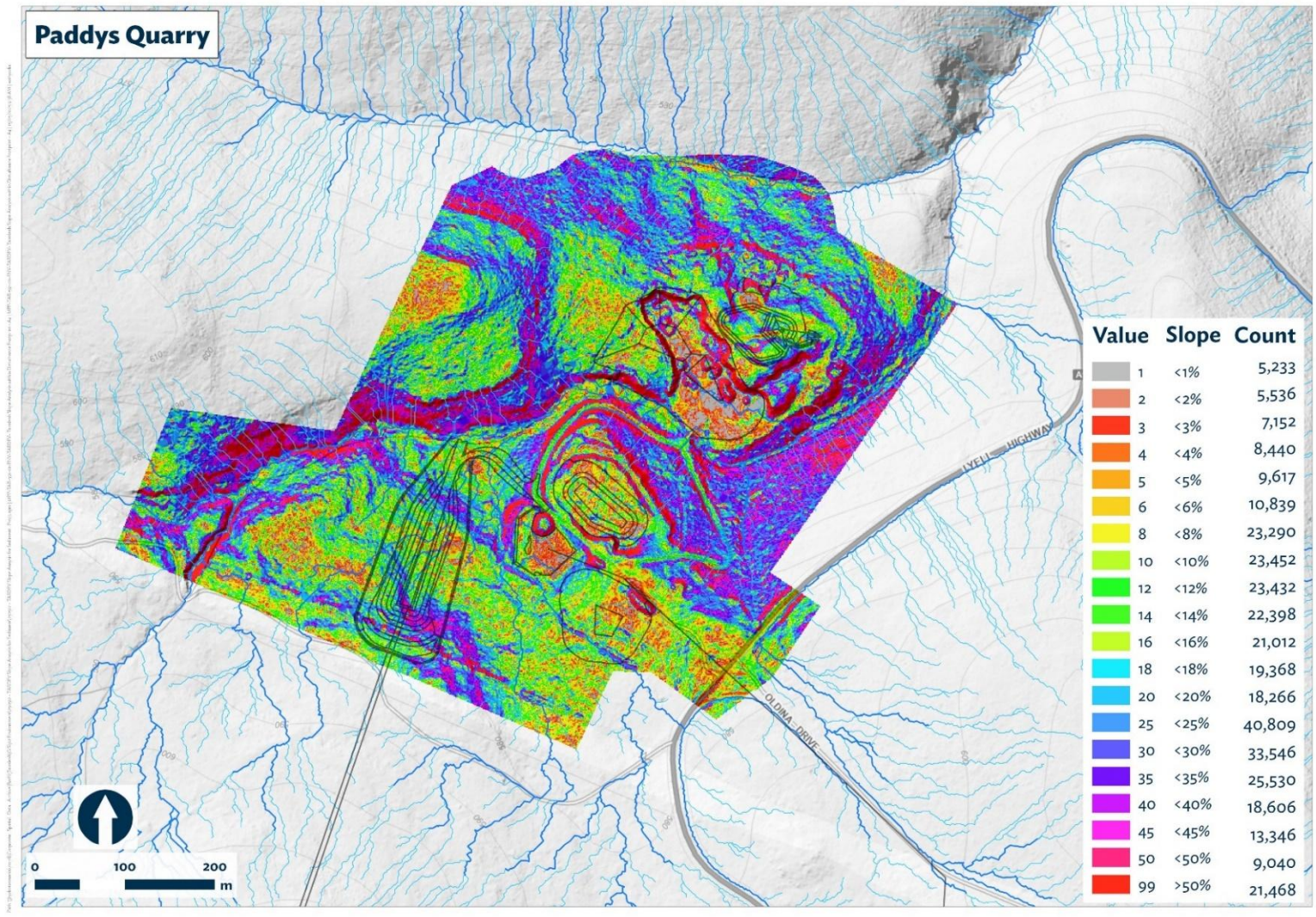


Figure A.7: Slope and drainage map for Paddy's quarry

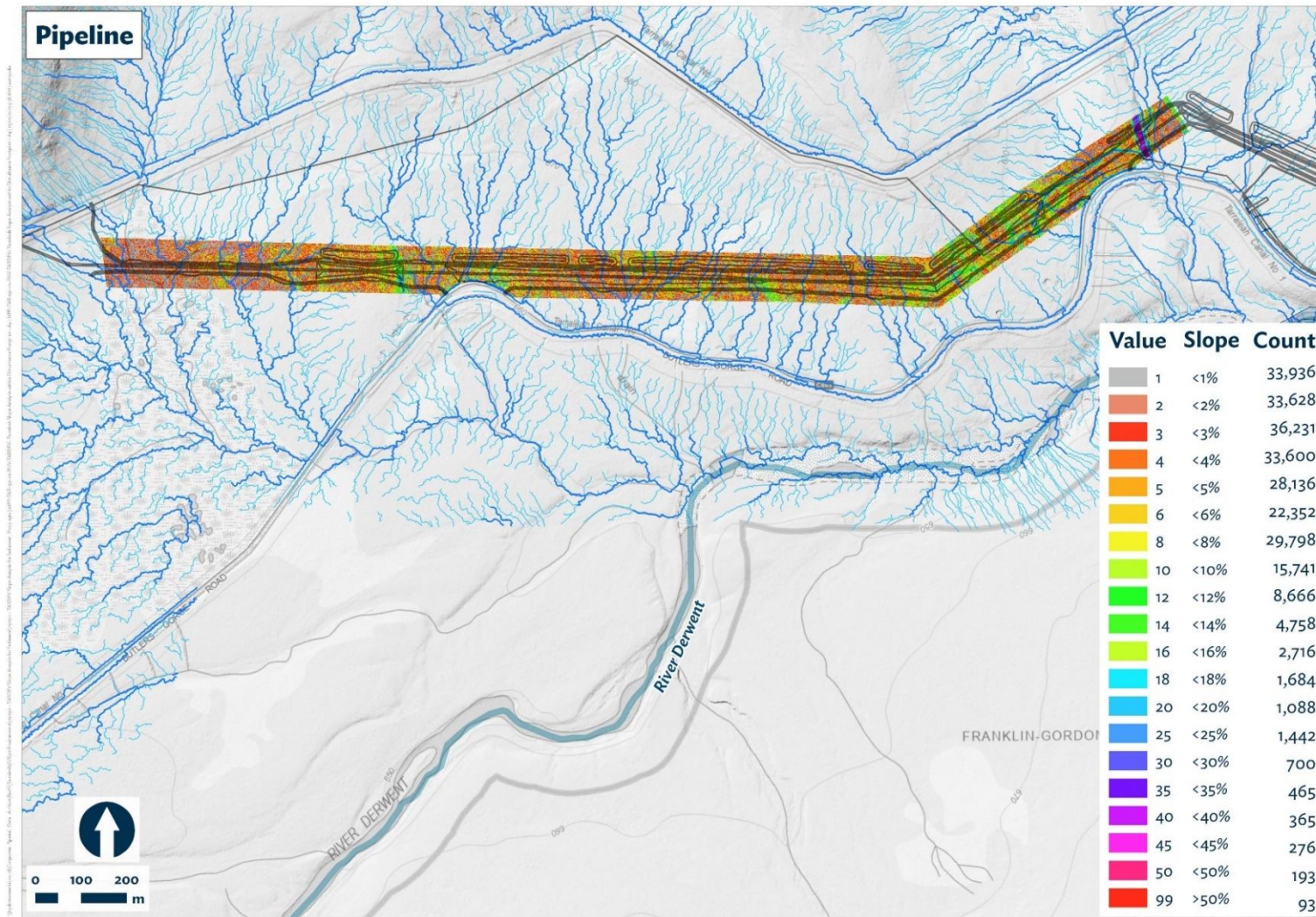


Figure A.8: Slope and drainage map for the pipeline

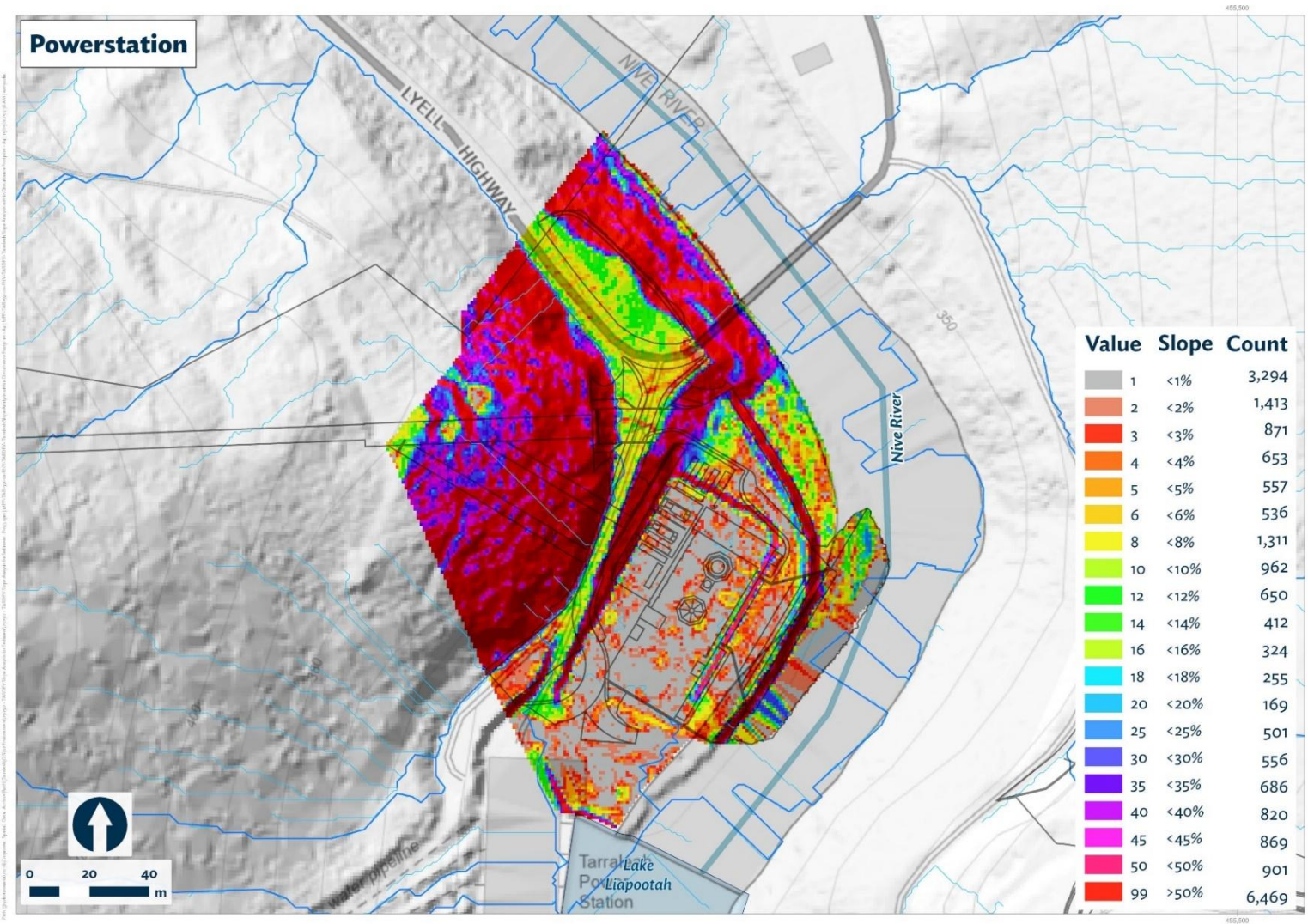


Figure A.9: Slope and drainage map for the power station

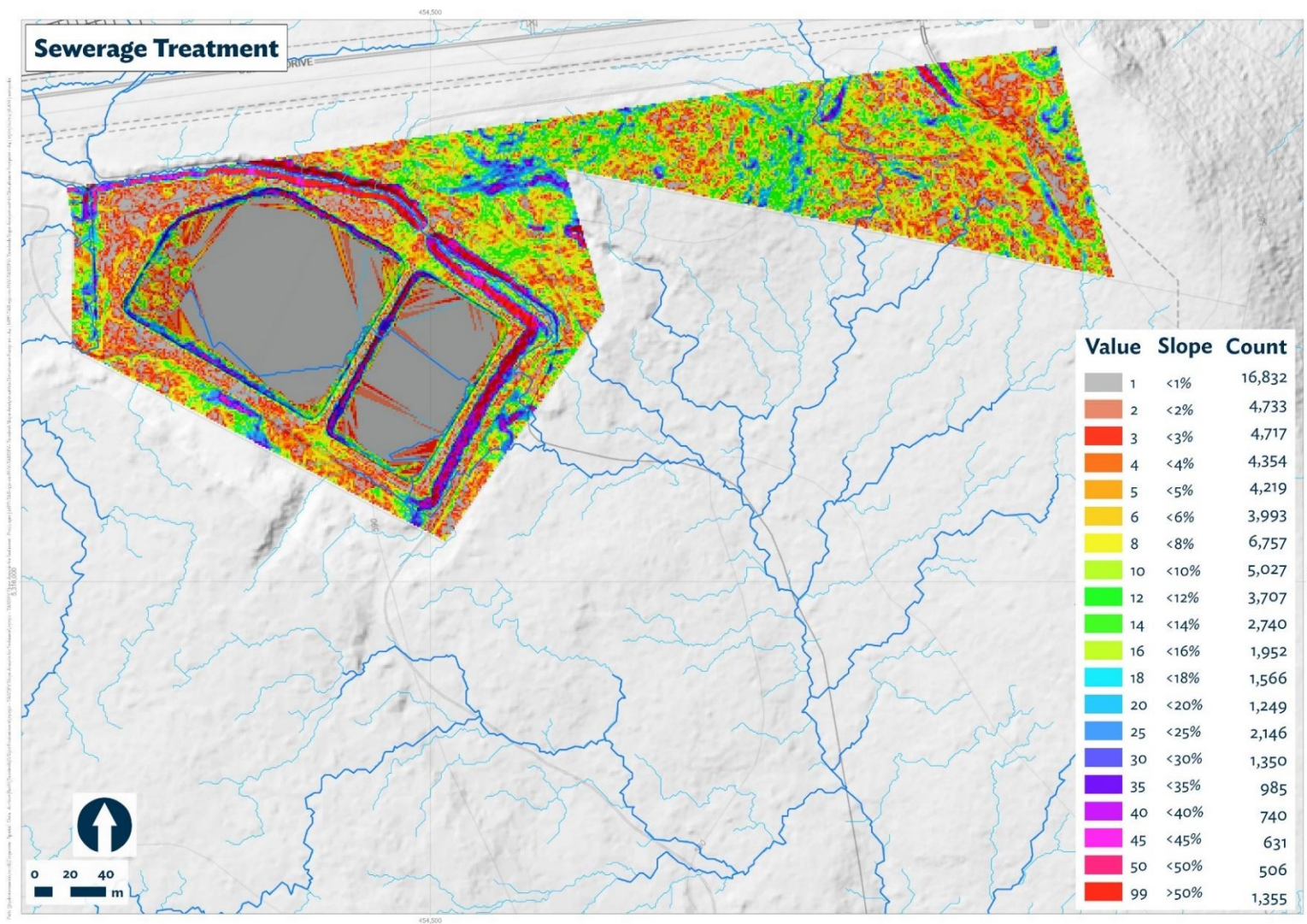


Figure A.10: Slope and drainage map for the sewage treatment area

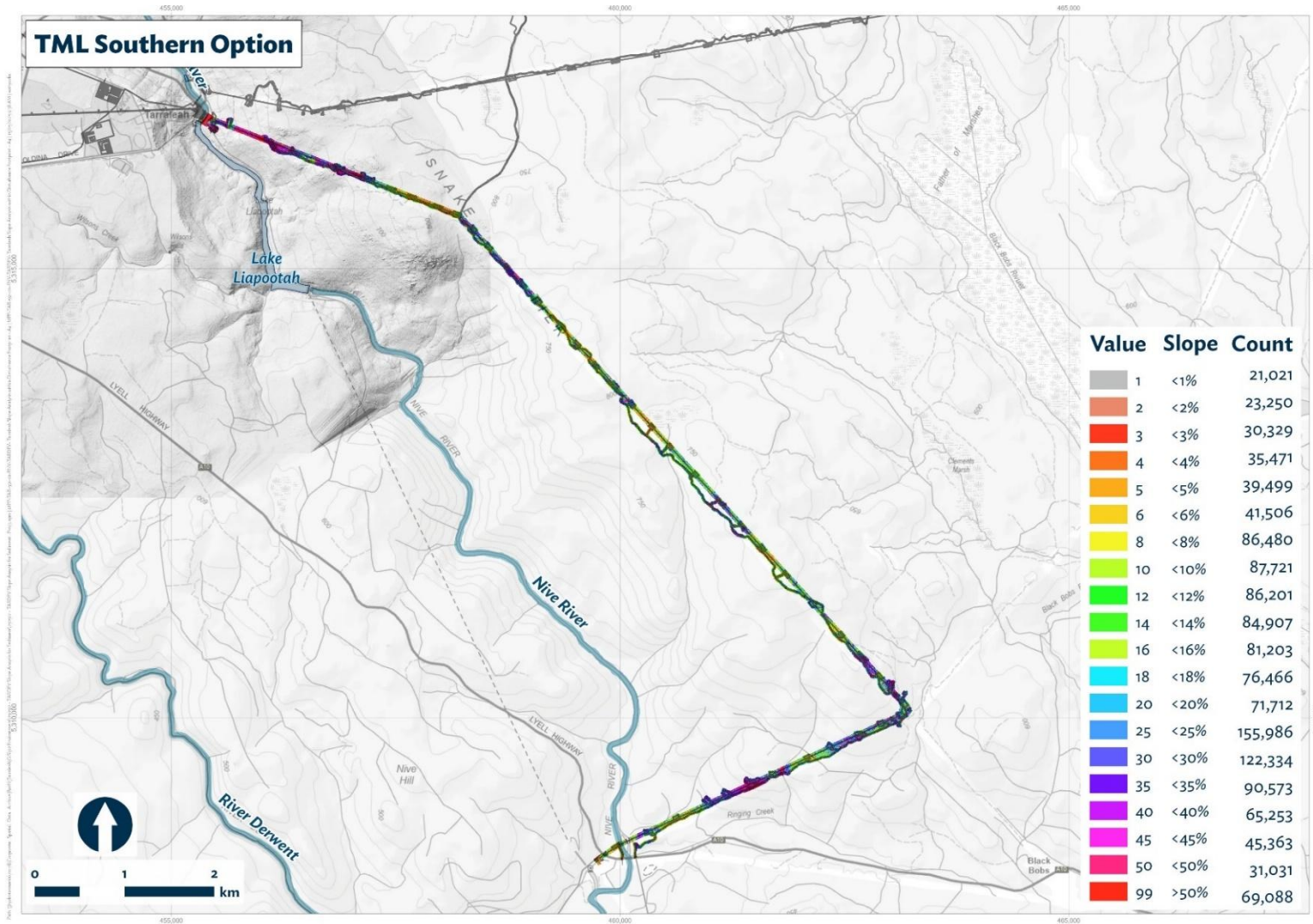


Figure A.11: Slope and drainage map for the southern transmission line option

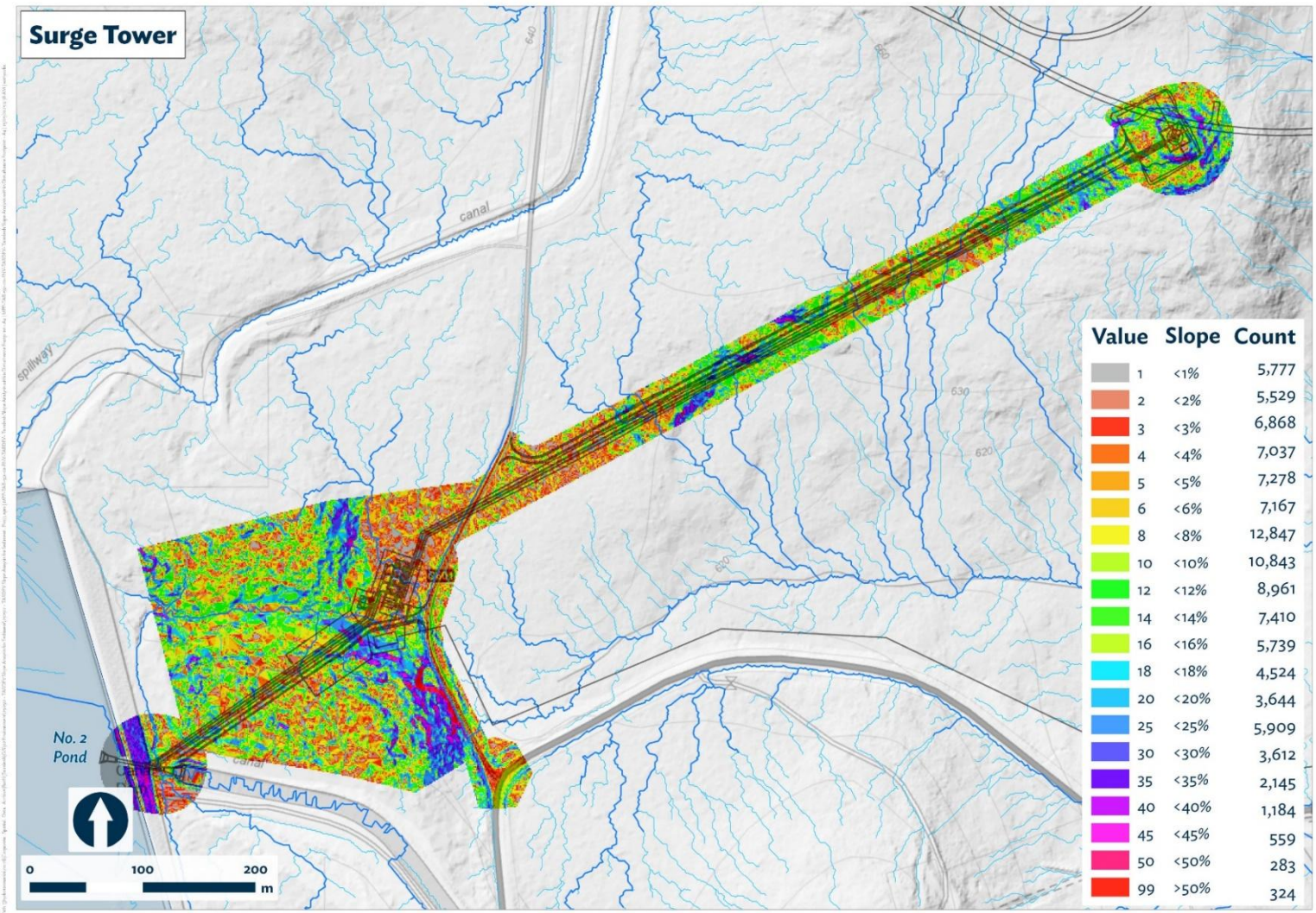


Figure A.12: Slope and drainage map for the surge tower and pump station

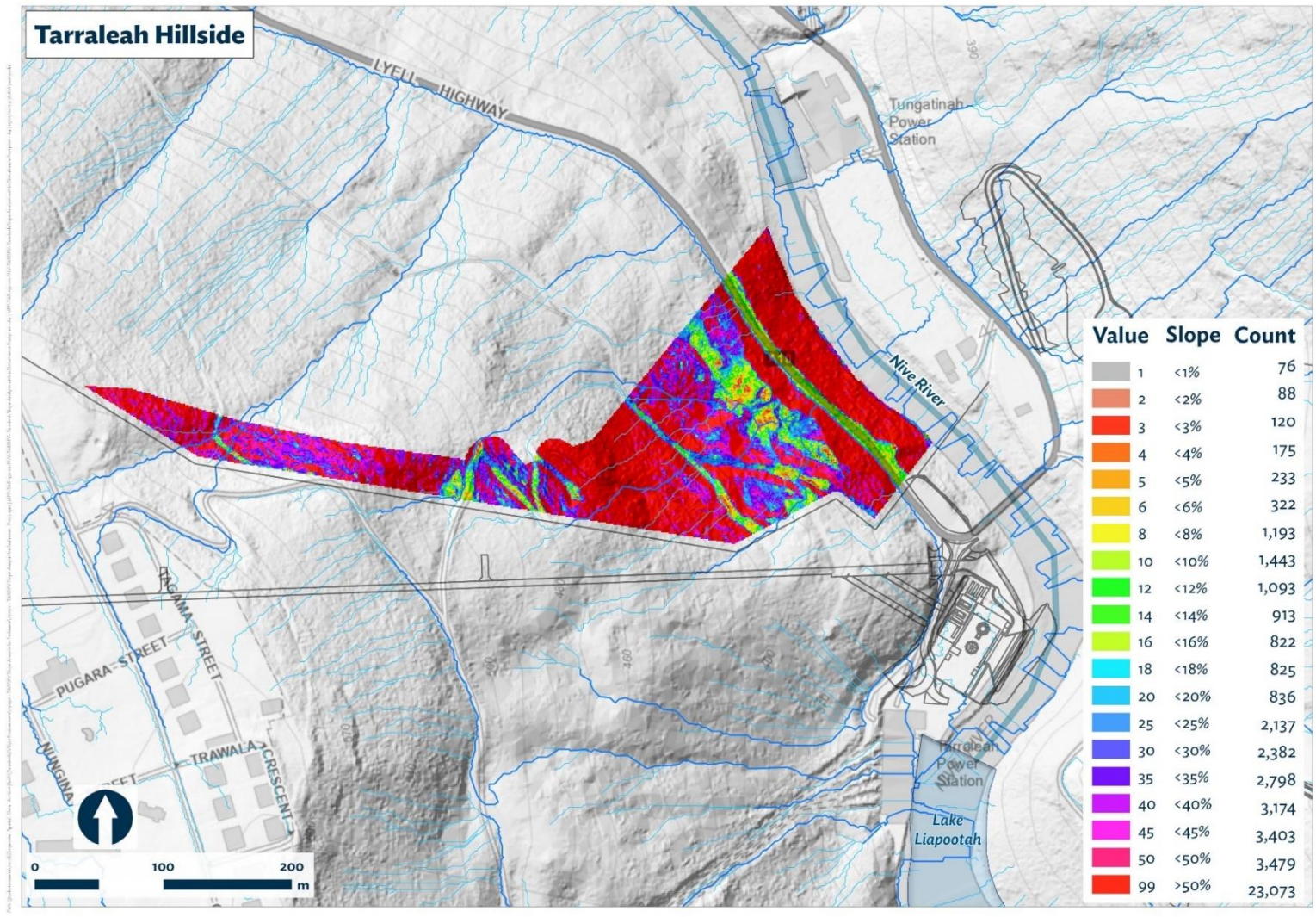


Figure A.13: Slope and drainage map for the Tarraleah hillside

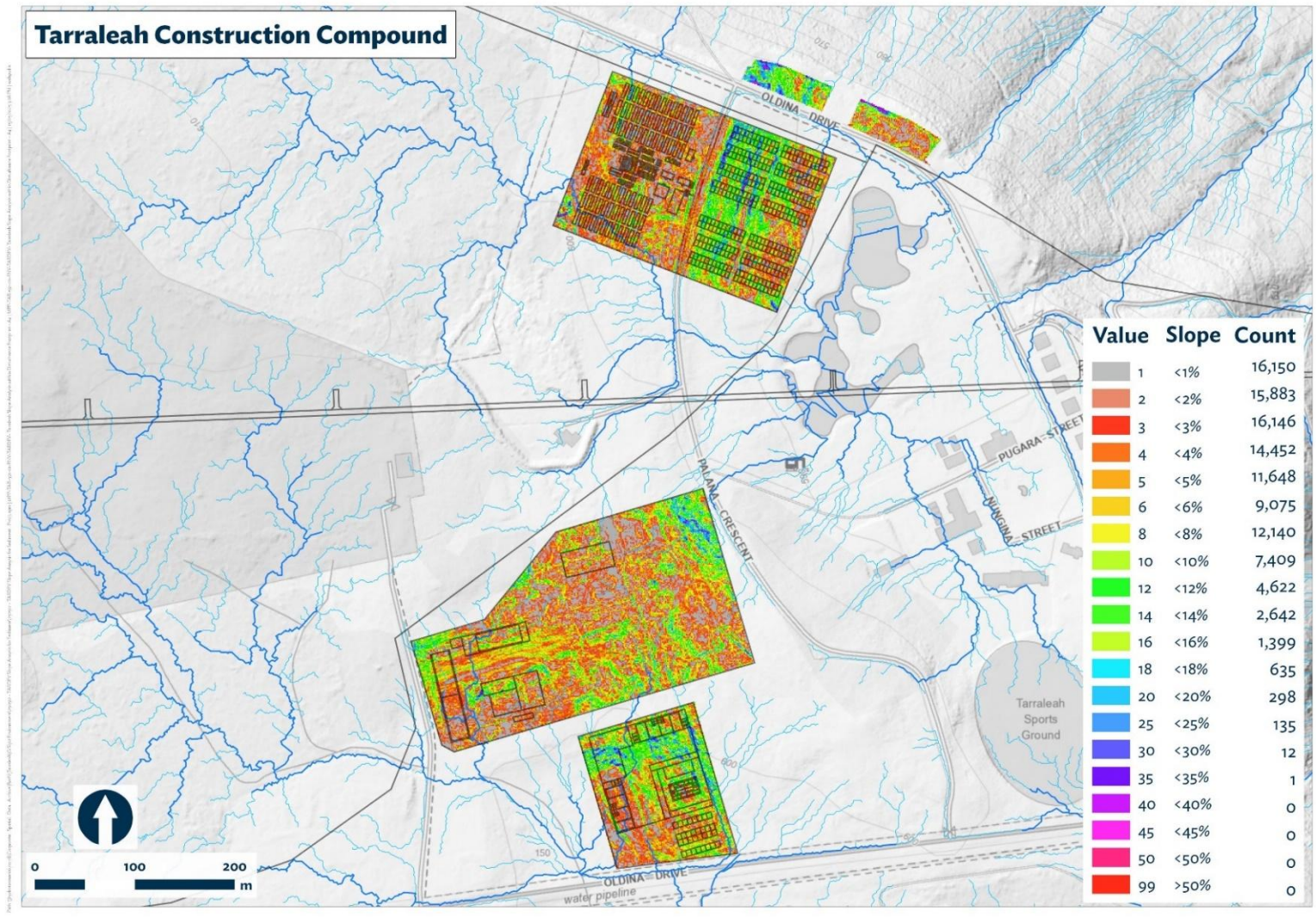


Figure A.14: Slope and drainage map for the Tarraleah construction compound

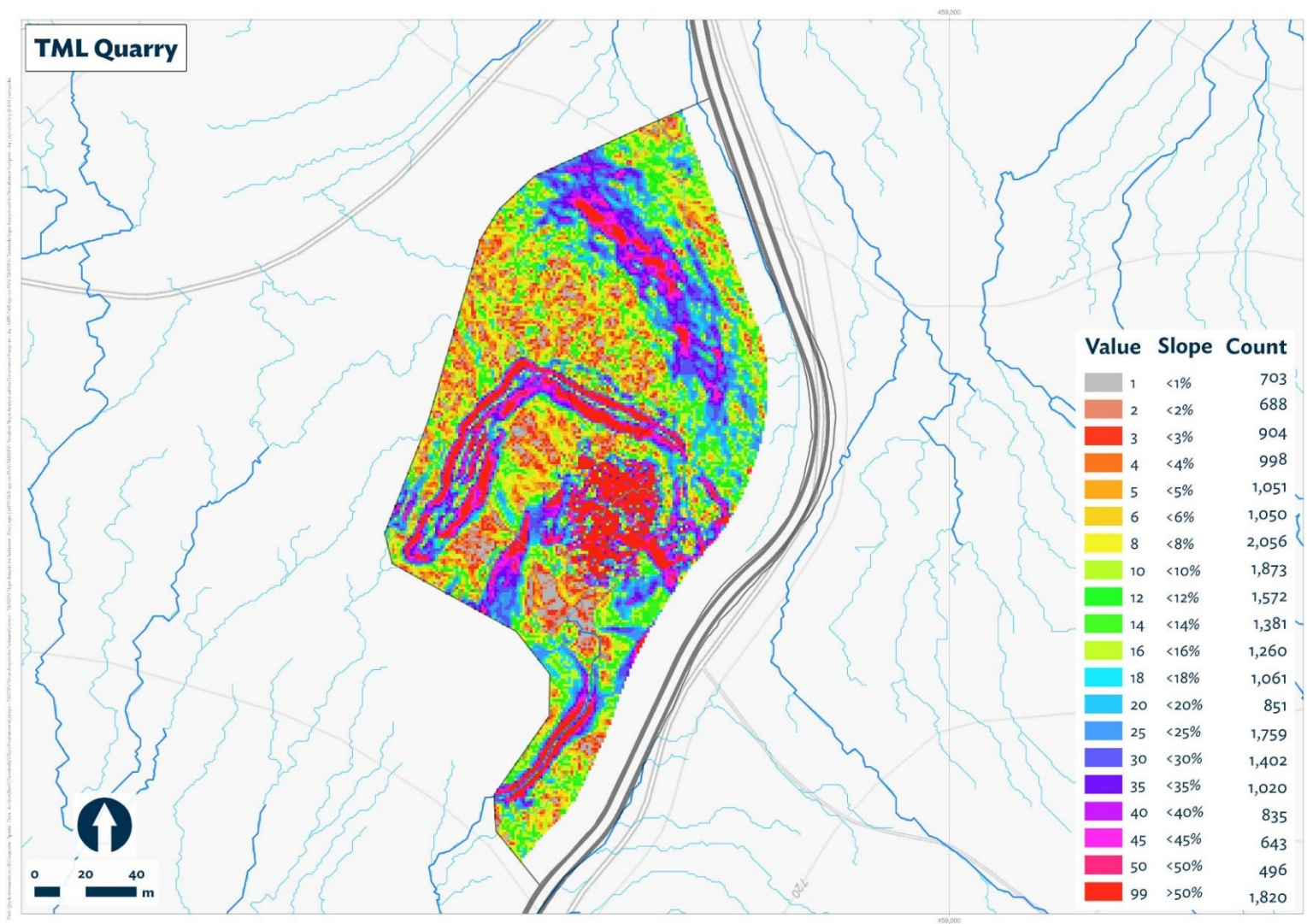


Figure A.15: Slope and drainage map for the transmission line quarry

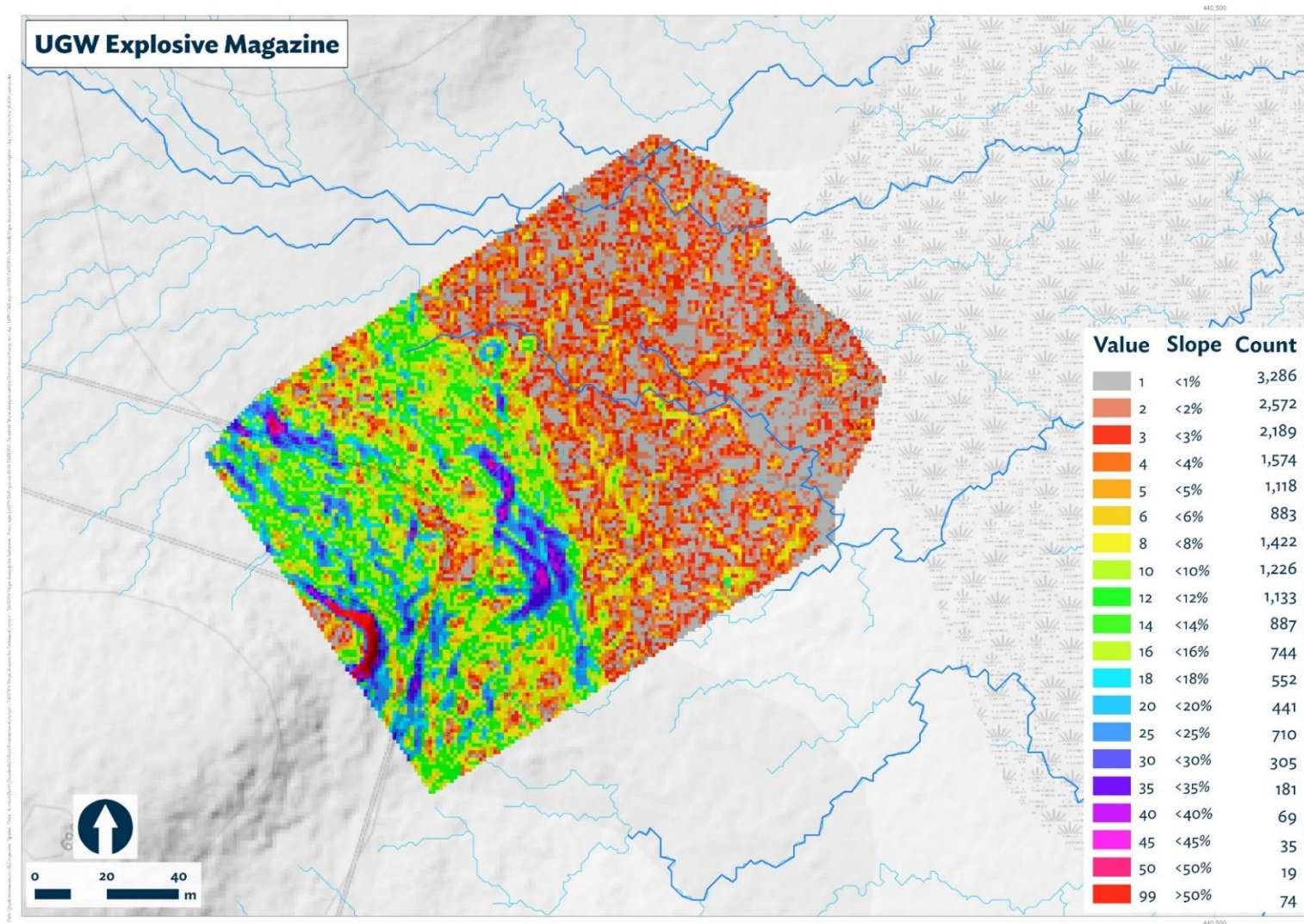


Figure A.16: Slope and drainage map for the upgrade works explosives magazine

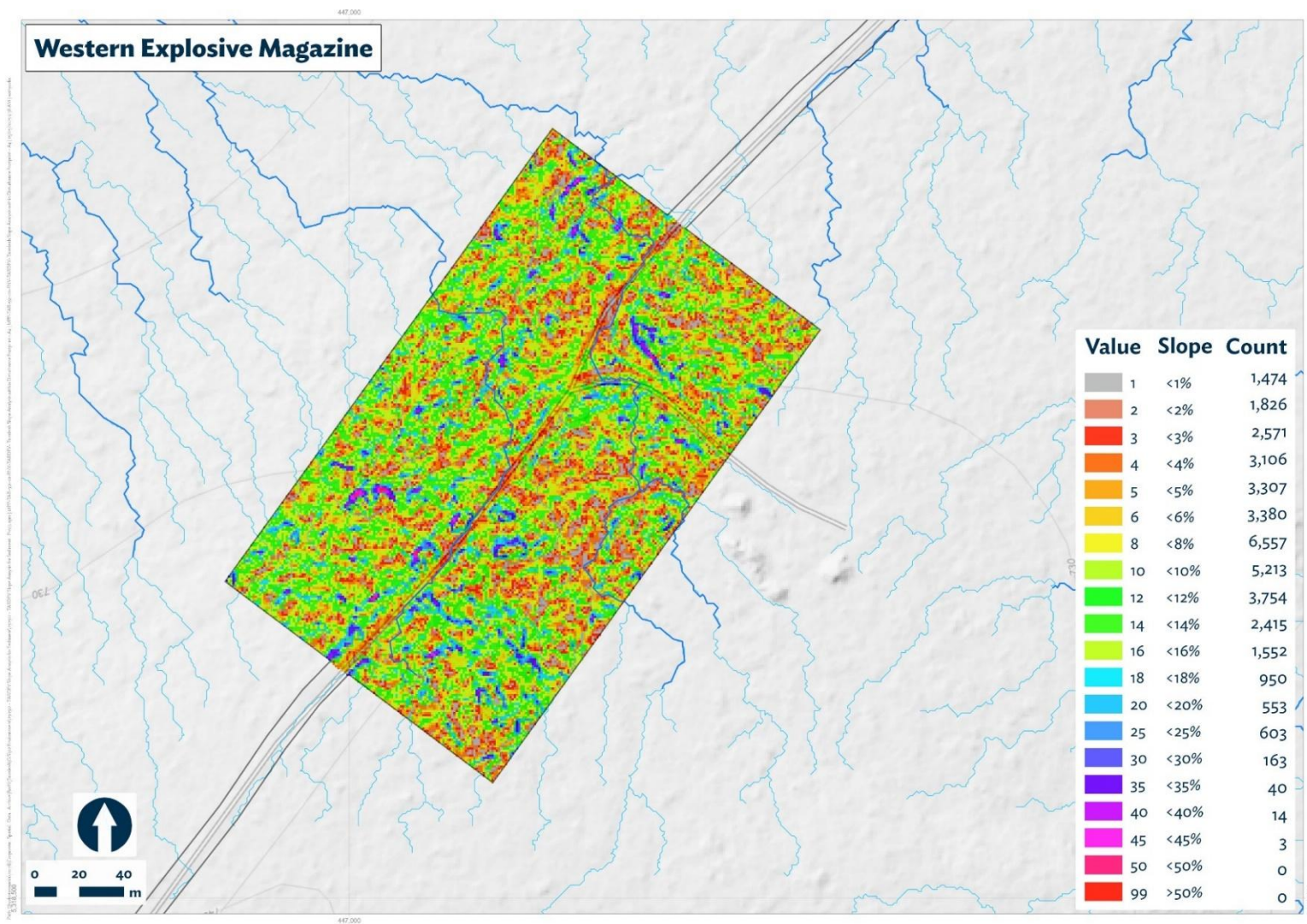


Figure A.17: Slope and drainage map for the western explosives magazine

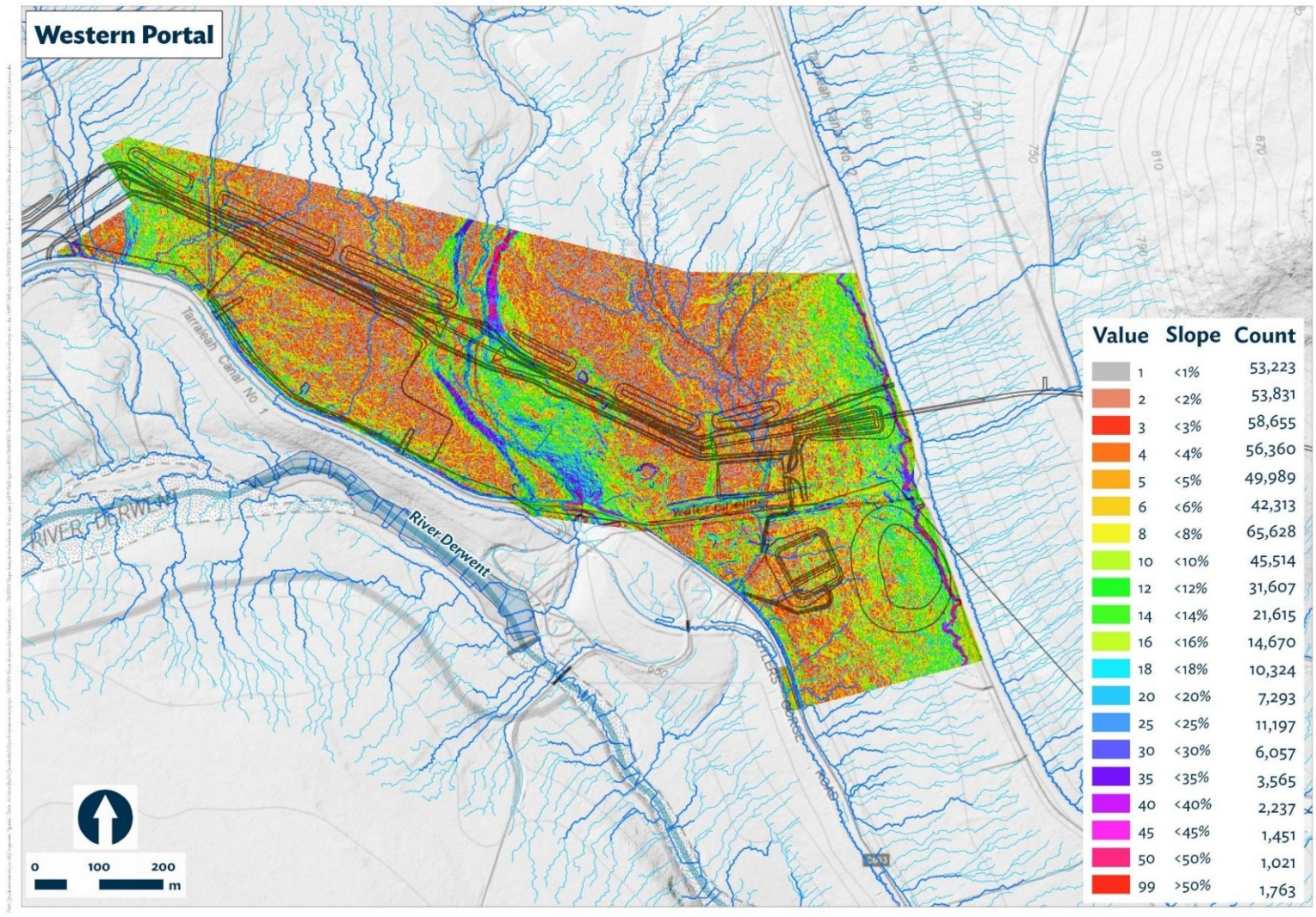


Figure A.18: Slope and drainage map for the western portal

A.3 References

IECA (2018) PSM (2024) Tarraleah Redevelopment Project Geotechnical Data Report, report number PSM4346-080R Rev 1, 20 December 2024.

PSM (2025a) *Tarraleah Redevelopment Project Geotechnical Interpretive Report*, report number PSM4346-085R Rev 1, 28 February 2025.

PSM (2025b) Tarraleah Redevelopment Project Hydrogeological Interpretive Report, report number PSM4346-115R Rev 2, 16 May 2025.

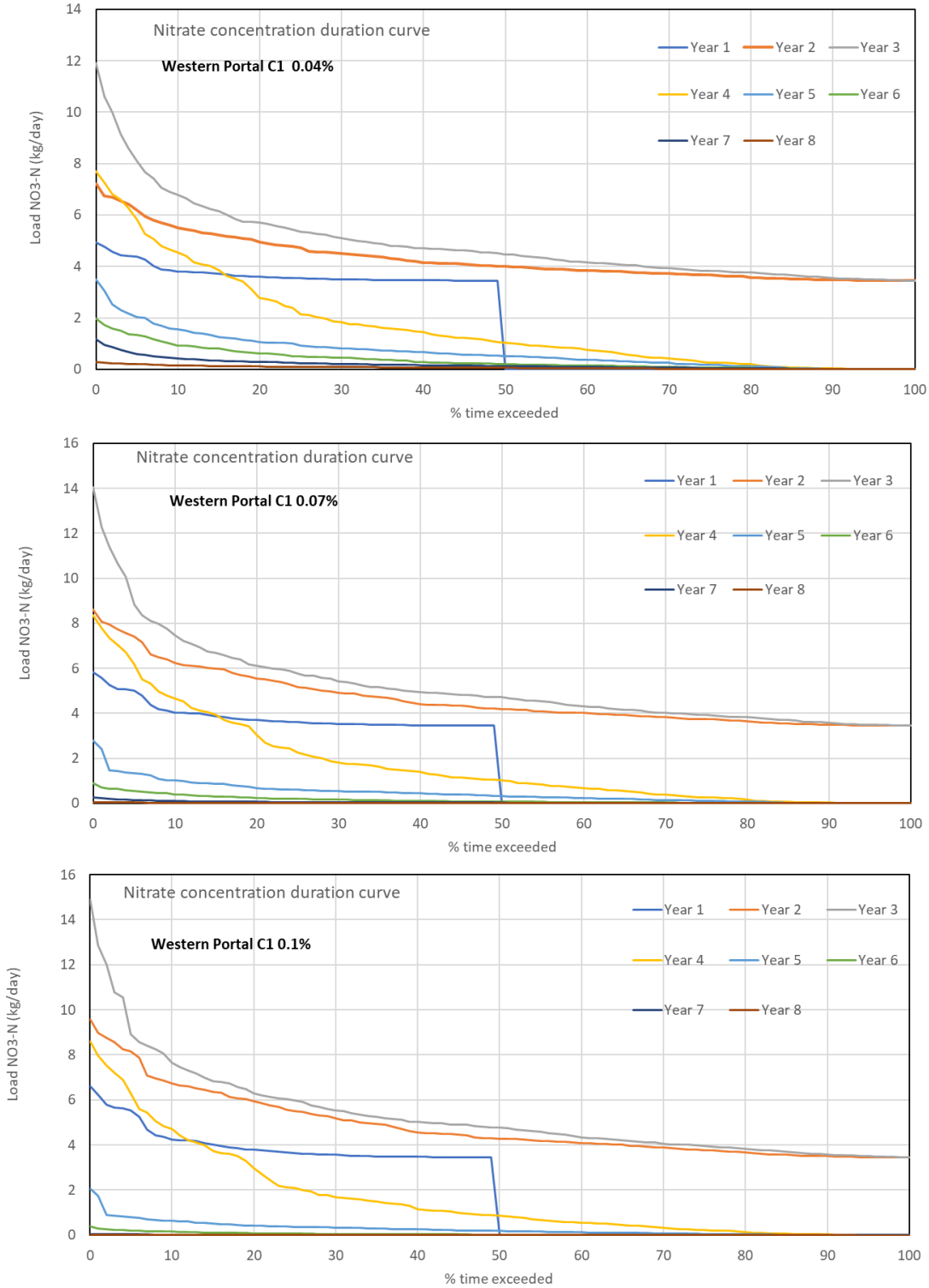
PSM (2022) Lake King William No. 3 Intake, Approach Channel, Downstream Outlet and Tunnel Factual Data Report, report number PSM4346-039R Rev 2, 31 October 2022.

Stuart-Smith, P. G. (2022) *Structure and Geology of the Tarraleah and Mossy Marsh Areas*, Report to Entura (unpublished).

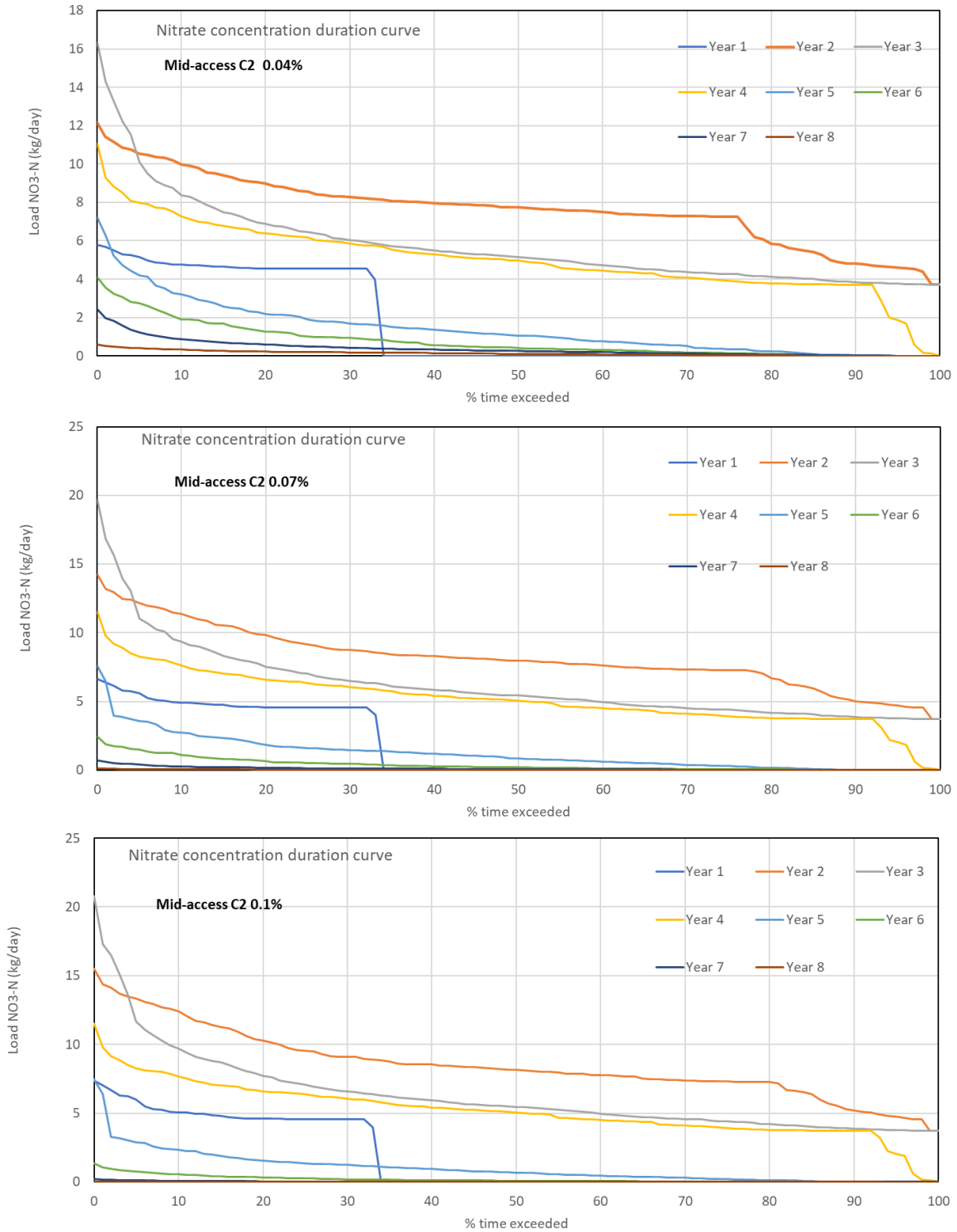
Stuart-Smith, P. G. (2023) Structure and geology of the Tarraleah Redevelopment Project Area, Report to Entura (unpublished).

B Modelled nitrate load durations (kg/d)

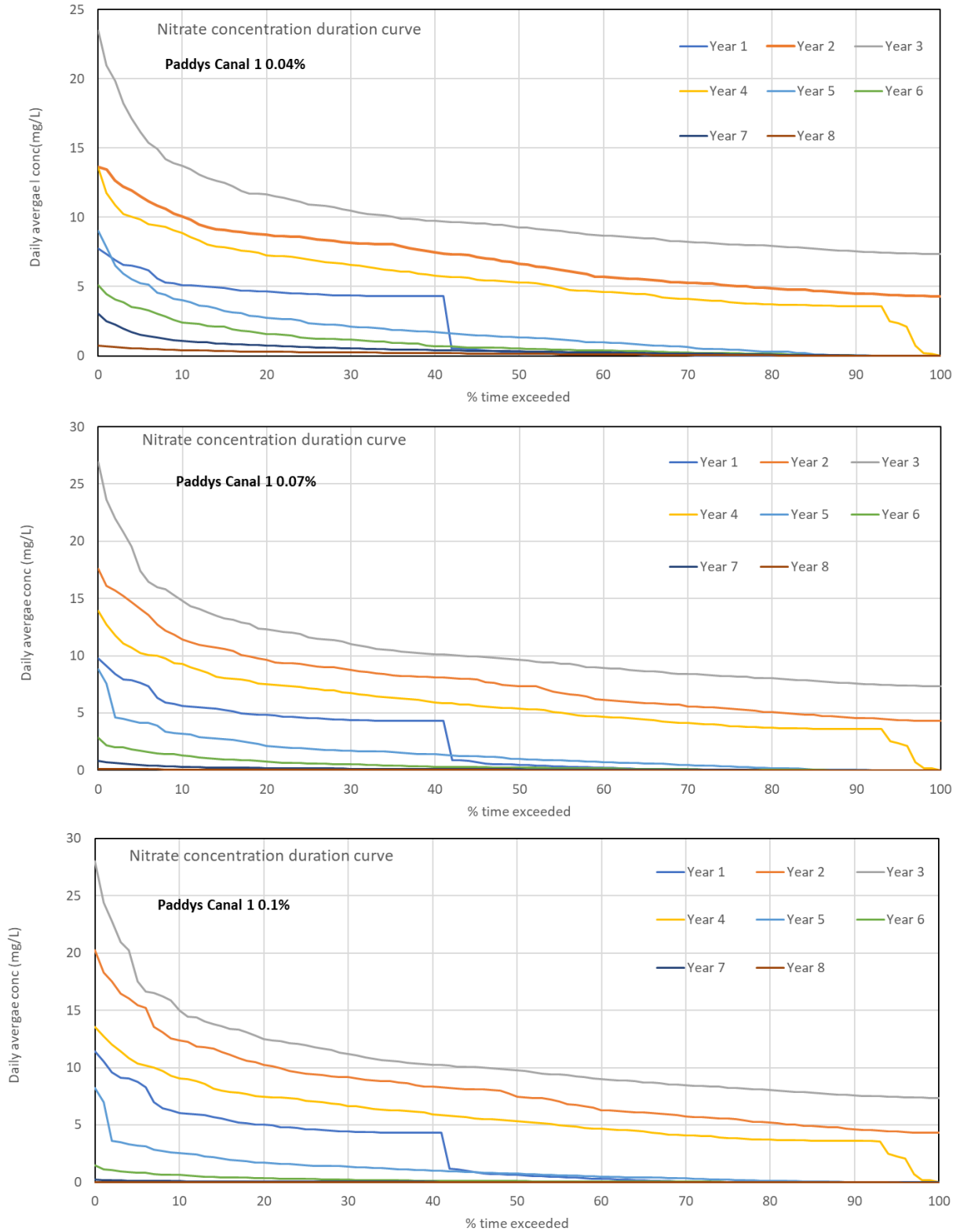
B.1 Western Portal and stockpile



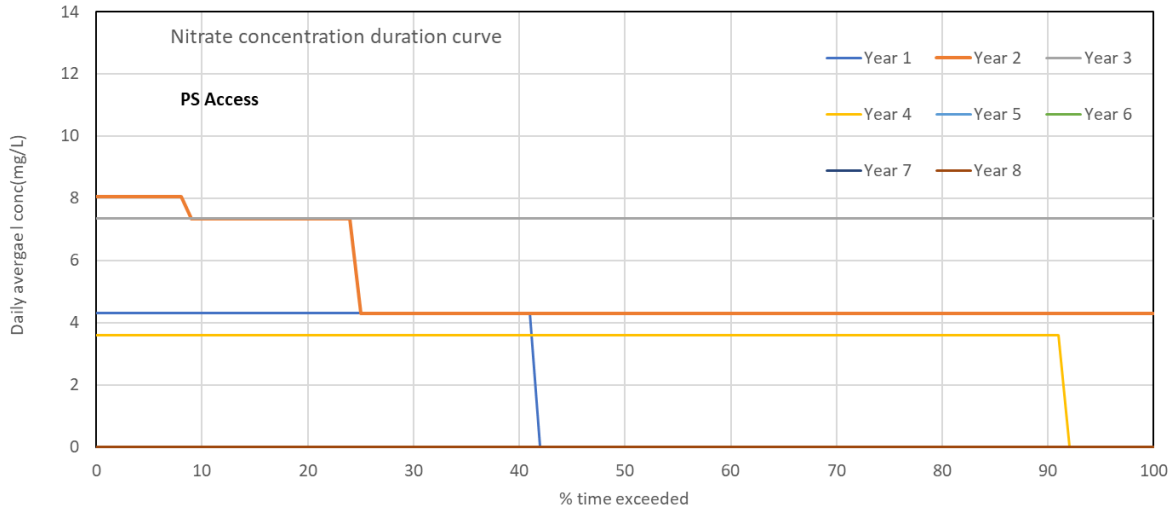
B.2 Mid-access portal and stockpile



B.3 Surge Tunnel Access and Paddy's Quarry Stockpile



B.4 Power Station



C Modelled nitrate annual loading by site

C.1 Western Portal and spoil emplacement

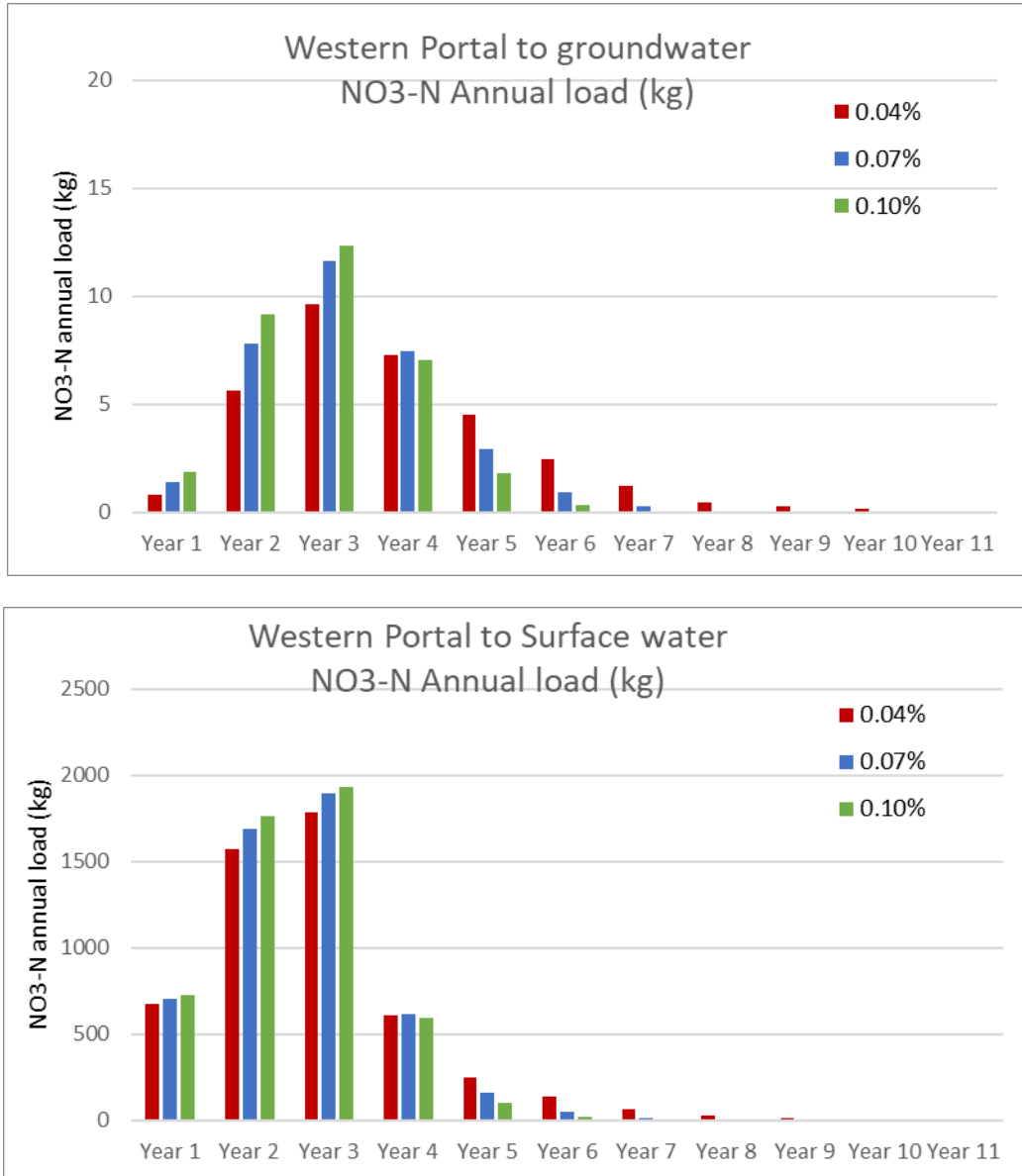


Figure C.1: Annual estimates of nitrate to groundwater using base case recharge rate (top) and to surface water (bottom) at the western portal site with different stockpile wash rates.

C.2 Mid-access portal and spoil emplacement

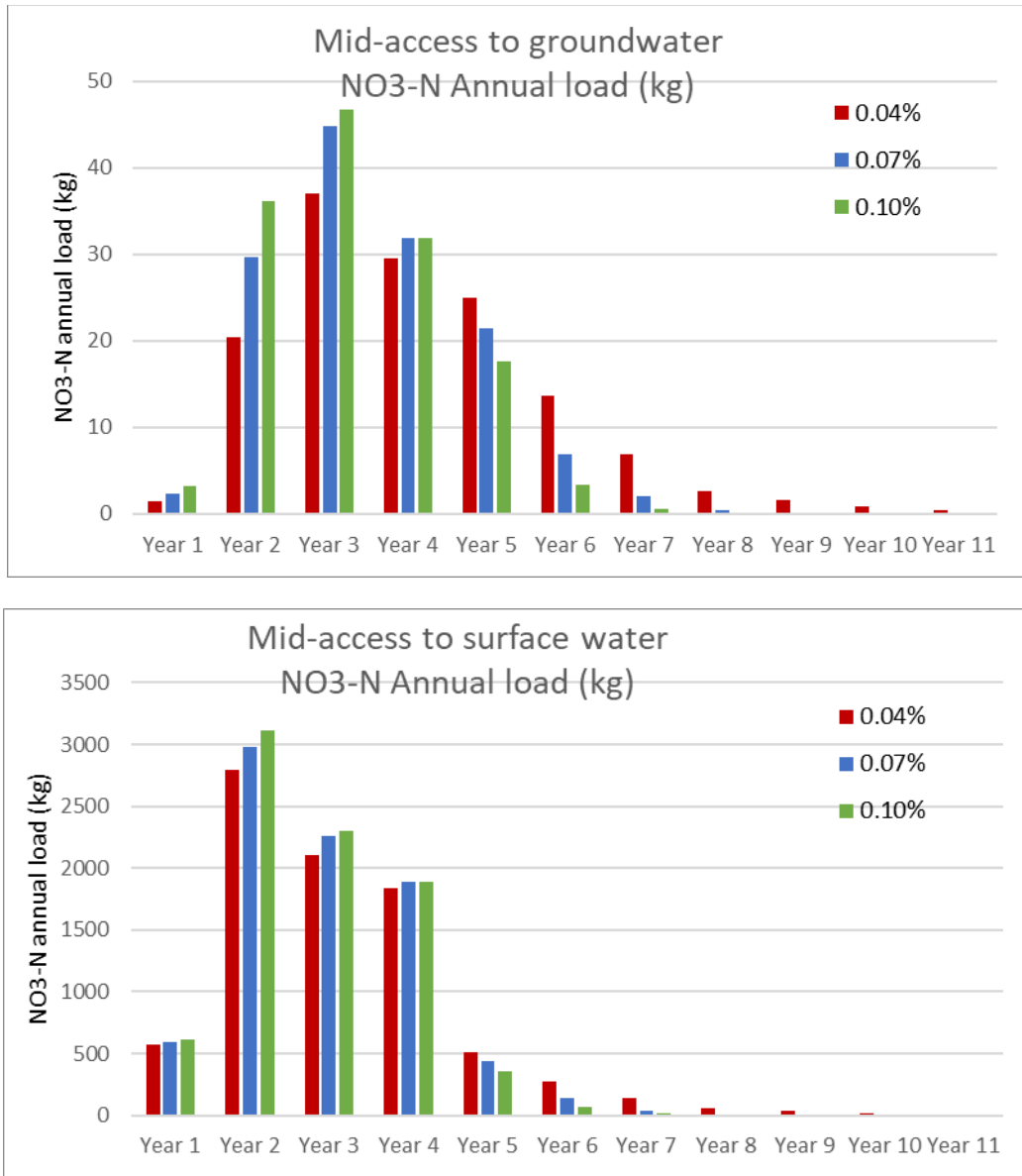


Figure C.2: Annual estimates of nitrate load to groundwater using base case recharge rate (top) and surface water (bottom) at the mid-access site with different stockpile wash rates.

C.3 Surge Tunnel Access and Paddy's Quarry Spoil emplacement

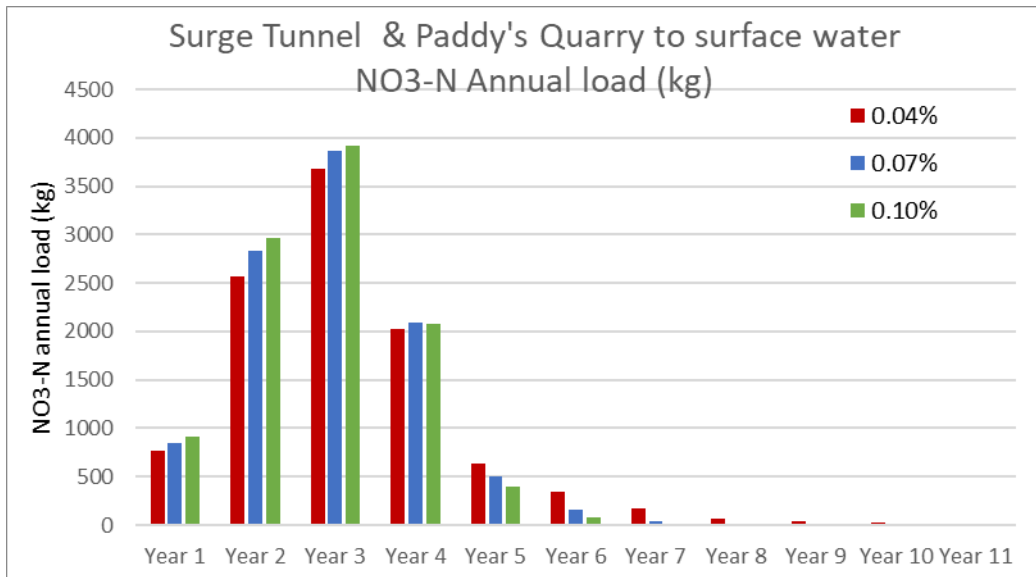
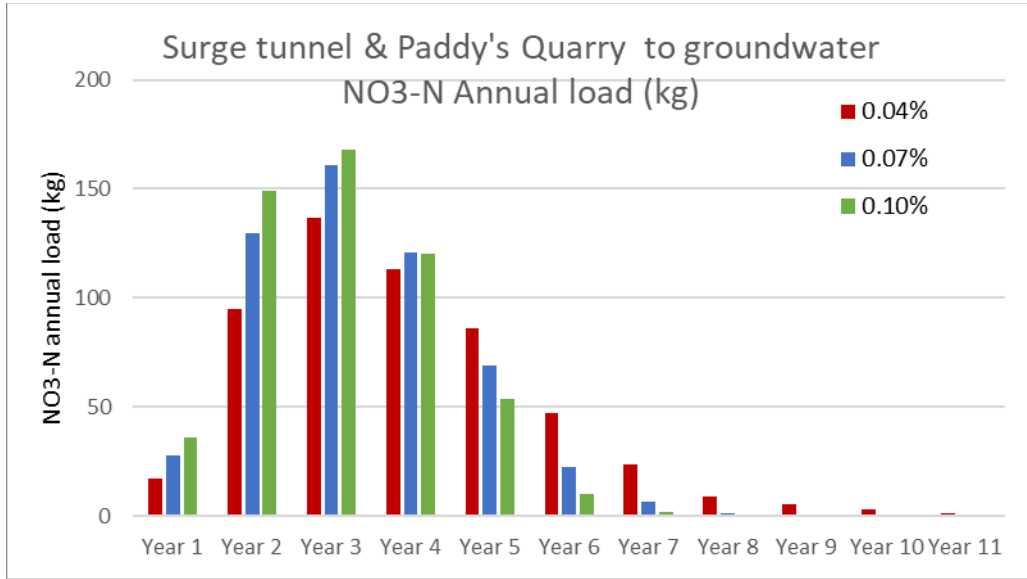


Figure C.3: Annual estimates of nitrate load to groundwater using base case recharge rate (top) and surface water (bottom) at the surge tunnel access and Paddy's Quarry spoil emplacement site with different stockpile wash rates.

C.4 Power Station

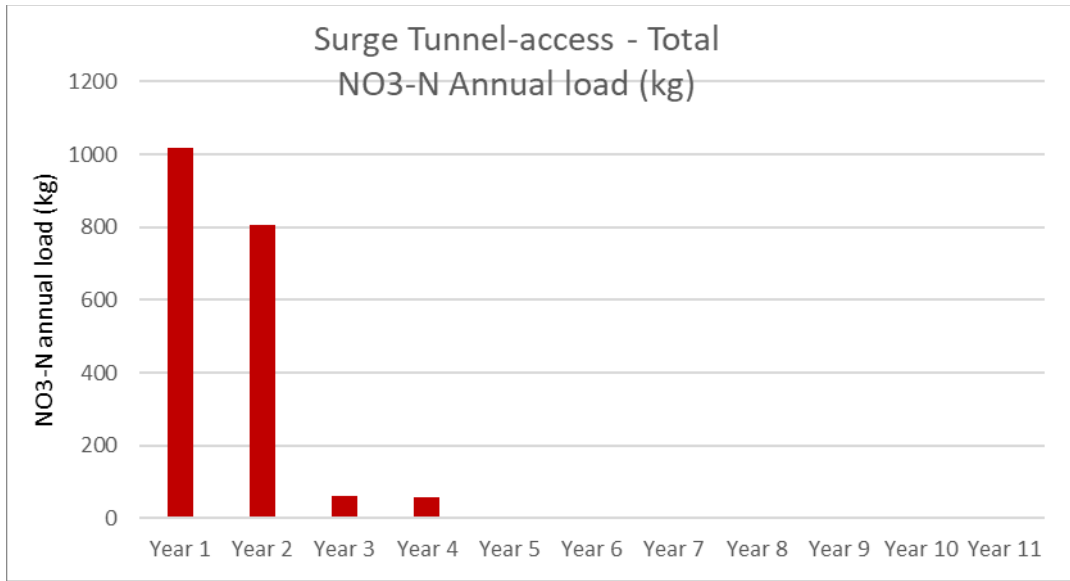


Figure C.4: Annual estimates of nitrate load to surface water from the power station access site.

C.5 Total point source loads – all sites combined

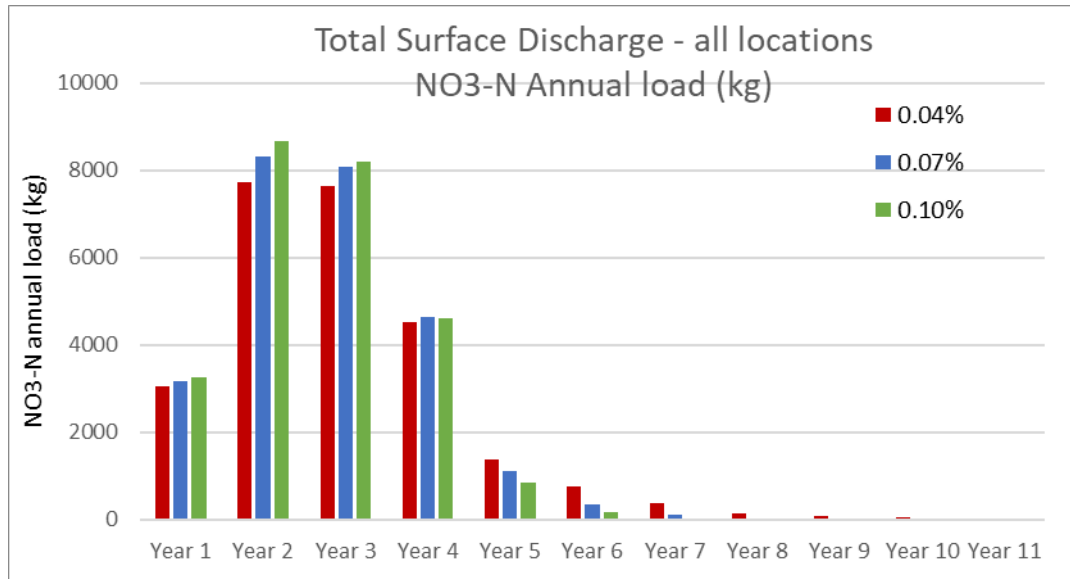


Figure C.5: Annual estimates of nitrate load to surface water from all sites.