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Turbidity Monitoring of Bed Levelling Operations – Brisbane River

Prepared For: Port of Brisbane Corporation

Prepared By: WBM Oceanics Australia

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	Title:	Turbidity Monitoring of Bed Levelling Operations – Brisbane River
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	Client:	Port of Brisbane Corporation
	Client Contact:	Wayne Young
	Client Reference:	Commissioning Letter of 22 May 2002.
	Synopsis:	A summary of turbidity measurements within the turbid plume created by bed levelling operations at the Incitec North berth at Pinkenba on the Brisbane River.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE	CHECKED BY		ISSUED BY	
0	15/8/02	T Cooper		C. Morgan	
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2	10/10/02	T Cooper		C Morgan	

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EXECUTIVE SUMMARY

The Port of Brisbane Corporation (PBC) operates bed-levelling equipment for the purpose of maintaining navigable water depths close to the quay line of all wharfs and berths within the Port. Due to the nature of the bed levelling activities (i.e. relocating fine bed sediments), operations have the potential to produce plumes of turbid water. To develop a clear understanding of the nature of plumes throughout the water column, therefore, the Port of Brisbane Corporation commissioned WBM Oceanics to undertake an assessment to identify the scale and movement of any plumes of turbid water generated during typical bed levelling operations in the Brisbane River adjacent to the Incitec North berth at Pinkenba.

A combination of aerial photography of any surface plume associated with levelling operations, measurements of real-time turbidity within any sub-surface plume using a survey vessel equipped with turbidity measuring towfish, analysis of levels of suspended solids within any plumes and collection of sediment samples for particle size analysis to examine the texture of sediments that would be relocated during levelling operations were used to assess the operation at Pinkenba.

The sediment to be relocated at the Incitec North Wharf comprised mainly a mixture of sand, silt and clay, with a relatively high proportion of fine material (40 - 60% silt and clay) likely to be become resuspended during bed levelling. At the water surface, the spatial scale of the turbid plume generated by bed levelling appeared to be relatively small, having a maximum visible length of between approximately 120 – 150 m and an approximate width of 30 m at any given time.

Greatest levels of turbidity measured during bed levelling operations were approximately 10 NTU near the water surface and 70 NTU adjacent to the seabed. Prior to the commencement of works, levels at the surface and adjacent to the seabed were approximately 5 and 10 NTU, respectively. The turbid plume associated with bed levelling was no longer visible from the survey vessel after approximately 20 minutes and was not visible from the helicopter as viewed some 25 minutes after the conclusion of bed levelling operations. Levels of turbidity at the water surface were comparable with the snapshot baseline levels (typically less than 5 NTU) approximately 20 minutes after the conclusion of bed levelling. Concentrations of suspended solids near the surface and seabed were comparable with baseline concentrations approximately 25 minutes after the cessation of bed levelling operations.

Whilst levels of turbidity were generally within acceptable limits at the water surface, elevated levels were recorded adjacent to the seabed and it is possible that these levels may have short term effects on biota such as benthic invertebrates living on or in the sediments or smaller, sedentary species of fish. These effects, however, are not considered to be ecologically significant given the range and frequency of disturbances, both natural and those associated with the maintenance of the Brisbane River as commercial port, which currently occur in the area.

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1 INTRODUCTION

The Port of Brisbane Corporation (PBC) operates bed-levelling equipment for the purpose of maintaining navigable water depths close to the quay line of all wharfs and berths within the Port. The bed levelling equipment consists of a heavy duty blade, deployed and controlled from a dedicated barge which is propelled and positioned using the small tug *Seahorse* (refer to Plate 1). The blade is similar in shape and function to that typically seen on conventional earthmoving equipment such as a road grader, in this instance, with the depth and angle of operation of the blade being fully controlled from the wheelhouse of the *Seahorse*.

The combined bed levelling plant is used to clear the accumulated sediment from the quayline and to grade it a sufficient distance offshore, so that it can be removed by the Corporation's trailer arm suction dredger *Brisbane* during routine maintenance dredging operations. A typical dredged profile offshore from the quayline includes an over dredged trench beyond the berth pocket, so that accumulated material removed by the bed leveller can be relocated temporarily into the trench without affecting water depths within or adjoining the berths.

Typically, the bed levelling plant is operated such that a number of consecutive 'C' shaped (in plan view) passes are required to remove the accumulated sediments from the quayline of a berth. With each pass, the sediment accumulated along a distance of some 20-30m (subject to the depth of sediment) of the quayline is pushed offshore to the over dredged trench.

Due to the nature of the bed levelling activities (i.e. relocating fine bed sediments), operations have the potential to produce plumes of turbid water. The size and extent of these plumes produced by the operation of the bed leveller are likely to be quite variable depending upon the texture of the accumulated sediments, duration of operation of the bed leveller and other variables such as the prevailing tidal currents. To develop a clear understanding of the nature of plumes throughout the water column, the Port of Brisbane Corporation commissioned WBM Oceanics to undertake detailed assessments to identify the scale and movement of any plumes of turbid water generated during typical bed levelling operations in the Brisbane River.

This report summarises measurements and observations of the plume conditions during normal operation of the bed levelling plant at the Incitec North berth, at Pinkenba on the 17th July 2002 (refer to Figure 3.1). This site was selected as both the set out of the berth pocket and sediments were considered typical of those encountered during normal operations. The absence of adjoining wharves, however, provided an opportunity to track plumes unimpeded.

2 METHODS

Preliminary discussions with PBC environmental personnel indicated that a range of different observation and measurement techniques should be employed to quantify the ambient conditions and the plume generated by bed levelling operations. These were to include:

- Aerial photography of any surface plume,
- Real-time turbidity measurements within any sub-surface plume using a survey vessel equipped with turbidity measuring towfish,
- Collection of water samples from the plume for the analysis of suspended solids concentrations,
- Collection of sediment samples for particle size analysis to examine the texture of sediments affected by levelling operations.

The date for the measurement of the plumes (17th July 2002) was selected to coincide with forecast fine weather conditions, suited to aerial photography. The predicted time of low water (0.4m above datum) at Pinkenba was approximately 0930hrs with the following high tide (1.91m above datum) predicted at 1540hrs. All measurements and observations were collected on the flooding tide between 1000 and 1300hrs coinciding with peak tidal velocities, presenting maximum opportunity for transport of the plume.

Bed levelling operations commenced at approximately 1135hrs and concluded at approximately 1220hrs, with the normal frequency of operations being maintained through this period. It is estimated that this resulted in 15 passes to clear the accumulated sediments at the berth, resulting in an approximate cycle time of 3 minutes. Bed levelling works began at the upstream end of Incitec North berth and progressed downstream against the flooding tide, resulting in the brief appearance of turbid plumes of water at the surface associated with each pass. The plumes were moved by the flooding tide in an upstream direction towards the Pinkenba bulk wharf.

2.1 Aerial Photography

Aerial photography was undertaken using a small helicopter. Photographs were obtained using handheld digital and 35 mm cameras from an approximate flying height of 200 m prior to the commencement of works, during and approximately 30 minutes after the cessation of bed levelling operations. Flying height was limited to 300 m due to the proximity of the flight path to Brisbane Airport.

2.2 Measurements of Turbidity

Real-time measurements of turbidity were collected before, during and after the bed levelling operations from a small survey vessel. A snapshot of baseline measurements was collected along two transects, each perpendicular to the Incitec North Wharf (refer to Figure 3.1) prior to the commencement of works. Real time measurements of turbidity were collected by towing a weighted line positioned at the stern of the survey vessel equipped with three turbidity sensors and one depth sensor. Each sensor was configured as a towfish (ie. equipped with a tailfin for orienting the sensors into the flow) and towed at slow speeds (1-2 knots) through the water column. The turbidity sensors were positioned at depths of 1 m, 5 m and 9 m. (Advice from PBC indicated that the design depth at the Incitec North berth was approximately 10.1 m below low water datum, though the accumulated sediment had in some areas reduced the available depth close to the wharf to approximately 9.8m below low water). The depth sensor was positioned at 9 m so that in the event that shallower water measurements were required, the weighted line could be shortened, whilst still providing a record of the correct depth of immersion of the sensors. Each of the turbidity sensors was interfaced to an onboard datalogger programmed to record the water turbidity at 10-second intervals. Using software supplied by the datalogger manufacturer, the turbidity data was displayed on a laptop computer (approximating real-time) aboard the survey vessel, so as to provide feedback on the appropriate times to start and stop each transect. The turbidity measuring system was constructed for this project and was to that time unproven. As such preliminary testing of the system was undertaken in Breakfast Creek and Moreton Bay in the preceding week. Sensor specifications and results of these tests are shown in APPENDIX B:.

Simultaneous positioning information for the vessel track was recorded using a DGPS. During the bed levelling operations, the survey vessel was positioned approximately 40-50 m astern of the *Seahorse* and followed its track. Measurements of turbidity generally commenced shortly before the bed leveller was adjacent to the quayline and concluded at a distance when the turbidity data displayed on-board had reduced to near baseline levels (typically this occurred some 50 to 80 m offshore of the quayline).

To facilitate the real time measurements of turbidity after bed levelling, a drogue was deployed within the surface plume to indicate the movement of sediments remobilised during levelling operations. The drogue consisted of a surface marker float and mast that supported a current vane set at a depth of 3 – 4 m. Turbidity profiles were collected adjacent to the drogue as it moved upstream with the flooding tide. The location of the drogue was recorded at approximately 5-minute intervals using a DGPS.

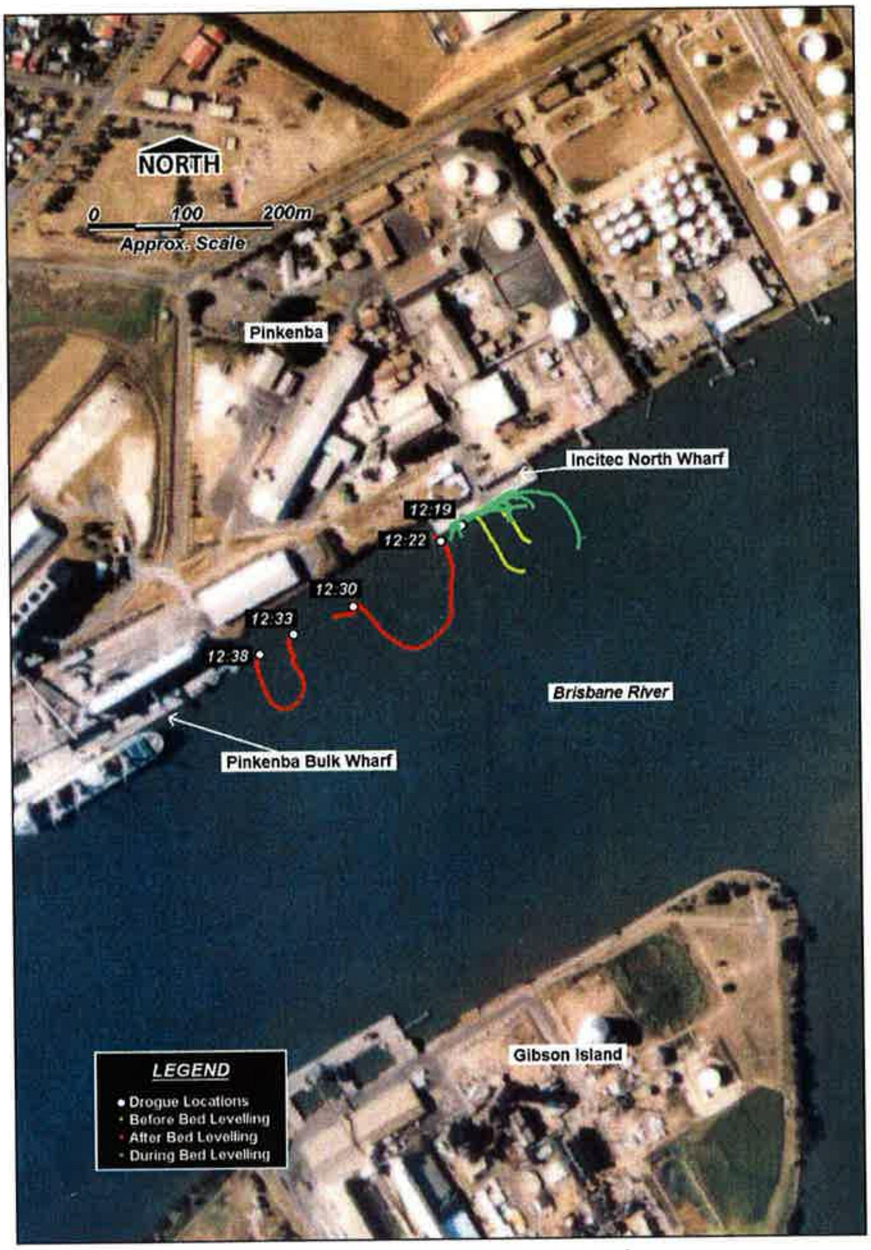
2.3 Analysis of Sediments and Water Samples

Prior to operation of the bed levelling equipment, two samples of sediments, each consisting of approximately 2kg of material, were collected from the Incitec North berth using a Van Veen grab. The samples comprised a composite of sediments collected at distances of 5 to 10 m from the wharf face adjacent to the upstream and downstream ends of the wharf. The Van Veen grab had an estimated depth of penetration into the sediment of approximately 0.1 m, therefore, the samples were considered to be representative of the surface material relocated during levelling operations. The bed samples were submitted to Earthtech Laboratories at Mansfield for particle sizing by hydrometer analysis so as to place the sediment texture in context with the observed and measured characteristics of the plumes of turbid water generated by the bed levelling operations at the Incitec North berth.

Similarly, replicate water samples (1 L) were collected from depths of 1 m and 9 m using a Van Dorn sampler for analysis of levels of suspended solids before and after the bed levelling operations. Whilst it was originally proposed that further water samples would be collected during the bed levelling operations; in practice, it was found that the normal cycle time of the bed leveller was too fast and the schedule of data collection using the turbidity datalogger and DGPS took priority over the collection of additional water samples. The water samples were analysed for concentrations of suspended solids by Australian Laboratory Services Pty Ltd. at Stafford.

3 RESULTS

The study area adjacent to the Incitec North Wharf with 'before' transects (yellow lines), 'during' transects (green lines) and 'after' transects (red lines) is provided in Figure 3.1.



Vessel Tracks and Drogue Locations
17/07/02

Figure 3.1

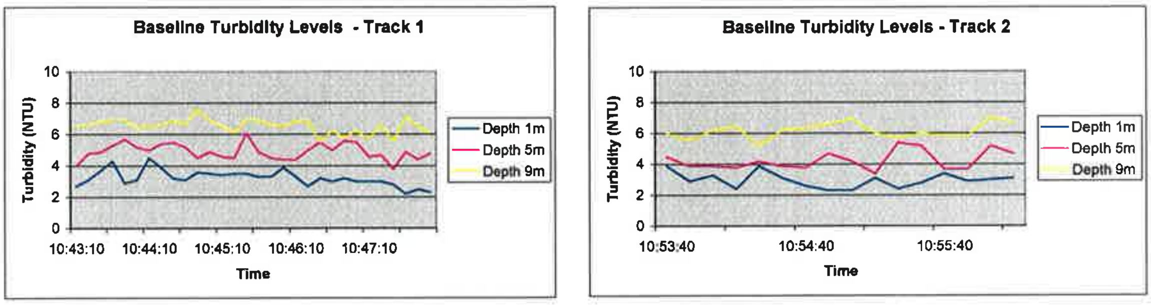
WBM OCEANICS AUSTRALIA

Figure 3.1 Map of study site adjacent to Incitec North Wharf.

3.1 Before Bed Levelling Operations

The results of the snapshot measurements of baseline turbidity adjacent to the berth area at the Incitec North Wharf are shown in Figure 3.2.

Figure 3.2 Baseline Turbidity, Incitec North Wharf, Tracks 1 and 2 – 17/7/2002.



The texture of the bed sediments within the berth prior to bed levelling is illustrated in Figure 3.3. Figure 3.4 shows the concentration of suspended solids approximately a half hour before and after bed levelling operations. The raw laboratory analysis results are included in APPENDIX A:

Figure 3.3 Bed Sediment Texture, Incitec North Wharf – 17/7/2002 (Prior to Bed Levelling)

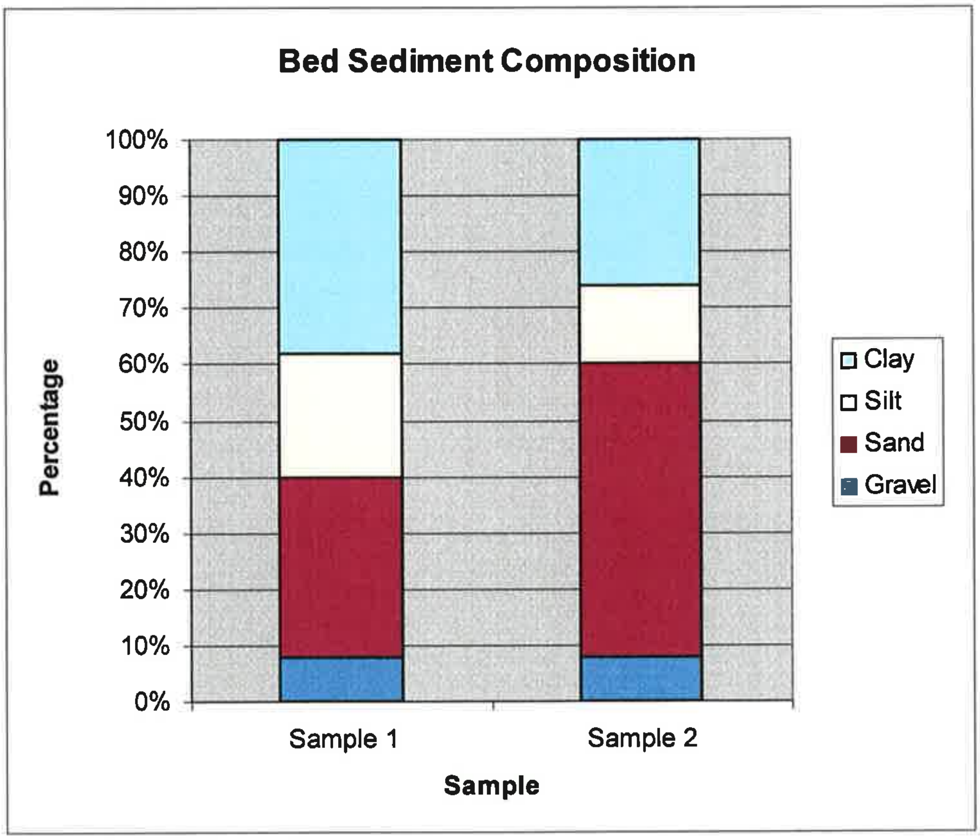
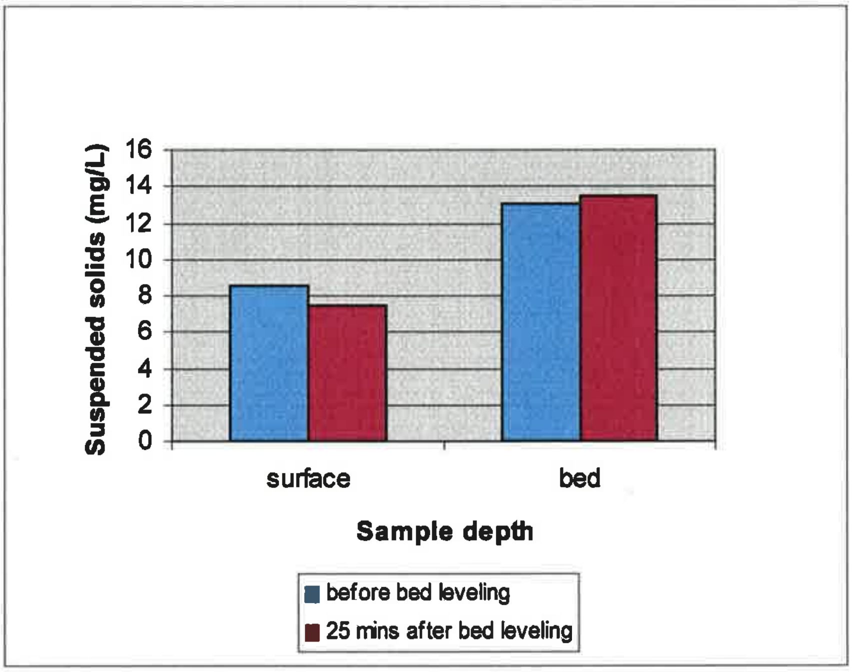


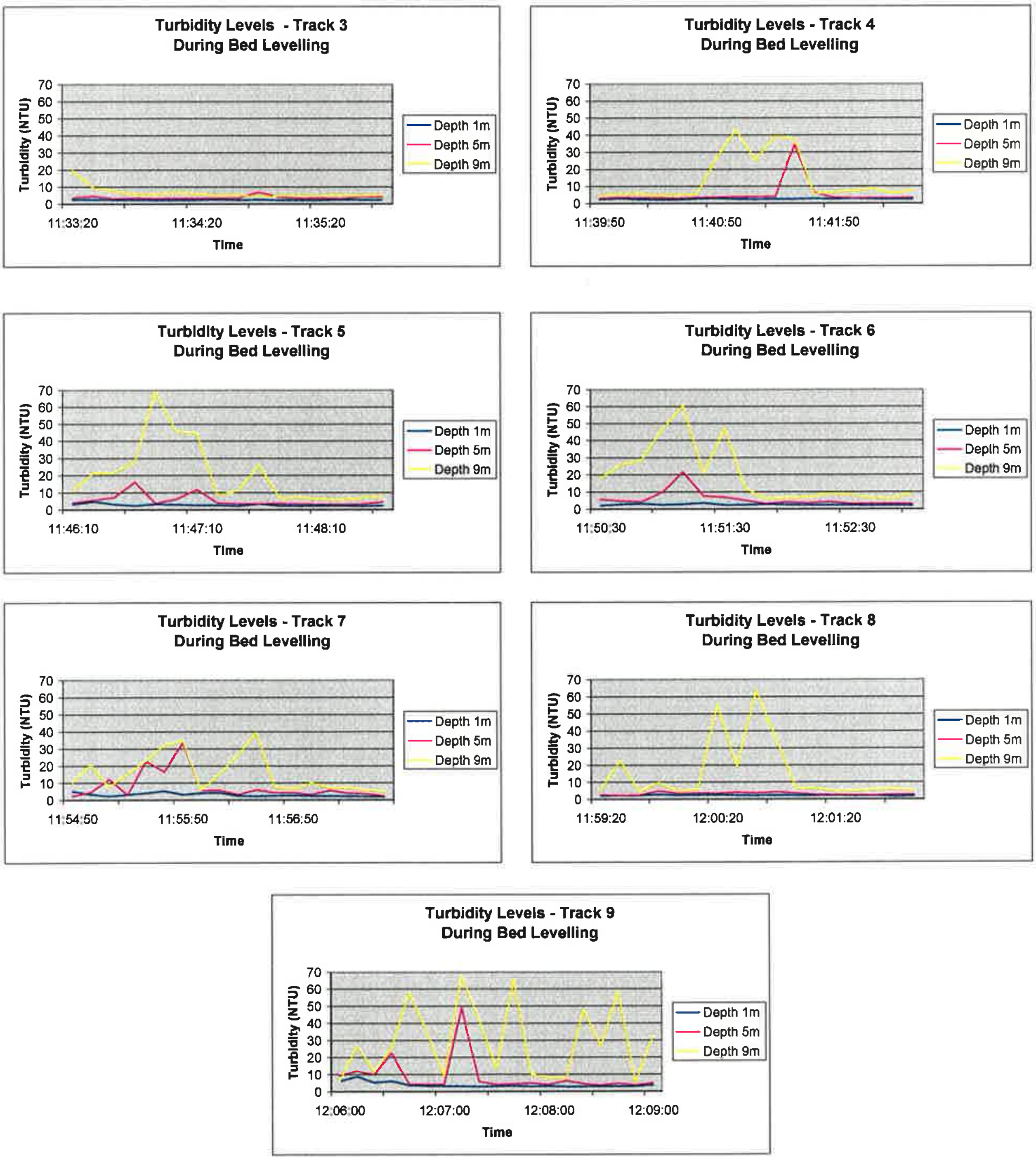
Figure 3.4 Concentrations of Suspended Solids Before and After bed levelling operations



3.2 During Bed Levelling Operations

The measurements of turbidity collected whilst following the operational bed levelling plant (survey vessel tracks 3-9) are illustrated in Figure 3.5.

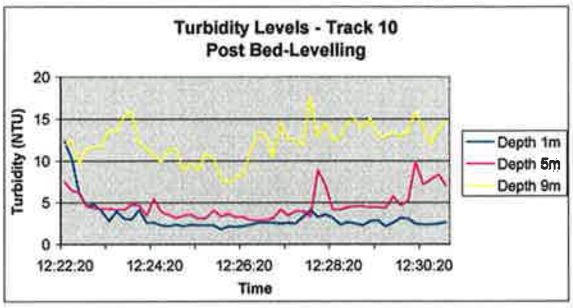
Figure 3.5 Turbidity During Bed Levelling, Incitec North Wharf, Tracks 3 - 9 – 17/7/2002.

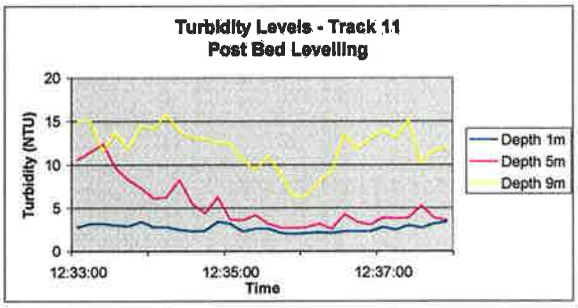


3.3 Post Bed Levelling Operations

Figure 3.6 shows the turbidity levels measured shortly after the completion of the bed levelling operation.

Figure 3.6 Turbidity After Bed Levelling, Upstream of Incitec North Wharf, Tracks 10 – 11, 17/7/2002.





4 AERIAL PHOTOGRAPHS

Plate 1: Tug *Seahorse* and bed levelling barge. The bed-levelling blade is deployed from the gantry at the stern of the barge.

Plate 2: Baseline turbidity conditions adjoining the Incitec North Wharf prior to bed levelling operations.

Plate 3: Bed levelling equipment in operation at the Incitec North Wharf. The bed leveller is preparing to start another pass (the 6th) along the face of the wharf, heading into the flood tide current. Note that the spatial extent of the plume created by previous bed levelling passes is relatively small (approximately 4 vessel lengths long).

Plate 4: Overhead view of the bed leveller in operation along the wharf face. Visible surface plume appears approximately 20m astern of the *Seahorse*.

Plate 5: Survey vessel traversing through turbid plume created by bed levelling operations.

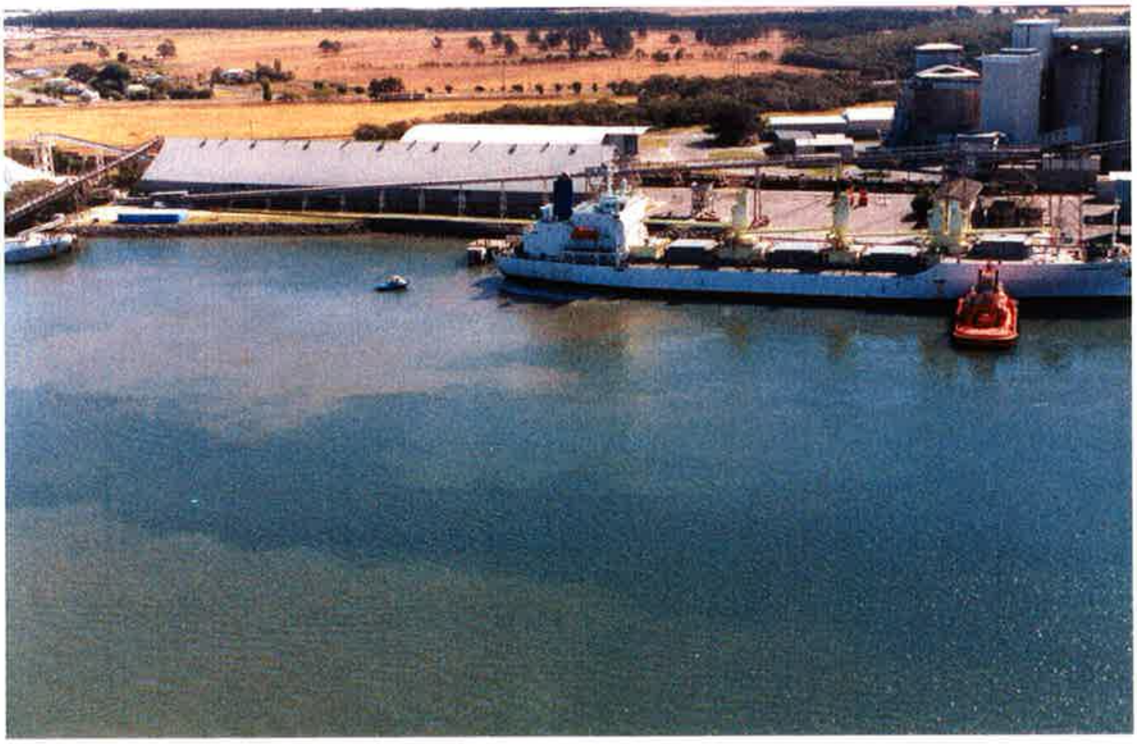


Plate 6: Shown for comparative purposes, the turbid plume created by ship berthing operations at the Pinkenba Bulk Wharf, just upstream of the Incitec North Wharf. Note the turbidity and the extent of the plume were much greater than that associated with bed levelling operations. Plume in foreground of photo was associated with the turning of the ship head to sea, prior to berthing.

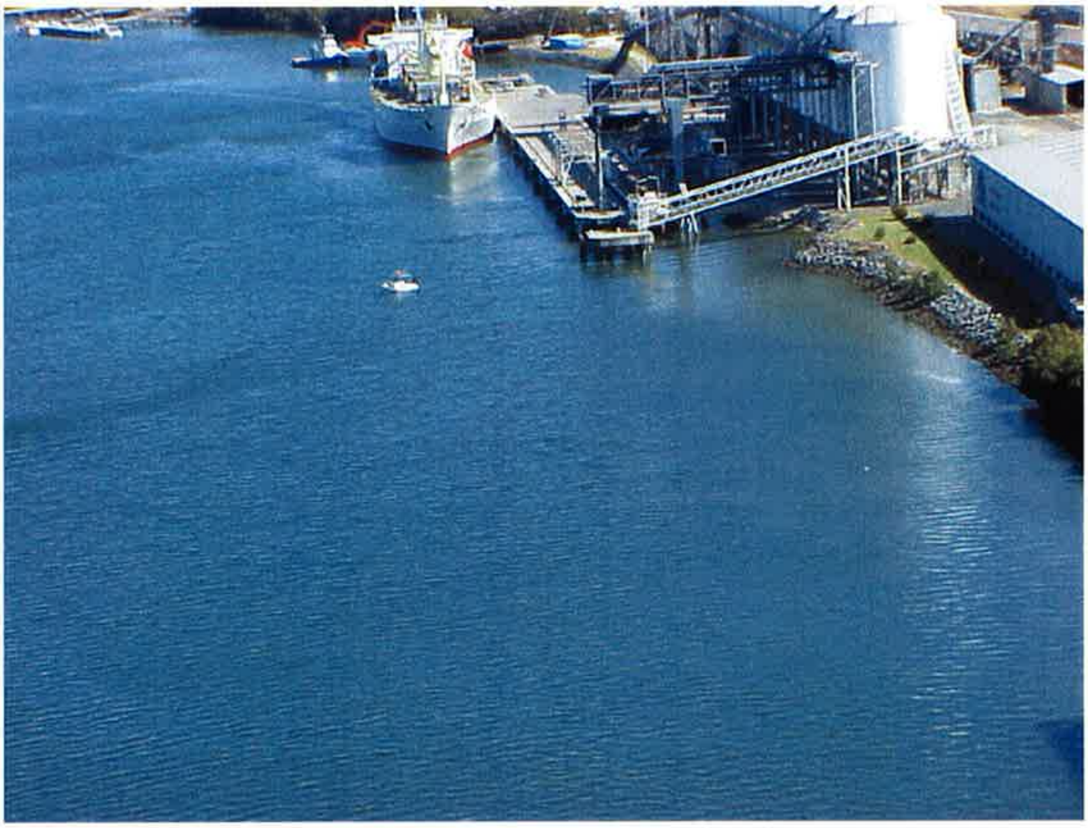


Plate 7 and Plate 8: Looking upstream to survey vessel, just after removal of the plume-indicating drogue. Photos were taken approximately 25 minutes after the

conclusion of bed levelling operations. Drogue was removed from the water column close to the Pinkenba bulk wharf. Note the general absence of visible surface plumes. The plume evident in shoal water adjoining the wharf was not due to the bed leveller but to an outflow of sediment-laden water from the drain located between the wharfs (Refer to Plate 9).

Plate 9: Photo looking downstream from the Pinkenba Bulk Wharf. Turbid plume in shoal water close to shore, downstream of the Pinkenba Bulk Wharf, is associated with a drain discharge and not the bed levelling operations. Drain is located at the mangrove line shown in centre of photo.

5 DISCUSSION

5.1 Before Bed Levelling Operations

The measurements of baseline turbidity and water samples for the analysis of suspended solids were collected during low current conditions, approximately one hour after low water. As shown in Figure 3.2 and Table 5.1, the snapshot levels of baseline turbidity prior to bed levelling operations were relatively low, ranging from 2-5 NTU at the water surface (1 m depth) to typically 6-7 NTU close to the bed (9 m depth).

Table 5.1 Summary of Snapshot levels of Baseline Turbidity (NTU) – Incitec North Wharf – 17/7/2002.

Statistics	Depth		
	1m	*5m*	*9m*
Maximum	5	6	8
Minimum	2	3	5
80th percentile	4	5	7
Median	3	5	7
20th percentile	3	4	6
n	46	46	46

Aerial photography (refer to Plate 2) taken prior to bed levelling did not indicate any significant visible turbid water plumes offshore from the face of the wharf at the surface. The analysis of water samples yielded a corresponding low range of suspended solids. The suspended solids were 7 to 10 mg/L near the water surface (1 m depth) and 12-14 mg/L adjacent to the bed (9 m depth).

The texture of bed sediments adjacent to the wharf face summarised in Figure 3.3 shows a mixture of sand, silt and clay as the dominant sediment types adjacent to the wharf. The particle size distribution of sediments from samples 1 and 2 generally displayed low percentages (8%) of coarse material (gravel: 2-60 mm). Sample 1 from the upstream end of the berth, tended to have a higher proportion of fine material (38% clay: 0.0002-0.002 mm and 22% silt: 0.002-0.02 mm), with approximately 40% of the sample being smaller than 2.9 microns, whereas Sample 2 from the downstream end of the berth was predominantly sand (52%: 0.02-2 mm) with the remaining 40% of the particles being smaller than 0.075 mm. Therefore, although there was some variation along the length of the wharf, the material to be levelled generally contained high percentages of fine (silt and clay) material capable of being resuspended into the surrounding water column.

5.2 During Bed Levelling Operations

Levels of turbidity measured during bed levelling operations were variable and depended upon the time of operation, the water depth and location. The results of water turbidity measurements illustrated in Figure 3.5 for survey vessel tracks 3 - 9, capture the range of turbidity associated with passes 4 - 15 of the bed levelling equipment. Of the 15 passes conducted by the bed leveller, turbidity measurements were not collected on Passes 1 - 3, (to allow for the development of associated plume conditions) nor subsequently on passes 5, 7, 9 and 11 due to time constraints.

Due to the variability in the measured turbidity at all depths during bed levelling, the range of measurements and summary statistics covering measurements from all 9 survey vessel tracks are shown in Table 5.2 below.

Table 5.2 Summary of levels of Turbidity during Bed Levelling Operations (NTU) – Incitec North Wharf –17/7/2002.

Statistics	Depth		
	1m	*5m*	*9m*
Maximum	9	49	69
Minimum	2	3	4
80th percentile	3	6	28
Median	3	4	8
20th percentile	2	3	6
n	119	119	119

The levels presented within Table 5.2 were measured immediately down current (i.e. upstream) of the bed levelling equipment and are, therefore, considered to be representative of the maximum levels generated by the bed levelling operation. The peak turbidity levels were approximately 12 NTU at the water surface (1 m depth), increasing to 69 NTU adjacent to the seabed (9 m depth).

Thus, levels of turbidity within the plume associated with bed levelling operations were greater than those recorded prior to the commencement of works (refer to Section 5.1), although the maximum levels and the relative size of the plume at the surface (approximate dimensions of 120 m long by 30 m wide) were not particularly elevated or large when compared with levels of turbidity measured previously during other dredging operations (WBM Oceanics Australia, 2002) or the plumes evident from shipping traffic in adjacent areas of the Port (refer to Plate 6). It appears, therefore, that the comparative size and density of the turbid plumes generated by bed levelling is at the small end of the scale of plumes associated with other standard port related activities (e.g. dredging, approach and docking manoeuvres of ships and tugs).

The possible impact of different modes or patterns of operation of the bed levelling equipment was not investigated in this study, though it was apparent that the smooth progression of the bed levelling equipment along the quayline seemed to result in lower turbidity levels than those resulting from occasional stop/start movements.

5.3 Post Bed Levelling Operations

The levels of turbidity measured after the cessation of bed levelling were based upon survey vessel tracks 10 and 11, which followed the course of the residual turbid plume as identified by a surface marker float and drogue. The summary turbidity statistics for each track are presented in Table 5.3 and Table 5.4.

Table 5.3 Summary of levels of Turbidity (NTU) After Bed Levelling Operations– Survey Track 10 Upstream of Incitec North Wharf –17/7/2002.

Statistics	Depth		
	1m	*5m*	*9m*
Maximum	12	10	18
Minimum	2	3	7
80th percentile	3	6	14
Median	3	4	12
20th percentile	2	3	10
n	52	52	52

Table 5.4 Summary of levels of Turbidity (NTU) After Bed Levelling Operations – Survey Vessel Track 11, Upstream of Incitec North Wharf –17/7/2002.

Statistics	Depth		
	1m	*5m*	*9m*
Maximum	3	12	16
Minimum	2	3	6
80th percentile	3	8	14
Median	3	4	13
20th percentile	2	3	10
n	30	30	30

These statistics indicate a rapid reduction in the plume intensity with time, such that approximately 20 minutes after the cessation of bed levelling, it became difficult to discern any obvious surface plume adjoining the drogue location. The summary statistics for survey vessel track 11 support this observation, since the surface (1 m depth) turbidity had reduced to baseline levels. It was apparent from the output of the deeper turbidity sensors (refer to Figure 3.6 and Table 5.4) that the turbidity remained elevated above the baseline levels at mid-depth and close to the seabed. However, because of the proximity of the drogue assembly to the Pinkenba Bulk wharf and the inability to retrieve any further data once the plume met the wharf structure, monitoring of the residual plume was discontinued, approximately 20 minutes after the cessation of bed levelling activities. Shortly after retrieval of the drogue, and approximately 25 minutes after the conclusion of bed levelling, a further two pairs of water samples from the surface and near bed were collected for suspended solids analysis. The analysis results for these samples (refer to Figure 3.4) show very similar concentrations of suspended solids to the baseline water samples.

As illustrated in Plate 7 to Plate 9, a visible plume of turbid water was evident in shoal water close to shore just downstream of the Pinkenba Bulk wharf. This plume was not related to the operation of the bed leveller, but was due to a drain discharge located approximately 100 m downstream of the Pinkenba Bulk Wharf.

6 CONCLUSIONS

Based upon the normal operation of the Port of Brisbane bed levelling equipment at the Incitec North Wharf on the 17th July 2002, the following observations and conclusions are made with respect to the extent and movement of the turbid plumes generated by this equipment.

- The sediment to be relocated at the Incitec North Wharf comprised mainly a mixture of sand, silt and clay, with a relatively high proportion of fine material (40 - 60% silt and clay) likely to be become resuspended during bed levelling.
- At the water surface, the spatial scale of the turbid plume generated by bed levelling appeared to be relatively small, having a maximum visible length of between approximately 120 – 150 m and an approximate width of 30 m at any given time. The plume appeared to be generated as a series of turbid pulses associated with each pass of the bed levelling equipment.
- Though no particular measurements were made to differentiate between different modes of operation, it appeared that a smooth progressive grading of sediments from the wharf face resulted in lower surface turbidity than did stop/start levelling operations, occasionally required when the blade became fouled or embedded too deeply adjacent to the wharf face.
- Greatest levels of turbidity measured during bed levelling operations were approximately 10 NTU near the water surface and 70 NTU adjacent to the seabed. Prior to the commencement of works, levels at the surface and adjacent to the seabed were approximately 5 and 10 NTU, respectively. The turbid plume associated with bed levelling was no longer visible from the survey vessel after approximately 20 minutes and was not visible from the helicopter as viewed some 25 minutes after the conclusion of bed levelling operations.
- Levels of turbidity at the water surface were comparable with the snapshot baseline levels (typically less than 5 NTU) approximately 20 minutes after the conclusion of bed levelling. Concentrations of suspended solids near the surface and seabed were comparable with baseline concentrations approximately 25 minutes after the cessation of bed levelling operations.
- The extent of the plume of turbid water produced by bed levelling appeared to be less than that resulting from nearby ship berthing operations and associated tug movements or from dredging operations, which have been reviewed previously on behalf of the Corporation.
- Whilst levels of turbidity were generally within acceptable limits at the water surface, elevated levels were recorded adjacent to the seabed and it is possible that these levels may have short term effects on biota such as benthic invertebrates living on or in the sediments or smaller, sedentary species of fish. These effects, however, are not considered to be ecologically significant given the range and frequency of disturbances, both natural and those associated with the maintenance of the Brisbane River as commercial port, which currently occur in the area. Therefore, any short-term effects associated with this type of operation would be considered as minimal and potentially less impacting than other forms of dredging.
- Whilst analysis of contaminants resuspended during bed levelling activities was not undertaken during the current study, the limited extent and short duration of sediment re-suspension observed would indicate that potential for remobilisation of contaminants is low. Further, bed levelling activities are used as part of the overall dredging strategy, with material relocated to designated areas to be removed by the Corporations dredging plant and subsequently relocated.

The Port conducts an annual Sediment Sampling and Analysis program to determine sediment contamination status. Material that exceeds the National Ocean Disposal Screening Limit Guidelines in any contaminant is placed within designated areas, such as the Fisherman Islands reclamation. As such the overall potential for bed levelling activities to distribute contaminants is negligible.

7 REFERENCES

WBM Oceanics Australia (2002) Comparison of Turbidity Concentrations resulting from Dredging at the Bar Cutting. Prepared for the Port of Brisbane Corporation.

APPENDIX A: LABORATORY ANALYSIS RESULTS

0 7 AUG 2002

CERTIFICATE OF ANALYSIS

CONTACT:	MR C MORGAN	**BATCH:**	EB47364
CLIENT:	WBM PTY LTD	**SUB BATCH:**	0
ADDRESS:	P O BOX 203 SPRING HILL QLD 4004	**LABORATORY:**	BRISBANE
		DATE RECEIVED:	17/07/2002
		DATE COMPLETED:	23/07/2002
		SAMPLE TYPE:	MARINE WATER
ORDER No.:	PORT OF BRISBANE	**No. of SAMPLES:**	8
PROJECT:	BED LEVELLING		

COMMENTS

Results apply to sample(s) as submitted.

NOTES

This is the Final Report and supersedes any preliminary reports with this batch number.
All pages of this report have been checked and approved for release.

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Signatory

Batch: EB47364
Sub Batch: 0
Date of Issue: 23/07/2002
Client: WBM PTY LTD
Client Reference: BED LEVELLING

CERTIFICATE OF ANALYSIS

				SAMPLE IDENTIFICATION									
		Laboratory I.D.		3	4	5	6	7	8	9	10		
		Date Sampled		17/07/2002	17/07/2002	17/07/2002	17/07/2002	17/07/2002	17/07/2002	17/07/2002	17/07/2002		
METHOD	ANALYSIS DESCRIPTION	UNIT	LOR	1	2	3	4	5	6	7	8		
EA-025	Suspended Solids (SS)	mg/L	1	7	14	10	12	7	8	13	14		

Batch: EB47364
Sub Batch: 0
Date of Issue: 23/07/2002
Client: WBM PTY LTD
Client Reference: BED LEVELLING

QUALITY CONTROL REPORT

METHOD	ANALYSIS DESCRIPTION	UNIT	LOR	SAMPLE IDENTIFICATION									
	Laboratory I.D.			200	201								
	Date Sampled			17/07/2002	17/07/2002								
				Method Blank 1	Inorg 1 LCS % Rec								
				CHECKS AND SPIKES									
EA-025	Suspended Solids (SS)	mg/L	1	<1	96.0%								

EARTHTECH LABORATORIES
SOILS & MATERIALS TESTING

EARTHTECH CONSULTANTS (QLD) Pty Ltd
NATA No. 1446
ACN 010 826 561

1/51 Secam Street, Mansfield Qld
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Phone: (07) 3343 3166
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Website: www.earthtech.com.au

NF/mai

Job No MA0999

31 July 2002

Australian Laboratory Services
PO Box 66
EVERTON PARK QLD 4053

ATTENTION: Mr G Lecornu

Dear Sir,

RE: LABORATORY TESTING – Batch No EB47364

Please find herewith results of Hydrometer Testing on the two samples delivered to our Laboratory on the 19th July 2002.

Yours faithfully
EARTHTECH LABORATORIES

NICK FARRER
SENIOR TECHNICAL OFFICER

Enc:

EARTHTECH LABORATORIES
Geotechnical and Environmental Soils and Materials Testing

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TEST RESULTS

Client : Australian Laboratory Services Pty Ltd
Project : Delivered Samples
Batch No. : EB 47364

Job No : MA-0999
Date Received: 19/07/02
Sampled By : Client

SUMMARY OF TEST RESULTS

Reg'n No.	Sample ID	Gravel (60 - 2 mm)	Sand (2 - 0.06 mm)	Silt (0.06 - 0.002 mm)	Clay (> 0.002 mm)
L0961/02	Berth 1	8	32	22	38
L0962/02	Berth 2	8	52	14	26

Remarks : Table shows percentage of total sample between sizes shown.

Test Procedure : AS 1289 3.6.1

Prepared by NF | Checked by GM4(

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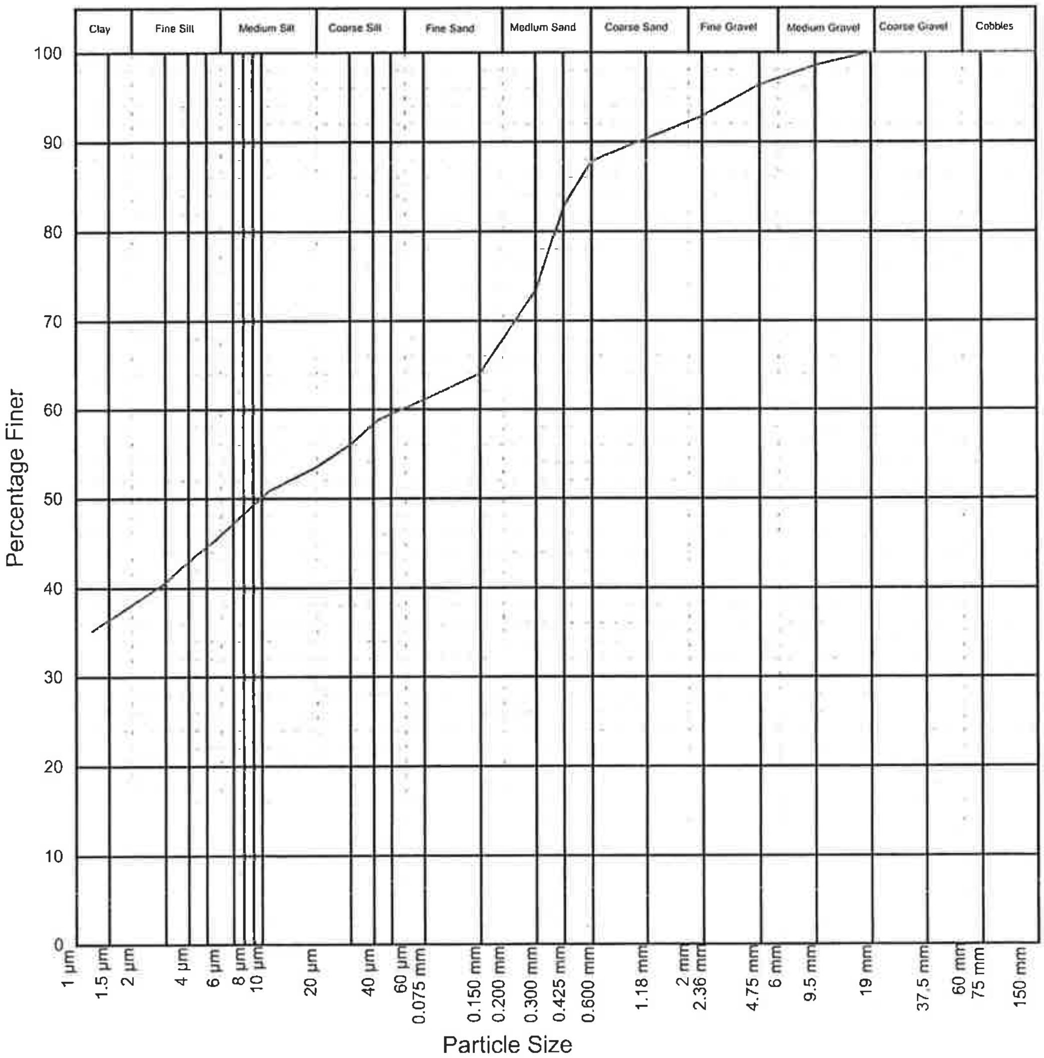
Website: www.earthtech.com.au

PARTICLE SIZE DISTRIBUTION BY HYDROMETER

Client :	ALS Environmental Brisbane	Report No. :	R5160
Address :	32 Shand Street, Stafford	Job No. :	MA-0999
Project :	Delivered Samples	Reg'n No. :	L0961/02
Sample ID :	Berth 1	Batch No. :	EB 47364 - 1
		Date Received :	19/07/2002
		Sampled By :	Client

SIZE FRACTIONS AS PER AUSTRALIAN STANDARDS AS 1726

Particle Size (mm)	Percent Passing
150	
75	
37.5	
19.0	100.0
9.5	98.5
4.75	96.3
2.36	92.8
1.18	90.4
0.600	87.8
0.425	82.6
0.300	73.3
0.150	64.0
0.075	61.1
Particle Size (Microns)	**Percent Passing**
42.7	58.8
30.7	56.1
19.7	53.5
10.9	50.8
7.9	48.1
5.7	45.5
4.0	43.0
2.9	40.3
1.2	35.2



Pretreatment	Tested as received	Soil Particle Density (assumed)	2.70
Loss in Pretreatment (%)	-	Type of Hydrometer	ASTM E100
Method of Dispersion	Mixer		

Material Description :	Sandy CLAY (CI) dark grey
Test Procedure :	AS 1289 3.6.2, 3.6.3 (up to 24 hours)
Prepared by : NF	Checked by : GCMK

NATA 1446

N Turner 26/7/2
Authorised Signatory

EARTHTECH LABORATORIES
Geotechnical and Environmental Soils and Materials Testing

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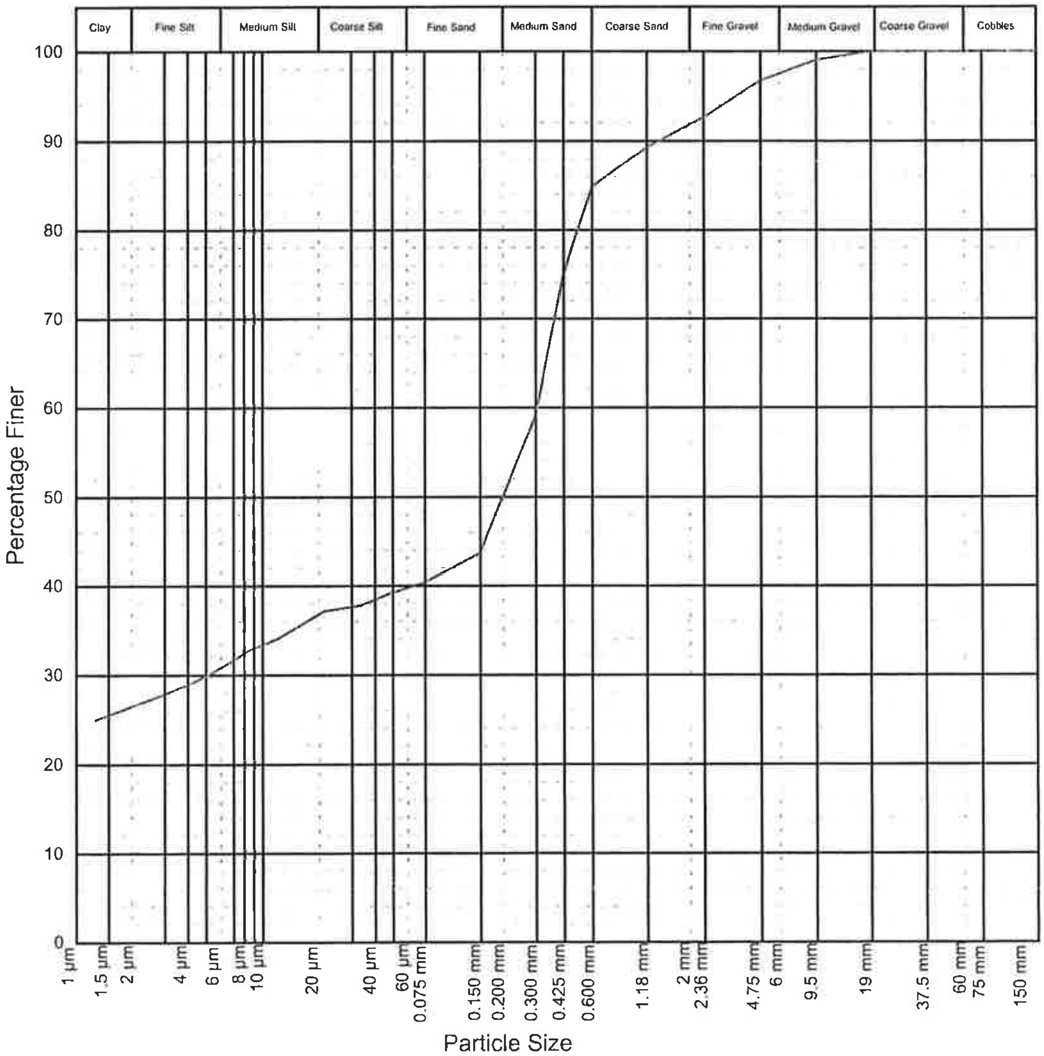
Website: www.earthtech.com.au

PARTICLE SIZE DISTRIBUTION BY HYDROMETER

Client :	ALS Environmental Brisbane	Report No. :	R5160
Address :	32 Shand Street, Stafford	Job No. :	MA-0999
Project :	Delivered Samples	Reg'n No. :	L0962/02
Sample ID :	Berth 2	Batch No. :	EB 47364 - 2
		Date Received :	19/07/2002
		Sampled By :	Client

SIZE FRACTIONS AS PER AUSTRALIAN STANDARDS AS 1726

Particle Size (mm)	Percent Passing
150	
75	
37.5	
19.0	100.0
9.5	99.0
4.75	96.7
2.36	92.6
1.18	89.3
0.600	84.8
0.425	75.1
0.300	59.1
0.150	43.7
0.075	40.4
Particle Size (Microns)	**Percent Passing**
47.2	39.1
33.6	37.8
21.3	37.2
12.0	34.0
8.5	32.8
6.1	30.9
4.3	29.2
3.1	27.9
1.3	25.0



Pretreatment	Tested as received	Soil Particle Density (assumed)	2.70
Loss in Pretreatment (%)	-	Type of Hydrometer	ASTM E100
Method of Dispersion	Mixer		

Material Description :	Clayey SAND (SC) dark grey
Test Procedure :	AS 1289 3.6.2, 3.6.3 (up to 24 hours)
Prepared by : NF	Checked by : [illegible]

NATA 1446

[signature] 26/7/2
Authorised Signatory

APPENDIX B: TURBIDITY INSTRUMENT SENSOR SPECIFICATIONS AND TRIAL RESULTS.

The turbidity sensors assembled for this project consisted of three Greenspan Model TS100 sensors. The optical geometry and infrared wavelength of these sensors conform to ISO 7027 "Turbidity measurement by attenuated radiation". Whilst of the same design, each sensor was manufactured to measure a different turbidity range. The upper sensor (1m depth) was capable of measurements in the range 0-100NTU. The mid-depth sensor (5m depth) was capable of measurements in the range 0-250NTU, whilst the lower sensor (9m depth) had a measurement range of 0-500NTU.

To verify the relative accuracy of the sensors, each was individually check calibrated in approximately 20L of a 90NTU formazin solution. The results for each sensor were within +/- 7% of the prepared standard solution (refer to Table B. 1 below). Please note that the 90-NTU standard was prepared as a dilution of a 4000NTU standard and therefore there may have been some inaccuracies in the preparation of the solution.

Table B. 1 Sensor Calibration Records

Sensor	**Measured Turbidity of 90NTU Formazin solution.** **(Average of 12 readings over 2 minutes)**
Upper (0-100NTU)	84
Middle (0-250NTU)	86
Lower (0-500NTU)	87

The sensor calibration demonstrated an approximate 3NTU difference between the upper and lower sensors within the 90NTU formazin solution.

Because of the size of the sensors and the difficulty in reducing visible edge effects for laboratory calibration of each sensor in clear (0.0NTU) water, the stability and precision of each sensor relative to the other was field checked within Breakfast Creek. The sensors were immersed side by side at a depth of 0.2 m in comparatively low turbidity water. It was evident from the results that the higher range (250 and 500 NTU) sensors were slightly less sensitive to small fluctuations and probably less precise at the lower turbidity range. Within Breakfast Creek there was an approximate 2NTU reading difference between the upper (100 NTU range sensor) and the lower (500NTU range) sensor. Although there were some small differences in sensor output for both the laboratory check calibration and the Breakfast Creek field comparison, these differences were considered to be sufficiently small for a study investigating comparatively high turbidity levels.

Once configured as towfish on the weighted line, the sensors were field tested to check their orientation and operation during slow speed towing at the depths required for the project. This trial was conducted in Moreton Bay within the Port of Brisbane entrance channel adjoining the Coffee Pots. The results from each field test are shown below in **Error! Reference source not found.**.

Figure B. 1 Field Test Results for the Turbidity Sensors.