Department of Sustainability and Environment

Environmental effects of desalination plant



Victorian Desalination Project Environment Effects Statement Volume 3

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Contents







Environmental effects of desalination plant

Victorian Desalination Project Environment Effects Statement - Volume 3

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Victorian Desalination Project document structure



Victorian Desalination Project document structure



Victorian Desalination Project Document Structure

This Victorian Desalination Project Environment Effects Statement comprises a main report and accompanying Technical Appendices. The main report is divided into five volumes. Volume 1 defines the Project and summarises its environmental effects. Volumes 2 to 5 provide detail on the Project's four components:

- Marine Structures
- Desalination Plant
- Transfer Pipeline
- Power Supply.

Volume 1 explains the requirement for the Environment Effects Statement, sets the policy context, and describes the Project evolution. It sets out the evaluation framework adopted to assess:

- the environmental effects of the Project, integrated across all of the Project components, as required by the *Environment Effects Act 1978* (Vic)
- the environmental effects of the Project on matters of national environmental significance, as required by the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth).

Volume 1 also presents an overview of the environmental impact and risk assessment contained in volumes 2 to 5 and the Technical Appendices, together with the Environmental Management Framework to mitigate, manage and monitor the effects.



Volumes 2 to 5 describe the Project components and summarise the potential interactions between the components and the environment during construction and operations phases. Each volume then presents the environmental effects of the component. The assessment of these effects is based on specialist reports provided in the Technical Appendices.

A Summary Brochure has been prepared to provide a concise and clear summary of the Victorian Desalination Project Environment Effects Statement, the environment of the region, the potential effects associated with the construction and operation of the Project, and mitigation measures to manage or avoid potentially significant effects. The Summary Brochure is based on information presented in this Environment Effects Statement.

Volume 3 Environmental Effects of Desalination Plant

This volume describes the Desalination Plant concept in detail and it describes the Reference Project and Options for assessment. It describes interactions of Project components with the terrestrial environment, including the identification of potential hazards and risks for key environmental assets. It describes existing conditions, provides impact assessment, and discusses mitigation and management strategies for physical material and environmental quality, cultural and scientific assets as well as infrastructure and services. The chapters in Volume 3 are shown for ease of reference in the following table.

Chapter	Title	Content
1	Introduction	An overview of the Project, the project delivery process and the environmental impact and approvals process
2	Desalination Plant Project Description	Discusses Reference Project and Options for assessment and details the Desalination Plant development and operation concept as well as Project Requirements
3	Interactions with the environment	Describes the general characteristics of the environment around the Desalination Plant

Chapter	Title	Content
4-13		Summarises existing conditions, provides impact assessment, and discusses mitigation and management strategies based on specialist investigations. The environmental aspects assessed are: ▪ Ch 4 Landscape character and visual amenity ▪ Ch 5 Geology, geomorphology and soils ▪ Ch 6 Surface water and groundwater ▪ Ch 7 Flora and fauna ▪ Ch 8 Cultural heritage ▪ Ch 9 Socio-economic effects ▪ Ch 10 Air quality ▪ Ch 11 Noise and vibration ▪ Ch 12 Transport infrastructure ▪ Ch 13 Physical infrastructure and services
14	Summary of environmental effects	Summarises the environmental, social and energy effects of the construction and operation of the Desalination Plant

1.0 Introduction





1 Introduction

1.1 Basis of the Project Description

An overview of the Project, the project delivery process and the environmental impact and approvals process is provided in Volume 1 Chapter 1. That chapter explains that the Project will be delivered by a Project Company under contract to the State under a Public Private Partnership (PPP) structure.

The ultimate Project design will be determined from among designs, bid competitively by commercial consortia, who will be seeking to provide value for money and design innovation to the Government for delivery of the Project. There are a number of forms in which the Project could be delivered by the Project Company to meet the broad objective of supplying desalinated water to Melbourne, and potentially to regional water authorities. Further detail of this process and its interaction with the EES is provided in Volume 1 Chapter 1.

The final form of the Project will not be determined until after the completion of the EES. Accordingly, the EES needs to be flexible so that it does not unduly impede innovation and reduce the benefits of the PPP procurement.

To meet this challenge, the EES is based on a Project Description that is more complex than is usual for an EES. This approach is explained more fully in Volume 1 Chapter 1 and is demonstrated in Volume 1 Chapter 4.

The Project Description and subject matter of this EES is:

- the Performance Requirements
- the Reference Project
- Variations.

The Performance Requirements govern the Project for EES purposes, and are intended to be the basis for any contract with the Project Company. The Performance Requirements set the environmental parameters for the Project.

The Reference Project is an integrated response to the Performance Requirements developed by the State. It is used in this EES to demonstrate the Project's feasibility and ability to achieve acceptable environmental outcomes.

Variations contemplate other design and management solutions which also meet the Performance Requirements and are within the scope of this EES assessment.

In addition, the EES identifies Options that may potentially be of interest to the Project but which have not been considered further for technical or commercial reasons, or because they did not appear to offer significant advantages over the Reference Project. While these Options have not been fully assessed in the EES, they are matters upon which comment is invited. Any further process for the Options will be determined by the Minister for Planning prior to any endorsement by the State for utilisation in the Project.

The key infrastructure elements of the Reference Project, Variations and Option for the Desalination Plant are shown in Figure 1-1 and Table 1-1 and are discussed in Chapter 2 of this volume.

Figure 1-1 Reference Project, Variations and Option for the Desalination Plant

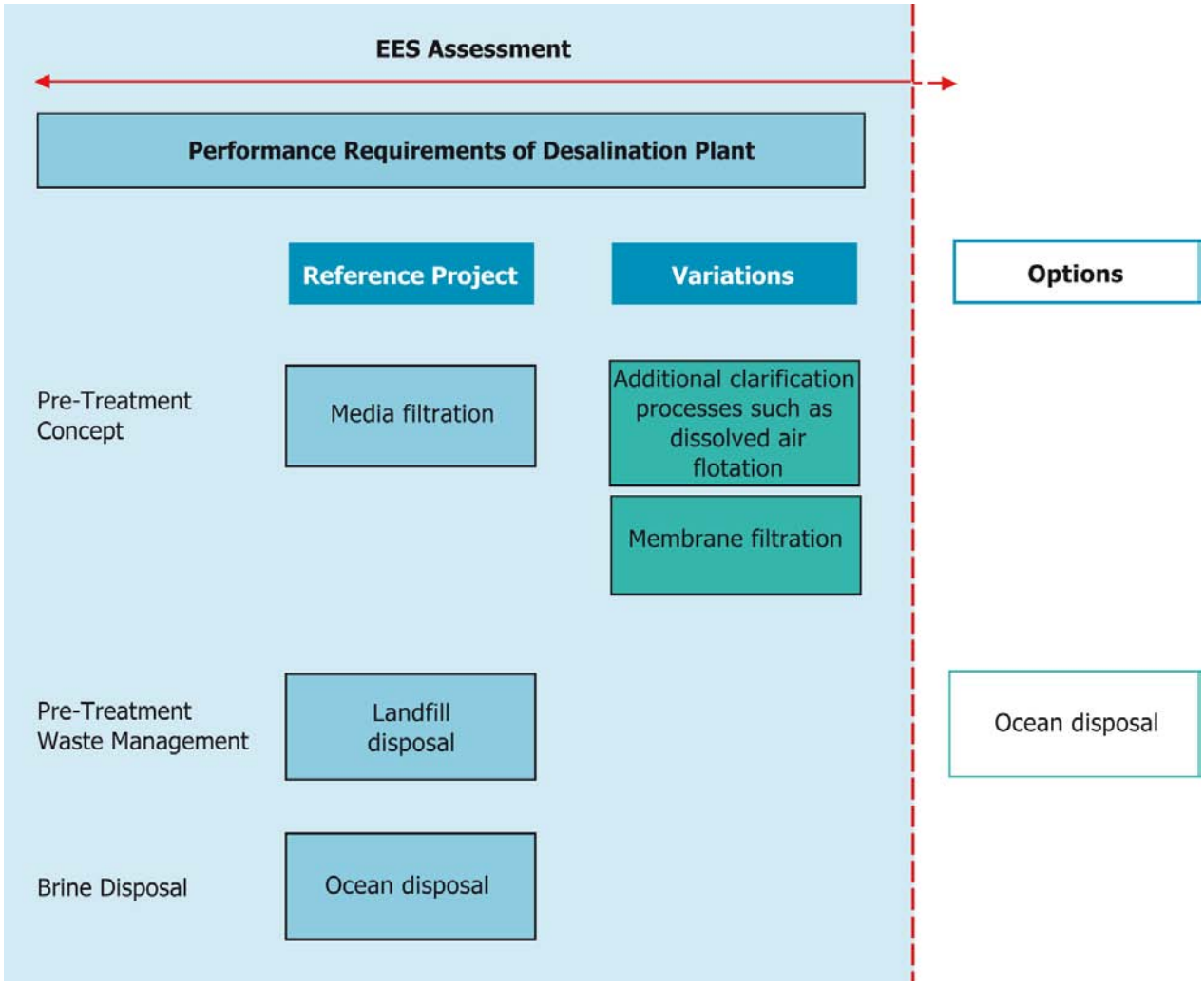


Table 1-1 Reference Project, Variations and Option for the Desalination Plant

Key elements	Reference Project	Variations	Option
Pre-treatment concepts	**Media filtration** Use of granular media to capture particles in the pre-treatment process	**Additional clarification processes such as Dissolved Air Flotation (DAF)** Additional stages of clarification (including DAF) may be required upstream depending on feed water quality. During clarification in the DAF process dissolved air release creates bubbles which float off contaminants prior to media filtration	
		Membrane filtration (MF/UF) Pre-treatment might employ microfiltration or ultrafiltration in place of granular media filters. This is referred to as MF/UF pre-treatment. Coagulation prior to MF/UF pre-treatment is likely to be needed depending on the water quality and the membrane supplier	
Pre-treatment Waste Management	**Landfill Disposal** The waste produced during pre-treatment stage is separated and thickened and dewatered prior to taking to landfill. Clarified water would be returned to the head of the plant, where practical and otherwise discharged to the ocean		**Ocean Disposal** The waste produced during pre-treatment would be blended and discharged in the ocean with the saline concentrate
Brine disposal	**Ocean Disposal** Saline concentrate from desalination process is discharged to the ocean		

1.2 Performance Requirements

The Performance Requirements (PRs) are intended to specify the Government's requirements for Project performance and will form the basis of contractual obligations.

In assessing the environmental effects of the Project, reliance should ultimately be placed on the PRs rather than the Reference Project. While a specific finding on the acceptability of the Reference Project and Variations is sought, the PRs are the Project outcomes which will apply regardless of the specific solutions adopted.

The PRs (as ultimately resolved from the outcomes of the environmental assessment processes) will be used:

- to assess the capacity of a bid project to perform in accordance with the PRs and the level of that performance
- to inform the contractual requirements for performance by the Project Company.

The PRs are incorporated into the Environmental Management Framework and embody the recommendations of environmental management arising from the environmental impact and risk assessment process.

The relevant PR's for each impact assessment are presented at the end of each Chapter in this EES Volume, along with commentary about linkages to the relevant management measures suggested in the technical investigations in relation to the Project.

2.0 Desalination Plant
project description



2 Desalination Plant components

2.1 Purpose of the Desalination Plant

The Desalination Plant (the Plant) will produce fresh drinking water from seawater by separating salts and other impurities from the seawater. It is the centrepiece of the Desalination Project and will contribute up to 200 gigalitres per year of potable water to Melbourne's water supply.

2.2 Evolution of the Reference Project Desalination Plant

2.2.1 Location

The Desalination Plant site is located approximately 90 kilometres south-east of Melbourne between the townships of Wonthaggi and Kilcunda in the South Gippsland region. The site is in the vicinity of the Powlett River as shown in Figure 2-1

The plant site is mainly cleared farmland, which is in the process of being acquired for the Project. There is a coastal reserve with vegetated high dunes between the site and Williamsons Beach. Access to the site is primarily via Lower Powlett Road, with secondary access available from Mouth of Powlett River Road. The site is elevated above the floodplain of the Powlett River. The aerial photographs in Figure 2-2 and Figure 2-3 illustrate the location of the site.

Figure 2-1 Desalination Plant site

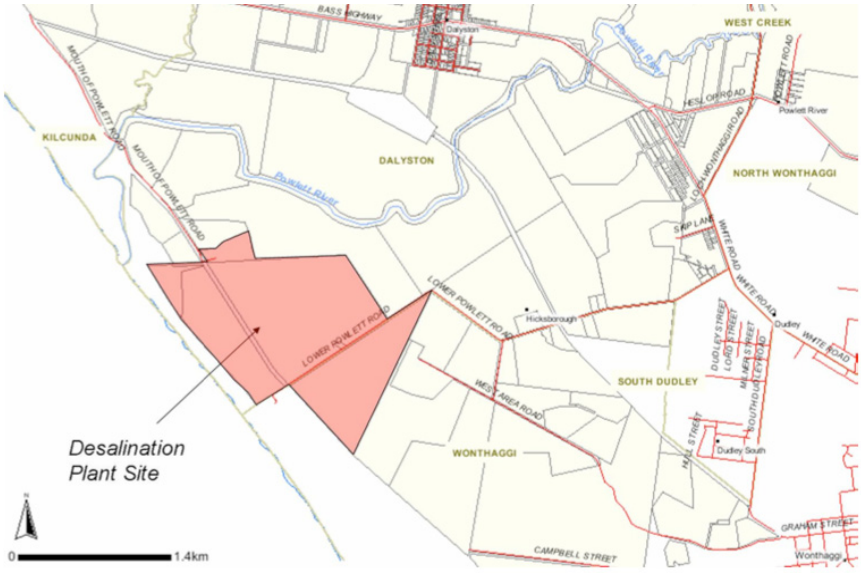


Figure 2-2 Aerial view of the Desalination Project area



Figure 2-3 Aerial view of Project area and plant site boundary



2.2.2 Site components

The Desalination Plant is to be a reverse osmosis plant with a 200 GL/year ultimate capacity to meet the State's water quality targets. The infrastructure components of the Desalination Plant include the following:

- tunnel shafts that connect the tunnels to the seawater pump station
- below ground seawater pump stations containing seawater pumps and intake screens
- pre-treatment plant and associated buildings
- pre-treatment waste treatment
- Desalination Plant and associated buildings
- clear water storage for desalinated water
- transfer pump station for pumping desalinated water to Cardinia Reservoir (referenced in Chapter 2 of Volume 4 Transfer Pipeline, but discussed more fully in this chapter because the transfer pump station will be located within the plant site)
- storage and use of chemicals for pre-treatment, desalination and post treatment (potabilisation)
- electrical sub-station to distribute power around the site
- offices, storage sheds, roads and stormwater management measures.

Each of these components is examined in further detail in this chapter.

2.2.3 Technologies

Desalination technology

The most mature and widely used technologies for desalinating seawater are:

- thermal (evaporative)
- reverse osmosis (RO) (membrane based).

Other existing desalination technologies are generally limited by constraints on their size and level of development and therefore were not considered for this Project.

All recent and proposed large Australian seawater desalination plants have adopted reverse osmosis, as it is typically more energy efficient, less visually intrusive and more cost effective in Australian circumstances than thermal processes. RO has been indicatively adopted for the Reference Project and as a Project Requirement by the State, with effect that thermal processes are not within the scope of this EES.

Seawater screening

Suspended solids and organics must be removed from the seawater to prevent fouling of the RO membranes before an RO process can desalinate seawater. The first stage of this process involves screening to remove gross matter. Active screening may take place either at the intake head or immediately prior to the water entering the RO membranes. Screening at the intake head is discussed in Chapter 2 of Volume 2 Marine Structures.

Onshore active screens can be located upstream or downstream of the pump which pumps seawater into the RO plant. While upstream screens involve more complex earthwork, they have the advantage of reducing the visual impact of the screens and making it easier to remove solids before the pumps macerate them.

Two kinds of active screens were considered for the Reference Project: rotating drum and active travelling band. Active travelling band screens have a smaller physical footprint, which makes them easier to install underground. Otherwise, both have similar environmental implications and operating costs.

After detailed investigation, the Reference Project indicatively adopted onshore screening with an active travelling band screen as discussed later in this chapter. However, the Project Company may adopt alternative approaches.

Pre-treatment filtration

The second stage of treatment prior to an RO process involves filtration to remove the finer particles, dissolved organics and other substances that could foul the RO membranes. There are a number of engineering constraints that determine what form of pre-treatment can be used. Two concepts for pre-treatment filtration were considered:

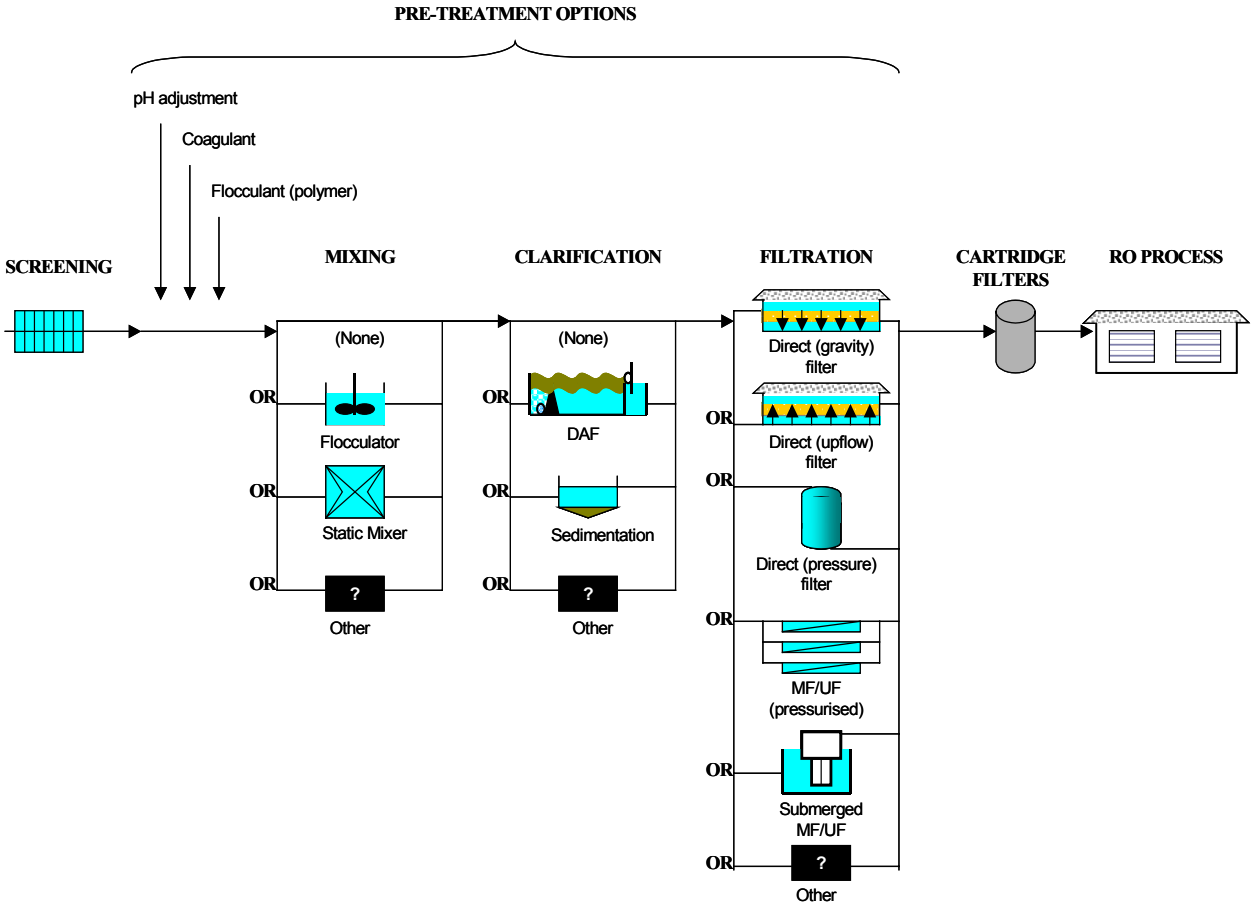
- media filtration (conventional filtration) with or without clarification
- membrane filtration.

For the Reference Project, both of these would take place onshore. However, for an intake Option such as seabed filtration (described in Chapter 2 of Volume 2 Marine Structures) some filtration could occur offshore though onshore filtration would still be required.

Both processes (onshore) may be implemented in series with other typical water treatment processes such as clarification and flotation. Seawater is usually chemically conditioned as part of the pre-treatment process. This may include pH adjustment, coagulation and flocculant dosing. Chemical selection would depend on process choice, feedwater quality and other environmental and design parameters.

There exist multiple treatment train possibilities within the pre-treatment system that may be adopted by the Project Company. These are depicted conceptually in Figure 2-4.

Figure 2-4 Conceptual representation of pre-treatment



In conventional filtration, the seawater would then be passed through a granular media filter to further capture particles. Granular media filters have three different design configurations, which include:

- single or dual media
- single or double stage
- gravity or pressure fed.

The Reference Project was based on dual media filtration, which involves anthracite above sand. Anthracite is a black coal which allows for longer run times than can be achieved by sand alone.

Membrane filtration pre-treatment involves forcing seawater through a membrane with very fine pores. Particles that are larger than the pores are filtered out. Current large plants utilise coagulation since dissolved organics can still pass through the membrane. There has been increasing utilisation of membrane filtration for reverse osmosis systems over the last few years although not yet at the scale of this Project.

2.2.4 Plant design strategies

Three design strategies were evaluated in developing the Reference Project for the Plant:

- engineered solution only
- integrated engineered solution with architectural considerations
- iconic architectural solutions.

An engineered solution with architectural considerations was selected for the Reference Project. This differs to a strategy based solely on engineering considerations, as it also seeks to meet community expectations by mitigating visual and other impacts of the Plant through architectural solutions. At the same time it aims to avoid the risks, costs and construction time associated with an iconic architectural solution. The Reference Project maintains a lower visual profile responding to the local landscape forms and local amenity.

2.3 Reference Project for the Desalination Plant

As set out above, the Reference Project for the Plant embodied both:

- an engineered solution (i.e. it contains a suite of inter-active and compatible technologies)
- architectural considerations (i.e. it seeks to address the impacts of the infrastructure on landscape and local amenity).

For this reason, the Reference Project for the Plant is discussed in two parts: the first concentrating on Plant engineering (including waste disposal) and the second concentrating on Plant design. This in turn is followed by an outline of construction methodologies.

2.3.1 Engineering

Modular capacity

The Reference Project was based on three indicative parallel modules with each module producing a third of the initial Plant capacity (50 GL per year). Allowances have been made in the site layout for a fourth module to be built at a later stage to achieve the ultimate Plant capacity of 200 GL per year. However, the Reference Project is indicative only and other modular solutions may be proposed by the Project Company.

Benefits of this staged module approach include:

- ability to construct the individual modules in parallel reducing construction time
- ability to maintain limited water supply even with major failure of one module
- ability to ramp the Plant up and down by turning on/off individual modules
- ability to reduce visual impact as buildings would generally be smaller and more easily blended into the landscape.

Process sequence

Seawater from the ocean intake would be screened and pumped to the Plant modules to undergo desalination. The key elements of this process would be:

- active screening of influent seawater
- seawater pump station (to lift screened water to the pre-treatment plant)
- pre-treatment
- reverse osmosis desalination
- potabilisation

- clear water storage
- transfer pump station (to transfer clean water to the Transfer Pipeline).

An indicative process flow diagram of the treatment process for the Reference Project is shown in shown in Figure 2-5.

Figure 2-5 Indicative process flow diagram

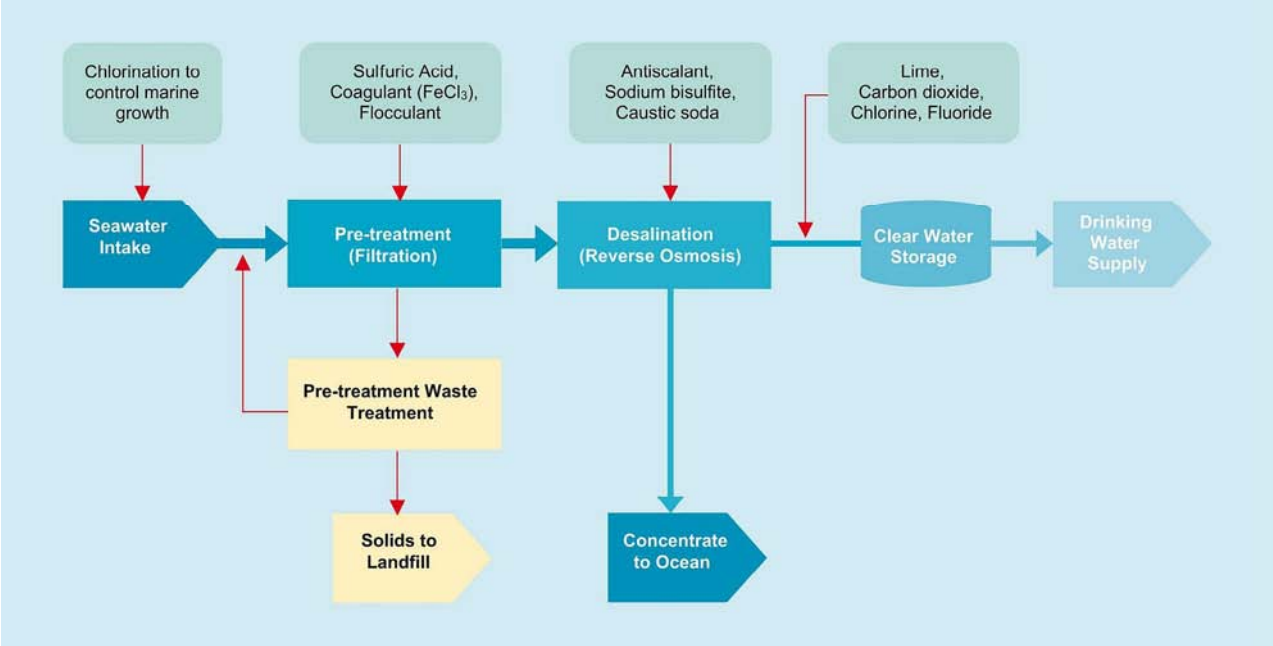


Figure 2-5 illustrates a sample of the range of chemicals selected for the Reference Project. These are commonly used in the treatment of drinking water and must meet quality standards for this purpose under the *Victorian Safe Drinking Water Act 2003* which is administered by the Department of Human Services. A range of alternatives are also possible and the final selection would be made by the Project Company to meet the State's water quality targets.

Active onshore screening

An active travelling band self-cleaning screen would be employed to filter the influent seawater. A typical active travelling band screen is presented in Figure 2-6.

Figure 2-6 Typical active travelling band screen



As previously mentioned, active travelling band screens have a smaller physical footprint, which makes them easier to accommodate in underground installations as proposed in the Reference Project.

Seawater pump station

Once screened, the water would be lifted by the seawater pump station from below sea level to a height above sea level, at which the seawater would be able to flow through the pre-treatment plant by gravity.

The seawater pump station would be arranged on a modular basis corresponding to the Plant configuration, i.e. separable portions that service 50 GL per year plant modules.

Pre-treatment process

The pre-treatment process would:

- remove turbidity and suspended solids
- manage risks from human activities such as oil leaks from shipping
- manage risks from naturally occurring events such as algal blooms.



Pre-treatment processes are similar to the processes utilised for treating fresh water (in surface water drinking supplies).

The seawater would first be chemically conditioned to coagulate and flocculate the suspended matter for removal in the pre-treatment filters.

Coagulation is a process where a coagulant (such as ferric chloride) is added to the water to destabilise small particles suspended in the water. Coagulation is a rapid process requiring rapid mixing to disperse the coagulant in the feed water. Since the pH of coagulation is critical, an acid is added prior to coagulation to maintain optimum pH conditions.

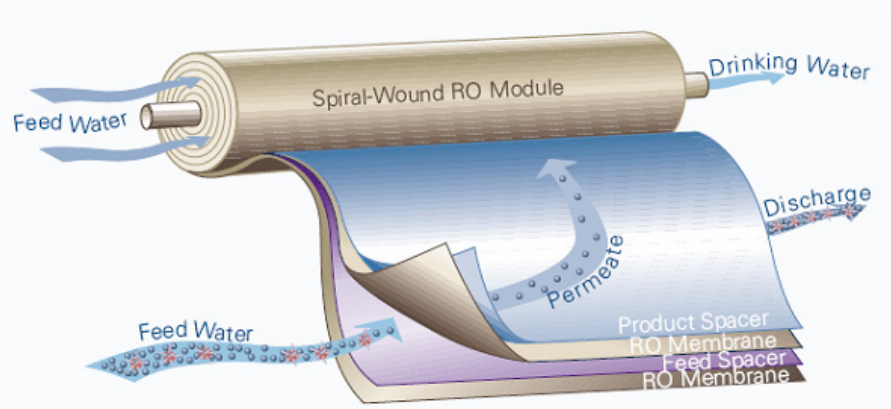
The coagulated water would discharge to flocculation tanks with mixers to provide gentle mixing of the coagulated water for the destabilised particles to form clumps, or 'floc'. At the entry to the flocculation tanks, flocculant (polyelectrolyte) would be added to aid the process.

Coagulated and flocculated material would be removed from the water by passing through the gravity filters, with a sand and anthracite (coal) granular medium. It is expected that sand and anthracite would be replaced about every 10 years.

RO membranes – treatment process

Spiral-wound RO membranes would be used to remove the salt from the seawater. Membrane elements would be connected in series and placed in a cylindrical pressure vessel. Pressurised seawater would enter the pressure vessel shell and flow through the channels between the spiral windings of the first membrane element. Some of the seawater feed would permeate through the RO membrane and travel a spiral path to the product-water collection tube at the centre of the membrane element. A typical RO membrane is shown schematically in Figure 2-7 and examples of RO membrane elements are shown in Figure 2-8. An example of a rack of RO pressure vessels is shown in Figure 2-9.

Figure 2-7 Schematic representation of the workings of a spiral wound RO membrane



Source: Sydney Water Corporation

Figure 2-8 Examples of RO membrane elements



Source: suppliers' websites

Figure 2-9 Rack of RO pressure vessels, Perth Desalination Plant

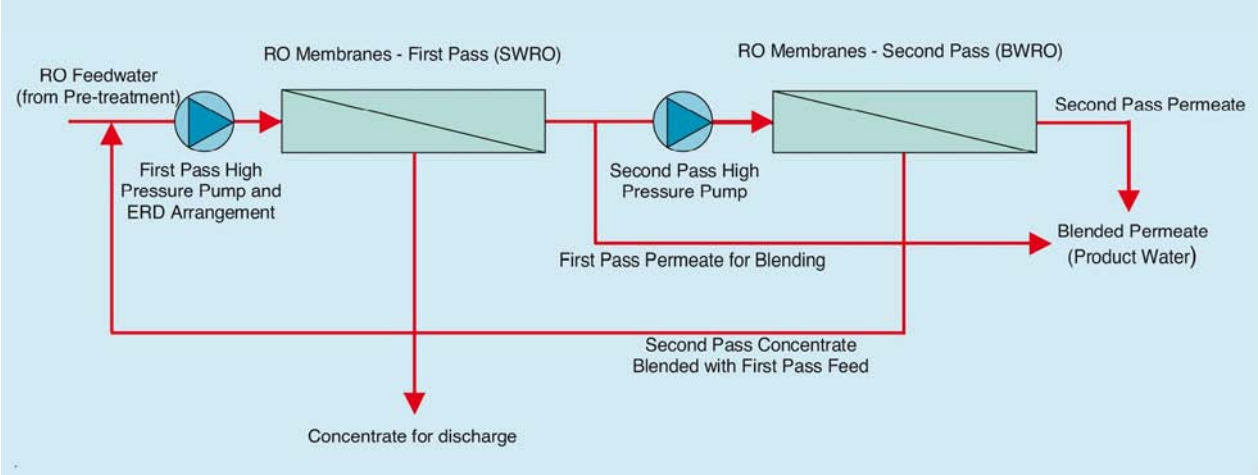


Source: G Crisp Water Corp

The RO process is pressure driven. The filtered seawater would be pressurised to a point at which the osmotic pressure of the solution is overcome and the water molecules in the seawater would be able to pass through the membranes. While most dissolved solids would be rejected by the membranes, a small amount of dissolved solids would pass through into the permeate. To achieve the required final treated water quality for the Reference Project, the permeate from the first pass would be treated by a second reverse osmosis system (second pass).

The first pass RO would produce a waste concentrate stream with a total dissolved solids (TDS) salinity roughly twice that of seawater. This stream would be discharged to the ocean including residual contaminant traces from the chemical dosing. The second-pass RO produces a concentrate stream that is lower in TDS than raw seawater and low in contaminants (as it has already passed through the first pass). Therefore, the second-pass RO concentrate could be returned to the head of the RO system to improve efficiency of the system. Membranes would typically have a service life of approximately five years, at which point they would typically need to be replaced. The two-pass RO process is illustrated in Figure 2-10.

Figure 2-10 Schematic of two-pass RO process



In the Reference Project, the RO system would be configured as a series of trains that would operate in parallel. Each train consists of the RO pressure vessels, a high-pressure pump, an energy recovery device (discussed below), booster pumps and cartridge filters. These trains could be operated independently of each other, providing scope to ramp the capacity of the Desalination Plant up and down and to conduct routine maintenance whilst still producing water.

Energy recovery

The pumps which would be required to pressurise the feed water to the first pass would be responsible for the largest proportion of the Plant's energy consumption. In the Reference Project, an isobaric positive displacement energy recovery device (ERD) would be used to recover some of this pressure energy. ERDs transfer pressure from the concentrate stream to the incoming feed stream, reducing the required pumping energy. Relative energy efficiency is presented for a range of ERDs in Figure 2-11. The configuration of a positive displacement ERD is shown schematically in Figure 2-12. The ERDs installed at the Perth and Barbados Desalination Plants are shown in Figure 2-13 and Figure 2-14 respectively.

Figure 2-11 Relative energy use from energy for ERD efficiency

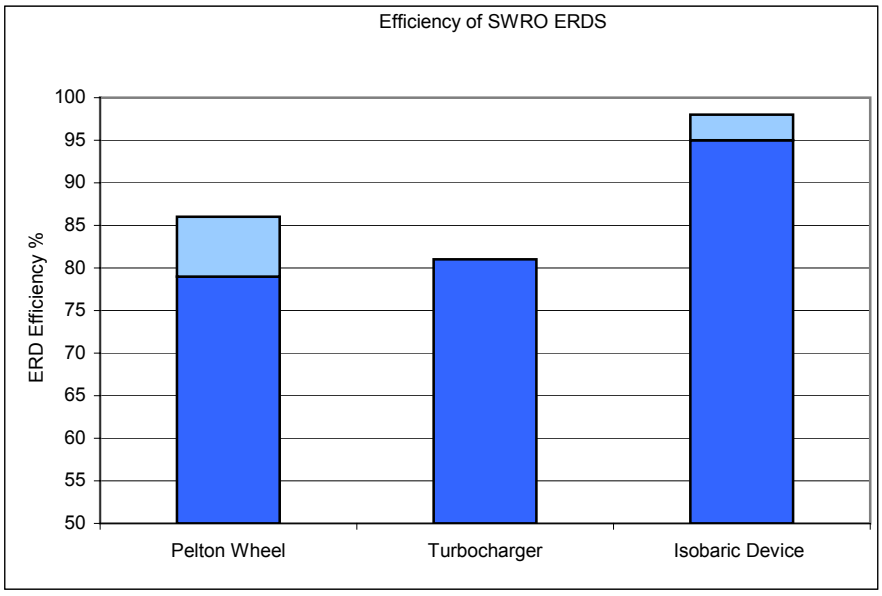


Figure 2-12 Positive displacement ERD

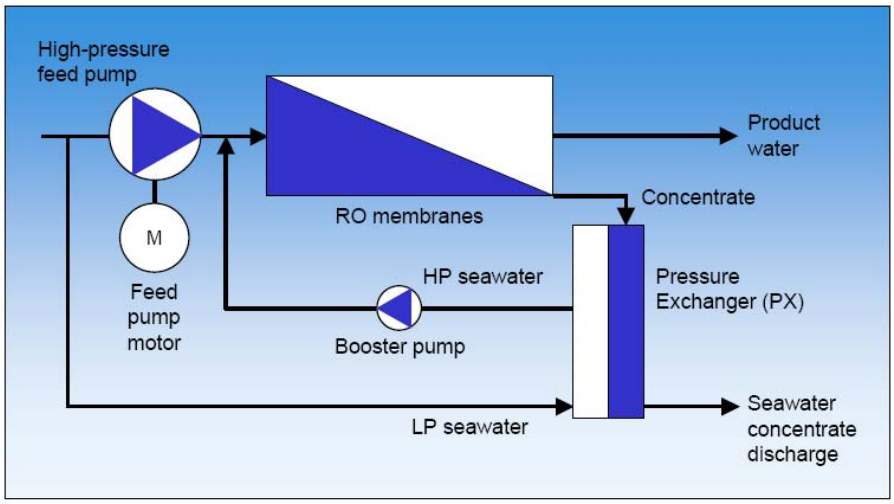


Figure 2-13 ERI PX energy recovery device in Perth's Kwinana SWRO



Figure 2-14 DWEER energy recovery devices





Potabilisation

The treated water quality targets will include targets for stabilisation, chlorine residual and fluoride to make it suitable for delivery into the Melbourne and regional water networks. The process through which this would be achieved is also referred to as potabilisation.

Water from the RO process would have very low residual hardness or alkalinity and is considered aggressive to some materials including steel and concrete. Before being supplied to the water network, the desalinated water would need to be stabilised to prevent corrosion of (new and existing) transfer and storage assets.

In the Reference Project, water would be stabilised by the addition of carbon dioxide and lime (calcium) to increase alkalinity. The calcium would be dosed via limewater, which would be produced by mixing powdered lime with desalinated water in on-site water saturators. The carbon dioxide gas would react with the lime to form calcium bicarbonate, which could buffer the water (increase the resistance to changes in pH), increase hardness and reduce its general corrosiveness. Carbon dioxide and lime are currently commonly used in Australia for treating conventional drinking water supplies.

Once stabilised, the water would be chlorinated for disinfection water and to provide disinfection residual in the transfer infrastructure to minimise biofilm growth and mitigate the risk of recontamination. Fluoride would also be added if required.

Clear water storage

Large storages would be required on-site to store the desalinated water prior to distribution. The storages would be sized to provide approximately eight hours of plant production. For the Reference Project, each plant module would have its own clear water storage.

Pump infrastructure

Pumping water from the Desalination Plant to Cardinia Reservoir requires overcoming the following:

- static lift (i.e. the difference in height between the plant and Cardinia Reservoir)
- maintaining pressure requirements of Melbourne Water
- friction losses along the Transfer Pipeline.

Most pumping would occur via the transfer pump station located at the Desalination Plant site. At high flow rates, this would result in high pressures at the start of the pipeline. Therefore, a booster pump would be used along the alignment (as detailed in Chapter 2 of Volume 4 Transfer Pipeline) to assist pumping along the route and to reduce the maximum pressure the pipe would be required to handle.

The final size and requirements of the transfer pump station would be influenced by the requirements determined by Melbourne Water for pressures and flow at Cardinia Reservoir. The transfer pump station would incorporate surge tanks to mitigate water hammer.

2.3.2 Key Engineering Data

Table 2-1, Table 2-2 and Table 2-3 set out the key engineering data for the Plant Reference Project to illustrate scale and technological parameters. The values provided are consistent with a Project capacity of 150 GL per year.

Table 2-1 Approximate daily flows based on Reference Project

Plant capacity	ML/day	GL/year
Seawater feed	1 035	360
Concentrate	600	210
Water production	435	150

Table 2-2 Summary of key data for plant components based on Reference Project

Plant components	Key data for 150 GL/year plant
Modules	3 50 GL/year each
Pre-treatment screens	Aperture size 3 mm

Plant components	Key data for 150 GL/year plant
Pre-treatment filters	Filter Modules – 3 Filters per module – 14 Filter area – approximately 160 m^2 Building dimensions – 131 m long x 72 m wide x 13 m high (approximately)
Seawater pump station	Water lifted from approximately 5 m below sea level to 10 to 20 m above sea level
Reverse osmosis Desalination Plant	Number of first pass trains per module – 8 duty and 1 standby Number of second pass trains per module – 4 duty and 1 standby Number of membrane elements in pressure vessel – 7 Membrane element length – approximately 100 cm Membrane element diameter – approximately 20 cm Feed water pressure – up to 68 bar RO Building dimensions: 179m long x 70 m wide x 16m high
Clear water storage	Capacity – 48 ML for each module Height – 19 m (approximately) Diameter – 70 m
Transfer pump station	Number of pumps expected – 6 duty and 2 standby (Note: 8 duty and 2 standby required by 200 GL/y plant) Pump head 225 to 250 m Pump motor – 2.5 MW each Surge protection – 3 No. vertical surge tanks Building dimensions – 95 m long x 13 m wide x 7 m high (approximately) Power supply – 2 transformers at one end that take up 6 m length x 13 m width x 4 m height (approximately)

Plant components	Key data for 150 GL/year plant
Area required for construction and operation	Tunnel shafts – 1 to 2 ha Construction area – 20 to 40 ha (any additional area for accommodation will depend on the accommodation and housing strategy employed) Desalination Plant including Transfer pump station – 30 to 40 ha Spoil disposal onsite – 10 to 20 ha Total area required – 60 to 100 ha

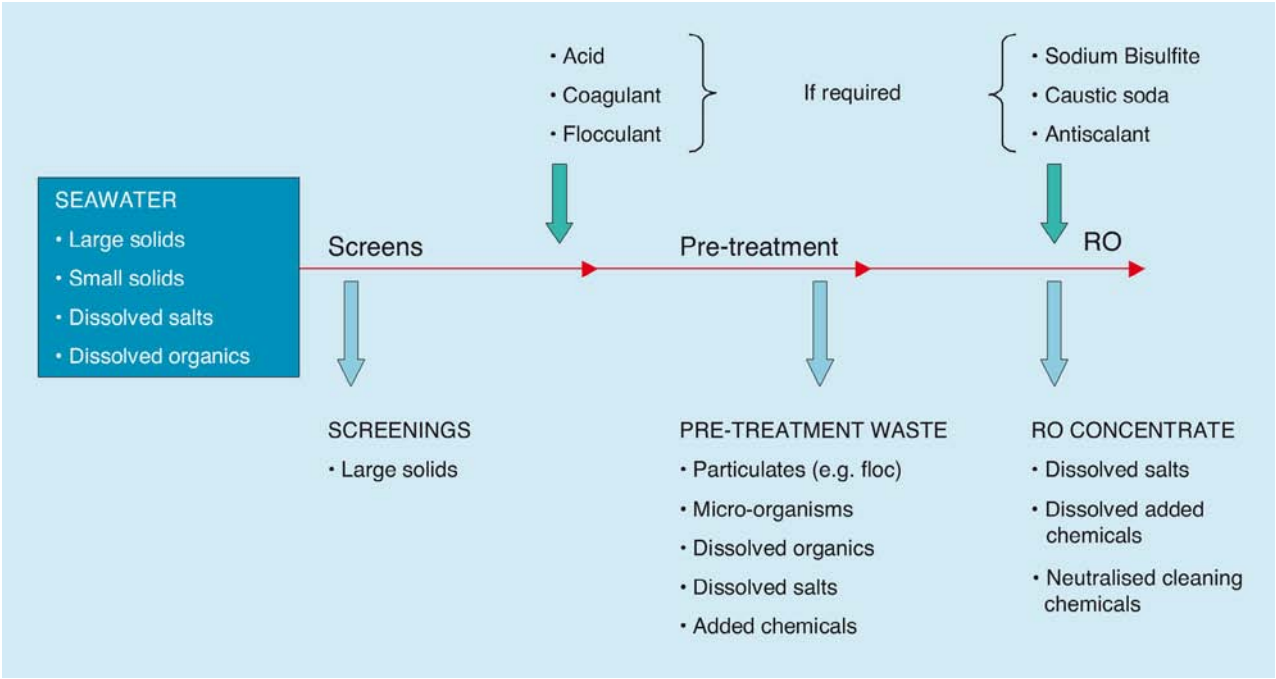
Table 2-3 Estimate of Seawater Reverse Osmosis (SWRO) concentrate composition based on Reference Project for 150 GL/year Plant

Parameter	Units	(SWRO) Concentrate
Flow	ML/day	600 to 700
Total dissolved solids (TDS)	mg/L	60 000 – 70 000
Chemicals such as Antiscalant	mg/L	0.1 to 3

2.3.3 Waste generation and disposal

In seawater reverse osmosis, seawater must be pre-treated to minimise membrane fouling. The pre-treatment processes remove suspended particles and dissolved organic molecules from seawater, and direct these into the waste stream. In the Reference Project the proposed washwater would be seawater and therefore this waste stream would be salty and contain both particulate contaminants such as sediment and micro-organisms, as well as dissolved metals (from seawater and added chemicals) and organic compounds. This is shown conceptually in Figure 2-15.

Figure 2-15 Waste streams and their composition



Screenings

'Screenings' is the collective term used for the sediment, debris and marine biota that would accumulate on the onshore intake screens. The likely volume of screenings would be determined by a range of variables including the intake location, seabed vegetation, intake velocity and sea conditions e.g. storms.

Based on the Reference Project, it is envisaged that the screenings would be transported by gravity from the top of the active travelling band screens via a sluice to the side of a wet well and collected in screenings baskets.

The screenings baskets would be raised from the bottom of the well to the surface using an overhead gantry crane. Given the potential for odours, the screenings would be stored in skips with airtight covers located in the screenings rooms until disposal. The air handling system for these rooms would have an activated carbon-filter system. The airtight cover to the skip would only be opened when all doors are closed to reduce any odour emissions to the pump station building. Buffer storage would be required to temporarily store skips with screenings while waiting for trucks to remove them from site to landfill.

The remainder of the screenings system located within the seawater pump station building, i.e. screens, sluice and screenings baskets would only contain fresh screenings where the potential for odour would be reduced.

Pre-treatment waste

The pre-treatment filters would be periodically cleaned to remove the filtered finer particulates to maintain effective and efficient operation. The approach for the Reference Project was that cleaning would be achieved by backwashing the filters with filtered seawater. Air would also be bubbled through the filter bed with the backwash water to remove solids. These solids would include the naturally occurring suspended matter in the seawater and material from the addition of the coagulant.

The solids in the backwash water would be separated out by thickening and dewatering.

Clarified water would be either returned to the head of the Plant or discharged to the outfall with the seawater concentrate. The solid sludge waste would be stored for off-site disposal at an appropriate EPA licensed landfill. This final waste sludge would be salty and contain iron from the ferric coagulant. It would have a reddish-brown colour owing to the iron content.

Antiscalants

Antiscalants would typically be used to protect and maintain membrane performance. They would assist in preventing precipitation of dissolved constituents onto the membranes. Antiscalants would be added to the seawater feed stream before processing through the RO membrane. The antiscalants would be rejected by the membranes and become constituents of the seawater concentrate stream to be discharged to the ocean.

Chemical cleaning of RO membranes

Over time, the RO membranes' permeability would be reduced due to fouling and scaling. Fouling and scaling would impair the system's performance by reducing the flux of water through the membranes at a given pressure. Fouling and scaling result in the need for higher pressures to generate the same water production and hence greater energy use.

The required cleaning frequency for RO membranes can vary from once every two years to four cleaning cycles per year. This frequency would be dependent on the seawater quality, the efficiency of the pre-treatment process and the antiscalants employed.

Possible cleaning and preservation chemicals include:

- caustic soda
- sodium bisulfite
- hydrochloric acid
- detergents
- biocides
- citric acid
- ammonia.

Cleaning occurs intermittently and these chemicals would not be used all at the same time. The amount and type of cleaning chemicals required would vary depending upon the degree of membrane fouling and the nature of the fouling.

At the completion of each clean, the wastewater would be sent to a neutralisation tank. The quantity of cleaning wastewater would depend on cleaning frequency. Once neutralised, the cleaning wastewater would be pumped under controlled conditions for disposal via the concentrate outfall, which is the approach adopted for the Perth and Sydney desalination plants.

Waste data

Table 2-4 sets out the estimated quantities of all types of waste, based on a 150 GL operation for the Reference Project.

Table 2-4 Anticipated waste generation based on Reference Project

Waste type/source	EPA classification	Approximate quantity for a 150 GL/yr project
Intake screen washings	Putrescible waste or prescribed industrial waste	Possibly up to several tonnes per day
Pre-treatment backwash sludge	To be determined based on final waste composition	20 to 100 m^3 per day of wet sludge (70-80 per cent seawater) depending on seawater quality and pre-treatment process
Seawater concentrate	To be determined based on final waste composition	600 to 700 ML/d depending on plant recovery
Lime sludge	Prescribed industrial waste	10 to 30 m^3 per day, depending on lime dose and centrifuge performance

Policy favours the recycling or reuse of waste where possible. Potential reuse and recycling applications that were considered for the pre-treatment waste in the evolution of the Reference Project included:

- acid treatment of the sludge to regenerate a lower grade coagulant (e.g. ferric chloride or ferrous sulfate) which could be directly recycled at the desalination plant through use as a supplement to the primary coagulant
- use the sludge as a raw material to produce other useful chemicals for off-site use (e.g. manufacture of an iron-based catalyst for arsenic removal from contaminated water)
- blending into cement kiln feed for mineral value
- blending (e.g. with soil, compost and/or sewage sludge) to form a beneficial soil additive

- use as landfill cover
- use of ferric hydroxide for phosphate removal in wastewater treatment (for eutrophication control)
- use as construction materials or additives
- energy recovery.

However, whilst some of these reuse options were considered to be technically feasible, no clear market opportunities were identified for the raw product considering the scale of the project and the costs and logistics involved in converting the waste to secondary product. It is considered unlikely that the Project Company would find this commercially attractive. Reuse and recycling opportunities are expected to develop over the Project life.

Further discussion of the waste streams and process for managing them is set out in Volume 1, Chapter 10 (for pre-treatment waste) and Volume 2, Chapters 2 (for saline concentrate).

2.3.4 Plant Design and landscaping

Consistent with the modular approach to engineering, the site layout for the Reference Project would include the major process buildings and storage tanks in three modules. The treatment plant, including some pumps and plant components, would be housed in buildings to protect equipment, to provide a suitable environment for operators and to reduce the noise levels at the Plant boundary.

An indicative architectural perspective of the Plant layout in Figure 2-16 reflects simple engineering design of buildings for the Reference Project and the built form prior to any visual amenity improvements.

Figure 2-16 Indicative built form architectural rendering



Landscaping is proposed to assist in blending the structures with the surrounding environment. Figure 2-17 indicates a possible landscape concept for the Reference Project utilising four different landscape types. The design also reflects the key objectives adopted for the Reference Project as set out in Table 2-5. These are:

1. adjacent to coastal dunes: featuring coastal banksias and dune scrublands
2. wetland/saltmarsh: planting is consistent with existing species
3. pasture: undulating cleared farmland
4. estuarine species: planted with indigenous plant species.

Figure 2-17 Indicative landscape concept



The design also reflects the key objectives adopted for the Reference Project as set out in Table 2-5.

Table 2-5 Plant layout – key objectives and approach adopted in Reference Project

Objective	Approach adopted
Allow for rapid and staged construction	Provision of corridors between buildings for equipment access Location of tunnels away from plant to permit concurrent construction
Minimise earthworks	Benching of site with two levels to match existing site contours Selection of RL 8 m minimum bench level to conform to existing site contours and avoid excavation of possible rock at RL 4 - 5 m
Minimise tunnel length	Location of inlet and outlet on western plant boundary (closest to ocean)

Objective	Approach adopted
Minimise power distribution losses	Location of site switchyard close to major power consumers (treated water pump station and RO buildings) Site switchyard also located away from entrance to minimise visual impact
Minimise settlement	Benching of site, with plant located on cut surface
Minimise pumping	Grouping of assets on 2 No. benches to allow gravity flow through the system where possible
Minimise piping	Central pipe corridor to allow common overflow and concentrate from plant modules
Minimise chemical safety risk	Provision of emergency access route Centralisation of potabilisation chemicals in one location Location of chlorine storage at lowest point of plant site away from boundary
Dispose of spoil on-site	Use of spoil to construct earthen wall along northern boundary of plant Earthen wall to act as visual screen and noise barrier for nearby sensitive receptors
Control truck movement	Location of administration building near truck entrance Separation of access routes for trucks and visitors
Minimise noise output	Location of major noise-producing equipment (such as RO pumps and treated water pumps) inside buildings with acoustic control
Maintain access	Maintain emergency access from Mouth of Powlett River Road to Lower Powlett Road. Integrate shared path into facility. Maintain access to Williamsons Beach car park.

Power supply

The Reference Project would include a power terminal station located on-site to step down the transmission voltage from the incoming high voltage supply so that the power would be suitable for distribution to load centres around the site. Refer to Volume 5 of this EES for more information on Power Supply.

Lighting

Lighting design at the plant site would be required to achieve the minimum task and energy requirement of:

- the Building Code of Australia (BCA)
- Australian Standard (AS) 1680 (Interior Lighting: General Principals and Recommendations)

- AS 2293 (Emergency Evacuation Lighting for Buildings –System Design Installation and Operations).

This is in addition to the functional, environmental and aesthetic objectives of the Project.

The Reference Project proposes limited external lighting outside the site boundary. However, lighting bollards and low-level external lights in areas of public access would be required, particularly at site access points.

Shaded streetlights (about one every 30 metres — refer AS 1680) would be provided around the major roads within the site. These would generally be located on or at a similar level to the architectural wall surrounding the Plant to reduce spot intensity.

If adopted, feature lighting would generally be contained within the internal landscape of the office and administration area. The Reference Project allows for highlights to the wetlands, site office and amenities features.

Buildings would have individual internal lighting schemes to achieve high intensity task lighting for Plant operations and emergency lighting to meet BCA Section J and AS 1680. Consideration shall be given to the energy usage and maintenance of light fixtures in the design.

Emergency lighting would be provided in compliance with the BCA and AS 2293. This would include:

- battery assisted permanent lighting
- exit and hazard identification
- lighting activated for duration of emergency event.

Stormwater and rainwater harvesting

The Desalination Plant in the Reference Project includes roof space and impervious surfaces that will generate significant rainfall runoff during storm events. This does not constitute a water use, but presents an opportunity to capture some of this water for re-use in the Plant as an alternative to desalinated or mains water. There are opportunities to use harvested stormwater in plant operations, site maintenance and fire water supplement. The Reference Project adopts a stormwater treatment train with the following components:

- an in-line trap would remove likely pollutants from the site such as oil, grease and hydrocarbons (a Humes' Humeceptor™ or equivalent)
- a sedimentation basin (or trap) would remove coarser sediments
- a wetland system would remove finer sediments and absorbed/dissolved pollutants (i.e. nutrients and metals).

In the Reference Project, as the two sides of the Plant would be virtually identical, the stormwater system is designed to have two identical treatment trains to improve the quality of runoff from the site. The treated runoff would be discharged to the Powlett River through flow channels, constructed with additional channel lining where necessary to prevent erosion of the natural surface.

A ridge at roughly the centre of the south-western Plant edge separates the proposed site drainage paths. Overland flows entering the proposed drainage path north of this ridge would be diverted around the northern edge of the Plant. Similarly, overland flows entering to the south of this ridge would be diverted in a separate drainage path around the southern edge of the Plant.

The Reference Project incorporates stormwater infrastructure as an integrated landscape feature within the overall site design. The wetland system would ensure that alterations to surface flow paths and absorption resulting from the construction and operation of the Plant and would not adversely affect the receiving waters of the Powlett River.

Visual profile

The Reference Project adopts a number of assumptions to achieve visual profiles for the Plant components that would minimise their visual impact on the surrounding area. These are set out in Table 2-6 below.

Table 2-6 Key assumptions for Reference Project

Plant aspect	Key assumption for visual profile
Plant location	Generally as close to the ocean as possible
Excavation	Excavation of topsoil to 12 m AHD for pre-treatment plant and 8 m AHD for reverse osmosis building and clear water storage tanks
Relative building heights (AHD)	Pre-treatment building: 25 m AHD Filtered seawater tank: 17 m AHD (at apex) RO building: 24 m AHD Clear water storage tank: 27 m AHD (at apex)
Building dimensions	Pre-treatment building: 131 m long x 72 m wide x 12 high Filtered seawater tank: 40 diameter x 9 m high RO building: 179 m long x 70 m wide x 16 m high Clear water storage tank: 70 diameter x 19 m high
Pump Stations	Building dimensions: 95 m long x 13 m wide x 7 m high, Power supply for pump station: 2 transformers at one end that take up 6 m length x 12 m width x 4 m height
Surge Tanks/Vessels (at transfer pump station)	Transfer pump station: 3 Dimensions: 3.5 m diameter x 6 m tall

Water use

During operation all water used on-site (for the Plant processes and for amenities and offices) would be sourced from the Plant itself. There would be a small connection to the Wonthaggi supply for essential uses (such as offices and amenities supply) that may be utilised in cases of Plant shutdown.

Noise

During operation noise would be generated by equipment as well as other standard sources. Most noise generating equipment that would be likely to be required during standard operation is listed in Table 2-7.

Table 2-7 Plant equipment for reference project

Plant aspect	Equipment
Seawater pump station	Seawater pump
	Screen drive
	Screen washwater booster pumps
Pre-treatment system	Coagulation basin mixer
	Flocculation basin mixer
	Backwash pump
	Backwash air blower
	Building ventilation
Reverse osmosis system	Feed booster pump RO
	Feed booster pump ERD
	HP pump 1st pass
	ERD booster pump
	Feed pump 2nd pass
	RO building ventilation
	Flushing pumps
	CIP pumps
Potabilisation system	Permeate pump
	Lime screw conveyor
	Lime slurry tank mixer
	Lime slurry pump
	Lime saturator mixer
	Lime water pump

Plant aspect	Equipment
	Lime sludge pump
	Lime sludge holding tank mixer
	Centrifuge decanter feed pump
	Centrifuge decanter
	Centrate pump
Treated water transfer pump station	Treated water transfer pump (plant site)
Wastewater treatment system	Feed pump
	Pre-treatment tank mixer
	Lamella clarifier mixer
	Clarified water return pump
	Thickener feed pump
	Thickener mixer
	Thickened sludge transfer
	Sludge holding tank mixer
	Plate press feed pump
	Plate press

2.4 Plant construction

Construction and commissioning of the Plant would occur over approximately a two year period to the end of 2011. Major construction activities would include:

- excavation of the shafts and tunnels
- general earthworks (including topsoil stripping, excavation, filling, topsoil spreading and rehabilitation works)
- building construction
- drainage installation (including, where required, measures to protect water quality and groundwater flows)
- power connection

- equipment fabrication and installation
- incidental vegetation clearance.

These activities would conclude with commissioning of the Plant, reinstatement of the site, visual screening and landscaping.

Construction activities would be likely to have noise, visual and vibration impacts from welding, building construction, construction machinery, a potential concrete batching plant and the likely presence of multiple large cranes.

One of the benefits of the Plant modular design is that the modules could be constructed in parallel and thus reduce the timeframe; although this may require greater area for construction and an increase in equipment, personnel and noise during construction.

Earthworks

Earthworks would include:

- excavation of the shaft and tunnels
- removal (and replacement) of topsoil over the Plant and construction area
- excavation of Plant site to achieve the required bench levels for each Plant component.

Bench levels would be influenced by several factors including building height and visual impact, geotechnical conditions (including presence of rock), flood level, hydraulic considerations within the Plant and cost of excavation. Figure 2-18 shows examples of the earthworks equipment required.

Figure 2-18 Tunnel-boring machine and earth moving equipment



Source: Lovat website

The Reference Project assumes that some of the volume of earth moved would be reused once construction is complete to reinstate the site. Management of excess spoil may include trucking this from site to an alternative location or incorporating the spoil in the existing site. Excess spoil could be used to create a vegetated visual and noise barrier.

Water use

During construction, water would be required for a number of uses, including personnel use, dust suppression, concrete batching and other uses. Some of these uses are less dependent on water quality than other uses. The source of construction water is unknown at this stage but would likely be from local supply for processes having occupational health and safety implications. The precise nature of any connection would be subject to approval from the relevant water authority and considerations of local amenity.

Power and lighting

Temporary power supply to the site for lighting, heating and machinery would be required during construction.

SP AusNet would connect local power to the site, however the existing power supply in the region may not have sufficient capacity during peak periods. An alternative on-site source of construction power will be required, and potential options include the use of diesel generators. The construction power requirements are discussed further in Volume 5, Chapter 2 of this EES.

Throughout construction and commissioning, lighting would be provided for safety and task lighting. This may occur 24 hours per day, seven days per week during this time.

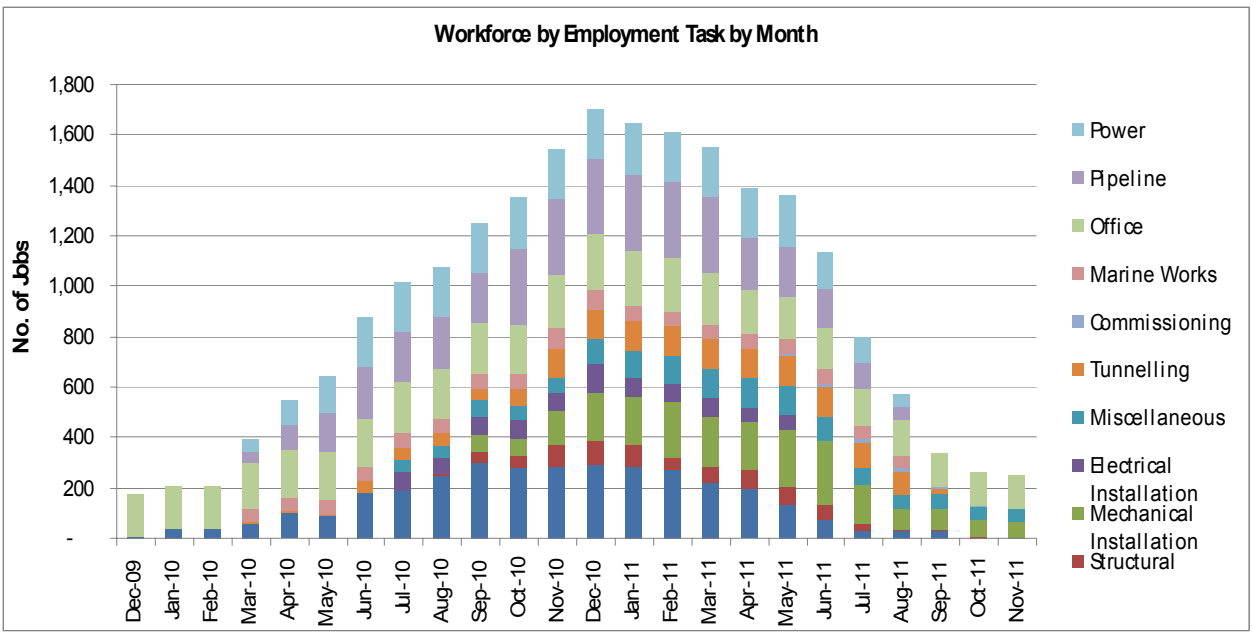
Construction workforce and site amenities

A variable workforce would attend the site throughout the investigation and construction period, with the maximum amount of people on-site during construction of the main Plant components. Site amenities would be required to support the workforce including offices, meeting rooms, showers and toilets, car parking and catering.

Estimated requirements

Figure 2-19 sets out the possible personnel according to employment task per month.

Figure 2-19 Construction workforces according to employment task



Construction traffic

During construction the following activities may increase volumes of traffic:

- 50 to 150 truck movements per day for delivering and removing materials from site (assuming, as planned, that spoil is managed on-site)
- construction worker vehicles entering and leaving the site
- tipper trucks entering and leaving the site removing topsoil and debris
- heavy vehicle carriers delivering the mobile plant at the start and end of construction.

A number of local road upgrades have been proposed to manage the increase in traffic volume and minimise the impact on the community. These include sealing roads with significant traffic increases such as Lower Powlett Road and widening roads to allow trucks to make appropriate turns at intersections, particularly the intersection of Lower Powlett Road with the Bass Highway.

The Lower Powlett Road is currently used for public access to the beach. It is likely that a new road to the beach would need to be constructed to allow public access to the beach and the current beach car park. The current road layout relative to the Plant site is presented in Figure 2-3.

Construction waste

Construction of the Plant would generate waste materials including seepage from showers and toilets, food wastes, plastics and packaging materials, spoil from earth works, garden wastes, office wastes, vehicle wash water and other wastewater and stormwater.

Table 2-8 sets out the estimated volumes of construction waste and its likely classification. Management of these waste streams is discussed in detail in Volume 1, Chapter 10.

Table 2-8 Anticipated waste generation based on Reference Project

Waste type/source	EPA classification	Approximate quantity for a 150 GL/yr project
Construction spoil (tunnels and site)	Depending on geological material encountered either fill material, waste ASS or prescribed industrial waste (bentonite slurry only)	1 000 000 to 1 500 000 bulked m^3 depending on final bench levels for plant and construction areas – expected to be reused on-site.
Construction spoil (marine construction activities)	Geotechnical data required to determine classification	Rock quantity from inlet and outlet risers – 600 m^3 approx (based on nominal depth risers at 20 m deep)
Wastes and contaminated soils encountered during construction	Depending on waste encountered either solid inert waste, putrescible waste, prescribed industrial waste or prescribed waste, acid sulfate soils (contaminated soils)	Likely to be minor but may be significant if large areas of contaminated soil encountered
General construction wastes	Solid inert waste, putrescible waste or prescribed industrial waste	Will be similar to other construction sites
Construction camp and office waste	Solid inert waste, putrescible waste or prescribed industrial waste	Dependent on accommodation strategy but approximately 600 to 700 t of domestic solid waste and about 150 m^3 per day of domestic wastewater for much of the construction period expected to be in the order of 2 years

2.5 Commissioning

Commissioning of the Plant would be dependent on the completion of the intake structures to provide a constant seawater flow and the outlet structures to provide for concentrate disposal. The Plant is likely to be started and commissioned in separate stages. Commissioning of the Plant would in turn provide water to allow commissioning of the Transfer Pipeline.

2.6 Operation

In the Reference Project, the Plant was designed to operate at a constant rate, 24 hours per day. This would require 24 hour operator attendance and regular delivery of consumables. The Reference Project would be modular and each module designed to operate independently.

The Project Company may adopt a different approach to operating the desalination plant.

2.6.1 Operating Regime

The Reference Project operating regime is based on the following:

- ordering of water on an annual basis, with the ability to order anywhere from 0% to 100% of the Plant's output
- as Cardinia Reservoir provides storage for the desalinated water, it would be possible for the plant to stop operation on any day without causing supply disruptions. This would reduce the need for redundancy and storage at the plant
- the plant may change production volume from time to time as required to meet overall system demands
- the plant may be expanded to 200 GL per year in the future
- minimum and maximum pressure and surge requirements guide design of the transfer pipeline and pumping
- treated water quality targets will apply at the connection point to Melbourne's water supply system.

2.6.2 Desalination Plant

Modern desalination plants have a high degree of automation, with most processes being fully automated. Analysers and sensors throughout the process monitor a range of parameters, feeding signals into the plant control system.

Pre-treatment

In the Reference Project, the pre-treatment process was designed and operated to condition the seawater to ensure it is of suitable quality for downstream desalination through the reverse osmosis plant. Acid, coagulant and flocculant would be dosed automatically to achieve effective coagulation of particulate matter in the seawater before the dosed water would be filtered through dual media filters. Filtered seawater would be collected in the filtered seawater tank ready for desalination through the reverse osmosis plant.

Over time, material would build up on the filters and they require backwashing to removal accumulated material and to maintain the performance of the pre-treatment process. Filters would typically require backwashing every 12-48 hours depending on seawater quality. In the Reference Project, each module would have multiple filters operating in parallel and backwashing of individual filters occurs in a sequential manner to maintain overall flow to the reverse osmosis plant.

Reverse Osmosis (RO) Plant

The Reference Project includes provision for a two-pass reverse osmosis process to achieve the treated water targets. Each module in the Reference Project would be made up of multiple RO trains operating in parallel. Ramping the plant production up and down could be achieved by bringing individual trains on or offline within each module or changing how many plant modules are online.

Feed water to the RO membranes would be dosed with antiscalant and sodium bisulphite to improve performance and protect the membranes. Caustic soda would also be added prior to the second pass to raise pH for process reasons to meet the treated water quality targets.

RO membranes require cleaning to maintain performance. This can vary from three cleaning cycles per year, to once every two years, depending on seawater quality and the approach adopted. Typically individual RO trains would be taken offline for cleaning in a sequential manner to maintain overall plant production.

Potabilisation

Potabilisation of the desalinated water is required to stabilise the water and provide a disinfection residual. The Reference Project includes dosing with lime water, carbon dioxide, chlorine and possibly fluorosilicic acid. Each chemical would be dosed on a flow based system to meet the treated water quality targets.

Transfer System

A transfer pump station and booster pump station will pump the treated water along the transfer pipeline to Melbourne's water supply system. The pump stations and pipeline will operate 24 hours per day during plant operation.

Plant Shutdown

From time to time and to meet fluctuations in system demand, the desalination plant or individual modules may require short-term shutdown of production or mothballing for more extended periods. In these cases, ongoing maintenance would still be required to:

- maintain equipment
- preserve reverse osmosis membranes
- facilitate recommissioning after shutdown.

2.7 Expansion of the Project

Expansion of the Project from 150 GL per year to the ultimate capacity of 200 GL per year would require construction of a fourth 50 GL per year module similar to the existing three modules along with additional interconnecting and shared infrastructure. The expansion would include:

- filtration pre-treatment component
- filtered seawater tank
- additional pre-treatment wastewater infrastructure
- cartridge filters and feed booster pump station
- RO component, including first and second pass RO membranes and intermediate storage
- additional RO clean in place infrastructure
- permeate storage tank and pumps within the existing shared pump station
- additional potabilisation systems for lime, carbon dioxide, chlorine and fluoride dosing
- clear water storage

- expansion of the main electrical substation
- additional miscellaneous and interconnecting infrastructure such as roads, pipework, chemical dosing, monitoring, control and power distribution systems.

Expansion of the plant is not planned at this stage.

2.8 Decommissioning

In the context of a PPP procurement where the form of the Project is uncertain, it is impractical to consider the implications of decommissioning other than in the broadest sense. Project infrastructure will have a design life of at least 30 years. There are standard decommissioning procedures employed in the water and gas industries in respect of buried pipe, which entail filling and sealing off the pipe ends and leaving the pipe in situ. Similarly, with the Marine Structures, while it is expected that above seafloor pipe, heads and risers would be removed at decommissioning, infrastructure in the sub-strata will be filled, sealed and made safe in accordance with accepted practice in relation to other marine infrastructure. Decommissioning of above-ground electricity infrastructure, if it occurs, will take place in accordance with the asset management practices of the relevant electricity generation company. In terms of the Desalination Plant, it is difficult to predict the further asset life of the plant or its capacity for adaptation or re-use. As with water treatment plants and power station infrastructure generally, the asset would be made secure and safe, with active components removed and disposed of or re-cycled. Demolition would most likely only occur in the context of an alternative, practicable use of the site necessitating demolition and justifying its cost.

2.9 Variations

Two variations to the Reference Project being contemplated are:

- additional clarification processes (such as Dissolved Air Flotation (DAF))
- membrane filtration.

Emissions to the environment from additional stages of clarification such as DAF, are not expected to differ from that of the filtration process. The Works Approval Application makes a detailed comparison of media and membrane filtration technologies. Emissions to the environment associated with both technologies are comparable, and as such a separate environmental assessment is not considered necessary.

2.9.1 Additional clarification processes including Dissolved Air Flotation

In the pre-treatment process, additional stages of clarification upstream of the filtration process may be contemplated by the Project Company depending on its design process. This clarification may involve the use of a Dissolved Air Flotation (DAF) unit which removes the bulk of the suspended solids by using air to float them to the surface of the backwash water. Alternative clarification processes such as sedimentation are also probable.

2.9.2 Membrane filtration

Membrane filtration could be used in place of conventional filtration to remove solid particles from seawater prior to the RO process.

Membrane pre-treatment relies on surface removal (straining) of particles whose diameter is larger than the diameter of the membrane pore spaces. Particles within a specified size range would be consistently removed, regardless of seawater quality.

Several different membrane filtration alternatives are available, depending upon pore size and operating pressure including:

- Ultrafiltration (UF): 0.02 – 0.2 µm
- Microfiltration (MF): <0.2 – 4.0 µm (Note that 1 µm = 0.001 mm)

Membrane pre-treatment is sometimes presented as environmentally and financially preferable compared to a conventional approach. However, closer inspection reveals that this would dependent on the number of project-specific factors and type of conventional processes to which the membrane option is compared. The applicability and relevance of advantages cited elsewhere for membrane pre-treatment (e.g. smaller footprint, lower coagulant dose, higher RO flux rate) are not always directly transferable in the context of a plant at Wonthaggi, in Victoria.

Greater consistency in RO feed water quality is reported for membrane pre-treatment, though conventional approaches meet RO feed requirements at the majority of plants around the world (operator experience overcoming difficulties in adapting to variable seawater quality conditions). An increase in RO flux rate is also reported as an advantage made possible by membrane pre-treatment. The extent of this advantage would need pilot testing to verify, and may not outweigh other factors.

Preliminary Net Present Cost and life cycle assessment studies indicate that energy consumption would be the largest contributing factor to environmental load (carbon footprint) and overall cost. Feed water quality would determine whether conventional pre-treatment is less energy intensive than membrane pre-treatment. Reduced coagulant use (associated with membrane pre-treatment) realises marginal cost savings in comparison to overall cost and uncertainty associated with these estimates. Furthermore, savings incurred via reduced coagulant dosing (for membrane pre-treatment) must be offset against increased use of membrane cleaning chemicals required to prevent fouling under this option. Avoidance of coagulation is rarely reported at full-scale RO plants, and can cause increased fouling of RO membranes and therefore may not be possible for the Wonthaggi plant, regardless of pre-treatment choice.

Given this, the limited global application of membrane filtration technology and the lack of long-term experience at this scale, membrane filtration of the pre-treatment stream was not included within the Reference Project. However, membrane filtration is considered to be an acceptable technology that has similar environmental impacts and is therefore included within the scope of this EES.

2.10 Options

The disposal of pre-treatment backwash with the concentrate stream to the ocean is identified as an Option to the Project. It is anticipated that some of this investigation work and analysis for this Option would need to be undertaken by the Project Company as part of a subsequent EPA Works Approval process under the EP Act.

2.11 Concepts outside scope of EES

Alternative methods for re-use/disposal of concentrate

Alternative methods for re-use/disposal of the concentrate considered during development of the Reference Project are summarised in Table 2-9 and discussed below.

Table 2-9 Options for the disposal of concentrate

Option	Description	Reason for exclusion from EES
Evaporation - ponds	Conventional/solar – using heat from the sun to evaporate the water, leaving salt crystals behind. The salt crystals can either be harvested for use in industry or be disposed to landfill	Evaporation ponds are used elsewhere in Melbourne region for salt production. Non-viability of this concept is due to Wonthaggi climate conditions.
Evaporation - mechanical	Mechanical – mechanical evaporators use energy (e.g. steam, electricity) to evaporate the water and recover salt	Potentially a feasible Option technologically, but high-energy consumption. There is no clear market for salt given large quantities and composition
Direct to sea - channel	Sea channel – constructing a concrete or earthen channel from the desalination plant through the dunes and beach to the sea	Does not meet environmental objectives to protect beneficial uses of the coastal environment
Direct to sea - existing infrastructure	Combine with wastewater outfall – the existing Wonthaggi Outfall located south east of the proposed treatment plant could be used as a means of disposing of the concentrate. The seawater concentrate could be piped or channelled in order to intercept the outfall	Not feasible — capacity of the existing outfall is not sufficient by more than two orders of magnitude.

Option	Description	Reason for exclusion from EES
Irrigation	Livestock irrigation – using the concentrate as a source of water for livestock Spray irrigation – using the concentrate to irrigate salinity tolerant crops or ornamental plants (e.g. lawns, parks, golf courses) (WHO 2007)	Not feasible — salinity level not suitable for land application
Well injection	Deep well injection – disposing the concentrate in wells drilled deep into formations that are well isolated from potential potable water aquifers Beach well injection – similar to deep well injection, the concentrate would be disposed to wells located at or near the shoreline	Local Aquifers are not suitable – not viable for the scale of the project.

Evaporation – ponds

Evaporation ponds are large, shallow reservoirs where seawater concentrate waste from desalination plants can be discharged. They are typically lined with a thin layer of plastic to prevent salt seepage into underground aquifers. As liquid is evaporated, a thin layer of salt crystals is typically left behind. This can be left in the reservoir, collected for another use (e.g. salt harvesting) or collected and disposed to a landfill.

For the installation of an evaporation pond, certain criteria must be considered including:

- climatic conditions including evaporation, rainfall and net evaporation
- construction requirements (e.g. excavation and compacting of soil)
- land requirements (e.g. net evaporation rate, local ambient temperature, humidity and water salinity)
- environmental and social impact (e.g. impact on land, wildlife and aquifers, including on any future development)
- technical feasibility.

The area required for an evaporation pond is proportional to the inflow volume and inversely proportional to the 'net evaporation less rainfall'. The climatic conditions at Wonthaggi mean that it is not practicable to evaporate the concentrate. Consequently, the Wonthaggi region is not considered suitable for evaporation ponds.

Evaporation – mechanical

Mechanical evaporation would use machines (as opposed to evaporation ponds) to produce zero liquid discharge.

Mechanical evaporators vary in size and cost, depending upon the capacity required, and are typically housed in buildings. Unlike evaporation ponds, mechanical evaporators do not require a large amount of space, but do require substantial amounts of energy for operation.

Given the high-energy requirements of the mechanical evaporators, this has not been considered a viable Option.

Direct to sea – channel

A common form of disposal for large desalination plants in the Middle East is direct disposal of concentrate to the ocean via open channel. However, this method does not meet the Project Requirement to protect coastal integrity by avoiding surface disturbance of the dune system, beach and intertidal zone. Further, it would not provide controlled dilution of the concentrate stream.

Direct to sea – existing infrastructure

The existing Wonthaggi Outfall with a capacity of three megalitres per day does not have sufficient capacity to accommodate the volume of concentrate (600 ML/day). In addition, the concentrate would need to be piped or channelled in order to intercept the outfall.

Livestock irrigation

Unlike humans, livestock are able to consume water with higher salinity in drinking water – salt concentrations of up to 6 000 mg/L. However, the estimated TDS concentration in the concentrate is approximately ten times this amount. Therefore, the concentrate could not be consumed directly by livestock and would require significant dilution with fresh water.

The use of the concentrate as a source of drinking water for livestock is not considered to be a viable Option.

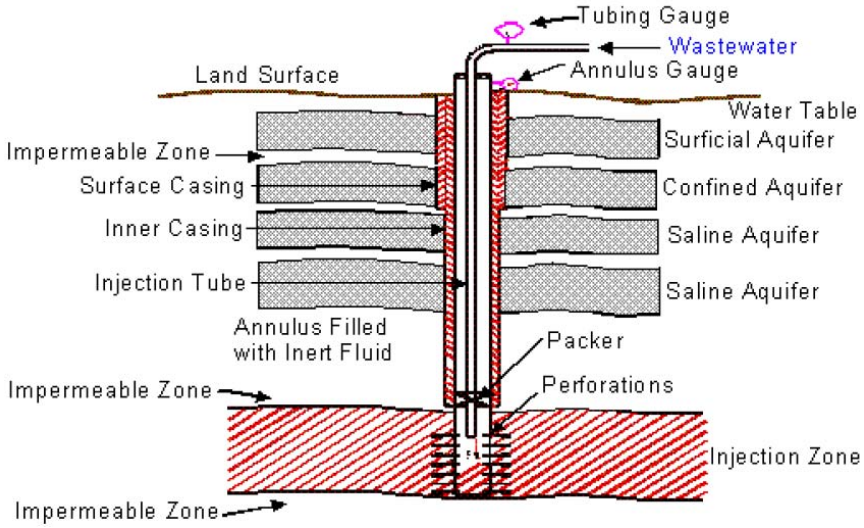
Spray irrigation

The use of the concentrate to irrigate salinity tolerant crops or parks is not viable because the salinity levels are unsuitable for land application.

Well injection

Deep well injection involves the disposal of liquid wastes underground, typically using abandoned wells drilled deep into the underground rock formation. See Figure 2-20 for a typical well configuration for deep well injection.

Figure 2-20 Well configuration for deep well injection



Source: http://web.deu.edu.tr/atiksu/ana58/deepwell.html

Extensive geological research must be conducted to determine whether or not a formation is suitable to receive injected waters and to determine its connectivity to existing nearby groundwater aquifers. Currently, Victorian groundwater guidelines require that any wastewaters being disposed via backfilling of underground mine workings or a bore must not degrade the water quality of an existing aquifer.

There is currently an abandoned coalmine in the vicinity of the Desalination Plant. However, using this location would result in a substantial increase in the salinity of the connected aquifer and eliminate any potential future beneficial use. Further, injection or storing of the seawater concentrate underground may also cause environmental impacts, which are difficult to quantify. Therefore, underground seawater concentrate disposal is not considered a viable solution.

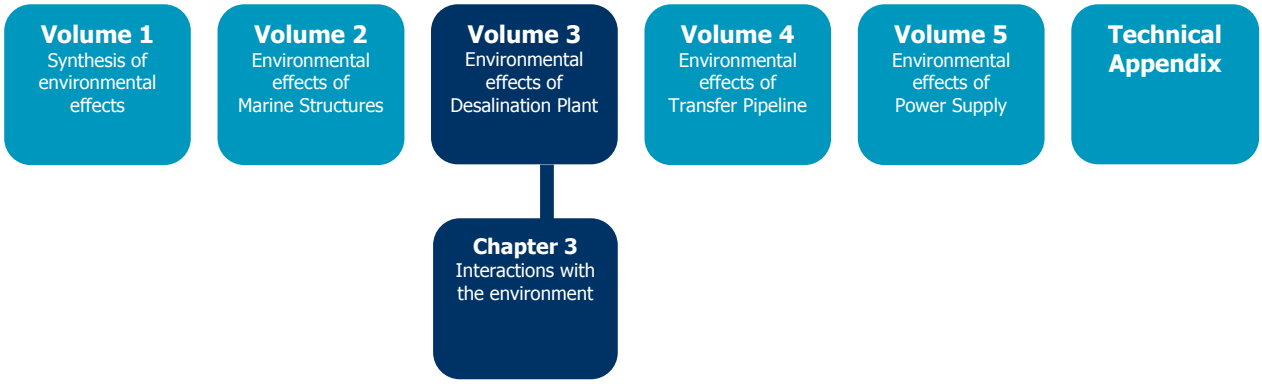
In addition, the quantity significantly exceeds the void space in the mines.

2.12 Conclusion

With the exception of the two elements that are 'outside scope', the above description of the Reference Project and Variations forms the basis of the approval sought by this EES.

3.0 Interactions with the environment





3 Interactions with the environment

This chapter characterises the physical and ecological features of the environment and how construction and operation of the Plant may interact with these features through a variety of causal pathways. This chapter explains how the risk assessment and impact assessment methodologies for the EES are based on analysis of these pathways.

3.1 Characterisation of the terrestrial environment

The Plant site is located between the Wonthaggi and Kilcunda in South Gippsland. The site is approximately 90 kilometres south-east of Melbourne, and covers 264 hectares. There are a number of different environments within the plant site, including:

- agricultural land
- the Powlett River and tributary
- coastal dunes
- Williamsons Beach.

3.1.1 Plant site

The Plant site is generally agricultural land, which has historically been used for grazing. A number of small remnant native vegetation patches remain within the farmed land. These patches contain a low diversity of indigenous species and a high weed cover. These patches of vegetation may act as 'stepping stones' between habitats for a number of bird species and possibly small mammal species. Prolonged agricultural use is the likely cause of the high incidence of introduced vegetation and weed species.

There are also a number of damp depressions on the site that provide habitat for native species. In addition to these damp depressions, there are a few farm dams scattered across the site. The farm dams may provide habitat for some bird and frog species, but they are not ecologically important because they are isolated from other water bodies and lack fringing aquatic vegetation.

A disused mineshaft from previous coal mining activities is located in the northern section of the site. Mining activities stopped in 1968 and the mine remains disused. In the surrounding area, there are buildings close to the Plant site, including the Powlett River Caravan Park and a number of tourist cottages. Lower Powlett Road and Mouth of Powlett Road provide road access to the plant site from Bass Highway. Lower Powlett Road also provides access to Williamsons Beach and a number of residential properties.



3.1.2 Powlett River and tributary

The Powlett River opens to Bass Strait less than one kilometre to the north-west of the Plant site. The Powlett River begins as several tributaries to the north-northeast of the Bass Highway.

An unnamed tributary of the Powlett River crosses the north-eastern perimeter of the plant site. This tributary is a small, slow flowing ephemeral creek that flows into the lower reaches of the Powlett River. Upstream of the Plant site there are deeper pools that do not completely dry out. Various migratory and freshwater fish may use these pools for habitat during summer months.

3.1.3 Coastal dunes

The coastal dune and adjacent foreshore run adjacent to the Plant site along Williamsons Beach. The crests of the dunes reach elevations of up to 20 metres. The vegetation on the dunes comprises mainly native coastal scrub species interspersed with weed species. Agricultural grazing has not extended into the dunes therefore this habitat is relatively undisturbed. This native vegetation is likely to provide habitat for a number of native animal species including small mammals and reptiles. In the past, local Aboriginal people used the coastal dunes; activity is evident by recorded culturally-significant, coastal-midden sites in the dunes.

3.1.4 Williamsons Beach

Williamsons Beach lies adjacent to the dunes and Bass Strait. This section of coastline is high energy and the beach is exposed to strong onshore winds. During low tide areas of rocks and reefs become exposed along the beach. The beach provides habitat and breeding area for various bird species, including species protected under the *Flora and Fauna Guarantee Act 1988* (Vic). Walkers with dogs can impact vegetation on Williamsons Beach and native fauna are under threat from red foxes that also inhabit this area.

Dinosaur fossils have been found in rocks in a stretch of coast between Kilcunda and Inverloch. Fossilised remains (bones, teeth and vertebrae) of dinosaurs and marine reptiles have reportedly been found in a rock shelf at the mouth of the Powlett River, to the west of the site, and at other locations on the coast near the site. Other fossils, including fish, insects and feathers have also been uncovered in this area.

3.2 Impact pathways for risk and impact assessment

The Project activities may affect environmental values through a variety of impact pathways. A single action or activity may have a number of impact pathways, for example dewatering of excavation which alters groundwater tables may affect native flora and fauna, surface water, and groundwater users. The risk assessment and impact assessment methodologies adopted for the EES are based on an analysis of the impact pathways.

3.3 Risk Assessment

The risk assessment process, as a framework for the impact assessment, is described in detail in Volume 1, Chapter 5 and in the Risk Assessment report (Maunsell 2008$_1$, Technical Appendix 6). The risk assessment process relevant to the Project component has been applied across all EES assessment areas with the exception of visual assessment. The visual assessment adopts a location-specific sensitivity analysis for assessment of impacts which is considered more appropriate than the risk framework for this specialism.

The risk assessment process identifies the impact pathways associated with each Project activity and assigns a consequence rating to the impact if it materialised. The next step is to consider and assign a rating to the likelihood of that impact occurring. The combination of consequence and likelihood is the risk rating, using the matrix in Table 3-1.

Table 3-1 Risk Assessment Matrix

Likelihood	**Consequence**				
	Negligible	Minor	Moderate	Major	Extreme
Rare	Low	Low	Low	Medium	High
Unlikely	Low	Low	Medium	Medium	High
Likely	Low	Medium	Medium	High	High
Almost certain	Medium	Medium	High	High	Critical
Certain	Medium	Medium	High	Critical	Critical

The effect of applying the risk matrix is that a risk that is rare but would have an extreme consequence it if did occur is allocated a high risk rating. A risk that is certain and has only a moderate consequence is also allocated a high risk rating. It is therefore necessary to consider the impact pathway both in terms of consequence and its likelihood for the development of potential management and mitigation measures in response to significant risks.

However, the risk matrix automatically designates any risk that is 'likely' as being 'medium' or higher unless its consequence is 'negligible'. While this ensures that likely risks are given appropriate prominence in the impact assessment and that remote risks with major (or above) consequences are appropriately recognised and managed to ensure that they do not eventuate, the risk ratings should not be confused with the outcomes of the impact assessment, which consider the likely impacts of the Project and focus on consequence.

A consequence level was assigned after taking into account project controls that would be in place to reduce risk. Project controls are defined as existing processes, policies, devices, practices or other actions that are in place to minimise the negative impact of Project activities. For the Project the controls included the requirements of applicable legislation and policy, operating procedures required for equipment and machinery and the design features of the Reference Project. It should be noted that the risks as assessed do not take into account all Performance Requirements as these were developed from the iterative risk and impact assessment process. Accordingly, lower risk outcomes would result with the implementation of all Performance Requirements.

3.4 Approach for Impact Assessment

All risks identified in the risk assessment were considered in the impact assessment. As the impact assessment was also used to define or refine the consequence and likelihood components of the risk analysis, some of the conclusions in the technical investigations presented in the Technical Appendices to this EES are expressed in the language of risk. However, this occurs in a minority of cases and, where it does, a conservative approach has been applied to the consequence rating in the risk assessment, which is then taken to be the relevant rating for the impact assessment.

The predominant purpose of the impact assessment is to draw conclusions, on balance, as to the likely impacts of the Project in the context of existing conditions and the measures that are available to mitigate its likely impacts. The impact assessment chapters focus on the risks with a rating of medium and above, with some distinction given to the likelihood of the impact pathway occurring. These risks are summarised in the sections below. A limited discussion of risks with a low rating is also provided to address issues raised during community consultation for the EES.

3.4.1 Construction activities and risks assessed medium and above

As set out in Chapter 2, the Project activities expected to occur during construction are listed below:

- earthworks and excavation
- tunnelling and construction of shafts
- site clearing and stockpiling
- truck movements
- lighting, noise and vibration
- management of spoil on-site
- increased access to Williamsons Beach.

The risks assessed as medium and above associated with the construction of the Desalination Plant are set out in Table 3-2. While the impact assessment is not confined to these risks, the table identifies the higher order risks.

Table 3-2 Summary of construction environmental risks at the plant site assessed as medium and above

Activity	Impact pathway	Consequence	Likelihood	Risk
Geology, geomorphology and soils				
Tunnelling under the dune system and construction of shafts	Causing vibration and disturbing the dune system disturbing or damaging historical and/or Aboriginal heritage items	Major	Unlikely	Medium
Earthworks, compaction and vibration from earthworks, truck movements and use of machinery	Ground subsidence, movement and instability which may affect public safety	Moderate	Unlikely	Medium
Excavation and tunnelling	Encountering contaminated soils which may affect human health	Major	Rare	Medium

Activity	Impact pathway	Consequence	Likelihood	Risk
Groundwater and surface waters				
Earthworks and stockpiling	Soil erosion or spoil from earthworks causing sediment discharge to waterways affecting aquatic flora and fauna	Moderate	Likely	Medium
Tunnelling	Seawater intrusion into existing groundwater affecting native flora and fauna habitats	Minor	Likely	Medium
Flora and fauna, terrestrial ecosystems				
Site clearing	Removal of habitat used by native fauna	Minor	Certain	Medium
Site clearing	Removal of native vegetation patches including threatened Ecological Vegetation Classes	Minor	Certain	Medium
All construction activities	Increased traffic affecting local fauna	Minor	Certain	Medium
All construction activities	Noise and vibration impacting native fauna	Minor	Likely	Medium
Earthworks and stockpiling	Sediment discharge to waterways resulting from soil erosion or spoil from earthworks, impacting on surface water ecosystems	Moderate	Likely	Medium
Tunnelling	Seawater intrusion in the existing groundwater table into effecting native terrestrial and aquatic flora and fauna	Minor	Likely	Medium
Aboriginal heritage, cultural heritage				
Earthworks and removal of topsoil	Removal, damage or destruction of Aboriginal artefacts and sites	Major	Almost certain	High
Earthworks	Removal of topsoil damaging or destroying historical artefacts and sites	Minor	Likely	Medium
Tunnelling under dune system	Vibration disturbing or damaging historic and/or Aboriginal heritage items	Major	Unlikely	Medium
Human health and safety, access and visual amenity				
Truck movements, earthworks and use of machinery	Generating dust impacting on visual amenity	Moderate	Unlikely	Medium

Activity	Impact pathway	Consequence	Likelihood	Risk
Truck movements, earthworks and use of machinery	Generating dust causing health problems	Major	Rare	Medium
Noise and vibration				
All construction activities	Noise and vibration impacting on sensitive receptors	Moderate	Likely	Medium
All construction activities	Noise and vibration disturbing flora and fauna	Minor	Likely	Medium
Transport infrastructure				
Physical location of the site	A reduction in access across the site affecting emergency response	Minor	Likely	Medium
Movement of trucks, machinery and workforce vehicles	More vehicles on roads causing increased road traffic congestion	Minor	Likely	Medium
Construction activities across roads	Construction activities causing limited or restricted road access	Minor	Likely	Medium
Socio-economic				
Accommodation for construction crews	Increased demand for accommodation impacting the availability and cost of accommodation and housing	Moderate	Certain	High
Use of existing services by construction crew	Reduction in community access to existing physical and social services and infrastructure	Minor	Likely	Medium
Use of construction crews and other skilled workers	Use of construction crews and other skilled workers reducing skilled labour available to other local industries	Moderate	Likely	Medium
Construction, trucks and machinery movements and reduced road access	Disruption to agricultural land uses	Minor	Likely	Medium

The above risk assessment is based on accepted construction practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the PRs are taken into account, both the likelihood and consequence of the risks may be significantly lower.

3.4.2 Operation and risks assessed medium and above

As set out in Chapter 2, the Project activities expected to occur during operation are listed below:

- desalination operation activities
- machinery, trucks and maintenance vehicles
- management of spoil
- lighting, noise and emissions.

The risks assessed as medium and above associated with the operation of the Desalination Plant are shown in Table 3-3. While the impact assessment is not confined to these risks, the table identifies the higher order risks.

Table 3-3 Summary of operational environmental risks at the plant site assessed as medium and above

Activity	Impact pathway	Consequence	Likelihood	Risk
Flora and fauna				
Stormwater runoff	Discharge to surrounding waterways impacting on surface water ecosystems	Major	Unlikely	Medium
Noise and vibration				
All construction activities	Noise impacts on sensitive receptors	Major	Unlikely	Medium
Socio-economic				
Operation of the Plant	Social impacts of the Plant on surrounding area	Moderate	Certain	High
Operation of the Plant	Plant operation resulting in reduced visitation and loss of business revenue due to perception that the Wonthaggi/Kilcunda coastline is becoming 'industrialised'	Moderate	Almost certain	High
Plant operation – noise, vibration and night lighting	Impact on agriculture – from noise and lighting disrupting livestock	Minor	Likely	Medium

Activity	Impact pathway	Consequence	Likelihood	Risk
Transportation and use of chlorine at the Desalination Plant	Accidental chlorine release impacting on public health and safety	Extreme	Rare	High

The above risk assessment is based on accepted construction practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the PRs are taken into account, both the likelihood and consequence of the risks may be significantly lower.

4.0 Landscape character and visual amenity



4 Landscape character and visual amenity

This chapter discusses the interactions of the Desalination Plant with landscape character and visual amenity. It describes existing conditions, assesses visual impacts of construction and operation of the Desalination Plant, and provides strategies for mitigation and management in the proposed performance requirements.

This chapter is based on the following report, Environmental Resources Management Australia (ERM) (2008_1) *The Desalination Project – The Desalination Plant Component Landscape and Visual Assessment* which can be found in Technical Appendix 34.

4.1 Coastal policy

The Victorian Coastal Strategy 2002 (VCS) establishes principles, guiding long-term planning of the coast. These principles are consistent with the concepts of ecologically sustainable development and integrated coastal zone planning and management. The following hierarchy of principles guide the decision-making process for development along the Victorian coast:

- **Protection of significant environmental features** – conservation of biological diversity, physical diversity and ecological integrity, and the preservation and maintenance of essential ecological processes and life support systems. Aboriginal and other sites of cultural, historic or scientific value will also be protected.

- **Sustainable use of natural coastal resources** – ensuring intergenerational equity that is meeting the needs of people today without comprising the needs of future generations.
- **Direction for the future** – integrating coastal zone planning and management, which has, regard to the environmental, social and economic implications of decisions and has a long-term view when making those decisions.
- **Sustainable development on the coast** – provide an environmental, social and/or economic benefit, enhancing the community's value of the coast.

The VCS outlines indicative coastal land use along the Victorian coast. The plant site is within an area listed within the 'Coastal Protection Zone', which applies to areas in 'relatively natural condition or which are significant for botanical, zoological, geological or geomorphological, archaeological, or historical reasons'. The strategy states that areas within the coastal protection zone should be managed to protect the natural values of the zone.

The Central Coast Board Region manages the area of the coast that the plant site covers. There are no relevant Coastal Action Plans that cover the area of coast affected by the plant site.

The Central Coast Board have prepared a Boating Coastal Action Plan, which provides a regional policy for planning and management of recreational boating facilities in Port Philip and Western Port. The plant site is within the area covered by the Boating Coastal Action Plan.

The VCS is currently under review. The Draft 2007 Coastal Strategy has been approved by Council and provided to the Minister for Environment and Climate Change for endorsement. The draft VCS (2007) includes:

- *stronger directions and a precautionary approach to climate change*
- *greater emphasis on marine planning and management*
- *stronger principles for planning, recommendations of Coastal Spaces (2006)*
- *initiatives to strengthen Victoria's coastal management capacity*
- *guidance for resolving on-going and historically difficult issues such as dependent uses and old inappropriate subdivisions.*

The Victorian Coastal Council has also published guidelines to assist the Victorian Coastal Council, coastal managers, local government and other stakeholders to implement the VCS by encouraging development sympathetic to the coastal environment and promoting excellence in coastal design. These guidelines are discussed below.

The Victorian Government has produced *Siting and Design Guidelines for Structures on the Victorian Coast (May 1998)* and *Landscape Settings Types for the Victorian Coast (May 1998)*, to assist the Victorian Coastal Council, coastal managers, Local Government and other stakeholders in implementing the Victorian Coastal Strategy. The documents outline the need for development that complements the surrounding landscape and raises awareness of the importance of achieving sensitive design and development along the Victorian coast.



The *Siting and Design Guidelines for Structures on the Victorian Coast* aims to raise awareness about sensitive design on the coast. It also aims to outline issues that should be considered in the siting, design and construction of new development and issues regarding improving existing structures in coastal areas.

The *Landscape Settings Types for the Victorian Coast* aims to provide a better understanding of the landscape characteristics of the coast. This document identifies various landscape characters of the coastline, based on site investigations, aerial inspection, and analysis of a large range of maps, aerial photographs and reports. These landscape characters should be considered in development at points along the coast, in order to achieve an integrated development sympathetic to the surrounding landscape.

The site is located within the Cape Paterson–Kilcunda to Arch Rock/Morgan Beach Area as outlined in the *Landscape Settings Types for the Victorian Coast*. The following describes the characteristics of this part of the coast:

- mainly medium to high cliff landscape interspersed with ponds and inlets
- where not under pasture and residential use, setting type features include extensive native vegetation
- there is considerable pressure for residential development, the landscape can accommodate such uses in more suitable places and maintain its intrinsic visual quality at appropriate places

- critical viewpoints include the cliffs in the vicinity of Cape Patterson/Eagles Nest and from car parks and roads that occur throughout the setting type.

The document outlines special considerations for this part of the coast stating the area is of high scenic quality requiring appropriate planning controls to protect the landscape *(Landscape Setting Types for the Victorian Coast, May 1998).*

Coastal spaces landscape assessment study (DSE, 2006) focuses on the coastal areas between Bass Coast to the NSW border (Gippsland), and the Bellarine Peninsula and the coast west of Warrnambool to the South Australian border. The study identifies significant landscapes and characteristics within these coastal regions and provides an implementation framework, assisting local government and other agencies in managing development impacts within coastal landscapes.

The study is designed to implement the objectives of the *Coastal Management Act 1995* and the *Victorian Coastal Strategy 2002*. The site falls within the 'Gippsland Region Landscape Character Type 1.3 – Bunurong Coast and Hinterland' and 'Significant Coastal Landscape – Gippsland Region'.

Bunurong Coast and Hinterland character area includes:

- Bunurong coastline between Kilcunda and Inverloch
- largely cleared, rolling pastoral hinterland extending inland to the Strzelecki Range and east to Cape Liptrap (including the Bald Hills)
- high sand dunes, sea cliffs, rocky headlands, rock stacks and beaches along the Bass Strait coast
- hinterland that is largely undeveloped and supports native heath vegetation in some parts of the coastal reserves
- open grazing land is interspersed with corridors of native vegetation (especially riparian reserves and at roadsides) further inland
- exotic windbreaks, farmhouses and settlements
- two major urban settlements (Wonthaggi and Inverloch) are within the character area
- Cape Paterson, coastal holiday home location is set atop the rugged coastline.

Kilcunda to Cape Patterson Coast is identified within the 'Gippsland Region' landscape, in which the plant site is located. Kilcunda to Cape Patterson Coast Significant Coastal landscape comprises:

- visually significant landscape features such as the Powlett River, sand dune system and dramatic rock formations and cliffs around Cape Patterson
- coastline including rugged high cliffs, dunes and rock stacks such as the Eagles Nest
- area valued by the community for open space and expansive views extending as far as Venus Bay to the east of Cape Woolamai to the West, and for the scenic values of the Powlett River Estuary.

The Gippsland region character type and significant landscape is considered part of the coastline within the site boundary, highlighting in particular the sensitivity of the coast and the Powlett River.

Two Environmental Significance Overlays under the Bass Coast Planning Scheme apply to the Desalination Plant site:

- Environmental Significance Overlay 1 (ESO1) – Coastal Wetland Areas
- Environmental Significance Overlay 4 (ESO4) – Land Subsidence.

The Environmental Significance Overlays identify areas where the development of land may be affected by environmental constraints and are to ensure that development is compatible with identified environmental values. There are no Significant Landscape Overlays applicable to the Plant site. Further details of other zones and overlays applicable to the site can be found in ERM 2008_1, Technical Appendix 34.

The planning controls, strategies and guidelines for development in coastal areas point to the sensitivity of, and the need to minimise, impacts on the coastal area. The policies direct attention to impacts on the dune system and the immediate surrounds of the Powlett River where it enters the ocean. The landscape units, which are outlined in the following section, describe these areas of environmental and visual sensitivity (ERM 2008_1, Technical Appendix 34).

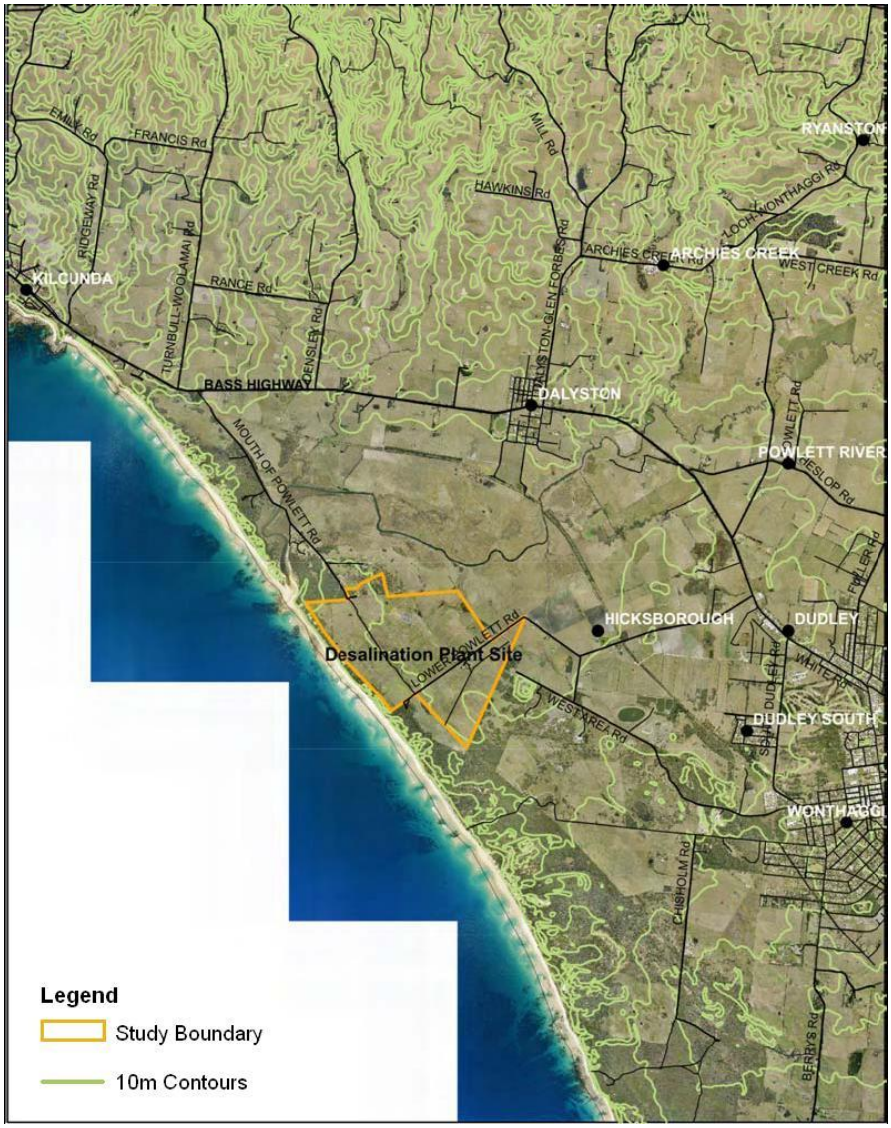
4.2 Existing conditions

This section describes existing conditions of the landscape and the landscape units at the Plant site and its environs.

4.2.1 Topography and vegetation

The Plant site and the areas to the north and north-east are relatively flat. The inner dune edge within the Plant site falls in a north-easterly direction. Steeper coastal dunes run along the coast, while undulating hills and foothills lie north to the Bass Highway and the Bass River valley. Figure 4-1 shows the topographical characteristics of the plant site and the surrounding area.

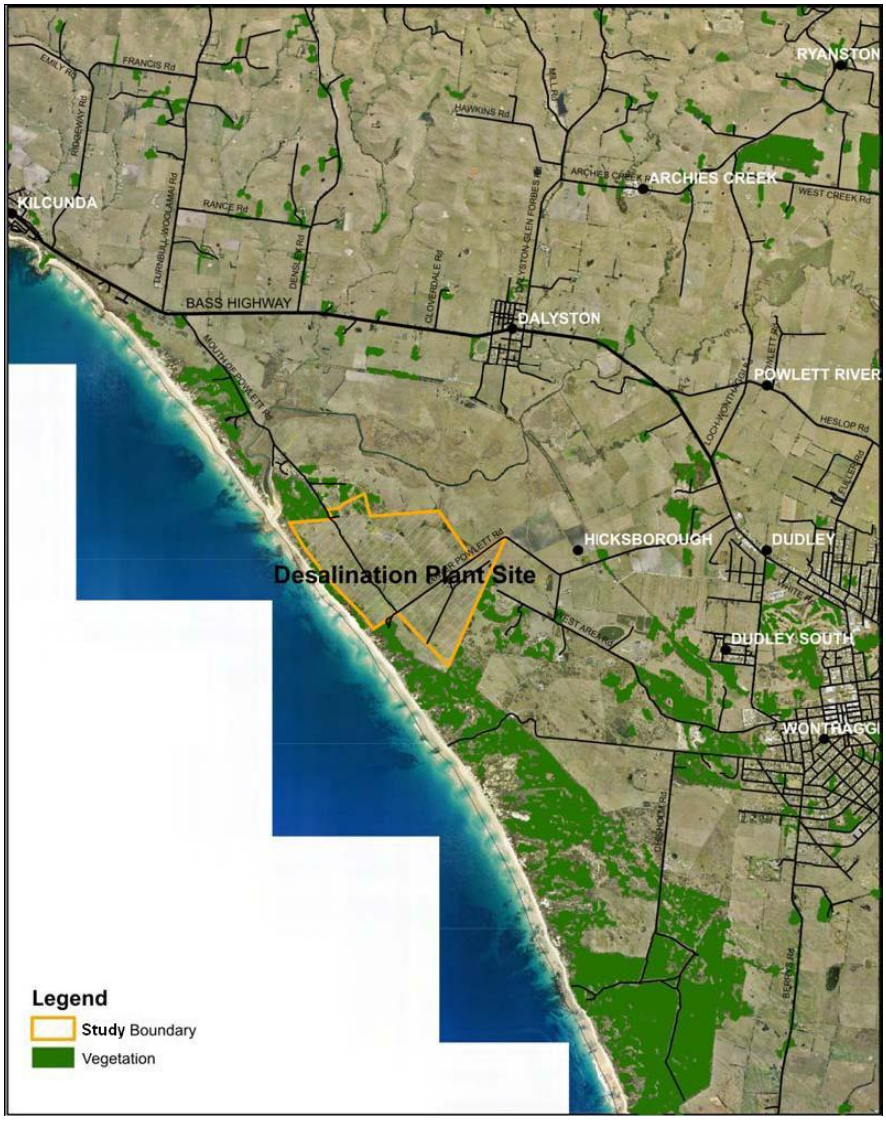
Figure 4-1 Topographical contours



Source: ERM 2008[1]

The Plant site and the surrounding areas are predominantly cleared of vegetation. Existing vegetation is present along the coast, typically found on the coastal dunes. Remnant areas of eucalypt and taller coastal vegetation exists to the south west of Wonthaggi. Figure 4-2 shows existing vegetation within the plant site and surrounding areas.

Figure 4-2 Vegetation surrounding the plant site



4.2.2 Landscape units

There are three landscape units within the site and three within the surrounding environs, these are discussed below. Characteristics that are commonly used to define landscape units include geology, vegetation, topography, drainage patterns and urban development. Each landscape unit within the Project area is based on the following:

- existing landscape characteristics
- visual amenity
- landscape character types
- relevant planning policy and guidelines.

Landscape units 1, 2, and 3 cover the site, while landscape units 4, 5 and 6 relate to surrounding areas. Each landscape unit discussed below is shown on an aerial. The plant site is shown in orange and the areas relating to the landscape unit are shown in yellow (ERM 2008$_1$, Technical Appendix 34).

Landscape unit 1: coastal cliffs and shoreline



The coastal cliffs and shoreline landscape unit covers the coastline within the Project area, adjacent to the Plant site. This landscape unit contains a narrow band of beach and a non- vegetated dune, which runs along the ocean edge. The coastline within the vicinity of Wonthaggi varies from steep sheer cliffs to less traversable inclines. There are no rugged high cliffs and rock stacks immediately adjacent to the site. The section of dune between the site and this landscape unit is well vegetated and has limited direct access. This landscape unit includes the mouth of the Powlett River, which is shown in the foreground of Figure 4-3. In this area the dunes are high and in some locations give way to cliffs, defining the coastal edge of this landscape.

The coastline within this landscape unit is a popular tourist attraction and is rated by the DSE's Coastal *Spaces Landscape Assessment Study* of September 2006 as regionally significant within the Gippsland Region.

Figure 4-3 View of the coastline next to the site looking south-east



Landscape unit 2: scrubby and low coastal heathland



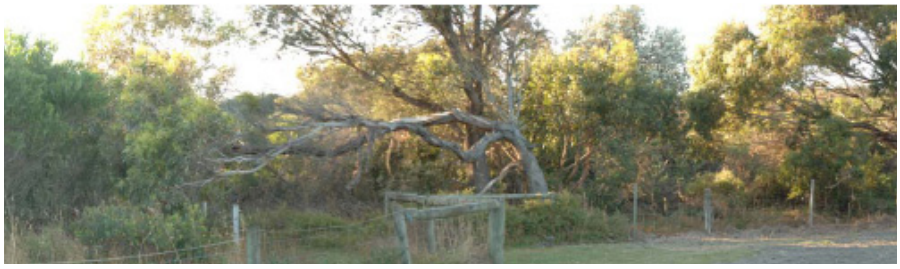
The scrubby and low coastal heathland landscape unit runs across the south-western edge the Plant site. This landscape unit ranges from steeper slopes near the coast to more gentle undulations further inland towards the farmland and features a variety of small trees and tall shrubs that form a low cover of vegetation blanketing the land.

The majority of the coastal dunes within this landscape unit are bordered by privately owned farmland. Sparse vegetation exists inland, whilst in areas the landscape transitions to scrubby heathland. Typical vegetation and landform characteristics along the coastal dunes are shown in Figure 4-4. Figure 4-5 shows that where vegetation is higher it is usually also dense and blocks views through it.

Figure 4-4 Coastal dunes near the site



Figure 4-5 Coastal heathland vegetation



The landscape ranges from steep slopes adjacent to the coast to gentle undulations inland towards the farmland. This landscape unit acts as a visual barrier between beach along the water's edge and the cleared agricultural hinterland. The views towards the beach immediately adjacent to this location are restricted.

Landscape unit 3: coastal plains



The coastal plains landscape unit is typically flat to undulating and has been extensively cleared of vegetation. Remnant patches of vegetation are confined to road reserves and occasional clumps in farmland. The topography in these landscape units is generally flat to gently undulating. This landscape unit has limited ability to prevent visual impacts as it typically has minimal vegetation.

The majority of the land is used for farming and rural residential land uses. Farm holdings comprise residential dwellings and agriculture outbuildings. A typical view across the coastal plains landscape unit is shown in Figure 4-6.

Figure 4-6 Coastal plains



Landscape unit 4: moderate to steeply undulating cleared farmland



The moderate to steeply undulating cleared-farmland landscape unit is most prevalent north of the plant site. Landscape characteristics include rolling hills, valley wetlands and creeks with views of the surrounding landscape achieved on elevated parts as shown in Figure 4-7.

Buildings within the landscape are generally farmholdings with one residential dwelling and a few agricultural sheds. Access roads tend to be curvy and contain patches of roadside vegetation. The Bass Highway to the north of the site has cuttings where it traverses the top of the hills.

Figure 4-7 Undulating cleared farmland



Landscape unit 5: riverine



The riverine landscape unit runs along the length of the Powlett River, comprising a narrow band cutting through the coastal plains. The estuary of the Powlett River is fringed by vegetation whilst further inland, the river degrades to a narrow channel traversing farmland. The landscape character of the Powlett River at the Mouth of Powlett River Road bridge crossing is shown in Figure 4-8 (ERM 2008$_1$, Technical Appendix 34).

Figure 4-8 Mouth of the Powlett River



Landscape unit 6: townships



The township landscape unit describes the urban areas within the plant site. The township of Wonthaggi lies to the east, Dalyston lies to the north and Kilcunda lies to the west of the Project area, as shown in Figure 4-9. Housing and landscapes associated with residential areas tend to screen views to surrounding rural areas. Views across rural areas are generally only possible at the periphery of the townships (ERM 2008[1], Technical Appendix 34).

Figure 4-9 Looking north-west over Kilcunda



4.2.3 Landscape sensitivity

The pre-European landscape of the area surrounding the site has been heavily modified through agricultural practices that have included the clearing of native vegetation for cropping and grazing. The landscape is interspersed with agricultural buildings including farmhouses, outbuildings, sheds, stockyards, access roads, silos as well as the road networks. Associated with these structures are plantings along roadsides or as shelterbelts.

This landscape unit on which the Plant is to be located is not rare, nor is it high in scenic quality and for these reasons the landscape sensitivity is considered to be low. However, some people value the appearance of cleared farmland with minimal signs of houses and farm sheds. For these viewers, the presence of the Plant may be perceived as a high visual impact due to the presence of large-scale structures in a rural landscape.

Servicing the rural areas are settlements, which in the larger townships also include commercial and public buildings as well as recreational areas. These rural townships are not uncommon, nor are the scenic qualities particularly high as they often contain many forms of infrastructure and development.

Table 4-1 summarises the sensitivity of each of the landscape units surrounding the Desalination Plant site (ERM 2008$_1$, Technical Appendix 34).

Table 4-1 Landscape sensitivity

Landscape unit	Sensitivity	Comments
1 – Coastal cliffs and shoreline	High	Planning controls, strategies and guidelines all support the value of this coastal edge.
2 – Scrubby and low coastal heathland	High	This area of remnant vegetation appears intact in an area that is largely cleared. There is a high degree of sensitivity to development that would impact on the visitor's experience to this area.
3 – Coastal plains	Low	A largely cleared landscape with many man-made modifications. Vegetation present is often planted in windbreaks.
4 – Moderate to steeply undulating cleared farmland	Moderate	The rolling hills of the hinterland are an attractive landscape type. They offer varying views back to the coast as well as views into the foothills of the Great Divide.

Landscape unit	Sensitivity	Comments
5 – Riverine	High to low	In some areas the Powlett River is greatly degraded and little more than a drain. The riverine environment is increasingly attractive as the river approaches the coast. Coastal policies also point to the sensitivity of the area where the Powlett River flows into the sea.
6 – Townships	Moderate	Views from residential townships are always important and result in increased sensitivity. This landscape unit is also able to accommodate change, as this is a common occurrence in urban areas.

4.3 Impact assessment

The impact assessment process for landscape character and visual amenity did not include a risk assessment. The visual assessment adopts a location-specific sensitivity analysis for assessment of impacts which is considered more appropriate than the risk framework for this specialism. The impacts were assessed on the expected visual impact during construction and operation of the Plant.

4.3.1 Changes to landscape character

Construction

The main construction activities that will be visible are earthworks and temporary structures such as a concrete batching plant. In the Reference Project, the Plant is built on benches that will take up approximately 45 hectares including spoil heaps, Plant and construction activities. The proposed mounding associated with the Reference Project Plant layout may double this area. There will be an obvious change to the landscape during construction of the Plant. However, earthworks activities associated with construction of the Desalination Plant will have similar visual appearance to farming activities such as ploughing and cropping.

A concrete batching plant may be required for construction and would be an obvious addition in the coastal plain, especially from nearby viewpoints. Further away, the plant would not be prominent.

Extensive and intense lighting will be required during the construction period. This will be concentrated and an apparent change on the coastal plain. The visual impact of this lighting, while noticeable, will not be great due to the existing lighting in the townships of Wonthaggi, Dalyston and Kilcunda (ERM 2008_1, Technical Appendix 34).

Operation

As demonstrated by the Reference Project, the main visual components of the Desalination Plant will be:

- building elements to house the four plant modules, including:
  - three pre-treatment buildings approximately 72 x 131 x 12 metres high
  - four buildings housing the reverse osmosis plant approximately 70 x 179 x 16 metres high
  - various other smaller buildings
- three clear water tanks approximately 70 metres diameter and 19 metres high (at apex)
- three filtered seawater tanks approximately 40 metres diameter and 9 metres high (at apex)
- car parking and service and access roads
- an on-site switchyard approximately 54 x 19 x 5 metres high.

The buildings housing the reverse osmosis plant and clear water storage tanks would be the tallest structures on sit at approximately 16 to 19 metres high. These are the tallest of the proposed buildings and structures proposed for the Plant, which may be visible from the surrounding landscape. These will be constructed on a bench level of 8 m AHD (ERM 2008_1, Technical Appendix 34).

Night lighting

It is expected that night lighting would need to be maintained at levels adequate for safety and security practises. Most critical equipment that might require night time operational personnel would be within buildings. Some light may be expected to spill from the buildings through windows. Plant lighting would be visible from adjacent to ridgelines and roads where intervening vegetation and topography does not screen or filter views.

The area already contains many examples of night lighting, including:

- the townships of Wonthaggi and Kilcunda
- lighting associated with houses and farms
- car headlights and taillights along the Bass Highway.

The relative isolation of the site and the screen planting shown on the landscape concept plan for the Reference Project around the perimeter of the site would reduce the visual impact of night lighting over time to a moderate to low level of illumination.

4.3.2 Visibility of the Desalination Plant

Viewshed

The area that potentially can be visually affected by a development is called the 'viewshed'. The viewshed extends to a distance at which built elements are considered visually insignificant, even though they may still be visible. Distance ranges can be used as a guide to determine zones of visual influence. The zone of visual influence analysis assists in identifying publicly accessible viewpoints. Climatic factors such as rainfall, sea haze, cloudy skies and sun angle also affect the visibility of a development. Table 4-2 describes the extent of the Plant viewshed, based on a building height of 20 metres for the Reference Project, and ranges of visual impact.

Table 4-2 Desalination Plant viewshed extent and zones of visual influence

Distance from an observer to the Desalination Plant	Zones of visual influence
> 4 km	Visually insignificant A very small element, difficult to discern and will be invisible in some lighting or weather conditions
2 – 4 km	Potentially noticeable, but will not dominate the landscape The degree of visual intrusion will depend on the landscape sensitivity and the sensitivity of the viewer, however the structures do not dominate the landscape
0.5 km – 2 km	Potentially noticeable and can dominate the landscape The degree of visual intrusion will depend on the landscape sensitivity and the sensitivity of the viewer and mitigating influences
<0.5 km	Highly visible and will usually dominate the landscape The degree of visual intrusion will depend on the buildings placement within the landscape and factors such as foreground screening

The viewsheds for the Plant, as shown in Figure 4-10, extend to a radius of four and six kilometres respectively, and are bounded by:

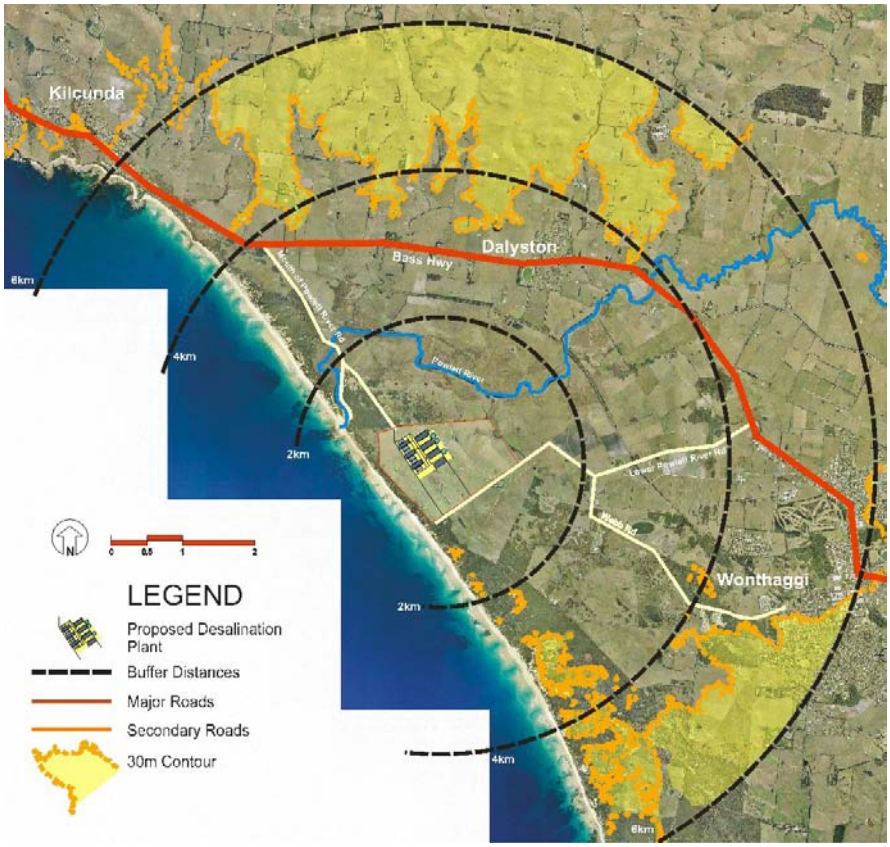
- the Mouth of the Powlett River Road to the west
- the Bass Highway to the north
- Wonthaggi to the east
- the ocean's edge as the southern land based boundary.

The zones of visual influence have been drawn with their centre being the centre of the Plant in a nominal envelope within the Plant site.

Topography

The greatest visual impact of the Plant would occur when the observer is located in an area higher than the roof of the Plant. The 30-metre contour has been mapped as a conservative estimate of areas that could potentially overlook the entire Plant. This is shown in Figure 4-10.

Figure 4-10 The zones of visual influence and the 30 metre contour

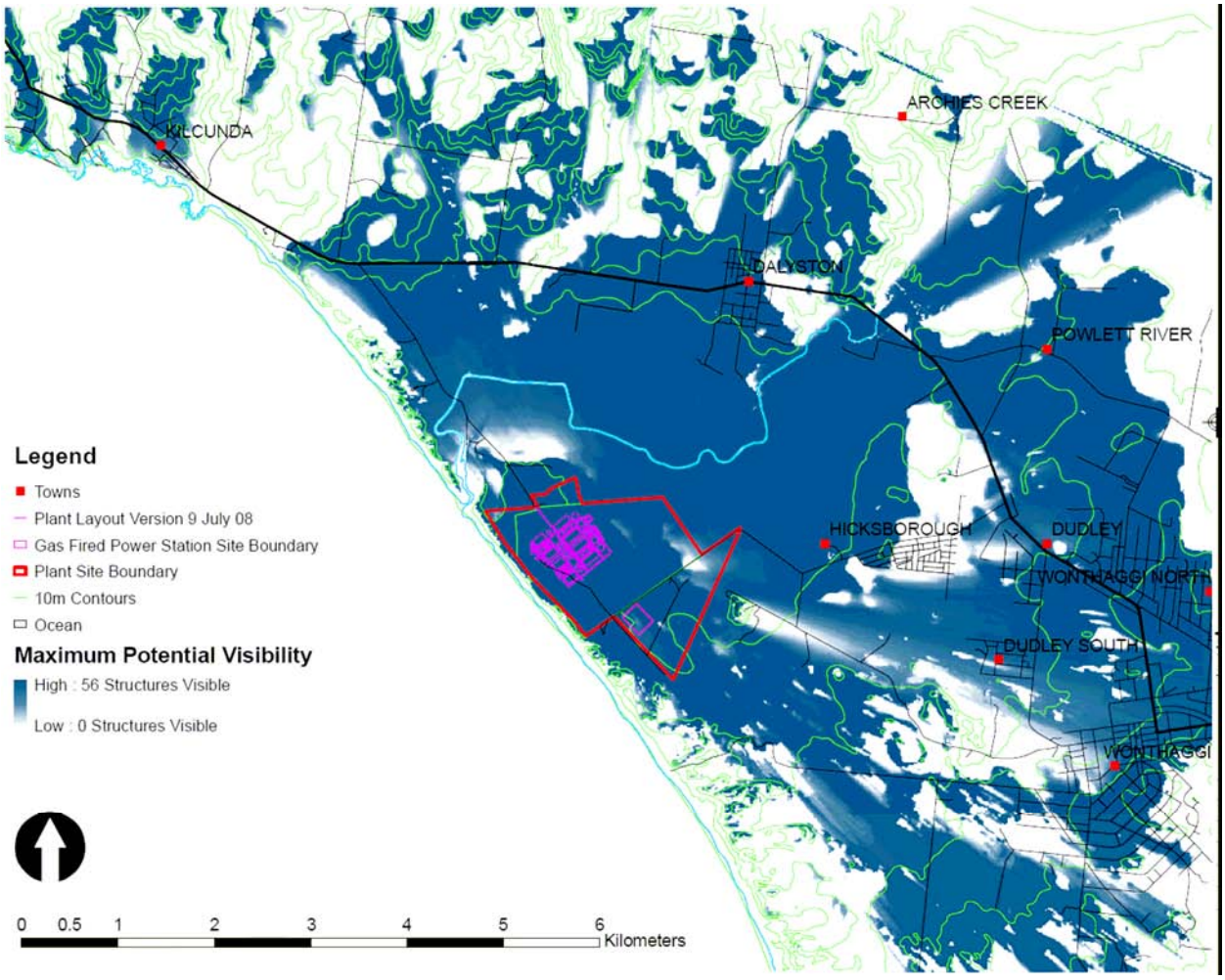


The 30-metre contour and areas that are higher in elevation are well north of the Bass Highway, approximately four kilometres or more from the Plant. Other areas that are higher than the plant are south-west of Wonthaggi, generally between four to six kilometres from the Plant. There are no locations along the Bass Highway within the viewshed with the potential to overlook the entire Plant (ERM 2008_1, Technical Appendix 34).

Seen area analysis

A seen area analysis determines where a development is screened by topography. This analysis graphically illustrates the areas from where a development, in whole or in part, would be visible within the viewshed. The analysis is conservative, as it does not take into account vegetation or other buildings that may block views. The methodology for undertaking a seen area analysis is presented in ERM 2008[1], Technical Appendix 34. Areas of maximum potential visibility are those areas with the greatest potential visual impact. This is shown in Figure 4-11.

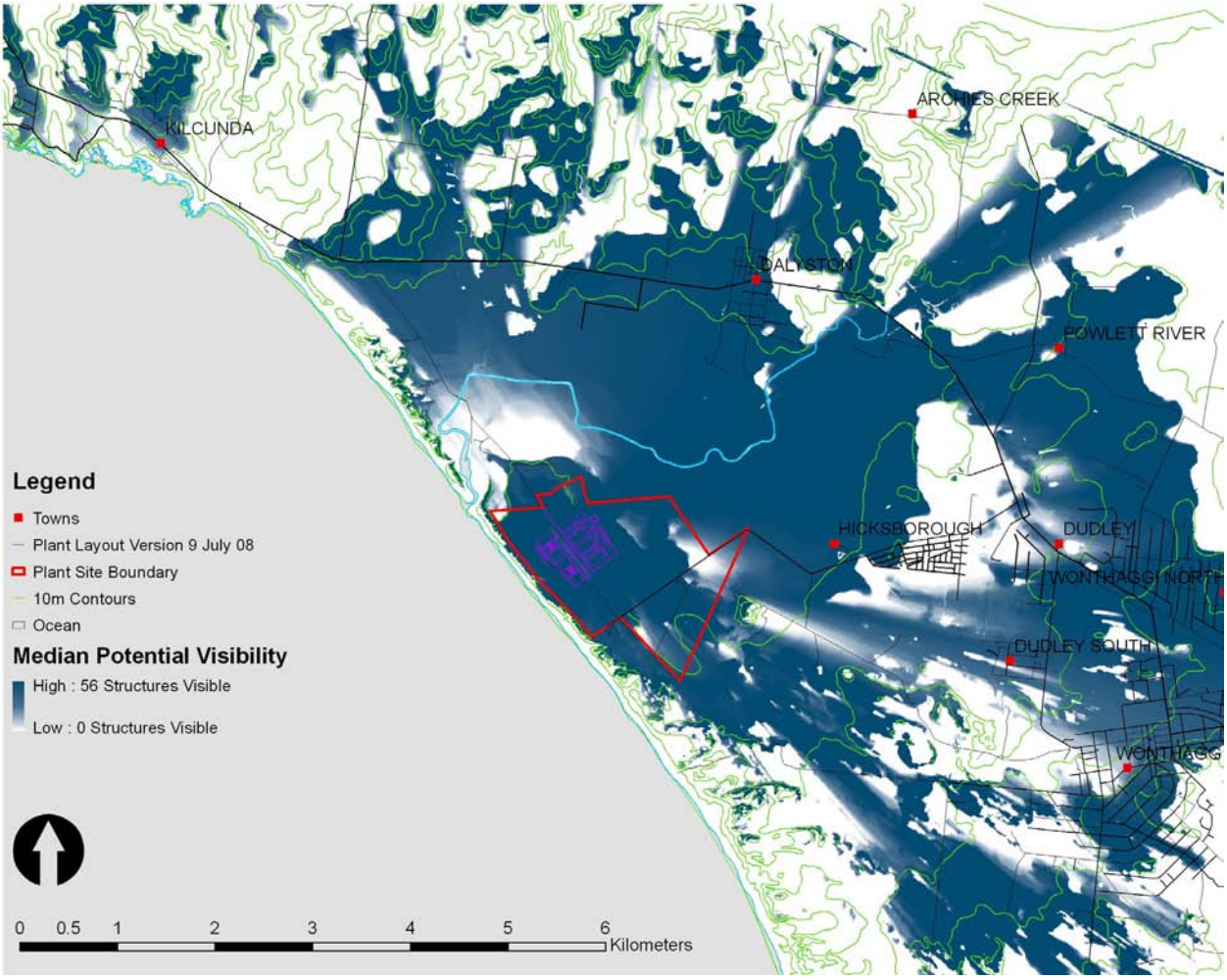
Figure 4-11 Areas of maximum potential visibility of the Desalination Plant



Areas with the greatest potential visual impact from the Plant in the Reference Project are expected to be on the Powlett River to the south of the Bass Highway. Some sections of the Bass Highway would be screened by topography and others would have views to the Plant.

The dunes that run parallel to the beach would screen areas immediately adjacent to the water's edge and along the beach. Areas that the model predicts would see a significant portion of the Plant are called areas of median visibility. These are shown in Figure 4-12.

Figure 4-12 Areas of median potential visibility



It is apparent that the area of major potential impact would be the Powlett River plain. The greatest reduction in potential visibility is predicted to be the area to the immediate west and east of the Plant. This is based on the ability of the gently undulating topography in these areas to reduce the visibility of the Plant (ERM 2008$_1$, Technical Appendix 34).

4.3.3 Visual impact at publicly accessible viewpoints

The seen area analysis identifies publicly accessible areas that have potential to be visually affected by the Plant. An assessment of the visual impacts from indicative viewpoints within the public domain is partly based on:

- the distance of the viewer from the development
- the nature of the surrounding landscape (including the landscape units represented and their sensitivity)
- the number of viewers able to see the development.

The overall visual impact of the Plant built components in the Reference Project from the indicative publicly accessible viewpoints have been assessed using the following scale:

- **Negligible adverse effect** – minute level of effect that is barely discernable over ordinary day-to-day effects
- **Low adverse effect** – adverse effects that are noticeable but that will not cause any significant adverse impacts
- **Medium adverse effect –** significant effects that my be able to be mitigated/remedied
- **High or unacceptable adverse effect** – extensive adverse effects that cannot be avoided, remedied or mitigated.

Publicly accessible viewpoints that have been assessed are shown in Figure 4-13 and described in Table 4-3. In most locations the Plant is screened from view by topography or existing roadside vegetation, however there are some places where it will be visible. The level of visual impact associated with the visibility of the Plant depends on the sensitivity of the area and the proximity of the Plant.

The main potential visual impact would be from nearby locations such as the Mouth of the Powlett River Road, the Lower Powlett Road and the Bass Coast Rail Trail as it crosses the coastal plain near the site. From viewpoints further away like the Bass Highway, the visual impact would be low. From even greater distances such as the Strzelecki foothills or from the George Bass Coastal Walk the Plant would be indiscernible and there would be no visual impact.

Figure 4-13 Publicly accessible viewpoint locations



The Mouth of the Powlett River Road is a sensitive location with a high tourist use. In response to the final design of the plant, landscape mitigation measures may need to be considered to reduce visual impact from this location. The most sensitive location is the beach between Lower Powlett River Road and the Powlett River, however there are unlikely to be views to the Plant from this location. A summary of the visual impact of the Reference Project at each viewpoint location is presented in Table 4-3 (ERM 2008$_1$, Technical Appendix 34).

Table 4-3 Public viewpoint descriptions and summary assessment of Reference Project

View point	Description	Visual impact
VP1	Ocean View Hotel, Kilcunda	Negligible
VP2	Kilcunda caravan park	Nil
VP3	Kilcunda Foreshore Reserve (railway bridge)	Nil
VP4	Mouth of the Powlett River Road #1	Low (without vegetation) Insignificant (with vegetation)
VP5	Mouth of the Powlett River Road #2 (on bridge)	Nil
VP6	Mouth of the Powlett River Road #3	Nil
VP7	Mouth of the Powlett River Road #4	Significant (without vegetation) Low-medium (with vegetation)
VP8	Caravan park at the Mouth of the Powlett River Road #5	Nil
VP9	Bass Highway #1	Low (without vegetation) Insignificant (with vegetation)
VP10	Bass Highway #2 (at Dalyston)	Nil
VP11	Bass Highway #3	Low (without vegetation) Insignificant (with vegetation)
VP12	Lower Powlett River Road #1	Low
VP13	Lower Powlett River Road #2	Low
VP14	Lower Powlett River Road #3	Nil
VP15	Donmix concrete batching plant	Nil
VP17	The beach near the end of the Lower Powlett Road	Nil

View point	Description	Visual impact
VP18	The beach at the mouth of Powlett River	Nil
VP19	Bass Coast Rail Trail	Low
VP20	Bass Highway #4	Negligible

Each publicly accessible viewpoint is discussed below. The plant site is shown in blue and the viewpoints are shown in yellow (ERM 2008[1], Technical Appendix 34).

Viewpoint 1: Ocean View Hotel, Kilcunda

Viewpoint 1 is located outside the Ocean View Hotel at Kilcunda approximately five kilometres north-west of the Plant. Views from this location look towards the Plant, as shown in Figure 4-14, and look across the coastal cliffs and shoreline and the coastal plain landscape units. Kilcunda is on a ridgeline above the coast and has panoramic views toward the ocean and Wonthaggi Wind Farm.

Figure 4-14 Viewpoint 1: Ocean View Hotel, Kilcunda



The seen area analysis shows that the Plant may be visible in the distance from this location, however it is unlikely, as intervening vegetation should screen views. At six kilometres from the site, this location is also outside the viewshed and any structure of 20 metres in height would have a negligible visual impact. The overall visual impact from this location due to the Plant would be negligible.

Viewpoint 2: Kilcunda Caravan Park

Viewpoint 2 is from the Kilcunda Caravan Park looking south-east and is shown in Figure 4-15. The Kilcunda Caravan Park is located on the eastern edge of Kilcunda with views over the ocean and along the coastal cliffs. The Desalination plant is located five kilometres from this location.

An ablutions block, topography and vegetation lie between the plant site and this entry road within the caravan park. The wind turbines, located in Wonthaggi Wind Farm are also just noticeable from this location. The Desalination Plant will not be visible from this location and therefore the visual impact is assessed as nil (ERM 2008$_1$, Technical Appendix 34).

Figure 4-15 Viewpoint 2: Kilcunda Caravan Park



Viewpoint 3: Kilcunda Foreshore Reserve (Railway Bridge)

Viewpoint 3 is located 200 metres east of Ridgeway Road on the Bass Coast Rail Trail, west of the Bourne Creek crossing point and adjacent to the Bass Highway as shown in Figure 4-16. Tourists enjoying the coastal views use the trail. The Plant is approximately five kilometres to the south-east. From this elevated location on the railway bridge, there would be no views to the Plant due to the land formation and intervening vegetation and as a result the overall visual impact is assessed as nil.

There would be no views to the Plant from the George Bass Coastal Walk, which is further west and runs from Kilcunda to San Remo along the coast and therefore the visual impact from this location is also assessed as nil (ERM 2008$_1$, Technical Appendix 34).

Figure 4-16 Viewpoint 3: Kilcunda Foreshore Reserve (Railway Bridge)



Viewpoint 4: Mouth of Powlett River Road #1

Viewpoint 4 is from the Mouth of Powlett River Road, approximately three kilometres north-west of the Plant, looking in a south-easterly direction as shown in Figure 4-17. The road links to a car park offering beach access next to where the Powlett River flows into the ocean. Views from this location mainly look across the coastal plains landscape unit. The estuary is an attractive location, well visited by beach users as well as fishermen.

Gaps in the screen planting along the road would allow views to the Plant. Further south, existing roadside vegetation would screen views to the Plant. The visual impact from this location would be minor without additional vegetation. Once vegetation was established any visual impact would be insignificant. The overall visual impact has been assessed as low (ERM 2008$_1$, Technical Appendix 34).

Figure 4-17 Viewpoint 4: Mouth of Powlett River Road #1



Viewpoint 5: Mouth of Powlett Road #2 (on bridge)

Viewpoint 5 is located on the Powlett River Road Bridge, approximately one kilometre from the car park at the estuary and the coast. Low-lying dunes covered in vegetation can be seen running north and south of where the Powlett River enters the ocean. This bridge is aligned in the direction of the Plant, which is approximately 1.6 kilometres to the south-east. From the bridge the scrubby and low coastal heathland and riverine landscape units can be seen, as shown in Figure 4-18. Both of these landscape units can vary from low to high degrees of sensitivity.

Figure 4-18 Viewpoint 5: Mouth of Powlett River Road #2



Based on the Reference Project, a small section of the Plant may be visible viewpoint over the house in the middle distance of this viewpoint.

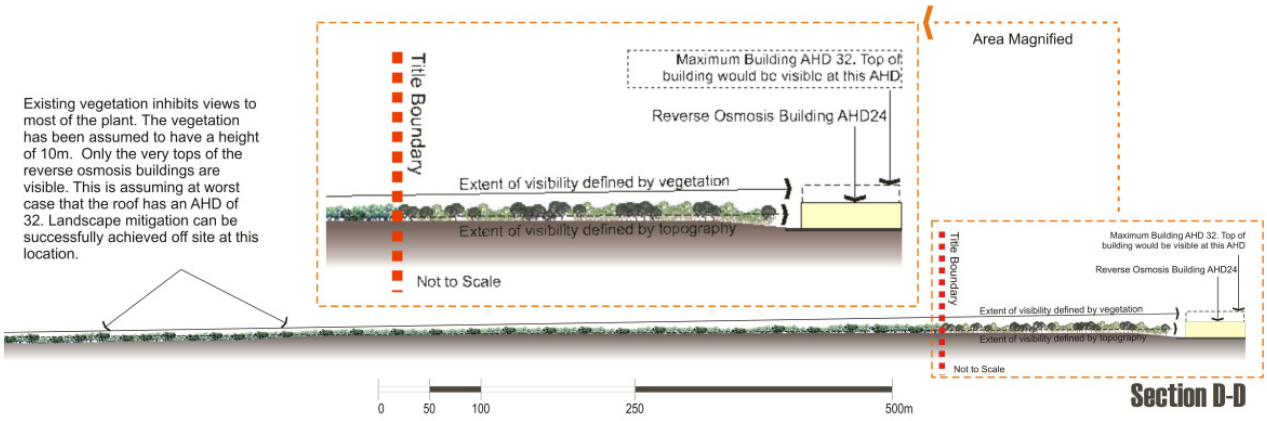
Figure 4-19 shows a photomontage of the Plant in viewpoint 5. The roof of the Desalination Plant is visible in the background. This photomontage was prepared on the basis that the buildings were constructed with a maximum roof height of 32 m AHD to demonstrate a worst-case scenario visual impact. This is approximately eight metres higher than the tallest building within the current Reference Project. If the Desalination Plant was constructed with the roof at 32 m AHD, as shown in Figure 4-19, then the Plant would just be visible above the existing vegetation in the centre of the image. However, as the maximum building height is eight metres lower than shown, the roofline of the Plant would not be visible and hence the visual impact is assessed as nil (ERM 2008$_1$, Technical Appendix 34).

Figure 4-19 Viewpoint 5 photomontage of proposed Desalination Plant



Figure 4-20 shows a section from the Powlett River Bridge, which is included within the indicative Landscape Concept Plan for the Reference Project. The cross-reference supports the findings shown in the photomontages, that the Desalination Plant will not be visible from this location.

Figure 4-20 Section from Powlett River Bridge



Viewpoint 6: Mouth of the Powlett Road #3

Viewpoint 6 is located at a small car park abutting the Mouth of Powlett River Road. The car park services the beach access track and is used by both day-visitors and caravan park tenants. The caravan park is located on the left hand side of Figure 4-21. Views from this location toward the Plant mainly look out across the scrubby and low coastal heathland landscape unit, which has a high degree of sensitivity. From this location the Plant would not be visible due to the dune system and existing vegetation between this location and the site. The overall visual impact from this location is assessed as nil (ERM 2008_1, Technical Appendix 34).

Figure 4-21 Viewpoint 6: Mouth of the Powlett River Road #3



Viewpoint 7: Mouth of Powlett River Road #4

Viewpoint 7 is located at the end of the Mouth of the Powlett River Road adjacent to the site. Existing wind turbines in the Wonthaggi Wind Farm are visible in the background, shown in Figure 4-22. Figure 4-23 shows an enlargement of these turbines. These are approximately 69 metres high to the hub with an overall height of 110 metres. A tourist accommodation venue directly abuts the site along the western boundary.

The Plant would be visible from this location however screening at the roads edge would be an effective way of reducing the visual impact. For the users of the tourism facility the visual impact would be high. Landscape mitigation would be effective, particularly if road access to the Plant was orientated to avoid a direct visual link between this location and the Plant. If landscape was established and the road did not draw a visitor's attention to the Plant the visual impact would be low to moderate. The overall impact is assessed as low (ERM 2008_1, Technical Appendix 34).

Figure 4-22 Viewpoint 7: Mouth of the Powlett River Road #4



Figure 4-23 Enlargement of Figure 4-22, showing wind turbines



Viewpoint 8: Caravan Park at the Mouth of the Powlett River Road #5

Viewpoint 8 is at the entry to the Powlett River Caravan Park, approximately 1.1 kilometres south-east of the Plant and is shown in Figure 4-24. The Powlett River Caravan Park is located on the dune ridge to the south of the Powlett River. Views from this location look across the shrubby and low coastal heathland landscape unit.

Figure 4-24 Viewpoint 8: caravan park at the Mouth of the Powlett River Road #5



There would be no views to the Plant from Viewpoint 8, nor from within the caravan park, which has considerable existing vegetation. The overall visual impact from the Plant is assessed as nil (ERM 2008$_1$, Technical Appendix 34).

Viewpoint 9: Bass Highway #1

Viewpoint 9 is from the Bass Highway approximately 450 metres west of Densley Road and approximately three kilometres from the Plant. Viewpoint 9 is one of several locations along the Bass Highway that has views out across the coastal plain to the site. Views from other locations along the Bass Highway are screened by vegetation and sometimes by road cuttings through low hills.

Residential properties in Figure 4-25 would be able to see the Plant if there was no screening vegetation between these residences and the Plant. The Plant would be visible from the highway; however landscape mitigation measures either at the site or along the highways edge could screen or filter views.

The overall visual impact from the Plant from the highway would be low and could be reduced to negligible with appropriate landscape treatment.

Figure 4-25 Viewpoint 9: Bass Highway #1, looking south-west



Figure 4-26 shows a photomontage of the view from this location with the Desalination Plant superimposed on the view. The proposed Desalination Plant may be visible from this location on the Bass Highway. The photomontage shows that the Plant will comprise a very small part of the view when looking south-east from this location.

Figure 4-26 Photomontage of viewpoint 9 with the Desalination Plant superimposed into view



Viewpoint 10: Bass Highway #2 (at Dalyston)

Viewpoint 10 is located on the Bass Highway at Dalyston approximately three kilometres from the Plant. Figure 4-27 and Figure 4-28 show the view looking east and west along the Bass Highway and across the shrubby and low coastal heathland landscape unit. There would be no views to the Plant from residences to the northern side of the highway or from the highway. It may be possible to view the Plant from residential properties on the southern side of the Bass Highway.

Figure 4-27 Viewpoint 10: Bass Highway #2, looking east and west along the Bass Highway



Figure 4-28 Viewpoint 10, looking west along the Bass Highway



The Plant would be a minor addition to a view that already includes many obvious signs of man-made changes to the landscape. Landscape at the Plant would further reduce any visual impact. The overall visual impact from this viewpoint is assessed as nil (ERM 2008$_1$, Technical Appendix 34).

Viewpoint 11: Bass Highway #3

Viewpoint 11 is located on the Bass Highway approximately 1.2 kilometres east of Dalyston. The Plant site is approximately 3.5 kilometres south-west of this location. In this section of the Bass Highway there is little roadside vegetation and views to the Plant across the coastal plains would only be screened by cuttings from the highway or by vegetation. Figure 4-29 shows the view looking south-west.

Figure 4-30 is a photomontage showing that the Plant is visible on the horizon line with little intervening vegetation to minimise the visual impact. This photomontage assumes an level of 12 m AHD across the entire site. Visual impact could be reduced through the use of mounding and screening at the site. The existing wind turbines are already visible from this location and are considered more likely to attract the casual observer's attention due to their greater height than the Plant. The overall visual impact from the Plant is assessed as low, however if landscape planting around the site is established the impact would be expected to be reduced further to negligible.

Figure 4-29 Viewpoint 11: view looking south-west



Figure 4-30 Viewpoint 11: Bass Highway #3 photomontage



Source: ERM 2008

Viewpoint 12: Lower Powlett River Road #1

Viewpoint 12 is located on the Lower Powlett Road approximately 2.3 kilometres from the Plant. This road is little used, with fewer visitors than the Mouth of the Powlett River Road. Views from this location towards the Plant are across the coastal plain landscape unit as shown in Figure 4-31.

The Plant would be visible from this location. Landscape mitigation, similar to the vegetation further down the road, could screen views to the Plant. As this is a little used road, the visual impact would be negligible. The overall visual impact is assessed as low (ERM 2008_1, Technical Appendix 34).

Figure 4-31 Viewpoint 12: Lower Powlett River Road #1



Viewpoint 13: Lower Powlett River Road #2

Viewpoint 13 is located on the Lower Powlett River Road just west of Viewpoint 12 and approximately two kilometres from the Plant. Views from this location are across the coastal plain as shown in Figure 4-32. Without landscape screening the Plant would be highly visible, however as the road is seldom used, the visual impact would be negligible. Landscaping, especially adjacent to the road edge, could effectively screen the Plant from view. The overall visual impact at this location is assessed as low.

Figure 4-32 Viewpoint 13: Lower Powlett Road #2



Viewpoint 14: Lower Powlett River Road #3

Viewpoint 14 is located at the small gravel car park at the end of the Lower Powlett River Road, approximately 600 metres from the Plant. This car park serves Williamsons Beach. Views from this location towards the Desalination Plant look out across shrubby and low coastal heathland landscape unit, which has a high degree of sensitivity. Existing vegetation screens all views from this location to the Plant as shown in Figure 4-33. The overall visual impact at this location is assessed as low (ERM 2008$_1$, Technical Appendix 34).

Figure 4-33 Viewpoint 14: Lower Powlett Road #3



Viewpoint 15: Donmix Concrete Batching Plant

Viewpoint 15 is located on West Area road, adjacent to the existing Donmix Concrete Batching Plant as shown in Figure 4-34. This is an important reference point as although it has a smaller building footprint than the Plant, the concrete batching plant contains a structure that is approximately 15 metres in height. From nearby locations the concrete batching plant is not visible due to the screening provided by intervening vegetation, demonstrating the effectiveness of screening vegetation limiting views to structures such as the Desalination Plant. The overall visual impact is assessed as nil (ERM 2008$_1$, Technical Appendix 34).

Figure 4-34 Viewpoint 15: Donmix Concrete Batching Plant



Viewpoint 16: Wonthaggi

Viewpoint 16 is located on West Area Road on the western edge of Wonthaggi as shown in Figure 4-35. The concrete batching plant is just visible in the foreground and wind turbines are visible in the background. The Plant would not be visible from this location. However, it is a good reference point to confirm the ability of this landscape, particularly where vegetation is established, to screen structures such as the concrete batching plant and the existing wind turbines. The visual impact from the Plant at this location would be nil.

Figure 4-35 Viewpoint 16: Wonthaggi



Viewpoint 17: Williamsons Beach south

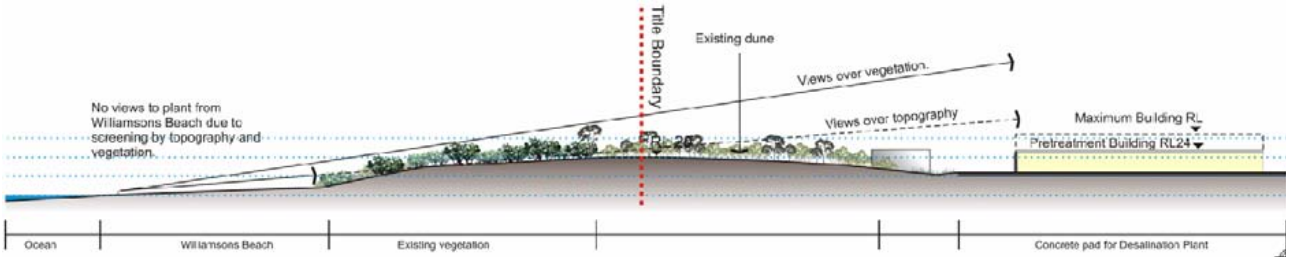
Viewpoint 17 is located on Williamsons Beach, at the end of the access track at Lower Powlett Road near the southern end of the site. This location is approximately midway along the south-west boundary of the site. The beach is publicly accessible and runs north-east to south-west. In the Reference Project the Plant will be approximately 650 metres to the north. Views from this location look across the coastal cliffs and shoreline landscape unit. As shown in Figure 4-36, the dunes rise steeply and would inhibit views of the Plant.

Figure 4-36 Viewpoint 17: View towards the Plant site from the beach



Figure 4-37 is an indicative section from Williamsons Beach foreshore, through the existing dune system to the Desalination plant.

Figure 4-37 Section through dune to the Desalination Plant site



The section shows that the landform of the dune screens views inland, when looking towards the Plant from Williamsons Beach foreshore. The existing vegetation located on the dunes will also assist to filter views of the site; therefore the overall visual impact at this location would be nil (ERM 2008$_1$, Technical Appendix 34).

Viewpoint 18: Williamsons Beach north

Viewpoint 18 is located on the Mouth of Powlett River foreshore at the north-western end of the site. The beach is publicly accessible and runs north-east to south-west. The Plant is approximately 800 metres to the east. Views from this location look across the coastal cliffs and shoreline landscape unit. The Plant would not be visible from this section of the coast. There is potential for the Plant to be visible from points near the Powlett River mouth.

As for Williamsons Beach south, Figure 4-38 shows that the dune system rises very steeply preventing views of the Plant. As a result, the overall visual impact at this location would be nil.

Figure 4-38 Viewpoint 18: Williamsons Beach north



Viewpoint 19: Bass Coast Rail Trail

Viewpoint 19 is located along the Bass Coast Rail Trail to the east of Mouth of Powlett Road. The rail trail is used by tourists and locals and runs between Wonthaggi to Kilcunda in this section. The proposed Desalination Plant site is located approximately 2.4 kilometres to the south-east of this location. Views from this location toward the proposed Desalination Plant look out across landscape unit 3 – coastal plain. Figure 4-39 shows the view looking south-west towards the Desalination Plant from this location. The existing wind turbines that are located in the Wonthaggi Wind Farm further to the south of the proposed Desalination Plant are just visible beyond a low rise and the existing vegetation. Figure 4-40 shows an enlarged view, which includes the wind turbines.

Figure 4-39 View looking south-west towards the Desalination Plant site



Figure 4-40 Enlargement of Figure 4-39, showing wind turbines



The wind turbines located in the Wonthaggi Wind Farm are approximately 69 metres tall to the nacelle (hub height). There is a low vegetated rise between this location and the proposed Desalination Plant site. This is demonstrated by the limited visibility of the towers of the existing wind turbines. From this location it is unlikely that the proposed Desalination Plant would be visible due to the topography and existing vegetation which would screen views. The visual impact of the proposed Desalination Plant would be low.

Viewpoint 20: Bass Highway

Viewpoint 20 is located along the Bass Highway approximately midway between Anderson and Kilcunda. This view represents the first view of the coastline that motorists would experience when heading towards Kilcunda. The proposed Desalination Plant Site is located approximately 7.3 kilometres to the South East of this location.

Views from this location toward the proposed Desalination Plant look out across landscape unit 1 – coastal cliffs and shoreline.

Views along the Bass Highway when travelling south-east are through a landscape that contains areas of extensive road side vegetation, hills and many roadside cuttings which all assist to filter or confine views. From viewing locations beyond six kilometres it would be difficult to discern the proposed Desalination Plant site. At six kilometres the Desalination Plant is beyond the extent of the defined viewshed. The overall visual impact is assessed as negligible.

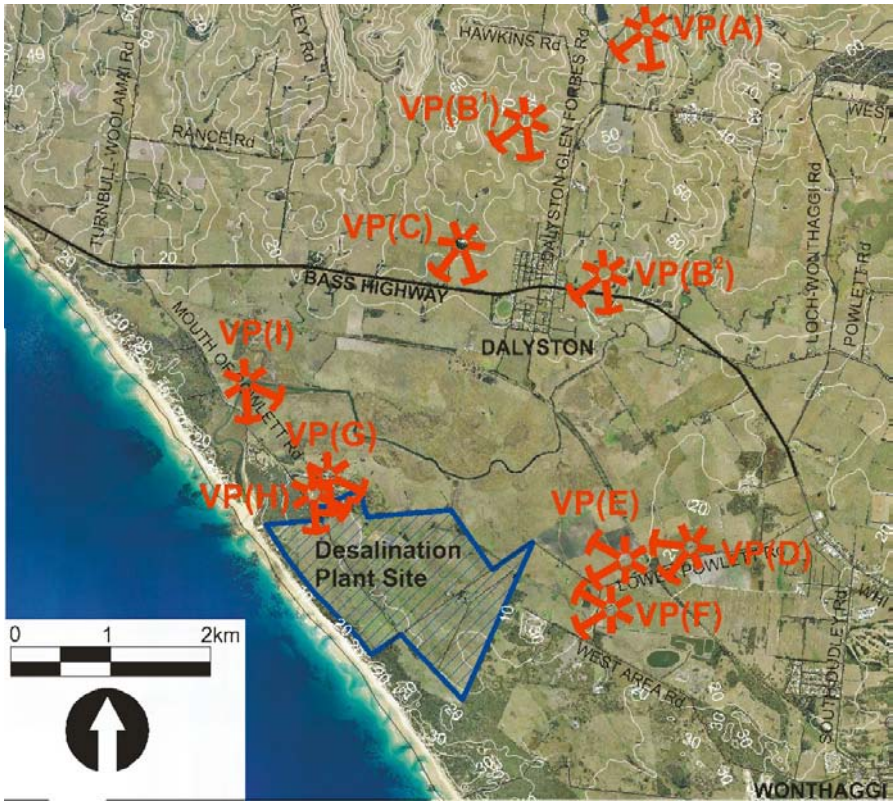
4.3.4 Visual impact at private viewpoints

The greatest potential visual impact is likely to be on residential properties within two kilometres of the Plant. There are two houses within 0.5 kilometres of the Desalination Plant and 12 houses between 0.5 kilometres and two kilometres from the Plant. A visual impact assessment was undertaken at nine residential properties, labelled A to I and is summarised in Table 4-4. The locations of these residents are shown in Figure 4-41 (ERM 2008$_1$, Technical Appendix 34).

Table 4-4 Private viewpoint descriptions and summary assessment of Reference Project

View point	Description	Visual impact
VPA	309 Glen Forbes Road, Archies Creek	Low (negligible with screening)
VPB	4255 Bass Highway, Dalyston	Low (negligible with screening)
VPC	50 Cloverdale Road, Dalyson	Low (negligible with screening)
VPD	130 Lower Powlett Road, South Dudley	High (negligible with screening)
VPE	Allotment opposite 185 Lower Powlett Road, South Dudley	Moderate (low with screening)
VPF	25 Webb Road, South Dudley	Low (negligible with screening)
VPG	290 Mouth of Powlett Road	Low
VPH	255 Mouth of Powlett Road	Low
VPI	205 Mouth of Powlett Road	Negligible

Figure 4-41 Residential Viewpoints



Source: ERM 2008

Viewpoint A: 309 Glen Forbes Road, Archies Creek

Viewpoint A is located on low hills approximately 5.5 kilometres north of the plant. This property looks towards the coast. There is an existing 66 kV powerline running through the valley in the middle distance and the Wonthaggi Wind Farm is visible to the left as shown in Figure 4-42. The visual impact at this property would be low due to the distance from the plant site. The overall visual impact would be low without screening and negligible if screening were established around the Plant (ERM 2008$_1$, Technical Appendix 34).

Figure 4-42 Viewpoint A, looking south towards the Desalination Plant



Viewpoint B: 4255 Bass Highway, Dalyston

Viewpoint B has two different viewpoints:

- B1: a hill on the property near Archies Creek Road, Dalyston approximately 4.3 kilometres from the Desalination Plant
- B2: 4255 Bass Highway, Dalyston at the house approximately 3.3 kilometres from the Desalination Plant.

The elevated location at Viewpoint B1 looks towards the coast with the view including Dalyston and Wonthaggi Wind Farm as shown in Figure 4-43. The house at Viewpoint B2 is on lower lying land further to the south, however it still has a view of Dalyston and Wonthaggi as shown in Figure 4-44. Whilst the plant would be visible, it would be a small component in these views, diminishing further if vegetation is established. The overall visual impact from the house site would be low without screening and negligible with screening.

Figure 4-43 Viewpoint B1, looking south from a high point on the rural property



Figure 4-44 Viewpoint B2, looking south from the front of the house



Viewpoint C: 50 Cloverdale Road, Dalyston

Viewpoint C is a rural property approximately three kilometres north of the Plant site, north of the Bass Highway. There would be no views to the plant from the house due to extensive boundary plantings, which screen views, as shown in Figure 4-45. The overall visual impact from this property would be low and negligible with landscape screening (ERM 2008$_1$, Technical Appendix 34).

Figure 4-45 Viewpoint C, the existing house



Viewpoint D: 130 Lower Powlett Road, South Dudley

Viewpoint D is a house on a large allotment on the western side of Lower Powlett Road near Wonthaggi, approximately two kilometres from the Plant site. The current view from this house is shown in Figure 4-46. Figure 4-47 shows a photomontage of the view of the Plant from this location looking south-west.

The photomontage shows that the Plant will be visible from this location. Landscaping at selected locations along the property boundary will assist in reducing any visual impact, as well, as appropriate colour palette for structures within the Plant site. The overall visual impact would be high without landscaping and negligible with landscaping.

Figure 4-46 Viewpoint D, view from rear of house and main living areas



Figure 4-47 Viewpoint D, photomontage looking south-west from rear of house



Viewpoint E: an allotment opposite 185 Lower Powlett Road, South Dudley

Viewpoint E is an allotment that forms part of a vegetable farm, approximately 2.0 kilometres from the plant. There is no residence currently on the property. However, one is proposed adjacent to Lower Powlett Road.

Views from the house site to the plant site are partially screened by the low rise as shown in Figure 4-48. The visual impact at this location without landscape mitigation would be moderate without landscape mitigation and low with landscape mitigation (ERM 2008$_1$, Technical Appendix 34).

Figure 4-48 Viewpoint E, panorama from rear of property



Viewpoint F: 25 Webb Road, South Dudley

Viewpoint F is on the north side of Webb Road and features a house approximately 1.7 kilometres from the plant site. Views from the house towards the plant site are screened by existing vegetation as shown in Figure 4-49. The only open view to the Plant site is near the fence line, as shown in Figure 4-50. The veranda of the house presents a view of the traffic along Lower Powlett Road. The owner expressed concern regarding visual impacts from traffic along this road during construction.

The overall impact of the Plant on this viewpoint is assessed as low. The visual impact of traffic would be negligible if additional screening is undertaken along the Lower Powlett Road boundary. The overall visual impact at this location is assessed as low to negligible (ERM 2008$_1$, Technical Appendix 34).

Figure 4-49 Viewpoint F, view from veranda towards Desalination Plant



Figure 4-50 Viewpoint F, view from fence line towards Desalination Plant



Viewpoint G: 290 Mouth of Powlett River Road

Viewpoint G is a residential property located at 290 Mouth of Powlett River Road. The Plant is approximately 0.7 kilometres to the south of this residential dwelling. The Wonthaggi Wind Farm is also located further to the south of the plant site. Figure 4-51 shows a view looking south towards the plant site. Existing vegetation is located between the house yard and the Plant to the south. It is unlikely that there would be any views to the Plant and therefore the visual impact is assessed as low (ERM 2008$_1$, Technical Appendix 34).

Figure 4-51 View looking south towards Desalination Plant



Viewpoint H: 255 Mouth of Powlett River Road

Viewpoint H is a residential property located at 255 Mouth of Powlett River Road. There are two dwellings located at this address. The Plant would be approximately 0.4 kilometres to the south of the nearest dwelling on this property. House (H1) is the primary residential dwelling on this property and has a veranda that faces north, away from the Plant. House (H2) has views to the south, but these are screened by existing vegetation. It is unlikely that there would be views of the plant site from this location.

Figure 4-52 shows the view looking south from the main dwelling yard. There is a small break in vegetation in the background where views are available to the existing Wonthaggi Wind Farm. It is unlikely that there would be views of the Plant site from this location and therefore the overall visual impact is assessed as low.

Figure 4-52 View looking south towards the Desalination Plant



Viewpoint I: 205 Mouth of Powlett River Road

Viewpoint I is a residential property located at 205 Mouth of Powlett River Road. This dwelling is approximately 1.9 kilometres north of the Plant. The house has a veranda that faces east which affords an excellent view of Lower Powlett Road. Figure 4-53 shows the view to the plant site looking south.

The nacelle of the wind turbine can just be seen, which is 69 metres above the ground. Therefore, the Desalination Plant will not be visible from this location and the overall visual impact is assessed as negligible.

Figure 4-53 View looking south from the rear of the existing dwelling



4.4 Mitigation and management

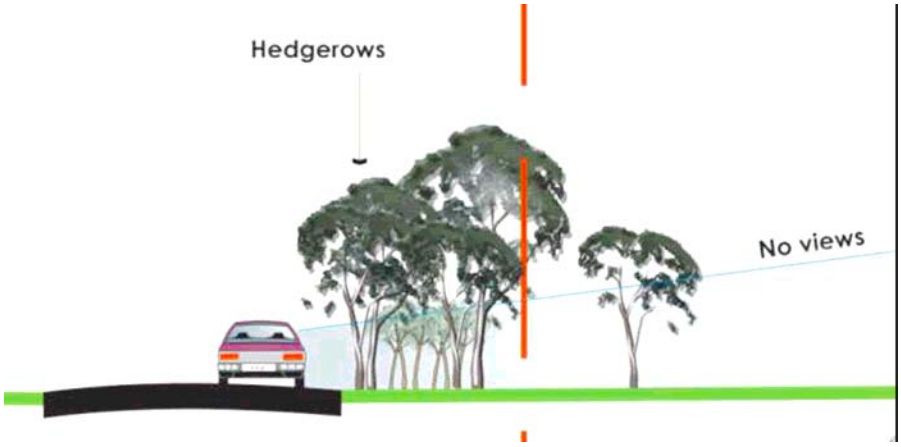
This section discusses mitigation and management measures at public and private viewpoints.

4.4.1 Public viewpoints

Landscaping along roads

Strategic landscaping could be considered for publicly accessibly areas to screen views to the plant. Planting of vegetation as shown in Figure 4-54 can screen views from nearby roads, such as sections of the Bass Highway. Flora and fauna values may also be improved by utilising indigenous species.

Figure 4-54 Landscaping along roads



Reducing visual impact of the built form

As well as strategies that involve landscape there are also proven methods to reduce the visual impact of developments such as the Desalination Plant by breaking down the building mass using colour and design of the built-form.

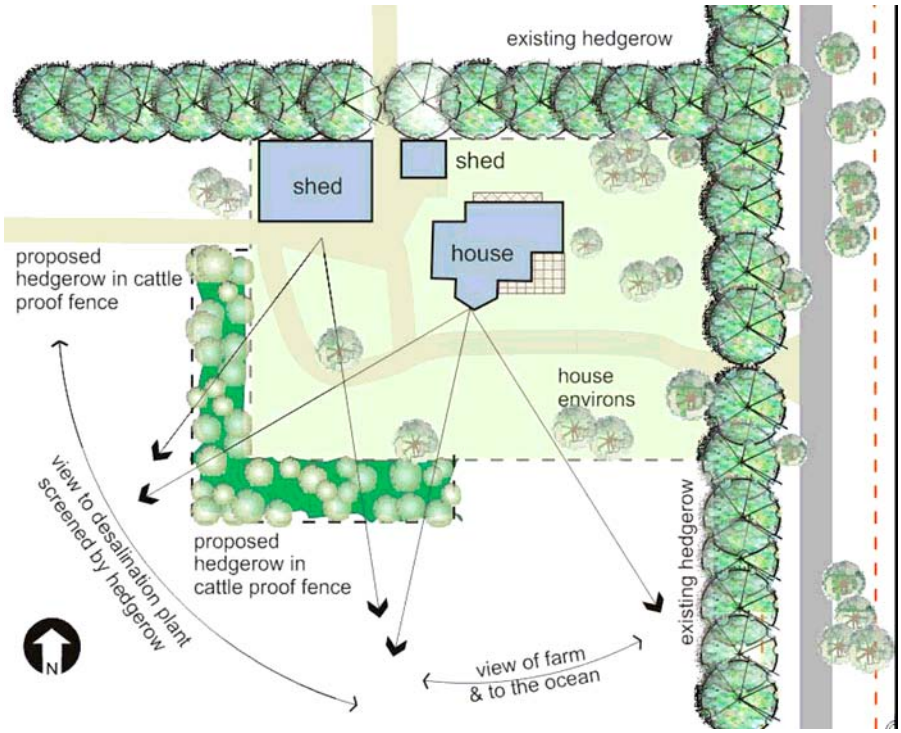
4.4.2 Private viewpoints

Landscape mitigation strategies

Plantings at residential properties could be designed to either screen the Plant from view, or significantly reduce the visual dominance through filtering. The effectiveness of this as a mitigation measure depends on the landowner's objectives and the residence's orientation in relation to the Plant.

Residential properties to the north of the Plant could be easily screened by vegetation on the southern boundary. This vegetation would also protect the properties from southern winds and would not affect solar access. However, properties to the north of the Plant have oriented living areas to gain views to the ocean and the coastline and may not wish to establish boundary plantings, which would screen these views. Figure 4-55 shows a potential mitigation plan for a hypothetical property. This scenario keeps some views to the ocean, whilst screening views to the Plant.

Figure 4-55 Landscape mitigation plantings on the southern boundary



Landscape mitigation measures are more desirable for houses to the east and west of the Plant than for those to the north. Landscape mitigation measures for these properties could provide a reduction in the visual impact of the Plant, however could affect the solar access to living areas or courtyards.

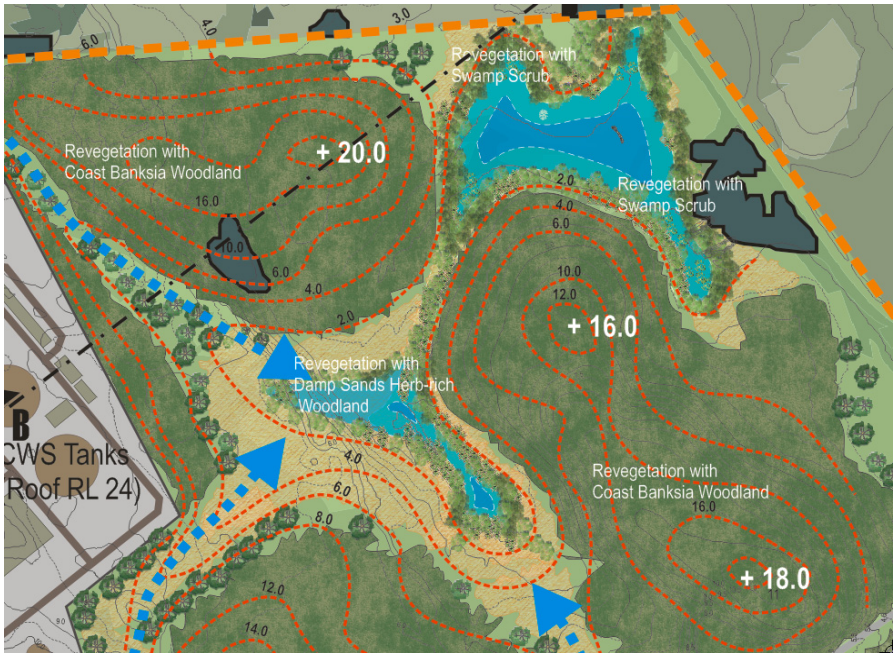
4.4.3 Landscape treatment for the plant site

As reflected in the Reference Project, opportunities for landscaping around the site include grading, rehabilitation of wetland areas and re-vegetation.

The proposed landscape works on the Desalination Plant site would aim to replicate the existing dune structure that is located to the south-west of the site. This objective would also ensure that the existing grades and drainage lines of this dune system are replicated to ensure that the final site grading appears as a natural landform. This grading would assist in reducing the visual impact to areas north-west of the site near the Mouth of the Powlett River Caravan Park and to the north near the Bass Highway. In the Reference Project, the western half of the plant site would be benched at 12 metres AHD and the eastern half at 8 metres AHD. Mounding has been designed with a maximum grade of 1:5. This grading will assist in channelling surface run-off through a wetland area prior to being discharged into the Powlett River.

The proposed landscape concept in the Reference Project illustrates the incorporation of wetland areas along the north eastern boundary and these are intended to rehabilitate an existing wetland system and treat surface run off water before it enters the Powlett River. Figure 4-56 shows a portion of the overall landscape concept, illustrating the proposed wetland dunes and drainage lines.

Figure 4-56 Landscaping concept plan, showing wetland dunes and drainage lines



Revegetation would be undertaken to ensure the resulting landscape appears as a seamless transition between the existing dunes adjacent to the foreshore area and the low-lying swamp scrub to the north-east of the proposed Desalination Plant site. This landscape treatment would assist in screening the proposed Desalination Plant from viewpoints within the surrounding landscape. However it must be recognised that greater screening will eventuate as the vegetation establishes, and these dune formations will support the establishment of Ecological Vegetation Classes (EVCs) that contain taller vegetation such as Eucalypts and Banksias. The local EVCs have been used as a basis for plant selection for the site that reflects the locally indigenous flora. The strategy to be used is to rehabilitate the new higher areas on the site with Coast Banksia Woodland and then to provide a gradual transition to Damp Sand, Herb Rich Woodland at the centre of the site. Swamp Scrub would be established toward the lower portion of the site to the north where the wetlands are proposed. The resultant landscape will mimic the pre-European landscape and is shown in Figure 4-57.

Figure 4-57 Landscaping around the Desalination Plant



4.5 Performance Requirements

Performance Requirements (PRs) have been developed to provide an environmental framework for managing potential impacts on landscape character and visual amenity associated with the Project during construction and operation. The PRs are focussed on the environmental 'outcomes' that the State wishes to achieve through the Project delivery. The PRs relevant to managing the visual impacts of the Plant are set out below. The full suite of PRs for the Project is provided in Volume 1 Chapter 10 as part of the overall Environmental Management Framework.

As part of the environmental impact and risk assessment process relating to landscape character and visual amenity at the Plant, ERM (2008a) has identified a range of suggested management measures that could be implemented to manage potential impacts. These suggested management measures have been formulated in response to the Plant design. In effect, the suggested management measures demonstrate how the Reference Project can achieve the PRs. These detailed management measures have formed an important input to the PRs for the Project.

The following management measures suggested by ERM (2008_1) address landscape and visual issues at the site:

- mitigating visual impacts from public view points include:
  - strategic landscaping along roads, such as sections of the Bass Highway, could be considered to screen views to the plant site
  - breaking the building mass of the plant site using colour shading and non-reflective, dark roofing
- mitigating visual impacts from private view points include:
  - landscape planting at residential properties north and particularly east and west of the plant site, could be designed to screen or filter views
  - landscaping to be offered to all residential properties within two kilometres of the plant site
- landscape treatments for the plant site include:
  - incorporating areas of mounding that aim to replicate the existing, natural dune structure located to the south west of the site
  - re-establishment of the existing wetlands along the north eastern boundary of the Plant site utilising species from locally occurring EVCs
  - screening the Desalination Plant with integrated landscape and re-vegetation treatments
- infrastructure designs at the Plant site should remain at the lower bench level to minimise the visual impact across the coastal plain.

The PRs specific to landscape character and visual amenity are shown in the Table 4-5.

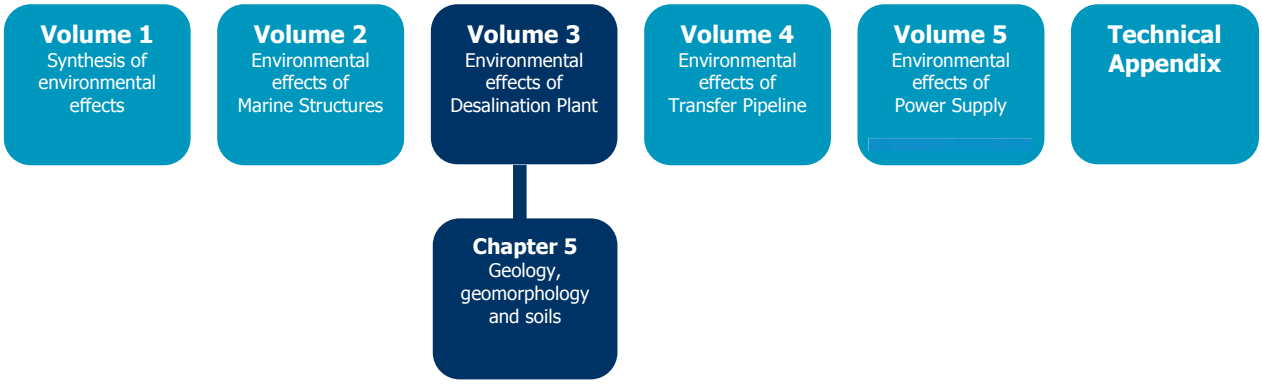
Table 4-5 Performance Requirements

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Visual Amenity – Plant Site	✓	✓	Protect visual amenity, including landscape and recreational values of the coast.	Minimise visual impact on coastal landscapes, rural and residential properties and on publicly accessible locations. No permanent marine Project infrastructure visible from the beach. Minimise nocturnal light spill beyond the Desalination Plant.	Comply with the Performance Criteria. Design and site Desalination Plant infrastructure to minimise visual impacts on coastal landscapes, rural and residential properties, and publicly accessible locations. The Desalination Plant is to use building forms (including massing) and a palette of materials and finishes for all buildings, structures and open space elements that are responsive to the character of the surrounding coastal landscape. The impact of the configuration of the Desalination Plant on the surrounding landscape from close up, middle distance and long distance should be studied and demonstrated by visual modelling from critical viewpoints defined in the Landscape and Visual Assessment report. The Desalination Plant Building Envelope is defined by: ▪ Figure PR Visual Sensitivity Area – Desalination Plant Building Envelope in Technical Appendix 5 ▪ a maximum building height of +32m elevation Australian Height Datum (AHD) If constructing any building outside the Desalination Plant Building Envelope, demonstrate compliance with the Performance Criteria. Provide integrated landscaping on the plant site, including perimeter landscape buffering between the Desalination Plant Building Envelope and plant site boundaries. Provide visual screening along the public access to Williamson Beach as an integrated component of the Landscape Sensitive Design. Landscape sensitive design to be an integral part of the Desalination Plant layout and design, incorporating coastal tolerant vegetation and areas of mounding that use the nearby coastal dune system as an appropriate landform. An example of an acceptable outcome could be mounding with grades less than 1:3 to allow ease of maintenance and varying heights to mimic

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			natural landforms. Keep lighting levels within and external to buildings at minimum required for operation and safety. Landscape sensitive design for the Desalination Plant to minimise visual impacts including: ■ Landscaping using species from locally occurring Ecological Vegetation Classes (EVCs) to achieve screening from rural and residential properties and on publicly accessible locations ■ Respecting the local landscape character and landform in any significant earthworks or landscaping ■ Use of non-reflective materials for roofs ■ Re-establishment of wetland (unnamed tributary of the Powlett River) on the Desalination Plant site Offer landscape mitigation measures on a case by case basis to existing residential buildings within 2 km of the Desalination Plant site

5.0 Geology, geomorphology and soils





5 Geology, geomorphology and soils

This chapter describes the existing geology and geomorphology at the site. It considers the impact of construction and operation of the Plant and assesses the impacts of this interaction. Where significant impacts are identified, strategies for mitigation and management are proposed in the Performance Requirements for the Project.

This chapter is based on specialist findings from the following reports in the Technical Appendices:

- Rosengren, N. and Boyd, C. (2008_1) *Existing site conditions, Impacts and Risk Assessment, Geology, Geomorphology, and Acid Sulphate Soils* (Technical Appendix 37)
- GHD Pty Ltd (2008_6) *Land Contamination Existing Conditions and Impact Assessment Report – Plant site* (Technical Appendix 36).

The reports included desktop studies, literature review, field investigations and surveys.

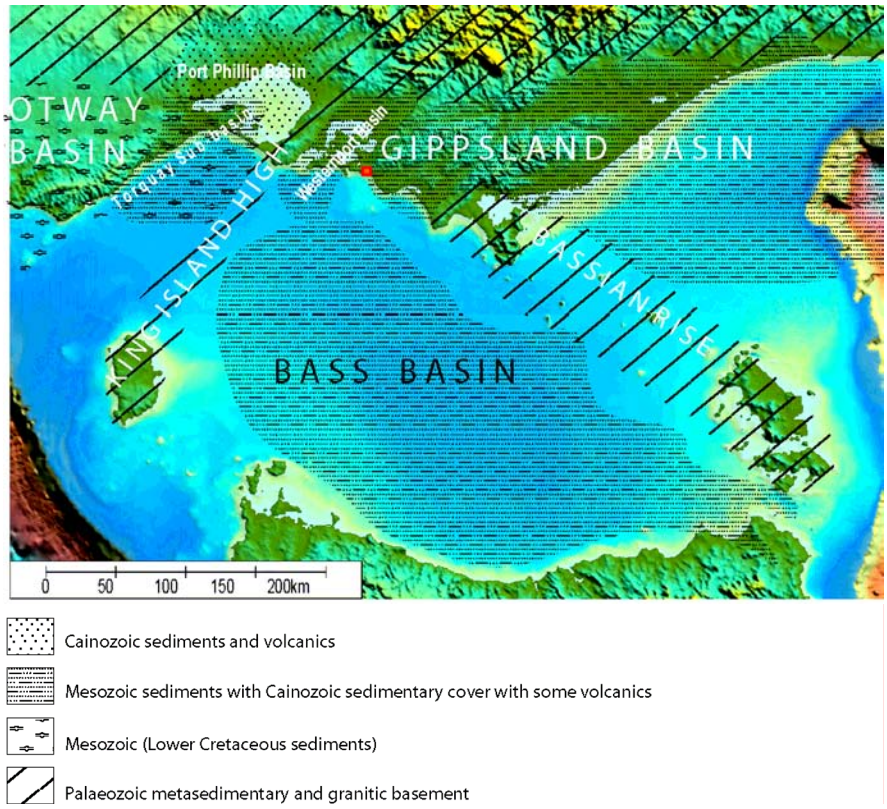
5.1 Existing conditions

The following section discusses the existing geology and geomorphology of the site and surrounding area. It also identifies sources of potential acid sulfate soils, contaminated land, and significant geological features such as the disused State Coal Mine.

5.1.1 Geology

The geology of southern Victoria is comprised of a number of sedimentary basins separated by bedrock 'highs'. The site lies inside one of these basins. This is shown in red in Figure 5-1.

Figure 5-1 Geological basins of southern Victoria and Bass Strait



The site is located in the Gippsland Basin, close to the basins western boundary and the Western Port Basin. The Gippsland Basin consists mostly of Mesozoic sediments, with Cainozoic sediments and Volcanics. Mesozoic sediments are referred to as the Strzelecki Group. Figure 5-2 shows typical Mesozoic sedimentary rocks near the site (Rosengren and Boyd 2008[1], Technical Appendix 37).

Figure 5-2 Dipping, cross-bedded Mesozoic sedimentary rocks on shore platform at Harmers Haven



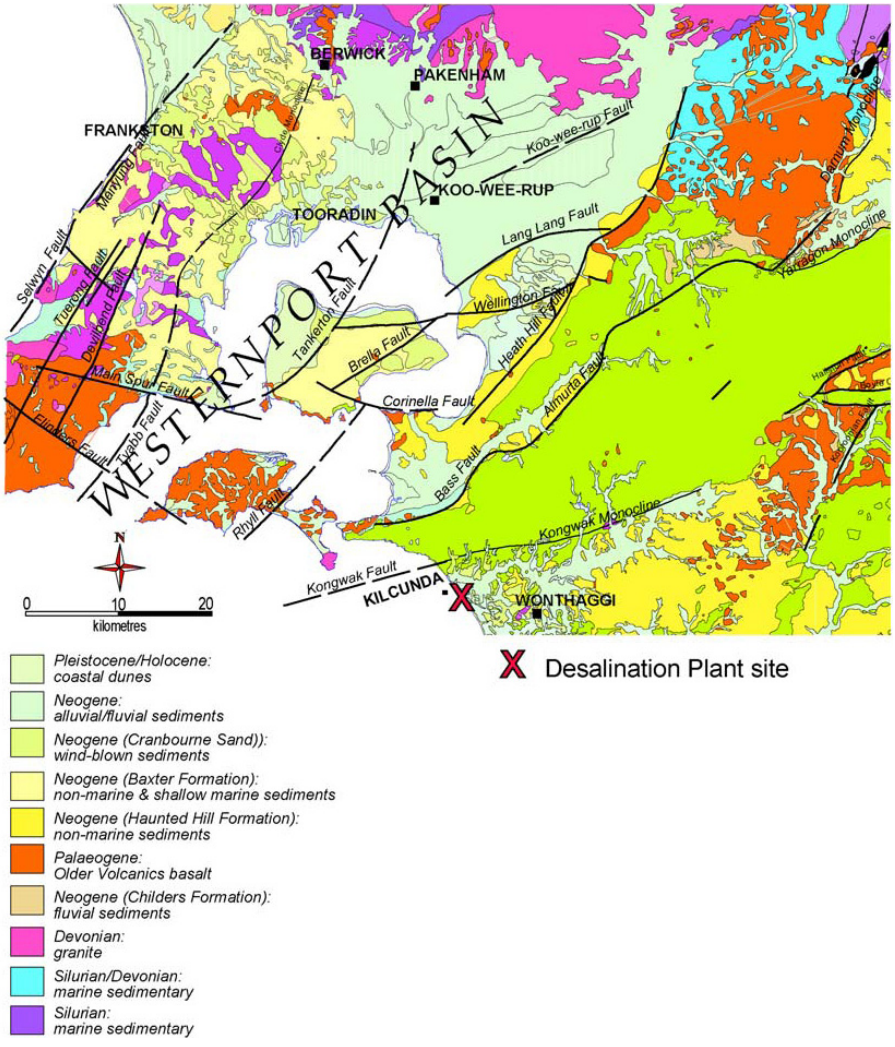
The outcrop area of the Strzelecki Group beds is large and underlies the site, at depths of more than 300 metres.

Rock formations in the South Gippsland region range from the Cambrian period (540 to 488 million years ago) to those formed in modern times. The rock formations and ages at the site and surrounding areas are:

- the Cape Liptrap peninsula is a plateau developed on Devonian marine sediments, and Silurian/Devonian sedimentary rocks. These rocks form the Hoddle Range and crop out in a northerly trending ridge that passes through Wonthaggi (440 to 360 million years ago)
- the Palaeogene is a subdivision of the Cainozoic that incorporates the Palaeocene, Eocene and Oligocene ages (65.5 to 23.3 million years ago)
- the Neogene includes the Miocene and Pliocene (23.3 million years ago) to the base of the Quaternary and beginning of the Pleistocene (1.8 to 2.5 million years ago) (Rosengren and Boyd 2008[1], Technical Appendix 37).

The geology of the area is shown in Figure 5-3. Detailed explanation of the geological formations at the site is provided in Technical Appendix 37.

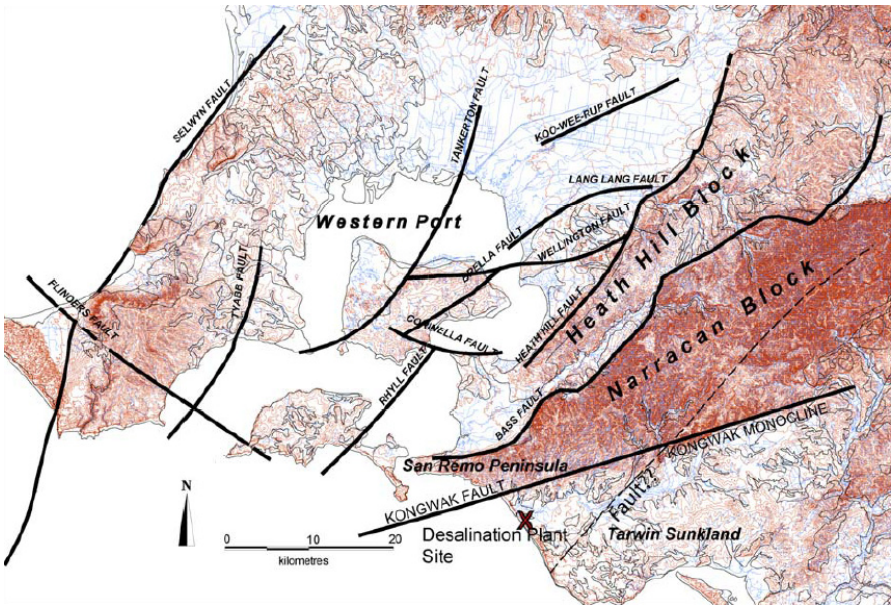
Figure 5-3 Geology of Western Port and west Gippsland



Structure and tectonics

The south and west Gippsland region is structurally complex with a number of faults and basins. The site is in a region of undulating lowland referred to as the Tarwin Sunkland (Figure 5-4), which forms part of the Eastern Plains of Victoria. The location of the site is on the undulating Powlett Plains, an area of floodplain and sand-covered plain (Rosengren and Boyd 2008[1], Technical Appendix 37).

Figure 5-4 Structural regions and fault blocks of west Gippsland



Areas of geological significance

The Strzelecki Group rocks contain numerous fossils that are unevenly distributed. Dinosaur fossils have been found in rocks of similar age and origin in a stretch of coast between Kilcunda and Inverloch. Fossilised remains (bones, teeth and vertebrae) of dinosaurs and marine reptiles have reportedly been found in a rock shelf at the mouth of the Powlett River, to the west of the site, and at other locations on the coast near the site. Other fossils, including fish, insects and feathers have also been uncovered in this area, making it one of Victoria's most significant fossil areas. However, no dinosaur or marine reptile fossils have been identified at the actual Desalination Plant site.

Several small coalfields were worked in south and west Gippsland, the major production being from the fields at Wonthaggi and Korumburra. The last mine at Wonthaggi closed in 1968. The coal seams mined until the 1960s disclosed many plant and insect fossils, and other significant fossil occurrences have been recorded from terrestrial outcrops in south Gippsland.

Sites of geoscience significance are places with geological and/or landform features. These are important for displaying geological materials and/or landforming processes than contribute to understanding of the origin and dynamics of landscape. Professional earth scientists use them as teaching and research sites. They may be significant in that they represent specific characteristics of a region e.g. Westernport, Bass River catchment, Gippsland, or geological unit e.g. Mesozoic sediment, or may be rare or outstanding examples of a geological of landform feature of wider extent (Rosengren and Boyd 2008$_1$, Technical Appendix 37). The site illustrates a complex history and a diversity of land forms and materials.

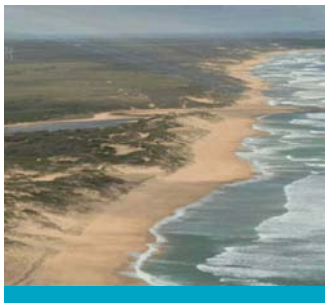
There are no single areas or features of outstanding significance to be assessed within the site; however the site is close to the geological landforms and/or processes of the Lower Powlett River valley and the barrier and wetland system, which would be included because of the complex geological landforms and processes involved at the site.

5.1.2 Topography and geomorphology

The site is flat and low-lying. The only steep slopes in the area are along the coastline where the highest elevations (over 20 metres) are at the top of the coastal dunes.

There are three defined terrain patterns in the Project area:

- Terrain Pattern 1: Coastline – shore platforms, beaches, rock cliffs, foredunes, transgressive dunes
- Terrain Pattern 2: Gently undulating and terraced sand-covered plain
- Terrain Pattern 3: Alluvial floodplain and swamp.



Terrain pattern 1 – coastline

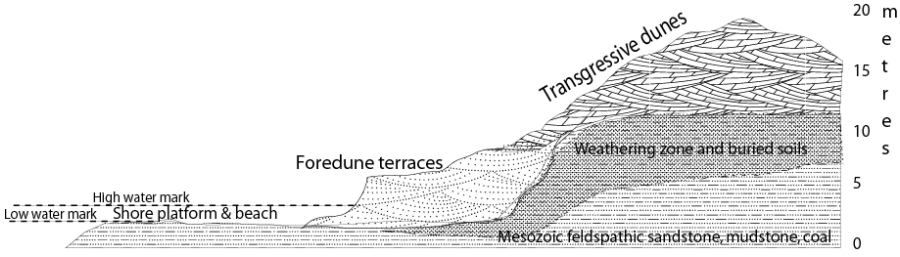
The coastline from the Powlett River mouth to south of Williamsons Beach is straight and is a south-west facing coastline. At Kilcunda the coastline changes from a south-facing headland and embayment, to a south-west facing coastline. The coastline experiences a west to southwest swell and strong onshore winds.

An intertidal shore platform fringes the coastline at the Powlett River, and south of the Powlett River when the river mouth is open. A sandy beach with areas of shore platform and numerous rocks and reefs back the shore. This platform is blanketed by sand, which is exposed at low tide.

Aerial photographs show the shore platform extends for 1.5 kilometres southeast of the Powlett River when the river mouth is open. At the river mouth the shore platform was 270 metres long and 130 metres wide, extending 300 metres offshore (Rosengren and Boyd 2008[1], Technical Appendix 37).

The Powlett River East beach extends east from the Powlett River, at the site. The beach above high-tide water mark consists of dune terraces, and is backed by rock cliff that is submerged at high spring tide. Figure 5-5 shows the beach and dune profile. The low tide exposed beach is relatively narrow and steep. The underwater beach is scattered with rock platforms and scoured rip channels.

Figure 5-5 Profile across beach and dune sequences



The rock cliffs and bluffs underlie the coastal dunes southeast of the Powlett River mouth, and protect the shoreline from erosion. The rock cliffs are weathered and covered with a loose layer of thick and sandy clay. Some of this cover has moved down the cliff and formed rubble at the base, which is broken up and removed by waves.

A variety of coastal dunes occur along this coast, which fall into the foredune (closest to the beach) and transgressive dune categories. Figure 5-6 shows the coastal dunes near the site (Rosengren and Boyd 2008$_1$, Technical Appendix 37).

Figure 5-6 Coastal dunes at the Plant site

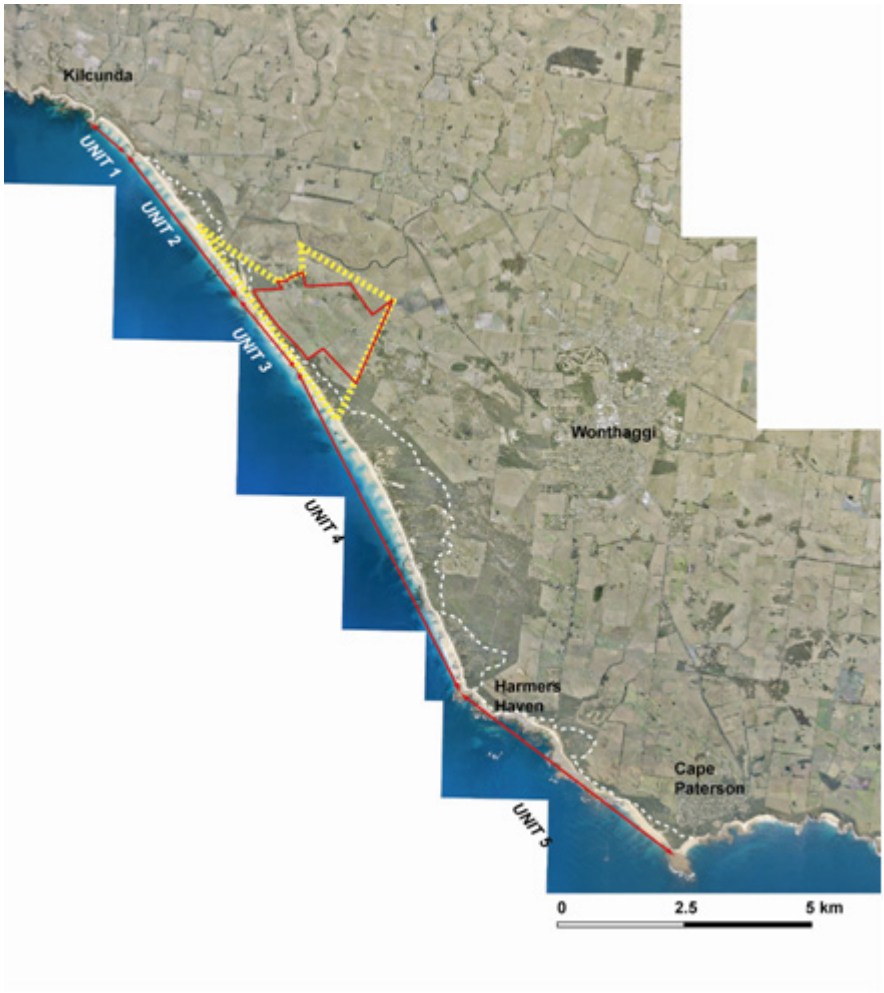


The white line encloses active and fixed transgressive dunes; the broken line shows former inland extension of blowing sand now stabilized in farmland.

Foredunes are covered in a variety of vegetation including grasses, scrub and woodland. This vegetation plays a major role in dune shape, movement and stability. Vegetation reduces wind speed, allowing for sand accumulation and dune growth. A narrow zone of eroded transgressive dunes is located behind the foredunes at the site. The bare sand bodies are adjacent to public access points at either end of the coastal section, due to human traffic and greater volumes of sand at these points (Rosengren and Boyd 2008$_1$, Technical Appendix 37).

From Kilcunda to Cape Paterson there are five distinct coastal units, based on coastline materials and processes. These units are shown in Figure 5-7 and are based on morphology, coastline materials, coastline process and the geomorphology of the site.

Figure 5-7 Coastal Units between Kilcunda and Cape Paterson



Unit 1 extends between two headlands south of Kilcunda. At Kilcunda the coastline changes from a south-facing headland and embayment, to a straight shoreline. A swampy lagoon has developed in the lower reaches of this area, as a beach terrace often blocks the valley mouth. Seven hundred metres south of this area cliffs rise to form a headland and shore platform.

Figure 5-8 shows Unit 2, which extends 3.2 kilometres south of the Powlett River mouth. It is a continuous beach backed by a broad grassy foredune terrace and a number of dunes with irregular grass and shrub cover.

Figure 5-8 Coastal Unit 2 coastal barrier across mouth of Powlett River



The red line outlines the site.

Unit 3 extends 2.2 kilometres from the Powlett River mouth to just south of Williamsons Beach and lies directly in front of the site. It is a straight part of the coast with a steep sandy beach and a shore platform that is only exposed at low tide, as shown in Figure 5-9. The beach is backed by a terraced foredune, two to four metres high and 10 metres wide. In places there is a second higher rear dune terrace.

Figure 5-9 Coastal Unit 3



Figure 5-10 shows Unit 4, which extends south from Williamsons Beach Road to just north of Harmers Haven. It is a cliff-top dune similar to Unit 3, but has several higher, wider dunes.

Figure 5-10 Coastal Unit 4 (northern section) with Wonthaggi in background



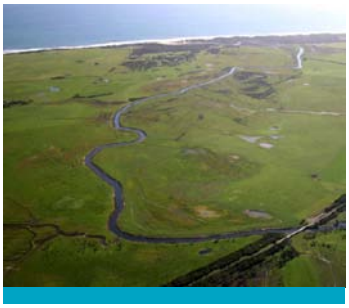
Unit 5 is oriented north-west to south-east from Harmers Haven to Cape Paterson. It is a coastal cliff fringed by a wide shore platform with few cliff-top dunes developed (Rosengren and Boyd 2008$_1$, Technical Appendix 37).



Terrain pattern 2 – coastal plains

In the Reference Project, the Plant is located on the coastal plains inland of the coastal dunes (Powlett Plains). The Powlett Plains are relatively flat and sandy.

The elevation steadily declines in height from the coastal area, between 10 and 15 metres high, inland towards the Powlett River floodplain, which is less than five metres in height. The elevations terraces are shown in Figure 5-11 (Rosengren and Boyd 2008$_1$, Technical Appendix 37).



Terrain pattern 3 – alluvial floodplain and swamp

North-east of the site a wide gently sloped valley opens onto the Powlett River floodplain where the surface is below two metres elevation. At the lowest areas of the site the deepest sediments are probably of marine and estuarine origin. Poor drainage lines in the area result in water collecting in this low lying area and along the Powlett River floodplain, reflected by the areas of standing water.

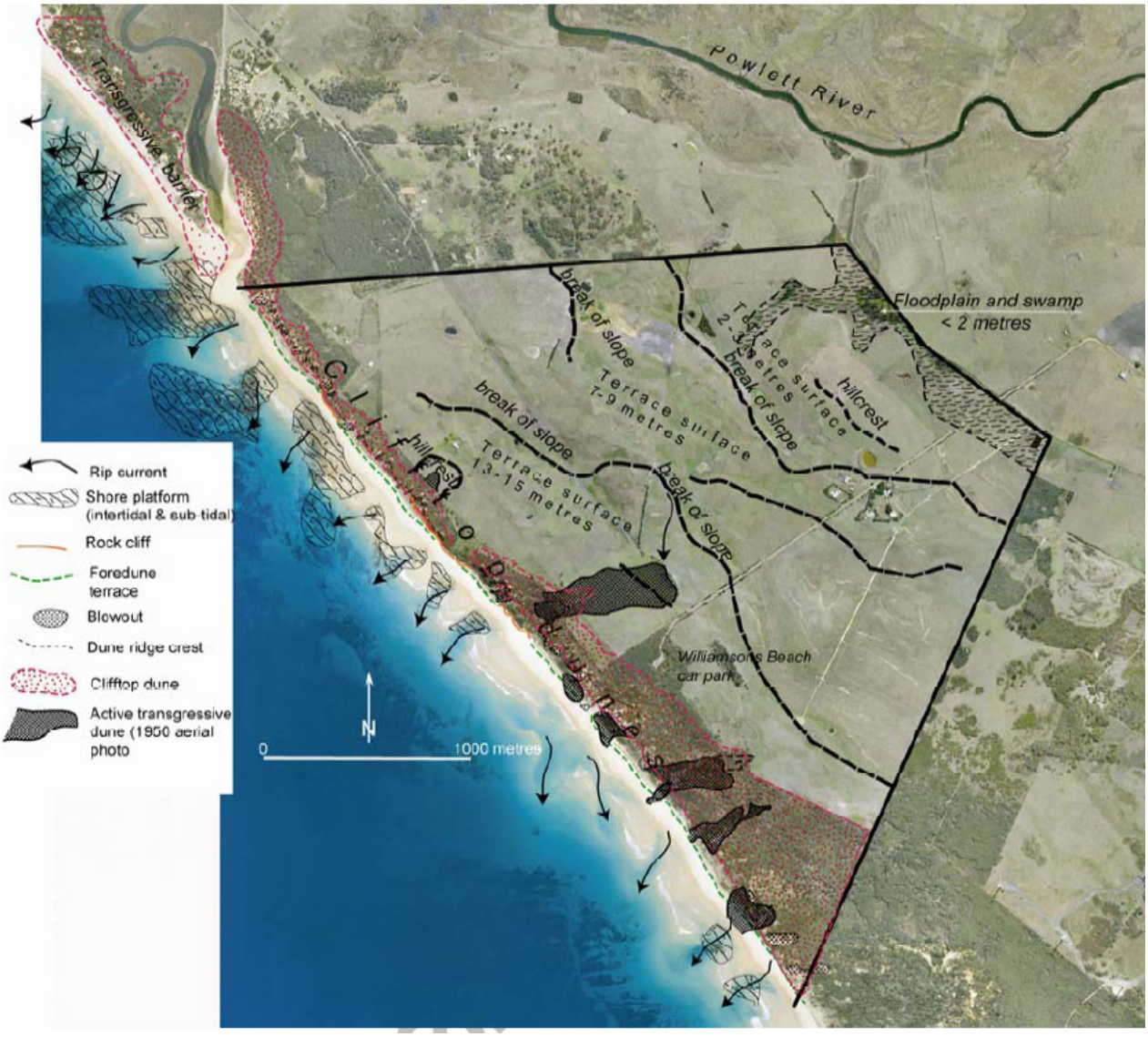
The Powlett River floodplain extends from upstream of Outtrim for over 30 kilometres to the Powlett River mouth. The floodplain margins are less defined than those of the Bass River, and the river channel has a low gradient. The lower reaches of the Powlett River are tidal.

Past and ongoing human activities have substantially altered the natural geomorphology of the Powlett River. These changes include:

- channel straightening and realignment
- swamp drainage and flood cuts
- bank construction and stabilisation.

The lowest parts of the site are backfilled swamps most likely formed by flooding from the Powlett River (Rosengren and Boyd 2008$_1$, Technical Appendix 37).

Figure 5-11 Terraces and geomorphology of the Plant



5.1.3 State Coal Mine

The Western Area Mine at Wonthaggi was operated by the State Coal Mine and covered an area of 622 hectares. It was the largest mine in the Wonthaggi area. The old mine workings known as the 'Western Area Mine' extends underneath the site. No historic mining shafts exist within the site.

There were two seams that were worked in the area at a depth of approximately 110 metres below the grounds surface. The two seams were closer together than elsewhere in this area. The seams were inconsistent across the site with faulting believed to be responsible for vertical displacement.

Based on available information the historic mining openings are expected to be at a depth of 110 metres or greater. The estimated subsidence due to the historic mining ranges from 0.2 metres to up to one metre. Monitoring of ground subsidence for the Western Area Mine has not been undertaken in the past, but visual evidence does not indicate ground subsidence.

5.1.4 Soils

The surface soil of the site is dark grey sand with pH 5.0 to 5.5 and low organic content. The soils overlay light grey to white sand. Below this sand is compacted brown to dark reddish-brown sand with seams of variably cemented 'coffee rock'. Coffee rock is an accumulation of iron, manganese and humus material, washed and concentrated at the level of temporary water tables.

Acid sulfate soils

Potential acid sulfate soil (PASS) is the general term applied to soil and sediment containing oxidisable, or already oxidised, sulphides. If the material remains covered and saturated in a reduced state so no oxidisation occurs it is referred to as PASS.

PASS occurs where naturally occurring iron sulphides are stored in sediments. These sulphides oxidise when exposed to air producing sulphuric acid and forming actual acid sulfate soils (AASS). This changes the soil pH by increasing its acidity, and lowering the pH to approximately pH 2. AASS causes the soil to become hostile to organisms, and the acidity can contaminate other systems through runoff and flood discharge (Rosengren and Boyd 2008_1, Technical Appendix 37).

The accumulation of sulphides is associated with coastal lowlands being submerged under rising sea levels. In eastern Australia, this occurs mostly in coastal lagoons and estuaries with small freshwater catchments and a tidal influence. While sulphide accumulation in sediments is confined to the coastal region, sulphides can be preserved in coastal deposits further inland due to earlier higher sea levels.

The Powlett River has a different configuration than it did in the past as a result of human intervention, and natural system changes millions of years ago. A preliminary study of PASS along the Victorian coast detected acid sulfate soils at greater than one metre depth in a drill hole near the lower Powlett River Bridge. This indicates a broad area of PASS along the lower Powlett River, which is shown in Figure 5-12 (Rosengren and Boyd 2008_1, Technical Appendix 37). Figure 5-13 shows the predicted extent of PASS at the Plant site and adjacent Powlett River estuary and floodplain.

Figure 5-12 Area of Potential acid sulfate soil area along lower Powlett River

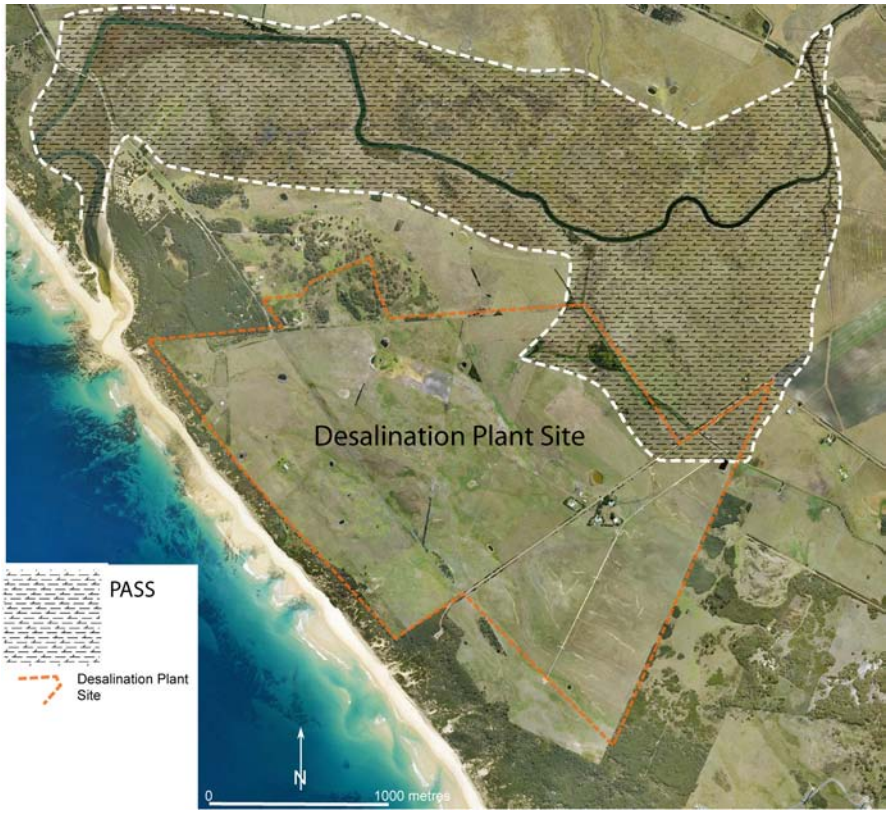
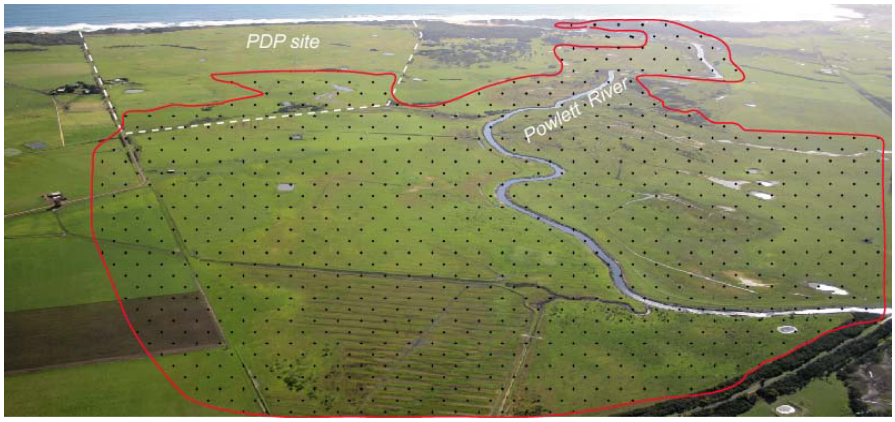


Figure 5-13 Predicted extent of Potential acid sulfate soil at the Plant site



Only the lowest terrain at the eastern edge of the site, where the deepest sediments of marine and estuarine origin are found, is considered to be a potential PASS area. The greater part of the site is not considered to have PASS, as it is too elevated to have been underwater in earlier geological eras (Rosengren and Boyd 2008[1], Technical Appendix 37).

The surface soils at the site are considered to be very low PASS. Although deeper soils in the area may be of coastal and marine origin from submergence at higher sea levels during the Last Interglacial period (over 100 000 years ago), the potential for acid sulfate soil materials to be preserved is considered low for two reasons:

- the materials are predominantly sandy rather than marsh/mud deposits and are low in organic content
- sub-aerial exposure, oxidation and leaching during the 100 000 years of lower sea level, has greatly reduced the potential for unoxidised sulphides to remain.

It is still possible that some unoxidised sulphides remain deeper in the sand bodies.

Coastal acid sulfate soils

Within the site, the lowest parts where coastal acid sulfate soils are likely to be found are within a small pocket of sediments in the north-east corner of the site, which is subject to flooding. This is because the naturally occurring iron sulphides may be present in sediments that form part of a former marine and estuarine environment (Rosengren and Boyd 2008_1, Technical Appendix 37).

Contaminated land

The nature of land use, both past and present, can result in contamination of soil. The contaminant types, mass, extent, quantity and mobility, are often linked to land use activities (GHD 2008_6, Technical Appendix 36).

There are several potential land uses that may be sources of contaminated land in the area:

- the State Coal Mine
- pastoral land and grazing.

A search of the EPA Priority Sites Register indicated that there were no listed sites within the site or surrounding area. A copy of the relevant extracts of the EPA Priority Site Register search is included in Technical Appendix 36.

State Coal Mine

The West Dip section of the West Area Mine was operated until its closure in 1968. Mining commenced in the area in 1952 and continued until 20 March 1964 when mining operations were terminated. The majority of the coal workings were well underground and there is minimal opportunity for potential contamination to be released as a result of construction activities.

Based on review of existing information, no mining activities are associated with potential for contamination within the site (GHD 2008_6, Technical Appendix 36).

Pastoral land and grazing

Agricultural land use for pasture and grazing has the potential to lead to both point source and dispersed contamination. The main point sources of contamination for this type of land use are:

- Dip sites used to treat animals for pests, involving historic use of all pesticides in liquid piles for the animals. Once treatment was completed the pits were generally just backfilled leaving the solution in the ground.
- Holding pen and milking areas are where high animal density causes point sources of nutrients, suspended solids and pathogens from concentrated wastes.

In addition to point sources, dispersed contamination sources can also occur with this type of land use. These dispersed sources generally involve application of fertilisers or other pastoral improvement substances across individual fields sub regions. These types of sources are generally associated with heavy metals and nutrients.

Review of aerial photographs indicates that this type of land use is the predominant land use at the site. There are a number of dams that have been located within the study area over the period of available aerial photos, some of which appear to have been backfilled. The ability to identify potential dip sites was limited as these areas are often only a few metres wide and not readily identifiable in aerial photos. There are some localised areas of ground disturbance that may be related to excavations and potential waste disposal. This type of localised waste disposal is relatively typical of farming activities (GHD 2008$_6$, Technical Appendix 36).

5.2 Impact assessment

This section discusses the potential impacts of the construction and operation of the Desalination Plant on the geology and geomorphology of the site.

5.3 Construction

5.3.1 Risks assessed as medium and above

Table 5-1 sets out the risks associated with the construction of the Desalination Plant which are assessed as medium and above. The risks are discussed in order of likelihood with those most likely to occur discussed first.

Table 5-1 Summary of construction risks assessed as medium and above

Activity	Impact pathway	Consequence	Likelihood	Risk
Tunnelling under the dune system and construction of shafts	Causing vibration and disturbing the dune system disturbing or damaging historical and/or Aboriginal heritage items	Major	Unlikely	Medium
Earthworks, compaction and vibration from earthworks, truck movements and use of machinery	Ground subsidence, movement and instability which may affect public safety	Moderate	Unlikely	Medium
Excavation and tunnelling	Encountering contaminated soils which may affect human health	Major	Rare	Medium

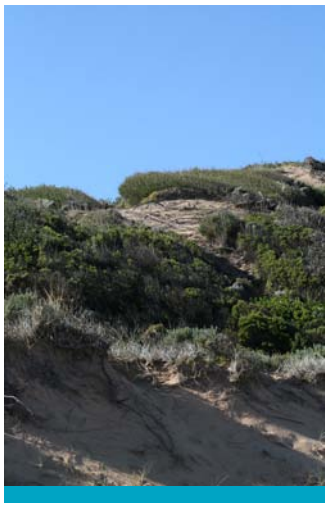
The above risk assessment is based on accepted construction practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the PRs are taken into account, both the likelihood and consequence of the risks may be significantly lower.

Tunnelling under the dune system

The construction of the Plant intake and outlet structures includes tunnelling shafts under the dunes. The Reference Project avoids direct contact with the coastal system and dunes by tunnelling beneath the dunes at depths of 40 metres to 60 metres, cutting through rock. This method is considered to have minor to negligible impact on the stability of the coastal systems and coastal physical processes due to the tunnel depth below the surface, and the rock being a poor conductor of vibration (Rosengren and Boyd 2008_1, Technical Appendix 37).

The Reference Project proposes the use of a tunnel-boring machine or roadheader to complete the tunnelling. The vibration that will occur within the dune system using these methods, and given the above tunnelling conditions, is likely to be very low. Therefore, tunnelling is unlikely to cause any movement of sand on the dunes.

The potential risk of dune instability on cultural heritage or Aboriginal heritage items was assessed as medium as there are four known Aboriginal cultural heritage sites within the foreshore dune reserve, at least one of which is a site of high significance. This is discussed in detail in Chapter 8 Cultural heritage.



Earthworks, compaction and vibration

Ground subsidence is the sinking of land below its existing level. At the site, areas susceptible to subsidence are the historic mining area and an inundated area on the north-west corner of the site (Rosengren and Boyd, 2008_1). However, project activities are unlikely to cause ground subsidence in either of these areas.

In general, ground movement including settlement is considered unlikely as the site is dominated by sand and weathered rock, which is not susceptible to consolidation. Compaction may occur beneath the Plant buildings, but it is expected that construction would be controlled so that the compaction does not cause subsidence. Additionally, the site is relatively flat and slope instability is unlikely to occur. Dewatering activities are likely to be short-term and minimal and are not expected to sufficiently lower the groundwater table below the inundated area to cause subsidence (Rosengren and Boyd 2008_1). Therefore, it is considered unlikely that construction activities would cause subsidence (Rosengren and Boyd 2008_1, Technical Appendix 37).

The old mine workings for the Western Area Mine extend beneath the site boundary. The mine has not been monitored for subsidence but visual evidence indicates no significant ground subsidence has occurred. Subsidence of the historic mines is considered unlikely to occur, but since there is limited information on subsidence for the Wonthaggi area, the risk assessment applied a conservative approach. Subsidence of these mines could potentially occur due to the mining technique and is largely independent of above ground activities. Investigative drilling at the site did not encounter historic mine workings, although there may be mine openings located below the 90-metre drill depth (Rosengren and Boyd 2008$_1$, Technical Appendix 37). These historic mines could cause subsidence of 0.2 to 1 metre.

Therefore the risk of ground subsidence, movement and instability on public safety is considered to be medium with injury possible as a worst-case and unlikely scenario.

Excavation and tunnelling

As well as tunnelling for the Marine Structures, construction of the Plant would require some excavation. These construction activities at the site may encounter contaminated soils, which could impact on human health.

People on the construction site may come into contact with unearthed contaminated soil through:

- skin contact causing the contaminants to be absorbed into the underlying tissue and blood stream
- ingestion of contaminated soil and water
- inhalation of components and contaminated dust.

The potential impacts to human health depend on the severity and duration of the concentration and type of chemical encountered (e.g. arsenic associated with dip sites or pesticides and fertilisers associated with other agricultural activities). These impacts are likely to be localised and limited to the construction zone and immediate surrounds.

The likelihood that contaminated soils would be encountered during excavation and or tunnelling at the site is considered to be rare. A historical review of aerial photography shows that the site has historically been cleared grazing land with no identifiable extensive site filling activities or intense application of fertilisers, pesticides and herbicides.

No landfill or waste disposal sites are likely to occur on the site, although small waste burial sites, dip sites and holding pens/milking areas associated with farming activities may be present. With the exception of the former State Coal Mine, there are no known historic commercial or industrial activities on the site.

Few sites are likely to have been contaminated by historic land uses and any contaminated sites are likely to have been small. If contaminated soils are encountered, they are unlikely to be at a concentration that would cause detrimental effects. The exception to this is the former farmland dip sites as they could release localised higher concentrations of contaminants.

Therefore, the risk that construction works would encounter contaminated land is considered to be rare and any contamination is likely to be diffuse.

5.3.2 Risks assessed as low

The risk assessment for the Project explored a comprehensive list of potential environmental risks in order to identify the priority areas. The following environmental effects are expected to have a minor or negligible effect on the environment with generally a rare or unlikely probability of occurrence.

Ground subsidence, soil erosion and slope instability

Earthwork activities could cause ground subsidence, soil erosion or slope instability through ground vibrations or compaction arising from works undertaken near mine openings or on steep sloping ground. As discussed previously, ground subsidence is unlikely to occur at the site as there are few areas susceptible to consolidation, and construction activities are expected to be sufficiently short-term and localised as to minimise the likelihood of subsidence. The consequence of subsidence on flora and fauna is considered to be minor and is discussed in Chapter 7.

Acid sulfate soils and contaminated land

Potential acid sulfate soils (PASS) are only expected in a low-lying area on the north-east corner of the site. The development of the Reference Project avoids this area, so PASS is unlikely to be disturbed by construction works. The location of PASS can be established with some confidence, so it is unlikely that construction works would encounter PASS at the site. If PASS is encountered, contamination could affect construction workers if they handled the excavated materials and leaching of contaminates could affect nearby waterways. However, normal construction management of PASS would ensure appropriate handling and neutralisation (Rosengren and Boyd 2008$_1$, Technical Appendix 37).

If contaminated soils are encountered, the contaminants are unlikely to be at a concentration that would cause detrimental effects on flora and fauna or social amenity. The impact of the contaminated land on social amenity (through the generation of odour) would depend on which contamination source is uncovered. The impact would be localised and the odour is likely to disperse rapidly for chemicals, fuels and oils, and may potentially linger for animal carcasses and waste disposal sites.

The likelihood that these contamination sources would be encountered is considered to be rare, and if they were encountered, the odour generated would likely have only a localised impact. The consequence of this impact to social amenity is considered to be minor.

Dune instability and vibration

There is a low risk that drilling under the dunes could cause dune instability and vibration, and have an effect on flora on fauna. Dune movement beyond natural circumstances could potentially remove dune vegetation or disturb sensitive species such as the Hooded Plover. This effect is described in more detail in Chapter 7 Flora and Fauna. As previously discussed, it is unlikely that vibrations generated during tunnelling under the dune system would cause dune instability, and hence this risk has been assessed as low.

Dinosaur fossils

As the Reference Project includes intake and outlet tunnels that pass underneath the dunes, the coast, and the areas where dinosaur fossils have been found, it is unlikely that dinosaur fossils will be disturbed.

5.4 Operation

5.4.1 Risks assessed as medium and above

No risks to geology and geomorphology assessed as medium and above are expected to occur during operation of the Desalination Plant.

5.4.2 Risks assessed as low

The risk assessment determined that only one risk assessed as low may affect the geology at the site. Vibration generated during vehicle movements has the potential to cause ground subsidence, which could affect public safety. During operation of the Plant, maintenance vehicles would regularly enter and exit the site.

The operation vibration assessment shows that truck movements produce low vibration levels that dissipate close to the source. Therefore, vehicle movements during operation are unlikely to emit significant vibration. Additionally, the operational vibration assessment states that vibration from Plant operation would have a negligible impact (GHD 2008_{15}, Technical Appendix 50). Subsidence of historic mines could occur but this would largely be independent of aboveground activities. As a worst-case scenario, subsidence could affect public safety, but any impact is likely to be minor.

5.5 Performance Requirements

Performance Requirements (PRs) have been developed to provide an environmental framework for management of potential geology and geomorphology impacts associated with the Project during construction and operation. The PRs are focussed on the environmental 'outcomes' that the State wishes to achieve through the Project delivery. The PRs relevant to managing the impacts of the Plant on geology and geomorphology are set out below. The full suite of PRs for the Project is provided in Volume 1 Chapter 10 as part of the overall Environmental Management Framework.

As part of the environmental impact and risk assessment process relating to geology and geomorphology for the Plant, Rosengren and Boyd (2008_1) and GHD (2008_6) have identified a range of suggested management measures that could be implemented to manage potential impacts. These suggested management measures have been formulated in response to the Reference Project and relevant Variations for the Plant. In effect, the suggested management measures demonstrate how the Reference Project and relevant Variations can achieve the PRs. These detailed management measures have formed an important input to the PRs for the Project.

The management measures suggested by Rosengren and Boyd (2008_1) and GHD (2008_6) addresses the following matters:

- reinstatement and rehabilitation to prevent soil erosion and settlement following construction activities
- if encountered, management of PASS in accordance with the Industrial Waste Management Policy (Waste Acid Sulfate Soils)
- management of soils in accordance with EPAs best practice environmental management guidelines to minimise the risk of erosion and sediment loss
- management of pedestrian traffic accessing the dune system to protect the existing physical and ecological integrity
- management of contaminated sites in accordance with the State environment protection policy (Prevention and Management of Contamination of Land), the National Environment Protection (Assessment of Site Contamination) Measure, NEPC 1999 and the nominated beneficial uses of land as defined by the SEPP

- complying with the requirements of EPA Publication 448, Classification of Wastes.

The PRs proposed for geology, geomorphology and acid sulfate soils are shown in Table 5-2.

Table 5-2 Performance Requirements

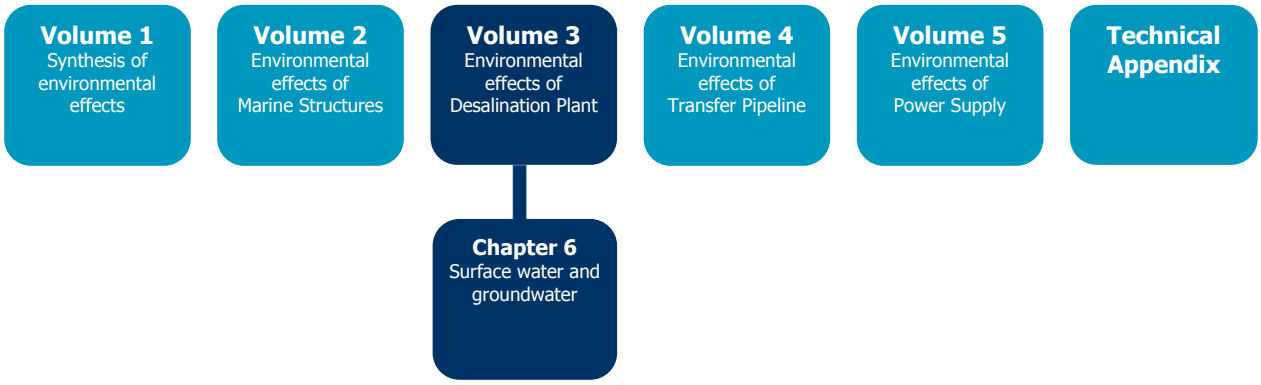
Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Geology and geomorphology	✓		Protect sites of regional geoscience significance.	Minimise impacts on sites of regional geoscience significance.	Comply with the Performance Criterion. Design any Project works to be able to tolerate any differential settlement resulting from potential subsidence including from the old mining works.
Erosion and sediment control	✓	✓	Minimise erosion and sediment movement.	Comply with EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996) and EPA Construction Techniques for Sediment Pollution Control (1991).	Comply with Performance Criterion. Develop, implement and maintain construction methods and management systems consistent with EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996) and EPA Construction Techniques for Sediment Pollution Control (1991) to limit erosion and sediment movement by: ▪ Identifying highly erodible soil and avoiding activities involving disturbance of these areas where possible. Where avoidance is not possible, additional control measures to be implemented for these identified areas ▪ Limiting clearance of vegetation, particularly along streams ▪ Designing drainage outlets and diversion channels to limit flow velocities and erosion
Acid sulfate soils	✓		Manage Acid Sulfate Soils.	Manage potential and actual acid sulfate soils in accordance with relevant legislation, standards and guidelines including the waste hierarchy. Comply with EPA's Industrial Waste Management Policy (Waste Acid Sulfate Soils) and EPA Publication 655, Acid Sulfate Soil and Rock.	Comply with Performance Criteria. Identify and where possible avoid disturbing areas of Potential Acid Sulfate Soils. Develop and implement methods and management systems to manage Acid Sulfate Soils and construction where Acid Sulfate Soils are encountered to minimise environmental impacts.

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Vibration	✓	✓	Protect buildings from vibration impacts. Protect the dune system from vibration.	Compliance with Section 5.5 of EPA Publication 480 – Guidelines for Major Construction Sites. Minimise damage from vibration caused by construction activities and Desalination Plant operations.	Comply with Performance Criteria. Develop and implement methods and management systems to protect buildings from vibration impacts. Undertake site investigations, property and land surveys and ground and infrastructure condition surveys of vibration generation works prior to and after carrying out vibration generation works on a case-by-case basis for all potentially impacted dwellings. During any blasting, undertake a monitoring strategy to measure and mitigate ground vibrations in the dune system. Short-term vibration levels must not exceed 3 – 10 mm/s Peak Particle Velocity (frequency dependent limit) at Heritage buildings, 5 to 20 mm/s Peak Particle Velocity (frequency dependent limit) at rural and residential buildings and 20 to 50mm/s Peak Particle Velocity (frequency dependent limit) at commercial or industrial buildings.
Site rehabilitation	✓	✓	Restore pre-construction land quality and uses.	All disturbed land progressively reinstated: ▪ In the case of the Desalination Plant, to the standards agreed with the State ▪ In the case of all other private land directly affected by the Project Activities, as agreed with private land owner ▪ In the case of public land, as agreed with the public land manager	Progressively and prior to its disturbance, conduct pre-construction surveys of the land within 50 metres of the Project Area to be disturbed. Develop a rehabilitation plan with each private landowner. Develop a rehabilitation plan to address as applicable: ▪ Site protection and site preparation ▪ Planting design including plant densities relative to EVC benchmarks ▪ Source of planting stock ▪ Post-planting maintenance Identify areas where there is a risk of subsidence, and develop construction approaches to mitigate the risk. Where revegetation is to take place, any revegetation works in accordance with Native Vegetation, Revegetation Planting Standards, DSE (2006).

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Contaminated land	✓	✓	Protect beneficial uses of land.	Manage and remediate contaminated soils. Comply with the State Environment Protection Policy (Prevention and Management of Contamination of Land). Protect human health and ecosystems from exposure to contaminated soil.	Comply with Performance Criteria. Assess any contamination in accordance with the National Environment Protection (Assessment of Site Contamination) Measure, NEPC 1999 and other relevant guidelines. Identify any contaminated land and properties and assess the potential for long term impacts. Detail the methodology for any soil removal, assessment, reuse and management. Manage decontamination of any buildings being demolished or sites in which pre-existing land, water or ground contamination is identified or exposed. Identify procedures to manage contaminated soil and buildings during the construction works, including during building demolishing. Develop and implement methods and management systems that seek to protect human health and the environment.

6.0 Surface water and groundwater





6 Surface water and groundwater

This chapter describes the existing surface water and groundwater conditions at the site. It considers the potential impact of construction and operation of the Desalination Plant, and provides strategies for mitigation and management in the proposed Performance Requirements.

This chapter is based on specialist findings from the following reports:

- GHD Pty Ltd (2008[7]) *Existing Conditions Report and Impact Assessment – Groundwater* (Technical Appendix 40)
- GHD Pty Ltd (2008[10]) *Surface Water EES – Plant* (Technical Appendix 43).

6.1 Existing conditions

The following section discusses the existing conditions of surface water and groundwater at the site within the Powlett River Catchment.

The Powlett River Catchment rises to 310 metres AHD in its north-eastern sections and has an area of approximately 500 square kilometres. The plant site is located on the floodplains of the catchment, known as the Powlett Plains. These floodplains extend south of the Strzelecki Ranges between Kilcunda and Cape Paterson, and east to Inverloch.

6.1.1 Surface water

Surface water is the water that flows in streams and rivers and sits in natural lakes, wetlands and reservoirs. This section will describe:

- waterways and catchment hydrology
- Powlett River flood hydraulics and the influence of climate change
- river discharge and stormwater drainage
- water quality.



Waterways and catchment hydrology

Waterways around the plant site include the Lower Powlett River and associated tributaries. There is an unnamed tributary of the Lower Powlett River that traverses the site. There are no known channels or streams of environmental significance on the site although a number of small farm dams are scattered at various locations across the site. These dams are man-made and do not influence or interfere with natural flow systems. Lance Creek and Foster Creek are in the Powlett River Catchment. The Powlett River catchment and the major rivers in the area are shown in Figure 6-1 (GHD 2008_{10}, Technical Appendix 43).

The Powlett River is in the South Gippsland Basin. It originates over 30 kilometres upstream of the river mouth, upstream of Outtrim. The plant site is adjacent to the tidal zone of the Lower Powlett River. The channel plan form suggests that the river may be tidally influenced six kilometres upstream to the Bass Highway Bridge at Daylston.

The shape and form of rivers in the Powlett River catchment have remained relatively constant over the past 50 years. A few channelised farm drains enter the Powlett River close to the site. These channels are likely to drain water from the site to the Lower Powlett River during high flow events.

The Powlett river flows are seasonally influenced, with the bulk of flows occurring between late autumn to early spring. Flow events outside this period are rare and generally do not exceed more than 500 ML per day. The number of flows exceeding 2000 ML per day dropped from 63 for the period 1980 to 1996 to 15 for the period 1997 to 2007 with annual flow volumes in this later period around a third of those of the preceding 16 years (GHD 2008_{10}, Technical Appendix 43).

Figure 6-1 Powlett River catchment (red) and rivers (blue) in the vicinity of the Desalination Plant site



Flood hydraulics

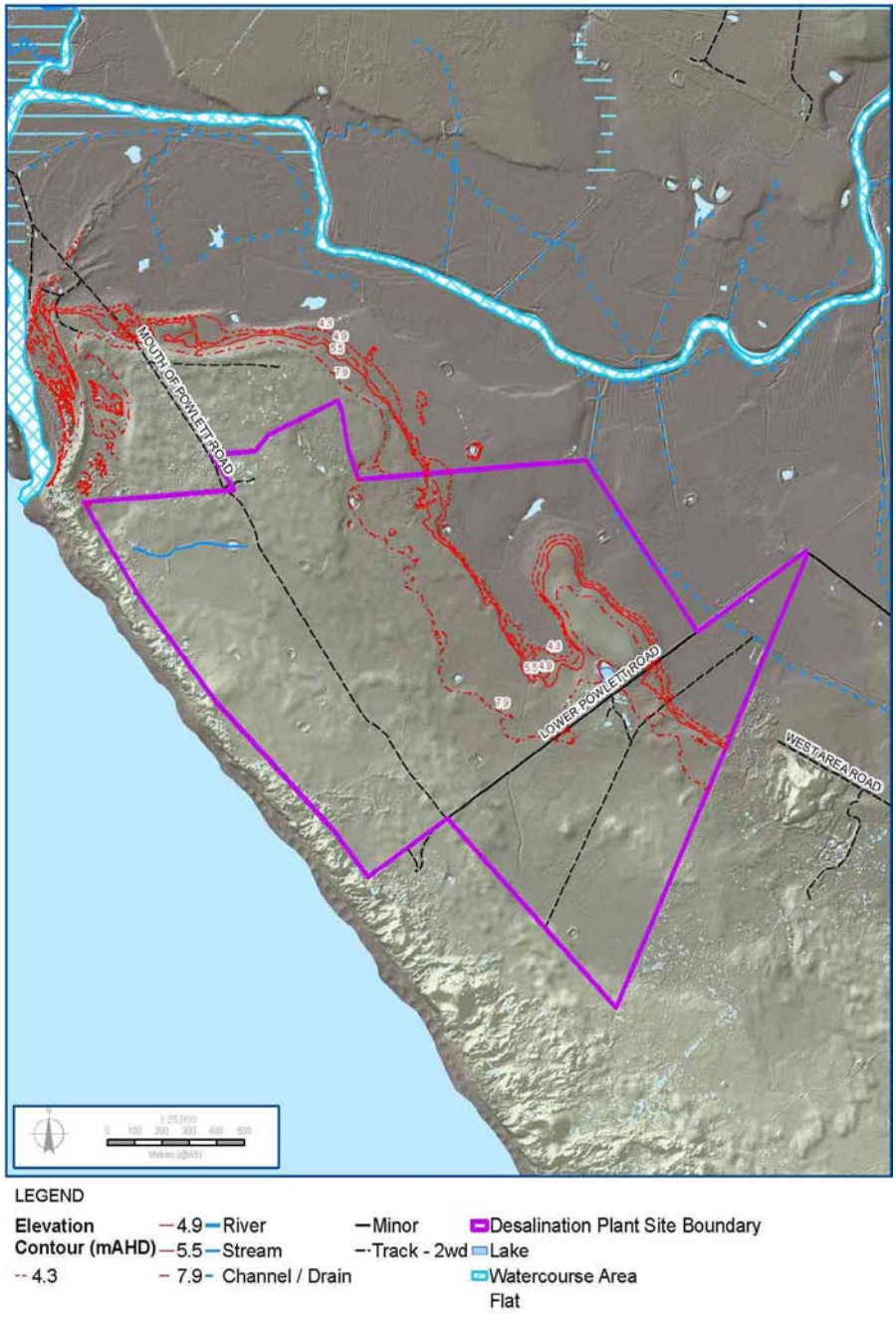
Surface waterways are typically recharged through rainfall and overland runoff in the catchment. The Powlett River Catchment provides most of the water for the Powlett River and when flows exceed the river's capacity the Powlett River floods into the floodplain. These flood events are influenced by the height and shape of the sandbar at the river mouth and Bass Strait sea levels.

Coastal processes and river flow affect the stability and height of the sandbar in a coastal entrance. The mouth of the river typically opens and closes on a seasonal basis. When the river's flow is low the sandbar builds up closing the river mouth. This exacerbates flooding of the low-lying river flats and floodplain. The river mouth will remain closed until it is naturally opened by a significant flow in the Powlett River or the West Gippsland CMA permit the manual breaching of the sandbar.

Sea levels in Bass Strait are influenced by astronomical tides and oceanographic processes and storm surge including barometric effects, wind and waves. These effects influence the occurrence of flooding of the Powlett River.

Peak 100-year flood levels are predicted to be around 4.3 metres AHD. The flood extents at the site are shown in Figure 6-2 (GHD 2008_{10}, Technical Appendix 43).

Figure 6-2 100-year flood extents for the Powlett River



Climate change

It is widely recognised that climate change will impact on sea level and rainfall intensities which may impact on flooding. Global sea level is projected to rise by 0.18 to 0.59 metres by 2100, with a possible addition of 0.1 to 0.2 metres from ice sheets. This combines to give the range for global mean sea level rise of 0.18 to 0.79 metres. The mean sea level rise near the east cost of Australia is projected to be 0.18 to 0.91 metres, 0.12 metres greater than the global mean sea level rise.

In addition to mean sea level rise, more intense weather systems are predicted. Larger storm surges and increased wind speeds during high tides are predicted to penetrate further inland. In Bass Strait increases in wind speeds during storm surge events may increase local sea level by up to 0.17 metres by 2030 and up to 0.49 metres by 2070. The effect of climate change on a 100-year flood event was modelled as resulting in an increase of the peak flood elevation to 5m by 2040 (moderate estimate) and 5.46m by 2100 (high estimate). Less rainfall is likely for Victoria. Annual rainfall is estimated to change between –9 per cent and +3 per cent by 2030 and between –25 per cent and +9 per cent by 2070.

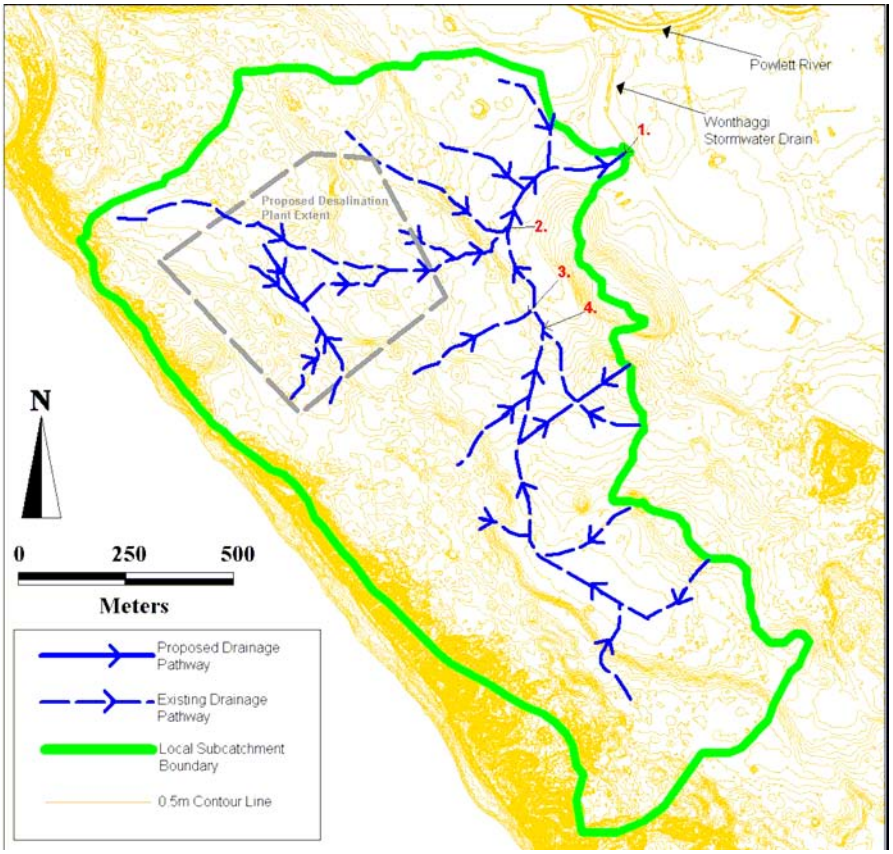
Where average rainfall decreases, more dry periods are likely, and where average rainfall increases, more extreme wet years are projected. Increases in rainfall intensities will result in rare events becoming more common. The current "100-year storm design ocean level" may occur monthly by 2100. The frequency of this occurring and its chance of coinciding with flood producing rainfall events will therefore increase (GHD 2008_{10}, Technical Appendix 43).

Discharge and drainage

The Plant is approximately one kilometre south-east of the Powlett River mouth and approximately five kilometres west of Wonthaggi, shown previously in Chapter 2, Figure 2-1. The Powlett River mouth discharges into the Bass Strait.

The site is located within a 300-hectare sub-catchment of the Powlett River (GHD 2008_{10}, Technical Appendix 43). This sub-catchment drains into an unnamed Powlett River tributary, which crosses the north eastern corner of the site. This tributary also functions as the southern Wonthaggi stormwater drain. The existing and proposed drainage paths of surface water at the site are shown in Figure 6-3.

Figure 6-3 Local drainage network and pathways in the Powlett River catchment



Surface Water Drainage with Climate Change

The increase in flows from the local subcatchment due to construction of the plant is approximately 2.4m^3/s in a 1 in 100 AEP event. For conservative impact assessment, in the unlikely scenario where rainfall intensities actually increased by 30 per cent, the estimated impact of the plant on 1 in 100 AEP flows from this subcatchment would be 3.1m^3/s. This is not expected to significantly alter overland flow paths or environmental impacts of the Desalination Plant. The potential for environmental impacts such as increased erosion is further reduced because stormwater infrastructure and surrounding landscapes should be well established by the time any climate related impacts eventuate.

Although no significant impact on surface water drainage, sediment runoff or water quality of receiving waterbodies is anticipated, the detailed design of any surface water drainage works should include a suitable tolerance to account for a small increase in flows that may potentially result from climate change and other design uncertainties. For example scour velocity thresholds should not be exceeded by a small increase in design flow

Surface water quality

The site is predominantly agricultural land and the surface water quality for the plant site was modelled using agricultural land uses as the base for the model. The model predicted total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) loads of stormwater from the site based on average rainfall. A range of flow scenarios including wet, dry and average conditions were modelled to investigate the potential sediment and nutrient loads from the site. The modelled annual loads are shown in Table 6-1.

Table 6-1 Modelled existing conditions for pollutant loads

Rainfall scenario	Average flow ML/year	Average annual loads (kg/year)		
		Total suspended solids	Total phosphorus	Total nitrogen
Average conditions	181	32 600	90.2	632
Dry conditions	87.9	13 300	37.7	271
Wet conditions	287	56 100	154	1090

It is estimated that, on average, the existing plant site contributes up to 32 600 kilograms of suspended solids, 90 kilograms of phosphorus, and 630 kilograms of nitrogen each year into the Powlett River. Under wet weather conditions, the annual loads are predicted to increase to 56 100 kilograms of suspended solids, 154 kilograms of phosphorus, and 1 090 kilograms of nitrogen each year (GHD 2008_{10}, Technical Appendix 43). This equates to a contribution of approximately 0.6 per cent of the total nutrient and sediment load from the site to the entire Powlett River catchment.

6.1.2 Groundwater

Groundwater is the water below the earth's surface that supplies wells and springs with its upper surface being the watertable.

Groundwater sources

There are two aquifers relevant to the site. The primary aquifer is from the Strzelecki Group (the Cretaceous aquifer) which is a principally fractured rock aquifer system. The other aquifer, referred to as the Quaternary Aquifer System is closer to the surface and consists of soft sediments such as swamp and dune system deposits. In both aquifers, water levels are less than six metres below the surface which is above sea level. Groundwater flow reflects the local topography of the area and most probably flows from the northern and eastern highlands, towards the Powlett River and Bass Strait. The site is slightly more elevated than the Powlett River floodplain and is separated from the coastline by a dune system.

The level of confinement of an aquifer is defined by the relative pressure levels of groundwater when it becomes trapped under impermeable soil or rock, or bound between layers of impermeable materials. Water pressure in a confined aquifer can cause water in the aquifer to rise above the natural aquifer level.

The fractured rock that makes up the Cretaceous Aquifer has areas of outcrop, which is considered to be a regional unconfined aquifer. Other areas of the same aquifer may be semi-confined, particularly where weathering occurs, or where the rock is buried beneath thick layers of low permeability Quaternary age sediments (GHD 2008$_7$, Technical Appendix 40). The Cretaceous Aquifer and the Quaternary sediments are considered to be unconfined to semi-confined.

Groundwater recharge and discharge

Recharge of groundwater is primarily from rainfall infiltrating down though overlying rock and soils to aquifers. The Quaternary aquifer is most likely to be recharged from rainfall infiltration as it is near the surface and the sediments overlying this aquifer are sandy and more permeable. The Cretaceous aquifer is overlain with clays, which have lower permeability and infiltration rates so recharge to this aquifer may not be entirely from rainfall. The Cretaceous aquifer could also be recharged from flows from other aquifers east of the plant site towards the Bass Highway, or areas of outcrop remote from the site. Recharge through the more permeable sandy Quaternary aquifers should be greater than those in the clayey soils overlying the Cretaceous aquifers.

The Quaternary Aquifer system is expected to discharge into Bass Strait and onto the land following the subdued reflection of topography. Discharge from the Cretaceous aquifer is expected to flow towards the Powlett River floodplain into Bass Strait, forming a coastal aquifer. Where fresh water contacts and mixes with saline groundwater beneath the seafloor it is referred to as a saline or seawater interface. The saline interface is likely to occur at an average groundwater elevation of five metres above sea level. The theoretical depth of the saltwater interface is about 200 metres below sea level (GHD 2008_7, Technical Appendix 40).

Groundwater quality and uses

The SEPP (Groundwaters of Victoria) categorises groundwater into segments (A_1, A_2, B, C and D) based on salinity levels that determine the range of beneficial uses. The salinities of the Quaternary Aquifer systems are less than 1 000 mg/L which is segment A_1 and A_2 and has beneficial uses for:

- maintenance of ecosystems
- potable water
- potable mineral water supply
- agricultural parks and gardens
- stock watering

- industrial use
- primary contact recreation
- buildings and structures.

Groundwater sampling of the Cretaceous Aquifer showed a range of salinities from 1 600 mg/L, 2 800 mg/L and 4 600 mg/L, which is segments B and C, and has beneficial uses for:

- maintenance of ecosystems
- stock watering
- industrial use
- primary contact recreation such as swimming and bathing
- buildings and structures.

Generally groundwater around the site is taken from bores and used for stock and domestic purposes. The nearest private bore is two kilometres northwest of the site and 17 metres deep. It has a recorded yield of 0.8 L/s and a standing water level of eight metres. Due to its depth the aquifer sourcing this bore is likely to be the Cretaceous aquifer.

Regional bores from the Cretaceous aquifer typically yield less than 3 L/s, although the yield can vary greatly, and is usually dependent on the properties of the aquifer. Groundwater yields from the Quaternary aquifer are likely to be limited due to shallow aquifer thickness and restricted distribution, although is some areas there may be localised high flows.

6.2 Impact assessment

This section discusses the potential impacts of the construction and operation of the Desalination Plant on the surface water and groundwater at and around the site.

6.3 Construction

6.3.1 Risks assessed as medium and above

Table 6-2 sets out the risks associated with the construction of the Desalination Plant which are assessed as medium and above. The risks are discussed in order of likelihood with those most likely to occur discussed first.

Table 6-2 Construction risks assessed as medium and above

Activity	Impact pathway	Consequence	Likelihood	Risk
Earthworks and stockpiling	Soil erosion or spoil from earthworks causing sediment discharge to waterways affecting aquatic flora and fauna	Moderate	Likely	Medium
Tunnelling	Seawater intrusion into existing groundwater affecting native flora and fauna habitats	Minor	Likely	Medium

The above risk assessment is based on accepted construction practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the Performance Requirements are taken into account, both the likelihood and consequence of these risks may be significantly lower.

Earthworks and stockpiling

At certain times during construction, bare expanses of earth and uncovered stockpiles will be created. These exposed areas and stockpiles may be on slopes on the plant site. On-site work practices would be in place during construction to minimise the potential for erosion from exposed areas and stockpiles, and the potential for transport of erodible material from the construction site to natural waterways during small, frequent rainfall events.

If there were to be an exceptionally high rainfall, event sediment could enter the stormwater and discharge via the Wonthaggi South tributary to the Powlett River. This could result in an effect on aquatic flora and fauna and will require management of sediment during construction. This is discussed in more detail in Chapter 7 Flora and fauna.

Tunnelling

Saline intrusion is when saline water from the sea flows into neighbouring fresh water aquifers. This usually occurs when groundwater is pumped from aquifers that are in direct hydraulic connection with the sea. It is considered likely that pumping groundwater out of the tunnels during construction will result in some seawater intrusion. In this case a change in groundwater quality could impact on flora and fauna species that are dependant in some way on groundwater.

Once dewatering activities stop, the aquifer will recover, although it may take some time. Native flora and fauna species that rely on shallow groundwater processes are likely to be outside the zone of influence of saline intrusion, and the overall consequence is minor. This is discussed further in Chapter 7 Flora and fauna.

6.3.2 Risks assessed as low

The risk assessment explored a comprehensive list of potential environmental effects in order to identify the priority areas for management through the Performance Requirements. The following risks have been assessed as low and are expected to have a minor or negligible impact on the environment.

Lowering the watertable

During the construction of the Desalination Plant, excavations may penetrate the watertable and need to be dewatered. Water will be required on-site during construction and one method of obtaining water for construction could be the use of groundwater from either a bore or out of an excavated trench. Using groundwater or dewatering excavations on-site may impact environmental aspects of the plant site by lowering the watertable. The watertable will be locally lowered from dewatering activities and therefore only groundwater users (such as flora and fauna) close to the dewatering site would be affected by a reduction in the watertable. Impacts to groundwater will be short-term and the groundwater table is expected to return to its original level when groundwater is no longer used on-site. The impact to flora and fauna is considered to be minor and is discussed in Chapter 7 Flora and fauna.

Alteration of groundwater and surface water

Changes in the amount or composition of ground or surface water could create imbalances in natural ecosystems, causing impacts to flora and fauna or groundwater users. During construction, dewatering at the plant site, using freshwater which then enters groundwater system or sediment runoff and chemical spills all have the potential to change the surface water and water table levels and affect aquatic flora and fauna, as well as the salt marsh ecosystems of the mouth of the Powlett River and groundwater quality for other users. However, these impacts are unlikely to occur as standard management measures will be adopted.

Lower Powlett River flows

There is a low risk that earthworks at the plant site may alter the natural flow regimes and flow extents of the lower Powlett River. It is unlikely that development would have an impact on the flooding characteristics of the Powlett River as the Powlett River floodplain is relatively wide and is unlikely to be constricted by any development on the selected plant site. The potential for obstructing the flood plain with development of the plant site remote from the waterway was modelled and no change in flood levels was predicted (GHD 2008_{10}, Technical Appendix 43).

Surface water ecosystems

Construction activities may potentially affect surface water ecosystems. However, this is unlikely to occur as construction activities will occur a significant distance away from waterways. With appropriate construction practices and design, it is unlikely that there will be any impacts on surface water ecosystems.

Dewatering mines

As discussed previously, it is possible that groundwater may be used for construction water supply, which could cause dewatering of the nearby mine. Coal strata may be subject to subsidence which could affect existing structures at the Plant site, which may be used for construction activities. As dewatering will be of a temporary nature, recovery of water levels could be reasonably expected when such activities cease. As such, the risk to structures on the site is considered low and recoverable.

6.4 Operation

6.4.1 Risks assessed as medium and above

There are no risks to surface water and groundwater assessed as medium and above during operation of the Desalination Plant.

6.4.2 Risks assessed as low

A number of risks to surface water and groundwater during the operation of the Plant have been assessed as low. These environmental impacts are expected to have a negligible or minor effect on the environment with generally a rare or unlikely probability of occurrence.

Chemical spills and stormwater leakage

Changes in the amount or composition of ground or surface water could create imbalances in natural ecosystems, causing impacts to flora and fauna and groundwater users. During operation, leakage from incorrectly lined stormwater retention ponds or chemical spills have to potential to affect the water table levels and effect aquatic flora and fauna, as well as the salt marsh ecosystems of the mouth of the Powlett River and groundwater quality for other users. These impacts are unlikely to occur, as standard management measures will be adopted. In particular, as long as guidelines for bunding and handling chemicals on-site are implemented, the likelihood of chemicals spilling and entering the groundwater would be rare. In addition, it is expected that procedures would be in place to rapidly clean up and minimise the extent of any spill if it did occur.

Increased stormwater runoff

There is a risk that excess stormwater runoff from the Plant structures and sealed roads could cause an alteration of flow regimes and flood extents of the Lower Powlett River reducing amenity during wet periods. However, modelling has demonstrated that the increased impervious area of the plant site and resultant increase in runoff is insignificant in size with respect to the size of the Powlett River Catchment. Consequently, hardstand areas of the Desalination Plant are unlikely to translate to any measurable effect on the flow patterns, velocities and depths of flow in the Powlett River or its major tributary.

Surface water drainage, flooding and climate change

The increase in flows from the local subcatchment due to construction of the plant is approximately 2.4 m^3/s in a 1 in 100 AEP event. For conservative impact assessment, in the unlikely scenario where rainfall intensity actually increased by 30 per cent, the estimated impact of the plant on 1 in 100 AEP flows from this subcatchment would be 3.1 m^3/s. This is not expected to significantly alter overland flow paths or environmental impacts of the Desalination Plant. The potential for environmental impacts such as increased erosion is further reduced because stormwater infrastructure and surrounding landscapes should be well established by the time any such impacts eventuated.

Although no significant impact on surface water drainage, sediment runoff or water quality of receiving waterbodies is anticipated, the detailed design of any surface water drainage works should include a suitable tolerance to account for a small increase in flows that may potentially result from climate change and other design uncertainties. For example scour velocity thresholds should not be exceeded by a small increase in design flow.

A scenario was assessed assuming a high range sea level increase of 1.0 metre with a consequent increase in the entrance sand bar level, resulting in an entrance bar level of 4.5 metres AHD combined with a 30 per cent increase in the rainfall intensities. This is recognised as being not representative of current climate change predictions but is tested here to ensure the plant remains protected from flooding. There is sufficient high ground on the plant site to enable the plant to be constructed so that it will remain relatively free from flooding even under current circumstances.

6.5 Performance Requirements

Performance Requirements (PRs) have been developed to provide an environmental framework for management of potential surface water and groundwater impacts associated with the Project during construction and operation. The PRs are focussed on the environmental 'outcomes' that the State wishes to achieve through the Project delivery. The PRs relevant to managing the impacts of the Plant on surface water and groundwater are set out below. The full suite of PRs for the Project is provided in Volume 1 Chapter 10 as part of the overall Environmental Management Framework.

As part of the environmental impact and risk assessment process relating to surface water and groundwater for the Desalination Plant, GHD (2008_7, 2008_{10}) has identified a range of suggested management measures that could be implemented to manage potential impacts. These suggested management measures have been formulated in response to the Reference Project and relevant Variations for the Desalination Plant. In effect, the suggested management measures demonstrate how the Reference Project and relevant Variations can achieve the PRs. These detailed management measures have formed an important input to the PRs for the Project.

The management measures suggested by GHD (2008_7, 2008_{10}) address the following matters:

- protecting surface water during construction by:
  - designing the drainage system to have non-erosive velocities reducing sediment flows
  - determining the location of temporary stream diversion paths preventing untreated water entering waterbodies
  - identifying highly erodible soil and developing an erosion and sediment control plan or soil and water management plan
  - establishing baseline environmental conditions and monitoring for nearby surface water
- protecting surface water during operation by:
  - implementing procedures aimed at preventing contaminants entering the drainage system
  - treating all surface water in water quality treatment trains prior to downstream discharge

  - designing fuel storage, chemical facilities and any other similar storage with perimeter bunding
  - monitoring inflow and outflow water quality parameters to verify compliance with State Environmental Protection Policy (Waters of Victoria)
- maintaining the levels of flood protection at the site during construction and account for any changes in flood hydraulics, particularly around the Powlett River
- protecting groundwater quality and quantity during construction by:
  - undertaking site specific assessments to identifying the interaction between surface and groundwater
  - if necessary providing alternative water sources to groundwater users, reducing dewatering times or varying construction methods
  - protecting quality by effectively managing spills as a result of construction activities
  - minimising impacts on the interaction between groundwater and flora and fauna habitats, including wetlands and dune vegetation by limiting the magnitude of dewatering activities and the selection of appropriate waterway crossing techniques
  - monitoring groundwater levels to prevent saline intrusion caused by excessive pumping
  - management of groundwater maximising potential reuse opportunities
- protecting of groundwater quality and quantity during operation by:
  - reinstatement that achieves pre-construction groundwater flow, quality and availability conditions
  - conducting ongoing monitoring to ensure minimisation of impacts on groundwater.

The PRs proposed for surface water quality and groundwater are outlined in Table 6-3.

Table 6-3 Performance Requirements

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Surface water quality	✓	✓	Protect and maintain surface water quality.	Minimise impacts on surface water quality. Comply with State Environment Protection Policy (Waters of Victoria). Achieve the Urban Stormwater Best Practice Environmental Management Guidelines performance objectives during construction and operation. Comply with EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996). Stormwater treatment system is to be fully integrated into the overall detail design of the Desalinated Water Supply System and include spill management infrastructure to protect surface water quality.	Comply with the Performance Criteria. Develop and implement construction methods and management systems that seek to maintain surface water quality consistent with State Environment Protection Policy (Waters of Victoria) and EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996). Design and construct Temporary Works to isolate construction runoff from catchment runoff and treat it prior to discharge to receiving waterways. Establish a surface water quality monitoring (including reporting) program for the Powlett River, in the vicinity of the Desalination Plant Site in consultation with the EPA. Manage maintenance to avoid release of water with chemical concentrations above State Environment Protection Policy (Waters of Victoria) objectives.
Waterways and wetlands	✓	✓	Protect waterways and wetlands.	Comply with the State Environment Protection Policy (Waters of Victoria). No significant impact on Western Port Ramsar site. Maintain the environmental values of waterways and wetlands. Compliance with all relevant Authority requirements for waterway crossings.	Comply with the Performance Criteria. Develop and implement construction methods and site rehabilitation plans that seek to protect the habitat values of waterways and wetlands including: ▪ Developing appropriate construction methods to minimise environmental impacts for crossing sensitive waterways such as: - Powlett River *Refer to PR Sensitivity Areas – Plant Area in Technical Appendix 5.* ▪ Site specific construction methods to minimise environmental impacts including erosion, sedimentation and pollution ▪ Reinstating and revegetating disturbed areas ▪ Limiting impact on ecological processes such as fish movements and breeding Develop and implement monitoring and reporting

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
					on the effects of construction on waterways and wetlands. Develop and implement methods and management systems to limit impacts on waterways and wetlands during operation. Re-establishment of wetland (unnamed tributary of the Powlett River) on the Desalination Plant site. Design and locate scour and other relief valves to meet the Performance Criteria.
Groundwater	✓	✓	Protect the beneficial uses of groundwater.	Minimise impact on groundwater. Minimise impact on the interaction between flora and fauna habitats, including wetlands and dune vegetation. Comply with the Water Act 1989 and State Environment Protection Policy (Groundwaters of Victoria) requirements for groundwater quantity, quality, availability and flow including meeting any Authority licensing requirements.	Comply with Performance Criteria. Develop and implement methods and management systems which do not cause deterioration to groundwater systems including: ■ Consideration of the interaction between surface water and groundwater ■ Recognition of the interaction with flora and fauna habitats, including wetlands and dune vegetation ■ Management of extracted groundwater seeking to maximise potential reuse and disposal ■ Limiting any impact or diminution on the existing flow regime in nearby waterways or on the use of groundwater as a resource arising out of any interception and/or drainage of groundwater ■ Minimise any reduction of existing groundwater recharge to wetlands resulting from the construction or operation of the Desalination Plant water supply system Undertake a site specific assessment, in consultation with the relevant Authority and the EPA, if intercepted groundwater is proposed to be discharged to waterway segments and demonstrate that water quantity, quality, availability and flow will meet the relevant licensing requirements. Monitor groundwater quality during the Project Term in accordance with the requirements of the EPA and/or relevant Authorities.

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Erosion and sediment control	✓	✓	Minimise erosion and sediment movement.	Comply with EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996) and EPA Construction Techniques for Sediment Pollution Control (1991).	Comply with Performance Criterion. Develop, implement and maintain construction methods and management systems consistent with EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996) and EPA Construction Techniques for Sediment Pollution Control (1991) to limit erosion and sediment movement by: ▪ Identifying highly erodible soil and avoiding activities involving disturbance of these areas where possible. Where avoidance is not possible, additional control measures to be implemented for these identified areas ▪ Limiting clearance of vegetation, particularly along streams ▪ Designing drainage outlets and diversion channels to limit flow velocities and erosion
Flooding Control	✓	✓	Protect public and private assets from flooding.	Limit impacts of flooding from Project Activities.	Comply with the Performance Criterion. Design and construct Project infrastructure to avoid impacts on flood potential or obtain approval of the relevant Authority to any change in waterway flood levels. Design and construct the Desalination Plant to be sufficiently above the 1 in 100 Annual Exceedance Probability (AEP) flood level under expected climate change conditions to allow for the natural closing of the river mouth, coincident levels in Bass Strait and a reasonable allowance for the uncertainty in these estimates (AEP is the probability of exceedance of a given discharge within a period of one year). Develop and implement methods and management systems that seek to: ▪ Identify and investigate potential interactions with flood protection systems during Project Activities ▪ Maintain existing flood protection systems during Project Activities Any Project activities on waterways are to be in accordance with the requirements of the relevant Authority.

7.0 Flora and fauna



7 Flora and fauna

This chapter discusses the environmental impact of the Desalination Plant on flora and fauna. It describes existing conditions, assesses impacts of construction and operation of the Desalination Plant, and provides strategies for mitigation and management proposed in the Performance Requirements.

This chapter is based on, Biosis Research Pty Ltd (2008_3) *Flora and Fauna Assessment: Desalination Plant, Bass Coast, Victoria: Existing Conditions and Impact Assessment Report* (Technical Appendix 14).

7.1 Existing conditions

Literature and database reviews were completed for the site and foreshore reserve. Field surveys of sections of the plant site and foreshore reserve were completed in August, September and November 2007 and May and June 2008. These included an instream aquatic habitat assessment of the unnamed tributary of the Powlett River and targeted searching for threatened terrestrial fauna and flora (Biosis Research 2008_3, Technical Appendix 14).

Further seasonal ecological surveys of the Plant site will be undertaken to inform further environmental assessment and decision making as well as the detailed design phase of the Project including preparation of environmental management plans.

The *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC) protects matters of national environmental significance from significant impact. Matters of national environmental significance relevant to this Project are:

- listed threatened species and communities
- Ramsar wetlands of international importance.

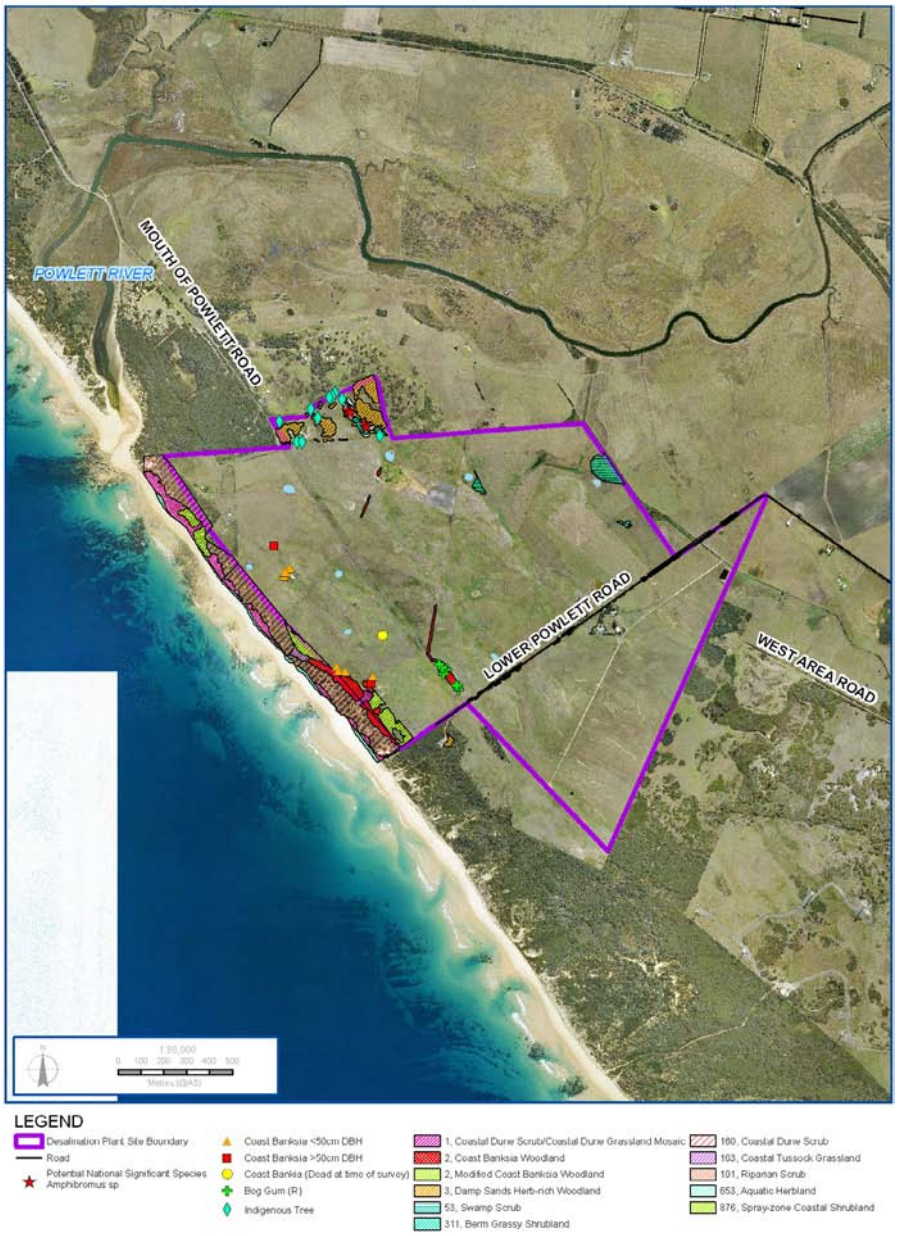
The Flora and Fauna Guarantee Act 1988 (FFG) protects Victoria's threatened plant and animal species, ecological communities from potentially threatening processes. Flora and fauna species and communities that are offered protection under these acts are discussed in the following chapter.

7.1.1 Flora

Vegetation communities

The Plant is located within the Gippsland Plain Bioregion. There are eleven different Ecological Vegetation Classes (EVCs) present as remnant vegetation patches within the Project area, shown in Figure 7-1. The characteristics of each patch is described in Table 7-1. The EVCs constitute remnant vegetation patches as defined under the Native Vegetation Management Framework. In Table 7-1 EVCs in each patch are listed along with their conservation status within the Gippsland Plain Bioregion (Biosis Research 2008$_3$, Technical Appendix 14).

Figure 7-1 Native vegetation on the plant site and foreshore reserve



Source: Biosis Research 2008[3]

Table 7-1 Native vegetation on the plant site and foreshore reserve

Location	EVC	General description	Species present
Patch A	Coast Banksia Woodland (Vulnerable)	Features an overstorey of Coast Tea Tree with Scattered Coast Banksia and Bog Gum. Weed cover is high, particularly towards the north-western end of the patch	Coast Tea Tree, Coast Banksia, Bog Gum, Coast Wattle, Seaberry Saltbush, Climbing Lignum, Bower Spinach, Kikuyu
Patch B	Coast Banksia Woodland (Vulnerable)	Shelterbelt with a mix of indigenous and planted species. Has been protected from grazing, allowing indigenous species to persist or colonise the site. Introduced pasture grasses and weeds have infiltrated from adjacent paddocks	One medium Coast Banksia, Eucalyptus spp, Westringia spp, Callistemon spp, Hakea spp, Coast Wattle, Coast Tea-tree, Seaberry Saltbush, Bower Spinach, Woolly Tea-tree, Swamp Paperbark, Pithy Sword-sedge, Bidgee Widgee, Kidney-weed, Onion Grass, Cape Weed
Patch C	Swamp Scrub (Endangered)	Dense over-storey of swamp paperbark. Introduced species dominate the understorey, however a number of native species that favour damp environments are also present	Swamp Paperbark, Panic Veldt-grass, Cleavers, Variable Willow-herb, Common Spike-sedge
Patch D	Swamp Scrub (Endangered)	Contains Swamp Paperbark over predominantly introduced vegetation. Swamp Paperbark is regenerating however is in poor health, as cattle grazing is affecting the growth of young individuals	Swamp Paperbark, predominantly introduced vegetation
Patch E	Swamp Scrub (Endangered)	Contains a mix of Swamp Paperbark and graminoid-dominated areas. Weed levels are high and are mainly aquatic weeds. It could be expected that grassy weeds would have a higher level of cover during drier conditions	Swamp Paperbark, Rush, Sedge, Australian Sweet-grass, Common Spike-sedge, Variable Willow-herb, Buttercup, Scrub Nettle, Water Buttons, Water Crassula, Common Starwort
Patch F	Coast Banksia Woodland (Vulnerable)	Shelterbelt with a mix of indigenous and planted species. Has been protected from grazing, allowing indigenous species to persist or colonise the site. Introduced pasture grasses and weeds have infiltrated from adjacent paddocks	Eucalyptus spp, Westringia spp, Callistemon spp, Hakea spp, Coast Wattle, Coast Tea-tree, Seaberry Saltbush, Bower Spinach, Woolly Tea-tree, Swamp Paperbark, Pithy Sword-sedge, Onion Grass, Cape Weed

Location	EVC	General description	Species present
Patch G	Coast Banksia Woodland (Vulnerable)	Over-storey of Coast Tea-tree and Coast Wattle. Little of the original Coast Banksia Woodland understorey vegetation is remaining. The ground layer is mostly bare ground. Some patches of grassy and herbaceous weeds are present	Two Coast Banksias are present, Coast Tea-tree, Coast Wattle, Seaberry Saltbush, Bower Spinach, Austral Bracken
Patch H	Modified Coast Banksia Woodland (Vulnerable before modification)	Contains elements of Coast Banksia Woodland vegetation, however no over-storey layer remains. Low diversity and abundance of shrubs. Contains a cover of introduced grassy and herbaceous species, including the high threat weed Marram Grass	Regeneration of Coast Banksia, Knobby Club-sedge, Australian Salt-grass, Sea Rush, Australian Hound's-tongue, Sea Celery, Annual Fireweed, Variable Groundsel, Kidney Weed, Marram Grass
Patch I	Coast Banksia Woodland (Vulnerable)	Features a high cover of Kikuyu, however a diverse array of Coast Banksia Woodland species have persisted	Medium Coast Banksias and Coast Tea-trees (two of each), Coast Daisy-bush, Seaberry Saltbush, Crane's Bill, Kidney Weed, Bower Spinach, Australian Salt-grass, Kikuyu
Patch J	Modified Coast Banksia Woodland (Vulnerable before modification)	Contains elements of Coast Banksia Woodland vegetation, however no over-storey layer remains. Low diversity and abundance of shrubs. Contains a cover of introduced grassy and herbaceous species, including the high threat weed Marram Grass	Coast Daisy-bush, Knobby Club-sedge, Australian Salt-grass, Sea Rush, Australian Hound's-tongue, Sea Celery, Annual Fireweed, Variable Groundsel, Kidney Weed, Marram Grass
Patch K	Coastal Dune Scrub/Coastal Dune Grassland Mosaic (Least concern)	A sandy dune with indigenous shrubs dominating the vegetation. Weed levels are generally low with the exception of the northern edge of the patch where Kikuyu is invading from the adjacent grassy area	Coast Wattle, Coast Tea-tree, Coast Daisy-bush, Small-leafed Clematis, Bower Spinach, Dune Thistle, Karkalla, Australian Hound's-tongue, Kidney-weed, Kikuyu
Patch L	Coast Banksia Woodland (Vulnerable)	Sparse indigenous shrub layer, dominated by Coast Wattle. Graminoids dominate the ground layer. Other typical coastal species are also present	One large Coast Banksia, Coast Wattle, Australian Salt-grass, Knobby Club-sedge, Sea Rush, Karkalla, Strand Sedge, Bower Spinach, Kikuyu, Hare's-tail Grass, Sheep Sorrel

Location	EVC	General description	Species present
Patch M	Coast Banksia Woodland (Vulnerable)	Located in the southern and eastern boundaries of the site, extending into the foreshore reserve. Features an over-storey of mature Coast Banksias and a thick medium shrub layer. Bower Spinach dominates the ground layer. Scattered woody weeds are present and some areas have a high cover of shade tolerant ground layer weeds	Mature Coast Banksias, including large old trees, Coast Tea-tree, Coast Beard-heath, Swamp Paperbark, Bower Spinach, Coast Sword-sedge, Kidney Weed, Crane's Bill, Stinking Pennywort, Shade Pellitory, Mirror Bush, African Box-thorn, Panic Veldt-grass
Patch N	Coast Banksia Woodland (Vulnerable)	Located in the southern and eastern boundaries of the site extending into the foreshore reserve. Features an over-storey of mature Coast Banksias and a thick medium shrub layer. Bower Spinach dominates the ground layer. Scattered woody weeds are present and some areas have a high cover of shade tolerant ground layer weeds	Mature Coast Banksias, including large old trees, Coast Tea-tree, Coast Beard-heath, Swamp Paperbark, Bower Spinach, Coast Sword-sedge, Kidney-weed, Crane's Bill, Stinking Pennywort, Shade Pellitory, Mirror Bush, African Box-thorn, Panic Veldt-grass
Plant site, east of Powlett River	Damp Sands Herb-Rich Woodland (Vulnerable)	Coast Manna-gum dominates the overstorey. These patches contain a sparse shrub layer with species such as Spike Beard Heath and Coast Banksia. Austral Bracken dominates the ground layer, with scattered herbs and graminoids. Weed levels in these patches are relatively low	Coast Manna-gum, Spike Beard Heath, Coast Banksia, Austral Bracken, Ivy-leaf Violet, Rosy Hyacinth-orchid, Weeping Grass, Spiny-headed Mat-rush, Panic Veldt-grass, Chickweed, Sweet Vernal-grass
Plant site, east of Powlett River	Damp Sands Herb-Rich Woodland (Vulnerable)	The Damp Sands Herb-rich Woodland patches west of the Riparian Scrub are dominated by Coast Tea-tree with scattered indigenous eucalypts present. Weed levels within the patches are relatively low due to the dense overstorey of Coast Tea-tree, however common agricultural weeds are present	Coast Tea-tree, Coast Manna-gum, White Sallee, Coast Banksia, Weeping Grass, Small-leafed Clematis, Bower Spinach, Cape Weed, Red-ink Weed
Plant site, east of Powlett River	Aquatic Herbland (Endangered)	Three patches of Aquatic Herbland on Property 48 are present within low-lying treeless areas. The composition of flora species within each patch is different; however a mix of herbs, rushes, sedges and grasses variously dominates them. Weed levels are highest within the Aquatic Herbland patch surrounded by Riparian Scrub. Due to their current drier condition, the other two patches contain a different mix of weedy species	Centella, Swamp Goodenia, Shining Pennywort, Loose-flower Rush, Tall Rush, Swamp Club-sedge, Common Blown-grass, Swamp Wallaby-grass, Water Buttons, Common Water-starwort, Buck's-horn Plantain, Hairy Hawkbit, Water Couch

Location	EVC	General description	Species present
Plant site, east of Powlett River	Riparian Scrub (Vulnerable)	One patch of Riparian Scrub is present within Property 48. A dense cover of shrub species dominates the patch. Between the shrubs, scrambling species are present. Where light is able to penetrate to the ground layer, grassy and herbaceous species including were recorded. Weed levels within the patch are moderate.	Scented Paperbark, Prickly Tea-tree, Prickly Moses, Spreading Rope-rush, Scrambling Coral-fern, Common Blown-grass, Common Cud-weed, Centella, Water Couch, Panic Veldt-grass, Flatweed, Spear Thistle.
Plant site, east of Powlett River	Swamp Scrub (Endangered)	Property 48 contains two patches of Swamp Scrub with the dominant shrub being Swamp Paperbark. The western patch is fairly species poor due to heavy shading by the Swamp Paperbark; however the eastern patch contains a greater diversity of ground species, including herbs. The eastern patch also contains a greater level of weed cover.	Swamp Paperbark, Angled Lobelia, Ivy-leaf Violet, Tangled Bedstraw, Blackberry, Panic Veldt-grass

Excluding the foreshore reserve adjacent Williamsons Beach and Property 48, the majority of the site consists of grazed agricultural paddocks. These feature predominantly introduced vegetation with scattered indigenous species such as Rush. Most patches contain a low species diversity and high weed cover, which is likely to be a result of fragmentation and a history of livestock grazing. Lower Powlett Road reserve contains linear strips of Modified Coast Banksia Woodland and Swamp Scrub. These patches are in poor condition, being low in species diversity and high in weed cover due to their narrow width, position next to the road and proximity to paddocks dominated by introduced vegetation.

There are a number of damp depressions where indigenous species such as White Purslane and Buttercup have been recorded. Other indigenous species are also likely to be present, however were not detected due to the season and heavy grazing pressure at the time of field investigations. The cover of indigenous species at these sites is insufficient for them to be assessed as a patch under the Native Vegetation Management Framework.

The majority of Property 48 is dominated by Austral Bracken with scattered Weeping Grass and may be considered by DSE to be Degraded Treeless Vegetation, as defined under the Native Vegetation Management Framework. Most patches within the eastern half of Property 48 (Damp Sands-herb Rich Woodland, Riparian Scrub, Aquatic Herbland and Swamp Scrub) are in moderate to good condition, with reasonable species diversity and low-medium levels of weed invasion. The Damp Sands Herb-rich Woodland patches west of the Riparian Scrub patch are in poor to moderate condition. Species diversity is low, and most patches are small and have been invaded by grassy and herbaceous weedy species. Scattered indigenous trees within the site are in good to poor condition. At least two individuals are experiencing severe dieback, however the remainder of the scattered trees are in good condition (Biosis Research 2008$_3$, Technical Appendix 14).

Vegetation communities in the foreshore reserve

The majority of vegetation in the foreshore reserve is in good condition, with the exception of some patches of modified Coast Banksia Woodland adjacent the agricultural land that are in poor-moderate condition. Table 7-2 describes the vegetation on the foreshore reserve; the location of this vegetation is shown in Figure 7-1 (Biosis Research 2008$_3$, Technical Appendix 14).

Table 7-2 Native vegetation on the foreshore reserve

EVC	General Description	Species present
EVC 876 – Coastal Dune Scrub/Coastal Dune Grassland Mosaic (Least concern)	There are two quality zones of this EVC along the foredune. Grassy species dominate closer to the ocean, whilst shrub species dominate further from the ocean as the mosaic grades into Coastal Dune Scrub	Coast Fescue, Spinifex, Marram Grass, Coast Wattle, Coast Daisy-bush, Coast Everlasting and Coast Tea-tree
EVC 2 – Coast Banksia Woodland (Vulnerable)	Coast Banksia dominates the over-storey, while Coast Tea-tree dominates the medium shrub layer. Bower Spinach has densely overgrown the shrubs. Many of the coast banksias are senescing. Weeds dominate the ground layer	Coast Banksia, Coast Tea-tree, Bower Spinach, Kidney-weed, Buttercup, Crane's-bill, Pink Fairies, Panic Veldt-grass
Modified Coast Banksia Woodland	These patches contain a high cover of introduced grassy and herbaceous species. There are no coast banksias. Vegetation consists of planted shrubs over a layer of Australian Salt-grass, Knobby Club-sedge and a mix of herbaceous species	Australia Salt-grass, Knobby Club-sedge, Australian Hound's-tongue, Kidney-weed, Crane's bill, Capeweed, Yorkshire Fog

EVC	General Description	Species present
EVC 160 – Coastal Dune Scrub (Least concern)	Dense shrubs of Coast Tea-tree, 1 to 5 m in height, dominate the canopy. The ground layer varies from being almost entirely dominated by the weedy Panic Veldt-grass to areas dense with organic litter	Coast Tea-tree, Coast Beard-heath, Coast Wattle, Coast Banksia, Swamp Paperbark, Bower Spinach, Kidney-weed, Bottle Daisy, Panic Veldt-grass
EVC 163 – Coastal Tussock Grassland (Least concern)	This patch is located at the top of small cliffs. Coast Tussock-grass and Coast Sword-sedge to 1 m high dominate	Coast Tussock-grass, Coast Sword-sedge, Australian Salt-grass, Knobby Club-sedge, Spiny-headed Mat-rush
EVC 879 – Coastal Dune Grassland (Endangered)	This patch is located immediately above the high tide mark at the start of the foredune. It has a low cover of plants due to recent windblown sand deposits. Hairy Spinifex dominates, with a low cover of Marram Grass. Other native species are establishing in between the grasses	Hairy Spinifex, Karkalla, Dune Thistle, Annual Fireweed, Variable Groundsel, Marram Grass
EVC 311 – Berm Grassy Shrubland (Endangered)	The Berm Grassy Shrubland is present at the western end of the foreshore reserve, immediately above the high tide mark. It is dominated by Hairy Spinifex and the introduced Marram Grass, with Seaberry Saltbush providing the shrubby component of the EVC	Hairy Spinifex, Marram Grass, Seaberry Saltbush
EVC 876 – Spray-zone Coastal Shrubland (Vulnerable)	Shrub species such as Coast Wattle, Coast Beard-heath, Coast Daisy-bush, Coast Everlasting and Sea Box dominate this low shrubland, which is buffeted by coastal winds	Coast Wattle, Coast Beard-heath, Coast Daisy-bush, Coast Everlasting, Sea Box
EVC 3 – Damp Sands Herb-rich Woodland (Vulnerable)	A small patch of Damp Sands Herb-rich Woodland with a sparse overstorey of Coast Manna-gum is present on the eastern side of the car park along the eastern edge of the reserve.	Coast Manna-gum
EVC 653 – Aquatic Herbland (Endangered)	A small circular patch of Aquatic Herbland, dominated by (and almost exclusively) Shiny Swamp-mat is present in the revegetation area on the mid-northeastern boundary of the fenced area.	Shiny Swamp-mat

Significant flora species

A total of 118 indigenous and 64 introduced vascular plant species were recorded in the Project area during surveys. Database searches revealed records of 337 indigenous and 156 introduced flora species within five kilometres of the Project area.

One EPBC-listed flora species, River Swamp Wallaby Grass *Amphibromus fluitans* was recorded on the plant site. This species is listed as vulnerable. Four individual plants were located on the plant site during November 2007. This population is not an important population as defined under the EPBC Act. An important population is "a population that is necessary for a species' long-term survival and recovery'. An additional population of Swamp Wallaby-grass is supported in the north-western section of the plant site (property 48). These plants could not be identified to a species level as they were not flowering. Given that River Swamp Wallaby-grass is present on the adjacent section of the plant site, it is considered likely hat these individuals are also River Swamp Wallaby-grass. These plants are located outside of the construction footprint of the Desalination Plant. The site is not considered to constitute suitable habitat for any other EPBC-listed threatened flora species.



One FFG-listed flora species has potential to occur on the plant site and foreshore reserve. This is the Merran's Sun-orchid *Thelymitra X merraniae* and was not recorded during field investigations. It is unlikely that this species would be present on the site because of habitat modification (Biosis Research 2008_3, Technical Appendix 14).

7.1.2 Fauna

Fauna habitats

There are three types of fauna habitat within the plant site and foreshore, these are:

- pastoral land on private properties and road reserve within the plant site
- dunes within the foreshore reserve
- freshwater habitat in a tributary of the Powlett River and connected waterbodies (Biosis Research 2008_3, Technical Appendix 14).

Pastoral land

The private properties and road reserve are largely cleared with a few remnant patches and revegetated areas of native vegetation. A number of farm dams are scattered across the site. The cleared land supports introduced pasture and offers limited habitat value to indigenous fauna. Common fauna species, which have adapted to cleared agricultural land, are most likely to use it. Significant fauna species may use the land from time to time, however similar pasture is widely available and hence its habitat values are not a limiting resource.

Native vegetation is present in small, isolated patches. Some of these have been substantially disturbed by browsing and trampling by stock. The exception to this is property 48, which is part of a larger area of indigenous vegetation that extends north and east beyond the Project area. The patches of native vegetation provide 'stepping stones' in the landscape for a number of bird species, some reptiles and possibly some small mammals. These species would not otherwise occur on these properties.

Revegetated areas near the foreshore dune vegetation community are likely to provide habitat for small mammals and reptiles. The farm dams are isolated from other waterbodies and lack fringing and aquatic vegetation. They are likely to provide some limited value to common waterbirds and frogs, but are of low value to other indigenous fauna and fish. The dam within property 48 supports better quality habitat for frogs and contains some fringing and emergent vegetation (Biosis Research 2008$_3$, Technical Appendix 14).



Dunes

The foreshore reserve includes a steep primary dune, secondary and often tertiary dunes. The section of foreshore reserve adjacent the plant site is narrower than that to the north and south. The dunes support indigenous vegetation that is continuous with habitat at the Powlett River mouth, and Wonthaggi Heathland and Coastal Reserve. This is likely to provide habitat for small mammals and reptiles, with species likely to include the White-footed Dunnart, Southern Brown Bandicoot, Swamp Antechinus and Swamp Skink.

Red Foxes, people walking, unrestrained dogs and recreational surf fishing may disturb fauna on the foreshore and beach. This disturbance could kill beach-nesting birds and ground-dwelling mammals and reptiles (Biosis Research 2008$_3$, Technical Appendix 14).

Freshwater habitats

An ephemeral tributary of the Powlett River crosses the north-eastern edge of the plant site. Near Lower Powlett Road there may be areas with deeper pools that do not completely dry out. At the time of assessment this watercourse was flowing and consisted predominantly of pools and glides interspersed with the occasional run. The sediment consisted entirely of silt, with an average wetted channel width of 2.5 metres and maximum depth of around one metre. The tributary and the associated wetland provide a moderate to high cover to aquatic fauna. Vegetation provided the predominant source of the cover, with snags, coarse particulate organic matter and fringing/overhanging terrestrial vegetation also providing cover. Aquatic vegetation generally consisted of emergent forms, with the exception of the large online wetland which supported submergent and floating forms. The tributary is subject to varying degrees of disturbance. Deep pools within the tributary provide permanent habitat to migratory and exclusively freshwater fish species such as the Southern Pygmy Perch (Biosis Research 2008$_3$, Technical Appendix 14).

Significant fauna species

The *Flora and Fauna Guarantee Act 1988* (FFG) protects Victoria's threatened plant and animal species, ecological communities from potentially threatening processes. The EPBC Act protects matters of national environmental significance from significant impact. Matters of national environmental significance are:

- listed threatened species and communities
- listed migratory species
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- World Heritage properties
- National Heritage places
- nuclear actions.

A total of 114 vertebrate fauna species were recorded during field investigations, including:

- sixty-four native and seven introduced birds
- five native and five introduced mammals
- six native reptiles
- four native frogs
- twenty-three fish (21 native and two introduced).

Sixty-two of these species were found in the plant site and 11 were located in the adjacent foreshore and dune area, 68 from the Lower Powlett River environs and 23 from the waterbodies of the Powlett River catchment. Nineteen of the species recorded were encountered in the Project area, three exclusively in the foreshore/dune habitats, 29 exclusively within the Lower Powlett River environs and 20 exclusively in the waterbodies of the Powlett River catchment.

Three terrestrial EPBC-listed fauna species are likely to inhabit or visit the plant site or foreshore reserve. EPBC-listed marine species and migratory birds of national significance are discussed further in Volume 2, Chapter 5. An additional 13 fauna species are FFG-listed. Table 7-3 lists protected species and describes their potential presence at the site.

Table 7-3 Protected fauna species

Common name	Scientific name	EPBC Act	FFG Act	Presence
Orange-bellied Parrot	*Neophema chrysogaster*	Critically endangered	Listed	Previously recorded in the area. Fauna surveys did not identify this species
Southern Brown Bandicoot	*Isoodon obesulus obesulus*	Endangered	—	Previously recorded in the Wonthaggi-Cape Patterson area. Fauna surveys did not identify this species
Dwarf Galaxias	*Galaxiella pusilla*	Vulnerable	Listed	May occur in refuge pools of the unnamed tributary of the Powlett River
Little Egret	*Egretta garzetta*	—	Listed	Possible rare visitor to farm dams on-site
Intermediate Egret	*Ardea intermedia*	—	Listed	Possible rare visitor to farm dams on-site

Common name	Scientific name	EPBC Act	FFG Act	Presence
Eastern Great Egret	*Ardea modesta*	—	Listed	Recorded during survey
Freckled Duck	*Stictonetta naevosa*	—	Listed	Possible rare visitor to farm dams on-site
Blue-billed Duck	*Oxyura australis*	—	Listed	Possible rare visitor to farm dams on-site
Grey Goshawk	*Accipiter novaehollandiae*	—	Listed	Possible rare visitor to site
White-bellied Sea-eagle	*Haliaeetus leucogaster*	—	Listed	Recorded during survey over foreshore portion of site
Hooded Robin	*Melanodryas cucullata*	—	Listed	Possible rare visitor
Swamp Antechinus	*Antechinus minimus*	—	Listed	Probably occurs in the Williamsons Beach foreshore reserve
Swamp Skink	*Egernia coventryi*	—	Listed	Possibly occurs in Williamsons Beach foreshore reserve or remnant swamp scrub patches of the Project area
Australian Mudfish	*Neochanna cleaveri*	—	Listed	The unnamed tributary could potentially support the Australian mudfish
Magpie Goose	*Anseranas semipalmata*	—	Listed	Possible rare visitor to farm dams and open pastures on-site
White-footed Dunnart	*Sminthopsis leucopus*	—	Listed	Probably occurs in the Williamsons Beach foreshore reserve

EPBC listed species

Three terrestrial EPBC-listed fauna species are likely to inhabit or visit the plant site or foreshore reserve. These species are discussed below.



Orange-bellied Parrot

The Orange-bellied Parrot is listed as critically endangered under the EPBC Act and is also listed under the FFG Act. The species may occasionally visit the Plant site, however the site does not offer any resources that are not otherwise abundant and widespread across agricultural areas in the coastal zone. The Orange-bellied Parrot utilises portions of coastal South Gippsland during the annual non-breeding period when the species inhabits mainland Australia. The Orange-bellied Parrot was previously recorded in 1991 and 1996 at the Powlett River mouth and one kilometre upstream of the Powlett River mouth.

Favoured foraging habitat for Orange-bellied Parrots on the mainland is saltmarsh and this occurs in the reserve near the Powlett River mouth. There are 56 documented food plants of the Orange-bellied Parrot, a number of these are indigenous and introduced plants that are common and abundant in agricultural pastures in coastal Victoria. Sixteen of these species, the majority of which are common introduced weeds, are present on the plant site. The presence of these plants and the close proximity of the site to the Powlett River mouth suggest the possibility that the Orange-bellied Parrot could occur at the site occasionally (Biosis Research 2008_3, Technical Appendix 14).

Southern Brown Bandicoot

The Southern Brown Bandicoot is listed as endangered under the EPBC Act. This species occurs in dry heath, shrubland and heathy forest and woodland. There are records of the Southern Brown Bandicoot from the Wonthaggi–Cape Patterson area. This species may occur in the coastal dune vegetation and forage in the adjacent pasture, but was not found during any surveys at and around the Plant site (Biosis Research 2008_3, Technical Appendix 14).

Dwarf Galaxias

Dwarf Galaxias is a tiny fish species that occurs in still or slow flowing, usually ephemeral waterbodies that in many instances partially dry up over summer. Dwarf Galaxias usually occurs in relatively shallow waterbodies and typically requires abundant marginal and aquatic vegetation. Dwarf Galaxias is short lived (1-2 years) and opportunistic, appearing to have physiological and behavioural adaptations that allow it to survive in very small bodies of permanent water with low dissolved oxygen content. The species can rapidly recolonise large low lying ephemeral areas under suitable conditions before contracting back again in large numbers to small permanent pools.

This species has not been recorded from the Powlett River catchment or neighbouring catchments, however it has been recorded from the South Gippsland Basin and is undersurveyed due to its small size and habitat preferences. The species could potentially inhabit the freshwater reaches of the un-named tributary of the Powlett River, particularly given the existence of other exclusively freshwater fish species (i.e. Southern Pygmy Perch) indicative of permanent freshwater habitat, and the apparent absence of the introduced Eastern Gambusia, which presents a threat to the Dwarf Galaxias from predation and competition. If present within the tributary, this species could potentially inhabit and utilise large expanses of connected freshwater habitat to breed over winter and spring (Biosis Research 2008$_3$, Technical Appendix 14).

FFG listed species

Two species listed under the FFG Act that are not also listed as threatened under the EPBC Act, were recorded within the Desalination Plant site. They are the Eastern Great Egret *Ardea modesta* and White-bellied Sea-eagle *Haliaeetus leucogaster*. The White-bellied Sea-eagle is listed as a migratory species under the EPBC Act. Two species of small mammals, the Swamp Antechinus *Antechinus minimus* and the White-footed Dunnart *Sminthopsis leucopus*, may inhabit vegetation in the dune system between the Desalination Plant site and Williamsons Beach.

Three other FFG-listed species are considered to have potential to inhabit appropriate small portions of the site. They are the Swamp Skink *Egernia coventryi*, which may occur in very small remnants of Melaleuca Swamp Scrub, and the Dwarf Galaxias *Galaxiella pusilla* and Australian Mudfish *Neochanna cleaveri*, both of which may possibly inhabit the unnamed tributary of the Powlett River in the northern part of the site.

Eight other FFG listed species, all of which are wide-ranging birds, are considered to have low potential to visit the site on rare occasions. The relevant species are the Blue-billed Duck *Oxyura australis*, Freckled Duck *Stictonetta naevosa*, Grey Goshawk *Accipiter novaehollandiae*, Hooded Robin *Melanodryas cucullata*, Intermediate Egret *Ardea intermedia*, Little Egret *Egretta garzetta* and Magpie Goose *Anseranas semipalmate* and Orange-bellied Parrot *Neophema chrysogaster.* The habitat at the Plant site is largely unsuitable for these birds and none of these species would be solely dependant on it.

White-bellied Sea-eagle

White-bellied Sea-eagle has declined in numbers along Victoria's coast in recent years. It is most usually recorded along or near coastal areas in the east of the state, and around large inland rivers such as the Murray River. They hunt over open habitats, particularly large wetlands and deep freshwater swamps, lakes and reservoirs, but will fly over densely vegetated habitats.

Breeding occurs mainly along the coast and offshore islands, and inland beside large rivers and lakes. They usually nest in tall trees but occasionally on cliffs and rocky outcrops in a prominent position with a view of the surrounding area. Established pairs are mostly sedentary with a home range of up to 100 square kilometres (Marchant and Higgins 1993, cited in Biosis Research 2008$_3$, Technical Appendix 14). This species has been recorded over dune/foreshore portion of the site. The site offers limited resources to this species, none on which it is dependent.

Eastern Great Egret

The Great Egret is usually found in terrestrial wetland, estuarine and wet grassland habitats. They prefer permanent well-vegetated waterbodies but also use freshwater meadows, channels and farm dams. This species usually roost and breed in wetlands with fringing or flooded trees; most Victorian breeding sites are in the Murray-Darling Basin. The Eastern Great Egret was recorded foraging within the lower reaches of the Powlett River. It is possible this species may be a visitor to farm dams within the Project Area.

Swamp Antechinus

Swamp Antechinus is found near coastal areas from Robe, South Australia in the west of its range to Corner Inlet in Victoria. Habitat for this species is typically wet heath, heathy woodland, sedgeland and dense tussock grassland (Menkhorst 1995, cited in Biosis Research 2008$_3$, Technical Appendix 14).

This species was recorded during survey of the Wonthaggi Heathland and Coastal Reserve (Homan 2004, cited in Biosis Research 2008$_3$, Technical Appendix 14). The sites sampled during that survey were just beyond the five-kilometre database search radius of the Project area. It is probable this species occurs in the Williamsons Beach foreshore reserve adjacent to the Project area.

White-footed Dunnart

White-footed Dunnart occurs along the entire coastline of Victoria in a range of habitats including coastal tussock grassland, wet heath, forest and woodland with dense understorey or mid-storey vegetation (Menkhorst 1995, cited in Biosis Research 2008$_3$,). This species was recorded during survey of the Wonthaggi Heathland and Coastal Reserve (Homan 2004, cited in Biosis Research 2008$_3$, Technical Appendix 14).

The sites sampled during that survey were just beyond the five-kilometres database search radius of the Project area. It is probable this species occurs in the Williamsons Beach foreshore reserve adjacent to the site.

Australian Mudfish

Australian Mudfish is a benthic diadromous fish species found in coastal swamps of Victoria and Tasmania. Within Victoria the species is recorded in low abundances from coastal waterbodies of the Otway, South Gippsland (Wilsons Promontory), Barwon and Yarra Basins and its preferred habitat consists of dense aquatic or inundated terrestrial vegetation over a mud or silt substrate. The species is capable of partial aestivation, is cryptic in nature and hence poorly surveyed. Waterbodies in the lower reaches of the Powlett River catchment may offer potential habitat to this species.

Swamp Skink

Swamp Skink inhabits low-lying areas, swamp margins, sedge-tussock vegetated areas and swamp scrub thickets in Victoria. This species was recorded during survey of the Wonthaggi Heathland and Coastal Reserve. The sites sampled during that survey were just beyond the five kilometres database search radius of the Desalination Plant site. It is possible this species occurs in limited portions of Kilcunda - Harmer's Haven Coastal Reserve or remnant swamp scrub patches of the Plant site.

Migratory species

The list of migratory species under the EPBC Act is a compilation of species listed under four international conventions: China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA), Republic of Korea – Australia Migratory Bird Agreement (ROKAMBA) and Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Five species were recorded in the local area, principally within the lower reaches of the Powlett River, which is not expected to be directly impacted by the proposed development. The proposed site for the Desalination Plant does not provide important habitat for an ecologically significant proportion of any of these species. Eight additional species have been recently recorded from within five kilometres of the site and four other species have broad geographic ranges that encompass the site. While some of these species would be expected to use the site on occasions, and some of them may do so regularly or may be resident, it does not provide habitat for an ecologically significant proportion of any of these species.

Fauna communities

There are no known EPBC-listed threatened ecological communities or FFG-listed fauna communities present on the plant site, foreshore reserve or local area (Biosis Research 2008$_3$, Technical Appendix 14).

7.2 Impact assessment

This section discusses the potential impacts of the construction and operation of the Desalination Plant on flora and fauna at and around the site.

7.3 Construction

7.3.1 Risks assessed as medium and above

Table 7-4 sets out the flora and fauna risks associated with the construction of the Desalination Plant which are assessed as medium and above. The risks are discussed in order of likelihood with those most likely to occur discussed first.

Table 7-4 Construction flora and fauna risks assessed as medium

Activity	Impact pathway	Consequence	Likelihood	Risk
Site clearing	Removal of native vegetation patches including threatened Ecological Vegetation Classes	Minor	Certain	Medium
Site clearing	Removal of habitat used by native fauna	Minor	Certain	Medium
All construction activities	Increased traffic affecting local fauna	Minor	Certain	Medium
All construction activities	Noise and vibration impacting native fauna	Minor	Likely	Medium
Earthworks and stockpiling	Sediment discharge to waterways resulting from soil erosion or spoil from earthworks, impacting on surface water ecosystems	Moderate	Likely	Medium
Tunnelling	Seawater intrusion in the existing groundwater table into effecting native terrestrial and aquatic flora and fauna	Minor	Likely	Medium

The above risk assessment is based on accepted construction practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the Performance Requirements are taken into account, both the likelihood and consequence of these risks may be significantly lower.

Site clearing

In the Reference Project, the Desalination Plant envelope is located on land that is largely cleared, pastoral land with a very low abundance of indigenous plant species. The total area of vegetation cleared would depend on final siting of the Plant, but it is assumed that remnant vegetation on the whole plant site may be cleared. Clearing the Plant footprint would remove four small vegetation patches of Coast Banksia Woodland. These patches are highly fragmented and contain a low diversity of indigenous species with high weed cover. Five scattered Coast Banksias are also likely to be removed. There are three endangered EVCs on the Plant site, Swamp Scrub, Aquatic Herbland and Berm Grassy Shrubland. The Reference Project avoids direct impacts to these EVCs through Plant siting and tunnelling under the dunes and foreshore reserve. Based on the small extent of the patches and the scattered trees involved, this would constitute a minor impact on Coast Banksia Woodland and would be unlikely to change its conservation status.

In the Reference Project, the Plant has been situated to avoid clearing native vegetation where possible. Current siting of the Plant may remove four individuals of the River Swamp Wallaby-grass, which is listed as vulnerable under the EPBC Act, but these individuals are not considered an important population. Additionally, clearing may remove eight individual Bog Gums. This eucalyptus species is native to Australia, but is not listed under the EPBC or FFG Acts. Site clearing is expected to have only a minor effect on native vegetation with mortality likely to be no greater than natural annual variability because the area of vegetation likely to be removed by the Project is small and has limited diversity of the vegetation.

Selection of the current site, which is very substantially cleared of indigenous vegetation will assist in meeting the first principle of the Native Vegetation Management Framework through avoidance of clearing. Impacts to areas of native vegetation have been estimated for the Reference Project. Less than one hectare of an Endangered EVC would be impacted (Swamp Scrub). Depending on the results of the Net Gain assessment, these areas would be from high to very high conservation significance under the Native Vegetation Management Framework. Less than one hectare of a Vulnerable EVC would be impacted (Coast Banksia Woodland). Depending on the results of the Net Gain assessment, these areas would be from medium to very high conservation significance under the Native Vegetation Management Framework.

It is considered that offset requirements for losses of native vegetation on the Plant site would be achievable and there is the ability to achieve enhancements to the site's biodiversity values through the implementation of landscaping works. Removal of vegetation of very high conservation significance will require the approval of the Minister for Environment and Climate Change. Approved offsets would be determined by DSE in accordance with Victoria's Net Gain Policy.

Therefore, clearing of native vegetation for the Plant would result in the loss of individual plants, but without reductions in the viability of populations in the local area or region.

The Plant site offers areas offer limited habitat value for native fauna, and most of the fauna found at the site and likely to inhabit these areas are common species that have adapted to cleared agricultural land in South Gippsland (Biosis Research 2008_3, Technical Appendix 14). Although these areas may be used from time to time by significant species (e.g. Southern Brown Bandicoot and Orange-bellied Parrot), this habitat is not a limiting resource, as similar pasture is widely available throughout the region. Additionally, a net gain offset applied to the Project would ameliorate the loss of these areas of native vegetation. Net gain is where overall gains in native vegetation are greater than overall losses. This means that equivalent areas must be revegetated for all areas of native vegetation that are cleared.

Construction activities

Construction activities would introduce vehicle movements at the plant site and increase traffic on nearby roads. It is certain that traffic would impact some local fauna as habitats such as the coastal dunes occur adjacent to the construction area. However, the construction site is likely to be fenced, providing another barrier to fauna accessing the areas most frequented by traffic associated with the development. Traffic is expected to have a minor effect on fauna populations with the loss of only a small number of individuals and mortality is likely to be only within natural variation experienced by the local fauna populations (Biosis Research 2008_3, Technical Appendix 14).

Noise and vibration levels are likely to increase during construction of the Plant which may disturb native fauna. Noise and vibration is likely to disturb native fauna, as construction would emit periodic substantial noise levels (as discussed in Chapter 10 Noise and vibration), which is expected to act as a deterrent for fauna utilising habitats in the vicinity of the site. This could potentially have an impact upon threatened species within the locality. This impact is expected to be minor as it would be short term and restricted to the construction period. Further to this, fauna are likely to acclimatise to the majority of consistent construction noise.

Tunnel construction may emit some noise and vibration during drilling and blasting (if required). As soon as the tunnels reach a depth below ground surface, the noise would be attenuated by the ground, which would minimise the noise to fauna inhabiting the dunes. Additionally, it is likely that the dunes would shield Williamsons Beach from tunnel noise. Therefore, increased noise during construction is expected to have a minor consequence for native flora and fauna, with only local or regional effects on ecosystem interactions and ecosystem recovery in less than one year.

Earthworks and stockpiling

Excavated soil would be stockpiled on-site. On-site work practices would be in place during construction to minimise the amount of erosion of stockpiles, but a high rainfall event could cause sediment to enter the stormwater and discharge into the tributary in the northwest corner of the plant site and the Powlett River. The likelihood of this occurring is discussed in Volume 3, Chapter 6 Surface water and groundwater.

This tributary has little native vegetation, but significant sediment loads could smother the adjacent small patch of Swamp Scrub or the salt marshes in the Lower Powlett River. As Swamp Scrub is an endangered EVC any impact from sedimentation during earthworks and stockpiling may have a moderate impact, but the area affected is likely to be small and construction practices will minimise the risk.

Tunnelling and shaft construction

The Marine Structures would be connected to the Desalination Plant via tunnels under the dunes. Tunnelling could potentially allow seawater to intrude into the groundwater at the site (discussed in Chapter 5 Geology and geomorphology). Saline intrusion occurs where groundwater is pumped from aquifers that are connected with saline waters.

Vegetation on the dunes may use some groundwater and changes to groundwater quality may prevent plants from using this water source (depending on the changes in salinity). Any increased salinity in the groundwater is expected to have a minor impact on vegetation in the local area with the possible loss of some individuals.

Once dewatering activities stop, the aquifer is likely to recover from the change in water quality, and vegetation communities would likely recover in response to amelioration of the aquifer. Additionally, plant species differ in their salinity tolerances and short-term salinity stress would manifest differently in different species, so alterations of the ecosystem would be expected to be within the natural annual variation.

7.3.2 Risks assessed as low

The risk assessment for the Desalination Project explored a comprehensive list of potential environmental effects in order to identify the priority areas for management through the Performance Requirements. The risks discussed below have been assessed as low and are expected to have a negligible or minor impact on flora and fauna.

Disturbance to flora

Construction of the Desalination Plant would require a large portion of the site to be cleared. There is potential for native seeds stored in the topsoil to be removed during site clearing, but it is unlikely that these seeds would have remained viable over the years of agricultural use.

Disturbance to fauna

Significant fauna species, such as the White-footed Dunnart, Southern Brown Bandicoot, Swamp Antechinus and Swamp Skink have potential to occur in the foreshore and dunes adjacent to the site. Access to the foreshore during construction would be restricted, though some disturbance may occur if workers cross the dunes to access the beach.

A number of native and significant migratory bird species have been seen at the site or have the potential to use the habitat of the site and the foreshore reserve. Artificial lights may affect these birds and some nocturnal mammals. Species most likely to be affected are those that rely on the dark for concealment, mammals that used defined tracks and some migrating bird species. Bats may be positively affected by increased lighting, as insects that they forage for tend to cluster around lights. Minimal lighting would be used to minimise impacts to native fauna.

Increased mortality of eggs or chicks of various species of birds may occur as a result of disturbance to nests and entrapment of terrestrial fauna in open construction trenches. However, the mortality rate is not expected to vary significantly from natural variation.

Vibrations during tunnelling works under the dune system could potentially cause instability in the dune system which could native flora and fauna. The intended construction works will not directly impact the foreshore reserve. Vibrations associated with construction or tunnelling may cause indirect impacts. Vibration impacts associated with tunnelling are generally associated with structures directly above or adjacent to the tunnel route, and are generally within the 90 to 120 Hz range. Assessment of the potential effects of vibration for construction of the Desalination Plant shows that vibration is unlikely to have an impact on the stability of the foreshore dunes (discussed further in Volume 3 Chapter 5 Geology and geomorphology and Volume 3 Chapter 10 Noise and vibration). Therefore the risk to native flora and fauna from vibration is assessed as low.

Disturbance of Orange-bellied Parrots could occur due to increased numbers of people accessing the mouth of the Powlett River, particularly during construction. This impact would be confined to the March to September period when the species is present in Southern Victoria and would only occur in the unlikely event that Orange-bellied Parrots visit the area. Primary access to the Desalination Plant will be via Powlett Road, which will assist to minimise potential access by construction workers outside the Plant site to the Powlett River.

Weeds, pests, dust and disease

Existing weed levels on the Desalination Plant site are generally high. Physical disturbance within areas of the native vegetation would generally promote weed colonisation from other areas.

Pathogens of flora and fauna, such as Cinnamon Fungus *Phytophthora cinnamomi* and Amphibian Chytrid Fungus *Batrachochytrium dendrobatidis* occur in the South Gippsland area. Cinnamon Fungus is an introduced soil borne fungus that causes root rot in many species of native and introduced plants, and Amphibian Chytrid Fungus causes skin disease in amphibians. These pathogens may be accidentally transported to the site by vehicles, machinery and people. This risk has been assessed as low as mitigation measures will reduce the likelihood of pathogens being transported to or from the site.

Construction activities at the site have the potential to create large amounts of dust, which could affect flora and fauna at and around the plant site. If significant amounts of dust settle on vegetation, it could affect the health of the vegetation and impact on fauna that feed on the vegetation. Also, an unnatural increase in dust levels may directly impact the health of terrestrial fauna. Any contaminants that may be contained within the dust exacerbate these effects. However, dust will be managed using EPA controls and it is considered that this level of dust would fall within natural variability. Therefore, any impacts to flora and fauna would be negligible.

Surface water ecosystems and groundwater

Changes in the amount or composition of ground or surface water could create imbalances in natural ecosystems, causing impacts to flora and fauna. Runoff, chemical spills or changes to groundwater levels during construction all have to potential to affect aquatic flora and fauna, as well as the salt marsh ecosystems of the mouth of the Powlett River. These activities could occur during construction of the Desalination Plant, but the risk is considered to be low.

Excavations may need to be dewatered if the watertable is encountered during construction of the Desalination Plant. Additionally, water may be required on-site during construction and groundwater is one possible water source (from either a bore or from an excavated trench). The watertable may be locally lowered flora and fauna close to the dewatering site or the groundwater bore may be affected by the reduction in the watertable (discussed further in Volume 3, Chapter 5 Geology and geomorphology). Overall, the risk to flora and fauna is low as only a few individuals may be affected by dewatering and the groundwater table is expected to return to its original level after construction ceases.

7.4 Operation

7.4.1 Risks assessed as medium

Table 7-5 sets out the only flora and fauna risk associated with the operation of the Desalination Plant which is assessed as medium and above.

Table 7-5 Operation flora and fauna risks assessed as medium and above

Activity	Impact pathway	Consequence	Likelihood	Risk
Stormwater runoff	Discharge to surrounding waterways impacting on surface water ecosystems	Major	Unlikely	Medium

The above risk assessment is based on accepted operation practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the Performance Requirements are taken into account, both the likelihood and consequence of these risks may be significantly lower.

Stormwater runoff

Increased stormwater runoff may potentially have a major impact on surface water ecosystems. However this impact is unlikely to occur, as the ground surface at the site would be graded to ensure that the natural direction and quantity of stormwater is maintained. By doing this, direction and levels of stormwater runoff during operation should not differ significantly from natural runoff.

7.4.2 Risks assessed as low

The risk assessment for the Desalination Project explored a comprehensive list of potential environmental effects in order to identify the priority areas for management through the Performance Requirements. The flora and fauna risks associated with the operation of the Desalination Plant have been previously discussed, as all of them have the potential to also occur during construction. These low risks relate to vehicle movements which may create dust and vibrations and spread disease, weeds or pests and also the risk of noise, night light or vibration from operation of the Desalination Plant impacting native fauna.

7.5 Performance Requirements

Performance Requirements (PRs) have been developed to provide an environmental framework for management of potential flora and fauna impacts associated with the Project during construction and operation. The PRs are focussed on the environmental outcomes that the State wishes to achieve through the Project delivery. The PRs relevant to flora and fauna for the Plant are set out below. The full suite of PRs for the Project is provided in Volume 1 Chapter 10 as part of the overall Environmental Management Framework.

As part of the environmental impact and risk assessment process relating to flora and fauna for the Plant, Biosis Research (2008_3) has identified a range of suggested management measures that could be implemented to manage potential impacts. These suggested management measures have been formulated in response to the Reference Project and relevant Variations for the Plant. In effect, the suggested management measures demonstrate how the Reference Project and relevant Variations can achieve the PRs. These detailed management measures have formed an important input to the PRs for the Project.

The management measures suggested by Biosis Research (2008_3) address the following matters:

- Avoiding or minimising impacts during the construction phase by:
  - managing Ecological Vegetation Classes (EVCs) consistent with Victoria's Native Vegetation Management Framework, Net Gain 3-step process of avoid, minimise, offset losses of indigenous vegetation

  - avoiding direct or indirect impacts on significant areas of native vegetation, including restricting access by machinery or construction personnel
  - maximising the use of existing disturbed areas
  - conducting habitat assessments to determine the conservation significance of vegetation
  - implementing a weeds, pests and disease management program
  - implementing a dust management regime
  - developing a sediment and drainage management plan to prevent movement of sediment or pollutants from the construction zone into adjacent vegetation and waterways
  - educating construction and operations personnel about conservation measures in place for the dune ecosystems
  - banning dogs from the construction site and prohibiting personnel taking leashed or unleashed dogs into Kilcunda–Harmer's Haven Coastal Reserve
- Avoiding or minimising impacts during operation by:
  - developing spill control measures to protect flora and fauna from potential chemical spills
  - utilising lighting that is least attractive to insects and positioned as low to the ground as practicable
- Recommended monitoring programs including:
  - Monitoring the location and breeding success of the Hooded Plover
  - Monitoring the presence of the Orange-bellied Parrot between March to September during construction activities.

The PRs proposed for flora and fauna are outlined in Table 7-6.

Table 7-6 Performance Requirements

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Terrestrial flora and fauna	✓	✓	Minimise impacts on terrestrial flora and fauna.	Minimise impacts on terrestrial flora and fauna. Achieve compliance with the net gain approach set out in the Victorian Native Vegetation Management Framework. Avoid where practicable or minimise impacts in the designated areas presented in Figures: ▪ PR Sensitivity Areas – Plant Area in Technical Appendix 5. Apply EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996) to limit impacts during construction.	Comply with the Performance Criteria. Apply the net gain approach consistent with the Victorian Native Vegetation Management Framework to the satisfaction of the Department of Sustainability and Environment. Develop and implement methods and management systems to limit impacts on terrestrial flora and fauna including: ▪ Management of the volume, velocity and quality of stormwater entering the declared Western Port Ramsar site during construction and operation ▪ Management of noise, light spill, vehicle movements, domestic animals, open trenches, dust suppression and weeds ▪ Monitoring and reporting protocols, including water quality criteria, to determine compliance with the above matters Where disturbance is to occur, the agreement of the State is to be obtained for the processes to apply to: ▪ Management of Ecological Vegetation Classes (EVC) to ensure compliance with the Victorian Native Vegetation Management Framework ▪ Salvage of plant species and plant collection ▪ Conservation of significant fauna species (Hooded Plover, Giant Gippsland Earthworm, Southern Brown Bandicoot, Dwarf Galaxias, Australian Mudfish and Growling Grass Frog, Swamp Skink and Orange-bellied Parrot) ▪ Taking of protected flora from public land ▪ Translocation, disturbance or handling of native wildlife Develop a Vegetation Management Plan detailing the appropriate revegetation techniques and the species to be revegetated Develop and implement methods and systems for managing imported soils or gravel material used for construction, particularly in and around areas that support native vegetation. Ensure any

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
					imported materials are pathogen free.
Coastal flora and fauna	✓	✓	Protect the ecological values of coastal habitat.	No reduction in habitat values for significant species. Minimise loss of significant species' individuals. No removal of coastal vegetation.	Comply with the Performance Criteria. Develop and implement methods and management systems designed to ensure no adverse effect on the dune system, beach and intertidal zone from Project Activities including: ▪ Induction programs for Project personnel ▪ Implement management measures to minimise access of construction personnel to Williamsons Beach and foreshore reserve, particularly during Hooded Plover breeding season (August to February) ▪ Collaborate with Parks Victoria and DSE to achieve additional protective measures such as fencing off portions of the beach used by nesting Hooded Plovers to exclude people, uncontrolled dogs and increased fox and cat control ▪ Ensure that external lights are kept to a minimum, that they are positioned as low to the ground as is practicable and that they are shielded to avoid light spill upward and toward the foreshore, beach and sea ▪ Implement a program of monitoring the locations and breeding success of resident Hooded Plovers along Williamsons Beach to measure the impact of Project Activities and inform opportunities for mitigation. This should continue at least monthly from prior to construction until the plant is in routine operation. Implement a program of monitoring for the Orange-bellied Parrot from March to September prior to and during construction activities and inform opportunities for mitigation.
Erosion and sediment control	✓	✓	Minimise erosion and sediment movement.	Comply with EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996) and EPA Construction Techniques for Sediment Pollution Control (1991).	Comply with Performance Criterion. Develop, implement and maintain construction methods and management systems consistent with EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996) and EPA Construction Techniques for Sediment Pollution

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
					Control (1991) to limit erosion and sediment movement by: ▪ Identifying highly erodible soil and avoiding activities involving disturbance of these areas where possible. Where avoidance is not possible, additional control measures to be implemented for these identified areas ▪ Limiting clearance of vegetation, particularly along streams ▪ Designing drainage outlets and diversion channels to limit flow velocities and erosion
Hazardous materials and dangerous goods	✓	✓	Protect beneficial uses of air, land, water, human and environmental health, from the impacts of hazardous materials and dangerous goods.	Manage, store, handle and dispose any hazardous substances and dangerous goods in accordance with relevant policies, regulations and guidelines including the Victorian Workcover Authority and Australian Standard AS1940 Storage and Handling of Flammable and Combustible Liquids, EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996) and EPA Publication 347 – (Bunding Guidelines).	Comply with the Performance Criteria. Develop and implement methods and management systems (including contingency plans) that: ▪ Limit the on-site and on-vessel storage and/or use of hazardous substances and dangerous goods ▪ Manage hazardous materials and dangerous goods to avoid environmental damage ▪ Install bunds (if appropriate) and take precautions to reduce the risk of spills entering the stormwater drainage system ▪ Seek to contain any spills captured by the stormwater drainage system ▪ Provide for management of hydrocarbon spills
Site rehabilitation	✓	✓	Restore pre-construction land quality and uses.	All disturbed land progressively reinstated: ▪ In the case of the Desalination Plant, to the standards agreed with the State	Progressively and prior to its disturbance, conduct pre-construction surveys of the land within 50 metres of the Project Area to be disturbed. Develop a rehabilitation plan with each private landowner. Develop a rehabilitation plan to address as applicable: ▪ Site protection and site preparation ▪ Planting design including plant densities relative to EVC benchmarks ▪ Source of planting stock ▪ Post-planting maintenance Identify areas where there is a risk of subsidence,

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
					and develop construction approaches to mitigate the risk. Where revegetation is to take place, any revegetation works in accordance with Native Vegetation, Revegetation Planting Standards, DSE (2006).
Air quality – dust	✓		Protect air quality.	Limit dust emissions. Compliance with the State Environmental Protection Policy (Air Quality Management) and EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996). Minimise dust impacts on sensitive receiver sites.	Comply with the Performance Criteria. Develop and implement methods and management systems (including monitoring) to maintain air quality during construction consistent with State Environmental Protection Policy (Air Quality Management) intervention levels for particulates and EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996).
Traffic and Transport	✓	✓	Maintain public access and protect safety of road users.	Minimise traffic impacts and maintain road safety. Comply with VicRoads and Council requirements during construction activities. Undertake specified traffic and pedestrian infrastructure upgrades to provide safe access to the Project.	Comply with Performance Criteria. Develop and implement a traffic management strategy and systems to address: ▪ Communication ▪ Incident and emergency management ▪ Route specification to avoid sensitive facilities and activities ▪ Temporary construction site parking ▪ Staging works and construction traffic to minimise impact on the road network ▪ Road closures ▪ Site access Access to the Desalination Plant site in normal conditions shall be via Lower Powlett Road. Implement the following infrastructure upgrades to a reasonable standard subject to the agreement of VicRoads and Bass Coast Shire Council (as relevant): ▪ Improvement to Bass Highway and Lower Powlett Road intersection ▪ Reconstruction of Lower Powlett Road Plan and implement a new pathway around the periphery of the Desalination Plant site to

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
					maintain public access around the site for pedestrians, cyclists and equestrian activities. Provide emergency access to the Desalination Plant site from both Mouth of Powlett Road and Lower Powlett Road. Provide emergency access for the Mouth of Powlett Community from both Mouth of Powlett Road and Lower Powlett Road. Maintain all weather vehicular access to Williamsons Beach Car Park from Lower Powlett Road.

8.0 Cultural heritage





8 Cultural heritage

This chapter discusses the impact of the Plant on Aboriginal and post-settlement cultural heritage. It describes existing conditions, assesses impacts of construction and operation of the Plant and describes strategies for mitigation and management proposed in the Performance Requirements.

This chapter is based on Biosis Research Pty Ltd (2008[7]) *Desalination Plant Component – Cultural Heritage Existing Conditions and Impact Assessment Report* (Technical Appendix 45).

Palaeontology and sites of geomorphic significance are discussed in Volume 3 Chapter 5 Geology and geomorphology. Maritime heritage and shipwrecks are discussed in Volume 2 Chapter 5 Existing conditions.

8.1 Existing conditions

The following section discusses the existing Aboriginal and cultural heritage sites in and around the site.

Fieldwork, including subsurface testing, and consultation with the relevant Aboriginal groups will be ongoing to assist the finalisation of the Cultural Heritage Management Plan which will be submitted for approval following the Minister for Planning's Assessment of the EES. A Draft Cultural Heritage Management Plan for the Desalination Plant is provided in Technical Appendix 82 based on the field investigations and consultation to date.

8.1.1 Aboriginal cultural heritage

Most of the recorded Aboriginal sites within the south-west Gippsland region are located along the coastal margin. Other sites have been recorded on the coastal plain to the south of the site, but relics are not as readily found in these locations.

The sand dunes within the Project area have high potential for Aboriginal sites, particularly shell middens and stone artefact scatters. There is also a possibility of human burial sites. Aboriginal campsites may be present along the Powlett River and its lagoons and secondary, seasonal watercourses (Biosis Research 2008$_7$, Technical Appendix 45).



Consultation

Two Aboriginal Cultural Heritage organisations have applied to become Registered Aboriginal Parties for the region (under the provisions of the *Aboriginal Heritage Act 2006*): the Boon Wurrung Foundation Ltd and the Bunurong Land Council Aboriginal Corporation. Representatives of these two Registered Aboriginal Parties applicant groups were consulted during the preparation of the desk-top cultural heritage assessment and have participated in fieldwork. Consultation has been ongoing during sub-surface testing and preparation of the CHMP.

Previously recorded sites

There were no previously recorded Aboriginal archaeological sites on the site on the Aboriginal Affairs Victoria (AAV) Heritage Register prior to commencement of assessment for the Project.

Prior to the current assessment, one previously registered Aboriginal site (AAV 8020-0001) was known outside of the site at the Powlett River mouth, within approximately 400 metres of the site. This is a coastal dune midden site containing mussel and limpet shells as well as stone artefacts. Survey work completed as part of this assessment indicates that this site extends at least 350 metres further south-east along the foreshore dune, adjacent to the site.

A number of additional Aboriginal midden sites were recorded in the 1980s by a La Trobe University survey on this section of coast, but they have not yet been transferred to the Aboriginal Heritage Register. These coastal midden sites occur frequently along the coastal dunes fronting the site and are exposed where tracks have eroded the dunes.

Fourteen of the coastal midden sites recorded during the La Trobe University survey are located within the local area of the site. One site had been previously registered on the Aboriginal Heritage Register (Powlett River: 8020-0001). Three of the midden sites detected during the La Trobe University survey were found again during this assessment and have been added to the Aboriginal Heritage Register (AAV8020-0215, 8020-0216 and 8020-0217). The remaining ten sites recorded by the La Trobe University survey are also to be registered on the Aboriginal Heritage Register. The locations of these sites are shown in Figure 8-1 and are listed in Table 8-1.

There are 68 registered Aboriginal sites within a 10-kilometres radius of the site, 14 of these lie within the site and were discovered during field surveys for the Project. These are mainly located in eroding dunes along the coast and are characterised by deposits of shell material, usually with lithics, charcoal and bone (coastal middens).

In addition to the registered sites, another 14 coastal midden sites have been recorded but not listed on the Aboriginal Heritage Register. There are no recorded post-contact Aboriginal archaeological sites or Aboriginal Places on the Aboriginal Heritage Register within 10 kilometres of the site.

Field investigations

Field investigations on the site and foreshore dunes were conducted between August and October 2007 and May and July 2008. The fieldwork included surface surveys and sub-surface investigations. Representatives from the two Aboriginal cultural heritage groups for the area (the Bunurong Land Council and Boon Wurrung Foundation) have participated in each stage of field investigation and have been consulted during the assessment.

Midden material is visible at various locations along the coastal dunes adjacent to the site. Survey work along the foreshore dune indicates that this site is more extensive than originally recorded, forming a discontinuous band extending south-east over a distance of 350 metres.

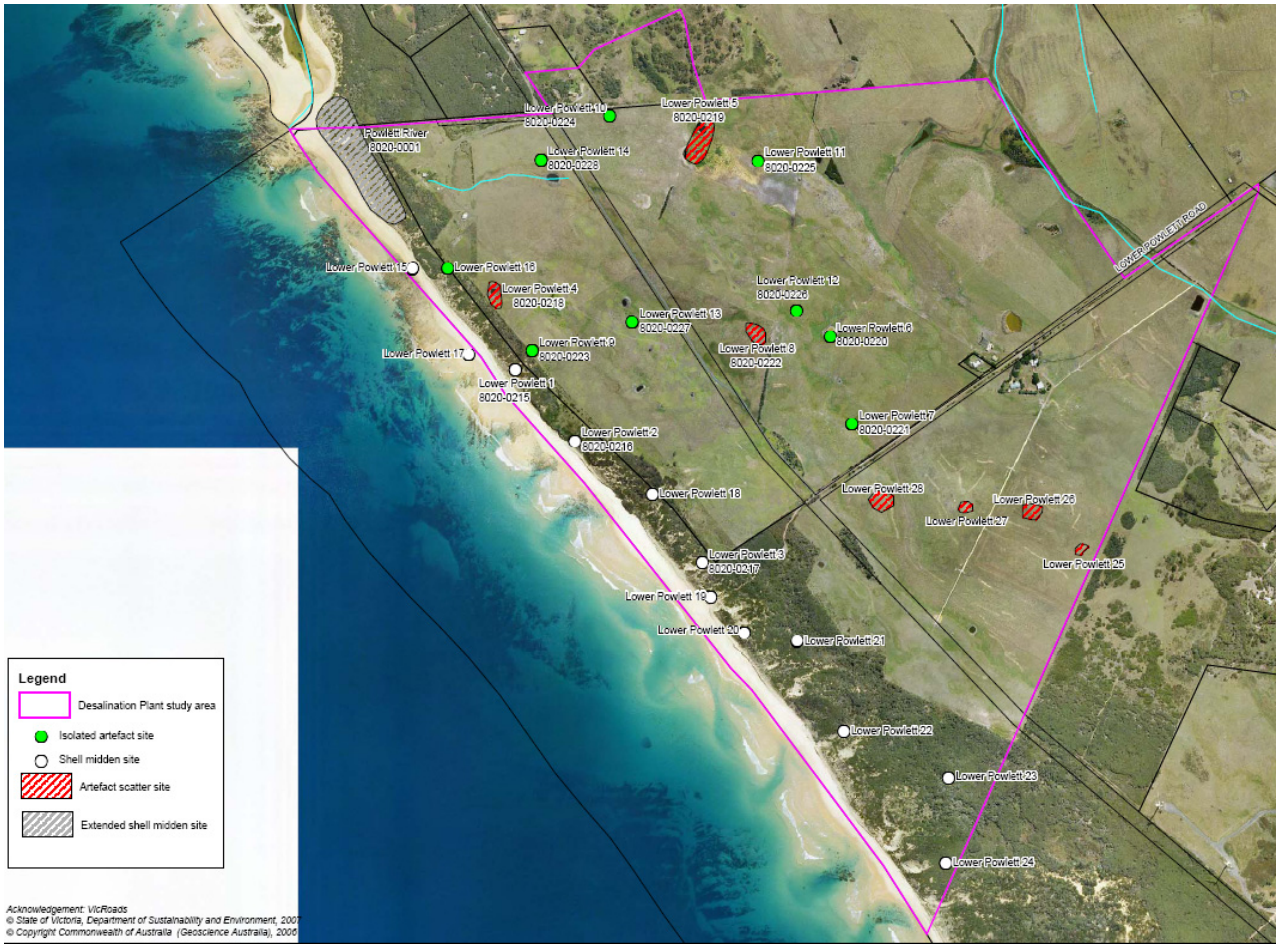
Table 8-1 Recorded Aboriginal cultural heritage sites within the local area of the site

Site name/number*	Description	Landform	Significance
Powlett River (8020-001)	Aboriginal coastal midden site, extending from the Powlett River mouth over 385 metres along the foreshore dunes	Coastal dune on south side of Powlett River mouth	High
Lower Powlett 1 (8020-0215)	Aboriginal coastal midden site, within the foreshore dune reserve	Coastal dunes	Moderate
Lower Powlett 2 (8020-0216)	Aboriginal coastal midden site, within the foreshore dune reserve	Coastal dunes	Moderate
Lower Powlett 3 (8020-0217)	Aboriginal coastal midden site, within the foreshore dune reserve	Coastal dunes	Moderate
Lower Powlett 4 (8020-0218)	Aboriginal isolated artefact site, found on the surface adjacent to a dam. Sub-surface testing showed crushed shell and charcoal	Coastal paddocks and secondary dunes	Low
Lower Powlett 5 (8020-0219)	Aboriginal artefact scatter site, consisting of six silcrete and quartz flakes found on the surface near two dams	Former heath mounds and old floodplain terrace	Low
Lower Powlett 6 (8020-0220)	Aboriginal isolated artefact site, consisting of a single flake of clear quartz found on the surface of a dam	Former heath mounds and old floodplain terrace	Low
Lower Powlett 7 (8020-0221)	Aboriginal isolated artefact site, consisting of three angular quartz fragments found on the surface of a dam	Floodplain	Low

Site name/number*	Description	Landform	Significance
Lower Powlett 8 (8020-0222)	Aboriginal artefact scatter site found during sub-surface testing on a prominent sandy rise. Site contains 15 flakes and lithic fragments, including quartzite, white and crystal quartz and silcrete flakes	Former heath mounds and old floodplain terrace	Low
Lower Powlett 9 (8020-0223)	Aboriginal isolated artefact site, consisting of a single worked crystal quartz flake found on the surface of a dam	Coastal paddocks and secondary dunes	Low
Lower Powlett 10 (8020-0224)	Aboriginal isolated artefact site consisting of two cores and two flakes in fine-grained silcrete found during machine testing at depths of 0.75 metres to 1.10 metres	Heath mounds	Low
Lower Powlett 11 (8020-0225)	Aboriginal isolated artefact site consisting of a single large broken silcrete flake found during machine testing at a depth of 0.75 metres	Heath mounds	Low
Lower Powlett 12 (8020-0226)	Aboriginal isolated artefact site consisting of one white quartz angular fragment found during machine testing	Heath mounds	Low
Lower Powlett 13 (8020-0227)	Aboriginal isolated artefact site consisting of a single flint flake, with evidence of weathering, found during machine testing	Heath mounds	Low
Lower Powlett 14 (8020-0228)	Aboriginal isolated artefact site consisting a single piece of angular quartz found during machine testing from just above the base of the trench	Heath mounds	Low
Lower Powlett 25	Site containing two struck flakes detected during sub-surface testing on a sandy rise to the east of Lower Powlett Road	Plant site study area	Moderate
Lower Powlett 26	Extensive lithic scatter occupying a prominent sandy rise to the east of Lower Powlett Road, detected during sub-surface testing	Plant site study area	Moderate
Lower Powlett 27	Extensive lithic scatter including a basalt axe occupying a prominent sandy rise to the east of Lower Powlett Road, detected during sub-surface testing	Plant site study area	Moderate
Lower Powlett 28	Small lithic scatter occupying a prominent sandy rise to the east of Lower Powlett Road, detected during sub-surface testing	Plant site study area	Moderate

*Aboriginal Affairs Victoria Heritage Register number

Figure 8-1 Aboriginal cultural heritage sites



Areas of potential archaeological sensitivity

The foreshore dunes and the slight sandy rises within the secondary dune system and former heath mounds are areas of potential cultural sensitivity.

Field surveys along this part of the coastline show that the Aboriginal shell midden material is visible wherever there are exposures of the prominent foreshore dune. Artefact scatters and isolated artefact sites are also visible at approximately 30 per cent of exposures, mostly around dams, located inland of the foreshore dune within the site. Although no human burials have been recorded, if they were present, they may be well preserved (Biosis Research 2008$_7$, Technical Appendix 45).



Significance

The Aboriginal sites are evidence of past Aboriginal occupation and use of the area, and are the main source of information about the Aboriginal past. All pre-contact (pre-European settlement) sites that are located in the site are considered to be of cultural significance to the Aboriginal community and it is important that comment on the area is provided directly by members of this Aboriginal community.

The coastal midden sites within the foreshore reserves are generally considered to have a greater scientific significance than those on the inland section of the Study Area. This reflects the greater diversity of artefactual material that coastal middens in this area may contain, and their potential for stratified primary deposits of in-situ cultural material.

Although few sites inland of the foreshore dunes have been previously recorded in the vicinity of the Desalination Plant Study Area, most of the sites recorded for this assessment are classified as having low to moderate levels of representativeness. Most of the sites to the north-west of Lower Powlett Road were also assessed as having low site contents classification because the materials recovered were waste flakes and angular fragments. Few or no tools were found within the recorded assemblages.

The condition ranking for the sites in the farmland north-west of Lower Powlett Road was also classified as low as natural activities and recent human activities have affected the integrity of sub-surface sites. In particular, reworking of the upper parts of the soil profile in this area by relatively recent processes has disturbed some of the archaeological horizons in this area.

In contrast, the sites recorded on the sand and clay rises to the south-east of Lower Powlett Road (Lower Powlett 25 – 28) have a greater range of site types, including probable tool-making floors. The sites on these rises also contain a greater diversity of artefacts, with a number of tools and flakes found. The sites on the rises on the south-east side of the road have greater integrity, with intact soil profiles that have experienced little disturbance from recent land-use processes.

8.1.2 Non-Aboriginal historical archaeology

Previously recorded sites

Prior to the current assessment, no historical archaeological sites had been recorded within the site. Within 10 kilometres of the site there are four previously recorded sites on the Heritage Register and an additional 10 previously recorded sites on the Heritage Inventory. Two further previously recorded sites are listed on Heritage Victoria's D list. These D-listed sites are of local historical interest but are not protected by State legislation. Also within 10 kilometres of the site are an additional 15 buildings and structures of historical interest listed on the Registers of the National Trust and National Estate. The Kilcunda Coastline is listed on the Register of the National Estate for natural significance. This site is considered to be of potential cultural heritage value and extends from San Remo to Kilcunda to the north-east of the site.

One previously recorded site listed on the Heritage Inventory, Wonthaggi Western Area H8020-0007, is adjacent the site. This site is an extensive mining and haulage site, located around a main shaft and marks the most westerly working of the Dudley Basin. The Bass Coast Shire heritage overlay lists 43 sites within a 10 kilometre radius of the site (Biosis Research 2008$_7$, Technical Appendix 45).

Field survey

Background historical research was undertaken in combination with a field survey to detect sites of potential historical archaeological significance on the site. The investigation identified one site of historical archaeological significance on the site (Lower Powlett Road 1: H8020-0017). This site, a nineteenth-century enclosure known from map evidence, has been added to the Heritage Inventory.

A further two historical landscape features on the site (Selection Boundary [Mouth of Powlett Road]: D8020-0015 and Mouth of Powlett Road (Former Rail Reserve): D8020-0016) have been given D-listed status. Figure 8-2 shows the location of these sites.

Lower Powlett Road 1 H8020-0017

A survey for the Victorian Mining Department of the Gippsland coalfield dated 1882 shows a trackway extending through the site on the approximate line of the present unsealed Mouth of Powlett Road. A second track is shown extending from the north-west, on the approximate line of the present Lower Powlett Road. To the east of the junction of the two tracks, in the paddock on the east side of Lower Powlett Road, the 1882 plan shows a distinctive double rectangular feature. This is likely to be a stock enclosure, possibly with a homestead enclosure on its west side (Biosis Research 2008$_7$, Technical Appendix 45).

Field survey of the site of the historical enclosure did not detect any surface archaeological features. Investigation, which will include trial excavation, is ongoing.

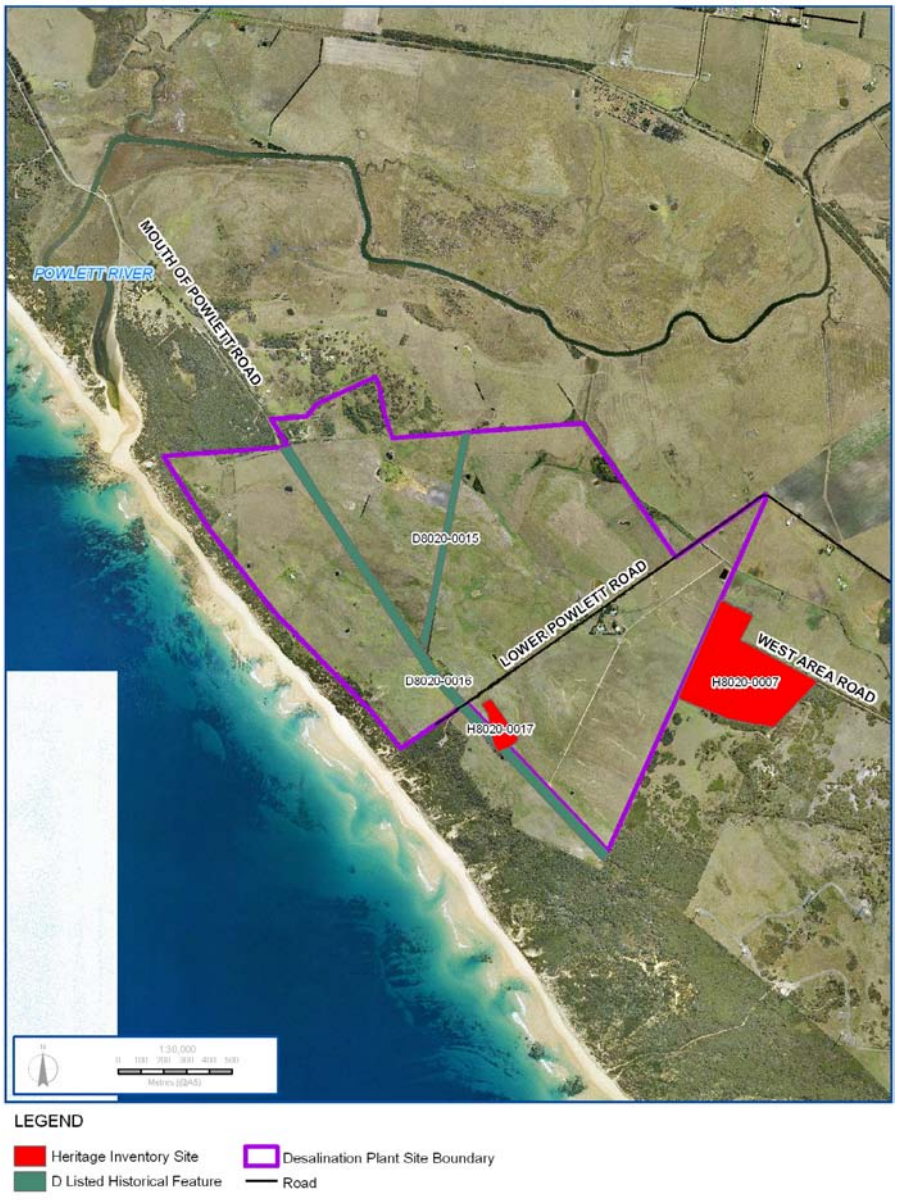
Mouth of Powlett Road (former Rail Reserve) D8020-0016

The 1882 Mining Department survey also shows a meandering track on the approximate line of the present unsealed Mouth of Powlett Road. At this time a new railway was proposed from the collieries at Cape Patterson to Western Port. With the closure of the Cape Patterson mines in the 1880s, the proposed railway (the Cape Patterson to Kilcunda Junction Railway) was never constructed. The Government had reserved this proposed line, which now forms the unsealed Mouth of Powlett Road. A survey in 1885 for the proposed new railway shows the railway reserve, crossing the site (Biosis Research 2008$_7$, Technical Appendix 45).

Selection boundary (Mouth of Powlett Road) D8020-0015

The site straddles two intended mid-nineteenth century sections: Lot 25 and Lot 26. Part of the boundary between these selections has been preserved as a one-kilometre length of paddock boundary on the site. The boundary is only defined on the north side of an old bush track, which later became the Mouth of Powlett Road. The defined part of the selection boundary stops at the northern edge of the later nineteenth-century leasehold property. This site is unlikely to have any associated archaeological sub-surface features (Biosis Research 2008$_7$, Technical Appendix 45).

Figure 8-2 Historical sites



8.2 Impact assessment

This section discusses the potential impacts of the construction and operation of the Desalination Plant on cultural heritage at and around the site.

8.3 Construction

8.3.1 Risks assessed as medium and above

Table 8-2 sets out the cultural heritage risks associated with the construction of the Desalination Plant which are assessed as medium and above. The risks are discussed in order of likelihood with those most likely to occur discussed first.

Table 8-2 Construction risks assessed as medium and above

Activity	Impact pathway	Consequence	Likelihood	Risk
Earthworks and removal of topsoil	Removal, damage or destruction of Aboriginal sites	Major	Almost certain	High
Earthworks	Removal of topsoil damaging or destroying historical sites	Minor	Likely	Medium
Tunnelling under dune system	Vibration disturbing or damaging historic and/or Aboriginal heritage items	Major	Unlikely	Medium

The above risk assessment is based on accepted construction practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the Performance Requirements are taken into account, both the likelihood and consequence of these risks may be significantly lower.

Earthworks affecting Aboriginal sites

Plant construction would involve the clearance of a large proportion of the site. Most of the known and potential cultural heritage features are within the top 1.2 metres of soil. Any disturbance to the present ground surface of the site through earthworks or tunnelling may impact on known or undetected cultural heritage. Disturbance below this depth such as through benching to establish plant levels, deep drainage installations or directional drilling would have a minimal impact on cultural heritage, though there is a slight possibility that Pleistocene Aboriginal deposits could exist at a greater depth than the archaeological horizons presently known from the area.

There are fifteen known Aboriginal cultural heritage sites within the Plant site. These are either isolated artefact sites or low-density artefact scatter sites. Eleven sites have been assessed as having low significance and four having moderate significance and are protected under the *Aboriginal Heritage Act* 2006.

The recorded sites include:

- Lower Powlett 4 (8020-0218)
- Lower Powlett 5 (8020-0219)
- Lower Powlett 6 (8020-0220)
- Lower Powlett 7 (8020-0221)
- Lower Powlett 8 (8020-0222)
- Lower Powlett 9 (8020-0223)
- Lower Powlett 10 (8020-0224)
- Lower Powlett 11 (8020-0225)
- Lower Powlett 12 (8020-0226)
- Lower Powlett 13 (8020-0227)
- Lower Powlett 14 (8020-0228)
- Lower Powlett 25 (AAV registration pending)
- Lower Powlett 26 (AAV registration pending)
- Lower Powlett 27 (AAV registration pending)
- Lower Powlett 28 (AAV registration pending).

Aboriginal sites on the coastal dunes are unlikely to be impacted by construction works at the Plant site. The Aboriginal features that might be affected by the construction of the Desalination Plant are generally on sandy rises. The location of these sites is shown in Figure 8-1.

The risk that earthworks and disturbance of topsoil might remove, damage or destroy these sites was assessed as high. Performance Requirements have been developed to address this risk. The Performance Requirements relating to Aboriginal heritage are set out in Table 8-3, and include a requirement to avoid Aboriginal sites that are within or near the Project Area to the extent practicable and specific requirements aimed at minimising impacts on these sites where avoidance is not practicable. Compliance with the Performance Requirements will ensure that any impacts on Aboriginal sites due to earthworks or removal of topsoil are avoided or minimised.

Earthworks affecting Historical sites

One known historical site on the heritage inventory has been recorded within the Plant site. This is the 19th century enclosure complex, Lower Powlett Road: H8020-0017. This site may be directly impacted by the works or by landscaping or revegetation. Two sites of local historical interest may also be directly impacted, these are: Selection Boundary (Mouth of Powlett Road (80200001) and Mouth of Powlett Road (Former Rail Reserve) 8020-0016). Although it is considered likely that these sites will be affected by earthworks associated with the construction of the Desalination Plant, the potential impact on these sites is considered to be minor.

Tunnelling

Four known sites of Aboriginal cultural heritage within the foreshore dune reserve adjacent to the site have been recorded on the Aboriginal Heritage Register. These are:

- Powlett River: (AAV8020-0001)
- Lower Powlett 1: (AAV8020-0215)
- Lower Powlett 2: (AAV8020-0216)
- Lower Powlett 3: (AAV8020-0217).

These are all Aboriginal coastal midden sites that have been recorded during the field survey for the present assessment and that can be identified with individual sites recorded by La Trobe University in the 1980s. The Powlett River site has high significance and the other three sites have moderate significance. Powlett River site extends along the coastal dunes from the Powlett River to the dunes adjacent to the north-west corner of the site. A further ten coastal midden sites were recorded during the La Trobe University survey within the site but were not detected again during the present assessment.

All of the Aboriginal sites within the foreshore reserve (whether included on the Heritage Register or not) are protected under the *Aboriginal Heritage Act 2006*. The intended construction works will not directly impact any of these sites within the foreshore reserve. However, vibrations associated with construction or tunnelling may cause indirect impacts. Vibration impacts associated with tunnelling generally affect structures directly above or adjacent to the tunnel route, and are generally within the 90 to 120 Hz range. Assessment of the potential effects of vibration for construction of the Plant component shows that vibration is unlikely to have an effect on the foreshore dunes. This is described further in Volume 3 Chapter 5 Geology and geomorphology and Volume 3 Chapter 10 Noise and vibration.

8.3.2 Risks assessed as low

The risk of earthworks, tunnelling or topsoil removal damaging local mining heritage was assessed as low. This impact is unlikely to occur as there are no local mining heritage sites located on the site. The Wonthaggi Western Area H8020-0007 is located adjacent the site, but is unlikely to be directly impacted by the proposed works. The below-ground mine workings associated with the Wonthaggi Western Area site extend within the site boundary. However, these underground workings are not included within the Heritage Inventory site area, and are not considered to be of archaeological significance. Damage or destruction of local mining heritage from earthworks, tunnelling and topsoil removal is therefore unlikely.

8.4 Operation

8.4.1 Risks assessed as medium and above

There are no risks to cultural heritage in connection with the operation of the Desalination Plant that have been assessed as medium and above.

8.4.2 Risks assessed as low

There are no risks to cultural heritage in connection with the operation of the Desalination Plant that have been assessed as low.

8.5 Performance Requirements

Performance Requirements have been developed to provide an environmental framework for management of potential cultural heritage impacts associated with the Project during construction and operation. The PRs are focussed on the environmental 'outcomes' that the State wishes to achieve through the Project delivery. The PRs relevant to traffic management for the Plant are set out below. The full suite of PRs for the Project is provided in Volume 1 Chapter 10 as part of the overall Environmental Management Framework.

As part of the environmental impact and risk assessment process relating to cultural heritage for the Plant, Biosis Research (2008$_7$) has identified a range of suggested management measures that could be implemented to manage potential impacts. These suggested management measures have been formulated in response to the Reference Project and relevant Variations for the Plant. In effect, the suggested management measures demonstrate how the Reference Project and relevant Variations can achieve the PRs. These detailed management measures have formed an important input to the PRs for the Project.

The management measures suggested by Biosis Research (2008$_7$) address the following matters:

- developing a mitigation strategy to form part of the Cultural Heritage Management Plan (CHMP) to assist in managing:
  - the extent of Aboriginal cultural heritage

  - the discovery of sites during construction
  - the protection of sites from damage during construction
  - communication and consultation with the relevant Registered Aboriginal Parties (RAPs)
  - conditions of approvals to disturb or destroy historic places and sites
  - soils excavated during construction that demonstrate potential for archaeological material
  - contractors and their obligations under State and Commonwealth legislation for protection of the heritage sites
- managing Aboriginal cultural heritage during construction and operation of the Desalination Plant:
  - protecting Aboriginal cultural heritage sites in-situ wherever possible
  - wherever possible, avoid impacts on Aboriginal sites, and fence off sites with an appropriate buffer for protection during works
  - minimising impacts when complete avoidance is not possible
  - complying with the specific salvage measures outlined in the CHMP
- developing a hierarchy of management measures for the known Aboriginal sites outlined in section 8.3 above, that include:
  - *Level one:* Retrieval of known artefacts for widely scattered or isolated artefacts of low cultural heritage significance
  - *Level two:* Limited controlled archaeological salvage
  - *Level three:* Extensive controlled archaeological salvage for deposits of considerable cultural significance
- protecting sites of Aboriginal cultural heritage within the plant site, in particular artefact scatter site Lower Powlett 8 (AAV8020-0222) near the south-eastern site boundary, as far as practicable. Where not feasible, a salvage prior to development. Sites Lower Powlett 25 to 28 will also be recommended strongly for protection. This will particularly concern Lower Powlett 25, 26 and 27
- developing a buffer zone to further protect and minimise impacts on sites of heritage significance
- avoiding groundworks closer than 50 metres inland from the fenceline separating the foreshore dune reserve from the farm paddocks

- managing soils stripped and excavated during construction potentially containing Aboriginal artefacts including:
  - stockpiling and storing at an agreed secure location
  - minimising potential harm to stripped cultural heritage material
- Managing recorded heritage sites during construction by:
  - Protecting archaeological site Lower Powlett Road 1 (H8020-0017) from direct and indirect impacts, where possible
- recording D-listed historical features (Mouth of Powlett Road) D8020-0015 and (Former Rail Reserve) D8020-0016 to an appropriate level of field survey in advance of any disturbance.

The PRs proposed for cultural heritage are outlined in Table 8-3.

Table 8-3 Performance Requirements

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Aboriginal heritage	✓		Protect known Aboriginal sites of cultural heritage significance. Manage potential interactions with Aboriginal sites where impacts are unavoidable and for previously unrecorded Aboriginal sites of significance.	Minimise impacts on Aboriginal sites that are within or near the Project Area. To the extent practicable avoid sites. Development of and compliance with the requirements of the approved Cultural Heritage Management Plan (CHMP). Minimise impacts as far as possible and undertake and complete recording and salvage operations. Avoid where practicable or minimise impacts in the designated areas presented in Figures: ▪ PR Sensitivity Areas – Plant Area in Technical Appendix 5	Comply with Performance Criteria. Assess the extent of Aboriginal cultural heritage. Design extent of Works and Temporary Works to avoid known sites if practicable. If not practicable, comply with the terms of all required approvals to disturb or destroy Aboriginal cultural heritage sites. Mark known sites on construction plans and on site. Protect sites that are at risk of accidental damage during construction activities. Provide cultural awareness training to relevant construction personnel. Consult with relevant Registered Aboriginal Parties (RAPs). Comply with recommendations and contingencies specified in the CHMP.
Heritage	✓		Protect listed historical heritage (including	Minimise impacts on historical heritage sites that are within or near the Project Area.	Comply with Performance Criteria. Develop a list of known places and sites of heritage significance.

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
			maritime heritage) places and sites from disturbance. Manage potential interactions with historic places and sites (including historic maritime places and sites).	Minimise impacts on places and sites listed on the relevant registers and protected under planning schemes.	heritage significance. Design extent of Works and Temporary Works to avoid known sites if practicable. If not practicable, comply with the terms of all required approvals to disturb or destroy historic places and sites. Mark known sites on construction plans and monitor where works are in proximity. Monitoring to be carried out by a qualified Archaeologist. Protect sites that are at risk of accidental damage during construction activities.

9.0 Air quality



9 Air quality

This chapter discusses the impacts of the Desalination Plant on air quality. It describes existing conditions, assesses impacts of construction and operation of the Desalination Plant, and provides strategies for mitigation and management proposed in the Performance Requirements.

This chapter is based on findings from:

- GHD Pty Ltd (2008_{12}) *Existing Conditions Report – Air Quality – Desalination Plant* (Technical Appendix 47)
- GHD Pty Ltd (2008_{13}) *Report for Assessment of Impacts on Air Quality – Victorian Desalination Plant* (Technical Appendix 48).

9.1 Existing conditions

Meteorological data has been sourced from the climatic weather station at Wonthaggi and used to characterise conditions at the plant site. As no substantiative air quality data has been recorded for the local area, the existing conditions have been based on an interpretation of the air quality data recorded in surrounding regions.

9.1.1 Ambient air quality

Local air quality is strongly influenced by the air quality over Bass Strait. In particular fine particulate (PM_{10}) levels would be elevated from the contribution of sea salt particles. Air-borne pollutants may originate locally, or may be wind-blown from Bass Strait, greater Melbourne or the Latrobe Valley (GHD 2008_{12}, Technical Appendix 47).

Ambient air quality levels at the Desalination Plant were estimated using guidelines set out in the SEPP (AQM) and EPA monitoring data. These data give a conservative measure of ambient dust levels at air quality monitoring stations around Victoria as shown in Table 9-1, and have been used to estimate ambient dust levels at the Plant site.

Table 9-1 Daily concentrations of particulate matter and pollutants in Victoria (75^{th} percentiles during 2006)

Performance monitoring station	Region	75^{th} percentile (µg/m^3)
Brighton	Port Phillip	19.8
Geelong South		26.9
Moe	Latrobe Valley	21.6
Traralgon		22.1
Ballarat	Regional	20.1
Warrnambool		24.0

Source: GHD 2008_{12}

The generally windier conditions that occur in coastal areas would cause lower levels of ambient dust at the plant site compared to most of the EPA's monitoring network sites (GHD 2008_{12}, Technical Appendix 47). The nearest air quality monitoring sites to the Bass Coast are Melbourne and the Latrobe Valley, but the ambient levels in the region of the plant site are more comparable to the regional Victorian sites listed in Table 9-1.

With consideration to the exposed nature of the Bass Coast, low population density and distance from major airsheds, a conservative estimate of 20 µg/m^3 for ambient respirable dust (PM_{10}) have been made for the Plant site area.

9.1.2 Odour

At the plant site, the background odour will have a dual character. An onshore wind (sea breeze) will result in a distinctly marine background odour, whereas an offshore wind (land breeze) will result in a typically rural background odour. Marine odours can be offensive at times, as a result of:

- large amounts of decomposing seaweed on the shore
- animal carcases
- stranded marine algal blooms.

No data are currently available to quantify background odour at the plant site or any other Victorian coastal site. The new Olfactometry Standard AS4323.3 has an effective non-detect level of approximately 30 odour units (OU). GHD predicts that background levels at the plant site are generally below this level (GHD 2008_{12}, Technical Appendix 47).

9.1.3 Climate

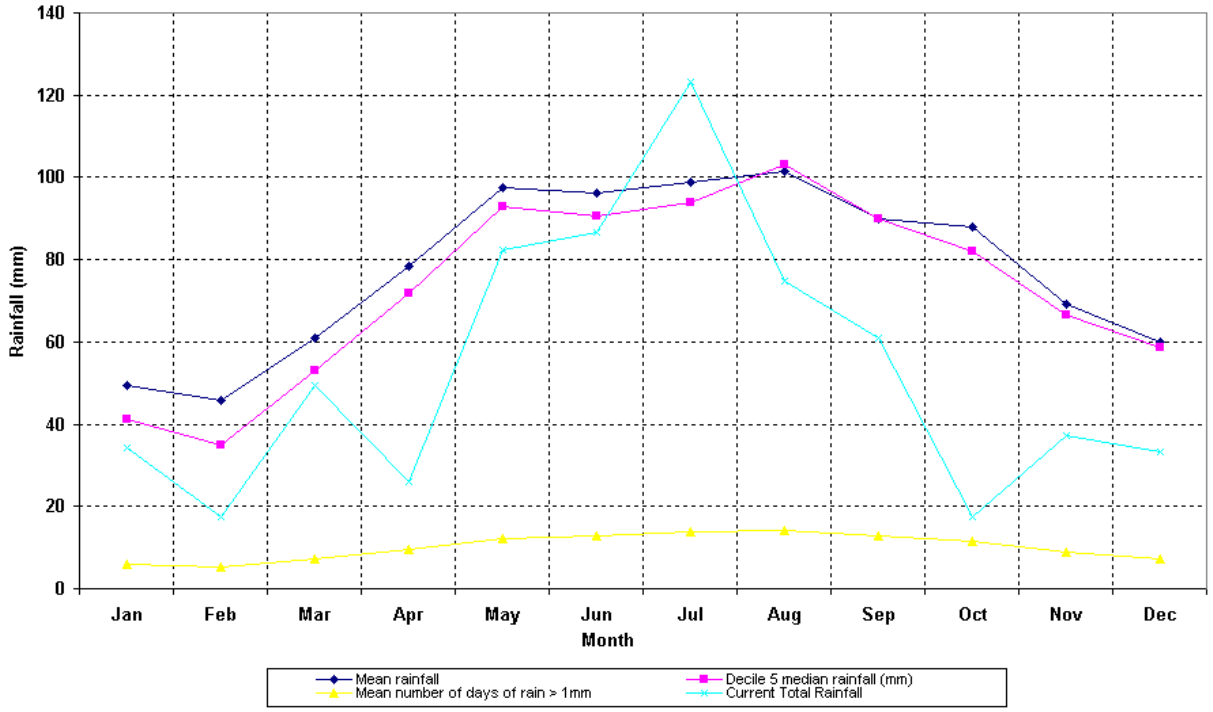
Temperature

The general climatic classification of the Desalination Plant site is temperate with a sub-division classification of 'warm summer with no distinct dry season' (Stern *et al*, 2000 cited in GHD 2008_{12}, Technical Appendix 47). This classification describes a climate with the warmest monthly average between 18 ºC and 22 ºC and the coldest monthly average above -3 ºC. Wonthaggi is within this classification, with a warmest monthly average of 19 ºC and coldest monthly average of 10 ºC.

Rainfall

A dry season is defined by the differences in summer and winter rainfall being greater than multiples of three or ten (depending on climatic indicator). Rainfall data at the Wonthaggi weather station show no distinct dry season, as shown in Figure 9-1. Wonthaggi has a mean annual rainfall of 940 millimetres and a mean of 148 rain days per year. Exposed areas such as Kilcunda Ridge and the Bass Coast receive slightly more rain than other low-lying inland areas due to prevailing synoptic rain-producing systems.

Figure 9-1 Monthly rainfall statistics for the Wonthaggi area



Source: GHD 2008

Cloud

Cloud is measured at the three local weather stations as the mean daily solar exposure, which is measured in MJ/m². The mean daily exposure at Wonthaggi is 14.7 MJ/m². There is little effect on cloudiness from geographical features, but there may be a slight trend for coastal areas to be slightly cloudier. This is associated with the slightly higher rainfall on and south of the Kilcunda Ridge.

Frost and fog

Frost and fog conditions most often occur during light wind conditions in the colder months. Frost occurrence is indicated by the number of days recording a minimum temperature below 2 ºC. Wonthaggi experiences 8.8 frost-prone days per year (peak occurrence in July) and Rhyll has only 2.2 frost-prone days per year. The Cranbourne weather station does not monitor frost levels, but the closed Bureau of Meteorology site at Tooradin indicated an annual average of 49.3 frost-prone days. This is because the Mornington Peninsula shields Tooradin from strong westerly winds and it is exposed to night time cool air drainage flows from the Dandenong Ranges to the north.

Fog forms in still conditions when the temperature is cool enough to condense atmospheric water vapour. In these conditions, and when the dew point of the atmosphere is above zero, fog will occur in preference to frost. Therefore, fog is most likely to occur in autumn and less in winter, as winter tends to have lower dew points.

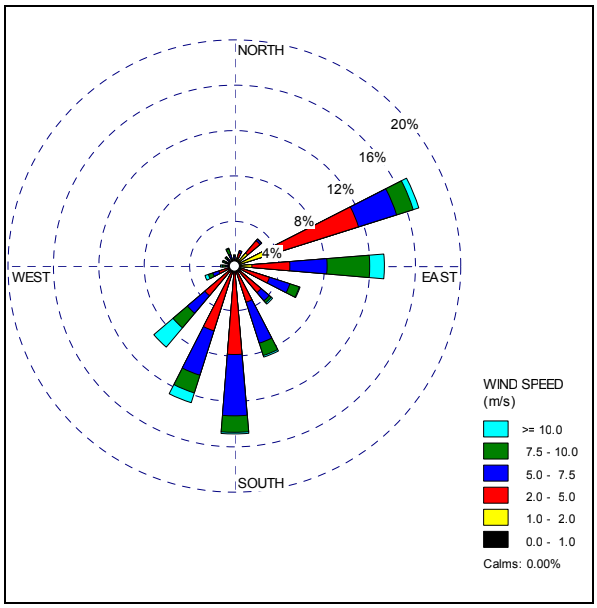
The top of the Kilcunda Ridge is exposed to conditions that are windier with cold air draining off to lower elevation ground. Therefore, the surrounding sheltered, low-lying areas of Kilcunda Ridge are more likely to experience fog than the ridge. Also, sea fog may occur near the edge of Western Port because of the higher relative humidity associated with a large waterbody.

9.1.4 Meteorology

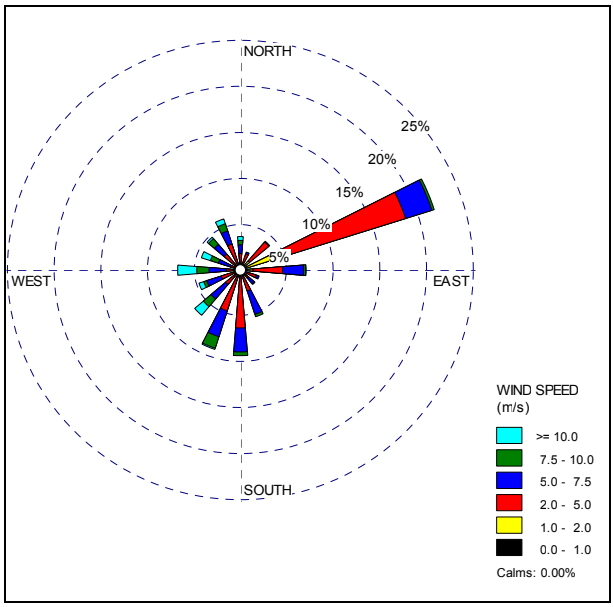
An onsite meteorological station has been in operation at Wonthaggi from November 2007. Wind roses for Wonthaggi for the period from November 2007 to June 2008 are shown in Figure 9-2. The average wind speed during this time was 5.2 m/s in summer, and 4.8 m/s in autumn. It was rarely calm, with wind speeds less than 0.5 m/s occurring only 0.13 per cent of the time. Predominant wind directions are from the south-south-west (SSW) and the east-north-east (ENE). The SSW winds are associated with the sea breeze and occur mostly during the day and are more common in summer. The ENE winds occur mostly at night as a land breeze or drainage flow from the eastern extension of the Kilcunda Ridge and the Powlett River Valley.

Figure 9-2 Wind roses from on-site monitoring at Wonthaggi

Summer



Autumn



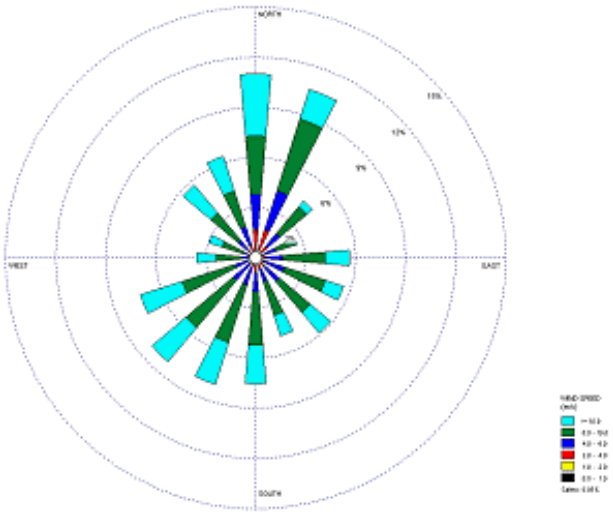
Source: GHD 2008[12]

To understand the annual wind climate at the site, additional wind information was obtained for other nearby areas, where available. Wind monitoring was conducted during the 1980's across the top of the Kilcunda Ridge. The Bureau of Meteorology operates an Automatic Weather Station at Rhyll.

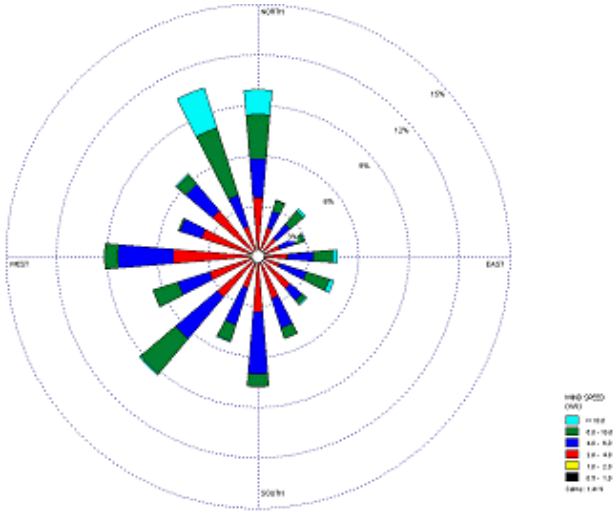
The annual wind roses for Kilcunda and Rhyll are given in Figure 9-3. Although Kilcunda Ridge is much closer to the site, Rhyll gives the closest representation of wind climate at the Plant site. This is because wind speeds are much higher on the exposed Kilcunda Ridge, with an average of 8.10 m/s. The average wind speed at Rhyll is 4.75 m/s. The Rhyll wind data shows that north to north-west winds are the most common (winter-time) but the summer-time sea breezes come from the south through to the west. The sea-breeze influence is similar to that found at Wonthaggi (south through west) but the north to north-west winds are more likely to come from the east than the north-east at Wonthaggi.

Figure 9-3 Annual wind roses at Kilcunda Ridge and Rhyll

Kilcunda Ridge annual wind rose



Rhyll annual wind rose



Source: GHD 2008[12]

9.2 Impact assessment

This section discusses the potential impacts of the construction and operation of the Desalination Plant on the air quality at and around the site.

9.3 Construction

9.3.1 Risks assessed as medium and above

Table 9-2 sets out the air quality risks associated with the construction of the Desalination Plant which are assessed as medium and above. The risks are discussed in order of likelihood with those most likely to occur discussed first.

Table 9-2 Construction risks assessed as medium and above

Activity	Impact	Consequence	Likelihood	Risk
Truck movements, earthworks and use of machinery	Generating dust impacting on visual amenity	Moderate	Unlikely	Medium
Truck movements, earthworks and use of machinery	Generating dust causing health problems	Major	Rare	Medium

The above risk assessment is based on accepted construction practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the Performance Requirements are taken into account, both the likelihood and consequence of these risks may be significantly lower.

Truck movements, earthworks and use of machinery

Two air quality risks have been assessed as medium for the construction of the Desalination Plant in the Reference Project. These risks are both as a result of truck movements, earthworks and use of machinery, which are likely to generate dust during construction of the Desalination Plant, impacting on human health and visual amenity. There are a number of activities that may create dust during construction of the Desalination Plant. These include:

- constructing access roads
- removing of topsoil
- transferring and stockpiling excavated material from intake and outlet tunnels

- constructing boundary bunds
- levelling the site to benchmarks
- removing solid wastes from the plant site.

Potential impacts on visual amenity

Dust generated during construction may impact on the visual amenity at the plant site and the surrounding area. In the local area, the impact of dust generation would include the appearance of settled dust at the plant site, whereas the visual impact from dust generation in a regional area may come from visible dust plumes. Both these issues could negatively alter perceptions of the area. As outlined above, the generation of dust would be managed by implementation of EPA environmental guidelines to prevent major dust emissions (such as ground watering and minimising works on dry, windy days) (GHD 2008_{13}, Technical Appendix 48). Therefore, it is unlikely that dust would be generated by truck movements, earthworks and use of machinery during construction of the desalination plant and impact on visual amenity.

Potential impacts on human health

Dust generated during construction of the Desalination Plant may impact on the health of the general public in the area. Dust has the potential to cause an asthma attack in a sensitive person. In a severe case, the fine particles generated from the soil, can penetrate deep into the lungs and cause longer-term health issues (GHD 2008_{13}, Technical Appendix 48).

The areas where people may potentially be affected are the areas close to the source of dust on the construction site. However, occupational health and safety controls would be enforced in these areas to prevent impact to workers. The EPA Environmental Guidelines for Major Construction Sites contains controls to limit the impact of dust at and away from the work site and these measures are expected to be implemented during construction. Additional controls near sensitive receivers, such as real-time dust monitors, may further manage potential impact by alerting site managers to implement dust suppression measures. Therefore, the likelihood that dust generation would impact on the health of the general public is considered to be rare.

9.3.2 Risks assessed as low

The following risks have been assessed as low in the impact and risk assessment process. These risks are expected to have a negligible minor impact on air quality with generally a rare or unlikely probability of occurrence.

Risks to native flora and fauna

Dust generated during construction of the Desalination Plant may impact the flora and fauna at the Plant site and the surrounding area. The consequence of this occurring would be negligible, as it is considered that this level of dust would fall within natural variability and the implementation of EPA environmental guidelines (such as ground watering and minimising works on dry, windy days) would minimise dust emissions (GHD 2008_{13}, Technical Appendix 48).

Risks to human health and amenity

Construction machinery would involve the use of diesel-fuelled mobile equipment and generators that would have emissions to air. Machinery would be operated outdoors and would often be moving, which would increase dispersion and prevent high concentrations of emissions occurring. Exhaust emissions are sometimes visible but this is unlikely to occur with the combination of regular maintenance and daily inspections (including start-up checks). These emissions are unlikely to impact amenity, as they would be no greater than for other activities undertaken in coastal Victoria. If diesel generators are used during construction, flue heights of 25 metres to disperse emission would be required to comply with SEPP-AQM design criteria (GHD 2008_{13}, Technical Appendix 48).

9.4 Operation

9.4.1 Risks assessed as medium and above

There are no risks to air quality in connection with the operation of the Desalination Plant that have been assessed as medium and above.

9.4.2 Risks assessed as low

In the environmental impact and risk assessment process, the following risks have been assessed as low. These risks are expected to have a negligible or minor impact on air quality with generally a rare or unlikely probability of occurrence.

Dust affecting flora and fauna, amenity and human health

Trucks, machinery and maintenance vehicles may generate dust during operation of the Desalination Plant. However, it is assumed that all roads and access routes to the Desalination Plant will be paved; therefore, dust emissions during operation will be insignificant.

Emissions affecting human health and affecting amenity

Trucks, machinery and maintenance vehicles are likely to generate emissions during operation of the Desalination Plant. Machinery will be operated outdoors and will often be moving: increasing dispersion and preventing high concentrations of emissions from occurring. With the combination of regular maintenance and daily inspections (including start-up checks), as well as separation of machinery from sensitive receptors, it is unlikely that emissions will affect human health.

The only likely sources of odour from vehicle and machinery emissions during operation would be from back-up diesel generators or large trucks being stationary for long periods with the engine running. Back-up generators would only be used for emergencies and trucks would not leave engines running for long periods. Odours will be generated on a small scale and dispersed relatively quickly, and the site is relatively far from sensitive receptors (GHD 2008[13], Technical Appendix 48).

Odour affecting public amenity

The removal of biota from seawater via coarse and fine screenings may lead to odour emissions from the Desalination Plant. However, there are few sensitive receptors near the Plant and solids entrained during the screening process will be stored in skips in a deodorisation facility. The deodorisation facility is ventilated and the exhaust air will be treated to reduce odours before release to the atmosphere. The skips can be sealed so that no odour is released during transportation. Modelling was used to assess the effectiveness of two options for odour dispersion (louvre release and stub stacks), these models are described in detail in Technical Appendix 47. This modelling has shown that odour emissions from the Desalination Plant are likely to comply with EPA guidelines (SEPP-AQM).

9.5 Performance Requirements

Performance Requirements have been developed to provide an environmental framework for management of potential air quality impacts associated with the Project during construction and operation. The PRs are focussed on the environmental 'outcomes' that the State wishes to achieve through the Project delivery. The PRs relevant to air quality management for the Desalination Plant are set out below. The full suite of PRs for the Project is provided in Volume 1 Chapter 10 as part of the overall Environmental Management Framework.

As part of the environmental impact and risk assessment process relating to air quality at the plant site, GHD (2008_{13}) has identified a range of suggested management measures that could be implemented to manage potential impacts. These suggested management measures have been formulated in response to the Reference Project and relevant Variations for the Desalination Plant. In effect, the suggested management measures demonstrate how the Reference Project and relevant Variations can achieve the PRs. These detailed management measures have formed an important input to the PRs for the Project.

The management measures suggested by GHD (2008_{13}) address the following matters:

- dust mitigation measures to be managed in accordance with EPA's Typical Dust Management Measures as outlined in the EPA's Best Practice

Environmental Management Guidelines for Major Construction Sites. Appropriate measures include:

  - keeping construction and maintenance equipment/vehicles operated and maintained to manufacturer's specifications in order to minimise exhaust emissions
  - clearly defined haul routes used where necessary for vehicles to traversing unsealed surfaces or unformed roads
  - restricting vehicular speeds to 25 kilometres per hour on areas of unsealed soil
  - applying chemical stabilisers where appropriate
  - adequate supply of water to be available at all times
  - avoiding runoff and mud on roads from water use for dust suppression that could potentially enter surface waterbodies
  - re-vegetate areas of disturbed soil as soon as practicable
- operation of the concrete batching plant to be controlled so that dust emissions are minimised. Measures include:
  - keep sand and aggregates damp
  - cover or enclose conveyor belts and hoppers
  - keep pavements and surfaces clean
  - fit cement silos with high level alarms, fabric filter dust collector, airtight inspection hatches and automatic cut-off switches on filler lines
  - keep ductwork airtight
  - enclose loading bay
- develop and implement an inspection regime for all dust control components, including:
  - employing high level dust management measures such as utilising a real-time particulate monitoring during construction and operation
- develop management and mitigation measures to meet the State Environment Protection Policy (Air Quality Management) and State Environmental Protection Policy (Ambient Air Quality) requirements.

These suggested management and mitigation measures are also relevant to dust control activities along the Transfer Pipeline and the northerly grid connection found in Volume 4, Chapter 9 and Volume 5, Chapter 9.

The PRs proposed for air quality are outlined in the Table 9-3.

Table 9-3 Performance Requirements

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Air quality – dust	✓		Protect air quality.	Limit dust emissions. Compliance with the State Environmental Protection Policy (Air Quality Management) and EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996). Minimise dust impacts on sensitive receiver sites.	Comply with the Performance Criteria. Develop and implement methods and management systems (including monitoring) to maintain air quality during construction consistent with State Environmental Protection Policy (Air Quality Management) intervention levels for particulates and EPA Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites (1996).
Air quality – odour and emissions		✓	Protect air quality.	Limit odour and emissions from Desalination Plant operations. Compliance with the State Environment Protection Policy (Air Quality Management) and State Environmental Protection Policy (Ambient Air Quality). Comply with the EPA Licence for the Desalination Plant.	Comply with the Performance Criteria. Development and implement methods and management systems consistent with State Environment Protection Policy (Air Quality Management) and State Environmental Protection Policy (Ambient Air Quality) to limit odour and emissions from the operation of the Desalination Plant. Monitor and report the effect of Project Activities on air quality.

10.0 Noise and vibration



10 Noise and vibration

This chapter discusses the noise and vibration impacts of the Plant in the Reference Project on the surrounding environment. It describes existing conditions, assesses impacts of construction and operation of the Plant, and provides strategies for mitigation and management.

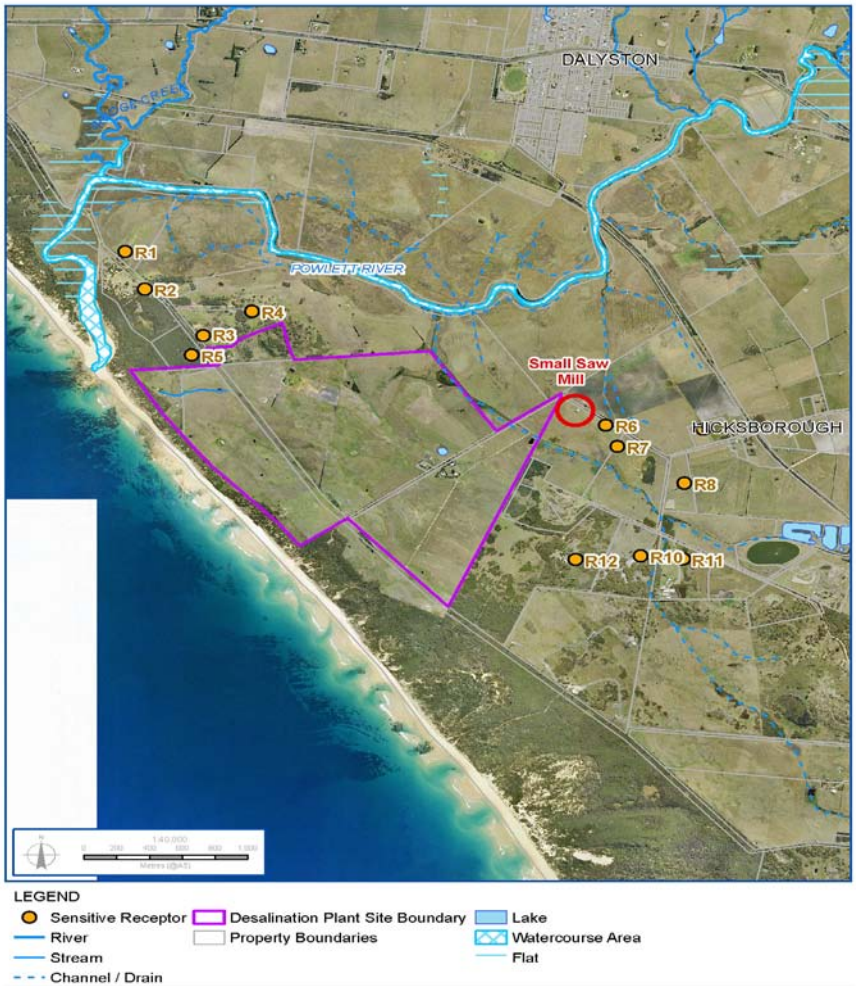
This chapter is based on findings from GHD Pty Ltd (2008_{15}) *Report for the Desalination Project: Impact Assessment Report – Noise and Vibration (Plant)* (Technical Appendix 50).

10.1 Existing conditions

Twelve residences have been identified as potentially sensitive to noise and vibration disturbance within a distance of 1.5 kilometres of the site (GHD 2008_{15}, Technical Appendix 50). These are shown in Figure 10-1 and identified as R1-R12. Properties within the site are not considered as they will be acquired and form part of the site.

The existing noise environment around the site is characterised by surf, wind, rain and general agricultural noise sources. There is also a low volume of slow traffic on Lower Powlett Road and Mouth of Powlett Road. During periods of low swell and wind, ambient noise is low. Local industry consists of agriculture and a small saw mill, approximately 500 metres east on Lower Powlett Road. When in operation the sawmill will likely influence ambient noise levels at nearby receptors, however this was not in operation during any site inspections for this study (GHD 2008[15], Technical Appendix 50). With the exception of vehicle traffic, there were no obvious sources of vibration in the vicinity of the site.

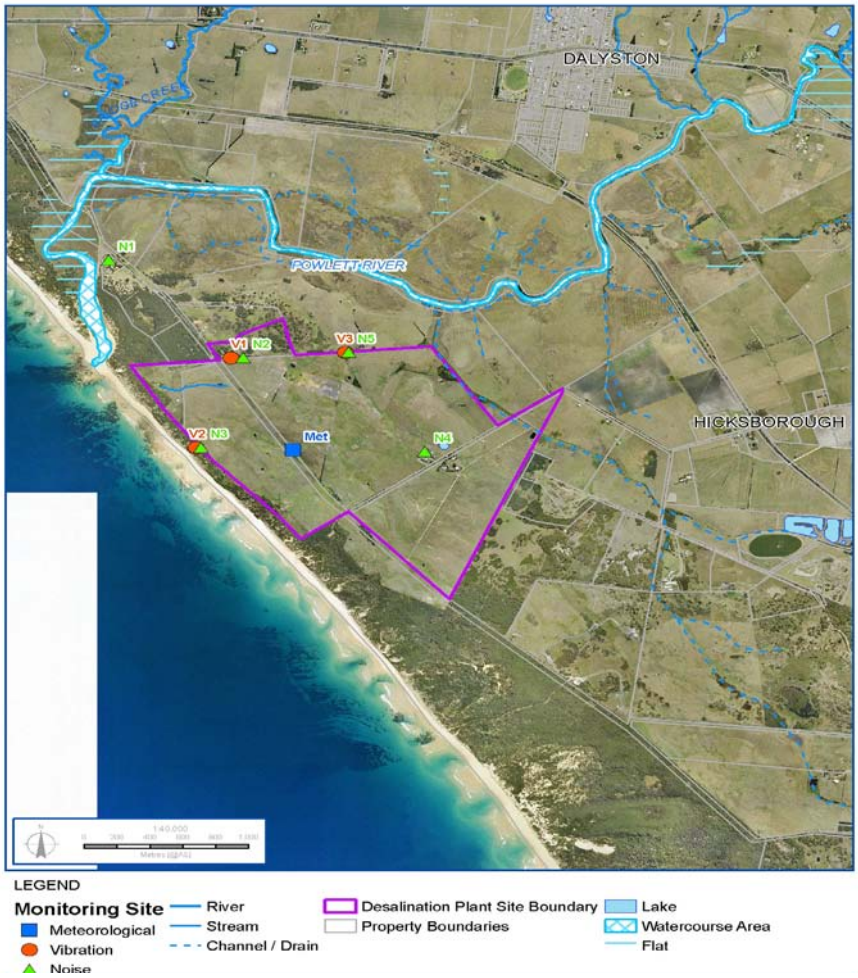
Figure 10-1 Potentially sensitive residencies within 1.5 km of the site



10.1.1 Background noise monitoring

To determine background noise levels, long-term unattended noise monitoring was conducted at five locations on the site for a period of two weeks. Monitoring was conducted at four locations (N1 to N4) commencing in September 2007, and at an additional site (N5) commencing March 2008. Locations of the monitoring sites are shown in Figure 10-2. Details of the monitoring, including timing and specific locations, can be found in GHD (2008_{15}, Technical Appendix 50).

Figure 10-2 Location of noise and vibration modelling sites



The results of unattended noise monitoring are presented in Table 10-1, which shows the minimum, and average recorded background levels (L_{A90} levels) over the monitoring period. This is the definition of background noise level under the SEPP-N1 and N3/89. Time series of recoded L_{A90} levels are provided in Technical Appendix 50.

Table 10-1 Periodic average and minimum L_{A90} levels for day, evening and night

Receptor	Recorded noise level (dB(A))					
	Day		Evening		Night	
	Avg	Min	Avg	Min	Avg	Min
N1	42	34	39	34	38	32
N2	37	34	37	35	38	34
N3	41	37	42	38	45	42
N4	33	31	35	33	37	33
N5	32	29	34	30	34	32

Night time noise levels are generally higher than daytime noise levels. Minimum noise levels occurred around 10 am, and to a lesser degree, around 4 pm to 6 pm. These features are likely to be related to diurnal meteorological trends.

At night, the relative humidity increases and radiative cooling of the surface generates a temperature inversion. These conditions enhance propagation of noise in the atmosphere. The differences in night time noise levels between the five monitoring sites suggest that surf/swell is the dominant noise source at night. This is shown by monitoring of location N3, which is located nearest to the shoreline and experienced the highest night time noise levels.

Noise levels measured during the day tend to be lower and more erratic than at night. Wind speeds during the day are on average 2 m/s higher than at night, and generally produce more variable noise than the surf. Nonetheless, the influence of surf/swell on ambient noise is still a major factor in the differing noise levels between monitoring sites (GHD 2008_{15}, Technical Appendix 50).

Operational noise goals

At present, there are no regulations or State environment protection policies (SEPPs) that impose industrial noise limits in regional Victoria (i.e. in and around the site). The EPA Victoria Interim Guidelines for Control of Noise from Industry in Country Victoria (N3/89) are used as a guide to determine operational noise goals applicable at residential premises within regional locations throughout Victoria that have the potential to be exposed to noise emissions from the proposed works. The selection of appropriate noise goals in regional Victoria can be summarised as follows:

- For cases where the recorded background sound levels (L_{A90}) at rural locations are very low (i.e. less than 25 dB(A) at night or 30 dB(A) during the day), N3/89 provides a list of the minimum applicable sound level goals for comparison against the effective industrial noise impact (L_{Aeq}).
- In cases where the recorded background sound levels at residential locations are comparable to Metropolitan Melbourne, N3/89 refers to the procedures for determining noise limits outlined in the SEPP-N1. These limits are also comparable against the L_{aeq}.
- Finally, in cases where the recorded background is *not* very low (i.e. *greater* than 25 dB(A) at night or 30 dB(A) during the day), but is *not* considered to be comparable to Metropolitan Melbourne, N3/89 makes no recommendations. The identification of project specific noise goals in such situations is therefore, by necessity, a discretionary decision based on professional judgment between the goals outlined in N3/89 and the SEPP N-1.

Noise criteria for the site were determined based on recorded minimum noise levels, and were calculated using:

- application of N3/89 for the daytime and evening-time period at sensitive receivers. Although SEPP N1 would be applicable during the daytime and evening-time period at receivers representative of monitoring locations N1 and N2, application of N3/89 provides a measure of conservatism and consistency for all receivers
- application of SEPP N1 for the night time period for all receivers. The SEPP N1 procedure enables determination of criteria based on local zoning and background noise levels.

Based on these, noise criteria for operation of the Desalination Plant have been determined and are shown in Table 10-2. As the vast majority of noise sources are stationary or continuous, with a typically broadband noise spectrum, no adjustment has been made for tonality, intermittency or impulsiveness.

Table 10-2 Operational Noise Criteria L_{eq} dB(A)

Sensitive receiver	Representative monitoring location	Operation noise criteria		
		Day	Evening	Night
R1	N1	45	37	41
R2	N1	45	37	41
R3	N2	45	37	41
R4	N5	45	37	40
R5	N2	45	37	42
R6	N5	45	37	39
R7	N5	45	37	39
R8	N5	45	37	39
R9	N5	45	37	39
R10	N5	45	37	39
R11	N5	45	37	39
R12	N5	45	37	39

Construction noise goals

The EPA Interim Guidelines for the Control of Noise from Industry in Country Victoria (N3/89) and the EPA Noise Control Guidelines (TG 302/92) apply during construction. N3/89 allows an additional 10 dB(A) during the construction period of an industrial facility for the day period only and no adjustments for other time periods.

Clause 12 of TG 302/92 is relevant to the construction of industrial premises. These guidelines place no restriction on construction noise during normal working hours (7 am to 6 pm Monday to Friday, 7 am to 1 pm Saturdays), but require:

- for the first 18 months of construction, construction noise must not exceed background by more than 10 dB(A) outside normal working hours
- once construction has been ongoing for 18 months or more, construction noise must not exceed background by more than 5 dB(A) outside normal working hours
- construction noise to be inaudible inside a dwelling between 10 pm and 7 am.

TG 302/92 also allows for construction works to continue through the night when it is a matter of necessity and provided that residents are given notification. As outlined in Section 5 of the EPA Environmental Guidelines for Major Construction Sites, limits from N3/89 and TG302/92 are not statutory. Therefore, all noise nuisances from construction activities should be reduced wherever possible. For this assessment, TG 302/92 will be applied to all receivers in the vicinity of the site.

10.1.2 Background vibration monitoring

Vibration monitoring was conducted at three locations (V1 to V3) on the site to determine background vibration levels. The methodology of this monitoring can be found in GHD (2008_{15}, Technical Appendix 50). Vehicle traffic was the only obvious source of vibration in the vicinity of the site, and vibration levels from local industry were found to be negligible.

Vibration goals

Vibration goals for the Project have been determined with consideration to the relevant vibration standards and guidelines. Vibration standards and guidelines generally distinguish intermittent vibration from continuous vibration. Continuous vibration is defined as uninterrupted vibration for a defined period (usually throughout daytime and/or night time). Intermittent vibration is defined as interrupted periods of continuous vibration (e.g. drill) or repeated periods of impulsive vibration (e.g. pile driver), or continuous vibration that varies significantly in magnitude.

Vibration goals for human exposure (perception)

Vibration goals related to human perception are detailed in Table 10-3 for intermittent vibration and in Table 10-4 for continuous vibration. Intermittent vibration is measured as the Vibration Dose Value, which accumulates the vibration energy received over the daytime and night time periods. Continuous vibration is measured as weighted root-mean-squared (rms) acceleration in the one to 80 hertz range.

Table 10-3 Accepted vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime (7 am to 10 pm)		Night time (10 pm to 7 am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas (hospital operating theatres, precision laboratories, etc.)	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Table 10-4 Preferred and maximum weighted root-mean-squared values for continuous vibration acceleration (m/s^2) 1-80 hertz

Location	Assessment period	Preferred values		Maximum values	
		z-axis	x- and y- axes	z-axis	x- and y- axes
Critical areas (hospital operating theatres, precision laboratories, etc.)	Day or night time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night time	0.020	0.014	0.040	0.028
Workshops	Day or night time	0.040	0.029	0.080	0.058

Vibration goals for building damage

Vibration limits to prevent damage to buildings have been determined from German Standard DIN4150-3 as this has a more stringent set of building damage criteria than the British Standard BS7385-2. If these values are complied with, damage from intermittent or continuous vibration that reduces the serviceability of the building is unlikely to occur. These vibration lower limit values are shown in Table 10-5.

Table 10-5 Building damage vibration limits

Type of structure	Guideline values for velocity vi(t) [mm/s]			
	Short-term vibration at frequency of:			Long-term vibration at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	
1. Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	10
2. Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	5

Type of structure	Guideline values for velocity vi(t) [mm/s]			
	Short-term vibration at frequency of:			Long-term vibration at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	
3. Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order	3	3 to 8	8 to 10	2.5

10.2 Impact assessment

This section discusses the potential noise and vibration impacts of the construction and operation of the Desalination Plant on sensitive receptors at and around the site.

10.3 Construction

10.3.1 Risks assessed as medium and above

Table 10-6 sets out the noise and vibration risks associated with the construction of the Desalination Plant which are assessed as medium and above. The risks are discussed in order of likelihood with those most likely to occur discussed first.

Table 10-6 Construction noise and vibration risks assessed as medium and above

Activity	Impact pathway	Consequence	Likelihood	Risk
All construction activities	Noise and vibration impacting on sensitive receptors	Moderate	Likely	Medium
All construction activities	Noise and vibration disturbing flora and fauna	Minor	Likely	Medium

The above risk assessment is based on accepted construction practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the Performance Requirements are taken into account, both the likelihood and consequence of these risks may be significantly lower.

Noise

Construction activities impacting on sensitive receptors within the vicinity of the Desalination Plant site would occur over approximately two years and would include activities such as clearing of vegetation, excavation of shafts and tunnels, general earthworks, building construction, drainage installation, power connection and equipment fabrication and installation.

Typical noise levels produced by the type of construction plant anticipated to be used are shown in Table 10-7. These represent the loudest construction noise sources expected to occur on the Plant site. Other construction noise sources such as diesel generators or the concrete batching plant are expected to have similar sound power levels to these noise sources (GHD 2008$_{15}$, Technical Appendix 50).

Table 10-7 Predicted plant item noise levels, dB(A)

Plant	Estimated sound power level of the source [dB(A)]	Estimated sound pressure level dB(A) at distance (m)						
		50	100	200	400	600	1 200	2 400
Crane	115	73	67	61	55	51	45	39
Bulldozer	115	73	67	61	55	51	45	39
Excavator	118	76	70	64	58	54	48	42
Back Hoe	108	66	60	54	48	44	38	32

Plant	Estimated sound power level of the source [dB(A)]	Estimated sound pressure level dB(A) at distance (m)						
		50	100	200	400	600	1 200	2 400
Compactor	110	68	62	56	50	46	40	34
Dump Truck	106	64	58	52	46	42	36	30
Road Truck	110	68	62	56	50	46	40	34
Compressor	107	65	59	53	47	43	37	31
Concrete Pump	109	67	61	55	49	45	39	33
Concrete Saw	118	76	70	64	58	54	48	42
Paver	113	71	65	59	53	49	43	37
Diesel Generator	104	62	56	50	44	40	34	28

The magnitude of off-site noise impact would be dependent on a number of factors including:

- the intensity and location of construction activities
- the type of equipment used
- existing local noise sources
- intervening terrain and prevailing weather conditions.

In addition, construction machinery would move about the site, changing the noise source for individual receivers. During any given period, the machinery items would operate at maximum sound power levels of only brief stages. At other times, machinery may produce lower sound levels while carrying out activities that do not require full power. It is highly unlikely that all construction equipment would be operating at maximum sound power levels at any one time. Finally, certain types of construction machinery would be present in the study area for only brief periods during construction.

Nevertheless, Table 10-7 suggests that the construction noise goals may potentially be exceeded during construction, resulting in elevated noise levels at sensitive receptors. It is anticipated that construction would occur 24 hours per day, seven days per week to meet project timelines. On the basis of recorded night time background noise levels, EPA noise goals may not be met, as noise impacts exceeding background plus 10 dB(A) are likely to occur within approximately 400 metres from a residence. Noise exceedances, if any, are more likely to occur over the night time and on weekends when construction noise goals are more stringent. This is best addressed by implementation of noise control measures and monitoring adapted to the construction activities occurring at any one time and would be managed through the Performance Requirements.

Vibration

It is likely that local sensitive receivers would perceive construction vibration at times. However, the level of annoyance would depend on individuals and would be best managed by site monitoring. The distance between potentially impacted receivers and site construction activities is generally in excess of 100 metres, although it is possible that infrastructure and road works could be carried out at smaller distances. The typical vibration levels of common construction activities are shown in Table 10-3 and show that the building damage 5 mm/s lower limit is normally not exceeded by general construction activities at distances greater than 20 to 30 metres from the nearest sensitive receivers.

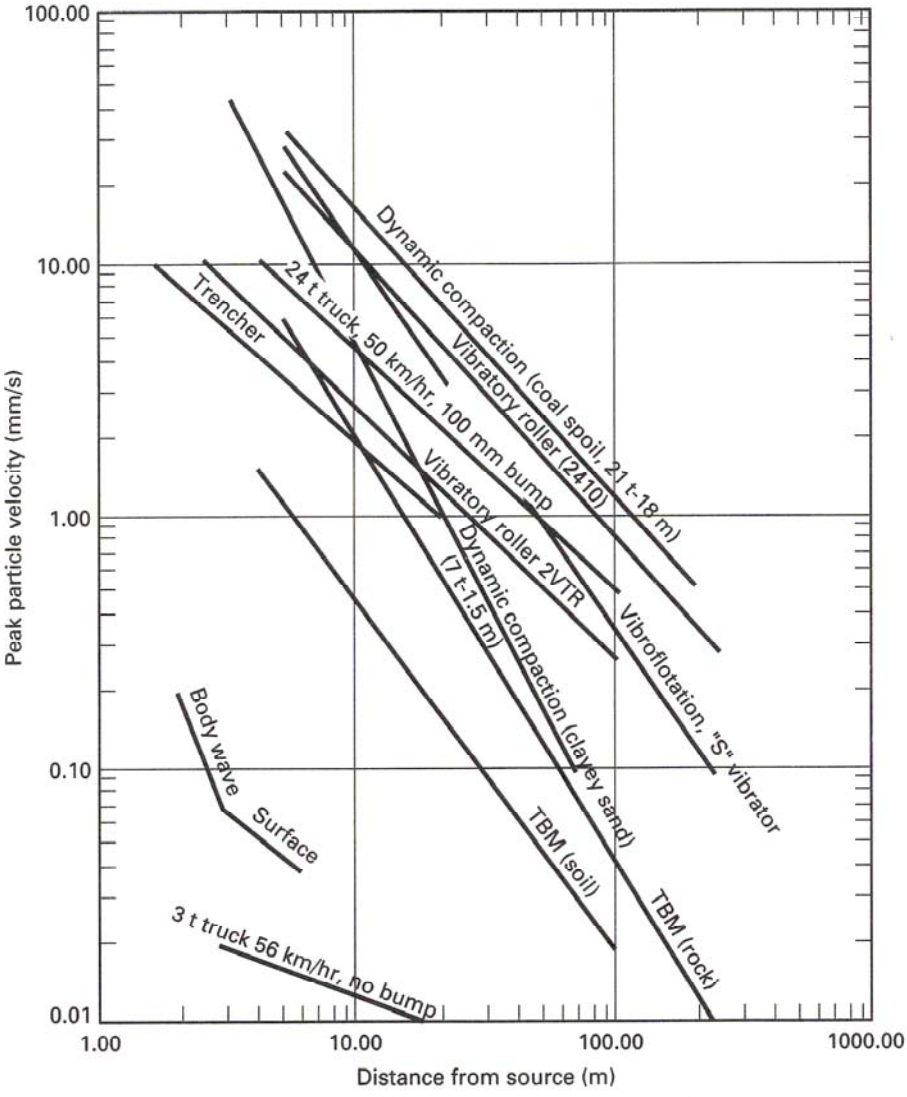
Foundations for major and minor structures on the Desalination Plant site would be supported on bored piles. This is essentially a drilling activity and would result in minimal vibration levels. If pile driving were to occur, then vibration impacts might occur. However these would not normally cause structural damage when carried out further than 30 metres from a sensitive structure. The minimum distance between the nearest residences and the site structures exceeds several hundred metres and as a result vibration impacts from pile-driving, if it occurred on site, are not expected to be a concern from a structural damage point of view.

The noise and vibration from blasting may be undertaken as part of the construction activities. This has been raised as a concern by the community, in particular with regards to potential impacts on horses stabled in the local area. To manage this impact, a monitoring strategy during any blasting has been included in the Performance Requirements. This strategy would be used to measure and mitigate ground vibration in the dune system as well as the development and implementation of a community strategy with key stakeholders and the community to manage the impacts of construction noise.

Vibrations generated by tunnel boring machines are typically within the 90 to 120 hertz range. Vibration impacts associated with tunnel boring are generally associated with structures located directly above or adjacent to the tunnel route. In the context of the Project, the nearest sensitive receivers would be located further than 100 metres from the tunnelling activities and as such no appreciable impact is expected from tunnel boring.

Effects of construction noise and vibration on flora and fauna are discussed in Chapter 7 Flora and fauna.

Figure 10-3 Typical vibration levels of common construction activities



Source: GHD 2008[15]

10.3.2 Risks assessed as low

No noise and vibration risks that have been assessed as low are expected to occur during construction of the Desalination Plant.

10.4 Operation

10.4.1 Risks assessed as medium and above

Table 10-8 sets out the only noise and vibration risk associated with the construction of the Desalination Plant which is assessed as medium and above.

Table 10-8 Operational risks assessed as medium and above

Activity	Impact	Consequence	Likelihood	Risk
All construction activities	Noise impacts on sensitive receptors	Major	Unlikely	Medium

The above risk assessment is based on accepted operation practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the Performance Requirements are taken into account, both the likelihood and consequence of these risks may be significantly lower.

The Plant would operate 24 hours a day with an initial capacity of 150 GL of treated water per year, with potential for extension to 200 GL per year. Internal noise levels are expected to be highest in the cartridge and feed booster pumps building, treated water pump station and reverse osmosis bunker. There would be five to twenty truck movements per day for chemical deliveries and waste removal, generally during normal workday hours. These trucks would only be moving onsite for short periods. For this reason, noise impacts from trucks were not included in the noise impact assessment. Workshops and administration buildings are expected to generate small amounts of noise. Details of sound power levels for primary site operational noise sources, estimated internal sound pressure levels in buildings, and sound transmission loss from building components are contained in GHD 2008[15], Technical Appendix 50.

Noise modelling was conducted under normal and adverse weather conditions to determine the requirements enabling the Plant in its 200 GL configuration to achieve 37 dB(A) at the site boundary. This is the most stringent criterion applicable to site noise emissions, as discussed in section 10.1.1.

The noise modelling considered local topography, weather conditions, reflection, ground absorption, relevant building structures, site sources and the location of receiver areas to predicted noise levels. Adverse weather conditions that enhance noise propagation in the atmosphere were modelled, as well as temperature inversion conditions (stable atmosphere) and a 5 m/s southerly wind (blowing from source to receptors).

Modelling results indicate that operation of the Plant can comply with the EPA noise requirements in both 150 GL and 200 GL configurations (GHD 2008[15], Technical Appendix 50).

10.4.2 Risks assessed as low

The noise and vibration risks that have been assessed as low in the impact and risk assessment process are expected to have a negligible or minor impact on the environment with generally a rare or unlikely probability of occurrence.

Noise and vibration during operation of the Desalination Plant has the potential to disturb fauna and cause subsidence which may impact native fauna. The consequence of these risks is minor, and is discussed in Volume 3 Chapter 7, Flora and fauna. There is also a risk to public safety from ground subsidence, movement and instability, the consequence of which is discussed in Volume 3 Chapter 5, Geology and geomorphology. Both of these impacts are unlikely to occur, as performance requirements would be implemented to enable compliance with noise and vibration standards during operation of the Desalination Plant.

10.5 Performance Requirements

Performance Requirements (PRs) have been developed to provide an environmental framework for management of potential noise and vibration impacts associated with the Project during construction and operation. The PRs are focussed on the environmental 'outcomes' that the State wishes to achieve through the Project delivery. The PRs relevant to noise and vibration management for the Plant are set out below. The full suite of PRs for the Project is provided in Volume 1 Chapter 10 as part of the overall Environmental Management Framework.

As part of the environmental impact and risk assessment process relating to noise and vibration for the Plant, GHD (2008_{15}) has identified a range of suggested management measures that could be implemented to manage potential impacts. These suggested management measures have been formulated in response to the Reference Project and relevant Variations for the Plant. In effect, the suggested management measures demonstrate how the Reference Project and relevant Variations can achieve the PRs. These detailed management measures have formed an important input to the PRs for the Project.

The management measures suggested by GHD (2008_{15}) address the following matters:

- reducing noise nuisance from vehicles, fixed machinery and general construction activities wherever possible
- undertaking works in accordance with EPA Publication TG302/92, Clause 12 Construction and Demolition Site Noise
    - construction activities to undertaken 24 hours per day. When this not the case works will primarily be conducted between 7 am and 6 pm Monday to Friday, and 7 am to 1 pm Saturdays
- where practicable, noisy construction activities to be kept within the normal daytime working hours
- communication and consultation with potentially effected residents, where works are outside normal working hours
- pre-construction surveys, where there is potential for vibrational damage to properties
- night time noise measurements to be undertaken on a regular basis.

The suggested management and mitigation measures are also relevant to airborne noise and vibration management along the Transfer Pipeline and the northerly grid connection found in Chapter 10 Volume 4 and Chapter 10 Volume 5.

The PRs proposed for noise and vibration are outlined in Table 10-9.

Table 10-9 Performance Requirements

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Airborne noise	✓	✓	Protect neighbourhood amenity.	Minimise impacts from airborne noise. During construction, comply with TG302/92 for Desalination Plant. Comply with EPA N3/89 during day and evening, and with State Environment Protection Policy N1 at night-time for Desalination Plant operational activities.	Comply with the Performance Criteria. Develop and implement a communication strategy with the key stakeholders and the community to manage the impacts of construction noise and limit disturbance to local amenity. Model and report predicted airborne noise levels during operation to demonstrate that the design meets the Performance Criteria. As part of the modelling and reporting exercise, include an assessment of tonality and other character adjustments with consideration to the relevant provisions of State Environment Protection Policy N1. If found present, tonality or character adjustments should be eliminated through the detailed design stage. Alternatively reduced noise limits, with consideration to State Environment Protection Policy N1, may be applicable. Develop and implement a noise mitigation strategy for construction activities. Night-time construction works outside the provisions of TG302/92 should be subject to a specific noise mitigation strategy, through consultation with the EPA, prior to commencement of works. Monitor and report on airborne noise levels.
Vibration	✓	✓	Protect buildings from vibration impacts. Protect the dune system from vibration.	Compliance with Section 5.5 of EPA Publication 480 – Guidelines for Major Construction Sites. Minimise damage from vibration caused by construction activities and Desalination Plant operations.	Comply with Performance Criteria. Develop and implement methods and management systems to protect buildings from vibration impacts. Undertake site investigations, property and land surveys and ground and infrastructure condition surveys of vibration generation works prior to and after carrying out vibration generation works on a case-by-case basis for all potentially impacted dwellings. During any blasting, undertake a monitoring strategy to measure and mitigate ground vibrations in the dune system. Short-term vibration levels must not exceed 3 – 10 mm/s Peak Particle Velocity (frequency dependent limit) at Heritage buildings, 5 to 20

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
					mm/s Peak Particle Velocity (frequency dependent limit) at rural and residential buildings and 20 to 50 mm/s Peak Particle Velocity (frequency dependent limit) at commercial or industrial buildings.

11.0 Transport infrastructure



11 Transport infrastructure

This chapter discusses the impacts of the Plant on transport infrastructure. It describes existing transport infrastructure conditions, assesses impacts of construction and operation of the Plant and provides strategies for mitigation and management.

This chapter is based on findings from:

- GHD (2008_{16}) *Existing Traffic Conditions – Plant* (Technical Appendix 51)
- Maunsell (2008_3) *Victorian Desalination Project – Traffic Impact Assessment: Preliminary Assessment* (Technical Appendix 53).

11.1 Existing conditions

The following section discusses the existing conditions of transport infrastructure at and around the Desalination Plant site.

11.1.1 Existing roads

There are a number of key roads in the vicinity of the site that may be used as access routes to the site. Each of these roads is described below.

Bass Highway

The Bass Highway is a VicRoads-Declared Arterial Road that begins at the Strzelecki Highway termination at Leongatha and runs south-west from Leongatha through Inverloch and Wonthaggi. From Wonthaggi, the Bass Highway runs north-west to Anderson and then north to its termination at the South Gippsland Highway.

Between the South Gippsland Highway interchange and Grantville, the Bass Highway is four-lane, two-way with a divided carriageway and sealed shoulders on both sides. The road is divided by long sections of wire rope barrier and shorter sections of guard fence as shown in Figure 11-1. The majority of the Bass Highway south of Grantville is two-lane, two-way with a width of 7.0 metres and sealed shoulder of 2.0 metres as shown in Figure 11-2. There are overtaking lanes in both directions of the highway north of the Anderson roundabout.

Figure 11-1 Bass highway north of Grantville, southbound view



Figure 11-2 Bass Highway, south of Grantville, southbound view

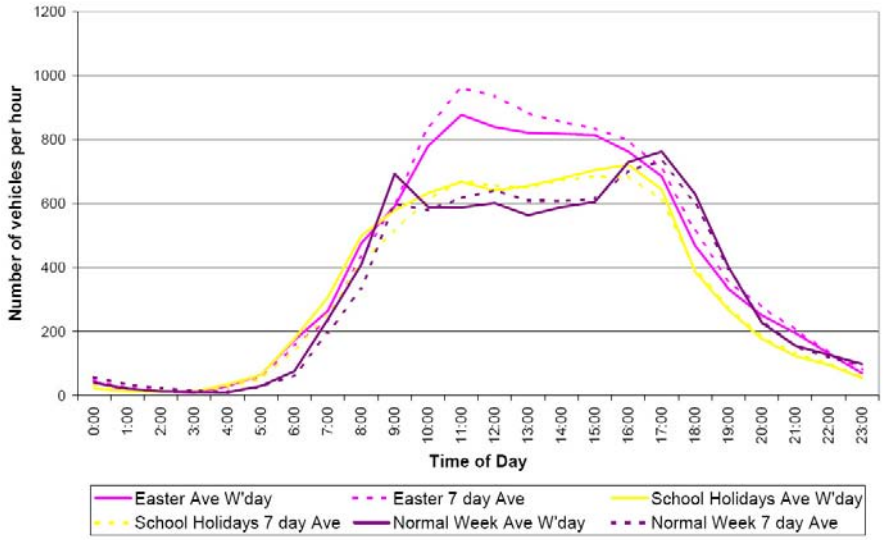


Duplication works are currently underway on sections of the Bass Highway south of Grantville. Some sections are nearing completion (such as the section directly south of Grantville) and other sections further south are in the planning stages.

The Bass Highway predominantly has a posted speed limit of 100 kmh. Between the site and the South Gippsland Highway, the Bass Highway passes through Kilcunda, Grantville and Dalyston, with reduced speed limits at each town. Near Wonthaggi and the site, where Bass Highway meets Lower Powlett Road (eastbound), the speed limit changes from 100 kmh to 70 kmh.

Traffic volume information for three one-week periods including Easter, school holidays and a typical week was collected. Information was collected along the Bass Highway 100 metres north of Lower Powlett Road and is shown graphically in Figure 11-3.

Figure 11-3 Traffic volumes of Bass Highway, north of Lower Powlett Road



Source: Maunsell 2008[3]

The traffic surveys indicate that Bass Highway carried approximately 9 500 vehicles per day over the Easter period, 8 200 vehicles per day during the school holidays and 8 200 vehicles per day during a normal traffic week (GHD 2008[16], Technical Appendix 51). Traffic volumes are significantly higher over the Easter period compared to the other survey periods, as shown in Figure 11-3. The peak period over Easter was also earlier in the day, occurring between 11 am and 12 pm. The peak period during a normal week occurred between 5 pm and 6 pm. During the week of Easter, daily traffic volumes were the highest on the Thursday. For both the school holidays and under normal operating conditions, the highest daily traffic volumes were recorded on a Friday.

During the Easter period, a maximum hourly two-way volume of 1 245 vehicles per hour on Bass Highway north of Lower Powlett Road was recorded. The calculated two-way capacity of Bass Highway is 1 318 vehicles per hour. Due to the high tourism in the region, summer school holidays and the Easter period result in high traffic volumes for this stretch of the Bass Highway.

South Gippsland Highway

The South Gippsland Highway runs from the interchange with the Bass Highway near Lang Lang towards Melbourne. The majority of the highway is a four-lane, two-way divided carriageway with a typical posted speed limit of 100 kmh as shown in Figure 11-4.

Figure 11-4 South Gippsland Highway, north of Bass Highway, southbound view



Traffic volume data was collected on the South Gippsland Highway between Craig Road and Jennifer Street in Cranbourne during November 2003. These data are summarised in Table 11-1.

Table 11-1 South Gippsland Highway – traffic volume summary (GHD 2008[16])

	Average 7-day volume Thurs-Wed (veh/day)	Average 5-day volume Mon-Fri (veh/day)	Maximum daily volume (veh/day)	Maximum AM peak volume (veh/hr)	Maximum PM peak volume (veh/hr)
South Gippsland Highway, northbound	9 127 (12.2% Heavy Vehicles)	8 932 (13.9% Heavy Vehicles)	10 827 (Sun 23/11)	770 (Mon 8 am 17/11)	1 133 (Sun 4 pm 23/11)
South Gippsland Highway, southbound	9 000 (12% Heavy Vehicles)	9 051 (13.5% Heavy Vehicles)	11 301 (Fri 21/11)	851 (Sat 11 am 21/11)	902 (Sat 12 pm 21/11)

Lower Powlett Road

Lower Powlett Road will be the primary access road from the Bass Highway to the Plant. It is a two-lane, two-way local road that runs south from the Bass Highway to the car park at Williamsons Beach. As there is no posted speed limit, the default 100-kmh rural speed limit applies. The road has a number of open sections as well as several tight curves and crests that limit sight lines.

Lower Powlett Road has a 5.7 metre-wide sealed carriageway from the Bass Highway to approximately 100 metres west of Webb Road as shown in Figure 11-5. Past Webb Road, Lower Powlett Road is unsealed with a 4.5 metre-wide carriageway. There is an existing 11-metre long culvert near the Project area, towards the end of Lower Powlett Road as shown in Figure 11-5. Adjoining land-uses along the road are predominantly rural and farming uses, with some residential dwellings.

Figure 11-5 Lower Powlett Road, east of rail trail crossing, westbound view



Figure 11-6 Lower Powlett Road, approach to the site, westbound view



Austroads developed standards for Levels of Service (LOS) for urban streets within Australia. LOS is based on average through-vehicle travel speed for the segment, section, or entire urban street under consideration. Definitions for LOS categories are summarised in Table 11-2.

Table 11-2 Austroads Level of Service categories and definitions

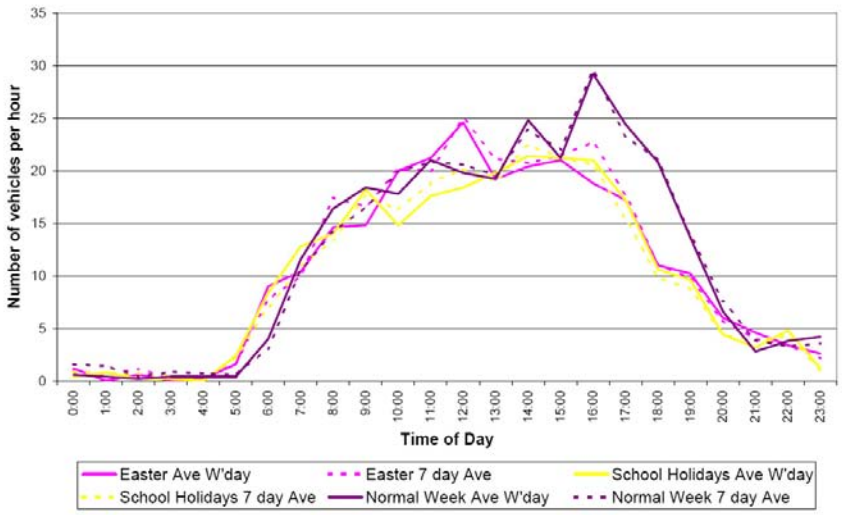
LOS category	LOS definition
A	Primarily free-flow operations at average travel speeds, usually about 90% of the free flow speed (FFS) for the given street class. Vehicles are completely unimpeded in their ability to manoeuvre within the traffic stream. Control delay at signalised intersections is minimal.
B	Reasonable unimpeded operations at average travel speeds, usually about 70% of the FFS for the street class. The ability to manoeuvre within the traffic stream is only slightly restricted, and control delays at signalised intersections are not significant.
C	Stable operations, but ability to manoeuvre and change lanes is restricted and average travel speeds are of about 50% of the FFS for the street class.
D	Small increases in flow may cause substantial increases in delay and decreases in travel speed. LOS D may be due to adverse signal progression, inappropriate signal timing, high volumes, or a combination of these factors. Average travel speeds are about 40% of FFS.
E	Significant delays and average travel speeds of 33% or less of the FFS. Such operations are caused by a combination of adverse progression, high signal density, high volumes, extensive delays at crucial intersections, and inappropriate signal timing.
F	Characterised by urban street flow at extremely low speeds, typically one-third to one-fourth of the FFS. Intersection congestion is likely at critical signalised locations, with high delays, high volumes, and extensive queuing.

Two-way capacities of Lower Powlett Road have been calculated to show corresponding LOS values. Carrying 241 vehicles per hour, Lower Powlett Road would be operating at LOS B. Carrying 445 vehicles per hour would result in LOS C and 661 vehicles per hour would result in LOS D. LOS D is generally acknowledged as the minimum acceptable LOS for a public road (GHD 2008_{16}, Technical Appendix 51).

Traffic volume information was collected for three weeks, including Easter week, one week of school holidays and one typical week during March and April 2008. The volume information was collected along Lower Powlett Road west of Bass Highway. This information shows seven-day average volumes of Lower Powlett Road as 262 vehicles per day during Easter, 259 vehicles per day during school holidays and 283 vehicles per day under normal traffic conditions.

Figure 11-7 shows that the highest peak volumes were recorded during a normal week at 4 pm. Traffic volumes during the school holidays and Easter were quite similar, with the daily peak occurring at 2 pm. During normal traffic conditions, volumes were generally higher with the daily peak occurring at 4 pm.

Figure 11-7 Traffic volumes of Lower Powlett Road, west of Bass Highway



Source: Maunsell (2008[3])

Mouth of Powlett Road

Mouth of Powlett Road is a two-lane, two-way local road that runs from Bass Highway to the south-eastern point of the site. As with Lower Powlett Road, the default 100-kmh rural speed limit applies, as there is no posted speed limit. Mouth of Powlett Road is described as having 'level' terrain as shown in Figure 11-8.

Figure 11-8 Mouth of Powlett Road, between the Bass Coast Rail Trail and the bridge, eastbound view



From the Bass Highway to the bridge crossing the Powlett River (1.8 kilometres south-east of the highway), Mouth of Powlett Road is approximately 6.0 metres wide and sealed. The recently constructed bridge is a single lane, 4.5 metres wide and appears to be in good condition (GHD 2008[16], Technical Appendix 51), as shown in Figure 11-9. From the bridge to the site, Mouth of Powlett Road is typically 6.5 metres wide and unsealed.

Figure 11-9 Mouth of Powlett Road at the bridge, westbound view



Figure 11-10 Mouth of Powlett Road at Y-intersection, eastbound view



Approximately 270 metres southeast of the bridge is a Y-intersection as shown in Figure 11-10, which provides access to a caravan park on one arm and the site on the other. There is currently no give-way signage at the intersection.

Webb Road

Webb Road is a minor local road that intersects Lower Powlett Road approximately two kilometres west of the Bass Highway. The road is a two-lane, two-way 4.8 metres wide, unsealed carriageway as shown in Figure 11-11. As there is no posted speed limit, the default 100-kmh rural speed limit applies.

Figure 11-11 Webb Road, southbound view



11.1.2 Bicycle trails

The Bass Coast Rail Trail is a 16-kilometre long coastal trail that runs from the old railway station in Murray Street Wonthaggi, and the railway station in Anderson (at the intersection of the Bass Highway and Phillip Island Road). The trail travels through a variety of land types including farmland, coastal bushland, historic coalmine reserves and rugged coastline. The first five kilometres of the track from Wonthaggi is a fully constructed, even gravel surface track. After this section, the trail is an uneven natural track to Anderson.

The Bass Coast Rail Trail has two road crossings within the vicinity of the Plant: Lower Powlett Road and Mouth of Powlett Road. Both of these crossings are in the vicinity of the site.

The rail trail was surveyed at the intersection of Lower Powlett Road for twelve hours (7 am to 7 pm) on a weekday (Thursday) and on a weekend (Saturday) in April 2008. On the Thursday, 49 cyclists and four pedestrians were counted using the trail. On the Saturday, 56 cyclists and 12 pedestrians were recorded, with a relatively even split in those heading north and south.

Lower Powlett Road Crossing

The rail trail crosses Lower Powlett Road approximately 1.6 kilometres west of the intersection with Bass Highway. The trail is lined with vegetation, shown in Figure 11-12, which limits visibility of Lower Powlett Road from the trail. Cyclists and pedestrians coming from the south have limited sight distance until they are two metres from Lower Powlett Road, and 4.5 metres when coming from the north. Once within these distances, cyclists and pedestrians have site distances of approximately 135 metres and 125 metres to the east and west respectively.

Figure 11-12 Bass Coast Rail Trail at Lower Powlett Road, view south



Advance warning signs have been installed on Lower Powlett Road to alert drivers of the rail trail crossing, as well as a 60-kmh advisory speed sign. The rail trail crossing and advance-warning signage are considered appropriate for a crossing, given the existing traffic volumes and supplementary speed signs.

Mouth of Powlett Road Crossing

The rail trail crosses Mouth of Powlett Road approximately 330 metres southeast of the Bass Highway. There is little vegetation to obstruct the view of Mouth of Powlett Road from the rail trail (Figure 11-13), and advance-warning signs on Mouth of Powlett Road alert drivers to the trail as shown in Figure 11-14.

Figure 11-13 Bass Coast Rail Trail at Mouth of Powlett Road, view east



Figure 11-14 Mouth of Powlett Road approaching the rail trail crossing, eastbound view



11.1.3 Public access

A roadway easement runs through the site, connecting Lower Powlett Road and Mouth of Powlett Road, shown in Figure 11-15. The easement was closed to public traffic by the Bass Coast Council in 2006, but was retained for emergency and pedestrian access. The road was closed by DSE in July 2008 but emergency access has been retained.

Figure 11-15 Road easement running through the site.



11.1.4 Casualty crash history

Crash history data were sourced from VicRoads for roads in the vicinity of the site. This area includes the Bass Highway from Korumburra-Wonthaggi Road and Dalyston-Glen Forbes Road (not including their intersections) and the length of Lower Powlett Road. Crash history data for this area is presented for the period from 2001 to 2007. Due to a change in the VicRoads data collection techniques (December 2005), the data are divided into two sections: 2001-2005 and 2006-2007.

From 2001 to 2005, there were 19 reported casualty crashes in the vicinity of the site. The crashes occurred at 11 sites, and there were two sites with three or more crashes:

- Bass Highway between unnamed minor street (just south of Lower Powlett Road) and South Dudley Road – four casualty crashes (three rear-end crashes)

- Bass Highway between an unidentified road (Possibly Poplar Street) and a minor unnamed street (possibly White Road) – three casualty crashes (three different crash types).

Three crashes were recorded at three separate locations on Lower Powlett Road. All of these crashes were single-car accidents where the driver lost control. A single crash was recorded at the intersection of Lower Powlett Road and Bass Highway. This was also a single-car accident where the driver lost control.

The locations and details of all crashes recorded for the 2001 to 2005 period can be found in Technical Appendix 51. Of these 19 crashes:

- no fatal injuries were recorded
- five crashes occurred at intersections, two at the intersection of Bass Highway and South Dudley Road
- 25 cars, one truck and one motorcycle were involved in the 19 crashes
- 10 crashes were single-vehicle accidents where the driver lost control
- crashes were recorded during both day and night
- crashes were recorded in both wet and dry conditions.

From 2006 to 2007, only one crash was recorded in the vicinity of the site. This crash occurred on the Bass Highway between South Dudley Road and a minor unnamed street just south of Lower Powlett Road. It was a rear-end collision with no serious injuries.

The casualty crash data generally indicate that there are no significant existing traffic safety issues on the existing road network within the vicinity of the site.

11.1.5 Key intersection details

Lower Powlett Road and Bass Highway

The intersection of Lower Powlett Road and Bass Highway forms a T-intersection. At the intersection, Bass Highway runs north-south, and Lower Powlett Road intersects on the western side of the road. At this intersection, Bass Highway is 6.8 metre wide with a widened shoulder to enable safe right-hand turns (minimum basic right turn treatment). A 10-metre long splitter island is located on Lower Powlett Road, set three metres back from the edge of the Bass Highway. As shown in Figure 11-16, a car yard and a gravel car park are located on the opposite side of Bass Highway to Lower Powlett Road.

Figure 11-16 Bass Highway and Lower Powlett Road intersection, eastbound view



The speed limit along the Bass Highway at the intersection is 70 kmh. However, the speed zone changes to a 100-kmh zone 50 metres north of the intersection. As a result, driver speeds at the intersection vary from 70 kmh as they break/accelerate in response to the change in posted speed.

Sight distances at the intersection were measured using a laser rangefinder. The sight distance along Bass Highway was 200 metres to the north and 195 metres to the south.

Mouth of Powlett Road and Bass Highway

The intersection of Mouth of Powlett Road and Bass Highway forms a T-intersection. Lanes are widened on the far side of Bass Highway to enable through vehicles to pass on the left of vehicles waiting to turn right into Mouth of Powlett Road (typical AUR type intersection treatment), shown in Figure 11-17. The Bass Highway has a posted speed limit of 100 kmh at this intersection.

Figure 11-17 Bass Highway and Mouth of Powlett Road intersection, eastbound view



The Bass Highway runs east-west at the intersection, with Mouth of Powlett Road joining from the south. Mouth of Powlett Road joins at an angle, which means that traffic turning left from Bass Highway must turn greater than 90 degrees, as shown in Figure 11-18. As a result, large vehicles may temporarily cross onto the opposite side of Mouth of Powlett Road when performing this turn.

Figure 11-18 Bass Highway and Mouth of Powlett Road intersection, southbound view



Sight distances along Bass Highway from Mouth of Powlett Road were measured using a rangefinder. Sight distances of 75 metres and 130 metres were recorded looking east and west respectively (GHD 2008_{16}, Technical Appendix 51).

Webb Road and Lower Powlett Road

Webb Road intersects Lower Powlett Road approximately two kilometres from the Bass Highway. This is a minor T-intersection, with the entrance to Webb Road flaring significantly. Webb Road is sealed for approximately 25 metres from the intersection, after which it is unsealed gravel. This causes a large amount of gravel to be scattered on the road at the intersection, which is evident in Figure 11-19.

Figure 11-19 Webb Road and Lower Powlett Road Intersection, sight distance to the east



11.2 Impact assessment

This section discusses the potential impacts of the construction and operation of the Desalination Plant on transport infrastructure at and around the site.

11.3 Construction

11.3.1 Risks assessed as medium and above

Table 11-3 sets out the transport infrastructure risks associated with the construction of the Desalination Plant which are assessed as medium and above. The risks are discussed in order of likelihood with those most likely to occur discussed first.

Table 11-3 Construction transport infrastructure risks assessed as medium and above

Activity	Impact	Consequence	Likelihood	Risk
Physical location of the site	Reduction in access across the site affecting emergency response	Minor	Likely	Medium
Movement of trucks, machinery and workforce vehicles	More vehicles on roads causing increased road traffic congestion	Minor	Likely	Medium
Construction activities across roads	Construction activities causing limited or restricted road access	Minor	Likely	Medium

The above risk assessment is based on accepted construction practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the Performance Requirements are taken into account, both the likelihood and consequence of these risks may be significantly lower.

Physical location of the site

In the Reference Project, the location of the Plant on the site will result in removal of the roadway easement. Accordingly, access across the site will no longer be available. This may affect the access of emergency response vehicles to this area. The impact on emergency response will be minor, as emergency access will be available via Mouth of Powlett Road and Lower Powlett Road at all times.

Movement of trucks, machinery and workforce vehicles

Projected pre-construction traffic volumes

The Reference Project has estimated that the peak construction activities for the Plant could occur in December 2010. For assessment purposes, it has been assumed that background traffic will grow at two per cent per annum between 2008 and late 2010. Therefore, expected volumes have been projected for 2011 to enable a conservative assessment of traffic conditions. Table 11-4 summarises the expected traffic conditions for the intersection of Lower Powlett Road and Bass Highway in 2011 during the peak hour from 3 pm to 4 pm without taking into account any increase in traffic due to the construction of the Desalination Plant.

The modelled intersection operation shows that the intersection should be operating with a good level of service during the 2011 peak, although delays of approximately 18.6 seconds could be experienced by vehicles entering Bass Highway from Lower Powlett Road. Queues experienced on Bass Highway (up to 25 metres) may be a result of traffic waiting to turn right into Lower Powlett Road.

Table 11-4 Predicted intersection operation at Lower Powlett Road and Bass Highway in 2011 (3 pm to 4 pm)

Road section	Total flow (veh/hr)	Degree of saturation*	Level of service	Average delay (sec/veh)	Queue length (m)
Lower Powlett Road	14	0.420	C	18.6	1
Bass Highway (westbound)	435	0.229	A	0.3	0
Bass Highway (eastbound)	367	0.202	A	4.9	25

* Degree of saturation (DOS) is a measure of congestion at an intersection (Maunsell 2008[3]). Corresponding values are:

- DOS of < 0.75 Very good conditions
- DOS of 0.75 - 0.90 Good operating conditions
- DOS of 0.90 - 0.95 Acceptable operating conditions
- DOS > 0.95 Congested operating conditions

Projected construction traffic volumes

During construction, trucks, machinery and workforce vehicles will regularly access the site. To assess the impact of construction-related traffic, the likely numbers, size and frequency of vehicles were modelled against the operation capability of Lower Powlett Road, Bass Highway and the intersections of these roads.

The peak daytime construction workforce has been estimated as 910 workers. To enable a conservative traffic assessment, the peak in workforce traffic has been modelled to coincide with the normal daily traffic peak. Table 11-5 shows the shift change traffic movement scenario for this peak time, whereby 40 per cent of the workforce is departing the site and 20 per cent are arriving at the site (with 40 per cent remaining onsite). Delivery and removal of materials to the site will generate up to 150 truck movements per day, which equates to nine inbound and nine outbound trucks per hour over an eight-hour workday. To provide a conservative assessment, the impacts of trucks and workforce vehicles have been assessed for the traffic time on the Bass Highway and Lower Powlett Road.

Table 11-5 Approximate workforce generation during construction of the Plant

Workforce movements	Total number of workforce vehicles
Arriving at site	121
Departing from site	242
Remaining onsite	242

Modelling for the Bass Highway and Lower Powlett Road intersection was shown to operate with a reasonable level of service (see Table 11-2 for definitions) during peak periods (Maunsell 2008_3, Technical Appendix 53). The delay experienced by vehicles exiting Lower Powlett Road will be approximately 35 seconds. Modelling shows that the existing intersection can operate successfully during construction. The queues experienced due to construction traffic are minimal. Other delays experienced along Bass Highway are minimal and would not effect its overall operation as they occur only once per day. Table 11-6 shows the intersection operation at Bass Highway and Lower Powlett Road during construction for the peak traffic period.

Table 11-6 Intersection operation during construction peak (3 pm to 4 pm)

Intersection Leg	Total Flow (veh/hr)	Degree of Saturation*	Level of Service	Average Delay (sec/veh)	Queue Length (m)
Lower Powlett Road	237	0.740	D	34.8	51
Bass Highway, westbound)	473	0.251	A	0.9	0
Bass Highway, eastbound)	449	0.320	A	7.0	35

* Degree of saturation (DOS) is a measure of congestion at an intersection (Maunsell 2008$_3$). A DOS of less than 0.75 indicates very good operating conditions

Traffic volumes on the Bass Highway for 2011 have been estimated for existing volumes and projected volumes during construction using the Austroads Guide to Traffic Engineering: Part 2. The modelling assessed the ability of Bass Highway's current layout to accommodate predicted traffic demand during peak construction activity and still operate at an acceptable Level of Service (LOS). These volumes and corresponding LOS values are presented in Table 11-7.

The projected traffic volumes show that during construction of the Plant, Bass Highway will be operating to a satisfactory level. The maximum predicted delay is 34.8 seconds for vehicles existing Lower Powlett Road and traffic volumes are below the capacity of Lower Powlett Road and Bass Highway. Increases in construction traffic volumes are expected to be relatively modest, and will only occur for a short period each day. The Bass Highway can accommodate the additional traffic generated by the Plant during the peak construction phase, without adversely impacting on existing traffic conditions (Maunsell 2008$_3$, Technical Appendix 53). Therefore, although traffic congestion is likely to occur, the impact of this would be minor.

Table 11-7 Projected 2011 traffic volumes on Bass Highway (3 pm to 4 pm)

Location	Existing traffic		Construction traffic	
	Traffic volume (veh/hr)	Level of Service	Traffic volume (veh/hr)	Level of Service
West of Mouth of Powlett Road	631	C	836	D
West of Lower Powlett Road	885	D	1 089	D

A revised layout for the intersection of Bass Highway and Lower Powlett Road was recommended by Maunsell (2008_3). Recommended improvements include:

- an exclusive right-turn lane on Bass Highway for eastbound traffic turning into Lower Powlett Road
- widening of Lower Powlett Road near Bass Highway to enable both left and right-turn lanes leaving Lower Powlett Road.

Lower Powlett Road must meet VicRoads Class C standards to safely accommodate the traffic associated with construction of the Plant. The road does not currently meet these standards and must be widened to be of Class C standard. The current layout of Bass Highway is satisfactory to manage the increased traffic generated by construction of the Plant.

Construction activities across roads

Construction activities across roads during construction of the Plant may require road closures, impacting on public access to roads surrounding the site. Upgrade works may be required for the roads surrounding the site, particularly Lower Powlett Road which may limit or restrict public access to those roads. The impact of upgrade works would be minor, because although there will be some delays during this time, access should be maintained at all times.

11.3.2 Risks assessed as low

The risk of Plant construction activity on road safety has been assessed as low. The above assessments of road capacity and intersection operation demonstrate that the additional traffic generated during construction will have a negligible impact on road safety.

11.4 Operation

11.4.1 Risks assessed as medium and above

There are no transport infrastructure risks in connection with the operation of the Desalination Plant that are rated as medium and above.

11.4.2 Risks assessed as low

In the environmental impact and risk assessment process, the only transport infrastructure risk associated with the operation of the Desalination Plant that was rated low is the risk that an increased number of vehicles on the road would impact road safety.

During operation of the Plant, more vehicles may be on the roads surrounding the site. This in turn may impact on road safety. It is estimated in the Reference Project that approximately thirty to fifty on-site workers will be required to operate the Plant once construction is complete. Chemical delivery will account for approximately five to twenty trucks per day. Assuming trucks will operate within an eight-hour working day, this equates to one to two trucks accessing and departing the Plant each hour. Waste removal will be predominantly for liquid waste, requiring approximately nine trucks per day. Fewer trucks would be required if pre-treatment waste was disposed of via an ocean outfall. The traffic generated from staff and maintenance vehicles and trucks during operation will not significantly increase existing traffic numbers on roads surrounding the Plant site. Therefore, it is considered that operation-related vehicles will have a negligible impact on road safety.

11.5 Performance Requirements

Performance Requirements have been developed to provide an environmental framework for management of potential traffic impacts associated with the Project during construction and operation. The PRs are focussed on the environmental 'outcomes' that the State wishes to achieve through the Project delivery. The PRs relevant to traffic management for the Plant are set out below. The full suite of PRs for the Project is provided in Volume 1 Chapter 10 as part of the overall Environmental Management Framework.

As part of the environmental impact and risk assessment process relating to traffic for the Plant, Maunsell (2008_3) has identified a range of suggested management measures that could be implemented to manage potential impacts. These suggested management measures have been formulated in response to the Reference Project and relevant Variations for the Plant. In effect, the suggested management measures demonstrate how the Reference Project and relevant Variations can achieve the PRs. These detailed management measures have formed an important input to the PRs for the Project.

The management measures suggested by Maunsell (2008$_3$) address the following matters:

- minimising impacts of temporary construction traffic and activity on and adjacent to the roads in the surrounding area by:
  - developing a communication strategy
  - implementing an incident management strategy
  - considering sensitive routes past hospitals, schools, child minding centres, aged care facilities, churches
  - providing for emergency service access routes
  - providing for construction site parking requirements
  - implementing travel demand management initiatives such as ridesharing or site bus services
  - utilising temporary traffic signage
  - providing daily, weekly and seasonal peaks and how these affect construction
  - ensuring that Traffic Management Plans are audited on site, and that reinstatement is completed in a timely and safe manner
- considering potential road improvements, including nomination of the following works:
  - pavement management and upgrades
  - improvements to roads and intersections, particularly Bass Highway/Lower Powlett Road Intersection and Lower Powlett Road
  - improvements in the transition from rural to urban zones for Wonthaggi by installing appropriate threshold treatments (i.e. kerb and channel, speed signs and town signage)
  - Bass Highway speed limit and rest area review
- minimising impacts on the surrounding road network by:
  - providing for continual emergency access between Mouth of Powlett Road and Lower Powlett Road
  - maintaining a public access path across or around the Plant construction site for pedestrian, cyclists and equestrians
  - maintaining public access to Williamsons Beach
  - providing adequate car parking on-site

- key traffic management strategies during construction to minimise the impacts of temporary construction traffic and activity on and adjacent to the roads in the surrounding area should include:
  - communication strategies
  - an incident management strategy
  - sensitive routes past hospitals, schools, child minding centres, aged care facilities, churches
  - emergency service access routes
  - construction site parking requirements
  - travel demand management initiatives such as ridesharing
  - temporary traffic signage
  - daily, weekly and seasonal peaks and how these affect construction
  - mechanisms to ensure that TMPs are audited on site, and that reinstatement is completed in a timely and safe manner.

The PRs proposed for transport infrastructure are outlined in Table 11-8.

Table 11-8 Performance Requirements

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Traffic and transport	✓	✓	Maintain public access and protect safety of road users.	Minimise traffic impacts and maintain road safety. Comply with VicRoads and Council requirements during construction activities. Undertake specified traffic and pedestrian infrastructure upgrades to provide safe access to the Project.	Comply with Performance Criteria. Develop and implement a traffic management strategy and systems to address: ▪ Communication ▪ Incident and emergency management ▪ Route specification to avoid sensitive facilities and activities ▪ Temporary construction site parking ▪ Staging works and construction traffic to minimise impact on the road network ▪ Road closures ▪ Site access Access to the Desalination Plant site in normal conditions shall be via Lower Powlett Road. Implement the following infrastructure upgrades

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			to a reasonable standard subject to the agreement of VicRoads and Bass Coast Shire Council (as relevant): ▪ Improvement to Bass Highway and Lower Powlett Road intersection ▪ Reconstruction of Lower Powlett Road Plan and implement a new pathway around the periphery of the Desalination Plant site to maintain public access around the site for pedestrians, cyclists and equestrian activities. Provide emergency access to the Desalination Plant site from both Mouth of Powlett Road and Lower Powlett Road. Provide emergency access for the Mouth of Powlett Community from both Mouth of Powlett Road and Lower Powlett Road. Maintain all weather vehicular access to Williamsons Beach Car Park from Lower Powlett Road.

12.0 Socio-economic



12 Socio-economic

This chapter discusses the socio-economic effects of the Plant during construction and operation. It describes the existing conditions and assesses impacts of construction and operation of the Plant.

This chapter is based on specialist findings from the following reports:

- Essential Economics Pty Ltd (2008_1) *Existing Conditions Report* – Economic (Technical Appendix 10)
- Essential Economics Pty Ltd (2008_2) *Impact Assessment – Economic* (Technical Appendix 11)
- GHD (2008_{17}) *Report for Victorian Desalination Plant Preliminary Hazard Analysis* (Technical Appendix 54)
- Maunsell Australia Pty Ltd (2008_4) *Victorian Desalination Plant Environment Effects Statement, Social Impact Assessment - Existing Conditions Report* (Technical Appendix 55)
- Maunsell Australia Pty Ltd (2008_5) *Victorian Desalination Plant Environment Effects Statement, Social Impact Assessment Report* (Technical Appendix 56)
- Phillips Agribusiness (2008) *Desalination Project EES – Agricultural Impacts* (Technical Appendix 17).

12.1 Existing conditions

This section provides an overview of the regional and local study area, together with a brief description of the role and function of towns located close to the proposed Project area. In addition, township characteristics are described including population size, housing characteristics, distance and drive time from the site, and availability of retail and other services.

The Bass Coast Shire is the focus of this assessment, however regional and local catchments are considered where appropriate. Figure 12-1 shows the project area and the key towns in the region.

Figure 12-1 Project area – in relation to the Plant



12.1.1 Township characteristics

The population, accommodation facilities, distance from the site and infrastructure services within the key towns are discussed below and summarised in Table 12-1 below.

Table 12-1 Township Overview

Town	Population	Accommodation	Distance from site	Services
Wonthaggi	7 200	670 rental properties, 3 motels, 2 caravan parks, numerous holiday houses	5 to 7 km (10 min)	Major service centre with retail shops, trade supplies, eateries, supermarkets, banks, pubs, fuel options, medical and community services
Kilcunda	270	20 rental properties plus holiday homes	3 to 4 km (5 min)	Few services apart from a pub and a few shops. Key activities are agriculture and tourism
Inverloch	4 300	350 rental properties plus holiday homes. Large commercial sector including cottages, motels and apartments	20 km (20 min)	Wide selection of shops, restaurants, cafes, banks, trade supplies, fuel options, supermarket, and two pubs
Phillip Island/Cowes	8 500 (Cowes 4 215)	670 rental properties plus holiday homes	30 km (25 min)	Cowes has a full range of township services. Services in the smaller townships are focused on tourism
San Remo	1 000	100 rental properties	15 km (15 min)	Facilities are of a convenience nature (e.g. take-away, small supermarket)
Dalyston	290	30 rental properties	2 to 3 km (5 min)	Pub plus general store/post office
Cape Paterson	700	50 rental properties plus holiday homes and a caravan park	15 km (15 min)	Few retail and town centre services apart from a pub, general store and take-away food shop

Source: Essential Economics 2008[1]

Wonthaggi

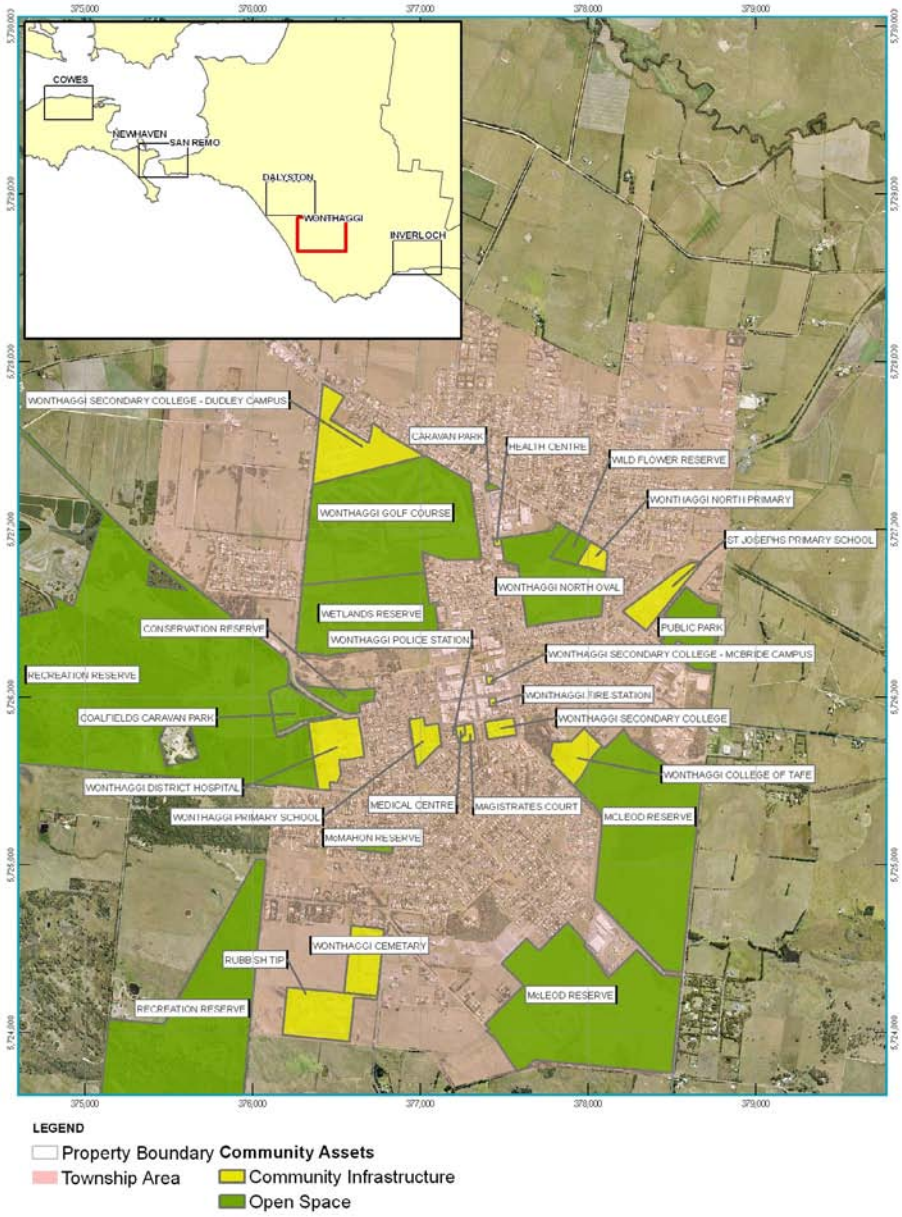
Wonthaggi is the largest town in Bass Coast Shire and has a population of 7 200. The town is located five to seven kilometres east of the site (a 10-minute drive). Wonthaggi is the major service centre for the region and includes an extensive range of retail shops, trades supplies, restaurants, supermarkets, banks, pubs, petrol stations, medical and community services. Wonthaggi's commercial area represents the largest shopping centre in the South Gippsland region.

Wonthaggi also acts as an important base for holidaymakers to the region, with three motels, two caravan parks and approximately 670 rental properties. Wonthaggi is likely to be the key location in terms of labour supply, business support services and accommodation services for project workers. Nearby attractions include Cape Paterson, the adjoining Bunurong Marine Park, and Hamers Haven.

The Bass Coast Regional Health Service including the Wonthaggi hospital is the main hospital service within the Shire. This hospital has been identified by the Department of Human Services (DHS) to be upgraded from a local to a sub-regional hospital. This upgrade is due to the expected increasing demand for hospital services from a growing population (Maunsell 2008_4, Technical Appendix 55).

The Wonthaggi Secondary College is one of two secondary schools located within the Bass Coast Shire. The College has approximately 11 075 students. Additional community assets within the town are shown in Figure 12-2.

Figure 12-2 Community Assets – Wonthaggi





Kilcunda

Kilcunda is a seaside town situated between Phillip Island and Wonthaggi, with a population of approximately 270 people and is located three to four kilometres west of the proposed project site (a five-minute drive). Kilcunda has approximately 20 rental properties, and many more holiday homes. Kilcunda's main economic sectors are agriculture and tourism. Kilcunda offers a range of recreational facilities including fishing, surfing and swimming beaches. Land uses within the area relate mainly to residential, recreation and community uses. Kilcunda has few services apart from a pub and a few shops.

Inverloch

Inverloch is a seaside resort and fishing port at the mouth of Andersons Inlet in Venus Bay, approximately 12 kilometres east of Wonthaggi and 20 kilometres east (or a 25-minute drive) of the proposed project site. It has a population of 4 300 and about 350 rental properties, plus a number of holiday houses.

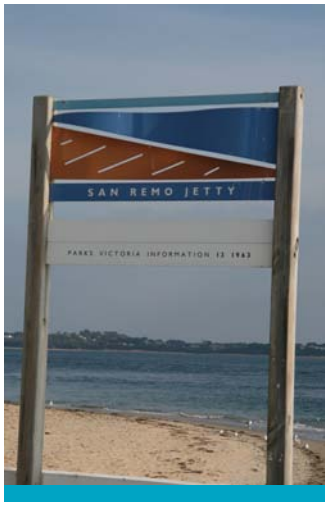
Inverloch's seaside location and proximity to Wilson's Promontory makes it one of the most attractive tourist locations in the region, and economic activities are predominantly focused on servicing the visitor market. In addition to Inverloch's large holiday rental market, a number of new residential developments are under-construction throughout the town.

Inverloch has a large commercial accommodation industry that includes cottages, motels and apartments close to the coast. The town's main commercial centre is A'Beckett Street, and has a variety of shops, restaurants, cafes, banks, trade supplies, petrol stations, a supermarket, and two pubs. Inverloch has reasonably-sized rental and commercial accommodation and offers a full range of supporting town and business support services.

Cowes

Phillip Island has a population of approximately 8 500 people. Its main town is Cowes with a population of 4 215, approximately half of the Island's population. Cowes provides significant residential and holiday housing, together with a full range of town services. Cowes is located approximately 30 kilometres (a 25-minute drive) from the site.

There are other smaller settlements on Phillip Island including Newhaven, Cape Woolamai and Summerland. These locations are primarily focused on tourism and have few town services. There is one secondary school in Newhaven, the Newhaven College. This is a private secondary school, with an enrolment of approximately 700 students, of which approximately 50 per cent are residents of Phillip Island and San Remo.



San Remo

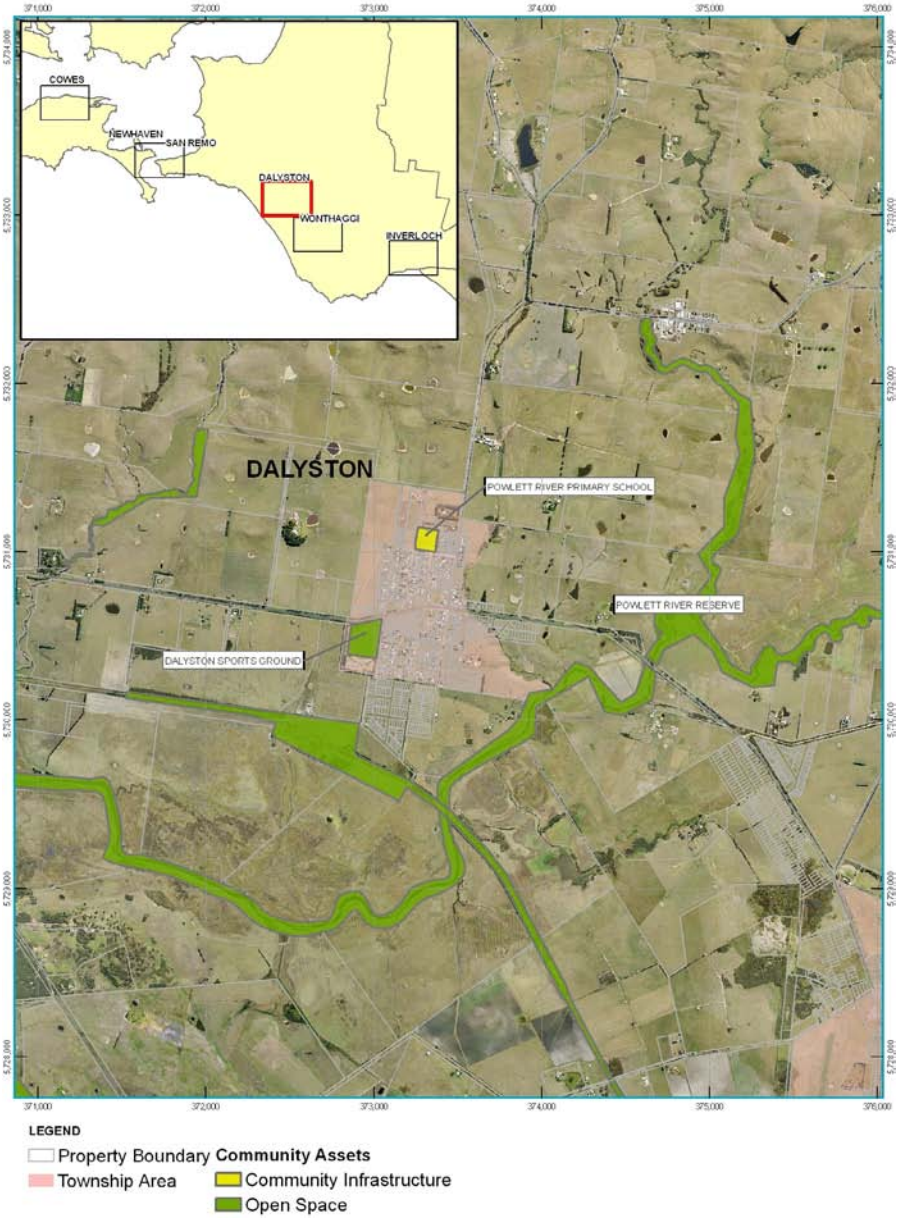
San Remo is located approximately 15 kilometres (a 15-minute drive) from the site on the mainland, directly east of Phillip Island. It has a population of just over 1 000 people, and approximately 100 rental properties.

San Remo principally services the Phillip Island holiday market, including visitor accommodation. Its facilities include take-away shops and a small supermarket rather than the wider scale of services found in larger towns, such as Wonthaggi or Cowes.

Dalyston

Dalyston is a small inland town straddling the Bass Highway and has a population of approximately 290 people. The town contains approximately 30 rental properties, and its only facilities are a pub and a general store/post office. Dalyston is located just two to three kilometres from the site (a five-minute drive). It is expected to fulfil only a minor role in servicing the Desalination Project, like that of Kilcunda (Maunsell 2008$_4$, Technical Appendix 55). Additional community assets are shown in Figure 12-3.

Figure 12-3 Community assets – Dalyston



Cape Paterson

Cape Paterson is located approximately eight kilometres from Wonthaggi and approximately 15 kilometres from the proposed project site (a 20-minute drive). Cape Paterson is best known as a holiday destination and has a permanent population of 700 people. The town has approximately 50 rental properties, and a significant number of holiday homes. Cape Paterson has a caravan park, but few supporting retail and town centre services other than a pub, general store and a take-away food shop. Apart from potentially providing some worker accommodation, Cape Patterson is only expected to provide a small service role to the Project (Maunsell 2008$_4$, Technical Appendix 55).

12.1.2 Demographic profile

This section briefly outlines the demographic profile of the area with respect to population and income levels. A detailed description of existing social infrastructure and future capacity of existing infrastructure with the area can be found in Technical Appendix 55.

Population

The population growth in Bass Coast Shire has been rapid in recent years. This trend is forecast to continue with Bass Coast's population projected to rise from approximately 27 500 to 36 000 residents by 2020. A consequence of this growth will be increased demand for social infrastructure, particularly for older people.

In 2006 the Bass Coast Shire had a population of around 27 520 residents and was experiencing a population growth rate of approximately 1.4 per cent or 380 residents per year. This is greater than the Victorian average growth rate of 0.8 per cent and reflects the increasing popularity of the Bass Coast and in particular the coastal towns as a popular residential location. Population projections for Bass Coast Shire predict continuing strong population growth over the next five years. The resident population is forecast to increase from an estimated 28 670 people in 2008 to 30 895 people by 2012. Growth rates for townships in the Bass Coast Shire are presented in Table 12-2.

Additional housing will be required to accommodate the expanding population. An increase in demand for holiday homes is also anticipated as the popularity of the Shire increases. Recent residential market assessments in the southern part of the Shire highlight particularly strong demand for new housing in Kilcunda, Dalyston and Wonthaggi (Essential Economics 2008$_1$, Technical Appendix 10).

Table 12-2 Population trends for selected towns within the Bass Coast Shire

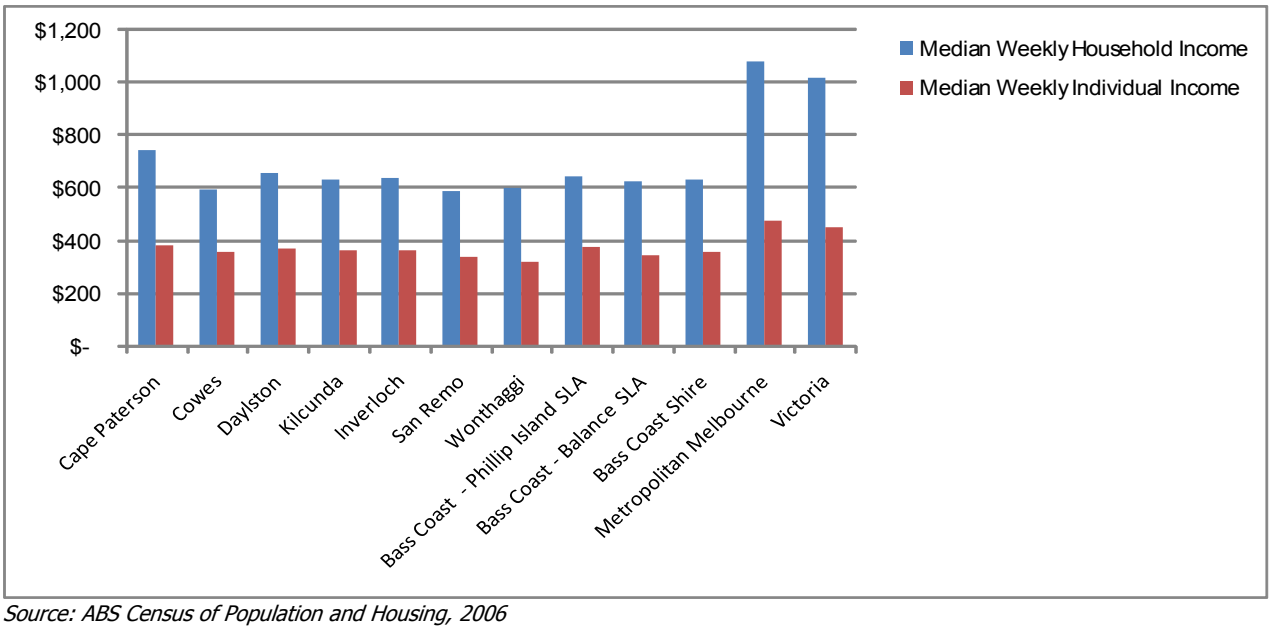
Location	2001	2006	Average annual growth	
			%	No of people
Coastal towns				
Phillip Island	7 470	8 510	2.6%	208
Kilcunda	230	270	3.3%	8
Inverloch	3 910	4 280	1.8%	74
Cape Paterson	710	700	-0.3%	-2
San Remo	970	1 050	1.6%	16
Coronet Bay	650	670	0.6%	4
Corinella	510	520	0.4%	2
Grantville	440	470	1.3%	6
Subtotal	**14 890**	**16 470**	**2.0%**	**316**
Inland towns				
Wonthaggi	6 940	7 170	0.7%	46
Dalyston	190	290	8.8%	20
Subtotal	**7 130**	**7 460**	**0.9%**	**66**

Source: ABS Census of Population and Housing, 2001 and 2006

Income levels

In general, Bass Coast Shire residents have lower income levels than metropolitan Melbourne and State averages. Within Bass Coast Shire, the main towns of Wonthaggi, Cowes and San Remo have the lowest income levels, whilst Cape Paterson and Inverloch have the highest income levels. Factors contributing to this may include a higher proportion of households comprising families with children or retirees, higher unemployment levels, lower wage levels, or more part time workers. Median weekly household and individual income data is shown in Figure 12-4.

Figure 12-4 Median weekly household and individual income levels



Source: ABS Census of Population and Housing, 2006

12.1.3 Tourism and recreation

Tourism is a major contributor to the local economy within the Shire. There are a number of recreational activities in the area that are available to tourists. This section discusses tourism and recreation in the shire.

Tourism

The Gippsland tourism region, including Phillip Island, attracts more than seven million visitors annually with three million of them staying overnight. The Bass Coast Shire alone attracts an estimated 3.4 million visitors annually, 94 per cent of who visit the Shire's primary attraction: Phillip Island. Visitors to the Gippsland tourism region are predominantly couples or family groups with higher than average incomes.

The majority (66 per cent) of the region's touring visitors (those staying overnight in more than one location) are from Melbourne with a further 24 per cent coming from country Victoria. The largest proportions of interstate visitors are from New South Wales. The remaining states only contribute approximately 1 per cent of overnight visitations as shown in Table 12-3.

Table 12-3 Origin of domestic overnight visitors – Gippsland tourism region

Origin	Total (%)
Melbourne	66%
Other Vic	24%
Total Vic	90%
NSW	6%
Queensland	1%
South Australia	1%
ACT	1%
Interstate Total	10%

Source: National Visitor Survey, year ending 2005, Tourism Research Australia

Day-trip visitors are mainly from Victoria, with Melbourne accounting for 50 per cent, country Victoria 47 per cent and New South Wales accounting for 3 per cent. As the Bass Coast Shire is in relatively close proximity to Melbourne in comparison to the rest of the tourism region, it attracts a relatively larger proportion of daytrip visitors (58 per cent) to overnight visitors (42 per cent) compared with the rest of the region.

Most visitors to the region are aged between 35 and 49. In contrast half of the international travel market is under 35 years of age. The predominant age group for day trip visitors was between 30 and 45.

More than half of the visitors to the region are there for a holiday. Touring is also a popular reason for visiting the region, making up 23 per cent of the region's visitors (Table 12-4).

Table 12-4 Profile of touring visitors including Bass Coast

Reason for visit	Proportion of visitors
Holiday/leisure	52%
Touring	23%
Visiting friends/relatives	17%
Travelling through	12%
Events	9%
Business	5%
Other	6%

Source: Maunsell 2008[4]



Of the people visiting the Bass Coast Shire for holidays or leisure, 26 per cent visited Wonthaggi, while 13 per cent visited Kilcunda. The average length of stay for overnight visitors is 4.8 nights, with 27 per cent of overnight visitors staying just two nights. A further 24 per cent stay three to four nights. Visitor surveys indicate that 75 per cent of visitors have been to Gippsland previously; and that visitor satisfaction surveys undertaken across the Gippsland region indicate that 94 per cent of respondents would visit Gippsland again.

Demand for overnight tourism and holiday accommodation in coastal locations is likely to increase over the coming years. New sites will be sought by the tourism industry for purpose-built accommodation complexes and caravan parks. The Bass Coast Strategic Planning Framework (June 2005) ranks development locations within the Shire (Maunsell 2008[4], Technical Appendix 55).

Major events

A number of major events on Phillip Island affect visitor numbers in the area. Phillip Island hosts two four-day international events per year:

- Australian Motorcycle Grand Prix (early October)
- Super Bike World Championship (February).

The three-day attendances at the 2007 Motorcycle Grand Prix and at the 2007 Super bike World Championship were 90 000 and 50 000 respectively; up to 3 000 people associated with each event stayed longer in the region.

Other events held through out the year include:

- a round of the Australian V8 Supercar Series
- the International Historic Car Festival.

The race circuit also hosts rounds of many national and state championship events. In 2007, the V8 event attracted a three-day attendance of 67 000 people. The four-day Shannon's International Festival has become the most important historic car race in the Asia Pacific region. This event is always held a week before the Formula One event at Albert Park in March/April, and this encourages participants and patrons to extend their stay at Phillip Island. Attendance for the four days of the event in 2007 totalled 30 000 people (Maunsell 2008_4, Technical Appendix 55).



Activities by location

The coastal area of Bass Coast Shire offers a range of day visitor activities, including swimming, picnicking, diving, snorkelling, fishing, nature observation and walking. Popular destinations include Harmers Haven with its extensive sandy beaches. The diverse natural settings of the area are an important part of its appeal for many visitors. A further attraction is the beaches; with the Cape Paterson Surf Life Saving Club and the Wonthaggi Royal Life Saving Club providing beach patrol services to swimmers and surfers at The Bay and First Surf beach on public holidays and weekends from December to Easter.

It is possible to walk along most of the coastline within the area, although tides and gutters within the intertidal rock platform, and headlands can make walking difficult. Beach access tracks provide links to the coast at numerous points including the Wonthaggi Heathland Nature Conservation Reserve.

Wonthaggi provides a number of attractions including the State Coal Mine. It holds a number of festivals including the Gung Ho Working Together Multicultural Festival of art, music, dance and food in March and the Bass Coast Summer Agricultural Show in January. Both of these events place a greater demand on the local infrastructure and tourism facilities due to the influx of visitors. A number of tours focused primarily on either the scenic landscape or the area's gastronomic specialities cater for a range of visitors.

The Bass Coast Rail Trail is Victoria's only coastal rail trail stretching 16 kilometres from Wonthaggi to Anderson, highlighting areas coal mining history. To the north-west is Kilcunda, which provides opportunities for fishing and swimming. Additionally there is the George Bass Coastal Walk from the Powlett River westwards towards San Remo along the cliff tops to the Punch Bowl car park (Maunsell 2008$_4$, Technical Appendix 55).

Income generation

Visitors to the Gippsland region spend approximately $1 billion per year, with a flow on expenditure (indirect business benefits) of approximately $699 million, resulting in expenditure from tourism of $1.7 billion. Daytrip and overnight visitors to the Bass Coast Shire (not including those staying in holiday homes) spend an estimated $224 million per annum in the Shire. Consequently, tourism is a significant driver of the Gippsland economy and is likely to become increasingly so, as trends indicate that Gippsland's level of visitation is increasing.

The vast majority of visitors (82 per cent) stay in holiday homes. Visitors staying in holiday homes spend $189 per person per visit as opposed to other overnight visitors who spend $260 per person per visit and daytrip visitors who spend on average $78 per person per visit.

There are over 1 000 businesses in the Bass Coast Shire. This includes commercial, industrial and retail businesses, but excludes agri-business (farms). The largest concentrations (41 per cent) of business in the Bass Coast are located in Cowes on Phillip Island.

Tourism businesses in the Shire include visitor accommodation and specialised tourism businesses such as wineries, attractions, tours and activities, and restaurants. There are more than 242 of these businesses in the Shire, equating to 23 per cent of all businesses within the Shire.

A further 327 businesses in the Shire receive an average of 26 per cent of their income from visitors, which include supermarkets, specialised food retailing, departments stores, motor vehicle retailing and other retail businesses. Overall, in 2005 tourism underpinned the business income of 569 of the businesses in the Shire (52 per cent of all businesses).

More than 2 100 people in the Bass Coast Shire are employed as a result of tourism out of a total labour force of 8 295 (as at 2001). This represents 26 per cent of the labour force in the Bass Coast Shire. Thirty-five per cent of the people employed in specialised tourism businesses were employed on a casual basis. Twenty-eight per cent of people are employed on a full-time and 37 per cent on a part-time basis (Maunsell 2008$_4$, Technical Appendix 55).



Recreation

The main recreational activities undertaken in the vicinity of the Project area are based around the coastline. Local people predominately use this area, particularly the beaches.

Tourists are less likely to visit the area in the vicinity of the site, particularly Williamsons beach, located adjacent to the site. Access to the beach area is poorly defined, signage is limited and the roads are split into a number of tracks, making navigation difficult. In contrast, the area in the vicinity of the mouth of the Powlett River has good signage, predominantly sealed road access to the car park, beach area and caravan park located adjacent to the foreshore dunes and the river.

The following activities undertaken within the vicinity of the Plant are discussed in detail below:

- bird watching
- marine wildlife watching
- walking and dog walking
- cycling
- horse riding
- recreational boating.

Bird watching

Conservation reserves throughout the Wonthaggi area provide a haven for plants and wildlife. Popular areas for bird watching include areas of exposed rock adjoining the foreshore and heath lands located in close proximity to the site. Species include warblers, honeyeaters and flycatchers.

Hooded Plovers nest on the beaches above the high tide mark between August and March. Signs located adjacent to the foreshore advise beach users to beware of stepping on Hooded Plover nests and prohibit dogs from being walked on the beach as they can disturb nests. Additional information on Hooded Plovers can be found in Volume 2 Chapter 5 (Maunsell 2008$_4$, Technical Appendix 55).

Marine wildlife watching

Phillip Island attracts 94 per cent of the Shire's visitors. The Penguin Parade is Australia's most popular wildlife attraction. Additionally the Australian Fur Seals that frequent seal rocks are a significant tourist attraction in their own right. The coastal area near the site, including Williamsons Beach, is also a popular whale watching location (Maunsell 2008$_4$, Technical Appendix 55).

Walking and dog walking

Walking and dog walking is popular in the vicinity of the Project area. It is possible to walk along most of the coastline within the area, although tides and gutters within the inter-tidal rock platform, and headlands can limit access.

Walks commence from the car park on Chisholms Road and link the heathlands to Baxters, Cutlers and Williamsons Beaches. A number of walks traverse the heathlands from Wonthaggi.

A survey conducted in 1999 of the Bass Coast Shire indicated that walking on the beach and bush walking ranked first in order of participation numbers, with approximately 40 per cent of the population walking for recreation.

Cycling

The Bass Coast Rail Trail is 16 kilometres from Wonthaggi to Anderson. The rail trail generally follows the route of the Bass Highway between Kilcunda and Wonthaggi and is used by locals and visitors.

The rail trail crosses a number of roads in the vicinity of the Project area including Lower Powlett Road and Mouth of Powlett Road. The Bass Coast Open Space Strategy encourages the upgrading of bicycle facilities to provide cyclists with priority use of the junction, linking the Powlett River with the rail trail and the coast through the preparation of a Foreshore Management Plan. Further details of these road crossing can be found in Chapter 11 Transport infrastructure.

Horse riding

Members of the Wonthaggi Pony Club ride their horses on the beach, surrounding laneways and tracks and along the Bass Coast Rail Trail, from Wonthaggi, down Lower Powlett Road and then back towards Wonthaggi along the beach. Informal riding by locals and tourists also occurs within the local area.

Recreational boating and kayaking

Recreational boating occurs along the coastline between Phillip Island and Inverloch. The Bass Coast Kayak Club uses the area off Williamsons Beach for sea kayaking. Club members meet weekly from September through to May at the mouth of the Powlett River. A more detailed list of recreational activities can be found in Technical Appendix 55.

Agriculture

The landform of the site is an undulating sand plain, with soils comprising a dark grey peaty loam lightening with depth. A weakly developed cemented layer may be present at 900 millimetres. The soils are acid, with nutrient deficiencies in phosphorous and potassium and trace element deficiencies in copper, molybdenum and zinc.

The land capability of the site is limited to grazing, usually beef production. Where perennial pastures have been established and soil fertility increased through fertiliser application, stocking rates of up to 15 dry sheep equivalents per hectare can be supported. Dry sheep equivalent is the amount of dry matter required by one mature wether per annum (Phillips Agribusiness 2008, Technical Appendix 17).

12.1.4 Industry overview



Bass Coast Shire industry overview

The industry structure of an area is a good indicator of the locality's skills base. In comparison to metropolitan Melbourne, the Bass Coast Shire has a high proportion of residents employed in the following industries:

- construction (1 303 residents)
- accommodation and food services (900 residents)
- retail trade (1 358 residents)
- arts and recreational services (291 residents)
- agriculture, forestry and fishing (726 residents).

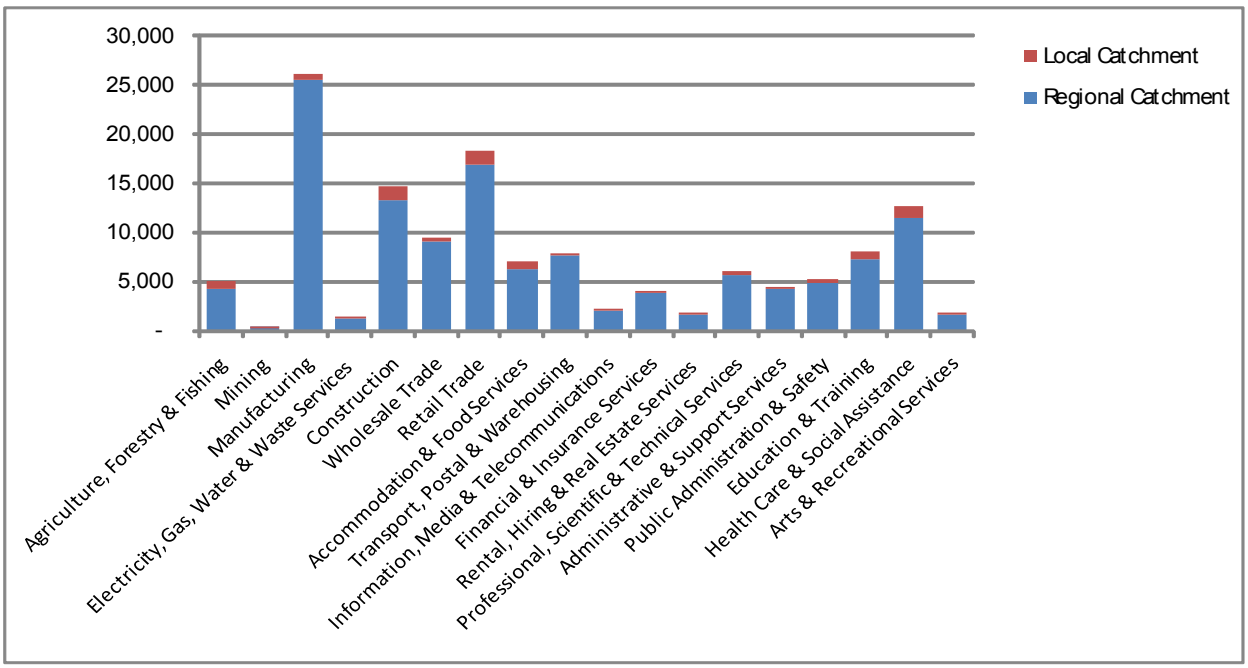
A significantly lower proportion of Bass Coast residents are employed in manufacturing and in professional, scientific and technical services than in metropolitan Melbourne.

Regional industry overview

The regional labour catchment for the Project includes South Gippsland Shire, Casey City and Cardinia Shire. There is a large and varied pool of workers located in the regional catchment, as shown in Figure 12-5. The resident labour force from both the local catchment (Bass Coast Shire) and the regional catchment totals approximately:

- 26 000 manufacturing workers
- 15 000 construction workers
- 6 000 professional, scientific and technical services workers.

Figure 12-5 Number of resident workers by sector in the local and regional catchments (2006)



Source: ABS Census of Population and Housing, 2006

Bass Coast business structure

There are approximately 2 450 business in the Bass Coast Shire, with the key industries being construction; agriculture, forestry and fishing; property and business services; and retail trade. These are characterised by small scale and family-operated businesses, particularly in the construction and agribusiness sectors. A summary of the Bass Coast Shire businesses is presented in Table 12-5.

Table 12-5 Bass Coast Shire business summary

Industry sector	Number of businesses	Prevalent business type	Annual business turnover		Bass Coast annual turnover estimates	No. of residents employed/ No. of jobs provided in the Shire
			Turnover	% of bus.		
Construction	585 (24%)	Small businesses	< $100 000 $100 000 to $200 000 $200 000 to $500 000 $500 000 to $1 million > $1 million	50% 20% 20% 5% 5%	$400 to $500 million per annum	1 300 people/ 785 jobs
Agriculture, forestry and fisheries	500 (21%)	80% non-employing 14% 1-4 people 5% 5-19 people 1% 20-99 people	< $100 000 $100 000 to $200 000 $200 000 to $500 000 $500 000 to $1 million > $1 million	46% 18% 19% 10% 7%	$175 million per annum ($72 million per annum agriculture)	290 people/ 635 jobs
Retail/township services	290 (12%)	40% non-employing 38% 1-4 people 21% 5-19 people 1% 20-50 people	< $100 000 $100 000 to $200 000 $200 000 to $500 000 $500 000 to $1 million > $1 million	26% 15% 32% 16% 11%	$145 million per annum	1 360 people/ 1 510 jobs

Industry sector	Number of businesses	Prevalent business type	Annual business turnover		Bass Coast annual turnover estimates	No. of residents employed/ No. of jobs provided in the Shire
			Turnover	% of bus.		
Manufacturing	100 (4%)	53% non-employing 32% 1–4 people 15% 5-19 people	< $100 $100 000 to $200 000 $200 000 to $500 000 $500 000 to $1 million	44% 19% 28% 9%	$20 million per annum	690 people/ 580 jobs
Tourism	24 commercial accommodation establishments with a total of 430 rooms				$7 million per annum (commercial accom.) $250 million per annum (tourism)	170 people (commercial accom. only) 900 resident workers/ 760 jobs

Source: ABS Counts of Australian Businesses, Cat. No. 8165.0 (2007)

12.1.5 Labour market and skills assessment

Labour force and job provision

There is a total of 157 000 workers in the local and regional catchments for the Project. Of these workers, 149 300 are employed and 7 700 are unemployed. The unemployment rate for Bass Coast (6.1 per cent) is high compared to that of the regional catchment (4.9 per cent), metropolitan Melbourne (4.3 per cent), regional Victoria (4.9 per cent) and Victoria (4.5 per cent).

The Bass Coast Shire provides approximately 7 940 jobs for 9 976 people. This job provision ratio is low by metropolitan standards, where Melbourne provides approximately one job for every person, but close to regional Victorian averages. A summary of occupations of workers in the Bass Coast is provided in Table 12-6.

Table 12-6 Occupations in the Bass Coast (2006)

Occupation	Bass Coast		Metropolitan Melbourne%
	No.	%	
Clerical and administrative workers	1 010	10.1%	15.9%
Community and personal service workers	938	9.4%	8.1%
Labourers	1 282	12.9%	8.7%
Machinery operators and drivers	545	5.5%	6.4%
Managers	1 692	17.0%	12.5%
Professionals	1 432	14.4%	22.6%
Sales workers	1 130	11.3%	10.2%
Technicians and trades workers	1 764	17.7%	13.6%
Inadequately described	84	0.8%	1.1%
Not stated	99	1.0%	0.9%
Total	**9 976**	**100.0%**	**100.0%**

Source: ABS Census of Population and Housing (2006)

Regional skills shortage

According to the State Government's Regional Skill's Shortage Survey (2006), skills shortages are widespread across the Gippsland region, including the Bass Coast Shire, but are particularly evident in the construction and manufacturing sectors. A summary of this is provided in Table 12-7.

Table 12-7 Summary of skills shortages

Aspect	Construction industry	Manufacturing industry
Recruitment difficulties	Around 29% of vacancies remain unfilled, compared with the average of 13% for all industry sectors 52% of vacancies for tradespersons such as electricians and carpenters remain unfilled 30 to 45% of vacancies for intermediate production and transport workers, such as mobile construction and Plant operators, and labourers remain unfilled	Around 19% of vacancies remain unfilled, compared with the average of 13% for all industry sectors 35% of vacancies for tradespersons such as metal fitters and machinists remain unfilled
Retainment	Less than one in five employers (16%) reported difficulties retaining workers. The proportion of employers who offered staff better remuneration or conditions in order to retain them was higher than average (54% compared with 43% across industry sectors)	35% of employers reported difficulty retaining workers (industry average 23%), even though 54% of employers offered staff better remuneration or conditions to retain them
Employment growth expectations	40% of employers anticipate employment growth in their business (compared with 35% across all industry sectors) Over half (51%) expect to recruit in the next 12 months	Similar to other sectors. 35% of employers anticipate employment growth in their business 56% expect to recruit in the next 12 months
Recruitment targets	Highly skilled staff 68% of employers anticipate the need to recruit staff with a tertiary education or trade qualification in the next 12 months	Highly skilled staff 81% of employers anticipate the need to recruit staff with a tertiary education or trade qualification in the next 12 months
Apprentices	56% of surveyed employers had, at some point, taken on an apprentice	65% of employers had, at some point, taken on an apprentice
Key skill shortages	Electricians, carpenters, mobile construction plant operators, plumbers assistants	Metal fitters, machinists, automotive electricians and labourers

Source: Department for Victorian Communities – Regional Skills Shortage Survey (2006)

Employment commuting patterns

Eighty-seven per cent of jobs in the Bass Coast Shire are taken by local residents, while residents from outside the municipality take only 12 per cent of jobs. This is largely due to the many employment opportunities provided in the South East Region (including Dandenong and Monash) and the lack of opportunities in Bass Coast. Commuting distances, as shown in Table 12-8, between metropolitan areas such as Casey and Cardinia and the Bass Coast Shire may also be a deterrent to workers.

Seventy per cent of Bass Coast Shire residents work within the Shire and a further 6.7 per cent are employed in western parts of South Gippsland Shire such as Korumburra, Bena and Leongatha. Relatively few resident workers commute to Cardinia (1.7 per cent), Casey (1.3 per cent) or areas such as Dandenong (1.7 per cent) and Monash (0.6 per cent).

Table 12-8 Commuting distances from the Bass Coast Shire

Location	One way		Two way	
	Distance	Time	Distance	Time
Dandenong	100 km	90 minutes	200 km	180 mins
Cranbourne	90 km	70 minutes	180 km	140 mins
Pakenham	80 km	75 minutes	160 km	150 mins
Warragul	75 km	70 minutes	150 km	140 mins
Leongatha	40 km	45 minutes	80 km	90 mins
Korumburra	30 km	35 minutes	60 km	70 mins

Source: National Roads and Motorists Association – Travel Planner

12.1.6 Housing market assessment

Occupied and unoccupied dwellings

The inland towns of Wonthaggi and Dalyston have more occupied private dwellings compared with coastal towns such as Kilcunda, Inverloch and Cape Paterson. This reflects the significant holiday role of coastal towns and indicates that permanent residents typically occupy places such as Wonthaggi and Dalyston, while the coastal townships are typically popular holiday and weekend destinations.

Bass Coast Shire is characterised by a high proportion (91.5 per cent) of detached occupied private dwellings, and a low proportion of flat/unit/apartments (4.7 per cent) and semi-detached (1.9 per cent) occupied private dwellings. Many townships are characterised by two and three bedroom dwellings, with a smaller amount of four-bedroom stock.

Wonthaggi contains 234 holiday homes and Kilcunda has 111 holiday homes. The number of days that holiday homes are occupied varies seasonally. Holiday homes are occupied for 41.2 per cent of days in summer, 21 per cent of days in autumn, 16.6 per cent of days in winter, and 21.6 per cent of days in spring. Occupancy rates are also affected by events in the area including a number of motor sport events that take place primarily in late spring and early autumn. The timing of these events extends the peak Christmas/Easter holiday periods.

A number of accommodation facilities are either planned or recently completed within the vicinity of Phillip Island providing an additional 900 units located within commuting distance of the Plant.

Building activity

The Bass Coast Shire is the twelfth fastest growing municipality in Victoria and one of the fastest growing regional locations. This is highlighted by strong residential building activity observed in Bass Coast Shire over recent years, confirming the strength of demand for residential living in many of the Shire's townships. Permits for new dwellings have increased from 626 in 2001, to 728 in 2006 but dropped to 541 permits in 2007. From 2001 to 2007, Bass Coast Shire averaged 625 new building approvals per year. New dwelling activity has been strongest on Phillip Island, but lower in other Bass Coast locations. Land supply constraints in some townships, such as Wonthaggi, and a general decline in construction activity (mainly due to increasing interest rates), have contributed to a slowing in building permit activity over recent years (Essential Economics 2008$_1$, Technical Appendix 10).

House price and land value trends

In general, towns in the Bass Coast Shire are characterised by strong housing demand and a relatively limited supply of residential land.

Substantial growth in median house price has occurred in Bass Coast Shire over recent years and, in general, median house prices in coastal towns across the Bass Coast Shire are above the median house price for Regional Victoria, particularly for townships in the Bass Coast Phillip Island SLA. This reflects the popularity of the Bass Coast Shire for holiday homes.

Median house prices for the inland townships of Wonthaggi ($205 000) and Dalyston ($180 000) have increased substantially over the five year period to 2006, but remain well below the median house price for the Bass Coast Shire ($255 000). This is reflective of their location and the fact that Wonthaggi is a regional services centre rather than a coastal township.

Strong increases in median vacant residential land prices occurred in the Bass Coast Shire over the period 2001 to 2006. The median vacant house block price increased from $42 000 in 2001 to $137 500 in 2006 representing an average annual growth of 26.8 per cent per annum. This is well above regional Victoria (15.8 per cent per annum) and metropolitan Melbourne (13.8 per cent per annum) growth averages for the period. This confirms the increasing attractiveness of Bass Coast Shire as a residential location compared to many other areas (Essential Economics 2008_1, Technical Appendix 10).

Rental market

In 2006, 22.4 per cent of private occupied dwellings were rented, which is slightly lower than for regional Victoria (23.5 per cent). Wonthaggi had a higher proportion of dwellings being rented (25.8 per cent), as did Inverloch (24.2 per cent), reflecting the regional service roles of these townships and their importance to the Shire's long-term rental market. Approximately 49 per cent of occupied private dwellings in the Bass Coast Shire are fully owned, which is higher than the figure for regional Victoria (41 per cent).

There are approximately 100 rental properties listed for Phillip Island and the main townships surrounding the Project area. These are primarily three bedroom properties, with some two and four bedroom properties. Rental vacancy rates in the area are low, especially in the key areas of Wonthaggi, 3 to 4 per cent, and Inverloch, 4 to 5 per cent. Phillip Island has a slightly higher vacancy rate at seven to 8 per cent. Rental prices in Bass Coast Shire are considered very affordable compared to metropolitan Melbourne (Essential Economics 2008_1, Technical Appendix 10).

Commercial accommodation market

There is an increasing role for tourism in rural areas, with tourism co-existing with primary production across the region. Bed and breakfast and farm stay enterprises have emerged over the past two decades to provide rural experiences not readily available to many urban dwellers. Similarly, boutique and door sales enterprises have experienced similar expansion.

There are 24 commercial establishments in Bass Coast Shire, comprising a total of 430 rooms. Seventy per cent of these are located on Phillip Island. The highest demand period is during the March quarter (January, February and March), followed by the December quarter (October, November and December) (Essential Economics 2008$_1$, Technical Appendix 10). It is likely that during holiday period's accommodation facilities will be in much higher demand with little spare capacity (Maunsell 2008$_4$, Technical Appendix 55).

There are a number of commercial developments of a resort nature that are planned, under construction or have been recently completed. These have the potential to provide a further 900 units/rooms to the visitor market.

There are 24 caravan parks in Bass Coast Shire with a total capacity of 3 065 sites/units. These include 80 on-site vans, 2 414 powered and 270 unpowered sites and 301 cabins, flats and units (Essential Economics 2008$_1$, Technical Appendix 10).

12.1.7 Community involvement

The social impacts of the project have been based on the following:

- stakeholder interviews
- telephone surveys of 500 households in Bass Coast Shire
- Focus groups with residents of Bass Coast Shire.

In addition to the above community participation, DSE has conducted a number of community consultation events in Wonthaggi. Information on the community consultation carried out is included in Appendix 2

Community Feedback

The issues identified by the community through community consultation are summarised below in eight broad categories:

- health risks (community perceived impact)
- visual amenity (caused by the construction of the Desalination Plant)
- environmental degradation (loss of flora and fauna and associated habitats, as well as pollution related to the potential resultant industrial growth)
- concerns about potential decreases in property value (as a result of construction and amenity)
- short-term inconvenience during construction (e.g. noise, dust, materials transport)
- local business (changes to demographics, real estate values, business opportunities and visitor accommodation impacts)
- tourism (visual impact, industrial tourism potential and marketing and promotion)
- infrastructure (hospitals and medical facilities, increased traffic on local road networks, strain on community facilities and emergency services during construction) (Maunsell 2008_6, Technical Appendix 56).

12.2 Impact assessment

This section discusses the potential socio-economic impacts of the construction and operation of the Desalination Plant.

12.3 Construction

12.3.1 Risks assessed as medium and above

Table 12-9 sets out the socio-economic risks associated with the construction of the Desalination Plant which are assessed as medium and above. The risks are discussed in order of likelihood with those most likely to occur discussed first.

Table 12-9 Construction socio-economic risks assessed as medium and above

Activity	Impact	Consequence	Likelihood	Risk
Accommodation for construction crews	Increased demand for accommodation impacting the availability and cost of accommodation and housing	Moderate	Certain	High
Construction of the Desalination Plant	Loss of land for agricultural production	Negligible	Certain	Medium
Use of existing services by construction crew	Reduction in community access to existing physical and social services and infrastructure	Minor	Likely	Medium
Use of construction crews and other skilled workers	Use of construction crews and other skilled workers reducing skilled labour available to other local industries	Moderate	Likely	Medium
Physical location of the plant site	Reduction in public access	Moderate	Likely	Medium

The above risk assessment is based on accepted construction practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the Performance Requirements are taken into account, both the likelihood and consequence of these risks may be significantly lower.

Construction Crews

Large construction crews are expected to be required during the construction of the Plant. The size of the on-site workforce would vary from month to month and the highest peak workforce on-site at the Plant is estimated to be approximately 910 workers. There is expected to be a rapid mobilisation on the project and a short commissioning period at the end, with most onsite activity occurring between September 2010 and June 2011.

It is assumed that the construction of the Plant would occur over 24 hours, seven day per week. It is possible for all workers to be present on-site during the daytime during the peak period. However, the construction activities are likely to drop to a maximum of approximately 300 workers during the night.

The workforce is likely to originate from a mix of local (Wonthaggi/Dalyston, Inverloch and Cape Paterson), regional (Bass Coast and South Gippsland) and external catchments. It is estimated that approximately fifty per cent of the external workforce would temporarily relocate to the Bass Coast region. Some workers from Melbourne would choose to temporarily relocate to the local region from Monday to Friday and return home on weekends. Of the 50 per cent that relocate, it is assumed 10 per cent would bring their families with them. This would result in around 60 new families living in the Bass Coast region during the peak construction period with around 73 children. Approximately 28 children would need to be enrolled in primary school and approximately 24 would need to be enrolled in secondary school.

Potential impacts on existing housing market

There are a number of options for accommodating the temporary construction workforce. These include locating some of the workers in existing accommodation such as caravan parks, commercial accommodation, rental properties or dwellings, holiday homes, or large tourist complexes and accommodating some workers in a purpose built construction village. The likely impacts and benefits of these options to the existing housing market are discussed below.



Existing accommodation

Caravan park accommodation may be most suitable for commuting workers who return home to their families on weekends. Potential impacts associated with this option would include a reduction in the availability of low-cost long-term caravan park accommodation for low-income local residents. The majority of commercial accommodation is likely to be unsuitable for the construction workforce as it is targeted at the 'high-end' visitor market; however such accommodation may suit workers who are employed intermittently or only need to stay in the region for short periods. Both of these options would result in a reduction in available accommodation during holiday periods for holidaymakers and create potential conflict between construction workers and holidaymakers due to their different activity patterns.

Some of the existing long-term rental accommodation within commuting distance of the site may be used by the construction workforce and would be a particularly suitable option for workers with families. This may place upward pressure on rental availability and housing prices, as the existing rental market is described as 'tight' by local real estate agents, and landlords may seek to capitalise on the ability of project workers to pay higher rental prices. Although landlords and property sellers would benefit from this scenario, it could potentially result in the following social impacts:

- existing or potential residents being forced to pay significantly higher rents, leading to an increase in housing stress and potentially leading to financial stress for the Bass Coast community
- existing or potential renters being temporarily priced out of the market and forced to move away from the area, resulting in a significant dislocation impact at the household level
- existing renters not having their contracts renewed in anticipation of landlords securing higher paying Project workers, which may force tenants to move elsewhere with a consequent reduction in quality of life
- reduced housing affordability due to increased competition in the market from members of the construction and operation workforce.

Vacant holiday homes may be sought as accommodation for construction workers, however only a small proportion of homes are likely to be suitable and available for the construction workforce. This may be a suitable option for commuting workers, since they would leave the properties vacant on the weekends, when the owners are most likely to want to use them. Existing permanent residents are accustomed to temporary residents using these properties and hence should not experience a significant disruptive impact.

Impacts and benefits associated with this option would be similar to those for caravan park and commercial accommodation options. Other benefits would include holiday homeowners receiving rent outside traditional holiday rental periods and, if homes are available for long-term rental, reduced stress on the general housing market. However, overall the holiday home market is considered a limited option for Project workers.

A number of large accommodation complexes exist or are being constructed within the Bass Coast Region that could potentially house contractors. However, these are of a resort nature and are unlikely to be suitable to house construction workers as they will be relatively expensive. Many of these developments will come on-line during the construction period of the Plant and may free up other commercial accommodation such as motels, which may then become available for construction workers (Maunsell 2008$_5$, Technical Appendix 56).

Construction village

A construction village, containing a hub of facilities surrounded by accommodation units, could be established to accommodate a large proportion of the construction workforce. Once the construction of the Plant is complete a temporary construction village could be relocated. If a permanent facility was constructed, it could be used for ongoing accommodation (e.g. as a retirement village or low cost housing) or other purposes. Given the planned project timing, it is unlikely that time would permit necessary approvals and construction of a permanent facility prior to construction commencing and hence it is assumed that a construction village would be a temporary facility.

Impacts associated with a construction village option include potential isolation of construction workers from the general community, potentially resulting in increased social conflict when they do interact with the community. Also, it would be less likely that additional recreational and social services would be provided to the general community, as the short-term needs of the construction workforce would be provided for at the construction village. Benefits of a construction village may include reduced impact on accommodation availability for holidaymakers, reduced potential for project-induced housing stress, provision of cheap accommodation for workers and limited long-term impacts on the existing housing market in the Bass Coast Shire (Maunsell 2008$_5$, Technical Appendix 56).

Summary

The extent of impacts on the existing housing market (including accommodation availability, housing prices, housing stress and financial stress), would depend on the accommodation options selected for the construction workforce. Housing impacts are certain as the construction workforce would require accommodation. It is assumed that there would be a maximum requirement for the local area to support up to 450 construction workers at the peak of the Desalination Plant construction works. Only a small proportion of these workers could be accommodated in existing commercial, holiday home and long-term rental accommodation without significantly disrupting the housing market. Alternative accommodation would need to be provided for the remaining workforce. The PRs require the Project Company to develop an accommodation management plan.

Impacts on services and infrastructure

The Bass Coast region contains a wide range of social infrastructure commensurate with the population base and historical levels of investment. Sustained population growth, an ageing population and seasonal peaks are currently leading to capacity constraints. The hospital and education facilities in Wonthaggi provide a range of services and plans are already in place to upgrade them to cater for long-term population growth in the region. The Project construction workforce would place increased demands on services and infrastructure in the region, primarily in Wonthaggi and the Bass Coast Shire. This would result in competition for access to services and facilities from employees and their families and social disruption could arise as a result of new people moving to the area for periods of time and then leaving. Due to the required timeframes for the Project there is limited time to strategically plan and upgrade services and infrastructure to cater for the increased demand.

A summary of potential impacts on services and infrastructure is provided in Table 12-10.

Table 12-10 Impacts to services and infrastructure

Activity	Impact pathway
Arts and culture	There could be increased demand for arts and cultural activities and higher attendance at community activities and events organised by the Council which would be a positive social impact. Increased demand for library and toy library services may occur if workers bring their families to the area and this may be a positive social impact if it provides children with more social interaction. The anticipated small number of additional families is unlikely to lead to any reduction in available library and toy library inventory for other residents.
Economic development	There may be an opportunity for local businesses to leverage off the investment made in the Plant, and it would be the role of the economic development department to facilitate this. This is a significant potential social benefit of the project. The economic development department should monitor impacts on the tourism, retail and entertainment sectors and be ready to manage any adverse impacts.
Community development and health	This department could play a role in developing community engagement and activities to help integrate the temporary and long-term workforces into the regional community. There may be a short-term increase in demand for community and health services during construction. The Council may need to increase their resources to meet these demands.
Environment and waste management	There would be increased demand for waste management services, particularly waste collection if currently vacant dwellings are occupied full time, or if new dwellings are constructed.
Transport	Council transport services are generally provided to community groups and people with mobility issues. This service would only be affected if members of the temporary workforce or their families join the community groups that use Council transport or if any of them have mobility difficulties. Given the small number of families expected to move to the area during construction, this impact is likely to be negligible or even non-existent.
Parks and recreation	Local education provides consider that both the construction and operational workforces and their families may use parks and recreational facilities. Increased social interaction in public spaces could have social benefits, for example if these people join sporting teams. There is sufficient supply of these resources to cater for the permanent and temporary populations. There may be a need to increase resources for management and maintenance of facilities.
Education services	The estimated number of children relocating to the Bass Coast area during the course of construction of the Plant would be manageable, with the proviso that some increase in funding from the Department of Education may be required for some schools to employ more staff. Education providers manage these issues on a regular basis and there are established processes and systems in place to deal with them.

Activity	Impact pathway
Health services and facilities	It is considered likely that existing health and community services would have sufficient physical capacity to cater for temporary workforce and their families during the construction period of the Plant, and for the permanent population associated with the operation of the Plant. However, existing services may require additional funding for extra staff if increased demand exceeds their capacity. General practice and hospital services are the most likely to require supplementation.
Emergency services	It is likely there would be increased demand for emergency services, particularly during the construction period. Some extra resources may be required to support the increased demand. DSE and the Project Company should liaise with these emergency services on a regular basis to ensure they have appropriate information to manage increased demand.

Key impacts on social infrastructure and services are considered to be those on health services. The increased demand could result in restricted access to affordable health services, which is particularly important for the local community given their relatively low socio-economic status. Increased demand on Council services, which may not be matched by additional rate income to increase provision of these services, may lead to a need for alternative funding sources. The legacy of individuals and families leaving the region once the Project is completed could also have subsequent economic impacts and effects on social cohesion.

Potential beneficial outcomes in terms of social infrastructure and services may include:

- increased visitation to community activities and events
- greater social interaction and diversity at schools, opportunities for the Project to provide educational activities
- increased opportunities for social interaction within the local community and potentially increased participation in sporting and recreational activities
- opportunities for local services to invest as a result of increased income from providing services to the project workforce, leading to greater overall access (including social and commercial services).

The temporary increase in demand for some social infrastructure may lead to a need to supplement the capacity of some elements of the existing range of social services and facilities found in the area. A positive long-term social outcome could be achieved if existing regional services are supported in order to provide a legacy for the region (Maunsell 2008$_5$, Technical Appendix 56).

Use of construction crews and skilled labourers

The use of construction crews, specialist workers and labourers have the potential to impact on some local industries by reducing the number of available skilled workers. However, due to the specialist nature of the Project it is expected that the local labour requirement would be relatively small. It is estimated that over the two-year construction period 260 direct full-time equivalent (FTE) and 290 indirect FTE jobs would be generated locally, while a further 260 direct FTE and 290 indirect FTE jobs would be generated at a regional level. This labour requirement represents approximately 21 per cent of the available unemployed pool of workers in the region.

The regional unemployed labour pool is considered reasonably large for Project labour requirements and this would help minimise adverse labour market outcomes. The match between job seekers skills and Project skills requirements would determine the extent to which these unemployed persons can secure Project employment. However, this pool of unemployed workers has the potential to 'backfill' positions that become vacant by labour force participants transferring from existing employment to Project-related employment.

The 2006 Regional Skills Shortage Survey Report indicates regional skills shortages in the construction and manufacturing industries, which may mean that Project labour may need to be sourced from other locations, such as Melbourne. However, there is currently a decline in construction activity in the Bass Coast Shire and this is likely to increase the number of construction workers looking for new employment opportunities over the coming years. The Project would provide new opportunities for some of these workers, assuming that there are reasonable skills matches.

It is recognised that local/regional labour force participants with specific Project skills (e.g. experience in water-related Projects such as employees of South Gippsland Water) would be in high demand and may be enticed to transfer current employment for Project employment due to better remuneration, opportunities for up-skilling and other factors. However, the construction phase of the Project presents a maximum opportunity of two years employment; and in most cases, contracts would be for significantly shorter periods (e.g. three to six months). The short-term nature of employment offered may deter some workers from switching from their current jobs. There may be some longer-term opportunities available once the Desalination Plant is operational. However, the number of workers required is likely to be small.

In general, the local/regional Project labour requirements can be serviced with limited adverse impact on local and regional employers. This is due to a number of factors including the large pool of existing unemployed workers in the region, the potential for higher labour force participation, the potential for increased employment by part-time workers, and increased availability of construction workers in the coming years due to a downturn in regional construction activity. These factors would increase the capacity of the local/regional labour market. However, the comments made above, it is likely that the Desalination Project would put some upward pressure on wage rates in some sectors of the local and regional economy (Essential Economics 2008_2, Technical Appendix 11) which is why the potential impact is assessed as moderate.

Loss of agricultural production

The physical location of the Plant site will impact on agriculture as the land that is required for the Desalination Plant and assorted infrastructure will not be available for agriculture and restrictions may be placed on the use of land within the buffer zone. Based on the soil characteristics and land capability, the impact on agriculture would be minor, being the loss of 900 dry sheep equivalent (60 hectares at 15 dry sheep equivalent/hectare) and a possible drop in carrying capacity on the buffer area should constraints be placed on farm management practices (Phillips Agribusiness 2008, Technical Appendix 17).

Truck movements and reduced road access may result in minor impacts to agriculture. However, these impacts are manageable through standard traffic and construction management measures and are therefore assessed as minor. Impacts related to traffic and relevant Performance Requirements are discussed further in Chapter 11 of this volume.

Reduction in public access

The area in the vicinity of the proposed Plant, including Williamsons Beach is used for a number of land and marine based activities. Activities include bird watching, whale watching, walking and dog walking, cycling, shore and boat based fishing, swimming, surfing, horse riding, and recreational boating. The dominant users are local people who are aware of the area's natural features, particularly the beaches and the access routes to them. Tourists are less likely to visit the area in the vicinity of the proposed Plant as access to the coast is poorly defined and there is limited tourist information. Lower Powlett Road provides sealed access from the Bass Highway towards Williamsons Beach with a small section of unsealed road near the beach car park. The Mouth of Powlett Road provides sealed road access to the car park, beach area and caravan park located adjacent to the foreshore dunes and the river.

Potential impacts on recreational activities would depend on the application and size of any exclusion zone from the Plant and marine structures proposed by the project and would vary between the construction and operational phases. There may be minor disruptions to access to Williamsons Beach during construction, but access will be generally maintained to the beach car parks. Potential marine construction activities may impact on access to the marine environment for surfing, fishing and water-based recreation opportunities. This would depend on the definition of the marine exclusion zones. The mostly likely effect on access during construction would be extra traffic related to construction. This impact is likely to be minor and of short duration.

The existing informal pedestrian access track through the plant site to the dunes may be closed. This track is currently used by pedestrians and recreational users (such as horse and bicycle riders). This could have environmental benefits and would protect cultural heritage, but may lead to a small reduction in informal access patterns. Alternative access would be provided to maintain public access. Therefore, there should be minimal impacts on horse riding and other recreational use of the area (Maunsell 2008$_6$, Technical Appendix 56).

12.3.2 Risks assessed as low

The risk assessment for the Desalination Project explored a comprehensive list of potential environmental effects in order to identify the priority areas for management through the Performance Requirements. One socio-economic risk in connection with the construction of the Desalination Plant has been assessed as low and. This impact relates to the physical location of the site resulting in reduced public access across the site.

The area in the vicinity of the Plant, including Williamsons Beach is used for a number of land and marine based activities. Activities include bird watching, whale watching, walking and dog walking, cycling, shore and boat based fishing, swimming, surfing, horse riding, and recreational boating. There may be minor disruptions to access to Williamsons Beach during construction, but access will be generally maintained to the beach car park. The existing informal pedestrian access track through the plant site would be closed. As long as alternative access is provided, there would be a minor impact on public use of the area (Maunsell 2008$_5$, Technical Appendix 56).

12.4 Operation

12.4.1 Risks assessed as medium and above

Table 12-11 sets out the socio-economic risks associated with the operation of the Desalination Plant which are assessed as medium and above. The risks are discussed in order of likelihood with those most likely to occur discussed first.

Table 12-11 Operation socio-economic risks assessed as medium and above

Activity	Impact	Consequence	Likelihood	Risk
Operation of the Plant	Social impacts of the Plant on surrounding area	Moderate	Certain	High
Operation of the Plant	Plant operation resulting in reduced visitation and loss of business revenue due to perception that the Wonthaggi/Kilcunda coastline is becoming 'industrialised'	Moderate	Unlikely	Medium
Transportation and use of chlorine at the Desalination Plant	Accidental chlorine release impacting on public health and safety	Extreme	Rare	High

The above risk assessment is based on accepted operation practices but does not take into account the mitigation measures embodied in the Performance Requirements. If the Performance Requirements are taken into account, both the likelihood and consequence of these risks may be significantly lower.

Operation of the Plant

Social impacts on the surrounding area

The operational workforce based in Wonthaggi is likely to consist of approximately 50 employees. The degree of technical skill required by employees would dictate the number of existing local or regional people employed. A highly skilled work force may need to be sourced from the broader Victorian region and beyond, leading to a long-term demand for housing and associated infrastructure in Bass Coast Shire by the Plant's employees. Wonthaggi may experience an influx of 30 to 50 workers and their families, who would require a similar number of dwellings. The development sector currently perceives a shortage of land for new residential development in Wonthaggi.

In order to accommodate the influx of a skilled work force, the approvals process and subsequent residential development would need to increase. Without a significant increase in residential development the influx of workers, combined with the town's ambient growth (which was 4.5 per cent between 1996 and 2001), could lead to a shortage of permanent accommodation, resulting in increased house and rental prices. The impacts of this shortage are likely to be felt primarily by low-income renters who may be placed under increased housing stress.

If a less technically skilled work force were required, this would enable utilisation of a higher proportion of the existing local workforce and therefore place less demand on the accommodation infrastructure, while providing a boost to the local economy. However, some additional permanent accommodation would still be necessary to house workers with skills that cannot be sourced locally.

Social impacts of accommodating the operational workforce may include:

- increased competition in the housing market, which may lead to housing stress at the lower end of the market
- the need to construct more dwellings in Wonthaggi and surrounding areas may have social impacts associated with urbanisation
- increased patronage of community and social services, which may not have the capacity to manage more clients.

These impacts may potentially have a moderate impact on the local area. However, the presence of the operational workforce may benefit the community as the catchments of community and social services may also increase to a level where significant new investment is required, thereby improving access to these services generally. New urban development may also increase the supply of housing to the general community of Bass Coast Shire.

Potential impacts on recreational activities largely relate to restricted access to the beach and marine environment for surfing, fishing and water-based recreation opportunities. The extent of this impact during operation would depend on the application and size of any exclusion zone from the Plant and marine structures. The existing informal pedestrian access track across the Plant site may be closed and alternative access provided. This would have environmental benefits as it would protect cultural heritage, but may lead to a small reduction in informal access patterns depending on the location of the alternative access. As long as alternative access is provided, the impacts on horse riding and other recreational uses of the area would be minor.

Reduced visitation and loss of business revenue

It is considered that the Project would have a minor impact on perceptions of the coastal landscape of tourists, given that their perceptions tend to be formed based on the totality of their experience rather than on specific sites. Investment in landscaping and visual impact mitigation works may improve the landscape quality in some areas and also has potential to improve recreation infrastructure such as new access paths and car parks. Opportunities also exist to diversify tourism in the area with tours of coalmines, the Plant, wind farm and power station.

Also, there is likely to be very little impact from the Project on penguins, seals and other wildlife attractions associated with the area, either during construction or in the longer-term and therefore it is unlikely that eco-tourism would experience a downturn in business due to impacts on marine life. As most tourism occurs in and around Phillip Island and well away from the site (and most eco-tourism operators are located on Phillip Island), it is unlikely that visitation or eco-tourism would be impacted in the longer-term.

Accidental chlorine release

The Reference Project includes a chlorine treatment facility that could store up to twenty 920 kg drums of liquefied chlorine for use in potabilisation.

Chlorine gas is a respiratory irritant. If inappropriately used or spilt, chlorine has the potential to disperse outside the site boundary and cause an impact off-site. Exposure to chlorine through inhalation, ingestion and direct contact can result in injury or fatality.

A chlorine release could occur by:

- leakages during drum delivery to site
- leakages during drum transfer phase
- leakages under normal operating conditions (eg security incident, corrosion, valve/equipment failure, maintenance activities)
- leakages under storage conditions.

The consequence and likelihood of a chlorine release causing an off-site impact has been modelled based on the Reference Project and using the standard industry methodology for Quantitative Risk Assessments (QRA). The results of the QRA are shown in more detail in Technical Appendix 54.

The QRA shows that the likelihood of a catastrophic release is rare. In particular, the individual risk profile satisfies the Victorian Interim Risk Criteria for Individual Risk, as the 1 x 10-7/yr individual risk contour does not exceed the site boundary.

In addition, although the quantity of chlorine expected to be stored on the Desalination Plant site is below the threshold value used to classify the storage area as a Major Hazard Facility (MHF), it is greater than 10 per cent of the threshold value and therefore Worksafe Victoria may determine the facility to be a Major Hazard Facility. If the Plant is determined to be a MHF, it will require a Safety Case to demonstrate that the risk that it poses to the public and on-site employees has been reduced so far as is reasonably practicable.

12.4.2 Risks assessed as low

The risk assessment for the Desalination Project explored a comprehensive list of potential environmental effects in order to identify the priority areas for management through the Performance Requirements. The following socio-economics risks associated with the operation of the Desalination Plant have been assessed as low.

Reduced public access across the site

The physical location of the Plant would result in changes to the current access to public open space and recreational areas as existing access around the site would close. It is unlikely that this would affect public access to open space and recreational areas as this access would be reinstated elsewhere and nearby areas can also be reached by other roads. As a result the changes in the current access to public open space and recreational areas would have a negligible impact on the public (Maunsell 2008_5, Technical Appendix 56).

Potential impacts to agriculture

As discussed previously for construction, impacts to agriculture would primarily arise from the direct loss of land that would be required for the Desalination Plant and associated infrastructure and any restrictions on land use within the buffer zone. Other impacts may arise from noise, vibration and lighting disrupting livestock. Vibration from the plant is expected to be negligible, and the Australian standards for lighting and noise would be followed to reduce impacts on surrounding farming practices. Also, site access and egress would be appropriately positioned to ensure access to surrounding land uses is not impacted. Overall, whilst these impacts are likely to occur, it is expected that they would be minor.

12.5 Performance Requirements

Performance Requirements (PRs) have been developed to provide an environmental framework for management of potential social and economic impacts associated with the Project during construction and operation. The PRs are focussed on the environmental 'outcomes' that the State wishes to achieve through the Project delivery. The PRs relevant to managing the impacts of the Plant on social and economic assets are set out below. The full suite of PRs for the Project is provided in Volume 1 Chapter 10 as part of the overall Environmental Management Framework.

As part of the environmental impact and risk assessment process relating to social and economic assets, Maunsell (2008_5) and Essential Economics (2008_2) have identified a range of suggested management measures that could be implemented to manage potential impacts. These suggested management measures have been formulated in response to the Reference Project and relevant Variations for the Plant. In effect, the suggested management measures demonstrate how the Reference Project and relevant Variations can achieve the PRs. These detailed management measures have formed an important input to the PRs for the Project.

The social impact management measures suggested by Maunsell (2008_6) address the following matters:

- managing socio-economic impacts during construction and operation by:
  - implementing a communications strategy that informs the community about project activities, particularly during construction. This will include informing emergency services about the nature of the project activities that may require emergency response
  - developing a Community Reference Group (CRG) providing information on aspects of the Project and minimising the impacts on the local community
  - maximising local community participation by developing a local industry participation strategy that supports purchasing and employment
  - minimising the impacts on the local accommodation industry by developing a construction workforce accommodation strategy
- managing potential exclusion zones established during the Project by:

- educating and communicating the purposes behind potential exclusion zones
- providing opportunities for alternative access for pedestrians and horse riders
- minimising disruption to public access to Williamsons Beach during the construction and operation phases of the Project

- minimising the impacts on landscape value and recreational activities by:
  - developing design guidelines that focus on minimising the visual intrusion into the landscape
  - seeking CRG input into the development of standards for design and landscape
  - providing opportunities for community involvement in site landscaping, such as tree planting days, which may enable local people to familiarise themselves with the site
  - continuing communication and consultation with the community that provides details of the Project and the likely impacts and outcomes

The PRs proposed for socio-economic aspects are outlined in Table 12-12.

Table 12-12 Performance Requirements

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Social and economic	✓	✓	Minimise adverse social and economic impacts and encourage social and economic benefits.	Inform the community about Project Activities. Support local procurement, employment and industry participation. Manage construction workforce accommodation impacts.	Comply with the Performance Criteria. Develop and implement a communications strategy to inform the community about Project Activities. Establish, during construction, a Community Reference Group to provide timely information on aspects of the Project in order to minimise any potential impacts on the local community. Develop and implement a local industry participation strategy supporting local purchasing and employment, and maximising local industry participation where appropriate. Develop and implement a construction workforce accommodation strategy to minimise impacts on the local accommodation sector.

Subject	Timing		Objective	Performance Criteria	Performance Requirements
	D&C	O&M			
Public Safety		✓	Protect neighbourhood amenity and site personnel.	Comply with the Occupational Health and Safety legislation and Australian Dangerous Goods Code in relation to any toxic and flammable materials transferred to site and used onsite. Comply with major Hazard Facility legislation if it is determined that the Project Company will be operating a Major Hazard Facility.	Comply with the Performance Criteria. Undertake a Quantitative Risk Assessment (QRA) to determine the off-site impacts of the facility and to demonstrate that the off-site risk complies with Victorian Interim Risk Criteria. Develop a Safety Management System for the facility that complies with Major Hazard Facility legislation, if it is determined that the Project Company will be operating a Major Hazard Facility.

13.0 Infrastructure and services



13 Infrastructure and services

This chapter discusses the impacts of the Plant on infrastructure and services. It describes existing conditions, assesses the impacts of construction and operation of the Plant and provides strategies for mitigation and management. This chapter is based on findings from GHD (2008_{18}) *Services Impact Assessment*, found in Technical Appendix 57.

13.1 Existing conditions and infrastructure usage

This section describes the existing services and infrastructure at the site and its surrounds.

13.1.1 Electricity

SP AusNet is the sole authority for the electricity distribution and transmission network in the vicinity of the site. High-voltage 22 kV overhead powerlines run along Bass Highway, 2.6 kilometres north of the site, and along Lower Powlett Road near the site boundary.

13.1.2 Gas

There are no gas distribution networks within the immediate vicinity of the site. The nearest existing gas distribution network is located in Cranbourne and is operated by Envestra.

Multinet Gas, (a subsidiary of Alinta) plan to reticulate natural gas in five nearby towns: Inverloch, Korumburra, Lang Lang, Leongatha and Wonthaggi. None of the proposed networks are expected to enter the Plant site. Construction of this reticulation network commenced in 2007 and is expected to be complete in 2010.

13.1.3 Stormwater

Bass Coast Shire Council manages all underground stormwater assets and roadside drains in the vicinity of the site. There are no underground drainage pipe assets within the site, though there are open drains along the adjoining roads. Currently, run-off from the site flows to the north where it collects in a local open drain which discharges into the Powlett River.

13.1.4 Telecommunications

Telstra owns telecommunications cables located at Mouth of Powlett Road and north of the site at Dalyston. Telstra is the only provider of telecommunication infrastructure in the area, and has indicated they would upgrade the existing network to meet demand for telephone lines if required. Optus have a number of mobile phone base station towers in the Western Port region; however, none of these are within the vicinity of the site.

13.1.5 Water and wastewater

Westernport Water manages the water services to the area surrounding the Plant. Water services include an 80-mm PVC water main that services customers along Mouth of Powlett Road and 200-mm PVC pipe that runs along Bass Highway that supplies water to the 80-mm main. There are no water main assets on the site (GHD 2008_{18}, Technical Appendix 57).

Westernport Water manages a 180-mm polyethylene rising main, which is located 2.5 kilometres north of the site. The nearest pump station is located in Dalyston, on Station Street. The rising main transports wastewater to the Wonthaggi Treatment Plant, which is located approximately 2.5 kilometres east of the site. South Gippsland Water operates the treatment plant. There are no known sewer assets on the site.

13.2 Impact assessment

This section discusses the potential impacts of the construction and operation of the Desalination Plant on the infrastructure and services at and around the site.

13.3 Construction

Water usage during construction

Two megalitres (maximum) of potable water will be required each day during construction. This value has been determined based on design flows in the Water Supply Code of Australia and has been reviewed by WesternPort Water. Design flows would require approval by WesternPort Water as part of the design process by the Project Company.

Wastewater management

A number of options have been identified to manage wastewater at the site, including:

- connect to the existing 180 mm PE rising main owned by Westernport Water that runs from the sewer network in Dalyston southeast to the Wonthaggi Wastewater Treatment Facility
- provide a new rising main to connect to the existing Wonthaggi Wastewater Treatment Facility that is located between the site and Wonthaggi (operated by South Gippsland Water)
- treat the wastewater generated during construction locally at a treatment facility provided by the Project Company.

If either the connection to the Wonthaggi Wastewater Treatment Facility or the Westernport Water rising main were to be considered, further investigation of available capacity would need to be conducted by South Gippsland Water and Westernport Water. If the existing network were found to require upgrades, they would need to be implemented prior to construction of the Plant to prevent impacts on the existing network (GHD 2008[18], Technical Appendix 57).

Other construction requirements

Stormwater infrastructure will be required for the construction of the Plant. This can be provided with little to no impact on the existing networks.

Telecommunication infrastructure will be required for the construction of the Plant. This can be provided with little or no impact on the existing networks.

13.3.1 Risks assessed as medium and above

No risks to infrastructure and services assessed as medium and above are expected to occur during construction of the Desalination Plant.

13.3.2 Risks assessed as low

In the environmental impact and risk assessment process, the potential for excavation and foundation activities to interrupt existing infrastructure and services on the site was assessed as a low risk.

There are no known infrastructure assets on the Desalination Plant site, and therefore it is unlikely that any assets would be interrupted by excavation and foundation activities. All assets would be identified and proved by hand prior to construction commencing and a spotter would be in place once construction begins (GHD 2008[18], Technical Appendix 57).

13.4 Operation

Augmentation of the existing electricity network to supply the Desalination Plant is discussed as one of the Power Supply options in Volume One of this EES and the potential effects of this upgrade are discussed in detail in Volume Five.

13.4.1 Risks assessed as medium and above

No risks to infrastructure and services assessed as medium and above are expected to occur during operation of the Desalination Plant.

13.4.2 Risks assessed as low

No risks to infrastructure and services assessed as low are expected to occur during operation of the Desalination Plant.

14.0 Summary of effects of Desalination Plant



14 Summary of effects of the Desalination Plant

The Plant will draw saline water from Bass Strait and treat it to potable standards using reverse osmosis technology. The Plant will comprise a number of components, including:

- seawater intake tunnels with pumps and screens
- pre-treatment plant and buildings
- reverse osmosis plant and buildings
- clear water storage
- transfer pump station
- electrical sub-station
- ancillary buildings.

14.1 Assessment methodology

Based on the Reference Project and Variations, the key effects of the Desalination Plant were identified taking into account legislative and policy obligations, community and stakeholder concerns and guidance from the EES Scoping Requirements. Potential impacts of the Plant on the terrestrial environment, social values or economic uses of the Project area and surrounds were identified as part of the environmental impact investigations. Informed by analysis, modelling, field studies, literature reviews and specialist opinion, these issues were assessed in the risk assessment and by specialists in their investigations and impact assessment.

Project controls — expressed as Performance Requirements in the Environmental Management Framework — embody the recommendations of environmental management arising from the environmental impact and risk assessment. The Performance Requirements (PRs) form an envelope to guide the Project Company in the design, construction and operation of the Desalination Plant and its components. This will prevent any adverse impacts to the environment and the community, whilst allowing the Project Company to create an innovative design for the Project.

14.2 Existing environment

The Desalination Plant site is located in a rural area, with some dwellings nearby, including the Powlett River Caravan Park. Surrounding towns include Dalyston to the north, Wonthaggi to the east and Kilcunda to the west. The two main access roads to the site are Mouth of Powlett Road and Lower Powlett Road, both of which connect to Bass Highway. Lower Powlett Road is expected to be the main access route to the Plant.

The site consists mostly of privately owned, cleared farmland with little native vegetation. An area of public land comprising vegetated coastal dunes and foreshore reserve lies between the site and Williamsons Beach. Williamsons Beach is a straight section of coast with steep sandy beaches and a shore platform that is often exposed at low tide. The beach is used for a range of recreational activities all year round. A number of Aboriginal artefact scatters have been found on the site and adjoining coastal dunes. The Powlett River is located to the north-east of the site, and its floodplain extends into the north-east area of the site.

14.3 Construction of the Desalination Plant

Construction activities for the Plant will include site clearing earthworks and excavation, tunnelling excavation, building construction, drainage installation, power connection, equipment installation and landscaping. Construction of the Desalination Plant and its components is expected to take slightly over two years, with completion of the Plant by the end of 2011. The majority of the Marine Structures will be tunnelled below the seabed, the connection to the Plant will be through tunnels below the coastal dunes. Construction of the Desalination Plant and associated tunnels is expected to have a peak workforce of approximately 910 people in late 2010.

Clearing of the site for Plant construction will result in the limited removal of native vegetation, since the site is dominated by pasture and a high of weed species. This minimal native vegetation cover means that there is limited habitat value for native fauna and although these areas could be used occasionally by significant species, this type of habitat is widespread throughout the region. Other construction activities such as dewatering (which may be required in a limited area on the site), generation of noise and vibration, possible generation of sediment from stockpiles and increased traffic could directly or indirectly affect native fauna and flora. These activities will be managed through the implementation of the PRs. In particular, the PRs require the development and implementation of methods and management systems to limit the impacts on terrestrial flora and fauna including management of noise, light spill, vehicle movements, domestic animals, open trenches, dust, and weeds. Additionally processes will be applied to manage works to ensure compliance with the Victorian Native Vegetation Management Framework.

There are fifteen known Aboriginal heritage sites within the site boundary. Eleven sites have been assessed as having low significance and four having moderate significance. Earthworks could affect known or undetected Aboriginal heritage sites or objects, as topsoil will be removed for the building foundations. During design and construction of the Plant, Aboriginal representatives will be consulted to assist in the location, assessment and management of Aboriginal artefacts and sites. A Cultural Heritage Management Plan will be finalised for approval following the Assessment of the EES by the Minister for Planning. Additionally, there will be a need to comply with approvals processes if Aboriginal heritage sites cannot be avoided during construction.

One known historical site on the heritage inventory and two sites of local historical interest have been recorded within the site. Earthworks, landscaping or revegetation could affect known or undetected historical sites. There will be a need to comply with approvals processes if historical sites cannot be avoided during construction.

As with other construction projects requiring clearing and building construction, some noise, vibration, dust and other emissions could be generated during Plant construction. Specialist investigations, including modelling, were conducted to characterise any emissions. Investigations also show that vibration from major sources (e.g. pile driving) is not expected to cause structural damage to the closest residents to the site and the Plant will be designed to take account of this.

Emissions (including noise, vibration and dust) will be managed pursuant to regulatory requirements and the PRs. For dust, management systems will be implemented to maintain air quality consistent with the SPP (Air Quality Management) intervention levels for particulates and EPA Best Practice Environmental Management-Environmental Guidelines for Major Construction Sites. It is expected that any potential impacts from emissions would be relatively short lived and restricted to the construction period.

The Plant would be constructed in a portion of the Western Area Mine. Subsidence of these historic coal mines can occur, largely due to historic mining practices. Although there is little local information on subsidence of mines in the local area, subsidence is not expected to occur at the site.

Construction of the Plant is unlikely to directly interact with surface waters and groundwater in the area including the Powlett River. Some limited areas could require dewatering, particularly for tunnel excavation. Intrusion of saline waters into groundwater can occur for dewatering activities near the coastline, which can cause a change in groundwater quality. Dewatering activities for the site are expected to be temporary and once dewatering activities stop, the aquifer is expected to recover from any saline intrusion. Any potential change in water quality is unlikely to cause any lasting effects on aquatic or terrestrial ecosystems.

Construction of the Plant will require a large workforce. A significant proportion of these workers may relocate to the Wonthaggi area for the duration of the construction period and will require accommodation. Approximately 260 full-time equivalent workers are expected to be employed by the Project from the local labour pool and these workers would not require relocation. Most commercial accommodation is unlikely to be suitable for the majority of the workforce. Other temporary accommodation (in existing accommodation or in temporary construction accommodation) may be feasible for most of the workforce. Some people may choose to acquire housing in the area surrounding the site, which could place upward pressure on rental and housing prices.

Although property owners and agents would benefit from these market changes, a potential price increase could affect existing and potential residents of the area. This workforce could also place added pressure on facilities and services. However, this temporary increase in demand for services may have a positive long-term social outcome as businesses are expanded. Some of the temporary workforce would require accommodation in the area and the PRs require implementation of a construction workforce accommodation strategy to minimise any impacts on the local accommodation sector.

14.4 Operation of the Desalination Plant

The Plant will be designed to have an initial operating capacity of 150 GL per year (by the end of 2011), with an ultimate capacity of 200 GL per year. The Plant will operate 24 hours per day, but could cease operation at any time if water inflows into storages are greater than predicted. It is expected that approximately 50 staff will be required to operate the Plant.

Ground disturbing activities will largely cease after construction and any operational interactions with terrestrial flora and fauna, surface water, groundwater and cultural heritage will be minimal. The PRs have been developed to minimise impacts during operation. For example, the PRs require implementation of methods and management systems to limit impacts on waterways and wetlands during operation.

The Plant will be a permanent structure on the landscape encompassing a number of building elements, car parks and access roads. The Plant is most likely to be at least partially visible at the Powlett River and south of the Bass Highway. The dunes that run parallel to the beach would screen the Plant from the areas immediately adjacent to the ocean and along the beach. The PRs have been developed to minimise the visual impact of the Plant on residential properties and publicly accessible areas. Landscape sensitive design will be integrated into siting and design of the Plant, which could use coastal vegetation and mounding appropriate with the coastal dunes.

Emissions created by the Project (such as dust) will largely be restricted to the construction period. Sealing of the access roads and other parts of the Plant footprint will prevent dust emissions. Components that will produce the most noise at the Desalination Plant will be housed inside the Plant buildings with acoustic controls in place to minimise noise. Modelling of possible Plant operation noise and vibration emissions shows that the Plant will comply with EPA Victoria noise requirements at nearby receptors during normal and adverse weather conditions. While equipment with pumps and mechanical equipment have the potential to generate vibrations, they are not expected to generate any appreciable vibration impacts to sensitive receptors.

14.5 Conclusions

Although the Desalination Project will be the largest in Australia, the technology being used is well known and state of the art. The final design will use advanced technology to desalinate water, whilst minimising impacts to the environment and surrounding community. The Plant will be built under strict construction guidelines, not only conforming to all applicable policies, legislation and guidelines, but adhering to the Performance Requirements and statutory approvals.

During operation, the Desalination Plant will operate according to strict environmental standards, with regular maintenance activities to prevent disruption to operation. The reverse osmosis technology that will be implemented is widely used not only for desalination but also at many other water and wastewater treatment plants around Australia. As with the construction phase, operation of the Plant will be guided by legislation obligations policy, including an EPA license, and is expected to have a minimal impact to the surrounding environment and community.

