

MTR Corporation Limited

HONG KONG SECTION OF GUANGZHOU –
SHENZHEN – HONG KONG EXPRESS RAIL LINK
(No. EP-349/2009/B)

Groundwater Drawdown Contingency Plan for
Mai Po to Ngau Tam Mei Tunnels (Rev 2)

Verified by:	
Position:	<u>Independent Environmental Checker</u>
Date:	<u>18 March 2011</u>

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(No. EP-349/2009/B)

Groundwater Drawdown Contingency Plan for
Mai Po to Ngau Tam Mei Tunnels (Rev 2)

Certified by: Glenn Frommer

Position: Environmental Team Leader

Date: 16 MAR 2011

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GW Drawdown Contingency Plan	Ref: CVL/GWCP/908	Revision: 3	
Express Rail Link Contract No. 825 – Mai Po To Ngau Tam Mei Tunnels			Page: 1 of 15

Groundwater Drawdown Contingency Plan

For

Mai Po To Ngau Tam Mei Tunnels

Contract No. 825

Control Copy No.
Issued to

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Date	Status	Prepared and Reviewed By:	Approved By:
		Environmental Officer	Sr. Project Manager
14 March 2011	Issue for Construction	 M.H. Isa	 T. Nakayama

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1. PROJECT SPECIFICS

1.1 General

The Construction period for the excavation of shaft & tunnel tentatively start from May 2010 to End Mar 2015.

This Plan is prepared in compliance with the Environmental Permit Condition 2.11.

1.2 Project Description

The Works to be executed under this project comprises but not exclusively, the following major items:-

- (a) The northbound and southbound tunnels from Mai Po Ventilation Building (VB1) to the Ngau Tam Mei Ventilation Building (VB2);
- (b) A TBM launch shaft at VB1, which also serves as a TBM launch shaft for Contract 826;
- (c) Cross-passages between the two tunnels;
- (d) Site formation at the Mai Po Ventilation Building site;
- (e) The Mai Po Ventilation Building and associated ventilation shaft, including ABWF Works;
- (f) External works including access roads, landscaping and utility services at the Mai Po Ventilation Building;
- (g) Provision for Designated Contracts;
- (h) Earth mats;
- (i) Temporary accommodation for the Engineer; and
- (j) A temporary barging facility at Siu Lam including various facilities for the explosives unloading point.

Our Contract 825 works area has been demarcated in Drawing No. 825/C/320/POC/T02/101 (attached).

1.3 General Overview of the Potential Groundwater Drawdown Risks

With reference to Section 5 of the updated HIA report for Tunnel (North) deposited under EP Condition 2.10 and Section 3 of the approved EIA report, the hydrostatic pressure is effectively supported by the pressure maintained in front of the TBM head, only insignificant impact was identified due to TBM operation. The un-drained design of TBM lining would not cause any groundwater drawdown after installation of lining. Refer to the SEEP/W assessment of Excavation And Lateral Support System (ELS) design which is attached in Appendix III of this Plan, there is no hydrogeological impact due to excavation works anticipated at the nearby fishpond located 110m away from the shaft. Nonetheless, groundwater monitoring with contingency actions in case of exceedance would be implemented as recommended under the EIA and HIA reports.

2. GROUNDWATER DRAWDOWN CONTINGENCY PLAN

Groundwater (GW) monitoring shall be undertaken in accordance with the approved drawings for monitoring works, and a monthly monitoring report presenting daily records of groundwater level and analysis for the variation shall be submitted to the Engineer (MTRCL). Any recommendations made and remedial actions taken in controlling the groundwater should also be documented in the monthly report.

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Furthermore, regular monitoring work would be conducted and contingency actions under AAA would be carried out in order to closely monitor the ground water drawdown due to the works.

There are two main works for the project. Namely, Mai Po Ventilation Shaft (MPV) and tunnels to Ngau Tam Mei.

It is anticipated that MPV will entirely be in soft ground. The shaft excavation will only require temporary dewatering during their construction.

Where shaft excavation takes place through Grade III rock, temporary support shall be installed to stabilise the rock mass. The permanent lining of the shaft shall consist of cast in place concrete backed by waterproofing membrane and geotextile.

The tunnels will be designed as twin single bores using TBM. The permanent ground support will be in the form of an undrained precast reinforced concrete segmental lining providing immediate ground support and any overcut annulus will be back-grouted as TBM advance forwards.

Hydrostatic head can be effectively supported by the pressure maintained in the front of TBM head which reduces groundwater losses at the TBM face. As a consequence groundwater drawdown due to TBM tunnel excavation is expected to be insignificant and ground settlement induces by groundwater drawdown is considered negligible. As the TBM bored tunnel lining will be designed as undrained, groundwater drawdown after installation of permanent lining should not arise.

2.1 General Requirements

- All necessary actions shall be taken to ensure that the works will not adversely affect the fish pond and the utilities in the close proximity of the site;
- Prior to the commencement of construction works, base readings of all monitoring instruments shall be established and agreed with the Engineer (MTRCL). A set of initial readings of all monitoring instruments shall be submitted to the Engineer (MTRCL) for record purpose;
- During the construction works, the piezometers and standpipe shall be monitored daily or more frequently as required by the Engineer (MTRCL);
- Whenever, a significant difference between successive readings is observed / recorded, the Engineer (MTRCL) will be informed;
- The Engineer (MTRCL) would inform Agriculture, Fisheries and Conservation Department (AFCD) of the start of excavation;
- A complete set of monitoring records including plots of readings versus time shall be continuously updated and kept on site and made available for inspection upon request by the Engineer (MTRCL) / local authority; and
- Penta-Ocean Construction Co., Ltd. (POC) shall be responsible for the maintenance of the monitoring points during the construction works. Any damaged instruments shall be repaired / reinstated or replaced as directed by the Engineer (MTRCL) or his representative on site.

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3. MONITORING LOCATIONS AND FREQUENCY

Locations for the standpipes / piezometers were provided in Drawing No. 825/C/320/POC/T02/101 (attached). GW monitoring would be conducted surrounding the excavation shaft for monitoring of the GW drawdown.

Summary of standpipes / piezometers are:

Instrument No.	Location	Monitoring Frequency
ABH1	Beyond Site Boundary	Daily (During excavation for tunnel)
ABH2	Within Site Boundary	
ABH3	Within Site Boundary	
ABH4-P	Within Site Boundary	
ABH24	Within Site Boundary	
ABH25-PU	Within Site Boundary	
ABH25-PL	Within Site Boundary	
ABH26-P	Within Site Boundary	
ABH29	Beyond Site Boundary	
BH1-P	Within Site Boundary	
BH1-S	Within Site Boundary	
BH4-A	Within Site Boundary	
BH4-B	Within Site Boundary	
BH5-A	Beyond Site Boundary	
BH5-B	Beyond Site Boundary	
D254-P	Within Site Boundary	
D254-S	Within Site Boundary	
D256-P	Within Site Boundary	
D256-S	Within Site Boundary	
D257	Within Site Boundary	
D258	Within Site Boundary	
EDH18-P	Beyond Site Boundary	
EDH18-S	Beyond Site Boundary	

4. ALERT, ACTION AND ALARM LEVEL (AAA) AND EMERGENCY RESPONSE

With reference to Drawing No. 825/C/320/POC/T02/100 (attached), the AAA response values for the water table (lowest groundwater level) are shown below:

Monitoring Point		Alert	Action	Alarm
All Piezometers / Standpipes (Groundwater Drawdown)	Within Works Area Boundary	9500mm with reference to Lowest Historical Groundwater Level	10500mm with reference to Lowest Historical Groundwater Level	11500mm with reference to Lowest Historical Groundwater Level
	Outside Works Area Boundary	500mm with reference to Lowest Historical Groundwater Level	800mm with reference to Lowest Historical Groundwater Level	1000mm with reference to Lowest Historical Groundwater Level

Note: This table is taken from Drawing No. 825/C/320/POC/T02/100

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4.1 Alert Level Exceedance

- (a) POC shall inform the Engineer (MTRCL) immediately;
- (b) POC shall immediately submit a written report to the Engineer (MTRCL) before Action Level status is reached. The report will also include actions to be implemented for reaching the Alert Level and Action Level;
- (c) POC shall implement the “Response Actions” identified in the report for reaching Alert Level;
- (d) Where it is considered and agreed by the Engineer (MTRCL) that movement trends indicate that “action level” may also be reached during the course of works, POC shall implement the “Response Actions” for reaching action level to limit further movement.

4.2 Action Level Exceedance

- (a) POC shall inform the Engineer (MTRCL) immediately;
- (b) POC will implement the “Response Actions” for reaching Action Level to limit further excavation-induced structure/building, railway, roads, footpath, slope, utilities and ground movements and change in groundwater and piezometric levels, and to control vibrations, to maintain the structural integrity of adjacent structures/buildings and utilities and to carry out additional support measures where necessary;
- (c) POC shall take all necessary steps so that the Alarm Level is not reached;
- (d) Works may only proceed if the Response Actions have been implemented and are effective in the opinion of the Engineer (MTRCL);
- (e) POC shall make appropriate amendments to the report submitted at Alert Level stage, where necessary.

4.3 Alarm Level Exceedance

- (a) POC shall inform the Engineer (MTRCL) immediately and the Engineer (MTRCL) will inform AFCD;
- (b) POC to implement emergency Response Actions to diminish the deformations and ground responses including the suspension of works;
- (c) POC shall submit a complete report to review of the construction methods, full history of the movements and Response Actions to be taken related to construction sequence for the Engineer (MTRCL) Approval. The Engineer (MTRCL) to provide an interim report to AFCD within 3 working days;
- (d) Works may only resume upon the written instruction of the Engineer (MTRCL);
- (e) Alarm Level exceedance and the Response Actions implemented would be included in the monthly EM&A report to EPD.

4.4 Monitoring and Reporting Team

- (a) The contact of monitoring and reporting team of POC is shown below. The Sr. Construction Manager (SCM) will be the key contact person in relation to groundwater issues during tunnelling works. The Environmental Officer (EO) will be responsible to see that the Sr. Engineer (SE) implement the monitoring programme

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and check the compliance with the project's environmental requirements during construction;

(b) The SE will also monitor the mitigation measures implemented by POC on a regular basis to check compliance with the intended aims of the measures. The duties and responsibilities of SE under this Plan are:

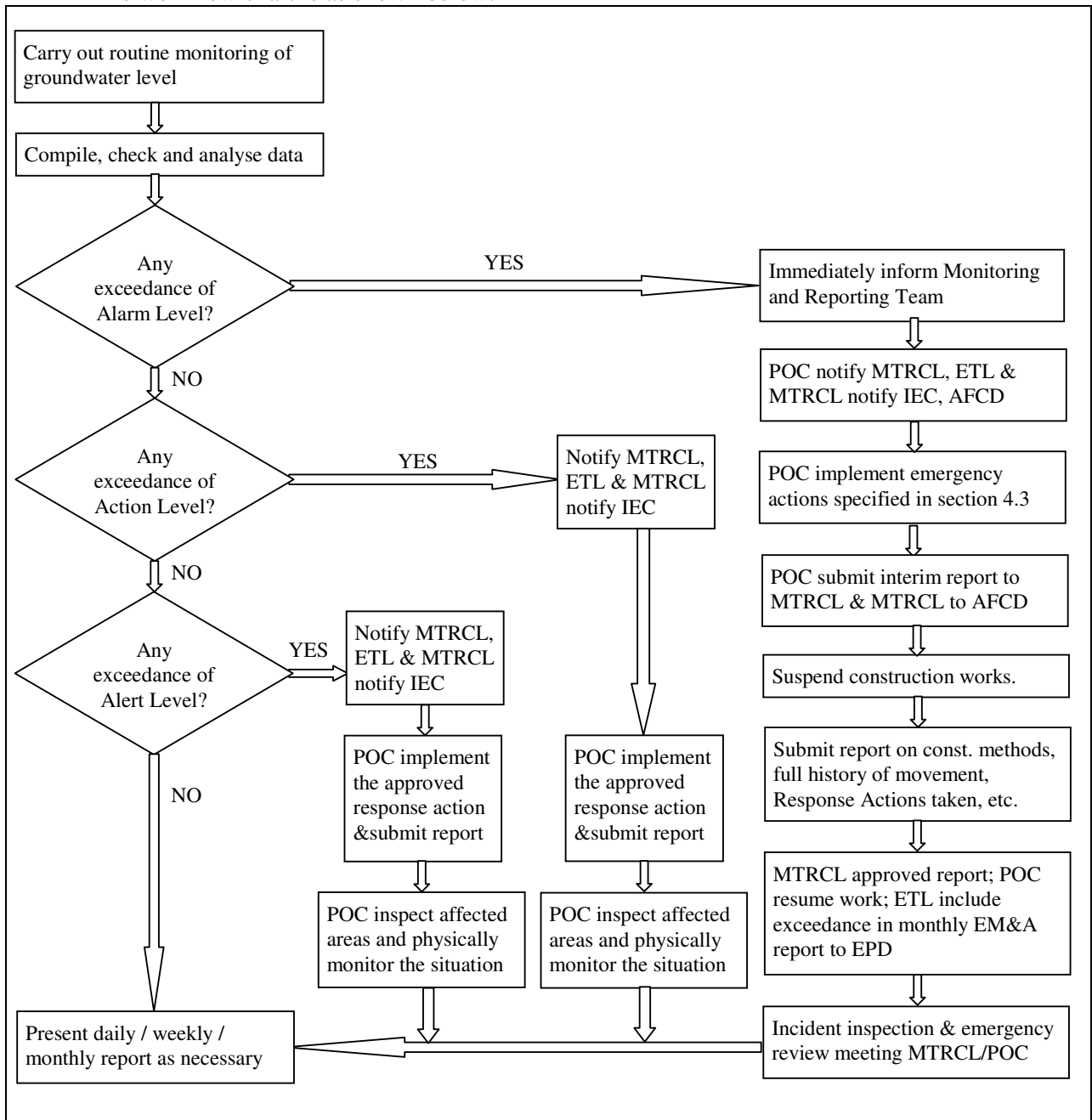
- Supervise monitoring as required in this Plan;
- Carry out regular site inspection to record the activities conducted;
- Analysis the monitoring data, review the success of monitoring programme to confirm the adequacy of mitigation measures implemented;
- Provide monthly monitoring record to the Mass Transit Railway Corporation Ltd. (MTRCL); and
- Review Response Actions proposal with the SCM in the case of exceedance of AAA Levels.

(c) The Sr. Construction Manager (SCM) will assist in the investigation and be responsible to identify the possible mitigation measures for alleviating the impact on groundwater/fish ponds, if any.

Name	Position	Contact No.
T. Nakayama	Sr. Project Manager	9864-4906
Philip Boothroyd	Project Director	9309-1392
S. Koketsu	Sr. Construction Manager	9864-4907
E. Yamaguchi	Sr. Construction Manager	9864-4908
I. Amino	TBM Manager	9864-4331
T. Seki	Sr. Civil Manager	9723-4500
N. Sakamoto	Civil Manager (Tunnel)	9866-1078
Y. Matsuda	Deputy Civil Manager (Tunnel)	9864-4332
S. Kawasaki	TBM Engineer	9864 4088
Eric Lee	Sr. Engineer	9723-4725
Tracy Chung	Sr. Engineer	9723-4720
Josh Liu	Sr. Engineer	9723-4502
M.C. Fan	Sr. Engineer	9723-4672
Michelle Kwan	Sr. Engineer	9723-4503
Y.W. Cheung	Superintendent	9723-4721
M.H. Isa	Environmental Officer	9884-0810

4.5 Workflow Chart

The workflow chart is as shown below.



Abbreviations: MTRCL – Mass Transit Railway Corporation Ltd.; ETL – Environmental Team Leader; IEC – Independent Environmental Checker; POC – Penta-Ocean Construction Co. Ltd.; AFCD – Agriculture, Fisheries and Conservation Department; EM&A – Environmental Monitoring

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4.6 Mitigation Measures

As per Section 11 of the EIA report and Section 5 and 7 of the updated HIA report, mitigation measures to be carried out are summarized as below:

Cut-and-cover excavation

- Toe grouting should be applied beneath the toe level of the temporary/permanent cofferdam walls as necessary to lengthen the effective flow path of groundwater from outside and thus control the amount of water inflow to the excavation.
- Recharge wells shall be installed as necessary outside the excavation to pump water obtained from the excavation back into the ground.
- Subsequent to the completion of diaphragm wall construction and toe grouting and prior to the commencement of excavation work, a full scale pumping test will be undertaken to verify the water cut-off effectiveness and the effects of dewatering on adjacent structures.

TBM tunnelling

- Groundwater drawdown can effectively be reduced through ground treatment in the form of grouted canopy tubes drilled out from the segments to form an umbrella around the future excavation. Following pre-excavation grouting, construction activity is not expected to affect the existing local groundwater regime by more than 1m. The permanent cast-in-situ lining would be designed and constructed as undrained, therefore long term groundwater drawdown is not anticipated.

In case of AAA levels exceedance during construction of shaft or tunnelling, the Contractor shall inform both the Engineer and their design consultants immediately and submit plan of actions enclosing a series of actions (remedial measures) which would be taken to limit further groundwater level drawdown for the Engineer's review and approval. Generally speaking, local practice often be used to limit excessive groundwater drawdown include groundwater recharge, application of hydraulic cut-off measures and detailed review of construction sequence and/or works design if found necessary.

It should however be noted that the selection of mitigation measures would be reviewed on a case-by-case basis in view factors including effectiveness and applicability etc.

4.7 Monitoring of Ecological and Fisheries Impact

As per Ecological Monitoring Plan, the ecological monitoring would be carried out monthly during construction in the vicinity of Mai Po Ventilation Building Works Area. The monitoring area covers fishpond in the vicinity of the works area to ensure that any ecological and fisheries impacts due to groundwater drawdown is closely monitored. The number and abundance of avifauna species would be monitored during the ecological

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monitoring. For details of ecological monitoring, please refer to the approved Ecological Monitoring Plan. The findings of which would be reported in the monthly EM&A report and reviewed by the IEC.

5. CONCLUSION

Regular monitoring work would be conducted and weekly report submitted to MTRC under “Geotechnical Instrumentation Interpretative Report”. Monitoring would be carried out in order to closely monitor the ground water drawdown due to the works and contingency actions would be carried out if there is any exceedance.

LEGEND:

	EXISTING BUILDINGS AND STRUCTURES TO BE DEMOLISHED OR MODIFIED
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NOTES:

1. GENERAL NOTES AND MONITORING FREQUENCY AND TYPICAL DETAILS REFER TO DRAWING NOS. 825/C/230/C/067/100/100.
2. THE INSTRUMENTATION WILL BE CARRIED OUT IN PHASES. THE INSTRUMENTS SHOWING IN THIS DRAWING ARE FOR BACKGROUND MONITORING ON EXISTING PNEUMOTERS AND SETTLEMENT AND TILT POINTS ONLY. FURTHER INSTRUMENTS WILL BE PROPOSED, INSTALLED AND MONITORED AFTER REVIEW OF THE CONDITION SURVEY. INSTRUMENTATION PLANS FOR OTHER PHASES WILL BE SUBMITTED UNDER SEPARATE COVER.
3. THE GEOTECHNICAL INSTRUMENTATION LAYOUT FOR PUMPING AND EXCAVATION OF SHAFT WILL BE SUBMITTED SEPARATELY.
4. THE ATPC INSTRUMENT NUMBERS SYSTEM WILL BE ADOPTED AS SHOWN IN TABLES. FILL NAME NOT SHOWN ON PLAN FOR 100/100. (ATPC NUMBER SYSTEM REFER TO 825/C/30/C/067/100/100)

SETTING OUT TABLE FOR BUILDING SETTLEMENT POINT (BS-P)			INSTRUMENT NUMBERING SYSTEM	
POINT ID	EASTING	NORTHING		
BS-P-1	824138.13	836872.83	825-117534-BSP-1	
BS-P-2	824122.30	836861.31	825-117534-BSP-2	
BS-P-3	824121.48	836878.62	825-117522-BSP-3	
BS-P-4	824114.83	836862.05	825-117517-BSP-4	
BS-P-5	824106.21	836862.71	825-117515-BSP-5	
BS-P-6	824115.13	836861.96	825-117517-BSP-6	

POINT ID	EASTING	NORTHING	INSTRUMENT NUMBERING SYSTEM
TP-1	824135.74	838864.47	825-117545-TP-1
TP-2	824141.17	838870.63	825-117536-TP-2
TP-3	824125.68	838872.10	825-117530-TP-3
TP-4	824115.13	838881.96	825-117517-TP-4

SETTING OUT TABLE FOR ROUND SETTLEMENT		INSTRUMENT RUBEENS SYSTEM	
POINT ID	EASTING	NORTHING	INSTRUMENT RUBEENS SYSTEM
GPS-01	826400.49	836668.67	825-1716-63P-26
GPS-02	824022.41	836683.11	825-1716-63P-27
GPS-03	826666.50	836625.10	825-1716-63P-28
GPS-04	826831.24	836631.35	825-1716-63P-29
GPS-05	826666.50	836631.35	825-1716-63P-30
GPS-06	826666.50	836631.35	825-1716-63P-31
GPS-07	826666.50	836631.35	825-1716-63P-32
GPS-08	826666.50	836631.35	825-1716-63P-33
GPS-09	826666.50	836631.35	825-1716-63P-34
GPS-10	826666.50	836631.35	825-1716-63P-35
GPS-11	826666.50	836631.35	825-1716-63P-36
GPS-12	826666.50	836631.35	825-1716-63P-37
GPS-13	826666.50	836631.35	825-1716-63P-38
GPS-14	826666.50	836631.35	825-1716-63P-39
GPS-15	826666.50	836631.35	825-1716-63P-40
GPS-16	826666.50	836631.35	825-1716-63P-41
GPS-17	826666.50	836631.35	825-1716-63P-42
GPS-18	826666.50	836631.35	825-1716-63P-43
GPS-19	826666.50	836631.35	825-1716-63P-44
GPS-20	826666.50	836631.35	825-1716-63P-45
GPS-21	826666.50	836631.35	825-1716-63P-46
GPS-22	826666.50	836631.35	825-1716-63P-47
GPS-23	826666.50	836631.35	825-1716-63P-48
GPS-24	826666.50	836631.35	825-1716-63P-49
GPS-25	826666.50	836631.35	825-1716-63P-50
GPS-26	826666.50	836631.35	825-1716-63P-51
GPS-27	826666.50	836631.35	825-1716-63P-52
GPS-28	826666.50	836631.35	825-1716-63P-53
GPS-29	826666.50	836631.35	825-1716-63P-54
GPS-30	826666.50	836631.35	825-1716-63P-55
GPS-31	826666.50	836631.35	825-1716-63P-56
GPS-32	826666.50	836631.35	825-1716-63P-57
GPS-33	826666.50	836631.35	825-1716-63P-58
GPS-34	826666.50	836631.35	825-1716-63P-59
GPS-35	826666.50	836631.35	825-1716-63P-60
GPS-36	826666.50	836631.35	825-1716-63P-61
GPS-37	826666.50	836631.35	825-1716-63P-62
GPS-38	826666.50	836631.35	825-1716-63P-63
GPS-39	826666.50	836631.35	825-1716-63P-64
GPS-40	826666.50	836631.35	825-1716-63P-65
GPS-41	826666.50	836631.35	825-1716-63P-66
GPS-42	826666.50	836631.35	825-1716-63P-67
GPS-43	826666.50	836631.35	825-1716-63P-68
GPS-44	826666.50	836631.35	825-1716-63P-69
GPS-45	826666.50	836631.35	825-1716-63P-70
GPS-46	826666.50	836631.35	825-1716-63P-71
GPS-47	826666.50	836631.35	825-1716-63P-72
GPS-48	826666.50	836631.35	825-1716-63P-73
GPS-49	826666.50	836631.35	825-1716-63P-74
GPS-50	826666.50	836631.35	825-1716-63P-75
GPS-51	826666.50	836631.35	825-1716-63P-76
GPS-52	826666.50	836631.35	825-1716-63P-77
GPS-53	826666.50	836631.35	825-1716-63P-78
GPS-54	826666.50	836631.35	825-1716-63P-79
GPS-55	826666.50	836631.35	825-1716-63P-80
GPS-56	826666.50	836631.35	825-1716-63P-81
GPS-57	826666.50	836631.35	825-1716-63P-82
GPS-58	826666.50	836631.35	825-1716-63P-83
GPS-59	826666.50	836631.35	825-17

Power ID	Eastings	Northings	Instrument Wavelength (m)
ABH1	823592.02	838019.51	825-17425.6-ABH1
ABH2	823600.55	838043.26	825-17425.6-ABH2
ABH3	823601.33	838050.56	825-17448.9-ABH3
ABH4	823625.43	838041.43	825-17452.6-ABH4
ABH5	823688.97	838030.03	825-17455.2-ABH5
ABH6	823690.96	838030.03	825-17455.2-ABH6
ABH7	823698.96	838031.43	825-17455.2-ABH7
ABH8	823698.96	838031.43	825-17455.2-ABH8
ABH9	823698.96	838031.43	825-17455.2-ABH9
ABH10	823698.96	838031.43	825-17455.2-ABH10
ABH11	823698.96	838031.43	825-17455.2-ABH11
ABH12	823698.96	838031.43	825-17455.2-ABH12
ABH13	823698.96	838031.43	825-17455.2-ABH13
ABH14	823698.96	838031.43	825-17455.2-ABH14
ABH15	823698.96	838031.43	825-17455.2-ABH15
ABH16	823698.96	838031.43	825-17455.2-ABH16
ABH17	823698.96	838031.43	825-17455.2-ABH17
ABH18	823698.96	838031.43	825-17455.2-ABH18
ABH19	823698.96	838031.43	825-17455.2-ABH19
ABH20	823698.96	838031.43	825-17455.2-ABH20
ED-H8	823698.96	838031.43	825-17455.2-ED-H8
D04	823698.96	838031.43	825-17455.2-D04
D06	823698.96	838031.43	825-17455.2-D06
D07	823698.96	838031.43	825-17455.2-D07
D08	823698.96	838031.43	825-17455.2-D08

PERIOD	EASTING	NORTHING	INSTRUMENT NUMBERS SYSTEM
BH1	624005.83	838697.95	825-117465-P-BH1-P
	624005.88	838697.97	825-117465-P-BH-S
BH4	624040.19	838693.45	825-117447-P-BH4-A
	624040.18	838693.45	825-117447-P-BH4-B
BH5	624006.12	838693.59	825-117395-P-BH5-A
	624006.12	838693.59	825-117395-P-BH5-B

[illegible]

Appendix I – Drawings (Cont’d)

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GROUNDWATER DRAWDOWN	9500mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL	10500mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL	11500mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL
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PIEZOMETRIC HEAD WITHIN THE EXCAVATION AT WALL TOE LEVEL (-45,000)	0.80 Pwp	0.90Pwp	Pwp

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4. RESPONSE TESTS SHALL BE CARRIED OUT FOR ALL STANDPIPES / PIEZOMETERS WITHIN 3 DAYS OF COMPLETION OF INSTALLATION, AND ON MONTHLY BASIS THEREAFTER. ANY MALFUNCTIONING SHALL BE REINSTATED OR REPLACED AS NECESSARY TO THE SATISFACTION OF THE ENGINEER.

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10. DRAFT MONITORING RESULTS WITHIN 24 HOURS WILL BE SUBMITTED AFTER THE READINGS ARE TAKEN. FORMAL MONITORING RESULTS SHALL BE SUBMITTED ON WEEKLY BASIS.

11. THE FOLLOWING INSTRUMENT NUMBERING SYSTEM WILL BE ADOPTED:

825-XXXXX-XXXX-XXX-XX

INSTRUMENT NUMBER

INSTRUMENT TYPE

STRUCTURE NUMBER IF ANY

SB CHAINAGE

CONTRACT NUMBER

12. ALL MONITORING RESULTS SHALL BE PRESENTED IN A FORMAT APPROVED BY THE ENGINEER, WHICH SHALL AT LEAST INCLUDE DATA AND PLOTS OF READINGS AGAINST TIME.

13. MONITORING WITHIN MONITORING ZONE V81 SHALL BE CARRIED OUT IN ACCORDANCE WITH THE FOLLOWING TABLE 1.

STRUCTURE / MONITORING POINT	ALERT	ACTION	ALARM
GROUND SETTLEMENT DUE TO WALL INSTALLATION	13mm	20mm	25mm
GROUND SETTLEMENT DUE TO DEWATERING	35mm	56mm	70mm
GROUND SETTLEMENT DUE TO EXCAVATION	53mm	84mm	105mm
TEMPORARY RETAINING WALL DEFLECTION	100mm	160mm	200mm
GROUND SETTLEMENT DUE TO SITE FORMATION	17mm	28mm	35mm
GROUNDWATER DRAWDOWN	9500mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL	10500mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL	11500mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL
OUTSIDE WORK AREA BOUNDARY	500mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL	800mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL	1000mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL
TEMPORARY STRUT FORCE (WHERE BY ULTIMATE CAPACITY OF THE STRUT)	0.50Py	0.70Py	0.80Py
PIEZOMETRIC HEAD WITHIN THE EXCAVATION AT WALL TOE LEVEL (-45,000)	0.80 Pwp	0.90Pwp	Pwp

Pwp = $\gamma_w Z + 3.8H$

WHERE γ_w (kN/m³) = UNIT WEIGHT OF WATER =10

Z (m) = DEWATERING LEVEL – WALL TOE LEVEL (-45,000)

H (m) = HIGHEST DESIGN GROUNDWATER LEVEL (-44,100) – DEWATERING LEVEL

NOTES ON MONITORING :

1. PRIOR TO THE INSTALLATION OF ALL MONITORING INSTRUMENTS, THE EXACT EXTENT AND QUANTITY OF MONITORING AND INSTRUMENTATION SHALL BE DETERMINED BASED ON THE CONDTION SURVEY RESULT.

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OUTSIDE WORK AREA BOUNDARY	500mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL	800mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL	1000mm WITH REFERENCE TO LOWEST HISTORICAL GROUNDWATER LEVEL
TEMPORARY STRUT FORCE (WHERE BY ULTIMATE CAPACITY OF THE STRUT)	0.50Py	0.70Py	0.80Py
PIEZOMETRIC HEAD WITHIN THE EXCAVATION AT WALL TOE LEVEL (-45,000)	0.80 Pwp	0.90Pwp	Pwp

Pwp = $\gamma_w Z + 3.8H$

WHERE γ_w (kN/m³) = UNIT WEIGHT OF WATER =10

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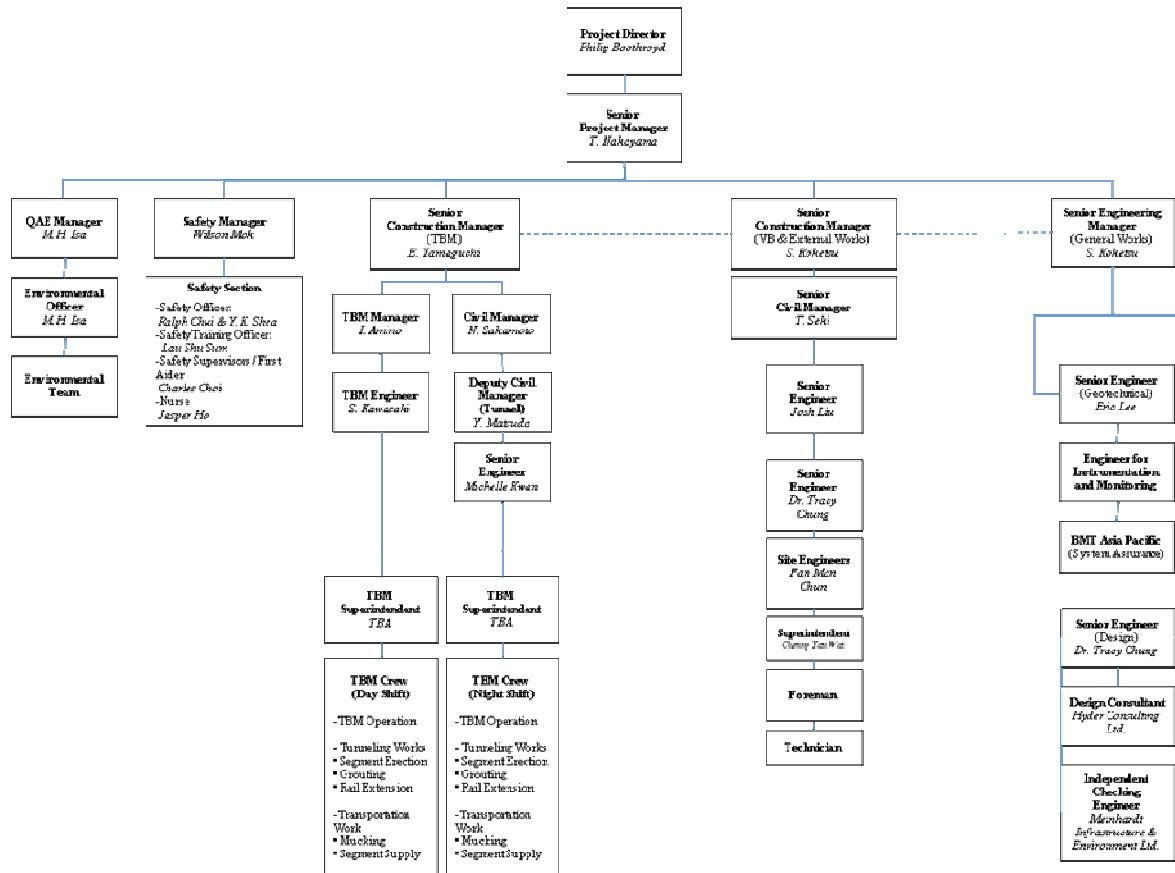
STRUCTURE NUMBER IF ANY

SB CHAINAGE

CONTRACT NUMBER

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Appendix II – Organisation Chart for GW Drawdown Contingency Plan



PENTA-OCEAN CONSTRUCTION CO., LTD.			 PENTA-OCEAN CONSTRUCTION CO., LTD. 五洋建設
GW Drawdown Contingency Plan	Ref: CVL/GWCP/908	Revision: 3	
Express Rail Link Contract No. 825 – Mai Po To Ngau Tam Mei Tunnels			Page: 14 of 15

Appendix III – Extract from Detail Design Approval – Excavation And Lateral Support System (Option 2) Appendix F on Ground Settlement Assessment

Appendix F

Ground Settlement Assessment

	Hyder Consulting Limited	By MM	Job No.
	Job Contract 825	Date Mar 10	EB000563
	Subject Design Statement for Settlement Estimation		Sheet 1

I) General

Ground movements due to the construction works can be attributed to three main effects:

- Settlement due to the diaphragm wall construction (guide wall construction and trenching)
- Lateral movement of the diaphragm wall during excavation
- Settlement due to groundwater drawdown

A) Settlement induced by guide wall and trenching construction

A slurry trench will be formed during construction of diaphragm wall panels. The settlement induced by the construction is estimated based on the C580 Embedded Retaining Walls – Guidance for Economic Design (CIRIA, 2003) and the calculation is presented as Appendix F. The detailed guide wall and trenching design will be enclosed for reference.

B) Settlement induced by diaphragm wall deflection

The ground settlement due to deep excavation depends on the soil stiffness and strength, the stiffness of wall and temporary struts. The effect of the bulk excavation behind the diaphragm wall has been determined using the computer programme FREW. From FREW, the maximum wall deflection envelope has been obtained. The correlation between the lateral deflection of the wall and the vertical ground settlement is based on the method presented in Nicholson (1987). The settlement calculations due to wall deflection are provided in Appendix F.

C) Settlement induced by dewatering during excavation

The groundwater drawdown due to the dewatering of the excavation has been calculated using the computer programme SEEP/W. Based on the calculated groundwater drawdown, the associated ground consolidation settlements are assessed by using elastic theory :

settlement = $\Delta\sigma L / E$

where

$\Delta\sigma$ = Average increase in effective stress due to groundwater drawdown;

L= Thickness of soil subjected to the effect of groundwater drawdown;

E= Average elastic modulus of soil strata under the influence of groundwater drawdown.

Settlement due to Guide Wall Construction / Trenching

**Calculation Sheet****Date:** Mar-10**Sheet No.:** 1 of 1**Project Title:** MTR Contract 825 Mai Po to Ngau Tam Mei**Project No.:****Subject:** Total Settlements**By:** MM

EB000563

GROUND SETTLEMENT DUE TO GUIDE WALL/ TRENCHING

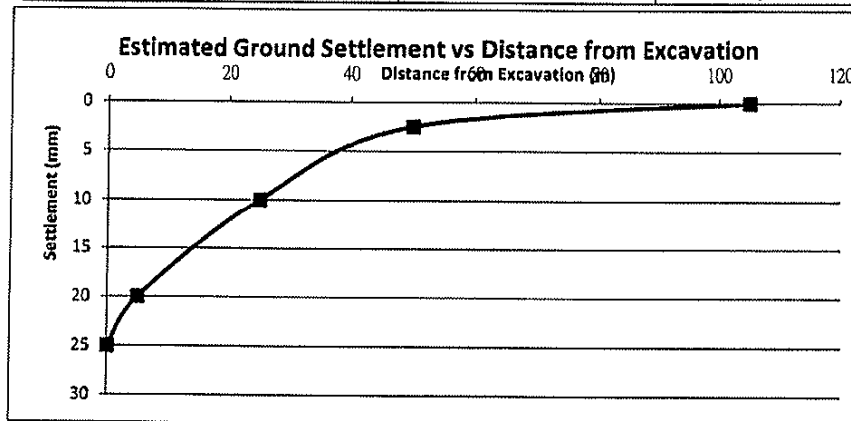
Settlement due to guide wall/ trenching

Trenching depth

L = 50 m (approx.)

Summary Table of Settlement vs Distance from the Excavation

Distance from the face of Excavation	Distance from wall/ wall depth	Settlement / wall depth	Settlement (mm)
0	0.00	0.05	25
5	0.10	0.04	20
25	0.50	0.02	10
50	1.00	0.01	2.5
105	2.10	0.00	0



Reference: CIRIA C580

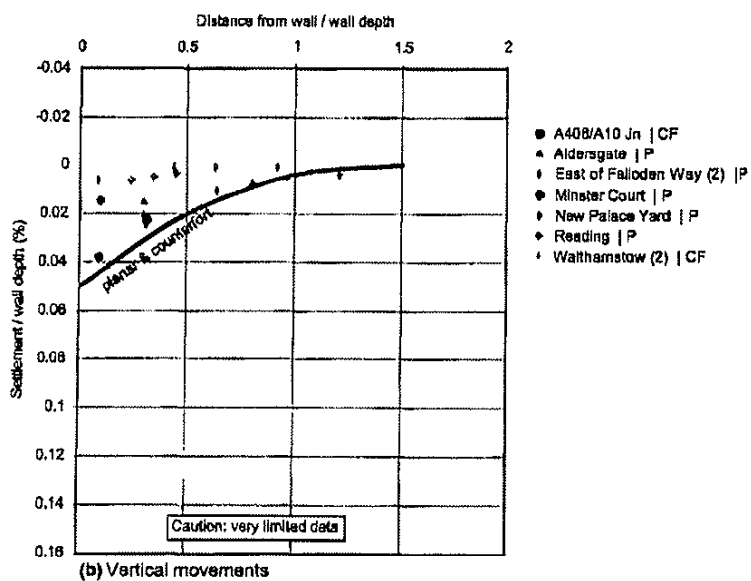
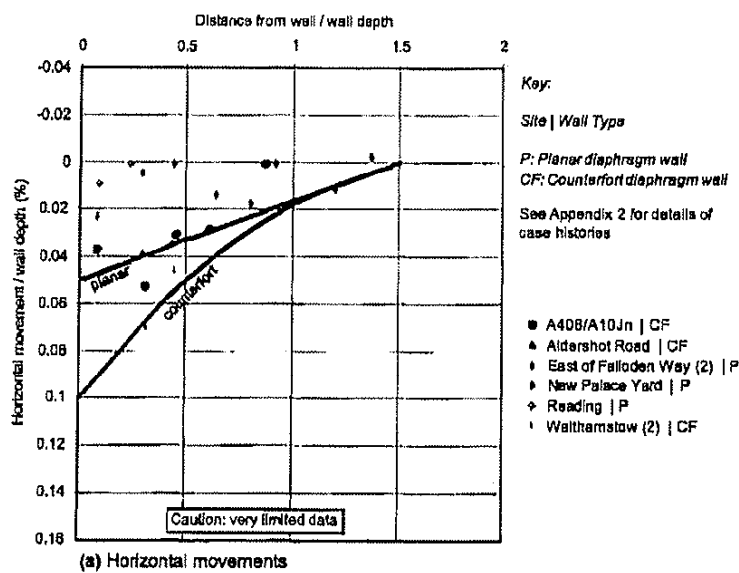


Figure 2.9 Ground surface movements due to diaphragm wall installation in stiff clay

Settlement due to Groundwater Drawdown



Hyder Consulting Limited		By	MM	Job No.
Job	Contact No. 825	Date	Mar-10	EB000563
Subject	SEEPAGE ANALYSIS: DESIGN STATEMENT			

APPROVED PROGRAM

1. Program Name : SEEP/W
2. Program Version : 4.02
3. Program Developer's Identification : GEO-SLOPE International Ltd.
4. BD Reference No. : G0054

SOIL/MATERIAL PARAMETERS

1.

	<u>k (m/s)</u>	<u>Elastic Modulus (kPa)</u>
Fill	1×10^{-5}	10000
Alluvium (Clay)	2.13×10^{-7}	8800
Alluvium (Sand)	5.28×10^{-6}	15000
CDMS	2.39×10^{-7}	70000
CDMS (N>100)	2.39×10^{-7}	200000/400000
Grout	1×10^{-8}	
D-Wall	1×10^{-10}	
2. Groundwater Regime : The maximum measured groundwater level is +3.87mPD (ref: 2108/XRL/D256)
The design groundwater level has been derived from the maximum measured GWL and the Wetting Band Approach with a 1 in 5 year return period (Geotechnical Manual for Slopes - Section 4.4.3, GEO (1984) and Technical Note 58, HKO (1981)).
The design groundwater level derived for use in this analysis is **+4.1mPD**.

INPUT DATA PREPARATION

1. Cross section : The critical cross-section that has been considered for analysis is **Section 1 - 1** where the maximum wall deflection is anticipated and the toe grouting extends to -55mPD
2. Geological Profiles : As determined from ground investigations and engineering judgment.

SETTLEMENT PREDICTION

The consolidation settlements associated with groundwater drawdown have been calculated using the elastic theory, $s = \Delta\sigma L/E$

Where

s = Settlement;

$\Delta\sigma$ = Average increase in effective stress due to groundwater drawdown;

L = Thickness of soil subjected to the effect of groundwater drawdown;

E = Average elastic modulus of soil strata under the influence of groundwater drawdown



Hyder Consulting Limited

By MM

Job No.

Job Contact No. 825

Date Mar-10

EB000563

Subject SEEPAGE ANALYSIS: DIAPHRAGM WALL TOE
LEVEL AT -55mPD (WITH TOE GROUT)

ESTIMATION OF SETTLEMENT DUE TO HEADLOSS OF DEWATERING

Total Head before excavation = 4.10 mPD

a) Head loss due to dewatering at 0 m away from the diaphragm wall
(from SEEP/W analysis)

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	3.08	1.02	10
2	ALL - clay	2.88	1.22	12
3	ALL - sand	2.67	1.43	14
4	CDM - U	0.86	3.24	31.8
5a	CDM - L1	-6.5	10.6	104
5b	CDM - L2	-4.7	8.8	86.3

Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	10	3.40	3.4
2	ALL - clay	8800	12	6.00	8.16
3	ALL - sand	15000	14.0	6.00	5.61
4	CDM - U	70000	31.8	24.2	11
5a	CDM - L1	200000	104	32.3	16.8
5b	CDM - L2	400000	86	32.3	6.96

$\Sigma =$ 51.9 mm

b) Head loss due to dewatering at 5 m away from the diaphragm wall

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	3.08	1.02	10
2	ALL - clay	2.88	1.22	12
3	ALL - sand	2.67	1.43	14
4	CDM - U	0.90	3.20	31.4
5a	CDM - L1	-5.1	9.2	90
5b	CDM - L2	-4.3	8.4	82

Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	10	3.40	3.4
2	ALL - clay	8800	12	6.00	8.16
3	ALL - sand	15000	14.0	6.00	5.61
4	CDM - U	70000	31.4	24.2	10.9
5a	CDM - L1	200000	90	32.3	14.5
5b	CDM - L2	400000	82	32.3	6.61

$\Sigma =$ 49.1 mm



Hyder Consulting Limited		By MM	Job No.
Job Contact No. 825		Date Mar-10	EB000563
Subject SEEPAGE ANALYSIS: DIAPHRAGM WALL TOE LEVEL AT -55mPD (WITH TOE GROUT)			

c) Head loss due to dewatering at 10 m away from the diaphragm wall

<u>Layer</u>	<u>Soil</u>	<u>Head (mPD)</u>	<u>Headloss - ΔH (m)</u>	<u>Δσ = ΔH x γ_w (kPa)</u>
1	FILL	3.09	1.01	9.91
2	ALL - clay	2.90	1.20	11.8
3	ALL - sand	2.70	1.40	13.7
4	CDM - U	1.01	3.09	30.3
5a	CDM - L1	-3.8	7.9	77
5b	CDM - L2	-3.8	7.9	77

<u>Layer</u>	<u>Soil</u>	<u>E (Kpa)</u>	<u>Δσ (kN/m²)</u>	<u>Thickness (m)</u>	<u>δ(mm)</u>
1	FILL	10000	9.91	3.40	3.37
2	ALL - clay	8800	11.8	6.00	8.03
3	ALL - sand	15000	13.7	6.00	5.49
4	CDM - U	70000	30.3	24.2	10.5
5a	CDM - L1	200000	77	32.3	12.5
5b	CDM - L2	400000	77	32.3	6.22

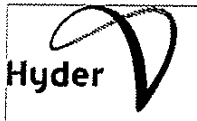
Σ = **46.1** mm

d) Head loss due to dewatering at 15 m away from the diaphragm wall

<u>Layer</u>	<u>Soil</u>	<u>Head (mPD)</u>	<u>Headloss - ΔH (m)</u>	<u>Δσ = ΔH x γ_w (kPa)</u>
1	FILL	3.11	0.99	9.71
2	ALL - clay	2.93	1.17	11.5
3	ALL - sand	2.73	1.37	13.4
4	CDM - U	1.17	2.93	28.7
5a	CDM - L1	-2.8	6.9	68
5b	CDM - L2	-3.2	7.3	72

<u>Layer</u>	<u>Soil</u>	<u>E (Kpa)</u>	<u>Δσ (kN/m²)</u>	<u>Thickness (m)</u>	<u>δ(mm)</u>
1	FILL	10000	9.71	3.40	3.3
2	ALL - clay	8800	11.5	6.00	7.83
3	ALL - sand	15000	13.4	6.00	5.38
4	CDM - U	70000	28.7	24.2	9.94
5a	CDM - L1	200000	68	32.3	10.9
5b	CDM - L2	400000	72	32.3	5.78

Σ = **43.2** mm

	Hyder Consulting Limited		By	MM	Job No. EB000563
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	Subject SEEPAGE ANALYSIS: DIAPHRAGM WALL TOE LEVEL AT -55mPD (WITH TOE GROUT)				

e) Head loss due to dewatering at 20 m away from the diaphragm wall

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	3.14	0.96	9.42
2	ALL - clay	2.97	1.13	11.1
3	ALL - sand	2.78	1.32	12.9
4	CDM - U	1.35	2.75	27.0
5a	CDM - L1	-2.0	6.1	60
5b	CDM - L2	-2.7	6.8	66

Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	9.42	3.40	3.2
2	ALL - clay	8800	11.1	6.00	7.56
3	ALL - sand	15000	12.9	6.00	5.18
4	CDM - U	70000	27	24.2	9.33
5a	CDM - L1	200000	60	32.3	9.63
5b	CDM - L2	400000	66	32.3	5.34

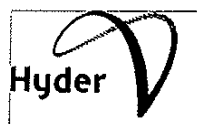
$\Sigma = 40.2$ mm

f) Head loss due to dewatering at 25 m away from the diaphragm wall

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	3.18	0.92	9.03
2	ALL - clay	3.01	1.09	10.7
3	ALL - sand	2.84	1.26	12.4
4	CDM - U	1.56	2.54	24.9
5a	CDM - L1	-1.3	5.4	53
5b	CDM - L2	-2.1	6.2	61

Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	9.03	3.40	3.07
2	ALL - clay	8800	10.7	6.00	7.29
3	ALL - sand	15000	12.4	6.00	4.94
4	CDM - U	70000	24.9	24.2	8.61
5a	CDM - L1	200000	53	32.3	8.54
5b	CDM - L2	400000	61	32.3	4.9

$\Sigma = 37.4$ mm



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Subject SEEPAGE ANALYSIS: DIAPHRAGM WALL TOE LEVEL AT -55mPD (WITH TOE GROUT)			

g) Head loss due to dewatering at 30 m away from the diaphragm wall

<u>Layer</u>	<u>Soil</u>	<u>Head (mPD)</u>	<u>Headloss - ΔH (m)</u>	<u>$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)</u>
1	FILL	3.22	0.88	8.63
2	ALL - clay	3.07	1.03	10.1
3	ALL - sand	2.91	1.19	11.7
4	CDM - U	1.77	2.33	22.9
5a	CDM - L1	-0.7	4.8	47
5b	CDM - L2	-1.5	5.6	55

<u>Layer</u>	<u>Soil</u>	<u>E (Kpa)</u>	<u>$\Delta\sigma$ (kN/m²)</u>	<u>Thickness (m)</u>	<u>δ(mm)</u>
1	FILL	10000	8.63	3.40	2.94
2	ALL - clay	8800	10.1	6.00	6.89
3	ALL - sand	15000	11.7	6.00	4.67
4	CDM - U	70000	22.9	24.2	7.9
5a	CDM - L1	200000	47	32.3	7.58
5b	CDM - L2	400000	55	32.3	4.45

$\Sigma = 34.4$ mm

h) Head loss due to dewatering at 35 m away from the diaphragm wall

<u>Layer</u>	<u>Soil</u>	<u>Head (mPD)</u>	<u>Headloss - ΔH (m)</u>	<u>$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)</u>
1	FILL	3.28	0.82	8.04
2	ALL - clay	3.13	0.97	9.52
3	ALL - sand	2.98	1.12	11
4	CDM - U	1.98	2.12	20.8
5a	CDM - L1	-0.1	4.2	42
5b	CDM - L2	-1.0	5.1	50

<u>Layer</u>	<u>Soil</u>	<u>E (Kpa)</u>	<u>$\Delta\sigma$ (kN/m²)</u>	<u>Thickness (m)</u>	<u>δ(mm)</u>
1	FILL	10000	8.04	3.40	2.74
2	ALL - clay	8800	9.52	6.00	6.49
3	ALL - sand	15000	11.0	6.00	4.39
4	CDM - U	70000	20.8	24.2	7.19
5a	CDM - L1	200000	42	32.3	6.71
5b	CDM - L2	400000	50	32.3	4.02

$\Sigma = 31.5$ mm



Hyder Consulting Limited

By MM

Job No.

Job Contact No. 825

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i) Head loss due to dewatering at 40 m away from the diaphragm wall

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	3.33	0.77	7.55
2	ALL - clay	3.21	0.89	8.73
3	ALL - sand	3.07	1.03	10.1
4	CDM - U	2.19	1.91	18.7
5a	CDM - L1	0.4	3.7	37
5b	CDM - L2	-0.5	4.6	45

Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	7.55	3.40	2.57
2	ALL - clay	8800	8.73	6.00	5.95
3	ALL - sand	15000	10.1	6.00	4.04
4	CDM - U	70000	18.7	24.2	6.48
5a	CDM - L1	200000	37	32.3	5.92
5b	CDM - L2	400000	45	32.3	3.6

$\Sigma = 28.6$ mm

j) Head loss due to dewatering at 45 m away from the diaphragm wall

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	3.40	0.70	6.87
2	ALL - clay	3.28	0.82	8.04
3	ALL - sand	3.16	0.94	9.22
4	CDM - U	2.40	1.70	16.7
5a	CDM - L1	0.8	3.3	32
5b	CDM - L2	0.1	4.0	40

Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	6.87	3.40	2.33
2	ALL - clay	8800	8.04	6.00	5.48
3	ALL - sand	15000	9.2	6.00	3.69
4	CDM - U	70000	16.7	24.2	5.77
5a	CDM - L1	200000	32	32.3	5.19
5b	CDM - L2	400000	40	32.3	3.19

$\Sigma = 25.7$ mm

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k) Head loss due to dewatering at 50 m away from the diaphragm wall

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	3.46	0.64	6.28
2	ALL - clay	3.36	0.74	7.26
3	ALL - sand	3.26	0.84	8.24
4	CDM - U	2.60	1.50	14.7
5a	CDM - L1	1.3	2.9	28
5b	CDM - L2	0.6	3.5	35

Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	6.28	3.40	2.13
2	ALL - clay	8800	7.26	6.00	4.95
3	ALL - sand	15000	8.2	6.00	3.3
4	CDM - U	70000	14.7	24.2	5.09
5a	CDM - L1	200000	28	32.3	4.51
5b	CDM - L2	400000	35	32.3	2.79

$\Sigma = 22.8$ mm

l) Head loss due to dewatering at 55 m away from the diaphragm wall

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	3.54	0.56	5.49
2	ALL - clay	3.45	0.65	6.38
3	ALL - sand	3.36	0.74	7.26
4	CDM - U	2.80	1.30	12.8
5a	CDM - L1	1.7	2.4	24
5b	CDM - L2	1.1	3.1	30

Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	5.49	3.40	1.87
2	ALL - clay	8800	6.38	6.00	4.35
3	ALL - sand	15000	7.3	6.00	2.9
4	CDM - U	70000	12.8	24.2	4.41
5a	CDM - L1	200000	24	32.3	3.86
5b	CDM - L2	400000	30	32.3	2.41

$\Sigma = 19.8$ mm



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m) Head loss due to dewatering at 60 m away from the diaphragm wall

<u>Layer</u>	<u>Soil</u>	<u>Head (mPD)</u>	<u>Headloss - ΔH (m)</u>	<u>Δσ = ΔH x γ_w (kPa)</u>
1	FILL	3.61	0.49	4.81
2	ALL - clay	3.54	0.56	5.49
3	ALL - sand	3.46	0.64	6.28
4	CDM - U	3.00	1.10	10.8
5a	CDM - L1	2.05	2.05	20.1
5b	CDM - L2	1.53	2.57	25.2

<u>Layer</u>	<u>Soil</u>	<u>E (Kpa)</u>	<u>Δσ (kN/m²)</u>	<u>Thickness (m)</u>	<u>δ(mm)</u>
1	FILL	10000	4.81	3.40	1.63
2	ALL - clay	8800	5.49	6.00	3.75
3	ALL - sand	15000	6.28	6.00	2.51
4	CDM - U	70000	10.8	24.2	3.73
5a	CDM - L1	200000	20.1	32.3	3.24
5b	CDM - L2	400000	25.2	32.3	2.03

Σ = 16.9 mm

n) Head loss due to dewatering at 65 m away from the diaphragm wall

<u>Layer</u>	<u>Soil</u>	<u>Head (mPD)</u>	<u>Headloss - ΔH (m)</u>	<u>Δσ = ΔH x γ_w (kPa)</u>
1	FILL	3.69	0.41	4.02
2	ALL - clay	3.63	0.47	4.61
3	ALL - sand	3.57	0.53	5.2
4	CDM - U	3.20	0.90	8.83
5a	CDM - L1	2.42	1.68	16.5
5b	CDM - L2	1.99	2.11	20.7

<u>Layer</u>	<u>Soil</u>	<u>E (Kpa)</u>	<u>Δσ (kN/m²)</u>	<u>Thickness (m)</u>	<u>δ(mm)</u>
1	FILL	10000	4.02	3.40	1.37
2	ALL - clay	8800	4.61	6.00	3.14
3	ALL - sand	15000	5.2	6.00	2.08
4	CDM - U	70000	8.83	24.2	3.05
5a	CDM - L1	200000	16.5	32.3	2.66
5b	CDM - L2	400000	20.7	32.3	1.67

Σ = 14 mm



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o) Head loss due to dewatering at 70 m away from the diaphragm wall

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	3.77	0.33	3.24
2	ALL - clay	3.73	0.37	3.63
3	ALL - sand	3.68	0.42	4.12
4	CDM - U	3.39	0.71	6.97
5a	CDM - L1	2.8	1.32	12.9
5b	CDM - L2	2.4	1.66	16.3

Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	3.24	3.40	1.1
2	ALL - clay	8800	3.63	6.00	2.47
3	ALL - sand	15000	4.12	6.00	1.65
4	CDM - U	70000	6.97	24.2	2.41
5a	CDM - L1	200000	12.9	32.3	2.09
5b	CDM - L2	400000	16.3	32.3	1.31

$\Sigma = 11$ mm

p) Head loss due to dewatering at 75 m away from the diaphragm wall

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	3.86	0.24	2.35
2	ALL - clay	3.82	0.28	2.75
3	ALL - sand	3.79	0.31	3.04
4	CDM - U	3.58	0.52	5.1
5a	CDM - L1	3.1	0.96	9.42
5b	CDM - L2	2.9	1.22	12

Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	2.35	3.40	0.8
2	ALL - clay	8800	2.75	6.00	1.87
3	ALL - sand	15000	3.04	6.00	1.22
4	CDM - U	70000	5.1	24.2	1.76
5a	CDM - L1	200000	9.42	32.3	1.52
5b	CDM - L2	400000	12	32.3	0.96

$\Sigma = 8.14$ mm



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q) Head loss due to dewatering at 80 m away from the diaphragm wall

<u>Layer</u>	<u>Soil</u>	<u>Head (mPD)</u>	<u>Headloss - ΔH (m)</u>	<u>$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)</u>
1	FILL	3.94	0.16	1.57
2	ALL - clay	3.92	0.18	1.77
3	ALL - sand	3.90	0.20	1.96
4	CDM - U	3.76	0.34	3.34
5a	CDM - L1	3.5	0.62	6.08
5b	CDM - L2	3.3	0.78	7.65

<u>Layer</u>	<u>Soil</u>	<u>E (Kpa)</u>	<u>$\Delta\sigma$ (kN/m²)</u>	<u>Thickness (m)</u>	<u>δ(mm)</u>
1	FILL	10000	1.57	3.40	0.53
2	ALL - clay	8800	1.77	6.00	1.2
3	ALL - sand	15000	1.96	6.00	0.78
4	CDM - U	70000	3.34	24.2	1.15
5a	CDM - L1	200000	6.08	32.3	0.98
5b	CDM - L2	400000	7.65	32.3	0.62

$\Sigma = 5.27$ mm

r) Head loss due to dewatering at 85 m away from the diaphragm wall

<u>Layer</u>	<u>Soil</u>	<u>Head (mPD)</u>	<u>Headloss - ΔH (m)</u>	<u>$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)</u>
1	FILL	4.03	0.07	0.69
2	ALL - clay	4.02	0.08	0.78
3	ALL - sand	4.01	0.09	0.88
4	CDM - U	3.95	0.15	1.47
5a	CDM - L1	3.8	0.27	2.65
5b	CDM - L2	3.8	0.35	3.43

<u>Layer</u>	<u>Soil</u>	<u>E (Kpa)</u>	<u>$\Delta\sigma$ (kN/m²)</u>	<u>Thickness (m)</u>	<u>δ(mm)</u>
1	FILL	10000	0.69	3.40	0.23
2	ALL - clay	8800	0.78	6.00	0.54
3	ALL - sand	15000	0.88	6.00	0.35
4	CDM - U	70000	1.47	24.2	0.51
5a	CDM - L1	200000	2.65	32.3	0.43
5b	CDM - L2	400000	3.43	32.3	0.28

$\Sigma = 2.33$ mm



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s) Head loss due to dewatering at 90 m away from the diaphragm wall

Layer	Soil	Head (mPD)	Headloss - ΔH (m)	$\Delta\sigma = \Delta H \times \gamma_w$ (kPa)
1	FILL	4.10	0.0	0
2	ALL - clay	4.10	0.0	0
3	ALL - sand	4.10	0.0	0
4	CDM - U	4.10	0.0	0
5a	CDM - L1	4.10	0.0	0
5b	CDM - L2	4.10	0.0	0

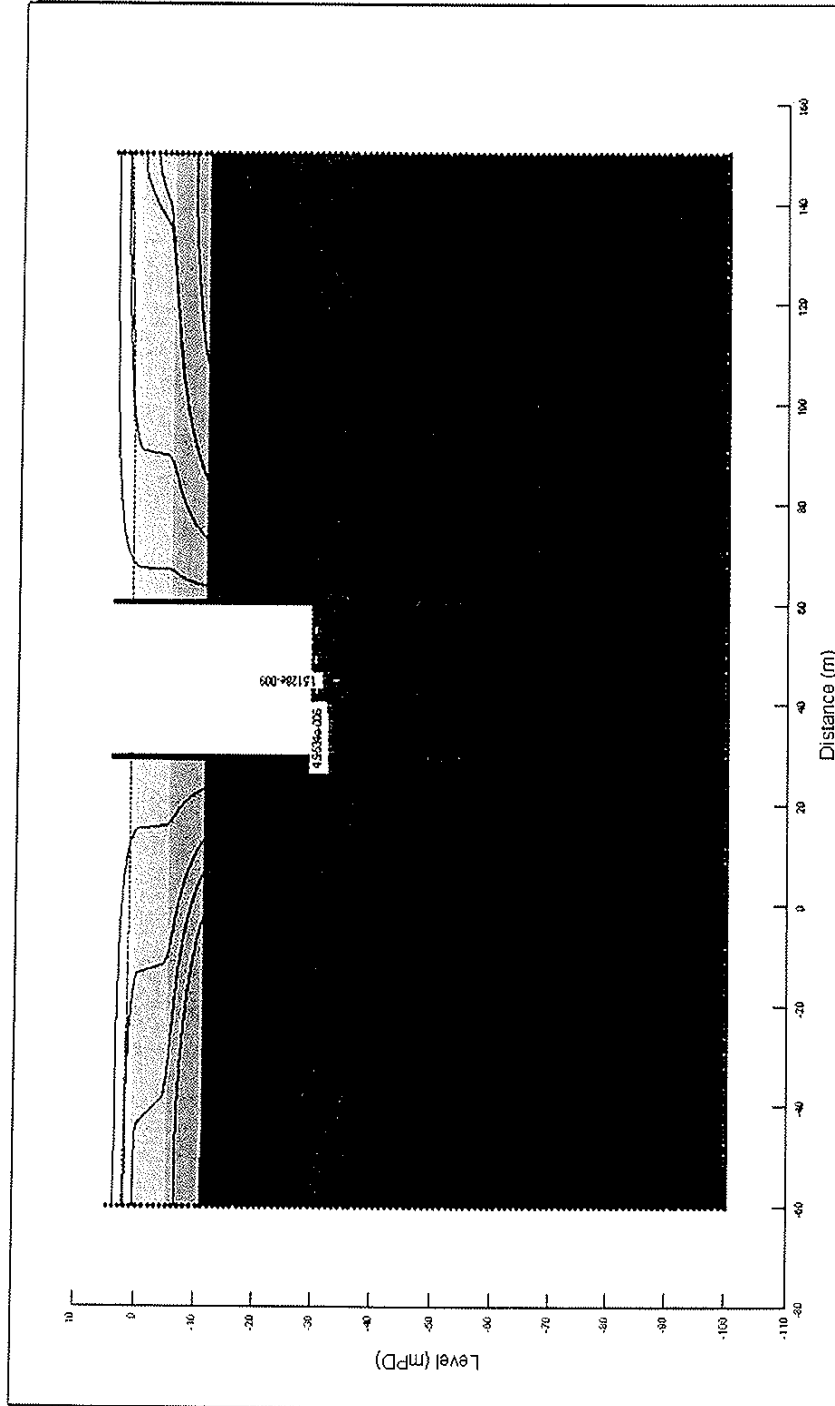
Layer	Soil	E (Kpa)	$\Delta\sigma$ (kN/m ²)	Thickness (m)	δ (mm)
1	FILL	10000	0	3.40	0
2	ALL - clay	8800	0	6.00	0
3	ALL - sand	15000	0	6.00	0
4	CDM - U	70000	0	24.2	0
5a	CDM - L1	200000	0	32.3	0
5b	CDM - L2	400000	0	32.3	0

$\Sigma = 0$ mm

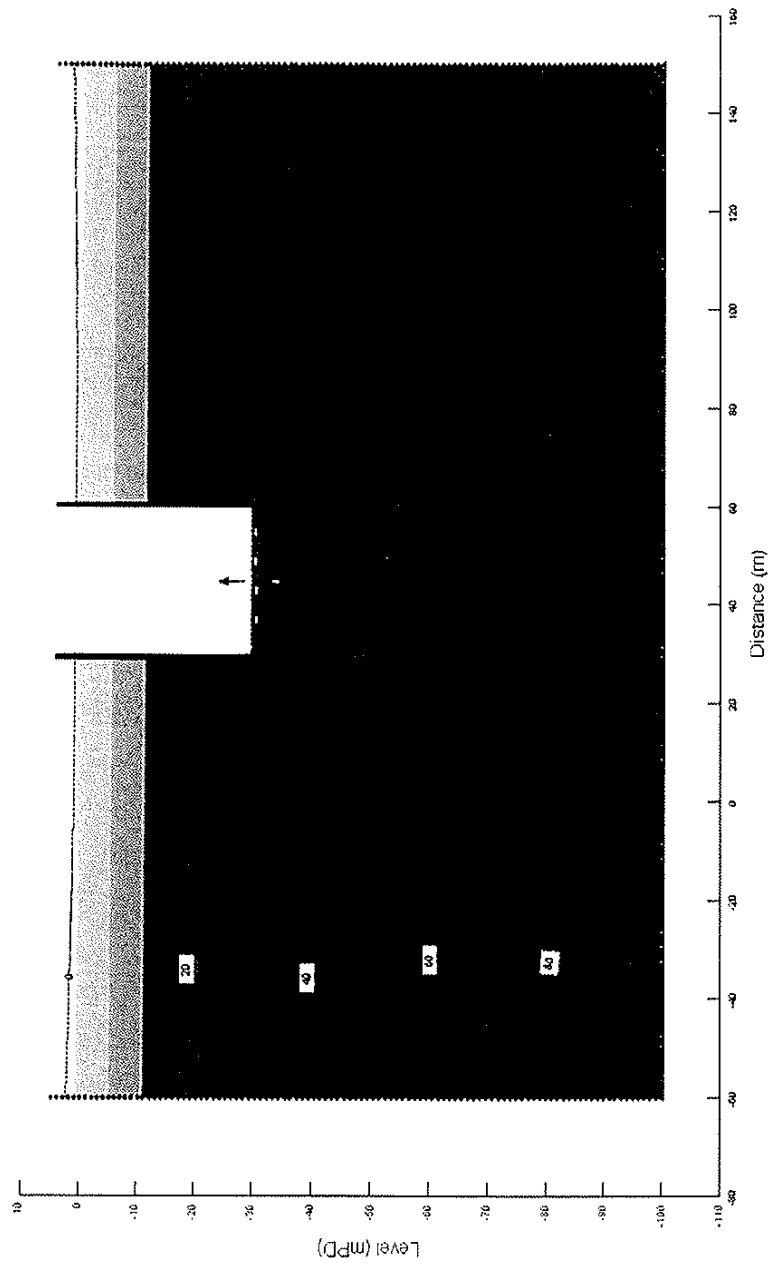
Remarks

Layer 1 - from +4.7mPD to +0.7mPD
 Layer 2 - from +0.7mPD to -5.3mPD
 Layer 3 - from -5.3mPD to -11.3mPD
 Layer 4 - from -11.3mPD to -35.5mPD
 Layer 5a & 5b - from -35.5mPD to -100mPD

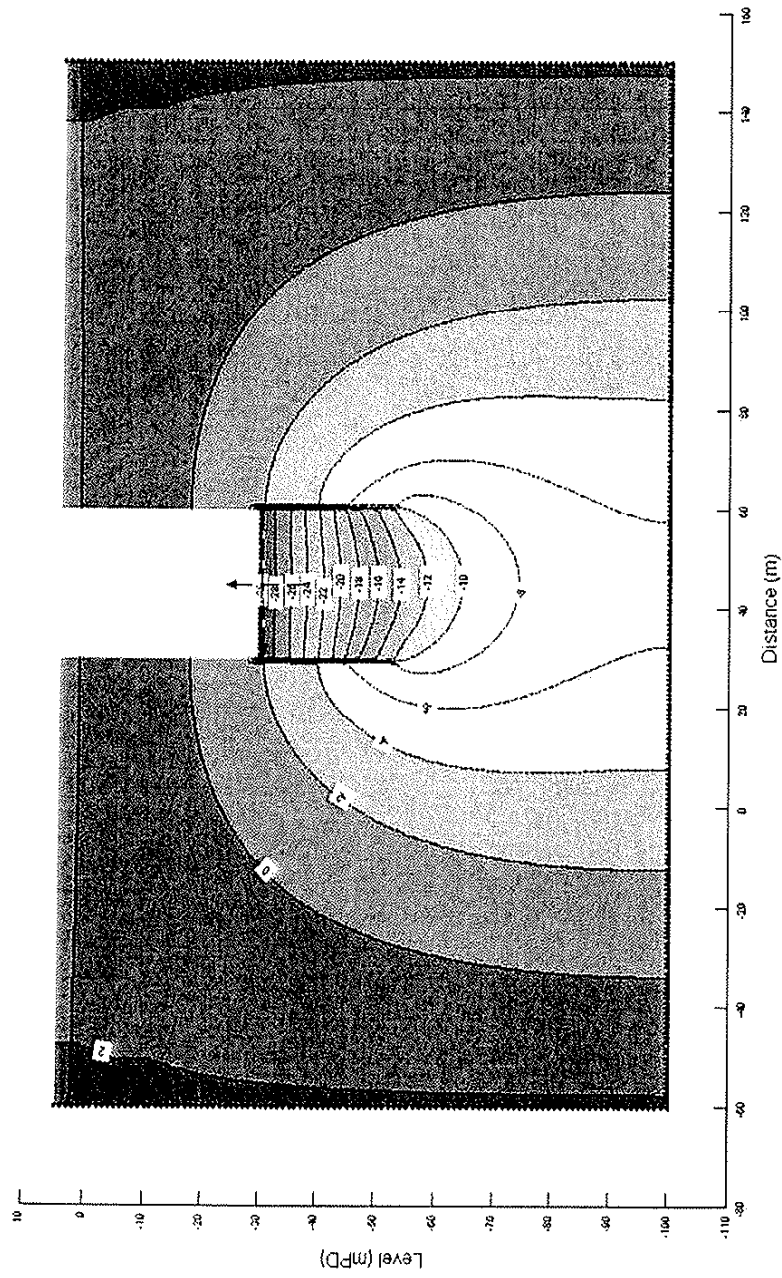
D-Wall With Grout - Flow Path



D-Wall With Grout - Pressure Head



D-Wall With Grout - Total Head

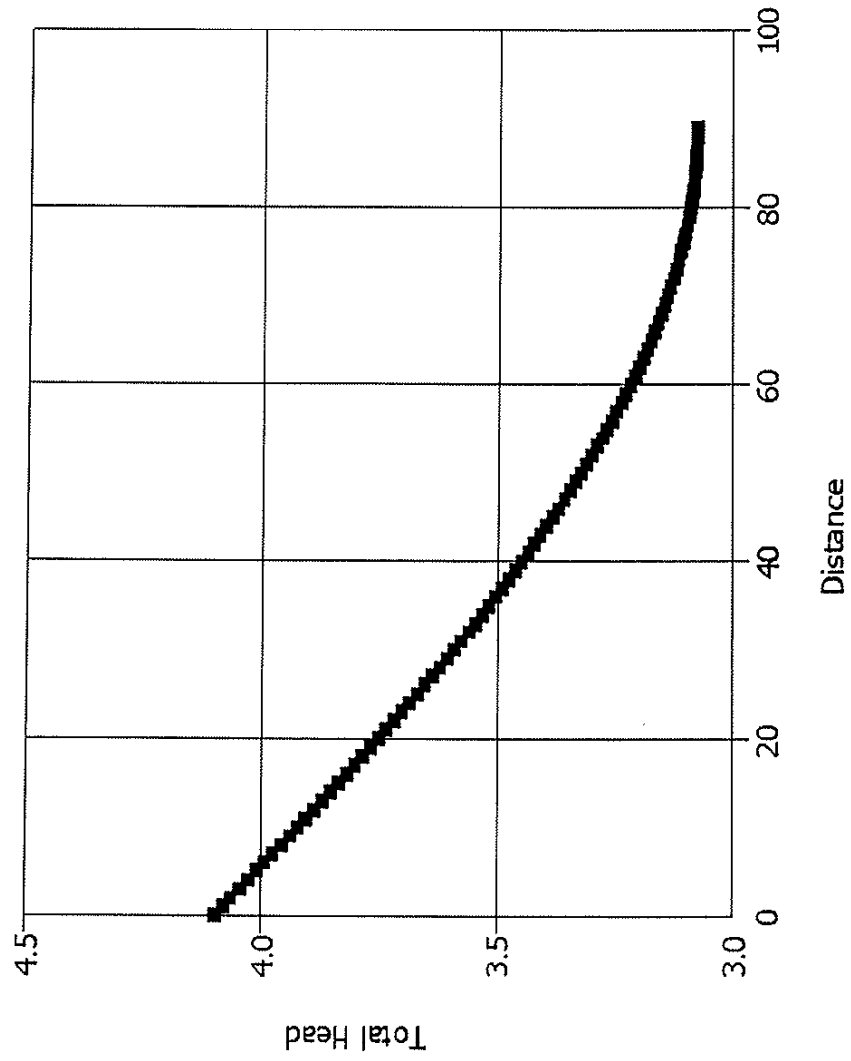


D-Wall with Grout to -55mPD

SEEP/W OUTPUTS

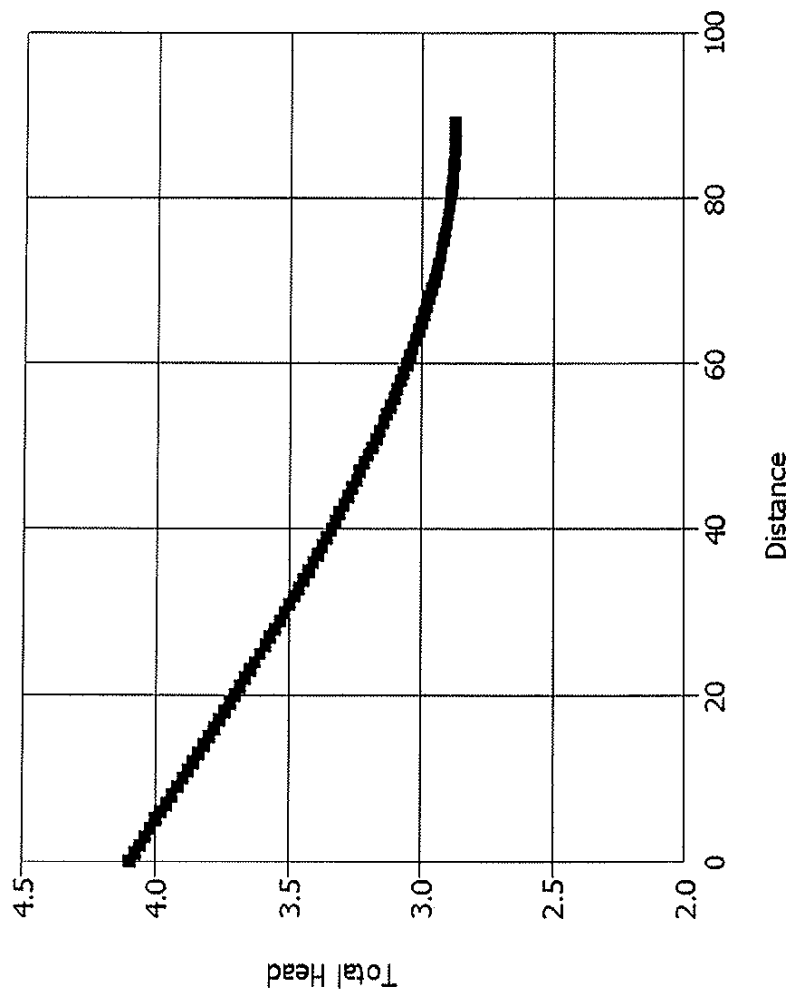
Pt #	Total Head0	Distance (m)	Pt #	Total Head0	Distance (m)	Soil Layer:	Pt #	Total Head0	Distance (m)	Fill
1	4.10E+00	89	33	3.57E+00	57		65	3.18E+00	25	
2	4.08E+00	88	34	3.55E+00	56		66	3.17E+00	24	
3	4.07E+00	87	35	3.54E+00	55		67	3.16E+00	23	
4	4.05E+00	86	36	3.52E+00	54		68	3.16E+00	22	
5	4.03E+00	85	37	3.51E+00	53		69	3.15E+00	21	
6	4.01E+00	84	38	3.49E+00	52		70	3.14E+00	20	
7	4.00E+00	83	39	3.48E+00	51		71	3.14E+00	19	
8	3.98E+00	82	40	3.46E+00	50		72	3.13E+00	18	
9	3.96E+00	81	41	3.45E+00	49		73	3.12E+00	17	
10	3.94E+00	80	42	3.44E+00	48		74	3.12E+00	16	
11	3.93E+00	79	43	3.42E+00	47		75	3.11E+00	15	
12	3.91E+00	78	44	3.41E+00	46		76	3.11E+00	14	
13	3.89E+00	77	45	3.40E+00	45		77	3.10E+00	13	
14	3.88E+00	76	46	3.38E+00	44		78	3.10E+00	12	
15	3.86E+00	75	47	3.37E+00	43		79	3.10E+00	11	
16	3.84E+00	74	48	3.36E+00	42		80	3.09E+00	10	
17	3.82E+00	73	49	3.35E+00	41		81	3.09E+00	9	
18	3.81E+00	72	50	3.33E+00	40		82	3.09E+00	8	
19	3.79E+00	71	51	3.32E+00	39		83	3.08E+00	7	
20	3.77E+00	70	52	3.31E+00	38		84	3.08E+00	6	
21	3.76E+00	69	53	3.30E+00	37		85	3.08E+00	5	
22	3.74E+00	68	54	3.29E+00	36		86	3.08E+00	4	
23	3.72E+00	67	55	3.28E+00	35		87	3.08E+00	3	
24	3.71E+00	66	56	3.27E+00	34		88	3.08E+00	2	
25	3.69E+00	65	57	3.25E+00	33		89	3.08E+00	1	
26	3.68E+00	64	58	3.24E+00	32		90	3.08E+00	0	
27	3.66E+00	63	59	3.23E+00	31					
28	3.64E+00	62	60	3.22E+00	30					
29	3.63E+00	61	61	3.22E+00	29					
30	3.61E+00	60	62	3.21E+00	28					
31	3.60E+00	59	63	3.20E+00	27					
32	3.58E+00	58	64	3.19E+00	26					

Total Head vs. Distance



D-Wall with Grout to -55mPD				SEEP/W OUTPUTS				Alluvium (Clay)			
Pt #	Total Head0	Distance (m)	Pt #	Total Head0	Distance (m)	Pt #	Total Head0	Pt #	Total Head0	Distance (m)	
1	4.10E+00	89	33	3.48E+00	57	65	3.01E+00	25			
2	4.08E+00	88	34	3.47E+00	56	66	3.00E+00	24			
3	4.06E+00	87	35	3.45E+00	55	67	2.99E+00	23			
4	4.04E+00	86	36	3.43E+00	54	68	2.98E+00	22			
5	4.02E+00	85	37	3.41E+00	53	69	2.98E+00	21			
6	4.00E+00	84	38	3.40E+00	52	70	2.97E+00	20			
7	3.98E+00	83	39	3.38E+00	51	71	2.96E+00	19			
8	3.96E+00	82	40	3.36E+00	50	72	2.95E+00	18			
9	3.94E+00	81	41	3.35E+00	49	73	2.94E+00	17			
10	3.92E+00	80	42	3.33E+00	48	74	2.94E+00	16			
11	3.90E+00	79	43	3.31E+00	47	75	2.93E+00	15			
12	3.88E+00	78	44	3.30E+00	46	76	2.92E+00	14			
13	3.86E+00	77	45	3.28E+00	45	77	2.92E+00	13			
14	3.84E+00	76	46	3.27E+00	44	78	2.91E+00	12			
15	3.82E+00	75	47	3.25E+00	43	79	2.91E+00	11			
16	3.80E+00	74	48	3.24E+00	42	80	2.90E+00	10			
17	3.78E+00	73	49	3.22E+00	41	81	2.90E+00	9			
18	3.76E+00	72	50	3.21E+00	40	82	2.89E+00	8			
19	3.75E+00	71	51	3.19E+00	39	83	2.89E+00	7			
20	3.73E+00	70	52	3.18E+00	38	84	2.89E+00	6			
21	3.71E+00	69	53	3.16E+00	37	85	2.88E+00	5			
22	3.69E+00	68	54	3.15E+00	36	86	2.88E+00	4			
23	3.67E+00	67	55	3.13E+00	35	87	2.88E+00	3			
24	3.65E+00	66	56	3.12E+00	34	88	2.88E+00	2			
25	3.63E+00	65	57	3.11E+00	33	89	2.88E+00	1			
26	3.61E+00	64	58	3.10E+00	32	90	2.88E+00	0			
27	3.59E+00	63	59	3.08E+00	31						
28	3.58E+00	62	60	3.07E+00	30						
29	3.56E+00	61	61	3.06E+00	29						
30	3.54E+00	60	62	3.05E+00	28						
31	3.52E+00	59	63	3.04E+00	27						
32	3.50E+00	58	64	3.03E+00	26						

Total Head vs. Distance



D-Wall with Grout to -55mPD

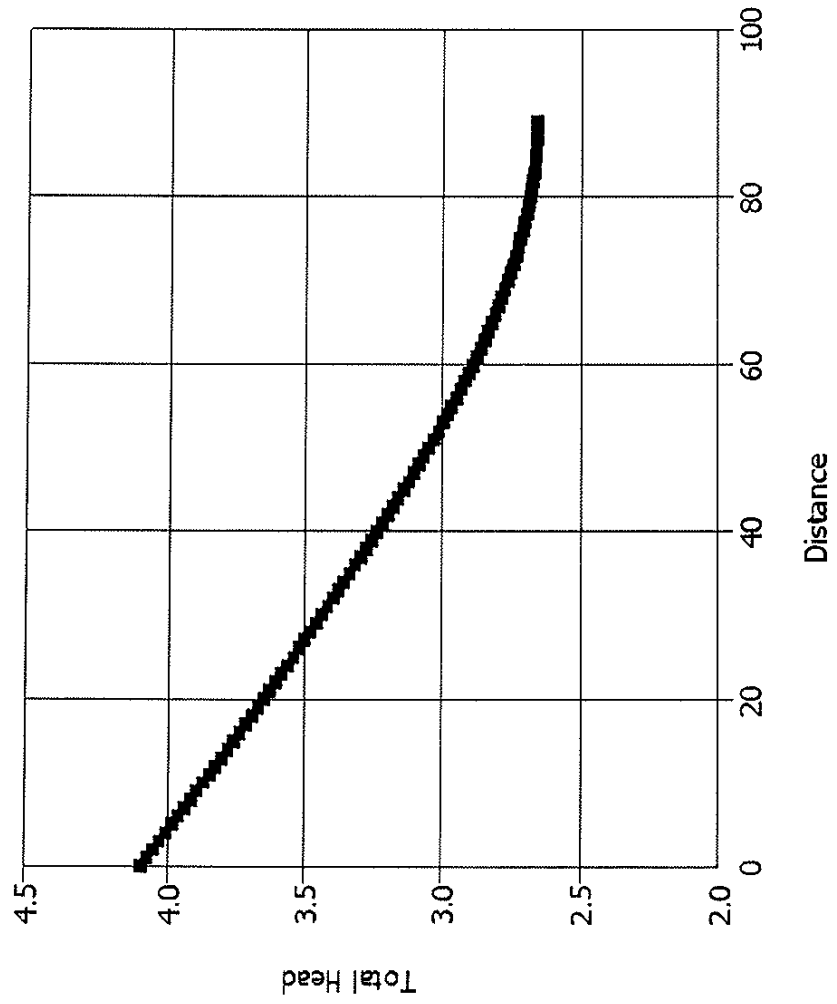
SEEP/W OUTPUTS

Soil Layer:

Alluvium (Sand)

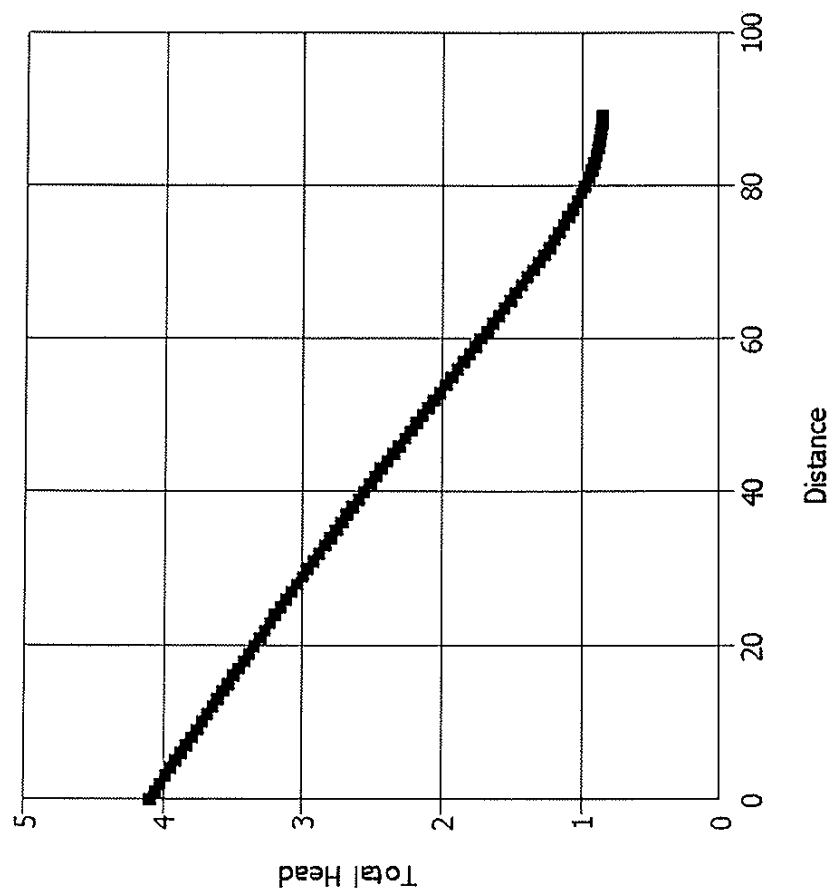
Pt #	Total Head0	Distance (m)	Pt #	Total Head0	Distance (m)	Pt #	Total Head0	Distance (m)
1	4.10E+00	89	32	3.42E+00	58	63	2.86E+00	27
2	4.08E+00	88	33	3.40E+00	57	64	2.85E+00	26
3	4.05E+00	87	34	3.38E+00	56	65	2.84E+00	25
4	4.03E+00	86	35	3.36E+00	55	66	2.83E+00	24
5	4.01E+00	85	36	3.34E+00	54	67	2.81E+00	23
6	3.99E+00	84	37	3.32E+00	53	68	2.80E+00	22
7	3.96E+00	83	38	3.30E+00	52	69	2.79E+00	21
8	3.94E+00	82	39	3.28E+00	51	70	2.78E+00	20
9	3.92E+00	81	40	3.26E+00	50	71	2.77E+00	19
10	3.90E+00	80	41	3.24E+00	49	72	2.76E+00	18
11	3.88E+00	79	42	3.22E+00	48	73	2.75E+00	17
12	3.85E+00	78	43	3.20E+00	47	74	2.74E+00	16
13	3.83E+00	77	44	3.18E+00	46	75	2.73E+00	15
14	3.81E+00	76	45	3.16E+00	45	76	2.72E+00	14
15	3.79E+00	75	46	3.14E+00	44	77	2.71E+00	13
16	3.76E+00	74	47	3.12E+00	43	78	2.71E+00	12
17	3.74E+00	73	48	3.11E+00	42	79	2.70E+00	11
18	3.72E+00	72	49	3.09E+00	41	80	2.70E+00	10
19	3.70E+00	71	50	3.07E+00	40	81	2.69E+00	9
20	3.68E+00	70	51	3.05E+00	39	82	2.68E+00	8
21	3.65E+00	69	52	3.03E+00	38	83	2.68E+00	7
22	3.63E+00	68	53	3.02E+00	37	84	2.68E+00	6
23	3.61E+00	67	54	3.00E+00	36	85	2.67E+00	5
24	3.59E+00	66	55	2.98E+00	35	86	2.67E+00	4
25	3.57E+00	65	56	2.97E+00	34	87	2.67E+00	3
26	3.55E+00	64	57	2.95E+00	33	88	2.67E+00	2
27	3.52E+00	63	58	2.94E+00	32	89	2.67E+00	1
28	3.50E+00	62	59	2.92E+00	31	90	2.67E+00	0
29	3.48E+00	61	60	2.91E+00	30			
30	3.46E+00	60	61	2.89E+00	29			
31	3.44E+00	59	62	2.88E+00	28			

Total Head vs. Distance



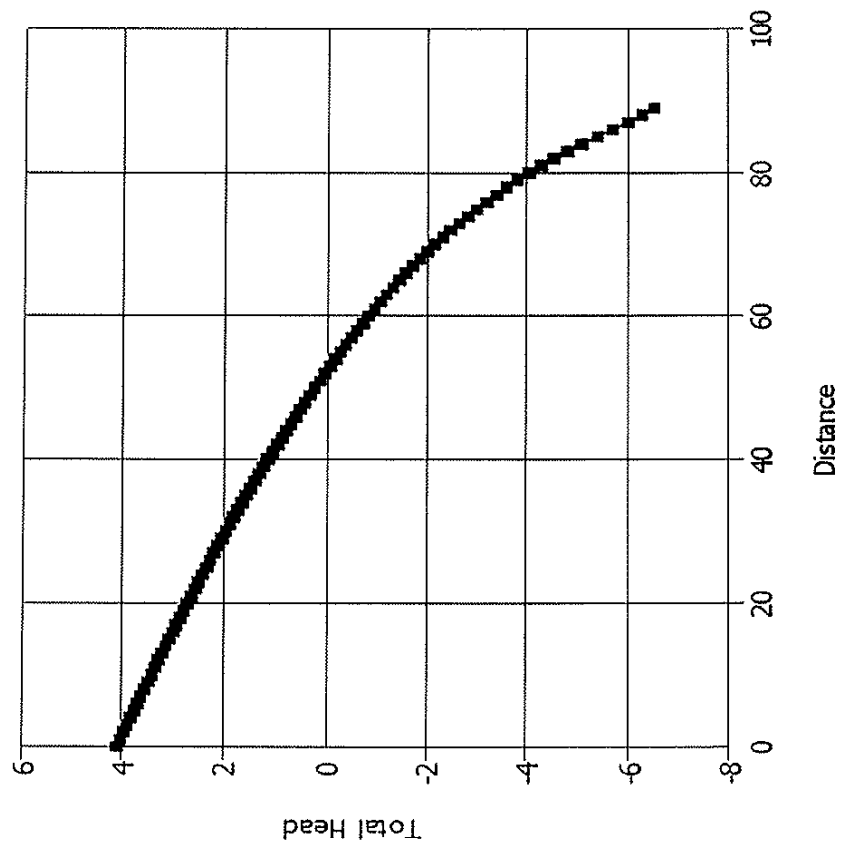
D-Wall with Grout to -55mPD				SEEP/W OUTPUTS				Soil Layer:				CDMS - U			
Pt #	Total Head0	Distance (m)	Pt #	Total Head0	Distance (m)	Pt #	Total Head0	Distance (m)	Pt #	Total Head0	Distance (m)	Pt #	Total Head0	Distance (m)	Pt #
1	4.10E+00	89	33	2.88E+00	57	65	1.56E+00	25							
2	4.06E+00	88	34	2.84E+00	56	66	1.52E+00	24							
3	4.03E+00	87	35	2.80E+00	55	67	1.47E+00	23							
4	3.99E+00	86	36	2.76E+00	54	68	1.43E+00	22							
5	3.95E+00	85	37	2.72E+00	53	69	1.39E+00	21							
6	3.91E+00	84	38	2.68E+00	52	70	1.35E+00	20							
7	3.88E+00	83	39	2.64E+00	51	71	1.31E+00	19							
8	3.84E+00	82	40	2.60E+00	50	72	1.28E+00	18							
9	3.80E+00	81	41	2.56E+00	49	73	1.24E+00	17							
10	3.76E+00	80	42	2.52E+00	48	74	1.20E+00	16							
11	3.73E+00	79	43	2.48E+00	47	75	1.17E+00	15							
12	3.69E+00	78	44	2.44E+00	46	76	1.13E+00	14							
13	3.65E+00	77	45	2.40E+00	45	77	1.10E+00	13							
14	3.61E+00	76	46	2.36E+00	44	78	1.07E+00	12							
15	3.58E+00	75	47	2.32E+00	43	79	1.04E+00	11							
16	3.54E+00	74	48	2.28E+00	42	80	1.01E+00	10							
17	3.50E+00	73	49	2.23E+00	41	81	9.83E-01	9							
18	3.46E+00	72	50	2.19E+00	40	82	9.59E-01	8							
19	3.42E+00	71	51	2.15E+00	39	83	9.37E-01	7							
20	3.39E+00	70	52	2.11E+00	38	84	9.18E-01	6							
21	3.35E+00	69	53	2.07E+00	37	85	9.01E-01	5							
22	3.31E+00	68	54	2.02E+00	36	86	8.87E-01	4							
23	3.27E+00	67	55	1.98E+00	35	87	8.75E-01	3							
24	3.23E+00	66	56	1.94E+00	34	88	8.67E-01	2							
25	3.20E+00	65	57	1.90E+00	33	89	8.62E-01	1							
26	3.16E+00	64	58	1.85E+00	32	90	8.61E-01	0							
27	3.12E+00	63	59	1.81E+00	31										
28	3.08E+00	62	60	1.77E+00	30										
29	3.04E+00	61	61	1.73E+00	29										
30	3.00E+00	60	62	1.68E+00	28										
31	2.96E+00	59	63	1.64E+00	27										
32	2.92E+00	58	64	1.60E+00	26										

Total Head vs. Distance



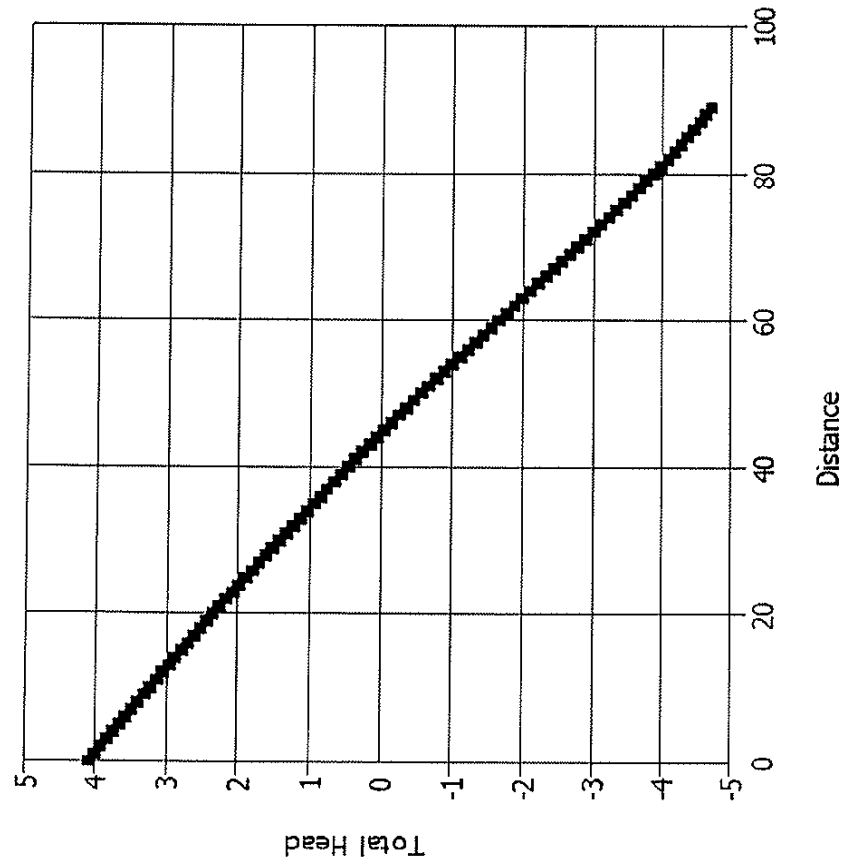
D-Wall with Grout to -55mPD				SEEP/W OUTPUTS		Soil Layer:		CDMS - L1	
Pt #	Total Head0	Distance (m)	Pt #	Total Head0	Distance (m)	Total Head0	Distance (m)	Pt #	Total Head0
1	4.10E+00	89	32	1.89E+00	58	63	-1.05E+00	27	
2	4.03E+00	88	33	1.82E+00	57	64	-1.17E+00	26	
3	3.96E+00	87	34	1.74E+00	56	65	-1.30E+00	25	
4	3.90E+00	86	35	1.66E+00	55	66	-1.43E+00	24	
5	3.83E+00	85	36	1.58E+00	54	67	-1.56E+00	23	
6	3.76E+00	84	37	1.50E+00	53	68	-1.70E+00	22	
7	3.69E+00	83	38	1.42E+00	52	69	-1.85E+00	21	
8	3.62E+00	82	39	1.33E+00	51	70	-1.99E+00	20	
9	3.55E+00	81	40	1.25E+00	50	71	-2.14E+00	19	
10	3.48E+00	80	41	1.17E+00	49	72	-2.30E+00	18	
11	3.42E+00	79	42	1.08E+00	48	73	-2.46E+00	17	
12	3.35E+00	78	43	9.95E-01	47	74	-2.63E+00	16	
13	3.28E+00	77	44	9.07E-01	46	75	-2.81E+00	15	
14	3.21E+00	76	45	8.19E-01	45	76	-2.99E+00	14	
15	3.14E+00	75	46	7.29E-01	44	77	-3.18E+00	13	
16	3.07E+00	74	47	6.38E-01	43	78	-3.37E+00	12	
17	3.00E+00	73	48	5.45E-01	42	79	-3.58E+00	11	
18	2.93E+00	72	49	4.52E-01	41	80	-3.80E+00	10	
19	2.86E+00	71	50	3.57E-01	40	81	-4.02E+00	9	
20	2.78E+00	70	51	2.60E-01	39	82	-4.26E+00	8	
21	2.71E+00	69	52	1.62E-01	38	83	-4.52E+00	7	
22	2.64E+00	68	53	6.24E-02	37	84	-4.78E+00	6	
23	2.57E+00	67	54	-3.91E-02	36	85	-5.06E+00	5	
24	2.50E+00	66	55	-1.42E-01	35	86	-5.36E+00	4	
25	2.42E+00	65	56	-2.48E-01	34	87	-5.67E+00	3	
26	2.35E+00	64	57	-3.55E-01	33	88	-5.98E+00	2	
27	2.27E+00	63	58	-4.64E-01	32	89	-6.26E+00	1	
28	2.20E+00	62	59	-5.75E-01	31	90	-6.50E+00	0	
29	2.12E+00	61	60	-6.89E-01	30				
30	2.05E+00	60	61	-8.06E-01	29				
31	1.97E+00	59	62	-9.25E-01	28				

Total Head vs. Distance



D-Wall with Grout to -55mPD			SHEEP/W OUTPUTS		Soil Layer:		CDMS - L2	
Pt #	Total Head0	Distance (m)	Pt #	Total Head0 Distance (m)	Total Head0 Distance (m)	Pt #	Total Head0 Distance (m)	Total Head0 Distance (m)
1	4.10E+00	89	33	1.25E+00	57	65	-2.09E+00	25
2	4.01E+00	88	34	1.15E+00	56	66	-2.20E+00	24
3	3.93E+00	87	35	1.05E+00	55	67	-2.31E+00	23
4	3.84E+00	86	36	9.59E-01	54	68	-2.43E+00	22
5	3.75E+00	85	37	8.62E-01	53	69	-2.54E+00	21
6	3.67E+00	84	38	7.65E-01	52	70	-2.65E+00	20
7	3.58E+00	83	39	6.67E-01	51	71	-2.77E+00	19
8	3.49E+00	82	40	5.68E-01	50	72	-2.88E+00	18
9	3.41E+00	81	41	4.69E-01	49	73	-2.99E+00	17
10	3.32E+00	80	42	3.69E-01	48	74	-3.10E+00	16
11	3.23E+00	79	43	2.69E-01	47	75	-3.21E+00	15
12	3.15E+00	78	44	1.68E-01	46	76	-3.32E+00	14
13	3.06E+00	77	45	6.66E-02	45	77	-3.43E+00	13
14	2.97E+00	76	46	-3.55E-02	44	78	-3.54E+00	12
15	2.88E+00	75	47	-1.38E-01	43	79	-3.65E+00	11
16	2.80E+00	74	48	-2.42E-01	42	80	-3.76E+00	10
17	2.71E+00	73	49	-3.46E-01	41	81	-3.86E+00	9
18	2.62E+00	72	50	-4.51E-01	40	82	-3.96E+00	8
19	2.53E+00	71	51	-5.56E-01	39	83	-4.07E+00	7
20	2.44E+00	70	52	-6.62E-01	38	84	-4.16E+00	6
21	2.35E+00	69	53	-7.68E-01	37	85	-4.26E+00	5
22	2.26E+00	68	54	-8.76E-01	36	86	-4.36E+00	4
23	2.17E+00	67	55	-9.83E-01	35	87	-4.45E+00	3
24	2.08E+00	66	56	-1.09E+00	34	88	-4.54E+00	2
25	1.99E+00	65	57	-1.20E+00	33	89	-4.62E+00	1
26	1.90E+00	64	58	-1.31E+00	32	90	-4.70E+00	0
27	1.81E+00	63	59	-1.42E+00	31			
28	1.71E+00	62	60	-1.53E+00	30			
29	1.62E+00	61	61	-1.64E+00	29			
30	1.53E+00	60	62	-1.75E+00	28			
31	1.43E+00	59	63	-1.86E+00	27			
32	1.34E+00	58	64	-1.98E+00	26			

Total Head vs. Distance



Settlement due to Excavation

	Calculation Sheet		Date: Apr-10	Sheet No.: 1 of 1
	Project Title: MTR Contract 825 Mai Po to Ngau Tam Mei			Project No.:
	Subject: Results from FREW Analysis (Section 1)		By: MM	EB000563

Node	Level	Displacements		Moments		Shears	
		Min	Max	Min	Max	Min	Max
	[m]	[mm]	[mm]	[kNm/m]	[kNm/m]	[kN/m]	[kN/m]
1	4.7	30.84	75.02	0	0	0	0
2	3	38.59	79.07	-83.05	1.621E-06	-512.2	87.77
3	2	36.2	81.48	-132	390.2	-438.2	96.51
4	1	33.82	83.93	-263.9	793.3	-364.8	172.5
5	0	31.49	86.44	-477.1	1120	-283	261.8
6	-1	29.22	88.97	-787.4	1359	-186.9	371
7	-2	27.03	91.5	-1219	1494	-883.6	503.3
8	-3	24.92	93.96	-407	1505	-711.5	33.67
9	-4.5	21.92	97.48	-295.4	1409	-501.7	118.8
10	-5.5	20.02	100.5	-530.9	1522	-308.6	333.9
11	-7	17.35	105.3	-1179	1588	-984.7	543
12	-8	15.69	107.9	-305.4	1482	-761.9	165
13	-9.5	13.38	110.9	-277.5	1444	-544.8	254.1
14	-11	11.97	112.4	-506.1	1591	-344.8	340.4
15	-12	10.69	113.7	-958.2	1581	-1060	623.7
16	-13	9.563	114.7	-348	1408	-687.9	272.3
17	-14	8.196	116	-457	1625	-399.9	333.3
18	-15	7.49	117	-486.6	1913	-192.7	350.5
19	-16	6.929	118	-683.9	2010	-1181	632.6
20	-17	6.488	119.1	-753.9	1904	-935.8	629.6
21	-19	5.996	121.4	-1615	2076	-638.8	334.9
22	-20	5.64	125.3	-601.8	2784	-725.6	396.2
23	-21	5.45	128.4	-254	2954	-1191	585.8
24	-22	5.282	131.3	-212	2869	-877	324.8
25	-24	5.05	134.6	-295.7	2907	-651.6	408.2
26	-25	4.822	135.7	-333.7	3361	-948.8	507.9
27	-26	4.665	134.9	-259.2	3545	-612	523.8
28	-27	4.499	132.6	-160.9	3759	-312.1	487.2
29	-28	4.321	128.9	-49.43	3666	-111.7	503.9
30	-29	4.129	123.4	-217.9	3348	-108.3	593.4
31	-30	3.919	116.3	-447.5	2944	-97.94	694.4
32	-31	3.69	107.7	-494.7	2370	-81.25	757
33	-32	3.439	97.88	-385.4	1675	-115.4	784.2
34	-33	3.164	87.23	-330.6	911.4	-101.1	786.3
35	-35	2.545	64.95	-1255	314.1	7.53E-05	720.4
36	-36	2.206	54.09	-1838	169.1	0.000136	593.3
37	-38	1.688	39.11	-2415	-0.000696	0.000197	255.7
38	-39	1.356	30.36	-2279	-0.0008934	-334.5	7.834
39	-40	0.894	19.06	-1479	-0.00119	-566.6	0.000197
40	-41	0.598	12.41	-892.3	0.9832	-562.6	0.000167
41	-42	0.302	6.139	-366.1	74.07	-442.1	7.264
42	-43	0	0	-18.32	-0.00166	-0.4468	0.5346
Max		136		3759		786.3	
Min				-2415		-1191	

	Calculation Sheet		Date: Apr-10	Sheet No.: 1 of 1
	Project Title: MTR Contract 825 Mai Po to Ngau Tam Mei			Project No.: EB000563
	Subject: Results from FREW Analysis (Section 1)		By: MM	
Ground Movement due to Deflection of Diaphragm Wall (Results Envelope in Frew Analysis)				
Existing Ground Level		=	4.7	mPD
Level at which max. wall deflection occurs		=	-25.0	mPD
Depth at which max. wall deflection occurs (D)		=	29.7	m
Max. Deflection		=	135.7	mm
Max. Settlement		=	67.85	mm
Depth at which the zero wall deflection occurs (Do)		=	47.7	m
Level (m)	Deflection from FREW results (mm)	Level (mPD)	Vert. Movement (mm)	Distance (m)
4.7	75.02	4.7	37.51	0.00
3.0	79.07	3.0	39.54	0.85
2.0	81.48	2.0	40.74	1.35
1.0	83.93	1.0	41.97	1.85
0.0	86.44	0.0	43.22	2.35
-1.0	88.97	-1.0	44.49	2.85
-2.0	91.5	-2.0	45.75	3.35
-3.0	93.96	-3.0	46.98	3.85
-4.5	97.48	-4.5	48.74	4.60
-5.5	100.5	-5.5	50.25	5.10
-7.0	105.3	-7.0	52.65	5.85
-8.0	107.9	-8.0	53.95	6.35
-9.5	110.9	-9.5	55.45	7.10
-10.5	112.4	-10.5	56.20	7.60
-11.5	113.7	-11.5	56.85	8.10
-12.5	114.7	-12.5	57.35	8.60
-14.0	116	-14.0	58.00	9.35
-15.0	117	-15.0	58.50	9.85
-16.0	118	-16.0	59.00	10.35
-17.0	119.1	-17.0	59.55	10.85
-18.5	121.4	-18.5	60.70	11.60
-20.0	125.3	-20.0	62.65	12.35
-21.0	128.4	-21.0	64.20	12.85
-22.0	131.3	-22.0	65.65	13.35
-23.5	134.6	-23.5	67.30	14.10
-25.0	135.7	-25.0	67.85	14.85
-26.0	134.9	-26.0	67.45	16.68
-27.0	132.6	-27.0	66.30	18.50
-28.0	128.9	-28.0	64.45	20.33
-29.0	123.4	-29.0	61.70	22.15
-30.0	116.3	-30.0	58.15	23.98
-31.0	107.7	-31.0	53.85	25.80
-32.0	97.88	-32.0	48.94	27.63
-33.0	87.23	-33.0	43.62	29.45
-35.0	64.95	-35.0	32.48	33.10
-36.0	54.09	-36.0	27.05	34.93
-37.5	39.11	-37.5	19.56	37.66
-38.5	30.36	-38.5	15.18	39.49
-40.0	19.06	-40.0	9.53	42.23
-41.0	12.41	-41.0	6.21	44.05
-42.0	6.139	-42.0	3.07	45.88
-43.0	0	-43.0	0.00	47.70

	Calculation Sheet		Date:	Apr-10	Sheet No.: 1 of 1
	Project Title:		MTR Contract 825 Mai Po to Ngau Tam Mei		Project No.:
	Subject: Results from FREW Analysis (Section 3)		By:	MM	EB000563

Node	Level	Displacements		Moments		Shears	
		Min	Max	Min	Max	Min	Max
	[m]	[mm]	[mm]	[kNm/m]	[kNm/m]	[kN/m]	[kN/m]
1	4.7	33.03	74.7	0	0	0	0
2	3	40.39	76.8	-68.4	6E-06	-501.5	75.41
3	2	37.78	78	-72.9	397.9	-434	40.94
4	1	35.2	79.2	-94.15	799.5	-365.3	46.05
5	0	32.66	80.5	-143.7	1129	-283.6	132.8
6	-1	30.19	81.8	-276.6	1367	-187	238.9
7	-2	27.82	83	-572.6	1503	-739.1	360.8
8	-3	25.55	84.1	-215.1	1525	-600.9	12.94
9	-4	23.38	85.1	-223.7	1502	-425.9	137.1
10	-5.5	20.35	87.4	-234	1562	-213.4	364.2
11	-7	17.57	89.8	-777.3	1654	-734.6	606
12	-8	15.87	90.7	-672.1	1548	-500.9	461.7
13	-9.5	13.51	91.3	-1285	1210	-884.8	721
14	-10.5	12.09	91.5	-1354	991.1	-636.8	488.9
15	-11.5	10.8	91.5	-1693	817.5	-979.4	824.5
16	-12.5	9.669	91.5	-1933	790.6	-536.1	740.6
17	-14	8.304	92.3	-3285	764.2	-1337	1258
18	-15	7.603	93.3	-3202	730.6	-953.4	503.2
19	-16	7.047	94.9	-3470	608.8	-1986	546.1
20	-17	6.612	97.2	-2200	678.7	-1696	598.9
21	-18	6.272	101	-2746	818.8	-1456	164.2
22	-19	6.003	105	-1492	1557	-1505	138.5
23	-20	5.784	112	-320.9	2384	-1584	232.3
24	-21	5.6	118	-271.5	3265	-1294	582.5
25	-22	5.437	123	-225.5	3895	-984.6	86.55
26	-23	5.284	126	-183.3	4259	-703.2	248.8
27	-24	5.135	127	-144.5	4343	-432	354.8
28	-25	4.983	126	-108.4	4128	-1262	427.5
29	-26	4.824	123	-73.43	3655	-925.8	686
30	-27	4.654	118	-38.4	3071	-611.2	1015
31	-28	4.47	112	-0.9033	3175	-301.2	1356
32	-29	4.268	105	-0.0018	3319	-560.6	1709
33	-30	4.047	98	-0.0021	3090	-264	563.8
34	-31	3.803	91.1	-0.0026	2629	-38.02	559.8
35	-32	3.535	84.3	-0.0031	1998	-16.62	704.3
36	-33	3.244	76.6	-346.5	1240	0.00054	799.1
37	-34	2.93	68.2	-921.7	405.2	0.00051	847.4
38	-35	2.603	59.6	-1393	65.45	0.00051	846.5
39	-36	2.277	51.2	-1756	-0.01	0.00054	684.4
40	-37	1.974	43.5	-2025	-0.01	-12.58	347
41	-38	1.705	36.7	-2062	-0.01	-209.9	0.0005
42	-39	1.472	30.9	-1728	-0.01	-398.8	-0.0005
43	-40	1.268	26	-1265	-0.01	-463	0.0006
44	-41	1.084	21.7	-873.6	-0.01	-429.3	0.0006
45	-42	0.91	17.8	-539.3	1.47	-340.1	0.0006
46	-43	0.738	14.1	-274	74.25	-231.3	0.0007
47	-44	0.563	10.5	-76.76	122.4	-165.3	11.13
48	-45	0.385	6.96	-0.0105	75.46	-4.653	0.0007
49	-46	0	0	-0.0112	80.12	-4.653	0.0007
Max		127		4343		1709	
Min				-3470		-1986	

	Calculation Sheet		Date:	Apr-10	Sheet No.: 1 of 1
	Project Title: MTR Contract 825 Mai Po to Ngau Tam Mei			Project No.: EB000563	
	Subject: Results from FREW Analysis (Section 3)		By: MM		
Ground Movement due to Deflection of Diaphragm Wall (Results Envelope in Frew Analysis)					
Existing Ground Level		=	4.7	mPD	
Level at which max. wall deflection occurs		=	-24.0	mPD	
Depth at which max. wall deflection occurs (D)		=	28.7	m	
Max. Deflection		=	127	mm	
Max. Settlement		=	63.50	mm	
Depth at which the zero wall deflection occurs (Do)		=	50.7	m	
Level (m)	Deflection from FREW results (mm)	Level (mPD)	Vert. Movement (mm)	Distance (m)	
4.7	74.74	4.7	37.37	0.00	
3.0	76.76	3.0	38.38	0.85	
2.0	77.97	2.0	38.99	1.35	
1.0	79.21	1.0	39.61	1.85	
0.0	80.48	0.0	40.24	2.35	
-1.0	81.75	-1.0	40.88	2.85	
-2.0	82.98	-2.0	41.49	3.35	
-3.0	84.12	-3.0	42.06	3.85	
-4.0	85.14	-4.0	42.57	4.35	
-5.5	87.35	-5.5	43.68	5.10	
-7.0	89.77	-7.0	44.89	5.85	
-8.0	90.69	-8.0	45.35	6.35	
-9.5	91.33	-9.5	45.67	7.10	
-10.5	91.45	-10.5	45.73	7.60	
-11.5	91.47	-11.5	45.74	8.10	
-12.5	91.53	-12.5	45.77	8.60	
-14.0	92.26	-14.0	46.13	9.35	
-15.0	93.29	-15.0	46.65	9.85	
-16.0	94.85	-16.0	47.43	10.35	
-17.0	97.2	-17.0	48.60	10.85	
-18.0	100.6	-18.0	50.30	11.35	
-19.0	105.3	-19.0	52.65	11.85	
-20.0	111.8	-20.0	55.90	12.35	
-21.0	118.2	-21.0	59.10	12.85	
-22.0	123.2	-22.0	61.60	13.35	
-23.0	126.2	-23.0	63.10	13.85	
-24.0	127	-24.0	63.50	14.35	
-25.0	125.7	-25.0	62.85	16.00	
-26.0	122.5	-26.0	61.25	17.65	
-27.0	117.9	-27.0	58.95	19.31	
-28.0	112	-28.0	56.00	20.96	
-29.0	105.3	-29.0	52.65	22.61	
-30.0	98.02	-30.0	49.01	24.26	
-31.0	91.12	-31.0	45.56	25.92	
-32.0	84.33	-32.0	42.17	27.57	
-33.0	76.55	-33.0	38.28	29.22	
-34.0	68.16	-34.0	34.08	30.87	
-35.0	59.57	-35.0	29.79	32.53	
-36.0	51.23	-36.0	25.62	34.18	
-37.0	43.52	-37.0	21.76	35.83	
-38.0	36.73	-38.0	18.37	37.48	
-39.0	30.91	-39.0	15.46	39.13	
-40.0	25.96	-40.0	12.98	40.79	
-41.0	21.66	-41.0	10.83	42.44	
-42.0	17.77	-42.0	8.89	44.09	
-43.0	14.11	-43.0	7.06	45.74	
-44.0	10.53	-44.0	5.27	47.40	
-45.0	6.958	-45.0	3.48	49.05	
-46.0	0	-46.0	0.00	50.70	

Total Settlement

	Calculation Sheet	Date: Apr-10	Sheet No.:
	Project Title: MTR Contract 825 Mai Po to Ngau Tam Mei	Project No.:	
	Subject: Section 1 - Total Settlements	By: MM	EB000563

ASSESSMENT OF TOTAL GROUND SETTLEMENT

Diaphragm wall toe level at -42mPD with toe grout to -55mPD (with dewatering effect)

Settlement due to Diaphragm wall construction and deflection

Depth of Diaphragm Wall	L	=	46.7	m
Depth of Excavation	D	=	28.5	m
Maximum Estimated Settlement Due to Construction of Diaphragm Wall	Max Sc	=	25.0	mm
Maximum Estimated Settlement Due to Excavation	Max Se	=	67.9	mm
Depth to Maximum Wall Deflection	De	=	29.7	m (FREV analysis)

Settlement Due to Dewatering

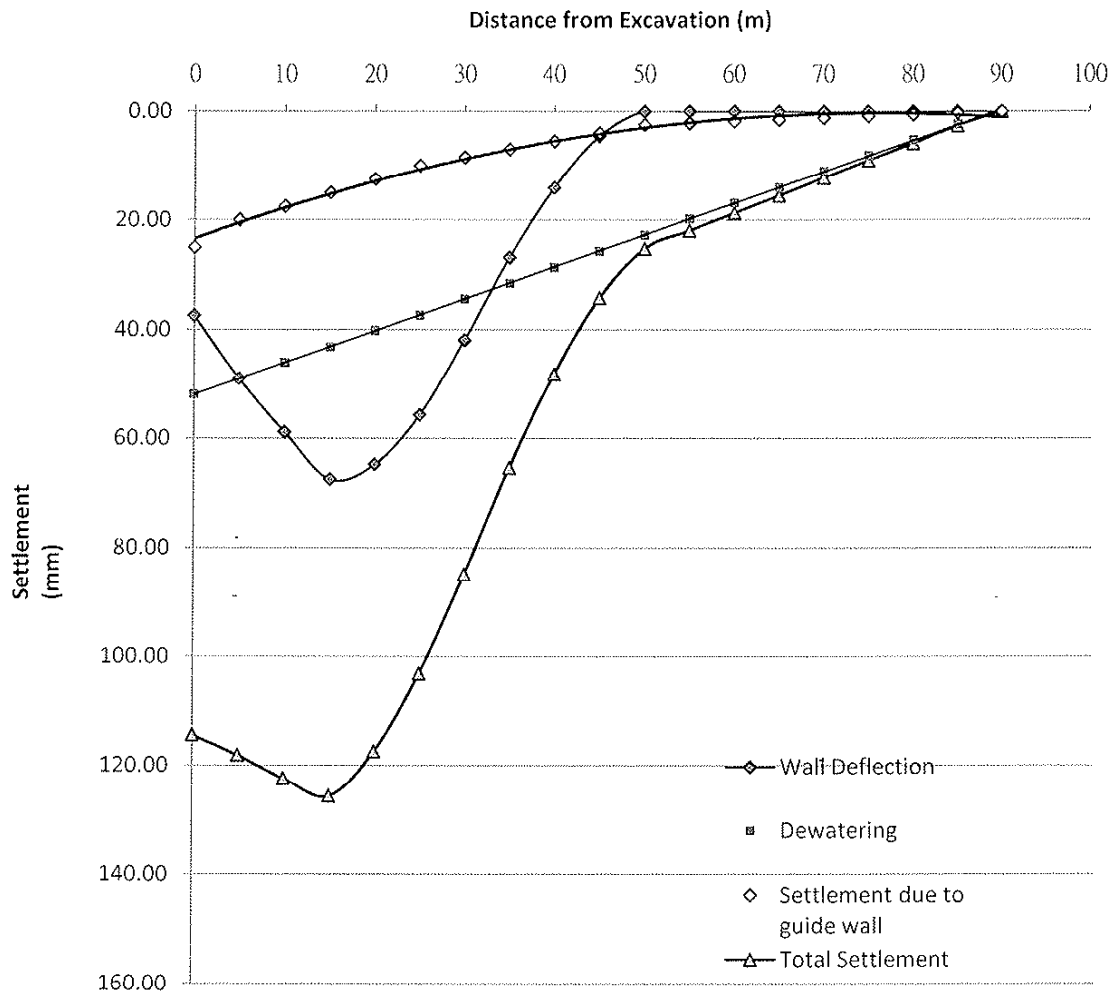
Average permeability of soil	k	=	1.61x10 ⁻⁶
Constant (for trench)	C	=	2000
Maximum Settlement Due to Dewatering	Sw	=	51.9 mm (SEEP analysis)

Summary Table of Settlement vs Distance from the Excavation (without toe grout)

Distance from the face of Excavation	Settlement Due to Wall Deflection (mm)	Settlement due to guide wall (mm)	Settlement due to Dewatering (mm)	Total Settlement (mm)
0	37.51	25.00	51.9	114.41
5	49.04	20.00	49.1	118.14
10	58.85	17.50	46.1	122.45
15	67.48	15.00	43.2	125.68
20	64.78	12.50	40.2	117.48
25	55.73	10.00	37.4	103.13
30	41.94	8.50	34.4	84.84
35	26.84	7.00	31.5	65.34
40	14.12	5.50	28.6	48.22
45	4.57	4.00	25.7	34.27
50	0.00	2.50	22.8	25.30
55	0.00	2.19	19.8	21.99
60	0.00	1.88	16.9	18.78
65	0.00	1.56	14	15.56
70	0.00	1.25	11	12.25
75	0.00	0.94	8.14	9.08
80	0.00	0.63	5.27	5.90
85	0.00	0.31	2.33	2.64
90	0.00	0.00	0.0	0.00

F 33

**Estimated Ground Settlement vs Distance from Excavation
(-42mPD with toe grout to -55mPD)**



F39

ASSESSMENT OF TOTAL GROUND SETTLEMENT
Diaphragm wall toe level at -42mPD with toe grout to -55mPD (with dewatering effect)
Settlement due to Diaphragm wall construction and deflection

Depth of Diaphragm Wall

L = 49.7 m

Depth of Excavation

D = 34.2 m

Maximum Estimated Settlement Due to Construction of Diaphragm Wall

Max Sc = 25.0 mm

Maximum Estimated Settlement Due to Excavation

Max Se = 63.5 mm

Depth to Maximum Wall Deflection

De = 28.7 m (FREV analysis)

Settlement Due to Dewatering

Average permeability of soil

 k = 1.61×10^{-6}

Constant (for trench)

C = 2000

Maximum Settlement Due to Dewatering

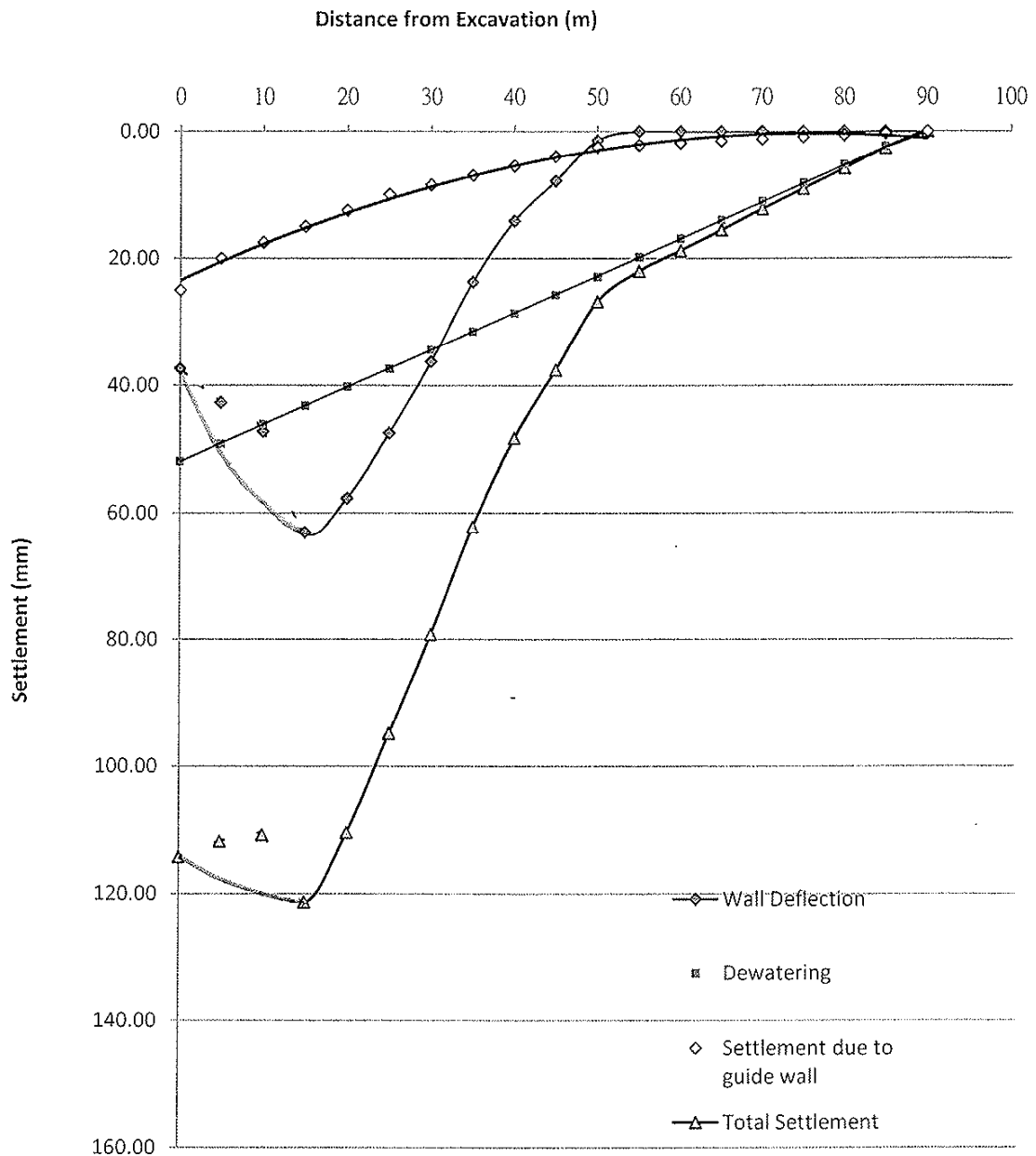
Sw = 51.9 mm (SEEP analysis)

Summary Table of Settlement vs Distance from the Excavation (without toe grout)

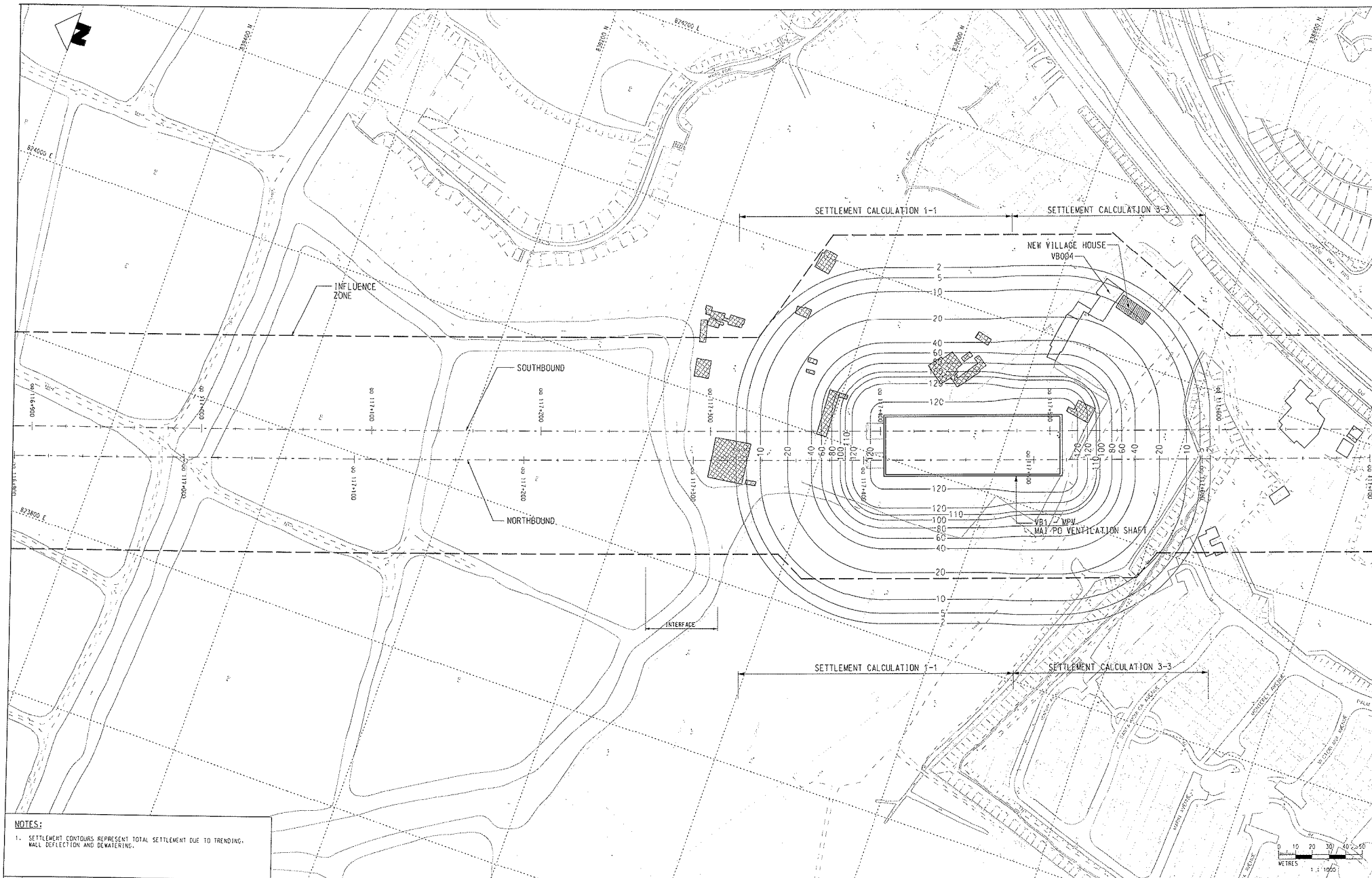
Distance from the face of Excavation	Settlement Due to Wall Deflection (mm)	Settlement due to guide wall (mm)	Settlement due to Dewatering (mm)	Total Settlement (mm)
0	37.37	25.00	51.9	114.27
5	42.72	20.00	49.1	111.82
10	47.19	17.50	46.1	110.79
15	63.11	15.00	43.2	121.31
20	57.71	12.50	40.2	110.41
25	47.47	10.00	37.4	94.87
30	36.30	8.50	34.4	79.20
35	23.70	7.00	31.5	62.20
40	14.16	5.50	28.6	48.26
45	7.88	4.00	25.7	37.68
50	1.47	2.50	22.8	26.77
55	0.00	2.19	19.8	21.99
60	0.00	1.88	16.9	18.78
65	0.00	1.56	14	15.56
70	0.00	1.25	11	12.25
75	0.00	0.94	8.14	9.08
80	0.00	0.63	5.27	5.90
85	0.00	0.31	2.33	2.64
90	0.00	0.00	0.0	0.00

F40

**Estimated Ground Settlement vs Distance from Excavation
(-45mPD with toe grout to -55mPD)**



F41



NOTES:

1. SETTLEMENT CONTOURS REPRESENT TOTAL SETTLEMENT DUE TO TRENDING, WALL DEFLECTION AND DEWATERING.

										DRAWN TK				FILE		CONTRACT 825	
										DESIGNED ML				EXPRESS RAIL LINK		MAI PO TO NGAU TAM MEI	
										CHECKED FL						MAI PO SHAFT (OPTION 2)	
										APPROVED RL		ORIGINATOR		Supported by :		GROUND SETTLEMENT CONTOURS	
										DATE 26/MAR/2010						F42	
										DO NOT SCALE DIMENSIONS. ALL DIMENSIONS SHALL BE QUOTED ON SETS. ALL DIMENSIONS SHOWN ON THIS DRAWING ARE TO BE USED FOR CONSTRUCTION. THE DIMENSIONS OF THIS DRAWING SHALL BE USED TO CHECK THE DIMENSIONS OF THE WORK. THE DIMENSIONS OF THE WORK SHALL BE USED TO CHECK THE DIMENSIONS OF THE WORK.		CAD REF.		825.C.320.PDC.T03.F1a F1.1.DGN			
REV	DESCRIPTION	BY	DATE	APPROVED	REV	DESCRIPTION	BY	DATE	APPROVED	SA	26/MAR/2010	SA	26/MAR/2010	SCALE	DRAWING NO.	REV.	
					1	REVISED TO MTR COMMENTS								1:1000 (A1)	FIGURE F-1	1	

EXPRESS RAIL LINK
 Supported by:
 Hyder Consulting Limited

CONTRACT 825
 MA1 PO TO NGAU TAM MEI
 MA1 PO SHAFT (OPTION 2)
 GROUND SETTLEMENT CONTOURS

F42

SCALE: 1: 1000 (A1)
 DRAWING NO: FIGURE F-1
 REV: 1

EXTRACTED FROM
EXISTING BUILDING IMPACT ASSESSMENT REPORT
(ARUP, 2009.)

NOTE:
1. FOR LEGEND REFER TO FIGURE SAR.001.

LEGEND

 STRUCTURES TO BE DEMOLISHED

WORK CONTRACT 826 WORK CONTRACT 825

VE1 - MIV
MAI PD VENTILATION SHAFT

NB005
TO BE
DEMOLISHED BY
OTHER PARTIES

CP6
CP117.575

0 10 20 30 40 50
METRES
1:1000

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DRAWN	TJM
DESIGNED	JUN
CHECKED	PAT
APPROVED	JUN
DATE	27/MAR/2009

MTR

EXPRESS RAIL LINK

ARUP

Supported by:
Alstom, TFP, Ferrel, DLS,
Knight Frank, SYUAN,
Urbis, BMT Asia

CONTRACT 826
HUANGGANG TO MAI PD
AFFECTED EXISTING BUILDING AND
STRUCTURES LOCATION PLANS
SHEET 3

SCALE 1:1000 (A1) DRAWING NO. FIGURE SAR.002

REV. B

PENTA-OCEAN CONSTRUCTION CO., LTD.			 PENTA-OCEAN CONSTRUCTION CO., LTD. 五洋建設
GW Drawdown Contingency Plan	Ref: CVL/GWCP/908	Revision: 3	
Express Rail Link Contract No. 825 – Mai Po To Ngau Tam Mei Tunnels			Page: 15 of 15

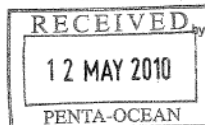
Appendix IV – Letter from Consultant

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SITE COPY

Hyder



11 May 2010

BY FAX (2598 9338) AND POST

Penta-Ocean Construction Co., Ltd.
Unit 601, K. Wah Centre,
191 Java Road,
North Point,
Hong Kong

Your Ref: -

Our Ref: EB000563-601/G10-49584

For attention of: Mr. Paul Li/ Mr. Eric Lee

Dear Sirs

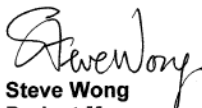
MTR Express Rail Link Contract 825 – Mai Po to Ngau Tam Mei Tunnels Excavation and Lateral Support System for Mai Po Shaft (Option 2)

We refer to the Excavation and Lateral Support System (ELS) proposed for the Mai Po Shaft where the layout as per Option 2 is followed. There are existing fish ponds located at the northern side of the shaft at a distance over 110m away.

According to the captioned ELS design, there is no groundwater drawdown at the fish pond anticipated and there is no hydrogeological impact at the fish ponds if approved construction procedures are followed.

Should you have any query, please contact our Ms Iris Chan at 2911 2753 or the undersigned at 2911 2996.

Yours faithfully
for HYDER CONSULTING LIMITED


Steve Wong
Project Manager

SW/sw