Appendix 3 – Proactive turbidity reduction measures – Best Environmental Practice Techniques.

Best Environmental Practice (BEP) Techniques were established within the DSDMP to proactively reduce environmental impacts from the Pluto LNG Project dredging program. Table 1 identified each BEP and demonstrates compliance.

Table 1: Best Environmental Practice Water Quality Management Measures.

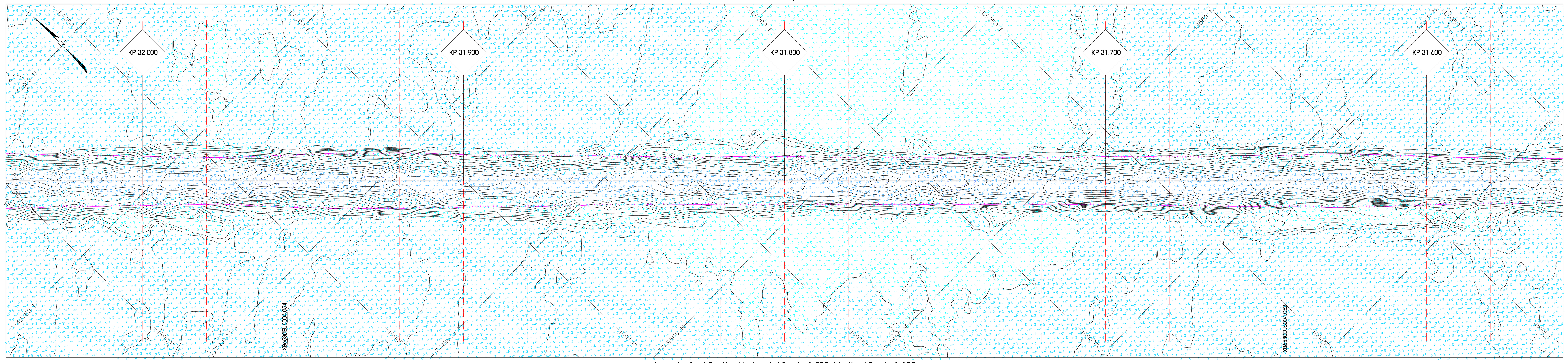
Ref No.	BEP Method	Application of BEP to Dredging and Disposal Works	Effectiveness of BEP technique / Beneficial Outcome	Monitoring and Reporting	Timing	Compliance Statement & Evidence 2009	Relevant Appendix 3 Figures
BEP#01	Justify depth and width of channels during design	- Modelling & simulation of the proposed navigation channel conducted during design stage; - Varying depth turning basin to minimise dredging required	Minimises amount of dredging and disposal work required, thereby reducing the extent and duration of any impacts	Final Design Drawings	Completed during design phase with further improvements being investigated	Finalised during EIA and prior to DSDMP development. Refer to DSDMP.	N/A
BEP#02	Use of tidal range to assist entry of deep draught vessels	- Design of navigation channel includes the use of tides for departure of laden vessels	Minimises the amount of dredging and disposal work required, thereby reducing the extent and duration of any impacts	Final Design Drawings	Completed during design phase	Finalised during EIA and prior to DSDMP development. Maximised within safety constraints. Refer to DSDMP.	N/A
BEP#03	Coordinate dredging operations to satisfy multiple planning requirements	- Reuse of dredge spoil from Spoil Ground 2B for trunkline stabilisation thereby reducing need for sourcing material from undisturbed areas	Minimises the impact footprint of the works	Final Design Drawing	During trunkline post-lay works	As only a reduced scope of backfill material is required dredge spoil will no longer be removed from Spoil Ground 2B.	N/A
BEP#04	Minimise the use of temporary spoil sites	- Re-handling minimised; - All side casting and re-handling will be carried out within dredging footprint	Minimises the impact footprint of the works	Hydrographic surveys	During side-casting operations	Spoil re-handling works were carried out in two locations during Phase 1 in 2008. These were i) calcarenite areas within the approach channel; and ii) the jetty exclusion zone and turning basin. Both occurred within the approved dredging footprint. No spoil-rehandling works have been conducted in 2009.	N/A
BEP#05	Optimise location of disposal ground	- Numerical modelling and environmental surveys completed during design and planning stage	Ensures optimal location of the spoil disposal grounds	Final Planning	Undertaken during design phase	Finalised during EIA/DSDMP development. Refer to Appendix L of the DSDMP.	N/A
BEP#06	Utilise rapid and latest survey equipment technology	- Use of Multi beam hydrographic survey system.	Allows effective management of operations to reduce extent and duration of impact	Contract Documents, Contractors method statements	During all survey activities	A Multi Beam Echo Sounder was used for all survey work. Regular bathymetric surveys were completed during 2009 dredging works for operational purposes (i.e. to ensure that design depth was reached, and to confirm volumes). Weekly surveys were compiled and provided to the DEMG for review during monthly meetings. Refer to Figure 1 for an example of a survey along the trunkline route. Refer to Figure 2 for an example of a survey of Phase 2 channel dredging works. Refer to Figure 3 for an example of surveys of Spoilground 2B.	Figure 1 Figure 2 Figure 3
BEP#07	Utilise on-line visualisation of updated bathymetric charts including topographic data, coastlines, disposal areas, dredge position, dredge head /cutter head position, tidal information	- Modern, fully equipped dredging vessels which include these features as standard to be utilised; - Daily survey updates to be provided to the vessel; - Real time tide information will be made available.	Allows effective management of operations to minimise impact	Contractor method statements	During all dredging and disposal activities with all dredging vessels	Real time on-line visualisation of updated bathymetric charts including topographic data, coastlines, disposal areas, dredge position, dredge head/cutter head position and tidal information were employed at all times on the trailer dredgers Nile River and Queen of the Netherlands. The presence and function of these systems was verified in a pre-start audit by Woodside personnel. General photograph showing the operation of this equipment on the bridge of the 'Queen of the Netherlands' and 'Nile River' has been provided in Figures 4 and 5.	Figure 4 Figure 5
BEP#08	Visualisation/ evaluation of dredged tracks/profiles/zones	- Regular track plots to be provided by contractor and analysed to ensure optimum methods are used so that no dredging outside the required area occurs	Allows effective management of operations to minimise impact	Vessel track plots	During all dredging and disposal activities with all dredging vessels	Regular bathymetric, cross sections and trailer dredger track plots were provided by the contractor from every survey undertaken and analysed by the Woodside Resident Dredging Engineer to ensure optimum methods were used so that no dredging outside the required area occurs. Refer to Figures 6 and 7 for example track plots. Weekly track plots for the entire dredging program are available if required.	Figure 6 Figure 7
BEP#09	Online measurement of: - mixture velocity; - mixture concentration; - vessel heading, speed; - dredge production.	- Modern, fully equipped dredging vessels which include these features as standard will be utilised.	Improves operational efficiency leading to increased production and decreasing the duration of dredging	Vessel specification	During all dredging and disposal activities with all dredging vessels	Modern, fully equipped dredgers that include all of these features as standard were deployed during Phase 2 trunkline and channel dredging works. The presence and function of these systems was verified in pre-start audits by Woodside personnel. General photographs showing the operation of this equipment on the bridge of the Queen of the Netherlands and 'Nile River' has been provided in Figures 4 and 5.	Figure 4 Figure 5
BEP#10	Use of submerged diffuser to place spoil low in water column to reduce velocity of mixture	- Diffuser to be used when CSD side casting via a pipeline	Ensure material is released as close as possible to the seabed, leading to less solids entering the water column and significantly lower settlement times	Contractors Method Statement	During all CSD side casting activities	During the 2009 dredging program no cutter suction dredges were used eliminating the need for diffusers to be installed.	N/A
BEP#11	Adjustable anti-turbidity overflow shaft	- Anti-turbidity valve in overflow shaft to be utilised on TSHD	Lowers the intensity, duration and spatial extent of the turbidity plume	Vessel specification	During all TSHD dredging activities	TSHD Nile River and Queen of the Netherlands were both fitted with anti-turbidity valves in the hopper overflow. The anti-turbidity valve was always used. Figures 8 shows dredging on the TSHD Nile River using overflowing. Figure 9 show the Nile River dredging while not using overflow as a turbidity reduction technique.	Figure 8 Figure 9
BEP#12	Submerged Dredge Pumps	- To be utilised on CSD; - No benefit for TSHD at required dredging depths	Improves operational efficiency leading to increased production and decreasing the duration of dredging	Vessel specifications	During all CSD dredging works	During the 2009 dredging program no cutter suction dredges were used eliminating the need for diffusers to be installed.	N/A
BEP# 13	Establish optimum overflow time for the TSHD using loading diagrams	- Loading charts / data to be used by contractor to establish optimum overflow times; - Loading charts / data to be provided by contractor for analysis	Improve operational efficiency leading to increased production and decreasing the duration of dredging	Loading charts	Optimisation of the overflow process will be an ongoing process throughout the TSHD dredging activities. As the project proceeds, the data available from the monitoring programs will also be applied to the overflow optimisation process. In the event that conditions where overflow causes unacceptable impacts on benthic habitats are identified, overflow will be reduced or eliminated when dredging in similar condition during the remainder of the works.	TSHD Nile River and Queen of the Netherlands were loaded for optimal dredging efficiency when material allowed. Whilst a loading chart was available; during the loading phase of dredge cycle optimisation was provided by an onboard real time dredge management system. The system alerts the operator once the optimum load has been reached (i.e. the mass loaded plateaus), dredging ceases, and the dredge departs for the dump site.	Figure 10
BEP# 14	Minimal Overflow for bulk dredging of low density / high moisture content sediments by the TSHD	- Contractor to dredge with minimal overflow when bulk dredging low density/high moisture content sediments	Reduces introduction of sediments into water column	Loading charts	During all dredging of low density / high moisture content sediments by the TSHD. Also see BEP #13	TSHD Nile River and Queen of the Netherlands were loaded for optimal dredging efficiency when material allowed. Loading phase of dredge cycle optimisation provided by onboard, real time dredge management system thereby minimising discharge of fine fractions from the hopper (Figure 10).	Figure 10

BEP#15	Minimise disturbance of sediments outside dredging footprint	- Sailing routes to and from the disposal grounds will be selected to minimise the impact of propeller wash (within constraints of DPA operations); - Existing shipping routes will be used where possible. Where this is not possible, routes will be chosen on the basis of water depths and the location of sensitive receivers; - Dredging vessels will be required to enter the navigation channel/turning basin dredging area via the navigation channel route and where practical, stay within the confines of the navigation channel / turning basin during dredging operations; - Short-cuts across shallow non footprint areas while sailing empty, will not be permitted. Entry into the proposed Dampier Archipelago Marine Park, other than for safety purposes, will not be permitted,	Limits the generation of turbidity via propeller wash thus lowering the extent, duration and spatial distribution of the turbidity plume	Track plots to be submitted to Woodside regularly	During all transiting activities with dredging vessels. Particular attention will be applied to sailing routes during dredging operations involved with the trunkline route near sensitive benthic habitats	TSHD Nile River and Queen of the Netherlands always sailed to/from the Offshore Spoil Ground and dredging areas via the route of new Pluto shipping channel or in areas with sufficient under keel clearance. Refer to Figures 6 and 7 for examples of a sailing track plot. Weekly track plots for the entire dredging program are available if required.	Figure 6 Figure 7
BEP#16	Minimise use of lean mixture bypass system on the TSHD	The use of the lean mixture by-pass system will be minimised by using experienced operators and where practical planned dredging tracks to minimise turning requirements.	Minimises the intensity and spatial extent of the sediment plume	Track plots	During all TSHD dredging activities	LMOB system (lean mixture overboard) was not using by the the Queen of the Netherlands. Loading patterns were planned to make this unnecessary.The Nile River did use the LMOB system, however operations where kept to a minimum and only used when required during turning.	N/A
BEP#17	Minimise time when unconsolidated side cast material is available for re-suspension	- Any unconsolidated material that has been side casted by the CSD will be re dredged as soon as practically possible by the TSHD; - Regular hydrographic surveys will be undertaken to ensure all side casted material is removed efficiently	Limits duration of sediments available for re-suspension	Regular hydrographic surveys	During side casting operations by the CSD	During the 2009 dredging program no cutter suction dredges were used eliminating the need for diffusers to be installed.	N/A
BEP#18	Avoid sediment losses during transport via the TSHD	- Sea-state to be monitored, lower fill levels to be utilised during extreme rough conditions; - Overflow levels to be set at highest level during transport; - Hopper door seals to be in good condition to avoid leaking	Limits the inadvertent loss of sediments during transport, thereby lowering the spatial extent of the plume	Visual inspection	During all sediment transport activities	Physical size and construction of TSHD Nile River and Queen of the Netherlands made these provisions unnecessary. No sea state conditions existed that risked loss of dredged material from hopper over flow system or overboard from the hopper itself.	N/A
BEP#19	Plan hopper dewatering activities	De-watering of the hopper will be confined to the following areas to avoid impacts on sensitive receptors. These areas include: - at the spoil disposal site; - within the dredging area; - the proposed Pluto LNG shipping channel; and - outside Mermaid Sound Note that no hopper dewatering activities are to take place near sensitive benthic habitats.	Minimise the generation of sediment plumes near sensitive receptors	Visual inspection	During all dredging activities by the TSHD.	The TSHD Nile River and Queen of the Netherlands hoppers were only pumped out whilst within the boundaries of the Offshore Spoil Ground (2B).	N/A
BEP#20	Ensure equipment correctly calibrated	Calibration before starting and regular calibration checks to be undertaken with respect to: - dredge survey systems; - hydrographic survey systems; - dredge hopper volume and load.	Improves operational efficiency leading to increased production and decreasing the duration of dredging	Calibration reports	Before commencing works and as required during works	Calibrations were carried out prior to commencement of work and verified by Woodside personnel. These calibrations are also necessary to ensure the accuracy/efficiency of the work from an operational perspective.	N/A
BEP#21	Monitoring of disposal operations	- Disposal activities will be monitored to ensure that no disposal of spoil occurs outside the designated disposal grounds; - DGPS Positioning system to be employed to ensure accurate positioning; - Contractor to ensure the hopper doors are completely closed prior to departure from the disposal ground	Minimises the impact footprint of the spoil disposal works	Track logs, visual inspections	Throughout Works	The dump position of each load was monitored and recorded. Discharge of each and every load was planned to ensure placement in accordance with the DEC approved spoil ground material configuration, and the DPA Dredging and Spoil Management Plan (PL-914). Refer to Figure 11 for an example of a weekly dumping track plot. Hopper doors were always closed before dredger egress from the Offshore Spoil Ground.	Figure 11
BEP#22	Strategic placement of material	Spoil disposal into Spoil Ground 2B will be planned to ensure that material suitable for reuse is kept separated from unsuitable material	Allows for reuse of material, minimising disturbance of any other source	Track plots	During all sediment disposal activities	Dredge Disposal Management Plan was used to plan the discharge point of each and every load. Offshore Spoil Ground 2B was divided into three sub-divisions (fine, medium, and coarse) and each hopper discharged according to the nature of the significant part of each load. Refer to Figure 11 for an example of weekly dumping track plots showing fine versus coarse material disposal. Dumping track plots for the entire dredging program are available if required.	Figure 11
BEP#23	Minimise Impact of Drilling and Blasting Activities	Where drilling and blasting is required, limit the instantaneous charge rate to 50kg pre delay and if impact observed or addition caution is required, lower the charge rate to 25kg per delay	Limits the impact of the drilling and blasting activities	Contractors Method Statement	As required	No drilling or blasting activities were undertaken during the 2009 dredging program.	N/A
BEP#24	Ensure optimum timing of works with respect to sea and meteorological conditions	Relocate the TSHD away from the turning basin during periods of flood tides combined with sustained westerly winds in excess of 15knots.	Lowers potential impact of sediment plume from turning basin works on fringing corals	Track plots	During times where flood tides combine with sustained westerly winds.	Dispersion of the turbidity plume from dredging works in the Turning Basin and its approach was continually monitored during Phase 2. TSHD Queen of the Netherlands was deployed to the entrance channel as appropriate to minimise the spread of turbidity to the north from the Turning Basin. Monitoring continues to show no loss in coral cover within Zone A.	N/A
BEP#25	Minimise the abrasion path while crushing soft rock	Minimise transport distance during pumping of soft rock	Limits creation of rock flour	Contractors Method Statement	During all pumping activities with the CSD	During the 2009 dredging program no cutter suction dredges were used eliminating the need for diffusers to be installed.	N/A
BEP#26	Strategic use of drag head water jets	The use of water jets from the drag head will only occur when dredging appropriate material.	Limits suspension of material due to jetting	Contractors Method Statement	During all dredging activities with the TSHD. Jets will usually not be used while dredging low density / high moisture content sediments.	Trailer dredger draghead jetting systems were only used when dredging the heavier materials. Appropriate use of draghead use was verified with crew during regular dredging audits.	N/A

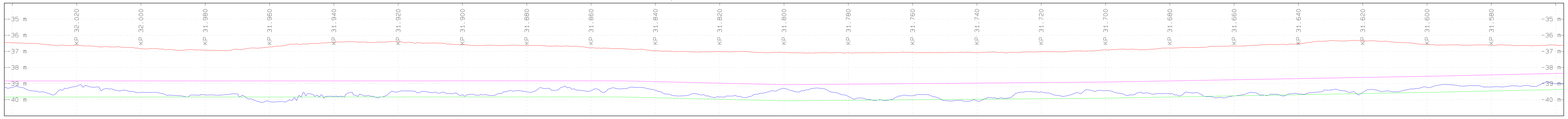
Figure 1. Best Environmental Practice Compliance

Description:
Bathymetric survey of the Pluto LNG trunkline from section KP 31.600 to 32.000. Red lines indicated the pre dredge depth as surveyed on 6 March 2009. Pink lines indicate design depth and blue lines indicate post dredging depth as surveyed on 5 May 2009.

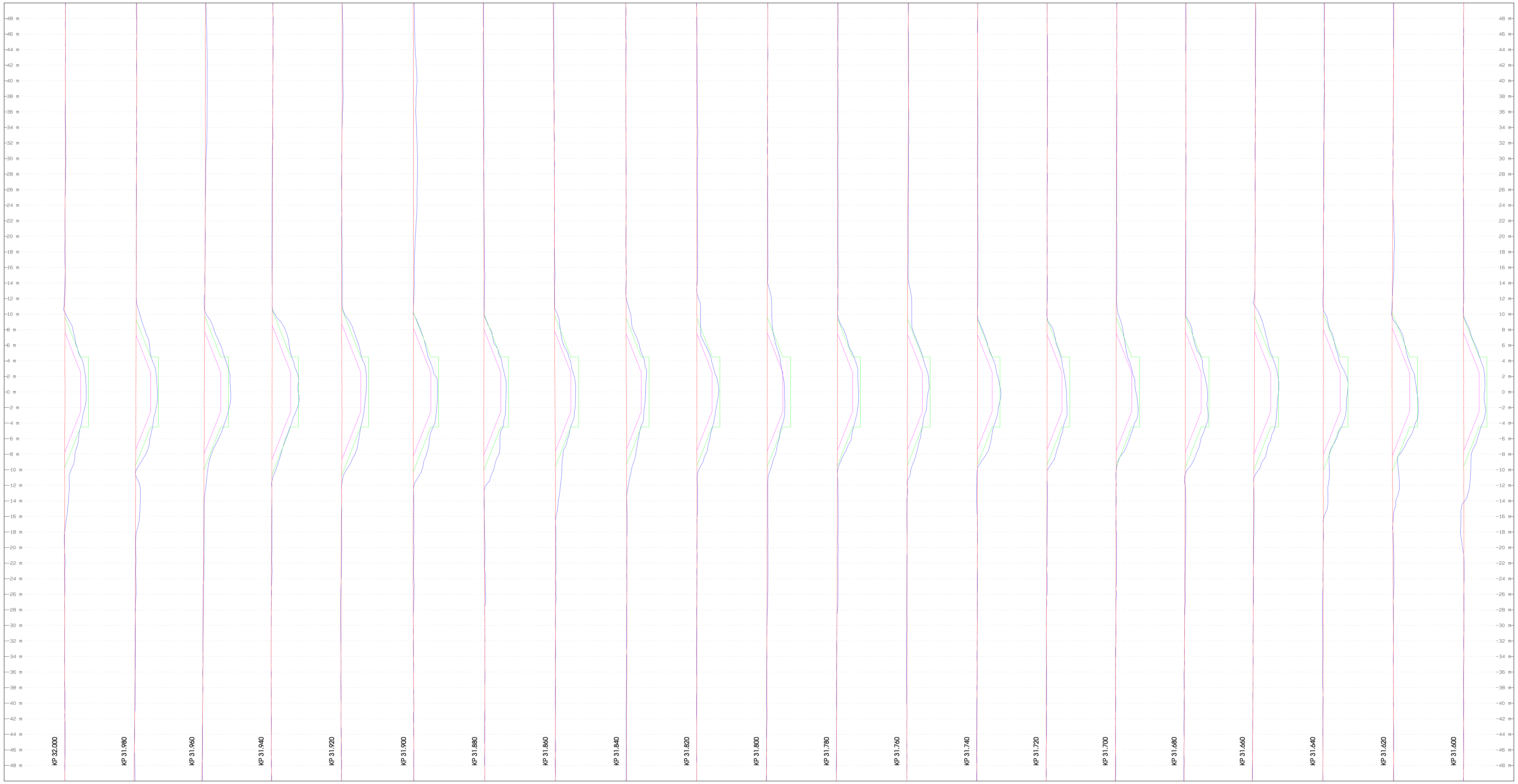
Plan View: Survey Scale 1:500



Longitudinal Profile: Horizontal Scale 1:500 Vertical Scale 1:100



Cross Section Profiles: Scale 1:200



GEODETIC INFORMATION

All co-ordinates in metres.

Datum	: GDA94
Spheroid	: GRS80
Semi-major axis (a)	: 6,378,137.0 m
Inverse flattening (1/f)	: 298.257222101
Projection	: Universal Transverse Mercator (UTM)
Zone	: 50 South
Central Meridian	: 117° East
Scale factor on CM	: 0.9996
False Easting	: 500,000 m
False Northing	: 10,000,000 m

DATUM SHIFT PARAMETERS (WGS84 to GDA94, Bursa-Wolf Convention, Epoch 2009.5)

Translation X	: 0.0284 metres
Translation Y	: -0.0529 metres
Translation Z	: -0.1209 metres
Rotation X	: 0.01859"
Rotation Y	: 0.01574"
Rotation Z	: 0.01920"
Scale Factor (ppm)	: 0.002824

BATHYMETRY : All depths in metres reduced to Lowest Astronomical Tide (LAT)

AHD (Australian Height Datum)
2.65m
LAT (Lowest Astronomical Tide)
0.12m
ACDD (Australian Chart Datum Dampler)

KILOMETRE POINTS : Kilometre points according to the As Designed Route of the trunkline by Woodside (ref XB0700DN0050.001_rev1.dwg)

HARDWARE SURVEY EQUIPMENT

Positioning	: Aquarius 02 LRK / CNAV C2050M Sat. Diff.
Multibeam echosounder	: Reson Seabat 8125
Gyro / Motion Sensor	: IXSEA Octans IV
Sound Velocity Probe	: Odom SVP15T
Mini Sound Velocity Probe	: Valeport Mini SVP
Tide gauge	: MGB Tech MTU821-WTR / DRO

DTM PARAMETERS

Plan View - Data Plotted and Contoured at 2m Grid
Longitudinal and Cross Section Profiles - Data Plotted at 1m Grid

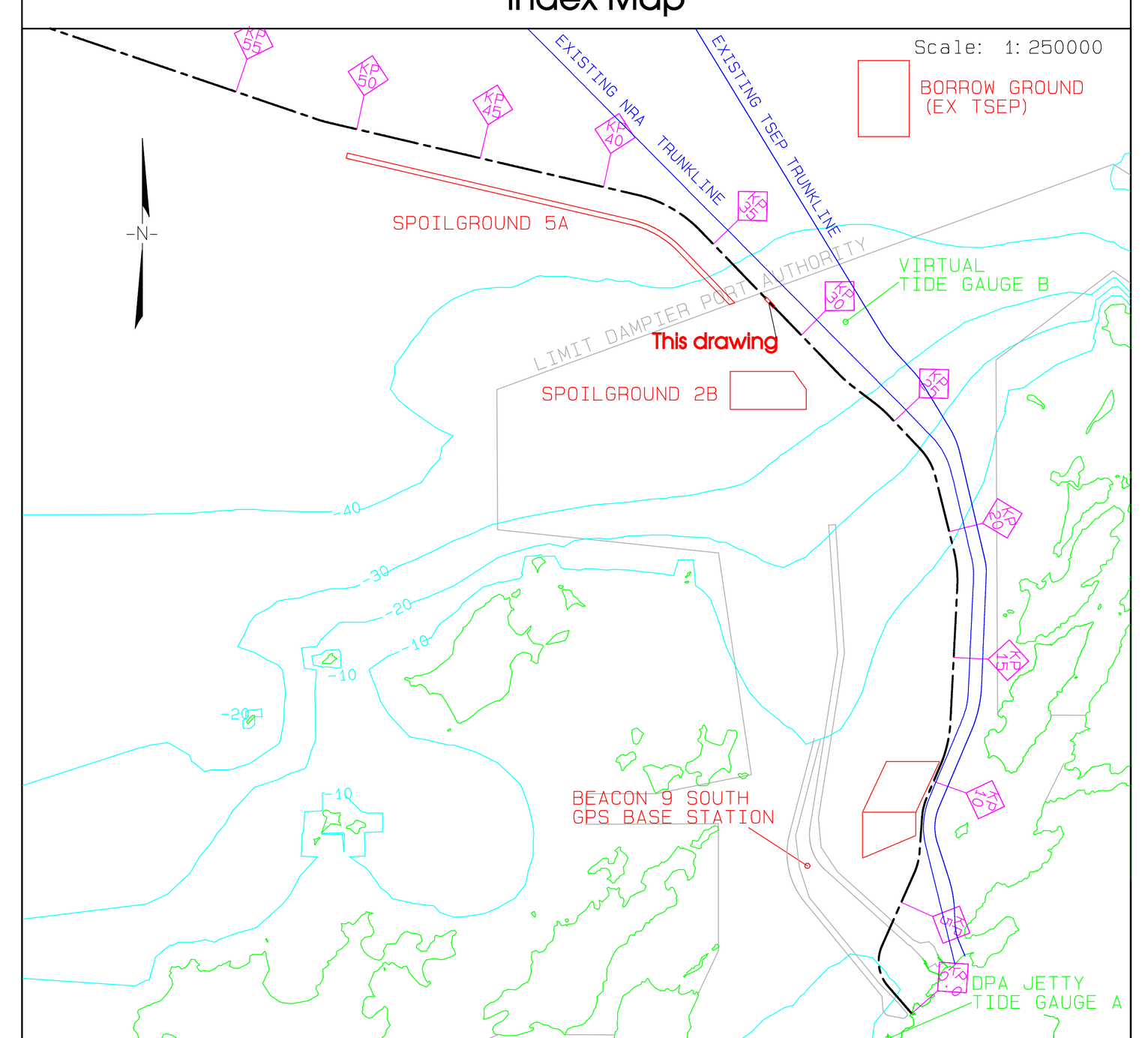
LEGEND

PLAN VIEW
- As Designed Route with KP annotation
- Position of cross profiles
- Design
- Bathymetric contour with depths in metres
- Matchline of previous / following drawing

LONGITUDINAL PROFILE
- Pre Dredge Survey
- Design
- Tolerance

CROSS PROFILES
- Pre Dredge Survey
- Design
- Tolerance

Index Map



Plan view Scale 1 : 500

10m 0m 10m 20m 30m 40m 50m 60m 70m

COMPANY

WOODSIDE Burrup Pty Ltd
240 St Georges Terrace
Perth, Western Australia 6000

woodside

CONTRACTOR

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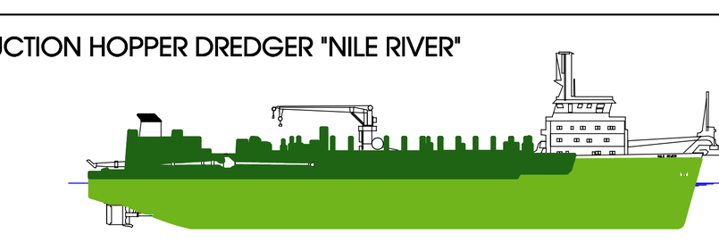
Minervum 7442, P.O. Box 7074
4817 ZG Breda, the Netherlands
Tel : +31 76 520 41 40

Tideway Offshore Contractors

TRAILING SUCTION HOPPER DREDGER "NILE RIVER"



PROJECT

Pluto LNG Project
Offshore Dredging and Backfill

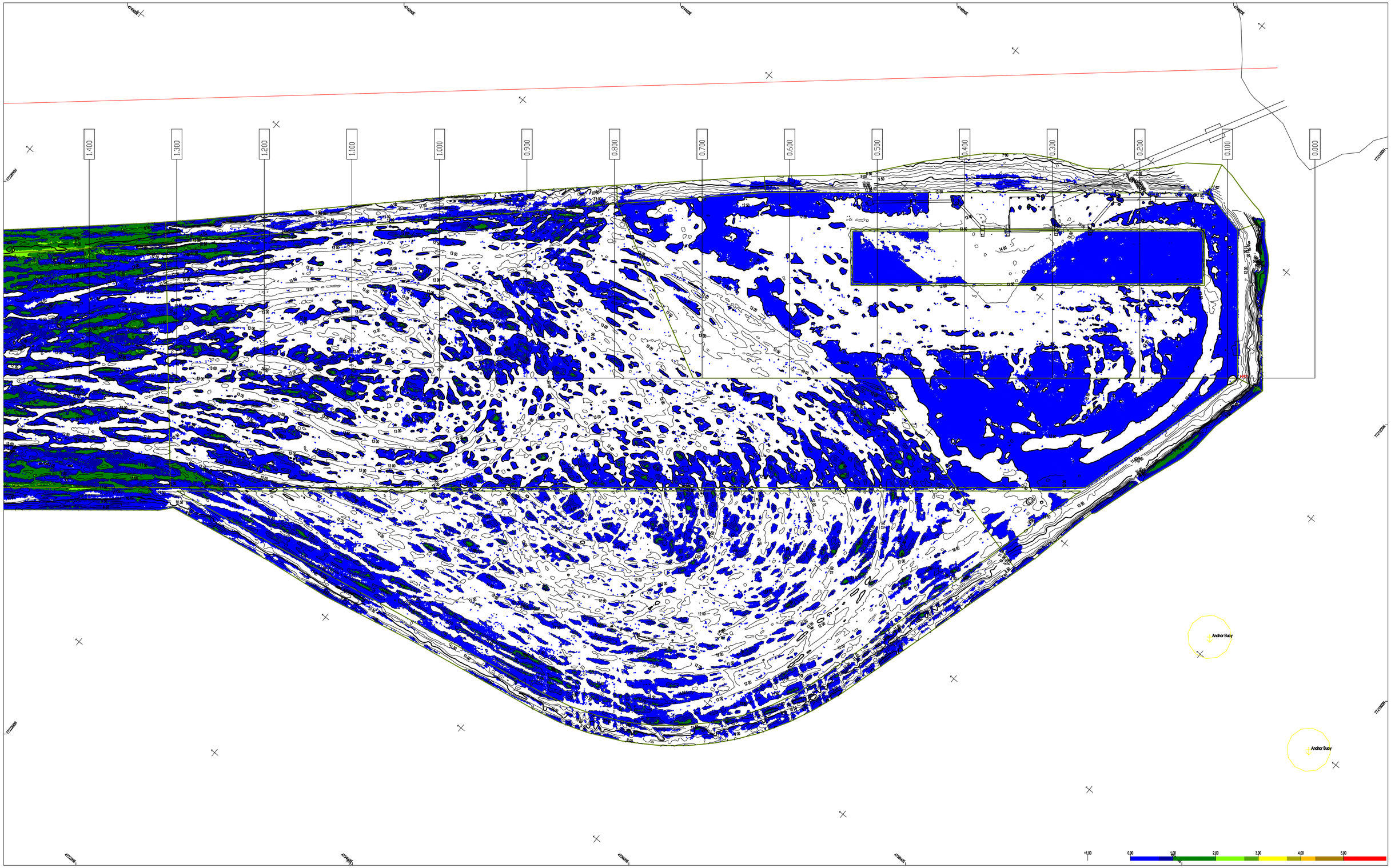
TITLE

Trench Acceptance Survey
Trunkline Route
KP 31.600 to KP 32.000

Woodside Doc. No.	: XB6530EU6004.053					Sheet 53 of 99
Tideway DWG No.	: 4260_DWG_004					Format : A0
Pre-Survey :		06 Mar 09	Post-Survey :		05 May 09	
0	09 May 09	Issued for approval	SPG	SVG	HOR	
REV No.	DATE	DESCRIPTION	PREP	CHK	APP	
			CONTRACTOR			COMPANY

Figure 2. Best Environmental Practice Compliance

Description:
A bathymetric survey of the Pluto LNG Project Turning Basin and Entrance Channel from Week 46, 2009. While indicates area that has been dredged to design depth, and blue indicates areas which are 1 metre above design depth.



Boskalis Australia Pty. Ltd.
P.O. Box 341
Chatswood NSW 2057
PH: (02) 9406 0400
FAX: (02) 9406 0424

Notes:

Mapping Grid GDA94 (GRS80), Zone 50

Depth Datum ACDD - relationship to AHD at PWD BM A958 (located near tide gauge @ KBSB)
ACDD = RL 7.477m AHD = RL 4.709m

TITLE: Basin & Channel 1 of 6, Week 48

AREA: Kp 0.000 -- 1.450

TYPE OF SURVEY: Progress vs Theoretical, Shallowest Depth's

REV.	BY	DATE	DESCRIPTION	CKD.	APP.
01	LEBA	29-11-2009	Progress versus Theoretical, Shallowest Depth's		

woodside
A.B.N. 63005 482 986
Woodside Plaza
240 St Georges Terrace
Perth WA 6000

WOODSIDE BURRUP Pty Ltd

PLUTO LNG Project Phase II

DRAWING No:					
BKA-036-10090-404-PRO					1 of 6
SCALE:	DRAWN: LEBA	CHK'D:	APP'D:	APP'D:	REVISION
1: 2000	DATE: 29-11-2009	DATE:	DATE:	DATE:	01