

Mangrove Surveillance and Chemical Monitoring Program

The Mangrove Monitoring Program for the operations phase includes a set of core monitoring components to be undertaken on an annual basis.

The scope of work includes:

- Mangrove Surveillance (including groundwater monitoring).
- Chemical Monitoring – collection and analysis of mangrove sediments and biota for hydrocarbon and heavy metals concentrations.

The methods employed for each of the above components of the monitoring program are as follows.

Mangrove Surveillance

Canopy density

Canopy density is a quantitative measure indicating the percentage of the site occupied by the mid and upper vegetation strata (i.e. foliage cover comprised of leaves and branches). This parameter is considered to be a useful indicator for environmental stress, as leaf defoliation and leaf growth are sensitive to a wide range of environmental indicators (English, Wilkinson & Baker 1997). Changes in canopy density can therefore provide a measure of mangrove health/condition and associated factors causing such changes.

Canopy density is determined using a spherical forestry densiometer to provide estimates of the foliage cover within each of the four subplots formed by the four plot corner markers (1, 2, 3, 4) and the plot centre point. The technique employed follows that used for the DIPE Darwin Harbour Mangrove Monitoring as described in Moritz-Zimmerman, Comley and Lewis 2002. The overall canopy density at each site is calculated as the mean of the readings recorded from each subplot.

Species composition and tree density

To provide a baseline description of the mangrove communities at each site, the tree species composition and density was determined when each site was established (i.e. once only data collection). The classification of 'tree' vegetation follows the criteria suggested by Brocklehurst and Edmeades (1996), being vegetation where DBH (Diameter at Breast Height) is >2 cm and height is >1 m.

Defoliation index

Defoliation index is a semi-quantitative index of mangrove health that is applied to individual trees or groups of trees. At each surveillance site the degree of defoliation of the canopies is assessed visually for each subplot using a numbering system from 0–5, where 0 represents complete defoliation of the stand, 1 represents up to 25% of the canopy present, 2 represents 25–50% of the canopy present, 3 represents 50–75% of the canopy present, 4 represents greater than 75% of the canopy present and 5 represents a full canopy.

Relative ground levels - sediment accumulation or erosion

Relative ground levels are recorded to monitor any potential accumulation of sediment in mangroves from erosion of unconsolidated construction site surfaces or potential erosion/undermining of mangroves from constructed off-site drainage facilities. Sediment eroded from non-vegetated surfaces or uncontained areas (e.g. levees, stockpiles, laydown areas) may be deposited into adjacent mangrove areas. This has the potential to cause impacts to mangrove fauna and tree stress if the depositing material accumulates in excess of natural sedimentation rates and to sufficient depths to bury or smother the aerial root system.

At each surveillance site sediment heights are recorded relative to each corner marker by measuring the vertical distance between the top of the corner marker and the ground. The overall ground level for a site during a sampling event is calculated as the mean of the readings recorded from each corner.

The mean height from subsequent surveys is then subtracted from the original mean height (i.e. height recorded when a site was originally established) to obtain a net height or ground level difference. Where possible, ground levels are taken by placing the tape measure on an area that is representative of the surrounding ground surface, and irregularities caused by mud lobster mounds, etc., are avoided.

Surveillance monitoring photographs

To characterise the condition of mangroves at each site, photographs are taken from each corner facing towards the centre of the plot. General photographs of mangrove areas adjacent to the construction site are also taken regularly from standard vantage points (e.g. from on top of perimeter embankments).

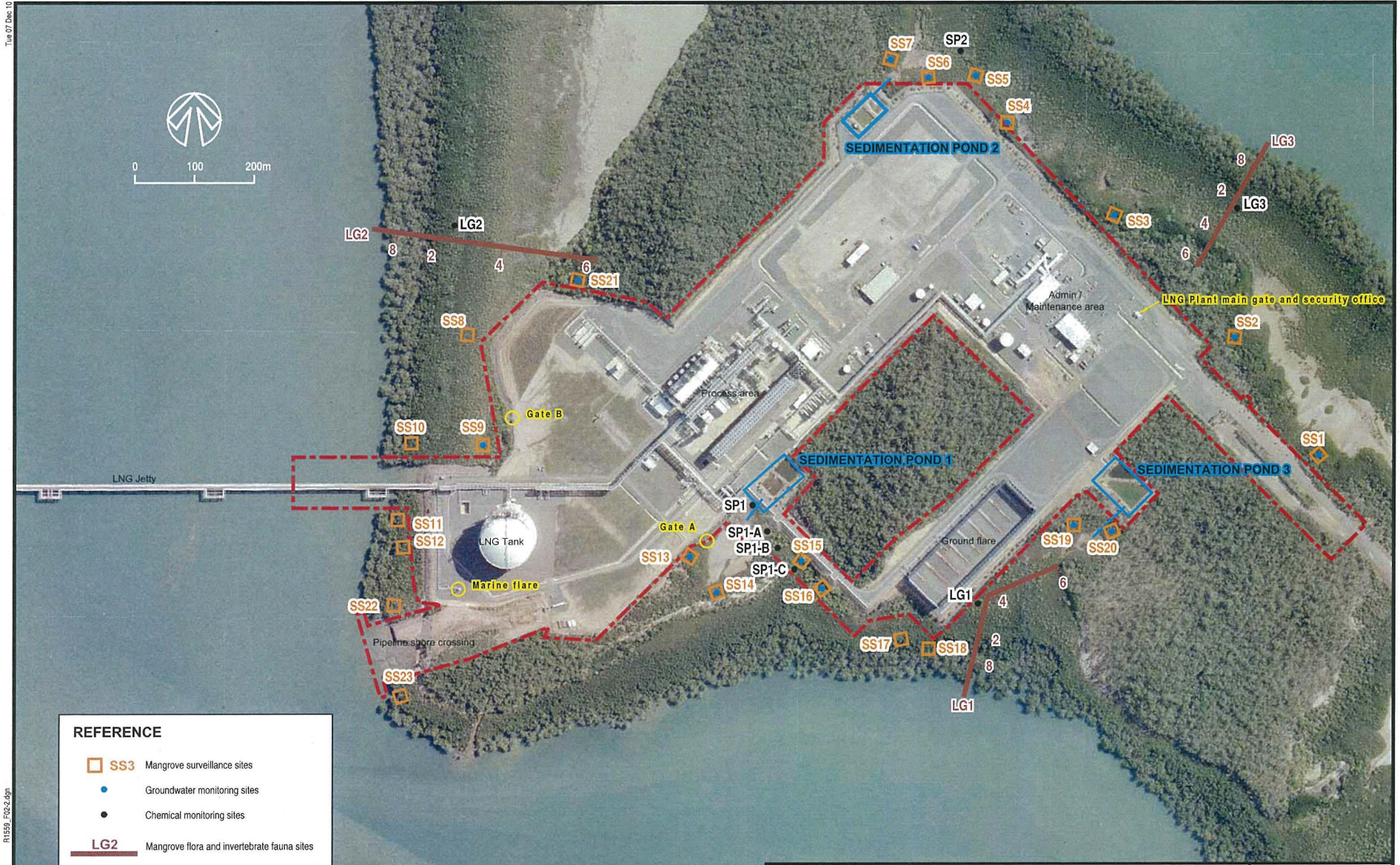
Groundwater conditions






Monitoring of groundwater conditions is undertaken at those surveillance sites where the potential modification of freshwater input (from the DLNG site) may potentially affect mangroves. This monitoring focuses on the 'hinterland fringe' mangrove zone where the maintenance of mangrove stands are, to some degree, reliant on freshwater input from upslope terrestrial areas where the LNG plant has been constructed.

At the start of construction, shallow depth [<2 m below ground level (BGL)] groundwater monitoring bores were excavated by hand auger (75 mm diameter) to approximately 1.0–1.5 m below ground surface, the depth being determined by the occurrence of compact sand/gravel or rock that could not be penetrated by the auger. The water table at all sites was shallow (<1 m BGL) as is typically found in mangrove and tidal flat environments. The bores consisted of PVC casing (50 mm) with a slotted, gravel-packed and sealed construction. Monitoring bore construction details are provided in URS (2004).

The monitoring bores are located within surveillance sites to link potential changes in freshwater input to hinterland fringe mangroves to changes in mangrove health. The location of the 15 groundwater monitoring bores is shown in Figure 2-2. The sampling of the groundwater bores is undertaken during monitoring of the surveillance sites and coincides with neap tide periods to negate the influence of tidal inundation and focus on the influence of freshwater seepage from hinterland areas on groundwater conditions. The following basic environmental parameters are recorded on-site from samples collected after purging and recharge of the bores has occurred:

- depth BGL to the water table
- groundwater salinity [Total Dissolved Salts (TDS) ‰] using a temperature-compensated refractometer
- pH using Merck indicator strips.



REFERENCE	
	SS3 Mangrove surveillance sites
	Groundwater monitoring sites
	Chemical monitoring sites
	LG2 Mangrove flora and invertebrate fauna sites
	Approved 3.24MTPA disturbance boundary

Job No. :	42907324
Report No. :	R1559
Date :	Dec 10

ConocoPhillips Australia Pty Ltd
MANGROVE MONITORING PROGRAMME
**LOCATION OF MONITORING SITES
ADJACENT TO THE DARWIN LNG PLANT**

Figure 2-2



Chemical Monitoring

The chemical monitoring provides information on metal and hydrocarbon concentrations in mangrove sediments and in the tissue of the mudwhelk, *Telescopium telescopium*. The scope of work involves:

- Sediment sampling and analyses to determine:
 - grain size distribution;
 - concentrations of the metals cadmium, chromium, copper, lead, iron, nickel and zinc; and
 - concentrations of hydrocarbons.

- Mudwhelks are collected from mangrove areas and tissue of the mudwhelks analysed to determine:
 - concentrations of the metals cadmium, chromium, copper, lead, nickel and zinc; and
 - concentrations of hydrocarbons.