Surface Water Assessment

Goschen Mineral Sands and Rare Earths Project (Goschen Project)

VHM Exploration Pty Ltd

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1 INTRODUCTION

This report details the findings of a desktop surface hydrology and hydraulic review undertaken by Water Technology for the proposed Goschen Mineral Sands and Rare Earths Project (Goschen Project), a mineral sand mine in north-western Victoria.

The purpose of this report is to assess the potential impacts of the proposed mineral sands mine with respect to overland flows through existing waterways, the significance and history of these waterways and water quality, thereby providing supporting information required for the Environment Effects Statement (EES).

1.1 Project Description

VHM Exploration are currently undertaking studies to evaluate the potential for developing the Goschen Project, an area covering 775 km² to the south of Swan Hill.

1.2 Purpose of the Report

The report assesses the potential impact to surface water associated with the planning and construction of the Mineral Sands Mine and identifies performance requirements necessary to address these impacts.

The objectives of the report are as follows:

- Characterise the surface hydrology within the project area, and the nature of the beneficial uses;
- Determine the significance of historical and existing water systems;
- Identify the origin (e.g. upper catchment) and destination (e.g. wetlands) of the water systems occurring within the tenement area; and
- Map the surface hydrology structures within the tenement area (i.e. historical and existing), water flow directions, and the catchment.

The key aspects included in the report are as follows:

- The collation of data, including:
  - meteorological data
  - relevant legislation and best practice guidelines
  - site topography
  - surface water features and land use
- Identification of key risks and impacts associated with development of the proposed Goschen Project;
- Environmental performance requirements; and
- Mitigation measures recommended to be incorporated into the design of the Goschen Project.

1.3 Study Area

The study area for this assessment includes the 775 km² tenement areas of the proposed mineral sands and rare earths mine, and the surrounding drainage catchment. The tenements are bounded to the south by James Road, to the east by Loughran Road, to the west by Omeara Road and to the north by Lake Boga-Ultima Road, as shown in Figure 1-1. The study is for the most part located within the drainage catchment of the Avoca River, Lalbert and Back Creeks which drain into the lakes system to the north. The majority of channels and drainage lines that once traversed the study area which may have changed the course of natural flow have been decommissioned and filled in some time after the year 2000.

The majority of the site is covered by Farming Zone in the Swan Hill Rural City Council, Buloke and Gannawarra Shire Councils Planning Schemes, along with Public Conservation and Resource Zone (Victorian Planning Scheme Online), as seen in Figure 1-2 and Table 1-1. Flood related overlays associated with the Avoca River, Back Creek and Lalbert Creek exist within the Planning Schemes, these are shown in Figure 1-3 and Table 1-2.

The proposed site is located between the Lalbert Creek and Back Creek, with a large, high dune in the landscape. The land is generally characterised by slightly undulating farmland, cleared for cropping and grazing, with patches of remnant vegetation. Some of these patches are of high environmental value (DELWP, NatureKit, 2018), and areas such as Lake Lalbert are of high cultural value (Aboriginal Victoria, 2018).

TABLE 1-1 PLANNING ZONES FOUND WITHIN THE STUDY SITE (DELWP, PLANNING SCHEMES ONLINE, 2018)

Zone Codes	Zone Description
C1Z	Commercial Zone
FZ	Farm Zone
GRZ	General Residential Zone
IN1Z	Industrial Zone
LDRZ	Low Density Residential Zone
PCRZ	Public Conservation and Resource Zone
PPRZ	Public Park and Recreation Zone
PUZ1,2,3,4,5,6,7	Public Use Zone
RDZ1	Road Zone
SUZ2	Special Use Zone
TZ	Township Zone

TABLE 1-2 PLANNING OVERLAYS FOUND WITHIN THE STUDY SITE (DELWP, PLANNING SCHEMES ONLINE, 2018)

Overlay Codes	Overlay Descriptions
ESO1	Environmental Significance Overlay 1
ESO2	Environmental Significance Overlay 1
ESO3	Environmental Significance Overlay 1
ESO4	Environmental Significance Overlay 1
FO	Floodway Overlay
LSIO	Land Subject to Inundation Overlay

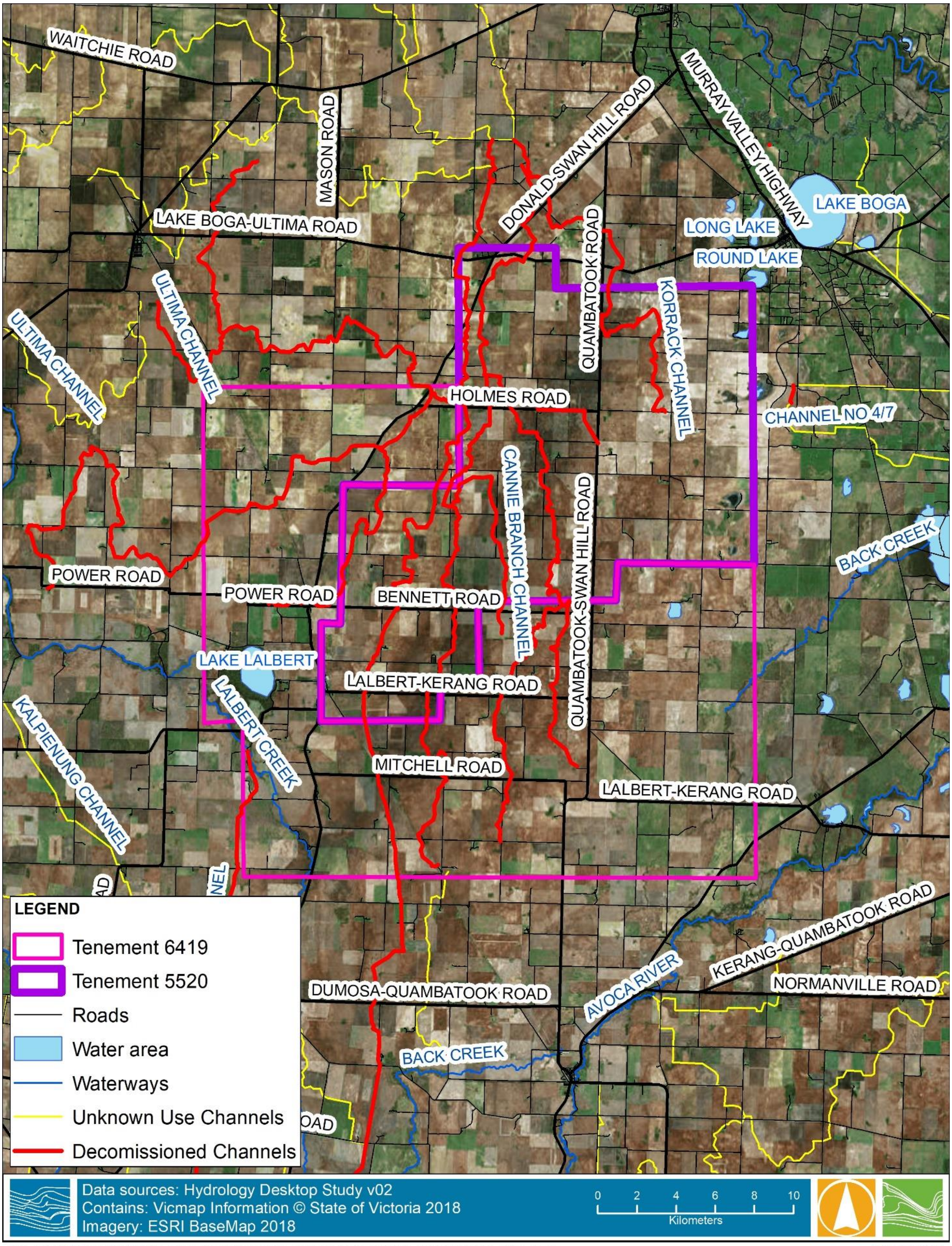

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FIGURE 1-1 STUDY SITE LOCATION

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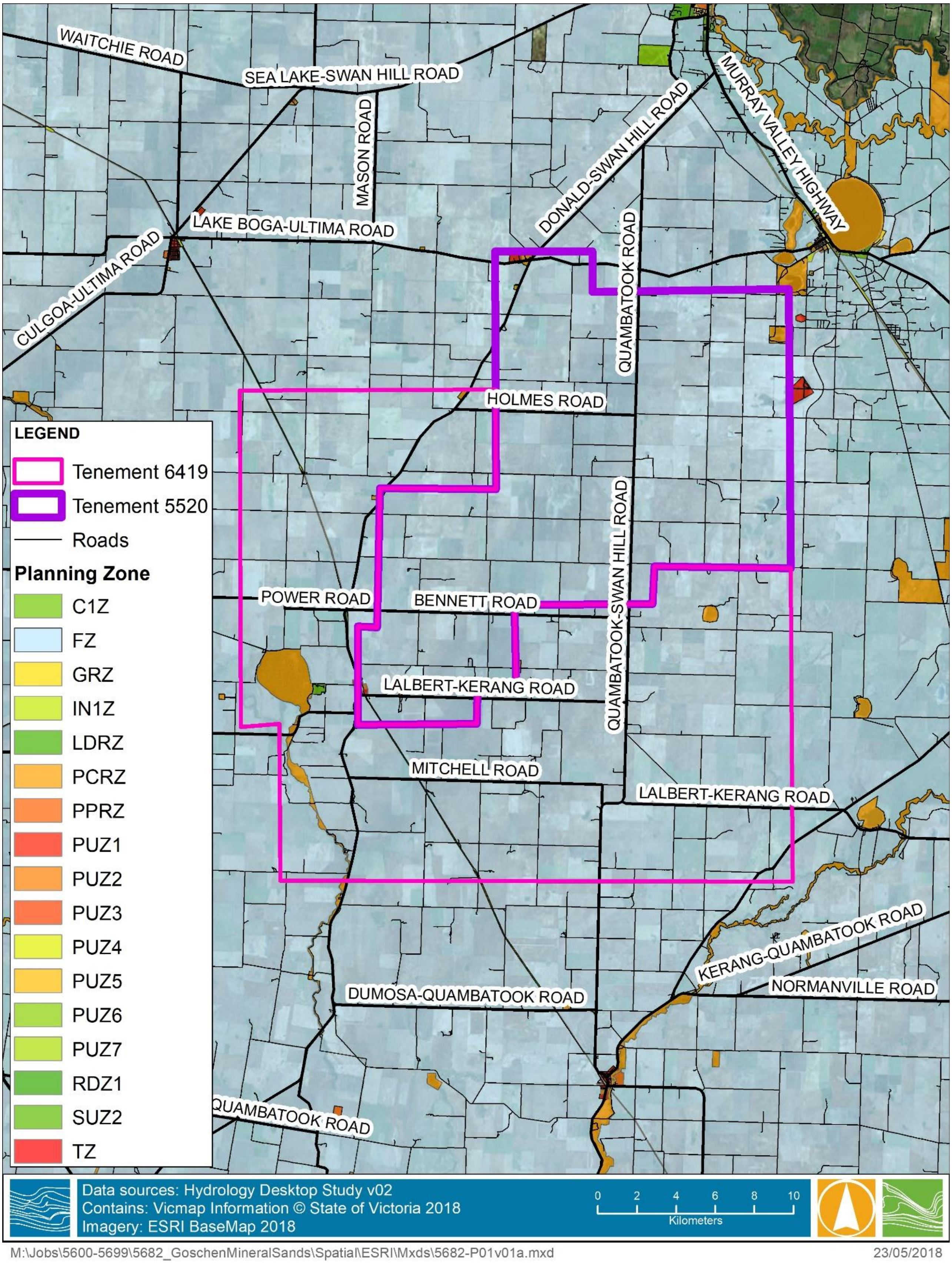

FIGURE 1-2 PLANNING MAP OF PROPOSED SITE LOCATION

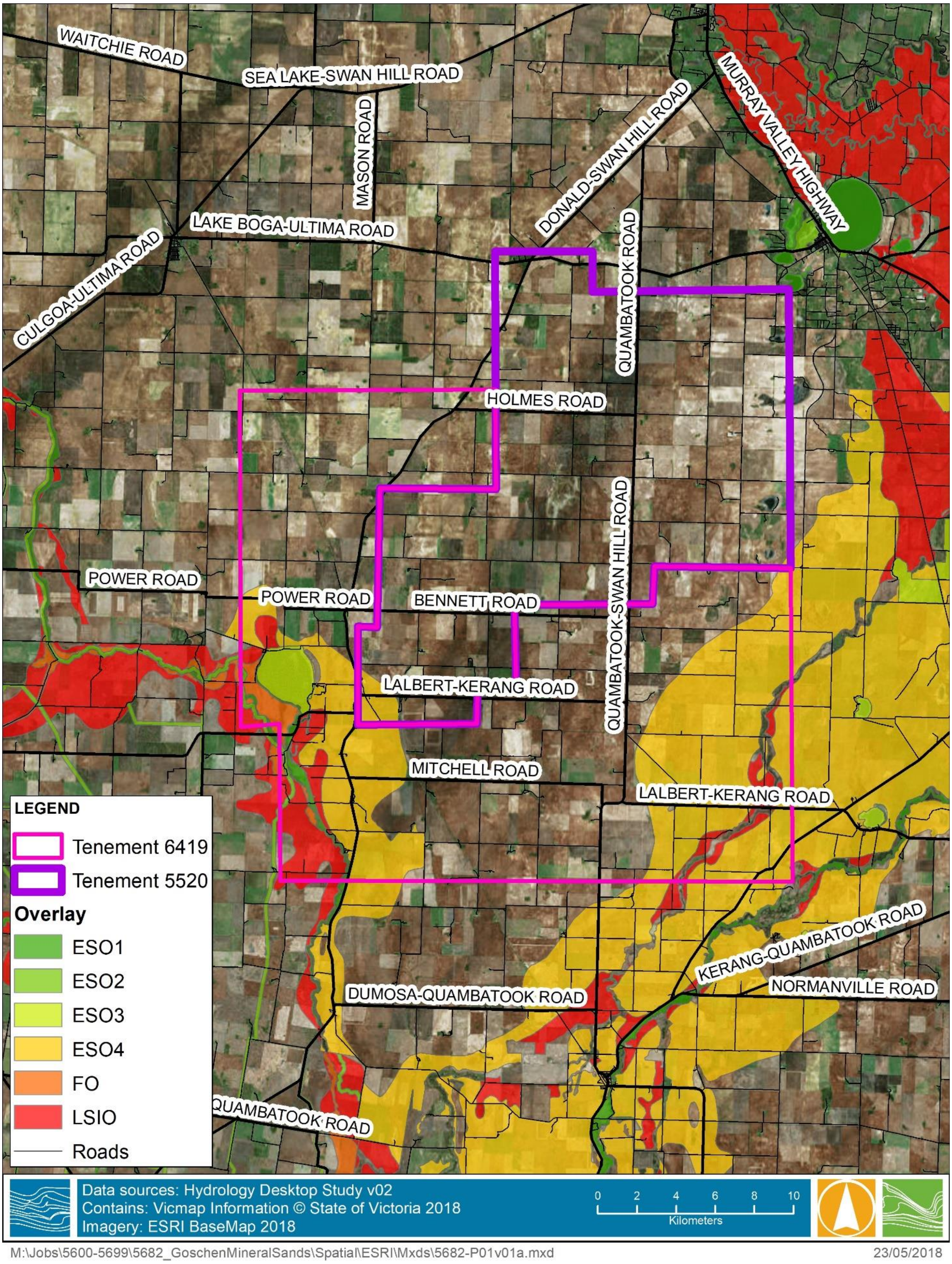

FIGURE 1-3 OVERLAY MAPPING OF PROPOSED SITE LOCATION

2 BACKGROUND

2.1 Legislation, Policy and Guidelines

The ***Environmental Protection and Biodiversity Conservation Act (1999)*** enables the Australian Government to legislate environment and heritage protection and biodiversity conservation. It refers responsibility to the States for matters that are not of national environmental significance. Matters that are considered of national environmental significance include:

- Wetlands of national importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed.
- Nationally threatened species and ecological communities.
- Migratory species.

  These communities exist around surface water drainage lines and relevant to this project due to the offsite impacts to the wetlands system. Environmental protection of assets includes waterways and wetlands pertinent to the surrounding area.

The ***Water Act (1989)*** *(Vic)* provides a legal framework for managing Victoria's water resources. It authorizes Catchment Management Authorities (CMAs) various powers for the control, management and authorization of works and activities in or over designated waterways in the CMA's waterway management district. The CMA authorises works on designated waterways via an authority permit in accordance with the CMA's by-law number four, *Waterways Protection.*

The types of work that require approval from the CMA, that may be relevant to this project, includes (but are not limited to):

- Waterway crossings – bridges, fords, culverts and repairs to existing crossings.
- Stabilisation – erosion management.
- Vegetation – vegetation removal including removal of weed species and clearing of fallen timber.
- Works – stormwater outlets and pipeline crossings.
- Extractions – sand, rock or other material.
- Waterway clearing – in stream vegetation, silt and sediment build up.

Any work that is in the vicinity of a designated waterway (at the discretion of the CMA) will be subject to a Works on Waterways permit from the North Central or Mallee CMA (depending on location), as shown in Figure 2-1.

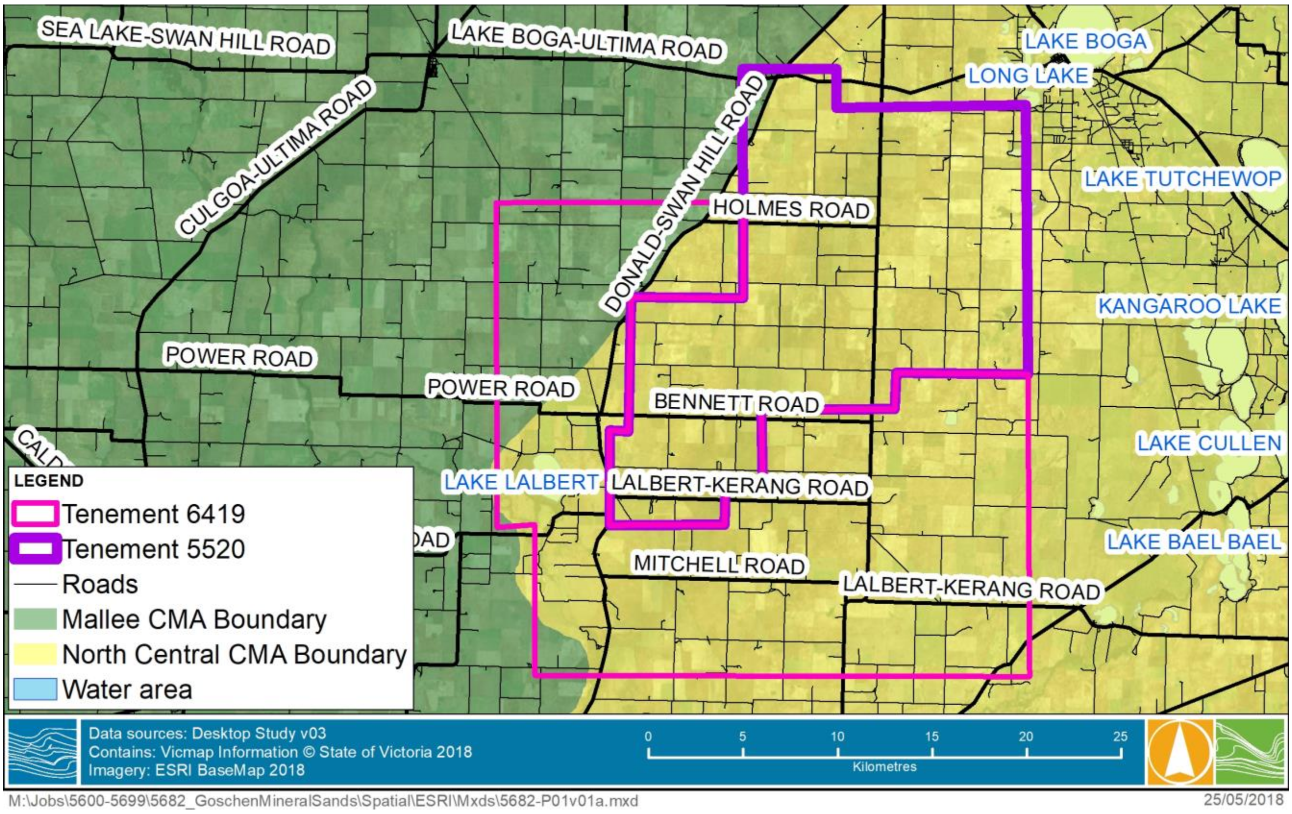

FIGURE 2-1 NORTH CENTRAL AND MALLEE CMA REGIONS

The **Victorian Planning Provisions (VPP)** includes policies with respect to floodplain and catchment management. Relevant policies include:

13.02-1 Floodplain Management which assists the protection of:

- Life, property and community infrastructure from flood hazard
- The natural flood carrying capacity of rivers, streams and floodways
- The flood storage function of floodplains and waterways
- Floodplain areas of environmental significance or of importance to river health

14.02-1 Catchment planning and management which assists the protection and, where possible, restoration of catchments, waterways, water bodies, groundwater, and the marine environment.

Both policies aim to ensure any changes to a waterway or its associated floodplain allow the free flow of flood water without hindrance or negative environmental impact. This is relevant to the Project as several designated waterways exist across the site.

Surface Water in Victoria is also governed by the ***State Environment Protection Policy (Waters of Victoria)***, which sets the framework to rehabilitate Victoria's surface water environments. The SEPPs set out environmental quality objectives and indicators to measure whether beneficial uses (e.g. drinking, industrial use and aquatic ecosystems that a waterway or waterbody can support) are being protected.

Water quality impacts through mining have been assessed for aquatic ecosystems, similar to those of Lake Boga and Lake Lalbert, in accordance with the ***Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000)***. The drainage pathways within the proposed tenement site locations are considered potential drainage point sources for contamination off site. Referring to these guidelines, all water draining off-site must be adhering to key trigger values.

Cultural heritage sites throughout Victoria lie scattered along floodplains, water resource zones, wetlands/lakes and rivers/creeks. It is important to protect these assets and prevent issues from occurring. As such as a proposed activity, a Preliminary Aboriginal Heritage Test (PAHT) provides certainty about whether a Cultural Heritage Management Plan (CHMP) is required. Under the ***Aboriginal Heritage Act 2006*** and the ***Aboriginal Heritage Regulations 2007*** when a proposed site is subject to high impact activities (significant ground disturbance) a CHMP is required. The Mallee District Aboriginal Services, traditional custodians can provide an appropriate pathway along with Aboriginal Victoria (AV).

3 METHODOLOGY

The surface water assessment has focused on a desktop assessment of the climatic influences, flow regimes, biodiversity, land-use and geology, on the distribution of surface water, and the potential impacts of the Goschen Project on these characteristics.

3.1 Surface Water Assessment

The surface water assessment is composed of three sections; the desktop study assessment, a field assessment and finally hydrological assessment.

The desktop assessment investigated all relevant environmental contributions in and around the site, outlining key hydraulic structures, topographic variations, climatic data, biodiversity, cultural heritage, land use and the hydrological data (watercourses and streamflow) relevant to the area. The information was collected from various government agencies with knowledge of the area. This data collection process was conducted prior to any field investigation in order to define what features required specific attention during the field inspection.

The field assessment component was undertaken in February 2018 and outlined the various watercourses (waterways and channels) which were still in use and would impact the local drainage. The site visit identified that for the most part, channels have been decommissioned throughout the region. It also outlined that depressions in the topography were more often ecological niche areas with patches of native vegetation remaining which attract native fauna (DELWP, NatureKit, 2018). Finally, by observing the topography first-hand, an improved understanding of the local surface water regime in the region became apparent.

The surface water assessment investigated the flood risk from the three primary waterways that traverse or pass nearby to the site, and inundation caused by direct rainfall on the site through local runoff from the intermittent waterways, shown in Figure 1-1. A rainfall-and-runoff model using TuFLOW was developed in order to determine flow direction and velocities on site. This involved the use of Bureau of Meteorology rainfall data to determine 1% Annual Exceedance Probability (AEP) rainfall events in the region (i.e. a rare storm event with a 1% chance of being equalled or exceed in any given year), and modelling where that rainfall would flow over the land, determining potential paths.

3.2 Risk and Impact Assessment

An environmental risk assessment was completed for potential impacts to surface water due to the proposed mineral sands mine. The overall risk assessment process adopted was based on AS/NZS ISO 31000:2009, as illustrated in Figure 3-1. Water Technology has used this same process to undertake risk assessments on other similar infrastructure projects.

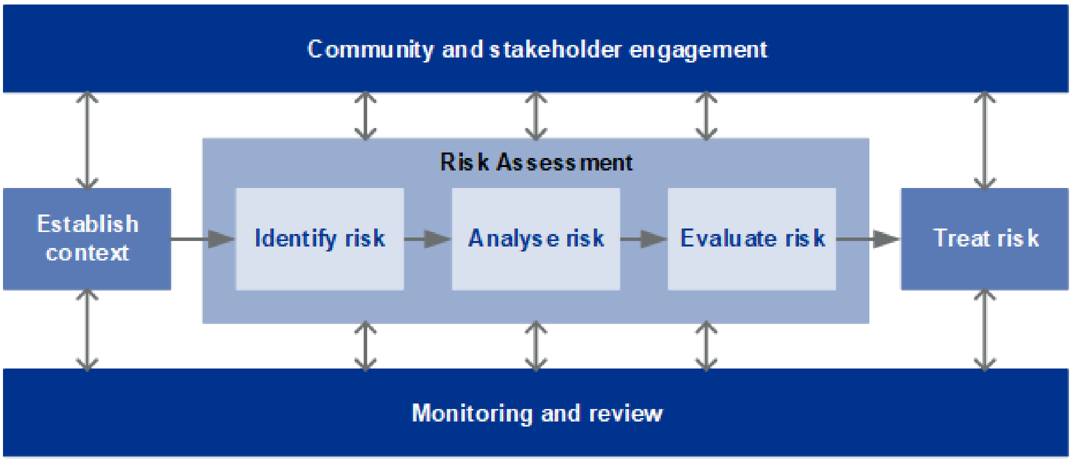

FIGURE 3-1 OVERVIEW OF AS/NZS ISO 3100-2009 RISK PROCESS

The following tasks were undertaken to determine the impact pathways and assess the risks:

- Setting of the context for the environmental risk assessment
- Development of consequence and likelihood frameworks and the risk assessment matrix
- Review of Project description and identification of impact assessment pathways by surface water specialists
- Allocation of consequence and likelihood categories and determination of preliminary initial risk
- Identification of environmental performance requirements during the impact assessment
- Revision of the initial risk levels after allowing for implementation of the environmental performance requirements and, in doing so, identifying residual risk levels.

The likelihood rating criteria used in the risk assessment is shown in Table 3-1.

TABLE 3-1 LIKELIHOOD RATING CRITERIA

Level	Description
Rare	The event is very unlikely to occur but may occur in exceptional circumstances.
Unlikely	The event may occur under unusual circumstances but is not expected.
Possible	The event may occur once within a five-year timeframe.
Likely	The event is likely to occur several times within a five-year timeframe.
Almost Certain	The event is almost certain to occur one or more times a year.

The consequence criteria framework used in the risk assessment is shown in Table 3-2.

TABLE 3-2 CONSEQUENCE FRAMEWORK

Level	Qualitative description of biophysical/environmental consequence	Qualitative description of socio-economic consequence
Negligible	No detectable change in a local environmental setting.	No detectable impact on economic, cultural, recreational, aesthetic or social values.

Level	Qualitative description of biophysical/environmental consequence	Qualitative description of socio-economic consequence
Minor	Short-term, reversible changes, within natural variability range, in a local environmental setting.	Short-term, localised impact on economic, cultural, recreational, aesthetic or social values.
Moderate	Long-term but limited changes to local environmental setting that are able to be managed.	Significant and/or long-term change in quality of economic, cultural, recreational, aesthetic or social values in local setting. Limited impacts at regional level.
Major	Long-term, significant changes resulting in risks to human health and/or the environment beyond the local environmental setting.	Significant, long-term change in quality of economic, cultural, recreational, aesthetic or social values at local, regional and State levels. Limited impacts at national level.
Severe	Irreversible, significant changes resulting in widespread risks to human health and/or the environment at a regional scale or broader.	Significant, permanent impact on regional economy and/or irreversible changes to cultural, recreational, aesthetic or social values at regional, State and national levels.

The consequence rating criteria used in the risk assessment specifically developed for this assessment is shown in Table 3-3 and

Table 3-4.

TABLE 3-3 CONSEQUENCE RATING CRITERIA – SURFACE WATER (FLOODING)

Level of consequence	Consequence criteria
Negligible	■ No floodplain or overland flow impacts (on or off-site) ■ No over floor flooding ■ No inundation of access / egress routes ■ No disruption to commercial, residential, transportation (e.g. train, major roads, etc.) ■ No failure of infrastructure and delivery services
Minor	■ Short term (impact of less than one week), resulting in manageable changes in floodplain and overland flow paths through implementation of management strategies. ■ Maintains compliance with planning approvals. ■ Localised impact upon floodplain or overland flow paths requiring a year of natural process or intervention to remediate ■ Minor over floor flooding of less than 300 mm of non-habitable floor (<2 properties) ■ Minor loss of infrastructure and delivery services for less than 6 hours ■ Inundation of access / egress routes but alternate access / egress available. Less than 1-hour closure ■ Velocity – depth product ≤ 0.35 m^2/s

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Level of consequence	Consequence criteria
Moderate	■ Short term (impact of less than 3 months), resulting in, recoverable changes in floodplain and overland flow paths. ■ Exceeds maximum compliance levels for planning approvals. ■ Significant local impact upon floodplain and overland flow paths requiring several years of natural processes or intervention to remediate ■ Moderate over floor flooding (of less than 300 mm) at less than 5 properties ■ Inundation of access / egress routes, alternate access / egress available. Less than 24-hour route closure. ■ Damage to infrastructure requiring repair works to rectify damage resulting in loss of services for less than one week. ■ Velocity depth product ≥ 0.35 m^2/s ■ Impacts resulting in minor injury to person(s)
Major	■ Long term, recoverable changes in floodplain and overland flow paths, impacts exceed maximum planning approvals compliance levels. ■ Extended significant impact upon floodplain and over land flow path (local and further afield) requiring several years of natural process or intervention to remediate. ■ Major over floor flooding greater than 300mm at greater than 10 properties. ■ Inundation of access / egress routes, no alternate access / egress available. Less than 1-week closure. ■ Damage to infrastructure requiring significant works to reconstruct affecting services for up to 3 months. ■ Velocity – depth product ≥ 0.35m^2/s ■ Impacts resulting in serious injury to person(s)
Severe	■ Irrecoverable damage to floodplain or overland flow paths ■ Damage to infrastructure requiring extensive reconstruction impeding services and/or transportation for at least 3 months ■ Impacts resulting in death of person(s)

TABLE 3-4 CONSEQUENCE RATING CRITERIA – SURFACE WATER (QUALITY)

Level of consequence	Consequence criteria
Negligible	■ No detectable change in water quality ■ No impact / disturbance to river bed or banks ■ No loss of ecosystem structure or function ■ No downstream impacts
Minor	■ Minor disturbance to river bed or bank. ■ Transient/ ephemeral/ short term impact to river bed, banks and downstream environments with sufficient resilience retained by ecosystem to fully bounce back from minor disturbance. ■ Small and short-term degradation of water quality. Water quality remains within the long term historical background range and returns to pre-impact conditions quickly.
Moderate	■ Moderate disturbance of river bed or bank resulting in some diminished capacity of moderate value moderate condition in-stream habitat. ■ Environment stress observed, short term disruption to breeding cycles for aquatic biota and ecological processes. ■ Ecosystem resilience is reduced, and moderately difficult or expensive rehabilitation is required ■ Water quality impact that exceeds background conditions for an extended period and extends downstream beyond the immediate impact zone.
Major	■ Major disturbance to bed and banks resulting in significantly diminished capacity of high value stream segment to maintain habitat and support of flora/fauna. ■ Significant harm to in-stream habitat, uncertain whether enough resilience retained to allow restoration to pre-disturbance conditions. ■ Water quality exceeds background conditions and exceeds State Environment Protection Policy (SEPP) guidelines for an extended period and area downstream of the immediate impact zone.
Severe	■ Irreversible damage to habitat, potential loss of species/functional groups/guilds, catastrophic shift in ecosystem processes. ■ Extinction of rare or threatened aquatic flora/fauna, habitat lost for spawning/nesting/roosting/critical refuge. ■ Loss of recruitment / regeneration ability (e.g. through construction of barrier to fish passage). ■ Total loss of biological functions and processes, possibly irreversible, long term harm to native flora and fauna. Ecosystem is unable to recover and rehabilitation to previous condition is not possible.

TABLE 3-5 CONSEQUENCE RATING CRITERIA – WATER USERS DOWNSTREAM (FLOOD/QUALITY)

Level of consequence	Consequence criteria
Negligible	■ No detectable change in water availability ■ No impact / disturbance to local landholder's water availability ■ No loss of water availability ■ No downstream impacts on water availability
Minor	■ Potential minor change in water availability ■ Transient/ ephemeral/ short term impact to water availability with sufficient resilience retained by the hydrological system to fully bounce back from minor disturbance. ■ Water availability remains within the long term historical background range & returns to pre-impact conditions quickly.
Moderate	■ Moderate disturbance of water availability resulting in some diminished capacity for local landholders and ecological niches. ■ Environment and economic stress observed, short term disruption to breeding cycles for aquatic biota and loss of stock water supply. ■ Ecosystem resilience and farming capacity is reduced, and moderately difficult or expensive rehabilitation is required ■ Water availability impact that exceeds background conditions for an extended period and extends downstream beyond the immediate impact zone.
Major	■ Major disturbance to flow pathways resulting in significantly diminished water availability to maintain habitat and support local landholders. ■ Significant harm to in-stream habitat, uncertain whether enough resilience retained to allow restoration to pre-disturbance conditions. ■ Significant harm to landholders and stock water supply, uncertain whether enough water supply is available.
Severe	■ Total loss of flow pathways resulting in no water availability to local landholder's and ecological niches.

The environmental risk assessment matrix used to determine levels of risk from the likelihood and consequences ratings is shown in Table 3-6.

TABLE 3-6 RISK ASSESSMENT MATRIX

		Consequences rating				
		Negligible	Minor	Moderate	Major	Severe
Likelihood rating	Rare	Very low	Very low	Low	Medium	Medium
	Unlikely	Very low	Low	Low	Medium	High
	Possible	Low	Low	Medium	High	High
	Likely	Low	Medium	Medium	High	Very High
	Almost certain	Low	Medium	High	Very High	Very High

Section 3.2 provides a summary of surface water risks assessed as part of the surface water assessment.

4 DATA COLLECTION AND REVIEW

4.1 Topography and Geology

A VicMap Digital Terrain Model (DTM) with 10 metre resolution, extending across the entire catchment, was available through the Department of Environment, Land, Water and Planning (DELWP). This DTM is a raster representation of the area, capturing details of natural relief features across the catchment, as shown in Figure 4-1. The vertical and horizontal accuracy of this DTM is coarse at ± 5 m and ± 12.5 m respectively (relative to Australian Height Datum (AHD)).

More detailed Light Detection and Ranging (LiDAR) data sets were not available for the site.

Other land feature information such as major road, rail, waterway, water bodies and township location and alignment details were available through VicMap data.

The tenement areas are characterised by an undulating topography with depressions in the landscape feeding groundwater dependent ecological niches. At the centre of the tenements is a peak in the topography, this distributes surface water flows to the east and west portions of the site down to Lake Lalbert, Back Creek and Avoca River floodplains.

The tenements are a part of the Murray Basin of north-western Victoria, spanning the Late Proterozoic to Recent geological time periods (Holdgate & Gallagher, 2003). The area encompasses a complex series of structures and formations that have developed through volcanism, sedimentation, and deformation. The margins of the Murray Basin remain prospective for economic deposits for mineral sands with the extensive Parilla Sand unit (Holdgate & Gallagher, 2003; Evans & Merz, 2013).

The soils are sandy, loamy and weakly developed, red in colour with white and grey variations laid sporadically throughout the tenements. These characteristics contribute to high evaporation and infiltration rates in the region restricting surface water flow and feeding groundwater reserves.

4.2 Stream Flow

No streamflow gauges exist within the proposed site or on any of the waterways traversing the proposed site. However it is understood, via field assessments and local knowledge that the waterways across the site are ephemeral and only flow after significant rains. The Mallee region catchments are typically sandy, with the lower floodplains, waterways, and waterbodies having heavier clays. As such, the sandy catchment tends to allow a significant amount of infiltration into the soil profile, requiring heavy rains to generate enough surface runoff to concentrate in the waterways. This was evident upon visiting the study site where very few natural waterways are present, however drainage pathways do exist and are shown in Figure 5-3.

4.3 Rainfall

Several Bureau of Meteorology rainfall gauge records are available at locations within the tenement areas and surrounds. This data record extends back to as far as 1897 at the Ultima (Post Office) gauge. These rainfall gauges are shown in Figure 4-2 and include:

- 077021 Lake Boga (Kunat)
- 077094 Swan Hill Aerodrome
- 077025 Lake Boga
- 077048 Ultima (Post Office)
- 077023 Lalbert VIC
- 076044 Nyah VIC
- 076046 Nyah (Yarraby Tank)
- 077056 Quambatook VIC

There are no instantaneous rainfall gauges located in close proximity to the proposed site location.

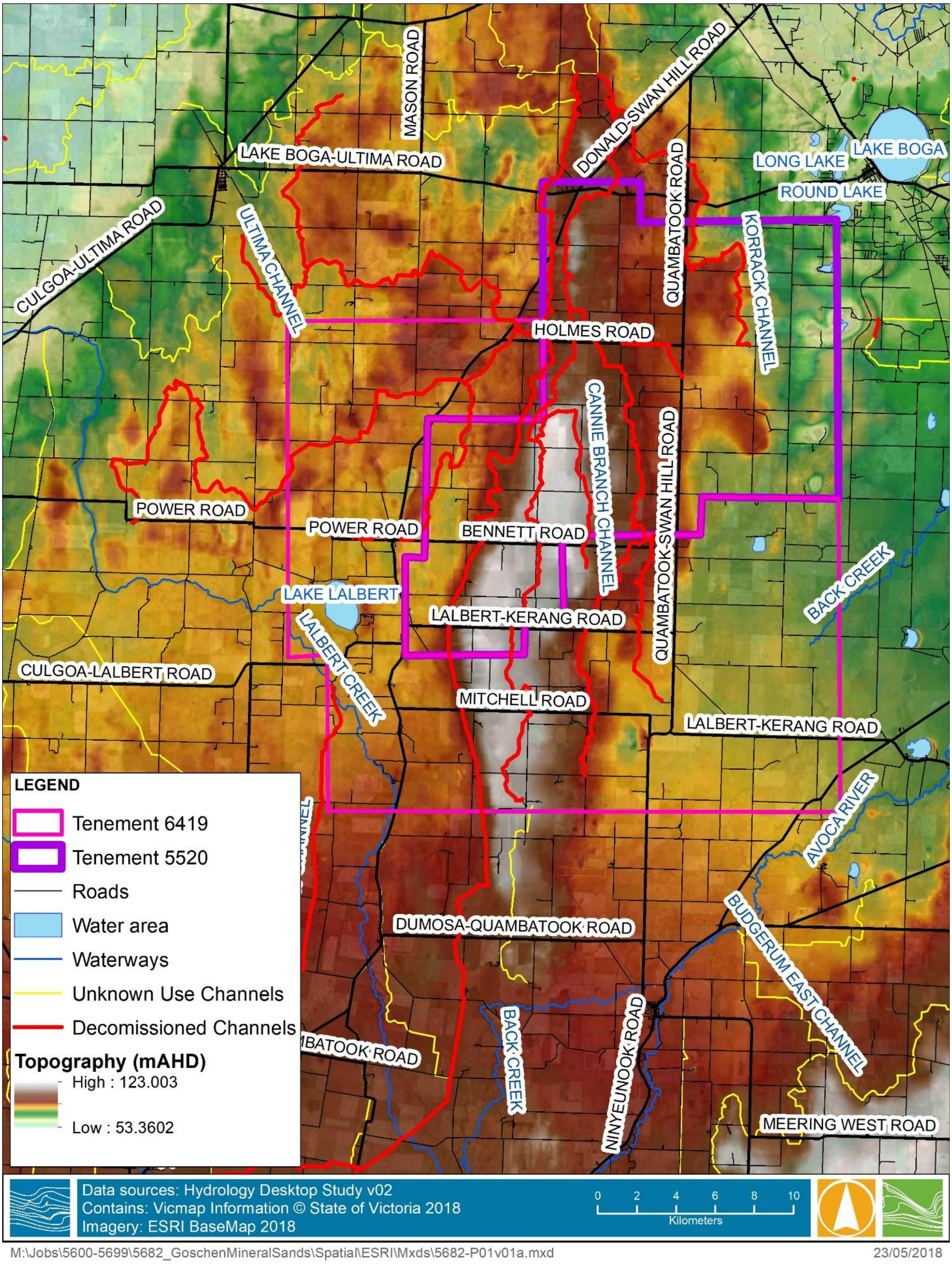


FIGURE 4-1 SITE TOPOGRAPHY

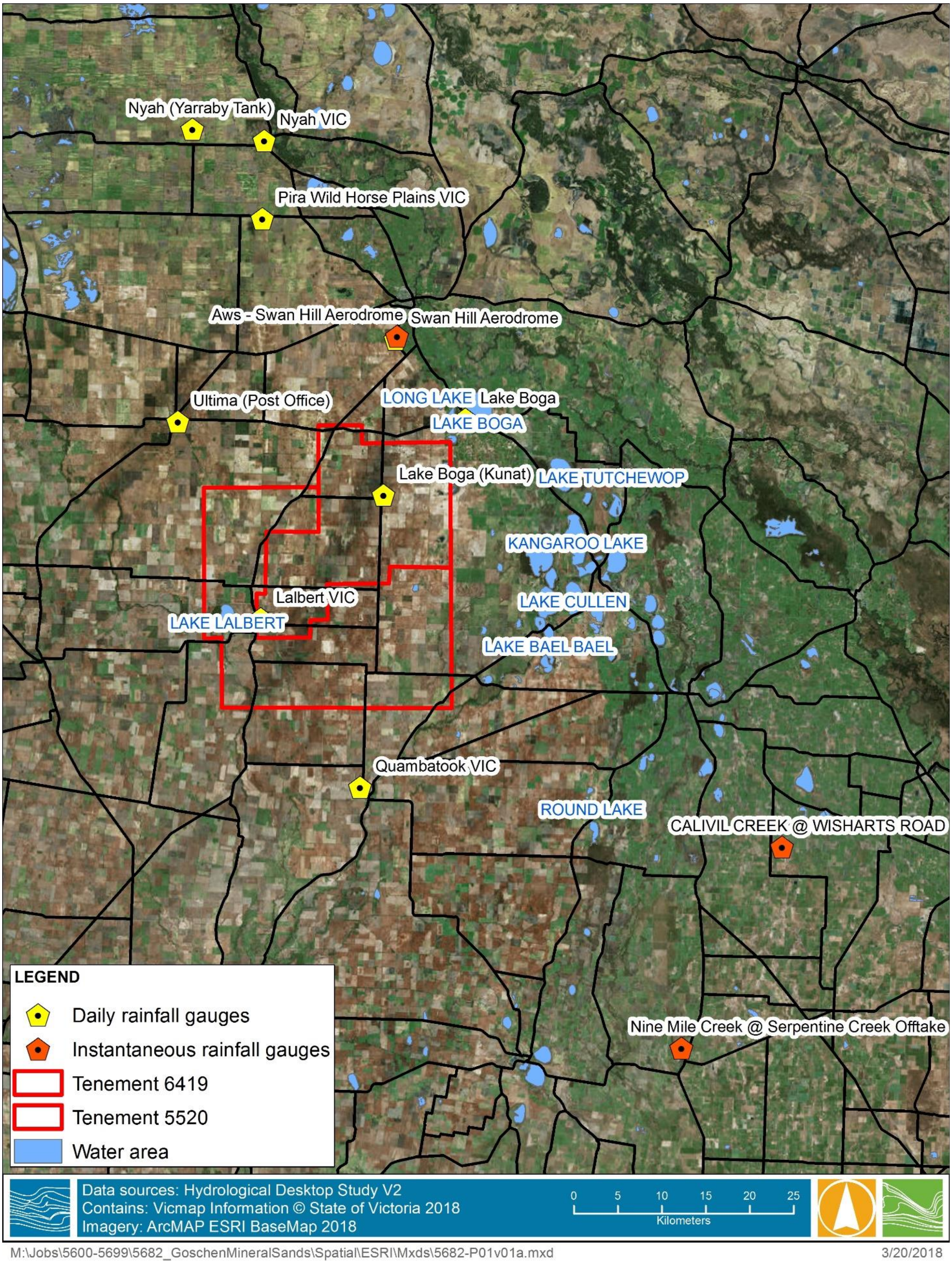
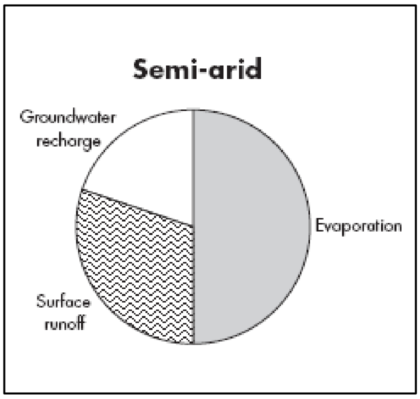


FIGURE 4-2 RAINFALL GAUGES

4.4 Climate



The semi-arid climate has a mean annual rainfall of 300 to 400 mm as shown in Figure 4-3, with the typical rainfall distribution across the year shown in Figure 4-4. Note the relatively consistent spread across the year, with higher totals in the winter-spring months. The average evaporation rates are 1400 to 1600 mm per annum, shown in Figure 4-5. The climate zones based on temperature and humidity is considered to be hot dry summer and cold winter, shown in Figure 4-6, this characterises much of central Australia.

The classification provides relevant information on the total infiltration and runoff characteristics of the region.

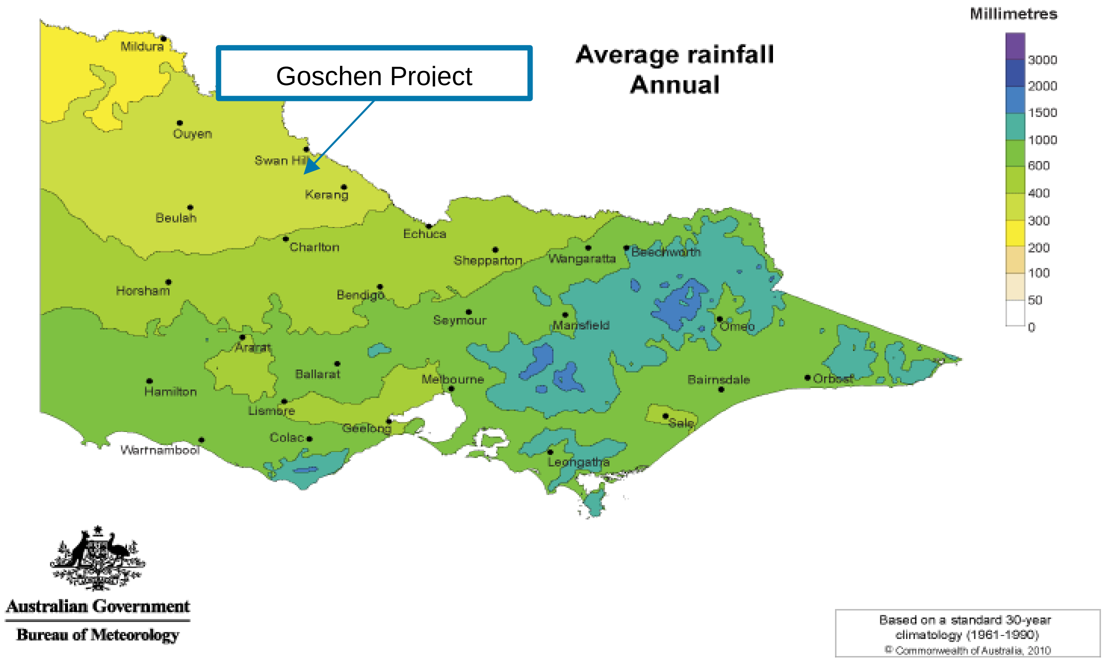


FIGURE 4-3 AVERAGE VICTORIAN ANNUAL RAINFALLS (BOM)

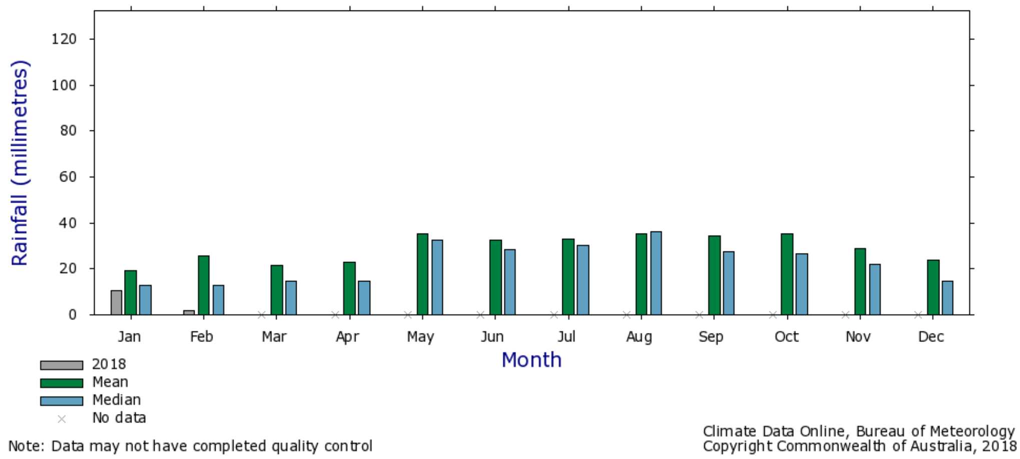


FIGURE 4-4 ULTIMA (POST OFFICE) MEAN AND MEDIAN RAINFALL OVER RECORD PERIOD

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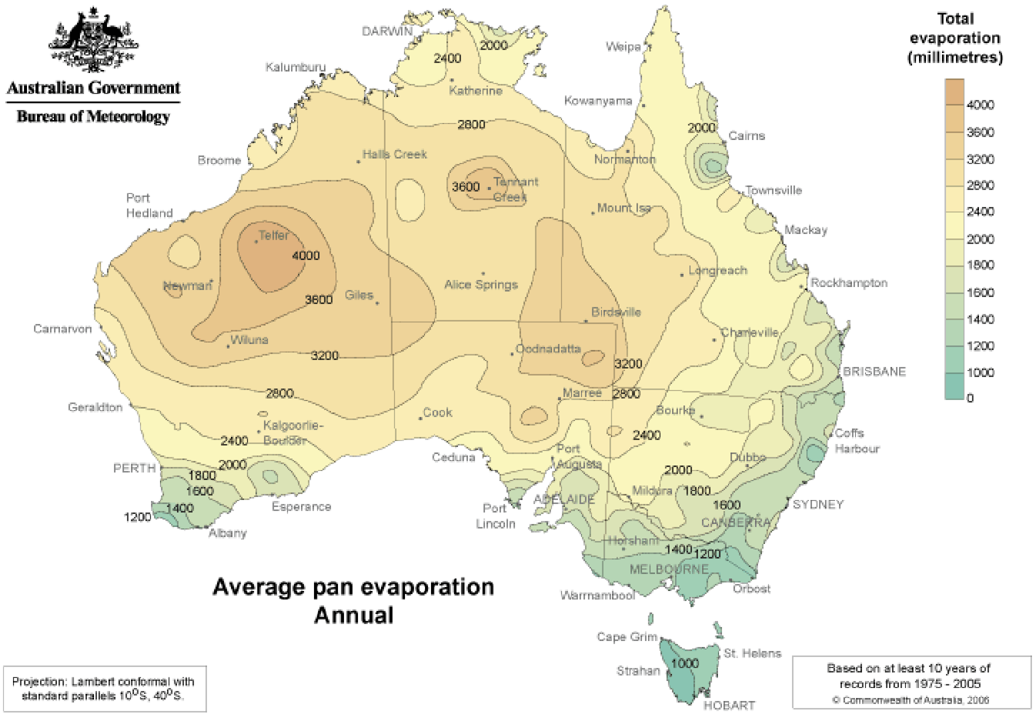

FIGURE 4-5 AVERAGE ANNUAL AUSTRALIAN EVAPORATION RATES (BOM)

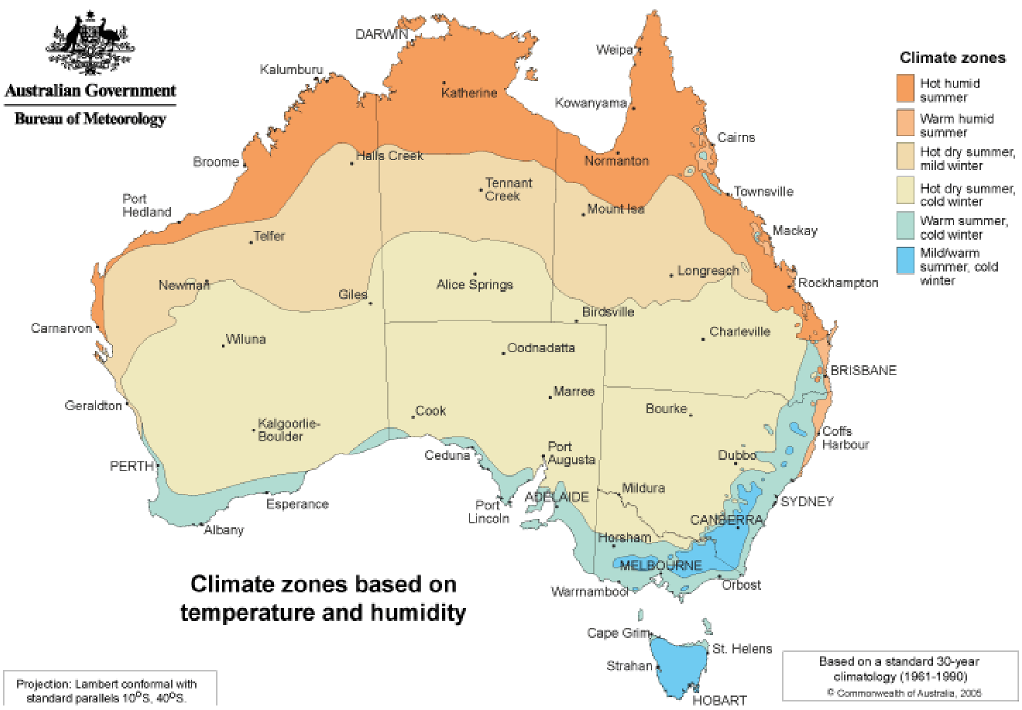

FIGURE 4-6 CLIMATIC ZONES AUSTRALIA (BOM)

4.5 Biodiversity

The proposed Goschen Project area is listed as within the Murray Mallee and Victorian Riverine bioregions. These two regions are characterised by eucalypt woodlands, however, since European settlement only scattered remnants remain as represented in the NatureKit tool. The bioregion has few surface water bodies as the highly permeable soil and climatic conditions tend to drain any and all precipitation.

The site visit conducted in February 2018 saw that the majority of ecological niche areas were present in depressions in the landscape. It is possible that these areas are terrestrial groundwater dependant ecosystems as identified in the Bureau of Meteorology's Groundwater Dependent Ecosystems Atlas. They are also most likely to receive what little surface water runoff is generated from the local catchment in large storm events.

The Victorian Government' "NatureKit", shown in Figure 4-7, displays Victoria's Biodiversity within proposed tenements. The Strategic Biodiversity values vary from 1 to 100 in the Goschen Project area, which is due to the significance of the nearby lakes system and the local depressions in landscape which creates ecological niche sites. The majority of the site, as mentioned previously, is highly modified and therefore are low in biodiversity value.

The Victoria Biodiversity Atlas states that there are a number of critically endangered and vulnerable terrestrial and aquatic fauna in the region which may be affected by any changes to water quality or quantity.

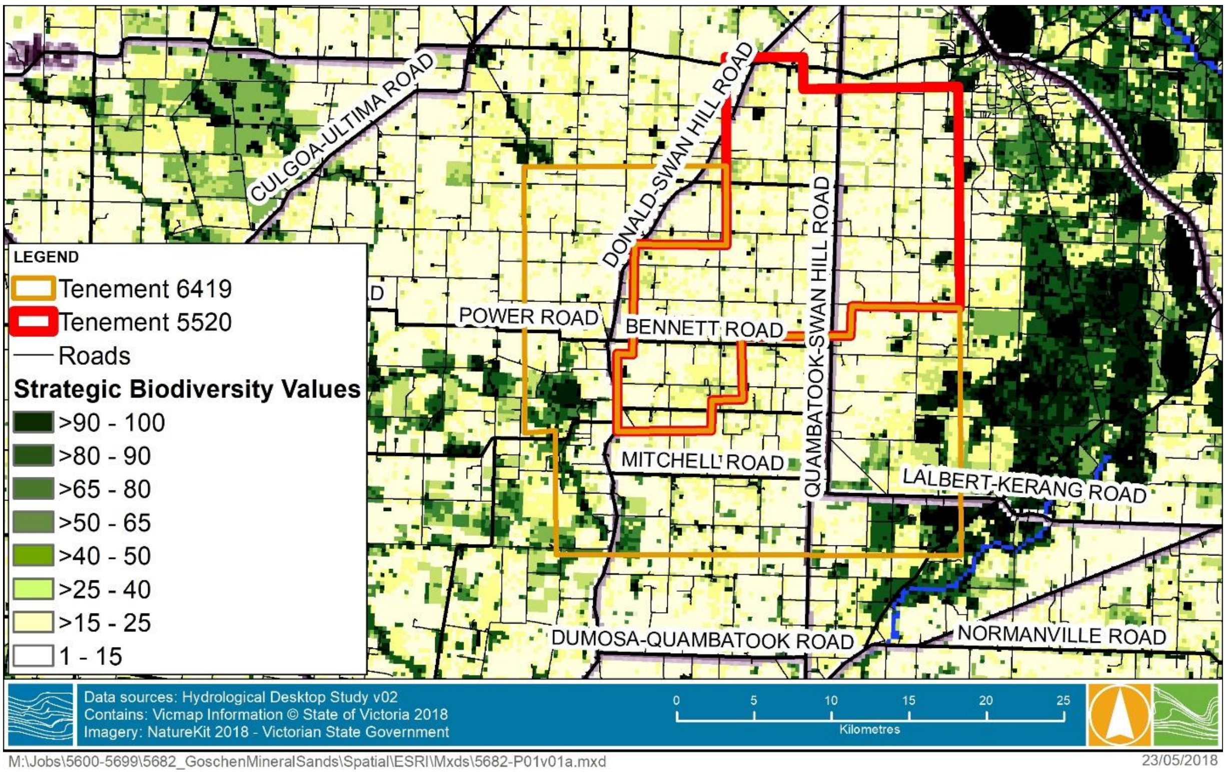

FIGURE 4-7 NATUREKIT ECOLOGICAL NICHE LOCATIONS

FIGURE 4-8 SMALL DEPRESSION IN LANDSCAPE

FIGURE 4-9 ECOLOGICAL NICHE ZONE IN TOPOGRAPHIC DEPRESSION

4.6 Cultural Heritage

The Wemba Wemba and Barapa Barapa indigenous people are the traditional custodians of the land, once utilising the lakes and waterways as a source of food and water (Murray–Darling Basin Authority, 2015). Indigenous culture is evident by the large number of ovens and middens scattered throughout the region, as such, the region holds cultural significance for the indigenous people (Aboriginal Victoria, 2018).

4.7 Key Land Use

4.7.1 Historic Uses

In 1836, the region was visited by Europeans, however the commencement of colonisation of the region began much later due to the proximity to railways and water sources (Ballinger, 2008). Since then, most of the land has been cleared of native vegetation and is used for primary production in the region. Due to the low annual rainfall, dry land farming consisting of cereal cropping, and sheep grazing are prominent (DEDJTR, 2017) (DEDJTR, Victorian Resources Online, 2017).

The tenement area was bisected by numerous stock and domestic channels, supplying water to the otherwise dry region. These channels have now been decommissioned with water supply now piped for stock and domestic purposes.

Irrigation to the north was sustained by water supply from the Kerang Lakes system allowing dairying, horticulture, olives, almonds and vegetable growing (DEDJTR, Victorian Resources Online, 2017).

4.7.2 Beneficial Users

Due to the relatively low undulating geography of the study area, the historic agricultural land use and the significant water sources (wetlands) have subsequent impacts on the beneficial uses of the stormwater drainage.

The beneficial uses include:

- Stock watering
- Environmental water
- Water-based recreation
- Aquatic plants and animals
- Water-based recreation
- Cultural and spiritual values
- Water suitable for agriculture.

The beneficial users of surface water in the Goschen Project area are local landholders, farmers, the local community and the environment.

5 SURFACE WATER ASSESSMENT

5.1 Regional Catchment Behaviour

5.1.1 Background and Overview

There are four primary waterways in this region; the Murray River, Back Creek, Lalbert Creek and Avoca River.

Murray River – The Murray River to the north of the project area forms part of the Murray-Darling basin river system which drains most of the inland waterways in Victoria and New South Wales.

Avoca River – The Avoca River has a history of flooding, with large events occurring recently in September 2010 and January 2011. These significant events filled the Avoca Marshes and flowed through to Lake Boga. The Avoca River is an anabranching system, with the majority of flood water leaving the river downstream of Charlton and spreading across the floodplain and through various anabranching waterways.

Back Creek – Back Creek is part of the Avoca floodplain and is one of its anabranching waterways. Back Creek also drains a large local catchment to the west of the Avoca River. Back Creek flows back into the Avoca River system at the Avoca Marshes.

Lalbert Creek – Lalbert Creek is an effluent stream of the Avoca River, carrying flood flows to the terminal lake systems of Lake Lalbert and Lake Timboram. Lalbert Creek also drains a large local catchment.

Lalbert Creek and Back Creek intersect the tenement area. Lalbert Creek intersects the southwestern corner of the tenement, as shown in Figure 5-1. Back Creek originates in the outer western boundary of the tenement and flows in a easterly direction into Avoca River system, as shown in Figure 5-1. The local catchment is gently undulating, with a major raised dune running north-south through the middle of the tenement areas. Due to the low rainfall, sandy soils with high infiltration and gradually sloping land surface, the formation of natural waterways appears to be inhibited.

There were many stock and domestic channels that bisected the tenement areas, once delivering water to the region. The larger channels included the Witchetella, Harpers, Nullawil, Kings and Kalpienung Channels, all with small spur channels which were used to connect to farm dams. The majority of these channels have now been decommissioned, with water supplied to the area via pipeline. The channels have mostly been filled in, but some channels remain and may be blocked at road crossings, or do not receive any stock and domestic water supply. The channels across the tenements and throughout the catchments were historically for stock and domestic purposes. These channels were fed from the Grampians-Wimmera-Mallee Water Storages as well as runoff from the nearby tributaries during flooding events. The channels were typically distribution channels and although they cover a large area do not have their own catchments.

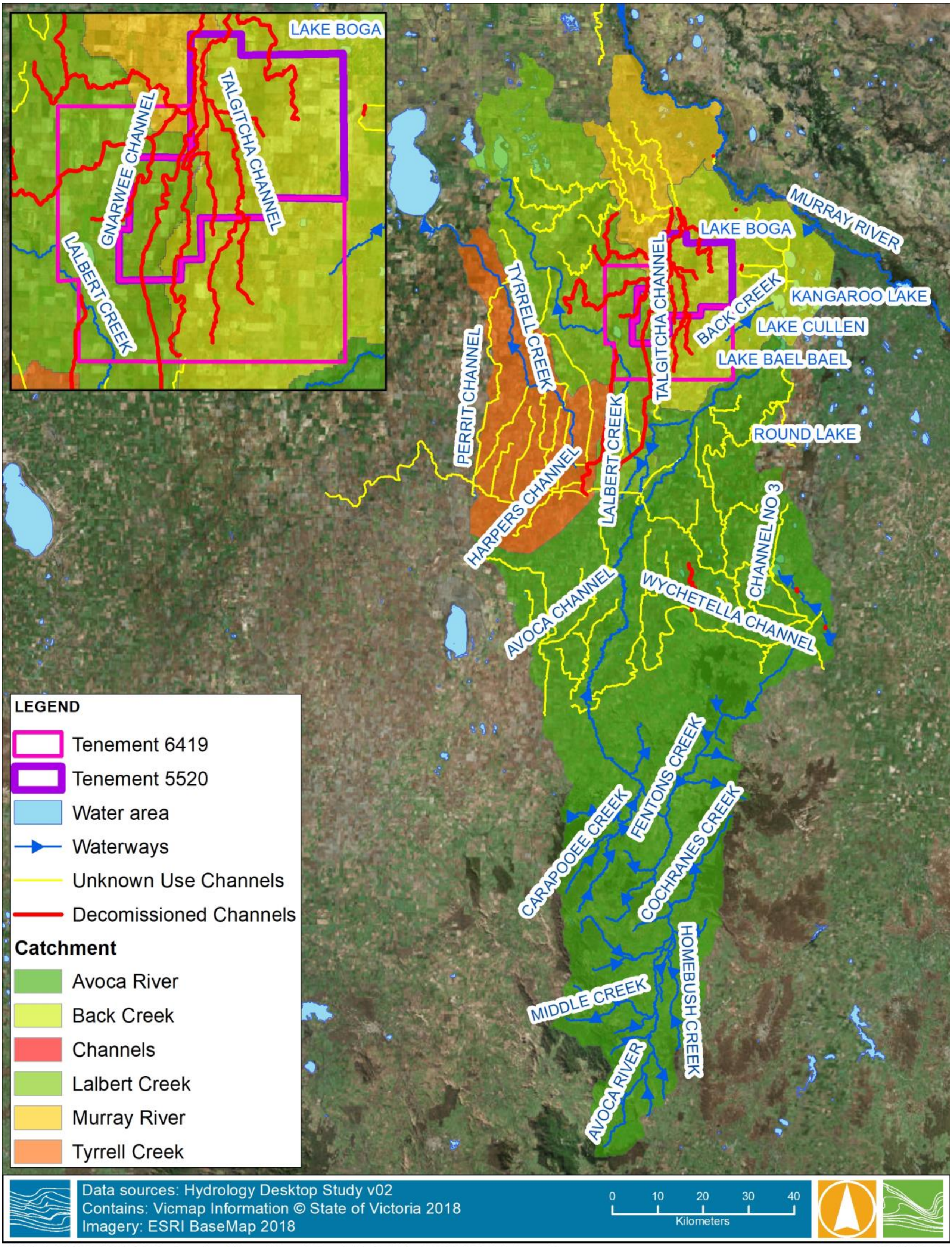

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FIGURE 5-1 CATCHMENT AREA RELEVANT TO THE GOSCHEN PROJECT

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5.2 Local Catchment Behaviour

5.2.1 Background and Overview

There were nine major channels traversing the study area with multiple dams and drainage lines alongside them. The study area includes two designated waterways, that of Lalbert Creek and Back Creek. The remainder of the site drains to various locations as described in Table 5-1.

Historically there was a detailed network of stock and domestic channels that were once active in the region, supplying water to the dry region. GWMWater decommissioned the Wycheproof Goschen Channel via infill, and suggested that many other channels may have been filled by local farmers. The site investigation revealed that most of the channels have been filled with only a small number remaining in the landscape unused. Figure 5-2 shown below, includes some field observations of the area.

TABLE 5-1 CATCHMENT DESCRIPTIONS

Catchment	Description of Catchment
Avoca River	The Avoca River catchment is large, extending back to the northern slopes of the Great Dividing Range. Once the river passes through Charlton, the river capacity is greatly diminished, with breakouts occurring into various effluent streams around Jeruk, 35 km south of Lalbert township.
Lalbert Creek	Lalbert Creek receives flood flows from the Avoca River. Lalbert Creek also drains the local catchment, including the western part of the tenement areas. The western slopes of the dune which runs north-south through the tenement area drains into Lalbert Creek.
Back Creek	Back Creek receives flood flows from the Avoca River, with a small fixed crest weir called Kops Orchard on the western bank of the Avoca River allowing breakout flows to occur during relatively minor Avoca River floods. Back Creek also drains a local catchment, including the south-east tenement areas.

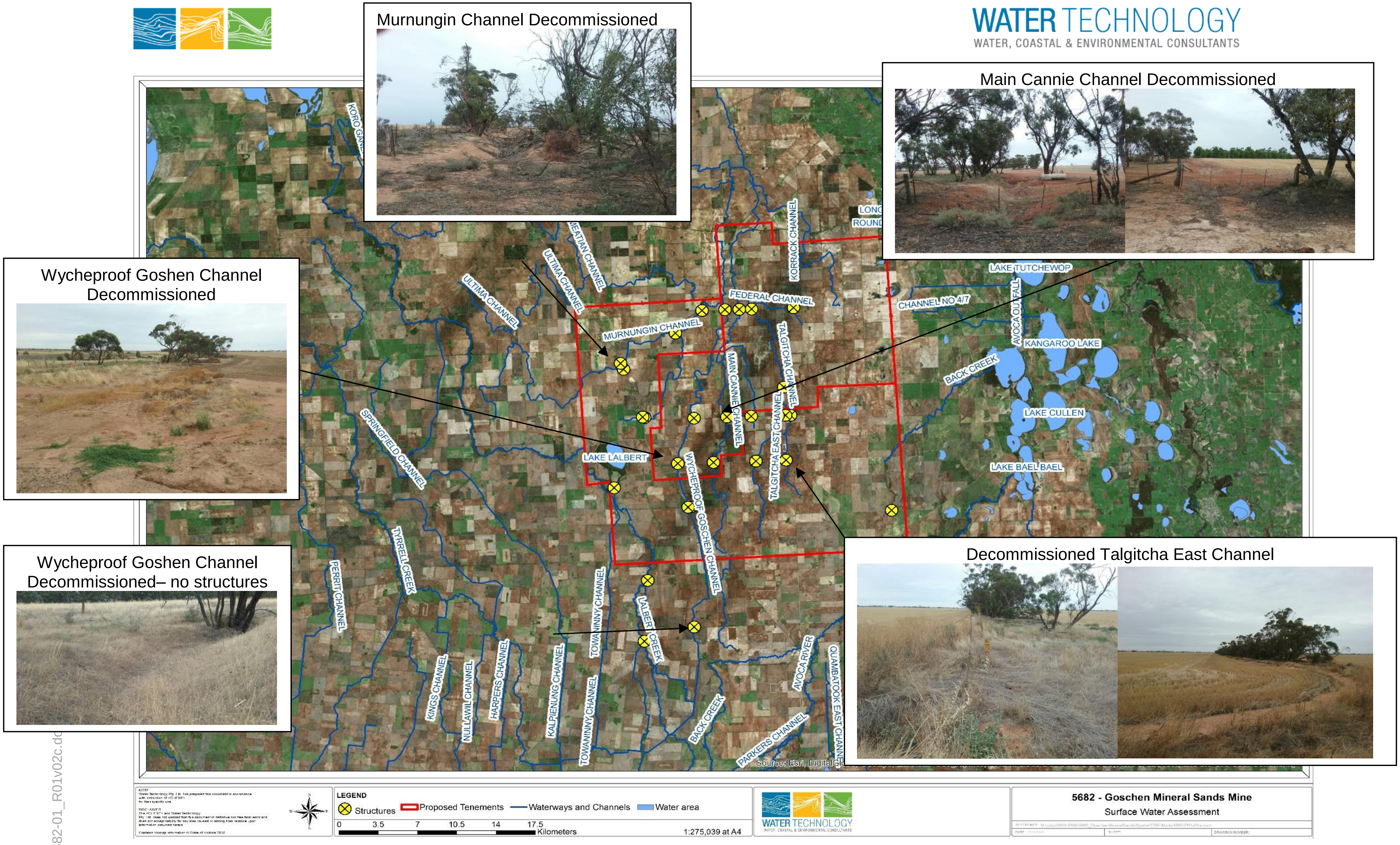

FIGURE 5-2 SITE INVESTIGATION INFORMATION

5.2.2 Design Rainfall Modelling

To understand and map natural drainage paths across the study area, some rapid overland flow flood modelling was completed. The modelling requires design rainfall data.

The 1% AEP rainfall depths were determined through the Bureau of Meteorology online Intensity-Frequency-Duration (IFD) tool at a location at the centroid of the tenements (723815.89, 6056362.48). The critical duration rainfall event was determined to be 12 hours across most of the site.

Every storm is different, with rainfall sometimes occurring steadily over the storm, sometimes in intense bursts. Two different storm types were modelled, one with a relatively steady rainfall temporal pattern across the storm (temporal pattern 5 from ARR datahub), and one with three discrete bursts (temporal pattern 9 from ARR data hub).

Design losses due to infiltration were adopted based on local knowledge and previous modelling Water Technology has undertaken on the lower Avoca River. An initial loss of 20 mm and a continuing loss of 2.7 mm/hr was adopted for most of the catchment, with lower losses adopted for roads, urban areas and permanent water bodies.

5.2.3 Surface Water Modelling

5.2.3.1 Overview

Hydraulic modelling conceptualises the various components of a hydrologic cycle via rainfall, infiltration, surface water runoff and baseflow linking them with the hydraulic controls present on site. A TuFLOW rainfall-on-grid model was constructed to determine the various drainage pathways present on site. This type of flood modelling and mapping allows all the minor drainage paths within the site to be modelled and mapped.

There were minimal hydraulic structures observed across the site, and given the accuracy of the underlying topography used for this coarse modelling, detailed hydraulic structures (i.e. culverts and bridges), were not included in the modelling of the catchment.

The TuFLOW model requires the following inputs:

- Roughness – manning's' n (used roughness map)
- Rainfall depths (BoM 1% AEP IFD for 12 hour duration)
- Infiltration losses (20 mm initial loss, 2.7 mm/hr continuing loss)
- Rainfall temporal patterns (pattern 5 and 9 were adopted)
- Rainfall spatial patterns (uniform pattern adopted)

5.2.3.2 Model Development

The drainage pathways and sub-catchments were identified and delineated in *ArcHydro* for *AcrGIS*. This used a coarse State wide DEM product which combines detailed LiDAR with coarse satellite DEMs to provide full coverage. These subareas and drainage pathways represent the best representation of the natural drainage pathways, excluding all the decommissioned channels, as shown in Figure 5-3.

The rainfall-on-grid model was developed based on a 10 metre x 10 metre grid resolution, to optimise run times and provide a good representation of the area.

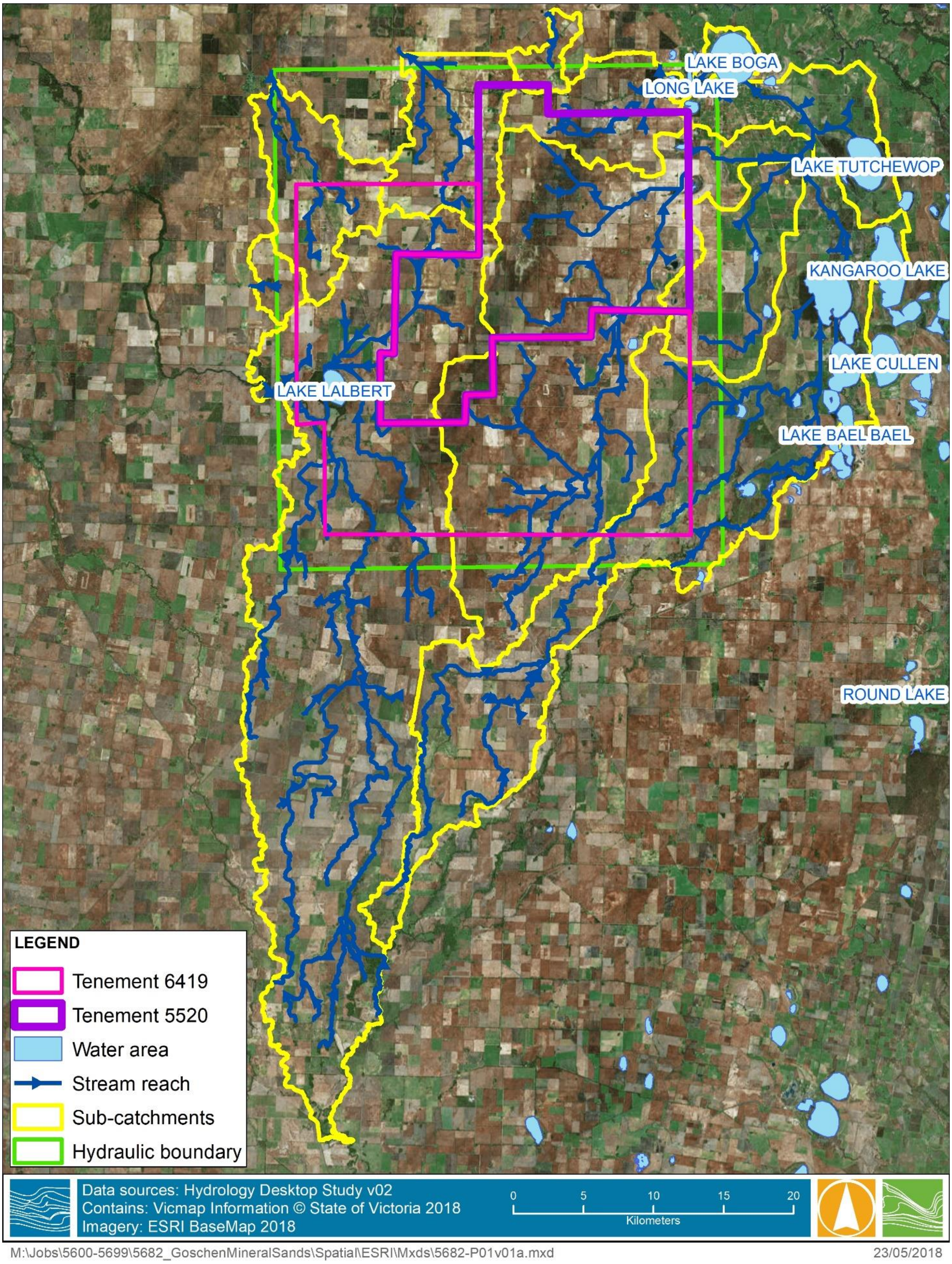

FIGURE 5-3 SUB-CATCHMENTS AND STREAM REACHE WITH TENEMENTS

5.2.3.3 Hydraulic Roughness

The hydraulic roughness is the measure of frictional resistance for storm and floodwaters traversing overland pathways. The adopted roughness parameters were mapped using planning and parcel layers verified from aerial imagery (Vieux, 2004). The catchment is comprised primarily of rural farming land. Table 5-2 gives the Manning's roughness values adopted for the overland flow model, these are based on standard industry values (VicRoads Road Design Guidelines). Figure 5-4 gives a visual representation of the modelled Manning's roughness values.

TABLE 5-2 MANNING'S VALUE FOR THE TUFLOW MODEL AREA, REFER TO FIGURE 5-4.

Land Type	Manning's Value (n)
Agricultural and Pastoral land (Farm Land)	0.05
Open water (with reedy vegetation)	0.06
Car park/pavement/wide driveways/roads	0.02
Railway Line	0.125
Residential – Urban (Higher density)	0.35

5.2.3.4 Timestep

A time step of 2.5 seconds was adopted for the local overland flow modelling for the rain-on-grid modelling. This means that during the model simulation the model will run the full suite of hydrodynamic calculations on every active wet cell, every 2.5 seconds of model time. In general, the smaller the grid cell size the smaller the time step required for the model to run stable, and the longer the run times take.

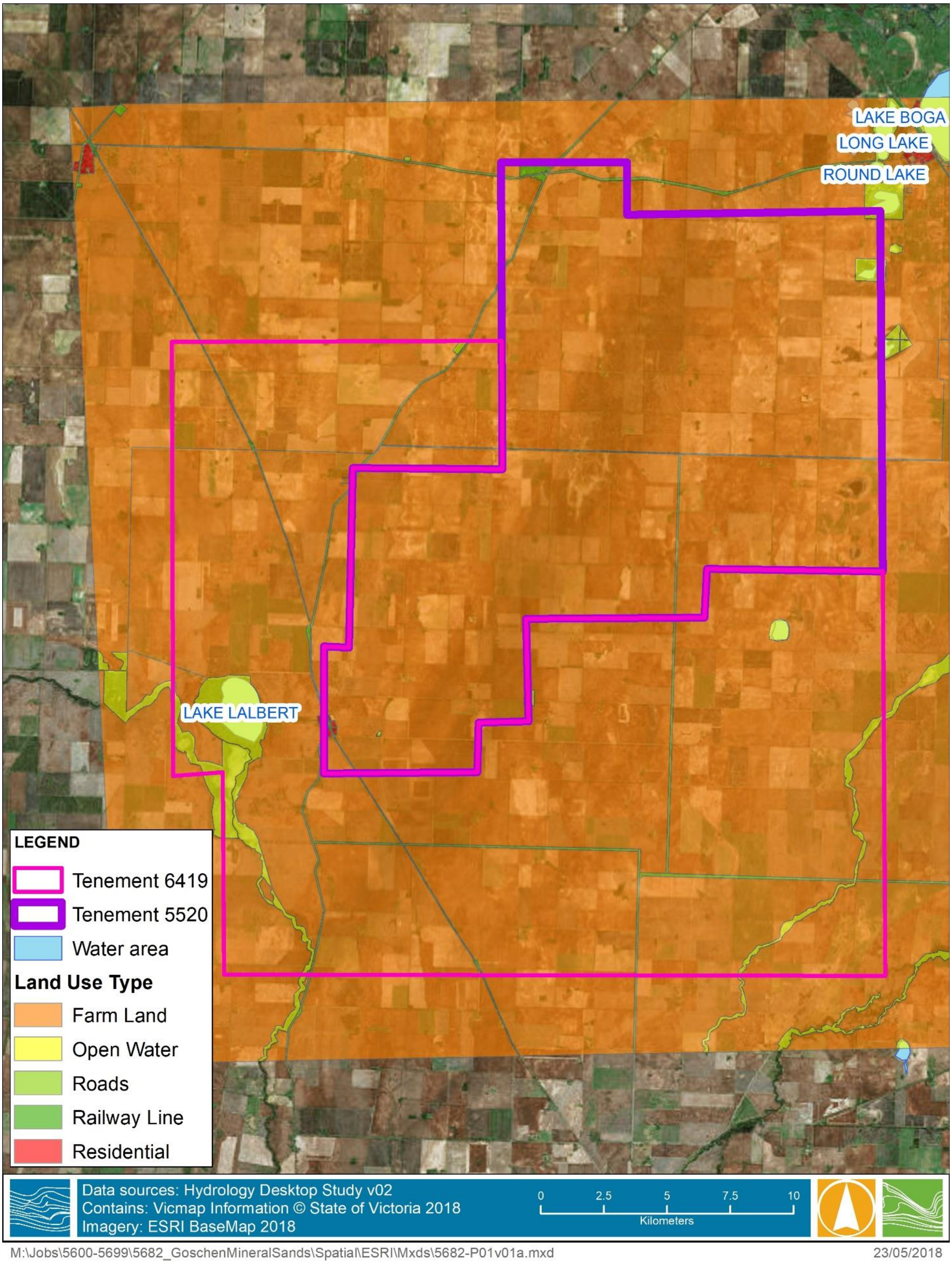

FIGURE 5-4 HYDRAULIC ROUGHNESS AND LOSS VALUES

5.2.4 Results

Figure 5-5, Figure 5-6 and Figure 5-7 show the results of the 1% AEP rain-on-grid model simulation over a 12 hour duration, with clearly defined drainage pathways following the projected stream flow drainages estimated through *ArcHydro* shown in Figure 5-3. The modelling identifies localised ponding across the site which are characterised as the lowland ecological niches observed in depressions in the topography, and lakes in the region with depths of 0.3 meters up to over 2 metres.

Velocities are generally low, with higher velocities observed in the steeper sections of the topography. These steeper sections may have a higher risk of erosion and transport of sediment

The eastern half of the tenement areas are at a lower elevation, with the modelling showing larger areas of water pooling, shown in Figure 5-7 where velocities remain slow. The inundated area in the east is noticeably different than the western area. This observation in the modelling is exaggerated due to the low quality of the coarse satellite DEM in the western portion of the study area. The eastern portion of the study has detailed LiDAR survey available so show a better definition of the natural drainage pathways. This makes it somewhat difficult to compare the risk across the site using the modelling. From visiting the site, it is expected that inundation across most of the eastern half of the tenement would be shallow and ill-defined due to the flatness of the landscape.

Preliminary Avoca regional flood mapping was added to represent modelled and historic extents from the January 2011 flooding, the largest recorded in the region, as shown in Figure 5-5. These extents and depths match to the Rain-on-Grid modelling pathways, however, there is a larger area inundated around the Avoca River, Back Creek and Lake Lalbert. Preliminary analysis indicates that the modelled flood mapping of Back Creek is over exaggerated and is currently under revision by Water Technology and Local Government.

In general, surface water drainage should be able to be managed using standard best practice approaches, diverting surface flows around mining extraction areas, treating runoff from extraction sites, etc. The larger depressions where water collects are generally associated with areas of high biodiversity value and should be avoided where possible.

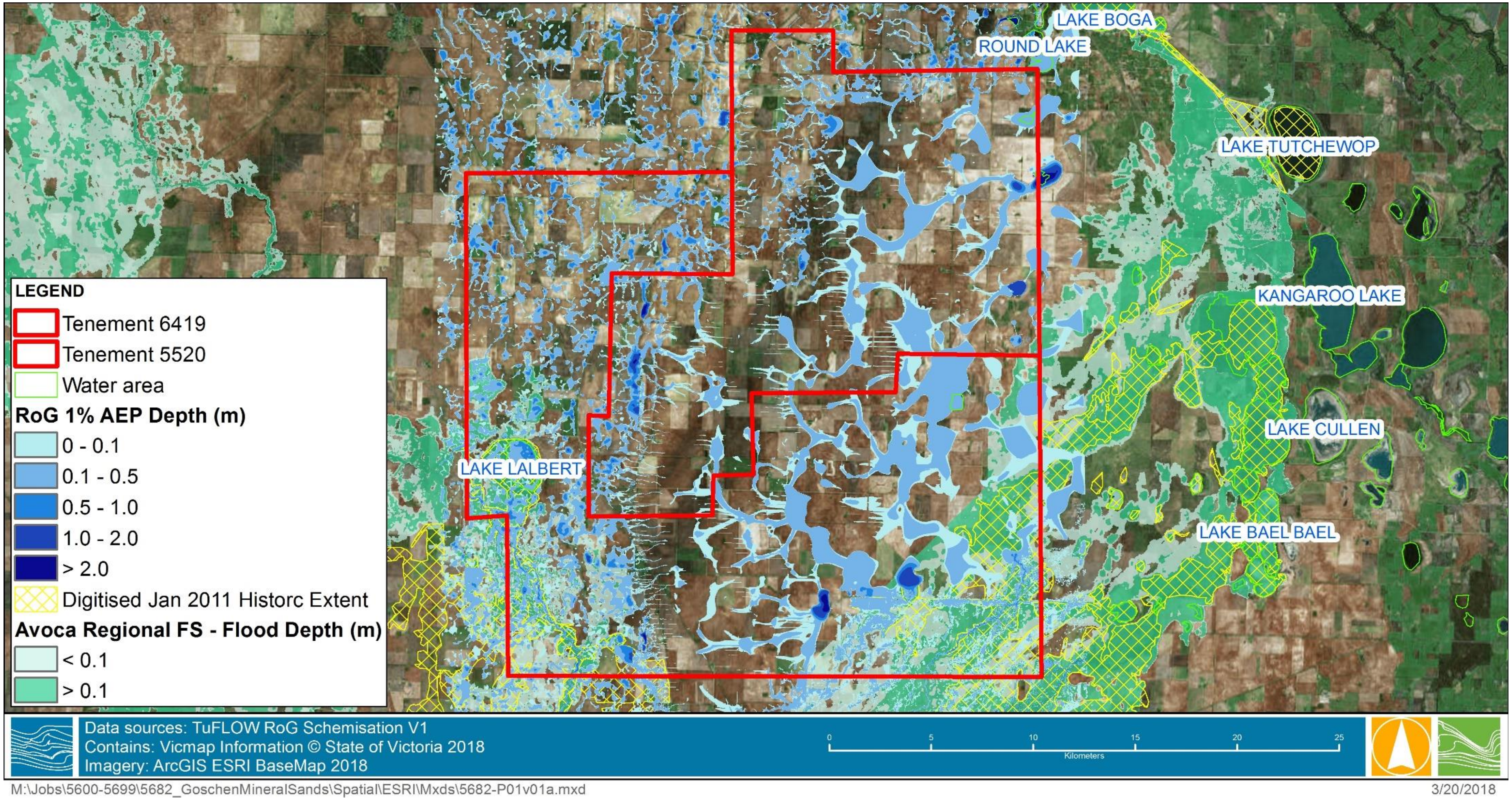

FIGURE 5-5 RAINFALL ON GRID 1% AEP FLOOD DEPTH WITH AVOCA REGIONAL FLOOD DEPTH OVERLAY

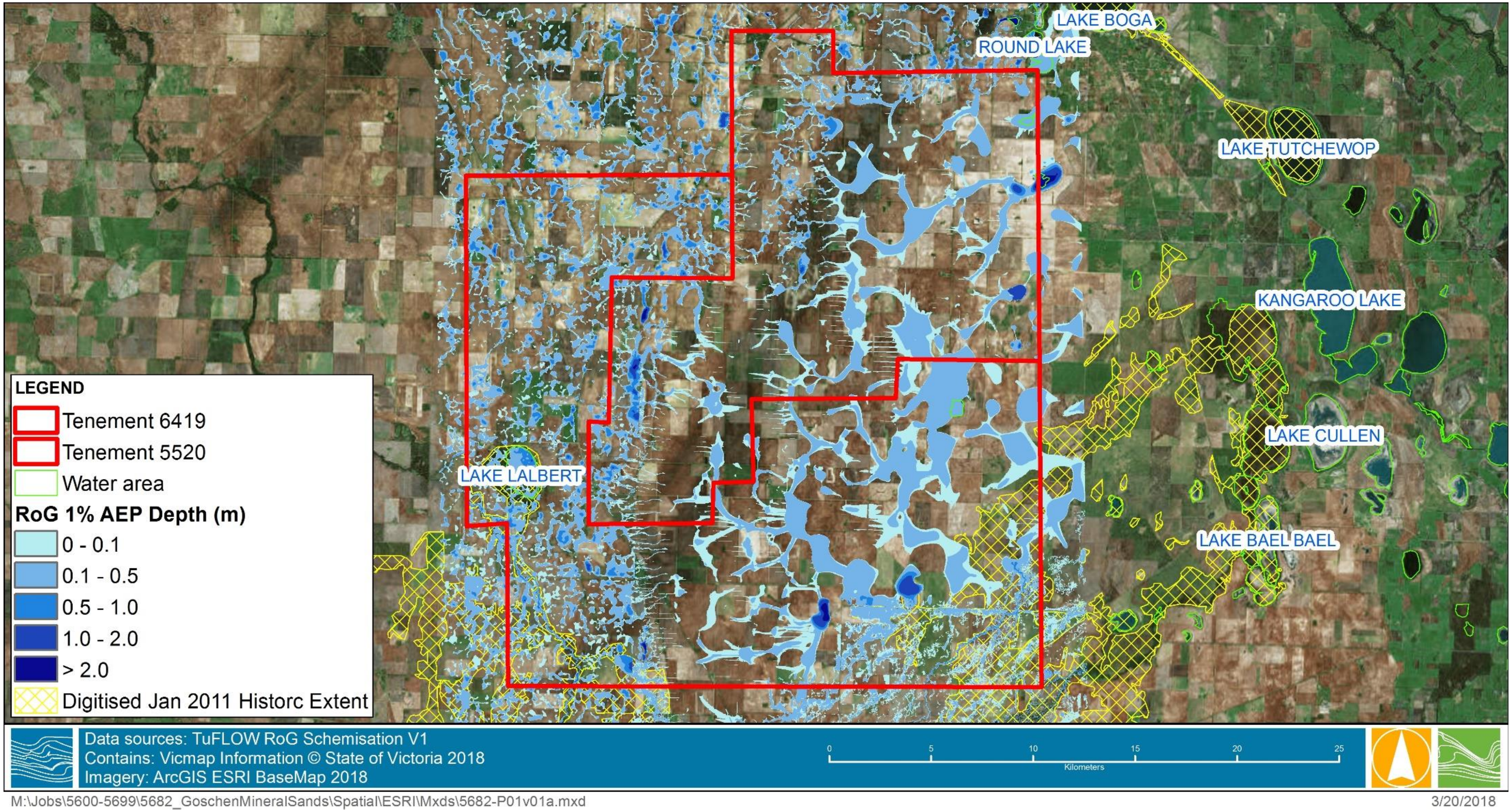

FIGURE 5-6 LOCAL 1% AEP RAIN-ON-GRID MAPPING DEPTH (M)

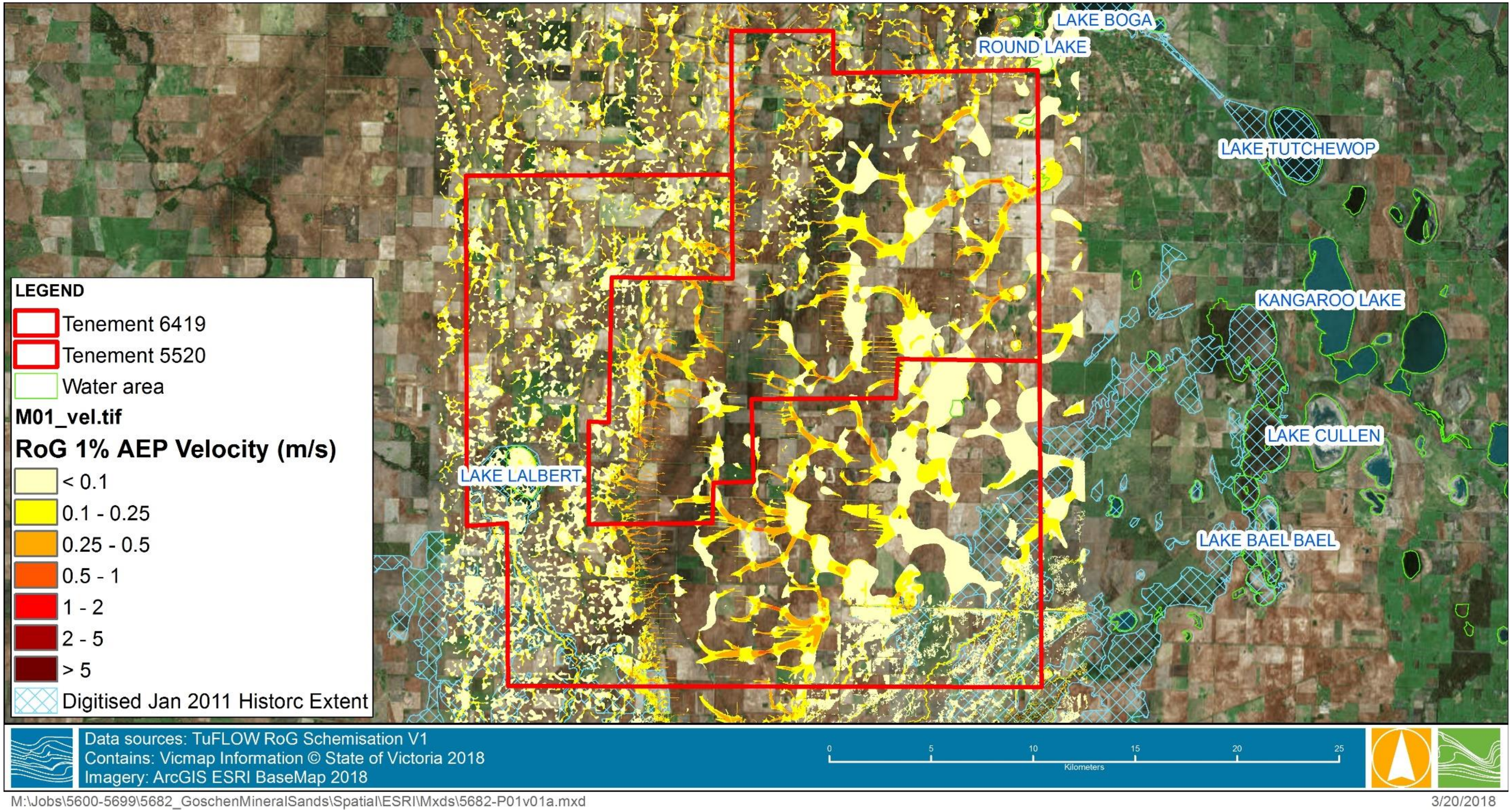

FIGURE 5-7 RAINFALL ON GRID 1% AEP FLOOD VELOCITY (M/S)

5.3 Water Quality

The study area drains to a number of environmentally sensitive areas, along Lalbert Creek, Lake Lalbert, Back Creek, the Avoca Marshes and into a number of smaller depressions of high biodiversity value in the area.

There is limited data on the water quality for the region and particularly within the lakes system. Much of the data is historical data and may be used as a guideline for typical water quality parameters seen in the region and can be found in the DELWP Water Measurement Information System website. Community groups, i.e. WaterWatch monitor water quality throughout the North Central region and may have more information.

The gauges of particular interest are those of the following:

- Lake Bael Bael @ Bael Bael 408602 (26 km from tenement centroid)
- Kangaroo Lake @ Mystic Park 407601 (28.4 km from tenement centroid)
- Sand Hills Lake @ Sandhill Lake 408604 (21.5 km from tenement centroid)
- Lake Lookout @ Bael Bael 408603 (18.5 km from tenement centroid). It is recommended that as part of any ongoing water quality compliance monitoring that the water quality at this site be compared to baseline water quality data pre-development of the mineral sands mine, to identify if any trends in water quality occur post-development. Given the flatness of the terrain it is likely that any extraction activities will have a limited impact on surrounding water quality, as if any runoff was to occur from the site during a storm event it would most likely be captured in local depressions and soaks, and not travel through to a defined waterway. The exceptions to this would be if the extraction activities were to be located in close proximity to catchments of Back Creek, Lalbert Creek and Lake Lalbert.

The Victorian Government and Environmental Protection Agency State Environment Protection Policies (SEPP) set out a framework protecting and rehabilitating surface water environments throughout Victoria. The policies outline key legal tools under the *Environmental Protection Act 1970* setting in law community expectations, needs and priorities (EPA, 2018).

There are three primary outcomes from current policy which include:

- Beneficial uses; involving the health of water and its direct impact on uses and values including drinking, industrial use, recreational and aquatic ecosystems that a waterway or waterbody can support.
- Environmental quality objectives; objectives and indicators measuring whether the beneficial uses are being protected, outlined in Section 4.7.2. The indicators used include:
  - Water quality indicators (Oxygen, sediment, phosphorus etc)
  - Biological indicators (Indicator species)
  - Flow
  - Sediment quality (density, amount – potential to suffocate biological indicators)
  - Habitat indicators – degradation
- Attainment program
  - Actions required to meet specific purpose
    - Identifies clear roles and responsibilities for environment protection and rehabilitation
    - Identifies strategic actions and tools to address activities that pose a risk to Victoria's water environments

The Goschen Project as a minimum requirement under SEPP would require a monitoring program focusing on sediment loads in any nearby wetlands and waterways. The commonly measured water quality parameters consist of:

- Salinity (measured as electrical conductivity)
- Dissolved oxygen (as percentage saturation corrected for altitude and temperature)
- pH
- Turbidity
- Total phosphorus
- Total nitrogen

The commonly measured biological indicators are macro-invertebrate communities due to their relative susceptibility to changes in environment.

It is understood that hydrocarbons will be stored on the Goschen Project area, monitoring for hydrocarbons may be required downstream of any hydrocarbon storage areas.

Monitoring would be required prior to and after mining activities to provide a complete characterisation of the study area and off-site impacts. Regular monitoring to determine quality and potential degradation will be required as a precautionary measure.

6 SUMMARY

Presented below is a summary of the key findings noted through the literature review and field assessment. The detailed findings and other analysis is discussed below.

- The Goschen project falls under legislation from the ***Environmental Protection and Biodiversity Conservation Act (1999),*** the ***Water Act (1989)*** and the ***Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000)***. Legislation informs decision on environmental protection, significance and monitoring.
- **Environmentally and culturally significant waterways and wetlands** surround the study area tenements predominately from Back Creek and Lalbert Creek.
- In the early-mid 2000s GMWater and local landholders began **decommissioning stock and domestic channels** via backfilling throughout the region, including within the Goschen Project area. As such there are no large stock and domestic channels remaining in use within the study area.
- **Topography and geology** in the region is gently undulating sloping from the centre of the tenements where a large mound runs north south. The area is part of the Murray-Darling Basin and developed through volcanism, sedimentation, and deformation leading to erosional platforms.
- **Surface water flow** follows overland drainage pathways to nearby environmentally significant depressions, waterways and offsite wetlands.
- **Water quality** monitoring will be required to ensure that water within nearby waterways and wetlands is not impacted by the Goschen Project.

7 RISK AND IMPACT ASSESSMENT

7.1 Risk Assessment

Table 7-1 presents the surface water risks associated with the Project. The environmental risk assessment methodology is outlined in Section 3.2, and is summarised Table 3-6.

1. Activities that may impact on surface water were identified.
2. The potential impacts of the identified risks were assessed and initial risk ratings developed.
3. Project-specific environmental performance requirements were recommended to reduce risks, which included the application of best practice approaches and guidelines and adherence to relevant legislation.
4. A Residual Risk Rating was then developed based on the successful implementation of the recommended environmental performance requirements.

The risk assessment is summarised in Table 7-1.

TABLE 7-1 RISK REGISTER FOR IMPACT ASSESSMENT AND ENVIRONMENTAL PERFROMANCE REQUIREMENTS

Activity and Impact	Description of Consequences	Initial Risk			Avoidance, Mitigation and Management Measures and Environmental Performance Requirements	Residual Risk			Timing
		C	L	Risk Level		C	L	Risk Level	
Discharge of stormwater runoff containing sediment and other contaminants from mine activities.	■ Degradation of water quality (turbidity, etc) and in-stream habitats within downstream waterways. ■ Sedimentation of downstream waterways, impacting in-stream habitats. ■ Hydrocarbon and chemical contamination from re-fuelling stations and chemical storage facilities degrading downstream waterways. ■ Shallow groundwater may uptake contaminates from stormwater discharge.	Minor to Moderate	Likely	Medium	■ Implement appropriate sediment and erosion control measures prior to commencement of ground disturbance works and throughout construction, including diversion of upstream flows around construction zones. ■ Revegetate disturbed areas as quickly as possible on completion of construction and/or mining. ■ Implement appropriate spill control and bunding measures to control and contain spills; minimise the amount of fuels and chemicals stored on site; implement contingency plans to clean up / manage spills. ■ Develop and maintain a water quality monitoring program that will comply with applicable legislation and guidelines. ■ Develop and implement a construction environmental management plan in accordance with EPA Publication 480: Environmental Guidelines for Major Construction Sites, including a sediment, erosion and water quality management plan addressing the requirements of the SEPP (Waters of Victoria), SEPP (Groundwaters of Victoria) and EPA Publication 275: Construction Techniques for Sediment Pollution Control. (The sediment, erosion and water quality management plan should be developed in consultation with the CMA and approved by the responsible authority before development commences.) ■ All hydrocarbons and hazardous substances are to be stored in facilities designed in accordance with EPA Publication 347: Bunding Guidelines and AS 1940:2004.	Minor to Moderate	Unlikely	Low	Construction, Operations, Decommissioning and Closure
Modifications to drainage lines (Lalbert Creek and Back Creek)	■ Damage to stream bed and banks and associated flora and fauna due to works on waterways. ■ Redistribution of flows potentially impacting neighbouring properties, and or preventing water from entering natural systems.	Moderate to Major	Unlikely	Medium	■ Avoidance of any large modifications to natural waterways. ■ Comply with specific requirements in Works on Waterways permits for any works in vicinity of a designated waterway. ■ Ensure runoff from around work areas is captured in water treatment infrastructure (sedimentation ponds, wetlands etc.). ■ Include appropriately sized culverts or bridges on drainage lines crossed by access roads, as stipulated in Works on Waterways permits. Allow time for assessment by local government and CMA. ■ Ensure that any surface water diversion that are implemented discharge into the natural downstream discharge point as prior to the works. ■ Ecological and water quality monitoring of any surface water diversions to ensure they have no impact on downstream ecosystems. If change is detected, must remedial action steps to rectify the problem immediately to avoid irreversible damage to downstream ecosystems.	Moderate	Unlikely	Low	Construction and Decommissioning

Activity and Impact	Description of Consequences	Initial Risk			Avoidance, Mitigation and Management Measures and Environmental Performance Requirements	Residual Risk			Timing
		C	L	Risk Level		C	L	Risk Level	
Clearance of vegetation	■ Increased erosion and sediment runoff, leading to degradation of water quality and/or destabilisation of waterway banks ■ Destruction of environmental values in the region ■ Lowers the groundwater, leaving the ecological niche sites vulnerable	Moderate	Likely	Medium	■ Any works to occur (including vegetation removal) within the bed and banks of a designated waterway are to be undertaken in accordance with a Works on Waterways Permit from CMA and the necessary vegetation removal permits. ■ Conduct Ecological Site Investigations to determine whether works will impact the flora and fauna in the region.	Minor	Unlikely	Low	Construction
Construction in a flood prone area with flooding of mineral sands mine or other infrastructure.	■ Transport of contaminants offsite in flood waters ■ Damage to infrastructure ■ Mining halted during dewatering and recovery works	Minor	Unlikely	Low	■ Access routes are to be designed to maintain access to mine sites and associated infrastructure with flood depths below 300 mm during construction and maintenance operations. ■ Any infrastructure within the 1% AEP storm extent is to be designed to withstand potential flooding and would be subject to compliance with the specific requirements of North Central and Mallee CMA's floodplain works approval process. ■ All mine sites located minimum 100 m from designated waterways. ■ Comply with specific requirements of CMA floodplain works approval process. ■ Any infrastructure within the 1% AEP flood extent should be designed to withstand potential flooding.	Moderate	Unlikely	Low	Construction, Operation and Decommissioning
Increasing sediment loads to waterways.	■ Increased erosion and sediment runoff, leading to degradation of water quality ■ Destruction of environmental values within waterways	Moderate	Possible	Medium	Management of sedimentation issues should be a specific requirement of the environmental management plan for the site. The sediment, erosion and water quality management will include as a minimum: ■ Details of sediment and erosion control measures to be implemented prior to commencing ground disturbance works and throughout construction, including diversion of upstream flows around construction zones, stockpiles, progressive vegetation clearance and rehabilitation, and contingency plans to remediate localised erosion and sedimentation issues. ■ Details of spill control and bunding measures to control and contain spills, minimise the amount of fuels and chemicals stored on site, and contingency plans to clean-up / manage spills. ■ A monitoring program (including as a minimum visual monitoring during construction activities). ■ A complaint investigation and response plan.	Moderate	Unlikely	Low	Construction, Operation and Decommissioning

7.2 Impact Assessment

7.2.1 Waterways

There are two waterways within the Goschen Project tenement locations, Lalbert Creek and Back Creek, there are also a number of drainage pathways and channels which traverse the site which flow during intense periods of rain. Works occurring within close proximity to a designated waterway will require a Works on Waterways permit from the North Central CMA or Mallee CMA. It is recommended that mining works avoid areas in close proximity to the declared waterways and any other natural lakes and water bodies.

Assuming sufficient crossings are designed for any infrastructure that intersects the waterways (i.e. fords/culverts that do not impede flow), the proposed Goschen Project will not alter the hydrology of the waterways. Groundwater pumping may however be an issue and would require further analysis as the "cone of depression" surrounding any mine may lower stream base flows. Again, it is recommended that mining works avoid areas adjacent to the declared waterways.

Surface water runoff from mining areas is likely to have a higher sediment load and potentially an elevated level of other contaminants. It is recommended that runoff from the catchment be diverted around any mining extraction areas and stockpiles, with the diversion leading back to the natural point of discharge on the downstream side of the mining area. Any surface water runoff from the mining area should be treated so that any downstream users and environmental values are not impacted by a reduction in water quality. This is required through the construction and operation phase of the mining.

Disturbed sites should be rehabilitated immediately after operations cease at the site. Rehabilitation should occur in a staged manner rather than at the end of the whole mining operation.

It is recommended that prior to construction the final layout plan be reviewed by North Central and Mallee CMA's for approval. The CMA is the relevant flood authority in the region and will require that the mine does not have any adverse effect on flooding of the nearby landholders and the downstream river and lakes system.

7.2.2 Flood Risk

The 1% AEP flood event mapping shows overland flow paths are typically shallow, with higher depths in localised depressions. The flood mapping does over exaggerate the flood risk in the eastern areas of the tenements due to poor quality land survey in that area. However, mining areas should avoid any significant natural depressions, where surface water depths are likely to be high, and may pose a flood risk to mining infrastructure, equipment and mining staff. It must be noted that flood mapping results are approximate only and are based on poor quality land survey suitable only for high level risk assessment.

If mining locations are within identified overland flow paths, then appropriately designed diversions around mining areas will be required to minimise the flood risk. Diversions must not alter the course of flood flow on to neighbouring properties and should ensure that water outfalls into the natural drainage line downstream of the mining site. Access to and from the mining site should be maintained and designed to have 1% AEP flood depths less than 300 mm.

7.2.3 Treatment of Risk

By applying the avoidance, mitigation and management measures and environmental performance requirements indicated in the risk assessment above in Section 6, it is Water Technology's opinion that all risks associated with surface water can be reduced to a low risk level.

8 CONCLUSIONS

This report has documented the investigations undertaken to determine surface water implications of the project. The investigations have addressed the scoping requirements of characterising surface water environments and drainage features and identifying and assessing the effects of the Project on water environments (including surface water flow and quality).

There are three waterways within and nearby the mineral sands mine tenement areas, along with a number of ecological depressions, lakes, and intermittent flow paths. There are existing 1% AEP flood levels for the Avoca River, including Back Creek and Lalbert Creek which suggest areas within the vicinity of the waterways are flood prone and should be avoided.

Flood risk is manageable if the proposed mineral sands mine and associated infrastructure is located away from any significant low depressions in the landscape which currently collect surface water. These locations are mostly vegetated with native vegetation and likely have high biodiversity values also.

The natural flow of water should be diverted around any mining excavation or stockpile areas, and returned to the natural flow path downstream of the mining site. All stormwater runoff from the mine site itself should be treated to best practice guidelines to avoid any impacts to downstream water users and the environment.

An environmental management plan in accordance with EPA Publication 480: Environmental Guidelines for Major Construction Sites, including a sediment, erosion and water quality management plan addressing the requirements of the SEPP (Waters of Victoria), SEPP (Groundwaters of Victoria) and EPA Publication 275: Construction Techniques for Sediment Pollution Control, will help to prevent any adverse impact on downstream water users and the environment. In addition, by applying the avoidance, mitigation and management measures and environmental performance requirements indicated in the risk assessment, it is Water Technology's opinion that all risks associated with surface water can be reduced to a low risk level.

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