INVESTIGATIONS FOR HORIZONTAL DIRECTIONAL DRILLING (HDD) — THREE SE QUEENSLAND CASE STUDIES

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ABSTRACT

The Parsons Brinckerhoff Brisbane office has been involved in three major horizontal directional drilling (HDD) projects for water and wastewater infrastructure in south-east Queensland for local government clients.

Three case studies illustrate the methodology developed for the geotechnical investigations and preliminary design for HDD projects, and highlight the key issues to be addressed in the preparation of AS 4300–1995 General Conditions of Contract for Design and Construct tender documents. The three case studies are:

1. Australia TradeCoast Sewerage Project (Brisbane), Brisbane Water

- 750 m long x OD400 PN20 HDD crossing under the Brisbane River from Lytton to Pinkenba for a sewerage rising main to transfer sewage from the Lytton Road pump station to the Serpentine Road pump station

2. Coochiemudlo Island Wastewater Project (Redland Bay), Redland Water & Waste

- 1,100 m long x OD180 PN16 HDD crossing under Moreton Bay from Coochiemudlo Island to Victoria Point for a sewerage rising main that transfers sewage from the island to the mainland's gravity sewerage system

3. Granville Trunk Water Main Project (Maryborough), Maryborough City Council

- 330 m long x OD400 PN16 HDD crossing under the Mary River to strengthen the water supply capacity to the Granville area.

KEYWORDS

Horizontal directional drilling, geotechnical investigations, approvals, alignment, profile.

1 INTRODUCTION

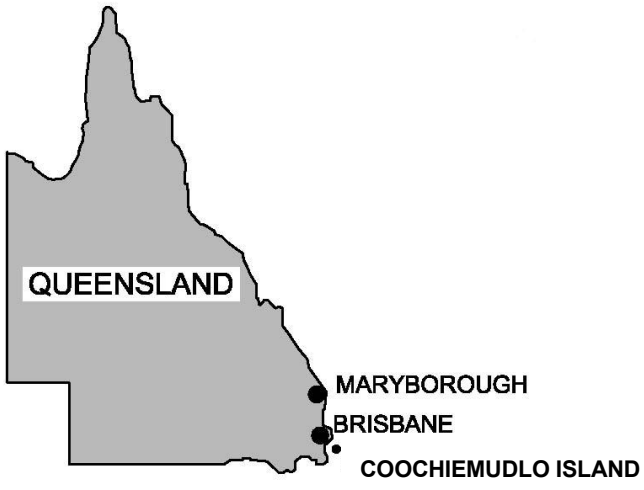
Table 1 summarises the scope of the three horizontal direction drilling (HDD) projects detailed in this paper. All three projects were located in south-east Queensland, Australia, and involved the Brisbane office of Parsons Brinckerhoff (PB).

Table 1: Summary table.

	Australia TradeCoast Sewerage	**Coochiemudlo Island Wastewater**	**Granville Trunk Water Main**
Client	Brisbane Water (now known as Queensland Urban Utilities)	Redland Water & Waste (now known as Redland City Council)	Fraser Coast Regional Council (formerly Maryborough City Council)
Contract type	AS 4300 General Conditions of Contract for Design and Construct	AS 4300 General Conditions of Contract for Design and Construct	AS 2124 General Conditions of Contract (with a design component in the contract required for the HDD works)
Crossing	Brisbane River	Moreton Bay	Mary River, Maryborough
Contractor	Leighton Contractors	Redline Contractors	Contract not awarded
HDD subcontractor	Coe Drilling	Pipeline Drillers Group Pty Ltd	Not applicable
Dimensions: **Diameter** **Length** **Material**	 OD400 750m PE100 PN200	 OD180 1100m PE100 PN16	 OD400 330m PE100 PN16
PB role	Design, approvals, community consultation	Superintendent consultant	Consultant

Figure 1 shows the locations of the three project sites.

Figure 1: Locations of the three project sites.



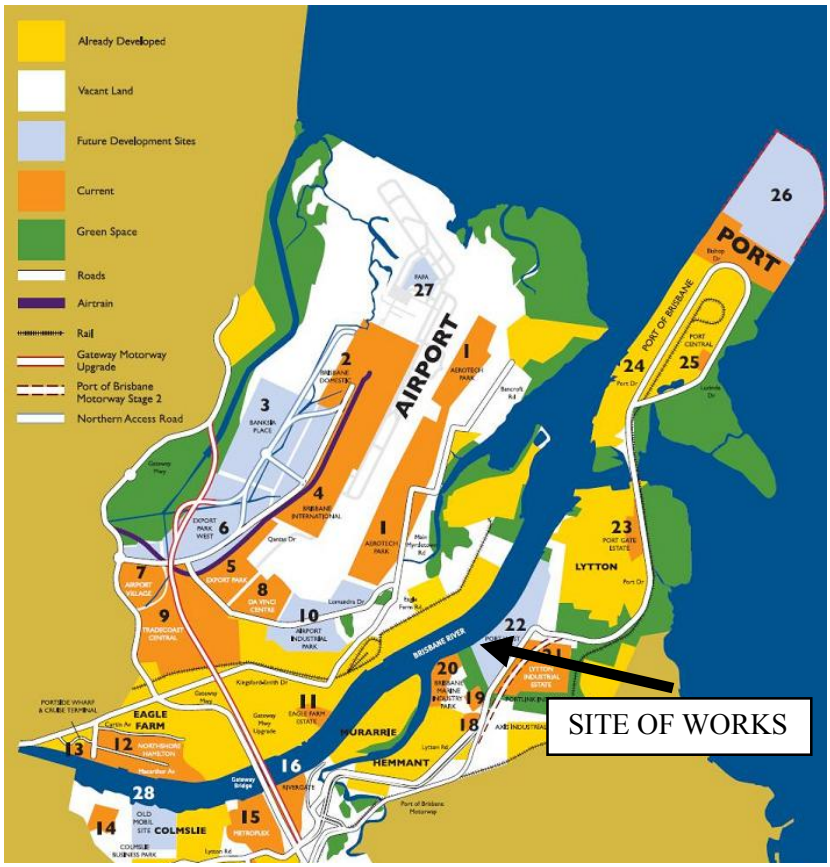
2 DISCUSSION

2.1 NEED FOR HDD CROSSING

2.1.1 AUSTRALIA TRADECOAST SEWERAGE PROJECT

Australia TradeCoast is a huge new industrial development on the site of the old Brisbane Airport. In its planning for the project, Brisbane Water realised that a connection was required under the Brisbane River to allow raw sewage to be diverted from the south side to the north side of the river; Brisbane's major sewerage treatment plant is located at Luggage Point on the river's northern bank, downstream of Pinkenba. Figure 2 shows the location of the Australia TradeCoast Sewerage project.

Figure 2: Location of the Australia TradeCoast Sewerage project.

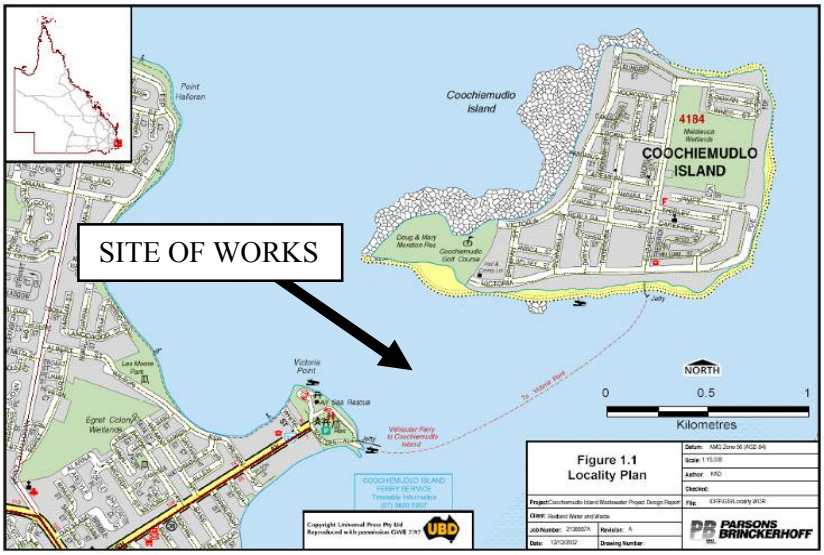


2.1.2 COOCHIEMUDLO ISLAND WASTEWATER PROJECT

Coochiemudlo Island is located in Moreton Bay, approximately 1 km east of Victoria Point and within the Moreton Bay Marine Park (see Figure 3 and Photograph 1). The island had been serviced by on-site sewerage systems — predominantly septic tanks.

During community consultation for the Coochiemudlo Island Sewerage project, the community asked that raw sewage be conveyed from the island to the mainland for treatment at the Victoria Point Sewage Treatment Plant. This would protect the water quality of Moreton Bay from effluent discharges from septic tank and package sewage treatment plants.

Figure 3: Map of Coochiemudlo Island.



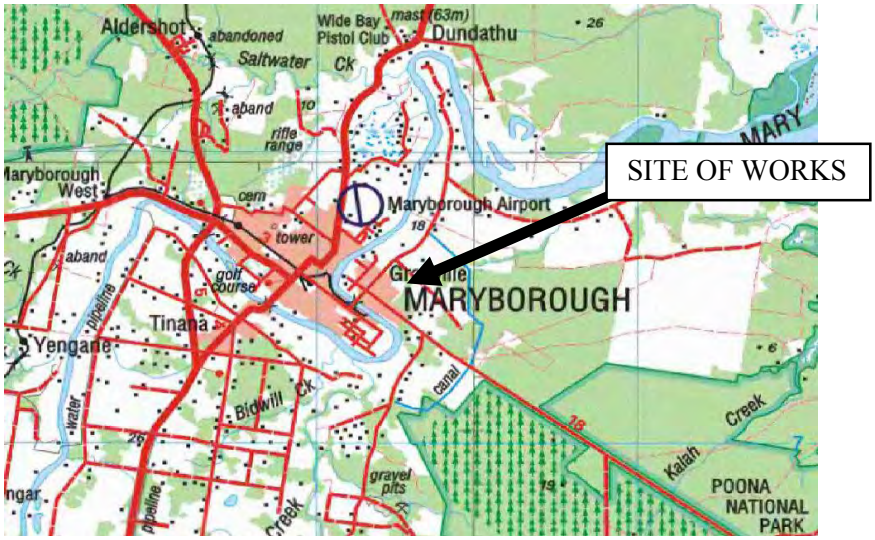
Photograph 1: Aerial photo of HDD crossing to Coochiemudlo Island.

2.1.3 GRANVILLE TRUNK WATER MAIN PROJECT

Fraser Coast Regional Council commissioned Parson Brinckerhoff (PB) to prepare the detailed design and tender documentation associated with construction of the new Granville Trunk Water Main. Council's hydraulic modelling department determined that the new water main was needed to improve the distribution of water to the Granville area.

The project involved installing a 1.4 km long, 300 mm diameter water main across the Mary River's approximately 200 m width. The project's location is shown in Figure 4; more details are provided in PB Drawing 2138346A-WAT-0021 in Appendix C.

Figure 4: Location of Granville Trunk Water Main.



2.2 CONSTRAINTS

2.2.1 AUSTRALIA TRADECOAST SEWERAGE PROJECT

The project needed to be constructed and to operate within the constraints of:

- an existing oil refinery and BP products wharf on the north bank of the Brisbane River (see Photograph 2)
- Port of Brisbane's dredge limit down to -16.25 m AHD
- a ship-turning basin over the proposed HDD alignment
- HDD pipe laydown across a busy road in an industrial area; the pipeline also needed to be elevated over shipping containers.

Photograph 2: Oil refinery on north bank of Brisbane River.

2.2.2 COOCHIEMUDLO ISLAND WASTEWATER PROJECT

The project was constrained by its need to limit the following impacts:

- closure of part of a public park on Victoria Point foreshore to set up HDD drill equipment during drilling operations

- noise and light during 24-hour HDD drilling operations, impacting on residents
- HDD exit point within Coochiemudlo Island golf course, impacting on golf players
- HDD pipe laydown on narrow streets on Coochiemudlo Island, impacting on local traffic flows.

2.2.3 GRANVILLE TRUNK WATER MAIN PROJECT

Constraining this project were:

- its proximity to residential houses that could be impacted by noise and light from 24-hour HDD operations
- the difficulty of laying out PE pipe strings (suitable for pipe pull-back) within the residential area. Short lengths were required to minimise access to residents' homes
- the need to negotiate with nearby residents to achieve the preferred entry pit footprint of 30m x 30m, even though the southern side of the Mary River was undeveloped.

2.3 GEOTECHNICAL INVESTIGATIONS

Table 2 summarises the geotechnical investigations for each project.

Table 2: Geotechnical investigations summary.

	Australia TradeCoast Sewerage	**Coochiemudlo Island Wastewater**	**Granville Trunk Water Main**
Organisation responsible for geotechnical investigations	City Design (Brisbane City Council)	PB	PB
Drilling over water	Yes (Brisbane River)	Yes (Moreton Bay)	Yes (Mary River)
Borehole locations	6 (4 were in Brisbane River)	10 (6 were in Moreton Bay)	3 (1 was in river bed)
Borehole results within water crossing	• Alluvium • Gravel • Clay • Basalt	• Marine sediments • Weathered basalt • Basalt	• Alluvium (gravelly sand) • Weathered sandstone
Borehole maximum depth	58 m (bank) 55 m (Brisbane River)	5 m (bank) 12.5 m (Moreton Bay)	23.6 m (bank) 15.6 m (Mary River)
Organisation responsible for HDD profile preliminary	PB/Coe Drilling	PB	PB/Coe Drilling

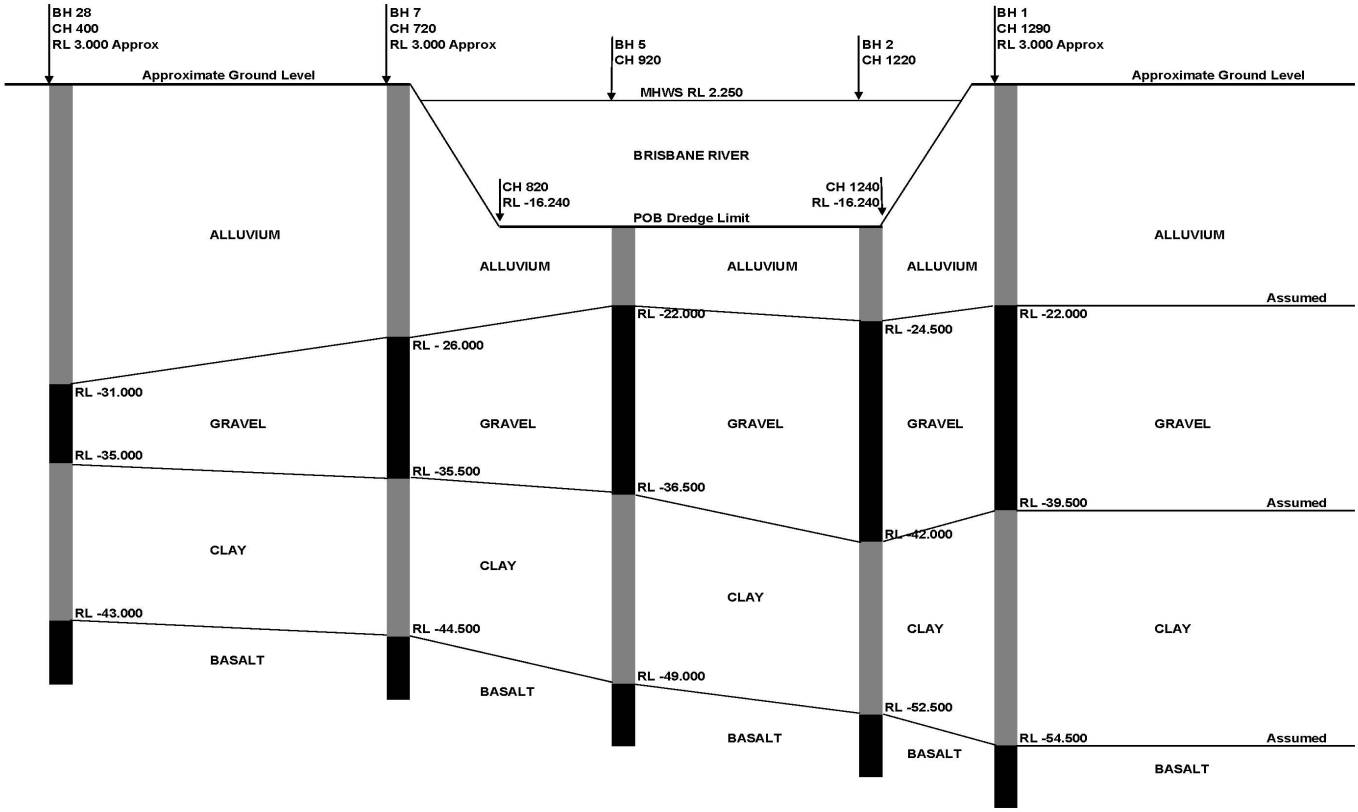
2.3.1 AUSTRALIA TRADECOAST SEWERAGE PROJECT

A geotechnical conceptual model (see Figure 5) was developed from the geotechnical investigations. It revealed the major challenge faced by this project — an up-to-18-metre-thick gravel band on the north bank of the Brisbane River.

Coe Drilling decided to sleeve the gravel band with a 609 mm OD steel casing, and to drill through this steel casing (from a 711 OD steel casing from the surface).

Coe Drilling judged it would be able to drill through the thinner gravel band, which was between 4 and 9.5 metres thick on the south bank, and this proved to be the case.

Figure 5: Brisbane River geotechnical cross-section.



2.3.2 COOCHIEMUDLO ISLAND WASTEWATER PROJECT

In its geotechnical investigations on this project, PB used a drill rig mounted on a barge for the over-water drilling in Moreton Bay (see Photograph 3).

Photograph 3: Moreton Bay geotechnical drilling off Victoria Point.

2.3.3 GRANVILLE TRUNK WATER MAIN PROJECT

For the geotechnical investigations for this project too, PB used a drill rig mounted on a barge, and drilled one borehole in the Mary River (see Photograph 4).

Photograph 4: Drilling rig on the barge on the Mary River in calm conditions

2.4 HDD PROFILE

2.4.1 AUSTRALIA TRADECOAST SEWERAGE PROJECT

PB completed preliminary design of the HDD profile after compiling all the information provided by City Design (Brisbane City Council).

A workshop involving Brisbane Water, Leighton Contractors, PB and Coe Drilling was held to discuss the scoping and design of the HDD profile. (See Appendix B drawings for the final HDD profile.)

The HDD design and construction were the subject of a subcontract between Coe Drilling and Leighton Contractors. Photographs 5, 6 and 7 show the HDD works being undertaken for the project.

PB, as design consultant to Leighton Contractors, and Brisbane Water, the client, completed a design review of the HDD profile developed by Coe Drilling.

Appendix A drawings provide further details.

Photograph 5: HDD drill rig on the south side of Brisbane River.

Photograph 6: Pipe drawback from the north side of Brisbane River.

2.4.2 COOCHIEMUDLO ISLAND WASTEWATER PROJECT

A preliminary design of the HDD profile was prepared by PB, and this formed part of the project's tender documentation. The preliminary profile was developed to maximise the length of HDD pipeline located within the weathered basalt. As the geotechnical investigations showed that the depth of basalt along the alignment increased at the start and end of the profile, the contractor designed steeper profiles for the final alignment to minimise potential construction risks, such as drilling mud break-out.

Appendix B shows the preliminary direction drill profile that PB developed for the project.

Photograph 7: HDD drill rig at Victoria Point, drilling towards Coochiemudlo Island.

2.4.3 GRANVILLE TRUNK WATER MAIN PROJECT

During the design development for the Granville Trunk Water Main project, and after completion of the geotechnical investigations, PB discussed with Brisbane-based HDD drilling contractor Coe Drilling the feasibility and likely extent and profile of HDD drilling under the Mary River. From these discussions, it was decided that the project was suitable for HDD technology and that a likely HDD entry point for the project would be on the southern side of the Mary River at approximately Chainage 1035 m (see PB Drawing 2138346A-WAT-0023 in Appendix C).

Coe Drilling also provided the following information, which formed the basis for the preliminary design of the project:

- a preliminary HDD design profile, requiring the water main to be installed at a depth of 10 m below the river bed to ensure no break-out of drill fluid occurs (see to Appendix C drawings)
- a likely entry and exit angle of 15 degrees
- approximately 330 m of HDD (i.e. from Chainage 1042 m to Chainage 1369 m)
- entry pit layout dimensions of 30 m x 20 m (preferably 30 m x 30 m)
- exit pit dimensions of 6 m x 6 m (fenced area), and exit pit hole dimensions of 2 m x 2 m x 1 m deep
- entry pit near Chainage 1035 m
- approximate project duration (including the trenched section along Banana Street) of 10 weeks, as HDD drilling and trenching would occur at the same time.

2.5 CONSTRUCTION APPROVALS

Construction approvals were obtained for each project as detailed in Table 3.

Table 3: Construction approval summary.

Australia TradeCoast Sewerage approvals	Coochiemudlo Island Wastewater approvals	Granville Trunk Water Main approvals
• S51 Fisheries Act (marine plants) • Coastal Management Protection Act • Brisbane City Council (DRS – roads) • Department of Natural Resources, Mines & Energy • Queensland Transport, Maritime Safety Queensland • Port of Brisbane Corporation • Environmental Protection Agency (tidal works)	• S51 Fisheries Act (marine plants) • Coastal Management Protection Act • Queensland Transport, Maritime Safety Queensland • Environmental Protection Agency (tidal works)	• Department of Environment and Resource Management (tidal works) • *Coastal Protection and Management Act 1995* • Queensland Transport, Maritime Safety Queensland

2.6 CHALLENGES

The challenges faced by each project were as follows:

2.6.1 AUSTRALIA TRADECOAST SEWERAGE PROJECT

- Possible anchor drag in the turning basin above the proposed HDD alignment
- Significant gravel shoals, particularly under the north bank of the Brisbane River
- Shut-down of the work site for accident investigations because of a Workplace Health & Safety accident during drilling

2.6.2 COOCHIEMUDLO ISLAND WASTEWATER PROJECT

- Existing seagrass beds between Victoria Point and Coochiemudlo Island

- Existing water main and power supply cable between Victoria Point and Coochiemudlo Island; damage to seagrass beds from its construction was still evident

2.6.3 GRANVILLE TRUNK WATER MAIN PROJECT

- Logistics of arranging suitable barge to access Mary River, and of coordinating the loading of the drill rig onto a barge. Fortunately, a loading ramp was found nearby.

- Depth of Mary River, which limited access for the barge-mounted drill rig; and the river's large tidal range, which compromised the effectiveness of spud lengths of barge and limited the time for drilling the bore. Further investigations are essential to select a barge that is suitable for geotechnical work and able to handle the tidal range.

- Potential difficulties associated with presence of very loose to loose sands above and below the water table, and weathered rock along alignment. Careful design of the HDD profile and selection of the construction technique should reduce these geotechnical risks for the proposed project considerably.

2.7 MANAGING RISK

The construction of any transfer main using HDD technology has an associated risk that needs to be minimised. Due to the significant costs associated with this type of work, potential costs and time delays must be minimised as much as possible.

The experience gained from supervising the long-distance HDD has resulted in the following recommendations:

- Undertake sufficient geotechnical and survey investigations to provide the HDD contractor with a detailed knowledge of prevailing ground conditions.

- Notify the Department of Environment and Resource Management (DERM) early about the project, and let them know the HDD works are likely to operate almost 24 hours a day. Document DERM's requirements in the specification.

- Undertake sufficient research in the tender evaluation phase to ensure that the HDD contractor is experienced and has a successful track record on similar-sized projects.

- State in the technical specification that the HDD works must utilise a weak link to prevent overstressing the polyethylene (PE) pipe during pull-back (see Photograph 8). It is recommended that the HDD contractor provide detailed calculations on determining the break-away strength associated with the proposed weak-link device. The American Society for Testing and Material standard specification ASTM F1804 - 08 Standard Practice for Determining Allowable Tensile Load for Polyethylene (PE) Gas Pipe During Pull-In Installation is recommended.

- Ask that the HDD contractor provide a detailed work method statement explaining how they propose to complete the works. This is to ensure they have a thorough understanding of the HDD process.

- Clearly document the testing regime of the PE pipe string prior to pull-back. For example, state whether the entire pipe string needs to be hydrostatically tested prior to pull-back.

Photograph 8: Typical weak-link arrangement.

2.8 INNOVATIONS

The following innovations were developed to improve project safety.

2.8.1 AUSTRALIA TRADECOAST SEWERAGE PROJECT

- Pigging points were designed on both sides of the HDD crossing so the pipeline can be pigged should grit build up under the Brisbane River.

- A locally elevated high point with an air valve was constructed on the HDD-connected pipeline to prevent siphoning under the Brisbane River during pump failure.

2.8.2 COOCHIEMUDLO ISLAND WASTEWATER PROJECT

- Dual-flow meters either side of the HDD crossing were linked to a telemetry alarm to ensure pumps shut down if leakage is detected in the HDD crossing.

3 CONCLUSIONS

All projects have their own constraints, challenges and opportunities. These projects were no exception.

To maximise the opportunity for HDD projects to succeed, it is essential to fully understand the client's functional requirement for the project.

A comprehensive geotechnical investigation needs to be completed that is extensive enough to encompass the proposed maximum envelope for the HDD profile. These three case studies provide some guidance in this regard.

It is important that the preliminary HDD design be discussed with experienced HDD contractors and that the final design be developed collaboratively by the client, designer and HDD contractor.

Constructions risks need to be managed by the party best qualified to manage each risk, and this risk allocation needs to be agreed between the HDD contractor and client or principal contractor (if applicable).

ACKNOWLEDGEMENTS

The authors wish to thank Queensland Urban Utilities (formerly Brisbane Water), Redland City Council (formerly Redland Water and Waste), and Fraser Coast Regional Council for allowing these projects to be discussed in this paper.

REFERENCES

American Society for Testing and Material (2004–2008) ASTM F1804 – 08: Standard Practice for Determining Allowable Tensile Load for Polyethylene (PE) Gas Pipe During Pull-In Installation, American Society for Testing and Material.

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Domanti, A., Cameron I. and Manton P. (2010) 'Sewering Island Communities — Lessons Learnt from the Coochiemudlo Island Wastewater Project', paper presented to the Australian Water Association Ozwater Convention & Exhibition, Brisbane, March.

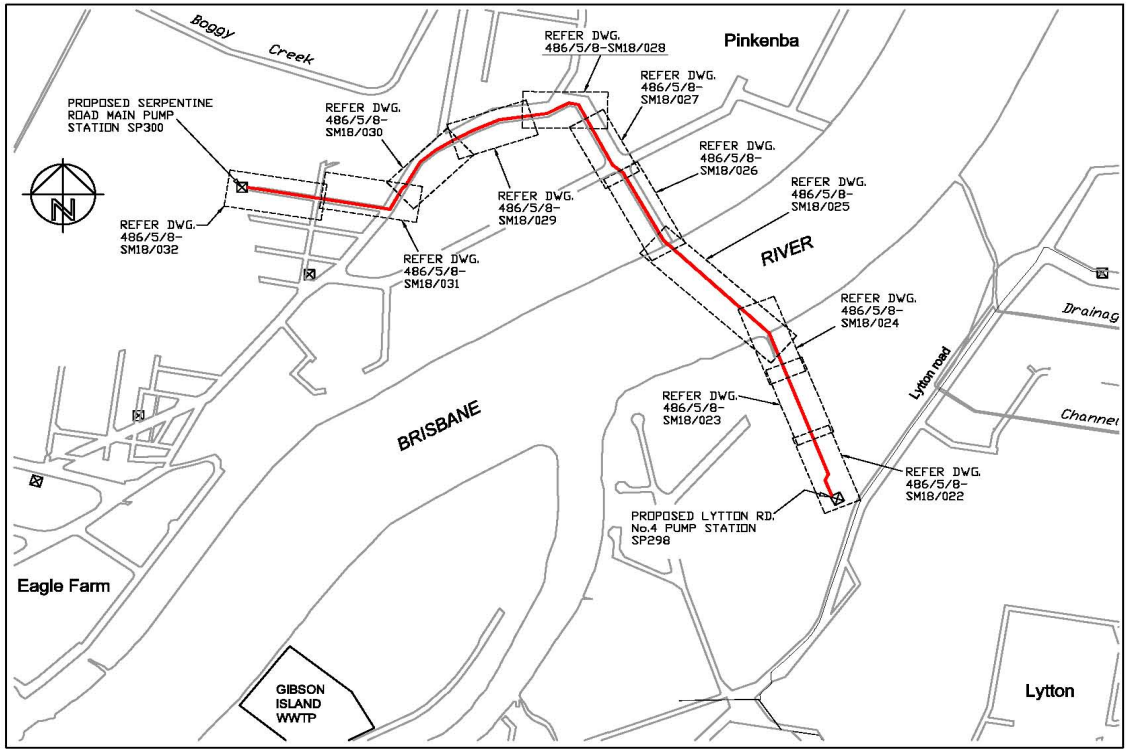
APPENDICES

Appendix A: Australia TradeCoast Sewerage Project Drawings

Appendix B: Coochiemudlo Island Wastewater Project Drawings

Appendix C: Granville Trunk Water Main Project Drawings

SEWER RISING MAIN, LYTTON ROAD PUMP STATION (SP298) TO SERPENTINE ROAD PUMP STATION (SP300).



LOCALITY PLAN
1:10000

DRAWING No.	DRAWING TITLE
486/5/8-SM18/021	OVERALL LAYOUT
486/5/8-SM18/022	PLAN AND LONG SECTION - CH 10.936 TO CH 300.000
486/5/8-SM18/023	PLAN AND LONG SECTION - CH 300.000 TO CH 602.080
486/5/8-SM18/024	PLAN AND LONG SECTION - CH 602.080 TO CH 606.45
486/5/8-SM18/025	PLAN AND LONG SECTION - CH 606.45 TO CH 1355.21
486/5/8-SM18/026	PLAN AND LONG SECTION - CH 1355.21 TO CH 1600.000
486/5/8-SM18/027	PLAN AND LONG SECTION - CH 1600.000 TO CH 1900.000
486/5/8-SM18/028	PLAN AND LONG SECTION - CH 1900.000 TO CH 2200.000
486/5/8-SM18/029	PLAN AND LONG SECTION - CH 2200.000 TO CH 2500.000
486/5/8-SM18/030	PLAN AND LONG SECTION - CH 2500.000 TO CH 2800.168
486/5/8-SM18/031	PLAN AND LONG SECTION - CH 2800.168 TO CH 3100.000
486/5/8-SM18/032	PLAN AND LONG SECTION - CH 3100.000 TO ~~CH 3427.84~~ CH 3339.39
486/5/8-SM18/033	NOT USED
486/5/8-SM18/034	NOT USED
486/5/8-SM18/035	DIRECTIONAL DRILL DETAIL (CH. 2000.0)
486/5/8-SM18/036	SCOUR AND AIR VALVE DETAILS - SHEET 1 OF 2
486/5/8-SM18/037	SCOUR AND AIR VALVE DETAILS - SHEET 2 OF 2
486/5/8-SM18/038	NOT USED
486/5/8-SM18/039	TRENCH DETAILS

BRISBANE CITY COUNCIL STANDARD DRAWINGS

DRAWING No.	DRAWING TITLE
486/5/25-SB008	VALVE CHAMBER DETAILS FOR SLUICE VALVES ON SEWER SYSTEMS.
486/5/25-SF004/1 TO 4	MAINTENANCE HOLE COVER SEWER-CLASS D COVER, RISER RING AND FRAME DETAILS.
486/5/25-SF009	STANDARD M.S. LADDERS AND ASSOCIATED FITTINGS.
486/5/25-SF010	CAST IRON VALVE BOX & COVER - SEWERAGE.
486/5/25-WD005	CAST IRON VALVE BOX & COVER LONG TYPE.
486/5/25-WM003	ONE SEGMENT C.I. COVER AND FRAME FOR WATER SUPPLY AND RECYCLED WATER VALVE PITS.
486/5/25-WM004	COVER AND FRAME FOR WATER SUPPLY, SEWERAGE AND RECYCLED WATER AIR VALVE PIT.

CO-ORDINATE TABLE
CONTROL POINTS ●

EASTING	NORTHING	LEVEL	STATION
47973.491	37859.149	2.915	TS50
47926.037	37929.089	2.498	TS51
47913.995	37944.583	2.408	TS52
47882.347	37989.064	2.633	TS53
47815.192	38056.993	2.771	TS54
47780.577	38135.006	2.935	TS55
47662.667	38196.445	1.694	TS56
47563.314	38304.917	1.573	TS57
47432.638	38324.677	1.717	TS58
47303.504	38281.643	1.46	TS59
47245.009	38280.448	1.916	TS60
47165.569	38196.979	1.612	TS61
47065.79	38148.445	1.728	TS62
47031.448	38120.112	1.676	TS63
47000.463	38082.177	1.706	TS64
46959.789	38027.849	1.915	TS65
46933.133	37959.304	1.941	TS66
46913.21	37895.023	2.00	TS67
46862.741	37798.231	1.725	TS68
46775.835	37801.624	1.85	TS69
46697.094	37798.863	1.742	TS70
46612.999	37842.539	1.608	TS71
46536.182	37811.221	1.756	TS72
46472.75	37811.554	1.542	TS73
46431.718	37811.534	1.595	TS74
46886.303	36915.522	2.791	TS6
46871.707	36859.066	2.053	PSM40

NOTES

HDPE PIPE
HDPE pipe shall be installed in accordance with the manufacturer's recommendations and project specifications. Joints shall be butt welded, electrofusion couplings, or flanged joints as indicated. Unless indicated otherwise changes in direction shall be achieved by bending the pipe. The minimum bending radius shall be 50 times the nominal diameter of the pipe. Where specified preformed bends shall be used. Bends shall be moulded long radius sweep bends. Fabricated welded bends shall not be used. Tees shall be moulded
Stub flanges shall be provided with stainless steel, class 316L, backing plates. Thickness of backing plates shall comply with the flange thicknesses specified in AS4087, Figure B7. Flange bolting shall be stainless steel, class 316L. Buried flanges to be coated with Denso petrolatum tape system.

MSCL PIPE
MSCL pipe shall be coated with medium density polyethylene in compliance with AS4321. Flange bolting shall be stainless steel, class 316L. Buried flanges to be wrapped with Denso petrolatum tape system. On-site welds and coating damage to be made good with MDPE coating system.

EXISTING SERVICES
Contractor to locate all services prior to commencing construction.

ENVIRONMENT
Carry out all works in accordance with environmental management plan

LIVE WORKS
Connection to live works shall be carried out by Brisbane Water

ACCESS TO AIR VALVES AND SCOURS
Where access is provided to air valves and scour valves grade existing road side drain to ensure flow can be maintained in the side drain.

Acid sulphate soils
Acid sulphate soils occur along the rising main alignment. Mapping shows levels to range from high to extremely high. The treatment and handling of acid sulphate soils shall be carried out in compliance with the Environmental Management Plan

Marine Plants
Section 51 permit areas are shown on the drawings. Marine plants (i.e. mangroves, salt couch, samphire, etc) can be removed or disturbed only in these areas. No disturbance to marine plants outside these areas is permitted. Storage of plant or equipment is not permitted outside these areas. Refer to permit for more information

Works In Tidal Zones
CMP approval allows works in tidal areas. Refer to permit for further information.

Salt Couch and Samphire Relocation
Any salt couch or samphire removed shall be retained for reuse in restoration of trenches and disturbed areas

Watercourses
The alignment crosses watercourses. Environmental impacts relating to sediment and erosion control and water contamination from oils and fuels may occur during construction. Mapping shows the location of these water courses and management instructions Q-EN-504, Q-EN-505, Q-EN-516 detail management measures.

Fire Ants
The Hemmant and Lytton areas are DPI restricted areas. It is a legal responsibility to report any sighting of fire ants - Ph 13 25 23. All soil delivered to site must be from a source that provides a written confirmation that it is fire ant free. All vehicles/plant and equipment entering and leaving the site shall be inspected and verified fire ants free (free of loose soil).

Wetland Areas
Wetland areas occur with the alignment and surrounding low lying areas. Care should be taken when working in or near wetland areas.

Contaminated Land
If any contamination is found during construction immediately contact the Superintendant.

100 0 100 200 300 400 500
SCALE OF METRES
1 : 10000 FULL SIZE A1 SHEET

PROJECT: AUSTRALIA TRADE COAST SEWERAGE PROJECT

AS CONSTRUCTED
PLOTTED: A.M. DATE: 31/03/05
CHECKED: DATE:

DESIGN MANAGER — R.P.E.Q. NO. 2241 — DATE 04/05
BW NETWORK DELEGATE — DATE

NO.	DATE	AMENDMENT	INITIALS
A	31/03/05	AS CONSTRUCTED	
O	22/09/04	ISSUE FOR CONSTRUCTION	

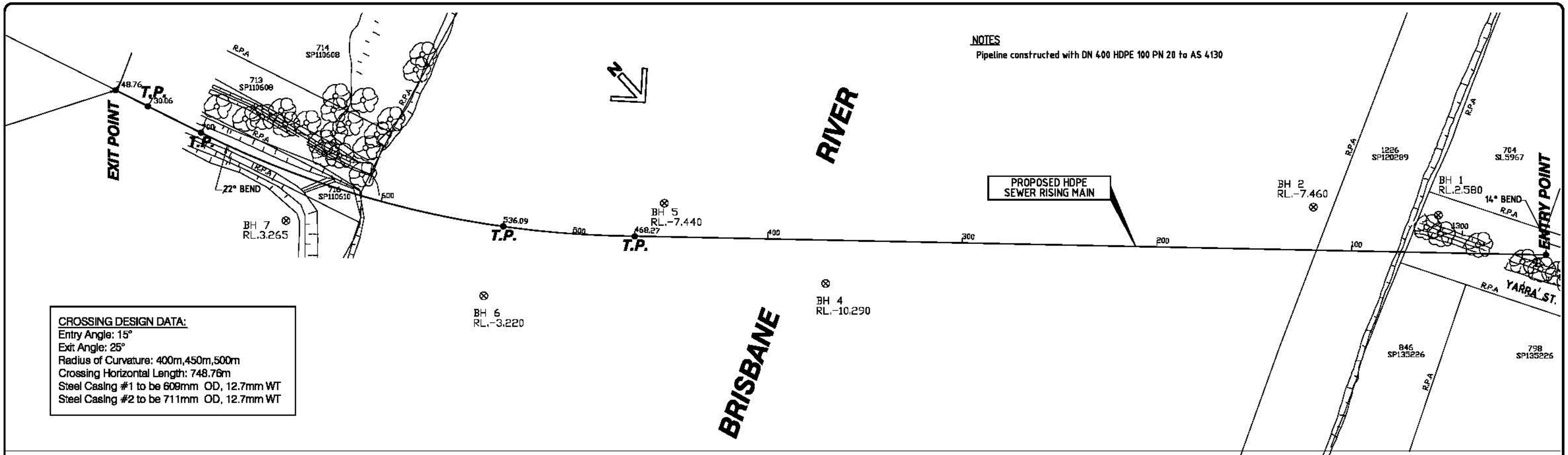
CADD FILE		DESIGN	R.J. — JUNE 2004
JOB FILE		DESIGN CHECK	
SURVEYED		DRAWN	A.M. — JUNE 2004
SURVEY NO.	FIELD BOOK	DRAFTING CHECK	

Cardno MBK (Qld) Pty Ltd — Level 1, 5 Gardner Close, Milton 4064. TELEPHONE (07) 3369 9822 FAX (07) 3369 9722 Email cardno@cardno.com.au
PB PARSONS BRINCKERHOFF — 12th Floor IBM Centre, 348 Edward Street, Brisbane QLD. 4000 — GPO BOX 2907, Brisbane QLD. 4000, Australia — ABN 84 797 323 433 — Telephone +61 7 3218 2222 Facsimile +61 7 3831 4223 Email: brisbane@pb.com.au
LEIGHTON — Level 3, 143 Coronation Drive, Milton 4064. TELEPHONE (07) 3215 4400 FAX (07) 3215 4490 www.leightoncontractors.com.au
Brisbane Water

PROJECT: Sewer Rising Main, Lytton Road Pump Station (SP298) to Serpentine Road Pump Station SP300)

TITLE: OVERALL LAYOUT CONTROL POINTS AND DRAWING NUMBERS

BW CONTRACT No.	30137-02/03
LEIGHTON JOB No.	Q1112
PB JOB No.	2138110B
SCALE	AS SHOWN
DATUM	A.H. DATUM
SHEET No.	1 OF 19 SHEETS
DRAWING No.	486/5/8-SM18/021
AMEND.	A



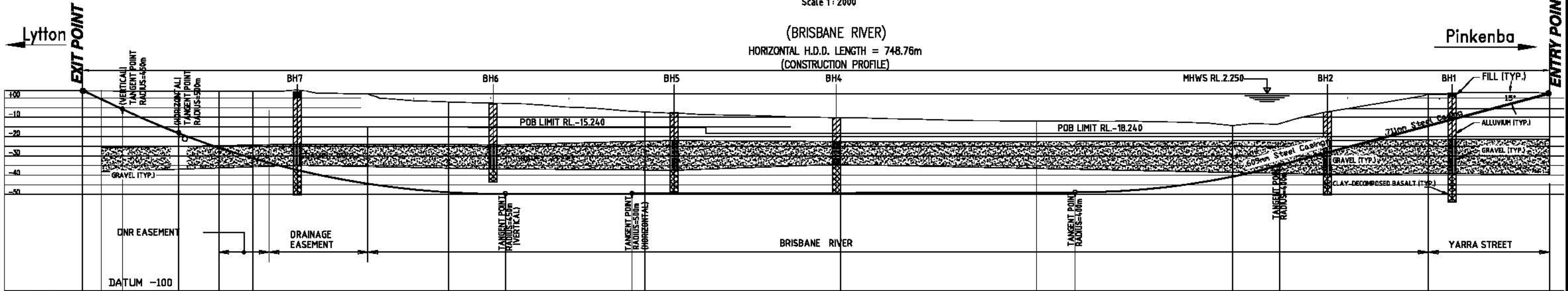
NOTES

Pipeline constructed with DN 400 HDPE 100 PN 20 to AS 4130

CROSSING DESIGN DATA:
Entry Angle: 15°
Exit Angle: 25°
Radius of Curvature: 400m,450m,500m
Crossing Horizontal Length: 748.76m
Steel Casing #1 to be 609mm OD, 12.7mm WT
Steel Casing #2 to be 711mm OD, 12.7mm WT

PLAN

Scale 1 : 2000



HORIZONTAL CHAINAGE	DEPTH OF COVER	TOP OF PIPE LEVEL	GROUND LEVEL
748.76 # (629.18)	4.16	-0.34	
728.34	9.25	-5.60	
699.64	21.57	-18.11	
691.13 679.20	29.08	-25.62	3.459
661.89	34.65	-31.12	3.532
561.89	46.68	-48.75	-2.061
532.99	46.80	-49.59	-2.802
468.27		-49.41	
461.89	42.19	-49.39	-7.194
361.89	38.90	-49.11	-10.202
261.89	36.96	-48.83	-11.866
242.26	36.90	-48.77	-11.866
161.89	26.36	-40.61	-14.247
137.83	21.62	-34.89	-10.399
61.89	16.05	-14.05	2.000
0.00 *(1367.88)		2.382	2.382

REFER TO DWG. 486/5/8-SM18-024

LONGITUDINAL SECTION OF CROSSING

REFER TO DWG. 486/5/8-SM18-026 *

PROJECT AUSTRALIA TRADE COAST SEWERAGE PROJECT

AS CONSTRUCTED
PLOTTED: A.M. DATE: 03/08/04
CHECKED: DATE:

COE DRILLING AUSTRALIA PTY LTD — HORIZONTAL DIRECTIONALLY DRILLED CROSSINGS

20 0 20 40 60 80 100m 1:2000
SCALE BEFORE REDUCTION

Cardno MBK — Cardno MBK (Qld) Pty Ltd, Level 1, 5 Gardner Close, Milton 4064. TELEPHONE (07) 3369 9822 FAX (07) 3369 9722 Email cardno@cardno.com.au

PB Parsons Brinckerhoff — 12th Floor IBM Centre, 348 Edward Street, Brisbane QLD 4000; GPO BOX 2907 Brisbane QLD 4000 Australia; ABN 84 797 323 433; Telephone +61 7 3218 2222 Facsimile +61 7 3831 4223 Email: brisbane@pb.com.au

LEIGHTON — Level 3, 143 Coronation Drive, Milton 4064. TELEPHONE (07) 3215 4400 FAX (07) 3215 4460 www.leightoncontractors.com.au

BW CONTRACT No.	30137-02/03
LEIGHTON JOB No.	Q1112
PB JOB No.	2138110B

NO.	DATE	AMENDMENT	INITIALS
B	17/10/05	AS CONSTRUCTED	

DESIGN MANAGER [signature] R.P.E.Q. NO. 2241 DATE 10/05
BW NETWORK DELEGATE DATE

CADD FILE		
JOB FILE		
SURVEYED		
SURVEY NO.	FIELD BOOK	

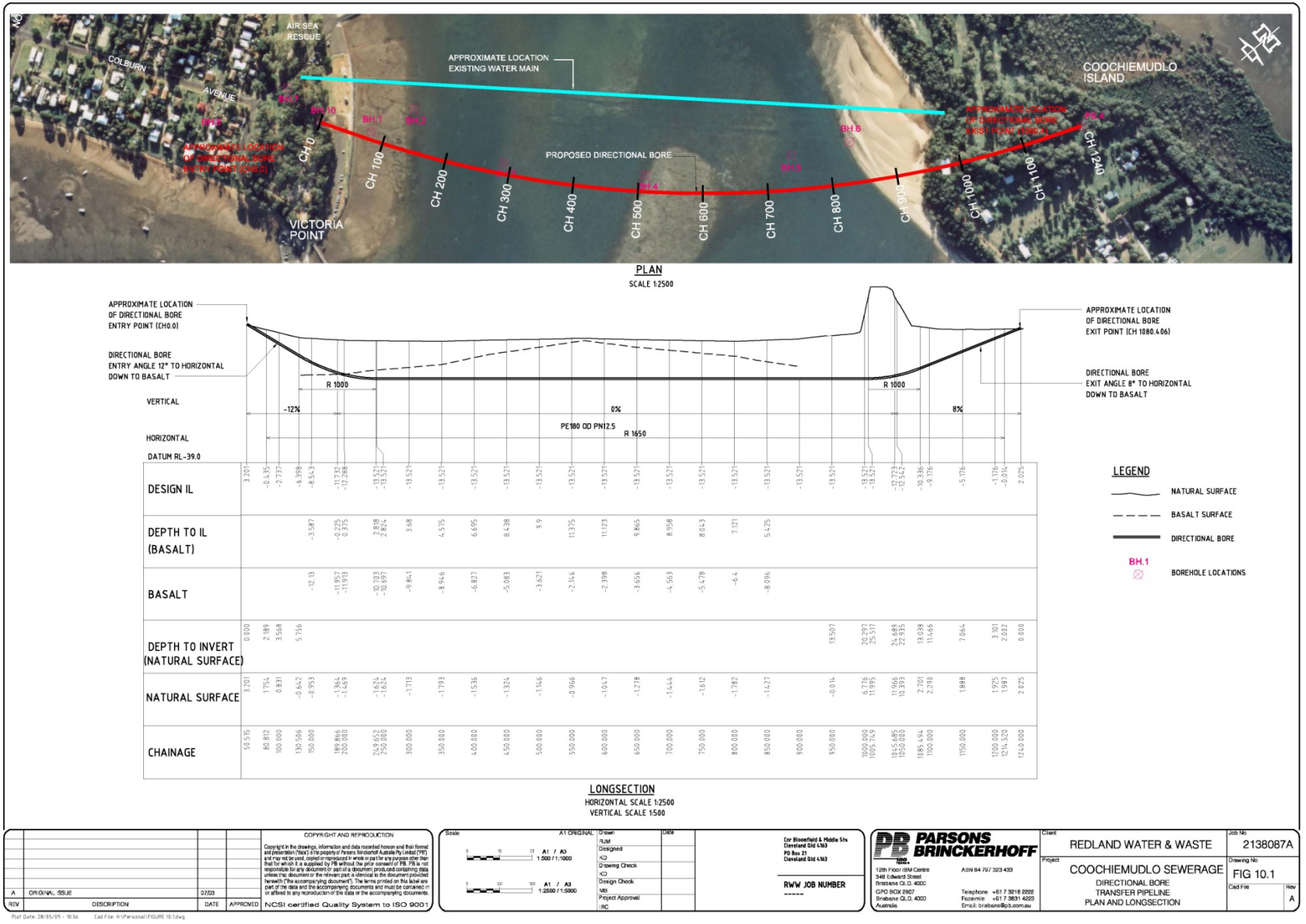
DESIGN	MB	JUNE 2004
DESIGN CHECK	IRC	JUNE 2004
DRAWN	RJM	JUNE 2004
DRAFTING CHECK	MB	JUNE 2004

Brisbane Water

PROJECT Sewer Rising Main, Lytton Road Pump Station (SP298) to Serpentine Road Pump Station SP300)

TITLE DIRECTIONAL DRILL DETAIL BRISBANE RIVER CROSSING PLAN AND LONGSECTION

SCALE AS SHOWN — A.H. DATUM — No. 5 OF 19 SHEETS
DRAWING No. 486/5/8-SM18/025 — AMEND. B



REV	DESCRIPTION	DATE	APPROVED
A	ORIGINAL ISSUE	07/09	

NCSI certified Quality System to ISO 9001

Scale: A1 ORIGINAL — A1 / A3 1:500 / 1:1000 — A1 / A3 1:2500 / 1:5000

Drawn: RJM
Designed: KD
Drawing Check: KD
Design Check: MS
Project Approval: INC
Date:

Cnr Bloomfield & Middle Sts
Cleveland Qld 4163
PO Box 21
Cleveland Qld 4163

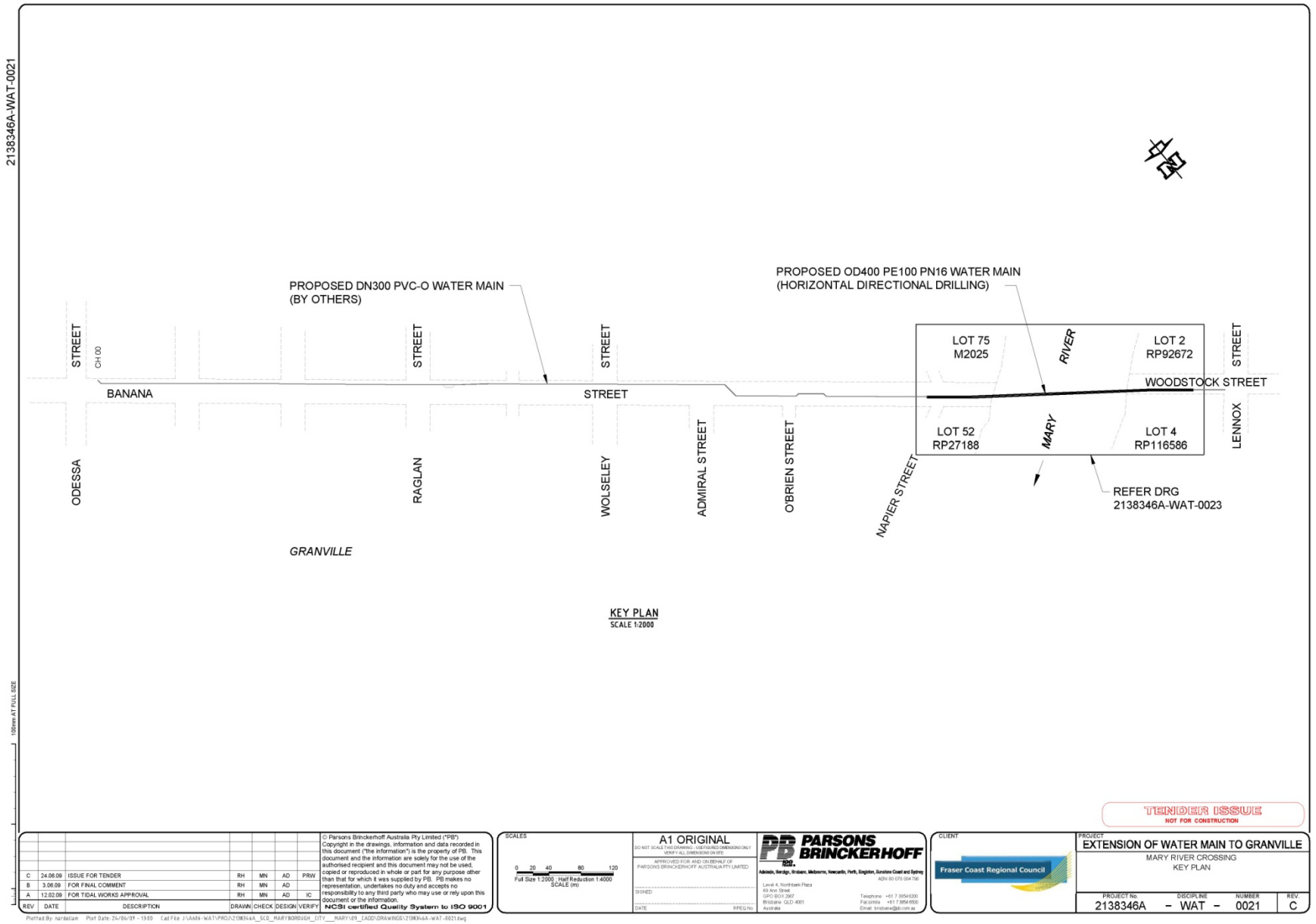
RWW JOB NUMBER

PARSONS BRINCKERHOFF
12th Floor IBM Centre
348 Edward Street
Brisbane QLD 4000
GPO BOX 2907
Brisbane QLD. 4000
Australia
ABN 84 797 323 433
Telephone +61 7 3218 2222
Facsimile +61 7 3831 4223
Email: brisbane@pb.com.au

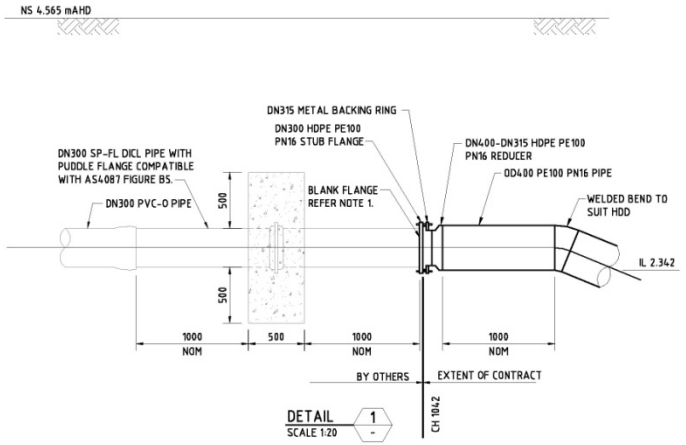
Client: REDLAND WATER & WASTE
Job No: 2138087A
Project: COOCHIEMUDLO SEWERAGE
DIRECTIONAL BORE
TRANSFER PIPELINE
PLAN AND LONGSECTION
Drawing No: FIG 10.1
Cad File:
Rev: A

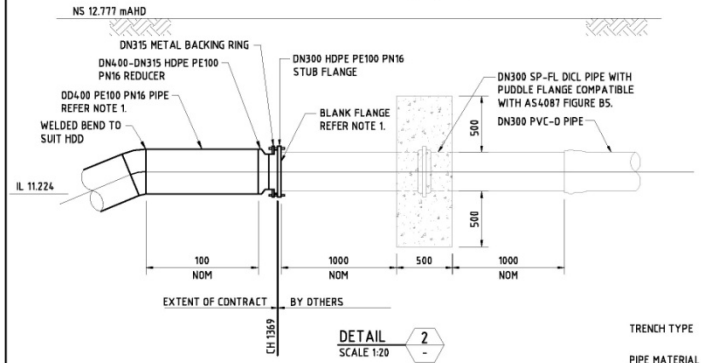
Plot Date: 28/05/09 - 10:56 Cad File: H:\Personal\FIGURE 10.1.dwg

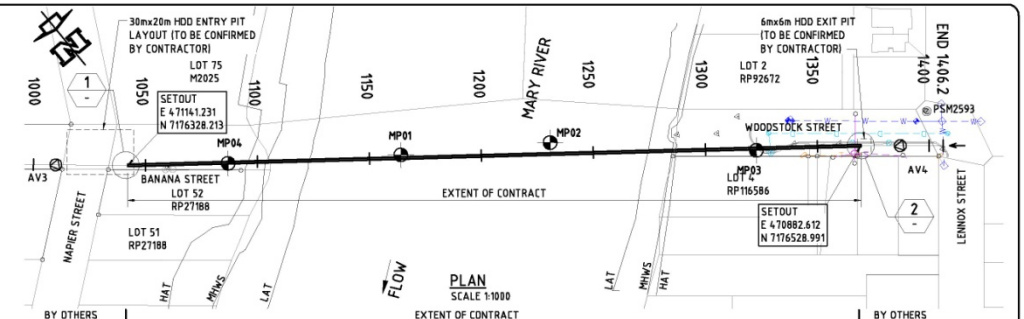
Appendix C: Granville Water Main Project Drawings

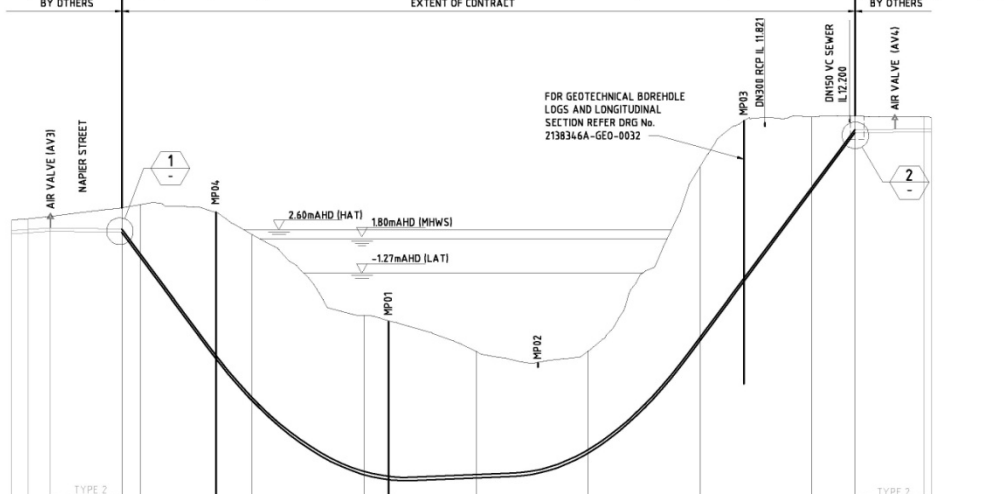


2138346A-WAT-0023









LONGITUDINAL SECTION
HORIZONTAL SCALE 1:1000
VERTICAL SCALE 1:200

TENDER ISSUE
NOT FOR CONSTRUCTION

NOTES

1. CONTRACTOR SHALL SEAL OFF THE PIPE WITH A BLANK FLANGE FOR FUTURE CONNECTION BY OTHERS.
2. TRENCHES 1.5m OR MORE DEEP SHALL BE SUPPORTED TO THE REQUIREMENTS OF THE WORKPLACE HEALTH AND SAFETY ACT.

REV	DATE	DESCRIPTION	DRAWN	CHECK	DESIGN	VERIFY
C	24.06.09	ISSUE FOR TENDER	RH	MN	AD	PRW
B	3.06.09	FOR FINAL COMMENT	RH	MN	AD	
A	12.02.09	FOR TIDAL WORKS APPROVAL	RH	MN	AD	IC

SCALES
0 200 400 800 1200
Full Size 1:20 : Half Reduction 1:40 SCALE (mm)
0 10 20 40 60
Full Size 1:1000 : Half Reduction 1:2000 SCALE (m)
0 2 4 8 12
Full Size 1:200 : Half Reduction 1:400 SCALE (m)

A1 ORIGINAL
DO NOT SCALE THIS DRAWING - USE FIGURED DIMENSIONS ONLY. VERIFY ALL DIMENSIONS ON SITE

APPROVED FOR AND ON BEHALF OF PARSONS BRINCKERHOFF AUSTRALIA PTY LIMITED
SIGNED
DATE
RPEQ No.

PARSONS BRINCKERHOFF
Adelaide, Bendigo, Brisbane, Melbourne, Newcastle, Perth, Singleton, Sunshine Coast and Sydney
ABN 80 078 004 798
Level 4, Northbank Plaza
69 Ann Street
GPO BOX 2907
Brisbane QLD 4001
Australia
Telephone +61 7 3854 6200
Facsimile +61 7 3854 6500
Email: brisbane@pb.com.au

CLIENT
Fraser Coast Regional Council

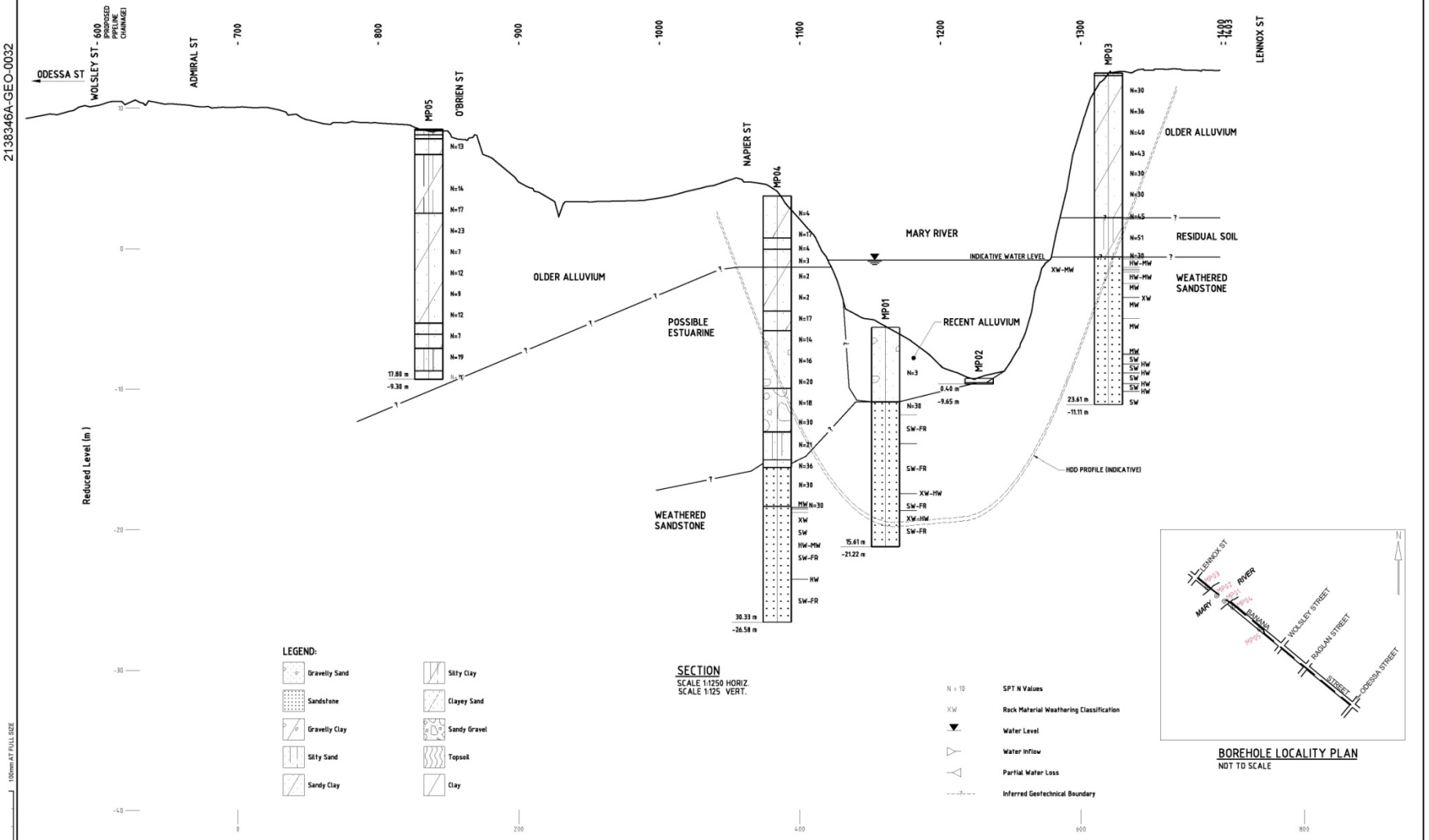
PROJECT
EXTENSION OF WATER MAIN TO GRANVILLE
MARY RIVER CROSSING
PLAN, LONGITUDINAL SECTION AND DETAILS

PROJECT No.	DISCIPLINE	NUMBER	REV.
2138346A	- WAT -	0023	C

Plotted By: nardellam Plot Date: 24/06/09 - 13:03 Cad File: J:\A666-WAT\PRO\2138346A_SCD_MARYBOROUGH_CITY___MARY\09_CADD\DRAWINGS\2138346A-WAT-0023.dwg

100mm AT FULL SIZE

2138346A-GEO-0032



LEGEND:

- Gravelly Sand
- Sandstone
- Gravelly Clay
- Silty Sand
- Sandy Clay
- Silty Clay
- Clayey Sand
- Sandy Gravel
- Topsoil
- Clay

N = 10 SPT N Values

XW Rock Material Weathering Classification

Water Level

Water Inflow

Partial Water Loss

Inferred Geotechnical Boundary

SECTION

SCALE 1:1250 HORIZ.
SCALE 1:125 VERT.

BOREHOLE LOCALITY PLAN

NOT TO SCALE

TENDER ISSUE
NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRAWN	CHECK	DESIGN	VERIFY
	24.06.09	ISSUE FOR TENDER	RH	MN	AD	PRW
B	3.06.09	FOR FINAL COMMENT	RH	MN	AD	
A	12.02.09	FOR TIDAL WORKS APPROVAL	RH	MN	AD	IC

SCALES
0 25 50 75
Full Size 1:1250 : Half Reduction 1:2500
SCALE (m)
0 2.5 5.0 7.5
Full Size 1:125 : Half Reduction 1:250
SCALE (m)

A1 ORIGINAL
DO NOT SCALE THIS DRAWING - USE FIGURED DIMENSIONS ONLY
VERIFY ALL DIMENSIONS ON SITE

APPROVED FOR AND ON BEHALF OF PARSONS BRINCKERHOFF AUSTRALIA PTY LIMITED
SIGNED
DATE RPEQ No.

PARSONS BRINCKERHOFF
Adelaide, Bendigo, Brisbane, Melbourne, Newcastle, Perth, Singleton, Sunshine Coast and Sydney
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Brisbane QLD 4001
Australia
Telephone +61 7 3854 6300
Facsimile +61 7 3854 6500
Email: brisbane@pb.com.au

CLIENT
Fraser Coast Regional Council

PROJECT
EXTENSION OF WATER MAIN TO GRANVILLE
MARY RIVER CROSSING
GEOTECHNICAL
LONGITUDINAL SECTION

PROJECT No.	DISCIPLINE	NUMBER	REV.
2138346A	- GEO -	0032	B

100mm AT FULL SIZE

Plotted By: nardellam Plot Date: 24/06/09 - 13:07 Cad File: J:\A666-WAT\PRO\2138346A_SCD_MARYBOROUGH_CITY___MARY\09_CADD\DRAWINGS\2138346A-GEO-0032.dwg