Cardno LawsonTreloar
Shaping the Future

BLUESCOPE STEEL LIMITED
ILLAWARRA CO-GENERATION PLANT (ICP)
PROPOSED SALT WATER COOLING
NUMERICAL COOLING WATER STUDIES
ADDENDUM REPORT

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LJ2375/R2449

Report Prepared for

BlueScope Steel

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1. INTRODUCTION

BlueScope Steel Ltd has identified a need to modify aspects of the currently approved Illawarra Cogeneration Plant (ICP) Project. The project is located at the Port Kembla Steelworks. Figure 1.1 provides a general locality plan of the site and its relationship to Port Kembla.

The modified ICP Project includes a proposed once-through salt water cooling system. Operation of the ICP would involve decommissioning of the No. 1 Power House and cessation of the associated flows and temperature loads into the Main Drain. Saltwater used for cooling of the steam turbine generator (STG) condenser of the ICP would be drawn from Port Kembla Outer Harbour via the existing saltwater lift pump and channel, used as cooling water for the ICP and then returned back to Port Kembla Inner Harbour at a location in the mouth of Allan's Creek; approximately 170m downstream of the existing No. 2 Blower Station drain - see Figure 1.2.

As part of environmental investigations and planning activities for the proposed ICP, BlueScope Steel have engaged Cardno Lawson Treloar to undertake a range of 3D numerical cooling water studies. The purpose of these analyses was to simulate the temperature fields arising from the existing and post ICP heat-loads in order to describe any changes in heat field conditions. Apart from environmental effects, this information was to extend to a description of any changes in heat re-circulation to the saltwater intake at the lift-pump station. The impact on the hydrodynamics (currents) within the Inner Harbour due to the ICP has also been investigated.

This report describes the data available to this study, the numerical modelling simulations undertaken and the outcomes from this study. It is an addendum to the previous report prepared in August 2006 (Cardno Lawson Treloar, 2006a). It forms part of the input to CH2M HILL's Salt Water Cooling report.

2. PREVIOUS STUDIES

Cardno Lawson Treloar has previously reported the outcomes of a range of numerical modelling scenarios for typical summer and winter conditions as well as maximum heat-loads (Cardno Lawson Treloar, 2006a). These investigations included the existing heat-load conditions and post-ICP heat load scenarios. The model system (Delft3D), setup and verification are described in Cardno Lawson Treloar (2006a). Since that study, the ICP design has been refined and this report addresses investigations undertaken for the refined ICP design.

3. ICP DESIGN

3.1 Discharge Structure

Cooling water will be discharged from the underground return pipeline to the mouth of Allan's Creek, see Figure 1.2. This discharge will be via a 30m long structure to be constructed parallel with and at the creek shoreline in the location indicated on Figure 1.2. The outlet laterally discharges cooling water into the top 1/3rd/half of the water column depending on the tide level. BlueScope have undertaken detailed numerical flow analyses to ensure that this discharge flows evenly into the upper half of the water column in Allan's Creek at all tide levels.

Based on CFD modelling results discussed with Cardno Lawson Treloar in December 2007, the proposed structure is likely to function as required and discharge cooling water into the top 1/3rd to 1/2 of the water column, depending on the tide level. Provided that these conditions are fulfilled, temperature increases at Location (22, 67) will be less than $3^{o}C$.

3.2 Maximum Heat Load Conditions

The maximum heat load condition from the ICP is a temperature differential (ΔT) of $10.29^{o}C$ and a discharge rate of $8.682m^3/s$, as compared to a ΔT of $9.4^{o}C$ and a discharge rate of $7.5m^3/s$ presented in Cardno Lawson Treloar (2006a). Table 3.1 presents all the heat load sources applied to the Delft3D model for the post-ICP maximum load simulation. The existing condition (pre-ICP) maximum heat-loads are also presented in Table 3.1.

Table 3.1 – Post ICP Maximum Heat-Loads (Summer)

Modelled Drain Flows – Maximum Summer Conditions					
Model Source No	Drain	Existing Condition		Post – ICP	
		Q (m^3/s)	ΔT (^{o}C)	Q (m^3/s)	ΔT (^{o}C)
1	Main Drain	1.431	9.5	0	0
2	No.2 Blower Station	8.233	8.5	7.32	8.0
3	Iron Making East	0.232	7.5	0.156	6.27
4	3500mm Plate Mill Drain	0.43	3.5	0.43	3.5
5	Slab Mill Drain	0.013	32.68*	0.013	32.68*
6	No.1 Flat Products East Drain	0.112	10.5	0.112	10.5
7	Allan's Creek Flow	0.17	22.5*	0.17	22.5*
8	North Gate Drain	0.13	30.22*	0.13	30.22*
9	New ICP Drain	-	-	8.682	10.29

* This is not a power station source, absolute temperature (°C)
ΔT refers to the temperature difference at the outlet compared to the inlet temperature

It should be noted that natural and stormwater flows from Cringila report to the Main Drain. The drain flows listed in Table 3.1 only include the salt water cooling flow from No. 1 Power House.

4. METHODOLOGY

4.1 Model Setup

A full description of the Delft3D model setup, including the modelled meteorological conditions, is presented in Cardno Lawson Treloar (2006a). Since that study BlueScope Steel, as part of final design preparation, have moved the ICP discharge point approximately 30m east from its original location. This is to discharge into a wider section of Allan's Creek thus minimising/reducing any rebound and erosion from the discharge flow on the opposite bank. However, for the modelling reported herein, the original heat-load output location has been maintained, as well as the position of Location (22, 67). Hence the same spatial relativities have been maintained for purposes of model result comparison. Moving the discharge point will lead to slightly smaller temperature increases at Location (22, 67).

The model set up for these simulations relates to the case where cooling water discharge from the ICP to the entrance area of Allan's Creek is to be in the upper half of the water column and where continuous maximum summer heat-load conditions are adopted.

4.2 Harbour Layout and Bathymetry

Since the ICP cooling-water model system was set up, there have been some changes and proposed changes to the layout of Port Kembla Harbour. Those changes were outlined in CH2M HILL's email of 5 February 2008 and the related attached Port Kembla Port Corporation plans (Appendix A); principally Dwg No. 60013335-G004, Rev. A. A generally qualitative assessment has been made on the basis of this information and AUS chart 195 (2000).

There is some potential for changes in tidal prism and harbour volume to affect cooling processes. Additionally, flushing and turnover times may be affected. The following sections describe these assessments.

4.2.1 Volume Changes

Based on the dredging data provided by CH2M HILL, there has been an increase in harbour volume of 131,000m^3 through disposal of this volume of spoil to sea. Other dredged material has been placed in the Outer Harbour reclamation area and in a deep area near The Cut. The total harbour volume at MSL is approximately 24.3 x 10^6 m^3.

Based on the footprints described by developments EB4, MPB3 and MPB130, the following volume changes have been estimated:-

- Loss of harbour volume = 85,000m^3 – based on typical depths in the berth development areas shown on AUS 195
- Loss of tidal prism = 8,000m^3 – based on a Mean Sea Level to High Water height of 0.7m - typical spring tide

Thus there has been a 0.2% net increase in harbour volume ((131,000-85,000)/(24.3x10^6 x 100)) and 0.3% decrease in tidal prism, see below also. These changes are very small and have a negligible impact on the modelling results.

4.2.2 Tidal Exchange

DECC have suggested that an extraction index be used to provide a basis for assessing the likely present condition and change to plankton impacts. The calculation of this index (I) was undertaken as follows:-

$I = T_i/T_r$

where T_i = time required to extract a volume of cooling water equal to the volume of water Port Kembla Harbour (taken as the Inner and Outer Harbours)
T_r =average residence time of harbour water (has been estimated from existing models based on flushing).

T_i required an estimate of the harbour volume. This was determined to be about 24.25 x $10^6 m^3$, based on the present model bathymetry.

Cooling water flows were based on the flows presented in our report (Cardno Lawson Treloar, 2006a), Tables 4.1, 5.1 and 6.1, including only those flows drawn in from the Outer Harbour by the lift-pump.

Flushing times were determined by re-running the cooling water simulations for:-

- existing average summer and typical summer post-ICP cases
- existing average winter and typical winter post-ICP cases
- existing peak summer and peak summer post-ICP cases,

including all cooling water flows, winds and tides.

That is, these simulations were the same as those undertaken for Cardno Lawson Treloar (2006a) previous report. However, they now include a conservative marker contaminant with no density or temperature. This marker was set initially to be 100 (dimensionless units) everywhere within Allan's Creek and the Inner and Outer Harbours. As each model simulation progressed, the marker contaminant diluted. The rate of dilution depended on cooling water flows, as well as the tide and wind driven flows. Flushing time was estimated using the e-folding time which is defined from:-

$$C_T = C_o/e \quad (1)$$

where flushing time T is the time for concentration to reduce to 1/e of an initial concentration. C_T and C_0 are concentrations on a specific tracer decay curve separated by time T when Equation (1) is fully fulfilled. These seasonal and pre and post-ICP differences arise from the different cooling water flows and environmental conditions.

The present harbour and tidal prism volume changes marginally increase T_i and decrease T_r leading to changes in the computed indices of less than 0.5%. The results from Cardno Lawson Treloar (2006b) are reproduced in Table 4.1 and the computed changes, shaded, show little difference.

Table 4.1 – Impact on Flushing and Exchange Times of Port Kembla as the result of Recent Dredging and Expansion of the Multi-Purpose Berth

Parameter	Summer-Pre-Ave	Summer-Post-Ave	Winter-Pre-Ave	Winter-Post-Ave	Summer-Pre-Peak	Summer-Post-Peak
T_i (days)	28.5/28.6	18.4/18.4	26.9/27.0	18.4/18.4	26.9/27.0	17.9/17.9
T_r (days)	3.8/3.8	3.2/3.2	6.5/6.5	6.0/6.0	3.2/3.2	2.4/2.4
Index	7.5/7.5	5.8/5.8	4.1/4.2	3.1/3.1	8.4/8.4	7.5/7.5
Pump Flow (m^3/s)	9.85	15.26	10.43	15.26	10.44	15.72

Typically, an index greater than 1 is theoretically 'good' because it means that harbour water is replaced more quickly than it is passed through the cooling water system. However, as a factor of safety, it is recommended that a minimum index of 3 is likely to indicate satisfactory conditions.

4.2.3 Effects on Cooling Water

The above results have shown that there would most likely be only very minor changes in harbour flushing compared to the results presented in Cardno Lawson Treloar (2006b).

Harbour flushing is the principle which underlies the cooling water processes and re-circulation. Hence the changes in harbour volume would have only minor changes on the cooling water processes. The changes to the layout of Port Kembla Harbour have no identifiable impact on the cooling water processes or the potential for recirculation.

4.3 Impact on Hydrodynamic Conditions – Inner Harbour

The potential impact on hydrodynamic conditions, in particular currents, inside the Inner Harbour due to the ICP cooling water system has been investigated. For this particular investigation, the model bathymetry was adjusted to reflect the development of the MB3 berth and the 2006-2007 dredging works. Current speeds and directions (depth-averaged) inside the Inner Harbour have been investigated for existing and post-ICP maximum heat load conditions – see Section 5.2 and Table 3.1.

5. RESULTS

5.1 Water Temperature

Tables 5.1 and 5.2 present a comparison of the maximum summer average temperature (Table 5.1) and standard deviation (Table 5.2) at selected locations for the existing (as reported in Cardno Lawson Treloar, 2006a) and post-ICP simulations for maximum heat load summer conditions. As with the previous simulations, the largest temperature increases between the existing and post-ICP cases are observed in Layer 10 at Location (22, 67). At this location (Layer-10, Location (22, 67)), the average temperature difference between the existing maximum heat-load case and the post-ICP case is equal to 2.6°C. Figure 5.1 presents a plan view of the Delft3D model time series output points.

Table 5.1 - Existing and Post-ICP Average Water Temperatures (°C) – Maximum Heat-Load Conditions - Summer

	Layer 1 (Surface)		Layer 5 (Middle)		Layer 10 (Bottom)		Vertical Gradient (1-10)*	
Location	Existing	Post-ICP	Existing	Post-ICP	Existing	Post-ICP	Existing	Post-ICP
22,67	28.62	27.89	28.04	28.63	23.92	26.49	4.72	1.95
45,68	25.08	26.24	23.38	23.74	22.94	23.11	2.13	3.13
60,62	24.30	25.25	23.30	23.66	22.84	22.97	1.47	2.28
77,46	23.86	24.60	23.06	23.34	22.66	22.72	0.81	1.89
81,40	23.64	24.29	22.89	23.06	22.70	22.79	0.76	1.50
80,34	23.16	23.51	23.15	23.46	23.01	23.25	0.22	0.32

* Note: Gradient result is the average vertical gradient based on the time series results, not gradient of the average temperatures

Table 5.2 - Existing and Post-ICP Water Temperatures Standard Deviation (°C) – Maximum Heat-Load Conditions - Summer

	Layer 1 (Surface)		Layer 5 (Middle)		Layer 10 (Bottom)		Vertical Gradient (1-10)*	
Location	Existing	Post-ICP	Existing	Post-ICP	Existing	Post-ICP	Existing	Post-ICP
22,67	1.93	2.18	1.65	1.49	1.46	1.14	2.48	1.57
45,68	0.92	0.92	0.30	0.37	0.19	0.19	0.89	0.90
60,62	0.84	0.99	0.26	0.29	0.19	0.19	0.82	0.99
77,46	0.75	0.91	0.25	0.27	0.19	0.18	0.74	0.94
81,40	0.72	0.87	0.30	0.32	0.22	0.22	0.68	0.88
80,34	0.58	0.64	0.51	0.56	0.43	0.48	0.26	0.36

* Note: Gradient result is the standard deviation of vertical gradient based on the time series results, not gradient of the average standard deviations

In addition to the post-ICP heat load presented in Table 3.1, an extreme temperature pulse simulation was undertaken. BlueScope advised that every 3-weeks, a discharge of 10,000 kL/hr (2.78m^3/s) with an outlet temperature of 40^{o}C (associated with a thermal macro-antifouling treatment process, in the event that this method is implemented instead of, or in conjunction with, chemical dosing) may occur for 8 hours during a period of low power generation. This condition was applied to the Delft3D model. At all specified outlet locations, the water temperature changes compared to the maximum summer heat-load conditions were very small. There were no changes to the statistics presented in Tables 5.1 and 5.2. In fact, for the higher temperature case, the heat load (flow x temperature) is lower during the pulse condition compared to the maximum heat-load condition presented in Table 3.1.

Figure 5.2 presents a plan view of the change in average water temperature through the water column between the existing (maximum summer condition) and the post-ICP (maximum summer condition) cases. The increase in mid-depth average temperature near the ICP cooling water outlet is up to 3^{o}C. The water temperature increase may exceed 3^{o}C in the initial mixing zone which may extend between 30m to 40m from the ICP cooling water outlet. This increase in water temperature in the immediate vicinity of the ICP outlet rapidly decreases beyond this distance from the outlet. Within the Inner Harbour, the average temperature increase for the post-ICP condition is generally less than 0.5^{o}C in the middle to bottom layers of the water column and less than 1.5^{o}C for the upper layers. Within the Outer Harbour, the average temperature increase for the post-ICP condition is generally less than 0.5^{o}C in the surface layer and less than 0.2^{o}C in the middle and bottom layers.

5.2 Hydrodynamics – Inner Harbour

The potential impact on currents in the Inner Harbour has been investigated by comparing depth-averaged currents in the Inner Harbour for an existing case maximum heat-load summer condition, and the maximum post-ICP heat-load summer condition. The simulations were undertaken in 3D for a 31-day period.

Figures 5.3 to 5.9 present plan views of depth-averaged currents over a 12-hour flood-ebb tide period (2-hour time intervals). The existing condition is indicated by the black vectors, and the post-ICP condition is indicated by the red vectors. A time-series plot at the bottom of Figures 5.3 to 5.9 indicates the tide condition for each of the vector plots. In all cases, the pre-and-post ICP current vectors are small, less than 0.05m/s in the Inner Harbour.

A time-series comparison of existing and post-ICP depth-averaged current speed and direction for the time-series Location (45,68) is presented as Figure 5.10. (Location (45,68) is displayed on Figures 5.2 to 5.8). Figures 5.1 to 5.8 indicate that the currents inside the Inner Harbour are small – generally less than 0.02m/s (depth-averaged). The ICP is not expected to change the general current conditions and changes to current speeds are small, generally less than 0.005m/s. Hence, where some changes in current direction are indicated, this is not a concern because the forces that would be impinging on ships would be very small. There is not expected to be any impact on shipping operations inside the Inner Harbour as a result of the ICP cooling water flows.

6. POST – ICP VERIFICATION – WATER TEMPERATURE IMPACTS

The following section provides a general concept for a water quality sampling plan that could be used to provide the necessary data to validate the post-ICP operation impacts on water temperature. From experience, the most effective approach to achieve regulatory requirements is to prepare a comprehensive water quality monitoring plan – water column data. The key water quality indicator for the ICP project is water temperature.

The objective of the plan will be to ensure that there is suitable pre-and-post ICP construction water temperature data with which to undertake reliable analyses that can verify the predicted water temperature changes, whilst acknowledging that model results are not precise and field data will need to be considered in terms of sample variability. It is important to develop a water quality monitoring plan that is effective in achieving the verification objectives for the ICP project and to also be consistent with current guidelines – for example ANZECC (2000). Based on similar projects and ANZECC (2000) guidelines, it is recommended that water temperature be monitored at 5 to 6 sites inside Port Kembla Harbour and Allan's Creek for a period of at least 12 months prior to the operation of the ICP and at least 12 months after the commencement of the ICP operations. Water temperature could be sampled monthly at all locations, from three points in the water column. It is recommended that samples be collected during adjoining flood and ebb tides for each of the sites. At the end of a 12 month period this would result in 12 flood-tide and 12 ebb-tide data sets from each location. Samples could be collected 0.5m below the water surface, mid-depth and 0.5m above the seabed for example. The pre-ICP data can be used to define the baseline water temperature condition.

An indicative layout of four potential water quality monitoring locations inside Port Kembla Harbour is presented as Figure 6.1. An additional site would likely be selected in Allan's Creek, well upstream of the ICP cooling water outlet. Site 1 can be used as a reference site to define the ambient ocean water temperature at the time of each sample.

Ideally the pre and post ICP measurements should be taken under similar meteorological and oceanographic conditions. However, it is likely that there will be ocean water temperature variation between the pre and post ICP measurements due to natural variations in the meteorological and oceanographic forcing mechanisms over the data collection period (approximately two years). As a result, meteorological data - including temperature, humidity, rainfall and solar radiation, should also be sampled at Port Kembla Harbour or obtained from nearby sites for the duration of the ICP verification data collection period.

When analysing the post-ICP water temperature data, it will be important to consider any differences in the meteorological conditions or ambient ocean temperatures between the pre-and-post ICP operation periods.

7. CONCLUSIONS

This addendum report should be considered together with the previous report (Cardno Lawson Treloar, 2006a).

The results presented herein have shown that:-

- Recent developments within Port Kembla Harbour and associated changes in the harbour water volume will not have had any significant effect on previous modelling results.
- The proposed increase in maximum ICP heat-load will cause temperature increases higher than those reported in Cardno Lawson Treloar (2006a), but remain below DECC recommendations. The maximum temperature increase is 2.6^{o}C at the seabed near Location (22, 67). More typically, average temperature increases are 0.4^{o}C, or less.
- The proposed thermal pulse which may be released during the anti-fouling treatment would not cause higher seabed temperatures near Location (22,67) compared to the maximum ICP heat-load case.
- At the ICP salt water intake location, the mid-depth average temperature would increase 0.17^{o}C above the existing condition hence there is little additional heat re-circulation.
- Maximum current speeds caused by combined tidal and ICP flows at Inner Harbour shipping berths located near the entrance to Allan's Creek will not exceed 0.02m/s. Compared to the tide only case, the ICP flows would increase current speeds by up to 0.005m/s. Current speeds of these magnitudes will not affect shipping because the pressure forces imposed on vessel hulls will be very small.

8. REFERENCES

ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality, Volume 1, National Water Quality Management Strategy, No 4, Environment Australia, October 2000.

Cardno Lawson Treloar (2006a): Steelworks Co-Generation Plant (SCP). Proposed Saltwater Cooling, Numerical Cooling Water Studies. Report (LJ2375/R2257) Prepared for BlueScope Steel Limited.

Cardno Lawson Treloar (2006b): Numerical Modelling of Cooling Water Field – Plankton Fatality and Flushing Issues. (LJ2375/L9920) Prepared for BlueScope Steel Limited September 2006.

FIGURES

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BlueScope Steel - ICP Project

LOCALITY PLAN

Figure 1.1

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PROPOSED ICP DISCHARGE LAYOUT

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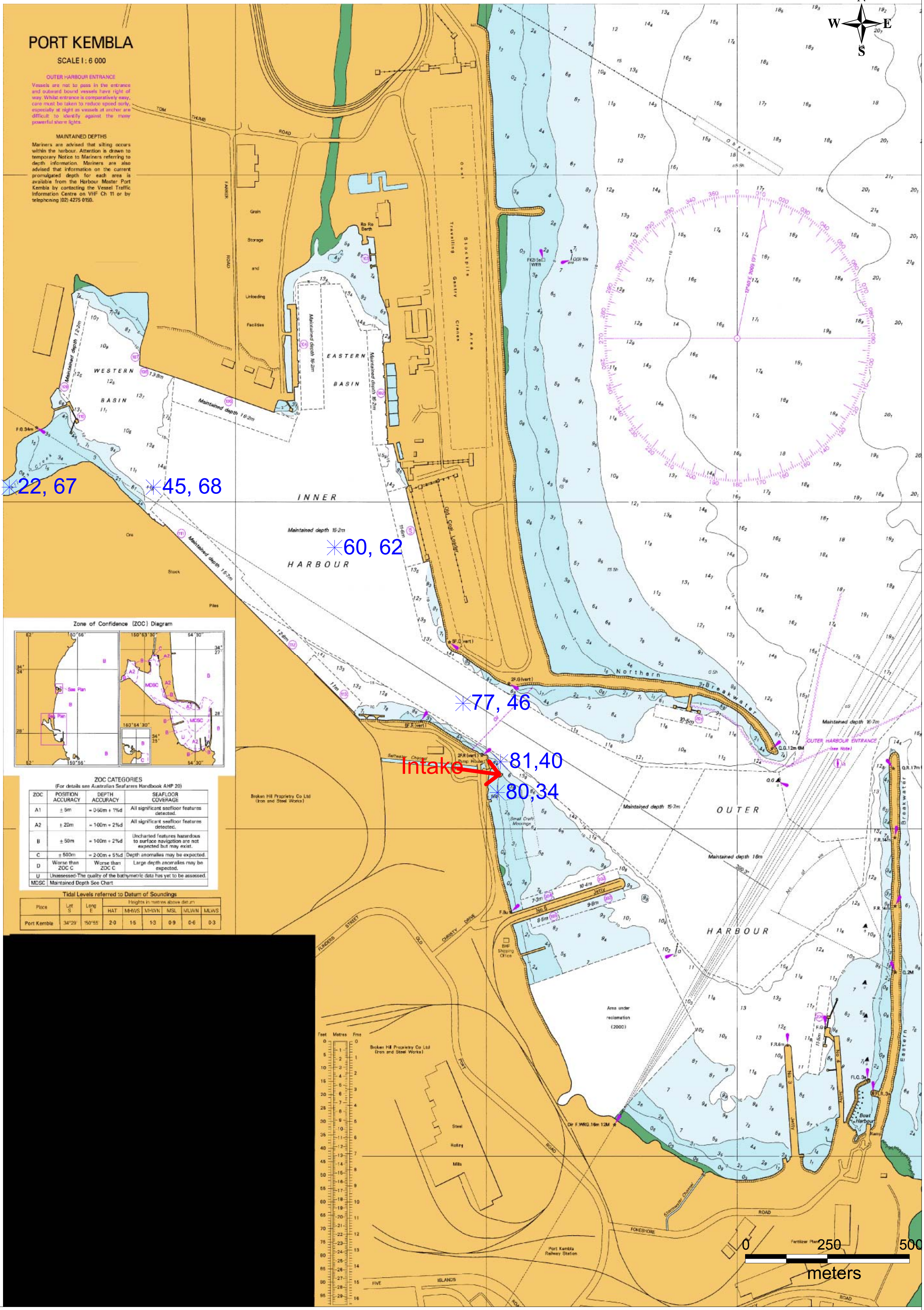
Figure 1.2



BlueScope Steel - ICP Project

DELFT3D TIME SERIES OUTPUT LOCATIONS
(AUS195 - Aust. Hydrographic Service)
Figure 5.1

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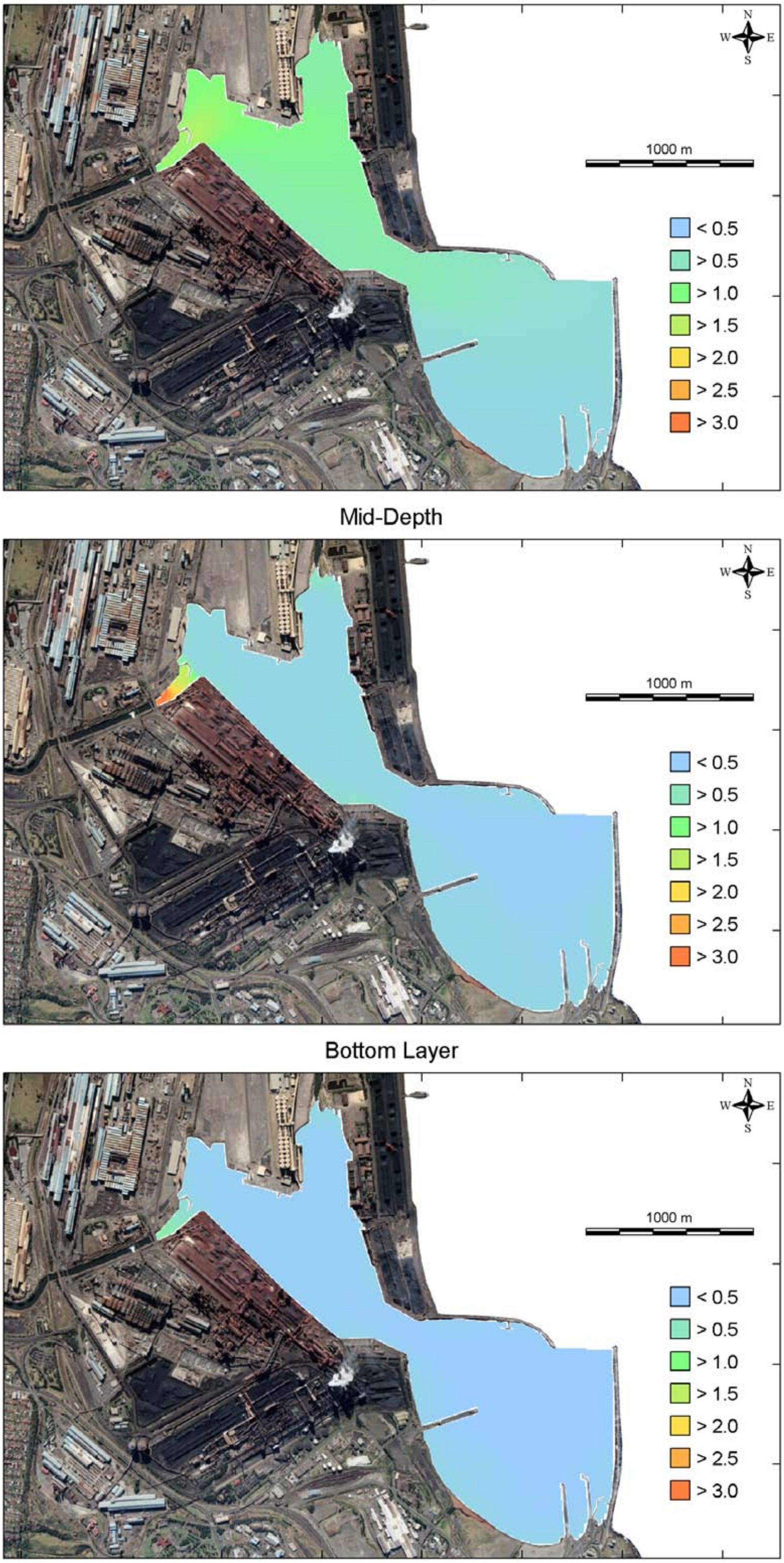
Surface Layer

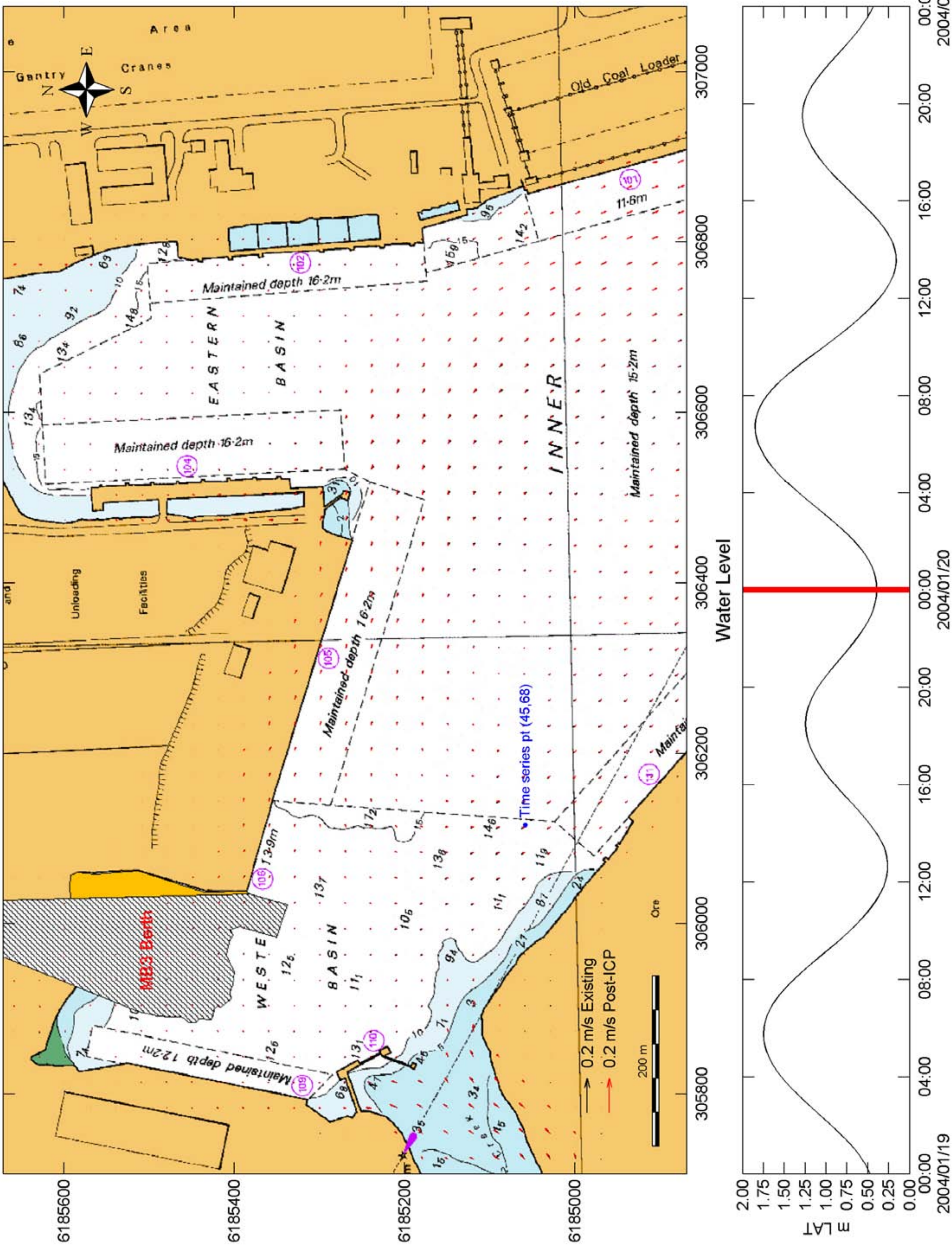


Bluescope Steel - ICP Project

AVERAGE CHANGE IN WATER TEMPERATURE

PEAK SUMMER LOAD CONDITIONS

Figure 5.2



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Bluescope Steel - ICP Project
VELOCITY VECTORS (Depth-Averaged)
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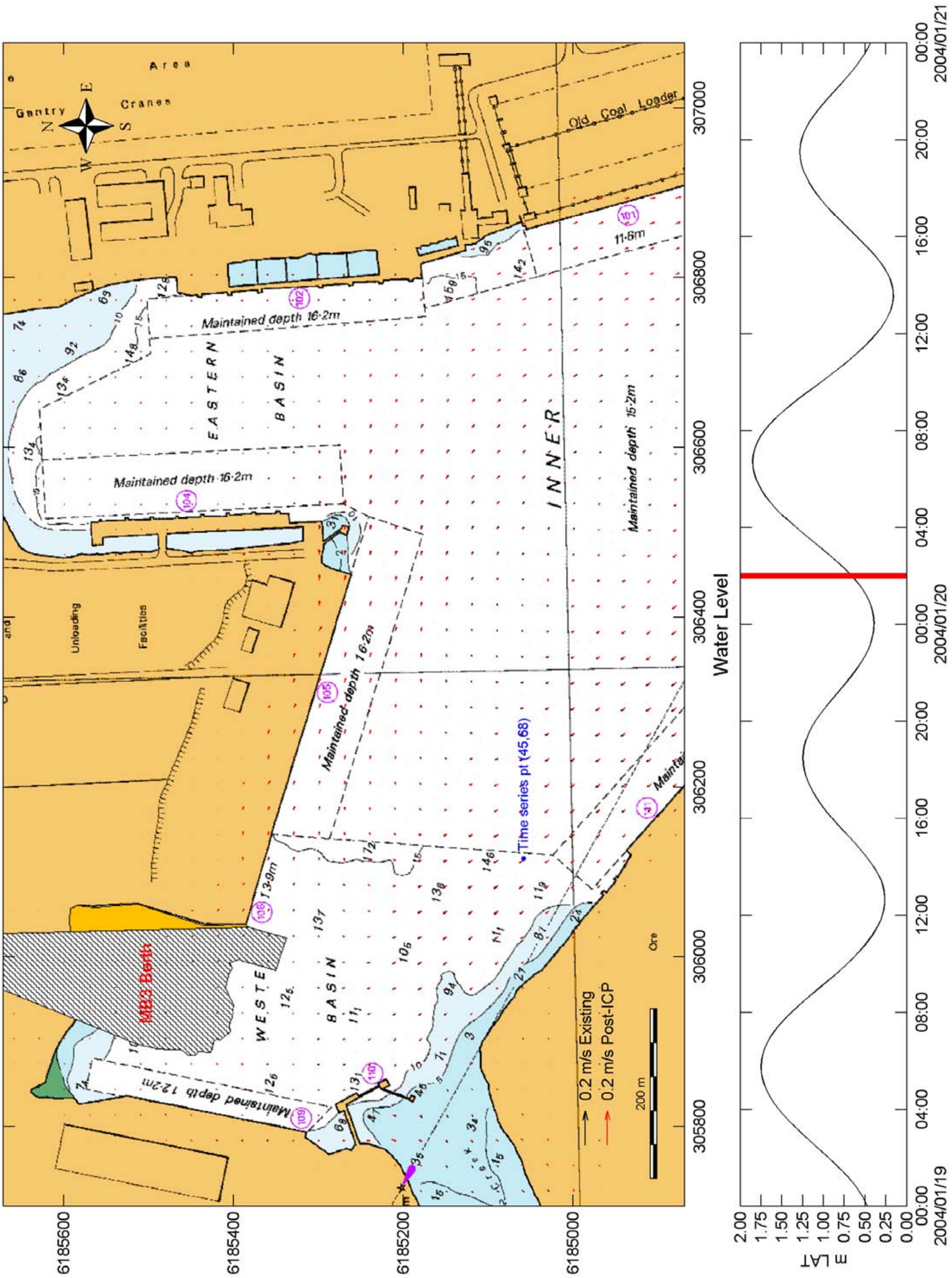
Figure 5.3



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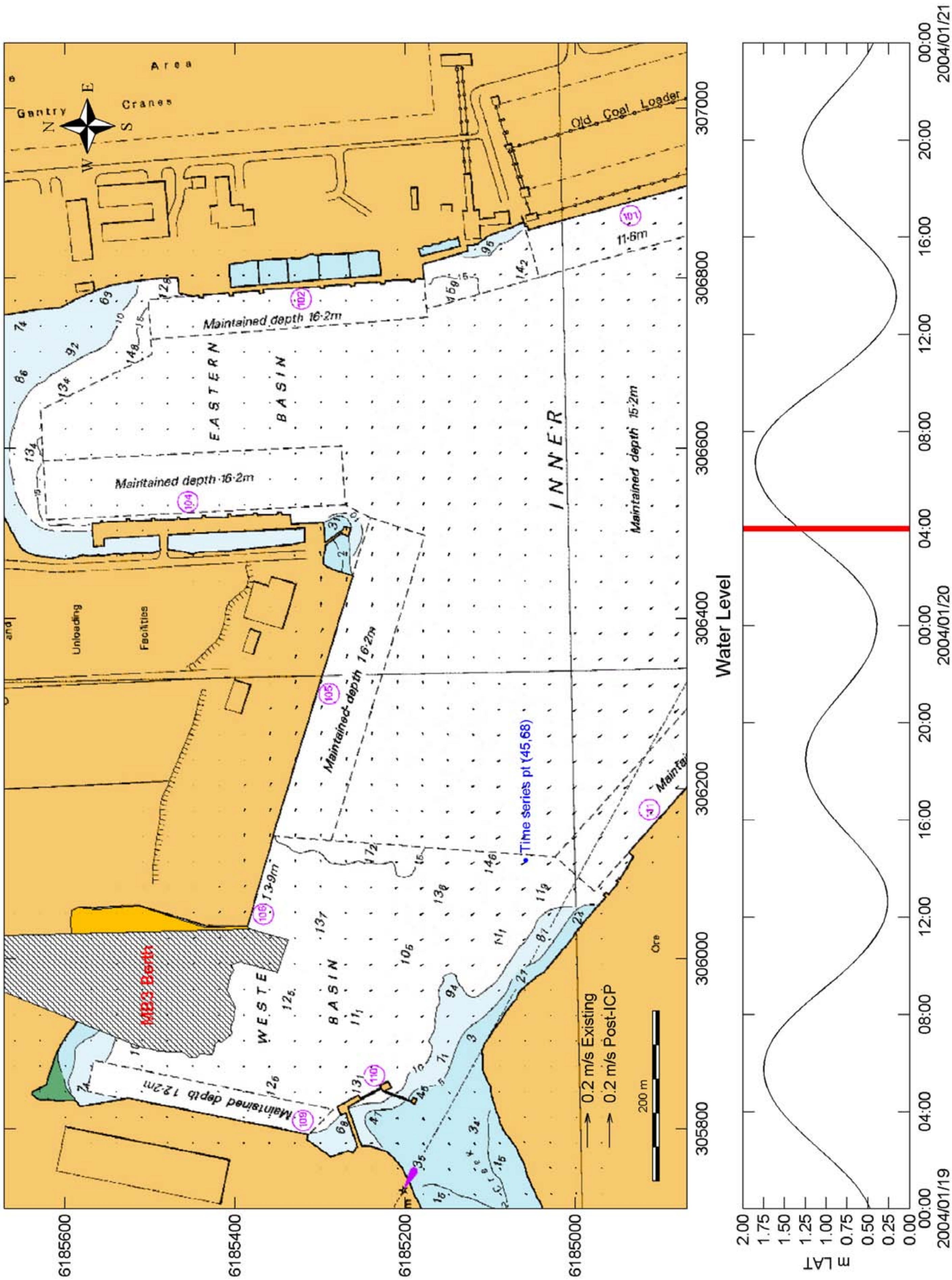

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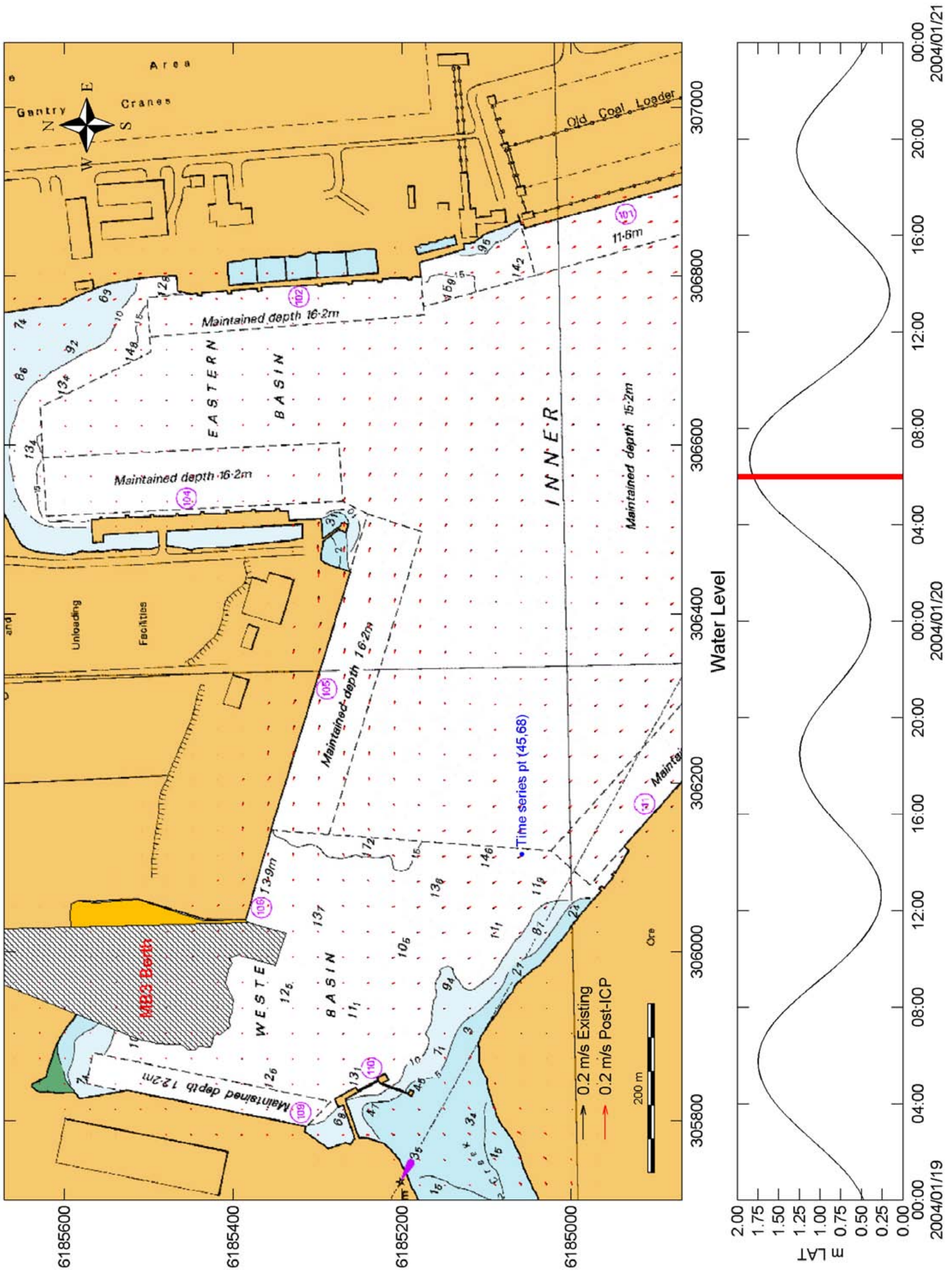

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Bluescope Steel - ICP Project
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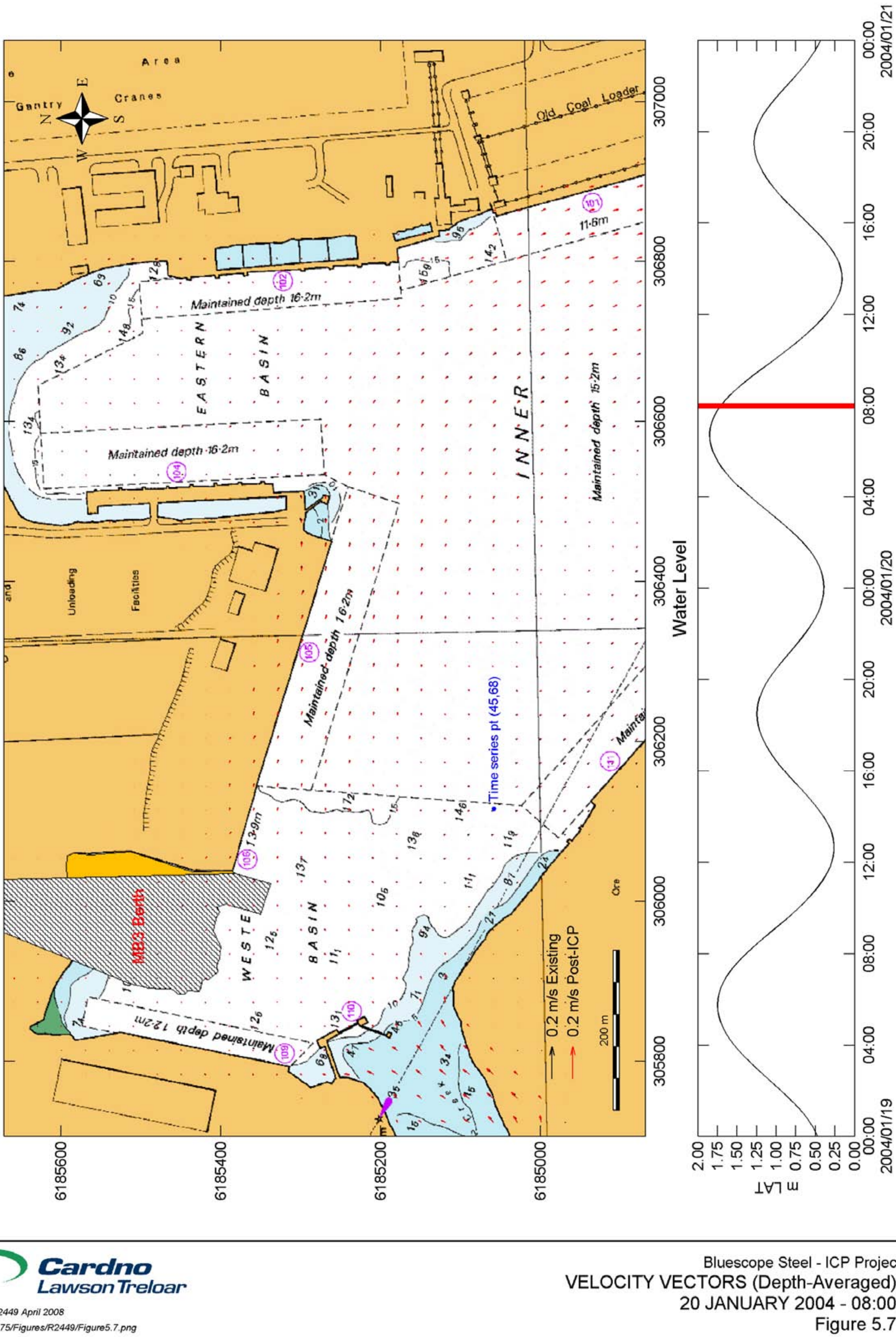

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Bluescope Steel - ICP Project

VELOCITY VECTORS (Depth-Averaged)

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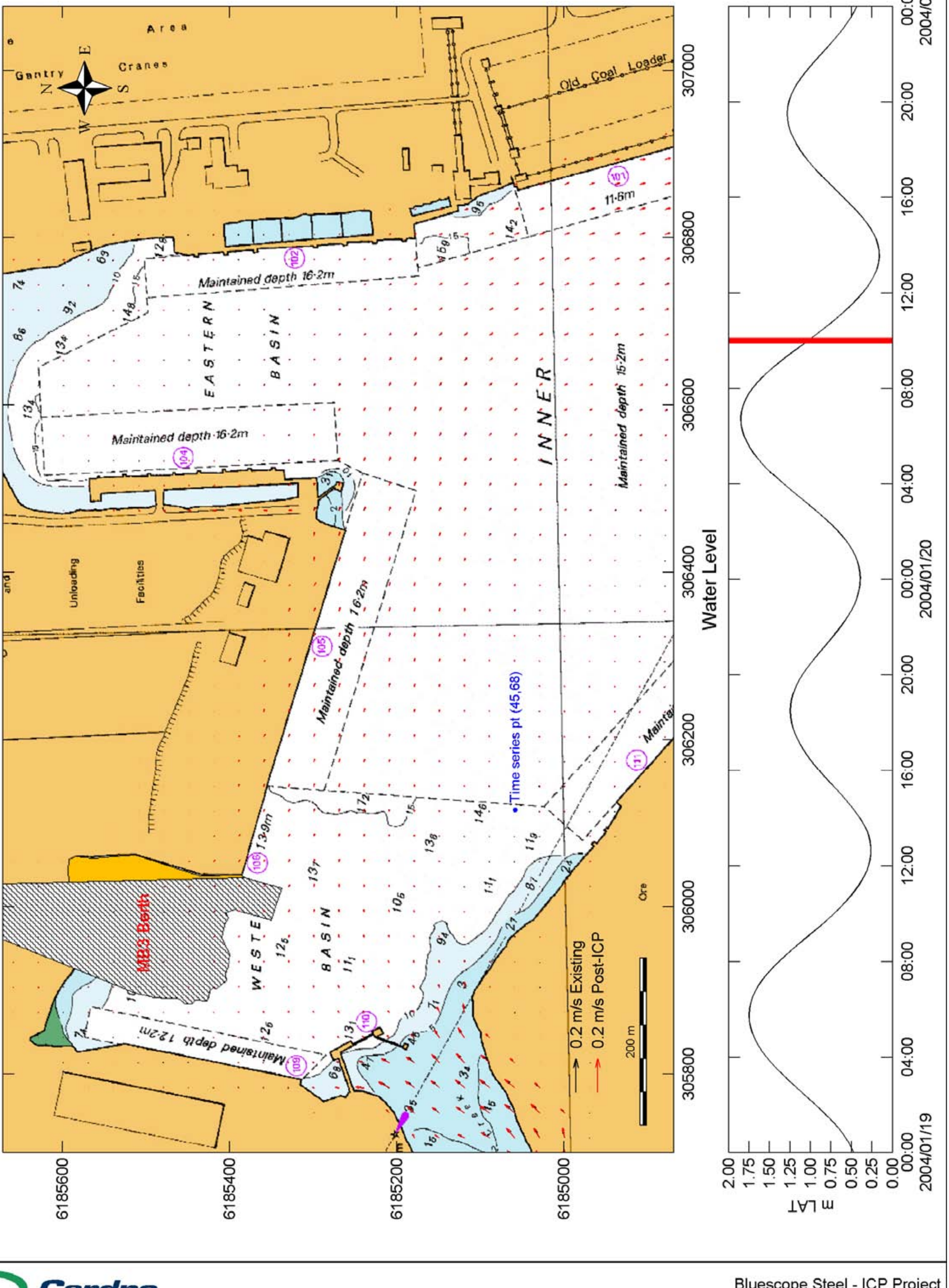
Figure 5.7



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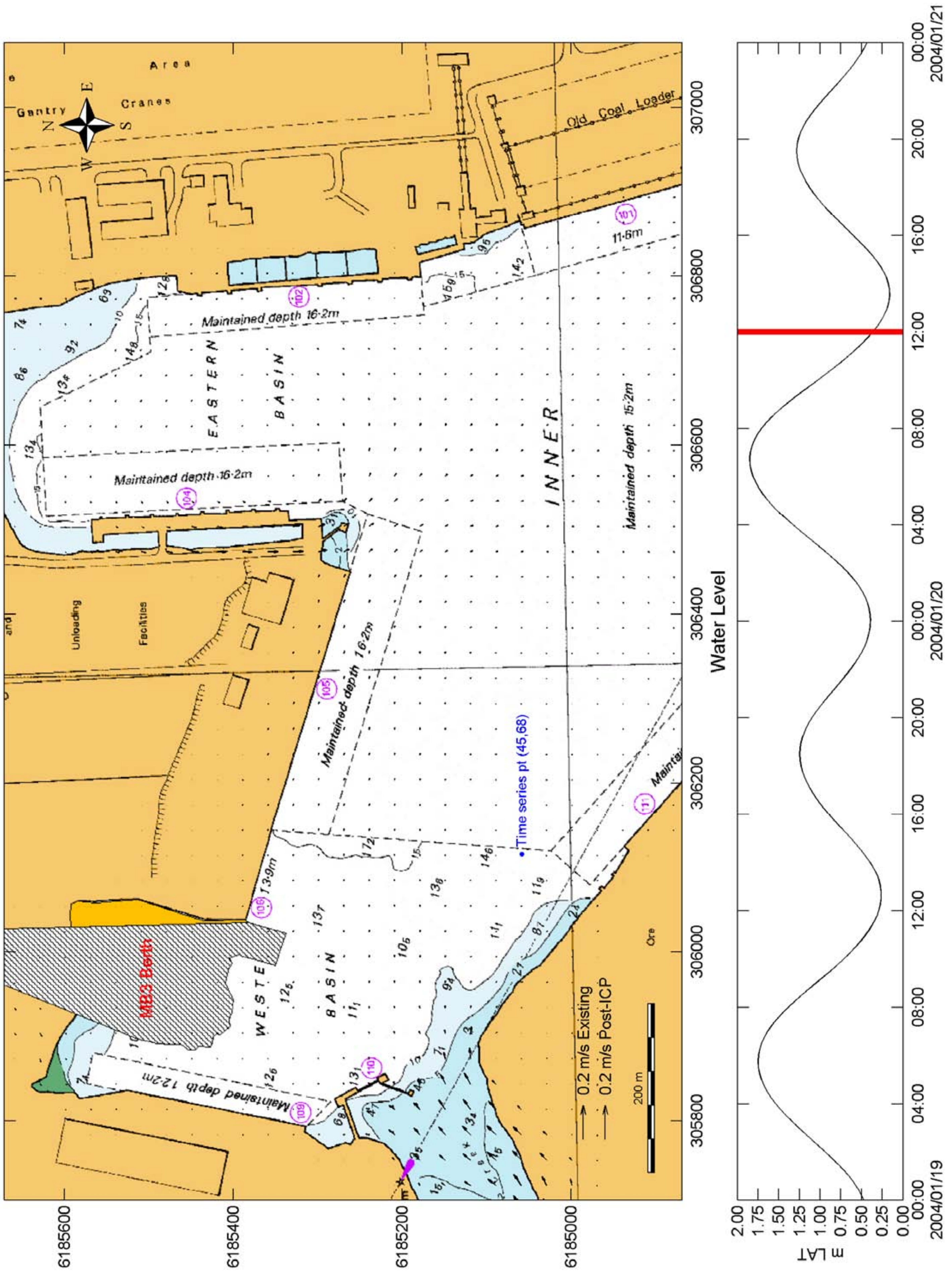

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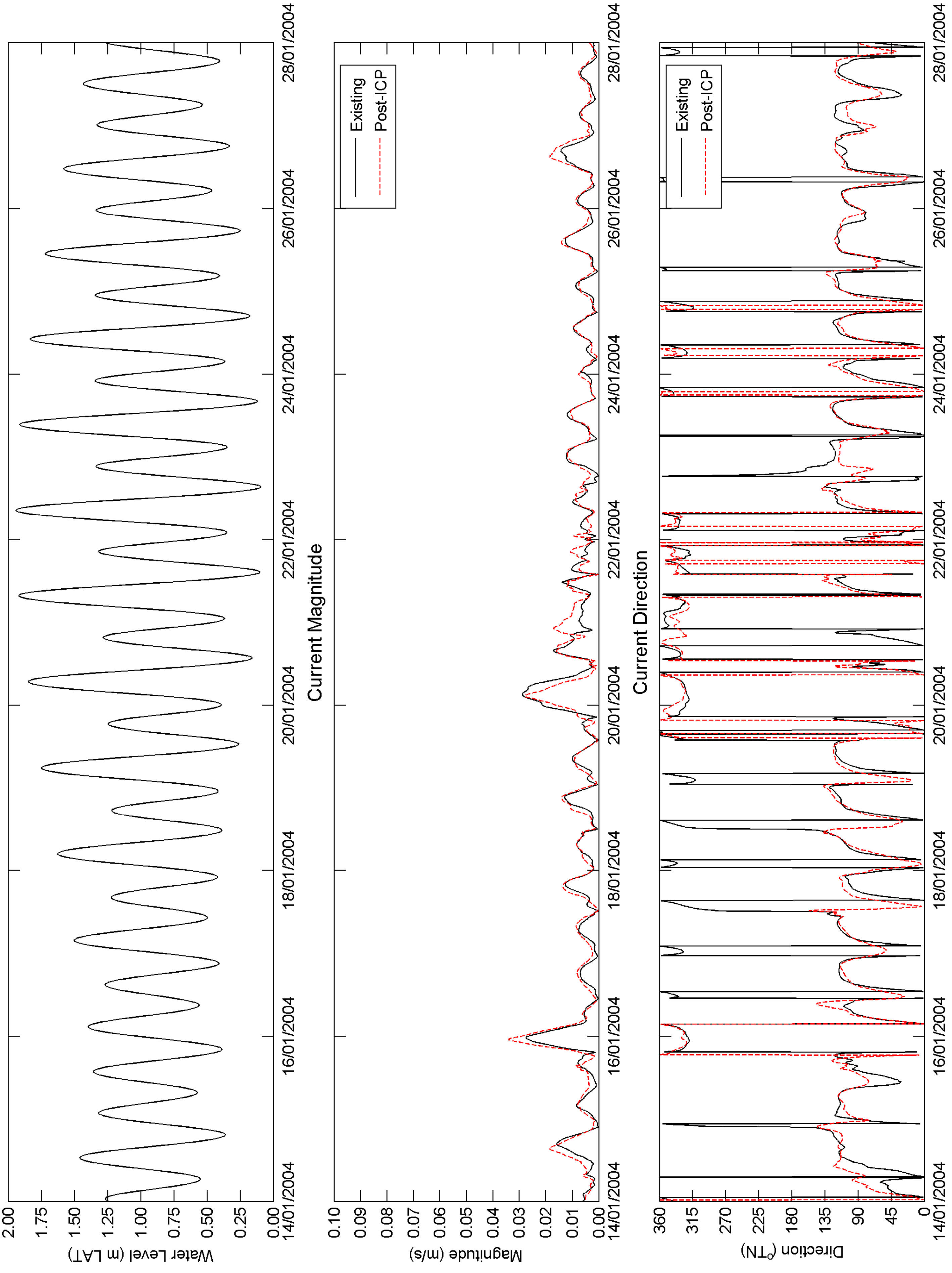

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LJ2375/R2449 April 2008

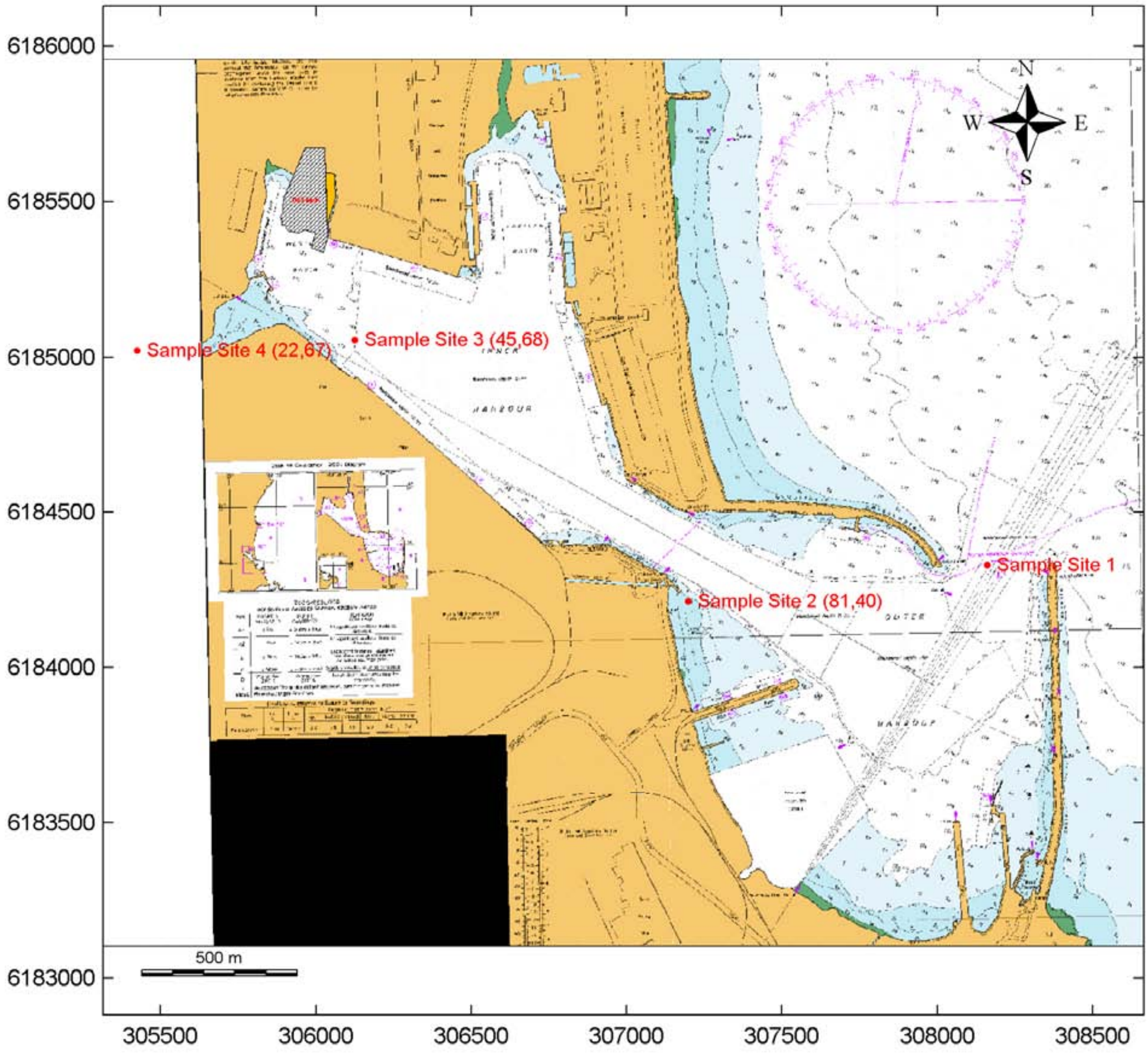
J:/CM/J2375/Figures/R2449/Figure5.10.png

Bluescope Steel - ICP Project

WATER LEVEL AND CURRENT TIME SERIES (Depth-Averaged)

Location 45,68

Figure 5.10



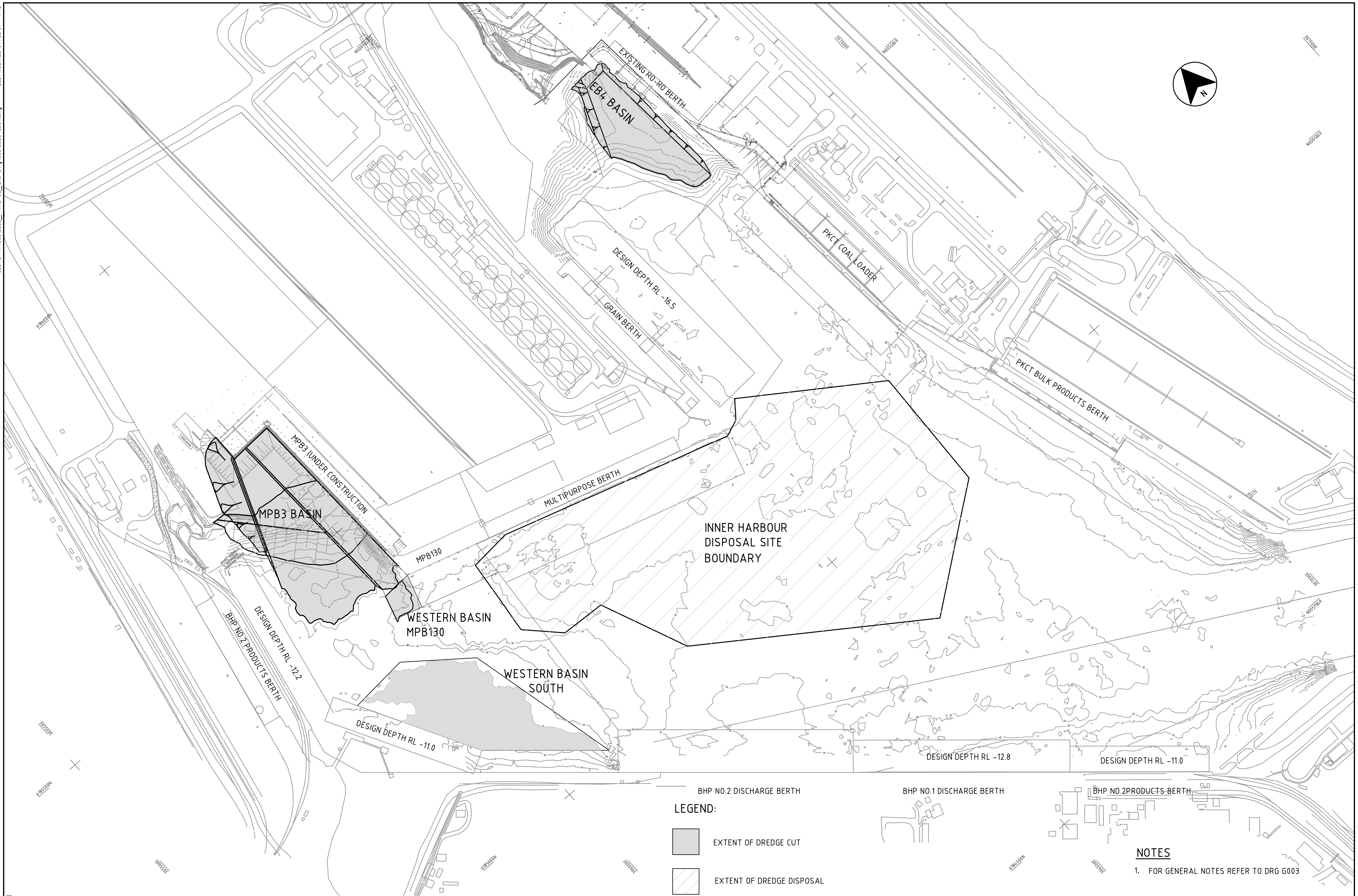
Bluescope Steel - ICP Project

INDICATIVE WATER TEMPERATURE SAMPLING LOCATIONS

Figure 6.1

APPENDIX A

Port Kembla MPB Expansion and Dredging Plans – Provided by CH2M HILL



LEGEND:

EXTENT OF DREDGE CUT

EXTENT OF DREDGE DISPOSAL

NOTES

1. FOR GENERAL NOTES REFER TO DRG G003

No.	BY	DATE	DESCRIPTION	APPD
A	SG	19.01.07	ISSUED FOR CONSTRUCTION	MC

THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE MAUNSELL QUALITY ASSURANCE SYSTEM TO ISO 9001-2000

DESIGNED	B.G	CHECKED	R.N
DRAWN	S.G	CHECKED	R.N
APPROVED		DATE	19.01.07

SCALES: 25 0 50 100m
1 : 2500 FULL SIZE A1

CLIENT: PORT KEMBLA PORT CORPORATION

Approved By Port Engineer:

DESIGNER: MAUNSELL | AECOM

Maunsell Australia Pty Ltd A.B.N. 20 093 846 925

PORT KEMBLA INNER HARBOUR DREDGING

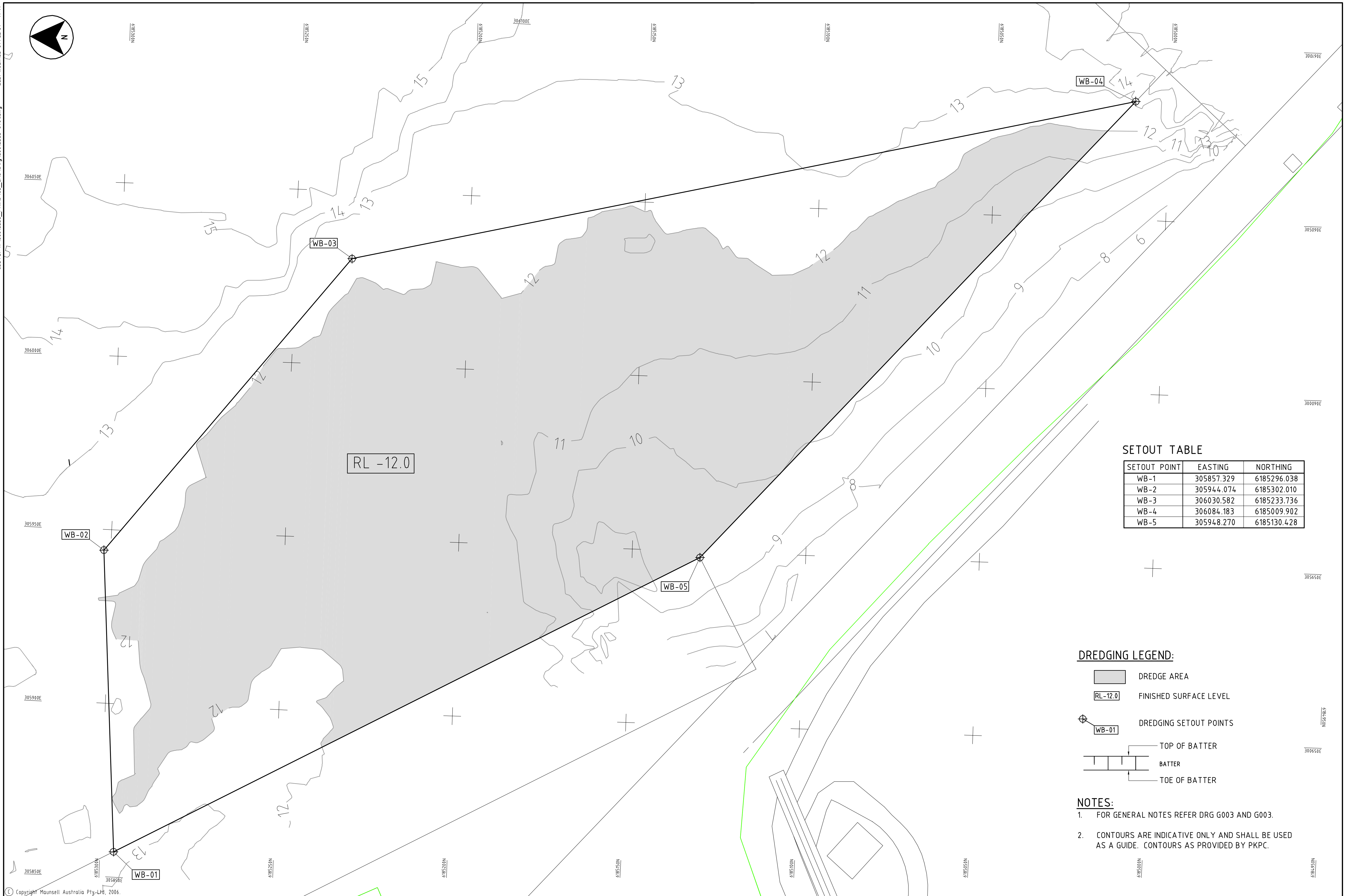
GENERAL ARRANGEMENT
INNER HARBOUR WORKS

STATUS: CONSTRUCTION

DRAWING No: 60013335-G004

REV: A

Cad ref: K:\60013335_PKIHD\02_CAD\Dwg\60013335-C401.dwg   Last modified: 01 Feb 07 - 17:14



SETOUT TABLE

SETOUT POINT	EASTING	NORTHING
WB-1	305857.329	6185296.038
WB-2	305944.074	6185302.010
WB-3	306030.582	6185233.736
WB-4	306084.183	6185009.902
WB-5	305948.270	6185130.428

DREDGING LEGEND:

DREDGE AREA

RL-12.0 FINISHED SURFACE LEVEL

WB-01 DREDGING SETOUT POINTS

TOP OF BATTER

BATTER

TOE OF BATTER

NOTES:

1. FOR GENERAL NOTES REFER DRG G003 AND G003.
2. CONTOURS ARE INDICATIVE ONLY AND SHALL BE USED AS A GUIDE. CONTOURS AS PROVIDED BY PKPC.

No.	BY	DATE	DESCRIPTION	APPD
A	SG	19.01.07	ISSUED FOR CONSTRUCTION	MC

THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE MAUNSELL QUALITY ASSURANCE SYSTEM TO ISO 9001-2000

DESIGNED	B.G	CHECKED	R.N
DRAWN	S.G	CHECKED	R.N
APPROVED		DATE	19.01.07

SCALES: 5 0 10 20m — 1 : 500 FULL SIZE A1

CLIENT: PORT KEMBLA PORT CORPORATION

Approved By Port Engineer:

DESIGNER: MAUNSELL | AECOM

Maunsell Australia Pty Ltd A.B.N. 20 093 846 925

PORT KEMBLA INNER HARBOUR DREDGING

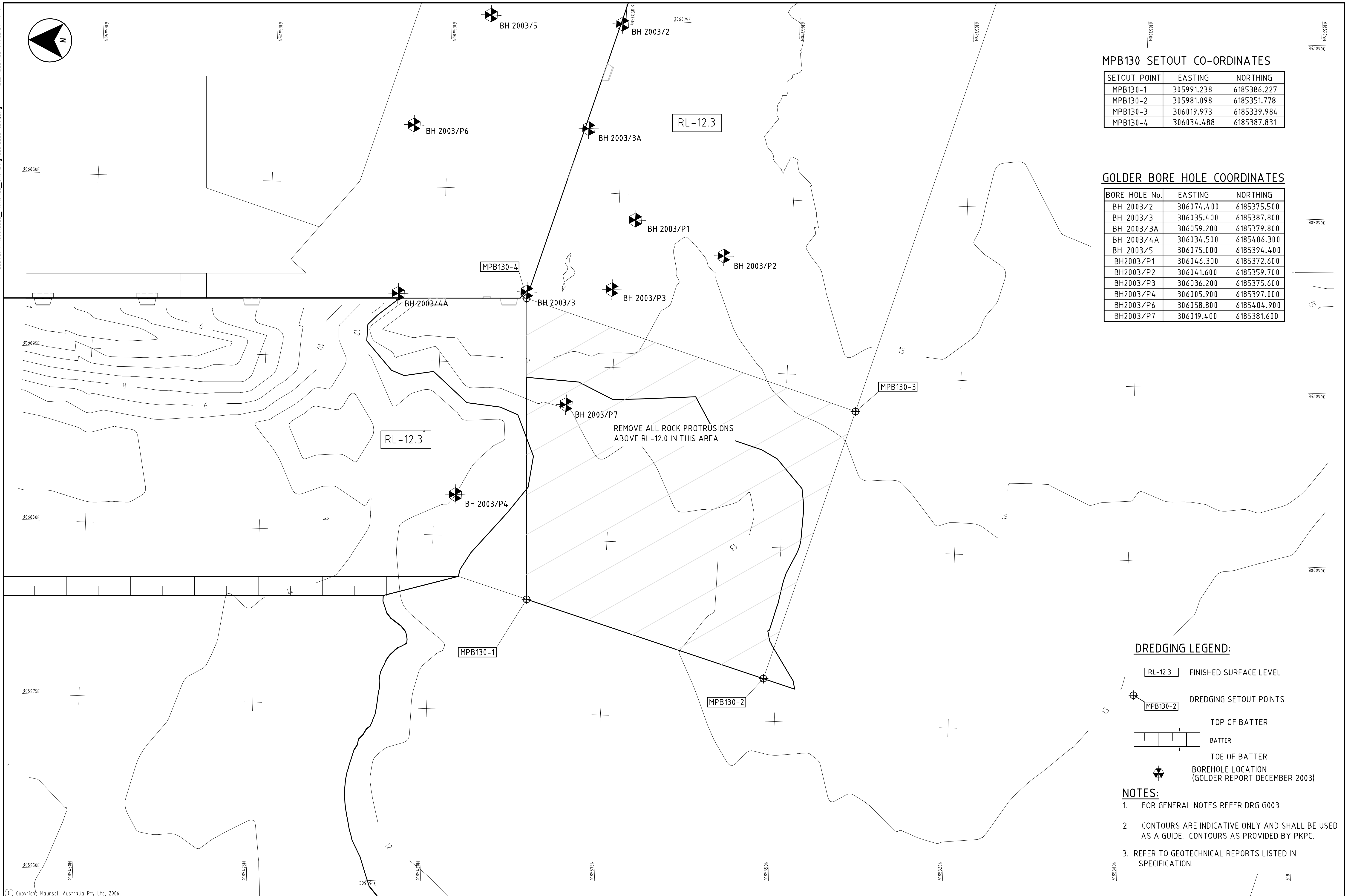
WESTERN BASIN
WBS PLAN & SETOUT

STATUS: CONSTRUCTION

DRAWING NO: 60013335-C401

REV: A

Cad ref: K:\60013335_PKIHD\02_CAD\Dwg\60013335-C301.dwg   Last modified: 01 Feb 07 - 17:14



MPB130 SETOUT CO-ORDINATES

SETOUT POINT	EASTING	NORTHING
MPB130-1	305991.238	6185386.227
MPB130-2	305981.098	6185351.778
MPB130-3	306019.973	6185339.984
MPB130-4	306034.488	6185387.831

GOLDER BORE HOLE COORDINATES

BORE HOLE No.	EASTING	NORTHING
BH 2003/2	306074.400	6185375.500
BH 2003/3	306035.400	6185387.800
BH 2003/3A	306059.200	6185379.800
BH 2003/4A	306034.500	6185406.300
BH 2003/5	306075.000	6185394.400
BH2003/P1	306046.300	6185372.600
BH2003/P2	306041.600	6185359.700
BH2003/P3	306036.200	6185375.600
BH2003/P4	306005.900	6185397.000
BH2003/P6	306058.800	6185404.900
BH2003/P7	306019.400	6185381.600

DREDGING LEGEND:

RL-12.3 FINISHED SURFACE LEVEL

MPB130-2 DREDGING SETOUT POINTS

TOP OF BATTER

BATTER

TOE OF BATTER

BOREHOLE LOCATION
(GOLDER REPORT DECEMBER 2003)

NOTES:

1. FOR GENERAL NOTES REFER DRG G003
2. CONTOURS ARE INDICATIVE ONLY AND SHALL BE USED AS A GUIDE. CONTOURS AS PROVIDED BY PKPC.
3. REFER TO GEOTECHNICAL REPORTS LISTED IN SPECIFICATION.

No.	BY	DATE	DESCRIPTION	APPD
A	SG	19.01.07	ISSUED FOR CONSTRUCTION	MC

THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE MAUNSELL QUALITY ASSURANCE SYSTEM TO ISO 9001-2000

DESIGNED	B.G	CHECKED	R.N
DRAWN	S.G	CHECKED	R.N
APPROVED		DATE	19.01.07

SCALES: 2.5 0 5 10m
1 : 250 FULL SIZE A1

CLIENT: PORT KEMBLA PORT CORPORATION

Approved By Port Engineer:

DESIGNER: MAUNSELL | AECOM

Maunsell Australia Pty Ltd A.B.N. 20 093 846 925

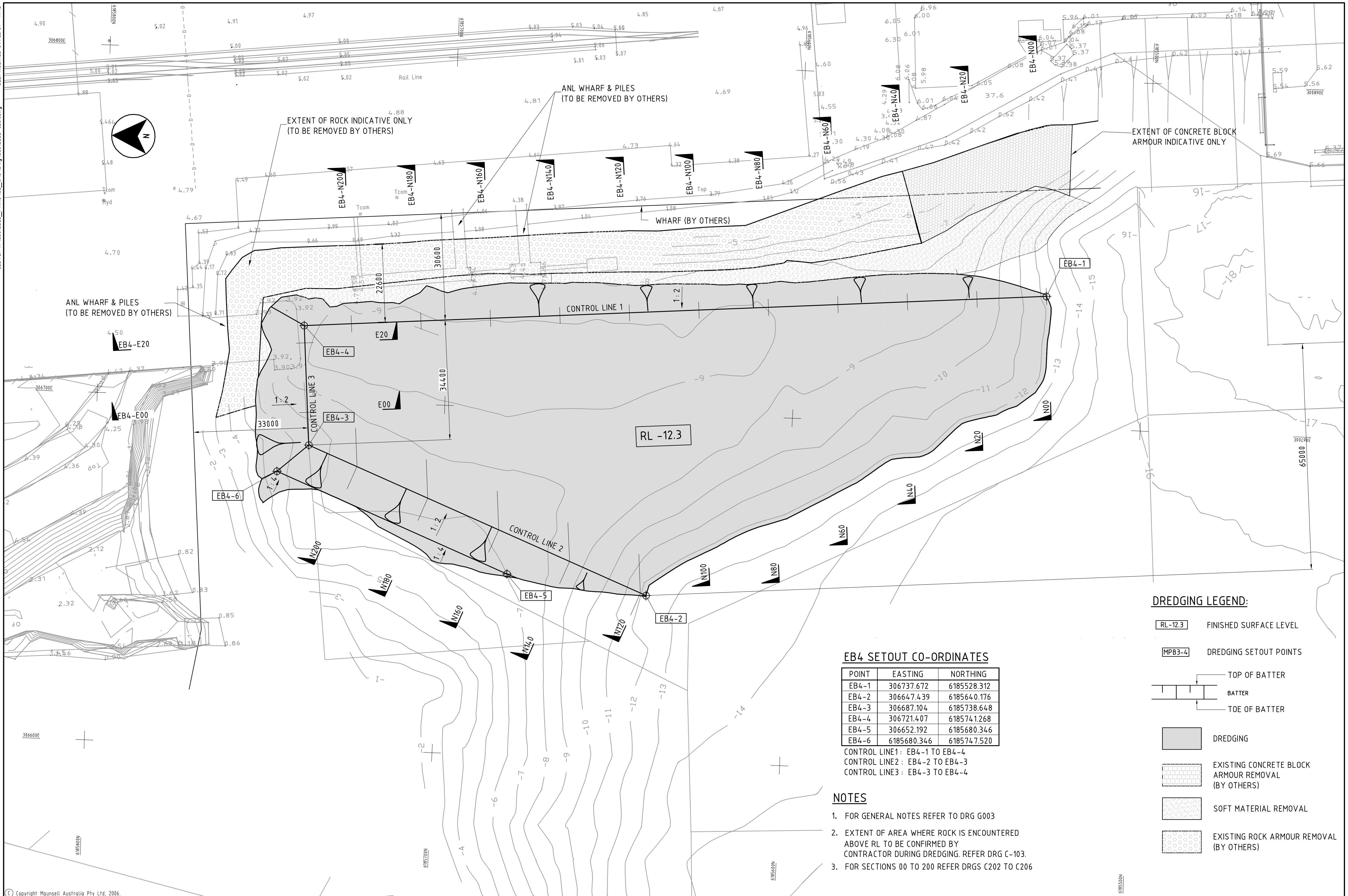
PORT KEMBLA INNER HARBOUR DREDGING

WESTERN BASIN
MPB130 BOREHOLE & SETOUT

STATUS: CONSTRUCTION

DRAWING No: 60013335-C301

REV: A



EB4 SETOUT CO-ORDINATES

POINT	EASTING	NORTHING
EB4-1	306737.672	6185528.312
EB4-2	306647.439	6185640.176
EB4-3	306687.104	6185738.648
EB4-4	306721.407	6185741.268
EB4-5	306652.192	6185680.346
EB4-6	6185680.346	6185747.520

CONTROL LINE1 : EB4-1 TO EB4-4
CONTROL LINE2 : EB4-2 TO EB4-3
CONTROL LINE3 : EB4-3 TO EB4-4

NOTES

1. FOR GENERAL NOTES REFER TO DRG G003
2. EXTENT OF AREA WHERE ROCK IS ENCOUNTERED ABOVE RL TO BE CONFIRMED BY CONTRACTOR DURING DREDGING. REFER DRG C-103.
3. FOR SECTIONS 00 TO 200 REFER DRGS C202 TO C206

DREDGING LEGEND:

- RL-12.3 — FINISHED SURFACE LEVEL
- MPB3-4 — DREDGING SETOUT POINTS
- TOP OF BATTER / BATTER / TOE OF BATTER
- DREDGING
- EXISTING CONCRETE BLOCK ARMOUR REMOVAL (BY OTHERS)
- SOFT MATERIAL REMOVAL
- EXISTING ROCK ARMOUR REMOVAL (BY OTHERS)

No.	BY	DATE	DESCRIPTION	APPD
A	SG	19.01.07	ISSUED FOR CONSTRUCTION	MC

DESIGNED	B.G	CHECKED	R.N
DRAWN	S.G	CHECKED	R.N
APPROVED		DATE	19.01.07

SCALES: 1 : 500 FULL SIZE A1

CLIENT: PORT KEMBLA PORT CORPORATION

Approved By Port Engineer:

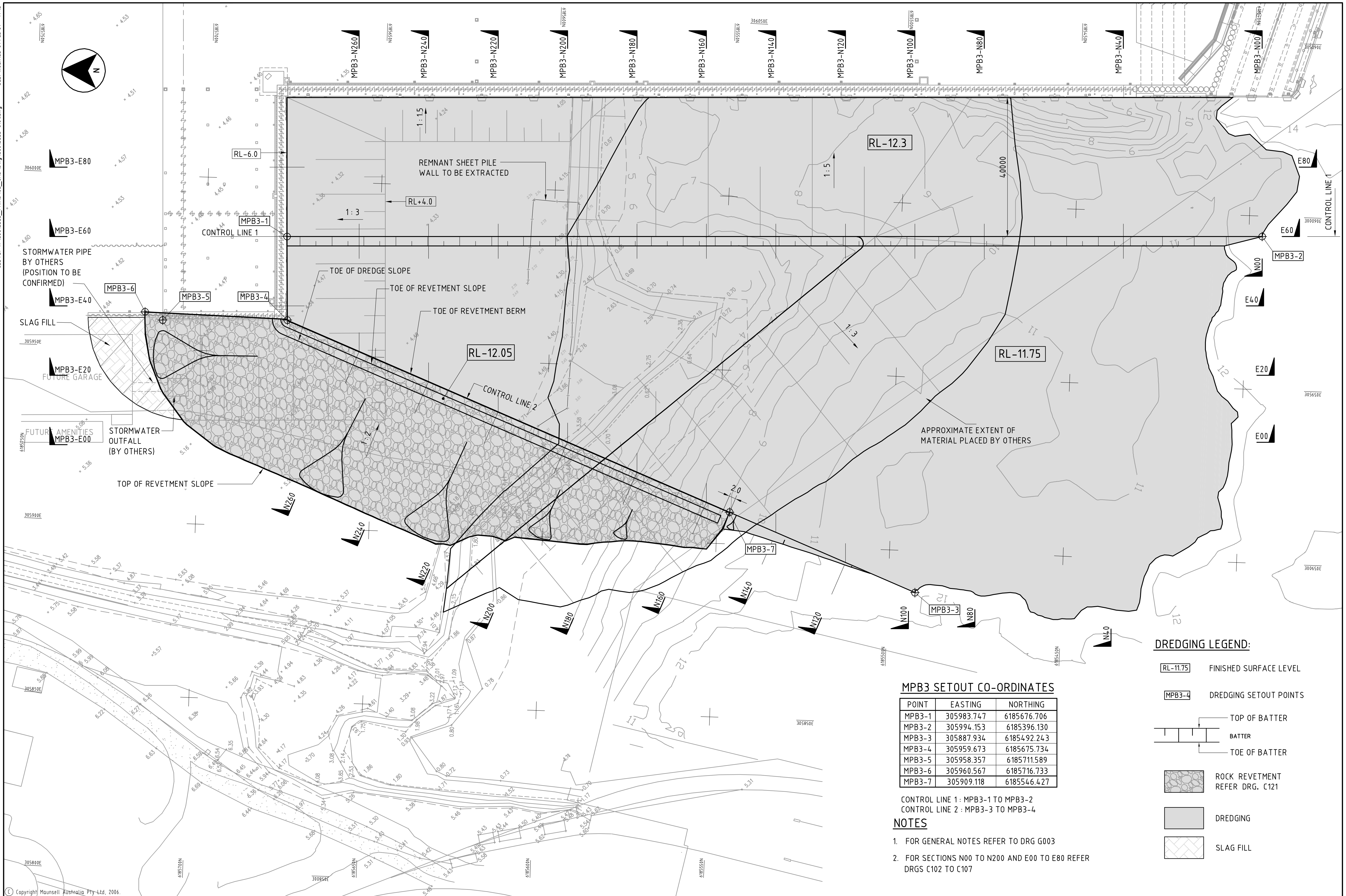
DESIGNER: MAUNSELL | AECOM
Maunsell Australia Pty Ltd A.B.N. 20 093 846 925

PORT KEMBLA INNER HARBOUR DREDGING

EB4 BASIN
DREDGING PLAN & SETOUT

SHEET ? OF ?

STATUS: CONSTRUCTION
DRAWING NO: 60013335-C201
REV: A



MPB3 SETOUT CO-ORDINATES

POINT	EASTING	NORTHING
MPB3-1	305983.747	6185676.706
MPB3-2	305994.153	6185396.130
MPB3-3	305887.934	6185492.243
MPB3-4	305959.673	6185675.734
MPB3-5	305958.357	6185711.589
MPB3-6	305960.567	6185716.733
MPB3-7	305909.118	6185546.427

CONTROL LINE 1 : MPB3-1 TO MPB3-2
CONTROL LINE 2 : MPB3-3 TO MPB3-4

NOTES

1. FOR GENERAL NOTES REFER TO DRG G003
2. FOR SECTIONS N00 TO N200 AND E00 TO E80 REFER DRGS C102 TO C107

DREDGING LEGEND:

RL-11.75 FINISHED SURFACE LEVEL
MPB3-4 DREDGING SETOUT POINTS
TOP OF BATTER
BATTER
TOE OF BATTER
ROCK REVETMENT REFER DRG. C121
DREDGING
SLAG FILL

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No.	BY	DATE	DESCRIPTION	APPD
A	SG	19.01.07	ISSUED FOR CONSTRUCTION	MC

DESIGNED	B.G	CHECKED	R.N
DRAWN	S.G	CHECKED	R.N
APPROVED		DATE	19.01.07

SCALES: 1 : 500 FULL SIZE A1 (5 0 10 20m)

CLIENT: PORT KEMBLA PORT CORPORATION

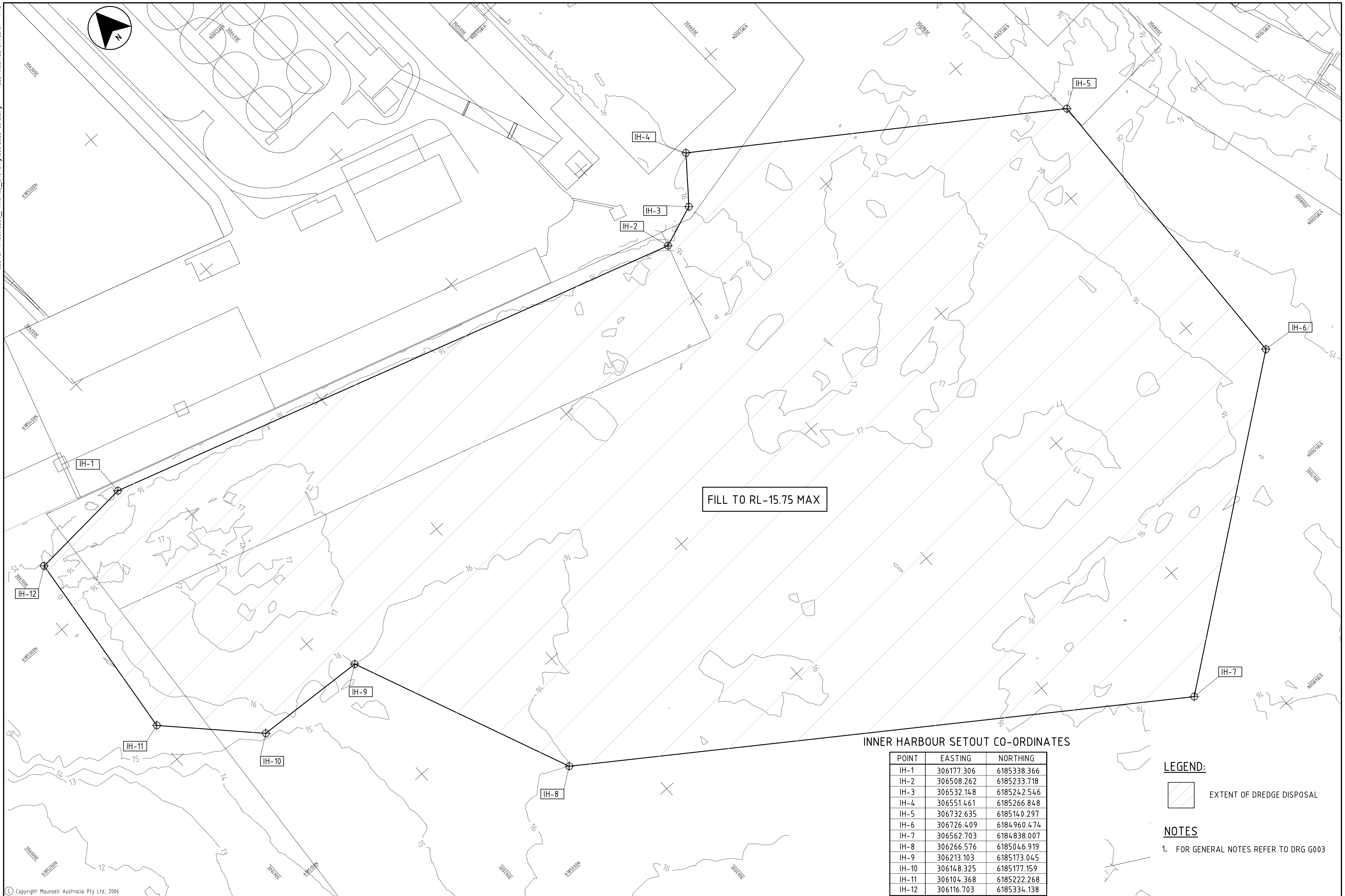
Approved By Port Engineer:

DESIGNER: MAUNSELL | AECOM
Maunsell Australia Pty Ltd A.B.N. 20 093 846 925

PORT KEMBLA INNER HARBOUR DREDGING
MPB3 BASIN
DREDGING PLAN & SETOUT

STATUS: CONSTRUCTION
DRAWING No: 60013335-C101
REV: A

Cad ref: K:\60013335_PKIHD\02_CAD\Dwg\60013335-C101.dwg Last modified: 01 Feb 07 - 17:13



INNER HARBOUR SETOUT CO-ORDINATES

POINT	EASTING	NORTHING
IH-1	306177.306	6185338.366
IH-2	306508.262	6185233.718
IH-3	306532.148	6185242.546
IH-4	306551.461	6185266.848
IH-5	306732.635	6185140.297
IH-6	306726.409	6184960.474
IH-7	306562.703	6184838.007
IH-8	306266.576	6185046.919
IH-9	306213.103	6185173.045
IH-10	306148.325	6185177.159
IH-11	306104.368	6185222.268
IH-12	306116.703	6185334.138

LEGEND:

EXTENT OF DREDGE DISPOSAL

NOTES

1. FOR GENERAL NOTES REFER TO DRG G003

No.	BY	DATE	DESCRIPTION	APPD
A	SG	19.01.07	ISSUED FOR CONSTRUCTION	MC

THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE MAUNSELL QUALITY ASSURANCE SYSTEM TO ISO 9001-2000

DESIGNED	B.G	CHECKED	R.N
DRAWN	S.G	CHECKED	R.N
APPROVED		DATE	19.01.07

SCALES: 1 : 1000 FULL SIZE A1

CLIENT: PORT KEMBLA PORT CORPORATION

Approved By Port Engineer:

DESIGNER: MAUNSELL | AECOM

Maunsell Australia Pty Ltd A.B.N. 20 093 846 925

PORT KEMBLA INNER HARBOUR DREDGING

INNER HARBOUR DISPOSAL SETOUT

STATUS: CONSTRUCTION

DRAWING No: 60013335-G010

REV: A