



Government and Infrastructure
256 St Georges Terrace • Perth WA 6000 • PO Box 7779 • Cloisters Square WA 6850 • Australia
Phone 08 9278 4100 • Fax 08 9278 4200

5EN742-B-S001-L
DC:ayf

30 August 2006

Mr John Mills
Principal Project Manager
Water Corporation
629 Newcastle Street
LEEDERVILLE WA 6007

Dear Sir

MARINE INVESTIGATIONS—TARANTO ROAD, BINNINGUP

INTRODUCTION

The Water Corporation operates a small-scale wastewater treatment plant at Taranto Road in Binningup. The plant is located on a beachside site of approximately 60 hectares that is owned in freehold tenure by Water Corporation. Given the sites size, close proximity to the sea and location in the growing South West, Water Corporation is considering a range of future uses for the site.

To assist the Water Corporation in an overall viability study of the site and surrounds KBR were requested by Water Corporation to provide marine monitoring advice related to the Taranto Road site in Binningup. The objective of this program is to describe the existing marine environment to assist in any potential site developments and infrastructure designs as well as to understand the possible impacts Water Corporation infrastructure may have on the marine environment.

In addressing the above request, KBR have paid particular attention predicted requirements in characterising the following aspects related to the site:

- Benthic communities and habitat
- Bathymetry
- Oceanographic conditions such as wind, waves, tides, currents, turbulence and buoyancy
- Hydrodynamics
- Sediment quality
- Coastal processes
- Water quality

Detailed advice on monitoring and modelling requirements for the above items is addressed in detail below.

A preliminary ocean outfall has been proposed in order to commence this work. The proposed outfall is located north of existing long-term ocean outfalls in the Bunbury region. Major contributors to these ocean outfalls include the Millennium Inorganic Chemicals Australind plant, the Water Corporations Bunbury wastewater treatment plant and the Collie Power Station. Possible effects that these discharges may have on the above aspects of marine investigations have been considered in the scope of work below.

This proposal is valid for a period of 30 days upon submission.

SCOPE OF WORK

BENTHIC COMMUNITIES AND HABITAT

An initial benthic survey will be conducted to identify the requirement for and additional study. The initial survey will consist of video footage along transects located near the proposed outfall location. The survey will be conducted in an area of 5 km (north-south) by 3 km (east-west) centred approximately at the proposed outfall location. The need to perform additional surveying and at which locations will be determined by the outcomes of the initial survey.

KBR has not yet been able to finalise costs associated with the benthic survey component of this project. These costs and a clarification of scope will be presented to the Water Corporation as soon as possible.

BATHYMETRY

A substantial amount of detailed bathymetric data exists for the proposed outfall site. An inspection of existing navigation charts indicates that the area is relatively flat mildly sloping towards deeper water and without obvious deep closed sections (i.e. holes that could trap brine). It is not anticipated at this stage that additional bathymetric data will be required. It is proposed that initial work be undertaken using available recent (March 2006) navigational charts. More detailed bathymetric data may be collected at a later stage, if deemed necessary.

OCEANOGRAPHIC CONDITIONS SUCH AS WIND, WAVES, TIDES, CURRENTS, TURBULENCE AND BUOYANCY

METHODOLOGY

It is proposed to deploy a mooring in 10 m water over a period of 12 months consisting of the following instruments:

- (1) One RDI 1200 kHz Acoustic Doppler Current Profiler to measure the vertical current profile at 5-minute intervals. The vertical resolution will be set to 0.25 m. In addition to the current profile, water depth and bottom temperature will be recorded. The instruments will also be able to measure the wave characteristics at 2-hourly intervals (Wave information will be important for any design of structures in the ocean).

- (2) Two 'Seabird' CTD instruments, each equipped with a dissolved oxygen sensor to measure the surface and bottom temperature, salinity and dissolved oxygen concentrations.
- (3) One wind anemometer to record the wind field over the period of deployment (12 months). This will be deployed on-shore close to the site.

In addition to above, intensive field studies at 3 separate occasions to cover summer, autumn and winter conditions will be undertaken, each over period of 3 days to include:

- (1) CTD surveys to define the spatial structure in the vertical stratification. The CTD will consist of sensors to measure temperature, salinity, dissolved oxygen, fluorescence and turbidity. Oceanic turbulence will be also be continuously monitored at the proposed location of the outfall.
- (2) Drifter (drogue) studies to define the horizontal dispersion.

DELIVERABLES

The deliverables from this component will consist of a report describing the field data collection, analysis of the results, conclusions and recommendations for further work. Critical situations, in terms of oxygen variability with regard to water circulation and vertical stratification if identified during the measurement period will be highlighted.

HYDRODYNAMICS

NUMERICAL MODELLING

Hydrodynamic modelling will be performed at the proposed outfall location. The modelling shall address three major components:

- Modelling of the hydrodynamics of the area surrounding the seawater concentrate outfall diffuser, by evaluating the ocean currents and variations in the ocean surface, driven by forces such as wind, tide and Coriolis force;
- Evaluation of the initial mixing in the vicinity of the outfall diffuser. The most rapid effluent dilution takes place over a distance of only a few tens of metres from the diffuser ('nearfield zone'). This dilution results from the entrainment of sea water in the outfall diffuser jets and mixing caused by the negatively buoyant plume settling towards the bottom. The transition zone between the nearfield region and where further dilution of the effluent becomes dominated by ocean currents is known as the 'farfield' region;
- Modelling of the advection and dispersion in the farfield. Once the dilution in the nearfield/farfield region was evaluated, this information is used to define the initial conditions at the diffuser cell (ie. the computational cell where the outfall diffuser was located) for use in the transport modelling. This next stage of modelling accounts for the transport and dispersion of the diluted plume away from the outfall diffuser.

Numerical modelling occurs in two phases: a preliminary analysis of nearfield dilution and 3D oceanographic models to verify nearfield mixing and investigate intermediate and farfield mixing.

PRELIMINARY NEAR-FIELD MIXING ANALYSIS

Preliminary analysis of the nearfield mixing and dilution will be carried out through the use of PLUMES model and empirical relationships by Roberts et. al (1997). The analysis will be performed on a selected diffuser design, along the selected outfall alignment to maximise mixing and dilution to satisfy environmental quality guidelines. The analysis will be preliminary and will not incorporate hydraulic requirements of the outfall. Further analysis will need to be carried out when this becomes known.

The results from the nearfield model area would then be used to define the initial conditions and location for the 3D hydrodynamic modelling to establish the concentration of the seawater concentrate plume at the boundary of the 'diffuser' cell.

3D HYDRODYNAMIC MODELLING SET UP

A 3D model will be used for hydrodynamic modelling of the nearfield, intermediate and farfield. The software to be used for the modelling will be the Environmental Fluid Dynamics Computer Code (EFDC) model. The EFDC model solves the three-dimensional, vertically hydrostatic, free surface, turbulent averaged equations of motions for a variable density fluid. The model uses a stretched or sigma vertical coordinate and Cartesian or curvilinear, orthogonal horizontal coordinates. Dynamically coupled transport equations for turbulent kinetic energy, turbulent length scale, salinity and temperature are also solved. The two turbulence parameter transport equations implement the Mellor-Yamada level 2.5 turbulence closure scheme (Mellor & Yamada, 1982) as modified by Galperin et al (1988).

Water quality

Quality of the brine discharge is required as input for the hydrodynamic model. The characteristics of the brine discharge used here will be those adopted for the Water Corporation Desalination Plant 1.

Oceanographic data input

The oceanographic data required as input to the model are: wind, tides and ocean currents and will be sourced from currently available data:

- wind data from nearest representative station
- ocean currents from available data and literature
- published tide charts at Bunbury harbour as boundary conditions.

Model grids

Setting of the model grid will be based on the Department of Planning and Infrastructure's bathymetry. Based on KBR's experience with modelling of ocean outfalls along Perth coastal waters it is envisaged that a model grid will span some 15 km south, 15 km north and some 10 km offshore from the location of outfall diffusers. The grid spacing will be 100 m everywhere, and refined to 50 m spacing to cover critical areas of diffusers and any nearby benthic habitat.