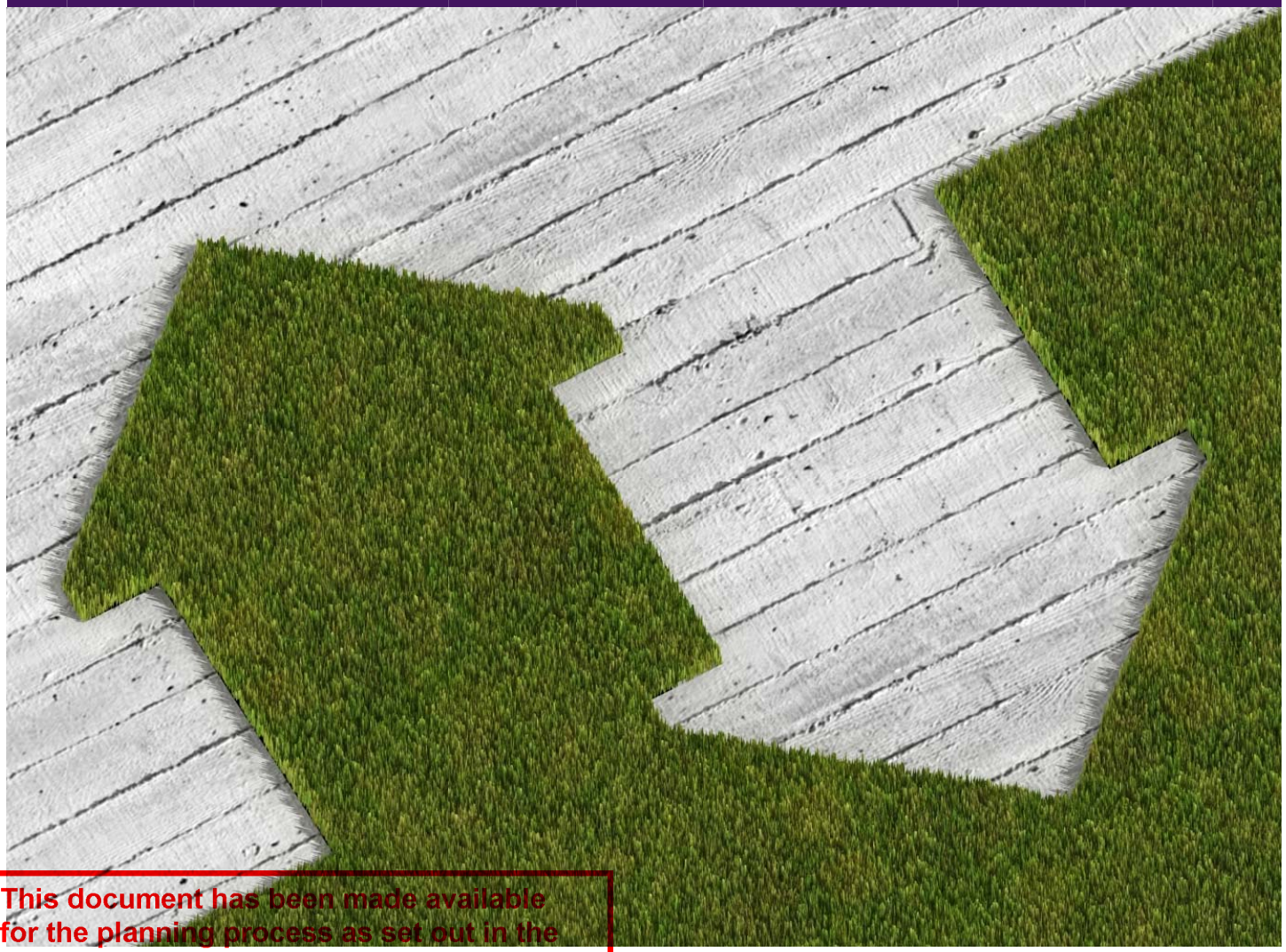
Lake Narracan Precinct Structure Plan Area

DESKTOP ENVIRONMENTAL, HYDROLOGICAL AND GEOTECHNICAL ASSESSMENTS

Final V1 | June 2013



growth areas AUTHORITY

SINCLAIR KNIGHT MERZ
SKM

Lake Narracan Precinct Structure Plan Area

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Contents

List of Abbreviations

AHD	Australian Height Datum
AMG	Australian Map Grid
ANZECC	Australian New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS	Australian Standard
ASRIS	Australian Soil Resources Information System
ATES	Aquifer Thermal Energy Storage
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
BH	Borehole
CoC	Chain of Custody
DS	Stock and Domestic
DM	Domestic
DO	Dissolved Oxygen
DQO	Data Quality Objective
DY	Dairy
EAO	Environmental Audit Overlay
EC	Electrical Conductivity
EHS	Environment, Health and Safety
EIL	Ecological Investigation Levels
EMP	Environmental Management Plan
EPA	Environment Protection Authority
ESA	Environmental Site Assessment
FZ1	Farming Zone Schedule 1
GAA	Growth Areas Authority
GME	Groundwater Monitoring Event
GMS	Groundwater Management System
GQO	Groundwater Quality Objective
GWZ1	Green Wedge Zone 1
HIL	Health Investigation Levels
IR	Irrigation
IV	Investigation
LPP	Local Planning Policies
LPPF	Local Planning Policy Framework
mbgl	Metres below ground level
MAH	Monocyclic Aromatic Hydrocarbons
MAR	Managed Aquifer Recharge

MI	Miscellaneous
MSS	Municipal Strategic Statement
MW	Monitoring Well
NATA	National Association of Testing Authorities, Australia
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NKN	Not known
OCP	Organochlorine Pesticides
OPP	Organophosphate Pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PASS	Potential Acid Sulphate Soils
PSP	Precinct Structure Plan
RWL	Reduced Water Level
SAP	Sampling & Analysis Plan
SB	Soil Bore
SEPP	State Environment Protection Policy
SKM	Sinclair Knight Merz
SPPF	State Planning Policy Framework
ST	Stock
SWL	Standing Water Level
TDS	Total Dissolved Solids
TPH	Total Petroleum Hydrocarbons
UST	Underground Storage Tank
UGZ	Urban Growth Zone
WSPA	Water Supply Protection Area

Executive summary

Background and objectives

Sinclair Knight Merz Pty Ltd (SKM) was commissioned by the Growth Areas Authority (GAA) to undertake a Desktop Environmental, Hydrogeological and Geotechnical Site Assessment of the Lake Narracan Precinct Structure Plan (PSP) Areas (GAA reference number Latrobe/12/10918), hereafter referred to as "the site" or "PSP area").

The Lake Narracan site has been identified as future land supply primarily for residential land use, although also with a view to various commercial and community land uses. The aim of this assessment is to identify opportunities and constraints to the proposed land development which may potentially be caused by existing or past land uses, and site and sub-surface conditions. The assessment comprised two stages; Stage 1 being a review of the history of land use at the site and a preliminary desktop review of information, with Stage 2 involving inspections of the properties within the PSP area identified as presenting a potential risk. Risk in this regard relates to potential contamination, hydrogeology and/or geotechnical issues. Site investigations were not conducted for all properties due to access limitations and property owner constraints during the investigation period. This report includes the findings of both the Stage 1 and 2 assessment completed.

Scope of works

The following scope of work was undertaken at the site:

- The Stage 1 assessment comprised the gathering of relevant information (including the use of literature sources) for the purposes of identifying potential sources of contamination, hydrogeological and geotechnical issues
- The Stage 2 assessment included inspecting the site for potential sources of contamination, and areas of geotechnical and hydrogeological significance (i.e.: areas of water logging, existing groundwater bores, etc.) identified during the stage one assessment

The approach and findings of the assessment, together with supporting information, are documented within this report.

Conclusions

Site contamination assessment

Based on the information gathered during the Stage 1 & 2 assessments, the following conclusions can be made in relation to the Lake Narracan PSP area:

- The site history assessment found that the site has a long history of agricultural land uses with much of the areas remaining under cultivation to the present day.
- Based on the available information including a site walkover and site history assessment the following primary potential sources of contamination have been identified:
  - Potentially contaminative land uses associated with intensive agricultural (industrial agriculture) or other industrial/commercial activities. These sites include a vehicle maintenance garage (property LN09), a former poultry/broiler farm (LN36) as well as a dilapidated former piggery site (LN28). At these sites potential contamination may not be confined to a single, localised area but instead encountered across the wider extent of the site to one degree or another owing to the intensity and nature of the associated land use.
  - Highly localised areas of potential contamination associated with frequently encountered land uses. These include potential contamination hotspots associated with uses such as stockyards and general farm premises. These hotspots are likely to be localised to areas such fuel tanks, chemical storage areas and similar.

  - Diffuse but low level sources of contamination associated with the widespread application of agricultural chemicals on farmland as well as orchards and plant nurseries. These chemicals may include pesticides, herbicides, fungicides and fertilizers.

- A number of off-site sources of contamination have been identified in the vicinity of the PSP site. Owing to the nature of the site uses (typically farms, water treatment ponds, farm industries) at these sites and their proximity to the study areas they are considered to represent a low risk of causing contamination at the PSP site.

Based on the information obtained from the sources described in this report, there do not appear to be any significant risks from a site contamination perspective which would render the land unsuitable for a particular land use. Localised contamination is likely to be able to be effectively managed or remediated.

**In relation to potential odour issues and constraints on development, property LN51 (Gippsland Water Treatment Facility), adjacent the western boundary was identified. The impact of odours (if any) from this offsite source should be assessed prior to any development within the PSP Area.

Geotechnical assessment

Based on the available geological information, it is anticipated that the site is underlain by highly reactive residual clay overlying basalt rock. An indicative site classification of Class “M to H1” has been assessed in accordance with Table D1, AS2870-2011.

Key geotechnical issues associated with development of the site include the depth and reactivity of the clay in terms of its influence on site classification, foundation selection, differential settlement, subgrade performance and excavations.

Fill material, if present, is expected to be uncontrolled and may not be suitable for development in its present state. Areas subject to poor drainage may comprise soft material which provides low bearing capacity for foundations.

Hydrology Assessment

The Latrobe PSP area is situated at the confluence of several large rivers in the Latrobe Valley, and as such, is located in an area of significant flood risk unless appropriate flood mitigation measures are introduced. The spatial representation of the current 1% AEP flood level in the eastern portion of the PSP area appears to be in error and should be reviewed. The PSP area offers opportunities to incorporate integrated water cycle management and water sensitive urban design to manage flood risk from local drainage lines, and could be an important factor in maintaining water quality for recreation in Lake Narracan and the downstream Ramsar listed Gippsland Lakes wetlands.

Hydrogeological assessment

Based on the regional hydrogeological information and bore data in the vicinity of the site, the unconfined aquifer is associated with the Quaternary Alluvium and the Haunted Hills Gravel. The LVCM, Thorpdale Volcanics and Childers Formation are either semi-confined or confined in nature.

There do not appear to be any significant hydrogeological constraints which would render the land unsuitable for development at the Narracan PSP. The following issues would need to be considered however, in the planning and design of any development:

- The shallow watertable may cause groundwater inflow to excavations
- The high quality of groundwater will require careful monitoring and protection as the beneficial use of the groundwater cannot be altered below its current classification of A1

- Increases to groundwater recharge rates (particularly over summer and autumn) has the potential to raise the water table to within a few metres of the ground surface, potentially causing damage to infrastructure and buildings
- Decreased local groundwater recharge in winter and early spring has the potential to reduce discharge to nearby surface water features, which could potentially have a negative impact on the ecological health of local waterways.

Opportunities for groundwater use include extraction for garden watering and irrigation of parks and ovals.

Recommendations

We understand that the proposed future use of the site is as a broad ranging urban development and is likely thus to include sensitive uses such as residential and community facilities in addition to open space, retail and a range of business uses such as offices.

No general contamination, geological or hydrogeological constraints have been identified warranting further investigation at this stage.

Some potential specific issues have been identified; however the risks to any future development are likely to be readily addressed once particular land uses have been defined. This will require the implementation of an informed investigation strategy, with this best being done once further information on the proposed land uses for specific areas of the site is available. Future intrusive assessment works should be timed to coincide with the cessation or scaling down of current site operations and prior to the commencement of the proposed development and construction works.

Further assessment works may include, but are not limited to, the following activities:

- Assessment of potentially contaminative farm industry land uses located at properties LN09, LN28 and LN36. These sites are likely to present the greatest potential for property-wide contamination issues. This process may be best undertaken through the preparation of a Sampling, Analysis and Quality Plan (SAQP) followed by a Phase 2 Environmental Site Assessment (which may include targeted sampling of soils and groundwater).
- Odour monitoring / assessment should be undertaken along the PSP boundary adjacent off-site property LN51 (Gippsland water Treatment Facility), prior to any development of the PSP area. Odours (if any) emanating from this property could potentially impact upon future development in the vicinity of this site. Additionally, if this property is ever incorporated into a future PSP Area, it should be thoroughly assessed (e.g. via a Phase 2 ESA).
- Further limited assessment of frequently encountered land uses which may present potential hotspots of contamination. Such sites include stockyards and general farm storages. Rather than target each individual property where such features have been identified, it is recommended that a limited number of representative sites are selected from which targeted soil samples are collected around potential point sources of contamination (i.e. fuel tanks or stockyard structures). The results for these targeted locations can then be used to clarify the potential for contamination at similar sites elsewhere within the PSP areas.
- Further limited assessment of the potential for contamination associated with diffuse but low level sources of contamination. Given the long history of agricultural land use within the PSP area and the potential widespread use of agricultural chemicals throughout this period, further limited sampling would provide valuable information as to the true extent and significance of these potential contaminants of concern. Such an investigation may comprise the collection of 10 to 20 soil samples from selected representative fields and orchards across the study area. These samples would be analysed for pesticides, herbicide and nutrients with the results providing an overview of the potential risk associated with these diffuse sources.
- Further drilling and collection of soil samples for the purposes of assessing the geotechnical soil properties for building foundation and road design.

- Drilling and installation of groundwater monitoring wells to determine the depth to groundwater as well as aquifer hydraulics testing to determine aquifer properties
- Excavation and removal of underground storage tanks, soil remediation and tank pit validation if USTs are found on properties
- Removal of other potentially contaminating infrastructure (e.g. septic tanks and above ground storage tanks) followed by soil validation.

Based on the findings of this report, SKM recommend that Phase 2 ESAs be undertaken at properties LN09, LN28 and LN36 prior to determining whether a statutory environmental audit is necessary. If an environmental audit of a site is required, a period of at least 6 months prior to development should be allowed to progress through the audit process. It is likely that a longer period of time will be required should significant contamination be identified at the site to allow for remediation works.

1. Introduction

1.1 Background and objectives

Sinclair Knight Merz Pty Ltd (SKM) was commissioned by the Growth Areas Authority (GAA) to undertake a Desktop Environmental, Hydrogeological and Geotechnical Site Assessment of the Lake Narracan Precinct Structure Plan (PSP) Areas (GAA reference number Latrobe/12/10918), hereafter referred to as "the site" or "PSP area").

The Lake Narracan site has been identified as future land supply primarily for residential land use, although also with a view to various commercial and community land uses. The aim of this assessment is to identify opportunities and constraints to the proposed land development which may potentially be caused by existing or past land uses, and site and sub-surface conditions. The assessment comprised two stages; Stage 1 being a review of the history of land use at the site and a preliminary desktop review of information, with Stage 2 involving inspections of the properties within the PSP area identified as presenting a potential risk. Risk in this regard relates to potential contamination, hydrogeology and/or geotechnical issues. Site investigations were not conducted for all properties due to access limitations and property owner constraints during the investigation period. This report includes the findings of both the Stage 1 and 2 assessment completed.

1.2 Scope of work

The following scope of work was undertaken at the site:

- The Stage 1 assessment comprised the gathering of relevant information (including the use of literature sources) for the purposes of identifying potential sources of contamination, hydrogeological and geotechnical issues
- The Stage 2 assessment included inspecting selected properties within the two PSP areas for potential sources of contamination and areas of geotechnical and hydrogeological significance (e.g. areas of water logging, existing groundwater bores, etc.) identified during the Stage 1 assessment

The approach and findings of the assessment, together with supporting information, are documented within this report.

1.3 Statement of limitations

This Report has been prepared by SKM for the sole use of the Growth Areas Authority ("the Client").

Undertaking an assessment or study of the on-site conditions may reduce the potential for exposure to the presence of contaminated or inadequate bearing ground and/or groundwater. All reports and conclusions that deal with sub-surface conditions are based on interpretation and judgement and as a result have uncertainty attached to them. It should be noted that this report contains interpretations and conclusions which are uncertain, due to the nature of the investigations. No study can completely eliminate risk, and even a rigorous assessment and/or sampling program may not detect all problem areas within a site. The following information sets out the limitations of the Report.

This Report should only be presented in full and should not be used to support any objective other than those detailed within the Agreement. In particular, the Report does not contain sufficient information to enable it to be used for any use other than the project specific requirements for which the Report was carried out, which are detailed in our Agreement. SKM accepts no liability to the Client for any loss and/or damage incurred as a result of changes to the usage, size, design, layout, location or any other material change to the intended purpose contemplated under this Agreement.

It is imperative to note that the Report only considers the site conditions current at the time of investigation, and to be aware that conditions may have changed due to natural forces and/or operations on or near the site. Any decisions based on the findings of the Report must take into account any subsequent changes in site conditions

and/or developments in legislative and regulatory requirements. SKM accepts no liability to the Client for any loss and/or damage incurred as a result of a change in the site conditions and/or regulatory/legislative framework since the date of the Report.

The Report is based on an interpretation of factual information available and the professional opinion and judgement of SKM. Unless stated to the contrary, SKM has not verified the accuracy or completeness of any information received from the Client or a third party during the performance of the services under the Agreement, and SKM accepts no liability to the Client for any loss and/or damage incurred as a result of any inaccurate or incomplete information.

The Report is based on assumptions that the site conditions as revealed through selective sampling are indicative of conditions throughout the site. The findings are the result of standard assessment techniques used in accordance with normal practices and standards, and (to the best of our knowledge) they represent a reasonable interpretation of the current conditions on the site. However, these interpretations and assumptions cannot be substantiated until specifically tested and the Report should be regarded as preliminary advice only.

Any reliance on this Report by a third party shall be entirely at such party's own risk. SKM provides no warranty or guarantee to any third party, express or implied, as to the information and/or professional advice indicated in the Report, and accepts no liability for or in respect of any use or reliance upon the Report by a third party.

This Report makes no comment on the presence of hazardous materials, unless specifically requested.

2. Investigation methodology

2.1 General assessment approach

2.1.1 Stage 1 assessment

A Stage 1 assessment (also referred to as a Phase 1 Environmental Site Assessment (ESA)) is typically undertaken to establish site conditions, historical site uses and practices. As part of this Stage 1 assessment the following sources of information have been reviewed:

- relevant reports
- EPA priority sites register
- EPA list of certificates and statements of environmental audit (current and completed audits)
- topographical maps
- groundwater management system (GMS) bore searches
- geological maps
- hydrogeological maps
- potential acid sulphate soils (pass) probability maps.

The Stage 1 assessment seeks to identify if possible:

- the potential source(s) of on and off site contamination
- pathways and receptors of contamination
- areas of environmental concern (contamination, hydrogeological and geotechnical) which will form the basis of subsequent assessments at the site.

2.1.2 Stage 2 assessment

For this particular investigation, the site inspection works are referred to as a Stage 2 assessment. The site inspections undertaken included a close inspection of areas that were identified during the Stage 1 as presenting a low, medium or high risk from a contamination, hydrogeological and geotechnical perspective. Those properties identified during the Stage 1 assessment as presenting a very low risk were not inspected. Based on the findings of the site inspections, the need for further soil and groundwater investigation (typically by sampling and analysis) has been identified. While the completion of these further investigations does not form part of this scope of work, **Section 2.1.3**, **Section 2.1.4** and **Section 2.1.5** below provides an overview of the typical objectives/outcomes of such assessments.

2.1.3 Stage 3 assessment

The Stage 3 intrusive site investigation may be undertaken to characterise the site with respect to contamination, hydrogeology and geotechnical conditions. Note that this stage of site investigation is usually referred to as a Stage 2 (or Phase 2) ESA. With respect to each of the abovementioned disciplines, the following works may be undertaken as part of a Stage 3 assessment:

- ***A contamination assessment*** will typically seek to determine the level (if any) of contamination present on site, establish the lateral and vertical distribution of contamination and identify the source(s) of on-site and off-site contamination. Prior to undertaking any intrusive soil and/or groundwater investigation, a Sampling and Analysis Plan (SAP) is generally prepared. The SAP defines the intended sampling locations and the contaminants which will be tested for, based on the site characteristics as determined in a Phase 1 ESA.

- ***A geotechnical assessment*** will typically seek to obtain information on the sub-surface conditions at the site through a geotechnical site investigation comprising a series of boreholes and/or test pits and laboratory testing. Field and laboratory test data is used to develop a site model describing the soil and/or rock profile and the variability across the site. A geotechnical assessment would generally include advice on site classification and allowable bearing capacity for shallow foundation design and comments regarding excavations, foundation systems, pavement design and other items relevant to the proposed development.
- ***A hydrogeological assessment*** will typically include determination of the depth to the water table and the potentiometric surface of deeper confined aquifers through the installation of groundwater observation bores, assessment of groundwater and surface water interaction and assessment of aquifers suitability for managed aquifer recharge (MAR).

2.1.4 Remediation

If significant contamination is identified at a site, to a level where the beneficial uses of land, surface water or groundwater are at risk or precluded (described in further detail in **Section 3**), remediation of the identified contamination may be required in order to allow for a particular land use to continue or commence in future.

2.1.5 Environmental auditing

The environmental audit system under the Environment Protection Act 1970 is administered by the Victorian Environment Protection Authority. A statutory Environmental Audit of a site involves the appointment of an EPA accredited environmental auditor to undertake an independent assessment of the environmental condition of a site and provide an opinion regarding the site's suitability for feasible or proposed end uses. A range of information including a site history assessment and results of relevant soil and groundwater testing undertaken are evaluated by the environmental auditor when forming such an opinion. At the conclusion of the audit a certificate or statement of environmental audit may be issued. A certificate indicates that the use of the land is unrestricted, whereas a statement indicates that particular beneficial uses of the land or groundwater are either precluded or suitable only under specified conditions.

3. Regulatory framework for assessment

3.1 Legislation and policy

3.1.1 Planning and Environment Act 1987

The *Planning and Environment Act 1987* sets out the requirements of planning authorities when preparing planning schemes or amendments to planning schemes. The Act requires planning authorities to "take into account any significant effects which it considers the scheme or amendment might have on the environment or which it considers the environment might have on any use or development envisaged in the scheme or amendment".

Under Section 12 (2) (a) of the *Planning and Environment Act 1987*, the *Ministerial Direction No. 1 – Potentially Contaminated Land* requires planning authorities to satisfy themselves that the environmental conditions of land proposed to be used for a sensitive use, agriculture or public open space are, or will be, suitable for that use. This is generally done through the completion of an environmental site assessment and audit process.

3.1.2 Environment Protection Act 1970

The *Environment Protection Act 1970* established the Victorian Environment Protection Authority (EPA) and made provisions with respect to the powers, duties, and functions of the EPA and the protection of the environment. The Act provides for environmental audits, which are used to provide an authoritative opinion on the suitability of potentially contaminated land for future use, and form an integral part of the land use planning and approval process. The Act also provides the basis for the various State Environment Protection Policies (outlined below) which provide the framework for the assessment and management of the environmental quality of land, surface waters and groundwater in Victoria.

3.1.3 Land State Environment Protection Policy 2002

The State Environment Protection Policy (Prevention and Management of Contamination of Land) (Land SEPP) sets out the regulatory framework for the prevention and management of contaminated land within the State of Victoria. The intent of this framework is to maintain and maximise, to the extent practicable, the quality of the land environment in Victoria, in order to protect its existing and potential beneficial uses. The Land SEPP was declared in June 2002 in accordance with Section 16 of the *Environment Protection Act 1970*, and the Victorian EPA is responsible for its implementation.

The Land SEPP identifies a range of land use categories and a range of protected beneficial uses for each of these categories. The EPA considers that land (soil) is *polluted* where current and/or future protected beneficial uses for the relevant land use categories are precluded. Beneficial uses of land are considered to be precluded when relevant soil quality objectives set out in the Land SEPP for those beneficial uses have been exceeded. Further information on the beneficial uses of land with respect to specific land use categories can be found in Appendix A.

3.1.4 Groundwater State Environment Protection Policy 1997

The quality of groundwater in Victoria is protected under the 1997 State Environment Protection Policy (SEPP) 'Groundwaters of Victoria' (Groundwater SEPP), declared under the *Environment Protection Act 1970* and administered by the EPA. The groundwater SEPP defines a range of protected beneficial uses for defined segments of the groundwater environment, which are based on the total dissolved solids (TDS) content of the groundwater. The EPA considers that groundwater is *polluted* where protected beneficial uses for the relevant segment are precluded. Beneficial uses of groundwater are considered to be precluded when relevant groundwater quality objectives set out in the groundwater SEPP for those beneficial uses have been exceeded, or where non-aqueous phase liquid is present.

Where groundwater has been polluted, groundwater must be cleaned up such that the protection of beneficial uses is restored, or to be cleaned up the extent practicable. Further information on the beneficial uses of groundwater with respect to the various segments of groundwater can be found in Appendix A.

3.1.5 Surface Water State Environment Protection Policy 2003

The quality of Victoria's surface water environments are protected under the 2003 State Environment Protection Policy 'Waters of Victoria' (Surface Water SEPP) declared under the *Environment Protection Act 1970* and administered by the EPA. The Surface Water SEPP sets out the environmental values and beneficial uses of water which are to be protected for each segment of the surface water environment and includes schedules which cover some specific surface water catchments in Victoria. Beneficial uses of surface waters are considered to be precluded when relevant water quality objectives set out in the surface water SEPP for those beneficial uses have been exceeded.

In addition to assessment of surface water quality, the relevant water quality objectives stated in this SEPP are applied to groundwater at the point of groundwater discharge to a surface water system, to assess whether the maintenance of ecosystems beneficial use of groundwater is protected.

3.2 Guidelines and standards

3.2.1 National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999

The NEPM is the national guideline for assessing contaminated sites and was prepared by the National Environment Protection Council (NEPC). The NEPM is implemented in each Australian jurisdiction under the *National Environment Protection Measures (Implementation) Act 1998 (Commonwealth)*. The NEPM document ensures there is a nationally consistent approach to the assessment of contamination. The NEPM includes two main schedules which provide guidance on the methods of site contamination assessment, environmental and health based investigation levels for soil and groundwater contaminants, human and environmental health risk assessment and reporting requirements.

3.2.2 Various EPA publications and guidelines

The following publications and guidelines from the Victorian and New South Wales Environment Protection Authorities are commonly applied and referenced for intrusive soil and groundwater site assessments:

- EPA Victoria, 2000. Groundwater Sampling Guidelines. Publication 669;
- EPA Victoria, 2006. Hydrogeological assessment (groundwater quality) guidelines. Publication 668; and
- NSW EPA, 1994. Guidelines for Assessing Service Station Sites.

The above NSW EPA publication is typically adopted in the absence of a comparable EPA Victoria publication for assessing petroleum hydrocarbons in soils.

3.2.3 Potentially Contaminated Land General Practice Note 2005

This general practice note was produced by the Department of Sustainability and Environment in conjunction with the Victorian EPA and provides guidance to the general public and planners on the identification of potentially contaminated land and the stages of assessment and audit required should a site be considered contaminated.

3.2.4 Australian Standard AS4482.1-2005: Guide to the investigation and sampling of sites with potentially contaminated soil – Part 1: Non-volatile and semi-volatile compounds

Australian Standard 4482.1 provides guidance on the collection of sufficient and reliable information when assessing potentially contaminated sites. In particular this standard focuses on the assessment of sites potentially contaminated with non-volatile and semi-volatile compounds. The standard covers key elements of

preliminary site investigations (i.e. Stage 1 or Phase 1 ESAs), detailed site investigation methods (i.e. Phase 2 ESAs), data quality objectives (DQO), developing sampling strategies, the collection of samples and quality assurance procedures.

3.2.5 Australian Standard AS4482.2-1999: Guide to the sampling and investigation of potentially contaminated soil – Part 2: Volatile substances

This standard refers to AS448.1 regarding the establishment of preliminary site information, and provides more specific guidance on field screening and sample collection techniques when assessing sites that are potentially contaminated with volatile compounds.

3.2.6 Australian Standard AS1726-1993: Geotechnical Site Investigations

Australian Standard AS1726 sets out minimum requirements for a geotechnical site investigation, as a component in the engineering design, construction, commissioning and operation of civil engineering and building works.

The standard specifies considerations affecting the design and construction of works which must be made in a geotechnical site investigation. Assessment of these factors enables the identification of field and laboratory work to obtain the geotechnical data required to facilitate the engineering design and construction of the works. The standard provides guidance on suitable field and laboratory examination and testing of geotechnical materials and outlines a system of material classification.

The applications of this Standard include assessment of natural or filled ground, new construction, maintenance of existing facilities, the evaluation of post construction performance and the assessment of failure.

3.3 Regulatory framework in the context of this assessment

The acts, policies, guidelines and standards relevant for each stage of assessment are set out in Table 3.1.

Table 3.1 : Acts, policies, guidelines and standards relevant for site assessments

Stage of Assessment	Relevant Acts and Policies	Relevant Guidelines and Standards	How the Regulatory Framework Applies
Proposed Change to Land Use	*Planning and Environment Act 1987*	*Ministerial Direction No. 1 – Potentially Contaminated Land* *DSE Potentially Contaminated Land Practice Note 2005*	The Planning and Environment Act requires planning authorities to satisfy themselves that the environmental conditions of land proposed to be used for a sensitive use, agriculture or public open space are, or will be, suitable for that use. This is generally done through the completion of an environmental site assessment and audit process (see below).
Desktop Investigation (Phase 1 ESA)	*Environment Protection Act 1970* *Planning and Environment Act 1987* *National Environment Protection Measures (Implementation) Act 1998 (Commonwealth)*	NEPM 1999 AS4482.1-2005 AS4482.2-1999	The Environment Protection Act and SEPPs provide the legislative basis and policy framework for the assessment and management of contaminated land and groundwater in Victoria. The guidelines and standards provide guidance on the collection of reliable information in order to assess the environmental condition of a site appropriately.
Intrusive Soil, Groundwater and Geotechnical Assessments (Phase 2 ESA)	*Environment Protection Act 1970* *Land SEPP 2002* *Groundwater SEPP 1997* *Waters of Victoria SEPP 2003*	NEPM 1999 AS4482.1-2005 AS4482.2-1999 AS1726-1993	

Stage of Assessment	Relevant Acts and Policies	Relevant Guidelines and Standards	How the Regulatory Framework Applies
Statutory Environmental Auditing	*Environment Protection Act 1970* *Planning and Environment Act 1987* *Land SEPP 2002* *Groundwater SEPP 1997* *Waters of Victoria SEPP 2003*	NEPM 1999 Various Victorian EPA Guidelines and Publications	The environmental audit system is provided for in the Environment Protection Act 1970 and the audit process is administered by the Victorian EPA.

4. Site description

General information relating to the Lake Narracan PSP area is presented in Table 4.1 below. Refer to **Figure 1** for a site location map and **Figure 2** for a site plan, attached at the end of this report.

Table 4.1 : Details for Lake Narracan PSP areas

Item	Lake Narracan PSP Area Description
Location / Address	The Lake Narracan PSP area comprises a single irregularly shaped area of land to the immediate north of Newborough and north-east of Moe. The PSP area is demarcated to the north by the approximate centre of Lake Narracan and demarcated to the south by Moe-Yallourn Rail Track and Old Sale Road.
Australian Map Grid Coordinates	Centre at 438,780mE; 5,775,795mN Northern extent at 436,265mE; 5,777,415mN Eastern extent at 441,990mE; 5,775,880mN Southern extent at 437,410mE; 5,774,805mN Western extent at 435,830mE; 5,776,110mN
Current Title Information	The Lake Narracan PSP area is divided into 15 individual parcels of land. Current title information for each parcel of land is summarised in Appendix B. Each parcel of land within the PSP area has been assigned a property number which are referred to throughout this report. **Figure 2** shows the location of each property and the assigned number.
Site Area (ha)	822.7 hectares
Local Council	Latrobe City Council
Current Land Zoning	Under the Latrobe Planning Scheme, the majority of the PSP area is zoned as Farming Zone (FZ) with the following notable exceptions: • The northern extent of the PSP includes the southern half of Lake Narracan itself (totalling 203 ha) which is zoned as Public Park and Recreation Zone (PPRZ) • A linear encroachment of land (7.1 ha) zoned as Road Zone 1 (RZ1) where Thompsons Road traverses the site. • Two areas to the south of the PSP area (totalling 89.3 ha) zoned as Rural Living Zone 6 (RLZ6) • One area to the south of the PSP area (totalling 16.5 ha) zoned as Rural Living Zone 3 (RLZ3) • A small area to the west of the PSP area (5.5 ha) zoned as Public Conservation and Resource Zone (PCRZ) **Figure 4** and **5** shows the land zoning relevant to the Lake Narracan PSP Area.
Zoning of Surrounding Land	Under the Latrobe Planning Scheme, the PSP area is bounded variously by the following zones: • Road Zone 1 (RDZ1) • Public Park and Recreation Zone (PPRZ) • Public Conservation and Resource Zone (PCRZ) • Rural Living Zone 2 (RLZ2) • Rural Living Zone 2 (RLZ3) • Rural Living Zone 2 (RLZ6) • Residential 1 Zone (R1Z) • Public Use Zone 1 (PUZ1) • Public Park and Recreation Zone (PPRZ) • Special Use Zone 1 (SUZ1) **Figure 4** and **5** shows the land zoning relevant to the Lake Narracan PSP Area.
Environmental Audit Overlay	There are no sites with an environmental audit overlay within the PSP area or within 200 m of the site.
Site Layout	The site is relatively open and flat lying and bisected by a number of roads and access tracks. Lake Narracan

Item	Lake Narracan PSP Area Description
	occupies the northern part of the site while the remainder is largely open farmland with some residential dwellings and a golf course. Refer to **Figure 2** for a site layout plan.
Current Land Uses	The site is primarily used for agricultural purposes with large areas of open farmland and associated infrastructure (farm buildings, local access roads etc.). However, the following additional land uses are notable: • Low density residential properties towards the southern extent of the PSP area along Thompsons Road and Old Sale Road • A golf course occupying an area of approximately 47 ha towards the east of the PSP area. • Lake Narracan itself, which occupies an area of 203 ha at the northern part of the PSP area.
Proposed Land Uses	The proposed future use of the site is as future land supply for various land uses including sensitive uses such as residential and community facilities in addition to open space, retail and a range of business uses such as office, light industrial and manufacturing. At present, no specific land uses have been allocated to individual parcels of land.
Surrounding Land Uses	To the north of the site is the northern half of Lake Narracan with farmland beyond. To the south is Moe and Newborough with residential properties bounding much of the southern boundary of the PSP with some further farmland beyond the south-eastern boundary of the site. To the west of the site is a Gippsland Water treatment facility.

5. Environmental setting

Information on the general environmental setting of the Lake Narracan PSP area is outlined in the following sections.

5.1 Regional geology

The Department of Primary Industries (DPI) Online Geological Map (accessed in April 2013) and the Department of Natural Resources and Environment Warragul Map Sheet (Scale 1:250,000) were reviewed to determine the geological conditions at each of the two PSP areas. The expected geological stratigraphy at the sites from surface to depth is outlined below:

- Quaternary aged non-marine alluvial sands and gravels of an unnamed formation (Qra)
- Neogene Aged Haunted Hills Gravel formation which is characterised by fluvial sand, silt, gravel and ferrugineous sand (Nph)
- Older Volcanic Group (Pvo) which is characterised by tholeiitic and minor alkaline basalts
- Devonian Aged Walhalla Group characterised by undifferentiated marine sediments of sandstone, mudstone and minor conglomerate (Dwa).

The main geological units encountered during future development of the site are likely to be alluvial/fluvial deposits of sands, gravels and silts. However, there may also be some degree of basalt (Older Volcanic Group) outcropping towards the eastern extent of the site. The surface geology for the site and the immediate surrounding area is presented in **Figure 3** at the end of this report.

5.2 Soils and acid sulphate soils map review

A review of the Australian Soil Resources Information System (ASRIS) online map in April 2013 describes the soil at the Lake Narracan PSP site as sandy loam (10 – 20%) ranging to loam, silty loam or sandy clay loam (20 – 30%).

The ASRIS online map was also accessed for information regarding acid sulphate soils. The map indicates that soils within the two PSP areas can be classed as having an extremely low probability of acid sulphate soil occurrence (ASRIS, 2010).

5.3 Regional hydrology

The site is located on the southern edge of Lake Narracan. Lake Narracan is situated at the junction of several major tributaries in the Latrobe Valley, including the Latrobe River, Tanjil River, Moe River and Narracan Creek. The hydrologic catchment area upstream of the site is in excess of 1600 km^2. The flow in the Tanjil River can be regulated by the upstream Blue Rock Lake (208 gigalitre capacity), but the remainder of the catchment runoff is unregulated by upstream storage and would therefore be subject to natural rates of rise and fall in the river.

Blue Rock Lake and Lake Narracan are predominantly used to regulate water supply to power generators in the Latrobe Valley, urban water users and private irrigators. The ownership of the water in Lake Narracan is specified within the bulk entitlements for the Latrobe River, which are stored on the Victorian Water Register (http://waterregister.vic.gov.au).

A number of smaller natural drainage lines run through the PSP area in a northerly direction, some of which include small constructed storages (farm dams). Some of these drainage lines include drainage from upstream urban areas of Moe. From aerial photography of the site, there also appear to be several irrigation channels or constructed irrigation drains across the site.

Topographic maps indicate several areas of swamp land on the north-western edge of the PSP area adjacent to Narracan Creek. Aerial photographs suggest that this swamp land is not permanently inundated and is currently used for pasture.

5.4 Regional Hydrogeology

The PSP area resides within the Gippsland Basin; a large sedimentary basin covering an area extending between Morwell and Yarram in the west, to Bairnsdale in the east. The basin also extends offshore. The sedimentary sequence is comprised mainly of Tertiary marine limestone and marl and non-marine sand clay and coal. The PSP area resides in a relatively thin part of the basin, where aquifer thickness is on the order of 100 – 200 m, as opposed to the basin sediments to the east that ascertain a maximum thickness of around 2000 m.

Mapped aquifer surface for Victoria (DSE, 2012) and the Warragul 1:250 000 Hydrogeological Map (Foley et al., 1995) are the primary sources of information for aquifer descriptions, extent and thickness across the site. The primary hydrogeological units at the PSP area include:

- Quaternary Alluvium Sediments
- Haunted Hills Gravel
- Latrobe Valley Coal Measures (LVCM)
- Thorpdale Volcanics
- Childers Formation

The deposition of the Quaternary Alluvium is associated with the surfaced water features at the site and it ranges from absent to approximately 10 m thick. It comprises undifferentiated alluvium, including silty silty clay, silt, sand, gravel. It is not a major aquifer.

The Haunted Hills Gravel range from being absent to the east of site, to approximately 20 m thick. This unit comprises mottled and sometimes ferruginous clay, clayey sand and sandy gravels and coarse sand. Although it forms a significant aquifer to the west within the Moe GMA where it occurs up to 100m thick, it is not a significant aquifer in this area. The Quaternary Alluvium and Haunted Hills Gravel comprise the watertable aquifer across most of the site, except for a small area to the east where the Thorpdale Volcanics outcrop.

The Latrobe Valley Coal Measures (LVCM) comprise thick brown coal seams, clay, silt and minor gravel. Aquifers in the LCVM are generally reasonably thin, and possibly the best aquifers are represented by the marine intercalations. Hydraulic conductivities of up to 22m/d have been recorded (SKM, 2001). At the PSP site the LVCM are absent to the north (this represents the onshore northern extent of LVCM) to approximately 30 m thick.

The Thorpdale Volcanics comprise basaltic layers with interbedded with clays, sands and coals. Weathering and alteration to clays is common in these basalts. The fresh and slightly weathered basalts predominating at depth are regarded as important aquifers (Brumley et al, 1983). The Thorpdale Volcanics reach a thickness of approximately 30 m at the site.

The Childers Formation comprises interbedded gravel, sand, clay and coal seams. It ranges from absent to approximately 70 m thick and overlies the relatively impermeable basement rock.

Depth to water across most of the site is within 5 m of the surface, according to the watertable mapping undertaken by SKM (2012).

Lake Narracan resides within the Moe basin. Recharge has been calculated for the Moe GMA by SKM (1998) based on calculations of rainfall infiltration and river recharge. River recharge is associated with the LaTrobe River and Narracan Creek. These can be considered the primary recharge mechanisms in this area. Groundwater flow within the Moe basin moves from the elevated margins of the basin towards the centre.

There has been no hydrogeological testing at the site, however SKM (2001) reported hydraulic conductivity of the Latrobe Valley Coal Measures of about 22 m/d, and storage coefficients of about 1 x10 $^{-3}$. These values were derived from a pumping test conducted on sands at the Morwell Open Cut.

Table 5.1 provides a summary of pumping test data for aquifers that are found at the PSP area. This indicates that the hydraulic conductivity for the Quaternary Alluvium is variable and between 3 – 17 m/day. The LVCM demonstrate higher hydraulic conductivity ranging from 21 – 26 m/day for pumping tests undertaken in the Wy Yung area in Gippsland. This is consistent with the rate adopted by SKM (2001) to calculate the PCV for the LVCM in the Rosedale GMA, of 22 m/day. Two sets of pumping test data for the Childers Formation in the Moe and Narracan area indicate hydraulic conductivity ranges from 2 – 50 m/day.

Table 5.1 : Pumping test data for aquifers present in the PSP area.

Current Bore ID	Date of Test	Parish	Reported Aquifer	Pumping Duration (hrs)	Rate (m^3/day)	Average Transmissivity (T) m^2/day	Average Hydraulic Conductivity (K) m/day	Average Storage Coefficient
4764	1/05/1989	Tongala	Quaternary Aquifer	240	520	120		2.E-03
51575	17/12/1991	Briagolong	Quaternary Aquifer	5	864	3000		
51590	18/12/1991	Briagolong	Quaternary Aquifer	4	717	1000		
84879		Nepean	Quaternary Aquifer	96	78.48	186	17	
109652	1/07/1979	Porepunkah	Quaternary Aquifer	1	84.2	16	3	
105727	1/11/1973	Wy Yung	Latrobe Valley Coal Measures	48	17.33	790	26	2.E-04
105725	26/05/1905	Wy Yung	Latrobe Valley Coal Measures	17	82	930	21	5.E-03
79783	1/06/1974	Moe	Lower Tertiary Aquifer (Childers Fmn)	15		93	2	5.E-05
324533	1/11/1982	Narracan	Lower Tertiary Aquifer (Childers Fmn)	58	860	400	50	

The western part of the site resides within the Moe Groundwater Management Area (GMA) and the eastern part of the site resides within the Stratford and Rosedale GMAs. The central portion of the site does not reside within a GMA and therefore is located in an Unincorporated Area. The Moe GMA represents the groundwater resources at depths greater than 25 m deep and associated with the Haunted Hills Gravel, Yarragon Formation, Thorpdale Volcanics and Childers Formation.

The Rosedale GMA represents the LVCM and the Balook Formation at depths greater than 25 m, 50 m or 200 m (depth limit is variable throughout the GMA). The Stratford GMA resides beneath the Rosedale GMA and represents the Latrobe Group aquifers at depths greater than 150 m or 350 m, again varying across the GMA.

The Victorian Groundwater Management System (GMS) database was accessed to identify the presence of any nearby registered groundwater bores. A wide search radius for bores around the site is not representative of the area, as it captures the high density of bores in the adjacent GMAs where more significant aquifers exist. For this reason the search radius was reduced to within 1 km of the PSP area and this returned 6 bore registered for private groundwater use. 192 additional bores were identified for unknown use types and use for investigation purposes.

The locations of the groundwater bores are shown on **Figure 3** and information on each of the registered groundwater bores is presented in **Appendix D**.

5.5 Regional Groundwater Quality

The Warragul 1:250 000 Hydrogeological map provides an indication of groundwater salinity for the regional aquifers. This indicates:

- Quaternary Alluvium Sediments: Low salinity (500-1000 mg/L TDS)
- Haunted Hills Gravel: Low salinity (500-1000 mg/L TDS)
- Latrobe Valley Coal Measures: Low salinity (<500 mg/L TDS)
- Childers Formation: Low salinity (<500 mg/L TDS)

This is supported by the two salinity readings recorded for bores in the area, which were less than 300 mg/L TDS.

Limited chemistry information is available for the area, however laboratory analysis information was available for three bores and the results are summarised in Table 5.2.

Based on the regional and local bore information, the groundwater TDS in the vicinity of the site is likely to be between 0 – 1,000 mg/L.

This is supported by the Beneficial Use mapping for Victoria (DCNR, 1995; DCNR, 1995b) that indicates that for the watertable aquifer and the deeper aquifers associated with the Haunted Hills Formation, Latrobe Valley Coal Measures and Childers Formation, are classified as groundwater of segment A1 (0 – 500 mg/L TDS). This is the highest quality groundwater segment and is appropriate for all groundwater use types.

Table 5.2 : Summary of Regional Groundwater Chemistry

Parameter	Reported Concentration(s)
TDS*	212 - 289 mg/L
pH	5 – 8.1
Chloride (Cl)	32 - 92 mg/L
Carbonate (CO_3)	N/A
Bicarbonate (HCO_3)	13 – 171 mg/L
Total Alkalinity	N/A
Sulphate (SO_4)	1 – 67 mg/L
Nitrogen (N)	N/A
Calcium (Ca)	1 - 24 mg/L
Magnesium (Mg)	3 - 15 mg/L
Sodium (Na)	34 mg/L
Potassium (K)	12 mg/L
Iron (Fe)	3 – 23 mg/L

Notes: * Converted from EC to TDS using a conversion factor of 0.65.

TDS – Total Dissolved Solids and EC – Electrical Conductivity

5.6 Groundwater Use

Only the east and west corners of the site are represented by GMAs, which would have been declared in response to significant groundwater use and declining water levels in the area. The purposes of the GMAs are to protect groundwater supply and quality for future users, by maintaining groundwater levels. Applications for additional groundwater may not be approved by the relevant water management authority (Southern Rural Water). The majority of the site does not fall within a declared water management area, and as such there are no legislated restrictions on the extraction and use of groundwater at the site. There are only a very small number of private groundwater users in the PSP area.

A summary of the groundwater bore uses as registered in the GMS is provided in Table 5.3.

Table 5.3 : Summary of Registered Groundwater Bore Uses

Groundwater Bore Use(s)	No. of Registered Groundwater Bores
Domestic and Stock (DS / ST DM)	4
Irrigation and Stock (IR ST)	1
Commercial (CO)	1
Not Known (NKN)	4
Investigation (IV)	8
Non Groundwater (NG)	21
SEC Bores (SEC)	159
Total	**198**

5.7 Ecology

A review of the following Victorian Department of Sustainability and Environment (DSE) and Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) databases was undertaken to provide information on wetlands and sites of national significance in proximity to the investigation area.

- Victorian Biodiversity Atlas (DSE. 2013b)
- Protected Matters Search Tool (DSEWPaC, 2013)

5.7.1 Wetlands

A review of the Victorian Biodiversity Atlas identified five wetlands in the vicinity of the Lake Narracan PSP site as outlined in Table 5.4 below. All wetlands identified are human-made and none are listed under the Ramsar Convention. It is recommended those features within the PSP boundaries be retained during any future development, including any native vegetation.

Table 5.4 : Wetlands in proximity to Lake Narracan PSP site

Latitude/ Longitude	Wetland ID	Name	Wetland Category	Area (Ha)	Subcategory	Proximity to Site
38°9'26"S, 146°15'50"E	355763	Moe Sewage Farm	Sewerage pond	31.92	None	Adjacent to site to west
38°9'11"S, 146°16'42"E	366768	-	Open water	3.02	Impoundment	Within site
38°9'17"S, 146°18'3"E	400760	Yallourn Storage	Open water	318.61	Impoundment	Within and adjacent to site to north

5.7.2 Sites of National Significance

A review of the Protected Matters Search Tool identified no sites of National Significance within or adjacent to the Lake Narracan PSP area.

5.8 Australian Heritage Database search

5.8.1 General

The Australian Heritage Database contains information about more than 20,000 natural, historic and Indigenous places. The following sections describe each of the heritage lists that are on the Australian Heritage Database.

World Heritage List

Is a United Nations Educational, Scientific and Cultural Organisation (UNESCO) organised list that recognises heritage that is of “outstanding universal value”.

National Heritage List

The National Heritage List is a list of places with outstanding heritage value to our nation, including places overseas. So important are the heritage values of these places that they are protected under the *Environment Protection and Diversity Conservation Act* 1999. This means that a person cannot take an action that has, will have, or is likely to have, a significant impact on the national heritage values of a national heritage place without the approval of the Australian Government Minister for the Environment and Heritage. It is a criminal offence not to comply with this law and there are significant penalties.

Commonwealth Heritage List

The Commonwealth Heritage List is a list of places managed or owned by the Australian Government.

Register of the National Estate

The RNE is a record of Australia’s natural, cultural and Aboriginal heritage places that are worth keeping for the future. The Australian Heritage Council compiles and maintains the RNE under the *Australian Heritage Council Act* 2003. Following amendments to the *Australian Heritage Council Act* 2003*,* the RNE was frozen on 19 February 2007, which means that no new places can be added, or removed. As of February 2012 all references to the RNE have be removed from the *Environment Protection and Diversity Conservation Act 1999*and the *Australian Heritage Council Act* 2003. The RNE has been maintained on a non-statutory basis as a publicly available archive.

5.8.2 Results

The Australian Heritage Database was searched by Jeff Hill (Project Archaeologist, SKM) on 17 April 2013. For Lake Narracan no search results were returned for the PSP area.

6. Information review

This section summarises the various sources of information, records and reports reviewed as part of the Stage 1 desktop assessment.

6.1 Current Certificate of title information

Certificates of title were reviewed to ascertain information on the current and historical land uses within and in the immediate vicinity of the Lake Narracan PSP area. A summary of the title information is provided in Appendix B. A review of the titles revealed the following information:

- a number of the land owners appear to be private individuals with no stated occupation or stated as farmers
- a single property (parcel PS401788) has been owned since at least 1950 to the present day by either Central Gippsland Regional Water Authority (current) or prior to that, Moe Sewerage Authority. This parcel lies immediately adjacent to the western edge of the Lake Narracan PSP area and is currently part of the water treatment plant
- the linear piece of land currently occupied by the rail alignment to the south of the study area is designated Crown Land
- a single property parcel (parcel TP711113) was owned in 1975 by the County Roads Board. This parcel is located adjacent to the Princes Freeway within sub-area DA. This parcel is now owned by a private individual
- two parcels which are now owned by Moe Golf Club (PS319131 and TP168948) were formerly owned by the State Electricity Commission of Victoria in the 1960s.

All title searches were conducted by Feigl and Newell Title Searchers. Where possible, the three most recent titles were reviewed for each identified parcel at the site.

6.2 EPA Priority Sites Register

A search of the EPA's Priority Sites Register (PSR), which lists those sites for which EPA has requirements for active management of land and groundwater contamination, was conducted. Sites within the Lake Narracan PSP area were not listed on the Register, nor were there any registered priority sites within a 5km radius of the area. A copy of the reviewed PSR (dated 28th February 2013) is provided in Appendix C.

6.3 EPA List of sites issued with Statements and Certificates of Environmental Audit

Under Victoria's *Environment Protection Act 1970*, statutory environmental audits of potentially contaminated land result in the issue of a Certificate of Environmental Audit if the site is considered suitable for any beneficial use (and land uses). Sites are issued a Statement of Environmental Audit if they are not found to be suitable for all beneficial uses (or land uses), as defined under Section 4 of the Act. Issue of a Statement indicates that some contamination remains at the site. A statement precludes one or more beneficial uses and/or requires management for the site to be suitable for one or more land uses.

The Victorian EPA maintains a list of all sites for which a Certificate or Statement of Environmental Audit has been issued. At the time of reporting there were no sites either within the PSP boundary or within a 5km radius of the area which have been audited.

6.4 EPA List of current environmental audit sites

The Victorian EPA also maintains a list of all sites which are currently subject to the environmental audit process. At the time of reporting there were no sites either within the PSP boundary or within a 5km radius of the area which are the subject of an ongoing audit.

6.5 Historical aerial photography review

Aerial photographs from 1945 to 2009 were reviewed for land use changes. Observations are summarised in Table 6.1 below. Refer to **Figure 6A** through **Figure 6F** for aerial photographs.

Table 6.1 : Aerial Photograph and Historical Plan Summary

Date	Photo / Plan	Description	Source
1945	Aerial Photo	The 1945 imagery reveals the absence of Lake Narracan at the site, with the northern-most extent of the PSP boundary demarcating the alignment of the Latrobe River. The study area itself appears to be mainly agricultural land with a modest number of farm buildings present. Thompsons Road also appears towards the south of the study area. Moe to the south-west is limited to sparse development along Narracan Drive and Moore Street while Newborough does not appear at all (although the southern extent of the imagery available does not reach the current town centre).	DSE – LIC
1960	Aerial Photo	By 1960 there is evidence of construction work having commenced on the existing coal power station located to the south east of the PSP boundary, although Lake Narracan has not been created with the Latrobe River still demarcating the northern extent of the study area boundary. The railway line that currently marks the southern extent of the PSP boundary also appears under construction in 1960. The site itself appears relatively unchanged since 1945, dominated by agricultural land although imagery for an area to the south of the PSP boundary was not available for review. Moe now appears to have expanded north towards the southern extent of the study area although the site itself is still largely surrounded by agricultural land.	DSE – LIC
1964	Aerial Photo	In 1964 Lake Narracan first appears, occupying the same area it currently covers. As such, some agricultural land previously located to the north of the study area has been submerged. The remainder of the study area remains largely open agricultural land. The broiler farm to the south-west of Moe Golf Club has however emerged since 1945, so too has the piggery site located half way along Hayes Road. Newborough also appears in 1964 (the rapid expansion likely associated with the recent emergence of the local power station), with properties located approximately 100m south of the PSP area across the railway line. Despite these encroachments (and the presence of Lake Narracan) the majority of the site continues to be bounded by agricultural land .	DSE – LIC
1976	Aerial Photo	Moe Golf Course appears within the study area by 1976 although the remainder of the site remains largely unchanged and under continued cultivation. Modest further expansion of Moe and Newborough has continued, although with limited encroachment on the PSP study area. There is some commercial/industrial development near the western extent of the PSP along Moore Street however. To the west of the PSP area the ponds associated with the WWTW are also evident which were not present in 1964.	DSE – LIC
1991	Aerial Photo	Agricultural land use continues to dominate within the PSP although increasing residential development is evident along Thompsons Road towards the south of the site. Off-site there also appears to be some industrial/commercial development to the east of Newborough just south of the railway line.	DSE – LIC
2010	Aerial Photo	There is little change in land use between 1991 and 2010 with much of the PSP remaining open farmland with Moe Golf Course also present. To the south of the PSP area Moe and Newborough have continued to expand, including development along Old Sale Road which marks the south-western boundary of the study area.	Geoscience Australia

6.6 Historical zoning records review

The Department of Planning and Community Development (DPCD) website was accessed for historical zoning information in relation to the site. However, no information is held for the Lake Narracan PSP area or the immediate surrounding area.

6.7 Data integrity assessment

It is recognised that not all prior land use information has been identified, and given the resources provided for this investigation only a relatively general history of the site has been established. However, the completeness and quality of the historical data is considered to be sufficient for the purposes of the investigation.

The table below represents the years for which site use history data collected during this investigation was available.

Table 6.2 : Information availability

	1880 - 1900	1900 - 1920	1920 - 1940	1940 - 1960	1960 – 1980	1980 - 2000	2000 - 2020
Historical Plans							
Aerial Photographs							
Historical Photos							

Note: Blank boxes indicate no information was available.

Shaded Boxes indicate information was viewed.

7. Site characterisation

7.1 Site Contamination Assessment

Based on the information presented in the previous sections, a number of potential sources of contamination were identified during the Stage 1 assessment of the Lake Narracan area. The potential sources of on-site contamination were assigned a qualitative level of risk based on the likelihood of the contamination representing a potential constraint to future development at the site. Where potential on-site sources of contamination were identified as having a high risk of contamination during the Stage 1 assessment, a site inspection was recommended and then carried out during the Stage 2 assessment.

Off-site potential sources of contamination were also inspected during the Stage 2 assessment (where possible). These too were assigned a qualitative risk level based on the likelihood of the contamination representing a potential constraint to future development of the Lake Narracan PSP area.

The site inspections were undertaken by visually assessing each identified site from publicly accessible areas (such as roads and footpaths). This assessment did not include a detailed walkover at each site. As such, some sites identified during the Stage 1 assessment as presenting a potential for contamination could not be assessed owing to limited visibility. This limitation has been considered in assigning the revised qualitative risk ranking.

While each identified property is slightly different with respect to the potential for contamination, there are some land uses which recur throughout the site assessments. The most common potential sources of contamination observed within the study area include farms residences and associated sheds, stockyards and imported fill (including tipped waste and miscellaneous stockpiles). While Table 7.1 and Table 7.2 identify potential contaminants of concern relevant to each property assessed, the presence of other contaminants of concern cannot be ruled out at this stage owing to the limited assessment of each individual property. These common land uses are discussed below as well as general comments relating to the PSP area and surrounding land use.

Farm residences and associated sheds

Farm residences and associated sheds are the most common potential source of contamination at each of the two PSP areas. These areas are typically used for storage of farm machinery (both operational and non-operational), materials, vehicles and many other miscellaneous items. These yards may also include fuel storage areas for refuelling farm machinery (typically in above-ground storage tanks) as well as storage areas for items such as agricultural chemicals (pesticides, herbicides etc.) and oils, lubricants and solvents for machinery maintenance.

Since farm residences can be fairly isolated, the use of septic tanks for sewerage purposes rather than mains sewerage is fairly common. However, since these are underground structures they can be difficult to identify.

Storage shed construction can vary depending on their age and can be variously formed of timber, corrugated iron, asbestos cement sheeting, blocks/bricks and concrete. Some sheds may also incorporate concrete floor slabs while others do not.

Plate 7.1 : Example of above ground storage tank

Plate 7.2 : Example of typical farm machinery shed

Based on the above, the most likely sources of contamination include spillages of fuels as well as impacts on soils by metals resulting from general machinery/equipment storage and maintenance of farm vehicles. However, spillages of other agricultural chemicals may also impact upon soils. Given that such chemicals are typically stored in small volumes (less than 20L) impacts are therefore likely to be extremely localised in extent. Additional contaminants of concern can also include biological contaminants and nutrients associated with leakages from septic tank systems.

Asbestos was also commonly used as a building material with a number of applications in Australia as early as the 1880s (although more frequently in the mid to late 1900s). While asbestos presents a limited risk while it remain in a bonded matrix (i.e. as bonded asbestos cement sheeting), mobilised free fibres can present a greater potential risk. Mobilisation can occur through a number of processes including (but not limited to) abrasion, sanding and cutting.

Stockyards

Stockyard structures were frequently noted within the PSP study areas. These are used to hold livestock prior to loading on to trucks. They are typically timber enclosures, sometimes including a small covered shed for storage.

Stockyards can also be accompanied by adjacent sheep dips used which are used to dose/treat sheep. Typically forming a narrow pit/channel, they are filled with a liquid formulation of fungicide/insecticide through which the sheep are passed before being held in an enclosure to allow surplus formulation to drain.

It should be noted that no sheep dips were observed during the site inspections. However, a number of properties could not be visually assessed to confirm their absence. It should also be noted that the absence of a dedicated in-situ sheep dip does not rule out such an activity taking place at a stockyard. Metals troughs are also used a mobile alternative.

Contamination of soil and groundwater can result from the above activities as the liquid formulation either leaks from defects in the dipping infrastructure (be it a permanent sheep dip or mobile trough) or drains from sheep while they are retained in the holding enclosures after dipping is completed.

Plate 7.3 : Example of a stockyard structure

Plate 7.4 : Example of typical sheep dip

Imported fill, tipped waste and stockpiled material

The presence of imported fill can be difficult to identify without undertaking intrusive investigations, particularly in areas which are heavily vegetated. Fill material is most likely to be found in locations where previous construction/development works have been undertaken. Stockpiles of soil and tipped waste material were also noted relatively frequently across the study areas.

Potential contaminants of concern associated with fill material, tipped waste and stockpiled materials can vary significantly depending on their source and time at which they were deposited. Since such information is rarely available specific contaminants of concern often cannot be adequately identified without laboratory analysis (although visual and olfactory observations can provide limited information). However, the most commonly encountered contaminant groups include TPH, PAHs and metals. However, asbestos is also a contaminant of concern, particularly in building rubble.

General agricultural land use

Much of the land forming the PSP area has been used for agricultural purposes for an extended period of time. As such, there is likely to be a long history of general agricultural processes within the study area. The most notable of these is crop spraying. Contaminants of concern associated with this process typically include pesticides, herbicides and fungicides as well as potentially nutrients (from manure, slurry application and other fertilizers).

While this general use has not been explicitly identified in Table 7.1 and Table 7.2 owing to their site-wide relevance, this historical use is considered to present a low to moderate risk of causing contamination. On the basis of this risk ranking and broad-scale and historical nature of these potential sources it is considered likely that further assessment of the land (through intrusive soil and groundwater assessments) may be required at a later date, once more certainty regarding the proposed land uses is available and an informed sampling strategy can be prepared. Further discussion on this topic is provided in Sections 8 and 9.

7.1.1 Potential Sources of Contamination On-Site and Findings of Site Inspection

The potential on-site sources of contamination were targeted during the site inspection of the Lake Narracan PSP area on 4th April 2013. Each of the potential sources of on-site contamination identified during the Stage 1 and 2 assessments are presented in Table 7.1 along with the findings of the Stage 2 site inspection. The original risk rankings have been re-evaluated following the site inspection with the revised risk rankings also provided.

The property numbers referred to in Table 7.1 have been allocated to a particular property parcel by SKM for the purposes of this investigation. These identifiers refer to the PSP area (in this case LN) followed by a property number. **Figure 7A** and **Figure 7B** show the allocated property number and the location of each of these identified potential sources of contamination where possible.

Table 7.1 : Summary of potential on site sources of contamination

Property No.	Site Use/Activity	Potentially Contaminated Medium	Potential Contaminants of Concern	Findings of Site Inspection	Revised Potential Contamination Risk
Lake Narracan PSP Area					
LN01	Farm shed with potential stockyard structure	Soil and groundwater	TPH, metals, herbicides, fungicides and insecticides	Could not be viewed/ accessed.	**M**
LN02	Farm residence with sheds	Soil	TPH and metals	Sheds and well maintained house. Multiple tractors and related farming machinery were observed.	**L**
LN03	Farm residence with sheds	Soil	TPH and metals	Well maintained house. No other notable features.	**L**
LN04	Farm residence with sheds	Soil	TPH and metals	Tractor and machinery were observed with some wood and brick stockpiles.	**L**
LN05	Farm residence with sheds	Soil	TPH and metals	Well maintained house. No other notable features.	**L**
LN06	Farm residence with sheds	Soil	TPH and metals	Well maintained house. No other notable features.	**L**
LN07	Farm residence with sheds	Soil	TPH and metals	Could not be viewed/ accessed.	**L - M**
LN08	Farm shed	Soil	TPH and metals	Could not be viewed/ accessed.	**L - M**
LN09	Farm residence with sheds and car storage/garage	Soil	TPH, metals, oils and solvents,	Vehicle maintenance works undertaken onsite. Other notable features include the storage of vehicle parts and evidence of minor oil in drainage outside the property. Some evidence of an old stockyard.	**M - H**
LN10	Farm residence with sheds, potential stockyard structure and area of disturbed soil	Soil and groundwater	TPH, metals, herbicides, fungicides and insecticides	A house and wood stockpile noted. No evidence of a stockyard although limited visibility.	**L - M**
LN11	Farm residence with sheds	Soil	TPH and metals	Could not be viewed/ accessed.	**L - M**
LN12	Farm shed	Soil	TPH and metals	Could not be viewed/ accessed.	**L - M**
LN13	Farm shed with potential stockyard structure	Soil and groundwater	TPH, metals, herbicides, fungicides and insecticides	Could not be viewed/ accessed.	**M**
LN14	Farm residence with sheds	Soil	TPH and metals	Well maintained house. No other notable features.	**L**
LN15	Potential stockyard structure	Soil and groundwater	Herbicides, fungicides and insecticides	Cattle present with a stockyard which appears to be in good condition.	**L – M**
LN18	Farm residence with sheds	Soil	TPH and metals	Well maintained house and shed. No other notable features.	**L**
LN19	Farm residence with sheds	Soil	TPH and metals	Well maintained house and shed. No other notable features visible.	**L**
LN20	Farm residence with sheds	Soil and groundwater	TPH and metals	New house with building materials (bricks and wood) stockpiled outside. A rusted vehicle and rusted metal stockpile noted onsite. Fuel tank also present.	**M**
LN21	Potential stockyard structure	Soil and groundwater	Herbicides, fungicides and insecticides	Operational stockyard observed as well as cattle. Tractor observed to be leaking unknown fluids. Tractor could be connected to a sprayer. Gravel possibly for road use is stockpiled on site.	**M**
LN22	Former farm residence with sheds and potential stockyard structure	Soil	TPH and metals	Well maintained house and shed with wood stockpile noted in shed. Stockyard not observed.	**L**
LN23	Potential stockyard structure	Soil and groundwater	Herbicides, fungicides and insecticides	Old stockyard noted.	**L - M**
LN24	Potential stockyard structure	Soil and groundwater	Herbicides, fungicides and insecticides	Could not be viewed/ accessed.	**M**
LN25	Potential stockyard structure	Soil and groundwater	Herbicides, fungicides and insecticides	Could not be viewed/ accessed.	**M**
LN26	Farm residence with sheds and potential stockyard structure	Soil and groundwater	TPH, metals, herbicides, fungicides and insecticides	An old stockyard and shed though unable to see contents of the shed. Other features present include a tractor, horses and dumped wood.	**L - M**
LN27	Farm residence with sheds	Soil	TPH and metals	Property appears to be well maintained. A tractor was present.	**L**
LN28	Piggery site	Soil and groundwater	TPH, metals, nutrients, biological	An abandoned dilapidated wooden structure with no notable features. Old stockyard present.	**M - H**
LN29	Farm residence with sheds		TPH and metals	House and shed which appear to be well maintained.	**L**
LN30	Farm sheds or farm residence	Soil	TPH, metals, oils, solvents	Potential paint and panel works conducted onsite. Well maintained house noted with garages though contents are unknown. No other notable features.	**L - M**
LN31	Potential stockyard structure	Soil and groundwater	Herbicides, fungicides and insecticides	Could not be viewed/ accessed.	**M**
LN32	Farm residence with sheds	Soil	TPH and metals	House and shed which appear to be well maintained.	**L**
LN33	Potential stockyard structure	Soil and groundwater	Herbicides, fungicides and insecticides	Old stockyard located behind the house.	**L - M**
LN34	Potential stockyard structure	Soil and groundwater	Herbicides, fungicides and insecticides	Old stockyard located behind the house (refer LN68).	**L - M**
LN35	Farm residences with sheds	Soil	TPH and metals	Well maintained house noted that appears to be in residence. Wood and dirt stockpiles observed to the east. A drive through cinema is also present.	**L**
LN36	Former broiler farm	Soil and groundwater	TPH, metals, nutrients and biological	Dilapidated metal sheds which are not in use. No other notable features.	**M - H**

Property No.	Site Use/Activity	Potentially Contaminated Medium	Potential Contaminants of Concern	Findings of Site Inspection	Revised Potential Contamination Risk
LN37	Farm residence with sheds	Soil and groundwater	TPH and metals	Residence appears to be well maintained. However there are disused and dilapidated metal sheds present. Other site features include multiple silo type structures and wood stockpiles.	**M**
LN38	Farm sheds and stockyard	Soil and groundwater	TPH, metals, herbicides, fungicides and insecticides	Could not be viewed/ accessed.	**M**
LN39	Farm residence with sheds and potential stockyard structure	Soil and groundwater	TPH, metals, herbicides, fungicides and insecticides	Could not be viewed/ accessed.	**M**
LN40	Golf Course	Soil and groundwater	Pesticides, herbicides, nutrients	Golf course present.	**L**
LN41	Golf Course Buildings	Soil and groundwater	Metals, TPH, pesticides, herbicides, nutrients	Could not be viewed/ accessed.	**L**
LN42	Caravan Park	Soil	Metals, TPH, nutrients, microbiologicals and pharmaceuticals	Site consists of a caravan park and a public toilet.	**L**
LN43	Farm sheds or farm residence	Soil	TPH and metals	Could not be viewed/ accessed.	**L – M**
LN44	Farm residence with trucks present	Soil	TPH and metals	Well maintained residence with multiple large garages however no vehicles or fuel storage facilities were observed.	**L - M**
LN45	Farm residence with sheds	Soil	TPH and metals	Well maintained residence with wood stockpile.	**L**
LN46	Farm residence with sheds	Soil	TPH and metals	Well maintained house and shed.	**L**
LN47	Farm shed	Soil	TPH and metals	Wood stockpile observed with no other notable features.	**L**
LN48	Farm residence with sheds	Soil	TPH and metals	Stockpile of wood and metals noted.	**L**
LN49	Farm residence with sheds	Soil	TPH and metals	Well maintained residence with garages and a tractor observed.	**L**
LN50	Potential stockyard structure	Soil and groundwater	Herbicides, fungicides and insecticides	Could not be viewed/ accessed.	**M**
LN53	Disturbed soil along rail line - potentially a former station complex.	Soil	Various associated with fill as well as herbicides	Track has been removed from old rail line. There is also a dirt track which appears to have been cleared as no weeds are present. No evidence of former station.	**M**
LN54	Immediate area adjacent rail line	Soil	Various associated with fill as well as herbicides	Track has been removed from old rail line. There is also a dirt track which appears to have been cleared as no weeds are present.	**M**
LN55	Public Toilets	Soil	Nutrients, microbiologicals and pharmaceuticals	Public toilets with gravel parking area.	**L - M**
LN56	Residences with sheds	Soil	TPH and metals	Well maintained house and a trailer hire business with several trailers and bobcats present. Stockpiles of wood and scrap metal were observed.	**L – M**
LN57	Residences with sheds	Soil	TPH and metals	Well maintained house and shed with no other notable features.	**VL**
LN58	Residences with sheds	Soil	TPH and metals	Well maintained house and shed with no other notable features.	**VL**
LN59	Residences with sheds	Soil	TPH and metals	Well maintained house with a small stockpile of wood.	**VL**
LN60	Residences with sheds	Soil	TPH and metals	Well maintained house and shed with no other notable features.	**VL**
LN61	Shed	Soil	TPH and metals	Shed present. Nothing notable.	**L**
LN62	Shed	Soil and groundwater	TPH and metals	Old shed noted. Possibly stockyard.	**L – M**
LN63	Unknown structure	Soil	Unknown	Crane or similar type machinery were observed in the vicinity though location was obscured by trees.	**L**
LN64	Farm residence and stockyard	Soil and groundwater	TPH, metals, herbicides, fungicides and insecticides	Well maintained house and shed. Machinery, forklifts and evidence of an old stockyard were observed.	**L – M**
LN65	Farm residence and sheds	Soil	TPH and metals	Forestry services business is present at the site. Other notables include a bobcat and a wood stockpile.	**L**
LN66	Stockyard	Soil and groundwater	Herbicides, fungicides and insecticides	Evidence of an old stockyard was noted.	**L – M**
LN67	Farm residence	Soil	TPH and metals	Well maintained house and shed with no other notable features.	**VL**
LN68	Farm residence and sheds	Soil	TPH and metals	Well maintained house with an old stockyard located behind the house (refer LN34).	**L – M**
LN69	Residences with sheds	Soil	TPH and metals	Well maintained houses with a stockpile of wood.	**VL**
LN70	Residences with sheds	Soil	TPH and metals	Well maintained house with an old stockyard located behind the house (refer LN33)	**L – M**
LN71	Residence with sheds	Soil	TPH and metals	Well maintained residence with a large gas tank. Materials stored onsite including stockpiles of wood and building materials and a tip full of bicycle tyres.	**L**
LN73	Stockyard	Soil and groundwater	Herbicides, fungicides and insecticides	A large 2 storied stockyard was observed. More detail was difficult to see as the view was obscured by trees.	**L – M**

Notes:

TPH – Total Petroleum Hydrocarbons

Nutrients – Ammonia, nitrate, nitrite, phosphate

7.1.2 Potential Sources of Contamination Off-Site

The areas surrounding the site were also considered during the Stage 1 assessment in order to identify the presence of off-site facilities or land uses that could potentially cause environmental impact to the site. The off-site sources identified in the vicinity of the site are summarised in Table 7.2 and illustrated on **Figure 7A** and **Figure 7B**. Sites listed in this table were inspected during the Stage 2 assessment based on their proximity to the PSP area and the land use.

Owing to the nature of the operations at these sites and their proximity to the relevant PSP areas they are considered to represent a low risk of causing contamination at the PSP sites.

**In relation to potential odour issues and constraints on development, two key off-site properties were also identified. Properties LN17 (Broiler Farm), approximately 80m away from the southern site boundary and property LN51 (Gippsland Water Treatment Facility), adjacent the western boundary were identified. SKM understands that the broiler farm is no longer operational – therefore SKM deems that there is a low risk of odours (if any) from this site impacting upon the PSP area. However, give the water treatment facility is operational, the impact of odours (if any) from this offsite source should be assessed prior to any development within the PSP Area.

Table 7.2 : Summary of potential off site sources of contamination

Property No.	Site Use/Activity	Potentially Contaminated Medium	Potential Contaminants of Concern	Findings of Site Inspection	Revised Potential Contamination Risk
Lake Narracan PSP Area					
LN16	Potential stockyard structure	Soil and groundwater	Herbicides, fungicides and insecticides	Stockyard observed which appears to be in good condition.	**L**
LN17	Broiler farm	Soil and groundwater	TPH, metals, nutrients and biological	Farm machinery, wooden sheds and cattle observed. Wooden sheds in disrepair with a vehicle noted in one. Wood and metal stockpile on eastern side.	**L**
LN51	Gippsland Water Treatment Facility	Soil and groundwater	Nutrients, microbiologicals and pharmaceuticals	Site consists of a water treatment facility.	**M**
LN52	Farm residence with sheds	Soil	TPH and metals	Well maintained house and shed.	**VL**
LN72	Plant nursery	Soil and groundwater	Pesticides, herbicides, fungicides and nutrients	Site consists of a plant nursery.	**L**

Notes:

TPH – Total Petroleum Hydrocarbons

Nutrients – Ammonia, nitrate, nitrite, phosphate

7.1.3 Potential receptors of contamination

Potential receptors of contamination (should any exist) at or near the site include:

- site workers at the site
- residents at the site
- future construction workers at the site
- visitors to the site
- underground utilities located on and around the site (including easements)
- surrounding residents and occupants and visitors (via windblown contamination during excavation works)
- sensitive land based ecosystems on and near the site
- the nearest surface water bodies (including aquatic ecosystems), namely Lake Narracan and the Latrobe River as well as associated tributaries.

7.1.4 Exposure pathways & routes

These potential receptors may be impacted through ingestion, inhalation or dermal contact with potentially contaminated soil (on site) and groundwater (on and off site). Off-site receptors (including humans and aquatic and land based ecosystems) may be impacted through the transport of contamination via a number of pathways such as trenches/conduits containing underground services (from the site to off-site locations), storm water drainage networks, surface drainage via overland flow (runoff), groundwater flow and surface water transport (e.g. to and in the nearest surface water bodies to the site Lake Narracan and the Latrobe River as well as associated tributaries.

7.2 Geotechnical assessment

Based on the Geological Survey of Victoria (1967) Mirboo North map sheet, the Project area comprises the following geological units:

- Quaternary alluvial flats and high level terraces, comprising sand, silt, clay and gravel.
- Tertiary Haunted Hills Formation, comprising gravel, sand, clay and ligneous sediments.

The Quaternary alluvial flats and high level terraces typically comprise sand, silt, clay and gravel. The unit is likely to be highly variable and potentially compressible due to the depositional nature of alluvial environments, and is also likely to comprise a shallow groundwater table. It is anticipated that Tertiary Haunted Hills Formation underlies this unit.

The Tertiary Haunted Hills Formation typically comprises gravel, stiff sandy clays and clayey sands and some organic material (ligneous sediment).

It should be noted, however, there is the possibility of other geotechnical units, such as:

- La Trobe Valley Coal Measures, comprising coal seams and organic material of variable thicknesses, which can lead to differential settlements
- Overburden fill material, which is likely to have been placed in a non-engineered manner and as such, can comprise soft layers and voids, and problems associated with differential and creep settlements.

As such it is anticipated that the sub-surface conditions would comprise interbedded clays, sands and gravels.

An indicative site classification of Class “M to H1” is applicable in accordance with Table D1, AS2870-2011 (Residential Slabs and Footings). This classification would depend on the depth, thickness and reactivity of the clay material in this area.

Should area of fill material may be present a site classification of Class “P” would apply for such areas where the history of the filling is unknown. A site classification of Class “P” requires that footings be designed on the basis of engineering principles as opposed to the adoption of the standard footing designs presented in AS2870.

The above site classifications are based on regional geological information and are intended for preliminary consideration only. Geotechnical site investigations including soil sampling and laboratory testing should be undertaken prior to the design and construction of any footing systems, pavements and associated civil infrastructure.

7.3 Hydrogeological General

Based on the regional hydrogeological information and bore data in the vicinity of the site, the conceptual hydrogeological model for the site is:

- The site resides in a part of the Gippsland Basin where the (typically thick) sequence of basin sediments are relatively thin and ascertain a thickness of less than 200 m. The negligible number of private groundwater use bores (i.e. 6 registered in the Victorian GMS) in the immediate vicinity of the site are testament to this.
- The Quaternary alluvium, Haunted Hills Gravel, LVCM, Thorpdale Volcanics and Childers Formation are considered reasonably well connected in this area.
- The 6 registered bores range in depth for from 9 – 70 m. The depths of these bores indicate that they are probably extracting groundwater from the shallow unconfined aquifers associated with the Haunted Hills Gravel and LVCM. The deeper aquifers associated with the Thorpdale Volcanics and Childers Formation are likely to be semi-confined to confined in nature, due to the presence of low permeability layers within the aquifers themselves
- Recharge occurs via rainfall infiltration and river leakage from the LaTrobe River and Narracan Creek. The underlying aquifers are recharge by direct infiltration where they outcrop, and vertical recharge from surrounding units
- Hydraulic conductivity values derived from historical pumping test results for these aquifers indicate moderate rates for the LVCM and the highest rates observed for the Childers Formation aquifer
- The watertable primarily occurs within the Quaternary Alluvium and Haunted Hill Formation and are typically less than 5 m below the surface
- Groundwater quality for shallow and deep aquifers is of very low salinity and fit for all purposes.

8. Development opportunities and constraints

8.1 Site Contamination

Based on the information described in this report, there do not appear to be any significant constraints from a site contamination perspective which would render the land unsuitable for any feasible land use.

However, there are particular areas which have been identified as having a potentially moderate to high risk of contamination (refer Table 7.1). It is likely that the identified areas of concern will comprise discrete or localised areas of contamination that can be cost-effectively remediated or managed. Using the DSE (2005) Potentially Contaminated Land General Practice Note as a guide, these areas will need to be assessed in greater detail through intrusive soil and potentially groundwater sampling before a more robust conclusion regarding the site's suitability for a particular land use can be made.

Given several stockyards and farm storage areas were identified (together with a long history of agricultural land uses), many areas were also designated a low-moderate and moderate contamination risk. SKM recommends that less intense sampling is to be undertaken of these areas (as per Section 9.2).

**In relation to sites designated a medium-high risk of potential contamination, (LN09, LN28 and LN36), SKM recommend that Phase 2 ESAs be undertaken prior to determining whether a statutory environmental audit is necessary. If a statutory environmental audit was required, it may be considered a potential constraint due to the time and cost implications. If a Statement of Audit is achieved (not a Certificate of Audit), the Statement may also specify site management measures that may constrain future development.

8.2 Geotechnical

The following issues require consideration in the planning and design of any development and should be assessed through a geotechnical site investigation.

- The reactivity of the near surface soils is dependent on clay content, would determine the site classification for foundation design. As such, a geotechnical investigation is required to assess the depth to rock across the site. However, it is expected that the site would be considered moderately to highly reactive (Class "M to H1").
- La Trobe Valley Coal Measures, comprising coal seams and organic material of variable thicknesses, which can lead to differential settlements.
- Design of roads, drainage works and underground assets would require consideration of the highly reactive nature of the clays and variable ground conditions to ensure serviceable performance and minimise ongoing maintenance requirements.
- Fill material, which may be present, is expected to be uncontrolled and may not be suitable as a founding material in its current state.

8.3 Hydrological

The location of the site at the junction of several major rivers creates the potential for large peak runoff events. Whether these transpire into the flooding of land in the PSP area will depend on several factors, including the timing of runoff peaks from each river, antecedent conditions in Blue Rock Lake and the catchment as a whole, and the topography at the site. Parts of Moe have flooded in the past (e.g. March 2011), which suggests that this site could be at risk of flooding without suitable mitigation measures. The land surface is below the 1% AEP flood level across the northern half of the PSP area, which confirms that there is a significant flood risk in the land adjacent to the lake. Any development in the northern half of this PSP area will need to be cognisant of this significant flood risk. It is also noted that there appears to be an error in the spatial representation of the 1% AEP flood level in the vicinity of Lake Narracan. A clear discontinuity in the flood level extent is evident in flood level boundary immediately adjacent to Becks Bridge Road, as well as outside of the PSP area in the Latrobe River directly upstream of Lake Narracan. This discontinuity warrants further investigation of the

hydraulic modelling used to derive the layer, in order to confirm the actual flood extent or the reason for this discontinuity. SKM understand the relevant catchment management authority (CMA) is undertaking revised flood modelling at the present time, however, this information was not available at the time of writing this report.

Managing local catchment runoff will need to consider the interaction of the proposed urban area with upstream areas which have already been developed. The possibility to capture urban stormwater at the drainage outlets of these upstream areas could create the opportunity to both manage local flooding in the PSP area and provide a supply of stormwater for the area's parks and gardens. The areas immediately adjacent to these drainage lines were designated as being above the 1% AEP flood level (prior to PSP area development), so current flood risk in these areas is low. The existing farm dams within the PSP area may be able to be used to minimise the cost of stormwater harvesting on the site. Dam safety risk would need to be assessed if the dams are retained on site and if they could result in property damage or loss of life from dam failure.

Given the use of Lake Narracan for recreational purposes, maintaining good quality water in the lake will be important for preserving its ongoing use for these activities. Water sensitive urban design within the development area is likely to be important for minimising the transport of nutrients and other pollutants to Lake Narracan.

The Ramsar listed wetlands of the Gippsland Lakes are located at the outlet of the Latrobe River, downstream of Lake Narracan, and are known to have experienced algal blooms in the past as a result of high nutrient loads discharging into upstream rivers. Any increase in nutrient loads from urban development could further exacerbate this environmental risk. By changing the land use from rural to urban and introducing water sensitive urban design, there is the potential to reduce nutrient loads to the Latrobe River and Gippsland Lakes as a result of the development.

Integrated water cycle management could potentially be utilised to harvest stormwater or recycled water from the developed area for use by the power generators who divert water at Lake Narracan. This would reduce the need to divert water from the river, which in turn would maintain greater environmental flows in the Latrobe River. Stormwater from the PSP area could also potentially be used to supply parks and gardens within Moe.

8.4 Hydrogeological

Based on the hydrogeological conceptual model described in this report, there does not appear to be any significant hydrogeological constraints which would render the land unsuitable for development. The following issues would need to be considered however, in the planning and design of any development:

- The shallow depth of the water table at the site means that excavations may intersect the water table and cause groundwater to flow into underground structures. This water would subsequently need to be collected and disposed of, or alternatively underground structures (e.g. basements) would need to be fully lined to prevent inflows. The depth of the watertable at the site would need to be confirmed through further investigations to determine whether a shallow watertable is an actual constraint to development.
- Increases to groundwater recharge rates can occur due to the cumulative impacts of excessive urban irrigation of lawns and gardens over summer and autumn, recharge from artificially constructed lakes and wetlands, and leaky water supply and drainage infrastructure. This has the potential to increase recharge to groundwater, which may have two consequences.

  1. Increased discharge to nearby surface water features, which could potentially have a negative impact on the ecological health of local waterways as a result of increased salinity (SKM, 2009).
  2. Threaten the beneficial use of the groundwater which is currently categorised as the highest grade groundwater (i.e. segment A1).

  The depth and salinity of the water table aquifer at the site would need to be confirmed through further investigations to determine whether this is an actual constraint to development.
- The increased proportion of hard impermeable surfaces associated with the development of the site is likely to decrease local recharge to the underlying aquifers in winter and early spring, which could in turn

reduce discharge to nearby surface water features. This could potentially have a negative impact on the ecological health of local waterways (SKM, 2009).

Several opportunities exist in relation to the use of groundwater at the site, reducing reliance on mains water. These include:

- installation of bores for stock and domestic uses, such as watering gardens
- installation of bores for irrigation of public reserves or ovals

9. Conclusion and recommendations

9.1 Conclusions

Site Contamination Assessment

Based on the information gathered during the Stage 1 & 2 assessments, the following conclusions can be made in relation to the Lake Narracan PSP area:

- The site history assessment found that the site has a long history of agricultural land uses with much of the areas remaining under cultivation to the present day.
- Based on the available information including a site walkover and site history assessment the following primary potential sources of contamination have been identified:
  - Potentially contaminative land uses associated with intensive agricultural (industrial agriculture) or industrial/commercial activities. These sites include a vehicle maintenance garage (property LN09), a former poultry/broiler farm (LN36) as well as a dilapidated former piggery site (LN28). At these sites potential contamination may not be confined to a single, localised area but instead encountered across the wider extent of the site to one degree or another owing to the intensity and nature of the associated land use.
  - Highly localised areas of potential contamination associated with frequently encountered land uses. These include potential contamination hotspots associated with uses such as stockyards and general farm premises. These hotspots are likely to be localised to areas such fuel tanks, chemical storage areas and similar.
  - Diffuse but low level sources of contamination associated with the widespread application of agricultural chemicals on farmland as well as orchards and plant nurseries. These chemicals may include pesticides, herbicides, fungicides and fertilizers.
- A number of off-site sources of contamination have been identified in the vicinity of the PSP site. Owing to the nature of the site uses (typically farms, water treatment ponds, farm industries) at these sites and their proximity to the study areas they are considered to represent a low risk of causing contamination at the PSP site.

Based on the information obtained from the sources described in this report, there do not appear to be any significant risks from a site contamination perspective which would render the land unsuitable for a particular land use. Localised contamination is likely to be able to be effectively managed or remediated.

**In relation to potential odour issues and constraints on development, property LN51 (Gippsland Water Treatment Facility), adjacent the western boundary was identified. The impact of odours (if any) from this offsite source should be assessed prior to any development within the PSP Area.

Geotechnical Assessment

Based on the available geological information, it is anticipated that the site is underlain by highly reactive residual clay overlying basalt rock. An indicative site classification of Class “M to H1” has been assessed in accordance with Table D1, AS2870-2011.

Key geotechnical issues associated with development of the site include the depth and reactivity of the clay in terms of its influence on site classification, foundation selection, differential settlement, subgrade performance and excavations.

Fill material, if present, is expected to be uncontrolled and may not be suitable for development in its present state. Areas subject to poor drainage may comprise soft material which provides low bearing capacity for foundations.

Hydrology Assessment

The Latrobe PSP area is situated at the confluence of several large rivers in the Latrobe Valley, and as such, is located in an area of significant flood risk unless appropriate flood mitigation measures are introduced. The spatial representation of the current 1% AEP flood level in the eastern portion of the PSP area appears to be in error and should be reviewed. The PSP area offers opportunities to incorporate integrated water cycle management and water sensitive urban design to manage flood risk from local drainage lines, and could be an important factor in maintaining water quality for recreation in Lake Narracan and the downstream Ramsar listed Gippsland Lakes wetlands.

Hydrogeological Assessment

Based on the regional hydrogeological information and bore data in the vicinity of the site, the unconfined aquifer is associated with the Quaternary Alluvium and the Haunted Hills Gravel. The LVCM, Thorpdale Volcanics and Childers Formation are either semi-confined or confined in nature.

There do not appear to be any significant hydrogeological constraints which would render the land unsuitable for development at the Narracan PSP. The following issues would need to be considered however, in the planning and design of any development:

- the shallow watertable may cause groundwater inflow to excavations
- the high quality of groundwater will require careful monitoring and protection as the beneficial use of the groundwater cannot be altered below its current classification of A1
- increases to groundwater recharge rates (particularly over summer and autumn) has the potential to raise the water table to within a few metres of the ground surface, potentially causing damage to infrastructure and buildings
- decreased local groundwater recharge in winter and early spring has the potential to reduce discharge to nearby surface water features, which could potentially have a negative impact on the ecological health of local waterways.

Opportunities for groundwater use include extraction for garden watering and irrigation of parks and ovals.

9.2 Recommendations

We understand that the proposed future use of the site is as a broad ranging urban development and is likely thus to include sensitive uses such as residential and community facilities in addition to open space, retail and a range of business uses such as offices.

No general contamination, geological or hydrogeological constraints have been identified warranting further investigation at this stage.

Some potential specific issues have been identified; however the risks to any future development are likely to be readily addressed once particular land uses have been defined. This will require the implementation of an informed investigation strategy, with this best being done once further information on the proposed land uses for specific areas of the site is available. Future intrusive assessment works should be timed to coincide with the cessation or scaling down of current site operations and prior to the commencement of the proposed development and construction works.

Further assessment works may include, but are not limited to, the following activities:

- Assessment of potentially contaminative farm industry land uses located at properties LN09, LN28 and LN36. These sites are likely to present the greatest potential for property-wide contamination issues. This process may be best undertaken through the preparation of a Sampling, Analysis and Quality Plan (SAQP) followed by a Phase 2 Environmental Site Assessment (which may include targeted sampling of soils and groundwater).

- Odour monitoring / assessment should be undertaken along the PSP boundary adjacent off-site property LN51 (Gippsland water Treatment Facility), prior to any development of the PSP area. Odours (if any) emanating from this property could potentially impact upon future development in the vicinity of this site. Additionally, if this property is ever incorporated into a future PSP Area, it should be thoroughly assessed (e.g. via a Phase 2 ESA).
- Further limited assessment of frequently encountered land uses which may present potential hotspots of contamination. Such sites include stockyards and general farm storages. Rather than target each individual property where such features have been identified, it is recommended that a limited number of representative sites are selected from which targeted soil samples are collected around potential point sources of contamination (i.e. fuel tanks or stockyard structures). The results for these targeted locations can then be used to clarify the potential for contamination at similar sites elsewhere within the PSP areas.
- Further limited assessment of the potential for contamination associated with diffuse but low level sources of contamination. Given the long history of agricultural land use within the PSP area and the potential widespread use of agricultural chemicals throughout this period, further limited sampling would provide valuable information as to the true extent and significance of these potential contaminants of concern. Such an investigation may comprise the collection of 10 to 20 soil samples from selected representative fields and orchards across the study area. These samples would be analysed for pesticides, herbicide and nutrients with the results providing an overview of the potential risk associated with these diffuse sources.
- Further drilling and collection of soil samples for the purposes of assessing the geotechnical soil properties for building foundation and road design.
- Drilling and installation of groundwater monitoring wells to determine the depth to groundwater as well as aquifer hydraulics testing to determine aquifer properties
- Excavation and removal of underground storage tanks, soil remediation and tank pit validation if USTs are found on properties
- Removal of other potentially contaminating infrastructure (e.g. septic tanks and above ground storage tanks) followed by soil validation.

Based on the findings of this report, SKM recommend that Phase 2 ESAs be undertaken at properties LN09, LN28 and LN36 prior to determining whether a statutory environmental audit is necessary. If an environmental audit of a site is required, a period of at least 6 months prior to development should be allowed to progress through the audit process. It is likely that a longer period of time will be required should significant contamination be identified at the site to allow for remediation works.

10. References

ASRIS, 2010. Australian Soil Resources Information System Online Map. URL: http://www.asris.csiro.au/mapping/viewer.htm. Date Accessed: April 2013.

DCNR, 1995. Victorian Groundwater Beneficial Use Map Series, Eastern Victoria Regional Aquifer Systems.

Department of Conservation and Natural Resources, 1995. Victorian Groundwater Beneficial Use Map Series. South-western Victoria Water Table Aquifers.

Department of Planning and Housing Victoria, 1992. Minister's Direction No. 1: Potentially Contaminated Land. As amended 14 May 1992.

Department of Planning and Community Development, 2010. 1985 Historical Planning Scheme. URL: http://services.land.vic.gov.au/maps/mpmo.jsp. Date Accessed: April 2013.

Department of Sustainability and Environment, 2010. Victorian Planning Schemes Online. URL: http://www.dse.vic.gov.au/planningschemes/. Date Accessed: April 2013.

Department of Primary Industries, 2010. Online Geological Map. URL: http://new.dpi.vic.gov.au/earth-resources/products-and-services/online-services/geovic. Date Accessed: April 2013.

Department of Sustainability and Environment (DSE, 2005). General Practice Note: Potentially Contaminated Land. URL: http://www.dse.vic.gov.au/CA256F310024B628/0/415C761104FCC951CA2573690007E0B4/$File/Potentially+Contaminated+Land+General++Practice+Note+June+2005.pdf

Department of Sustainability and Environment (DSE), 2009. Melbourne Groundwater Directory. URL: http://www.ourwater.vic.gov.au/monitoring/groundwater/general/melbourne-groundwater-directory

Dillon, P., Pavelic, P., Page, D., Beringen, H., and Ward, J. Managed Aquifer Recharge: An introduction. Waterlines Report Series No. 13, February 2009.

Foley, G. et al, 1995. Warragul/Sale Hydrogeological Map (1:250 000 scale). Victorian Hydrogeological Map Series, SKM, Victoria.

EPAV, 2000. Groundwater Sampling Guidelines. Environment Protection Authority Victoria, Publication 669.

Leonard, J., 1992. Drought Management Plan for Victoria's Resources, An Overview of Victoria's Groundwater Resources, Background report S3, Department of Water Resources, January 1992.

Leonard, 2003 Groundwater: a vital renewable resource. In Birch W. D., ed. Geology of Victoria pp. 519-531. Geological Society of Australia Special Publication 23. Geological Society of Australia (Victoria Division)

NEPC, 1999. National Environment Protection (Assessment of Site Contamination) Measure 1999. National Environment Protection Council Service Corporation, December 1999.

NEPC, 1999. National Environmental Protection (Assessment of Site Contamination) Measure: Schedule B(2) - Guideline on Data Collection, Sample Design and Reporting. National Environmental Protection Council, December 1999.

NSW EPA, 1994. Guidelines for Assessing Service Station Sites. New South Wales Environment Protection Authority, December 1994.

SKM (1998) Permissible Annual Volume – Moe GMA. Prepared for the Department of Natural Resources and Environment.

SKM (2001) Permissible Annual Volume – Rosedale GMA. Prepared for Southern Rural Water.

SKM (2002). Feasibility of ASR in the Melbourne Region, report for Melbourne Water, September 2002.

SKM (2007). Werribee Formation Aquifer, Prefeasibility assessment of a groundwater source to augment Melbourne's water supply – consolidated report, report for Melbourne Water, May 2007.

SKM (2009). Groundwater Risk Audit – Audit of risks: Groundwater use and interactions within the Melbourne Water Region, report for Melbourne Water, September 2009.

SKM (2012) Victorian state wide watertable mapping. Prepared for the DSE, 2012.

SRW 2009, Hydrogeological Mapping of Southern Victoria, report prepared by SKM and GHD

Standards Australia, 2005. Guide to the investigation and sampling of sites with potentially contaminated soils. Part 1: Non-volatile and Semi-volatile Compounds. November 2005. Australian Standard AS4482.1-2005.

Standards Australia, 1999. Guide to the sampling and investigation of potentially contaminated soil. Part 2: Volatile substances. Australian Standard AS 4482.2-1999.

Standards Australia, 1996. AS2870-1996 Residential slabs and footings – Construction.

Victorian Government, 2003. State Environment Protection Policy (Waters of Victoria). Vic. Govt. Gazette No. S107, 4 June 2003.

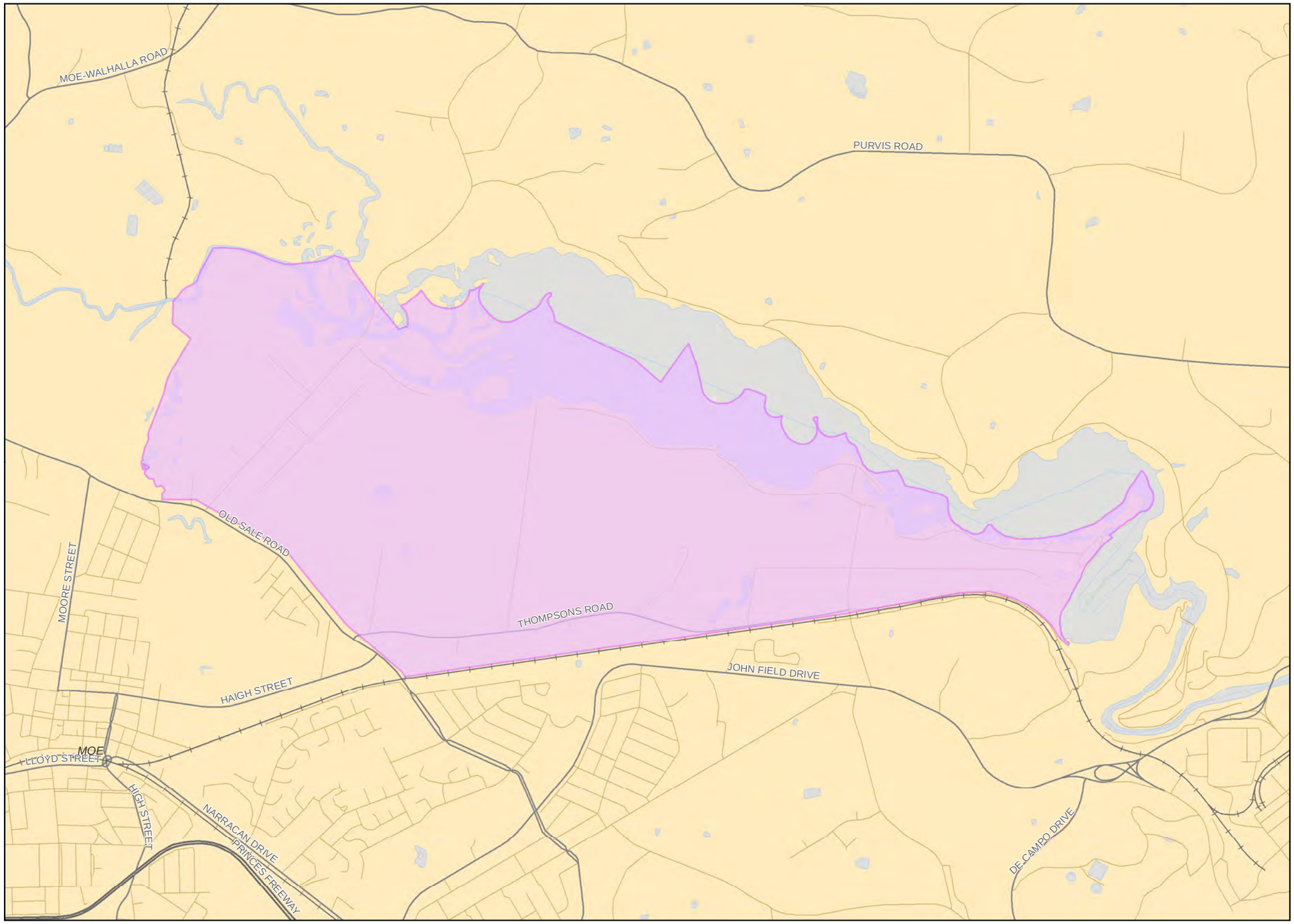
Victorian Government, 1997. State Environment Protection Policy (Groundwaters of Victoria). Vic. Govt. Gazette, 17 December 1997.

Victorian Government, 2002. State Environment Protection Policy (Prevention and Management of Contamination of Land). Vic. Govt. Gazette No S95, 4 June 2002.

Victorian Mineral Springs Committee, 2010. URL: http://www.mineralwater.vic.gov.au/. Date Accessed: 27 May 2010.

Figures

[Figure 1 - Site Location Plan]



LEGEND

- Precinct Structure Plan Boundary

Infrastructure

- Freeway
- Major Roads
- Local Road
- Walking Track
- Railway
- Railway Station

Hydrology

- Watercourse
- Waterbody

NOTES

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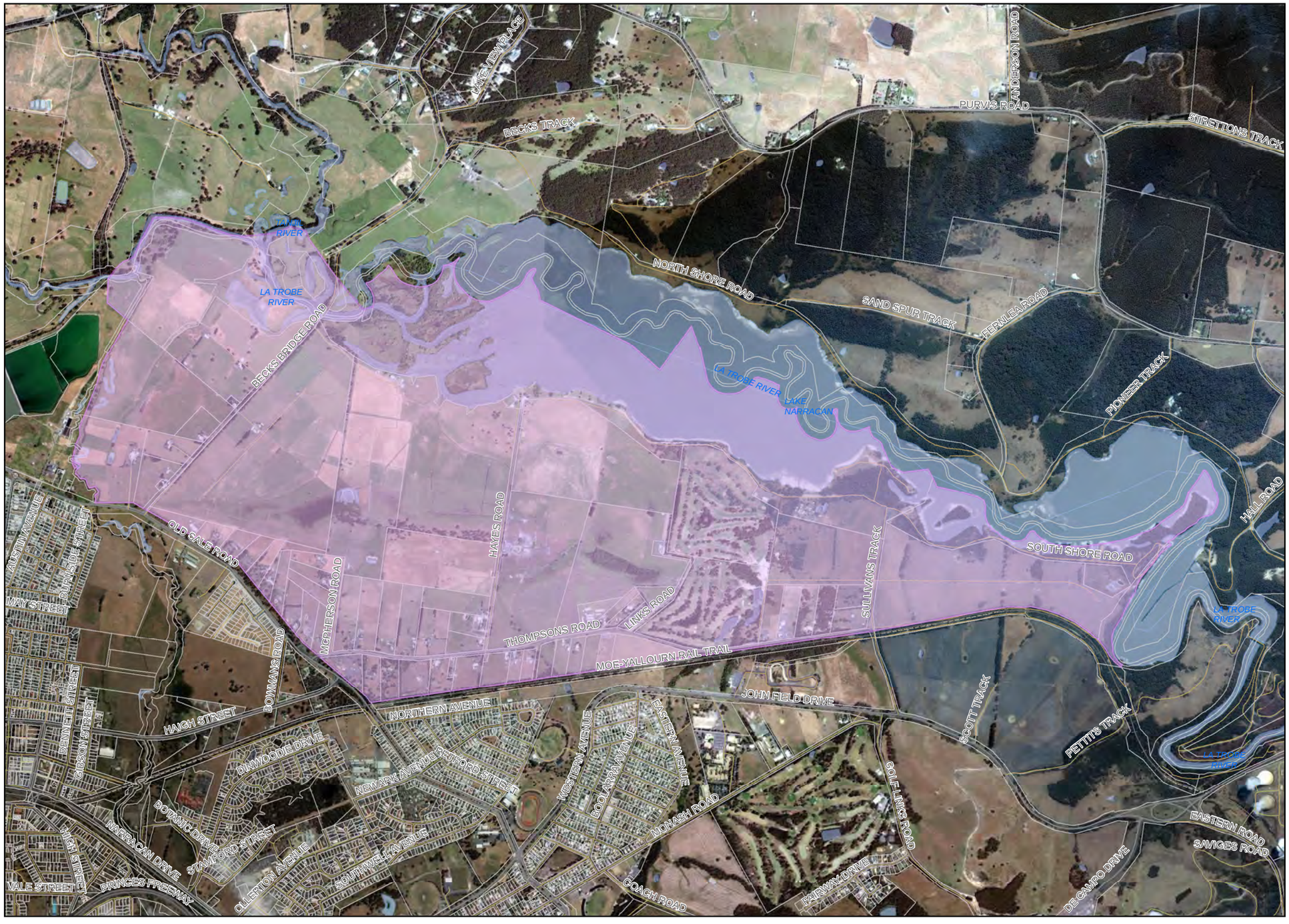
[Figure 2 - Site Layout Plan]



LEGEND

- Precinct Structure Plan Boundary
- Cadastre

Infrastructure

- Freeway
- Major Roads
- Local Road
- Walking Track
- Railway
- Railway Station

Hydrology

- Watercourse
- Waterbody

NOTES

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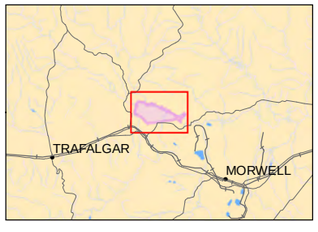

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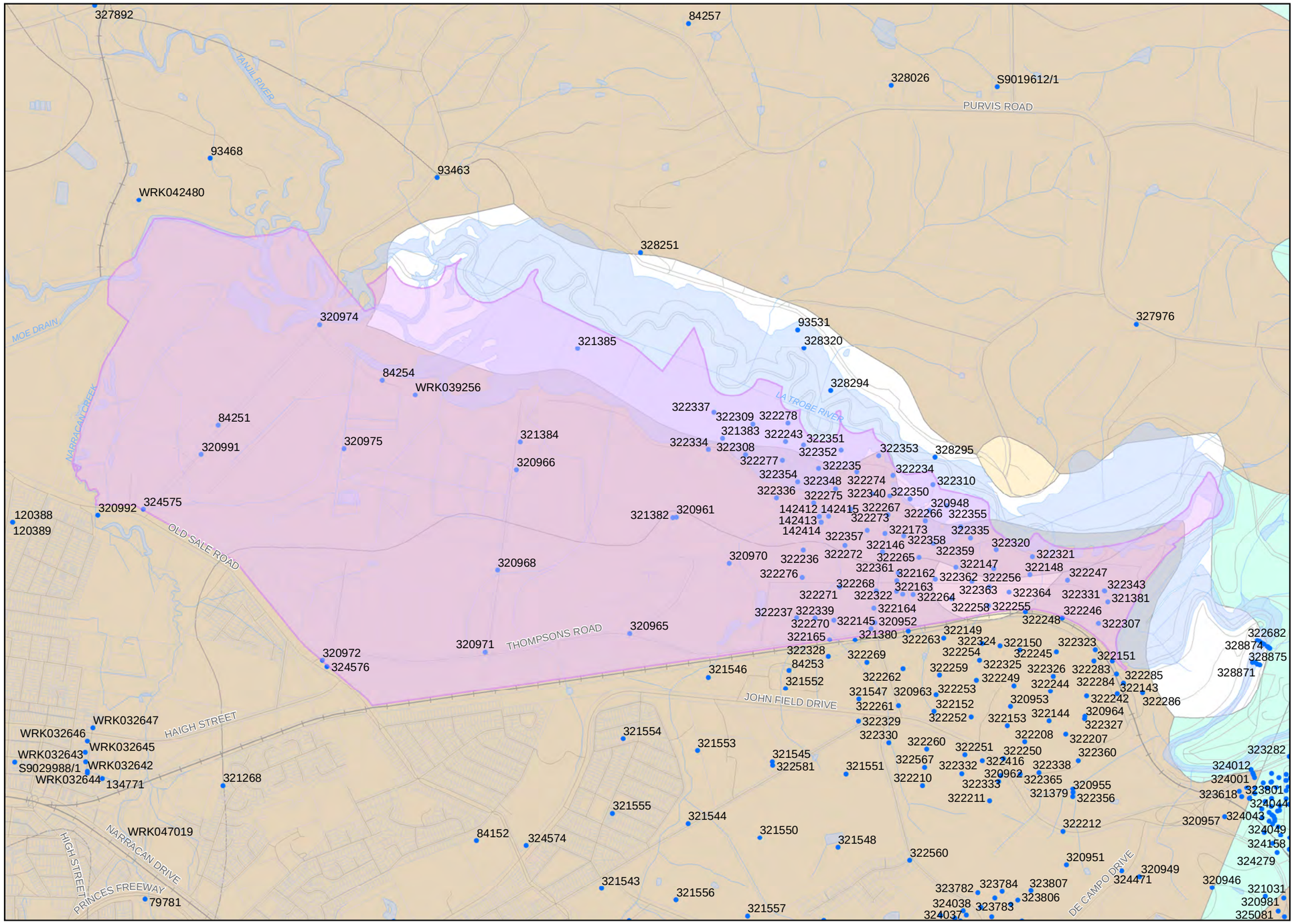
[Figure 4 - Lake Narracan PSP Site Environmental Setting]



LEGEND

- GMS Bore
- Environmental Audit Sites
- Cadastre
- Precinct Structure Plan Boundary

Geology

- Igneous (Extrusive)
- Sedimentary (Marine)
- Sedimentary (Non-Marine (Alluvial))
- Sedimentary (Non-Marine (Colluvial))

NOTES

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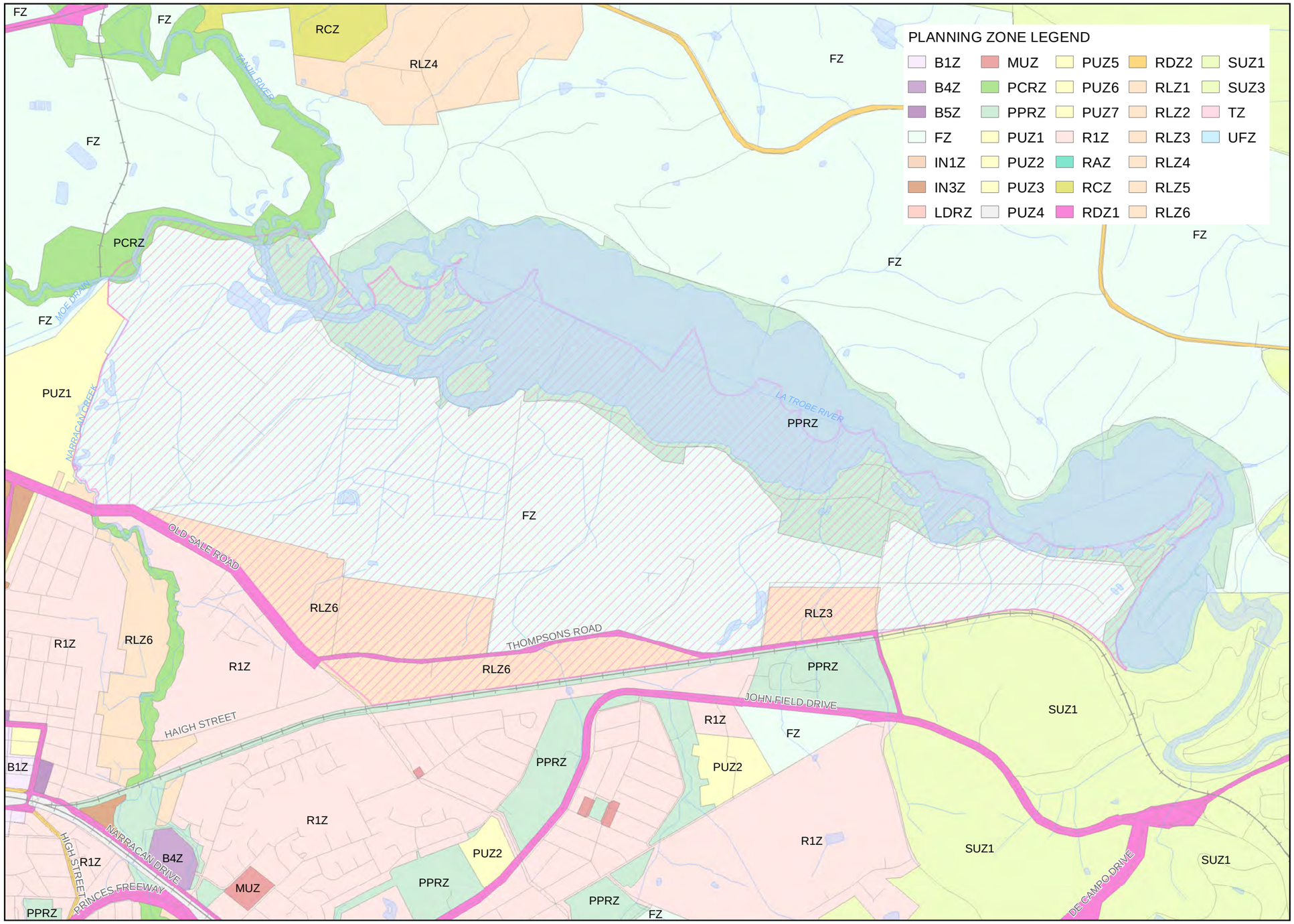
[Figure 4 - Lake Narracan Planning Zone]



LEGEND

Precinct Structure Plan Boundary

Infrastructure

- Road
- Railway Station
- Railway

Hydrology

- Watercourse
- Waterbody

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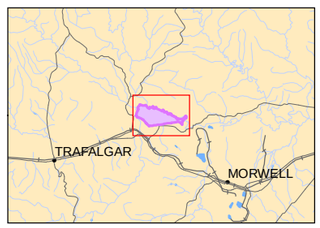

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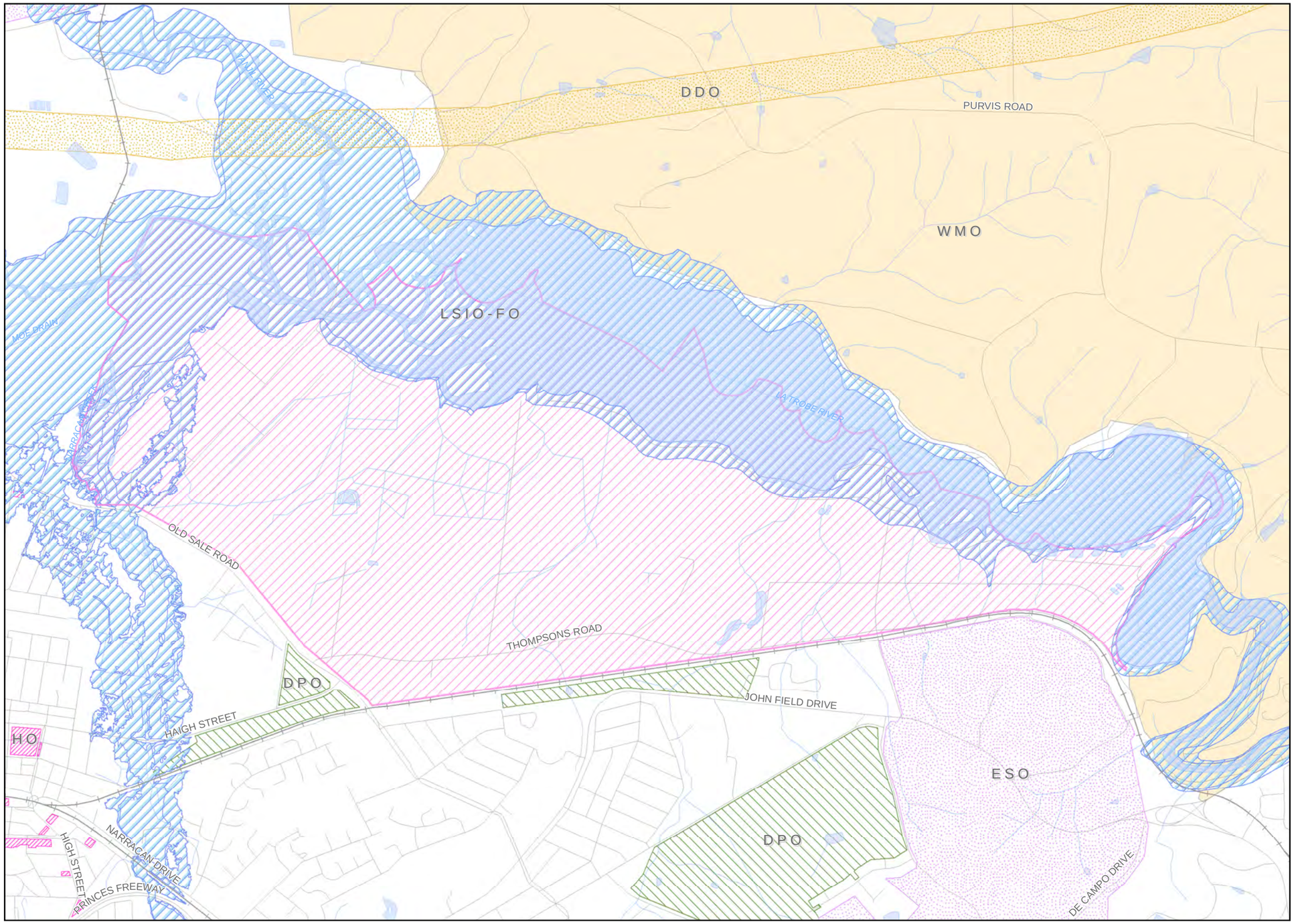
[Figure 5 - Lake Narracan Planning Overlay]



LEGEND

Precinct Structure Plan Boundary

Planning Overlay

- DDO
- LSIO-FO
- ESO
- HO
- DPO
- EAO
- WMO

Infrastructure

- Road
- Railway Station
- Railway

Hydrology

- Watercourse
- Waterbody

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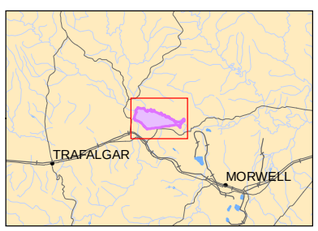

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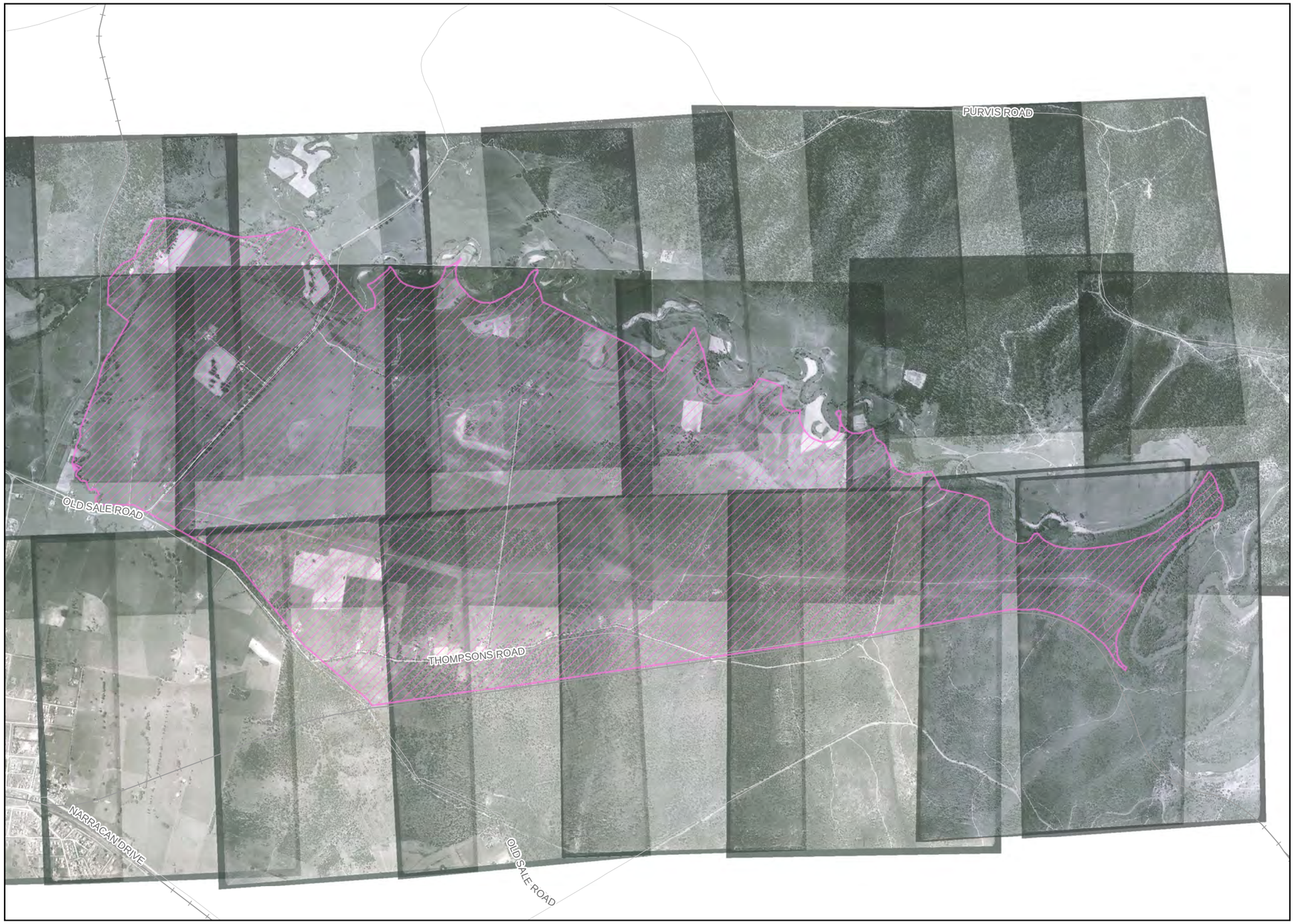
[Figure 6A - Lake Narracan - 1945]



LEGEND

Precinct Structure Plan Boundary

Infrastructure

Road

Railway

Railway Station

NOTES

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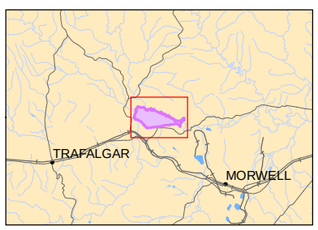

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[Figure 6B - Lake Narracan - 1960]

LEGEND

- Precinct Structure Plan Boundary

Infrastructure

- Road
- Railway
- Railway Station

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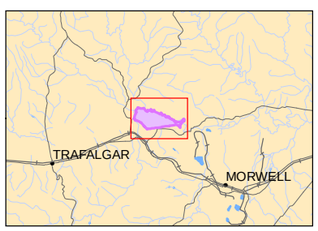

[Figure 6C - Lake Narracan - 1964]

LEGEND

Precinct Structure Plan Boundary

Infrastructure

Road

Railway

Railway Station

NOTES

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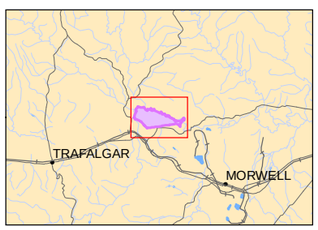

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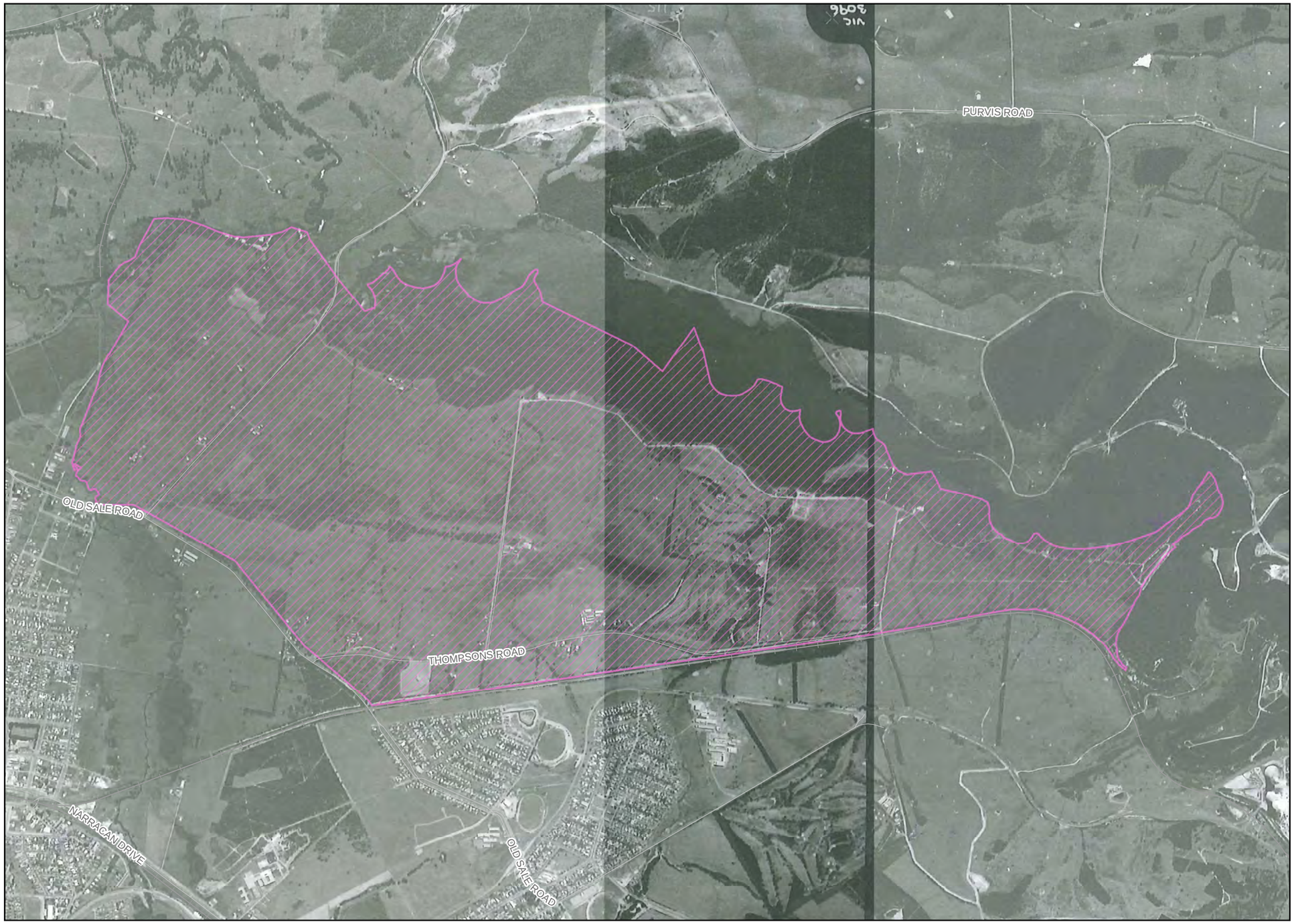
[Figure 6D - Lake Narracan - 1976]



LEGEND

Precinct Structure Plan Boundary

Infrastructure

Road

Railway

Railway Station

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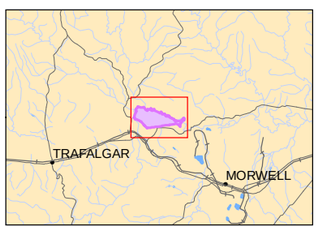
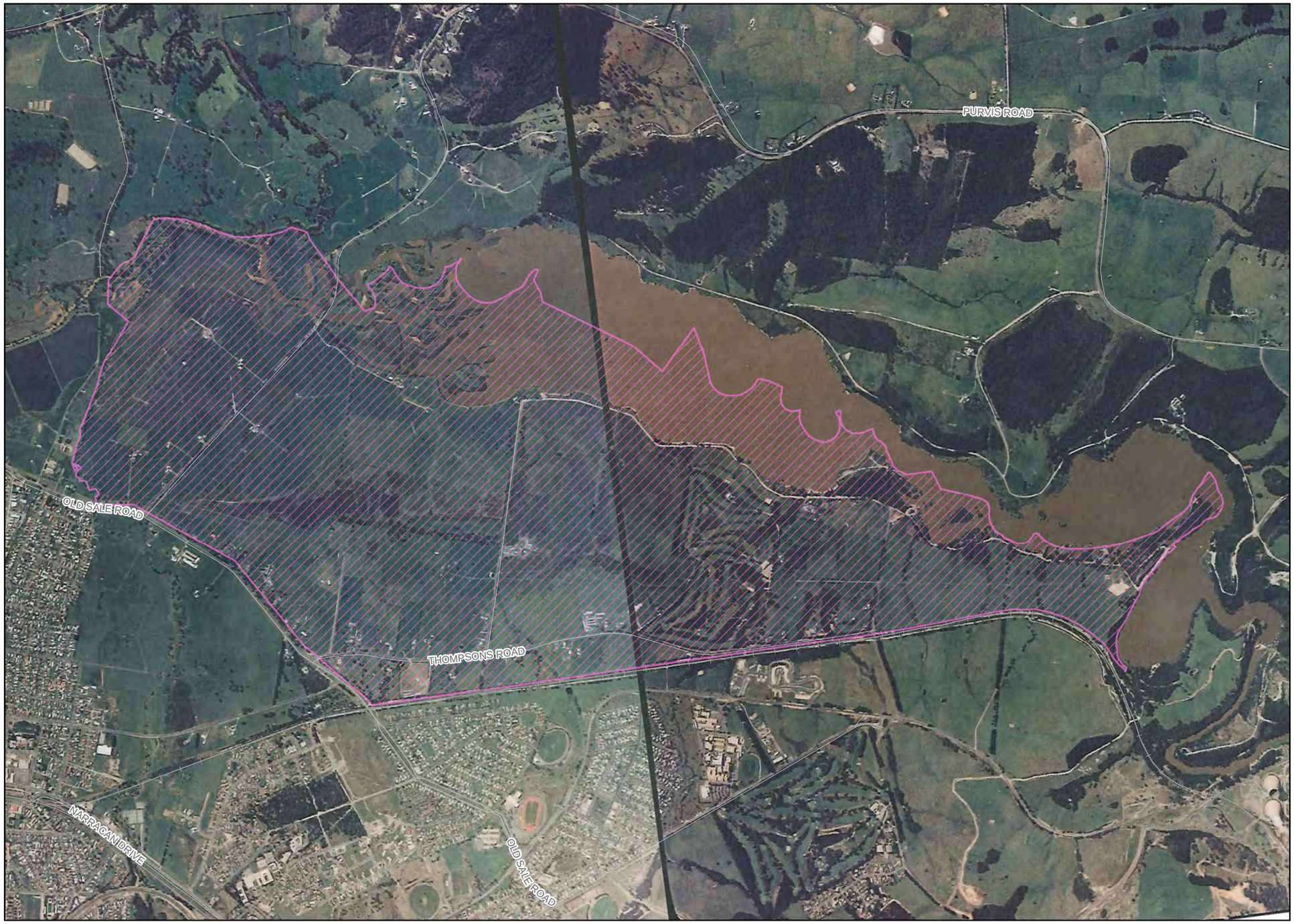


[Figure 6D - Lake Narracan - 1976]



LEGEND

Precinct Structure Plan Boundary

Infrastructure

Road

Railway

Railway Station

NOTES

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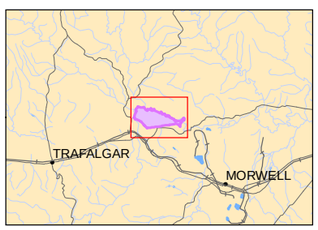
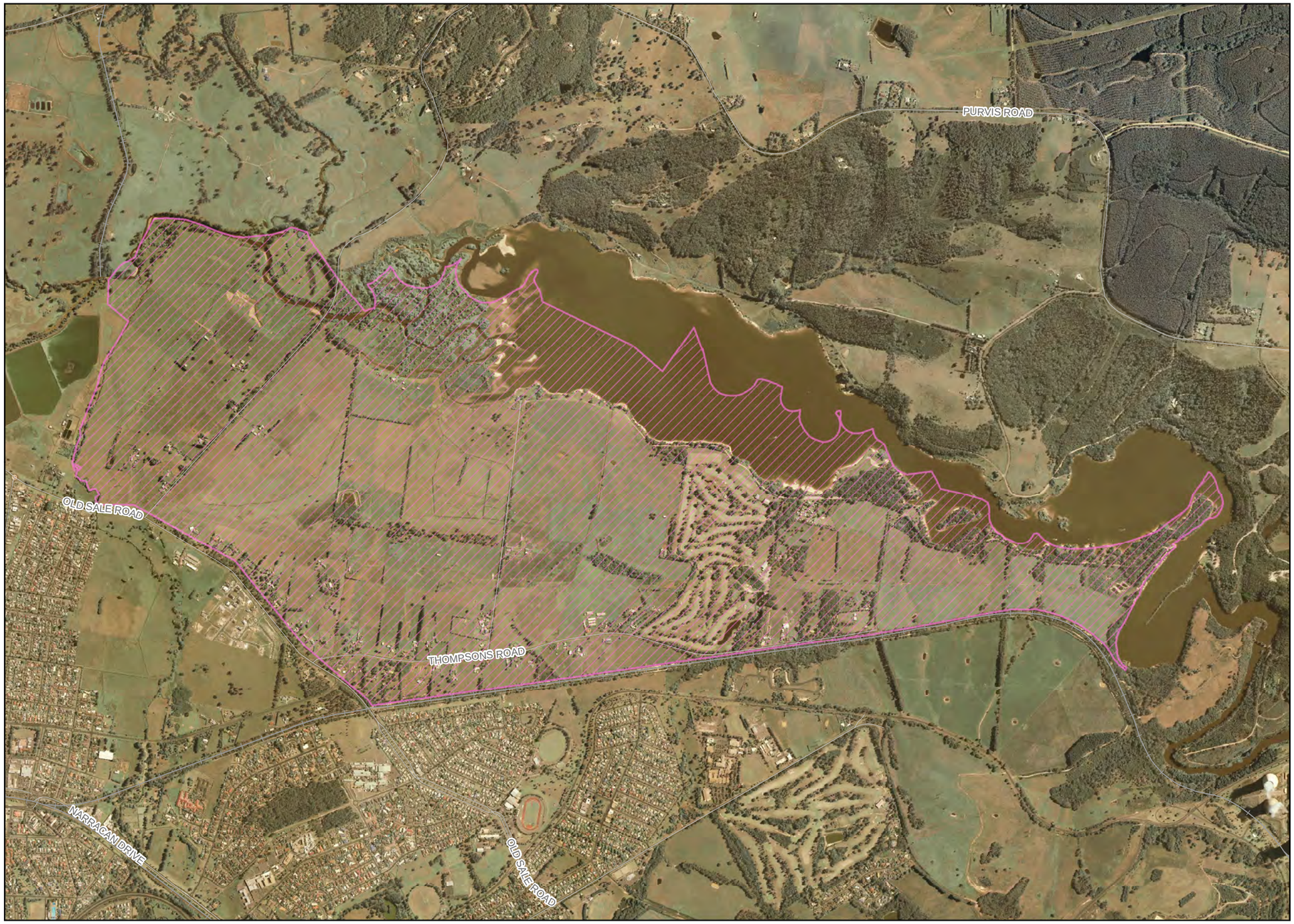


[Figure 6E - Lake Narracan - 2010]



LEGEND

Precinct Structure Plan Boundary

Infrastructure

Road

Railway

Railway Station

NOTES

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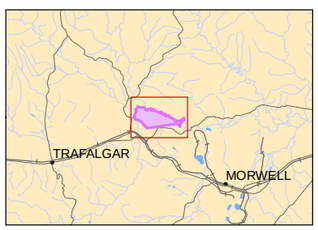

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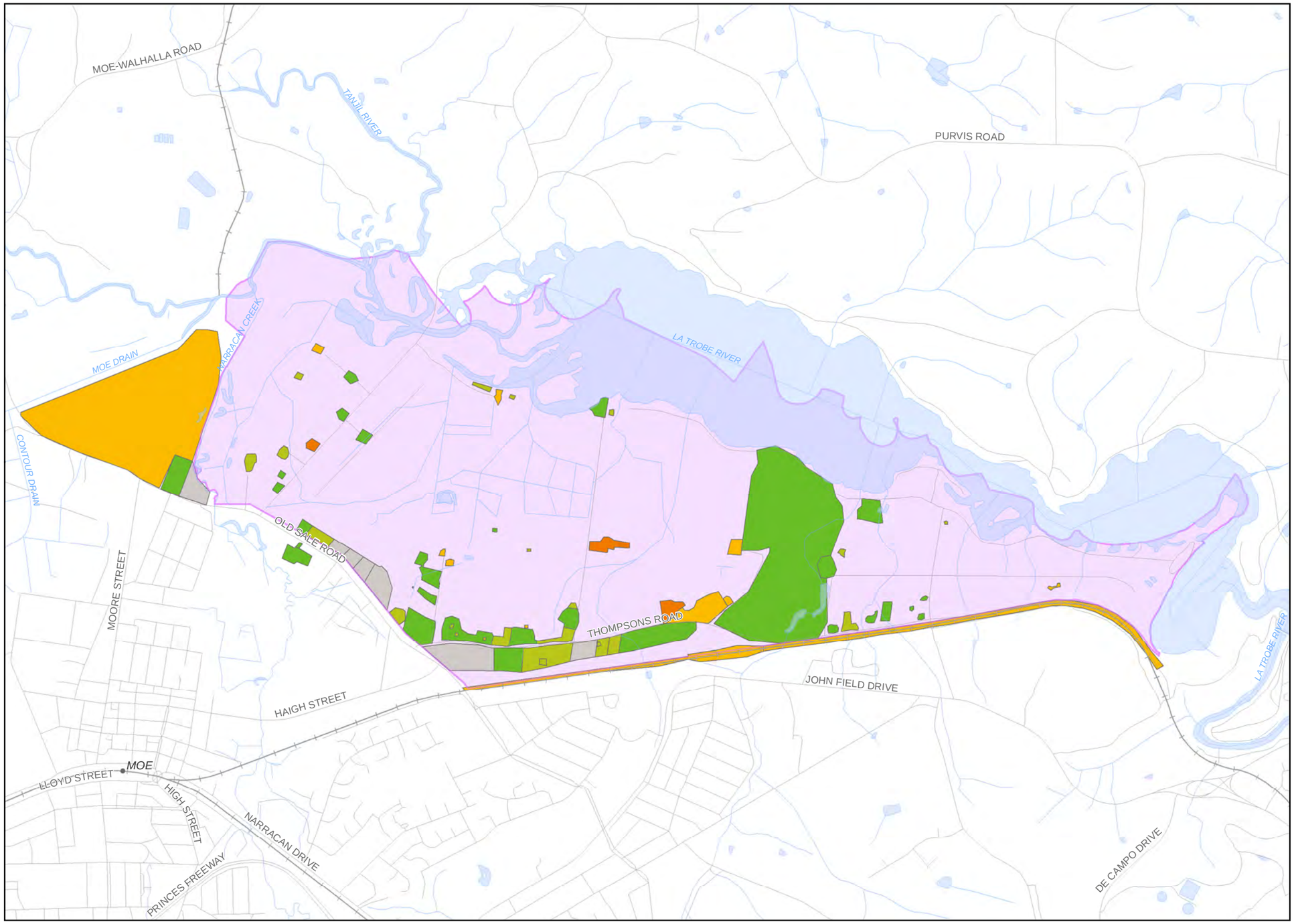
[Figure 7 - Lake Narracan PSP Site Qualitative Risk Assessment Overview]



LEGEND

Precinct Structure Plan Boundary

Qualitative Risk Rating

- H
- M - H
- M
- L - M
- L
- VL

Infrastructure

- Road
- Railway Station
- Railway

Hydrology

- Watercourse
- Waterbody

NOTES

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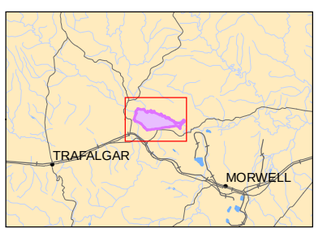

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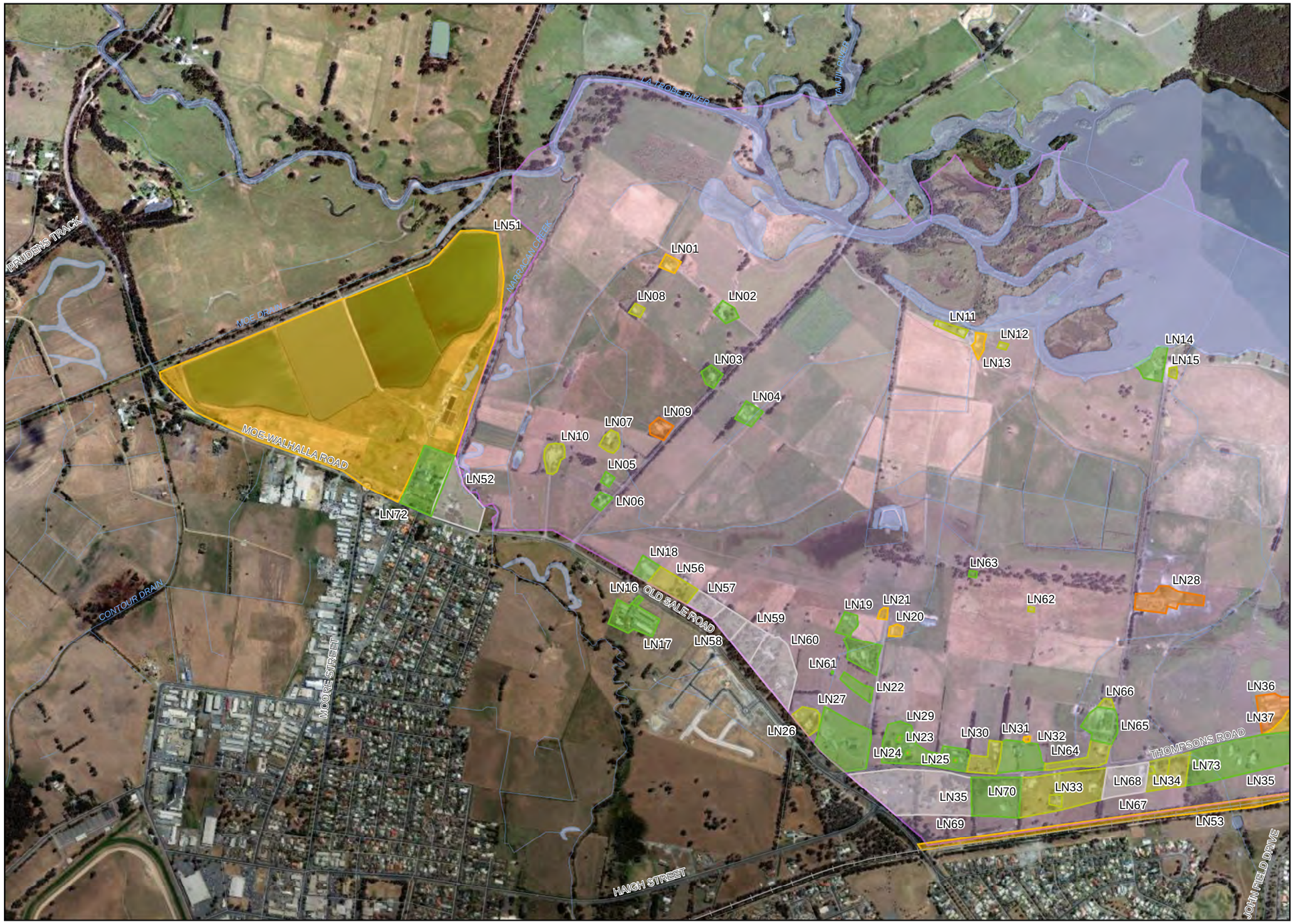
[Figure 7A - Lake Narracan PSP Site Qualitative Risk Assessment]



LEGEND

Precinct Structure Plan Boundary

Qualitative Risk Rating

- H
- M - H
- M
- L - M
- L
- VL

Infrastructure

- Road
- Railway Station
- Railway

Hydrology

- Watercourse
- Waterbody

NOTES

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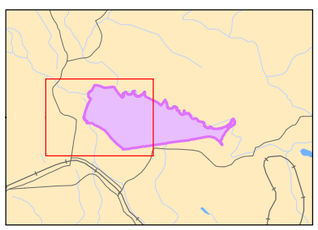
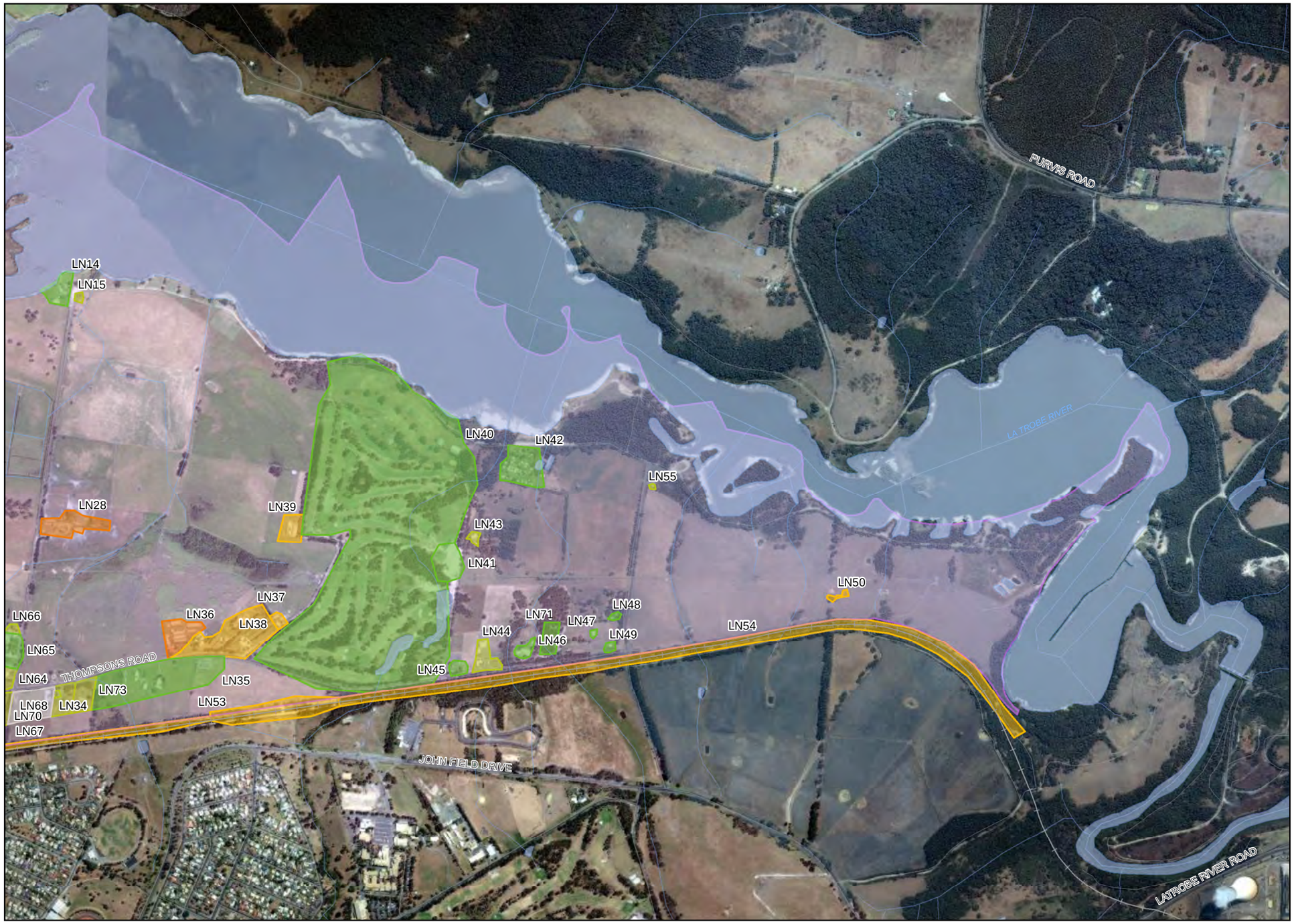


[Figure 7B - Lake Narracan PSP Site Qualitative Risk Assessment]



LEGEND

Precinct Structure Plan Boundary

Qualitative Risk Rating

- H
- M - H
- M
- L - M
- L
- VL

Infrastructure

- Road
- Railway Station
- Railway

Hydrology

- Watercourse
- Waterbody

NOTES

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DATA SOURCES

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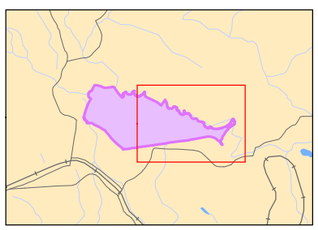
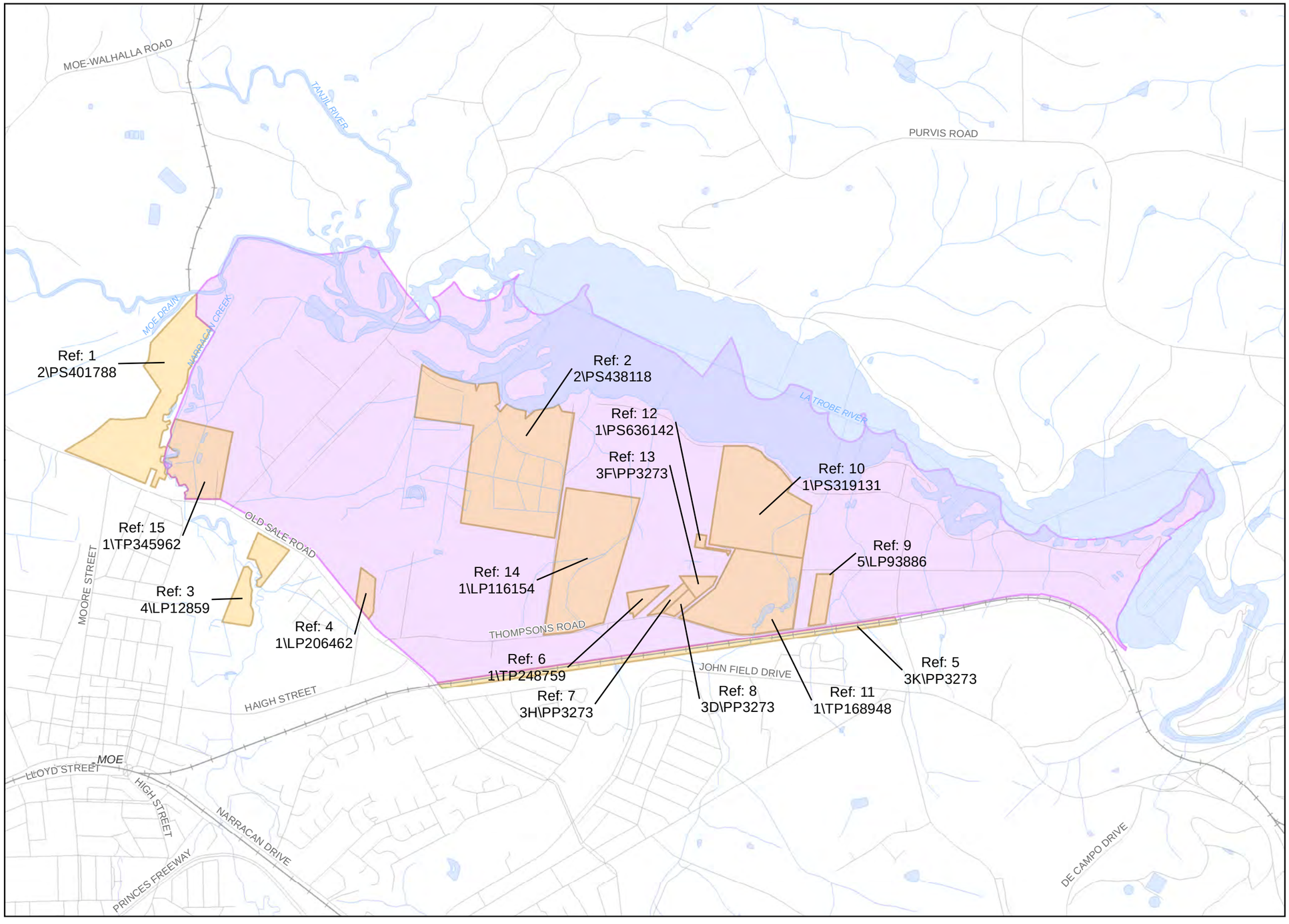


[Figure 8 - Lake Narracan PSP Current Property Titles]



LEGEND

- Title Information
- Precinct Structure Plan Boundary

Infrastructure

- Road
- Railway Station
- Railway

Hydrology

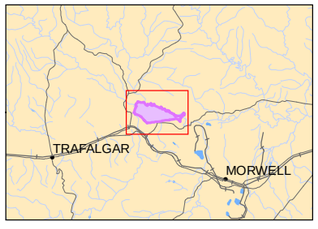
- Watercourse
- Waterbody

NOTES

DRAFT ONLY

[GDA 94 | MGA Zone 55]
1:24,000

0 1,000
Meters



19 Apr 2013 | Path: C:\Users\Public\Workspace\VW07131\Spatial\ArcGIS\LNFig08_ParcelID.mxd

Appendix A. SEPP information

A.1 Land SEPP

A.1.1 Land Use Categories

The following land use categories are defined in Clause 9(1) of the Land SEPP:

- *"Sensitive uses: consisting of land used for residential use, a child care centre, pre-school, or primary school. A sensitive use may occur in an area of high density)where development makes maximum use of available land space and there is minimal access to soil) or in Other low density areas (where there is generally substantial access to soil)";*
- *"Agricultural: consisting of rural areas involved in agricultural or horticultural practices"*
- *"Parks and Gardens: consisting of parks and forested area as defined in any Victorian or Commonwealth legislation or subordinate legislation, or any regions designated by the Authority or Department of Natural Resources and Environment"*
- *"Recreation / Open Space: consisting of general open space and public recreation areas";*
- *"Commercial: consisting of a range of commercial and business activities"; and*
- *"Industrial: consisting of utilities and a range of industrial activities".*

We understand that the end use of the site is yet to be determined and may comprise one or more of the above land uses.

A.1.2 Beneficial Uses of Land to be Protected

The Land SEPP (2002) states that the following beneficial uses must be protected for the following land uses:

Table A.1 : Beneficial Uses of Land

Land Use/ Beneficial Use	**Parks & Reserves**	**Agricultural**	**Sensitive Use**		**Recreation / Open Space**	**Commercial**	**Industrial**
			High Density	***Other***			
Maintenance of Ecosystems							
• *Natural Ecosystems*	✓						
• *Modified Ecosystems*	✓	✓		✓	✓		
• *Highly Modified Ecosystems*		✓	✓	✓	✓	✓	✓
Human Health	✓	✓	✓	✓	✓	✓	✓
Buildings and Structures	✓	✓	✓	✓	✓	✓	✓
Aesthetics	✓		✓	✓	✓	✓	
Production of food, flora & fibre	✓	✓		✓			

A.2 Groundwater SEPP

A.2.1 Beneficial Uses of Groundwater to be Protected

Table A.2 : Beneficial Uses of Groundwater

	Segment (TDS)				
Segment / Beneficial Use	**Segment A1 (0-500 mg//L)**	**Segment A2 (501-1000 mg//L)**	**Segment B (1001-3500 mg//L)**	**Segment C (3501-13000 mg/L)**	**Segment D (> 13,000 mg/L)**
Maintenance of Ecosystems	✓	✓	✓	✓	✓
Potable Water Supply					
a) Desirable	✓				
b) Acceptable		✓			
Potable Mineral Water Supply	✓	✓	✓		
Agricultural, parks & gardens	✓	✓	✓		
Stock Watering	✓	✓	✓	✓	
Industrial Water Use	✓	✓	✓	✓	✓
Primary Contact Recreation	✓	✓	✓	✓	
Buildings and Structures	✓	✓	✓	✓	✓