4.9 Hydrodynamics

4.9.1 Description of Existing Environment

4.9.1.1 Overview

The purpose of this section is to:

» Describe the tidal hydrodynamics of Abbot Point in terms of water levels and current velocities and directions at different tidal stages.

» Describe the wave climate in the vicinity of the Project area and the adjacent beaches including a description of inter-annual variability and details of historical and predicted extreme wave conditions generated by tropical cyclones or other severe storm events.

The maximum spring tidal range at Abbot Point is 2.4 m and tides are mixed semidiurnal. Maximum spring tidal currents adjacent to the wharf are reported by Hilliard *et al.* (1997) to be in the order of 0.5 m/s. Wind-driven currents of up to 0.1 m/s flow parallel to the coast, towards the west.

Sand and mud deposits adjacent to the mouth of the Don River are deposited mainly on the northwest bank, which indicates that littoral drift is in the northwest direction. An estimated 18,000 m^3 per annum of littoral drift transport was cited by Hilliard *et al.* (1997).

4.9.1.2 Bathymetry and Coastline

The bathymetry (geometry of the sea bed) in the modelled region is based primarily on Australian series navigational charts (Table 4-16) supplemented with:

» Thirty arc second grid data for the deeper waters offshore of the extent of the navigational charts obtained from the Australian Geological Survey Organization; and

» C-MAP.

Coastline information has been extracted from the navigational charts and supplemented with data from C-MAP and Quantitative Structure–activity relationship tool for Innovative Discovery (QSID).

Table 4-16 Chart details

Item	Reference	Name	Scale
1	Aus 826	Bowen to Cape Bowling Green	1:150,000
2	Aus 255	Approaches to Abbot Point	1:25,000

4.9.1.3 Tides

Tidally, Abbot Point is classified as mixed, mainly semidiurnal, with a form number of 0.50, while Bowen has a form number of 0.48. The form number is determined on the basis of the ratio of the amplitudes as shown in Table 4-17.

Table 4-17 Tide classification by form number

Form Number	Tidal Type
< 0.25	Semidiurnal
0.25 – 1.5	Mixed, mainly semidiurnal
1.5 – 3.0	Mixed, mainly diurnal
> 3.0	Diurnal

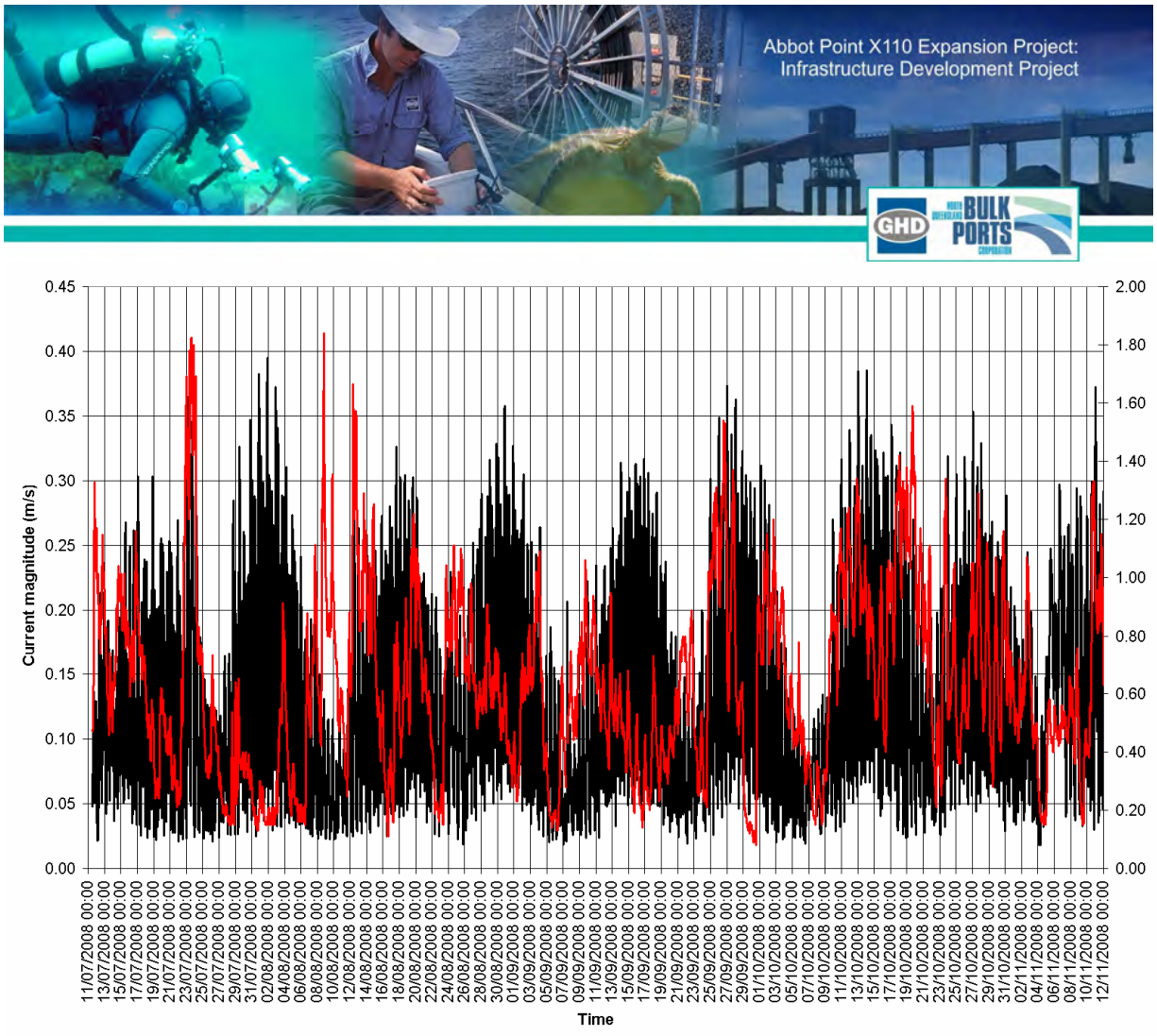
Abbot Point has a period of 12 hours and 25 minutes, producing typical maximum diurnal inequality of the order of 1.0 m at high water and 0.5 m at low water. Tidal planes for Abbot Point as determined by Queensland Transport are presented in Table 4-18.

Table 4-18 Tidal planes at Abbot Point

Tidal Plane	Tidal Level (m LAT)
Highest Astronomical Tide (HAT)	3.60
Mean High Water Springs (MHWS)	2.69
Mean High Water Neaps (MHWN)	2.07
Australian Height Datum (AHD)	1.63
Mean Low Water Neaps (MLWN)	1.29
Mean Low Water Springs (MLWS)	0.67
Lowest Astronomical Tide (LAT)	0.00

4.9.1.4 Currents

GHD and Oceanographic Field Services Pty Ltd deployed an Acoustic Doppler Current Profiler (ADCP) in the X110 project area which generated time histories of current magnitude and current direction for a period of four months. Figure 4-31 illustrates the character of the coastal circulation and the intensity of the wave climate in the area during the monitoring period. Observed tidal currents reach a maximum in excess of 0.35 m/s, but less than 0.40 m/s during peak spring tides. Typical currents are in general less than 0.3 m/s. During the monitoring period, significant wave heights (H_s) of up to 1.8 m were recorded twice (during the last week of July and during the first week of August 2008).



Source: Acoustic Doppler Current Profiler deployed by GHD and Oceanographic Field Services Pty Ltd in the study area.

Figure 4-31 Measured currents (black solid line) and significant wave height (red solid line)

4.9.1.5 Wave Data

The datasets described in this section have been used in conjunction with numerical analysis results to describe the wave climate in the vicinity of the Project area and the adjacent beaches, including a description of the inter-annual variability and details of historical and predicted extreme wave conditions generated by tropical cyclones or other severe storm events.

DERM Data (EPA, 1997)

DERM operated a Datawell non-directional waverider buoy system at off-shore locations near Abbot Point from 1977 until 2000. The system recorded data that consisted of significant wave height (H_s) and peak wave period (T_p). DERM analysed the recoded wave data in the time domain by the zero up-crossing method and in the frequency domain by spectral analysis. Results of more advanced primary analysis have been summarised in EPA (1997) and comprise the following relationships:

- Peak energy wave period (T_p) in seconds versus significant wave height (H_s) occurrences—all data, all directions, measured in days and percentage occurrences;
- Same as above, summer data;
- Same as above, winter data;
- Percentage of time exceedance of wave height (H_s) for all periods (T_p);

» Histogram percentage of time occurrence of wave periods (T_p) for all wave heights (H_s);

» Histogram percentage of time occurrence of wave heights (H_s) for all wave periods (T_p);

» Percentage of time occurrence for the ratios of a number of parameters such as H_{max}, H_s, H_{rms}, T_p, T_s, and T_z; and

» Time histories of wave heights (H_s) and wave periods (T_p).

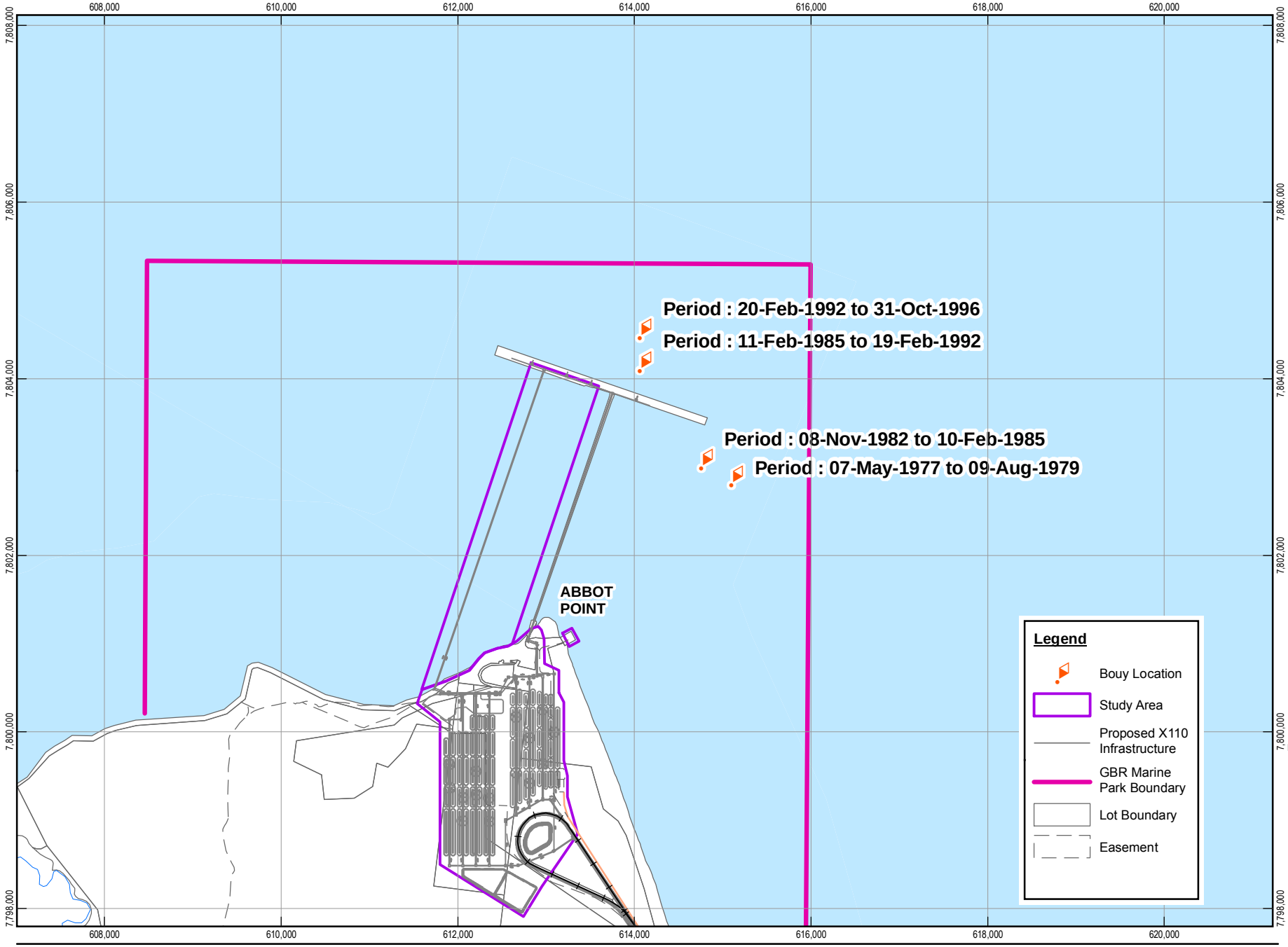
It is noted that:

» The Abbot Point waverider buoy and recording station were temporarily decommissioned for the period 09 August 1979 to 8 November 1982; and

» Recording frequency gradually increased from twice daily at the beginning of the monitoring period (07 May 1977 to 28 June 2000) to hourly in the last seven years (Table 4-19).

Table 4-19 Summary of wave recording frequency during the monitoring period

#	Period	Recording Frequency
1	07 May 1977 to 01 Jan 1979	Two 20 minute records daily at 0300 and 1500 hours Australian Eastern Standard Time (AEST)
2	08 Nov 1982 to 10 Nov 1993	Four 20 minute records per day at 0300, 0900, 1500 and 2100 AEST
3	11 Nov 1993 to 28 June 2000	Hourly to half-hourly when significant wave height exceeded 2 m



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Job Number	41-20175
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1:60,000 (at A4)

0 500 1,000 1,500 2,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

WAVE RIDER BOUYS and ADCP LOCATIONS

FIGURE 4-32

G:\41\20175\05 GIS\Projects\mxd's\41-20175-060_waveRider_Fig4-32_revB.mxd

Data Source: DERM: cadastre - 2009, GA: road, rail, watercourse - 2006, Connel Hatch: proposed layout - 2008. Created : jvc

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

ADCP Data

An Acoutsic Doppler Current Profiler (ADCP) (RDI 600 kHz Workhorse Sentinel) was deployed on July 11, 2008 in depths of approximately 21.3 m Mean Sea Level (MSL) to the east-northeast of the Abbot Point Wharf (19° 51.175´ S, 148° 05.960´ E) by Oceanographic Field Services Pty Ltd and used to collect data on wave and currents. The recorded data set comprises 10 minute records of current velocity and hourly wave statistics, based on a 20 min burst sample at 2 Hz.

On August 16 2008, after a brief period of servicing, the instrument was moved to a new, more protected location (19° 50.756´ S, 148° 05.960´ E) in depths of 21.1 m MSL,some 3,000 m east south-east from the first deployment site. The instrument remained at this second location until November 14, 2008, thus providing a practically uninterrupted four-month record of the current and wave climate at the site. The wave data included hourly time series of significant wave height H_s, peak wave period T_p(s), peak wave direction D_p and water depth. Data on currents was presented in terms of current magnitude and direction and east-west and north-south velocity components, corrected for local magnetic variation + 9 degrees.

NOAA Wave Data

This is a twelve-year uninterrupted wave hindcast data record sourced from National Oceanic and Atmospheric Administration (NOAA) WAVEWATCH III global ocean wave model, with a resolution of 1.0x1.25°. The model provides local sea and swell data and wind characteristics.

Winds

Winds were sourced from:

» Bowen Airport meteorological station for the period 1988 to 2008. The data consisted of measurements taken at 6:00, 9:00 12:00 and 15:00 hours daily.

» Bureau of Meteorology (BoM) Wave Analysis Model (WAM) which provides one wind field daily over the extent of study area.

The Bowen Airport wind data was found to be best correlated to the winds in the study area. Average and monthly wind roses generated by BoM are presented in Section 4.5.2.

4.9.1.6 Hydrodynamic Models

To ensure that the identification of potential impacts from the proposed construction of the new jetty and berths is carried out in an effective manner whilst protecting sensitive habitats, a sound understanding of the dominant physical forces and processes in the coastal area of interest is essential. The acquired knowledge is then synthesised in a numerical model capable of providing a quantitative description of water circulation patterns, flushing characteristics and transport trends as well as answers to “what-if” scenarios which are fundamental to the impact assessment process. The usefulness of numerical hydrodynamic-transport and water quality models as powerful tools for impact assessment studies has long been recognised, with methodologies for their rigorous implementation well established (STOWA 99-05).

All simulations and resulting predictions for the X110 Expansion Project have been carried out using two modelling systems in parallel. The adopted approach ensures maximum flexibility in the implementation of the models thus, for each task, a solution is generated by the best performing model. The approach

also implies that, during the modelling process, for each task, two solutions are consistently generated. The result is a strengthened quality assurance process based on comparative analysis of quantifiable and deterministic physical entities.

A second major advantage of this "multiple-tool, best of two" approach is that it also creates a solid foundation for the undertaking of hydrodynamic and water quality investigations associated with any further development of infrastructure in the study area, irrespective of the level of complexity of the proposed configuration or physical processes involved.

The adopted modelling systems are:

» Delft-3D developed by Delft Hydraulics; and

» Mike 21 Flexible Mesh developed by the Danish Hydraulic Institute.

These are state-of-the-art, fully interactive coastal area modelling frameworks, with a long history of successful applications to coastal and estuarine waters and a proven capability of modelling hydrodynamics, transport and water quality processes in complex coastal areas. The first of the two systems relies on the representation of the coastal area using a boundary fitted quasi-orthogonal curvilinear grid and the implementation of the concept of nesting. The second modelling system provides the advantages associated with the use of unstructured grids, making it particularly suitable for hydrodynamic analysis involving complex structural layouts.

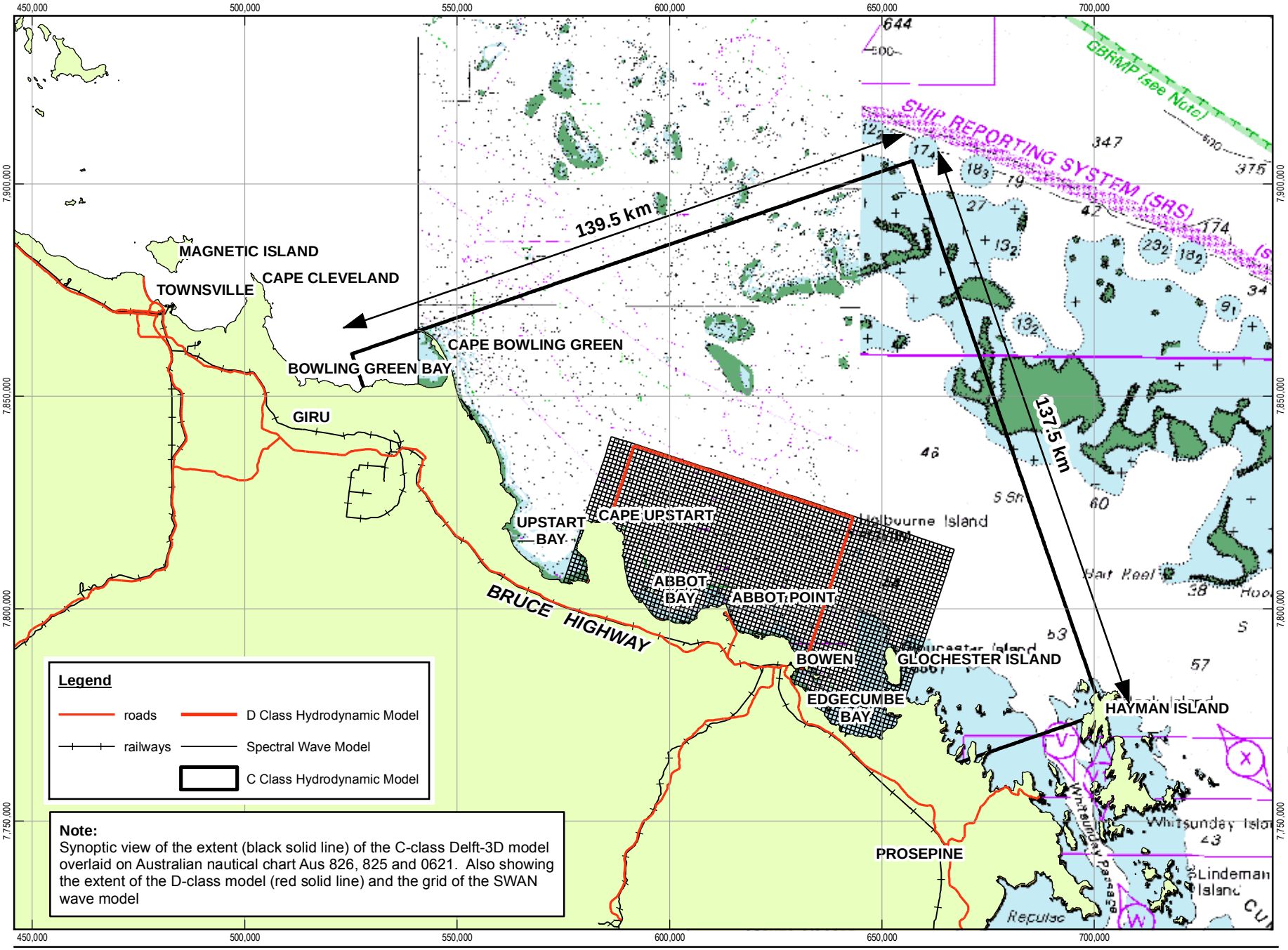
Delft-3D Models

The Delft-3D models were based on the FLOW module of Delft-3D and were developed using the concept of grid nesting. The models, which are part of a larger multi-functional modelling system, are referred to as **C**-class parent model and **D**-class child model, following a nomenclature adopted by GHD to indicate the adopted sequence in the nesting process. In this case, the **D**-class child model was nested in the outer **C**-class model. Figure 4-33 and Figure 4-34 show the extents of the models.

As seen from Table 4-20, both the **C**- and **D**-class models are implemented on rectangular grids with uniform horizontal resolution of 500 m and 250 m, respectively.

Table 4-20 Details of the C- and D-class Delft-3D Hydrodynamic Models

	C	D
Extent	139.5 x 137.5 km	37.25 x 54.25 km
Type of Grid	Rectangular	Rectangular
Horizontal Resolution	500 m	250 m



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Job Number	41-20175
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1:1,250,000 (at A4)

0 10 20 30 40 50
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

Delft3D Hydrodynamic and Wave Model Extents

FIGURE 4-33

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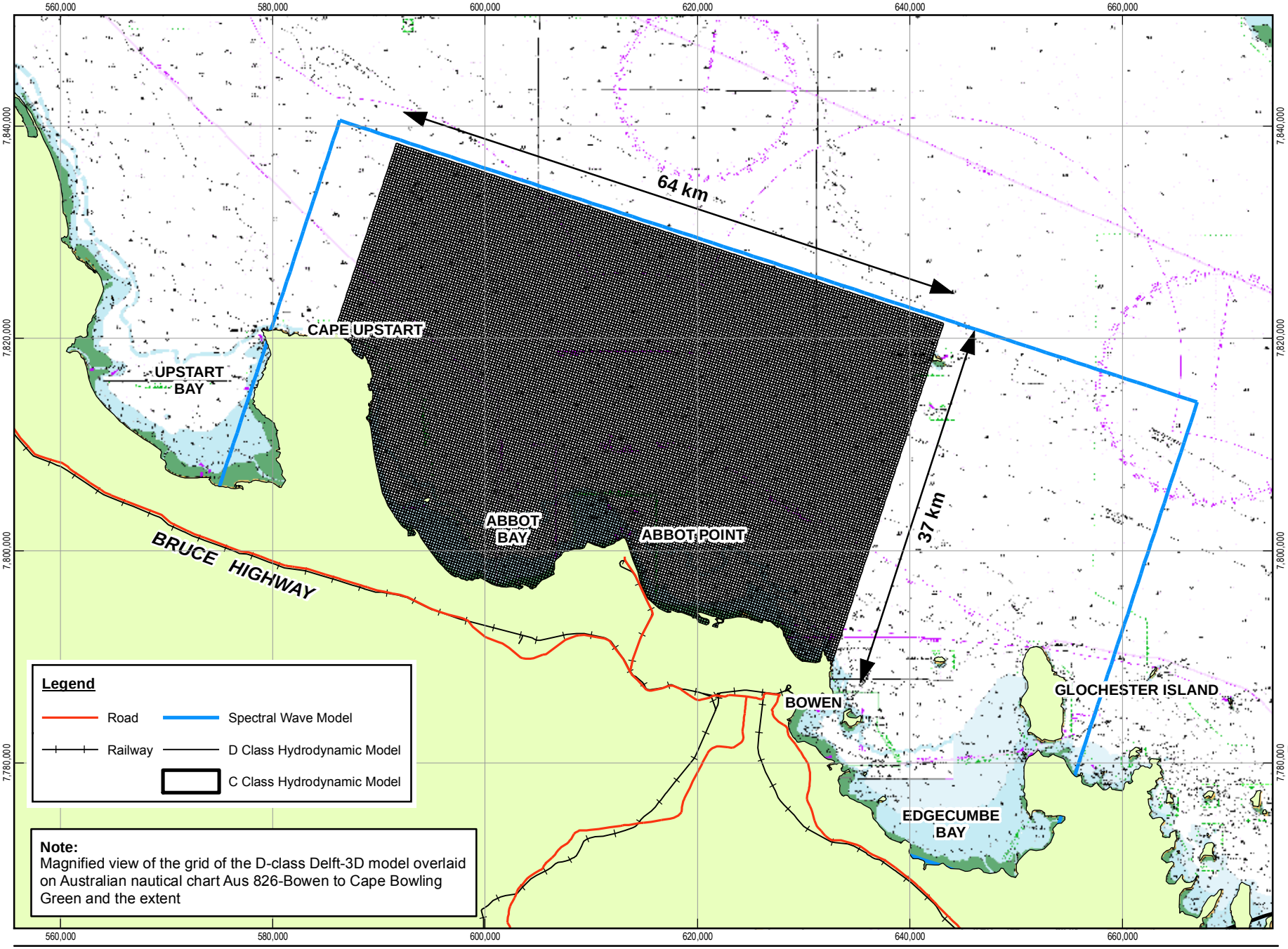
Data Source: GA: roads, rail, coastline - 2006, Seafarer: Hygrographis Charts AUS 826, 825, 0621 - 2007. Created : ms & jvc



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1:500,000(at A4)

0 5 10 15 20

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

Delft3D Hydrodynamic and Wave Model Extent

FIGURE 4-34

G:\41\20175\05 GIS\Projects\mxd's\41-20175-034_hydrodynamicsDelft_Fig4-34_revB.mxd

Data Source: GA: road, rail, coastline - 2006, Seafarer: Hygrographis Charts AUS 826, 825, 0621 - 2007. Created : ms & jvc

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Both models were operated in two-dimensional, depth-integrated mode and were forced by the tide, time-varying winds and waves with the adopted wave climate covering a range of climatological conditions. Details on the extent of the hydrodynamic models and considerations taken into account in the model are included in Appendix D.

Flexible Mesh (FM) Models

Introduced by DHI as FM (Flexible Mesh) models, these are implementations of the Finite-Element Method (FEM), in contrast with the Delft-3D models described in the previous section, which are based on the Finite-Difference Method (FDM). Both the FEM and FDM solve the shallow water partial differential equations that form the basis of coastal hydrodynamics analysis.

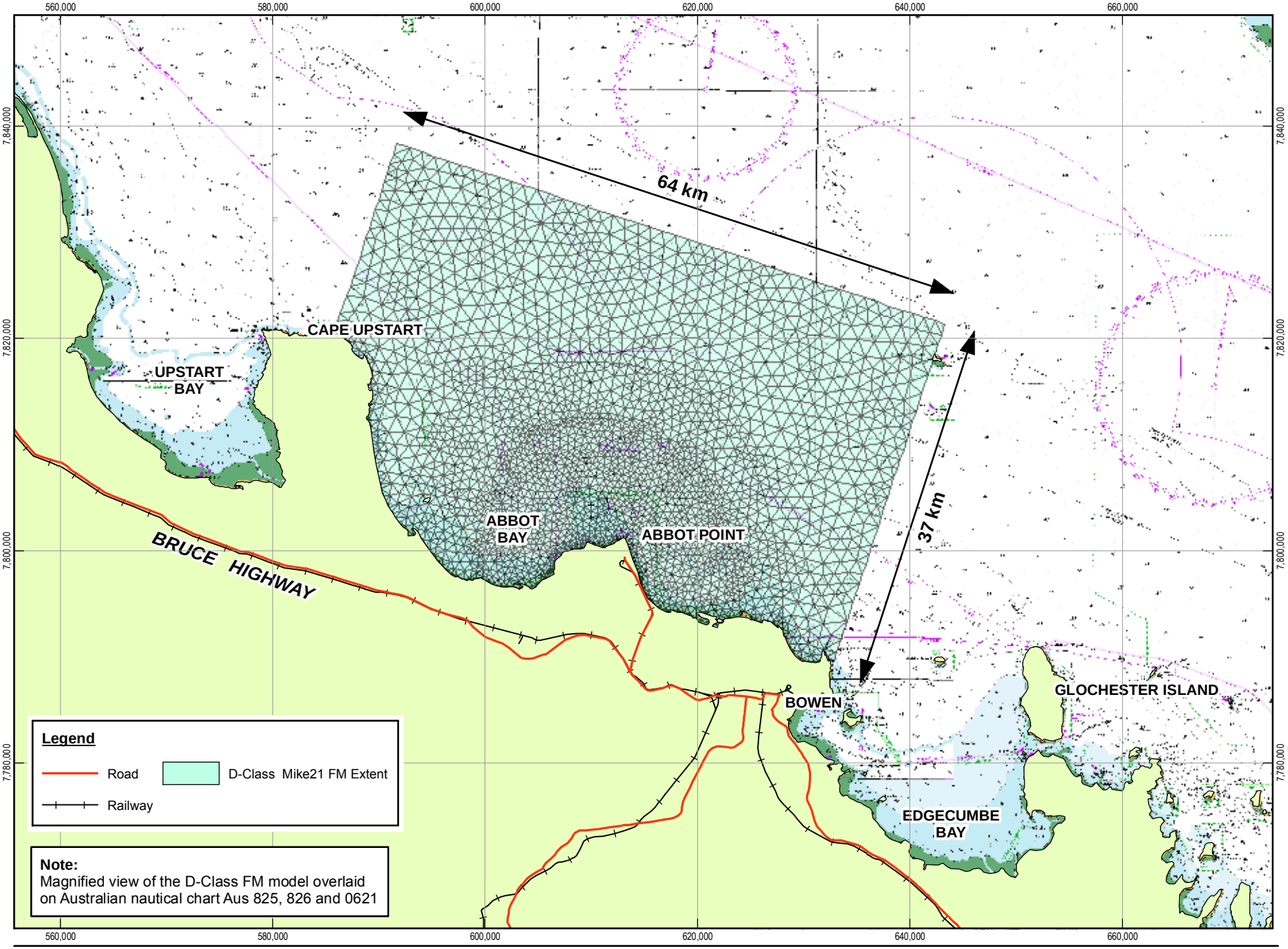
Similar to the Delft-3D models, two FM models of variable extent were developed and their performance tested under a range of boundary conditions generated by two global tidal models (DHI and GOT00).

Large scale FM model: Most of the preliminary tests were conducted on the large scale FM model illustrated in Figure 4-35 and included sensitivity analysis involving boundary conditions, mesh resolution and model extent. The results of the tests were in favour of the selection of a model of a reduced extent similar to the one adopted for the **D**-class Delft-3D model. Logically, the FM model of reduced extent was named the **D**-class FM model.

D-class FM model: A FM model of reduced extent (Figure 4-36) was deployed over the exact same area as the **D**-class Delft-3D model, that is, 37.25 km in the offshore direction and 54.25 km in the alongshore direction. The objective was to preserve consistency across the two modelling platforms (FEM and FDM) in terms of the adopted bathymetry and quality of boundary condition signal.

The quality of the predictions and the performance of the FM models were compared during the calibration process. The **D**-class FM model confirmed its ability to outperform the larger FM model and was adopted as the primary FM predicting tool for the study.

Details on the D-class FM model, model assumptions and datum references are provided in Appendix D.



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1:500,000(at A4)

0 5 10 15 20
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

Mike 21 FM Hydrodynamic and Wave D-Class Scale Model Extent

FIGURE 4-36

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Data Source: GA: road, rail, coastline - 2006, Seafarer: Hygrographis Charts AUS 826, 825, 0621 - 2007. Created : ms & jvc

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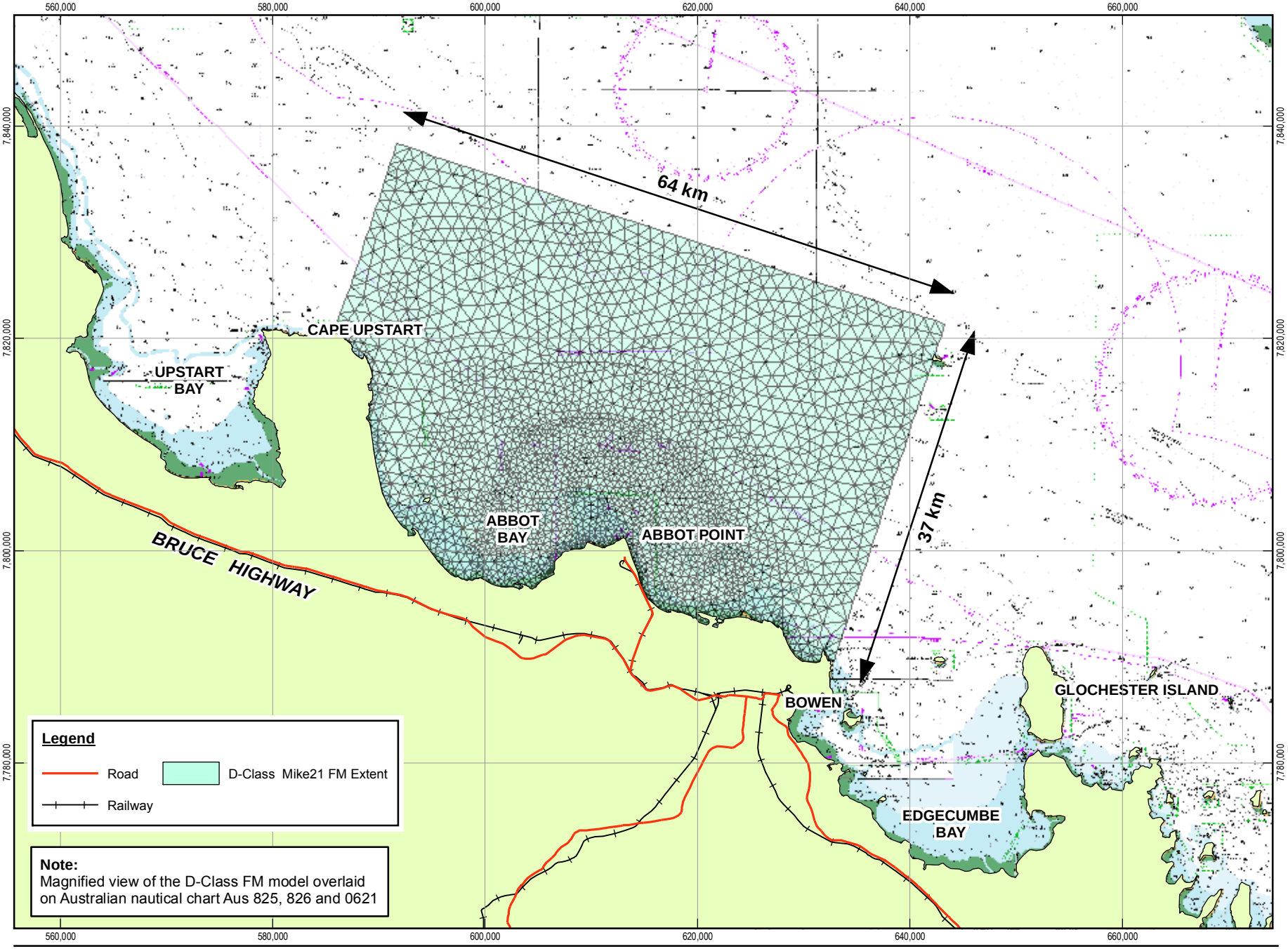

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1:500,000(at A4)

0 5 10 15 20
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

Mike 21 FM Hydrodynamic and Wave D-Class Scale Model Extent

FIGURE 4-36

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Data Source: GA: road, rail, coastline - 2006, Seafarer: Hygrographis Charts AUS 826, 825, 0621 - 2007. Created : ms & jvc

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4.9.1.7 Wave Model

In addition to the hydrodynamic models presented in section 4.9.1.6, a separate wave simulation model was developed to represent the propagation of waves to inshore shallow locations where phenomena such as refraction, shoaling, bed friction and wave breaking are dominant, with the latter resulting in the generation of wave-induced currents inshore of the surf zone. The wave model is an implementation of Simulating Waves Nearshore (SWAN) developed by the Technical University of Delft (The Netherlands). The model computes random, short-crested wind-generated sea states in coastal regions and inland waters and predicts a 2D wave field on a rectangular or curvilinear grid.

In the current implementation, the model takes into account the following effects:

» shoaling and refraction due to current and depth;

» wave generation by wind;

» white capping, bottom friction and depth induced breaking; and

» wave induced set-up.

A rectangular grid of uniform spacing was used in the calculations (refer Appendix D). The grid of the SWAN model is shown in Figure 4-33. The bathymetry for the wave model has been derived from the bathymetry of the **C**-class hydrodynamic model.

4.9.1.8 Elevated Water Levels

Additional storm tide levels (no wave set-up) applicable to the Abbot Point area have been extracted from Queensland Climate Change and Community Vulnerability to Tropical Cyclones, Synthesis Report (2004). The storm tide levels have been obtained for Bowen, the closest station where data was available in the Synthesis Report (2004). The latter data also includes storm tide estimates in combination with greenhouse effects and provides a useful reference for comparison with the findings from the Connel Wagner Study reported in WBM 2006. For practical purposes, GHD recommends using the largest of the two values (where two values are available).

Table 4-21 Comparison of available storm tide data for Bowen

Data Source	100 year		500 year		1,000 year	
	Storm tide (m)	Storm tide + greenhouse effects (m)	Storm tide (m)	Storm tide + greenhouse effects (m)	Storm tide (m)	Storm tide + greenhouse effects (m)
Synthesis report (2004)	2.15	2.52	2.52	3.01	2.71	3.22
Connell Wagner study	2.12		2.70		2.86	

4.9.1.9 Model Calibration

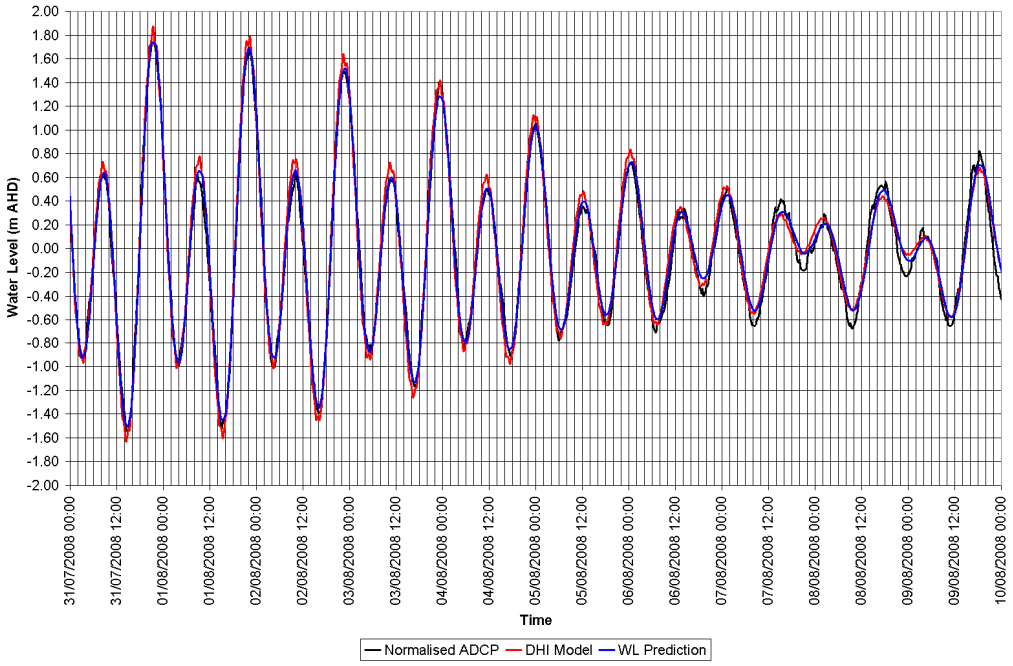
The two series of models (Delft-3D and FM) have undergone a process of extensive calibration involving comparison of model predictions to measured water levels and currents forced by the tide, winds and waves. Tidal and wave measurements used in the analysis were as recorded by the ADCP deployed in the Abbot Point area for the period 11 July 2008 to 14 November 2008. For the purpose of calibration, the models were operated for a period of three months (01 July to 01 October 2008). Specific details of this calibration are provided in Appendix D.

The calibration process demonstrated that the two series of models (Delft-3D and FM) were able to reproduce the observational data fairly well over the entire three-month period which also included high energy wave events. The level of agreement between model predictions and measurements was quantified by obtaining estimates of the Root Mean Square Error (RMSE) of water levels and current magnitude for each of the above described calibration simulations (refer Appendix D).

A comparison of modelled versus measured and predicted water levels is presented in Figure 4-37. The figure illustrates the achieved level of agreement between model and observations during a period of transition from spring to neap tide (31 July to 10 August 2008). Additional graphs with coverage of the entire period of simulation are presented in Appendix D.

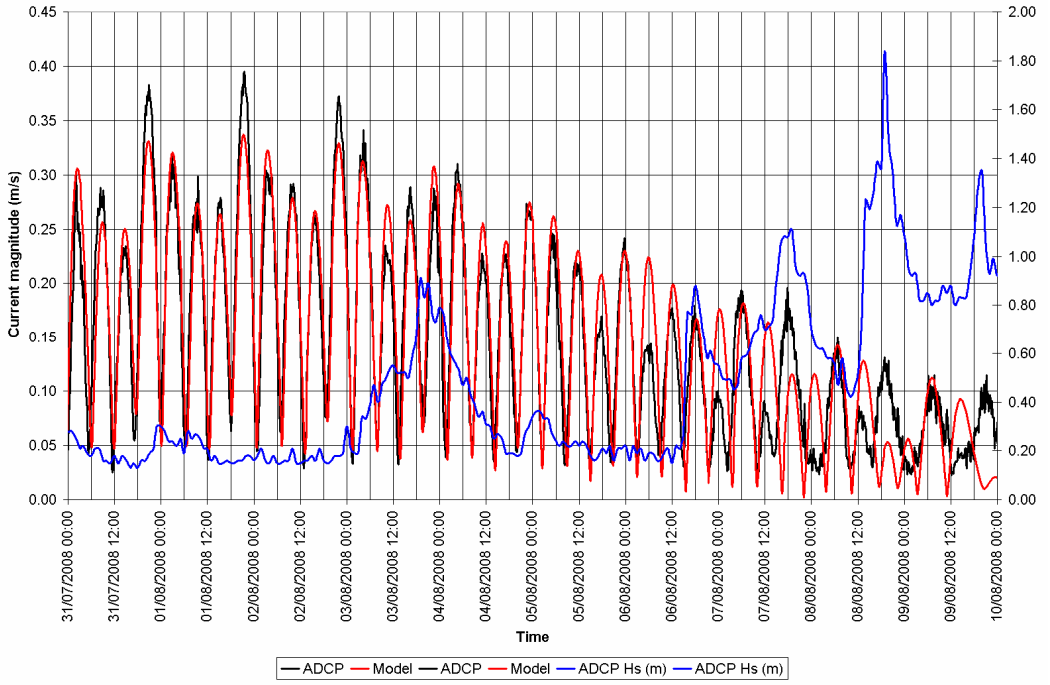
All predictions of water level at Abbot Point have been carried out using the 8 major tidal constituents as provided by NTC. Similarly, Figure 4-38 depicts the level of agreement achieved between modelled and measured current magnitude for the same period. As seen from the figure, the modelled currents are in the same range as the measured most of the time, with instances of interaction between the normal tide currents and the local wave climate. In this particular case, a significant enhancement of the tidal currents is observed over short periods of time during the neap tide when the significant wave heights exceeded 1.0 m.

The agreement achieved between modelled and measured current direction under the effect of the tides is illustrated in Figure 4-39. Understanding of how the wave climate modulates the direction of tidal currents can be gained by observing the process of realignment of the modelled currents with measurements as it occurred on 09 September 2008 (Figure 4-40). The figure shows clearly an instance of tidal reversal of currents being suppressed by the interacting waves.



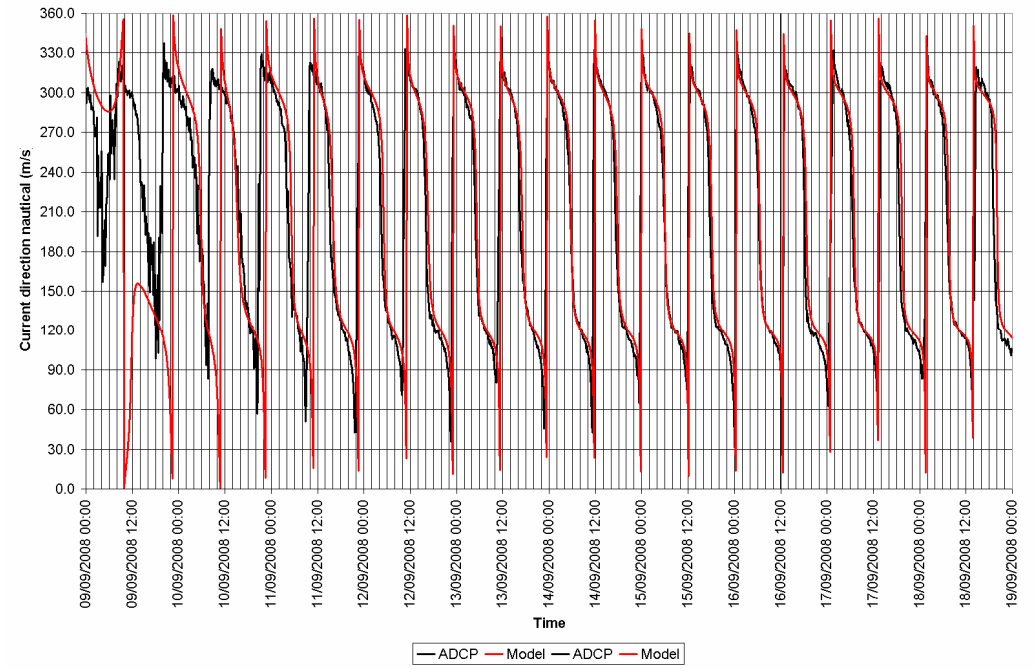
Note: ADCP measurements (solid black line), model (red) and NTC predictions based on 8 major constituents (blue). RMS = 0.11

Figure 4-37 Comparison of water levels for the period 31 July to 10 August 2008



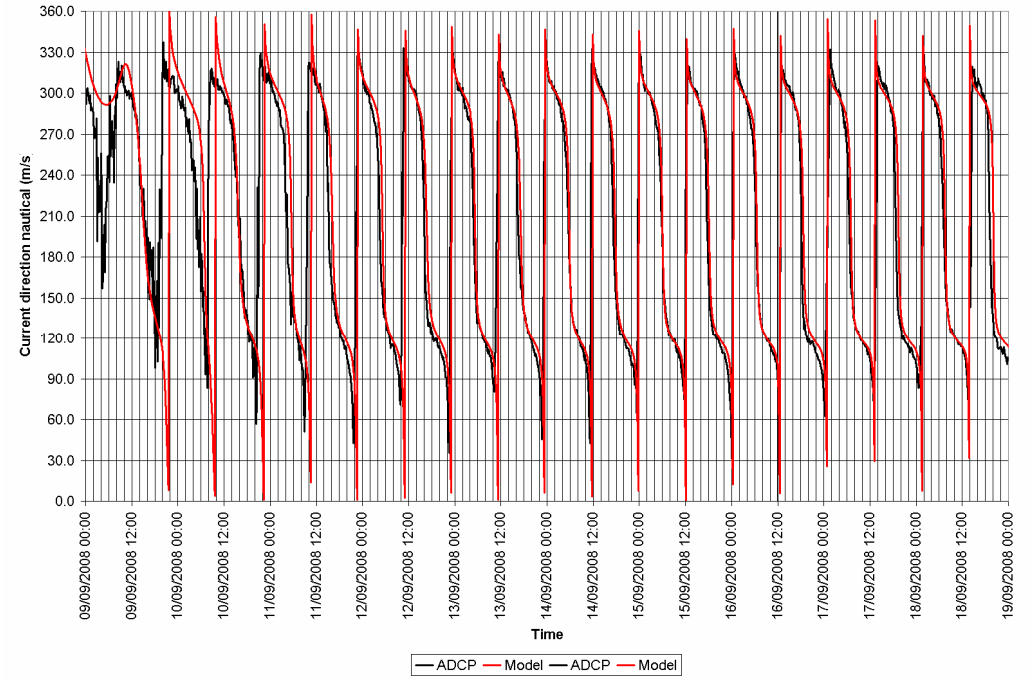
Note: Depth-averaged ADCP measurements (solid black line) versus model (solid red line). Solid blue line indicates measured significant wave height (m).

Figure 4-38 Comparison of current magnitude for the period 31 July to 10 August 2008



Note: Depth-averaged ADCP measurements (solid black line) versus model (solid red line)

Figure 4-39 Comparison of current direction under the effect of the tides for the period 09 September to 19 September 2008



Note: Depth-averaged ADCP measurements (solid black line) versus model (solid red line)

Figure 4-40 Comparison of current direction under the effect of the tides, winds and waves for the period 09 September to 19 September 2008

The results of the calibration are summarised for each period of deployment of the ADCP in Appendix D.

4.9.2 Potential Impacts and Mitigation Measures

4.9.2.1 Numerical Assessment of Pier Resistance

The results of the GHD analysis involved the use of either a finite difference rectangular grid (structured mesh), with uniform spacing or an unstructured, finite element mesh. The structured mesh resolves the coastal area under investigation at a horizontal resolution of 250 m, while the unstructured mesh is somewhat coarser and varies in the 600.0 m to 1,200.0 m range. The adopted resolution in both meshes implies that the piers of the two approach trestle jetties are not directly resolvable on the computation grid. Nevertheless, the resistance imposed by the piers on the flow can be still assessed by using the traditional drag force formulation and modelling the piers as sub-grid structures (refer Appendix D).

The formulations in Appendix D have been implemented in the **D**-class FM model to account for the resistance of the piers to flow. Based on acquired design information, the two trestle jetties have been modelled with a total of 360 piers each.

The piers have a circular shape, a diameter of 1.2 m and are uniformly distributed at 10 m interval along the trestle jetty. The pier height exposed to current was adopted equal to 10 m.

To investigate the sensitivity of the solution to pier resistance, two model scenarios were conceived:

» Scenario 1 – no trestle jetty piers, i.e. the effect of the piers on flow is neglected; and

» Scenario 2 – piers represented in the analysis as sub-grid structures.

The scenarios were operated for a period of three months (01 July to 01 October 2008) thus including a range of tidal conditions in the obtained solution. The results of the analysis were monitored at twelve numerical monitoring stations defined in water depths of 10-12 m, at an approximate distance of 10 m parallel to the axis of the existing trestle jetty (Figure 4-41). The stations (red dots in the figure) recorded the water level, current magnitude and current direction predicted at each time step by the model. The results of the analysis have been visualised in Appendix D as time histories, tidal orbits and histograms at a representative numerical monitoring station - #10. Station #10 has been deployed at a distance of 10 m from the piers in approximate depth of 15 m LAT.

In addition, water level, current magnitude and current direction residuals were estimated at one hour intervals by subtracting the values corresponding to scenario 2 from those corresponding to scenario 1. The use of residuals made it possible to track the difference between the two modelled scenarios as the solution progressed and quantify in an objective manner, the influence of the piers on flow. Maximum values of residuals for the three modelled variables have been summarised in Table 4-22 .

Table 4-22 Maximum residuals of modelled variables

#	Modelled variable	Maximum residuals
1	Water level (m)	< 0.001
2	Current magnitude (m/s)	< 0.004
3	Current direction (degrees)	6 to 23 depending on the position of the numerical station

As seen from the table, the maximum residual was less than 0.001 m for water level and less than 0.004 m/s for current magnitude. The residuals for current direction were in general, less than 0.5-1.0 degrees however, isolated residual peaks of 6 to 23 degrees were also observed. These are rare occurrences associated exclusively with periods of current reversal from flood and ebb tide as shown in Figure 4-42.

Figure 4-41 Numerical monitoring stations adopted for analysis

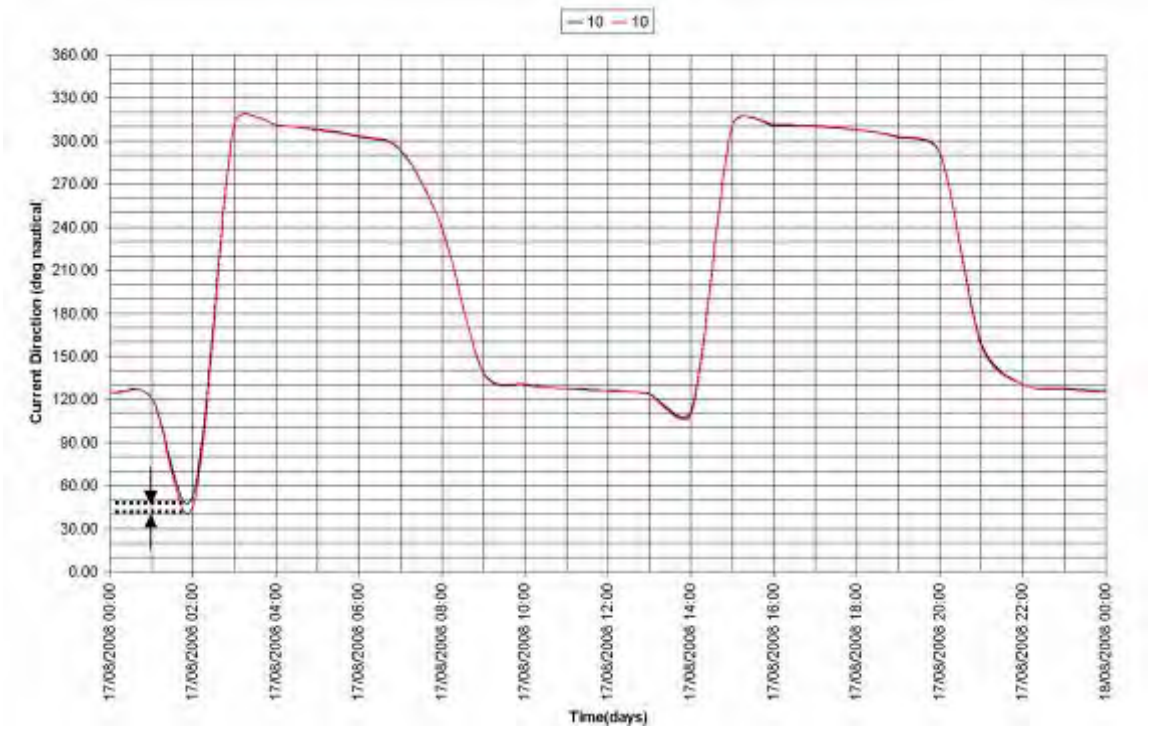


Figure 4-42 Residual (distance between arrows) or current direction reaching peak value during period of reversal of tidal currents

4.9.2.2 Conclusions

Based on the above findings, it can be stated that:

» The influence of the trestle jetty piers on flow has been found to be negligible for the range of tidal conditions corresponding to the modelled three-month period (01 July to 01 October 2008). It is reasonable to expect that the findings of the numerical assessment will remain valid regardless of the modelled season.

» The differences or residuals between the two scenarios are perceptible but insignificant. Water level residuals for the modelled period were less than 0.001 m. Current magnitude residuals for the same period were less than 0.004 m/s.

» Current direction residuals were in general, less than 0.5-1.0 degree for the modelled period, however, isolated peak residual values of up to 23 degrees were also observed. It was found, however, that a residual of current direction of that magnitude is a rare occurrence associated exclusively with periods of current reversal from flood to ebb tide.

Refer to Appendix D for qualifications on the above.

4.10 Terrestrial Ecology

4.10.1 Description of the Existing Environment

4.10.1.1 Introduction

The following section provides a description of the existing environmental values for terrestrial ecosystems of the Abbot Point X110 Project area (hereafter referred to as the study area). The ecological values are described based on a review of existing reports, database searches and dry and wet season flora and fauna surveys conducted during November 2008 (dry) and April 2009 (wet).

The aims of the ecological assessment were to:

» ground truth remnant vegetation mapping;

» highlight sensitive or important vegetation types and habitats, including habitats of known rare and threatened species;

» record flora and fauna diversity;

» ascertain the integrity of ecological processes and natural places;

» note broad distribution patterns of terrestrial fauna;

» record the seasonality of the habitats present by conducting field assessments in the wet and dry seasons; and

» identify suitable habitats and confirm the presence of, or potential presence of, any species of conservation significance that may be impacted by the Project.

A summary of the ecological assessment methodology is provided below.

4.10.1.2 Existing Data Review

A review of background information for the Project was undertaken using the following data sources:

» The DEWHA Protected Matters search tool was used to identify species listed under the Commonwealth EPBC Act that are predicted to occur within the study area (see Appendix E). The search area was defined as a 2 km radius around the centre of the study area (19.89261ºS; 148.0764ºE).

» The DERM Wildlife Online database was queried to identify flora and fauna species that have been historically recorded in, or surrounding, the study area. Records were returned for a search area within a 2 km radius of the approximate centre of the study area (19.89261ºS; 148.0764ºE).

» DERM's Regional Ecosystem (RE) and Essential Habitat mapping (Version 5.0, 2005) was examined to determine the type and extent of remnant vegetation as well as areas recognised as essential habitat within the study area.

» DERM's Biodiversity Planning Assessment (BPA) mapping was examined to determine if any habitats of importance are affected within the study area.

» Queensland Herbarium HERBRECS database was used to identify any previously recorded flora species located within the specified site.

» Existing ecological assessment reports undertaken at Abbot Point (WBM, Ecoserve 2007) and existing reports on the ecology of the biographic region (Young *et al*, 1999) and Caley Valley Wetlands (including Blackman *et al*, 1999).

» GHD ecological surveys for the Multi Cargo Facility (MCF) infrastructure corridor conducted on behalf of NQBP. These surveys were conducted immediately west of the study area at the same time as X110 fieldwork. Data recorded has been used to supplement the incidental observations recorded from similar habitat types within the study area. This wet and dry season data was collected using the following methods:

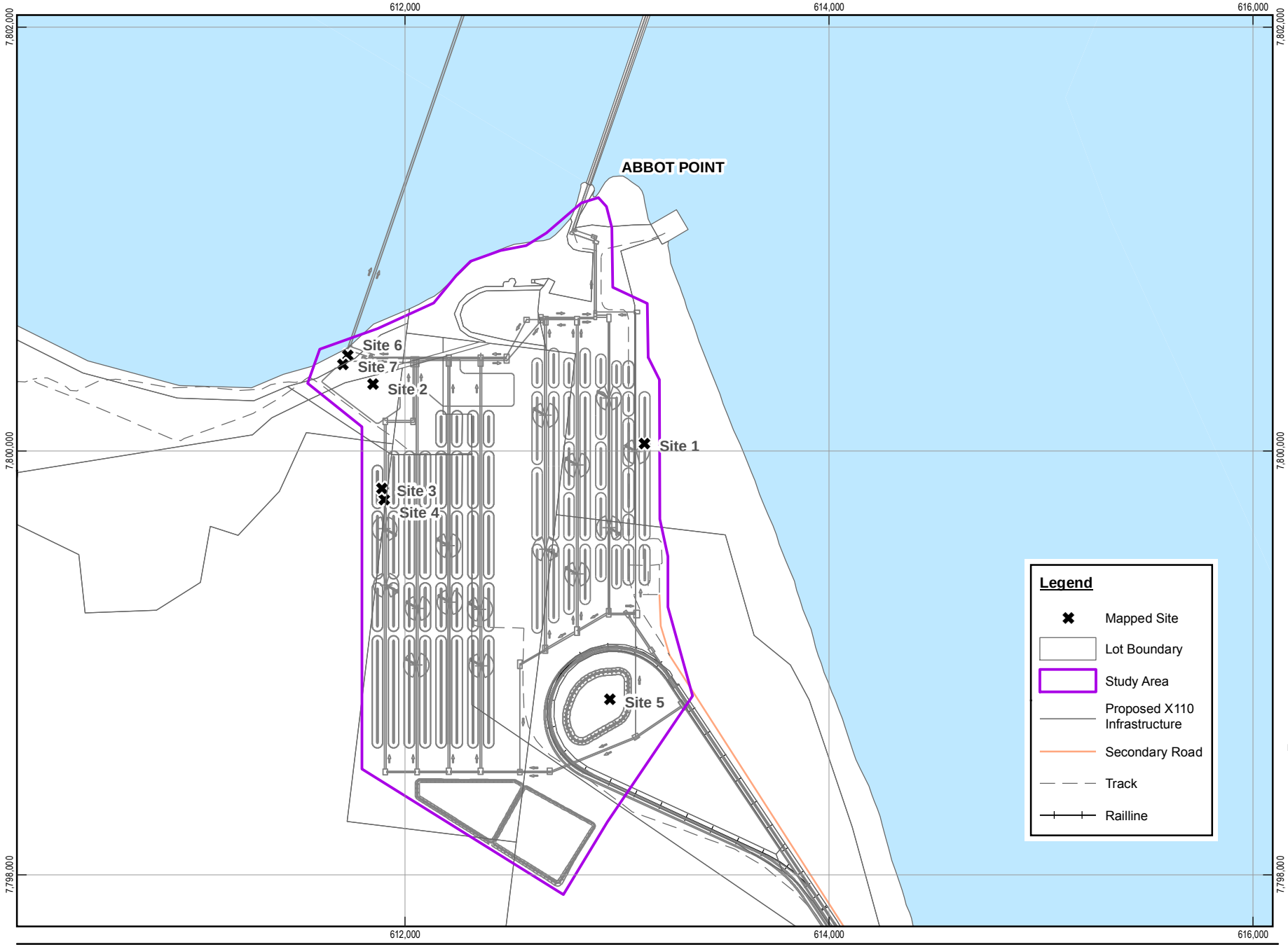
  – Spotlighting;
  – Fauna trapping and diurnal active searches;
  – Standardised bird surveys;
  – Aquatic surveys; and
  – Incidental observations.

4.10.1.3 Fieldwork Methodologies

GHD ecologists completed dry and wet season ecological field assessments from November 10 - 11, 2008 and April 4, 2009, respectively. The assessments involved surveys at defined sampling sites within each representative RE, as well as random meanders within the broader study area. The sampling sites are shown in Figure 4-43 and the location of each site (using GPS co-ordinates in MGA Zone 55) is listed in Table 4-23.

Table 4-23 GPS co-ordinates of the sample sites

Site Identification Number	Easting	Northing
Site 1	613,127	7,800,038
Site 2	611,846	7,800,321
Site 3	611,888	7,799,828
Site 4	611,899	7,799,771
Site 5	612,963	7,798,829
Site 6	611,797	7,800,510
Site 7	613,127	7,800,020



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Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

TERRESTIAL ECOLOGY SURVEY SITES

FIGURE 4-43

G:\41\20175\05 GIS\Projects\mxd's\41-20175-048_EcoSurveySites_Fig4-43_revB.mxd

Data Source: DERM: cadastre - 2009; DERM: RE - 2008. Created : jvc

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At each of the sites, the following information was recorded:

» RE type and boundary;

» Height and structural complexity of vegetation (i.e. tree density, canopy cover, vertical structural complexity, ground cover, leaf litter);

» All vascular plant species present;

» Sources of disturbance (i.e. traffic noise, predation, weed infestation);

» Targeted search for threatened species likely to be recorded within each season;

» Fauna habitat assessments recorded the presence of:

  – The structure and complexity of ground substrates and vegetation strata;

  – Habitat features (i.e. hollows, fallen logs, rock outcrops, water bodies);

  – Records of wildlife traces (i.e. scats, scratches, burrows, nests, diggings, tracks);

  – Presence of habitat trees and the proportion which contained scratches; and

  – Specific resources such as shelter, basking, roosting, nesting and foraging sites for amphibians, birds, bats, arboreal mammals, ground-dwelling mammals and reptiles;

» All opportunistic sightings of fauna and number of individuals sighted were recorded within each habitat area; and

» The site location using handheld GPS and photographs (Table 4-23).

4.10.1.4 Limitations

Wet season surveys were delayed due to access difficulties from wet season weather and road obstructions. Ecologists conducting the wet season survey in early April 2009 did not have vehicular or safe foot access to Site 5 (rail loop), or the southern boundary of the study area within the margins of Caley Valley Wetland. Sufficient information is obtained for these habitats from the MCF wet season field assessment conducted at the same time and analogous habitats within the study area (for example the Melaleuca Woodland data recorded in X110 Site 1 is used for the adjacent X110 Site 5 sample area).

4.10.1.5 Nomenclature

For the purposes of consistency, scientific and common names for flora and fauna species follow those used in the following sources:

» Census of the Queensland Flora (Bostock and Holland, 2007);

» Field Guide to the Birds of Australia (Pizzey and Knight, 2003);

» Field Guide to Mammals of Australia (Menkhorst and Knight, 2004); and

» A Field Guide to Reptiles of Queensland (Wilson, 2005).

RE descriptions follow those of the Regional Ecosystem Description Database (REDD) Version 5.0 published by the DERM.

4.10.1.6 Study Site Land Use History

The study area within the Abbot Point development zone has a history of agricultural and industrial land use. Grazing still occurs in narrow linear areas along the southern and western margins of the study area during the dry season. The wet season causes the grazing land to become inaccessible.

4.10.2 Description of Environmental Values

4.10.2.1 Overview

The study area is located within the Bogie River Hills (BRB2) and the Townsville Plains (BRB1) provinces of the Brigalow Belt bioregion. The vegetation within the Bogie River Hills subregion consists of open eucalypt woodlands on undulating hilly areas with duplex and shallow stony soils. There are scattered patches of vine thicket in sheltered areas and fringing saltmarsh along the coast (Young *et al*., 1999). The region has a defined wet (summer) and dry (winter) season and as such, is subject to seasonal fluctuations in species composition and abundance.

The Townsville Plains subregion supports open Eucalyptus woodlands on duplex soils, clays and loams. Near the coast, saltmarsh areas and paperbark woodlands occur on finer marine sediments. Minor volcanic rocky outcrops occur, forming low hills throughout the subregion.

The site consists of different land zones, including coastal dunes, marine deposits and palustrine wetlands. The diverse landscape features and seasonal climatic variations provide a broad range of habitats for vegetation communities, plants and animals. This includes a range of migratory bird species (see Section 4.10.2.5).

The coastline along the north and east boundaries of the existing terminal supports remnant vegetation, including areas comprising beach scrub (EPBC listed vegetation community). The southern and western boundaries of the development area are adjacent to, and within margins of, the Caley Valley Wetland. The Caley Valley Wetland is a highly seasonal ecosystem changing from a salt marsh dominated landscape in the dry season, to a freshwater wetland dominated system with fringing brackish and salt tolerant flora species in the wet season.

Despite past vegetation clearing and on-going disturbances from weed invasion and cattle grazing, a diverse array of vegetation community types are represented in the X110 project site. These include *Corymbia* and *Melaleuca* woodlands (11.2.5), beach scrub (11.2.3), samphire forblands (11.1.2b), *Acacia* low woodlands (11.12.16x1) and palustrine wetlands (11.3.27c). None of the REs are identified as Essential Habitat by DERM. The beach scrub RE (11.2.3) also forms part of threatened ecological community: Semi-evergreen vine thickets of the Brigalow Belt, which is listed as endangered under the EPBC Act. The vegetation and flora present in the study area is further detailed in Section 4.10.2.4.

DERM maintains the BPA map and database information product. BPA mapping identifies areas of biodiversity significance at State, regional, and local levels. Criteria used to determine biodiversity significance levels are based upon the Biodiversity Assessment and Mapping Methodology (BAMM) (EPA 2002). BAMM uses remnant vegetation mapping data, generated or approved by the Queensland Herbarium, to provide a consistent approach for assessing biodiversity values in the landscape and identifying areas with various levels of significance for biodiversity reasons. Specific diagnostic criteria, based on uniformly available data and other essential criteria using non-uniform data, are assessed as outlined in the BAMM guidelines (EPA 2002). Current BPA mapping (Version 1.3, released 29 January

2007), shows that no areas of state, regional or local biodiversity value occur within or adjacent to the study area.

4.10.2.2 Sensitive Environmental Areas

Caley Valley Wetland

The boundary of Caley Valley Wetland was mapped by the Queensland Department of Primary Industries based on landsat imagery. The mapping is reproduced in Figure 4-17 and shows that a small part of the X110 project encroaches into the area covered by the wetland during the wet season.

Caley Valley wetland is listed in the Australian Government's "Directory of Important Wetlands" (Environment Australia 2001) and supports a variety of conservation-significant species and migratory birds (DEWHA 2008a). Wetland vegetation comprises a mixture of permanent estuarine waters, intertidal mud and sand flats, mangroves, salt marshes, freshwater marshes and freshwater impoundments (Blackman *et al*., 1999; Blackman *et al*., 2002). The freshwater impoundments have been created by two man-made bund walls. Caley Valley wetland is considered an important site for waterfowl in north Queensland (Blackman *et al*., 1999). The Caley Valley wetland also provides foraging habitat for a range of migratory shorebirds which visit Australia in spring and summer after breeding in the northern hemisphere (Blackman *et al*., 1999). The wetland is classified as important habitat for animal species at a critical stage in their life cycles and provides a refuge. Also, the wetland is classified as nationally important, as it supports 1% or more of the national populations of any native plant or animal species (Environment Australia 2001).

The wetland has historically and is currently extensively grazed, including the portions of the wetland that are within the study area. This has lead to degradation in the quality of vegetation and fauna habitat values, particularly around the perimeter of the wetland, which is subject to more pronounced grazing pressure due to its accessibility.

Beach Scrub

The beach scrub (RE 11.2.3) vegetation community located in the north-east of the study area within the proposed Bund 1 (Figure 4-44) is listed as a threatened ecological community of national importance under the EPBC Act due to its limited distribution. It is described as a low notophyll to microphyll vine forest, frequently occurring on secondary dune swales that are generally protected from strong coastal winds. It forms part the threatened vegetation community- semi-evergreen vine thickets of the Brigalow Belt bioregion (north and south). Common threats to this RE include coastal development, weed invasion and inappropriate fire regimes.

The beach scrub RE is also listed as Of Concern under Queensland's VMA. The beach scrub within the study area is currently a narrow band (10-15m wide) (0.34 ha) along the coastline and within the proposed footprint of Bund 0. The margins of this RE are modified due to weed invasion and activities associated with the existing terminal.

Regional Ecosystems

The desktop searches and site investigation identified the presence of six REs within the study area (Table 4-24). Ground-truthing of the certified RE mapping (Figure 4-44) identified mapping errors. The errors detected were of two types:

» Areas of remnant vegetation that have been cleared under development approvals have not been removed from the certified mapping; and

» Errors in the regional ecosystem attribution – due to species composition inconsistencies.

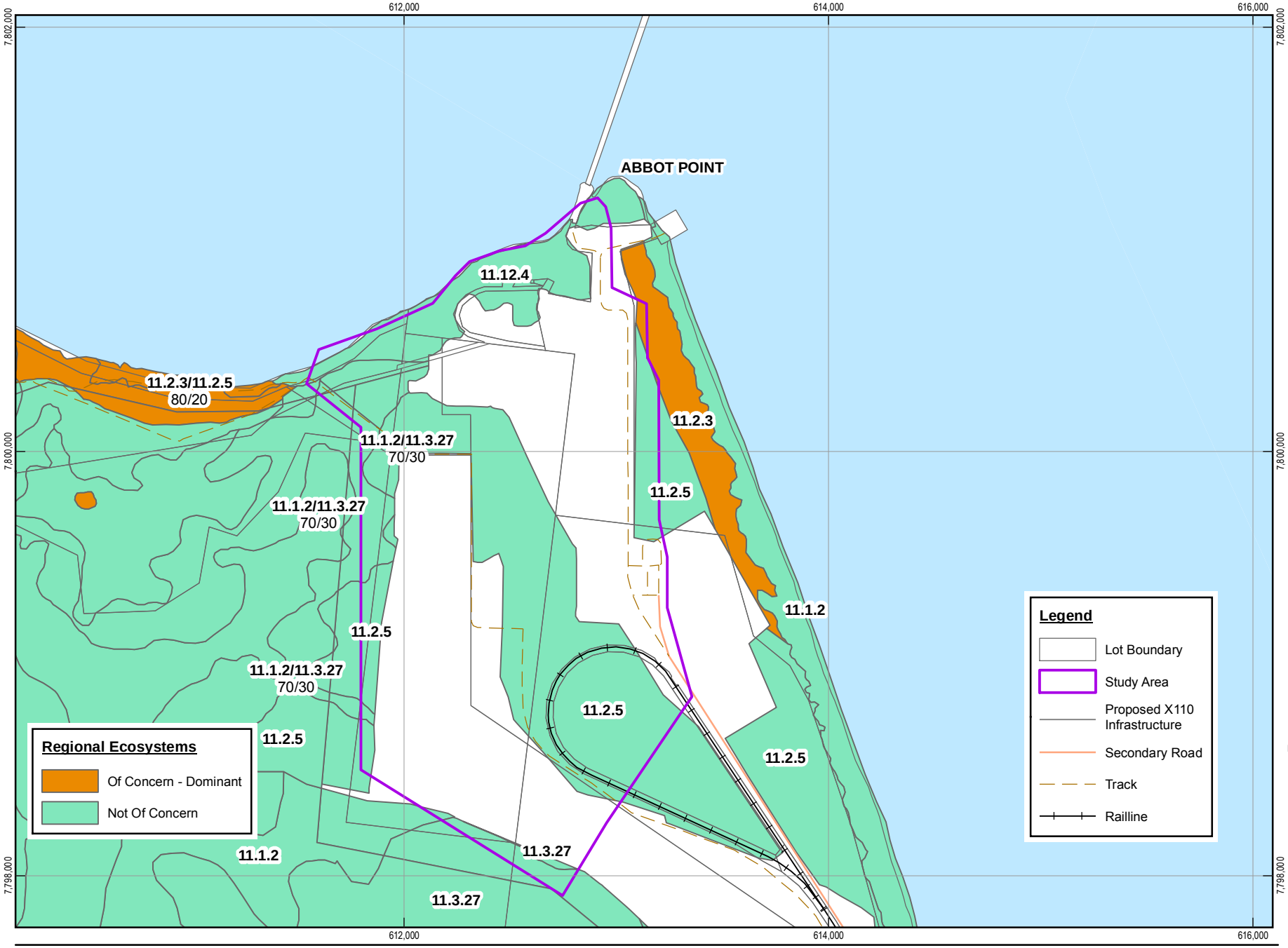
Updated RE mapping that corrects the errors identified above is provided in Figure 4-45. The RE type, status and distribution on site are provided in Table 4-24.

Table 4-24 Regional Ecosystems mapped on site

RE (status)	Short Description	Project Distribution
11.1.2 Not of Concern	Samphire forbland on marine clay pans.	Located on the outer zones of Caley Valley Wetland. Associated with RE 11.3.27.
11.2.3 Of Concern-Nationally Listed	Microphyll vine forest ("beach scrub") on sandy ridges and dune swales.	Occurs in a narrow band along the primary dunes. This RE is mapped incorrectly as 11.12.4.
11.2.5 Not of Concern	*Corymbia*, *Melaleuca* woodland complex of beach ridges and swales.	Occurs behind the beach scrub community and in higher lying areas around Caley Valley Wetland.
11.3.27 Not of Concern	Palustrine wetland (vegetated swamp). Sedgelands to grasslands on quaternary deposits.	Forms the freshwater reaches of Caley Valley Wetland, within the project area is associated with 11.1.2 and experiences seasonal changes in floristic values.
11.12.4 Not of Concern	Semi-evergreen vine thicket and microphyll vine forest on igneous rocks.	This RE is located at Abbot Point Headland and extends along the granite hills. This is incorrectly mapped in parts.
11.12.16 Of Concern	*Acacia* spp. low woodland on igneous rocks. Coastal hills.	Forms the western slopes of Abbot Point Headland, it has been incorrectly mapped as 11.12.4.

Moratorium Mapping

On the 7 of April 2009, the Queensland Government announced moratorium on clearing of high-value regrowth vegetation. Under the moratorium, all native regrowth vegetation within 50 m of a watercourse in the priority reef catchments of the Wet Tropics, Burdekin and Mackay/Whitsunday regions and endangered regrowth vegetation in rural areas across the state on freehold and agricultural and grazing leasehold land are afforded protection while vegetation clearing laws are amended to include these areas. A review of the DERM Moratorium Map for the area shows there are no moratorium watercourses within the project study area. The Caley Valley Wetland is not classified as a watercourse.



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Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

CERTIFIED REGIONAL ECOSYSTEM MAPPING

FIGURE 4-44

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Data Source: DERM: cadastre - 2009; DERM: RE - 2008. Created : jvc

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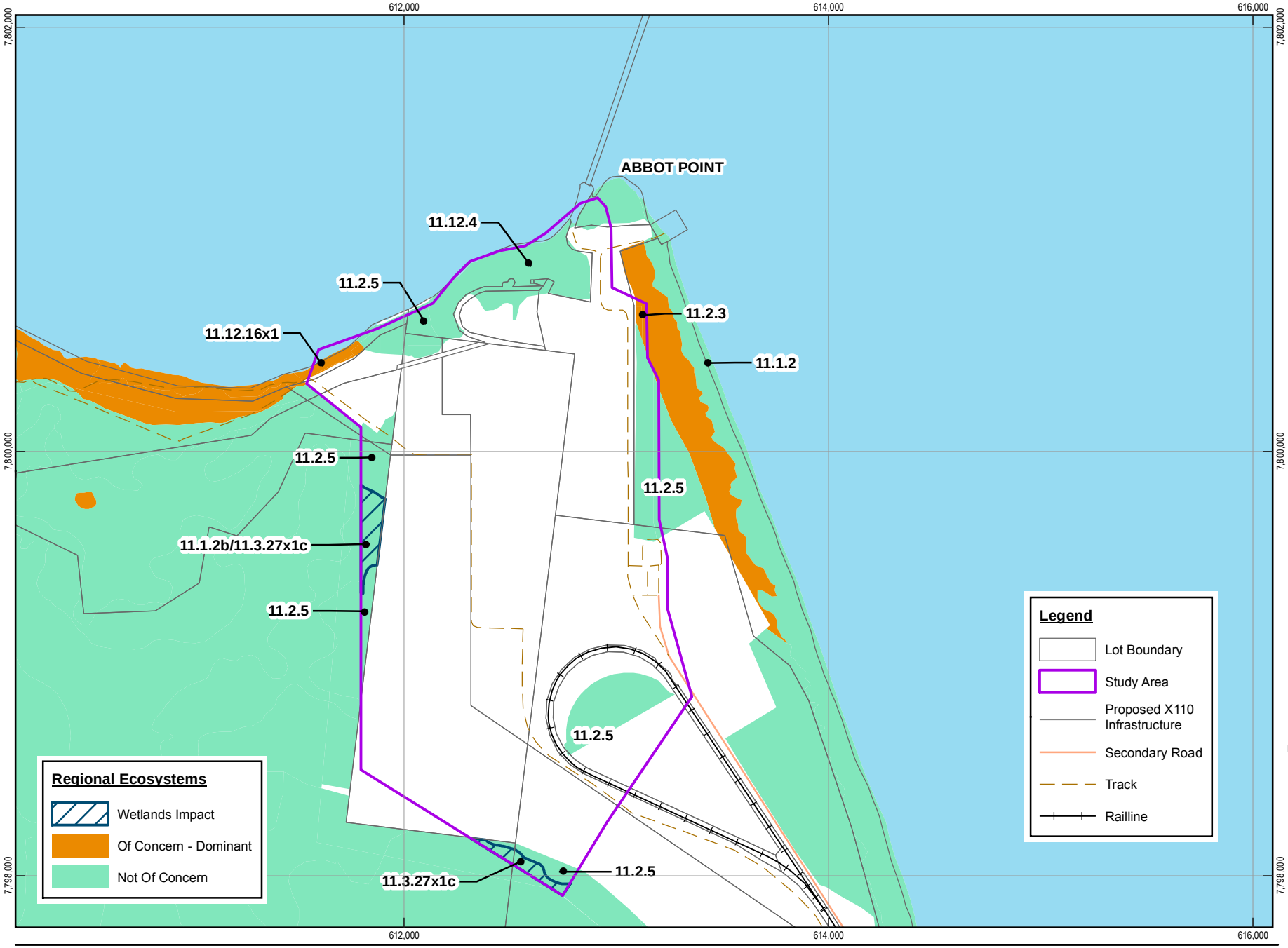

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Date	06 OCT 2009

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Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

ADMENDED REGIONAL ECOSYSTEM MAPPING

FIGURE 4-45

G:\41\20175\05 GIS\Projects\mxd's\41-20175-049_REMapping_Fig4-45_revB.mxd

Data Source: DERM: cadastre - 2009; DERM: RE - 2008. Created : jvc

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4.10.2.3 Description of Vegetation Communities

The following vegetation community descriptions are based on the composition, structure and condition of vegetation communities as recorded in the study area. The extent, species composition, land form and soil type correspond with the amended RE mapping (Figure 4-45).

Areas mapped as non-remnant either contain port infrastructure, or have been previously cleared for grazing and contain improved pastures.

1. Samphire forbland on marine sediments (RE 11.1.2/11.3.27)

This unit is characterised by a low forbland dominated by samphire or salt tolerant species on soils derived from marine deposits. The ecologically dominant layer is typically low (approximately 20 cm tall) and open. Representative species include; *Halosarcia halocnemoides* subsp. *tenuis*, *H. pergranulata*, *Sarcocornia quinqueflora*, *Sesuvium portulacastrum*, and *Tecticornia australasica*. Clumps of sedges are also common.

During the wet season, the vegetation community changes to a brackish to freshwater system. The saltmarsh flora species retract to the margins of this area and include persistent species such as salt couch *Sporobolus virginicus*. Freshwater species, *Schoenoplectus littoralis* and tall spike rush *Eleocharis sphaculata*, form dense clumps and mosaics in deeper water.

This vegetation community is associated with Caley Valley wetland and occurs on the western and southern boundaries, it experiences pronounced seasonal changes and consistent with a heterogenous mixture of RE 11.1.2/11.3.27. Survey site 4, shown in Photo 4-6, is representative of this community.

Photo 4-6 Site 4: Saltmarsh site fringed by salt couch- wet season

2. Sedgeland/grassland on alluvial sediments

This unit is characterised by sedgeland to grasslands on alluvial deposits. The ecologically dominant layer is characterised by *Schoenoplectus litoralis*, *Eleocharis* sp., *Juncus* sp., *Fimbrystylis polytrichoides*, *Sporobolus virginicus*, and **Cynodon dactylon*. Sedges/rushes tend to dominate in low lying areas with grasses becoming dominant on adjacent, slightly elevated areas.

Survey sites 2 and 4 are representative of this community (see Photo 4-7). Wet season conditions demonstrate a significant increase in flora species diversity and abundance. A mosaic of submerged, emergent and floating freshwater aquatic species were recorded within areas of open water. Grassland and sedgeland species were restricted to the margins of this area during the wet season sampling.

A secondary settlement pond was constructed in the north western corner of the site (Figure 4-20). This pond reduces sediment loads to manage water quality within Caley Valley. Plant species listed above have regenerated within the pond (see Photo 4-7). This settlement pond is non-remnant vegetation, but the species composition corresponds with RE 11.3.27.

Photo 4-7 Site 2: Settlement Pond looking north to beach – wet season

3. Beach ridge system on coastal sediments (11.2.5)

This unit is characterised by eucalypt/melaleuca woodlands on Quaternary coastal sediments. Soils tend to be sandy with organic matter present on the soil surface and in the A-horizon. Two sub-units of this vegetation type are defined for the X110 site, with these sub-units frequently merging with each other.

3a. *Corymbia tessellaris* woodland

The canopy of this subunit is characterised by a dominance of Moreton Bay ash *Corymbia tessellaris* woodland ± *Corymbia clarksoniana*. Canopy height is variable, but may range from 12 to 20 m. A moderately dense understorey is typically present and is composed of *Alphitonia excelsa*, *Planchonia careya*, *Pandanus spiralis*, *Melaleuca viridiflora* and *Cupaniopsis anacardioides*. A shrub layer is

present, characterised by *Acacia holosericea* and *Lantana camara* (lantana). Ground cover tends to be dominated by grass species and is variable in cover. The weeds rubber vine (**Cryptostegia grandiflora*) and lantana (*Lantana camara*) were frequently recorded throughout this sub-unit. The species composition, land form and soil type correspond with the broad description of RE 11.2.5 (VMA Status: Not of Concern). Survey sites 1, 3 and 5 are representative of this RE (see Photo 4-8).

Photo 4-8 Site 3: *Corymbia tessellaris* woodland

Site 3: Moreton Bay Ash *Corymbia tessellaris* woodland on western boundary of study area

Structural floristic species are consistent between the dry and wet season surveys. Ground layer was dominated by annual pasture grass species, introduced shrubs and herbs in the wet season. Weed species present include cobbler's pegs *Bidens pilosa*, buffel grass *Cenchrus ciliaris* and lantana *lantana camara*. Rubber vine *Cryptostegia grandiflora* is a major threat to this vegetation community within and surrounding the study area.

3b. *Melaleuca viridiflora* woodland

The canopy of this sub-unit is dominated by *Melaleuca viridiflora,* with occasional occurrences of *Pandanus spiralis*. Canopy tends to be dense with *Melaleuca viridiflora* and blue-leaved paperbark *Melaleuca dealbata* forming an almost mono-specific layer. Shrub layer and ground cover tends to be sparse. The species composition, land form and soil type correspond with the broad description of RE 11.2.5 (VMA Status: Not of Concern).

Site 1 is representative of this sub-unit (see Photo 4-9). This RE supports an increased sedge and herb layer in the ground strata in the wet season, compared to the dry season. These ground species were particularly evident where sunlight was reaching the ground, so distribution across the site was patchy.

* exotic/ non native

Additional ground species recorded in the wet season include *Cyperus involucratus*, sundew *Drosera indica*, *Fimbrystylis polytrichoides* and club sedge *Isolepis fluitans*.

Photo 4-9 Site 1: Melaleuca woodland on eastern boundary of study area

4. Beach scrub (11.2.3)

This unit is typically characterised by dry rainforest/vineforest species on soils derived from Quaternary coastal sands. The canopy of this unit is composed of a mix of species including *Mimusops elengi*, *Diospyros geminata*, and *Pleiogynium timorensis* among others. A tall shrub layer is commonly present, comprised of *Cupaniopsis anacardioides*, *Geijera salicifolia*, *Pavetta australiensis*, *Pouteria sericea*, *Drypetes deplanchei*, and *Eugenia reinwardtiana*. Vines are a conspicuous component of this vegetation community and include *Pleogyne australis*, *Tinospora smilacina*, and *Jasminum didymum*. The species composition, land form and soil type correspond with the broad description of RE 11.2.3 (VMA Status: Of Concern). The beach scrub is a very stable vegetation community exhibiting little change in structural species between the dry and wet season.

The beach scrub adjacent to the northern beach (see Photo 4-10) is unchanged in structure and floristics compared to the dry season sampling. There is a small increase in the species diversity and abundance in the ground strata. These include sedges and graminoids such as *Fimbrystylis bisumbellata* and right angle grass *Entolasia marginata*, respectively.

Photo 4-10 Site 7: Beach scrub on northern beach

5. Grassland/shrubland on rocky headland (11.12.16)

This vegetation unit is characterised by grassland and shrubland growing on a headland and on soils derived from granite. Grassland areas are dominated by *Aristida* spp., *Heteropogon contortus*, *Themeda triandra* and **Pennisetum ciliaris*. Patches of shrubs are present and were characterised by *Acacia salicina* and *Alphitonia excelsa*. The listed weeds *Cryptostegia grandiflora, Parkinsonia aculeata* and **Ziziphus mauritiana* were present in this vegetation type. The species composition, land form and soil type correspond with the broad description of RE 11.12.16 (VMA Status: Not of Concern).

Site 6 is representative of this vegetation unit (see Photo 4-11). The lower slopes of the western edge of this area is highly modified and dominated by Chinese apple *Ziziphus jamaicensis* and rubber vine, which have both increased in abundance since the dry season survey. Narrow-leaved ironbark *Eucalyptus crebra* is restricted to the top of the slope and is interspersed with Sally's wattle *Acacia salicina*. The ground stratum is dominated by pasture species including Bothriochloa species and scattered *Pterocaulon serrulata*.

Photo 4-11 Site 6: Coastal headland shrubland

6. Vine Thicket shrubland on rocky headland (11.12.4)

The area that corresponds to this vegetation community is located on the higher slopes of Abbot Point. Surveys were not completed within this area, as the community does not occur within the Project footprint.

4.10.2.4 Flora Species

DERM's Wildlife Online database identified 68 flora species previous recorded within the study area (Appendix E). The HERBRECS database lists 240 plant species that have previously been recorded within 2 km of the site.

During the dry season survey, a total of 67 flora species were recorded from the sites surveyed within the study area. The wet season survey recorded the presence of 137 flora species. The changes in species diversity recorded during the dry and wet season surveys are a result of the seasonal nature of the vegetation communities and habitats sampled. The most species diverse REs within the study area are the Melaleuca woodland on the eastern boundary (Sites 1 and 5) and the Moreton Bay ash woodland on the western boundary (Site 3).

A plant species list was generated for each sampling site (Appendix E). This included an assessment of the presence of conservation significant flora and declared weed species.

Conservation Significant Flora Species

The EPBC Protected Matters search tool identified one species of national conservation significance likely to occur within the study area, this being the Magnetic Island croton (*Croton magneticus*: listed as Vulnerable under the NCA and EPBC Act) (Appendix E).

The preferred habitat for this species is vine thickets on skeletal granite, limestone or sandstone soils, including rocky seashores. It has previously been recorded in isolated populations between Magnetic Island and Collinsville (Calvert *et al.* 2005). There is potential habitat for this species within the beach scrub (RE 11.2.3) vegetation community, however, this species has not previously been recorded on site (based on Wildlife Online and HERBRECS searches) and was not recorded during dry or wet season field surveys.

The HERBRECS database also records the occurrence of the rainforest cassia (*Senna acclinis*), which is listed as Rare under the *Nature Conservation (Wildlife) Regulation 1994*. The preferred habitat for this species is subtropical rainforests (Harden, 2002). This species is unlikely to occur within the study area as there is no suitable habitat.

Weeds

A weed is defined as any plant that requires some form of action to reduce its harmful effects on the economy, the environment, human health and amenity (Natural Resource Management Ministerial Council, 2006). Weeds have an adverse effect on an area's environmental values and ecological functioning due to:

- Competition with native species;
- Change in the structure and floristic diversity of a plant community;
- Repressing recruitment of native species;
- Changing the natural fire fuel characteristics, which can change the natural fire regime to the detriment of native species, often resulting in the loss of native species;
- Changing the food sources and habitat values available to native fauna, reducing some and increasing others;
- Potentially modifying geomorphological processes such as erosion; and
- Potentially leading to changes in the hydrological cycle.

Under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act), introduced species that represent a serious threat to primary industries, natural resources and the environment can be declared as Class 1, 2 or 3 Pests (see Table 4-25).

Weeds that cause detrimental impacts worth billions of dollars to the sustainability of Australia's productive capacity and natural ecosystems, have been endorsed by the Agricultural and Resource Management Council of Australia and New Zealand, Australia and New Zealand Environment and Conservation Council and Forestry Ministers as Weeds of National Significance (WONS).

Of the 137 plant species recorded from all sites surveys during the field inspections (Appendix E), six are either exotic or non-indigenous native species. Of these introduced species, four are declared under the LP Act, three of which are also WONS (Table 4-26).

Table 4-25 Priority pest and weed classes

Priority Class	Description
Class 1	A Class 1 pest is one that is not commonly present in Queensland and if introduced, would cause an adverse economic, environmental or social impact. Class 1 pests established in Queensland are subject to eradication from the State. Landowners must take reasonable steps to keep land free of Class 1 pests.
Class 2	A Class 2 pest is one that is established in Queensland and has, or could have, a substantial adverse economic, environmental or social impact. The management of these pests requires coordination and they are subject to local government, community or landowner-led programs. Landowners must take reasonable steps to keep land free of Class 2 pests.
Class 3	A Class 3 pest is one that is established in Queensland and has or could have a substantial adverse economic, environmental or social impact. Its impact, or potential impact, is considered to be less significant than that of a Class 2 pest.

Table 4-26 Declared plants listed under the *Land Protection (Pest and Stock Route Management) Act 2002* recorded from the Project site

Taxon	Common Name	Impact
Cryptostegia grandiflora (Rubber Vine)	Class 2 and Weed of National Significance	This plant is a vigorous climber that is invasive. Rubber vine's ability to spread and quickly colonise areas has led to it becoming a threat to many areas of northern Australia. Due to this ability, rubber vine is listed as a Weed of National Significance (Biosecurity Queensland, 2007a).
Parkinsonia aculeata (Parkinsonia)	Class 2 and Weed of National Significance	Parkinsonia can form dense, and often impenetrable, thorny thickets along watercourses and bore drains. Parkinsonia has been recognized as a Weed of National Significance (Biosecurity Queensland, 2007b).
Ziziphus mauritiana (Chinee Apple)	Class 2	Dense infestations create impenetrable thickets (Biosecurity Queensland, 2007c).
Lantana camara (Lantana)	Class 3 and Weed of National Significance	Lantana forms dense thickets that smother and kill native vegetation and are impenetrable to animals, people and vehicles (Biosecurity Queensland, 2007d)

4.10.2.5 Fauna Species

The study area contains a range of habitats which have varying levels of ecological significance to terrestrial fauna. Assessments identified seven fauna habitat types within the study area. These are described in Section 4.10.2.3. These habitats include open forests, woodlands, seasonal wetlands and coastal vine thickets and closely correspond to the vegetation communities already described. A description of the seven habitat types and their fauna values is provided in Appendix E. Generally,

habitats that support the greatest microhabitat diversity and structural complexity support the highest fauna species abundance. The coastal beach scrub and eucalypt open forest support the greatest structural and floristic diversity and this is reflected in the richness and diversity of the fauna species recorded. The melaleuca woodlands would provide a food source for nectar feeding species when in flower and during this time, would be locally important for those species.

Caley Valley Wetlands is recognised as an important site for waterfowl in north Queensland (Blackman *et al.* 1999). The seasonal wetlands located along the western margins of the study area provide a mosaic of wetland systems (sedge/grassland, open water and salt marshes) that would support species (providing both nesting and foraging resources) utilising the Caley Valley Wetlands. Waterbirds were the most conspicuous component of the fauna species present, particularly during the wet season when large flocks of birds were present.

The portions of Caley Valley wetland within the X110 study area have been extensively grazed and as such, contain limited structural complexity and a low habitat value.

In seasonal environments, rodents and other small mammals can exploit the increased ground cover and seasonal availability of food (for example seed) during the wet season. However, survey records indicate that trapping success was higher during the dry season. This is often the case in seasonal surveys, as during the dry season, food resources are more scarce and animals are more likely to seek out alternative food resources. During the dry season, animals also tend to constrict around available resource areas, such as any water bodies and streams, which can increase the number of observations.

Important Habitat Features and Wildlife Corridors

During surveys undertaken by GHD in 2008 (dry season) and March 2009 (wet season), a total of 153 bird species were identified in habitats across the broader Caley Valley Wetlands area. The Caley Valley Wetlands are discussed in further detail in Section 4.10.2.2.

The secondary settlement pond provides a mosaic of aquatic flora species and open water. During the wet season survey, large flocks of birds were observed. This area contains deeper water that persists into the dry season (see Photo 4-12). This would be important to local fauna that gather to available resources during the dry season (see Appendix E).

At a local scale, the coastal scrub habitat provides a semi-continuous tract of vegetation heading west between the Caley Valley Wetland and the beach.

Photo 4-12 Secondary settlement pond at Northern edge of existing APCT

Species Diversity

Species listed below have been gathered using existing reports and database searches, GHD surveys and opportunistic records from the site visits.

During fauna assessments, trapping and opportunistic records were undertaken in habitat types that were representative of those recorded within the study area. The survey provided records for 228 vertebrate fauna species which comprised 35 mammals, 34 reptiles, six amphibians and 153 birds. The opportunistic records from the study area identified two mammals, three amphibians, three reptiles and 40 birds. GHD also completed a second survey of the proposed MCF transport corridor, located on the eastern side of the Caley Valley Wetland during the survey period. As the two surveys were completed within close spatial proximity to each other (within 500 m), it is highly likely that species identified during the MCF transport corridor study would either utilise the study area as habitat and/or an additional foraging resource (particularly during onset and throughout the dry season when resources become more scarce). The difference in species recorded is likely to result from the spatial difference in survey effort and scale, ie: the MCF transport corridor study area is substantially larger than that for the X110 Expansion. The results from GHD's surveys in the area were largely consistent with previous surveys of the Caley Valley Wetlands and are summarised in Table 4-27. Results of this survey are contained at Appendix E.

Table 4-27 Overall Summary of Fauna Survey Results

Fauna Group	Database Records (Wildlife Online)	GHD Surveys (MCF Corridor)	Ecoserve Surveys (2007)	X110 Survey (Study Area)
Mammals	0	27 Dry, 10 Wet Total 30	19 Dry, 21 Wet Total 26	2 Dry, 2 Wet Total 2
Reptiles	0	19 Dry, 13 Wet Total 24	21 Dry, 21 Wet Total 29	0 Dry, 2 Wet Total 2
Amphibians	1	3 Dry, 5 Wet Total 7	5 Dry, 12 Wet Total 12	1 Dry, 2 Wet Total 3
Birds	118	111 Dry, 139 Wet Total 153	104 Dry, 149 Wet Total 164	40 Dry, 25 Wet Total 40

Bird surveys recorded 153 species present. Many of these species utilise a range of habitats and the species richness of each habitat type is provided below:

» Wetland: 54 dry season, 80 wet season: with a total of 85 birds;

» Open Forest: 52 dry season, 56 wet season: with a total of 62 birds;

» Grassland: 28 dry season, 30 wet season: with a total of 30 birds;

» Coastal waters: 4 dry season, 5 wet season: with a total of 5 birds;

» Foreshore: 1 dry season, 3 wet season: with a total of 3 birds;

» Woodland: 34 dry season, 34 wet season: with a total of 36 birds; and

» Littoral Rainforest (beach scrub): 21 dry season, 18 wet season: with a total of 18 birds.

As the surveys were located in close proximity to the study area, it is anticipated that all the species listed above would use the area either as fly over or foraging. There is suitable habitat for the wetland, open forest, grassland and woodland species within the study area. Most fauna species recorded in the study area are relatively common in the coastal, woodland and open-forest environments of the Brigalow Belt bioregion.

Fauna of Conservation Significance

Database searches, previous reports and field investigations identified twelve terrestrial fauna species (two mammal, one reptile and nine bird species) under the EPBC Act and NCA that have been recorded, or are predicted to occur within the study area. This excludes marine and migratory species, which are detailed separately in this VEA.

During recent field investigations, the following species were identified on site:

» Black necked stork (*Ephippiorhynchus asiaticus*): Rare under NCA, recorded at the settlement pond and Caley Valley Wetland. This was the only species of conservation significance recorded during the survey of the directly impacted area;

» Squatter pigeon (southern subspecies) (*Geophaps scripta scripta*): vulnerable under EPBC Act and NCA, observed in grassland and regrowth melaleuca communities at the western extent of the Caley Valley Wetland;

» Little tern (*Sterna albifrons*): endangered under the NCA: observed at the western extent of the Caley Valley Wetland; and

» Eastern curlew (*Numenius madagascariensis*): rare under the NCA; observed at the western extent of the Caley Valley Wetland.

Unrecorded Species of Significance

A wide range of existing sources of information were reviewed for this report. These provided records or predicted occurrences for a variety of conservation significant species. During the field investigation, the potential for these species to occur was assessed, based on available species habitat information and presence of suitable habitat on site. This assessment is provided at Appendix E.

The following species were not recorded by GHD but potentially occur at the X110 site, based on suitable habitat:

» Beach stone curlew (*Esacus magnirostris* – Vulnerable under NCA): this species was recorded in the broader area (Wildlife Online; Ecoserve, 2007) and suitable habitat exists within the study area;

» Australian painted snipe (*Rostratula australis* – Vulnerable under EPBC Act and NCA): this species has no previous records (Wildlife Online; Ecoserve 2007), however, suitable habitat exists within the study area;

» Australian cotton pygmy goose (*Nettapus coromandelianus albipennis* – Rare under the NCA): this species has no previous records (Wildlife Online; Ecoserve 2007), however, suitable habitat exists within the study area; and

» Sooty oystercatcher (*Haematopus fuliginosus* – Rare under the NCA): this species has no previous records (Wildlife Online; Ecoserve 2007), however, suitable habitat exists within the study area.

The following EPBC listed species of mammals are identified in the EPBC Online Database as potentially occurring within the study area.

» Coastal sheathtail bat (*Taphozous australis*): there are no roosting colonies of bat within the study development area and preferred habitat for this species does not occur within the study area.

» Striped tailed Delma (*Delma labialis*): the range of this species is listed as being north of Magnetic Island. As such, the study area is not within the documented range of this species.

Neither of these species have previously been identified on-site and were not identified during the most recent field survey.

Copies of the database searches are contained in Appendix E.

Migratory and Marine Species

The Australian Government has entered into three bilateral agreements to protect migratory bird species. These agreements are the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA) and the Republic of Korea-Australia Migratory Bird Agreement

(ROKAMBA). These agreements require that migrating terrestrial, water and shorebirds are protected by:

» limiting the circumstances under which migratory birds are taken or traded;

» protecting and conserving important habitats;

» exchanging information; and

» building cooperative relationships.

Migratory species are also protected under the Bonn Convention. This is an international convention on the Conservation of Migratory Species of Wild Animals (DEWHA 2008b).

All migratory bird species listed in the annexes to these bilateral agreements and conventions are protected in Australia as matters of National Environmental Significance under the EPBC Act.

Marine species include threatened marine mammals, marine birds, fish, turtles, and reptiles. Marine fauna are discussed in Section 4.11. Under Section 248 of the EPBC Act, bird species are listed as marine species if they naturally occur in a Commonwealth Marine Area.

Appendix E lists the migratory and marine bird species that have the potential to occur in the study area. During the field survey, the white bellied sea eagle (*Haliaeetus leucogaster*) was recorded flying over the shoreline of the coastal rocky hill and beach scrub habitats.

Eleven bird species listed as marine species under the EPBC Act have previously been recorded in the adjoining Caley Valley Wetland (Appendix E). The majority of these species were recorded within the secondary settlement pond with the remaining species recorded in the eucalypt open-forest habitats adjacent to the wetland environments. The occurrence of migratory and marine bird species in wetland and adjacent open-forest habitats, suggests such habitats are important as feeding and roosting resources for protected species all year round and gives value to these habitats on a regional scale.

Aquatic Fauna

No previous records of freshwater reptile species were identified from the desktop assessment.

Two species of freshwater turtle were recorded in the study area. An adult Rankin's turtle (*Chelodina rankini*- formally *Chelodina canni*) was found moving through the coastal scrub around the eastern side of the wetland. Rankin's turtle (*Chelodina rankini*) (Photo 4-13) is not a listed species under Queensland or Commonwealth legislation, though it is considered to have a restricted distribution (Cann 2008). Its current status is not well understood, though like other long-necked turtles, the drying of lagoons is expected to have a detrimental effect (Cann 2008).

A number of decomposing shells of freshwater turtles (including but not limited to the Eastern snake-necked turtle (*Chelodina longicollis*)) were found in the general study area, but outside the proposed X110 development area. This included:

» A collection of individuals in a pile adjacent to a fence, inland of the wetland during the wet season. The reason for these mortalities was not clear, however it is likely, given placement next to a fence in a pile, that they were prey of a predatory bird transporting the animals to a roost (on the fence) for feeding. This location of these shells is outside the study area of the X110 project, however the presence of the shells was identified by Traditional Owners during consultations and has therefore been noted.

» A number of individuals around the edges of the wetland water body, including the saline area. These mortalities could be attributed to individuals being washed down stream to saline areas during higher flows and being unable to navigate back to the freshwater environment, or, natural dry season mortality (such as mortality during migration between water bodies, susceptibility to predation in drier periods, degradation of habitat quality as a result of declining water quality), or mortality associated with habitat disturbance from feral pigs.

Turtle populations can experience mortalities during the dry season when aquatic environments become limited, especially in extreme dry periods. Many turtle species have natural movement behaviours as water bodies dry and alternative aquatic sources are sought. These turtle species are expected to utilise the wetland habitats throughout the wet season and either retreat to upper reaches of the adjoining waterways as the wetland dries, or utilise the moister vegetation communities (such as the coastal scrub) as refuge during this dry time.

No previous records of crustaceans were identified during the desktop assessment, however, during the field survey for the X110 project, two species of crab were observed in the upper wetland area. The fiddler crab (*Uca* sp.) and its burrows, were observed in high densities. A second species of shore crab (*Grapsidae sp.*) was less common. During consultation with Traditional Owners, it was noted that what is known as a 'coral crab' is often found in the area, however the coral crab is a marine species only occurring within coral habitat. It is though that this reference is actually to the *Grapsidae sp.*

Photo 4-13 Rankin's turtle (*Chelodina rankin*)

Pest and Feral Animals

Scats of the European rabbit (*Oryctolagus cuniculus*), a Class 2 declared pest under the LP Act, were located in the eucalypt woodland habitat of the study area. Although no other traces of this species were observed, it is suspected that the European rabbit is widespread throughout the other habitats of the study area, including wetland habitats during the dry season. Due to the disturbed nature of the surrounding landscape, it is likely that other pest and feral animal species, such as the house mouse

(*Mus musculus*), fox (*Vulpes vulpes*), pig (*Sus scrofa*), goat (*Capra hircus*), cane toad (*Rhinella marinus*) and wild dogs (*Canis familiaris*), are also present in the study area. These species have all been recorded within the study area in previous investigations (WBM 2006).

These pest and feral species are likely to reduce habitat availability and security for native ground dwelling fauna, particularly small ground mammals and birds, through competition of resources (rabbits, mice, cane toads), predation (foxes, pigs, cane toads) and habitat disturbance (cattle, goats, pigs).

4.10.3 Potential Impacts and Mitigation Measures

4.10.3.1 Overview

The X110 Project will result in a range of potential direct and indirect impacts on terrestrial ecosystems. This section outlines potential impacts during the construction and operation phases, which include:

- Loss of vegetation and habitat;
- Mortality of fauna;
- Disruption of wildlife behaviour due to construction activities;
- Increased predation and competition by/with exotic pest species.
- Restricted fauna movement; and
- Impacts on the Caley Valley wetland and the Beach Scrub TEC.

4.10.3.2 Loss of Vegetation and Habitats

Potential Impacts

Loss of vegetation results in direct and indirect impacts to vegetation communities and animal and plant species. These impacts are discussed in further detail below:

- Reduction in the extent of vegetation communities: this project will require the clearing of 58.1 ha of remnant vegetation, of which 48.19 ha is Not of Concern and 9.96 ha is Of Concern (Table 4-28). The areas to be cleared are located adjacent to existing infrastructure and some have been extensively grazed and invaded by weeds. With the exception of the two Of Concern REs (11.2.3 and 11.12.16), the clearing occurs within Not of Concern REs that are well represented in the area.
- Loss of individual species: no conservation significant plant species were identified during the surveys. Clearing will result in the removal of 'common' plants, however, removal of any native vegetation will require a permit under the NCA where the removal is not undertaken by the landholder; and
- Destruction of fauna habitat: vegetation clearing will also involve the removal of some hollow bearing trees (mostly located within RE 11.2.5), foraging habitat and micro-habitats. As detailed above, many of the habitats are well represented elsewhere in the area. Conservation significant species identified as either occurring or potentially occurring within the project area preferentially utilise Caley Valley wetland. The project will remove 12.21 ha (being RE 11.3.27x1c and 11.1.2b/11.3.27x1c) along the eastern boundary of the wetland, which due to its degraded state, offers low habitat value when compared to other areas within Caley Valley. The secondary settlement pond was noted as important wildlife habitat. As part of the proposed works, the capacity of the settlement ponds will increase

through the construction an additional settlement ponds in the south. This will provide an additional permanent water area during the dry periods and will likely provide valuable wildlife habitat.

Table 4-28 Areas of regional ecosystem that require clearing

RE ID	VMA Status	Amount present in the study area (hectares)
11.2.5	Not of Concern	35.98
11.3.27x1c	Not of Concern	5.77
11.1.2b/11.3.27x1c	Not of Concern	6.44
Sub Total	*Not of Concern*	*48.19*
11.12.16x1	Of Concern	9.62
11.2.3	Of Concern	0.34
Sub Total	*Of Concern*	*9.96*
Total		**58.15**

Mitigation Measures

Pre-construction

» Ensure all necessary permits and approvals are gained prior to the commencement of construction;

» Minimise vegetation clearing and habitat disturbance by avoiding vegetation clearing where possible, this may include actions such as:

  – designating areas for temporary laydown/stockpiles within existing cleared areas;

  – during detailed design select locations that avoid clearing, or are located adjacent to existing infrastructure to minimise fragmentation.

» Clearly identifying clearing boundaries in the field; and

» Installation of erosion and sediment controls to protect the surrounding native vegetation and Caley Valley wetland from potential sediment runoff (further details on management actions for water quality are contained in Section 4.6.2).

Construction

» Induction of works personnel on the environmental sensitivity of the surrounding habitats.

» Regular auditing of the Project's environmental performance;

» Avoid clearing hollow bearing trees and trees containing large nests where possible;

» Retain large hollow logs and cleared hollow bearing trees where possible to use in suitable rehabilitation activities; and

» Maintain erosion and sediment controls.

Operational Phase

» Ongoing audits of surrounding vegetation integrity, particularly the Caley Valley Wetlands and the beach scrub community;

» Rehabilitate disturbed areas where possible, particularly around wetland environments and habitats of moderate/high value;

» Limit access to areas of retained vegetation to reduce ongoing disturbance;

» Where possible, design future works within existing cleared areas;

» Undertake ongoing dust and water quality management to reduce the impact on retained vegetation; and

» Manage edge effects (See Section 4.10.3.5) to prevent further degradation of retained vegetation communities

4.10.3.3 Fauna Issues

Potential Impacts

The greatest potential for fauna injury or death is during vegetation clearing. Some mobile species, such as birds, may be able to move away from the path of clearing, whereas other species that are less mobile, or nocturnal animals that shelter in hollow trees and beneath rocks, logs during the day, are particularly at risk.

Mitigation Measures

Construction Phase

These impacts can be mitigated by:

» Ensuring a fauna spotter is located on site during all vegetation removal to identify, capture and relocate fauna from within areas of vegetation as they are cleared;

» Ensuring all native fauna is protected (including snakes) and not intentionally harmed as a result of construction works or worker actions;

» Developing a threatened species relocation plan to ensure individuals are relocated according to species requirements;

» Educating employees of environmental responsibilities during inductions; and

» Enforcing on-site speed limits to restrict the incidence of wildlife road kill.

Operational Phase

» Enforcing on-site speed limits to restrict the incidence of wildlife road kill.

4.10.3.4 Disruption of Wildlife Behaviour due to Light, Noise and Vibration Disturbance

Potential Impacts

The noise and vibration study (Section 4.13) predicted noise levels within the Caley Valley Wetland to range from 60 dB(A) near the port facility, to approximately 40 dB(A) near the southern extents. This represents an approximate 5 dB(A) increase when compared to noise level predictions for the X50 expansion during operation.

Noise from the port facility is constant in nature and wildlife in the area will likely adjust to the gradual increases in noise expected at the Abbot Point Coal Terminal. This is supported by the persistence of a diverse waterbird community on the eastern side of Caley Valley wetland. Nevertheless, it must be recognised that light and noise disturbance can have an impact on native wildlife if they restrict access to a limited resource or inhibit wildlife behaviours during a critical phase of the animals' life-cycle. Local wildlife resources that are particularly vulnerable to light and noise disturbance include:

» Nesting habitat for wetland birds in Caley Valley wetland (within the core habitat area adjacent to the Project);

» Nesting habitat for marine turtles: these are discussed in the Marine Ecology Chapter (Section 4.11);

» Feeding habitat for flying foxes in RE 11.2.5 *Melaleuca*; and

» Dry season drinking water sources (such as the settlement pond).

Mitigation Measures

Construction Phase

Develop a Construction Environmental Management Plan (CEMP) detailing all mitigation measures during the construction phase. Management actions for noise and vibration are provided in Section 4.13. In addition to these, the following should be considered:

» Where practical, limit construction during the primary breeding season (wet season).

Operational Phase

Management actions for operational noise and vibration are provided in Section 4.13. Should noise exceed predicted levels, the revised noise emissions will be assessed to determine whether the risk on native fauna is increased and appropriate corrective actions will be implemented.

4.10.3.5 Increased Predation and Competition by/with Exotic Pest Species

Potential Impacts

An increase in human activity is often associated with an increase in the abundance of introduced species. European rabbit (*Oryctolagus cuniculus*), house mouse (*Mus musculus*), fox (*Vulpes vulpes*), pig (*Sus scrofa*), goat (*Capra hircus*), cane toad (*Rhinella marinus*) and wild dogs (*Canis familiaris*), are present in the study area. It is important to ensure that populations of these feral predators does not increase.

Vegetation clearing can often lead to an increase in edge effects; changes in environmental conditions occurring along the edges of habitat fragments. These new environmental conditions along the edges can promote the growth of different vegetation types (including weeds) and allow invasion by pest animals specialising in edge habitats. Management of edge effects is particularly important in the beach scrub community, as this community is currently in good condition and contains few weeds.

Mitigation Measures

» Development of a weed management program to decrease weed population abundance due to propagules moving from cleared land into existing REs;

» Installation of sediment control measures will significantly reduce the potential of new and expanded weed populations to invade sensitive areas;

» Adaptive weed management strategies to be conducted where required, on the advice of a qualified personnel;

4.10.3.6 Restricted Fauna Movement

Potential Impacts

The proposed footprint is located adjacent to existing infrastructure and areas that have previously been cleared and as such, remnant vegetation will not be further fragmented by the proposed works.

A wildlife corridor exists along the coastline and the project will have a minor impact on this corridor due to the construction of the proposed jetty. As the jetty will be built off the ground and enable fauna to move beneath the structure, limited disturbance to wildlife movement is expected.

Mitigation Measures

Pre-Construction

» Design the jetty to allow for fauna movement; and

» Any proposed fencing should allow fauna movement along the coastal strip of vegetation.

Construction Phase

» During construction, restrict the extent of vegetation clearing along the coastal wildlife corridor to the minimal amount necessary;

» During construction of the jetty, temporary fencing should allow fauna movement, unless there are dangerous areas where fauna need to be excluded.

Operational Phase

» Revegetate areas not required for operational safety or security surrounding the jetty; and

» Consider movement along the coastal wildlife corridor with future detailed design.

4.10.3.7 Impacts on Caley Valley Wetlands

Potential Impacts

The Project has a range of potential direct and indirect impacts on Caley Valley wetland. Direct impacts resulting from the Project include:

» Minor vegetation and habitat clearance – the Project will affect approximately 12.21 ha of Caley Valley wetland. The mapped area of saltpan associated with the wetland is approximately 1,900 ha, therefore the area of filling equates to a reduction in the mapped extent of Caley Valley wetland of 0.64%. As previously detailed (Section 4.10.2.2), the project impacts on marginal areas of Caley Valley that are currently heavily grazed and highly disturbed. The areas to be impacted provide low habitat value and no nesting sites were observed during surveys. These areas provide additional foraging habitat. The vegetation and RE types (11.1.2/11.3.27) are well represented within the local area.

» Water quality/altered water regime - the impacts on water quality and water regimes of the wetland are detailed in Section 4.6.2. The area of wetland to be developed has been minimised as far as possible during the engineering design. In the context of the overall wetland, it is considered to be a small portion at the fringe of the wet season extent of the wetland and is expected to have minimal impact on the overall integrity of the habitat. The proposed stormwater management plan for the X110 expansion more than doubles the capacity of the existing system and sees the addition of a stormwater return dam for management of water from the Secondary Settlement Ponds which will further reduce the frequency of discharge. The increased capacity of the Primary and Secondary Settlement ponds will result in increased residency of water within the system prior to pump-out to the stormwater return dam or discharge to the wetland. The predicted changes identified are not expected to result in changes in water quality/regime that impact on the flora and fauna characteristics of the wetland.

» Impacts from dust - the most likely source of dust during the operational phase will be coal dust. Modelling results (presented in Section 4.12) demonstrate that the coal terminal is unlikely to cause adverse impacts at the nearest sensitive receptors. Compliance with the relevant air quality objectives is achieved at all sensitive receptors. Considering the conservative nature of the emission rates and ability to manage dust generating activities, the impact on local air quality due to the coal terminal expansion is likely to be low.

Mitigation Measures

» Implement management actions outlined in previous sections;

» During construction, the contractor will implement an environmental management plan to control erosion or construction runoff. Draft erosion and sediment control measures for the construction period are included in Section 5 of this report;

» Minimise the area of direct impact by clearly identifying the extent of the development area. High visibility tape, barricade webbing or similar should be utilised;

» Manage weeds within X110 site, along the boundary with Caley Valley to reduce the spread of weeds.

4.10.3.8 Impacts on the Beach Scrub TEC

Potential Impacts

The beach scrub (RE 11.2.3) is present as a narrow linear strip along the coastline. Works associated with the Project will remove 0.34 ha of beach scrub and vegetation currently acting as a buffer between the beach scrub and the adjacent land use.

Mitigation Measures

In order to mitigate the impact on the Beach Scrub TEC, clearing of remnant vegetation and habitat disturbance should be minimised by clearly identifying vegetation removal boundaries in the field. High visibility tape, barricade webbing or similar should be utilised. The coastal scrub habitat to the north of the settlement pond is particularly important, as this habitat maintains the ecological integrity of coastal and wetland habitats for migratory and marine birds protected under the EPBC Act.

Vegetation offsets will be provided for clearing of the beach scrub TEC in accordance with the Vegetation Management Act and as stipulated under the Policy for Vegetation Management Offsets. It should be

noted that offsets will only be accepted when all reasonable attempts have been made to avoid clearing or minimise impacts and that if offsets are required, they will need to be legally secured.

4.10.3.9 Pest and weed management

Potential Impacts

As identified above, there are a number of species identified on-site that are listed under the LP Act. The requirements for the management of pests and weeds listed under the LP Act are provided in Table 4-29.

Table 4-29 Priority pest and weed classes

Priority Class	Description
Class 1	A Class 1 pest is one that is not commonly present in Queensland and if introduced, would cause an adverse economic, environmental or social impact. Class 1 pests established in Queensland are subject to eradication from the state. Landowners must take reasonable steps to keep land free of Class 1 pests.
Class 2	A Class 2 pest is one that is established in Queensland and has, or could have, a substantial adverse economic, environmental or social impact. The management of these pests requires coordination and they are subject to local government, community or landowner-led programs. Landowners must take reasonable steps to keep land free of Class 2 pests.
Class 3	A Class 3 pest is one that is established in Queensland and has or could have a substantial adverse economic, environmental or social impact. Its impact, or potential impact, is considered to be less significant than that of a Class 2 pest.

Mitigation Measures

- Development of a weed management program to minimise potential for weeds spreading.
- Installation of sediment control measures to reduce the potential of new and expanded weed populations invading sensitive areas;
- Adaptive weed management strategies to be conducted where required, on the advice of a qualified personnel;
- Construction personnel to be instructed to appropriately dispose of waste on site to discourage the migration of exotic predators (foxes, cats, dogs etc) into the area; and

4.10.3.10 Legislative Requirements

As the Project involves the clearing of remnant vegetation, an operational works permit to clear native vegetation is required from DERM, unless exemptions are met under Schedule 8, Table 4 of the IPA.

Under the Queensland *Nature Conservation (Protected Plants) Conservation Plan 2000*, permits may also be required to remove protected species listed under the *Nature Conservation (Wildlife) Regulation 2006*, unless an exemption is granted to NQBP.

The eastern beach scrub site proposed for clearance may require offsetting under Queensland's *Native Vegetation Offsets Policy 2007*, dependent on existing exemptions. The quality of this vegetation is consistent with the beach scrub on the northern beach area.

A permit will also be required for the clearing of 'least concern' vegetation where it occurs on land not held under legal tenure by NQBP. This currently applies to clearing necessary to occur on the Collinta Holdings land comprising the western part of the study area (see Section 4.2.1.4).

4.10.3.11 Offsets

Offsets for this Project will be determined following detailed design and based on residual impacts, once all reasonable alternatives to avoid impacts have been investigated.

As the Project involves the clearing of remnant vegetation, an operational works permit to clear native vegetation is required from DERM, unless exemptions are met under Schedule 8, Table 4 of the IPA. In preparing the development application, the Project will need to demonstrate compliance with requirements for offsets under State legislation, specifically the:

» Management Code for the Brigalow Belt and New England Tablelands Bioregions (Department of Natural Resources and Water 2006); and

» Policy for Vegetation Management Offsets (Department of Natural Resources and Water 2007).

To meet the requirement of the State legislation, offsets will need to be established for clearing 'Of Concern' (11.2.3 and 11.12.16) and wetland REs (Caley Valley).

Environmental offsets for impacts on matters of National Environmental Significance (NES) may be used to maintain or enhance the health, diversity and productivity of the environment as it relates to NES. Environmental offsets are not applicable to all approvals under the EPBC Act and the requirement for offsets is assessed on a case by case basis. As offsets are already proposed for the beach scrub TEC (RE 11.2.3), these offsets could meet both Commonwealth and State requirements.