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Proposed Santos LNG Facility EIS – Marine Water Quality Assessments

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Proposed Santos LNG Facility EIS - Marine Water Quality Assessments

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Title :	Proposed Santos LNG Facility EIS - Marine Water Quality Assessments
Author :	Tony McAlister
Synopsis :	This report presents the methodology, data and findings of marine water quality assessments of the proposed Santos LNG facility at Gladstone.

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EXECUTIVE SUMMARY

This report presents the methodology, findings and key recommendations of a sub consultancy conducted by BMT WBM to URS Australia Pty Ltd (URS), on behalf of Santos Ltd (Santos). This work assesses salient marine water quality aspects of a proposed LNG facility intended for construction on Curtis Island at Gladstone. This is being referred to as the GLNG project, and this work will contribute to an Environmental Impact Statement (EIS) being developed by URS.

Key tasks undertaken as part of BMT WBM's study were as follows:

1 Collation and review of existing baseline water quality data;

2 The collection of additional locally specific baseline water quality and hydrodynamic data collection via two snapshot surveys conducted in 2008; and

3 Hydrodynamic and advection-dispersion numerical modelling to assess the potential impacts of the construction and operation of the proposed facility on receiving water quality.

Baseline existing water quality data collation and review

Key review outcomes were as follows:

- Port Curtis is a well connected estuary which allows dissolved material to be dispersed relatively evenly, however material does not as readily leave the estuary to the offshore environment. This reduced flushing time is likely to contribute to the anomalous bioaccumulation of some metals in biota of Port Curtis;
- The characters of the estuarine waters within Port Curtis are generally close to seawater.
- Nutrient, total organic carbon and biochemical oxygen demand concentrations appear generally low, consistent with high quality estuarine water;
- Water clarity as defined by Secchi disc visibility is generally poor, being less than 2 m. Similarly, turbidities and suspended solids concentrations are moderate. Turbidity increases with depth and tidal velocity;
- Low chlorophyll *a* concentrations characterise Port Curtis;
- Elevated metal concentrations can exist within the Port; and
- Trace element, cyanide and phenol concentrations do not appear to be elevated above typical seawater or the ANZECC guideline concentrations.

When compared with relatively stringent water quality guidelines, water quality is generally good, though spatially variable. Some metal concentrations are high in places, and water quality objective exceedances may occur at times.

Baseline water quality and hydrodynamic data collection

Two separate water quality and hydrodynamic field data collection snapshot surveys were undertaken in Port Curtis adjacent to the proposed LNG facility to collect locally specific data as follows:

- Campaign 1: 3rd to 7th February 2008; and
- Campaign 2: 4th to 8th June 2008.

The following suite of measurements was undertaken at each campaign:

- Tidal water levels;
- Tidal currents;
- Echo soundings;
- Boat mounted Acoustic Doppler Current Profiler (ADCP) transects of waterways proximate to the LNG facility site at varying stages of the tide;
- Hand held (YSI) physical water quality profiles; and
- Water quality grab samples (only during Campaign 2).

Key findings were as follows:

- Tides in the area are semi-diurnal and the (spring) tidal range is of the order of 4 metres, with significant wetting and drying of mangrove and inter-tidal areas occurring;
- The area of interest represents a high energy environment, with strong tidal flows dominating local hydrodynamics;
- Typical peak (spring) tidal velocities reach 1.2 to 1.3 m/s;
- Velocities are relatively uniform over the water column, however some evidence of vertical shear was found around areas of local bathymetric features;
- Tidal flows largely follow natural and constructed channels, with these locations consistently experiencing the highest velocities, as measured with ADCP transects;
- There is a local asymmetry in the magnitude of tidal velocities offshore from the proposed facility, with ebbing tides being characterised by greater velocities than flooding tides;
- Small tidal velocity reversals were noted on flood tides in the vicinity of the shoreline at the southern end of China Bay;
- Turbidity increases with depth and tidal velocity, most likely due to bottom sediment resuspension;
- pH and temperature are relatively uniform with depth (observed during both campaigns), with evidence of only slight thermal stratification;
- Salinity appears to be responsive to rainfall and associated inflow events; and
- Catchment-derived pollutants may enter the area (either locally or remotely) with freshwater inflows.

Hydrodynamic and Advection Dispersion Numerical Modelling

The study combined field assessments, mathematical modelling and expert interpretation in order to determine the significance of potential hydrodynamic and water quality changes and also to guide potential management action interventions. These assessments are discussed and documented below.

Hydrodynamic Impacts

The following features were included in the hydrodynamic mesh to represent proposed works associated with the GLNG project:

- Dredging of the Santos GLNG swing basin;
- Dredging of access channels to the Santos GLNG swing basin (and proposed jetty) from existing Gladstone shipping channels (Targinie Channel);
- Removal of shoals and other dredging works in and around the Clinton Channel;
- Construction of a proposed bridge from Friend Point/Kangaroo Island to Curtis Island, including relevant abutments; and
- An approach road to the above bridge which crossed intertidal mud flats was also included in a limited number of simulations.

The hydrodynamic impacts of the proposed works were found to be generally minimal, with the exception of in the immediate vicinity of the proposed dredged swing basin, where the significant dredging will reduce velocities quite considerably.

Tidal Flushing Impacts

Tidal flushing times for the pre and post GLNG cases were estimated. In most cases however, even though the model was run for a 45 day period, the required definitive 'e-folding' value (equivalent to 37% flushing) was not reached and as such definitive flushing times cannot be reported. What can be reported is that there were practically indiscernible differences in flushing behaviour with and without the GLNG project.

Reverse Osmosis Concentrate Discharge Impacts

Near and far field numerical modelling of the proposed discharge of a brine waste stream from a desalination facility associated with the project was undertaken. Both modelling activities found that there is unlikely to be detectable changes in local salinity due to this discharge.

Construction Stage Sediment Assessments

Sediment plume dispersion analyses were executed for representative swing basin dredging, bridge and pipeline construction activities using the far field model. Appropriate sediment resuspension rates were estimated for the scenarios.

In the case of swing basin dredging, greater concentrations were realised during neap tides, where dispersion was less as a result of reduced tidal velocities. An immediate impact zone of the order of several hundred metres in scale was identified during these times, and outside this area, maximum additional TSS concentrations of approximately 25 mg/L were predicted (over ambient). These values are in the order of the natural variability of TSS concentrations across the site. Concentration increases during spring tides were generally less than during neap tides.

Similar behaviour was observed in the model results for the bridge and pipeline construction scenarios. The immediate impact zones were again in the order of hundreds of metres in dimension during neap tides (and considerably smaller during spring tides) with maximum additional TSS concentrations outside this zone of 14 to 16 mg/L.

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ABBREVIATIONS

ACOM	Australian Community Ocean Model
ADCP	Acoustic Doppler Current Profiler
Al	Aluminium
ANOVA	Analysis of Variance
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
As	Arsenic
AWQG	Australian Water Quality Guidelines
C	Celsius
Cd	Cadmium
CDOM	Coloured Dissolved Organic Material
CMOS	Complementary metal–oxide–semiconductor
CN	Total Cyanide
CPU	Central Processing Unit
CQPA	Central Queensland Port Authority
Cr	Chromium
CRC	Cooperative Research Centre
CSG	Coal Seam Gas
Cu	Copper
DEH	Department of Environment and Heritage
DGT	Diffusive Gradient in Thin Films
DNR	Department of Natural Resources
DO	Dissolved Oxygen
EH	Ecosystem Health
EIS	Environmental Impact Statement
EPA	Queensland Environmental Protection Agency
F	Fluoride
Fe	Iron
GLNG	Gladstone Liquefied Natural Gas
GPCL	Gladstone Ports Corporation
L	Litre
LD	Less than Detection
LNG	Liquefied Natural Gas
LOD	Limits of Detection
Mg	Magnesium
mg	Milligram
Mn	Manganese
Mtpa	million tones per annum
N	Nitrogen
Ni	Nickel
NLWRA	National Land and Water Resources Audit
NSW	New South Wales
NTU	Nephelometric Turbidity Units
P	Phosphorus
PAH	Polyaromatic Hydrocarbons
Pb	Lead
PCIMP	Port Curtis Integrated Monitoring Program
QAL	Queensland Alumina Limited
QCL	Queensland Cement Limited
QHSS	Queensland Health Scientific Services
QLD	Queensland
QWQG	Queensland Water Quality Guidelines
RAM	Random Access Memory
RO	Reverse Osmosis
ROC	Reverse Osmosis Concentrate
Se	Selenium
SLERA	Screening Level Ecological Risk Assessment

STP	Sewage Treatment Plant
TBT	Tri-butyl Tin
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TSM	Total Suspended Inorganic Material
TSS	Total Suspended Solids
WCS	Worst Case Scenario
WICT	Wiggins Island Coal Terminal
WQO	Water Quality Objectives
YSI	Yellow Springs Instrument Company
Zn	Zinc
μg	Microgram

1 INTRODUCTION

This report presents the methodology, findings and key recommendations of a sub consultancy conducted by BMT WBM (WBM) to URS Australia Pty Ltd (URS), on behalf of Santos Ltd (Santos). This work assesses salient marine water quality aspects of a proposed LNG facility intended for construction on Curtis Island at Gladstone. This is being referred to as the GLNG project, and this work will contribute to an Environmental Impact Statement (EIS) being developed by URS.

2 PROJECT SCOPE AND ACTIVITIES

Key activities conducted as part of WBM's assistance on the GLNG EIS were as follows:

- Collate and review all relevant background marine water quality data (Section 4 of this report);
- Collect additional, locally specific, hydrodynamic and water quality data in those areas of Port Curtis adjacent to the proposed LNG facility (Section 5 of this report);
- Re-establish and refine (where necessary), pre-existing two-dimensional (2-D) hydrodynamic and advection dispersion models of Port Curtis and The Narrows (Section 6 of this report);
- Undertake several relevant impact assessments using these models and infer from the modelling results the potential marine water quality implications of several elements of the proposed GLNG operation (Section 6 of this report). These impact assessments have focussed on hydrodynamic and water quality impacts of the following aspects of the project:
  - dredging associated with the creation of shipping channels and swing basins to enable vessels to access the LNG facility;
  - construction of a bridge to Curtis Island from the mainland;
  - the generation of transient sediment plumes from dredging, bridge construction and laying/installation of a gas transmission pipeline across Port Curtis; and
  - the discharge of reverse osmosis concentrate (ROC) waters from desalination plants required to supply water to the proposed LNG facility.
- Propose, where relevant, appropriate mitigation measures to minimise any potentially adverse impacts which may be associated with the project (Section 7 of this report); and
- Document all work undertaken and findings for inclusion in the EIS.

3 PROJECT DESCRIPTION

A full description of the GLNG project is provided in Chapter 3 of the EIS report. For completeness, the following elements of the entire project which could have a potential water quality impact on Port Curtis, this being the zone selected as having 'marine' water characteristics for the purposes of the study, are summarised:

- the proposed location and orientation of the LNG facility and access road may affect local stormwater quantity and quality patterns, which could in turn affect water quality;
- any potential liquid waste streams (e.g. wastewater and ROC discharges) from the LNG facility could affect water quality;
- the location of the proposed access bridge from the mainland to Curtis Island could affect overall tidal water movement patterns, which could in turn affect marine water quality; and
- the development includes jetty facilities, dredging and a gas transmission pipeline water crossing, and hence there are potential direct (e.g. construction stage sediment plumes) and indirect (e.g. changes in tidal flushing) impacts on tidal hydraulics and water quality.

4 BASELINE DATA COLLATION/STATE OF PORT CURTIS WATER QUALITY

4.1 Introduction

4.1.1 Scope

This section addresses the relevant aspects and requirements of the Final Terms of Reference (August 2008) relating to marine water quality in Port Curtis for the EIS being prepared under the *State Development and Public Works Organisation (SDPWO) Act 1999*, associated with the Santos LNG Project at Gladstone.

The specific items from the Final Terms of Reference (Section 3.4.2.1, Marine Water and Sediments) addressed by this report include providing baseline information and environmental values on estuarine and marine water quality below the limit of tidal influence, in terms of;

- Heavy metals;
- Acidity;
- Turbidity;
- Oil;
- pH;
- Suspended solids;
- Nitrogen; and
- Phosphorus.

Section 2.3 and 2.4 of BMT WBM memorandum M.B16752.001.doc proposed to collate and review existing water quality data and undertake two water quality surveys. This report presents the results from these two water quality surveys undertaken by WBM and existing relevant water quality data for the Port Curtis region.

4.1.2 Brief Project Description

Santos Ltd proposes to develop a Liquefied Natural Gas (LNG) export facility at Gladstone in Central Queensland Australia. Figure 4-1 shows the location of the study site. The facility will allow Santos to liquefy the coal seam gas and export the gas in the form of LNG to overseas markets. The facility will initially be constructed to produce three to four million tonnes per annum (Mtpa) of LNG with the potential to expand to a nominal ten Mtpa.

The facility will be developed on Curtis Island in the Hamilton Point area in close proximity to the industrial deepwater port at Gladstone. The project will source gas from Santos' coal seam gas (CSG) fields around the Fairview, Arcadia Valley and Roma project areas, with gas being transported to the Gladstone LNG (GLNG) facility via a 425km subsurface gas transmission pipeline.

Title:

Study Area

Figure: 4-1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Approx. Scale

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4.1.3 Data Sources

The following data sources were reviewed and relevant data analysed to provide an account of the condition of water quality in Port Curtis;

- Department of Environment and Heritage and the Department of Natural Resources (DEH/DNR) (1999)
- Queensland Environmental Protection Agency (EPA) (2002-2008);
- National Land and Water Resources Audit (NLWRA) condition assessment reports (1998 and 2001);
- Connell Hatch Wiggins Island Coal Terminal Environmental Impact Statement (EIS) (2006);
- Geoscience Australia Australian Ports Literature Review (1998);
- Port Curtis Integrated Monitoring Program (PCIMP) Ecosystem health report card and Biomonitoring (2005, 2006 and 2007);
- Cooperative Research Centre (CRC) for Coastal Zone, Estuary and Waterway Management studies; and
- BMT WBM studies (1999, 2001, 2008).

A brief description of the data reviewed is provided in Table 4-1 below.

Table 4-1 Summary of data sources consulted

Source	Year	Location	Description
DEH/DNR	1992- 1996	Calliope River	Broadscale physicochemical monitoring
EPA	2002-2008	Calliope River	Physicochemical monitoring
NLWRA	1998 2001	Calliope River Fitzroy River Boyne River	Physicochemical and nutrients
Connell Hatch	2006	Calliope River	Physicochemical and nutrients
Geoscience Australia	1998	Gladstone Port	Turbidity, tidal regime, sediments and bedforms and seagrasses and biota
PCIMP	2005 2006 2007	Port Curtis	Pilot program conducted in 2005, expanded in 2006, monitored range of water quality indicators in nine major zones of Port Curtis
CRC	2003-2006	Port Curtis	Contaminants, spatial interpolation of water quality parameter distributions, remote sensing, biomonitors, DGT and oyster metals accumulation
BMT WBM	1999 2001 2008	Port Curtis	Review of existing water quality data Water quality profiles every 2 months from 1998-2000 Hand held physical water quality profiles and water quality grab samples

4.2 Water Quality Guidelines

The Queensland Water Quality Guidelines (EPA, 2006) provide guideline values for waters in this region (see Table 4-2) including those in Port Curtis and within adjoining waterways. It is likely that waters within Port Curtis would be classified as 'Enclosed Coastal Waters', while waters at the lower end of Boat Creek would be classified as 'Mid Estuarine' up to the point of the in-stream weir and upstream of this location, the waters would be classified as 'Lowland Stream'.

Table 4-2 Queensland Water Quality Guideline Values for waters in Study Area

Parameter	units	Water body type		
		Enclosed coastal	Mid Estuarine	Lowland Stream
Ammonia Nitrogen	µg/L	6	10	20
Oxidised Nitrogen	µg/L	3	10	60
Organic Nitrogen	µg/L	180	260	420
Total Nitrogen	µg/L	200	300	500
FRP	µg/L	6	8	20
Total Phosphorus	µg/L	20	25	50
Chlorophyll *a*	µg/L	2	4	5
Dissolved Oxygen (% saturation)	lower	90	85	85
	upper	100	100	110
Turbidity	NTU	6	8	50
Secchi	m	1.5	1	NA
Suspended Solids	mg/L	15	20	-
pH	lower	8	7	6.5
	upper	8.4	8.4	7.5

4.3 DEH/DNR (1999)

Broad scale physicochemical data for the Calliope River was collected by DEH and DNR water quality monitoring programs between 1992 and 1996, and compiled in the 1999 'Testing the Waters' report on the quality of Queensland's waters. DEH sites were monitored monthly while DNR sites were monitored quarterly. Parameters monitored in the Calliope River (monitoring sites in Figure 4-2) included dissolved oxygen, turbidity, total phosphorus, oxidised nitrogen and chlorophyll *a*. Results are summarised in Table 4-4.

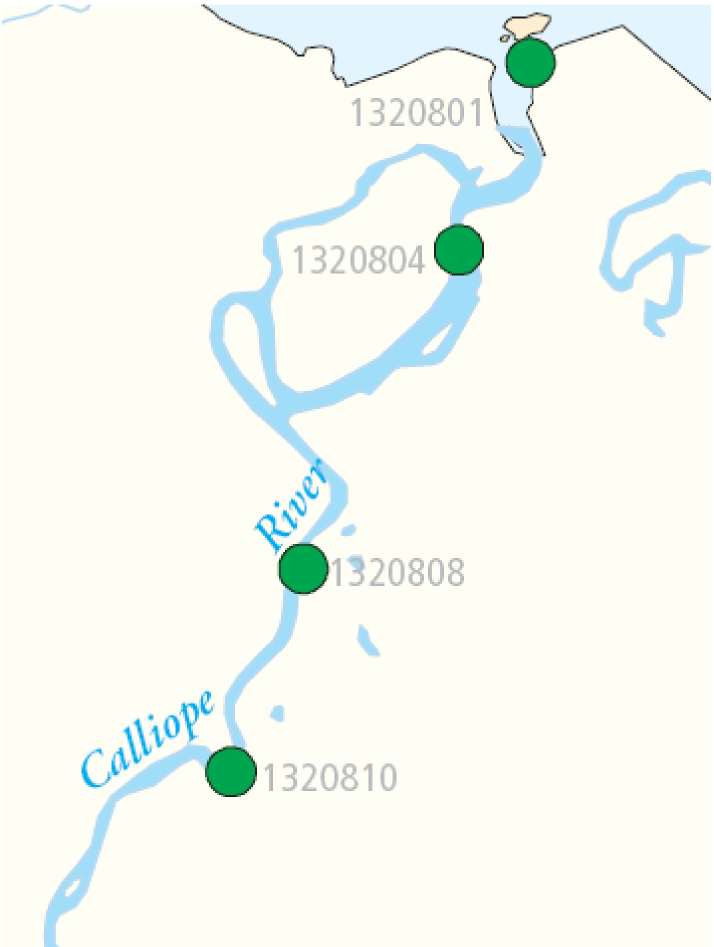


Figure 4-2 DEH/DNR water quality monitoring sites, Calliope River (DEH/DNR, 1999)

Median range guideline values for each water quality parameter were calculated and defined in terms of a category 1, 2 and 3; good, moderate and poor respectively (Table 4-3). If a median value from a monitoring site falls within this range of values, it is categorised as such. All sites in the Calliope River were classified as 'estuarine' and fell within the 'good' category for all parameters monitored (Table 4-4).

Table 4-3 Median range guidelines for surface water physicochemical indicators (DEH/DNR 1999)

Indicator		Quality Category		
		Good	Moderate	Poor
Dissolved Oxygen (% Saturation)	△ Freshwater ○ Estuarine □ Marine	>85 or <110 >80 or <110 >90 or <110	65-85 or 110–120 60-80 or 110–120 80-90 or 110–120	<65 or >120 <60 or >120 <80 or >120
Turbidity (NTU)	△ freshwater ○ Estuarine □ Marine	<5 <30 <10	5–50 30–80 10-30	>50 >80 >30
Oxidised N (µg/L N)	△ Freshwater ○ Estuarine □ Marine	<40 <40 <25	40–300 40–300 30–80	>300 >300 >80
Total P (µg/L P)	△ Freshwater ○ Estuarine □ Marine	<50 <50 <40	50–100 50–100 40–70	>100 >100 >70
Chla (µg/L)	△ Freshwater ○ Estuarine □ Marine	<2 <7 <3	2–10 7–15 3–6	>10 >15 >6

Table 4-4 Physicochemical monitoring results (DEH/DNR, 1999)

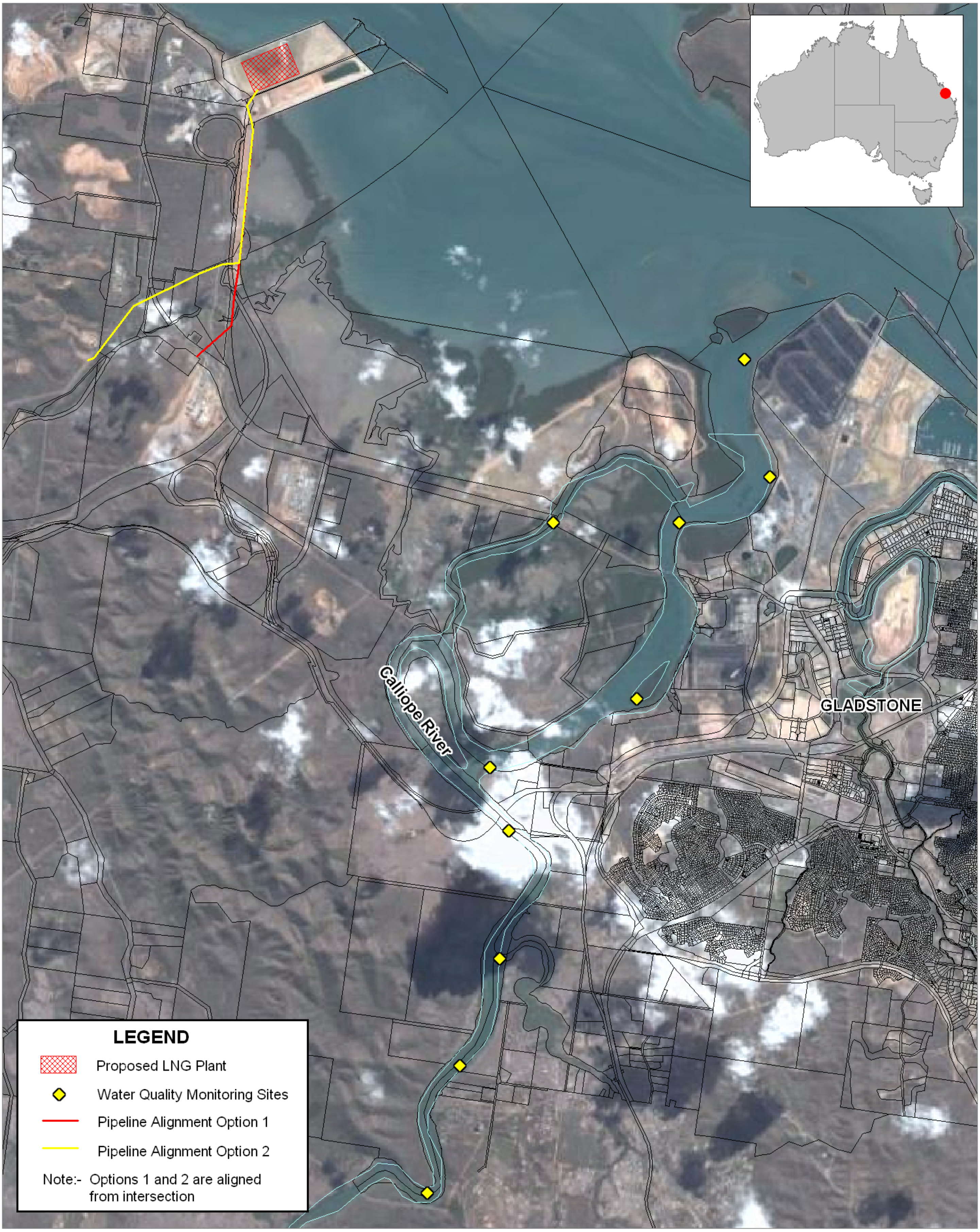
Parameter	QWQG	Site			
		1320801	1320804	1320808	1320810
Dissolved Oxygen (% saturation)	85-100	>80 and <110	>80 and <110	>80 and <110	>80 and <110
Turbidity (NTU)	8	<30	<30	<30	<30
Total Phosphorus (µg/L)	25	ID	ID	<50	ID
Oxidised Nitrogen (µg/L)	10	ID	ID	<40	ID
Chlorophyll *a* (µg/L)	4	<7	<7	<7	<7

ID: insufficient data

From this monitoring it can be seen that the water quality in the Calliope River is generally 'good'. The relevancy of this data to this particular study is mostly concerned with the site at the mouth of the Calliope River, as this site is within Port Curtis. The data also suggests that the Calliope River does not directly contribute to any high levels of turbidity, TP, NOx or Chlorophyll *a* in Port Curtis.

4.4 EPA Water Quality Monitoring (2002-2008)

Available water quality information at the nearest Environmental Protection Agency (EPA) monitoring sites in the Calliope River (Figure 4-3) was sourced from the EPA. A summary of data has been provided in Table 4-5. The sites within the Calliope River would be considered estuarine. Table 4-5 shows that the majority of water quality parameters within the Calliope River comply with Queensland Water Quality Guidelines (QWQGs), with the exception of turbidity, which exceeds the QWQG of 8 NTU at all sites.



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EPA Water Quality Monitoring Sites on the Calliope River

Figure: 4-3

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Table 4-5 EPA Water Quality Data for sites in the Calliope River (2002 to 2008)

Parameter	QWQG	0km		1.6km		3.2km		4.8km		6.4km		11.3km		12.9km		14.5km		16.1km		Anabranch	
		n	median	n	median	n	median	n	median	n	median	n	median	n	median	n	median	n	median	n	median
Chlorophyll-a (ug/L)	4	57	1.5	0		56	2.0	0		0		0		58	2.8	0		56	4.0	0	
Conductivity at 25 deg C (mS/cm)	NA	70	55.4	70	55.3	69	55.3	69	55.1	69	54.5	69	54.4	69	53.4	68	52.4	68	51.3	70	55.3
Light penetration (Secchi depth) (metres)	1	69	1.1	69	1.0	68	1.0	68	1.0	68	1.0	68	0.9	66	1.0	67	0.9	68	0.8	69	0.7
Nitrogen (ammonia) as N (mg/L)	0.01	0		0		0		0		0		0		49	0.01	0		0		0	
Nitrogen (organic) as N (mg/L)	0.26	0		0		0		0		0		0		69	0.18	0		0		0	
Nitrogen (oxidised) as N (mg/L)	0.01	0		0		0		0		0		0		42	0.02	0		0		0	
Nitrogen (total) as N (mg/L)	0.3	0		0		0		0		0		0		70	0.19	0		0		0	
Oxygen per cent saturation (%)	85 to 100%	70	97	70	97	69	98	69	98	69	97	69	97	69	97	68	97	68	95	70	96
pH (Unit)	7 to 8.4	70	8.0	70	8.0	69	8.0	69	8.0	69	8.0	69	8.0	69	8.0	68	8.0	68	7.9	70	8.0
Phosphorus (dissolved reactive) as P (mg/L)	0.008	0		0		0		0		0		0		52	0.005	0		0		0	
Phosphorus (total) as P (mg/L)	0.025	0		0		0		0		0		0		70	0.019	0		0		0	
Temperature (deg C)	NA	70	26.3	70	27.3	69	28.3	69	28.6	69	28.5	69	28.1	69	27.2	68	26.7	68	26.5	70	27.9
Turbidity (NTU)	8	69	10.0	69	9.0	68	11.5	68	12.0	68	11.7	68	10.0	68	10.0	67	12.0	67	14.0	69	16.0

Notes: n is the number of samples; all samples collected at 0.2m depth below water surface; all distances are from mouth of river, Anabranch is 2.8km from mouth of river; highlighted cells represent exceedances of the water quality guidelines

4.5 National Land and Water Resources Audit (1998 and 2001)

The following data was gathered as part of the National Land and Water Resources Audit (NLWRA; 1998) and was sourced through the Ozcoast and OzEstuaries search facility.

Data includes estuary location and geometry (length, width, perimeter); catchment and water areas; estuary condition and classification; wave height, period, range and type; and habitat areas. All available water quality data for the Port Curtis region is summarised in Table 4-6.

Table 4-6 Summary of estuary assessments in the study area, median values (NLWRA, 1998 & 2001)

Parameter	Calliope River			Fitzroy River			Boyne River		
	Head	Middle	Mouth	Head	Middle	Mouth	Head	Middle	Mouth
Chlorophyll *a* (µg/L)	3.5	2.4	1.6	2.4	2.3	ND	2.2	1.2	0.8
Turbidity (NTU)	9	14	12	27	39	119	5	2	3
Secchi depth (m)	ND	0.5	0.7	ND	ND	ND	0.5	0.8	1.0
Dissolved Oxygen (% sat)	88	93	93	88	87	91	82	81	91
Ammonia (µg/L) Average	11			8			10		
Oxidised Nitrogen (µg/L) Average	7			265			6		
Phosphate (µg/L) Average	10			81			5		

ND: No Data

4.6 Connell Hatch Wiggins Island Coal Terminal EIS (2006)

A component of the EIS undertaken by Connell Hatch in 2006 dealt with water quality aspects of the area surrounding Wiggins Island. Three data sets were obtained to assess water quality in the Calliope River and mouth of the river in Port Curtis. Previous water quality monitoring undertaken by GHD (Appendix A) and EPA (Appendix B) were combined with water quality data collected by Connell Hatch in the wet and dry seasons of 2006.

The GHD study (monitoring sites in Figure 4-4) revealed that physicochemical parameters were within natural ranges with parameters varying over the course of the eight week monitoring program with no identifiable trend. Slightly elevated turbidity was recorded at all sites and was thought to be attributable to a combination of the nature of the substrate composition, runoff from residential developments and construction activities on the mid-upper catchment and natural resuspension of sediments by tidal action (Connell Hatch, 2006).

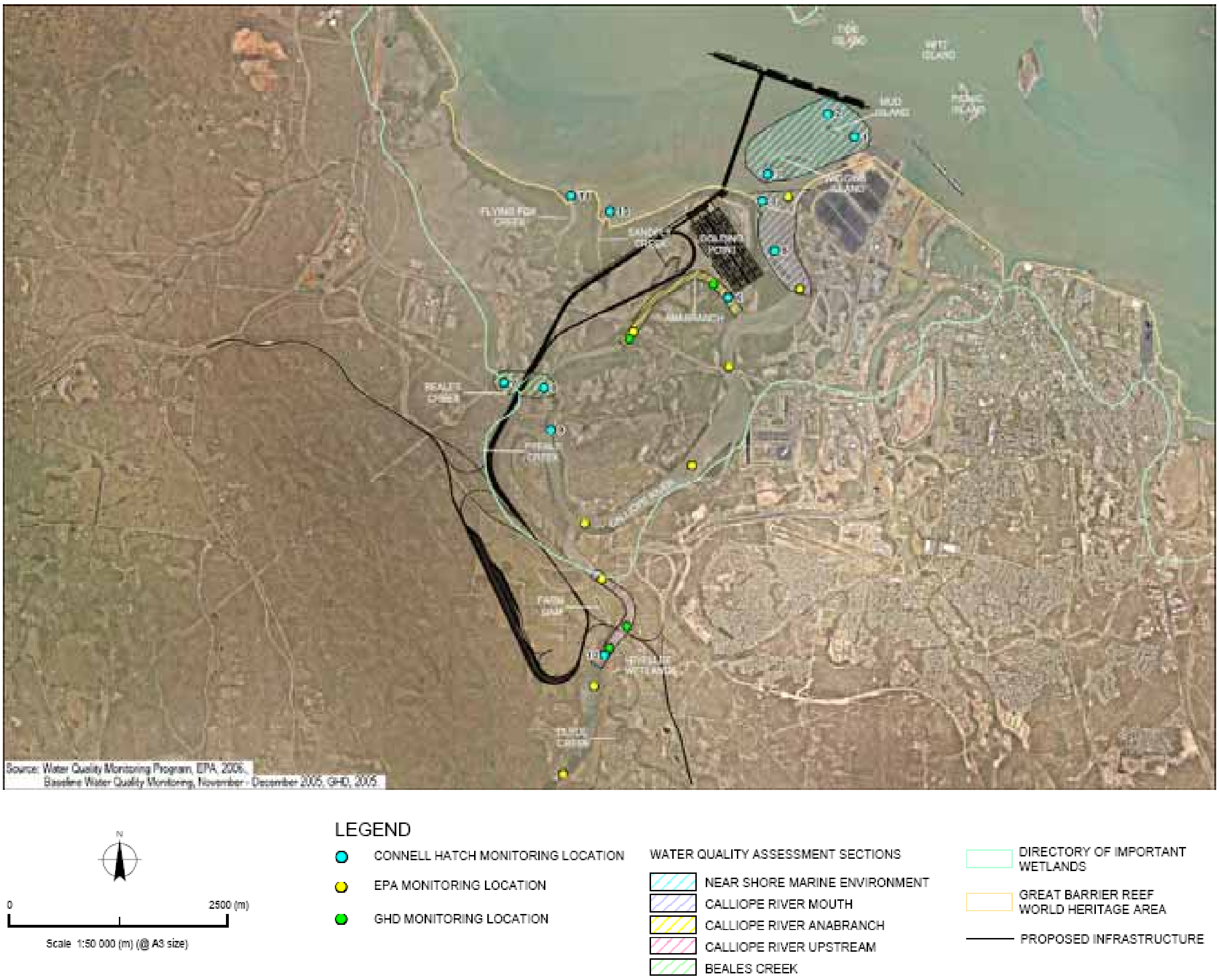


Figure 4-4 Connell Hatch Water Quality Monitoring Sites (Connell Hatch, 2006)

Monitoring sites were grouped into sections (Table 4-7) according to areas potentially affected by the Wiggins Island Coal Terminal Project.

Table 4-7 Description of Connell Hatch Water Quality Monitoring Locations (Connell Hatch, 2006)

Section	Description	Characteristics
Section 1	Near Shore/ Marine Environment	Sites in Section 1 are in the intertidal, marine areas adjacent to Wiggins Island and Mud Island. The near shore waters of this area are primarily intertidal, with large tracts of exposed substrate during low tides.
Section 2	Calliope River Mouth	Sites in Section 2 were targeted within the mouth of the Calliope River adjacent to the proposed stockyard. This section included sites monitored by Connell Hatch and the EPA.
Section 3	Calliope River Anabranch	Sampling in Section 3 was undertaken at a downstream and an upstream site (downstream of the Calliope River Oxbow/Anabranch junction and upstream of the Calliope River/Anabranch junction). A large area of reclamation will be undertaken directly adjacent to this watercourse that will be utilised for the rail loop and holding yards. This section included sites monitoring by Connell Hatch, the EPA and GHD.
Section 4	Calliope River Upstream	Sites in Section 4 were sampled downstream and upstream of the proposed rail crossing bridge. Sites consisted of Connell Hatch, EPA and GHD monitoring locations.
Section 5	Beales Creek	Section 5 assesses the water quality of Beales Creek. This tributary of the Calliope River Anabranch has been targeted due to the potential developed nature of this creek and the proposed reclamation and rail line crossing.

Flying Fox Creek and Sandfly Creek, each of which discharges into Port Curtis, were not targeted as part of this EIS. These creeks can be defined as tidal creeks, which function primarily as a result of tide energy. These systems drain approximately 500ha of marine communities and tidal flats within and adjacent to the proposed project area.

4.7 Australian Ports Environmental Data and Risk Analysis Literature review (1998)

4.7.1 Port of Gladstone

Gladstone Port Authority (GPA) compiled a report in 1998 summarising available water quality data and hydrology information for use within a Geoscience Australia and Australian Ports Environmental Data and Risk Analysis Literature Review.

4.7.1.1 Turbidity

GPA continuous monitoring systems showed turbidity in the harbour at Clinton and Boyne Island Wharves to range from 30-40 NTU during Spring tides and 1-5 NTU on Neap tides

4.7.1.2 Tidal regime

Mean spring tidal range at Gladstone is 3.3m. Tides are semidiurnal with a small diurnal inequality. Spring current speeds of 1.75 m/s are evident in the main shipping channel in the port area (GPA, 1998).

4.7.1.3 Sediments and bedforms

Surficial sediments within 10km of Gladstone are characterised by quartzose benthic foram moderate to poorly sorted sand, high in feldspar and rock fragments (Harris and O'Brien, 1998).

Seabed undulations are likely to be common in Curtis Channel due to the strong tidal currents. Dunes 4 to 10m in height and 250 to 1200m in wavelength, occur with crestlines trending northwest. At the northern end of Curtis Channel, Marshall (1977) described a field of large dunes in 70 to 80m water depth. The dunes are 2 to 20m in height (significant wave height of 11m) and most have a wavelength of between 200 to 500m. Dune asymmetries indicate east-west transport. Marshall (1977) suggests that the dunes are moribund (formed in relation to a lower sea level and no longer active) based on hydrodynamic evidence and as sediments from the adjacent reefs appear to be prograding over the dune deposits (Harris and O'Brien, 1998).

Gladstone Port Authority's analysis of dredged material from the harbour revealed the sediment to be composed of <6% mud and <7% gravel (Harris and O'Brien, 1998).

Aerial photographs show dunes associated with East Bank extending offshore from Gatcombe Head, and superimposed on an ebb tidal delta extending about 3 km offshore from Colosseum Inlet. The banks may provide a source of sediment to the dredged section of the shipping channels (Harris and O'Brien, 1998).

4.7.1.4 Seagrasses and biota

Lee Long *et al.* (1993) reported 17.17 km2 of seagrass beds in Gladstone Harbour. Port Curtis is also fringed by intertidal zones with mangroves and salt flats, having areas in 1989 of 3264 ha (mangroves) and 2824 ha (salt flats). These areas have been reduced by about 21% since 1941 by coastal development (QDEH, 1994).

Saenger et al. (1980) studied the macrobenthos of the Calliope River. A similar study on the macrobenthos of Port Curtis by Walker and McNamara (1998) tabulated the abundances of polychaetes, crustaceans, bivalves, gastropods and other taxa. Generally, the muddier, fine-grained sediments were found to support the greatest diversities of macrobenthic invertebrates (Walker and McNamara, 1998).

4.8 Port Curtis Integrated Monitoring Program (PCIMP)

4.8.1 Ecosystem Health Report Card

The PCIMP is a stakeholder representative group that has developed a collaborative monitoring program for the management of the ecological health of Port Curtis. Stakeholders (mostly industry) fund the PCIMP, and the majority of the information provided by the program is returned to these stakeholders and is not available to the general public. In some instances, the data collected by the PCIMP meets the statutory monitoring/reporting needs of the EPA and information collected by the program is provided to the EPA to satisfy these needs.

The PCIMP was launched in 2006 after completion of a pilot program in 2005. The PCIMP currently has four major monitoring themes including:

- Water quality including bio-monitoring;
- Seagrass Health;
- Oil Spill Assessment; and
- Intertidal Monitoring.

Data obtained through the 2005 and 2006 monitoring exercises has been incorporated into the program's inaugural Ecosystem Health Report Card, which was released in 2007. As such, the report card provides no specific data, rather it provides data that has been synthesized according to methodologies detailed in the report card to provide an interpretation of ecosystem health.

Information provided in the report card data is divided into nine monitoring zones across the study area (which stretches from the Narrows in the north, to Colosseum Inlet in the south and 3km out into the open ocean from the ocean passages between Curtis and Facing Islands and Facing Island and the mainland). Of interest to this investigation is 'Zone 2' or 'Inner Harbour' which is centred on the existing Fisherman's Landing reclamation area.

Under the four monitoring themes, Table 4-8 overviews the monitoring parameters assessed.

Table 4-8 PCIMP Monitoring Parameters

Water quality	**Intertidal monitoring**
pH, dissolved oxygen, temperature, oxidation reduction potential, specific conductivity, turbidity, light attenuation, fluoride, nutrients (total phosphorus, orthophosphate, ammonia, nitrate, nitrite, total nitrogen and total Kjeldahl nitrogen) Biomonitoring (Oyster bioaccumulation- 17 metals and fluoride in oyster shells and diffuse gradients in thin films- 10 metals)	Sediment characterisation, particle size, moisture and porosity, total organic carbon; Contaminants (17 metals, 19 Poly Aromatic); Hydrocarbons (PAHs) and fluoride; Intertidal macroinvertebrates (abundance, diversity and species richness); Mangrove condition (species diversity, tree density and biomass, projective foliage cover, seedling density and biomass, crabhole density, metals in mangrove roots)
Seagrass Health	**Oil Spill Assessment**
Meadow area, biomass, species composition, temperature, turbidity, light, amphipod abundance and diversity	Similar parameters to Intertidal monitoring

To provide an assessment of the ecosystem health of a monitoring zone, Ecosystem Health (EH) and Worst Case Scenario (WCS) values were derived. The EH values are defined in the report as being mostly, ANZECC/ARMCANZ (2000) water quality or ANZECC/ARMCANZ (2000b) sediment quality trigger values (TV) for data specific to estuarine ecosystems of tropical Australia for the protection of 99% of species. WCS values were derived using 90% protection levels from the same guidelines. In all cases where trigger values were not available information, these were derived from local reference data.

Monitoring values were then provided a standardised score by application of the following formula:

Standardised score = 1 – (Recorded Value – EH)/(WCS – EH)

Thus values near or above 1 represent values near or above the desired result (i.e. near guideline values). Values less than 1 represent recorded values deviating from the guideline values. The standardised scores for all parameters were then combined and an average standardised score and an average lowest standardised score were presented in the report card as ‘Rating Scores’.

Based on the monitoring data obtained in 2005 and 2006, the Inner Harbour zone achieved an overall Grade of B+ with a lowest score grade of B and a highest score grade of A. In relation to particular performance categories, the following rating scores were achieved:

- Water Chemistry, Average 0.96, Lowest 0.76;
- DGT-Labile Metals, Average 0.9, Lowest 0.61;
- Oyster-Labile Metals, Average 0.87, Lowest 0.67;
- Sediment Metals, Average 0.95, Lowest 0.79;
- Sediment PAHs, Average 1.00, Lowest 1.00; and
- Average Total Score, Average 0.94, Lowest 0.77.

Turbidity for Port Curtis is mapped in the PCIMP EcoCard as shown in Figure 4-5. Lower pH and higher turbidity tended to occur in the more estuarine sites, particularly in shallow mangrove lined upper estuaries.

The majority of parameters monitored in Port Curtis were below ANZECC guidelines for protection of 95% of species and no parameters excessively exceeded the guidelines in any of the zones.

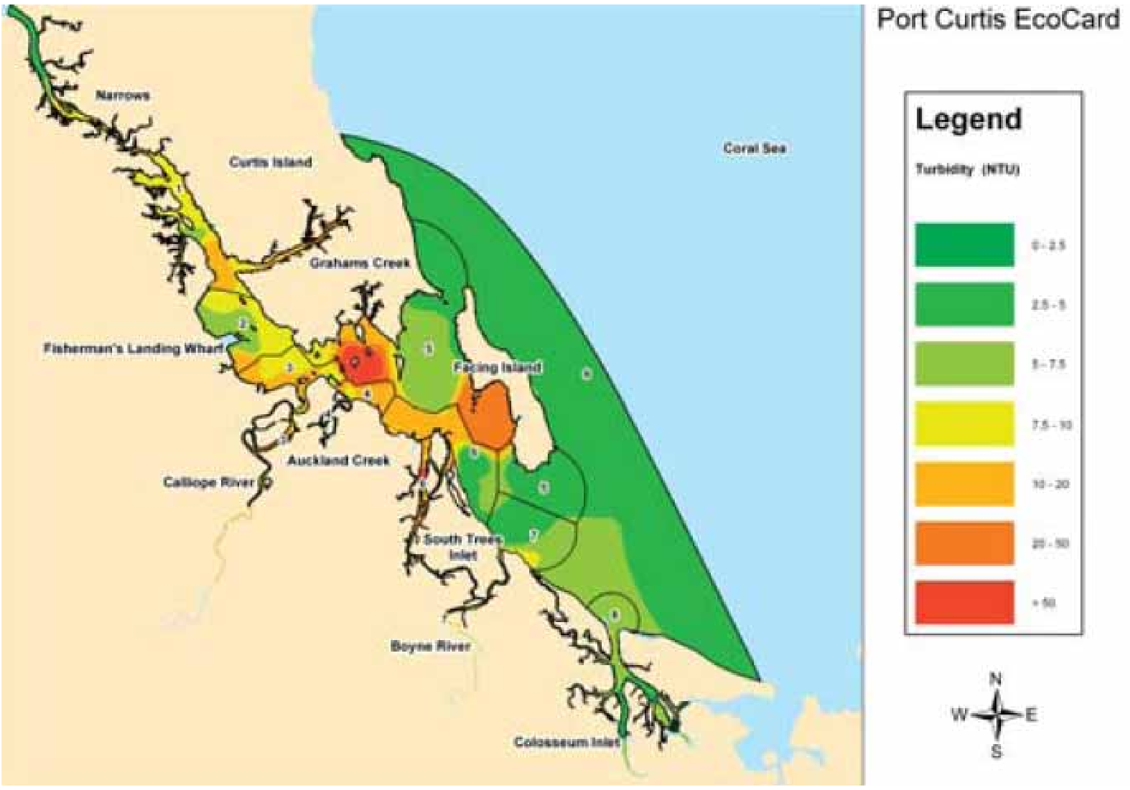


Figure 4-5 PCIMP turbidity EcoCard (Storey *et al.*, 2007)

The report card notes that there are two licensed discharge points associated with the Fisherman's Landing wharf including Rio Tinto Aluminium (Yarwun) and the Trade Waste Outfall. The report also provides a summary of results obtained. In this summary it notes,

> *"The low scores can be mainly attributed to conditions in Boat Creek, which does not receive licensed discharges from any of the surrounding industries. Similar to other mangrove lined estuaries, Boat Creek tended to have lower pH and higher turbidity, coupled with much lower DO in the upper estuary. As with other zones in Port Curtis, total phosphorus was moderately elevated in this zone. Most of the elevations for aluminium, copper, cobalt and manganese in DGT (refer section 4.8.2) that were observed in this zone could be attributed to conditions in Boat Creek. They may also be influenced by the low DO coupled with lower pH, assisting these metals to become more bio-available. Copper, nickel and zinc uptake in oysters, however, was noted across the whole zone. Although some metals in sediment were elevated compared to the background estuarine reference zone (cobalt, copper and cadmium), all metals were below recommended guidelines. Sediment PAHs were of low concentration and scored well."*

Overall, the report card highlights the generally good environmental health of the zone, but did identify some potential issues with Boat Creek.

4.8.2 DGT Technique

The following biomonitoring programs utilise the Diffusive Gradient in Thin-films (DGT) technique for metals analysis. The following is a brief description of the DGT technique as explained in the PCIMP 2006 biomonitoring report:

'The DGT technique was first developed by Davison and Zhang (1994) as a time integrated, in situ speciation measurement of heavy metals in waters. Since its introduction it has been validated in the field for the determination of metals in fresh (Denney et al., 1999) and coastal waters (Dunn et al., 2003). The DGT technique is based on a simple device, which accumulates metal ions in a well-defined manner from solution. Soluble species diffuse through a layer of known thickness. Behind this diffusive layer is a binding layer in which reactive metal species are rapidly and irreversibly bound (Figure 4-6), thereby maintaining a concentration gradient within the diffusive layer. The mass of accumulated metal is measured following retrieval and is used to calculate the average concentration of DGT-labile metal species in the measured water over the deployment time using the DGT equation, which is derived from Fick's First Law of Diffusion (Teasdale et al., 2002). As the device does not accumulate the major ions that cause interference with most elemental measurement techniques, the DGT measurement does not suffer the degree of interference often associated with the direct analysis of saline waters. In accordance with the ANZECC/ARMCANZ (2000) water quality guidelines, DGT may be used as a speciation measurement to provide a better estimate of the reactive metal concentration if the total and dissolved metal concentrations exceed the guideline trigger values (Teasdale et al., 2002)'.

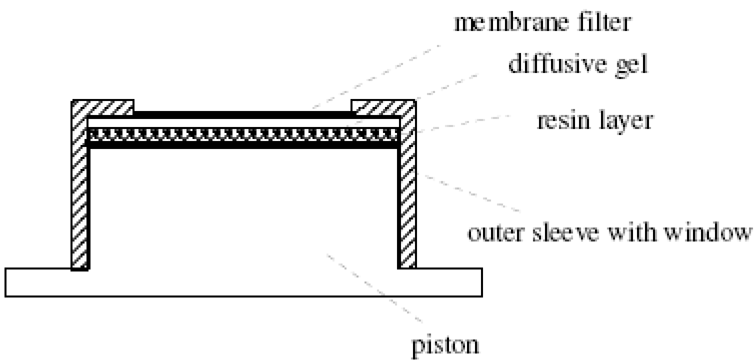


Figure 4-6 Cross section through a DGT device (Anderson *et al.,* 2006)

4.8.3 Biomonitoring 2005

The 2005 Biomonitoring study included measurement of physicochemistry, and metals using two techniques; DGT (passive samplers) and transplanted oysters. The main advantage of these techniques is that they 'capture' pulse discharges of contaminants, whereas spot measurements of water quality may miss such events (Anderson *et al.,* 2006).

4.8.3.1 Zones and monitoring sites

Port Curtis harbour was divided into areas relevant to the interests of each PCIMP industry participant in addition to the reference areas. Sites representing areas of site-specific interest to each participant were selected based on past sampling or previously discussed sampling strategies. Participants each sponsored an extra site in the main harbour as a contribution to the general PCIMP report card.

The following results report on data collected from CQPA sponsored sites and reference sites; sites C2 and C3 sponsored by CAR; site N2 sponsored by NRG; site Q1 sponsored by QAL, and site B7 sponsored by BSL. Sites included in the CQPA reports were selected along two transects; a north south and an east west, covering the inner to outer harbour areas (Figure 4-7).

All sites were then allocated to zones within the harbour based on geographical location, knowledge of hydrodynamic flows within the harbour and contaminant results from previous studies. This resulted in 19 zones across the harbour including estuarine and oceanic reference zones (Table 4-9).

Table 4-9 PCIMP zones and transects within Port Curtis (Anderson *et al.*, 2006)

Zone No.	Zone name	Transect No.	Transect name
1	Narrows	1	Targinnie
2	Grahams Creek	2	Grahams
3	Inner Harbour – Fisherman's		
4	Boat Creek	4	Boat Creek
5	Wiggins Island		
6	Calliope Anabranch	6	Anabranch
7	Calliope River	7	Calliope
8	Auckland Creek	8	Auckland
9	Mid Harbour		
10	Inner Harbour – Sth Trees		
11	South Trees – North		
12	Wappentake Creek	12A	Wappentake Nth
		12B	Wappentake Sth
13	South Trees – Mid	13	South Trees
14	South Trees – South		
15	Spillway Creek	15	Spillway
16	Boyne Tannum	16	Boyne
17	Outer Harbour		
18	Reference – Estuarine		
19	Reference - Oceanic		

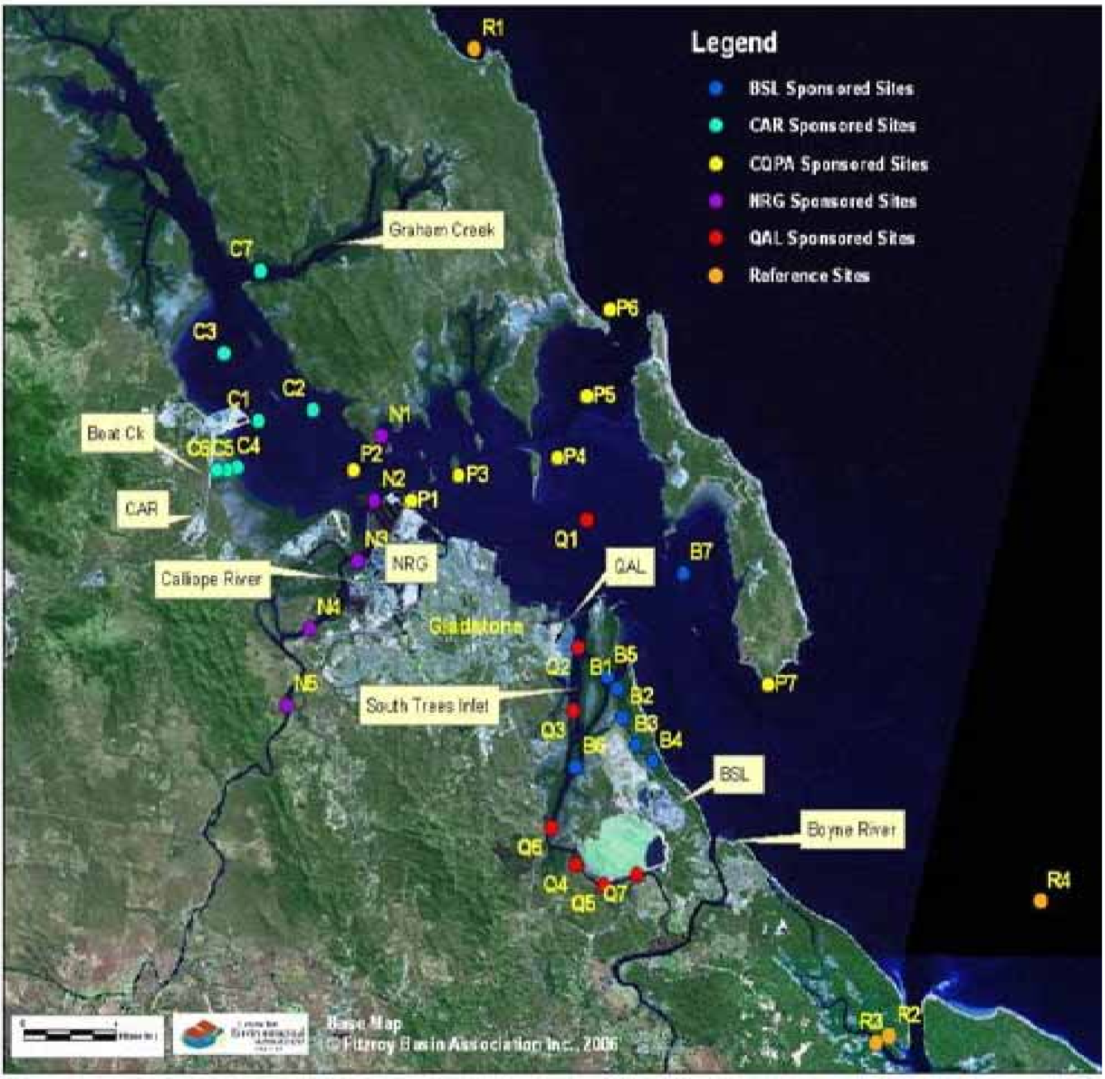


Figure 4-7 2005 PCIMP monitoring sites (Anderson *et al.*, 2006)

4.8.3.2 Physicochemical

Physicochemical characteristics were recorded on three occasions throughout July and August 2005. Temperature, conductivity, dissolved oxygen, pH and turbidity were measured using a YSI water quality meter just below the surface. Results are recorded in Table 4-10.

Table 4-10 Physicochemical characteristics of CQPA sites. Values are means ± se (n=3) (Anderson *et al.*, 2006)

Site	Temperature (°C)	Conductivity (mS/cm)	Dissolved oxygen (% saturation)	pH	Turbidity (NTU)
R1	19.7 ± 0.2	55.2 ± 0.7	116 ± 11	8.2 ± 0.0	3.5 ± 0.5
R2	19.1 ± 0.5	56.0 ± 1.0	113 ± 2	8.0 ± 0.1	5.2 ± 2.3
R3	19.3 ± 0.3	55.8 ± 1.2	112 ± 2	8.0 ± 0.0	3.6 ± 1.0
R4	19.5 ± 0.5	55.0 ± 0.7	120 ± 4	8.2 ± 0.0	3.7 ± 1.1
P1	20.3 ± 0.5	56.2 ± 0.7	118 ± 5	8.1 ± 0.0	4.0 ± 0.2
P2	20.3 ± 0.5	56.5 ± 0.8	122 ± 12	8.1 ± 0.0	5.4 ± 0.5
P3	19.8 ± 0.5	56.2 ± 0.8	115 ± 5	8.1 ± 0.0	10.3 ± 5.3
P4	19.7 ± 0.7	56.0 ± 0.8	118 ± 6	8.1 ± 0.0	8.3 ± 2.3
P5	19.9 ± 1.0	56.0 ± 0.7	116 ± 8	8.1 ± 0.0	4.1 ± 0.2
P6	20.1 ± 0.6	55.2 ± 0.6	118 ± 7	8.2 ± 0.0	2.7 ± 0.6
P7	20.1 ± 0.3	55.3 ± 0.7	122 ± 9	8.2 ± 0.0	3.4 ± 0.2
C2	19.7 ± 0.2	56.5 ± 0.7	116 ± 3	8.1 ± 0.0	5.6 ± 1.1
C3	19.6 ± 0.2	56.8 ± 0.7	112 ± 3	8.1 ± 0.0	5.3 ± 0.6
N2	21.0 ± 1.1	56.6 ± 0.8	116 ± 6	8.1 ± 0.0	4.9 ± 0.4
B7	19.8 ± 0.4	55.8 ± 0.1	116 ± 7	8.2 ± 0.0	10.0 ± 5.2
Q1	19.7 ± 0.5	55.9 ± 0.7	118 ± 4	8.2 ± 0.0	5.2 ± 1.0

Physicochemical values were analysed using Analyses of Variance (ANOVA) to determine whether there were significant differences between each parameter. Physicochemical parameters were then compared to current Australian Water Quality Guidelines (AWQG) for conditions in marine waters (ANZECC/ARMCANZ 2000) (Anderson *et al.,* 2006).

Temperature

No significant differences in temperature were exhibited among any of the sites. There was a slight trend for cooler temperatures in the reference sites (19.1-19.7°C), and Fisherman's Landing sites (19.6-19.7ºC), than in the outer harbour sites (19.7-20.1 ºC) and the inner harbour and Calliope River sites (19.8-21.0ºC) (Anderson *et al.,* 2006).

Conductivity

Conductivity did not differ significantly among any of the sites, although conductivity at the reference sites (55.0-56.0mS/cm) and the outer harbour sites (55.2-56.0mS/cm) tended to be slightly lower than the inner harbour (56.2-56.5mS/cm) and Fisherman's Landing and Calliope River sites (56.5-56.8mS/cm) (Anderson *et al.,* 2006).

Dissolved oxygen

No significant differences in dissolved oxygen were exhibited among any of the sites, with levels in reference sites (112-120% saturation), similar to levels in all other sites (112-122% saturation). All values were above the AWQG recommended lower limit (90%) suggested for marine waters in tropical Australia (ANZECC/ARMCANZ 2000) (Anderson *et al.,* 2006).

pH

pH did not differ significantly among the sites, with values at reference sites (8.0-8.2) similar to all other sites (8.1-8.2). All values fell within the recommended upper and lower limits for pH in tropical marine waters, 8.0 to 8.4 (ANZECC/ARMCANZ 2000) (Anderson *et al.,* 2006).

Turbidity

No significant differences in turbidity were evident among any of sites, although reference sites (3.5-5.2NTU) tended to be slightly less turbid than the majority of the harbour sites (2.7-10.3NTU). All turbidity values were lower than the turbidity suggested for tropical marine waters, 20 NTU (ANZECC/ARMCANZ 2000) (Anderson *et al.,* 2006).

4.8.3.3 Metals

Mean site concentrations of individual DGT and oyster metals are listed in Table 4-11 and Table 4-12. Results were analysed using one-way ANOVAs to determine whether there were significant differences between sites for each parameter. DGT-labile concentrations were then compared to current Australian Water Quality Guidelines (AWQG) for contaminants in marine waters (ANZECC/ARMCANZ 2000) (Anderson *et al.,* 2006).

Table 4-11 DGT-labile metal concentrations (µg/L) in CQPA reported sites. Values are means ± se (n=3) (Anderson *et al.*, 2006)

	DGT-labile concentration (µg/L)									
	Al	Cd	Cr	Co	Cu	Fe	Mn	Ni	Pb	Zn
95% TV[1]	-	5.5	27.7	1	1.3	-	-	70	4.4	15
LOD[2]	0.55	0.001	0.10	0.001	0.01	0.2	0.01	0.05	0.001	4.15
R1	< 0.55	< 0.001	0.003 ± 0.003	0.01 ± 0	0.08 ± 0.01	6 ± 0.3	0.11 ± 0.01	0.15 ± 0	0.002 ± 0	1.66 ± 0.34
R2	1.6 ± 0.2	0.002 ± 0.001	0.034 ± 0.031	0.07 ± 0	0.08 ± 0.02	8 ± 1.2	0.12 ± 0.03	0.23 ± 0.04	0.005 ± 0.001	4.62 ± 0.07
R3	1.2 ± 0.3	<0.001	0.012 ± 0.008	0.06 ± 0	0.06 ± 0.01	10 ± 1.9	0.09 ± 0.01	0.19 ± 0.01	0.004 ± 0.001	1.19 ± 0.13
R4	< 0.55	<0.001	ND	0.01 ± 0	0.06 ± 0.02	6 ± 0.4	0.09 ± 0.02	0.12 ± 0.01	0.002 ± 0	1.83 ± 0.98
P1	8.3 ± 0.9	0.004 ± 0	0.035 ± 0.008	0.05 ± 0	0.32 ± 0.05	17 ± 2.4	0.37 ± 0.05	0.35 ± 0.01	0.007 ± 0.001	0.93 ± 0.40
P2	6.3 ± 2.0	0.023 ± 0.004	0.014 ± 0.010	0.05 ± 0	0.50 ± 0.16	17 ± 4.3	0.68 ± 0.15	0.51 ± 0.08	0.007 ± 0.001	1.78 ± 0.31
P3	2.0 ± 0.3	0.003 ± 0.001	ND	0.02 ± 0	0.17 ± 0.03	8 ± 1.0	0.21 ± 0.03	0.33 ± 0.08	0.004 ± 0.001	3.51 ± 0.61
P4	< 0.55	0.010 ± 0.002	0.006 ± 0.004	0.02 ± 0	0.25 ± 0.02	4 ± 0.1	0.29 ± 0.02	0.29 ± 0.01	0.008 ± 0.001	5.01 ± 2.61
P5	1.4 ± 0.7	0.002 ± 0	0.001 ± 0.001	0.02 ± 0	0.18 ± 0.01	7 ± 1.4	0.22 ± 0.01	0.23 ± 0.03	0.003 ± 0	3.67 ± 1.56
P6	< 0.55	<0.001	0.148 ± 0.063	0.01 ± 0	0.06 ± 0.01	5 ± 0.4	0.09 ± 0.01	0.13 ± 0.01	0.002 ± 0	8.03 ± 1.04
P7	3.0 ± 0.9	0.002 ± 0	0.083 ± 0.026	0.02 ± 0	0.10 ± 0.01	9 ± 1.0	0.13 ± 0.01	0.14 ± 0.01	0.006 ± 0.001	0.44 ± 0.44
C2	1.3 ± 1.1	0.005 ± 0.001	ND	0.04 ± 0	0.23 ± 0.03	10 ± 0.3	0.27 ± 0.03	0.36 ± 0.03	0.003 ± 0	1.08 ± 1.08
C3	1.6 ± 0	0.021 ± 0	ND	0.05 ± 0	0.27 ± 0.01	8 ± 0.6	0.31 ± 0.01	0.44 ± 0.05	0.003 ± 0	1.92 ± 0.59
N2	1.8 ± 0.2	0.004 ± 0	0.007 ± 0.007	0.06 ± 0	0.36 ± 0.03	9 ± 1.5	0.41 ± 0.03	0.35 ± 0	0.003 ± 0.001	3.00 ± 0.88
B7	0.6 ± 0.3	0.002 ± 0.001	ND	0.02 ± 0	0.12 ± 0.01	6 ± 0.5	0.16 ± 0.01	0.19 ± 0	0.001 ± 0	0.51 ± 0.46
Q1	0.6 ± 0.1	0.002 ± 0	0.027 ± 0.019	0.02 ± 0	0.17 ± 0.02	7 ± 0	0.21 ± 0.02	0.28 ± 0.04	0.002 ± 0.001	6.46 ± 0.87

[1] 95% trigger values listed for Australian and New Zealand Water Quality Guidelines for marine waters (ANZECC/ARMCANZ, 2000). Guidelines not available for aluminium, iron or manganese.

[2]The majority of chromium and zinc concentrations were below the analytical limit of detection. Where possible, the laboratory values were listed, however these values should be treated with caution.

ND indicates not detected.

Table 4-12 Metal concentrations (µg/L)in oysters at CQPA sites. Values are means ± se (n=3) (Anderson *et al.*, 2006)

	Oyster metal concentration (µg/g)																
	Ag	Al	As	Cd	Cr	Co	Cu	Fe	Ga	Hg	Mn	Mo	Ni	Pb	Se	V	Zn
	5.2	133	16	3.2	0.61		57	233		0.10	6.4	0.89	1.2	0.5	5.1	1.47	487
Base	± 0.5	± 3	± 0	± 0.2	± 0.01	<0.5	± 7	± 7	<0.5	± 0.01	± 0.7	± 0.12	± 0.2	± 0	± 0.1	± 0.12	± 28
	4.1	143	17	2.8	0.65		64	213		0.07	8.1	2.27	1.1		5.4	2.07	430
R1	± 0.1	± 23	± 1	± 0.4	± 0.08	<0.5	± 4	± 23	<0.5	± 0	± 1.0	± 0.19	± 0	<0.4	± 0.2	± 0.13	± 70
	3.8	80	18	2.5	0.50	0.58 ±	62	173		0.07	7.9	2.83	1.0	0.5	4.4	0.43	470
R2	± 0.2	± 8	± 0	± 0.4	± 0	0.06	± 1	± 33	< 0.5	± 0	± 1.1	± 0.07	± 0.1	± 0	± 0.2	± 0.06	± 36
	3.8	43	16	2.4		0.53	54	130		0.09	6.5	1.93	0.8		4.0	0.36	493
R3	± 0.3	± 4	± 1	± 0.1	<0.5	± 0	± 3	± 21	<0.5	± 0.01	± 0.4	± 0.27	± 0	<0.4	± 0.2	± 0.04	± 35
	3.7	148	18	2.8	0.56	0.53	57	213		0.08	10.6	0.57	1.5		4.0	0.68	417
R4	± 0.5	± 34	± 1	± 0.4	± 0	± 0	± 8	± 35	<0.5	± 0.02	± 2.0	± 0.05	± 0.2	<0.4	± 0.3	± 0.11	± 81
	3.5	210	14	2.7	0.86	0.69	120	263		0.08	8.6	0.99	1.0		4.1	0.54	780
P1	± 0.5	± 38	± 1	± 0.6	± 0.08	± 0.03	± 6	± 33	<0.5	± 0.01	± 1.7	± 0.06	± 0.1	<0.4	± 0.3	± 0.08	± 6
	3.7	200	14	2.4	0.76	0.58	111	250		0.08	7.7	0.85	1.1		4.1	0.45	737
P2	± 0.1	± 21	± 1	± 0.1	± 0.05	± 0.05	± 14	± 26	<0.5	± 0.01	± 0.7	± 0.06	± 0.1	<0.4	± 0.3	± 0.06	± 78
	4.3	253	16	2.5	0.79	0.64	107	300		0.08	9.1	1.97	1.2		4.4	0.62	650
P3	± 0.5	± 30	± 0	± 0.1	± 0.16	± 0.07	± 3	± 36	<0.5	± 0	± 1.3	± 0.41	± 0.1	<0.4	± 0.3	± 0.06	± 31
	3.4	233	16	2.1	0.82	0.62	98	270		0.06	17.5	0.61	1.1	0.8	4.5	0.45	563
P4	± 0.1	± 22	± 1	± 0.1	± 0.20	± 0	± 8	± 15	<0.5	± 0.01	± 0.5	± 0.09	± 0.2	± 0.3	± 0.3	± 0.07	± 54
	4.1	227	17	2.3	0.68	0.63	96	287		0.09	9.2	3.43	1.0		4.3	0.57	563
P5	± 0.1	± 3	± 1	± 0.1	± 0.04	± 0.02	± 3	± 3	<0.5	± 0.01	± 0.1	± 0.20	± 0.1	<0.4	± 0.4	± 0.03	± 23
	3.5	200	18	2.4	0.62	0.59	70	247		0.06	13.3	0.62	1.2		3.7	0.36	393
P7	± 0.4	± 6	± 1	± 0.5	± 0.03	± 0.04	± 2	± 3	<0.5	± 0.01	± 2.1	± 0.04	± 0.1	<0.4	± 0.5	± 0.04	± 35
	4.4	41	14	2.5	0.88	0.56	115	119		0.09	10.9	1.03	1.3	0.4	5.1	0.38	760
C2	± 0.3	± 11	± 1	± 0.1	± 0.08	± 0	± 11	± 17	<0.5	± 0	± 1.1	± 0.13	± 0	± 0	± 0.3	± 0.06	± 44
	3.5	68	13	2.1	0.74	0.70	97	173		0.08	9.2	0.74	1.2	0.5	4.5	0.42	607
C3	± 0.2	± 18	± 1	± 0.3	± 0.12	± 0.01	± 3	± 39	<0.5	± 0	± 1.0	± 0.06	± 0.1	± 0	± 0.4	± 0.06	± 12
	3.8	220	15	2.3	0.63	0.74	147	283		0.08	10.8	0.53	1.0		4.0	0.52	1011
N2	± 0.6	± 0	± 0	± 0.2	± 0.03	± 0.03	± 7	± 3	<0.5	± 0.01	± 0.8	± 0.02	± 0	<0.4	± 0.4	± 0.07	± 41
	4.9	360	17	2.7	1.37	0.71	102	410		0.10	13.4	4.40	1.4		5.4	1.02	670
B7	± 0.4	± 36	± 0	± 0.1	± 0.18	± 0.02	± 4	± 36	<0.5	± 0.01	± 3.1	± 0.25	± 0.1	<0.4	± 0.4	± 0.04	± 46
	4.6	227	16	3.3	1.07	0.68	108	283		0.08	7.6	2.50	1.2		4.8	0.64	697
Q1	± 0.2	± 57	± 1	± 0.1	± 0.03	± 0.07	± 12	± 54	<0.5	± 0	± 0.9	± 0.26	± 0.1	<0.4	± 0.6	± 0.10	± 98

<u>Copper</u>

<u>DGT</u>

Site P2 (0.50µg/L) adjacent to Wiggins Island seagrass beds contained DGT-labile copper concentrations significantly higher than any other site except N2 (0.36µg/L), an adjacent site in the mouth of the Calliope River. These two sites, in addition to P1 (0.32µg/L) in the inner harbour and C3 (0.27µg/L) near Fisherman's Landing contained copper concentrations significantly higher than all reference sites (0.06-0.08µg/L), which contained some of the lowest concentrations. Copper at the mid and outer harbour sites (0.06-0.25µg/L) did not differ significantly from reference sites. All recorded copper concentrations were well under the AWQG 95% trigger value (ANZECC/ARMCANZ 2000) for copper in marine waters, 1.3µg/L (Anderson *et al.,* 2006).

<u>Oysters</u>

Baseline and reference site oysters tended to contain the lowest copper concentrations, 54-64 µg/g. The highest concentrations of copper were found at site N2 in the Calliope River (147 µg/g), in the inner harbour sites, P1 and P2 (111-120 µg/g), and site C2 near Fisherman's Landing (115 µg/g), with N2 having significantly higher concentrations then all other remaining sites. These four sites in addition to the mid harbour sites P3, B7 and Q1 (102-108µg/g) contained oyster copper concentrations which were significantly higher than all reference sites (Anderson *et al.,* 2006).

<u>Summary of copper concentrations</u>

DGT-labile and oyster copper showed similar accumulation trends, with lowest copper concentrations reported in the reference sites and significantly higher copper concentrations in the inner harbour area (P1 and P2) and mouth of the Calliope River (N2). The outer harbour area also tended to accumulate less copper than the inner harbour sites (Anderson *et al.,* 2006).

Zinc

DGT

Highest concentrations of DGT-labile zinc were found at site P6, adjacent to the North Entrance but this site was not significantly different to P3, P4, P5 or Q1. Concentrations at this site (8.03µg/L) were significantly higher than the oceanic reference site concentrations, R1 and R4 (1.66 – 1.83µg/L) but did not differ significantly from the estuarine reference site, R2 (4.62µg/L) (Anderson *et al.,* 2006).

Oysters

Oyster zinc concentrations tended to be highest in the Calliope River (N2), inner harbour (P1 and P2) and C2 at Fisherman's Landing, similar to the oyster copper concentrations. Concentrations at N2 (1011µg/g) and P1 (780µg/g) were significantly higher than all reference site and baseline concentrations (417-493 µg/g), with concentrations at C2 (760µg/g) and P2 (737 µg/g) significantly higher than the oceanic reference site concentrations. Oyster zinc in all other potential impact sites did not vary significantly from the reference site and baseline concentrations (Anderson *et al.,* 2006).

Summary of zinc concentrations

Although DGT-labile zinc did not exhibit any completely reliable trends, oyster zinc concentrations indicated that zinc accumulation tended to be highest in the inner harbour area, with lower concentrations in the outer harbour and reference sites, in a similar pattern to copper accumulation.

All other potential impact sites (0.44-6.46µg/L) did not differ significantly from the reference sites. Results should be treated with caution as all values were below the accepted laboratory limits of accurate detection but are presented here in order to identify trends among sites. All recorded zinc concentrations were well under the AWQG 95% trigger value (ANZECC/ARMCANZ 2000) for copper in marine waters, 15µg/L (Anderson *et al.,* 2006).

Aluminium

DGT

DGT-labile aluminium concentrations in the inner harbour sites, P1 and P2 (6.3 - 8.3µg/L), were significantly higher than concentrations at all reference sites (<0.55- 1.6µg/L), and for P1, all other potential impact sites (<0.55 – 3.0µg/L). P2 was also significantly more elevated than all other sites except P7, which was not significantly different to remaining sites. At present, no AWQGs have been published for aluminium in marine water (ANZECC/ARMCANZ 2000) (Anderson *et al.,* 2006).

Oysters

Lowest concentrations of oyster aluminium were found at the reference sites (43-148µg/g and baseline (133µg/g), which were similar to sites opposite Fisherman's Landing (41-68 µg/g). Concentrations tended to be higher in the mid and outer harbour sites, such as B7, Q1, P3, P4 and P5. However, only concentrations at B7 (360 µg/g) adjacent to Facing Island were significantly higher than baseline and reference site concentrations (43-148 µg/g). Oyster aluminium concentrations in the inner harbour sites did not differ significantly from reference concentrations (Anderson *et al.,* 2006).

Summary of aluminium concentrations

Different trends were exhibited for DGT-labile and oyster aluminium accumulation. DGT-labile aluminium accumulation was highest in the inner harbour area, however oyster aluminium accumulation tended to be higher in the mid to outer harbour sites, particularly at B7 (Anderson *et al.,* 2006).

Cadmium

DGT

Sites P2 adjacent to Wiggins Island and C3 near Fisherman's Landing contained DGT-labile cadmium concentrations (0.021-0.023µg/L) which were significantly higher than all other sites, including reference sites (<0.001-0.002µg/L). Cadmium at Site P4 (0.010µg/L) was significantly higher than all remaining sites except for C2, which was not significantly elevated compared to the majority of other sites. DGT labile cadmium tended to be lowest in the reference sites but not significantly lower than remaining sites. DGT-labile cadmium concentrations at all sites were well below the AWQG 95% trigger value for cadmium in marine waters, 5.5µg/L (ANZECC/ARMCANZ 2000) (Anderson *et al.,* 2006).

Oysters

There was no significant difference in cadmium accumulation among sites (Tables 5 and 6, Figure 16) (Anderson *et al.,* 2006).

Summary of cadmium concentrations

DGT-labile cadmium tended to be higher in the inner harbour, however for oysters there was no significant difference among sites (Anderson *et al.,* 2006).

Chromium

DGT

Although DGT-labile chromium concentrations were highest at P6 at North Entrance, (0.148µg/L), no significant differences were found among any of the sites. Similar to zinc, most reported concentrations were below the laboratory level of detection (LOD) and therefore results should be treated with caution. At some sites Cr was not detected by DGT. DGT-labile chromium concentrations at all sites were well below the AWQG 95% trigger value for chromium III (27.4µg/L) in marine waters (ANZECC/ARMCANZ, 2000) (Anderson *et al.,* 2006).

Oysters

Oyster chromium concentrations tended to be lowest in the reference sites (<0.5- 0.65µg/g) and baseline oysters (0.61µg/g), however these were not significantly different to the majority of other sites. Highest concentrations were found in the mid harbour sites, Q1 (1.07µg/g) and B7 (1.37µg/g), although only B7 was significantly higher than all reference sites, and the majority of potential impact sites (Anderson *et al.,* 2006).

Summary of chromium concentrations

Although no significant differences were found in DGT-labile chromium concentrations among reference and potential impact sites, oyster chromium concentrations in reference sites tended to be lower than potential impact sites, particularly site Q1 and B7.

Cobalt

DGT

There was a trend for lowest concentrations of DGT-labile cobalt in the oceanic reference sites, R1 and R4 (0.01µg/L), with highest concentrations found in the estuarine reference sites, R2 and R3 (0.06-0.07µg/L). R2 was significantly more elevated than all other sites except R3 and N2. Therefore, concentrations at all potential impact sites were not significantly higher or lower than concentrations at reference sites. Generally, the mid and outer harbour sites tended to contain lower cobalt concentrations (0.02µg/L) than inner harbour sites (0.02-0.05µg/L), Fisherman's Landing sites (0.04-0.05µg/L), and the Calliope River site (0.06µg/L) (Anderson *et al.,* 2006).

Concentrations of DGT-labile cobalt at all sites were below the 95% trigger value of 1µg/L (ANZECC/ARMCANZ 2000).

Oysters

Cobalt concentrations were lowest in reference sites (<0.5-0.58µg/g) and baseline oysters (<0.5µg/g) but these were not significantly different to all other sites. Highest oyster cobalt concentrations were seen in the Calliope River site, N2 (0.74µg/g), with concentrations at this site and B7, C3 and P1 significantly higher than baseline and R1 concentrations only (Anderson *et al.,* 2006).

Summary of cobalt concentrations

Both DGT-labile and oyster cobalt were lowest in oceanic reference sites, with potential impact sites tending to contain higher concentrations. However, in an unusual trend, DGT-labile concentrations were higher in the estuarine reference sites than in any of the potential impact sites (Anderson *et al.,* 2006).

Iron

DGT

DGT-labile concentrations of iron tended to be lowest in oceanic reference sites (6µg/L) and mid to outer harbour sites (4-9µg/L), which were not significantly lower than the majority of other sites. Highest concentrations were found in the inner harbour sites, P1 and P2 (17µg/L), and these were significantly higher than oceanic reference sites, but not all harbour sites, or from estuarine reference sites, R2 and R3 (8-10µg/L). At present, no AWQGs have been published for iron in marine water (ANZECC/ARMCANZ 2000 (Anderson *et al.,* 2006)).

Oysters

Lowest concentrations of oyster iron were found at the reference sites (130-213µg/g), baseline oysters (233µg/g) and Fisherman's Landing sites (119-173µg/g), with concentrations in the inner and outer harbour slightly higher, but not necessarily significantly so. Only site B7 (410µg/g) in the mid harbour near Facing Island contained oyster iron concentrations which were significantly higher than all reference, baseline and Fisherman's Landing oysters (Anderson *et al.,* 2006).

Summary of iron concentrations

Both DGT-labile and oyster iron concentrations tended to be lowest in oceanic reference sites, however trends for both mediums tended not to be similar.

Manganese

DGT

DGT-labile manganese was significantly higher at P2 (0.68µg/L) than at any other site. Concentrations at P1 and N2 (0.37-0.41(0.68µg/L) were significantly higher than all reference site concentrations (0.09-0.12µg/L). The remaining potential impact sites (0.09- 0.31µg/L) did not differ significantly from reference sites or each other. However, manganese concentrations tended to be slightly lower in the reference and outer harbour sites. At present, no AWQGs have been published for manganese in marine water (ANZECC/ARMCANZ 2000) (Anderson *et al.,* 2006).

Oysters

The lowest manganese concentrations were found in the baseline oysters (6.4µg/g), with sites P7, B7 and P4 the only sites containing significantly higher concentrations. However, no potential impact site (7.6-17.5µg/g) contained significantly different oyster manganese concentrations than all reference site concentrations (6.5- 10.6µg/g) (Anderson *et al.,* 2006).

Summary of manganese concentrations

While DGT-labile manganese concentrations were highest in the inner harbour areas, oyster concentrations were generally not elevated at any of the potential impact sites, in comparison with reference sites and did not demonstrate a similar trend (Anderson *et al.,* 2006).

Nickel

DGT

Concentrations of DGT-labile nickel tended to be highest in the inner harbour, Calliope River and Fisherman's Landing sites (0.32-0.51µg/L), and lower in the reference (0.12- 0.23µg/L) and outer harbour sites, 0.13-0.28µg/L. Concentrations at P2 and C3 were significantly higher than at all reference sites, whereas concentrations at P1, C2 and N2 were significantly higher than oceanic reference site concentrations. However, concentrations at all sites were well below the AWQG 95% trigger value for nickel in marine waters, 70µg/L (ANZECC/ARMCANZ 2000) (Anderson *et al.,* 2006).

Oysters

Concentrations of oyster nickel were similar throughout reference and potential impact sites. Highest concentrations were found in sites R4 and B7 (1.4-1.5µg/g) which was only significantly higher than R3 (0.8µg/g) (Anderson *et al.,* 2006).

Summary of nickel concentrations

Although oyster nickel concentrations did not vary greatly between sites, concentrations of DGT-labile nickel in the inner harbour, Calliope River and Fisherman's Landing sites were significantly elevated in comparison with the oceanic reference sites (Anderson *et al.,* 2006).

Lead

DGT

Although concentrations of DGT-labile lead at P4, P1 and P2 (0.007-0.008µg/L) were significantly higher than the oceanic reference site concentrations (0.002µg/L), they were not significantly higher than estuarine reference site concentrations (0.004-0.005µg/L). All other potential impact sites (0.002-0.007 µg/L) did not differ significantly from the reference site concentrations (Tables 3 and 4, Figure 22). DGT-labile lead concentrations at all sites were well below the AWQG 95% trigger value for lead in marine waters, 4.4µg/L (ANZECC/ARMCANZ 2000) (Anderson *et al.,* 2006).

Oysters

The majority of oyster lead concentrations were below the analytical detection limit of 0.4µg/g. Only baseline oysters and oysters from C2, C3, P4 and R2 exhibited lead concentrations above this level (0.4-0.8µg/g) (Anderson *et al.,* 2006).

Summary of lead concentrations

Although oyster lead concentrations were mostly below LOD, DGT-labile lead concentrations did demonstrate some site differences. However, there was a trend for site P4 to contain the highest concentrations of lead in both mediums (Anderson *et al.,* 2006).

For the following metals, only oyster data is reported because DGT do not currently accumulate these particular metals.

Silver

There were no significant site differences in silver concentrations except for baseline oysters (5.2µg/g), which were significantly higher than concentrations at site P4 (3.4µg/g), which contained some of the lowest silver concentrations (Anderson *et al.,* 2006).

Arsenic

Arsenic concentrations tended to be highest in the reference sites (16-18 µg/g), and several of the outer harbour site P7, but these were not significantly more elevated than the majority of other sites. Inner harbour sites (14- 16µg/g), Fisherman's Landing sites (13-14 µg/g) and the Calliope River site

(15µg/g) generally contained some of the lower arsenic concentrations, but again there was some degree of overlap among sites. Site P7 contained significantly higher oyster arsenic concentrations (18 µg/g) than the inner harbour and Fisherman's Landing sites (Anderson *et al.,* 2006).

Gallium

Baseline oysters and oysters at all sites contained gallium concentrations which were below the analytical detection limit of 0.5µg/g. Thus, no site comparison can be made in regard to oyster gallium accumulation (Anderson *et al.,* 2006).

Mercury

Reference site and baseline oyster mercury concentrations (0.07-0.010µg/g) were similar to all potential impact concentrations, 0.06-0.10µg/g. The significant difference among the sites was between B7, containing concentrations significantly higher than Sites P4 and P7 (Anderson *et al.,* 2006).

Molybdenum

Concentrations of oyster molybdenum tended to be highest in three of the four reference sites and several of the mid to outer harbour sites. As reference site concentrations were so varied, only one site, B7, contained molybdenum concentrations which differed significantly from all reference sites. B7 (4.4µg/g) was also significantly higher than all other sites, except for P5. Overall, the inner harbour, Calliope River and Fisherman's Landing sites tended to contain some of the lowest molybdenum concentrations (Anderson *et al.,* 2006).

Selenium

Similar concentrations of selenium were found in the baseline oysters (5.1µg/g), oysters from reference sites (4.0-5.4µg/g), outer harbour sites (3.7-5.4µg/g), inner harbour sites (4.1-4.4µg/g), Fisherman's Landing sites (4.5-5.1µg/g) and the Calliope River site (4.0µg/g). No significant differences in oyster selenium concentrations were found among any of the reported sites (Anderson *et al.,* 2006).

Vanadium

Concentrations of oyster vanadium at R1 (2.07µg/g) were significantly higher than all other sites. Baseline oyster concentrations, although significantly lower than R1 concentrations, were also significantly higher than all remaining sites (1.47µg/g). The remaining sites did not vary significantly from one another, with the exception of B7 (1.02µg/g), which was significantly higher than all sites except P3, Q1 and R4 (Anderson *et al.,* 2006).

4.8.3.4 Conclusions

Water physicochemistry at all potential impact sites was similar to reference sites with none of the parameters exceeding the boundaries in the Australian and New Zealand Water Quality Guidelines (ANZECC/ARMCANZ, 2000) (AWQG) at any of the sites (Anderson *et al.,* 2006).

All metals in both DGT and oysters, with the exception of arsenic and vanadium exhibited a trend to be elevated at impact sites in comparison to reference sites. Metal concentrations in DGT adjacent to the Calliope River mouth, Wiggins Island and RG Tanna Coal wharf, demonstrated some of the highest metal concentrations particularly for copper, aluminium, iron, manganese, nickel and lead. The trend was also evident for copper and zinc in oysters and indicates point and diffuse source discharges into this area (Anderson *et al.,* 2006).

Sites opposite Fisherman's Landing generally tended to have the next highest elevations of most metals, in particular copper, cadmium, manganese and nickel. Of the reference sites, the oceanic reference sites in particular showed a trend for the lowest concentrations of most metals with the exception of arsenic and to a lesser extent vanadium. The sites opposite South Trees demonstrated accumulation of some metals in oysters but not in DGT. DGT measures the fraction of metal that is potentially available to biota whereas the oyster measures the fraction that was actually accumulated. However, generally results confirm that the two techniques are complimentary (Anderson *et al.,* 2006).

Decreasing gradients of metal concentrations along both a northern and eastern transect from inner to outer harbour were identified, which indicates metal inputs for some metals from point and diffuse sources in the inner harbour area (Anderson *et al.,* 2006).

4.8.4 Biomonitoring 2006

4.8.4.1 Physicochemical characteristics

Physicochemical results are displayed in Table 4-13.

No significant difference was noted between zones for Oxygen Reduction Potential (ORP). Conductivity was mostly similar among zones with only the Calliope River being significantly lower than all other zones, except the Narrows. Dissolved oxygen (DO) levels were highest in the oceanic reference zones, however there was no significant differences observed between zones. Only the Oceanic reference zone was above the AWQG recommended lower limit for DO (90%) for marine waters in tropical Australia (ANZECC/ARMCANZ, 2000).

The Anabranch recorded the highest temperatures, however again zones did not differ significantly. The Calliope River was also more elevated than all other zones but not significantly different to Wiggins Island.

The Narrows and Anabranch had the lowest pH, but were not significantly different to the Calliope River zone. The Outer harbour and Oceanic reference zones tended to have the highest pH but Oceanic was not significantly higher than mid harbour. All other zones were fairly similar in terms of pH. An opposite trend was observed for turbidity, with the Oceanic reference and Outer harbour zones tending to have lowest values and the Anabranch, Auckland Ck. and Calliope River reporting some of the highest turbidity. Only Calliope Anabranch slightly exceeded the AWQG recommended limit (20 NTU) suggested for marine waters in tropical Australia (ANZECC/ARMCANZ, 2000) (Anderson *et al.*, 2007).

Table 4-13 Physicochemical characteristics in CQPA zones (Anderson *et al.*, 2007)

Zone	Temperature (ºC)	Conductivity (mS/cm)	Dissolved oxygen (% saturation)	pH	Turbidity (NTU)	ORP (mV)
Narrows (NW)	20.3 ± 0.4	55.1 ± 1.1	45 ± 2	8.0 ± 0.0	8.2 ±0.5	174 ± 3
Fisherman's Landing (FL)	20.9 ± 0.6	56.3 ± 0.0	43 ± 3	8.1 ± 0.0	8.8 ± 1.2	173 ± 4
Wiggins Island (WI)	21.4 ± 0.4	56.1 ± 0.0	47 ± 3	8.1 ± 0.0	12.7 ± 2.3	165 ± 3
Calliope Anabranch (Ana)	23.9 ± 0.5	55.3 ± 0.2	51 ± 2	8.0 ± 0.0	20.7 ± 3.9	172 ± 2
Calliope River (CR)	23.5 ± 0.4	54.0 ± 0.5	47 ± 2	8.0 ± 0.0	14.5 ± 1.9	170 ± 1
Auckland Creek (AC)	20.6 ± 0.3	56.1 ± 0.0	65 ± 5	8.1 ± 0.0	15.1 ± 5.8	177 ± 3
Mid harbour (Mid)	20.6 ± 0.4	55.9 ± 0.0	63 ± 10	8.2 ± 0.0	8.0 ± 1.0	165 ± 11
Inner harbour/ South Trees (ST)	20.8 ± 0.5	55.9 ± 0.1	65 ± 7	8.1 ± 0.0	9.5 ± 2.0	177 ±6
Outer harbour (Out)	20.9 ± 0.6	55.6 ± 0.1	72 ± 20	8.2 ± 0.0	5.0 ± 2.5	170 ± 16
Reference – Estuarine (RE)	20.5 ± 0.4	54.0 ± 1.8	68 ± 5	8.1 ± 0.0	5.9 ±0.4	180 ± 4
Reference- Oceanic (RO)	20.5 ± 0.4	55.5 ± 0.1	94 ± 12	8.2 ± 0.0	2.6 ±0.2	178 ± 10
AWQG trigger			80/90*	7.0-8.5	1-20	

* Estuaries/Marine Inshores

Values are means ± se (n=6 to 32)

4.8.4.2 Metals

DGT and oyster results for metals are displayed in Table 4-14 and Table 4-15.

Table 4-14 DGT-labile metal concentrations in CQPA zones (Anderson *et al.*, 2007)

Zone	DGT-labile metal concentration (µg/L)									
	Cu	Zn	Al	Cd	Co	Cr	Fe	Mn	Ni	Pb
LOD	0.04	10.97	0.167	0.001	0.001	0.077	0.68	0.005	0.027	0.001
Narrows (NW)	0.10 ± 0.00	<10.97	0.92 ± 0.16	0.004 ± 0.001	0.07 ± 0.01	0.12 ± 0.01	10 ± 1	2.8 ± 0.6	0.37 ± 0.02	0.003 ± 0.001
Fisherman's Landing (FL)	0.15 ± 0.01	<10.97	2.0 ± 0.3	0.004 ± 0.000	0.03 ± 0.00	0.13 ± 0.02	9 ± 0	1.1 ± 0.1	0.29 ± 0.01	0.004 ± 0.000
Wiggins Island (WI)	0.20 ± 0.01	<10.97	3.1 ± 1.5	0.010 ± 0.003	0.03 ± 0.00	<0.077	14 ± 2	1.2 ± 0.1	0.32 ± 0.03	0.006 ± 0.001
Calliope Ananbranch (Ana)	0.22 ± 0.01	<10.97	7.7 ± 2.6	0.004 ± 0.000	0.07 ± 0.01	<0.077	12 ± 1	3.5 ± 0.6	0.30 ± 0.01	0.005 ± 0.001
Calliope River (CR)	0.20 ± 0.02	<10.97	0.8 ± 0.2	0.004 ± 0.000	0.04 ± 0.00	<0.077	9 ± 0	2.1 ± 0.6	0.27 ± 0.01	0.003 ± 0.000
Auckland Creek (AC)	0.22 ± 0.02	<10.97	0.6 ± 0.2	0.006 ± 0.001	0.02 ± 0.00	0.09 ± 0.01	9 ± 0	1.2 ± 0.1	0.20 ± 0.01	0.003 ± 0.000
Mid harbour (Mid)	0.12 ± 0.01	<10.97	5.9 ± 2.7	0.003 ± 0.000	0.03 ± 0.00	<0.077	19 ± 5	1.0 ± 0.2	0.21 ± 0.02	0.008 ± 0.002
Inner harbour/ South Trees (ST	0.20 ± 0.02	<10.97	21 ± 11	0.011 ± 0.003	0.05 ± 0.01	0.13 ± 0.01	53 ± 24	2.8 ± 1.1	0.24 ± 0.03	0.021 ± 0.008
Outer harbour (Out)	0.05 ± 0.01	<10.97	0.6 ± 0.3	0.004 ± 0.003	0.01 ± 0.00	<0.077	8 ± 1	0.4 ± 0.1	0.10 ± 0.01	0.006 ± 0.001
Reference – Estuarine (RE)	0.06 ± 0.01	<10.97	0.6 ± 0.2	0.002 ± 0.001	0.06 ± 0.00	0.11 ± 0.02	10 ± 0	2.6 ± 0.4	0.13 ± 0.00	0.004 ± 0.001
Reference-Oceanic (RO)	0.07 ± 0.01	<10.97	0.3 ± 0.1	0.012 ± 0.005	0.01 ± 0.00	0.10 ± 0.02	10 ± 2	0.4 ± 0.1	0.11 ± 0.01	0.007 ± 0.001
AWQG 95% trigger	1.3	15	-	5.5	1	(III) 27 (VI) 4.4	-	-	70	4.4

Values are means ± se (n=6 to 19). LOD indicates laboratory reporting limit of detection for each metal. AQWG 95% trigger values (ANZECC/ARMCANZ, 2000)

Table 4-15 Oyster metal concentrations in CQPA zones (Anderson *et al.*, 2007)

Zone	Oyster metal concentration (µg/L)																
	Cu	Zn	Al	Cd	Co	Cr	Fe	Mn	Ni	Pb	Ag	As	Ga	Hg	Mo	Se	V
LOD	<0.5	<0.5	<0.3	<0.2	<0.5	<0.5	<1.0	<0.5	<0.5	<0.4	<0.5	<1.0	<0.5	<0.01	<0.5	<0.5	<0.5
Baseline	71 ± 5	418 ± 27	84 ± 7	3.7 ± 0.2	<0.5	<0.5	158 ± 10	5 ± 0	0.8 ± 0.1	<0.4	4.7 ± 0.2	17 ± 1	<0.5	0.08 ± 0.00	1.3 ± 0.1	3.8 ± 0.2	0.9 ± 0.1
Narrows (NW)	109 ± 5	630 ± 33	174 ± 14	2.2 ± 0.1	<0.5	<0.5	269 ± 18	11 ± 1	1.1 ± 0.0	<0.4	3.5 ± 0.2	15 ± 1	<0.5	0.07 ± 0.00	<0.5	4.2 ± 0.2	0.7 ± 0.1
Fisherman's Landing (FL)	128 ± 18	809 ± 31	188 ± 7	2.7 ± 0.1	0.5 ± 0.0	<0.5	288 ± 10	12 ± 0	1.1 ± 0.0	<0.4	4.0 ± 0.1	16 ± 0	<0.5	0.09 ± 0.00	<0.5	4.5 ± 0.1	0.8 ± 0.0
Wiggins Island (WI)	137 ± 9	1020 ± 25	197 ± 16	2.4 ± 0.1	0.6 ± 0.0	0.5 ±0.0	322 ± 19	12 ± 1	1.1 ± 0.0	<0.4	3.8 ± 0.1	16 ± 0	<0.5	0.09 ± 0.00	0.8 ± 0.1	4.7 ± 0.2	0.9 ± 0.0
Calliope Ananbranch (Ana)	140 ± 8	925 ± 44	235 ± 23	2.3 ± 0.3	0.7 ± 0.0	<0.5	383 ± 25	12 ± 2	0.9 ± 0.0	<0.4	2.9 ± 0.2	12 ± 0	<0.5	0.08 ± 0.00	<0.5	4.5 ± 0.2	0.9 ± 0.0
Calliope River (CR)	144 ± 6	907 ± 41	177 ± 15	1.9 ± 0.1	0.5 ± 0.0	<0.5	303 ± 23	16 ± 1	0.9 ± 0.0	<0.4	2.9 ± 0.2	15 ± 0	<0.5	0.08 ± 0.00	<0.5	4.8 ± 0.2	0.7 ± 0.1
Auckland Creek (AC)	182 ± 9	1119 ± 15	249 ± 40	2.5 ± 0.1	0.6 ± 0.0	<0.5	373 ± 50	12 ± 1	1.0 ± 0.0	<0.4	3.9 ± 0.3	16 ± 0	<0.5	0.08 ± 0.00	0.7 ± 0.1	4.8 ± 0.3	1.1 ± 0.1
Mid harbour (Mid)	115 ± 5	735 ± 23	146 ± 14	2.7 ± 0.1	<0.5	<0.5	249± 19	11 ± 1	1.0 ± 0.0	<0.4	4.4 ± 0.2	18 ± 0	<0.5	0.10 ± 0.0	0.8 ± 0.1	4.5 ± 0.1	0.8 ± 0.0
Inner harbour/ South Trees (IH)	127 ± 5	867 ± 35	147 ± 12	2.6 ± 0.1	<0.5	<0.5	238 ± 16	12 ± 1	0.9 ± 0.0	<0.4	4.0 ± 0.1	18 ± 0	<0.5	0.08 ± 0.00	0.7 ± 0.1	4.8 ± 0.1	0.7 ± 0.1
Outer harbour (Out)	103 ± 8	573 ± 25	118 ± 11	3.5 ± 0.1	<0.5	<0.5	207 ± 17	10 ± 1	1.1 ± 0.1	<0.4	5.3 ± 0.3	17 ± 0	<0.5	0.10 ± 0.00	0.9 ± 0.0	4.2 ± 0.1	0.9 ± 0.0
Reference – Estuarine (RE)	68 ± 4	492 ± 24	165 ± 6	2.5 ± 0.1	<0.5	<0.5	246 ± 7	11 ± 1	0.8 ± 0.0	<0.4	3.8 ± 0.3	19 ± 0	<0.5	0.09 ± 0.00	0.8 ± 0.1	3.7 ± 0.1	0.7 ± 0.0
Reference-Oceanic (RO)	84 ± 4	486 ± 42	79 ± 6	3.3 ± 0.2	0.6 ± 0.0	<0.5	159 ± 7	8 ± 1	0.9 ± 0.0	<0.4	4.4 ± 0.3	19 ± 0	<0.5	0.11 ± 0.00	0.7 ± 0.1	4.0 ± 0.1	0.7 ± 0.0

Values are means ± se (n=6 to 21)

Copper

DGT

There was a trend for estuarine impact zones to have higher DGT-labile copper concentrations, with the Anabranch, Auckland Ck. and Calliope River having highest concentrations. However, they were not significantly different to South Trees, Wiggins Is., Fisherman's and mid harbour. The reference zones and the Outer harbour had lowest copper concentrations. All recorded copper values were well under the AWQG 95% trigger value of 1.3µg/L (ANZECC/ARMCANZ, 2000) (Anderson *et al.*, 2007).

Oyster

Oyster copper accumulation followed a similar trend to DGT-labile concentrations, with the exception of Auckland Ck., which had highest concentrations and was significantly higher than all other zones. This zone was highly influenced by the three sites in the marina, which demonstrated some of the highest oyster copper concentrations (Anderson *et al.*, 2007).

Zinc

DGT

DGT-labile zinc concentrations were not plotted, as the majority of values were below the laboratory limits of detection (Anderson *et al.*, 2007).

Oyster

Zinc accumulation in oysters followed a similar pattern to that of copper. Auckland Ck. had more elevated concentrations than all other zones except the Wiggins Zone, however most sites in this zone including the marina had elevated concentrations. Wiggins Island zone was also influenced by high concentrations at P1 at RG Tanna wharf. Baseline oysters had lowest concentrations, but they were not significantly lower than the reference sites. The reference sites and Outer harbour were lower than all other impact zones except the Narrows (Anderson *et al.*, 2007).

Aluminium

DGT

There was no significant difference in DGT-labile aluminium concentrations among most zones however the South Trees zone tended to have higher concentrations than the majority of other sites. This could be due to the high variation in data for this zone which was influenced by particularly high concentrations at B8 adjacent to BSL wharf. Anabranch had second highest concentrations and was significantly higher than some other zones. At present, no AWQG have been published for aluminium in marine waters (ANZECC/ARMCANZ, 2000) (Anderson *et al.*, 2007).

Oyster

Most zones with the exceptions of mid and Outer harbour and Baseline had more elevated oyster aluminium concentrations than Oceanic reference zone oysters, however oysters in impact zones did not vary significantly from the estuarine reference oysters. Estuarine impact zones had the highest concentrations (Anderson *et al.*, 2007).

Summary of aluminium concentrations

Similar accumulation trends for impact zones were not observed for DGT-labile and oyster aluminium among zones, however, the Oceanic reference zone tended to have the lowest concentrations and Anabranch some of the highest in both mediums (Anderson *et al.*, 2007).

Cadmium

DGT

DGT-labile cadmium concentrations were similar among zones. The Estuarine reference zone had the lowest cadmium concentrations but this was not significantly different to most other zones. The Oceanic reference site reported the highest concentrations but there was high variation among sites and again this zone was not significantly different to most other zones. DGT-labile cadmium concentrations at all sites were well below the AWQG 95% trigger value for cadmium in marine waters, 5.5µg/L (ANZECC/ARMCANZ, 2000) (Anderson *et al.*, 2007).

Oyster

Baseline, Outer harbour and Oceanic reference zone oysters had the highest concentrations of oyster cadmium with the first two zones being significantly higher than all remaining zones. There was a trend for more estuarine zones to have the lowest concentrations but most zones were not significantly different from one another (Anderson *et al.*, 2007).

Summary of cadmium concentrations

DGT-labile cadmium appeared to demonstrate a different trend to oyster cadmium in terms of accumulation among zones, however the Oceanic reference tended to have some of the highest concentrations in both mediums (Anderson *et al.*, 2007).

Cobalt

DGT

The Oceanic reference and Outer harbour zones tended to have lowest cobalt concentrations but were not significantly different to Auckland Ck. and mid harbour zones. The Anabranch had highest cobalt values but there was no significant difference to the Narrows, the estuarine reference and South Trees zones. DGT-labile cobalt concentrations at all sites were well below the AWQG 95% trigger value for cobalt in marine waters, 1.0µg/L (ANZECC/ARMCANZ, 2000) (Anderson *et al.*, 2007).

Oyster

Oyster cobalt accumulation was below the laboratory limits of accurate detection in Baseline oysters, the Narrows, South Trees, Reference estuarine, mid and outer harbour zones. All other zones were not significantly different from each other, with Anabranch tending to have the highest oyster cobalt concentrations (Anderson *et al.*, 2007).

Summary of cobalt concentrations

DGT-labile cobalt and oyster cobalt accumulation patterns were not similar among zones, however Anabranch had the highest and Outer harbour the lowest concentrations of cobalt in both mediums (Anderson *et al.*, 2007).

Chromium

DGT

Most values in estuarine impact sites including Wiggins Island, Calliope, Mid, Outer and Anabranch zones, were below the accepted laboratory limits of accurate detection, 0.077µg/L. Fisherman's Landing had the highest chromium concentrations but was not significantly different to all remaining zones above the detection limit. All sites were well below the AWQG 95% trigger value for chromium (III) in marine waters, 27µg/L (Anderson *et al.*, 2007).

Oyster

Most oyster chromium concentrations were below limits of detection (<0.5µg/g) and, thus were not plotted (Anderson *et al.*, 2007).

Iron

DGT

DGT-labile iron concentrations were not significantly different among all zones, except for the South Trees zone, which had highest concentrations. However, there was a large variation in data from the South Trees zone which was again influenced by particularly high results at B8 adjacent to BSL wharf. At present, no AWQG have been published for iron in marine waters (ANZECC/ARMCANZ, 2000) (Anderson *et al.*, 2007).

Oyster

Baseline oysters and the Oceanic reference reported the lowest oyster iron concentrations, but were not significantly different from the Outer harbour, South Trees and Estuarine reference zones. Highest concentrations were observed at Calliope Anabranch, but again concentrations were not significantly different to other estuarine impact zones. Auckland zone was influenced by higher concentrations in the upper catchment (Anderson *et al.*, 2007).

Summary of iron concentrations

DGT-labile and oyster iron concentrations did not demonstrate a similar pattern of uptake among zones (Anderson *et al.*, 2007).

Manganese

DGT

DGT-labile manganese concentrations were highest in the Anabranch zone and significantly more elevated than all other zones except the Narrows, South Trees, Estuarine reference and Calliope

River. Oceanic reference and Outer harbour zones had the lowest manganese concentrations, but were not significantly different from most other zones, with some degree of overlap. At present, not AWQG have been published for manganese in marine waters (ANZECC/ARMCANZ, 2000) (Anderson *et al.*, 2007).

Oyster

Oyster manganese was highest in the Calliope River but concentrations were not significantly higher than Anabranch, Wiggins or Auckland zones. Baseline had lowest oyster manganese concentrations which were significantly lower than all other zones. There was a trend for concentrations to be lowest in the mid to outer harbour and Oceanic reference zones. Most zones had similar concentrations to estuarine reference oysters (Anderson *et al.*, 2007).

Summary of manganese results

Some similar trends were observed for DGT-labile and oyster manganese concentrations, with higher values found in estuarine zones and lowest in the Oceanic reference and mid to Outer harbour zones (Anderson *et al.*, 2007).

Nickel

DGT

All harbour impact zones demonstrated significantly higher DGT-labile nickel concentrations than the Outer harbour and both reference zones, which were not significantly different from each other. Concentrations in the Narrows tended to be highest but not significantly different from Wiggins Island, Anabranch and Fisherman's Landing. All sites were well below the AWQG 95% trigger value for nickel in marine waters, 70µg/L (ANZECC/ARMCANZ, 2000 (Anderson *et al.*, 2007)).

Oyster

Baseline and Estuarine reference zone nickel concentrations were lowest but not significantly lower than most impact zones. Oyster nickel concentrations were highest in the Narrows but again not significantly different from most zones (Anderson *et al.*, 2007).

Summary of nickel results

DGT and oysters followed some similar patterns for nickel with highest concentrations in the Narrows (Anderson *et al.*, 2007).

Lead

DGT

There was no significant difference among most zones with respect to DGT-labile lead concentrations. However South Trees had higher concentrations than all other zones except mid harbour and Oceanic reference sites. Again the South Trees zone was influenced by particularly high concentrations at B8 adjacent to BSL wharf. Concentrations at all sites were well below the AWQG 95% trigger value for lead in marine waters, 4.4µg/L (ANZECC/ARMCANZ, 2000) (Anderson *et al.*, 2007).

Oyster

Oyster lead concentrations were all below the accepted laboratory limits of accurate detection (0.4µg/g) (Anderson *et al.*, 2007).

Silver

Oyster

Calliope River zone contained one of the lowest oyster silver concentrations, but was not significantly different from Anabranch, Narrows and Wiggins Island zones. Highest concentrations were observed for the Outer harbour, but Baseline oysters, the Oceanic reference and mid harbour zones had similar values (Anderson *et al.*, 2007).

Arsenic

Oyster

Oyster arsenic concentrations were fairly similar among zones. Estuarine impact zones tended to have lowest concentrations, whereas the reference and oceanic zones were among the highest concentrations (Anderson *et al.*, 2007).

Gallium

Oyster

All oysters contained gallium concentrations which were below the analytical detection limit of 0.5µg/g. Thus no site comparison can be made (Anderson *et al.*, 2007).

Mercury

Oyster

Oceanic Reference, Mid and Outer harbour zones contained some of the highest oyster mercury concentrations, but were not significantly different to Wiggins Island, Fisherman's and Estuarine reference zones. The Narrows tended to have lowest mercury concentrations, but was not significantly different to other estuarine impact zones or Baseline (Anderson *et al.*, 2007).

Molybdenum

Oyster

Anabranch, Calliope River, Fisherman's and the Narrows zones contained oyster molybdenum concentrations that were below the limit of analytical detection. However these zones were not significantly different to most other zones except for Baseline oysters, which had significantly higher concentrations than all other zones except Outer harbour (Anderson *et al.*, 2007).

Selenium

Oyster

There was a trend for lowest oyster selenium concentrations in the reference, baseline and outer harbour zone oysters however there was a fair degree of overlap among all sites (Anderson *et al.*, 2007).

Vanadium

Oyster

Most concentrations were similar among all zones in terms of oyster vanadium concentrations with no clear patter of accumulation (Anderson *et al.*, 2007).

4.8.4.3 Spatial Variation in Physicochemical properties and Metal concentrations along the Harbour

Sampling was undertaken along a NW to SE transect from the Narrows to the mid harbour zone and then a Northern transect to the Outer harbour zone to determine if gradients of metal concentrations exist from inner harbour to outer harbour. The transect would be influenced by several diffuse source discharges from the surrounding catchment areas, point source discharges from Fisherman's Landing, the Calliope River, Auckland Creek and the RG Tanna Coal Facility, prior to exiting the harbour (Anderson *et al.*, 2007).

Spatial patterns of physicochemical properties in addition to metal concentrations in both DGT devices and oysters were plotted, in order to elucidate any visual geographic trends and anthropogenic influences in the data. Fifteen sites located along the harbour (QE6, the most upstream site in the Narrows to P6 on the oceanic side of Curtis Island) were plotted in the geographical analysis (Anderson *et al.*, 2007).

Physicochemical properties

Temperature tended to increase slightly from upstream to Fisherman's Landing before peaking at the Calliope River mouth and Wiggins seagrass beds (GN3-1 to N2-1), which were around one to two degrees warmer than all other sites in the transect. After declining to background the outer transect remained steady. Turbidity increased around the same sites, but decreased again towards the outer harbour. There was a slight decreasing gradient for conductivity from the Narrows towards the Outer harbour. An opposite trend existed for dissolved oxygen and pH, which showed an overall increasing trend from the Narrows towards the outer harbour. There was a slight decrease for ORP in the middle of the transect which, increased again in the outer harbour (Anderson *et al.*, 2007).

Metal concentrations

Copper

Low DGT-labile copper concentrations were observed in the Narrows with a steep increasing gradient to the mid harbour peaking at site P1 before declining again to the outer harbour. A similar pattern was seen for oyster copper concentrations (Anderson *et al.*, 2007).

Aluminium

No clear pattern was observed for DGT-labile and oyster aluminium concentrations, as they were quite variable. However, a peak was seen in both mediums at site P1 with considerably higher concentrations than surrounding sites (Anderson *et al.*, 2007).

Cadmium

Overall there was a slight decreasing gradient in DGT-labile cadmium concentrations, except for two peaks at the mid harbour, with the peak at P1 being more than double the concentration at site GN3-1. An opposite trend was observed for oyster cadmium concentrations (Anderson *et al.*, 2007).

Chromium

Although DGT-labile chromium concentrations were quite variable, there was an overall decreasing gradient towards the outer harbour, except for a peak at site GN3-1. Concentrations slightly increased again from the mid harbour towards the outer harbour. Oyster chromium was not plotted as most concentrations were below limits of detection (Anderson *et al.*, 2007).

Zinc

Oyster zinc concentrations followed an almost identical pattern to DGT copper, more than doubling along the length of the harbour transect from the Narrows to a peak at mid harbour site P1. Concentrations decreased again towards the outer harbour. DGT-labile zinc was below limits of detection (Anderson *et al.*, 2007).

Cobalt

There was a decreasing gradient for DGT-labile cobalt concentrations along the length of the transect. Oyster cobalt concentrations also decreased slightly along the transect however, the mid harbour area showed some minor elevations (Anderson *et al.*, 2007).

Iron

There was also a slight decrease of iron concentrations in DGT, with large peaks in the mid harbour area particularly GN3-1. Oyster iron concentrations demonstrated a similar pattern peaking in the mid to outer harbour area, particularly P1 and P3 before sharply declining to the outer harbour (Anderson *et al.*, 2007).

Manganese

DGT-labile manganese concentrations were very variable along the transect, however an overall decreasing gradient was observed. One of the peaks was again located around P1. Oyster manganese concentrations were also quite variable, but some elevations were apparent towards the mid harbour section, declining to the outer harbour (Anderson *et al.*, 2007).

Lead

Lead concentrations in DGT were quite variable along the transect, however peaks at sites GN3-2 and P1 in the mid harbour area were more than double the concentration of the remainder of the transect. Oyster lead concentrations were below limits of detection (Anderson *et al.*, 2007).

Nickel

A decreasing gradient was observed for nickel concentrations in both DGT and oysters, however the gradient was more pronounced in DGT. A peak was observed at site N2-1 (Calliope mouth) in DGT (Anderson *et al.*, 2007).

Silver

There was a trend for increasing silver concentrations along the length of the harbour, with lowest concentrations upstream in the Narrows and highest concentrations near the outer harbour (Anderson *et al.*, 2007).

Arsenic

Arsenic concentrations in oysters were very variable along the length of the harbour. However, there was a slight trend for lower concentrations in the Narrows and higher concentrations in the outer harbour (Anderson *et al.*, 2007).

Mercury

Similar to silver, there was an increasing gradient for mercury concentrations in oysters. A peak was observed at site P3 (Anderson *et al.*, 2007).

Molybdenum

Molybdenum concentrations in oysters were below detectable limits at all sites upstream to GN3-2 in the mid harbour. No trend was apparent at outer harbour sites (Anderson *et al.*, 2007).

Selenium

There was a trend for increasing selenium concentrations in oysters from the Narrows to site GN3-3 in the mid harbour section of the transect, before declining again to the outer harbour (Anderson *et al.*, 2007).

Vanadium

Vanadium concentrations demonstrated an increasing gradient from the Narrows to mid harbour before declining again at the outer harbour. Two peaks were observed at sites N2-1 to P3 (Anderson *et al.*, 2007).

4.8.4.4 Conclusion

An assessment of water physicochemistry and metal concentrations in conjunction with oyster metal concentrations in the CQPA receiving environment in comparison to reference zones, indicates the area conforms to current Australian water quality guidelines. Similar patterns of accumulation of metals to the 2005 survey were evident.

Although inner harbour and estuarine zones generally exhibited higher elevations of most metals in both DGT and oysters, for the most part the concentrations were not significantly more elevated than the Outer harbour or reference zones. A hyperthermic influence was evident in the Calliope River in 2006 as it was in 2005 and persisted for some length along the transect. The effect of this thermal influence on the ecology of the river is not currently known. The Anabranch, South Trees, Auckland and Wiggins zones tended to have some of the highest concentrations for both DGT and oysters (Anderson *et al.*, 2007).

Copper which exceeded the 99% trigger value in 2005 conformed to this guideline in 2006, however cobalt remains problematic in most estuarine zones. A transect through the harbour zone demonstrated that a decreasing metal gradient also exists for some metals from inner harbour to outer harbour, however an anthropogenic influence can be also observed in the middle harbour area. The change in design for gradient analysis, incorporating additional sites along the length of the creek by creating sub-sites provides greater power to detect changes, by providing greater spatial coverage and reducing intersite distance. Analyses show this to be a very effective approach to detecting elevated metal levels and gradients for those metals (Anderson *et al.*, 2007).

4.8.5 Biomonitoring 2007

4.8.5.1 Zones and monitoring sites

New sites were added in 2007 so the Narrows and Auckland Creek zones were extended and an additional reference site established. Abbreviated zone names are listed in Table 4-16 while the 2007 zones are illustrated in Figure 4-8.

Table 4-16 Zones for Biomonitoring sites within Port Curtis (Anderson *et al.*, 2008)

*Where a transect has been plotted within a zone, the name of the transect has been added to the zone name in parentheses. * indicates North Harbour reported zones.*

Zone No.	Zone name	Abbreviated zone name
1*	Narrows	NW
2*	Grahams Creek (Grahams Crk)	GC
3*	Fisherman's Landing	FL
4*	Boat Creek (Boat Crk)	BC
5*	Wiggins Island	WI
6*	Calliope Anabranch (Anabranch)	Ana
7*	Calliope River (Calliope River)	CR
8*	Auckland Creek (Auckland Crk)	AC
9*	Mid Harbour	Mid
10	Inner Harbour – South Trees	IH
11	South Trees – North (Sth Trees Inlet)	STN
12	Wapentake Creek (Nth & Sth of Crk)	WC
13	South Trees – Mid (Sth Trees Inlet)	STM
14	South Trees – South (Sth Trees Inlet)	STS
15	Spillway Creek (Spillway Crk)	SC
16	Boyne Tannum (Boyne River)	BT
17*	Outer Harbour	Out
18*	Reference – Estuarine 1	RE1
19*	Reference - Oceanic	RO
20*	Reference - Estuarine 2	RE2

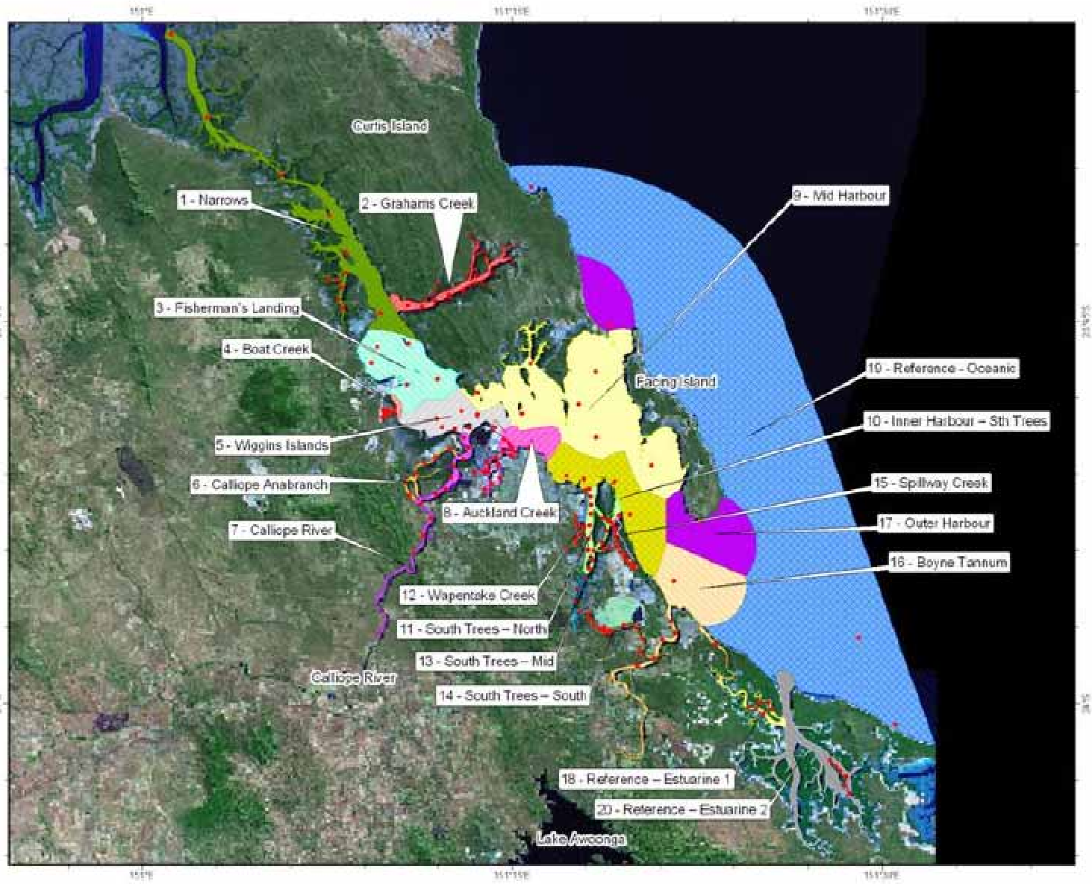


Figure 4-8 PCIMP 2007 Biomonitoring zones (Anderson *et al.*, 2008)

4.8.5.2 Physicochemical

Physicochemical characteristics were recorded on three occasions throughout July and September 2007. Temperature, conductivity, dissolved oxygen, pH and turbidity was measured using a YSI water quality meter just below the surface. Results are recorded in Table 4-17.

Table 4-17 Physicochemical characteristics in the North harbour zones (Anderson *et al.*, 2008)

Values are means ± SE (n = 2 to 25). Values shaded in yellow indicate those which are outside the AWQG range recommended by ANZECC/ARMCANZ (2000) for tropical estuarine waters.

Zone	Temperature (ºC)		Conductivity (mS/cm)		Dissolved Oxygen (% saturation)		pH		Turbidity (NTU)	
	July	Sept	July	Sept	July	Sept	July	Sept	July	Sept
Narrows (NW)	15.7 ± 0.3	20.6 ± 0.0	54.4 ± 0.2	54.6 ± 0.1	85 ± 2	121 ± 1	8.0 ± 0.1	7.9 ± 0.0	6.3 ± 2.1	4.8 ± 1.4
Grahams Creek (GC)	15.8 ± 0.4	20.4 ± 0.0	54.4 ± 0.5	54.8 ± 0.0	81 ± 1	123 ± 1	8.0 ± 0.1	7.9 ± 0.0	3.6 ± 0.7	4.0 ± 0.9
Fisherman's Landing (FL)	16.7 ± 0.7	21.8 ± 0.4	54.7 ± 0.1	55.0 ± 0.1	87 ± 3	127 ± 2	8.1 ± 0.1	8.0 ± 0.0	5.7 ± 1.4	3.9 ± 1.6
Boat Creek (BC)	14.5 ± 0.6	19.6 ± 0.2	56.1 ± 0.6	55.3 ± 0.2	89 ± 4	115 ± 1	8.0 ± 0.1	8.0 ± 0.0	5.8 ± 1.0	5.8 ± 1.5
Wiggins Island (WI)	16.7 ± 0.5	22.1 ± 0.3	55.2 ± 0.2	54.7 ± 0.0	87 ± 2	128 ± 2	8.2 ± 0.1	8.0 ± 0.0	4.4 ± 1.4	2.9 ± 0.7
Anabranch (Ana)	18.9 ± 0.4	24.9 ± 0.1	55.6 ± 0.2	54.7 ± 0.0	85 ± 2	124 ± 1	8.1 ± 0.1	7.9 ± 0.0	7.6 ± 2.9	12.9 ± 1.4
Calliope River (CR)	18.6 ± 0.6	24.0 ± 0.3	55.4 ± 0.2	54.7 ± 0.0	85 ± 1	123 ± 1	8.1 ± 0.0	7.9 ± 0.0	6.3 ± 1.5	4.4 ± 0.6
Auckland Creek (AC)	16.7 ± 0.2	21.3 ± 0.1	54.7 ± 0.1	54.7 ± 0.1	87 ± 2	106 ± 1	8.2 ± 0.0	7.9 ± 0.0	3.8 ± 0.6	4.8 ± 0.7
Mid Harbour (Mid)	16.8 ± 0.3	21.4 ± 0.0	54.7 ± 0.1	54.7 ± 0.1	88 ± 3	127 ± 2	8.3 ± 0.0	8.0 ± 0.0	3.0 ± 0.6	3.5 ± 1.4
Outer Harbour (Out)	17.5 ± 0.6	20.9 ± 0.1	54.3 ± 0.3	54.2 ±0.0	98 ± 5	140 ± 1	8.4 ± 0.1	8.1 ± 0.0	0.4 ± 0.3	2.0 ± 0.4
Reference Estuarine 1 (RE1)	15.8 ± 0.1	20.7 ± 0.0	54.8 ± 0.1	54.3 ± 0.0	86 ± 1	108 ± 1	8.1 ± 0.0	8.0 ± 0.0	1.5 ± 0.4	0.6 ± 0.1
Reference Oceanic (RO)	17.3 ± 0.2	20.8 ± 0.2	53.9 ± 0.1	54.1 ± 0.0	90 ± 2	133 ± 4	8.4 ± 0.0	8.1 ± 0.0	0.2 ± 0.1	0.8 ± 0.5
Reference Estuarine 2 (RE2)	15.7 ± 0.1	20.6 ± 0.0	54.8 ± 0.0	54.7 ± 0.0	83 ± 1	109 ± 2	8.0 ± 0.0	7.9 ± 0.0	1.8 ± 0.5	0.8 ± 0.3
AWQG (tropical estuaries)	-	-	-	-	80-120	80-120	7.0-8.5	7.0-8.5	<20	<20

Temperature

A similar pattern of temperature ranges among zones was observed between July and September with Boat Creek zone exhibiting the lowest, and Calliope River and Anabranch the highest temperature in both sample periods. These differences were significantly higher or lower than the other zones, except for Boat Creek in September. Temperatures ranged from 14.5 to 19.6 ºC in Boat Creek and 18.9 to 24.9 ºC in the Anabranch, in July and September respectively (Anderson *et al.,* 2008).

Conductivity

Conductivity was not significantly different among zones in July, ranging from 53.9 mS/cm in the Oceanic Reference zone to 56.1 mS/cm in Boat Creek. These two zones again exhibited the lowest and highest conductivity respectively, in September. Values ranged from 54.1 to 55.3 mS/cm, which were statistically significantly different, but probably had little ecological significance (Anderson *et al.,* 2008).

Dissolved Oxygen

Dissolved oxygen was generally lower in July than September across all zones, ranging from 81% at Grahams Creek to 98% in the Outer Harbour in July, and 106% at Auckland Creek to 140% in the Outer harbour in September. Although all values were within the Australian Water Quality Guidelines (ANZECC/ARMCANZ, 2000) in July, nine out of thirteen zones including the Oceanic Reference were slightly above those guidelines in September (Anderson *et al.,* 2008).

pH

Slightly higher pH was observed in July (8.0 in Boat Creek to 8.4 in Oceanic Reference) compared to September (7.9 in Estuarine Reference 2 to 8.1 in Outer harbour), with all values within AWQG. Generally estuarine zones tended to have lower pH than outer harbour or more oceanic zones. Similarly higher turbidity was experienced in the more estuarine zones with the Anabranch demonstrating some of the highest values in both months although these were not significantly different than most other estuarine zones (Anderson *et al.,* 2008).

4.8.5.3 Nutrients

Nutrient results are listed below in Table 4-18. Few significant differences among zones were noted, although the Anabranch and Boat Creek zones tended to contain some of the highest nutrients and the Oceanic Reference zone the lowest.

Table 4-18 Nutrient concentrations in North Harbour Zones (Anderson *et al.,* 2008)

Values are means ± SE (n = 2 to 8) Values shaded in yellow indicate those which are outside the AWQG range recommended by ANZECC/ARMCANZ (2000) for tropical estuarine waters.

Zone	Phosphorus (µg/L)	Orthophosphate (µg/L)	Total nitrogen (µg/L)	Ammonium nitrogen (µg/L)	Kjeldahl nitrogen (µg/L)	Nitrate (µg/L)	Nitrite (µg/L)
NW	50 ± 0	<5	130 ± 20	<5	130 ± 20	<5	<5
GC	50 ± 0	<5	160 ± 60	9 ± 6	160 ± 60	<5	<5
FL	50 ± 0	<5	190 ± 20	10 ± 3	190 ± 20	<5	<5
BC	40 ± 10	<5	250 ± 10	10 ± 4	250 ± 10	<5	<5
WI	50 ± 10	<5	200 ± 10	<5	190 ± 10	<5	<5
Ana	60 ± 20	<5	260 ± 40	<5	260 ± 40	<5	<5
CR	60 ± 10	<5	180 ± 10	<5	180 ± 10	<5	<5
AC	40 ± 0	<5	200 ± 10	<5	200 ± 10	<5	<5
Mid	50 ± 0	<5	190 ± 10	<5	190 ± 10	<5	<5
Out	40 ± 10	<5	190 ± 0	<5	190 ± 0	<5	<5
RE1	<20	<5	200 ± 20	<5	200 ± 20	<5	<5
RO	40 ± 10	<5	110 ± 10	5 ± 3	110 ± 10	<5	<5
RE2	50 ± 10	<5	150 ± 10	<5	150 ± 10	<5	<5
AWQG	20		250	15		30	20

Phosphorus was elevated in all impact zones (40-60 µg/L) including two of the three reference zones (40-50 µg/L). Phosphorus in all zones was two to three times above the AWQG except the Estuarine Reference 1 zone (<20 µg/L), which could be attributed to one anomalously low reading (Anderson *et al.,* 2008).

Elevated total nitrogen was also recorded at or above AWQG in the Boat Creek (250 µg/L) and Anabranch (260 µg/L) zones, respectively, whilst all other measured nutrients remained within guidelines. Kjeldahl nitrogen is the sum of the ammonium nitrogen and organic nitrogen present in a sample. The similarity between concentrations of Kjeldahl nitrogen and those of total nitrogen (whilst ammonium nitrogen is a comparatively small proportion of the Kjeldahl nitrogen) indicates that most of the nitrogen present is in an organic form (Anderson *et al.,* 2008).

The biologically available forms, orthophosphate, nitrate and nitrite, were all below limits of detection (LOD) (Anderson *et al.,* 2008).

Increased ammonium nitrogen in areas associated with mangroves would be expected to result from breakdown of nitrogen within the anaerobic environments contained within such areas (Anderson *et al.,* 2008).

4.8.5.4 Metals

Metals results for DGT and oyster methods are displayed in Table 4-19 and Table 4-20.

Table 4-19 DGT-labile metal concentrations in North Harbour zones (Anderson *et al.,* 2008)

Values are means ± SE (n = 6 to 24). Values exceeding the appropriate AWQG are shaded in blue, green, yellow and orange, indicating exceedence of the 99%, 95%, 90% and 80% AWQG, respectively.

Zone	DGT-labile concentration (µg/L)									
	Copper	Zinc	Aluminium	Iron	Cobalt	Manganese	Nickel	Cadmium	Chromium	Lead
LOD	0.10	2.9	0.875	1.97	0.006	0.014	0.053	0.008	0.087	0.009
NW	0.12 ± 0.01	3.4 ± 0.5	1.7 ± 0.6	26 ± 11	0.09 ± 0.01	3.5 ± 0.5	0.52 ± 0.02	<0.008	0.10 ± 0.02	0.018 ± 0.004
GC	<0.10	<2.9	<0.875	6 ± 1	0.07 ± 0.00	2.2 ± 0.3	0.39 ± 0.02	0.008 ± 0.003	<0.087	0.010 ± 0.002
FL	0.12 ± 0.01	3.9 ± 1.1	<0.875	8 ± 1	0.04 ± 0.00	1.3 ± 0.1	0.34 ± 0.01	<0.008	<0.087	0.011 ± 0.002
BC	0.13 ± 0.02	<2.9	4.2 ± 3.0	36 ± 23	0.39 ± 0.08	87 ± 16	0.43 ± 0.04	<0.008	<0.087	0.021 ± 0.008
WI	0.16 ± 0.01	4.7 ± 0.9	7.2 ± 3.6	20 ± 8	0.04 ± 0.01	1.5 ± 0.3	0.29 ± 0.02	<0.008	0.09 ± 0.02	0.013 ± 0.003
Ana	0.20 ± 0.03	4.9 ± 3.0	1.7 ± 0.8	34 ± 19	0.10 ± 0.02	8.7 ± 1.7	0.37 ± 0.03	<0.008	0.22 ± 0.03	0.026 ± 0.009
CR	0.22 ± 0.02	3.7 ± 0.8	3.5 ± 0.9	18 ± 2	0.07 ± 0.00	4.8 ± 0.7	0.36 ± 0.02	<0.008	0.24 ± 0.02	0.019 ± 0.005
AC	0.24 ± 0.02	3.1 ± 0.5	<0.875	11 ± 1	0.04 ± 0.01	5.0 ± 2.2	0.26 ± 0.02	<0.008	0.15 ± 0.02	0.011 ± 0.001
Mid	0.12 ± 0.02	4.8 ± 0.8	27 ± 10	78 ± 25	0.08 ± 0.02	4.4 ± 1.4	0.24 ± 0.01	<0.008	0.15 ± 0.02	0.030 ± 0.007
Out	<0.10	3.3 ± 1.0	<0.875	8 ± 1	0.01 ± 0.00	0.7 ± 0.0	0.14 ± 0.01	<0.008	0.11 ± 0.02	<0.009
RE1	<0.10	5.0 ± 2.0	<0.875	9 ± 2	0.06 ± 0.01	3.2 ± 0.7	0.15 ± 0.01	<0.008	0.12 ± 0.02	0.020 ± 0.009
RO	<0.10	<2.9	<0.875	7 ± 1	0.01 ± 0.00	1.0 ± 0.1	0.11 ± 0.01	<0.008	0.11 ± 0.02	0.013 ± 0.002
RE2	<0.10	6.7 ± 1.8	<0.875	9 ± 1	0.07 ± 0.00	1.9 ± 0.1	0.16 ± 0.01	<0.008	<0.087	0.015 ± 0.003
AWQG									(Cr III)	
99%	0.3	7			0.005		7	0.7	7.7	2.2
95%	1.3	15			1		70	5.5	27.4	4.4
90%	3	23			14		200	14	48.6	6.6
80%	8	43			150		560	36	90.6	12

Table 4-20 Oyster metal accumulation rates in North Harbour zones (Anderson *et al.,* 2008)

Values are means ± SE (n = 5 to 24). - indicates no accumulation. Lead, gallium, molybdenum and vanadium not listed as these metals were not accumulated.

Zone	Oyster accumulation rate (µg/g/day)												
	Copper	Zinc	Aluminium	Iron	Cobalt	Manganese	Nickel	Cadmium	Chromium	Silver	Arsenic	Mercury	Selenium
NW	0.7 ± 0.1	3.2 ± 0.3	1.4 ± 0.2	2.1 ± 0.2	0.005 ± 0.000	0.04 ± 0.01	0.009 ± 0.001	-	0.005 ± 0.001	0.004 ± 0.002	0.001 ± 0.000	-	-
GC	0.7 ± 0.1	3.9 ± 0.7	0.7 ± 0.2	0.9 ± 0.2	0.001 ± 0.001	0.01 ± 0.01	0.006 ± 0.000	-	0.004 ± 0.001	-	-	0.001 ± 0.000	-
FL	0.7 ± 0.1	4.7 ± 0.4	1.4 ± 0.1	1.8 ± 0.2	0.003 ± 0.001	0.04 ± 0.01	0.004 ± 0.000	0.001 ± 0.001	0.002 ± 0.000	0.004 ± 0.003	-	0.001 ± 0.000	-
BC	0.6 ± 0.1	4.3 ± 0.5	1.8 ± 0.2	3.1 ± 0.5	0.006 ± 0.000	0.12 ± 0.03	0.004 ± 0.001	-	0.005 ± 0.001	-	-	0.001 ± 0.000	-
WI	1.0 ± 0.1	6.0 ± 0.3	1.4 ± 0.1	1.5 ± 0.2	0.001 ± 0.000	0.05 ± 0.01	0.003 ± 0.000	-	0.002 ± 0.001	0.002 ± 0.001	-	0.001 ± 0.000	-
Ana	1.1 ± 0.1	8.2 ± 1.0	1.3 ± 0.3	1.8 ± 0.4	0.003 ± 0.001	0.11 ± 0.01	0.004 ± 0.000	-	-	-	-	0.001 ± 0.000	-
CR	1.4 ± 0.1	7.0 ± 0.5	2.0 ± 0.2	2.4 ± 0.3	0.003 ± 0.001	0.15 ± 0.02	0.004 ± 0.001	-	0.003 ± 0.001	0.001 ± 0.001	-	0.001 ± 0.000	-
AC	1.5 ± 0.2	8.1 ± 0.6	1.3 ± 0.1	1.7 ± 0.2	0.001 ± 0.001	0.04 ± 0.01	0.003 ± 0.000	0.002 ± 0.001	0.002 ± 0.000	-	-	0.001 ± 0.000	-
Mid	0.6 ± 0.1	3.3 ± 0.3	0.8 ± 0.2	1.0 ± 0.2	-	0.04 ± 0.01	0.002 ± 0.000	-	0.002 ± 0.000	0.003 ± 0.001	-	0.001 ± 0.000	-
Out	0.3 ± 0.1	1.6 ± 0.3	0.8 ± 0.3	0.9 ± 0.4	-	0.03 ± 0.01	0.002 ± 0.000	-	0.001 ± 0.001	-	0.004 ± 0.002	-	-
RE1	0.2 ± 0.1	1.8 ± 0.4	0.5 ± 0.2	0.7 ± 0.3	0.001 ± 0.001	0.04 ± 0.02	0.002 ± 0.000	-	0.004 ± 0.001	-	0.030 ± 0.009	-	-
RO	0.2 ± 0.0	0.7 ± 0.4	0.5 ± 0.1	0.8 ± 0.3	-	0.04 ± 0.02	0.004 ± 0.000	-	0.005 ± 0.001	-	0.034 ± 0.008	-	0.001 ± 0.001
RE2	0.2 ± 0.0	1.6 ± 0.4	0.5 ± 0.2	0.6 ± 0.2	0.001 ± 0.001	0.01 ± 0.01	0.001 ± 0.000	-	0.001 ± 0.000	-	0.019 ± 0.007	-	-

<u>Copper</u>

<u>DGT</u>

There was a trend for Auckland Creek, Calliope and Anabranch zones to have the highest DGT-labile copper concentrations, significantly higher than the Reference zones, Outer Harbour and Grahams Creek, which contained concentrations below laboratory limits of detection. All recorded copper concentrations were well below the AWQG 95% trigger value of 1.3 µg/L (ANZECC/ARMCANZ, 2000) (Anderson *et al.,* 2008).

Oysters

Oysters followed a similar trend to DGT for copper uptake with accumulation recorded in all zones. The accumulation rates in the Reference zones were significantly lower than all other zones, except the Outer Harbour. Highest accumulation rates were exhibited in the Auckland Creek, Calliope River and Anabranch zones (Anderson *et al.,* 2008).

Zinc

DGT

There was no significant difference among zones in DGT-labile zinc concentrations, most of which were at or below laboratory limits of detection (LOD), and all below the AWQG 95% trigger value of 15 µg/L (ANZECC/ARMCANZ, 2000). Estuarine Reference zones tended to contain the highest concentrations (Anderson *et al.,* 2008).

Oysters

Oyster zinc accumulation followed a similar pattern to that of copper accumulation in oysters with lower concentrations in the Reference and Outer harbour zones, and significantly higher concentrations at the Anabranch, Auckland Calliope and Wiggins Island zones (Anderson *et al.,* 2008).

Aluminium

DGT

Although the Mid Harbour zone exhibited the highest DGT-labile aluminium concentrations, this zone did not differ significantly from most other impact zones. There was considerable variation within the Mid Harbour zone with two sites (B7 and Q1) demonstrating concentrations that were orders of magnitude above the other sites in this zone. The Reference and Outer Harbour zones, as well as Fisherman's Landing, Grahams Creek and Auckland Creek, contained concentrations below LOD, but these were only significantly lower than the Mid Harbour zone. There are currently no AWQG for aluminium (Anderson *et al.,* 2008).

Oysters

Similar to the DGTs, Reference and Outer Harbour zone oysters accumulated the least aluminium. The Calliope River and Boat Creek oysters exhibited the highest aluminium accumulation but were not significantly more elevated than most of the other impact sites (Anderson *et al.,* 2008).

Iron

DGT

Similar to aluminium, the Mid Harbour zone exhibited the highest DGT-labile iron concentrations, although this zone only differed significantly from Grahams Creek. There was substantial variation within the Mid Harbour zone with two sites (B7 and Q1) largely contributing to the elevated value. Similar to aluminium, the Reference and Outer Harbour zones contained the lowest DGT-labile iron concentrations but were similar to all other zones. There are currently no AWQG for iron (Anderson *et al.,* 2008).

Oysters

Oyster iron accumulation was similar to aluminium. The highest accumulation was evident at Boat Creek, significantly higher than all zones except the Calliope River, Narrows, Anabranch, Fisherman's Landing and Auckland Creek. The lowest iron accumulation was observed in oysters from the Reference zones, with iron significantly lower than in Boat Creek and Calliope River (Anderson *et al.,* 2008).

Cobalt

DGT

Concentrations of DGT-labile cobalt were significantly higher in Boat Creek than all other zones, which were generally similar to one another. Mean concentrations in Boat Creek were almost four times more elevated than in the Anabranch, which contained the next highest concentration. The Outer Harbour and Oceanic Reference zones contained the lowest concentrations, significantly lower than all zones except Fisherman's Landing, Wiggins Island and Auckland Creek. All mean zone concentrations, including those at the Reference zones, exceeded the AWQG 99% trigger value of 0.005µg/L, but were below the AWQG 95% trigger value of 1 µg/L (ANZECC/ARMCANZ, 2000) (Anderson *et al.,* 2008).

Oysters

The highest oyster accumulation rates of cobalt were also observed in the Boat Creek zone, significantly higher than all zones except the Narrows, Calliope River, Anabranch, Fisherman's Landing and Grahams Creek zones. There was no cobalt accumulation in the Mid Harbour, Outer Harbour or Oceanic Reference zones (Anderson *et al.,* 2008).

Manganese

DGT

DGT-labile manganese demonstrated a similar pattern to cobalt with significantly higher concentrations in Boat Creek in comparison with all other zones. Manganese in Boat Creek was up to 10 times higher than the Anabranch, which contained the next highest concentration. In turn, the Anabranch was also significantly higher than all remaining zones except Auckland Creek and Calliope River. The Outer Harbour and Oceanic Reference zones contained the lowest concentrations and differed significantly from Boat Creek, the Anabranch and Auckland Creek. There are currently no AWQG for manganese in marine waters (Anderson *et al.,* 2008).

Oysters

Although Boat Creek contained the second highest oyster manganese accumulation rate, it did not differ significantly from the Calliope River, Anabranch or Wiggins Island zones. The former three zones, however, were significantly more elevated than all other zones. Lowest concentrations were observed at the Estuarine Reference zones and Grahams Creek but were not significantly lower than most other zones (Anderson *et al.,* 2008).

Nickel

DGT

The Narrows zone exhibited significantly higher DGT-labile nickel concentrations than all zones sites, except Boat Creek and Grahams Creek. The Reference and Outer Harbour zones contained significantly lower DGT-labile nickel concentrations than all other zones except for the Mid Harbour zone. All concentrations of nickel were well below the AWQG 99% trigger value of 7 µg/L (ANZECC/ARMCANZ, 2000) (Anderson *et al.,* 2008).

Oysters

Nickel accumulation in oysters exhibited a similar trend to the DGT results. The Narrows contained significantly higher accumulation rates than all other zones, except Grahams Creek, which was similar to most other impact sites. The Estuarine Reference zones contained the lowest nickel accumulation rates, and only differed significantly from the Narrows and Grahams Creek (Anderson *et al.,* 2008).

Chromium

DGT

The Calliope River and Anabranch tended to contain the highest DGT-labile chromium concentrations, but concentrations did not vary significantly from the Oceanic Reference and Estuarine Reference 1. Mean concentrations at all zones were below the AWQG 99% trigger value of 7.7 µg/L (ANZECC/ARMCANZ, 2000) for chromium (III) which is the predominant species accumulated by the DGT devices used in this study. However, chromium (VI) oxyanions are also expected to be present in marine waters. Concentrations of chromium were below LOD at the Estuarine Reference 1, Grahams Creek, Fisherman's Landing and Boat Creek zones (Anderson *et al.,* 2008).

Oysters

Apart from the Anabranch and Estuarine Reference 2 zones, which exhibited the highest and lowest oyster chromium accumulation rates respectively, there were few similarities between DGT-labile and oyster chromium accumulation rates among zones. Most zones did not differ significantly from one another (Anderson *et al.,* 2008).

Lead

DGT-labile lead concentrations did not differ significantly among the zones. All concentrations were well below the AWQG 99% trigger value of 2.2 µg/L (ANZECC/ARMCANZ, 2000).

The following metals are reported only for oysters as these metals are currently not measured in DGT. Gallium, molybdenum and vanadium were not accumulated by oysters at any site, while selenium demonstrated low accumulation rates at three sites only: QE10, C2 and R1.

Silver

Silver was accumulated by oysters in five zones only; Narrows, Fisherman's Landing, Mid Harbour, Wiggins Island and Calliope River. No significant differences were observed among these zones (Anderson *et al.,* 2008).

Arsenic

Although recorded in only six zones, there was significantly higher arsenic accumulation in the Oceanic Reference and Estuarine Reference 1 zones. The Estuarine Reference 2 zone was also significantly elevated in comparison with all remaining zones. Oysters in the Outer Harbour, Narrows and Mid Harbour zones also accumulated low levels of arsenic (Anderson *et al.,* 2008).

4.8.5.5 Conclusions

Temporal differences were again observed between the July and September sampling, similar to the 2006 monitoring program, indicating the importance of seasonal sampling particularly for physicochemical properties. The effect of rainfall although minimal, was also obvious during both years. The effect of significant rainfall events on physicochemistry and metal concentrations in Port Curtis is yet unknown and requires investigation (Anderson *et al.,* 2008).

Elevated temperatures in the Calliope River, attributed to the Gladstone power station discharge, are constant and widely distributed. The effect of long term temperature elevation on biodiversity is unknown but has recently been highlighted in light of concerns over the effects of climate change. Increased water temperature may lead to increased algal growth, thus providing habitat for invertebrates, which in turn provides an increased food source for fish. In contrast, the increased algal growth may lead to the dominance of one algal species which out-competes all other algal and seagrass species, which may lead to a decline in dugong populations (Anderson *et al.,* 2008).

Anomalous conditions in Boat Creek in comparison with other Port Curtis estuaries have been highlighted during the previous three years of PCIMP monitoring. This has included lower pH and higher conductivity, coupled with uncharacteristically high concentrations of some metals particularly in DGT. The results suggest the possibility of a ground water intrusion or surface water runoff in the upper reaches of Boat Creek which warrants further investigation (Anderson *et al.,* 2008).

Elevated total phosphorus was identified at all major sites, including reference sites, sampled in the 2007 PCIMP Biomonitoring Program, with concentrations often above AWQG. Elevated nitrogen was also observed at some sites. The elevated phosphorus is not thought to be bioavailable, but the source, whether natural or anthropogenic, is at this stage unknown (Anderson *et al.,* 2008).

The complimentary use of DGT and oysters has once again demonstrated to be a useful technique, with elevations of certain metals in DGT being confirmed by concurrent accumulation of these metals in oysters at certain sites. The monitoring has identified a consistent estuarine influence for cobalt, nickel and manganese, with elevated nickel found particularly in the Narrows area. Boat Creek has been highlighted as containing anomalously high concentrations of certain metals, with the Calliope and Anabranch also demonstrating an anthropogenic influence. The findings have been reasonably consistent over three years of monitoring and emphasize the importance of regular data collection at least annually (Anderson *et al.,* 2008).

4.9 CRC Studies

4.9.1 Aspects of statistical design for monitoring waters of Port Curtis (Harche *et al.,* 2003)

This study focused on two design aspects of the PCIMP sampling; the optimal number of macrobenthos grabs required at each sampling time and the spatial interpolation of water quality and contaminants. Spatial modelling techniques were used to investigate a range of water quality parameters to provide information on the optimal spatial configuration of sampling stations.

Water quality readings were taken in the Port Curtis area in August 2001 and February 2002 at 50 stations. The variables that were used for spatial analyses were pH, salinity, fluoride, arsenic and selenium.

The coefficient of variation maps revealed that the predictions for the variables from the sediment samples have a relatively greater variability that the predictions for the quality samples. The coefficient of variation values for arsenic in the sediment maps (Figure 4-9 and Figure 4-10) mostly fall in the range 25 to 50 percent, while the coefficient of variation values for arsenic in the water quality map for February 2002 (Figure 4-14) all the are less than or equal to 10 percent and for the August 2001 (Figure 4-12) all the coefficient of variation values are less than 25 percent.

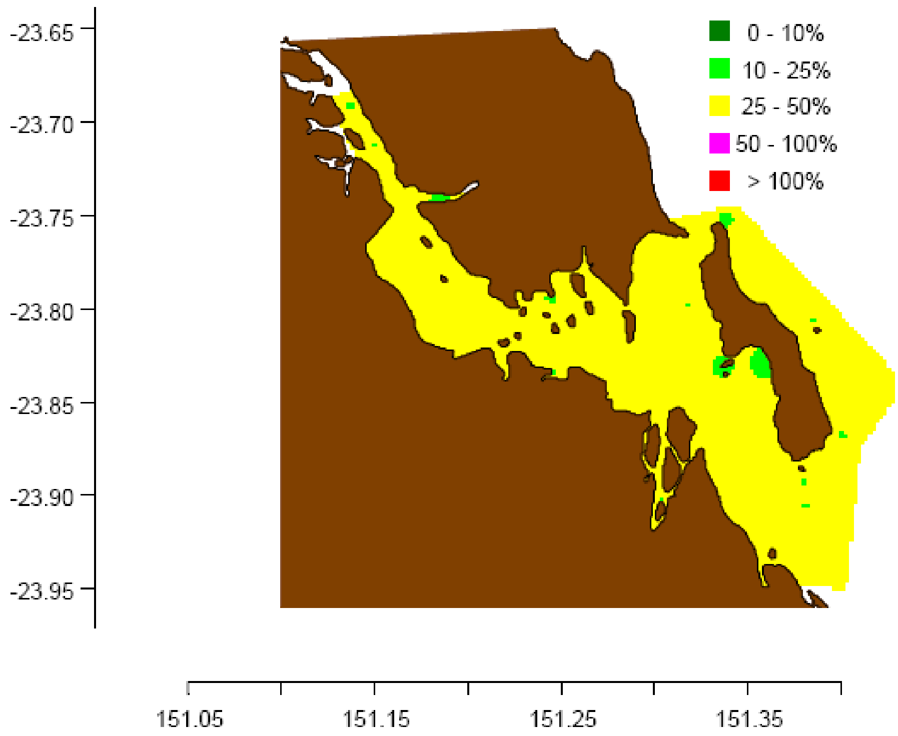


Figure 4-9 September 2001 coefficient of variation map for sediment arsenic (Harche *et al.,* 2003)

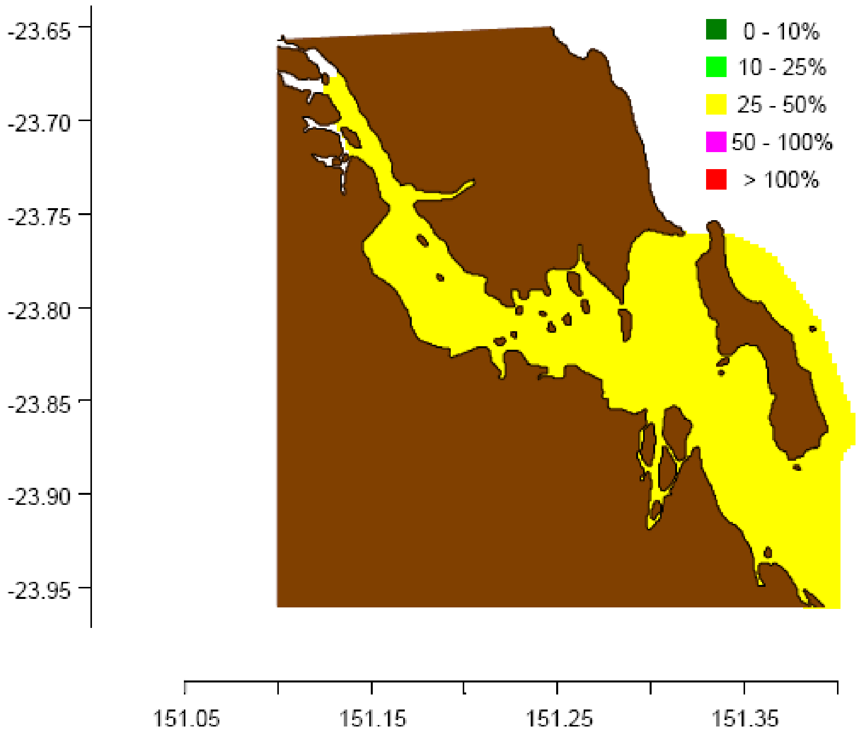


Figure 4-10 March 2002 coefficient of variation map for sediment arsenic (Harche *et al.,* 2003)

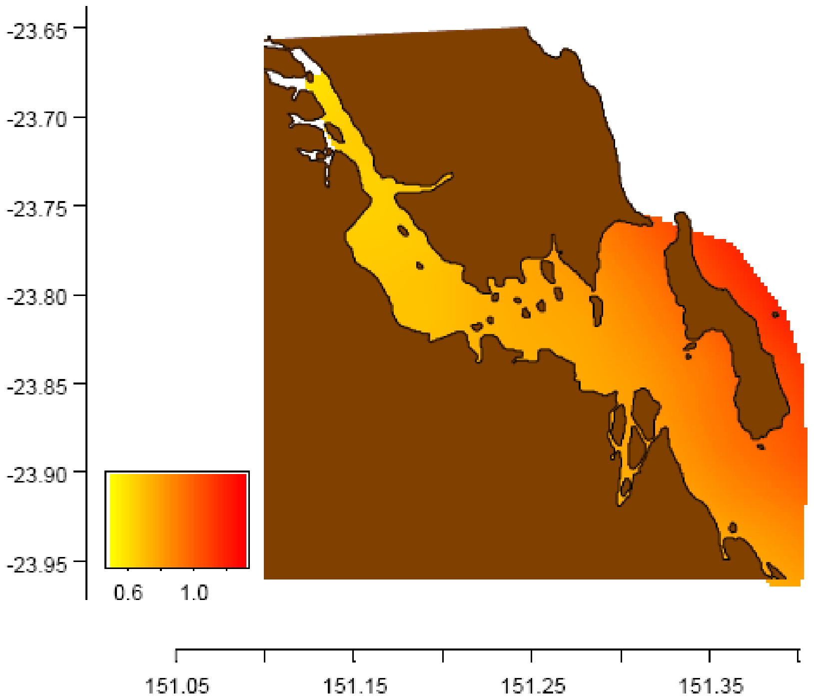


Figure 4-11 August 2001 water quality prediction map for arsenic (µg/L) (Harche *et al.,* 2003)

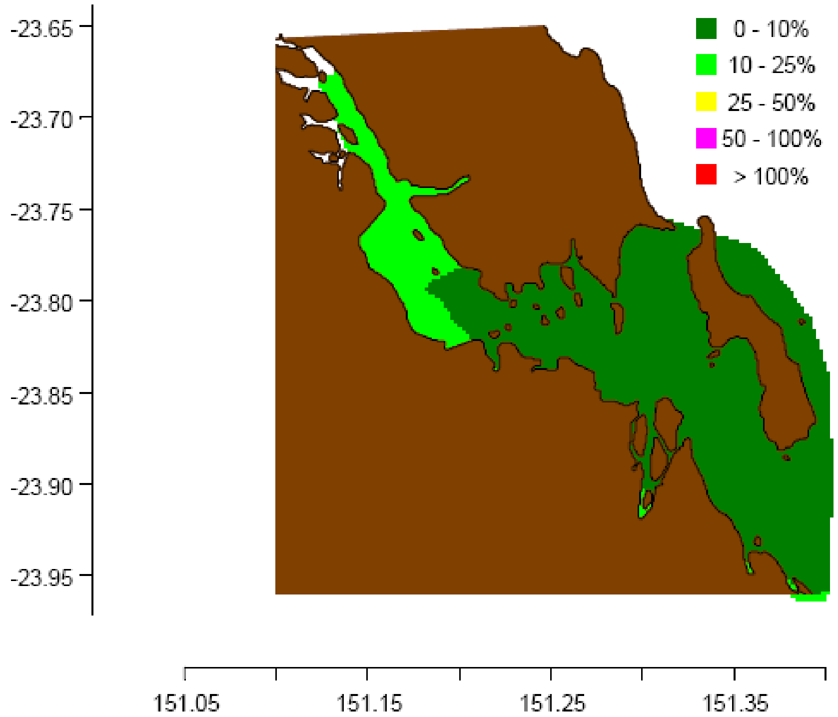


Figure 4-12 August 2001 coefficient of variation water quality map for arsenic (Harche *et al.*, 2003)

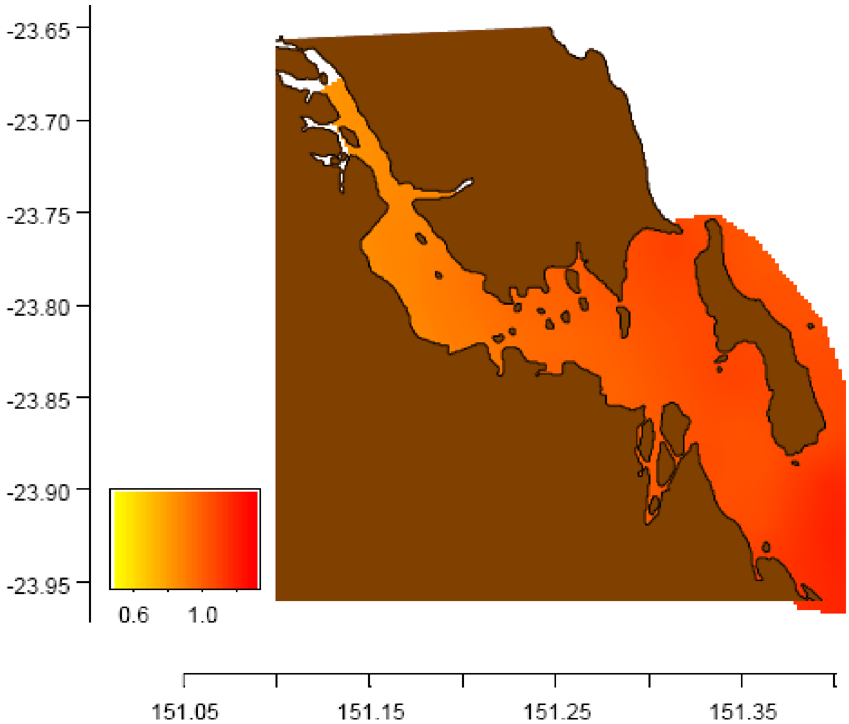


Figure 4-13 February 2002 water quality prediction map for arsenic (µg/L) (Harche *et al.*, 2003)

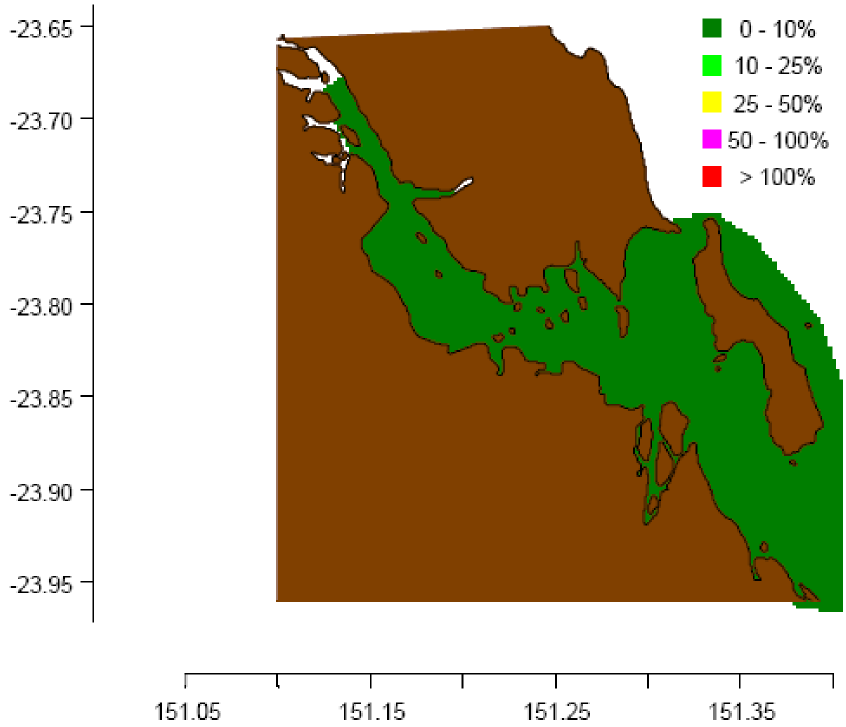


Figure 4-14 February 2002 coefficient of variation water quality map for arsenic (Harche *et al.*, 2003)

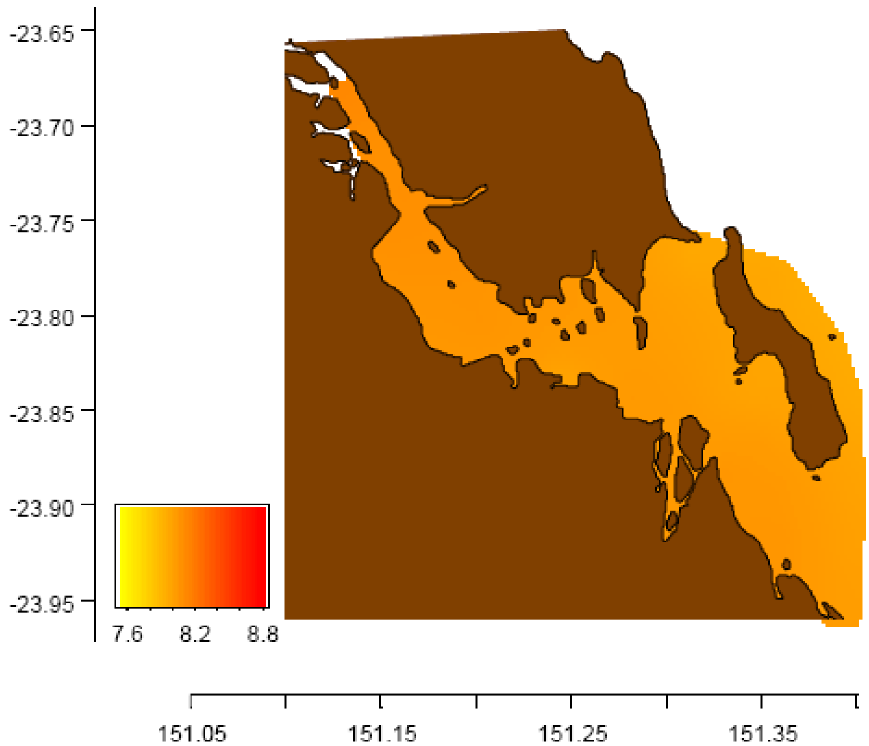


Figure 4-15 August 2001 water quality prediction map for pH (Harche *et al.*, 2003)

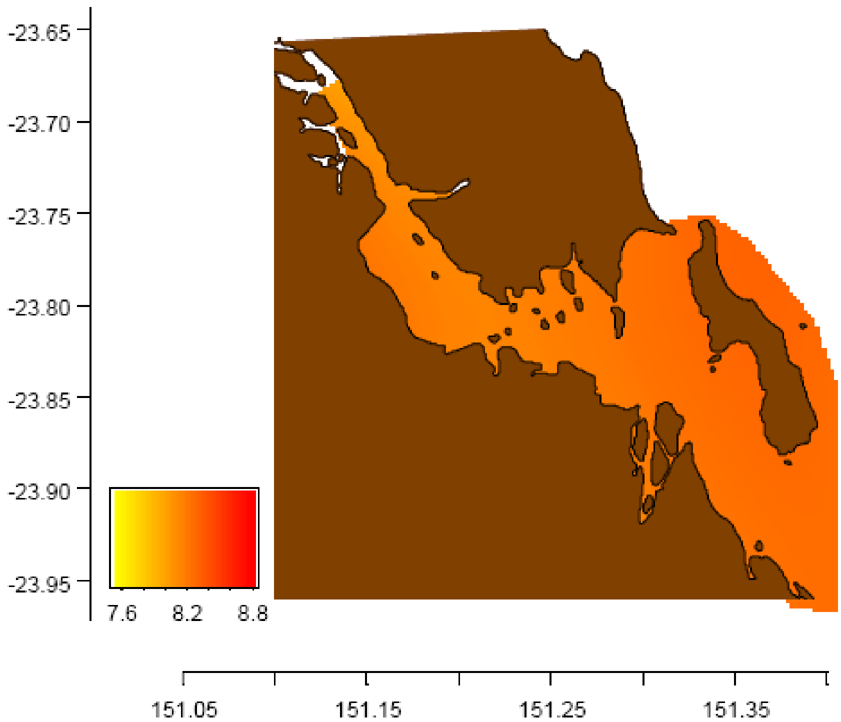


Figure 4-16 February 2002 water quality prediction map for pH (Harche *et al.*, 2003)

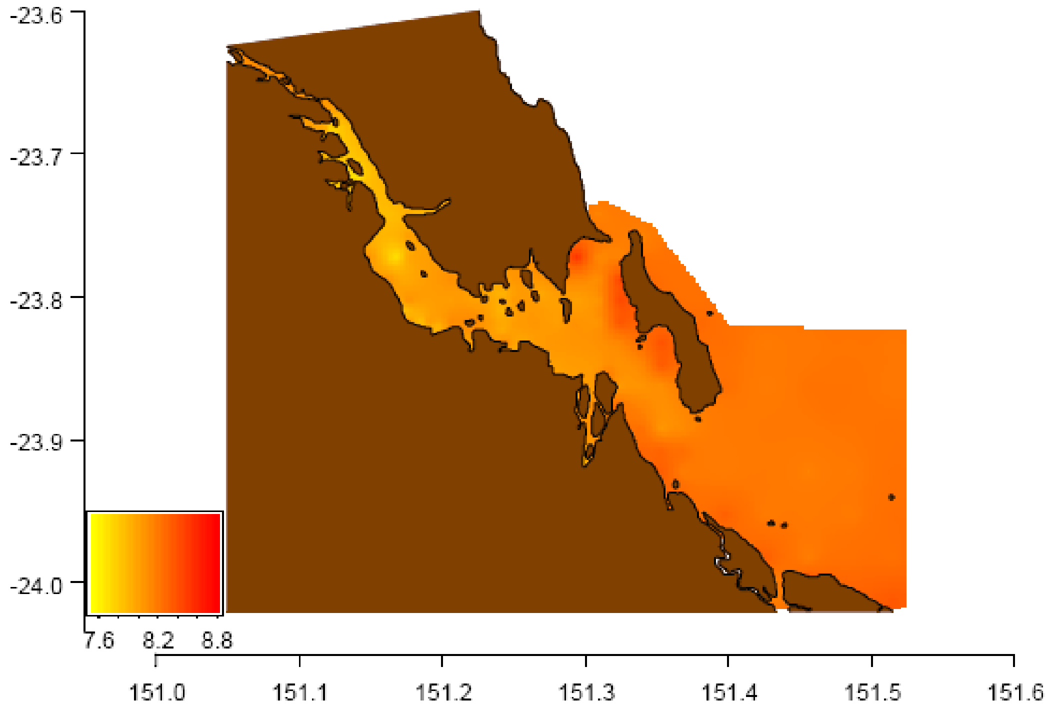


Figure 4-17 July/September 2003 intensive water quality prediction map for pH (Harche *et al.*, 2003)

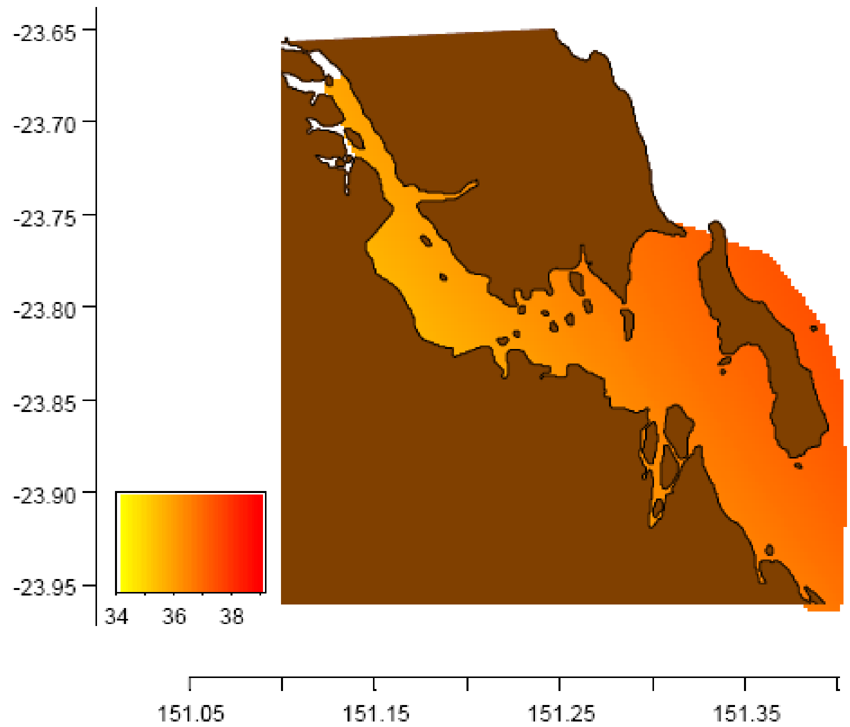


Figure 4-18 August 2001 water quality prediction map for salinity (Harche *et al.*, 2003)

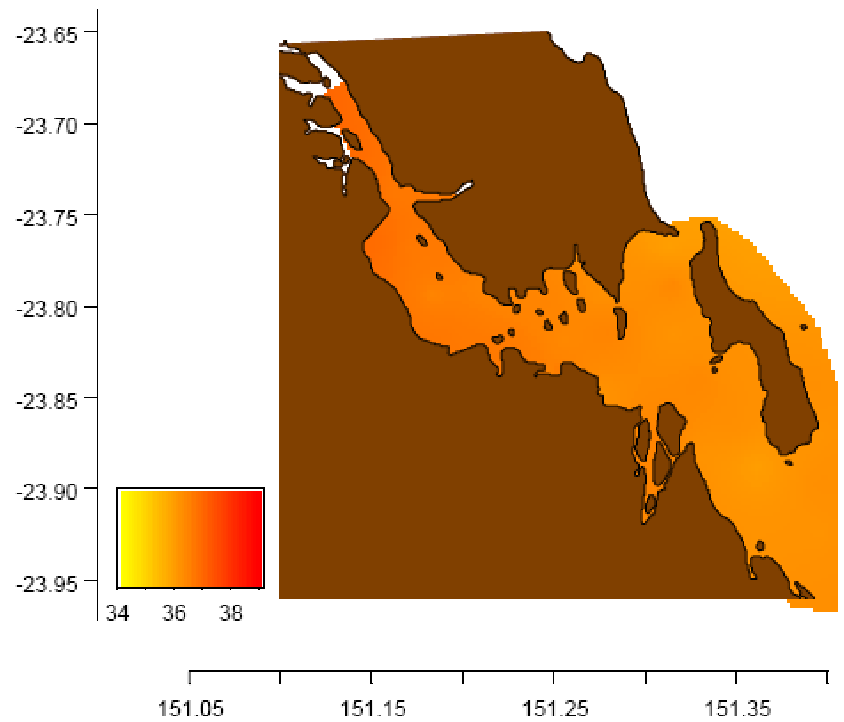


Figure 4-19 February 2002 water quality prediction map for salinity (Harche *et al.*, 2003)

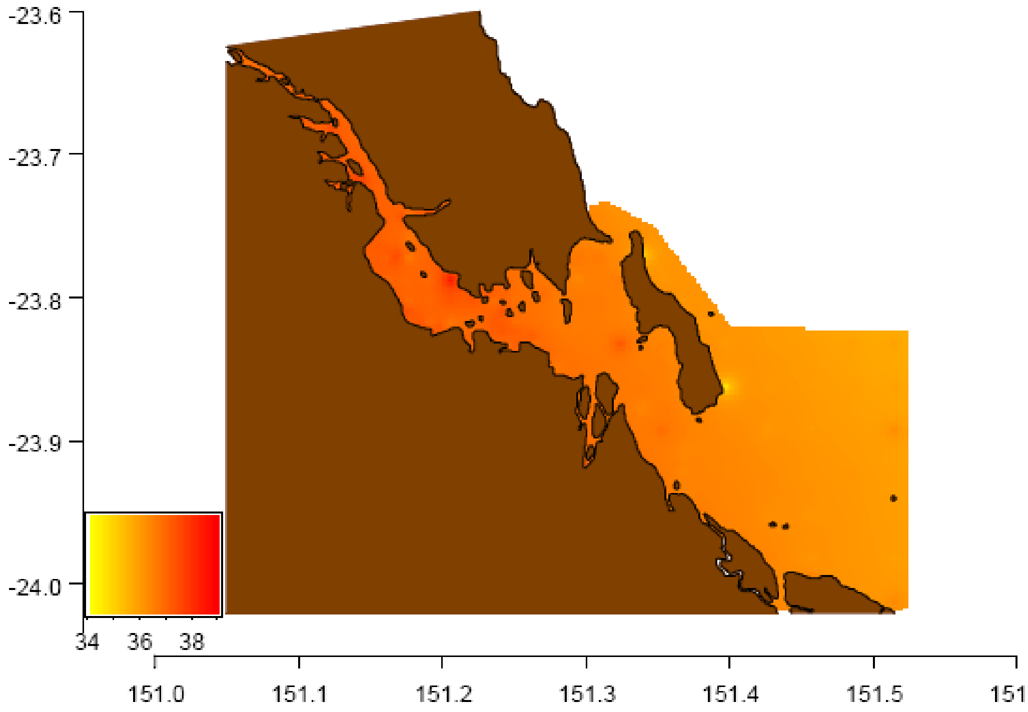


Figure 4-20 July/September 2003 intensive water quality prediction map for salinity (Harche *et al.,* 2003)

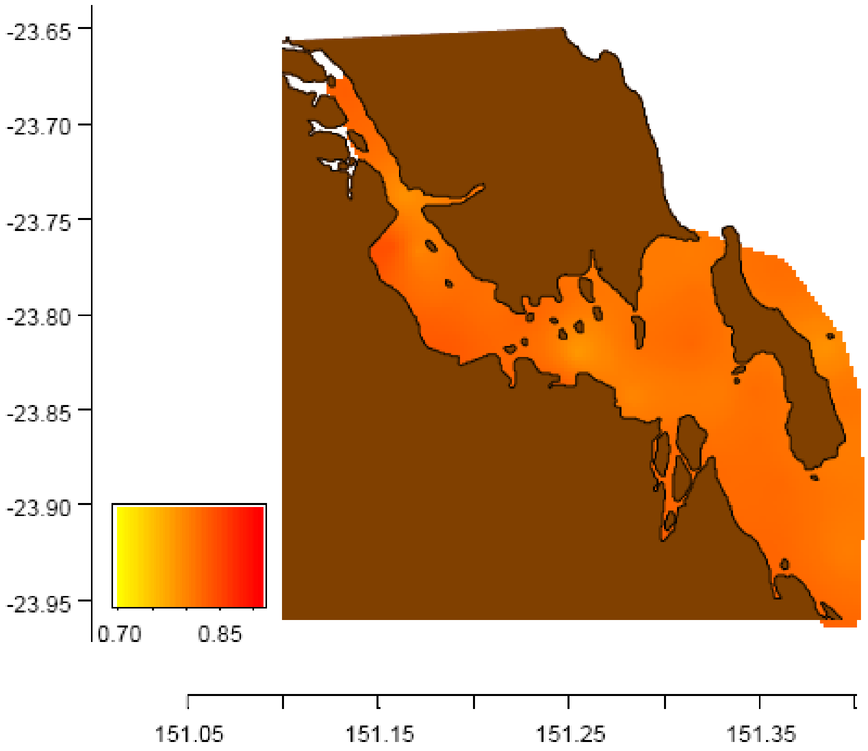


Figure 4-21 August 2001 water quality prediction map for fluoride (mg/L) (Harche *et al.,* 2003)

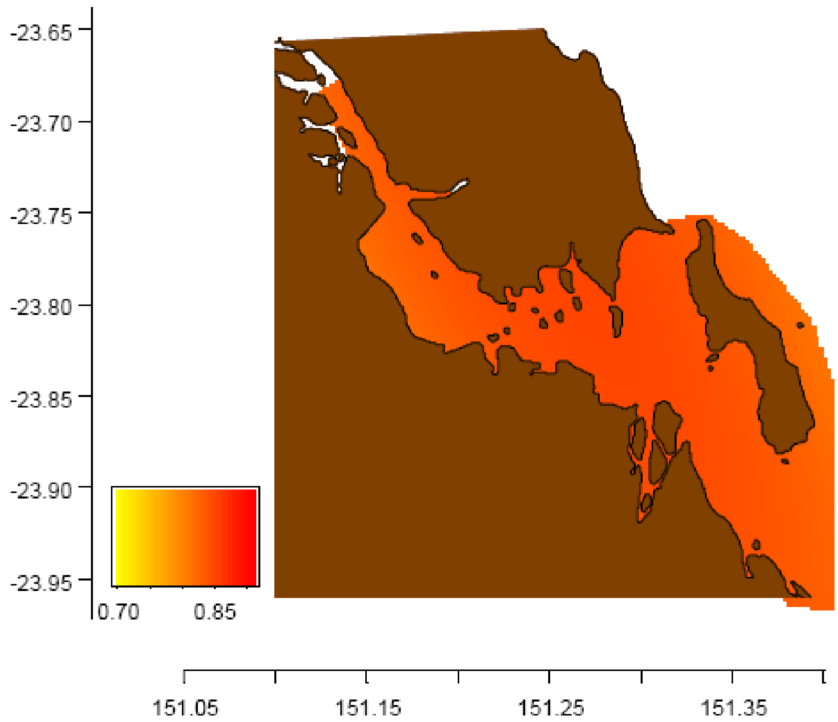


Figure 4-22 February 2002 water quality prediction map for fluoride (mg/L) (Harche *et al.*, 2003)

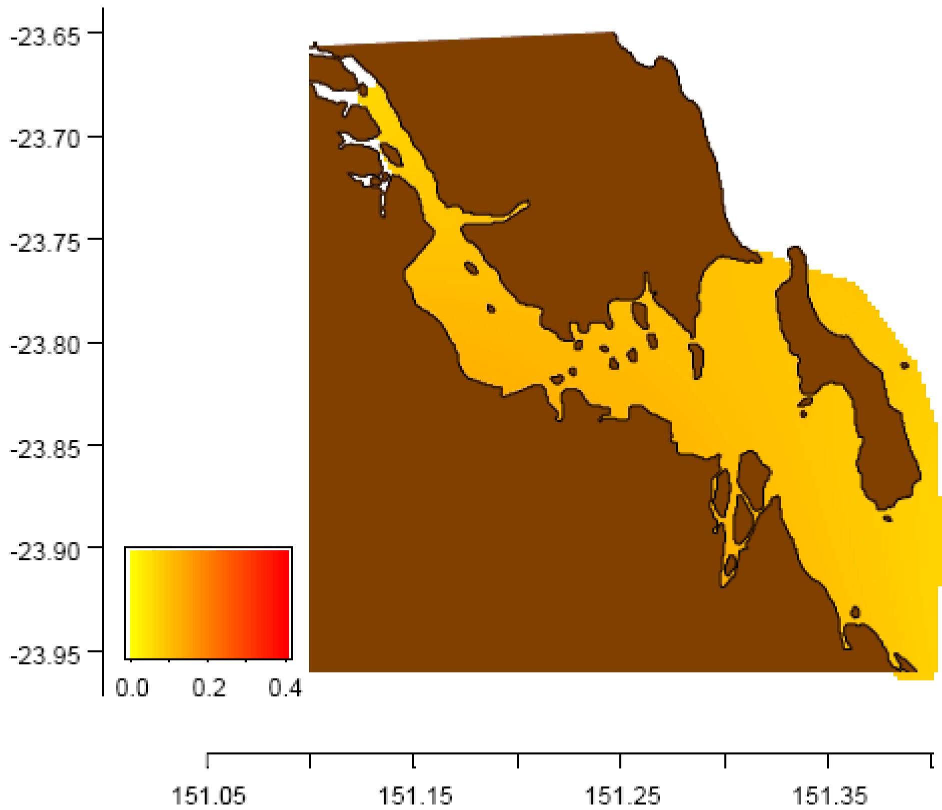


Figure 4-23 August 2001 water quality prediction map for selenium (µg/L) (Harche *et al.*, 2003)

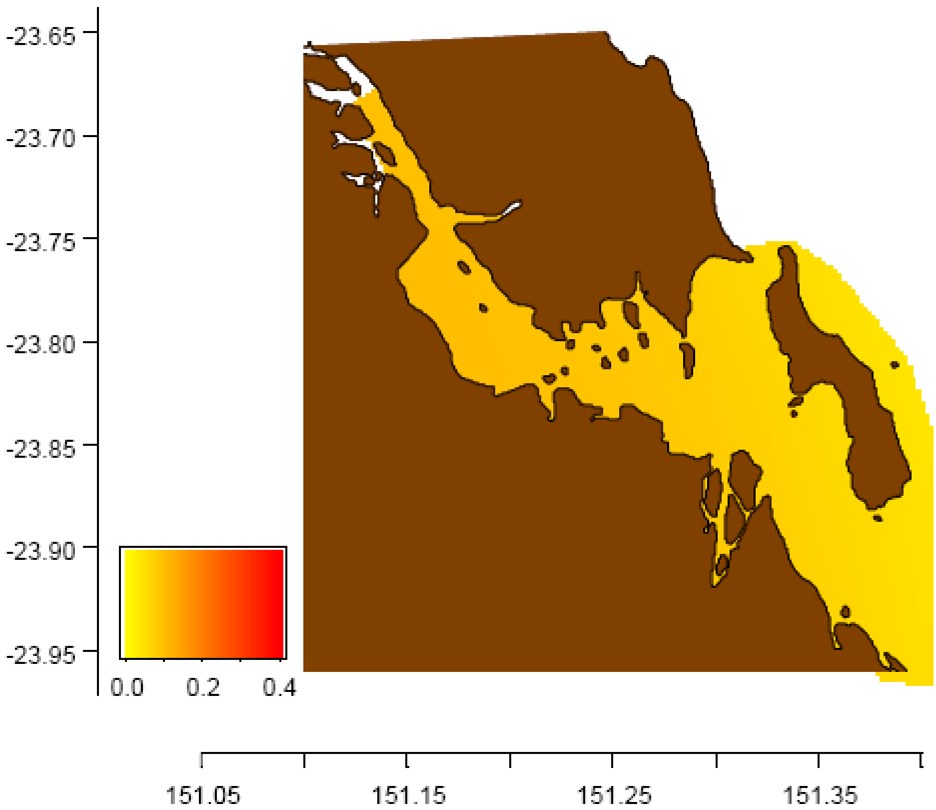


Figure 4-24 February 2002 water quality prediction map for selenium (µg/L) (Harche *et al.*, 2003)

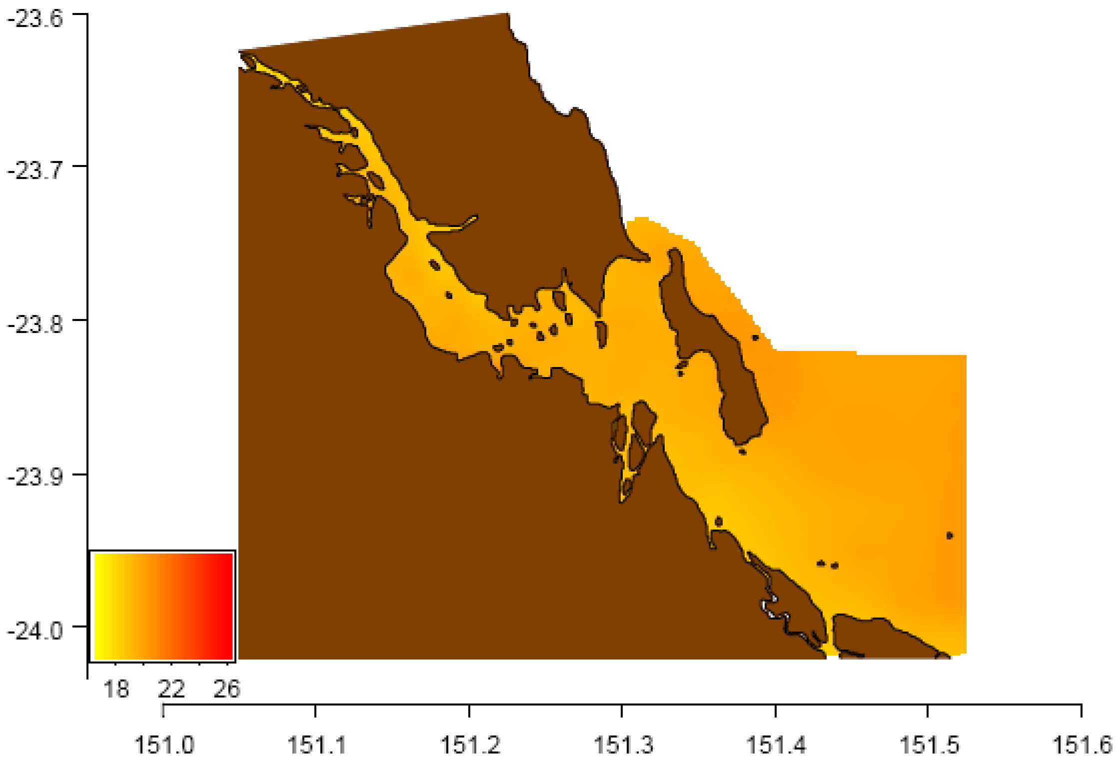


Figure 4-25 July/ September 2003 intensive water quality prediction map for temperature (°C) (Harche *et al.*, 2003)

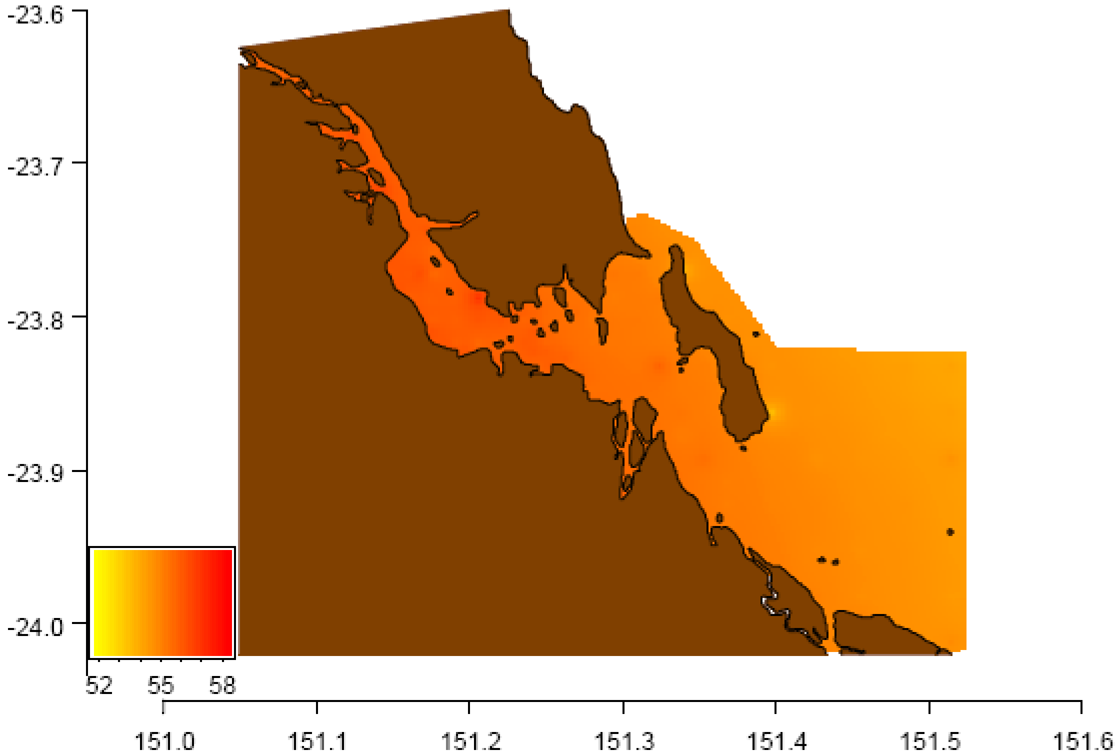


Figure 4-26 July/ September 2003 intensive water quality prediction map for conductivity (ms/cm) (Harche *et al.*, 2003)

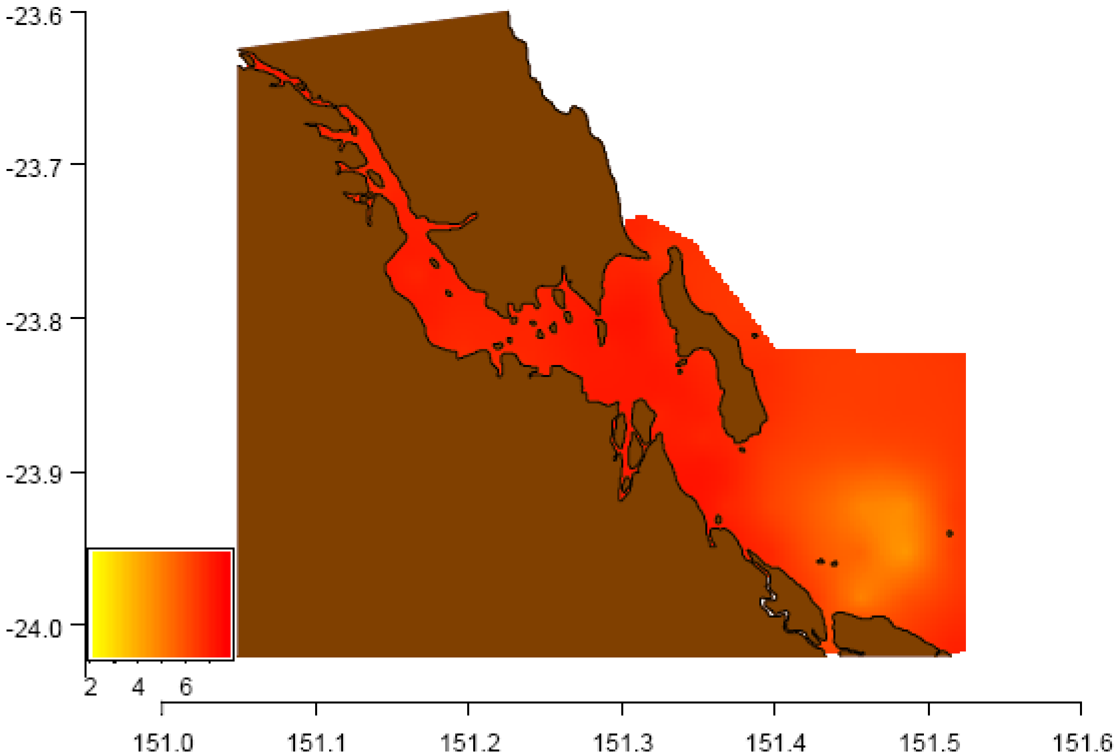


Figure 4-27 July/ September 2003 intensive water quality prediction map for dissolved oxygen (mg/L) (Harche *et al.*, 2003)

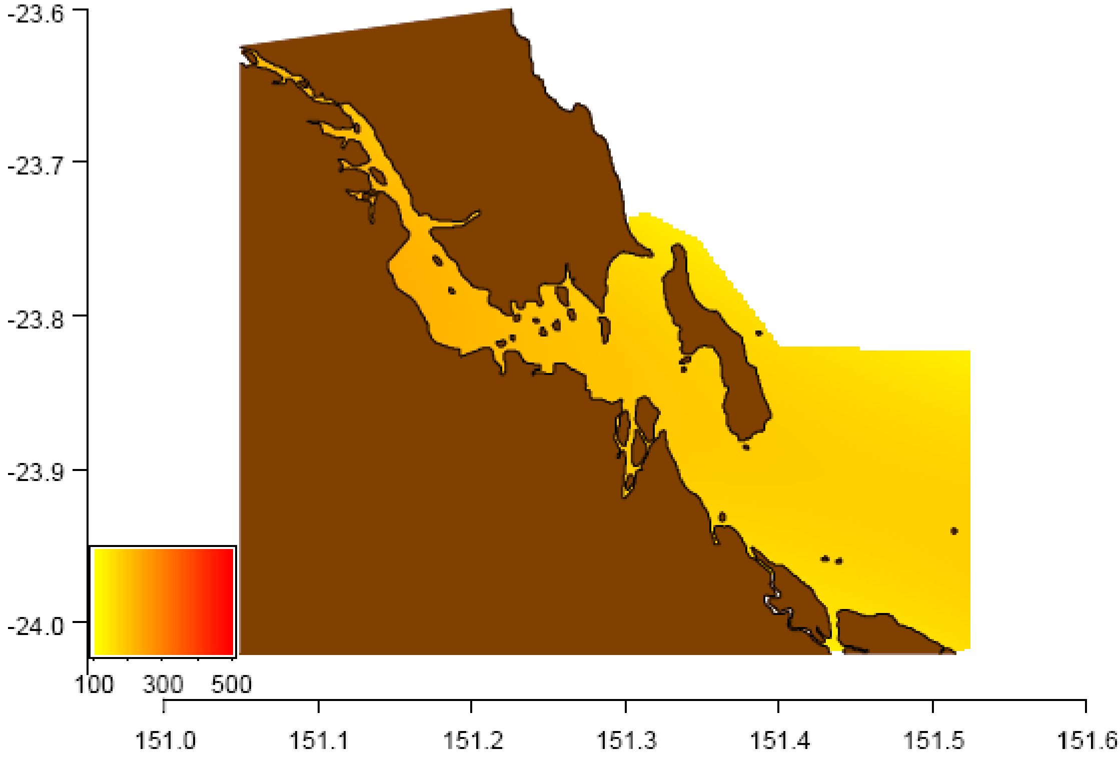


Figure 4-28 July/ September 2003 intensive water quality prediction map for Oxidation/Radiation potential (ORP) (mv) (Harche *et al.,* 2003)

4.9.2 Hydrodynamic modelling of the Port Curtis region (Herzfeld *et al.,* 2004)

Temperature and salinity input for hydrodynamic model sourced from Australian Community Ocean Model (ACOM) (Schiller, 2003). Temperature and salinity conditions were generated as at January 1 1999 (Figure 4-29 and Figure 4-30).

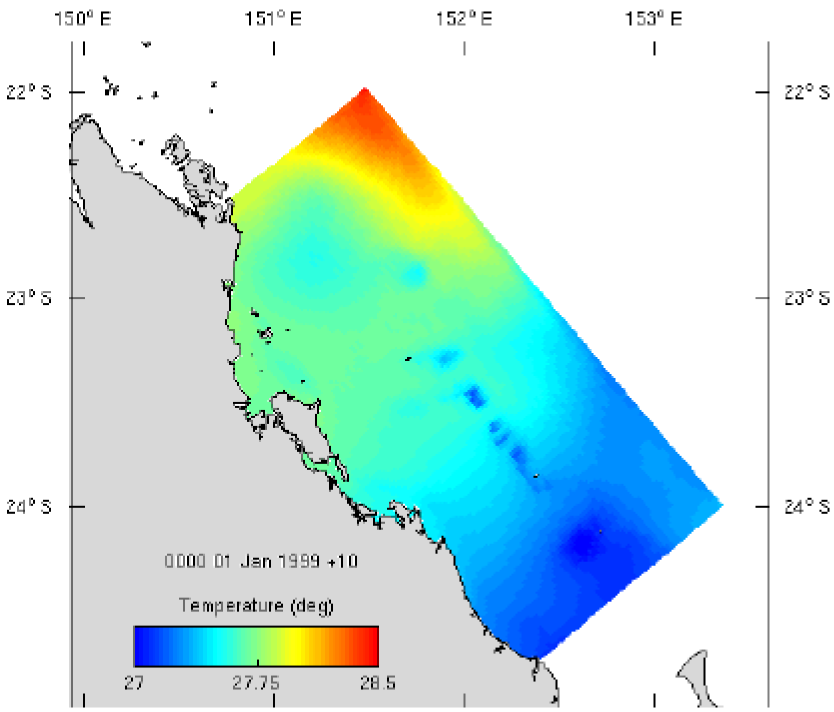


Figure 4-29 Temperature distribution at 1 Jan 1999 (Herzfeld *et al.,* 1999)

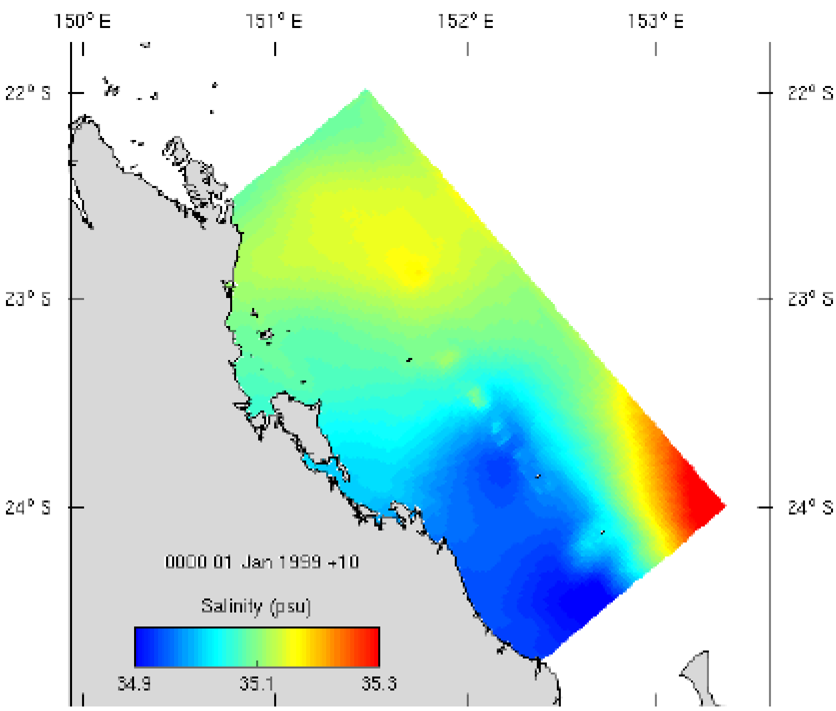


Figure 4-30 Salinity distribution at 1 Jan 1999 (Herzfeld *et al.,* 1999)

4.9.3 Intertidal crabs as potential biomonitors in Port Curtis (Anderson *et al.,* 2004)

The fiddler crab (*Uca coarctata*) was assessed for its biomonitoring suitability in Port Curtis. Fiddler crabs have a sedentary lifestyle and their feeding and burrowing activities expose them to water, dietary and sediment-derived contaminants. They are therefore potentially a useful biomonitoring tool for assessing site-specific differences in contaminants, including metals. Fiddler crabs and sediments were collected from a number of sites in Port Curtis, representing increasing distance from the source of likely anthropogenic inputs. Crabs and sediments were also collected from reference sites outside the harbour and analysed for metal concentrations (Anderson *et al.,* 2004).

Overall, results did not indicate that any one site was more contaminated than any other site. Copper and metal burdens and to a lesser extent aluminium and cadmium, were elevated in fiddler crabs from inner harbour sites compared to outer harbour sites. Correlations were established between metal concentrations in fiddler crabs and sediment for copper and strontium only, although the relationships were not strong (Anderson *et al.,* 2004).

4.9.4 Stable isotopes on nitrogen as potential indicators of nitrogen contamination in Port Curtis- a pilot study (Melzer and Johnson, 2004)

No evidence of general nitrogenous contamination using $\delta^{15}N$ in mangrove foliage (ratio of nitrogen stable isotopes in vegetation relative to that ratio in air) was detected in Port Curtis or Rodds Bay. Slightly elevated $\delta^{15}N$ was detected at the northwest tip of Curtis Island. $\delta^{15}N$ in the Upper Fitzroy Estuary suggests chronic nitrogenous contamination is present.

4.9.5 Port Curtis and Fitzroy River Estuary remote sensing tasks (Dekker and Phinn, 2005)

This study utilised Landsat images in conjunction with field measurements (sampling sites in Figure 4-31) to map the constituents controlling the optical properties of water, namely coloured dissolved organic material (CDOM), tripton and total suspended inorganic material (TSM) and also to map the transparency and substratum type and cover. This approach is based on measuring and understanding the underwater light climate characteristics or properties controlling the absorption, scattering and transmission of sun and sky light, in different sections of the Fitzroy River Estuary and Port Curtis waters. For each image pixel, the appropriate combination of optically active substances is selected. Thresholds based on these specific inherent optical properties are applied using an automated routine that determines how to apply the algorithms for mapping water quality variables (e.g. TSM, CDOM concentration and Secchi disk transparency) and thresholds based on transparency determine where to map the appropriate substrate types (Dekker and Phinn, 2005).

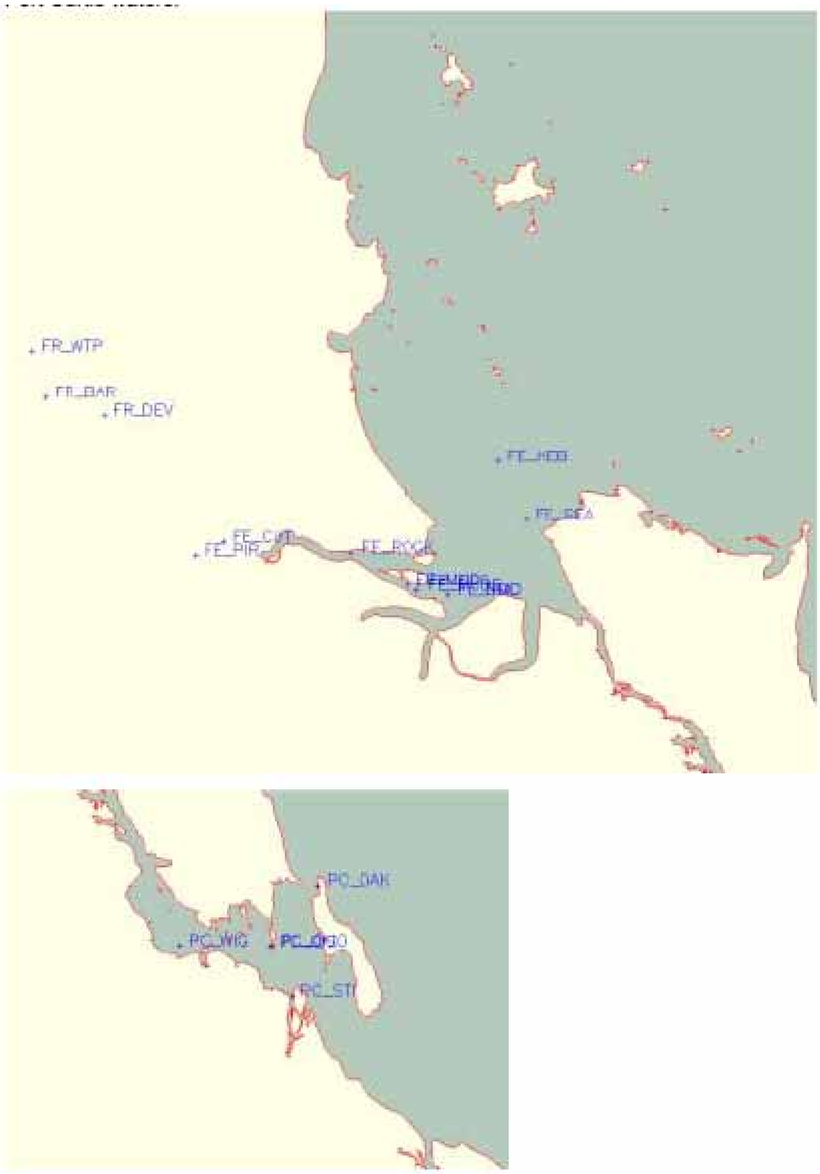


Figure 4-31 Port Curtis and the Fitzroy River Estuary sample sites (Dekker & Phinn, 2005)

A Total Suspended matter (TSM) to tripton (lifeless component of suspended matter) close to 1 indicates a dominance of TSM and a relatively very low chlorophyll *a* contents. Table 4-21 shows that the tripton to TSM ratio is very close to 1 at all sites.

Table 4-21 Concentration of the organic and inorganic water column constituents for the 18 sites sampled in January and June 2002 (Dekker & Phinn, 2005)

Site	Site description	TSM (mg/L)	Chl a (ug/L)	CHL as DW(mg/L)	Tripton (mg/L)	Tripton/TSM
FE_CUT	Fitzroy River at Cut-through	346.0	4.0	0.28	345.8	0.999
FE_MUD	Fitzroy River Mouth - Mud Island	8.9	13.6	0.95	7.9	0.893
FE_SEA	Keppel Bay (near Sea Hill)	22.7	2.2	0.15	22.5	0.993
FE_MUDE	Fitzroy River Mouth - east of Mud Island	18.7	6.8	0.48	18.2	0.974
FE_EGG	Fitzroy River Mouth - Egg Island	24.6	3.7	0.26	24.3	0.989
FE_ROCK	Fitzroy River at Rocky Point (~ 10 km upstream the mouth)	74.6	4.4	0.31	74.3	0.996
FR_WTP	Fitzroy River upstream the Barrage at the Water Treatment Plant	122.6	4.0	0.28	122.3	0.998
FR_BAR	Fitzroy River just upstream the Barrage	95.2	2.6	0.19	95.0	0.998
FR_DEV	Fitzroy River 5 km downstream the Barrage at Devil's Elbow	78.1	3.4	0.24	77.9	0.997
FE_KEB	Keppel Bay (in the middle)	25.0	1.3	0.09	24.9	0.996
FE_RMO	Fitzroy River Mouth	60.7	3.4	0.24	60.5	0.996
FE_PIR	Fitzroy River at Pirate Point	27.0	2.6	0.18	26.8	0.993
FE_SOC	Fitzroy River Mouth - Southern Channel	12.1	0.9	0.06	12.0	0.995
PC_OAK	Northern edge of Facing Island at "the OAKES"	10.8	0.3	0.02	10.8	0.998
PC_QUO	SW of Quoin Island	12.2	0.8	0.06	12.1	0.996
PC_QIS	SW of Quoin Island	10.5	1.0	0.06	10.4	0.994
PC_STI	South Trees Inlet (upstream causeway of QLD alumina)	10.3	1.2	0.08	10.2	0.992
PC_WIG	Wiggins Island (mouth of Calliope River)	12.4	0.9	0.06	12.3	0.995

4.9.6 Contaminants in Port Curtis; screening and risk level assessment (Apte *et al.,* 2005)

The report 'Contaminants in Port Curtis; screening and risk level assessment' by Apte *et al.* (2005) for CRC for Coastal Zone, Estuary and Waterway Management describes a screening level ecological risk assessment (SLERA) focussed on key contaminants in the Port Curtis Estuary. Existing physical, chemical and biological data sourced from regulatory agencies and local industry was reviewed and collated with new data on contaminants in waters and sediments collected in 2001 and 2002.

For the SLERA, the study area was split into six geographical zones (Figure 4-32) based on land use and potential contaminant sources (Table 4-22). A seventh zone on the eastern side of facing island was used as a reference zone. The ecological data was grouped according to these zones (Apte *et al.,* 2005).

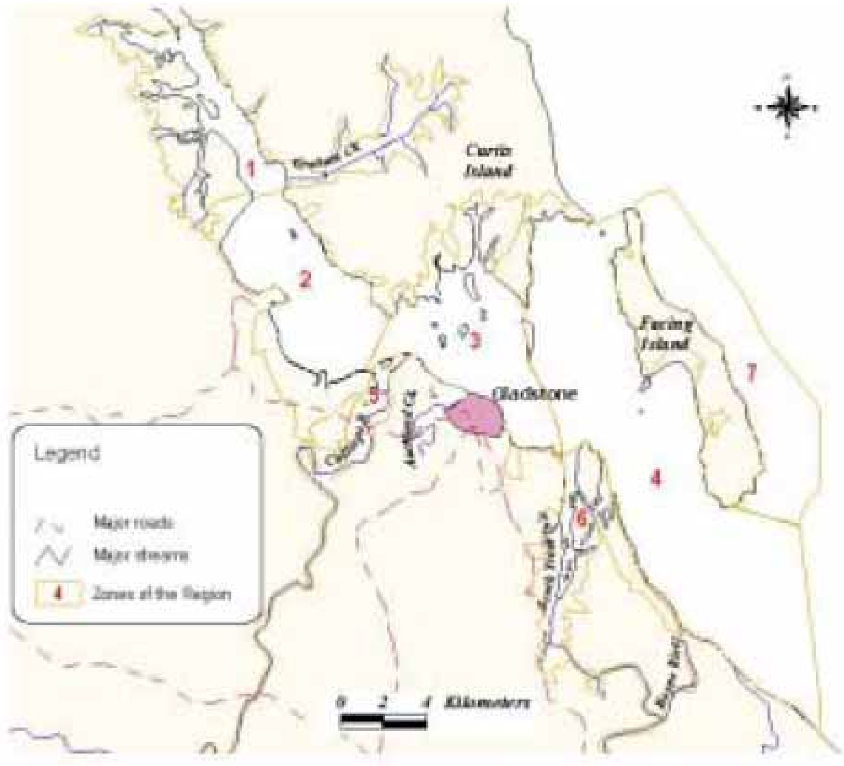


Figure 4-32 Geographical areas used in the SLERA (Apte *et al.,* 2005)

Table 4-22 Geographical areas used in the SLERA of the Port Curtis estuary and the known major sources of chemical stressors to these areas (Apte *et al.,* 2005)

Zone	Name	Known Major Sources of Chemical Stressors
1	The Narrows	Horticulture
2	Targinnie section of the harbour	Oil shale, cement and cyanide industries, shipping, horticulture
3	Middle harbour	Shipping, urban runoff, downstream of other zones
4	Southern and outer harbour	Alumina industries, shipping, urban runoff
5	Calliope River	Catchment runoff, STP, urban runoff, power station
6	Boyne River and South Trees Inlet	Catchment runoff, STP, urban runoff, alumina industries
7	Eastern side of Facing Island	Control site

New water quality data was collected in a winter dry season in 2001 and a summer wet season in 2002. 50 sites per survey were sampled (Figure 4-33). Water samples were taken at an approximate depth of 50cm. Samples for metal analyses were taken at all sites. Water samples for analysis of cyanide, fluoride, and TBT were collected at locations likely to be influenced by a source. Salinity and pH were recorded at all sites (Apte *et al.,* 2005).

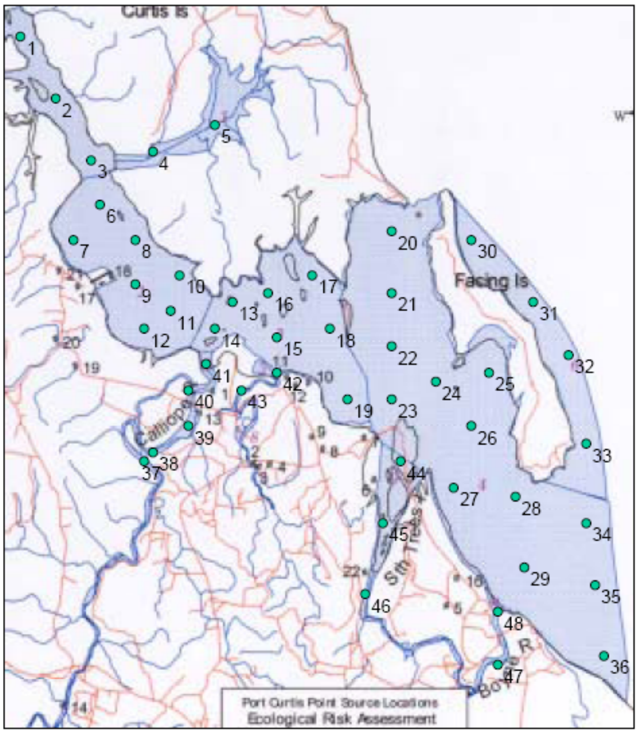


Figure 4-33 Approximate location of water and sediment survey sampling sites (Apte *et al.*, 2005)

Table 4-23 summarises water quality contaminant results for both surveys. In the 2001 dry season survey, salinity ranged from 35.8 to 37.1 and pH ranged from 7.88 to 8.10. In the 2002 wet season survey, salinity ranged from 36 to 37 and pH ranged from 8 to 8.22. Concentrations of dissolved Cd, Cr, Cu, Pb, Ni, Zn, As, Se and total fluoride were below levels of regulatory concern in all samples collected. Fluoride concentrations were typical of coastal seawaters. Cyanide concentrations were below the method detection limit of 5 µg/L in all samples collected (Apte *et al.,* 2005).

Table 4-23 Dissolved contaminants in surface waters (µg/L^{-1}): combined survey results (Apte *et al.,* 2005)

Concentration	CN[c]	F	TBT[d]	Al	As	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Se	Zn
No. of samples	25	100	7	100	100	100	100	100	100	100	100	100	100	100
Mean	<5[g]	1,220	0.012	<3	0.90	0.006	<2	0.42	<6.8	<1.2	0.31	<0.10	0.10	0.25
Min	<5	1,110	<0.005	<3	0.51	<0.004	<2	0.05	<5	<0.5	0.14	<0.08	0.04	<0.22
Max	<5	1,320	0.021	34	1.27	0.013	<2	1.18	16	7	0.66	0.68	0.38	1.35
Trigger value[a]	**4**	**-**	**0.006**	**40**	**2.3[e]**	**0.7**	**4.4[f]**	**1.3**	**-**	**80**	**14**	**4.4**	**3**	**15**
Exceedances[b]	?	0	5	0	0	0	0	0	0	0	0	0	0	0

[a] Water quality guideline trigger values for 95% species protection (ANZECC/ARMCANZ 2000). [b]Number of values exceeding trigger values. [c]CN = Total cyanide. [d] TBT = Tributyltin as µg-Sn L^{-1}. [e]As(III), [f] Cr(VI). [g]Below detection limit data set to half detection limit concentration.

Mean concentrations of dissolved metals in each zone for both surveys are shown in Table 4-24. Elevated concentrations of dissolved cadmium, copper, selenium and zinc at the Calliope River sites are clearly evident. Dissolved copper and nickel data are plotted in Figure 4-34 and Figure 4-35, respectively.

Tributyltin was detected in five out of the seven samples analysed for this contaminant. Water column TBT concentrations exceeded the ANZECC/ARMCANZ guideline trigger value of 0.006 µg Sn/L in these samples, but were much lower than concentrations in world harbours recorded prior to the restriction of TBT to larger vessels (Apte *et al.,* 2005). The highest TBT concentration (0.021 µg Sn/L) was detected at the Marina site.

Table 4-24 Mean dissolved metals concentrations (µg/L) by zone: combined survey data (Apte *et al.,* 2005)

Zone	Name	As	Cd	Cu	Ni	Se	Zn
1	The Narrows	0.71	0.005	0.53	0.53	0.09	0.21
2	Targinnie section of the harbour	0.79	0.005	0.50	0.34	0.10	0.18
3	Middle harbour	0.88	0.005	0.45	0.31	0.10	0.22
4	Southern and outer harbour	1.00	0.004	0.26	0.22	0.08	0.21
5	Calliope River	0.84	0.018	0.60	0.40	0.20	0.35
6	Boyne River and South Trees Inlet	0.93	0.003	0.29	0.22	0.11	0.17
7	Eastern side of Facing Island	1.05	0.003	0.36	0.17	0.06	0.30

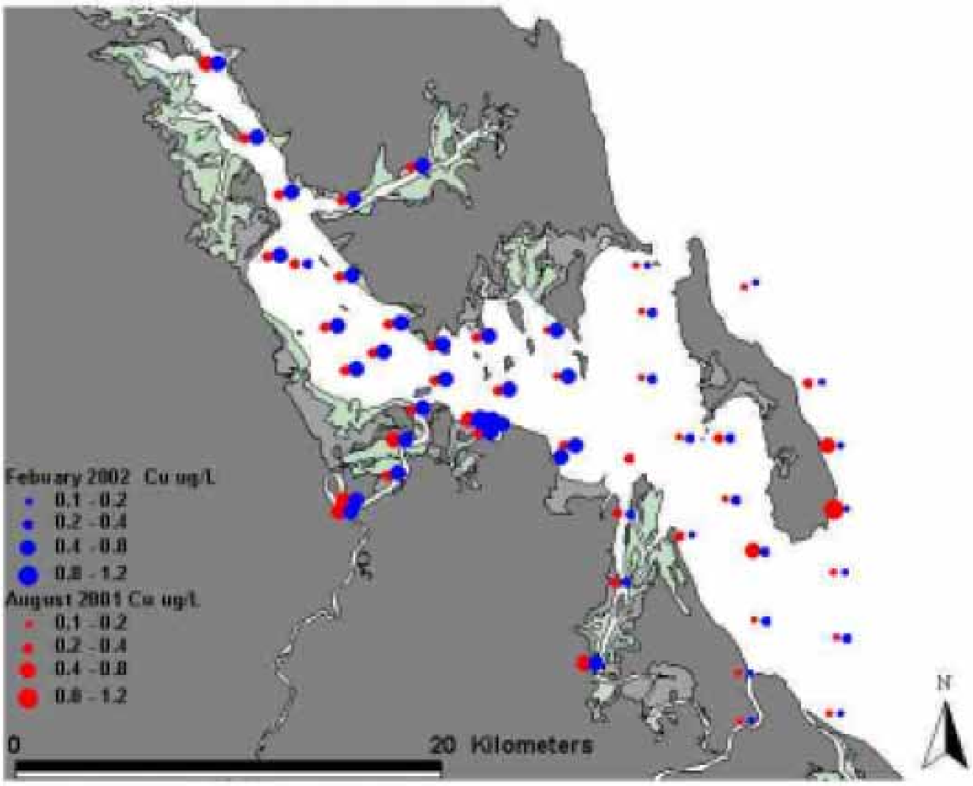


Figure 4-34 Dissolved copper concentrations in Port Curtis (Apte *et al.,* 2005)

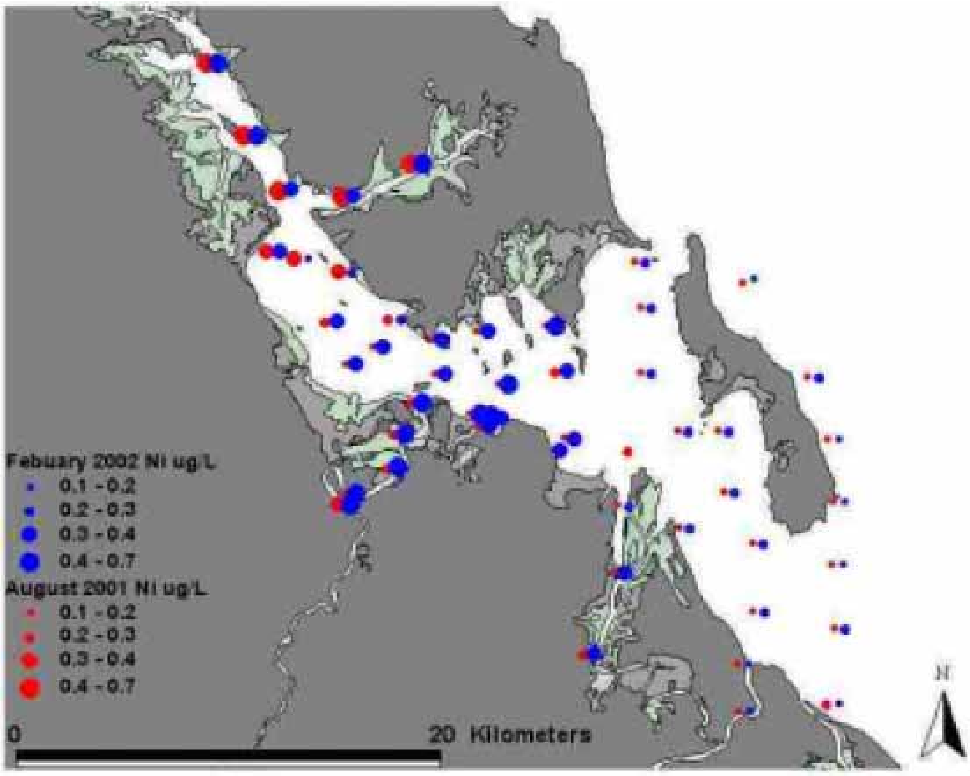


Figure 4-35 Dissolved nickel concentrations in Port Curtis (Apte *et al.,* 2005)

Mean dissolved metal concentrations in Port Curtis are compared in Table 4-25 to concentrations measured in other marine systems. The comparison indicates that dissolved copper concentrations are approximately 13 times higher than in NSW coastal waters. Nickel is also elevated (Apte *et al.,* 2005).

Table 4-25 Comparison of mean dissolved metal concentrations (µg/L) in port Curtis with other marine locations (Apte *et al.,* 2005)

Metal	Port Curtis (This study)	[1]Pacific Ocean (Surface waters)	NSW Coastal waters (Apte *et al.* 1998)
Arsenic	0.89	1.2-1.5	1.53
Cadmium	0.006	0.002-0.003	0.0024
Copper	0.42	0.027-0.092	0.031
Nickel	0.31	0.12	0.18
Lead	<0.010	0.006-0.017	0.009
Zinc	0.26	0.004-0.006	<0.022

[1]data summarised in Apte *et al.* (1998).

National Pollution Inventory reports for chemicals released in water emissions in Port Curtis are summarised in Table 4-26. Contaminants enter Port Curtis from both point and diffuse source inputs via regulated waste effluents, accidental spills and leakages, hosing down of ships, antifouling paints, STP releases and agricultural chemicals (Apte *et al.,* 2005).

Table 4-26 Inventory of chemicals released in water emissions in Port Curtis (Apte *et al.*, 2005)

Industry	Substance	Water Emissions ($kg\ yr^{-1}$)
*BP Oil Aust., terminal[2]	Benzene Cumene Cyclohexane Ethylbenzene n-Hexane Toluene Xylenes	10 30 30 4 30 10 12
*Boyne Smelters Ltd (BSL)[1]	Fluoride (F) compounds	7,500
*Caltex Oil Terminal[2]	Benzene Toluene Xylene	0.3 0.1 0.5
*NRG (Power Station)[2]	Arsenic (As) compounds Chromium (Cr) (VI) Lead (Pb) compounds	147 76 24
*Queensland Alumina Ltd (QAL)[1]	As compounds Cd compounds F compounds Pb compounds Mercury (Hg) compounds Total Nitrogen (TN) Total Phosphorus (TP)	1,050 3 135,720 13 12 30,126 11,400
*Stuart Oil Shale Project Stage One	Pb compounds	0.20
*Ticor Chemicals Co. Pty. Ltd.[1]	Ammonia Cyanide (inorganic)	580 2.8

*Source = National Pollution Inventory, 2000. [1]Reporting period: 01/07/1999-30/06/2000. [2]Reporting period 01/07/1998-30/06/1999.

For contaminants in waters, the SLERA identified Tributyltin (TBT) as a potential ecological concern. The main sources of TBT are commercial shipping and historically, the leisure boats that utilise the area. TBT contamination is a problem affecting all large commercial ports. TBT concentrations are expected to decline in Port Curtis over the next decade as it is completely phased out worldwide.

The concentrations of dissolved metals in waters of the Port Curtis estuary were below levels of regulatory concern. However, the concentrations of dissolved copper, nickel lead and zinc were elevated relative to concentrations at pristine coastal water sites in Australia. The reasons for these elevated concentrations may be industrial discharges or natural inputs of metals from local geological formations (Apte *et al.,* 2005).

4.9.7 Contaminant pathways in Port Curtis (Apte *et al.,* 2006)

4.9.7.1 Introduction

The screening level ecological risk assessment (SLERA) of contaminants in Port Curtis as summarised above indicated that the concentrations of dissolved metals were below levels of regulatory concern (Apte *et al.* 2005). Trace metal concentrations were, however, generally elevated relative to other coastal Australian waters. This indicated additional sources of metals to the water column within Port Curtis which may be related to local industry or regional geology (Apte *et al.,* 2006).

This study involved two surveys in December 2003 and 2004 extending along transects away from potential point sources and within the Narrows and selected waterways (Figure 4-36). The study involved a detailed investigation of cadmium, copper, nickel, lead and zinc concentrations in waters, the influence of small pH variations and sediment resuspension on metal release and fixed location sampling to determine possible temporal variations in dissolved metal concentrations (Apte *et al.,* 2006)

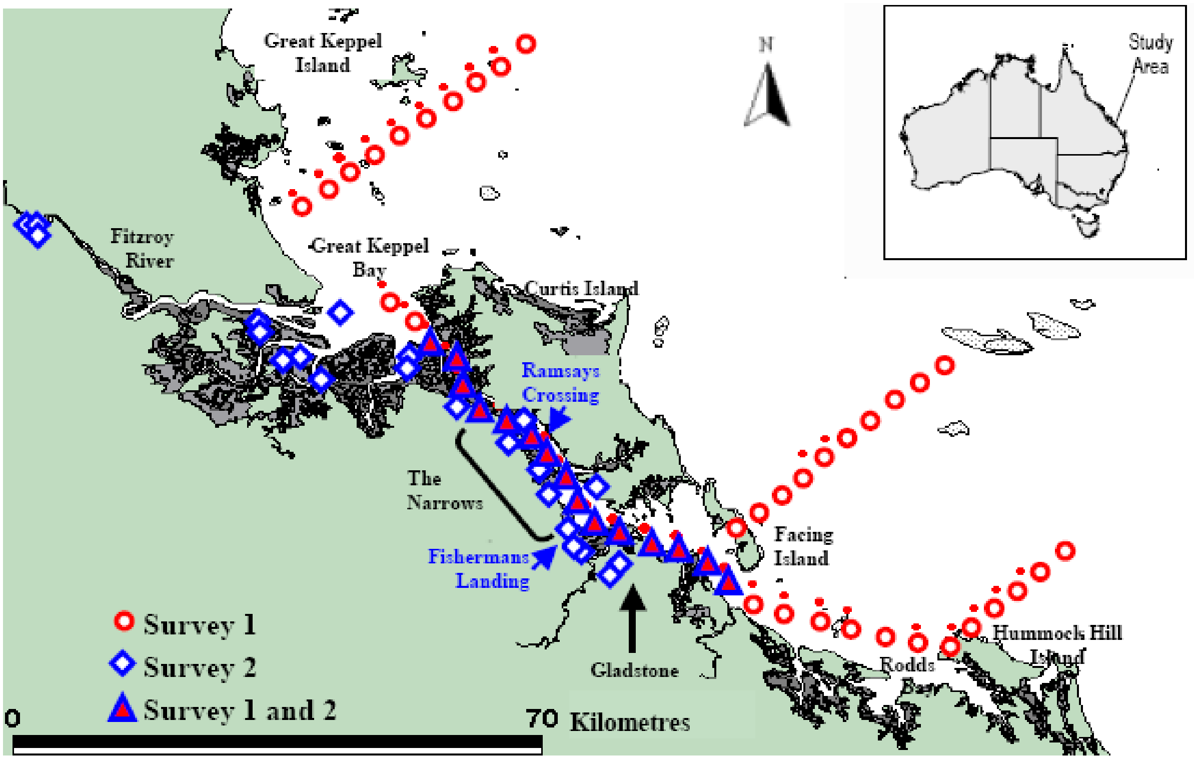


Figure 4-36 Port Curtis estuary and surrounding waters showing positions of SLERA sampling sites during Survey 1 and Survey 2 (Apte *et al.,* 2006)

4.9.7.2 Dissolved metal concentrations

The dissolved and particulate metals results for the two surveys are summarised in Table 4-27 and Table 4-28. Figure 4-37 shows the dissolved concentrations of copper, nickel and zinc along Survey 1 and Survey 2 sampling transects.

Dissolved concentrations of copper and zinc were typically in the low parts per billion range (µg/L) and dissolved concentrations of cadmium, nickel and lead were typically in the low parts per trillion range (ng/L). The lowest metal concentrations occurred in the open water sites north-east of Facing Island (dissolved cadmium, copper, nickel, lead, and zinc were <1.5, <19, 118, <11 and <31 ng/L, respectively). Dissolved concentrations were typically higher in the mid-harbour close to Gladstone, in the middle of The Narrows near Ramsays Crossing, and up the Fitzroy River (Figure 4-37). Nevertheless, these concentrations were well below the Queensland water quality guidelines that apply for enclosed coastal waters (Table 4-2) (Apte *et al.,* 2006).

Cadmium concentrations ranged from <1.5 to 38 ng/L, with the highest concentration measured in The Narrows during Survey 2. Cadmium concentrations were typically <1.5 ng/L in the open ocean waters off Facing Island and Great Keppel Island and were generally 5–20 ng/L closer to Gladstone and in The Narrows. Dissolved copper concentrations were typically <40 ng/L in the open ocean waters off Facing Island and Great Keppel Island and were generally in the 400–800 ng/L range closer to Gladstone and in The Narrows. The maximum dissolved copper concentration occurred in the southern Narrows during Survey 1 and in the mid harbour close to Fisherman's Landing in Survey 2 (Apte *et al.,* 2006).

The highest measured concentrations of dissolved copper occurred in the Fitzroy River with concentrations of 650 and 694 ng/L near the mouth of the estuary and 1290, 1200, and 1410 ng/L near the city of Rockhampton. Dissolved nickel concentrations were above 100 ng/L at all sites, with typical concentrations of 300–700 ng/L in the harbour and Narrows, 1000–2000 ng/L measured in The Fitzroy River, and as high as 535 ng/L in Great Keppel Bay. A dissolved nickel maximum (800–900 ng/L) occurred in the middle of The Narrows in both surveys. The highest measured dissolved nickel concentrations occurred in the Fitzroy River, and were 982 and 1080 ng/L near the mouth of the estuary and 1760, 1450 and 1570 ng/L at river sites adjacent to the city of Rockhampton. Dissolved zinc concentrations were typically higher closer to Gladstone, in the middle of The Narrows, and up the Fitzroy River (Figure 4-37) (Apte *et al.,* 2006).

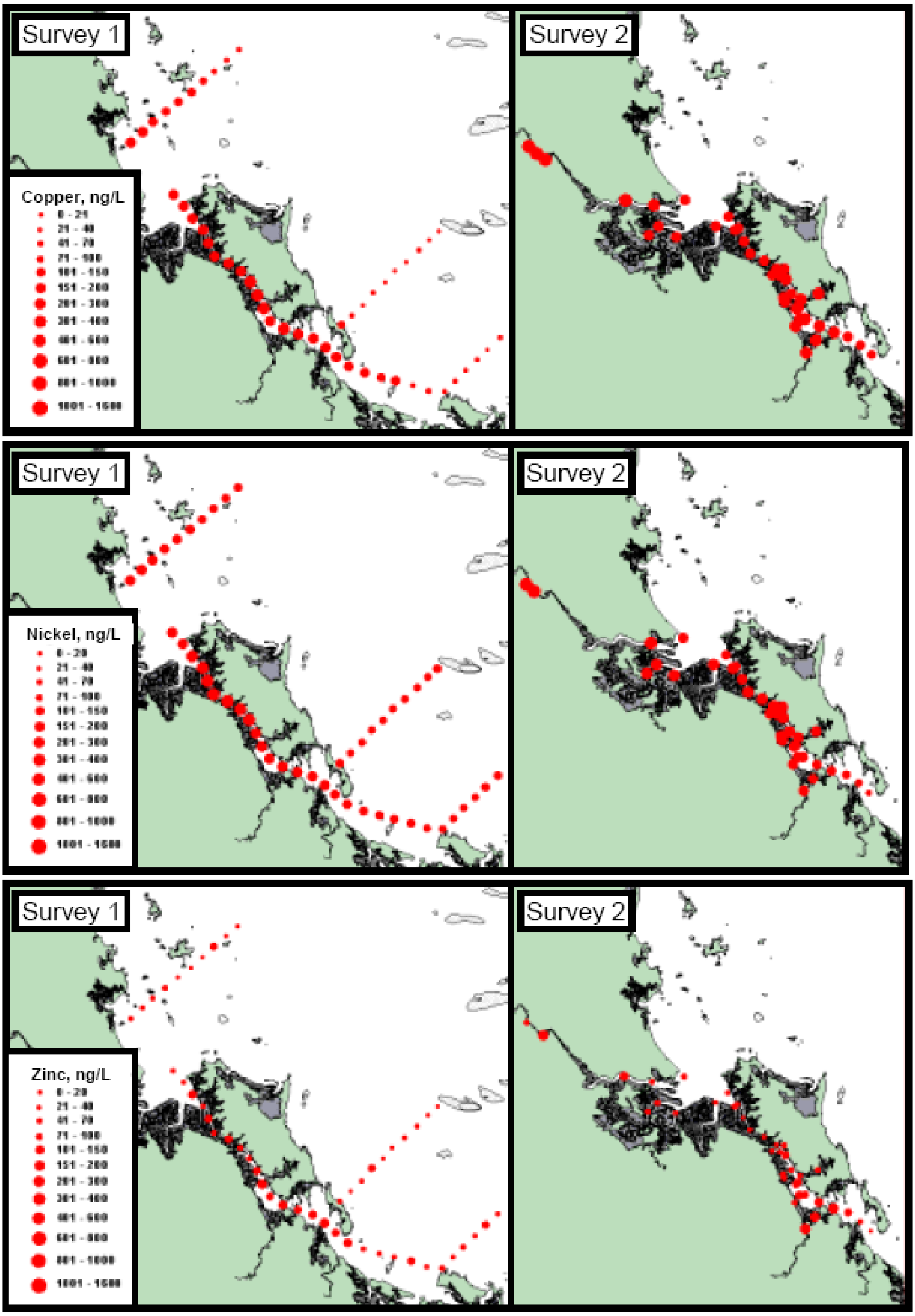


Figure 4-37 Dissolved copper, nickel and zinc concentrations in Port Curtis estuary and surrounding waters (Apte *et al.*, 2006)

Table 4-27 Dissolved and particulate metal concentrations: Survey 1 (Apte *et al.*, 2006)

Site		Dissolved metals (ng/L)					Suspended particulate metals (µg/g)					TSS	
The Narrows		Ni	Cd	Cu	Pb	Zn	Al	Mn	Fe	Cu	Zn	(mg/L)	Salinity
A1.1	South of	334	4.5	523	33	128	9190	917	15400	24	46	3.7	37.5
A1.2	The Narrows	360	15.0	606	133	197	8700	882	14800	22	56	6.1	36.4
A1.3		334	2.0	551	<11	133	7780	748	12400	16	30	6.7	37.2
A1.4		466	5.0	623	21	209	8370	952	13700	14	61	5.5	37.2
A1.5		519	3.0	637	25	138	9310	936	14900	19	55	5.7	38.4
A1.6		623	3.0	607	<11	91	8360	665	12500	17	57	6.3	38.0
A1.7	Ramsays	781	3.5	510	15	92	9590	671	16200	14	55	11.5	37.9
A1.8	Crossing	842	4.0	548	52	134	8450	643	13900	9	43	12.5	37.4
A1.9		905	5.8	557	17	76	8430	555	11000	6	44	11.1	39.0
A1.10		875	5.8	582	47	102	7810	456	9720	9	32	18.0	37.9
A1.11		700	3.5	539	20	55	6810	356	9520	9	26	17.5	38.7
A1.12		611	6.5	516	82	152	4320	235	7040	8	19	39.5	37.0
A1.13	North end of	504	3.5	431	30	57	7030	408	11900	11	22	32.4	36.3
A1.14	The Narrows	458	3.0	384	17	61	7000	424	12000	13	26	21.2	37.4
Gladstone to Hummock Hill Island and then to open ocean													
A2.1	Gladstone	348	4.5	504	16	164	6310	603	10700	15	29	11.1	37.1
A2.2		305	15.0	455	445	234	4480	480	8236	10	26	15.1	35.9
A2.3		282	6.3	411	11	129	8830	771	14000	20	61	5.1	36.3
A2.4		225	15.0	295	422	189	2160	187	3600	46	27	11.7	36.3
A2.5		196	2.0	250	32	70	6370	467	8590	14	88	2.8	35.8
A2.6		195	3.8	185	96	64	2420	172	2900	3	34	5.8	34.8
A2.7		187	3.0	215	54	57	8110	-	-	-	-	2.2	35.2
A2.8		170	10.0	66	228	142	-	-	-	-	-	0.8	35.2
A2.9	Hummock	136	1.8	84	28	61	6440	354	7460	-	71	2.9	34.5
A2.10	Hill Island	124	3.0	70	65	92	2560	126	2520	16	19	6.6	34.3
A2.11		148	<1.5	69	<11	42	490	85	595	4	53	4.6	34.9
A2.12		114	3.0	60	106	95	600	90	729	-	44	5.0	34.5
A2.13		124	<1.5	41	17	68	370	51	506	-	51	4.3	34.9
A2.14		163	2.0	39	<11	138	-	-	-	-	-	0.8	35.7
A2.15	Ocean	164	<1.5	63	19	41	-	-	-	-	-	0.6	33.6
Facing Island to open ocean													
A3.1	Facing Island	168	<1.5	118	<11	61	-	-	-	-	-	0.8	35.5
A3.2		150	1.5	68	14	<31	-	-	-	-	-	0.6	34.0
A3.3		145	1.5	38	<11	41	-	-	-	-	-	1.0	34.9
A3.4		118	<1.5	51	12	128	230	160	400	-	-	1.9	34.9
A3.5		141	<1.5	19	12	<31	420	280	640	-	-	1.4	36.4
A3.6		130	<1.5	<19	<11	37	-	-	-	-	-	0.7	34.9
A3.7		143	<1.5	30	21	67	-	-	-	-	-	0.9	34.3
A3.8		137	1.5	41	120	43	-	-	-	-	-	0.4	34.4
A3.9		142	<1.5	22	<11	<31	-	-	-	-	-	1.0	35.5
A3.10	Ocean	161	<1.5	35	<11	<31	-	-	-	-	-	0.8	33.6
Great Keppel Bay to Beyond Great Keppel Island													
A4.1	Great	535	3.0	429	14	48	9260	413	13700	14	31	19.5	36.8
A4.2	Keppel Bay	435	3.0	373	<11	64	4570	233	7140	7	26	43.1	36.6
A4.3		341	2.0	272	23	46	7960	510	12200	10	68	7.7	35.8
A4.4		247	<1.5	194	11	82	8280	462	10700	10	82	4.7	35.6
A4.5		256	<1.5	174	<11	<31	7270	397	7640	8	80	2.7	36.7
A4.6		256	<1.5	160	11	<31	4210	458	4480	7	108	1.3	34.7
A4.7		185	<1.5	118	<11	<31	1710	360	2280	-	101	1.3	36.4
A4.8	Beyond	172	4.0	85	112	103	420	82	507	-	18	6.2	35.2
A4.9	Great Keppel	161	<1.5	61	11	<31	1690	255	1960	-	69	1.1	35.1
A4.10	Island	183	<1.5	67	39	33	-	-	-	-	-	0.1	36.0

Table 4-28 Dissolved and particulate metal concentrations: Survey 2 (Apte *et al.,* 2006)

Site		Dissolved metals (ng/L)					Suspended particulate metals (µg/g)					TSS		
		Ni	Cd	Cu	Pb	Zn	Al	Mn	Fe	Cu	Zn	(mg/L)	Salinity	pH
Middle Port Curtis and The Narrows (repeat transect)														
B1.1	South of	147	2.3	179	<7	62	-	-	-	-	-	-	34.7	8.16
B1.2	The Narrows	195	2.3	272	9	94	-	-	-	-	-	-	35.8	8.16
B1.3		275	4	520	14	153	3850	275	6320	12	78	12	36.3	8.16
B1.4		296	12	578	14	306	4600	298	7610	11	74	16	36.5	8.10
B1.5		371	6	652	9	262	4850	389	8640	13	78	21	36.7	-
B1.6		478	13.3	636	<7	154	-	-	-	-	-	-	37.1	7.99
B1.7		526	5.4	637	11	168	4190	326	6780	11	77	13	37.3	8.01
B1.8	Ramsays	704	11.5	598	<7	101	-	-	-	-	-	-	37.7	7.95
B1.9	Crossing	798	10.6	610	<7	183	5780	408	9650	11	68	24	37.9	8.04
B1.10		803	14.8	564	<7	83	-	-	-	-	-	-	37.5	8.01
B1.11		696	4.8	467	10	87	4650	286	6930	8	75	15	37.1	8.09
B1.12		644	38.3	451	9	89	-	-	-	-	-	-	36.7	8.06
B1.13		531	4.1	401	<7	61	4440	283	6160	7	75	14	36.3	8.15
B1.14	North end of	390	3	348	8	79	-	-	-	-	-	-	35.9	-
B1.15	The Narrows	382	9.6	332	14	76	5160	253	7840	9	69	14	35.9	8.20
Creeks and inlets in direction of Port Curtis to The Narrows through to the Fitzroy Delta														
B2.1	Calliope 1	330	5.6	670	12	343	5340	369	10100	17	78	25	36.1	8.08
B2.2	Calliope 2	429	9.2	725	<7	496	-	-	-	-	-	-	22.8	7.95
B2.3	Boat Creek	481	5.6	768	<7	136	-	-	-	-	-	-	36.2	8.01
B2.4	Fisher. Landing	411	5	737	11	215	-	-	-	-	-	-	-	8.12
B2.5	Gully	446	4	712	8	167	4790	468	8800	14	72	18	37.1	8.12
B2.6	Targinnie	644	6	606	<7	122	-	-	-	-	-	-	38.1	7.99
B2.7	GC1	511	3.9	631	<7	94	-	-	-	-	-	-	37.4	8.11
B2.8	GC2	599	4.2	632	<7	138	-	-	-	-	-	-	38.4	8.00
B2.9	Black Swan	789	4	557	<7	84	-	-	-	-	-	-	37.8	8.11
B2.10	TS average	771	6	509	10	101	5960	365	9990	10	55	30	37.2	8.08
Fitzroy delta to Fitzroy mouth and up the Fitzroy River														
B3.1	DP	673	5.2	433	8	119	4490	295	6610	8	74	15	36.8	8.17
B3.2	Connors	664	16.0	436	16	93	-	-	-	-	-	-	36.4	8.12
B3.3	Port Alma	756	6.8	533	<7	90	5570	255	8140	12	67	22	36.3	8.24
B3.4	Casuarina 1	710	7	538	8	261	7430	434	12700	15	55	31	36.2	8.18
B3.5	Casuarina 2	767	19.9	566	13	118	-	-	-	-	-	-	36.4	8.12
B3.6	Cattle Point	469	8.8	413	11	124	6050	256	9000	10	71	41	35.9	8.18
B3.7	Lower Fitzroy 1	1080	7.2	694	18	96	6720	437	11300	13	55	89	36.5	8.11
B3.8	Lower Fitzroy 2	982	8.9	650	23	139	-	-	-	-	-	-	36.6	8.12
B3.9	Upper Fitzroy 1	1570	4.1	1198	18	363	8490	2520	14900	22	157	23	11.9	7.73
B3.10	Upper Fitzroy 2	1430	2	1214	8	143	10200	2720	17500	29	234	8	0.2	8.12
B3.11	Upper Fitzroy 3	1760	4.3	1291	30	582	-	-	-	-	-	-	11.0	7.80

Dissolved metals in Port Curtis, The Narrows and the adjacent coastal sites were compared to data for other coastal water locations in Australia and overseas (Table 4-29). Open water coastal sites adjacent to Port Curtis had low dissolved metal concentrations similar to those measured at other uncontaminated coastal sites in Australia (Apte *et al.,* 2006).

Table 4-29 Concentration of trace metals in water around the world (Apte *et al.,* 2006)

Location	Metal concentration, ng/L					Reference
	Cd	Cu	Ni	Pb	Zn	
Port Curtis (average)	6	496	407	76	163	This study
The Narrows (average)	7	512	536	21	124	This study
Central Queensland Coastal waters (average)	1	42	147	13	34	This study
Lower Fitzroy River (saline)	8	672	1030	21	118	This study
NSW coast	2.4	31	180	9	<22	Apte *et al.* 1998
North Pacific	1.1	38	120	–	–	Mackey *et al.* 2002
North Atlantic	0.7	68	–	136	–	Kremling & Pohl 1989
Port Jackson, Australia	6–104	932–2550	175–1610	–	3270–9660	Hatje *et al.* 2003
Torres Straight and Gulf of Papua	<1–29	36–986	940–4600		–	Apte & Day 1998
Humber estuary, UK	50–450	1800–10100	2500–12000		3000–20500	Comber *et al.* 1995
Mersey estuary, UK	10–110	800–4950	2000–10500		6500–28000	Comber *et al.* 1995
San Francisco Bay estuary	22–123	315–2230	140–2410	–	160–1960	Sanudo-Wilhelmy *et al.* 1996
Guideline values (95% species protection)	55000	1300	70000	44000	15000	ANZECC/ ARMCANZ 2000

4.9.7.3 Particulate metal concentrations in suspended solids

Total suspended solids (TSS) concentrations and particulate metal concentrations of suspended sediments are shown in Table 4-27 and Table 4-28.

The highest TSS concentrations occurred close to the mouth of the Fitzroy River (22–89 mg/L). At most sites, suspended particulate copper ranged between 10–20 µg/g and suspended particulate zinc ranged between 30–80 µg/g. In comparison, particulate copper and zinc concentrations in suspended particulate matter from Sydney Harbour are typically 100 and 700 µg/g, respectively (Apte *et al.,* 2006).

Concentrations of particulate metals both in the suspended sediment and benthic sediments in Port Curtis do not suggest gross contamination or geological enrichment of metals. Mass balance calculation using the combined data set from both surveys indicate that 73 ± 14% and 19 ± 12 % of total copper and zinc, respectively, were present in the dissolved phase. Owing to the low sediment metals load, it is therefore unlikely that desorption of copper and zinc from suspended sediments and/or release of metals from benthic sediments are significant sources of metals to the water column. It appears that inputs of copper and zinc to the system are predominantly in dissolved forms (Apte *et al.,* 2006).

4.9.7.4 Temporal variations in metal concentrations

Time series samples were taken at two locations to investigate the variability of dissolved metals with tidal state (Figure 4-38). The data showed very little variation of metal concentration over the relatively short time period of the study. There was little evidence of pulsed inputs of metals from industrial sources or release from sediments Apte *et al.,* 2006).

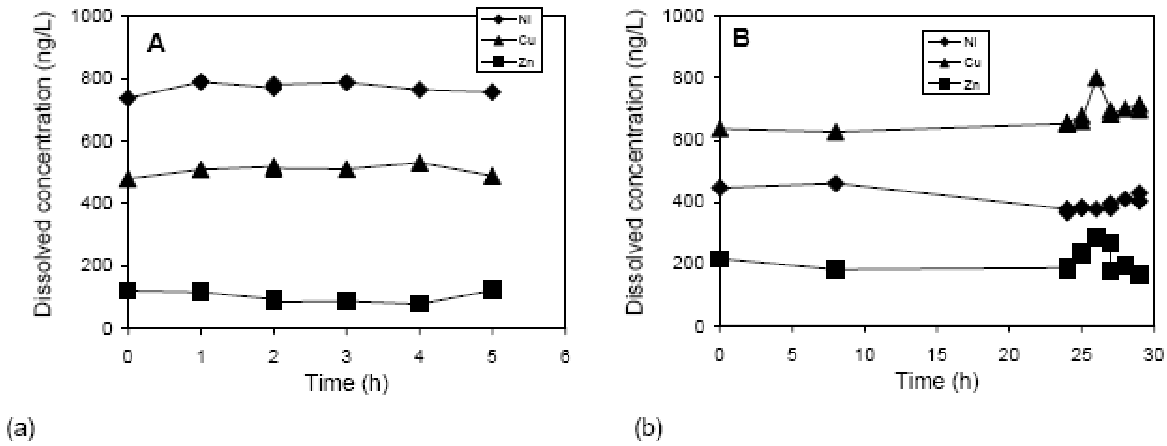


Figure 4-38 Extent of dissolved metal fluctuations with time at a) The Narrows and b) Fisherman's Landing (Apte *et al.,* 2006)

Salinities in Port Curtis, The Narrows and at coastal sites ranged between 33.6 ‰ and 39.0‰ (Figure 4-39). Freshwater inputs resulted in lower salinities being measured at upstream sites in the Calliope and Fitzroy Rivers. In general, the waters of Port Curtis were highly saline with little evidence of freshwater inputs. In both surveys the salinities in Port Curtis and The Narrows were slightly higher than the adjacent ocean waters. Analysis of the major ions contributing to salinity showed no individual major ion was responsible for this increase. The elevated salinity conditions may therefore be a result of evaporative losses of water occurring in the more enclosed areas of the estuary. Low salinity groundwater inputs are not significant in the area as these would cause a drop in salinity or a change in the ratio of major ions to salinity (Apte *et al*., 2005).

The pH measured at sample sites in Survey 2 ranged between 7.73 and 8.24 (Figure 4-39). The lowest pH values were measured at sites receiving freshwater inputs (Upper Fitzroy and Calliope Rivers). In The Narrows, the pH ranged between 7.95 and 8.2, with a minimum occurring near Ramsays Crossing. Decreases in pH similar to those observed in Port Curtis and The Narrows have been reported for other mangrove systems (Apte *et al.,* 2006). Lower pH values within mangrove-lined systems may be attributed to the breakdown of organic matter, as the organism-facilitated aerobic oxidation of organic matter results in a net increase in the concentration of H+, thus lowering the pH of the sediment pore waters. Humic and fulvic acids formed during decomposition also contribute to the lowering of pH. Abiotic oxidation occurring during periods of low tide, also contributes to the release of H+, and the lowering of pH. These processes have a greater effect in mangrove systems because there is usually a greater volume of organic matter available for oxidation, and there are often more surfaces exposed to oxygen at low tide, resulting in greater release of H+ (Apte *et al.,* 2006).

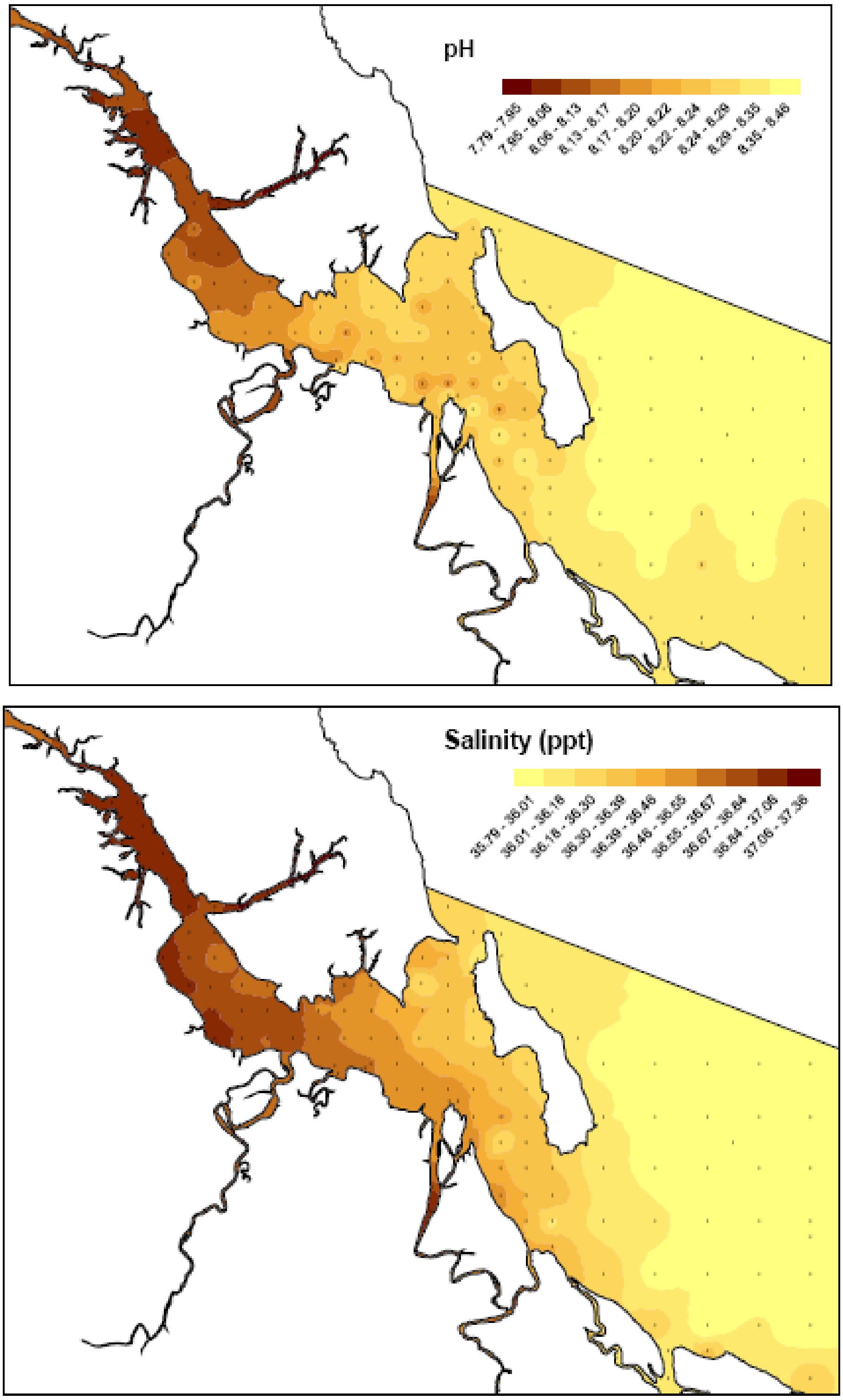


Figure 4-39 pH and salinity for Port Curtis surface waters (Apte *et al.,* 2006)

4.9.7.5 Sources of dissolved metals

Based on data summarised in Table 4-29 and the transect plots shown in Figure 4-37, it is evident that The Narrows region is elevated in trace metals, especially nickel and copper.

During Survey 1, the maximum dissolved copper and nickel concentrations in The Narrows were 637 and 905ng/L, respectively. The site of the maximum dissolved nickel concentration occurred approximately 8km further north than the dissolved maximum copper concentration, which may reflect different sources of these metals.

Dissolved lead and zinc concentrations were highest in Port Curtis (Table 4-29) and may reflect the importance of industrial inputs. Also shown in Table 4-29, the Fitzroy River plume is particularly enriched in dissolved nickel and to a lesser extent dissolved copper. This may act as a potential source of dissolved metals to the north of The Narrows (Apte *et al.,* 2006).

4.9.7.6 Conclusions

1. In the offshore coastal waters, dissolved metal concentrations were extremely low and were comparable to concentrations measured at open Pacific Ocean and New South Wales coastal water locations. Trace metal limitation rather than trace metal contamination is likely to be more of an issue for organisms inhabiting these waters;

2. Elevated metal concentrations exist within the harbour. The Narrows region was found to have the highest concentrations of copper and nickel;

3. The Fitzroy River is a source of dissolved metals to the local coastal region. Under some flow conditions, the Fitzroy plume may enter The Narrows region and potentially supply dissolved metals to Port Curtis;

4. There were no conspicuous sources of trace metals within Port Curtis. Metals in suspended and benthic sediments are low and are not a likely source of trace metals to the water column. The trace metal distributions in Port Curtis are likely to reflect a mixture of metal inputs including industrial discharges, mobilisation of metals from mangrove regions in The Narrows and the Fitzroy River plume;

5. Salinity and pH gradients were observed in Port Curtis. Salinities tend to be higher in the north of Port Curtis than in the surrounding coastal waters. This could reflect evaporation losses in these more sheltered areas where water circulation is restricted. Water column pH was lowest in The Narrows regions and is most likely related to acid inputs from the adjacent mangrove regions; and

6. Particulate metals data indicated that desorption of metals from suspended sediments is unlikely to be a major source of dissolved trace metals. The concentrations of copper and zinc in suspended sediments were, in most parts, typical of the benthic sediments and did not indicate enrichment of these metals. Trace metal inputs to Port Curtis which contribute to the observed dissolved metal concentrations are most likely to be delivered in solution form.

4.10 WBM Studies

4.10.1 WBM Port Curtis marine water quality summary (2001)

4.10.1.1 Marine water quality monitoring program

A marine water quality monitoring program undertaken by WBM and Capline took place from December 1998 to December 2000 to characterise the water quality in the region of proposed oil shale extraction works. Routine sampling was conducted every two months and event based sampling took place following periods of extended or heavy rainfall, major dredging activities or major industrial effluent discharges. The first water quality surveys were designed as a pilot program to trial sampling and measurement techniques and to statistically evaluate the appropriate level of replication for water sampling in subsequent routine and event water quality surveys.

Thirteen routine and four event based surveys were completed in the two year period. The first two event water quality surveys were conducted following significant catchment rainfall in January 1999 and in March 1999. The third survey was conducted after the unscheduled release of gaseous and particulate contaminants to the atmosphere from the Stuart Project site in October 1999, during trials of the Stage 1 plant. The fourth survey was undertaken after heavy catchment rainfall in October 2000.

The water quality monitoring programme used six water quality sampling sites (Figure 4-40) for both the routine and event surveys. The sites consisted of four potential impact sites (1-4) and two control sites (5-6) in Port Curtis as shown in Table 4-30.

Table 4-30 Description of water quality monitoring sites (WBM, 2001)

Site	Impact/Control	Description	Latitude	Longitude	Water depth
1	Impact	Mouth of Boat Creek	313750E	7365910N	2.5m
2	Impact	Fisherman's Landing Wharf	314050E	7368130N	12.5m
3	Impact	Mouth of Gully C	311500E	7368950N	2.5m
4	Impact	Targinie Creek	309900E	7372650N	3m
5	Control	Mouth of drainage line, Curtis Island	315620E	7369430N	3m
6	Control	Hamilton Point	317600E	7367480N	13m

Sampling sites 1, 3 and 4 were selected to characterise the water quality within those areas which may be affected by the oil shale Project, principally from changes to stormwater runoff and/or diversion of the major drainages on the oil shale Project site. Each is situated in the intertidal zone in comparatively shallow water and must therefore be accessed close to high water.

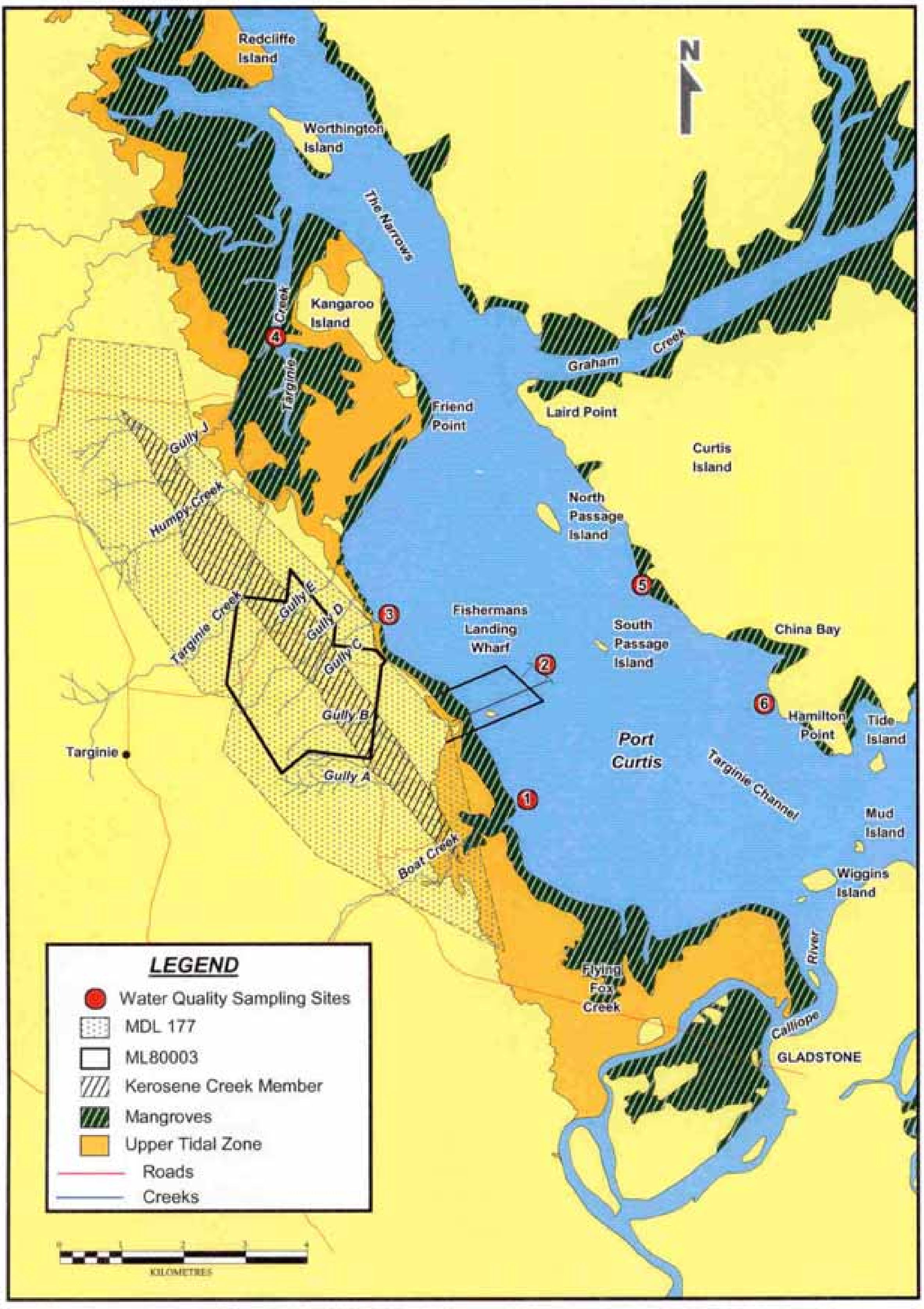


Figure 4-40 Marine Water Quality Monitoring Programme Sampling Sites (WBM, 2001)

4.10.1.2 Sampling and Measurement Sites

All routine and event surveys were timed to coincide with high water so as to maximise the available measurement and sampling times in these shallow waters and to provide consistency in the stage of the tide for each set of measurements and samples.

Site 2, in deep water, was selected for its proximity to the existing QCL bulk-handling wharf, the existing trade-waste discharge situated on the seabed below the QCL wharf and the recently constructed wharf and storage area developed for the Stuart Project.

Two control locations (sites 5 and 6) on the east side of Port Curtis were considered to be sufficiently hydrographically and geographically isolated from the potential impact area to be unlikely to suffer any impact from the oil shale Project. Control site 5 was selected to characterise the catchment runoff from a nearby undisturbed catchment on Curtis Island to the waters of Port Curtis (cf. the potentially disturbed catchments adjoining the Project site). Site 6 was selected to reflect the general water quality for a deeper water location adjacent to Curtis Island, comparable to impact site 2 without any development or trade waste discharges.

Physical water quality parameters were measured in-situ through the water profile at each of the above sites. Surface water samples (0.3 m depth) were collected for analysis from all sites, with the exception of sample site 2. At site 2, because of its moderate depth and the presence of the trade waste outfall on the seabed, surface (identified as site 2A) and near-bed (1 m above the seabed, identified as site 2B) water samples were collected. Therefore, seven water samples were collected for analysis from the six sampling sites.

Typically, each water sample was analysed for a range of trace elements, cyanide, nutrients, and suspended solids. During routine sampling survey No. 2 in February 1999, water samples were also collected from the water surface for the analysis of petroleum hydrocarbons.

Water sampling and profiling was conducted at all sites within one to two hours of local high water as predicted by the official tide tables (Queensland Transport, 1999). All water quality sampling for both routine and event surveys coincided with high water spring tidal conditions. The commitment to water quality sampling at high water spring tidal conditions resulted in a variation for the times of water quality sampling and measurements according to the season. Routine water quality surveys were scheduled with spring high tides at night during winter and during the day in the warmer months.

Surface water samples were collected using a 6 L Van Dorn sampler filled with water from a depth of 0.3 m. Care was taken to ensure that water samples were collected from the ‘clean’ water stream unaffected by prior contact with the hull of the sampling vessel. From each sample, a range of 1 L and 250 mL containers were filled for the specific analytes (one 250 mL for trace elements excluding mercury, one 250 mL for mercury, one 250 mL for cyanide and one 1 L for nutrients and suspended solids). Water within the sampler was kept agitated whilst filling the sample containers to prevent the suspended load within the sampler from settling. The near-bed water samples were collected from a depth of 1m above the seabed (approximately 11-11.5 m depth) at site 2 using the Van Dorn sampler.

At each site, the in-situ physical water quality measurements collected from the water column included Secchi disc, temperature, conductivity, salinity, dissolved oxygen, Redox and turbidity.

Water quality profiling measurements were conducted using a calibrated Hydrolab Datasonde 4 water quality instrument and a Secchi disc. Measurements were obtained at the water surface (0.3 m) and at 1 m intervals to the seabed where the total depth was less than 5 m. At locations where the water depth was greater, the measurements were collected at intervals of 2 m to the seabed.

The water samples collected at each site were analysed for trace elements, cyanide, nutrients and suspended solids.

4.10.1.3 Summary of water quality data

A summary of the mean (plus or minus one standard deviation) results for all in-situ measurements and the laboratory analysis results from all of the water samples collected from each site are shown in Table 4-32 presents the recorded range of all in-situ measurements and laboratory analysis results.

Figure 4-41 presents box and whisker plots for compiled depth measurements for all in-situ parameters over the 2 year period. Error bars indicate the range of measurements (i.e. maximum and minimum values) recorded for the in-situ parameters.

Table 4-31 Mean and standard deviation water quality values in Port Curtis (All data, December 1998 - December 2000, High Water Conditions) (WBM, 2001)

Parameter	Unit	1 Boat Creek	2 Fishermans Landing		3 Gully C	4 Targinie Creek	5 Curtis Island (1)	6 Curtis Island (2)	ANZECC Guideline*or Seawater Range
In-situ measurements: (Mean ± Standard Deviation)									
Temperature	ºC	25.0 ± 2.3	24.3 ± 3.2		24.5 ± 3.3	24.3 ± 3.5	24.6 ± 3.4	24.4 ± 3.3	***<2° increase***
Conductivity	mS/cm	53.5 ± 2.9	53.4 ± 2.6		52.7 ± 3.7	52.5 ± 3.6	53.2 ± 2.8	53.5 ± 2.5	-
Salinity	g/L	35.4 ± 2.1	35.3 ± 1.9		34.8 ± 2.7	34.7 ± 2.6	35.1 ± 2.0	35.4 ± 1.8	***[35.5]***
pH	Units	8.10 ± 0.09	8.11 ± 0.12		8.08 ± 0.13	7.90 ± 0.14	8.08 ± 0.11	8.12 ± 0.12	***[8.1]***
Redox	mV	218 ± 82	275 ± 96		278 ± 96	318 ± 117	277 ± 97	264 ± 94	-
DO	mg/L	5.87 ± 0.72	6.24 ± 0.58		6.49 ± 0.78	5.97 ± 0.84	6.39 ± 0.65	6.33 ± 0.60	***>6.0***
DO %	% Sat	87.7 ± 10.4	92.1 ± 9.0		95.6 ± 12.0	87.4 ± 10.5	95.4 ± 11.1	93.5 ± 8.9	***>80***
Turbidity	NTU	13.7 ± 5.5	25.0 ± 20.9		18.6 ± 16.0	20.1 ± 13.9	28.8 ± 19.8	29.9 ± 24.3	***<10% change in seasonal mean***
Secchi Depth	m	1.2 ± 0.2	1.1 ± 0.5		1.0 ± 0.2	1.1 ± 0.3	0.9 ± 0.4	1.0 ± 0.4	***As above***
Trace Elements:			2A	2B					
Aluminium	µg/L	94 ± 155	177 ± 376	326 ± 657	118 ± 161	180 ± 374	322 ± 877	263 ± 639	***[5]***
Arsenic	µg/L	1.1 ± 0	1.1 ± 0	1.1 ± 0	1.1 ± 0	1.0 ± 0	1.0 ± 0	1.0 ± 0	***50***
Barium	µg/L	12.8 ± 7	10.8 ± 6	9.9 ± 5	13.2 ± 6	12.4 ± 4	11.4 ± 7	9.6 ± 5	-
Boron	µg/L	4,523 ± 577	4,585 ± 578	4,628 ± 597	4,555 ± 532	4,488 ± 602	4,569 ± 651	4,600 ± 611	***[4440]***
Cadmium	µg/L	<1.0 ± 0.0	<1.0 ± 0.0	<1.0 ± 0.0	<1.0 ± 0.0	<1.0 ± 0.0	<1.0 ± 0.0	<1.0 ± 0.0	***2***
Chromium	µg/L	1.6 ± 2.4	1.0 ± 0.0	2.6 ± 5.5	1.0 ± 0.0	1.1 ± 0.2	1.1 ± 0.5	1.2 ± 0.6	***50***
Copper	µg/L	1.2 ± 0.6	1.1 ± 0.3	1.3 ± 0.4	1.2 ± 0.7	1.2 ± 0.4	1.3 ± 0.6	1.1 ± 0.3	***5***
Iron	µg/L	91 ± 108	158 ± 239	332 ± 470	127 ± 151	166 ± 248	254 ± 503	219 ± 376	***[3]***
Lead	µg/L	<1.0 ± 0.0	<1.0 ± 0.0	<1.0 ± 0.0	<1.0 ± 0.0	<1.0 ± 0.0	<1.0 ± 0.0	<1.0 ± 0.0	***5***
Manganese	µg/L	8.1 ± 4.7	8.3 ± 6.3	15.6 ± 12.9	9.9 ± 7.4	14.1 ± 12.1	14.1 ± 17.4	11.0 ± 10.7	***[2]***
Mercury	µg/L	<0.1 ± 0.0	<0.1 ± 0.0	<0.1 ± 0.0	<0.1 ± 0.0	<0.1 ± 0.0	<0.1 ± 0.0	<0.1 ± 0.0	***0.1***
Nickel	µg/L	1.5 ± 0.9	2.1 ± 2.2	2.9 ± 3.7	1.4 ± 0.9	2.2 ± 2.2	3.3 ± 5.0	2.3 ± 2.9	***15***
Zinc	µg/L	2.0 ± 2.0	2.5 ± 2.6	3.5 ± 3.4	2.0 ± 1.5	2.2 ± 1.3	2.7 ± 2.5	2.0 ± 1.5	***50***
Fluoride	µg/L	1,259 ± 912	1,265 ± 820	1,144 ± 665	1,264 ± 864	1,272 ± 829	1,308 ± 926	1,335 ± 976	***[1300]***
Compounds:									
Cyanide	µg/L	5.3 ± 1.2	<5.0 ± 0.0	<5.0 ± 0.0	<5.0 ± 0.0	5.1 ± 0.2	<5.0 ± 0.0	<5.0 ± 0.0	***5***
Nutrients:									
Total Nitrogen	µg/L	196.9 ± 102	184.0 ± 92	177.4 ± 79	194.1 ± 83	210.9 ± 135	205.5 ± 82	199.1 ± 83	-
Total Kjeldahl Nitrogen	µg/L	183.5 ± 93	169.8 ± 85	163.8 ± 76	185.9 ± 75	178.5 ± 75	184.9 ± 78	187.6 ± 79	-
Organic Nitrogen	µg/L	163.3 ± 83	152.8 ± 83	141.1 ± 71	166.6 ± 73	161.5 ± 70	165.8 ± 76	171.6 ± 70	-
Ammonia	µg/L	21.9 ± 22	19.4 ± 19	23.6 ± 28	20.4 ± 18	19.9 ± 21	26.1 ± 46	18.8 ± 19	***(<5)***
Nitrite	µg/L	6.3 ± 4	7.5 ± 5	7.4 ± 5	6.3 ± 4	30.0 ± 101	8.0 ± 7	7.1 ± 5.0	-
Nitrate	µg/L	13.6 ± 15	12.6 ± 11	11.9 ± 9	9.4 ± 12	8.9 ± 14	14.4 ± 17	10.4 ± 7.6	***(10-100)***
Total Phosphorus	µg/L	39.4 ± 17	39.8 ± 17	38.8 ± 17	39.4 ± 17	38.8 ± 18	40.2 ± 17	38.9 ± 17.8	-
Orthophosphorus	µg/L	7.3 ± 4	7.5 ± 4	9.1 ± 7	7.2 ± 3	7.8 ± 5	9.7 ± 9	9.5 ± 11	***(5-15)***
Suspended Solids:									
Suspended Solids	mg/L	26.1 ± 21	37.2 ± 23	44.9 ± 28	30.0 ± 21	34.0 ± 18	46.7 ± 31	41.9 ± 31.0	***<10% change in seasonal mean***

Table 4-32 Range of water quality values in Port Curtis (All Data, December 1998 - December 2000, High Water Conditions) (WBM, 2001)

Parameter	Unit	1 Boat Creek	2 Fishermans Landing		3 Gully C	4 Targinie Creek	5 Curtis Island (1)	6 Curtis Island (2)	***ANZECC Guideline*or Seawater Range***
In-situ measurements: (Minimum - Maximum)									
Temperature	°C	17.8 - 29.0	17.5 - 29.1		17.8 - 28.9	17.0 - 29.2	17.4 - 29.3	17.4 - 29.2	***<2° increase***
Conductivity	mS/cm	38.8 - 57.3	44.3 - 56.8		41.5 - 57.4	43.6 - 57.9	46.7 - 57.0	47.2 - 57.0	***-***
Salinity	g/L	24.7 - 38.2	28.6 - 37.8		26.6 - 38.2	28.3 - 38.7	30.4 - 38.0	30.7 - 37.8	***[35.5]***
pH	Units	7.87 - 8.35	7.79 - 8.36		7.85 - 8.39	7.68 - 8.28	7.87 - 8.32	7.81 - 8.37	***[8.1]***
Redox	mV	115 - 420	111 - 437		117 - 426	137 - 605	114 - 430	112 - 435	***-***
DO	mg/L	5.03 - 7.93	5.36 - 7.80		5.32 - 8.40	4.45 - 7.77	5.41 - 7.87	5.33 - 7.67	***>6.0***
DO %	% Sat	77.0 - 124.4	79.0 - 122.9		80.9 - 130.4	67.8 - 111.5	80.9 - 123.3	81.9 - 120.1	***>80***
Turbidity	NTU	2.7 - 31.8	2.5 - 143.0		2.6 - 85.0	2.2 - 55.0	4.4 - 104.0	3.0 - 168.8	***<10% change in seasonal mean***
Secchi Depth	m	0.8 - 1.9	0.6 - 2.1		0.6 - 1.4	0.6 - 2.0	0.3 - 1.7	0.4 - 1.8	***As above***
Trace Elements:			2A	2B					
Aluminium	µg/L	5 - 670	5 - 1,600	7 - 2,700	5 - 680	5 - 1,600	5 - 3,700	5 - 2,700	***[5]***
Arsenic	µg/L	<1 - 3	<1 - 2	<1 - 2	<1 - 2	<1 - 1	<1 - 1	<1 - 1	***50***
Barium	µg/L	<1 - 27	<1 - 23	<1 - 21	<1 - 28	<1 - 21	<1 - 37	<1 - 24	***-***
Boron	µg/L	3,400 - 5,800	3,700 - 6,000	3,600 - 6,100	3,600 - 5,500	3,400 - 5,700	3,400 - 6,200	3,500 - 5,800	***[4440]***
Cadmium	µg/L	<1	<1	<1	<1	<1	<1	<1	***2***
Chromium	µg/L	<1 - 11	<1 - 1	<1 - 23	<1	<1 - 2	<1 - 3	<1 - 3.2	***50***
Copper	µg/L	<1 - 3.6	<1 - 2	<1 - 2.3	<1 - 4	<1 - 2.5	<1 - 3	<1 - 2	***5***
Iron	µg/L	<5 - 400	<5 - 960	<5 - 1,700	<5 - 550	<5 - 1,000	<5 - 2,100	<5 - 1,500	***[3]***
Lead	µg/L	<1	<1	<1	<1	<1-1	<1	<1	***5***
Manganese	µg/L	<1 - 19	<1 - 24	<1 - 42	<1 - 28	<1 - 51	<1 - 59	<1 - 39	***[2]***
Mercury	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	***0.1***
Nickel	µg/L	<1 - 4	<1 - 9	<1 - 15	<1 - 4	<1 - 10	<1 - 20	<1 - 13	***15***
Zinc	µg/L	<1 - 9.4	<1 - 11	<1 - 10	<1 - 5.6	<1 - 5	<1- 9	<1 - 5	***50***
Fluoride	µg/L	670 - 3,700	720 - 3,600	840 - 3,600	560 - 3,800	810 - 3,600	830 - 3,900	750 - 4,100	***[1300]***
Compounds:									
Cyanide	µg/L	<5 - 10	<5 - 5	<5 - 5	<5	<5 - 6	<5	<5	***5***
Nutrients:									
Total Nitrogen	µg/L	50 - 370	50 - 410	50 - 310	50 - 340	50 - 630	60 - 330	78 - 364	***-***
Total Kjeldahl Nitrogen	µg/L	50 - 354	50 - 370	40 - 300	50 - 336	50 - 310	60 - 300	78 - 364	***-***
Organic Nitrogen	µg/L	40 - 307	46 - 360	40 - 290	50 - 300	50 - 300	50 - 290	78 - 300	***-***
Ammonia	µg/L	<5 - 77	<5 - 72	<5 - 110	<5 - 65	<5 - 93	<5 - 200	<5 - 64	***(<5)***
Nitrite	µg/L	<5 - 20	<5 - 20	<5 - 20	<5 - 20	<5 - 420	<5 - 30	<5 - 20	***-***
Nitrate	µg/L	<5 - 58	<5 - 41	<5 - 31	<5 - 51	<5 - 61	<5 - 72	<5 - 26	***(10-100)***
Total Phosphorus	µg/L	<10 - 50	<10 - 50	<10 - 50	<10 - 50	<10 - 50	<10 - 60	<10 - 50	***-***
Orthophosphorus	µg/L	<5 - 20	<5 - 20	<5 - 30	<5 - 17	<5 - 20	<5 - 40	<5 - 50	***(5-15)***
Suspended Solids:									
Suspended Solids	mg/L	8 - 79	5 - 91	9 - 116	7 - 81	3 - 65	2 - 113	9.0 - 116.0	***<10% change in seasonal mean***

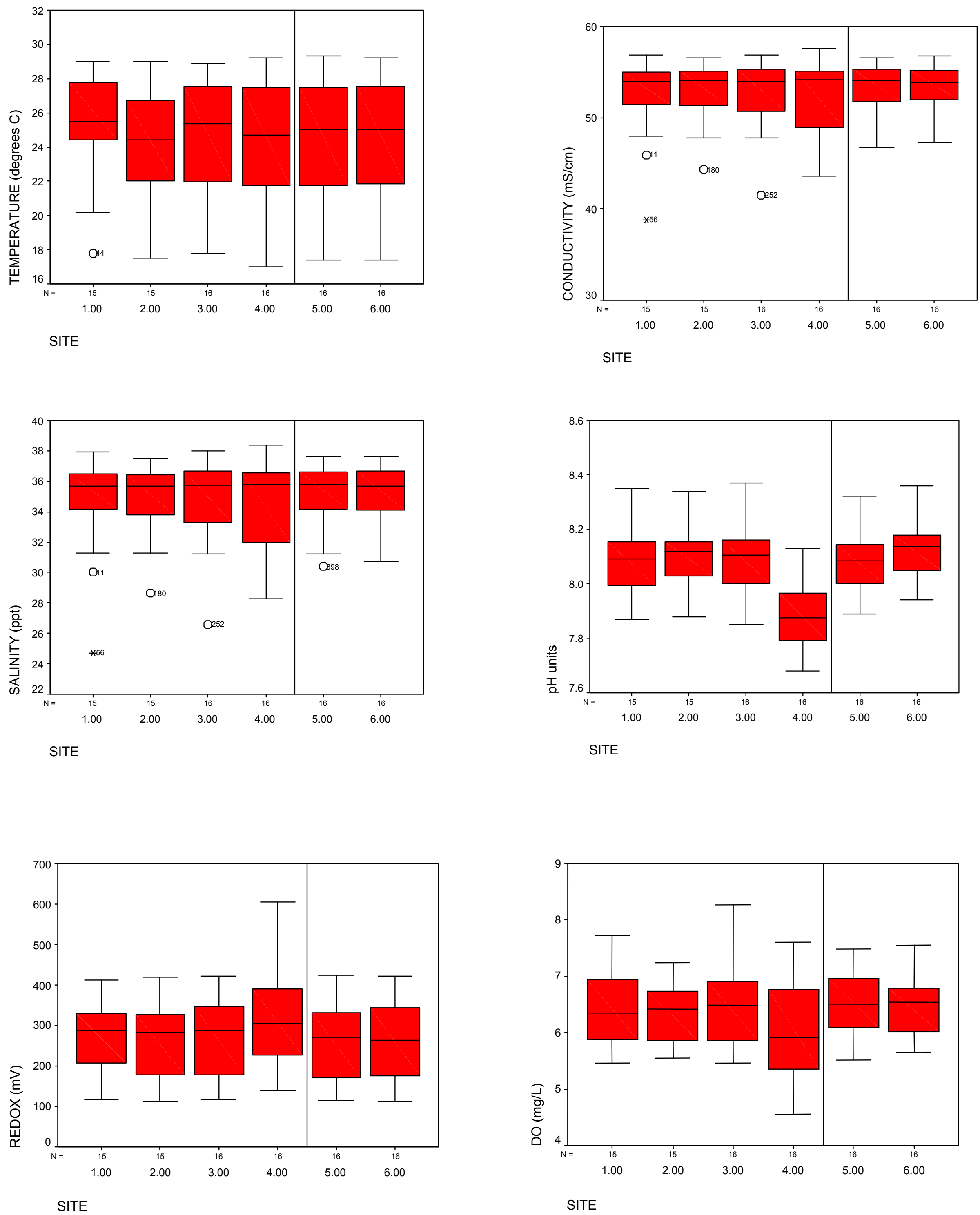


Figure 4-41 In-situ Physical Water Quality Measurements (December 1998 - December 2000) (WBM, 2001)

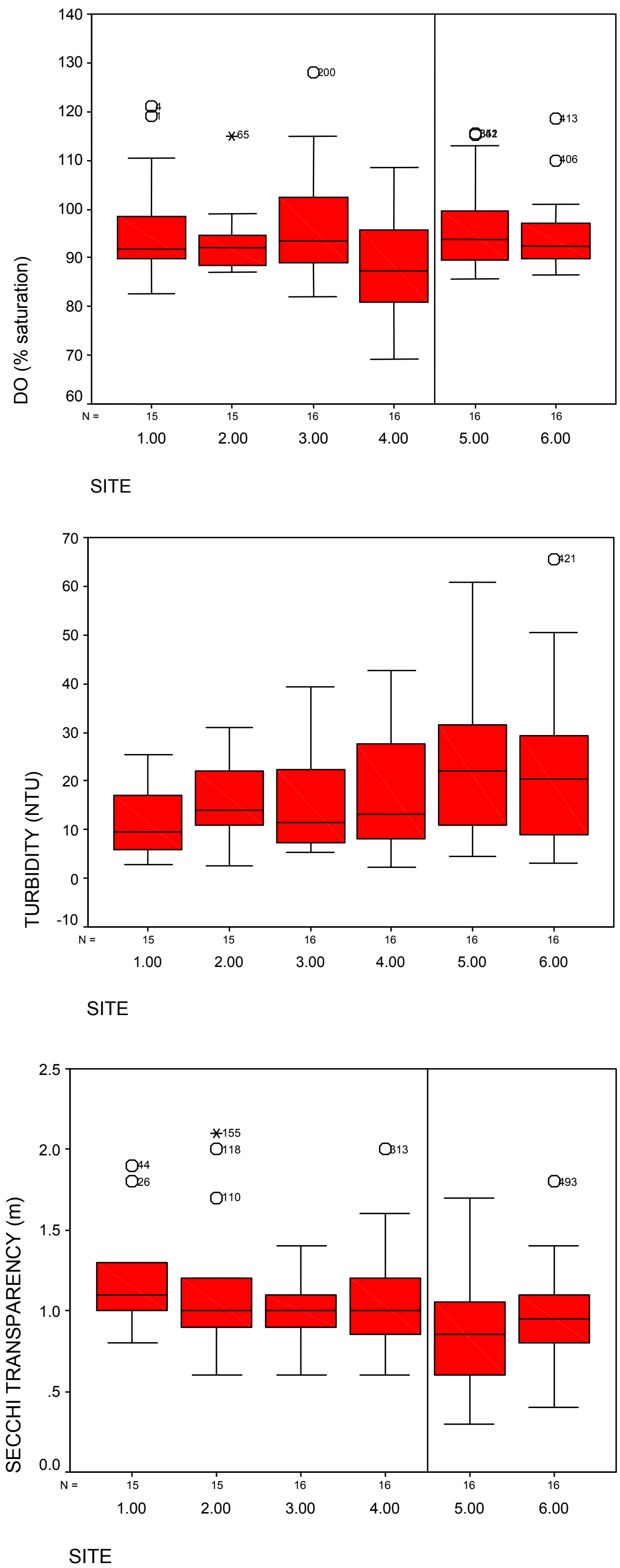


Figure 4-41 (continued) In-situ Physical Water Quality Measurements (December 1998 - December 2000) (WBM, 2001)

4.10.1.4 Discussion

The temporal coverage of the data generally provided a wide variability in most water quality parameters, which often exceeded the inter-site variation for a particular time. Despite the temporal range of data compiled, it is important to note that all the water quality data was representative of conditions close to high water during spring tidal conditions. It could therefore be reasonably expected that some parameters might lie outside the recorded range at other stages of the tide.

For most parameters, the mean concentration or median value for the potential impact sites (1 - 4) was contained within one standard deviation or the 25th percentile of the data for comparative control sites (5 - 6), generally indicating that the water quality conditions between the potential impact and control sites were similar.

The only exception was pH. pH was slightly lower at site 4 (Targinie Creek) than either of the two control locations at Curtis Island because of the site's upstream location within a well defined creek and the lowering influence of catchment drainage on pH. The differences may be the result of catchment geology, vegetation and/or existing land use.

Based upon the data compiled by the Marine Water Quality Monitoring Programme between December 1998 and December 2000, the water quality characteristics for Port Curtis adjoining the study area were as follows:

In-situ measurements

Temperature

Water temperature varied between a maximum of approximately 29°C in December 1999 to a minimum of 17°C in June 2000. There was consistently little variation in water temperature (less than 0.5°C) between the water surface and near the sea bed at all locations for each water quality survey. Surface water temperatures were slightly warmer in summer and cooler in winter than the water nearest the sea bed. The winter water temperature was approximately 3°C cooler in June 2000, than the corresponding period in 1999.

Conductivity and Salinity

Conductivity/salinity displayed little variation through the routine surveys of 1999, remaining at approximately seawater levels (typically 53 mS/cm and 35.5 g/L). Slightly higher salinities, up to 37 g/L, were reported for the routine surveys in February 1999, April and October 2000, which were all conducted on high spring tides. Conductivities and salinities were more variable in 2000, with reduced salinities in June and November 2000, following catchment rainfall. The generally small changes in water temperature and conductivity/salinity through the water column indicated that the water was generally well-mixed at all locations at spring high water.

Surprisingly, the conductivity/salinity levels remained high (usually above 45 mS/cm and 30 g/L), that is near seawater levels, following significant catchment rainfall (in excess of 200 mm of rainfall was reported at Gladstone prior to the second event survey in March 1999 and approximately 180 mm preceded the fourth event survey in November 2000). The relatively low salinities measured at all locations in June 2000 appeared to result from rainfall which was not recorded as being significant in the immediate Gladstone area. An approximate total of only 45mm was registered in the local catchment preceding the June 2000 survey, though there was evidence to suggest significant rainfall just offshore. The anecdotal evidence for offshore rainfall is supported by the consistent conductivity/salinity at all locations in June 2000 which suggests that the lower salinity water was well mixed at all locations, in contrast to the other surveys following catchment rainfall where there was some variation in the water salinity. Furthermore, the water clarity was generally high for the June 2000 survey, which is not consistent with significant catchment rainfall.

There was some variation in the conductivity/salinity within and between sites following the catchment rainfall events in January and March 1999 and particularly in November 2000. Site 4 at Targinie Creek generally had the lowest conductivity/salinity of all the measurement locations, whilst site 6 at Curtis Island generally had the highest conductivity/salinity. However, it is noteworthy that site 4 at Targinie Creek had the highest conductivity/salinity of any of the sampling locations during the drier months of August and October 1999 and October 2000 and also had the highest conductivity/salinity during the two year term of the monitoring programme in October 2000 being approximately 57.7 mS/cm and 38 g/L. Figure 4-41 shows that variation in salinity was relatively consistent at all locations, except site 4 (Targinie Creek), which had a greater range of values.

pH

pH levels generally remained alkaline at approximately pH 8.0 - 8.3 for all locations over the period 1998-2000, with the exception of Targinie Creek. An alkaline pH of 8.1 - 8.3 is consistent with the properties of oceanic seawater. The lowest pH occurred consistently at Targinie Creek (which generally had the lowest salinity, though as noted above there were some exceptions in the drier months when salinity in Targinie Creek was highest) where the pH was usually 0.2 units lower than at other locations. The box plot illustrates the 0.2 unit difference in pH between Targinie Creek and the other sites. This would seem to suggest that there is an alternative source of acidity, other than catchment runoff, which affects the Targinie Creek catchment. The source of acidity might include organic acids from catchment vegetation or alternatively, may be derived from regional shale deposits. Interestingly, the pH did not always appear to follow the fluctuations in salinity evident in 2000. For example, it would be expected that the reduced salinities, which occurred during the event survey in November 2000, might have been associated with lower pH levels (e.g. 7.8-7.9) than the approximate 8.1 measured on this survey.

Dissolved oxygen

Dissolved oxygen levels at all locations, with the exception of site 4 (Targinie Creek), were generally close to being fully saturated. Slightly supersaturated dissolved oxygen concentrations (>100%) were measured at most locations in the summer months of December 1998/ January 1999 and in October 1999 and October 2000. Dissolved oxygen concentrations at site 4 within Targinie Creek were generally lower than at other locations, being between 80-90% saturation, with measurements falling just below 70% in December 1999 and a little above 70% saturation in February and November 2000. Apart from the lower saturation concentrations measured at Targinie Creek, the dissolved oxygen concentrations at all other locations were always above the ANZECC (1992) desirable minimum concentration of 80% saturation (or 6 mg/L) at the times of measurement.

Turbidity

Turbidity concentrations demonstrated a considerable variability between and within the measurement sites. Generally, turbidity was lowest close to the water surface and highest near the seabed. A single high turbidity measurement near the seabed often inflated the depth averaged turbidity concentration presented for a particular site. In general, the depth averaged water turbidity was lowest at sites 1, 3 and 4 (Boat Creek, Gully Creek and Targinie Creek) and highest at Fisherman's Landing (site 2) and at Curtis Island (control sites 5 and 6). The depth averaged turbidities at sites 1, 3 and 4 typically ranged between 15 and 30 NTU. At sites 2, 5 and 6, the average turbidities were more frequently in the range 30-60 NTU. There was a seasonal trend of reduced turbidity (<20 NTU) at most sites in the cooler months of each year (August and October 1999 and April, June August and October 2000) which is supported, though more pronounced, for the Secchi disc measurements. The Secchi disc measurements illustrate a seasonal peak in water clarity (i.e. low turbidity) in August and October 1999 and again in June 2000.

Deepwater sites 2 and 6 (Fisherman's Wharf and Curtis Island) tended to display the greatest variation in turbidity concentrations between the surface and the seabed. This was likely due to the considerable tidal current speeds (>1m/s) observed at these locations during spring tides. The strong tidal currents readily suspended the fine bed sediments into the water column, thereby increasing the water turbidity.

Turbidities measured following significant catchment runoff in January and March 1999 were elevated, though only slightly, above the concentrations measured during some of the routine surveys. However the water turbidities in November 2000 (event survey No.4) were not notably elevated by catchment runoff. Catchment runoff appeared to influence the turbidity of water at Gully C following the rainfall event in March 1999, where discharges from the study area may have increased the turbidity of the receiving water.

It appears that the combination of season, wind speed, direction and tidal range and/or tidal height has as important influence on water turbidities as does catchment runoff. Water quality measurements coincided with very high tides (above a predicted height of 4.3m) and large range tides in February and October 1999 and in August and December 2000. Measured turbidities were on average highest and displayed more variation during conditions of large spring tides and moderate winds in February 1999 than at any other time. However, tides of equal or higher range and height, which occurred at times of light wind, for example during August and December 2000 coincided with lower turbidity conditions. The turbidities measured in August 2000 were by comparison quite low even though the tidal height, range and weather conditions were similar to conditions in December 2000. This suggests that perhaps there are seasonal or other influences (e.g. such as the phase of the spring tide cycle or preceding weather conditions) which are important in controlling the water turbidity.

<u>Secchi depth</u>

Secchi disc visibility measurements are indicative of the clarity of surface waters only and therefore cannot be directly comparable with the depth averaged results for turbidity. However, the Secchi disc results tend to reinforce most observations made regarding turbidity. That is, the surface water clarity was low during the high spring tidal conditions, for the second routine water quality survey in February 1999 and subsequent summer season surveys in February and December 2000. Secchi disc visibility typically varied between 0.5 and 1.5 m at most sites, with peak water clarities approaching 1.8 to 2.0 m in August and October 1999 and in June 2000. The maximum Secchi disc visibility of 2.1 m was measured at site 2 (Fisherman's Landing) in June 2000. A visibility of 2.0 m was measured at Fisherman's Landing in October 1999 and at Targinie Creek in June 2000. Secchi disc measurements in June, August and October 1999 and 2000 were recorded at night (refer to Appendix B) using a torch and therefore the measurements may not have been directly comparable with those from other surveys made in daylight. Table 4-32 demonstrates that the median Secchi disc depth was generally lowest at control Site 5 (Curtis Island).

Nutrients and Suspended Solids

Suspended solids

Consistent with the observations made regarding turbidity and Secchi disc visibility, suspended solids concentrations were generally highest during the spring tidal conditions in February 1999, February 2000 and December 2000.

The peak suspended solids concentration (116 mg/L) occurred at site 6, (Curtis Island) in February 1999 and also at site 2B (Fisherman's Landing) in March 1999, following significant catchment rainfall. The suspended solids concentration generally varied between 5 and 70 mg/L at most locations. Suspended solids concentrations at or exceeding 80 mg/L were recorded for all locations.

Suspended solids concentrations less than 10 mg/L were recorded at most sites in June 1999. Whilst the suspended solids concentrations, generally based on surface water samples were lowest in June 1999, the highest water clarity (based upon turbidity profiles and Secchi disc measurements) occurred during the August and October 1999 and June 2000 surveys.

Orthophosphate

The ANZECC guideline range of acceptable orthophosphorus concentrations in estuarine waters is between 5 and 15 µg/L. Most measurements from all locations have been below 10 µg/L. However, there were exceptions in February 1999 (following large spring tides) when the orthophosphorus concentration at almost all locations exceeded 10 µg/L. Levels up to 50 µg/L were reported for the sample from site 6 at Curtis Island on this survey. The other exceptions occurred in April 2000, when the orthophosphorus concentrations were between 16 and 20 µg/L at all locations.

By contrast to the results for February 1999, there was only a small increase in orthophosphorus concentrations at site 1 (Boat Creek) and near bed waters at site 2 (Fisherman's Landing) to 20 µg/L following the significant catchment rainfall which occurred in early March 1999.

Ammonia

The ANZECC guideline acceptable concentration for ammonia in estuarine waters is less than 5 µg/L. Most analysis results were below 10 µg/L, with a peak level of 200 µg/L occurring at site 5 (Curtis Island) in December 1999. Ammonia concentrations were significantly elevated at all locations in December 1999 with a range of 60 to 200 µg/L. The results for February and August 2000 were also elevated well above 10 µg/L, with a peak value of 110 µg/L at Fisherman's Landing in August 2000. It is uncertain whether the ammonia concentrations were elevated at these times by resuspension of bed sediments or organic detritus, from coastal intrusion of nutrient rich water, or from sample contamination.

Ammonia concentrations following catchment runoff events in January and March 1999 and November 2000 were generally less variable and smaller, being typically close to 10 µg/L. There did not appear to be any apparent pattern to ammonia concentrations.

Nitrate/ Nitrite

Acceptable nitrate concentrations in estuarine waters as outlined by ANZECC, (1992) range between 10 and 100 µg/L. The peak nitrate concentration of 72 µg/L occurred at site 5 (Curtis Island) in December 1999. This corresponded to the (time and location of the) peak in the ammonia concentrations. Typical concentrations at most locations were less than 10 µg/L. Elevated nitrate concentrations were reported for all sample sites from the November 2000 survey, which followed significant catchment rainfall. Typical nitrate concentrations at this time ranged between 20 and 60 µg/L.

Trace Elements

The processes of tidal resuspension of bed sediments and/or catchment runoff appear to be responsible for elevating some of the trace element concentrations within the waters of Port Curtis adjoining the study area.

Those elements with concentrations apparently elevated above ANZECC (1992) guidelines or typical seawater concentrations by the tidal mobilisation of bed sediments included:

- Aluminium (up to 3,700 µg/L at site 5, Curtis Island);
- Iron (up to 2,100 µg/L at site 5, Curtis Island);
- Manganese (up to 59 µg/L at site 5, Curtis Island); and
- Nickel (up to 20 µg/L at site 5, Curtis Island).

The trend of elevated element concentrations was most pronounced in February 1999 at control site 5 (Curtis Island). This location was visited shortly after high water on each water quality survey and it was noted that it experienced strong tidal currents early in the ebb tide. These currents would quickly suspend the bed sediments and there was often a visible turbidity plume at the site. It appears that the increased concentrations of the above elements evident at all sites in February 1999 were due to the concentration of suspended solids containing trace quantities of metals. Duplicate filtered water samples (analysed for quality control purposes) indicated that dissolved element concentrations were typically much lower, and comparable with oceanic seawater. Other elevated concentrations occurred during the high tides of June 1999, and February and December 2000, though the concentrations of the above elements at these times were generally much lower.

A limited range of elements (arsenic, and barium) and cyanide indicated elevation following catchment runoff events in January or March 1999 or in November 2000. The results for each were as follows:

- Arsenic was detected following catchment runoff in January 1999, with a maximum concentration of 3 µg/L at site 1 (Boat Creek). Arsenic concentrations were detected at all locations at this time, though all concentrations were well below the ANZECC (1992) criterion of 50 µg/L for the protection of marine ecosystems;

- Barium was slightly elevated following catchment runoff in March 1999 and November 2000, and also in October 1999 (though there was no significant rainfall at this time). All sites indicated an elevation in concentration at these times. The maximum concentration was 37 µg/L at site 5 (Curtis Island) in November 2000, which was slightly higher than the typical seawater concentration of 30 µg/L;
- Cyanide concentrations at some sites (1, 2A, 2B and 4) were elevated above the ANZECC criterion of 5 µg/L (for the protection of marine ecosystems) following catchment runoff in March 1999. At that time, the maximum concentration of 10 µg/L was reported for site 1 (Boat Creek). Concentrations of 5 µg/L were reported at Fisherman's Landing (surface and near-bed) and 6 µg/L was reported for site 4 at Targinie Creek. Elevated cyanide concentrations may occur naturally through the decomposition of catchment vegetation and/ or micro-organisms in receiving waters (ANZECC, 1992). It is feasible that the measured concentrations of cyanide were due to these influences in catchment runoff from the major creeks and gullies;
- Fluoride concentrations appeared not to follow any identifiable temporal or event pattern. The peak fluoride concentration recorded at all sites was between 3,000 to 4,000 µg/L in December, 1989 and January 1999. Subsequently, concentrations have been close to those in oceanic seawater (1,300 µg/L); and
- Some elements such as cadmium, mercury, and lead remained completely or largely undetected over the 2 year period. Other elements such as chromium and copper were detected more frequently at one or a number of sites, though at concentrations below their respective ANZECC (1992) guideline criteria.

Box and whisker plots of aluminium, copper and iron concentrations show somewhat higher typical concentrations at Site 2 (Fisherman's Landing) than for other locations, though these plots represent cumulative data for both the surface and subsurface water samples collected at Site 2 (compared with other sites for which only surface samples are analysed). There do not appear to be any definitive patterns for other trace metal concentrations.

Petroleum Hydrocarbons

Owing to the visual absence of petroleum hydrocarbons at all of the sampling sites during all of the water quality surveys, laboratory analysis of collected water samples for petroleum hydrocarbons was only conducted on one sampling occasion. Samples were collected for petroleum hydrocarbon analysis as a confirmation of the visual results during the second of the routine surveys in February 1999. The results of analysis of these samples were all below the respective level of reporting (<1 µg/L) for each hydrocarbon group. Due to the confirmed absence of petroleum hydrocarbons by laboratory analysis, no further laboratory analysis of water samples for petroleum hydrocarbon analysis was scheduled for subsequent routine or event surveys unless visible slicks were evident.

4.10.2 WBM marine water quality and flow modelling study (1999)

4.10.2.1 Historical data

The collection of water quality data from Port Curtis in the vicinity of the study area dates from September 1977 when some water quality data was collected from The Narrows for the Rundle Oil

Shale development proposal by consulting engineers, Rankine and Hill. Subsequently, water quality information for the study area has been compiled by government and commercial interests for a wide range of development proposals and projects.

More comprehensive water quality information for the Port Curtis area was collected on behalf of the Co-ordinator Generals Department in 1978 (ETM Consultants,1980) and subsequently by the then Water Quality Council of Queensland (now the Queensland Environmental Protection Agency) between 1980 and 1986. Both data sets are now comparatively old and, because of the continuing industrial development of the port, are unlikely to accurately reflect existing conditions in Port Curtis. Relevant water quality information was collected within Port Curtis by Dames and Moore Pty Ltd in September 1995 and again in November 1997. However, the water quality measurements, sample analyses and locations adopted for this study were not consistent for each survey date and therefore lack temporal continuity.

The studies and other sources of water quality data or information that was reviewed in this study are as follows. Relevant sampling locations from these previous studies are shown in Figure 4-42.

- Department of Harbours and Marine (1977) Environmental Impact Study, Proposed Cement Clinker Ship loading Facility, Fisherman's Landing, Calliope Shire. The study utilised water quality information (consisting of major and trace elements concentrations) which was collected at approximate two monthly intervals from the present-day location of the Clinton Coal wharf between May 1975 and September 1979. Due to the age and distant location of the collected data from that former and the present study area, it is not considered to be of direct relevance;
- Rankine and Hill (1978) Rundle Oil Shale Proposal, Environmental Study Report and Rankine and Hill (1980) Rundle Oil Shale Project, Supplementary Report. These reports presented estuarine water quality data for The Narrows on four sampling occasions at approximately three monthly intervals covering the period September 1977 to May 1978. The only relevant sampling location (N6) was situated north of the study area at Black Swan Inlet. The data set for this location includes some in-situ physical measurements (temperature, conductivity, salinity dissolved oxygen and pH) together with major and trace element and nutrient analyses results from collected water samples;
- ETM Consultants Pty Ltd (1980) Water Quality Plan for Port Curtis. This report contains relevant water quality data for the study area of Port Curtis between The Narrows and the mouth of the Calliope River. Monthly data from June to November 1978 includes physical in-situ measurements, nutrients and suspended solids, hydrocarbons, chlorophyll a, faecal coliforms, BOD and TOC;
- Queensland Environmental Protection Agency (EPA), formerly the Water Quality Council of QLD when the data was collected, (1980-1986) unpublished data. Relevant data held by the EPA includes physical in-situ measurements and suspended solids at two sampling locations at approximately three monthly intervals between September 1980 and August 1986. Some components of the EPA data set have been variously reported or summarised by others (e.g. WBM Pty Ltd, 1990; Gladstone Port Authority and the Queensland Department of Environment and Heritage, 1994);
- WBM Pty Ltd (1990) Impact Assessment Study, Reclamation of Land West of Calliope River. This report contains a summary of the EPA water quality data (1980-1986) for two relevant

locations (PC6 and PC7) as well as some suspended solids results from the mouths of Boat and Flying Fox Creeks in November 1989;

- WBM Oceanics Australia (1992a) Fisherman's Landing, Trade Waste Outfall, Benthic Monitoring Report 1990-1991. This report presents some limited physical in-situ water quality measurements (consisting of temperature, salinity, turbidity) at two locations adjacent to the Fisherman's Landing wharf and also at one location near China Bay, Curtis Island. The data were collected at four monthly intervals over the 12 month period September 1990 to September 1991;
- WBM Oceanics Australia (1992b) Stuart Oil Shale Environmental Studies, Aquatic Biology, Oil Spills, Wastewater Disposal and Creek Diversion. Water quality data presented in this report were based upon water sample collection and analysis from one set of samples collected in February 1992. The sampling locations included one location (L1) adjacent to the Fisherman's Landing wharf as well as three locations (L2, L3, L4) at approximate distances 500, 1000 and 2000m seaward of Gully C, within the study area. Analysis included some physical parameters (conductivity, pH) as well as major and trace elements, nutrients, phenols and BOD;
- WBM Oceanics Australia (1992c) Gladstone Industrial Land Study, Water Quality Investigations, Interim Report, Stage 2. Relevant water quality data consisting of three sets of in-situ physical measurements (temperature, conductivity, salinity, pH, dissolved oxygen and Secchi disc) as well as the analysis of four sets of water samples (for nutrients, suspended solids and TOC) was compiled for three relevant locations (PC2, PC3, PC4) over a two day period in June 1992;
- Dames and Moore Pty Ltd (1998) Comalco Alumina Project Gladstone, Impact Assessment Study, Environmental Impact Statement. A range of water quality information including limited physical and nutrient analyses (conductivity, pH, total nitrogen and total phosphorus), suspended solids, total dissolved solids, major and trace elements and TOC was presented for a location (G2-1) near the Fisherman's Landing wharf and one location (G1-2) within the Targinie Channel between the Fisherman's Landing wharf and South Passage Island. Similar information was also collated for site G1-1 within the Targinie Channel opposite Tide Island at the southern limit of the study area and site G2-3 towards Friend Point. Some water quality data consisting of suspended solids and limited nutrient analyses together with total dissolved salts and TOC was also collected at a site (G1-3) within Targinie Creek. The above information was based on the collection of water samples during a survey in September 1995. In-situ physical water quality measurements were collected at two locations, (S1 and S2) south of the Fisherman's Landing wharf in November 1997;
- Southern Pacific Petroleum/Central Pacific Minerals (1998) Unpublished data. The data consists of the laboratory analysis of water samples collected at two distances of 50 and 100 m seaward of Gully C in the study area as well as water samples from four locations near seagrass beds at Friend Point. The samples were collected in October 1998 following catchment rainfall which resulted in the discharge of site runoff water from the clean water holding pond on Project land to Gully C. The water samples, consisting of surface and near-bed samples, were analysed for some physical parameters (conductivity, pH, total dissolved solids, colour and turbidity) together with some major and trace elements; and
- Gladstone Port Authority (1996-1999) Unpublished data. Relevant data collated by the Gladstone Port Authority consists of long-term continuous recordings of turbidity at two locations within the seagrass beds offshore from Wiggins Island for a three year period 1996 to date. The

data (consisting of hourly readings for the first year and subsequently at intervals of 10 minutes) exists only in a raw uncalibrated form (direct nephelometer output) and would require considerable time and effort for calibration, error checking and validation.

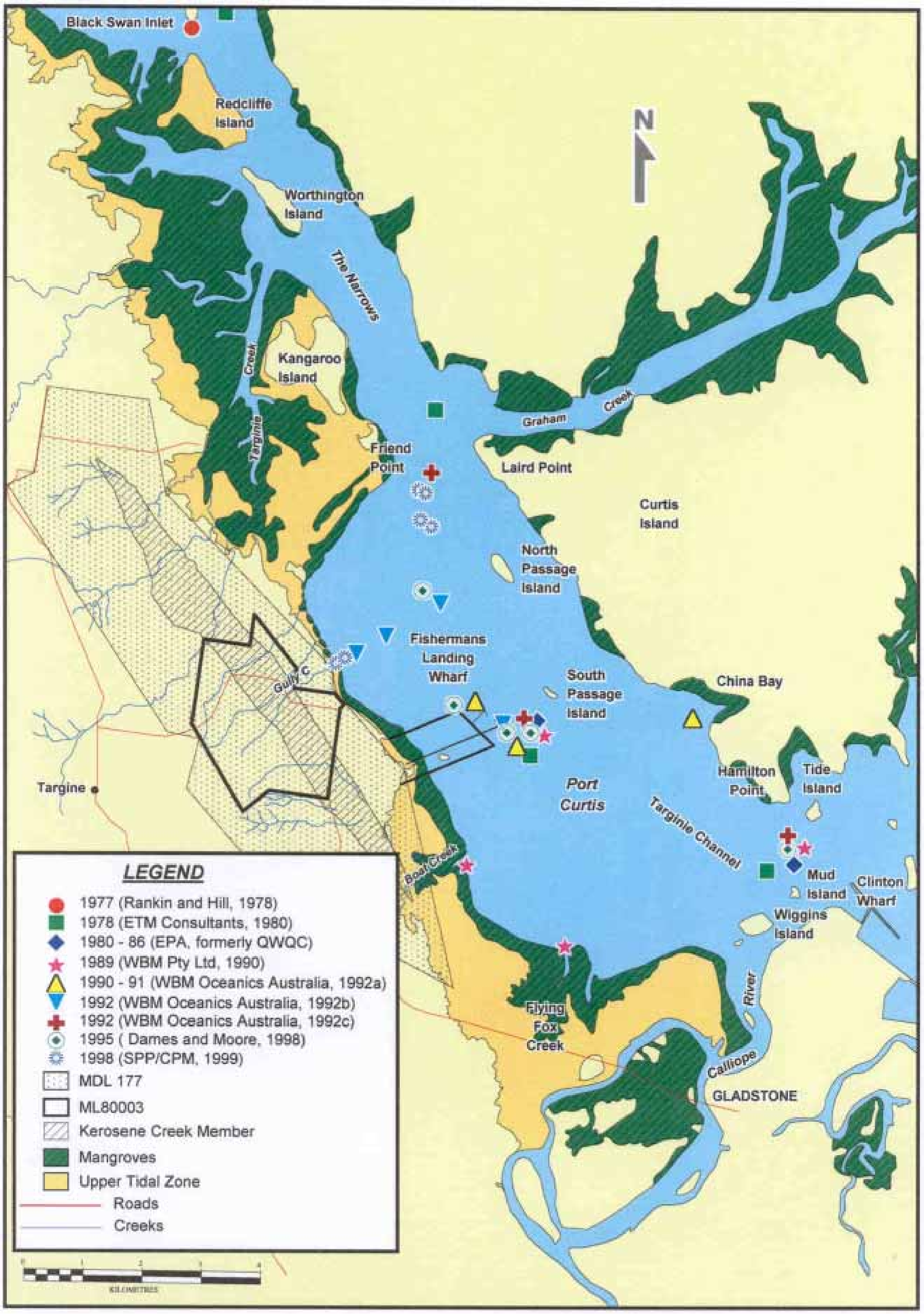


Figure 4-42 Previous water quality sampling locations (WBM, 1999)

As described above and illustrated in Figure 4-42 there exists a wide variety and spatial scatter of previous water quality information collected from Port Curtis between 1977 and 1999, spanning a range of tidal and weather conditions. However there are several general sampling locations for which much information already exists. These general locations (to include locations within a 1km radius of the following locations) were selected by WBM in 1999 to provide a summary of the most recent 10 years of collected water quality information from the above studies. These general locations relevant to Port Curtis are:

1 Friend Point;

2 Gully C;

3 Fisherman's Landing wharf; and

4 Hamilton Point, Curtis Island.

Table 4-33 below summarises the range of previous water quality data for surface waters at these locations over 10 years (1989-1999). Table 4-33 does not include the EPA data due to its original collation in the early to mid 1980's. ANZECC guideline criteria for the protection of aquatic ecosystems are shown where applicable for comparison.

Table 4-33 Range of Surface Water Quality Data for Port Curtis Compiled from Previous Reports (1989-1999) (WBM, 1999)

Water Quality Parameter	Unit	Friend Point	Gully C	Fishermans Landing	Hamilton Point	ANZECC Guideline*
In-situ Measurements (Minimum - Maximum)						
Temperature	°C	19.5-25.0	23-25.0	19.6-32.7	20.1-27.0	-
Conductivity	mS/cm	44-49.2	44.5-55.0	49.0-55.0	49.0-49.4	-
Salinity	g/L	32.0-32.1	-	30.5-36.0	32.1-32.4	[35.5]
Dissolved Oxygen	mg/L	7.27-7.53	-	7.41-7.61	7.56-7.59	> 6
Dissolved Oxygen	% saturation	96-99	-	94.8-101.0	76.1-102.0	> 80
pH		8.0-8.2	8.0-8.1	8.0-8.3	7.9-8.3	[8.1]
Turbidity	NTU	4-10	11-28	3.3-16	7-10	< 10% change in seasonal mean
Secchi Disc	m	1.7-2.0	-	1.4-1.9	0.8-1.7	As above
Major Elements:						
Aluminium	µg/L	260-< 500	< 300-700	30-< 500	60	[5]
Boron	µg/L	4200-4300	4000-4200	-	-	[4440]
Fluorine	µg/L	900	900	900	-	[1300]
Iron	µg/L	80-480	< 100-460	30-< 100	20	[3]
Manganese	µg/L	< 10-< 200	< 30-< 200	< 10-< 100	< 10	[2]
Trace Elements:						
Arsenic	µg/L	3-< 5	< 5	3	3	50
Barium	µg/L	< 100	< 100	< 100	-	-
Cadmium	µg/L	< 0.5-< 2	< 0.5-< 3	< 2-< 3	< 2	2
Chromium	µg/L	5-< 10	5-< 50	< 10-< 50	< 10	50
Cobalt	µg/L	1	-	1	1	-
Copper	µg/L	< 5-< 500	< 500	< 5	< 5	5
Lead	µg/L	< 5-< 10	< 10-< 30	< 5-< 30	< 5	5
Mercury	µg/L	< 0.5-< 150	< 0.2-< 150	< 0.2-< 150	< 0.5	0.1
Molybdenum	µg/L	15-< 500	< 10-< 500	< 10-15	15	-
Nickel	µg/L	< 10-< 300	< 30-< 300	10-< 30	< 10	15
Selenium	µg/L	< 10-< 40	< 5-< 40	< 5-< 10	< 10	-
Tin	µg/L	< 10	-	< 10	< 10	-
Zinc	µg/L	< 60-< 200	< 60-< 800	< 800	-	50
Compounds:						
Cyanide	µg/L	-	< 10	< 10	-	5
Phenols	µg/L	-	< 5	< 5	-	50
Nutrients:						
Total Nitrogen	µg/L	-	-	10-600	20-140	-
Organic Nitrogen	µg/L	-	200	300	-	-
Ammonia	µg/L	-	< 20	< 20	-	(< 5)
Nitrite	µg/L	-	< 20	< 20	-	
Nitrate	µg/L	-	< 20	< 20	-	(10-100)
Total Phosphorus	µg/L	< 10-50	30-40	< 10-40	< 10-20	-
Orthophosphorus	µg/L	-	20	20	-	(5-15)
Total Organic Carbon	mg/L	< 2-3.4	-	1.2-< 2	1-5	-
Biochemical Oxygen Demand	mg/L	-	1-2	< 1	-	[< 1]
Suspended Solids:						
Suspended Solids	mg/L	8-23	-	10-25	8-14	< 10% change in seasonal mean

*ANZECC (1992) Guideline values for the protection of aquatic ecosystems (marine waters). Bracketed values shown thus ( ), indicate typical range for estuarine waters as outlined by ANZECC (1992). Bracketed values shown [ ], indicate typical concentration of oceanic seawater as outlined by Head (1985) and University of Sheffield (1999).

4.10.2.2 Summary of water quality data

From the data compiled in Table 4-33, the following trends are evident for the study area:

- The reported range of physical measurements indicates that the character of the estuarine waters within Port Curtis is generally close to seawater. Salinities at all locations are often only slightly below that for oceanic seawater (35.5 g/L) and can sometimes be slightly higher due to local characteristics (high temperatures, evaporation and low rainfall);
- Water clarity as defined by Secchi disc visibility is generally poor, being less than 2 m. Similarly, turbidities and suspended solids concentrations are moderate being generally less than 30 NTU and 30 mg/L respectively;
- Nutrient, total organic carbon and biochemical oxygen demand concentrations appear generally low and consistent with high quality estuarine water;
- Aluminium and iron concentrations can be significantly higher than those for oceanic seawater.
- The concentrations of other major elements (e.g. boron, fluoride, manganese) appear to be consistent with those of oceanic seawater; and
- Trace element, cyanide and phenol concentrations do not appear to be elevated above typical seawater or the ANZECC guideline concentrations.

As expected, there are some limitations or deficiencies in the previously collected data which limits the accurate interpretation of estuarine water quality conditions within Port Curtis. Some previous studies have often adopted levels of reporting, particularly for nutrients and trace elements, which are not consistent with or less than the ANZECC guideline criteria for the protection of aquatic ecosystems, making the meaningful comparison of results with the criteria difficult. Similarly, most of the previous data reviewed over the past ten years has been captured from only one or two surveys, therefore the data inadequately represent any time varying or seasonal influences which might exist in Port Curtis (WBM, 1999).

4.11 Summary of water quality data for Port Curtis

The salient points from the reviewed studies include the following;

- Port Curtis is a well connected estuary which allows dissolved material to be dispersed evenly, however material does not as readily leave the estuary to the offshore environment (Herzfeld et al., 2004). This reduced flushing time is likely to contribute to the anomalous bioaccumulation of some metals in biota of Port Curtis (Anderson et al., 2005);
- Port Curtis is the receiving environment for sewage and diffuse nitrogen sources from a small number of settlements fringing the port as well as nitrogen discharges from industrial sources (Melzer & Johnson, 2004);
- However, nutrient, total organic carbon and biochemical oxygen demand concentrations appear generally low and consistent with high quality estuarine water (WBM, 1999);
- The character of the estuarine waters within Port Curtis is generally close to seawater. Salinities are often only slightly below that for oceanic seawater (35.5 g/L) and can sometimes be slightly higher (WBM, 1999);

- Salinities are higher in the north of Port Curtis than in the surrounding coastal waters. This could reflect evaporation losses in these more sheltered areas where water circulation is restricted. Water column pH was lowest in The Narrows regions and is most likely related to acid inputs from the adjacent mangrove regions (Apte *et al.,* 2006);
- Salinity appears to be responsive to rainfall and associated inflow events, although it is not clear whether local or remote inflows (or a combination of both) dominate in this regard (WBM, 2008);
- pH and temperature are relatively uniform with depth, with evidence of only slight thermal stratification (WBM, 2008);
- Lower pH and higher turbidities were noted by PCIMP in the shallow mangrove lined upper estuaries;
- A salinity and pH gradient is evident from low tide to high tide and north to south, where salinity and conductivity is highest and pH is lowest at low tide in the northern reaches of Port Curtis. Salinity and conductivity decreases and pH increases further south and as the tide rises (WBM, 2008b)
- Primary variations in spatial distribution and nature of Coloured Dissolved Matter, Total Suspended Matter and Secchi depth appear to be controlled by tidal stage and stream flow of major rivers flowing into the harbour (Dekker & Phinn, 2005);
- Water clarity as defined by Secchi disc visibility is generally poor, being less than 2 m. Similarly, turbidities and suspended solids concentrations are moderate (WBM, 1999);
- Turbidity increases with depth and tidal velocity, most likely due to bottom sediment resuspension (WBM, 2008);
- Low chlorophyll *a* concentrations were noted throughout Port Curtis (Dekker & Phinn, 2005);
- Elevated metal concentrations exist within the harbour. The Narrows region has the highest concentrations of dissolved copper and nickel which may be attributable to natural geological sources. The Fitzroy River is a source of dissolved metals to the local coastal region. In particular, the Fitzroy River contains elevated dissolved nickel concentrations. Under some flow conditions, the Fitzroy River plume may enter The Narrows region and supply dissolved metals to Port Curtis. Trace metal distributions in Port Curtis are likely to reflect a subtle mixture of metal inputs including industrial and other anthropogenic discharges, inputs from unidentified sources in The Narrows and the Fitzroy River plume. Trace metal inputs to Port Curtis which contribute to dissolved metal concentrations are most likely to be delivered in solution form and not by release of metals from particulates (Apte *et al.,* 2006);
- Aluminium and iron concentrations can be significantly higher than those for oceanic seawater (WBM, 1999);
- Concentrations of other major elements (e.g. boron, fluoride, manganese) appear to be consistent with those of oceanic seawater (WBM, 1999);
- Trace element, cyanide and phenol concentrations do not appear to be elevated above typical seawater or the ANZECC guideline concentrations (WBM, 1999);
- Inner harbour PCIMP sampling sites had significantly higher copper levels than oceanic reference sites (PCIMP, 2008); and

- PCIMP oceanic reference sites had highest cadmium concentrations compared to harbour zones (PCIMP, 2007).

When compared with relatively stringent water quality guidelines, it can be surmised that water quality is generally good, though variable in the area. Water quality appears to be relatively strongly correlated with tidal state and hence bedload resuspension. In particular, low tides exhibit generally worse water quality than high tides, with the majority of nutrient and metal species at these times being associated with particulate (rather than dissolved) phases (WBM, 2008).

5 BASELINE DATA COLLECTION (GLNG 2008)

Two separate water quality and hydrodynamic field data collection snapshot surveys (referred to as Campaigns 1 and 2 hereon) were undertaken in Port Curtis adjacent to the proposed LNG facility to collect locally specific data as follows:

- Campaign 1: 3rd to 7th February 2008; and
- Campaign 2: 4th to 8th June 2008.

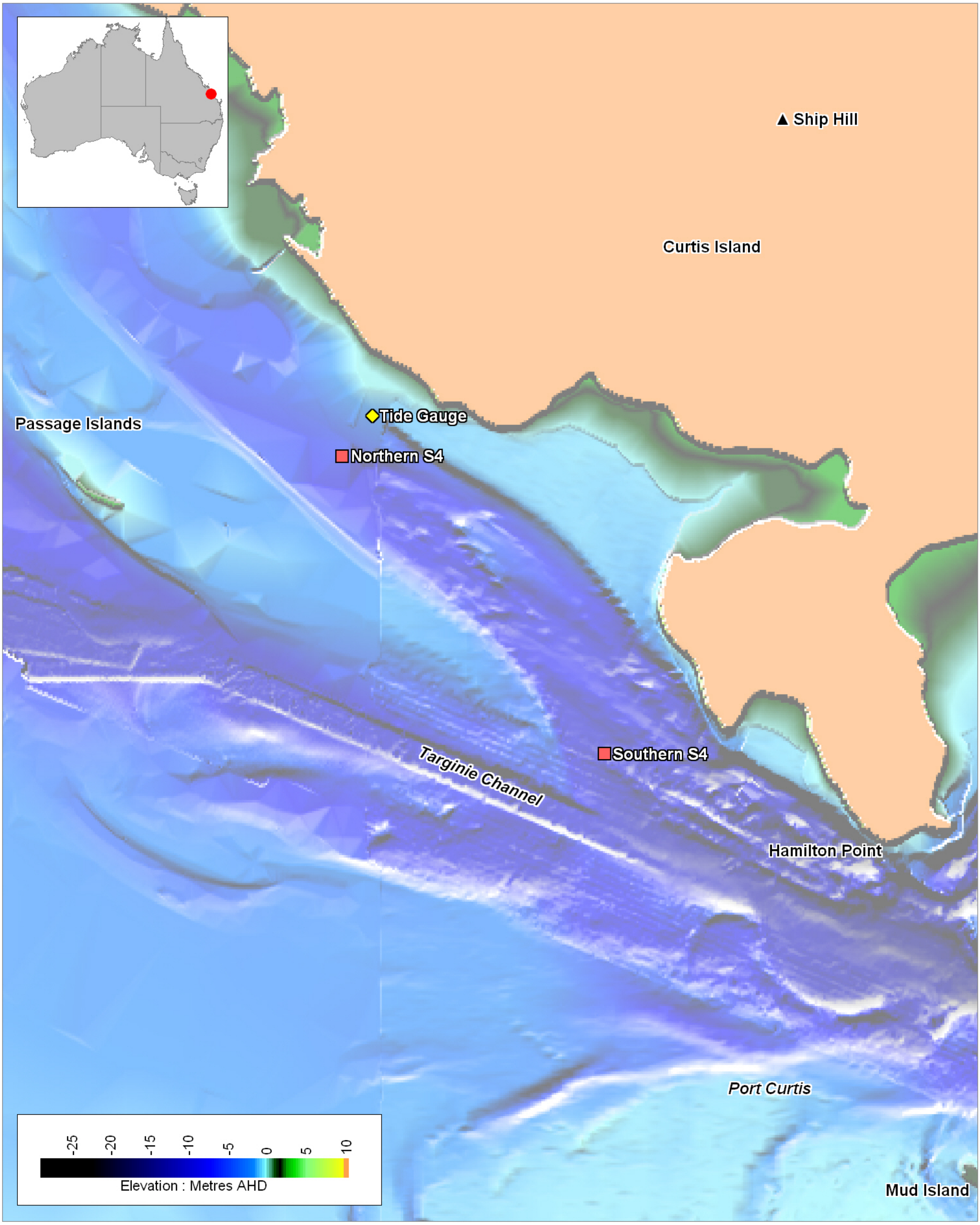
As well as water quality measurements, it was proposed to deploy current meters in the vicinity of the site of the proposed LNG facility on these occasions. Additional works were also executed to assist in providing an improved characterisation of the study area. As such, the following suite of measurements was undertaken at each campaign:

- Tidal water level measurements;
- Current measurements;
- Echo soundings;
- Boat mounted Acoustic Doppler Current Profiler (ADCP) transects of waterways proximate to the LNG facility site at varying stages of the tide;
- Hand held (YSI) physical water quality profiles; and
- Water quality grab samples (only during Campaign 2).

Details of the methodology and instrumentation used in each of the above are provided below.

5.1 Tidal Water Level Measurements

A single tide gauge was deployed at the location shown in Figure 5-1 during both campaigns. An additional gauge was set to log at Graham Creek during the second campaign. The locations of the current meters (which were the same to within 40 metres between campaigns) are also shown on Figure 5-1.



Title:

S4 Current Meter and Tide Gauge Campaign Locations

Figure: 5-1

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N

0 0.5 1km

Approx. Scale

BMT WBM

www.wbmpl.com.au

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The tide gauge unit was a Greenspan (non-vented) pressure and temperature logger (Figure 5-2) that was set to log every 6 minutes, with each sample being an average of a suite of one-second measurements. This averaging was undertaken to remove the influence of surface waves. The logger was mounted on a steel frame and was locatable via a small float, similar to that shown in Figure 5-3.

Figure 5-2 Tide Gauge

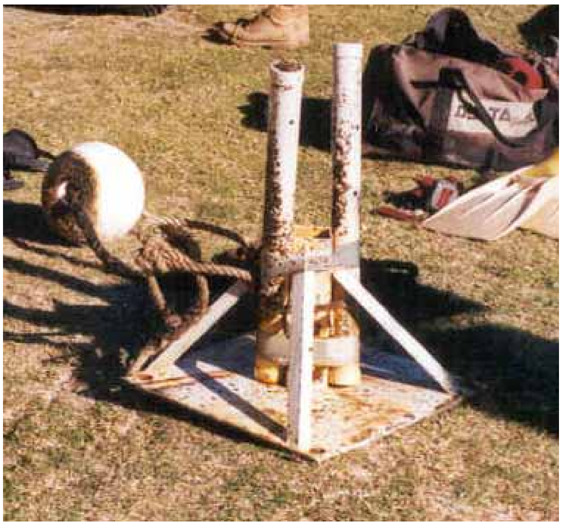


Figure 5-3 Tide Gauge and Representative Configuration

5.2 Current Meters

Three InterOcean S4 current meters (Figure 5-4) were deployed on each campaign, with campaign locations shown in Figure 5-1.

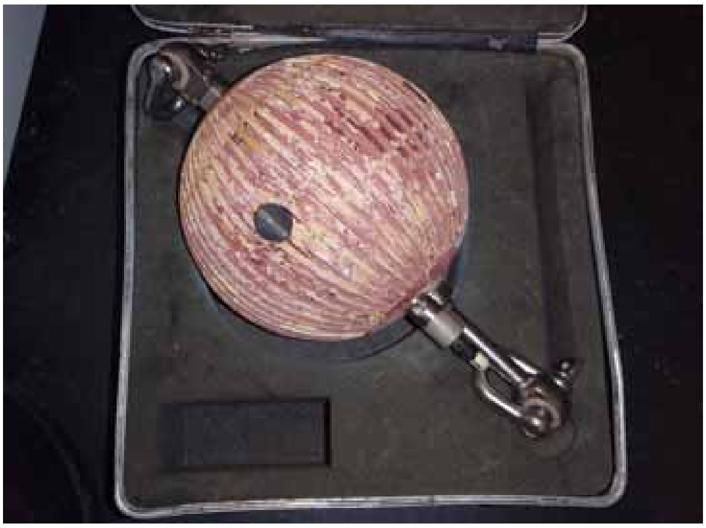


Figure 5-4 InterOcean S4 Current Meter

The InterOcean S4 is an electromagnetic recording current meter that measures the magnitude and direction of horizontal current motion. Water flowing through a magnetic field generated by the instrument induces a voltage proportional to the current speed, which is then sensed by two pairs of electrodes. An internal flux-gate compass provides information that is then used to reference the current direction to magnetic north. The CPU acquires current and compass information twice per second and processes it to provide north and east velocity components. The S4's were set up to 'burst' sample over a one-minute period at regular six minute intervals. An average current speed and direction was then computed and logged. The data was stored internally in static CMOS RAM and retrieved following recovery via an RS232C port. The instrument has a stated velocity accuracy of 2% of reading ±1.0 cm/s and directional accuracy of ±2%.

As per Figure 5-1, one S4 was deployed at the northern location, and two at the southern location during Campaign 1. The two at the southern location were spaced across the water column so that the bottom instrument was approximately 2 metres off the bed and the other was at mid depth. The single northern S4 was set at approximately mid depth. After review of the first campaign data, only one S4 was set up at the southern site for Campaign 2. The general configuration of each unit, as deployed, is below.

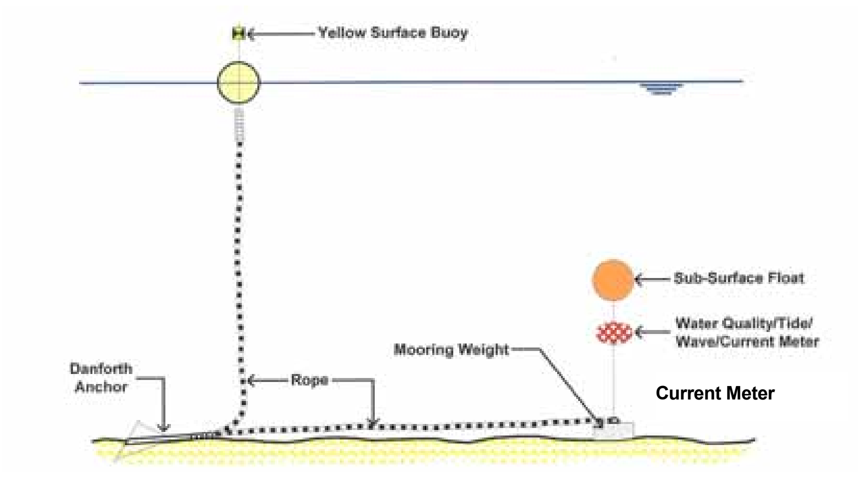
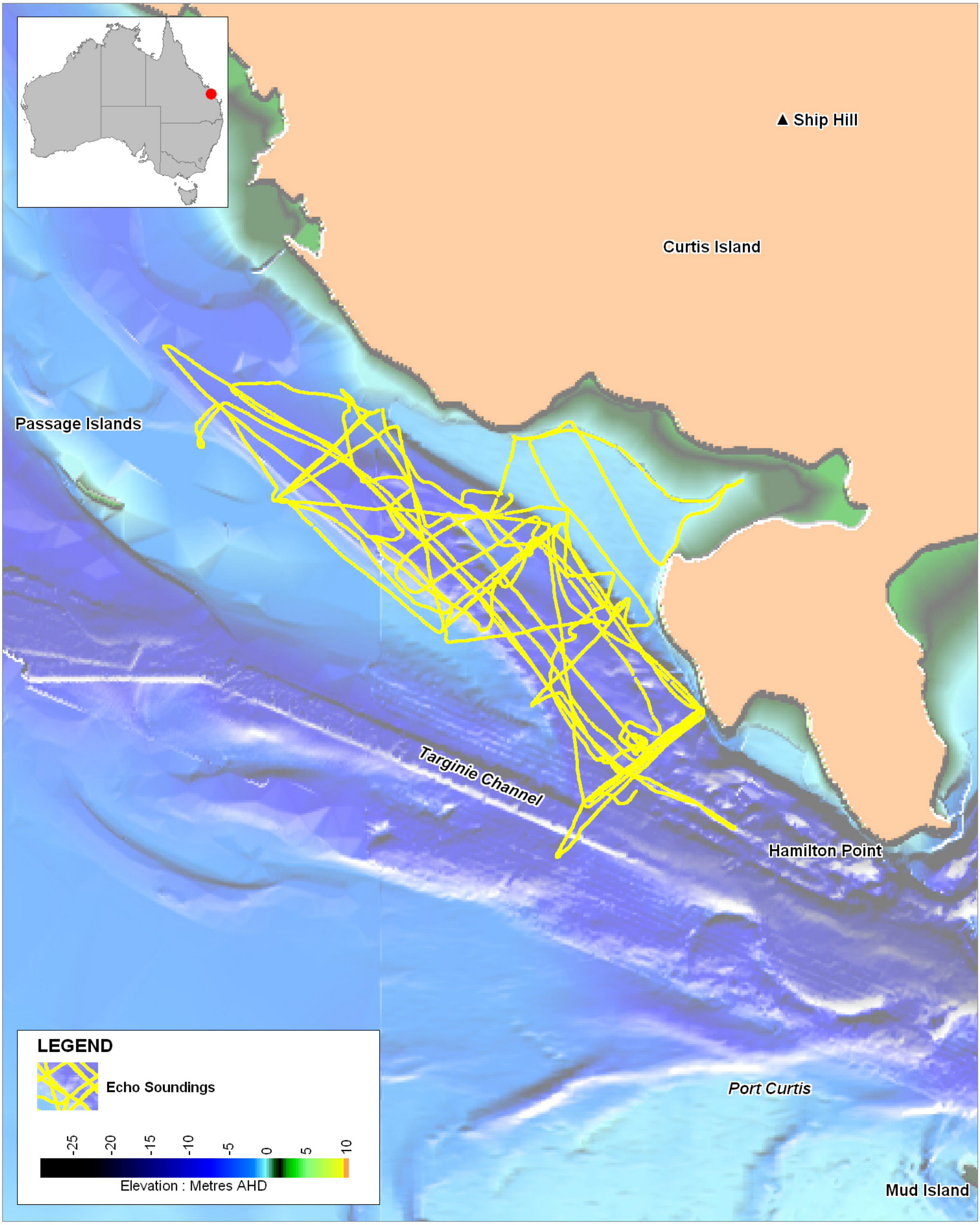


Figure 5-5 General S4 Campaign Arrangement

Following review of the turbidity profile results collected during Campaign 1, it was determined that additional continuous turbidity measurements would be of use, especially in investigating a possible relationship between turbidity and tidal velocity. As such, a turbidity logger was attached to the southern S4 rigging apparatus and set to collect data at six minute intervals over the current data collection period.

5.3 Echo Soundings

Echo soundings were taken at 2 second intervals during the majority of each field mobilisation. Boat mounted synchronised dgps and echo sounder instruments were used to passively log depth during execution of all other field operations. The simultaneous tidal measurements (Section 5.1) were used to correct the depth soundings for tidal water level variations. The locations of soundings from Campaigns 1 and 2 are shown as points in Figure 5-6 and Figure 5-7, respectively.



Title:

Location of Echo Soundings - Campaign 1

Figure: **5-6**

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BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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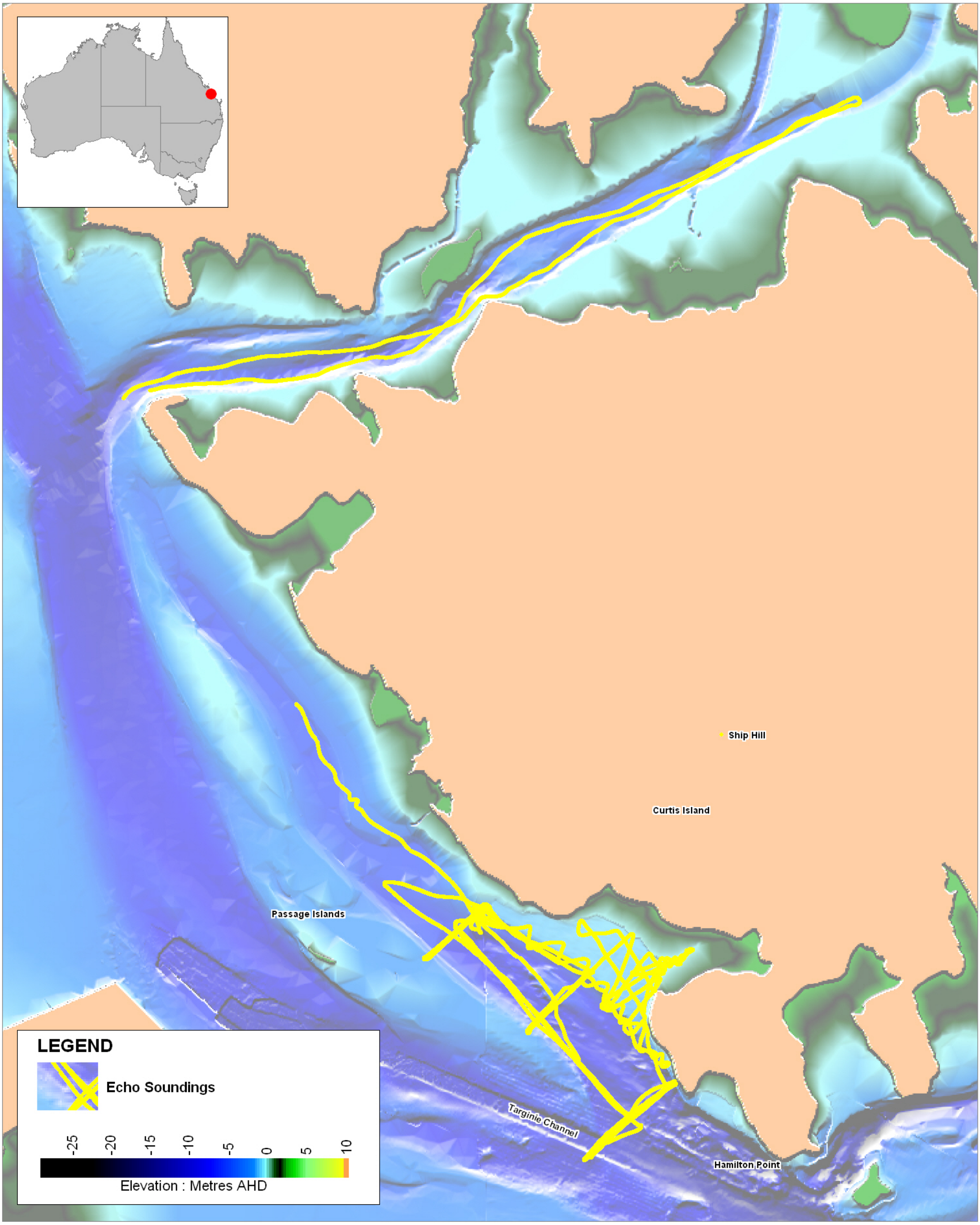

Title:

Location of Echo Soundings - Campaign 2

Figure: **5-7**

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N

0 0.5 1km

Approx. Scale

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5.4 ADCP Measurements

A boat mounted ADCP was used to collect current profile data at a range of locations and tidal times. The BMT WBM survey vessel "Resolution 2" was equipped with a 1200kHz Workhorse Sentinel Model ADCP (Figure 5-8) manufactured by RD Instruments and a TRIMBLE Model ProXRS dGPS and Model TSC1 data collector for navigation and position fixing.

Figure 5-8 ADCP

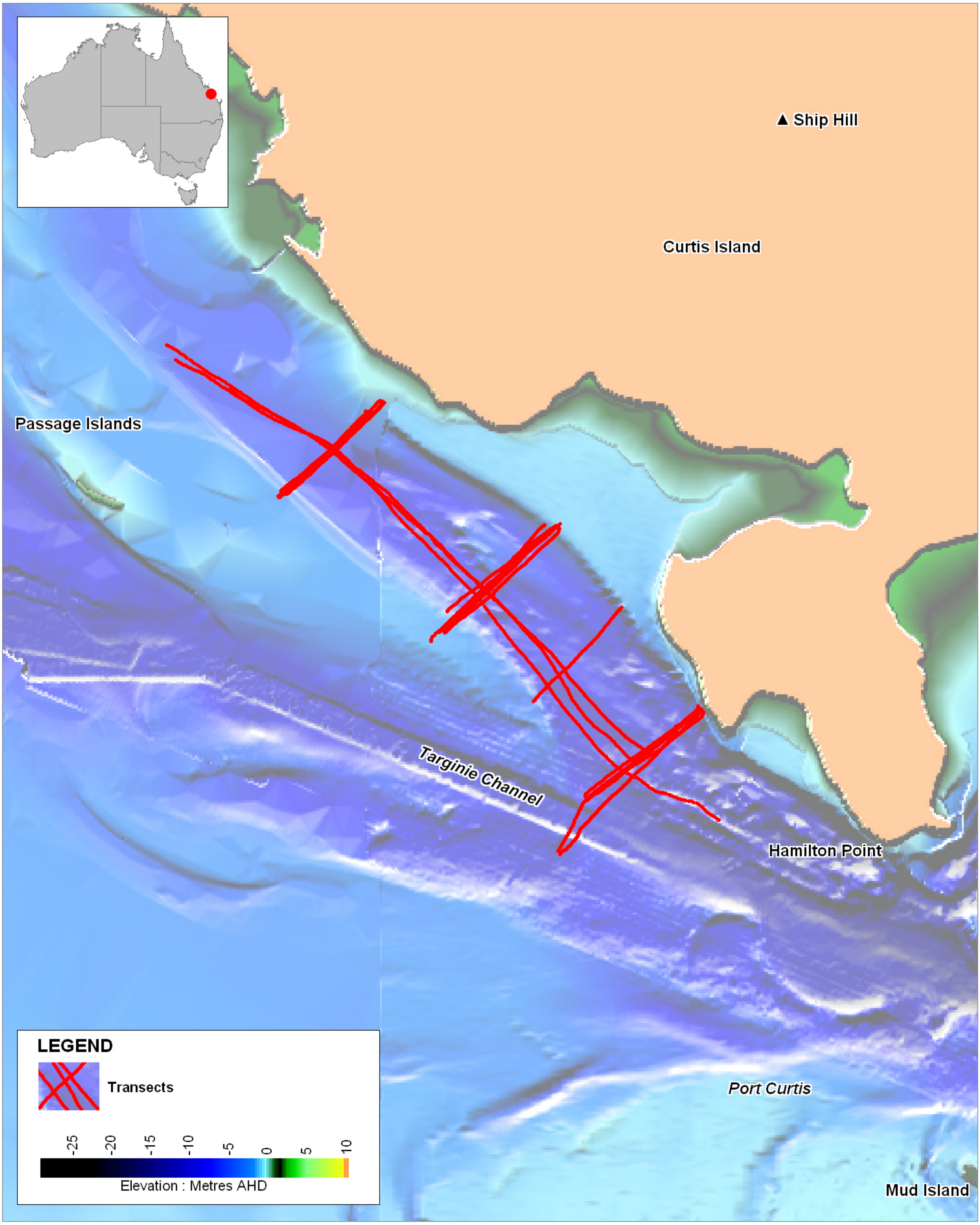
ADCP measurements were conducted along selected transects (see Figure 5-9 and Figure 5-10 for Campaigns 1 and 2 respectively) and the vessel was driven at slow speed (approximately 6km/h) along each transect, with each transect requiring approximately 10 minutes for completion. A total of 115 ADCP transects were completed over both field campaigns. The ADCP was dynamically linked to the dgps, and lat/long measurements were incorporated into all ADCP measurement files.

The ADCP transmits bursts of sound (pings) at a known frequency (in this instance, 1200kHz) into the water column. Each complete set of pings is called an ensemble. The sound is scattered by plankton sized particles (reflectors) carried by the water currents and some is received by the ADCP which also 'listens' for reflected echoes from the transmitted sound. As echoes are received from deeper in the water column, the ADCP assigns different water depths (depth cells or bins) to corresponding parts of the return echo. This enables the ADCP to define vertical profiles of current velocity. The motion of the reflectors relative to the ADCP causes the echo to change frequency by an amount proportional to velocity. The ADCP measures the frequency change, or the Doppler shift, and thus constructs vertical current velocity profiles for the water profile.

In a vessel mounted configuration, the ADCP looks down through the water column and measures current profiles continuously as the vessel travels along a transect. The current profiles, which are initially measured relative to the ADCP, are then converted to earth-referenced currents via the link to the dgps.

The ADCP was configured for measurements of water speed and direction in 0.5m bins using a water salinity of 35g/L. ADCP output was sent to an on-board laptop computer and current measurement and navigation data were displayed and recorded in real time using the RD Instruments software package WinRiver.

The transect locations were selected to provide the greatest spatial coverage possible during the S4 campaign period during both field surveys, and to support an overall representation of the hydrodynamics characterising the designated study area. Further details of each transect and individual relationships to tide are presented in subsequent sections.



Title:

ADCP Transect Locations - Campaign 1

Figure: 5-9

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0 0.5 1km

Approx. Scale

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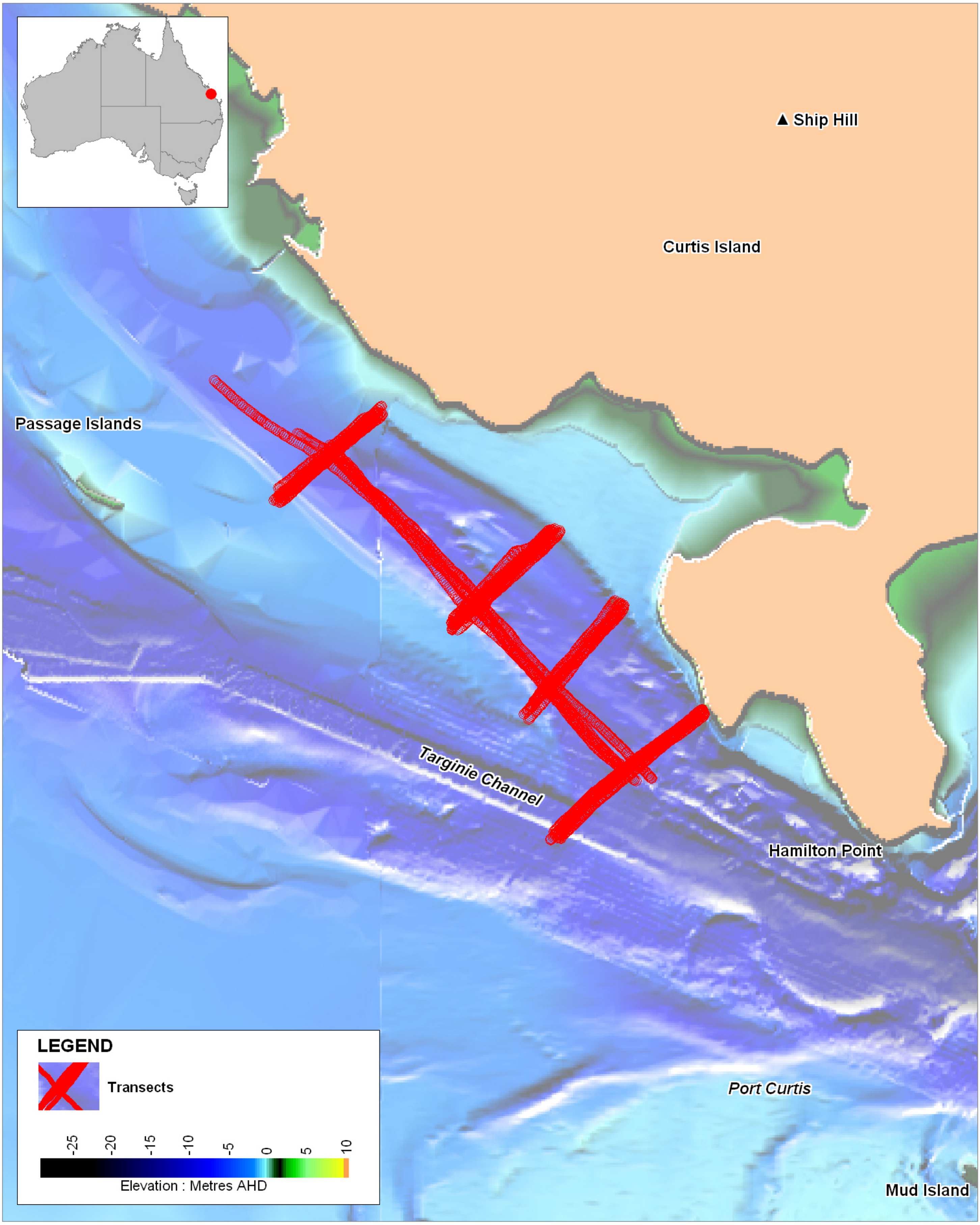

Title:
ADCP Transect Locations - Campaign 2

Figure: 5-10

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0 0.5 1km
Approx. Scale

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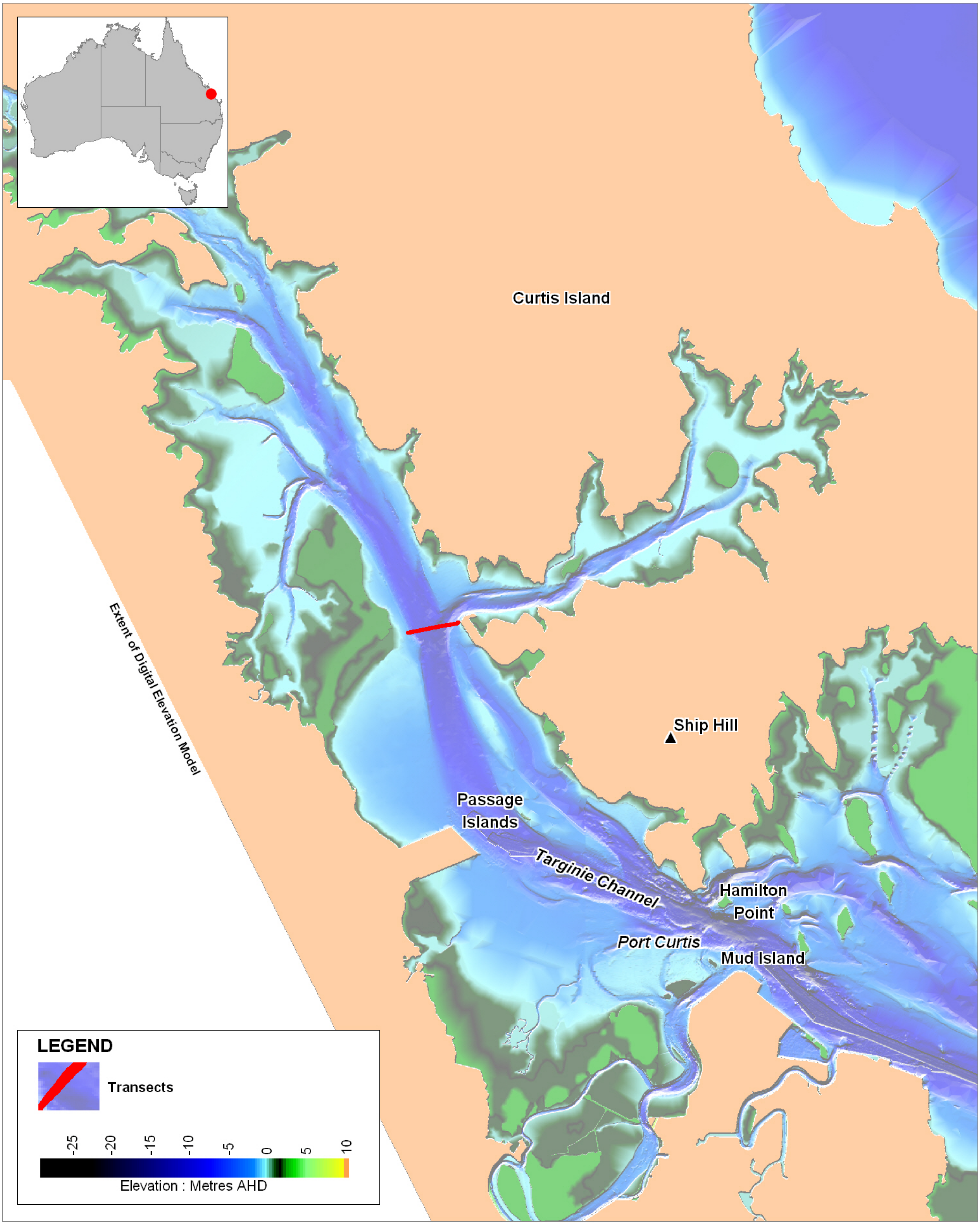
In addition to the above, 46 supplementary ADCP transects were run over a complete tidal cycle at the location of a proposed Curtis Island bridge structure. This location is shown in Figure 5-12.

5.5 Physical Water Quality Measurements

A hand held Model 6600 water quality instrument equipped with a YSI Model 650 MDS data collector instrument (Figure 5-11) was deployed at a range of locations throughout the study area, and at varying times of the tide. The locations of all campaigns are shown in Figure 5-13 and Figure 5-14 for Campaigns 1 and 2, respectively. Labels correspond to the presentation of results in later sections of this report.

Figure 5-11 YSI Water Quality Instrument

The YSI was set to log turbidity, pH, temperature and salinity with depth, with each campaign consisting of lowering the instrument over the side of the vessel. Measurements were generally taken at approximately 1m depth intervals. Given the constraints of other higher priority field measurements, YSI campaigns only took place at low or high water during times of relatively low tidal velocities.



Title:

Supplementary ADCP Transect Location

Figure: **5-12**

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0 2 4km

Approx. Scale

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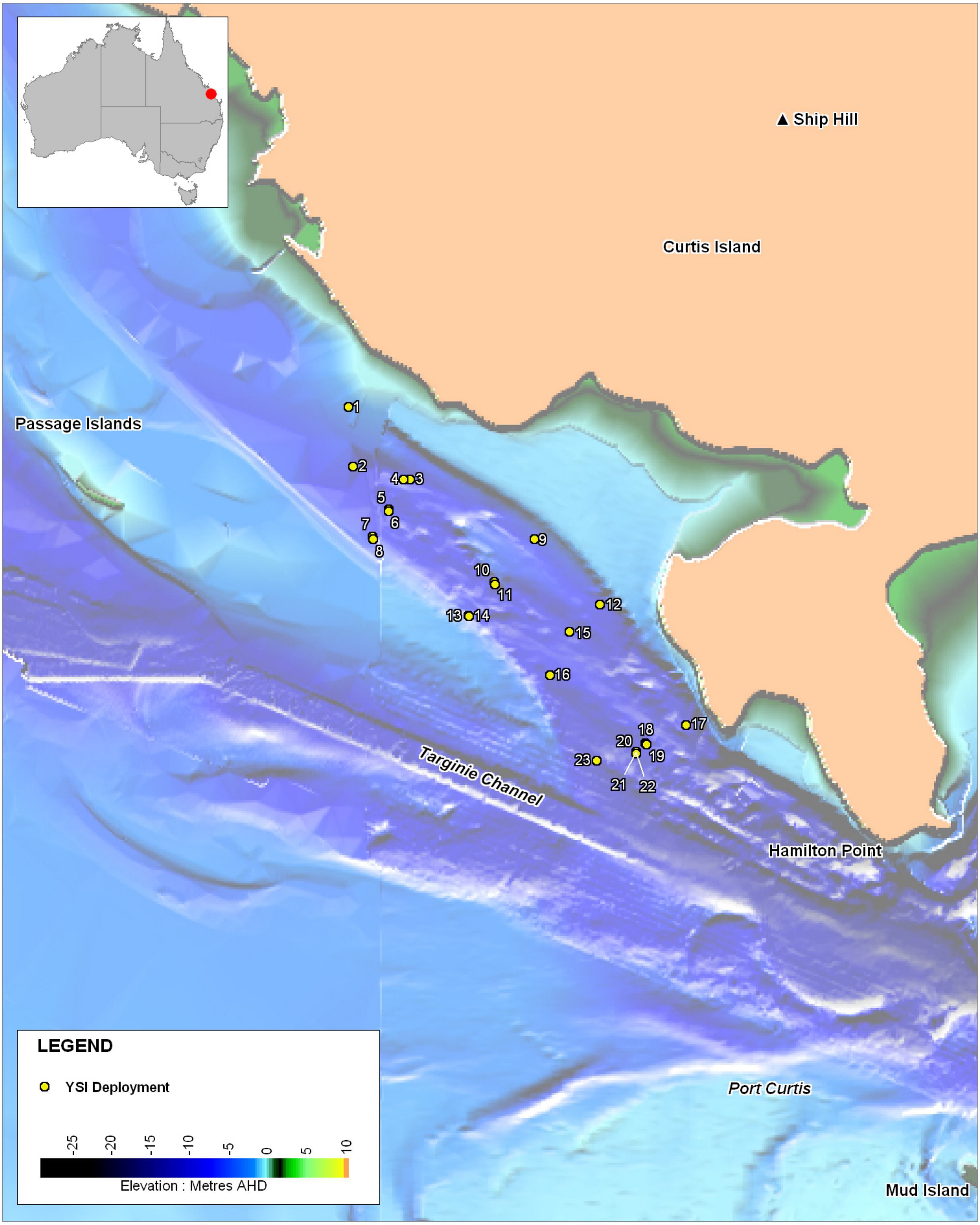

Title:
YSI Deployment Locations - Campaign 1

Figure: 5-13

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Approx. Scale

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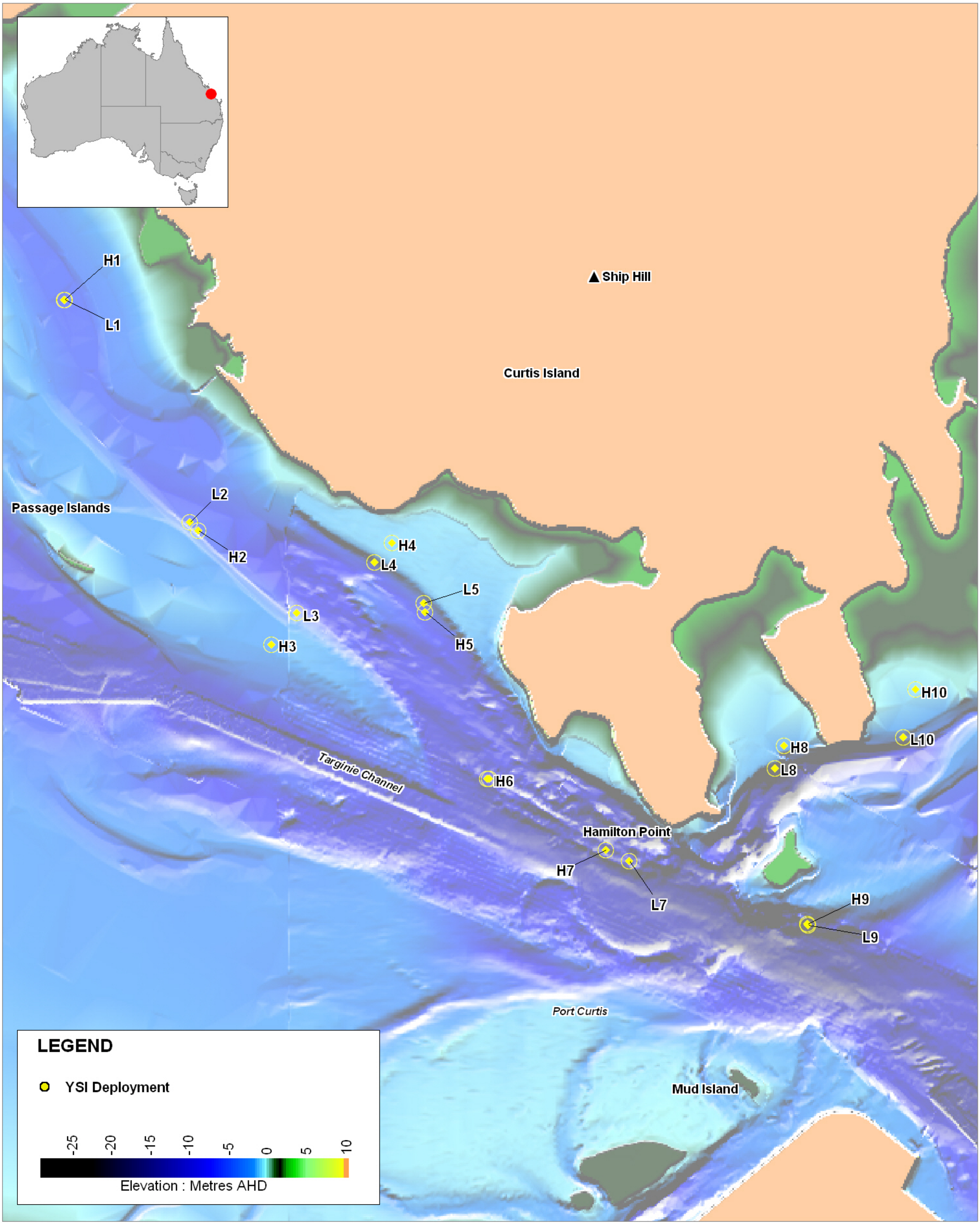

Title:

YSI Cast Locations - Campaign 2

Figure: **5-14**

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0 0.5 1km

Approx. Scale

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5.6 Water Quality Grab Samples

A series of water quality grab samples was collected at ten sites across the area of interest as part of the second campaign. The same ten sites were visited during each survey, and sampling was performed concurrently with the YSI casts, and hence the grab sample locations are the same as those shown in Figure 5-14.

Two separate grab sample surveys were undertaken: one at high water and one at low water. In each case, grab samples from the top, middle and bottom of the water column were collected, then composited to form a single, representative sample for each site at each tidal condition. This equated to 20 samples in total. These samples were then sent to the Queensland Health Scientific Services (QHSS) laboratory for analysis of the following parameters:

- Total suspended solids (TSS);
- Total nitrogen (TN);
- Total phosphorus (TP);
- Dissolved nitrogen components: ammonia (NH_4), nitrate (NO_3) and nitrite (NO_2);
- Dissolved phosphorus components: free reactive phosphorus (FRP);
- Total metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc); and
- Dissolved metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc).

5.7 Results

5.7.1 Tidal Water Levels

The tidal water levels for both campaigns are presented below as metres of water (including atmospheric pressure) above the gauge. Concurrent temperature measurements are also presented. The dashed line in Figure 5-16 is the tidal data collected at Graham Creek.

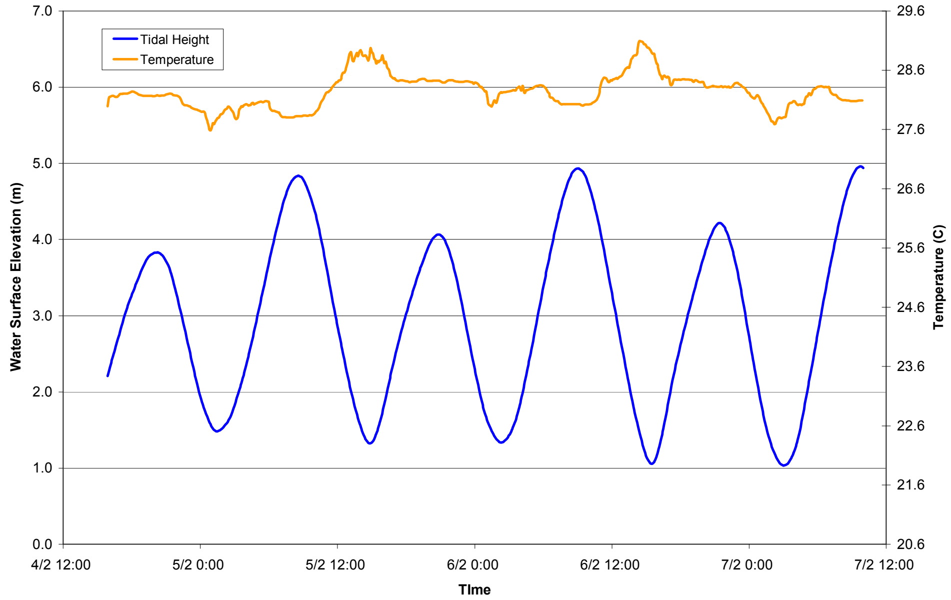


Figure 5-15 Tidal Water Level and Temperature Measurements – Campaign 1

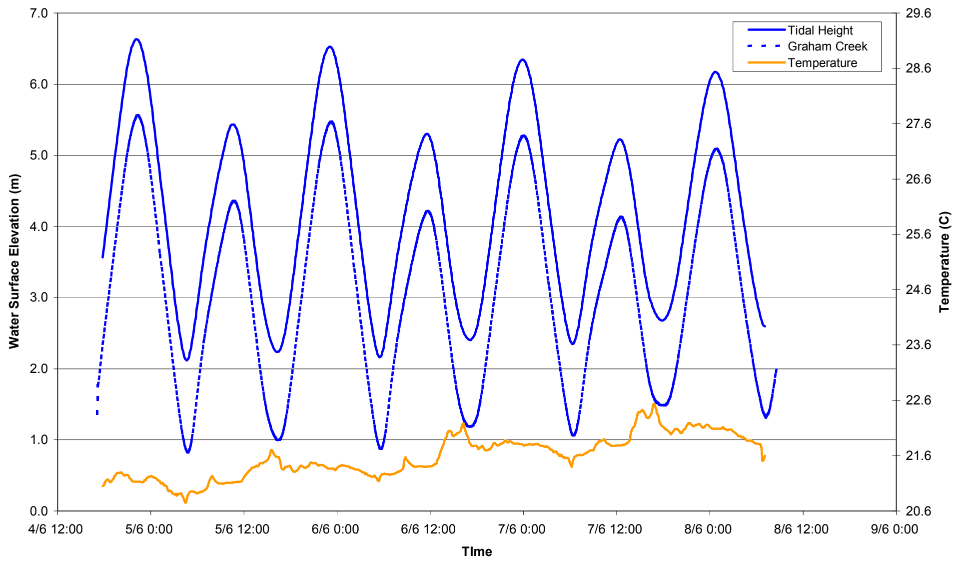


Figure 5-16 Tidal Water Level and Temperature Measurements – Campaign 2

The figures show that the area is characterised by semi-diurnal tides (as is well known for the region) and that the studies took place over periods where maximum tidal ranges were of the order of three to four metres, with some tides exceeding four metres during the initial stages of the second campaign. In general, the tidal ranges were greater during the second campaign. To provide some contrast, the first study took place over a period of increasing tidal ranges, whereas the second campaign spanned a period characterised by a temporal reduction in tidal amplitudes.

The measured temperatures show a clear seasonal trend, with those from the first (summer) campaign being some six to seven degrees warmer than those of the second campaign. The peak temperatures in both campaigns, however, occur at low tides during the afternoon periods, consistent with localised heating of shallow waters. Conversely, reductions in temperature were recorded at low tides occurring overnight, consistent with atmospheric heat loss and diurnal cooling of shallow waters.

The tidal signal at Graham Creek is of similar amplitude to that measured concurrently at the standard tide gauge site, and exhibits a slight phase angle delay, as expected.

5.7.2 Current Meters

The S4 current meters record both speed and direction, and these data are presented as timeseries plots below. Current direction is in degrees, with directions of 0 and 180 corresponding to water flowing *to* magnetic north and south, respectively. The measurements are presented on the same ordinates as Figure 5-15 and Figure 5-16 to facilitate comparison.

At the broadest level, the results are consistent with the semi-diurnal tidal cycle of the area, as expected, with directions alternating twice a day, and remaining relatively constant during both ebb (100 to 150 degrees) and flood (300 to 350 degrees) tides. The measurements at these specific locations show that peak velocity magnitudes (which typically occur at mid-tide) are generally reflective of a high-energy environment, with peak spring tide velocity magnitudes in the second campaign being initially of the order of 1.0 m/s. Generally, the peak tidal velocities increase with time in the first campaign, with this trend being reversed during the second campaign. This is consistent with the previously described temporal increase and decrease in tidal ranges over the first and second campaign periods, respectively. Further, peak tidal velocities at both sites were generally greater during the second campaign, due to the greater tidal ranges experienced over that time.

The northern instrument results are consistent with an asymmetry in tidal velocity magnitude during both campaigns, with ebb tides generally being associated with stronger currents than flooding tides. This is in part related to local topography: water leaving Port Curtis on an ebb tide from regions north of the study site preferentially flows directly adjacent to Curtis Island rather than out into the shipping channel. Conversely, the flooding tide sees inflowing water preferentially follow the shipping channel to Fisherman's Landing, resulting in a relative reduction of tidal velocities through the northern end of the study site at these times. It is noted that local changes to bathymetry (such as those due to dredging) may change this behaviour. Such potential changes will be assessed via later numerical modelling.

This asymmetry is not as pronounced at the southern site, suggesting a more uniformly oscillating hydrodynamic regime, at least over the study survey periods. The S4 measurements also demonstrate only a small vertical variation in velocity magnitude and direction at the southern S4 location during the first campaign. Typically the variation in magnitude between top and bottom instruments is within, or close to, the expected instrument error, so is likely to be insignificant. The clearest difference in the two southern instrument measurements is in the direction signals, where at the commencement of two flood tides (just after midnight on the 5th and 6th of February 2008), surface waters appear to change direction an hour or so earlier than the bottom waters. This creates some vertical shear, albeit short-lived and relatively small in magnitude, given that the bottom velocity magnitudes at these times are typically small. It is noted that this shear is not a consistent feature of the flow, as it does not occur at the onset of every flood tide. It was these findings from the first campaign that motivated the decision to only set one S4 in the southern location during the second campaign.

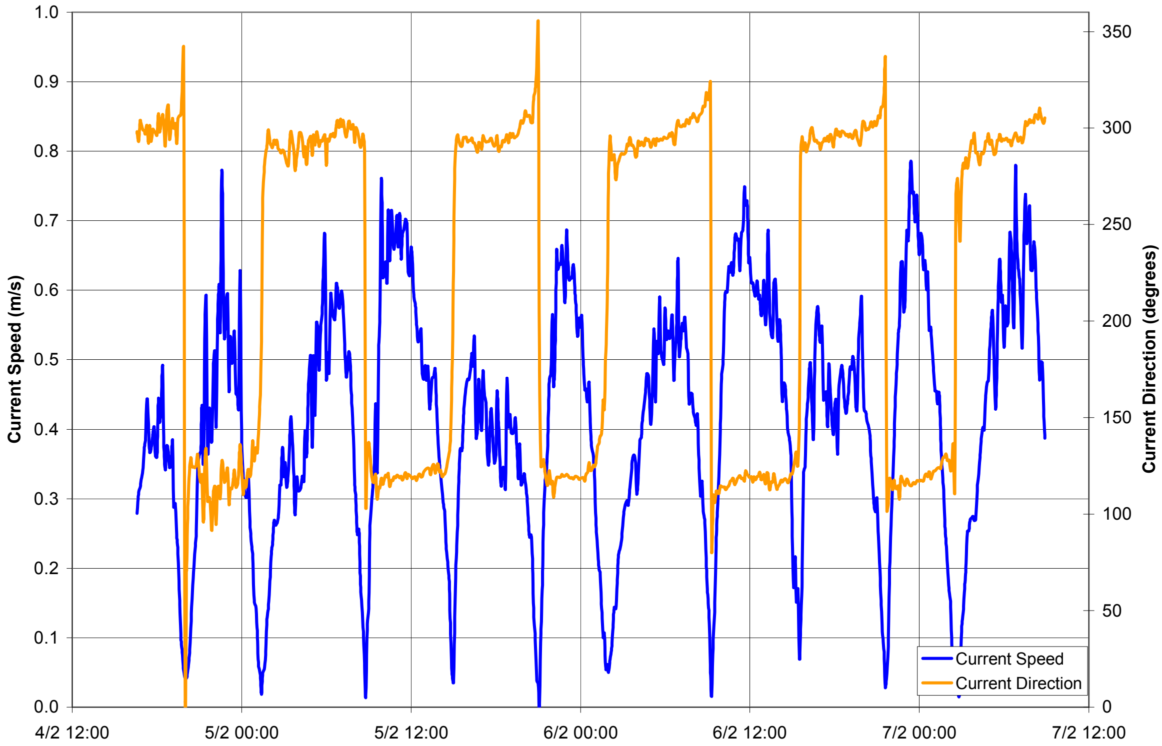


Figure 5-17 Single Northern S4 Measurements – Campaign 1

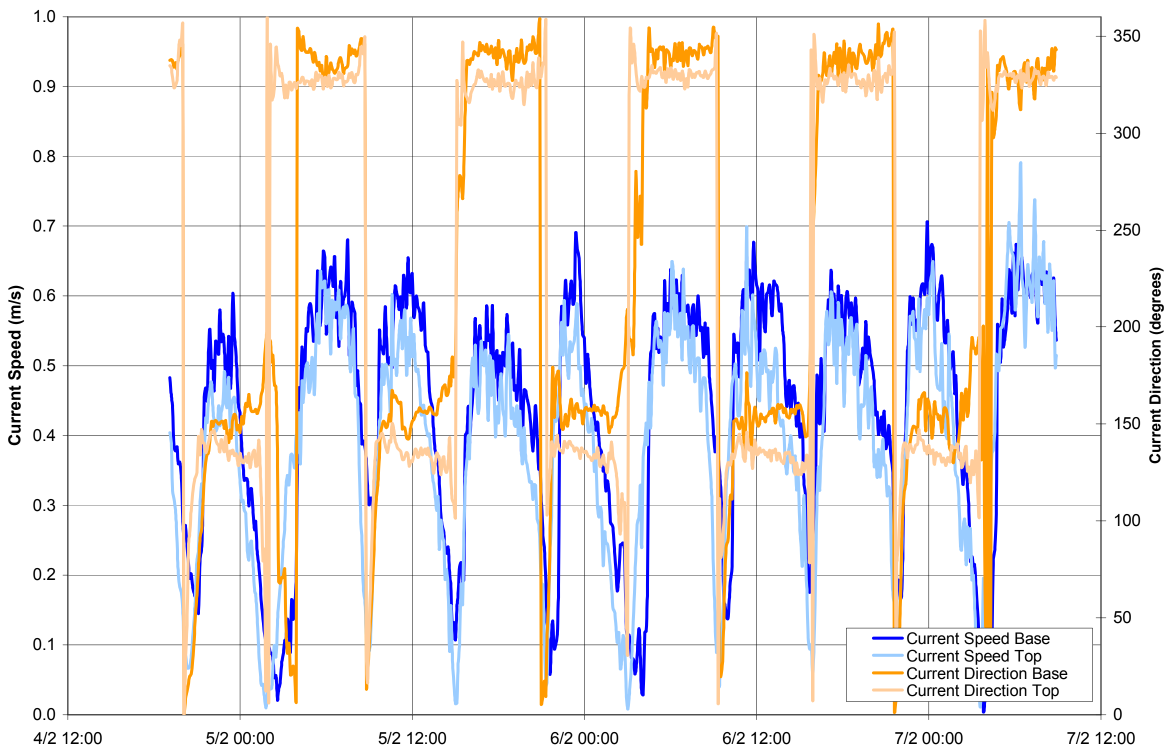


Figure 5-18 Both Southern S4 Measurements – Campaign 1

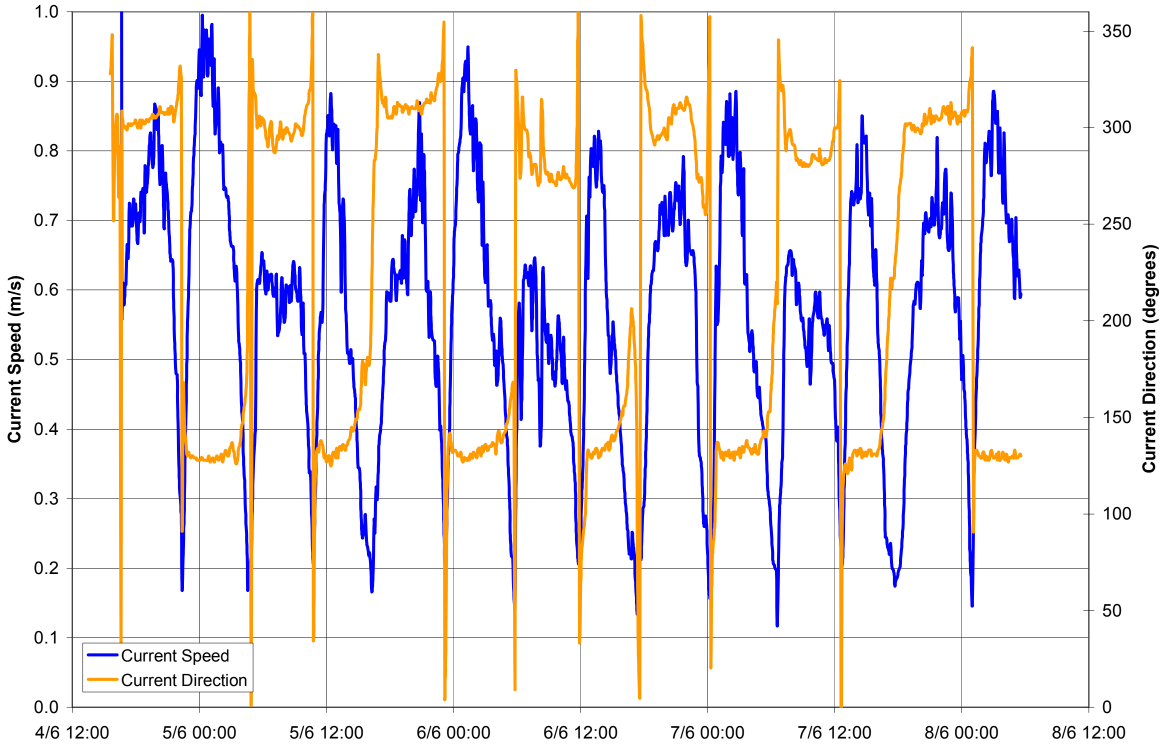


Figure 5-19 Single Northern S4 Measurements – Campaign 2

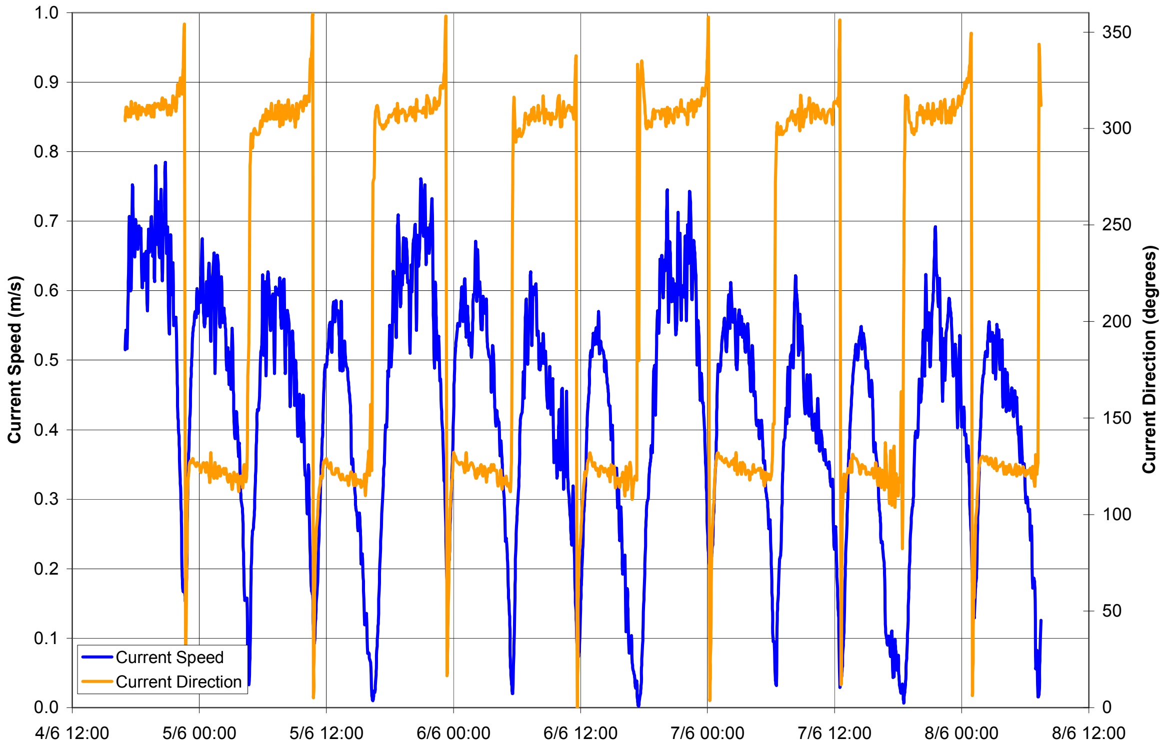


Figure 5-20 Single Southern S4 Measurements – Campaign 2

The observed flow directions at the northern site are relatively consistent between campaigns, that is, approximately 300 and 125 degrees for flooding and ebbing tides, respectively. Some variation in current direction is demonstrated, however, between campaigns at the southern site, with the current direction axis rotating slightly towards the east-west plane during the second campaign. This change is relatively small (less than approximately 20 degrees) and may be related to slight positional changes of the southern S4 between campaigns.

5.7.3 Echo Soundings

Passive echo soundings were taken from the BMT WBM vessel throughout the majority of the data collection program. The locations of these soundings are presented in Figure 5-6 and Figure 5-7.

5.7.4 ADCP Measurements

The boat mounted ADCP was used to collect current profile data at a range of locations and tidal times. The ADCP records current speed and direction with depth across a given transect, and these data are presented below. A single figure has been produced for each transect, for both campaigns, totalling 115 transects (refers to Figure 5-22 to Figure 5-89). It shows:

- The transect plan location in red. This has been presented against a digital elevation model (DEM) of the local bathymetry to assist interpretation of the results;
- Surface water velocity vectors or ‘sticks’ across the transect. These sticks point in the direction of water flow, and their length is scaled to the velocity magnitude. One stick is plotted for each vertical ADCP ping, which are typically 3-5 metres apart. A scale length stick is provided in each drawing to allow quick visual estimation of surface velocities;
- The profile of all velocity measurements through each transect at all depths, presented as a colour contour map. The colours correspond to velocities as per the colour bar scale, and the left and right ends of each contour are marked with an approximate compass point location (e.g. ‘SW’ for south west); and
- The timing of each transect in relation to the tidal cycle, with the corresponding date and time available from Figure 5-15 or Figure 5-16.

In general, the ADCP measurements were consistent with those of the S4s for both campaigns. The ADCPs provide a more detailed view of the local hydrodynamics, however, and key observations are described below.

All ADCP transects show that tidal flows largely follow bathymetric channels, both in the study area and the adjacent shipping channel. Further, peak velocities tend to be in the central reaches of channels, as could be expected. These velocities can be as high as 1.2 m/s.

The data are consistent with minor vertical velocity shear at some locations, but in comparing repeat transects (e.g. Transects 3 and 4 from Campaign 1) the shear appears to be unsteady. One clear example of persistent ebb tide vertical shear is provided at the south eastern ends of Transects 7 and 15 from Campaign 1, where boundary layer effects appear to be causing sheltering behind local bathymetric features at depth. The sheltering is not apparent on the corresponding flood tide transect (Campaign 1 Transect 21).

Ebb tides generally display greater velocity magnitudes when compared to corresponding flood tides, especially as demonstrated by Transects 7 and 21 from Campaign 1 and Transects 5 and 28 from Campaign 2. This is consistent with the S4 measurements from both campaigns.

Finally, the ADCP data shows some flood tide current reversals in the lee of geomorphologic features. This is particularly evident in Transect 24 from Campaign 1 and Transects 6 and 7 from Campaign 2, where a transverse eddy structure appears to be shed off the southern point of China Bay.

The supplementary ADCP transects carried out at the location shown in Figure 5-12 have been processed to derive the total flow across each transect. These flows have been plotted against time in Figure 5-21, and the tidal elevation at China Bay has been superimposed for reference.

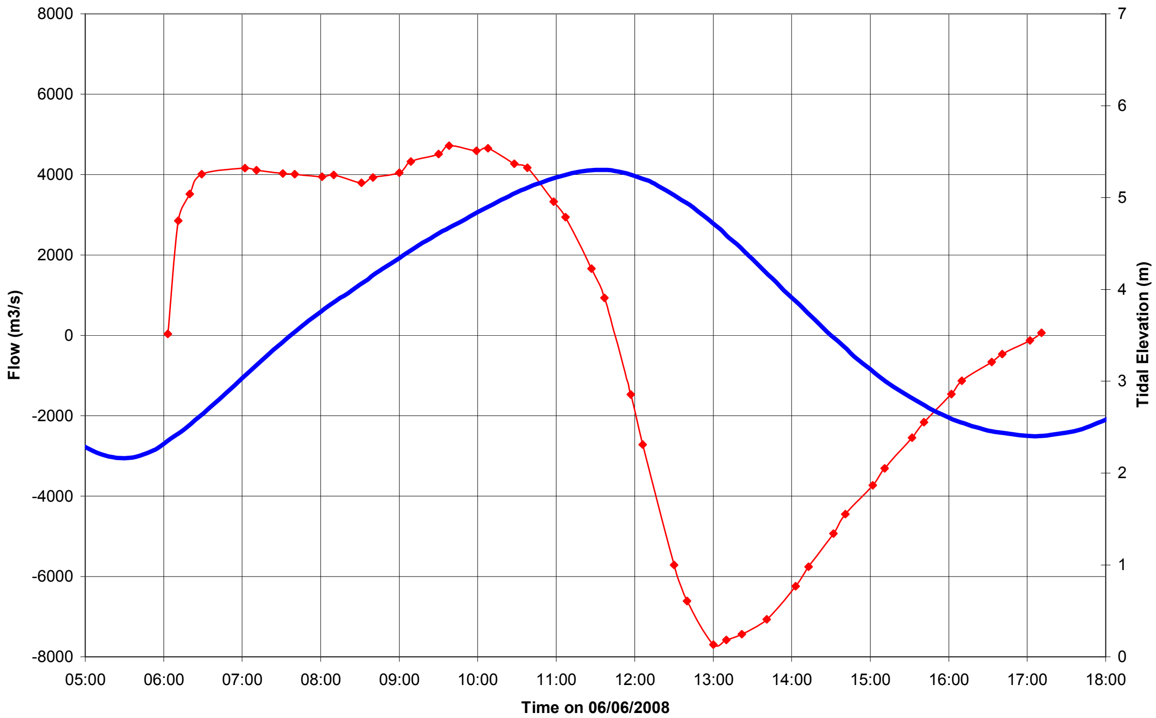
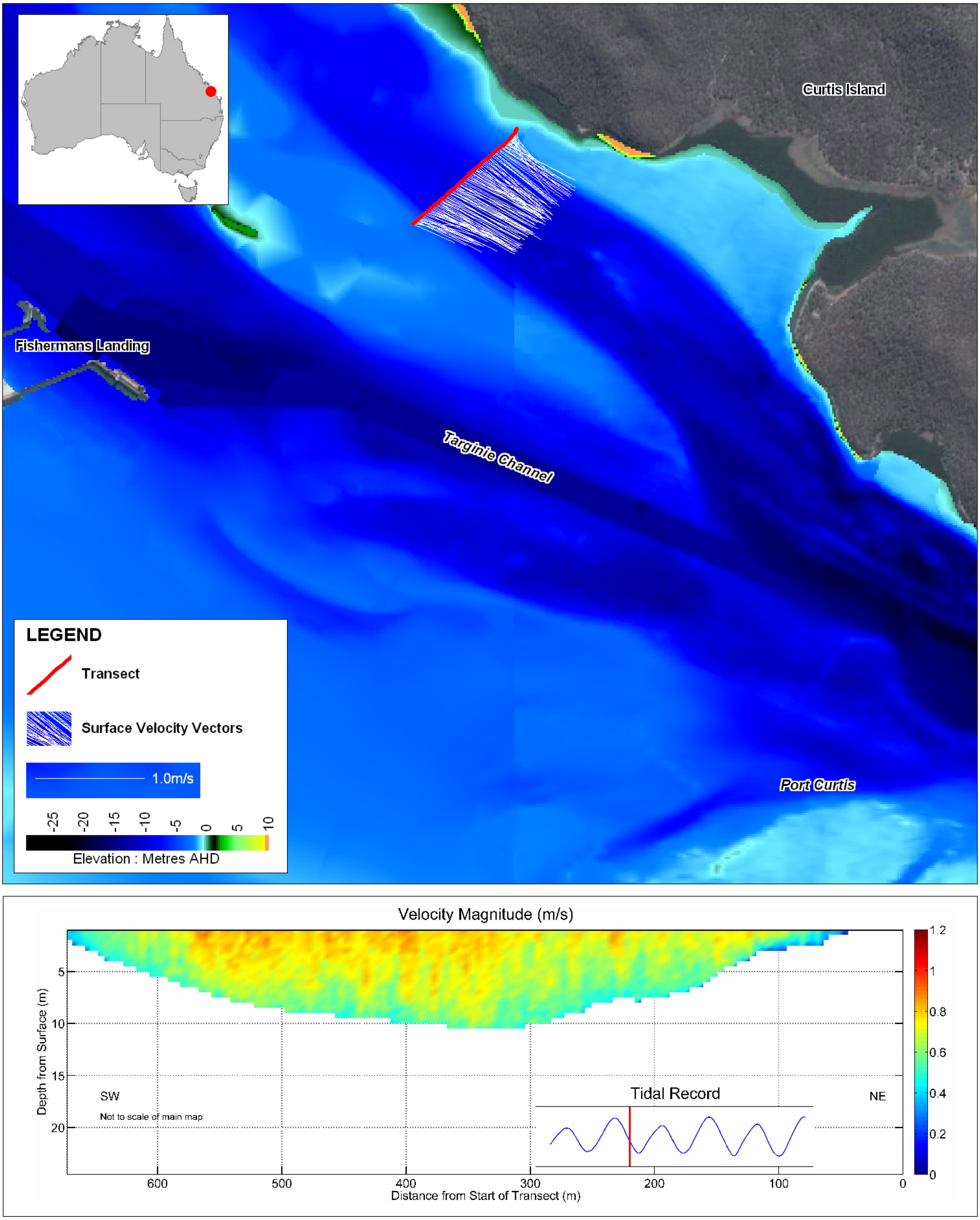


Figure 5-21 Supplementary ADCP Flows

The figure shows a typical asymmetrical flood-ebb tide discharge signal, with peak discharges reaching 4000 and 8000 m^3/s on the flood and ebb tides, respectively. These flows have been used in other reports to validate the existing hydrodynamic model in the area, and provide guidance on the likely impacts of bridge construction on local flow dynamics, and hence potential water quality impacts.



Title:

ADCP Transect 1 - Campaign 1

Figure: **5-22**

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Approx. Scale - Main Map

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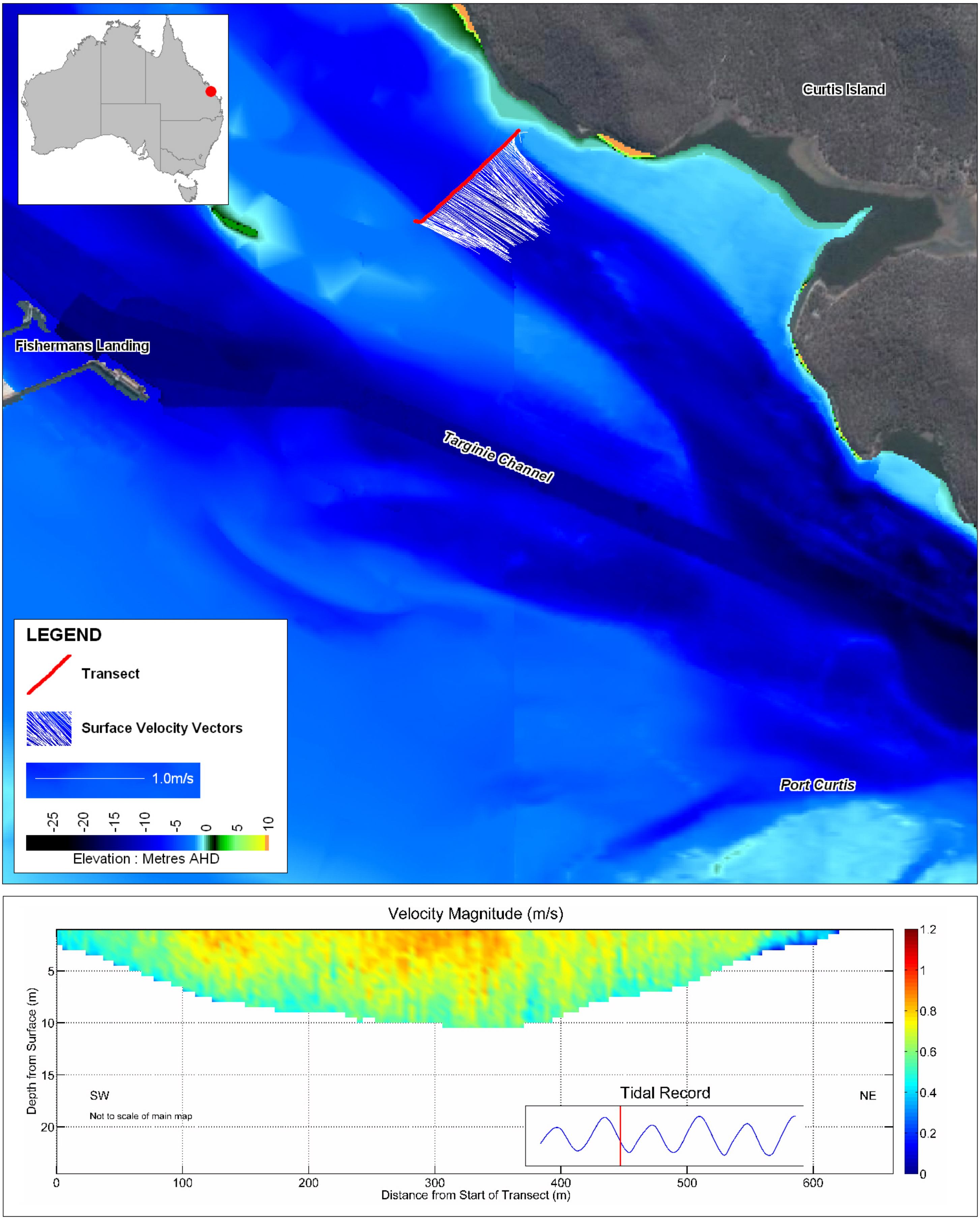

Title:

ADCP Transect 2 - Campaign 1

Figure: 5-23

Rev: B

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Approx. Scale - Main Map

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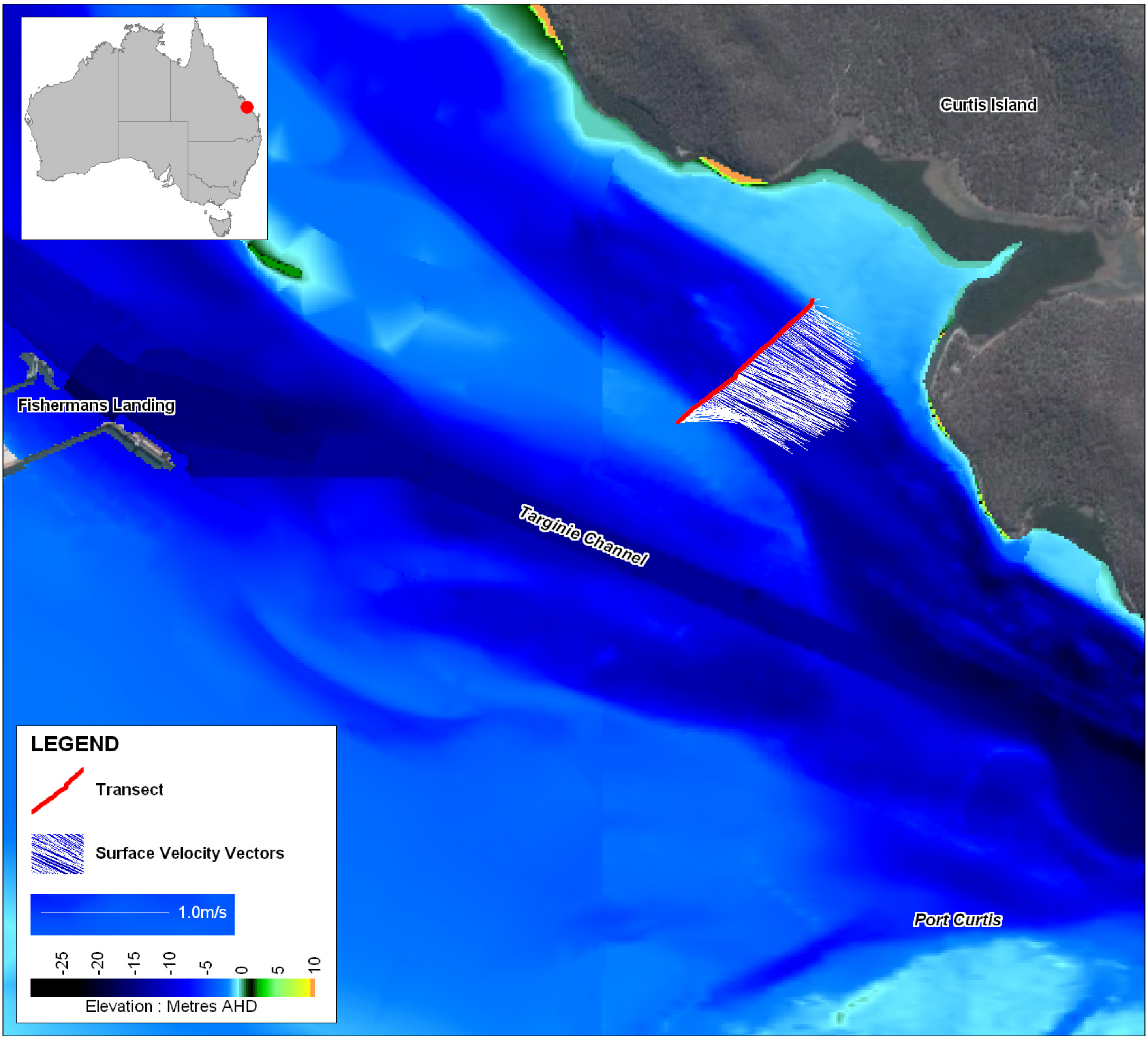

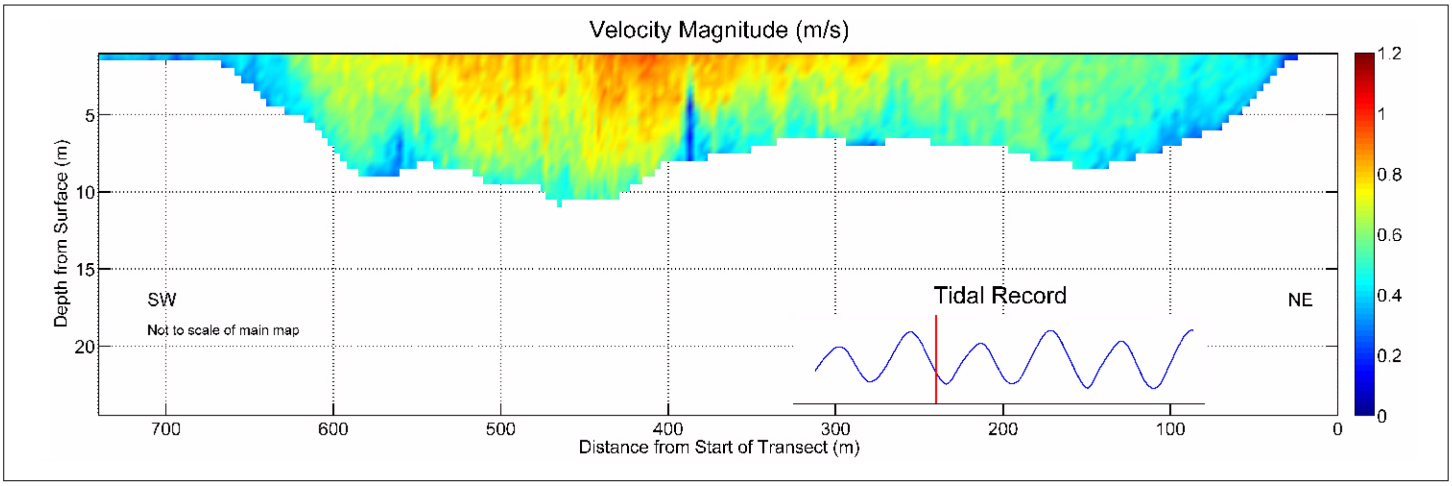

Title:

ADCP Transect 3 - Campaign 1

Figure: **5-24**

Rev: **B**

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Approx. Scale - Main Map

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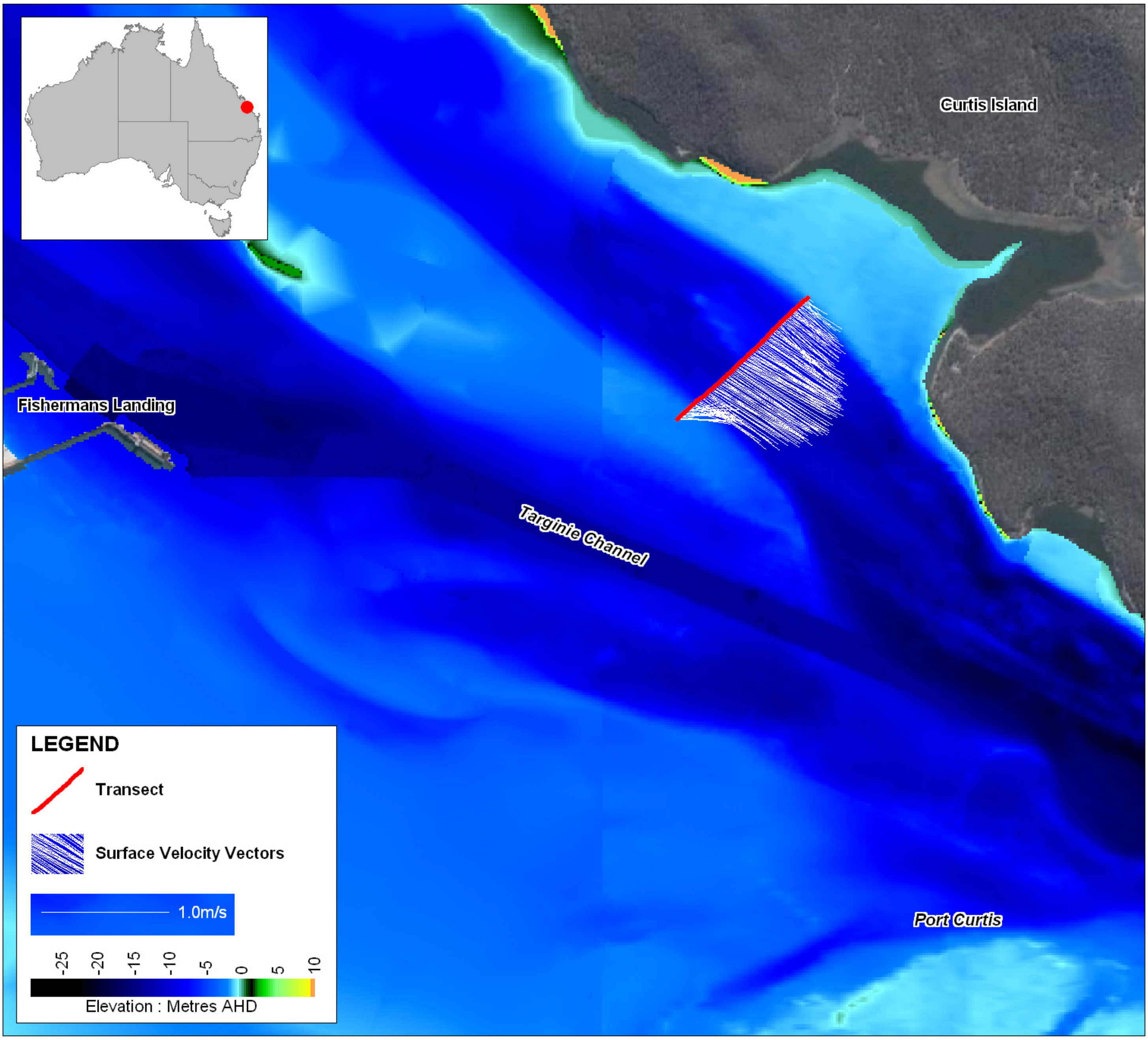

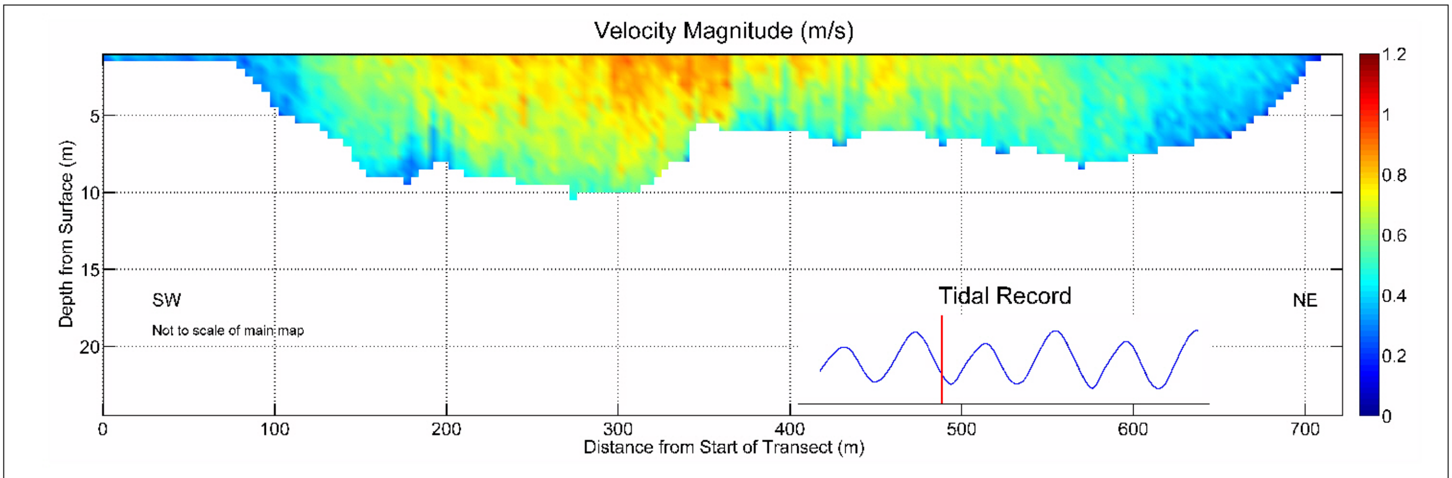

Title:

ADCP Transect 4 - Campaign 1

Figure: 5-25

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Approx. Scale - Main Map

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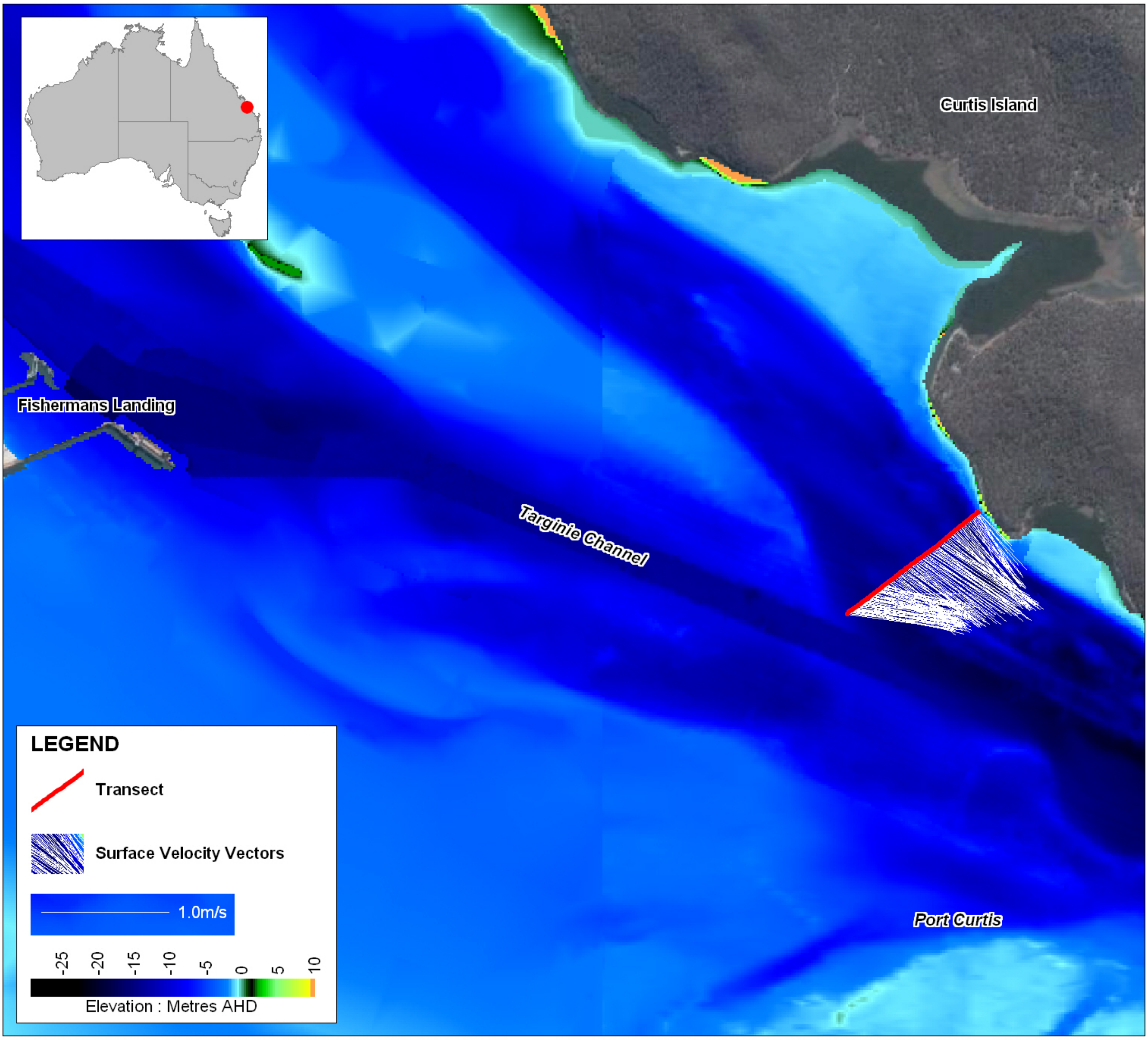

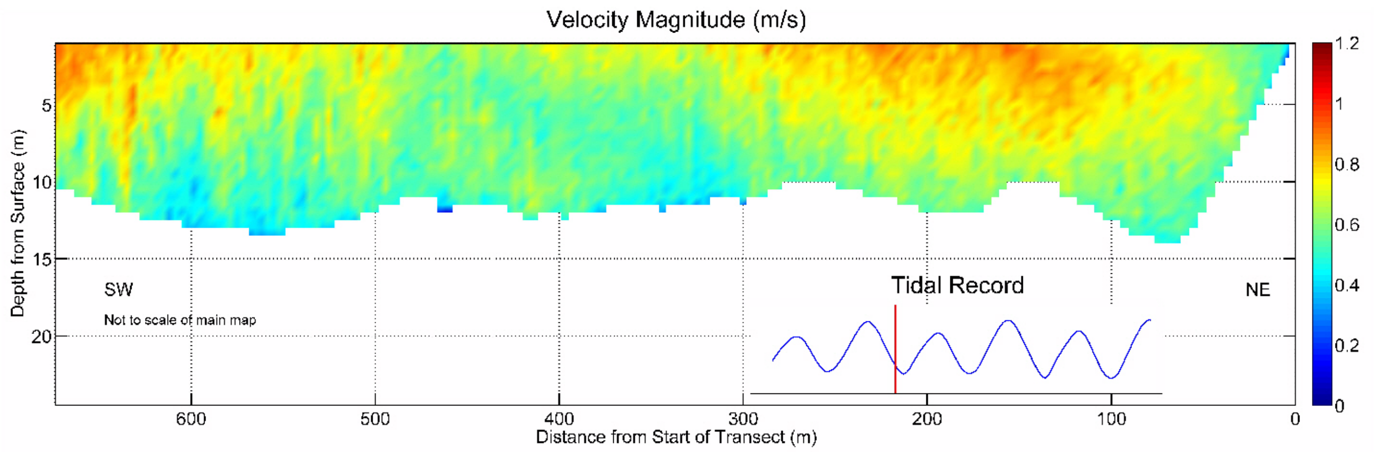

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ADCP Transect 5 - Campaign 1

Figure: **5-26**

Rev: **B**

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Approx. Scale - Main Map

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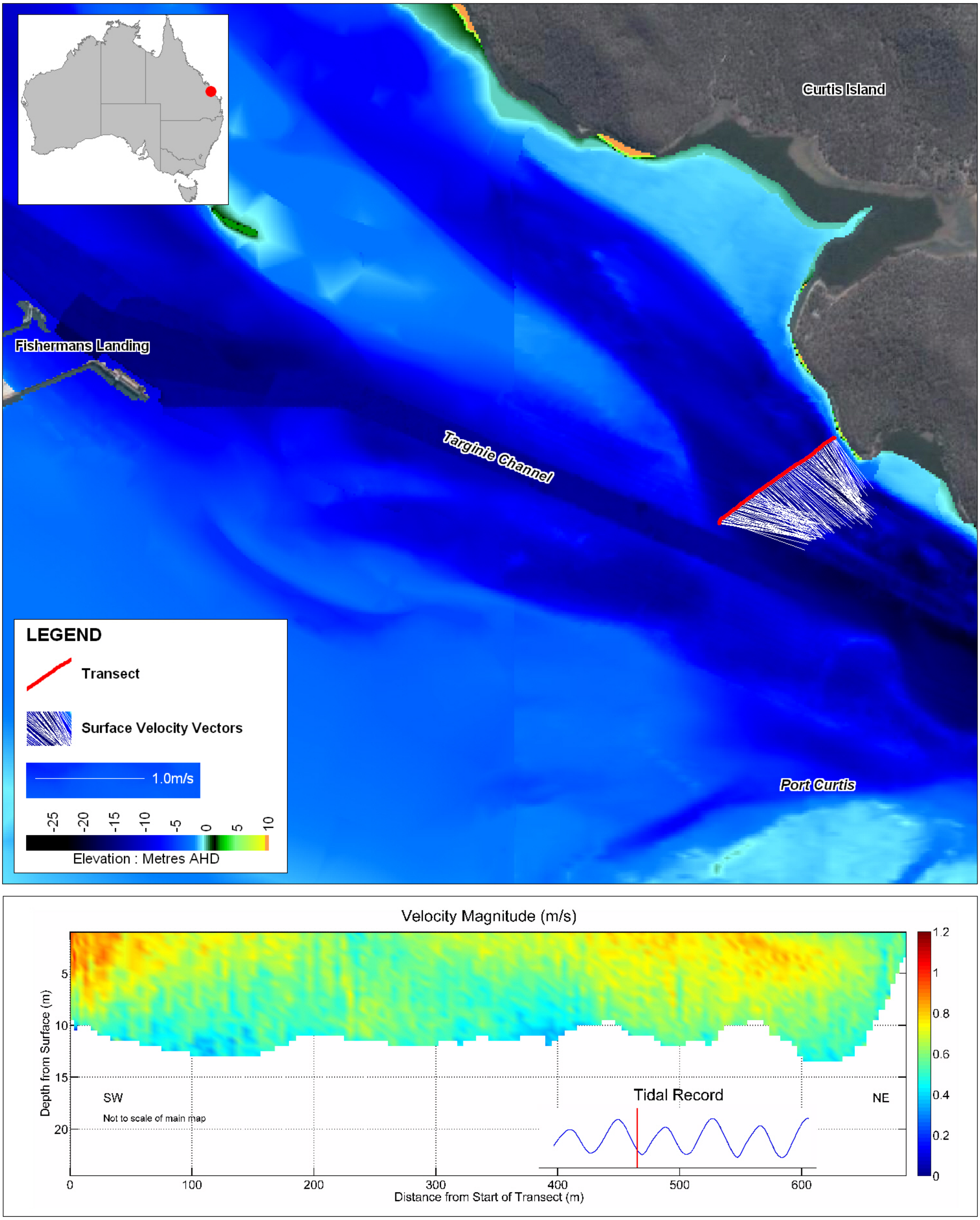

Title:

ADCP Transect 6

Figure:

5-27

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Approx. Scale - Main Map

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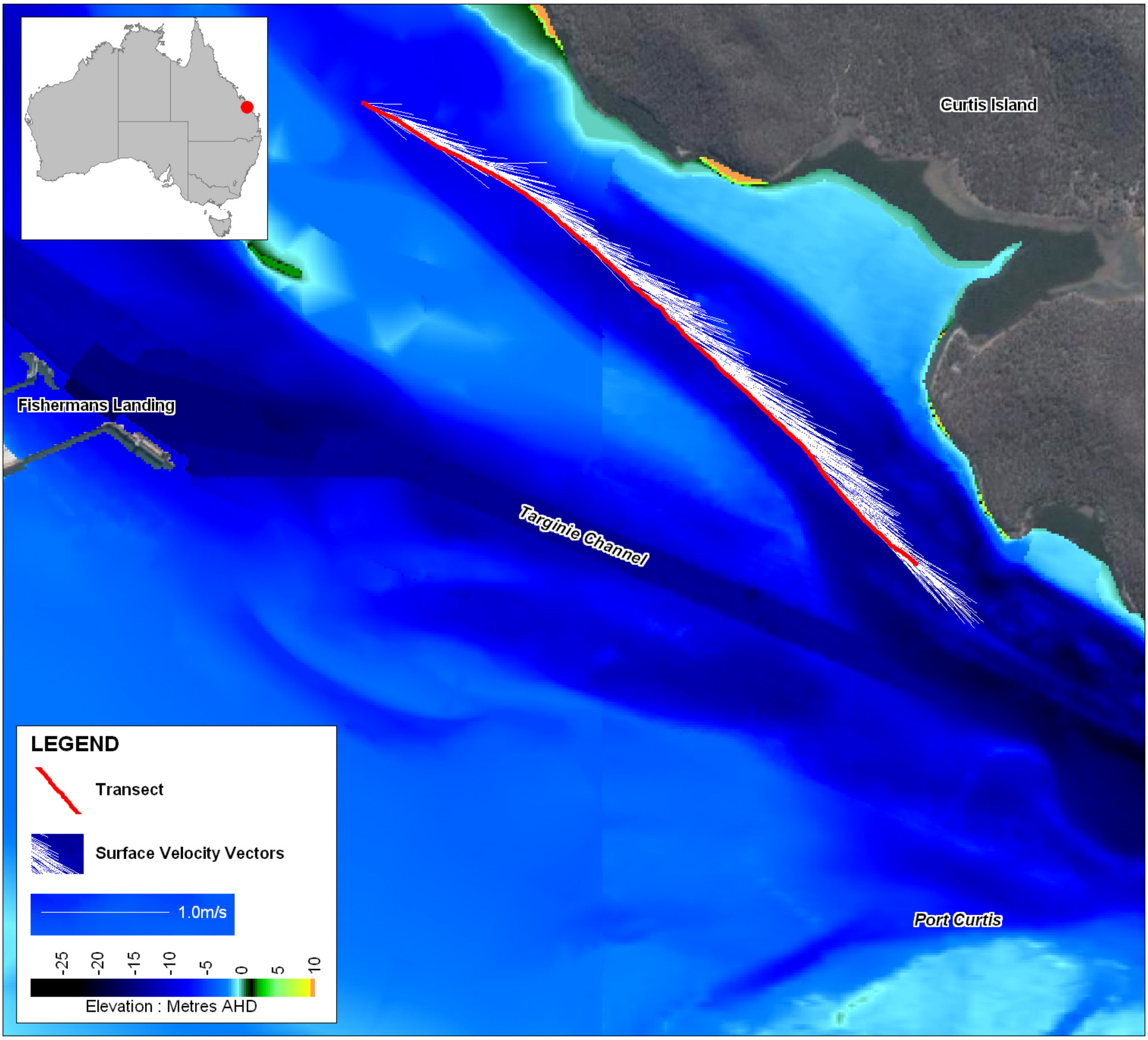

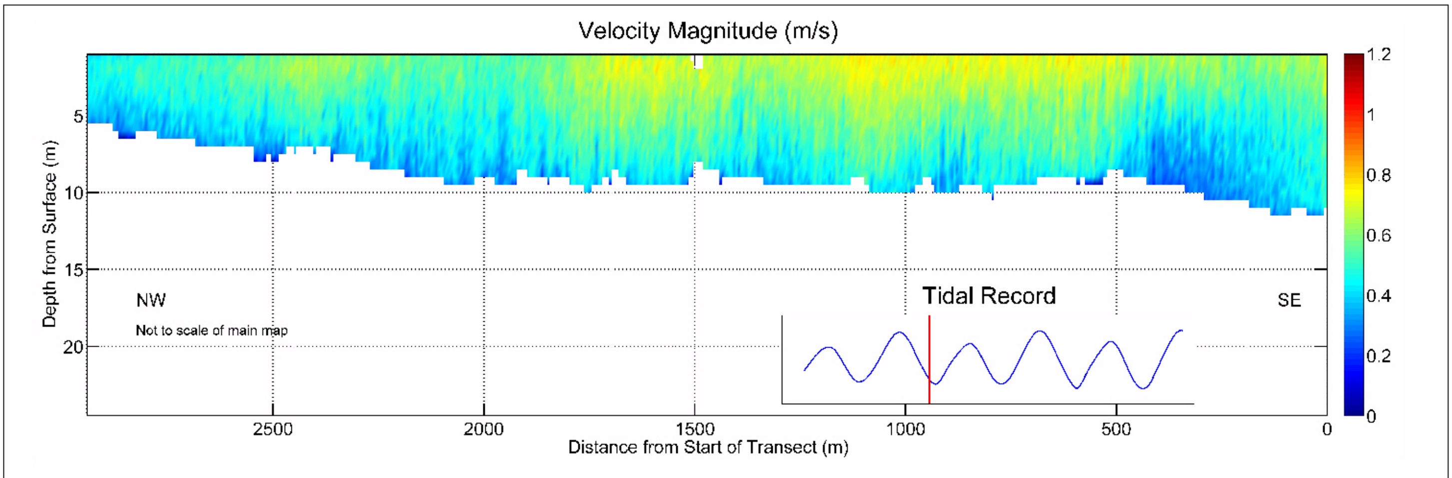

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ADCP Transect 7 - Campaign 1

Figure: 5-28

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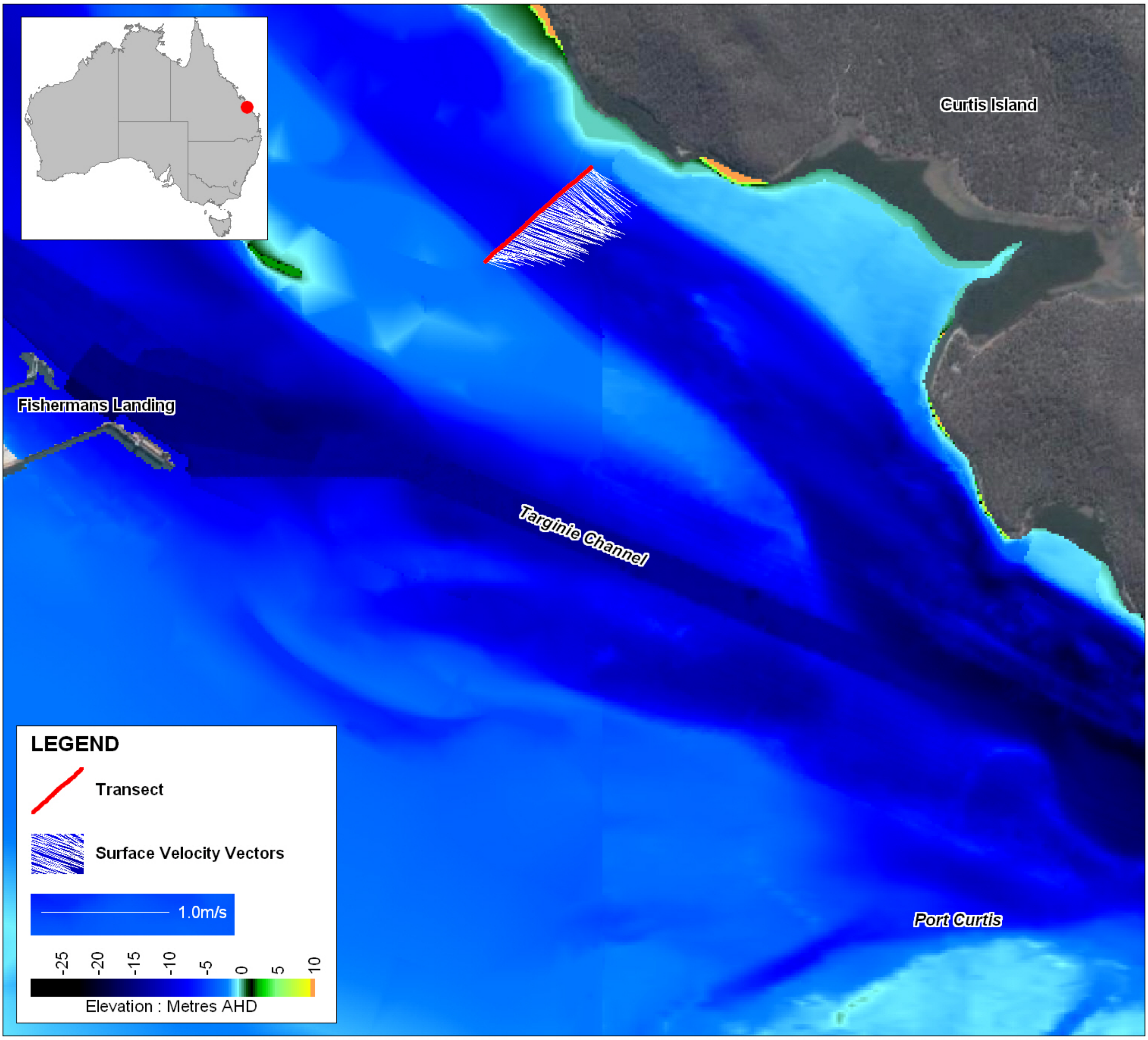

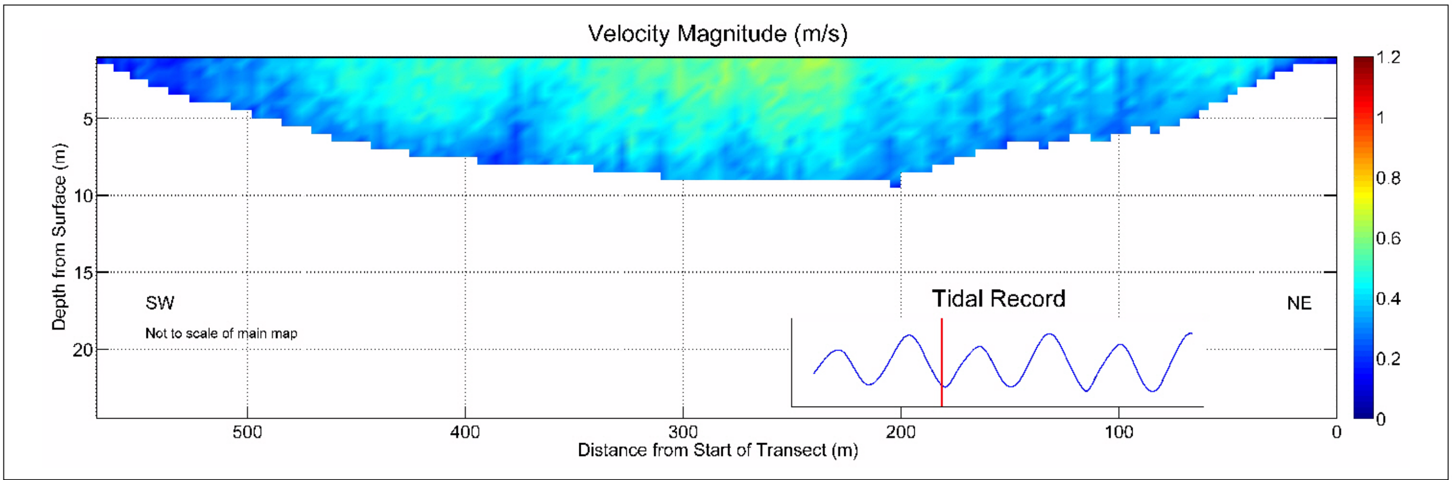

Title:

ADCP Transect 8 - Campaign 1

Figure: 5-29

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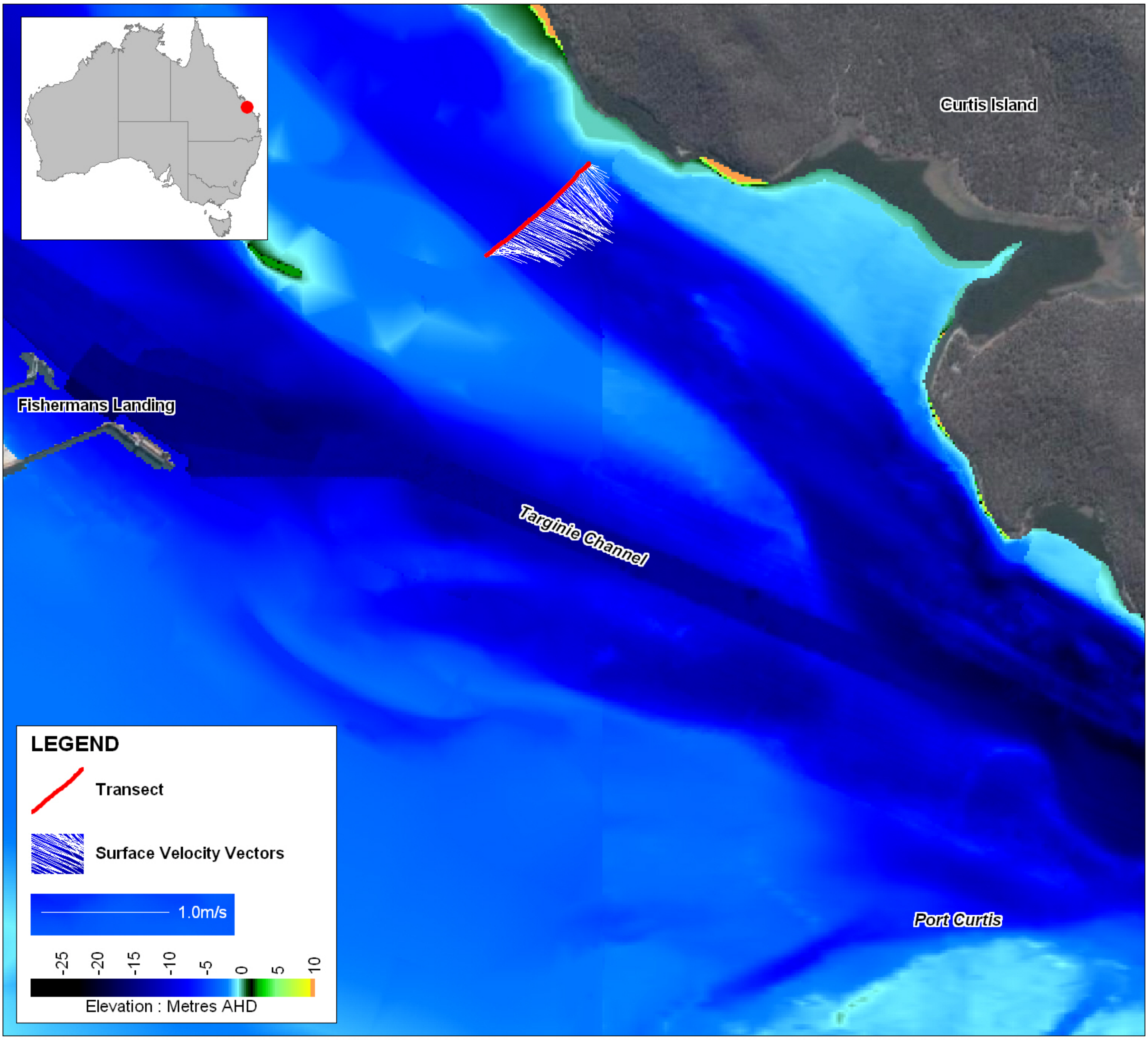

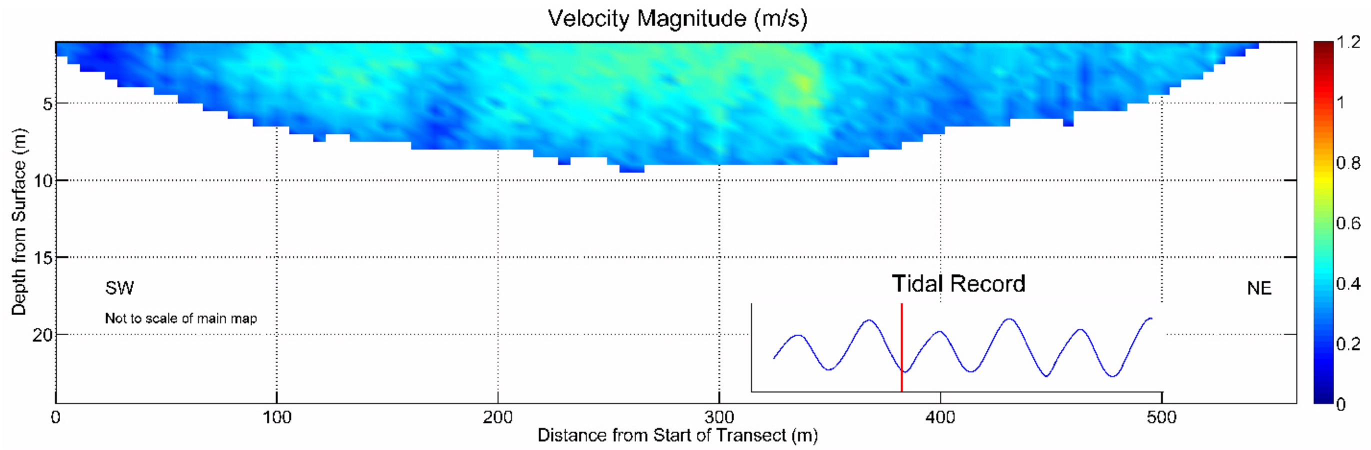

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ADCP Transect 9 - Campaign 1

Figure: **5-30**

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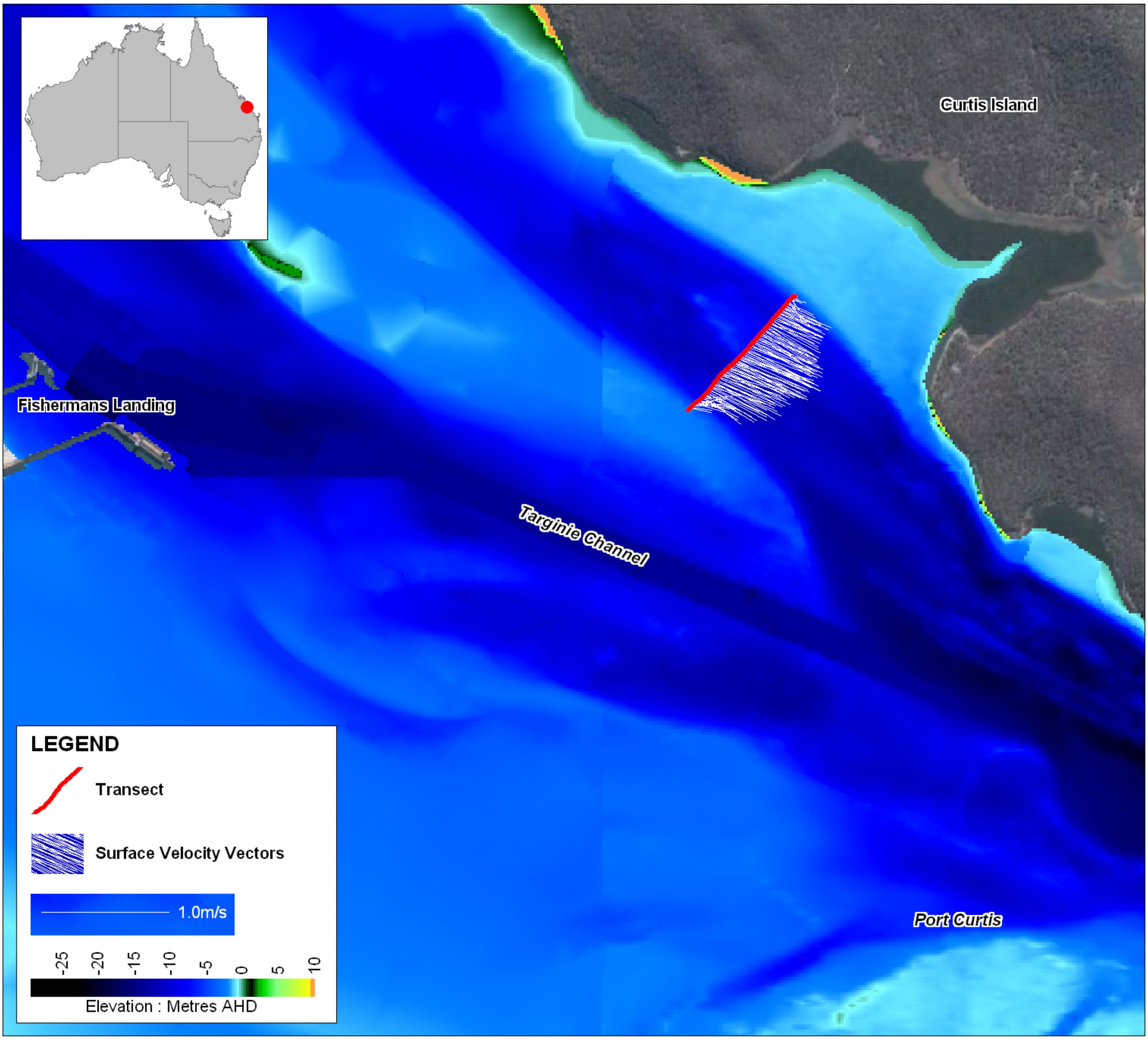

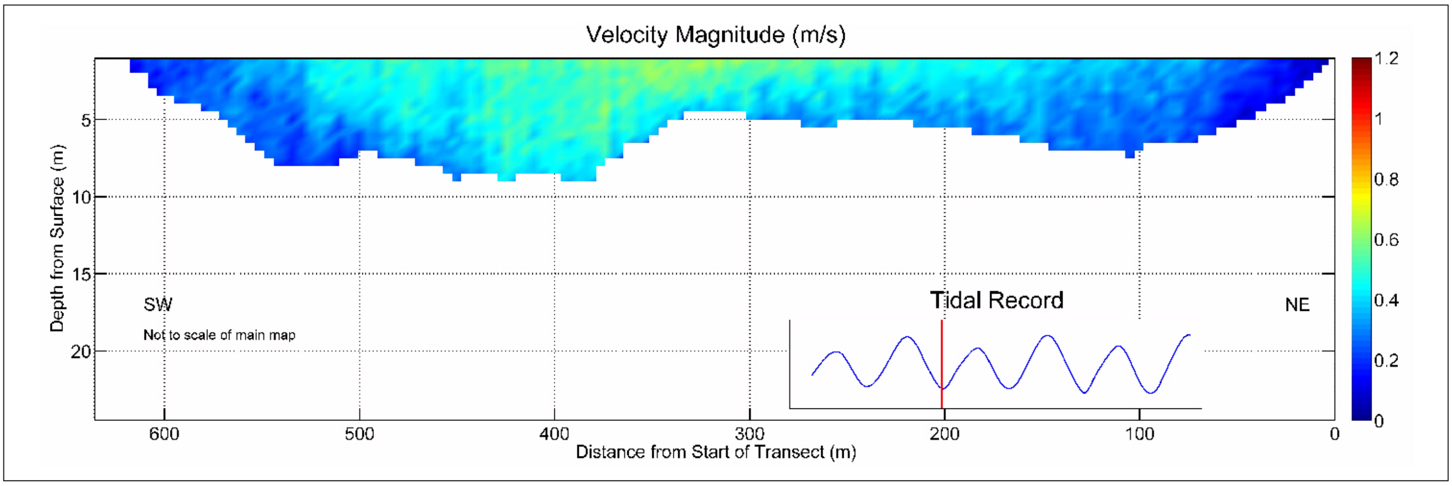

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ADCP Transect 10 - Campaign 1

Figure: **5-31**

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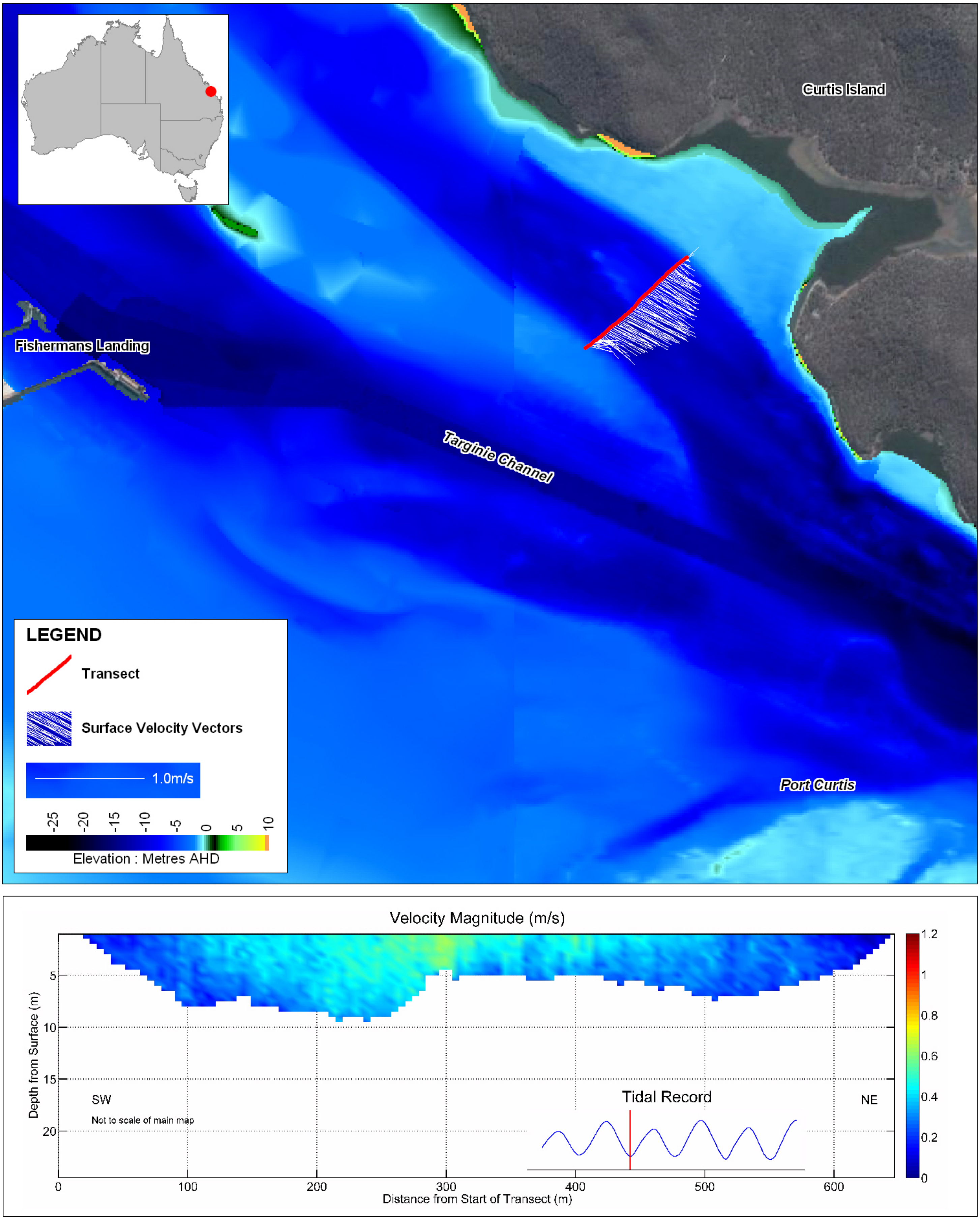

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Figure: **5-32**

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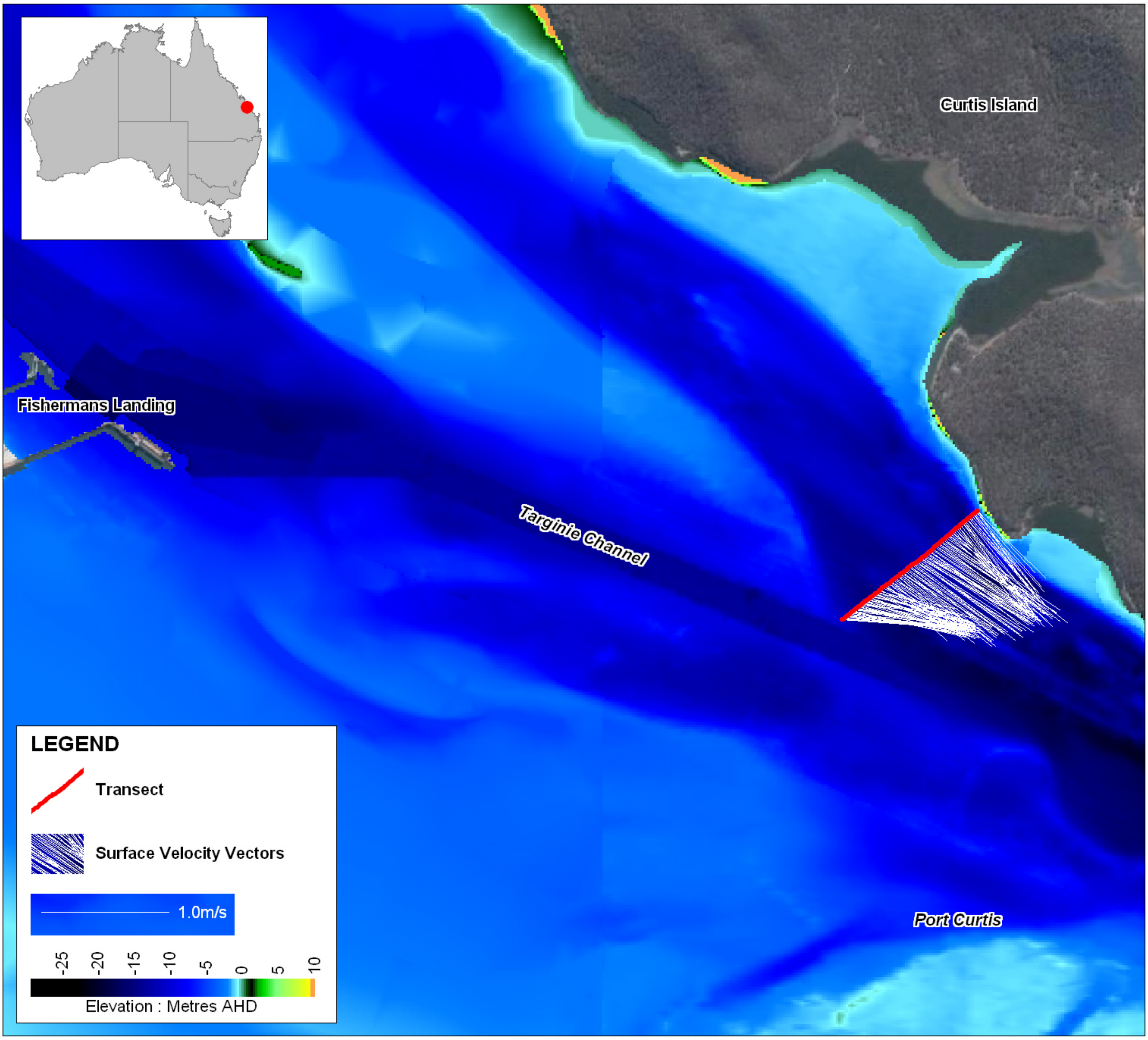

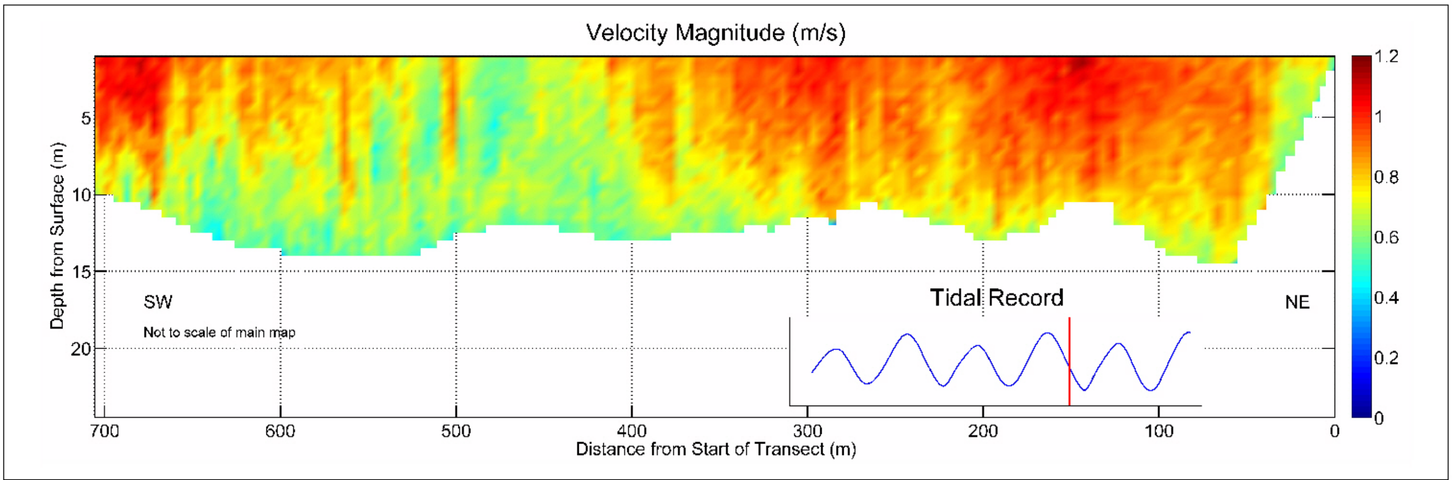

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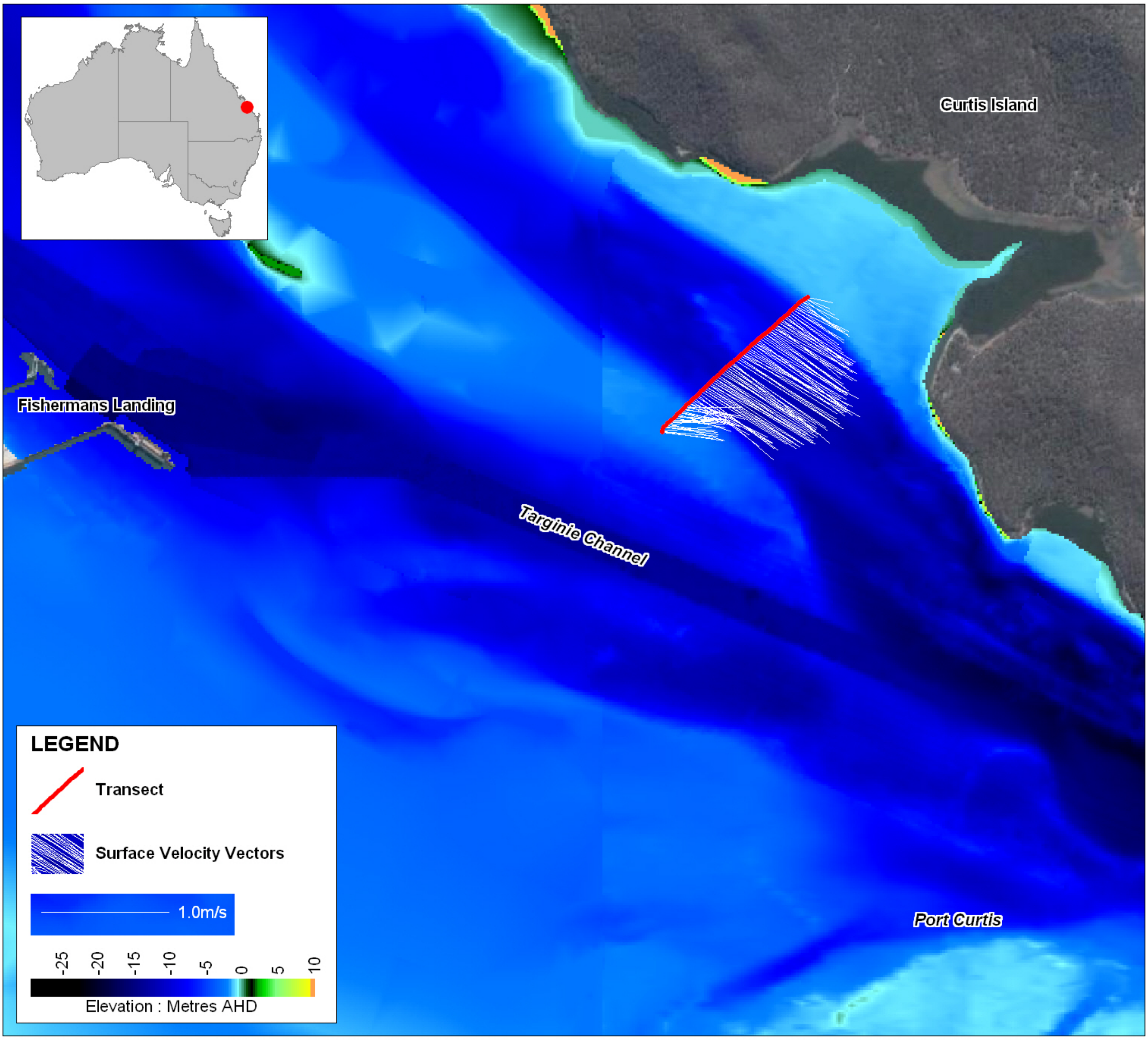

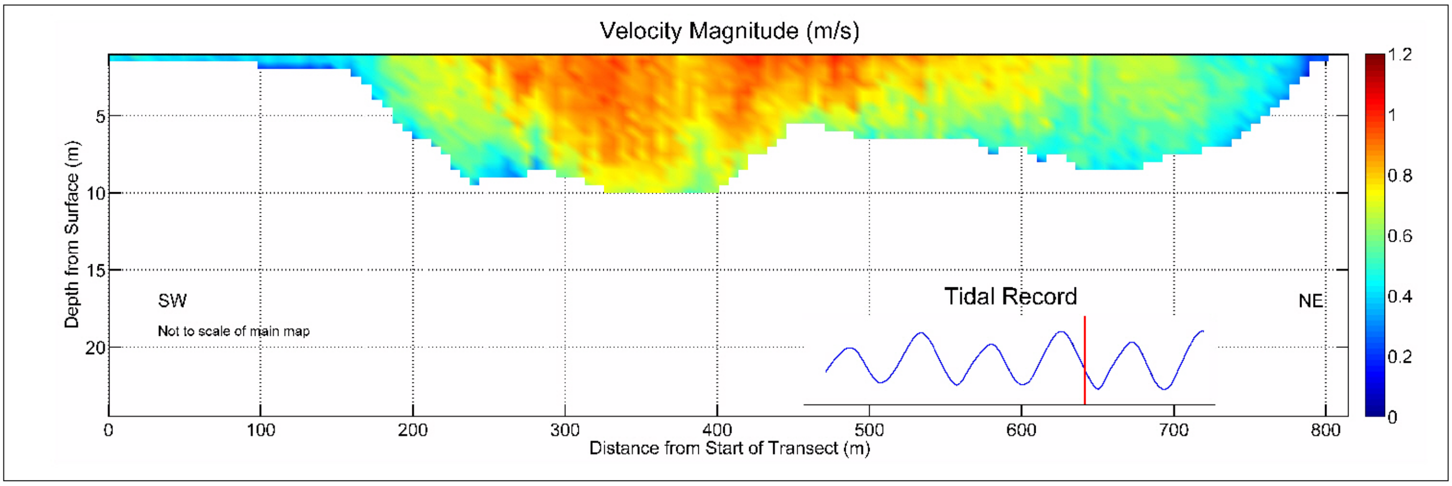

Title:
ADCP Transect 13 - Campaign 1

Figure: **5-34**

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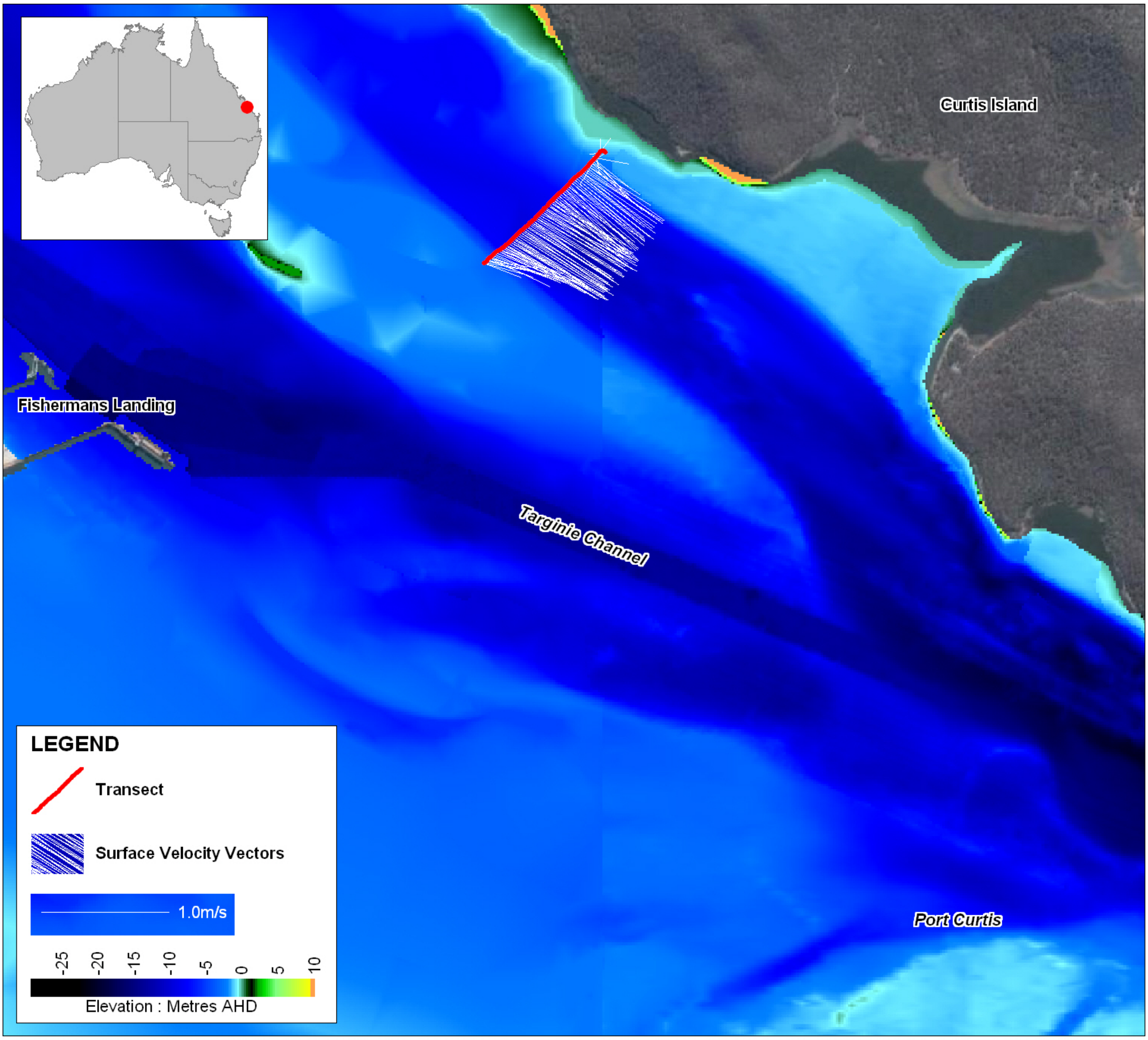

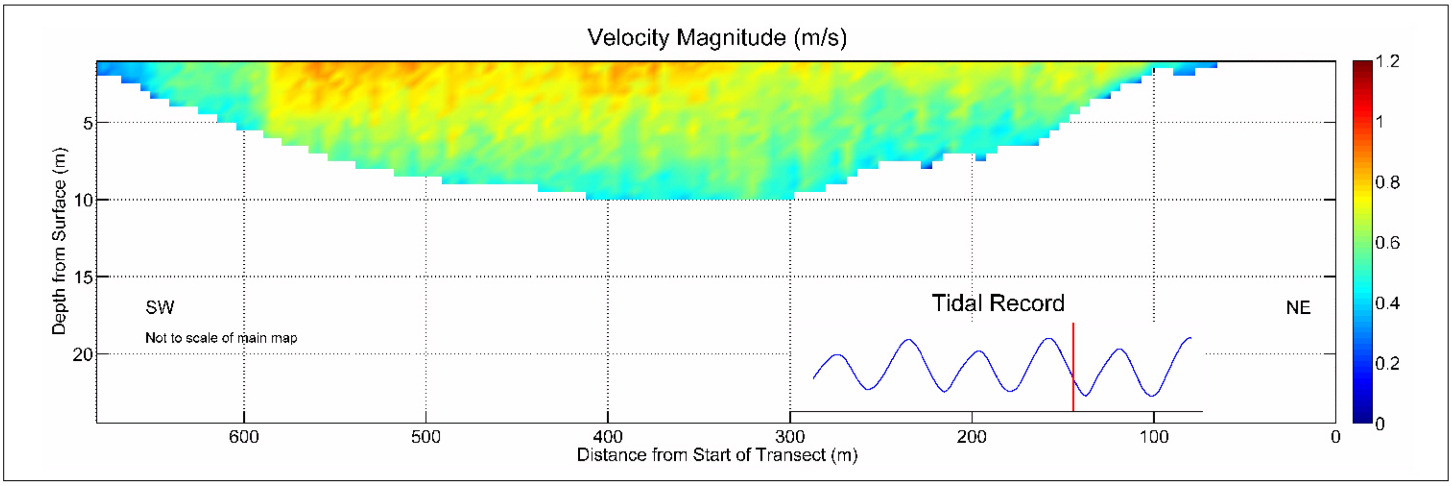

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Figure: **5-35**

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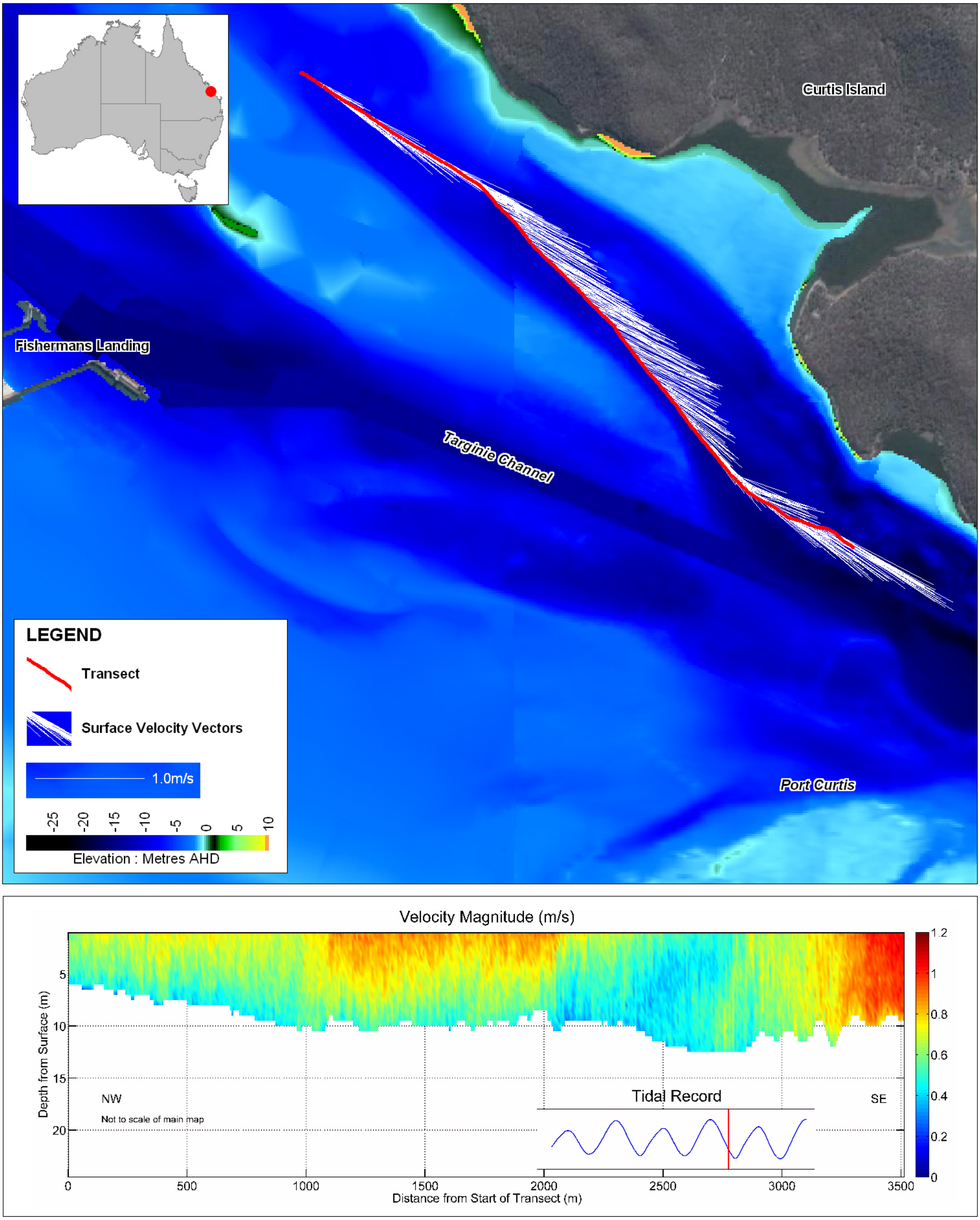

Title:

ADCP Transect 15 - Campaign 1

Figure: **5-36**

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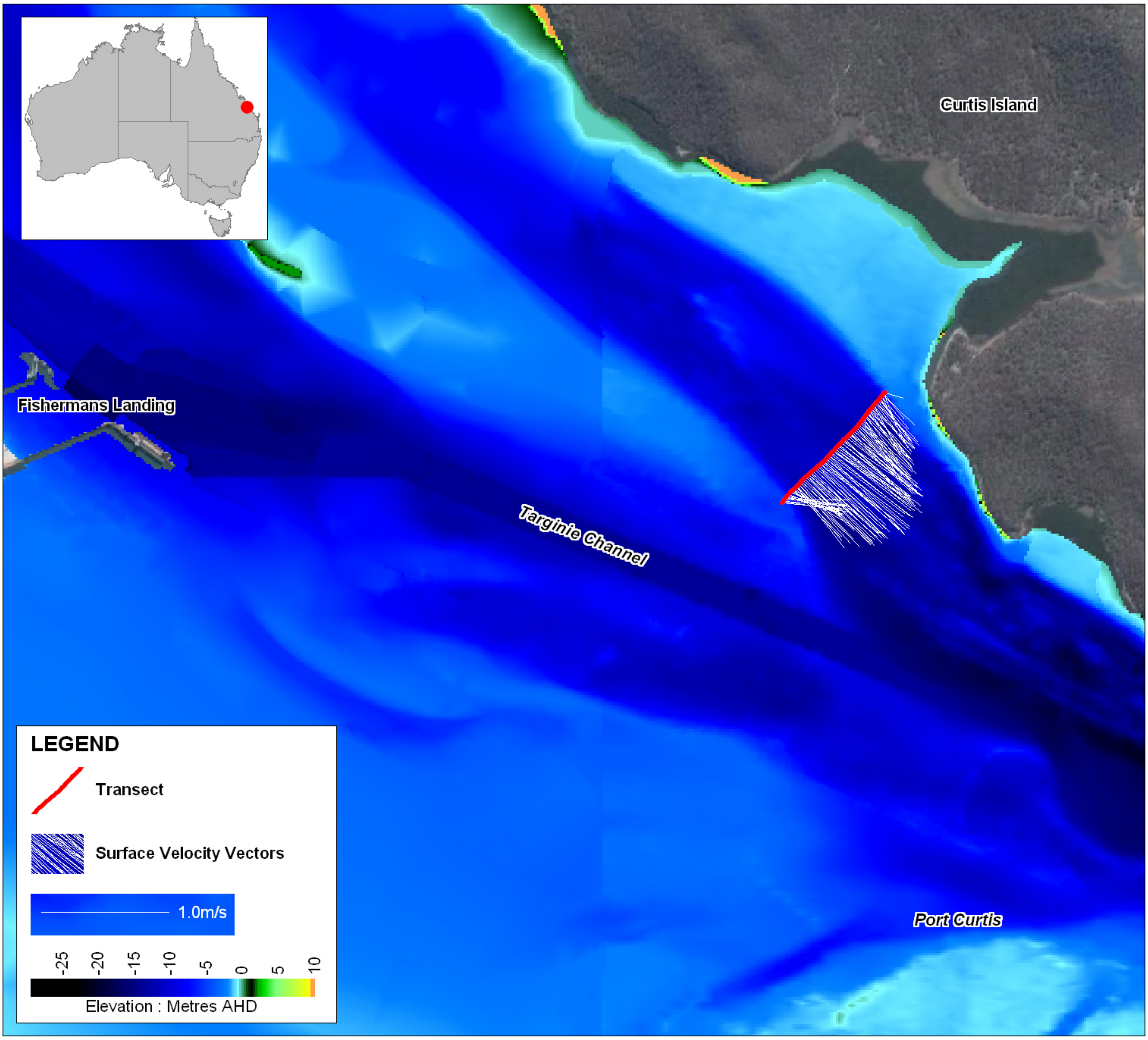

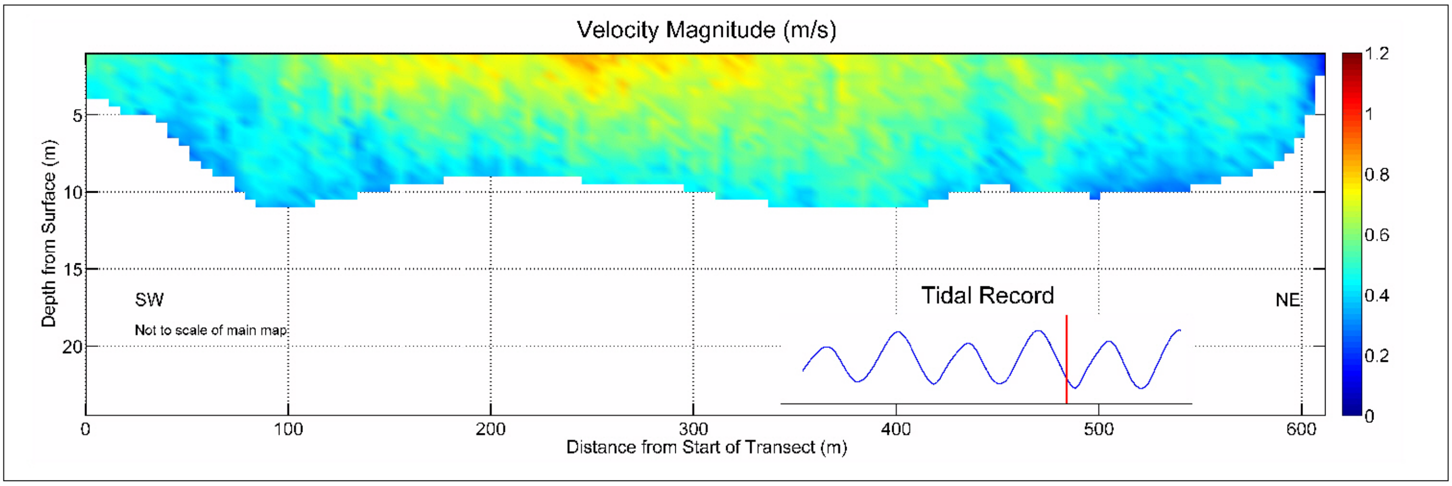

Title:

ADCP Transect 16 - Campaign 1

Figure: **5-37**

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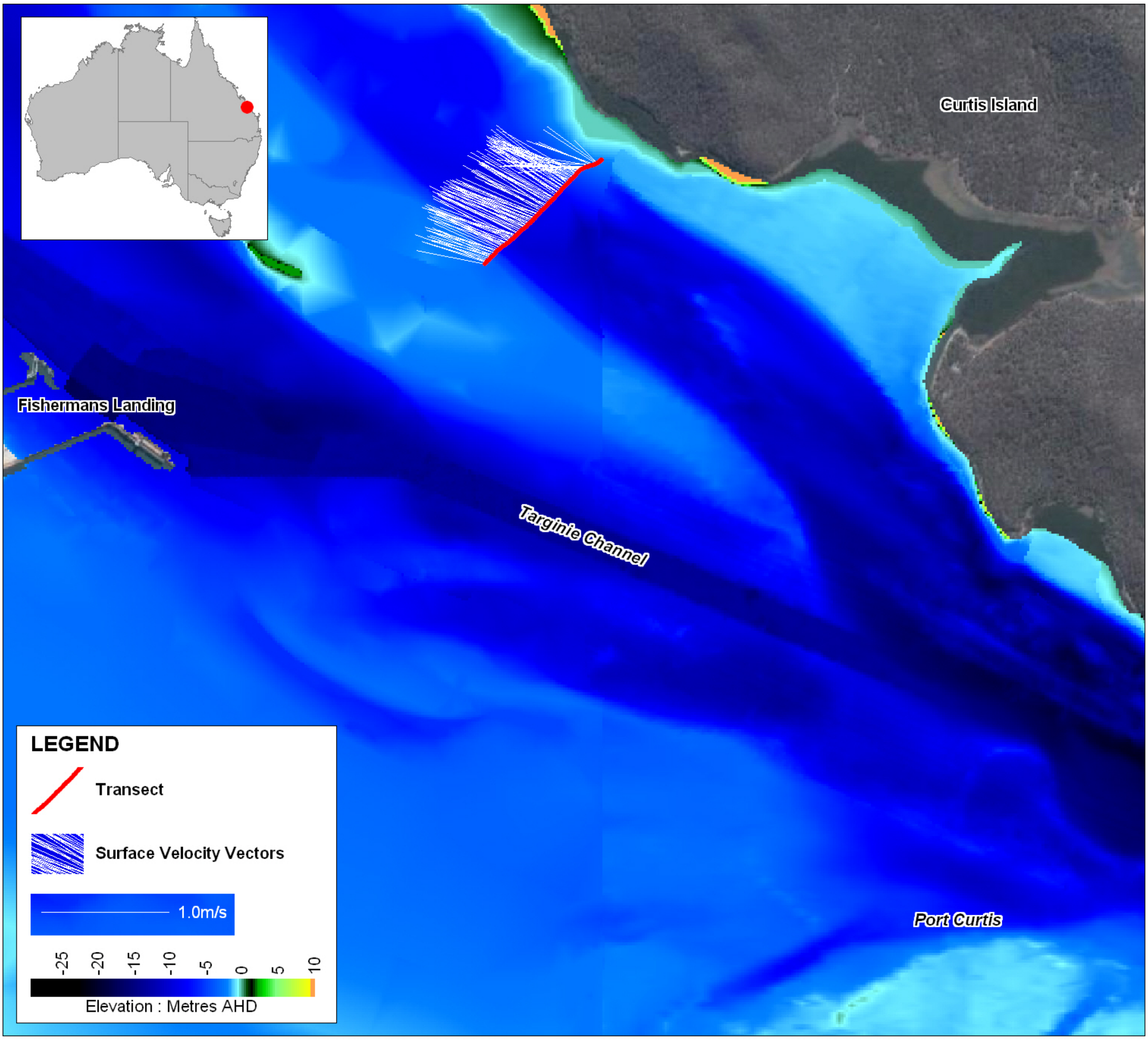

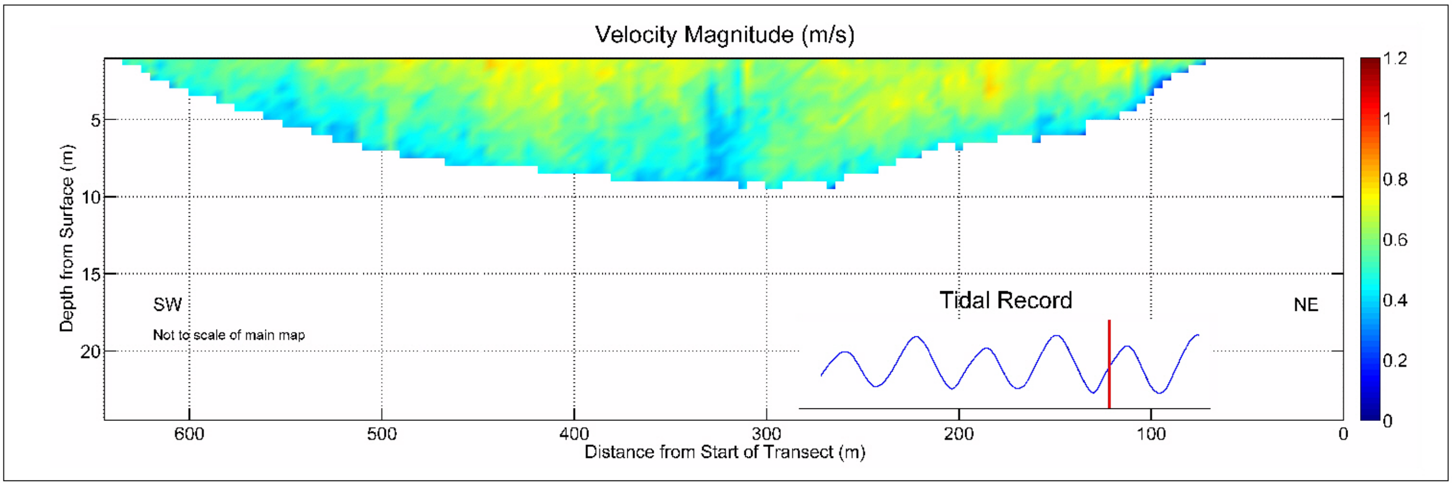

Title:

ADCP Transect 17 - Campaign 1

Figure: **5-38**

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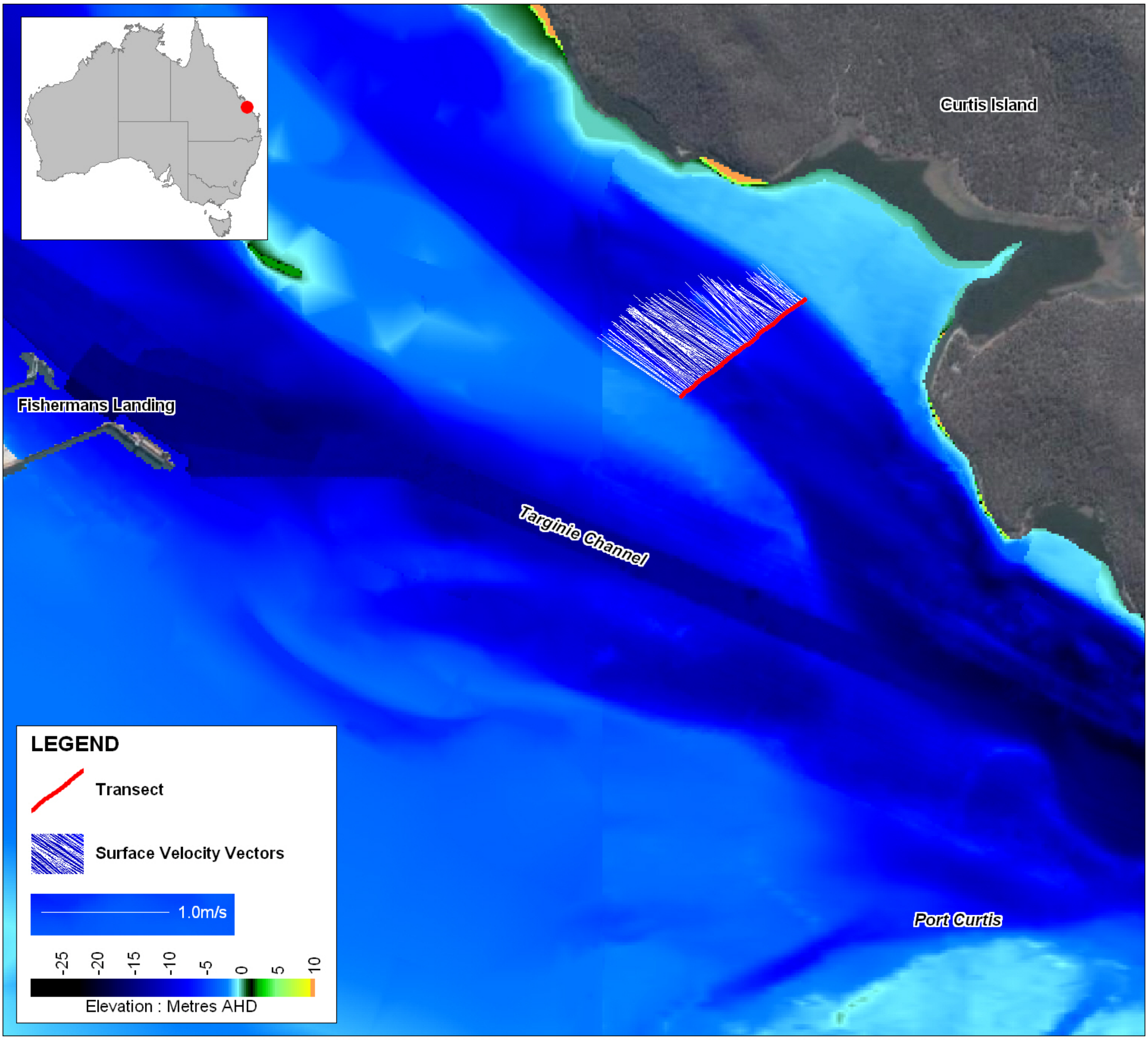

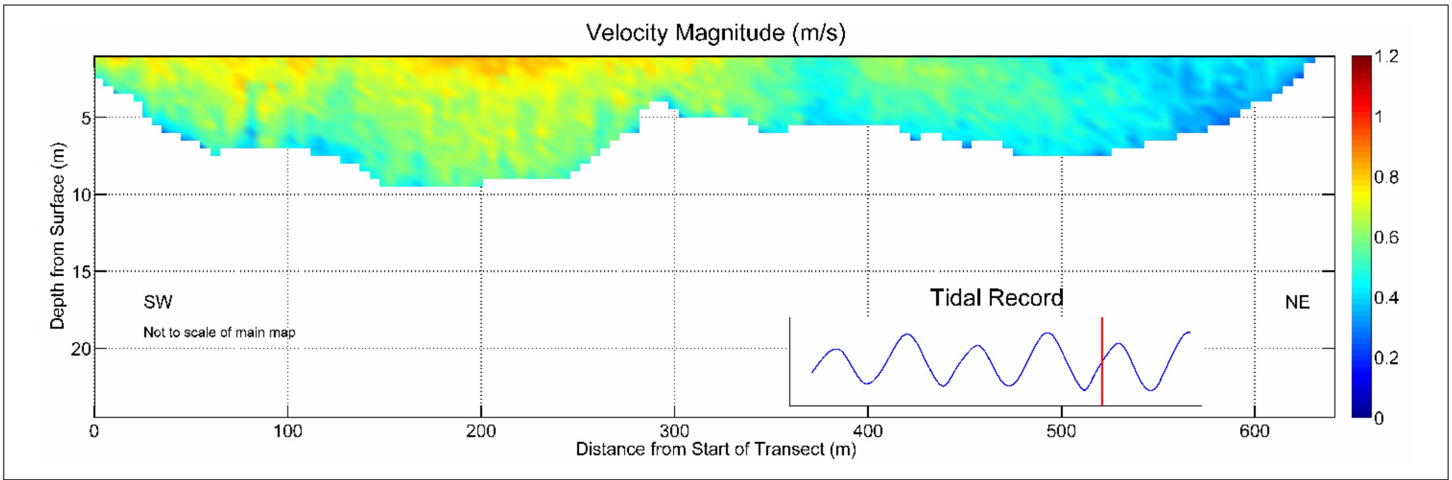

Title:

ADCP Transect 18 - Campaign 1

Figure: 5-39

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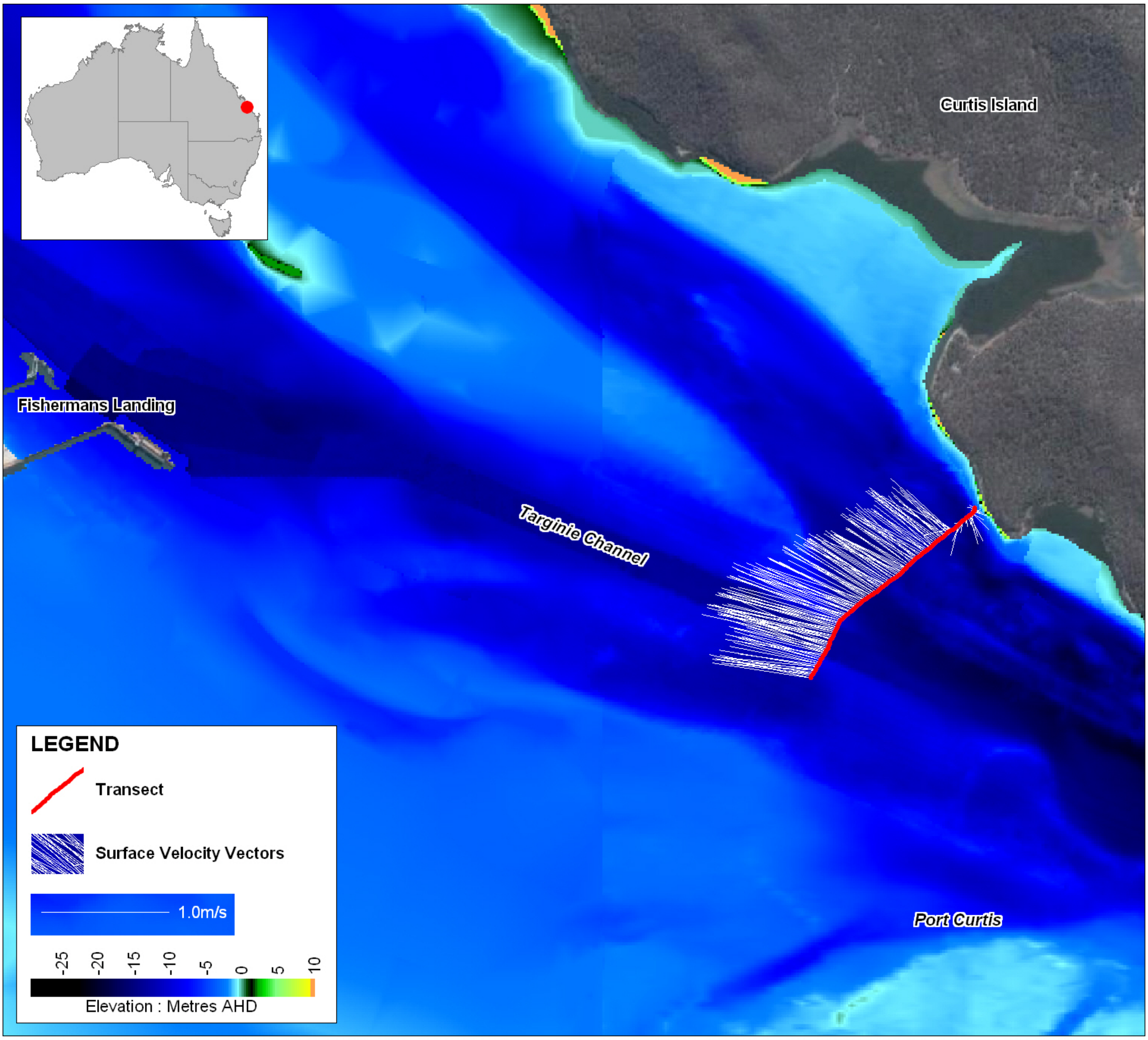

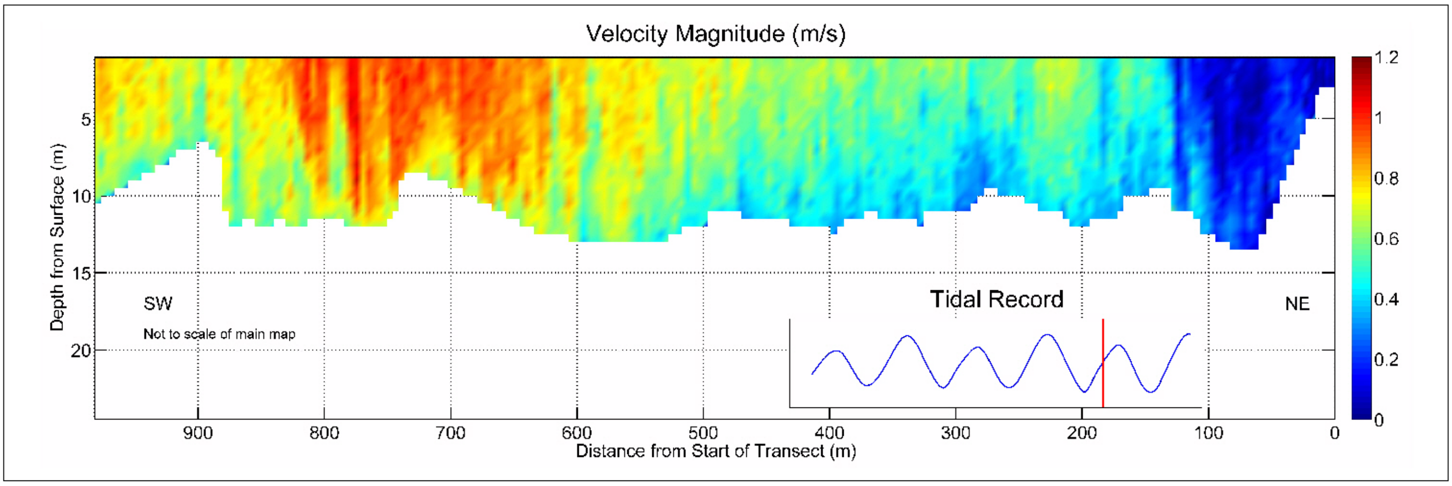

Title:

ADCP Transect 19 - Campaign 1

Figure: **5-40**

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Approx. Scale - Main Map

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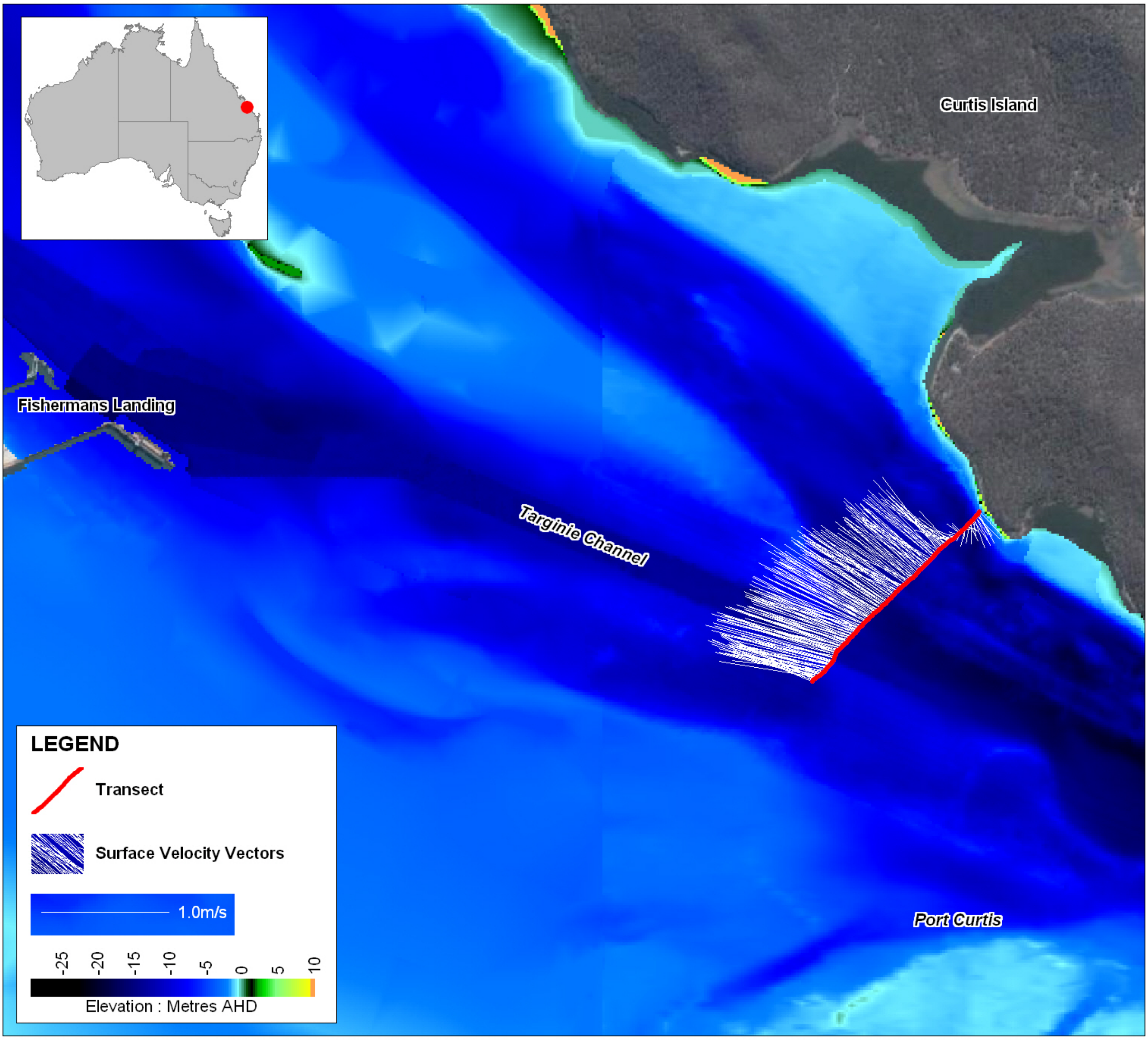

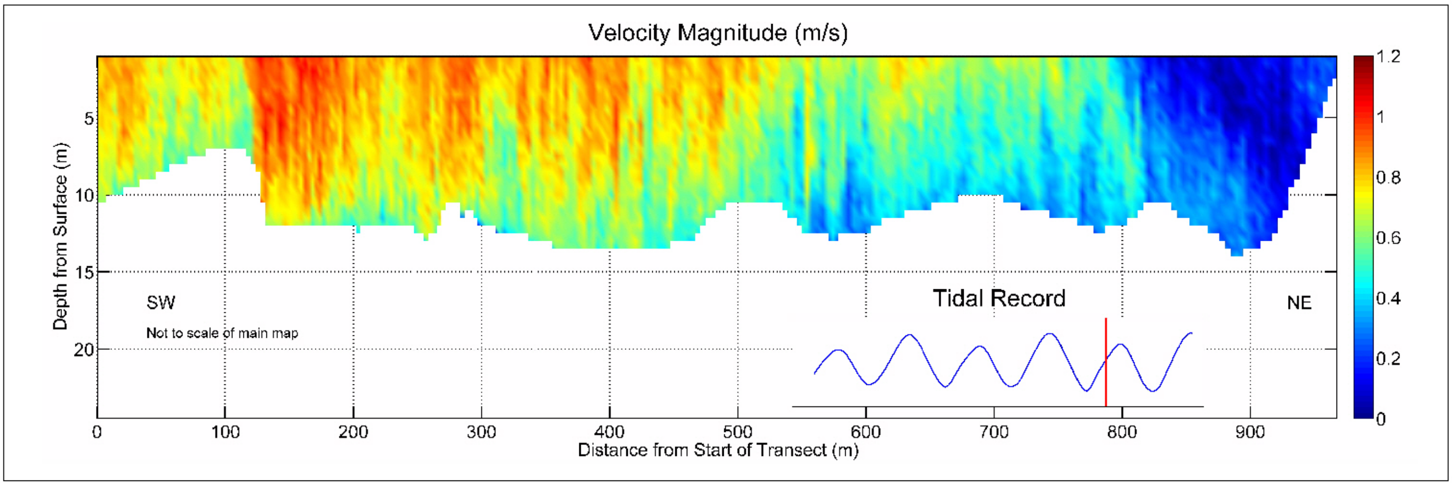

Title:

ADCP Transect 20 - Campaign 1

Figure: **5-41**

Rev: **B**

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N

0 0.5 1km

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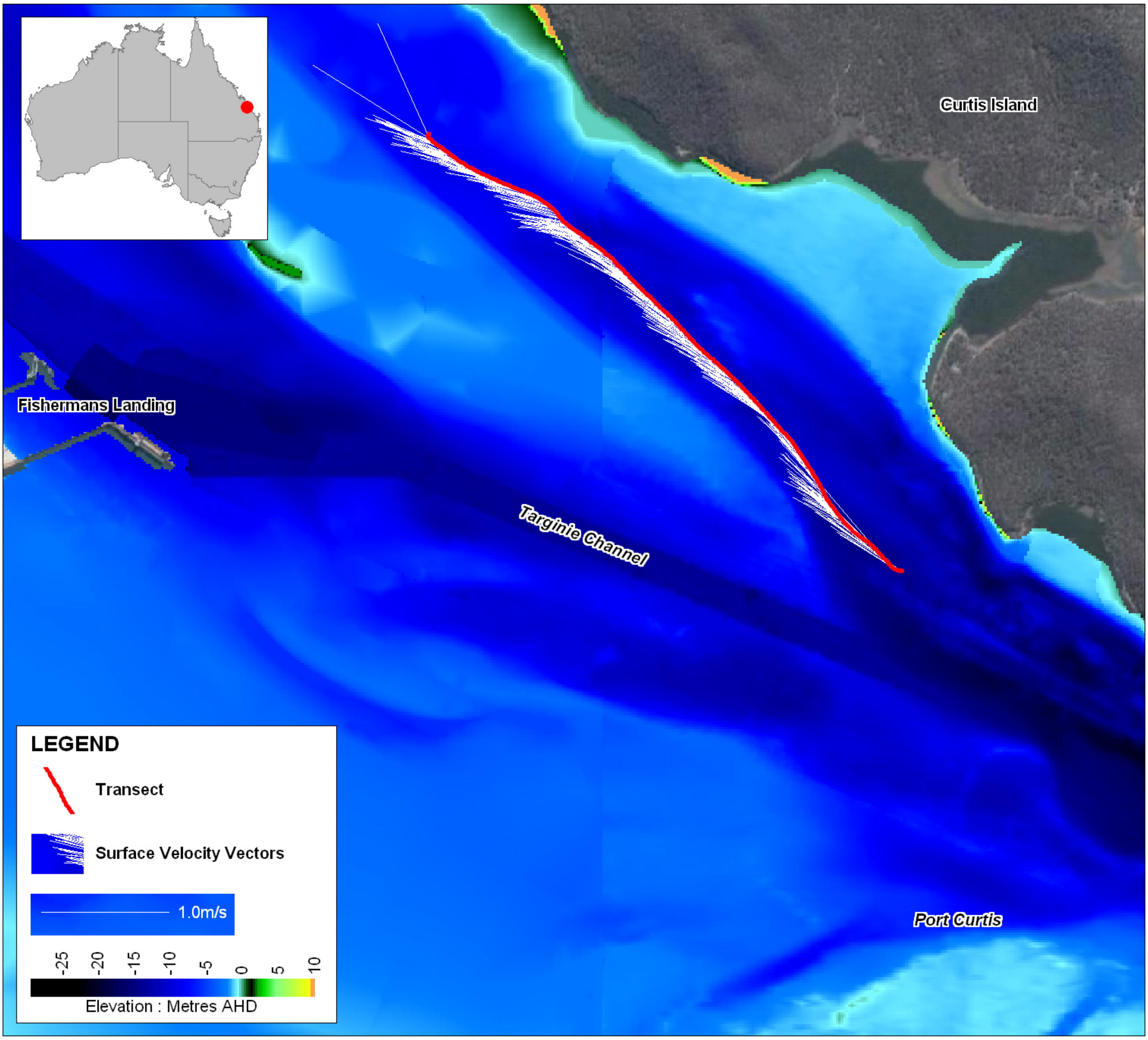

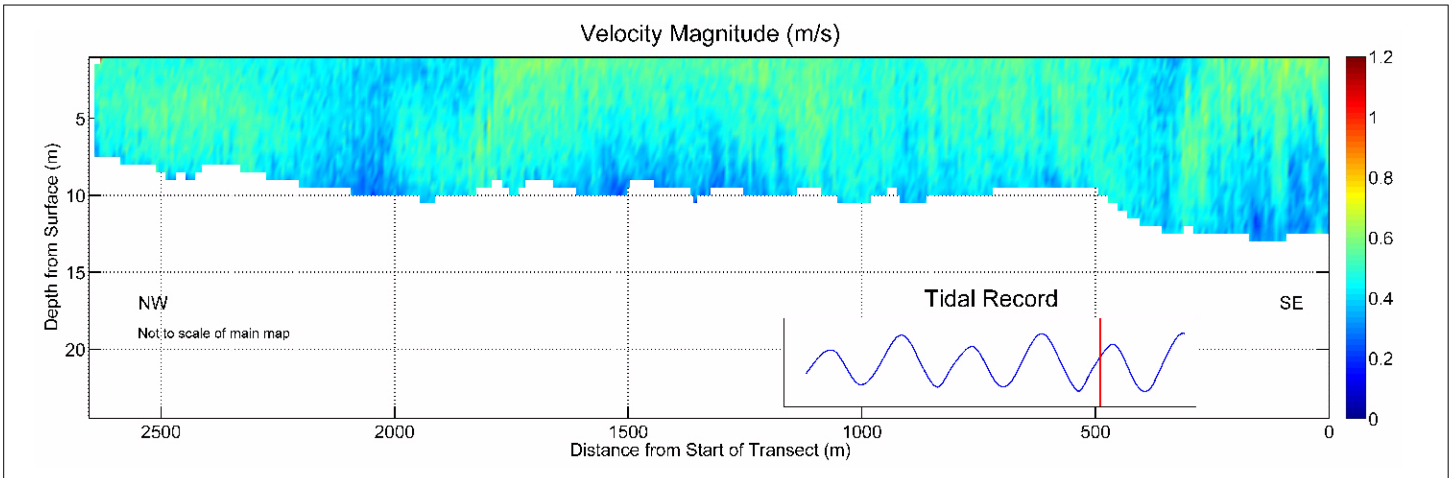

Title:

ADCP Transect 21 - Campaign 1

Figure: 5-42

Rev: B

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Approx. Scale - Main Map

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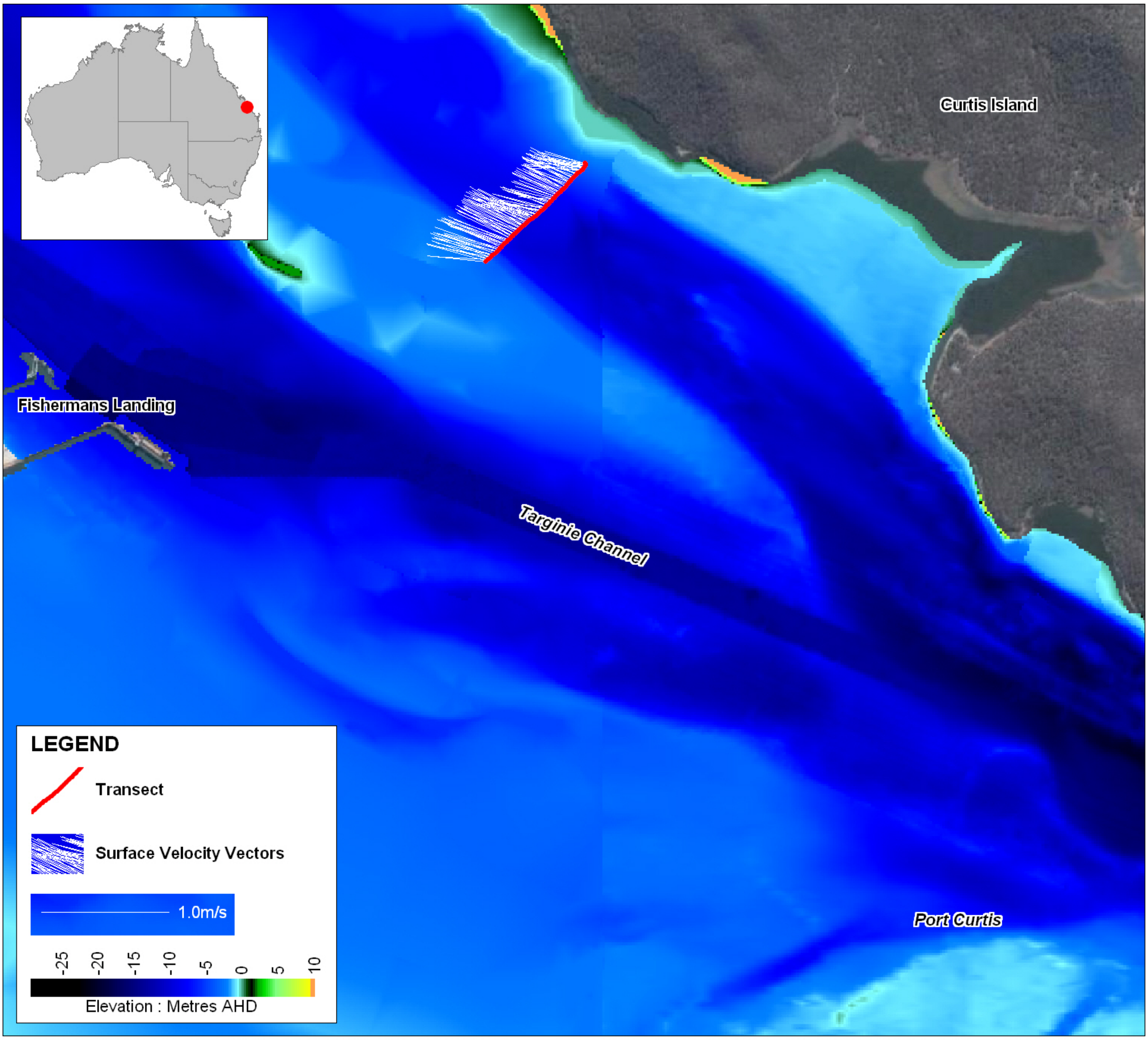

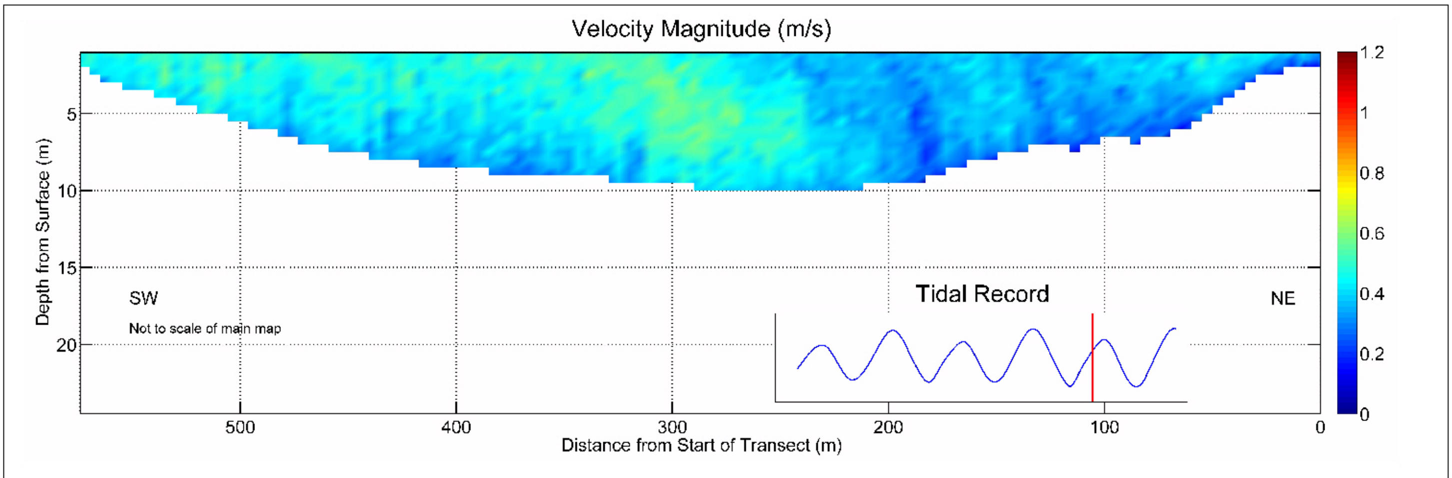

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ADCP Transect 22 - Campaign 1

Figure: **5-43**

Rev: **B**

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Approx. Scale - Main Map

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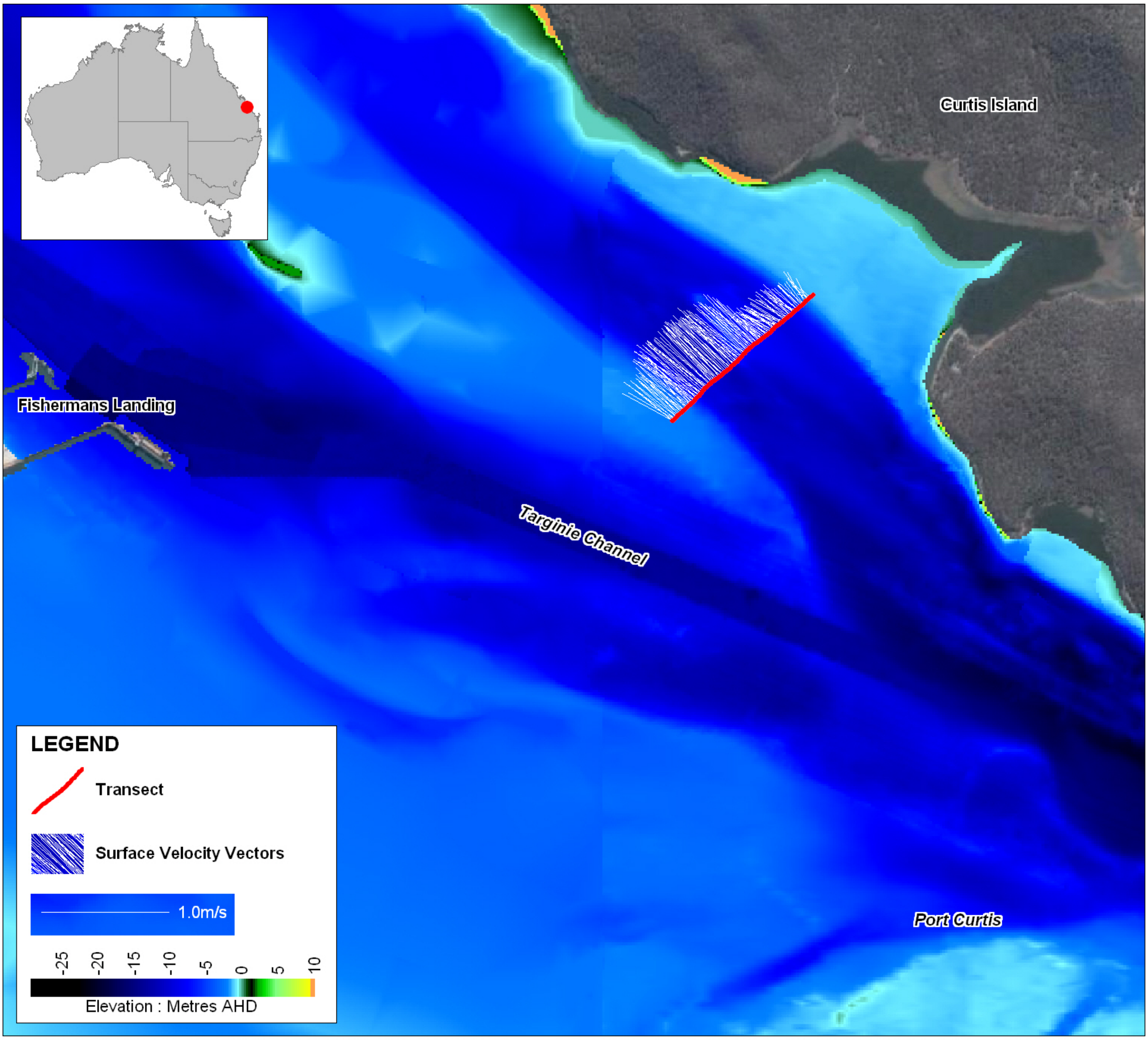
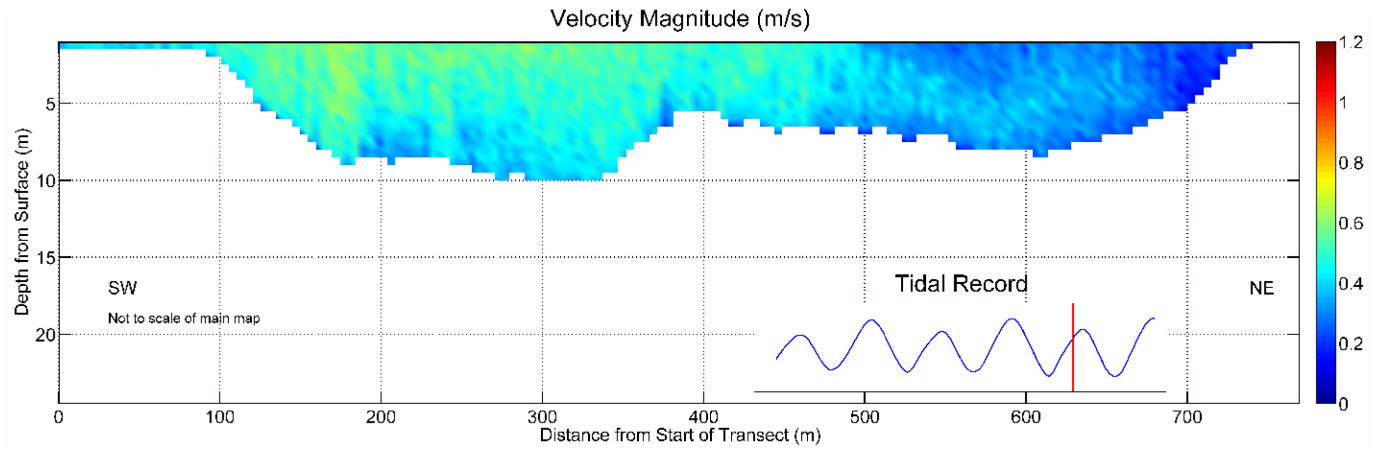




Title:

ADCP Transect 23 - Campaign 1

Figure: 5-44

Rev: B

N

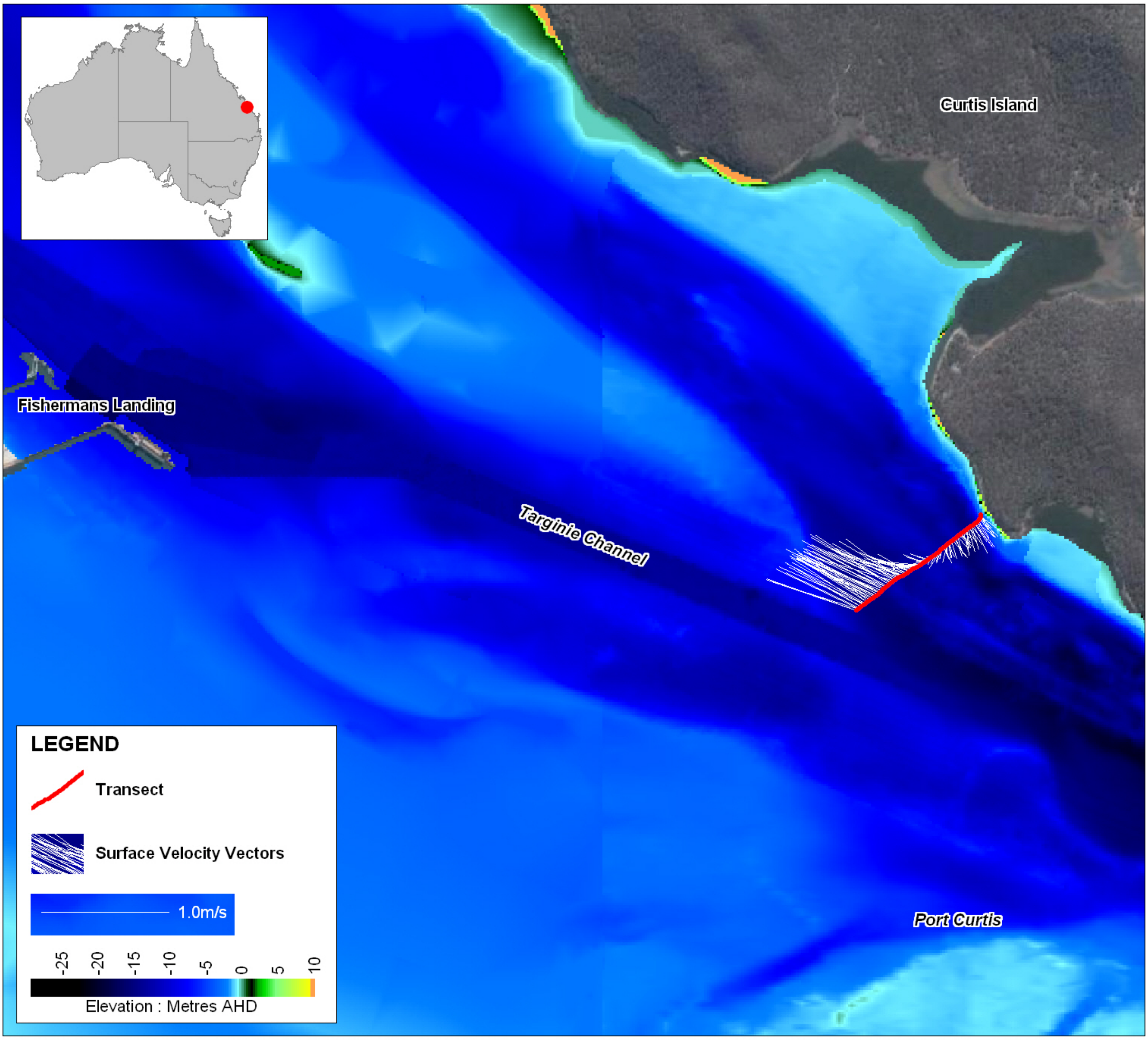
0 0.5 1km

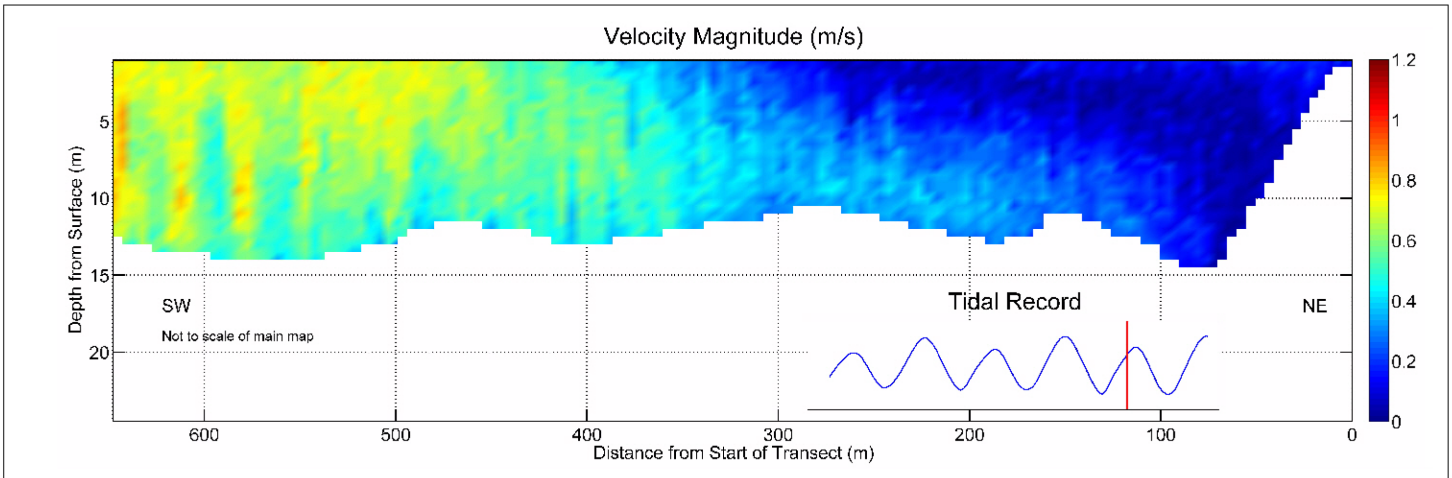
Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_028_080229_5023_Collage.wor





Title:

ADCP Transect 24 - Campaign 1

Figure: **5-45**

Rev: **B**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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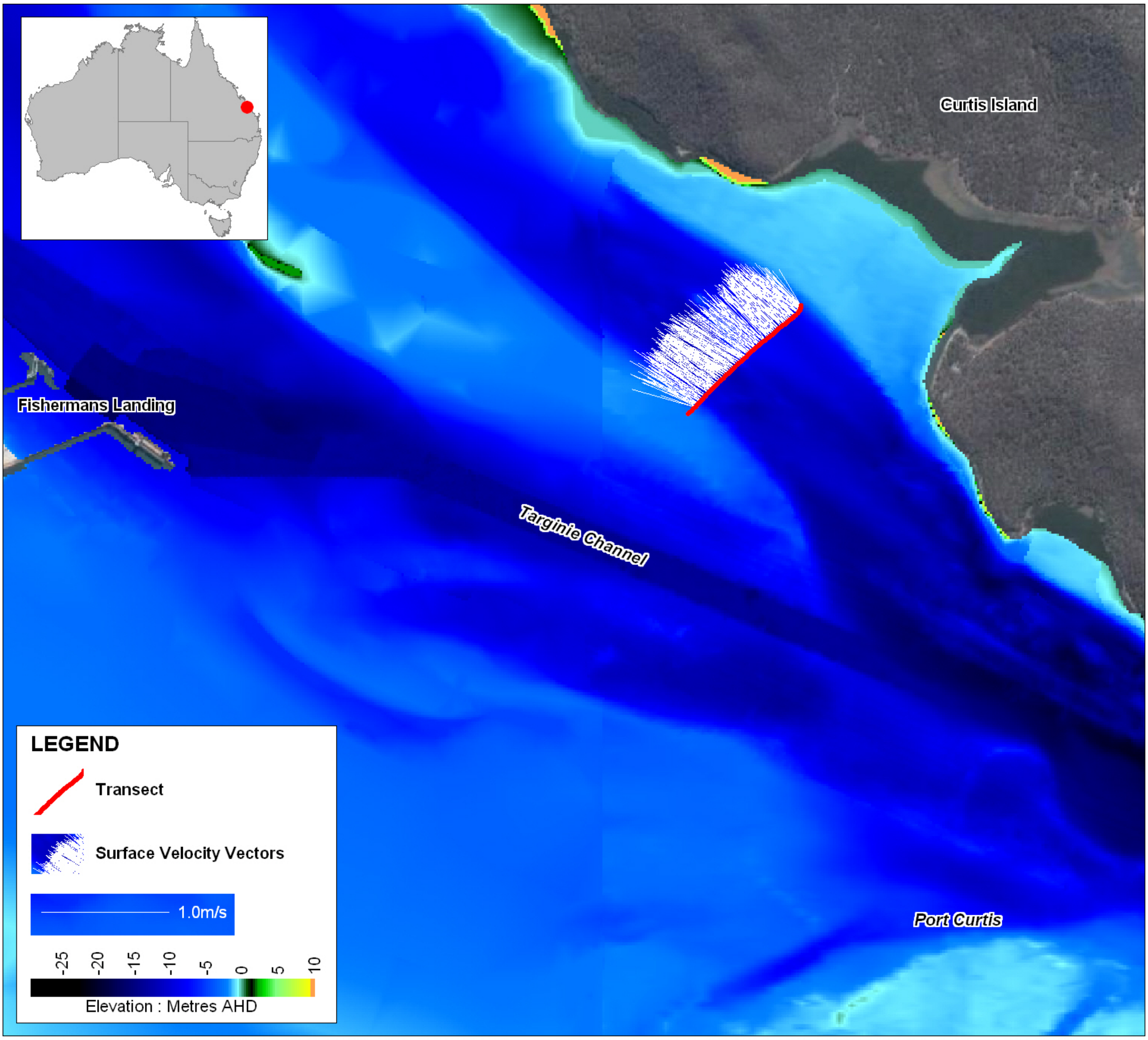
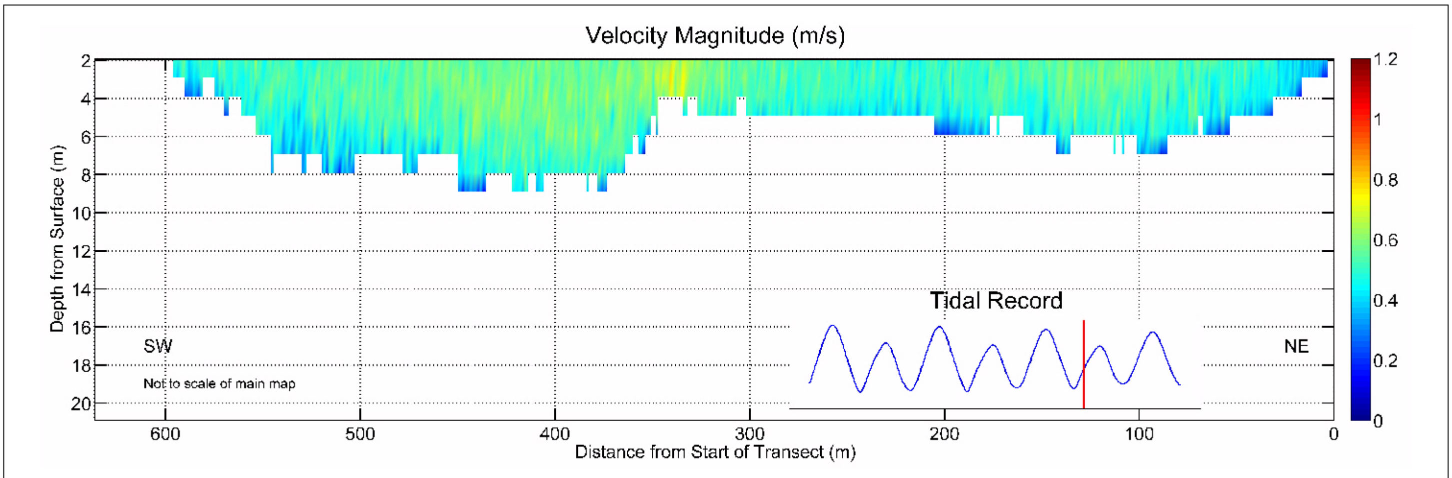




Title:

ADCP Transect 1 - Campaign 2

Figure: **5-46**

Rev: **A**

N

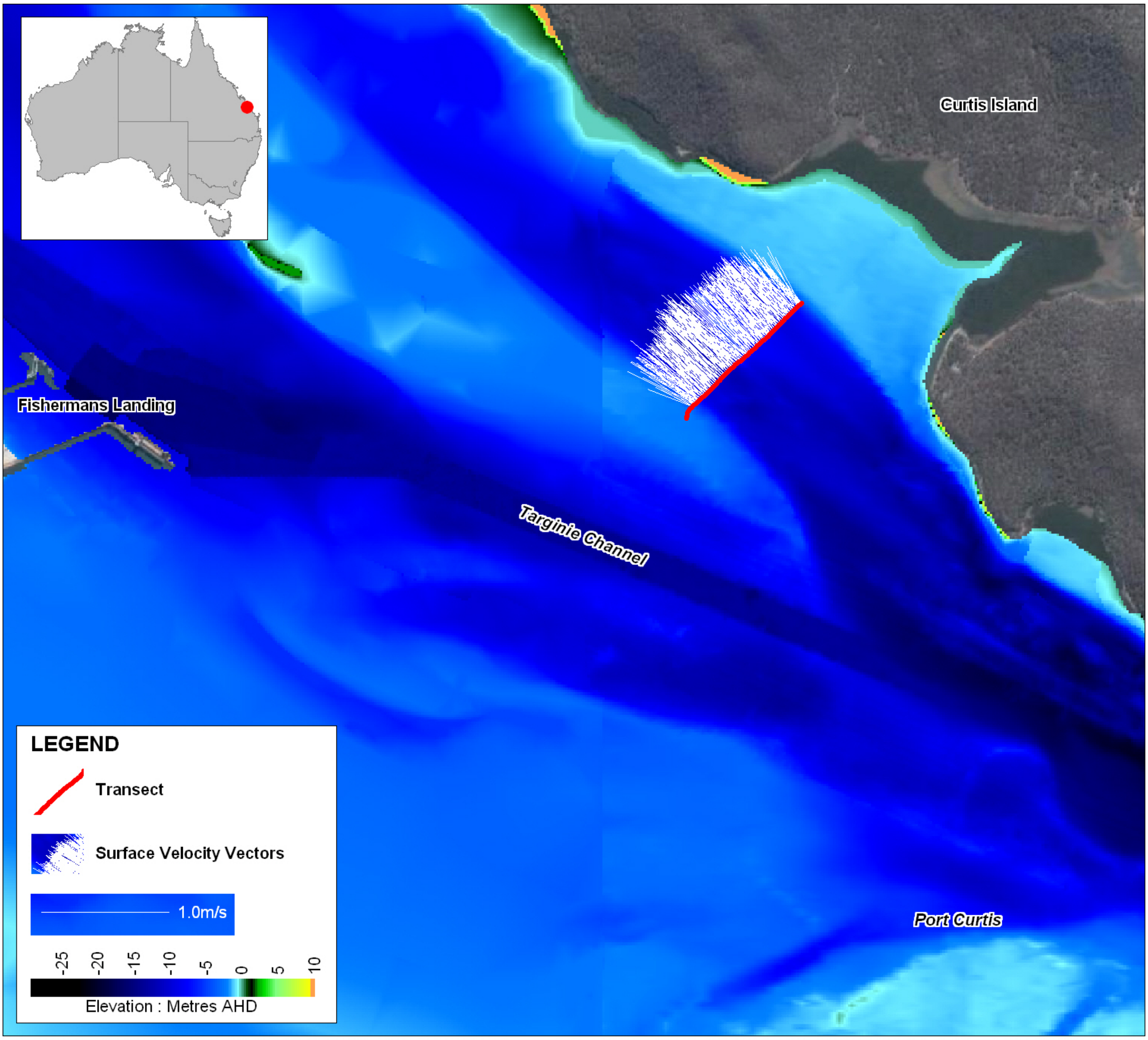
0 0.5 1km

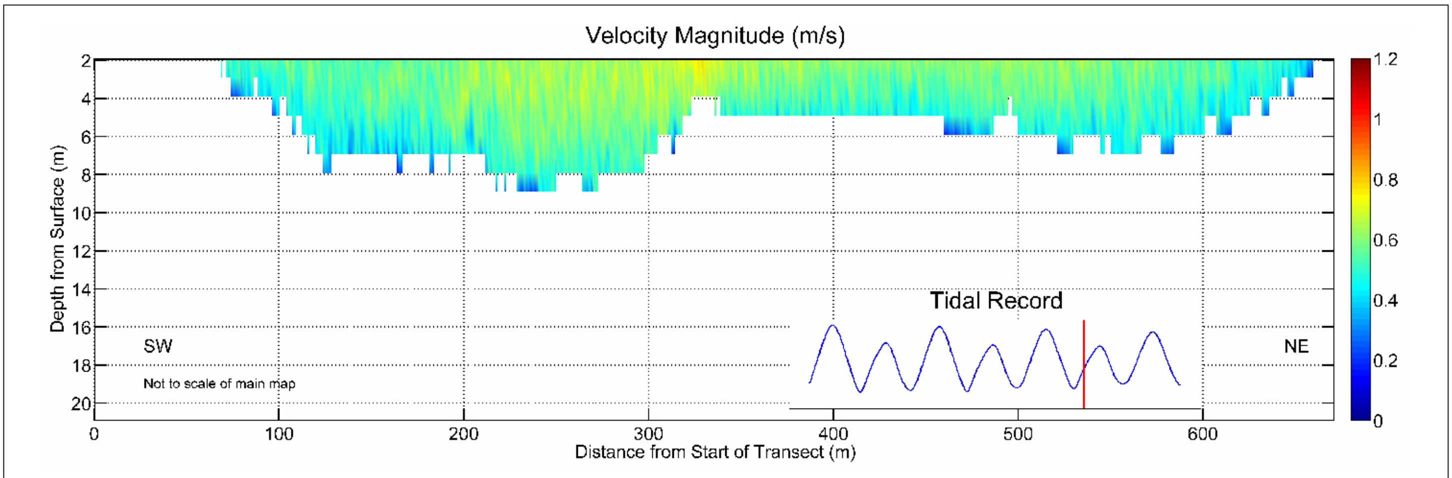
Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_035_080630_5047_Collage.wor





Title:

ADCP Transect 2 - Campaign 2

Figure: **5-47**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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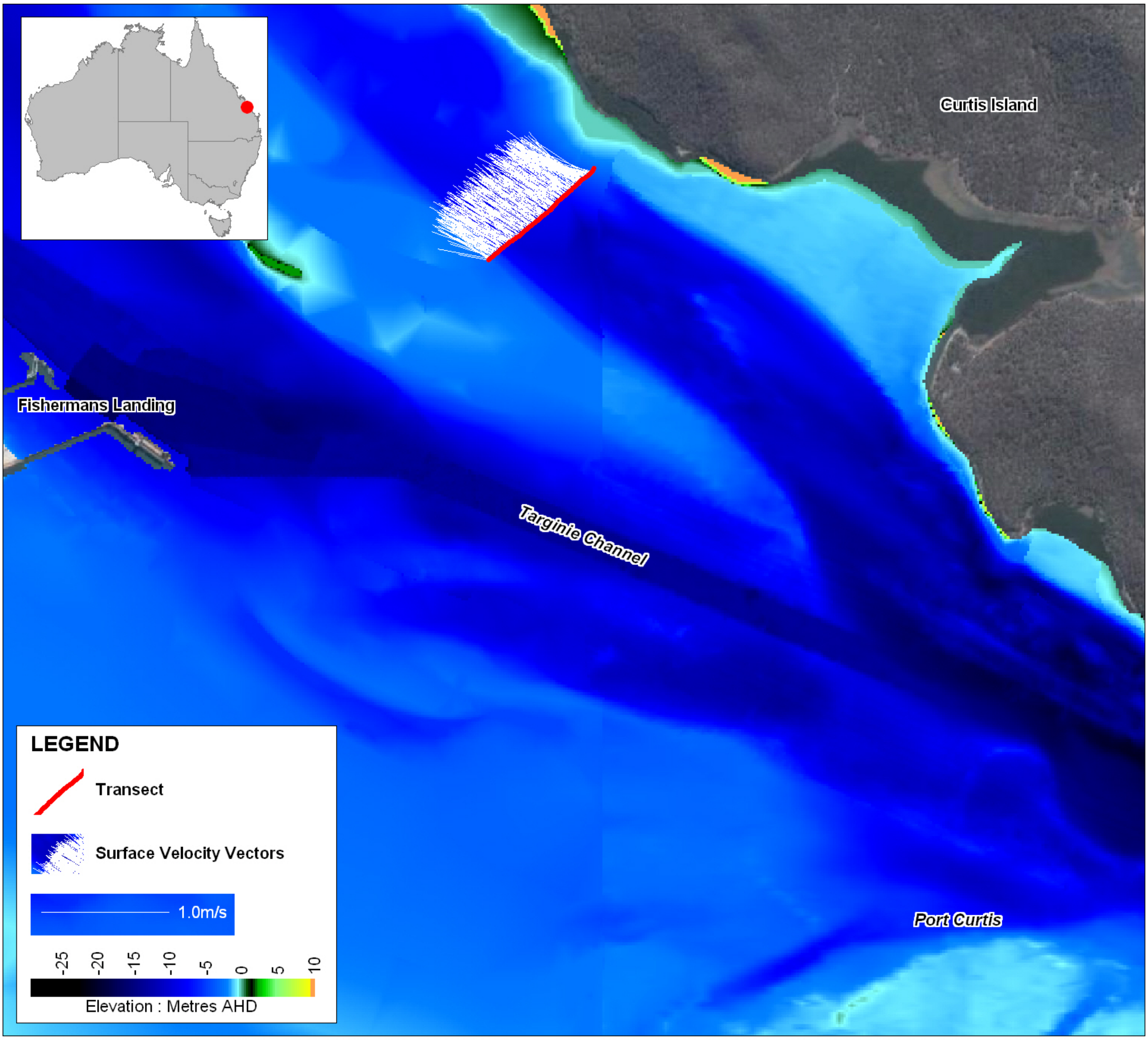

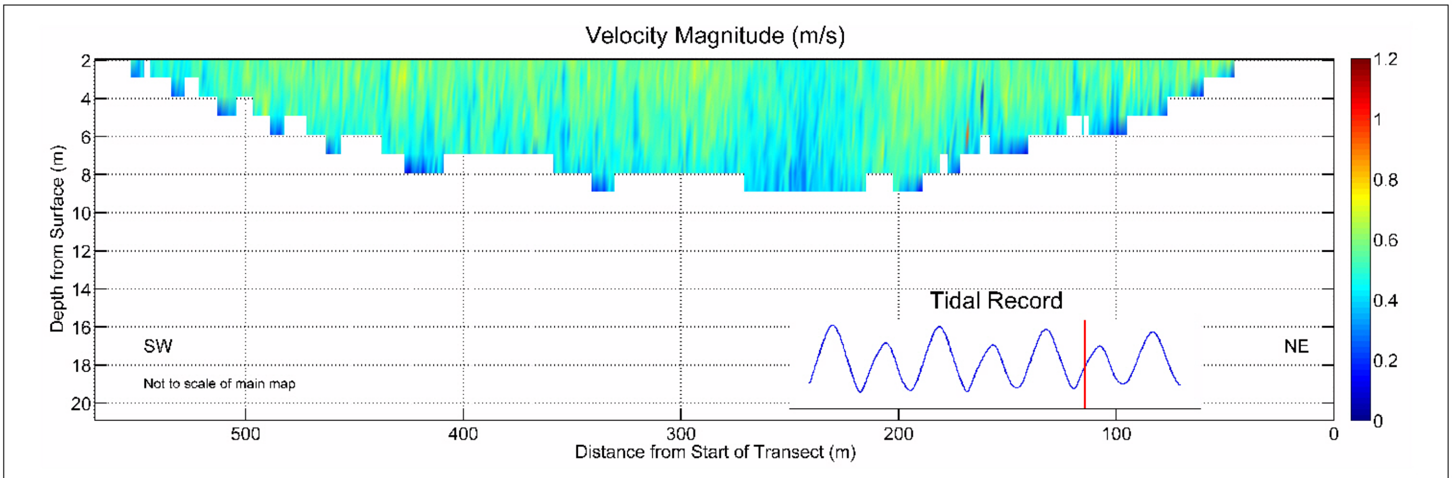

Title:

ADCP Transect 3 - Campaign 2

Figure: **5-48**

Rev: **A**

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N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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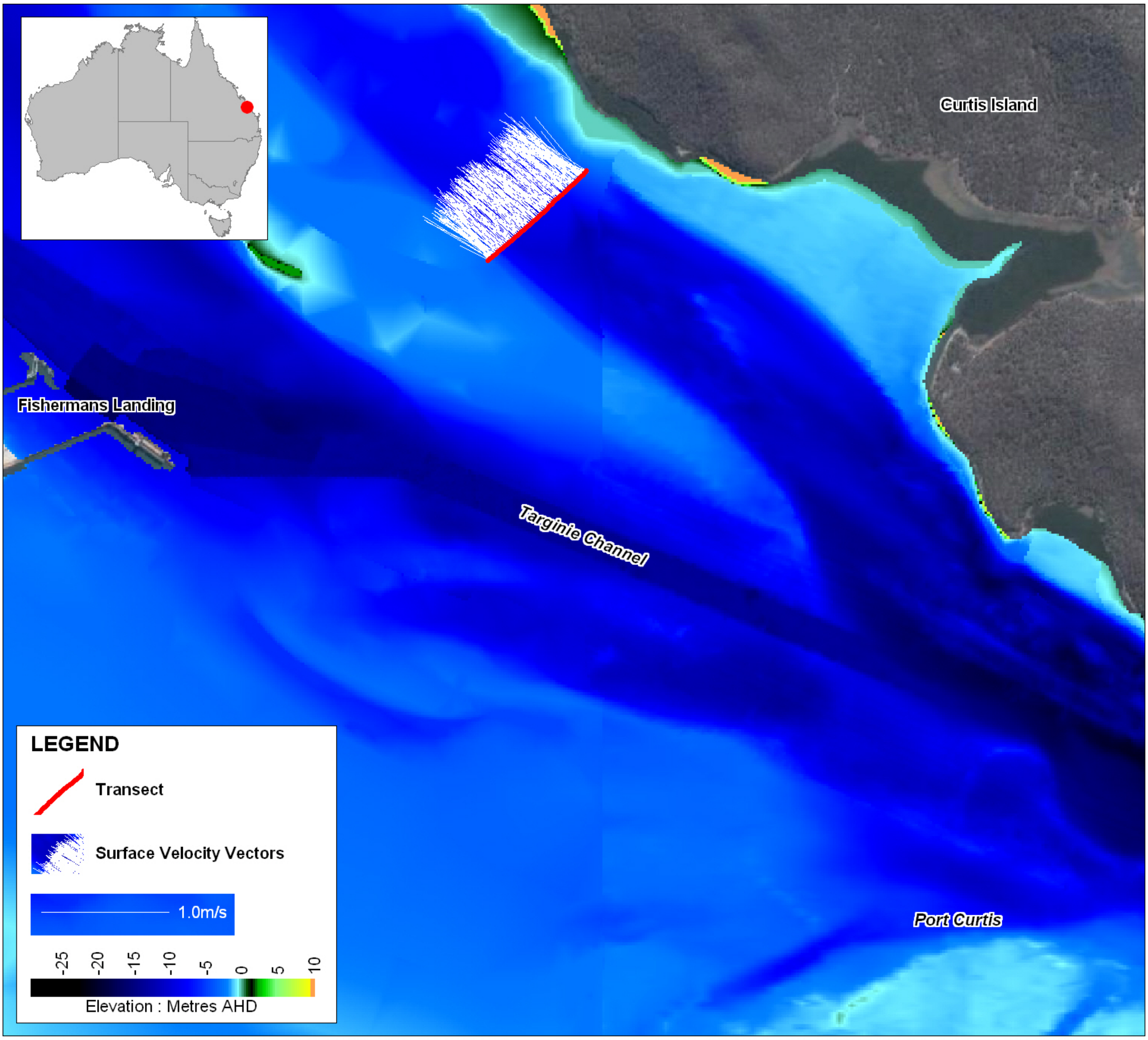
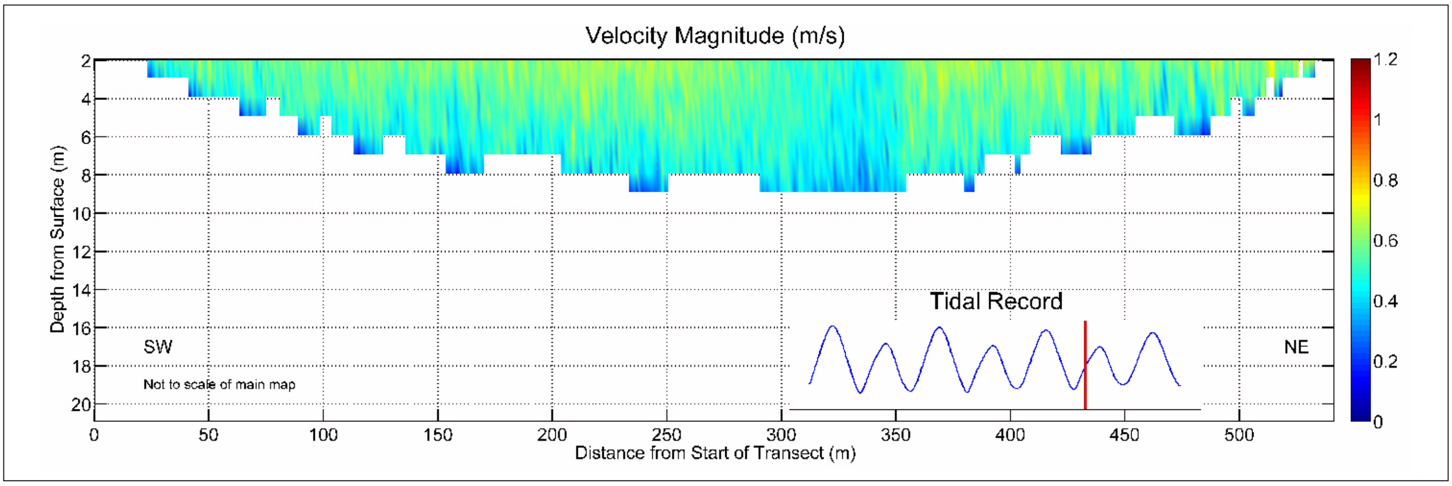
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_037_080630_5049_Collage.wor





Title:

ADCP Transect 4 - Campaign 2

Figure: **5-49**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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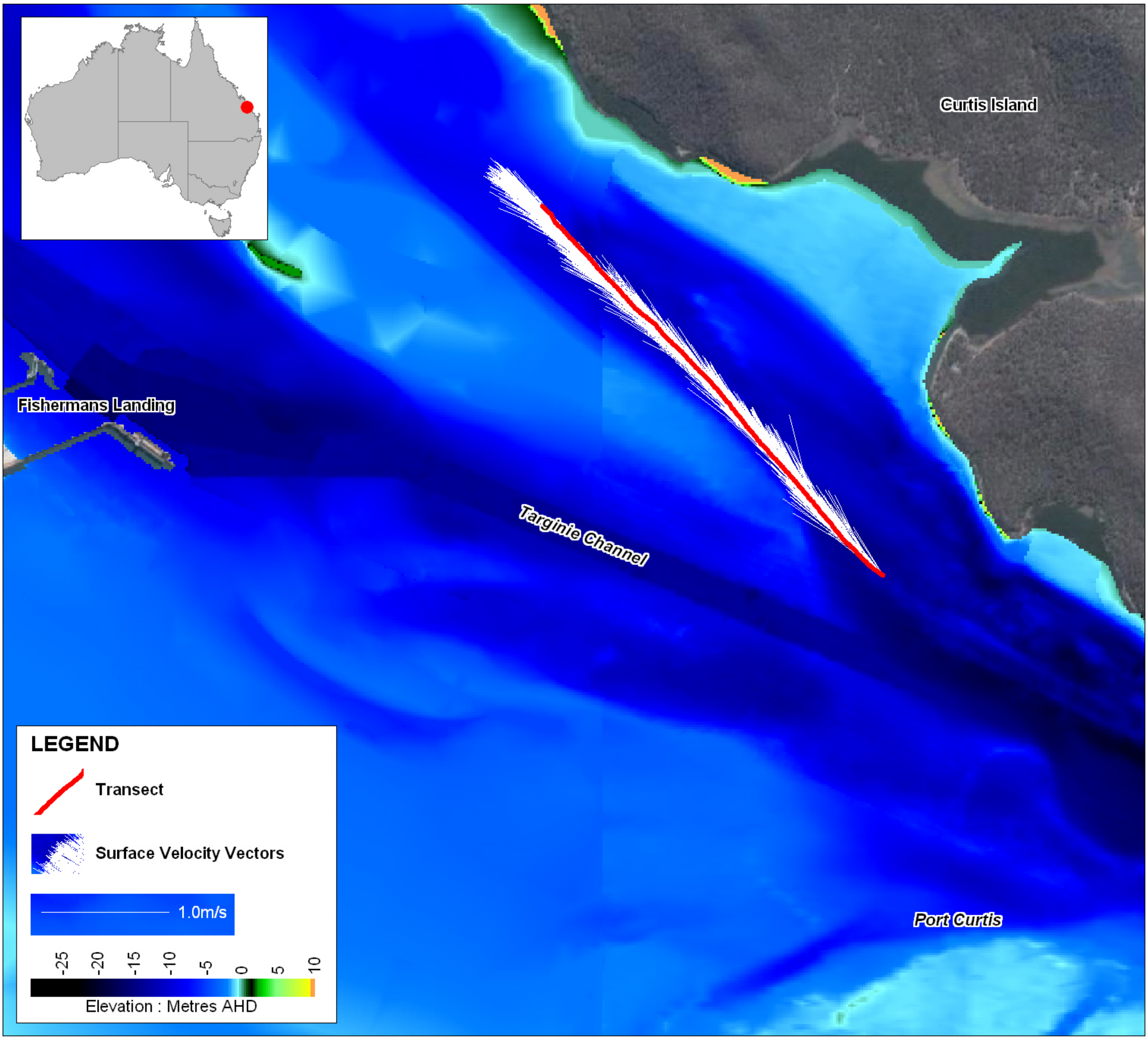

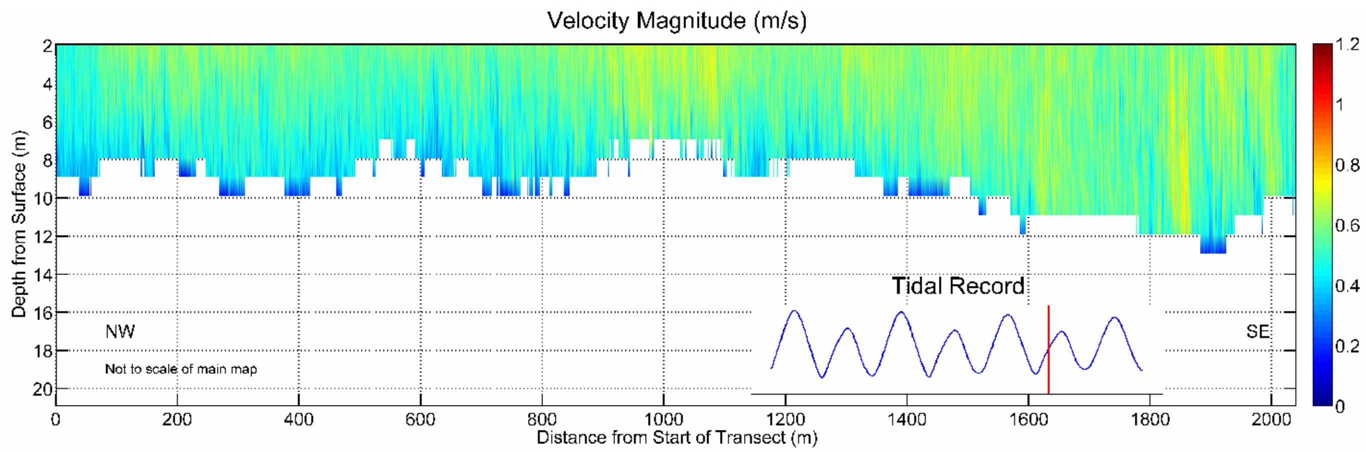

Title:

ADCP Transect 5 - Campaign 2

Figure: **5-50**

Rev: **A**

N

0 0.5 1km
Approx. Scale - Main Map

BMT WBM
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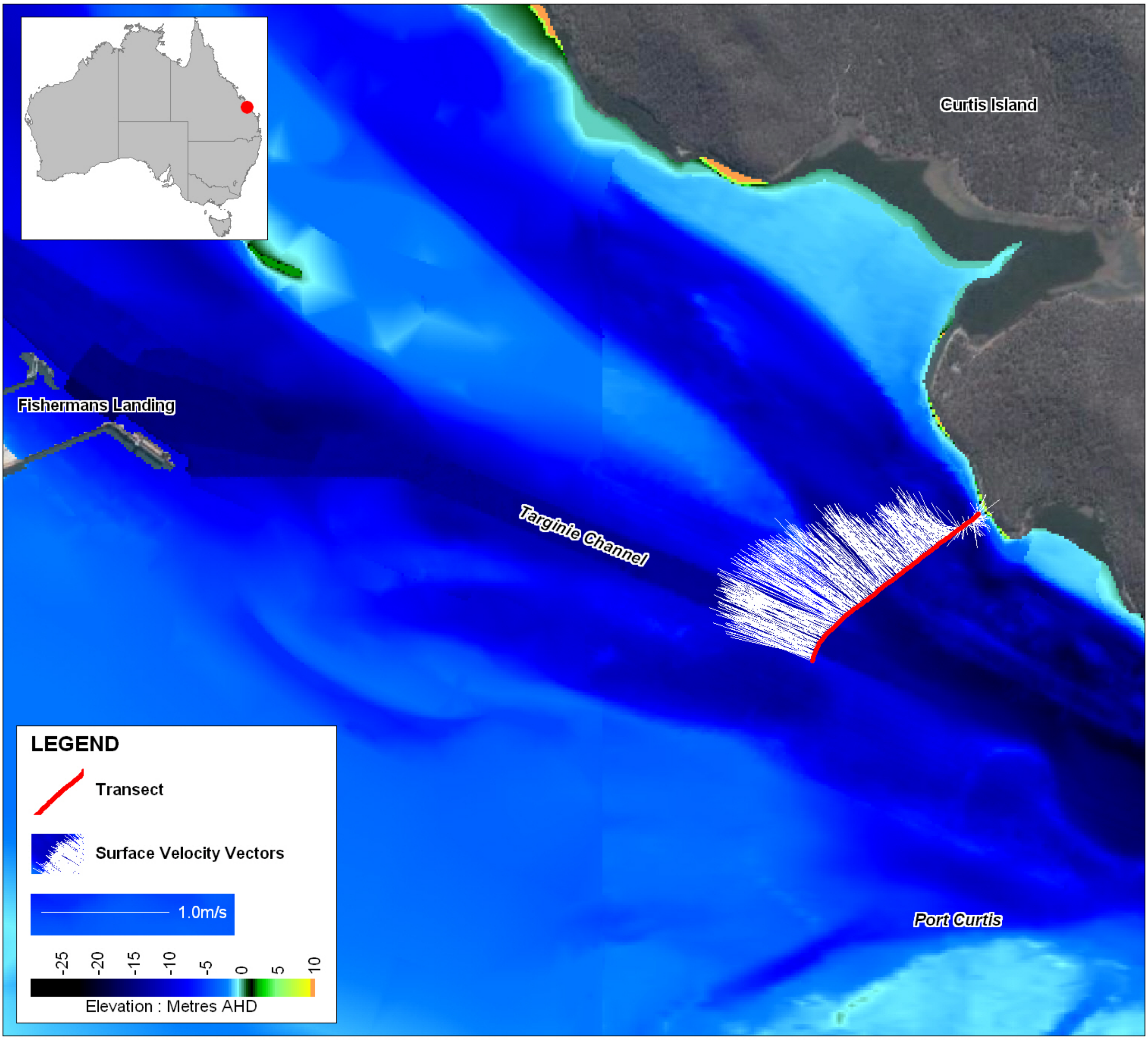
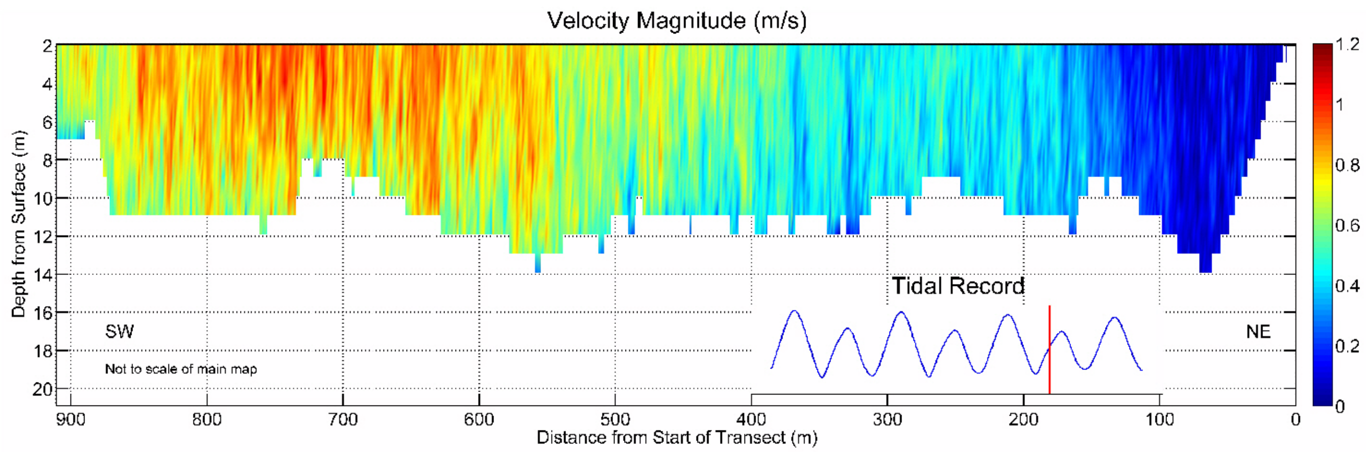
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_039_080630_5051_Collage.wor





Title:

ADCP Transect 6 - Campaign 2

Figure: 5-51

Rev: A

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N

0 0.5 1km
Approx. Scale - Main Map

BMT WBM
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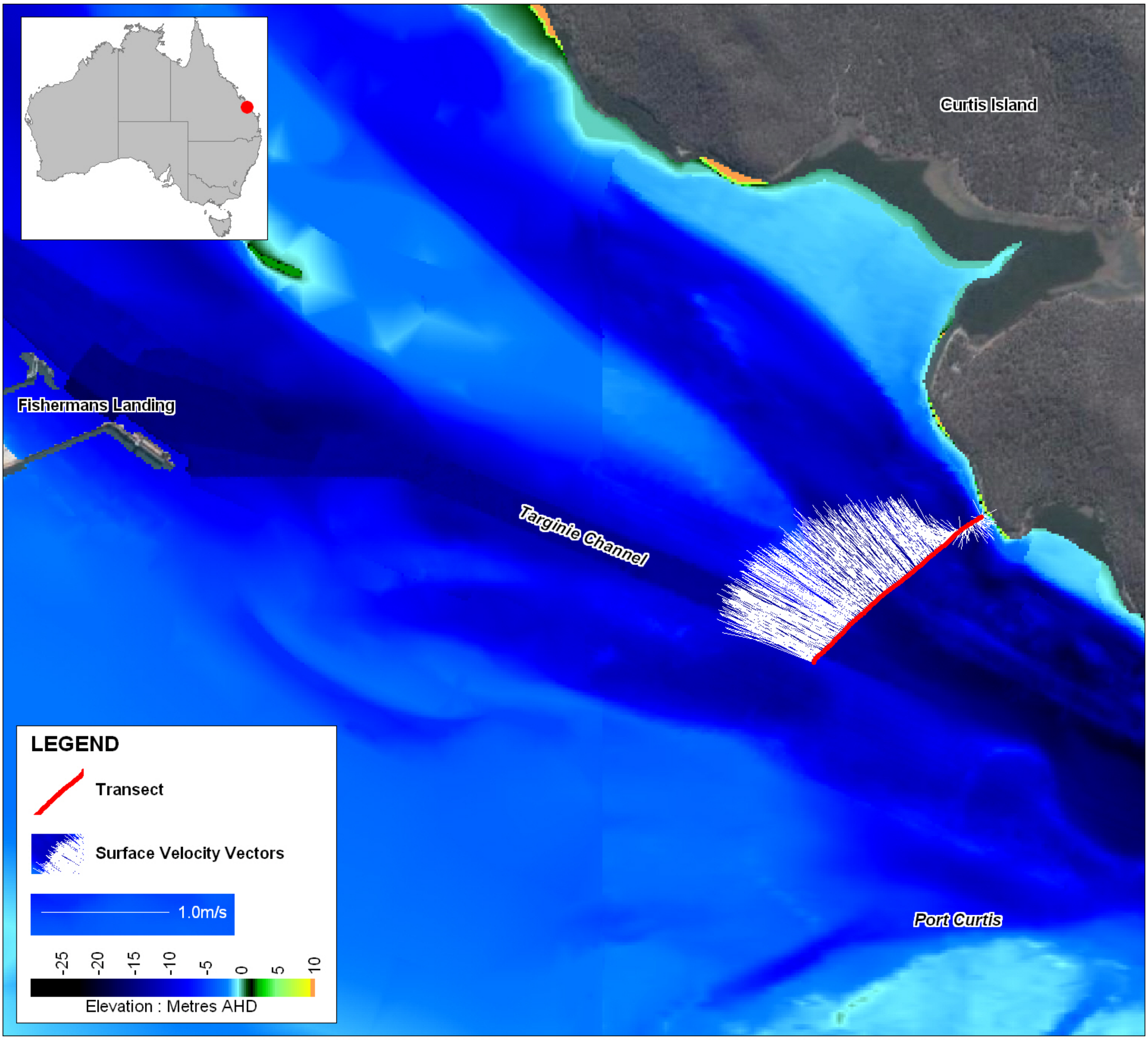
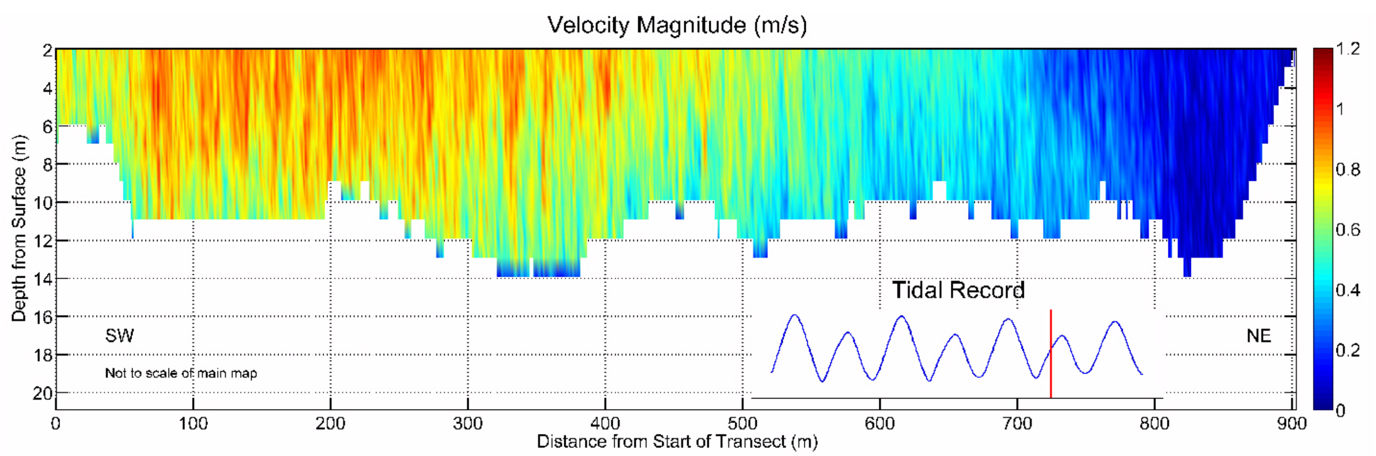
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_040_080630_5052_Collage.wor





Title:

ADCP Transect 7 - Campaign 2

Figure: **5-52**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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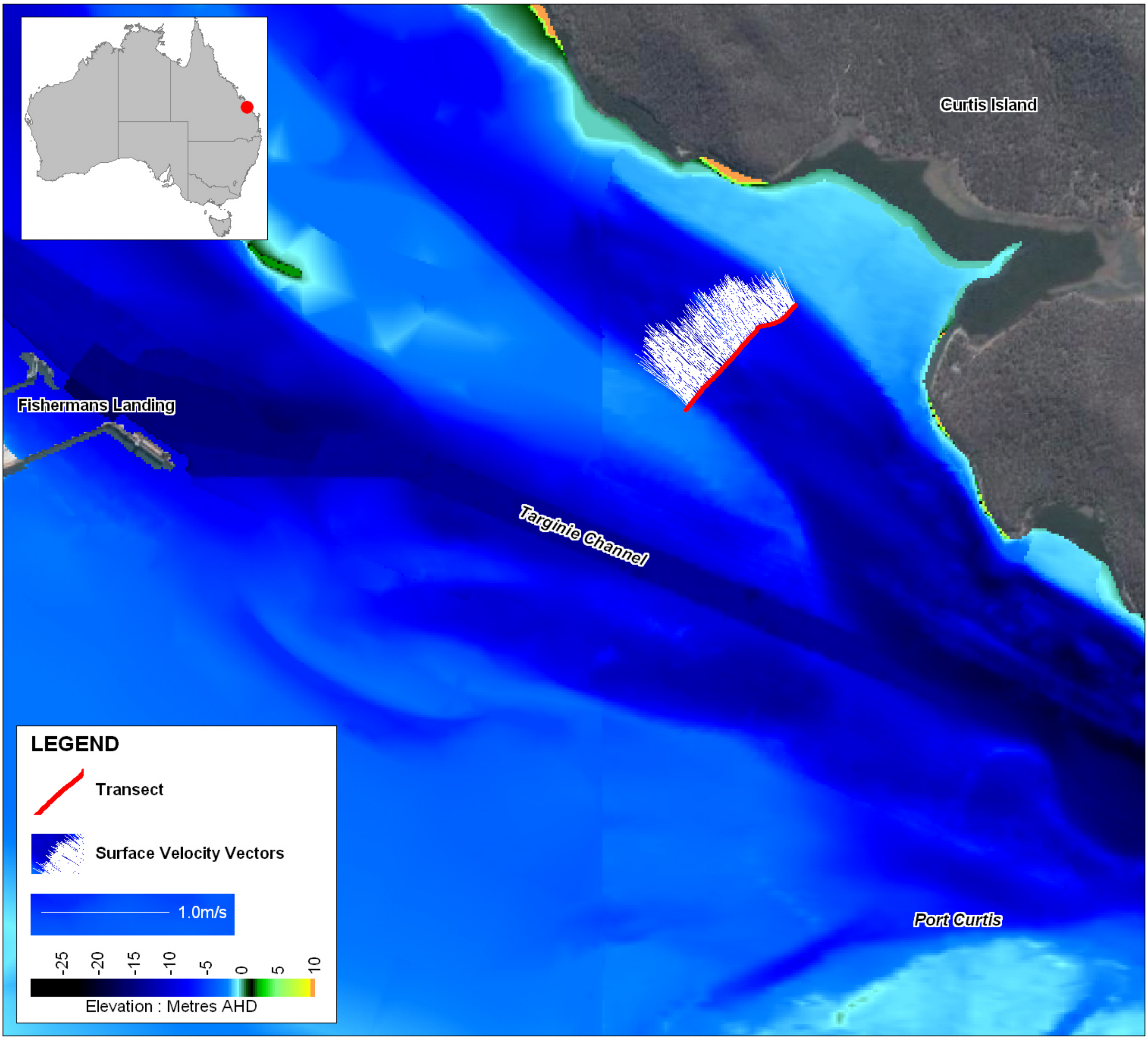
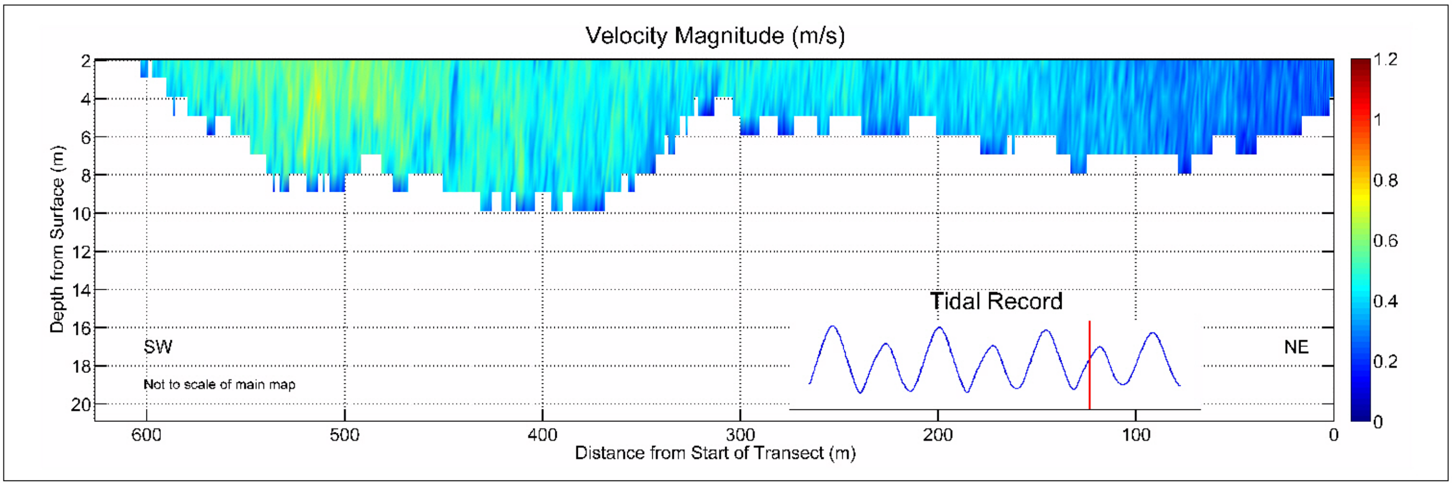
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_041_080630_5053_Collage.wor





Title:

ADCP Transect 8 - Campaign 2

Figure:

5-53

Rev:

A

N

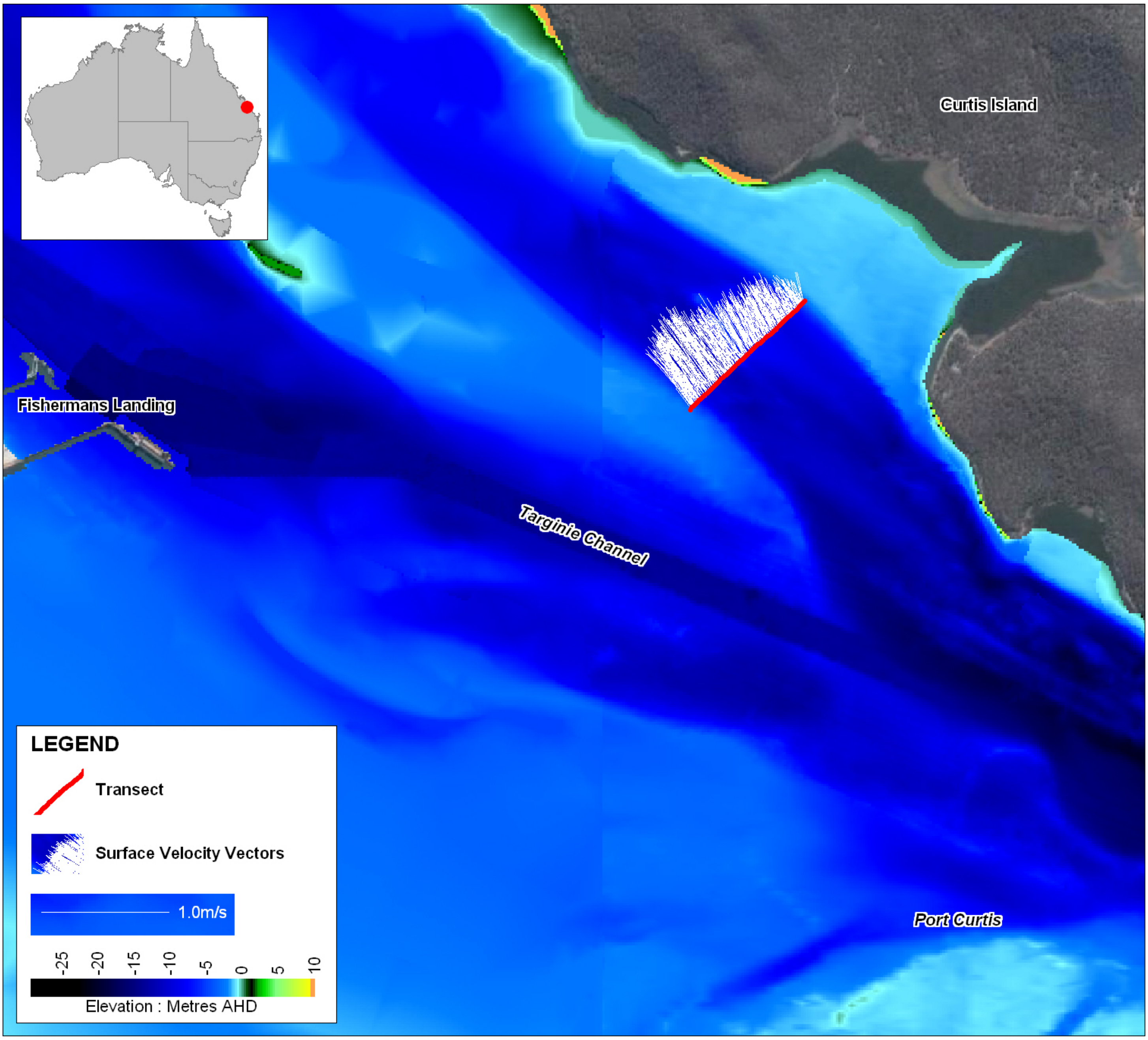
0 0.5 1km

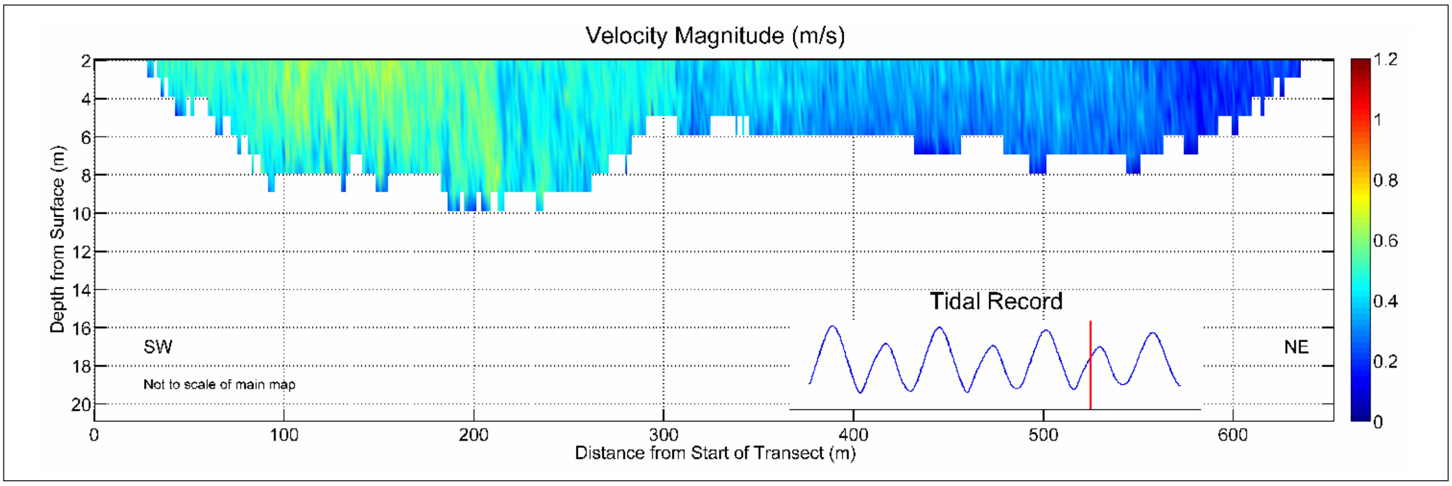
Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_042_080630_5055_Collage.wor





Title:

ADCP Transect 9 - Campaign 2

Figure: 5-54

Rev: A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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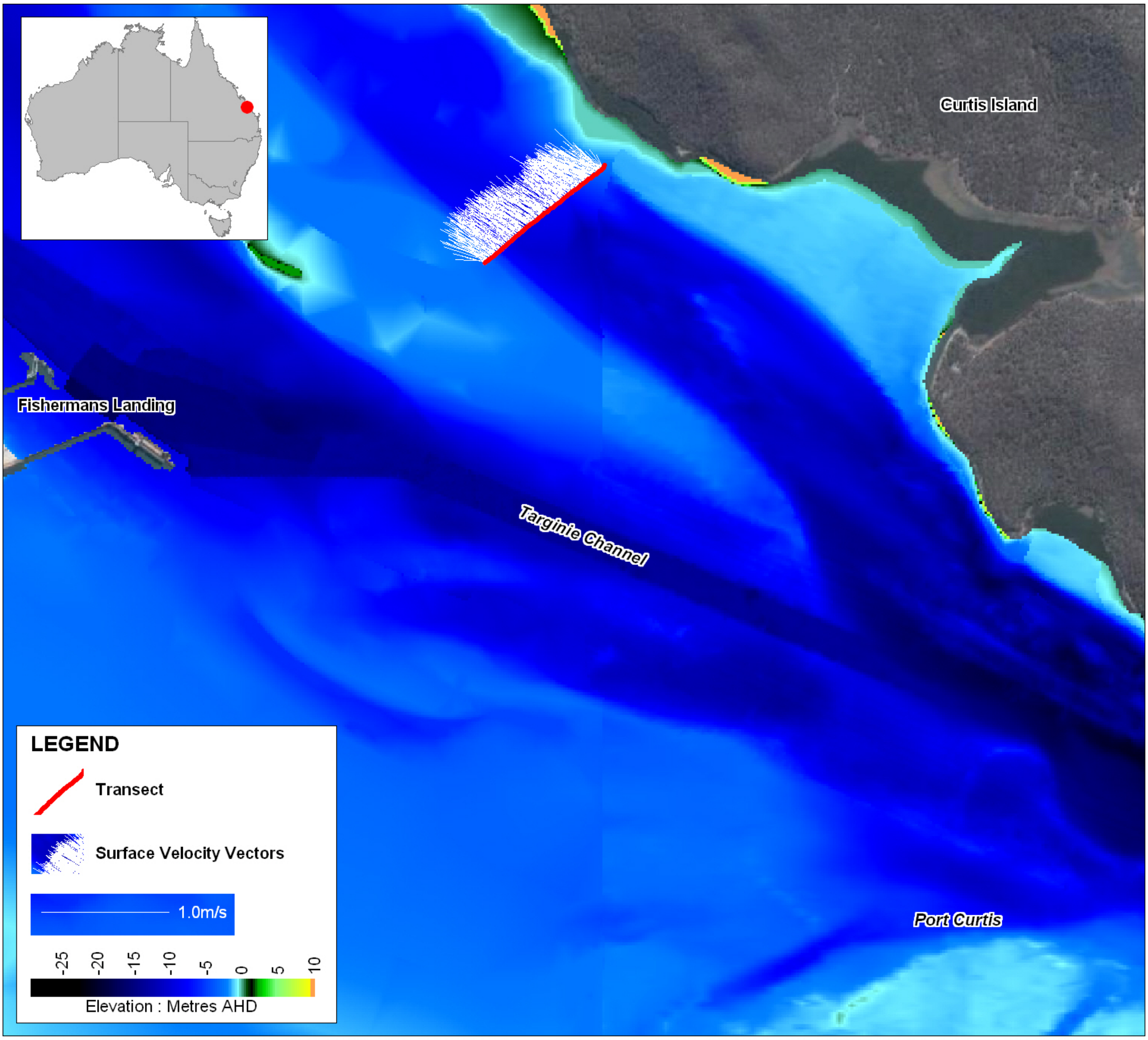
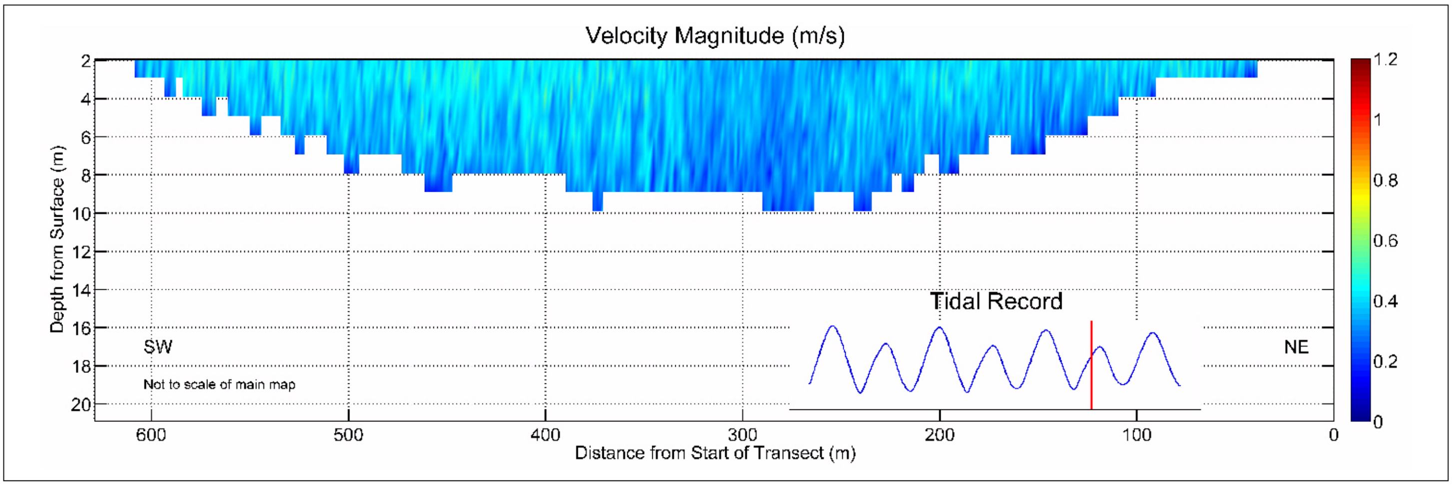
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_043_080630_5056_Collage.wor





Title:

ADCP Transect 10 - Campaign 2

Figure: **5-55**

Rev: **A**

N

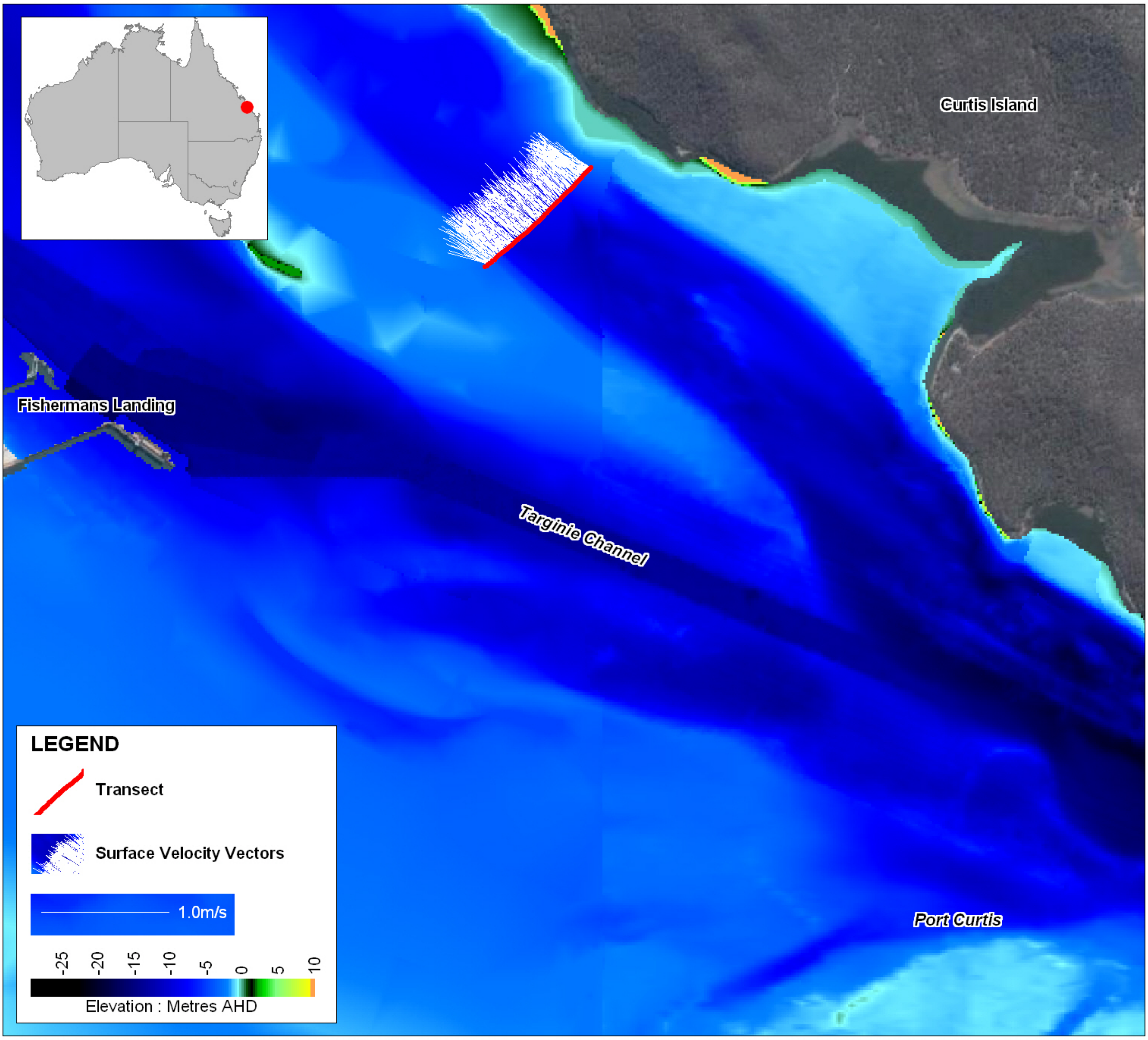
0 0.5 1km

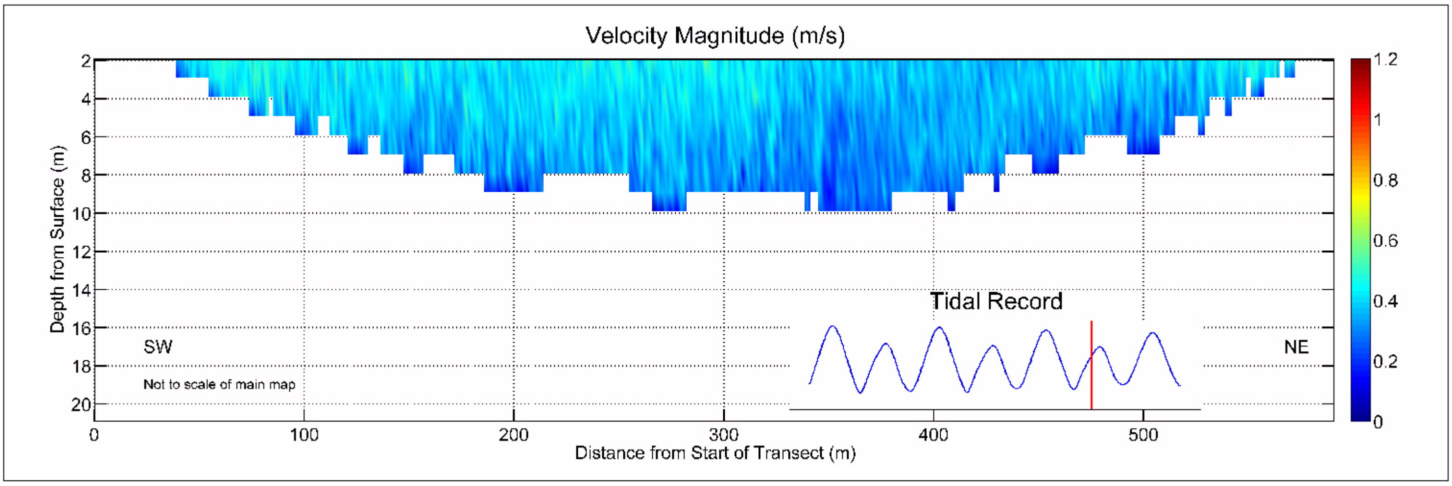
Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_044_080701_5057_Collage.wor





Title:

ADCP Transect 11 - Campaign 2

Figure: **5-56**

Rev: **A**

N

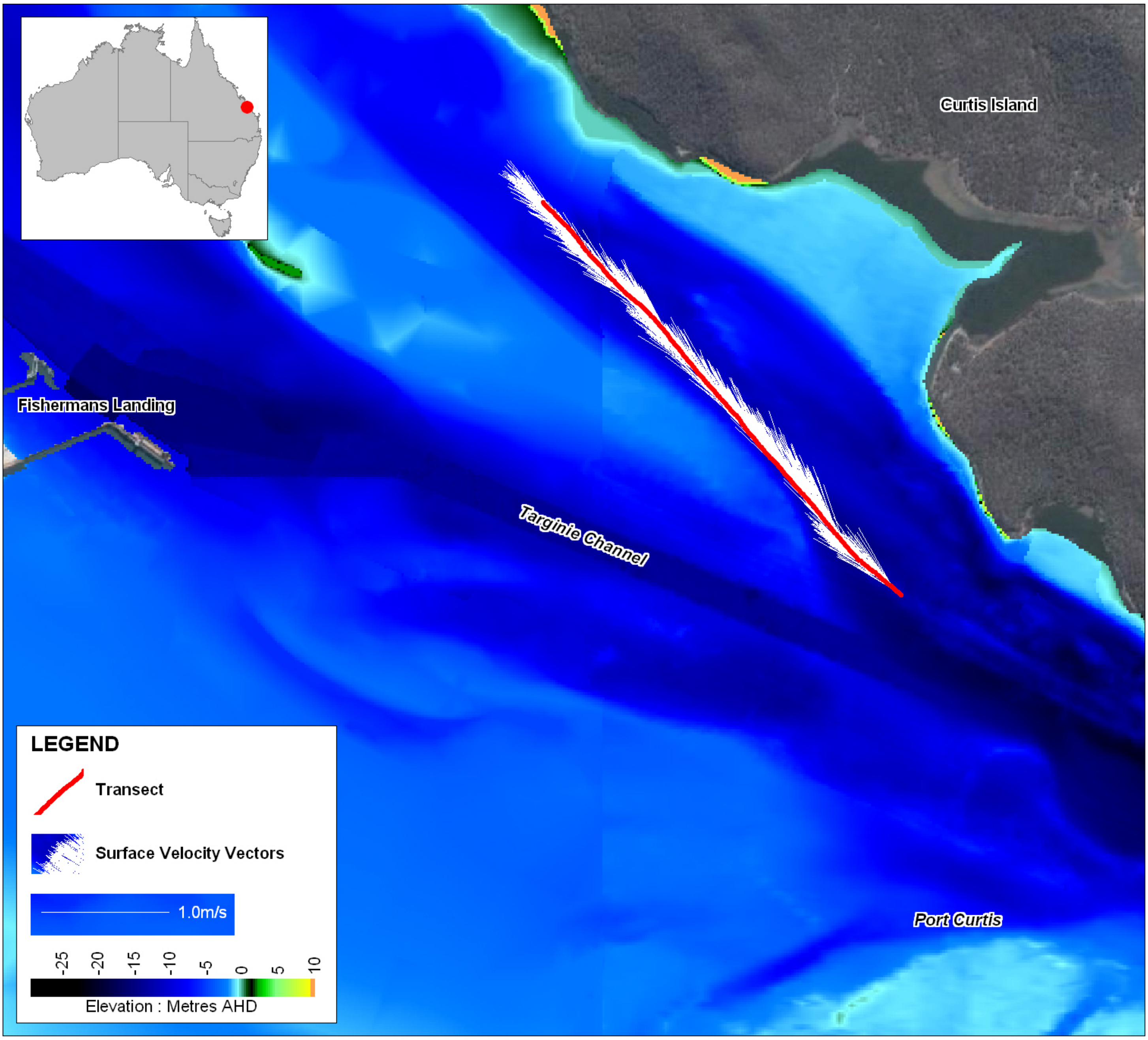
0 0.5 1km

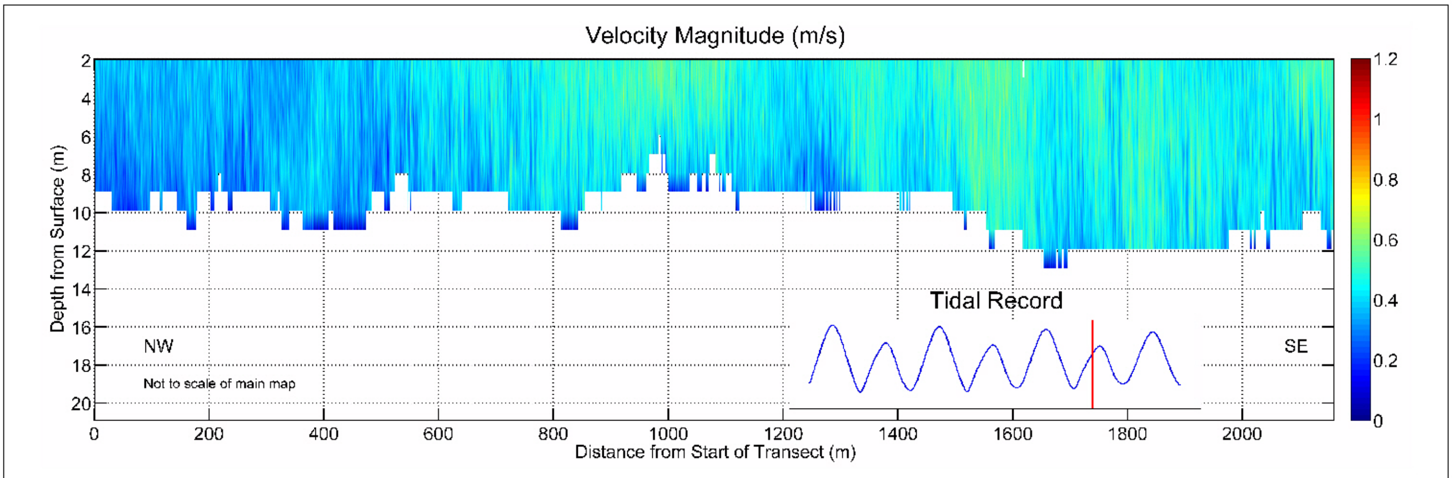
Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_045_080701_5058_Collage.wor





Title:

ADCP Transect 12 - Campaign 2

Figure: **5-57**

Rev: **A**

N

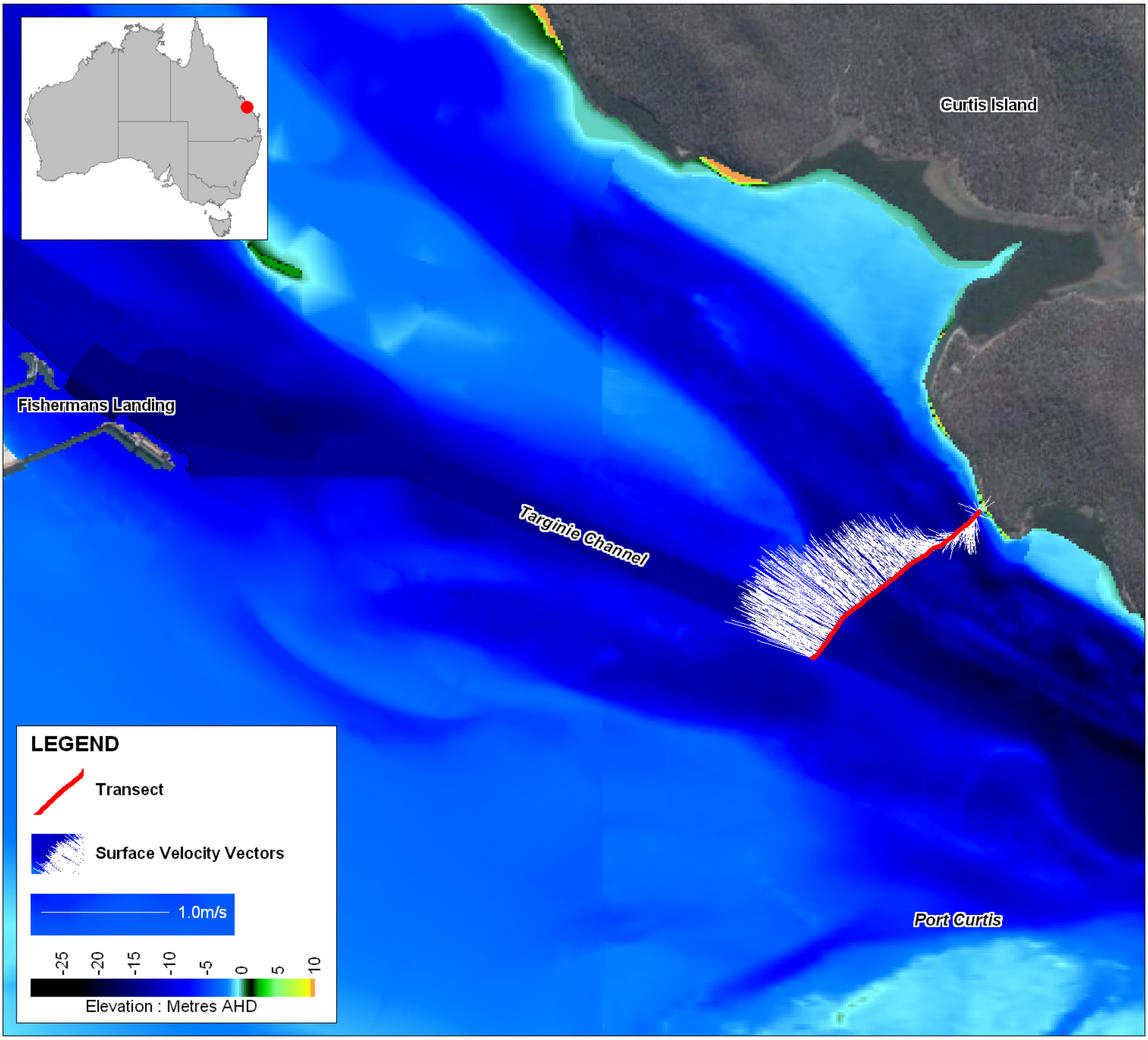
0 0.5 1km

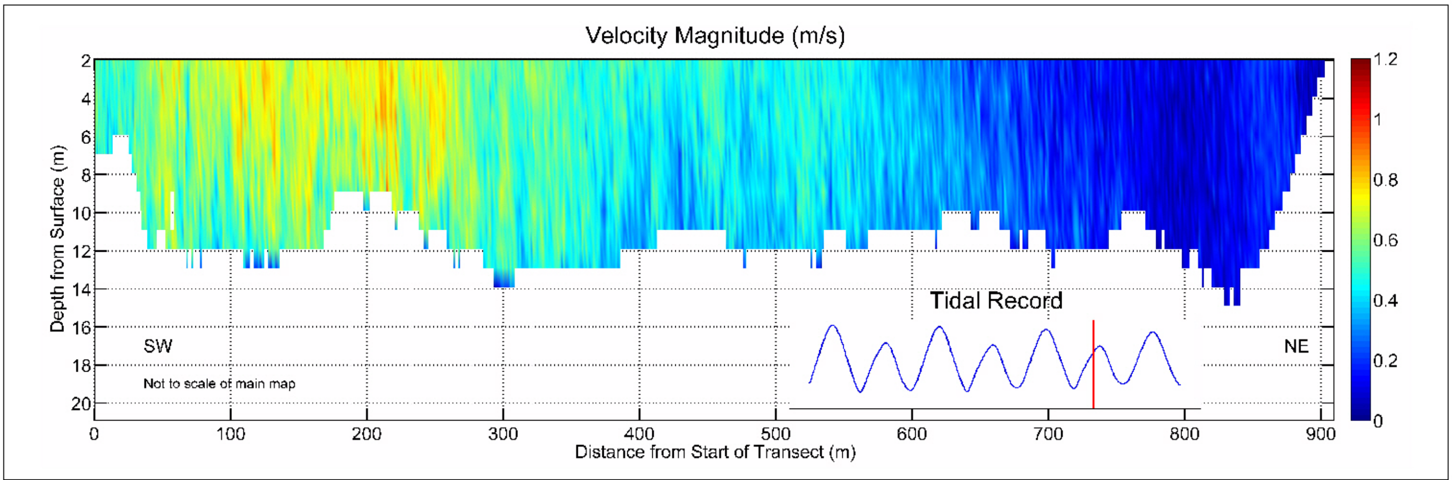
Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_046_080701_5059_Collage.wor





Title:

ADCP Transect 13 - Campaign 2

Figure:

5-58

Rev:

A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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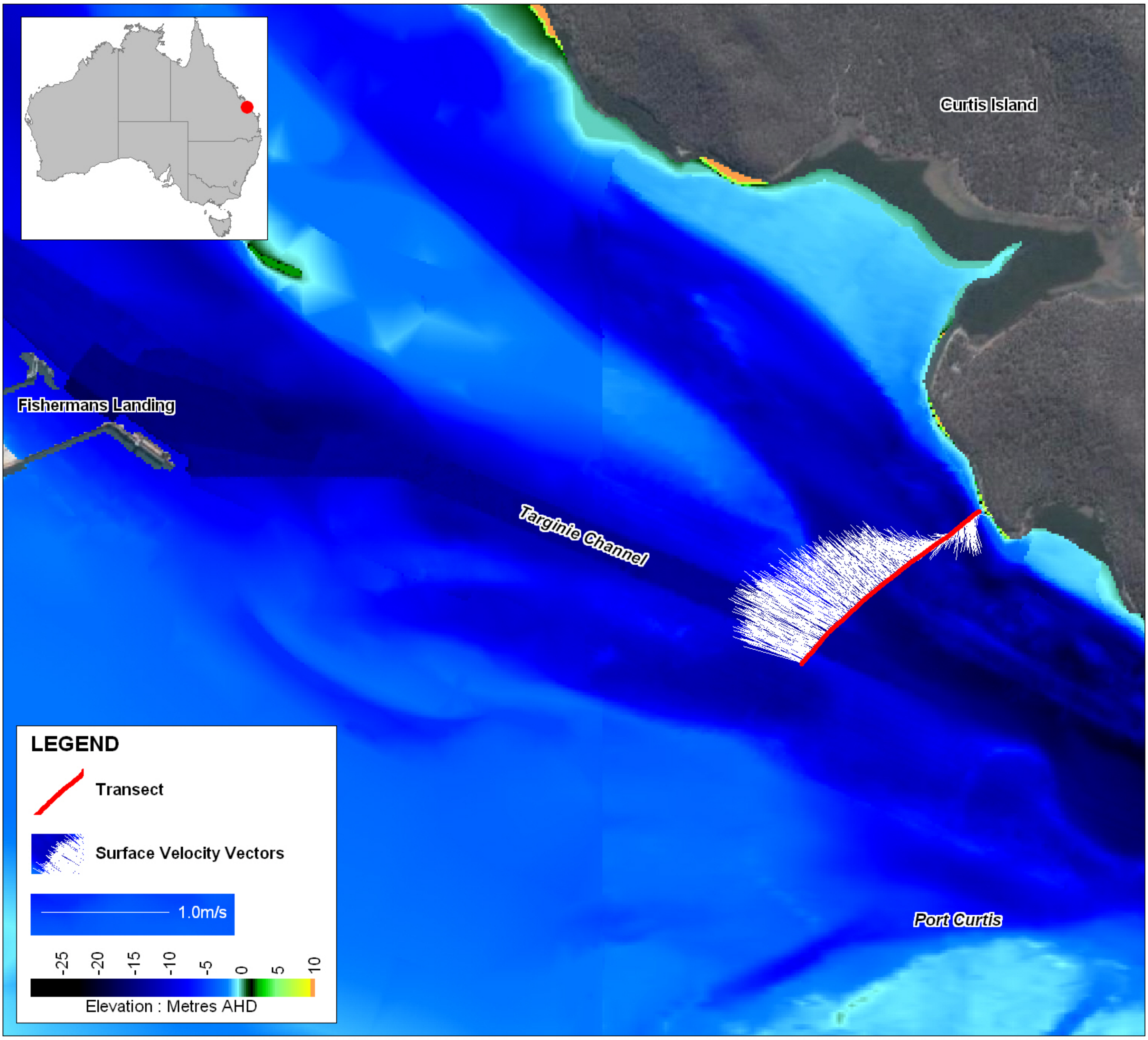

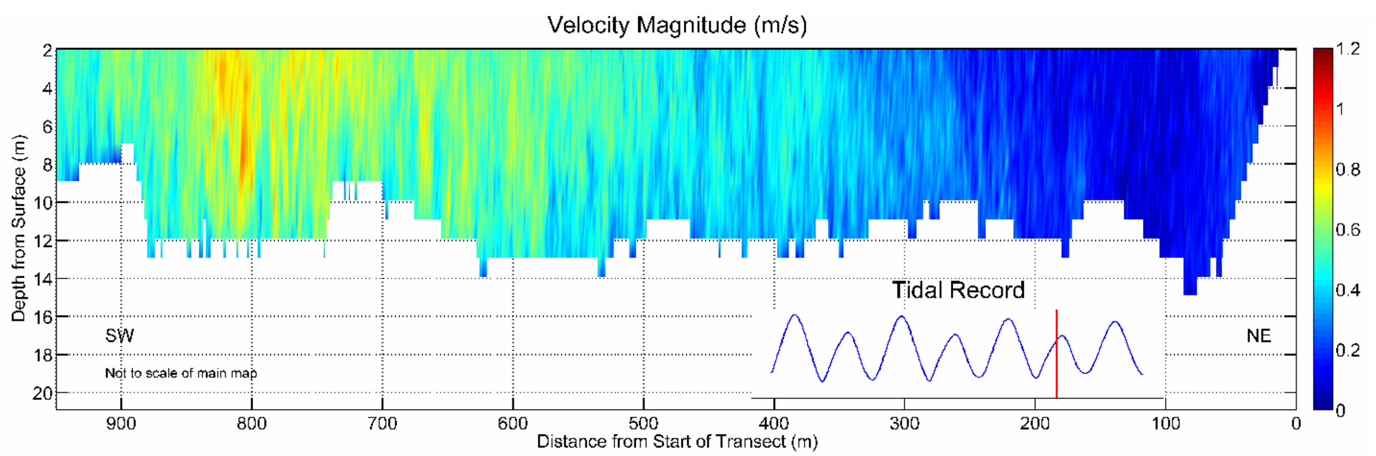

Title:

ADCP Transect 14 - Campaign 2

Figure: **5-59**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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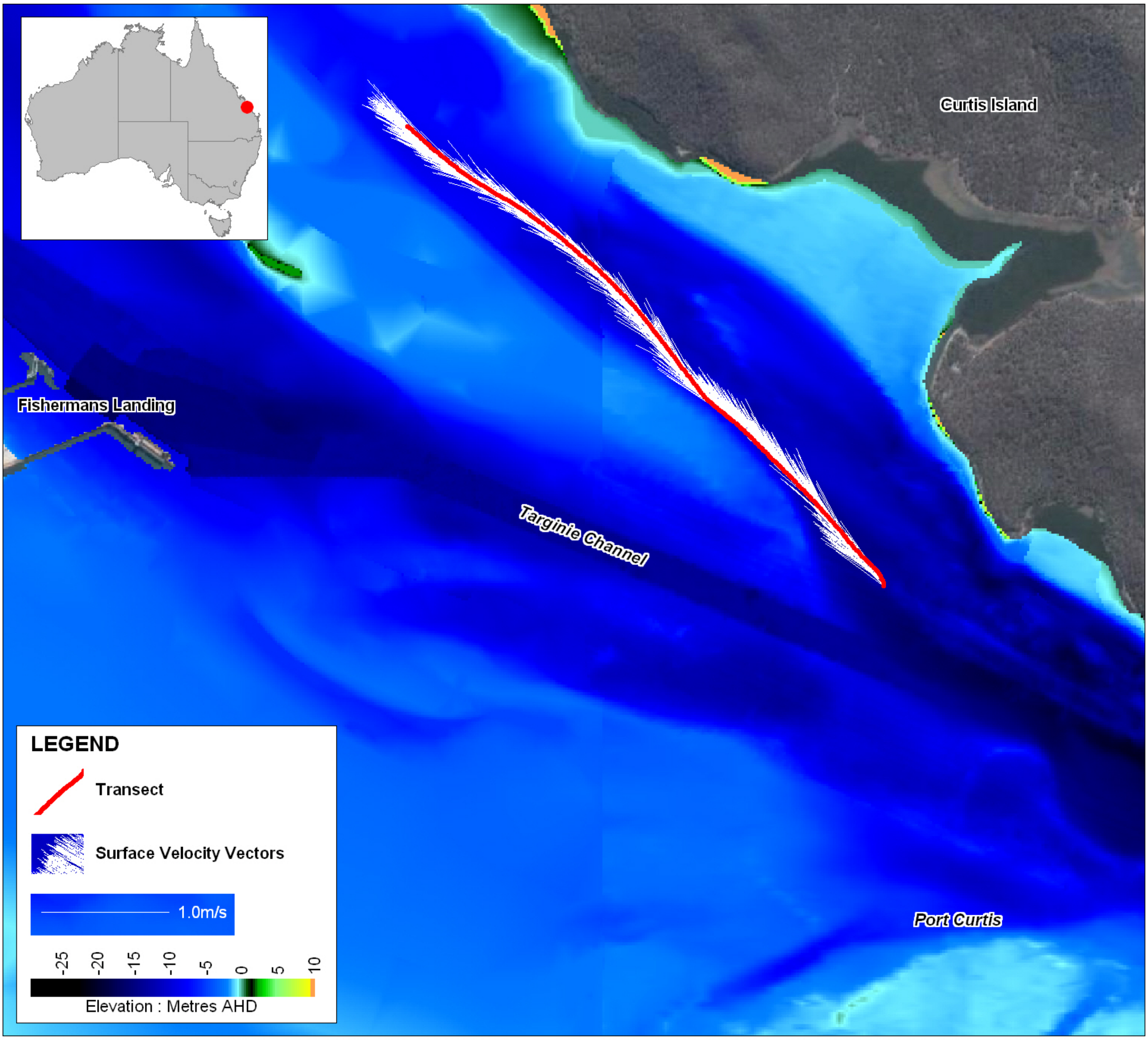

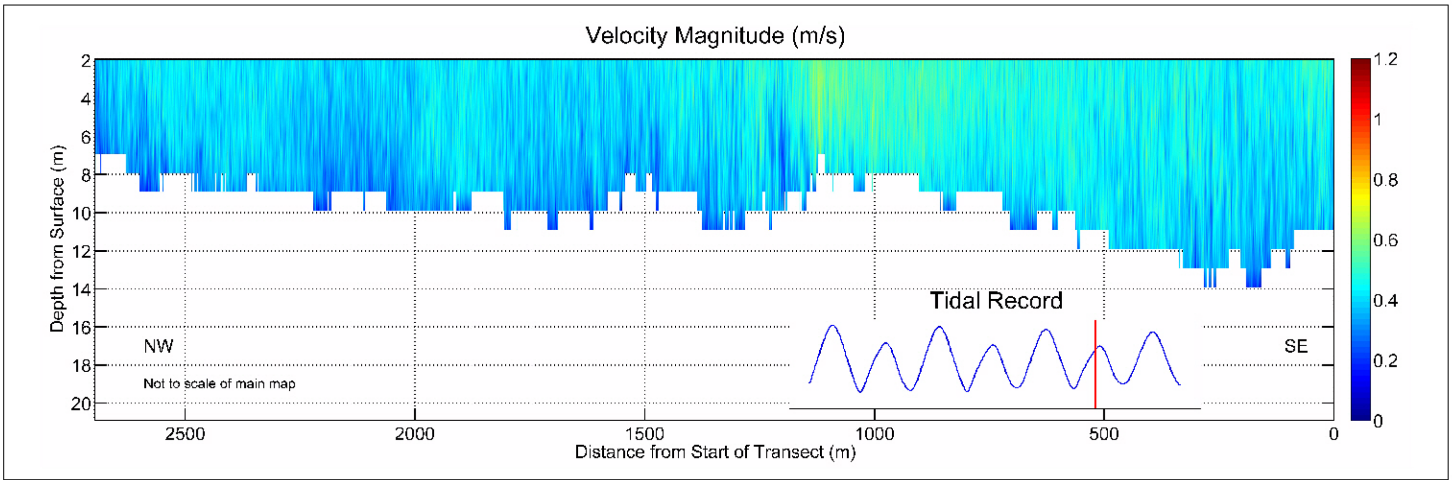

Title:

ADCP Transect 15 - Campaign 2

Figure: **5-60**

Rev: **A**

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N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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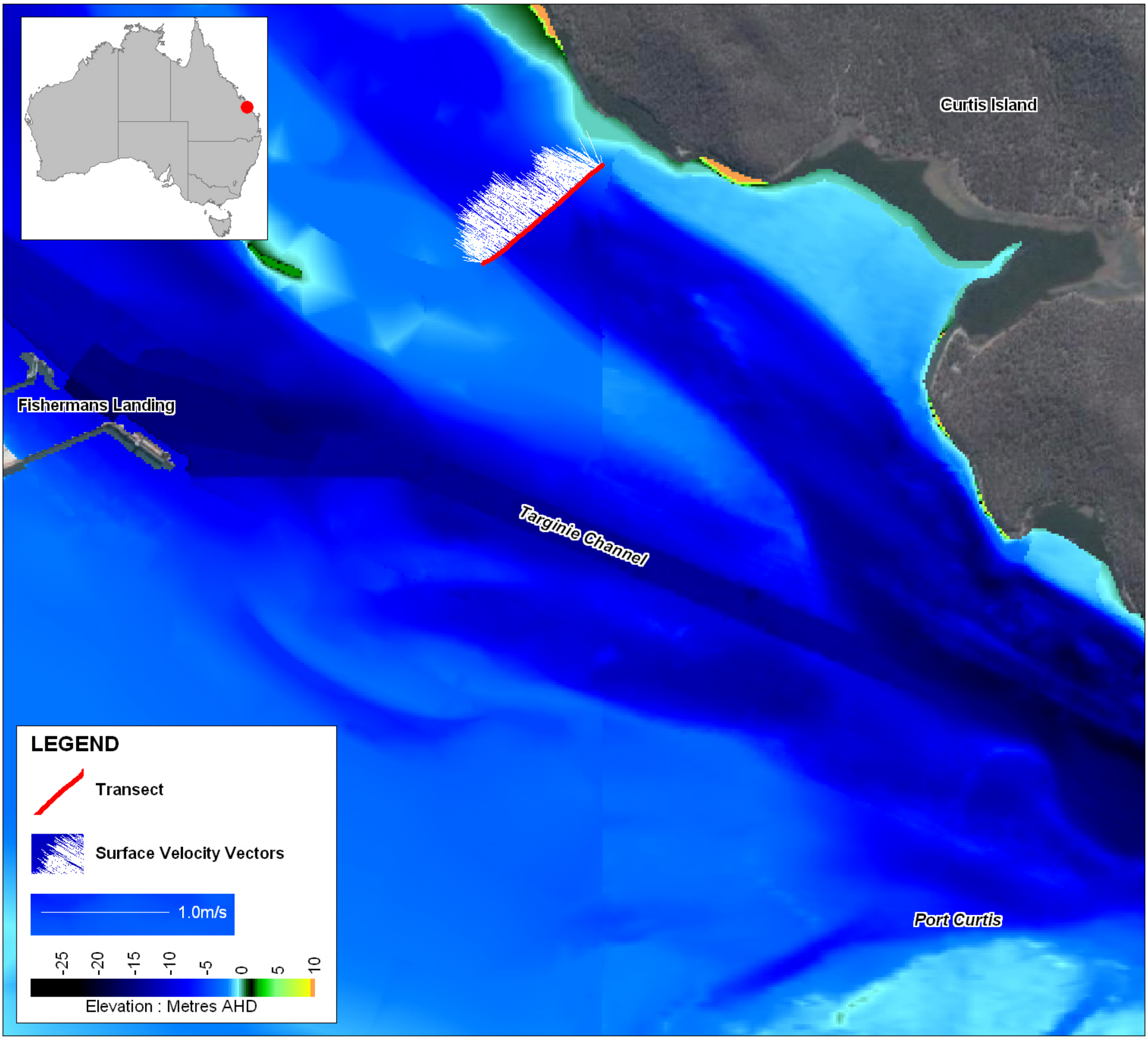
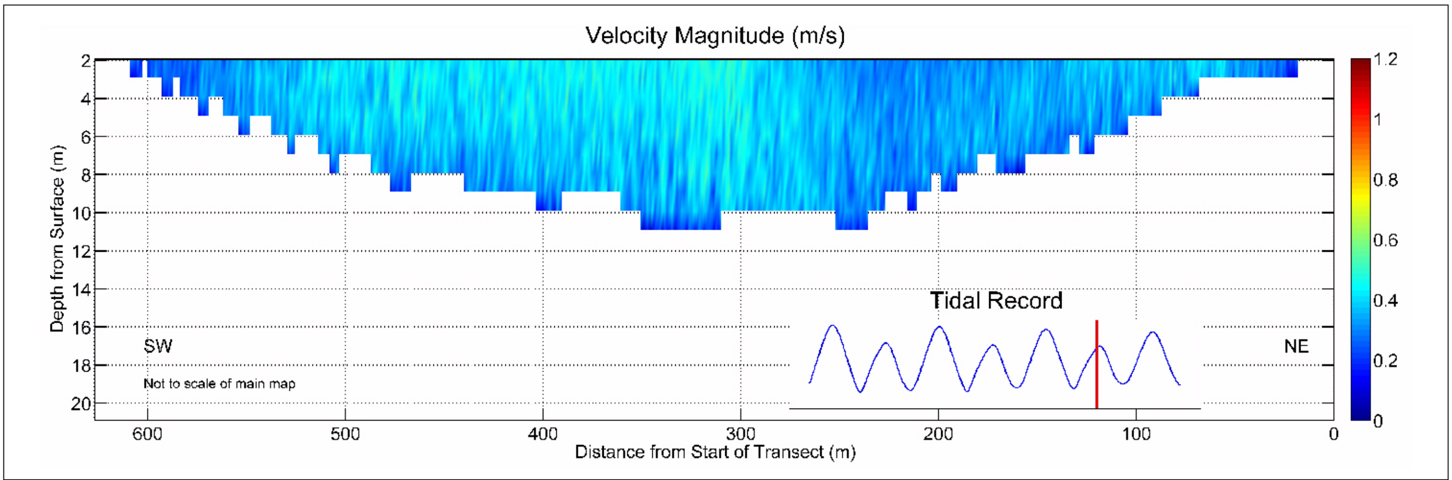
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_049_080701_5062_Collage.wor





Title:

ADCP Transect 16 - Campaign 2

Figure:

5-61

Rev:

A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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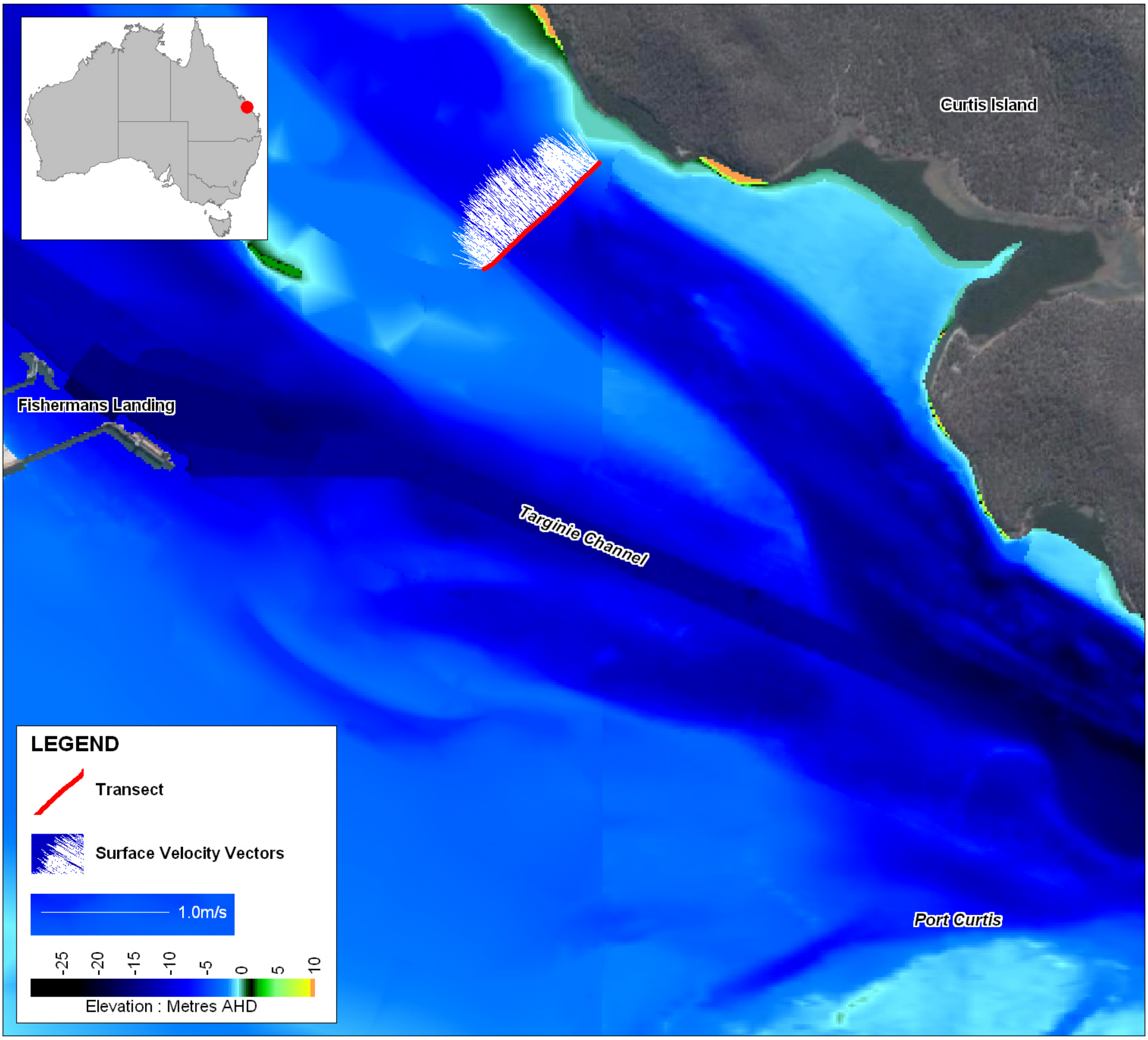
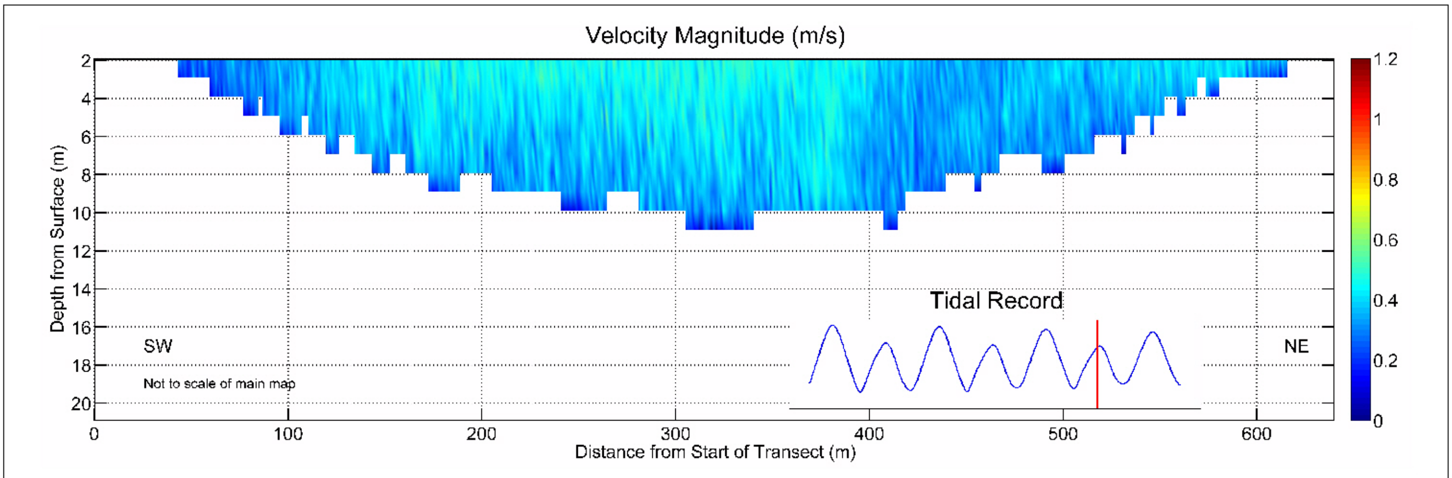
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_050_080701_5063_Collage.wor





Title:

ADCP Transect 17 - Campaign 2

Figure: 5-62

Rev: A

N

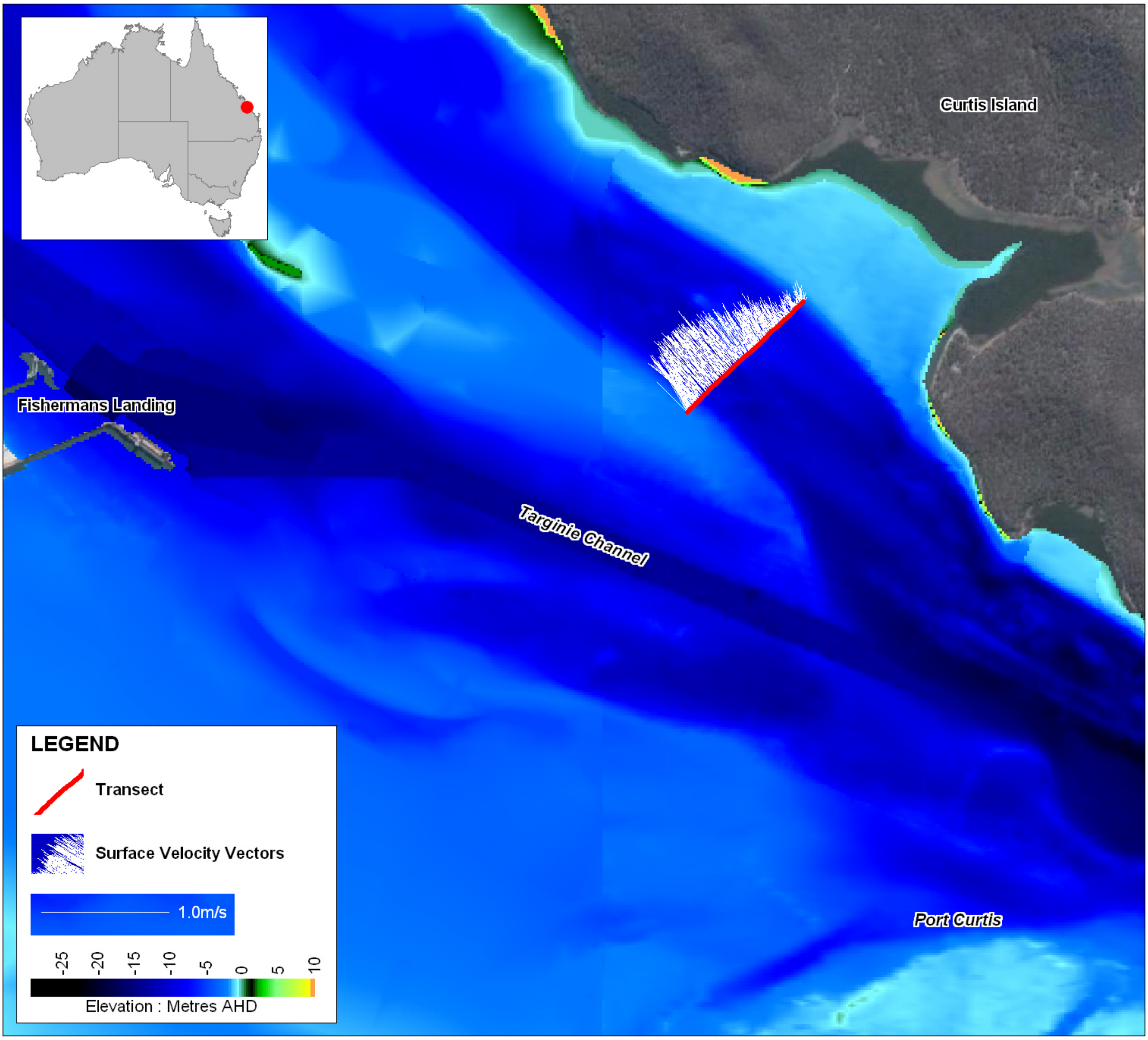
0 0.5 1km

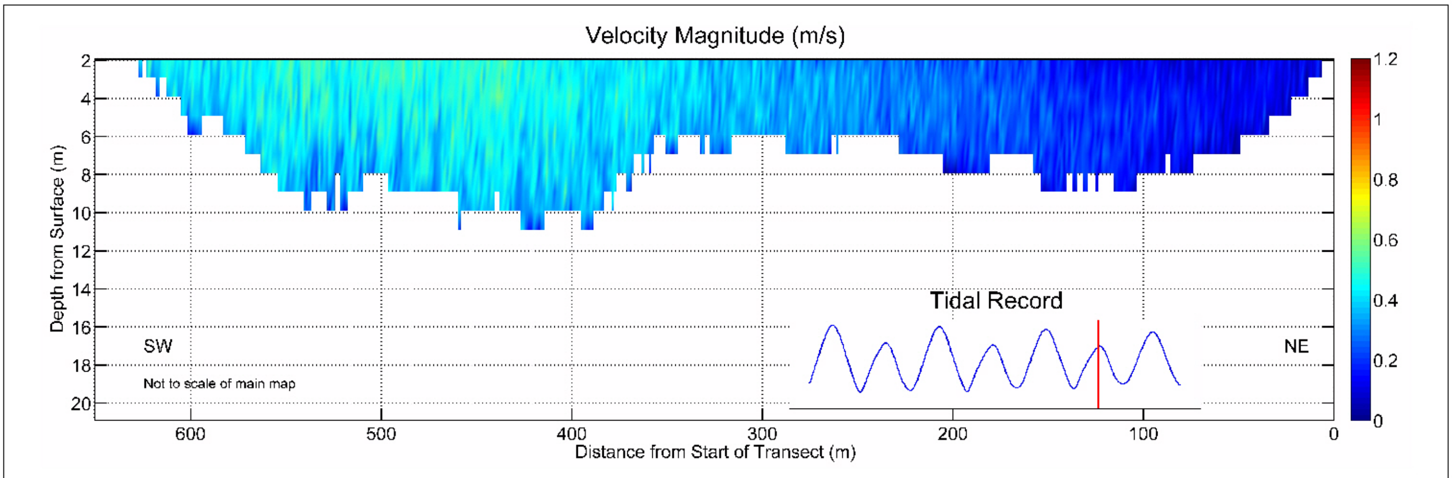
Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_051_080701_5064_Collage.wor





Title:

ADCP Transect 18 - Campaign 2

Figure:

5-63

Rev:

A

N

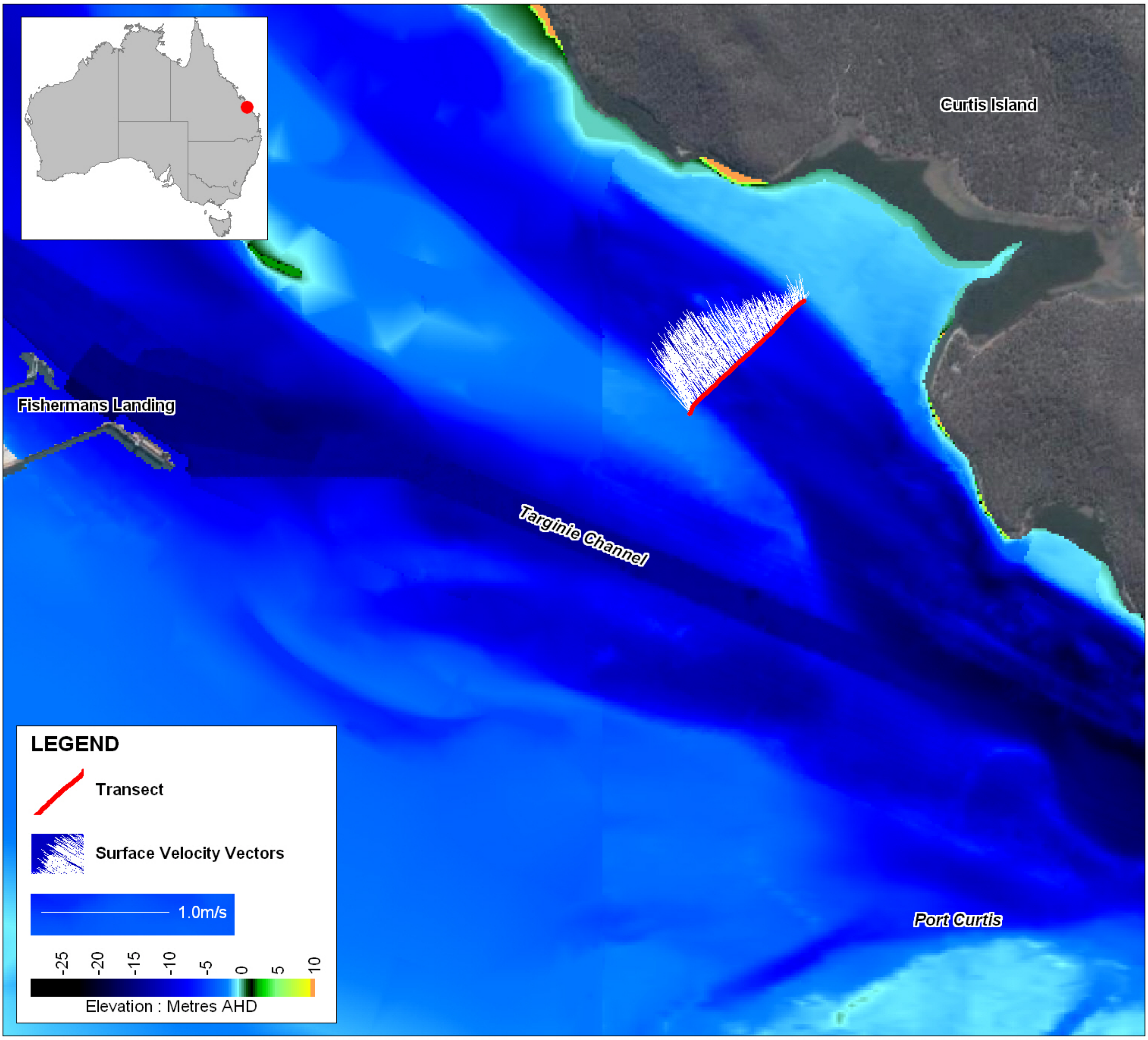
0 0.5 1km

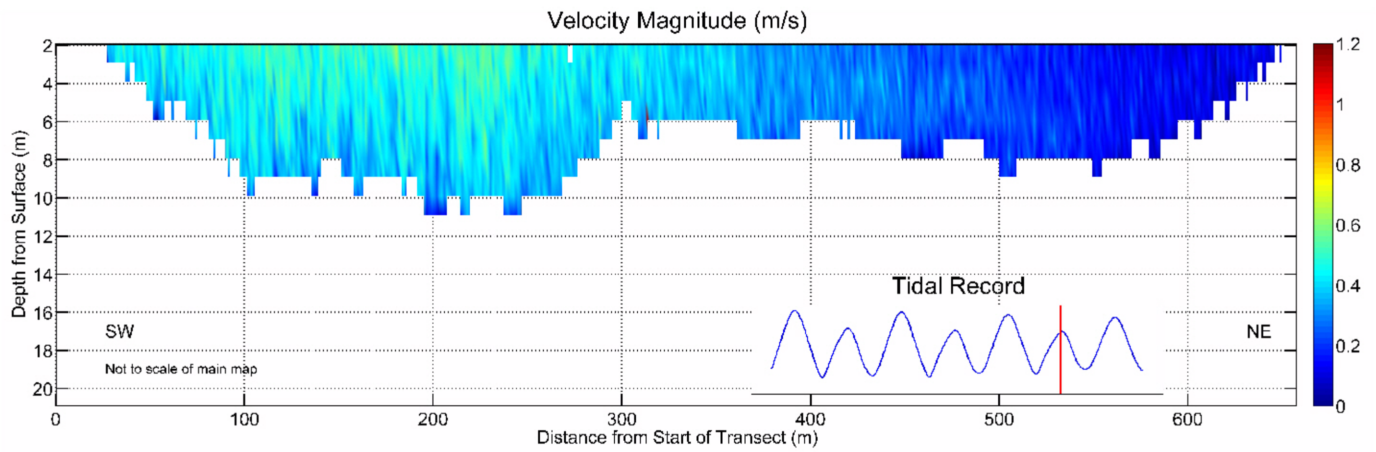
Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_052_080701_5065_Collage.wor





Title:

ADCP Transect 19 - Campaign 2

Figure: 5-64

Rev: A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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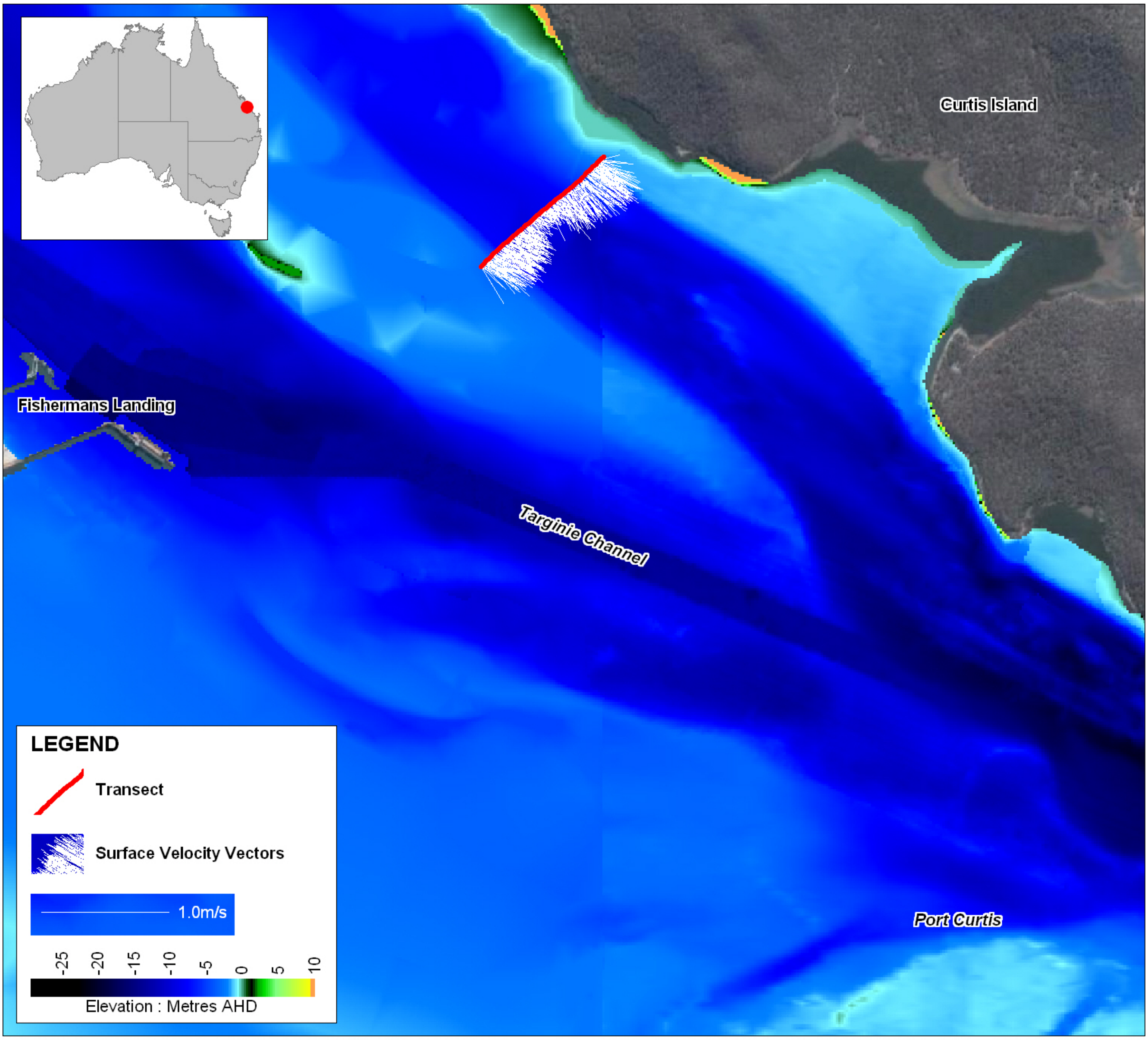
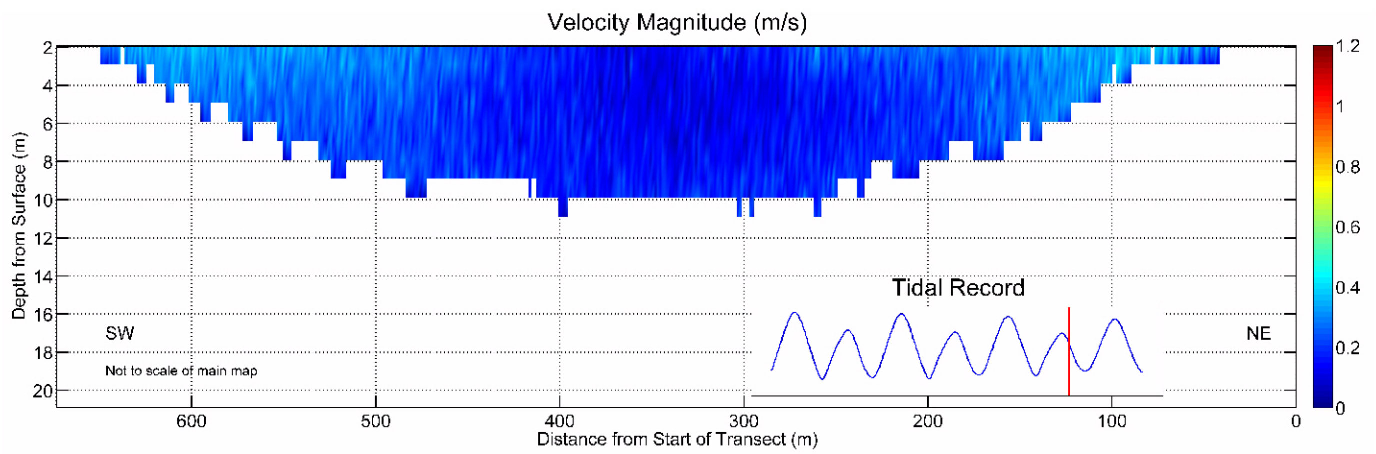
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_053_080701_5066_Collage.wor





Title:

ADCP Transect 20 - Campaign 2

Figure: **5-65**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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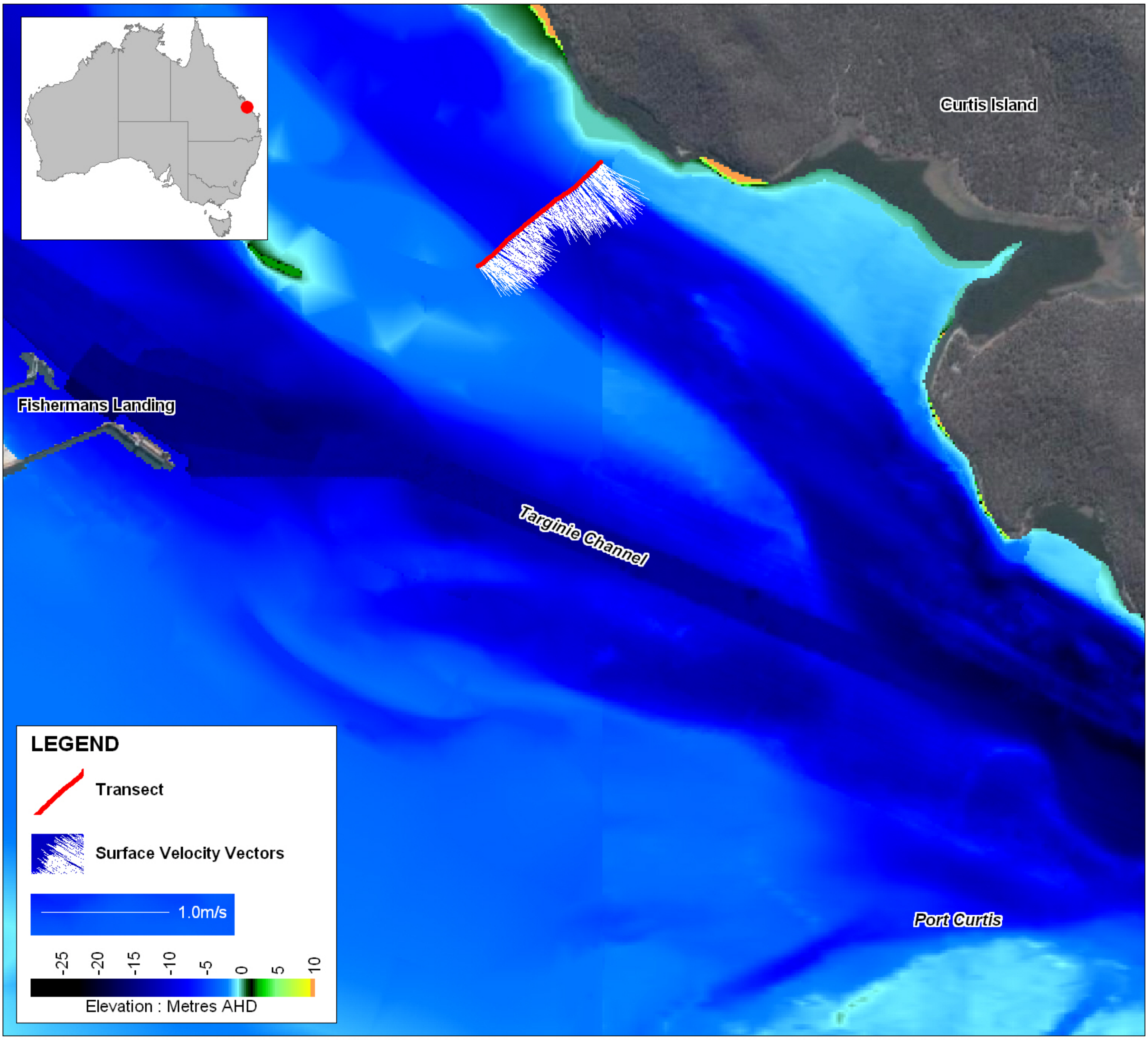
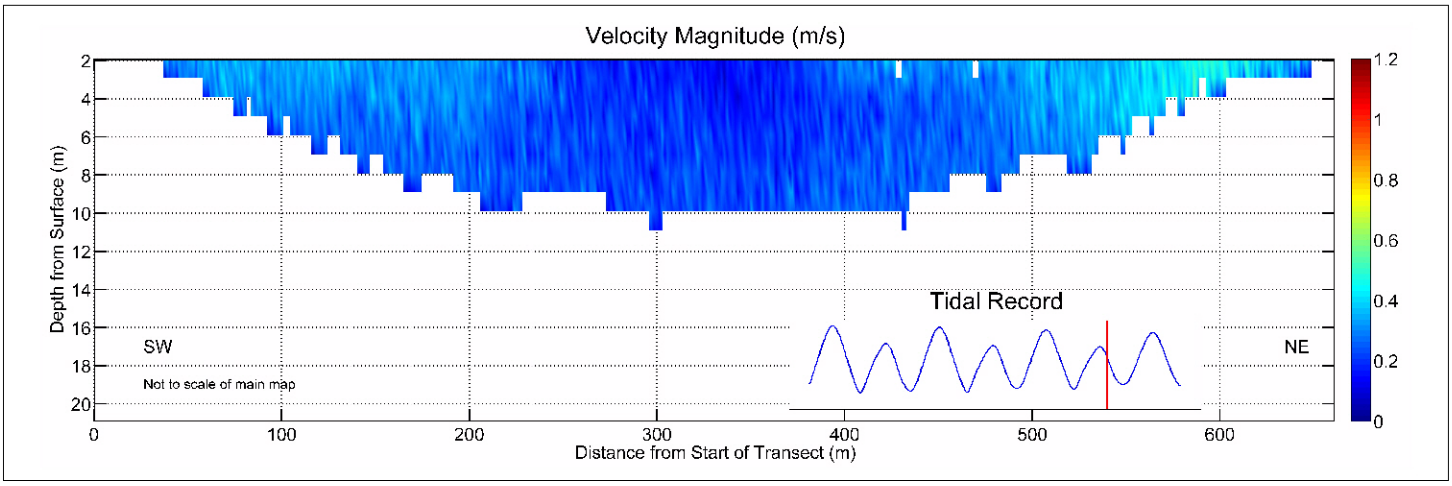
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_054_080701_5067_Collage.wor





Title:

ADCP Transect 21 - Campaign 2

Figure:

5-66

Rev:

A

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N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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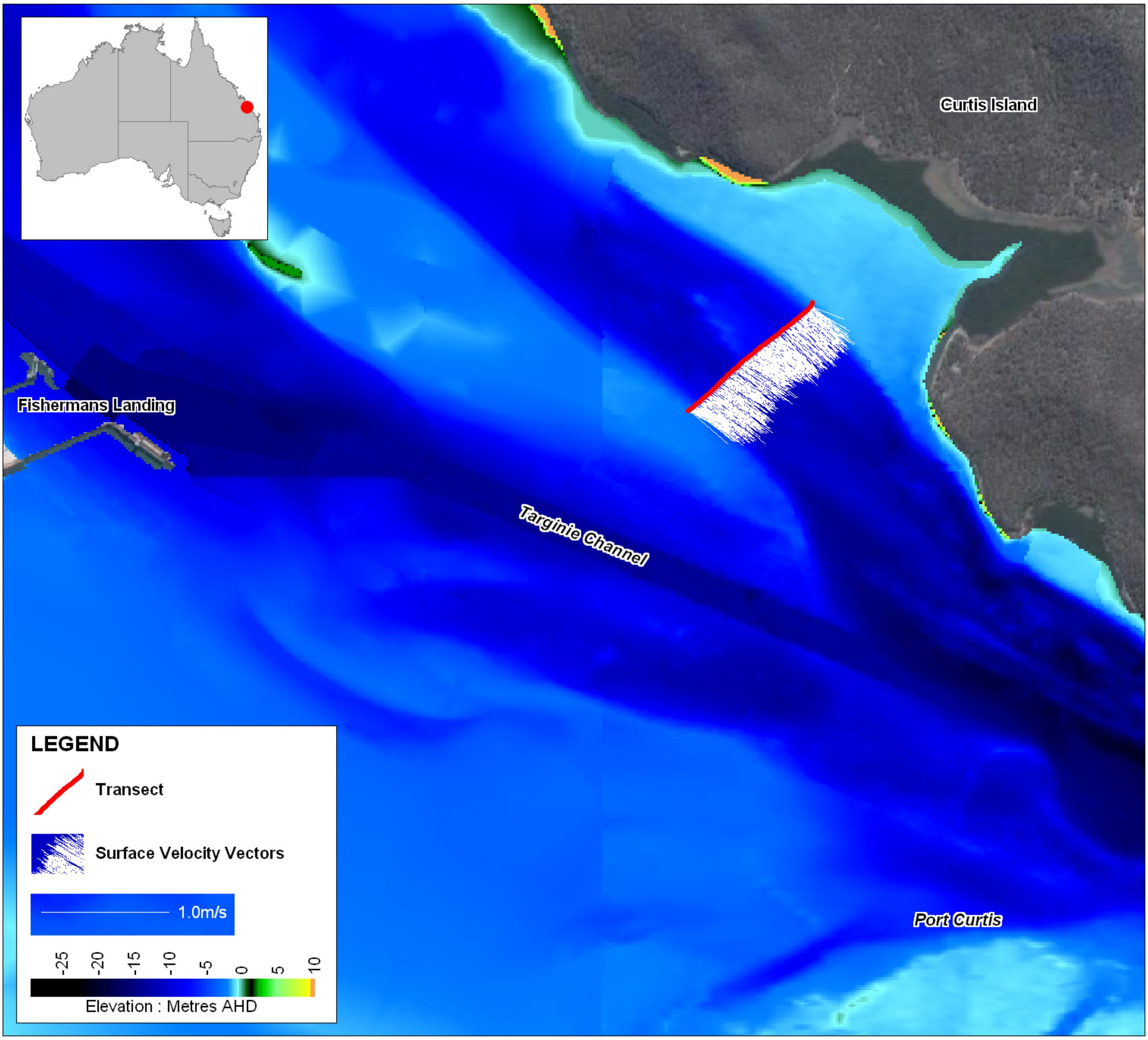
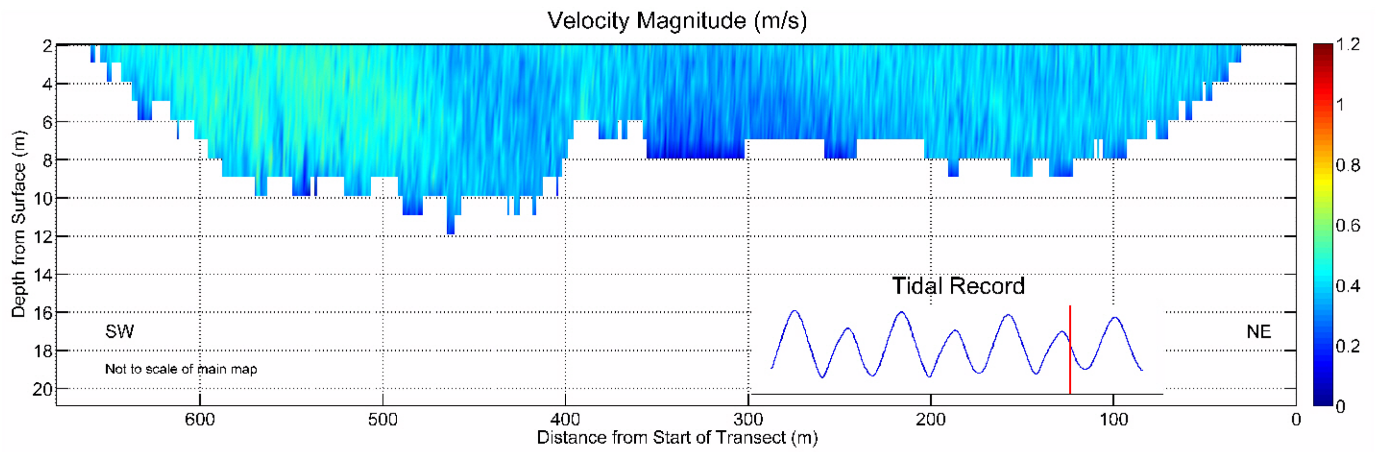
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_055_080701_5068_Collage.wor





Title:

ADCP Transect 22 - Campaign 2

Figure: 5-67

Rev: A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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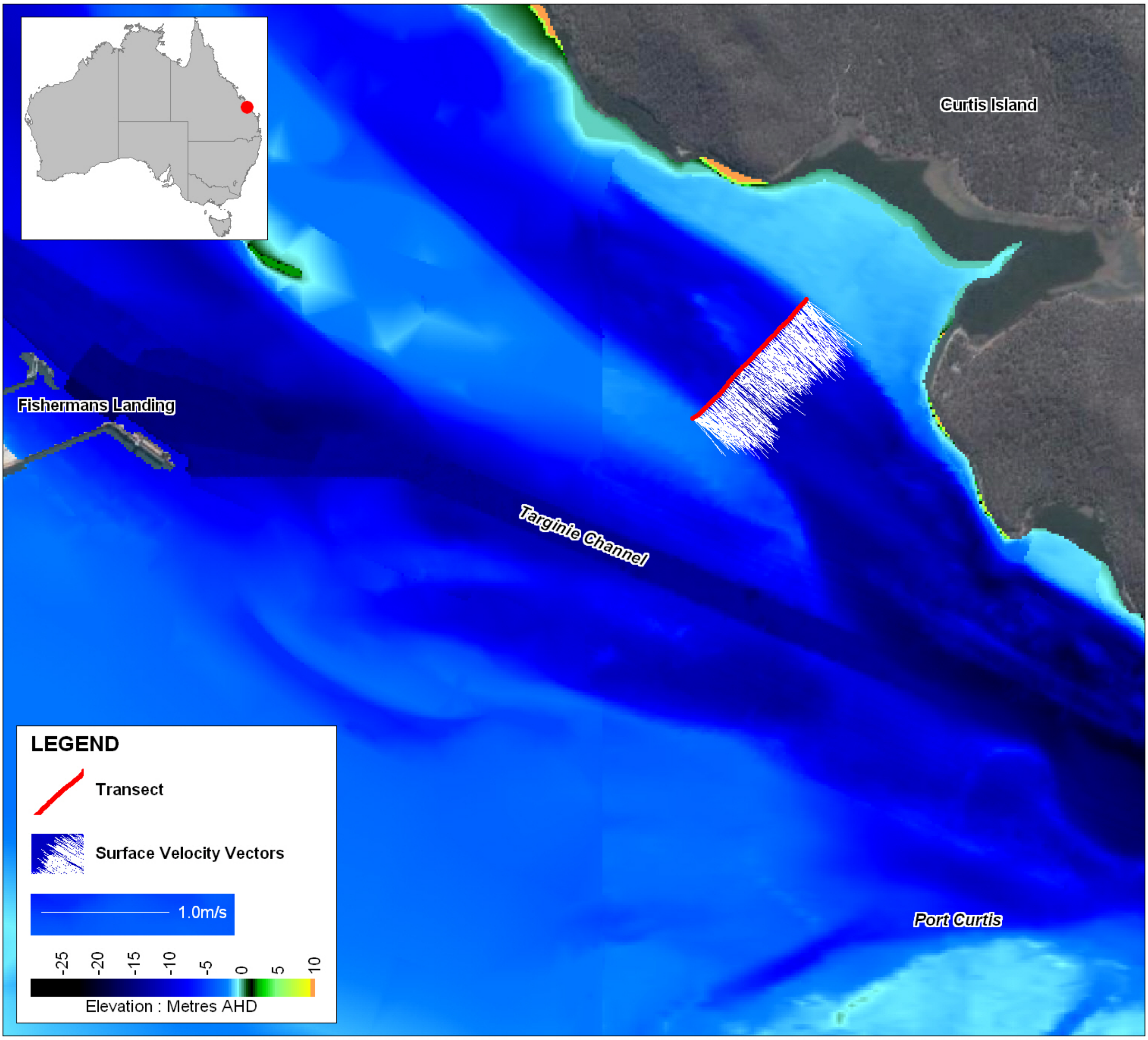
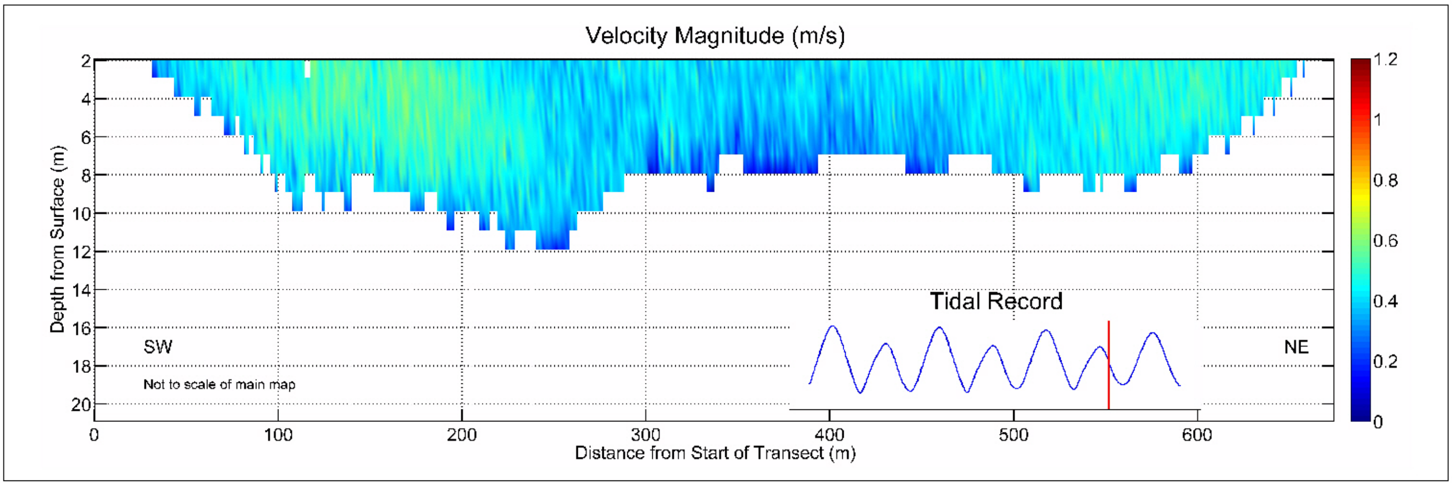
Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_056_080701_5069_Collage.wor





Title:

ADCP Transect 23 - Campaign 2

Figure: **5-68**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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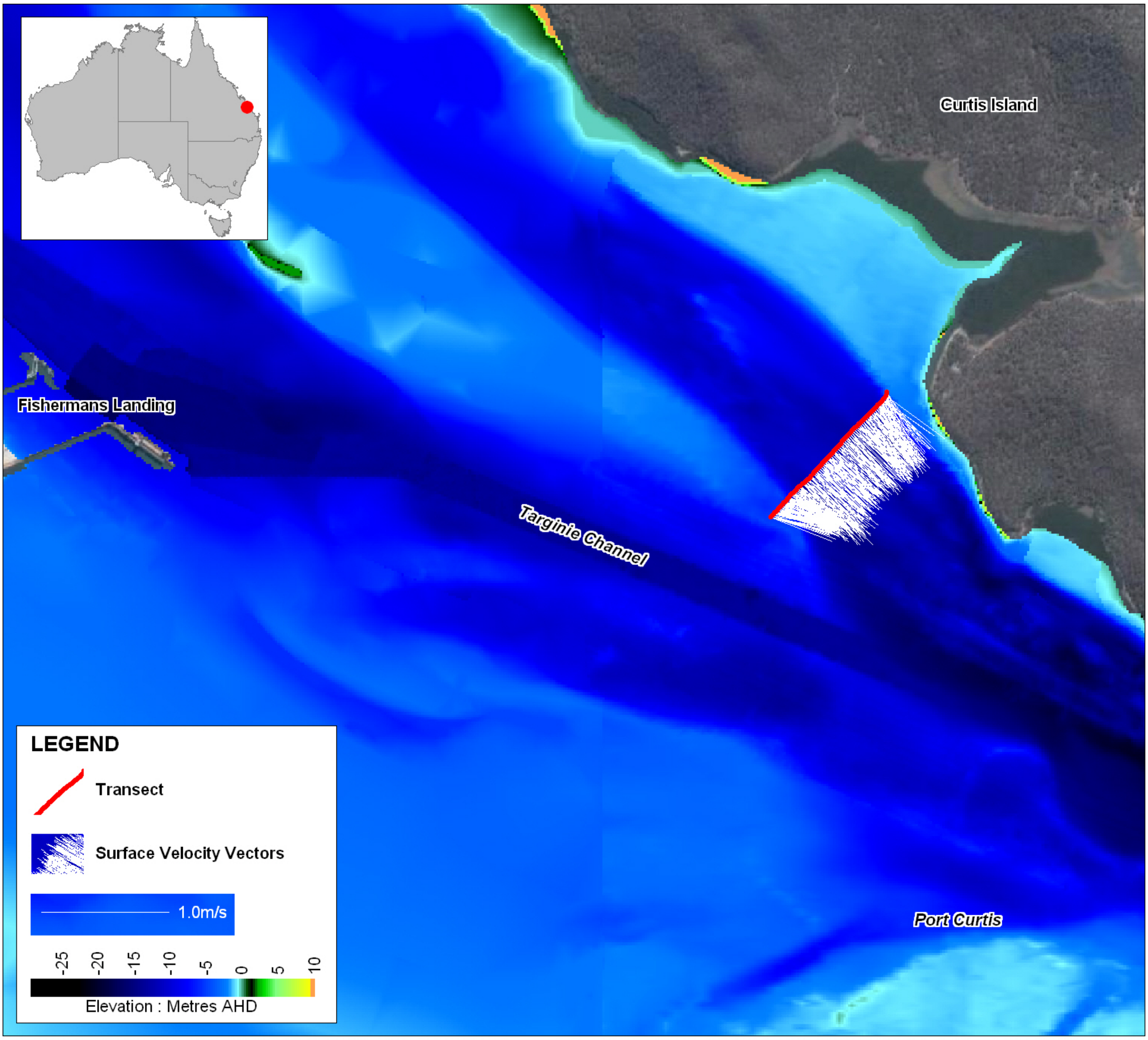

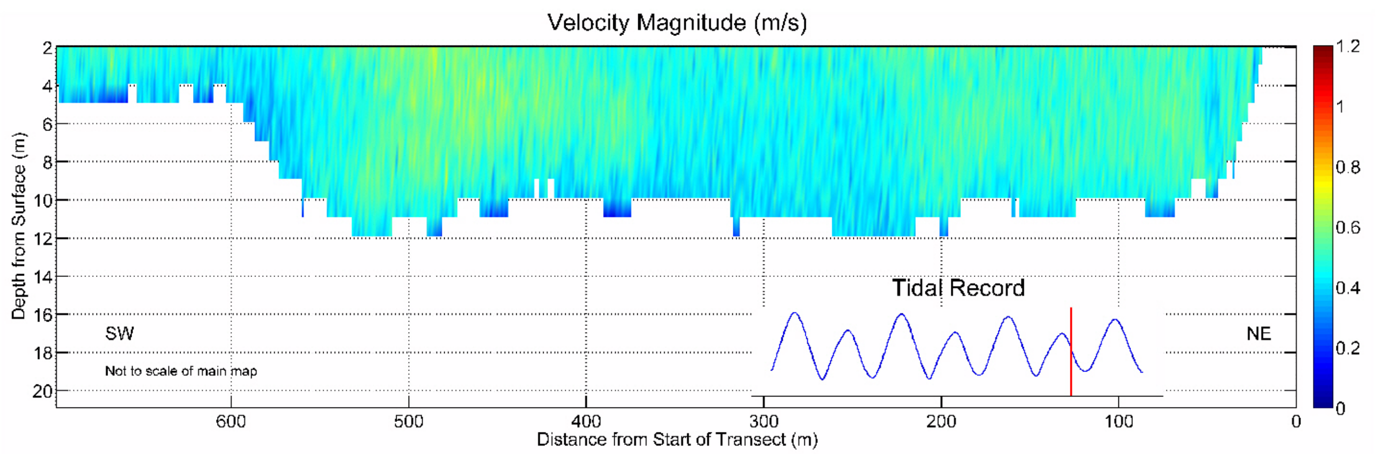

Title:

ADCP Transect 24 - Campaign 2

Figure:

5-69

Rev:

A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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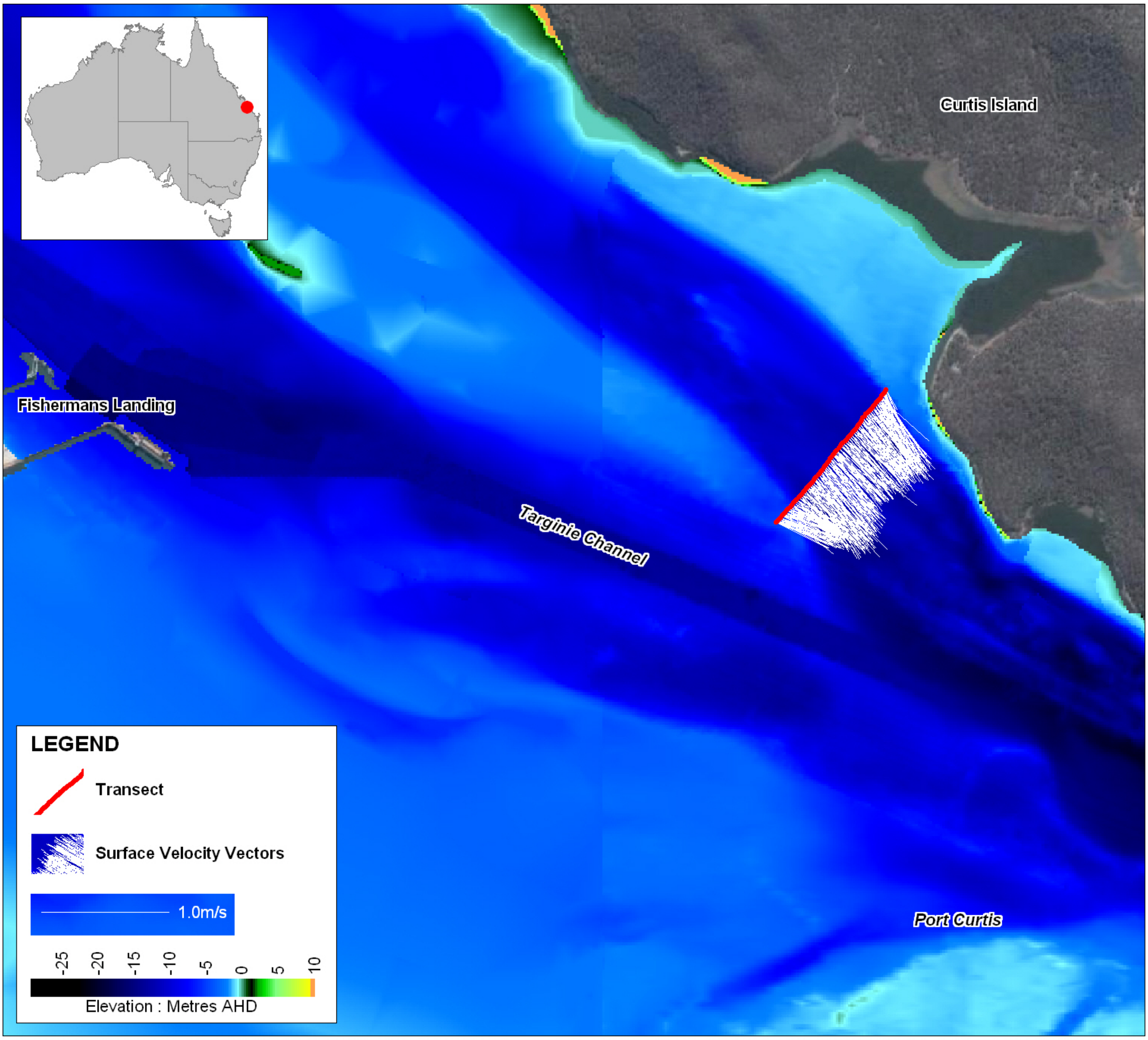

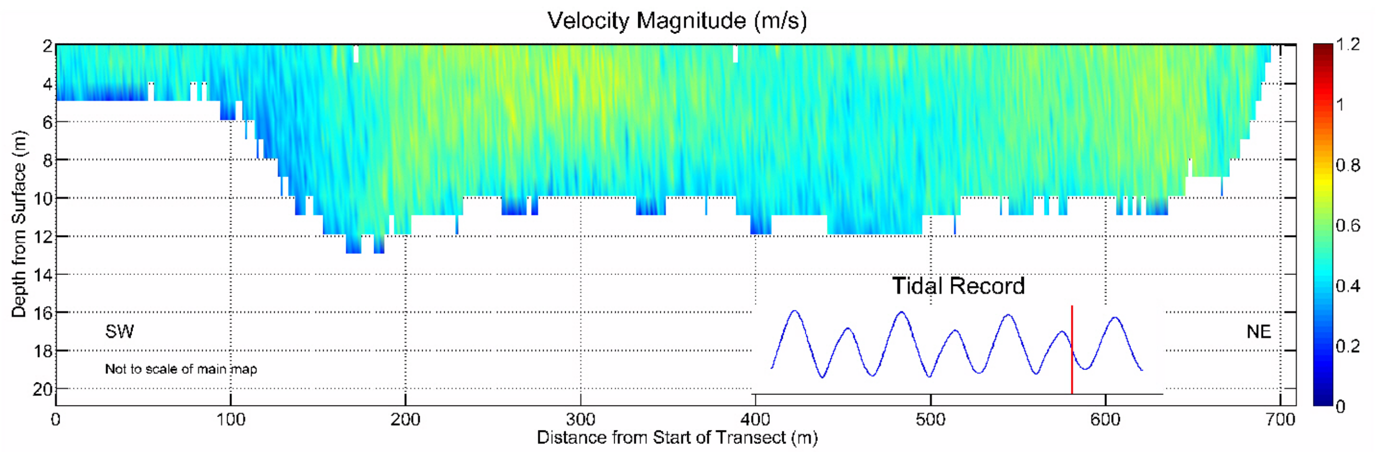

Title:

ADCP Transect 25 - Campaign 2

Figure: **5-70**

Rev: **A**

N

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Approx. Scale - Main Map

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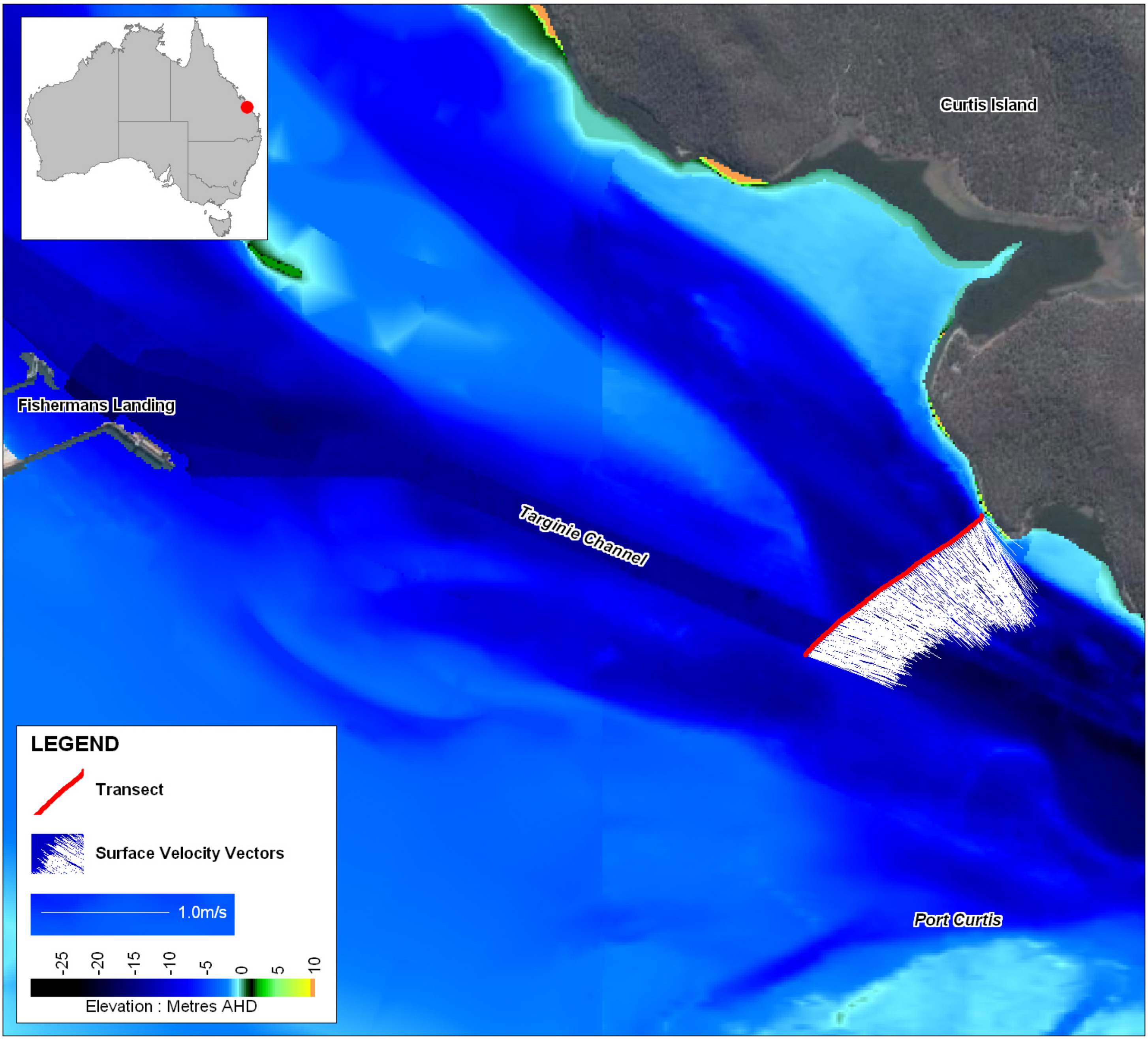

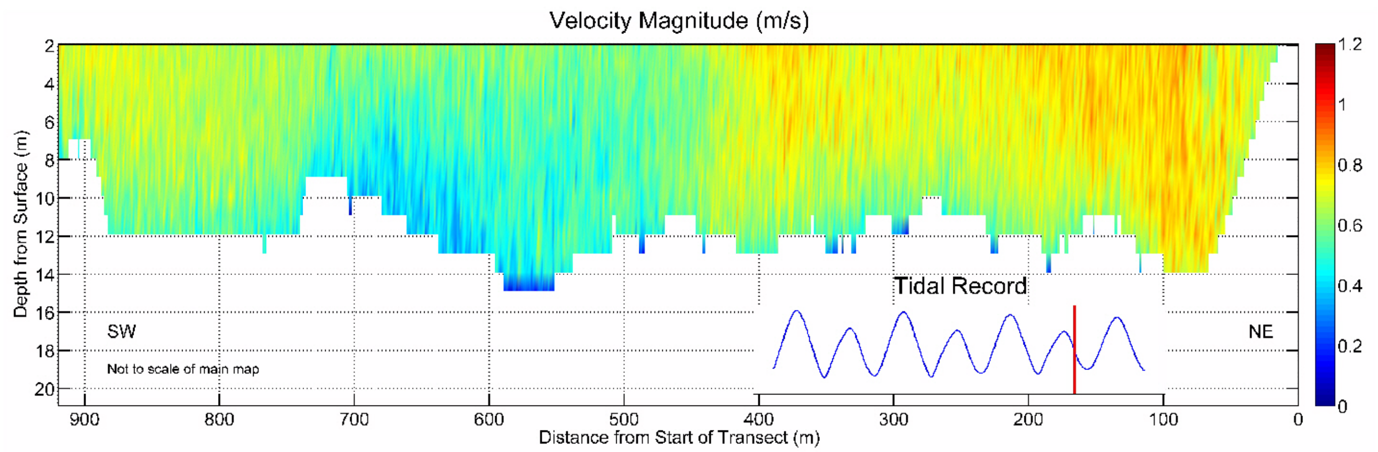

Title:

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Figure: **5-71**

Rev: **A**

N

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Approx. Scale - Main Map

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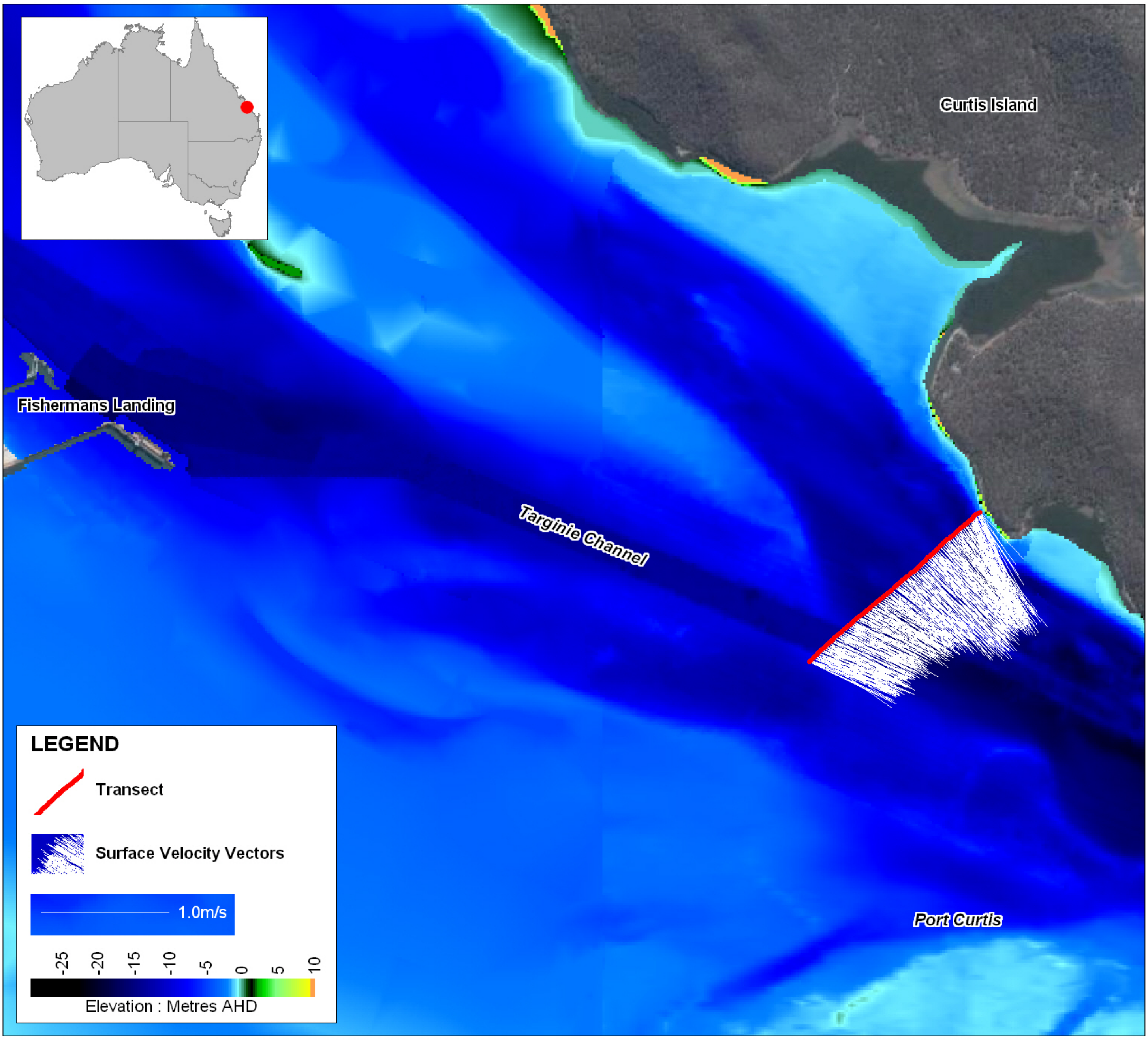

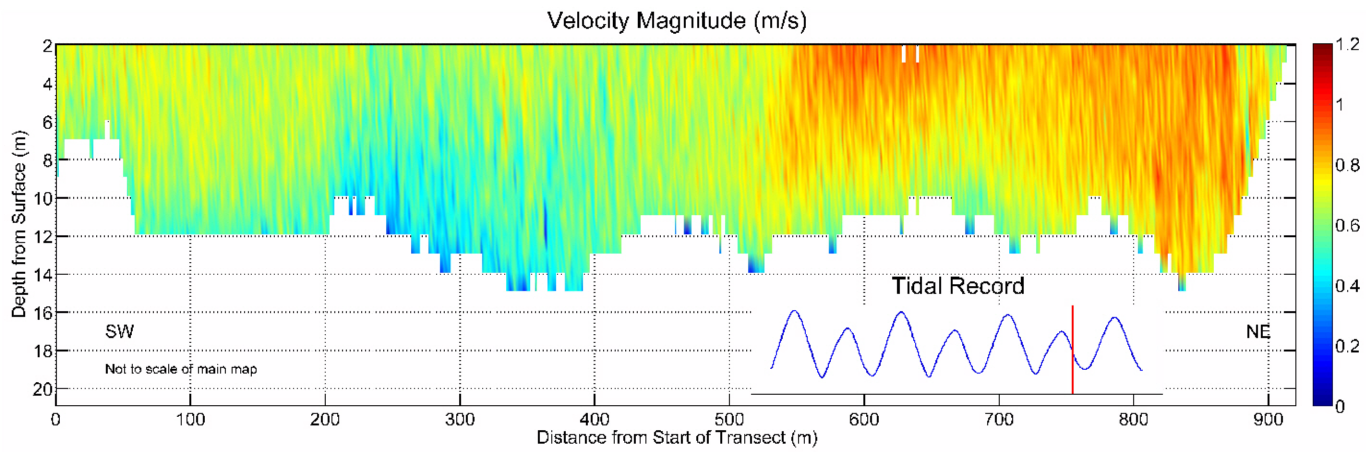

Title:

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Figure: **5-72**

Rev: **A**

N

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Approx. Scale - Main Map

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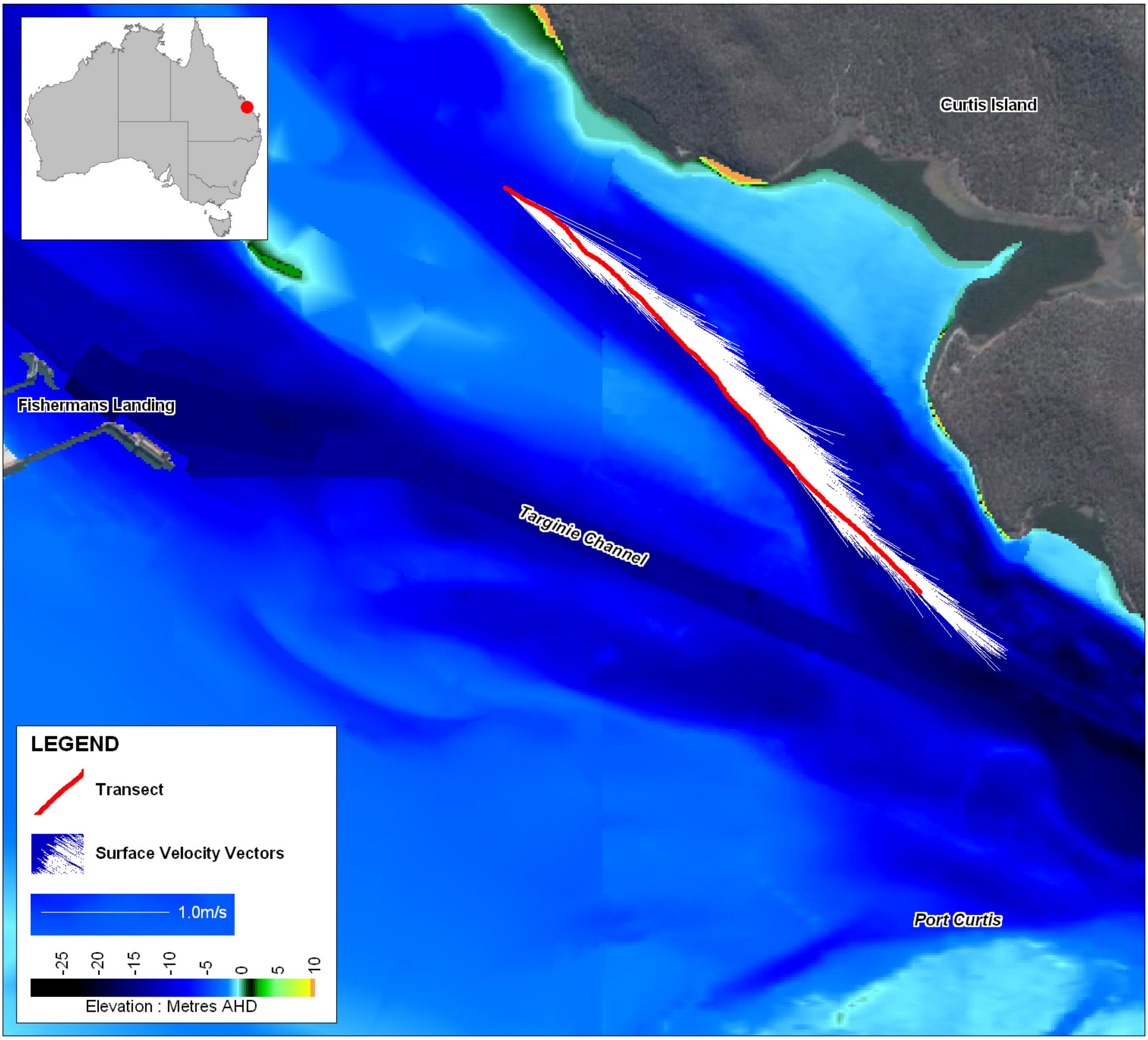

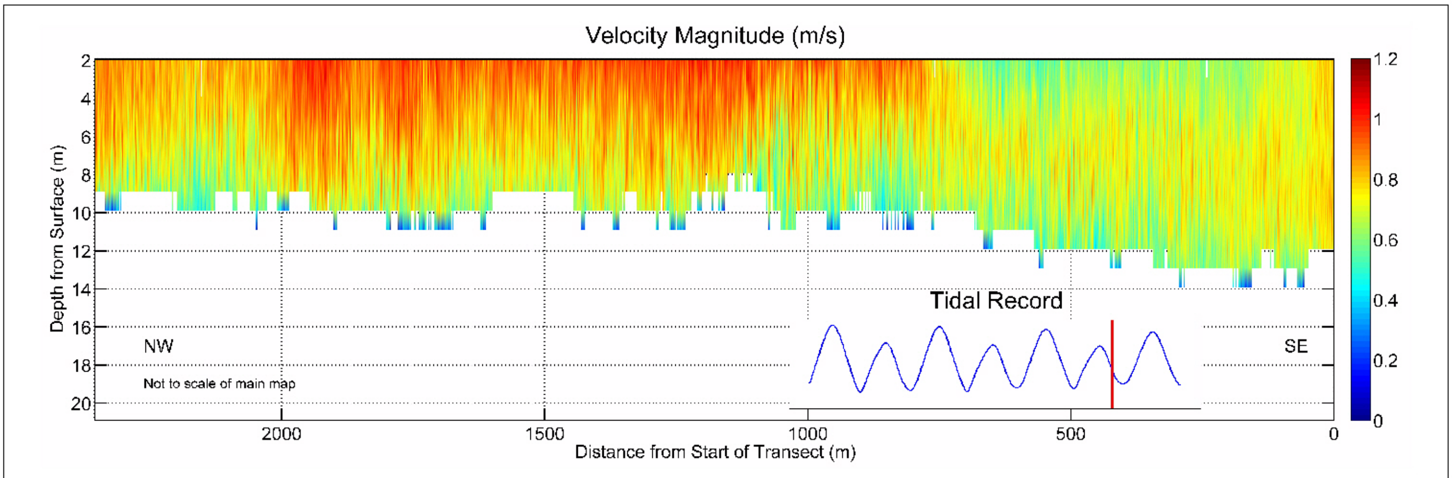

Title:

ADCP Transect 28 - Campaign 2

Figure: 5-73

Rev: A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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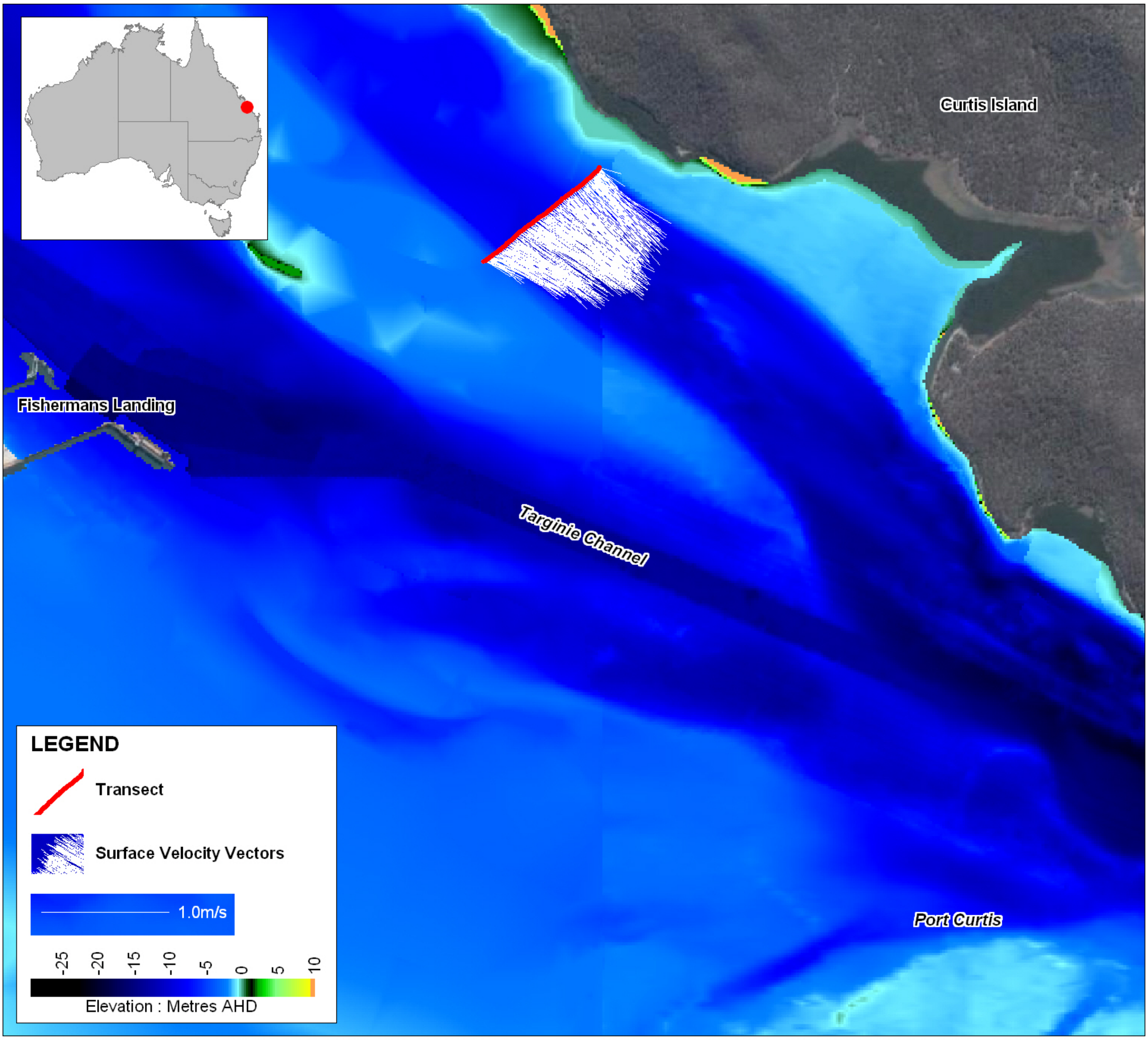

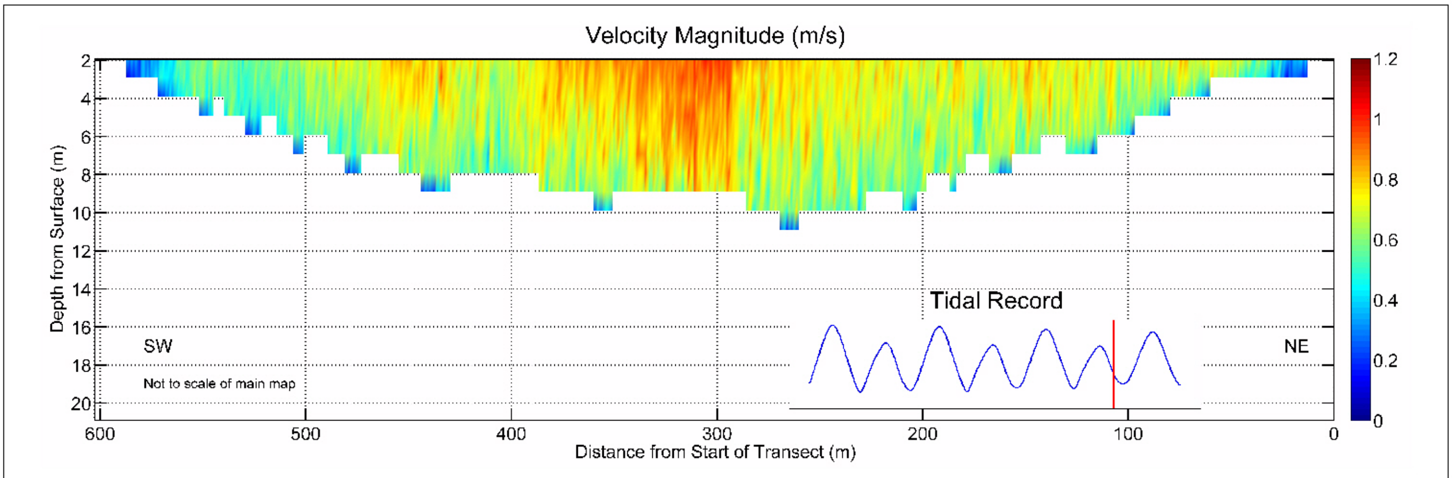

Title:

ADCP Transect 29 - Campaign 2

Figure:

5-74

Rev:

A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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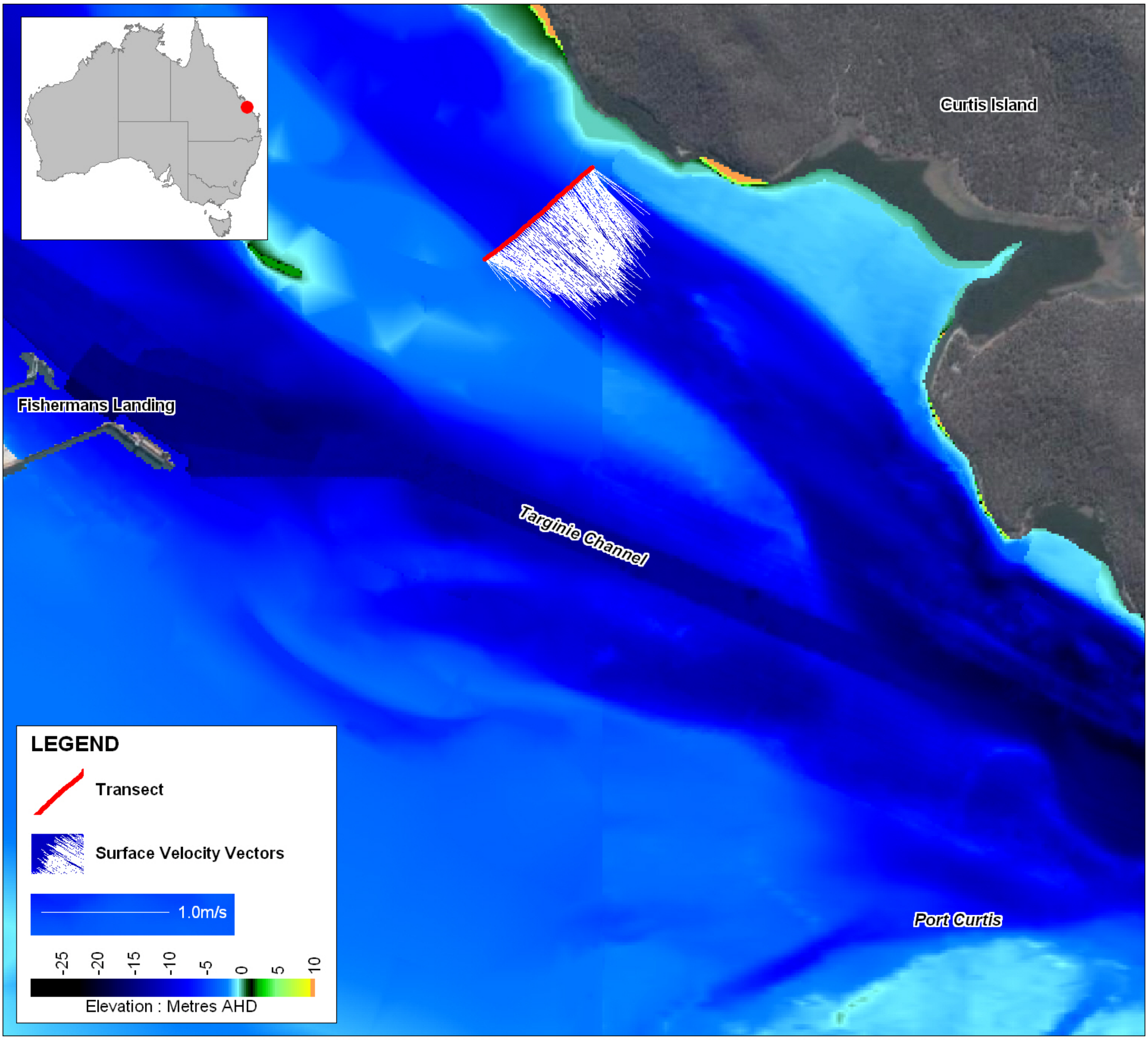

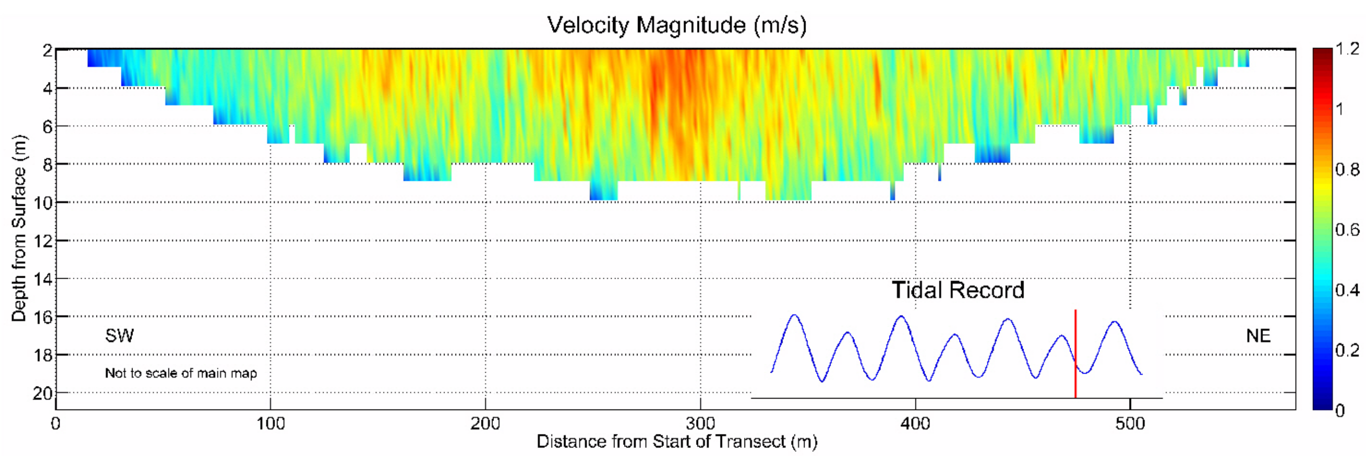

Title:

ADCP Transect 30 - Campaign 2

Figure: **5-75**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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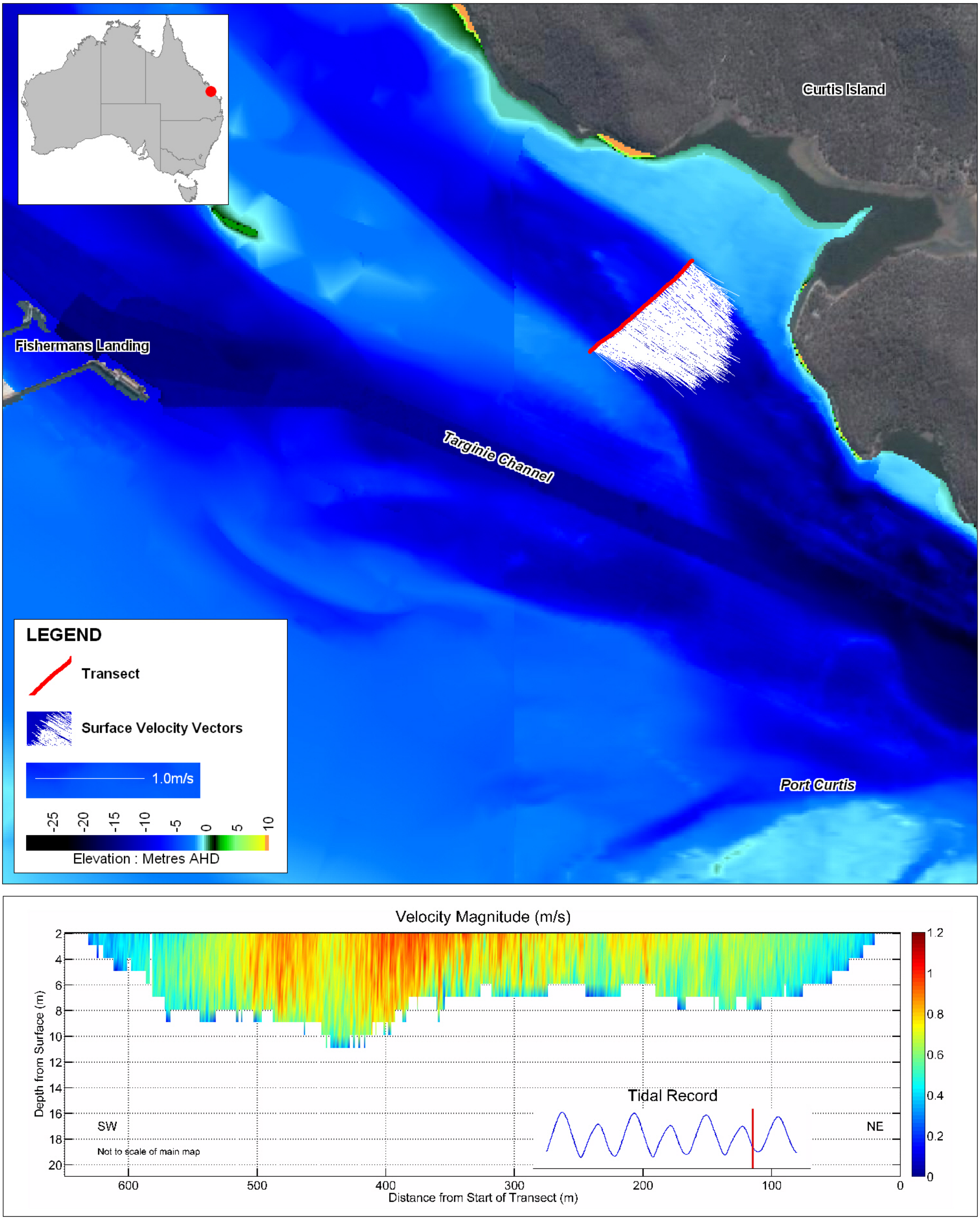

Title:

ADCP Transect 31 - Campaign 2

Figure: **5-76**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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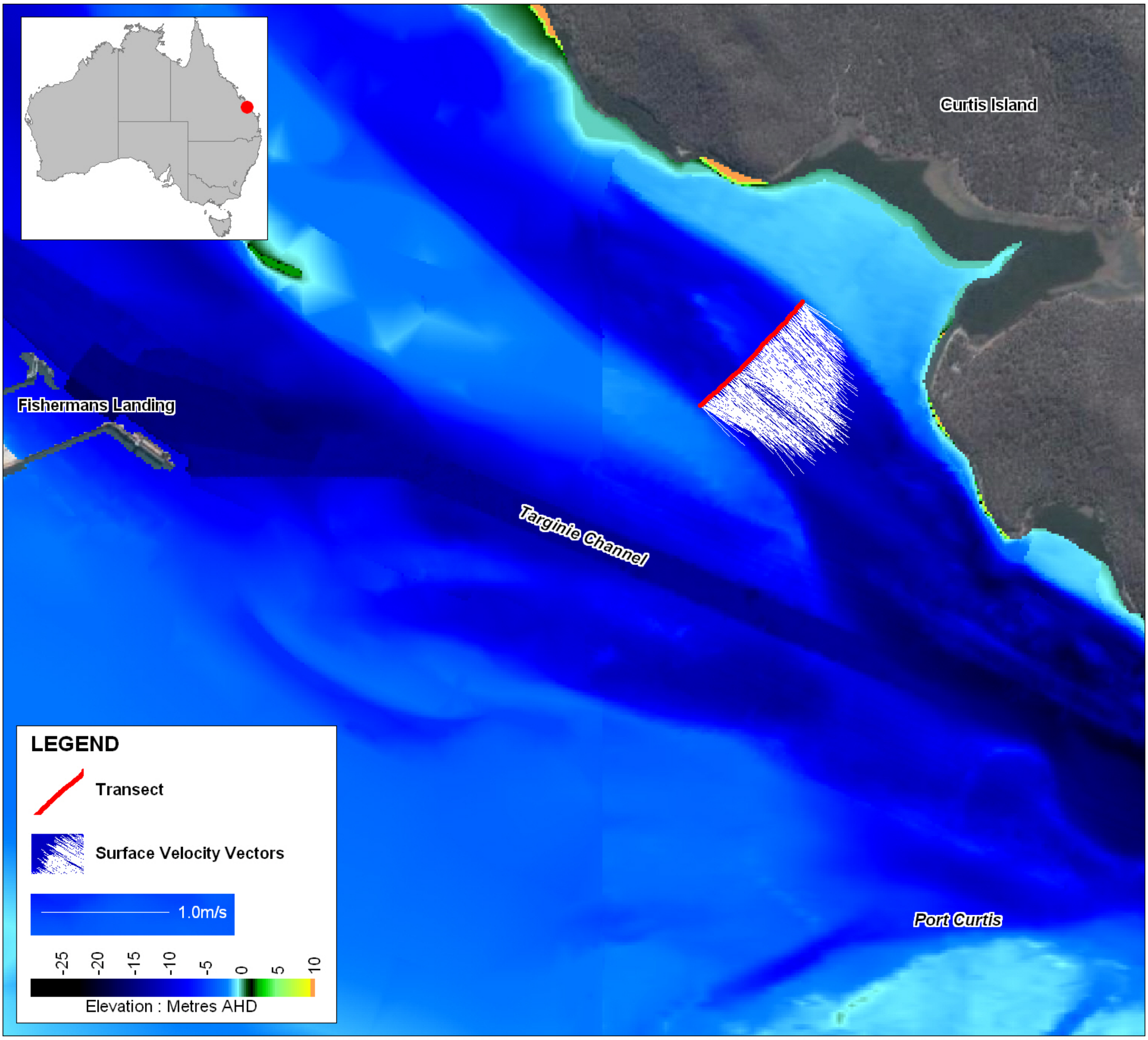

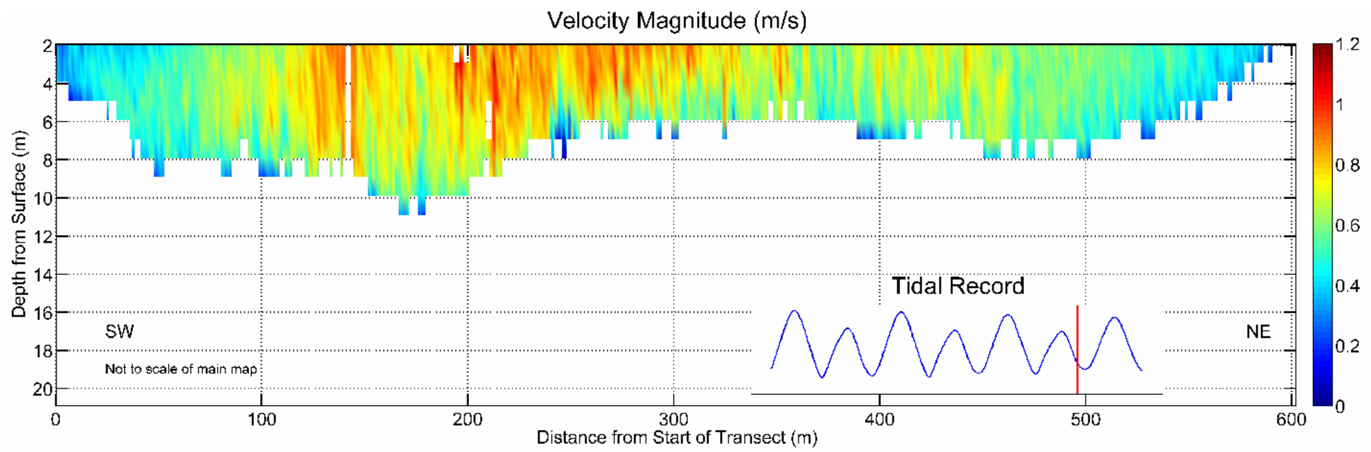

Title:

ADCP Transect 32 - Campaign 2

Figure: **5-77**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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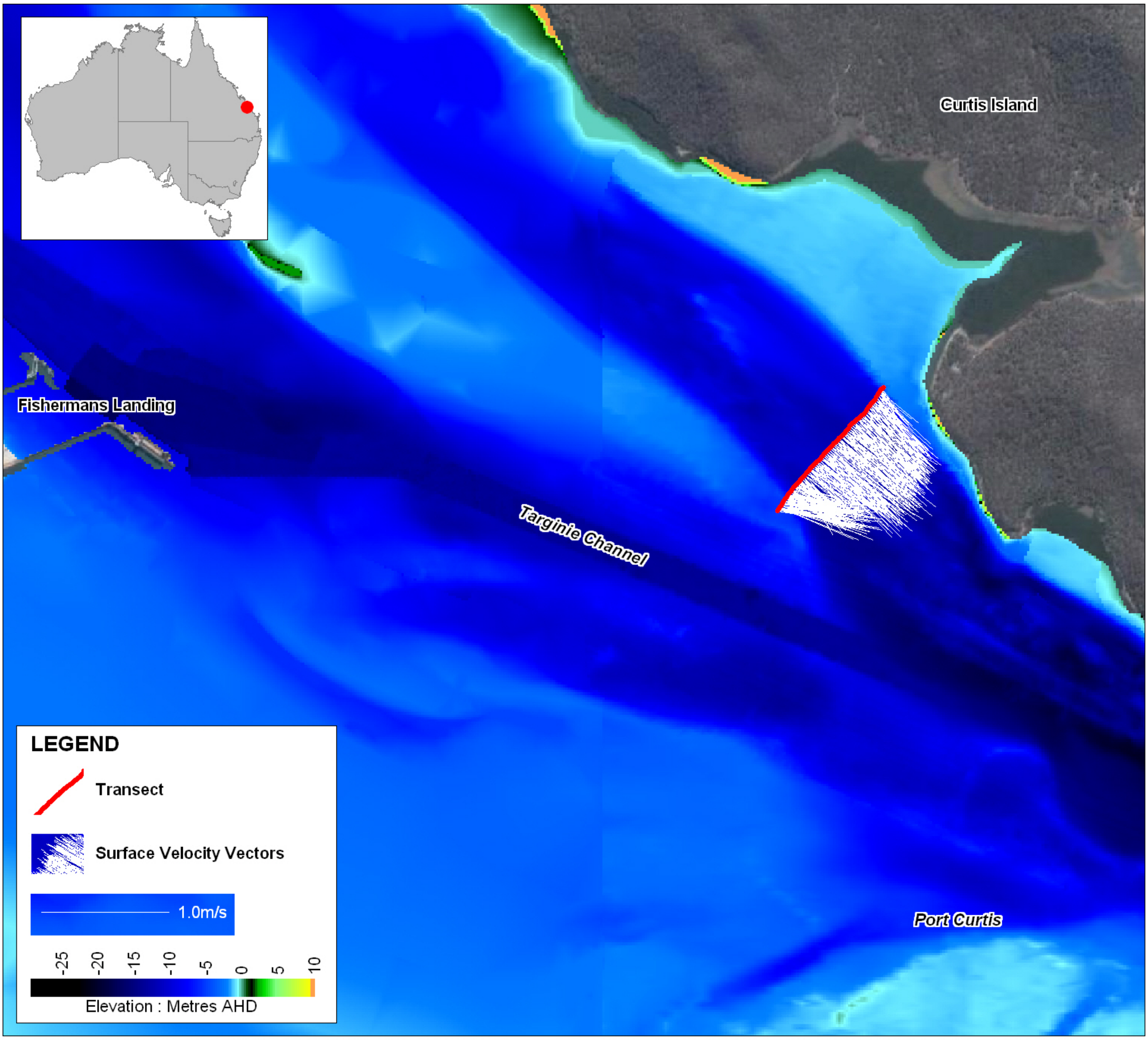

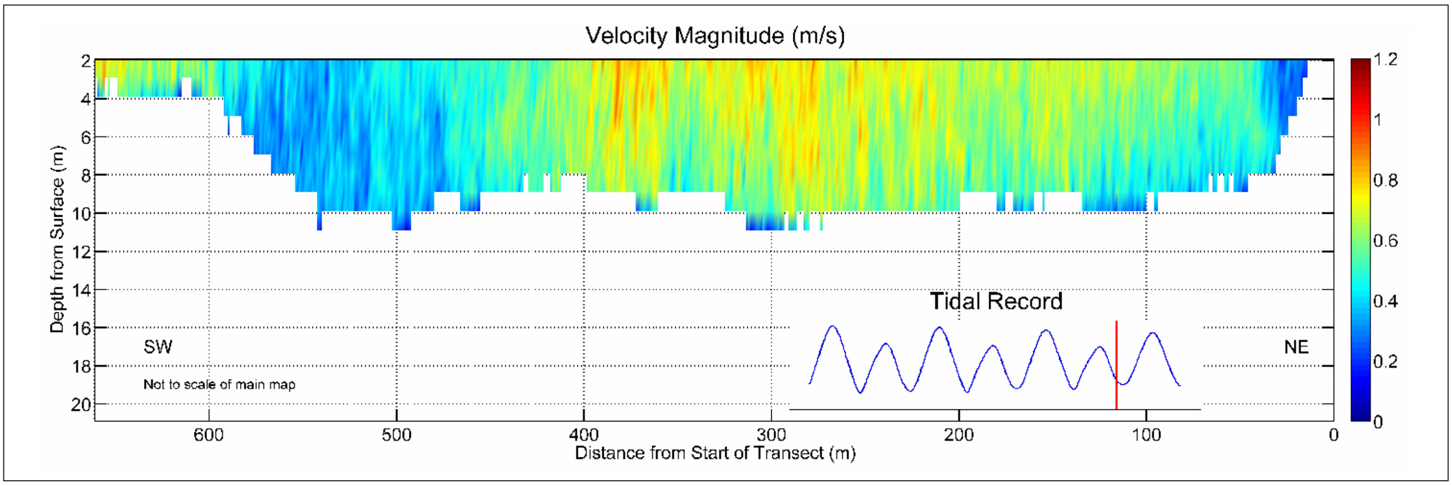

Title:

ADCP Transect 33 - Campaign 2

Figure: **5-78**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 0.5 1km

Approx. Scale - Main Map

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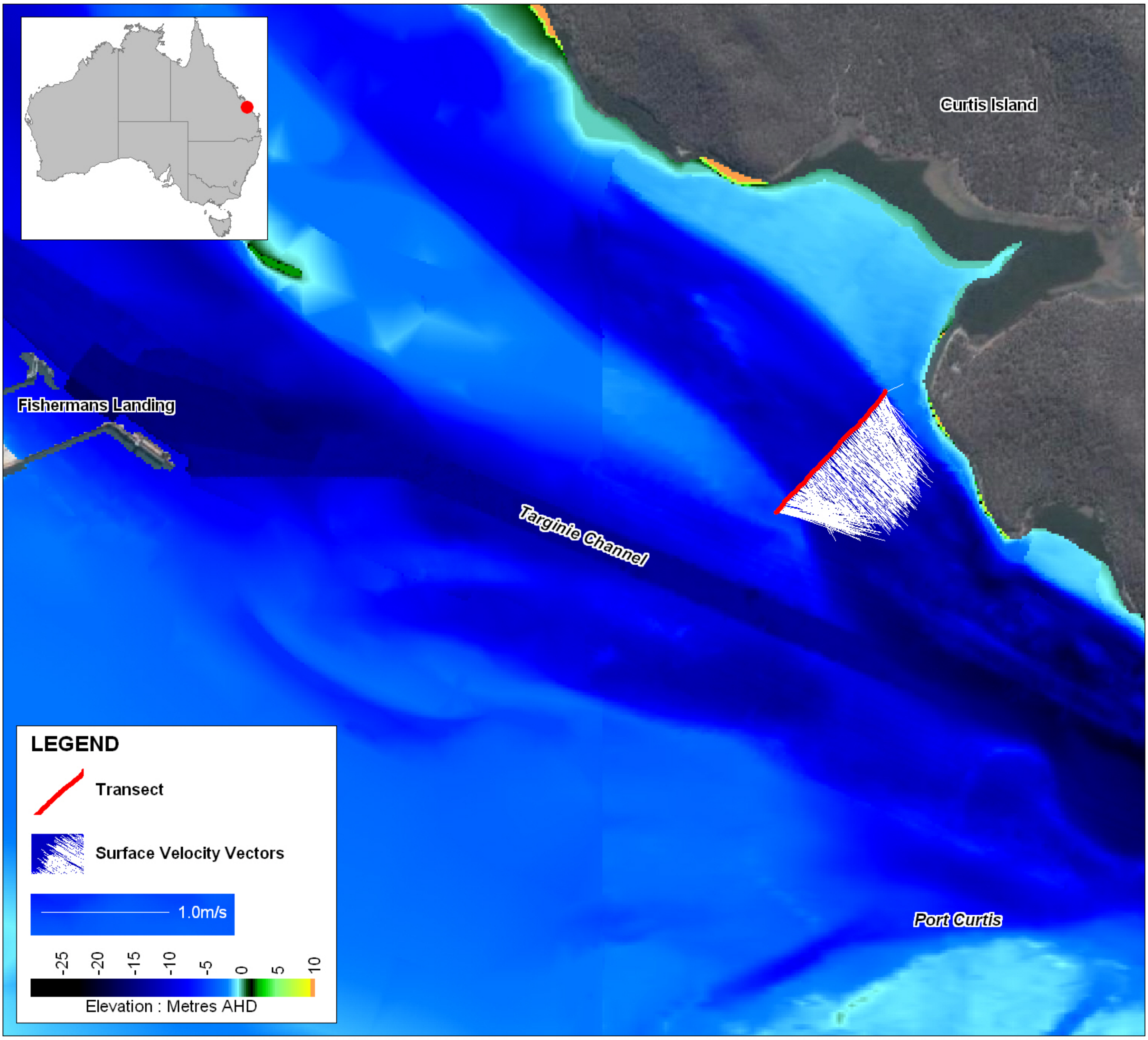

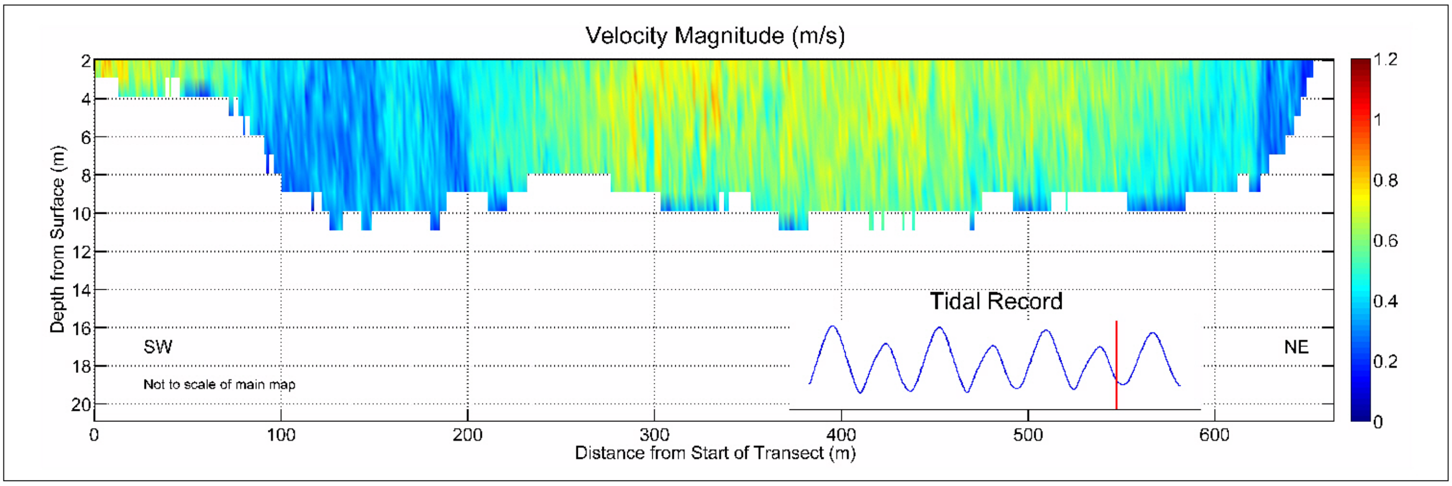

Title:

ADCP Transect 34 - Campaign 2

Figure: **5-79**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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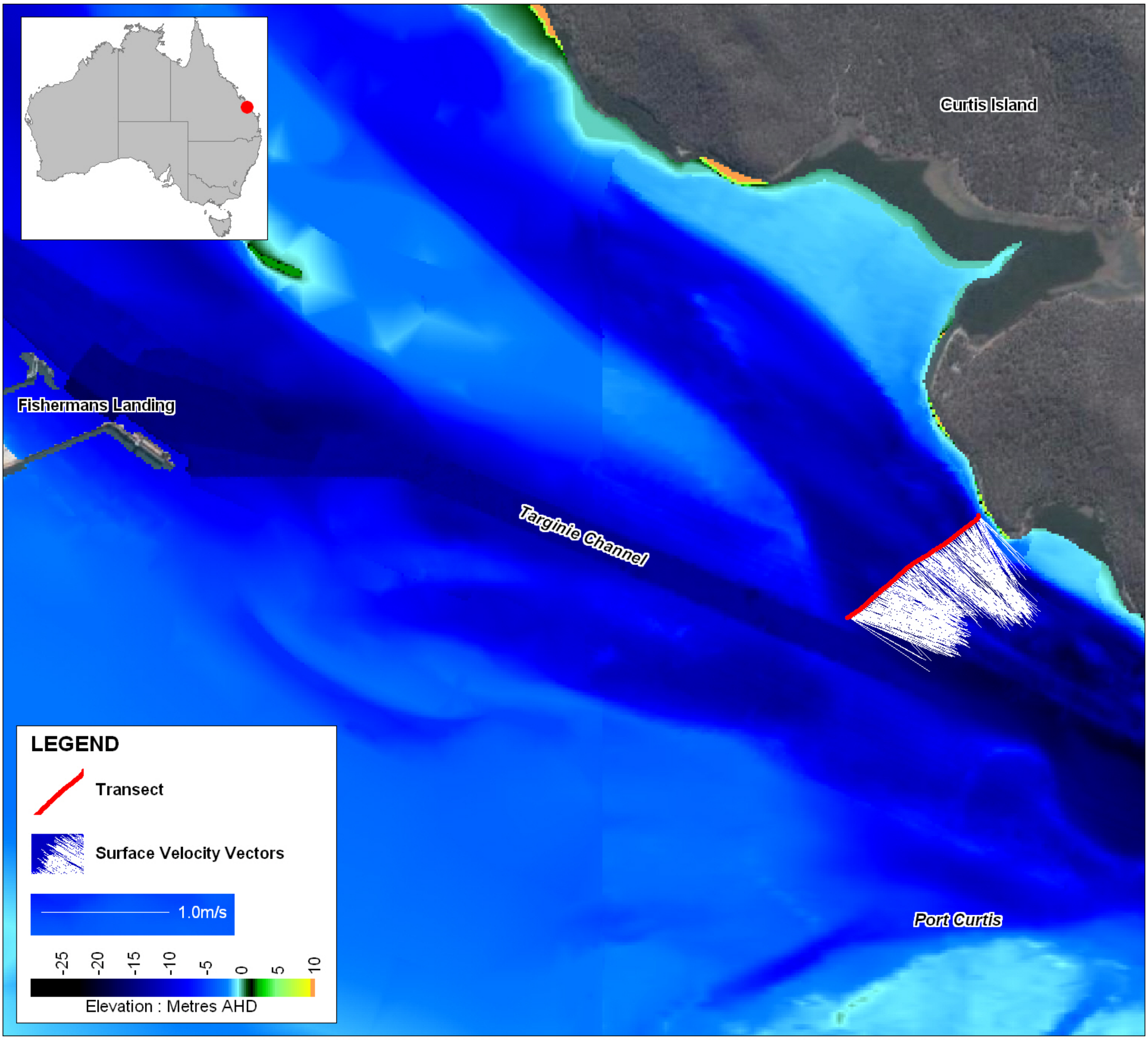

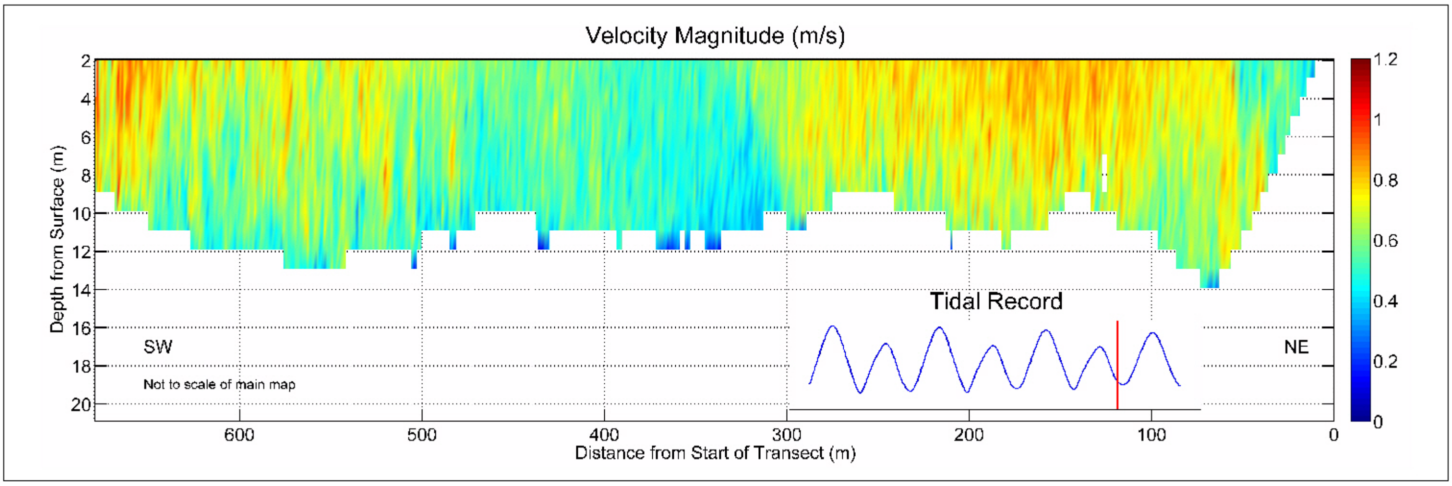

Title:

ADCP Transect 35 - Campaign 2

Figure:

5-80

Rev:

A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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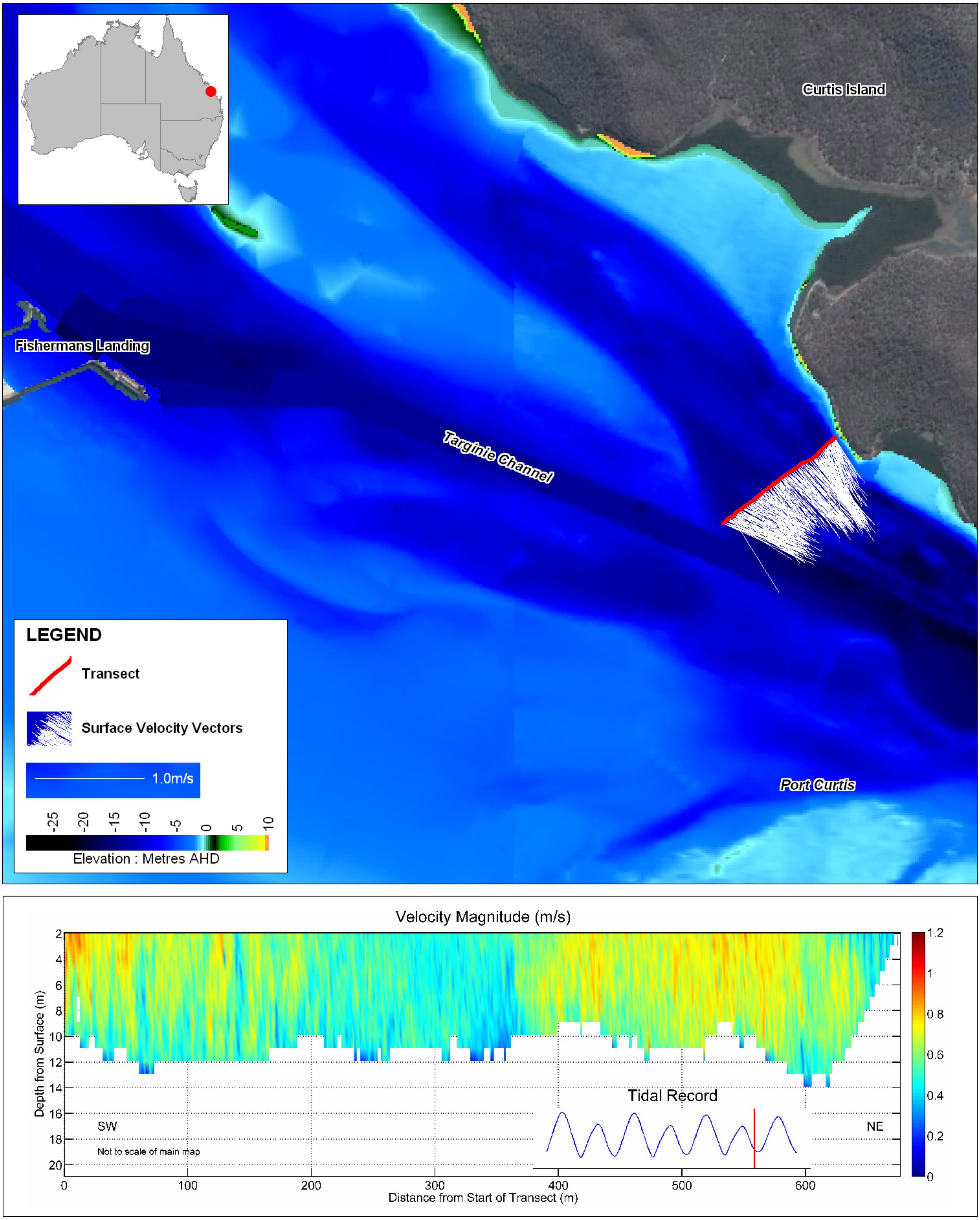

Title:

ADCP Transect 36 - Campaign 2

Figure: **5-81**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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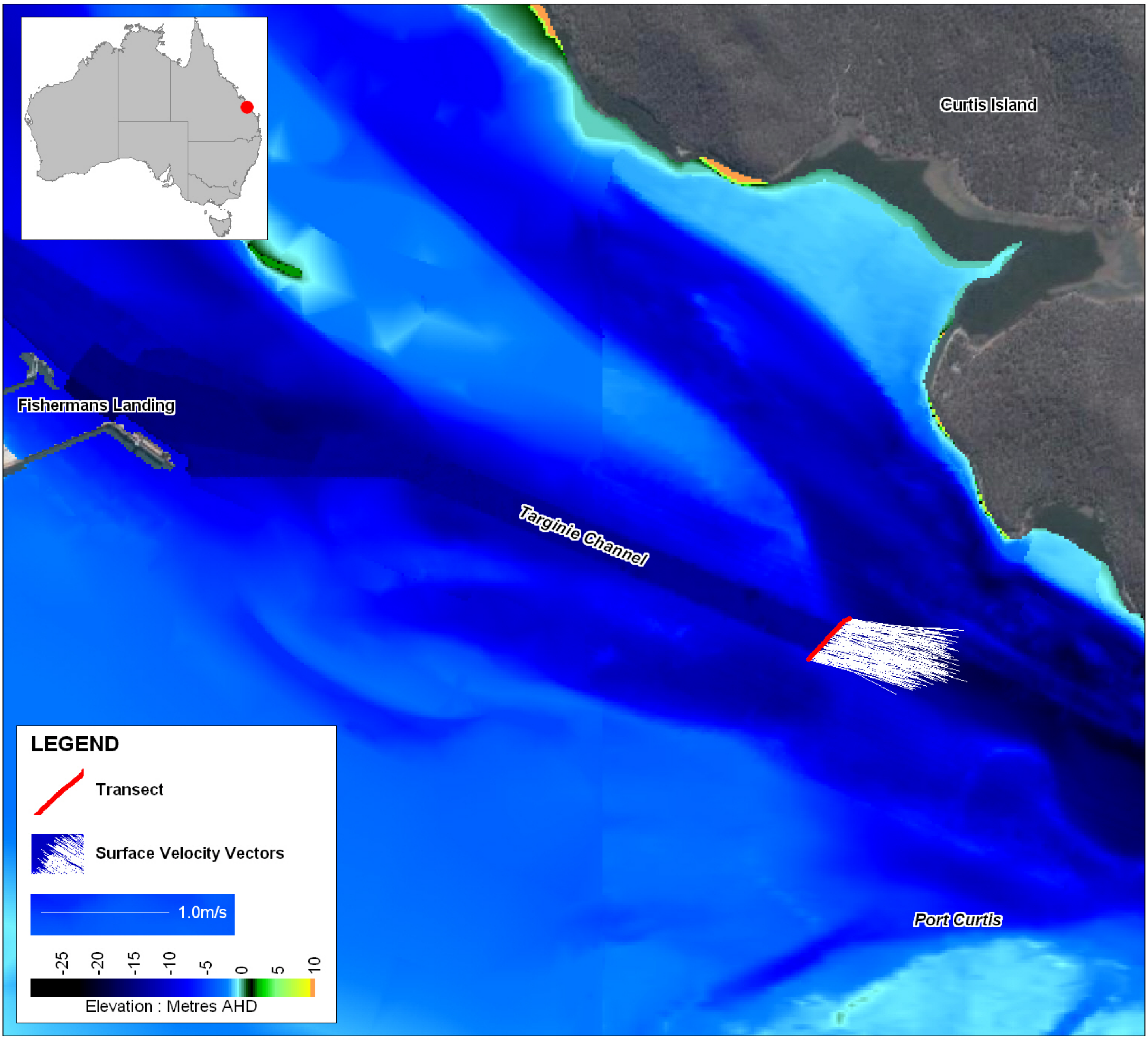

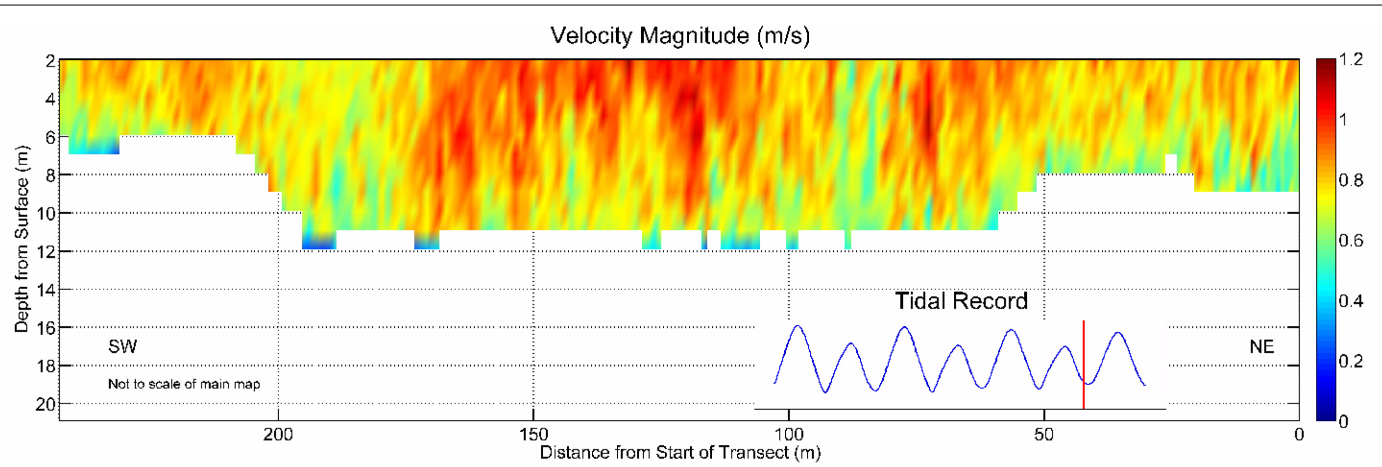

Title:

ADCP Transect 37 - Campaign 2

Figure: 5-82

Rev: A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

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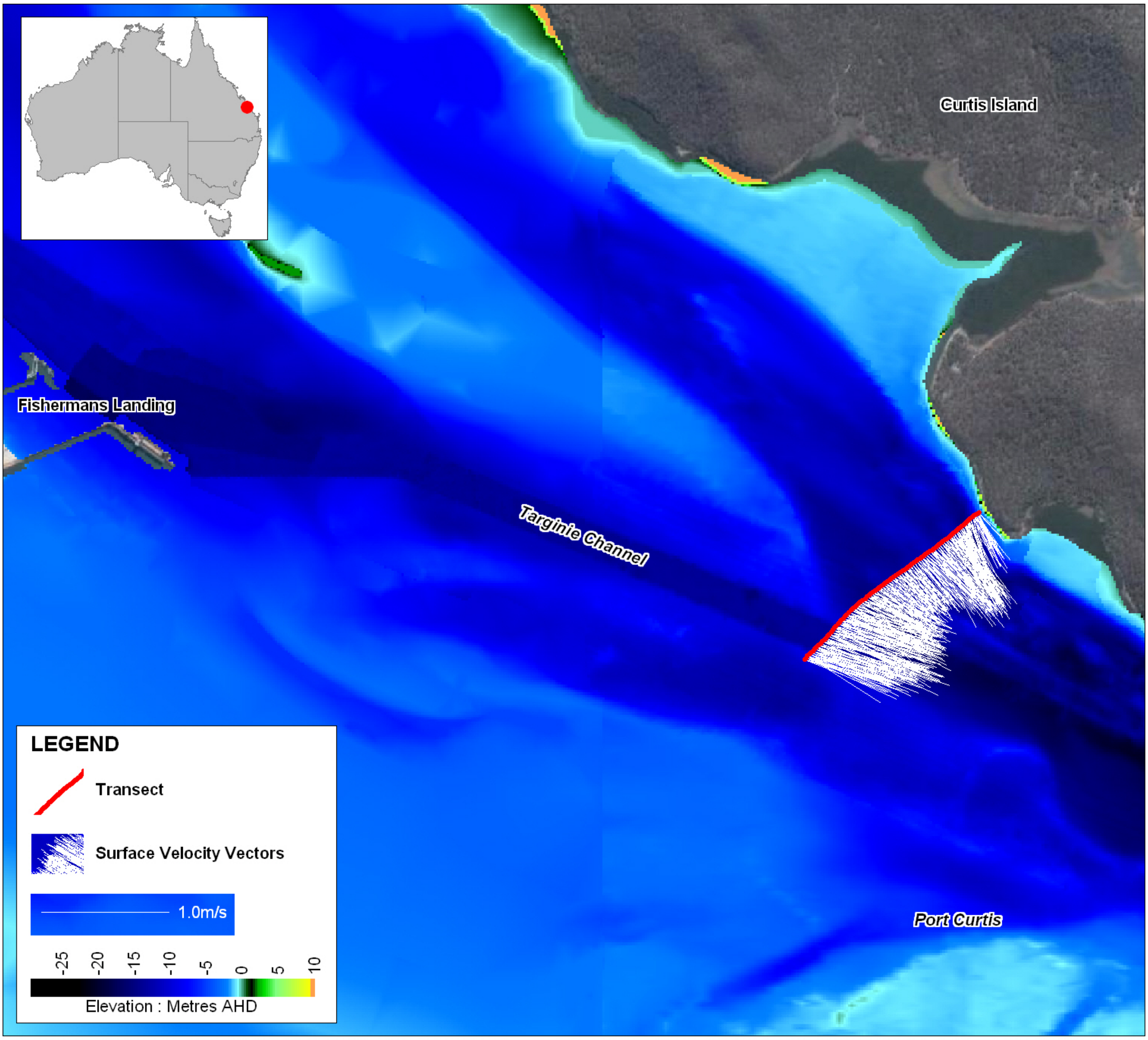

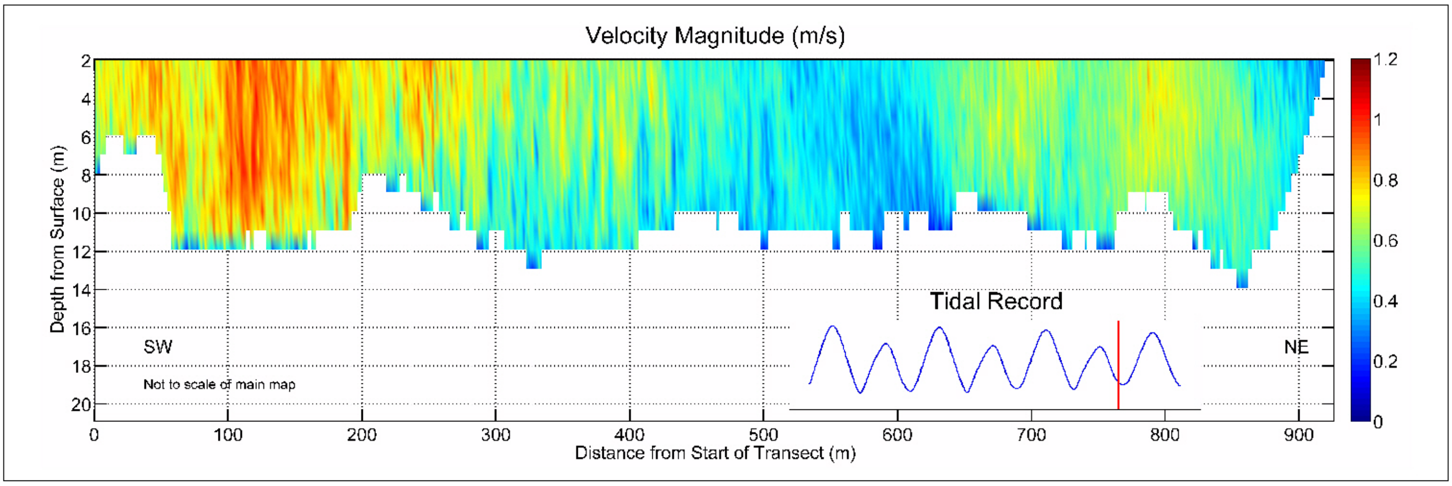

Title:

ADCP Transect 38 - Campaign 2

Figure:

5-83

Rev:

A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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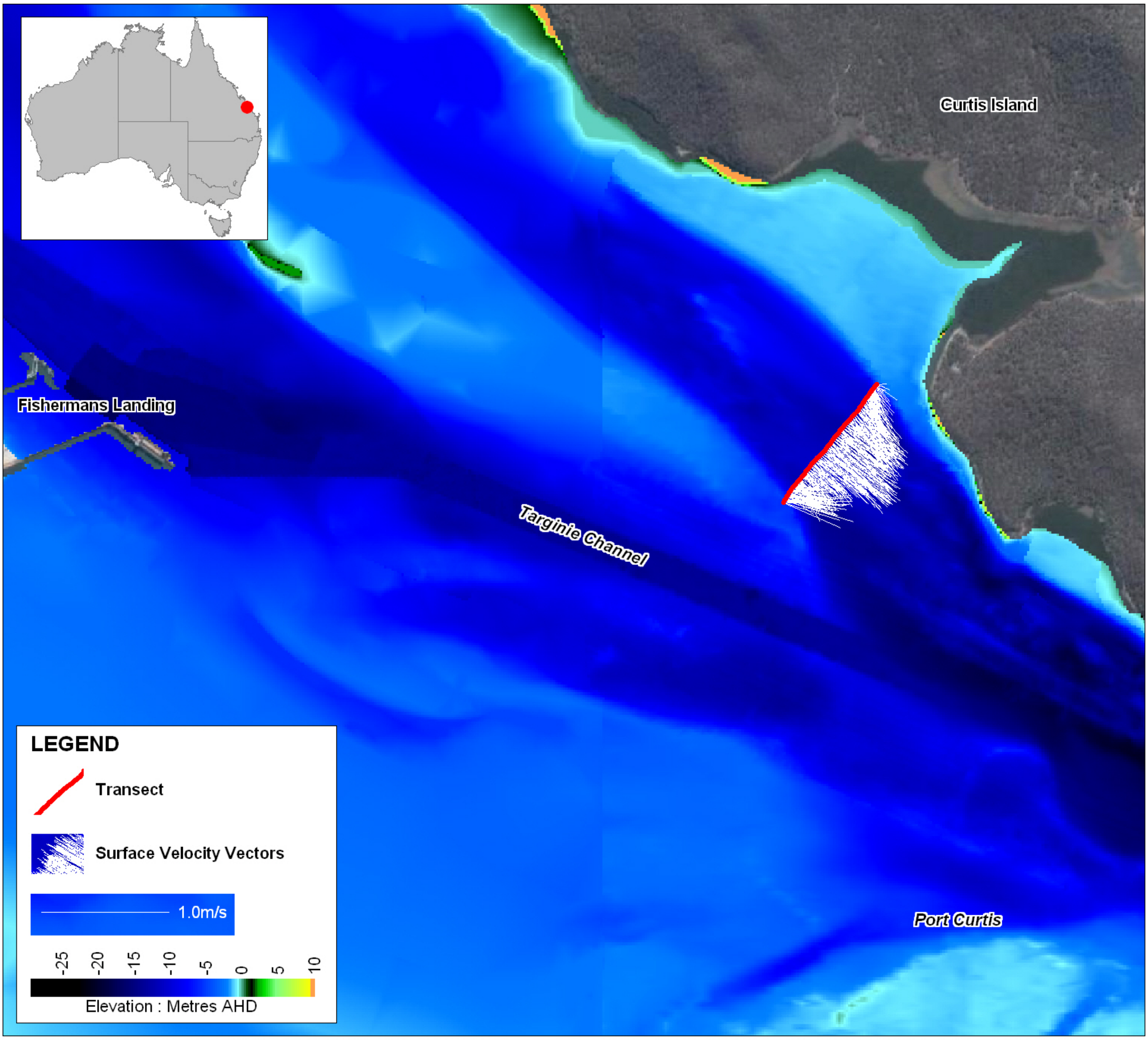

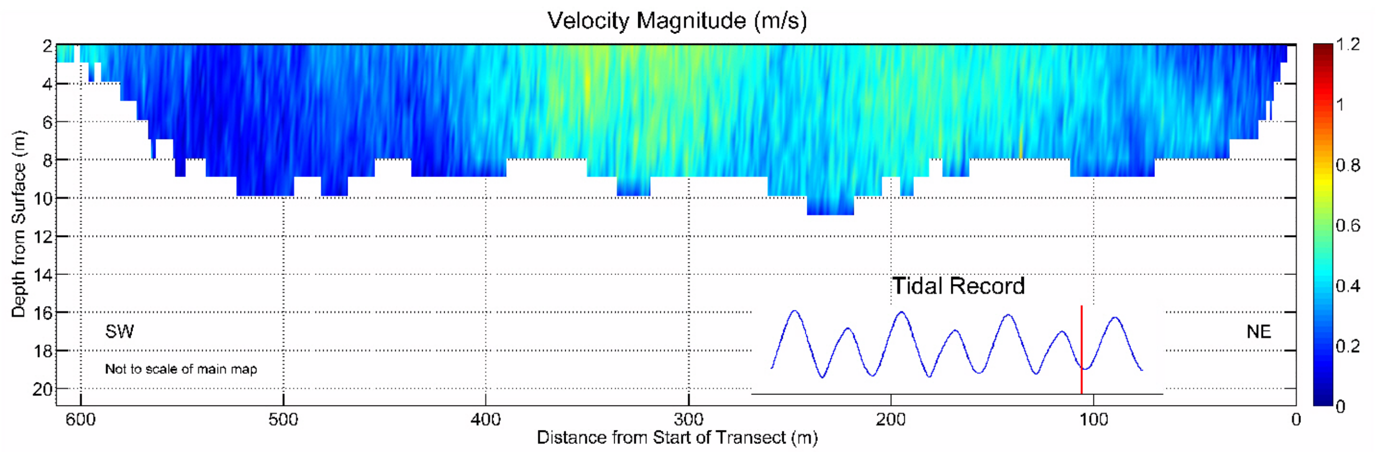

Title:

ADCP Transect 39 - Campaign 2

Figure:

5-84

Rev:

A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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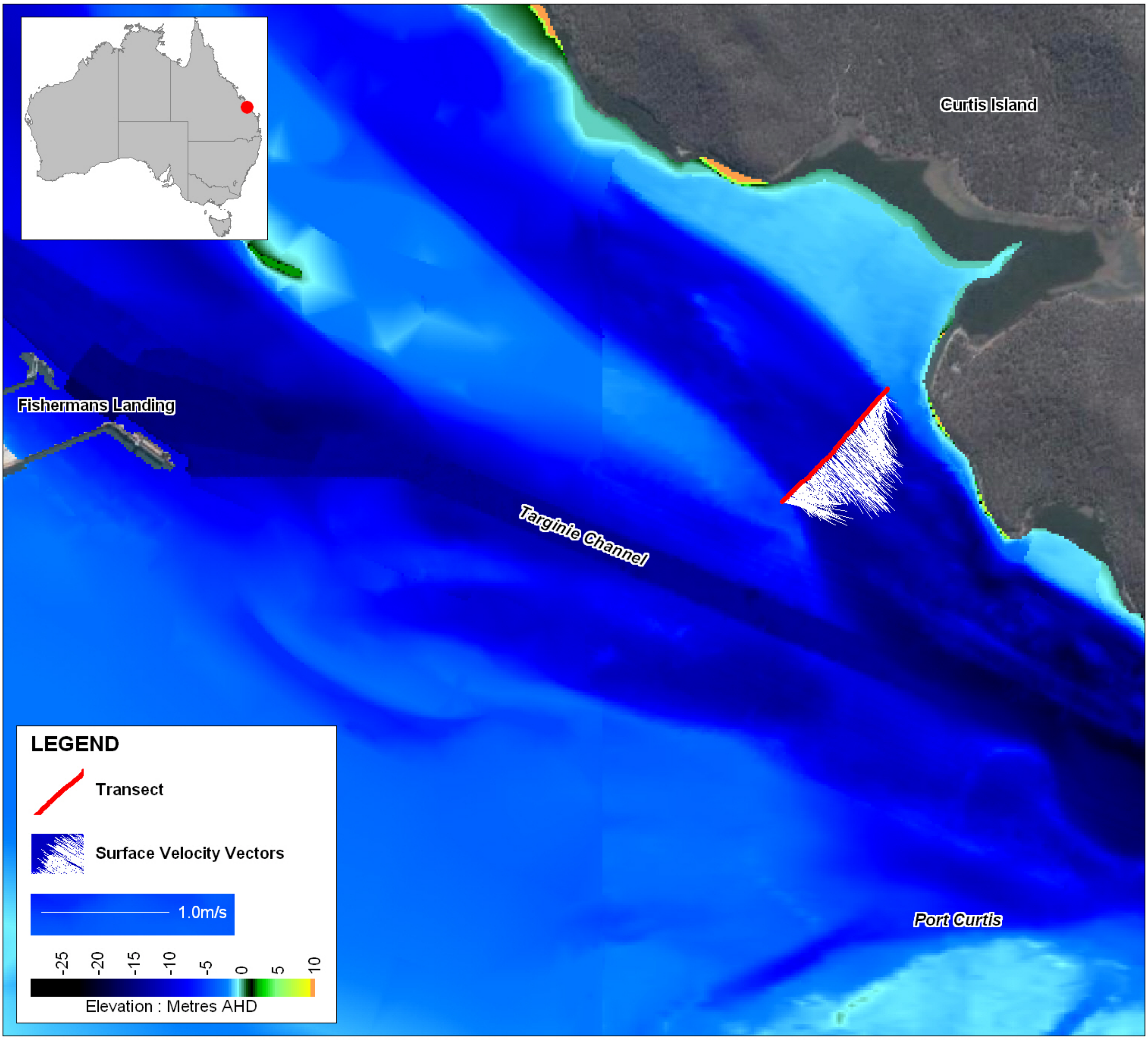

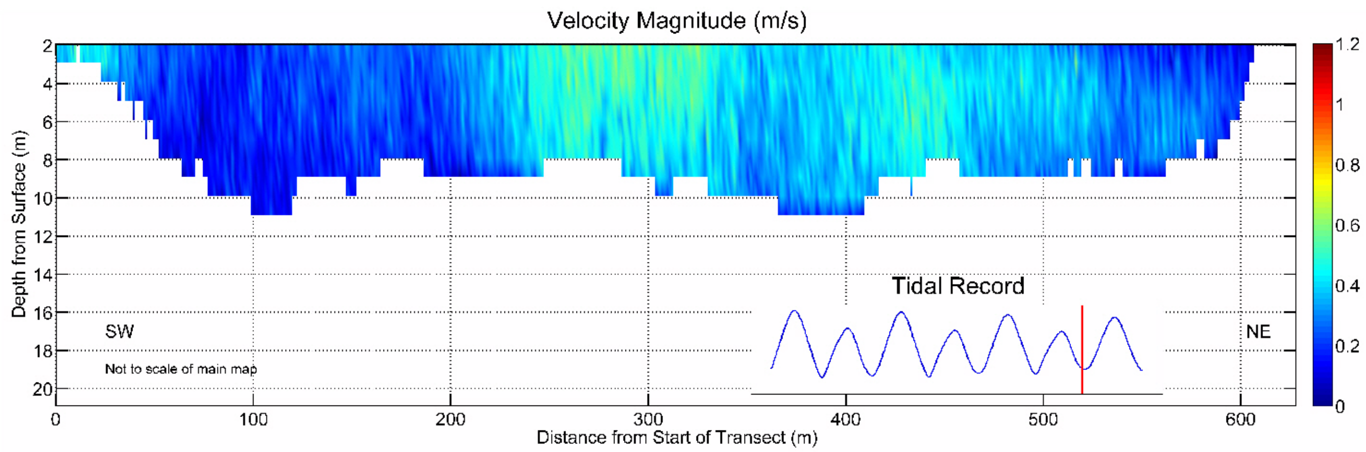

Title:

ADCP Transect 40 - Campaign 2

Figure: **5-85**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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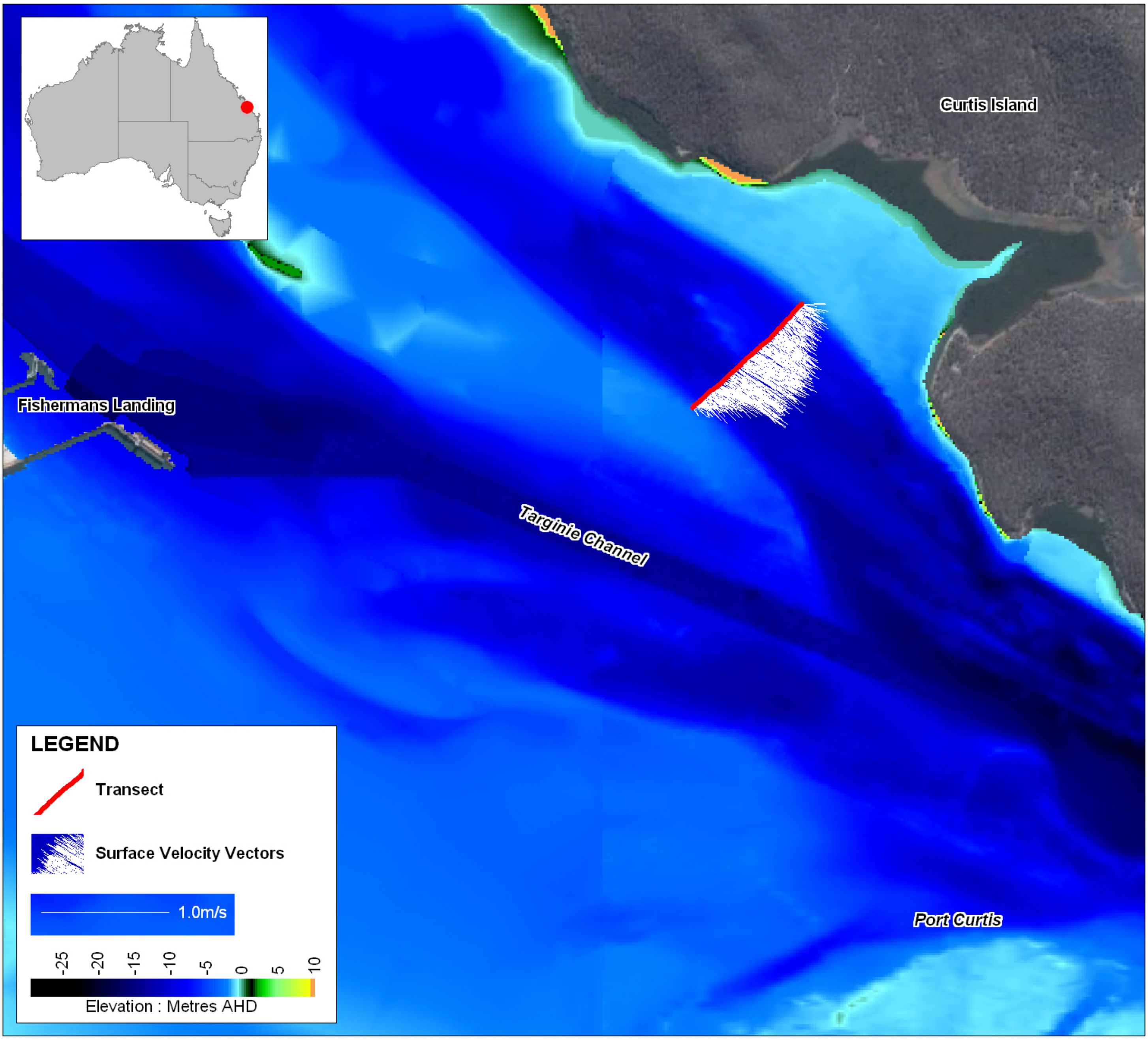

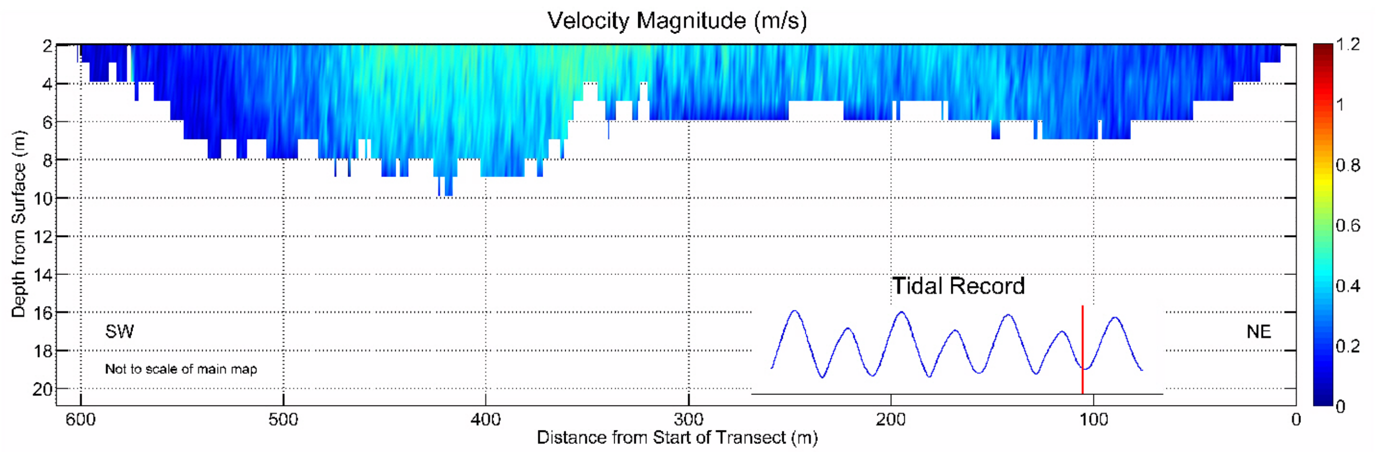

Title:

ADCP Transect 41 - Campaign 2

Figure: **5-86**

Rev: **A**

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

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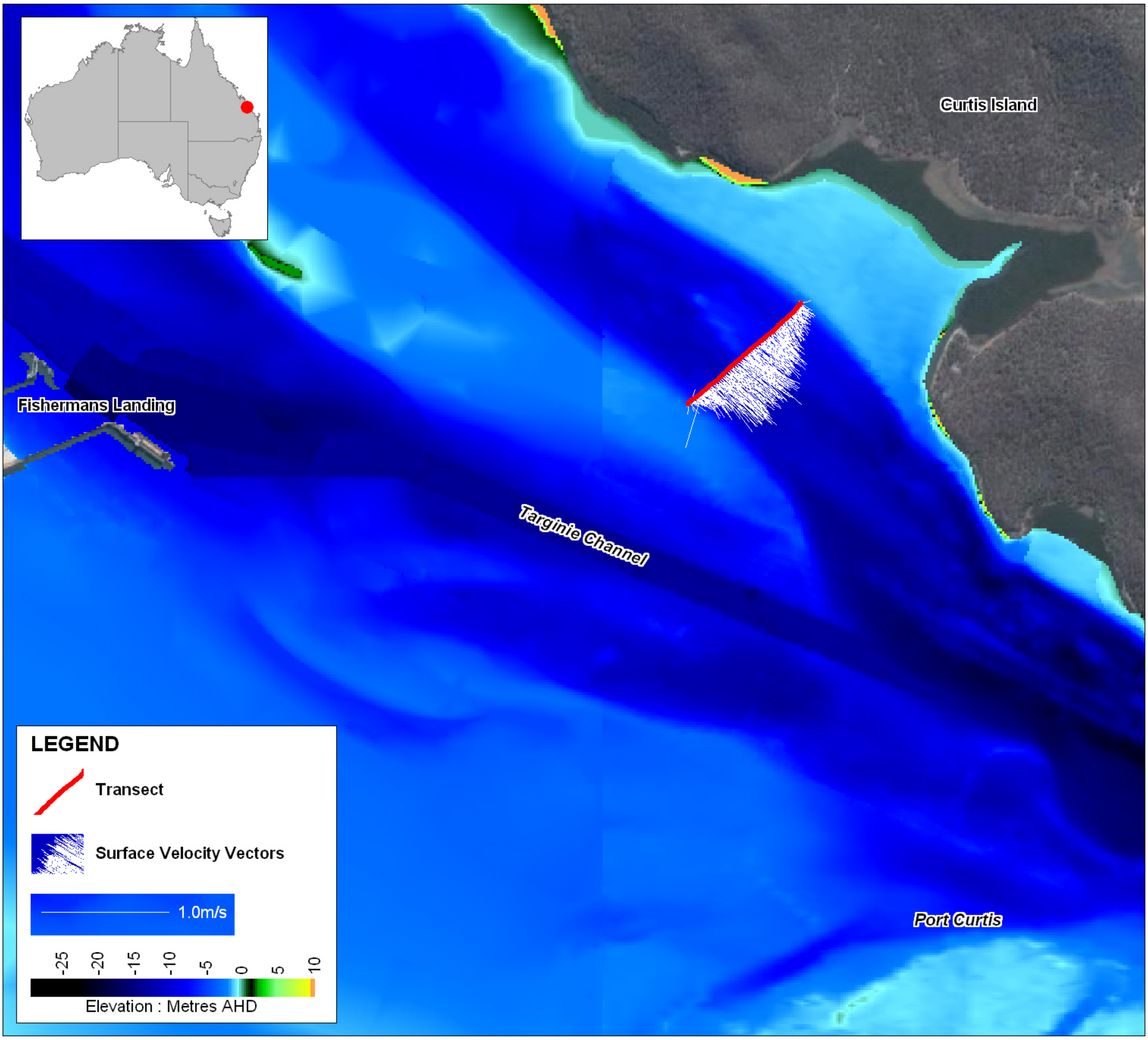

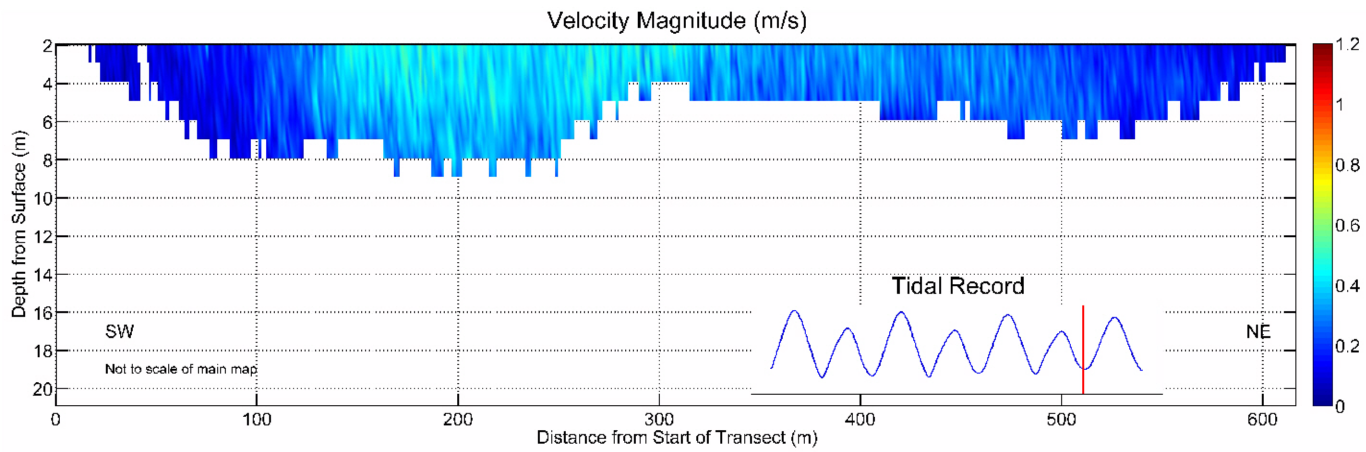

Title:

ADCP Transect 42 - Campaign 2

Figure: **5-87**

Rev: **A**

N

0 0.5 1km
Approx. Scale - Main Map

BMT WBM
www.wbmpl.com.au

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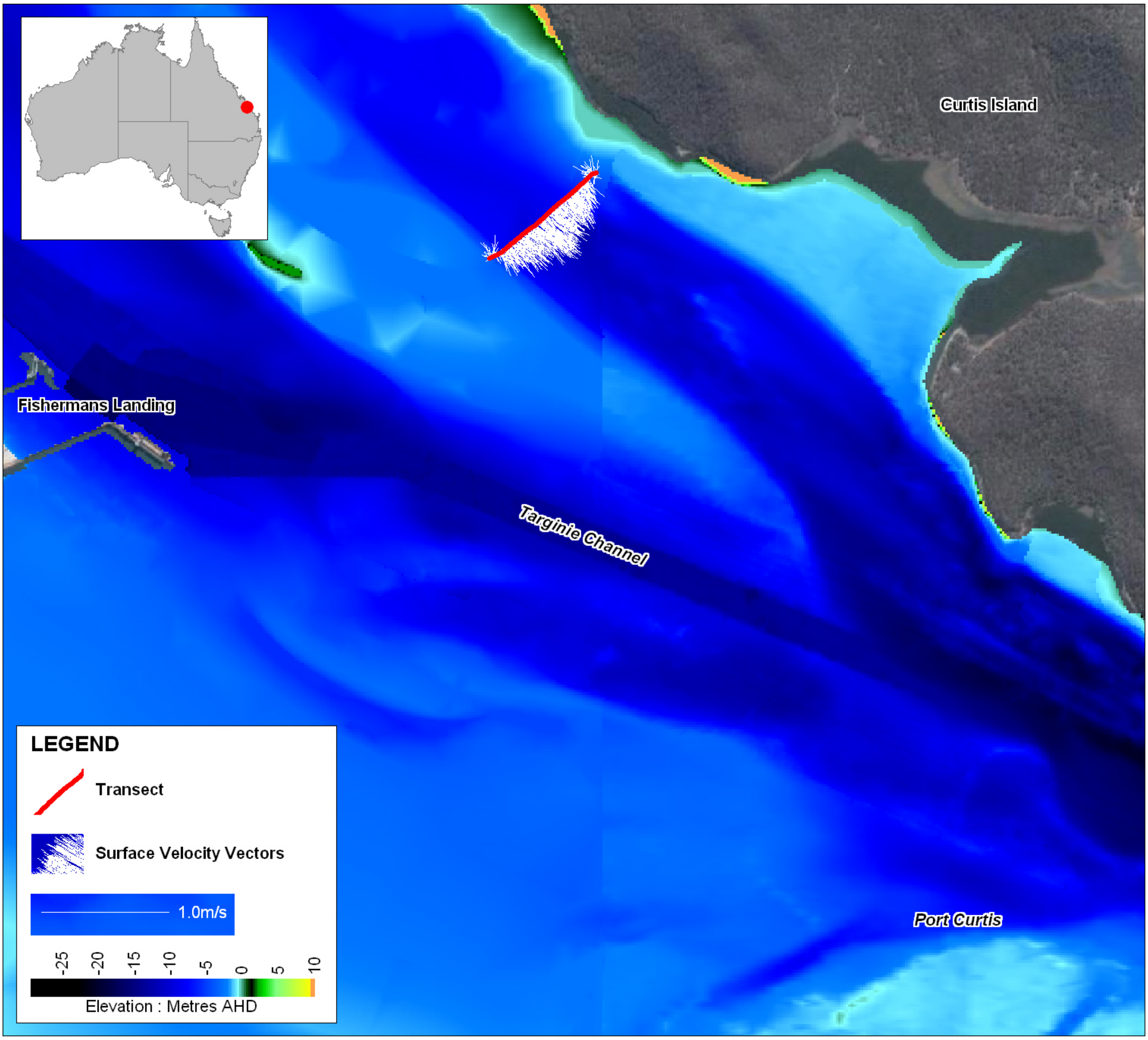
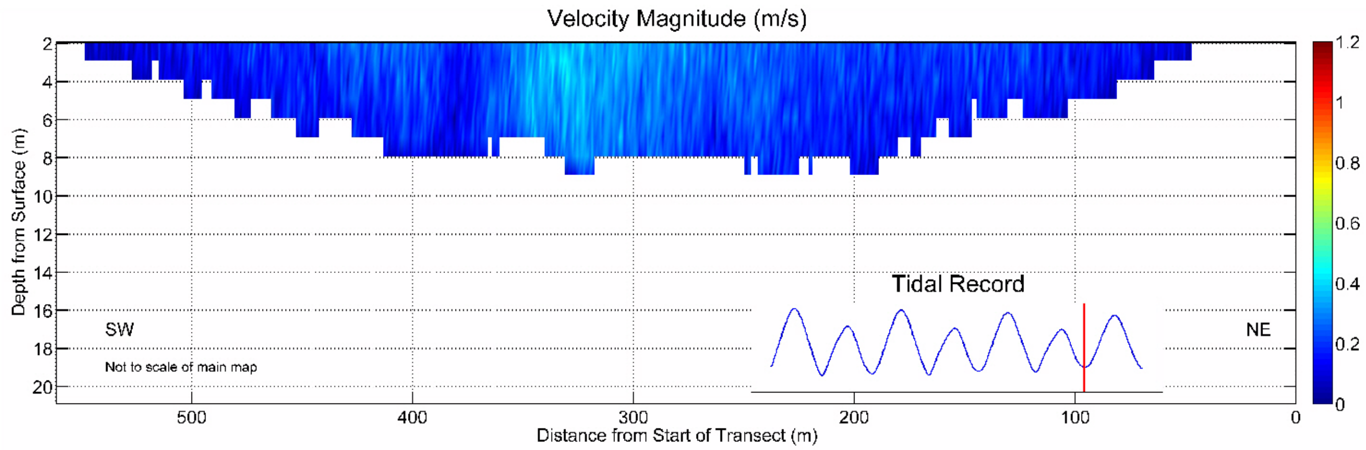




Title:

ADCP Transect 43 - Campaign 2

Figure: **5-88**

Rev: **A**

N

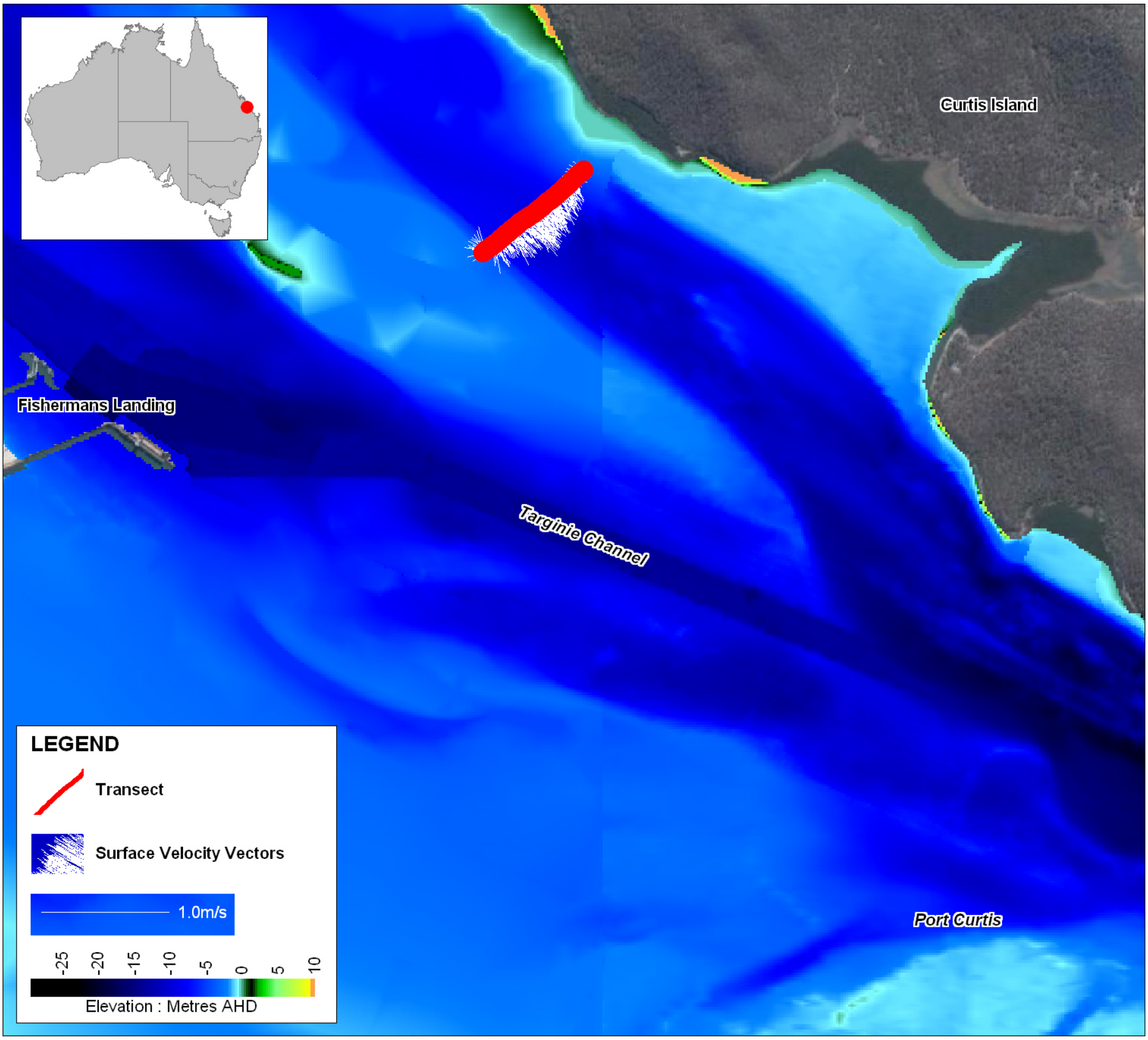
0 0.5 1km

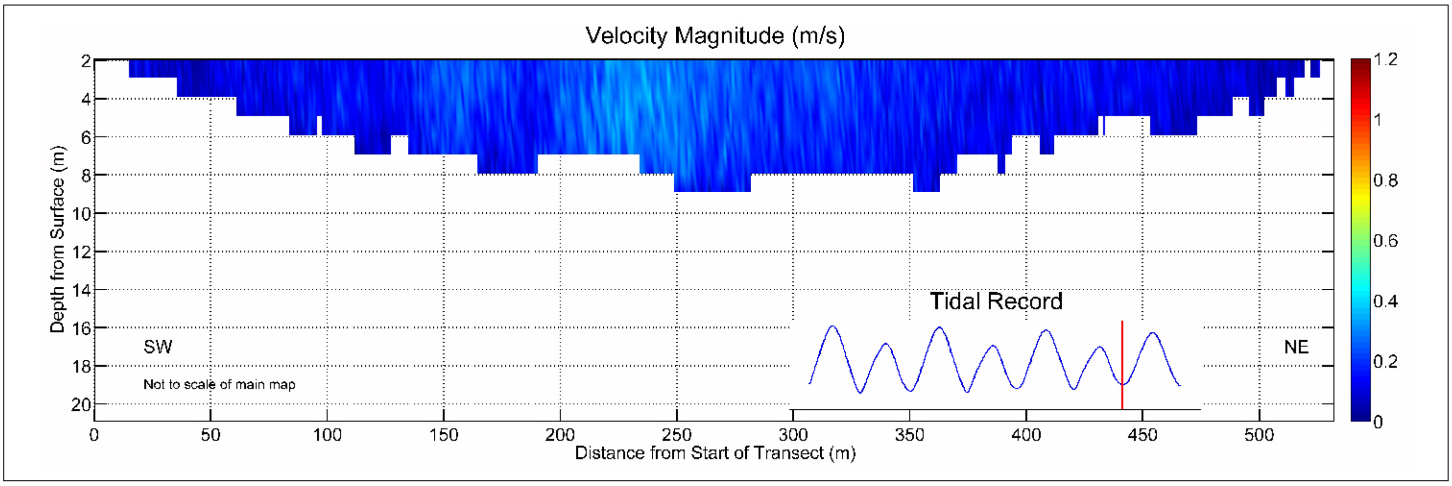
Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_077_080701_5090_Collage.wor





Title:

ADCP Transect 44 - Campaign 2

Figure:

5-89

Rev:

A

N

0 0.5 1km

Approx. Scale - Main Map

BMT WBM

www.wbmpl.com.au

Filepath : I:\B16752_I_BRH_GLNG\DRG\WQU_078_080701_5091_Collage.wor

5.7.5 Physical Water Quality Measurements

The YSI instrument was cast at the locations shown in Figure 5-13 and Figure 5-14. The timings of all casts relative to each tide are shown in Figure 5-90 and Figure 5-91. For Campaign 1, these casts were largely at, or near, the bottom of the tide, with the exception of the last 4 measurements, which were taken as a flood tide commenced. As such, any tidal influence on YSI measurements is small for that campaign. There was a greater temporal spread of YSI casts in Campaign 2, due in part to the need to collect coincident water quality grab samples. Given this difference, the casts from both campaigns are described separately below.

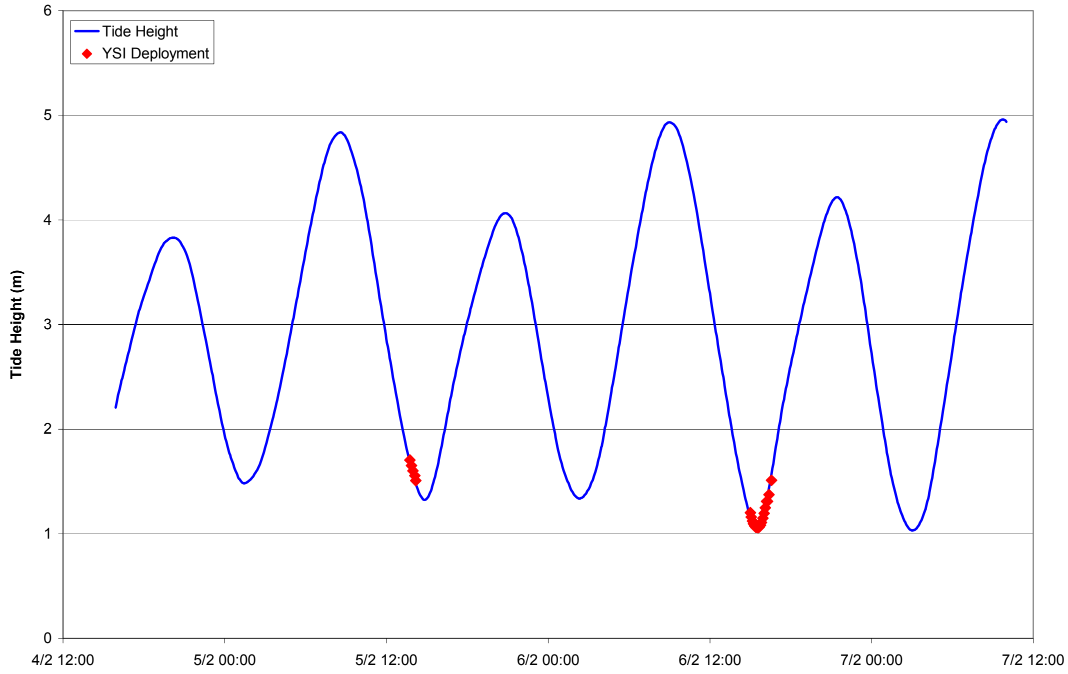


Figure 5-90 YSI Cast Times – Campaign 1

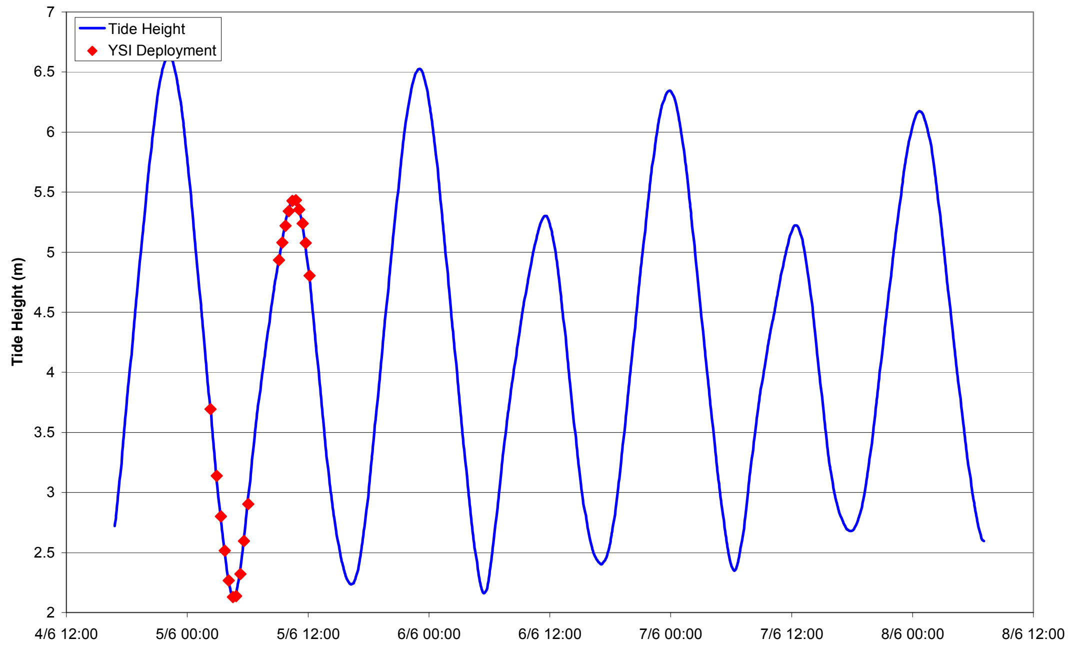


Figure 5-91 YSI Cast Times – Campaign 2

5.7.5.1 Campaign 1

Turbidity

Given the small tidal influence for Campaign 1, turbidity data has been spatially analysed. To this end, the profiles have been grouped into three areas: northern (profiles 1 to 8), mid (profiles 9 to 16) and southern (profiles 17 to 20). Profiles 20 to 23 are essentially replicates collected as the flood tide began, and as such they are presented separately. Results under these spatial groupings are presented below.

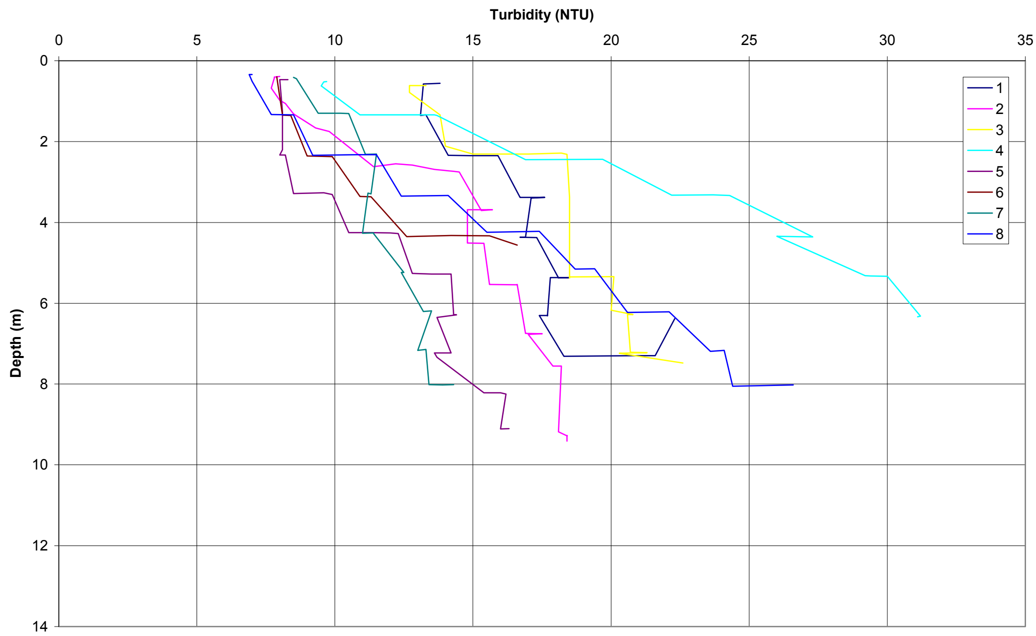


Figure 5-92 Northern Sites Turbidity – Campaign 1

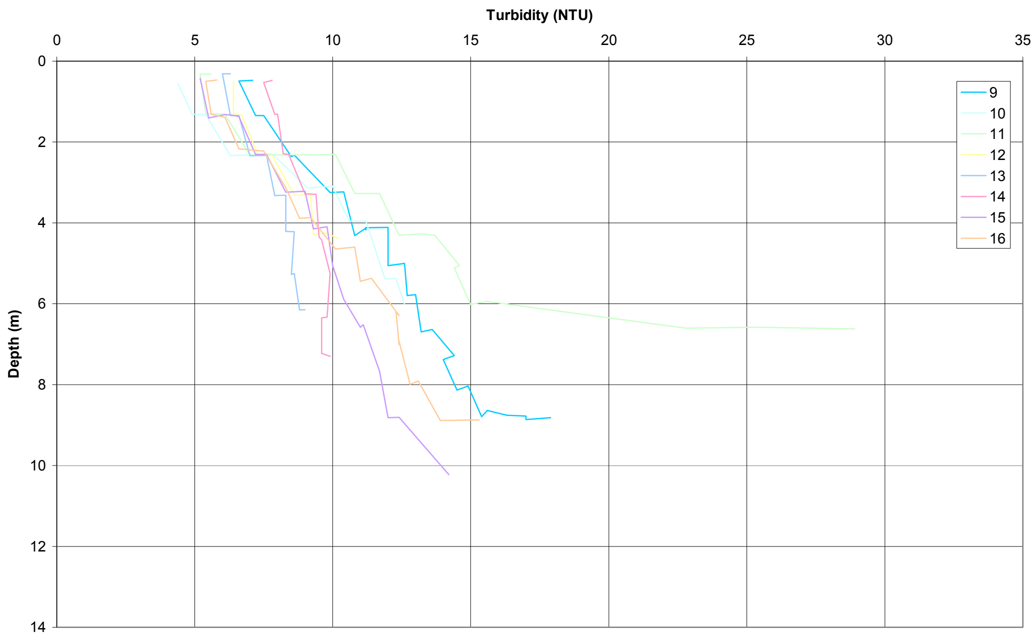


Figure 5-93 Mid Sites Turbidity – Campaign 1

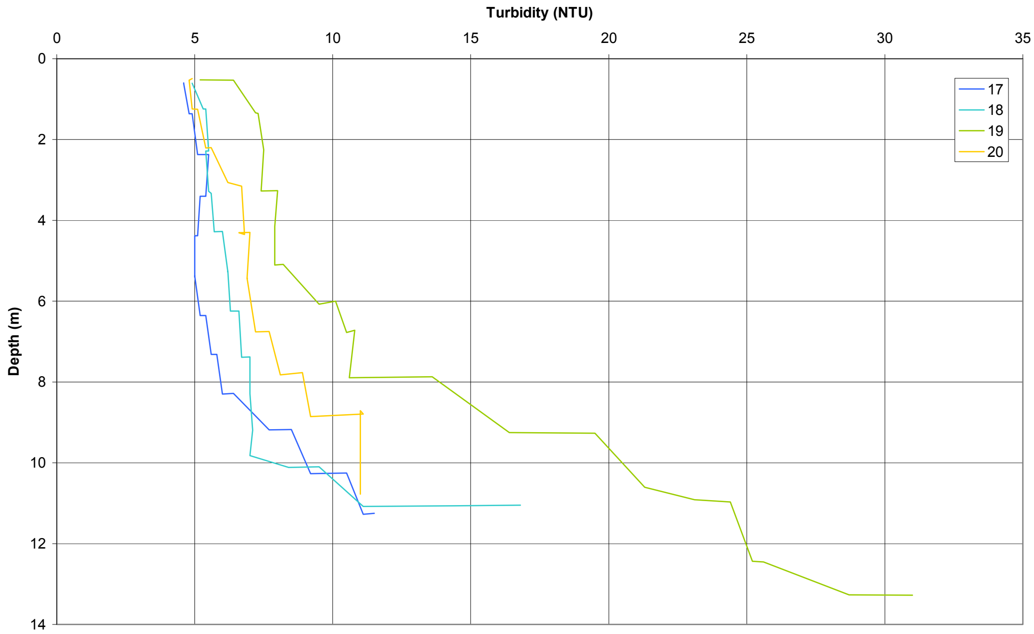


Figure 5-94 Southern Sites Turbidity – Campaign 1

Noting that the dataset is very small and should not be viewed as representative of long term trends in the area, there are nonetheless some features of the data that deserve comment.

The key feature of all profiles, regardless of location, is the observed increase in turbidity with depth. This is consistent with bedload resuspension being an important process contributing to water column turbidity in the system. This is a well-know characteristic of the Port Curtis marine environment.

The second observation is that there appears to be a gradient in ambient turbidity from north to south, within the constraints of the data set size. This gradient is from approximately 15 NTU in the north to

7 NTU in the south, at mid depth. The S4 measurements at both the north and south locations (which correspond approximately to the spatial divisions adopted in this analysis) over the preceding ebb tides of all measurements show that the northern location consistently experienced peak tidal velocities approximately 10 cm/s greater than in the south (see Figure 5-17 and Figure 5-18). These elevated velocities and turbidities in the northern region are thus again consistent with the notion of tidal bedload resuspension influencing water column turbidity.

This potential relationship was identified in the field after a brief review of the above YSI data, and as such a final suite of profiles was collected at a single (southern) location at the onset of a flooding tide. The results are shown in Figure 5-95.

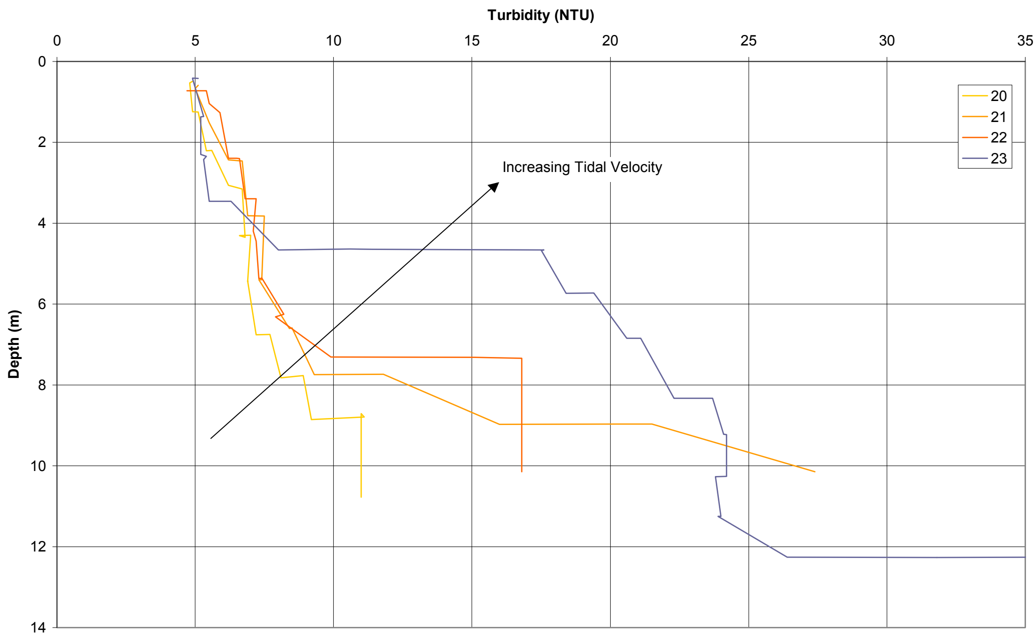


Figure 5-95 YSI Turbidity Profiles at a Single Location during the onset of a Flood Tide – Campaign 1

The data in the figure are again consistent with tidal resuspension of bedload, in that the turbidity profiles show increasing turbidity with depth and time as the flood tide intensifies.

pH

All pH data from Campaign 1 is plotted in Figure 5-96.

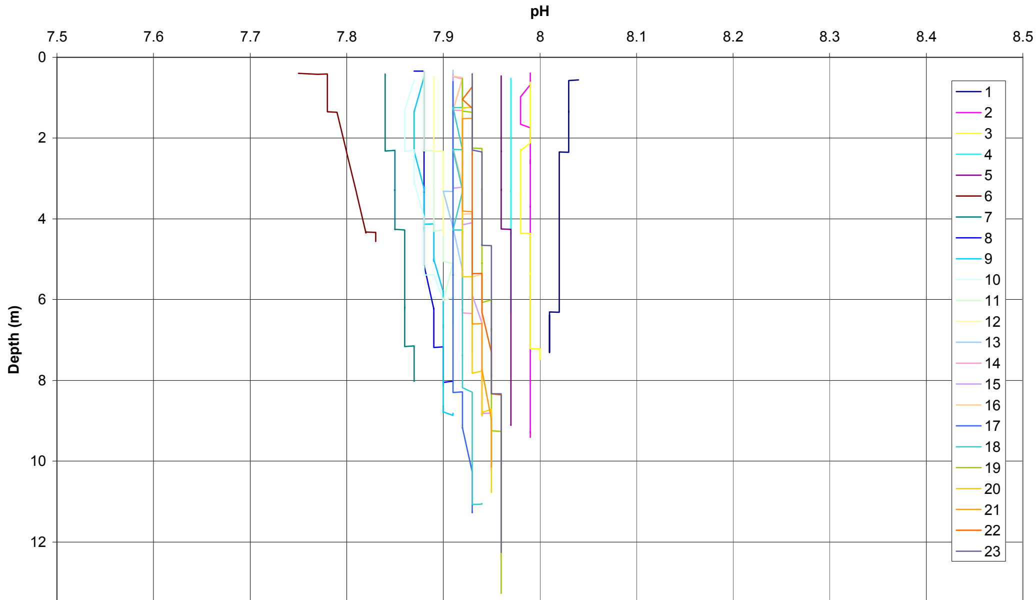


Figure 5-96 YSI pH Profiles – Campaign 1

There is little variation in the data, with all measurements being within the typical 'neutral' range. As such, spatial analysis has not been undertaken.

<u>Salinity</u>

All salinity data is plotted in Figure 5-97.

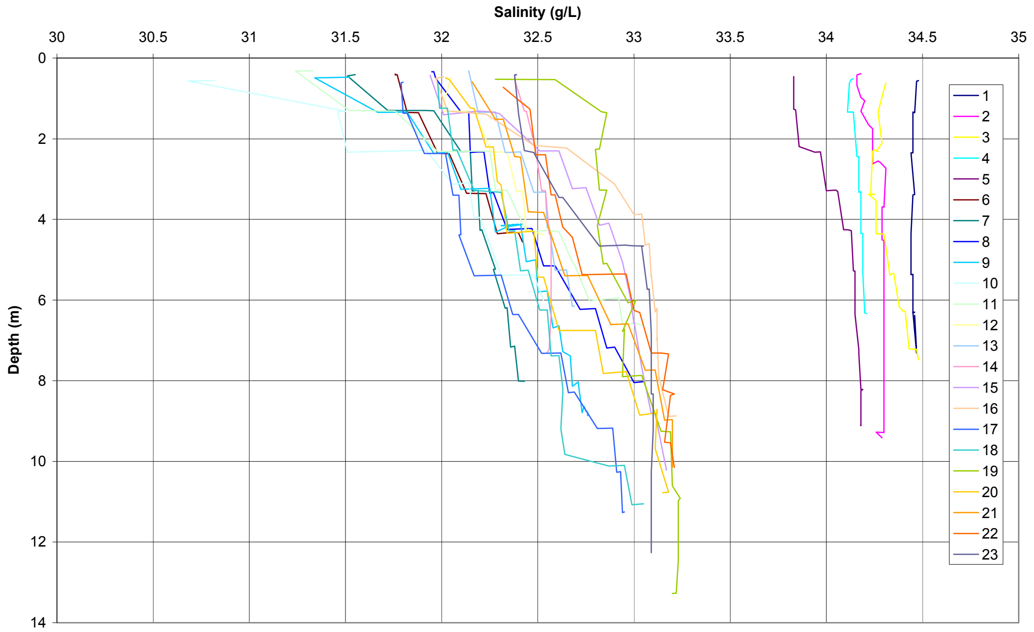


Figure 5-97 YSI Salinity Profiles – Campaign 1

The salinity data appears divided into two groups: profiles 1 to 5 and profiles 6 to 23. The former consist of salinities typical of seawater, with little evidence of vertical stratification, whereas the remainder present lower salinities, with some evidence of stratification. Importantly, profiles 1 to 5 were collected on the 5th February, and the remainder the following day. Rainfall records for Gladstone over the period of the field study have been sourced, and are presented in Figure 5-98.

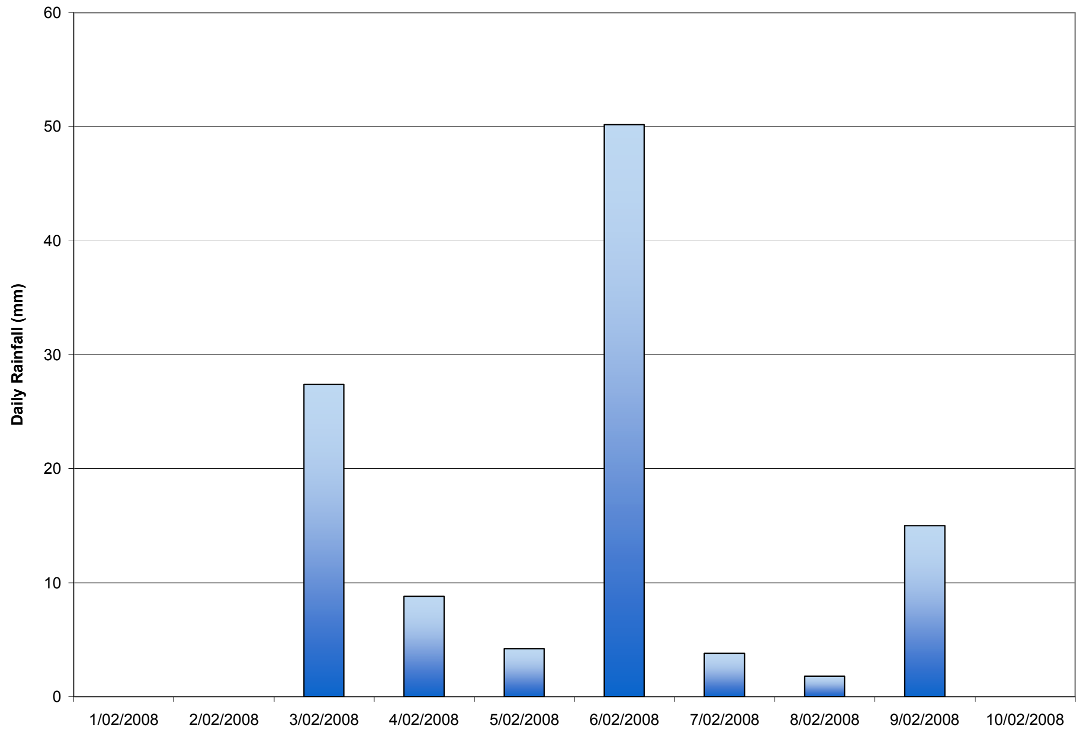


Figure 5-98 Rainfall Records For Gladstone, Early February 2008

The figure shows that considerable rainfall fell on the 6th February, and the field team's observations were that it fell largely in the very early morning, with little, if any, rain during the day. As such, it is expected that the observed reductions in salinity presented in Figure 5-97 are a direct result of fresh catchment inflows entering the system between sampling events on the 5th and 6th of February. This is consistent with qualitative field observations made near RG Tanna wharf on the morning of the 6th February, where significant fresh (and turbid) flows were seen exiting the Calliope River and heading out to sea with the ebbing tide. A photo of these outflows passing the RG Tanna wharf is shown below.

Figure 5-99 Interface of Calliope River Turbid Freshwater Outflow during Campaign 1

Other similar inflows are likely to have occurred in, and nearby, the survey region and contributed to the reductions in both overall salinity and slight vertical stratification.

<u>Temperature</u>

All temperature data is plotted in Figure 5-100.

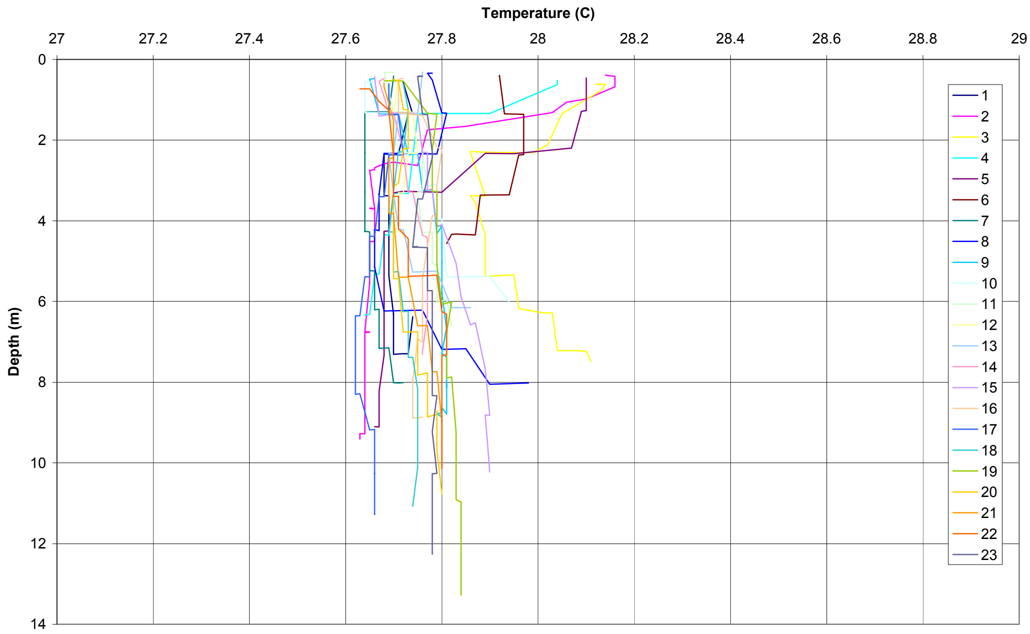


Figure 5-100 YSI Temperature Profiles – Campaign 1

Again, there is little variation in the data, with all measurements being in a typically expected range, with no evidence of strong thermal stratification. This is consistent with the area being a well-mixed, high-energy environment, as described in previous sections. Minor surface heating is observed in profiles 2 to 6, with profiles 2 to 5 being collected on the 5th February prior to the rain event described above. Whilst it is possible that the overnight rainfall may have dismantled this slight stratification, insufficient data exists to confirm this.

5.7.5.2 Campaign 2

<u>Turbidity</u>

In this second analysis, we have elected to exploit the greater temporal spread of casts around tidal maxima and minima to further investigate the potential influence of tidal currents on ambient turbidity. As such, all 10 high and low water turbidity casts are presented together in Figure 5-101 and Figure 5-102, respectively. Profiles were taken in order of their numerical label, from 1 to 10.

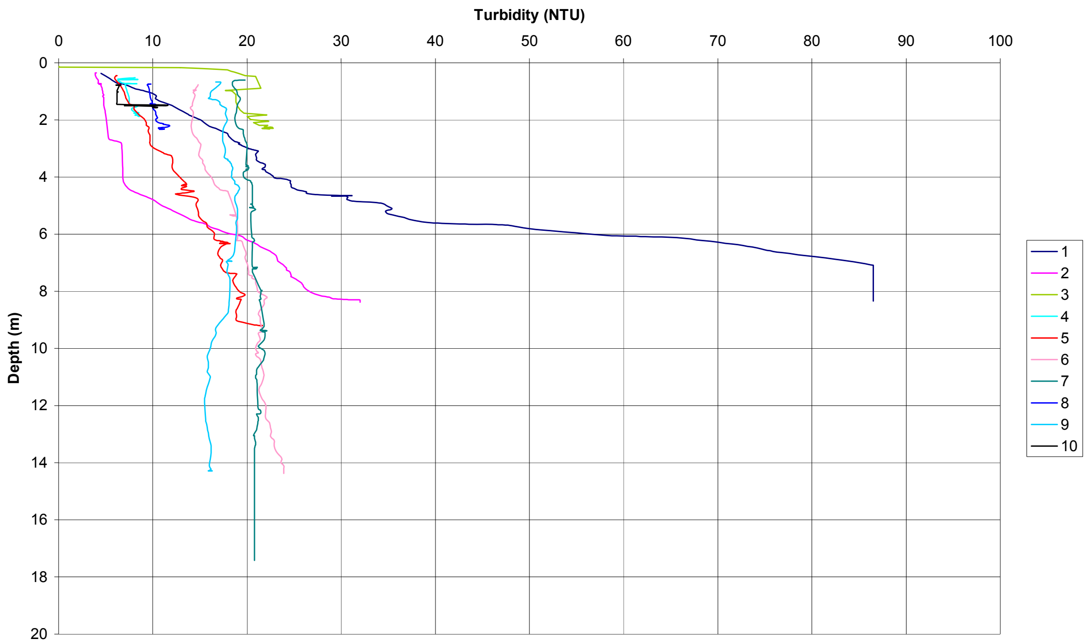


Figure 5-101 YSI Turbidity Profiles – Campaign 2 High Water

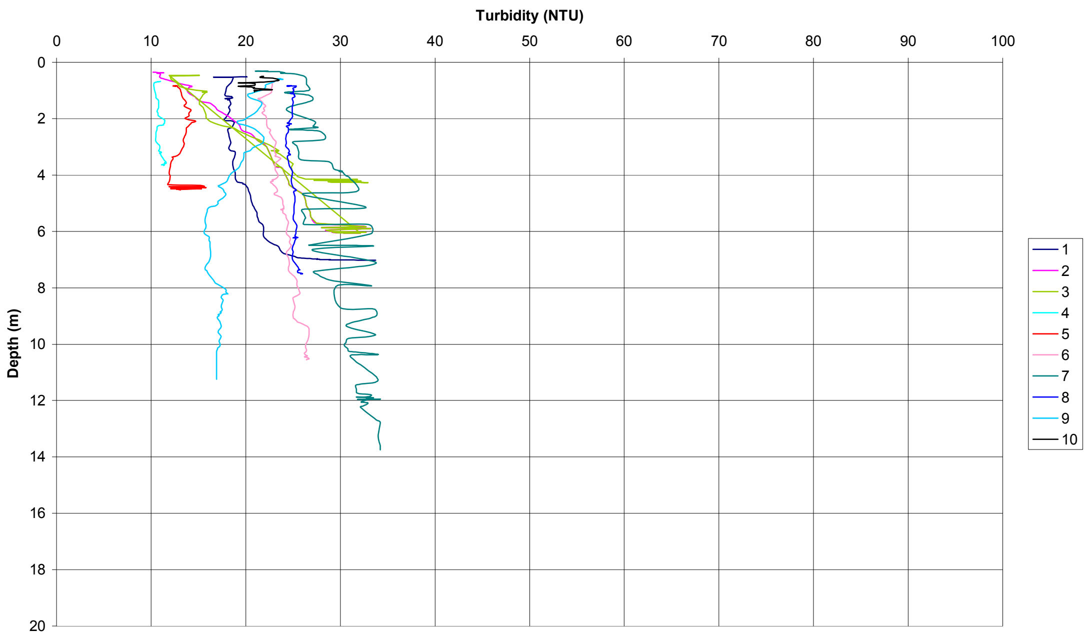


Figure 5-102 YSI Turbidity Profiles – Campaign 2 Low Water

In general, the magnitudes of the turbidities are similar to those of the first campaign. Both high and low tide surveys show evidence of decreasing vertical variation in turbidity with decreasing tidal velocity, and this is particularly pronounced in the high tide measurements. For example, profiles 1 and 2 show evidence of this stratification, whilst profiles 5, 6 and 7 do not, with the latter being collected close to the top of the tide and low tidal velocities. A similar, although less pronounced, trend is evident in the low tide measurements.

The turbidity timeseries data collected as part of Campaign 2 at the southern S4 site are presented below, together with the S4 speed data.

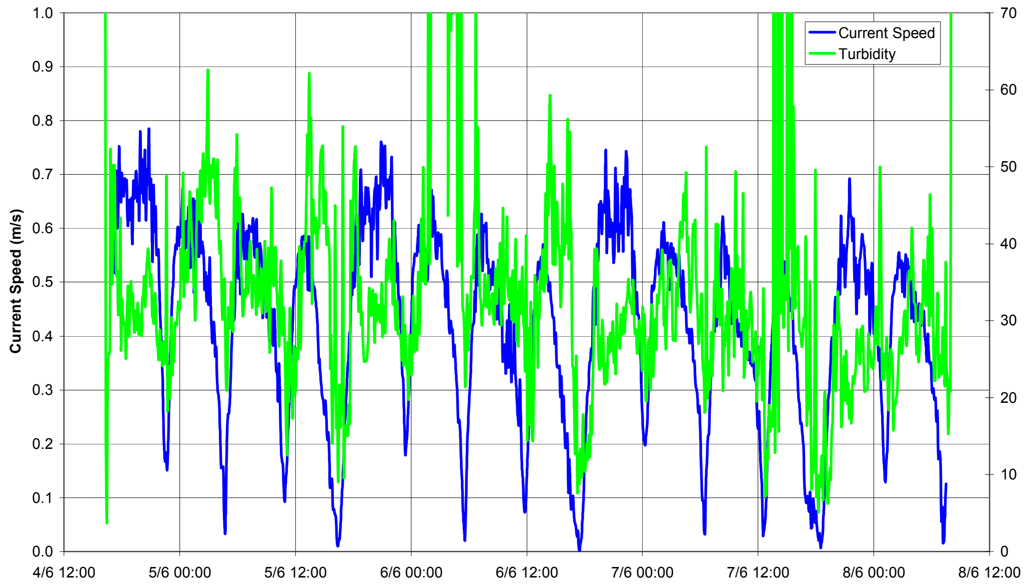


Figure 5-103 Turbidity Timeseries at Southern S4 Site – Campaign 2

The figure clearly demonstrates the relationship between tidal current speed and turbidity, with the peaks and troughs in both data sets generally being well aligned.

<u>pH</u>

High and low tide pH measurements are presented in Figure 5-104 and Figure 5-105.

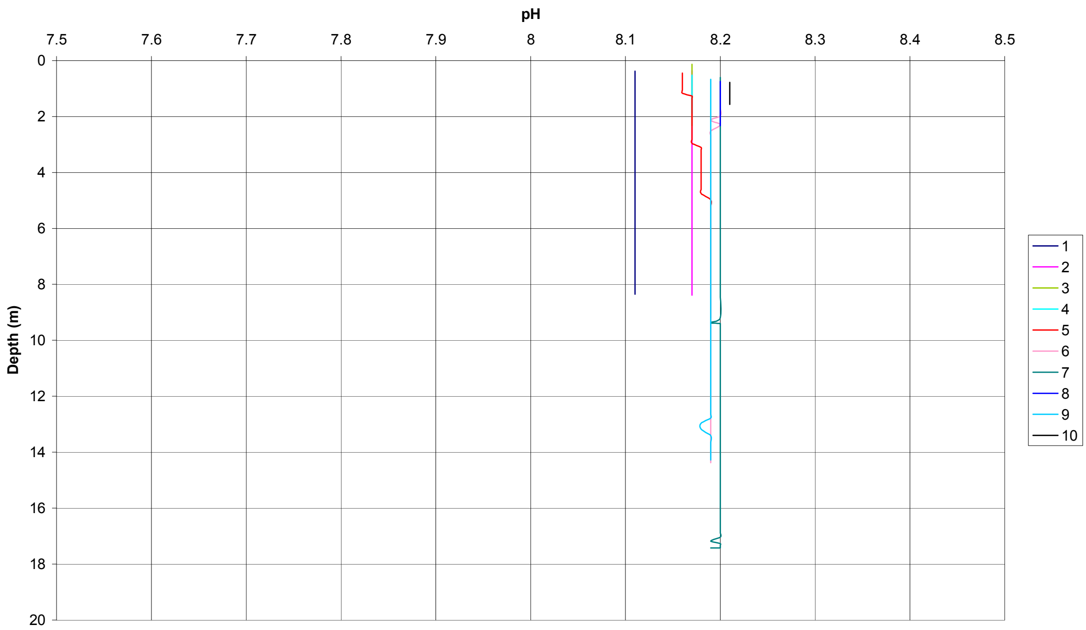


Figure 5-104 YSI pH Profiles – Campaign 2 High Water

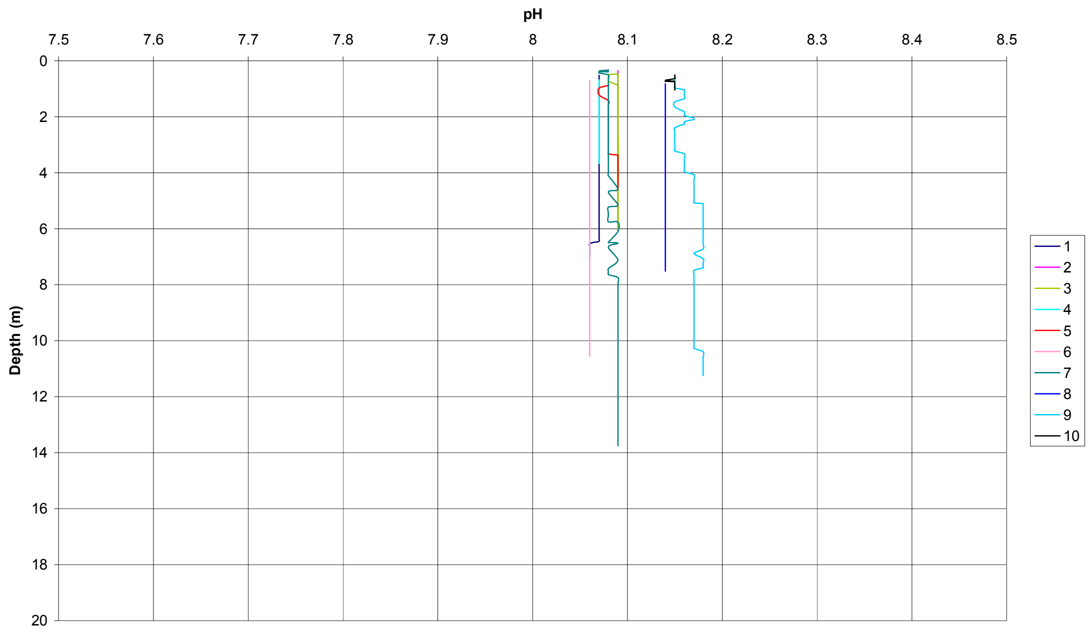


Figure 5-105 YSI pH Profiles – Campaign 2 Low Water

Both data sets are consistent with typical seawater pH values, with no discernable vertical, temporal or spatial trends.

<u>Salinity</u>

High and Low tide salinity profiles are presented in Figure 5-106 and Figure 5-107.

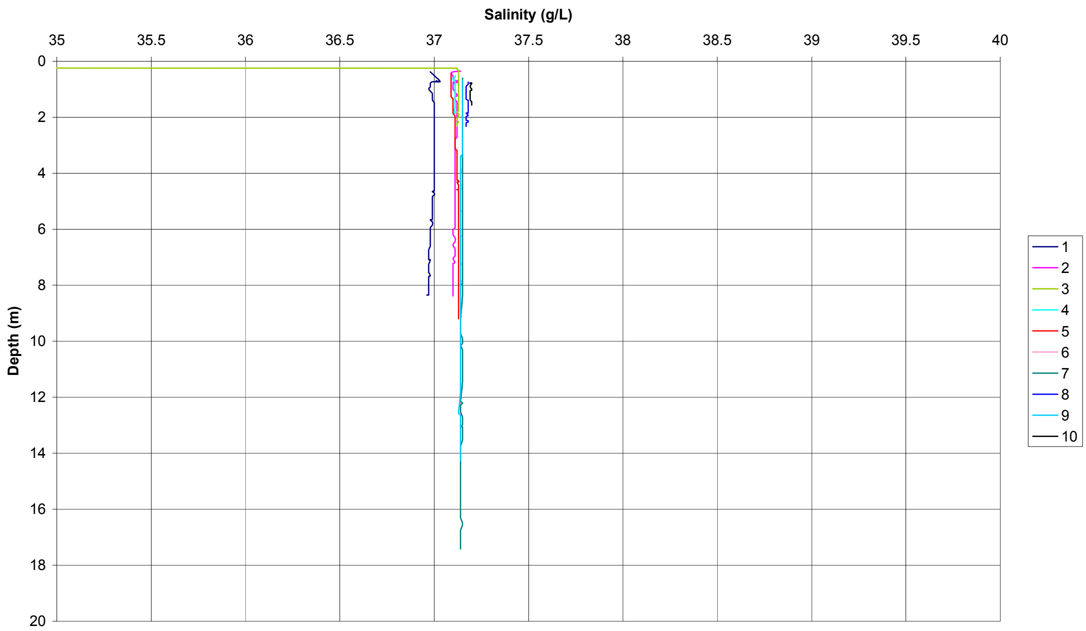


Figure 5-106 YSI Salinity Profiles – Campaign 2 High Water

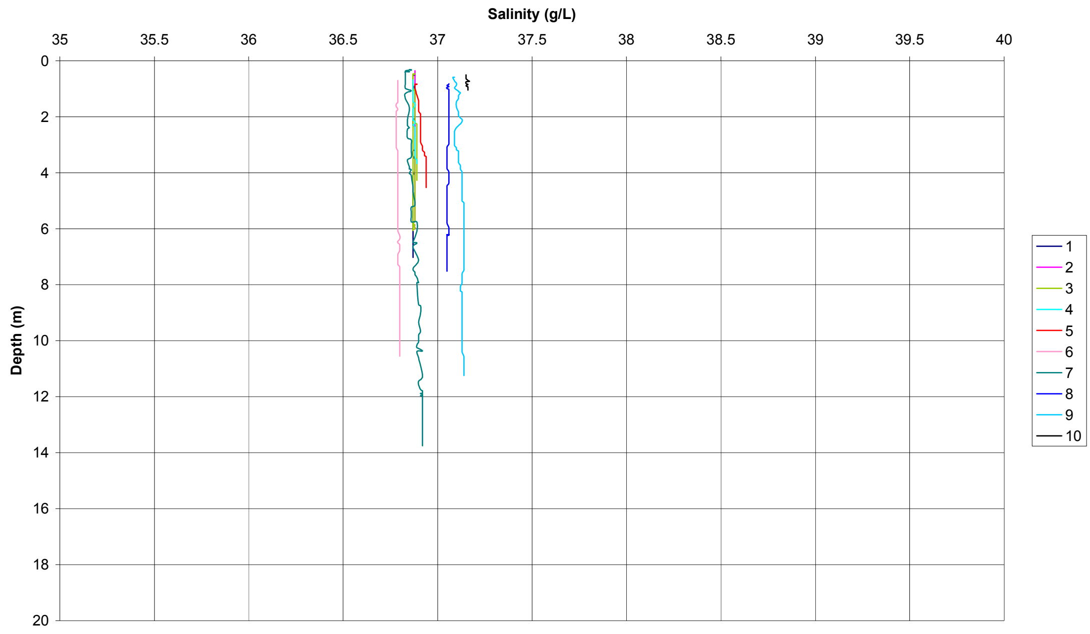


Figure 5-107 YSI Salinity Profiles – Campaign 2 Low Water

Campaign 2 salinities were generally higher than those measured during Campaign 1, and this is consistent with the campaigns being during dry and wet seasons, respectively. The rainfall record for the weeks preceding Campaign 2 is provided in Figure 5-108.

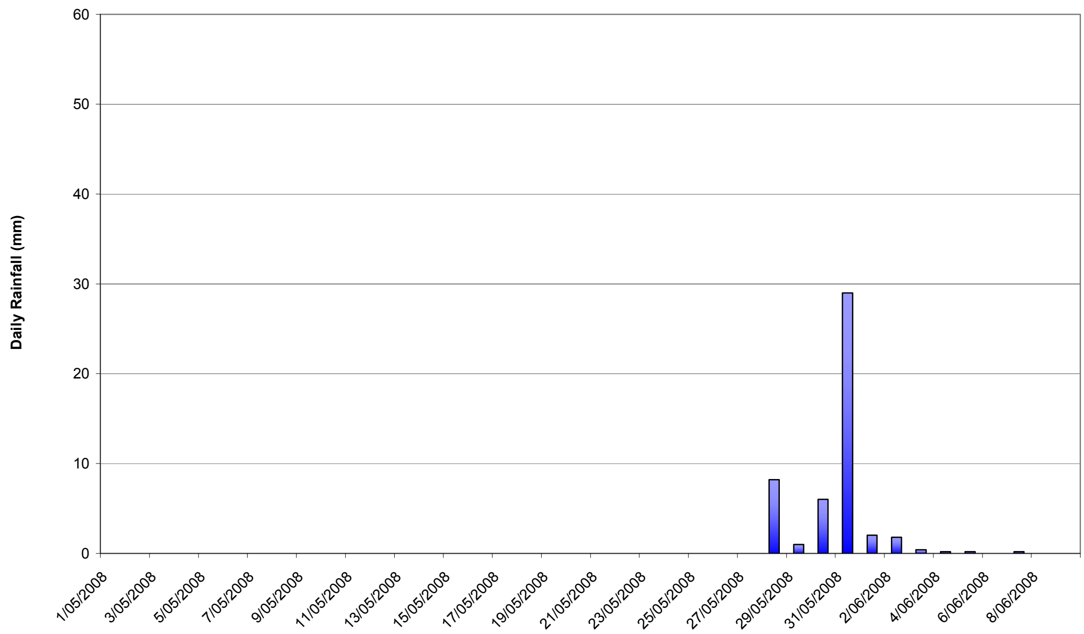


Figure 5-108 Rainfall Records for Gladstone, May and June 2008

The figure shows that, other than a 29mm rainfall event in late May, little or no rain fell in the Gladstone area preceding Campaign 2. This is consistent with the higher observed salinities during this campaign, compared to Campaign 1, where two rainfall events of 26 and 50mm occurred over the data collection period.

Temperature

All temperature data are plotted in Figure 5-109 and Figure 5-110.

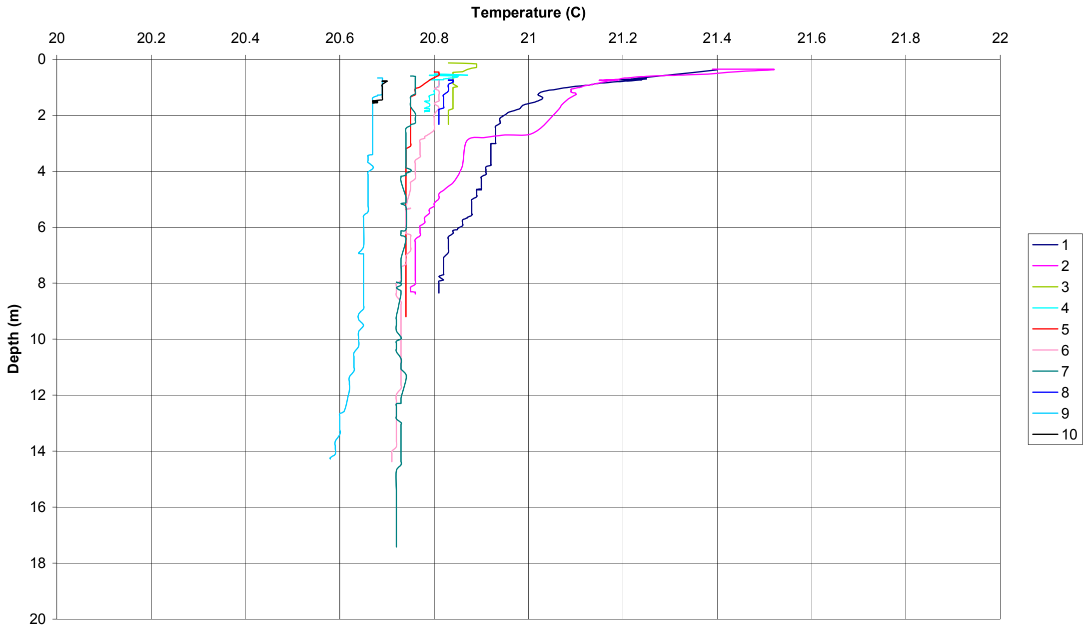


Figure 5-109 YSI Temperature Profiles – Campaign 2 High Water

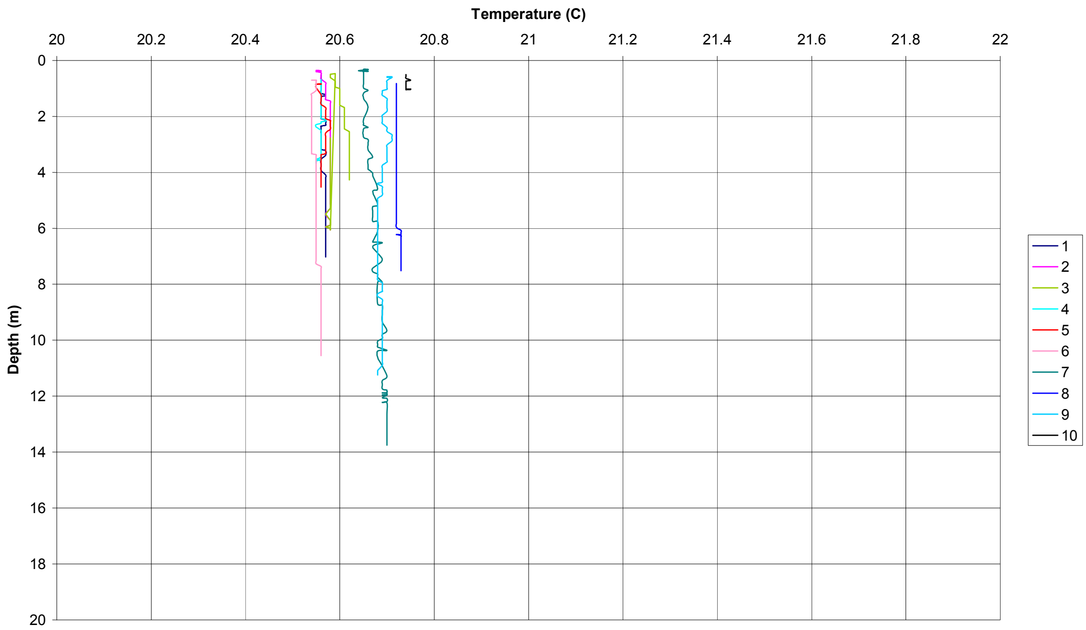


Figure 5-110 YSI Temperature Profiles – Campaign 2 Low Water

The observed Campaign 2 temperatures were 7 to 8 degrees cooler than those of Campaign 1, as is expected for the contrasting seasons. Other than for high water profiles 1 and 2, little vertical stratification is evidenced in the data, again consistent with a well mixed system.

5.7.6 Water Quality Grab Samples

High and low tide water quality grab samples were collected at 10 locations as part of Campaign 2. The analysed species, and a draft list of corresponding water quality objectives (WQO's) are provided in Table 5-1. The suspended sediment and nutrient WQO's have been sourced from the Queensland Water Quality Guidelines (QWQG 2006) Table 2.5.2.1, for slightly to moderately disturbed open coastal systems in the Central Coast Queensland region. Metal WQO's have been sourced from Table 3.4.1 of the ANZECC (2000) guidelines for slightly to moderately disturbed marine environments in South East Australia at the 95% percentile protection level (http://www.mincos.gov.au/__data/assets/pdf_file/0019/316126/wqg-ch3.pdf). All WQO's are subject to review, if needed, and are provided for initial comparative purposes. With regard to this comparison, it is noted that the current survey is a 'snapshot' (i.e. instantaneous measurements) whereas the WQO's are typically based on annual statistics. As such, formal benchmarking of the present study results against WQO's is not appropriate, but rather any comparison is of an informal, semi-quantitative nature. Further, it is noted that the ANZECC guidelines encourage the use of locally specific data, where available, for defining WQO's. Such locally specific data does exist for Port Curtis, however ownership of this data is unclear and as such has not been presented or used in detail in this report.

Table 5-1 Water Quality Species and Corresponding Draft WQO's

Species	WQO
Turbidity[a]	1 NTU
TSS	10 mg/L
TN	140 μg/L
TP	20 μg/L
Ammonia	6 μg/L
Nitrate + Nitrite	3[b] μg/L
FRP	6 μg/L
Aluminium	ID
Arsenic	ID
Cadmium[c]	5.5 μg/L
Copper	1.3 μg/L
Chromium (VI)	4.4 μg/L
Iron	ID
Lead	4.4 μg/L
Manganese[d]	ID
Mercury[c]	0.4 μg/L
Nickel[c]	70 μg/L
Zinc[c]	15 μg/L

[a] Data from previous sections shows that this guideline value is regularly exceeded due to natural resuspension of bedload, so this WQO may not be appropriate for this system

[b] Combined value for NO_x

[c] May not necessarily protect all species with respect to chronic toxicity

[d] A value of 140 μg/L has been used elsewhere in Port Curtis

ID Insufficient Data

Table 5-2 and Table 5-3 provide the high and low tide results for the total and dissolved species at each of the 10 collection locations, respectively. Water quality objectives are included for reference. H and L refer to high and low tide samples, respectively. Potential exceedances of draft WQOs (within the limitations described above) are greyed.

5.7.6.1 Suspended Sediment

Suspended sediment concentrations are generally consistent with a high energy environment where current-driven sediment resuspension contributes to water column sediment load. Without exception, the TSS concentrations at high tide are less than, or equal to, those at low tide. This is also generally true (with a few exceptions) for the nutrient data sets, as shown by Figure 5-111.

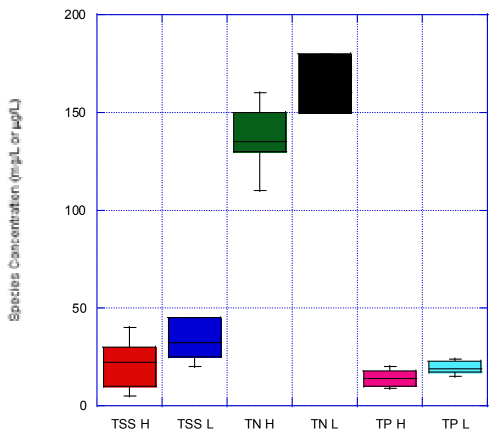


Figure 5-111 TSS and Total Nutrient Box and Whisker Plot

This suggests that coming into, and at low tide, a greater fraction of the water column interacts with resuspended bedload than at high tide, assuming that sediment and total nutrients are sourced from the bed.

5.7.6.2 Nutrients

The nutrient results suggest a dominance of particulate fractions in both nitrogen and phosphorus, consistent with bedload resuspension of nutrients. Within the limitations described above, total and oxidised nitrogen generally exceed the nominated WQO's (potentially suggesting WQO revision is needed), whereas both phosphorus fractions are generally compliant.

Table 5-2 Nutrients and Total Metal Concentrations

Species/Tide State	Site																				WQO
	1		2		3		4		5		6		7		8		9		10		
	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	(draft)
TSS (mg/L)	20	30	5	25	30	30	10	20	25	25	30	45	40	45	20	45	30	35	10	45	N/A
TN (µg/L)	160	160	130	160	150	160	130	150	130	150	150	180	160	180	130	170	140	150	110	180	140 µg/L
TP (µg/L)	14	17	9	18	18	18	10	15	14	15	18	24	20	23	13	23	17	20	9	23	20 µg/L
Ammonia (µg/L)	4	5	3	9	4	5	5	5	2	5	3	3	4	4	3	5	3	7	6	3	6 µg/L
Nitrate + Nitrite (µg/L)	10	7	8	8	10	12	9	10	8	10	10	7	9	8	6	17	9	10	10	9	3 µg/L
FRP (µg/L)	2	LD	LD	LD	LD	2	LD	LD	LD	LD	LD	LD	LD	2	LD	LD	LD	LD	LD	LD	6 µg/L
Total Aluminium (µg/L)	520	720	190	1180	900	1460	590	910	550	1000	830	1470	960	1680	600	1640	810	1210	390	1300	ID
Total Arsenic (µg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	ID
Total Cadmium (µg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	5.5 µg/L
Total Copper (µg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	5	LD	LD	LD	1.3 µg/L
Total Chromium (µg/L)	LD	LD	LD	LD	LD	4	LD	4	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	4.4 µg/L
Total Iron (µg/L)	530	860	240	1000	940	1220	470	800	620	920	860	1410	1050	1520	620	1510	1600	1080	380	1300	ID
Total Lead (µg/L)	40	40	LD	40	40	LD	40	40	LD	40	40	LD	40	40	40	40	40	40	40	LD	4.4 µg/L
Total Manganese (µg/L)	14	24	7	22	26	27	10	18	18	22	23	35	28	34	16	34	27	26	11	33	ID
Total Mercury (µg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	0.4 µg/L
Total Nickel (µg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	70 µg/L
Total Zinc (µg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	15 µg/L

LD = Less that detection limit. Relevant detection limits are as follows:

FRP:	2 µg/L	Chromium:	3 µg/L
Copper:	5 µg/L	Cadmium:	2 µg/L
Iron:	10 µg/L	Nickel:	15 µg/L
Zinc:	20 µg/L	Arsenic:	20 µg/L
Lead 40:	0.2 µg/L	Mercury:	0.2 µg/L

Table 5-3 Dissolved Metal Concentrations

Species/Tide State	Site																				WQO
	1		2		3		4		5		6		7		8		9		10		
	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	(draft)
Dissolved Aluminium (μg/L)	20	20	20	30	20	30	20	40	20	20	10	40	100	40	10	10	20	10	20	30	ID
Dissolved Arsenic (μg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	ID
Dissolved Cadmium (μg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	5.5 μg/L
Dissolved Copper (μg/L)	LD	LD	LD	5	LD	LD	LD	LD	LD	LD	LD	LD	LD	11	LD	9	LD	LD	LD	LD	1.3 μg/L
Dissolved Chromium (μg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	4.4 μg/L
Dissolved Iron (μg/L)	10	20	LD	20	10	20	10	30	10	10	10	40	110	30	LD	10	10	10	10	20	ID
Dissolved Lead (μg/L)	40	LD	LD	40	40	40	40	40	40	40	40	40	LD	LD	40	LD	40	40	40	40	4.4 μg/L
Dissolved Manganese (μg/L)	1	2	1	2	1	2	1	2	1	2	1	2	4	4	2	2	1	2	4	4	ID
Dissolved Mercury (μg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	0.4 μg/L
Dissolved Nickel (μg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	LD	70 μg/L
Dissolved Zinc (μg/L)	LD	LD	LD	LD	LD	LD	LD	LD	LD	21	LD	24	LD	28	LD	29	LD	23	LD	24	15 μg/L

LD = Less that detection limit. Relevant detection limits are as follows:

FRP:	2 μg/L	Chromium:	3 μg/L
Copper:	5 μg/L	Cadmium:	2 μg/L
Iron:	10 μg/L	Nickel:	15 μg/L
Zinc:	20 μg/L	Arsenic:	20 μg/L
Lead 40:	0.2 μg/L	Mercury:	0.2 μg/L

5.7.6.3 Metals

In general, comparison of observed metals concentrations with WQO's is difficult, as the majority of measurements were below detection limits. Where this was not the case, WQO's are not defined (e.g. aluminium, iron and manganese). Where sufficient data exists, however, the following trends are apparent:

- Total metal concentrations are generally 10 to 100 times greater than corresponding dissolved fractions;
- Similar to nutrients, measurements at low tide are typically greater than those at high tide.

Both the above are consistent with metals being associated with sediment dynamics. In particular, the former suggests that metals are largely either attached to sediments (i.e. the total fraction dominates) or existing in an oxidised (particulate) form and are following sediment movements. The latter is consistent with the attached/oxidised metals being resuspended to the water column at low tide due to tidal shear re-entrainment. These observations are similar to those of nutrients described above.

To illustrate the above, four box and whisker plots follow. The first two (Figure 5-112) compare total and dissolved concentrations across all tidal states for aluminium and iron, and manganese, respectively. The second two (Figure 5-113) show a comparison between high and low tide total concentrations for the same metals, again with manganese in a separate box and whisker plot.

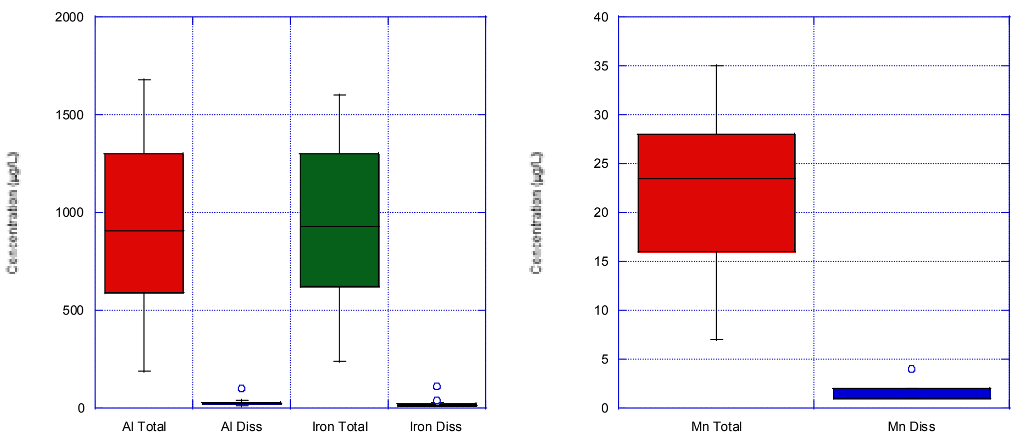


Figure 5-112 Total and Dissolved Metals Comparison

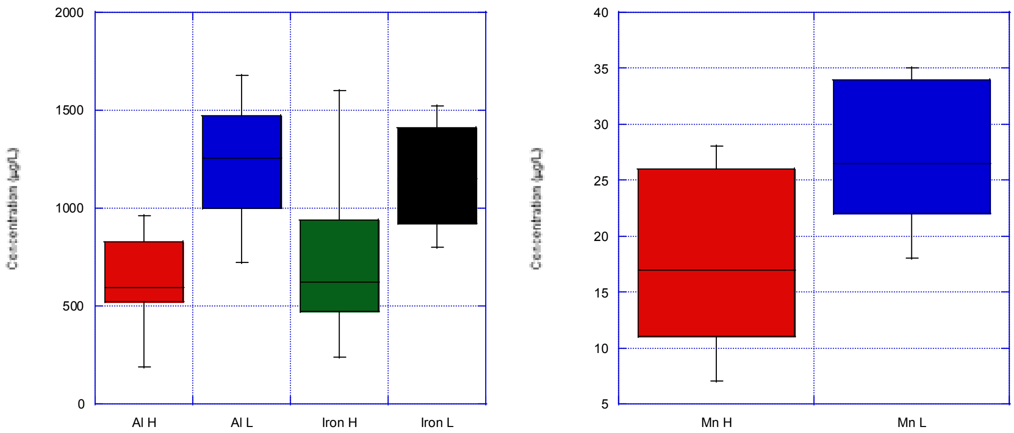


Figure 5-113 High and Low Tide Total Metals Comparison

5.8 Discussion

Two data collection field campaigns were executed in Port Curtis in February and June 2008, in the vicinity of the proposed LNG facility on Curtis Island. Tidal, current, echo sounding, ADCP and water quality measurements were made during both surveys. As part of Campaign 2, selected ADCP transects were also conducted in the vicinity of the proposed bridge crossing. Key findings are as follows:

- Tides in the area are semi-diurnal and the (spring) tidal range is of the order of 4 metres, with significant wetting and drying of mangrove and inter-tidal areas occurring;
- The area of interest represents a high energy environment, with strong tidal flows dominating the local hydrodynamics;
- Typical peak (spring) tidal velocities reach 1.2 to 1.3 m/s;
- Velocities are relatively uniform over the water column, however some evidence of vertical shear was found around areas of local bathymetric features;
- Tidal flows largely follow natural and constructed channels, with these locations consistently experiencing the highest velocities, as measured with ADCP transects;
- There is a local asymmetry in the magnitude of the tidal velocities, with ebbing tides being characterised by greater velocities than flooding tides. This is attributed to local bathymetric and geomorphological features;
- Small tidal velocity reversals were noted on flood tides in the vicinity of the shoreline at the southern end of China Bay;
- Turbidity increases with depth and tidal velocity, most likely due to bottom sediment resuspension;
- pH and temperature are relatively uniform with depth (over both campaigns), with evidence of only slight thermal stratification;
- Salinity appears to be responsive to rainfall and associated inflow events, although it is not clear whether local or remote inflows (or a combination of both) dominate in this regard;

- Catchment-derived pollutants may enter the area (either locally or remotely) with freshwater inflows; and
- When compared with relatively stringent water quality guidelines, it can be surmised that water quality is good, though variable in the area. Water quality levels appear to be relatively strongly correlated with tidal state and hence bedload resuspension. In particular, low tides exhibit generally worse water quality that high tides, with the majority of nutrient and metal species at these times being associated with the particulate (rather than dissolved) phase.

6 IMPACT ASSESSMENTS

There are a range of potential mechanisms whereby the proposed LNG facility could affect local and regional receiving water quality levels. These mechanisms were reviewed in association with these investigations and the following key mechanisms were identified:

- Major changes in tidal hydrodynamics which could inturn affect tidal flushing and water residence times in Port Curtis as a whole. These changes would then affect long term, ambient, water quality levels;
- Discharges of Reverse Osmosis Concentrate (ROC) and any other wastewaters from the LNG facility; and
- Transient, construction stage generation of in-water column sediment plumes due to activities such as dredging, pipeline construction and bridge pier piling/construction.

There are additional possible, more localised, sources of potential impacts on water quality such as accidental spillages and major changes in catchment stormwater quantity and quality. We have assumed respectively that standard operational procedures and catchment management/stormwater treatment measures would reduce the likelihood and significance of these potential impacts such they do not warrant detailed modelling.

As such, this study has combined field assessments, mathematical modelling and expert interpretation in order to determine the significance of potential water quality changes and to guide potential management action interventions. These assessments are discussed and documented below.

6.1 Hydrodynamic Impacts

The potential hydrodynamic impacts associated with the GLNG project were assessed using a two-dimensional (2D) hydrodynamic model of Port Curtis that BMT WBM has developed and repeatedly refined and improved calibration and model performance for many years, primarily for Gladstone Ports Corporation Limited (GPCL), but also for other clients. This model, illustrated in Figure 6-1, extends from the Pacific Ocean boundary/extent of Port Curtis north to beyond The Narrows. As discussed above, this model has been extensively calibrated and validated for numerous previous applications. For brevity, such details are not reproduced here at length, however Figure 6-2 and Figure 6-3 are provided to illustrate the robust nature of model performance.

The Port Curtis hydrodynamic model was used to assess potential impacts associated with the GLNG project as follows:

- a base case model was run for a mean spring tide boundary condition;
- modifications were made to the model mesh and model bathymetry to enable the simulation of works associated with the GLNG project (note: these modifications are discussed further below); and
- a post-development scenario was run in the model and subsequent comparisons conducted of predicted 'before' and 'after' hydrodynamic behaviour in Port Curtis and The Narrows.

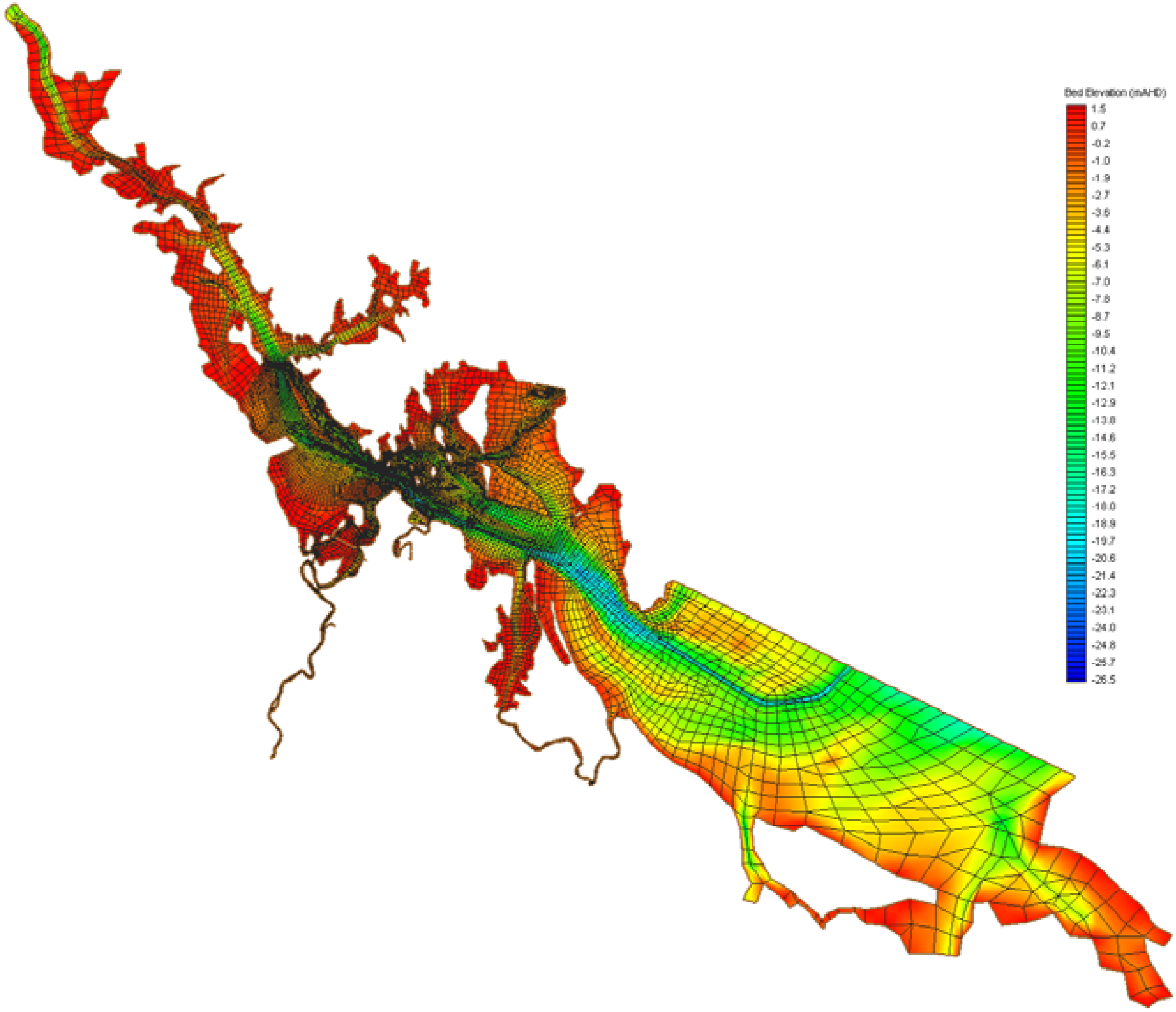


Figure 6-1 Port Curtis Hydrodynamic Model Mesh

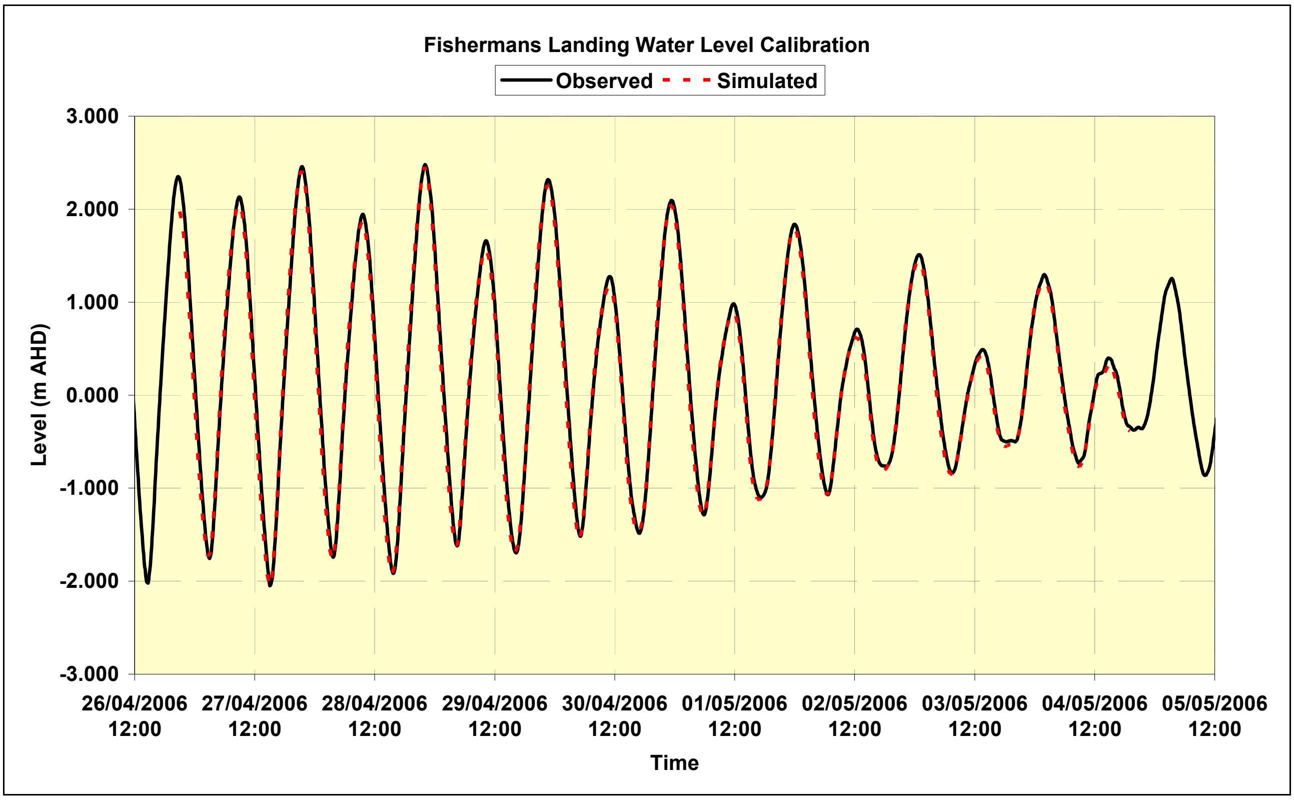


Figure 6-2 Model Hydrodynamic Calibration Example

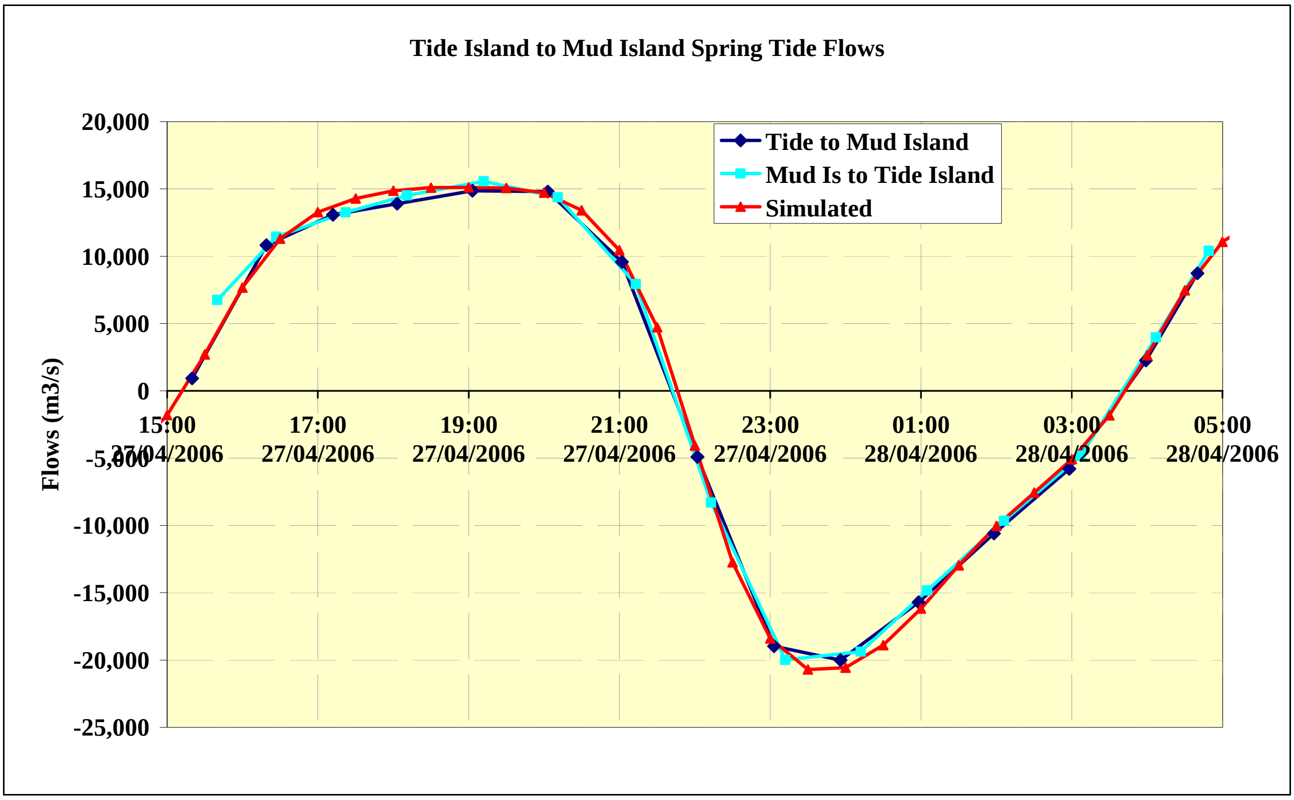


Figure 6-3 Model Hydrodynamic Calibration Example

The modifications required to be made to the Port Curtis model encompassed three key areas, as discussed below:

- The model mesh was adjusted to provide more detail in those areas potentially affected by the GLNG project. The modified model mesh is illustrated in Figure 6-7, with existing bathymetry;
- New bathymetry as will exist following dredging works associated with the GLNG project was mapped onto the new model grid. This new bathymetry (illustrated in part in Figure 6-8) encompassed the following activities:
    - dredging for the Santos GLNG swing basin;
    - dredging for access to the Santos GLNG swing basin (and proposed jetty) from existing Gladstone shipping channels (Targinie Channel); and
    - removal of shoals and other dredging works in and around the Clinton Channel, this being likely to be required to enable safe access of LNG vessels in and out of the harbour.
- Adjustments were also made to the model to account for the effects associated with the proposed bridge from Friend Point/Kangaroo Island to Curtis Island which will be required to enable access to Laird Point and subsequently to the Santos LNG facility, and other proposed developments on Curtis Island. This bridge will require a number of piled structures to be constructed, which will reduce the available flow area at the commencement to the southern boundary of 'The Narrows'. It was decided that refining the model to simulate the individual piled structures (typically less than 4m wide) was not feasible, and hence an alternative approach was adopted to simulate the flow obstruction effect of the bridge. This alternative approach saw the application of relevant techniques (as outlined in US DOT (1978)) whereby the effective (reduced) conveyance of the bridge channel was derived and then simulated in the hydraulic model of Port Curtis via an increased Manning 'n' value for those refined model mesh elements where the bridge will be located.
- Adjustments were also made to the model to account for the flow blockage effects associated with the western abutments to the proposed bridge, which will cross intertidal mudflats.
- The proposed approach road was included in a limited number of simulations. It is noted that the model bathymetry and calibration status in the area of the proposed approach road is highly uncertain, and as such results from the model in this area are treated with caution and should not be relied on for detailed assessments.

Following all of the aforementioned changes to the model, relevant 'before' and 'after' GLNG simulations were conducted for a 14 day representative neap-spring tidal cycle and the model was interrogated in order to determine relevant impacts of the bridge on tidal hydraulics. These impacts are summarised below:

- Tidal water levels:
    - Minimum (i.e. spring low tide) water levels at sites upstream and downstream of the bridge reduce by no more than 4mm, with the maximum change predicted immediately upstream (north) of the bridge;

- Maximum (i.e. spring high tide) water levels at sites upstream and downstream of the bridge also reduce, in this case by no more than 3mm, with the maximum change predicted immediately upstream (north) of the bridge;
- There was no detectable change in tidal phasing; and
- The maximum predicted reduction in tidal range associated with the bridge is 6mm, or 0.13%

- Tidal velocities:
  - There was no predicted change in minimum velocities, which were all zero at slack water;
  - Maximum (i.e. spring tide) velocities at sites upstream and downstream of the bridge also reduced, in this case by no more than 0.003 m/s (or 0.27% of the peak pre-bridge velocity), with the maximum change predicted immediately downstream (south) of the bridge; and
  - There was no detectable change in tidal phasing.
- Tidal flow rates:
  - Predicted changes in tidal flow rates mirrored the above changes in tidal velocities.
- Tidal flow distribution:
  - There was no detectable change in tidal flow distribution.

A simple analysis of the likely flows across the proposed alignment of the approach road was conducted, within the strong model limitations in this area noted above. The following figure presents predicted tidal flow rates across the alignment for the simulation duration. As noted, these predictions are highly uncertain.

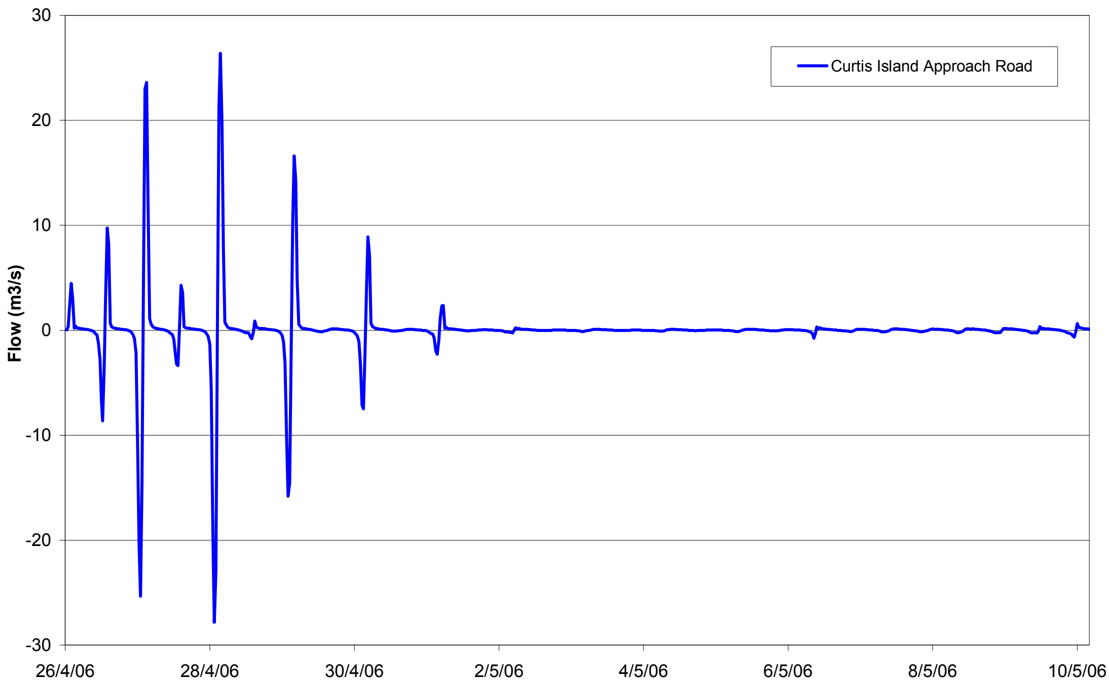


Figure 6-4 Flows across the Proposed Approach Road

Whilst uncertain, the model predicts that the flows across the proposed alignment are likely to be small in comparison to flows through the Narrows, for example, with the latter reaching up to 8,000 m^3/s.

As an example of the likely changes in hydraulics nearer the Santos site due to all the proposed works (including the approach road), the following figures show base and developed water surface elevations and tidal velocities northwest of the proposed Santos swing basin.

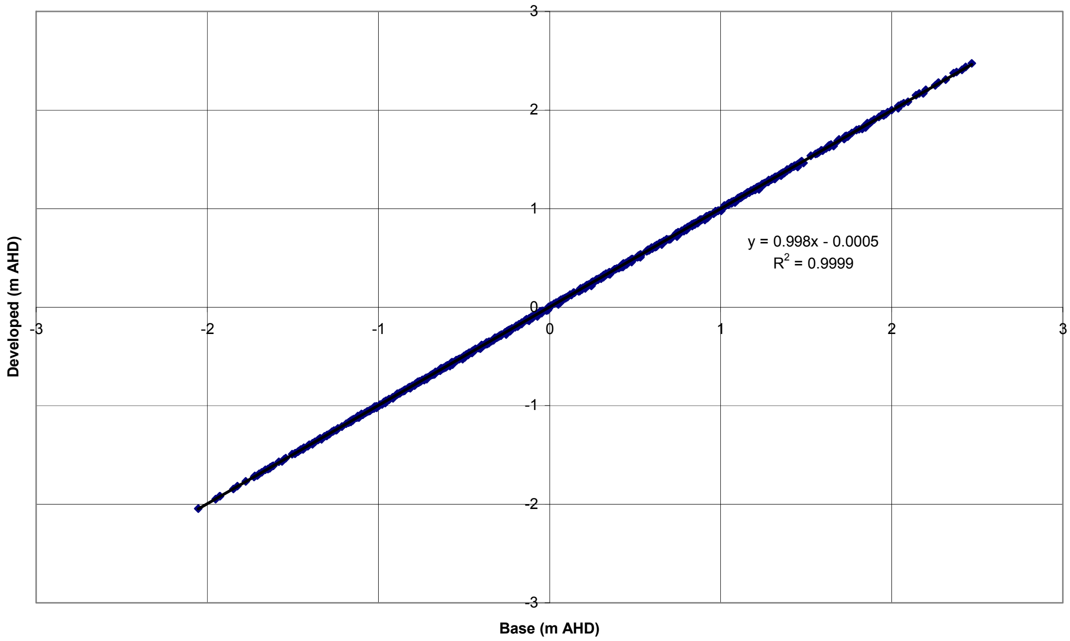


Figure 6-5 Water Surface Elevations NorthWest of the Proposed Santos Swing Basin

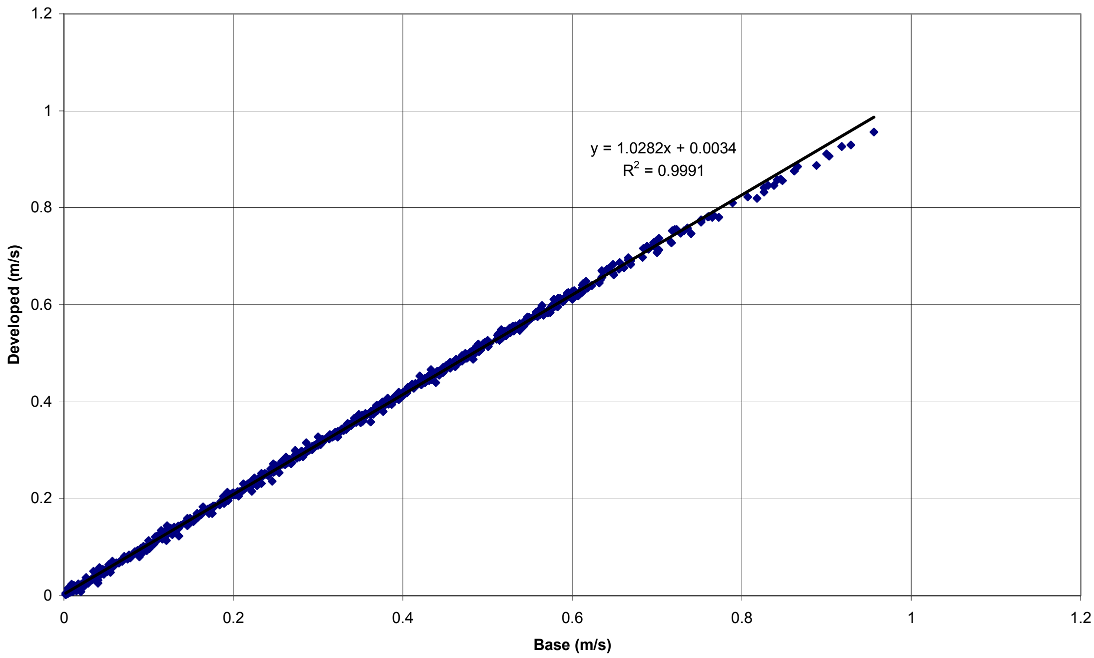


Figure 6-6 Velocity Magnitudes NorthWest of the Proposed Santos Swing Basin

By way of a general comment, it would appear that the tidal hydraulic impacts of the GLNG project are minimal at the selected locations. It is noted that more detailed hydrodynamic information has been provided to Santos (and its nominees) for the purposes of ship simulation analyses, where the specific impacts of the above works have been assessed in terms of shipping.

6.2 Tidal Flushing / Advection Dispersion Assessment

In order to assess the potential implications of the GLNG project on tidal flushing and to then infer impacts on water quality processes, the Port Curtis modelling system was again applied, in this case using the advection-dispersion routines of the model. These routines have also been used for numerous previous studies in Port Curtis. Whilst calibration of such routines can be more difficult to complete than in the case of tidal hydraulics (due to complications associated with collecting robust data sets), in this case dye release testing in Port Curtis conducted several years ago has been used to previously define relevant model dispersion coefficients.

In order to quantify changes in tidal flushing with development of the GLNG project, the following approach was adopted:

- pre and post GLNG advection dispersion models were again developed, built upon the hydraulic models previously described;
- the domain of both of these models was then assumed to have a uniform initial concentration of a conservative tracer, with this concentration being prescribed an arbitrary value of 1 mg/L;
- the boundaries of the models were also appropriately configured with a defined concentration of 0 mg/L. That is, when the tide is flooding and oceanic waters are moving 'into' the model domain, inflowing waters have no conservative tracer; whereas when the tide is ebbing, tracer from within the model domain leaves through the model boundaries, and does not return; and
- for this model paradigm, pre and post GLNG simulations were conducted for a 45 day period and tracer 'flushing times' were calculated at several representative locations within the model (see Figure 6-9). These flushing times were defined by the industry/scientifically accepted technique of 'e-folding' time. This is the time taken for an initial tracer concentration to reduce to 37%, or 1/e, of its initial value.

Based on the above model parameterisation/simulation, tidal flushing times for the pre and post GLNG cases were estimated. In most cases however, even though the model had been run for a 45 day period, the required value of 37% flushing had not been reached and as such definitive flushing times cannot be reported. What can be reported is that there were practically indiscernible differences in flushing behaviour, and (if anything) flushing improved very slightly. As the dredging and bridge construction works associated with the GLNG project will have minimal impact on tidal flushing times, and the fact that there are minimal additional pollutant loads associated with the GLNG project, it can be inferred that there is minimal potential for changes in the existing water quality regime of Port Curtis associated with this project.

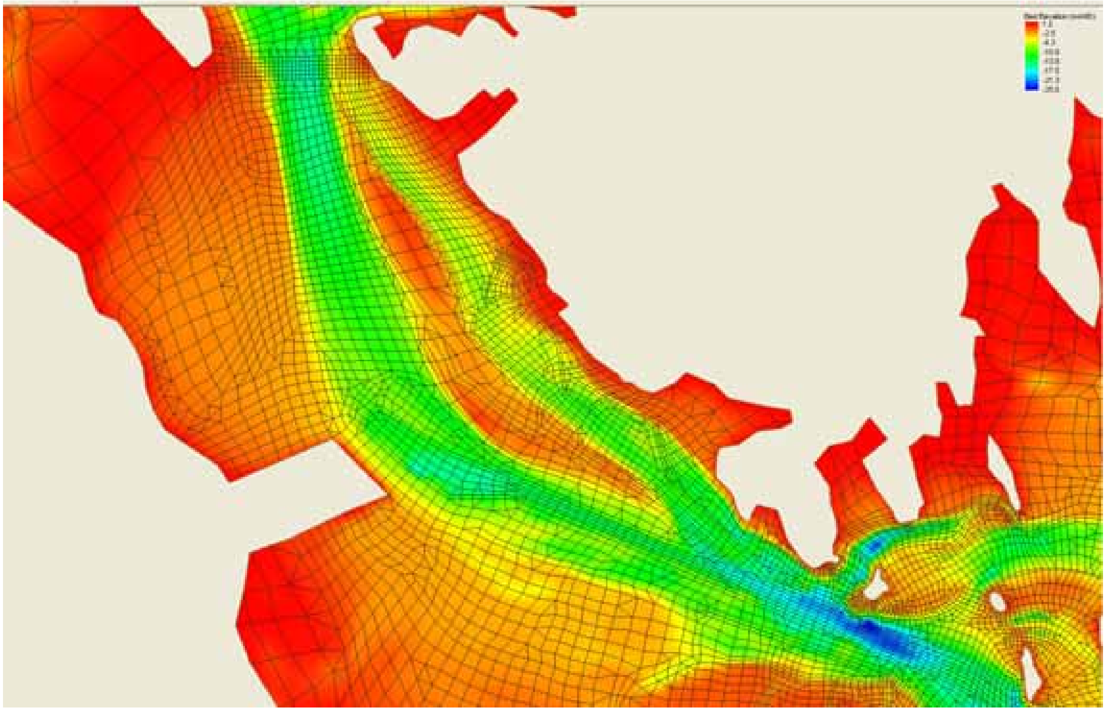


Figure 6-7 Modified Model Mesh

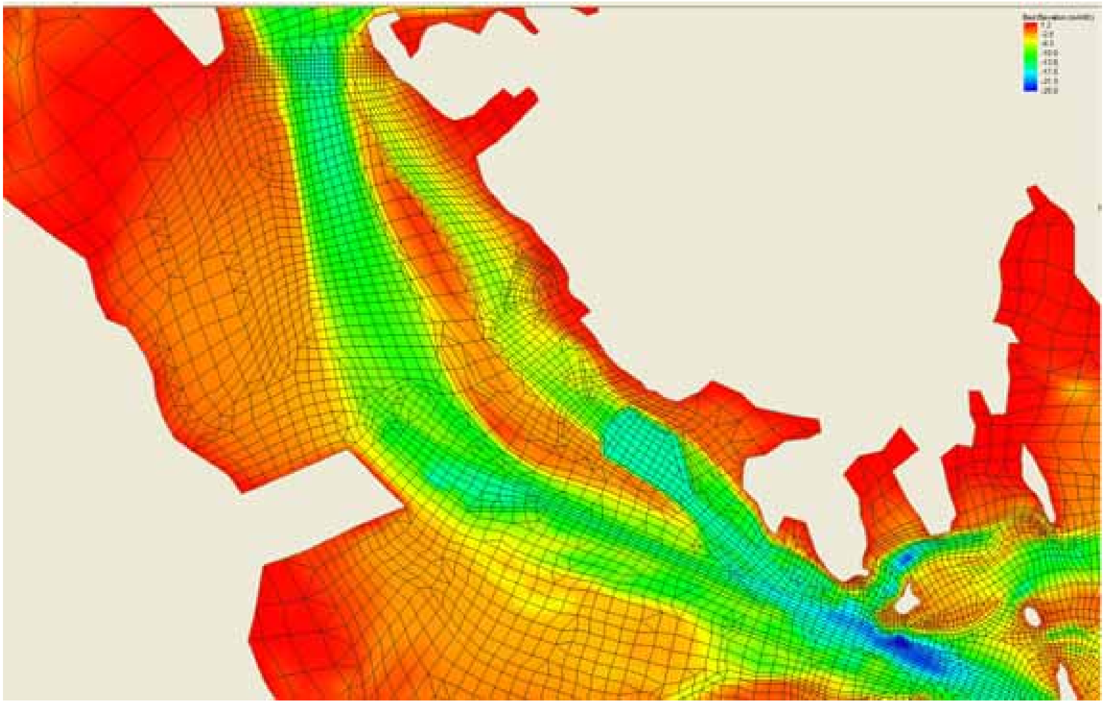


Figure 6-8 New Model Bathymetry

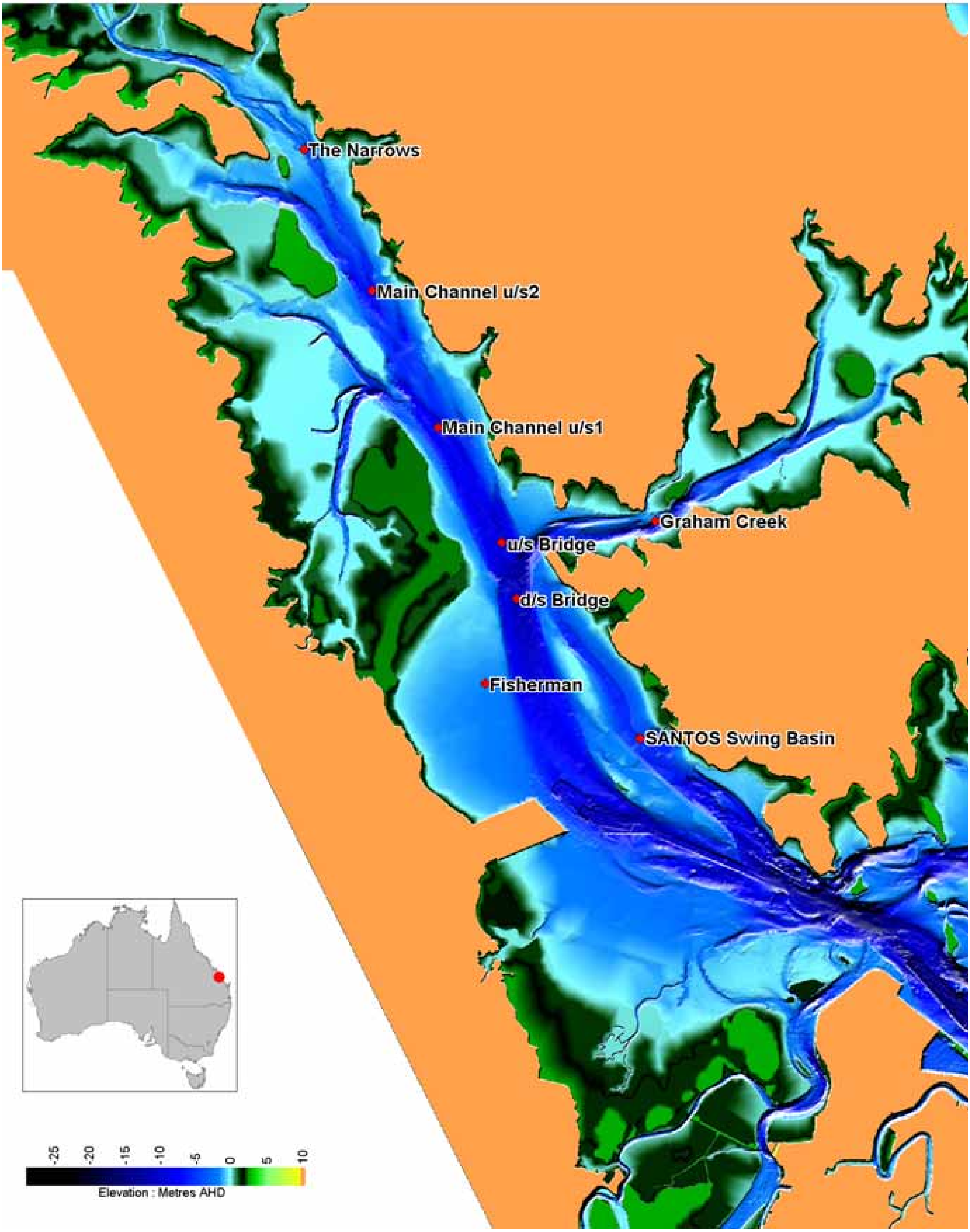


Figure 6-9 Adopted Model Tidal Flushing Time Calculation Sites

6.3 Reverse Osmosis Concentrate Discharge Assessments

6.3.1 Preamble / Background

A modest reverse osmosis (RO) plant is proposed for installation in association with the LNG facility operation. This RO plant will have a feed supply rate of 120 m³/hr and will produce a brine, or reverse osmosis concentrate (ROC), stream of approximately 54 m³/hr (15 L/s). Based on a worst-case salinity level in intake waters of 35 g/L, this brine stream will have a commensurate salinity level of 63.5 g/L. As well as producing ROC, the proposed desalination system will produce wastewater at a small rate (of the order of 22 L per hour) associated with periodic membrane cleaning. This waste stream will be treated and disposed of on site, and will not discharge via an outfall into Port Curtis.

As a component of this study, near and far field modelling was conducted of the proposed ROC discharge. Assumptions made in regard to this discharge were as follows:

- The ROC will be discharged as a constant wastewater stream at the stated flow rate of 15 L/s;
- It will also have a constant salinity of 63.5 g/L. In regard to the near field modelling, where receiving water density is important, we have assumed ambient water will have a salinity of 35 g/L;
- The ROC temperature will be the same as that of the adjacent receiving waters. For the near field modelling, we assumed that this temperature was 24° C; and
- We have assumed that there are no 'exotic' pollutants in the brine/ROC stream that would warrant detailed assessment.

6.3.2 Near Field Assessments

Near field, or initial mixing, assessments were conducted using the accepted industry standard model for such applications, CORMIX. A CORMIX model was established of the proposed outfall, with this model being parameterised using the key assumptions outlined above. Additional specific considerations associated with the near field modelling were as follows:

- Several outfall configurations were assessed, and the recommended configuration comprised a 10m long diffuser, with 0.04m diameter orifices located every 1m along the diffuser (i.e. 11 in total), facing in alternate directions. This configuration will have an exit velocity from each outfall port of the order of 1.0 m/s, which will encourage maximum initial mixing;
- It was assumed that the diffuser was oriented perpendicular to the prevailing current direction and that the minimum water depth at this site was 6m; and
- Spring–neap tide model duration velocity time series data were extracted from the far field hydrodynamic model to inform the near field modelling. For conservativeness, the lower 10th percentile velocity value from this data record was adopted for modelling. For information, the analysed velocity data as extracted from the model are summarised in Table 6-2.

Table 6-1 Near Field Modelling - Interrogated Velocity Data

Percentile	Velocity (m/s)
10	0.030
25	0.076
50	0.154
75	0.228
90	0.293

Based on this set of assumptions, a relevant CORMIX model was developed and simulations of near field mixing were performed. The findings of these simulations were as follows:

- the discharge receives greater than 30:1 dilution within 3 m of the end of the outfall;
- by the time the discharge plume falls to the seabed, dilution rates exceed 250:1; and
- the patterns of plume dilution are further illustrated in Figure 6-10 and Figure 6-11.

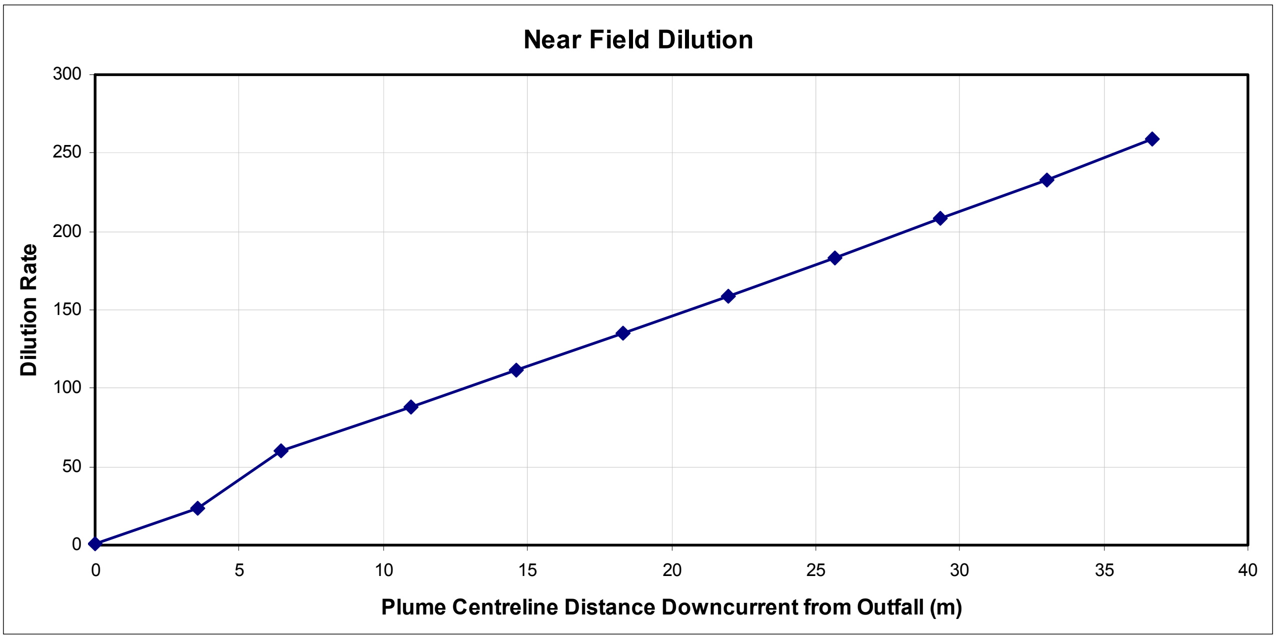


Figure 6-10 Near Field Dilution With Distance Down Current From Outfall

Further CORMIX modelling was also conducted under mean velocity conditions, and bottom impact dilutions of more than 840:1 were predicted.

From these assessments it can safely be concluded that there will no detectable changes in local water quality patterns due to this extremely small discharge.

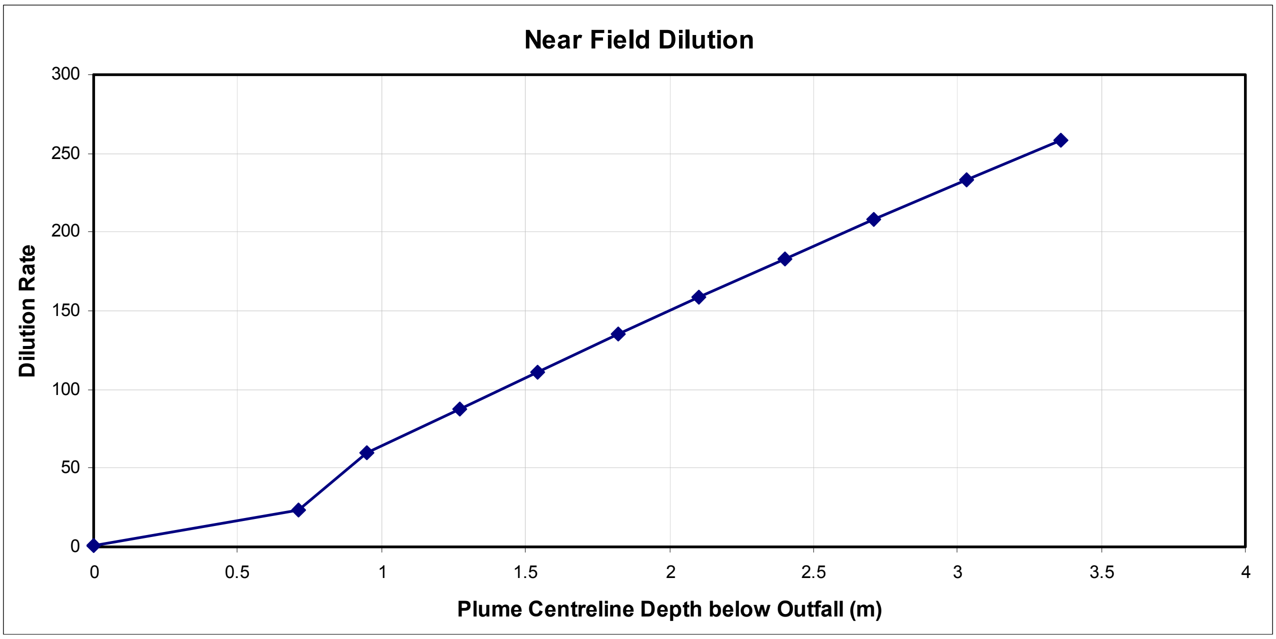


Figure 6-11 Near Field Dilution With Depth Below Outfall

6.3.3 Far Field Assessments

From a far field perspective, the desalination/ROC impact was assessed by simulating a 952 g/s discharge of a conservative tracer (e.g. salt) at the likely location of the outfall. This is equivalent to the 54 m^3/hr ROC discharge at a salinity of 63.5 g/L. The model was run until quasi steady state conditions resulted and results were extracted for the sites shown in Figure 6-12.

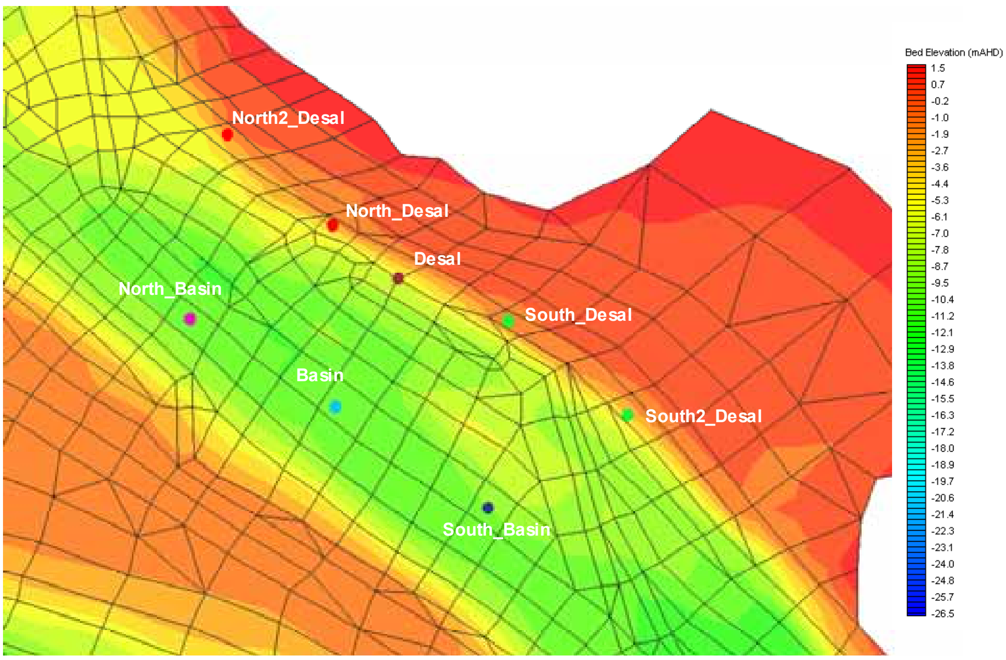


Figure 6-12 Salinity Model Result Extraction Locations

The results of these assessments are presented in Figure 6-13. These results show a maximum far field salinity increase of the order of 0.22 g/L, which given background levels of more than 35 g/L at many times of the year, and also natural variability levels in the region, will be essentially undetectable.

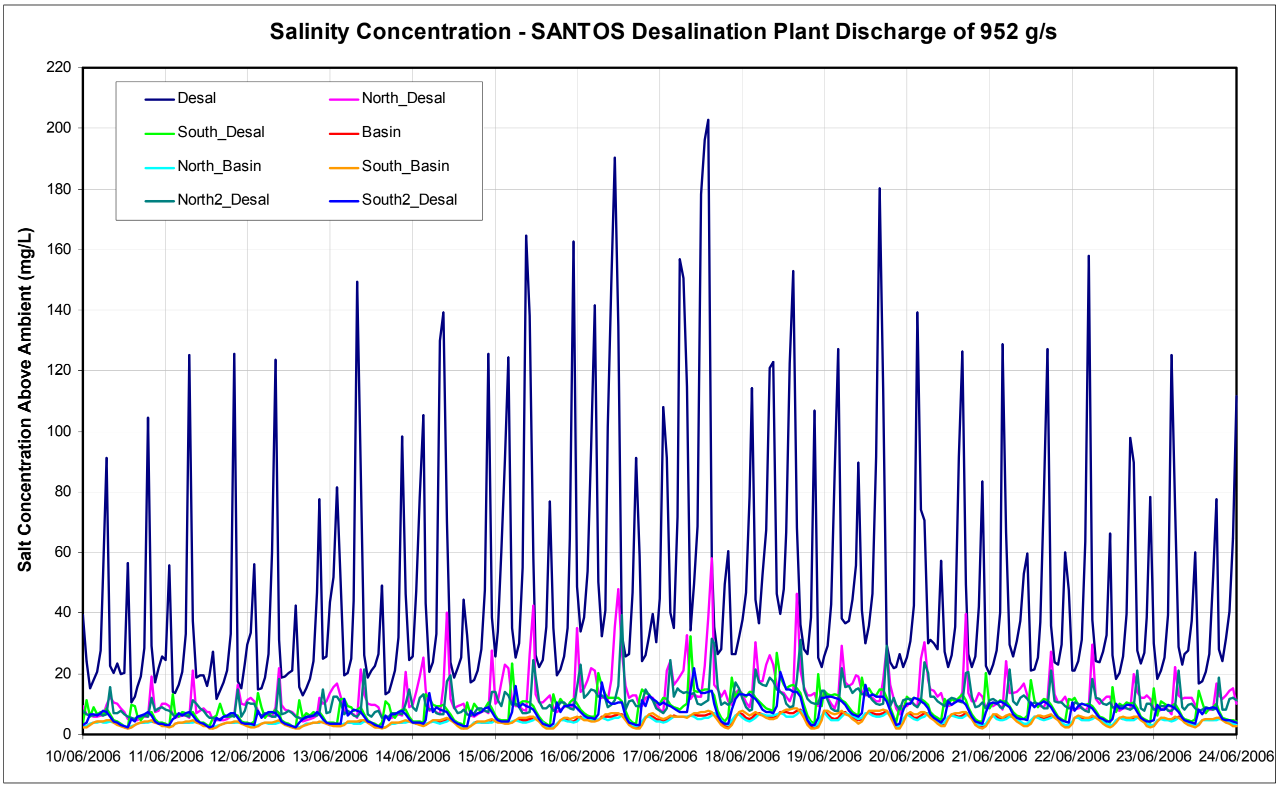


Figure 6-13 Far Field Salinity Modelling Results

6.4 Construction Stage Sediment Assessments

As well as the long-term hydrodynamic change/flushing impact and discharge related water quality impacts associated with this project, there are a number of potential short-term, transient, construction related water quality impacts which warrant careful consideration. These transient impacts essentially pertain to the following construction activities:

- Dredging for the LNG facility swing basin and associated access channels;
- Works associated with laying a gas transmission pipeline across Port Curtis, from the mainland to Curtis Island; and
- Pile and pier construction activities associated with the establishment of the Curtis Island Bridge.

Quantitative impact assessments of each of these sources of potential water quality impact were conducted, and are discussed below.

6.4.1 Dredging

Significant quantities of capital dredging will be required to enable the creation of suitably sized swing basins and access channels for the LNG facility operations. At this stage of preparation of this advice, no material was available to BMT WBM in regard to how (i.e. by what type of dredger) this capital dredging would take place. Such information is important, as is the nature of materials being dredged, as each of these factors considerably affect the quantities of material mobilised into the water column.

With respect to the former of the above, it is considered highly likely that a cutter suction dredger will be used for most, if not all, of the capital works for the GLNG project. The primary reason for this belief relates to the fact that the majority of the areas which will be excavated currently experience no major vessel passage. Hence, efficient and cost-effective cutter suction dredgers should be able to operate without impeding the day-to-day operations of the Port. Cutter suction dredgers also typically produce lower levels of water column suspended sediments.

In regard to the latter of these issues, that is the nature of the materials being dredged, it is highly likely that a wide range of sediment types will be encountered and disturbed by capital dredging. Previous experience of BMT WBM staff in Port Curtis has shown that much of the region is comprised of a mixture of sediment facies, ranging from gravels through sands to silts, mud and clay deposits. As such, it is highly likely that there may be occasional episodes (e.g., when silts are encountered) when relatively high rates of sediment generation may occur associated with capital dredging.

Given the above, and also based on material (as reported in CIRIA 2000) describing the results of field measurements of the rates of liberation of sediments into the water column due to the action of cutter suction dredgers in 'mixed' sediment, we are able to estimate the likely rates of mobilisation of sediment from capital dredging. CIRIA (2000) reports various studies in this regard, and upon inspection of these studies it is apparent that as a worst-case (e.g. for wholly silty clay and clay sediments) the loss rate of sediments by a cutter suction dredger is of the order of 0.9 kg/s to 1.6 kg/s. Given this range of potential loss rates, we have conservatively adopted a value of 1.5 kg/s for this study as the rate at which sediment will be mobilised into the water column by capital dredging works.

In order to quantify the potential impact of this rate of sediment resuspension on ambient water quality levels, and also to understand the potential spatial extent of sediment plumes which may be generated by such works, we have undertaken sediment transport fate modelling of the area in and around Curtis Island, where dredging will occur. This modelling has assumed a source of sediment at the above identified rate, which is equivalent to the action of a cutter suction dredger. For simplicity, we have located this hypothetical sediment source centrally within the proposed Santos GLNG swing basin, and also have (again conservatively), used existing bathymetry in the modelling. That is, the simulation effectively replicates the initial commencement of dredging when depths are at their shallowest and tidal velocities are at their highest. This will:

a. minimise the quantum of local sediment their position which would otherwise occur in the modelling; and

b. transport suspended sediments much further distances than would be the case later in the project when dredging would have increased depths and reduced velocities.

In this modelling, we have allowed for the deposition/settling of disturbed sediment. In a similar manner to work we have conducted elsewhere in the region (e.g. background studies for the Wiggins Island Coal Terminal project), we have adopted a suspended sediment settling rate of 1m/day. This is equivalent to the settling rate of finer silty material, which we expect to be the dominant material of concern in this regard

All modelling assessments have been conducted separately from neap and spring tide conditions. In each case, we have run the model for a two-day warm-up (with the sediment discharge included), and then through a two-day analysis period (respectively under neap and spring tide conditions). The maximum and average increases in total suspended solids levels associated with this two-day period (for both spring and neap tide conditions) are presented in Figure 6-14 to Figure 6-17.

Model time series results have also been extracted at the sites illustrated in Figure 6-18 (note that the "SANTOS Swing Basin" site is not directly at the modelled dredge point). The results of this extraction are presented in Figure 6-19. These results, together with those in Figure 6-14 to Figure 6-17, show that for this case there are elevated TSS levels in and around the area of proposed dredging work, with this region occupying an area of approximately 150m by 500m during neap tides and approximately 200m by 150m during spring tides. These areas are those approximately corresponding to the red contour regions in the respective maximum contour plots. It is noted that these plots are *not snapshots in time*, but rather represent atemporal aggregations of maxima throughout each selected two day period. As such, the red areas in the maximum plots do not represent concentrations expected at one time, but rather, the region for which higher TSS concentrations could be expected to occur across each two day period.

Outside this area, maximum levels are in the order of 25 mg/L. When compared with typical background levels in this region of Port Curtis (Table 4-31), it is apparent that these TSS levels, while high, are comparable to the existing levels of variability in TSS present in the region. Further afield, additional maximum TSS levels are predicted to be less than 5 mg/L, which will be close to undetectable.

6.4.2 Pipeline construction

BMT WBM was also asked to review the potential water quality impacts of gas transmission pipeline construction and deployment across Port Curtis. In order to do this, we have had to make relevant assumptions and draw on previous experience in regard to how this infrastructure could be built, and what the commensurate water quality impacts may be. This is summarised below:

- Methods for constructing the pipeline were still undecided, and as such, we have assumed that it will be installed completely within a trench to (a) ensure it is unlikely to be damaged and (b) to protect the pipeline from tidal current impacts. This assumption was also recommended by URS as being the worst case scenario in regard to potential water quality impacts.
- Given the trenched assumption, the most likely method of excavation is by clamshell bucket dredge. The clamshell would operate by crane on a flat topped barge, secured by a temporary mooring system. The barge would operate in Port Curtis to allowed excavation of the required trench, and to assist in placing of the pipe sections, armouring and backfilling activities. The excavated trench would be formed in sections to allow the relevant pipeline sections to be placed. Excavated material from the trench is likely to be stored and placed over complete sections of the pipeline as backfill. The dredged trench is highly likely to accumulate some sediment prior to the placement of pipe sections, and this will be removed just before installation. Pipe sections will be weighted to provide temporary stability during installation, and to prevent

uplift during backfill. Pipe sections will be lowered into the excavated trench and mechanically jointed to the previous section. Once the pipe section has been installed, backfill and armouring will be placed to stabilise the pipe.

- Following from the above, we have used available information and previous studies to guide our selection of sediment mobilisation rates associated with pipeline construction. Our approach to derivation of these rates is discussed below;

  - **Trenching** - Sediments will be entrained into the water column during trenching by the release from the clamshell dredge of excess water, containing high concentrations of fine sediments. A sediment entrainment rate of 50kg per bulk m^3 of material excavated was conservatively assumed, based on typical published values for clamshell dredging operations. For instance, CIRIA (2000) provides indicative entrainment rates for grab dredgers of 11-25 kg/m^3. Tavolaro (1984) derived a sediment entrainment rate of 2% of the total dry mass removed during clamshell dredging, which is broadly consistent with the expected values assuming realistic dry material densities;

    If we assume industry-standard excavation rates of 1000 m^3/day for a 15 hour day, then a commensurate sediment entrainment rate of 0.93 kg/s is obtained. The assumed sediment entrainment rate of 50 kg per bulk m^3 is twice the high-end literature values just stated. This introduces some conservatism into the model predictions, given the high current speeds and significant tidal ranges experienced at Port Curtis. That is, the model predictions are expected to be at the high end of likely plume concentrations.

  - **Backfilling** - Trench backfilling, which will involve the replacement of excavated material into the dredged trench, will also contribute to sediment plume generation. Tavolaro (1984) estimated that between 3% and 7% of dredged material was lost to sediment plumes during disposal. BMT WBM (2007) identified that around 2% of dumped material left the dump site as a suspended sediment plume during detailed monitoring of a spoil disposal event. If we assume (conservatively) a 3% loss of backfill material, that the 1000 m^3 per day of extracted material is also reapplied as backfill and that the material has a dry bulk density of 1200 kg/m^3, this equates to a further 0.67 kg/s of potential sediment entrainment into the water column due to backfilling.

- Given the above, the likely worst-case rate of sediment immobilisation due to the combined influence of gas transmission pipeline trenching and backfilling is some 1.6 kg/s. For simplicity in the modelling, we have slightly reduced this rate to 1.5 kg/s, this being exactly the same as the rate derived for the effect of a cutter suction dredger.

In order to quantify the potential impact of this rate of sediment resuspension on ambient water quality levels, and also to understand the potential spatial extent of sediment plumes which may be generated by such works, we have undertaken further sediment transport fate modelling of the area being traversed by the gas transmission pipeline. This modelling has assumed a source of sediment at the above identified rate. We have located this hypothetical sediment source centrally in Port Curtis along the proposed path of the gas transmission pipeline.

In this modelling, we have allowed for the deposition/settling of disturbed sediment at the same rate as adopted for the capital dredging assessments. This is equivalent to the settling rate of finer silty material, which we expect to be the dominant material of concern in this regard.

All modelling assessments have again been conducted separately from neap and spring tide conditions. In each case, we have run the model for a two-day warm-up (with the sediment discharge included), and then through a two-day analysis period (respectively under neap and spring tide conditions). The maximum and average increases in total suspended solids levels associated with this two-day period (for both spring and neap tide conditions) are presented in Figure 6-20 to Figure 6-23.

Model time series results have also been extracted for this scenario at the sites illustrated in Figure 6-18. The results of this extraction are presented in Figure 6-24. These results, together with those in Figure 6-20 to Figure 6-23, show that for this case there are elevated TSS levels in and around the area of proposed dredging work, with this region occupying an area of approximately 600m by 200m during neap tides and approximately 150m by 150m during spring tides. These areas are those approximately corresponding to the red contour regions in the respective maximum contour plots. It is again noted that these plots are *not snapshots in time*, but rather represent atemporal aggregations of maxima throughout each selected two day period. As such, the red areas in the maximum plots do not represent concentrations expected at one time, but rather, the region for which higher TSS concentrations could be expected to occur at any time within each two day period.

Outside these areas, maximum levels of increase of the order of 14-16 mg/L are predicted. When compared with typical background levels in this region of Port Curtis (Table 4-31), it is apparent that these TSS levels, while high, are comparable to the existing levels of variability in TSS present in the region. Unlike the case of capital dredging, these TSS levels extend much further afield, both upstream and downstream of the bridge, due to the much higher velocities in this region.

6.4.3 Bridge pier piling / construction

While it is recognised that there is potential for the generation of sediment plumes during bridge construction, it is highly likely that with appropriate management intervention, such plumes should be far smaller than those which will be developed by the other sources of potential construction impact already assessed above. Due to this, and the fact that the likely path of the bridge is almost concurrent with the gas transmission pipeline crossing (and hence there are likely to be similar spatial areas of impact as assessed for the pipeline crossing), the decision was made to not explicitly simulate the effects of the bridge piling, but rather to assume that the potential impacts are largely addressed by the other assessments and to recommend that a high level of management control be placed over such actions during the construction phase.

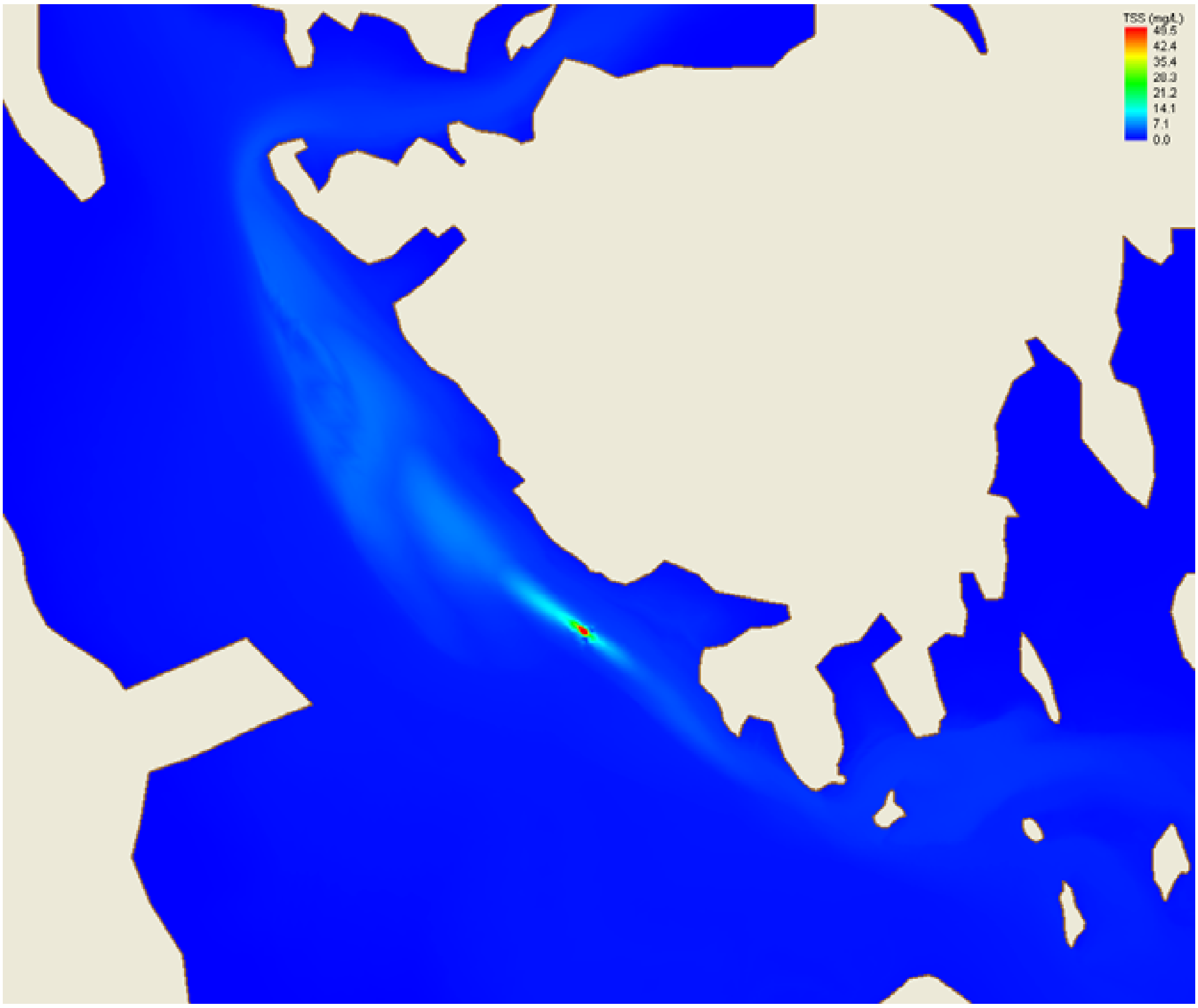


Figure 6-14 Maximum Total Suspended Solids Increases, Due to Capital Dredging Works-Spring Tide

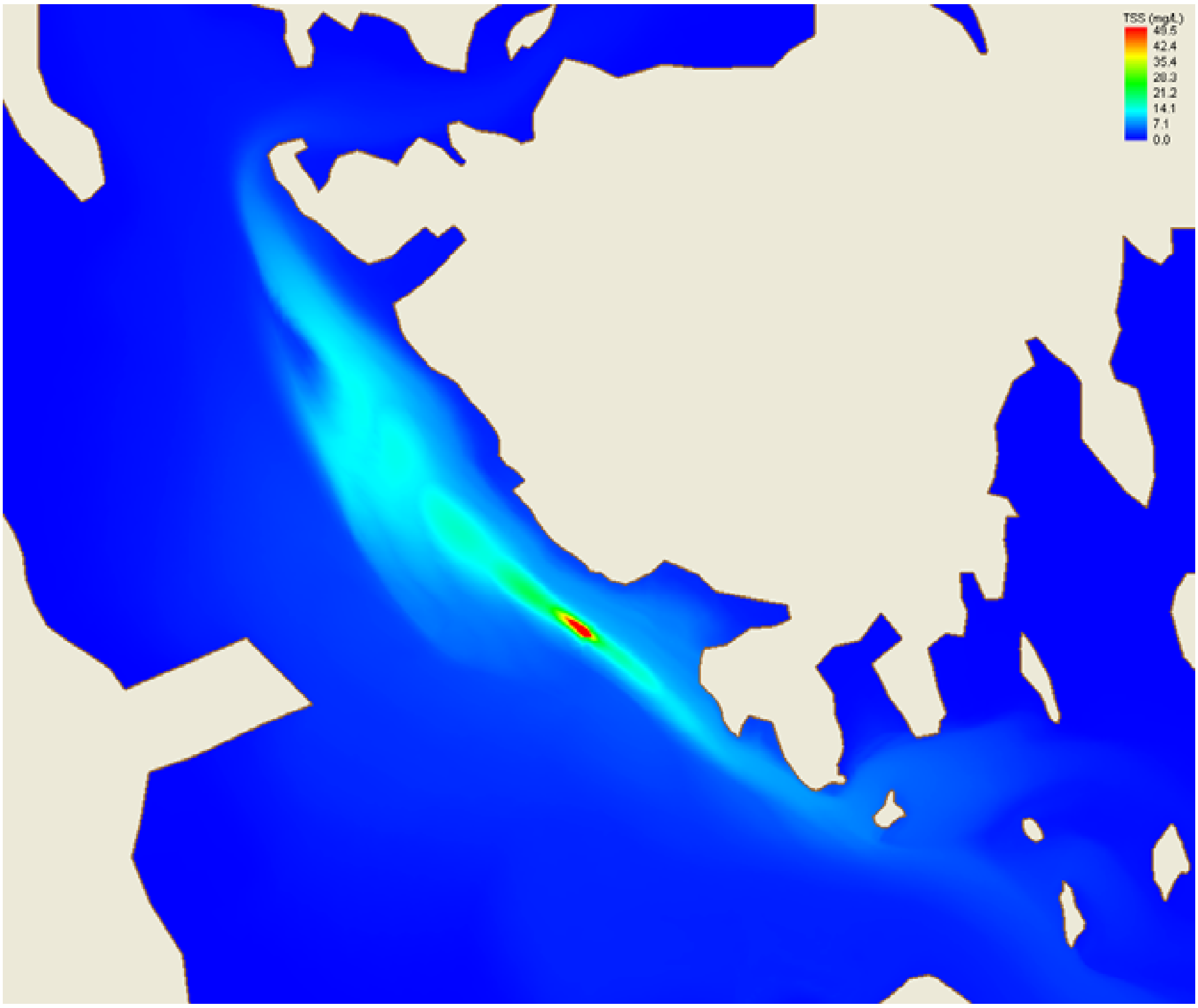


Figure 6-15 Maximum Total Suspended Solids Increases, Due to Capital Dredging Works- Neap Tide

Figure 6-16 Average Total Suspended Solids Increases, Due to Capital Dredging Works-Spring Tide

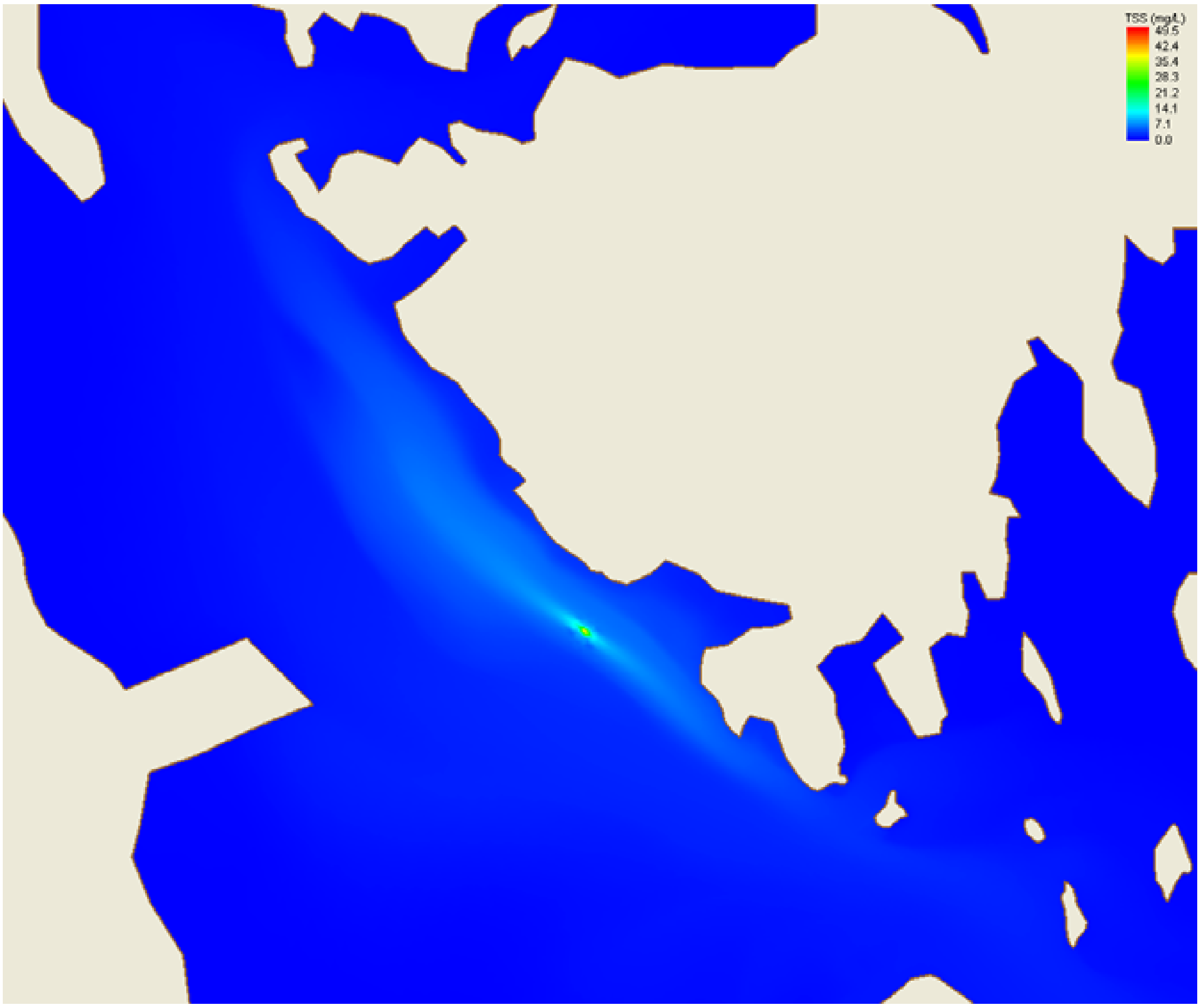


Figure 6-17 Average Total Suspended Solids Increases, Due to Capital Dredging Works-Neap Tide

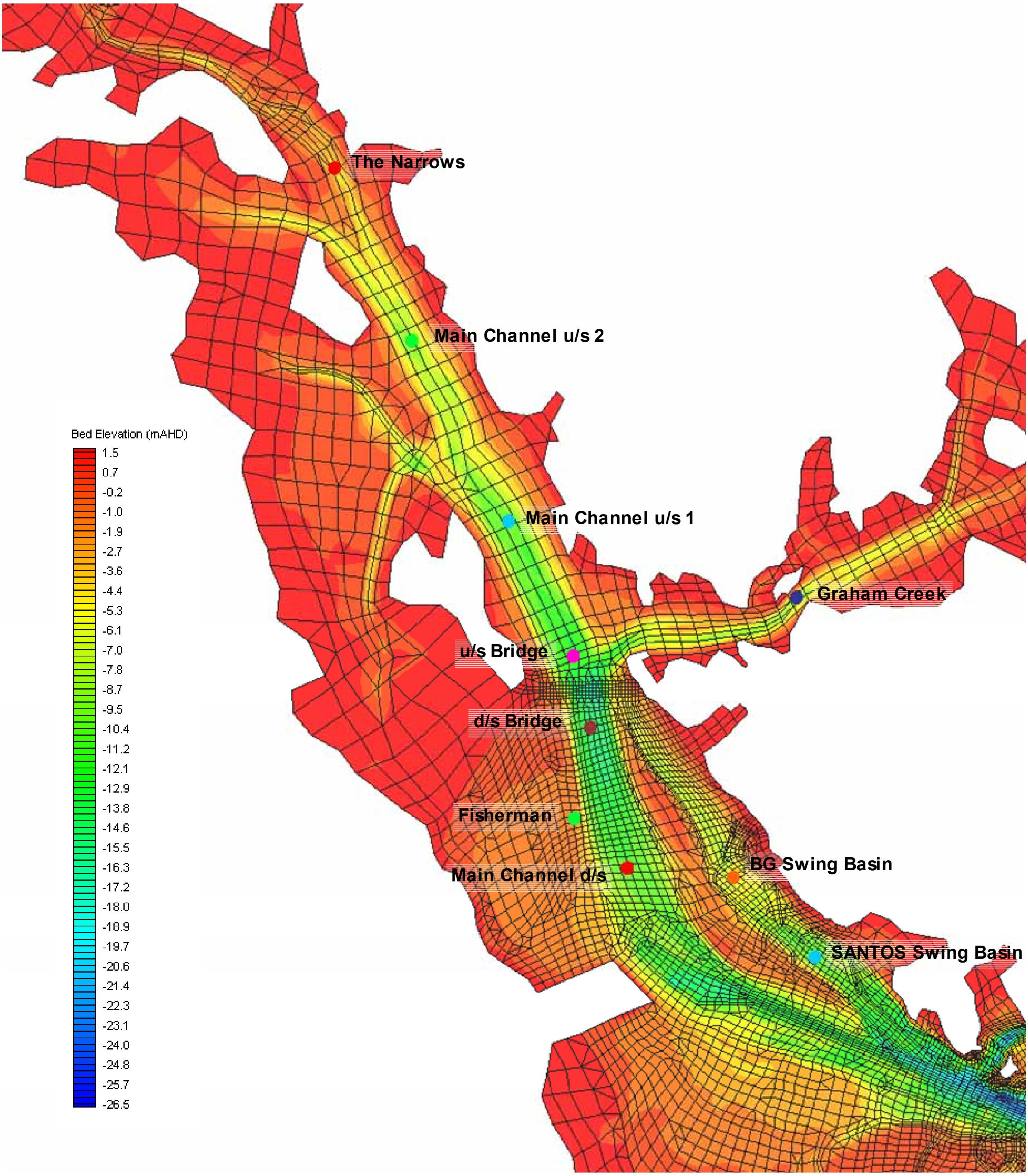


Figure 6-18 Sediment Model Result Extraction Locations

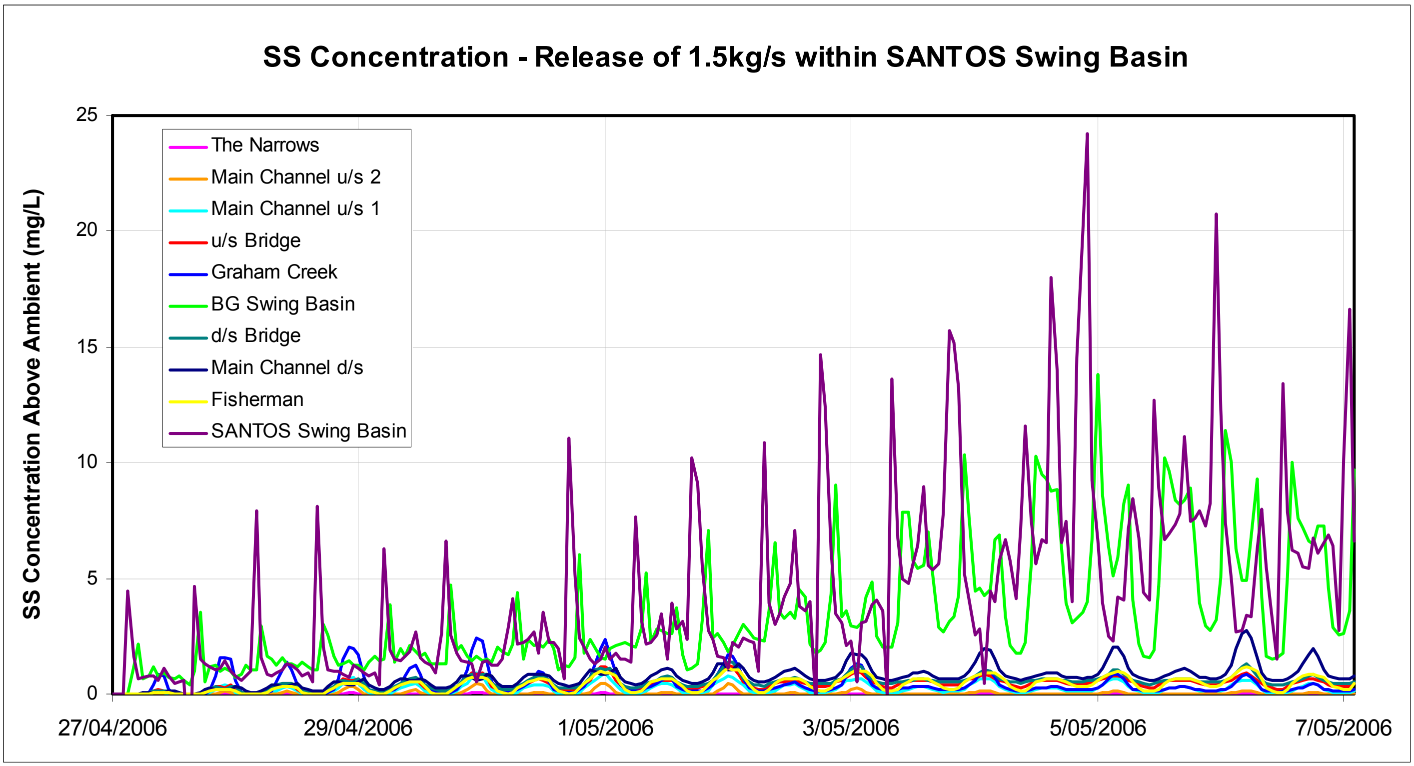


Figure 6-19 Far Field Sediment Modelling Results – Capital Dredging Works

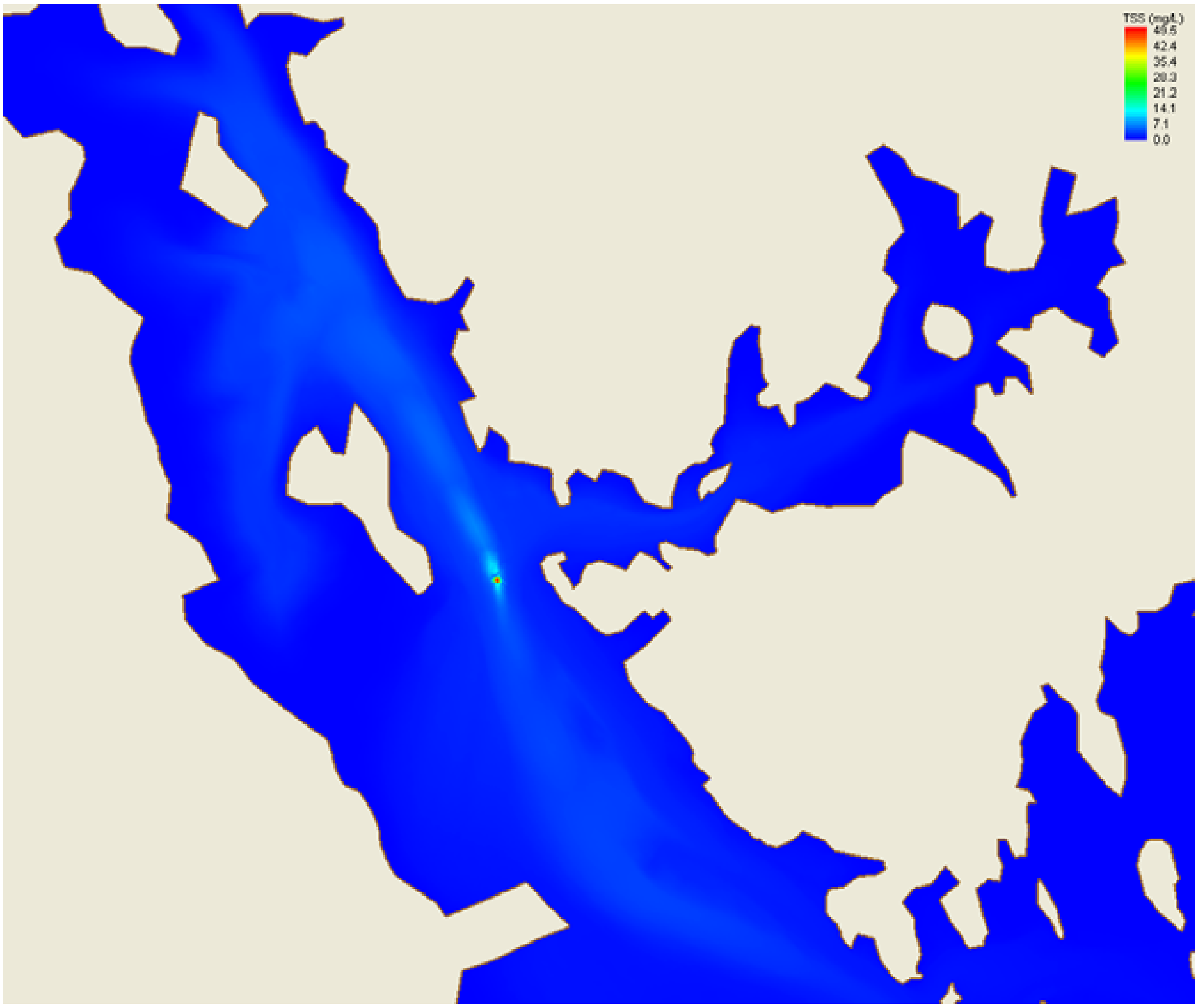


Figure 6-20 Maximum Total Suspended Solids Increases, Due to Pipeline Construction - Spring Tide

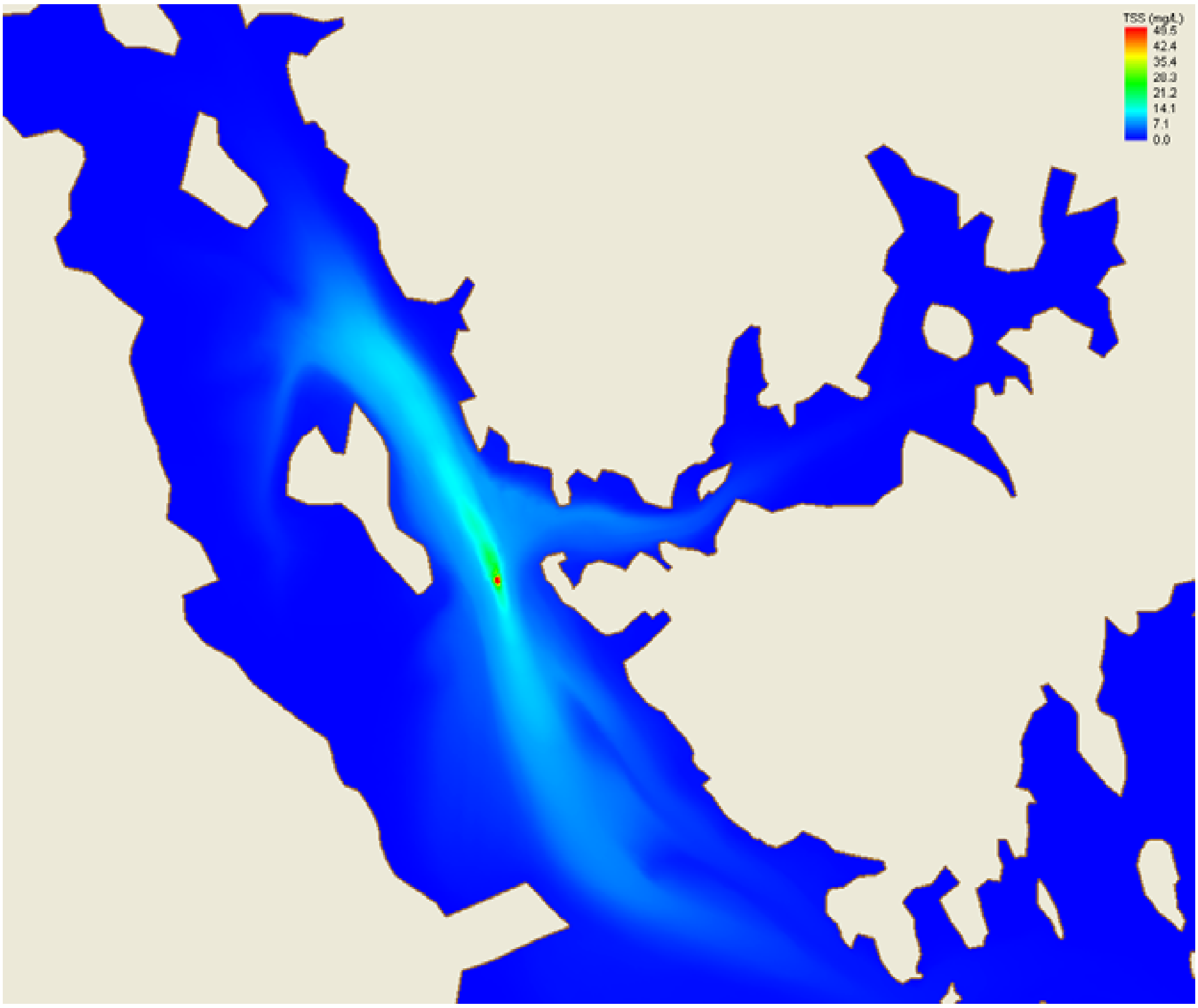


Figure 6-21 Maximum Total Suspended Solids Increases, Due to Pipeline Construction - Neap Tide

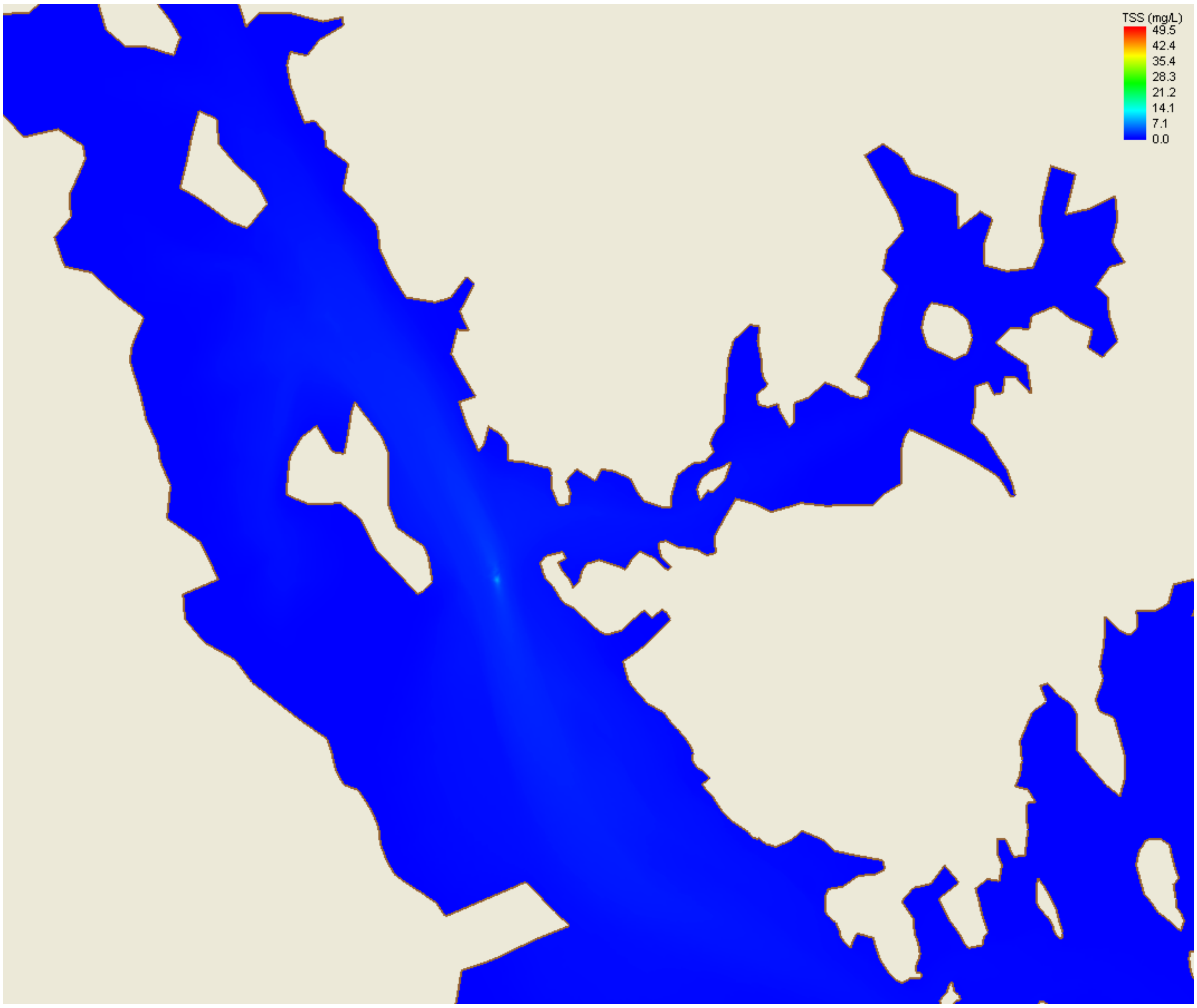


Figure 6-22 Average Total Suspended Solids Increases, Due to Pipeline Construction - Spring Tide

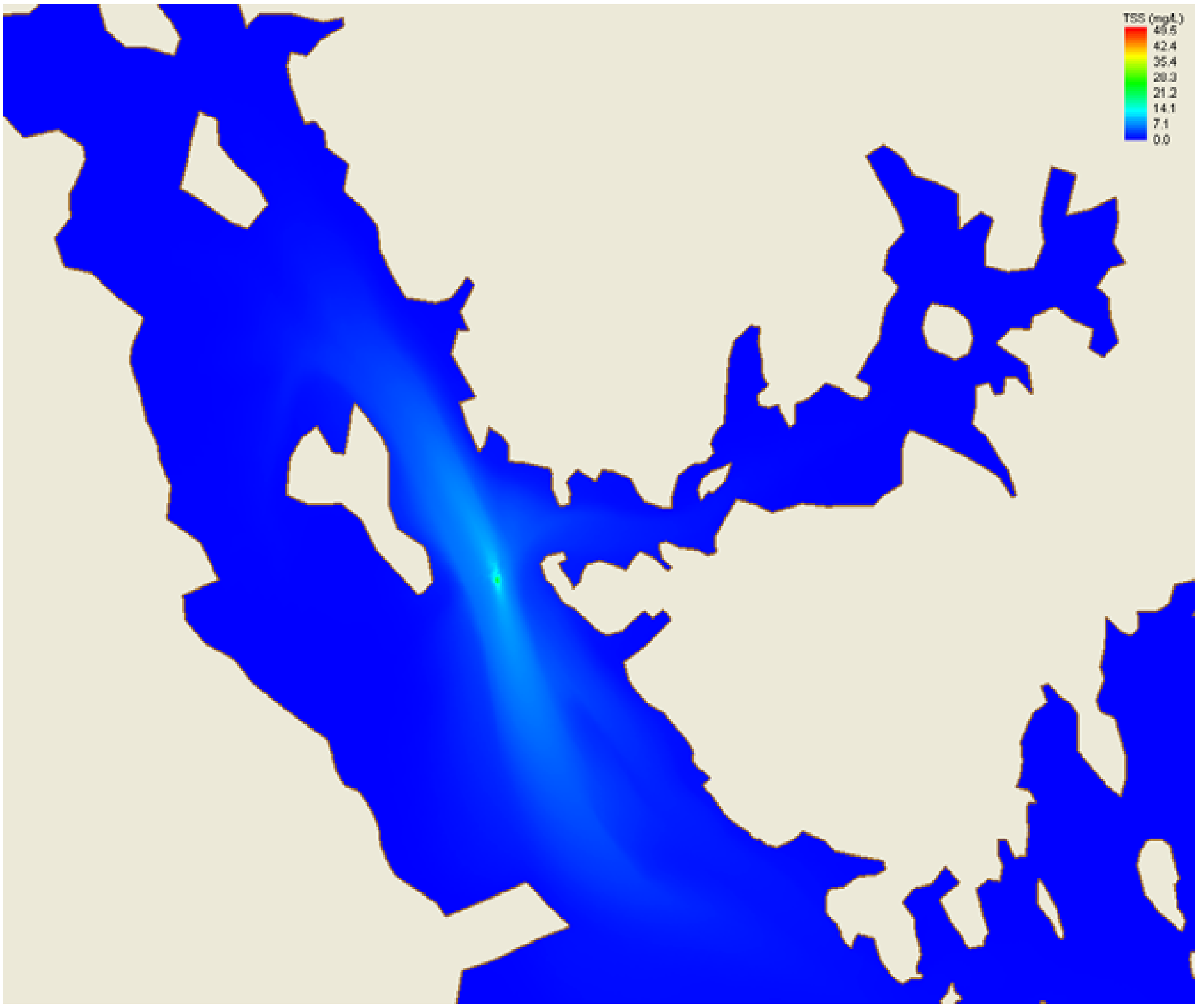


Figure 6-23 Average Total Suspended Solids Increases, Due to Pipeline Construction - Neap Tide

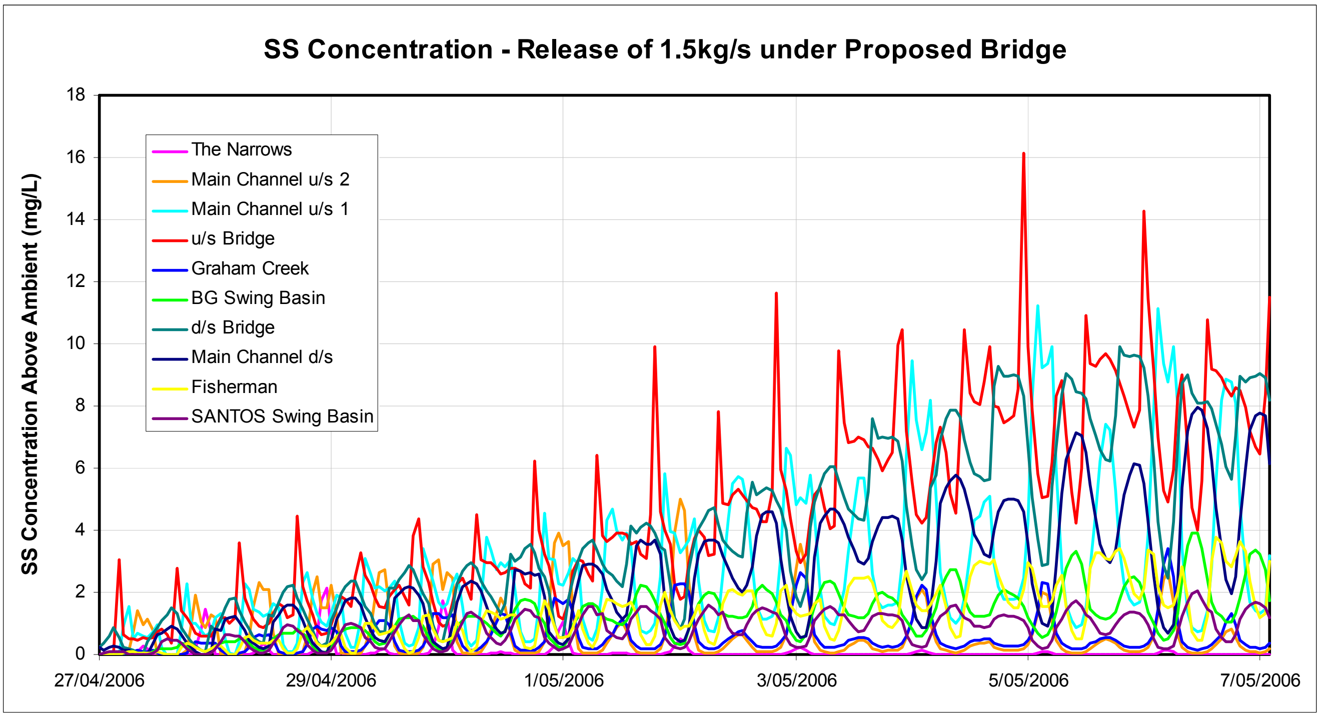


Figure 6-24 Far Field Sediment Modelling Results – Pipeline Construction

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

7.1.1 Water Quality in Port Curtis

Key baseline water quality data review outcomes for Port Curtis as a whole were as follows:

- Port Curtis is a well connected estuary which allows dissolved material to be dispersed relatively evenly, however material does not as readily leave the estuary to the offshore environment. This reduced flushing time is likely to contribute to the anomalous bioaccumulation of some metals in biota of Port Curtis;
- The characters of the estuarine waters within Port Curtis are generally close to seawater.
- Nutrient, total organic carbon and biochemical oxygen demand concentrations appear generally low, consistent with high quality estuarine water;
- Water clarity as defined by Secchi disc visibility is generally poor, being less than 2 m. Similarly, turbidities and suspended solids concentrations are moderate. Turbidity increases with depth and tidal velocity;
- Low chlorophyll *a* concentrations characterise Port Curtis;
- Elevated metal concentrations can exist within the Port; and
- Trace element, cyanide and phenol concentrations do not appear to be elevated above typical seawater or the ANZECC guideline concentrations.

When compared with relatively stringent water quality guidelines, water quality is generally good, though spatially variable. Some metal concentrations are high in places, and water quality objective exceedances may occur at times.

7.1.2 Water Quality in the vicinity of the GLNG Operation

Key findings of locally specific hydrodynamic and water quality data collection for the area of Port Curtis in the vicinity of the proposed operations were as follows:

- Tides in the area are semi-diurnal and the (spring) tidal range is of the order of 4 metres, with significant wetting and drying of mangrove and inter-tidal areas occurring;
- The area of interest represents a high energy environment, with strong tidal flows dominating local hydrodynamics;
- Typical peak (spring) tidal velocities reach 1.2 to 1.3 m/s;
- Velocities are relatively uniform over the water column, however some evidence of vertical shear was found around areas of local bathymetric features;
- Tidal flows largely follow natural and constructed channels, with these locations consistently experiencing the highest velocities, as measured with ADCP transects;
- There is a local asymmetry in the magnitude of tidal velocities offshore from the proposed facility, with ebbing tides being characterised by greater velocities than flooding tides;

- Small tidal velocity reversals were noted on flood tides in the vicinity of the shoreline at the southern end of China Bay;
- Turbidity increases with depth and tidal velocity, most likely due to bottom sediment resuspension;
- pH and temperature are relatively uniform with depth (observed during both campaigns), with evidence of only slight thermal stratification;
- Salinity appears to be responsive to rainfall and associated inflow events; and
- Catchment-derived pollutants may enter the area (either locally or remotely) with freshwater inflows.

7.1.3 Hydrodynamic and Water Quality Impacts

7.1.3.1 Hydrodynamic Impacts

The hydrodynamic impacts of the proposed works were found to be generally minimal, with the exception of in the immediate vicinity of the proposed dredged swing basin, where the significant dredging will reduce velocities quite considerably.

7.1.3.2 Tidal Flushing Impacts

Differences in flushing behaviour with and without the GLNG project are practically indiscernible.

7.1.3.3 Reverse Osmosis Concentrate Discharge Impacts

There are unlikely to be detectable changes in salinity levels due to this discharge.

7.1.3.4 Construction Stage Sediment Assessments

In the case of swing basin dredging, greater concentrations were realised during neap tides, where dispersion was less as a result of reduced tidal velocities. An immediate impact zone of the order of several hundred metres in scale was identified during these times, and outside this area, maximum additional TSS concentrations of approximately 25 mg/L were predicted (over ambient). These values are in the order of the natural variability of TSS concentrations across the site. Concentration increases during spring tides were generally less than during neap tides.

Similar behaviour was observed in the model results for the bridge and pipeline construction scenarios. The immediate impact zones were again in the order of hundreds of metres in dimension during neap tides (and considerably smaller during spring tides) with maximum additional TSS concentrations outside this zone of 14 to 16 mg/L.

7.2 Recommendations and Mitigation Strategies

- Any brine outfall from the site should adopt the diffuser design and configuration recommended by this study; and
- Best practice techniques should be adopted for dredging and pipeline construction activities in order to minimise the extent and duration of sediment plumes which may otherwise be generated during the construction phase of the project.

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APPENDIX A: GHD (2006) WATER QUALITY DATA

Appendix I1 GHD Water Quality Data

Site 1 Physical

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Surface	88		8.7	6.1	27.2	Surface	Flooding	90.2			4.3	30.9
Surface	88	51.7	8.08	6.1	27	Surface	Flooding	90.1			5.4	30.9
Surface	87.9	51.7	8.08	6.1	27.1	Surface	Flooding	89.8			5.9	30.9
Surface	87.7	51.7	8.08	6.1	27.1	Surface	Flooding	89.7			6.2	30.9
Surface	87.7	51.7	8.08	5.9	27.1	Surface	Flooding	89.4			5.3	30.9
Surface	87.7	51.6	8.08	5.6	27.1	Surface	Flooding	88.6			5.6	30.9
Surface	87.4	51.6	8.08	5.9	27.1	Surface	Flooding	89.1			5.5	30.9
Surface	87.4	51.6	8.08	6.6	27.1	Surface	Flooding	88.4			5.8	30.9
Surface	87.2	51.6	8.08	5.9	27.1	Surface	Flooding	88.6			5.7	30.9
Surface	87.6	51.6	8.08	5.6	27.1	Surface	Flooding	87.9			6.8	30.9
Surface	83.5	56.8	7.4	40.8	27.74	Surface	Flooding	88.9	56.1	7.6	9.5	33.8
Surface	83.6	56.8	7.41	39.5	27.73	Surface	Flooding	88.9	56.1	7.6	8.8	33.8
Surface	83.7	56.8	7.41	34.7	27.73	Surface	Flooding	89.1	56.1	7.6	9.4	33.79
Surface	83.7	56.8	7.42	36.5	27.75	Surface	Flooding	89.1	56.1	7.6	9.1	33.8
Surface	83.9	56.8	7.43	37.4	27.78	Surface	Flooding	89.3	56.1	7.6	9.5	33.79
Surface	84	56.8	7.43	38	27.78	Surface	Flooding	89.4	56.1	7.6	9.8	33.79
Surface	84.1	56.8	7.43	36.5	27.77	Surface	Flooding	89.4	56.1	7.6	9.4	33.79
Surface	84.2	56.8	7.44	41.3	27.77	Surface	Flooding	89.5	56.1	7.6	9.8	33.8
Surface	84.3	56.8	7.44	41.4	27.77	Surface	Flooding	89.5	56.1	7.6	9.8	33.8
Surface	84.4	56.8	7.44	41.8	27.78	Surface	Flooding	89.6	56.1	7.6	9.5	33.8
Surface	77.1	57.3	7.98	12.7	28.27	Middle	Flooding	108.50			7.40	30.40
Surface	78.3	57.3	7.99	13.9	28.25	Middle	Flooding	108.60			6.80	30.40
Surface	78.2	57.3	7.99	13.1	28.24	Middle	Flooding	106.90			6.20	30.50

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Surface	78.1	57.3	7.99	13.5	28.22	Middle	Flooding	105.60			5.80	30.50
Surface	78.1	57.3	7.99	12.8	28.24	Middle	Flooding	105.20			5.90	30.50
Surface	78.1	57.3	7.99	12.1	28.25	Middle	Flooding	104.40			5.90	30.50
Surface	78.1	57.3	7.99	14.4	28.24	Middle	Flooding	104.80			5.80	30.50
Surface	78.1	57.3	7.99	12.9	28.25	Middle	Flooding	102.00			6.70	30.60
Surface	78.1	57.3	7.99	12.8	28.26	Middle	Flooding	101.10			6.30	30.60
Surface	78.1	57.3	7.99	11.9	28.26	Middle	Flooding	102.40			6.20	30.60
Surface	87.4	56.2	6.66	25.6	26.4	Middle	Flooding	89.30	56.10	7.61	9.00	33.78
Surface	86.7	56.4	6.67	26.5	26.4	Middle	Flooding	89.30	56.10	7.61	8.80	33.78
Surface	86.9	56.4	6.67	25.1	26.4	Middle	Flooding	89.30	56.10	7.61	8.80	33.78
Surface	86.4	56.4	6.66	29.2	26.4	Middle	Flooding	89.40	56.10	7.61	9.40	33.77
Surface	86.7	56.4	6.67	26	26.4	Middle	Flooding	89.40	56.10	7.61	9.40	33.77
Surface	86.2	56.4	6.68	28.4	26.4	Middle	Flooding	89.40	56.10	7.61	9.50	33.77
Surface	86.3	56.4	6.68	27	26.4	Middle	Flooding	89.40	56.10	7.61	9.40	33.77
Surface	86.3	56.4	6.69	28.7	26.4	Middle	Flooding	89.40	56.10	7.61	10.00	33.77
Surface	86	56.4	6.68	34.4	26.4	Middle	Flooding	89.50	56.20	7.62	9.10	33.78
Surface	85.7	56.4	6.69	28.7	26.4	Middle	Flooding	89.40	56.10	7.62	9.00	33.79
Surface	84.6	56.8	6.03	17.8	26.5	Bottom	Flooding	111.10			5.90	30.60
Surface	84.1	56.8	6.03	16.8	26.5	Bottom	Flooding	110.10			7.00	30.60
Surface	84.2	56.8	6.03	18.9	26.5	Bottom	Flooding	111.00			6.60	30.60
Surface	84.4	56.8	6.03	18.9	26.5	Bottom	Flooding	110.40			6.00	30.60
Surface	84.4	56.7	6.04	15.9	26.5	Bottom	Flooding	106.30			5.70	30.60
Surface	84.2	56.7	6.04	14.8	26.5	Bottom	Flooding	105.30			5.90	30.60
Surface	84.4	56.7	6.04	18	26.5	Bottom	Flooding	106.60			6.90	30.60
Surface	84.4	56.7	6.04	17.7	26.5	Bottom	Flooding	106.60			6.40	30.60
Surface	84.4	56.7	6.04	16.6	26.5	Bottom	Flooding	103.40			6.00	30.60
Surface	84.5	56.7	6.04	15.7	26.5	Bottom	Flooding	104.20			5.80	30.60

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Middle	86.60	51.60	8.08	7.80	26.90	Bottom	Flooding	87.80	56.10	7.63	14.00	33.62
Middle	86.90	51.60	8.08	8.40	26.90	Bottom	Flooding	88.20	56.10	7.63	18.00	33.54
Middle	86.80	51.60	8.08	8.50	26.90	Bottom	Flooding	88.00	56.10	7.63	15.70	33.52
Middle	87.00	51.70	8.09	8.40	26.90	Bottom	Flooding	87.70	56.10	7.63	16.00	33.49
Middle	88.50	51.70	8.08	9.20	26.00	Bottom	Flooding	87.40	56.00	7.63	18.70	33.46
Middle	92.30	52.20	8.21	9.60		Bottom	Flooding	86.70	56.10	7.63	22.30	33.33
Middle	94.10	52.20	8.27	9.00		Bottom	Flooding	85.80	56.20	7.64	15.70	33.43
Middle	94.20	52.20	8.28	8.80		Bottom	Flooding	85.40	56.10	7.64	16.40	33.49
Middle	94.50	52.20	8.28	8.50		Bottom	Flooding	85.60	56.10	7.64	16.30	33.49
Middle	94.50	52.20	8.28	7.90		Bottom	Flooding	85.90	56.20	7.64	14.00	33.51
Middle	84.70	56.80	7.52	45.40	27.73							
Middle	84.70	56.70	7.53	44.90	27.73							
Middle	84.70	56.80	7.54	43.40	27.72							
Middle	84.70	56.80	7.54	42.30	27.73							
Middle	84.80	56.80	7.55	41.60	27.72							
Middle	84.80	56.80	7.55	44.90	27.72							
Middle	84.80	56.80	7.55	41.80	27.72							
Middle	84.90	56.80	7.55	46.70	27.72							
Middle	84.90	56.80	7.56	44.10	27.72							
Middle	85.00	56.70	7.56	43.90	27.73							
Middle	77.90	57.30	8.00	14.20	28.23							
Middle	77.90	57.30	8.00	13.50	28.24							
Middle	77.90	57.30	8.00	16.80	28.22							
Middle	77.90	57.30	8.00	16.80	28.22							
Middle	77.90	57.30	8.00	21.00	28.22							
Middle	77.90	57.30	8.00	14.40	28.21							
Middle	78.00	57.30	8.00	13.90	28.23							

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Middle	77.90	57.30	8.00	13.40	28.24							
Middle	77.90	57.40	8.00	13.40	28.25							
Middle	77.90	57.40	8.00	13.40	28.25							
Middle	88.10	56.80	6.56	39.90	26.40							
Middle	86.40	56.80	6.55	31.90	26.40							
Middle	86.30	56.80	6.52	28.30	26.40							
Middle	86.60	56.80	6.52	28.50	26.40							
Middle	86.00	56.80	6.52	21.20	26.40							
Middle	85.30	56.90	6.53	32.50	26.40							
Middle	84.40	56.80	6.53	28.10	26.40							
Middle	84.00	56.90	6.52	22.80	26.40							
Middle	84.60	56.90	6.52	27.20	26.40							
Middle	84.20	56.80	6.52	23.70	26.40							
Middle	84.00	56.70	6.04	14.50	26.60							
Middle	84.10	56.70	6.04	14.20	26.60							
Middle	84.20	56.70	6.04	15.60	26.50							
Middle	84.20	56.70	6.04	15.60	26.50							
Middle	84.40	56.70	6.04	10.90	26.50							
Middle	84.60	56.70	6.04	9.90	26.60							
Middle	84.60	56.70	6.04	12.30	26.60							
Middle	84.20	56.60	6.04	14.40	26.60							
Middle	84.20	56.70	6.04	13.70	26.60							
Middle	84.50	56.70	6.04	11.90	26.60							
Bottom	93.60	52.20	8.28	8.60								
Bottom	93.80	52.20	8.28	8.00								
Bottom	93.90	52.20	8.28	8.90								
Bottom	94.00	52.20	8.28	8.10								

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Bottom	94.20	52.20	8.27	8.90								
Bottom	94.10	52.20	8.27	8.50								
Bottom	94.00	52.30	8.27	8.00								
Bottom	94.00	52.30	8.27	11.00								
Bottom	94.00	52.30	8.27	8.20								
Bottom	93.60	52.30	8.26	9.10								
Bottom	85.70	56.80	7.60	43.30	27.74							
Bottom	85.80	56.80	7.60	44.70	27.73							
Bottom	85.70	56.80	7.60	45.40	27.74							
Bottom	85.90	56.80	7.61	43.90	27.73							
Bottom	85.90	56.80	7.61	51.60	27.73							
Bottom	85.90	56.80	7.61	46.90	27.72							
Bottom	85.90	56.70	7.61	50.50	27.73							
Bottom	86.00	56.80	7.61	46.90	27.72							
Bottom	85.90	56.70	7.61	42.70	27.73							
Bottom	85.90	56.80	7.61	45.10	27.74							
Bottom	77.80	57.30	8.00	31.60	28.21							
Bottom	77.80	57.30	8.00	35.20	28.21							
Bottom	77.70	57.30	8.00	37.80	28.21							
Bottom	77.70	57.30	8.00	37.80	28.21							
Bottom	77.70	57.30	8.00	38.80	28.20							
Bottom	77.70	57.30	8.00	35.50	28.21							
Bottom	77.60	57.30	8.00	35.50	28.22							
Bottom	77.60	57.30	8.00	35.50	28.22							
Bottom	77.60	57.30	8.00	21.30	28.22							
Bottom	77.60	57.30	8.00	26.00	28.22							
Bottom	86.10	56.90	6.51	25.70	26.40							

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Bottom	85.30	56.90	6.50	27.90	26.40							
Bottom	85.50	56.90	6.49	27.50	26.40							
Bottom	85.10	56.90	6.49	26.30	26.40							
Bottom	85.50	56.80	6.49	31.80	26.40							
Bottom	85.10	56.90	6.49	25.50	26.40							
Bottom	85.30	56.80	6.50	35.00	26.40							
Bottom	84.50	56.90	6.49	31.10	26.40							
Bottom	84.60	56.80	6.49	33.70	26.40							
Bottom	83.80	56.90	6.50	37.70	26.40							
Bottom	84.90	56.60	6.03	27.10	26.60							
Bottom	84.80	56.70	6.03	12.60	26.60							
Bottom	84.80	56.60	6.03	23.70	26.60							
Bottom	84.80	56.60	6.03	19.50	26.60							
Bottom	84.80	56.70	6.03	17.70	26.50							
Bottom	84.80	56.70	6.03	19.20	26.60							
Bottom	84.80	56.70	6.03	19.10	26.60							
Bottom	84.80	56.70	6.03	21.20	26.50							
Bottom	84.80	56.70	6.03	21.40	26.50							
Bottom	84.80	56.70	6.04	19.10	26.50							

Site 2 Physical

	Ebbing						Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (°C)	Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (°C)
Surface	87.4	51.5	8.08	7.1	27.4	Surface	86.1			9.2	31.2
Surface	86.9	51.4	8.11	8.4	27.4	Surface	87.2			9	31.3
Surface	86.8	51.3	8.1	8.4	27.4	Surface	86.4			9.4	31.3
Surface	87.2	51.3	8.11	6.8	27.4	Surface	85.6			7.7	31.3
Surface	86.7	51.4	8.1	8.2	27.4	Surface	85.5			7.9	31.3
Surface	87	51.4	8.11	7.5	27.4	Surface	86.4			7.7	31.3
Surface	86.7	51.4	8.11	8	27.4	Surface	87.2			9.2	31.3
Surface	86.7	51.4	8.11	7	27.4	Surface	87.1			8.4	31.3
Surface	86.7	51.5	8.1	7.1	27.5	Surface	87			7.8	31.3
Surface	86.5	51.5	8.1	6.8	27.5	Surface	86.7			9	31.3
Surface	86.9	56.8	7.66	42.4	27.72	Surface	88.2	55.8	7.67	15	32.82
Surface	87	56.8	7.66	41.4	27.72	Surface	88.4	55.7	7.67	15.9	32.78
Surface	87	56.8	7.67	40	27.72	Surface	88.4	55.8	7.66	15.2	32.81
Surface	87.1	56.8	7.67	40.5	27.72	Surface	88.5	55.7	7.66	15.7	32.79
Surface	87.1	56.8	7.67	45.4	27.72	Surface	88.4	55.8	7.66	14.7	32.82
Surface	87.2	56.8	7.67	44.6	27.72	Surface	88.6	55.8	7.66	15.4	32.82
Surface	87.2	56.8	7.67	43.3	27.72	Surface	88.6	55.7	7.66	15.3	32.81
Surface	87.2	56.8	7.67	43.1	27.72	Surface	88.6	55.7	7.66	15.6	32.81
Surface	87.2	56.8	7.67	40.5	27.72	Surface	88.6	55.7	7.66	15.6	32.8
Surface	87.3	56.8	7.67	45.3	27.72	Surface	88.6	55.7	7.66	15.4	32.8
Surface	77.2	57.3	7.99	14.2	28.3	Middle	108.1			10.4	31.3
Surface	77.6	57.3	7.99	14.4	28.3	Middle	107.6			8.3	31.3
Surface	77.6	57.3	7.99	14.4	28.3	Middle	107.9			7.7	31.3
Surface	77.6	57.3	7.99	14.4	28.3	Middle	107.9			9	31.3
Surface	77.7	57.3	7.99	18.1	28.25	Middle	109			9.5	31.3
Surface	77.7	57.3	7.99	18.1	28.25	Middle	107.7			8.8	31.3

	Ebbing						Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (^{0}C)	Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (^{0}C)
Surface	77.7	57.3	7.99	16.5	28.25	Middle	105.8			9.9	31.3
Surface	77.6	57.3	7.99	15.1	28.28	Middle	104.9			8.8	31.3
Surface	77.5	57.3	7.99	15.1	28.28	Middle	103.4			8.5	31.3
Surface	77.5	57.3	7.98	14.5	28.3	Middle	103.8			8.6	31.3
Surface	88.6	56.9	6.67	17	26.4	Middle	88.6	55.7	7.65	17.3	32.62
Surface	87.9	56.9	6.67	16.9	26.4	Middle	88.6	55.9	7.65	17.7	32.58
Surface	87.2	56.9	6.67	17.5	26.4	Middle	88.3	55.9	7.65	16.3	32.69
Surface	86.6	56.9	6.68	18.2	26.5	Middle	88.2	55.8	7.65	16.6	32.74
Surface	86.3	56.9	6.68	14.8	26.5	Middle	88.1	55.7	7.65	16	32.8
Surface	86.3	56.9	6.68	15.4	26.5	Middle	88.3	55.8	7.65	16	32.76
Surface	86.2	56.9	6.68	17.5	26.5	Middle	88.4	55.7	7.65	17.3	32.74
Surface	86	56.9	6.69	16.5	26.5	Middle	88.8	55.6	7.65	18.1	32.62
Surface	85.6	56.9	6.69	13.6	26.5	Middle	88.8	55.7	7.65	17.3	32.61
Surface	85.5	56.9	6.69	12.6	26.5	Middle	88.4	55.8	7.65	16.8	32.68
Surface	84.7	56.7	6.07	21.2	26.5	Bottom	120.9			10.9	31.3
Surface	84.5	56.7	6.08	19.5	26.5	Bottom	118.8			8.7	31.3
Surface	84.1	56.7	6.08	17.9	26.6	Bottom	115.8			10.4	31.3
Surface	84.4	56.6	6.08	18.7	26.6	Bottom	114.8			12.5	31.3
Surface	84.4	56.6	6.08	18	26.6	Bottom	112.2			9	31.3
Surface	84.1	56.6	6.08	18.3	26.6	Bottom	112.4			10.4	31.3
Surface	84	56.6	6.08	16.5	26.6	Bottom	112.8			11.8	31.3
Surface	84	56.6	6.08	16.9	26.6	Bottom	112.6			10.7	31.3
Surface	83.8	56.6	6.09	17.5	26.6	Bottom	110.6			11.9	31.3
Surface	83.4	56.5	6.08	19.1	26.6	Bottom	110.9			10.6	31.3
Middle	94.4	51.9	8.3	7.1		Bottom	86.5	55.6	7.65	22.6	32.42
Middle	94.3	52	8.3	7.5		Bottom	86.5	55.6	7.65	22	32.4
Middle	94.1	52	8.3	7.5		Bottom	86.4	55.6	7.65	20.5	32.42

	Ebbing						Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (^{0}C)	Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (^{0}C)
Middle	94	52	8.3	7.6		Bottom	86.3	55.7	7.65	19.5	32.46
Middle	93.9	52	8.29	7.8		Bottom	86.4	55.7	7.65	21.8	32.44
Middle	93.7	52	8.29	8.1		Bottom	86.5	55.6	7.65	23	32.41
Middle	93.6	51.9	8.29	7.6		Bottom	86.5	55.6	7.65	23.6	32.39
Middle	93.5	51.9	8.28	8.5		Bottom	86.5	55.6	7.65	23.4	32.39
Middle	93.3	52	8.28	8.1		Bottom	86.3	55.7	7.65	21.9	32.4
Middle	93.2	52	8.28	8.2		Bottom	86.1	55.7	7.65	22.6	32.41
Middle	87.7	56.8	7.7	44.3	27.71						
Middle	87.7	56.8	7.7	42.3	27.71						
Middle	87.8	56.8	7.7	49	27.71						
Middle	87.8	56.8	7.71	42.8	27.7						
Middle	87.8	56.8	7.71	41.7	27.7						
Middle	87.8	56.8	7.71	45.3	27.71						
Middle	87.8	56.8	7.71	44.6	27.7						
Middle	87.9	56.8	7.71	46.2	27.7						
Middle	87.9	56.8	7.71	44	27.71						
Middle	87.9	56.8	7.71	46.7	27.7						
Middle	77.2	57.3	7.99	17.1	28.22						
Middle	77.2	57.3	7.99	17.1	28.23						
Middle	77.2	57.3	7.99	16.8	28.23						
Middle	77.2	57.3	7.99	16.5	28.24						
Middle	77.1	57.3	7.99	18.7	28.22						
Middle	77.2	57.3	7.99	20.4	28.21						
Middle	77.2	57.3	7.99	16.7	28.24						
Middle	77.2	57.3	8	17	28.24						
Middle	77.2	57.3	8	16.2	28.24						
Middle	77.2	57.3	8	16.2	28.24						

	Ebbing						Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (^{0}C)	Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (^{0}C)
Middle	86.1	56.9	6.59	20.4	26.4						
Middle	85.5	56.9	6.58	21	26.4						
Middle	84.7	56.9	6.58	24.6	26.4						
Middle	83.6	56.8	6.58	21.1	26.4						
Middle	83.3	56.9	6.58	22.6	26.4						
Middle	83.1	56.8	6.58	19.5	26.4						
Middle	82.6	56.8	6.58	16.4	26.4						
Middle	82.5	56.8	6.59	23.9	26.4						
Middle	81.8	56.8	6.59	27.3	26.4						
Middle	81.5	56.9	6.59	21.3	26.4						
Middle	84	56.6	6.01	16.7	26.6						
Middle	84.1	56.7	6.01	18.2	26.6						
Middle	84.1	56.6	6.01	18.7	26.5						
Middle	84.1	56.7	6.01	18	26.5						
Middle	84	56.7	6.01	16.3	26.5						
Middle	84	56.7	6.01	18.3	26.5						
Middle	83.9	56.7	6.01	16.8	26.5						
Middle	83.6	56.7	6.01	20.6	26.5						
Middle	83.3	56.7	6.01	18.6	26.5						
Middle	83.3	56.7	6.01	19.6	26.5						
Bottom	91.6	52.1	8.27	10.3							
Bottom	91.5	52.1	8.27	10.2							
Bottom	91.5	52.1	8.27	10							
Bottom	91.6	52.2	8.27	8.6							
Bottom	91.9	52.1	8.27	9.7							
Bottom	91.5	52.1	8.27	9.7							
Bottom	91.5	52.1	8.27	11.3							

	Ebbing						Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (^{0}C)	Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (^{0}C)
Bottom	91.4	52.1	8.27	11.3							
Bottom	91.4	52.1	8.27	11							
Bottom	88	56.8	7.72	49.6	27.7						
Bottom	88	56.8	7.72	50.6	27.7						
Bottom	88	56.8	7.72	52.6	27.7						
Bottom	88.1	56.8	7.72	54.8	27.7						
Bottom	88.1	56.8	7.72	52.8	27.69						
Bottom	88.1	56.8	7.72	56.6	27.69						
Bottom	88.1	56.8	7.72	54.5	27.69						
Bottom	88.1	56.8	7.72	53.5	27.69						
Bottom	88.1	56.8	7.72	51.8	27.69						
Bottom	88.1	56.8	7.72	53.9	27.69						
Bottom	77.3	57.3	8	17.3	28.23						
Bottom	77.4	57.3	8	18.3	28.23						
Bottom	77.4	57.3	8	17	28.23						
Bottom	77.4	57.3	8	17	28.23						
Bottom	77.4	57.3	8	17.3	28.23						
Bottom	77.4	57.3	8	16	28.23						
Bottom	77.4	57.3	8	17.4	28.23						
Bottom	77.4	57.3	8	19.1	28.23						
Bottom	77.4	57.3	8	17	28.23						
Bottom	77.4	57.3	8	20	28.23						
Bottom	84.2	56.9	6.53	36	26.4						
Bottom	83	56.9	6.53	47.2	26.4						
Bottom	82.3	56.9	6.53	41.7	26.4						
Bottom	81.3	56.9	6.53	28.1	26.4						
Bottom	79.7	56.9	6.53	42.2	26.4						

	Ebbing						Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (^{0}C)	Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (^{0}C)
Bottom	78.6	56.9	6.53	27	26.4						
Bottom	78	56.9	6.53	35.4	26.4						
Bottom	77.3	56.9	6.53	45.1	26.4						
Bottom	77.1	56.9	6.53	37.2	26.4						
Bottom	77.7	56.9	6.52	37.4	26.4						
Bottom	83.3	56.7	5.98	17.3	26.5						
Bottom	83	56.7	5.98	17.1	26.5						
Bottom	82.9	56.7	5.98	15	26.5						
Bottom	83	56.7	5.98	19.7	26.4						
Bottom	82.9	56.8	5.99	17.9	26.5						
Bottom	84.1	56.7	5.99	21.8	26.5						
Bottom	84.8	56.8	5.98	24.3	26.5						
Bottom	84.2	56.9	5.98	25.5	26.5						
Bottom	84.2	56.8	5.99	25.5	26.5						
Bottom	84.4	56.7	5.99	22.2	26.5						

Site 3 Physical

	Ebbing						Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Surface	88.5	52.7	8.23	13		Surface	96.60			5.70	29.90
Surface	88.5	52.6	8.22	9.6		Surface	95.00			7.10	30.00
Surface	88.4	52.6	8.22	9.6		Surface	94.40			5.80	30.00
Surface	88.3	52.6	8.23	9		Surface	93.40			6.50	30.10
Surface	88.6	52.6	8.23	9.9		Surface	94.30			7.00	30.10
Surface	88.7	52.5	8.23	9.3		Surface	93.20			6.30	30.10
Surface	88.9	52.5	8.23	9.3		Surface	92.50			8.50	30.20
Surface	88.9	52.5	8.23	8.1		Surface	92.00			6.40	30.20
Surface	88.9	52.5	8.23	9.1		Surface	91.20			7.00	30.30
Surface	88.9	52.5	8.23	8.5		Surface	91.90			7.30	30.30
Surface	84.6	56.9	7.59	20	31.11	Surface	90.20	50.50	7.69	8.70	31.64
Surface	84.6	56.9	7.59	18.8	31.11	Surface	90.40	50.60	7.69	7.60	31.63
Surface	84.7	56.9	7.59	19.4	31.12	Surface	90.50	50.50	7.69	8.70	31.64
Surface	84.7	56.9	7.6	19.8	31.12	Surface	90.60	50.50	7.69	7.60	31.64
Surface	84.8	56.9	7.59	20	31.12	Surface	90.60	50.50	7.69	8.10	31.64
Surface	85	56.9	7.6	18.3	31.11	Surface	90.70	50.50	7.69	8.00	31.64
Surface	85	56.9	7.6	19.1	31.11	Surface	90.70	50.50	7.69	7.90	31.63
Surface	85.1	56.9	7.6	19.3	31.11	Surface	90.70	50.50	7.69	7.40	31.64
Surface	85.2	56.9	7.6	17.1	31.09	Surface	90.50	50.50	7.69	8.00	31.64
Surface	85.2	56.9	7.6	17.5	31.09	Surface	90.50	50.50	7.69	9.50	31.64
Surface	70	56.6	7.82	11.9	30.92	Middle	127.80			6.10	30.40
Surface	73	56.6	7.83	11.8	30.93	Middle	123.60			7.50	30.50
Surface	73.9	56.6	7.83	11.9	30.93	Middle	120.60			6.80	30.50
Surface	74.2	56.6	7.83	11.5	30.92	Middle	120.70			6.60	30.50
Surface	74.5	56.6	7.83	11.9	30.93	Middle	119.20			8.20	30.50
Surface	74.6	56.6	7.83	12.4	30.93	Middle	117.20			5.80	30.50

	Ebbing						Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Surface	74.7	56.6	7.83	12.4	30.93	Middle	115.60			7.00	30.50
Surface	74.7	56.6	7.83	11.6	30.93	Middle	114.20			7.80	30.50
Surface	74.7	56.6	7.83	11.5	30.93	Middle	113.70			6.60	30.50
Surface	74.8	56.6	7.84	11.9	30.92	Middle	112.30			6.90	30.50
Surface	83.4	56.1	6.49	7.1	29.2	Middle	90.30	50.70	7.69	8.30	31.64
Surface	81	56.3	6.49	7.9	29.2	Middle	90.30	50.70	7.69	9.10	31.64
Surface	80.5	56.2	6.49	10.3	29.3	Middle	90.40	50.80	7.69	10.10	31.64
Surface	81	56.1	6.5	9.6	29.4	Middle	90.30	50.80	7.69	11.10	31.65
Surface	80.6	56	6.5	9.1	29.4	Middle	90.30	50.80	7.69	10.90	31.65
Surface	79.4	56.1	6.51	6.7	29.4	Middle	90.20	50.90	7.69	12.40	31.65
Surface	78.8	56	6.51	6.8	29.4	Middle	90.00	50.80	7.69	10.80	31.65
Surface	79.2	55.9	6.51	7.3	29.4	Middle	89.80	50.80	7.69	9.80	31.65
Surface	79.5	55.9	6.51	11.5	29.4	Middle	89.80	50.80	7.69	10.00	31.65
Surface	79.1	55.9	6.51	9.9	29.5	Middle	89.80	50.80	7.69	11.10	31.65
Surface	85.1	55.8	6.11	8.1	29.8	Bottom	128.60			6.70	30.60
Surface	84.8	55.7	6.11	7.8	29.8	Bottom	125.40			6.80	30.60
Surface	84.8	55.8	6.11	7.1	29.8	Bottom	124.50			7.00	30.60
Surface	84.6	55.6	6.11	7.8	29.8	Bottom	124.30			6.80	30.60
Surface	84.1	55.6	6.11	6.4	29.9	Bottom	124.30			5.80	30.60
Surface	84.1	55.6	6.11	8.4	29.9	Bottom	122.40			6.10	30.60
Surface	84.1	55.6	6.12	7.5	29.9	Bottom	121.20			6.30	30.60
Surface	84	55.6	6.12	7.2	29.9	Bottom	118.50			7.90	30.60
Surface	84	55.5	6.12	7.9	29.9	Bottom	118.40			7.40	30.60
Surface	83.9	55.5	6.12	6.9	29.9	Bottom	117.70			6.90	30.60
Middle	88.60	52.40	8.23	13.20		Bottom	86.60	51.80	7.68	27.60	31.77
Middle	88.10	52.40	8.23	11.20		Bottom	86.40	51.80	7.68	25.40	31.77
Middle	87.60	52.40	8.23	9.40		Bottom	86.30	51.70	7.68	24.10	31.77

	Ebbing						Flooding				
Depth	**Dissolved oxygen (%)**	**Conductivity (uS/cm)**	**pH**	**Turbidity (NTU)**	**Temperature (0C)**	**Depth**	**Dissolved oxygen (%)**	**Conductivity (uS/cm)**	**pH**	**Turbidity (NTU)**	**Temperature (0C)**
Middle	87.90	52.40	8.23	8.50		Bottom	86.30	51.70	7.68	26.00	31.77
Middle	88.10	52.40	8.23	10.30		Bottom	86.30	51.70	7.68	23.90	31.77
Middle	88.20	52.40	8.23	9.50		Bottom	86.30	51.40	7.68	22.70	31.75
Middle	87.90	52.40	8.23	9.20		Bottom	86.30	51.70	7.68	23.30	31.76
Middle	87.70	52.40	8.23	10.40		Bottom	86.30	51.60	7.68	26.50	31.77
Middle	87.60	52.40	8.23	10.00		Bottom	86.30	51.70	7.68	22.90	31.77
Middle	88.00	52.40	8.23	9.60		Bottom	86.40	51.70	7.68	25.10	31.77
Middle	85.30	56.90	7.62	20.70	31.11						
Middle	85.40	56.90	7.62	21.60	31.10						
Middle	85.40	56.90	7.62	21.10	31.10						
Middle	85.50	56.90	7.62	22.60	31.09						
Middle	85.50	56.90	7.63	21.00	31.09						
Middle	85.40	56.90	7.63	23.40	31.10						
Middle	85.50	56.90	7.62	22.70	31.11						
Middle	85.50	56.90	7.63	21.10	31.09						
Middle	85.50	56.90	7.63	22.00	31.09						
Middle	85.50	56.90	7.63	20.60	31.09						
Middle	74.80	56.50	7.84	12.10	30.94						
Middle	74.90	56.60	7.84	12.10	30.94						
Middle	74.90	56.50	7.84	12.40	30.94						
Middle	74.90	56.60	7.84	11.40	30.93						
Middle	75.00	56.60	7.85	12.10	30.94						
Middle	75.10	56.60	7.85	12.90	30.93						
Middle	75.10	56.60	7.85	12.50	30.93						
Middle	75.10	56.60	7.85	13.10	30.93						
Middle	75.10	56.60	7.85	12.10	30.94						
Middle	75.10	56.50	7.85	12.20	30.94						

	Ebbing						Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Middle	77.90	55.80	6.33	6.90	29.60						
Middle	76.80	55.70	6.33	8.20	29.60						
Middle	75.80	55.70	6.33	8.90	29.60						
Middle	76.40	55.80	6.33	8.60	29.60						
Middle	77.70	55.80	6.34	9.60	29.60						
Middle	78.60	55.80	6.34	12.30	29.60						
Middle	77.90	55.70	6.34	7.50	29.60						
Middle	75.90	55.60	6.34	9.30	29.60						
Middle	75.80	55.70	6.35	9.30	29.60						
Middle	76.50	55.70	6.35	9.10	29.60						
Middle	84.20	55.50	6.10	9.40	29.90						
Middle	84.20	55.50	6.10	8.50	29.90						
Middle	84.10	55.50	6.10	6.90	29.90						
Middle	83.90	55.50	6.10	8.50	29.90						
Middle	83.60	55.50	6.11	8.40	29.90						
Middle	83.60	55.50	6.11	8.90	29.90						
Middle	83.20	55.50	6.11	8.70	29.90						
Middle	83.20	55.50	6.11	8.10	29.90						
Middle	83.20	55.50	6.11	8.60	29.90						
Middle	83.30	55.50	6.12	8.70	29.90						
Bottom	87.40	52.40	8.22	10.50							
Bottom	86.50	52.40	8.23	11.60							
Bottom	86.70	52.40	8.23	11.10							
Bottom	86.50	52.40	8.23	10.80							
Bottom	86.80	52.40	8.23	11.20							
Bottom	86.70	52.40	8.23	9.50							
Bottom	86.80	52.40	8.23	10.40							

	Ebbing						Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Bottom	86.80	52.40	8.23	10.80							
Bottom	86.80	52.40	8.23	10.90							
Bottom	86.60	52.40	8.23	11.90							
Bottom	85.10	56.90	7.64	25.20	31.02						
Bottom	85.10	56.90	7.64	28.90	31.02						
Bottom	85.20	56.90	7.64	30.80	31.02						
Bottom	85.20	56.90	7.64	25.70	31.02						
Bottom	85.00	56.90	7.65	29.50	31.02						
Bottom	85.00	56.90	7.65	26.60	31.02						
Bottom	85.00	56.90	7.65	27.70	31.03						
Bottom	85.00	56.90	7.65	31.10	31.02						
Bottom	85.00	56.90	7.65	29.60	31.02						
Bottom	85.00	56.90	7.65	28.60	31.02						
Bottom	75.30	56.60	7.85	14.70	30.92						
Bottom	75.30	56.60	7.86	13.50	30.93						
Bottom	75.30	56.60	7.86	13.50	30.92						
Bottom	75.30	56.60	7.86	13.20	30.92						
Bottom	75.30	56.60	7.86	15.70	30.91						
Bottom	75.40	56.60	7.86	12.70	30.94						
Bottom	75.40	56.60	7.86	12.50	30.94						
Bottom	75.50	56.60	7.86	12.90	30.94						
Bottom	75.60	56.60	7.86	12.70	30.93						
Bottom	75.70	56.60	7.86	12.50	30.94						
Bottom	79.70	55.60	6.32	9.70	29.60						
Bottom	78.90	55.60	6.32	10.70	29.60						
Bottom	78.60	55.60	6.32	10.40	29.60						
Bottom	79.10	55.60	6.32	10.60	29.60						

	Ebbing						Flooding				
Depth	**Dissolved oxygen (%)**	**Conductivity (uS/cm)**	**pH**	**Turbidity (NTU)**	**Temperature (0C)**	**Depth**	**Dissolved oxygen (%)**	**Conductivity (uS/cm)**	**pH**	**Turbidity (NTU)**	**Temperature (0C)**
Bottom	79.50	55.60	6.32	11.20	29.60						
Bottom	79.10	55.60	6.32	12.50	29.60						
Bottom	78.20	55.60	6.32	13.60	29.60						
Bottom	76.70	55.60	6.32	7.90	29.60						
Bottom	76.00	55.60	6.32	11.00	29.70						
Bottom	76.10	55.60	6.32	11.80	29.70						
Bottom	81.60	55.50	6.09	9.90	29.80						
Bottom	81.30	55.50	6.09	9.60	29.80						
Bottom	81.50	55.50	6.09	9.70	29.80						
Bottom	81.30	55.50	6.09	10.10	29.80						
Bottom	81.10	55.50	6.09	9.40	29.80						
Bottom	80.50	55.50	6.09	9.90	29.80						
Bottom	80.40	55.40	6.09	9.90	29.80						
Bottom	80.10	55.40	6.08	10.50	29.80						
Bottom	80.10	55.40	6.08	10.70	29.80						
Bottom	79.80	55.50	6.08	11.70	29.80						

Site 4 Physical

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Surface	90.7	0	8.22	11.7		Surface	Flooding	93.3			6	29.9
Surface	88.1	52.1	8.23	11		Surface	Flooding	92.8			6.9	30
Surface	87.8	52.1	8.23	12.2		Surface	Flooding	92.4			5.7	30
Surface	87.9	52.1	8.24	12.2		Surface	Flooding	92.2			7.7	30.1
Surface	88	52.1	8.24	12.2		Surface	Flooding	91.9			5.4	30.3
Surface	88.2	52.1	8.24	11.1		Surface	Flooding	92.6			6.3	30.3
Surface	87.7	52	8.24	12.3		Surface	Flooding	92.6			5.8	30.3
Surface	87.9	52.1	8.24	11.3		Surface	Flooding	92.3			5.8	30.4
Surface	88.2	52.1	8.25	12.1		Surface	Flooding	92.3			5.9	30.4
Surface	88.5	52	8.24	10.9		Surface	Flooding	92.1			5.6	30.5
Surface	85.1	56.9	7.69	15.1	31.19	Surface	Flooding	88.6	50.5	7.67	8.3	31.66
Surface	85.2	56.9	7.69	15.5	31.18	Surface	Flooding	88.7	50.5	7.67	9	31.65
Surface	85.3	56.9	7.69	15.1	31.17	Surface	Flooding	89	50.5	7.67	9	31.65
Surface	85.3	56.9	7.69	15.4	31.18	Surface	Flooding	89.1	50.6	7.67	10	31.66
Surface	85.3	56.9	7.69	16.7	31.19	Surface	Flooding	89.2	50.5	7.67	9	31.65
Surface	85.4	56.9	7.69	15.7	31.19	Surface	Flooding	89.2	50.5	7.68	8.3	31.66
Surface	85.5	56.9	7.69	17	31.19	Surface	Flooding	89.3	50.6	7.68	9.5	31.66
Surface	85.6	56.9	7.69	15.5	31.18	Surface	Flooding	89.4	50.5	7.67	9.8	31.66
Surface	85.6	56.9	7.69	15	31.19	Surface	Flooding	89.4	50.5	7.68	9.4	31.67
Surface	85.6	56.9	7.69	15.1	31.19	Surface	Flooding	89.4	50.6	7.68	10.1	31.66
Surface	72.1	56.6	7.91	16	30.97	Middle	Flooding	114.5			6.2	30.5
Surface	74	56.6	7.91	17.8	30.97	Middle	Flooding	114.2			6.5	30.5
Surface	75.1	56.6	7.91	18	30.97	Middle	Flooding	112.6			6.8	30.5
Surface	75.5	56.6	7.91	13.1	30.98	Middle	Flooding	113.5			6.7	30.5
Surface	75.8	56.6	7.91	14.2	30.98	Middle	Flooding	109.9			6.3	30.5
Surface	76.1	56.6	7.91	13.8	30.98	Middle	Flooding	108.1			5.6	30.5

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Surface	76.4	56.6	7.91	13.5	30.98	Middle	Flooding	107.4			6.6	30.5
Surface	76.5	56.6	7.91	12.9	30.98	Middle	Flooding	107.3			6.1	30.5
Surface	76.7	56.6	7.91	14.8	30.97	Middle	Flooding	106.5			6.2	30.6
Surface	76.9	56.6	7.91	15.1	30.98	Middle	Flooding	105.8			7.7	30.6
Surface	83.6	56	6.24	8.9	29.5	Middle	Flooding	87.1	51	7.67	20.4	31.63
Surface	82.6	55.7	6.26	10.1	29.5	Middle	Flooding	86.9	51.1	7.67	22.3	31.63
Surface	81.9	55.6	6.26	10.9	29.5	Middle	Flooding	86.7	51.2	7.67	25.7	31.64
Surface	81.7	55.7	6.26	11.2	29.5	Middle	Flooding	86.7	51.2	7.67	23.9	31.64
Surface	79.1	55.5	6.27	9.5	29.6	Middle	Flooding	86.4	51.1	7.67	22.7	31.64
Surface	78.8	55.7	6.27	8.4	29.6	Middle	Flooding	86.2	51.1	7.67	23.4	31.64
Surface	79.1	55.6	6.28	8.4	29.6	Middle	Flooding	86.2	51.1	7.68	22.6	31.64
Surface	79.4	55.6	6.28	8.4	29.6	Middle	Flooding	86.2	51	7.68	21.9	31.64
Surface	79.5	55.6	6.28	9.8	29.7	Middle	Flooding	86.3	51	7.68	20.8	31.64
Surface	81	55.4	6.3	10.1	29.7	Middle	Flooding	86.4	51.1	7.68	22	31.64
Surface	78.8	55.4	6.29		29.9	Bottom	Flooding	127.7			6.8	30.5
Surface	78.6	55.3	6.29		29.9	Bottom	Flooding	125.5			7.3	30.5
Surface	78.9	55.3	6.29		29.8	Bottom	Flooding	125			8.9	30.5
Surface	78.9	55.3	6.3		29.8	Bottom	Flooding	121.6			6.7	30.5
Surface	78.8	55.2	6.3		29.8	Bottom	Flooding	120			8	30.5
Surface	78.9	55.2	6.3		29.8	Bottom	Flooding	117.9			6.4	30.5
Surface	78.9	55.2	6.3		29.8	Bottom	Flooding	117.3			9.2	30.6
Surface	78.6	55.2	6.3		29.8	Bottom	Flooding	116.5			7.5	30.5
Surface	78.1	55.2	6.31		29.8	Bottom	Flooding	116.2			6.7	30.6
Surface	77.9	55.3	6.31		29.8	Bottom	Flooding	112.7			6.1	30.6
Middle	88.6	52.2	8.25	9.9		Bottom	Flooding	84	51.5	7.67	28.2	31.73
Middle	88.6	52.2	8.24	10.4		Bottom	Flooding	84.1	51.4	7.67	28.1	31.71
Middle	88.4	52.2	8.24	10.6		Bottom	Flooding	84	51.4	7.67	29.9	31.71

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Middle	87.9	52.2	8.24	11.1		Bottom	Flooding	84.1	51.2	7.67	25.4	31.71
Middle	88.2	52.2	8.24	11.5		Bottom	Flooding	84.3	51.4	7.67	25.4	31.69
Middle	88.1	52.2	8.25	10.9		Bottom	Flooding	84.5	51.5	7.67	29.2	31.71
Middle	88	52.1	8.25	12.1		Bottom	Flooding	84.5	51.5	7.67	31	31.73
Middle	87.7	52.2	8.24	11.7		Bottom	Flooding	84.4	51.5	7.67	29.9	31.73
Middle	87	52.2	8.24	10.5		Bottom	Flooding	84.2	51.4	7.67	29.5	31.73
Middle	87.1	52.2	8.24	12.3		Bottom	Flooding	84.2	51.4	7.67	27.2	31.71
Middle	85.1	56.9	7.7	23.7	31.16							
Middle	85.1	56.9	7.7	22.9	31.16							
Middle	85.1	56.9	7.7	26	31.16							
Middle	85.1	56.9	7.7	22.6	31.16							
Middle	85.1	56.9	7.7	21.9	31.16							
Middle	85.1	56.9	7.7	20.3	31.16							
Middle	85.1	56.9	7.7	22.9	31.17							
Middle	85.1	56.9	7.7	23.6	31.16							
Middle	85.2	56.9	7.7	23	31.16							
Middle	85.2	56.9	7.7	21.7	31.16							
Middle	76.8	56.6	7.9	18	30.98							
Middle	76.8	56.6	7.9	16.4	30.98							
Middle	76.8	56.6	7.9	14.2	30.97							
Middle	76.9	56.6	7.9	18.7	30.98							
Middle	77	56.6	7.9	16.2	30.98							
Middle	77.1	56.6	7.9	17.5	30.98							
Middle	77.1	56.6	7.9	17.5	30.98							
Middle	77.1	56.6	7.9	18.3	30.98							
Middle	77.1	56.6	7.9	19.1	30.98							
Middle	77.1	56.6	7.9	18.1	30.98							

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Middle	81.3	55.5	6.24	9.9	29.8							
Middle	81	55.5	6.24	10.3	29.8							
Middle	80.9	55.4	6.24	10.2	29.8							
Middle	79.9	55.4	6.24	11.5	29.8							
Middle	79.2	55.4	6.24	14.4	29.8							
Middle	78.1	55.4	6.24	10.9	29.8							
Middle	77.5	55.4	6.24	10.9	29.8							
Middle	77.3	55.4	6.24	9.4	29.8							
Middle	77.3	55.4	6.24	11.3	29.8							
Middle	77.1	55.4	6.24	11	29.8							
Middle	78.6	55.5	6.2	12	29.9							
Middle	78.3	55.5	6.19	11.9	29.9							
Middle	78.2	55.4	6.19	11.1	29.9							
Middle	78.6	55.4	6.2	14.4	29.9							
Middle	78.4	55.4	6.19	12.8	29.9							
Middle	78.2	55.4	6.2	11.9	29.9							
Middle	78.1	55.4	6.2	13.5	29.9							
Middle	77.9	55.4	6.2	12.1	29.9							
Middle	77.3	55.4	6.2	16.6	29.9							
Middle	77.3	55.4	6.2	14.2	29.8							
Bottom	88.2	52.2	8.25	11								
Bottom	87.6	52.2	8.25	12								
Bottom	87.4	52.2	8.25	10.6								
Bottom	86.7	52.2	8.25	11.1								
Bottom	86.7	52.2	8.25	11.4								
Bottom	86.5	52.2	8.24	11								
Bottom	86.9	52.2	8.25	10.1								

	Ebbing							Flooding				
Depth	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)	Depth	Tide	Dissolved oxygen (%)	Conductivity (uS/cm)	pH	Turbidity (NTU)	Temperature (0C)
Bottom	87.1	52.2	8.25	11.2								
Bottom	86.8	52.2	8.25	10.7								
Bottom	87.1	52.2	8.25	12.1								
Bottom	85.3	56.9	7.7	20.6	31.16							
Bottom	85.3	56.9	7.7	22.4	31.17							
Bottom	85.4	56.9	7.71	24	31.16							
Bottom	85.4	56.9	7.71	26.2	31.16							
Bottom	85.4	56.9	7.71	30.8	31.16							
Bottom	85.4	56.9	7.71	20.7	31.16							
Bottom	85.4	56.9	7.71	19.4	31.16							
Bottom	85.4	56.9	7.71	22.1	31.16							
Bottom	85.4	56.9	7.71	21.3	31.16							
Bottom	85.4	56.9	7.71	27.9	31.16							
Bottom	77	56.6	7.9	18.5	30.98							
Bottom	77.1	56.6	7.9	19.4	30.98							
Bottom	77.1	56.6	7.9	22	30.98							
Bottom	77.1	56.6	7.9	20.1	30.98							
Bottom	77.1	56.6	7.9	22	30.98							
Bottom	77.1	56.6	7.9	22.1	30.98							
Bottom	77.1	56.6	7.89	23.4	30.98							
Bottom	77.1	56.6	7.9	23.3	30.98							
Bottom	77.1	56.6	7.9	21.1	30.98							
Bottom	77	56.6	7.9	21	30.98							
Bottom	78.6	55.5	6.2	21.2	29.8							
Bottom	77.6	55.4	6.2	16.9	29.8							
Bottom	77.6	55.4	6.2	23	29.8							
Bottom	77.3	55.4	6.19	14.6	29.8							

	Ebbing							Flooding				
Depth	**Dissolved oxygen (%)**	**Conductivity (uS/cm)**	**pH**	**Turbidity (NTU)**	**Temperature (0C)**	**Depth**	**Tide**	**Dissolved oxygen (%)**	**Conductivity (uS/cm)**	**pH**	**Turbidity (NTU)**	**Temperature (0C)**
Bottom	76.4	55.4	6.19	11.3	29.8							
Bottom	76.6	55.4	6.19	14.9	29.8							
Bottom	77.3	55.4	6.19	16.9	29.8							
Bottom	76.1	55.4	6.19	14	29.8							
Bottom	75.9	55.4	6.19	10.7	29.8							
Bottom	75.8	55.4	6.19	12.4	29.8							
Bottom	77.7	55.4	6.18	16.3	29.8							
Bottom	78	55.4	6.18	15.1	29.8							
Bottom	78.1	55.4	6.18	15.2	29.8							
Bottom	78.1	55.4	6.17	16.8	29.8							
Bottom	78.1	55.4	6.17	13.9	29.8							
Bottom	78.1	55.4	6.17	14	29.8							
Bottom	78.2	55.5	6.17	11.4	29.8							
Bottom	78.2	55.4	6.17	12.8	29.8							
Bottom	78.2	55.5	6.17	13.7	29.8							
Bottom	78.2	55.5	6.17	15.9	29.8							

Site 1

Date	Ammonia (mg/L)	Nitrate + Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Reactive Phosphorous (mg/L)	Suspended Solids (mg/L)	TPH (C6-C9)	TPH (C10-C14)	TPH (C15-C28)	TPH (C29-C36)
4/11/2005							28				
10/11/2005	0.113	0.022	0.5	0.5	0.03	0.01	16	20	20	20	20
17/11/2005							66				
24/11/2005	0.104	0.018	0.1	0.1	0.16	0.01	34	50	50	50	50
1/12/2005							32				
8/12/2005	0.072	0.017	0.1	0.1	0.07	0.01	18	100	100	100	100
15/12/2005							31				
21/12/2005	0.085	0.010	0.1	0.1	0.05	0.01	16	50	50	50	50

Site 2

Date	Ammonia (mg/L)	Nitrate + Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Reactive Phosphorous (mg/L)	Suspended Solids (mg/L)	TPH (C6-C9)	TPH (C10-C14)	TPH (C15-C28)	TPH (C29-C36)
4/11/2005							30				
10/11/2005	0.091	0.038	0.2	0.3	0.03	0.01	34	20	20	20	20
17/11/2005							72				
24/11/2005	0.058	0.016	0.1	0.1	0.16	0.01	38	50	50	50	50
1/12/2005							71				
8/12/2005	0.081	0.010	0.1	0.1	0.09	0.01	14	100	100	100	100
15/12/2005							41				
21/12/2005	0.031	0.010	0.1	0.1	0.06	0.01	24	50	50	50	50

Site 3

Date	Ammonia (mg/L)	Nitrate + Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Reactive Phosphorous (mg/L)	Suspended Solids (mg/L)	TPH (C6-C9)	TPH (C10-C14)	TPH (C15-C28)	TPH (C29-C36)
4/11/2005							32				
10/11/2005	0.094	0.023	0.6	0.7	0.03	0.01	26	20	20	20	20
17/11/2005							46				
24/11/2005	0.069	0.012	0.1	0.1	0.16	0.01	27	50	50	50	50
1/12/2005							32				
8/12/2005	0.041	0.010	0.1	0.1	0.08	0.01	16	100	100	100	100
15/12/2005							20				
21/12/2005	0.033	0.010	0.1	0.1	0.05	0.01	34	50	50	50	50

Site 4

Date	Ammonia (mg/L)	Nitrate + Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Reactive Phosphorous (mg/L)	Suspended Solids (mg/L)	TPH (C6-C9)	TPH (C10-C14)	TPH (C15-C28)	TPH (C29-C36)
4/11/2005							25				
10/11/2005	0.092	0.016	0.6	0.6	0.04	0.01	36	20	20	20	20
17/11/2005							25				
24/11/2005	0.069	0.011	0.1	0.1	0.16	0.01	29	50	50	50	50
1/12/2005							45				
8/12/2005	0.047	0.010	0.1	0.1	0.08	0.01	18	100	100	100	100
15/12/2005							21				
21/12/2005	0.033	0.010	0.1	0.1	0.05	0.01	29	50	50	50	50

APPENDIX B: EPA WATER QUALITY DATA (1996-2006)

Appendix I2 EPA Water Quality Data

0.0km

Depth (m)	Date	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
0.2	17/01/1996	39.482	29	12	6.7468	91.8	7.87	15.4
2.0	17/01/1996	39.252	29.1	14	2.7388	92.4	7.88	6.9
4.0	17/01/1996	39.228	29.1	14	2.171	93.3	7.89	29.2
5.0	17/01/1996	39.042	29.2	15	3.0283	93.7	7.9	27.9
0.2	7/02/1996	48.74	31	7	4.9432	93.9	8.12	8.3
2.0	7/02/1996	48.94	31	7	1.7177	95.3	8.13	10.3
4.0	7/02/1996	48.952	30.8	8	1.336	93.8	8.15	10
6.0	7/02/1996	49.008	30.6	8	1.3855	92.4	8.14	
0.2	6/03/1996	52.964	26	27	1.5772	95.3	8.05	
2.0	6/03/1996	53.332	25.9	34	2.171	95.9	8.08	
4.0	6/03/1996	53.284	25.9	35	1.4195	96.2	8.09	
5.0	6/03/1996	53.26	25.9	32	3.2064	94.8	8.1	
0.2	17/04/1996	59.5	29.59	9	2.4048	87.8	7.57	
2.0	17/04/1996	59.5	29.49	23	2.338	84.1	7.57	
4.0	17/04/1996	59.5	29.46	27	2.1376	84	7.58	
0.2	15/05/1996	44.978	25.2	5	2.2712	96.5	8.1	
2.0	15/05/1996	45.226	25.2	7	1.336	97.8	8.11	
3.0	15/05/1996	45.202	25.2	7	1.8704	98	8.12	
0.2	19/06/1996	50.874	20.6	6	2.3046	98.2	7.97	
2.0	19/06/1996	50.9	20.5	7	4.8987	99	7.95	
4.0	19/06/1996	50.978	20.4	9	1.4696	98.8	7.96	
5.5	19/06/1996	50.9	20.5	11	0.9352	98.5	7.96	
0.2	17/07/1996	52.9	18.09	0	1.7368	92.5	7.79	
2.0	17/07/1996	52.8	18.1	0	1.8788	90.2	7.79	
4.0	17/07/1996	52.9	17.87	1	3.9662	90.3	7.79	
5.5	17/07/1996	52.9	17.72	3	4.676	90.5	7.79	
0.2	14/08/1996	53.372	20	5	2.3751	104.3	7.86	
2.0	14/08/1996	53.288	20	6	2.672	104.5	7.85	
3.5	14/08/1996	53.232	20	6	1.336	104.9	7.82	
0.2	25/09/1996	54.54	22.8	14	1.336	90.6	8.22	
2.0	25/09/1996	54.65	22.7	17	0.8016	89.5	8.33	
4.0	25/09/1996	54.626	22.7	15	1.0688	89.4	8.37	
6.0	25/09/1996	54.626	22.7	18	1.1451	90.3	8.4	
0.2	23/10/1996	52.348	24.8	10	1.336	89.9	8.16	
2.0	23/10/1996	52.476	24.8	13	2.004	91.2	8.17	
3.5	23/10/1996	52.45	24.8	14	2.5384	90.3	8.17	
0.2	20/11/1996	56.6	27.6	8	3.6072	88.5	7.76	
2.0	20/11/1996	56.6	27.57	12	1.8704	88	7.77	
4.0	20/11/1996	56.6	27.53	13	1.8428	88.5	7.77	
0.2	11/12/1996	54.248	29.2	19	1.336	91.5	8.21	
2.0	11/12/1996	54.524	29.2	20	1.0688	92.5	8.21	
4.0	11/12/1996	54.478	29.2	21	0.6012	92.3	8.21	
0.2	22/01/1997	54.5	26.9	20	1.0688	87.6	7.79	
2.0	22/01/1997	54.5	26.96	28	0.668	87.1	7.79	
3.0	22/01/1997	54.5	26.91	30	1.0688	86.5	7.79	
0.2	19/02/1997	56.38	29.8	16	1.1356	86.2	8.19	

Depth (m)	Date	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
2.0	19/02/1997	56.472	29.8	16	1.336	87.3	8.2	
4.0	19/02/1997	56.496	29.8	16	1.6032	87.6	8.2	
4.5	19/02/1997	56.526	29.7	17	2.8724	88.1	8.2	
0.2	12/03/1997	54.7	24.8	51	2.4811	85.8	8.1	
2.0	12/03/1997	54.7	24.8	53	2.338	88.5	8.1	
4.0	12/03/1997	54.7	24.8	57	1.336	88.2	8.1	
0.2	9/04/1997	51.778	25.3	23	1.4575	86	8.09	
10.0	9/04/1997	52.002	25.3	27	0.9668	86.3	8.17	
2.0	9/04/1997	51.802	25.3	25	0.9352	86.2	8.1	
4.0	9/04/1997	51.802	25.3	28	1.4146	86.4	8.11	
6.0	9/04/1997	51.828	25.3	30	2.9392	86.2	8.12	
8.0	9/04/1997	51.902	25.3	26	2.6068	86.5	8.15	
0.2	14/05/1997	54.112	24.6	4	1.7893	87.9	8.15	
2.0	14/05/1997	54.088	24.6	4	2.0471	87.7	8.15	
4.0	14/05/1997	54.112	24.6	3	2.672	87.9	8.15	
6.0	14/05/1997	54.112	24.6	4	1.2024	87.5	8.15	
0.2	4/06/1997	52.7	22.76	3	1.1356	93.7	7.9	
2.0	4/06/1997	52.7	22.74	4	2.0708	93.8	7.91	
4.0	4/06/1997	52.8	22.57	4	0.6012	93.4	7.91	
5.5	4/06/1997	52.9	22.5	6	1.7368	92.7	7.92	
0.2	16/07/1997	52.3	23.24	0	1.72759	99.2	7.88	
2.0	16/07/1997	52.3	23.16	0	1.59382	98.6	7.89	
4.0	16/07/1997	52.3	22.97	0	1.06493	97.5	7.89	
6.0	16/07/1997	52.3	22.97	0	0.5344	96.5	7.9	
8.0	16/07/1997	52.3	22.94	0	1.48964	96	7.9	
9.0	16/07/1997	52.3	22.93	0	0.82832	94.9	7.9	
0.2	20/08/1997	55.296	21.5	8	0.668	91	8.13	
2.0	20/08/1997	55.456	21.5	9	0.8684	92.1	8.14	
4.0	20/08/1997	55.49	21.4	12	4.08222	91.3	8.14	
5.0	20/08/1997	55.462	21.4	11	3.7408	91.1	8.14	
0.2	30/09/1997	55.5	24.56	23	1.6032	88.1	7.95	
2.0	30/09/1997	55.5	24.56	18	2.0708	86.5	7.95	
0.2	28/10/1997	56.7	24.61	4	0.97973	91	7.93	
2.0	28/10/1997	56.7	24.61	4	1.28462	90.2	7.93	
0.2	26/11/1997	58.1	27.45	9	1.6032	93.9	7.89	
1.5	26/11/1997	58.1	27.44	11	1.48444	92.3	7.89	
0.2	11/12/1997	58.9	29.4	33	0.8684	90.7	7.88	
2.0	11/12/1997	58.9	29.41	35	3.1396	89.2	7.88	
0.2	8/01/1998	59	27.5	52	6.5464	91.9	7.83	
2.0	8/01/1998	59	27.5	51	1.2024	91.6	7.83	
0.2	5/02/1998	59	31.52	14	4.008	103.3	8.02	
2.0	5/02/1998	58.8	31.43	15	0.9352	100.6	8.02	
3.0	5/02/1998	58.8	31.41	15	0.75707	99.9	8.02	
0.2	11/03/1998	54.6	28.18	45	0.6012	96.9	7.99	
2.0	11/03/1998	57.5	28.15	43	0.334	93.8	7.99	
4.0	11/03/1998	57.5	28.15	52	2.24448	93.1	7.99	
5.0	11/03/1998	57.5	28.15	56	1.002	93.4	7.99	
0.2	8/04/1998	60	27.32	44	11.356	95	7.91	
2.0	8/04/1998	60	27.32	46	3.0728	96.3	7.92	

Depth (m)	Date	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
3.0	8/04/1998	60	27.32	46	1.6032	96.4	7.92	
0.2	22/05/1998	60.5	24.33	15	1.8704	98.6	7.88	
2.0	22/05/1998	60.5	24.33	16	0.5344	97.1	7.88	
0.2	24/06/1998	56	19.64	14	1.4195	99.5	7.8	
2.0	24/06/1998	55.9	19.65	14	0.8016	97.7	7.82	
4.0	24/06/1998	55.9	19.65	15	0.8016	96.8	7.83	
0.2	22/07/1998	46.9	20.33	0	0.7348	90.5	7.78	
2.0	22/07/1998	46.9	20.32	0		93.6	7.79	
0.2	21/08/1998	56.3	22.28	5		97.6	7.75	
2.0	21/08/1998	56.3	22.28	5		96.1	7.75	
0.2	18/09/1998	51.5	22.52	25		97.1	8.02	
1.5	18/09/1998	51.8	22.47	25		97.4	8.02	
0.2	19/10/1998	52.7	26.26	12		95.6	7.92	
2.0	19/10/1998	52.7	26.26	12		93.3	7.93	
3.0	19/10/1998	52.7	26.26	13		93.2	7.93	
0.2	18/11/1998	53.5	27.28	6		100.5	7.96	
2.0	18/11/1998	53.5	27.27	6		98.8	7.97	
0.2	16/12/1998	53.3	29.51	6		99.4	7.89	
2.0	16/12/1998	53.4	29.26	9		98	7.89	
4.0	16/12/1998	53.3	29.58	7		99.6	7.89	
0.2	13/01/1999	52.6	33.87	2		100.4	7.8	
2.0	13/01/1999	52.7	33.51	6		98.6	7.79	
3.5	13/01/1999	52.7	33.47	9		98	7.8	
0.2	12/02/1999	54.7	29.86	4		98.1	7.68	
2.0	12/02/1999	54.9	29.39	10		95.9	7.68	
3.0	12/02/1999	54.9	29.35	9		95.9	7.68	
0.2	17/03/1999	52.8	27.53	30		99.7	7.81	
2.0	17/03/1999	52.8	27.51	32		97.4	7.82	
4.0	17/03/1999	52.8	27.49	34		96.4	7.82	
5.0	17/03/1999	52.8	27.47	36		97.4	7.82	
0.2	14/04/1999	56.6	24.65			95	7.98	
2.0	14/04/1999	56.6	24.64			95.2	7.99	
4.0	14/04/1999	56.6	24.62			94.1	7.99	
0.2	26/05/1999	55.1	24.6			98.5	7.88	
2.0	26/05/1999	55.2	24.6			98.9	7.88	
0.2	28/06/1999	55.1	18.4			98	7.87	
2.0	28/06/1999	55.2	18.37			96.7	7.93	
3.5	28/06/1999	55.2	18.36			96.5	7.93	
0.2	28/07/1999	55.7	18			100.2	7.88	
2.0	28/07/1999	55.7	17.95			99.3	7.9	
4.0	28/07/1999	55.7	17.93			98.7	7.9	
0.2	25/08/1999	56	21.09	5		101.1	7.82	
2.0	25/08/1999	56.1	20.99	5		99.1	7.86	
3.0	25/08/1999	56.1	20.94	5		99.5	7.87	
0.2	28/09/1999	56.3	22.52	15		96.4	7.83	
2.0	28/09/1999	56.3	22.5	16		97.5	7.83	
4.0	28/09/1999	56.3	22.49	16		96.7	7.83	
5.0	28/09/1999	56.3	22.49	17		96.7	7.83	
0.2	13/10/1999	56.6	24.96	0		94.9	8.04	

Depth (m)	Date	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
2.0	13/10/1999	56.6	24.96	1		94.8	8.05	
4.0	13/10/1999	56.6	24.95	1		94.5	8.05	
0.2	10/11/1999	53.9	26.15	1		97	8.01	
2.0	10/11/1999	54.6	25.6	2		93.8	8.03	
4.0	10/11/1999	54.4	25.56	2		92.9	8.04	
0.2	8/12/1999	55.1	25.27	5		96	8.02	
2.0	8/12/1999	55.1	25.3	5		95.7	8.02	
4.0	8/12/1999	54.6	25.18	5		96.1	8.03	
5.5	8/12/1999	54.2	25.18	6		95.6	8.03	
0.2	10/01/2000	52	27.74	2		95.4	7.9	
2.0	10/01/2000	52.1	27.72	2		96.7	7.9	
4.0	10/01/2000	52	27.7	2		93.8	7.9	
6.0	10/01/2000	51.6	27.68	3		95.2	7.9	
8.0	10/01/2000	51.3	27.64	3		92.3	7.91	
0.2	9/02/2000	57.6	25.87	25		83.9	8.18	
2.0	9/02/2000	57.4	25.87	28		83	8.18	
3.5	9/02/2000	57.5	25.88	30		77.1	8.18	
0.2	9/03/2000	53.018	27.5	14		91.8	8.08	
2.0	9/03/2000	53.162	27.4	17		92.8	8.08	
4.0	9/03/2000	53.14	27.4	18		93.1	8.08	
5.0	9/03/2000	53.14	27.4	18		93.8	8.08	
0.2	4/04/2000	57.6	28.08	20		94	7.78	
2.0	4/04/2000	57.6	28.05	20		93.2	7.78	
4.0	4/04/2000	57.4	28.04	21		92.5	7.78	
0.2	19/05/2000	57.9	22.88	15		92.6	7.85	
2.0	19/05/2000	57.9	22.87	14		94.5	7.86	
4.0	19/05/2000	57.1	22.77	15		97.4	7.86	
0.2	16/08/2000	53.5	19.89			96.5	8.12	
2.0	16/08/2000	53.4	19.87			97.3	8.13	
4.0	16/08/2000	52.8	19.86			96.8	8.13	
0.2	15/09/2000	55.7	22.75			98.7	8.08	
2.0	15/09/2000	55.9	22.76			97.7	8.09	
4.0	15/09/2000	55.8	22.74			96	8.09	
6.0	15/09/2000	55.4	22.74			96	8.09	
0.2	13/10/2000	57	25.03	5		97	8	
2.0	13/10/2000	57.2	25	6		95.2	8	
4.0	13/10/2000	57.1	24.93	6		93.6	8	
5.0	13/10/2000	56.8	24.88	6		93	8.01	
0.2	13/11/2000	48.8	25.56	37		90.3	7.87	
2.0	13/11/2000	48.8	25.53	44		89.1	7.87	
4.0	13/11/2000	48.4	25.48	43		87.6	7.87	
5.5	13/11/2000	48.2	25.44	45		89.3	7.88	
0.2	13/12/2000	50.544	28.18			93.2	7.73	
2.0	13/12/2000	50.582	28.15			93	7.74	
4.0	13/12/2000	50.577	28.14			92.9	7.75	
6.0	13/12/2000	50.573	28.13			92.9	7.76	
0.2	21/02/2001	54.4	27.7	17		91.8	8.1	
2.0	21/02/2001	54.4	27.7	19		91	8.1	
4.0	21/02/2001	54.3	27.6	19		90.6	8.1	

Depth (m)	Date	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
5.0	21/02/2001	54.3	27.6	26		90.5	8.1	
0.2	22/03/2001	54.7	31.6	11		102	7.9	
2.0	22/03/2001	54.7	31.7	12		101.4	7.9	
4.0	22/03/2001	54.7	31.5	16		101	7.9	
6.0	22/03/2001	54.8	31.1	15		100.8	7.9	
0.2	20/04/2001	55.5	26.26	14		93.5	8.08	
2.0	20/04/2001	55.5	26.6	16		92.1	8.08	
4.0	20/04/2001	55.6	26	16		92.2	8.08	
0.2	23/05/2001	56.56	23	9		103.9	8.16	
2.0	23/05/2001	56.568	22.9	10		104.6	8.16	
4.0	23/05/2001	56.63	22.5	11		102.4	8.16	
0.2	14/06/2001	56.331	25.61	5		102.1	8.06	
2.0	14/06/2001	56.322	25.61	4		102.1	8.06	
0.2	4/07/2001	54.379	22.95	5		101.7	7.99	
2.0	4/07/2001	54.387	22.9	5		101.6	7.98	
4.0	4/07/2001	54.383	22.89	7		102.2126	7.98	
6.0	4/07/2001	54.378	22.88	5		100.9701	7.98	
8.0	4/07/2001	54.374	22.87	7		100.6935	7.98	
0.2	8/08/2001	55.502	20.8	2		100.4286	8.15	
2.0	8/08/2001	55.706	20.6	3		96.3	8.14	
4.0	8/08/2001	55.706	20.6	2		96.3	8.14	
6.0	8/08/2001	55.732	20.6	4		94.1	8.13	
0.2	17/10/2001	56.3	25.62	31		93.5	7.63	
2.0	17/10/2001	56.5	25.61	33		93.3	7.64	
0.2	21/11/2001	55.2	29.6	4		93.2	8.6	
2.0	21/11/2001	55.1	28.9	4		93.2	8.6	
4.0	21/11/2001	55.1	28.8	4		90	8.6	
6.0	21/11/2001	55.1	28.8	4		89.3	8.6	
8.0	21/11/2001	55.1	28.6	4		88.6	8.5	
0.2	19/12/2001	55.369	26.83	11		88.2	7.95	
2.0	19/12/2001	55.355	26.78	11		88.3	7.94	
4.0	19/12/2001	55.352	26.77	10		87.4	7.94	
6.0	19/12/2001	55.333	26.77	12		86.4	7.94	
8.0	19/12/2001	55.319	26.76	13		86.2	7.94	
0.2	30/01/2002	54.1	28.33			86.3	7.91	
2.0	30/01/2002	54.1	28.3			86.7	7.91	
4.0	30/01/2002	54.1	28.27			100.9	7.91	
6.0	30/01/2002	53.9	28.26			100.8	7.92	
7.0	30/01/2002	53.7	28.24			100.8	7.92	
0.2	15/05/2002	55.675	24.9	9		102.9	8.12	
2.0	15/05/2002	55.739	24.72	11		102.6	8.13	
4.0	15/05/2002	55.613	24.01	12		102.3	8.14	
0.2	13/06/2002	53.013	22.23	7		101.3	8.2	
2.0	13/06/2002	53.024	22.02	10		100.9	8.21	
4.0	13/06/2002	53.013	21.8	11		86.8	8.21	
6.0	13/06/2002	52.998	21.28	10		87.6	8.22	
7.0	13/06/2002	53.011	21.21	11		100.1	8.21	
0.2	10/07/2002	53.815	22.19	6		100	8.35	
2.0	10/07/2002	53.815	22.18	6		99.9	8.35	

Depth (m)	Date	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
0.2	7/08/2002	54.518	24.03	8		106.4	8.03	
2.0	7/08/2002	54.524	24.04	9		105.8	8.03	
3.5	7/08/2002	54.518	24.01	8		106.2	8.03	
0.2	4/09/2002	54.937	26.66	4		106.2	8.2	
10.0	4/09/2002	54.944	26.71	5		106.1	8.21	
2.0	4/09/2002	54.933	26.67	4		105.9	8.2	
4.0	4/09/2002	54.94	26.68	4		96.2	8.21	
6.0	4/09/2002	54.94	26.7	4		94.8	8.21	
8.0	4/09/2002	54.94	26.69	4		94.7	8.21	
0.2	9/10/2002	53.92	24.4	28		96	8.13	
2.0	9/10/2002	53.929	24.36	31		95.7	8.12	
4.0	9/10/2002	53.921	24.31	33		95.5	8.12	
0.2	6/11/2002	56.615	27.61	35		88.1	8.13	
2.0	6/11/2002	56.615	27.61	35		89.3	8.13	
4.0	6/11/2002	56.605	27.58	36		89.1	8.13	
0.2	4/12/2002	58.213	30	31		94.2	8.06	
2.0	4/12/2002	58.208	29.86	34		94	8.06	
4.0	4/12/2002	58.222	29.82	33		94.1	8.06	
0.2	22/01/2003	57.986	28.44	23		94.1	8.16	
2.0	22/01/2003	57.943	28.32	24		78.8	8.16	
4.0	22/01/2003	57.983	28.46	29		78.6	8.16	
6.0	22/01/2003	57.953	28.4	31		78.4	8.16	
0.2	19/02/2003	42.925	28.99	129		103.7	8.25	
2.0	19/02/2003	42.912	28.91	173		102.1	8.25	
4.0	19/02/2003	42.977	28.85	225		101.2	8.25	
0.2	19/03/2003	47.688	27.14	68		103.9	8.28	
2.0	19/03/2003	47.7	27.11	71		103.5	8.29	
3.5	19/03/2003	47.699	27.11	77		103	8.28	
0.2	31/07/2003	55.606	20.11	10		102.5	8.05	
2.0	31/07/2003	55.619	20.03	11		101.9	8.05	
4.0	31/07/2003	55.587	19.69	12		97.1	8.05	
6.0	31/07/2003	55.609	19.44	14		96.4	8.05	
7.0	31/07/2003	55.587	19.38	16		96.3	8.05	
0.2	27/08/2003	54.486	22.41	12		96.2	7.97	
2.0	27/08/2003	54.552	22.32	14		104.8	7.97	
4.0	27/08/2003	54.56	22.22	14		107.9	7.97	
6.0	27/08/2003	54.562	22.21	14		102.6	7.97	
0.2	24/09/2003	55.452	25.64	17		100.9	7.95	
2.0	24/09/2003	55.443	25.61	18		101.1	7.95	
3.5	24/09/2003	55.443	25.61	20		101.8	7.95	
0.2	22/10/2003	55.719	26.38	9		97	7.99	
2.0	22/10/2003	55.715	26.33	10		96.4	7.99	
3.5	22/10/2003	55.711	26.34	10		95.6	7.99	
0.2	19/11/2003	55.193	29.83	6		95.6	8.04	
2.0	19/11/2003	55.2	29.25	7		94.1	8.04	
4.0	19/11/2003	55.179	28.95	7		93.8	8.04	
6.0	19/11/2003	55.184	29.07	7		93.7	8.03	
0.2	17/12/2003	50.69	30.05	6		103.8	8.06	
2.0	17/12/2003	54.06	28.59	6		98	8.09	

Depth (m)	Date	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
4.0	17/12/2003	54.184	28.46	7		97	8.09	
0.2	14/01/2004	46.734	32.01	3		102.1	7.74	
10.0	14/01/2004	51.613	30.55	6		101.4	7.74	
11.0	14/01/2004	51.944	30.4	9		100.6	7.73	
2.0	14/01/2004	49.038	31.33	5		99.4	7.76	
4.0	14/01/2004	49.779	31.11	4		80.6	7.75	
6.0	14/01/2004	50.385	30.94	5		81.1	7.75	
8.0	14/01/2004	50.918	30.75	4		81.8	7.74	
0.2	4/02/2004	29.955	29.09	20		81.8	7.81	
2.0	4/02/2004	41.494	29.19	59		95.4	7.83	
4.0	4/02/2004	43.859	29.15	71		94.8	7.89	
6.0	4/02/2004	44.508	29.11	74		94.5	7.91	
0.2	3/03/2004	47.848	30.53	7		93.6	7.97	
2.0	3/03/2004	47.969	30.45	7		95.6	7.98	
4.0	3/03/2004	48.032	30.43	8		95.3	7.99	
5.0	3/03/2004	48.143	30.31	8		94.9	7.99	
0.2	21/04/2004	54.634	26.86	22		96.3	7.83	
2.0	21/04/2004	54.597	26.75	24		93.1	7.82	
3.0	21/04/2004	54.61	26.74	27		94.7	7.83	
0.2	19/05/2004	54.881	23.31	6		92.5	7.88	
2.0	19/05/2004	54.897	23.27	7		91.6	7.89	
4.0	19/05/2004	54.871	23.27	8		92.3	7.9	
0.2	23/06/2004	56.157	21.33	5		92.2	8.02	
10.0	23/06/2004	56.165	21.3	4		91.9	8.04	
2.0	23/06/2004	56.16	21.33	5		91.7	8.03	
4.0	23/06/2004	56.16	21.33	4		97.3	8.04	
6.0	23/06/2004	56.161	21.32	4		97	8.04	
8.0	23/06/2004	56.166	21.32	5		96.9	8.04	
0.2	21/07/2004	55.983	18.19	6		95.1	8.04	
2.0	21/07/2004	55.985	18.2	6		94.8	8.04	
4.0	21/07/2004	55.986	18.2	6		94.4	8.05	
0.2	25/08/2004	55.197	23.84	3		94.4	8.07	
2.0	25/08/2004	55.305	23.79	3		94.5	8.08	
4.0	25/08/2004	55.305	23.46	3		101.6	8.08	
6.0	25/08/2004	55.24	23.02	4		101.1	8.09	
8.0	25/08/2004	55.182	22.73	4		100.5	8.09	
0.2	29/09/2004	56.221	25.14	19		93.7	7.89	
2.0	29/09/2004	56.287	25.01	22		93.1	7.86	
3.0	29/09/2004	56.276	24.95	28		92.6	7.85	
0.2	28/10/2004	55.271	28.03	16		104.1	8.05	
2.0	28/10/2004	55.254	28	18		96.6	8.04	
4.0	28/10/2004	55.259	27.97	17		104.3	8.04	
0.2	17/11/2004	56.813	28.93	13		98.4	8.23	
10.5	17/11/2004	56.777	28.89	14		97.4	8.25	
2.0	17/11/2004	56.823	28.98	17		96.8	8.24	
4.0	17/11/2004	56.65	28.62	15		92	8.25	
6.0	17/11/2004	56.723	28.74	15		91.9	8.24	
8.0	17/11/2004	56.775	28.87	14		92.2	8.25	
0.2	15/12/2004	56.828	30.66	29		92.2	8.19	

Depth (m)	Date	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
2.0	15/12/2004	56.811	30.67	33		96.2	8.19	
4.0	15/12/2004	56.811	30.66	34		95.6	8.19	
6.0	15/12/2004	56.807	30.63	38		95	8.19	
0.2	22/02/2005	52.494	29.25	20		92.9	7.96	
2.0	22/02/2005	52.509	29.27	23		93.2	7.96	
4.0	22/02/2005	52.493	29.25	28		93.1	7.95	
0.2	21/03/2005	54.684	30.24	8		93.3	7.99	
2.0	21/03/2005	54.695	30.26	7		93.2	7.99	
4.0	21/03/2005	54.681	30.21	9		99.9	7.99	
6.0	21/03/2005	54.706	30.21	9		99.8	7.99	
7.5	21/03/2005	54.728	30.16	12		99.5	7.99	
0.2	20/04/2005	55.387	27.17	7		100	7.92	
2.0	20/04/2005	55.409	27.14	9		96	7.92	
3.0	20/04/2005	55.399	27.09	9		97.7	7.92	
0.2	24/05/2005	56.412	23.07	11		96.9	7.91	
10.0	24/05/2005	56.384	23	13		96.4	7.92	
2.0	24/05/2005	56.406	23.03	14		96.2	7.9	
4.0	24/05/2005	56.417	23.06	19		99.2	7.9	
6.0	24/05/2005	56.381	23.04	13		99.4	7.91	
8.0	24/05/2005	56.387	23	11		99.4	7.92	
0.2	22/06/2005	54.364	21.9	15		95.3	8.11	
2.0	22/06/2005	54.41	21.91	15		95.7	8.1	
4.0	22/06/2005	54.411	21.91	16		95.8	8.1	
0.2	19/07/2005	55.725	21.67	5		95.8	8.17	
2.0	19/07/2005	55.724	21.66	5		95.9	8.17	
4.0	19/07/2005	55.731	21.63	6		100.5	8.16	
6.0	19/07/2005	55.7	21.56	6		100.2	8.17	
8.0	19/07/2005	55.707	21.58	5		100	8.16	
0.2	17/08/2005	55.195	21.31	6		92.4	7.92	
2.0	17/08/2005	55.162	21.22	6		91.5	7.92	
3.0	17/08/2005	55.171	21.19	6		92	7.92	
0.2	26/10/2005	56.861	30.2	4		91.3	7.97	
10.0	26/10/2005	56.815	27.32	8		91.2	7.99	
2.0	26/10/2005	56.862	30.16	4		91.3	7.97	
4.0	26/10/2005	56.85	29.82	4		95.4	7.98	
6.0	26/10/2005	56.872	29.57	4		94.8	7.98	
8.0	26/10/2005	56.848	29.15	5		89.6	7.98	
0.2	24/11/2005	57.499	30.82	3		97.5	7.99	
2.0	24/11/2005	57.474	30.78	3		92.9	7.99	
4.0	24/11/2005	57.457	30.3	3		92.7	7.97	
0.2	21/12/2005	56.951	32.23	11		95.2	7.96	
10.0	21/12/2005	56.944	29.94	17		94.1	7.96	
12.0	21/12/2005	56.945	29.94	18		93.4	7.96	
2.0	21/12/2005	56.948	30.65	12		93	7.96	
4.0	21/12/2005	56.946	30.39	13		108.6	7.96	
6.0	21/12/2005	56.947	30.14	16		104.7	7.96	
8.0	21/12/2005	56.954	30	15		103.1	7.96	
0.2	19/01/2006	50.48	30.51	7		95.2	7.99	
2.0	19/01/2006	50.383	30.07	8		95	7.97	

Depth (m)	Date	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
4.0	19/01/2006	50.355	30	12		94.8	7.97	
0.2	22/02/2006	50.592	31.64	5		100.2	8.08	
2.0	22/02/2006	50.578	31.67	4		99.9	8.08	
3.0	22/02/2006	50.579	31.72	4		99.5	8.08	
0.2	28/03/2006	56.5	26.25	37			7.96	
2.0	28/03/2006	56.492	26.26	38			7.96	
4.0	28/03/2006	56.476	26.26	37			7.96	

1.6km

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
17/01/1996	0.2	36.822	29.8	12	93.7	7.9
17/01/1996	2.0	37.064	29.5	14	91.5	7.87
17/01/1996	4.0	38.494	29.7	18	89.9	7.88
7/02/1996	0.2	48.33	30.9	8	92.4	8.08
7/02/1996	2.0	48.554	30.9	12	92.1	8.11
7/02/1996	4.0	48.562	30.7	34	90.8	8.12
7/02/1996	6.0	48.624	30.6	57	89.8	8.12
6/03/1996	0.2	52.718	26	31	95.2	8.07
6/03/1996	2.0	52.84	26	35	95.5	8.08
6/03/1996	4.0	52.938	26	36	94.9	8.09
6/03/1996	6.0	53.112	25.9	42	95.6	8.11
6/03/1996	7.5	52.966	25.9	43	95.6	8.1
17/04/1996	0.2	59.3	30.1	9	87.6	7.58
17/04/1996	2.0	59.4	29.86	19	84.7	7.57
17/04/1996	4.0	59.4	29.73	24	83.9	7.57
15/05/1996	0.2	43.6	26.2	3	102.5	8.13
15/05/1996	2.0	43.756	26.1	7	102.3	8.14
15/05/1996	4.0	44.088	26.2	4	100.4	8.14
15/05/1996	6.0	44.26	26.2	4	100.4	8.14
19/06/1996	0.2	50.584	21.6	5	98.4	8.05
19/06/1996	2.0	50.83	20.9	8	98.2	8.05
19/06/1996	4.0	50.924	20.4	15	96.7	8.04
19/06/1996	5.0	50.868	20.4	13	96.3	8.03
17/07/1996	0.2	52	19.21	0	92.5	7.78
17/07/1996	2.0	52.2	18.92	2	91.2	7.78
17/07/1996	4.0	52.3	18.74	2	91	7.79
17/07/1996	6.0	52.4	18.71	1	91.4	7.79
17/07/1996	7.0	52.4	18.84	4	90.7	7.79
14/08/1996	0.2	53.322	21.1	4	102.8	8
14/08/1996	2.0	53.16	21	6	104	7.99
14/08/1996	4.0	53.192	20.8	8	104.2	7.98
14/08/1996	6.0	53.254	20.4	7	104.4	7.96
14/08/1996	7.0	53.284	20.2	6	106	7.95
25/09/1996	0.2	54.372	23.8	13	89.1	8.16
25/09/1996	2.0	54.192	23.8	15	89.1	8.23
25/09/1996	4.0	54.178	23.5	17	89.2	8.29
25/09/1996	6.0	54.24	23.2	17	90.4	8.33
25/09/1996	7.5	54.24	23.2	16	90.8	8.34
23/10/1996	0.2	51.396	26.2	9	90.9	8.13
23/10/1996	2.0	51.616	26.2	14	90.4	8.14
23/10/1996	4.0	51.592	26.2	21	89.2	8.15
20/11/1996	0.2	56.2	29.54	3	87.4	7.74
20/11/1996	2.0	56.2	29.48	7	85.9	7.74
20/11/1996	4.0	56.3	28.99	11	87.1	7.75
11/12/1996	0.2	53.936	29.6	19	91.8	8.19
11/12/1996	2.0	54.212	29.6	22	91.9	8.19
11/12/1996	4.0	54.142	29.6	23	91.2	8.19
11/12/1996	6.0	54.238	29.5	25	91.5	8.19
11/12/1996	7.0	54.33	29.5	25	91.7	8.19

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
22/01/1997	0.2	54.1	28.22	20	86.7	7.76
22/01/1997	2.0	54.1	28.1	25	85.3	7.75
22/01/1997	4.0	54.2	28.07	27	85.1	7.75
22/01/1997	6.0	54.2	27.92	29	84.1	7.76
19/02/1997	0.2	56.272	30.4	10	90.2	8.19
19/02/1997	2.0	56.33	30.2	14	89	8.19
19/02/1997	4.0	56.306	30.2	15	88.7	8.19
19/02/1997	6.0	56.36	30.1	17	88.6	8.19
19/02/1997	6.5	56.384	30.1	21	88.4	8.19
12/03/1997	0.2	54.6	24.8	48	87.7	8.1
12/03/1997	2.0	54.6	24.8	57	87.7	8.1
12/03/1997	4.0	54.6	24.8	54	88.1	8.1
12/03/1997	6.0	54.6	24.8	55	88.2	8.1
12/03/1997	8.0	54.7	24.8	59	88.2	8.1
9/04/1997	0.2	51.452	25.2	21	86.4	8.13
9/04/1997	2.0	51.528	25.2	27	86.6	8.15
9/04/1997	4.0	51.752	25.2	26	86.4	8.17
9/04/1997	6.0	51.952	25.3	31	85.9	8.18
9/04/1997	8.0	51.952	25.3	27	85.8	8.18
14/05/1997	0.2	53.928	24.9	3	88.4	8.18
14/05/1997	2.0	53.952	24.9	3	87.9	8.18
14/05/1997	4.0	54.214	24.6	5	86.3	8.17
4/06/1997	0.2	52.2	24.02	4	91.4	7.89
4/06/1997	2.0	52.2	23.95	8	90	7.89
4/06/1997	4.0	52.3	23.86	10	90.3	7.89
4/06/1997	6.0	52.3	23.84	10	90.3	7.9
16/07/1997	0.2	52.1	23.12	0	96.8	7.9
16/07/1997	2.0	52.2	22.76	0	93.6	7.89
16/07/1997	4.0	52.2	22.83	0	94.7	7.9
16/07/1997	6.0	52.2	22.84	0	94.3	7.9
20/08/1997	0.2	55.406	21.9	9	92.1	8.13
20/08/1997	2.0	55.412	21.8	10	92.3	8.13
20/08/1997	4.0	55.306	21.8	10	92.3	8.14
20/08/1997	6.0	55.326	21.9	11	91.6	8.13
30/09/1997	0.2	55.2	26.04	15	89.2	7.95
30/09/1997	2.0	55.2	26.02	13	87.9	7.95
30/09/1997	4.0	55.3	25.68	18	88.7	7.95
30/09/1997	6.0	55.3	25.66	27	86.5	7.95
28/10/1997	0.2	56.2	27.4	2	93.1	7.9
28/10/1997	2.0	56.3	27.01	3	90.7	7.9
28/10/1997	4.0	56.4	26.77	8	89.6	7.89
26/11/1997	0.2	57.6	31.16	7	95.8	7.88
26/11/1997	2.0	57.8	30.59	10	93.1	7.88
26/11/1997	4.0	57.8	30.03	18	91.3	7.87
11/12/1997	0.2	58.7	31.72	23	91.3	7.84
11/12/1997	2.0	58.8	31.49	27	88.9	7.84
11/12/1997	4.0	58.9	30.87	45	86.5	7.83
8/01/1998	0.2	58.7	30.26	41	94.4	7.8
8/01/1998	2.0	58.8	29.86	46	91.4	7.8
8/01/1998	4.0	58.8	29.5	56	90	7.79

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
8/01/1998	6.0	58.8	29.32	59	90.4	7.8
5/02/1998	0.2	58.2	35.54	12	117.3	8.02
5/02/1998	2.0	58.3	35.26	13	106	7.98
5/02/1998	4.0	58.4	35.02	15	101.5	7.97
5/02/1998	4.5	58.3	34.84	19	100.8	7.97
11/03/1998	0.2	57.6	29.03	46	93.8	7.98
11/03/1998	2.0	57.5	29.03	49	91.8	7.98
11/03/1998	4.0	57.6	29.01	54	91.5	7.98
11/03/1998	6.0	57.6	29	59	92.9	7.98
11/03/1998	8.0	57.6	28.97	70	92.8	7.98
8/04/1998	0.2	59.7	29.57	32	100.5	7.9
8/04/1998	2.0	59.8	29.36	33	96.9	7.9
8/04/1998	3.0	59.8	29.2	57	95.9	7.89
22/05/1998	0.2	60.2	26.4	11	98.3	7.85
22/05/1998	2.0	60.3	26.31	16	97.3	7.84
22/05/1998	4.0	60.3	26.24	25	96.7	7.84
24/06/1998	0.2	55.6	21.12	18	94.5	7.83
24/06/1998	2.0	55.7	20.97	17	97.2	7.84
24/06/1998	4.0	55.7	20.84	17	99.5	7.84
22/07/1998	0.2	46.6	22.28	3	89.8	7.79
22/07/1998	2.0	46.7	21.99	3	71.5	7.8
22/07/1998	4.0	46.8	21.73	3	84.3	7.8
22/07/1998	6.0	46.8	21.59	5	85.5	7.8
22/07/1998	7.5	46.8	21.55	5	85.7	7.8
21/08/1998	0.2	56.1	24.27	7	99.5	7.74
21/08/1998	2.0	56.2	24.16	7	99	7.74
21/08/1998	4.0	56.1	23.98	9	98.9	7.74
21/08/1998	6.0	56.1	23.82	10	86.5	7.74
18/09/1998	0.2	50.6	24.31	30	98.1	8
18/09/1998	2.0	50.7	23.92	32	97.1	8
18/09/1998	4.0	50.7	23.87	40	94.7	8
18/09/1998	5.0	50.7	23.84	42	96.3	8
19/10/1998	0.2	52.4	27.76	11	95.5	7.92
19/10/1998	2.0	52.5	27.29	12	94	7.92
19/10/1998	4.0	52.5	27.14	16	93	7.92
19/10/1998	6.0	52.5	27.11	16	92.1	7.92
18/11/1998	0.2	53.2	29.07	2	102.9	7.97
18/11/1998	2.0	53.2	29.03	3	100.3	7.97
18/11/1998	4.0	53.3	28.65	6	99.4	7.97
18/11/1998	5.5	53.3	28.63	8	99.7	7.96
16/12/1998	0.2	52.6	31.16	2	102.3	7.89
16/12/1998	2.0	52.7	30.93	4	99.9	7.88
16/12/1998	4.0	52.7	30.78	5	98	7.88
16/12/1998	6.0	52.7	30.81	5	97.9	7.88
13/01/1999	0.2	51.6	34.89	2	102.6	7.79
13/01/1999	2.0	51.7	34.49	5	100	7.78
13/01/1999	4.0	52.6	33.29	9	95.1	7.77
12/02/1999	0.2	53.9	31.25	1	98.1	7.66
12/02/1999	2.0	54	30.91	7	96.3	7.66
12/02/1999	4.0	54.1	30.76	11	95.1	7.66

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
17/03/1999	0.2	52.5	28.19	26	98.6	7.82
17/03/1999	2.0	52.5	28.19	25	96.3	7.82
17/03/1999	4.0	52.5	28.19	39	95	7.82
17/03/1999	6.0	52.5	28.16	38	93.8	7.82
14/04/1999	0.2	56.2	25.6	3	96.4	7.98
14/04/1999	2.0	56.3	25.33	6	94.2	7.98
14/04/1999	4.0	56.3	25.3	6	93.9	7.98
26/05/1999	0.2	54.9	25.44	14	100.4	7.86
26/05/1999	2.0	55	25.38	15	99.1	7.86
26/05/1999	4.0	55	25.3	17	97	7.86
28/06/1999	0.2	54.7	20.68	18	100.3	7.93
28/06/1999	2.0	54.9	20.3	0	98.6	7.94
28/06/1999	4.0	55.2	19.48	2	98.3	7.94
28/06/1999	6.0	55.2	19.27	2	97.6	7.94
28/07/1999	0.2	55.2	20.25	2	102	7.88
28/07/1999	2.0	55.4	19.74	2	100.3	7.9
28/07/1999	4.0	55.6	19.41	1	98.7	7.91
28/07/1999	6.0	55.6	18.88	2	98.4	7.91
25/08/1999	0.2	55.6	23.26	2	100.8	7.86
25/08/1999	2.0	55.8	22.81	2	96.9	7.87
25/08/1999	4.0	55.8	22.72	3	96.9	7.87
28/09/1999	0.2	56.4	22.72	5	97.1	7.82
28/09/1999	2.0	56.4	22.77	6	95.4	7.82
28/09/1999	4.0	56.5	22.75	5	95.3	7.82
28/09/1999	6.0	56.5	22.76	6	93.4	7.82
13/10/1999	0.2	56.6	25.23	2	94.7	8.06
13/10/1999	2.0	56.6	24.93	2	95.1	8.06
13/10/1999	4.0	56.6	24.94	2	94.8	8.06
13/10/1999	6.0	56.6	24.93	3	94.9	8.06
13/10/1999	7.5	56.6	24.89	31	94.4	8.06
10/11/1999	0.2	53	26.41	33	95.9	8.03
10/11/1999	2.0	54.3	25.68	37	93.1	8.04
10/11/1999	4.0	54.2	25.61	40	93.2	8.04
10/11/1999	6.0	53.7	25.61	41	92.8	8.04
10/11/1999	7.5	53.4	25.62	16	92	8.04
8/12/1999	0.2	55.1	25.34	21	93	8.03
8/12/1999	2.0	55	25.34	21	93.8	8.03
8/12/1999	4.0	54.9	25.3	23	94.9	8.03
8/12/1999	6.0	54.3	25.28	22	92.4	8.03
10/01/2000	0.2	51.7	27.87	17	94.6	7.88
10/01/2000	2.0	51.7	27.83	19	94.4	7.88
10/01/2000	4.0	51.8	27.76	23	94.4	7.89
10/01/2000	6.0	51.7	27.7	25	91.8	7.89
9/02/2000	0.2	57.8	26.12	7	75.5	8.16
9/02/2000	2.0	57.8	26.02	6	81	8.16
9/02/2000	4.0	57.3	25.95	8	74	8.16
9/02/2000	6.0	56.5	25.9	10	79.9	8.16
9/02/2000	7.0	55.9	25.87	12	79.1	8.16
9/03/2000	0.2	53.098	28.7	4	92.2	8.05
9/03/2000	2.0	53.194	28.5	4	92.6	8.05

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
9/03/2000	4.0	53.1	28.4	4	92.3	8.05
9/03/2000	6.0	53.106	28.1	5	91.4	8.06
9/03/2000	8.0	53.13	28.1	6	92.1	8.06
4/04/2000	0.2	57.5	29.32	54	94	7.76
4/04/2000	2.0	57.4	29.24	50	92.9	7.76
4/04/2000	4.0	57.2	29.06	50	91.8	7.76
4/04/2000	5.0	56.9	28.96	49	91.2	7.75
19/05/2000	0.2	57.6	24.83	59	92	7.83
19/05/2000	2.0	57.8	24.51	8	90	7.83
19/05/2000	4.0	57.5	24.46	11	90.8	7.83
19/05/2000	6.0	56.9	24.27	9	89.4	7.84
19/05/2000	7.0	56.4	24.21	8	89.3	7.84
16/08/2000	0.2	53.1	22.4	9	99.7	8.11
16/08/2000	2.0	53.1	21.95	11	99.6	8.11
16/08/2000	4.0	52.9	21.71	17	98.1	8.11
16/08/2000	5.5	52.7	21.46	10	97.5	8.12
15/09/2000	0.2	55.9	22.84	15	98.6	8.08
15/09/2000	2.0	56	22.7	12	96.9	8.08
15/09/2000	4.0	55.9	22.65	36	95.9	8.08
15/09/2000	6.0	55	22.63	7	95.4	8.08
15/09/2000	8.0	54.7	22.63	6	94.8	8.08
13/10/2000	0.2	57	25.93	6	97.6	7.99
13/10/2000	2.0	57	25.93	8	95.7	7.99
13/10/2000	4.0	56.6	25.89	9	94.5	8
13/10/2000	6.0	55.6	25.57	3	93.3	8
13/10/2000	7.0	55.5	25.47	3	93	8
13/11/2000	0.2	48.1	25.87	4	91.2	7.85
13/11/2000	2.0	48.1	25.81	3	90.3	7.86
13/11/2000	4.0	48	25.78	5	88.6	7.85
13/11/2000	6.0	48	25.78	7	87.6	7.86
13/11/2000	7.0	47.7	25.77	8	87.7	7.85
13/12/2000	0.2	50.481	28.38	2	93.2	7.83
13/12/2000	2.0	50.468	28.41	2	93	7.81
13/12/2000	4.0	50.457	28.41	3	92.9	7.82
13/12/2000	6.0	50.464	28.41	2	92.8	7.82
13/12/2000	8.0	50.47	28.42	3	92.6	7.82
21/02/2001	0.2	54.1	29.3	29	92	8
21/02/2001	2.0	54.1	29.3	32	92	8
21/02/2001	4.0	54.1	29	37	91.9	8
22/03/2001	0.2	54	33.1	38	101.6	7.9
22/03/2001	2.0	54.1	33	4	100.4	7.9
22/03/2001	4.0	54.1	32.9	5	99.6	7.9
22/03/2001	6.0	54.1	33	4	100	7.9
20/04/2001	0.2	54.7	28.04	5	95.6	8.05
20/04/2001	2.0	55	27.93	8	90.1	8.05
20/04/2001	4.0	55.1	27.63	8	93.1	8.05
20/04/2001	5.0	55.1	27.55	10	93.6	8.05
23/05/2001	0.2	56.258	24.2	17	92.7	8.15
23/05/2001	2.0	57.098	24.2	21	103	8.15
23/05/2001	4.0	56.76	24	11	102.7	8.15

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
23/05/2001	6.0	56.726	23.8	16	101.7	8.15
23/05/2001	7.5	56.648	23.8	17	101.2	8.15
14/06/2001	0.2	56.302	26.16	18	103.6	8.06
14/06/2001	2.0	56.271	25.98	18	101.8	8.05
14/06/2001	4.0	56.349	25.74	9	101.3	8.05
14/06/2001	5.5	56.285	25.66	9	101.8909	8.04
4/07/2001	0.2	54.358	23.09	11	100.3925	8.08
4/07/2001	2.0	54.377	22.86	11	100.2394	8.03
4/07/2001	4.0	54.371	22.82	6	98.9603	8.03
8/08/2001	0.2	55.516	21	7	97.442	8.14
8/08/2001	2.0	55.652	20.6	11	86.4	8.13
8/08/2001	4.0	55.714	20.5	7	81.6	8.13
8/08/2001	6.0	55.632	20.5	13	82.4	8.13
8/08/2001	8.0	55.632	20.5	12	83.6	8.13
17/10/2001	0.2	56.1	25.85	4	92.9	7.62
17/10/2001	2.0	56.3	25.89	5	92.7	7.62
17/10/2001	4.0	56	25.89	7	91.7	7.62
17/10/2001	5.0	55.8	25.88	30	91	7.62
21/11/2001	0.2	55.1	29.8	32	91.5	8.4
21/11/2001	2.0	55.2	29.7	33	90.7	8.4
21/11/2001	4.0	55.1	29.5	31	90	8.4
21/11/2001	6.0	55.1	29.1	30	89.2	8.3
19/12/2001	0.2	55.361	27.87	35	89	7.97
19/12/2001	2.0	55.362	28.05	38	92.2	7.97
19/12/2001	4.0	55.308	27.96	40	91.7	7.97
19/12/2001	6.0	55.382	27.07	44	89.8	7.95
19/12/2001	8.0	55.328	27.03	23	87	7.94
30/01/2002	0.2	53.9	29.49	27	88.5	7.9
30/01/2002	2.0	53.9	29.39	32	102.8	7.9
30/01/2002	4.0	53.9	29.27	32	101.8	7.9
30/01/2002	6.0	53.9	29.2	20	101.2	7.9
30/01/2002	7.0	53.7	29.2	27	100.4	7.9
15/05/2002	0.2	55.81	26.82	31	99	8.09
15/05/2002	2.0	55.823	26.43	35	105.2	8.09
15/05/2002	4.0	55.818	26.41	92	104.5	8.09
15/05/2002	6.0	55.796	25.85	97	104.1	8.1
15/05/2002	7.0	55.626	25.22	108	104.3	8.11
13/06/2002	0.2	52.994	24	54	87	8.19
13/06/2002	2.0	52.993	23.64	59	88.1	8.19
13/06/2002	4.0	52.98	23.74	68	87.8	8.19
13/06/2002	6.0	52.998	23.78	8	100.4	8.19
10/07/2002	0.2	53.865	22.76	11	99.8	8.34
10/07/2002	2.0	53.835	22.56	13	99.2	8.34
10/07/2002	4.0	53.868	22.47	16	106.4	8.34
7/08/2002	0.2	54.606	25.3	9	106.7	8.02
7/08/2002	2.0	54.615	25.14	12	107.1	8.02
7/08/2002	4.0	54.601	24.95	13	96.9	8.02
4/09/2002	0.2	54.968	26.89	15	96.4	8.21
4/09/2002	2.0	54.966	26.89	13	95.9	8.21
4/09/2002	3.0	54.959	26.88	19	95.8	8.22

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
9/10/2002	0.2	53.958	25.24	17	95.8	8.12
9/10/2002	2.0	53.979	25.22	17	96.5	8.12
9/10/2002	4.0	53.985	24.87	7	95.9	8.12
9/10/2002	6.0	53.994	24.83	8	95.5	8.12
9/10/2002	8.0	53.957	24.81	11	95.2	8.12
6/11/2002	0.2	56.753	28.18	12	93.3	8.12
6/11/2002	2.0	56.725	28.15	5	91.7	8.12
6/11/2002	4.0	56.736	28.1	6	91.2	8.12
6/11/2002	6.0	56.729	28.1	8	91.2	8.12
4/12/2002	0.2	58.295	31.35	7	96.8	8.05
4/12/2002	2.0	58.259	30.87	7	96.4	8.05
4/12/2002	4.0	58.272	30.77	7	96.2	8.05
4/12/2002	6.0	58.259	30.65	9	95.8	8.06
22/01/2003	0.2	58.124	29.48	8	79	8.15
22/01/2003	2.0	58.146	29.29	9	78.9	8.15
22/01/2003	4.0	58.14	29.19	2	78.7	8.15
22/01/2003	6.0	58.14	29.18	2	108.7	8.16
19/02/2003	0.2	42.188	29.1	2	104.7	8.23
19/02/2003	2.0	42.248	29.09	3	101.5	8.23
19/02/2003	4.0	42.274	29.09	23	103.1	8.24
19/03/2003	0.2	47.368	27.67	33	102.7	8.26
19/03/2003	2.0	47.373	27.6	48	102	8.26
19/03/2003	4.0	47.39	27.58	67	101.4	8.26
31/07/2003	0.2	55.681	20.85	94	96.9	8.06
31/07/2003	2.0	55.656	20.67	10	96.4	8.06
31/07/2003	4.0	55.662	20.22	10	95.9	8.06
31/07/2003	6.0	55.636	20.1	14	95.7	8.06
27/08/2003	0.2	54.301	23.26	16	104.6	7.96
27/08/2003	2.0	54.317	23.03	25	103.6	7.96
27/08/2003	4.0	54.344	22.78	30	101.7	7.96
27/08/2003	5.0	54.439	22.55	31	98.4	7.96
24/09/2003	0.2	55.47	27.06	7	103.1	7.94
24/09/2003	2.0	55.427	26.85	8	102.7	7.94
24/09/2003	4.0	55.434	26.67	11	102.3	7.94
24/09/2003	6.0	55.441	26.54	8	102	7.94
22/10/2003	0.2	55.261	27.87	4	96.6	7.99
22/10/2003	2.0	55.297	27.42	5	96	7.99
22/10/2003	4.0	55.396	27.1	4	94.6	7.98
22/10/2003	5.5	55.443	27.05	6	93.8	7.98
19/11/2003	0.2	55.152	30.67	7	94.1	8.03
19/11/2003	2.0	55.143	30.55	7	96.1	8.03
19/11/2003	4.0	55.128	29.72	8	95.2	8.02
19/11/2003	5.5	55.142	28.96	8	94.2	8.02
17/12/2003	0.2	49.2	30.76	3	93.9	8.05
17/12/2003	2.0	52.166	31.51	3	104.2	8.07
17/12/2003	4.0	52.478	30.74	3	104.5	8.07
17/12/2003	6.0	53.898	29.23	4	101	8.07
17/12/2003	7.0	54.047	29.12	17	100.3	8.07
14/01/2004	0.2	47.663	31.91	19	79.5	7.83
14/01/2004	2.0	47.601	31.94	20	78.6	7.83

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
14/01/2004	4.0	48.889	31.63	20	78.5	7.81
14/01/2004	5.0	48.943	31.64	17	79.7	7.81
4/02/2004	0.2	23.599	28.95	18	82.5	7.74
4/02/2004	2.0	28.623	29.15	22	94.9	7.69
4/02/2004	4.0	31.072	29.26	23	94.6	7.72
4/02/2004	6.0	36.747	29.73	25	91.7	7.76
4/02/2004	8.0	41.131	30.2	13	96.3	7.82
3/03/2004	0.2	47.178	30.98	14	95.5	8
3/03/2004	2.0	47.2	30.99	14	93.9	8.01
3/03/2004	4.0	47.374	30.4	15	93.8	7.99
21/04/2004	0.2	54.597	28.74	28	92.1	7.93
21/04/2004	2.0	54.455	28.33	31	94.8	7.93
21/04/2004	4.0	54.547	27.64	33	94.6	7.93
21/04/2004	6.0	54.574	27.33	36	94.3	7.93
19/05/2004	0.2	54.93	25.09	9	94	8.07
19/05/2004	2.0	54.989	25.21	13	93.4	8.07
19/05/2004	4.0	54.984	25.17	16	92.7	8.07
19/05/2004	5.5	54.945	25.38	19	92.3	8.08
23/06/2004	0.2	56.173	21.44	26	97.5	8.06
23/06/2004	2.0	56.164	21.44	6	96.9	8.05
23/06/2004	4.0	56.16	21.37	7	96.8	8.04
23/06/2004	6.0	56.167	21.35	13	96.7	8.04
21/07/2004	0.2	56.049	18.26	17	102.5	8.07
21/07/2004	2.0	56.034	18.3	6	100.7	8.06
21/07/2004	4.0	56.102	18.37	9	99.3	8.06
21/07/2004	6.0	56.096	18.36	13	98.9	8.06
25/08/2004	0.2	55.241	24.11	9	102.6	8.08
25/08/2004	2.0	55.307	24.1	13	102.1	8.08
25/08/2004	4.0	55.326	24	15	101.5	8.07
25/08/2004	6.0	55.301	23.95	20	101.3	8.07
29/09/2004	0.2	56.355	25.76	13	94.7	7.91
29/09/2004	2.0	56.331	25.87	15	94	7.9
29/09/2004	4.0	56.268	25.7	20	93.3	7.89
29/09/2004	6.0	56.296	25.63	21	92.9	7.89
28/10/2004	0.2	55.299	28.58	5	92.5	8.08
28/10/2004	2.0	55.299	28.47	6	95.7	8.07
28/10/2004	4.0	55.259	28.31	7	96.3	8.07
28/10/2004	6.0	55.268	28.23	6	96.3	8.07
28/10/2004	7.5	55.261	28.08	5	95.6	8.06
17/11/2004	0.2	56.691	28.73	7	94.8	8.24
17/11/2004	2.0	56.704	28.73	8	94	8.25
17/11/2004	4.0	56.725	28.71	4	93.8	8.25
17/11/2004	5.0	56.722	28.71	5	93.8	8.25
15/12/2004	0.2	56.728	31.04	4	95.4	8.2
15/12/2004	2.0	56.713	31.04	5	94.4	8.2
15/12/2004	4.0	56.715	31.01	4	94.1	8.2
15/12/2004	5.5	56.717	31.01	4	93.6	8.2
22/02/2005	0.2	52.213	30.64	4	93.5	7.95
22/02/2005	2.0	52.279	30.25	4	94.9	7.95
22/02/2005	4.0	52.308	30.06	10	93.5	7.95

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
22/02/2005	6.0	52.353	29.89	11	92.2	7.95
22/02/2005	8.0	52.349	29.88	16	92.4	7.95
21/03/2005	0.2	54.247	30.49	27	100.4	7.99
21/03/2005	2.0	54.266	30.31	32	99.8	7.98
21/03/2005	4.0	54.349	30.2	7	98.7	7.98
21/03/2005	6.0	54.492	30.3	7	97.1	7.99
20/04/2005	0.2	55.555	29.15	9	95.8	7.95
20/04/2005	2.0	55.484	29.09	13	95.2	7.93
20/04/2005	4.0	55.459	28.7	5	94.8	7.93
24/05/2005	0.2	56.476	24.06	5	98.4	8
24/05/2005	2.0	56.476	23.85	6	98.4	8
24/05/2005	4.0	56.467	23.78	7	98.4	8
24/05/2005	5.5	56.465	23.77	42	98.5	8
22/06/2005	0.2	54.291	23.14	46	96.2	8.09
22/06/2005	2.0	54.323	23.07	45	96	8.08
22/06/2005	4.0	54.325	22.86	48	95.8	8.08
22/06/2005	6.0	54.319	22.75		100.8	8.08
19/07/2005	0.2	55.797	22.61		100.3	8.15
19/07/2005	2.0	55.783	22.44		99.8	8.14
19/07/2005	4.0	55.81	22.35		99.4	8.14
17/08/2005	0.2	55.29	23.24		95.1	7.97
17/08/2005	2.0	55.258	23.2		94.5	7.95
17/08/2005	4.0	55.239	23.13		93.8	7.94
17/08/2005	6.0	55.253	23.07		92.1	7.94
26/10/2005	0.2	56.884	30.38		91.5	7.97
26/10/2005	2.0	56.878	30.33		96	7.97
26/10/2005	4.0	56.878	30.32		95.6	7.97
26/10/2005	6.0	56.854	30.12		93.4	7.97
26/10/2005	7.0	57.065	29.09		97.3	7.97
24/11/2005	0.2	57.454	31.29		96.5	8
24/11/2005	2.0	57.447	31.25		95	8
24/11/2005	4.0	57.434	30.79		93.9	7.99
21/12/2005	0.2	56.849	31.96		93.2	7.96
21/12/2005	2.0	56.836	31.7		111.9	7.96
21/12/2005	4.0	56.855	31.33		109.8	7.96
21/12/2005	6.0	56.902	30.42		106.3	7.96
21/12/2005	8.0	56.915	30.3		105.3	7.96
19/01/2006	0.2	50.452	30.6		101	8
19/01/2006	2.0	50.435	30.34		100.3	7.99
19/01/2006	4.0	50.407	30.09		95.9	7.98
19/01/2006	6.0	50.392	30.04		94.5	7.98
22/02/2006	0.2	50.659	33.24		100.2	8.07
22/02/2006	2.0	50.645	33.08		99.2	8.07
22/02/2006	4.0	50.617	31.92		98.8	8.06
22/02/2006	5.0	50.615	31.66		98.5	8.06
28/03/2006	0.2	56.621	26.74			8
28/03/2006	2.0	56.635	26.66			8
28/03/2006	4.0	56.608	26.65			8
28/03/2006	6.0	56.632	26.63			8

3.2km

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
17/01/1996	0.2	33.804	30.3	16	9.7528	88.3	7.88	22
17/01/1996	2.0	33.826	30.3	18	4.4191	88.7	7.89	12.4
17/01/1996	4.0	36.622	30.9	21	2.5384	92.6	7.92	38.6
17/01/1996	4.5	37.138	31.5	24	3.1491	94	7.99	22.1
7/02/1996	0.2	48.104	31.5	10	11.4896	92.3	8.09	10.2
7/02/1996	2.0	48.222	31.3	10	1.8036	91.8	8.1	11.7
7/02/1996	4.0	48.32	31.1	12	1.0688	90	8.11	10
7/02/1996	6.0	48.23	31.1	13	1.8704	89	8.11	
7/02/1996	7.0	44.862	31.2	34	2.6468	89.6	8.12	
6/03/1996	0.2	52.768	26	21	3.006	93.9	8.15	
6/03/1996	2.0	52.914	26	23	3.9412	95.6	8.15	
6/03/1996	4.0	52.988	25.9	31	4.4088	95.3	8.14	
6/03/1996	6.0	52.988	25.9	39	3.7217	95.6	8.14	
17/04/1996	0.2	58.7	31.14	11	12.1724	88.5	7.57	
17/04/1996	2.0	58.9	30.68	8	2.1376	88.4	7.57	
17/04/1996	4.0	59	30.44	10	2.672	84.7	7.57	
17/04/1996	5.5	59	30.47	10	1.6032	85.7	7.57	
15/05/1996	0.2	42.294	26.4	5	2.0708	108.1	8.14	
15/05/1996	2.0	42.366	26.4	5	1.9372	107.7	8.16	
15/05/1996	4.0	42.512	26.4	8	2.1376	107	8.17	
15/05/1996	6.0	42.508	26.5	9	2.004	105.7	8.18	
19/06/1996	0.2	50.076	22.7	5	1.6032	92.2	8.07	
19/06/1996	2.0	50.128	22.7	8	3.8744	92.3	8.07	
19/06/1996	4.0	50.18	22.7	7	6.4573	91.7	8.08	
19/06/1996	5.0	50.128	22.7	8	5.3909	91.7	8.08	
17/07/1996	0.2	52	21.45	0	9.7528	93.5	7.79	
17/07/1996	2.0	52.1	20.94	0	4.676	93	7.78	
17/07/1996	4.0	52.1	20.43	0	5.344	92.3	7.76	
17/07/1996	6.0	52.1	20.16	0	2.672	90.8	7.76	
17/07/1996	8.0	52.1	19.95	4	2.2712	89.5	7.74	
14/08/1996	0.2	52.968	21.4	12	1.336	103.5	8.04	
14/08/1996	2.0	52.968	21.4	12	1.6471	103	8.03	
14/08/1996	4.0	52.968	21.4	12	1.336	102.1	8.02	
25/09/1996	0.2	53.982	24.8	18	2.0994	88.9	8.12	
25/09/1996	2.0	53.984	24.7	17	2.672	89.3	8.18	
25/09/1996	4.0	53.984	24.7	20	2.672	89	8.22	
25/09/1996	6.0	53.934	24.7	20	4.008	88.6	8.24	
25/09/1996	8.0	53.984	24.7	20	2.8056	88.6	8.26	
23/10/1996	0.2	50.498	26.4	12	3.0249	90.7	8.12	
23/10/1996	10.0	51.704	27.4	15	2.505	92.1	8.16	
23/10/1996	2.0	50.742	26.4	14	1.0688	90.5	8.13	
23/10/1996	4.0	50.768	26.4	14	0.835	89.4	8.13	
23/10/1996	6.0	51.266	26.9	12	0.9352	90.5	8.15	
23/10/1996	8.0	51.19	26.8	15	1.2024	89.9	8.15	
20/11/1996	0.2	55.9	31.54	3	0.9824	91.4	7.75	
20/11/1996	2.0	56.1	30.81	1	1.002	89.6	7.74	
20/11/1996	4.0	56	30.41	1	2.2267	89.2	7.74	
11/12/1996	0.2	52.758	30.4	18	1.9595	89.6	8.14	
11/12/1996	2.0	53.008	30.4	24	3.5404	91.6	8.14	

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
11/12/1996	4.0	53.008	30.5	25	2.8056	91.1	8.14	
22/01/1997	0.2	53.9	28.39	13	2.2712	85.6	7.76	
22/01/1997	2.0	53.9	28.39	20	2.672	85.2	7.76	
22/01/1997	4.0	53.9	28.39	22	2.2005	85.3	7.76	
22/01/1997	6.0	53.9	28.36	22	1.67	84.6	7.76	
19/02/1997	0.2	55.178	31.9	28	0.8016	90.3	8.15	
19/02/1997	2.0	55.31	31.9	27	2.004	89.9	8.15	
19/02/1997	4.0	55.442	31.9	33	3.9294	90	8.15	
19/02/1997	6.0	55.378	31.9	26	4.4533	90	8.16	
19/02/1997	8.0	55.648	31.8	32	2.5607	88.7	8.16	
12/03/1997	0.2	54.2	25.1	39	1.8131	87.9	8.1	
12/03/1997	2.0	54.3	25.1	43	4.2084	87.7	8.1	
12/03/1997	4.0	54.2	25.2	48	1.67	87	8.1	
12/03/1997	6.0	54.4	25	54	0.8016	87.7	8.1	
12/03/1997	8.0	54.3	25	56	1.8704	87.5	8.1	
9/04/1997	0.2	51.63	25.3	20	0.84613	85.5	8.17	
9/04/1997	2.0	51.652	25.2	28	1.78133	85.5	8.17	
9/04/1997	4.0	51.652	25.2	29	1.17406	85.6	8.17	
9/04/1997	5.5	51.602	25.2	32	2.75422	85.7	8.17	
14/05/1997	0.2	53.61	25.6	2	1.42361	90.2	8.2	
14/05/1997	2.0	53.564	25.5	3	2.1376	89.1	8.19	
14/05/1997	4.0	53.62	25.2	8	1.57648	87.8	8.19	
4/06/1997	0.2	51.6	24.39	9	0.668	91.2	7.89	
4/06/1997	2.0	51.7	24.37	7	0.45424	90.7	7.89	
4/06/1997	4.0	51.6	24.38	8	10.11027	91.1	7.89	
4/06/1997	6.0	51.7	24.36	11	3.7408	91.2	7.89	
4/06/1997	8.0	51.7	24.35	10	2.2044	91.1	7.88	
16/07/1997	0.2	52.1	23.37	0	1.336	97.2	7.91	
16/07/1997	2.0	52.1	23.33	0	0.89067	97	7.91	
16/07/1997	3.5	52.1	23.14	0	2.08208	95.2	7.91	
20/08/1997	0.2	55.358	23.1	13	2.2712	90	8.09	
20/08/1997	2.0	55.358	23.1	14	1.503	89.5	8.09	
20/08/1997	4.0	55.244	23.3	20	1.4028	89.3	8.09	
20/08/1997	6.0	55.218	23.3	17	3.4736	89.2	8.09	
20/08/1997	8.0	55.244	23.3	16	9.4856	89.3	8.09	
30/09/1997	0.2	54.8	27.41	24	0.5344	86.6	7.88	
30/09/1997	2.0	54.8	27.44	28	5.7448	85.6	7.88	
30/09/1997	2.5	54.8	27.44	29	1.7368	85.7	7.88	
28/10/1997	0.2	56.2	27.53	3	1.69227	90.9	7.9	
28/10/1997	2.0	56.2	27.52	4	1.4696	91.2	7.9	
28/10/1997	3.0	56.2	27.52	4	0.9352	91.3	7.9	
26/11/1997	0.2	57.5	31.18	12	1.96392	94	7.87	
26/11/1997	2.0	57.6	31.2	16	3.34	93.6	7.87	
11/12/1997	0.2	58.5	32.71	37	1.23053	89.4	7.83	
11/12/1997	2.0	58.6	32.75	41	4.5424	88.7	7.84	
8/01/1998	0.2	58.6	30.65	42	4.2752	93	7.79	
8/01/1998	2.0	58.6	30.67	44	2.5384	91.8	7.79	
5/02/1998	0.2	58.1	36.42	14	2.8056	107.5	7.99	
5/02/1998	2.0	58.2	36.43	16	2.0875	108.6	7.99	
11/03/1998	0.2	56.7	30.62	92	0.95429	93.3	7.93	

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
11/03/1998	2.0	56.8	30.64	90	0.9352	92.9	7.93	
11/03/1998	4.0	56.8	30.65	93	0.9352	91.9	7.93	
8/04/1998	0.2	59.5	30.06	31		100.2	7.93	
8/04/1998	2.0	59.5	30.06	44		99.8	7.93	
22/05/1998	0.2	60	26.46	19		98.2	7.86	
22/05/1998	1.0	60	26.49	18		99.3	7.86	
24/06/1998	0.2	55.6	22.49	31		95.8	7.81	
24/06/1998	2.0	55.6	22.47	30		93.9	7.82	
24/06/1998	4.0	55.6	22.44	29		92.7	7.82	
22/07/1998	0.2	46.2	24.2	7		94.5	7.77	
22/07/1998	2.0	46.3	24.23	7		95.2	7.78	
21/08/1998	0.2	55.9	25.84	12		97.1	7.71	
21/08/1998	2.0	56	25.86	12		97.8	7.72	
21/08/1998	3.0	56	25.87	11		97.1	7.72	
18/09/1998	0.2	47.2	25.44	51		92.3	7.95	
18/09/1998	2.0	47.2	25.33	48		91	7.95	
18/09/1998	4.0	47	25.36	69		91	7.94	
19/10/1998	0.2	51.9	28.95	12		92.8	7.89	
19/10/1998	2.0	52	28.86	15		91.2	7.89	
19/10/1998	3.5	52	28.83	16		92.8	7.89	
18/11/1998	0.2	52.7	30.9	6		101.7	7.95	
18/11/1998	2.0	52.7	30.9	5		101.4	7.95	
18/11/1998	3.5	52.7	30.9	6		101.5	7.95	
16/12/1998	0.2	52.2	31.46	5		101.4	7.9	
16/12/1998	2.0	52.2	31.48	6		99.9	7.89	
16/12/1998	3.0	52.2	31.49	6		101.3	7.89	
13/01/1999	0.2	49.1	34.26	3		101.9	7.77	
13/01/1999	2.0	49.2	34.28	4		100.6	7.77	
13/01/1999	3.0	49.3	34.3	4		100.8	7.77	
12/02/1999	0.2	52.3	31.36	9		97.9	7.66	
12/02/1999	1.5	52.3	31.34	13		96.4	7.66	
17/03/1999	0.2	51.5	29.27	43		95.9	7.79	
17/03/1999	2.0	51.4	29.26	41		94.8	7.79	
17/03/1999	4.0	51.5	29.2	46		95.2	7.79	
14/04/1999	0.2	55.2	27.25	10		94.8	7.95	
14/04/1999	2.0	55.3	27.27	10		94.4	7.96	
14/04/1999	3.0	55.3	27.28	12		93.4	7.96	
26/05/1999	0.2	54.8	25.54	13		101.4	7.87	
26/05/1999	2.0	54.8	25.55	14		101.3	7.88	
28/06/1999	0.2	54.5	21.43	17		99	7.91	
28/06/1999	2.0	54.6	21.44	0		98.3	7.92	
28/06/1999	4.0	54.6	21.44	1		98	7.92	
28/07/1999	0.2	54.8	21.16	1		98.8	7.86	
28/07/1999	2.0	54.8	21.19	1		98.5	7.88	
28/07/1999	4.0	54.8	21.2	2		97.5	7.88	
25/08/1999	0.2	55.5	23.78	2		98.2	7.85	
25/08/1999	2.0	55.5	23.8	4		97	7.85	
28/09/1999	0.2	55.8	24.8	4		100.7	7.83	
28/09/1999	2.0	56.2	23.44	5		97.1	7.83	
28/09/1999	4.0	56.4	22.8	1		94.9	7.83	

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
28/09/1999	4.5	56.4	22.77	2		94.4	7.83	
13/10/1999	0.2	56.3	26.89	2		97.1	8.06	
13/10/1999	2.0	56.3	26.98	20		96.5	8.05	
13/10/1999	3.0	56.3	27.05	21		96.7	8.05	
10/11/1999	0.2	46.3	28.68	23		92.1	7.96	
10/11/1999	2.0	49.9	29.59	25		97.1	8	
10/11/1999	3.0	50.8	29.84	13		97.6	8.01	
8/12/1999	0.2	54.6	26.82	13		97.4	8.03	
8/12/1999	2.0	54.8	26.55	15		95.7	8.02	
8/12/1999	3.0	54.8	26.5	22		94.8	8.02	
10/01/2000	0.2	51	30.81	22		101	7.88	
10/01/2000	2.0	51.2	30.47	27		99.1	7.88	
10/01/2000	2.5	51.4	29.11	5		94.5	7.87	
9/02/2000	0.2	57.5	28.25	6		96.6	8.16	
9/02/2000	2.0	57.7	26.84	12		95.5	8.16	
9/02/2000	4.0	57.6	26.35	10		93.9	8.16	
9/02/2000	6.0	57	26.18	11		93.2	8.16	
9/03/2000	0.2	53.09	29.2	10		92.9	8.03	
9/03/2000	2.0	53.16	29.2	59		95.1	8.04	
9/03/2000	4.0	52.974	29.3	53		91.4	8.03	
4/04/2000	0.2	57.1	30.78	54		93	7.73	
4/04/2000	2.0	57.1	30.78	53		92.5	7.73	
4/04/2000	4.0	56.9	30.77	50		92.2	7.73	
19/05/2000	0.2	57.3	27.62	51		95.3	7.85	
19/05/2000	2.0	57.6	26.95	13		93.3	7.85	
19/05/2000	4.0	57.4	25.27	16		89.4	7.8	
16/08/2000	0.2	52.9	23.95	15		98.9	8.07	
16/08/2000	2.0	52.9	23.96	18		98.2	8.07	
16/08/2000	4.0	52.7	23.96	17		97.3	8.07	
15/09/2000	0.2	54.6	27.71	14		105	8.06	
15/09/2000	2.0	55.4	26.25	14		98.1	8.08	
15/09/2000	4.0	55.3	23.16	12		95.5	8.09	
13/10/2000	0.2	56.8	27.39	11		92.2	7.94	
13/10/2000	2.0	56.9	27.41	12		91.3	7.94	
13/10/2000	4.0	56.9	27.4	13		91.1	7.94	
13/11/2000	0.2	43.4	26.62	4		85.9	7.78	
13/11/2000	2.0	44.4	26.36	4		83	7.79	
13/11/2000	4.0	44.5	26.31	4		84	7.8	
13/11/2000	5.0	44.5	26.26	5		84	7.8	
13/12/2000	0.2	49.985	29.17	6		92.6	7.86	
13/12/2000	10.0	49.921	29.01	9		91.9	7.85	
13/12/2000	2.0	49.917	29.08	8		92.3	7.86	
13/12/2000	4.0	49.898	29.04	2		92.4	7.86	
13/12/2000	6.0	49.9	29.02	3		92.3	7.85	
13/12/2000	8.0	49.907	29.01	4		92	7.85	
21/02/2001	0.2	53.2	30.6	38		91.9	8	
21/02/2001	2.0	53.3	30.6	37		91.3	8	
21/02/2001	4.0	53.2	30.6	37		91	8	
22/03/2001	0.2	52.8	33.2	4		101.1	7.9	
22/03/2001	2.0	52.8	33.2	5		100.9	7.9	

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
22/03/2001	4.0	52.8	33.2	6		100.5	7.9	
20/04/2001	0.2	54.6	28.22	5		88.4	8.04	
20/04/2001	2.0	54.8	28.26	8		94.9	8.05	
23/05/2001	0.2	56.33	25.6	10		91.9	8.11	
23/05/2001	2.0	57.07	25.6	10		108.7	8.11	
23/05/2001	4.0	57.094	25.6	11		107	8.11	
14/06/2001	0.2	56.303	26.46	13		106.3	8.06	
14/06/2001	2.0	56.296	26.2	14		103.9	8.06	
14/06/2001	4.0	56.277	25.98	15		103.6	8.05	
4/07/2001	0.2	54.353	23.2	13		103.8	8.11	
4/07/2001	2.0	54.373	23.22	13		103.6	8.11	
4/07/2001	4.0	54.373	23.34	15		103.0677	8.11	
4/07/2001	6.0	54.35	23.28	11		98.3746	8.11	
8/08/2001	0.2	55.838	24.8	14		96.0531	8.09	
8/08/2001	2.0	55.736	23.3	10		93.4	8.08	
8/08/2001	4.0	55.736	23.3	10		90.1	8.08	
17/10/2001	0.2	56.3	27.47	10		86.9	7.58	
17/10/2001	2.0	56.3	27.46	8		97.7	7.58	
17/10/2001	3.5	56.3	27.46	9		93.1	7.58	
21/11/2001	0.2	55.1	30	11		92.6	8.4	
21/11/2001	2.0	55.1	29.9	5		89.3	8.3	
21/11/2001	4.0	55.1	29.8	5		88.5	8.3	
21/11/2001	6.0	55.1	29.5	6		93.2	8.2	
21/11/2001	8.0	55	29.4	33		90.9	8.2	
19/12/2001	0.2	55.211	29.68	34		90.1	7.97	
19/12/2001	2.0	55.199	29.68	37		90.7	7.97	
19/12/2001	3.5	55.189	29.69	34		91	7.97	
30/01/2002	0.2	53.9	29.16	31		90.6	7.9	
30/01/2002	2.0	53.9	29.16	32		90.4	7.9	
30/01/2002	4.0	53.9	29.16	33		103.3	7.9	
30/01/2002	5.0	53.9	29.16	34		103.1	7.9	
15/05/2002	0.2	55.786	26.54	39		103.2	8.1	
15/05/2002	2.0	55.784	26.53	35		103	8.1	
15/05/2002	3.0	55.783	26.52	38		103	8.1	
13/06/2002	0.2	52.904	24.44	25		102.7	8.19	
13/06/2002	2.0	52.898	24.45	26		102.6	8.2	
13/06/2002	4.0	52.898	24.43	24		102.2	8.2	
13/06/2002	6.0	52.894	24.41	25		88.2	8.2	
13/06/2002	7.5	52.89	24.38	105		88.2	8.2	
10/07/2002	0.2	53.839	22.66	105		88.7	8.35	
10/07/2002	2.0	53.841	22.66	117		100.5	8.35	
10/07/2002	4.0	53.839	22.66	45		100.4	8.35	
7/08/2002	0.2	54.624	25.24	46		100.2	8.02	
7/08/2002	2.0	54.623	25.26	46		108.4	8.03	
7/08/2002	3.0	54.632	25.29	9		107.5	8.02	
4/09/2002	0.2	54.938	26.6	11		107	8.21	
4/09/2002	2.0	54.939	26.59	11		97.6	8.21	
4/09/2002	4.0	54.938	26.58	11		97.2	8.21	
9/10/2002	0.2	54.107	25.66	11		96.9	8.12	
9/10/2002	2.0	54.089	25.61	13		96.5	8.11	

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
9/10/2002	4.0	54.086	25.58	14		95.2	8.11	
6/11/2002	0.2	57.034	29.35	11		95.2	8.09	
6/11/2002	2.0	57.017	29.31	11		92.6	8.09	
6/11/2002	4.0	57.024	29.26	12		91.9	8.09	
4/12/2002	0.2	58.406	32.8	17		91.3	8.04	
4/12/2002	2.0	58.425	32.8	15		91	8.03	
4/12/2002	4.0	58.404	32.8	15		90.4	8.04	
4/12/2002	6.0	58.403	32.78	16		95.3	8.04	
4/12/2002	8.0	58.414	32.79	8		96.2	8.04	
22/01/2003	0.2	58.218	29.88	9		96.2	8.13	
22/01/2003	2.0	58.294	29.93	8		94.9	8.13	
22/01/2003	4.0	58.321	29.86	11		85.4	8.14	
22/01/2003	6.0	58.384	29.77	7		84.8	8.1	
19/02/2003	0.2	39.908	30.11	6		84.6	8.23	
19/02/2003	2.0	39.931	30.09	6		107.2	8.23	
19/02/2003	4.0	39.959	30.07	6		104.1	8.24	
19/03/2003	0.2	46.804	28.38	9		102.9	8.23	
19/03/2003	2.0	46.813	28.36	8		106.3	8.23	
19/03/2003	3.5	46.815	28.35	11		104.2	8.24	
31/07/2003	0.2	55.726	23.64	2		102.8	8.07	
31/07/2003	2.0	55.781	22.67	2		101.9	8.06	
31/07/2003	4.0	55.689	22.56	5		100.4	8.05	
31/07/2003	6.0	55.556	22.22	45		101.1	8.05	
31/07/2003	8.0	55.7	21.97	46		100.8	8.05	
27/08/2003	0.2	54.535	25.3	45		99.9	7.99	
27/08/2003	2.0	54.255	24.89	47		98.4	7.98	
27/08/2003	4.0	54.324	24.9	48		98.3	7.98	
27/08/2003	6.0	54.138	24.39	10		99.9	7.97	
27/08/2003	8.0	54.158	24.48	10		104.4	7.97	
24/09/2003	0.2	55.23	27.79	13		96	7.96	
24/09/2003	2.0	55.236	27.8	11		96.9	7.97	
24/09/2003	4.0	55.228	27.79	13		102.7	7.97	
24/09/2003	5.5	55.226	27.78	21		103.2	7.97	
22/10/2003	0.2	54.818	28.27	24		103.3	7.99	
22/10/2003	2.0	54.843	28.27	38		103.2	7.99	
22/10/2003	4.0	54.835	28.25	19		98.6	7.99	
22/10/2003	5.5	54.833	28.25	21		97	7.99	
19/11/2003	0.2	55.363	31.93	23		96.5	8.03	
19/11/2003	2.0	54.857	30.89	21		96.4	8.02	
19/11/2003	4.0	54.93	30.84	6		92.3	8.02	
19/11/2003	6.0	54.934	30.84	7		92.8	8.02	
17/12/2003	0.2	46.936	31.26	8		92.9	8	
17/12/2003	2.0	48.446	31.87	5		106.9	8.01	
17/12/2003	3.0	49.026	31.74	6		99.4	8.01	
14/01/2004	0.2	42.984	32.9	5		94.5	7.9	
14/01/2004	2.0	47.293	32.33	5		75.4	7.85	
14/01/2004	4.0	48.126	32.16	6		74.7	7.83	
4/02/2004	0.2	17.961	28.58	7		74.4	7.69	
4/02/2004	2.0	18.716	28.81	9		74.6	7.63	
4/02/2004	4.0	18.723	28.89	10		75.1	7.61	

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
4/02/2004	6.0	19.758	28.97	5		96.6	7.59	
4/02/2004	8.0	22.709	29.22	4		96.7	7.58	
3/03/2004	0.2	45.249	31.12	4		96.6	8.02	
3/03/2004	2.0	45.281	31.18	4		96.9	8.03	
3/03/2004	4.0	45.274	31.22	5		97.1	8.03	
3/03/2004	6.0	45.52	31.38	29		96.4	8.05	
3/03/2004	8.0	46.571	31.81	30		96	8.06	
21/04/2004	0.2	54.455	29.4	34		95.9	8	
21/04/2004	10.0	54.457	29.39	30		96.4	8	
21/04/2004	11.5	54.449	29.37	26		96.3	8	
21/04/2004	2.0	54.457	29.41	26		96.1	8	
21/04/2004	4.0	54.452	29.4	14		95.9	8	
21/04/2004	6.0	54.455	29.39	14		95.8	8	
21/04/2004	8.0	54.452	29.4	15		96.6	8	
19/05/2004	0.2	54.911	25.72	17		96.9	8.08	
19/05/2004	2.0	54.893	25.75	37		95.8	8.09	
19/05/2004	2.5	54.886	25.77	38		95.2	8.09	
23/06/2004	0.2	56.139	21.44	33		94.2	8.04	
23/06/2004	2.0	56.136	21.39	35		93.7	8.04	
23/06/2004	4.0	56.143	21.36	39		93.2	8.04	
23/06/2004	6.0	56.132	21.34	36		96.4	8.03	
23/06/2004	8.0	56.132	21.34	40		96.1	8.03	
21/07/2004	0.2	56.198	20.43	14		95.9	8.05	
21/07/2004	2.0	56.164	20.13	14		101.1	8.05	
21/07/2004	3.5	56.154	20.08	17		97.6	8.05	
25/08/2004	0.2	55.36	27.04	6		95.7	8.08	
25/08/2004	2.0	55.427	24.97	6		95.4	8.07	
25/08/2004	4.0	55.412	25.14	9		95.3	8.05	
25/08/2004	6.0	55.391	24.93	12		99.9	8.04	
25/08/2004	8.0	55.376	24.92	6		98.5	8.04	
29/09/2004	0.2	56.552	27.53	9		98.1	7.93	
29/09/2004	2.0	56.59	27.52	7		91.5	7.91	
29/09/2004	3.0	56.583	27.53	10		91.1	7.9	
28/10/2004	0.2	55.432	29.48	9		90.6	8.09	
28/10/2004	2.0	55.424	29.47	8		97.6	8.09	
28/10/2004	4.0	55.422	29.43	11		97.8	8.09	
17/11/2004	0.2	56.829	29.36	16		97.1	8.24	
17/11/2004	2.0	56.765	29	17		96.6	8.25	
17/11/2004	4.0	56.767	28.94	16		92.7	8.26	
17/11/2004	5.5	56.774	28.93	19		92.1	8.26	
15/12/2004	0.2	54.386	32.04	19		93.4	8.17	
15/12/2004	10.0	54.886	32.16	19		91.5	8.18	
15/12/2004	12.0	54.889	32.44	6		91.3	8.18	
15/12/2004	2.0	54.47	32	6		92.1	8.17	
15/12/2004	4.0	54.532	31.99	7		92	8.17	
15/12/2004	6.0	54.837	32.1	6		95.7	8.18	
15/12/2004	8.0	54.716	32.02	8		95.8	8.18	
22/02/2005	0.2	51.417	31.74	8		95.7	7.94	
22/02/2005	2.0	51.398	31.8	9		95.2	7.94	
22/02/2005	4.0	51.397	31.81	5		95.1	7.94	

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L
21/03/2005	0.2	54.136	30.78	4		95.1	8.01	
21/03/2005	2.0	54.136	30.8	3		95.2	8.01	
21/03/2005	4.0	54.138	30.8	4		95	8.01	
21/03/2005	6.0	54.136	30.8	4		94.8	8.01	
21/03/2005	8.0	54.144	30.81	5		99.5	8.02	
21/03/2005	9.5	54.146	30.81	17		99.2	8.02	
20/04/2005	0.2	55.419	29.38	16		98.8	7.95	
20/04/2005	2.0	55.421	29.39	17		98	7.95	
20/04/2005	4.0	55.427	29.38	9		96.7	7.95	
24/05/2005	0.2	56.398	24.05	11		96.2	8.06	
24/05/2005	2.0	56.391	24.04	12		96.2	8.05	
24/05/2005	4.0	56.484	24.05	6		95.6	8.01	
24/05/2005	6.0	56.309	24.14	5		98.1	8.06	
24/05/2005	8.0	56.384	24.02	4		98.2	8.06	
22/06/2005	0.2	54.148	23.28	5		98.4	8.08	
22/06/2005	2.0	54.199	23.3	41		96.2	8.07	
22/06/2005	4.0	54.201	23.3	44		96.2	8.06	
19/07/2005	0.2	55.82	22.31	44		96.3	8.14	
19/07/2005	2.0	55.794	22.35	42		96.4	8.14	
19/07/2005	4.0	55.8	22.36			98.7	8.14	
19/07/2005	5.5	55.803	22.36			98.8	8.14	
17/08/2005	0.2	55.309	23.18			98.8	7.97	
17/08/2005	2.0	55.267	23.21			98.6	7.97	
17/08/2005	4.0	55.264	23.2			96.4	7.97	
26/10/2005	0.2	56.931	32.23			94.7	7.98	
26/10/2005	2.0	56.869	31.29			97.8	7.97	
26/10/2005	4.0	56.835	30.85			96.9	7.97	
24/11/2005	0.2	57.431	32.02			95.6	8.03	
24/11/2005	2.0	57.352	31.64			95.6	8.03	
24/11/2005	4.0	57.331	31.53			95.9	8.02	
21/12/2005	0.2	56.847	33.12			95.4	7.95	
21/12/2005	2.0	56.83	33.11			122	7.95	
21/12/2005	4.0	56.827	33.1			115.4	7.95	
19/01/2006	0.2	49.825	35.77			112.1	8	
19/01/2006	2.0	50.373	32.62			107.3	7.99	
19/01/2006	4.0	50.412	32.44			106.7	7.99	
22/02/2006	0.2	50.669	33.45			106.3	8.07	
22/02/2006	2.0	50.672	33.51			105.6	8.07	
22/02/2006	4.0	50.636	33.51			99.7	8.08	
22/02/2006	6.0	50.65	33.51			99.6	8.08	
28/03/2006	0.2	56.785	28.04			99	8	
28/03/2006	2.0	56.783	28.03			98.5	8	
28/03/2006	4.0	56.766	27.97				8	
28/03/2006	6.0	56.787	27.97				8	

11.3km

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
17/01/1996	0.2	21.672	30.5	10	83.2	7.76
17/01/1996	2.0	25.286	30.1	11	74.3	7.66
17/01/1996	4.0	27.906	30.1	11	75.4	7.68
17/01/1996	5.5	28.64	30	10	75	7.7
7/02/1996	0.2	45.748	33.7	11	96.2	8.09
7/02/1996	2.0	46.146	33.4	14	93.2	8.09
7/02/1996	4.0	46.168	33.4	16	90.4	8.09
7/02/1996	5.5	46.232	33.4	15	91.9	8.09
6/03/1996	0.2	52.092	28.2	13	92.9	8.05
6/03/1996	2.0	52.232	28.2	14	94.2	8.06
6/03/1996	4.0	52.256	28.1	20	92.8	8.05
6/03/1996	6.0	52.35	28	19	92.7	8.05
17/04/1996	0.2	56	28.26	4	83.3	7.47
17/04/1996	2.0	56.1	28.26	5	81.6	7.46
17/04/1996	4.0	56.2	28.27	8	79	7.46
17/04/1996	5.0	56.4	28.33	12	80.7	7.46
15/05/1996	0.2	34.23	26.1	2	125.5	8.22
15/05/1996	2.0	34.81	26	3	121.4	8.21
15/05/1996	4.0	36.55	26	3	111.6	8.17
15/05/1996	6.0	37.684	26.1	3	108.1	8.16
19/06/1996	0.2	46.952	22.6	5	88.4	8
19/06/1996	2.0	47.45	22.6	6	87.9	8
19/06/1996	4.0	47.554	22.6	7	87.6	8
19/06/1996	6.0	48.366	22.6	7	88	8.02
19/06/1996	7.0	48.558	22.7	10	87.5	8.03
17/07/1996	0.2	49.6	18.77	18	84.7	7.65
17/07/1996	2.0	49.6	18.79	17	85.3	7.65
17/07/1996	4.0	49.7	18.79	14	84.4	7.65
17/07/1996	6.0	49.8	18.88	11	85.9	7.66
17/07/1996	8.0	50	18.91	13	85	7.66
14/08/1996	0.2	51.506	20.7	4	98.6	7.94
14/08/1996	2.0	51.394	20.6	4	99.4	7.94
14/08/1996	4.0	51.53	20.6	5	99.3	7.93
14/08/1996	6.0	51.53	20.6	5	99.1	7.93
14/08/1996	8.0	51.53	20.6	5	99	7.92
25/09/1996	0.2	52.936	24.1	14	86.1	8.06
25/09/1996	2.0	52.784	24	19	84.9	8.13
25/09/1996	4.0	52.808	24	26	83.7	8.16
25/09/1996	6.0	52.834	24	25	83.7	8.17
25/09/1996	7.5	52.784	24	22	83.3	8.18
23/10/1996	0.2	44.436	25.9	3	86.1	8.08
23/10/1996	2.0	44.78	25.9	3	86.8	8.07
23/10/1996	4.0	45.172	25.9	4	86.1	8.07
23/10/1996	6.0	46.522	26.1	3	86.3	8.09
20/11/1996	0.2	53	29.29	0	82.5	7.67
20/11/1996	2.0	53.1	29.3	0	83.4	7.67
20/11/1996	4.0	53.2	29.34	0	83.2	7.68
20/11/1996	5.5	53.4	29.37	1	82.3	7.67
11/12/1996	0.2	49.672	30.8	8	97	8.13
11/12/1996	2.0	49.964	30.8	12	96.7	8.13
11/12/1996	4.0	49.988	30.8	10	95.5	8.12

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
11/12/1996	6.0	50.032	30.8	27	95.4	8.12
11/12/1996	7.0	50.216	30.9	29	93.8	8.12
22/01/1997	0.2	51.3	27.96	16	79.2	7.63
22/01/1997	2.0	51.4	27.93	16	77.6	7.63
22/01/1997	4.0	51.5	27.93	24	78.6	7.63
19/02/1997	0.2	54.324	31.7	13	90.4	8.13
19/02/1997	2.0	54.39	31.7	18	88.6	8.14
19/02/1997	4.0	54.39	31.7	20	87.7	8.13
19/02/1997	6.0	54.344	31.7	21	87.1	8.13
19/02/1997	7.0	54.368	31.7	27	87.3	8.13
12/03/1997	0.2	51.4	26.9	33	87.9	8
12/03/1997	10.0	51.9	27.1	33	87	8
12/03/1997	2.0	51.6	26.9	32	86.7	8
12/03/1997	4.0	51.8	27	33	87	8
12/03/1997	6.0	51.7	27	38	87.2	8
12/03/1997	8.0	51.8	27	33	87.9	8
9/04/1997	0.2	48.968	27.2	10	83.7	8.08
9/04/1997	2.0	49.074	27	12	82.3	8.08
9/04/1997	4.0	49.1	27	17	82.3	8.08
9/04/1997	6.0	49.266	27	27	82.1	8.08
9/04/1997	8.0	49.266	27	36	82.3	8.08
14/05/1997	0.2	48.486	23.1	3	80.4	8.07
14/05/1997	2.0	48.51	23.1	3	79.9	8.06
14/05/1997	4.0	49.196	23.3	3	79.4	8.07
14/05/1997	6.0	50.008	23.5	3	80	8.08
4/06/1997	0.2	45.7	23.02	5	84.4	7.79
4/06/1997	2.0	46	22.91	5	81.9	7.79
4/06/1997	4.0	46.2	22.97	6	81.7	7.8
4/06/1997	4.5	46.3	23.06	7	82.3	7.8
16/07/1997	0.2	49	21.17	0	90.1	7.82
16/07/1997	2.0	49.4	21.22	0	89	7.83
20/08/1997	0.2	53.712	22.6	13	85.3	8.04
20/08/1997	2.0	53.998	22.7	17	85.9	8.05
20/08/1997	4.0	53.79	22.6	28	84.9	8.04
20/08/1997	5.5	54.154	22.7	24	86.4	8.05
30/09/1997	0.2	54.1	27.31	23	84.9	7.85
30/09/1997	2.0	54.2	27.32	29	83.1	7.86
30/09/1997	4.0	54.2	27.32	30	83.7	7.86
30/09/1997	6.0	54.2	27.34	41	82.5	7.86
28/10/1997	0.2	55.1	26.51	5	89.4	7.82
28/10/1997	2.0	55.2	26.44	5	88.4	7.82
28/10/1997	4.0	55.2	26.44	8	87.7	7.82
28/10/1997	5.0	55.3	26.49	9	88.1	7.82
26/11/1997	0.2	57.2	29.32	7	90	7.78
26/11/1997	2.0	57.2	29.31	6	89.4	7.78
26/11/1997	4.0	57.2	29.32	9	88.9	7.78
26/11/1997	6.0	57.3	29.32	10	88.3	7.78
11/12/1997	0.2	56.9	31.19	36	84.5	7.76
11/12/1997	2.0	58.3	31.29	40	83.4	7.75
11/12/1997	4.0	58.3	31.3	51	83.8	7.76
11/12/1997	5.5	58.3	31.32	51	83.8	7.76
8/01/1998	0.2	58.1	29.46	50	89.6	7.7

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
8/01/1998	2.0	58	29.45	53	88.2	7.7
8/01/1998	4.0	58	29.45	54	87.9	7.7
8/01/1998	6.0	58.1	29.45	56	87.7	7.7
5/02/1998	0.2	53.9	33.24	2	134.6	8.01
5/02/1998	2.0	54.4	33.23	2	133.8	8.01
5/02/1998	4.0	55.9	33.2	4	122.4	7.98
5/02/1998	6.0	56.6	33.2	10	111.4	7.94
5/02/1998	7.0	56.7	33.21	20	108.5	7.94
11/03/1998	0.2	55.4	31.84	58	97.1	7.93
11/03/1998	2.0	55.5	31.88	57	95.5	7.93
11/03/1998	4.0	55.5	31.89	68	94.8	7.93
11/03/1998	6.0	55.7	31.93	82	92.3	7.93
8/04/1998	0.2	57.9	28.45	26	97.5	7.85
8/04/1998	2.0	58	28.34	30	95.9	7.84
8/04/1998	4.0	58	28.34	36	94.3	7.85
8/04/1998	6.0	58.1	28.35	38	94.3	7.85
22/05/1998	0.2	58.7	23.49	15	96	7.71
22/05/1998	2.0	58.7	23.49	18	94.5	7.71
22/05/1998	4.0	58.7	23.48	21	92.2	7.71
22/05/1998	6.0	58.7	23.5	21	92.3	7.71
22/05/1998	7.0	58.7	23.54	24	92.4	7.71
24/06/1998	0.2	54.8	23.15	27	87.9	7.81
24/06/1998	2.0	55	23.18	28	96	7.82
24/06/1998	4.0	55.1	23.12	33	92.7	7.82
24/06/1998	6.0	55.1	23.11	35	95	7.82
22/07/1998	0.2	46.2	23.86	10	84.2	7.76
22/07/1998	2.0	46.3	23.83	10	91.7	7.76
22/07/1998	4.0	46.3	23.85	11	90.2	7.76
22/07/1998	6.0	46.3	23.87	11	79.9	7.77
21/08/1998	0.2	55.7	25.06	17	96.9	7.69
21/08/1998	2.0	55.8	24.98	16	94.5	7.69
21/08/1998	4.0	55.8	24.92	21	94.5	7.68
21/08/1998	5.0	55.7	24.93	23	86.2	7.68
18/09/1998	0.2	38.9	26.11	32	87.2	7.88
18/09/1998	2.0	41.1	26.31	35	85.5	7.89
18/09/1998	4.0	43	26.54	43	87.3	7.91
18/09/1998	5.5	44.6	26.73	61	87.3	7.92
19/10/1998	0.2	50.7	30.06	12	96.2	7.88
19/10/1998	2.0	50.8	30.07	16	92.6	7.88
19/10/1998	4.0	50.9	30.05	18	92.8	7.88
19/10/1998	6.0	50.9	30.05	24	92.4	7.88
18/11/1998	0.2	50.9	30.42	0	101.1	7.93
18/11/1998	2.0	51	30.4	2	100.3	7.93
18/11/1998	4.0	51.1	30.4	4	99.2	7.93
18/11/1998	5.5	51.1	30.41	4	99.3	7.93
16/12/1998	0.2	46.8	30.35	0	102.4	7.89
16/12/1998	2.0	47.1	30.16	0	99.4	7.89
16/12/1998	4.0	47.6	30.13	1	98.1	7.88
16/12/1998	5.0	48.7	30.21	1	94.8	7.88
13/01/1999	0.2	37.4	32.57	2	102.7	7.75
13/01/1999	2.0	42.7	32.82	4	94.3	7.73
13/01/1999	4.0	45.1	33.28	7	93.4	7.73

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
13/01/1999	5.5	45.6	33.4	7	93.6	7.74
12/02/1999	0.2	47.2	30.83	0	95	7.62
12/02/1999	2.0	47.4	30.85	0	92.5	7.62
12/02/1999	4.0	48.1	30.88	2	91.3	7.62
12/02/1999	5.0	48.7	30.9	3	91.6	7.63
17/03/1999	0.2	49.4	31.85	43	95.7	7.76
17/03/1999	2.0	49.5	31.84	44	93.9	7.76
17/03/1999	4.0	49.6	31.81	67	93.4	7.75
17/03/1999	6.0	49.5	31.82	65	94.7	7.75
14/04/1999	0.2	53.6	27.16	3	92.3	7.93
14/04/1999	2.0	53.6	27.13	3	91	7.93
14/04/1999	4.0	53.7	27.12	4	92.1	7.93
26/05/1999	0.2	52.2	23.77	9	101.8	7.83
26/05/1999	2.0	52.2	23.76	10	101.4	7.83
26/05/1999	4.0	52.2	23.77	10	101	7.83
26/05/1999	6.0	52.3	23.82	12	101.3	7.83
28/06/1999	0.2	54.1	20.49	14	96.1	7.89
28/06/1999	2.0	54	20.32	1	96.9	7.89
28/06/1999	4.0	53.9	20.31	2	96.3	7.9
28/06/1999	6.0	53.9	20.31	2	94.4	7.9
28/06/1999	7.0	54	20.32	3	95.2	7.9
28/07/1999	0.2	54.2	20.59	4	95.5	7.86
28/07/1999	2.0	54.4	20.61	2	96	7.86
28/07/1999	4.0	54.4	20.62	2	96.3	7.86
28/07/1999	6.0	54.3	20.63	3	96.3	7.86
25/08/1999	0.2	54.9	22.36	4	93.1	7.8
25/08/1999	2.0	54.9	22.39	4	93	7.81
25/08/1999	4.0	55	22.36	4	94.3	7.81
25/08/1999	5.0	54.9	22.35	5	93.5	7.81
28/09/1999	0.2	56	25.56	5	94.4	7.78
28/09/1999	2.0	56	25.51	1	93.7	7.78
28/09/1999	4.0	56.1	25.45	1	92.3	7.78
28/09/1999	5.5	56.1	25.32	1	92.4	7.78
13/10/1999	0.2	56	28.32	2	96.3	8.02
13/10/1999	2.0	56	28.17	2	94	8.01
13/10/1999	4.0	56	28.11	10	92.5	8.01
13/10/1999	6.0	56	28.06	9	91.6	8.01
13/10/1999	7.0	56	28.04	8	91.2	8
10/11/1999	0.2	24.2	27	13	79.6	7.82
10/11/1999	2.0	30.1	26.86	16	77.7	7.82
10/11/1999	4.0	40.3	27.83	11	81.4	7.88
10/11/1999	5.5	41.2	27.97	15	80.7	7.89
8/12/1999	0.2	53.6	29.1	21	95.1	7.98
8/12/1999	2.0	53.8	29.08	20	94.9	7.98
8/12/1999	4.0	53.6	29.08	26	95	7.98
8/12/1999	6.0	53.2	29.08	30	94.5	7.98
10/01/2000	0.2	47.6	31.34	31	95.5	7.8
10/01/2000	2.0	48.5	31.38	37	92.6	7.8
10/01/2000	4.0	48.6	31.41	5	91.1	7.79
10/01/2000	6.0	48.3	31.38	4	90.6	7.79
10/01/2000	7.0	48.1	31.38	5	90.4	7.79
9/02/2000	0.2	55.1	30.25	9	96.2	8.11

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
9/02/2000	2.0	55.3	30.22	9	96.1	8.1
9/02/2000	4.0	55	30.09	9	92.6	8.09
9/02/2000	6.0	54.5	29.98	9	91.1	8.08
9/02/2000	7.0	53.9	29.95	10	90.4	8.08
9/03/2000	0.2	52.638	32	54	89.1	7.95
9/03/2000	2.0	52.614	32	56	89.7	7.94
9/03/2000	4.0	52.704	31.9	67	90.6	7.94
9/03/2000	6.0	52.704	31.9	73	90.1	7.94
4/04/2000	0.2	55.8	30.17	5	91.4	7.71
4/04/2000	2.0	55.8	30.17	6	89.5	7.71
4/04/2000	4.0	55.5	30.2	9	89.6	7.71
4/04/2000	5.0	55.2	30.31	16	89.8	7.71
19/05/2000	0.2	56.8	24.84	4	95.7	7.79
19/05/2000	2.0	56.9	24.87	4	94	7.8
19/05/2000	4.0	56.8	24.88	6	92	7.8
16/08/2000	0.2	52.8	22.91	8	96.8	8.05
16/08/2000	2.0	52.8	22.94	5	96.5	8.06
16/08/2000	4.0	52.6	22.86	6	95.6	8.06
16/08/2000	6.0	52.2	22.77	5	94.9	8.05
16/08/2000	7.0	51.4	22.78	13	84.7	8.05
15/09/2000	0.2	55.2	26.83	9	96.5	8.02
15/09/2000	2.0	55.4	26.77	13	95.9	8.02
15/09/2000	4.0	55.4	26.74	11	95	8.02
15/09/2000	6.0	55	26.69	15	94.7	8.02
15/09/2000	8.0	54.7	26.67	4	94.5	8.02
13/10/2000	0.2	56.6	28.08	4	92.7	7.95
13/10/2000	2.0	56.7	28.11	5	92.5	7.95
13/10/2000	4.0	56.7	28.02	4	92.2	7.95
13/10/2000	6.0	56.3	27.98	4	92	7.95
13/10/2000	8.0	55.9	27.93	6	91.6	7.95
13/11/2000	0.2	33.3	27.31	6	73.3	7.61
13/11/2000	2.0	35.4	27.26	9	74.1	7.64
13/11/2000	4.0	36.3	27.28	6	74.4	7.65
13/11/2000	6.0	37.1	27.3	3	75.4	7.66
13/12/2000	0.2	48.456	31.15	3	92	7.83
13/12/2000	2.0	48.488	31.15	6	91.7	7.83
13/12/2000	4.0	48.639	31.18	6	91.6	7.83
13/12/2000	6.0	48.649	31.19	48	91.6	7.83
21/02/2001	0.2	49.4	30	48	92.6	8
21/02/2001	2.0	49.5	30	51	92.4	8
21/02/2001	4.0	49.9	30	53	90.5	8
21/02/2001	6.0	50.6	30.1	4	89.9	8
22/03/2001	0.2	43.8	31.3	4	101.1	7.8
22/03/2001	2.0	44.8	31.3	4	99.5	7.8
22/03/2001	4.0	46.5	31.6	4	91	7.8
22/03/2001	5.0	48	31.9	5	90	7.8
20/04/2001	0.2	51.8	26.6	11	91.3	8
20/04/2001	2.0	52.1	26.59	16	90.2	8
20/04/2001	4.0	52.2	26.7	16	89.8	8
20/04/2001	5.0	52.4	26.73	20	89.8	8
23/05/2001	0.2	55.418	24.7	17	105.6	8.09
23/05/2001	2.0	55.896	24.7	13	105	8.09

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
23/05/2001	4.0	55.846	24.7	17	102.2	8.09
23/05/2001	6.0	56.02	24.7	18	100.9	8.09
14/06/2001	0.2	54.247	22.64	12	99.8	7.98
14/06/2001	2.0	54.212	22.44	11	98.5	7.97
14/06/2001	4.0	54.38	22.27	11	105.8	7.97
14/06/2001	6.0	54.461	22.27	11	105.1	7.97
14/06/2001	8.0	54.694	22.36	15	104.6	7.96
14/06/2001	9.5	54.903	22.5	8	97.3581	7.96
4/07/2001	0.2	53.008	20.79	7	97.7685	8.11
4/07/2001	2.0	53.066	20.82	7	96.4042	8.08
4/07/2001	4.0	53.122	20.9	5	96.8424	8.07
8/08/2001	0.2	55.624	24.2	4	84.5	8.07
8/08/2001	2.0	55.696	23.9	4	85.5	8.06
8/08/2001	4.0	55.682	23.7	4	85	8.06
8/08/2001	6.0	55.682	23.7	6	84.1	8.06
17/10/2001	0.2	56.2	27.67	5	92	7.55
17/10/2001	2.0	56.1	27.68	4	91	7.55
17/10/2001	4.0	56	27.69	6	90.4	7.55
17/10/2001	6.0	55.4	27.69	5	90.9	7.55
21/11/2001	0.2	55.2	28.7	31	90.4	8.1
21/11/2001	2.0	55.1	28.5	32	98	8
21/11/2001	4.0	55.2	28.5	31	96.8	8
21/11/2001	6.0	55.2	28.5	32	96.2	8
21/11/2001	8.0	55.2	28.4	34	94.8	8
19/12/2001	0.2	55.106	30.59	41	94.4	7.95
19/12/2001	2.0	55.106	30.6	45	88.1	7.95
19/12/2001	4.0	55.096	30.59	46	87.9	7.95
19/12/2001	6.0	55.08	30.54	47	87.9	7.94
19/12/2001	8.0	55.07	30.54	33	86.2	7.94
30/01/2002	0.2	52.9	32.13	49	101.7	7.84
30/01/2002	2.0	53.1	32.14	57	100.3	7.83
30/01/2002	4.0	53	32.13	26	100.3	7.83
30/01/2002	6.0	52.7	32.04	31	98.5	7.83
15/05/2002	0.2	55.552	24.67	33	98.5	8.07
15/05/2002	2.0	55.556	24.63	38	98.3	8.07
15/05/2002	4.0	55.551	24.63	70	98.2	8.06
13/06/2002	0.2	52.549	22.61	74	98.2	8.19
13/06/2002	2.0	52.541	22.59	85	85.5	8.19
13/06/2002	4.0	52.551	22.57	93	86.6	8.19
13/06/2002	6.0	52.557	22.61	99	85.8	8.19
13/06/2002	8.0	52.557	22.65	29	85.1	8.19
10/07/2002	0.2	53.666	19.47	30	103.1	8.32
10/07/2002	2.0	53.677	19.44	32	101.4	8.32
10/07/2002	4.0	53.669	19.41	34	100.3	8.32
10/07/2002	6.0	53.635	19.27	8	100.2	8.32
7/08/2002	0.2	54.47	21.58	8	104.6	8
7/08/2002	2.0	54.462	21.53	7	104.1	7.99
7/08/2002	4.0	54.48	21.5	8	103.5	7.99
7/08/2002	6.0	54.481	21.53	11	102.7	7.99
4/09/2002	0.2	54.751	23.21	9	96.8	8.11
4/09/2002	2.0	54.712	23.15	6	96.6	8.12
4/09/2002	4.0	54.713	22.98	6	96.5	8.12

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
4/09/2002	5.5	54.684	22.84	6	96.4	8.11
9/10/2002	0.2	54.399	28.71	6	96.4	8.07
9/10/2002	2.0	54.401	28.69	7	97.2	8.07
9/10/2002	4.0	54.393	28.69	20	95.7	8.07
9/10/2002	6.0	54.395	28.68	20	95.3	8.07
9/10/2002	7.0	54.397	28.67	22	95	8.07
6/11/2002	0.2	57.086	30.33	19	93.3	8.08
6/11/2002	2.0	57.121	30.25	23	91	8.08
6/11/2002	4.0	57.087	30.23	8	90	8.08
6/11/2002	6.0	57.089	30.22	8	92.8	8.08
4/12/2002	0.2	59.018	31.59	9	92.7	8
4/12/2002	2.0	58.977	31.42	9	92.5	8
4/12/2002	4.0	59.042	31.31	10	92	8
22/01/2003	0.2	58.354	32.33	5	107.5	8.09
22/01/2003	2.0	58.323	32.32	5	104.9	8.09
22/01/2003	4.0	58.318	32.27	5	102.6	8.09
22/01/2003	6.0	58.328	32.29	5	102.3	8.1
19/02/2003	0.2	33.932	32.22	8	103	8.33
19/02/2003	2.0	34.597	32.19	6	108.2	8.31
19/02/2003	4.0	34.952	32.16	7	104.7	8.3
19/02/2003	6.0	34.863	32.17	8	102	8.31
19/02/2003	7.0	34.807	32.18	9	100.7	8.31
19/03/2003	0.2	43.448	29.03	10	101.5	8.17
19/03/2003	2.0	43.6	29.05	11	100.7	8.17
19/03/2003	4.0	43.598	29.05	16	99.9	8.17
19/03/2003	6.0	43.614	29.06	191	99.2	8.17
31/07/2003	0.2	54.309	20	142	98.4	8.01
31/07/2003	2.0	54.305	19.99	208	97.1	8.01
31/07/2003	4.0	54.319	20	192	102.2	8.01
31/07/2003	6.0	54.335	20.01	161	101.8	8
31/07/2003	8.0	54.352	20.02	141	101.6	8.01
31/07/2003	9.5	54.34	20.03	10	101.3	8
27/08/2003	0.2	50.202	22.59	12	101.2	7.94
27/08/2003	2.0	50.203	22.58	12	100.6	7.94
27/08/2003	4.0	50.207	22.58	12	97.7	7.93
27/08/2003	6.0	50.202	22.59	13	94.9	7.93
27/08/2003	8.0	50.228	22.59	19	96.2	7.93
24/09/2003	0.2	53.362	26.49	16	94.6	7.92
24/09/2003	2.0	53.355	26.5	18	99	7.92
24/09/2003	4.0	53.336	26.46	7	99	7.91
24/09/2003	6.0	53.332	26.46	7	98.8	7.91
24/09/2003	8.0	53.344	26.47	9	99	7.91
22/10/2003	0.2	51.164	27.14	8	98.9	7.94
22/10/2003	2.0	51.24	27.16	6	92.6	7.94
22/10/2003	4.0	51.226	27.16	5	92	7.94
22/10/2003	6.0	51.299	27.2	8	91.9	7.94
22/10/2003	8.0	51.306	27.2	6	91.6	7.94
19/11/2003	0.2	51.142	28.29	6	77.7	7.94
19/11/2003	2.0	51.156	28.27	9	78.9	7.94
19/11/2003	4.0	51.256	28.3	9	81.5	7.94
19/11/2003	5.5	51.288	28.3	15	86.9	7.94
17/12/2003	0.2	32.206	30.16	12	82	7.81

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
17/12/2003	2.0	41.391	31.75	13	83.3	7.88
17/12/2003	4.0	43.448	32.01	16	83.6	7.91
17/12/2003	6.0	43.796	32.49	14	86.4	7.94
14/01/2004	0.2	34.062	32.62	5	69.1	7.71
14/01/2004	2.0	36.264	32.93	6	70.3	7.73
14/01/2004	4.0	37.958	33.09	5	67.1	7.74
14/01/2004	6.0	41.198	33.69	5	66.6	7.78
4/02/2004	0.2	2.096	26.8	38	68.4	7.72
4/02/2004	10.0	13.727	28.19	43	69.5	7.23
4/02/2004	2.0	2.445	26.81	46	86.9	7.52
4/02/2004	4.0	6.363	27.09	49	84.9	7.24
4/02/2004	6.0	12.957	27.75	34	84.8	7.12
4/02/2004	8.0	14.069	28.11	36	85.6	7.14
3/03/2004	0.2	38.466	31.52	36	96.8	7.92
3/03/2004	2.0	38.96	31.53	36	96.2	7.92
3/03/2004	4.0	40.926	31.46	40	95.4	7.95
3/03/2004	5.5	41.808	31.44	13	94.9	7.96
21/04/2004	0.2	51.997	28.24	14	96.5	7.97
21/04/2004	2.0	52.08	28.23	13	96.1	7.97
21/04/2004	4.0	52.187	28.27	14	97.4	7.96
21/04/2004	6.0	52.564	28.45	15	95.1	7.97
19/05/2004	0.2	53.381	24.37	17	94.8	8.06
19/05/2004	2.0	53.359	24.37	23	93.7	8.03
19/05/2004	4.0	53.35	24.37	26	93.3	8.03
19/05/2004	6.0	53.35	24.36	7	93	8.03
23/06/2004	0.2	55.677	20.25	9	92.8	8.02
23/06/2004	2.0	55.662	20.24	9	92.6	8
23/06/2004	4.0	55.645	20.26	9	96.5	7.99
23/06/2004	6.0	55.666	20.22	8	95.1	7.99
23/06/2004	8.0	55.653	20.23	11	96.2	7.99
23/06/2004	9.5	55.652	20.22	15	95.8	7.99
21/07/2004	0.2	56.161	22.59	9	95.7	8.04
21/07/2004	10.0	56.122	22.4	11	95.4	8.03
21/07/2004	2.0	56.16	22.6	13	94.3	8.03
21/07/2004	4.0	56.163	22.54	14	93.4	8.03
21/07/2004	6.0	56.159	22.54	13	92.2	8.03
21/07/2004	8.0	56.14	22.46	22	92	8.03
25/08/2004	0.2	54.619	20.84	19	94.6	7.93
25/08/2004	2.0	54.654	20.78	16	94.2	7.92
25/08/2004	4.0	54.654	20.74	20	93.7	7.92
25/08/2004	5.5	54.638	20.74	23	93.6	7.92
29/09/2004	0.2	56.3	27	31	90.5	7.8
29/09/2004	2.0	56.3	26.9	31	89.9	7.8
29/09/2004	4.0	56.3	26.9	26	89.6	7.8
29/09/2004	6.0	56.3	26.9	21	89.4	7.8
28/10/2004	0.2	55.476	31.31	21	89.3	8.1
28/10/2004	2.0	55.478	31.31	6	96.7	8.1
28/10/2004	4.0	55.484	31.32	6	96.2	8.1
28/10/2004	6.0	55.482	31.33	7	96	8.1
28/10/2004	8.0	55.482	31.32	7	95.8	8.1
17/11/2004	0.2	57.05	32.35	10	98.8	8.21
17/11/2004	2.0	57.052	32.31	10	96.1	8.21

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
17/11/2004	4.0	57.076	32.2	9	95.6	8.21
17/11/2004	6.0	57.086	32.19	9	96.6	8.21
15/12/2004	0.2	45.407	31.97	8	101.2	8.18
15/12/2004	2.0	46.456	32.1	6	100.3	8.16
15/12/2004	4.0	47.456	32.14	6	98.6	8.17
15/12/2004	5.0	47.384	32.13	6	97.7	8.17
22/02/2005	0.2	46.95	31.43	4	97.9	7.95
22/02/2005	2.0	47.329	31.43	4	97.6	7.94
22/02/2005	4.0	47.616	31.39	4	97.2	7.94
22/02/2005	6.0	47.991	31.41	5	103.3	7.94
21/03/2005	0.2	49.53	29.74	7	104.8	7.97
21/03/2005	2.0	49.66	29.66	14	105.1	7.97
21/03/2005	4.0	49.742	29.66	18	105	7.97
20/04/2005	0.2	53.508	27.68	24	104.8	7.98
20/04/2005	2.0	53.5	27.69	15	98	7.98
20/04/2005	4.0	53.499	27.67	15	96.9	7.98
20/04/2005	6.0	53.499	27.67	15	96.4	7.97
20/04/2005	8.0	53.481	27.67	18	96	7.97
24/05/2005	0.2	55.142	22.31	18	95.7	8.06
24/05/2005	2.0	55.145	22.31	23	95.9	8.05
24/05/2005	4.0	55.134	22.3	5	95.4	8.05
24/05/2005	6.0	55.14	22.29	5	95.1	8.05
24/05/2005	7.5	55.144	22.29	5	95	8.05
22/06/2005	0.2	53.697	21.7	7	94.8	8.07
22/06/2005	2.0	53.754	21.71	6	97.4	8.06
22/06/2005	4.0	53.741	21.71	46	96.6	8.05
22/06/2005	6.0	53.715	21.71	55	96.4	8.05
22/06/2005	8.0	53.707	21.7	62	96.2	8.04
19/07/2005	0.2	55.561	20.8	63	99.6	8.13
19/07/2005	2.0	55.659	20.78	66	98.9	8.12
19/07/2005	4.0	55.624	20.8		98.3	8.12
19/07/2005	6.0	55.674	20.9		98	8.11
17/08/2005	0.2	55.054	20.78		97.8	7.99
17/08/2005	2.0	55.114	20.79		95.1	7.96
17/08/2005	4.0	55.059	20.81		93.5	7.94
17/08/2005	6.0	55.075	20.81		92.8	7.94
17/08/2005	8.0	55.107	20.89		100.4	7.94
26/10/2005	0.2	56.837	28.18		98.7	7.86
26/10/2005	2.0	56.831	28.09		97.4	7.85
26/10/2005	4.0	56.827	28.08		95	7.85
24/11/2005	0.2	57.621	30.43		93.8	7.99
24/11/2005	2.0	57.623	30.26		102.5	7.98
24/11/2005	4.0	57.599	30.16		101.4	7.98
24/11/2005	6.0	57.651	29.92		101.3	7.96
24/11/2005	8.0	57.636	29.85		122.8	7.96
21/12/2005	0.2	55.672	34.05		120.3	7.96
21/12/2005	2.0	56.024	34.24		119.8	7.96
21/12/2005	4.0	56.306	34.48		118	7.96
19/01/2006	0.2	49.844	33.61		116.6	7.98
19/01/2006	2.0	49.874	33.61		114.9	7.98
19/01/2006	4.0	49.896	33.61		115.6	7.98
19/01/2006	6.0	49.905	33.6		113.5	7.98

Date	Depth (m)	Conductivity at 25 deg C mS/cm	Temperature deg C	Turbidity NTU	Oxygen per cent saturation %	pH
19/01/2006	8.0	49.917	33.58		109.7	7.98
19/01/2006	9.0	49.922	33.55		107.9	7.97
22/02/2006	0.2	48.15	30.91		106.6	8.04
22/02/2006	2.0	48.263	30.95		100.4	8.04
22/02/2006	4.0	48.761	31.13		100.4	8.04
22/02/2006	6.0	49.011	31.22		100.2	8.05
22/02/2006	8.0	49.099	31.25		100	8.05
28/03/2006	0.2	56.093	28.3		99.8	7.99
28/03/2006	2.0	56.083	28.25			7.99
28/03/2006	4.0	56.095	28.24			7.99
28/03/2006	6.0	56.101	28.24			7.99
28/03/2006	8.0	56.111	28.25			7.99

APPENDIX C: CONNELL HATCH WATER QUALITY DATA (2006)

Appendix I3 Connell Hatch Water Quality Data

Site 1

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Physical Parameters					
Dissolved oxygen (%)	0.2	93.00	102.40	103.20	106.40
	2.0	96.00	97.10	109.30	105.20
	4.0		95.70		
Conductivity (mS/cm)	0.2	56.00	54.50	56.40	56.90
	2.0	55.30	54.70	56.10	56.80
	4.0		54.80		
pH	0.2	8.03	8.25	7.91	7.60
	2.0		6.58	7.92	7.62
	4.0		6.52		
Turbidity (NTU)	0.2	12.00	4.20	18.00	15.00
	2.0	10.00	7.70		
	4.0		7.40		
Temperature (oC)	0.2	22.00	22.80	21.66	21.50
	2.0	22.00	22.70	21.75	21.57
	4.0		22.70		
Suspended Solids (mg/L)		32.00	32.00	54.00	59.00
Dissolved Metals by ICP-MS (ug/L)					
Aluminium		20	20	120	50
Arsenic		<50	<50	50	50
Cadmium		<0.1	<0.1	0.8	0.5
Chromium		3	3	5	5
Copper		<50	<50	50	5
Lead		<1	<1	5	5
Manganese		3	3	21	5
Zinc		<50	<50	50	5
Total Metals by ICP-MS (ug/L)					
Aluminium		690	510	1450	920
Arsenic		<50	<50	50	50
Cadmium		<0.1	<0.1	0.5	0.5
Chromium		3	3	5	5
Copper		<50	<50	50	50
Lead		1	1	5	5
Manganese		14	17	22	14
Zinc		<50	<50	50	50
Dissolved Mercury		<0.1	<0.1	0.1	0.1

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Total Mercury		<0.1	<0.1	0.1	0.1
Nutrients (ug/L)					
Ammonia as N		50	50		32
Nitrite + Nitrate as N		40	40	19	21
Total Kjeldahl Nitrogen as N		<100	<100	200	100
Total Nitrogen as N		<100	<100	200	100
Total Phosphorous		20	40	60	150
Reactive Phosphorous		<10	16	10	10
Chlorophyll a		<5	<5	<5	5
Organochlorine Pesticides (OC) (ug/L)					
alpha-BHC		<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene		<0.5	<0.5	<0.5	<0.5
beta-BHC		<0.5	<0.5	<0.5	<0.5
gamma-BHC		<0.5	<0.5	<0.5	<0.5
delta-BHC		<0.5	<0.5	<0.5	<0.5
Heptachlor		<0.5	<0.5	<0.5	<0.5
Aldrin		<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide		<0.5	<0.5	<0.5	<0.5
trans-Chlordane		<0.5	<0.5	<0.5	<0.5
Dieldrin		<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5
Endrin		<0.5	<0.5	<0.5	<0.5
beta-Endosulfan		<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5
Endrin aldehyde		<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate		<0.5	<0.5	<0.5	<0.5
4.4'-DDT		<2	<2	<2	<2
Endrin ketone		<0.5	<0.5	<0.5	<0.5
Methoxychlor		<2	<2	<2	<2
Organophosphorous Pesticides (OP) (ug/L)					
Dichlorvos		<0.5	<0.5	<0.5	<0.5
Demeton-methyl		<0.5	<0.5	<0.5	<0.5
Monocroptophos		<2	<2	<2	<2
Dimethoate		<0.5	<0.5	<0.5	<0.5
Diazinon		<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl		<0.5	<0.5	<0.5	<0.5
Parathion-methyl		<2	<2	<2	<2
Malathion		<0.5	<0.5	<0.5	<0.5
Fenthion		<0.5	<0.5	<0.5	<0.5

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Chlorpyfiros		<0.5	<0.5	<0.5	<0.5
Parathion		<2	<2	<2	<2
Pirimphos-ethyl		<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos		<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl		<0.5	<0.5	<0.5	<0.5
Fenamiphos		<0.5	<0.5	<0.5	<0.5
Prothiofos		<0.5	<0.5	<0.5	<0.5
Ethion		<0.5	<0.5	<0.5	<0.5
Carbophenothion		<0.5	<0.5	<0.5	<0.5
Azinophos Methyl		<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons (ug/L)					
C6-C6 Fraction		<20	<20	<20	<20
C10-C14 Fraction		<50	<50	<50	<50
C15-C28 Fraction		<100	<100	<100	<100
C29-C36 Fraction		<50	<50	<50	<50
BTEX (ug/L)					
Benzene		<1	<1	<1	<1
Toluene		<2	<2	<2	<2
Ethylbenzene		<2	<2	<2	<2
meta- & para-Xylene		<2	<2	<2	<2
ortho-Xylene		<2	<2	<2	<2
Organochlorine Pesticide Surrogate (%)					
Dibromo-DDE		82.7	72.7	91.3	55.7
Organophosphorous Pesticide Surrogate (%)					
DEF		86.1	68.3	91.1	56.1
TPH (V)/BTEX Surrogates (%)					
1.2-Dichloroethane-D4		100.0	106.0	113	101
Toluene-D8		95.5	108.0	107	96.5
4-Bromofluorobenzene		87.3	105.0	89.5	97.6

Site 2

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Physical Parameters					
Dissolved oxygen (%)	0.2	97.40	97.10	103.20	107.60
	2.0	95.10	93.40	102.30	106.40
	4.0				
Conductivity (mS/cm)	0.2	56.60	55.00	56.80	56.30
	2.0	55.40	54.70	56.20	56.70
	4.0				
pH	0.2	8.08	6.49	7.90	7.61
	2.0		5.65	7.90	7.65
	4.0				
Turbidity (NTU)	0.2	10.00	4.90	16.00	19.00
	2.0	11.00	4.80		
	4.0				
Temperature (oC)	0.2	22.00	22.70	21.73	21.40
	2.0	22.30	22.80	21.79	21.55
	4.0				
Suspended Solids (mg/L)		38.00	21.00	56.00	42.00
Dissolved Metals by ICP-MS (ug/L)					
Aluminium		10	10	100	50
Arsenic		<50	<50	50	50
Cadmium		<0.1	<0.1	0.7	0.5
Chromium		2	2	6	5
Copper		<50	<50	50	50
Lead		<1	<1	5	5
Manganese		2	2	17	5
Zinc		<50	<50	50	50
Total Metals by ICP-MS (ug/L)					
Aluminium		2320	4870	1130	910
Arsenic		<50	<50	50	50
Cadmium		<0.1	<0.1	0.5	0.5
Chromium		4	5	5	5
Copper		<50	<50	50	50
Lead		<2	<7	5	5
Manganese		16	8	20	14
Zinc		<50	<50	50	50
Dissolved Mercury		<0.1	<0.1	0.1	0.1
Total Mercury		<0.1	<0.1	0.1	0.1
Nutrients (ug/L)					

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Ammonia as N		30	50		36
Nitrite + Nitrate as N		20	20	18	25
Total Kjeldahl Nitrogen as N		<100	1500	200	100
Total Nitrogen as N		<100	1500	300	100
Total Phosphorous		40	50	60	320
Reactive Phosphorous		<10	27	10	10
Chlorophyll a		<5	<5	<5	<5
Organochlorine Pesticides (OC) (ug/L)					
alpha-BHC		0.5	0.5	<0.5	<0.5
Hexachlorobenzene (HCB)		0.5	0.5	<0.5	<0.5
beta-BHC		0.5	0.5	<0.5	<0.5
gamma-BHC		0.5	0.5	<0.5	<0.5
delta-BHC		0.5	0.5	<0.5	<0.5
Heptachlor		0.5	0.5	<0.5	<0.5
Aldrin		0.5	0.5	<0.5	<0.5
Heptachlor epoxide		0.5	0.5	<0.5	<0.5
trans-Chlordane		0.5	0.5	<0.5	<0.5
Dieldrin		0.5	0.5	<0.5	<0.5
4.4'-DDD		0.5	0.5	<0.5	<0.5
Endrin		0.5	0.5	<0.5	<0.5
beta-Endosulfan		0.5	0.5	<0.5	<0.5
4.4'-DDD		0.5	0.5	<0.5	<0.5
Endrin aldehyde		0.5	0.5	<0.5	<0.5
Endosulfan sulfate		0.5	0.5	<0.5	<0.5
4.4'-DDT		<2	<2	<2	<2
Endrin ketone		<0.5	<0.5	<0.5	<0.5
Methoxychlor		<2	<2	<2	<2
Organophosphorous Pesticides (OP) (ug/L)					
Dichlorvos		<0.5	<0.5	<0.5	<0.5
Demeton-methyl		<0.5	<0.5	<0.5	<0.5
Monocroptophos		<2	<2	<2	<2
Dimethoate		<0.5	<0.5	<0.5	<0.5
Diazinon		<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl		<0.5	<0.5	<0.5	<0.5
Parathion-methyl		<2	<2	<2	<2
Malathion		<0.5	<0.5	<0.5	<0.5
Fenthion		<0.5	<0.5	<0.5	<0.5
Chlorpyfiros		<0.5	<0.5	<0.5	<0.5
Parathion		<2	<2	<2	<2

	Depth	Season 1		Season 2	
		Flooding	Ebbing	Flooding	Ebbing
Pirimphos-ethyl		<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos		<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl		<0.5	<0.5	<0.5	<0.5
Fenamiphos		<0.5	<0.5	<0.5	<0.5
Prothiofos		<0.5	<0.5	<0.5	<0.5
Ethion		<0.5	<0.5	<0.5	<0.5
Carbophenothion		<0.5	<0.5	<0.5	<0.5
Azinophos Methyl		<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons (ug/L)					
C6-C6 Fraction		<20	<20	<20	<20
C10-C14 Fraction		<50	<50	<50	<50
C15-C28 Fraction		<100	<100	<100	<100
C29-C36 Fraction		<50	<50	<50	<50
BTEX (ug/L)					
Benzene		<1	<1	<1	<1
Toluene		<2	<2	<2	<2
Ethylbenzene		<2	<2	<2	<2
meta- & para-Xylene		<2	<2	<2	<2
ortho-Xylene		<2	<2	<2	<2
Organochlorine Pesticide Surrogate (%)					
Dibromo-DDE		88.3	82	130	89.3
Organophosphorous Pesticide Surrogate (%)					
DEF		84.5	78.7	128	90.3
TPH(V)/BTEX Surrogates (%)					
1.2-Dichloroethane-D4		104	107	114	91.4
Toluene-D8		93.8	105	105	98.3
4-Bromofluorobenzene		87.1	106	89.1	88.9

Site 3

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Physical Parameters					
Dissolved oxygen (%)	0.2	97.50	97.30	98.80	104.40
	2.0	96.50	97.20	100.70	105.30
	4.0	95.60	88.20	103.60	104.70
Conductivity (mS/cm)	0.2	55.80	54.70	58.00	57.00
	2.0	55.20	54.70	56.70	56.70
	4.0	54.90	54.80	56.50	56.50
pH	0.2	7.99	8.08	7.89	7.53
	2.0		5.80	7.90	7.58
	4.0		4.73	7.91	7.61
Turbidity (NTU)	0.2	10.00	4.80	20.00	13.00
	2.0	9.50	4.60		
	4.0	9.50	5.60		
Temperature (oC)	0.2	22.00	22.90	21.30	21.75
	2.0	22.30	22.80	21.40	21.80
	4.0	22.40	22.80	21.50	21.82
Suspended Solids (mg/L)		29.00	22.00	60.00	34.00
Dissolved Metals by ICP-MS (ug/L)					
Aluminium		130	20	140	50
Arsenic		<50	<50	50	50
Cadmium		<0.1	<0.1	0.6	0.5
Chromium		2	3	7	5
Copper		<50	<50	50	50
Lead		<1	<1	5	5
Manganese		11	4	23	5
Zinc		<50	<50	50	50
Total Metals by ICP-MS (ug/L)					
Aluminium		2210	840	1820	680
Arsenic		<50	<50	50	50
Cadmium		<0.1	<0.1	0.5	0.5
Chromium		4	3	5	5
Copper		<50	<50	50	50
Lead		2	<0.1	5	5
Manganese		16	7	29	10
Zinc		<50	<50	50	50
Dissolved Mercury		<0.1	<0.1	0.1	0.1
Total Mercury		<0.1	<0.1	0.1	0.1
Nutrients (ug/L)					

	Depth	Season 1 Flooding	Season 1 Ebbing	Season 2 Flooding	Season 2 Ebbing
Ammonia as N		40	40		24
Nitrite + Nitrate as N		20	20	18	21
Total Kjeldahl Nitrogen as N		800	2300	200	100
Total Nitrogen as N		900	2300	200	100
Total Phosphorous		20	60	50	60
Reactive Phosphorous		<10	<10	10	10
Chlorophyll a		<5	<5	<5	<5
Organochlorine Pesticides (OC) (ug/L)					
alpha-BHC		<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)		<0.5	<0.5	<0.5	<0.5
beta-BHC		<0.5	<0.5	<0.5	<0.5
gamma-BHC		<0.5	<0.5	<0.5	<0.5
delta-BHC		<0.5	<0.5	<0.5	<0.5
Heptachlor		<0.5	<0.5	<0.5	<0.5
Aldrin		<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide		<0.5	<0.5	<0.5	<0.5
trans-Chlordane		<0.5	<0.5	<0.5	<0.5
Dieldrin		<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5
Endrin		<0.5	<0.5	<0.5	<0.5
beta-Endosulfan		<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5
Endrin aldehyde		<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate		<0.5	<0.5	<0.5	<0.5
4.4'-DDT		<2	<2	<2	<2
Endrin ketone		<0.5	<0.5	<0.5	<0.5
Methoxychlor		<2	<2	<2	<2
Organophosphorous Pesticides (OP) (ug/L)					
Dichlorvos		<0.5	<0.5	<0.5	<0.5
Demeton-methyl		<0.5	<0.5	<0.5	<0.5
Monocroptophos		<2	<2	<2	<2
Dimethoate		<0.5	<0.5	<0.5	<0.5
Diazinon		<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl		<0.5	<0.5	<0.5	<0.5
Parathion-methyl		<2	<2	<2	<2
Malathion		<0.5	<0.5	<0.5	<0.5
Fenthion		<0.5	<0.5	<0.5	<0.5
Chlorpyfiros		<0.5	<0.5	<0.5	<0.5
Parathion		<2	<2	<2	<2

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Pirimphos-ethyl		<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos		<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl		<0.5	<0.5	<0.5	<0.5
Fenamiphos		<0.5	<0.5	<0.5	<0.5
Prothiofos		<0.5	<0.5	<0.5	<0.5
Ethion		<0.5	<0.5	<0.5	<0.5
Carbophenothion		<0.5	<0.5	<0.5	<0.5
Azinophos Methyl		<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons (ug/L)					
C6-C6 Fraction		<20	<20	<20	<20
C10-C14 Fraction		<50	<50	<50	<50
C15-C28 Fraction		<100	<100	<100	<100
C29-C36 Fraction		<50	<50	<50	<50
BTEX (ug/L)					
Benzene		<1	<1	<1	<1
Toluene		<2	<2	<2	<2
Ethylbenzene		<2	<2	<2	<2
meta- & para-Xylene		<2	<2	<2	<2
ortho-Xylene		<2	<2	<2	<2
Organochlorine Pesticide Surrogate (%)					
Dibromo-DDE		90.2	83.3	103	91.8
Organophosphorous Pesticide Surrogate (%)					
DEF		88.1	78.6	103	93.4
TPH(V)/BTEX Surrogates (%)					
1.2-Dichloroethane-D4		111	110	115	101
Toluene-D8		105	108	110	96.8
4-Bromofluorobenzene		102	103	90.1	103

Site 4

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Physical Parameters					
Dissolved oxygen (%)	0.2	97.40	90.10	103.60	109.10
	2.0	94.90	91.50	102.90	109.50
	4.0	92.70	93.90		109.20
Conductivity (mS/cm)	0.2	55.50	55.00	56.90	56.60
	2.0	54.90	54.90	56.90	56.40
	4.0	52.40	54.90		56.30
pH	0.2	7.83	7.04	7.81	7.55
	2.0	7.09	5.65	7.86	7.58
	4.0	5.07	5.80		7.69
Turbidity (NTU)	0.2	7.20	6.50	15.00	12.00
	2.0	7.30	6.10		
	4.0	7.90	5.40		
Temperature (oC)	0.2	21.90	22.60	21.40	21.88
	2.0	22.30	22.70	21.10	21.88
	4.0	22.30	22.60		21.85
Suspended Solids (mg/L)		33.00	23.00	45.00	34.00
Dissolved Metals by ICP-MS (ug/L)					
Aluminium		20	20	80	50
Arsenic		<50	<50	50	50
Cadmium		0.1	<0.1	0.5	0.5
Chromium		2	2	7	5
Copper		<50	<50	50	50
Lead		<1	<1	5	5
Manganese		4	4	13	5
Zinc		<50	<50	50	50
Total Metals by ICP-MS (ug/L)					
Aluminium		890	470	1010	580
Arsenic		<50	<50	50	50
Cadmium		<0.1	<0.1	0.5	0.5
Chromium		3	2	5	5
Copper		<50	<50	50	50
Lead		<1	<1	5	5
Manganese		7	14	18	10
Zinc		<50	<50	50	50
Dissolved Mercury		<0.1	<0.1	0.1	0.1
Total Mercury		<0.1	<0.1	0.1	0.1
Nutrients (ug/L)					

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Ammonia as N		50	50		32
Nitrite + Nitrate as N		50	30	160	25
Total Kjeldahl Nitrogen as N		1400	2300	200	100
Total Nitrogen as N		1500	2300	200	100
Total Phosphorous		70	30	50	80
Reactive Phosphorous		<10	<10	10	10
Chlorophyll a		<5	<5	<5	<5
Organochlorine Pesticides (OC) (ug/L)					
alpha-BHC		<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)		<0.5	<0.5	<0.5	<0.5
beta-BHC		<0.5	<0.5	<0.5	<0.5
gamma-BHC		<0.5	<0.5	<0.5	<0.5
delta-BHC		<0.5	<0.5	<0.5	<0.5
Heptachlor		<0.5	<0.5	<0.5	<0.5
Aldrin		<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide		<0.5	<0.5	<0.5	<0.5
trans-Chlordane		<0.5	<0.5	<0.5	<0.5
Dieldrin		<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5
Endrin		<0.5	<0.5	<0.5	<0.5
beta-Endosulfan		<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5
Endrin aldehyde		<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate		<0.5	<0.5	<0.5	<0.5
4.4'-DDT		<2	<2	<2	<2
Endrin ketone		<0.5	<0.5	<0.5	<0.5
Methoxychlor		<2	<2	<2	<2
Organophosphorous Pesticides (OP) (ug/L)					
Dichlorvos		<0.5	<0.5	<0.5	<0.5
Demeton-methyl		<0.5	<0.5	<0.5	<0.5
Monocroptophos		<2	<2	<2	<2
Dimethoate		<0.5	<0.5	<0.5	<0.5
Diazinon		<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl		<0.5	<0.5	<0.5	<0.5
Parathion-methyl		<2	<2	<2	<2
Malathion		<0.5	<0.5	<0.5	<0.5
Fenthion		<0.5	<0.5	<0.5	<0.5
Chlorpyfiros		<0.5	<0.5	<0.5	<0.5
Parathion		<2	<2	<2	<2

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Pirimphos-ethyl		<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos		<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl		<0.5	<0.5	<0.5	<0.5
Fenamiphos		<0.5	<0.5	<0.5	<0.5
Prothiofos		<0.5	<0.5	<0.5	<0.5
Ethion		<0.5	<0.5	<0.5	<0.5
Carbophenothion		<0.5	<0.5	<0.5	<0.5
Azinophos Methyl		<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons (ug/L)					
C6-C6 Fraction		<20	<20	<20	<20
C10-C14 Fraction		<50	<50	<50	<50
C15-C28 Fraction		<100	<100	<100	<100
C29-C36 Fraction		<50	<50	<50	<50
BTEX (ug/L)					
Benzene		<1	<1	<1	<1
Toluene		<2	<2	<2	<2
Ethylbenzene		<2	<2	<2	<2
meta- & para-Xylene		<2	<2	<2	<2
ortho-Xylene		<2	<2	<2	<2
Organochlorine Pesticide Surrogate (%)					
Dibromo-DDE		89.7	91	102	89.3
Organophosphorous Pesticide Surrogate (%)					
DEF		86.3	84.2	101	91.4
TPH(V)/BTEX Surrogates (%)					
1.2-Dichloroethane-D4		111	106	103	99.8
Toluene-D8		106	105	109	99.7
4-Bromofluorobenzene		102	106	95.8	92.7

Site 5

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Physical Parameters					
Dissolved oxygen (%)	0.2	95.10	92.80	102.30	103.10
	2.0	92.90	91.80	97.00	102.10
	4.0				
Conductivity (mS/cm)	0.2	55.70	55.10	56.90	57.40
	2.0	54.90	54.80	56.60	56.90
	4.0				
pH	0.2	7.42	7.89	7.83	7.48
	2.0	7.01	5.87	7.85	7.57
	4.0				
Turbidity (NTU)	0.2	10.20	11.10	18.00	18.00
	2.0	9.20	19.60		
	4.0				
Temperature (oC)	0.2	22.00	22.90	21.40	21.52
	2.0	22.20	22.90	21.90	21.56
	4.0				
Suspended Solids (mg/L)		36.00	33.00	48.00	34.00
Dissolved Metals by ICP-MS (ug/L)					
Aluminium		50	20	130	50
Arsenic		<50	<50	60	50
Cadmium		<0.1	<0.1	0.6	0.5
Chromium		3	2	6	5
Copper		<50	<50	50	50
Lead		<1	<1	5	5
Manganese		5	3	22	5
Zinc		<50	<50	50	50
Total Metals by ICP-MS (ug/L)					
Aluminium		670	380	1550	1200
Arsenic		<50	<50	50	50
Cadmium		<0.1	<0.1	0.5	0.5
Chromium		4	3	5	5
Copper		<50	<50	50	50
Lead		<1	<1	5	5
Manganese		14	8	28	18
Zinc		<50	<50	50	50
Dissolved Mercury		<0.1	<0.1	0.1	0.1
Total Mercury		<0.1	<0.1	0.1	0.1
Nutrients (ug/L)					

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Ammonia as N		50	40		40
Nitrite + Nitrate as N		40	40	16	17
Total Kjeldahl Nitrogen as N		200	<100	300	100
Total Nitrogen as N		200	<100	300	100
Total Phosphorous		70	40	50	90
Reactive Phosphorous		<10	<10	10	10
Chlorophyll a		<5	<5	<5	<5
Organochlorine Pesticides (OC) (ug/L)					
alpha-BHC		<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)		<0.5	<0.5	<0.5	<0.5
beta-BHC		<0.5	<0.5	<0.5	<0.5
gamma-BHC		<0.5	<0.5	<0.5	<0.5
delta-BHC		<0.5	<0.5	<0.5	<0.5
Heptachlor		<0.5	<0.5	<0.5	<0.5
Aldrin		<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide		<0.5	<0.5	<0.5	<0.5
trans-Chlordane		<0.5	<0.5	<0.5	<0.5
Dieldrin		<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5
Endrin		<0.5	<0.5	<0.5	<0.5
beta-Endosulfan		<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5
Endrin aldehyde		<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate		<0.5	<0.5	<0.5	<0.5
4.4'-DDT		<2	<2	<2	<2
Endrin ketone		<0.5	<0.5	<0.5	<0.5
Methoxychlor		<2	<2	<2	<2
Organophosphorous Pesticides (OP) (ug/L)					
Dichlorvos		<0.5	<0.5	<0.5	<0.5
Demeton-methyl		<0.5	<0.5	<0.5	<0.5
Monocroptophos		<2	<2	<2	<2
Dimethoate		<0.5	<0.5	<0.5	<0.5
Diazinon		<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl		<0.5	<0.5	<0.5	<0.5
Parathion-methyl		<2	<2	<2	<2
Malathion		<0.5	<0.5	<0.5	<0.5
Fenthion		<0.5	<0.5	<0.5	<0.5
Chlorpyfiros		<0.5	<0.5	<0.5	<0.5
Parathion		<2	<2	<2	<2

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Pirimphos-ethyl		<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos		<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl		<0.5	<0.5	<0.5	<0.5
Fenamiphos		<0.5	<0.5	<0.5	<0.5
Prothiofos		<0.5	<0.5	<0.5	<0.5
Ethion		<0.5	<0.5	<0.5	<0.5
Carbophenothion		<0.5	<0.5	<0.5	<0.5
Azinophos Methyl		<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons (ug/L)					
C6-C6 Fraction		<20	<20	<20	<20
C10-C14 Fraction		<50	<50	<50	<50
C15-C28 Fraction		<100	<100	<100	<100
C29-C36 Fraction		<50	<50	<50	<50
BTEX (ug/L)					
Benzene		<1	<1	<1	<1
Toluene		<2	<2	<2	<2
Ethylbenzene		<2	<2	<2	<2
meta- & para-Xylene		<2	<2	<2	<2
ortho-Xylene		<2	<2	<2	<2
Organochlorine Pesticide Surrogate (%)					
Dibromo-DDE		94.6	98	102	95.7
Organophosphorous Pesticide Surrogate (%)					
DEF		90.5	89.9	103	97.7
TPH(V)/BTEX Surrogates (%)					
1.2-Dichloroethane-D4		109	108	114	100
Toluene-D8		108	106	106	92.8
4-Bromofluorobenzene		103	106	88.4	99.6

Site 6

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Physical Parameters					
Dissolved oxygen (%)	0.2	96.60	91.00	103.00	102.30
	2.0	89.90	89.20	104.60	104.90
	4.0	89.90	87.70	104.90	104.80
Conductivity (mS/cm)	0.2	55.50	54.70	56.10	56.50
	2.0	55.10	54.80	55.50	56.40
	4.0	54.90	54.80	55.20	56.30
pH	0.2	8.02	8.11	7.76	7.72
	2.0	7.11	6.09	7.77	7.73
	4.0	4.60	5.85	7.79	7.75
Turbidity (NTU)	0.2	7.30	11.90	19.00	12.00
	2.0	8.50	13.00		
	4.0	10.00	27.60		
Temperature (oC)	0.2	22.30	24.20	23.76	21.75
	2.0	22.70	24.30	23.78	21.79
	4.0	22.80	24.20	23.80	21.78
Suspended Solids (mg/L)		38.00	16.00	32.00	36.00
Dissolved Metals by ICP-MS (ug/L)					
Aluminium		60	10	120	50
Arsenic		<50	<50	50	50
Cadmium		0.1	0.1	0.5	0.5
Chromium		2	2	6	5
Copper		<50	<50	50	50
Lead		<1	<1	5	5
Manganese		4	6	20	5
Zinc		<50	<50	50	50
Total Metals by ICP-MS (ug/L)					
Aluminium		570	410	1460	720
Arsenic		<50	<50	50	50
Cadmium		<0.1	<0.1	0.5	0.5
Chromium		3	2	5	5
Copper		<50	<50	50	50
Lead		<1	<1	5	5
Manganese		12	12	27	12
Zinc		84	<50	50	50
Dissolved Mercury		<0.1	<0.1	0.1	0.1
Total Mercury		<0.1	<0.1	0.1	0.1
Nutrients (ug/L)					

	Depth	Season 1		Season 2	
		Flooding	Ebbing	Flooding	Ebbing
Ammonia as N		50	50		35
Nitrite + Nitrate as N		30	20	23	18
Total Kjeldahl Nitrogen as N		200	<100	300	100
Total Nitrogen as N		200	<100	300	100
Total Phosphorous		40	30	50	60
Reactive Phosphorous		<10	<10	10	10
Chlorophyll a		<5	<5	<5	<5
Organochlorine Pesticides (OC) (ug/L)					
alpha-BHC		<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)		<0.5	<0.5	<0.5	<0.5
beta-BHC		<0.5	<0.5	<0.5	<0.5
gamma-BHC		<0.5	<0.5	<0.5	<0.5
delta-BHC		<0.5	<0.5	<0.5	<0.5
Heptachlor		<0.5	<0.5	<0.5	<0.5
Aldrin		<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide		<0.5	<0.5	<0.5	<0.5
trans-Chlordane		<0.5	<0.5	<0.5	<0.5
Dieldrin		<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5
Endrin		<0.5	<0.5	<0.5	<0.5
beta-Endosulfan		<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5
Endrin aldehyde		<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate		<0.5	<0.5	<0.5	<0.5
4.4'-DDT		<2	<2	<2	<2
Endrin ketone		<0.5	<0.5	<0.5	<0.5
Methoxychlor		<2	<2	<2	<2
Organophosphorous Pesticides (OP) (ug/L)					
Dichlorvos		<0.5	<0.5	<0.5	<0.5
Demeton-methyl		<0.5	<0.5	<0.5	<0.5
Monocroptophos		<2	<2	<2	<2
Dimethoate		<0.5	<0.5	<0.5	<0.5
Diazinon		<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl		<0.5	<0.5	<0.5	<0.5
Parathion-methyl		<2	<2	<2	<2
Malathion		<0.5	<0.5	<0.5	<0.5
Fenthion		<0.5	<0.5	<0.5	<0.5
Chlorpyfiros		<0.5	<0.5	<0.5	<0.5
Parathion		<2	<2	<2	<2

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Pirimphos-ethyl		<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos		<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl		<0.5	<0.5	<0.5	<0.5
Fenamiphos		<0.5	<0.5	<0.5	<0.5
Prothiofos		<0.5	<0.5	<0.5	<0.5
Ethion		<0.5	<0.5	<0.5	<0.5
Carbophenothion		<0.5	<0.5	<0.5	<0.5
Azinophos Methyl		<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons (ug/L)					
C6-C6 Fraction		<20	<20	<20	<20
C10-C14 Fraction		<50	<50	<50	<50
C15-C28 Fraction		<100	<100	<100	<100
C29-C36 Fraction		<50	<50	<50	<50
BTEX (ug/L)					
Benzene		<1	<1	<1	<1
Toluene		<2	<2	<2	<2
Ethylbenzene		<2	<2	<2	<2
meta- & para-Xylene		<2	<2	<2	<2
ortho-Xylene		<2	<2	<2	<2
Organochlorine Pesticide Surrogate (%)					
Dibromo-DDE		94.1	79.8	86.8	92
Organophosphorous Pesticide Surrogate (%)					
DEF		91.1	73.9	85.3	95.6
TPH(V)/BTEX Surrogates (%)					
1.2-Dichloroethane-D4		101	104	98.6	102
Toluene-D8		105	102	101	93.7
4-Bromofluorobenzene		102	101	101	99.6

Site 7

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Physical Parameters					
Dissolved oxygen (%)	0.2	91.90	94.10	94.40	104.90
	2.0	76.60		93.80	105.90
	4.0				
Conductivity (mS/cm)	0.2	55.50	56.60	56.00	56.30
	2.0	55.50		55.90	56.10
	4.0				
pH	0.2	7.97	7.97	7.72	7.67
	2.0	6.49		7.74	7.67
	4.0				
Turbidity (NTU)	0.2	4.10	13.00	14.00	11.00
	2.0	5.80			
	4.0				
Temperature (oC)	0.2	23.60	23.20	23.36	23.35
	2.0	23.70		23.22	23.36
	4.0				
Suspended Solids (mg/L)		38.00	16.00	38.00	32.00
Dissolved Metals by ICP-MS (ug/L)					
Aluminium		10	<10	80	50
Arsenic		<50	<50	50	50
Cadmium		0.1	<0.1	0.5	0.5
Chromium		3	3	6	5
Copper		<50	<50	50	50
Lead		<1	<1	5	5
Manganese		28	97	41	13
Zinc		<50	<50	50	50
Total Metals by ICP-MS (ug/L)					
Aluminium		440	1170	980	740
Arsenic		<50	<50	50	50
Cadmium		<0.1	<0.1	0.5	0.5
Chromium		3	3	5	5
Copper		<50	<50	50	50
Lead		<1	<1	5	5
Manganese		38	117	44	29
Zinc		<50	<50	50	50
Dissolved Mercury		<0.1	<0.1	0.1	0.1
Total Mercury		<0.1	<0.1	0.1	0.1
Nutrients (ug/L)					

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Ammonia as N		40	40		31
Nitrite + Nitrate as N		40	40	23	30
Total Kjeldahl Nitrogen as N		200	200	200	100
Total Nitrogen as N		200	300	300	100
Total Phosphorous		40	30	50	30
Reactive Phosphorous		<10	<10	10	10
Chlorophyll a		<5	<5	<5	<5
Organochlorine Pesticides (OC) (ug/L)					
alpha-BHC		0.5	0.5	---	<0.5
Hexachlorobenzene (HCB)		0.5	0.5	---	<0.5
beta-BHC		0.5	0.5	---	<0.5
gamma-BHC		0.5	0.5	---	<0.5
delta-BHC		0.5	0.5	---	<0.5
Heptachlor		0.5	0.5	---	<0.5
Aldrin		0.5	0.5	---	<0.5
Heptachlor epoxide		0.5	0.5	---	<0.5
trans-Chlordane		0.5	0.5	---	<0.5
Dieldrin		0.5	0.5	---	<0.5
4.4'-DDD		0.5	0.5	---	<0.5
Endrin		0.5	0.5	---	<0.5
beta-Endosulfan		0.5	0.5	---	<0.5
4.4'-DDD		0.5	0.5	---	<0.5
Endrin aldehyde		0.5	0.5	---	<0.5
Endosulfan sulfate		0.5	0.5	---	<0.5
4.4'-DDT		<2	<2	---	<2
Endrin ketone		<0.5	<0.5	---	<0.5
Methoxychlor		<2	<2	---	<2
Organophosphorous Pesticides (OP) (ug/L)					
Dichlorvos		<0.5	<0.5	---	<0.5
Demeton-methyl		<0.5	<0.5	---	<0.5
Monocroptophos		<2	<2	---	<2
Dimethoate		<0.5	<0.5	---	<0.5
Diazinon		<0.5	<0.5	---	<0.5
Chlorpyrifos-methyl		<0.5	<0.5	---	<0.5
Parathion-methyl		<2	<2	---	<2
Malathion		<0.5	<0.5	---	<0.5
Fenthion		<0.5	<0.5	---	<0.5
Chlorpyfiros		<0.5	<0.5	---	<0.5
Parathion		<2	<2	---	<2

		Season 1		Season 2	
	Depth	Flooding	Ebbing	Flooding	Ebbing
Pirimphos-ethyl		<0.5	<0.5	---	<0.5
Chlorfenvinphos		<0.5	<0.5	---	<0.5
Bromophos-ethyl		<0.5	<0.5	---	<0.5
Fenamiphos		<0.5	<0.5	---	<0.5
Prothiofos		<0.5	<0.5	---	<0.5
Ethion		<0.5	<0.5	---	<0.5
Carbophenothion		<0.5	<0.5	---	<0.5
Azinophos Methyl		<0.5	<0.5	---	<0.5
Total Petroleum Hydrocarbons (ug/L)					
C6-C6 Fraction		<20	<20	<20	<20
C10-C14 Fraction		<50	<50	---	<50
C15-C28 Fraction		<100	<100	---	<100
C29-C36 Fraction		<50	<50	---	<50
BTEX (ug/L)					
Benzene		<1	<1	<1	<1
Toluene		<2	<2	<2	<2
Ethylbenzene		<2	<2	<2	<2
meta- & para-Xylene		<2	<2	<2	<2
ortho-Xylene		<2	<2	<2	<2
Organochlorine Pesticide Surrogate (%)					
Dibromo-DDE		85.9	80.3	---	16.2
Organophosphorous Pesticide Surrogate (%)					
DEF		78	73.7	---	14.5
TPH(V)/BTEX Surrogates (%)					
1.2-Dichloroethane-D4		105	109	86.7	102
Toluene-D8		102	106	106	94
4-Bromofluorobenzene		100	106	92.8	100

Site 8

	Depth	Season 1 Flooding	Season 1 Replicate Flooding	Season 1 Ebbing	Season 2 Flooding	Season 2 Ebbing
Physical Parameters						
Dissolved oxygen (%)	0.2	88.00	89.00	92.60	94.40	103.40
	2.0	88.00	82.00	91.40	92.70	102.70
	4.0				91.90	103.30
Conductivity (mS/cm)	0.2	55.50	55.00	55.70	56.50	56.70
	2.0	55.00	55.00	55.60	55.30	55.40
	4.0				55.10	55.30
pH	0.2	8.20	8.10	8.11	7.72	7.66
	2.0	6.65	6.82	6.31	7.75	7.68
	4.0				7.76	7.68
Turbidity (NTU)	0.2	5.30	5.70	13.00	21.00	8.10
	2.0	5.80	6.00	23.20		
	4.0					
Temperature (oC)	0.2	24.00	24.50	24.10	23.84	24.22
	2.0	24.50	24.50	24.10	24.16	24.27
	4.0				24.25	24.24
Suspended Solids (mg/L)		24.00	27.00	38.00	28.00	12.00
Dissolved Metals by ICP-MS (ug/L)						
Aluminium		20	10	30	110	50
Arsenic		<50	<1	<50	50	50
Cadmium		0.1	0.1	<0.1	0.7	0.5
Chromium		3	3	2	5	5
Copper		<50	5	<50	50	50
Lead		<1	<1	<1	5	5
Manganese		7	7	38	28	5
Zinc		<50	<5	<50	50	50
Total Metals by ICP-MS (ug/L)						
Aluminium		400	440	520	1400	430
Arsenic		<50	<1	<50	50	50
Cadmium		<0.1	0.1	<0.1	0.5	0.5
Chromium		3	<1	3	5	5
Copper		<50	3	<50	50	50
Lead		<1	<1	<1	5	5
Manganese		16	16	46	28	10
Zinc		<50	<5	<50	50	50
Dissolved Mercury		<0.1	<0.1	<0.1	0.1	0.1
Total Mercury		<0.1	<0.1	<0.1	0.1	0.1

		Season 1			Season 2	
	Depth	Flooding	Replicate Flooding	Ebbing	Flooding	Ebbing
Nutrients (ug/L)						
Ammonia as N		50	40	30		36
Nitrite + Nitrate as N		40	10	40	26	24
Total Kjeldahl Nitrogen as N		2100	<100	100	200	100
Total Nitrogen as N		2100	<100	200	300	100
Total Phosphorous		90	50	50	50	60
Reactive Phosphorous		<10	<10	<10	10	10
Chlorophyll a		<5	<5	<5	<5	<5
Organochlorine Pesticides (OC) (ug/L)						
alpha-BHC		<0.5	0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)		<0.5	0.5	<0.5	<0.5	<0.5
beta-BHC		<0.5	0.5	<0.5	<0.5	<0.5
gamma-BHC		<0.5	0.5	<0.5	<0.5	<0.5
delta-BHC		<0.5	0.5	<0.5	<0.5	<0.5
Heptachlor		<0.5	0.5	<0.5	<0.5	<0.5
Aldrin		<0.5	0.5	<0.5	<0.5	<0.5
Heptachlor epoxide		<0.5	0.5	<0.5	<0.5	<0.5
trans-Chlordane		<0.5	0.5	<0.5	<0.5	<0.5
Dieldrin		<0.5	0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	0.5	<0.5	<0.5	<0.5
Endrin		<0.5	0.5	<0.5	<0.5	<0.5
beta-Endosulfan		<0.5	0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	0.5	<0.5	<0.5	<0.5
Endrin aldehyde		<0.5	0.5	<0.5	<0.5	<0.5
Endosulfan sulfate		<0.5	0.5	<0.5	<0.5	<0.5
4.4'-DDT		<2	<2	<2	<2	<2
Endrin ketone		<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor		<2	<2	<2	<2	<2
Organophosphorous Pesticides (OP) (ug/L)						
Dichlorvos		<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-methyl		<0.5	<0.5	<0.5	<0.5	<0.5
Monocroptophos		<2	<2	<2	<2	<2
Dimethoate		<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl		<2	<2	<2	<2	<2

	Depth	Season 1			Season 2	
	Depth	Flooding	Replicate Flooding	Ebbing	Flooding	Ebbing
Malathion		<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyfiros		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion		<2	<2	<2	<2	<2
Pirimphos-ethyl		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos		<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl		<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos		<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos		<0.5	<0.5	<0.5	<0.5	<0.5
Ethion		<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion		<0.5	<0.5	<0.5	<0.5	<0.5
Azinophos Methyl		<0.5	<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons (ug/L)						
C6-C6 Fraction		<20	<20	<20	<20	<20
C10-C14 Fraction		<50	<50	<50	<50	<50
C15-C28 Fraction		<100	<100	<100	<100	<100
C29-C36 Fraction		<50	<50	<50	<50	<50
BTEX (ug/L)						
Benzene		<1	<1	<1	<1	<1
Toluene		4	4	<2	<2	<2
Ethylbenzene		<2	<2	<2	<2	<2
meta- & para-Xylene		<2	<2	<2	<2	<2
ortho-Xylene		<2	<2	<2	<2	<2
Organochlorine Pesticide Surrogate (%)						
Dibromo-DDE		93.8	69.3	89.1	116	97.8
Organophosphorous Pesticide Surrogate (%)						
DEF		91.7	62	83.3	129	98.6
TPH(V)/BTEX Surrogates (%)						
1.2-Dichloroethane-D4		109	112	114	101	102
Toluene-D8		103	101	109	106	94.4
4-Bromofluorobenzene		100	99.7	107	96.5	100

Site 9

	Depth	Season 1 Flooding	Season 1 Ebbing	Season 2 Flooding	Season 2 Flooding Replicate	Season 2 Ebbing
Physical Parameters						
Dissolved oxygen (%)	0.2	94.90	94.20	102.30	104.70	103.10
	2.0	92.40	95.10	100.20	107.30	102.90
	4.0		87.60	103.70	107.70	103.10
Conductivity (mS/cm)	0.2	55.70	55.60	55.80	55.00	55.80
	2.0	55.30	55.30	55.30	54.30	55.40
	4.0		55.20	55.10	54.70	55.20
pH	0.2	8.13	7.96	7.75	7.75	7.68
	2.0	6.55	6.13	7.76	7.76	7.67
	4.0		6.15	7.76	7.76	7.69
Turbidity (NTU)	0.2	5.60	55.70	19.00	16.00	8.80
	2.0	6.30	180.00			
	4.0		24.60			
Temperature (oC)	0.2	24.10	24.70	24.25	24.42	24.37
	2.0	24.40	24.00	24.43	24.43	24.27
	4.0			24.39	24.46	24.16
Suspended Solids (mg/L)		29.00	24.00	38.00	36.00	29.00
Dissolved Metals by ICP-MS (ug/L)						
Aluminium		30	10	140	120	50
Arsenic		<50	<50	50	50	50
Cadmium		0.1	0.1	0.5	0.5	0.5
Chromium		3	2	7	5	5
Copper		<50	<50	50	50	50
Lead		<1	<1	5	5	5
Manganese		8	22	28	25	5
Zinc		<50	<50	50	50	50
Total Metals by ICP-MS (ug/L)						
Aluminium		360	580	1610	1530	380
Arsenic		<50	<50	50	50	50
Cadmium		<0.1	<0.1	0.5	0.5	0.5
Chromium		2	3	5	5	5
Copper		<50	<50	50	50	50
Lead		<1	<1	5	5	5
Manganese		15	33	29	28	10
Zinc		<50	<50	50	50	50
Dissolved Mercury		<0.1	<0.1	0.1	0.1	0.1
Total Mercury		<0.1	<0.1	0.1	0.1	0.1

		Season 1		Season 2		
	Depth	Flooding	Ebbing	Flooding	Flooding Replicate	Ebbing
Nutrients (ug/L)						
Ammonia as N		40	40			31
Nitrite + Nitrate as N		30	40	24	26	55
Total Kjeldahl Nitrogen as N		100	200	300	300	100
Total Nitrogen as N		200	300	300	400	200
Total Phosphorous		50	50	50	70	30
Reactive Phosphorous		<10	<10	10	10	10
Chlorophyll a		<5	<5	<5	<5	<5
Organochlorine Pesticides (OC) (ug/L)						
alpha-BHC		<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)		<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC		<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC		<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC		<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor		<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin		<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide		<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane		<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin		<0.5	<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5	<0.5
Endrin		<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan		<0.5	<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde		<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate		<0.5	<0.5	<0.5	<0.5	<0.5
4.4'-DDT		<2	<2	<2	<2	<2
Endrin ketone		<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor		<2	<2	<2	<2	<2
Organophosphorous Pesticides (OP) (ug/L)						
Dichlorvos		<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-methyl		<0.5	<0.5	<0.5	<0.5	<0.5
Monocroptophos		<2	<2	<2	<2	<2
Dimethoate		<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl		<2	<2	<2	<2	<2
Malathion		<0.5	<0.5	<0.5	<0.5	<0.5

		Season 1		Season 2		
	Depth	Flooding	Ebbing	Flooding	Flooding Replicate	Ebbing
Fenthion		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyfiros		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion		<2	<2	<2	<2	<2
Pirimphos-ethyl		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos		<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl		<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos		<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos		<0.5	<0.5	<0.5	<0.5	<0.5
Ethion		<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion		<0.5	<0.5	<0.5	<0.5	<0.5
Azinophos Methyl		<0.5	<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons (ug/L)						
C6-C6 Fraction		<20	<20	<20	<20	<20
C10-C14 Fraction		<50	<50	<50	<50	<50
C15-C28 Fraction		<100	<100	<100	<100	<100
C29-C36 Fraction		<50	<50	<50	<50	<50
BTEX (ug/L)						
Benzene		<1	<1	<1	<1	<1
Toluene		<2	<2	<2	<2	2
Ethylbenzene		<2	<2	<2	<2	<2
meta- & para-Xylene		<2	<2	<2	<2	<2
ortho-Xylene		<2	<2	<2	<2	<2
Organochlorine Pesticide Surrogate (%)						
Dibromo-DDE		77	61.2	91.8	100	97.7
Organophosphorous Pesticide Surrogate (%)						
DEF		69.2	56	91.2	98.8	100
TPH(V)/BTEX Surrogates (%)						
1.2-Dichloroethane-D4		109	104	118	119	100
Toluene-D8		103	97.8	92	103	97.7
4-Bromofluorobenzene		103	96.8	88.9	90.1	88.7

Site 10

	Depth	Season 1 Flooding	Season 1 Ebbing	Season 1 Replicate Ebbing	Season 2 Flooding	Season 2 Ebbing	Season 2 Replicate Ebbing
Physical Parameters							
Dissolved oxygen (%)	0.2	99.10	95.20		100.10	111.80	104.60
	2.0	97.00	94.60		103.50	112.30	105.20
	4.0	93.70	93.80		102.40	110.40	105.70
Conductivity (mS/cm)	0.2	55.30	54.70		55.40	54.80	54.30
	2.0	54.70	54.90		54.70	54.60	54.20
	4.0	54.60	54.90		54.40	54.50	54.10
pH	0.2	8.15	8.14		7.74	7.58	7.70
	2.0	6.52	6.26		7.74	7.62	7.70
	4.0	5.30	6.26		7.74	7.69	7.71
Turbidity (NTU)	0.2	4.50			18.00	10.10	10.40
	2.0	4.70					
	4.0	4.60					
Temperature (oC)	0.2	24.10	23.70		25.01	25.10	25.09
	2.0	24.70	23.80		25.05	25.07	25.11
	4.0	24.70	23.70		25.03	25.05	25.18
Suspended Solids (mg/L)		28.00	32.00	29.00	53.00	12.00	29.00
Dissolved Metals by ICP-MS (ug/L)							
Aluminium		10	10	20	120	50	50
Arsenic		<50	<50	1	50	50	50
Cadmium		0.1	0.1	<0.1	0.5	0.5	0.5
Chromium		3	2	2	6	5	5
Copper		<50	<50	6	50	50	50
Lead		<1	<1	<1	5	5	5
Manganese		6	5	5	26	5	5
Zinc		<50	<50	5	50	50	50
Total Metals by ICP-MS (ug/L)							
Aluminium		360	430	630	1820	500	680
Arsenic		<50	<50	5	50	50	50
Cadmium		<0.1	<0.1	<0.1	0.5	0.5	0.5
Chromium		3	3	<1	5	5	5
Copper		<50	<50	4	50	50	50
Lead		<1	<1	<1	5	5	5
Manganese		14	17	21	31	12	13
Zinc		<50	<50	<5	50	50	50
Dissolved Mercury		<0.1	<0.1	<0.1	0.1	0.1	0.1

	Depth	Season 1			Season 2		
		Flooding	Ebbing	Replicate Ebbing	Flooding	Ebbing	Replicate Ebbing
Total Mercury		<0.1	<0.1	<0.1	0.1	0.1	0.1
Nutrients (ug/L)							
Ammonia as N		40	30	30		32	35
Nitrite + Nitrate as N		30	20	<10	30	37	66
Total Kjeldahl Nitrogen as N		200	200	<100	300	100	100
Total Nitrogen as N		200	200	<100	300	100	100
Total Phosphorous		50	50	40	70	90	120
Reactive Phosphorous		<10	<10	<10	10	10	10
Chlorophyll-a		5	5	5	5	5	5
Organochlorine Pesticides (OC) (ug/L)							
alpha-BHC		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4.4'-DDD		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4.4'-DDT		<2	<2	<2	<2	<2	<2
Endrin ketone		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor		<2	<2	<2	<2	<2	<2
Organophosphorous Pesticides (OP) (ug/L)							
Dichlorvos		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-methyl		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Monocroptophos		<2	<2	<2	<2	<2	<2
Dimethoate		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

	Depth	Season 1 Flooding	Season 1 Ebbing	Season 1 Replicate Ebbing	Season 2 Flooding	Season 2 Ebbing	Season 2 Replicate Ebbing
Parathion-methyl		<2	<2	<2	<2	<2	<2
Malathion		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyfiros		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion		<2	<2	<2	<2	<2	<2
Pirimphos-ethyl		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethion		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Azinophos Methyl		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons (ug/L)							
C6-C6 Fraction		<20	<20	<20	<20	<20	<20
C10-C14 Fraction		<50	<50	<50	<50	<50	<50
C15-C28 Fraction		<100	<100	<100	<100	<100	<100
C29-C36 Fraction		<50	<50	<50	<50	<50	<50
BTEX (ug/L)							
Benzene		<1	<1	<1	<1	<1	<1
Toluene		<2	<2	<2	<2	<2	<2
Ethylbenzene		<2	<2	<2	<2	<2	<2
meta- & para-Xylene		<2	<2	<2	<2	<2	<2
ortho-Xylene		<2	<2	<2	<2	<2	<2
Organochlorine Pesticide Surrogate (%)							
Dibromo-DDE		73.6	62.5	68.3	98.6	104	106
Organophosphorous Pesticide Surrogate (%)							
DEF		69	57.9	65.7	98	106	105
TPH(V)/BTEX Surrogates (%)							
1.2-Dichloroethane-D4		116	109	117	109	98.6	99
Toluene-D8		103	104	101	102	92.7	93
4-Bromofluorobenzene		102	103	101	87.7	99.5	98.7

Site 11

	Season 1 Byellee Wetland	Season 2
Physical Parameters		
Dissolved oxygen (%)	140.00	140.00
Conductivity (mS/cm)	1.70	0.30
pH	8.92	8.87
Turbidity (NTU)	17.00	2.80
Temperature (oC)		20.69
Suspended Solids (mg/L)	43.00	15.00
Chloride (ug/L)	455 000	
Dissolved Metals by ICP-MS (ug/L)		
Aluminium	10	10
Arsenic	2	1
Cadmium	<0.1	0.1
Chromium	<1	1
Copper	2	1
Lead	<1	1
Manganese	100	42
Zinc	8	5
Total Metals by ICP-MS (ug/L)		
Aluminium	60	70
Arsenic	2	1
Cadmium	<0.1	0.1
Chromium	<1	5
Copper	1	1
Lead	<1	1
Manganese	80	41
Zinc	<5	5
Dissolved Mercury	<0.1	0.1
Total Mercury	<0.1	0.1
Nutrients (ug/L)		
Ammonia as N	100	31
Nitrite + Nitrate as N	<10	10
Total Kjeldahl Nitrogen as N	1300	900
Total Nitrogen as N	1300	900
Total Phosphorous	40	10
Reactive Phosphorous	31	10
Chlorophyll-*a*	8	5
Organochlorine Pesticides (OC) (ug/L)		
alpha-BHC	<0.5	<0.5

	Season 1	Season 2
	Byellee Wetland	
Hexachlorobenzene (HCB)	<0.5	<0.5
beta-BHC	<0.5	<0.5
gamma-BHC	<0.5	<0.5
delta-BHC	<0.5	<0.5
Heptachlor	<0.5	<0.5
Aldrin	<0.5	<0.5
Heptachlor epoxide	<0.5	<0.5
trans-Chlordane	<0.5	<0.5
Dieldrin	<0.5	<0.5
4.4'-DDD	<0.5	<0.5
Endrin	<0.5	<0.5
beta-Endosulfan	<0.5	<0.5
4.4'-DDD	<0.5	<0.5
Endrin aldehyde	<0.5	<0.5
Endosulfan sulfate	<0.5	<0.5
4.4'-DDT	<2	<2
Endrin ketone	<0.5	<0.5
Methoxychlor	<2	<2
Organophosphorous Pesticides (OP) (ug/L)		
Dichlorvos	<0.5	<0.5
Demeton-methyl	<0.5	<0.5
Monocroptophos	<2	<2
Dimethoate	<0.5	<0.5
Diazinon	<0.5	<0.5
Chlorpyrifos-methyl	<0.5	<0.5
Parathion-methyl	<2	<2
Malathion	<0.5	<0.5
Fenthion	<0.5	<0.5
Chlorpyfiros	<0.5	<0.5
Parathion	<2	<2
Pirimphos-ethyl	<0.5	<0.5
Chlorfenvinphos	<0.5	<0.5
Bromophos-ethyl	<0.5	<0.5
Fenamiphos	<0.5	<0.5
Prothiofos	<0.5	<0.5
Ethion	<0.5	<0.5
Carbophenothion	<0.5	<0.5
Azinophos Methyl	<0.5	<0.5
Total Petroleum Hydrocarbons (ug/L)		

	Season 1	Season 2
	Byellee Wetland	
C6-C6 Fraction	<20	<20
C10-C14 Fraction	<50	<50
C15-C28 Fraction	300	<100
C29-C36 Fraction	100	<50
BTEX (ug/L)		
Benzene	<1	<1
Toluene	<2	<2
Ethylbenzene	<2	<2
meta- & para-Xylene	<2	<2
ortho-Xylene	<2	<2
Organochlorine Pesticide Surrogate (%)		
Dibromo-DDE	65.9	110
Organophosphorous Pesticide Surrogate (%)		
DEF	63.2	113
TPH(V)/BTEX Surrogates (%)		
1.2-Dichloroethane-D4	113	97.1
Toluene-D8	99	92.6
4-Bromofluorobenzene	101	92.3

Site 12

	Season 1	Season 2
	Farm Dam	
Physical Parameters		
Dissolved oxygen (%)	48.00	40.00
Conductivity (mS/cm)	0.34	1.00
pH	7.52	7.03
Turbidity (NTU)	4.00	6.50
Temperature (oC)	21.60	18.46
Suspended Solids (mg/L)	4.00	14.00
Chloride (ug/L)	80 000	
Dissolved Metals by ICP-MS (ug/L)		
Aluminium	20	<10
Arsenic	<1	<1
Cadmium	0.1	0.1
Chromium	<1	<1
Copper	<1	2
Lead	<1	<1
Manganese	4	1.16
Zinc	11	<5
Total Metals by ICP-MS (ug/L)		
Aluminium	<10	60
Arsenic	2	<1
Cadmium	<0.1	0.1
Chromium	<1	3
Copper	<1	2
Lead	<1	<1
Manganese	3	1310
Zinc	15	8
Dissolved Mercury	<0.1	<0.1
Total Mercury	<0.1	<0.1
Nutrients (ug/L)		
Ammonia as N	50	73
Nitrite + Nitrate as N	10	10
Total Kjeldahl Nitrogen as N	1200	1800
Total Nitrogen as N	1200	1800
Total Phosphorous	30	60
Reactive Phosphorous	<10	10
Chlorophyll a	<5	10
Organochlorine Pesticides (OC) (ug/L)		
alpha-BHC	<0.9	<0.5

	Season 1	Season 2
	Farm Dam	
Hexachlorobenzene (HCB)	<0.9	<0.5
beta-BHC	<0.9	<0.5
gamma-BHC	<0.9	<0.5
delta-BHC	<0.9	<0.5
Heptachlor	<0.9	<0.5
Aldrin	<0.9	<0.5
Heptachlor epoxide	<0.9	<0.5
trans-Chlordane	<0.9	<0.5
Dieldrin	<0.9	<0.5
4.4'-DDD	<0.9	<0.5
Endrin	<0.9	<0.5
beta-Endosulfan	<0.9	<0.5
4.4'-DDD	<0.9	<0.5
Endrin aldehyde	<0.9	<0.5
Endosulfan sulfate	<0.9	<0.5
4.4'-DDT	<2	<2
Endrin ketone	<0.9	<0.5
Methoxychlor	<2	<2
Organophosphorous Pesticides (OP) (ug/L)		
Dichlorvos	<0.9	<0.5
Demeton-methyl	<0.9	<0.5
Monocroptophos	<2	<2
Dimethoate	<0.9	<0.5
Diazinon	<0.9	<0.5
Chlorpyrifos-methyl	<0.9	<0.5
Parathion-methyl	<2	<2
Malathion	<0.9	<0.5
Fenthion	<0.9	<0.5
Chlorpyfiros	<0.9	<0.5
Parathion	<2	<2
Pirimphos-ethyl	<0.9	<0.5
Chlorfenvinphos	<0.9	<0.5
Bromophos-ethyl	<0.9	<0.5
Fenamiphos	<0.9	<0.5
Prothiofos	<0.9	<0.5
Ethion	<0.9	<0.5
Carbophenothion	<0.9	<0.5
Azinophos Methyl	<0.9	<0.5
Total Petroleum Hydrocarbons (ug/L)		

	Season 1	Season 2
	Farm Dam	
C6-C6 Fraction	<20	<20
C10-C14 Fraction	<100	<50
C15-C28 Fraction	<200	<100
C29-C36 Fraction	<100	<50
BTEX (ug/L)		
Benzene	<1	<1
Toluene	<2	<2
Ethylbenzene	<2	<2
meta- & para-Xylene	<2	<2
ortho-Xylene	<2	<2
Organochlorine Pesticide Surrogate (ug/L)		
Dibromo-DDE	80.3	96.2
Organophosphorous Pesticide Surrogate (ug/L)		
DEF	75.1	101
TPH(V)/BTEX Surrogates (ug/L)		
1.2-Dichloroethane-D4	114	98
Toluene-D8	103	94.6
4-Bromofluorobenzene	103	93.8

Site 13

	Depth	Season 2 Flooding
Physical Parameters		
Dissolved oxygen (%)		108.70
		112.70
Conductivity (mS/cm)		56.40
		56.40
pH		7.85
		7.89
Turbidity (NTU)		15.00
Temperature (oC)		21.94
		21.83
Suspended Solids (mg/L)		44.00
Dissolved Metals by ICP-MS (ug/L)		
Aluminium		90
Arsenic		50
Cadmium		0.6
Chromium		5
Copper		50
Lead		5
Manganese		16
Zinc		50
Total Metals by ICP-MS (ug/L)		
Aluminium		1440
Arsenic		50
Cadmium		0.5
Chromium		5
Copper		50
Lead		5
Manganese		19
Zinc		50
Dissolved Mercury		0.1
Total Mercury		0.1
Nutrients (ug/L)		

		Season 2
	Depth	Flooding
Ammonia as N		
Nitrite + Nitrate as N		20
Total Kjeldahl Nitrogen as N		200
Total Nitrogen as N		200
Total Phosphorous		60
Reactive Phosphorous		10
Chlorophyll a		<5
Organochlorine Pesticides (OC) (ug/L)		
alpha-BHC		<0.5
Hexachlorobenzene (HCB)		<0.5
beta-BHC		<0.5
gamma-BHC		<0.5
delta-BHC		<0.5
Heptachlor		<0.5
Aldrin		<0.5
Heptachlor epoxide		<0.5
trans-Chlordane		<0.5
Dieldrin		<0.5
4.4'-DDD		<0.5
Endrin		<0.5
beta-Endosulfan		<0.5
4.4'-DDD		<0.5
Endrin aldehyde		<0.5
Endosulfan sulfate		<0.5
4.4'-DDT		<2
Endrin ketone		<0.5
Methoxychlor		<2
Organophosphorous Pesticides (OP) (ug/L)		
Dichlorvos		<0.5
Demeton-methyl		<0.5
Monocroptophos		<2
Dimethoate		<0.5
Diazinon		<0.5
Chlorpyrifos-methyl		<0.5
Parathion-methyl		<2
Malathion		<0.5
Fenthion		<0.5
Chlorpyfiros		<0.5
Parathion		<2

	Depth	Season 2 Flooding
Pirimphos-ethyl		<0.5
Chlorfenvinphos		<0.5
Bromophos-ethyl		<0.5
Fenamiphos		<0.5
Prothiofos		<0.5
Ethion		<0.5
Carbophenothion		<0.5
Azinophos Methyl		<0.5
Total Petroleum Hydrocarbons (ug/L)		
C6-C6 Fraction		<20
C10-C14 Fraction		<50
C15-C28 Fraction		<100
C29-C36 Fraction		<50
BTEX (ug/L)		
Benzene		<1
Toluene		<2
Ethylbenzene		<2
meta- & para-Xylene		<2
ortho-Xylene		<2
Organochlorine Pesticide Surrogate (%)		
Dibromo-DDE		71.4
Organophosphorous Pesticide Surrogate (%)		
DEF		70.6
TPH(V)/BTEX Surrogates (%)		
1.2-Dichloroethane-D4		87.6
Toluene-D8		107
4-Bromofluorobenzene		93.5

Site 14

	Depth	Season 2 Flooding
Physical Parameters		
Dissolved oxygen (%)		119.40
		115.50
		115.20
Conductivity (mS/cm)		56.50
		56.20
		56.10
pH		7.87
		7.87
		7.88
Turbidity (NTU)		12.00
Temperature (oC)		22.23
		22.18
		22.19
Suspended Solids (mg/L)		57.00
Dissolved Metals by ICP-MS (ug/L)		
Aluminium		90
Arsenic		50
Cadmium		0.5
Chromium		7
Copper		50
Lead		5
Manganese		15
Zinc		50
Total Metals by ICP-MS (ug/L)		
Aluminium		1110
Arsenic		50
Cadmium		0.5
Chromium		5
Copper		50
Lead		5
Manganese		16
Zinc		50
Dissolved Mercury		0.1
Total Mercury		0.1
Nutrients (ug/L)		

	Depth	Season 2 Flooding
Ammonia as N		
Nitrite + Nitrate as N		15
Total Kjeldahl Nitrogen as N		200
Total Nitrogen as N		300
Total Phosphorous		40
Reactive Phosphorous		10
Chlorophyll a		<5
Organochlorine Pesticides (OC) (ug/L)		
alpha-BHC		<0.5
Hexachlorobenzene (HCB)		<0.5
beta-BHC		<0.5
gamma-BHC		<0.5
delta-BHC		<0.5
Heptachlor		<0.5
Aldrin		<0.5
Heptachlor epoxide		<0.5
trans-Chlordane		<0.5
Dieldrin		<0.5
4.4'-DDD		<0.5
Endrin		<0.5
beta-Endosulfan		<0.5
4.4'-DDD		<0.5
Endrin aldehyde		<0.5
Endosulfan sulfate		<0.5
4.4'-DDT		<2
Endrin ketone		<0.5
Methoxychlor		<2
Organophosphorous Pesticides (OP) (ug/L)		
Dichlorvos		<0.5
Demeton-methyl		<0.5
Monocroptophos		<2
Dimethoate		<0.5
Diazinon		<0.5
Chlorpyrifos-methyl		<0.5
Parathion-methyl		<2
Malathion		<0.5
Fenthion		<0.5
Chlorpyfiros		<0.5
Parathion		<2

	Depth	Season 2 Flooding
Pirimphos-ethyl		<0.5
Chlorfenvinphos		<0.5
Bromophos-ethyl		<0.5
Fenamiphos		<0.5
Prothiofos		<0.5
Ethion		<0.5
Carbophenothion		<0.5
Azinophos Methyl		<0.5
Total Petroleum Hydrocarbons (ug/L)		
C6-C6 Fraction		<20
C10-C14 Fraction		<50
C15-C28 Fraction		<100
C29-C36 Fraction		<50
BTEX (ug/L)		
Benzene		<1
Toluene		<2
Ethylbenzene		<2
meta- & para-Xylene		<2
ortho-Xylene		<2
Organochlorine Pesticide Surrogate (%)		
Dibromo-DDE		100
Organophosphorous Pesticide Surrogate (%)		
DEF		98.5
TPH(V)/BTEX Surrogates (%)		
1.2-Dichloroethane-D4		108
Toluene-D8		101
4-Bromofluorobenzene		102

Section 1 Wet Season

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
CH	12.00	5.00	93.00	8.03	32.00	56.00	22.00	50.00	40.00	100.00	20.00	10.00
	10.00	5.00	96.00	8.25	32.00	55.30	22.00	50.00	40.00	100.00	40.00	16.00
	4.20	5.00	102.40	6.58	38.00	54.50	22.80	30.00	20.00	100.00	40.00	10.00
	7.70	5.00	97.10	6.52	21.00	54.70	22.70	50.00	20.00	1500.00	50.00	27.00
	7.40	5.00	95.70	8.08	29.00	54.80	22.70	40.00	20.00	900.00	20.00	10.00
	10.00		97.40	6.49	22.00	56.60	22.00	40.00	20.00	2300.00	60.00	10.00
	11.00		95.10	5.65		55.40	22.30					
	4.90		97.10	7.99		55.00	22.70					
	4.80		93.40	8.08		54.70	22.80					
	10.00		97.50	5.80		55.80	22.00					
	9.50		96.50	4.73		55.20	22.30					
	9.50		95.60			54.90	22.40					
	4.80		97.30			54.70	22.90					
	4.60		97.20			54.70	22.80					
	5.60		88.20			54.80	22.80					

80th %ile	10.00	5.00	97.32	8.08	32.00	55.48	22.80	50.00	40.00	1500.00	50.00	16.00
Max	12.00	5.00	102.40	8.25	38.00	56.60	22.90	50.00	40.00	2300.00	60.00	27.00
Median	7.70	5.00	96.50	6.58	30.50	54.90	22.70	45.00	20.00	500.00	40.00	10.00
Min	4.20	5.00	88.20	4.73	21.00	54.50	22.00	30.00	20.00	100.00	20.00	10.00
20th %ile	4.80	5.00	94.76	5.80	22.00	54.70	22.00	40.00	20.00	100.00	20.00	10.00

WQO	6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

Section 1 Dry Season

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
CH	18.00	5.00	103.20	7.91	54.00	56.40	21.66	32.00	19.00	200.00	60.00	10.00
	15.00	5.00	109.30	7.92	59.00	56.10	21.75	36.00	21.00	100.00	150.00	10.00
	16.00	5.00	106.40	7.60	56.00	56.90	21.50	24.00	18.00	300.00	60.00	10.00
	19.00	5.00	105.20	7.62	42.00	56.80	21.57		25.00	100.00	320.00	10.00
	20.00	5.00	103.20	7.90	60.00	56.80	21.73		18.00	200.00	50.00	
	13.00	5.00	102.30	7.90	34.00	56.20	21.79		21.00	100.00	60.00	
			107.60	7.61		56.30	21.40					
			106.40	7.65		56.70	21.55					
			98.80	7.89		58.00	21.30					
			100.70	7.90		56.70	21.40					
			103.60	7.91		56.50	21.50					
			104.40	7.53		57.00	21.75					
			105.30	7.58		56.70	21.80					
			104.70	7.61		56.50	21.82					
80th %ile	19.00	5.00	106.40	7.90	59.00	56.84	21.77	34.40	21.00	200.00	150.00	10.00
Max	20.00	5.00	109.30	7.92	60.00	58.00	21.82	36.00	25.00	300.00	320.00	10.00
Median	17.00	5.00	104.55	7.77	55.00	56.70	21.62	32.00	20.00	150.00	60.00	10.00
Min	13.00	5.00	98.80	7.53	34.00	56.10	21.30	24.00	18.00	100.00	50.00	10.00
20th %ile	15.00	5.00	102.84	7.61	42.00	56.36	21.46	27.20	18.00	100.00	60.00	10.00
WQO	6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

Section 2 Wet Season

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
CH	7.20	5.00	97.40	7.83	33.00	55.50	21.90	50.00	50.00	1500.00	70.00	10.00
	7.30	5.00	94.90	7.09	23.00	54.90	22.30	50.00	30.00	2300.00	30.00	10.00
	7.90	5.00	92.70	5.07	36.00	52.40	22.30	50.00	40.00	200.00	70.00	10.00
	6.50	5.00	90.10	7.04	33.00	55.00	22.60	40.00	40.00	100.00	40.00	10.00
	6.10	6.75	91.50	5.65	15.40	54.90	22.70					
	5.40	2.74	93.90	5.80	6.90	54.90	22.60					
	10.20	2.17	95.10	7.42	29.20	55.70	22.00					
	9.20	3.03	92.90	7.01	27.90	54.90	22.20					
	11.10	4.94	92.80	7.89	8.30	55.10	22.90					
	19.60	1.72	91.80	5.87	10.30	54.80	22.90					
EPA	12.00	6.75	91.80	7.87	15.40	39.48	29.00					
	14.00	2.74	92.40	7.88	6.90	39.25	29.10					
	14.00	2.17	93.30	7.89	29.20	39.23	29.10					
	15.00	3.03	93.70	7.90	27.90	39.04	29.20					
	7.00	4.94	93.90	8.12	8.30	48.74	31.00					
	7.00	1.72	95.30	8.13	10.30	48.94	31.00					
	8.00	1.34	93.80	8.15	10.00	48.95	30.80					
	8.00	1.39	92.40	8.14		49.01	30.60					
	27.00	1.58	95.30	8.05		52.96	26.00					
	34.00	2.17	95.90	8.08		53.33	25.90					
	35.00	1.42	96.20	8.09		53.28	25.90					
	32.00	3.21	94.80	8.10		53.26	25.90					
	9.00	2.40	87.80	7.57		59.50	29.59					
	23.00	2.34	84.10	7.57		59.50	29.49					
	27.00	2.14	84.00	7.58		59.50	29.46					
	5.00	2.27	96.50	8.10		44.98	25.20					
	7.00	1.34	97.80	8.11		45.23	25.20					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	7.00	1.87	98.00	8.12		45.20	25.20					
	19.00	1.34	91.50	8.21		54.25	29.20					
	20.00	1.07	92.50	8.21		54.52	29.20					
	21.00	0.60	92.30	8.21		54.48	29.20					
	20.00	1.07	87.60	7.79		54.50	26.90					
	28.00	0.67	87.10	7.79		54.50	26.96					
	30.00	1.07	86.50	7.79		54.50	26.91					
	16.00	1.14	86.20	8.19		56.38	29.80					
	16.00	1.34	87.30	8.20		56.47	29.80					
	16.00	1.60	87.60	8.20		56.50	29.80					
	17.00	2.87	88.10	8.20		56.53	29.70					
	51.00	2.48	85.80	8.10		54.70	24.80					
	53.00	2.34	88.50	8.10		54.70	24.80					
	57.00	1.34	88.20	8.10		54.70	24.80					
	23.00	1.46	86.00	8.09		51.78	25.30					
	27.00	0.97	86.30	8.17		52.00	25.30					
	25.00	0.94	86.20	8.10		51.80	25.30					
	28.00	1.41	86.40	8.11		51.80	25.30					
	30.00	2.94	86.20	8.12		51.83	25.30					
	26.00	2.61	86.50	8.15		51.90	25.30					
	4.00	1.79	87.90	8.15		54.11	24.60					
	4.00	2.05	87.70	8.15		54.09	24.60					
	3.00	2.67	87.90	8.15		54.11	24.60					
	4.00	1.20	87.50	8.15		54.11	24.60					
	33.00	0.87	90.70	7.88		58.90	29.40					
	35.00	3.14	89.20	7.88		58.90	29.41					
	52.00	6.55	91.90	7.83		59.00	27.50					
	51.00	1.20	91.60	7.83		59.00	27.50					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	14.00	4.01	103.30	8.02		59.00	31.52					
	15.00	0.94	100.60	8.02		58.80	31.43					
	15.00	0.76	99.90	8.02		58.80	31.41					
	45.00	0.60	96.90	7.99		54.60	28.18					
	43.00	0.33	93.80	7.99		57.50	28.15					
	52.00	2.24	93.10	7.99		57.50	28.15					
	56.00	1.00	93.40	7.99		57.50	28.15					
	44.00	11.36	95.00	7.91		60.00	27.32					
	46.00	3.07	96.30	7.92		60.00	27.32					
	46.00	1.60	96.40	7.92		60.00	27.32					
	15.00	1.87	98.60	7.88		60.50	24.33					
	16.00	0.53	97.10	7.88		60.50	24.33					
	6.00		99.40	7.89		53.30	29.51					
	9.00		98.00	7.89		53.40	29.26					
	7.00		99.60	7.89		53.30	29.58					
	2.00		100.40	7.80		52.60	33.87					
	6.00		98.60	7.79		52.70	33.51					
	9.00		98.00	7.80		52.70	33.47					
	4.00		98.10	7.68		54.70	29.86					
	10.00		95.90	7.68		54.90	29.39					
	9.00		95.90	7.68		54.90	29.35					
	30.00		99.70	7.81		52.80	27.53					
	32.00		97.40	7.82		52.80	27.51					
	34.00		96.40	7.82		52.80	27.49					
	36.00		97.40	7.82		52.80	27.47					
			95.00	7.98		56.60	24.65					
			95.20	7.99		56.60	24.64					
			94.10	7.99		56.60	24.62					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
			98.50	7.88		55.10	24.60					
			98.90	7.88		55.20	24.60					
	5.00		96.00	8.02		55.10	25.27					
	5.00		95.70	8.02		55.10	25.30					
	5.00		96.10	8.03		54.60	25.18					
	6.00		95.60	8.03		54.20	25.18					
	2.00		95.40	7.90		52.00	27.74					
	2.00		96.70	7.90		52.10	27.72					
	2.00		93.80	7.90		52.00	27.70					
	3.00		95.20	7.90		51.60	27.68					
	3.00		92.30	7.91		51.30	27.64					
	25.00		83.90	8.18		57.60	25.87					
	28.00		83.00	8.18		57.40	25.87					
	30.00		77.10	8.18		57.50	25.88					
	14.00		91.80	8.08		53.02	27.50					
	17.00		92.80	8.08		53.16	27.40					
	18.00		93.10	8.08		53.14	27.40					
	18.00		93.80	8.08		53.14	27.40					
	20.00		94.00	7.78		57.60	28.08					
	20.00		93.20	7.78		57.60	28.05					
	21.00		92.50	7.78		57.40	28.04					
	15.00		92.60	7.85		57.90	22.88					
	14.00		94.50	7.86		57.90	22.87					
	15.00		97.40	7.86		57.10	22.77					
			93.20	7.73		50.54	28.18					
			93.00	7.74		50.58	28.15					
			92.90	7.75		50.58	28.14					
			92.90	7.76		50.57	28.13					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	17.00		91.80	8.10		54.40	27.70					
	19.00		91.00	8.10		54.40	27.70					
	19.00		90.60	8.10		54.30	27.60					
	26.00		90.50	8.10		54.30	27.60					
	11.00		102.00	7.90		54.70	31.60					
	12.00		101.40	7.90		54.70	31.70					
	16.00		101.00	7.90		54.70	31.50					
	15.00		100.80	7.90		54.80	31.10					
	14.00		93.50	8.08		55.50	26.26					
	16.00		92.10	8.08		55.50	26.60					
	16.00		92.20	8.08		55.60	26.00					
	9.00		103.90	8.16		56.56	23.00					
	10.00		104.60	8.16		56.57	22.90					
	11.00		102.40	8.16		56.63	22.50					
	11.00		88.20	7.95		55.37	26.83					
	11.00		88.30	7.94		55.36	26.78					
	10.00		87.40	7.94		55.35	26.77					
	12.00		86.40	7.94		55.33	26.77					
	13.00		86.20	7.94		55.32	26.76					
			86.30	7.91		54.10	28.33					
			86.70	7.91		54.10	28.30					
			100.90	7.91		54.10	28.27					
			100.80	7.92		53.90	28.26					
			100.80	7.92		53.70	28.24					
	9.00		102.90	8.12		55.68	24.90					
	11.00		102.60	8.13		55.74	24.72					
	12.00		102.30	8.14		55.61	24.01					
	31.00		94.20	8.06		58.21	30.00					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	34.00		94.00	8.06		58.21	29.86					
	33.00		94.10	8.06		58.22	29.82					
	23.00		94.10	8.16		57.99	28.44					
	24.00		78.80	8.16		57.94	28.32					
	29.00		78.60	8.16		57.98	28.46					
	31.00		78.40	8.16		57.95	28.40					
	129.00		103.70	8.25		42.93	28.99					
	173.00		102.10	8.25		42.91	28.91					
	225.00		101.20	8.25		42.98	28.85					
	68.00		103.90	8.28		47.69	27.14					
	71.00		103.50	8.29		47.70	27.11					
	77.00		103.00	8.28		47.70	27.11					
	6.00		103.80	8.06		50.69	30.05					
	6.00		98.00	8.09		54.06	28.59					
	7.00		97.00	8.09		54.18	28.46					
	3.00		102.10	7.74		46.73	32.01					
	6.00		101.40	7.74		51.61	30.55					
	9.00		100.60	7.73		51.94	30.40					
	5.00		99.40	7.76		49.04	31.33					
	4.00		80.60	7.75		49.78	31.11					
	5.00		81.10	7.75		50.39	30.94					
	4.00		81.80	7.74		50.92	30.75					
	20.00		81.80	7.81		29.96	29.09					
	59.00		95.40	7.83		41.49	29.19					
	71.00		94.80	7.89		43.86	29.15					
	74.00		94.50	7.91		44.51	29.11					
	7.00		93.60	7.97		47.85	30.53					
	7.00		95.60	7.98		47.97	30.45					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	8.00		95.30	7.99		48.03	30.43					
	8.00		94.90	7.99		48.14	30.31					
	22.00		96.30	7.83		54.63	26.86					
	24.00		93.10	7.82		54.60	26.75					
	27.00		94.70	7.83		54.61	26.74					
	6.00		92.50	7.88		54.88	23.31					
	7.00		91.60	7.89		54.90	23.27					
	8.00		92.30	7.90		54.87	23.27					
	29.00		92.20	8.19		56.83	30.66					
	33.00		91.90	8.19		56.81	30.67					
	34.00		91.70	8.19		56.81	30.66					
	38.00		97.30	8.19		56.81	30.63					
	20.00		97.00	7.96		52.49	29.25					
	23.00		96.90	7.96		52.51	29.27					
	28.00		92.20	7.95		52.49	29.25					
	8.00		96.20	7.99		54.68	30.24					
	7.00		95.60	7.99		54.70	30.26					
	9.00		95.00	7.99		54.68	30.21					
	9.00		92.90	7.99		54.71	30.21					
	12.00		93.20	7.99		54.73	30.16					
	7.00		93.10	7.92		55.39	27.17					
	9.00		93.30	7.92		55.41	27.14					
	9.00		93.20	7.92		55.40	27.09					
	11.00		99.90	7.91		56.41	23.07					
	13.00		99.80	7.92		56.38	23.00					
	14.00		99.50	7.90		56.41	23.03					
	19.00		100.00	7.90		56.42	23.06					
	13.00		96.00	7.91		56.38	23.04					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	11.00		97.70	7.92		56.39	23.00					
	11.00		96.90	7.96		56.95	32.23					
	17.00		96.40	7.96		56.94	29.94					
	18.00		96.20	7.96		56.95	29.94					
	12.00		99.20	7.96		56.95	30.65					
	13.00		99.40	7.96		56.95	30.39					
	16.00		99.40	7.96		56.95	30.14					
	15.00		95.20	7.96		56.95	30.00					
	7.00		94.10	7.99		50.48	30.51					
	8.00		93.40	7.97		50.38	30.07					
	12.00		93.00	7.97		50.36	30.00					
	5.00		108.60	8.08		50.59	31.64					
	4.00		104.70	8.08		50.58	31.67					
	4.00		103.10	8.08		50.58	31.72					
	37.00		95.20	7.96		56.50	26.25					
	38.00		95.00	7.96		56.49	26.26					
	37.00		94.80	7.96		56.48	26.26					
	12.00		100.20	7.90		36.82	29.80					
	14.00		99.90	7.87		37.06	29.50					
	18.00		99.50	7.88		38.49	29.70					
	8.00		93.70	8.08		48.33	30.90					
	12.00		91.50	8.11		48.55	30.90					
	34.00		89.90	8.12		48.56	30.70					
	57.00		92.40	8.12		48.62	30.60					
	31.00		92.10	8.07		52.72	26.00					
	35.00		90.80	8.08		52.84	26.00					
	36.00		89.80	8.09		52.94	26.00					
	42.00		95.20	8.11		53.11	25.90					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	43.00		95.50	8.10		52.97	25.90					
	9.00		94.90	7.58		59.30	30.10					
	19.00		95.60	7.57		59.40	29.86					
	24.00		95.60	7.57		59.40	29.73					
	3.00		87.60	8.13		43.60	26.20					
	7.00		84.70	8.14		43.76	26.10					
	4.00		83.90	8.14		44.09	26.20					
	4.00		102.50	8.19		44.26	26.20					
	19.00		102.30	8.19		53.94	29.60					
	22.00		100.40	8.19		54.21	29.60					
	23.00		100.40	8.19		54.14	29.60					
	25.00		91.80	8.19		54.24	29.50					
	25.00		91.90	7.76		54.33	29.50					
	20.00		91.20	7.75		54.10	28.22					
	25.00		91.50	7.75		54.10	28.10					
	27.00		91.70	7.76		54.20	28.07					
	29.00		86.70	8.19		54.20	27.92					
	10.00		85.30	8.19		56.27	30.40					
	14.00		85.10	8.19		56.33	30.20					
	15.00		84.10	8.19		56.31	30.20					
	17.00		90.20	8.19		56.36	30.10					
	21.00		89.00	8.10		56.38	30.10					
	48.00		88.70	8.10		54.60	24.80					
	57.00		88.60	8.10		54.60	24.80					
	54.00		88.40	8.10		54.60	24.80					
	55.00		87.70	8.10		54.60	24.80					
	59.00		87.70	8.13		54.70	24.80					
	21.00		88.10	8.15		51.45	25.20					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	27.00		88.20	8.17		51.53	25.20					
	26.00		88.20	8.18		51.75	25.20					
	31.00		86.40	8.18		51.95	25.30					
	27.00		86.60	8.18		51.95	25.30					
	3.00		86.40	8.18		53.93	24.90					
	3.00		85.90	8.17		53.95	24.90					
	5.00		85.80	7.84		54.21	24.60					
	23.00		88.40	7.84		58.70	31.72					
	27.00		87.90	7.83		58.80	31.49					
	45.00		86.30	7.80		58.90	30.87					
	41.00		91.30	7.80		58.70	30.26					
	46.00		88.90	7.79		58.80	29.86					
	56.00		86.50	7.80		58.80	29.50					
	59.00		94.40	8.02		58.80	29.32					
	12.00		91.40	7.98		58.20	35.54					
	13.00		90.00	7.97		58.30	35.26					
	15.00		90.40	7.97		58.40	35.02					
	19.00		117.30	7.98		58.30	34.84					
	46.00		106.00	7.98		57.60	29.03					
	49.00		101.50	7.98		57.50	29.03					
	54.00		100.80	7.98		57.60	29.01					
	59.00		93.80	7.98		57.60	29.00					
	70.00		91.80	7.90		57.60	28.97					
	32.00		91.50	7.90		59.70	29.57					
	33.00		92.90	7.89		59.80	29.36					
	57.00		92.80	7.85		59.80	29.20					
	11.00		100.50	7.84		60.20	26.40					
	16.00		96.90	7.84		60.30	26.31					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	25.00		95.90	7.89		60.30	26.24					
	2.00		98.30	7.88		52.60	31.16					
	4.00		97.30	7.88		52.70	30.93					
	5.00		96.70	7.88		52.70	30.78					
	5.00		102.30	7.79		52.70	30.81					
	2.00		99.90	7.78		51.60	34.89					
	5.00		98.00	7.77		51.70	34.49					
	9.00		97.90	7.66		52.60	33.29					
	1.00		102.60	7.66		53.90	31.25					
	7.00		100.00	7.66		54.00	30.91					
	11.00		95.10	7.82		54.10	30.76					
	26.00		98.10	7.82		52.50	28.19					
	25.00		96.30	7.82		52.50	28.19					
	39.00		95.10	7.82		52.50	28.19					
	38.00		98.60	7.98		52.50	28.16					
	3.00		96.30	7.98		56.20	25.60					
	6.00		95.00	7.98		56.30	25.33					
	6.00		93.80	7.86		56.30	25.30					
	14.00		96.40	7.86		54.90	25.44					
	15.00		94.20	7.86		55.00	25.38					
	17.00		93.90	8.03		55.00	25.30					
	21.00		100.40	8.03		55.10	25.34					
	21.00		99.10	8.03		55.00	25.34					
	23.00		97.00	8.03		54.90	25.30					
	22.00		93.00	7.88		54.30	25.28					
	17.00		93.80	7.88		51.70	27.87					
	19.00		94.90	7.89		51.70	27.83					
	23.00		92.40	7.89		51.80	27.76					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	25.00		94.60	8.16		51.70	27.70					
	7.00		94.40	8.16		57.80	26.12					
	6.00		94.40	8.16		57.80	26.02					
	8.00		91.80	8.16		57.30	25.95					
	10.00		75.50	8.16		56.50	25.90					
	12.00		81.00	8.05		55.90	25.87					
	4.00		74.00	8.05		53.10	28.70					
	4.00		79.90	8.05		53.19	28.50					
	4.00		79.10	8.06		53.10	28.40					
	5.00		92.20	8.06		53.11	28.10					
	6.00		92.60	7.76		53.13	28.10					
	54.00		92.30	7.76		57.50	29.32					
	50.00		91.40	7.76		57.40	29.24					
	50.00		92.10	7.75		57.20	29.06					
	49.00		94.00	7.83		56.90	28.96					
	59.00		92.90	7.83		57.60	24.83					
	8.00		91.80	7.83		57.80	24.51					
	11.00		91.20	7.84		57.50	24.46					
	9.00		92.00	7.84		56.90	24.27					
	8.00		90.00	7.83		56.40	24.21					
	2.00		90.80	7.81		50.48	28.38					
	2.00		89.40	7.82		50.47	28.41					
	3.00		89.30	7.82		50.46	28.41					
	2.00		93.20	7.82		50.46	28.41					
	3.00		93.00	8.00		50.47	28.42					
	29.00		92.90	8.00		54.10	29.30					
	32.00		92.80	8.00		54.10	29.30					
	37.00		92.60	7.90		54.10	29.00					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	38.00		92.00	7.90		54.00	33.10					
	4.00		92.00	7.90		54.10	33.00					
	5.00		91.90	7.90		54.10	32.90					
	4.00		101.60	8.05		54.10	33.00					
	5.00		100.40	8.05		54.70	28.04					
	8.00		99.60	8.05		55.00	27.93					
	8.00		100.00	8.05		55.10	27.63					
	10.00		95.60	8.15		55.10	27.55					
	17.00		90.10	8.15		56.26	24.20					
	21.00		93.10	8.15		57.10	24.20					
	11.00		93.60	8.15		56.76	24.00					
	16.00		92.70	8.15		56.73	23.80					
	17.00		103.00	7.97		56.65	23.80					
	35.00		102.70	7.97		55.36	27.87					
	38.00		101.70	7.97		55.36	28.05					
	40.00		101.20	7.95		55.31	27.96					
	44.00		89.00	7.94		55.38	27.07					
	23.00		92.20	7.90		55.33	27.03					
	27.00		91.70	7.90		53.90	29.49					
	32.00		89.80	7.90		53.90	29.39					
	32.00		87.00	7.90		53.90	29.27					
	20.00		88.50	7.90		53.90	29.20					
	27.00		102.80	8.09		53.70	29.20					
	31.00		101.80	8.09		55.81	26.82					
	35.00		101.20	8.09		55.82	26.43					
	92.00		100.40	8.10		55.82	26.41					
	97.00		99.00	8.11		55.80	25.85					
	108.00		105.20	8.05		55.63	25.22					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	7.00		104.50	8.05		58.30	31.35					
	7.00		104.10	8.05		58.26	30.87					
	7.00		104.30	8.06		58.27	30.77					
	9.00		96.80	8.15		58.26	30.65					
	8.00		96.40	8.15		58.12	29.48					
	9.00		96.20	8.15		58.15	29.29					
	2.00		95.80	8.16		58.14	29.19					
	2.00		79.00	8.23		58.14	29.18					
	2.00		78.90	8.23		42.19	29.10					
	3.00		78.70	8.24		42.25	29.09					
	23.00		108.70	8.26		42.27	29.09					
	33.00		104.70	8.26		47.37	27.67					
	48.00		101.50	8.26		47.37	27.60					
	67.00		103.10	8.05		47.39	27.58					
	3.00		102.70	8.07		49.20	30.76					
	3.00		102.00	8.07		52.17	31.51					
	3.00		101.40	8.07		52.48	30.74					
	4.00		93.90	8.07		53.90	29.23					
	17.00		104.20	7.83		54.05	29.12					
	19.00		104.50	7.83		47.66	31.91					
	20.00		101.00	7.81		47.60	31.94					
	20.00		100.30	7.81		48.89	31.63					
	17.00		79.50	7.74		48.94	31.64					
	18.00		78.60	7.69		23.60	28.95					
	22.00		78.50	7.72		28.62	29.15					
	23.00		79.70	7.76		31.07	29.26					
	25.00		82.50	7.82		36.75	29.73					
	13.00		94.90	8.00		41.13	30.20					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	14.00		94.60	8.01		47.18	30.98					
	14.00		91.70	7.99		47.20	30.99					
	15.00		96.30	7.93		47.37	30.40					
	28.00		95.50	7.93		54.60	28.74					
	31.00		93.90	7.93		54.46	28.33					
	33.00		93.80	7.93		54.55	27.64					
	36.00		92.10	8.07		54.57	27.33					
	9.00		94.80	8.07		54.93	25.09					
	13.00		94.60	8.07		54.99	25.21					
	16.00		94.30	8.08		54.98	25.17					
	19.00		94.00	8.20		54.95	25.38					
	4.00		93.40	8.20		56.73	31.04					
	5.00		92.70	8.20		56.71	31.04					
	4.00		92.30	8.20		56.72	31.01					
	4.00		95.40	7.95		56.72	31.01					
	4.00		94.40	7.95		52.21	30.64					
	4.00		94.10	7.95		52.28	30.25					
	10.00		93.60	7.95		52.31	30.06					
	11.00		93.50	7.95		52.35	29.89					
	16.00		94.90	7.99		52.35	29.88					
	27.00		93.50	7.98		54.25	30.49					
	32.00		92.20	7.98		54.27	30.31					
	7.00		92.40	7.99		54.35	30.20					
	7.00		100.40	7.95		54.49	30.30					
	9.00		99.80	7.93		55.56	29.15					
	13.00		98.70	7.93		55.48	29.09					
	5.00		97.10	8.00		55.46	28.70					
	5.00		95.80	8.00		56.48	24.06					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	6.00		95.20	8.00		56.48	23.85					
	7.00		94.80	8.00		56.47	23.78					
	42.00		98.40	7.96		56.47	23.77					
			98.40	7.96		56.85	31.96					
			98.40	7.96		56.84	31.70					
			98.50	7.96		56.86	31.33					
			93.20	7.96		56.90	30.42					
			111.90	8.00		56.92	30.30					
			109.80	7.99		50.45	30.60					
			106.30	7.98		50.44	30.34					
			105.30	7.98		50.41	30.09					
			101.00	8.07		50.39	30.04					
			100.30	8.07		50.66	33.24					
			95.90	8.06		50.65	33.08					
			94.50	8.06		50.62	31.92					
			100.20	8.00		50.62	31.66					
			99.20	8.00		56.62	26.74					
			98.80	8.00		56.64	26.66					
			98.50	8.00		56.61	26.65					
						56.63	26.63					
80th %ile	32.00	3.06	99.50	8.12	29.20	56.87	30.40	50.00	44.00	1820.00	70.00	10.00
Max	225.00	11.36	117.30	8.29	36.00	60.50	35.54	50.00	50.00	2300.00	70.00	10.00
Median	16.00	1.87	94.10	7.98	15.40	54.60	28.33	50.00	40.00	850.00	55.00	10.00
Min	1.00	0.33	74.00	5.07	6.90	23.60	21.90	40.00	30.00	100.00	30.00	10.00
20th %ile	7.00	1.08	89.94	7.83	8.64	51.60	25.30	46.00	36.00	160.00	36.00	10.00

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
WQO	6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

Section 2 Dry Season

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
CH	15.00	5.00	103.60	7.81	45.00	56.90	21.40	32.00	160.00	200.00	50.00	10.00
	12.00	5.00	102.90	7.86	34.00	56.90	21.10	40.00	25.00	100.00	80.00	10.00
	18.00	5.00	109.10	7.55	48.00	56.60	21.88		16.00	300.00	50.00	10.00
	18.00	5.00	109.50	7.58	34.00	56.40	21.88		17.00	100.00	90.00	10.00
			109.20	7.69		56.30	21.85					
			102.30	7.83		56.90	21.40					
			97.00	7.85		56.60	21.90					
			103.10	7.48		57.40	21.52					
			102.10	7.57		56.90	21.56					
EPA	6.00	2.30	98.20	7.97		50.87	20.60					
	7.00	4.90	99.00	7.95		50.90	20.50					
	9.00	1.47	98.80	7.96		50.98	20.40					
	11.00	0.94	98.50	7.96		50.90	20.50					
	0.00	1.74	92.50	7.79		52.90	18.09					
	0.00	1.88	90.20	7.79		52.80	18.10					
	1.00	3.97	90.30	7.79		52.90	17.87					
	3.00	4.68	90.50	7.79		52.90	17.72					
	5.00	2.38	104.30	7.86		53.37	20.00					
	6.00	2.67	104.50	7.85		53.29	20.00					
	6.00	1.34	104.90	7.82		53.23	20.00					
	14.00	1.34	90.60	8.22		54.54	22.80					
	17.00	0.80	89.50	8.33		54.65	22.70					
	15.00	1.07	89.40	8.37		54.63	22.70					
	18.00	1.15	90.30	8.40		54.63	22.70					
	10.00	1.34	89.90	8.16		52.35	24.80					
	13.00	2.00	91.20	8.17		52.48	24.80					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	14.00	2.54	90.30	8.17		52.45	24.80					
	8.00	3.61	88.50	7.76		56.60	27.60					
	12.00	1.87	88.00	7.77		56.60	27.57					
	13.00	1.84	88.50	7.77		56.60	27.53					
	3.00	1.14	93.70	7.90		52.70	22.76					
	4.00	2.07	93.80	7.91		52.70	22.74					
	4.00	0.60	93.40	7.91		52.80	22.57					
	6.00	1.74	92.70	7.92		52.90	22.50					
	0.00	1.73	99.20	7.88		52.30	23.24					
	0.00	1.59	98.60	7.89		52.30	23.16					
	0.00	1.06	97.50	7.89		52.30	22.97					
	0.00	0.53	96.50	7.90		52.30	22.97					
	0.00	1.49	96.00	7.90		52.30	22.94					
	0.00	0.83	94.90	7.90		52.30	22.93					
	8.00	0.67	91.00	8.13		55.30	21.50					
	9.00	0.87	92.10	8.14		55.46	21.50					
	12.00	4.08	91.30	8.14		55.49	21.40					
	11.00	3.74	91.10	8.14		55.46	21.40					
	23.00	1.60	88.10	7.95		55.50	24.56					
	18.00	2.07	86.50	7.95		55.50	24.56					
	4.00	0.98	91.00	7.93		56.70	24.61					
	4.00	1.28	90.20	7.93		56.70	24.61					
	9.00	1.60	93.90	7.89		58.10	27.45					
	11.00	1.48	92.30	7.89		58.10	27.44					
	14.00	1.42	99.50	7.80		56.00	19.64					
	14.00	0.80	97.70	7.82		55.90	19.65					
	15.00	0.80	96.80	7.83		55.90	19.65					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	0.00	0.73	90.50	7.78		46.90	20.33					
	0.00		93.60	7.79		46.90	20.32					
	5.00		97.60	7.75		56.30	22.28					
	5.00		96.10	7.75		56.30	22.28					
	25.00		97.10	8.02		51.50	22.52					
	25.00		97.40	8.02		51.80	22.47					
	12.00		95.60	7.92		52.70	26.26					
	12.00		93.30	7.93		52.70	26.26					
	13.00		93.20	7.93		52.70	26.26					
	6.00		100.50	7.96		53.50	27.28					
	6.00		98.80	7.97		53.50	27.27					
			98.00	7.87		55.10	18.40					
			96.70	7.93		55.20	18.37					
			96.50	7.93		55.20	18.36					
			100.20	7.88		55.70	18.00					
			99.30	7.90		55.70	17.95					
			98.70	7.90		55.70	17.93					
	5.00		101.10	7.82		56.00	21.09					
	5.00		99.10	7.86		56.10	20.99					
	5.00		99.50	7.87		56.10	20.94					
	15.00		96.40	7.83		56.30	22.52					
	16.00		97.50	7.83		56.30	22.50					
	16.00		96.70	7.83		56.30	22.49					
	17.00		96.70	7.83		56.30	22.49					
	0.00		94.90	8.04		56.60	24.96					
	1.00		94.80	8.05		56.60	24.96					
	1.00		94.50	8.05		56.60	24.95					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	1.00		97.00	8.01		53.90	26.15					
	2.00		93.80	8.03		54.60	25.60					
	2.00		92.90	8.04		54.40	25.56					
			96.50	8.12		53.50	19.89					
			97.30	8.13		53.40	19.87					
			96.80	8.13		52.80	19.86					
			98.70	8.08		55.70	22.75					
			97.70	8.09		55.90	22.76					
			96.00	8.09		55.80	22.74					
			96.00	8.09		55.40	22.74					
	5.00		97.00	8.00		57.00	25.03					
	6.00		95.20	8.00		57.20	25.00					
	6.00		93.60	8.00		57.10	24.93					
	6.00		93.00	8.01		56.80	24.88					
	37.00		90.30	7.87		48.80	25.56					
	44.00		89.10	7.87		48.80	25.53					
	43.00		87.60	7.87		48.40	25.48					
	45.00		89.30	7.88		48.20	25.44					
	5.00		102.10	8.06		56.33	25.61					
	4.00		102.10	8.06		56.32	25.61					
	5.00		101.70	7.99		54.38	22.95					
	5.00		101.60	7.98		54.39	22.90					
	7.00		102.21	7.98		54.38	22.89					
	5.00		100.97	7.98		54.38	22.88					
	7.00		100.69	7.98		54.37	22.87					
	2.00		100.43	8.15		55.50	20.80					
	3.00		96.30	8.14		55.71	20.60					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	2.00		96.30	8.14		55.71	20.60					
	4.00		94.10	8.13		55.73	20.60					
	31.00		93.50	7.63		56.30	25.62					
	33.00		93.30	7.64		56.50	25.61					
	4.00		93.20	8.60		55.20	29.60					
	4.00		93.20	8.60		55.10	28.90					
	4.00		90.00	8.60		55.10	28.80					
	4.00		89.30	8.60		55.10	28.80					
	4.00		88.60	8.50		55.10	28.60					
	7.00		101.30	8.20		53.01	22.23					
	10.00		100.90	8.21		53.02	22.02					
	11.00		86.80	8.21		53.01	21.80					
	10.00		87.60	8.22		53.00	21.28					
	11.00		100.10	8.21		53.01	21.21					
	6.00		100.00	8.35		53.82	22.19					
	6.00		99.90	8.35		53.82	22.18					
	8.00		106.40	8.03		54.52	24.03					
	9.00		105.80	8.03		54.52	24.04					
	8.00		106.20	8.03		54.52	24.01					
	4.00		106.20	8.20		54.94	26.66					
	5.00		106.10	8.21		54.94	26.71					
	4.00		105.90	8.20		54.93	26.67					
	4.00		96.20	8.21		54.94	26.68					
	4.00		94.80	8.21		54.94	26.70					
	4.00		94.70	8.21		54.94	26.69					
	28.00		96.00	8.13		53.92	24.40					
	31.00		95.70	8.12		53.93	24.36					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	33.00		95.50	8.12		53.92	24.31					
	35.00		88.10	8.13		56.62	27.61					
	35.00		89.30	8.13		56.62	27.61					
	36.00		89.10	8.13		56.61	27.58					
	10.00		102.50	8.05		55.61	20.11					
	11.00		101.90	8.05		55.62	20.03					
	12.00		97.10	8.05		55.59	19.69					
	14.00		96.40	8.05		55.61	19.44					
	16.00		96.30	8.05		55.59	19.38					
	12.00		96.20	7.97		54.49	22.41					
	14.00		104.80	7.97		54.55	22.32					
	14.00		107.90	7.97		54.56	22.22					
	14.00		102.60	7.97		54.56	22.21					
	17.00		100.90	7.95		55.45	25.64					
	18.00		101.10	7.95		55.44	25.61					
	20.00		101.80	7.95		55.44	25.61					
	9.00		97.00	7.99		55.72	26.38					
	10.00		96.40	7.99		55.72	26.33					
	10.00		95.60	7.99		55.71	26.34					
	6.00		95.60	8.04		55.19	29.83					
	7.00		94.10	8.04		55.20	29.25					
	7.00		93.80	8.04		55.18	28.95					
	7.00		93.70	8.03		55.18	29.07					
	5.00		92.20	8.02		56.16	21.33					
	4.00		91.90	8.04		56.17	21.30					
	5.00		91.70	8.03		56.16	21.33					
	4.00		97.30	8.04		56.16	21.33					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	4.00		97.00	8.04		56.16	21.32					
	5.00		96.90	8.04		56.17	21.32					
	6.00		95.10	8.04		55.98	18.19					
	6.00		94.80	8.04		55.99	18.20					
	6.00		94.40	8.05		55.99	18.20					
	3.00		94.40	8.07		55.20	23.84					
	3.00		94.50	8.08		55.31	23.79					
	3.00		101.60	8.08		55.31	23.46					
	4.00		101.10	8.09		55.24	23.02					
	4.00		100.50	8.09		55.18	22.73					
	19.00		93.70	7.89		56.22	25.14					
	22.00		93.10	7.86		56.29	25.01					
	28.00		92.60	7.85		56.28	24.95					
	16.00		104.10	8.05		55.27	28.03					
	18.00		96.60	8.04		55.25	28.00					
	17.00		104.30	8.04		55.26	27.97					
	13.00		98.40	8.23		56.81	28.93					
	14.00		97.40	8.25		56.78	28.89					
	17.00		96.80	8.24		56.82	28.98					
	15.00		92.00	8.25		56.65	28.62					
	15.00		91.90	8.24		56.72	28.74					
	14.00		92.20	8.25		56.78	28.87					
	15.00		95.30	8.11		54.36	21.90					
	15.00		95.70	8.10		54.41	21.91					
	16.00		95.80	8.10		54.41	21.91					
	5.00		95.80	8.17		55.73	21.67					
	5.00		95.90	8.17		55.72	21.66					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	6.00		100.50	8.16		55.73	21.63					
	6.00		100.20	8.17		55.70	21.56					
	5.00		100.00	8.16		55.71	21.58					
	6.00		92.40	7.92		55.20	21.31					
	6.00		91.50	7.92		55.16	21.22					
	6.00		92.00	7.92		55.17	21.19					
	4.00		91.30	7.97		56.86	30.20					
	8.00		91.20	7.99		56.82	27.32					
	4.00		91.30	7.97		56.86	30.16					
	4.00		95.40	7.98		56.85	29.82					
	4.00		94.80	7.98		56.87	29.57					
	5.00		89.60	7.98		56.85	29.15					
	3.00		97.50	7.99		57.50	30.82					
	3.00		92.90	7.99		57.47	30.78					
	3.00		92.70	7.97		57.46	30.30					
	5.00		98.40	8.14		50.58	21.60					
	8.00		98.20	8.05		50.83	20.90					
	15.00		96.70	8.05		50.92	20.40					
	13.00		96.30	8.04		50.87	20.40					
	0.00		92.50	8.03		52.00	19.21					
	2.00		91.20	7.78		52.20	18.92					
	2.00		91.00	7.78		52.30	18.74					
	1.00		91.40	7.79		52.40	18.71					
	4.00		90.70	7.79		52.40	18.84					
	4.00		102.80	7.79		53.32	21.10					
	6.00		104.00	8.00		53.16	21.00					
	8.00		104.20	7.99		53.19	20.80					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	7.00		104.40	7.98		53.25	20.40					
	6.00		106.00	7.96		53.28	20.20					
	13.00		89.10	7.95		54.37	23.80					
	15.00		89.10	8.16		54.19	23.80					
	17.00		89.20	8.23		54.18	23.50					
	17.00		90.40	8.29		54.24	23.20					
	16.00		90.80	8.33		54.24	23.20					
	9.00		90.90	8.34		51.40	26.20					
	14.00		90.40	8.13		51.62	26.20					
	21.00		89.20	8.14		51.59	26.20					
	3.00		87.40	8.15		56.20	29.54					
	7.00		85.90	7.74		56.20	29.48					
	11.00		87.10	7.74		56.30	28.99					
	4.00		91.40	7.75		52.20	24.02					
	8.00		90.00	7.89		52.20	23.95					
	10.00		90.30	7.89		52.30	23.86					
	10.00		90.30	7.89		52.30	23.84					
	0.00		96.80	7.90		52.10	23.12					
	0.00		93.60	7.90		52.20	22.76					
	0.00		94.70	7.89		52.20	22.83					
	0.00		94.30	7.90		52.20	22.84					
	9.00		92.10	7.90		55.41	21.90					
	10.00		92.30	8.13		55.41	21.80					
	10.00		92.30	8.13		55.31	21.80					
	11.00		91.60	8.14		55.33	21.90					
	15.00		89.20	8.13		55.20	26.04					
	13.00		87.90	7.95		55.20	26.02					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	18.00		88.70	7.95		55.30	25.68					
	27.00		86.50	7.95		55.30	25.66					
	2.00		93.10	7.95		56.20	27.40					
	3.00		90.70	7.90		56.30	27.01					
	8.00		89.60	7.90		56.40	26.77					
	7.00		95.80	7.89		57.60	31.16					
	10.00		93.10	7.88		57.80	30.59					
	18.00		91.30	7.88		57.80	30.03					
	18.00		94.50	7.87		55.60	21.12					
	17.00		97.20	7.83		55.70	20.97					
	17.00		99.50	7.84		55.70	20.84					
	3.00		89.80	7.84		46.60	22.28					
	3.00		71.50	7.79		46.70	21.99					
	3.00		84.30	7.80		46.80	21.73					
	5.00		85.50	7.80		46.80	21.59					
	5.00		85.70	7.80		46.80	21.55					
	7.00		99.50	7.80		56.10	24.27					
	7.00		99.00	7.74		56.20	24.16					
	9.00		98.90	7.74		56.10	23.98					
	10.00		86.50	7.74		56.10	23.82					
	30.00		98.10	7.74		50.60	24.31					
	32.00		97.10	8.00		50.70	23.92					
	40.00		94.70	8.00		50.70	23.87					
	42.00		96.30	8.00		50.70	23.84					
	11.00		95.50	8.00		52.40	27.76					
	12.00		94.00	7.92		52.50	27.29					
	16.00		93.00	7.92		52.50	27.14					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	16.00		92.10	7.92		52.50	27.11					
	2.00		102.90	7.92		53.20	29.07					
	3.00		100.30	7.97		53.20	29.03					
	6.00		99.40	7.97		53.30	28.65					
	8.00		99.70	7.97		53.30	28.63					
	18.00		100.30	7.96		54.70	20.68					
	0.00		98.60	7.93		54.90	20.30					
	2.00		98.30	7.94		55.20	19.48					
	2.00		97.60	7.94		55.20	19.27					
	2.00		102.00	7.94		55.20	20.25					
	2.00		100.30	7.88		55.40	19.74					
	1.00		98.70	7.90		55.60	19.41					
	2.00		98.40	7.91		55.60	18.88					
	2.00		100.80	7.91		55.60	23.26					
	2.00		96.90	7.86		55.80	22.81					
	3.00		96.90	7.87		55.80	22.72					
	5.00		97.10	7.87		56.40	22.72					
	6.00		95.40	7.82		56.40	22.77					
	5.00		95.30	7.82		56.50	22.75					
	6.00		93.40	7.82		56.50	22.76					
	2.00		94.70	7.82		56.60	25.23					
	2.00		95.10	8.06		56.60	24.93					
	2.00		94.80	8.06		56.60	24.94					
	3.00		94.90	8.06		56.60	24.93					
	31.00		94.40	8.06		56.60	24.89					
	33.00		95.90	8.06		53.00	26.41					
	37.00		93.10	8.03		54.30	25.68					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	40.00		93.20	8.04		54.20	25.61					
	41.00		92.80	8.04		53.70	25.61					
	16.00		92.00	8.04		53.40	25.62					
	9.00		99.70	8.04		53.10	22.40					
	11.00		99.60	8.11		53.10	21.95					
	17.00		98.10	8.11		52.90	21.71					
	10.00		97.50	8.11		52.70	21.46					
	15.00		98.60	8.12		55.90	22.84					
	12.00		96.90	8.08		56.00	22.70					
	36.00		95.90	8.08		55.90	22.65					
	7.00		95.40	8.08		55.00	22.63					
	6.00		94.80	8.08		54.70	22.63					
	6.00		97.60	8.08		57.00	25.93					
	8.00		95.70	7.99		57.00	25.93					
	9.00		94.50	7.99		56.60	25.89					
	3.00		93.30	8.00		55.60	25.57					
	3.00		93.00	8.00		55.50	25.47					
	4.00		91.20	8.00		48.10	25.87					
	3.00		90.30	7.85		48.10	25.81					
	5.00		88.60	7.86		48.00	25.78					
	7.00		87.60	7.85		48.00	25.78					
	8.00		87.70	7.86		47.70	25.77					
	18.00		103.60	7.85		56.30	26.16					
	18.00		101.80	8.06		56.27	25.98					
	9.00		101.30	8.05		56.35	25.74					
	9.00		101.89	8.05		56.29	25.66					
	11.00		100.39	8.04		54.36	23.09					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	11.00		100.24	8.08		54.38	22.86					
	6.00		98.96	8.03		54.37	22.82					
	7.00		97.44	8.03		55.52	21.00					
	11.00		86.40	8.14		55.65	20.60					
	7.00		81.60	8.13		55.71	20.50					
	13.00		82.40	8.13		55.63	20.50					
	12.00		83.60	8.13		55.63	20.50					
	4.00		92.90	8.13		56.10	25.85					
	5.00		92.70	7.62		56.30	25.89					
	7.00		91.70	7.62		56.00	25.89					
	30.00		91.00	7.62		55.80	25.88					
	32.00		91.50	7.62		55.10	29.80					
	33.00		90.70	8.40		55.20	29.70					
	31.00		90.00	8.40		55.10	29.50					
	30.00		89.20	8.40		55.10	29.10					
	54.00		87.00	8.30		52.99	24.00					
	59.00		88.10	8.19		52.99	23.64					
	68.00		87.80	8.19		52.98	23.74					
	8.00		100.40	8.19		53.00	23.78					
	11.00		99.80	8.19		53.87	22.76					
	13.00		99.20	8.34		53.84	22.56					
	16.00		106.40	8.34		53.87	22.47					
	9.00		106.70	8.34		54.61	25.30					
	12.00		107.10	8.02		54.62	25.14					
	13.00		96.90	8.02		54.60	24.95					
	15.00		96.40	8.02		54.97	26.89					
	13.00		95.90	8.21		54.97	26.89					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	19.00		95.80	8.21		54.96	26.88					
	17.00		95.80	8.22		53.96	25.24					
	17.00		96.50	8.12		53.98	25.22					
	7.00		95.90	8.12		53.99	24.87					
	8.00		95.50	8.12		53.99	24.83					
	11.00		95.20	8.12		53.96	24.81					
	12.00		93.30	8.12		56.75	28.18					
	5.00		91.70	8.12		56.73	28.15					
	6.00		91.20	8.12		56.74	28.10					
	8.00		91.20	8.12		56.73	28.10					
	94.00		96.90	8.12		55.68	20.85					
	10.00		96.40	8.06		55.66	20.67					
	10.00		95.90	8.06		55.66	20.22					
	14.00		95.70	8.06		55.64	20.10					
	16.00		104.60	8.06		54.30	23.26					
	25.00		103.60	7.96		54.32	23.03					
	30.00		101.70	7.96		54.34	22.78					
	31.00		98.40	7.96		54.44	22.55					
	7.00		103.10	7.96		55.47	27.06					
	8.00		102.70	7.94		55.43	26.85					
	11.00		102.30	7.94		55.43	26.67					
	8.00		102.00	7.94		55.44	26.54					
	4.00		96.60	7.94		55.26	27.87					
	5.00		96.00	7.99		55.30	27.42					
	4.00		94.60	7.99		55.40	27.10					
	6.00		93.80	7.98		55.44	27.05					
	7.00		94.10	7.98		55.15	30.67					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	7.00		96.10	8.03		55.14	30.55					
	8.00		95.20	8.03		55.13	29.72					
	8.00		94.20	8.02		55.14	28.96					
	26.00		97.50	8.02		56.17	21.44					
	6.00		96.90	8.06		56.16	21.44					
	7.00		96.80	8.05		56.16	21.37					
	13.00		96.70	8.04		56.17	21.35					
	17.00		102.50	8.04		56.05	18.26					
	6.00		100.70	8.07		56.03	18.30					
	9.00		99.30	8.06		56.10	18.37					
	13.00		98.90	8.06		56.10	18.36					
	9.00		102.60	8.06		55.24	24.11					
	13.00		102.10	8.08		55.31	24.10					
	15.00		101.50	8.08		55.33	24.00					
	20.00		101.30	8.07		55.30	23.95					
	13.00		94.70	8.07		56.36	25.76					
	15.00		94.00	7.91		56.33	25.87					
	20.00		93.30	7.90		56.27	25.70					
	21.00		92.90	7.89		56.30	25.63					
	5.00		92.50	7.89		55.30	28.58					
	6.00		95.70	8.08		55.30	28.47					
	7.00		96.30	8.07		55.26	28.31					
	6.00		96.30	8.07		55.27	28.23					
	5.00		95.60	8.07		55.26	28.08					
	7.00		94.80	8.06		56.69	28.73					
	8.00		94.00	8.24		56.70	28.73					
	4.00		93.80	8.25		56.73	28.71					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	5.00		93.80	8.25		56.72	28.71					
	46.00		96.20	8.25		54.29	23.14					
	45.00		96.00	8.09		54.32	23.07					
	48.00		95.80	8.08		54.33	22.86					
			100.80	8.08		54.32	22.75					
			100.30	8.08		55.80	22.61					
			99.80	8.15		55.78	22.44					
			99.40	8.14		55.81	22.35					
			95.10	8.14		55.29	23.24					
			94.50	7.97		55.26	23.20					
			93.80	7.95		55.24	23.13					
			92.10	7.94		55.25	23.07					
			91.50	7.94		56.88	30.38					
			96.00	7.97		56.88	30.33					
			95.60	7.97		56.88	30.32					
			93.40	7.97		56.85	30.12					
			97.30	7.97		57.07	29.09					
			96.50	7.97		57.45	31.29					
			95.00	8.00		57.45	31.25					
			93.90	8.00		57.43	30.79					
				7.99								
80th %ile	16.00	3.05	99.84	8.13	46.20	56.30	27.05	38.40	79.00	240.00	84.00	10.00
Max	94.00	5.00	109.50	8.60	48.00	58.10	31.29	40.00	160.00	300.00	90.00	10.00
Median	8.00	1.60	95.70	8.00	39.50	55.26	23.76	36.00	21.00	150.00	65.00	10.00
Min	0.00	0.53	71.50	7.48	34.00	46.60	17.72	32.00	16.00	100.00	50.00	10.00
20th %ile	4.00	0.96	91.36	7.89	34.00	53.14	21.32	33.60	16.60	100.00	50.00	10.00

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
WQO	6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

Section 3 Wet Season

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
CH	7.30	5.00	96.60	8.02	38.00	55.50	22.30	50.00	30.00	200.00	40.00	10.00
	8.50	5.00	89.90	7.11		55.10	22.70	50.00	20.00	100.00	30.00	10.00
	10.00		89.90	4.60		54.90	22.80					
	11.90		91.00	8.11		54.70	24.20					
	13.00		89.20	6.09		54.80	24.30					
	27.60		87.70	5.85		54.80	24.20					
EPA	16.00	9.75	88.30	7.88	22.00	33.80	30.30					
	18.00	4.42	88.70	7.89	12.40	33.83	30.30					
	21.00	2.54	92.60	7.92	38.60	36.62	30.90					
	24.00	3.15	94.00	7.99	22.10	37.14	31.50					
	10.00	11.49	92.30	8.09	10.20	48.10	31.50					
	10.00	1.80	91.80	8.10	11.70	48.22	31.30					
	12.00	1.07	90.00	8.11	10.00	48.32	31.10					
	13.00	1.87	89.00	8.11		48.23	31.10					
	34.00	2.65	89.60	8.12		44.86	31.20					
	21.00	3.01	93.90	8.15		52.77	26.00					
	23.00	3.94	95.60	8.15		52.91	26.00					
	31.00	4.41	95.30	8.14		52.99	25.90					
	39.00	3.72	95.60	8.14		52.99	25.90					
	11.00	12.17	88.50	7.57		58.70	31.14					
	8.00	2.14	88.40	7.57		58.90	30.68					
	10.00	2.67	84.70	7.57		59.00	30.44					
	10.00	1.60	85.70	7.57		59.00	30.47					
	5.00	2.07	108.10	8.14		42.29	26.40					
	5.00	1.94	107.70	8.16		42.37	26.40					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	8.00	2.14	107.00	8.17		42.51	26.40					
	9.00	2.00	105.70	8.18		42.51	26.50					
	18.00	1.96	89.60	8.14		52.76	30.40					
	24.00	3.54	91.60	8.14		53.01	30.40					
	25.00	2.81	91.10	8.14		53.01	30.50					
	13.00	2.27	85.60	7.76		53.90	28.39					
	20.00	2.67	85.20	7.76		53.90	28.39					
	22.00	2.20	85.30	7.76		53.90	28.39					
	22.00	1.67	84.60	7.76		53.90	28.36					
	28.00	0.80	90.30	8.15		55.18	31.90					
	27.00	2.00	89.90	8.15		55.31	31.90					
	33.00	3.93	90.00	8.15		55.44	31.90					
	26.00	4.45	90.00	8.16		55.38	31.90					
	32.00	2.56	88.70	8.16		55.65	31.80					
	39.00	1.81	87.90	8.10		54.20	25.10					
	43.00	4.21	87.70	8.10		54.30	25.10					
	48.00	1.67	87.00	8.10		54.20	25.20					
	54.00	0.80	87.70	8.10		54.40	25.00					
	56.00	1.87	87.50	8.10		54.30	25.00					
	20.00	0.85	85.50	8.17		51.63	25.30					
	28.00	1.78	85.50	8.17		51.65	25.20					
	29.00	1.17	85.60	8.17		51.65	25.20					
	32.00	2.75	85.70	8.17		51.60	25.20					
	2.00	1.42	90.20	8.20		53.61	25.60					
	3.00	2.14	89.10	8.19		53.56	25.50					
	8.00	1.58	87.80	8.19		53.62	25.20					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	37.00	1.23	89.40	7.83		58.50	32.71					
	41.00	4.54	88.70	7.84		58.60	32.75					
	42.00	4.28	93.00	7.79		58.60	30.65					
	44.00	2.54	91.80	7.79		58.60	30.67					
	14.00	2.81	107.50	7.99		58.10	36.42					
	16.00	2.09	108.60	7.99		58.20	36.43					
	92.00	0.95	93.30	7.93		56.70	30.62					
	90.00	0.94	92.90	7.93		56.80	30.64					
	93.00	0.94	91.90	7.93		56.80	30.65					
	31.00		100.20	7.93		59.50	30.06					
	44.00		99.80	7.93		59.50	30.06					
	19.00		98.20	7.86		60.00	26.46					
	18.00		99.30	7.86		60.00	26.49					
	5.00		101.40	7.90		52.20	31.46					
	6.00		99.90	7.89		52.20	31.48					
	6.00		101.30	7.89		52.20	31.49					
	3.00		101.90	7.77		49.10	34.26					
	4.00		100.60	7.77		49.20	34.28					
	4.00		100.80	7.77		49.30	34.30					
	9.00		97.90	7.66		52.30	31.36					
	13.00		96.40	7.66		52.30	31.34					
	43.00		95.90	7.79		51.50	29.27					
	41.00		94.80	7.79		51.40	29.26					
	46.00		95.20	7.79		51.50	29.20					
	10.00		94.80	7.95		55.20	27.25					
	10.00		94.40	7.96		55.30	27.27					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	12.00		93.40	7.96		55.30	27.28					
	13.00		101.40	7.87		54.80	25.54					
	14.00		101.30	7.88		54.80	25.55					
	13.00		97.40	8.03		54.60	26.82					
	15.00		95.70	8.02		54.80	26.55					
	22.00		94.80	8.02		54.80	26.50					
	22.00		101.00	7.88		51.00	30.81					
	27.00		99.10	7.88		51.20	30.47					
	5.00		94.50	7.87		51.40	29.11					
	6.00		96.60	8.16		57.50	28.25					
	12.00		95.50	8.16		57.70	26.84					
	10.00		93.90	8.16		57.60	26.35					
	11.00		93.20	8.16		57.00	26.18					
	10.00		92.90	8.03		53.09	29.20					
	59.00		95.10	8.04		53.16	29.20					
	53.00		91.40	8.03		52.97	29.30					
	54.00		93.00	7.73		57.10	30.78					
	53.00		92.50	7.73		57.10	30.78					
	50.00		92.20	7.73		56.90	30.77					
	51.00		95.30	7.85		57.30	27.62					
	13.00		93.30	7.85		57.60	26.95					
	16.00		89.40	7.80		57.40	25.27					
	6.00		92.60	7.86		49.99	29.17					
	9.00		91.90	7.85		49.92	29.01					
	8.00		92.30	7.86		49.92	29.08					
	2.00		92.40	7.86		49.90	29.04					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	3.00		92.30	7.85		49.90	29.02					
	4.00		92.00	7.85		49.91	29.01					
	38.00		91.90	8.00		53.20	30.60					
	37.00		91.30	8.00		53.30	30.60					
	37.00		91.00	8.00		53.20	30.60					
	4.00		101.10	7.90		52.80	33.20					
	5.00		100.90	7.90		52.80	33.20					
	6.00		100.50	7.90		52.80	33.20					
	5.00		88.40	8.04		54.60	28.22					
	8.00		94.90	8.05		54.80	28.26					
	10.00		91.90	8.11		56.33	25.60					
	10.00		108.70	8.11		57.07	25.60					
	11.00		107.00	8.11		57.09	25.60					
	34.00		90.10	7.97		55.21	29.68					
	37.00		90.70	7.97		55.20	29.68					
	34.00		91.00	7.97		55.19	29.69					
	31.00		90.60	7.90		53.90	29.16					
	32.00		90.40	7.90		53.90	29.16					
	33.00		103.30	7.90		53.90	29.16					
	34.00		103.10	7.90		53.90	29.16					
	39.00		103.20	8.10		55.79	26.54					
	35.00		103.00	8.10		55.78	26.53					
	38.00		103.00	8.10		55.78	26.52					
	17.00		91.30	8.04		58.41	32.80					
	15.00		91.00	8.03		58.43	32.80					
	15.00		90.40	8.04		58.40	32.80					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	16.00		95.30	8.04		58.40	32.78					
	8.00		96.20	8.04		58.41	32.79					
	9.00		96.20	8.13		58.22	29.88					
	8.00		94.90	8.13		58.29	29.93					
	11.00		85.40	8.14		58.32	29.86					
	7.00		84.80	8.10		58.38	29.77					
	6.00		84.60	8.23		39.91	30.11					
	6.00		107.20	8.23		39.93	30.09					
	6.00		104.10	8.24		39.96	30.07					
	9.00		102.90	8.23		46.80	28.38					
	8.00		106.30	8.23		46.81	28.36					
	11.00		104.20	8.24		46.82	28.35					
	8.00		92.90	8.00		46.94	31.26					
	5.00		106.90	8.01		48.45	31.87					
	6.00		99.40	8.01		49.03	31.74					
	5.00		94.50	7.90		42.98	32.90					
	5.00		75.40	7.85		47.29	32.33					
	6.00		74.70	7.83		48.13	32.16					
	7.00		74.40	7.69		17.96	28.58					
	9.00		74.60	7.63		18.72	28.81					
	10.00		75.10	7.61		18.72	28.89					
	5.00		96.60	7.59		19.76	28.97					
	4.00		96.70	7.58		22.71	29.22					
	4.00		96.60	8.02		45.25	31.12					
	4.00		96.90	8.03		45.28	31.18					
	5.00		97.10	8.03		45.27	31.22					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	29.00		96.40	8.05		45.52	31.38					
	30.00		96.00	8.06		46.57	31.81					
	34.00		95.90	8.00		54.46	29.40					
	30.00		96.40	8.00		54.46	29.39					
	26.00		96.30	8.00		54.45	29.37					
	26.00		96.10	8.00		54.46	29.41					
	14.00		95.90	8.00		54.45	29.40					
	14.00		95.80	8.00		54.46	29.39					
	15.00		96.60	8.00		54.45	29.40					
	17.00		96.90	8.08		54.91	25.72					
	37.00		95.80	8.09		54.89	25.75					
	38.00		95.20	8.09		54.89	25.77					
	19.00		93.40	8.17		54.39	32.04					
	19.00		91.50	8.18		54.89	32.16					
	6.00		91.30	8.18		54.89	32.44					
	6.00		92.10	8.17		54.47	32.00					
	7.00		92.00	8.17		54.53	31.99					
	6.00		95.70	8.18		54.84	32.10					
	8.00		95.80	8.18		54.72	32.02					
	8.00		95.70	7.94		51.42	31.74					
	9.00		95.20	7.94		51.40	31.80					
	5.00		95.10	7.94		51.40	31.81					
	4.00		95.10	8.01		54.14	30.78					
	3.00		95.20	8.01		54.14	30.80					
	4.00		95.00	8.01		54.14	30.80					
	4.00		94.80	8.01		54.14	30.80					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	5.00		99.50	8.02		54.14	30.81					
	17.00		99.20	8.02		54.15	30.81					
	16.00		98.80	7.95		55.42	29.38					
	17.00		98.00	7.95		55.42	29.39					
	9.00		96.70	7.95		55.43	29.38					
	11.00		96.20	8.06		56.40	24.05					
	12.00		96.20	8.05		56.39	24.04					
	6.00		95.60	8.01		56.48	24.05					
	5.00		98.10	8.06		56.31	24.14					
	4.00		98.20	8.06		56.38	24.02					
			95.40	7.95		56.85	33.12					
			122.00	7.95		56.83	33.11					
			115.40	7.95		56.83	33.10					
			112.10	8.00		49.83	35.77					
			107.30	7.99		50.37	32.62					
			106.70	7.99		50.41	32.44					
			106.30	8.07		50.67	33.45					
			105.60	8.07		50.67	33.51					
			99.70	8.08		50.64	33.51					
			99.60	8.08		50.65	33.51					
			99.00	8.00		56.79	28.04					
			98.50	8.00		56.78	28.03					
				8.00		56.77	27.97					
				8.00		56.79	27.97					
GHD	6.10		88.00	8.70	28.00	51.70	27.20	113.00	22.00	500.00	30.00	10.00
	6.10		88.00	8.08	16.00	51.70	27.00	104.00	18.00	100.00	160.00	10.00

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	6.10		87.90	8.08	66.00	51.70	27.10	72.00	17.00	100.00	70.00	10.00
	6.10		87.70	8.08	34.00	51.70	27.10	85.00	10.00	100.00	50.00	10.00
	5.90		87.70	8.08	32.00	51.60	27.10	91.00	38.00	300.00	30.00	10.00
	5.60		87.70	8.08	18.00	51.60	27.10	58.00	16.00	100.00	160.00	10.00
	5.90		87.40	8.08	31.00	51.60	27.10	81.00	10.00	100.00	90.00	10.00
	6.60		87.40	8.08	16.00	51.60	27.10	31.00	10.00	100.00	60.00	10.00
	5.90		87.20	8.08	30.00	51.60	27.10					
	5.60		87.60	8.08	34.00	56.80	27.10					
	40.80		83.50	7.40	72.00	56.80	27.74					
	39.50		83.60	7.41	38.00	56.80	27.73					
	34.70		83.70	7.41	71.00	56.80	27.73					
	36.50		83.70	7.42	14.00	56.80	27.75					
	37.40		83.90	7.43	41.00	56.80	27.78					
	38.00		84.00	7.43	24.00	56.80	27.78					
	36.50		84.10	7.43		56.80	27.77					
	41.30		84.20	7.44		56.80	27.77					
	41.40		84.30	7.44		56.80	27.77					
	41.80		84.40	7.44		57.30	27.78					
	12.70		77.10	7.98		57.30	28.27					
	13.90		78.30	7.99		57.30	28.25					
	13.10		78.20	7.99		57.30	28.24					
	13.50		78.10	7.99		57.30	28.22					
	12.80		78.10	7.99		57.30	28.24					
	12.10		78.10	7.99		57.30	28.25					
	14.40		78.10	7.99		57.30	28.24					
	12.90		78.10	7.99		57.30	28.25					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	12.80		78.10	7.99		57.30	28.26					
	11.90		78.10	7.99		56.20	28.26					
	25.60		87.40	6.66		56.40	26.40					
	26.50		86.70	6.67		56.40	26.40					
	25.10		86.90	6.67		56.40	26.40					
	29.20		86.40	6.66		56.40	26.40					
	26.00		86.70	6.67		56.40	26.40					
	28.40		86.20	6.68		56.40	26.40					
	27.00		86.30	6.68		56.40	26.40					
	28.70		86.30	6.69		56.40	26.40					
	34.40		86.00	6.68		56.40	26.40					
	28.70		85.70	6.69		56.80	26.40					
	17.80		84.60	6.03		56.80	26.50					
	16.80		84.10	6.03		56.80	26.50					
	18.90		84.20	6.03		56.80	26.50					
	18.90		84.40	6.03		56.70	26.50					
	15.90		84.40	6.04		56.70	26.50					
	14.80		84.20	6.04		56.70	26.50					
	18.00		84.40	6.04		56.70	26.50					
	17.70		84.40	6.04		56.70	26.50					
	16.60		84.40	6.04		56.70	26.50					
	15.70		84.50	6.04		51.60	26.50					
	7.80		86.60	8.08		51.60	26.90					
	8.40		86.90	8.08		51.60	26.90					
	8.50		86.80	8.08		51.70	26.90					
	8.40		87.00	8.09		51.70	26.90					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	9.20		88.50	8.08		52.20	26.00					
	9.60		92.30	8.21		52.20	27.73					
	9.00		94.10	8.27		52.20	27.73					
	8.80		94.20	8.28		52.20	27.72					
	8.50		94.50	8.28		52.20	27.73					
	7.90		94.50	8.28		56.80	27.72					
	45.40		84.70	7.52		56.70	27.72					
	44.90		84.70	7.53		56.80	27.72					
	43.40		84.70	7.54		56.80	27.72					
	42.30		84.70	7.54		56.80	27.72					
	41.60		84.80	7.55		56.80	27.73					
	44.90		84.80	7.55		56.80	28.23					
	41.80		84.80	7.55		56.80	28.24					
	46.70		84.90	7.55		56.80	28.22					
	44.10		84.90	7.56		56.70	28.22					
	43.90		85.00	7.56		57.30	28.22					
	14.20		77.90	8.00		57.30	28.21					
	13.50		77.90	8.00		57.30	28.23					
	16.80		77.90	8.00		57.30	28.24					
	16.80		77.90	8.00		57.30	28.25					
	21.00		77.90	8.00		57.30	28.25					
	14.40		77.90	8.00		57.30	26.40					
	13.90		78.00	8.00		57.30	26.40					
	13.40		77.90	8.00		57.40	26.40					
	13.40		77.90	8.00		57.40	26.40					
	13.40		77.90	8.00		56.80	26.40					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	39.90		88.10	6.56		56.80	26.40					
	31.90		86.40	6.55		56.80	26.40					
	28.30		86.30	6.52		56.80	26.40					
	28.50		86.60	6.52		56.80	26.40					
	21.20		86.00	6.52		56.90	26.40					
	32.50		85.30	6.53		56.80	26.60					
	28.10		84.40	6.53		56.90	26.60					
	22.80		84.00	6.52		56.90	26.50					
	27.20		84.60	6.52		56.80	26.50					
	23.70		84.20	6.52		56.70	26.50					
	14.50		84.00	6.04		56.70	26.60					
	14.20		84.10	6.04		56.70	26.60					
	15.60		84.20	6.04		56.70	26.60					
	15.60		84.20	6.04		56.70	26.60					
	10.90		84.40	6.04		56.70	26.60					
	9.90		84.60	6.04		56.70	27.74					
	12.30		84.60	6.04		56.60	27.73					
	14.40		84.20	6.04		56.70	27.74					
	13.70		84.20	6.04		56.70	27.73					
	11.90		84.50	6.04		52.20	27.73					
	8.60		93.60	8.28		52.20	27.72					
	8.00		93.80	8.28		52.20	27.73					
	8.90		93.90	8.28		52.20	27.72					
	8.10		94.00	8.28		52.20	27.73					
	8.90		94.20	8.27		52.20	27.74					
	8.50		94.10	8.27		52.30	28.21					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	8.00		94.00	8.27		52.30	28.21					
	11.00		94.00	8.27		52.30	28.21					
	8.20		94.00	8.27		52.30	28.21					
	9.10		93.60	8.26		56.80	28.20					
	43.30		85.70	7.60		56.80	28.21					
	44.70		85.80	7.60		56.80	28.22					
	45.40		85.70	7.60		56.80	28.22					
	43.90		85.90	7.61		56.80	28.22					
	51.60		85.90	7.61		56.80	28.22					
	46.90		85.90	7.61		56.70	26.40					
	50.50		85.90	7.61		56.80	26.40					
	46.90		86.00	7.61		56.70	26.40					
	42.70		85.90	7.61		56.80	26.40					
	45.10		85.90	7.61		57.30	26.40					
	31.60		77.80	8.00		57.30	26.40					
	35.20		77.80	8.00		57.30	26.40					
	37.80		77.70	8.00		57.30	26.40					
	37.80		77.70	8.00		57.30	26.40					
	38.80		77.70	8.00		57.30	26.40					
	35.50		77.70	8.00		57.30	26.60					
	35.50		77.60	8.00		57.30	26.60					
	35.50		77.60	8.00		57.30	26.60					
	21.30		77.60	8.00		57.30	26.60					
	26.00		77.60	8.00		56.90	26.50					
	25.70		86.10	6.51		56.90	26.60					
	27.90		85.30	6.50		56.90	26.60					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	27.50		85.50	6.49		56.90	26.50					
	26.30		85.10	6.49		56.80	26.50					
	31.80		85.50	6.49		56.90	26.50					
	25.50		85.10	6.49		56.80	30.90					
	35.00		85.30	6.50		56.90	30.90					
	31.10		84.50	6.49		56.80	30.90					
	33.70		84.60	6.49		56.90	30.90					
	37.70		83.80	6.50		56.60	30.90					
	27.10		84.90	6.03		56.70	30.90					
	12.60		84.80	6.03		56.60	30.90					
	23.70		84.80	6.03		56.60	30.90					
	19.50		84.80	6.03		56.70	30.90					
	17.70		84.80	6.03		56.70	30.90					
	19.20		84.80	6.03		56.70	33.80					
	19.10		84.80	6.03		56.70	33.80					
	21.20		84.80	6.03		56.70	33.79					
	21.40		84.80	6.03		56.70	33.80					
	19.10		84.80	6.04		56.10	33.79					
	4.30		90.20	7.57		56.10	33.79					
	5.40		90.10	7.57		56.10	33.79					
	5.90		89.80	7.58		56.10	33.80					
	6.20		89.70	7.58		56.10	33.80					
	5.30		89.40	7.58		56.10	33.80					
	5.60		88.60	7.58		56.10	30.40					
	5.50		89.10	7.59		56.10	30.40					
	5.80		88.40	7.59		56.10	30.50					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	5.70		88.60	7.59		56.10	30.50					
	6.80		87.90	7.59		56.10	30.50					
	9.50		88.90	7.61		56.10	30.50					
	8.80		88.90	7.61		56.10	30.50					
	9.40		89.10	7.61		56.10	30.60					
	9.10		89.10	7.61		56.10	30.60					
	9.50		89.30	7.61		56.10	30.60					
	9.80		89.40	7.61		56.10	33.78					
	9.40		89.40	7.61		56.10	33.78					
	9.80		89.50	7.61		56.20	33.78					
	9.80		89.50	7.62		56.10	33.77					
	9.50		89.60	7.62		56.10	33.77					
	7.40		108.50	7.63		56.10	33.77					
	6.80		108.60	7.63		56.10	33.77					
	6.20		106.90	7.63		56.10	33.77					
	5.80		105.60	7.63		56.00	33.78					
	5.90		105.20	7.63		56.10	33.79					
	5.90		104.40	7.63		56.20	30.60					
	5.80		104.80	7.64		56.10	30.60					
	6.70		102.00	7.64		56.10	30.60					
	6.30		101.10	7.64		56.20	30.60					
	6.20		102.40	7.64		51.50	30.60					
	9.00		89.30	8.08		51.40	30.60					
	8.80		89.30	8.11		51.30	30.60					
	8.80		89.30	8.10		51.30	30.60					
	9.40		89.40	8.11		51.40	30.60					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	9.40		89.40	8.10		51.40	30.60					
	9.50		89.40	8.11		51.40	33.62					
	9.40		89.40	8.11		51.40	33.54					
	10.00		89.40	8.11		51.50	33.52					
	9.10		89.50	8.10		51.50	33.49					
	9.00		89.40	8.10		56.80	33.46					
	5.90		111.10	7.66		56.80	33.33					
	7.00		110.10	7.66		56.80	33.43					
	6.60		111.00	7.67		56.80	33.49					
	6.00		110.40	7.67		56.80	33.49					
	5.70		106.30	7.67		56.80	33.51					
	5.90		105.30	7.67		56.80	27.40					
	6.90		106.60	7.67		56.80	27.40					
	6.40		106.60	7.67		56.80	27.40					
	6.00		103.40	7.67		56.80	27.40					
	5.80		104.20	7.67		57.30	27.40					
	14.00		87.80	7.99		57.30	27.40					
	18.00		88.20	7.99		57.30	27.40					
	15.70		88.00	7.99		57.30	27.40					
	16.00		87.70	7.99		57.30	27.50					
	18.70		87.40	7.99		57.30	27.50					
	22.30		86.70	7.99		57.30	27.72					
	15.70		85.80	7.99		57.30	27.72					
	16.40		85.40	7.99		57.30	27.72					
	16.30		85.60	7.99		57.30	27.72					
	14.00		85.90	7.98		56.90	27.72					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	7.10		87.40	6.67		56.90	27.72					
	8.40		86.90	6.67		56.90	27.72					
	8.40		86.80	6.67		56.90	27.72					
	6.80		87.20	6.68		56.90	27.72					
	8.20		86.70	6.68		56.90	27.72					
	7.50		87.00	6.68		56.90	28.30					
	8.00		86.70	6.68		56.90	28.30					
	7.00		86.70	6.69		56.90	28.30					
	7.10		86.70	6.69		56.90	28.30					
	6.80		86.50	6.69		56.70	28.25					
	42.40		86.90	6.07		56.70	28.25					
	41.40		87.00	6.08		56.70	28.25					
	40.00		87.00	6.08		56.60	28.28					
	40.50		87.10	6.08		56.60	28.28					
	45.40		87.10	6.08		56.60	28.30					
	44.60		87.20	6.08		56.60	26.40					
	43.30		87.20	6.08		56.60	26.40					
	43.10		87.20	6.08		56.60	26.40					
	40.50		87.20	6.09		56.50	26.50					
	45.30		87.30	6.08		51.90	26.50					
	14.20		77.20	8.30		52.00	26.50					
	14.40		77.60	8.30		52.00	26.50					
	14.40		77.60	8.30		52.00	26.50					
	14.40		77.60	8.30		52.00	26.50					
	18.10		77.70	8.29		52.00	26.50					
	18.10		77.70	8.29		51.90	26.50					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	16.50		77.70	8.29		51.90	26.50					
	15.10		77.60	8.28		52.00	26.60					
	15.10		77.50	8.28		52.00	26.60					
	14.50		77.50	8.28		56.80	26.60					
	17.00		88.60	7.70		56.80	26.60					
	16.90		87.90	7.70		56.80	26.60					
	17.50		87.20	7.70		56.80	26.60					
	18.20		86.60	7.71		56.80	26.60					
	14.80		86.30	7.71		56.80	26.60					
	15.40		86.30	7.71		56.80	27.71					
	17.50		86.20	7.71		56.80	27.71					
	16.50		86.00	7.71		56.80	27.71					
	13.60		85.60	7.71		56.80	27.70					
	12.60		85.50	7.71		57.30	27.70					
	21.20		84.70	7.99		57.30	27.71					
	19.50		84.50	7.99		57.30	27.70					
	17.90		84.10	7.99		57.30	27.70					
	18.70		84.40	7.99		57.30	27.71					
	18.00		84.40	7.99		57.30	27.70					
	18.30		84.10	7.99		57.30	28.22					
	16.50		84.00	7.99		57.30	28.23					
	16.90		84.00	8.00		57.30	28.23					
	17.50		83.80	8.00		57.30	28.24					
	19.10		83.40	8.00		56.90	28.22					
	7.10		94.40	6.59		56.90	28.21					
	7.50		94.30	6.58		56.90	28.24					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	7.50		94.10	6.58		56.80	28.24					
	7.60		94.00	6.58		56.90	28.24					
	7.80		93.90	6.58		56.80	28.24					
	8.10		93.70	6.58		56.80	26.40					
	7.60		93.60	6.58		56.80	26.40					
	8.50		93.50	6.59		56.80	26.40					
	8.10		93.30	6.59		56.90	26.40					
	8.20		93.20	6.59		56.60	26.40					
	44.30		87.70	6.01		56.70	26.40					
	42.30		87.70	6.01		56.60	26.40					
	49.00		87.80	6.01		56.70	26.40					
	42.80		87.80	6.01		56.70	26.40					
	41.70		87.80	6.01		56.70	26.40					
	45.30		87.80	6.01		56.70	26.60					
	44.60		87.80	6.01		56.70	26.60					
	46.20		87.90	6.01		56.70	26.50					
	44.00		87.90	6.01		56.70	26.50					
	46.70		87.90	6.01		52.10	26.50					
	17.10		77.20	8.27		52.10	26.50					
	17.10		77.20	8.27		52.10	26.50					
	16.80		77.20	8.27		52.20	26.50					
	16.50		77.20	8.27		52.10	26.50					
	18.70		77.10	8.27		52.10	26.50					
	20.40		77.20	8.27		52.10	27.70					
	16.70		77.20	8.27		52.10	27.70					
	17.00		77.20	8.27		52.10	27.70					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	16.20		77.20	8.27		56.80	27.70					
	16.20		77.20	7.72		56.80	27.69					
	20.40		86.10	7.72		56.80	27.69					
	21.00		85.50	7.72		56.80	27.69					
	24.60		84.70	7.72		56.80	27.69					
	21.10		83.60	7.72		56.80	27.69					
	22.60		83.30	7.72		56.80	27.69					
	19.50		83.10	7.72		56.80	28.23					
	16.40		82.60	7.72		56.80	28.23					
	23.90		82.50	7.72		56.80	28.23					
	27.30		81.80	7.72		57.30	28.23					
	21.30		81.50	8.00		57.30	28.23					
	16.70		84.00	8.00		57.30	28.23					
	18.20		84.10	8.00		57.30	28.23					
	18.70		84.10	8.00		57.30	28.23					
	18.00		84.10	8.00		57.30	28.23					
	16.30		84.00	8.00		57.30	28.23					
	18.30		84.00	8.00		57.30	26.40					
	16.80		83.90	8.00		57.30	26.40					
	20.60		83.60	8.00		57.30	26.40					
	18.60		83.30	8.00		56.90	26.40					
	19.60		83.30	6.53		56.90	26.40					
	10.30		91.60	6.53		56.90	26.40					
	10.20		91.50	6.53		56.90	26.40					
	10.00		91.50	6.53		56.90	26.40					
	8.60		91.60	6.53		56.90	26.40					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	9.70		91.90	6.53		56.90	26.40					
	9.70		91.50	6.53		56.90	26.50					
	11.30		91.50	6.53		56.90	26.50					
	11.30		91.40	6.53		56.90	26.50					
	11.00		91.40	6.52		56.70	26.40					
	49.60		88.00	5.98		56.70	26.50					
	50.60		88.00	5.98		56.70	26.50					
	52.60		88.00	5.98		56.70	26.50					
	54.80		88.10	5.98		56.80	26.50					
	52.80		88.10	5.99		56.70	26.50					
	56.60		88.10	5.99		56.80	26.50					
	54.50		88.10	5.98		56.90	31.20					
	53.50		88.10	5.98		56.80	31.30					
	51.80		88.10	5.99		56.70	31.30					
	53.90		88.10	5.99		55.80	31.30					
	17.30		77.30	7.67		55.70	31.30					
	18.30		77.40	7.67		55.80	31.30					
	17.00		77.40	7.66		55.70	31.30					
	17.00		77.40	7.66		55.80	31.30					
	17.30		77.40	7.66		55.80	31.30					
	16.00		77.40	7.66		55.70	31.30					
	17.40		77.40	7.66		55.70	32.82					
	19.10		77.40	7.66		55.70	32.78					
	17.00		77.40	7.66		55.70	32.81					
	20.00		77.40	7.66		55.70	32.79					
	36.00		84.20	7.65		55.90	32.82					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	47.20		83.00	7.65		55.90	32.82					
	41.70		82.30	7.65		55.80	32.81					
	28.10		81.30	7.65		55.70	32.81					
	42.20		79.70	7.65		55.80	32.80					
	27.00		78.60	7.65		55.70	32.80					
	35.40		78.00	7.65		55.60	31.30					
	45.10		77.30	7.65		55.70	31.30					
	37.20		77.10	7.65		55.80	31.30					
	37.40		77.70	7.65		55.60	31.30					
	17.30		83.30	7.65		55.60	31.30					
	17.10		83.00	7.65		55.60	31.30					
	15.00		82.90	7.65		55.70	31.30					
	19.70		83.00	7.65		55.70	31.30					
	17.90		82.90	7.65		55.60	31.30					
	21.80		84.10	7.65		55.60	31.30					
	24.30		84.80	7.65		55.60	32.62					
	25.50		84.20	7.65		55.70	32.58					
	25.50		84.20	7.65		55.70	32.69					
	22.20		84.40	7.65			32.74					
	9.20		86.10				32.80					
	9.00		87.20				32.76					
	9.40		86.40				32.74					
	7.70		85.60				32.62					
	7.90		85.50				32.61					
	7.70		86.40				32.68					
	9.20		87.20				31.30					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	8.40		87.10				31.30					
	7.80		87.00				31.30					
	9.00		86.70				31.30					
	15.00		88.20				31.30					
	15.90		88.40				31.30					
	15.20		88.40				31.30					
	15.70		88.50				31.30					
	14.70		88.40				31.30					
	15.40		88.60				31.30					
	15.30		88.60				32.42					
	15.60		88.60				32.40					
	15.60		88.60				32.42					
	15.40		88.60				32.46					
	10.40		108.10				32.44					
	8.30		107.60				32.41					
	7.70		107.90				32.39					
	9.00		107.90				32.39					
	9.50		109.00				32.40					
	8.80		107.70				32.41					
	9.90		105.80									
	8.80		104.90									
	8.50		103.40									
	8.60		103.80									
	17.30		88.60									
	17.70		88.60									
	16.30		88.30									

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	16.60		88.20									
	16.00		88.10									
	16.00		88.30									
	17.30		88.40									
	18.10		88.80									
	17.30		88.80									
	16.80		88.40									
	10.90		120.90									
	8.70		118.80									
	10.40		115.80									
	12.50		114.80									
	9.00		112.20									
	10.40		112.40									
	11.80		112.80									
	10.70		112.60									
	11.90		110.60									
	10.60		110.90									
	22.60		86.50									
	22.00		86.50									
	20.50		86.40									
	19.50		86.30									
	21.80		86.40									
	23.00		86.50									
	23.60		86.50									
	23.40		86.50									
	21.90		86.30									

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Solids (suspended) mg/L	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	22.60		86.10									
80th %ile	32.00	3.94	95.68	8.08	38.24	56.90	31.30	93.60	23.60	220.00	104.00	10.00
Max	93.00	12.17	122.00	8.70	72.00	60.00	36.43	113.00	38.00	500.00	160.00	10.00
Median	16.00	2.17	88.10	7.86	29.00	56.40	28.23	76.50	17.50	100.00	55.00	10.00
Min	2.00	0.80	74.40	4.60	10.00	17.96	22.30	31.00	10.00	100.00	30.00	10.00
20th %ile	8.08	1.60	84.20	6.68	15.20	52.20	26.50	50.00	10.00	100.00	30.00	10.00
WQO	6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

Section 3 Dry Season

Dry Season	Turbidity NTU	Chlorophyll-a (ug/L)	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
CH	19.00	5.00	103.00	7.76	32.00	56.10	23.76	35.00	23.00	300.00	50.00	10.00
	12.00	5.00	104.60	7.77	36.00	55.50	23.78		18.00	100.00	60.00	10.00
			104.90	7.79		55.20	23.80					
			102.30	7.72		56.50	21.75					
			104.90	7.73		56.40	21.79					
			104.80	7.75		56.30	21.78					
EPA	5.00	1.60	92.20	8.07		50.08	22.70					
	8.00	3.87	92.30	8.07		50.13	22.70					
	7.00	6.46	91.70	8.08		50.18	22.70					
	8.00	5.39	91.70	8.08		50.13	22.70					
	0.00	9.75	93.50	7.79		52.00	21.45					
	0.00	4.68	93.00	7.78		52.10	20.94					
	0.00	5.34	92.30	7.76		52.10	20.43					
	0.00	2.67	90.80	7.76		52.10	20.16					
	4.00	2.27	89.50	7.74		52.10	19.95					
	12.00	1.34	103.50	8.04		52.97	21.40					
	12.00	1.65	103.00	8.03		52.97	21.40					
	12.00	1.34	102.10	8.02		52.97	21.40					
	18.00	2.10	88.90	8.12		53.98	24.80					
	17.00	2.67	89.30	8.18		53.98	24.70					
	20.00	2.67	89.00	8.22		53.98	24.70					
	20.00	4.01	88.60	8.24		53.93	24.70					
	20.00	2.81	88.60	8.26		53.98	24.70					
	12.00	3.02	90.70	8.12		50.50	26.40					
	15.00	2.51	92.10	8.16		51.70	27.40					
	14.00	1.07	90.50	8.13		50.74	26.40					

Dry Season	Turbidity NTU	Chlorophyll-a (ug/L)	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	14.00	0.84	89.40	8.13		50.77	26.40					
	12.00	0.94	90.50	8.15		51.27	26.90					
	15.00	1.20	89.90	8.15		51.19	26.80					
	3.00	0.98	91.40	7.75		55.90	31.54					
	1.00	1.00	89.60	7.74		56.10	30.81					
	1.00	2.23	89.20	7.74		56.00	30.41					
	9.00	0.67	91.20	7.89		51.60	24.39					
	7.00	0.45	90.70	7.89		51.70	24.37					
	8.00	10.11	91.10	7.89		51.60	24.38					
	11.00	3.74	91.20	7.89		51.70	24.36					
	10.00	2.20	91.10	7.88		51.70	24.35					
	0.00	1.34	97.20	7.91		52.10	23.37					
	0.00	0.89	97.00	7.91		52.10	23.33					
	0.00	2.08	95.20	7.91		52.10	23.14					
	13.00	2.27	90.00	8.09		55.36	23.10					
	14.00	1.50	89.50	8.09		55.36	23.10					
	20.00	1.40	89.30	8.09		55.24	23.30					
	17.00	3.47	89.20	8.09		55.22	23.30					
	16.00	9.49	89.30	8.09		55.24	23.30					
	24.00	0.53	86.60	7.88		54.80	27.41					
	28.00	5.74	85.60	7.88		54.80	27.44					
	29.00	1.74	85.70	7.88		54.80	27.44					
	3.00	1.69	90.90	7.90		56.20	27.53					
	4.00	1.47	91.20	7.90		56.20	27.52					
	4.00	0.94	91.30	7.90		56.20	27.52					
	12.00	1.96	94.00	7.87		57.50	31.18					
	16.00	3.34	93.60	7.87		57.60	31.20					

Dry Season	Turbidity NTU	Chlorophyll-a (ug/L)	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	31.00		95.80	7.81		55.60	22.49					
	30.00		93.90	7.82		55.60	22.47					
	29.00		92.70	7.82		55.60	22.44					
	7.00		94.50	7.77		46.20	24.20					
	7.00		95.20	7.78		46.30	24.23					
	12.00		97.10	7.71		55.90	25.84					
	12.00		97.80	7.72		56.00	25.86					
	11.00		97.10	7.72		56.00	25.87					
	51.00		92.30	7.95		47.20	25.44					
	48.00		91.00	7.95		47.20	25.33					
	69.00		91.00	7.94		47.00	25.36					
	12.00		92.80	7.89		51.90	28.95					
	15.00		91.20	7.89		52.00	28.86					
	16.00		92.80	7.89		52.00	28.83					
	6.00		101.70	7.95		52.70	30.90					
	5.00		101.40	7.95		52.70	30.90					
	6.00		101.50	7.95		52.70	30.90					
	17.00		99.00	7.91		54.50	21.43					
	0.00		98.30	7.92		54.60	21.44					
	1.00		98.00	7.92		54.60	21.44					
	1.00		98.80	7.86		54.80	21.16					
	1.00		98.50	7.88		54.80	21.19					
	2.00		97.50	7.88		54.80	21.20					
	2.00		98.20	7.85		55.50	23.78					
	4.00		97.00	7.85		55.50	23.80					
	4.00		100.70	7.83		55.80	24.80					
	5.00		97.10	7.83		56.20	23.44					

Dry Season	Turbidity NTU	Chlorophyll-a (ug/L)	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	1.00		94.90	7.83		56.40	22.80					
	2.00		94.40	7.83		56.40	22.77					
	2.00		97.10	8.06		56.30	26.89					
	20.00		96.50	8.05		56.30	26.98					
	21.00		96.70	8.05		56.30	27.05					
	23.00		92.10	7.96		46.30	28.68					
	25.00		97.10	8.00		49.90	29.59					
	13.00		97.60	8.01		50.80	29.84					
	15.00		98.90	8.07		52.90	23.95					
	18.00		98.20	8.07		52.90	23.96					
	17.00		97.30	8.07		52.70	23.96					
	14.00		105.00	8.06		54.60	27.71					
	14.00		98.10	8.08		55.40	26.25					
	12.00		95.50	8.09		55.30	23.16					
	11.00		92.20	7.94		56.80	27.39					
	12.00		91.30	7.94		56.90	27.41					
	13.00		91.10	7.94		56.90	27.40					
	4.00		85.90	7.78		43.40	26.62					
	4.00		83.00	7.79		44.40	26.36					
	4.00		84.00	7.80		44.50	26.31					
	5.00		84.00	7.80		44.50	26.26					
	13.00		106.30	8.06		56.30	26.46					
	14.00		103.90	8.06		56.30	26.20					
	15.00		103.60	8.05		56.28	25.98					
	13.00		103.80	8.11		54.35	23.20					
	13.00		103.60	8.11		54.37	23.22					
	15.00		103.07	8.11		54.37	23.34					

Dry Season	Turbidity NTU	Chlorophyll-a (ug/L)	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	11.00		98.37	8.11		54.35	23.28					
	14.00		96.05	8.09		55.84	24.80					
	10.00		93.40	8.08		55.74	23.30					
	10.00		90.10	8.08		55.74	23.30					
	10.00		86.90	7.58		56.30	27.47					
	8.00		97.70	7.58		56.30	27.46					
	9.00		93.10	7.58		56.30	27.46					
	11.00		92.60	8.40		55.10	30.00					
	5.00		89.30	8.30		55.10	29.90					
	5.00		88.50	8.30		55.10	29.80					
	6.00		93.20	8.20		55.10	29.50					
	33.00		90.90	8.20		55.00	29.40					
	25.00		102.70	8.19		52.90	24.44					
	26.00		102.60	8.20		52.90	24.45					
	24.00		102.20	8.20		52.90	24.43					
	25.00		88.20	8.20		52.89	24.41					
	105.00		88.20	8.20		52.89	24.38					
	105.00		88.70	8.35		53.84	22.66					
	117.00		100.50	8.35		53.84	22.66					
	45.00		100.40	8.35		53.84	22.66					
	46.00		100.20	8.02		54.62	25.24					
	46.00		108.40	8.03		54.62	25.26					
	9.00		107.50	8.02		54.63	25.29					
	11.00		107.00	8.21		54.94	26.60					
	11.00		97.60	8.21		54.94	26.59					
	11.00		97.20	8.21		54.94	26.58					
	11.00		96.90	8.12		54.11	25.66					

Dry Season	Turbidity NTU	Chlorophyll-a (ug/L)	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	13.00		96.50	8.11		54.09	25.61					
	14.00		95.20	8.11		54.09	25.58					
	11.00		95.20	8.09		57.03	29.35					
	11.00		92.60	8.09		57.02	29.31					
	12.00		91.90	8.09		57.02	29.26					
	2.00		102.80	8.07		55.73	23.64					
	2.00		101.90	8.06		55.78	22.67					
	5.00		100.40	8.05		55.69	22.56					
	45.00		101.10	8.05		55.56	22.22					
	46.00		100.80	8.05		55.70	21.97					
	45.00		99.90	7.99		54.54	25.30					
	47.00		98.40	7.98		54.26	24.89					
	48.00		98.30	7.98		54.32	24.90					
	10.00		99.90	7.97		54.14	24.39					
	10.00		104.40	7.97		54.16	24.48					
	13.00		96.00	7.96		55.23	27.79					
	11.00		96.90	7.97		55.24	27.80					
	13.00		102.70	7.97		55.23	27.79					
	21.00		103.20	7.97		55.23	27.78					
	24.00		103.30	7.99		54.82	28.27					
	38.00		103.20	7.99		54.84	28.27					
	19.00		98.60	7.99		54.84	28.25					
	21.00		97.00	7.99		54.83	28.25					
	23.00		96.50	8.03		55.36	31.93					
	21.00		96.40	8.02		54.86	30.89					
	6.00		92.30	8.02		54.93	30.84					
	7.00		92.80	8.02		54.93	30.84					

Dry Season	Turbidity NTU	Chlorophyll-a (ug/L)	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	33.00		94.20	8.04		56.14	21.44					
	35.00		93.70	8.04		56.14	21.39					
	39.00		93.20	8.04		56.14	21.36					
	36.00		96.40	8.03		56.13	21.34					
	40.00		96.10	8.03		56.13	21.34					
	14.00		95.90	8.05		56.20	20.43					
	14.00		101.10	8.05		56.16	20.13					
	17.00		97.60	8.05		56.15	20.08					
	6.00		95.70	8.08		55.36	27.04					
	6.00		95.40	8.07		55.43	24.97					
	9.00		95.30	8.05		55.41	25.14					
	12.00		99.90	8.04		55.39	24.93					
	6.00		98.50	8.04		55.38	24.92					
	9.00		98.10	7.93		56.55	27.53					
	7.00		91.50	7.91		56.59	27.52					
	10.00		91.10	7.90		56.58	27.53					
	9.00		90.60	8.09		55.43	29.48					
	8.00		97.60	8.09		55.42	29.47					
	11.00		97.80	8.09		55.42	29.43					
	16.00		97.10	8.24		56.83	29.36					
	17.00		96.60	8.25		56.77	29.00					
	16.00		92.70	8.26		56.77	28.94					
	19.00		92.10	8.26		56.77	28.93					
	5.00		98.40	8.08		54.15	23.28					
	41.00		96.20	8.07		54.20	23.30					
	44.00		96.20	8.06		54.20	23.30					
	44.00		96.30	8.14		55.82	22.31					

Dry Season	Turbidity NTU	Chlorophyll-a (ug/L)	Oxygen per cent saturation %	pH	SS (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	42.00		96.40	8.14		55.79	22.35					
			98.70	8.14		55.80	22.36					
			98.80	8.14		55.80	22.36					
			98.80	7.97		55.31	23.18					
			98.60	7.97		55.27	23.21					
			96.40	7.97		55.26	23.20					
			94.70	7.98		56.93	32.23					
			97.80	7.97		56.87	31.29					
			96.90	7.97		56.84	30.85					
			95.60	8.03		57.43	32.02					
			95.60	8.03		57.35	31.64					
			95.90	8.02		57.33	31.53					
80th %ile	23.20	4.28	99.96	8.11	35.20	56.17	28.27	35.00	22.00	260.00	58.00	10.00
Max	117.00	10.11	108.40	8.40	36.00	57.60	32.23	35.00	23.00	300.00	60.00	10.00
Median	12.00	2.20	96.08	8.02	34.00	55.10	24.93	35.00	20.50	200.00	55.00	10.00
Min	0.00	0.45	83.00	7.58	32.00	43.40	19.95	35.00	18.00	100.00	50.00	10.00
20th %ile	5.00	1.15	91.10	7.88	32.80	52.70	22.70	35.00	19.00	140.00	52.00	10.00
WQO	6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

Section 4 Wet Season

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
CH	4.50	5.00	99.10	8.15	28.00	55.30	24.10	40.00	30.00	200.00	50.00	10.00
	4.70	5.00	97.00	6.52	32.00	54.70	24.70	30.00	20.00	200.00	50.00	10.00
	4.60	5.00	93.70	5.30	29.00	54.60	24.70	30.00	10.00	100.00	40.00	10.00
			95.20	8.14		54.70	23.70					
			94.60	6.26		54.90	23.80					
			93.80	6.26		54.90	23.70					
EPA	10.00		83.20	7.76		21.67	30.50					
	11.00		74.30	7.66		25.29	30.10					
	11.00		75.40	7.68		27.91	30.10					
	10.00		75.00	7.70		28.64	30.00					
	11.00		96.20	8.09		45.75	33.70					
	14.00		93.20	8.09		46.15	33.40					
	16.00		90.40	8.09		46.17	33.40					
	15.00		91.90	8.09		46.23	33.40					
	13.00		92.90	8.05		52.09	28.20					
	14.00		94.20	8.06		52.23	28.20					
	20.00		92.80	8.05		52.26	28.10					
	19.00		92.70	8.05		52.35	28.00					
	4.00		83.30	7.47		56.00	28.26					
	5.00		81.60	7.46		56.10	28.26					
	8.00		79.00	7.46		56.20	28.27					
	12.00		80.70	7.46		56.40	28.33					
	2.00		125.50	8.22		34.23	26.10					
	3.00		121.40	8.21		34.81	26.00					
	3.00		111.60	8.17		36.55	26.00					
	3.00		108.10	8.16		37.68	26.10					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	8.00		97.00	8.13		49.67	30.80					
	12.00		96.70	8.13		49.96	30.80					
	10.00		95.50	8.12		49.99	30.80					
	27.00		95.40	8.12		50.03	30.80					
	29.00		93.80	8.12		50.22	30.90					
	16.00		79.20	7.63		51.30	27.96					
	16.00		77.60	7.63		51.40	27.93					
	24.00		78.60	7.63		51.50	27.93					
	13.00		90.40	8.13		54.32	31.70					
	18.00		88.60	8.14		54.39	31.70					
	20.00		87.70	8.13		54.39	31.70					
	21.00		87.10	8.13		54.34	31.70					
	27.00		87.30	8.13		54.37	31.70					
	33.00		87.90	8.00		51.40	26.90					
	33.00		87.00	8.00		51.90	27.10					
	32.00		86.70	8.00		51.60	26.90					
	33.00		87.00	8.00		51.80	27.00					
	38.00		87.20	8.00		51.70	27.00					
	33.00		87.90	8.00		51.80	27.00					
	10.00		83.70	8.08		48.97	27.20					
	12.00		82.30	8.08		49.07	27.00					
	17.00		82.30	8.08		49.10	27.00					
	27.00		82.10	8.08		49.27	27.00					
	36.00		82.30	8.08		49.27	27.00					
	3.00		80.40	8.07		48.49	23.10					
	3.00		79.90	8.06		48.51	23.10					
	3.00		79.40	8.07		49.20	23.30					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	3.00		80.00	8.08		50.01	23.50					
	36.00		84.50	7.76		56.90	31.19					
	40.00		83.40	7.75		58.30	31.29					
	51.00		83.80	7.76		58.30	31.30					
	51.00		83.80	7.76		58.30	31.32					
	50.00		89.60	7.70		58.10	29.46					
	53.00		88.20	7.70		58.00	29.45					
	54.00		87.90	7.70		58.00	29.45					
	56.00		87.70	7.70		58.10	29.45					
	2.00		134.60	8.01		53.90	33.24					
	2.00		133.80	8.01		54.40	33.23					
	4.00		122.40	7.98		55.90	33.20					
	10.00		111.40	7.94		56.60	33.20					
	20.00		108.50	7.94		56.70	33.21					
	58.00		97.10	7.93		55.40	31.84					
	57.00		95.50	7.93		55.50	31.88					
	68.00		94.80	7.93		55.50	31.89					
	82.00		92.30	7.93		55.70	31.93					
	26.00		97.50	7.85		57.90	28.45					
	30.00		95.90	7.84		58.00	28.34					
	36.00		94.30	7.85		58.00	28.34					
	38.00		94.30	7.85		58.10	28.35					
	15.00		96.00	7.71		58.70	23.49					
	18.00		94.50	7.71		58.70	23.49					
	21.00		92.20	7.71		58.70	23.48					
	21.00		92.30	7.71		58.70	23.50					
	24.00		92.40	7.71		58.70	23.54					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	0.00		102.40	7.89		46.80	30.35					
	0.00		99.40	7.89		47.10	30.16					
	1.00		98.10	7.88		47.60	30.13					
	1.00		94.80	7.88		48.70	30.21					
	2.00		102.70	7.75		37.40	32.57					
	4.00		94.30	7.73		42.70	32.82					
	7.00		93.40	7.73		45.10	33.28					
	7.00		93.60	7.74		45.60	33.40					
	0.00		95.00	7.62		47.20	30.83					
	0.00		92.50	7.62		47.40	30.85					
	2.00		91.30	7.62		48.10	30.88					
	3.00		91.60	7.63		48.70	30.90					
	43.00		95.70	7.76		49.40	31.85					
	44.00		93.90	7.76		49.50	31.84					
	67.00		93.40	7.75		49.60	31.81					
	65.00		94.70	7.75		49.50	31.82					
	3.00		92.30	7.93		53.60	27.16					
	3.00		91.00	7.93		53.60	27.13					
	4.00		92.10	7.93		53.70	27.12					
	9.00		101.80	7.83		52.20	23.77					
	10.00		101.40	7.83		52.20	23.76					
	10.00		101.00	7.83		52.20	23.77					
	12.00		101.30	7.83		52.30	23.82					
	21.00		95.10	7.98		53.60	29.10					
	20.00		94.90	7.98		53.80	29.08					
	26.00		95.00	7.98		53.60	29.08					
	30.00		94.50	7.98		53.20	29.08					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	31.00		95.50	7.80		47.60	31.34					
	37.00		92.60	7.80		48.50	31.38					
	5.00		91.10	7.79		48.60	31.41					
	4.00		90.60	7.79		48.30	31.38					
	5.00		90.40	7.79		48.10	31.38					
	9.00		96.20	8.11		55.10	30.25					
	9.00		96.10	8.10		55.30	30.22					
	9.00		92.60	8.09		55.00	30.09					
	9.00		91.10	8.08		54.50	29.98					
	10.00		90.40	8.08		53.90	29.95					
	54.00		89.10	7.95		52.64	32.00					
	56.00		89.70	7.94		52.61	32.00					
	67.00		90.60	7.94		52.70	31.90					
	73.00		90.10	7.94		52.70	31.90					
	5.00		91.40	7.71		55.80	30.17					
	6.00		89.50	7.71		55.80	30.17					
	9.00		89.60	7.71		55.50	30.20					
	16.00		89.80	7.71		55.20	30.31					
	4.00		95.70	7.79		56.80	24.84					
	4.00		94.00	7.80		56.90	24.87					
	6.00		92.00	7.80		56.80	24.88					
	3.00		92.00	7.83		48.46	31.15					
	6.00		91.70	7.83		48.49	31.15					
	6.00		91.60	7.83		48.64	31.18					
	48.00		91.60	7.83		48.65	31.19					
	48.00		92.60	8.00		49.40	30.00					
	51.00		92.40	8.00		49.50	30.00					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	53.00		90.50	8.00		49.90	30.00					
	4.00		89.90	8.00		50.60	30.10					
	4.00		101.10	7.80		43.80	31.30					
	4.00		99.50	7.80		44.80	31.30					
	4.00		91.00	7.80		46.50	31.60					
	5.00		90.00	7.80		48.00	31.90					
	11.00		91.30	8.00		51.80	26.60					
	16.00		90.20	8.00		52.10	26.59					
	16.00		89.80	8.00		52.20	26.70					
	20.00		89.80	8.00		52.40	26.73					
	17.00		105.60	8.09		55.42	24.70					
	13.00		105.00	8.09		55.90	24.70					
	17.00		102.20	8.09		55.85	24.70					
	18.00		100.90	8.09		56.02	24.70					
	41.00		94.40	7.95		55.11	30.59					
	45.00		88.10	7.95		55.11	30.60					
	46.00		87.90	7.95		55.10	30.59					
	47.00		87.90	7.94		55.08	30.54					
	33.00		86.20	7.94		55.07	30.54					
	49.00		101.70	7.84		52.90	32.13					
	57.00		100.30	7.83		53.10	32.14					
	26.00		100.30	7.83		53.00	32.13					
	31.00		98.50	7.83		52.70	32.04					
	33.00		98.50	8.07		55.55	24.67					
	38.00		98.30	8.07		55.56	24.63					
	70.00		98.20	8.06		55.55	24.63					
	9.00		92.70	8.00		59.02	31.59					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	9.00		92.50	8.00		58.98	31.42					
	10.00		92.00	8.00		59.04	31.31					
	5.00		107.50	8.09		58.35	32.33					
	5.00		104.90	8.09		58.32	32.32					
	5.00		102.60	8.09		58.32	32.27					
	5.00		102.30	8.10		58.33	32.29					
	8.00		103.00	8.33		33.93	32.22					
	6.00		108.20	8.31		34.60	32.19					
	7.00		104.70	8.30		34.95	32.16					
	8.00		102.00	8.31		34.86	32.17					
	9.00		100.70	8.31		34.81	32.18					
	10.00		101.50	8.17		43.45	29.03					
	11.00		100.70	8.17		43.60	29.05					
	16.00		99.90	8.17		43.60	29.05					
	191.00		99.20	8.17		43.61	29.06					
	12.00		82.00	7.81		32.21	30.16					
	13.00		83.30	7.88		41.39	31.75					
	16.00		83.60	7.91		43.45	32.01					
	14.00		86.40	7.94		43.80	32.49					
	5.00		69.10	7.71		34.06	32.62					
	6.00		70.30	7.73		36.26	32.93					
	5.00		67.10	7.74		37.96	33.09					
	5.00		66.60	7.78		41.20	33.69					
	38.00		68.40	7.72		2.10	26.80					
	43.00		69.50	7.23		13.73	28.19					
	46.00		86.90	7.52		2.45	26.81					
	49.00		84.90	7.24		6.36	27.09					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	34.00		84.80	7.12		12.96	27.75					
	36.00		85.60	7.14		14.07	28.11					
	36.00		96.80	7.92		38.47	31.52					
	36.00		96.20	7.92		38.96	31.53					
	40.00		95.40	7.95		40.93	31.46					
	13.00		94.90	7.96		41.81	31.44					
	14.00		96.50	7.97		52.00	28.24					
	13.00		96.10	7.97		52.08	28.23					
	14.00		97.40	7.96		52.19	28.27					
	15.00		95.10	7.97		52.56	28.45					
	17.00		94.80	8.06		53.38	24.37					
	23.00		93.70	8.03		53.36	24.37					
	26.00		93.30	8.03		53.35	24.37					
	7.00		93.00	8.03		53.35	24.36					
	8.00		101.20	8.18		45.41	31.97					
	6.00		100.30	8.16		46.46	32.10					
	6.00		98.60	8.17		47.46	32.14					
	6.00		97.70	8.17		47.38	32.13					
	4.00		97.90	7.95		46.95	31.43					
	4.00		97.60	7.94		47.33	31.43					
	4.00		97.20	7.94		47.62	31.39					
	5.00		103.30	7.94		47.99	31.41					
	7.00		104.80	7.97		49.53	29.74					
	14.00		105.10	7.97		49.66	29.66					
	18.00		105.00	7.97		49.74	29.66					
	24.00		104.80	7.98		53.51	27.68					
	15.00		98.00	7.98		53.50	27.69					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	15.00		96.90	7.98		53.50	27.67					
	15.00		96.40	7.97		53.50	27.67					
	18.00		96.00	7.97		53.48	27.67					
	18.00		95.70	8.06		55.14	22.31					
	23.00		95.90	8.05		55.15	22.31					
	5.00		95.40	8.05		55.13	22.30					
	5.00		95.10	8.05		55.14	22.29					
	5.00		95.00	8.05		55.14	22.29					
			120.30	7.96		55.67	34.05					
			119.80	7.96		56.02	34.24					
			118.00	7.96		56.31	34.48					
			116.60	7.98		49.84	33.61					
			114.90	7.98		49.87	33.61					
			115.60	7.98		49.90	33.61					
			113.50	7.98		49.91	33.60					
			109.70	7.98		49.92	33.58					
			107.90	7.97		49.92	33.55					
			106.60	8.04		48.15	30.91					
			100.40	8.04		48.26	30.95					
			100.40	8.04		48.76	31.13					
			100.20	8.05		49.01	31.22					
			100.00	8.05		49.10	31.25					
			99.80	7.99		56.09	28.30					
				7.99		56.08	28.25					
				7.99		56.10	28.24					
				7.99		56.10	28.24					
				7.99		56.11	28.25					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
GHD	13.00		88.50	8.23	32.00	52.70	31.11					
	9.60		88.50	8.22	26.00	52.60	31.11	94.00	23.00	700.00	30.00	10.00
	9.60		88.40	8.22	46.00	52.60	31.12	69.00	12.00	100.00	160.00	10.00
	9.00		88.30	8.23	27.00	52.60	31.12	41.00	10.00	100.00	80.00	10.00
	9.90		88.60	8.23	32.00	52.60	31.12	33.00	10.00	100.00	50.00	10.00
	9.30		88.70	8.23	16.00	52.50	31.11	92.00	16.00	600.00	40.00	10.00
	9.30		88.90	8.23	20.00	52.50	31.11	69.00	11.00	100.00	160.00	10.00
	8.10		88.90	8.23	34.00	52.50	31.11	47.00	10.00	100.00	80.00	10.00
	9.10		88.90	8.23	25.00	52.50	31.09	33.00	10.00	100.00	50.00	10.00
	8.50		88.90	8.23	36.00	52.50	31.09					
	20.00		84.60	7.59	25.00	56.90	30.92					
	18.80		84.60	7.59	29.00	56.90	30.93					
	19.40		84.70	7.59	45.00	56.90	30.93					
	19.80		84.70	7.60	18.00	56.90	30.92					
	20.00		84.80	7.59	21.00	56.90	30.93					
	18.30		85.00	7.60	29.00	56.90	30.93					
	19.10		85.00	7.60		56.90	30.93					
	19.30		85.10	7.60		56.90	30.93					
	17.10		85.20	7.60		56.90	30.93					
	17.50		85.20	7.60		56.90	30.92					
	11.90		70.00	7.82		56.60	29.20					
	11.80		73.00	7.83		56.60	29.20					
	11.90		73.90	7.83		56.60	29.30					
	11.50		74.20	7.83		56.60	29.40					
	11.90		74.50	7.83		56.60	29.40					
	12.40		74.60	7.83		56.60	29.40					
	12.40		74.70	7.83		56.60	29.40					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	11.60		74.70	7.83		56.60	29.40					
	11.50		74.70	7.83		56.60	29.40					
	11.90		74.80	7.84		56.60	29.50					
	7.10		83.40	6.49		56.10	29.80					
	7.90		81.00	6.49		56.30	29.80					
	10.30		80.50	6.49		56.20	29.80					
	9.60		81.00	6.50		56.10	29.80					
	9.10		80.60	6.50		56.00	29.90					
	6.70		79.40	6.51		56.10	29.90					
	6.80		78.80	6.51		56.00	29.90					
	7.30		79.20	6.51		55.90	29.90					
	11.50		79.50	6.51		55.90	29.90					
	9.90		79.10	6.51		55.90	29.90					
	8.10		85.10	6.11		55.80	31.11					
	7.80		84.80	6.11		55.70	31.10					
	7.10		84.80	6.11		55.80	31.10					
	7.80		84.60	6.11		55.60	31.09					
	6.40		84.10	6.11		55.60	31.09					
	8.40		84.10	6.11		55.60	31.10					
	7.50		84.10	6.12		55.60	31.11					
	7.20		84.00	6.12		55.60	31.09					
	7.90		84.00	6.12		55.50	31.09					
	6.90		83.90	6.12		55.50	31.09					
	13.20		88.60	8.23		52.40	30.94					
	11.20		88.10	8.23		52.40	30.94					
	9.40		87.60	8.23		52.40	30.94					
	8.50		87.90	8.23		52.40	30.93					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	10.30		88.10	8.23		52.40	30.94					
	9.50		88.20	8.23		52.40	30.93					
	9.20		87.90	8.23		52.40	30.93					
	10.40		87.70	8.23		52.40	30.93					
	10.00		87.60	8.23		52.40	30.94					
	9.60		88.00	8.23		52.40	30.94					
	20.70		85.30	7.62		56.90	29.60					
	21.60		85.40	7.62		56.90	29.60					
	21.10		85.40	7.62		56.90	29.60					
	22.60		85.50	7.62		56.90	29.60					
	21.00		85.50	7.63		56.90	29.60					
	23.40		85.40	7.63		56.90	29.60					
	22.70		85.50	7.62		56.90	29.60					
	21.10		85.50	7.63		56.90	29.60					
	22.00		85.50	7.63		56.90	29.60					
	20.60		85.50	7.63		56.90	29.60					
	12.10		74.80	7.84		56.50	29.90					
	12.10		74.90	7.84		56.60	29.90					
	12.40		74.90	7.84		56.50	29.90					
	11.40		74.90	7.84		56.60	29.90					
	12.10		75.00	7.85		56.60	29.90					
	12.90		75.10	7.85		56.60	29.90					
	12.50		75.10	7.85		56.60	29.90					
	13.10		75.10	7.85		56.60	29.90					
	12.10		75.10	7.85		56.60	29.90					
	12.20		75.10	7.85		56.50	29.90					
	6.90		77.90	6.33		55.80	31.02					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
.	8.20		76.80	6.33		55.70	31.02					
	8.90		75.80	6.33		55.70	31.02					
	8.60		76.40	6.33		55.80	31.02					
	9.60		77.70	6.34		55.80	31.02					
	12.30		78.60	6.34		55.80	31.02					
	7.50		77.90	6.34		55.70	31.03					
	9.30		75.90	6.34		55.60	31.02					
	9.30		75.80	6.35		55.70	31.02					
	9.10		76.50	6.35		55.70	31.02					
	9.40		84.20	6.10		55.50	30.92					
	8.50		84.20	6.10		55.50	30.93					
	6.90		84.10	6.10		55.50	30.92					
	8.50		83.90	6.10		55.50	30.92					
	8.40		83.60	6.11		55.50	30.91					
	8.90		83.60	6.11		55.50	30.94					
	8.70		83.20	6.11		55.50	30.94					
	8.10		83.20	6.11		55.50	30.94					
	8.60		83.20	6.11		55.50	30.93					
	8.70		83.30	6.12		55.50	30.94					
	10.50		87.40	8.22		52.40	29.60					
	11.60		86.50	8.23		52.40	29.60					
	11.10		86.70	8.23		52.40	29.60					
	10.80		86.50	8.23		52.40	29.60					
	11.20		86.80	8.23		52.40	29.60					
	9.50		86.70	8.23		52.40	29.60					
	10.40		86.80	8.23		52.40	29.60					
	10.80		86.80	8.23		52.40	29.60					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	10.90		86.80	8.23		52.40	29.70					
	11.90		86.60	8.23		52.40	29.70					
	25.20		85.10	7.64		56.90	29.80					
	28.90		85.10	7.64		56.90	29.80					
	30.80		85.20	7.64		56.90	29.80					
	25.70		85.20	7.64		56.90	29.80					
	29.50		85.00	7.65		56.90	29.80					
	26.60		85.00	7.65		56.90	29.80					
	27.70		85.00	7.65		56.90	29.80					
	31.10		85.00	7.65		56.90	29.80					
	29.60		85.00	7.65		56.90	29.80					
	28.60		85.00	7.65		56.90	29.80					
	14.70		75.30	7.85		56.60	29.90					
	13.50		75.30	7.86		56.60	30.00					
	13.50		75.30	7.86		56.60	30.00					
	13.20		75.30	7.86		56.60	30.10					
	15.70		75.30	7.86		56.60	30.10					
	12.70		75.40	7.86		56.60	30.10					
	12.50		75.40	7.86		56.60	30.20					
	12.90		75.50	7.86		56.60	30.20					
	12.70		75.60	7.86		56.60	30.30					
	12.50		75.70	7.86		56.60	30.30					
	9.70		79.70	6.32		55.60	31.64					
	10.70		78.90	6.32		55.60	31.63					
	10.40		78.60	6.32		55.60	31.64					
	10.60		79.10	6.32		55.60	31.64					
	11.20		79.50	6.32		55.60	31.64					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	12.50		79.10	6.32		55.60	31.64					
	13.60		78.20	6.32		55.60	31.63					
	7.90		76.70	6.32		55.60	31.64					
	11.00		76.00	6.32		55.60	31.64					
	11.80		76.10	6.32		55.60	31.64					
	9.90		81.60	6.09		55.50	30.40					
	9.60		81.30	6.09		55.50	30.50					
	9.70		81.50	6.09		55.50	30.50					
	10.10		81.30	6.09		55.50	30.50					
	9.40		81.10	6.09		55.50	30.50					
	9.90		80.50	6.09		55.50	30.50					
	9.90		80.40	6.09		55.40	30.50					
	10.50		80.10	6.08		55.40	30.50					
	10.70		80.10	6.08		55.40	30.50					
	11.70		79.80	6.08		55.50	30.50					
	5.70		96.60	7.69		50.50	31.64					
	7.10		95.00	7.69		50.60	31.64					
	5.80		94.40	7.69		50.50	31.64					
	6.50		93.40	7.69		50.50	31.65					
	7.00		94.30	7.69		50.50	31.65					
	6.30		93.20	7.69		50.50	31.65					
	8.50		92.50	7.69		50.50	31.65					
	6.40		92.00	7.69		50.50	31.65					
	7.00		91.20	7.69		50.50	31.65					
	7.30		91.90	7.69		50.50	31.65					
	8.70		90.20	7.69		50.70	30.60					
	7.60		90.40	7.69		50.70	30.60					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	8.70		90.50	7.69		50.80	30.60					
	7.60		90.60	7.69		50.80	30.60					
	8.10		90.60	7.69		50.80	30.60					
	8.00		90.70	7.69		50.90	30.60					
	7.90		90.70	7.69		50.80	30.60					
	7.40		90.70	7.69		50.80	30.60					
	8.00		90.50	7.69		50.80	30.60					
	9.50		90.50	7.69		50.80	30.60					
	6.10		127.80	7.68		51.80	31.77					
	7.50		123.60	7.68		51.80	31.77					
	6.80		120.60	7.68		51.70	31.77					
	6.60		120.70	7.68		51.70	31.77					
	8.20		119.20	7.68		51.70	31.77					
	5.80		117.20	7.68		51.40	31.75					
	7.00		115.60	7.68		51.70	31.76					
	7.80		114.20	7.68		51.60	31.77					
	6.60		113.70	7.68		51.70	31.77					
	6.90		112.30	7.68		51.70	31.77					
	8.30		90.30	8.22		0.00	31.19					
	9.10		90.30	8.23		52.10	31.18					
	10.10		90.40	8.23		52.10	31.17					
	11.10		90.30	8.24		52.10	31.18					
	10.90		90.30	8.24		52.10	31.19					
	12.40		90.20	8.24		52.10	31.19					
	10.80		90.00	8.24		52.00	31.19					
	9.80		89.80	8.24		52.10	31.18					
	10.00		89.80	8.25		52.10	31.19					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	11.10		89.80	8.24		52.00	31.19					
	6.70		128.60	7.69		56.90	30.97					
	6.80		125.40	7.69		56.90	30.97					
	7.00		124.50	7.69		56.90	30.97					
	6.80		124.30	7.69		56.90	30.98					
	5.80		124.30	7.69		56.90	30.98					
	6.10		122.40	7.69		56.90	30.98					
	6.30		121.20	7.69		56.90	30.98					
	7.90		118.50	7.69		56.90	30.98					
	7.40		118.40	7.69		56.90	30.97					
	6.90		117.70	7.69		56.90	30.98					
	27.60		86.60	7.91		56.60	29.50					
	25.40		86.40	7.91		56.60	29.50					
	24.10		86.30	7.91		56.60	29.50					
	26.00		86.30	7.91		56.60	29.50					
	23.90		86.30	7.91		56.60	29.60					
	22.70		86.30	7.91		56.60	29.60					
	23.30		86.30	7.91		56.60	29.60					
	26.50		86.30	7.91		56.60	29.60					
	22.90		86.30	7.91		56.60	29.70					
	25.10		86.40	7.91		56.60	29.70					
	11.70		90.70	6.24		56.00	29.90					
	11.00		88.10	6.26		55.70	29.90					
	12.20		87.80	6.26		55.60	29.80					
	12.20		87.90	6.26		55.70	29.80					
	12.20		88.00	6.27		55.50	29.80					
	11.10		88.20	6.27		55.70	29.80					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	12.30		87.70	6.28		55.60	29.80					
	11.30		87.90	6.28		55.60	29.80					
	12.10		88.20	6.28		55.60	29.80					
	10.90		88.50	6.30		55.40	29.80					
	15.10		85.10	6.29		55.40	31.16					
	15.50		85.20	6.29		55.30	31.16					
	15.10		85.30	6.29		55.30	31.16					
	15.40		85.30	6.30		55.30	31.16					
	16.70		85.30	6.30		55.20	31.16					
	15.70		85.40	6.30		55.20	31.16					
	17.00		85.50	6.30		55.20	31.17					
	15.50		85.60	6.30		55.20	31.16					
	15.00		85.60	6.31		55.20	31.16					
	15.10		85.60	6.31		55.30	31.16					
	16.00		72.10	8.25		52.20	30.98					
	17.80		74.00	8.24		52.20	30.98					
	18.00		75.10	8.24		52.20	30.97					
	13.10		75.50	8.24		52.20	30.98					
	14.20		75.80	8.24		52.20	30.98					
	13.80		76.10	8.25		52.20	30.98					
	13.50		76.40	8.25		52.10	30.98					
	12.90		76.50	8.24		52.20	30.98					
	14.80		76.70	8.24		52.20	30.98					
	15.10		76.90	8.24		52.20	30.98					
	8.90		83.60	7.70		56.90	29.80					
	10.10		82.60	7.70		56.90	29.80					
	10.90		81.90	7.70		56.90	29.80					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	11.20		81.70	7.70		56.90	29.80					
	9.50		79.10	7.70		56.90	29.80					
	8.40		78.80	7.70		56.90	29.80					
	8.40		79.10	7.70		56.90	29.80					
	8.40		79.40	7.70		56.90	29.80					
	9.80		79.50	7.70		56.90	29.80					
	10.10		81.00	7.70		56.90	29.80					
	9.90		78.80	7.90		56.60	29.90					
	10.40		78.60	7.90		56.60	29.90					
	10.60		78.90	7.90		56.60	29.90					
	11.10		78.90	7.90		56.60	29.90					
	11.50		78.80	7.90		56.60	29.90					
	10.90		78.90	7.90		56.60	29.90					
	12.10		78.90	7.90		56.60	29.90					
	11.70		78.60	7.90		56.60	29.90					
	10.50		78.10	7.90		56.60	29.90					
	12.30		77.90	7.90		56.60	29.80					
	23.70		88.60	6.24		55.50	31.16					
	22.90		88.60	6.24		55.50	31.17					
	26.00		88.40	6.24		55.40	31.16					
	22.60		87.90	6.24		55.40	31.16					
	21.90		88.20	6.24		55.40	31.16					
	20.30		88.10	6.24		55.40	31.16					
	22.90		88.00	6.24		55.40	31.16					
	23.60		87.70	6.24		55.40	31.16					
	23.00		87.00	6.24		55.40	31.16					
	21.70		87.10	6.24		55.40	31.16					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	18.00		85.10	6.20		55.50	30.98					
	16.40		85.10	6.19		55.50	30.98					
	14.20		85.10	6.19		55.40	30.98					
	18.70		85.10	6.20		55.40	30.98					
	16.20		85.10	6.19		55.40	30.98					
	17.50		85.10	6.20		55.40	30.98					
	17.50		85.10	6.20		55.40	30.98					
	18.30		85.10	6.20		55.40	30.98					
	19.10		85.20	6.20		55.40	30.98					
	18.10		85.20	6.20		55.40	30.98					
	9.90		76.80	8.25		52.20	29.80					
	10.30		76.80	8.25		52.20	29.80					
	10.20		76.80	8.25		52.20	29.80					
	11.50		76.90	8.25		52.20	29.80					
	14.40		77.00	8.25		52.20	29.80					
	10.90		77.10	8.24		52.20	29.80					
	10.90		77.10	8.25		52.20	29.80					
	9.40		77.10	8.25		52.20	29.80					
	11.30		77.10	8.25		52.20	29.80					
	11.00		77.10	8.25		52.20	29.80					
	12.00		81.30	7.70		56.90	29.80					
	11.90		81.00	7.70		56.90	29.80					
	11.10		80.90	7.71		56.90	29.80					
	14.40		79.90	7.71		56.90	29.80					
	12.80		79.20	7.71		56.90	29.80					
	11.90		78.10	7.71		56.90	29.80					
	13.50		77.50	7.71		56.90	29.80					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	12.10		77.30	7.71		56.90	29.80					
	16.60		77.30	7.71		56.90	29.80					
	14.20		77.10	7.71		56.90	29.80					
	11.00		78.60	7.90		56.60	29.90					
	12.00		78.30	7.90		56.60	30.00					
	10.60		78.20	7.90		56.60	30.00					
	11.10		78.60	7.90		56.60	30.10					
	11.40		78.40	7.90		56.60	30.30					
	11.00		78.20	7.90		56.60	30.30					
	10.10		78.10	7.89		56.60	30.30					
	11.20		77.90	7.90		56.60	30.40					
	10.70		77.30	7.90		56.60	30.40					
	12.10		77.30	7.90		56.60	30.50					
	20.60		88.20	6.20		55.50	31.66					
	22.40		87.60	6.20		55.40	31.65					
	24.00		87.40	6.20		55.40	31.65					
	26.20		86.70	6.19		55.40	31.66					
	30.80		86.70	6.19		55.40	31.65					
	20.70		86.50	6.19		55.40	31.66					
	19.40		86.90	6.19		55.40	31.66					
	22.10		87.10	6.19		55.40	31.66					
	21.30		86.80	6.19		55.40	31.67					
	27.90		87.10	6.19		55.40	31.66					
	18.50		85.30	6.18		55.40	30.50					
	19.40		85.30	6.18		55.40	30.50					
	22.00		85.40	6.18		55.40	30.50					
	20.10		85.40	6.17		55.40	30.50					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	22.00		85.40	6.17		55.40	30.50					
	22.10		85.40	6.17		55.40	30.50					
	23.40		85.40	6.17		55.50	30.50					
	23.30		85.40	6.17		55.40	30.50					
	21.10		85.40	6.17		55.50	30.60					
	21.00		85.40	6.17		55.50	30.60					
	21.20		77.00	7.67		50.50	31.63					
	16.90		77.10	7.67		50.50	31.63					
	23.00		77.10	7.67		50.50	31.64					
	14.60		77.10	7.67		50.60	31.64					
	11.30		77.10	7.67		50.50	31.64					
	14.90		77.10	7.68		50.50	31.64					
	16.90		77.10	7.68		50.60	31.64					
	14.00		77.10	7.67		50.50	31.64					
	10.70		77.10	7.68		50.50	31.64					
	12.40		77.00	7.68		50.60	31.64					
	16.30		78.60	7.67		51.00	30.50					
	15.10		77.60	7.67		51.10	30.50					
	15.20		77.60	7.67		51.20	30.50					
	16.80		77.30	7.67		51.20	30.50					
	13.90		76.40	7.67		51.10	30.50					
	14.00		76.60	7.67		51.10	30.50					
	11.40		77.30	7.68		51.10	30.60					
	12.80		76.10	7.68		51.00	30.50					
	13.70		75.90	7.68		51.00	30.60					
	15.90		75.80	7.68		51.10	30.60					
	6.00		77.70	7.67		51.50	31.73					

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	6.90		78.00	7.67		51.40	31.71					
	5.70		78.10	7.67		51.40	31.71					
	7.70		78.10	7.67		51.20	31.71					
	5.40		78.10	7.67		51.40	31.69					
	6.30		78.10	7.67		51.50	31.71					
	5.80		78.20	7.67		51.50	31.73					
	5.80		78.20	7.67		51.50	31.73					
	5.90		78.20	7.67		51.40	31.73					
	5.60		78.20	7.67		51.40	31.71					
	8.30		93.30									
	9.00		92.80									
	9.00		92.40									
	10.00		92.20									
	9.00		91.90									
	8.30		92.60									
	9.50		92.60									
	9.80		92.30									
	9.40		92.30									
	10.10		92.10									
	6.20		88.60									
	6.50		88.70									
	6.80		89.00									
	6.70		89.10									
	6.30		89.20									
	5.60		89.20									
	6.60		89.30									
	6.10		89.40									

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	6.20		89.40									
	7.70		89.40									
	20.40		114.50									
	22.30		114.20									
	25.70		112.60									
	23.90		113.50									
	22.70		109.90									
	23.40		108.10									
	22.60		107.40									
	21.90		107.30									
	20.80		106.50									
	22.00		105.80									
	6.80		87.10									
	7.30		86.90									
	8.90		86.70									
	6.70		86.70									
	8.00		86.40									
	6.40		86.20									
	9.20		86.20									
	7.50		86.20									
	6.70		86.30									
	6.10		86.40									
	28.20		127.70									
	28.10		125.50									
	29.90		125.00									
	25.40		121.60									
	25.40		120.00									

Wet Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	29.20		117.90									
	31.00		117.30									
	29.90		116.50									
	29.50		116.20									
	27.20		112.70									
			84.00									
			84.10									
			84.00									
			84.10									
			84.30									
			84.50									
			84.50									
			84.40									
			84.20									
			84.20									
80th %ile	22.10	5.00	95.82	8.06	32.80	56.60	31.63	69.00	20.00	200.00	80.00	10.00
Max	191.00	5.00	134.60	8.33	46.00	59.04	34.48	94.00	30.00	700.00	160.00	10.00
Median	11.65	5.00	87.10	7.80	29.00	55.14	30.60	41.00	11.00	100.00	50.00	10.00
Min	0.00	5.00	66.60	5.30	16.00	0.00	22.29	30.00	10.00	100.00	30.00	10.00
20th %ile	7.30	5.00	78.90	6.51	23.40	50.50	29.52	33.00	10.00	100.00	40.00	10.00
WQO	6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

Section 4 Dry Season

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
CH	18.00	5.00	100.10	7.74	53.00	55.40	25.01	32.00	30.00	300.00	70.00	10.00
	10.10	5.00	103.50	7.74	12.00	54.70	25.05	35.00	37.00	100.00	90.00	10.00
	10.40	5.00	102.40	7.74	29.00	54.40	25.03		66.00	100.00	120.00	10.00
			111.80	7.58		54.80	25.10					
			112.30	7.62		54.60	25.07					
			110.40	7.69		54.50	25.05					
			104.60	7.70		54.30	25.09					
			105.20	7.70		54.20	25.11					
			105.70	7.71		54.10	25.18					
EPA	5.00		88.40	8.00		46.95	22.60					
	6.00		87.90	8.00		47.45	22.60					
	7.00		87.60	8.00		47.55	22.60					
	7.00		88.00	8.02		48.37	22.60					
	10.00		87.50	8.03		48.56	22.70					
	18.00		84.70	7.65		49.60	18.77					
	17.00		85.30	7.65		49.60	18.79					
	14.00		84.40	7.65		49.70	18.79					
	11.00		85.90	7.66		49.80	18.88					
	13.00		85.00	7.66		50.00	18.91					
	4.00		98.60	7.94		51.51	20.70					
	4.00		99.40	7.94		51.39	20.60					
	5.00		99.30	7.93		51.53	20.60					
	5.00		99.10	7.93		51.53	20.60					
	5.00		99.00	7.92		51.53	20.60					
	14.00		86.10	8.06		52.94	24.10					
	19.00		84.90	8.13		52.78	24.00					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	26.00		83.70	8.16		52.81	24.00					
	25.00		83.70	8.17		52.83	24.00					
	22.00		83.30	8.18		52.78	24.00					
	3.00		86.10	8.08		44.44	25.90					
	3.00		86.80	8.07		44.78	25.90					
	4.00		86.10	8.07		45.17	25.90					
	3.00		86.30	8.09		46.52	26.10					
	0.00		82.50	7.67		53.00	29.29					
	0.00		83.40	7.67		53.10	29.30					
	0.00		83.20	7.68		53.20	29.34					
	1.00		82.30	7.67		53.40	29.37					
	5.00		84.40	7.79		45.70	23.02					
	5.00		81.90	7.79		46.00	22.91					
	6.00		81.70	7.80		46.20	22.97					
	7.00		82.30	7.80		46.30	23.06					
	0.00		90.10	7.82		49.00	21.17					
	0.00		89.00	7.83		49.40	21.22					
	13.00		85.30	8.04		53.71	22.60					
	17.00		85.90	8.05		54.00	22.70					
	28.00		84.90	8.04		53.79	22.60					
	24.00		86.40	8.05		54.15	22.70					
	23.00		84.90	7.85		54.10	27.31					
	29.00		83.10	7.86		54.20	27.32					
	30.00		83.70	7.86		54.20	27.32					
	41.00		82.50	7.86		54.20	27.34					
	5.00		89.40	7.82		55.10	26.51					
	5.00		88.40	7.82		55.20	26.44					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	8.00		87.70	7.82		55.20	26.44					
	9.00		88.10	7.82		55.30	26.49					
	7.00		90.00	7.78		57.20	29.32					
	6.00		89.40	7.78		57.20	29.31					
	9.00		88.90	7.78		57.20	29.32					
	10.00		88.30	7.78		57.30	29.32					
	27.00		87.90	7.81		54.80	23.15					
	28.00		96.00	7.82		55.00	23.18					
	33.00		92.70	7.82		55.10	23.12					
	35.00		95.00	7.82		55.10	23.11					
	10.00		84.20	7.76		46.20	23.86					
	10.00		91.70	7.76		46.30	23.83					
	11.00		90.20	7.76		46.30	23.85					
	11.00		79.90	7.77		46.30	23.87					
	17.00		96.90	7.69		55.70	25.06					
	16.00		94.50	7.69		55.80	24.98					
	21.00		94.50	7.68		55.80	24.92					
	23.00		86.20	7.68		55.70	24.93					
	32.00		87.20	7.88		38.90	26.11					
	35.00		85.50	7.89		41.10	26.31					
	43.00		87.30	7.91		43.00	26.54					
	61.00		87.30	7.92		44.60	26.73					
	12.00		96.20	7.88		50.70	30.06					
	16.00		92.60	7.88		50.80	30.07					
	18.00		92.80	7.88		50.90	30.05					
	24.00		92.40	7.88		50.90	30.05					
	0.00		101.10	7.93		50.90	30.42					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	2.00		100.30	7.93		51.00	30.40					
	4.00		99.20	7.93		51.10	30.40					
	4.00		99.30	7.93		51.10	30.41					
	14.00		96.10	7.89		54.10	20.49					
	1.00		96.90	7.89		54.00	20.32					
	2.00		96.30	7.90		53.90	20.31					
	2.00		94.40	7.90		53.90	20.31					
	3.00		95.20	7.90		54.00	20.32					
	4.00		95.50	7.86		54.20	20.59					
	2.00		96.00	7.86		54.40	20.61					
	2.00		96.30	7.86		54.40	20.62					
	3.00		96.30	7.86		54.30	20.63					
	4.00		93.10	7.80		54.90	22.36					
	4.00		93.00	7.81		54.90	22.39					
	4.00		94.30	7.81		55.00	22.36					
	5.00		93.50	7.81		54.90	22.35					
	5.00		94.40	7.78		56.00	25.56					
	1.00		93.70	7.78		56.00	25.51					
	1.00		92.30	7.78		56.10	25.45					
	1.00		92.40	7.78		56.10	25.32					
	2.00		96.30	8.02		56.00	28.32					
	2.00		94.00	8.01		56.00	28.17					
	10.00		92.50	8.01		56.00	28.11					
	9.00		91.60	8.01		56.00	28.06					
	8.00		91.20	8.00		56.00	28.04					
	13.00		79.60	7.82		24.20	27.00					
	16.00		77.70	7.82		30.10	26.86					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	11.00		81.40	7.88		40.30	27.83					
	15.00		80.70	7.89		41.20	27.97					
	8.00		96.80	8.05		52.80	22.91					
	5.00		96.50	8.06		52.80	22.94					
	6.00		95.60	8.06		52.60	22.86					
	5.00		94.90	8.05		52.20	22.77					
	13.00		84.70	8.05		51.40	22.78					
	9.00		96.50	8.02		55.20	26.83					
	13.00		95.90	8.02		55.40	26.77					
	11.00		95.00	8.02		55.40	26.74					
	15.00		94.70	8.02		55.00	26.69					
	4.00		94.50	8.02		54.70	26.67					
	4.00		92.70	7.95		56.60	28.08					
	5.00		92.50	7.95		56.70	28.11					
	4.00		92.20	7.95		56.70	28.02					
	4.00		92.00	7.95		56.30	27.98					
	6.00		91.60	7.95		55.90	27.93					
	6.00		73.30	7.61		33.30	27.31					
	9.00		74.10	7.64		35.40	27.26					
	6.00		74.40	7.65		36.30	27.28					
	3.00		75.40	7.66		37.10	27.30					
	12.00		99.80	7.98		54.25	22.64					
	11.00		98.50	7.97		54.21	22.44					
	11.00		105.80	7.97		54.38	22.27					
	11.00		105.10	7.97		54.46	22.27					
	15.00		104.60	7.96		54.69	22.36					
	8.00		97.36	7.96		54.90	22.50					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	7.00		97.77	8.11		53.01	20.79					
	7.00		96.40	8.08		53.07	20.82					
	5.00		96.84	8.07		53.12	20.90					
	4.00		84.50	8.07		55.62	24.20					
	4.00		85.50	8.06		55.70	23.90					
	4.00		85.00	8.06		55.68	23.70					
	6.00		84.10	8.06		55.68	23.70					
	5.00		92.00	7.55		56.20	27.67					
	4.00		91.00	7.55		56.10	27.68					
	6.00		90.40	7.55		56.00	27.69					
	5.00		90.90	7.55		55.40	27.69					
	31.00		90.40	8.10		55.20	28.70					
	32.00		98.00	8.00		55.10	28.50					
	31.00		96.80	8.00		55.20	28.50					
	32.00		96.20	8.00		55.20	28.50					
	34.00		94.80	8.00		55.20	28.40					
	74.00		98.20	8.19		52.55	22.61					
	85.00		85.50	8.19		52.54	22.59					
	93.00		86.60	8.19		52.55	22.57					
	99.00		85.80	8.19		52.56	22.61					
	29.00		85.10	8.19		52.56	22.65					
	30.00		103.10	8.32		53.67	19.47					
	32.00		101.40	8.32		53.68	19.44					
	34.00		100.30	8.32		53.67	19.41					
	8.00		100.20	8.32		53.64	19.27					
	8.00		104.60	8.00		54.47	21.58					
	7.00		104.10	7.99		54.46	21.53					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	8.00		103.50	7.99		54.48	21.50					
	11.00		102.70	7.99		54.48	21.53					
	9.00		96.80	8.11		54.75	23.21					
	6.00		96.60	8.12		54.71	23.15					
	6.00		96.50	8.12		54.71	22.98					
	6.00		96.40	8.11		54.68	22.84					
	6.00		96.40	8.07		54.40	28.71					
	7.00		97.20	8.07		54.40	28.69					
	20.00		95.70	8.07		54.39	28.69					
	20.00		95.30	8.07		54.40	28.68					
	22.00		95.00	8.07		54.40	28.67					
	19.00		93.30	8.08		57.09	30.33					
	23.00		91.00	8.08		57.12	30.25					
	8.00		90.00	8.08		57.09	30.23					
	8.00		92.80	8.08		57.09	30.22					
	142.00		98.40	8.01		54.31	20.00					
	208.00		97.10	8.01		54.31	19.99					
	192.00		102.20	8.01		54.32	20.00					
	161.00		101.80	8.00		54.34	20.01					
	141.00		101.60	8.01		54.35	20.02					
	10.00		101.30	8.00		54.34	20.03					
	12.00		101.20	7.94		50.20	22.59					
	12.00		100.60	7.94		50.20	22.58					
	12.00		97.70	7.93		50.21	22.58					
	13.00		94.90	7.93		50.20	22.59					
	19.00		96.20	7.93		50.23	22.59					
	16.00		94.60	7.92		53.36	26.49					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	18.00		99.00	7.92		53.36	26.50					
	7.00		99.00	7.91		53.34	26.46					
	7.00		98.80	7.91		53.33	26.46					
	9.00		99.00	7.91		53.34	26.47					
	8.00		98.90	7.94		51.16	27.14					
	6.00		92.60	7.94		51.24	27.16					
	5.00		92.00	7.94		51.23	27.16					
	8.00		91.90	7.94		51.30	27.20					
	6.00		91.60	7.94		51.31	27.20					
	6.00		77.70	7.94		51.14	28.29					
	9.00		78.90	7.94		51.16	28.27					
	9.00		81.50	7.94		51.26	28.30					
	15.00		86.90	7.94		51.29	28.30					
	9.00		92.80	8.02		55.68	20.25					
	9.00		92.60	8.00		55.66	20.24					
	9.00		96.50	7.99		55.65	20.26					
	8.00		95.10	7.99		55.67	20.22					
	11.00		96.20	7.99		55.65	20.23					
	15.00		95.80	7.99		55.65	20.22					
	9.00		95.70	8.04		56.16	22.59					
	11.00		95.40	8.03		56.12	22.40					
	13.00		94.30	8.03		56.16	22.60					
	14.00		93.40	8.03		56.16	22.54					
	13.00		92.20	8.03		56.16	22.54					
	22.00		92.00	8.03		56.14	22.46					
	19.00		94.60	7.93		54.62	20.84					
	16.00		94.20	7.92		54.65	20.78					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
	20.00		93.70	7.92		54.65	20.74					
	23.00		93.60	7.92		54.64	20.74					
	31.00		90.50	7.80		56.30	27.00					
	31.00		89.90	7.80		56.30	26.90					
	26.00		89.60	7.80		56.30	26.90					
	21.00		89.40	7.80		56.30	26.90					
	21.00		89.30	8.10		55.48	31.31					
	6.00		96.70	8.10		55.48	31.31					
	6.00		96.20	8.10		55.48	31.32					
	7.00		96.00	8.10		55.48	31.33					
	7.00		95.80	8.10		55.48	31.32					
	10.00		98.80	8.21		57.05	32.35					
	10.00		96.10	8.21		57.05	32.31					
	9.00		95.60	8.21		57.08	32.20					
	9.00		96.60	8.21		57.09	32.19					
	7.00		94.80	8.07		53.70	21.70					
	6.00		97.40	8.06		53.75	21.71					
	46.00		96.60	8.05		53.74	21.71					
	55.00		96.40	8.05		53.72	21.71					
	62.00		96.20	8.04		53.71	21.70					
	63.00		99.60	8.13		55.56	20.80					
	66.00		98.90	8.12		55.66	20.78					
			98.30	8.12		55.62	20.80					
			98.00	8.11		55.67	20.90					
			97.80	7.99		55.05	20.78					
			95.10	7.96		55.11	20.79					
			93.50	7.94		55.06	20.81					

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
			92.80	7.94		55.08	20.81					
			100.40	7.94		55.11	20.89					
			98.70	7.86		56.84	28.18					
			97.40	7.85		56.83	28.09					
			95.00	7.85		56.83	28.08					
			93.80	7.99		57.62	30.43					
			102.50	7.98		57.62	30.26					
			101.40	7.98		57.60	30.16					
			101.30	7.96		57.65	29.92					
			122.80	7.96		57.64	29.85					
80th %ile	22.00	5.00	98.48	8.06	43.40	55.70	28.16	34.40	54.40	220.00	108.00	10.00
Max	208.00	5.00	122.80	8.32	53.00	57.65	32.35	35.00	66.00	300.00	120.00	10.00
Median	9.00	5.00	94.35	7.94	29.00	54.39	24.15	33.50	37.00	100.00	90.00	10.00
Min	0.00	5.00	73.30	7.55	12.00	24.20	18.77	32.00	30.00	100.00	70.00	10.00
20th %ile	5.00	5.00	86.32	7.80	18.80	51.16	20.95	32.60	32.80	100.00	78.00	10.00
WQO	6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

Section 5 Wet Season

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
CH	4.10	5.00	91.90	7.97	38.00	55.50	23.60	40.00	40.00	200.00	40.00	10.00
	5.80	5.00	76.60	6.49	16.00	55.50	23.70	40.00	40.00	300.00	30.00	10.00
	13.00	5.00	94.10	7.97	24.00	56.60	23.20	50.00	40.00	2100.00	90.00	10.00
	5.30	5.00	88.00	8.20	27.00	55.50	24.00	40.00	10.00	100.00	50.00	10.00
	5.80	5.00	88.00	6.65	38.00	55.00	24.50	30.00	40.00	200.00	50.00	10.00
	5.70		89.00	8.10		55.00	24.50					
	6.00		82.00	6.82		55.00	24.50					
	13.00		92.60	8.11		55.70	24.10					
	23.20		91.40	6.31		55.60	24.10					

80th %ile	13.00	5.00	92.18	8.10	38.00	55.64	24.50	42.00	40.00	660.00	58.00	10.00
Max	23.20	5.00	94.10	8.20	38.00	56.60	24.50	50.00	40.00	2100.00	90.00	10.00
Median	5.80	5.00	89.00	7.97	27.00	55.50	24.10	40.00	40.00	200.00	50.00	10.00
Min	4.10	5.00	76.60	6.31	16.00	55.00	23.20	30.00	10.00	100.00	30.00	10.00
20th %ile	5.54	5.00	85.60	6.59	22.40	55.00	23.66	38.00	34.00	180.00	38.00	10.00

WQO	6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

Section 5 Dry Season

Dry Season	Turbidity NTU	Chlorophyll-a ug/L	Oxygen per cent saturation %	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia as N (ug/L)	Nitrite + Nitrate as N (ug/L)	Total Nitrogen as N (ug/L)	Total Phosphorous (ug/L)	Reactive Phosphorous (ug/L)
CH	14.00	5.00	94.40	7.72	38.00	56.00	23.36	31.00	23.00	300.00	50.00	10.00
	11.00	5.00	92.70	7.74	32.00	55.90	23.22	36.00	30.00	100.00	30.00	10.00
	21.00	5.00	91.90	7.67	28.00	56.30	23.35		26.00	300.00	50.00	10.00
	8.10	5.00	103.40	7.67	12.00	56.10	23.36		24.00	100.00	60.00	10.00
			102.70	7.72		56.50	23.84					
			103.30	7.75		55.30	24.16					
			94.40	7.76		55.10	24.25					
			93.80	7.66		56.70	24.22					
			104.90	7.68		55.40	24.27					
			105.90	7.68		55.30	24.24					
80th %ile	16.80	5.00	103.70	7.74	34.40	56.34	24.24	35.00	27.60	300.00	54.00	10.00
Max	21.00	5.00	105.90	7.76	38.00	56.70	24.27	36.00	30.00	300.00	60.00	10.00
Median	12.50	5.00	98.55	7.70	30.00	55.95	24.00	33.50	25.00	200.00	50.00	10.00
Min	8.10	5.00	91.90	7.66	12.00	55.10	23.22	31.00	23.00	100.00	30.00	10.00
20th %ile	9.84	5.00	93.58	7.67	21.60	55.30	23.36	32.00	23.60	100.00	42.00	10.00
WQO	6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

Summary

		Turbidity (NTU)	Chlorophyll-a (ug/L)	Oxygen (% sat)	pH	Suspended Solids (mg/L)	Conductivity (mS/cm)	Temperature (oC)	Ammonia N (ug/L)	Nitrates and Nitrites (ug/L)	Total Nitrogen (ug/L)	Total Phosphorous (ug/L)	Filterable Reactive Phosphorous (ug/L)
	Wet Season	7.70	5.00	96.50	6.58	30.50	54.90	22.70	45.00	20.00	500.00	40.00	10.00
Section 1	Dry Season	17.00	5.00	104.55	7.77	55.00	56.70	21.62	32.00	20.00	150.00	60.00	10.00
	Wet Season	16.00	1.87	94.10	7.98	15.40	54.60	28.33	50.00	40.00	850.00	55.00	10.00
Section 2	Dry Season	8.00	1.60	95.70	8.00	39.50	55.26	23.76	36.00	21.00	150.00	65.00	10.00
	Wet Season	16.00	2.17	88.10	7.86	29.00	56.40	28.23	76.50	17.50	100.00	55.00	10.00
Section3	Dry Season	12.00	2.20	96.08	8.02	34.00	55.10	24.93	35.00	20.50	200.00	55.00	10.00
	Wet Season	11.65	5.00	87.10	7.80	29.00	55.14	30.60	41.00	11.00	100.00	50.00	10.00
Section 4	Dry Season	9.00	5.00	94.35	7.94	29.00	54.39	24.15	33.50	37.00	100.00	90.00	10.00
	Wet Season	5.80	5.00	89.00	7.97	27.00	55.50	24.10	40.00	40.00	200.00	50.00	10.00
Section 5	Dry Season	12.50	5.00	98.50	7.70	30.00	55.95	24.00	33.50	25.00	200.00	50.00	10.00
WQO		6.00	2.00	90-100	8.0-8.4	15.00			8.00	3.00	200.00	20.00	6.00

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