KWINANA WATER RECLAMATION PLANT (KWRP):
EXPANDING PERTH'S WATER OPTIONS

USE OF CAPE PERON OUTLET PIPELINE TO DISPOSE OF INDUSTRIAL WASTEWATER TO SEPIA DEPRESSION KWINANA

PUBLIC ENVIRONMENTAL REVIEW

WATER CORPORATION OF WESTERN AUSTRALIA

NOVEMBER 2003

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ACKNOWLEDGMENTS

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GLOSSARY OF TERMS USED IN THIS DOCUMENT

TERM	MEANING
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZFA	Australian and New Zealand Food Authority
AOX	Adsorbable organic halogens
APHA	American Public Health Association
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASTM	The American Society for Testing and Materials
A conservative substance	Is a substance (pollutant) which does not degrade, decay or transform in chemical (or biochemical) reactions.
CPOP	Cape Peron Outlet Pipeline
DIN	Dissolved Inorganic Nitrogen
DoE	Department of Environment
end of pipe	*For the industry participants*: at the industry connection to the SDOOL or at the industries diffuser in Cockburn Sound immediately prior to the discharge to the environment. *For the Water Corporation*: at the SDOOL diffuser immediately prior to the discharge to the environment.
EPA	Environmental Protection Authority of Western Australia
EPP	Environmental Protection Policy
EQC	Environmental Quality Criteria
EQO	Environmental Quality Objective
ERMP	Environmental Review and Management Program
GEL	Generally Expected Level
GL	Gigalitre or one thousand megalitres or one billion litres
JBGRS	Jervoise Bay Groundwater Recovery Scheme
KWRP	Kwinana Water Reclamation Plant
LOR	Level of reporting
MF	Micro-filtration - removes particles down to 0.05 μm diameter
mg	milligram or one thousandth of a gram
ML	Megalitre or one million litres
MPC	Maximum Permissible Concentrations
NWQMS	National Water Quality Management Strategy
PCWS	Perth Coastal Waters Study
PER	Public Environmental Review
PLOOM	Perth Long-term Ocean Outlet Monitoring
RO	Reverse Osmosis - hyperfiltration - removes particles down to 0.0001 μm diameter (atomic radius)
SDOO	Sepia Depression Ocean Outlet
SDOOL	Sepia Depression Ocean Outlet Landline
TDS	Total Dissolved Solids
μg	microgram, or one thousandth of a milligram or one millionth of a gram
USEPA	The United States Environmental Protection Agency
WET	Whole Effluent Toxicity testing
WWTP	Wastewater Treatment Plant
ZID	Zone of Initial Dilution

INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. If you are able to, electronic submissions e-mailed to the EPA Service Unit project officer would be most welcome.

The Water Corporation of Western Australia is proposing to construct a plant (the Kwinana Water Reclamation Plant (KWRP)) capable of further treating secondary treated wastewater to a quality suitable for use as high grade industrial processing water by industries in the Kwinana industrial area. This water will replace a similar volume of potable scheme water currently or proposed to be used by industry.

The KWRP project has two distinct components:

1. Treatment of about 24 ML/day of secondary treated wastewater from the Woodman Point Wastewater Treatment Plant (WWTP) to a high quality industrial grade using microfiltration (MF) and reverse osmosis (RO) and supply of this water to industry participants in lieu of scheme water supply. This wastewater reuse is not the subject of this Public Environmental Review (PER) (discharge of KWRP concentrate is discussed below).
2. The receipt and disposal of wastewater streams from the industry participants for disposal via the Cape Peron Outlet Pipeline (CPOP) now known as the Sepia Depression Ocean Outlet Landline (SDOOL), to the Sepia Depression. A single pipeline will take around 7 ML/day of KWRP concentrate plus around 6 ML/day of industrial wastewater from industries back into the SDOOL for discharge offshore. Overall discharge from the SDOOL to the ocean will decrease by about 11 ML/day, and the wastewater discharged will comprise:
    a. Flow from the Woodman Point and Point Peron WWTPs including the Jervoise Bay Groundwater Recovery Scheme (JBGRS) water;
    b. KWRP concentrate; and
    c. Industrial wastewater from participating industries that is presently discharged into Cockburn Sound.

The use of the SDOOL to dispose of industrial wastewater to the Sepia Depression is the subject of this Public Environmental Review (PER).

In accordance with the Environmental Protection Act, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 10 weeks from 8 December 2003 closing on 16 February 2004.

Comments from government agencies and from the public will help the EPA to prepare an assessment report in which it will make recommendations to government.

Why write a submission?

- A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.
- All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the Freedom of Information Act, and may be quoted in full or in part in the EPA's report.

Why not join a group?
If you prefer not to write your own comments, it may be worthwhile joining with a group interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission
You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind
By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER/ ERMP;
- if you discuss different sections of the PER/ ERMP, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach any factual information you may wish to provide and give details of the source;
- make sure your information is accurate.

Remember to include:

- your name;
- address;
- date; and
- whether and the reason why you want your submission to be confidential.

Information in submissions will be deemed public information unless a request for confidentiality of the submission is made in writing and accepted by the EPA. As a result, a copy of each submission will be provided to the proponent but the identity of private individuals will remain confidential to the EPA.

The closing date for submissions is: 16 February 2004.

Submissions should ideally be emailed to
ann.stubbs@environment.wa.gov.au

OR addressed to:

Environmental Protection Authority
PO Box K822 OR Westralia Square, 141 St George's Terrace
PERTH WA 6842 PERTH WA 6000
Attention: Ms Ann Stubbs

EXECUTIVE SUMMARY

PROPONENT

The proponent is the Water Corporation of Western Australia (Water Corporation). The Water Corporation is responsible for the supply of drinking water and wastewater treatment services for the majority of Western Australia's population.

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WASTEWATER REUSE AND KWRP

Treated wastewater is becoming increasingly valued as a water resource, and the Water Corporation has an ongoing commitment to investigate and realise opportunities for wastewater re-use within the framework of the State Government's target of achieving reuse of 20% of the State's treated wastewater by the year 2012. As part of this commitment, the Water Corporation has proposed the Kwinana Water Reclamation Plant (KWRP) project, involving construction of a plant capable of further treating secondary treated wastewater to a quality suitable for use as high grade industrial processing water by industries in the Kwinana industrial area. This water will replace a similar volume of potable scheme water currently or proposed to be used for this purpose.

The KWRP project has two distinct components:

1. Component One

   Treatment of about 24 ML/day of secondary treated wastewater from the Woodman Point Wastewater Treatment Plant (WWTP) to produce a high quality industrial grade water using microfiltration (MF) and reverse osmosis (RO) and supply of this water to industry participants in lieu of scheme water supply, with the process concentrate around 7 ML/day) returned to the Cape Peron Outlet Pipeline (CPOP) now known as the Sepia Depression Ocean Outlet Landline (SDOOL). The KWRP will be designed to initially achieve the current industrial water demand of up to 17 ML/day as detailed in this PER. It is planned, depending upon demand, that the plant may be upgraded in the future to achieve a target industrial water production capacity of approximately 27 ML/day or more. This industrial water production process is not the subject of this Public Environmental Review (PER).

2. Component Two

   The receipt and disposal of wastewater streams from the industry participants for disposal via the SDOOL to the Sepia Depression. A single pipeline will take around 7 ML/day of KWRP concentrate plus around 6 ML/day of wastewater from industries back into the SDOOL for discharge offshore. Overall discharge from the SDOOL to the ocean will decrease by about 11 ML/day, and the wastewater discharged will comprise:

   a. Flow from the Woodman Point and Point Peron WWTPs including the Jervoise Bay Groundwater Recovery Scheme (JBGRS) water;

b. KWRP concentrate; and
c. Industrial wastewater from participating industries that is presently discharged into Cockburn Sound.

Table ES-01 describes the key characteristics of the proposed discharge of the combined Woodman Point, Point Peron, JBGRS and industrial wastewater to the Sepia Depression for the participants as currently proposed (2004) and to the projected final capacity of the SDOOL for 2019.

Table ES-0-1 Key Characteristics of the Kwinana Water Reclamation Project

Parameter	Description		
Location	Sepia Depression Ocean Outlet; approximately 4.1 km offshore west south west of Point Peron, Western Australia		
	Current (2003)	**Current plus initial KWRP (2004)**	**Ultimate Proposal (2019 worst case)**
Industry Reclaimed Water Reuse	0	17 ML/day	up to 27 ML/day
Industry Wastewater Discharge to SDOOL			up to 30 ML/day
Typical	0	6 ML/day	-
Worst Case	0	13 ML/day	-
Combined Treated Wastewater Quantity and Quality discharged to Sepia Depression			
Average Volume			
Typical Case	124 ML/day	113 ML/day	up to 200 ML/day
Worst Case	124 ML/day	122 ML/day	up to 208 ML/day
Suspended Solids	34 mg/L	39 - 42 mg/L	35 mg/L
Biochemical Oxygen Demand (BOD_5)	22 mg/L	24 - 32 mg/L	16 mg/L
Total Nitrogen (TN)	18 mg/L	22 - 32 mg/L	27 mg/L
Total Phosphorus (TP)	10 mg/L	11 - 12 mg/L	12 mg/L
Toxicants	as per PLOOM reporting, 1992 to 2002*	as per Table 4-2, PER	as per Table 4-4, PER
Sepia Depression Ocean Outlet Landline and Diffuser	As previously reported by EPA Bulletin 114, May 1982. No construction or terrestrial or marine ecological disturbance of the existing Sepia Depression Ocean Outlet Landline or diffuser is required for this proposal.		

*HGM 1992; Kinhill 1998a; DAL 1997a, 1997b, 1997c, 2000, 2002; DALSE 2002a, 2002b

WOODMAN POINT WWTP AND SDOOL

Until recently, wastewater from the Woodman Point WWTP was treated to primary level, however, the Woodman Point WWTP upgrade (completed in February 2002) means that treatment is now to a secondary level. The upgrade was undertaken to accommodate expected increases in wastewater flows (from population growth), and to meet the Water Corporation's commitment to the Department of Environment (DoE) to reduce total nitrogen loads discharged to the Sepia Depression ocean outlet to a level below 1994 loadings (estimated as 1,778 tonnes per year).

Nominally in the order of 110 ML/day from Woodman Point WWTP together with approximately 12 ML/day of Point Peron WWTP primary treated wastewater and infrequent minor volumes of MIEX concentrate is discharged 4.1 km offshore via the SDOOL into the Sepia Depression. Currently the SDOOL also receives 1.5 ML/day of groundwater from the JBGRS.

The Water Corporation has monitored the effects of wastewater discharge on the marine environment since the commissioning of the SDOOL and the Sepia Depression Ocean Outlet in 1984. The intensity of monitoring was increased following the Perth Coastal Waters Study (PCWS) from 1992–1994, which led to the development and implementation of the Perth Long-Term Ocean Outlet Monitoring (PLOOM) Programme (1996–2003). The PLOOM Programme was developed based on an understanding of the processes that occur during the discharge of the treated wastewater, and knowledge of the potential effects of treated wastewater on the marine environment. These studies have shown that the contaminant concentrations in treated wastewater discharged via the Sepia Depression Ocean Outlet have not had any measurable environmental impacts.

The upgrade of the Woodman Point WWTP has resulted in major reductions in the loads of suspended solids, bacteria, nutrients and contaminants discharged to the marine environment.

THIS PUBLIC ENVIRONMENTAL REVIEW

Component 2 of the KWRP project will involve the diversion of industrial effluent from specified participating industries (currently: BP, CSBP, Edison Mission Energy) who discharge to Cockburn Sound (under licence from the Department of Environment) to the SDOOL for discharge to Sepia Depression. The Water Corporation is only allowing industries with discharges that will meet its own stringent operational requirements to deliver their flows to SDOOL. The Environmental Protection Authority (EPA) has set the level of assessment for Component 2 of KWRP as Public Environmental Review (PER). The potential marine impacts associated with Component 2 of KWRP are related to the reduction in contaminant loads to Cockburn Sound and the increased loads to Sepia Depression.

The purpose of this document is to meet the 1982 request of the Environmental Protection Authority (EPA) to assess any intention to use the SDOOL to discharge industrial water to the Sepia Depression Ocean Outlet. The Water Corporation has assessed the potential environmental impacts of the KWRP project, and regards the proposal as not being environmentally significant as long as it is managed in accordance with the management framework proposed for governance of this project. Accordingly, the Water Corporation requests that the EPA to report to the Minister for Environment and Heritage on the management framework (governance model) proposed for the sound management of the project. In particular, the Corporation views as essential the continuation of the environmental regulation of the specified industry participants via Environmental Protection Act Part V licences. The Corporation is mindful that the earlier 1982 assessment of the SDOOL was carried out before the proclamation of the current Environmental Protection Act 1986 which put in place approval conditions and compliance requirements. Any relevant recommendations of the EPA from the 1982 assessment have been brought forward in this PER as commitments, thus bringing the management of the SDOOL and Sepia Depression Ocean Outlet into line with current statutory approaches.

The KWRP project will result in small changes to the volume and quality of water discharged from the SDOOL, and offers the combined benefits of responsible wastewater reuse and an overall reduction in environmental impact on Cockburn Sound. The wastewater reused by industry will free up an equivalent volume of potable scheme water. In turn, this reduces the environmental stress on those areas from which scheme water is obtained.

Although this PER briefly outlines the whole KWRP proposal to provide context for changes to the water quality aspects of the SDOOL outlet, it focuses on:

- The potential for marine environmental effects from the KWRP project resulting from the changes in the volume and quality of water discharged from the SDOOL into the Sepia Depression;
- The governance model which is proposed to ensure good environmental management of acceptance of industrial wastes to the SDOOL and their discharge to the Sepia Depression Ocean Outlet while ensuring that the current regulated environmental performance of the industry participants is not reduced;
- The benefits and consequences to Cockburn Sound of the diversion of industry effluent to the SDOOL that is currently discharged into the Sound;
- The consultation undertaken with stakeholders and the public to ensure their views on the proposal have been taken into account; and
- Proponent commitments.

This report demonstrates that the KWRP proposal can be readily managed to meet the Environmental Protection Authority's (EPA's) relevant environmental objectives for Perth's coastal waters if the environmental framework for management (governance model) as described within this document is implemented.

PRESENT LEVEL OF ENVIRONMENTAL IMPACT

Discharges from WWTP's typically contain three classes of contaminants of concern:

1. Pathogens: Organisms (e.g. bacteria, viruses) from faecal material, which are a potential threat to human health from accidental swallowing of contaminated waters during recreational activities, or consumption of uncooked contaminated seafood.
2. Toxicants: Metals and persistent organic compounds which are toxic to marine biota at high concentrations. These may also accumulate in biota at concentrations sufficient to be of concern for human consumption of seafood.
3. Nutrients: Dissolved inorganic forms make-up the majority of the nitrogen and phosphorus discharged from the ocean outlets. These can enhance the growth of aquatic plants in the water column (e.g. phytoplankton) and on the seabed (e.g. reef algae, seagrass epiphytes), which may lead to changes in the abundance and species composition of aquatic plant communities if some species are favoured more than others by the increased nutrient supply. Particulate organic material can also accumulate in sediments and may cause alterations to the abundance and species composition of benthic fauna from the increased food supply, or by depleting of the sediment oxygen.

The Water Corporation has carried out extensive environmental monitoring of the water, sediments and biota in the Sepia Depression and adjacent waters since the commissioning of the Sepia Depression Ocean Outlet in 1984. For most of that study period the wastewater was treated to primary level only. To date, no accumulation of contaminants in sediments and biota has been found. No statistically significant trend of nutrient-stimulated changes in phytoplankton species composition has been detected. (HGM 1992; Kinhill 1998a; DAL 1997a, 1997b, 1997c, 2000, 2002; DALSE 2002a, 2002b). National bacteriological guidelines for shellfish harvesting, primary contact recreation (e.g. swimming) and secondary contact recreation are met well before reaching the reefs and beaches that are the main focus of human activities.

CHANGES IN QUALITY OF WASTEWATER DISCHARGED RESULTING FROM THE KWRP

Until recently, the SDOOL discharged primary treated wastewater from the Woodman Point and Point Peron WWTPs and nitrogen elevated groundwater abstracted from the Jervoise Bay Groundwater Recovery Scheme (JBGRS) to the Sepia Depression.

With the recent upgrade to secondary treatment at Woodman Point WWTP, and the commissioning of the proposed KWRP, the SDOOL will discharge a composite of approximately 86 ML/day secondary treated domestic wastewater from the Woodman Point WWTP, approximately 7 ML/day KWRP concentrate, approximately 6.1 ML/day industrial wastewater, 1.5 ML/day from the JBGRS and approximately 12 ML/day primary treated wastewater from the Point Peron WWTP and infrequent minor volumes of MIEX concentrate to give a total discharge of approximately 112.6 ML/day (current discharge is approximately 123.5 ML/day).

The KWRP concentrate will largely consist of contaminants already entrained in SDOOL in the secondary treated wastewater from Woodman Point. Introduction of 7 ML/day of KWRP concentrate to the SDOOL will return—in slightly concentrated form—the contaminants from 24 ML/day of secondary treated wastewater that is currently discharged from the SDOOL without the KWRP being operational. With the operation of KWRP, the contaminants previously discharged in 110 ML/day of secondary treated domestic wastewater from the Woodman Point WWTP and 1.5 ML/day from JBGRS will be discharged in a volume of 94.5 ML/day. Small amounts of anti-scalant and backwash chemicals (sodium hydroxide, sulphuric acid, sodium hypochlorite and acid detergent) will be added to this through the KWRP process.

The operation of KWRP plus diversion of industrial wastewater discharge from Cockburn Sound to the SDOOL will thus reduce the total flow to the SDOOL, and also cause small increases in the concentrations and loads for a number of contaminants.

Table ES-02 shows the predicted wastewater quality and corresponding loads that will be discharged from the SDOOL to the Sepia Depression under typical KWRP project operating conditions compared with that previously discharged before the commissioning of the KWRP. The levels in the table are for the wastewater at the discharge point (i.e. the diffuser), immediately prior to the dilution that occurs on discharge to the ocean [which is typically a 300-fold to 500-fold dilution within the Zone of Initial Dilution (ZID) (DAL, 2002)].

*Table ES-0-2 Predicted typical wastewater quality discharged to Sepia Depression under current (2003) and typical initial KWRP operating conditions (2004)****

Contaminant	SDOO Discharge Pre KWRP*		SDOO Discharge Post KWRP**	
	Concentration*	Load (kg/day) except where shown otherwise	Concentration	Load (kg/day) except where shown otherwise
Total average daily flow (ML/day)	123.5		112.6	
Thermotolerant coliforms (cfu/ 100 mL)	1,208,921	1.49×10^{15} cfu/day	1,284,119	1.45E+15
Faecal streptococci (cfu/ 100 mL)	212,146	2.62×10^{14} cfu/day	228,419	2.57E+14
Suspended solids (mg/L)	34	4,200	39	4,369
Biological oxygen demand (mg/L)	22	2,667	24	2,744
Ammonia N (mg/L)	7.7	947	9.2	1,034
Nitrate N (mg/L)	8.1	998	9.4	1,057
Total N (mg/L)	18	2,249	22	2,428
Total P (mg/L)	10	1,248	11	1,276
Arsenic (mg/L)	0.0021	0.26	0.0030	0.34
Cadmium (mg/L)	0.0002	0.03	0.0007	0.07
Chromium (mg/L)	0.010	1.24	0.012	1.33
Cobalt (mg/L)	0.005	0.62	0.006	0.69
Copper (mg/L)	0.043	5.32	0.052	5.81
Lead (mg/L)	0.002	0.26	0.003	0.33
Mercury (mg/L)	0.00048	0.06	0.00058	0.07
Molybdenum (mg/L)	0.003	0.37	0.011	1.29
Nickel (mg/L)	0.012	1.47	0.014	1.63
Selenium (mg/L)	0.0030	0.37	0.0034	0.39
Silver (mg/L)	0.0012	0.15	0.0015	0.17
Vanadium (mg/L)	0.006	0.79	0.009	1.01
Zinc (mg/L)	0.08	10.10	0.11	12.52
Phenols (mg/L)	-	-	0.00063	0.07
AOX (mg/L)	0.250	30.5	0.27	30.51

Notes:
** Pre-KWRP discharge includes discharges from Woodman Point WWTP, Point Peron WWTP and groundwater from JBGRS.*
*** Post KWRP discharge includes discharge from Woodman Point WWTP, Point Peron WWTP, groundwater from JBGRS and industrial (CSBP, BP and Edison Mission Energy Energy) discharges.*
**** The figures in table ES-01 are for undiluted wastewater immediately prior to the dilution that occurs close to the diffuser.*

PREDICTED ENVIRONMENTAL EFFECTS OF THE KWRP PROJECT

The EPA has developed and published its position on the environmental values and objectives in Perth's coastal waters (EPA 2000), within which it proposes a high level of ecosystem protection (E2) for the coastal waters surrounding Sepia Depression, including the Shoalwater Islands Marine Park.

Following community consultation, the EPA has developed draft Environmental Quality Objectives (EQOs) and associated Environmental Quality Criteria (EQC) as part of an Environmental Protection Policy for Cockburn Sound (EPA 2002) which the EPA currently uses as a template for management of coastal waters in Western Australia. The EQOs include

Maintenance of Ecosystem Integrity, Maintenance of Seafood for Human Consumption, Maintenance of Aquaculture, Maintenance of Primary and Secondary Contact Recreation, and Maintenance of Aesthetic Values.

The Water Corporation has applied the Cockburn Sound E2 (high level of protection) EQC's for EQO 1 for this proposal, consistent with the EPA's position as stated in the EPA documents. This has provided a high level of conservatism because past concentrations higher than the Cockburn Sound E2 levels have not resulted in measurable environmental harm, as demonstrated by more than 10 years of data collected under the Perth Coastal Waters Study and the PLOOM monitoring program. These results are reported regularly to the EPA and public (HGM 1992; Kinhill 1998a; DAL 1997a, 1997b, 1997c, 2000, 2002; DALSE 2002a, 2002b). Accordingly, the relevant E2 criteria can be found in Tables 4-2, 4-3 and 4-4 of this report.

Although the Cockburn Sound EPP E2 criteria are referred to and used in this document as the acceptable level of environmental performance, the Water Corporation is fundamentally committed to doing even better within the framework of its Triple Bottom Line (social, economic and environmental) approach to providing a service to society.

Maintenance of Ecosystem Integrity

Assessment of the KWRP project demonstrates that the wastewater plume from the Sepia Depression Ocean Outlet will undergo no effective change in the size of the zone of initial dilution (ZID), and the relevant EPA (2002) toxicant EQC will be met at the edge of the ZID. Further, extensive monitoring in the Perth Long-term Ocean Outlet Monitoring (PLOOM) programme has found no evidence of metal or pesticide accumulation in the sediments or in sentinel organisms, even when primary treated wastewater was discharged.

For the KWRP proposal, the concentrations of contaminants after initial dilution of wastewater within the ZID of the Sepia Depression Ocean Outlet were calculated and compared against EPA (2002) high protection EQC. A conservative 'worst case' instantaneous dilution of 1:250 was used for these calculations (measurements and modelling suggest that dilutions are typically 300-fold to 500-fold). The results showed that all contaminants other than mercury were well below the EQC, many by a factor of 10-fold or more (the prescribed EQC for mercury appears to be in error as it is below natural background levels in seawater). Mercury concentrations after initial dilution within the ZID will be within a few percent of natural background levels in seawater.

Contaminant concentrations also remained below EQC (except for mercury as discussed), under the following conditions:

- Low flow and peak flow of domestic wastewater from the Woodman Point WWTP (and therefore differing dilutions of KWRP concentrate and industrial wastewater);
- Inclusion of KWRP cleaning wastes once a fortnight (when build-up of secondary wastewater 'scale' on the RO membranes is cleaned and discharged along with KWRP concentrate); and
- The worst case industrial discharge scenario (all industries simultaneously discharging maximum flows of worst permitted wastewater quality).

The efficient operation of the KWRP also requires the addition of small amounts of anti-scalant to ensure that blocking of reverse osmosis membranes is minimised. These will be discharged from the Sepia Depression Ocean Outlet at a concentration of about 0.5–0.8 mg/L. There are no specific EQC for anti-scalants used in the KWRP (as they are proprietary products). However, toxicological data for the primary ingredients in these compounds indicate that the anti-scalant will be discharged at concentrations many orders of magnitude below harmful levels. Again, these calculations are conservative. The Water Corporation have also committed to enhancing their Whole Effluent Toxicity (WET) testing programme to confirm this assessment. A low level of sodium hypochlorite is dosed into the inlet to the KWRP, which reacts with ammonium present in the feedwater to form chloramines. The chloramine controls biological growth in the KWRP process. Dosing of sodium hypochlorite is limited to very low levels, to ensure no free chlorine is present in the dosed water, as this would irreversibly damage the RO membranes.

Other EQOs

In terms of pathogens, the KWRP acts to kill off the pathogens in the wastewater diverted to KWRP, and so the total mass of bacteria discharged (the load) to the Sepia Depression will be slightly reduced (see Table ES-02). There will be a slight increase in bacterial concentrations in wastewater discharged. This is caused by the slightly lower volume of wastewater entering SDOOL to dilute primary treated wastewater from the Point Peron WWTP.

In terms of nutrients, the present discharge of nitrogen to the Sepia Depression is approximately 821 tonnes/year, which is around one-third of the approximately 2400 tonnes/year discharged in 2001 prior to the upgrade of the Woodman Point WWTP. The KWRP proposal will result in a slight increase in nitrogen loads, to approximately 886 tonnes/year—still well under (i.e. 37%) of the previous discharge of 2400 tonnes/year. More importantly, this slight increase in nutrients to the Sepia Depression will be from the diversion of nutrients that are presently discharged into the more sensitive Cockburn Sound environment, resulting in even greater benefit to Cockburn Sound (see below).

There is no aquaculture within the region affected by the discharges from the Sepia Depression Ocean Outlet.

Consequences for Cockburn Sound

The KWRP proposal is designed to replace potable scheme water use with treated wastewater on the Kwinana industrial strip. There is no change in total groundwater extraction by industry. There is a net benefit to Cockburn Sound in that industrial wastewater currently discharged to Cockburn Sound by the specified industries under DoE licence will now be diverted to the SDOOL.

Environmental benefits

The KWRP Proposal will produce a number of benefits, as follows:

- Nutrients, hydrocarbons and metals currently being discharged to Cockburn Sound by industry will be discharged to the Sepia Depression, which has a far greater capacity to receive these without sustaining environmental harm;
- A decrease in industrial demand for potable scheme water in the Perth Metropolitan area (Kwinana industry currently uses about 8 GL/annum of potable scheme water, and demand is expected to double in the next 10 years) which can be re-allocated to meet domestic demands;
- A reduction in demands on the $275 million Stirling-Harvey Redevelopment Scheme that is intended to meet projected increases in demand; and
- The implementation of a wastewater recycling system which can be expanded to meet future demand by industry without impacting on domestic water supplies.

ALTERNATIVES

The only alternatives to this proposal are to either, not proceed with the treated wastewater reuse scheme or, to proceed but maintain current industrial discharges to Cockburn Sound. Neither of these options would be preferable to the scheme proposed on environmental grounds.

TIMING

The Water Corporation awarded a Design and Construct contract for the KWRP treatment plant for the production of high grade industrial water supply to industry in April 2003. Construction of the treatment plant commenced on-site in September 2003. The completion date for treatment plant is July 2004. To meet the completion date of July 2004, testing and commissioning of the treatment plant will need to begin in May 2004. It is proposed that KWRP testing will begin prior to May 2004 and this will include discharge of KWRP concentrate to the SDOOL. Commissioning and acceptance of industrial wastewater for injection into SDOOL will not commence prior to environmental approvals being granted to do so, anticipated to be before May 2004.

ENVIRONMENTAL COMMITMENTS

The Water Corporation commits to the following actions and performance in the environmental management of the KWRP and SDOOL:

1. To attain an average dilution of the SDOOL wastewater stream of at least 1:300 with the dilution being above 1:200 at least 99% of the time within 100 metres of the centreline of the surface expression of the Sepia Depression Ocean Outlet (SDOO) diffuser.
2. To only accept wastewater from Kwinana Water Reclamation Plant (KWRP) industrial participants who demonstrate compliance with the relevant licences and/or Ministerial conditions issued to them, or as otherwise authorised by the DoE from time to time
3. To manage the discharge of treated wastewater to Sepia Depression, including that accepted from KWRP industrial participants and future expansion of the wastewater treatment system to ensure that the concentration of toxicants from the SDOOL discharge meets relevant EQC at the boundary of the ZID.
4. To continue to model, monitor and annually report the effects of wastewater discharge to Sepia Depression through the PLOOM program.
5. In the event that toxicants in the treated wastewater exceed concentrations which will result in the EPA's relevant high protection EQC being exceeded following 1:250 initial dilution, specific investigations will be conducted with the relevant KWRP industrial participants and in consultation with the DoE into the source and cause of the identified condition, the risk presented by it to ecological processes and any measures necessary to mitigate those risks.
6. To undertake Whole Effluent Toxicity (WET) testing generally following the testing principles contained in the USEPA, APHA and ASTM protocols at a NATA accredited laboratory in accordance with the protocols set out in ANZECC/ARMCANZ 2000, carrying out this testing three times in the first year, thereafter annually and following any significant change to operations.
7. To include the KWRP in the Corporate Environmental Management Plan which will address the following:
    - Routine sampling of contaminant levels in all streams of wastewater returned to the SDOOL;

- Processes for developing routine environmental acceptance criteria for quality of wastewater to be accepted into SDOOL for possible future participants that are not part of this proposal;
- Procedures to be implemented consistent with the Governance Model if wastewater contamination exceeds the Water Corporation's water quality criteria for acceptance to the SDOOL;
- Any amendments to environmental monitoring required to demonstrate that all relevant EQO's are being met and for detection of potentially unacceptable trends; and
- Procedures for reporting to the Environmental Protection Authority, Department of Environment and the public in accordance with existing statutory and Water Corporation EMS reporting requirements.

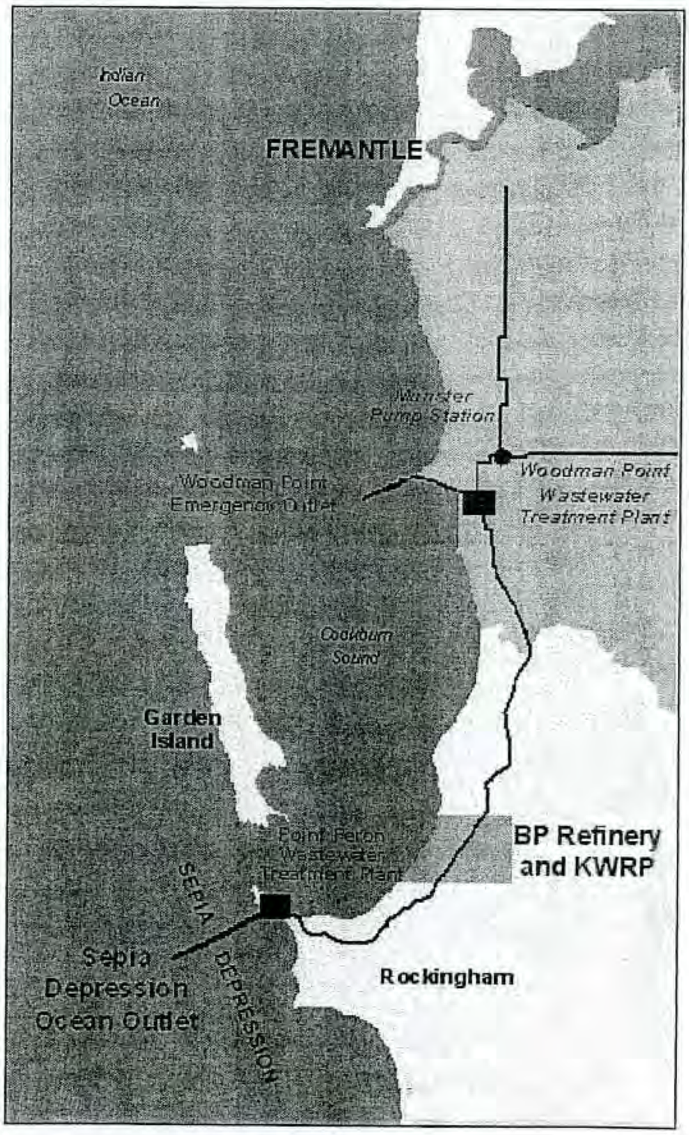
8. To prepare and implement, or modify existing management plans and operational procedures to incorporate matters arising from the KWRP to address:
    - Noise and vibration;
    - Storage and handling of chemicals;
    - Occupational health and safety; and
    - Risk;
9. To incorporate into the Water Corporation's Customer Service Program a community engagement plan to:
    - Raise awareness and understanding of the project;
    - Ensure that reports on KWRP environmental performance are readily available to the public;
    - Ensure that the results of PLOOM monitoring are readily available to the public;
    - Provide a complaints/response process to address matters arising from the project in accordance with the Water Corporation Environmental Management System.
10. To further refine the notional social EQO S2 and S3 EQC values and boundaries for treated wastewater discharge to the marine environment in close consultation with the Health Department and other relevant authorities.

1. INTRODUCTION

1.1 HISTORICAL BACKGROUND

The Water Corporation of Western Australia (Water Corporation) treats domestic wastewater from the majority of Perth's southern metropolitan suburbs at its Woodman Point Wastewater Treatment Plant (WWTP). Until recently, this wastewater was treated to primary level, and then discharged, together with the primary treated wastewater from the Point Peron WWTP, 4.1 km offshore via the Cape Peron Outlet Pipeline (CPOP), now known as the Sepia Depression Ocean Outlet Landline (SDOOL) into the Sepia Depression. In 2001, the SDOOL received primary treated wastewater from both the Woodman Point WWTP (typical daily discharge approximately 110 ML/day) and Point Peron WWTP (typical daily discharge approximately 12 ML/day).

Figure 1-1 Location of the Sepia Depression Ocean Outlet (SDOO) and the Kwinana Water Reclamation Plant (KWRP)



The Woodman Point WWTP's original design flow capacity was 125 ML/day, which will be exceeded during peak flow periods in the near future, and so the plants capacity required upgrading. The upgrade was also undertaken to meet the Water Corporation's commitment to the Department of Environment to reduce total nitrogen loads discharged to the Sepia Depression ocean outlet to a level below 1994 loadings (estimated as 1,778 tonnes). The Water Corporation upgraded the Woodman Point WWTP to treat wastewater to advanced secondary level, and to accommodate an annual average daily flow up to 160 ML/day (expected to be reached in 2019). The upgrade was completed on 20th February 2002.

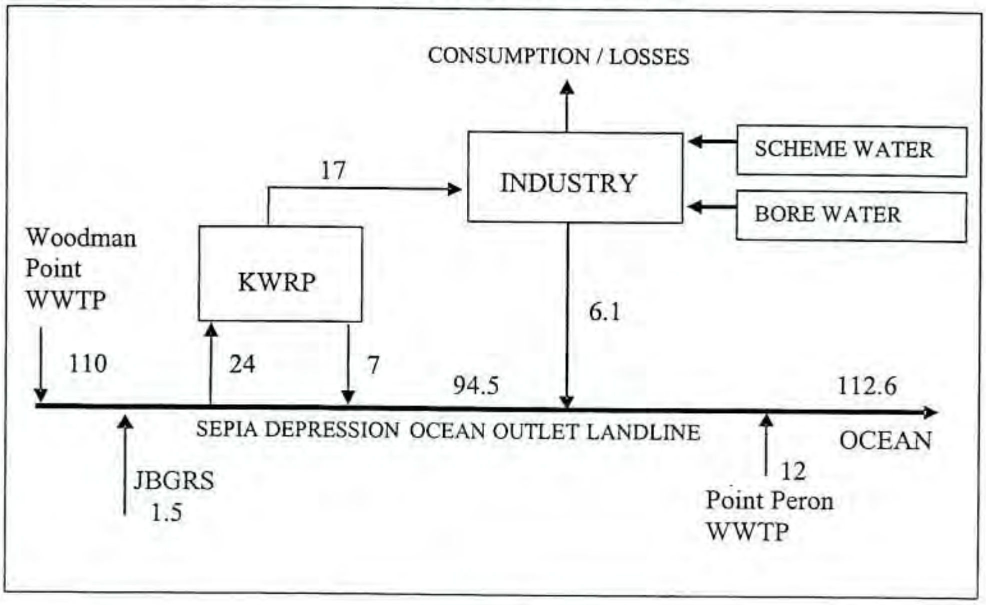
Upgrading the Woodman Point WWTP to advanced secondary treatment has resulted in significant reductions in the loads of bacteria, nutrients and contaminants in the wastewater being discharged to the marine environment. Treated wastewater is also becoming increasingly valued as a water resource (rather than just a waste to be disposed of), and so opportunities for water re-use are being pursued for reasons of responsible water use as well as reducing environmental impacts wherever possible.

1.2 TREATED WASTEWATER REUSE: WATERLINK

As part of its commitment to investigate opportunities for re-use of treated wastewater, the Water Corporation has undertaken the 'WaterLink' programme with local industries. The WaterLink programme involves building a Kwinana Water Reclamation Plant (KWRP) (located within the boundary fence of the existing BP Refinery, Kwinana). Production of high quality industrial water from the Woodman Point WWTP wastewater stream using microfiltration (MF) and reverse osmosis (RO) will initially be 8.7 ML/d, expanded in the first 6 months to approximately 17 ML/day. At ultimate design capacity it is planned that the plant will be capable of producing around 27 ML/d, depending upon demand in the future.

The high quality industrial water produced by the KWRP will be suitable for use as industrial processing and cooling water by industries in the Kwinana area. A single pipeline will take around 7 ML/day of KWRP concentrate plus around 6.1 ML/day of wastewater from specified industries back into the SDOOL for discharge offshore. Figure 1-2 shows the schematic flow diagram and water balance for the KWRP project.

Figure 1-2 Typical flow diagram and water balance for Sepia Depression Ocean Outlet Landline post-KWRP (i.e. 2004) (all values in ML/day)



Overall discharge from the SDOOL to the ocean will decrease by the order of 11 ML/day, but the wastewater discharged will continue to include flow from the WWTP's, with the additional input of KWRP concentrate, and industrial wastewater. The amounts of nutrients and contaminants being discharged to the Sepia Depression Ocean Outlet will, however, be far lower than those previously discharged when Point Peron and Woodman Point WWTPs were both discharging primary treated wastewater.

1.3 HISTORY OF ENVIRONMENTAL APPROVAL OF THE SEPIA DEPRESSION OCEAN OUTLET LANDLINE INTO SEPIA DEPRESSION AS CONTEXT FOR THE KWRP PROPOSAL

The Environmental Review and Management Programme (ERMP) for the Cape Peron Outlet Pipe (CPOP, now known as SDOOL) was first assessed by the Environmental Protection Authority in 1982 under the previous Environmental Protection Act (1971). At that time the EPA (and Minister) had no statutory means of ensuring that their requirements and recommendations were implemented, and no legally binding Environmental Conditions could be set.

The EPA report of 1982 included in its conclusions three statements of relevance to the KWRP Proposal, namely:

"*The Cockburn Sound Environmental Study clearly showed that it was not environmentally acceptable to continue to dispose of primary treated wastewater in Cockburn Sound and that an alternative must be found.*" (EPA, 1982, p.17, paragraph 3)

"*This proposal has been based on a sound environmental approach by first identifying the existing beneficial uses of the marine water and then* *designing the outlet so that none of these existing uses will be adversely affected.*" (EPA, 1982, p.17, paragraph 4).

"*Having considered the ERMP, the associated technical data, and the public submissions, the EPA finds that the proposal to construct and operate a wastewater discharge pipeline from Woodman Point to Sepia Depression, discharging 4km off Cape Peron in a water depth of 20m is environmentally acceptable with the following recommendations.*" (EPA, 1982, p.17, final paragraph).

A copy of all the recommendations made by the EPA in 1982 is provided in Appendix A. The Water Corporation has met all the requirements of recommendations 1, 2 and 5 and is meeting the requirements of recommendations 3 and 4 through the referral of the KWRP Proposal. These recommendations stated:

Recommendation 3
"*The Board* (Metropolitan Water Supply, Sewerage and Drainage Supply Board at that time) *continue and where possible expand its current research and trials on wastewater treatment, reuse, and groundwater recharge.*" (EPA, 1982, p.20)

Recommendation 4
"*Should the Board or any other body or person propose to use the Cape Peron outlet to dispose of industrial or other wastes which will alter the composition or character of the effluent, then a separate ERMP will be required. The EPA will then consider the proposal in terms of the receiving water quality and environmental effects, and recommend whether or not such a discharge should be permitted.*" (EPA, 1982, p.20)

At the time the EPA reported in 1982, the only mechanism for a "formal" EPA assessment was an ERMP, and in 1999 the Water Corporation sought clarification of the EPA's requirements for the above Recommendation 4, in the light of the new Environmental Protection Act, 1986.

The EPA Chairman advised on 25 May 1999 that the Water Corporation "*is not legally obliged by Recommendation 4 of the Report to conduct an ERMP if the disposal of industrial wastes or other wastes alter the composition or character of the effluent. This is because Recommendation 4 does not have continued effect under the 1986 Act and, in any event, the 1971 Act did not impose any enforceable obligation to follow the recommendation.*" He went on to indicate that, if the proposal to dispose of treated wastewater is likely to have a significant effect on the environment the proponent is obliged to refer it to the EPA under Section 38 of the 1986 Act.

Currently, the only marine environmental requirement for the quality of the wastewater discharged to Sepia Depression is that the monitored levels of faecal bacteria in the area excluded from primary contact are as shown on the best practice environmental licence.

1.4 THIS DOCUMENT

The Water Corporation referred the KWRP proposal to the EPA in March 2003. A level of assessment was set at Public Environmental Review (PER) and this document is submitted to meet that requirement, specifically to:

- meet the intent of the 1982 requirements, even though the Water Corporation is under no legal obligation to do so; and
- demonstrate to the EPA and the community that the water quality of the marine environment will not be adversely affected by the diversion of industrial wastewater from Cockburn Sound to Sepia Depression, in accordance with the intention of the EPA to assess the effects on water quality of any change to the character or composition of the effluent.

This PER for the KWRP Proposal briefly outlines the whole proposal and focuses on:

- The potential environmental impacts on the marine environment of the KWRP project resulting from the proposed changes in the volume and quality of water discharged from the SDOOL into the Sepia Depression;
- The governance model which will ensure:
  - good environmental and commercial management of acceptance of industrial wastewater to the SDOOL and subsequent discharge to the Sepia Depression, and
  - that industry maintains the current level of environmental performance;
- The benefits and consequences to Cockburn Sound of diverting the specified industrial wastewaters from the Sound to the Sepia Depression;
- The consultation undertaken with stakeholders and the public to ensure their views on the proposal have been taken into account; and
- Proponent commitments associated with managing the proposal.

1.5 KEY CHARACTERISTICS OF THE PROPOSAL TO DISCHARGE TO SEPIA DEPRESSION

Table 1-1 describes the key characteristics of the proposed discharge of the combined Woodman Point, Point Peron, JBGRS and industrial wastewater to the Sepia Depression for the participants as currently proposed (2004) and to the projected final capacity of the SDOOL for 2019.

Table 1-1 Key Characteristics of the Kwinana Water Reclamation Project

Parameter	Description		
Location	Sepia Depression Ocean Outlet; approximately 4.1 km offshore west south west of Point Peron, Western Australia		
	Current (2003)	**Current plus initial KWRP (2004)**	**Ultimate Proposal (2019 worst case)**
Industry Reclaimed Water Reuse	0	17 ML/day	up to 27 ML/day
Industry Wastewater Discharge to SDOOL			up to 30 ML/day
Typical	0	6 ML/day	-
Worst Case	0	13 ML/day	-
Combined Treated Wastewater Quantity and Quality discharged to Sepia Depression			
Average Volume			
Typical Case	124 ML/day	113 ML/day	up to 200 ML/day
Worst Case	124 ML/day	122 ML/day	up to 208 ML/day
Suspended Solids	34 mg/L	39 - 42 mg/L	35 mg/L
Biochemical Oxygen Demand (BOD_5)	22 mg/L	24 - 32 mg/L	16 mg/L
Total Nitrogen (TN)	18 mg/L	22 - 32 mg/L	27 mg/L
Total Phosphorus (TP)	10 mg/L	11 - 12 mg/L	12 mg/L
Toxicants	as per PLOOM reporting, 1992 to 2002*	as per Table 4-2, PER	as per Table 4-4, PER
Sepia Depression Ocean Outlet Landline and Diffuser	As previously reported by EPA Bulletin 114, May 1982. No construction or terrestrial or marine ecological disturbance of the existing Sepia Depression Ocean Outlet Landline or diffuser is required for this proposal.		

*HGM 1992; Kinhill 1998a; DAL 1997a, 1997b, 1997c, 2000, 2002; DALSE 2002a, 2002b

2. THE KWINANA WATER RECLAMATION PLANT (KWRP) PROPOSAL

2.1 OVERVIEW

2.1.1 Supply

The Kwinana Water Reclamation Plant (KWRP) will process secondary treated wastewater from the Woodman Point WWTP to high quality industrial grade water (total dissolved solids [TDS] concentration 40–50 mg/L) using microfiltration (MF), reverse osmosis (RO) and chlorination. This high quality water will then be supplied to industries in the Kwinana industrial area to replace potable scheme water for use in industrial processes.

2.1.2 KWRP concentrate

KWRP concentrate will largely consist of substances removed from secondary treated wastewater, plus small amounts of anti-scalant and backwash chemicals (sodium hydroxide, acid, sodium hypochlorite and acid detergent). Thus, introduction of KWRP concentrate to the SDOOL will mainly return—in a concentrated form—substances from secondary treated wastewater that would be discharged to the Sepia Depression if the KWRP was not operational.

2.1.3 Industrial water balance: existing industries

The BP Refinery (Kwinana) (BP) intends to replace a number of existing potable water uses with KWRP water. BP's treated wastewater that was previously discharged to Cockburn Sound will be discharged to the SDOOL. There will be no change in BP's groundwater usage.

CSBP Ltd (CSBP) will partially replace a number of existing groundwater uses with KWRP water and will supply some of its groundwater to Tiwest. CSBP will discharge treated wastewater to the SDOOL that previously was discharged to Cockburn Sound.

The Tiwest Joint venture (Tiwest) will use the groundwater supplied from CSBP to replace a number of existing potable scheme water uses. At present Tiwest's wastewater is not suitable for safe ongoing discharge to the SDOOL. However, it is Tiwest's long-term objective to discharge to the SDOOL, and Tiwest and the Water Corporation are currently in negotiations on this matter. Until these negotiations are concluded Tiwest will continue to discharge to Cockburn Sound. As some form of further treatment may be needed, the Water Corporation does not know the composition or volume of possible Tiwest discharge to the SDOOL at this stage.

Edison Mission Energy (EME) will replace some existing scheme water uses (cooling towers and steam generation) with KWRP water. EME will discharge wastewater (saline blowdown) to SDOOL that was previously discharged to the Cockburn Sound via the BP discharge.

2.1.4 Industrial water balance: future industries

The KWRP project will also provide HIsmelt with an alternative to scheme water.

2.1.5 KWRP discharge

A single pipeline will take KWRP concentrate plus wastewater from industries back into the SDOOL for discharge offshore in the Sepia Depression. The introduction of industrial wastewater to the Sepia Depression line will cause small increases in the concentrations and loads of some substances, which would otherwise be discharged to Cockburn Sound. Based on the anticipated quality of water supplied by the KWRP, industry will need lower quantities of some additives (eg. zinc phosphonate) to protect their processing infrastructure than required with the present water supply. Consequently the load of substances discharged by industry collectively to the Sepia Depression via the SDOOL may be less than currently discharged into Cockburn Sound. This proposal does not allow any of the specified participating industries to increase their discharge of contaminant loads to the marine environment.

2.1.6 Impacts on groundwater abstraction

The KWRP project is not known to have any effect on current groundwater abstraction regimes.

2.2 THE KWRP FACILITY

A description of the Kwinana Water Reclamation Plant is provided here for background information and completeness. This plant and the supply of industrial water is not the subject of this PER.

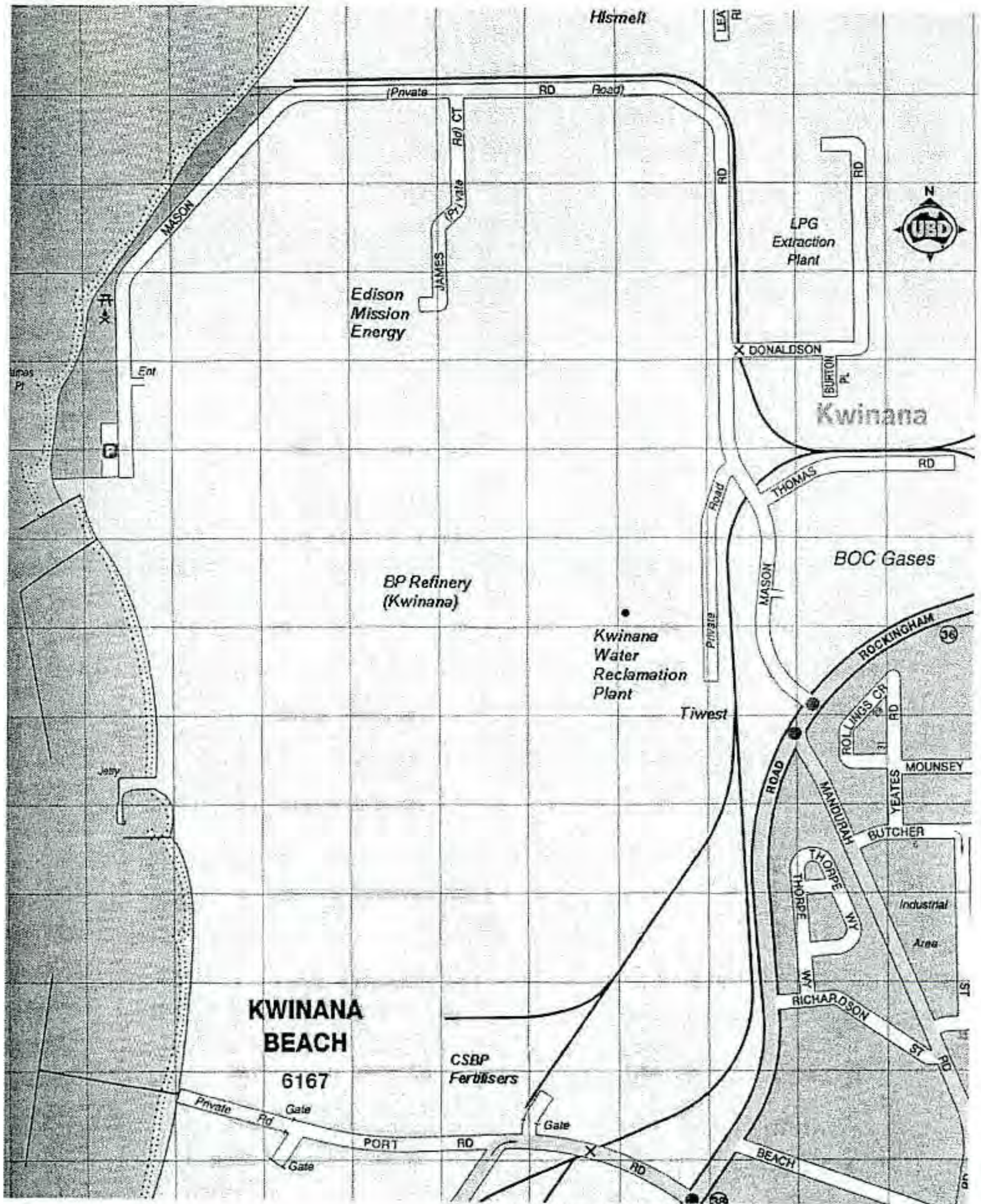
2.2.1 The KWRP site

KWRP is being constructed on BP land near the boundary adjoining Tiwest (Figure 2-1). The KWRP site will occupy in the order of 25,000 square metres and will be fully enclosed by security fencing.

The site will be designed to ensure that no substances from the process enter the soil on the site throughout the life of the facility. The soil on the site will be certified as complying with the same industrial criteria prior to the return to the owner at the end of any lease period.

The on-site plant will consist of the water treatment system (enclosed in a 30m x 100 m building) and includes three external process water storage tanks and two covered product water storage ponds. The site building will accommodate most of the processing equipment including; pumps, RO and MF membrane systems, chemicals, cleaning equipment, switchboards, control equipment, administration facilities, ablutions and a laboratory. The building will incorporate loading doors to provide access for the service of all equipment within the building. The site will also incorporate surface drainage for stormwater, paved service access, parking and hard stand areas for external tankage and other free-standing equipment and structures located on the site.

Figure 2-1 Proposed location of the KWRP



Modified from UBD Perth Street Directory 2002, Map 426

The administration section of the building will consist of an office and communications facilities for four people, plus a fully functional laboratory that is sufficient to meet all operating requirements of the facility. There will be internal access between the plant and administration sections of the building.

The plant section of the building will be illuminated to standard lighting levels for industrial facilities. Offices within the plant section of the building and the administration section of the building will be illuminated to standard lighting levels for commercial office facilities. The facility compound will also be illuminated for night-time safety and security.

Manual fire fighting equipment will be provided in accordance with all statutory requirements and best industry practices. Safety equipment (eg safety showers) will be provided within the plant section of the building where the use of chemicals is anticipated and within the laboratory for use with chemicals and/or other potentially harmful materials.

2.2.2 Off-site hardware

The pipelines and pumps to and from the Sepia Depression Ocean Outlet will be used. New off-site infrastructure will be located on customers' properties or various road / rail reserves and consists of:

- Treated water distribution pumps and pipework to customers;
- Wastewater collection pipework and pumps from customers;
- Instrument, controls and telemetry to monitor and control all water transfer activities.

2.2.3 Supply of high quality treated water to industries

Two covered and lined storage ponds will be used to store the high quality water (typically TDS 40–50 mg/L) generated by the KWRP. The ponds will provide typically 24 hours of water storage.

A pumping station will be located adjacent to the water storage ponds. The pumping station (for water supply to industry) will incorporate 100% duty / standby pump sets with suction and discharge pressure protection. The pumps will have sufficient capacity to provide water at an acceptable flow rate to all customers (i.e. industries) at their designated take-off locations. Variable flow rates will be accommodated.

Supply lines can be individually isolated (using valves) at key locations in case of pipeline damage and the need to undertake line maintenance.

2.2.4 Return of industrial wastewater to the SDOOL

A pumping station (to be supplied by the customer) will be located at the customer's end of each specified customer's wastewater pipeline. The pumping stations will incorporate duty / standby pump sets with suction and discharge pressure protection. The pumps will have sufficient capacity to pump the wastewater at the design / contracted flow rates to the SDOOL under all SDOOL pipeline flow / pressure scenarios.

Sampling and shut-off valves will be provided by the customer immediately prior to the wastewater pumps to arrest and isolate the wastewater flow if necessary.

Industrial wastewater pipe-work will tie into the return line for the SDOOL line adjacent to the KWRP site boundary. Protection for piping will be provided in accordance with applicable standards, codes of practice and best industry practice.

2.2.5 SDOOL off-take line and return line

An off-take pipeline will be run from the SDOOL to the KWRP on-site facility to provide feedwater for the plant. In addition to the minimum design requirements to meet the duty working pressure, this off-take line will be designed to provide additional safeguards against corrosion and mechanical damage.

The pumping system at the off-take from the SDOOL will be designed to cover the significant range of variations in supply pressure that exist in this line. Typically, five parallel lines will be provided using four pumps. The configuration will provide 100% standby capacity. All pumps are operated using variable speed drives. A flow / pressure regulated 100% capacity gravity line is provided for periods when the SDOOL is operating under high flow and pressure.

A return pipeline will be run from the on-site facility to the SDOOL. This line will return KWRP concentrate and the industrial wastewater to the SDOOL for disposal to the marine environment in the Sepia Depression. The pipeline will be designed to meet all duty working pressures and to provide additional safeguards against corrosion and mechanical damage.

The glass-fibre reinforced epoxy (GRE) pipes that run to and from the SDOOL will be buried (wherever possible) and will share the same easement where they cross roads, railways or are on BP's land.

The off-take line and the return line will be connected to the SDOOL and will be installed to minimise any interruption of the flow in the line from the Woodman Point WWTP. Installation of the tie-in for the return line is planned for January / February 2004.

The tie-in for the off-take line will be located upstream of that for the return line and will be separated by a sufficient distance to ensure that the concentrate from the facility and industrial effluent cannot backflow and mix with the KWRP feedwater.

2.2.6 Scheme water connections

The KWRP facility will also be connected to the existing Scheme water system to provide a back-up supply to customers. It is anticipated that this will be used infrequently to cover maintenance and commissioning activities at KWRP, Woodman Point WWTP or customer sites. The tie-in to the Scheme water system will be located adjacent to Mason Road. The tie-in will be performed using "hot tapping" techniques to prevent any interruption of the flow of Scheme water to the BP refinery. The scheme water connection will terminate at the Product Water Storage Ponds.

2.2.7 Instruments and controls

All distribution and wastewater pipework will be metered for flow. In addition, all wastewater will be analysed at source by the wastewater provider to demonstrate compliance with the Water Corporation's wastewater acceptance criteria.

All drives will be monitored to ensure that each pump is running within its normal operating range to identify potential blockages or low suction pressures.

The off-site hardware will be designed such that each customer will control and monitor equipment located on their site via their own control system. The data collected by each customer will be transmitted to the KWRP facility via a telemetry or optical fibre link.

2.2.8 Telemetry

Telemetry links will be provided between the KWRP facility and each customer to provide details of status and alarms for any off-site hardware, and from the KWRP facility to the Water Corporation network for control and monitoring of the facility. Each customer will install their required on-site hardware. The equipment necessary to monitor each customer's system will be installed at the KWRP facility.

2.2.9 Shutdown systems

Equipment will be designed to be failsafe on loss of either instrument air or electrical power. All drives on-site will be provided with a local emergency stop.

Each line that is located remote from the KWRP facility site will contain a means of shutting off the flow of water, in the form of either a pump or level control valve. Additionally, manual valves will be provided at each of these stations. This equipment will be the responsibility of the customer.

A standby generator is located at the KWRP site to enable a safe controlled shutdown and continued supply of stored product water to customers in the event of a power interruption.

In the event of a shutdown all process and feedwater at the site is contained in the on-site vessels.

2.2.10 Plant operation

The general piping plan of KWRP and off-site connections are shown in Figure 2-2.

At the KWRP, secondary treated wastewater (typical TDS concentration of 860 mg/L) will first be passed through a microfiltration (MF) system as pre-treatment to achieve water quality suitable for efficient reverse osmosis (RO). The MF system will remove extremely fine particles, colloids, bacteria and viruses, and will initially be capable of processing up to 23.4 ML/day, with a water recovery rate of 90% of the input volume.

The RO system will be capable of initially processing up to 21 ML/day of pre-filtered water, and of producing up to 16.7 ML/day of permeate (i.e. product water) with a TDS of 40–60 mg/L. The facility will initially be designed to accommodate future expansion to process up to 35 ML/day of pre-filtered effluent and produce around 27 ML/day of permeate. The RO permeate will be dosed on a continuous basis with caustic soda (for buffering), and transferred to the on-site storage tank.

Concentrate and backwash from the MF and RO systems will be stored together on-site, and returned to the SDOOL for discharge to the marine environment. The volume of concentrate will be about 30% of the total volume processed by the KWRP, i.e. about 7 ML/day, with future growth of product water demand this may expand to approximately 10 ML/day. Generally, about one third of the concentrate will be from the MF system (TDS similar to secondary treated wastewater) and two thirds will be concentrate from the RO system (TDS of about 3,600 mg/L, i.e. substances in secondary treated wastewater concentrated about five-fold, plus anti-scalant).

Approximately once a fortnight, the concentrate will include small amounts of acid detergent solution (see below) used in the cleaning of MF and RO membranes, plus any scale (predominantly carbonates and sulphates) washed off the membranes.

A number of chemicals will be required for efficient operation of the KWRP. These include anti-scalant, sulphuric acid and hypochlorite that will be continuously dosed to the treatment plant feed lines, and those required on an intermittent basis for neutralisation of process water and cleaning of the MF and RO membranes. Table 2-1 outlines the proposed level of chemical usage and on-site storage. Storage will comply with relevant Hazardous and dangerous Goods Regulations and requirements.

The MF system will be backwashed regularly, while chemically enhanced cleaning of both MF and RO membranes (with acidic detergent) will occur about four to ten times a year. As the MF system will consist of typically four trains (three on duty and one on standby) and the RO system typically six trains (five on duty and one on standby), chemically enhanced cleaning of one MF train and one RO train will occur about once a fortnight. All spent cleaning solutions are automatically neutralised in the on-site neutralisation pit before being combined with backwash water for discharge to the SDOOL.

Figure 2-2 General piping plan and off site connections of KWRP

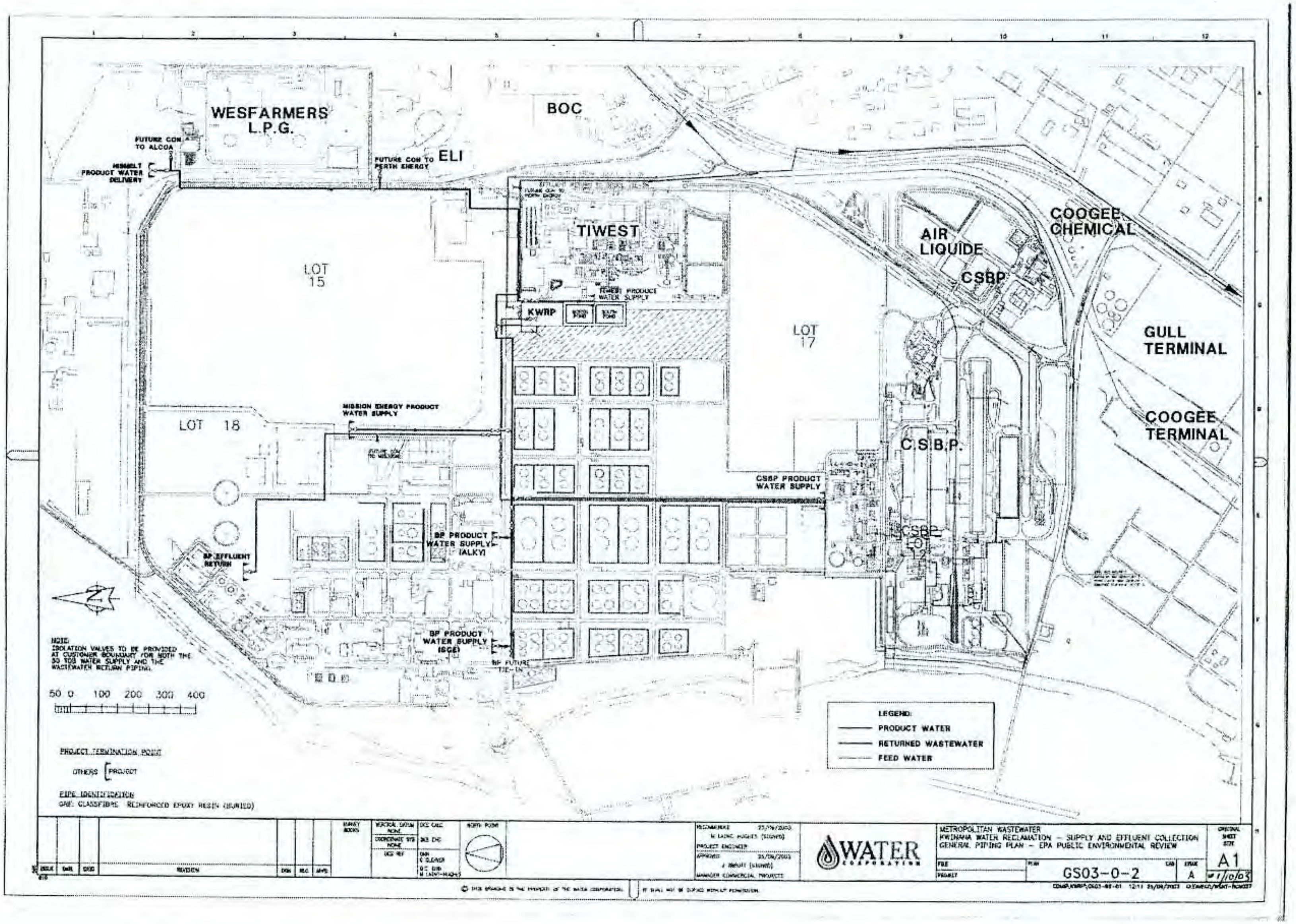


Table 2-1 Chemicals proposed to be used on site

Chemical	Estimated storage volume	Strength (% w/w)	Estimated max. consumption/year
Sulfuric acid	30 kL	98 %	250 kL
Sodium hypochlorite	20 kL	12.5 %	200 kL
Sodium hydroxide	10 kL	50 %	50 kL
Ammonia	5 kL	25 %	30 kL
Antiscalant (phosphonic acid)	5 kL	60 %	25 kL
Sodium EDTA	5 kL	40 %	10 kL
CIP solution	2 kL	50-60 % Water 10-30 % sodium gluconate 10 % citric acid 10 % aliphatic polyether	6 kL
Hydrogen peroxide	5 kL	50 %	5 kL
Citric Acid	1 tonne	-	4 tonne
Sodium triphosphate	1 tonne	-	4 tonne
Membrane preservative (Sodium Bisulphite)	1 kL	-	1 kL

Anti-scalant must be added to the RO feed water to control the precipitation of sparingly soluble salts that would affect membrane efficiency. As the anti-scalant will be discharged to the marine environment, it must not cause toxic or bioaccumulation effects. The anti-scalant(s) that may be used in the MF/RO system may contain phosphonic acid derivatives, sodium gluconate, citric acid, alkylpolyglucosite, aliphatic polyethers, sulfuric acid, and/or hydrogen peroxide: these are to control carbonate, sulphate and other less common scales on the membranes. These materials do not bioaccumulate and ultimately will be consumed in the SDOOL and/or degrade to harmless natural by-products.

Membrane preservative (around 1% Sodium Bisulphite) may be used on site on rare occasions for storage of RO / MF membranes if a section or all of the KWRP is shutdown for an extended period. Sodium hypochlorite is used to form monochloramines for control of biofilms on the MF membranes. The dosing of this chemical is closely controlled using on-line oxidation/reduction potential monitoring and free chlorine meters (it is also dose restricted) to low levels to ensure no free chlorine in the dosed water, as this will irreversibly damage the RO membranes.

The acid detergents proposed for use in cleaning membranes are citric acid and phosphonic acid based, or equivalent, for removal of hardness scales on MF and RO membranes during off-line 'Clean in Place' procedures. After cleaning the solution will be neutralised by the addition of sodium hydroxide, and the neutralised solution discharged back into the SDOOL.

Sulphuric acid will be dosed into the KWRP feedwater to ensure the pH is neutral. Sulphuric acid is also used in the neutralisation pit to neutralise spent cleaning solutions. All chemicals will be contained and bunded to meet the requirements of all applicable Dangerous Goods Regulations.

2.2.11 *Water requirements of industry*

Estimates of the current and future volumes and quality of treated water required by industry are shown in Table 2-2. The KWRP will be designed to initially achieve the current water demand levels presented in the table by building additional operating capacity into the 17 ML/day base case detailed in this PER. It is planned, dependent upon demand, that the plant may be upgraded in the future to achieve a target production capacity of approximately 27 ML/day or more.

Table 2-2 Forecast water demand of industrial process water required by industry

Customer	Indicative volume required
BP Refinery	Current: 1.5 ML/day Future: 1.5 ML/day
CSBP	Current: 2.0 ML/day Future: 2.0 ML/day
Tiwest	Current: 2.2 ML/day Future: 2.2 ML/day
Edison Mission Energy	Current: 3.0 ML/day Future: 3.0 ML/day
HIsmelt	Current: 8.0 ML/day Future: 18.0 ML/day
TOTAL	**Current (approx): 17 ML/day** **Future (approx): 27 ML/day**

3. THE EXISTING MARINE ENVIRONMENT AND THE EFFECTS OF CURRENT WASTEWATER DISCHARGE

The Sepia Depression Ocean Outlet discharges treated wastewater into an area (i.e. the Sepia Depression) where the bathymetry and hydrodynamic conditions are such that currents run strongly, parallel to the shore. Careful choice of outlet location and a diffuser design that takes into account the depth and typical current velocities in the area, has ensured that treated wastewater is very rapidly diluted and directed away from adjacent reefs (popular recreational areas) and the shore (the diffuser controls the degree of initial dilution of the wastewater plume as it rises to the ocean surface). Outlet location and diffuser design were undertaken specifically to ensure compliance with the Environmental Protection Authority's water quality criteria for ecosystem protection and recreational use (EPA, 1981), according to the types of benthic habitats present in the region, and known areas of recreational and commercial use.

The Sepia Depression Ocean Outlet (SDOO) was commissioned 1984, and the Water Corporation has undertaken extensive monitoring since then to confirm that the environmental values and uses of the broader ecosystem are not being compromised. In this section, descriptions are provided of the existing marine environment, the environmental guidelines and criteria relevant to Sepia Depression waters, and the results of the Water Corporation's monitoring programme.

It should be noted that any references to wastewater in this chapter do not include the KWRP and its impacts. This is done in Chapter 5.

3.1 EXISTING MARINE ENVIRONMENT

3.1.1 Geomorphology

Perth's shoreline consists of sandy beaches and limestone rocky shores and headlands. Offshore and aligned roughly parallel to the shore are chains of limestone ridges that crop out as a series of reefs and islands. Five Fathom Bank is a chain of reefs extending south from Rottnest Island to Mandurah, and the Garden Island Ridge is a parallel chain of reefs and islands located approximately 5 km inshore of Five Fathom Bank. The 5 km wide and 20 m deep trough between these two reef chains is known as the Sepia Depression. Sediments in the Sepia Depression are coarse, calcareous sands with a very low silt plus clay fraction (around 1%).

3.1.2 Climate

The Perth region has a Mediterranean climate, with hot dry summers and cool wet winters. The hottest month is February, with average daily maximum and minimum temperatures of 31°C and 20°C, respectively. The coolest month is August, with average daily maximum and minimum temperatures of 18°C and 9°C, respectively. The mean annual rainfall is typically 700–1,000 mm, nearly 75% of which falls during the months May to August, and only 5% during the months November to February.

In winter, low pressure systems and westerly winds dominate local weather patterns. Cold fronts associated with the low pressure systems frequently pass over the region, and can bring storm-force winds from the north-west through west and south-west directions.

In summer, high pressure cells dominate local weather patterns. As the high pressure cells approach, winds are from the south-east to east, changing to north-east to north as the pressure cells move eastwards. Superimposed on this pattern is the 'sea breeze' effect. This is a daily variation caused by differential heating of the land and sea, and usually results in the easterly winds being supplanted by a strong south-westerly sea breeze between mid-afternoon and evening.

3.1.3 Coastal hydrodynamics and circulation

The *offshore* wave climate of Perth is dominated by a persistent low- to moderate-energy wave regime, and is generally far more variable in winter than in summer. The summer swell arrives from the west to south-west and is typically 1–2 m in height. Winter swell arrives from almost due west and is typically 1–3 m in height. During summer the afternoon sea breeze results in the development of local seas (typical wave heights 0.5–1.5 m) which are superimposed upon the swell regime. Local seas are also generated by the passage of winter storms: wave height and direction varies considerably from storm to storm, but the wave heights often exceed 4 m (7 m or more in severe storms).

The *inshore* wave energy is reduced by dissipation through the offshore reef chains. The Five Fathom Bank reef line varies in depth to a maximum of 10 m and is sufficiently shallow to cause some attenuation of the swell wave energy within the Sepia Depression, but far greater attenuation is achieved by the shallower Garden Island Ridge. Therefore, the waters of the Sepia Depression are, in relative terms, of higher energy than most of the inshore waters of Perth.

Wind is the main factor influencing coastal circulation in the inshore waters, particularly in summer when up to 60% of the variation in the ocean currents can be explained by the wind field (Pattiaratchi and Knock, 1995). The prevailing winds generally drive northward-flowing littoral currents, although periods of current reversal can occur when winds come from the north, particularly in winter. Currents are strongly influenced by the inshore bathymetry, and the offshore reef chains result in flow being channelled parallel to the shore.

In the Sepia Depression the seasonal distribution of mid-depth current direction is bimodal, with northward flows predominating in summer and southward flows in winter. Ambient current velocities are typically 5–20 cm/s. A year of current measurements undertaken in the Sepia Depression in 1993 (deemed a 'typical' year in terms of winds and currents) showed that current speed equals or exceeds 5 cm/sec for 97.5% of the time, and averages 13 cm/s.

3.1.4 Marine ecology

Perth's submerged offshore reefs support extensive stands of macroalgae, predominantly larger species of brown algae (*Ecklonia radiata*, *Scytothalia dorycarpa* and *Sargassum* spp.), but also mixed assemblages of smaller species of red, green and brown algae, particularly on areas of limestone pavement. The reefs also maintain a colourful assemblage of sponges, gorgonians and other invertebrates. Seagrass habitats in Perth coastal waters occupy a larger area than the macroalgae-covered reefs, and occur in shallow (less than 10 m deep) sheltered waters inshore of the reef chains.

Unlike the western margins of the other southern continents, the coast of Western Australia lacks a major up-welling, and therefore does not have the highly productive plankton food chains that support the large finfish fisheries of the west coasts of South America and southern Africa. The fisheries stocks in the nutrient-poor near-shore waters of Perth depend largely on benthic-based food chains in the seagrass meadows, macroalgae-dominated reef systems and detritus-enriched basins. The Sepia Depression, although relatively deep, experiences too much wave energy for the accumulation of detritus from adjoining reefs. The relatively high wave energy experienced in the Sepia Depression is also evident in its coarse, sandy, nutrient-poor sediments. The benthic fauna of the Sepia Depression is accordingly naturally low in both biomass and species diversity.

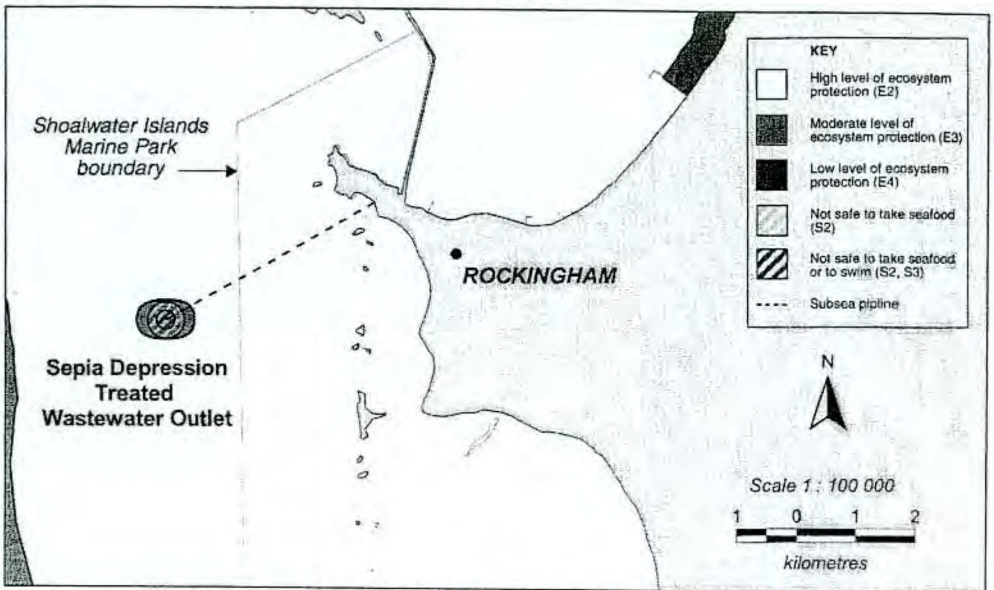
3.2 RELEVANT ENVIRONMENTAL GUIDELINES

In February 2000 the Environmental Protection Authority (EPA) of Western Australia released a working document describing Environmental Values (EVs) and Environmental Quality Objectives (EQOs) for Perth's coastal waters (EPA, 2000), and in December 2002 the EPA released its revised draft Environmental Protection (Cockburn Sound) Policy (EPA, 2002a). The management approach taken by the EPA is based upon that recommended by the National Water Quality Management Strategy (NWQMS), as outlined in the guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). The EQOs for Cockburn Sound include Maintenance of Ecosystem Integrity, Maintenance of Seafood for human consumption, Maintenance of Aquaculture, Maintenance of Primary and Secondary Contact Recreation, and Maintenance of Aesthetic Values.

The EPA has promoted the Cockburn Sound EPP as a framework for establishing environmental values, environmental quality objectives and environmental quality criteria for all of WA's marine waters. The performance of the SDOOL discharge has been assessed with respect to the E2 toxicant criteria in the Revised Environmental Quality Criteria Reference Document (Cockburn Sound) (EPA, 2002b), which is a supporting document to the EPP.

The management framework proposes various levels of protection for the EQO of Maintenance of Ecosystem Integrity, including 'pristine' (e.g. marine reserves), 'high' (likely to apply to most of WA's coastal waters), 'moderate' (e.g. buffer zones around outlets) and 'low' (e.g. outlet mixing zones). A high level of protection (E2) is likely to apply to the majority of Perth's coastal waters (3-1).

Figure 3-1 Levels of Protection for Sepia Depression



Adapted from Map 4, Perth Coastal Waters Environmental Values and Objectives (EPA 2000)

The Water Corporation has applied the Cockburn Sound E2 (high level of protection) EQC's for EQO 1 for toxicants. This provides a high level of conservatism because past concentrations of substances discharged to the Sepia Depression higher than the Cockburn Sound E2 levels did not cause measurable environmental harm, as demonstrated by the more than 10 years of data collected under the PLOOM and other monitoring programs. These results are reported regularly to the EPA and public (HGM 1992; Kinhill 1998a; DAL 1997a, 1997b, 1997c, 2000, 2002; DALSE 2002a, 2002b). Accordingly, the relevant Cockburn Sound E2 criteria can be found in Tables 4-2, 4-3 and 4-4 of this report.

3.3 WWTP DISCHARGE FROM THE SEPIA DEPRESSION OCEAN OUTLET

3.3.1 History of the Sepia Depression Ocean Outlet

Woodman Point WWTP has been treating wastewater from Perth's southern suburbs since 1966. Treated wastewater from the Woodman Point WWTP was originally discharged into Cockburn Sound via a 1.8 km long pipeline off Woodman Point. In the 1970s Cockburn Sound was under considerable environmental pressure from nitrogen discharge from industry and, to a lesser extent, from the Woodman Point WWTP. In acknowledgment of the potential impact of increased loads of nitrogen from the Woodman Point WWTP (from anticipated population growth), the Water Corporation (then the Water Authority of WA) carried out a 12-month feasibility study in 1981 to evaluate a series of alternatives for wastewater disposal.

A variety of options for wastewater disposal was considered, including discharge to rivers, discharge to groundwater, irrigation, industrial re-use and ocean disposal. Ocean disposal to a carefully chosen site in the Sepia Depression was considered the best option on environmental, economic and technical grounds.

Following studies undertaken as part of an Environmental Review and Management Programme (ERMP), the siting of the outlet and the design of the outlet diffuser were chosen with careful consideration of the hydrodynamic and ecological characteristics of the region, to ensure that the ecological and socio-economic values of the area were not compromised. The proposed outlet was deemed environmentally acceptable by the EPA, and the Sepia Depression Ocean Outlet Landline (SDOOL, or CPOP as it was then known) and Sepia Depression Ocean Outlet were commissioned in 1984.

3.3.2 Present and future discharges from the Sepia Depression Ocean Outlet

The SDOOL presently discharges advanced secondary treated wastewater from the Woodman Point WWTP, primary treated wastewater from Point Peron WWTP to Sepia Depression and—under an agreement with the Department of Industry and Technology—nutrient enriched groundwater from the Jervoise Bay Groundwater Remediation Scheme (JBGRS).

The Woodman Point WWTP serves the urban areas of Perth from Fremantle City south to Munster and east to Hazelmere, Kalamunda and Armadale. Domestic wastewater comprises the majority of influent to the WWTP, with a small proportion (8.2%) of the wastewater volume derived from industrial sources, and some stormwater leakage into the system in winter. The Point Peron WWTP serves the City of Rockingham.

The Woodman Point WWTP had a previous design flow capacity of 125 ML/day, which was predicted to be exceeded in 2002. As part of its commitment to good environmental practice, the Water Corporation upgraded the Woodman Point WWTP to treat wastewater to advanced secondary level, and to accommodate an annual average daily flow of up to 160 ML/day (expected to be reached in 2019). The upgrade was completed in February 2002. It is currently planned that the Point Peron WWTP will be decommissioned in 2010. This flow will be diverted to the proposed East Rockingham WWTP, which will treat wastewater to advanced secondary level before discharge to the Sepia Depression Ocean Outlet. This is the current medium-term plan to provide for continued discharge to the Sepia Depression Ocean Outlet, in the face of continued population growth and the inclusion of possible future industrial disposal.

The JBGRS is licensed to discharge up to 5 ML/day of recovered groundwater to the effluent pumping station downstream of the Woodman Point WWTP for disposal to the Sepia Depression via the SDOOL. The recovered groundwater contains elevated levels of inorganic nitrogen. Extensive monitoring and analyses has shown that no toxic contaminants are present in the recovered groundwater. The groundwater recovery scheme consists of four production bores and twenty seven monitoring bores, and commenced operation as part of the Jervoise Bay Northern Harbour Project in mid-December 2000 under approval of the Department of Environment. It is anticipated that the project will be subject to a full review within the next three years and a decision made to either continue or cease groundwater extraction.

By about 2019, the estimated average discharge from the Woodman Point and East Rockingham WWTPs to the Sepia Depression Ocean Outlet will be 200 ML/day, and the hydraulic capacity of the existing pipeline will be reached during peak flow.

The following important dates should be noted (excluding the JBGRS, as its long term continuation is unlikely):

- 2002, when the Woodman Point WWTP upgrade occurred. Estimated annual average flow of 127 ML/day from Sepia Depression Ocean Outlet (1,400 L/sec); 110 ML/day of secondary treated wastewater from Woodman Point WWTP and 12 ML/day of primary treated wastewater from Point Peron WWTP;
- 2010/2011, when the Point Peron WWTP is currently planned to close and flow diverted to the new East Rockingham WWTP (which will also discharge to the Sepia Depression Ocean Outlet). In 2010 the total estimated flow will be around 151 ML/day; 136 ML/day of secondary treated wastewater from Woodman Point WWTP and 15 ML/day of primary treated wastewater from Point Peron WWTP. After commissioning of the East Rockingham WWTP (in 2011), all wastewater discharged to the Sepia Depression Ocean Outlet will be secondary treated; and
- 2019, estimated flow around 200 ML/day (average flow 2,300 L/s), when discharge will frequently be at the design capacity of the existing pipeline (2,800 L/s).

Upgrading the Woodman Point WWTP to advanced secondary treatment has resulted in significant reductions in the loads of bacteria, nutrients and other substances discharged to the marine environment. The predicted changes in flow rates and nutrient loads are shown in Figure 3-2, and current estimates of changes in concentrations of bacteria, nutrients and contaminants in wastewater discharged through the SDOOL to the Sepia Depression Ocean Outlet with the changing proportions of primary and secondary wastewater are summarised in Table 3-1.

Figure 3-2 Sepia Depression Ocean Outlet current and predicted flow rates and nutrient loads

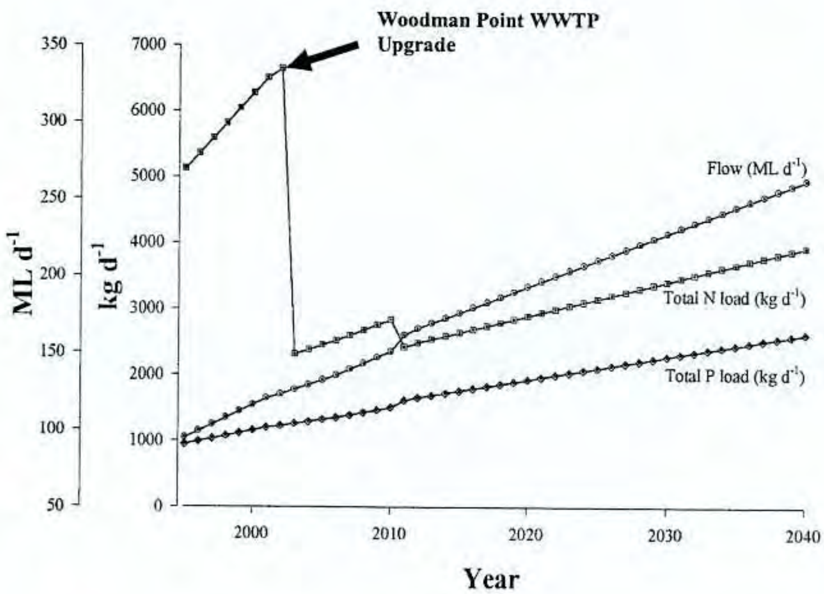


Table 3-1 Predicted changes in contaminant concentrations and flow in WWTP treated wastewater discharge from the Sepia Depression Ocean Outlet from present (2003) to 2019 based on typical treated wastewater composition (i.e. excluding KWRP, industry discharges and contributions from the Jervoise Bay Groundwater Recovery Scheme).

Variable^	Primary treated wastewater	Secondary treated wastewater	Wastewater discharged from the Sepia Depression Ocean Outlet		
			2003	2010#	2019
Flow (ML/day)	~100	127	127	151	200
Faecal coliforms (cfu/100 ml)	10,000,000	200,000	~1,200,000	~1,200,000	200,000
Faecal streptococci (cfu/100 ml)	2,000,000	20,000	~215,000	~215,000	20,000
NH_4 (mg/L)	43	3.2	7.4	7.5	3.2
NO_3 (mg/L)	0.4	8.8	8.0	8.0	8.8
TN (mg/L)	54	14.1	17.9	17.9	14.1
TP (mg/L)	10	10	10.2	10.2	10
TSS (mg/L)	120	26	34	29.9	26
Turbidity (NTU)	unknown	~15	-	-	~15
BOD (mg/L)	180	6.6	21.8	22.0	6.6
pH	6.5–7.3	6.9*	6.9	6.9	6.9
As (µg/L)	2.0	2**	2	2	2
Ag (µg/L)	3.5	1.2	1.2	1.2	1.0
Cd (µg/L)	0.33	0.20**	0.23	0.23	0.20
Cr (µg/L)	20.2	9.1	10.2	10.2	9.1
Cu (µg/L)	168	34	44	44	34
Hg (µg/L)	0.7	0.5**	0.5	0.5	0.5
Ni (µg/L)	13.0	12.8	11.9	11.9	12.8
Pb (µg/L)	7.2	2.0**	2.1	2.1	2.0
Zn (µg/L)	91	80	83	83	80
Aldrin (µg/L)***	<0.001	<0.001	<0.001	<0.001	<0.001
Chlordane (µg/L)***	<0.001	<0.001	<0.001	<0.001	<0.001
DDT (µg/L)***	<0.001	<0.001	<0.001	<0.001	<0.001
Dieldrin (µg/L)***	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor (µg/L)***	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (µg/L)***	<0.001	<0.001	<0.001	<0.001	<0.001
AOX (µg/L)***	160–240	170–340	160–240	170–340	170–340
EOX (µg/L)***	25–62	3.1–7.6	25–62	8–20	3.1–7.6

** the pH of wastewater in secondary treatment is buffered at 6.9 to ensure maintenance of denitrification rates.*
***below detection limit.*
****Kinhill (1998) data for Woodman Point, Subiaco and Beenyup.*
^ Additional parameters can be found in Tables 4-2, 4-3 and 4-4.
#The flow of 151 ML/day is made up of 36 ML/day of secondary treated wastewater from Woodman Point WWTP and 15 ML/day of primary treated wastewater from Point Peron WWTP

3.4 THE ENVIRONMENTAL EFFECTS OF WASTEWATER DISCHARGE

Discharge from WWTPs contains three classes of materials of potential environmental concern:

1. Pathogenic organisms from faecal material, which are a potential threat to human health from accidental swallowing of contaminated waters during recreational activities, or consumption of uncooked seafood (Note: cooking destroys enteric bacteria). Bacterial groups typically monitored are faecal streptococci (to assess recreational suitability) and thermo-tolerant coliforms (to assess suitability for shellfish harvesting).
2. Metals and persistent organic compounds which are potentially toxic to marine biota. These may accumulate in biota at concentrations sufficient to be a concern for human consumption of seafood. As the Woodman Point WWTP is not a combined system (i.e. it does not collect stormwater runoff) and accepts no heavy industrial waste, the persistent organic compounds of potential concern are mainly trace concentrations of pesticides, and do not include substances such as PCBs or petroleum hydrocarbons.
3. Nutrients. Dissolved inorganic forms make up the majority of nitrogen and phosphorus discharged from outlets. These enhance the growth of aquatic plants in the water column (i.e. phytoplankton) and on the seabed (e.g. reef algae, seagrass epiphytes), which may lead to changes in the abundance and species composition of aquatic plant communities if some species are favoured more than others by the increased nutrient supply. Particulate organic material can also accumulate in sediments and may cause alterations to the abundance and species composition of benthic fauna resulting from the increased food supply.

Treated wastewater discharged from the Sepia Depression Ocean Outlet enters the sea from a diffuser located on the sea floor. The fresh wastewater rises rapidly through the water column, entraining surrounding seawater as it rises. This is a highly efficient means of dilution and, by the time it reaches the surface from around 20 m depth, it will have been diluted a minimum of 250 times and more likely 400 times. The region within which this takes place is often called the Zone of Initial Dilution (ZID) or the 'near field' of the outlet. The process of initial dilution typically occurs within 25 m or so of either side of the diffuser at the surface. The rate of dilution is highly affected by currents, and under current speeds of greater than around 8 cm/s (which occur under moderate 'sea breeze' strength winds or greater) the plume is washed 'downstream' and undergoes further dynamic dilution. Dilution and dispersion of the surface or sub-surface plume beyond the ZID depend entirely on the hydrodynamic characteristics of the receiving waters, with mixing induced by density differences, by winds and currents, and by diffusion; the zone in which this occurs is generally referred to as the 'far-field'.

Contaminants in wastewater are present in both particulate material and (especially for nutrients) in dissolved forms. Coarser particulate material settles out relatively quickly from the water column onto the seabed (thereby accumulating in sediments), while dissolved forms and very fine particulates are transported further afield. Once wastewater is discharged into the marine environment, concentrations of substances in the plume are reduced by settling (particulates), dilution (nutrients, particulates, bacteria and viruses), biological removal (nutrients, bacteria and viruses), inactivation by chemical reaction and exposure to sunlight and saltwater (bacteria and viruses).

The Water Corporation has monitored the effects of wastewater discharge on the marine environment since the commissioning of the Sepia Depression Ocean Outlet in 1984. The intensity of monitoring was increased following the Perth Coastal Waters Study (PCWS) from 1992–1994, which led to the development and implementation of the Perth Long-term Ocean Outlet Monitoring (PLOOM) Programme (1996–present). The PLOOM Programme was developed based on an understanding of the processes that occur during the discharge of the treated wastewater, and knowledge of the potential effects of treated wastewater on the marine environment. The PLOOM programme for the Sepia Depression Ocean Outlet has included:

1. Hydrodynamic modelling of wastewater plume behaviour (initial dilution of plume and subsequent patterns of dispersion and dilution).
2. Regular collection of microbiological information (water quality surveys around the outlet, and monitoring of nearby beaches).
3. Regular surveys of contaminant concentrations (metals and pesticides) in wastewater, sediments, resident biota, and sentinel mussels deployed near the outlet.
4. Monitoring of the effects of nutrients via:
    - ⇒ Regular water quality surveys to enable the exact shape of the wastewater plume and dilution contours of nutrients to be determined;
    - ⇒ Measurement of chlorophyll concentrations in the water column (a measure of phytoplankton biomass);
    - ⇒ Bioassay information (to determine which nutrients are most important in controlling phytoplankton growth);
    - ⇒ Documentation of phytoplankton assemblages (to determine whether changes in species composition are occurring);
    - ⇒ Deployment of artificial samplers (periphyton collectors) at set distances from the outlet to predict the potential sphere of influence of wastewater discharge on reef communities;
    - ⇒ Surveys of reef algae abundance and composition at the nearest reefs likely to be affected by wastewater discharge; and
    - ⇒ Surveys of benthic infauna abundance and species composition.

The results of the PCWS and PLOOM programme for the Sepia Depression Ocean Outlet are summarised briefly below. Information is taken largely from the PLOOM Summary Report (DALSE, 2002a), and references cited therein.

3.4.1 Plume dilution and advection

The wastewater plume at the Sepia Depression Ocean Outlet typically undergoes an approximately 300-fold or more initial dilution within a ZID that extends for a distance of about 25 m from the surface expression of the plume directly above the outlet diffuser in calm conditions. This observation has been confirmed by both modelling studies and water quality surveys.

The diluted plume typically moves northward, parallel to the shore. The extent of the plume has been estimated by examining the maximum distance from the diffuser over which the nutrient and/or bacterial concentrations are elevated above the background concentrations. The plume is typically a narrow 'cigar' or 'tear' shape elongated along a shore-parallel axis and, prior to the upgrade, extended 1.5–5.0 km north of the outlet (Table 3-2).

Table 3-2 Wind, drogue and plume conditions during the water quality surveys at Sepia Depression

Date	Wind		Drogue		Plume		
	Speed ($m\ s^{-1}$)	* Direction	Speed ($m\ s^{-1}$)	Direction	Variable	Distance (km)	** Direction
7/02/95	7	E	0.09	N	NH_4	2.5	NNE
					FRP	2.0	NNE
2/05/95	9	SSE	n/a	n/a	NH_4	2.5	NE
10/10/95	7	NE	0.06	E	NH_4	1.5	SSE
					TTC	1.5	SSE
27/02/96	7	SW	0.12	NW	NH_4	4.0	N
					FS	3.75	N
15/10/96	7	SSE	0.16	NNE	FRP	5.0	NNW
					NH_4	5.0	NNW
11/02/97	7	S	0.08	NW	FRP	3.5	NNW
					NH_4	3.75	N
15/04/97	7	S	0.07	N	FRP	2.5	N
					NH_4	3.75	N
10/02/98	6	SSW	0.07	N	NH_4	3.0	NW
16/02/99	5	S	0.15	NNW	FRP	2	N
					NH_4	2.5	N
08/02/00	10	S	0.11	NNW	NH_4	1.0	S
30/01/01	10–18	NW	0.04	W then S	FRP	-	
					NH_4	2.5	N
05/02/02	7–8	NW	0.19	S	TP	-	-
					NH_4	2.5	S

*Note: n/a not available; * Wind direction specifies direction wind is coming from; ** Plume direction specifies direction plume is heading. FRP = filterable reactive phosphorus, TTC = thermotolerant coliforms, and FS = faecal streptococci.*

With the upgrade to secondary treatment, the increase in flows resulted in a small decrease (around 25%) in initial dilution and a small increase (around 10%) in the near-field zone (where initial dilution takes place), but this has been more than offset by the reduced concentrations of substances (see Table 3-1). Initial dilution should ensure nitrate concentrations will be 30–40 μg/L in the near-field, and subsequent dilution and dispersion should ensure background concentrations are rapidly attained within 1–2 km north of the outlet.

The most recent water quality survey was undertaken on 5th February 2002, when the Woodman Point WWTP upgrade was approximately 80% complete, and total nitrogen concentrations were about 11 mg/L, with the greater proportion (9 mg/L) consisting equally of nitrate plus nitrite and ammonium (compared to about 55 mg/L of predominantly ammonium, prior to the upgrade). The reduction in nitrogen concentrations in the discharged wastewater was evident in the February 2002 water quality survey results, with ammonium concentrations at sites within 250 m of the outlet (median of 4.0 and 4.0 $\mu g\ N\ L^{-1}$ for surface and bottom waters, respectively) differing little from those well removed from the outlet (median of 4.0 and 3.0 $\mu g\ N\ L^{-1}$ for surface and bottom waters, respectively). A similar pattern was found for nitrate plus nitrite (DALSE, 2002b).

Changes in the spatial extent of elevated bacterial concentrations are discussed in some detail in the next section.

3.4.2 *Microbiological information*

Deep water ocean outlets are designed with the primary goal of minimising risk to public health, and they do so in a highly effective manner. As such they form an integral part of the community's infrastructure and public health protection system.

The Water Corporation has been monitoring bacterial concentrations in the vicinity of the Sepia Depression Ocean Outlet prior to and since wastewater discharge commenced in 1984. The Rockingham City Council and the Water Corporation also routinely collect microbiological samples from shoreline sites which include beaches from southern Garden Island to southern Warnbro Sound. Shoreline data for these sites clearly show that water quality at beach sites in the Shoalwater Bay/Safety Bay region (closest to the outlet) is extremely good, and has not changed since 1980, over four years before the outlet commenced discharging (DAL, 1997a, 1997b, 1997c). Primary contact recreation guidelines (based on faecal streptococci) and shellfish harvesting guidelines (based on thermo-tolerant coliform concentrations) are attained well before reaching the reefs (where recreational diving is popular) and shoreline closest to the Sepia Depression Ocean Outlet.

With the upgrade from primary to secondary treatment, the concentrations of bacteria in wastewater discharged from the Woodman Point WWTP to the Sepia Depression Ocean Outlet decreased to about 1% of previous concentrations, which has resulted in a marked decrease in the spatial extent of the plume (DALSE, 2002b).

3.4.3 Contaminant concentrations in sediments and biota

The most recent survey of contaminants in sediments, natural biota and deployed mussels around the Sepia Depression Ocean Outlet was undertaken over the summer of 1997/1998 (Kinhill, 1998b) before the Woodman Point WWTP was upgraded to advanced secondary treatment. During the 1997/98 survey, the concentration of cadmium, lead, mercury, nickel and silver in the sediments from 150 m to 4 km from the outlet were at, or extremely close to, detection limits, and the concentrations of chromium, copper and zinc were generally above the detection limit but well below draft EPA (2002b) EQC (Table 3-3).

Table 3-3 Sediment contaminant concentrations obtained in 1997/1998 survey of Sepia Depression Ocean Outlet

Analyte	Study detection limit	Outlet sites (within 300 m of outlet)	Reference sites (4 km N and S of outlet)	EPA (2002b) Sediment EQC
Metals/metalloids (μg/g dry wt)				
Cadmium	0.5	<0.5	<0.5	1.5
Chromium	2.0	15–24	15–18	80
Copper	1.0	4–6	4–5	65
Lead	2.0	<2.0	<2.0	50
Mercury	0.01	<0.01	<0.01	0.15
Nickel	1.0	<1.0–1.0	<1.0	21
Silver	0.5	<0.5	<0.5	1
Zinc	0.5	1.0–5.0	<0.5–3.0	200
Organics (μg/g dry wt)				
Chlordane	2.0	<2.0	<2.0	0.5
Total DDT	2.0	<2.0	<2.0	1.6
Dieldrin	2.0	<2.0	<2.0	0.02
Lindane	2.0	<2.0	<2.0	0.32

The survey found no discernible spatial impact of the outlet on the concentrations of metals in sediment, nor any indication of concentrations increasing with time. The pesticide concentrations in the sediments were all below detection limits (2 μg/g dry wt).

Naturally-occurring cockles were obtained from sites within 50 m to 4 km of the outlet. The concentrations of heavy metals in the cockles obtained from all sites were well below Australian and New Zealand Food Authority (ANZFA) maximum permissible concentrations (MPCs), and no influence of the outlet was apparent (Table 3-4).

Deployment of mussels for approximately ten weeks at varying distances from the outlet (250 m to 2000 m north-east of the outlet, towards the nearest reef likely to be impacted by the plume, and at 4 km south of the outlet) also found no impact of the outlets on either the heavy metal or pesticide concentrations in mussels. The concentrations of heavy metals were well below ANZFA maximum permissible concentrations (MPCs) (Table 3-5) and, where relevant, also easily met the new generally expected levels (GELs) for copper and zinc (a median of 5 and 130 μg/kg fresh weight, respectively). All pesticide concentrations in mussels were below detection limits (and below ANZFA guidelines).

Table 3-4 Contaminant concentrations found in naturally occurring cockles in 1997/1998 survey of Sepia Depression Ocean Outlet

Analyte	Study detection limit	Outlet sites (within 300 m of outlet)	Reference sites (4 km N & 4 km S of outlet)	ANZFA MPC guideline*
Metals/metalloids (μg/g dry wt)				
Cadmium	0.5	2.0–4.0	2.5–3.5	10
Chromium	2.0	<2.0	<2.0	7.5
Copper	1.0	6–11	10	350
Lead	2.0	<2.0–4.0	<2.0	12.5
Mercury	0.01	0.02–0.06	0.06–0.09	2.5
Nickel	1.0	2.0–4.0	2.0	400
Silver	0.5	<0.5	<0.5	-
Zinc	0.5	140–400	110–130	5,000

** based on 80% moisture level in cockles*

Table 3-5 Contaminant concentrations found in sentinel mussels deployed in 1997/1998 survey of Sepia Depression Ocean Outlet

Analyte	Study detection limit	Outlet sites (250 m NE of outlet)	Reference site (4 km S of outlet)	ANZFA MPC guideline
Metals/metalloids (μg/g dry wt)				
Cadmium	0.5	0.6–0.7	1.2	13.3
Chromium	2.0	<2.0	<2.0	10
Copper	1.0	4–7	3–4	467
Lead	2.0	<2.0	<2.0	16.7
Mercury	0.01	0.05–0.06	0.07–0.13	3.3
Nickel	1.0	1.0–2.0	1.0	533
Silver	0.5	<0.5	<0.5	-
Zinc	0.5	110–160	140–160	6,667
Organics (μg/g dry wt)				
Chlordane	2.0	<2.0	<2.0	2.0
Total DDT	2.0	<2.0	<2.0	6.7
Dieldrin	2.0	<2.0	<2.0	2.0
Lindane	2.0	<2.0	<2.0	6.7

** based on 85% moisture level in mussels*

Overall, the concentrations of contaminants in the primary treated wastewater previously discharged from the outlet were such that there was negligible influence on the concentrations of substances in either sediments or biota in the vicinity of the outlet. With the upgrade to secondary treatment in 2002, the concentrations of all substances have further decreased (see Table 3-1), thereby ensuring even less environmental impact.

3.4.4 Nutrient effects

Phytoplankton

Monitoring of nutrient concentrations and phytoplankton (microscopic floating algae) has been carried out at four sites at fortnightly to monthly intervals since March 1996. The sites were selected following examination of hydrodynamic modelling results together with a consideration of phytoplankton response times, and are all in approximately the same depth of water and same distance from the shore. The sites are located around 5 km south of the outlet, directly over the outlet, and around 5 km and 10 km north of the outlet.

Nitrogen is generally the nutrient that limits primary production in marine waters around the world, and this has been confirmed for phytoplankton growth in the waters of the Sepia Depression via nutrient bioassays. Dissolved inorganic nitrogen (DIN) concentrations are particularly low in Perth's local coastal waters, and the annual cycle for nitrate (the dominant form of DIN) has a pronounced maximum in winter and a minimum in summer (Table 3-6). Inputs of nutrients from wastewater effluent should therefore have their biggest effect on the phytoplankton community in summer.

Table 3-6 Nitrate concentrations typical of Sepia Depression waters

Season	Mean (μg N L^{-1})	Median (μg N L^{-1})	90 percentile (μg N L^{-1})
Autumn	7	5	16
Winter	17	12	30
Spring	7	7	15
Summer	2	Below detection limit	7

Perth's coastal waters have unusually low natural background N:P ratios (compared to coastal waters world-wide), ranging from about 4:1 during winter and dropping to below 1:1 during summer. Such conditions theoretically favour the growth of blue-green algae (which are viewed as environmentally undesirable), but this does not happen: diatoms are the dominant phytoplankton group. Nutrient ratios in secondary treated wastewater are similar (around 2:1) to natural background conditions, while those in primary treated wastewater are actually *higher* (around 5:1) than background conditions in local coastal waters, and so rather than increasing the likelihood of a blue-green algae dominated ecosystem, the converse could be expected.

Phytoplankton biomass in Sepia Depression waters, as measured by chlorophyll a concentrations, is generally very low: median values using 1996–2002 data are 0.3 μg/L around 5 km south of the outlet, and 0.4 μg/L over the outlet and 5–10 km north of the outlet. Chlorophyll a concentrations vary seasonally, with a peak in late-winter/early-spring (August/September) and a steady decrease to a low in early summer (December) (Table 3-7). In autumn and spring there is little difference between sites near the outlet and those further distant. In summer, values are very slightly elevated in waters north of the outlet, while in winter differences are more pronounced (median values above the outlet about a third higher than around 5 km or so south). The PLOOM surveys generally show that there are small but statistically significant effects on primary phytoplankton production on sites to the north of the diffuser.

Table 3-7 Seasonal changes in chlorophyll a concentrations in waters of the Sepia Depression (around 5 km south of the outlet)

Season	Median (μg/l)	90th percentile (μg/l)
Autumn	0.4	0.6
Winter	0.8	1.0
Spring	0.7	1.4
Summer	0.3	0.4

Phytoplankton species assemblages in Sepia Depression waters are dominated throughout the year by diatoms and, to date, there have been no statistically significant shifts in species composition or biodiversity associated with wastewater discharge from the Sepia Depression Ocean Outlet. The species composition remains similar to that observed in the 1970s, well before the outlet was commissioned.

Since the upgrade to secondary treatment at Woodman Point WWTP in 2002, the concentration of DIN discharged from the Sepia Depression Ocean Outlet is about one quarter of that previously discharged with primary treated wastewater (Table 2-1).

Reef macroalgal communities

Two types of macroalgal communities occur near the Sepia Depression Ocean Outlet: 'kelp communities'—dominated by *Ecklonia radiata* and *Sargassum* spp.; and 'assemblage communities'—characterised by a mixed assemblage of red, green and brown macroalgae. Macroalgal communities typically respond to the addition of nutrients by an increase in productivity and/or by a change in the community structure. In the latter case, the slower growing, structurally complex or long lived species such as kelps and certain foliose red and brown algae are replaced by faster growing 'ephemeral' or 'nuisance' green algae such as *Enteromorpha*, *Cladophora* and *Ulva* spp.

Subtidal limestone reefs have been destructively sampled at a potentially impacted site (South Garden Island) and a control site (Buache Bay) since 1997. Non-destructive video surveys accompanied the sampling during spring 1998, summer 1999 and autumn 1999. No significant differences in the biomass of brown, red and green algae, or the relative abundance of nuisance green algae, have been observed between impact and control sites, and this is supported by video analysis data. The composition of macroalgal communities at the potentially impacted site is well within the natural range experienced within southern metropolitan coastal waters.

Periphyton collectors

Periphyton is a complex assemblage of microalgae and microscopic filamentous algae, algal propagules, bacteria, microfauna and particulate matter that form a mucous-like layer on biological or artificial substrata. Periphyton plates were deployed as 'artificial reef surface' to estimate the extent of nutrient enrichment in areas close to the outlet where there are no naturally occurring reefs. Periphyton collectors are deployed at three depths (2, 4 and 8 m), which enables monitoring of the effects of the initially buoyant plume and subsequent vertically mixed water column.

The periphyton surveys generally show enhanced growth north of the Sepia Depression Ocean Outlet, with maximum growth potential about 1 km north, but little effect to the east or west (in the direction of the nearest reefs).

Benthic invertebrates

The classic response of benthic invertebrate communities to nutrient enrichment is a decrease in species richness (the number of different types of species present), and the presence of large numbers of a few species of small, fast growing and highly prolific organisms (often polychaete worms).

Sediment infauna was sampled in the vicinity of the Sepia Depression Ocean Outlet in autumn between 1995 and 1998, at distances varying from 250 m to 4 km north and south of the outlet, and 250 m to 500 m east and west. However, neither infauna biomass nor abundance data provided conclusive evidence for an outlet-related influence. Variation among replicate samples at a site was often as great as variation between sites; hence, there were no significant differences between sites.

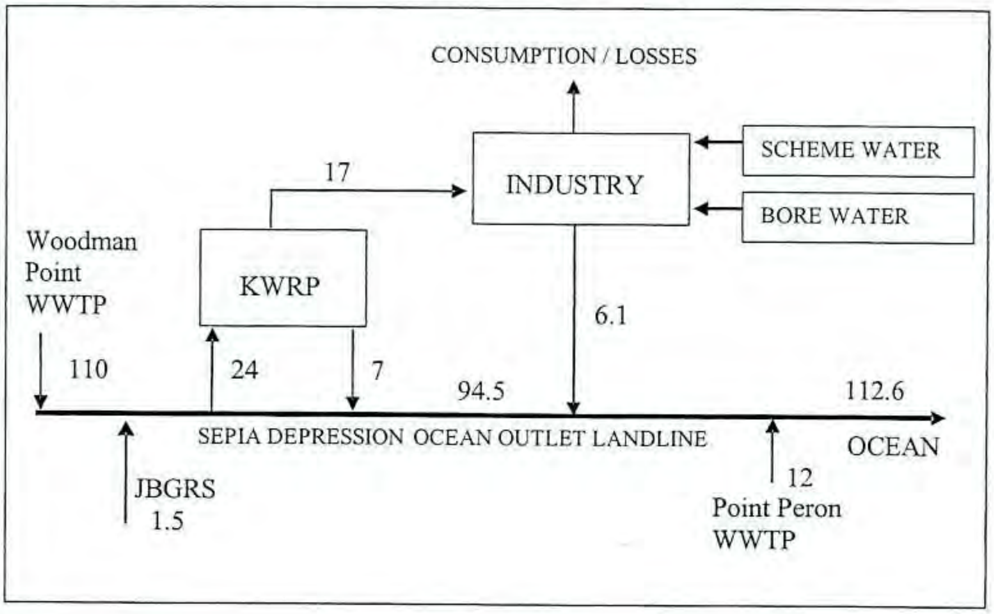
Previous surveys between spring 1993 and summer 1994, conducted as part of the PCWS, identified fauna to species level. A variety of techniques were used to analyse the data. Some techniques (indices of diversity or evenness) found little difference between sites, whereas others (ABC indices and MDS plots) indicated that sites within 300 m of the Sepia Depression outlet differed from sites 4 km north and 4 km south of the outlet, but the effects of sediment grain size and wave energy could not be discounted in contributing to these patterns (Lord and Hillman, 1995). In addition, species diversity was slightly *higher* closer to the outlet, which is the reverse of the adverse effects expected from nutrient enrichment.

4. EFFECTS ON SDOOL DISCHARGE TO THE SEPIA DEPRESSION OCEAN OUTLET

4.1 EFFECTS ON SDOOL DISCHARGE TO THE SEPIA DEPRESSION OCEAN FOR INITIAL KWRP (2004)

Typically 24 ML/day of the combined Woodman Point WWTP and JBGRS discharge will become feed water to the KWRP, and 7 ML/day concentrate from the KWRP will be returned to the SDOOL. Wastewater streams from some of the industries using KWRP treated water will also be returned to the SDOOL (see Figure 4-1). Tiwest does not intend to discharge wastewater to SDOOL at this time.

Figure 4-1 Typical flow diagram and water balance for Sepia Depression Ocean Outlet Landline post-KWRP (i.e. 2004) (all values in ML/day)



The basic characteristics of industrial wastewater streams to be returned to the Sepia Depression Ocean Outlet line are shown in Table 4-1.

Table 4-1 Typical and 'worst case' flow and quality of industrial wastewater to be discharged to the Sepia Depression Ocean Outlet

Industry	Wastewater flow	Wastewater quality
BP Refinery	Typical: 3.5 ML/day Worst case: 7.9 ML/day	Typical: 3,324 mg/L TDS Worst case: 20,192 mg/L TDS
CSBP	Typical: 1.7 ML/day Worst case: 2.0 ML/day	Typical: 3,400 mg/L TDS Worst case: 4,800 mg/L TDS
Edison Mission Energy	Typical: 0.9 ML/day Worst case: 2.4 ML/day	Typical: 4,865 mg/L TDS Worst case: 8,478 mg/L TDS
TOTAL	Typical: 6.1 ML/day Worst case: 12.3 ML/day	Typical: 3,572 mg/L TDS Worst case: 15,415 mg/L TDS

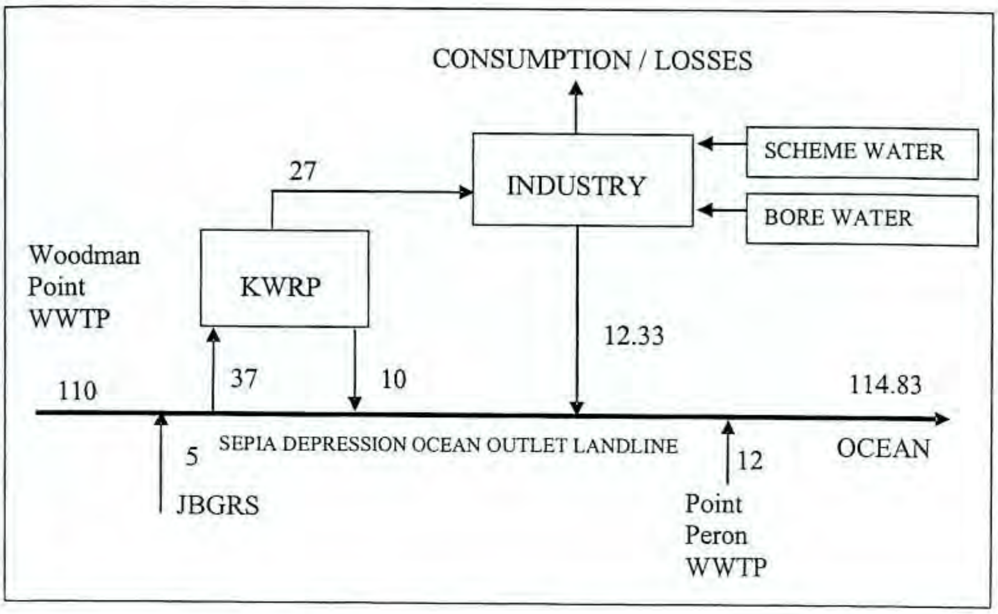
Implementation of KWRP will have the effect of reducing the total volume discharged to the SDOOL, as the 24 ML/day taken off is only replaced with about half the volume (comprising 7 ML/day KWRP concentrate and 6.1 ML/day industrial wastewater). In addition, with the operation of the KWRP most of the substances in 24 ML/day of secondary treated wastewater will be concentrated into 7 ML/day of KWRP concentrate. Therefore, the composite of KWRP concentrate/industrial wastewater/secondary treated wastewater discharged to the Sepia Depression via the SDOOL will contain higher concentrations of some trace metals and nutrients than if secondary treated wastewater alone were discharged to the Sepia Depression.

Diurnal variations in wastewater discharge from the Woodman Point WWTP will also occur according to gravitational flow from the WWTP storage dam, plus any pumping needed to cope with increased inflow to the WWTP in winter (due to stormwater inflow). In 2002, 'dry weather discharge' (which occurs for around 90% of the year) will be 1,000–1,400 L/s (i.e. 86–121 ML/day). In wet weather, instantaneous flow may peak at 2,500 L/s (i.e. 216 ML/day). Secondary treated wastewater will, however, generally vary little in flow and quality compared with industrial wastewater, which will potentially undergo up to three-fold variations in flow and six-fold variations in TDS concentrations.

In calculating the quality of wastewater entering the Sepia Depression, four scenarios of industrial wastewater discharge were initially considered:

- Scenario 1. Typical industrial wastewater flows and typical quality (i.e. the 'normal' industrial loading) (refer Figure 4-1);
- Scenario 2. Typical industrial wastewater flows but worst quality (i.e. all industries to simultaneously discharge their worst quality);
- Scenario 3. Peak industrial wastewater flows and typical quality (i.e. all industries to simultaneously discharge peak flows); and
- Scenario 4. Peak industrial wastewater flows and worst quality (i.e. all industries to simultaneously discharge peak flows of worst quality). Note that under the peak flow scenarios, KWRP could not supply the total water demand of industry, and the remainder would have to come from other water sources. For the purposes of this calculation, it was assumed that KWRP was upgraded to produce 27 ML/day of secondary treated wastewater (Figure 4-2).

Figure 4-2 'Worst-case' flow diagram for Sepia Depression Ocean Outlet Landline post-KWRP (i.e. 2004) (all values in ML/day)



The results of the first (the typical case) and fourth (the worst case) scenarios are shown in Tables 4-2 and 4-3 which show contaminant concentrations and loads, along with the EPA's draft Environmental Quality Criteria (EQC) for the Environmental Quality Objective (EQO) of 'Maintenance of Ecosystem Integrity' at a high (E2) level of protection. Scenario 1 should apply for the majority of the time, while the last three scenarios indicate varying worse cases, as it is unlikely that all three industries would discharge peak flows or worst quality at the same time. In particular, Scenario 4 is unlikely to ever occur, as it is extremely unlikely that all industries would simultaneously discharge peak flow and worst quality.

If data for secondary treated wastewater for Woodman Point are used as a reference, Table 4-2 indicates that operation of the KWRP proposal will typically result in an increase in the pre-dilution TDS concentration of about 33%, largely due to sodium and magnesium salts. Increases in most trace metal concentrations are generally 10–40% except for arsenic (43%), cadmium (188%) and molybdenum (281%). Total pre-dilution Nitrogen concentrations increase by about 18% (which is still about one third of that previously discharged in primary treated wastewater) and phosphorus increases by about 12% (largely because of inputs from CSBP and Edison Mission Energy).

Under worst case conditions for 2004 (Table 4-3), the TDS concentration (compared with pre-KWRP conditions) increases about three-fold, largely because of high discharges of sodium, potassium and magnesium salts. Concentrations of most metals increase by two to six-fold, except for cadmium (68 fold) and molybdenum (13 fold). Nitrogen concentration increases by about 78% (but is still almost half the 54 mg/L previously discharged in primary treated wastewater prior to the upgrade of the Woodman Point WWTP in February 2002), and phosphorus increases by about 22%. Low levels of oil and grease (2.0 mg/L) are present (originating from BP), but are still far less than previously discharged in primary treated wastewater. As indicated above, probability of this 'worst case' scenario occurring is low.

Table 4-2 Initial KWRP proposal – 2004 typical quality and quantity of wastewater discharged under typical conditions, and resulting mixture discharged to Sepia Depression Ocean Outlet

Variable	Separate Sources (Concentration/Value)						SDOOL Upstream of KWRP		SDOOL Downstream of KWRP		Ocean		
	CSBP	BP	Edison Mission Energy	Woodman Pt WWTP	Jervoise Bay	Point Peron WWTP**	Concent-ration	Loads (kg/d) or (cfu/d)	Concent-ration	Loads (kg/d) or (cfu/d)	Natural Seawater*	Edge of ZID***	E2 EQC
Volume (ML/day)	1.7	3.5	0.9	110	1.5	12	123.5		112.6				
Enteroccoci (cfu/100 mL)	0	0	0	20,000	0	2,000,000	212146	2.62E+14	228,419	2.57E+14	0	914	
TTC (cfu/100 mL)	0	0	0	196,250	0	10,642,857	1208921	1.49E+15	1,284,119	1.45E+15	0	5,136	
Suspended solids (mg/L)	18	19	60	25.7	7.5	113.5	34.0	4200	39	4,351	5	5	
TDS (mg/L)	3400	3324	4865	812	3259	812	842	103953	1,117	125,745	37000	37,004	
Colour (TCU)	10	43							1	168	0	0.006	
pH (units)	8	7.2	7	7.1	7.38	7.1	7.10	877	8.19	922	8.2	8.23	
Sodium (mg/L)	1026	913	1210	197	584	*197*	202	24910	275	30,939	10500	10,501	
Potassium (mg/L)	27	29	70	28.0	44.5	*28.0*	28	3479	33	3,689	420	420	
Calcium (mg/L)	210	50	155	33	161.5	*33*	35	4268	44	4,940	425	425	
Magnesium (mg/L)	1	93	60	11	71.6	*11*	12	1449	16	1,830	1350	1,350	
Iron (mg/L)	0.4	0.114	0.58	0.1	0.55	*0.1*	0.11	13.03	0.13	15	0.001	0.0015	
Manganese (mg/L)	0.03	0.062	0.06	0.041	0.04	*0.041*	0.04	5.06	0.048	5	0.0004	0.0006	
Boron (mg/L)		0.33	0.087	0.15	0.22	*0.15*	0.151	18.630	0.18	20	4.5	4.5	
Bicarbonate (mg/L)		206	352	120		*120*	119	14640	139	15,678	123	124	
Chloride (mg/L)	1513	1541	933	254	1050	*254*	264	32563	367	41,368	20000	20,001	
Fluoride (mg/L)	5	16	7	0.87	0.15	*0.87*	1	106	2	178	0.8	0.8	
Sulphate (mg/L)	300	407	1856	74.9	173	*74.9*	76	9397	115	13,001	2800	2,800	
Sulphide (mg/L)	0	0.02		0		*0*	0	0	0.0006	0.070	0	0.000002	
Silica as SiO2 (mg/L)	10	15	120	15.1	9.1	*15.1*	15	1856	18	2,033	0.13	0.20	
Cyanide (total) (mg/L)	0.5	0.01	0.03	0.05		*0.05*	0.05	6.10	0.062	7	0	0.0002	0.004
Chlorate (mg/L)	20						0	0	0.302	34	0	0.0012	
Ammonia N (mg/L)	47	1.51	2	3.2	27.7	46.1	8	947	9.2	1,034	0.003	0.04	0.91
Nitrate N (mg/L)	24	4.06	4	8.8	13.4	0.8	8	998	9.4	1,056	0.002	0.040	
Organic N (mg/L)	8	4.34	2	2.1	1.50	5.66	2	301	2.9	332	0.18	0.19	

Variable	Separate Sources (Concentration/Value)						SDOOL Upstream of KWRP		SDOOL Downstream of KWRP		Ocean		
	CSBP	BP	Edison Mission Energy	Woodman Pt WWTP	Jervoise Bay	Point Peron WWTP**	Concent-ration	Loads (kg/d) or (cfu/d)	Concent-ration	Loads (kg/d) or (cfu/d)	Natural Seawater*	Edge of ZID***	E2 EQC
Total N (mg/L)	79	10	8	14.1	44.5	52.6	18	2249	22	2,426	0.2	0.29	
Total P (mg/L)	6	3.32	6	10	0.125	12.3	10	1248	11	1,275	0.38	0.43	
Arsenic (mg/L)	0.01	0.01	0.030	0.002	0.012	0.002	0.002	0.262	0.0030	0.34	0.0017	0.0017	0.0023
Cadmium (mg/L)	0.025	0.001	0.00001	0.0002	0.0002	*0.0005*	0.0002	0.03	0.0007	0.07	0.00011	0.0001	0.0007
Chromium (mg/L)	0.01	0.02	0.007	0.0091	0.0005	0.020	0.010	1.24	0.012	1.33	0.000125	0.0002	0.0044
Cobalt (mg/L)	0.02	0.01	0.006	0.001	0.001	*0.042*	0.005	0.62	0.006	0.69	0.00039	0.0004	0.001
Copper (mg/L)#	0.2	0.02	0.090	0.034	0.006	0.131	0.043	5.32	0.052	5.81	0.001	0.001	0.0013
Lead (mg/L)	0.03	0.005	0.002	0.002	0.002	0.0034	0.002	0.26	0.003	0.33	0.00003	0.00004	0.0044
Mercury (mg/L)	0.0005	0.0014	0.000	0.0005	0.0005	0.0003	0.0005	0.059	0.00058	0.07	0.00015	0.00015	0.0001
Molybdenum (mg/L)	0.5	0.02	0.002	0.0024	0.0005	*0.009*	0.003	0.37	0.011	1.29	0.005	0.005	0.023
Nickel (mg/L)	0.05	0.02	0.006	0.0128	0.005	0.0041	0.012	1.47	0.014	1.63	0.004	0.004	0.007
Selenium (mg/L)		0.005	0.000	0.003	0.003	*0.003*	0.003	0.37	0.0034	0.39	0.0009	0.0009	0.003
Silver (mg/L)		0.005	0.001	0.001	0.001	0.0035	0.001	0.15	0.0015	0.17	0.00028	0.0003	0.0014
Vanadium (mg/L)	0.02	0.05	0.006	0.005	0.05	*0.014*	0.006	0.79	0.009	1.01	0.0019	0.002	0.1
Zinc (mg/L)	0.7	0.094	1.0	0.08	0.02	0.11	0.1	10.1	0.11	12.52	0.0025	0.003	0.015
BOD (mg/L)	20	8	11.5	6.6	5	161	21.6	2668	24	2,740	2	2	
COD (mg/L)		60	46.2	59	25	*59*	58.6	7236	66	7,487	2	2	
TOC (mg/L)	20						0	0	0	34.0	1.5	2	
Oil and grease (mg/L)		0.49	0	0			0	0	0.015	1.72	1	1.000	
Phenols (mg/L)	0	0.02	0.001	0			0	0	0.001	0.07	0	0.000003	0.4
PCBs (mg/L)		0					0	0	-	0	0		
AOX (mg/L)		0.003		0.25		0.25	0.247	30.5	0.27	30.5	0	0.0011	

* Seawater value is based upon measured values where possible (DALSE 2002c). If this is not available then the typical values from Horne (1968) and Turekian (1968) are averaged or, if only one is available, that value is used. However, if the seawater measured value is below detection, the lower of the detection and typical values is used.
** Values in italics taken from Woodman Pt.
*** Concentration of the discharge at the edge of the ZID (zone of initial dilution) after 250-fold dilution with natural seawater.
# total fraction used throughout, bioavailable fraction in treated wastewater is generally around 50% of total.

Table 4-3 Initial KWRP proposal – 2004 worst quality and quantity of wastewater discharged under typical conditions, and resulting mixture discharged to Sepia Depression Ocean Outlet

Variable	Separate Sources (Concentration/Value)						SDOOL Upstream of KWRP		SDOOL Downstream of KWRP		Ocean (Concentration)		
	CSBP	BP	Edison Mission Energy	Woodman Pt WWTP	Jervoise Bay	Point Peron WWTP**	Concent-ration	Loads (kg/d) or (cfu/d)	Concent-ration	Loads+ (kg/d) or (cfu/d)	Natural Seawater*	Edge of ZID***	E2 EQC
Volume (ML/day)	2	7.93	2.4	110	5	12	127		122.3		0		
Enteroccoci (cfu/100 mL)	0	0	0	20,000	0	2,000,000	206299	2.62E+14	210,251	2.57E+14	0	841	
TTC (cfu/100 mL)	0	0	0	196,250	0	10,642,857	1175605	1.49E+15	1,181,981	1.45E+15	0	4,728	
Suspended solids (mg/L)	100	59	79	25.7	7.5	114	33.3	4227	42	5,083	5	5	
TDS (mg/L)	4800	20192	8478	812	3259	812	908	115361	2,497	305,430	37000	37,010	
Colour (TCU)	15	52											
pH (units)	9	8.63	9.5	7.1	7.38	7.1	7.11	903.1	8.28	1012	8.2	8.23	
Sodium (mg/L)	1034	5295	2507	197	584	*197*	212	26955	630	77,030	10500	10,503	
Potassium (mg/L)	32	196	150	27.97	44.5	*28.0*	29	3635	46	5,613	420	420	
Calcium (mg/L)	260	235	252	33	162	*33*	38	4834	64	7,822	425	425	
Magnesium (mg/L)	2	696	71	11	71.6	*11*	13	1700	60	7,393	1350	1,350	
Iron (mg/L)	10.8	0.52	0.20	0.1	0.55	*0.1*	0.12	14.95	0.34	41	0.001	0.0023	
Manganese (mg/L)	1.6	0.16	0.05	0.041	0.04	*0.041*	0.04	5.20	0.080	10	0.0004	0.0007	
Boron (mg/L)		0.53	1.18	0.15	0.22	*0.15*	0.153	19.400	0.22	26	4.5	4.5	
Bicarbonate (mg/L)		468	433	120		*120*	115	14640	159	19,391	123	124	
Chloride (mg/L)	1525	9804	1063	254	1050	*254*	285	36237	978	119,584	20000	20,004	
Fluoride (mg/L)	28	36	7	0.87	0.15	*0.87*	1	107	4	465	0.8	0.8	
Sulphate (mg/L)	600	1961	3988	74.9	173	*74.9*	79	10001	297	36,322	2800	2,801	
Sulphide (mg/L)	0	1.18		0		*0*	0	0	0.076	9.36	0	0.00031	
Silica as SiO2 (mg/L)	15	31	205	15.1	9.1	*15.1*	15	1888	22	2,655	0.13	0.22	
Cyanide (total) (mg/L)	1	0	0.39	0.05		*0.05*	0.05	6.10	0.074	9	0	0.0003	0.004
Chlorate (mg/L)	20						0	0	-	-	0	0	
Ammonia N (mg/L)	158	18.7	24	3.2	27.7	46.1	8	1044	12.8	1,565	0.003	0.05	0.91
Nitrate N (mg/L)	99	22.4	55	8.8	13.4	0.8	8	1044	12.7	1,552	0.002	0.053	
Organic N (mg/L)	8	45	24	2.1	1.50	5.66	2	306	6.0	736	0.18	0.20	

Variable	Separate Sources (Concentration/Value)						SDOOL Upstream of KWRP		SDOOL Downstream of KWRP		Ocean (Concentration)		
	CSBP	BP	Edison Mission Energy	Woodman Pt WWTP	Jervoise Bay	Point Peron WWTP**	Concent-ration	Loads (kg/d) or (cfu/d)	Concent-ration	Loads+ (kg/d) or (cfu/d)	Natural Seawater*	Edge of ZID***	E2 EQC
Total N (mg/L)	265	96	110	14.1	44.5	52.6	19	2405	32	3,961	0.2	0.33	
Total P (mg/L)	70	12.6	10	10	0.125	12.3	10	1248	12	1,512	0.38	0.43	
Arsenic (mg/L)	0.060	0.1	0.030	0.002	0.012	0.002	0.002	0.304	0.0105	1.29	0.0017	0.0017	0.0023
Cadmium (mg/L)	0.15	0.2	0.00020	0.0002	0.0002	*0.0005*	0.0002	0.03	0.0157	1.92	0.00011	0.0002	0.0007
Chromium (mg/L)	0.05	0.1	0.095	0.0091	0.0005	0.020	0.010	1.24	0.019	2.36	0.000125	0.0002	0.0044
Cobalt (mg/L)	0.19	0.1	0.079	0.001	0.001	*0.042*	0.005	0.62	0.016	1.98	0.00039	0.0005	0.001
Copper (mg/L)#	0.6	0.21	0.090	0.034	0.006	0.131	0.042	5.34	0.069	8.42	0.001	0.0013	0.0013
Lead (mg/L)	0.2	0.1	0.024	0.002	0.002	0.0034	0.002	0.27	0.012	1.52	0.00003	0.0001	0.0044
Mercury (mg/L)	0.02	0.01	0.001	0.0005	0.0005	0.0003	0.0005	0.061	0.0015	0.18	0.00015	0.00016	0.0001
Molybdenum (mg/L)	2	0.1	0.032	0.0024	0.0005	*0.009*	0.003	0.37	0.043	5.24	0.005	0.005	0.023
Nickel (mg/L)	1.5	0.11	0.079	0.0128	0.005	0.0041	0.012	1.48	0.045	5.54	0.004	0.004	0.007
Selenium (mg/L)		0.1	0.004	0.003	0.003	*0.003*	0.003	0.38	0.0097	1.18	0.0009	0.0009	0.003
Silver (mg/L)		0.1	0.016	0.001	0.001	0.0035	0.001	0.16	0.0081	0.99	0.00028	0.0003	0.0014
Vanadium (mg/L)	0.2	0.1	0.079	0.005	0.05	*0.014*	0.008	0.97	0.019	2.35	0.0019	0.002	0.1
Zinc (mg/L)	5.4	0.34	2.0	0.08	0.02	0.11	0.1	10.2	0.23	28.47	0.0025	0.003	0.015
BOD (mg/L)	80	80	157.5	6.6	5	161	21.1	2685	32	3,858	2	2	
COD (mg/L)		550	630	59	25	*59*	57.7	7323	108	13,197	2	2	
TOC (mg/L)	60		0				0	0	1	120.0	1.5	2	
Oil and grease (mg/L)		30	0	0			0	0	1.94	238	1	1.01	
Phenols (mg/L)	0	4.2	0.008	0			0	0	0.272	33.3	0	0.0011	0.4
PCBs (mg/L)							0	0	-	0	0	-	
AOX (mg/L)		0.0078		0.25		0.250	0.240	30.5	0.25	30.5	0	0.0010	

* Seawater value is based upon measured values where possible (DALSE 2002c). If this is not available then the typical values from Horne (1968) and Turekian (1968) are averaged or, if only one is available, that value is used. However, if the seawater measured value is below detection, the lower of the detection and typical values is used.
** Values in italics taken from Woodman Pt.
*** Concentration of the discharge at the edge of the ZID (zone of initial dilution) after 250-fold dilution with natural seawater.
\# total fraction used throughout, bioavailable fraction in treated wastewater is generally around 50% of total.
\+ Loads are indicative of maximum daily loads and are not representative of average daily loads (daily average loads in Table 4-2 are more representative of daily average loads).

Under all the scenarios, the bacterial load discharged to the Sepia Depression will decrease slightly, due to the processing of 24 ML/day of secondary treated wastewater by the KWRP which kills off all bacteria so there will be no bacteria in the concentrate returned to the SDOOL.

Anti-scalant will also be present in wastewater discharged to the Sepia Depression. Assuming the anti-scalant is added to the RO feedwater at a concentration of about 3–5 mg/L, and that 90% of this is retained in KWRP concentrate, the ensuing concentration in the composite wastewater discharged to the Sepia Depression will, at most, be about 0.9 mg/L. It is concluded (see section 5.1.3) that the concentrations of anti-scalant discharged from the Sepia Depression Ocean Outlet (i.e. 0.004mg/L) will not cause any adverse environmental effects

In addition to typical operational flows from the KWRP, there will also be periodic (about one day per fortnight) increases in contaminant discharge associated with cleaning of MF and RO membranes. If the 10% of TDS assumed to be retained in the KWRP is released during cleaning (the worst possible case), the addition of cleaning wastes will result in substances discharged in KWRP concentrate being two to three-fold higher than during typical operating conditions. This will be discharged to the SDOOL which has a typical flow rate of 1,000 to 2,500 L/s at a controlled rate of about 50 L/s to ensure good mixing. As a result, the concentration of substances in the composite of KWRP concentrate/industrial wastewater/secondary treated wastewater will be more than 20% higher than under typical operating conditions.

4.2 EFFECTS ON SDOOL DISCHARGE TO THE SEPIA DEPRESSION OCEAN OUTLET FROM FUTURE GROWTH

It is anticipated that the population growth of Perth will ultimately require the closure of the Cape Peron WWTP around 2010 to 2011, and the commissioning of the East Rockingham WWTP at that time. The Water Corporation has predicted that by about 2019, the combined Woodman Point/East Rockingham advanced secondary wastewater flows to SDOOL will be about 200 ML/day (see Table 3-1).

It is also anticipated that greater wastewater re-use will be driven by the increasing pressure on the finite traditional potable water resources. Consequently, further opportunities for the re-use of treated wastewater will need to be developed.

Figure 4-3 and Table 4-4 present the 2019 scenario where the Water Corporation has expanded its WWTP operations in line with its projections (200 ML/day by 2019), and that two more significant future industrial participants will seek to discharge to the SDOOL (the first is assumed to be same composition as BP's while the second is assumed to discharge wastewater similar to typical cooling tower blowdown). The table shows the effect that these developments will have on the Water Corporation's ability to meet the E2 EQC at the boundary of the ZID in Sepia Depression for toxicants and metals. Where quality criteria exist, in all instances the E2 EQC's that are above natural seawater background levels are easily met. This indicates that new industry participants could use reclaimed water from the KWRP plant, and safely discharge their waste streams back into the sepia Depression.

Figure 4-3 'Worst-case' flow diagram for Sepia Depression Ocean Outlet Landline for the 2019 case (all values in ML/day)

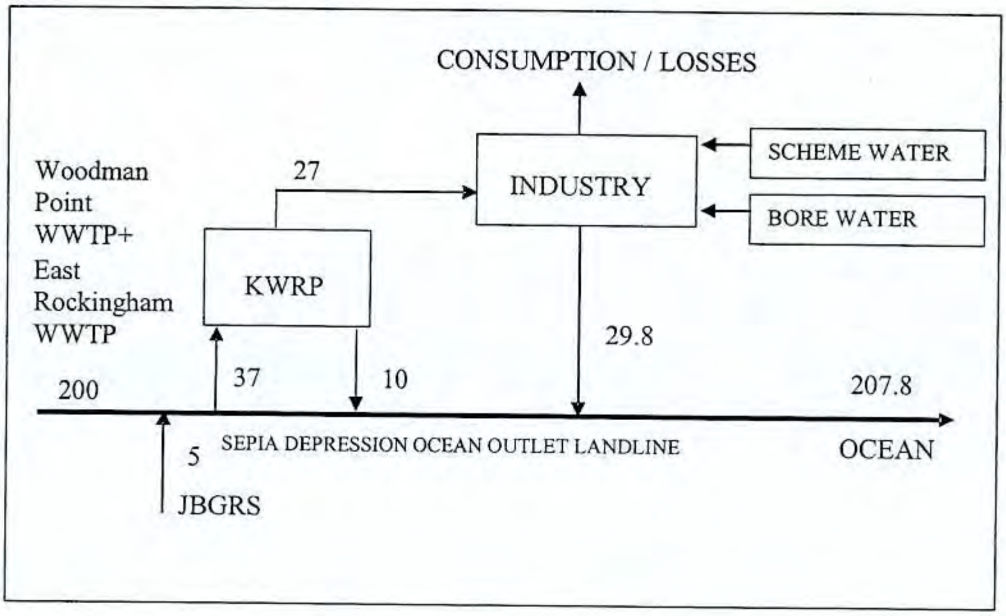


Table 4-4 Worst quality and quantity of wastewater discharged under projected conditions in 2019, and resulting discharge to Sepia Depression Ocean Outlet

Variable	Separate Sources (Concentration/Value)							SDOOL Downstream of KWRP		Ocean (Concentration)		
	CSBP	BP	EDISON MISSION	FUTURE OTHER I *	FUTURE OTHER II**	WOODMAN PT plus EAST ROCKINGHAM 2019***	JBGRS (post KWRP)	Concent-ration	Loads[+] (kg/d) or (cfu/d)	Natural Seawater^	Edge of ZID^^	E2 EQC
Volume (ML/day)	2	7.93	2.4	10.43	7	200	5	207.8		0		
Enteroccoci (cfu/100 mL)	0	0	0	0	0	20,000	0	15,691	3.26E+13	0	63	
TTC (cfu/100 mL)	0	0	0	0	0	196,250	0	153,970	3.20E+14	0	616	
Suspended solids (mg/L)	100	59	79	59	100	25.7	7.5	35	7,350	5	5	
TDS (mg/L)	4800	20192	8478	20192	4700	812	3259	2,947	612,269	37000	37,012	
Colour (TCU)	15	52		52				5	985	0	0.019	
pH (units)	9	8.63	9.5	8.63		7.1	7.38	7.97	1656	8.2	8.23	
Sodium (mg/L)	1034	5295	2507	5295	1606	197	584	765	158,864	10500	10,503	
Potassium (mg/L)	32	196	150	196	838	27.97	44.5	76	15,705	420	420	
Calcium (mg/L)	260	235	252	235	36	33	162	63	13,099	425	425	
Magnesium (mg/L)	2	696	71	696	0	11	71.6	75	15,511	1350	1,350	
Iron (mg/L)	10.8	0.52	0.20	0.52	3.00	0.1	0.55	0.36	75	0.001	0.0025	
Manganese (mg/L)	1.6	0.16	0.05	0.16	0.00	0.041	0.04	0.071	15	0.0004	0.0007	
Boron (mg/L)		0.53	1.18	0.53	0.70	0.15	0.22	0.23	49	4.5	4.5	
Bicarbonate (mg/L)		468	433	468	1775	120		222	46,057	123	124	
Chloride (mg/L)	1525	9804	1063	9804	2060	254	1050	1,233	256,072	20000	20,005	
Fluoride (mg/L)	28	36	7	36	94	0.87	0.15	8	1,567	0.8	0.8	
Sulphate (mg/L)	600	1961	3988	1961	3	74.9	173	301	62,638	2800	2,801	
Sulphide (mg/L)	0	1.18		1.18	1.55	0		0.157	32.527	0	0.00063	
Silica as SiO_2 (mg/L)	15	31	205	31	30	15.1	9.1	21	4,366	0.13	0.21	
Cyanide (total) (mg/L)	1	0	0.39	0		0.05		0.062	13	0	0.0002	0.004
Chlorate (mg/L)	20							0.193	40	0	0.00077	
Ammonia N (mg/L)	158	18.7	24	18.7		3.2	27.7	7.2	1,495	0.003	0.03	0.91
Nitrate N (mg/L)	99	22.4	55	22.4		8.8	13.4	12.4	2,568	0.002	0.051	
Organic N (mg/L)	8	45	24	45		2.1	1.50	6.4	1,326	0.18	0.21	

Variable	Separate Sources (Concentration/Value)							SDOOL Downstream of KWRP		Ocean (Concentration)		
	CSBP	BP	EDISON MISSION	FUTURE OTHER I *	FUTURE OTHER II**	WOODMAN PT plus EAST ROCKINGHAM 2019***	JBGRS (post KWRP)	Concent-ration	Loads+ (kg/d) or (cfu/d)	Natural Seawater^	Edge of ZID^^	E2 EQC
Total N (mg/L)	265	96	110	9		14.1	44.5	27	5,600++	0.2	0.31	
Total P (mg/L)	70	12.6	10	12.6		10	0.125	12	2,396	0.38	0.43	
Arsenic (mg/L)	0.060	0.10	0.030	0.10	0	0.002	0.012	0.0120	2.49	0.0017	0.0017	0.0023
Cadmium (mg/L)	0.15	0.20	0.00020	0.20	0	0.0002	0.0002	0.0193	4.01	0.00011	0.0002	0.0007
Chromium (mg/L)	0.05	0.10	0.095	0.10	0	0.0091	0.0005	0.019	3.99	0.000125	0.0002	0.0044
Cobalt (mg/L)	0.19	0.10	0.079	0.10	0	0.001	0.001	0.013	2.61	0.00039	0.0004	0.001
Copper (mg/L)#	0.6	0.21	0.090	0.21	0	0.034	0.006	0.058	12.10	0.001	0.0012	0.0013
Lead (mg/L)	0.2	0.10	0.024	0.10	0	0.002	0.002	0.013	2.70	0.00003	0.0001	0.0044
Mercury (mg/L)	0.02	0.01	0.001	0.01	0	0.0005	0.0005	0.0016	0.33	0.00015	0.00016	0.0001
Molybdenum (mg/L)	2	0.10	0.032	0.10	0	0.0024	0.0005	0.031	6.39	0.005	0.005	0.023
Nickel (mg/L)	1.5	0.11	0.079	0.11	0	0.0128	0.005	0.038	7.79	0.004	0.004	0.007
Selenium (mg/L)		0.10	0.004	0.10	0	0.003	0.003	0.0118	2.46	0.0009	0.0009	0.003
Silver (mg/L)		0.10	0.016	0.10	0	0.001	0.001	0.0100	2.08	0.00028	0.0003	0.0014
Vanadium (mg/L)	0.2	0.10	0.079	0.10	0	0.005	0.05	0.018	3.68	0.0019	0.002	0.1
Zinc (mg/L)	5.4	0.34	2.0	0.34	0	0.08	0.02	0.18	37.94	0.0025	0.003	0.015
BOD (mg/L)	80	80	158	80		6.6	5	16	3,352	2	2	
COD (mg/L)		550	630	550		59	25	113	23,535	2	2	
TOC (mg/L)	60		0					1	120	1.5	2	
Oil and grease (mg/L)		30	0	30		0		2.65	551	1	1.01	
Phenols (mg/L)	0	4.2	0.008	4.2		0		0.371	77.1	0	0.0015	0.4
PCBs (mg/L)								-	0	0	-	
AOX (mg/L)		0.0078				0.25		0.24	50.1	0	0.0010	

* Future Other Industry Participant (worst case). Wastewater quality postulated as similar to be similar to BP and 1.3 times the volume.
** Future Other Industry Participant (Worst Case). Wastewater quality postulated as similar to typical cooling tower blowdown.
*** predicted expansion of the WWTP capacity to 2019 (Table 3-1, PER) including closure of Cape Peron WWTP (primary) and commissioning of East Rockingham WWTP (advanced Secondary)
^ Seawater value is based upon measured values where possible (DALSE 2002c). If this is not available then the typical values from Horne (1968) and Turekian (1968) are averaged or, if only one is available, that value is used. However, if the seawater measured value is below detection, the lower of the detection and typical values is used.
^^ Concentration of the discharge at the edge of the ZID (zone of initial dilution) after 250-fold dilution with natural seawater.
# total fraction used throughout, bioavailable fraction in treated wastewater is generally around 50% of total.
+ Loads are indicative of maximum daily loads and are not representative of average daily loads.
++ Annual nitrogen loads will be around 2025 tonnes per annum.

5. PREDICTED ENVIRONMENTAL EFFECTS OF CHANGES IN WASTEWATER DISCHARGE RESULTING FROM THE KWRP

The operation of the KWRP proposal will result in small changes to the volume and quality of wastewater discharged from the Sepia Depression Ocean Outlet. To assess the potential environmental effects of these changes, concentrations of substances predicted to occur in the near field of Sepia Depression Ocean Outlet when the KWRP is operational were compared with the environmental criteria likely to be applied. The substances considered were pathogens, nutrients and toxicants.

As discussed in Section 3.2, the relevant Environmental Quality Objectives (EQOs) and associated Environmental Quality Criteria (EQC) derived for the Environmental Protection (Cockburn Sound) Policy (EPA, 2002a) have been used as the basis for assessment.

In terms of pathogens, the KWRP acts to kill off the pathogens in the wastewater stream, and so the total amount of bacteria discharged (the load) to the Sepia Depression will be slightly reduced (see Table 4-2). There will be a slight increase in bacteria concentrations in wastewater discharged, but this is caused by the slightly lesser volume of wastewater entering the SDOOL to dilute primary treated wastewater from the Point Peron WWTP. The KWRP proposal therefore results in negligible changes to the current level of pathogen impacts on relevant human health EQOs for Sepia Depression.

In terms of nutrients, the present discharge of nitrogen to the Sepia Depression equates to approximately 821 tonnes/year, which is 46.2% of the 1,778 tonnes/year set by the DoE as a limit based on 1994 performance data. The KWRP proposal will result in a small increase in nitrogen loads to approximately 886 tonnes/year — still well under the 1994 limit (i.e. 50%). More importantly, this slight increase in nutrients (around 65 tonnes/year) to the Sepia Depression is because of the diversion of nutrients that are presently discharged into Cockburn Sound, resulting in a benefit to Cockburn Sound (see Section 5.3).

Thus, the KWRP project only has the potential to slightly increase the environmental load of some toxicants. The discharge into the Sepia Depression is not visible except under extreme calm conditions, when minor surface agitation is visible. Consequently, this PER document focuses on establishing the size of the mixing zone for the outlet, at the edge of which toxicant EQCs need to be met. The nutrient, aesthetic and health related impacts will continue to be managed under the existing Best Practice Environmental Licence.

The draft EQC for the EQO of Maintenance of Ecosystem Integrity at a high (E2) level of protection, as derived for the revised draft EPP for Cockburn Sound (EPA, 2002a and 2002b) are the relevant guidelines, and are used as the basis for this assessment.

5.1 CONTAMINANT CONCENTRATIONS COMPARED WITH RELEVANT CRITERIA

5.1.1 Derivation of the zone of initial dilution (ZID)

A ZID for the Sepia Depression Ocean Outlet was derived from calculations of the size of the near-field mixing zone (hereafter called the Zone of Initial Dilution, or ZID) for the diffuser. The ZID is defined entirely by means of physical characteristics. It is a function of the water depth, the presence or absence of vertical density gradients, the diffuser design, the discharge flows and the ambient water currents.

The Sepia Depression Ocean Outlet has a diffuser that is 324 m long, and discharges at the seabed into water 20 m deep. Initial dilution achieved within the ZID of the Sepia Depression Ocean Outlet has been the subject of detailed modelling and field measurements, as part of the Water Corporation's PLOOM programme.

Ambient current speed in the Sepia Depression is typically 5–20 cm/s. A year of detailed current measurements taken in the Sepia Depression in 1993 (deemed a 'typical' year in terms of winds and currents) found that current speed equals or exceeds 5 cm/sec for 97.5% of the time, and averages 13 cm/s.

The range of anticipated flows from the outlet used to calculate ZIDs are shown in Table 5-1.

Table 5-1 Range in wastewater flow used to calculate ZIDs for the Sepia Depression Ocean Outlet

Year	Median flow rate L/s (MLD)	Maximum flow rate L/s (MLD)	Minimum flow rate L/s (MLD)
2002	1,300 (112)	2,400 (207)	1,000 (86)
2010	1,700 (147)	2,800 (242)	1,260 (109)
2019	2,000 (173)	2,800 (242)	1,630 (141)

The estimated dimensions of the ZID under various conditions of wastewater flow are shown in Table 5-2.

Table 5-2 Dimensions of the mixing zone of the Sepia Depression Ocean Outlet under various wastewater flows

Year	Wastewater flow case	Mixing zone radius (in metres, centred on the diffuser)
2002	Low	23.6
	Median	24.6
	Peak	28.6
2010	Low	23.9
	Median	26.1
	Peak	30.0
2019	Low	24.6
	Median	27.1
	Peak	30.0

The calculated mixing zone varies from 23.6 m to 30 m from the diffuser. In practice, the anchoring of a vessel and taking of water samples at the exact distances listed in Table 5-2 would simply not be possible in the swell and wave conditions typical of the Sepia Depression. Therefore monitoring of the ZID will be in accordance with the procedures utilised in the PLOOM program .

5.1.2 *Initial dilution achieved within the ZID*

As noted previously, the ambient current speed in the Sepia Depression is 5 cm/s or more for 97.5% of the time, and averages 13 cm/s. In Table 5-3, the initial dilutions of wastewater achieved within the ZID at ambient current speeds of 5 cm/s and 13 cm/s are shown for low, median and peak wastewater flow in 2002, 2010 and 2019.

Table 5-3 Initial dilution of wastewater from the Sepia Depression Ocean Outlet achieved during low, median and peak wastewater flow

Year	Wastewater flow	Diffuser port discharge velocity (m^3/s)	Initial dilution: ambient current of 5 cm/s	Initial dilution: ambient current of 13 cm/s
2002	Low	1.16	~320	~800
	Median	1.51	~250	~630
	Peak	2.79	~180	~350
2010	Low	1.47	~260	~650
	Median	1.98	~210	~500
	Peak	3.26	~160	~300
2019	Low	1.90	~210	~500
	Median	2.33	~200	~400
	Peak	3.26	~160	~300

The initial dilution of wastewater discharged from the Sepia Depression Ocean Outlet under most conditions (i.e. excluding infrequent peak flows and noting that currents normally exceed 5 cm/s) can be summarised as follows:

- 250-fold to 800-fold in 2002;
- 210-fold to 650-fold in 2010; and
- 200-fold to 500-fold in 2019.

Overall, dilutions are normally 300 to 500 fold.

5.1.3 *Comparison of predicted wastewater discharge with water quality criteria*

Concentrations of contaminants

To determine the environmental acceptability of discharge of substances from the Sepia Depression Ocean Outlet, the maximum concentrations of contaminants in wastewater that would be discharged were calculated.

Despite dilutions normally being 300 to 500-fold, a conservative approach was taken, and a worst-case initial dilution of 250-fold was assumed to apply at the edge of the ZID. The results for typical and 'worst case' and projected future (2019) wastewater discharge scenarios (as discussed in Section 4) are given in Tables 4-2 and 4-3 respectively.

Concentrations of all substances at the edge of the ZID meet the relevant EQC under typical worst case and projected future (2019) discharge scenarios (except for mercury for which the prescribed EQC appears to be in error as it is below natural background levels in seawater). Of particular note are the results for arsenic, cadmium, mercury, phenols and PCBs, which will be discharged from the Sepia Depression Ocean Outlet at higher concentrations than if domestic wastewater alone were discharged (i.e. without the KWRP proposal). The results indicate that the concentrations of arsenic, cadmium, phenols and PCBs are well below the E2 EQC for the Maintenance of Ecosystem Integrity (high level of protection), and so are not of environmental concern. The concentration of mercury at the edge of the ZID is within a few percent of natural background levels in seawater and therefore is not of environmental concern.

Assessment of organohalogens (as measured by AOX levels) is less straightforward as AOX encompasses a range of compounds (e.g. chlorinated alkanes, chlorinated alkenes, chlorobenzenes, chlorophenols and halogenated ethers), few of which have an EQC. However, there are EQCs for trichlorobenzene (0.02 mg/L) and pentachlorophenol (0.011 mg/L), which are two of the more toxic organohalogens, and even if the AOX load consisted solely of one or the other of these compounds (which is extremely unlikely), the EQCs are met at the edge of the ZID. On this basis, the risk from organohalogens is considered minimal.

During periods of low domestic (i.e. dry weather) wastewater flow from the Woodman Point WWTP (e.g. 136 ML/day in 2010), the concentrations of some metals and PCBs will up to 20% higher than the 2019 scenario while phenols will up to 20% higher. These concentrations are still within the relevant EQC or within a few percent of natural background levels in seawater for the case of mercury. During periods of peak domestic wastewater flow from the Woodman Point WWTP (216 ML/day in 2002, around 240 ML/day in 2010, the concentrations of cadmium, mercury, phenols and PCBs will decrease. The concentrations of other substances (i.e. those found in secondary treated wastewater) will undergo only minor variations in response to changes in the flow of domestic wastewater, as the degree of dilution of KWRP concentrate changes by less than 5%.

There are no EQCs for the anti-scalant to be used in the KWRP, which will be discharged at a concentration of about 0.8 mg/L (0.9 mg/L in Woodman Point/KWRP concentrate/industrial wastewater composite, diluted slightly by Point Peron discharge), and so will be assumed to dilute to less than 0.004 mg/L in the ZID under worst case conditions.

In general, the formulation for reverse osmosis anti-scalant is typically based on phosphinocarboxilic acid, and available toxicity data are as follows:

- Rainbow trout 96 hour LC_{50} >1,000 mg/L;
- Zebra fish 96 hour LC_{50} >1,000 mg/L;
- Brown shrimp 96 hour LC_{50} >10,000 mg/L;
- *Daphnia* 24 hour LC_{50} >320 mg/L; and
- Algal inhibition 72 hour LC_{50} >130 mg/L.

The above toxicity data are for freshwater organisms, which are typically more sensitive than marine organisms. It is also noted that phosphinocarboxilic acid is certified by the United Kingdom Drinking Water Inspectorate for use in reverse osmosis plants producing potable (i.e. drinking) water. Based on the information available, it is concluded that the concentrations of anti-scalant discharged from the Sepia Depression Ocean Outlet (i.e. less than 0.004 mg/L) will not cause any adverse environmental effects.

Further, the Water Corporation will undertake whole effluent toxicity testing in accordance with the protocols advocated by ANZECC/ARMCANZ (2000). This testing will include assessing the effect of anti-scalants added by the KWRP discharge.

5.1.4 Effects on Sepia Depression sediments

The potential for accumulation of contaminants in sediments is considered low. The loads of chromium (1.0–2.4 kg/day), copper (8–19 kg/day), lead (0.3–0.8 kg/day), nickel (0.6–1.5 kg/day) and zinc (4.3–10.6 kg/day) in primary treated wastewater that have been discharged from the Sepia Depression Ocean Outlet since 1985 are similar to or higher than those that will be discharged after the recent Woodman Point WWTP upgrade to secondary treatment and commissioning of the KWRP (see Tables 3-1 and 3-3). Discharge to date has not caused any of accumulation of these metals in sediments adjacent to the outlet, and this situation is not expected to change.

5.2 SUMMARY OF ENVIRONMENTAL EFFECTS

5.2.1 Toxicant Loads to Sepia Depression

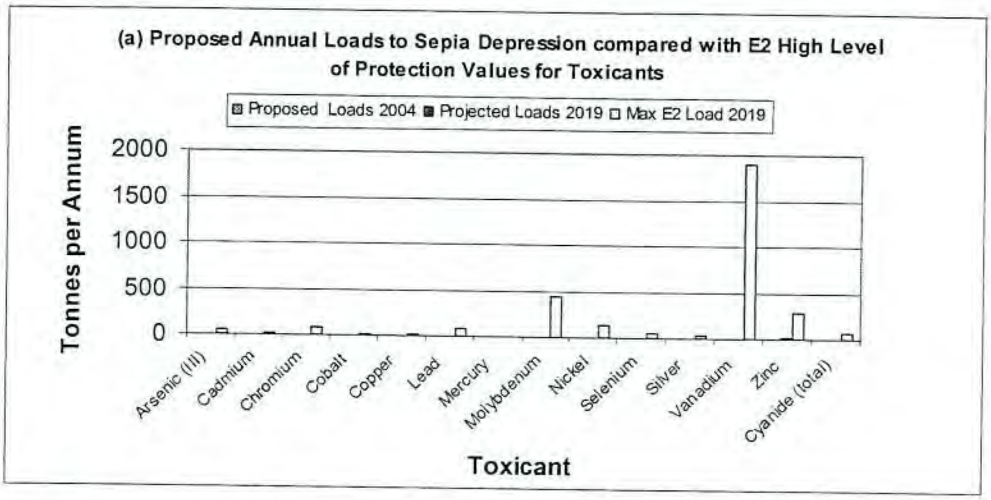
Available data show that the discharge of treated domestic wastewater combined with industrial wastewater from the Sepia Depression Ocean Outlet has no adverse environmental effects in relation to the discharge of toxicants. Figure 5-1 shows the annual toxicant loads to the Sepia Depression Ocean Outlet for 2004 (initial KWRP proposal) and 2019 (projected ultimate capacity of the SDOOL) compared to the maximum load that will achieve the E2 criteria at the edge of the ZID, assuming a 1:250 dilution in the ZID.

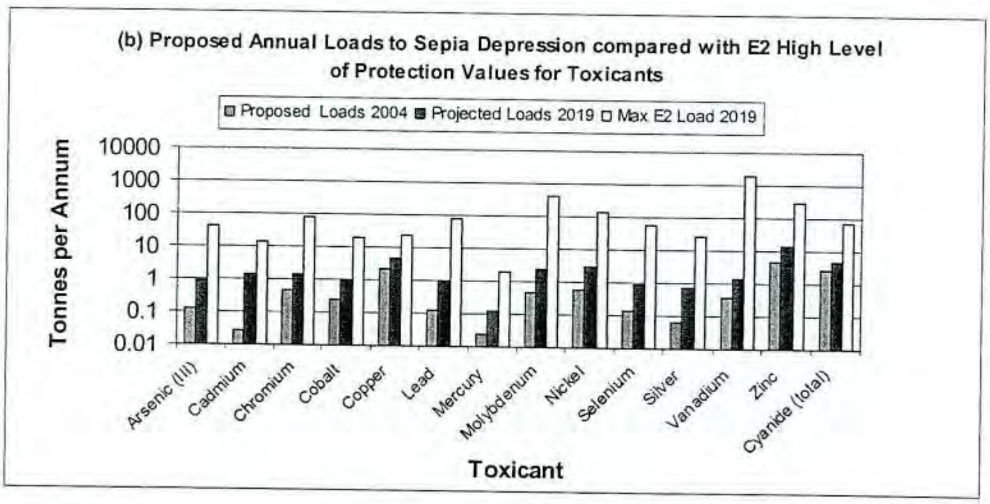
Figure 5-1 (a) shows the arithmetic representation of the loads, with negligible toxicant concentrations apparent relative to the E2 EQC. Figure

5-1 (b) presents the same data in logarithmic format so that the smaller loads can be seen. All toxicants are at least an order of magnitude (10x) lower than the EPA's E2 EQC.

The commissioning of the KWRP proposal will have negligible impact on the discharge of bacteria and nutrients. The increase in concentrations of toxicants is minor, and the EPA's draft high protection E2 EQCs for Cockburn Sound used here are easily met following initial dilution (conservatively assumed to be 1:250). The environmental effects on the Sepia Depression will be indiscernible from the current low level of impact.

Figure 5-1 ***Toxicant Loads to Sepia Depression compared with E2 High level of Protection Criteria***



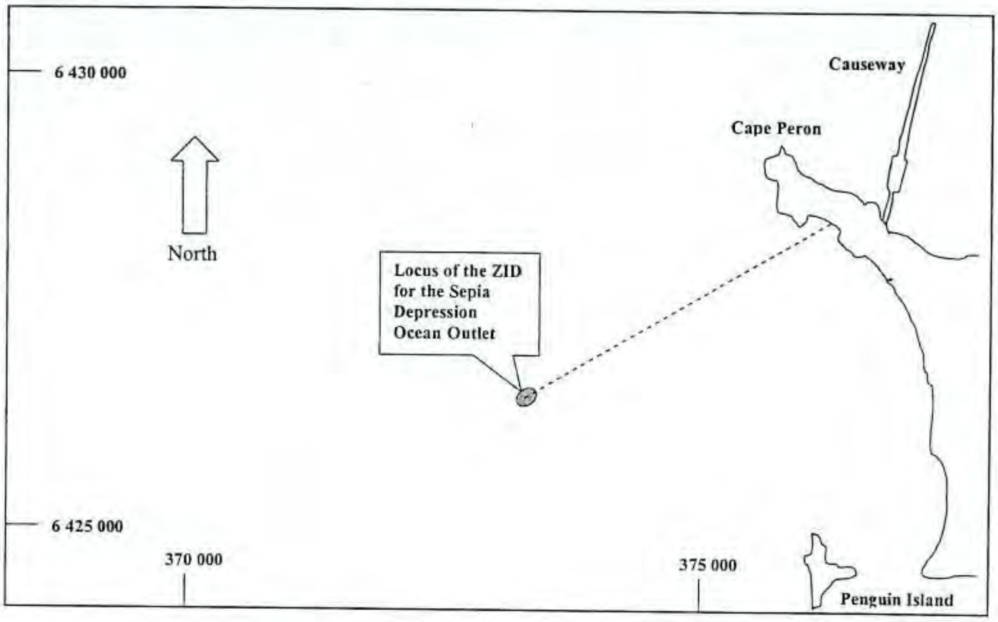


5.2.2 Spatial Extent of the Zone of Initial Dilution

As the plume from the SDOOL diffuser rises it is advected or moved by currents. Measurements indicate that the average current over the water column reaches as high as 0.4 m/s. Surface currents will be higher than this because of wind forcing. However, even in the strongest of winds, it is highly unlikely that the surface currents will exceed 2 m/s (as an approximation, the surface current speed can be assumed to be 3% of the wind speed for wind driven currents).

When subject to a surface current speed of 2 m/s, the ZID of the plume will move laterally 100 m at most. This means that the ZID will be confined to within 100 m of the SDOO diffuser as shown in Figure 5-2.

Figure 5-2 ***Sepia Depression Ocean Outlet Toxicant Boundary Based on the Locus of the ZID***



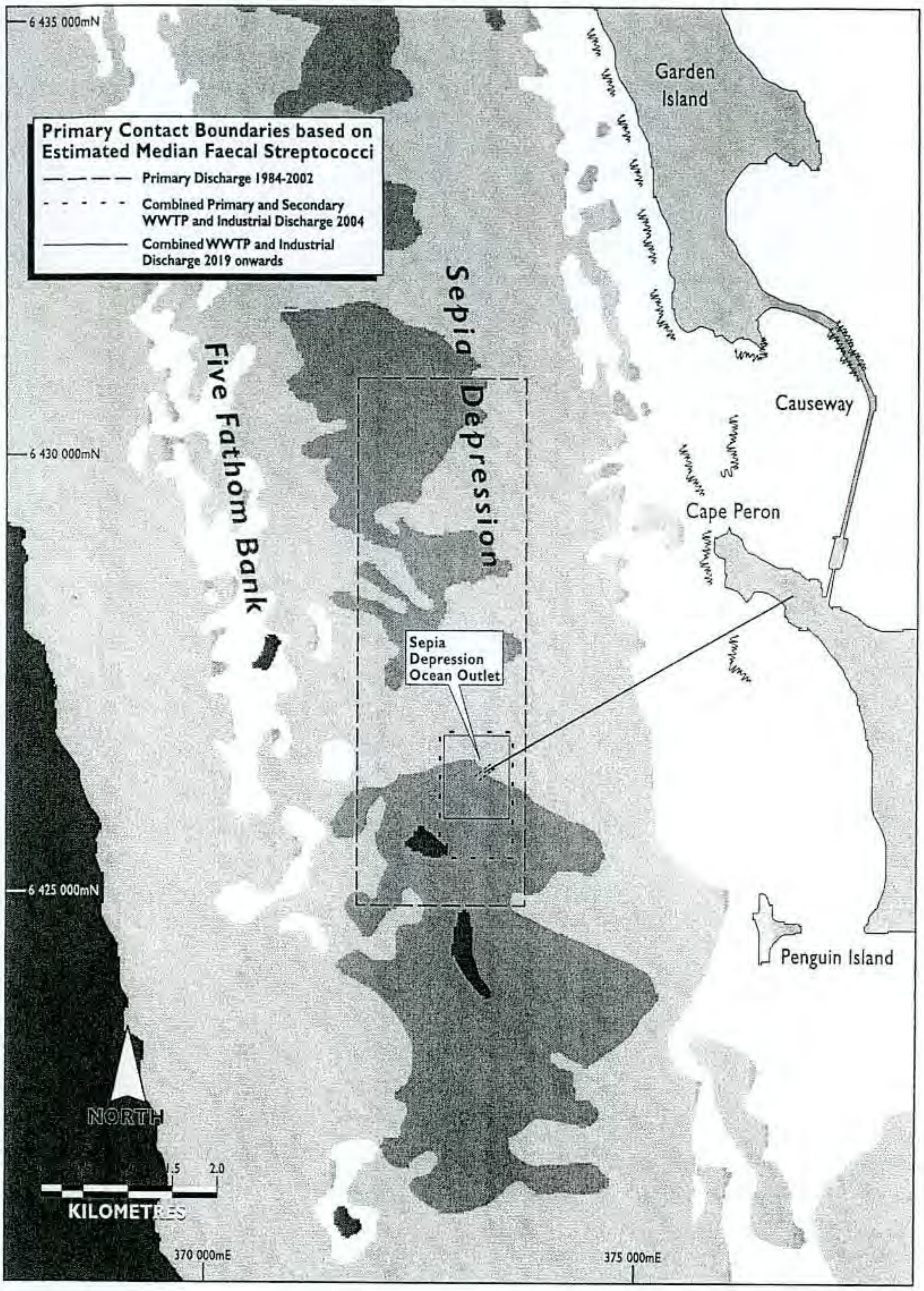
5.2.3 Contact Recreation and Aquaculture

Swimming is not recommended within the primary recreation contact boundaries as shown in Figure 5-3. These boundaries are drawn where estimated median faecal streptococci levels reach 35 enterococci organisms /100 mL and are as per Figure 5 of EPA (2000). PLOOM monitoring data is consistent with these estimated boundaries. Additional background information concerning primary contact can be found in ANZECC/ARMCANZ (2001) and WHO (2003).

Direct sampling of mussel tissue for faecal coliforms provides a much better estimate of the area affected by the SDOO discharge than indirect sampling of seawater to establish safe conditions for aquaculture. The only relevant data was collected in 2000 at the Ocean Reef outlet (SKM, 2001). Mussels (*Mytilus planulatus*) of uniform size (60-70 mm long) were obtained from cultured stocks in Cockburn Sound. These mussels were deployed at four stations 250 m from the outlet (north, east, south and west) and a control station near Quinns Rocks. At each of the five locations the mussels were suspended for 6 weeks 1 m above the seabed and 2 m below the surface.

Bacterial analysis was performed on the mussel flesh. None of the total plate counts for the mussels exceeded 1000 cfu/g and *E. Coli* levels were nil except for one sample which had a level of 2 MPN/g. This data is within the ANZECC guideline values of 2.3 MPN *E. coli*/g flesh and 100,000 organisms/g. Based on similarities between the Sepia depression and Ocean Reef outlets, it can be concluded that there is no impact on human consumers of aquaculture. Nonetheless, the Water Corporation will commit to future monitoring of sentinel mussels (see Table 8-1). As a very conservative assumption, aquaculture is not recommended within the primary recreation contact boundaries (see Figure 5-3).

Figure 5-3 Notional boundaries where contact recreation is not recommended near the Sepia Depression Ocean Outlet, 1984 to 2019 (redrawn from Figure 5, EPA 2000)



5.2.4 Key Environmental Benefits

The KWRP Proposal will result in the following key benefits:

- The nutrients, hydrocarbons and metals currently being discharged to Cockburn Sound by industry will be discharged to the Sepia Depression, which has a far greater capacity to receive these without sustaining environmental harm;
- A decrease in industrial demand for potable scheme water in the Perth Metropolitan area (Kwinana industry currently uses about 8 GL/annum of potable scheme water, and demand is expected to double in the next 10 years) which can be re-allocated to meet domestic demands;
- A reduction in demands on the $275 million Stirling-Harvey Redevelopment Scheme that is intended to meet projected increases in demand; and
- The implementation of a wastewater recycling system which can be expanded to meet future demand by industry without reducing domestic water supplies.

5.3 IMPLICATIONS FOR COCKBURN SOUND

5.3.1 Effects on point source loading to Cockburn Sound

Although the inclusion of industrial wastewater generally has little effect on the loads of substances discharged from the Sepia Depression Ocean Outlet, the proportional reduction in loads of substances discharged to Cockburn Sound is quite marked.

In Table 5-4, the quantities of contaminants discharged to Cockburn Sound from CSBP, BP Refinery and Edison Mission Energy are compared with the total anthropogenic inputs to Cockburn Sound. The estimates of total nutrient inputs include industrial and municipal point sources, ship unloading, groundwater, atmospheric deposition and surface water drainage, whereas TSS, metals, and organics only include industrial point sources (i.e. wastewater outlets). If the substances in CSBP, BP Refinery and Edison Mission Energy discharges are diverted into the Sepia Depression Ocean Outlet Landline there will be an appreciable reduction in anthropogenic discharges into Cockburn Sound, particularly for total nitrogen, total phosphorus, TSS, arsenic, cadmium, mercury and zinc.

Table 5-4 Discharges of contaminants from CSBP, BP Refinery and Edison Mission Energy, compared to estimated inputs to Cockburn Sound in 2001

Contaminant	Current Anthropogenic loads into Cockburn Sound	Combined CSBP/BP/Edison Mission Energy discharge	
		Load	% of total input to Cockburn Sound
TN (kg/d)	880	167	19%
TP (kg/d)	64	24	37.5%
TSS (kg/d)	210	80	38.1%
Arsenic (kg/d)	0.080	0.022	36.4%
Cadmium (kg/d)	0.038	0.021	55.3%
Copper (kg/d)	1.90	0.05	2.6%
Lead (kg/d)	0.80	0.003	0.4%
Mercury (kg/d)	0.021	0.007	33.3%
Nickel (kg/d)	Not Measured	0.007	-
Silver (kg/d)	Not Measured	0.007	-
Zinc (kg/d)	6.75	0.700	10.4%
Phenols (kg/d)	Not Measured	0.035	-

It is also likely that as a result of the high quality of water supplied by the KWRP, industry will need to use smaller quantities of additives (eg. zinc phosphonate) to protect their processing infrastructure, and so the total load of substances to local coastal waters (Sepia Depression plus Cockburn Sound) will decrease (particularly zinc), resulting in a net environmental benefit.

5.3.2 Impact on groundwater flows

As far as is known, the implementation of the KWRP proposal will not alter the status of current groundwater extraction in terms of volumes, bore locations or quality. Therefore there will be no positive or negative effects on groundwater pollutant loads to Cockburn Sound.

5.3.3 Future proposals

The implementation of the KWRP proposal will provide the opportunity for future industries and existing industries currently not part of the scheme to use treated wastewater instead of potable scheme water. The process for allowing additional sources of industrial wastewater to be discharged to the SDOOL is discussed in Section 6.4.

6. GOVERNANCE MODEL FOR THE KWRP PROPOSAL

This section outlines the philosophical model (the governance model) that will be applied to the management and governance of the discharges to the SDOOL and ultimately to the Sepia Depression Ocean Outlet. A management framework, giving effect to the model, will be developed and integrated into the Water Corporation's KWRP operational management system, specifying actions to be taken, procedures to be followed and assigning responsibility for those actions to specific parties.

6.1 OBJECTIVES OF THE MANAGEMENT FRAMEWORK

In order to provide the maximum overall environmental and social benefits, there are four objectives of the required management framework, which are:

- Protection of the environment (Sepia Depression and Cockburn Sound);
- Retention of environmental responsibility by each individual participant;
- Protection of assets, downstream re-use options and commercial viability of all participants; and
- Protection of the operations of all participants (including the Water Corporation).

In summary, the management framework strives to:

- Protect the marine environment in Sepia Depression (through the application in full of Environmental Protection Act Part V Licenses).
- Protect the marine environment in Cockburn Sound (through the application in full of Environmental Protection Act Pt V Licenses).
- Protect the assets of SDOOL and KWRP, these include the entire pipeline, pumps, tanks and other related infrastructure.
- Protect potential downstream reuse options in the Rockingham area. Reuse would primarily be irrigation of open grassed areas.

Stakeholders involved in the model are:

- Department of Environment – the regulator;
- Water Corporation – a participant, a discharger to and the owner / operator of the SDOOL; and as monitor of the overall system operation; and
- BP Refinery (Kwinana), Edison Mission Energy (EME) and CSBP Limited (and others in the future) – as participants and waste producers who discharge to the SDOOL or to Cockburn Sound.

6.2 THE MANAGEMENT FRAMEWORK

The proposal must meet any conditions specified under its Environmental Protection Act Licence and Ministerial conditions. The Management Framework is structured to ensure that this will occur. Specific elements of the framework include:

- Monitoring at various locations within the system enables identification of any changes to normal operations of the participants that may pose a risk to the asset, reuse options and/or the environment; and
- Timely intervention and mitigation can be applied before any potentially adverse environmental effect occurs. Tiered concentration limits applying to each industry form the basis of this approach under commercial agreements with industry. In addition, upper concentration limits along with load limits for each industry are specified under a legislated environmental regulatory framework. Load limits based upon assimilative capacity guarantee that the environment can cope with the pollutant, and ensures that should a waste discharge at higher than normal concentrations on one particular day, then other days in the relevant time period must be significantly lower than average, thus allowing for operational variability.

6.2.1 Monitoring

The governance model requires ecosystem monitoring under the PLOOM program in the Sepia Depression and "real time" monitoring of a set of indicator wastewater variables.

The PLOOM program will continue to monitor the condition of the environment in the Sepia Depression. In the event of a major incident a special investigation of the effects of the abnormal discharge on the Sepia Depression will occur, and this will be the responsibility of the polluter.

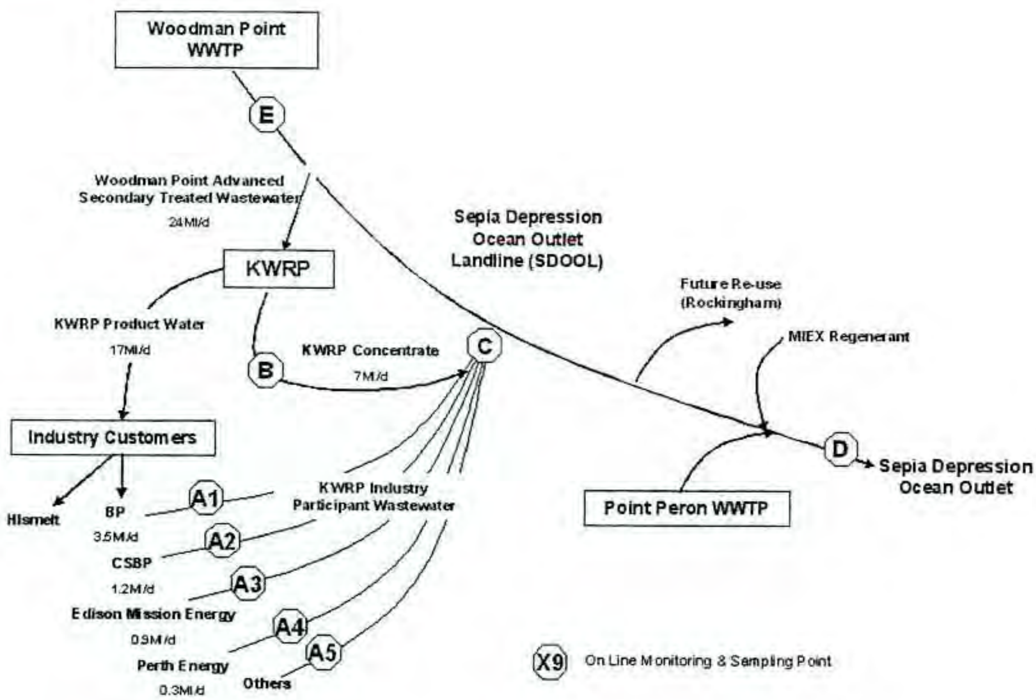
Monitoring of the indicator wastewater variables (flow rates, conductivity, turbidity, temperature and pH) will be used to gauge whether the individual participants are operating within the acceptance criteria for their effluent. A range of other parameters directly related to asset protection and reuse will be also measured on effluent samples at frequencies appropriate to the level of risk. This monitoring will also enable "backtracking" of any out-of-specification performance by any participant, to enable responsibility to be assigned to the non-conforming party, and not simply to the owner of the conveyancing and disposal system. Timely intervention to mitigate any operational or environmental risk that may develop will also be facilitated by this approach.

The following monitoring approach will enable close supervision of inputs to SDOOL, and identification of sources of contaminants in the event of an incident. An appropriate plan for sampling and analysis will be developed in consultation with the individual waste producers. In particular:

- Each waste producer will be required to fulfil its obligations in regard to monitoring and reporting its emissions as required by their respective Environmental Protection Act Licences;
- Each waste producer must provide a point from which samples may be taken for analysis at the point of discharge to the SDOOL; and
- There will be additional sampling points (see Figure 6-1) provided to enable determination of the collective effluent quality (post re-use) where it enters the SDOOL (at point C) downstream of the Woodman Point WWTP (point E) as well as downstream of the proposed effluent re-use off-take point (D), prior to discharge to the Sepia Depression (see Figure 6-2).

At the locations A to E (outlined above and on Figure 6-1) electronic real-time monitoring instruments will be installed to enable close supervision of the condition of wastewater inputs being made to SDOOL. Selected variables will be measured, including flow rate, pH, conductivity, turbidity and temperature and any other parameter relevant to process control and management. These data will be telemetered to the control room of the KWRP operations. Standard operating procedures and response protocols will be developed in consultation with the individual waste producers.

Figure 6-1 KWRP/Sepia Depression Ocean Outlet Pipeline (SDOOL) Online Monitoring Points



6.2.2 Overview of the approach to tiered discharge limits

The governance model is structured using a tiered approach to limits (trigger levels) and management responses. This approach applies to both environmental limits and asset management parameters (e.g. to prevent corrosion from chlorides and scaling of the SDOOL from calcium deposits). The greater the discharge deviates from the typical discharge the more intensive the supervision and management until that discharge is returned to a typical level.

Discharges that threaten or have the potential to increase the environmental impact are governed by a regulatory upper concentration limit. This upper concentration limit sets the "never to be exceeded" limit and would require immediate cessation of discharge to the SDOOL if the condition persists, unless otherwise approved by the DoE.

The regulatory upper concentration limit will ensure, prior to acceptance of waste to SDOOL (from the current proposed and future industrial participants), that the discharge of treated wastewater to Sepia Depression, including that accepted from KWRP industrial participants and future expansion of the wastewater treatment system will be managed to ensure that the concentration of toxicants from the SDOOL discharge meets relevant EQC at the boundary of the ZID (see Figure 5-2). The specified industry participants will be individually liable for ongoing compliance (including costs) with this commitment, where relevant to their operations.

The environmental controls and wastewater standards currently applicable to each industry discharging to the SDOOL will remain as an individual Environmental Protection Act Licence for each industry participant. More specifically, existing discharge points to Cockburn Sound will remain accessible for use during times when the SDOOL is unavailable, be it from routine maintenance activities, repair or catastrophic failure. Discharges to Cockburn Sound would be licensed in the current manner, to ensure protection of the Sound. Licence limits on these discharges would be governed by current or future environmental limits as determined by the regulator.

This approach allows flexibility in acceptance and control of wastewater, whilst preserving the ability of individual industries to be able to revert to discharge into Cockburn Sound during times of SDOOL unavailability, asset or reuse protection or when otherwise approved.

6.2.3 Determination and application of discharge limits to industry

The KWRP participants and the Water Corporation propose to apply a three-tiered set of discharge limits to address both operational management and environmental management, as discussed above. Table 6-1 summarises the intent of the discharge limits. The Notification and Review Limits ensure that the assets of the Water Corporation are protected and that should the water be reused downstream no contaminants are present at levels that are unacceptable. Review and Notification Limits when applied to a contaminant are always set below the Regulatory Upper Concentration Limit.

Table 6-1 Overview of intent of discharge limits for industry

Type of Limit	Limit	Description of Limit
Protection of Reuse Options and Water Corporation Assets		
Non-regulatory Limits for discharge to SDOOL	Notification Limit	Indication of abnormal discharge, early warning of increased contamination risk (based on industry best practice)
	Review Limit	Maximum concentration before a potential impact on reuse of water and/or impact on the assets (may act as an early warning for potential environmental impacts)
Protection of the Sepia depression Environment		
Regulatory Limits for discharge to SDOOL	Upper Concentration Limit	The maximum permissible concentration before a potential impact on the environment
	Load Limit	Mass limit to drive environmental improvement and performance in excess of the minimum standard
Protection of the Cockburn Sound Environment		
Regulatory Limits for discharge to Cockburn Sound	Upper Concentration Limit	The maximum permissible concentration before a potential impact on the environment
	Load Limit	Mass limit to drive environmental improvement and performance in excess of the minimum standard

There are two specific Regulatory Limits that apply directly to industry:

- **Cockburn Sound Concentration Limit.**
    - The maximum concentration limit for protection of the environment for each individual's discharge point into Cockburn Sound based on current or future regulations and environmental protection limits.
    - A waste producer will not be allowed to discharge into SDOOL when maintenance is being done on SDOOL. In the unlikely event of non-compliance by an industry with the asset protection or reuse limits then the Water Corporation may require them to terminate their discharge to SDOOL. It is anticipated that discharge to Cockburn Sound will only be permitted by the DoE in accordance with individual industry regulatory approvals, and must remain below the Cockburn Sound concentration limit.
- **Load Limit.**
    - The maximum allowable load of a contaminant to be discharged from the waste producers discharge point or points into the

environment. This applies to the total discharge of the waste producer regardless of the point of discharge (Cockburn Sound or the SDOOL).

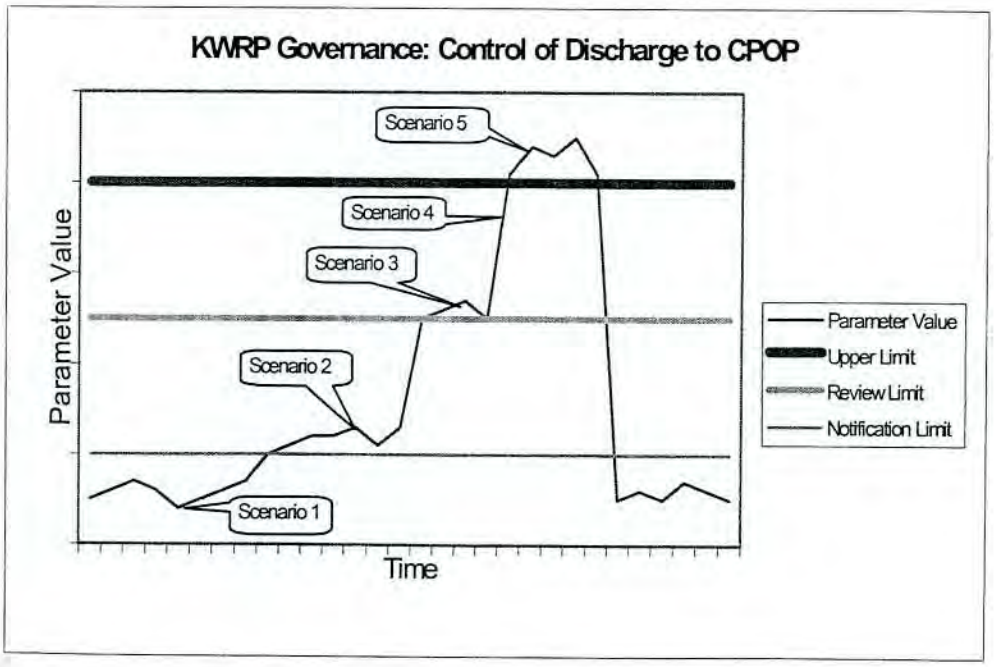
- Load limits would normally be based on an annual load but for specific parameters shorter time scales, such as monthly or even daily load limits, may be applied by the DoE to individual industries.

Where a variable exceeds a predetermined level (Licence and/or Ministerial condition, regulation etc) that has been set by the regulator to protect the environment, the industry will be required to notify the regulator that the licence conditions on that waste producer have been exceeded. The industry must respond in accord with their Environmental protection Act Licence and conditions, which may require that they provide the regulator with a management plan and take appropriate immediate actions as directed by the regulator. These limits refer solely to the protection of the environment including both the Sepia Depression and Cockburn Sound and will be contained in the waste producer's Environmental Protection Act Part V Licence.

6.2.4 *Illustration of the application of the limits to operational and environmental control*

Figure 6-2 provides an illustration of the application of the limits is presented in the scenarios below (Scenarios 6 and 7 not shown).

Figure 6-2 Management scenarios in relation to concentration limits (Scenarios 6 and 7 not shown)



For each level, an operational management response will be developed in consultation with the individual industry participants. Generally the approach will be according to four acceptance/rejection presumptions, namely "yes"; "yes if…"; "no unless …" and "no", as follows:

- **Scenario 1: Below Notification (Concentration) Limit**. Where the effluent remains below the Notification Limit (contained in the individual agreements between the Water Corporation and the industry), input to SDOOL is authorized. At this level asset protection and/or re-use risk or an adverse environmental consequence is highly improbable.
- **Scenario 2: Above Notification (Concentration) Limit but below Review (Concentration) Limit**. Where the effluent quality exceeds the Notification Limit, but remains below the Review Level (contained in the individual contract), there is a presumption for continuing input to SDOOL. The waste producer and Water Corporation will confer, and determine the management strategies and timing necessary to return to normal operating conditions. At this level, no asset risk or environmental consequence is likely.
- **Scenario 3: Above Review (Concentration) Limit and poses no significant risk**. Where the effluent quality exceeds the Review Limit, there is a presumption against continuing discharge to SDOOL. The waste producer and Water Corporation will confer to identify the cause, and determine the management strategies and timing to return to normal operating conditions. The Water Corporation will also assess the risk to the asset (SDOOL) and to downstream effluent reuse in the short to medium term from continuing input under this scenario. If the assessed risks are low, then the Water Corporation will allow continued input to SDOOL.
- **Scenario 4: Above Review (Concentration) Limit and poses significant risk**. If unacceptable risk to the asset or to downstream re-use is identified, or the input continues to move out of specification, the Water Corporation retains the right to cease accepting that wastewater stream to SDOOL.
- **Scenario 5: Above the Review (Concentration) Limit and above the Regulatory Upper Concentration Limit**. Where the effluent exceeds the Regulatory Upper Concentration Limit (specified in an individual Part V Licence), acceptance of the wastewater stream to SDOOL will be determined by direction from the environmental regulator (DoE). The DoE will determine if effluent discharge from the industry to SDOOL may be continued or is to cease and what further action shall be required. Such action may include diverting the wastewater stream to the participant's own storage or secondary licensed discharge point
- **Scenario 6: Discharging to Cockburn Sound and above the Cockburn Sound Regulatory Concentration Limit** (not shown) In the case that a waste producer is discharging to Cockburn Sound, as a result of routine maintenance, repair or failure of the SDOOL or otherwise approved, and the effluent quality exceeds the Cockburn

Sound Regulatory Concentration Limit (contained in current individual Part V Licence) then the waste producer must notify the environmental regulator (DoE), who will determine if effluent discharge may be continued or is to cease and what further action shall be required. This scenario indicates that damage to the Cockburn Sound environment may potentially result.

- **Scenario 7: Discharge to Cockburn Sound or the SDOOL and above the Regulatory Load Limit** (not shown). Should a waste producer over a given time period exceed the total load (mass) permitted to be disposed to the environment (Sepia Depression via the SDOOL or Cockburn Sound) then the waste producer must notify the environmental regulator (DoE) who will determine if effluent discharge may be continued or is to cease and what further action shall be taken. This indicates a failure by the waste producer to meet the environmental performance limits contained within the individual Part V Licence set by the environmental regulator.

6.2.5 An example of the operational and regulatory limits in practice

'Total oil and grease' and 'phenols' have notification and review limits to protect the Water Corporation assets, potential downstream reuse, and to protect the environment of the Sepia Depression. Currently no concentration limits are set by the DoE for total oil and grease for Cockburn Sound, but a concentration limit does exist for phenols. To manage the environmental performance of this particular waste, producer load limits have been set by the regulator based on a mass per day and a mass per day averaged over a calendar month.

If only a concentration limit had been set, as an example, at 30 mg/l for total oil and grease, based on an average discharge of 3.5 ML/day a load of 105 kg could be disposed of per day. This would represent a load almost twice that permissible under a load based licensing arrangement limiting discharge to an average of 60kg/day for any calendar month.

Table 6-2 gives an example of how some of the variables may be governed. The values are indicative only and are based on existing Environmental Protection Licenses, the Revised Environmental Quality Criteria Reference Document (Cockburn Sound) (EPA 2002b) and limits previously discussed through the KWRP proposal. All values are end of pipe (the final point of discharge from their premises to either the environment or SDOOL) for each industry.

Table 6-2 Example of indicative operational and regulatory limits for industry in practice

Type	Limit	Total Oil & Grease	Total Nitrogen	Phenols	Zinc
Protection of Water Corporation Assets and Re-use					
Non-regulatory (SDOOL) Limits	Notification Limit (mg/l)	10	25	1	0.25
	Review Limit (mg/l)	20	50	3	0.5
Protection of the Environment					
Regulatory Concentration (SDOOL) Limits	Upper Concentration Limit (mg/l)	30	80	5	1
	Cockburn Sound Concentration Limit (mg/l)	Currently no limits apply	Currently no limits apply	10.4	0.46
Environmental Performance and Improvement					
Regulatory Load Limits (determined for each individual waste producer)	Daily Regulatory Load Limit (kg/day)	120	200	20	Currently no limits apply
	Monthly Regulatory Load Limit (monthly average as kg/day)	60	100	10	Currently no limits apply
	Annual Regulatory Load Limit (kg/year)	Currently no limits apply	32850	Currently no limits apply	790

6.2.6 Proposed Regulatory Load Limits

Table 6-3 illustrates the proposed regulatory load limits as kg/annum for discharge to any point of the environment, based on the revised draft Cockburn Sound EPP, any historical data the waste producer had available and current Part V Environmental Protection Licences.

In some cases the Limit of Reporting (LOR) of analytical methodologies available to the waste producer may be above the Cockburn Sound EPP Limits. In these cases the load has been determined by multiplying the LOR by the waste producer's 80^{th} percentile flow. In these cases the ZID dilution factor was not used.

It is expected that the increased sampling and monitoring of a broader range of parameters in the SDOOL discharge will improve our understanding of the wastewater load and its interaction with the marine environment.

It should be highlighted the available analytical techniques for a number of the parameters contained within the Cockburn Sound Environmental Protection Policy have limits of detection that are higher than the regulatory limit. In many other cases, the statistical levels of certainty for the analytical techniques are low and so the reported level may have a high error factor (i.e. more than +/- 30%). The EPA / DoE should note and acknowledge the limited accuracy of the available recognised analytical techniques for a number of the regulated substances.

Over time it is expected that the wastewater producers and analytical laboratories in Perth will be able to measure to lower detection limits and to higher degrees of accuracy, and will begin to test at these levels.

Given the above it is considered to be unreasonable at this time to force tighter limits on a waste producer.

Table 6-3 Proposed regulatory load limits for industry discharges to the environment

Parameter	Units	BP (inc EME)	CSBP
Manganese	kg/annum	125[2]	88[3]
Fluoride	kg/annum	27,760[2]	20,000[3]
Sulphide	kg/annum	1826[3]	NR
Cyanide (total)	kg/annum	18[4]	NR
Total N	kg/annum	32,850[3]	73,000[3]
Total P	kg/annum	5,760[2]	36,500[3]
Arsenic	kg/annum	20[2]	16[3]
Cadmium	kg/annum	62[5]	50[3]
Chromium	kg/annum	37[2]	50[3]
Cobalt	kg/annum	18[4]	88[3]
Copper	kg/annum	108[2]	88[3]
Lead	kg/annum	9[4]	50[3]
Mercury	kg/annum	2.5[5]	8[3]
Molybdenum	kg/annum	104[2]	365[3]
Nickel	kg/annum	117[2]	88[3]
Selenium	kg/annum	9[4]	0[3]
Silver	kg/annum	9[4]	0[3]
Vanadium	kg/annum	90[4]	50[3]
Zinc	kg/annum	985[2]	1825[3]
BOD	kg/annum	43,375[3]	NR
COD	kg/annum	173,490[3]	NR
Oil and Grease	kg/annum	21,915[3]	NR
Phenols	kg/annum	3,655[3]	NR
PCB's	kg/annum	2[4]	NR
Aluminium	kg/annum	NR	365[3]
Iron	kg/annum	NR	730[3]

NR - Parameters that have insufficient data or unreliable data to determine load limit.

Values determined by multiplying the Moderate Protection Limits in Table 2a of the Revised EQC Reference Document (EPA, 2002b) by the waste producer's current discharge point mixing zone dilution factor and the 80^{th} percentile flow for each waste producer unless noted.

[1] EPA (2002b). Revised EQC Reference Document, Table 2c Low Reliability Values multiplied by the mixing dilution factor and the 80^{th} percentile flow .

[2] Calculated using average load from waste producer, where this is less than the method used above.

[3] Calculated from the waste producer's existing Environmental Protection Part V Licences, in the case of concentrations this was multiplied by the waste producer's 80^{th} percentile flow.

[4] Calculated using the Limit of Reporting available from the waste producer's approved laboratory, where the LOR is greater than the Cockburn Sound EPP limits and multiplied by the waste producer's 80^{th} percentile flow.

[5] EPA (2002b). Revised EQC Reference Document, Table 2a Low Protection Values multiplied by the 80^{th} percentile flow.

6.3 RESPONSIBILITIES OF THE PARTICIPANTS

6.3.1 Retention of environmental responsibility by individual participants

Individual waste producers, including the Water Corporation, will be responsible for ensuring that acceptable environmental performance with respect to their individual discharge is maintained. Participants will retain their current obligations and responsibilities under the Environmental Protection Act. This will be achieved by the DoE specifying load limits in individual Environmental Protection Act Part V Licenses for discharges to both the SDOOL and Cockburn Sound. These proposed limits will be set based on environmental protection and are not related to asset protection. For current dischargers there should be no increase to current load limits because of this project. The combination of concentration limits and load based licensing in a regulatory framework will ensure environmental protection. For this reason, the continuation of the existing Environmental Act licensing framework is the foundation of the governance model, whereby the responsibilities of the individual participants are maintained.

For discharges to Cockburn Sound when SDOOL is unavailable to participating industries, regulator authorisation will be required. Discharge to Cockburn Sound may be necessary due to future construction, routine maintenance or repair of the SDOOL, when asset and reuse limits have been exceeded or when otherwise approved for contingency purposes.

Participants' Environmental Protection Act licence will need to be changed to reflect that the point of discharge from their premises to the environment is amended to mean the point of entry to SDOOL. The Licenses will also need to authorise a secondary discharge option (equivalent to their current operations) for use in specified circumstances (e.g. emergency, upset to SDOOL, or scheduled maintenance).

Each participating industry discharging to SDOOL will do so in full compliance with their Environmental Protection Act licence conditions as amended above. Failure to do so will be a DoE/industry regulatory issue, which will not involve the Water Corporation as the SDOOL service provider. The Water Corporation will, however, provide all relevant information it has to assist the DoE in its investigations.

6.3.2 Responsibility for operational control and management

Operational controls and procedures will be established separate from the regulatory obligations. The commercial agreements between the Water Corporation and the individual waste producers will clearly identify the three trigger points of "Notification Limit", "Review Limit" and "Upper Concentration Limit" relating to the effluent parameters and specify the corrective action to be taken by the industry to return the specific component to "normal" operating condition.

The Water Corporation will be responsible for the environmental performance of SDOOL to the extent that it has control over its own inputs to the system, and can demonstrate that the criteria for acceptance of wastewater into the SDOOL has not put the environment at risk.

The Water Corporation will also retain responsibility for the collective environmental impact of waste discharges into the Sepia Depression where such compliance is within the direct control and responsibility of the Water Corporation. It will continue to monitor the ambient environment around the SDOOL outlet and demonstrate that the collective wastewater discharge is not causing unacceptable environmental impacts.

6.4 FUTURE PARTICIPANTS IN KWRP

Should new waste producers approach the Water Corporation to dispose to the SDOOL, the decision making process will involve the DoE, the Water Corporation and the new participant. In addition, other KWRP participants may be notified and involved in the decision making process. The Water Corporation would notify all KWRP participants during the approval process. The new participant would also be required to be involved in any reporting or reviews carried out.

Addition of new participants to the SDOOL must ensure that the end of pipe concentration is not increased above the SDOOL Regulatory Concentration limits. In all cases the regulator must grant approval and alter the new participant's Environmental Protection Part V Licence accordingly. The new participant's Part V Licence remains a licence between the regulator and the individual participant and does not involve the Water Corporation.

6.5 REVIEW AND COMMUNICATION

An annual review of the operations with the participant industries, DoE and the community is proposed. The review will allow participants and relevant stakeholders to discuss issues and determine future actions. The review will be conducted with representatives from each participant present. The aim of the review is to cover all issues related to the operation of KWRP and the impacts of KWRP on the participants and the environment and as the process becomes established involve the community or a community representative body.

New participants to use of the SDOOL and KWRP will be required to be involved in these reviews. Similarly should a new participant be seeking to discharge to the SDOOL, the review provides an opportunity for the Water Corporation to report to all stakeholders what progress has been made and what issues exist.

As a part of this review each participant will report on discharges to the environment and/or SDOOL, environmental performance and other issues relevant to the community as part of their individual public reporting procedures.

7. COMMUNITY CONSULTATION ON KWRP PROPOSAL

Community consultation began well ahead of any aspect of the proposal being finalised, to enable issues raised to be addressed where legitimate and feasible.

Community consultation on the KWRP proposal commenced in December 1999. The approach to consultation was more formalised in late 2000, and a summary of community consultation carried out since December 2000 is shown in Table 7-1. The table also indicates the consultation approach used, and comments.

Table 7-1 Kwinana Water Reclamation Plant – Summary of Community Consultation since December 2000

Audience (groups consulted)	Channels	When	Comments / Issues
Kwinana Industries	• Face-to-face • Meetings • Presentations • Information sheets	Ongoing *(Dec 2000 to present)*	Comprehensive communication throughout with KWRP industry partners.
Kwinana Industry Council members and staff	• Meeting progress reports • Fact Sheet	Ongoing *(Dec 2000 to present)*	Broad communication with other industries through KIC executive and monthly Community Relations Advisory Committee meetings.
Community Groups			
3.1 Communities and Industries Forum	• Public meeting • Meeting minutes	December 2000	Positive reaction to the proposal. Questions raised concerning salt content on reverse osmosis process and why the water has to be disposed into the Sepia Depression after use. ie. Why can't the water be continually recycled.
3.2 Rockingham IP14 Community Consultative Network	• Presentation • Personal briefings to members	December 2000	
3.3 Woodman Point (WA21) Community Reference Group	• Presentation	December 2000	
3.4 Cockburn Sound Conservation Committee	• Presentation	December 2000	
Overall Community	• Media releases • Advertising • Market research	December 2000 January 2002 May 2002 September 2002 December 2002	Announcing proposal KIC declares support for the proposal Announcement that the project would soon commence Notice of proposal to construct the plant. Questions on KWRP were incorporated in the KIC's 2000 Community Attitudes

Audience (groups consulted)	Channels	When	Comments / Issues
			survey, conducted immediately after the announcement of the project. Awareness was good and the results indicated overwhelming support for the project.
Government agencies	• Direct mail • Presentations	September 2002	Notice of proposal to construct the plant.
5.1 Cockburn Sound Management Council		December 2000	
5.2 Dept of Environment			
5.3 Environmental Protection Authority			
5.4 Water and Rivers Commission			
Members of Parliament	• Direct mail / e-mail • Stakeholder Mgt meetings	Ongoing	

Note: Consultation also occurred prior to December 2000, before staff changes within the Water Corporation.

8. PROPONENT COMMITMENTS

Commitments made by the proponent in regard to the KWRP Proposal are summarised in Table 8-1.

Table 8-1 Summary of Proponents Commitments for KWRP Proposal

Topic	Element	Objective	Commitment	Timing	Advice
Marine Environmental Values	Maintenance of ecosystem values in Sepia Depression	To minimise impact on the marine environment	To attain an average dilution of the SDOOL wastewater stream of at least 1:300 with the dilution being above 1:200 at least 99% of the time within 100 metres of the centreline of the surface expression of the Sepia Depression Ocean Outlet (SDOO) diffuser	During Operation	EPA
			To only accept wastewater from industrial participants who demonstrate compliance with the relevant licence and/or Ministerial conditions issued to them, or as otherwise authorised by the DoE from time to time.	During Operation	DoE
			To manage the discharge of treated wastewater to Sepia Depression, including that accepted from industrial participants and future expansion of the wastewater treatment system to ensure that the concentration of toxicants meets relevant EQC at the boundary of the ZID.	During Operation	EPA DoE
Marine Flora and Fauna	Protection of Marine Flora and Fauna	To monitor for, and respond to potentially significant impacts to marine flora and fauna from discharges from SDOOL	To continue to model, monitor and annually report the effects of wastewater discharge to Sepia Depression through the PLOOM program.	During Operation	DoE KWRP Participants
			In the event that toxicants in the treated wastewater exceed concentrations which will result in the EPA's relevant high protection EQC being exceeded following 1:250 initial dilution, specific investigations will be conducted with the relevant industrial participant/s and in consultation with the DoE into the source and cause of the identified condition, the risk presented by it to ecological processes and any measures necessary to mitigate those risks.	Triggered by trend or event	EPA DoE KWRP Participants
	Demonstrate that the diluted effluent quality		To undertake Whole Effluent Toxicity (WET) testing generally following the principles	During Operation	EPA

Topic	Element	Objective	Commitment	Timing	Advice
	is environmentally safe.		contained in the USEPA, APHA and ASTM protocols at a NATA accredited laboratory in accordance with the protocols set out in ANZECC/ARMCANZ 2000, carrying out this testing three times in the first year, thereafter annually and following any significant change to operations.		DoE
Public Health Values	Delineation of areas unsafe for seafood collection or swimming	To establish the relevant Social EQC's for discharge of treated wastewater to the Sepia Depression, and to delineate where those values may be exceeded	To further refine the notional social EQO S2 and S3 EQC values and boundaries for treated wastewater discharge to the marine environment in close consultation with the Health Department and other relevant authorities. It is proposed that sentinel mussels be deployed every 3 years to monitor tissue coliform levels.	During operation	Health Department
Environmental Management	Project Environmental Management System (PEMS) to cover operations	To minimise environmental impacts from the implementation of the proposal, and to ensure that environmental approval requirements are met.	To include the KWRP in the Corporate Environmental Management Plan which will address the following: 1. Routine monitoring of contaminant levels in all streams of wastewater returned to the SDOOL. 2. Process for developing routine environmental acceptance criteria for quality of wastewater to be accepted into SDOOL for possible future participants that are not part of this proposal. 3. Procedures to be implemented consistent with the Governance Model if wastewater contamination exceeds the Water Corporation's water quality criteria for acceptance to the SDOOL. 4. Any amendments to environmental monitoring required to demonstrate that all relevant EQO's are being met and for detection of potentially unacceptable trends. 5. Procedures for reporting to the EPA, DoE and the Public in accordance with	Upon accepting participating industries effluent into the SDOOL	DoE

Topic	Element	Objective	Commitment	Timing	Advice
			existing statutory and Water Corporation EMS reporting requirements		
Operational Management	Operational Management Plans and Procedures	To ensure that all commitments and statutory obligations are met.	To prepare and implement, or modify existing management plans and operational procedures to incorporate matters arising from the operation of KWRP to address: • Noise and vibration; • Storage and handling of chemicals; • Occupational health and safety; and • Risk.	During Operation	Water Corporation
Access to information	Community engagement	To ensure that the public has open access to information regarding the environmental performance of SDOOL and KWRP, and an avenue to address any significant issues arising.	To incorporate into the Water Corporation's Customer Service Program a community engagement plan to: • Address awareness and understanding of the project; • Ensure that reports on KWRP environmental performance are readily available to the public; • Ensure that the results of PLOOM monitoring are readily available to the public; and • Provide a complaints/response process to address matters arising from the project in accordance with the Water Corporation's Corporate Environmental Management System.	Prior to and during construction & during ongoing operations	DoE

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APPENDIX A

RECOMMENDATIONS MADE BY THE ENVIRONMENTAL PROTECTION AUTHORITY IN 1982 ASSESSMENT OF THE ERMP ON CAPE PERON OCEAN OUTLET

Appendix A Recommendations made by the Environmental Protection Authority in 1982 assessment of the ERMP on Cape Peron Ocean Outlet

RECOMMENDATIONS

1. Design and construction

1.1 When the final detailed design work is undertaken approval for the location of each drain point and any operational limitations should be obtained from the EPA.

1.2 The MWB should obtain prior advice from DCE and the Department of Agriculture on construction and revegetation procedures to be used in the environmentally sensitive areas of the land pipeline.

1.3 The MWB should have further talks with the Shire of Rockingham on construction procedures and land reinstatement in areas under the Shire's control, especially those matters listed in the Shire's submission.

1.4 The MWB should design the transition tower to prevent any odours escaping under the full range of operating and maintenance conditions.

1.5 The detailed design of the transition tower be such that the existing Cape Peron outlet be closed and the effluent from the treatment plant at Cape Peron be added to the new outlet.

2. Monitoring

2.1 The EPA stresses the importance of monitoring to ensure that other users of these waters continue to be protected as predicted in the ERMP. Accordingly, EPA proposes that a detailed monitoring programme be submitted by MWB to the EPA within three months for its approval. The monitoring programme proposed is outlined :

2.1.1 Water quality monitoring of the shape and extent of the detectable plume, to determine whether the plume conforms with the predictions of the ERMP.

2.1.2 Filter feeding sentinel organisms (mussels) to be held in the upper part of the water column at selected sites within Beneficial Use Areas 2 and 3 of Figure 6-1 (attached) to determine whether reef shellfish are being exposed to faecal bacteria.

2.1.3 If monitoring under items 1 or 2 above indicate that the discharge is extending further and at higher concentrations than predicted in the ERMP, MWB will immediately;

(a) Advise EPA;
(b) Intensify samping of receiving waters and biota to determine the extent of the impact; and
(c) Report to EPA on the further stPER MWB proposes to take in order to safeguard other users of the area.

2.1.4 Surveys of the seabed carried out for the ERMP showed that in the vicinity of the proposed outlet there was little fauna upon which rock lobsters could feed.

This might change after construction and operation of an outlet. Therefore the monitoring programme will include checks of the fauna within both the sediment and the rock fill close to the outlet, for increases in species of food value to rock lobsters. Such species will be checked for accumulation of faecal bacteria. The results of these investigations will be passed to the Department of Fisheries and Wildlife for consideration and advice to EPA.

2.1.5 Underwater check of pipeline each spring; advise EPA of any damage or alteration which could affect any other users of the area.

2.1.6 Establish bacterial die-off in the discharge area under various conditions as soon as possible after the discharge commences. These new values to be used to re-calculate the distribution of bacterial concentrations. The results to be reported to the EPA and to Public Health Department.

2.2 The EPA proposes to notify both the MWB and Government whenever corrective measures, including secondary treatment, are required so that water quality and other uses of the area are maintained throughout the life of discharge.

3. Future Sewage Disposal

The Board continue and where possible expand its current research and trials on wastewater treatment, reuse, and groundwater recharge.

4. Other Waste Material

Should the Board or any other body or person propose to use the Cape Peron outlet to dispose of industrial or other wastes which will alter the composition or character of the effluent, then a separate ERMP will be required. The EPA will then consider the proposal in terms of the receiving water quality and environmental effects, and recommend whether or not such a discharge should be permitted.

5. Reporting

The MWB report to the EPA six monthly in the first year, then annually on the performance of the outlet; these reports will include sufficient technical information to enable the Authority to satisfy itself that the discharge is meeting the Water Quality Criteria and that no adverse environmental effects are occurring.

This report should include the time, quantity and quality of any emergency effluent discharged through the Woodman Point outlet to Cockburn Sound. The EPA proposes to publish annually a report on the Cape Peron outlet performance.