Shatin to Central Link
Consultancy Agreement No.: C1104
Detailed Design for Kai Tak Station and Associated Tunnels

Working Paper – Pile Integrity Test to Former Kowloon City Pier

Consulting Engineers • Planners • Managers

Meinhardt (Hong Kong) Ltd

Shatin to Central Link
Consultancy Agreement No.: C1104
Detailed Design for Kai Tak Station and Associated Tunnels

Working Paper – Pile Integrity Test to Former Kowloon City Pier

Prepared by : Ho-yin Wong

Signature : _____

Date : 04 JAN 2011

Checked by : Jason Wong

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Date : 04 JAN 2011

Approved by : Francis Kung

Signature : _____

Date : 04 JAN 2011

SharePoint Ref.: C1104-DED-MHK-GEO-000057

Contents Page

Appendices

1.0 INTRODUCTION

The proposed Shatin to Central Link (SCL) will provide a new strategic rail corridor from Shatin to Central, which comprises two sections: (i) Tai Wai to Hung Hom Section which is an extension of the Ma On Shan Line (MOL) via East Kowloon to connect West Rail Line (WRL) at Hung Hom; and (ii) Cross Harbour Section which is an extension of the East Rail Line (EAL) at Hung Hom across the harbour to Admiralty.

The Tai Wai to Hung Hom Section of the SCL is an approximately 11km extension of the MOL from the current overrun south of Tai Wai Station through new stations at Hin Keng (HIK), Diamond Hill (DIH), Kai Tak (KAT), Sung Wong Toi (SUW), To Kwa Wan (TKW), Ho Man Tin (HOM) and connects the WRL at the stub tunnel south of the proposed Hung Hom Station (HUH). Except for a short elevated section at Hin Keng, the Tai Wai to Hung Hom Section will be underground or at-grade.

On completion of the SCL, the above rail lines will be reorganized to two operational lines: an East West Line (EWL) from Wu Kai Sha to Tuen Mun; and a North South Line (NSL) from Lo Wu / Lok Ma Chau to Admiralty.

Meinhardt (Hong Kong) Limited was awarded the C1104 Consultancy Agreement in May 2010 to develop the design of the Kai Tak Station and the associated tunnels to allow subsequent construction from 2012 onwards.

1.1 Background

Lung Tsun Stone Bridge (LTSB) formerly projected from the original shoreline outside Kowloon Walled City into Kowloon Bay. The first phase was constructed in about 1875. Remnants of the Bridge were subsequently buried under reclamations on which former Kai Tak Airport was built. Parts of the original Bridge and a concrete extension to the Bridge constructed in the 1930s have recently been exposed in archaeological excavations. The proposed SCL alignment between KAT and SUW will pass under the underneath the remains of the 1930s construction, i.e. Former Kowloon City Pier (FKCP).

Pile Integrity Test (PIT) was carried out on 25 August 2009 by Stangers Asia Limited, initialed by Kowloon Development Office CEDD, to determine the lengths of 5 nos. of the concrete pillars of the FKCP. It was concluded that the length of the concrete pillars ranges from 9.0m to 9.5m. Extracts of the test report is enclosed in **Appendix A**.

To further investigate the pillar length of FKCP within the alignment, and ensure that the tunnel construction will not adversely affect the remains of the FKCP, the MTR Corporation Limited appointed Geotechnics & Concrete Engineering (H.K.) Limited to carry out PIT on 4 November 2010 on selected concrete pillars of the FKCP to verify the length of the pillars.

2.0 THE PILE INTEGRITY TEST

2.1 General

Total 34 nos. of concrete pillar of the FKCP are located within the alignment of the MTR Corporation tunnel alignment. 10 nos. of the concrete pillars (namely TP4, TP5, TP6, TP8, TP9, TP11, TP12, TP16, TP26 and TP29) were selected for PIT on 4 November 2010. The concrete pillars tested were selected based on their existing conditions, including the quality of concrete, surface roughness, pile alignment and cleanliness of pillar top. The remaining 24 nos. pillars were found unsuitable for the test. The location of the pillars on which PIT was carried out is shown in **Appendix B**.

2.2 Test Result and Its Interpretation

From the test results, a strong reflection of transmitted signal was observed from 1.7m to 2.2m below the pillar top level at 8 of the pillars (i.e., TP4, TP5, TP6, TP9, TP12, TP16, TP26 and TP29). For TP11, reflected signal was detected at about 2m below pillar top, similar to the results at the 8 pillars as mentioned above. However, additional signal reflections were also noted from 8.66m to 10.80m below the pillar top. For TP11, multiple reflections of transmitted signal were observed. The location at which the transmitted signal is reflected is related to various parameters, including the variance of pillar's cross-sectional area, elastic modulus and stress wave propagation speed and change of soil stratum. The test results are enclosed in **Appendix C** for reference.

From the interpretation of the test results of PIT carried out by Geotechnics & Concrete Engineering (H.K.) Limited, except for TP11, the signal reflections observed may be due to a variance of cross-sectional area of the pillar such as bulging, change of soil strata or encountering the pillar tip. Nevertheless, it cannot be confirmed that the signal reflections were due to one single of these parameters. For TP11, the multiple signal reflections observed were probably due to poor quality of the pillar. To summarize, the length of the pillars cannot be conclusively determined through the PIT on 4 November 2010.

As mentioned in Section 1.1, the estimated pillar length is between 9.0m to 9.5m according to the results of PIT in 2009. This concurred with the reflected signals observed at TP8 (from 8.66m to 10.80m), which might be due to encountering the pillar toe.

Based on the limited available technology in the 1930s and the technical knowledge we have, it was not possible to cast concrete pillars in-situ up to a pile length of 9 meters during 1930s. Moreover, concrete driven pillars or cast in-situ concrete pillars are rare at that time.

For the FKCP concrete pillars with 9 meters length constructed in the 1930s, the concrete pillars were very likely to be precast elements either in one or multiple units. It is anticipated that the precast concrete pillars were driven through the soft marine deposit stratum via hand driven impact forces. The driving process was expected to be difficult and we couldn't envisage the concrete piles could be driven beyond the soft marine deposit stratum. Based on the longitudinal geological profile at the vicinity, we believe that the possible maximum pillars length of the FKCP is unlikely to exceed 9.5m as estimated.

3.0 MEASURES TO MINIMIZE THE EFFECT ON THE LTSB AND FKCP

With the estimation that the length of the concrete pillars at the FKCP is about 9.0 to 9.5m long, various measures are proposed and they are discussed in the paragraphs below to minimum and control any possible influence to concrete pillars of the FKCP during the construction of tunnel.

Buffer Zones

It is known that a buffer zone has been set out to the remains of the LTSB and FKCP. No at-grade construction activity will be proposed within these zones to limit any influence to the LTSB and FKCP.

Shifting of Tunnels Alignment

With consideration of minimizing the possible influence to the LTSB and FKCP during the construction as well as the operational issue of railway, the tunnels alignment (both vertical and horizontal) has been revised during the Scheme Design stage. In the revised alignment, the tracks have been shifted southward so that the alignment bypasses the buffer zone of the LTSB which limit any potential influence to it during construction.

In addition, the tunnel profile is lowered with rail track level at around -14.135mPD in the vicinity of the FKCP (-12.654mPD in preliminary design alignment) so that there will be around 1.8m to 2.2m clearance between the concrete pillars' tip at FKCP and the proposed tunnels. The proposed tunnels are founded on Alluvium, which is a stiffer material than Marine Sand Deposit. The construction of mined tunnel should post no direct impact to the FKCP structure.

The tunnel alignment for preliminary design and current proposal are shown in **Appendix D** for easy reference. In addition, a tunnel section through the FKCP is attached in **Appendix E** for reference.

Compensation Grouting

Compensation grouting is also proposed as a contingency measure to control any influence to the FKCP and ascertain the FKCP without unacceptable disturbance like settlement due to proposed tunnels construction.

Geotechnical / Structural Monitoring

CEDD advice that a public engagement (PE) session for LTSB and FKCP will be conducted. Ground settlement monitoring on loose backfill material directly above LTSB and FKCP is considered irrelevant taking into account of consolidation on loosely backfilling material and thus not recommended. The discovered FKCP remain are considered as split underground structure sit on pile foundation, the vibration and settlement during the construction and operation of MTR Corporation tunnels should post no significant effect to the FKCP remain. However, general ground monitoring instrumentations including ground settlement markers, inclinometers, standpipe piezometers and vibration monitoring points are proposed near FKCP site. This is to monitor the responses of the surrounding ground and confirm that responses are within the Alert, Action and Alarm (AAA) values set out in the proposed instrumentation. The alert value is set at 25mm. The proposed ground monitoring points is shown in **Appendix F**.

Protective Work for LTSB and FKCP

Several protective works have been proposed to protect the LTSB and ground for the construction of the proposed KAT. These include, but not limited to the follows:

- No Built / Working Zone – A no built / working buffer zone has been defined to protect the sensitive LTSB / FKCP.

- Sequences of Works and preloading of strut – In order to minimize the ground movement effects arisen from the movement of the cofferdam wall during excavation. The shoring system inclusive of the pre-loading force should be reviewed as required during the course of the works.

- Grouting – Grouting will be carried out along and surrounding the mined tunnel and surrounding the slope crest of the open cut excavation to minimize the groundwater drawdown arisen from the dewatering works. It is also a kind of ground improvement measure to enhance the stability of the sensitive structure.

Mined Tunnel Section underneath FKCP

In order not to disturb the FKCP, the tunnel face is excavated in stages under cover of improved ground condition by jack-grouting and horizontal canopy tube. The exposed ground will supported by steel arches and sprayed concrete. Each excavation stage (1.5m typically) is coordinated to ensure movements in the tunnel and at surrounding ground surface are within the limit. This method will be adopted for the critical tunnel section and length of about 40m.

The advantages of mined tunnel with horizontal canopy tube + grouting method are:

- The working area for tunnelling is minimized and therefore minimizes the possibility of disturbance to the FKCP.
- The grout curtain for the mined tunnel construction can act as a kind of soil stabilization and hence enhance the deflection control on FKCP.
- Minimize the risk on excavation sequence. The construction of the mined tunnel (excluded the temporary ELS works) is approximate 6 to 8 months to ensure the unsupported excavation length for each cycle is control within 1.5m.

The construction sequence of mined tunnel is attached in **Appendix G**.

The construction of mined tunnel at both ends is not recommended as the following consideration:

- Learning period during the initial construction stage is double and is not economic for short length of tunnelling.
- The excavation length will be shorten (0.75m at both ends) to minimize the risk of construction. The construction time for the mined tunnel is more or less the same as if construction from one end.

Reference is made to the pervious submitted working paper from AECOM – Shatin to Central Link Tai Wai to Hung Hom Section WP CE21 Preservation of Lung Tsun Stone Bridge dated March 2010.

4.0 CONCLUSIONS

Based on the results of PIT carried out on 4 November 2010 and the latest proposed design of the development, several conclusions are made as follow:

- From the results of PIT carried out on 4 November 2010 by Geotechnics & Concrete Engineering (H.K.) Limited, the length of the concrete pillars at the FKCP can not be confirmed.

- The test result of TP8 on 4 November 2010 concurred with the results of PIT carried out on 25 August 2009, which found that the maximum length of the concrete pillars at the FKCP is about 9.0m to 9.5m. According to the ancient deep foundation technique at 1930's and the relatively light weight structure of FKCP, the 9.5m pile length as tested is sufficient to support the FKCP.

- The tunnel construction methods are fully considered the risk on the existing underground foundation system of FKCP. The proposed tunnel alignment is a well balanced option between the rail operational issues as well as minimizing the risk on FKCP.

- The estimated clear zone range from 1.8m to 2.2m between the tip of existing piles and top of tunnel box which provide adequate buffer zone for the construction of mined tunnel.

- Proper measures have been proposed to limit the influence to the FKCP. These include avoidance of at-grade works within buffer zones, shifting of tunnels alignments, lowering of tunnel profile, compensation grouting and geotechnical / structural monitoring system. It is considered that with these measures, all potential influence to the LTSB and FKCP due to the proposed tunnel construction will be limited and controlled.

Appendix A - Extracts of Test Report by Stangers Asia Limited in 2009

STANGERS

Lab Reference No.: GEO\PILE\PIL08B\(client)\(Site)\(Report No.)

Report on Pile Integrity Test (PIT)

Contract No. KLN/2008/05
Existing Bridge and Column

(Visit no. 1)

Date of Test: 25th August 2009

Date of Report: 26th August 2009

Report No.: 1

Tested Column No.: C1, C2, C3, C4, C5

Prepared for:

Kin Wing Construction Co., Ltd
Flat A, Blk 2, 6/F, Kin Ho Industrial Bldg,
14 – 24 Au Pui Wan Street, Fotan, Shatin

Attn.: Mr. Wong Wai Pong

Prepared by:

Stanger Asia Limited
Room 309, 3/F, Fuk Shing Commercial Building,
28 On Lok Mun Street, On Lok Tsuen,
Fanling,
New Territories,
Hong Kong

STANGERS

Lab Reference No.: GEO\PILE\PIL08B\(client)\(Site)\(Report No.)

TABLE OF CONTENTS

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STANGERS

Lab Reference No.: GEO\PILE\PIL08B\(client)\(Site)\(Report No.)

1.0 Introduction

1.1 Kin Wing Construction Co., Ltd has instructed Stanger Asia Limited to carry out Pile Integrity Test on existing bridge and column at old Kai Tak Airport.

1.2 This report contains pile integrity testing work carried out on 25th August 2009 in which a total of 5 nos. of columns were tested.

1.3 The specialist test contractor is Stanger Asia Ltd.

Note: ASTM D5882 – 2000 <u>does not</u> detail requirements for data interpretation.

References:

- PIT Manual, GRL and Associates Inc.
- Rausche, F., and Seitz, J. "Integrity Testing of Shafts and Caissons," Presented at the Specialty Session on Shafts and Caissons, the ASCE Annual Convention, Philadelphia May 1983.
- Goble, G. G., Likins, G. E., Rausche, F. "Bearing Capacity of Piles from Dynamic Measurements," Final Report, Department of Civil Engineering, Case Western Reserve University, March 1975.
- Goble, G. G., Rausche, F., Likins, G. E. "The Analysis of Pile Driving, State of the Art, Proceedings of the International Seminar on the Application of Stress Wave Theory on Piles, Stockholm, June 4-5,1980.
- Timoshenko, S., and Goodier, J. M., "Theory of Elasticity", McGraw-Hill, Second Edition, p.438,1951.
- Rausche, F., and Goble, G. G. "Determination of Pile Damage by Top Measurements," Behavior of Deep Foundations ASTM, STP 670, Raymond Lundgren, Editor, American Society for Testing and Materials, pp.500-506,1979.
- ASTM D5882 – 2000

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STANGERS

2.0 Test Method (Low Strain Method)

2.1 Pile Integrity Tester (PIT) manufactured by Pile Dynamics Inc. of the USA is used for Pile Integrity Test.

2.2 The PIT test is carried out in accordance with ASTM D5882 –2000. The test method uses signals from a hand held hammer impacting the pile top and generating a compressive stress wave in the pile. The stress wave reflections from non-uniformities or from the bottom of the pile are recorded by the pile integrity tester for future reference and analysis.

For low strain test the preparation of the pile top Surface is very important. The top surface of the test area need to be clean and clear of bentonite slurry, soil or other contaminant accumulated on the pile face during construction. The accelerometer is then attached to the top surface with a thin layer of soft paste like Vaseline, petrowax or beeswax.

After this preparation, an impact with the hand held hammer is applied. Accelerations produced by several hammer blows are integrated and displayed as velocities on the pile Integrity Tester LCD screen. Consistent velocity and force records which are selected are avenged to reduce the random noise effect and stored in the pile integrity tester digital memory processor.

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STANGERS

Lab Reference No.: GEO\PILE\PIL08B\(client)\(Site)\(Report No.)

3.0 Equipment and Apparatus

3.1 PIT Collector
Manufactured by Pile Dynamic Inc., USA. The Pile Integrity Tester is a hand Battery powered signal data acquisition unit capable of providing signals conditioning, digital signal processing, digital signal storage and, for output, an LCD screen. The system is completed with an instrument hand held hammer with an integral plastic tip and an accelerometer.

3.2 Accelerometers
Manufactured by PDI. AIC accelerometers, range linear to at least 50g, time constant of at least 0.5 second, resonant frequency 30 kHz.

3.3 Instrumented Hammers
Manufactured by PDI, inclusive of accelerometers

3.4 Bonding materials such as petroleum wax or Vaseline

3.5 Site Forms and Stationary

3.6 Copies of Calibration Certificates and Method Statement PIL08

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Lab Reference No.: GEO\PILE\PIL08B\(client)\(Site)\(Report No.)

4.0 Column Information (Given by the Client)

The column information given by the client is listed as follow:

Column No.	C1	C5	C2
Cross Section Dimension Area	0.35m x 0.35m	0.35m x 0.35m	0.35m x 0.35m
Given Pile Length (m)	10	10	10
Wave Speed (m/s)	3500	3500	3500
Cast / Installation Date	N/A	N/A	N/A

Column No.	C3	C4	
Cross Section Dimension Area	0.35m x 0.35m	0.35m x 0.35m	
Given Pile Length (m)	10	10	
Wave Speed (m/s)	3500	3500	
Cast / Installation Date	N/A	N/A	

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STANGERS

Lab Reference No.: GEO\PILE\PIL08B\(client)\(Site)\(Report No.)

5.0 Test Results

The summaries of the test results are as follows:

Column No.	Computed Pile Length (m) *
C1	9.0
C5	9.5
C2	9.0
C3	9.5
C4	9.0

Remark:

1. The computed pile length was taken from Pile Integrity Tester only.
2. Wave speed was given by the Client, and will have directly impact of the result. The wave speed for concrete can range between 2,900 m/s to 4,500 m/s and shall depend on the strength of the tested concrete column. Client has selected 3,500 m/s as the tested concrete wave speed for this test.
3. The tie beam associated with the tested column has directly impact of the result.
4. The preparation of the column top surface is very important and will have directly impact of the result.

Remark: Precision and Bias : The precision of this test method for direct measurement of strain and acceleration in a pile by means of low-strain dynamic testing has not been determined. The precision cannot be determined due to the variability of the pile, and the soil surrounding the pile. There is no accepted reference value for this test method, therefore bias cannot be determined

Prepared by

p.p. Wilson Fok

Certified by

Managing Director
David Robert Wylie
For and on behalf of
Stanger Asia Limited

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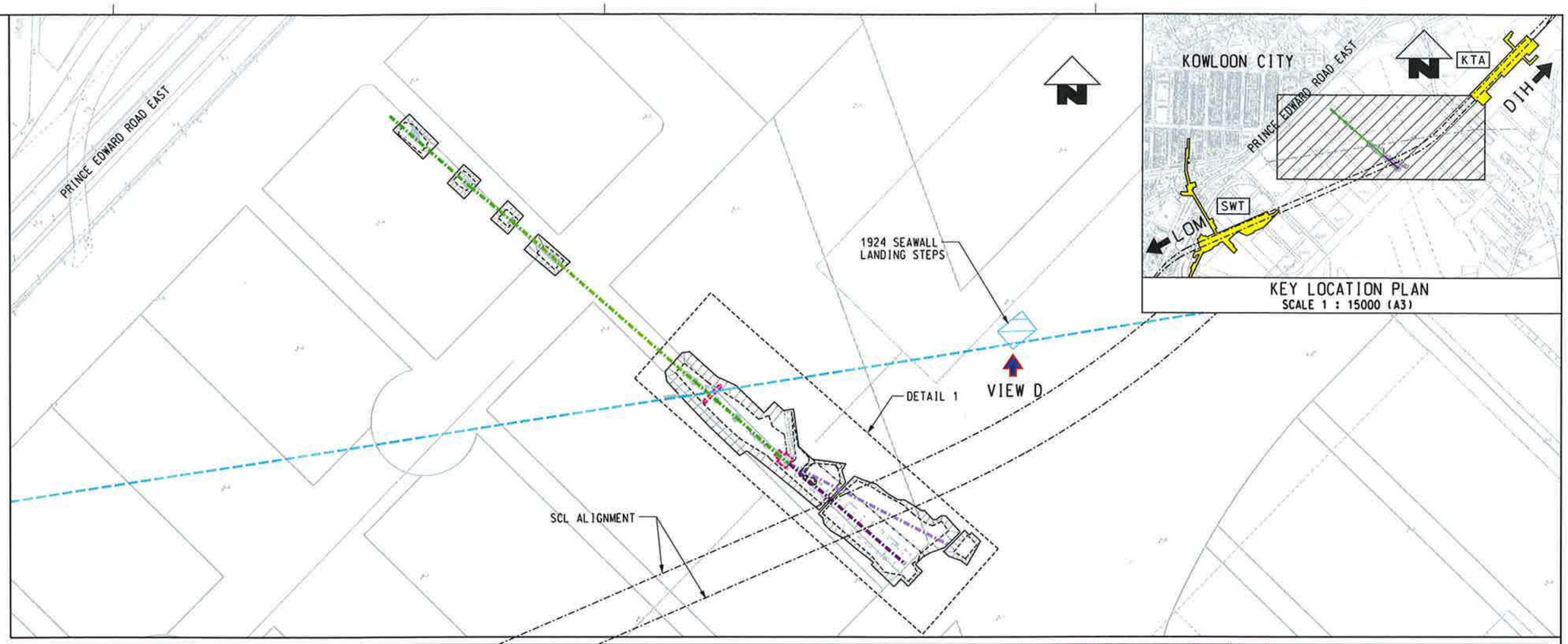
VIEW A
LONGJIN PIER

VIEW B
PIER END STRUCTURE (PES)

VIEW C
SUPPORTING PILLARS OF FORMER KOWLOON CITY PIER

VIEW D
1924 SEAWALL LANDING STEPS



KEY LOCATION PLAN
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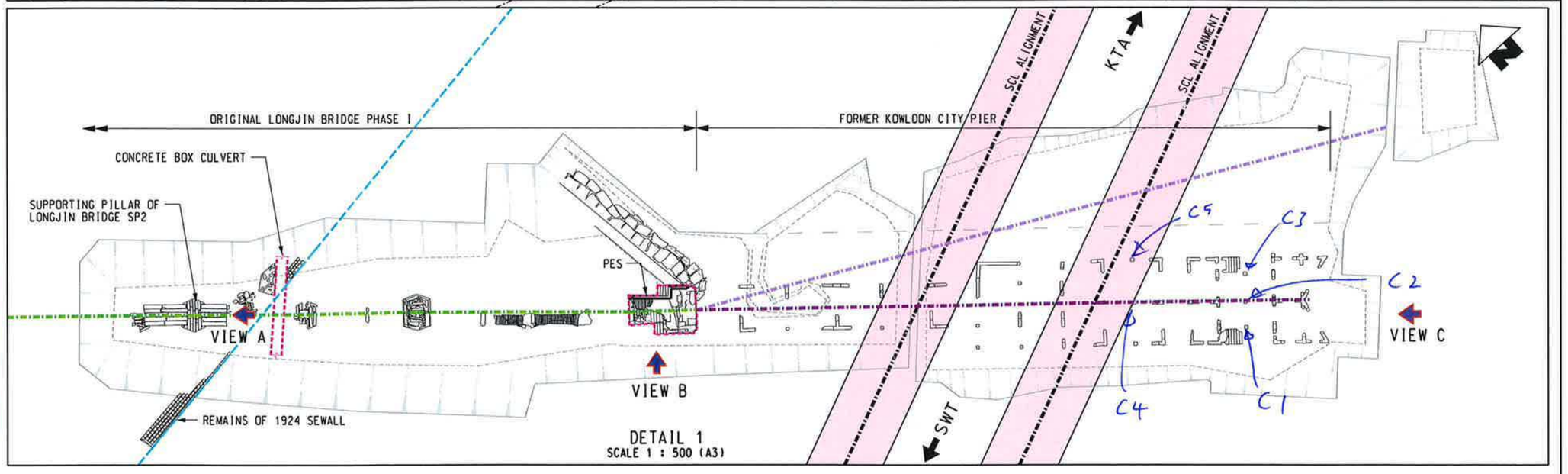

DETAIL 1
SCALE 1 : 500 (A3)

LEGEND:

ORIGINAL LONGJIN BRIDGE PHASE 1

ORIGINAL LONGJIN BRIDGE EXTENSION PHASE 2 & 3 (DEMOLISHED BEFORE 1932s)

FORMER KOWLOON CITY PIER

1924 SEAWALL/COASTLINE

REV	DESCRIPTION	BY	DATE	APPROVED	REV	DESCRIPTION	BY	DATE	APPROVED

DRAWN	KTH
DESIGNED	DYHP
CHECKED	JHW
APPROVED	IMW
DATE	24/AUG/2009

MTR

SHATIN TO CENTRAL LINK

ORIGINATOR

AECOM

in association with Atkins, PBA, Aedas, MVA, EDAW, and DLS

CADD REF. NEX2201_K_000_MCA_C01_295A.dgn

TITLE

NEX/2201 - TAW TO HUH SECTION
PRELIMINARY DESIGN
INTERFACE BETWEEN LONGJIN BRIDGE AND SCL ALIGNMENT

SCALE	FIGURE NO.	REV.
1 : 2000(A3)	1	A

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PRINTED BY: yuliung
16/10/2009 9:35:23 AM

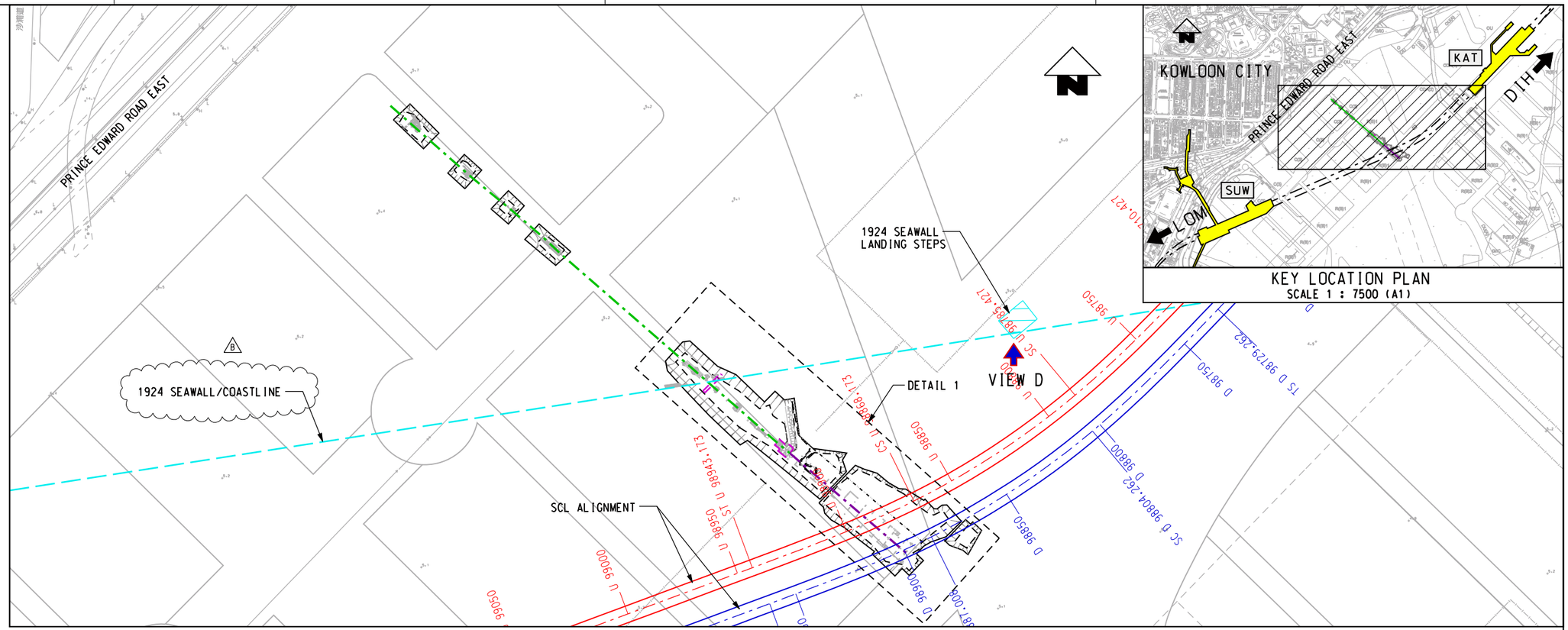
Appendix B - Location of Concrete Pillars under Pile Integrity Test on 4 Nov 2010

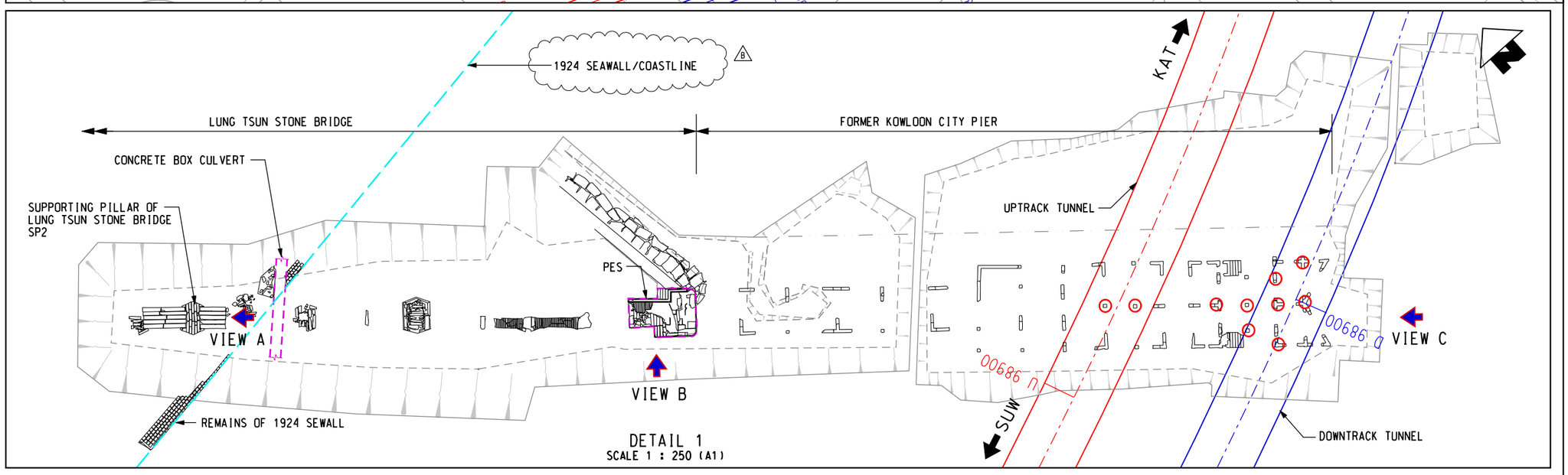
VIEW A
LUNG TSUN STONE BRIDGE PIER

VIEW B
PIER END STRUCTURE (PES)

VIEW C
SUPPORTING PILLARS OF FORMER KOWLOON CITY PIER

VIEW D
1924 SEAWALL LANDING STEPS





LEGEND:

LUNG TSUN STONE BRIDGE

FORMER KOWLOON CITY PIER

1924 SEAWALL/COASTLINE

O Concrete Pillars successfully tested on 4 Nov 2010

REV	DESCRIPTION	BY	DATE	APPROVED
B	RESPONSE TO COMMENTS	HYW	17SEP10	RC
A	FIRST ISSUE	HYW	23AUG10	RC

DRAWN	TWY
DESIGNED	HYW
CHECKED	AW
APPROVED	RC
DATE	20/AUG/2010

MTR

SHATIN TO CENTRAL LINK

ORIGINATOR

MEINHARDT
Meinhardt (Hong Kong) Ltd. Consulting Engineers
邁進(香港)工程顧問有限公司

in association with
Aedas, Mott MacDonald, MVA, DLS, Wilkinson Murry, Evans & Peck, AA

CADD REF. GMR_FIG_02.3B.dgn

TITLE
CONTRACT 1108
KAI TAK STATION
INTERFACE BETWEEN LUNG TSUN STONE BRIDGE AND TUNNEL ALIGNMENT LAYOUT PLAN

SCALE AS SHOWN (A1)

DRAWING NO. FIGURE 2.3

REV. B

PLOT DRV: is\CIID4\CADD\ME\CAD_ADMIN\MTR\Plot_Driver\PDF_Color_300dpi_080923.pltPRINTED BY: Default 07/10/2010 5:04:46 PM
MODELNAME: zhangll
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Appendix C - Results of Pile Integrity Test Carried Out on 4 Nov 2010

GROUND INVESTIGATION REPORT

By

GEOTECHNICS & CONCRETE ENGINEERING (HONG KONG) LTD.

FINAL REPORT OF PILE INTEGRITY TESTS AT REMNANTS OF FORMER KOWLOON CITY PIER

CLIENT ....MTR Corporation Limited....

CONTRACT NO. ....11202....

JOB NO. / WORKS ORDER NO. ....GCE1001SI....

PROJECT TITLE ....Contract No. 11202 Stage II Ground Investigation for Shatin to Central Link....

Checked and Certified by:

6 KO SHAN ROAD,
GROUND FLOOR,
HUNG HOM, KOWLOON,
HONG KONG.
TEL.: 852-2365 9123
FAX NO.: 852-2765 8034
E-MAIL: gce@gce.com.hk

JAMES LU
Geotechnical Engineer
DATE 04 December 2010

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TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

HOKLAS 024

PILE INTEGRITY TEST REPORT

Client : MTR Corporation Limited

Address : Shatin to Central Link Project Office
9/F Citylink Plaza
1 Shatin Station Circuit
Shatin, New Territories

Project : Stage II Ground Investigation for Shatin to Central Link
Pile Integrity Tests at Remnants of Former Kowloon City Pier

No. of Test: 10

Test Ref. No.: TP4, TP5, TP6, TP8, TP9, TP11, TP12, TP16, TP26 & TP29

Date of Test: 4 November 2010

GCE Ref. No.: GCE/QC102470

Test Unit No.: QC/FT10388

Test Procedure: PIL-P3

Reported By: _____
SHUM Wai Chi
Assistant Engineer

Approved By: _____
LAU Kar Yan, Connie
Testing Manager (Piling)

GEOTECHNICS & CONCRETE ENGINEERING (H.K.) LTD.
6 KO SHAN RD., GROUND FL., HUNG HOM, KOWLOON, HONG KONG.
TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

HOKLAS 024

CONTENTS

Part A

(This part is under HOKLAS accreditation)

1.0 Introduction

Geotechnics & Concrete Engineering (H.K.) Ltd. was appointed by MTR Corporation Limited to carry out Pile Integrity Test by pulse echo method on total 10 nos. of concrete pillar under Ground Investigation Works MTRC Contract 11202. Pile Integrity Test at Remnants of Former Kowloon City Pier was conducted on 4 November 2010 and in accordance with ASTM-D5882-00.

2.0 Test Method

The main purpose of Pile Integrity Test (PIT), alternatively called low strain integrity test, is to locate pile with major or serious defects or alternately to verify the pile length by measuring and analyzing the velocity response of the pile. With this method, a pile top is impacted with a small hand-held hammer and the resulting pile top motion is measured via an accelerometer attached to the pile top. The hammer impact generating a compressive wave that propagates down the pile. The wave is reflected when a change in "impedance", the pile toe, or soil resistance effects are encountered. Impedance is related to a pile's cross sectional area, elastic modulus, and stress wave propagation speed.

The first and sometimes most important step for PIT is the preparation of the pile top surface. A smooth, clean, healthy and hard concrete top surface should be exposed from water, then the accelerometer was attached to the pile top surface with a soft paste like Vaseline, petro wax, etc. An impact was then applied with the hand held hammer and consistent records were selected.

3.0 Limitation of Test

3.1 Integrity evaluation of a pile section below a crack that crosses the entire pile cross-sectional area or a manufactured mechanical joint is not normally possible since the impact wave likely will reflect completely at the discontinuity.

3.2 Soil resistance and pile material damping effects reduce the intensity of the incident and reflected wave. For that reason, a rule of thumb suggests that the test pile length should be limited to 30 diameters (i.e. L/D should not larger than 30). But for piles through water or soft soils, the pile length may be greater than 30 diameters.

3.3 Certain reflections produce secondary and even tertiary wave reflections. This let the signal response become increasingly complex and difficult to interpret.

3.4 Shafts with multiple or highly variable impedance changes produce complex records, which are difficult or impossible to analyze after the first or second major reflection.

3.5 The accuracy of the length determination depends on the assumed wave velocity. This factor, which depends on the grade and age of the concrete, varies from pile to pile and may cause an error of the order of 5 percent.

4.0 Test Equipment

Type of Equipment	Serial No.	Equipment Ref. No.	Calibration Factor[1]
PIT Collector	2546C	T004/01/01	--
Accelerometer (A1)	17825	T004/02/01	18.4 g/V

[1] Calibration certificate no. SSD20093876 as attached in Appendix D

5.0 Pile Test Information

Pile Ref. No.	TP4	TP5	TP6	TP8	TP9	TP11	TP12	TP16	TP26	TP29
Pile Type	Concrete Pillar									
Given Pile Length (m)	Not Provided by Client									
Pile Dimension	Not Provided by Client									
Casing Top Level (mPD)	N/A									
Pile Founding Level (mPD)	Not Provided by Client									
Rock Head Level (mPD)	N/A									

* Photos of tested piles are shown in Appendix C

6.0 Test Results

The printouts of representative blow for pile no. TP4, TP5, TP6, TP8, TP9, TP11, TP12, TP16, TP26 and TP29 are presented below; the interpretation on these piles refer to Part B Section 9.0.

GEOTECHNICS & CONCRETE ENGINEERING (H.K.) LTD.
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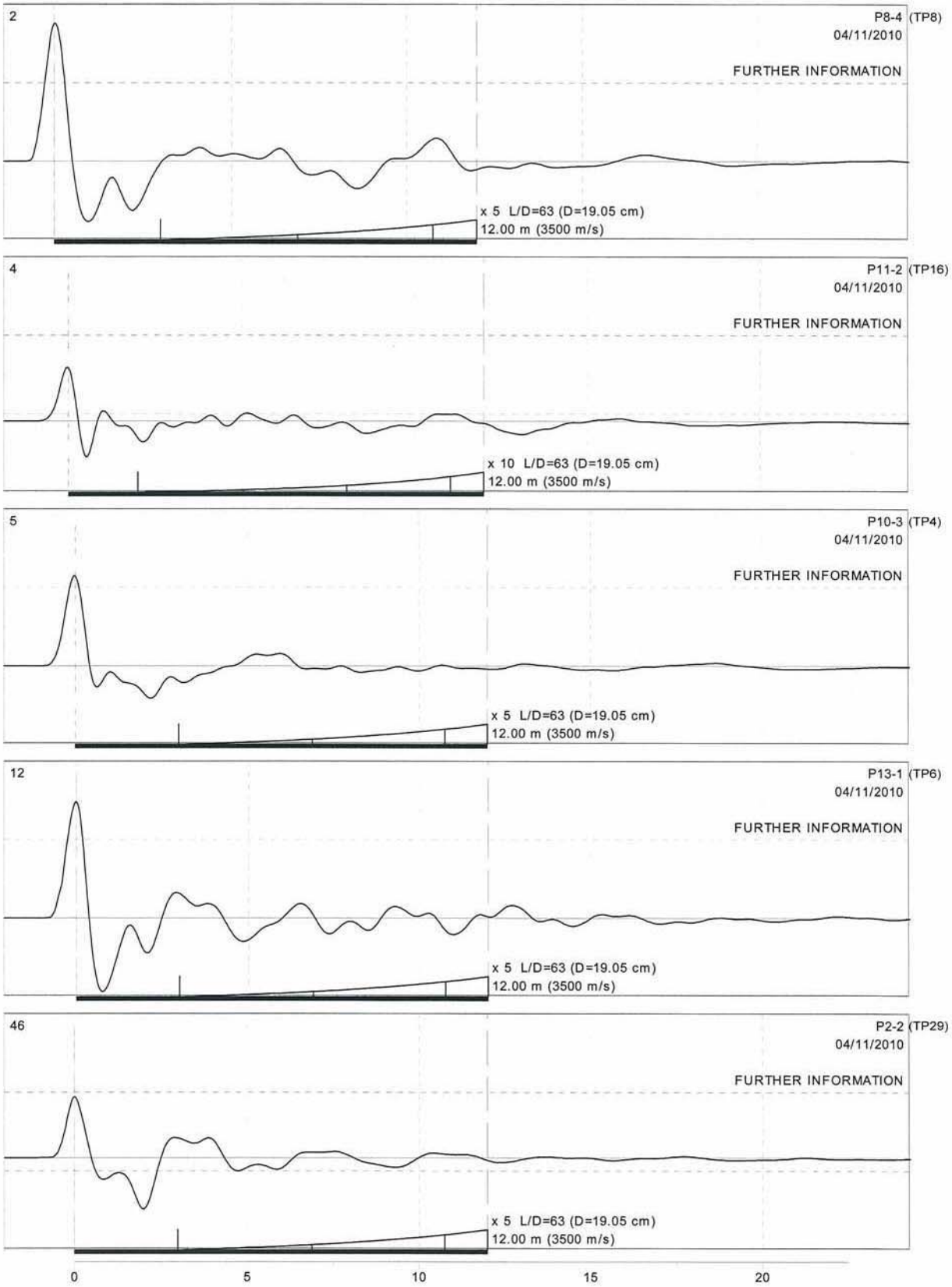
HOKLAS 024

Geotechnics & Concrete Engineering (HK) 10/11/2010

Remnants of Former Kowloon City Pier

PIT-W 2003-2



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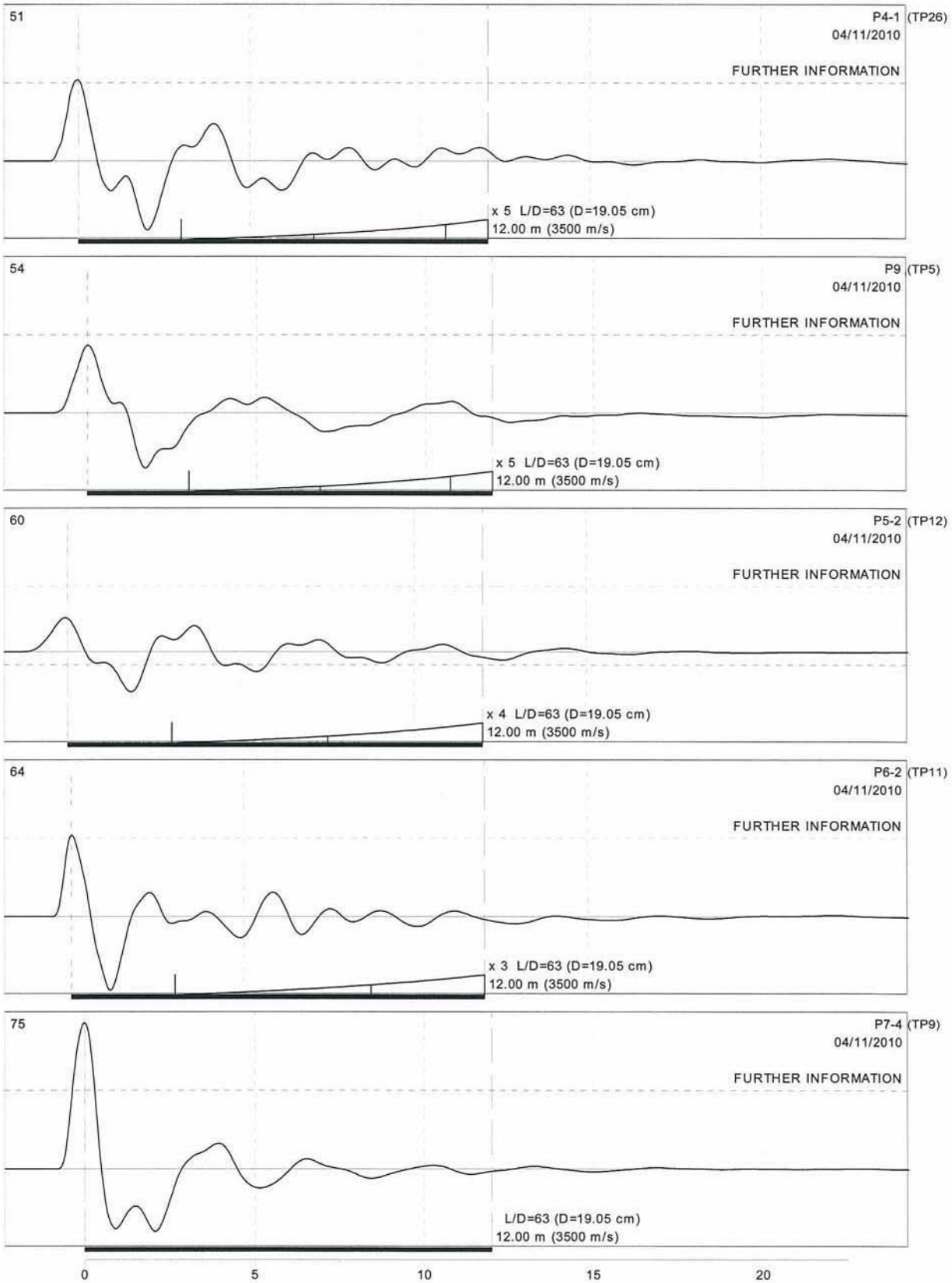
HOKLAS 024

Geotechnics & Concrete Engineering (HK) 10/11/2010

Remnants of Former Kowloon City Pier

PIT-W 2003-2



Part B

(This part is not under HOKLAS accreditation)

7.0 Site Condition Background

The remnants of Former Kowloon City Pier (FKCP) were identified in an archaeological investigation conducted under the Environmental Impact Assessment (EIA) Study of Kai Tak Development (KTD). It is about 60m long and projected obliquely from the reclamation constructed before 1924. This pile integrity test was carried out on the remnants of the FKCP. To avoid destruction and minimize impact to the remnants, no drilling or destructive activity to be carried out within 3m of the area.

8.0 Site Preparation

Total thirty-four (34) nos. of pillar were sat in the bay within Shatin to Central Link (SCL) tunnel alignment. Since ground to provide a smooth top surface or trimmed out the unsound concrete top was prohibited, visual inspection and general hammer tapping were first carried out to select the proper test piles. Factors that influenced in selection were summarized as follows:

- Concrete Quality – Poor pile head quality such as laitance on top should not be selected.
- Surface Roughness – Minor surface roughness could be overcome by smearing a thicker layer of bonding material between the pile top and accelerometer.
- Pile Alignment – Only vertical pile was suitable to test as the hammer impact had to be axial to pile alignment, in other words, pile head surface should be perpendicular to the test pile's longitudinal axis.
- Clean Pile Top – Pile head with protrude reinforcement bar or non-removable debris should not be selected.

Having inspected all the exposed piles, 9 out of 34 piles were found suitable to be tested. An addition pile, TP11, was also tested as the reference for the case of unstable test pile. Photographic records with description of the pillar condition are shown in Appendix C.

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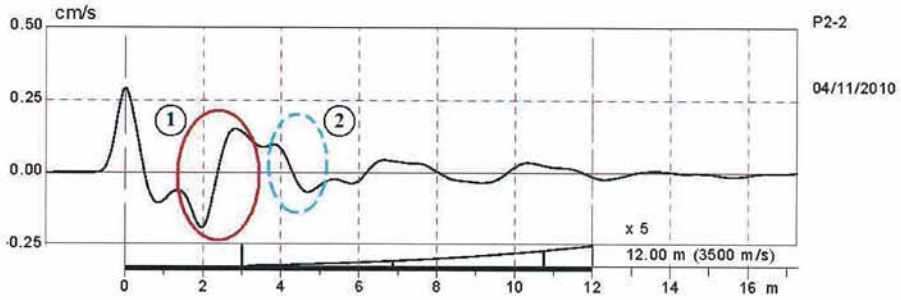
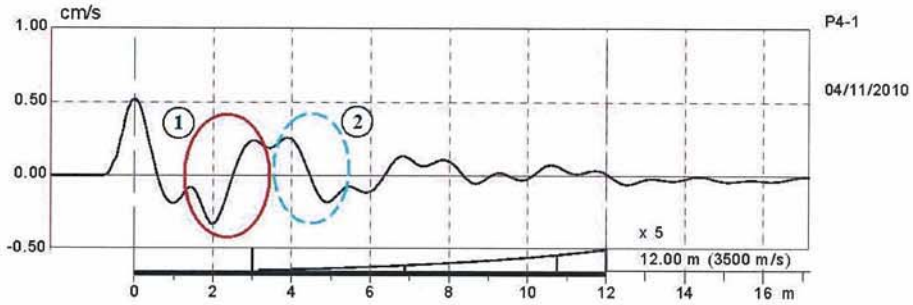
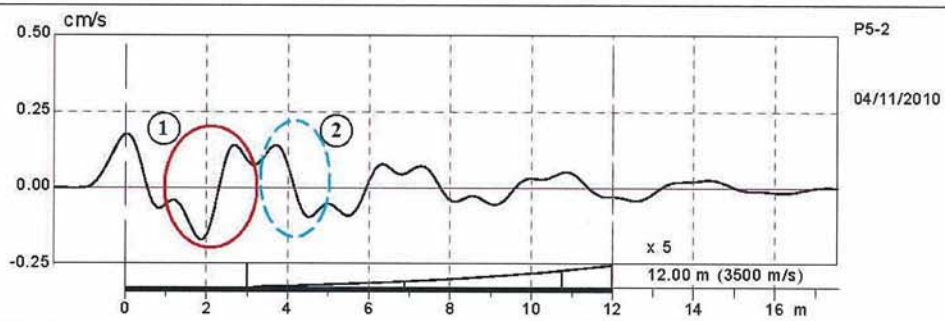
9.0 Interpretation

File No.	Pile No.	Reflectogram	Remarks[1]
P2	TP29		① Local increase of impedance is detected at approx. 2.00m below pile top. ② Second reflection of ① at approx. 3.96m.
P4	TP26		① Local increase of impedance is detected at approx. 2.00m below pile top. ② Second reflection of ① at approx. 3.96m.
P5	TP12		① Local increase of impedance is detected at approx. 1.86m below pile top. ② Second reflection of ① at approx. 3.78m.

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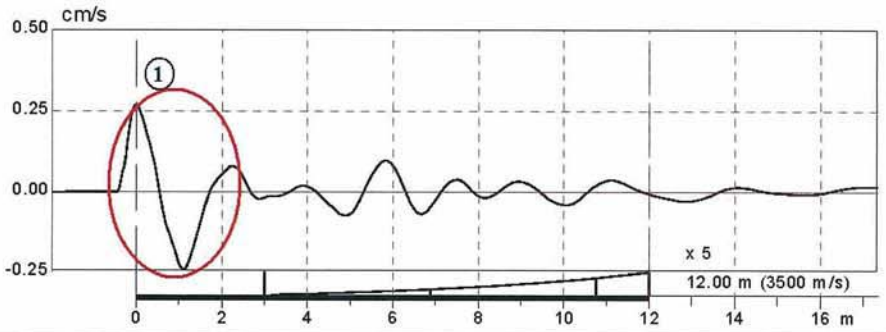
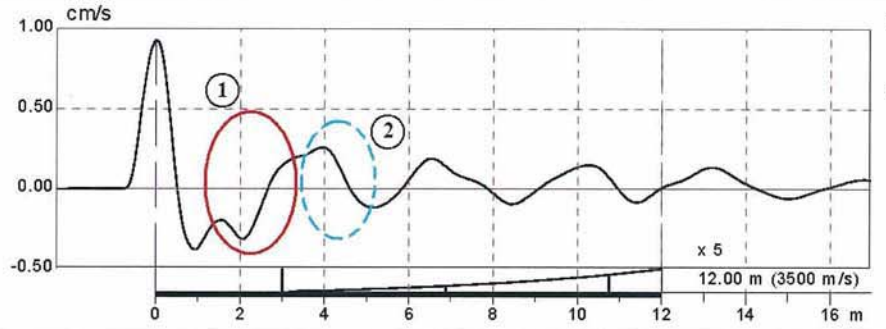
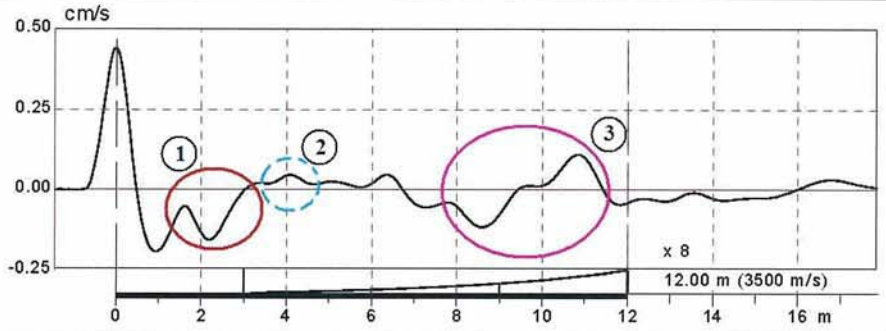
9.0 Interpretation (Cont'd)

File No.	Pile No.	Reflectogram	Remarks[1]
P6	TP11		① Significant reflection near pile top.
P7	TP9		① Local increase of impedance is detected at approx. 2.02m below pile top. ② Second reflection of ① at approx. 4.01m.
P8	TP8		① Increase of impedance is detected at approx. 2.12m below pile top. ② Second reflection of ① at approx. 4.16m. ③ Local increase of impedance is detected at approx. 8.66m.

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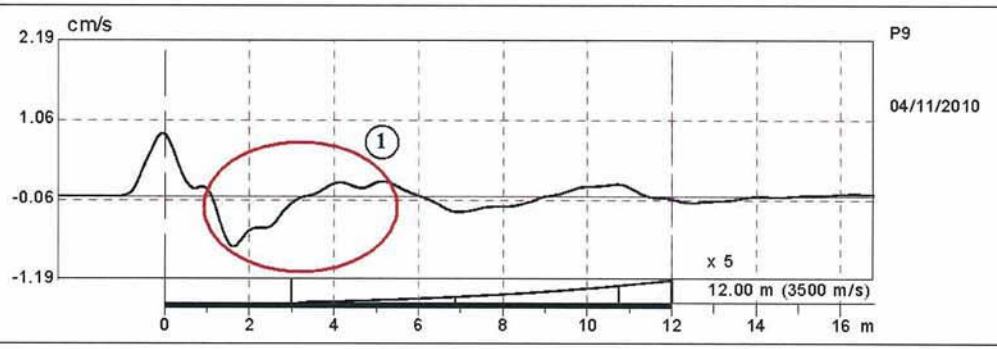
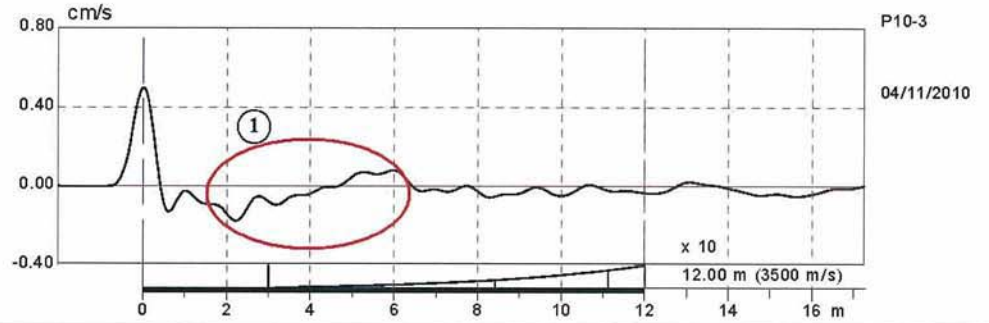
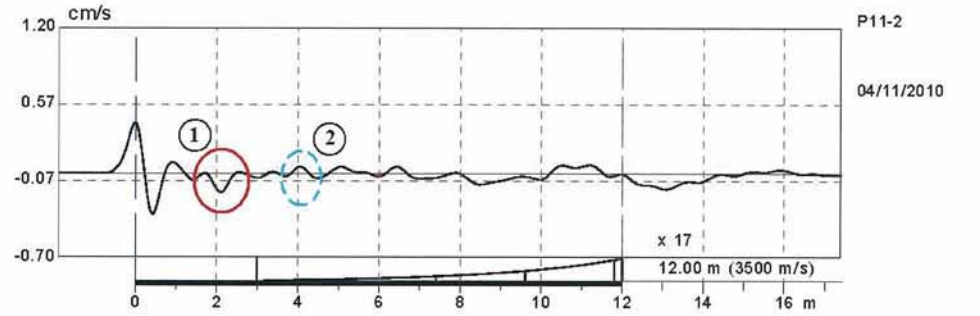
9.0 Interpretation (Cont'd)

File No.	Pile No.	Reflectogram	Remarks[1]
P9	TP5		① Increase of impedance is detected at approx. 1.71m & 2.58m below pile top.
P10	TP4		① Increase of impedance is detected at approx. 2.21m & 3.26m below pile top.
P11	TP16		① Increase of impedance is detected at approx. 2.10m below pile top. ② Second reflection of ① at approx. 4.00m.

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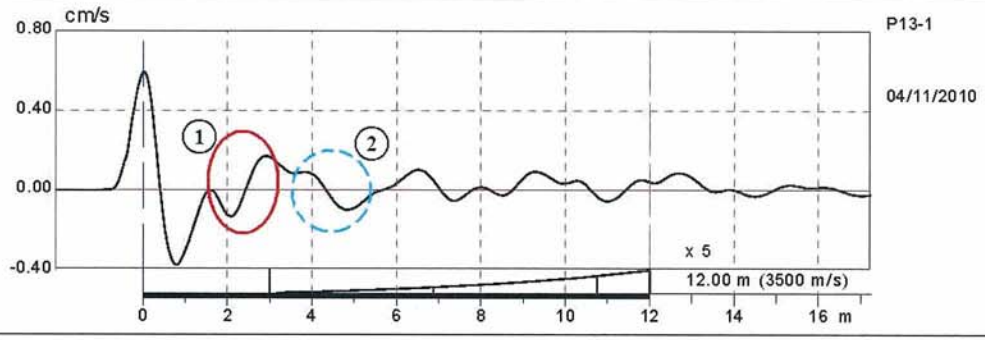
9.0 Interpretation (Cont'd)

File No.	Pile No.	Reflectogram	Remarks[1]
P13	TP6		① Local increase of impedance is detected at approx. 2.05m below pile top. ② Second reflection of ① at approx. 4.00m.

1 Generally, local change of impedance is due to localize change in either the cross sectional area or materials. An increase (decrease) of impedance is probably due to increase (decrease) of cross sectional area or drastically change of soil property, from soft to stiff (stiff to soft).

10.0 Conclusions

Similar pattern is noted from the pile integrity results of pile nos. TP4, TP5, TP6, TP9, TP12, TP16, TP26, TP29. A strong reflection of an impedance increases from range between 1.7m to 2.2 below pile top level, this may due to an increase of cross sectional area such as bulging, change in structural forms or soil strata change. This major reflection causes the following multiple reflections and toe reflection is not apparent.

Alike other piles, TP8 has reflection at approx. 2.12m. Moreover, an additional reflection is noted between 8.66m and 10.80m, which may be due to a local increase of cross sectional area such as bulging, soil strata change or pile toe reflection.

The data is inconclusive for TP11. Multiple reflections are noted probably because of poor pile top quality, low concrete strength or major impedance changes near pile top which block signals to travel through the shaft.

To conclude the results from all the tested piles, no definite pile length can be determined by this pile integrity test method due to its inherent limitation.

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Appendix A

Pile Location Plan

(1 page)

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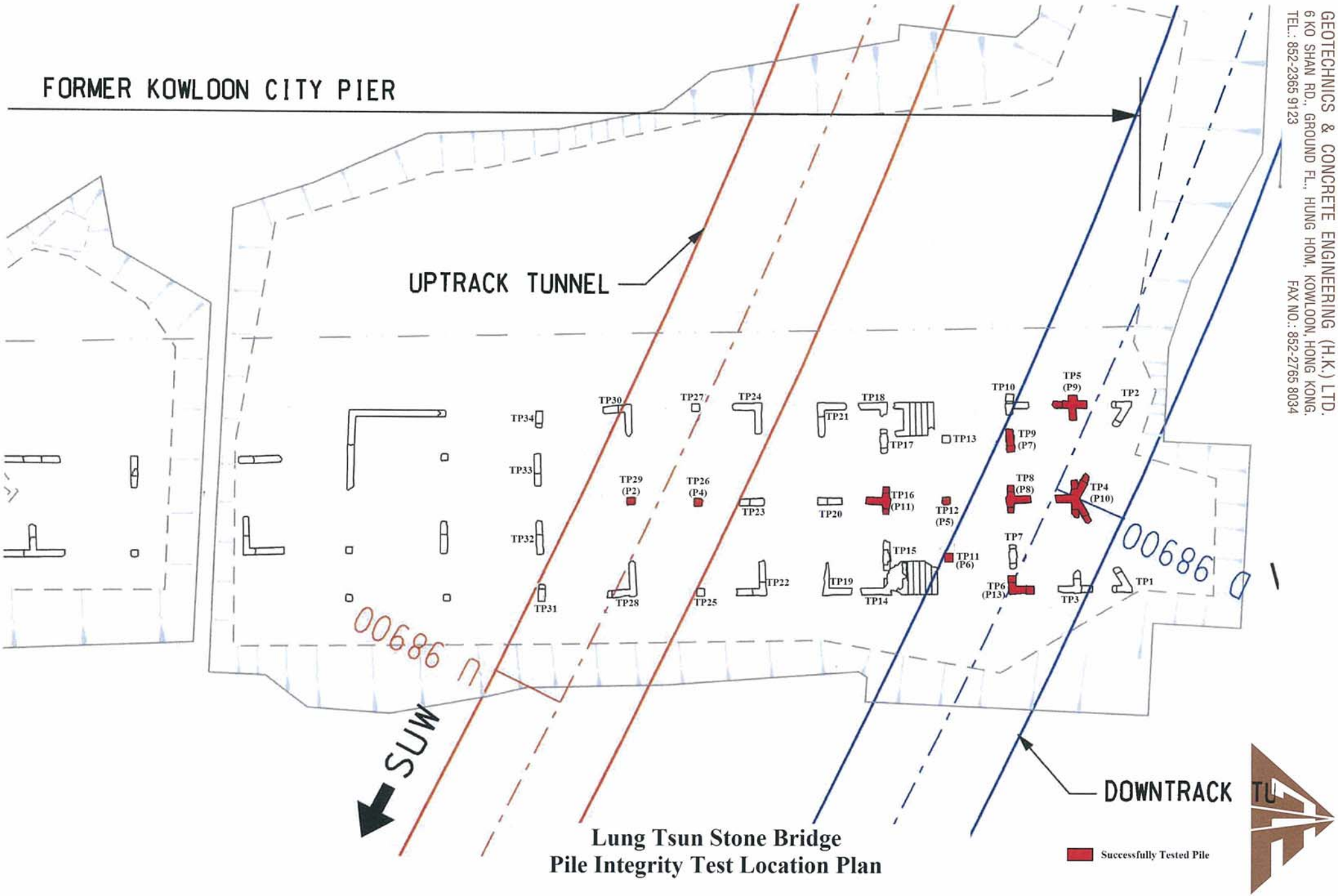

Lung Tsun Stone Bridge
Pile Integrity Test Location Plan

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Appendix B

Test Equipment and Field Test Photo

(1 page)

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Test Equipment & Field Test Photo

Plate 1: Pile Integrity Test Equipment

Plate 2: Pile Integrity Test on Site

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Appendix C

Photographic Record

(12 pages)

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Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP1 **Description:** Not suitable for test - buried pile	
Pile No.: TP2 **Description:** Not suitable for test - buried pile	
Pile No.: TP3 **Description:** Not suitable for test - exposed steel bar	

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TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP4 **Description:** Tested (also known as P10)	
Pile No.: TP5 **Description:** Tested (also known as P9)	
Pile No.: TP6 **Description:** Tested (also known as P13)	

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TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP7 **Description:** Not suitable for test - exposed steel bar & surface roughness	
Pile No.: TP8 **Description:** Tested (also known as P8)	
Pile No.: TP9 **Description:** Tested (also known as P7)	

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TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP10 **Description:** Not suitable for test - surface roughness	
Pile No.: TP11 **Description:** Tested (also known as P6) but poor conceret quality of pile head	
Pile No.: TP12 **Description:** Tested (also known as P5)	

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TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP13 **Description:** Not suitable for test - exposed steel bar	
Pile No.: TP14 **Description:** Not suitable for test - surface roughness	
Pile No.: TP15 **Description:** Not suitable for test - surface roughness	

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TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP16 **Description:** Tested (also known as P11)	
Pile No.: TP17 **Description:** Not suitable for test - surface roughness	
Pile No.: TP18 **Description:** Not suitable for test - surface roughness	

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TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP19 **Description:** Not suitable for test - exposed steel bar & debris on top	
Pile No.: TP20 **Description:** Not suitable for test - buried pile	
Pile No.: TP21 **Description:** Not suitable for test - poor concrete quality of pile head	

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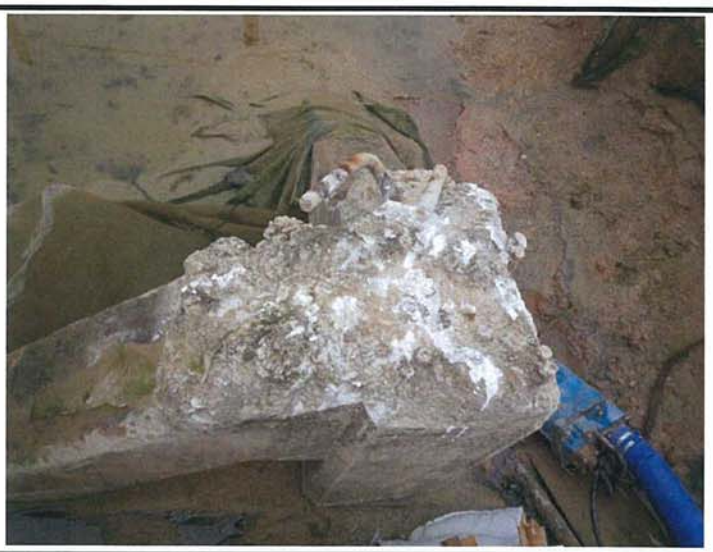
Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP22 **Description:** Not suitable for test - surface roughness	
Pile No.: TP23 **Description:** Not suitable for test - poor concrete quality of pile head	
Pile No.: TP24 **Description:** Not suitable for test - surface roughness	

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TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP25 **Description:** Not suitable for test - surface roughness	
Pile No.: TP26 **Description:** Tested (also known as P4)	
Pile No.: TP27 **Description:** Not suitable for test - exposed steel bar	

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Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP28 **Description:** Not suitable for test - surface roughness	
Pile No.: TP29 **Description:** Tested (also known as P2)	
Pile No.: TP30 **Description:** Not suitable for test - surface roughness	

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TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP31 **Description:** Not suitable for test - surface roughness	
Pile No.: TP32 **Description:** Not suitable for test - surface roughness	
Pile No.: TP33 **Description:** Not suitable for test - surface roughness	

GEOTECHNICS & CONCRETE ENGINEERING (H.K.) LTD.
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TEL.: 852-2365 9123 FAX NO.: 852-2765 8034

Photographic Records of Pillar Condition

Client : MTR Corporation Ltd.

Project : MTR Contract 11202 - Remnant of Former Kowloon City Pier

Pile No.: TP34	
Description: Not suitable for test - surface roughness	

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Appendix D

Calibration Certificate

(7 pages)

华南国家计量测试中心
广东省计量科学研究院
SOUTH CHINA NATIONAL CENTER OF METROLOGY
GUANGDONG INSTITUTE OF METROLOGY

CNAS 校准 CNAS L0730

校准证书
CALIBRATION CERTIFICATE

证书编号 Certificate No. SSD20093876

委托方 Client: Geotechnics & Concrete Engineering (H.K.) Ltd.

委托方地址 Add. of Client: 6 Ko Shan Road, G/F., Hung Hom, Kowloon, Hong Kong.

计量器具名称 Description: PILE INTEGRITY TESTER

型号规格 Model/Type: PIT

制造厂 Manufacturer: PILE DYNAMICS INC.

出厂编号 Serial No.: 2546C(T004/01/01)

接收日期 Date of Receipt: 2009年(Y) 11月(M) 23日(D)

校准日期 Date of Calibration: 2009年(Y) 11月(M) 27日(D)

GEOTECHNICS & CONCRETE ENGINEERING (HONG KONG) LIMITED CONTROLLED COPY

批准人 Approved Signatory 陈柏程

核验 Inspected by 杨德成

校准 Calibrated by 杨德俊

证书专用章

本中心地址：中国广州市广园中路松柏东街30号 邮政编码：510405
电话：(8620)86594172 传真：(8620)86590743 E-mail：scm@scm.com.cn
Add: No.30, Songbaidong Street, Guangyuanzhong Road, Guangzhou, P. R. China
Post Code: 510405 Tel: (8620)86594172 Fax: (8620)86590743

说　明

证书编号 SSD20093876
Certificate No.

DIRECTIONS

1. 本中心是国家质量监督检验检疫总局在华南地区设立的国家法定计量检定机构，计量授权证书号是：（国）法计（2007）01043号、（国）法计（2007）01032号。
This laboratory is the National Legal Metrological Verification Institution in southern China set up by the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ) under authorization certificates No.(2007)01043 & (2007)01032.

2. 本中心所出具的数据均可溯源至保存在中国计量科学研究院的国家计量基准和国际单位制(SI)。中国计量科学研究院于1999年代表中国签署了“国家计量基标准及国家计量研究院出具的校准和测量证书相互承认协议”。
All data issued by this laboratory are traceable to national primary standards maintained in National Institute of Metrology (NIM) and International System of Units (SI). NIM is the signatory to the Mutual Recognition Arrangement (MRA) for national measurement standards and for calibration and measurement certificates issued by national metrology institutes.

3. 本次校准的技术依据：
Reference documents for the calibration:

JJG 930-1998 基桩动态测量仪检定规程　V.R.of Pile Dynamic Measuring Instrument

4. 本次校准所使用的主要计量标准器具：
Major standards of measurement used in the calibration:

设备名称/型号 Name of Equipment /Model	编号 Serial No.	证书号/有效期 Certificate No. /Due Date	计量特性 Metrological Characteristic
比较法中频振动标准装置 Standard Vibrator in Middle Frequency Band (Comparison Method)	振01	[2004]国社量标华南证字第097号 /2010-03-31	参考点：U=1.0%(k=2)；通频带：U=2.0%(k=2)

CONCRETE ENGINEERING & GEOTECHNICS (HONG KONG) LIMITED
CONTROLLED COPY

5. 校准地点、环境条件：
Place and environmental conditions of the calibration:

地点 Place	声学/振动实验室 Acoustics/Vibration Lab.	温度 Temperature	(20±5) ℃	相对湿度 RH	≤80 %

6. 被校准仪器限制使用条件：
Limiting condition of the instrument calibrated:

注：1. 本证书校准结果只与受校准仪器有关。
2. 未经本中心书面批准，不得部分复制此证书。
Note:1. The results relate only to the items calibrated.
2. This certificate shall not be reproduced except in full, without the written approval of our laboratory.

校 准 结 果
RESULTS OF CALIBRATION

证书编号： SSD20093876 原始记录编号： 220093876 第 3 页，共 7 页
Certification No. Record No. Page of

1 动测仪外观及工作状况：

小应变动测仪参数设置、对振动信号的触发、采集、记录及波形复原等后处理分析等功能均能正常工作。

The appearance and working statue of the PIT:

The setting of the parameter, the function of vibration signal trigger, collection, register and the wave resume of the PIT are Pass.

2 小应变动测仪系统参考灵敏度：

The system's reference sensitivity of the PIT:

配1#加速度计的系统加速度参考灵敏度（峰值，参考频率160Hz）：

The acceleration's reference sensitivity of the system with the No.1 accelerometer (peak value, f=160 Hz)

加速度标准值（m/s^2）	系统示值（m/s^2）
Acceleration Reference Value	System Indication Value
14.14	14.1

3 内置式加速度计传感器的校准系数：1#：18.4×9.8 $(m \cdot s^{-2})/V$ 2#：18.8×9.8 $(m \cdot s^{-2})/V$

The calibrated accelerometer modulus

4 小应变测量系统对反射波时间测量：见表1

The measure of the PIT time to the emanate wave: The value showed in table 1

表1 Table 1

标准信号周期（ms） The standard signal period	频率（Hz） Frequency	周期实测值（ms） Measured Value of the period	频率（Hz） Frequency	结论 Conclusion
0.500	2000.0	0.500	2000.0	合格(Pass)
0.800	1250.0	0.800	1250.0	合格(Pass)
1.587	630.0	1.588	629.4	合格(Pass)
3.175	315.0	3.180	314.5	合格(Pass)
6.250	160.0	6.250	160.0	合格(Pass)
12.50	80.00	12.50	80.00	合格(Pass)
25.00	40.00	24.98	40.03	合格(Pass)
50.00	20.00	49.96	20.02	合格(Pass)

信号处理系统对反射波时间测量误差均在±1.0%以内。

The errors of the measured signal time are within ±1.0%.

校 准 结 果
RESULTS OF CALIBRATION

5 小应变动测系统加速度测量频率响应特性（参考频率：160 Hz）：

The frequency response of the PIT (Reference frequency: 160 Hz):

5.1 配1#加速度计：见表2，表3

With No.1# acceleration: The value showed in table 2, table 3

表2 Table 2

振动频率（Hz） Frequency	加速度标准峰值（m/s^2） Acceleration Peak Value	动测仪峰值示值（m/s^2） Indication Peak Value	允差（%） MPE	结论 Conclusion
20	14.14	14.20	±10	合格(Pass)
40	14.14	14.05	±10	合格(Pass)
80	14.14	14.09	±10	合格(Pass)
160 (ref.)	14.14	14.14	±10	合格(Pass)
315	14.14	14.14	±10	合格(Pass)
630	14.14	14.19	±10	合格(Pass)
1250	14.14	14.32	±10	合格(Pass)
2000	14.14	14.69	±10	合格(Pass)

表3 Table 3

振动频率（Hz） Frequency	频响特性（%） Frequency response	允差（%） MPE	结论 Conclusion
20	0.4	±10	合格(Pass)
40	-0.6	±10	合格(Pass)
80	-0.4	±10	合格(Pass)
160 (ref.)	0.0	±10	合格(Pass)
315	0.0	±10	合格(Pass)
630	0.4	±10	合格(Pass)
1250	1.3	±10	合格(Pass)
2000	3.9	±10	合格(Pass)

校 准 结 果
RESULTS OF CALIBRATION

证书编号： SSD20093876 原始记录编号： 220093876 第 5 页，共 7 页
Certification No. Record No. Page of

5.2 配2#加速度计：见表4，表5

With No.2# acceleration: The value showed in table 4, table 5

表4 Table 4

振动频率（Hz） Frequency	加速度标准峰值（m/s^2） Acceleration Peak Value	动测仪峰值示值（m/s^2） Indication Peak Value	允差（%） MPE	结论 Conclusion
20	14.14	14.27	±10	合格(Pass)
40	14.14	14.34	±10	合格(Pass)
80	14.14	14.05	±10	合格(Pass)
160 (ref.)	14.14	14.26	±10	合格(Pass)
315	14.14	14.38	±10	合格(Pass)
630	14.14	14.15	±10	合格(Pass)
1250	14.14	14.88	±10	合格(Pass)
2000	14.14	15.13	±10	合格(Pass)

表5 Table 5

振动频率（Hz） Frequency	频响特性（%） Frequency response	允差（%） MPE	结论 Conclusion
20	0.1	±10	合格(Pass)
40	0.6	±10	合格(Pass)
80	-1.5	±10	合格(Pass)
160 (ref.)	0.0	±10	合格(Pass)
315	0.8	±10	合格(Pass)
630	-0.8	±10	合格(Pass)
1250	4.3	±10	合格(Pass)
2000	6.1	±10	合格(Pass)

校准结果
RESULTS OF CALIBRATION

证书编号： SSD20093876 原始记录编号： 220093876 第 6 页，共 7 页
Certification No. Record No. Page of

6 小应变测量信号采集系统采样点数：

最低不少于1024点

The sampling precisions of PIT system are more than 1024.

7 对小应变测量信号后处理：

微分/积分功能正常，相位关系正常，其余功能正常。

The differential coefficient/integral function, phase relation and so on are OK, after the PIT deals with the measured signal.

8 冲击锤示值线性校准（整机灵敏度为212 g/V）：见表6

Calibration of shocker linear indication value (sensitivity : 212 g/V): The value showed in table 6

表6 Table 6

序号 No.	标准值（m/s^2） Reference Value	指示值（m/s^2） Indication Value	相对误差（%） Relative Error	允差（%） MPE	结论 Conclusion
1	510.4	485	-5.0	±10	合格(Pass)
2	644.8	611	-5.2	±10	合格(Pass)
3	918.9	918	-0.1	±10	合格(Pass)
4	1099	1100	0.1	±10	合格(Pass)
5	1220	1190	-0.5	±10	合格(Pass)
6	1323	1400	5.8	±10	合格(Pass)
7	1405	1410	0.4	±10	合格(Pass)
8	1692	1720	1.7	±10	合格(Pass)
9	2169	2310	6.5	±10	合格(Pass)
10	2495	2670	7.0	±10	合格(Pass)

校 准 结 果
RESULTS OF CALIBRATION

证书编号： SSD20093876 原始记录编号： 220093876 第 7 页，共 7 页
Certification No. Record No. Page of

说明(Note)：

1 加速度测量结果相对扩展不确定度：

Acceleration expanded uncertainty of measurement:

参考点：U=1.2%

Reference

通频带: U=2.4%

Transmission

包含因子：k=2

Coverage factor

（依据J JF1059-1999测量不确定度评定与表示）

(According to JJF1059-1999 Evaluation and Expression of Uncertainty in Measurement)

2 g为重力加速度：1 g = 9.80665 m/s^2

g is acceleration of gravity

3 1#加速度计编号：17825

Accelerometer sensor (No.1#) serial number

2#加速度计编号：17880

Accelerometer sensor (No.2#) serial number

冲击锤编号：23087

Shocker serial number

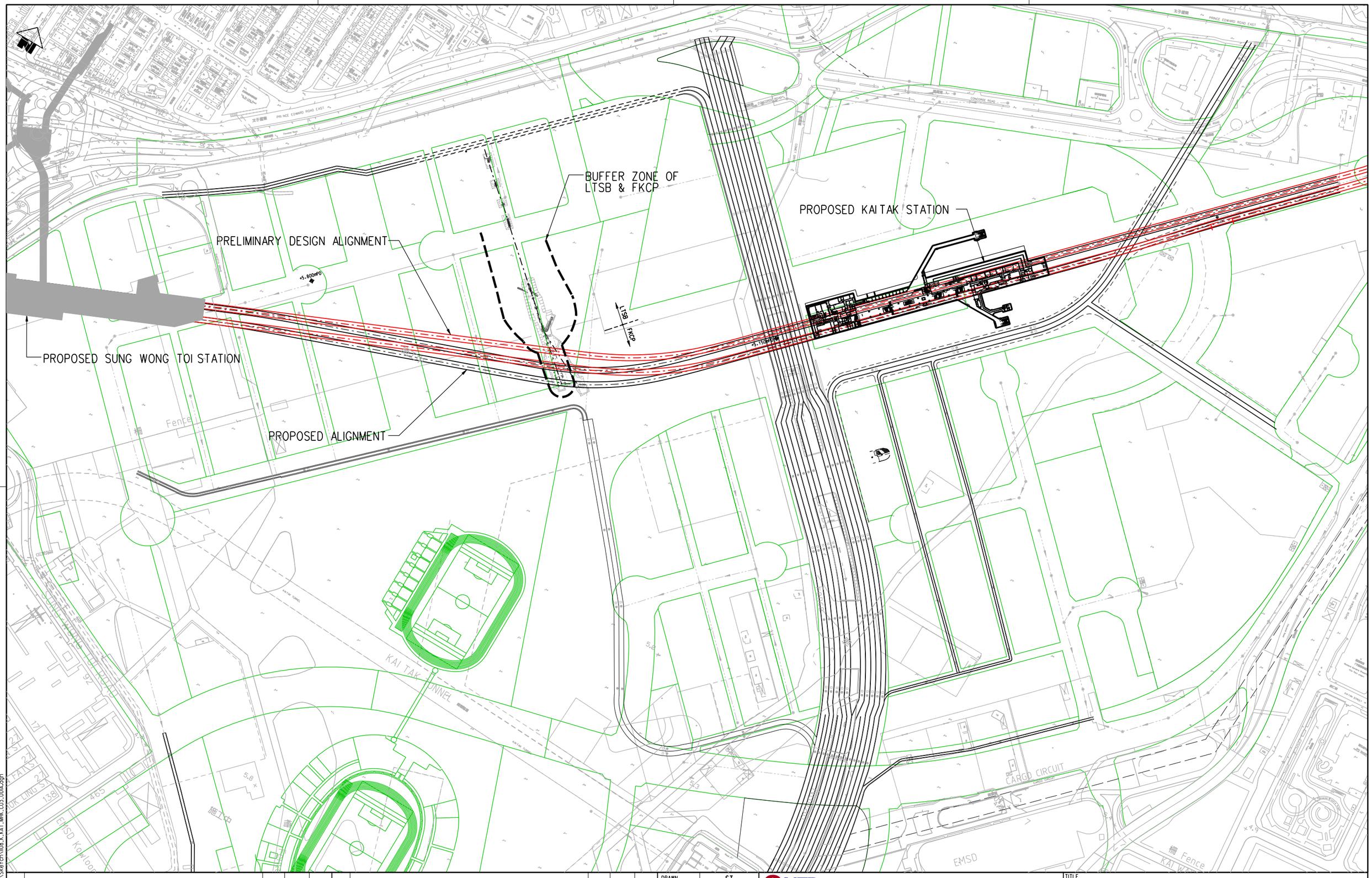
4 系统灵敏度设定值：1#：18.4 g/V 2#：18.8 g/V

System sensitivity setting value

5 建议校准周期不超过1年。

The period of calibration advised within one year.

Appendix D - Tunnel Alignment (Preliminary Design and Current Proposal)



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06/10/2010 3:49:43 PM

REV	DESCRIPTION	BY	DATE	APPROVED
A	FIRST ISSUE	NN	17DEC10	FK

DRAWN	ST
DESIGNED	NN
CHECKED	JAS
APPROVED	FK
DATE	17DEC10

MTR

SHATIN TO CENTRAL LINK

ORIGINATOR

MEINHARDT
Meinhardt (Hong Kong) Ltd. Consulting Engineers
邁進(香港)工程顧問有限公司

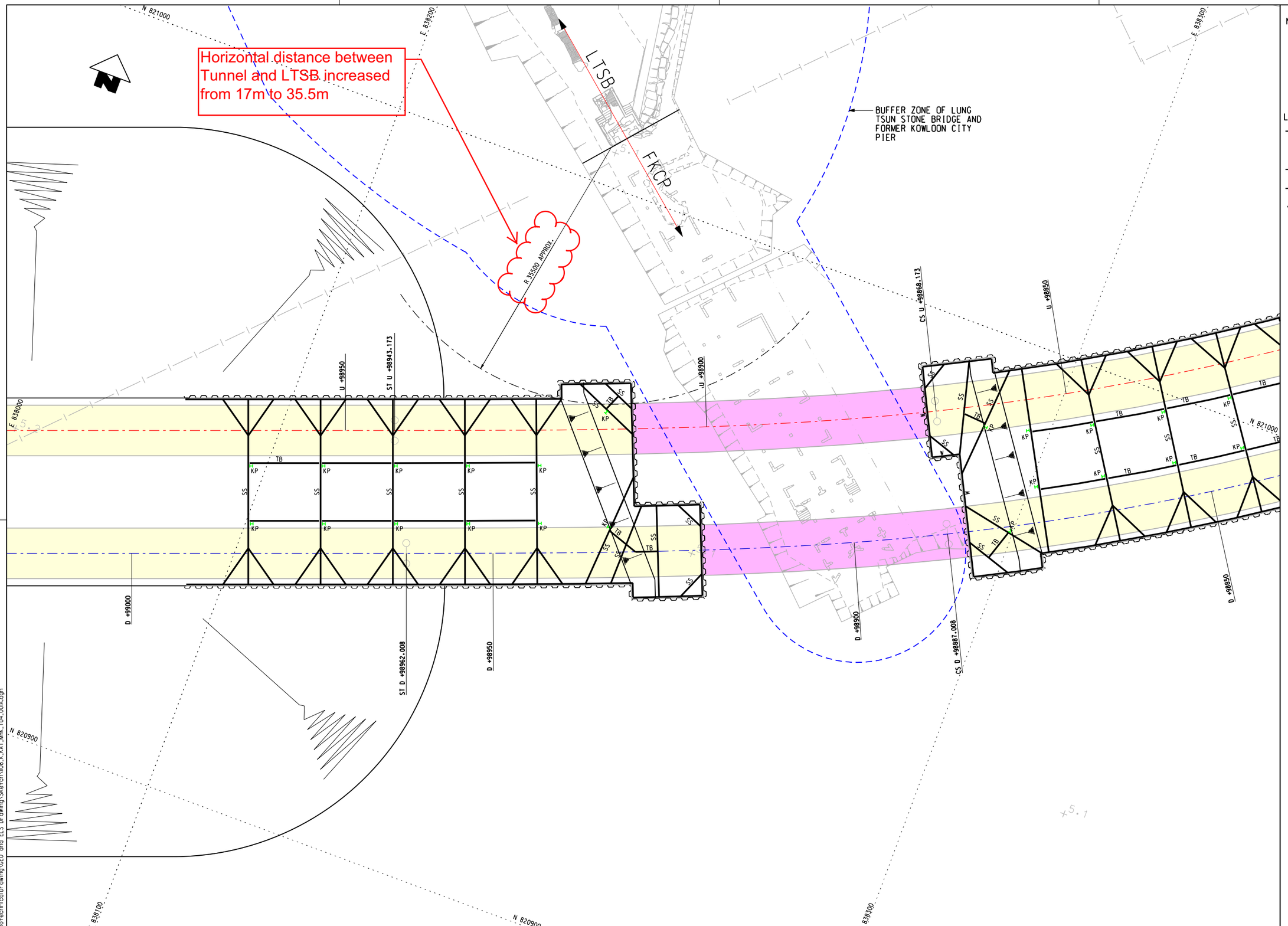
in association with
Aedas, Mott MacDonald, MVA, DLS, Wilkinson Murry, Evans & Peck, AA

CADD REF.
1108_K_KAT_MHK_C03_001C.dgn

TITLE
CONTRACT 1108
KAI TAK STATION
TUNNEL ALIGNMENT ALTERNATIVES

SCALE	DRAWING NO.	REV.
AS SHOWN (A1)	1108/K/KAT/MHK/C03/001	A

Horizontal distance between Tunnel and LTSB increased from 17m to 35.5m



NOTES:

1. ALL TEMPORARY WORKS ARE FOR INFORMATION ONLY.
2. FOR GENERAL NOTES & TYPICAL DETAILS REFER TO DRAWING NO. 1108/P/KAT/MHK/T04/001 TO 004.

LEGEND:

- W — WALING (FOR INFORMATION ONLY)
- KP — KING POST (FOR INFORMATION ONLY)
- TB — TIE BEAM (FOR INFORMATION ONLY)
- SS — STEEL STRUT (FOR INFORMATION ONLY)
- SHEET PILE WALL

FOR INFORMATION

0 2.5 5 7.5 10 12.5
METRES
1 : 250

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REV	DESCRIPTION	BY	DATE	APPROVED
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A	FIRST ISSUE	HYW	23AUG10	RC

DRAWN	RL
DESIGNED	HYW
CHECKED	AW
APPROVED	RC
DATE	21DEC10

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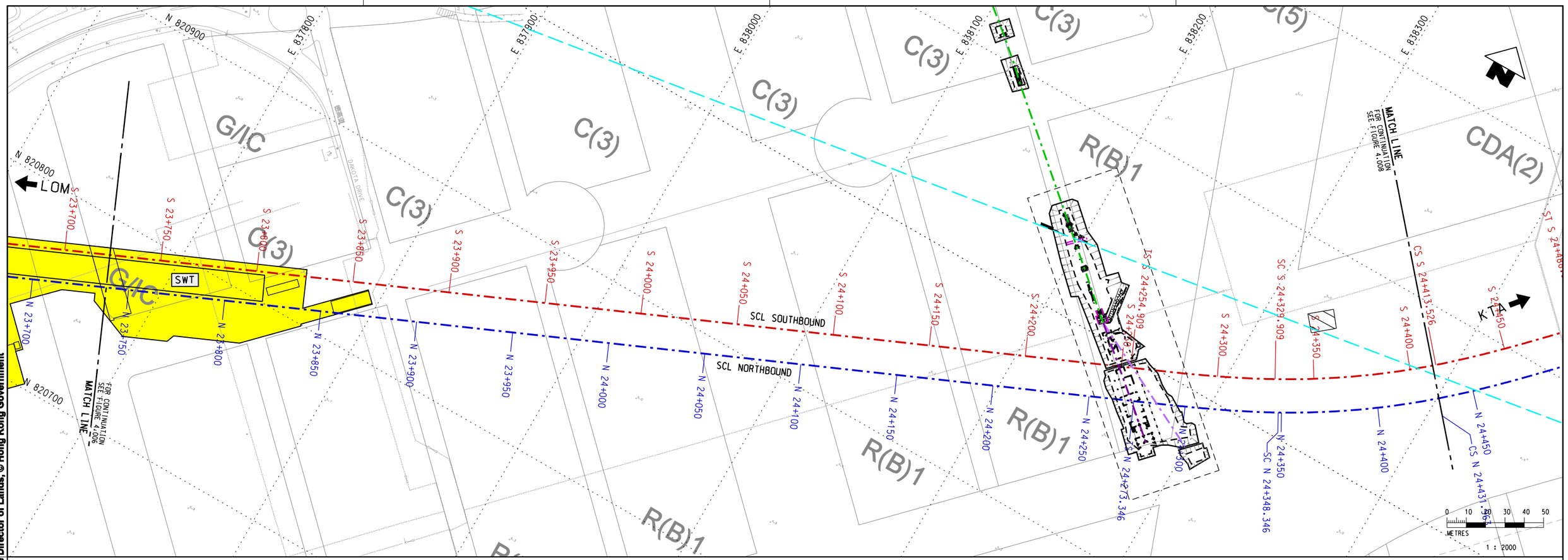
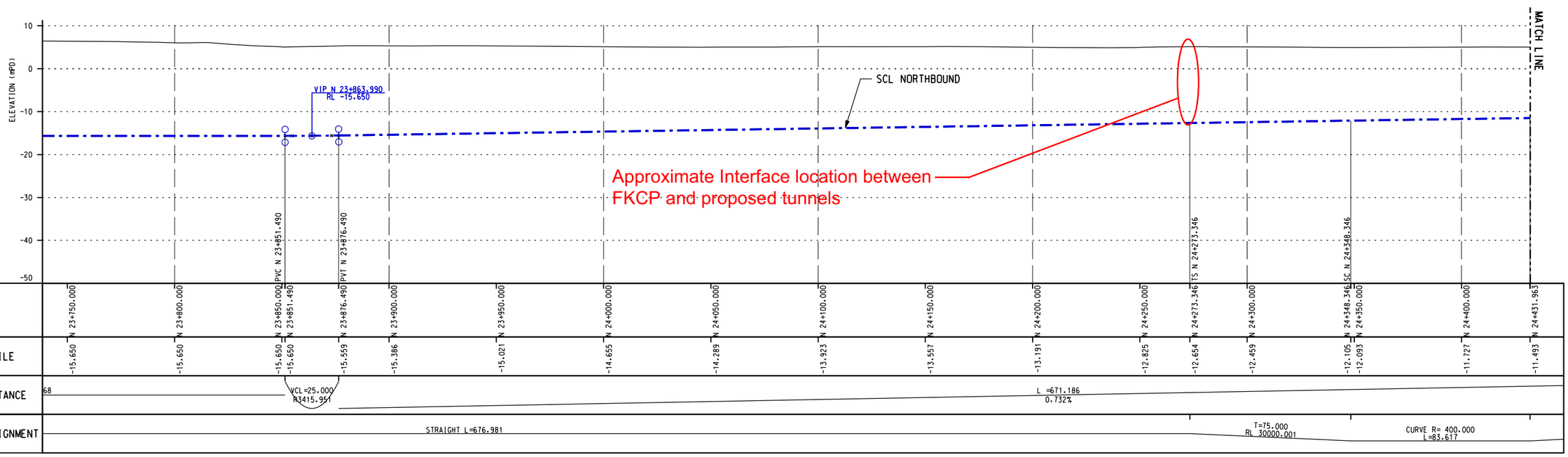
CADD REF. 1108_K_KAT_MHK_T04_001A.dgn

TITLE
CONTRACT 1108
KAI TAK STATION
EXCAVATION AND LATERAL SUPPORT
PART PLAN OF SHORING LAYOUT PLAN

SCALE	DRAWING NO.	REV.
1 : 250 @ A1	1108/K/KAT/MHK/T04/001	A





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DRAWN	KTH
DESIGNED	MTB
CHECKED	RDT
APPROVED	IMW
DATE	10/JUN/2009

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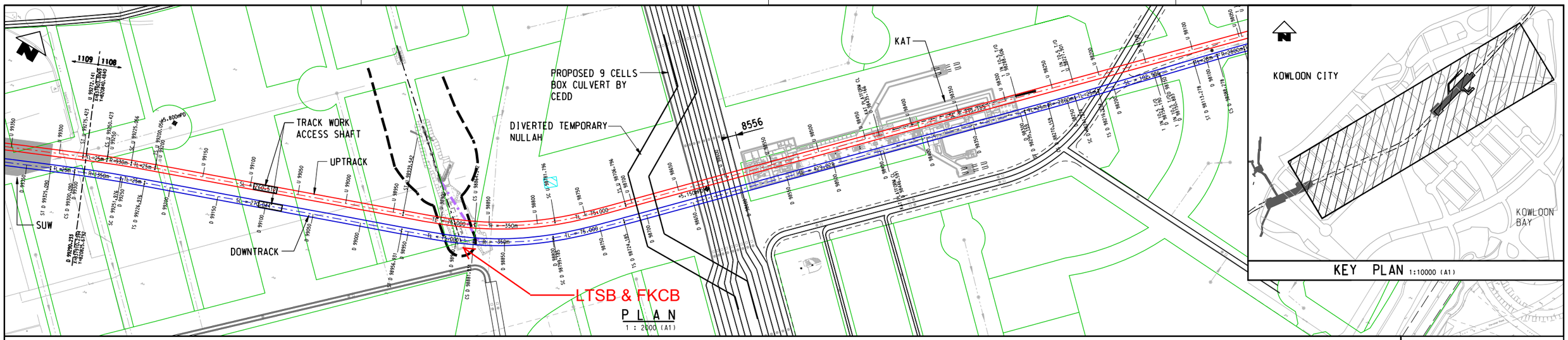
ORIGINATOR AECOM in association with Atkins, PBA, Aedas, MVA, EDAW, and DLS

CADD REF. NEX2201_P_000_MCA_C30_407A.dgn

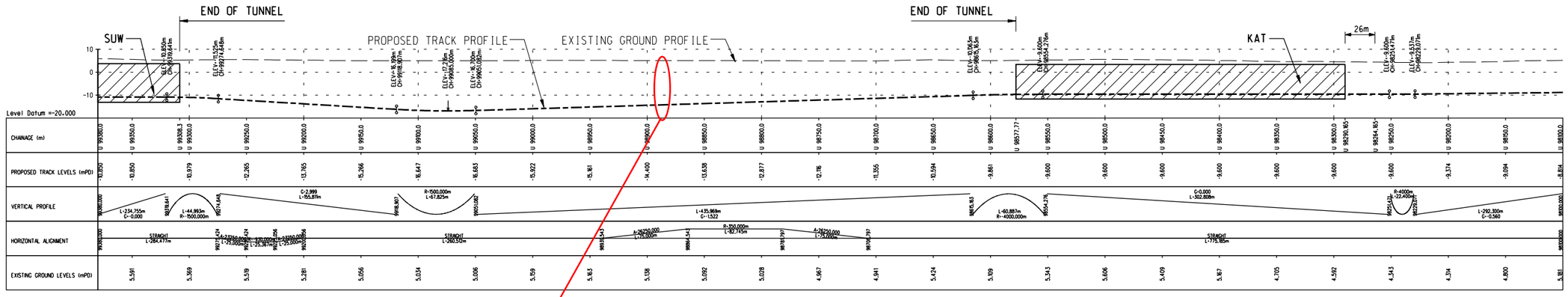
TITLE
NEX/2201 - TAW TO HUH SECTION
PRELIMINARY DESIGN
PLAN AND PROFILE (NORTHBOUND)
SHEET 7 OF 18

SCALE	FIGURE NO.	REV.
1 : 2000 (A3)	4.007	A



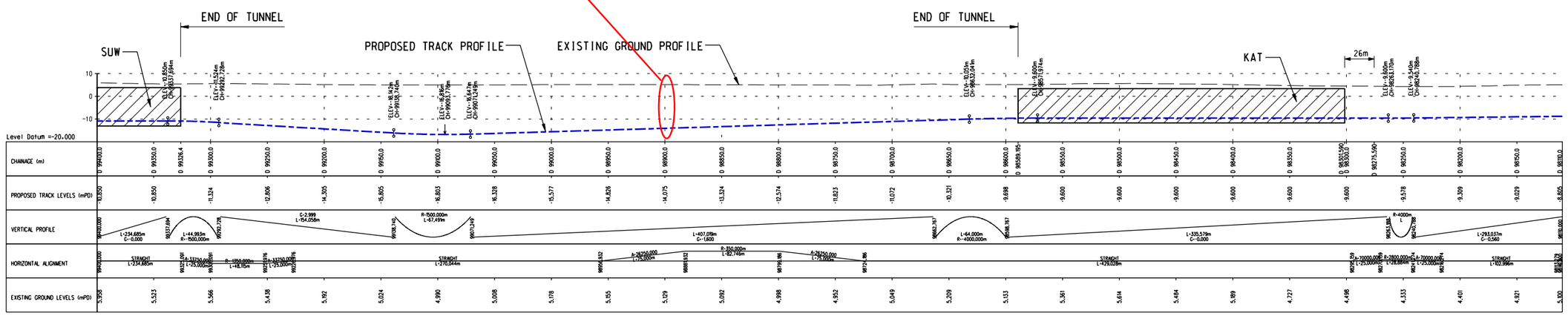
P L A N
1 : 2000 (A1)

KEY PLAN 1:10000 (A1)



Approximate Interface location between FKCP and proposed tunnels

VERTICAL PROFILE (UPTRACK)
HORI. 1 : 2000 (A1)
VERT. 1 : 1000 (A1)



VERTICAL PROFILE (DOWNTRACK)
HORI. 1 : 2000 (A1)
VERT. 1 : 1000 (A1)

NOTES:

1. CHAINAGE IS GIVEN IN METRES MEASURED ALONG THE HORIZONTAL TRACK CENTRELINE INCREASING IN THE DIRECTION FROM HUNG HOM TO TAI WAI.
2. ALL RADII REFER TO TRACK CENTRELINE RADII AND ARE GIVEN IN METRES.
3. VERTICAL ALIGNMENT SHOWN REFER TO THE CROWN OF THE GRADE RAIL (INSIDE/LOW RAIL ON CURVES).
4. CANT IS APPLIED BY RAISING THE OUTER RAIL ABOVE INNER RAIL.
5. BREAK CHAINAGE REFER TO A SINGLE POINT WITH TWO CHAINAGE VALUES.

LEGEND:

L = LENGTH OF STRAIGHT TRACK

T = LENGTH OF TRANSITION TRACK

R = RADIUS OF CIRCULAR CURVE

T/O = TURNOUT

REV	DESCRIPTION	BY	DATE	APPROVED
B	TRACK WORK ACCESS SHAFT ADDED, NAMES ADDED	NN	11OCT10	RC
A	FIRST ISSUE	NN	23AUG10	RC

DRAWN	TWY
DESIGNED	NN
CHECKED	AW
APPROVED	RC
DATE	09JUL10

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CADD REF. 1108_P_KAT_MHK_C03_001C.dgn

TITLE
CONTRACT 1108
KAI TAK STATION
TUNNEL ALIGNMENT PLAN AND PROFILE

SCALE AS SHOWN (A1)

DRAWING NO. 1108/P/KAT/MHK/C03/001

REV. C

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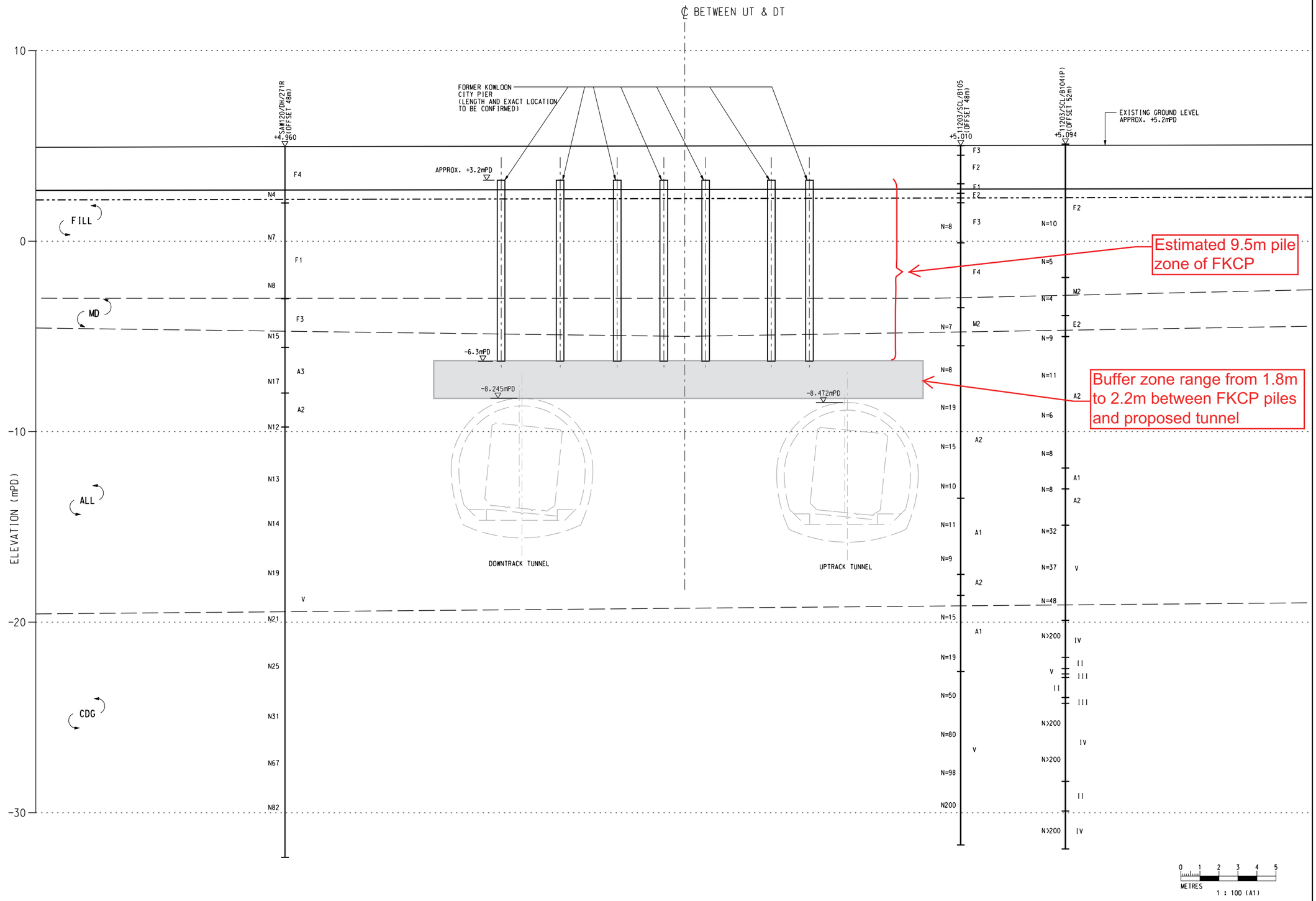
Appendix E - Section Between Tunnel and FKCP

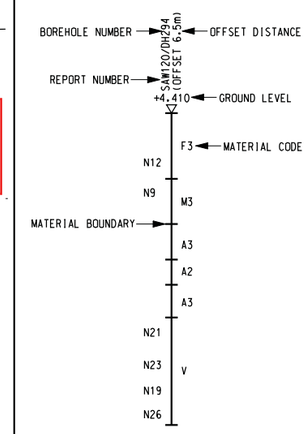


NOTES:

1. FOR GEOTECHNICAL INSTRUMENTATION NOTES & DETAIL TO DRAWING NO. 1108/P/KAT/MHK/C06/001 TO 003.

LEGEND:

MD	MARINE DEPOSIT
ALL	ALLUVIUM
CDG	COMPLETELY DECOMPOSED GRANITE
MDG	MODERATELY DECOMPOSED GRANITE
F	FILL
V	COMPLETELY DECOMPOSED
IV	HIGHLY DECOMPOSED
III	MODERATELY DECOMPOSED
II	SIGHTLY DECOMPOSED
N12	SPT 'N' VALUE = 12
	CORESTONE
1	VERY SOFT TO SOFT CLAY / SILT
2	FIRM TO STIFF CLAY / SILT
3	SAND
4	COBBLES / GRAVEL / BOULDERS
	ROCK HEAD
?	ROCK HEAD PROFILE



MAX. MEASURED GROUND WATER PROFILE

MIN. MEASURED GROUND WATER PROFILE

FOR INFORMATION

METRES 0 1 2 3 4 5

1 : 100 (A1)

REV	DESCRIPTION	BY	DATE	APPROVED
A	FIRST ISSUE	HYW	21DEC10	RC

DRAWN	RL
DESIGNED	HYW
CHECKED	AW
APPROVED	RC
DATE	21DEC10

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CADD REF. 1108_K_KAT_MHK_C05_002.dgn

TITLE

CONTRACT 1108
KAI TAK STATION
GEOLOGICAL SECTION

SCALE	DRAWING NO.	REV.
1 : 100 (A1)	1108/K/KAT/MHK/C05/002	A

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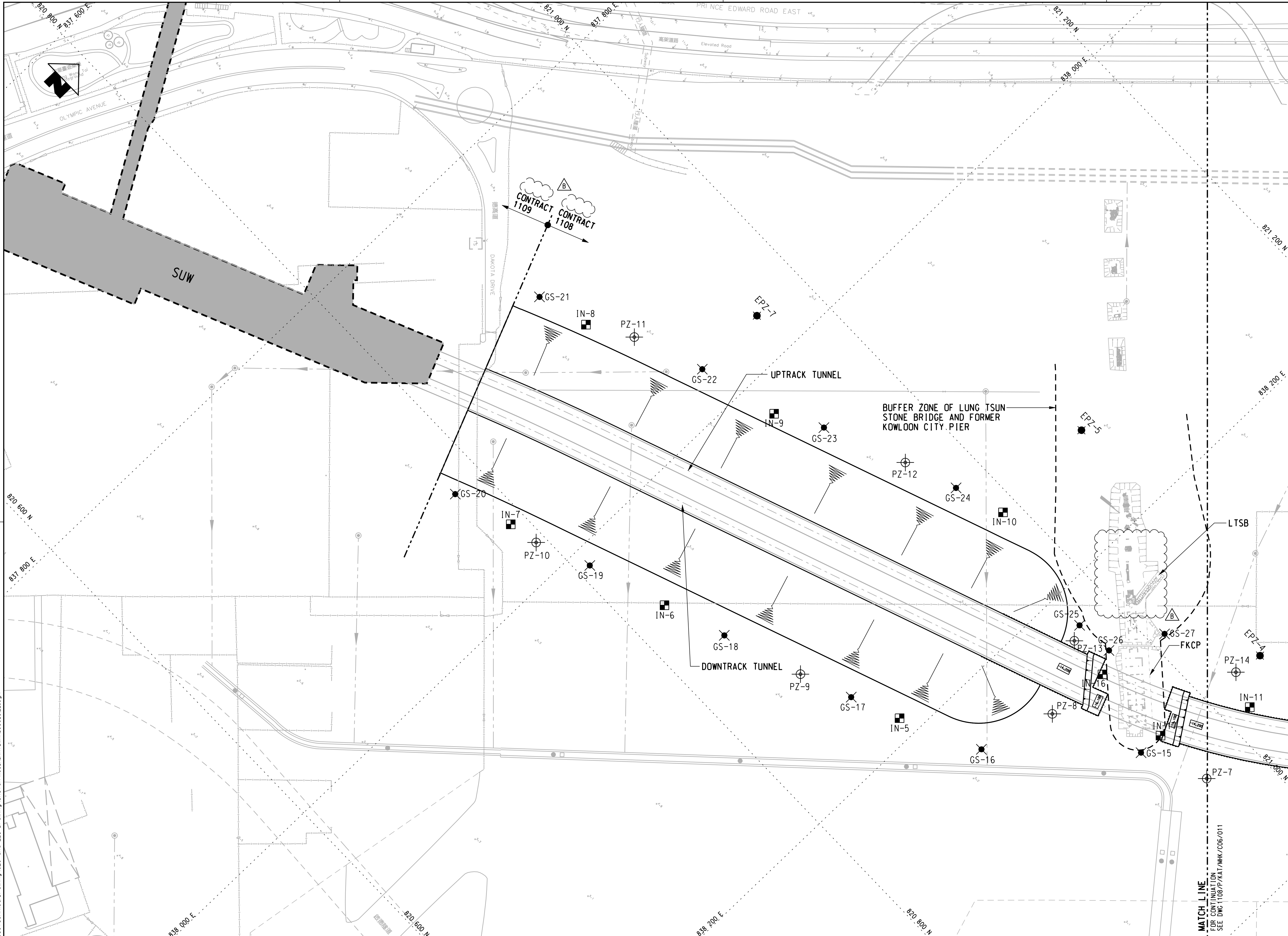
Appendix F - Ground Monitoring Points around FKCP



GENERAL NOTES:

1. FOR GEOTECHNICAL INSTRUMENTATION NOTES & DETAILS REFER TO DRAWING NO. 1108/P/KAT/MHK/C06/001 & 002.
2. FOR GEOTECHNICAL INSTRUMENTATION SCHEDULE REFER TO DRAWING NO. 1108/P/KAT/MHK/C06/003.

LEGEND

- GS-1 GROUND SETTLEMENT MARKER
- IN-1 VERTICAL INCLINOMETER
- PZ-1 STANDPIPE/PIEZOMETER
- BS-1 BUILDING SETTLEMENT MARKER
- EPZ-1 EXISTING STANDPIEP/PIEZOMETER
- US-1 UTILITY SETTLEMENT MARKER
- VM-1 VIBRATION MONITORING POINT
- HIN-1 HORIZONTAL INCLINOMETER

FOR INFORMATION

0 10 20 30 40 50 METRES 1 : 2000 (A3)

REV	DESCRIPTION	BY	DATE	APPROVED
B	RESPONSE TO COMMENTS	HYW	24SEP10	RC
A	FIRST ISSUE	HYW	23AUG10	RC

DRAWN	RL
DESIGNED	HYW
CHECKED	AW
APPROVED	RC
DATE	31JUL10

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CADD REF. 1108_P_KAT_MHK_C06_012B.dgn

TITLE

CONTRACT 1108
KAI TAK STATION
GEOLOGICAL INSTRUMENTATION LAYOUT PLAN
(SHEET 2 OF 2)

SCALE 1 : 1000 @ A1 | DRAWING NO. 1108/K/KAT/MHK/C06/012 | REV. B

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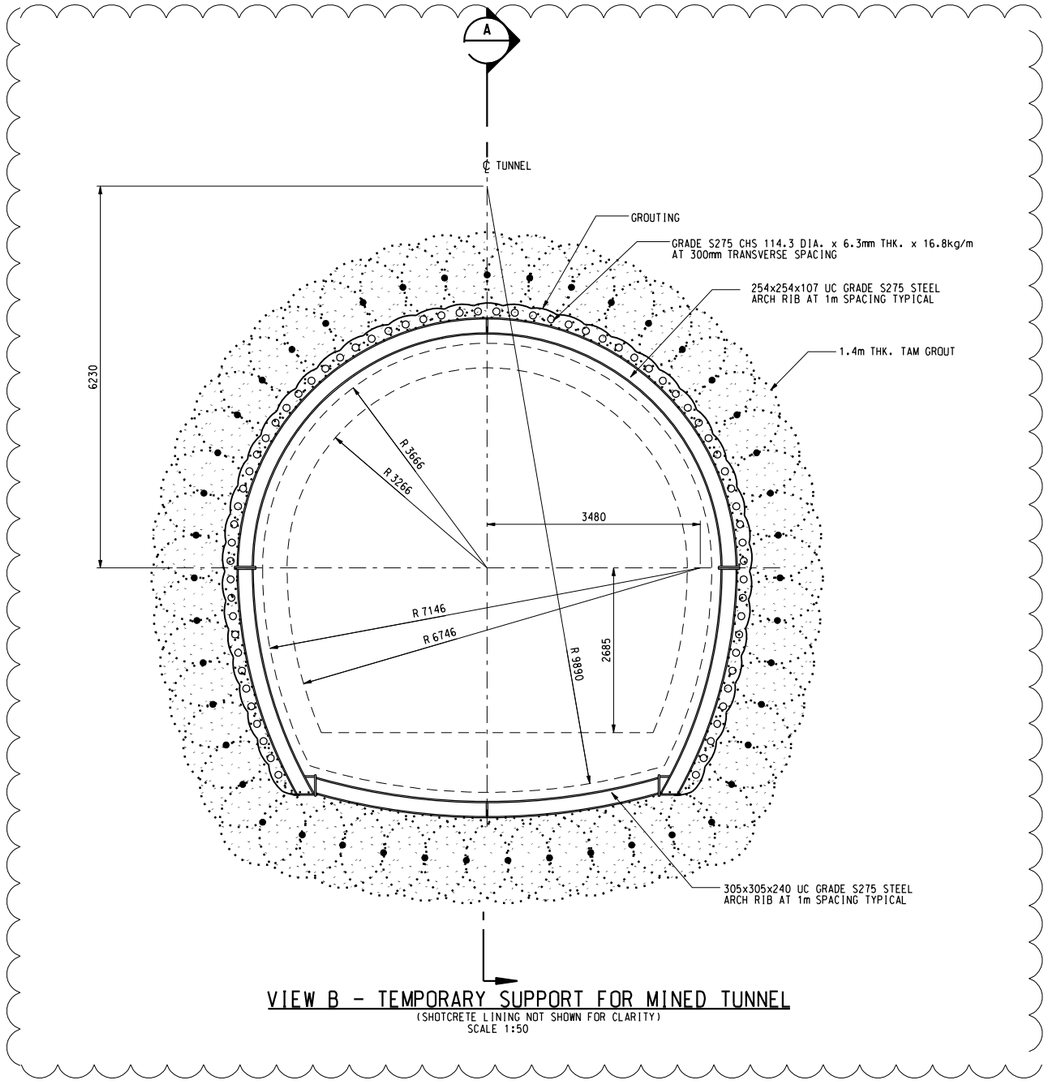
Appendix G - Construction Sequence of Mined Tunnel under FKCP Site

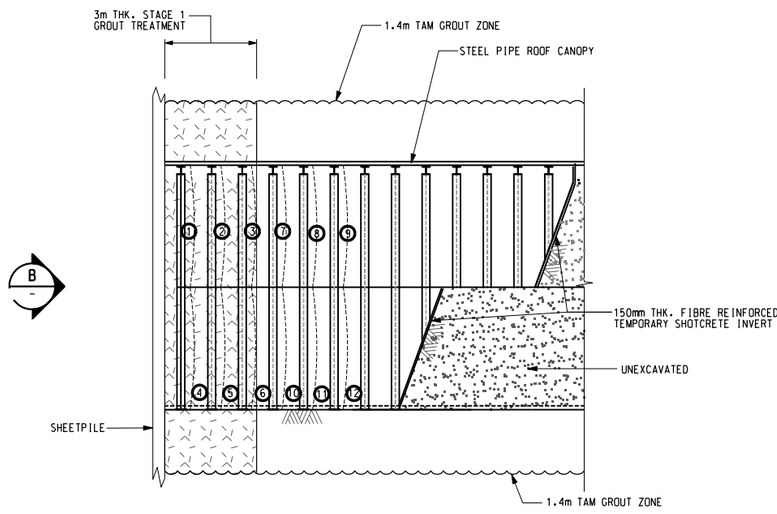
NOTES :

1. THIS DRAWING SHOWS THE DETAILS OF TYPICAL TEMPORARY SUPPORT FOR THE SOFT GROUND MINED TUNNEL.

2. THE CONTRACTOR SHALL SUBMIT MILL CERTIFICATES TO THE ENGINEER FOR RECORD.



VIEW B - TEMPORARY SUPPORT FOR MINED TUNNEL
(SHOTCRETE LINING NOT SHOWN FOR CLARITY)
SCALE 1:50



SECTION A - PORTAL EXCAVATION BY HEADING AND BENCHING METHOD
SCALE N.T.S.

LEGEND :

- ○ PRE-SUPPORT STEEL PIPE
- ● TAM GROUT PIPE

FOR INFORMATION

REV	DESCRIPTION	BY	DATE	APPROVED
B	RESPONSE TO COMMENTS	HYW	24SEP10	RC
A	FIRST ISSUE	HYW	23AUG10	RC

DRAWN	RL
DESIGNED	HYW
CHECKED	AW
APPROVED	RC
DATE	31JUL10

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in association with
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CADD REF. 1108_P_KAT_MHK_T11_004.DGN

TITLE
CONTRACT 1108
KAI TAK STATION
ENVISAGED TEMPORARY SUPPORT FOR MINED TUNNEL
TEMPORARY SUPPORT WORKS
SHEET 1 OF 2

SCALE N.T.S. (A1)
DRAWING NO. 1108/P/KAT/MHK/T11/004
REV. B

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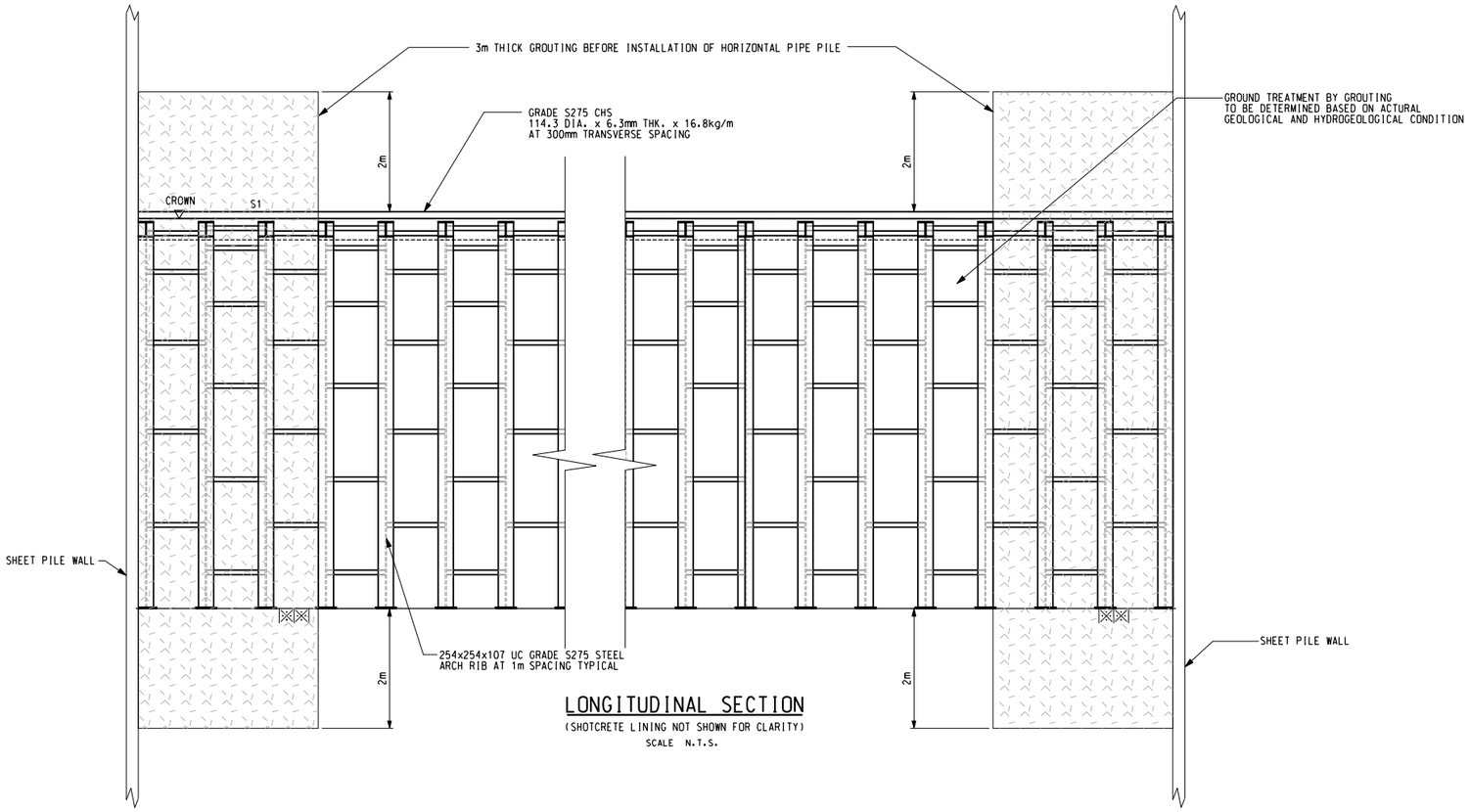

LONGITUDINAL SECTION

(SHOTCRETE LINING NOT SHOWN FOR CLARITY)

SCALE N.T.S.

GENERAL :

1. FOR GENERAL NOTES REFER TO DRG. NO. 1108/P/KAT/MHK/T11/001 TO 002 UNLESS NOTED OTHERWISE.
2. THIS DRAWING SHOWS THE MINIMUM REQUIREMENTS FOR THE INITIAL SUPPORT SYSTEM BASED ON GROUND CONDITIONS INFERRED FROM THE SITE INVESTIGATION RESULTS. THE CONTRACTOR SHALL CARRY OUT THE TUNNEL PRIMARY SUPPORT TO SUIT THE EXPOSED GROUND CONDITIONS WHERE NECESSARY.
3. FACE SUPPORT SHALL BE PROPOSED BY THE CONTRACTOR FOR THE APPROVAL OF THE ENGINEER.

CONSTRUCTION SEQUENCE FOR MINED TUNNEL:

THE GENERAL CONSTRUCTION SEQUENCE OF TUNNELING SHALL BE AS FOLLOWS:

1. CARRY OUT 3m THICK GROUTING FOR PRE-TREATMENT / WATER CUT-OFF FOR INSTALLATION OF HORIZONTAL PIPE PILES AT BOTH ENDS OF THE TUNNEL.
2. INSTALL HORIZONTAL PIPE PILES AND CARRY OUT GROUTING IN ACCORDANCE WITH DRG.
3. CARRY OUT 2m THICK TAM GROUTING FOR WATER CUT-OFF IN ACCORDANCE WITH DRG.
4. EXCAVATE IN SEQUENCE AS SHOWN ON THE DRAWINGS.
5. INSTALL TEMPORARY SUPPORT AT THE FACE OF EXCAVATION
6. INSTALL STEEL ARCH RIB AT 1000MM SPACING AND SHOTCRETE.
7. MONITORING IN ACCORDANCE WITH THE MONITORING DRAWINGS. THE FACE SHALL NOT BE ADVANCED UNTIL THE AREA IS ADEQUATELY SUPPORTED. THE TEMPORARY SUPPORT BUTTRESS SHALL BE PROTECTED BY 75MM MIN. THICK SHOTCRETE PRIOR TO THE INSTALLATION OF STEEL ARCH RIBS.
8. IN THE EVENT OF THE WORKS BEING DELAYED AND STOPPED FOR MORE THAN 24 HOURS, STEEL ARCH RIB TO BE PROVIDED AS CLOSE TO FACE AS PRACTICALLY FEASIBLE AND 75MM MIN. THICK SHOTCRETE TO BE APPLIED TO THE FACE.
9. THE TUNNEL SUPPORT DESIGN IS BASED UPON THE EXISTING GROUND INVESTIGATION INFORMATION. IF NECESSARY, THE CONTRACTOR SHALL INCREASE THE AMOUNT OF SUPPORT TO SUIT THE EXPOSED GROUND CONDITIONS. DEFORMATION MONITORING AND OBSERVATIONS ON SITE.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE SAFETY AND STABILITY OF THE WORKS. PRECAUTIONS SHALL BE TAKEN TO PREVENT DAMAGE TO ANY OF THE EXISTING BUILDINGS, STRUCTURES, AND UTILITIES IN THE VICINITY OF THE TUNNEL ALIGNMENT.
11. PERMANENT WORKS SHALL ONLY BE CARRIED OUT UPON THE APPROVAL FROM THE ENGINEER.

PIPE PILE SUPPORT CANOPY:

1. THE SUPPORT CANOPY SHALL BE FORMED BY HORIZONTAL DIRECTIONAL DRILLED-IN STEEL PIPE PILE (114.3 X 6.3mm THICK X 16.8 kg/m INSTALLED FROM PORTAL FACE.
2. THE GROUT SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 30MPa.
3. ALL TUBES SHALL BE FORMED OF GRADE S275 STEEL AND SHALL HAVE FULL STRENGTH JOINTING WHERE REQUIRED.
4. PRE-DRILLED TEMPORARY SUPPORTS SHALL BE INSTALLED TO CLEAR FROM THE PERMANENT SUPPORT ENVELOPE.
5. EXCAVATION OF THE TUNNEL SHALL NOT COMMENCE UNTIL THE GROUND HAS BEEN FULLY SUPPORTED. STAGED GROUTING MAY BE REQUIRED TO ACHIEVE THIS.
6. WHERE NOT REQUIRED, HOLES SHALL BE CLOSED BY WELDING.
7. THE SYSTEMATIC SUPPORT SHALL BE INSTALLED BEFORE FURTHER EXCAVATION IS CARRIED OUT.

WELDING:

WELDING REQUIREMENTS:

1 METAL ARC WELDING SHALL COMPLY WITH BS 5135.
2. ELECTRODES SHALL BE ES1 IN COMPLIANCE WITH BS 639.
3. WELDING TERMS AND STMBOLS SHALL COMPLY WITH BS 499:PART2.
4. ALL WELD SHALL BE 8mm F.W. UNLESS OTHERWISE STATED.
5. ALL SPLICES IN STEEL MEMBERS SHALL BE FULL PENETRATION BUTT WELD UNLESS STATED OTHERWISE
6. ALL WELDING TO BE CARRIED OUT BY QUALIFIED WELDER.
7. ALL WELDS SHALL BE VISUALLY INSPECTED IN ACCORDANCE WITH BS 5289.
8. ALL IMPROPER MATERIALS (SLAG, DIRT, OIL IRREGULARITIES, ETC) SHALL BE REMOVED FROM JOINTS PRIORTO WELDING.
9. 10% BUTT WELD SHALL BE SUBJECT TO NON-DESTRUCTIVE TESTING BY EITHER RAD GRAPHY OR ULTRASONIC EXAMINATION UNLESS SPECIFIED OTHERWISE TESTING SHALL BE CARRIED OUT IN ACCORDANCE WITH BS 2600:PART 1 & 2 AND BS 3923:PART 2 RESPECTIVELY.
10. 10% FILLET WELD SHALL BE SUBJECT TO MAGNETIC PARTICLE TEST.

STEEL ARCH RIBS :

1. SUPPLIES OF STEEL ARCH RIBS IN EACH SIZE REQUIRED FOR THE TUNNELS SHALL BE MANUFACTURED AND DELIVERED TO THE SITE BEFORE COMMENCING THE EXCAVATION IN THE TUNNELS.
2. THE NUMBER OF STEEL ARCH RIBS STORED ON SITE SHALL BE SUCH THAT IF ONE OF THE TUNNEL DRIVES ENCOUNTERS CONDITIONS REQUIRING THEIR USE, A FURTHER SUPPLY OF STEEL ARCH RIBS CAN BE OBTAINED BEFORE THE STORED STOCK IS EXHAUSTED, AND NO DELAY RESULTS TO THE PROGRESS OF TUNNEL EXCAVATION.
3. STRUCTURAL STEEL FOR STEEL ARCH RIBS SHALL CONFORM TO BS 5950 GRADE S275 STEEL FOR BOLTS, NUTS, WASHERS AND PLATES.
4. STEEL ARCH RIBS SUPPORT SHALL BE ERECTED IN ACCORDANCE WITH THE FOLLOWING REQUIREMENTS:
   A) STEEL ARCH RIBS SHALL BE FULLY BLOCKED SUCH THAT THE MAXIMUM DISTANCE FROM THE FACE TO THE BLOCKED RIB DOES NOT EXCEED 0.5m.
   B) STEEL ARCH RIBS SHALL BE FULLY ENCASED IN SHOTCRETE OF THE MINIMUM SPECIFIED THICKNESS WITHIN A MAXIMUM DISTANCE FROM THE FACE OF 1.0m.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE STEEL ARCH RIBS IN PROPER CONDITION AND ALIGNMENT BEFORE INFILL OF SHOTCRETE OR CONCRETE PLACEMENT. THE CONTRACTOR SHALL ADJUST ANY STEEL ARCH RIB SUPPORT ERECTED IMPROPERLY PRIOR TO INFILL OF SHOTCRETE OR CONCRETE PLACEMENT IMMEDIATELY UPON NOTIFICATION FROM THE ENGINEER OF THEIR IMPROPER ERECTION.
6. NO TIMBER BLOCKING, WEDGING AND LAGGING WHATSOEVER SHALL BE USED FOR FINAL SUPPORT OF STEEL ARCH RIBS. TEMPORARY SUPPORTS PRIOR TO BLOCKING AND LAGGING SHOTCRETE PLACEMENT SHALL BE ACHIEVED USING STEEL BARS, BOLTS, ETC., TO THE SATISFACTION OF THE ENGINEER.
7. BLOCKING AND LAGGING SHOTCRETE SHALL BE PLACED AS SOON AS PRACTICABLE AFTER STEEL ARCH RIB ERECTION AND INSTALLATION OF CHANNEL DRAINS AND DRAINAGE PIPES. SHOTCRETING SHALL BE SUCH AS TO ENSURE UNIFORM AND COMPLETE CONTACT BETWEEN THE STEEL ARCH RIB AND THE STEEL TUBE AND SHALL BE TO THE MINIMUM THICKNESS SHOWN ON THE DRAWINGS.
8. STEEL ARCH RIBS SHALL BE TIED WITH RIGID STEEL ELEMENTS IMMEDIATELY FOLLOWING THE ERECTION OF INDIVIDUAL SECTION.
9. THE CONTRACTOR SHALL MAKE GOOD THE EXCAVATION SURFACES FOR THE FOUNDATIONS.
10. THE CONTRACTOR SHALL PRODUCE FABRICATION DRAWING FOR APPROVAL BY THE ENGINEER PRIOR TO COMMENCEMENT OF FABRICATION.
11. THE UNSUPPORTED LENGTH OF EXCAVATION SHALL BE MAX. 1.3m

FOR INFORMATION

0 500 1000 1500 2000 2500

MILLIMETRES

1 : 50

REV	DESCRIPTION	BY	DATE	APPROVED	REV	DESCRIPTION	BY	DATE	APPROVED

DRAWN	RL
DESIGNED	HYW
CHECKED	AW
APPROVED	RC
DATE	31/JUL/2010

MTR

SHATIN TO CENTRAL LINK

ORIGINATOR

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邁進(香港)工程顧問有限公司

in association with
Aedas, Mott MacDonald, MVA, DLS, Wilkinson Murry, Evans & Peck, AA

CADD REF. 1108_P_KAT_MHK_T11_005A.DGN

TITLE

CONTRACT 1108
KAI TAK STATION
ENVISAGED TEMPORARY SUPPORT FOR MINED TUNNEL
TEMPORARY SUPPORT WORKS
SHEET 2 OF 2

SCALE	DRAWING NO.	REV.
N.T.S (A1)	1108/P/KAT/MHK/T11/005	A

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