3.4.4 Integration pipeline

Construction of the integration pipeline will predominately be carried out using open trenching within existing road reserves. Trenchless methods will be adopted where open trenching is not feasible such as major road crossings. Further detail about the proposed construction methods is provided in Table 3-3.

Table 3-3: Description of construction methods

Method	Description
Trenching	Trenching is an open cut excavation method of installing an underground pipeline, which is required for a majority of the construction of the pipeline alignment. The requirements for trenching will vary depending on specific ground conditions. Trenching requires a disturbance area of approximately 15 m in width for construction purposes which is expected to vary depending on site specific conditions but will not be greater than 30 m. Where the water table is intercepted during trenching, dewatering is likely to be required. Dewatering is not considered to be a risk to the surrounding environment, and management objectives and procedures will be addressed in the Terrestrial Construction Environmental Management Framework (TCEMF).
Trenchless	Trenchless construction involves a tunnel boring machine, pipejacking or horizontal directional drilling to install pipes at a minimum depth of approximately 2 m underground without disturbing the surface. The machine digs or forges an underground path into which the pipeline is installed. A pit is required at each end of the tunnel sections to launch (20 m x 20 m) and retrieve (10 m x 10 m) the pipe using machinery, final dimensions remain subject to confirmation following detailed engineering design.

Additional temporary construction areas will be required along the pipeline route for construction purposes. Figure 3-10 shows the configuration of the pipeline construction corridors that have been considered. The decision to use the restricted construction corridor or the slightly restricted construction corridor will be determined based on the presence of existing services and assets, overhead powerlines, and environmental constraints; however, the maximum construction footprint is expected to be less than 16 m.

Where the pipeline alignment follows the edge of an existing road, one lane of the road will be closed and utilised for construction to minimise the extent of clearing required within the road reserves. In areas comprising native vegetation, the construction corridor will be restricted to a 12 m width, where practicable.

Construction methodology

The following outlines the trenching construction methodology which will be utilised to install the majority of the pipeline route:

- centreline of the alignment will be delineated by a qualified surveyor
- the construction corridor will be delineated and any vegetation to be retained will be flagged
- clearing contractor will remove any required vegetation
- a trench approximately 7 m wide and up to 3 m deep will be excavated and the excavated fill stockpiled on the edge of the trench. The other edge of the trench will be utilised by construction vehicles and the crane used to lower the pipe into the trench

- the pipe will be surrounded with engineered material to keep it in place and to ensure its integrity. The remainder of the trench will be backfilled using either the material originally excavated if suitable or with clean fill imported from a suitable location
- the site will then be restored to its original condition by flattening the surface to ensure it is in line with the surrounding features.

Once construction is complete, Water Corporation require a 5 m wide access corridor above the pipeline to undertake routine maintenance. Any areas of native vegetation cleared in excess of this 5 m wide maintenance corridor for the purpose of construction will be revegetated on completion of installation.

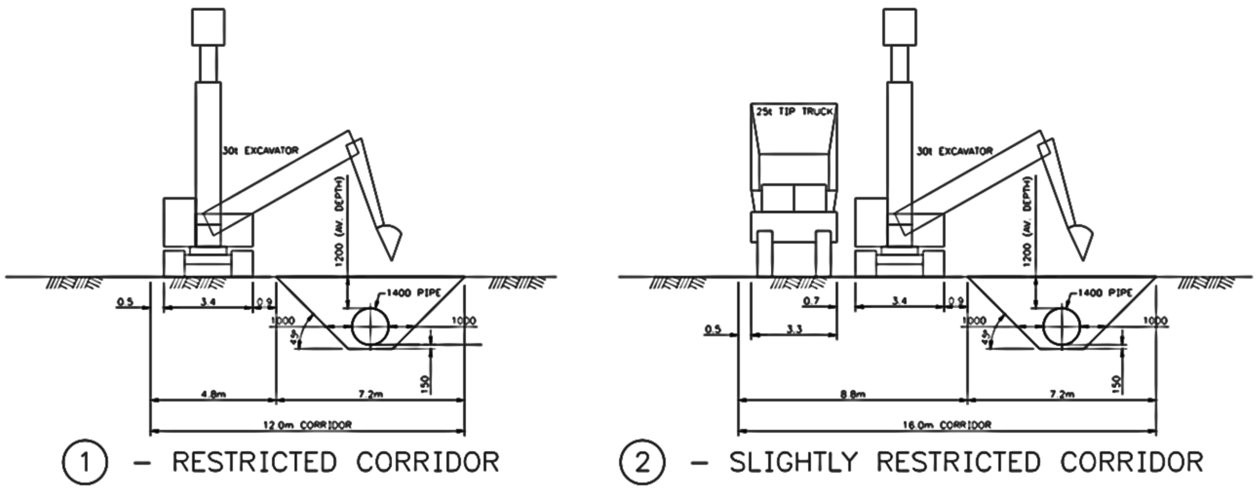

Figure 3-10: Typical cross-section of pipeline construction

3.5 Commissioning

3.5.1 Seawater Desalination Plant

Following the completion of the SDP construction works, a process of systematic testing and commissioning will be commenced which will continue for approximately six to eight months.

The testing and commissioning process will work through each process step of the SDP in sequence to progressively check and prepare the assets for integrated operation.

The testing process involves checks for water-tightness, pressure rating, electrical compliance and general functional checks for equipment. The commissioning process involves disinfection, energisation and performance testing of equipment and sub-systems to validate the operational performance of all process elements. On completion of individual sub-systems commissioning, full integrated testing and commissioning will take place which brings together the operation of all elements into an integrated plant capable of desalinating seawater and producing drinking water.

The testing and commissioning will culminate in performance and reliability tests over two to three months to prove acceptable and reliable performance of the SDP. During this period, treated drinking water will be delivered into the IWSS.

Water used for pressure tests and disinfection will be sourced from either the sea or from a potable water supply connection from the IWSS network. Where possible, water used for tests and disinfection will be recycled and used for subsequent tests to minimise intake and disposal volumes. Once testing and disinfection is complete, the water will be neutralised as required and either discharged to the ocean via the diffuser.

All discharges during testing and commissioning will comply with regulatory environmental discharge requirements (see Section 6.6).

3.5.2 Integration pipeline

The testing and commissioning of the integration pipeline will involve pressure testing and disinfection of the constructed works, typically undertaken in sections. This may occur progressively as the pipeline is constructed. Where practical, pressure test and disinfection water will be reused in subsequent sections.

Water used for pressure tests and disinfection will be sourced from a potable water supply connection from the IWSS network. Once testing and disinfection is completed, the water will be neutralised as required and discharged to the terrestrial environment using infiltration trenches or direct discharge to appropriate locations. All discharges during testing and commissioning will comply with regulatory environmental discharge requirements.

3.6 Operation

3.6.1 Seawater Desalination Plant process overview

The desalination process for the SDP is based on an improved version of the reverse osmosis (RO) system used in Water Corporation's two existing desalination plants (PDSP1 and SSDP). The RO process involves the pre-treatment of seawater (removal of particulates using physical filtration and chemical treatment) and then pressurising it over a RO membrane so that freshwater is driven through and higher salinity seawater is left behind. The concentrated seawater stream is then discharged back to the sea, while the freshwater stream will undergo further post treatment processing to ensure it is of a standard fit for drinking water purposes, before being integrated into the IWSS. The desalination process is shown diagrammatically in the process flow schematic in Figure 3-11.

The ultimate SDP plant will be designed to produce 330 ML/Day of potable water (nominal 100 GL/a). Water Corporation's experience of its existing metropolitan desalination plants has shown that the achievable daily production volumes are nominal because actual production has potential to be greater depending on factors such as seawater temperature and salinity which varies seasonally, and the condition of plant infrastructure such as membranes and pumps (e.g. new vs refurbished). The identification of production efficiencies will minimise the volume of brine discharged to the ocean and may allow Water Corporation to minimise the environmental footprint of its overall operations.

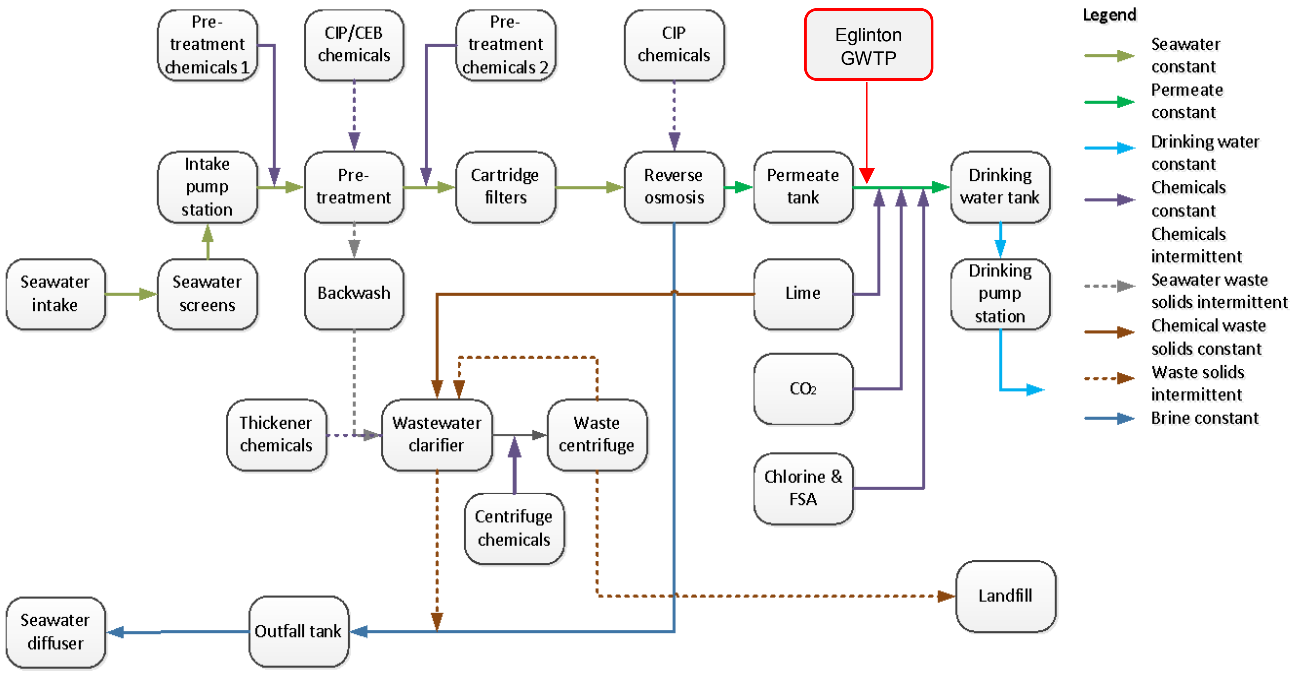

Figure 3-11: Process flow schematic

3.6.2 Maintenance and cleaning

The intake water will be filtered prior to entering the RO facility. Solids collected by the ultrafiltration media will be regularly backwashed into the wastewater holding tank. The solids will then be disposed to an appropriately licensed landfill.

On completion of the backwash, the filters will be rinsed and the rinsate directed to the outlet tank before being discharged to the ocean.

The filters (ultrafiltration and RO membranes) will also be regularly cleaned using commercial ‘clean-in-place’ (CIP) compounds (e.g. ferric sulphate as a coagulant, hypochlorite, small volumes of sulphuric acid and sodium metabisulphite) (Table 3-4).

The CIP chemicals in the backwash do not contain material quantities of the contaminants listed in the ANZECC & ARMCANZ (2000) guidelines (Table 3-5) but do include biocides (e.g. chlorine and DBNPA) and chemicals with the capacity to alter the characteristics (particularly the pH) of receiving waters (e.g. acids). To mitigate the potential environmental impacts associated with the biocides, neutralising chemicals to (i.e. sodium metabisulphite) will be used to neutralise the chlorine and correct pH will be added to the discharge as required. CIP chemicals are used infrequently (~15% of the time).

Table 3-4: Potential chemicals used in Seawater Desalination Plant maintenance

Chemical	Application
Continual discharge	
Antiscalant (likely phosphonate based)	RO system
Flocculant	Waste treatment (thickener)
Intermittent discharge	
Sulphuric acid	MF CIP and CIP neutralisation
Hydrochloric acid	CIP neutralisation
Coagulant	Solids removal
Cationic polymer	Aid coagulation
Sodium hypochlorite	MF CEB/CIP
Sodium hydroxide	CIP neutralisation
Citric acid	MF CEB/CIP and RO CIP
Caustic soda	RO CIP and CIP neutralisation
Detergent	RO CIP
Biocide (DBNPA)	RO CIP
Sodium metabisulphite	CIP neutralisation
Polyelectrolyte for waste centrifuges	Waste treatment (centrifuge)
Rare discharge (e.g. only during commissioning/testing)	
Lime	Potabilisation
Carbon dioxide	Potabilisation
Chlorine – ASDP & GWTP	Potabilisation and groundwater pre-oxidation
Fluorosilicic acid (FSA)	Potabilisation
Polyelectrolyte for lime saturator	Potabilisation

Table 3-5: Toxicants in the Seawater Desalination Plant cleaning chemicals

Category	Toxicant	Presence / absence
Metals and metalloids	CadmiumB	Absent
	Chromium III	Absent
	Chromium VI	Absent
	Cobalt	Absent
	Copper	Absent
	Lead	Absent
	Mercury (inorganic)B	Absent
	Nickel	Absent
	Silver	Absent
	Tributyltin (as µg/L Sn)	Absent
	Vanadium	Absent
	Zinc	Absent
	Aluminium	Absent
	Arsenic	Absent

Category	Toxicant	Presence / absence
	Arsenic	Absent
	Manganese	Absent
	Molybdenum	Absent
	Selenium	Absent
	Selenium	Absent
Non-metallic inorganics	Ammonia	Absent
	Cyanide	Absent
	Chlorine	Absent
	Hydrogen sulphide	Absent
Organics	Benzene	Absent
	Naphthalene	Absent
	Pentachlorophenol	Absent
	Phenol	Absent
	1,2,4-trichlorobenzene	Absent
	Toluene	Absent
	Ethylbenzene	Absent
	Nonylphenol	Absent
	o-xylene	Absent
	m-xylene	Absent
	p-xylene	Absent
	Total xylene	Absent
	Cumene	Absent
	Anthracene	Absent
	Phenanthrene	Absent
	Fluoranthene	Absent
	Benzo(a)pyrene	Absent
	Capacitor 21	Absent
	Aroclor 1016	Absent
	Aroclor 1221	Absent
	Aroclor 1232	Absent
	Aroclor 1242	Absent
	Aroclor 1248	Absent
	Aroclor 1254	Absent
	4,4’-dichlorobiphenyl	Absent
	2,3,4’-trichlorobiphenyl	Absent
	2,2’4,5,5’-pentachloro-1,1’-biphenyl	Absent
	2,4,6,2’,4’,6’- hexachlorobiphenyl	Absent
	Total PCBs	Absent
Surfactants	Linear alkylbenzene sulfonates (LAS)	Absent
	Alcohol ethoxylated sulphate (AES)	Absent

Category	Toxicant	Presence / absence
	Alcohol ethoxylated surfactants (AE)	Absent
Oils and petroleum hydrocarbons	Diesel	Absent
	Total petroleum hydrocarbons	Absent

3.7 Local and regional context

3.7.1 Physical and ecological characteristics of the terrestrial environment

Climate

Alkimos experiences a Mediterranean style climate characterised by mild, wet winters and warm to hot, dry summers. The average rainfall for the area is 613 mm per annum, with the majority falling in winter in association with cold fronts from the southwest. Atmospheric temperatures are highest in January/February and lowest in July/August. Monthly mean maximum temperatures range from 17°C in July/August to 29°C in January/February. Monthly mean minimum temperatures range from 10°C in July/August to 20°C in January/February (BoM 2018).

The wind regime in the Perth coastal region (including Alkimos) is driven largely by the seasonal migration of high-pressure systems to the north in winter and to the south in summer. During the morning, the wind is predominately offshore (from northeast or east), changing to onshore (from west or southwest) with an increase in speed during the mid-afternoon. An onshore wind occurs approximately 40% of the time during afternoon periods in the winter, increasing to 60% of the time during spring and summer, when it reaches speeds between 20 and 30 km/hr. Wind stresses are lowest in late Autumn (April/May).

Geomorphology

The natural geomorphology of the Proposal area is associated with deflation plains and basins surrounded by a parabolic and nested parabolic dune complex of the Quindalup Dunes. Elevations are expected to vary mostly from around 10 m to 20 m above sea-level (Jacobs & WorleyParsons 2018b).

Geology

The geology of the area is dominated by surficial sands over limestone rock. The engineering geological model recognises eight separate engineering geological units (Jacobs & WorleyParsons 2018b):

- fill
- Safety Bay Sand
- cemented Safety Bay Sand
- swamp deposits
- Tamala Sand
- Tamala Limestone
- Ascot Formation
- Osborne Formation (Kardinya Shale Member).

Hydrogeology

The Proposal is located in the Perth Basin, which comprises a regional sedimentary basin up to 12 km thick with several significant aquifers. The key aquifer of interest is the Superficial Aquifer, which is a shallow unconfined regional aquifer. The Superficial Aquifer is made up of multiple geological formations, but in the Proposal area comprises the Safety Bay Sand and Tamala Limestone Formations.

Groundwater flow in the region is westward from the Gnangara Mound towards the coast, where groundwater discharges over a saline wedge. Recharge is primarily from surface infiltration of rainfall and some run-off from the Gingin Scarp.

During geotechnical site investigations, groundwater was encountered at depths ranging from approximately 5.8 to 17.5 mbgl or between 0.2 and 3.2 mAHD (Jacobs & Worley Parsons 2018b).

Soils and topography

The Proposal is located within the Swan Coastal Plain 2 (SWA2 – Swan Coastal Plain subregion) of Western Australia (Mitchell et al 2002). The Swan Coastal Plain comprises five major geomorphologic systems that lie parallel to the coast, namely (from west to east) the Quindalup Dunes, Spearwood Dunes, Bassendean Dunes, Pinjarra Plain and Ridge Hill Shelf (Churchward & McArthur 1980; Gibson et al 1994). The DAF is located largely within the Quindalup Dune system with a portion in the north located in the Cottesloe unit of the Spearwood Dunes. The Quindalup Dune system comprises beach ridges and parabolic dunes, while the Cottesloe unit consists of shallow, yellow-brown sands and exposed limestone (Churchward & McArthur 1980).

The ASDP site is bound by steep-sided high-relief sand dunes to both the north and south of the site, which loosely follow the boundaries of existing conservation areas 9 and 10. The eastern boundary of the site is characterised by moderate relief sand dunes with steep to undulating topography; whilst the western boundary is characterised by a low-relief and gently undulating ridge of shallow limestone rock.

The central part of the ASDP site has gently undulating to flat topography and comprises an area of low elevation, defining a ‘central depression’ bound on all sides by relatively higher ground. The ‘central depression’ is characterised by sands, variably weakly cemented in places, underlain by a layer of peat and clay in the middle and eastern parts of the depression. The peats and clays are up to 1.5 m thick and occur from elevations of around 1 m AHD, near the groundwater table. These deposits are in turn underlain in places by several metres of loose sand which loosely correlate with a potential paleo-channel feature that trends south-east to north across the site and is delineated by tree-lined gullies between sand dunes.

Flora and vegetation

The Proposal is in the Swan Coastal Plain (SCP) Biogeographic Region of the South-West Botanical Province. The SCP bioregion consists of the Dandaragan Plateau and the Perth Coastal Plain and is comprised of a narrow belt less than 30 km wide.

The region is divided into the Dandaragan Plateau and the SCP subregions. The SCP subregion, described by Mitchell et al (2002), is a low-lying coastal plain covered with woodlands dominated by Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. The area includes a complex series of seasonal wetlands and includes Rottnest, Carnac and Garden Islands.

The area contains a number of rare features including Holocene dunes and wetlands and a large number of rare and threatened species and ecological communities.

Extensive clearing has occurred on the SCP for urban and agricultural development, and land use is predominantly cultivation, conservation, urban and rural residential.

Fauna

The environment and fauna habitats of the ASDP site are strongly influenced by dunal systems that are of most recent origin close to the coast. Fauna habitat within the ASDP site can be broadly be described as coastal shrublands overlying Quindalup and Spearwood dune systems. Near coastal localities are dominated by Acacia shrubland and Banksia woodlands dominate the pipeline DAF.

The vertebrate fauna is well documented at a regional level. Much of the fauna is widespread, but there are elements that are confined to the northern Swan Coastal Plain. The area represents the southern limit of the distribution of many species in the region. The region supports a range of conservation significant fauna species, including the Black Cockatoo, Western Brush Wallaby and Quenda. The invertebrate fauna is much less well documented than the vertebrate fauna, but some records of significant (threatened) invertebrate species are available.

3.7.2 Physical and ecological characteristics of the marine environment

The existing coastal environment consists largely of vegetated or partially vegetated sand dunes and sandy, relatively wide beaches. Seagrass and macroalgal communities dominate the shallow coastal waters from the beach to a depth of approximately 23 m (Figure 3-12 A, B). Complex reef structures provide habitats for a wide array of fish and invertebrate species, including western rock lobster (*Panulirus cygnus*) (Figure 3.14 C). The area supports an array of recreational activities from surfing and fishing to SCUBA diving (Figure 3.14 A, B).

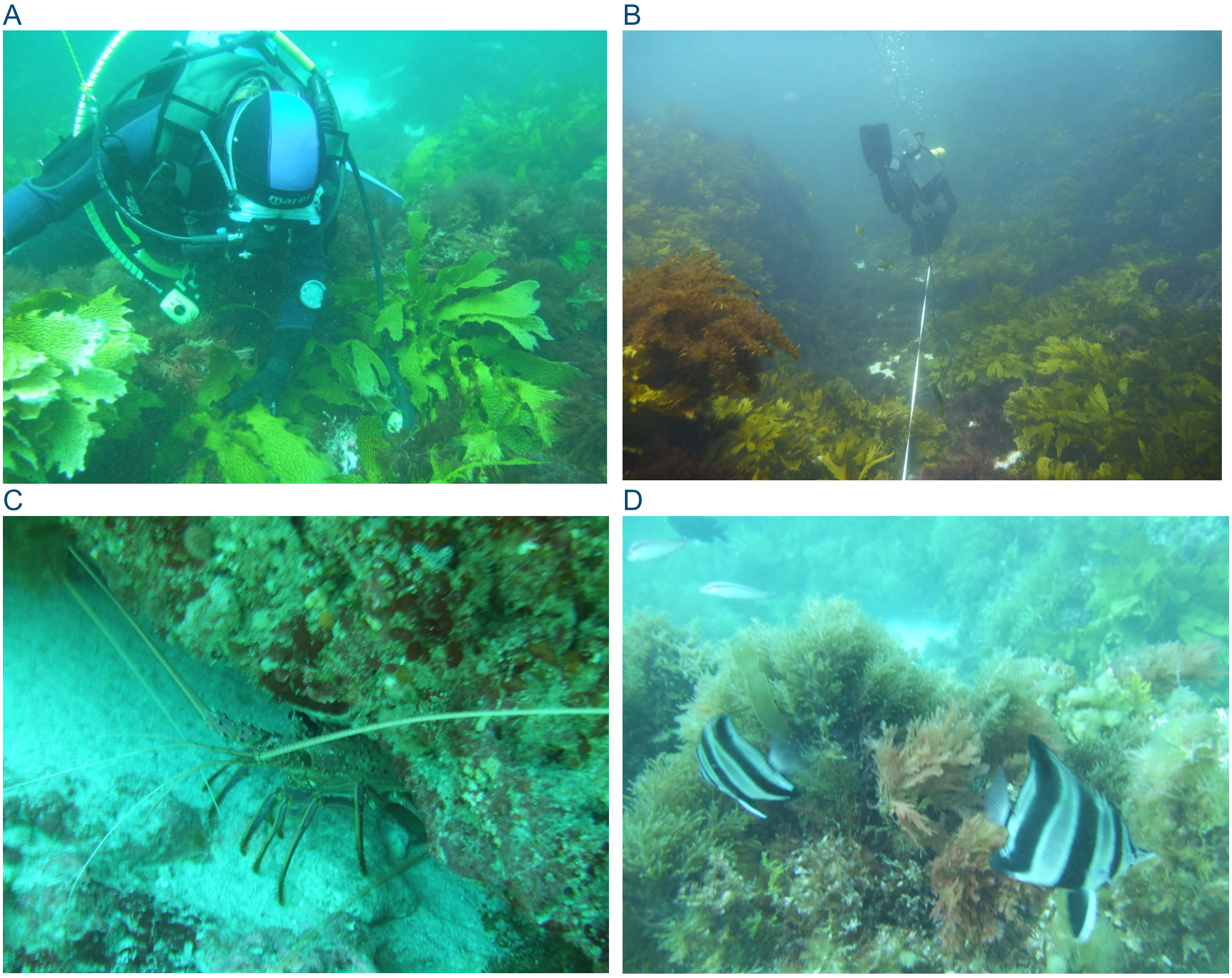

Figure 3-12: Features of the benthic environment at Alkimos

Marine ecology

The ecology of the marine environment in the area is well understood following approximately fifteen years of monitoring undertaken as a condition of Alkimos WWTP operation, and as part of the approvals process. The area is dominated by an extensive network of macroalgae and seagrass communities. Macroalgal communities consisting primarily of the kelp and foliose brown morphological groups, dominate the reef structures, whereas seagrasses tend to predominate in the shallow lagoons near the shoreline.

The benthic environment consists of an inner and outer reef offshore platform separated by a deep (20-23 m), sand dominated lagoon (Figure 3-13). The morphology of the benthic environment varies in rugosity from low relief to complex high relief structures, with networks of crevasses and caves. The reef structures provide habitats for a variety of reef fishes and commercially important invertebrates, including western rock lobster. A search of the EPBC Act Protected Matters Report found the region supports a number of birds, finfish, marine mammals and reptiles of relevance.

Currents

Nearshore currents in the study area can be complex due to interactions between regional currents, local wind-forced currents, waves, and irregularly shaped shallow reef systems. The reef systems offshore from the Alkimos coastline dissipate a significant proportion of ocean wave energy before it reaches the shoreline. However, the irregular bathymetry of the coastal shelf within 3 km of the shore diffract and refract swell waves, producing a complex pattern of nearshore water movement and wave energy which results in a relatively high energy coastal environment. Marine waters offshore from Alkimos are generally well mixed and display minimal stratification due to the energy of the system.

Median depth-averaged current speeds range from 9.9 cm/s in 21 m water immediately offshore of the outer reef to 7.8 cm/s at the existing WWTP outfall to 4.3 cm/s at 10 m depth within the inshore reef. The broader-scale circulation in the region is dominated by the Leeuwin Current, a warm boundary current flowing southward along the edge of the continental shelf. Inshore of the Leeuwin Current, the Capes Current flows northward as a result of upwelling and northward wind stresses and is thus strongest in spring and summer months.

Offshore, dominant mechanisms are a combination of meteorological and oceanographic (non-tidal) flows. Over the inner reef, wave-driven currents become important when waves are large. Due to the complexity of the reef structure, wave effects on mean flows tend to be manifested primarily as shoreward-directed flow over shallow areas and offshore-directed return flows in locally deeper areas.

Waves

The area is exposed to persistently high swell conditions, despite some sheltering to swell originating in the Southern Ocean from Rottnest Island. Annual mean wave conditions approaching the outer reef have been measured at a significant wave height of H_s=1.8m with an associated peak period of T_p=12.2s.

There are two broad categories of waves in the study area: swell waves and sea waves. Swell waves, typically with long periods, are generated over large distances in the Southern and Indian oceans and regularly reach heights of 2 m on approach to the Perth coastline. As they cross the continental shelf, swell waves are refracted from the south-south-west to a more westerly direction.

Sea waves, or local wind-driven waves, have a shorter period and generally travel away from the dominant wind direction and so change their angle of propagation with seasonal changes in wind direction. Sea waves tend to achieve greater wave heights than swell waves (exceeding 4 m under windy conditions). Sea waves tend to only interact with the seabed in relatively shallow waters and so can break onshore at an angle.

Figure 3-13: Alkimos bathymetry

N

Scale 1:35,000 at A4

0 500 1,000 m

Coordinate System:
GDA 1994 MGA Zone 50

Date: 7/03/2019

BMT

WATER CORPORATION

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environment.env@bmtglobal.com | www.bmt.org

Data source: Digital Globe December 2016. Client: Water Corporation, 3/2019. Created by: BMT

3.8 Socio-economic

3.8.1 Alkimos Water Precinct

The SDP is proposed to be located adjacent to Water Corporation's existing Alkimos WWTP on Lot 1050 (approximately 220 hectares) (see Figure 3-14). Alkimos is located approximately 40 km northwest of the Perth CBD in the northwest corridor, north of Quinns Rock beach and south of Yanchep beach.

The Alkimos WWTP is located in the centre of the Lot 1050 which also includes a designated odour buffer. The existing Alkimos WWTP site is primarily reserved for 'public purposes' under the Metropolitan Region Scheme (MRS), with a section zoned 'urban deferred' along the southern boundary of the site.

During the inclusion of the Alkimos WWTP into the MRS as zoned 'public purpose', Water Corporation committed to maintaining three conservation areas within the current WWTP odour buffer as shown in Figure 3-2. Amendment 1029/33 established the 'public purpose' reservation for the Alkimos WWTP and associated buffer; included in this were environmental conditions that require (among other things) retention of portions of the site for conservation purposes (refer Minister for the Environment's Statement that a Scheme May be Implemented (Ministerial Statement 722, published in April 2006).

The proposed SDP intake tunnel is also located in proximity to the existing WWTP outfall which has required due consideration towards mitigating a number of key risks including:

- intake water quality
- separation of assets to eliminate cross contamination
- separation of ocean outfall assets to manage potential plume interference
- management of airborne contaminants
- delineation of operational areas.

The location of the seawater intake structure was selected to ensure sufficient distance between the WWTP outfall (at its ultimate capacity) and the SDP intake (also at its ultimate capacity). The location was verified via hydrodynamic modelling.

3.8.2 Other surrounding land uses

The land between the western edge of Lot 1050 and the high-water mark is Lot 9001 on plan 69492 and registered in freehold title to Water Corporation. Between Lot 9001 and the high-water mark is crown reserve and *Bush Forever* Site 397, which is zoned 'parks and recreation' under the MRS (Figure 3-14). The land between the high tide mark out to the sea is owned by the Crown.

Water Corporation is currently working with LandCorp for the approval of a Local Structure Plan over Lot 9001 for its ultimate development as a residential and mixed-use coastal node. The structure plan indicates the retention by Water Corporation of an approximately 9.7 ha parcel within Lot 9001 to be zoned 'public purpose', for the future use as an infrastructure launching site for potential marine outfall infrastructure associated with the WWTP.

The site is also adjacent to Marmion Avenue to the east existing residential development to the south. The area around the ASDP site supports recreational activities associated with the conservation areas and beach.

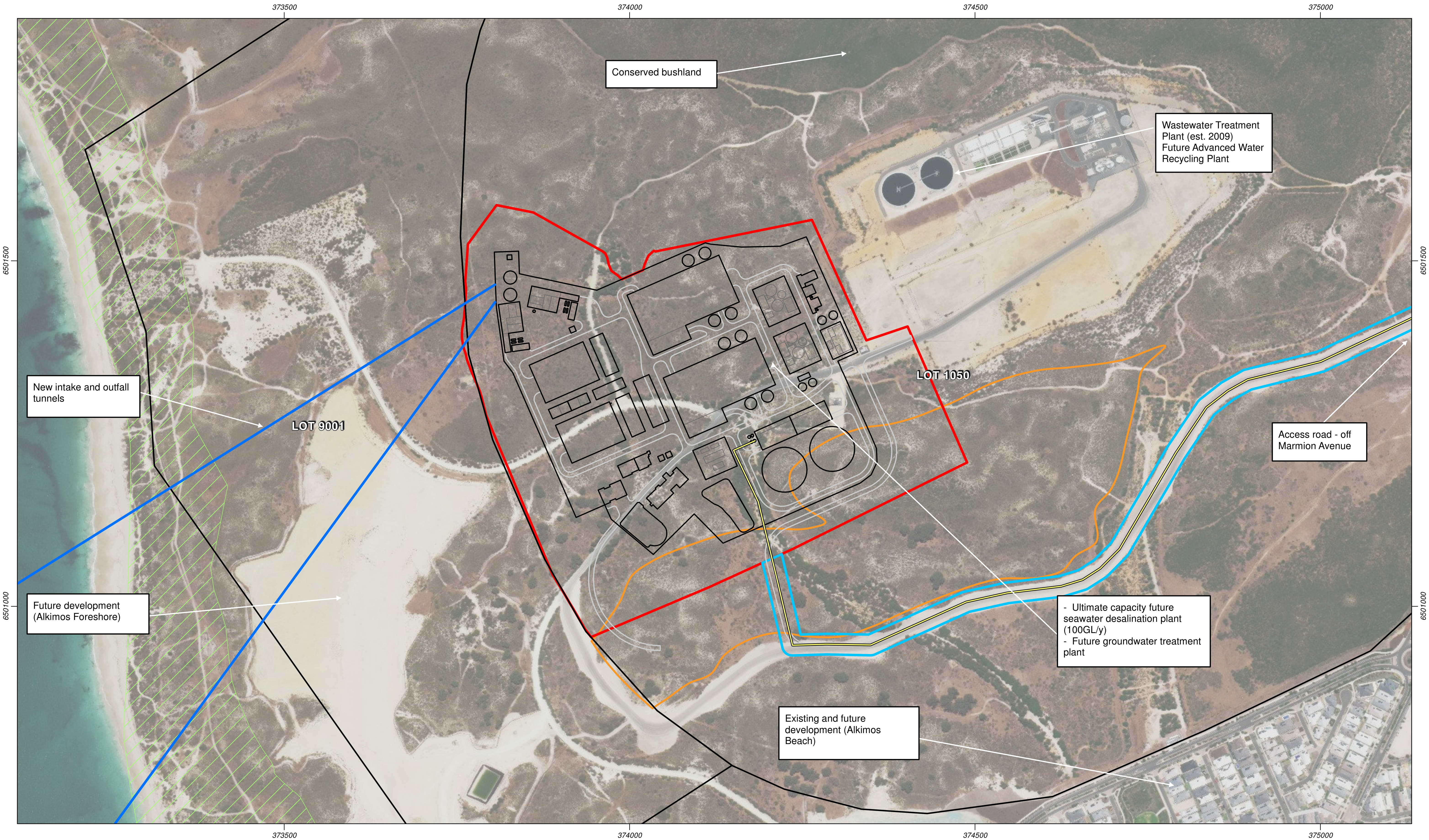

Figure 3-14: Alkimos Water Precinct Infrastructure

N

Scale 1:5,000 at A3

0 100 200 m

Coordinate System: GDA 1994 MGA Zone 50

Date: 18/03/2019

Legend

- Cadastral boundary
- Conservation area 10b
- Bush Forever site 387 (DOP)

Development Area Footprint

- ASDP Site
- Pipeline
- SDP Infrastructure

- Integration Pipeline
- Marine Tunnel
- Buildings
- Roads

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