Hong Kong Government
Territory Development Department
NT North Development Office

Agreement No. CE 10 / 95

Tin Shui Wai Development
Engineering Investigations for
Development of Areas 3, 30 & 31 of
the Development Zone and the Reserve Zone

ENVIRONMENTAL IMPACT ASSESSMENT

FINAL ASSESSMENT REPORT

(Volume 1 of 2)

FEBRUARY 1997

0018/C09/07.2

Binnie Consultants Limited

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Report Authorized For Issue By:	For and on Behalf of Binnie Consultants Limited

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* The Registered Recipient is responsible for destroying or marking as 'superseded' all superseded documents.

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1 INTRODUCTION

1.1 On 29th November 1995, Binnie Consultants Limited (BCL) was commissioned by the Territory Development Department to undertake the *Engineering Investigations for the Development of Areas 3, 30 and 31 of the Development Zone and the Reserve Zone* ('the Project') under *Agreement No. CE 10/95: Tin Shui Wai Development.* Tin Shui Wai lies in the far north west of the New Territories of Hong Kong, close to Deep Bay. It lies to the north west of Yuen Long and to the south west of Mai Po Marshes. A general site map is given on Figure 1.1.

1.2 Tin Shui Wai is divided into two similar sized zones: the Development Zone (DZ), which lies to the south and the Reserve Zone (RZ), which lies closest to Inner Deep Bay. Areas within the DZ are identified by numbers less than 100; areas within the RZ have been given numbers greater than 100 (Figure 1.2).

1.3 The site formation of the DZ, including Areas 3, 30 and 31 is complete. Apart from road and junction up-grading works, the engineering works for the DZ are also essentially complete.

1.4 The assignment under Agreement No. CE 10/95 primarily includes:

(a) the Site Formation Study;
(b) the Engineering Infrastructure Investigation;
(c) Transport and Traffic Assessment;
(d) Drainage Impact Assessment; and
(e) Project Cost and Implementation Study

as well as the Environmental Impact Assessment Study (EIA). The EIA study period is a little over a year.

1.5 This document is one of the series of reports produced as part of the EIA. Known as the EIA Final Assessment Report, it gives an overview of the Project and addresses the environmental issues related to all the site formation works and engineering infrastructure activities for both the construction and operational phases.

1.6 The Brief required the EIA to be presented in stages. The EIA Stage I Report covered environmental impacts associated with the site formation of Areas 101-108, 109a, 110 and 111. This site formation precedes the other construction works. The EIA Stage II Report addressed environmental issues related to the provision of engineering infrastructure/ upgrading works for the Priority Sites and Area 109a. The Priority Sites are defined in the Brief as Areas 3, 30, 31, 102, 103 and 104. The EIA Stage III Assessment Report addressed the site formation works for Areas 109b and 112-123 and the provision of all remaining infrastructure and road and junction upgrading works as well as the works assessed in the EIA Stage I and EIA Stage II Reports. The Final Assessment Report is accompanied by an Environmental Monitoring and Audit (EM&A) Manual for the Project and Executive Summaries in English and Chinese. The Stage III Assessment Report was identical to the Final Assessment Report except that the findings and recommendations for the 12 month ecological survey were those concluded so far.

Background History

1.7 In July 1982, the Government entered into an agreement with Mightycity Company Limited (MCL) and its wholly owned subsidiary, Tin Shui Wai Development Limited, to develop part of the Tin Shui Wai Landholding. The initial development was to be for a town of 135,000 persons within an area of 169 hectares. Since the agreement, Government has formed and partly serviced land adjacent to the initial development zone in accordance with the Development Zone Plan, thereby creating the DZ which has a developable area of 220 hectares. Up until the early 1990s there were no plans for the northern section known until recently as the Land Bank and now referred to as the Reserve Zone. However, for the purposes of design, the assumption was made that the total population of the Tin Shui Wai area could reach 340,000.

1.8 The original site for the Tin Shui Wai development covered an area of 488 hectares. It was a flat, low lying valley with hills to the west and east. It was once part of the Deep Bay foreshore but was separated from the sea by a low bund constructed in 1916 to enable the development of paddy agriculture. The Tin Shui Wai bund was constructed with sluices to allow a number of rivers passing through the site to discharge into Deep Bay. From the 1960s further bunds were constructed within the area to create ponds for fish and duck farming.

1.9 By the mid 1970s, the majority of the site and much of the area around the periphery was covered by ponds. The rivers passing through the site remained, although their courses had been altered by the bunds forming the ponds. A series of interconnecting drainage channels was formed within the site to facilitate the drainage and operation of the ponds.

1.10 As a result of the history of the area, the original site was underlain to a large extent by marine deposits. Within the ponds the marine deposits were overlain by 'pond deposits', the detritus from fish and duck farming. The surficial material within the river courses was recent agricultural wastes. The pond deposits and river deposits were 0.3 to 1 m thick. Ground levels within the site were typically 0.5 mPD in the ponds and 3 mPD on the bunds.

1.11 A number of recognised villages are located adjacent to the site along the original coast line. Some of these villages are on very low-lying ground (for example, ground levels in Ha Mei San Tsuen to the east are at 2.5 mPD). About 12 of these villages became increasingly prone to a greater frequency and severity of flooding during the 1960s to 1980s due to uncontrolled filling and construction of fish ponds, constrictions in watercourses, and deposition of animal wastes and rubbish in the watercourses. The Tin Shui Wai development presented an opportunity to rectify the adverse impacts on drainage caused by the uncontrolled land use changes, by constructing an adequate drainage system for the whole catchment. In addition, peripheral earth bunds were needed at six of the flood prone villages: the Village Flood Protection Schemes. Originally, there were also two squatter settlements within the site, Tin Shui Wai which gave its name to the development and Pak Sha Tsui. These settlements were resumed prior to the development of the site.

1.12 Drainage considerations had a major influence on the land formation design and determined the planned formation level of the site. Within Tin Shui Wai the drainage strategy was to concentrate the river flows into a single main channel on the western boundary of the site. This required diversion of the Tai river which formerly followed the eastern boundary through a 1.2 km long culvert up to 17 m wide. The pre-existing river along the western boundary, the Hung Shui Kiu, included two major constrictions at its downstream end. The first of these was the sluices in the Tin Shui Wai bund which provided protection against surge tides but would not be needed once the new channels were constructed. The other was a low bridge which was replaced. The drainage works included an inflatable dam across the main open channel with low flow interceptors to divert low flows to the sewerage system.

1.13 An *Environmental Impact Assessment of the Land Preparation Aspects* was issued by Binnie & Partners (Hong Kong) and Shankland Cox in 1985 for a joint venture of Hong Kong Government and Mightycity Company Ltd. This extensive report was one of a series of reports about Tin Shui Wai dealing with the Tin Shui Wai Development. About 20 million m^3 of fill was required to form the site. Rather than using land-based sources of fill, areas of marine sand were identified and detailed assessments of both engineering and environmental aspects were made. Many long term environmental modelling, monitoring and assessment studies were undertaken over nearly a decade.

1.14 The programming requirements and environmental considerations led to the selection of a hydraulic placement method. The ponds were drained, all but peripheral pond bunds were cut down and the bund material reserved for later use as topsoil. The pond bottom material was allowed to dry out to form a fairly impervious layer before filling with clean marine sand fill.

1.15 The bulk of the marine fill material was dredged from Urmston Road and Outer Deep Bay near Black Point. Dredging commenced on the 1st June 1988. Marine sand was won using a dustpan dredger and loaded into barges. The hydraulic fill (1 part sand to 4 parts seawater) was pumped up to 6 km from a rehandling basin sited at the end of a causeway constructed off Lau Fau Shan to the placement site, via a pipeline. Reclamation proceeded at a rate of about 750,000 m^3 per month and took a little over 2 years.

1.16 The Western Drainage Channel (WDC) and Western Temporary Channel (WTC) were fully operational by mid 1991. The eastern channel was confined within a culvert up to the northern edge of the DZ and Tin Wah road. The current Eastern Temporary Channel (ETC) has essentially taken its current shape as the result of land formation levels.

1.17 Protection of Inner Deep Bay and its sensitive environment have been of particular concern throughout the planning and implementation of land preparation works at Tin Shui Wai. Extensive environmental monitoring was undertaken prior to, during and after the land formation works. For example, baseline water quality data was collected for more than two years before works began.

1.18 Mitigation measures first recommended in the Tin Shui Wai Development reports were later incorporated into the *Deep Bay Guidelines for Dredging Reclamation and Drainage Works* issued by ERL (Asia) Ltd in association with Binnie Consultants Ltd in 1991 for the Environmental Protection Department, Hong Kong Government.

Current Situation

1.19 As outlined above, the initial development of Tin Shui Wai Landholding was to be within the 169 hectare DZ. Since 1982, Government has formed and partly serviced land adjacent to the initial development zone in accordance with the Development Zone Plan thereby creating the DZ which has a developable area of 220 hectares.

1.20 The DZ has a committed population of about 150,000 people of which 82,500 are to be in three public housing estates, namely Tin Yiu Estate, Tin Shui Estate and a new estate in Planning Area 13 of the DZ (see Figure 1.2). The remaining 67,500 of population will be in the 6 private housing estates. By November 1995, all the major engineering works were substantially complete; the Tin Yiu and Tin Shui estates were complete and occupied, and the third public housing estate was being constructed for completion in 1997; five of the private estates (namely Lots No. 1, 2, 3, 5 and 7) were complete and occupied, the construction of the remaining private estate (namely Lot No. 6) had been suspended. Construction on Lot No. 6 has recently recommenced. The construction of the private commercial complex (Lot No. 4) at the town centre has commenced and completion of its first phase is expected in 1996. The necessary community facilities are being provided by Government to suit the increased population.

Future Development

1.21 After careful consideration by the Working Group on Land Supply of the Task Force on Land Supply and Property Prices, headed by the Secretary for Planning, Environment and Lands, Areas 3, 30 and 31 in the DZ (22 hectares) and about 53 hectares in the RZ are to be used for housing. This 75 hectares of additional housing at Tin Shui Wai will have a population of about 150,000 thereby doubling the total committed population at Tin Shui Wai to about 300,000.

1.22 In September 1994, Planning Department commissioned Shankland Cox Ltd in association with BCL and MVA for *Agreement No. CE 40/94: Preparation of Layout Plans for Tin Shui Wai Reserve Zone*. The Final Report for this study was issued in July 1994 and included a 'Preferred Concept Plan' or future development of the RZ hereafter simply known as the Concept Plan. Layout Plans and a Master Plan were presented in this document.

1.23 The Task Force on Land Supply and Property Prices has decided that future housing at Tin Shui Wai must be developed as soon as possible. To this end, Area 102 in the south-western part of the RZ and Areas 3, 30 and 31 in the DZ were identified for early development. The Task Force has also decided to reserve 30 hectares of the remainder of the RZ for public housing. The rest will be used for private residential, commercial, institutional, recreational or transport purposes. To service these proposed developments, the site has to be equipped with the necessary engineering infrastructure, complemented by the upgrading of some existing engineering infrastructure.

1.24 The Brief for the Project defines Areas 3, 30 and 31 in the DZ and Areas 102, 103 and 104 of RZ as Priority Sites. Currently, first occupation of many Housing Department sites in the RZ follows very quickly on from those for the RZ Priority Sites.

Approach to the EIA Final Assessment Report

1.25 This report contains a description and assessment of all works to be carried out under this Project.

1.26 Each section is divided into Construction and Operational Impacts and Key Issues are identified early on. Mitigation measures and recommendations are given in detail for all construction works. The cumulative impacts from an overlap of activities are addressed and suitable mitigation recommended where construction coincides with operational phases ie. when occupation of the Priority Sites takes place.

1.27 The structure of the EIA Final Assessment Report is as follows:

Section 2: Project Description;

Section 3: Sensitive Receivers for noise, air, water and ecology;

Section 4: Noise;

Section 5: Visual Impacts;

Section 6: Air Quality;

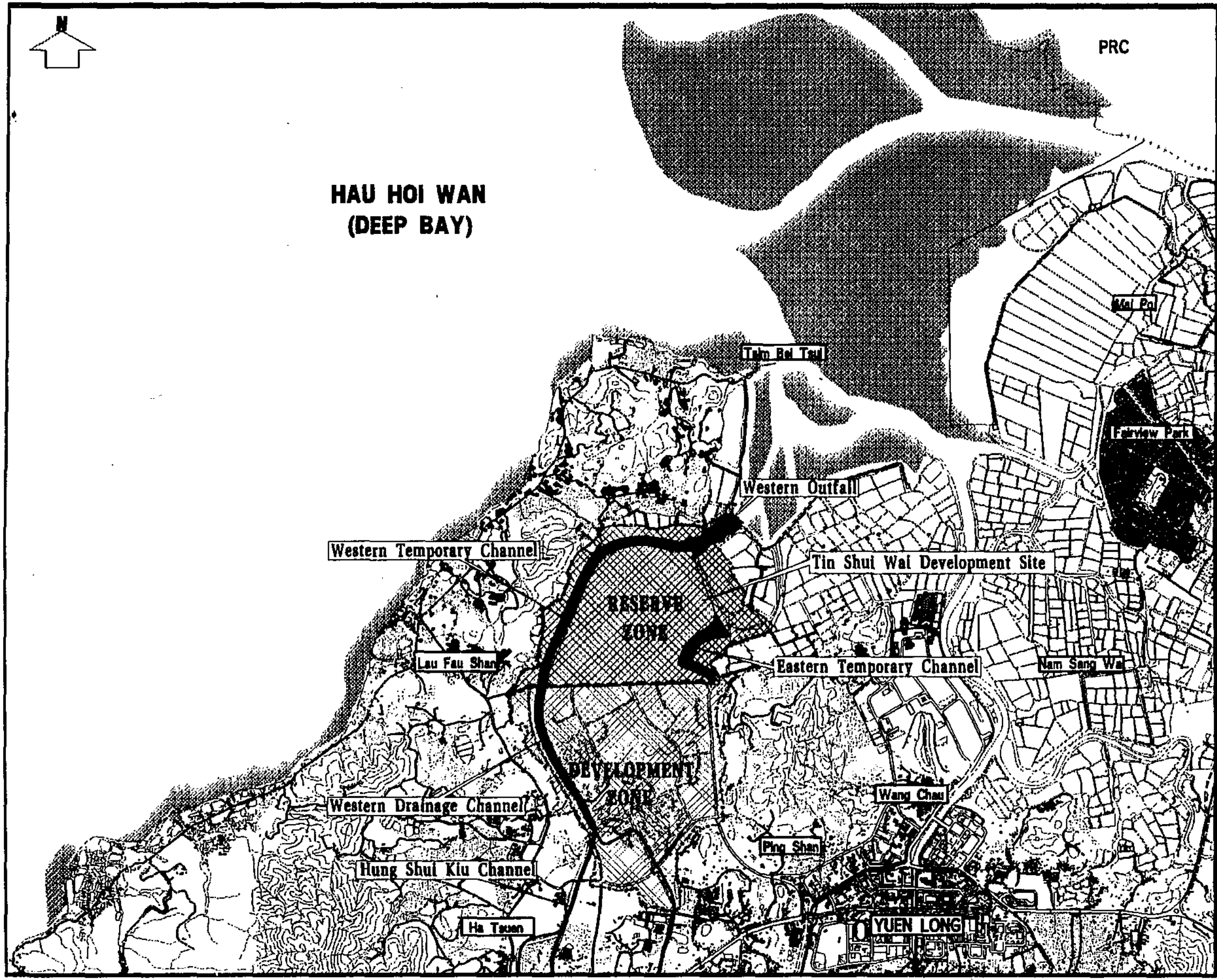
Section 7: Water Quality;

Section 8: Waste;

Section 9: Ecology;

Section 10: Impacts Summary and Recommendation.

1.28 The figures for each section are located at the end of each section.



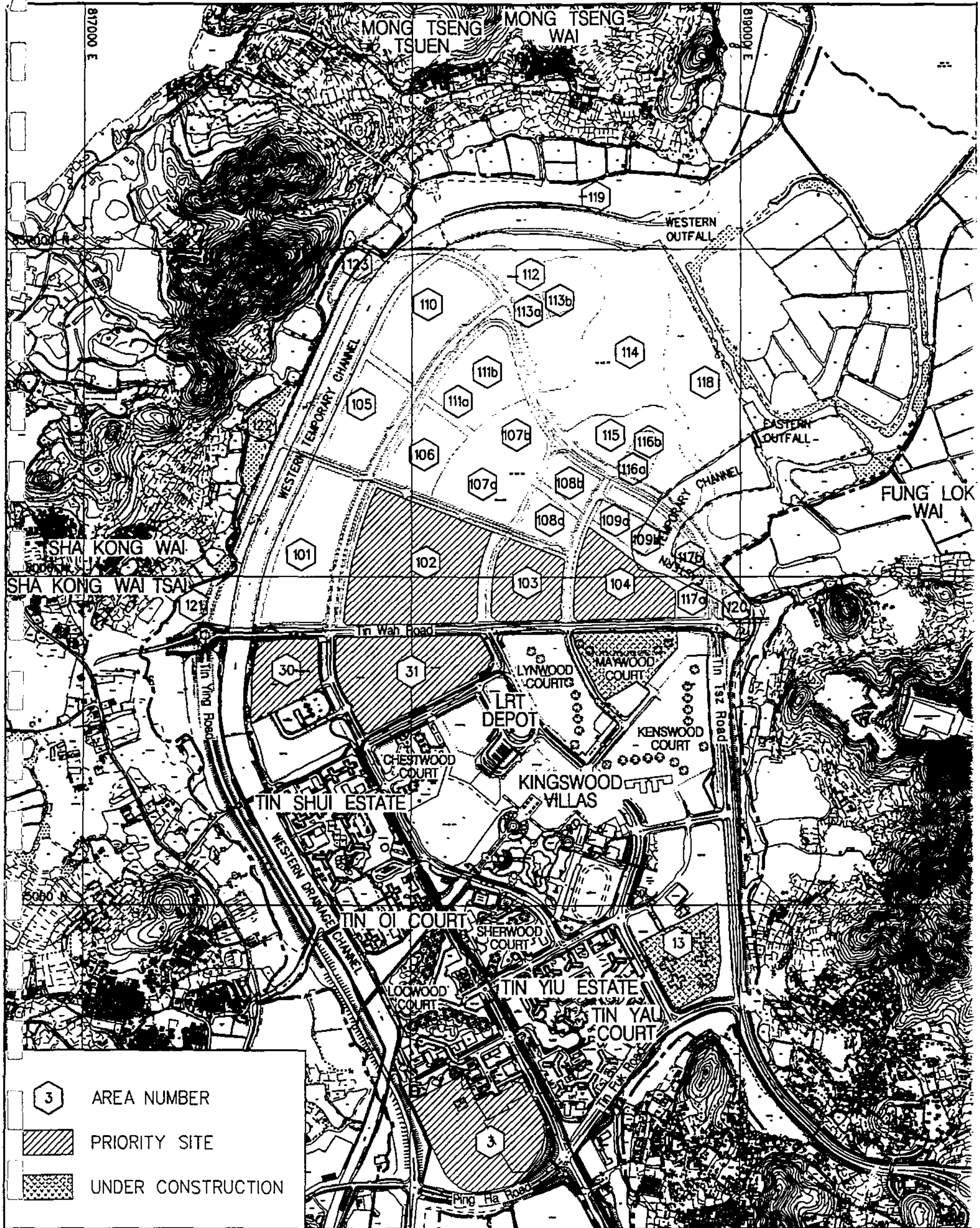
TIN SHUI WAI DEVELOPMENT

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS
OF THE DEVELOPMENT ZONE
AND THE RESERVE ZONE

GENERAL SITE LAYOUT

1.1

新界北拓展處
NEW TERRITORIES NORTH
DEVELOPMENT OFFICE
拓展署
Territory Development
Department, Hong Kong



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
賓尼工程顧問有限公司
ENGINEERS AND SCIENTISTS
賓尼

Title :

AREAS WITHIN THE TIN SHUI WAI DEVELOPMENT

Figure No. 1.2	Revision 1
Reference TSW-BASE	File Name 00110018.C09
Prepared MC	Checked PS
Date OCT. 96	Scale 1 : 15000

2 PROJECT DESCRIPTION

2.1 Introduction

2.1.1 This Section of the Report describes the Project. The Project has been divided into Package I, the Priority Works (outlined in Table 2.1), and Package II, the Remaining Works (outlined in Table 2.2). The Packages are further subdivided into eight Works contracts. The tables include estimated timescales and completion dates.

2.1.2 Six housing sites (Areas 3, 30 & 31 of the DZ and 102-104 of the RZ) have been designated as Priority Sites. These will be given precedence to ensure timely completion of site formation, infrastructure and subsequent building works.

Table 2.1 Summary of Package I Priority Works Including Formation and Infrastructure

Contract (duration)	Areas	Objectives	Works
1 (July - Dec. '97)	102	Site formation	- formation of Priority Area 102 excluding adjoining road reserves
2 (Sept.'97 - Nov.'98)	101-111, excluding 102 & 109b	Site formation	- formation of Priority Areas
3 (Oct.'98 - Jan.'00)	3, 30 & 31	Existing DZ infrastructure upgrading	- including widening of DZ junctions; provision of additional lanes
4 (Nov.'98 - Mar.'01)	102 - 104, & 109a	Engineering infrastructure	- construction of Roads L12, L13 & L14 including associated drains, sewers and water reticulation system; - dualling of Tin Wah Road (D2) and widening of Junction K; - dualling of Tin Tsz Road (P2); - formation of LRT reserve adjacent to Tin Tsz Road, L12 and Central Path; - rising mains from sewage pumping station in Area 101 to Ha Tsuen Pumping Station; - construction of Area 101 pumping station, roadbridge D2/V1 over WDCE, footbridge D2/CF1 over Junction M, subways L13/S1, L14/S1, P1/S1, Garden South culvert, Eastern culvert realignment near Junction P
5 (Oct.'98 - Mar.'01)	102 - 104, & 109a	Engineering infrastructure	- construct grade separated interchanges at Junctions A, D & W, and associated utility and drainage diversion; - widening of Long Tin Road to 3-lane dual carriageway; - widening of Hung Tin Road to 3-lane dual carriageway; - construction of roadbridges P1/V1 at Junction A, P2/V1 at Junction D and P2/V2 at Junction W; footbridge P2/CF1 across Road P2; and Eastern culvert realignment, Hung Tin Road culvert realignment

2.1.3 The remaining Package II Works are summarized in Table 2.2.

Table 2.2 Summary of Package II, Remaining Works

Contract	Areas	Objectives	Works
6 (Mar.'99 - May '01)	105 - 108, 110 - 113, 115 & 116	Infrastructure including roadworks, and drains and sewers	- construction of Road L12 and D4 and associated drains, sewers and water reticulation system; - dualling of Tin Ying Road (P1) between Junctions A-K; - formation of the LRT reserve next to Roads L12 and D4; - river training of 500 m of WDCE; - construction of roadbridges P1/V2 and P1/V3; footbridges L12/CF1 at Junction S; D4/F1 at Junction T; subways L12/S1 across Road L12; D4/S1 across Road D4; Garden Path culvert; subway extensions P1/S2 and P2/S3; and the Northern culvert
7 (Feb.'99 - Mar.'02)	109b, 112 - 117 & 120	Infrastructure works including roads, drains and sewers, and bridges; and site formation	- construction of Road D4 and associated drains, sewers and water reticulation system; - site formation of Areas 109b, 112 to 117 and 120; - formation of the LRT next to Road D4; - construction of roadbridge P2/V3 at Junction P; footbridge D4/CF2 at Junction V; subway D4/S2 across Road D4; Northeastern culvert; Eastern culvert extension
8 (Aug.'01 - Aug.'03)	Area 121, Road D3	Site formation, infrastructure and roadworks	- roads D3 and 1231 and associated drains, sewers and water reticulation system; - formation of Area 121; - construction of roadbridge D3/V1; road/footbridge L13/VCF1; footbridge WC/CF5

Note: At the time of printing of this EIA Report, Contract 6 and 7 are being considered to be incorporated into one contract: Contract 6. Contract 8 is being renamed Contract 7. The duration of each associated construction works under each contract will not change.

2.1.4 The locations of the individual Works Contracts are illustrated in plan form on Figures 2.1 - 2.8.

2.2 Site Formation

2.2.1 Site formation is required for the RZ and for various Engineering Infrastructure/ upgrading work sites. Areas 3, 30 and 31 are already formed. The site formation works required outside the RZ are almost wholly required for road and junction upgrading works.

2.2.2 The current ground levels within the RZ are shown on Figure 2.9. Figure 2.10 shows the proposed site formation levels. Calculation on the earthwork volumes shows that additional fill will have to be imported if all planning areas within the RZ are formed to above the average minimum formation levels at +5.5 mPD. Since the road levels are generally above +6.5 mPD at junctions, raising the general formation levels flush with the road formation levels further increases the need for additional fill.

2.2.3 For works outside the RZ, it is estimated that about 240,000 m^3 of fill will be required for the infrastructure and upgrading works, in particular dualling of Tin Ying Road and forming of Road D3 on the west bank of the WTC. In addition, about 40,000 m^3 of fill is likely to be needed: to replace the unsuitable materials which are to be dredged from the channels and from foundation of culverts, subways and bridges; to support the edge slopes of the formation and for the foundation of the Eastern Culvert extension.

2.2.4 Areas 101-108, 109a, 110 and 111 are to be formed under the first two works contracts. About 400,000 m^3 of surplus materials will be generated after the completion of these areas. The materials can be used in the site formation of the remainder of the RZ and in the Tin Ying Road dualling and Road D3 construction and other road works. Up to 58,000 m^3 may be used as additional fill to compensate for settlement.

2.2.5 This material will be stockpiled just north of Road D4 in Area 114 between Areas 112 and 115. Currently, stockpiles of sand fill and pond bund materials are placed to an elevation of 11 mPD in Areas 115 and 116. Peripheral drainage ditches need to be provided at the toe of the stockpile for connection to the existing drainage ditch running north towards the Tin Shui Wai Bund.

2.2.6 Areas 109b, 112-117 and 120 will be formed to provide the sites for developments in the area under Contract 7. The stockpile will be used and removed for formation of the planning areas and infrastructure/upgrading works.

2.2.7 Area 121 and Road D3 will be formed under Contract 8 requiring about 159,000 m^3 of fill.

2.2.8 Temporary drainage ditches in the form of 1 on 1.5 side slopes trapezoidal channels with 25 mm shotcrete or chunam facing are proposed to intercept the runoffs from the formation. Silt traps will be provided at the downstream ends of the ditches before discharging into the existing drainage systems. Figures 2.11 and 2.12 illustrates the temporary drainage layout.

2.3 Transport Infrastructure

2.3.1 As part of the engineering studies, extensive and comprehensive modelling of the existing, 2001, 2006 and 2011 road network has been undertaken. These studies have been endorsed. The endorsed traffic data results in traffic flows higher than those of the Layout Plan Study which have been used in assessment of traffic noise impacts on Areas 3, 30 and 31 by Housing Department. Road layouts described in later paragraphs are based on this endorsed data.

2.4 Roadworks

2.4.1 Figure 2.13 shows the existing and the proposed road hierarchy of the Tin Shui Wai new town. Again please note that the details of these works may change during detailed design.

Road P1 (Tin Ying Road)

2.4.2 Road P1 is a primary distributor along the western boundary of the DZ. It provides a direct link from the RZ to the expressway network via Hung Tin Road. To cater for the RZ development, Road P1 is proposed to be upgraded to a 7.3 m 2-lane and a 10 m 3-lane dual carriageway. Road widening reserves have been allowed for in some areas.

2.4.3 It is proposed that the additional northbound carriageway will be located to the west of the existing Road P1 with 4 m wide central reserve in between. A 3.5 m wide verge will also be provided on both side of Road P1.

Road P2 (Tin Tsz Road)

2.4.4 Road P2 is a primary distributor along the eastern boundary of the DZ. It provides a direct link from the RZ to the expressway network via Long Tin Road and Yuen Long West Link.

2.4.5 Like Road P1, Road P2 was recommended under the engineering infrastructure study for the DZ to be constructed in stages. Originally, the northbound carriageway would be constructed to meet the developments in the DZ with provisions for future upgrading to a dual three-lane carriageway.

2.4.6 As a result of the Tin Shui Wai Town Centre Study, an additional junction with Road 1402 was introduced to Road P2 and the section between this new junction and Junction D was upgraded to a 7.3 m dual carriageway to serve the additional traffic.

2.4.7 As part of the upgrading works for the RZ, Road P2 will be upgraded to a 3-lane dual carriageway throughout.

Road D2 (Tin Wah Road)

2.4.8 Road D2 is a district distributor connecting the two primary distributors P1 and P2 at Junctions K and P respectively on the southern boundary of the RZ. It also connects with the local distributors in the southern part of the RZ.

2.4.9 Road D2 was constructed for the DZ initially as a 10.3 m wide single carriageway with footpath on the southern side only. A short cycle track was provided between Junctions K and M. Road widening reserve was provided on the northern side of the carriageway for future upgrading to a dual 2-lane carriageway.

2.4.10 To cater for the RZ development, Road D2 is proposed to be upgraded to a 7.3 m dual 2-lane carriageway.

2.4.11 A 3.5 m wide footpath will be provided on both sides of Road D2. The existing 3.5 m wide southern cycle track at the western end of Road D2 will be extended to Junction P at the eastern end.

Road D3 (Formerly known as Road R1)

2.4.12 Road D3 is a district distributor connecting the primary distributor Road P1 and the district distributor Road D4 at Junctions K and T respectively. It forms the west arm of the peripheral road around the RZ and connects to local distributors at Junctions R and T. Road D3 is a 7.3 m 2-lane dual carriageway with a 4.5 m central divider.

2.4.13 Due to the close proximity of the WTC, a 3.5 m wide footpath and a 3.5 m wide cycle track will be provided along the western promenade of the channel to enhance the amenity value of the channel.

Road D4 (Formerly known as Road R3)

2.4.14 Road D4 is a district distributor linking the primary distributor P2 and the district distributor Road D3 at Junctions P and T respectively. It forms the east arm of the peripheral road around the RZ. It connects to local distributor roads at Junctions T and V. Road D4 is a 7.3 m dual 2-lane carriageway with a 4.5 m central divider.

2.4.15 A 3.5 m wide footpath will be provided on each side of the road and a 3.5 m wide cycle track on the southern side of the road. The LRT Reserve will be provided to the south of the road.

Road L12 (Formerly known as Road R2)

2.4.16 Road L12 is a major local distributor connecting Junctions L and T. It provides access to planning areas 101, 102, 105, 106, 110 and 111. Due to the number of LRT/road junctions, Road L12 is proposed to be a 2-lane 7.3 m dual carriageway to accommodate right turning vehicular and pedestrian movements. A 4.5 m central divider is provided to accommodate a right turning lane at junctions.

2.4.17 A 3.5 m wide footpath will be provided on both sides of the road and a 3.5 m wide cycle track on the eastern side of the road. An LRT reserve will be provided to the east of the road.

Road L13 (Formerly known as Road R5)

2.4.18 Road L13 is a local distributor connecting the district distributor Road D3 and local distributor Road L14 at Junctions R and U respectively. It provides access to planning areas 102, 103, 106, 107 and 108. Road L13 is a 7.3 m wide dual carriageway. A 3.5 m wide footpath will be provided on both sides of the road and a 3.5 m wide cycle track on the southern side of the road. There is no significant deviation from the findings of the earlier Layout Plan Study.

Road L14 (Formerly known as Road R4)

2.4.19 Road L14 is a local district distributor connection Junctions N and V. It provides access to planning areas 103, 104, 108a, 108b and 109. In view of the multitude of junctions along this short section of road, Road L14 is proposed to be a 2-lane 7.3 m dual carriageway to smoothen traffic turning movements and to enhance pedestrian safety. A 4.5 m central divider is provided to accommodate a right turning lane at junctions. A 3.5 m wide footpath will be provided on both sides of the road and a 3.5 m wide cycle track on the east side of the road.

Roads 1091 and 1201

2.4.20 These roads will provide access to the GIC facilities in Area 109 and to Area 120 respectively. Both roads will comprise a 10.3 m 2-lane carriageway with 2.5 m footpath on both sides.

Roads 1202 and 1231

2.4.21 Road 1202 will provide access to the GIC facilities in Area 120. Road 1231 will provide access to Area 123 and connect to the access track to Mong Tseng Tsuen. Both roads will comprise a 7.3 m 2-lane carriageway with 1.6 m footpaths on both sides.

Hung Tin Road and Long Tin Road

2.4.22 The northern end of these roads will be upgraded to a 3-lane dual carriageway roads (Figure 2.13).

LRT Provision

2.4.23 Two types of LRT reserve have been proposed in order to serve the RZ population effectively:

(i) local service - connecting the RZ development areas to the DZ.

(ii) express service - connecting the RZ development to the proposed WCR station south of the DZ.

LRV Stops

2.4.24 Seven LRV stops will be provided in the RZ for the Development. The locations of the LRV stops and other aspects of the LRT are shown on Figure 2.14.

LRT Terminus

2.4.25 In accordance with the *Report on Preparation of Layout Plans for Tin Shui Wai Reserve Zone*, the LRT terminus will be located at Area 106 of the RZ. Provision of engineering infrastructure has been investigated on this basis.

Rectifier Station

2.4.26 A rectifier station will be located at Area 109 of the RZ.

Highway Structures

2.4.27 There are a number of highway structures being investigated in the Study Area. Broadly speaking, they are classified into the following categories:

- vehicular bridge;
- LRT bridge;
- footbridge; and
- subway.

2.4.28 Various forms and layout of the bridges and subways have been investigated. Bridges are mainly employed to cross the Western Drainage Channel Extension (WDCE) and at grade-separated junctions while subways are used to provide pedestrian and cycle movement crossing carriageway and LRT reserve at open and amenity areas. Footbridges are used to link residential and commercial centres.

Pedestrian Networks

2.4.29 Extensive footpath and cycle track networks will be provided along carriageways. To facilitate pedestrians crossing the carriageway and LRT track safely and efficiently, at-grade crossings, footbridges and subways are proposed to link up open spaces, amenity areas, LRV stops, population and commercial centres and the DZ to form an integral pedestrian network for the Tin Shui Wai new town.

Highway Structures

2.4.30 There are a number of proposed highway structures ranging from vehicular bridges, cycle and pedestrian bridges, footbridges and subways under investigation. Examples of the types of 'flyover' junctions being examined are given on Figure 2.15.

2.5 Drainage

Catchment Drainage Systems

Fig 7.1

2.5.1 The Tin Shui Wai drainage basin covers an area of about 23 km^2 in the North West New Territories. The principal drainage systems lie respectively along the western and eastern boundaries of the Tin Shui Wai Landholding and consist of the WTC and the Eastern Temporary Channel (ETC) which discharge into Deep Bay. The existing drainage systems in the basin are shown on Figure 7.2. Since 1987, substantial improvement works in the drainage systems have been carried out in the basin in conjunction with the reclamation for Tin Shui Wai new town development. These main catchment drainage systems have been upgraded to have adequate flow capacities to deliver runoff generated in the basin when the extensive development of the whole basin as set down by the Territorial Development Strategy for the Northwest New Territories region is completed. Flows can be conveyed within banks in the WTC and ETC.

2.5.2 After the commissioning of the engineered channels and culverts in the early 1990s, the western and eastern catchment drainage systems have had adequate capacity to convey flood flows within the bank during the design storms and have operated satisfactorily in severe rainstorms and storm surge events in the past five years. Together with the implementation of village flood protection measures to low-lying villages around the southern boundary of Tin Shui Wai Landholding, runoff from most parts of the drainage basin can now discharge into the catchment drainage systems without causing flooding. However, there are several low-lying areas known as polders, in the northern and eastern parts of the drainage basin where runoff cannot drain into the catchment drainage systems when water levels in these systems are high and these areas remain flood prone.

2.5.3 As most of the flood loss mitigation schemes comprising river training and poldered village schemes in the basin have been completed, flooding is only a local problem to the areas which cannot drain by gravity during floods. Recommendations of embanking areas 114 and 118 or alternative means in order to use this area, as a possible means for flood conveyance have been investigated. Ponding at the mouth of the Eastern Culvert area is also a possibility to be addressed in detail in this report.

Local Drainage Systems

2.5.4 The Developments including Areas 3, 30, 31 and 33 of the DZ and the RZ will be served by local drainage systems. These will be gravity systems designed to deliver surface runoff generated in each area to the catchment drainage systems.

2.5.5 There are two existing drainage culverts, namely Western Central Culvert (WCC) and Eastern Central Culvert (ECC), lying along the southern boundary of the RZ underneath Tin Wah Road (Road D2). The WCC has been designed to deliver runoff from the southern part of Area 102 and Road L12. Similarly, the ECC has been sized to convey runoff from Areas 103, 104, and 108a, Road L14 and the LRT Reserve. To cater for further developments, four drainage culverts are proposed to discharge runoff generated within the RZ to the main catchment drainage system in the basin.

2.5.6 The proposed permanent drainage box culverts to be constructed within the RZ are shown on Figure 2.16. The sub-catchment areas they serve are given in Table 2.3.

Table 2.3 Proposed Drainage Culverts within RZ

Proposed Culvert	Location	Discharging Channel	Sub-catchment
Garden South Culvert (GSC)	Along Road L13	WDCE	Areas 101 (N), 102(N), 105(S), 106(S), 107a, Roads L12, L13
Garden Path Culvert (GPC)	Garden path	WDCE	Areas 105 (N), 106 (N), 110 (S), 111a, 107b, Garden Path, Road L12
Northern Culvert (NC)	Along Road D4	WDCE	Areas 110 (N), 111b, 112, 113a, b, Road D4
Northeastern Culvert (NEC)	Along Road D4	EDC	Areas 108, 109, 115, 116a, b, Roads D4, L14, 1091
Eastern Culvert Extension (ECE)	Along Road D4	EDC	Areas 117a, b, 120, Road D4, Culverts EC, ECC

Notes : 101 (N) denotes northern part of Area 101.
105 (S) denotes southern part of Area 105.
WDCE denotes Western Drainage Channel Extension.
EDC denotes Eastern Drainage Channel.

2.5.7 The floodwater levels in the WTC and ETC are estimated based on the landuses for extensive development of the whole drainage basin and upon completion of the RZ development and the DSD Stormwater Drainage Manual.

2.5.8 In order to reduce the impacts on the catchment drainage systems due to surface runoff coming from roads, sand traps and oil interceptors will be installed at the downstream end of the local drainage systems before they discharge into the catchment drainage systems.

Western Drainage Channel Extension

2.5.9 Paving of a 500 m length of the WTC immediately downstream of the inflatable dam for maintenance purposes will take place. This will involve construction activities during low tides (contractual clauses included), or in the dry season to isolate the work area so dredging can take place and paving installed.

2.6 Sewerage

2.6.1 The sub-regional sewerage strategy adopted by the SMP is to discharge sewage collected from the Yuen Long, Kam Tin and Tin Shui Wai areas through the NWNT sewerage system to the tidal channel at Urmston Road. The SMP has included a comprehensive network of new trunk sewers and sewage pumping stations to achieve this strategy. Implementation has been underway since 1992.

2.6.2 A number of the SMP trunk sewers have been proposed to run within Tin Shui Wai. Their preliminary layouts are shown on Figure 2.17 and the key data are summarised in Table 2.4. These proposed provisions are currently under review (see paragraph 2.7.3).

Table 2.4
Proposed SMP Trunk Sewers within Tin Shui Wai

Proposed Trunk Sewer	Diameter (mm)	Alignment within Tin Shui Wai	Implementation Programme
A pumping main/gravity sewer to transfer sewage from Ping Shun Street Pumping Station to the existing trunk sewer immediately upstream of Ha Tsuen Pumping Station	1000 (rising main) 1200 (gravity sewer)	Along Tin Fuk Road and Ping Ha Road	1995-1997 under construction
Two pumping mains to transfer sewage from Yuen Long Sewage Treatment Works to the sewer tunnel beneath Castle Peak Range	1200/1200	Along Tin Wah Road and eastern side of Western Drainage Channel	2000 - 2003 under review
Two pumping mains to serve Sha Kong Wai and Lau Fau Shan	200/250	Along western side of Western Drainage Channel	1999 - 2001 under review
One pumping main to serve Mong Tseng Tsuen and Mong Tseng Wai	150	Along western side of Western Drainage Channel (Extension)	2001 - 2003 under review

2.6.3 Concurrent with this engineering investigation for the RZ and related developments, a separate study entitled "Review of Yuen Long and Kam Tin Sewerage and Sewage Treatment Requirements" was commissioned by EPD in December 1995 to review the sewerage facilities in a sub-regional context taking account of the latest development forecasts. One of the objectives of the review is to assess whether all sewage flows from the latest Tin Shui Wai development could be discharged to Ha Tsuen Pumping Station or part of the sewage flows would have to be discharged directly to San Wai Sewage Treatment Works. Technical Note No. 1 of the review issued in February 1996 indicates that Ha Tsuen Pumping Station has sufficient capacity to receive all sewage flows from the ultimate Tin Shui Wai development.

Recommended Sewerage Strategy for the Development

2.6.4 A preliminary sewerage assessment has been conducted in the earlier part of the Assignment to investigate sewerage options for the Priority Sites. The findings and recommendations are contained in the final Preliminary Sewerage Assessment Report issued in April 1996. The report has been discussed at working group and steering group meetings for the Assignment and the recommended sewerage option, annotated Option A2, has been accepted by the groups as a preferred option.

2.6.5 The recommended option entails in broad terms discharging sewage generated from the Priority Sites to Ha Tsuen Pumping Station via the existing sewerage network in the DZ and constructing a new sewage pumping facility on the western fringe of TSW under a 2-stage implementation programme. Figure 4.5.4 shows a schematic layout of the option. The proposed sewerage works will form part of the permanent facilities for the Development.

2.6.6 Stage I utilizes the existing TSW sewerage network as an interim arrangement to meet the early population intakes of the development at Areas 3, 30 and 31. The interim arrangement will last for about half a year until the final sewerage scheme under Stage II is complete. A short section (approximately 500 m) of the trunk sewer beneath Tin Shing Road will be surcharged but still have adequate factor of safety against overflow. In assessing the surcharged condition, sewage from Area 33 has been excluded in view of the high priority of the development at Areas 3, 30 and 31 and the unconfirmed status of the Area 33 development. Additional provision will be required if first occupation of the development at Area 33 takes place before completion of Stage II and would be the developer's responsibility.

2.6.7 Stage II involves constructing new gravity sewers beneath Roads L12, L13 and L14 and Tin Wah Road, a new sewage pumping station at Area 101 and a pair of rising mains along the Western Drainage Channel to convey sewage generated from Areas 102, 103 and 104 to Ha Tsuen Pumping Station. In order to dispense with the surcharge condition caused under Stage I to the existing TSW sewerage system, provision will be made under Stage II to re-route sewage from receiving points 27a, 31b and 33b for Areas 27, 31 and 33 respectively to the proposed trunk sewer beneath Tin Wah Road. After re-routing of the sewerage, the existing TSW sewerage network will be reverted to normal flow condition with no surcharge.

Preliminary Design of Rising Mains

2.6.8 The sewage of the RZ will be pumped to Ha Tsuen Pumping Station via 2 km long rising mains along the western bank of the WDC.

2.6.9 A preliminary assessment suggests that the rising mains should consist of a pair of 600 mm diameter ductile iron pipes. Twin instead of single pipe is selected from the maintenance point of view. These rising mains have been sized to serve the whole RZ development including any developments in the DZ which would discharge through them.

2.6.10 A buried pipe system is recommended to avoid any adverse visual impact to the surrounding environment. Open excavation is considered as a suitable and cost effective method to lay the pipe beneath footpaths/cycle tracks and drainage channels. Consideration should however be given during detailed design to using trenchless techniques at locations where the rising mains cross the drainage channels.

2.6.11 Access manholes will be provided at the location where the rising mains change in direction/gradient to facilitate the maintenance works.

2.6.12 The sewage retention time within the rising mains will be kept to a minimum to prevent the sewage from turning septic.

Preliminary Design of Pumping Station

2.6.13 According to the latest preliminary implementation programme, first occupation of the developments would happen between years 1999 and 2003. Staged installation of pumps should be considered during detailed design to tie in with the sewage build-up.

2.6.14 A preliminary assessment suggests that the proposed pumping station shall have an ultimate capacity for a peak flow of 1278 l/s. This flow is calculated from the respective sewage flows in the Sewage Flows Inventory for the developments served by the pumping station under the recommended option.

2.6.15 Electrically operated vertical spindle non-clog dry well sewage pumps have been recommended for their proven reliability and ease of inspection and maintenance.

2.6.16 The layout is similar to the existing station in Area 14. The pumping station will comprise a dry well, a divided wet sump and an intake channel.

2.6.17 The pumping station will be designed for unattended operation with appropriate instrumentation and control systems. Remote monitoring and alarms will be provided by a telemetry system if required.

2.7 Utilities

2.7.1 The proposed Developments have been planned to accommodate a population of approximately 59,000 in the DZ and 124,000 in the RZ. The roadworks and utilities networks have in general been completed in the DZ, whereas the RZ is presently undeveloped and equipped with no existing utility serving the areas.

2.7.2 The Developments are scheduled to be completed in stages. First occupation of the areas in the DZ is scheduled for 1999, followed by occupation of the areas in the RZ from year 2000 onward. It is therefore required to ensure that adequate utility service will be available to meet the development schedule.

2.7.3 The utility undertakings are generally responsible for the design and construction of utilities. At this preliminary design stage it is required to determine in consultation with the utility undertakings the locations of existing and proposed utilities affected by the engineering infrastructure, to make recommendations on utility diversions and to propose utility layout. The following utilities have been considered in the Assignment:-

- water supply;
- power supply;
- gas supply;
- telephone service;
- cable TV service;
- street lighting; and
- traffic signals.

2.7.4 Due consideration would be given to avoid conflicts with the provisions of sewers and stormwater drains including box culverts.

Water Supply

2.7.5 The principal potable water supply for Tin Shui Wai is presently fed from Au Tau Water Treatment Works via a network of service reservoirs and distribution mains. To cope with increasing demand, a new treatment works would be built at Ngau Tam Mei. Stage 1 of this new treatment works is scheduled for commissioning in mid 1999. The principal potable water supply for Tin Shui Wai will then be fed from Ngau Tam Mei Water Treatment Works.

2.7.6 The DZ is currently served by Wang Chau Service Reservoir. Tan Kwai Tsuen North Service Reservoir will be built to cater for the proposed Developments. According to the present programme, this new service reservoir and the associated trunk mains will be completed in mid 1999 to coincide with the commissioning of Ngau Tam Mei Treatment Works.

2.7.7 The options of alignment identified for the 1800 mm diameter watermain from Tan Kwai Tsuen North Service Reservoir to the RZ is shown on Figure 2.19. The choice of these options will be subject to the recommendation of the investigation recently commissioned by WSD.

2.7.8 WSD advised that water supply for Areas 30, 31 and 33 would be fed from the existing network in the DZ.

2.7.9 Figure 2.20 shows the proposed fresh and flushing water reticulation system for the RZ, implementation of which has been entrusted by WSD to TDD projects.

2.7.10 In line with the current practice in Tin Shui Wai, the developments in the RZ would be provided with separate potable and non-potable water distribution systems. Until a source of non-potable water is available the non-potable water distribution system would be connected to the fresh water trunk main beneath Tin Wah Road. WSD have no definitive programme for commissioning a separate non-potable water system for Tin Shui Wai. WSD have allowed for using fresh water for irrigation in the planning of the water supply system for Tin Shui Wai.

Power Supply

2.7.11 The power supply for the proposed developments in the RZ based on the initial information provided by China Light & Power Company Limited (CLP) will be an extension of service from the existing network in the DZ. To effect power supply to the RZ, CLP have indicated in their proposed cable layout that two primary substations, one in Area 32 of the DZ and one in Area 120 of the RZ would be needed for extension of their 132 kV circuit from DZ to RZ. Power supply to the proposed development in the DZ will also be extended from the existing network.

2.7.12 There are presently no 11 kV cables in the RZ. A network of 11 kV cables has been proposed by CLP and is shown on Figure 2.21. It is also noted that some of these 11 kV cables have been proposed in open spaces where trunk utilities are not normally laid. Liaison of the power supply requirements with CLP with respect to the proposed 132 kV and 11 kV network as well as implementation of the two primary substations for the proposed Developments are in progress.

2.7.13 The existing 132 kV overhead line to Shenzhen, PRC traverses the RZ. The diversion of the existing 132 kV overhead line was the subject of a planning application rejected by the TPB in August 1996.

2.7.14 CLP have indicated their inclination to continue the practice in the proposed Development of housing their cables in concrete troughs. This will be investigated in conjunction with the requirements and layouts of other utilities on a case by case basis at the detailed design stage.

2.7.15 A new 132 kV circuit from Tin Shui Wai 'A' sub-station to New Shekow Sub-station has been proposed by CLP. The underground section of this proposed circuit runs through the DZ and RZ and is currently being discussed.

Gas Supply

2.7.16 The Hong Kong and China Gas Company Limited (HKCG) have confirmed that the gas supply to the proposed Developments will be fed from the existing gas supply network which includes the off-take plant at Au Tau, the distribution main through Yuen Long Town and beneath Long Tin Road and the distribution mains within Tin Shui Wai. The gas supply to the development areas in the RZ will be extended from the existing low and intermediate pressure gas mains beneath Tin Kwai Road, Tin Shing Road and Tin Shui Road in the DZ. No upgrading of the existing network will be required.

2.7.17 Figure 2.22 shows the proposed layout of low and intermediate gas mains in the RZ which is based on the preliminary layout provided by HKCG. HKCG have been requested to advise whether the 180 mm diameter low pressure gas main terminates somewhere adjacent to Areas 112 and 116 are for future extension. In addition, HKCG have been requested to advise how gas supply can be provided for areas 120 and 121, as no gas main has been proposed in the vicinity of these two areas. Five governor kiosks have been proposed to be installed at Areas 102, 103, 104, 105 and 110 for provision of gas supply in the RZ.

2.7.18 HKCG have informed that a new gas-off take station will be built in Tin Shui Wai or its vicinity to provide security of gas supply to Yuen Long Town and Tin Shui Wai including the RZ. HKCG have advised that this is not a prerequisite of gas supply to the proposed Developments.

Telephone Service

2.7.19 Hong Kong Telecom (HKT) have confirmed that their existing network and telephone exchange in Area 14 of the DZ are capable of providing telephone service for the proposed developments in the DZ. No new installation or upgrading of the existing network is required for provision of service to these developments.

2.7.20 It has also been confirmed with HKT that the existing telephone exchange in Area 14 has spare capacity to provide service for a population of 79,200 in the RZ development. HKT would upgrade the existing network by laying additional multi-way telephone ducts from the existing telephone exchange, along Tin Cheung Road and Tin Tsz Road and then across Tin Wah Road, to the RZ. This upgrading work is proposed to commence in mid 1996, subject to further confirmation by HKT.

2.7.21 A new telephone exchange will be required in Area 109 in the RZ at the end of 2000.

2.7.22 Figure 2.23 shows the preliminary layout of telephone ducts for the Developments taking into account the preliminary information given by HKT.

2.7.23 Other telecommunications companies will also provide telephone service for the Developments, through Hutchison Communication Ltd.

Cable TV Service

2.7.24 Wharf Cable Limited (WCL) have advised that there is presently no CATV cable in Tin Shui Wai. However, WCL have planned to provide cable TV service to the DZ as well as the RZ. The proposed CATV cable network consisting of a 2 way 100 mm diameter ducts generally covers the whole Tin Shui Wai Development. Figure 2.24 shows the CATV network proposed by WCL.

Other Utilities

2.7.25 Provision of street lightings, traffic signals, fire hydrants and military utilities for the Developments are being investigated and the design will be addressed at the detailed design stage.

Temporary Utility Services

2.7.26 Availability of temporary utility services for the purpose of construction of engineering infrastructure/upgrading work for the Development is under investigation. Telephone service, electricity and water supply will be the main services required for construction activities.

2.8 Landscaping

Method of Approach

2.8.1 A rational approach has been adopted to develop a coherent and co-ordinated preliminary landscape design for the amenity areas, transport reserves and drainage channels. The design will follow the principles of the Master Landscape Plan for the RZ and follow the former recommendations made for existing areas of Tin Shui Wai to create a strong and consistent landscape theme throughout the new town.

2.8.2 A collaborative design process will be adopted in the preliminary design of landscape works and engineering infrastructure. The principles of landscape design will be developed as those of engineering infrastructure design are formulated and will be summarised in a landscape manual which will become the basis of further landscape design.

Preliminary Design

2.8.3 The carriageways, footpaths, cycle tracks and highway structures will be the predominant elements of the engineering infrastructure and landscaping of these provide opportunities for achieving visual continuity and aiding navigation throughout the town. The development of design principles has commenced and will be further developed when the layout of engineering infrastructure for the whole RZ has been refined based on the findings of transport and traffic assessment.

2.9 Programming

2.9.1 Figures 2.25 and 2.26 provides the current implementation programme for construction works associated with the Project. For ease of visualisation Figures 2.27 to 2.37 show the main works envisaged at this time, year by year.

2.10 Concurrent Projects

2.10.1 During the construction phase for works under this Project many other major projects will be under construction (see Table 2.5). Those with the greatest potential for cumulative environmental impact with this Project are shown on the programme on Figure 2.38. Those within or close to Tin Shui Wai are shown on Figure 2.39. Those with the likelihood of impacting on water quality or ecological habitats just to the north of Tin Shui Wai are shown on Figure 2.40.

Housing Department Developments

2.10.2 Throughout the construction phase of the Projects, new blocks of apartments and associated schools, commercial areas etc. will be erected. The Housing Department contracts are particularly substantial. There will be piling foundation works, general erection works and finishing activities occurring in various areas of Tin Shui Wai throughout the Project Works. These works for Housing Department are particularly intense between 1999 and 2001.

Private Developments in Tin Shui Wai

Proposed Commercial/Residential Development above the LRT Terminus/Bus Terminus in Area 33

2.10.3 The development is a composite development with part of the G/F designed for the use of LRT terminus and bus terminus. The completion date of the proposed development had been anticipated to be 1999/2000.

Extension of the Low Flow Interceptor System

2.10.4 DSD is going to construct a 400 m x 1 m deep x 2.5 m wide low flow channel in the WDC, upstream of the inflatable dam. This interim measure to improve water quality in the WTC, will facilitate maintenance and is intended to alleviate the odour problem.

RZ Developments

2.10.5 No detailed layouts for the private developments in the RZ will be available during the EIA study. However tentative occupation dates are known and these developments have been considered both as sources of cumulative impact and as sensitive receivers.

Table 2.5
Concurrent Projects

Projects	Start Date	Approx. Completion	Key Impacts		Sensitive Receivers	Comments
Planning Application for proposed development over LRT/bus terminus	To be confirmed	To be confirmed	construction noise construction dust construction waste surface water	medium light light light	Lynwood Court & Chestwood Court of Kingswood Villas	building construction works
CLP substation B at Area 32	Jan 1997	Dec 1999	construction noise construction dust construction waste surface water operational noise	medium light light light light to medium	Tin Shui Estate, TWGH Yiu Dak Chi Memorial Primary School, TSW Public Primary School	construction works
CLP substation C at Area 120	mid 2001	mid 2003	construction noise construction dust construction waste surface water operational noise	medium light light light light to medium	Maywood Court & Kenswood Court of Kingswood Villas, Area 104, Special Measure Zone (SMZ)	construction works
HKT telephone exchange at Area 109	May 1998	May 2000	construction noise construction dust construction waste surface water	medium light light light	Area 104, SMZ	construction works
Proposed residential development at Lau Fau Shan	To be confirmed	To be confirmed	construction noise construction dust construction waste surface water	medium light light light	Mong Tseng Tsuen, SMZ, Area 110	S.16 application submitted on 24.1.95, approved by Town Planning Board on 14.7.95, no further information received from developer

Table 2.5
Concurrent Projects (cont'd)

Projects	Start Date	Approx. Completion	Key Impacts		Sensitive Receivers	Comments
West Rail Project (Tin Shui Wai Station)	To be confirmed	To be confirmed	construction noise construction dust construction waste surface water operational noise	medium medium light light medium to heavy	Area 3, Area 13, Tin Yiu Estate, Tin Yau Court	construction of West Rail and Tin Shui Wai Station
Yuen Long water supply, Tan Kwai Tsuen North fresh water reservoir (Phase I & II)	Oct 1997	Dec 2000	construction noise construction dust water quality	light light light	Tin Shui Estate, Area 3, WTC	to be constructed along Western Drainage Channel Phase I (Oct 97 - Jul 99) Phase II (Jul 99 - Dec 00)
Diversion of CLP 132kV overhead cable	Dec 1997	April 1998				alignment of diversion route not yet finalised
Yuen Long, Kam Tin Sewerage Master Plan (all phases)	1999	2003 (under review)	construction noise construction dust water quality	light light light	Tin Shui Wai Estate Locwood Court Sha Chau Lei	currently under review
Shenzhen River Training Project (all stages)	Nov 1995	1999- 2000	water quality hydrodynamics sedimentation erosion	heavy during Stage II light heavy during Stage II localised	Inner Deep Bay - especially at mouth Inner Deep Bay Inner Deep Bay -benthic organisms mangroves and mudflat	slight overall improvement in Inner Deep Bay increase in tidal range & velocities at mouth benthic organisms can withstand these levels deeper incised flow channels
Ngau Tam Mei, Yuen Long and Kam Tin - Main Drainage Channel (all phases)	Oct 1993	Dec 2000	water quality	very heavy	Inner Deep Bay	all stages involve some river training, deepening, widening and lining

Developments near Tin Shui Wai

Residential Development and Recreational Facilities at Lau Fau Shan Area

2.10.6 The proposed residential development (also referred as S. 16 planning report submitted on 24.1.95) was approved by the Town Planning Board upon review on 14.7.95. According to the proposed development programme, construction of the houses, club house and related recreation facilities was due to start in 01.07.96 lasting for 12 months. Land exchange and access road issues are delaying the programme and timing has to be confirmed.

Other Developments

2.10.7 Many other village-type developments are currently being considered by developers or have been submitted to the relevant government authorities. They are particularly common to the south of Tin Wah Road. While not all the development proposals will be approved it seems highly likely that many will proceed over the next eight or so years. In addition applications for other land-use changes are being made most of which will result in at least some site formation works and paving works.

Yuen Long Water Supply, Tan Kwai Tsuen North Fresh Water Service Reservoir

2.10.8 WSD has planned to augment the existing water supply system by construction of a new service reservoir in Tan Kwai Tsuen North together with associated trunk and distribution mains. The new reservoir is going to be constructed in two stages to meet the development programme. Planning Report No. 8/95 states that EPD completed an Environmental Review in 1994 of this project and concluded that no EIA was necessary.

2.10.9 WSD is commissioning a 5-month feasibility study on the service reservoir and the associated trunk mains. The implementation programme of the new service reservoir is expected to be finalised shortly.

Diversion of 132 kV Overhead Cable

2.10.10 The existing 132 kV overhead cable in the northeast portion of the RZ will need to be diverted before site formation of Areas 110, 111b, 107B and 109 can commence. The diversion was programmed to commence in November 1997 and be completed in April 1998, however the planning application was rejected by the TPB in August 1996. A new planning application is being made.

CLP Substations

2.10.11 To cope with electricity demand in the RZ, CLP anticipated 2 additional substations will be required, namely Stations B and C. Land application for Substation B in Area 32 of the DZ was submitted to District Lands Offices/Yuen Long in January 1995. CLP anticipated that substation B could be commissioned in 2000 to meet the population intake. Construction works will begin in January 1997.

2.10.12 A site in Area 120 has been reserved for Substation C. CLP envisage that Substation C will not be necessary before 2005; by then most of the development in the RZ will be completed.

Telephone Exchange at Area 109a

2.10.13 Hong Kong Telecom (HKT) confirmed that a new telephone exchange at Area 109a is needed to provide full telephone service to the Priority Sites (Areas 102 to 104) and subsequently, the rest of the development of the RZ. The site in Area 109a for the new telephone exchange will have to be formed and made available to HKT before February 1998, allowing two years for building construction to meet the population intake in Areas 102 to 104.

Main Drainage Channels (MDC) for Ngau Tam Mei, Yuen Long and Kam Tin

2.10.14 The MDC are currently being extensively dredged and widened. Very large volumes of materials have already been removed. The channels upstream of Castle Peak Road are to be cement-lined and these works will be concurrent with the construction phase of this Tin Shui Wai Project. Works will continue until mid 2004.

Shenzhen River Training Project

2.10.15 The Shenzhen and Hong Kong Authorities initiated cross border liaison meetings in 1982 to review and co-ordinate measures to prevent flooding and reduce pollution in the river catchment.

2.10.16 As a result of these initiatives a scheme to realign, widen and deepen the Shenzhen River downstream of Lo Wu was proposed in 1985.

2.10.17 This Project consists of a three stage scheme Stage 1 involves relatively localised works to truncate two existing meanders of the river close to Shenzhen City. Stage 2 involves more extensive dredging works downstream of Lo Wu to increase the depth and width of the Channel, and construction of flood protection works along both banks of the widened stream. Stage 3 involves dredging works upstream of Lo Wu.

2.10.18 Impacts from the concurrent project will be discussed further under each section of this report (e.g. noise, air, water quality, ecology).

2.10.19 Table 2.5 shows the summary of the concurrent projects likely to have an impact on the surrounding environment in Tin Shui Wai.

West Rail Project

2.10.20 The West Rail Project (previously known as Western Corridor Railway) is one of the several strategic routes that have been identified under the Railway Development Study, which is being managed by the Railway Division of Highways Department. The detailed feasibility of the West Rail is being undertaken by the KCRC. The project, currently the subject of much debate, has yet to be time tabled but would provide a new arterial transportation link to the border.

2.10.21 Part of the West Rail alignment will pass Tin Shui Wai, a rail station and public transport interchange is proposed for Tin Shui Wai.

2.10.22 Sections of the alignment in Tin Shui Wai will be constructed on a viaduct.

Village Flood Protection Schemes River Training Works

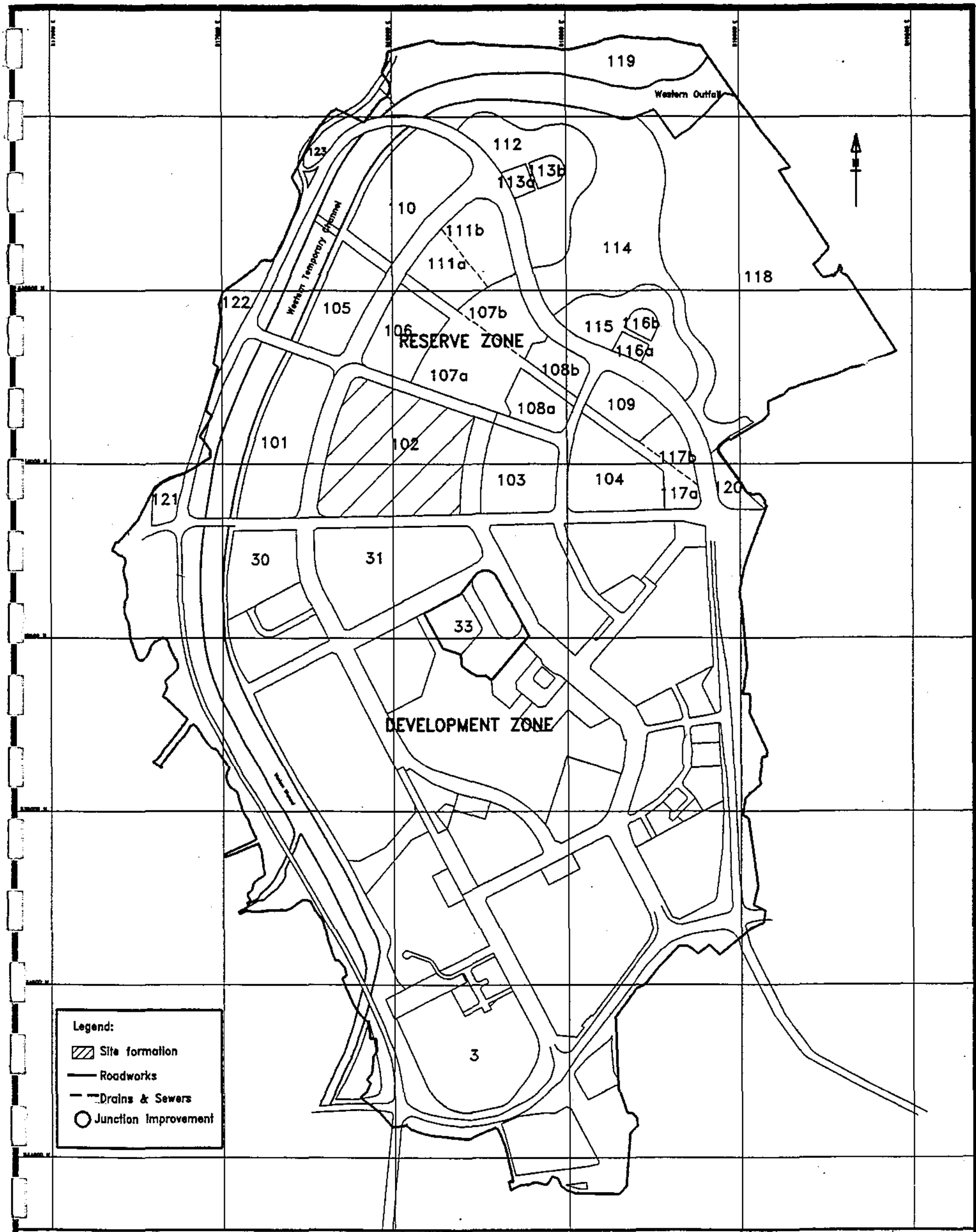
2.10.23 Only works for Ha Mei San Tsuen and Sheung Cheung Wai remain. Flood protection embankments are being completed and other upgrading works will be undertaken. The works at Ha Mei San Tsuen ~~will be completed in~~ early 2001. The works include formation of village expansion areas, stormwater drainage and sewerage systems, footpaths and landscaping. It is likely that minor river-training works on the secondary drainage system of the Tin Shui Wai Basin will be recommended as part of the Yuen Long, Kam Tin, Ngau Tam Mei and Tin Shui Wai Drainage Masterplan Study.

Yuen Long and Kam Tin Sewerage Master Plan

2.10.24 The Project is divided into five stages covering works in the whole North West New Territories, all of which will have a long term beneficial impact on watercourses draining into Inner Deep Bay.

2.10.25 The proposed Trunk Sewerage will be connecting areas surrounding the Tin Shui Wai DZ and RZ to the Ha Tsuen Pumping Station/San Wai Treatment Plant.

2.10.26 Stages 2, 4 and 5 involve a large area immediately south west and north of the Tin Shui Wai DZ and RZ respectively which will be connected by pumping and gravity mains via a series of receiving points and pumping stations to the Ha Tsuen Pumping Station.

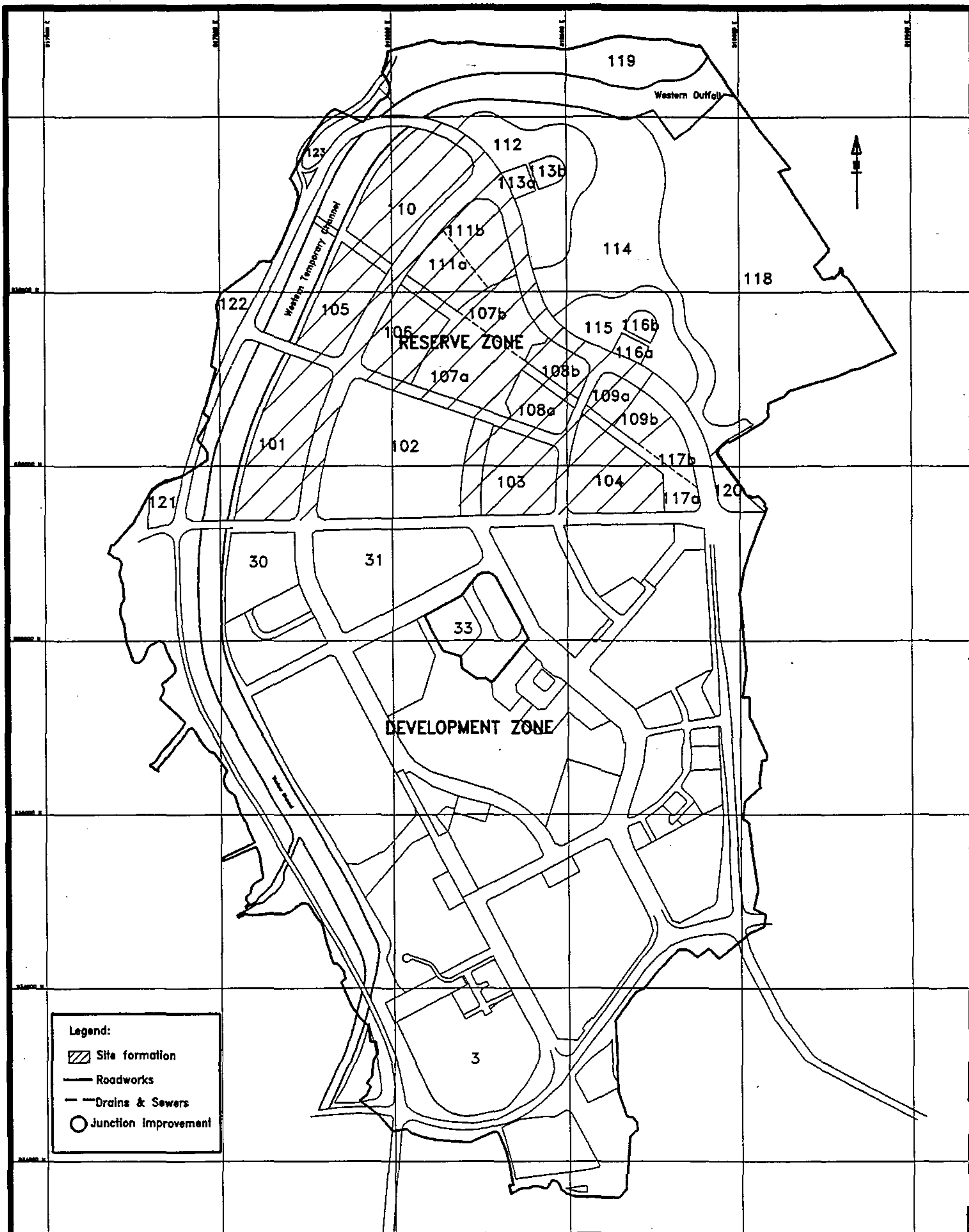


TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR
DEVELOPMENT OF AREAS 3,30 & 31
OF THE DEVELOPMENT ZONE
AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
賓尼工程顧問有限公司
ENGINEERS AND SCIENTISTS
賓尼

PRELIMINARY IMPLEMENTATION PROGRAMME
CONTRACT 1

Figure No. 2.1	
Prepared SCM	Checked CYH
Date 10/96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
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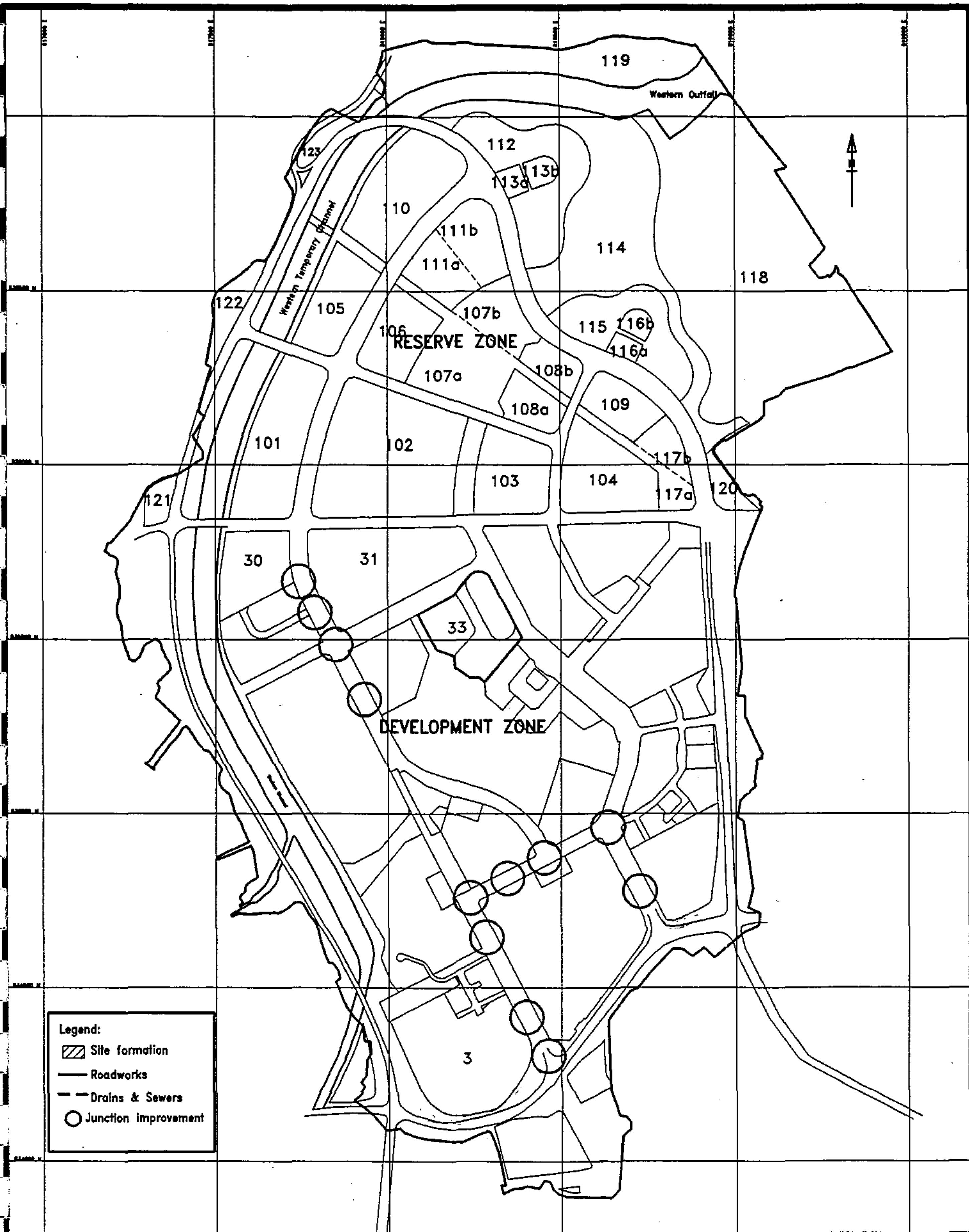
PRELIMINARY IMPLEMENTATION PROGRAMME
CONTRACT 2

Figure No. 2.2	
Prepared SCM	Checked CYH
Date 10/96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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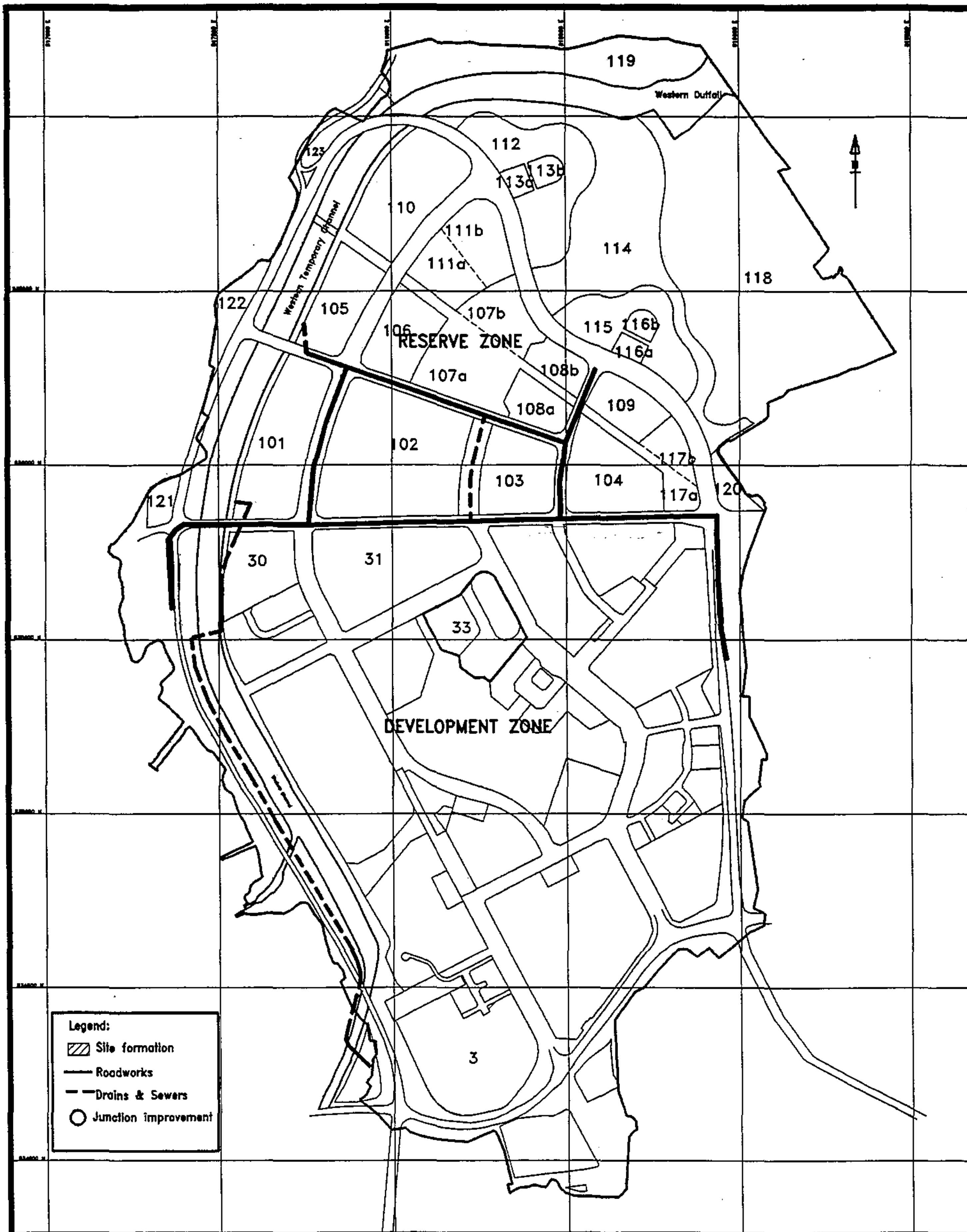
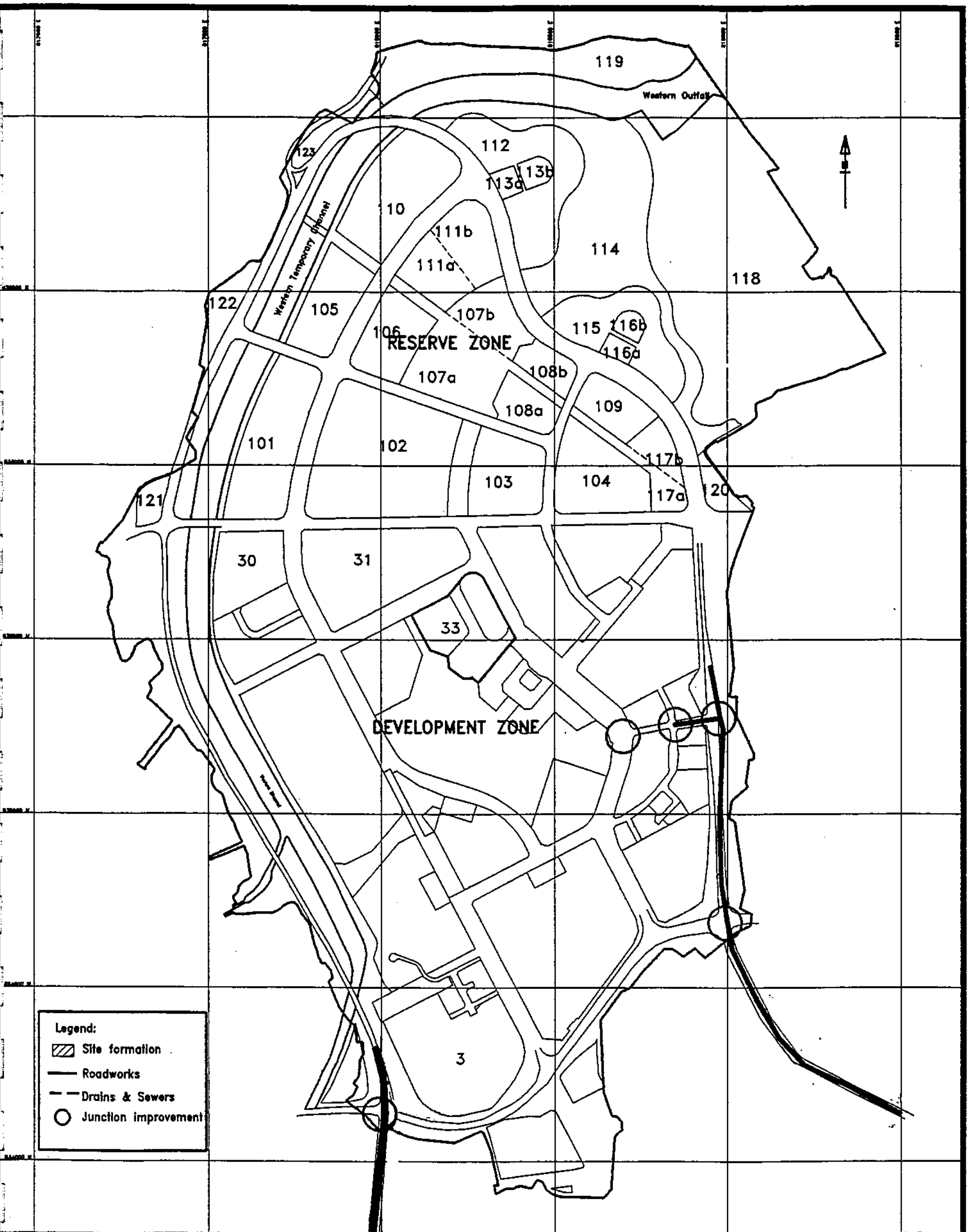
PRELIMINARY IMPLEMENTATION PROGRAMME
CONTRACT 3

Figure No.	2.3
Prepared	Checked
SCM	CYH
Date	Scale
10/96	N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	PRELIMINARY IMPLEMENTATION PROGRAMME CONTRACT 4	Sketch no. 2.4	
		Prepared SCM	Checked CYH
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Date 10/96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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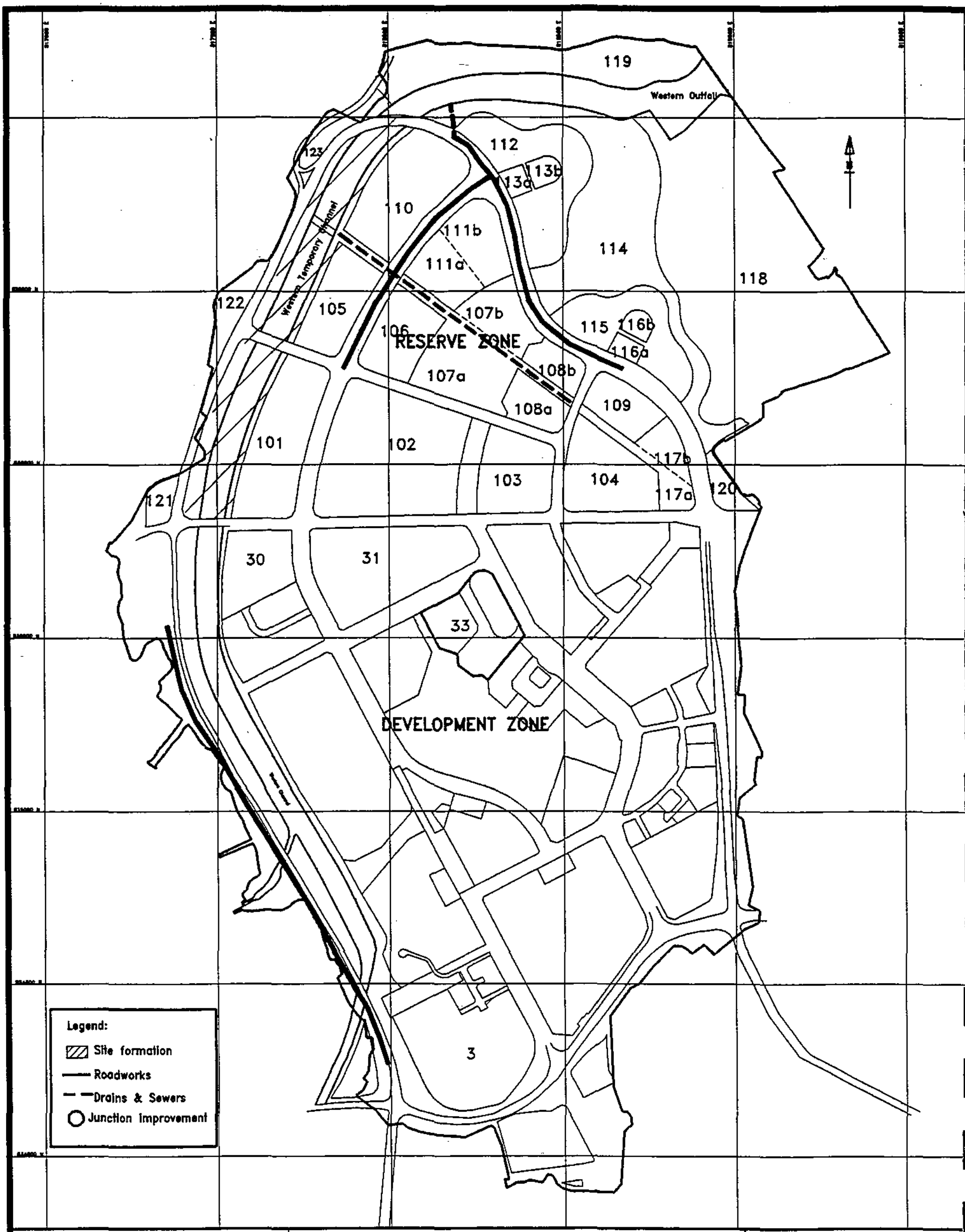
PRELIMINARY IMPLEMENTATION PROGRAMME
CONTRACT 5

Figure No.	2.5
Prepared: SCM	Checked: CYH
Date: 10/96	Scale: N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	PRELIMINARY IMPLEMENTATION PROGRAMME CONTRACT 6	Figure No. 2.6	
		Prepared SCM	Checked CYH
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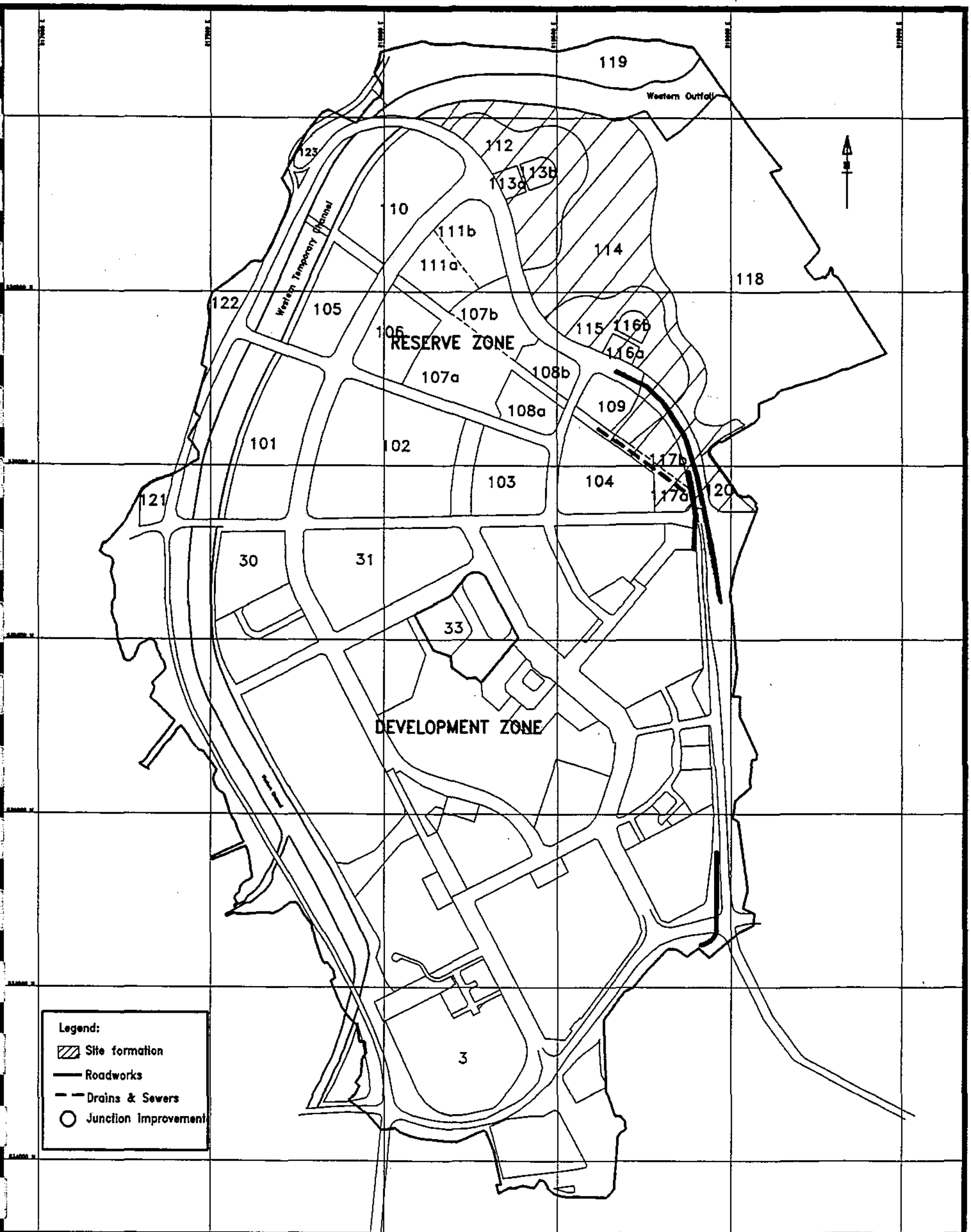

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AGREEMENT NO. CE 10/95
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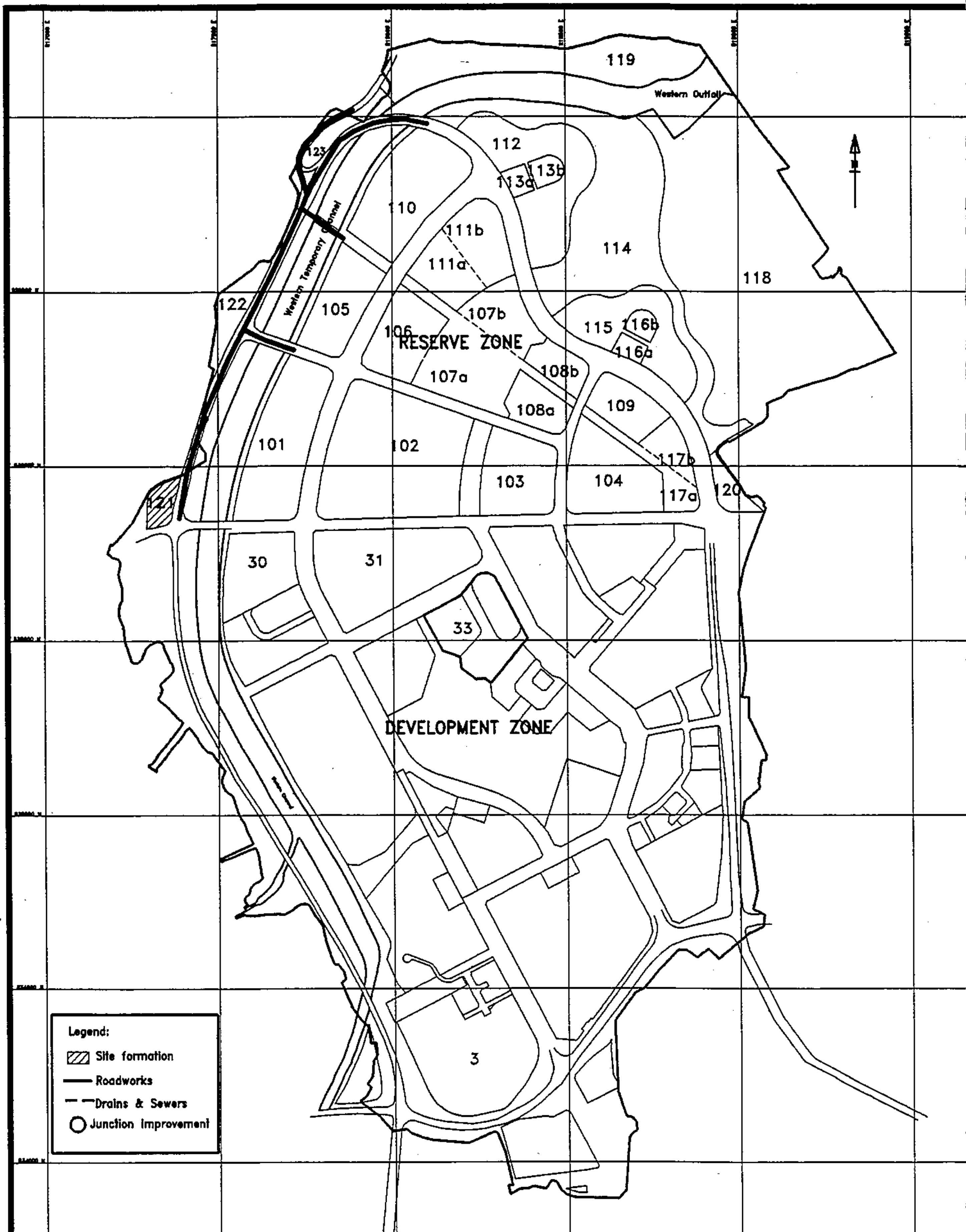
PRELIMINARY IMPLEMENTATION PROGRAMME
CONTRACT 7

Figure No.	2.7
Prepared	Checked
SCM	CYH
Date	Scale
10/96	N.T.S.



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AGREEMENT NO. CE 10/95
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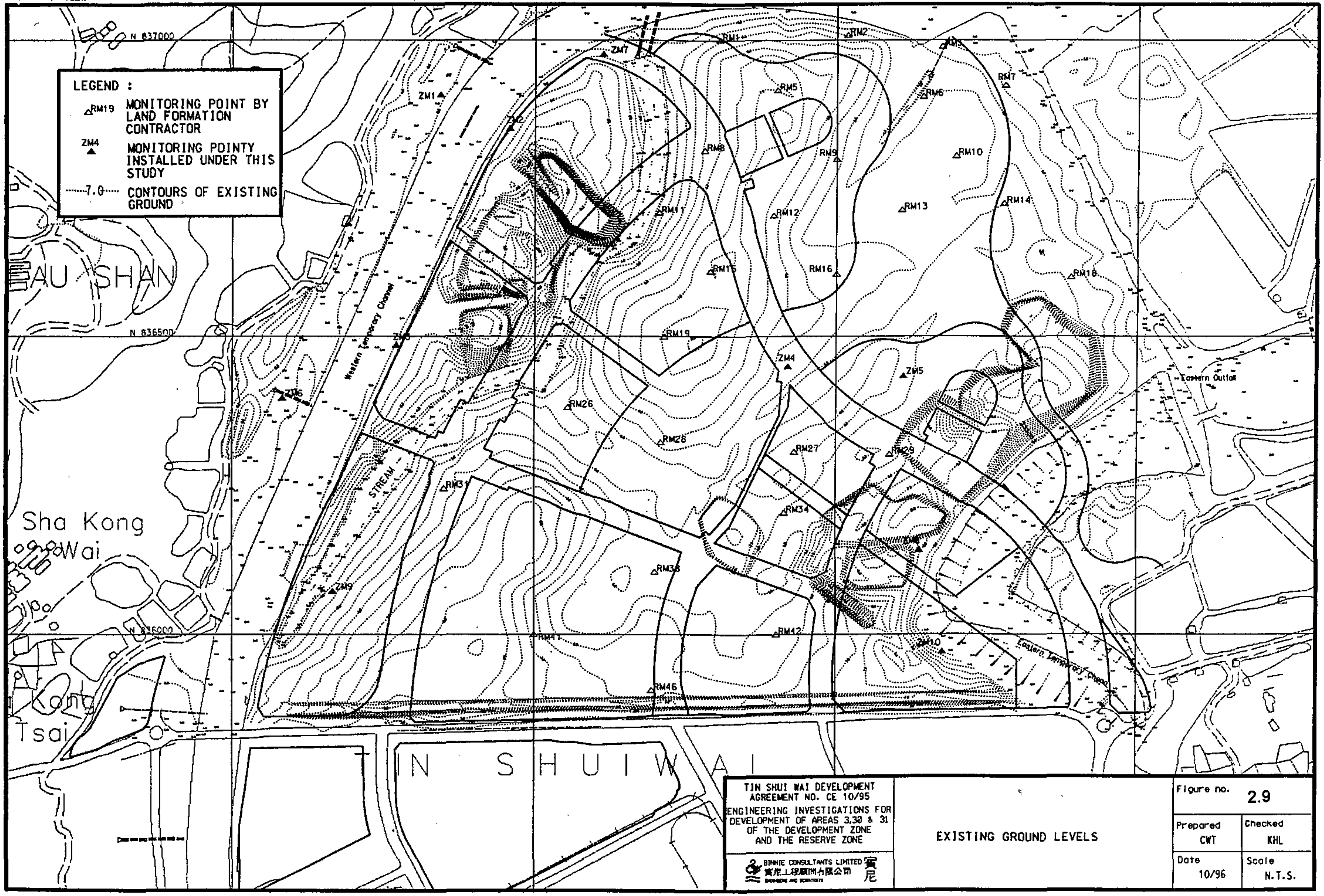
PRELIMINARY IMPLEMENTATION PROGRAMME
CONTRACT 8

Figure No.	2.8
Prepared SCM	Checked CYH
Date 10/96	Scale N.T.S.



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AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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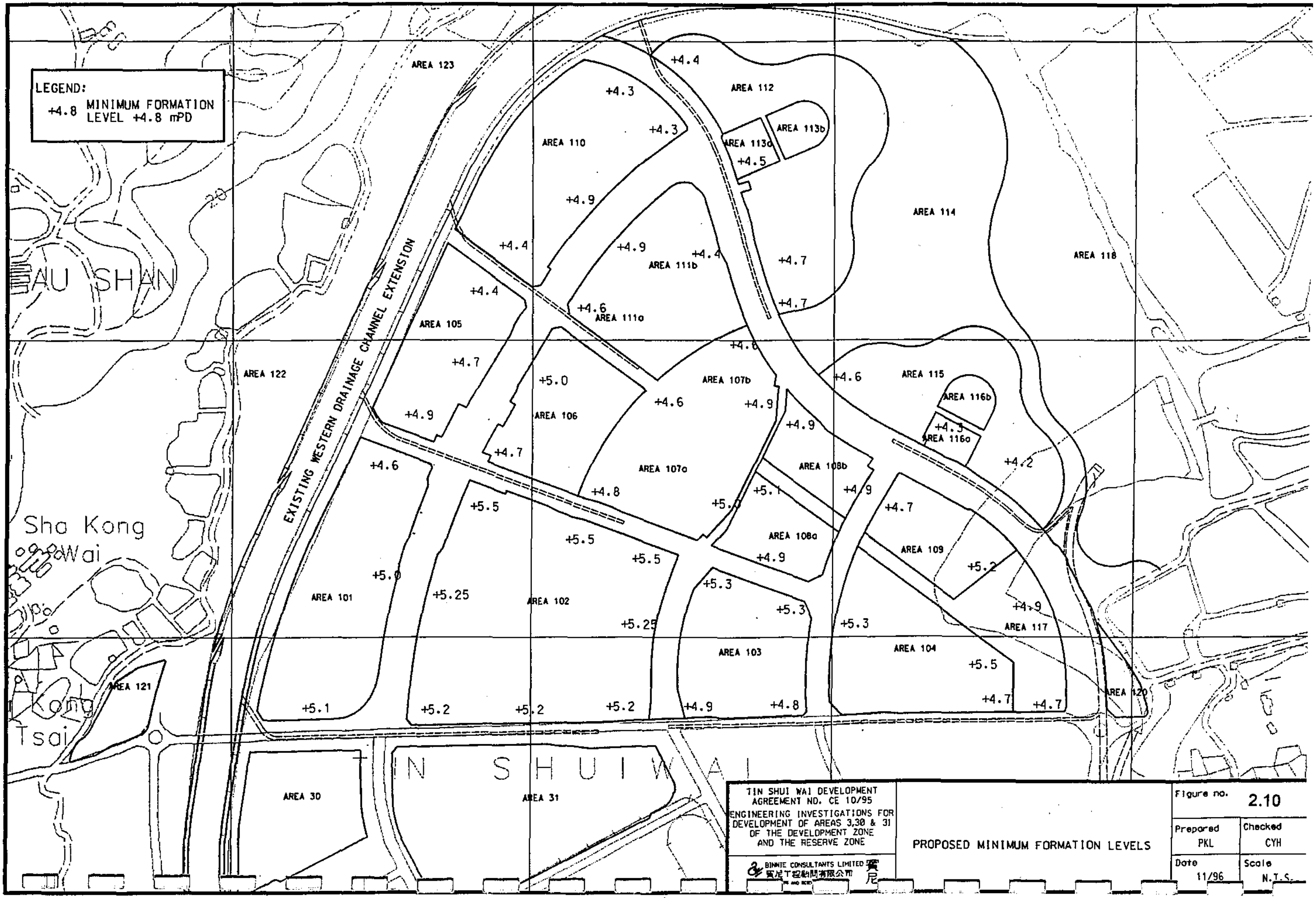
EXISTING GROUND LEVELS

Figure no.	2.9
Prepared CWT	Checked KHL
Date 10/96	Scale N.T.S.


LEGEND:
+4.8 MINIMUM FORMATION LEVEL +4.8 mPD
EXISTING WESTERN DRAINAGE CHANNEL EXTENSION
AREA 101
AREA 102
AREA 103
AREA 104
AREA 105
AREA 106
AREA 107a
AREA 107b
AREA 108a
AREA 108b
AREA 109
AREA 110
AREA 111a
AREA 111b
AREA 112
AREA 113a
AREA 113b
AREA 114
AREA 115
AREA 116a
AREA 116b
AREA 117
AREA 118
AREA 120
AREA 121
AREA 122
AREA 123
AREA 30
AREA 31
Sha Kong Wai
Kong Tsai
TIN SHUI WAI
TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE
BINNIE CONSULTANTS LIMITED
PROPOSED MINIMUM FORMATION LEVELS
Figure no. 2.10
Prepared PKL
Checked CYH
Date 11/96
Scale N.T.S.

TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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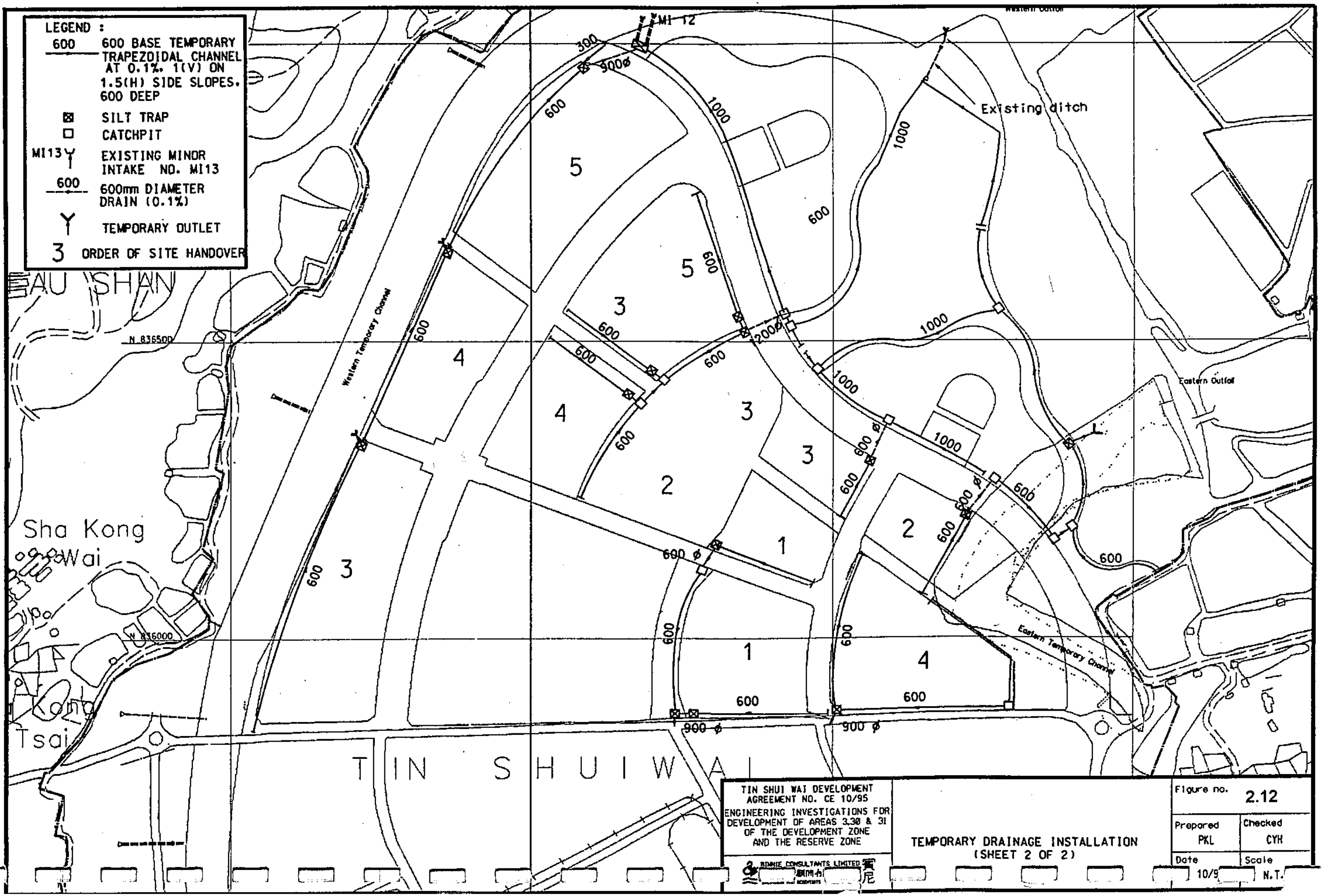
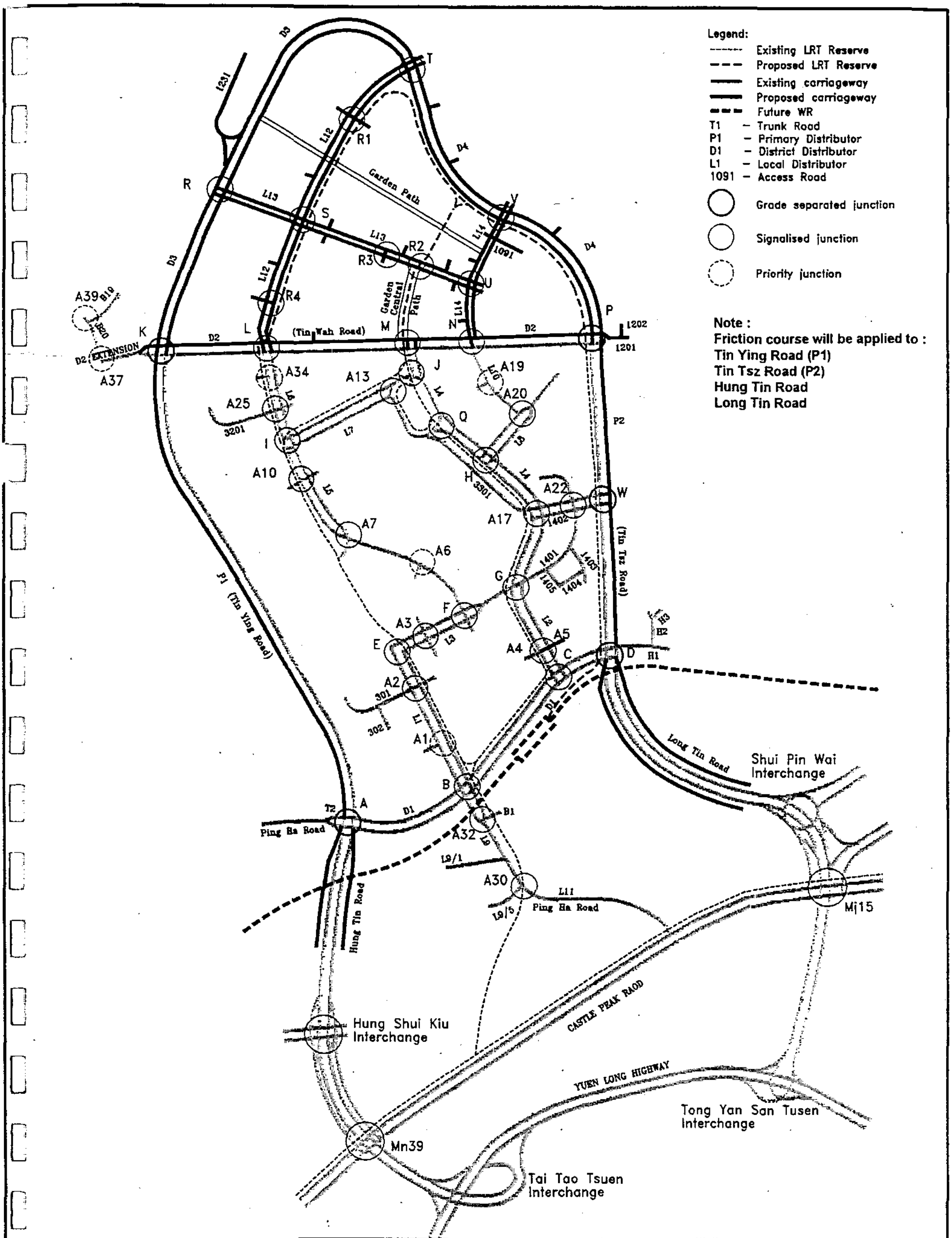
TEMPORARY DRAINAGE INSTALLATION
(SHEET 1 OF 2)

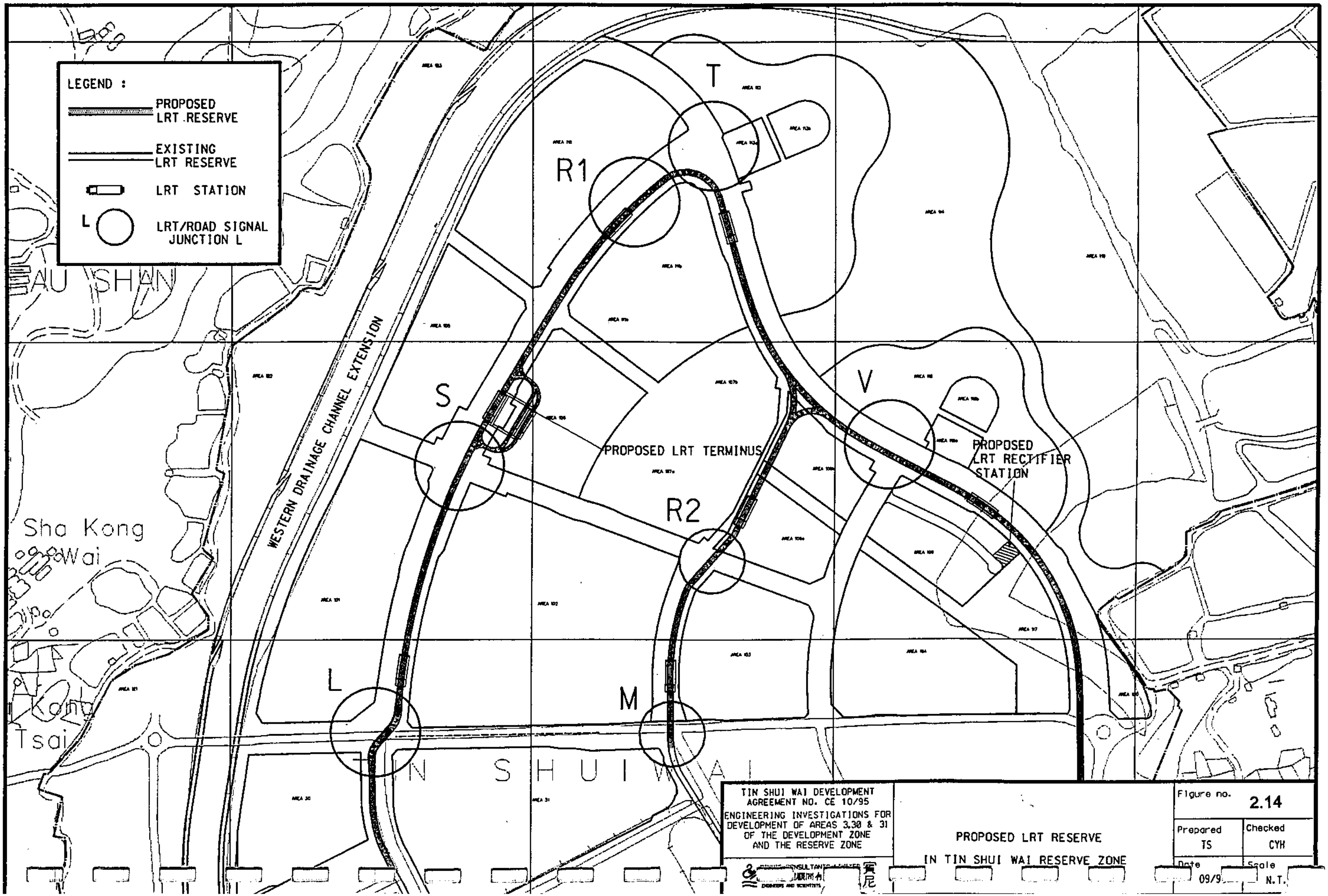
Figure no.	2.11
Prepared PKL	Checked CYH
Date 10/96	Scale N.T.S.



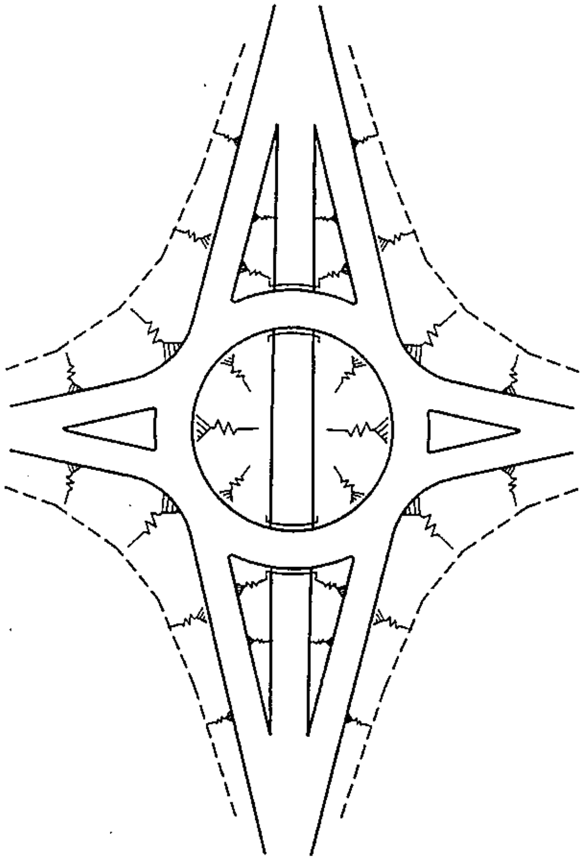
LEGEND :
600
600 BASE TEMPORARY TRAPEZOIDAL CHANNEL AT 0.1%. 1(V) ON 1.5(H) SIDE SLOPES. 600 DEEP
SILT TRAP
CATCHPIT
MI13
EXISTING MINOR INTAKE NO. MI13
600
600mm DIAMETER DRAIN (0.1%)
TEMPORARY OUTLET
3
ORDER OF SITE HANDOVER
MI 12
Existing ditch
Western Outfall
Eastern Outfall
Western Temporary Channel
Eastern Temporary Channel
N 836500
N 836000
Sha Kong Wai
Tsai
TIN SHUI WAI
300
900ø
1000
1200ø
900 ø
600 ø
TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE
BINNIE CONSULTANTS LIMITED
TEMPORARY DRAINAGE INSTALLATION (SHEET 2 OF 2)
Figure no.
2.12
Prepared
PKL
Checked
CYH
Date
10/9
Scale
N.T.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	ROAD AND JUNCTION NOMENCLATURE	Figure 2.13
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司		Prepared SCM / Checked CYH
		Date 10/96 / Scale NTS

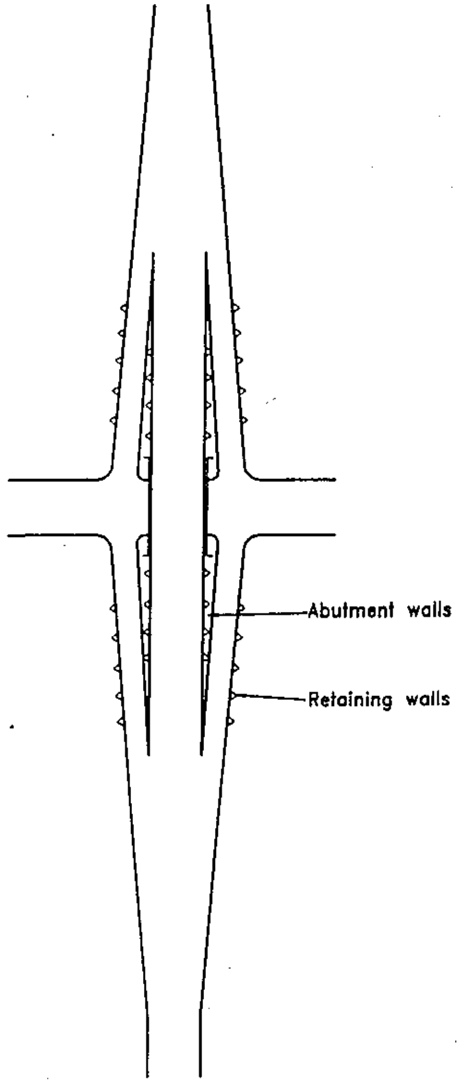


LEGEND :
PROPOSED LRT RESERVE
EXISTING LRT RESERVE
LRT STATION
L
LRT/ROAD SIGNAL JUNCTION L
AU SHAN
WESTERN DRAINAGE CHANNEL EXTENSION
Sha Kong Wai
Kong Tsai
TIN SHUI WAI
T
R1
S
V
R2
L
M
PROPOSED LRT TERMINUS
PROPOSED LRT RECTIFIER STATION
TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE
PROPOSED LRT RESERVE
IN TIN SHUI WAI RESERVE ZONE
Figure no.
2.14
Prepared
TS
Checked
CYH
Date
09/9
Scale
N.T.



OPTION 1

ELEVATED ROUNDABOUT



OPTION 2

COMPACT DIAMOND INTERCHANGE

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	INTERCHANGE OPTIONS	Figure no.	2.15
		Prepared SCM	Checked CYH
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EXISTING CULVERTS

INLET SIZE TO WCC :		INLET SIZE TO ECC :	
W1	900 DIA	E1	600 DIA
W2	1500 DIA	E2	750 DIA
W3	900 DIA	E3	450 DIA
W4	1350 DIA	E4	600 DIA
W5	1200 DIA	E5	450 DIA
W6	900 DIA	E6	2100 DIA
W7	1200 DIA	E7	1800 DIA
W8	1350 DIA	E8	1050 DIA
		E9	450 DIA
		E10	2550 DIA

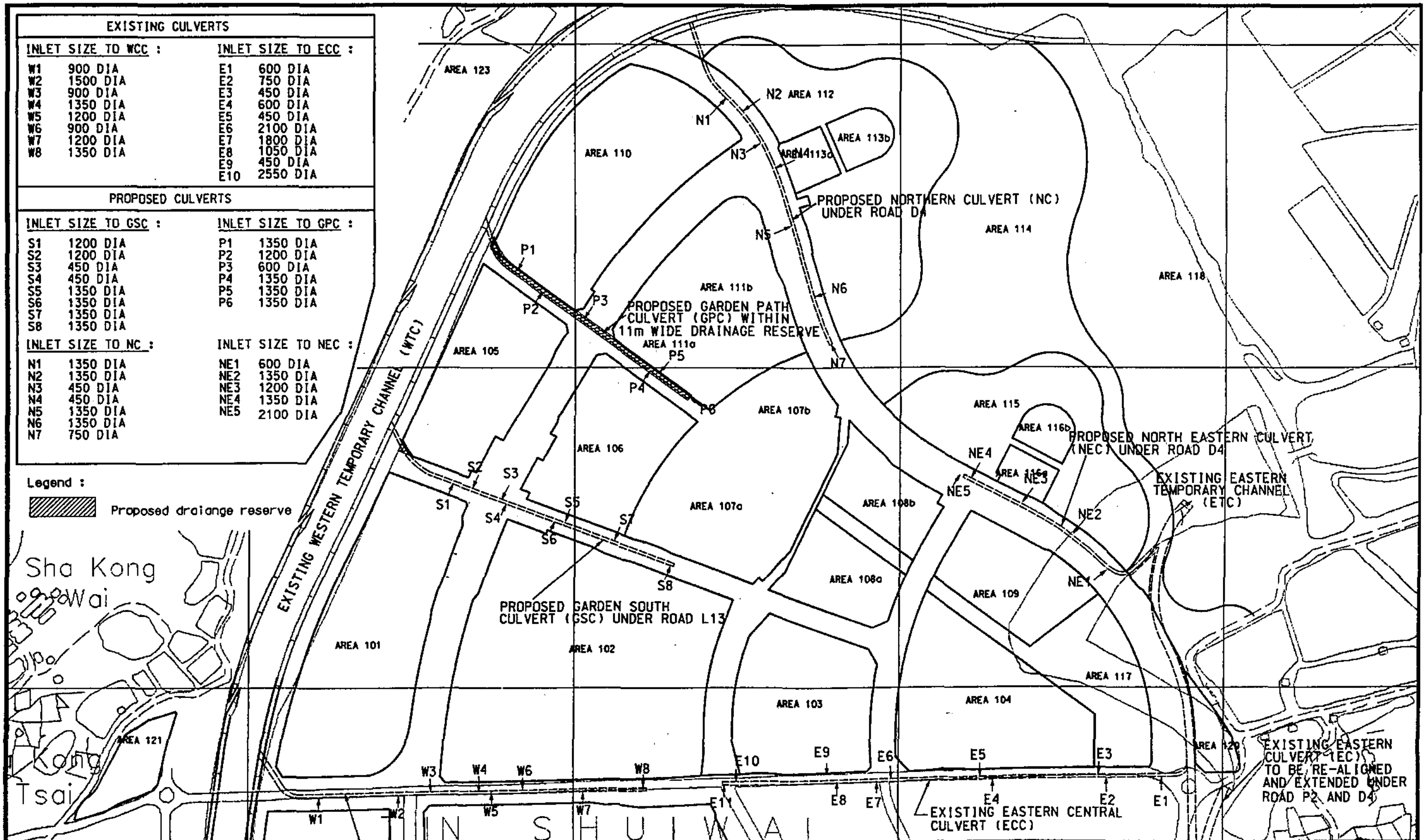
PROPOSED CULVERTS

INLET SIZE TO GSC :		INLET SIZE TO GPC :	
S1	1200 DIA	P1	1350 DIA
S2	1200 DIA	P2	1200 DIA
S3	450 DIA	P3	600 DIA
S4	450 DIA	P4	1350 DIA
S5	1350 DIA	P5	1350 DIA
S6	1350 DIA	P6	1350 DIA
S7	1350 DIA		
S8	1350 DIA		

INLET SIZE TO NC :		INLET SIZE TO NEC :	
N1	1350 DIA	NE1	600 DIA
N2	1350 DIA	NE2	1350 DIA
N3	450 DIA	NE3	1200 DIA
N4	450 DIA	NE4	1350 DIA
N5	1350 DIA	NE5	2100 DIA
N6	1350 DIA		
N7	750 DIA		

Legend :

Proposed drainge reserve



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
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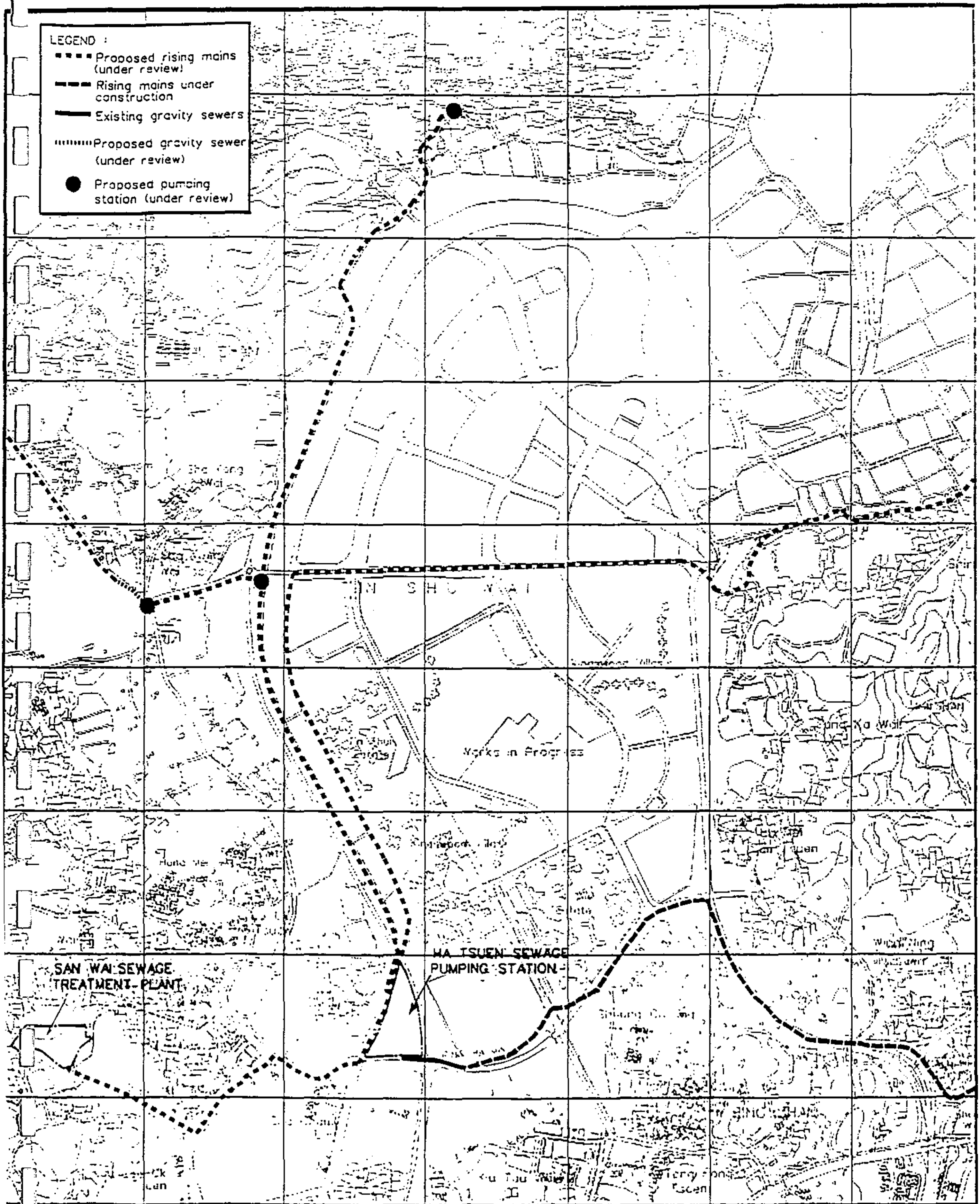
PROPOSED PERMANENT DRAINAGE ARRANGEMENT

Figure no.	2.16
Prepared PKL	Checked CYH
Date 10/	Scale N.



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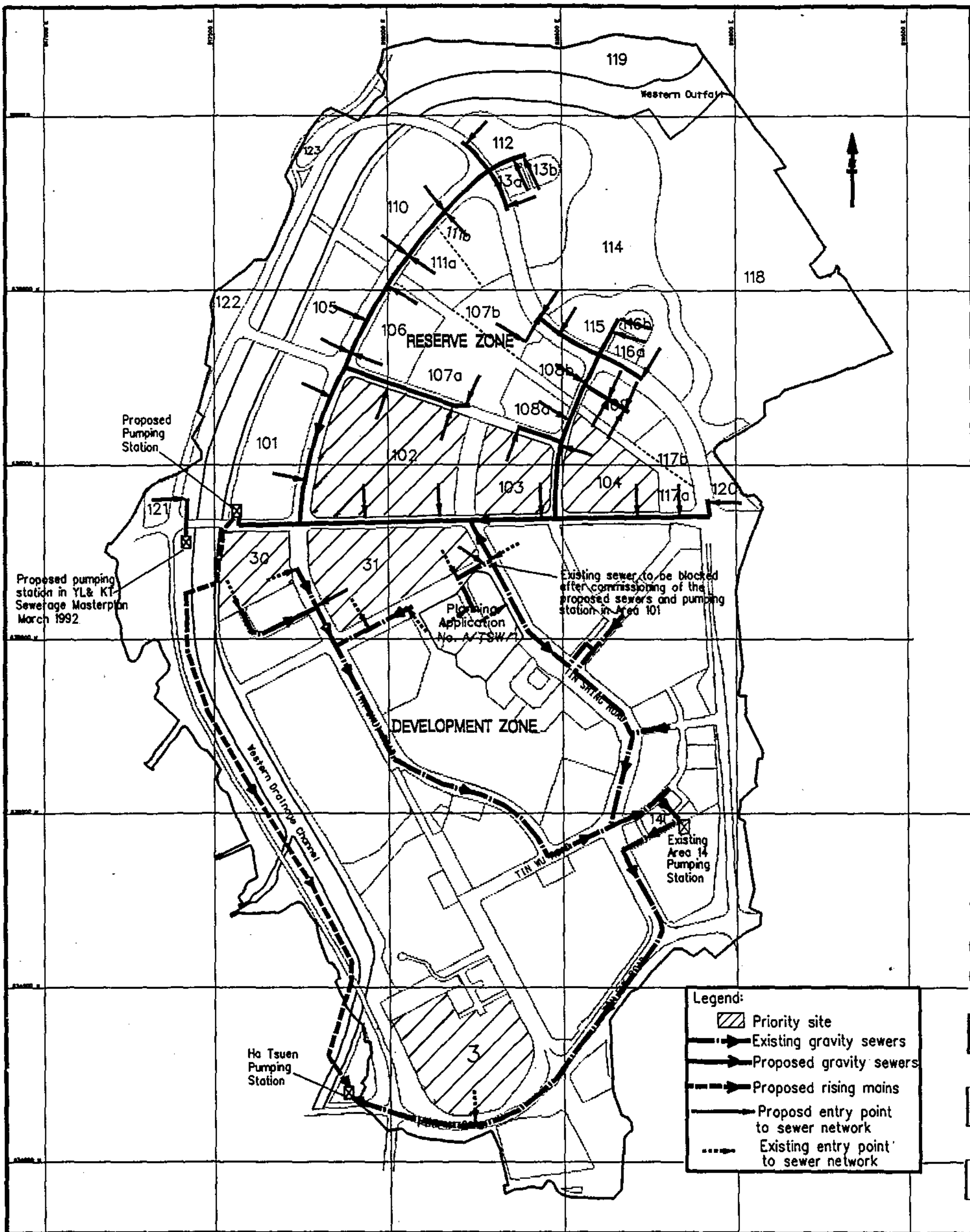
SEWERAGE MASTER PLAN TRUNK SEWER IN THE VICINITY OF TIN SHUI WAI

Sketch No.	2.17
Initial GC	Checked CYH
Date 10/96	Scale N.T.S.



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OF THE DEVELOPMENT ZONE
AND THE RESERVE ZONE

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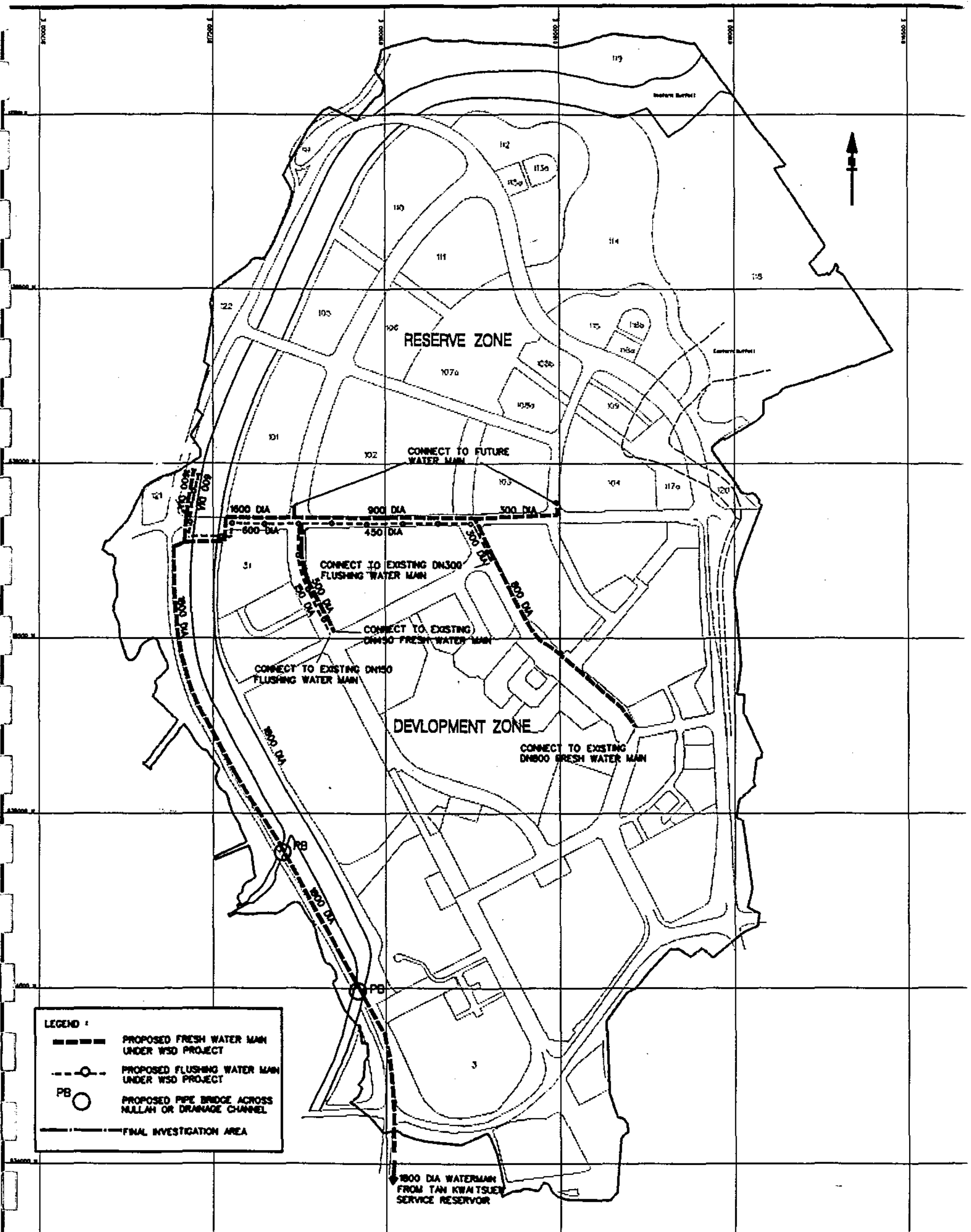
RECOMMENDED SEWERAGE NETWORK
FOR THE DEVELOPMENTS

Figure No.	2.18
Prepared GC	Checked CYH
Date 10/96	Scale N.T.S.



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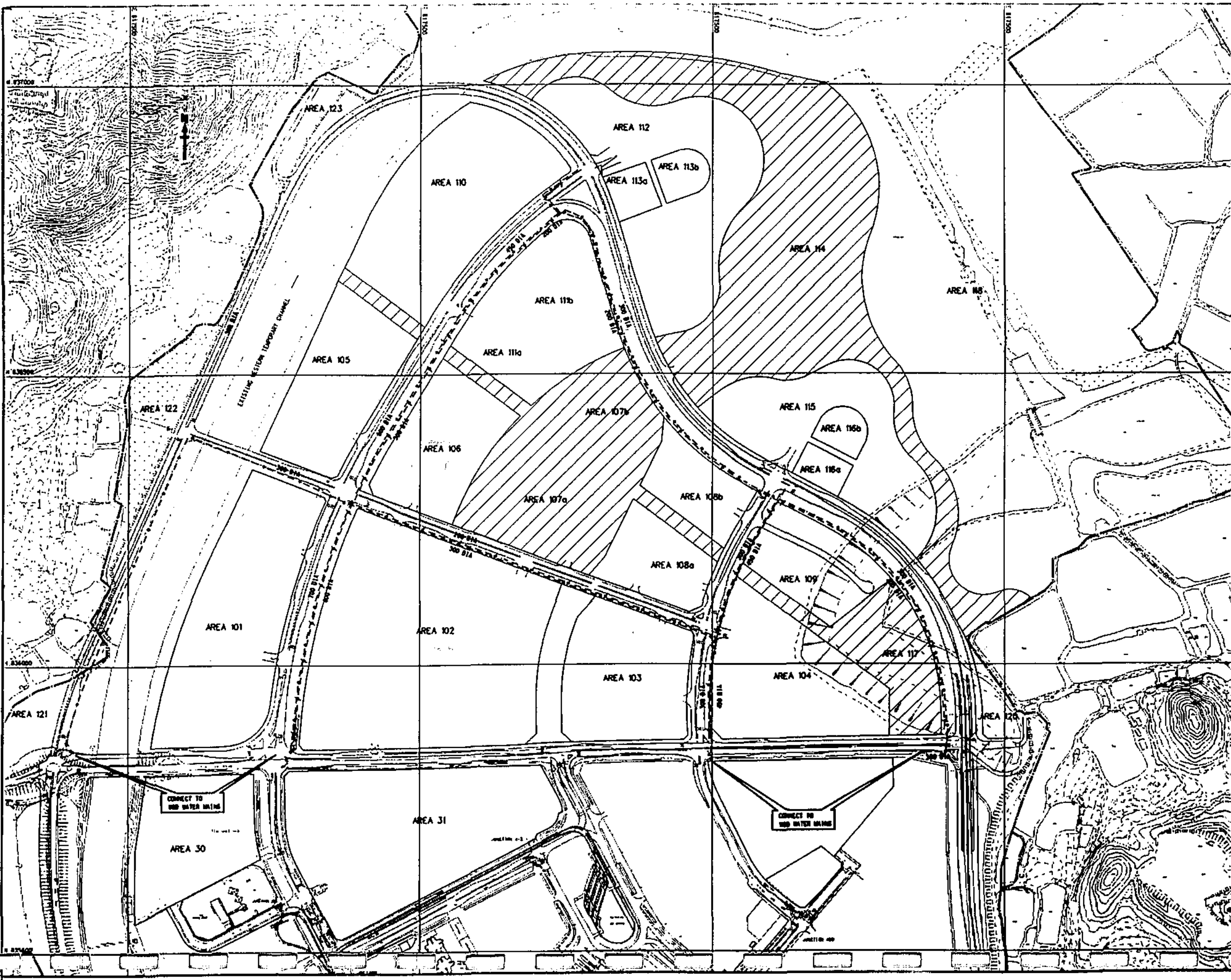
TRUNK MAIN FROM TAN KWAI TSUEN SERVICE RESERVOIR TO TIN SHUI WAI

Figure no.	2.19
Initial: ALM	Checked: TS
Date: 10/96	Scale: N.T.S.



Notes:

LEGEND :

- FRESH WATER MAINS (ENTRUSTED TO TDD PROJECT)
- FLUSHING WATER MAINS (ENTRUSTED TO TDD PROJECT)
- OPEN SPACE
- FINAL INVESTIGATION AREA

Prepared	Date	Checked	Date
ALN	10/96	TS	10/96

AGREEMENT No. CE 10 / 95

TIN SHUI WAI DEVELOPMENT

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

FRESH WATER AND FLUSHING WATER RETICULATION SYSTEMS

Figure no. 2.20

Scale 1 : 4000

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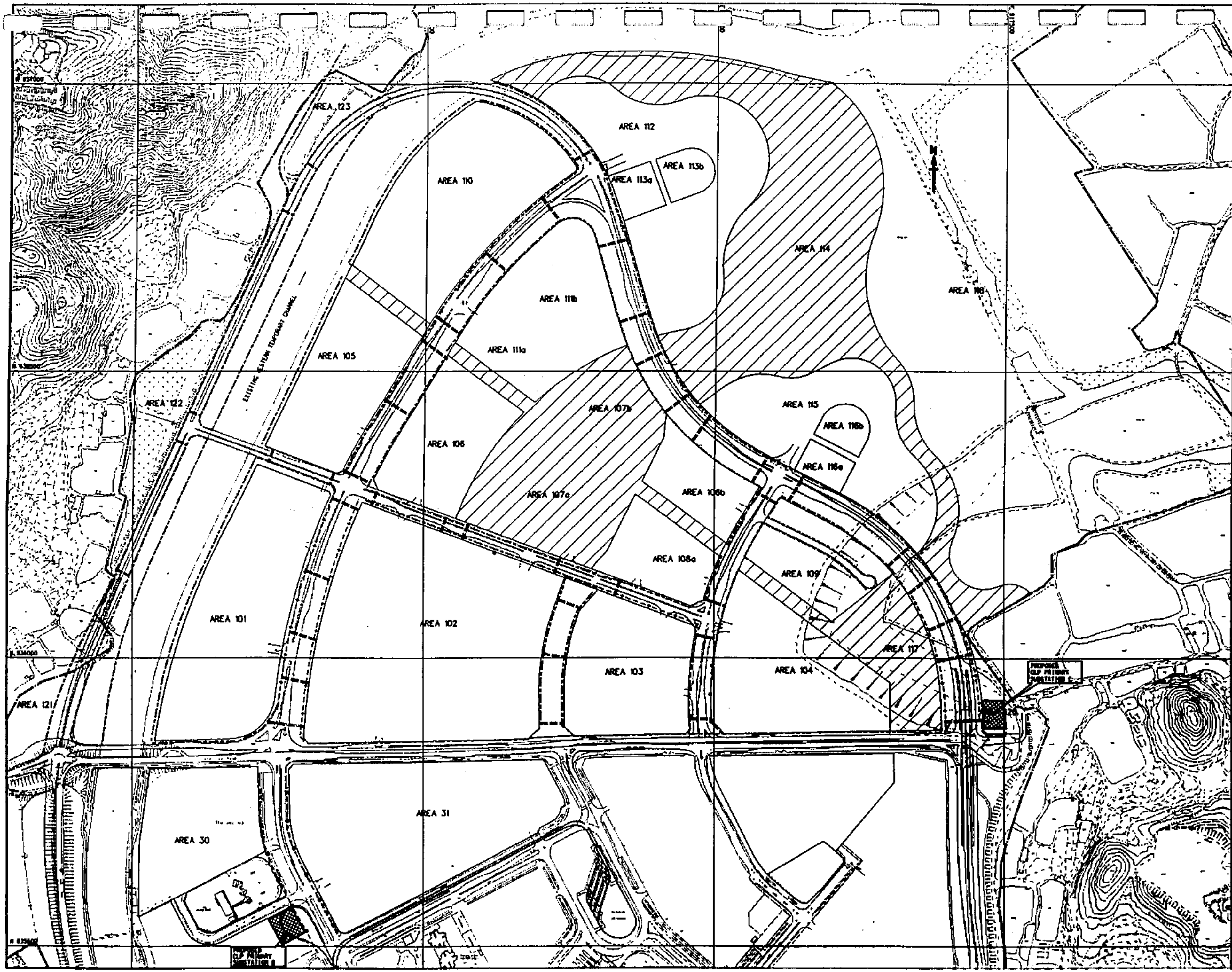

LEGEND :

6 WAY CABLE DUCT

OPEN SPACE

4x11 KV CABLES AND PILOT CABLES

6x11 KV CABLES AND PILOT CABLES

10x11 KV CABLES AND PILOT CABLES

FINAL INVESTIGATION AREA

Prepared	Date	Checked	Date
ALH	10/96	TS	10/96

AGREEMENT No. CE 10 / 95

TIN SHUI WAI DEVELOPMENT

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

PROPOSED
11 KV CALBE LAYOUT

2.21

Scale 1 : 4000

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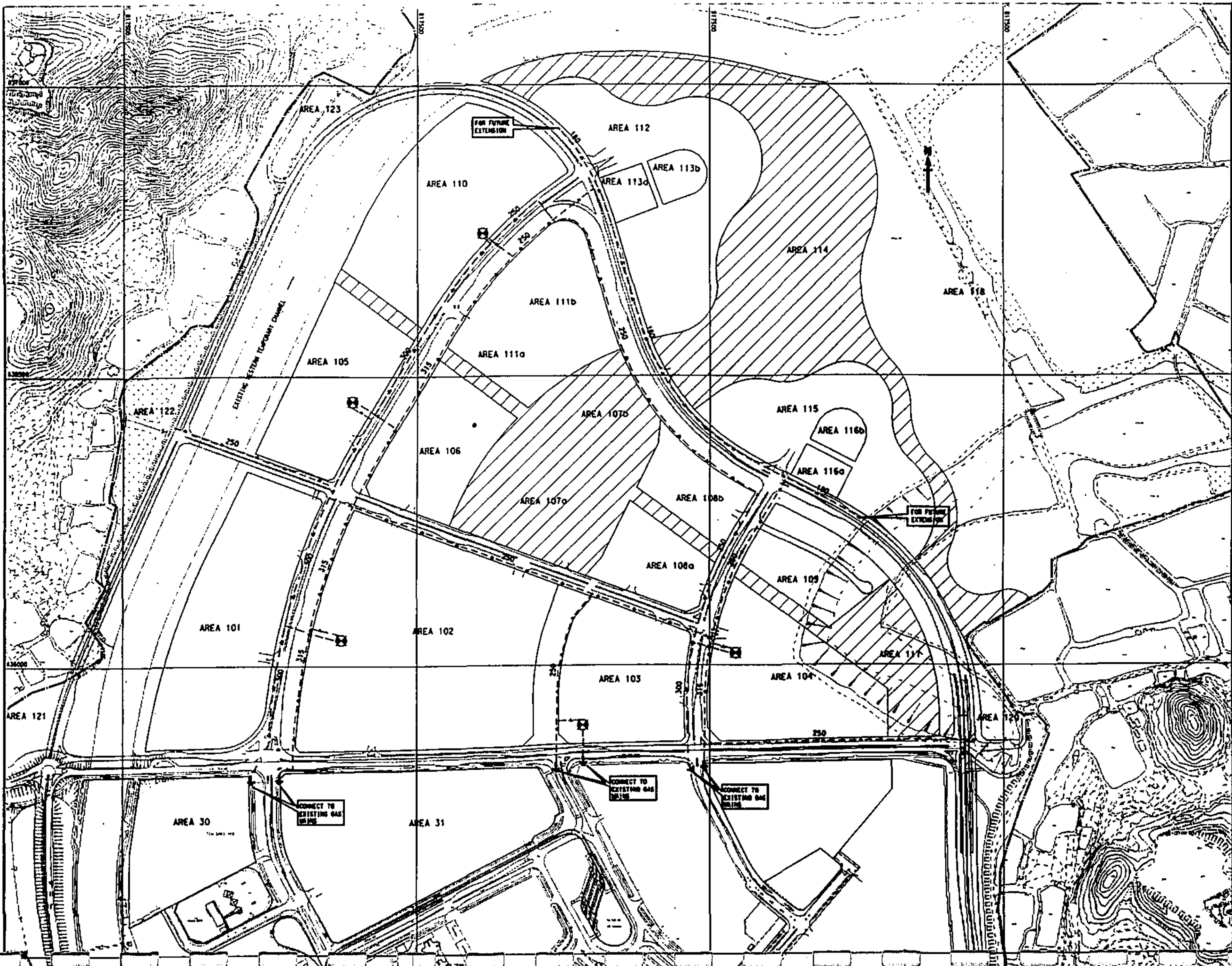

Notes:

1. NORMAL COVER OF GAS MAINS :
   i) FOR LOW PRESSURE (B) GAS MAIN 700mm IN FOOTPATH AND 1000mm IN CARRIAGEWAY.
   ii) FOR INTERMEDIATE PRESSURE STEEL GAS MAIN, 1000mm IN BOTH FOOTPATH AND CARRIAGEWAY.
2. AN ALL-ROUND CLEARANCE BETWEEN A GAS MAIN AND OTHER UTILITIES IS 300mm.

LEGEND :

- LOW PRESSURE (B) GAS MAINS
- INTERMEDIATE PRESSURE GAS MAINS
- PROPOSED GOVERNOR KIOSK
- OPEN SPACE
- FINAL INVESTIGATION AREA

Prepared	Date	Checked	Date
ALN	10/96	TS	10/96

AGREEMENT No. CE 10 / 95

TIN SHUI WAI DEVELOPMENT

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

Figure title

PROPOSED GAS MAINS LAYOUT

Figure no.	Scale
2.22	1 : 4000

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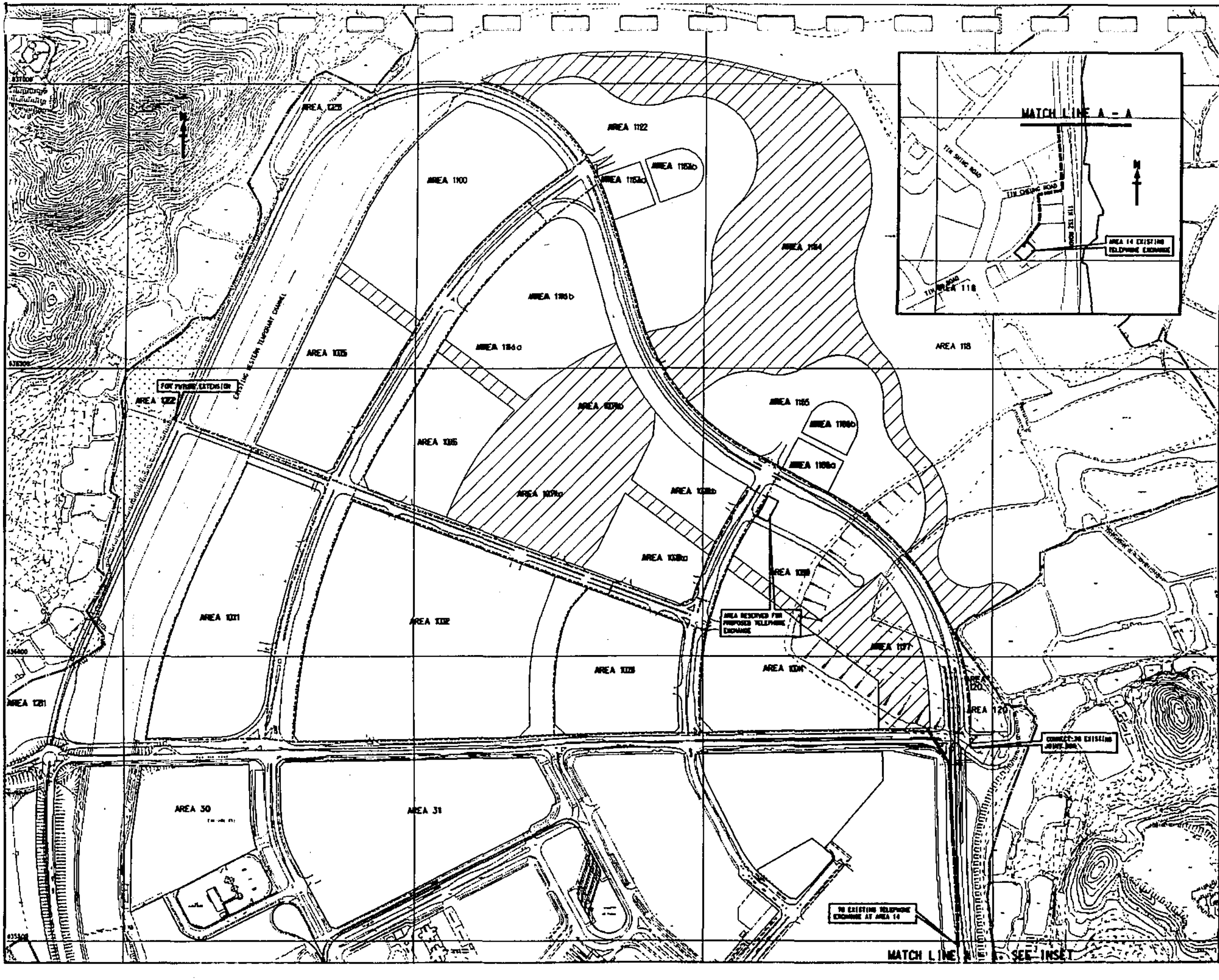

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1. LOCATIONS OF PROPOSED TELEPHONE MANHOLES AND JOINT BOXES SHALL BE DETERMINED IN THE DETAILED DESIGN.
2. DUCT ROUTE SHALL BE 6-9 WAY PVC DUCTS OF EACH 100mm DIAMETER EXCEPT THE MULTI-WAY TELEPHONE DUCTS.
3. NOMINAL COVER SHALL BE 450mm AT FOOTPATH AND 900mm AT CARRIAGEWAY.

LEGEND :

PROPOSED TELEPHONE CABLES
MULTI-WAY TELEPHONE DUCTS
OPEN SPACE
FINAL INVESTIGATION AREA

Prepared	Date	Checked	Date
ALM	10/96	TS	10/96

AGREEMENT No. CE 10 / 95

TIN SHUI WAI DEVELOPMENT

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

Figure title

PROPOSED HONG KONG TELECOM CABLE LAYOUT

Figure no. 2.23 Scale 1 : 5000

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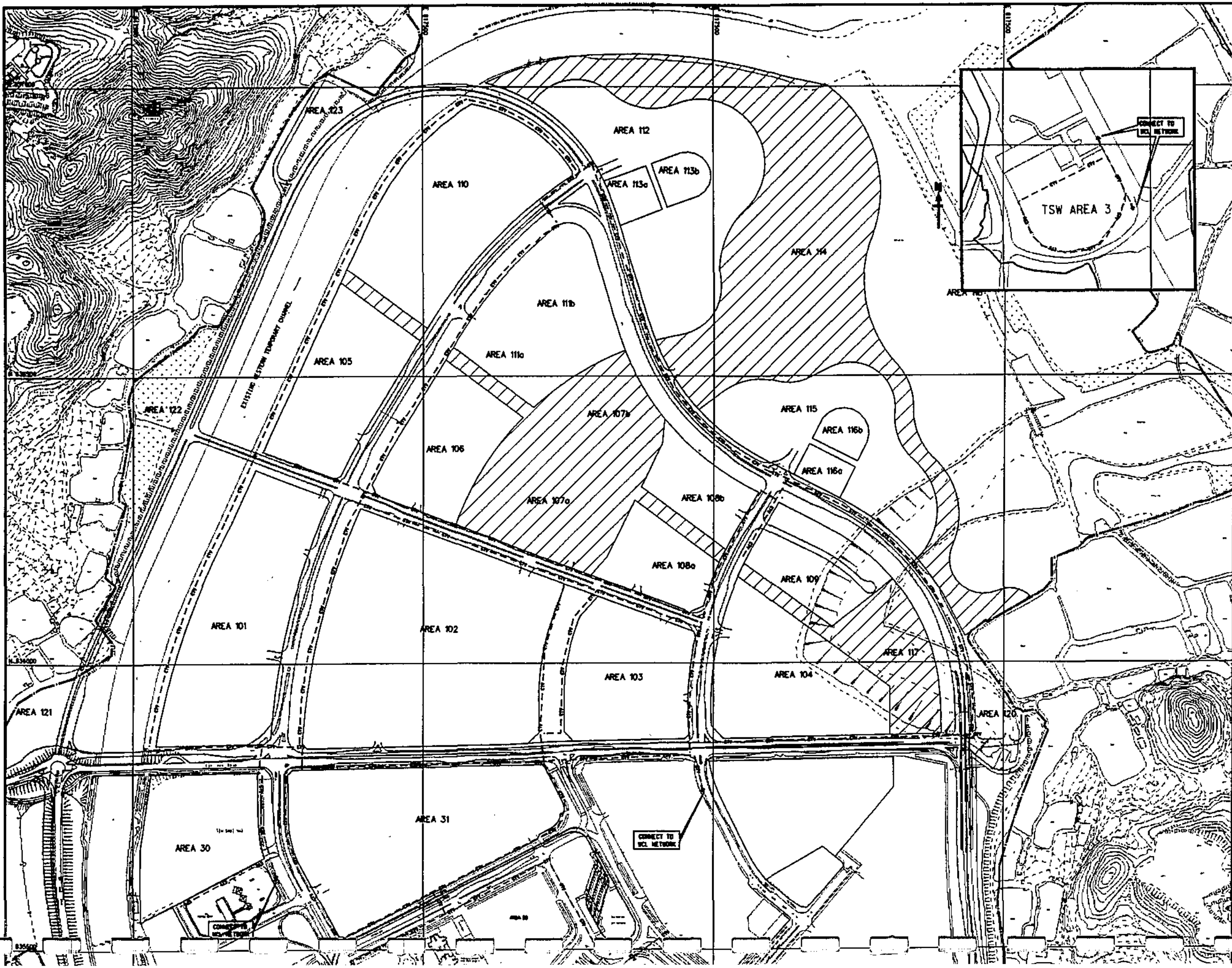

Notes:

1. LOCATIONS OF PROPOSED WCL JOINT BOX SHALL BE DETERMINED IN THE DETAILED DESI[GN]
2. DUCT ROUTE SHALL BE 2-WAY PVC DUCTS OF EACH 100mm DIAMETER.
3. NOMINAL COVER SHALL BE 450mm AT FOOTWAY AND 400mm AT CARRIAGEWAY.

LEGEND:

— EW — WCL CABLE

OPEN SPACE

FINAL INVESTIGATION AREA

Prepared	Date	Checked	Date
ALM	10/96	TS	10/

AGREEMENT No. CE 10 / 95

TIN SHUI WAI DEVELOPMENT

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 3[1] OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

PROPOSED
WCL CABLE LAYOUT

Figure no. 2.24

Scale 1 : 5000

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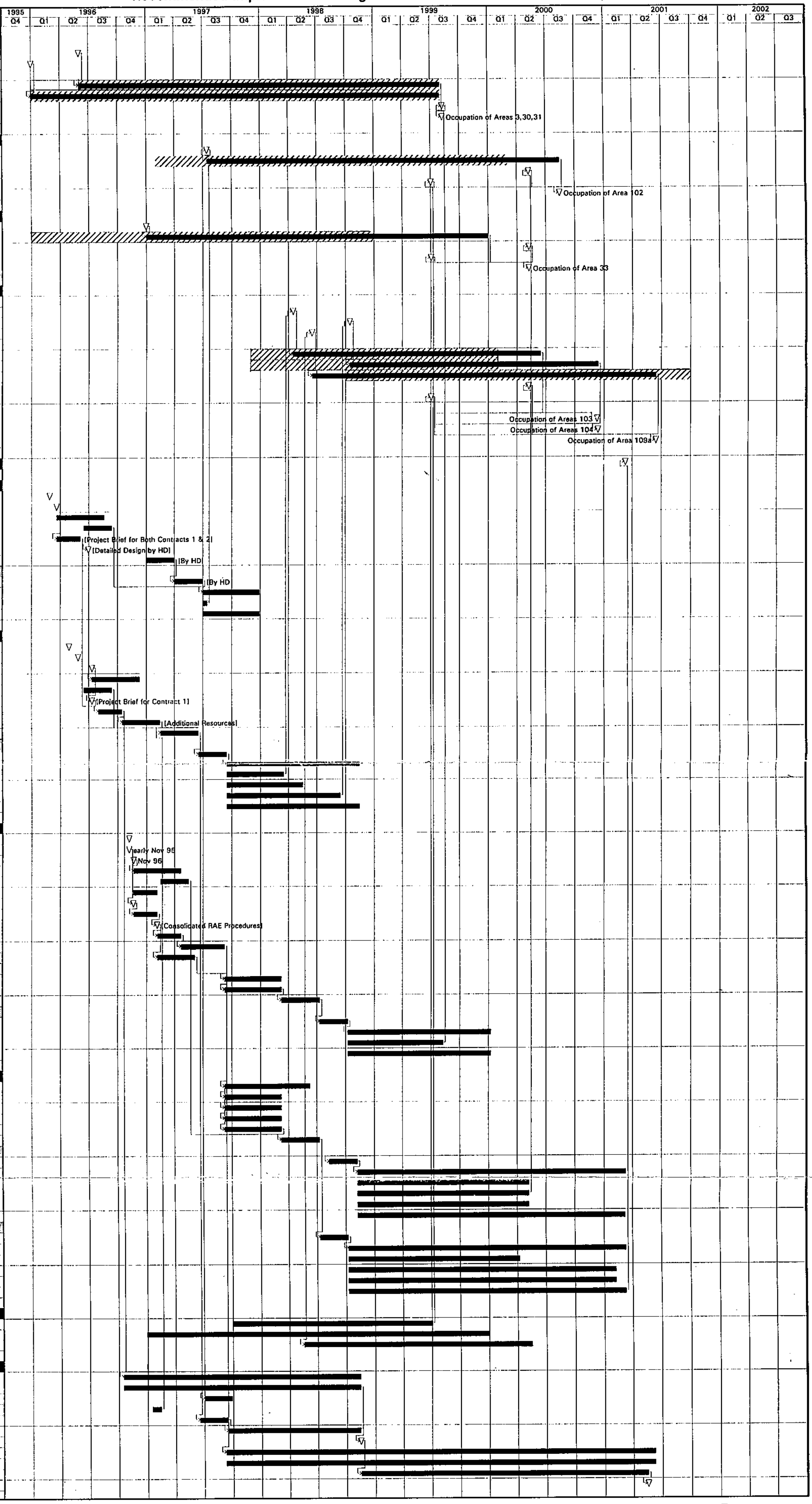
Figure 2.25 Engineering Infrastructure/Upgrading Works for the Priority Sites Recommended Implementation Programme

Task Name	Duration (Months)
AREAS 3, 30 & 31	
Handover to HD	
Area 3	
Areas 30, 31	
Building Works	
Area 3	38
Areas 30,31	43
Essential Infrastructure	
Occupation	
AREA 102	
Handover to HD	
Building Works	37
Essential Infrastructure	
Other Services & Installations	
Occupation	
AREA 33	
Handover to HD	
Building Works	36
Essential Infrastructure	
Other Services & Installations	
Occupation	
AREAS 103, 104, 109a	
Handover to Developer	
Area 103	
Area 104	
Area 109a	
Building Works	
Area 103	26
Area 104	26
Area 109a	36
Essential Infrastructure	
Other Services & Installations	
Occupation	
Area 103	
Area 104	
Area 109a	
INFRASTRUCTURE FOR FULL OCCUPATION	
PHASE 1- Site Formation for Area 102 (by HD)	
Final Stage I Investigation Report	
Endorsement from Steering Group	
DB Consultation	5
ACE Submission	3
Preparation of Project Brief	2.5
Engagement of Consultants	
Detailed Design	3
Contract 1	
Tender	3
Construction	6
I - Initial site formation	0.5
II - Remaining site formation	6
PHASE 2 - Site Formation for Area 103,104 & 109a	
Final EIA Stage I Assessment	
Final Stage II Investigation Report	
Endorsement from Steering Group	
DB Consultation	5
ACE Submission	3
Preparation of Project Brief	
Engagement of Consultants	2.5
Detailed Design	4
Upgrade to Cat A	4
Contract 2	
Tender	3
Construction	14
I - Site Formation for Area 103	6
II - Site Formation for Area 109a	8
IV - Site Formation for Area 104	12
V - Remaining works	14
PHASE 3 - Infrastructure for Areas 3, 30, 31	
Final EIA Stage II Assessment	
Final Stage III Investigation Report	
Endorsement from Steering Group	
DB Consultation	5
ACE Submission (for Final EIA)	3
Preliminary Project Feasibility Studies	2.5
Final PPFS	
Approved by Works & Finance Branches	2.5
CWRF RAE	0
Preparation of Project Brief	2.5
Engagement of Consultants	4.5
Upgrade to Cat A for D&C Agreement	4
Detailed Design	6
Roads Ordinance Procedures	6
Upgrade to Cat A for Works Item	4
Contract 3	
Tender	3
Construction - Junction Improvements in DZ	15
I - Tin Yiu Rd & Tin Shui Rd & Drainage Connection	10
II - Remaining Works	15
PHASE 4 - Infrastructure for Areas 102-104, 109a	
Detailed Design	9
Roads Ordinance Procedures*	6
Water Pollution Control Ordinance Procedures*	6
Foreshore and Seabed Ordinance*	6
Planning Submission to TPB for Sewage PS	6
Upgrade to Cat A	4
Contract 4	
Tender	3
Construction	28
I - Sewage Pumping Station & Rising Main	18
II - Road L12(S), L13(E), L14	18
III - LRT Outer Loop Portion A & D	18
IV - Tin Wah Rd & Tin Tsz Rd Dualling	28
Contract 5	
Tender	3
Construction	29
I - Grade Separtation of Jn W (P2/1402)	18
II - Grade Separation of Jn D & Long Tin Rd Widening	28
III - LRT Express Line (D2)	28
IV - Grade Separation of Jn A & Hung Tin Rd Widening	29
OTHER SERVICES & INSTALLATIONS	
Tan Kwai Tsuen F/W S/R Phase I (WSD)	21
Substation B (CLP)	36
Telephone Exchange in Area 109a (HKT)	24
ENVIRONMENTAL MONITORING & AUDIT	
Stage 1 - Baseline measurement & monitoring for Site Form	
Environmental Management Team	25
Baseline measurement & initial monitoring (under contract 1)	3
Preparation of Environmental Testing Contract	1
Tender	3
Environmental Testing Contract (Including Ecology)	14
Handover of Management Responsibility to Stage 2	
Stage 2 - Monitoring for Package I Infrastructure	
Environmental Management Team	45
Environmental Monitoring Team	30
Handover of Management Responsibility to Stage 3	



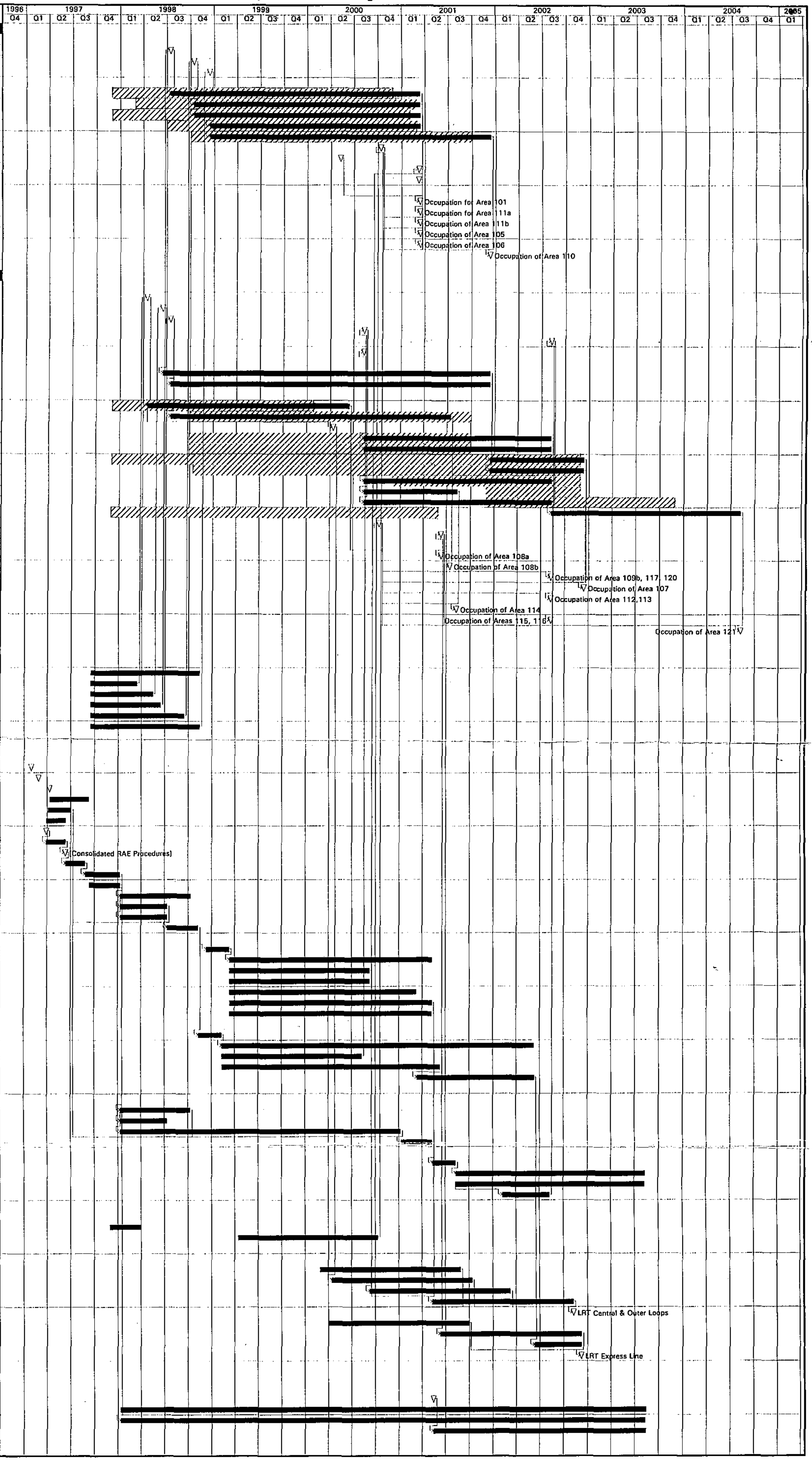
Printed: 17.Dec.96 (Version 2.2)

Notes : * 8 weeks allowed for resolving objections. Major objections may require ExCo's overruling and would delay the project by 6 months.

Milestone ▽ Summary ▬ Fixed Delay - - -

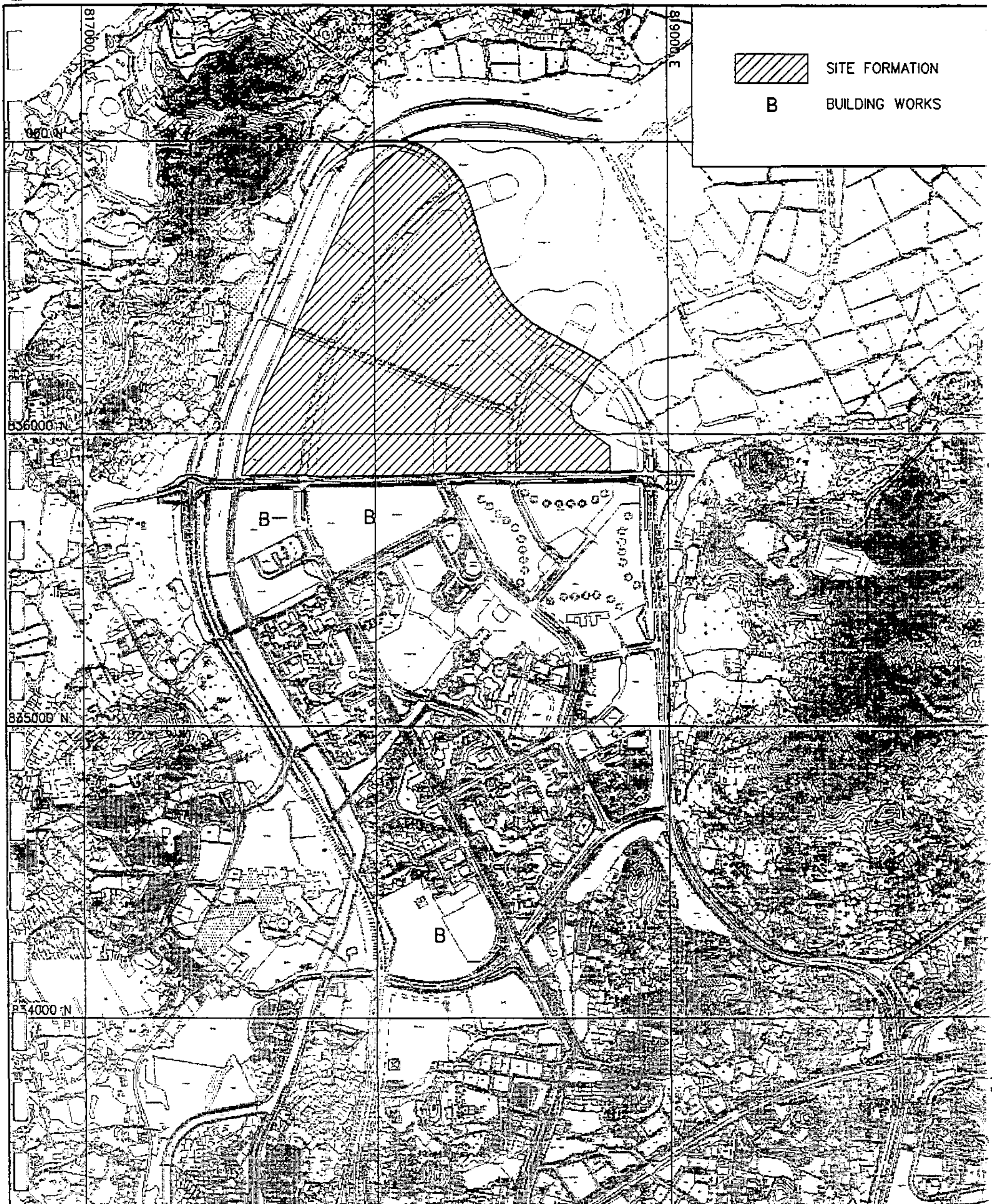
Figure 2.26 Engineering Infrastructure/Upgrading Works for the Remaining Areas Recommended Implementation Programme

Task Name	Duration (Months)
AREAS 101,105,106,110,111	
Handover to Developer	
Area 101,111a	
Area 105,106	
Area 110,111b	
Building Works	
Area 101,111a	31
Area 105	28
Area 106	28
Area 111b	26
Area 110	36
Other Services & Installation	
Essential Infrastructure for Area 101 (Under Contract 4)	
Essential Infrastructure	
Hung Tin Rd & Long Tin Rd Under Contract 5	
Occupation	
Area 101	
Area 111a	
Area 111b	
Area 105	
Area 106	
Area 110	
AREA 107,108, 109b, 120, 121	
Handover to Developer	
Area 108a	
Area 107a	
Area 107b, 108b	
Area 109b,117,120	
Area 121	
Areas 112-116	
Temporary Works Area/Storage Area	
Area 107a	
Area 107b	
Building Works	
Area 108a	26
Area 108b	36
Formation of LRT Portion C	
Area 109b @	24
Area 117, 120 @	24
Area 107a @	12
Area 107b @	12
Area 112,113	24
Area 114	12
Area 115,116	24
Area 121 @	24
Other Services & Installation	
Road D4(S)	
Occupation	
Area 108a	
Area 108b	
Area 109b,117,120	
Area 107	
Area 112,113	
Area 114	
Area 115,116	
Area 121	
PHASE 1 - Site Formation for Package II	
Contract 2	
Construction	14
I - Site Formation for Area 108a	6
II - Site Formation for Area 107a,109a	8
III - Site Formation for Area 101,107b,108b,111a	9
IV - Site Formation for Area 105,106	12
V - Site Formation for Area 110, 111b	14
PHASE 2 - Infrastructures for Remaining Areas	
PHASE 3 - Ting Ying Rd & WDC Extension	
Final EIA Assessment	
Final Investigation Report	
Endorsement from Steering Group	
DB Consultation	5
ACE Submission (for Final EIA)	3
Preliminary Project Feasibility Studies	2.5
Final PPFS #	
Approved by Works & Finance Branches	2.5
CWRF RAE	
Preparation of Project Brief	2.5
Engagement of Consultants	4.5
Upgrade to Cat A for D&C Agreemtn	4
Detailed Design	9
Roads Ordinance Procedures *	6
Foreshore & Seabed Ordinance *	6
Upgrade to Cat A	4
Contract 6	
Tender	3
Construction	24
I - Road L12(N)	18
II - LRT Central Loop Western Leg	18
IV - Tin Ying Rd Dualling	24
III - Road D4(N)	26
V - Western Drainage Channel Extension	26
Contract 7	
Tender	3
Construction	40
I - Site formation for Areas 109b, 112-117,120	18
II - Road D4 (S), Bridges P1/V3	28
III - Bridges P1/L1& P1/L2	12
PHASE 4 - Road D3 & Area 121	
Detailed Design	9
Roads Ordinance Procedures *	6
Land Resumption Procedures	36
Upgrade to Cat A	4
Contract 8	
Tender	3
Construction	24
I - Road D3	24
II - Site Formation of Area 121	6
OTHER SERVICES & INSTALLATIONS	
Diversion of 132kV Overhead line	4
Tan Kwai Tsuen F/W S/R Phase II (WSD)	18
LRT	
Outer Loop Portion A & D (By Contract 4)	18
Outer Loop Portion C	18
Central Loop Western Leg	18
Outer Loop Portion B	18
Commissioning of Central Loop & Outer Loop	
Express Line (DZ)	18
Express Line (RZ)	18
Bridge P1/L1 & P2/L2	6
Commissioning of Express Line	
ENVIRONMENTAL MONITORING & AUDIT	
Stage 2 - Monitoring for Package I Infrastructure	
Handover of Management Responsibility to Stage 3	
Stage 3 - Monitoring for Package II Infrastructure	67
Environmental Management Team	67
Environmental Monitoring Team	27



Printed: 17.Dec.96 [Version 2.2]
Notes : * 8 weeks allowed for resolving objections. Major objections may require ExCo's overruling and would delay the Project by 6 months.
@ the original allowance is considered excessive

Milestone ▽
Summary
Fixed Delay



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : WORKS YEAR BY YEAR JUL-DEC 1997	Figure No. 2.27	Revision 0
		Reference TSW-BASE	File Name 01420018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
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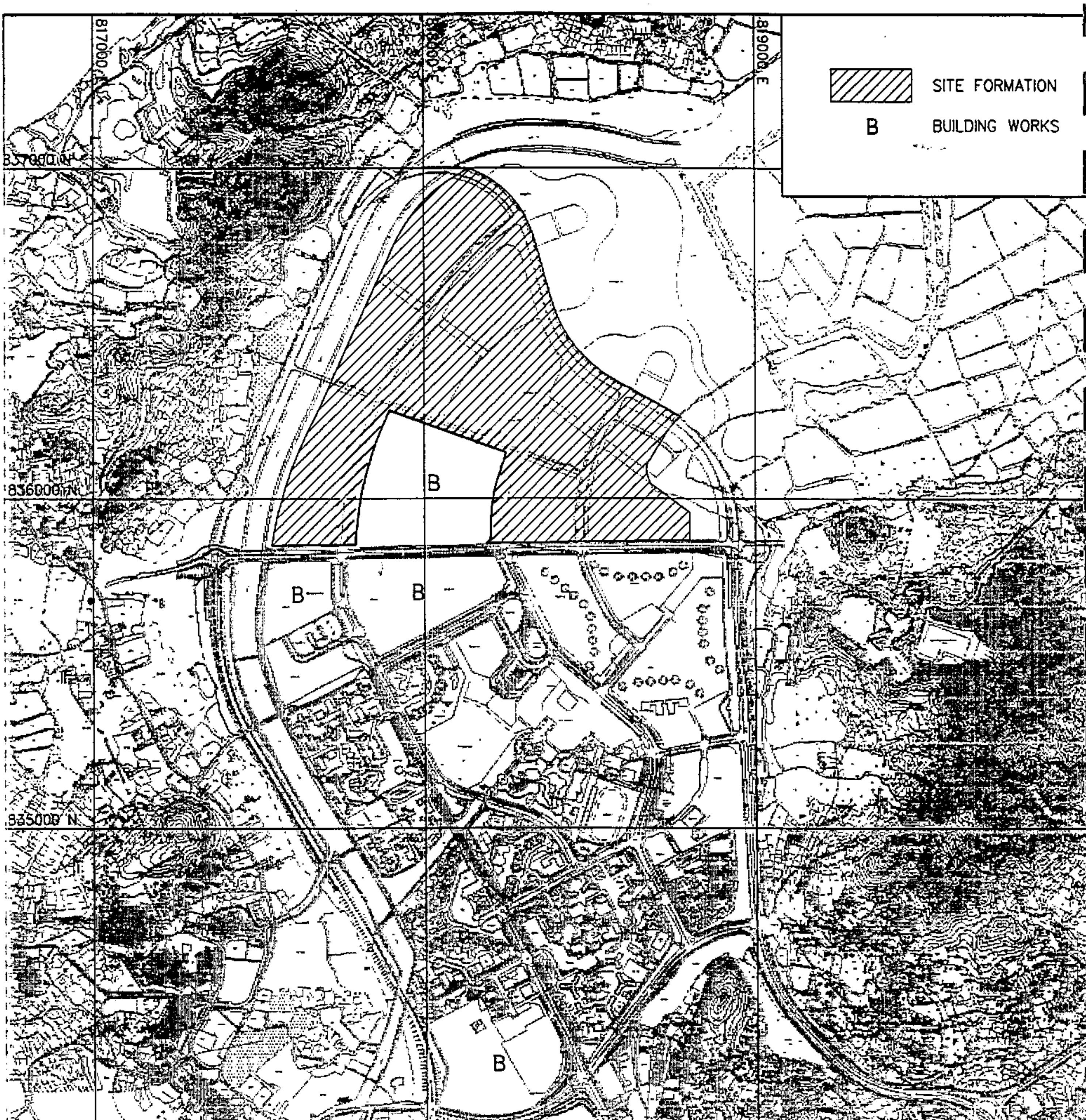

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		Reference TSW–BASE	File Name 01430018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
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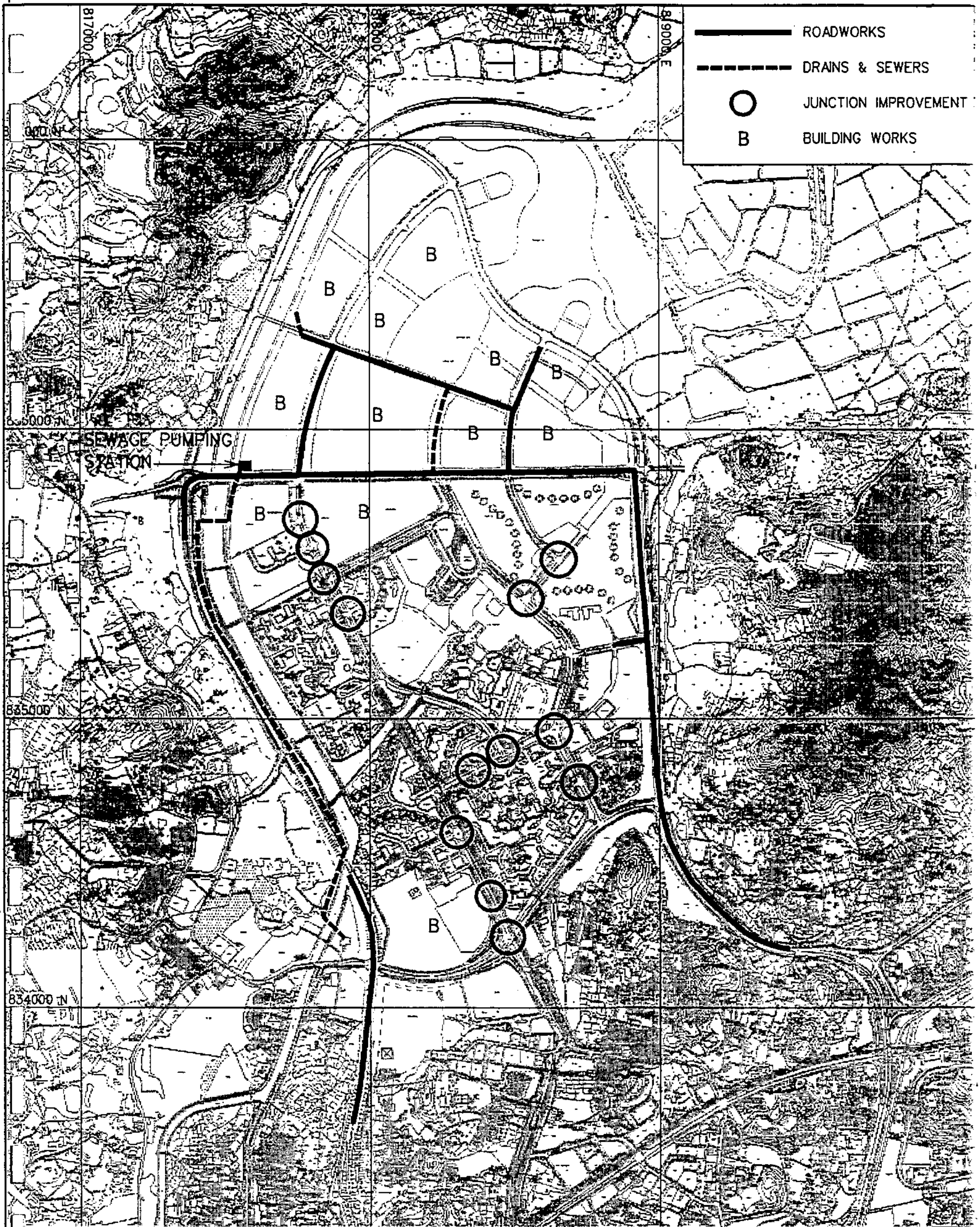

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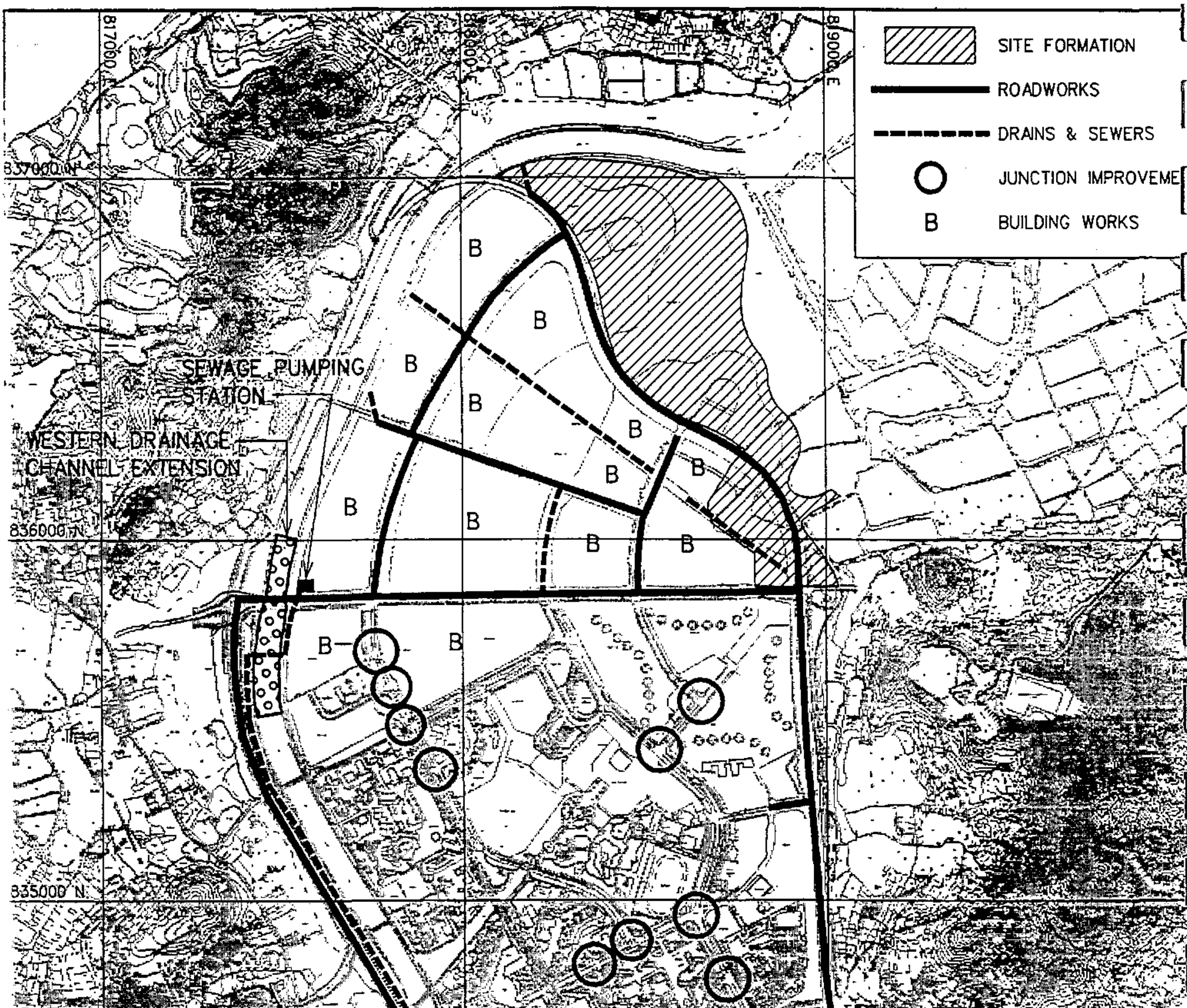
WORKS YEAR BY YEAR
OCT-DEC 1998

Figure No. 2.29	Revision 0
Reference TSW-BASE	File Name 01440018.C09
Prepared MC	Checked PS
Date NOV. 96	Scale N.T.S.



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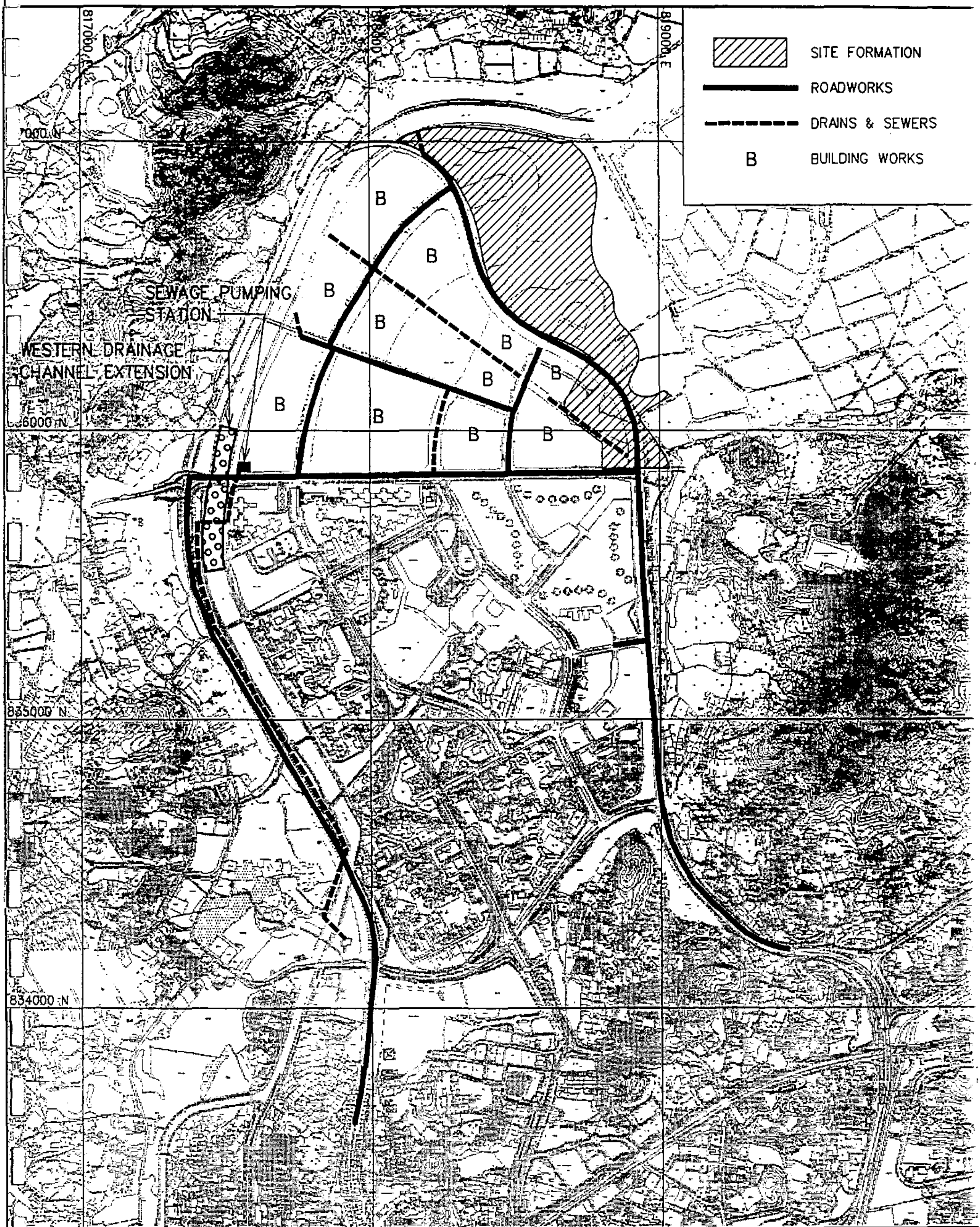
		Reference TSW–BASE	File Name 01450018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
		Date NOV. 96	Scale N.T.S.



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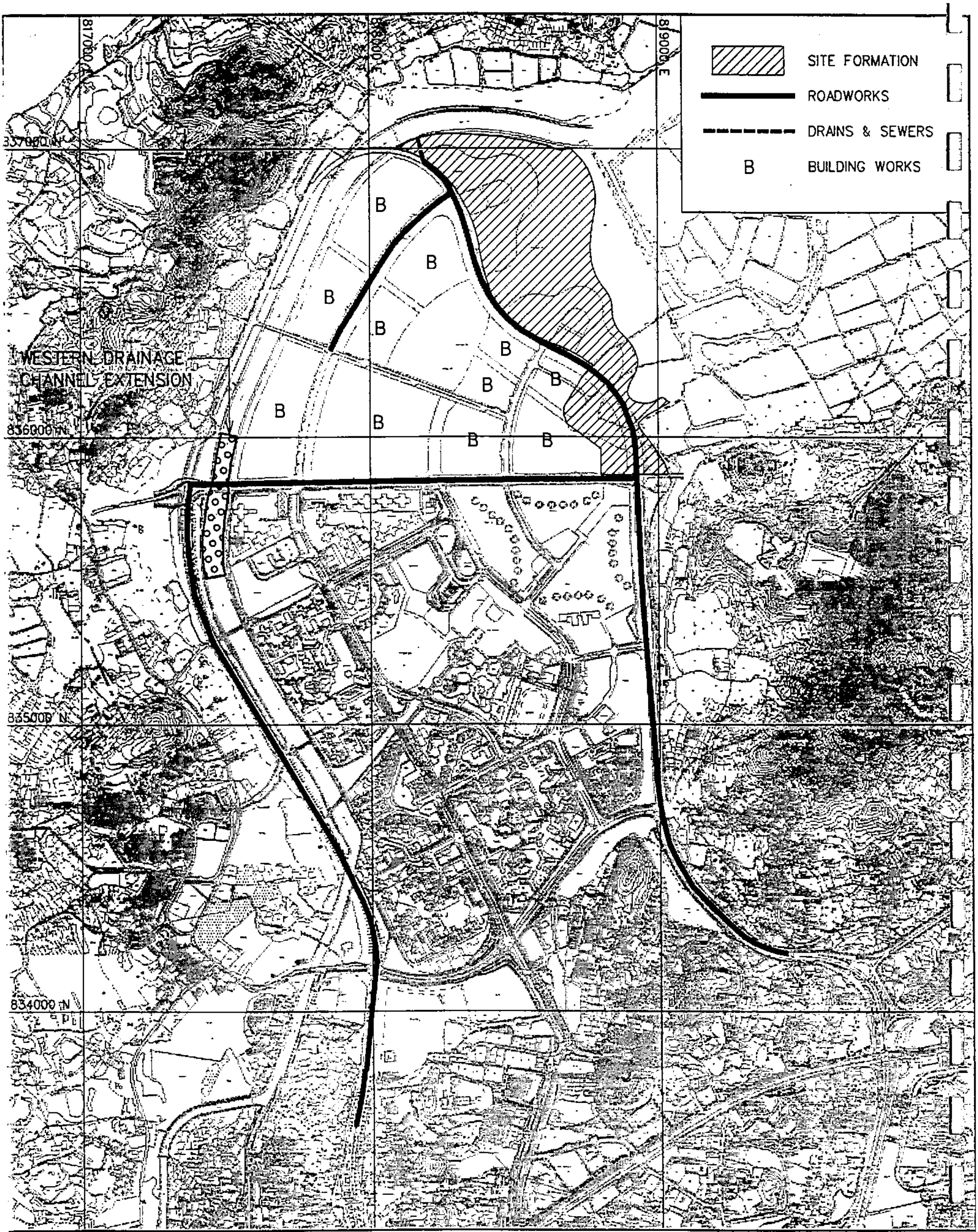
Title :

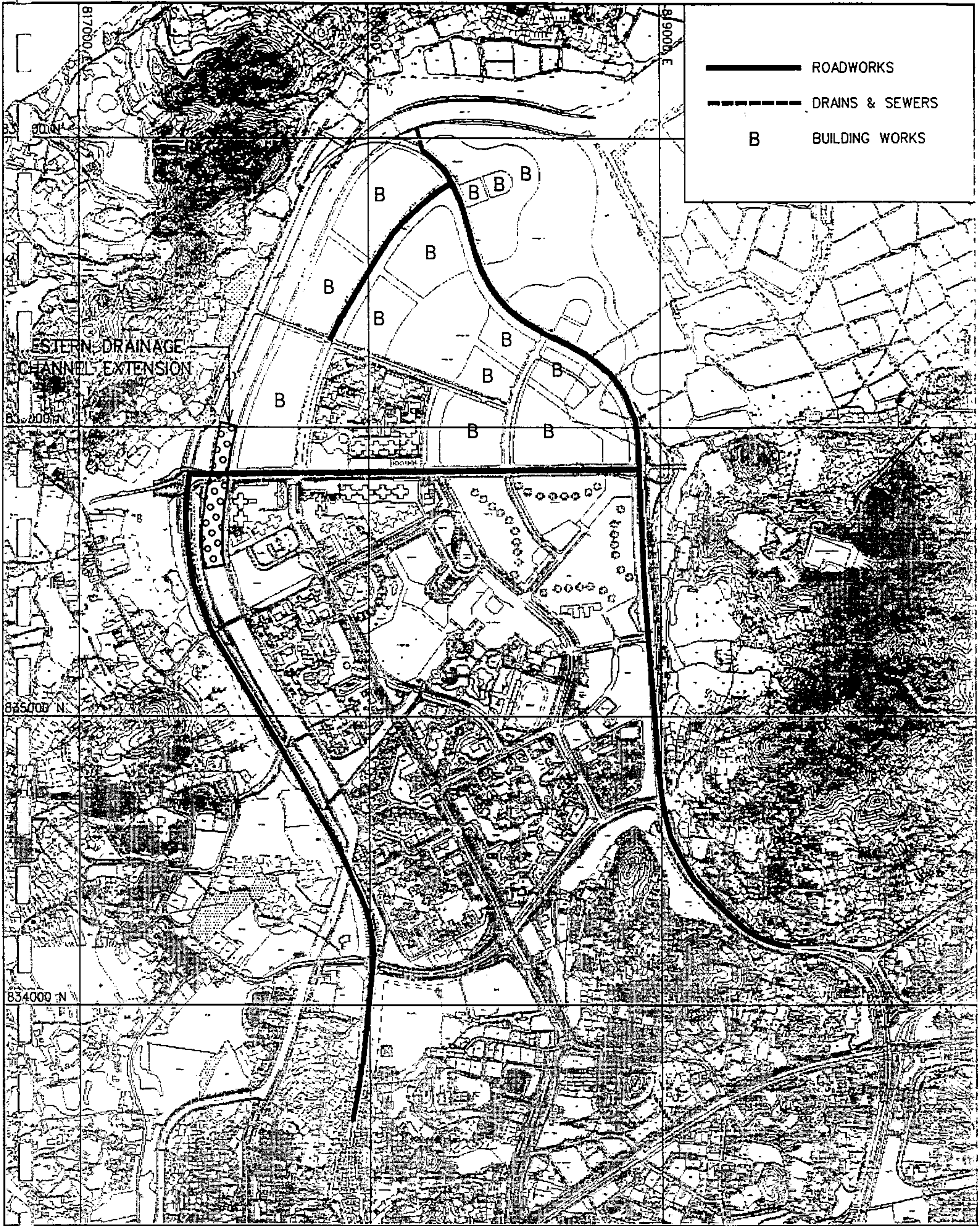
WORKS YEAR BY YEAR
SEP 1999–MAR 2000

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No. 2.31	Revision 0
Reference TSW-BASE	File Name 01460018.C09
Prepared MC	Checked PS
Date NOV. 96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : WORKS YEAR BY YEAR APR-AUG 2000	Figure No. 2.32	Revision 0
		Reference TSW-BASE	File Name 01470018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
	Note : Housing layout from HD as of July 1996. [Occupation dates based on recommended implementation programme version 2.1]	Date NOV. 96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
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Title :

WORKS YEAR BY YEAR
SEP-DEC 2000

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No.	Revision
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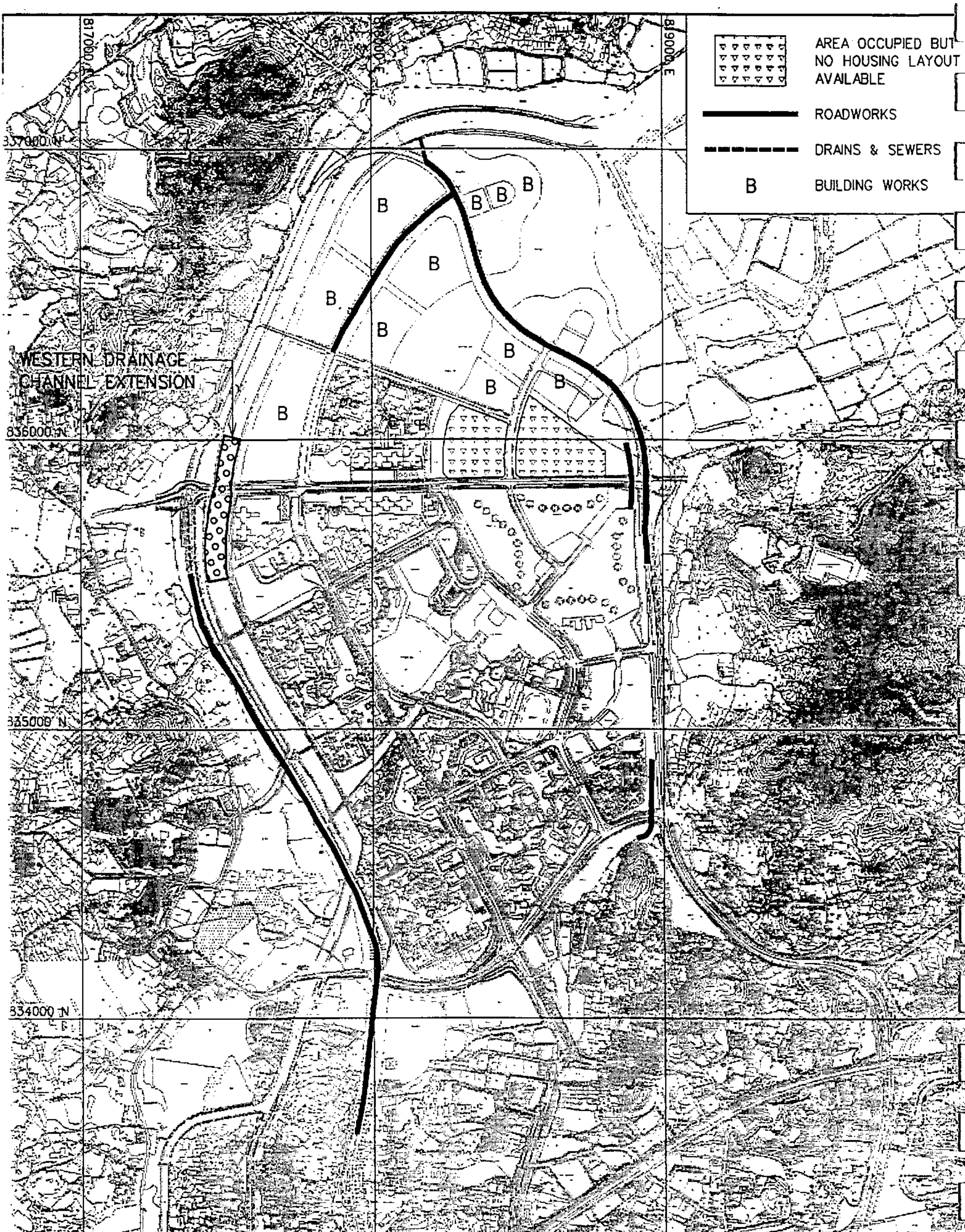
Reference: TSW-BASE	File Name: 01480018.C09
Prepared: MC	Checked: PS
Date: NOV. 96	Scale: N.T.S.



TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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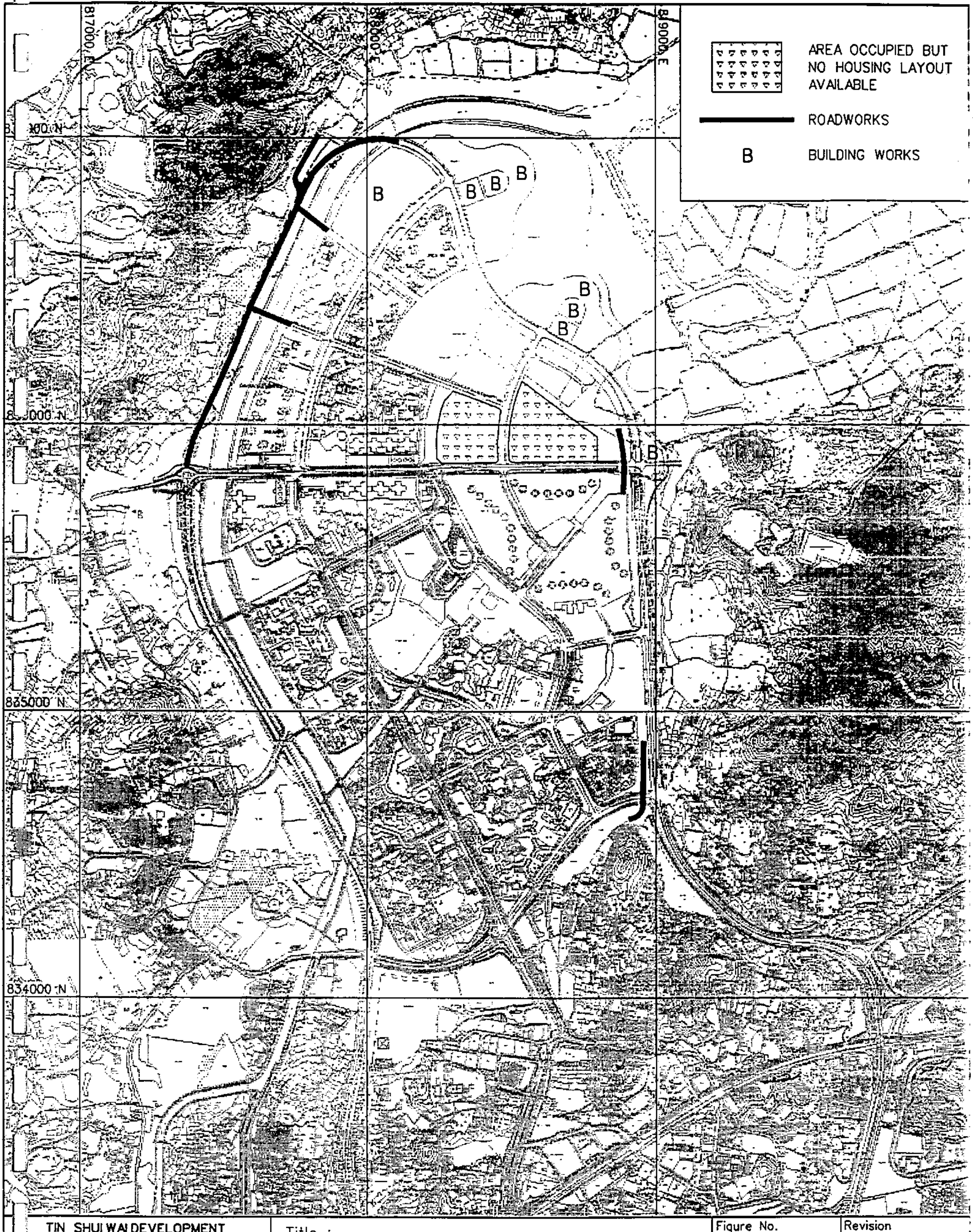
Title :

WORKS YEAR BY YEAR
JAN–JUN 2001

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No.	Revision
2.34	0
Reference TSW–BASE	File Name 01490018.C09
Prepared MC	Checked PS
Date NOV. 96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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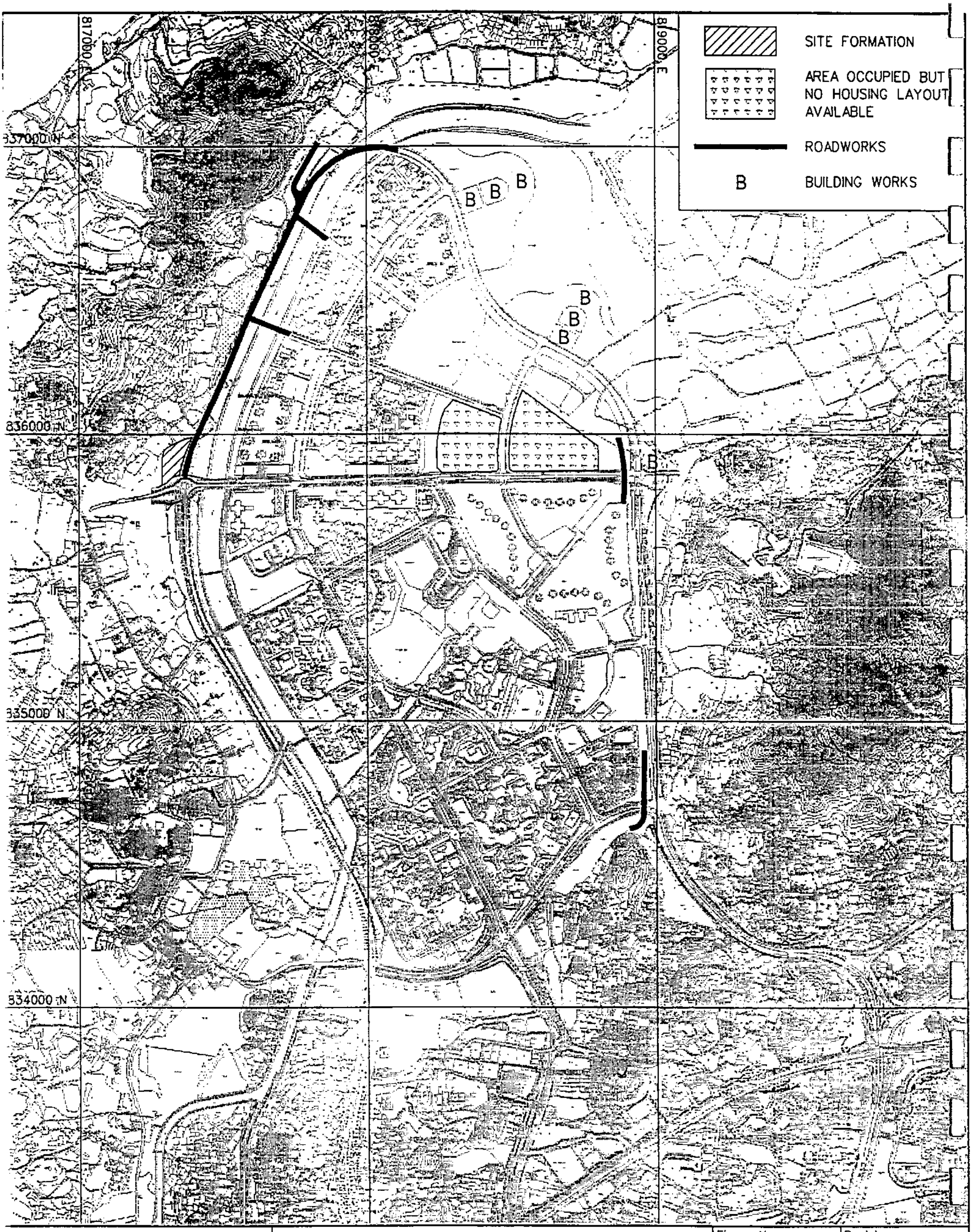
Title :

WORKS YEAR BY YEAR
JUL-DEC 2001

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No. 2.35	Revision 0
Reference TSW-BASE	File Name 01500018.C09
Prepared MC	Checked PS
Date NOV. 96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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Title :

WORKS YEAR BY YEAR
JAN–JUL 2002

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No.	Revision
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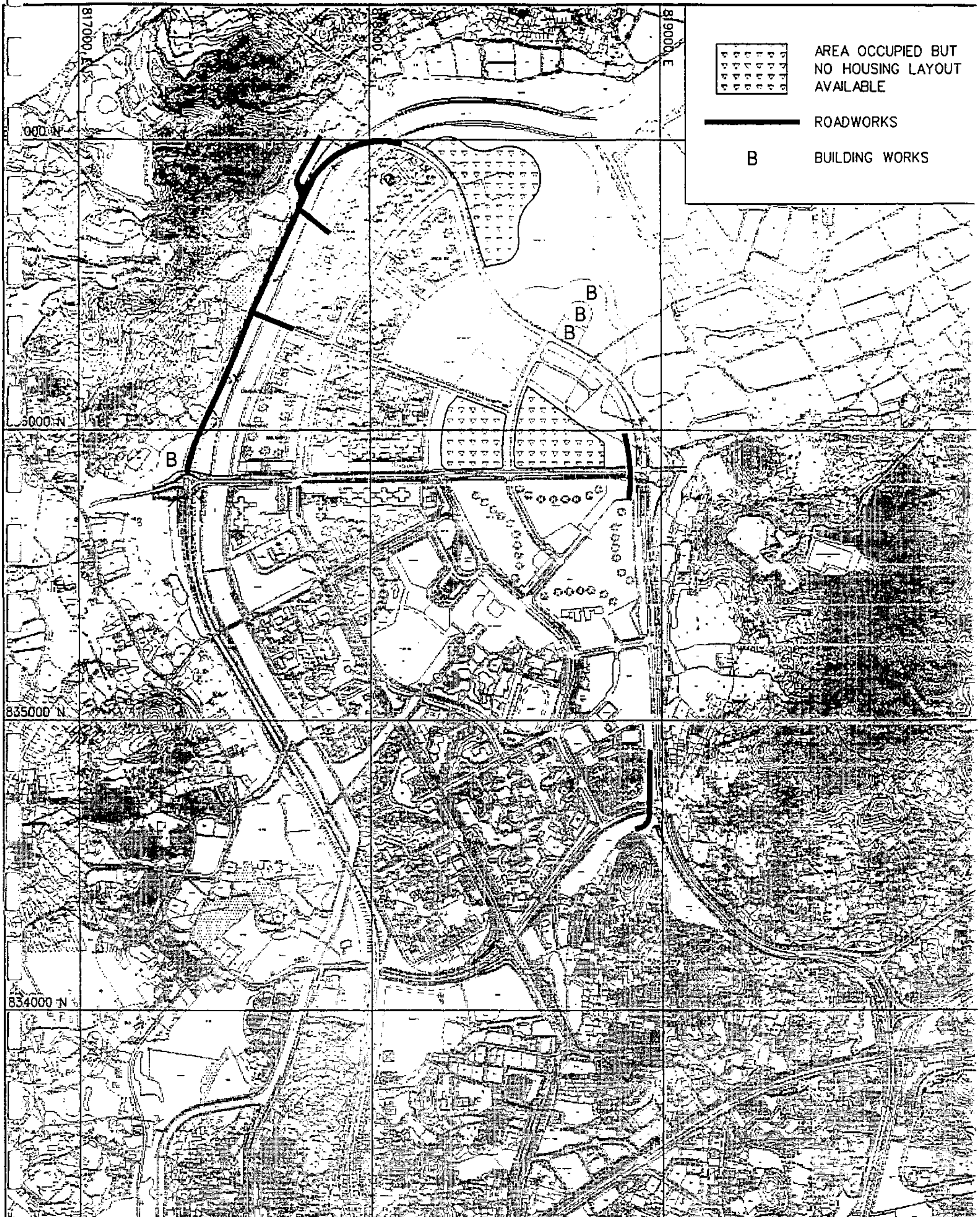
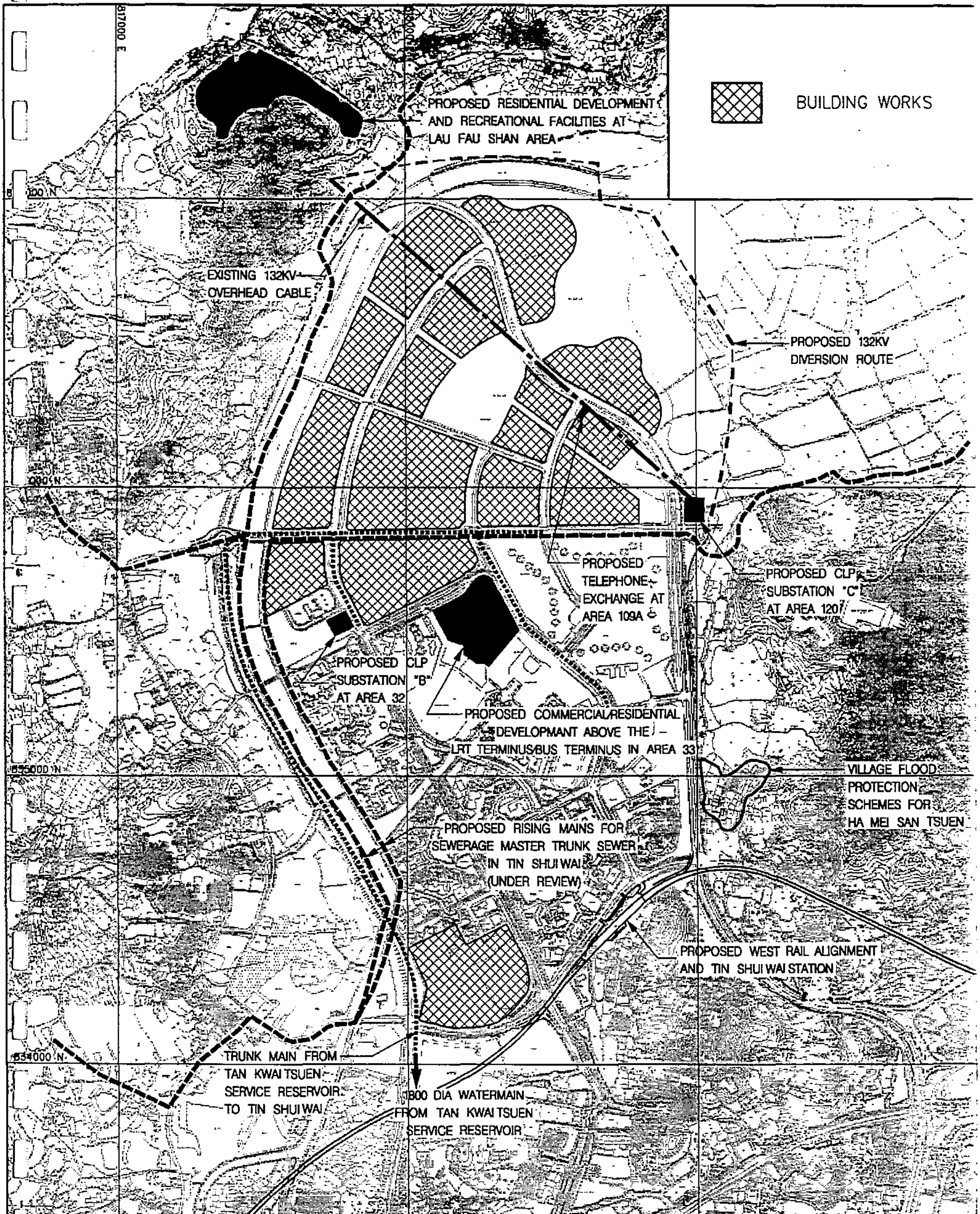
Prepared: MC	Checked: PS
Date: NOV. 96	Scale: N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : WORKS YEAR BY YEAR AUG 2002-AUG 2003	Figure No. 2.37	Revision 0
		Reference TSW-BASE	File Name 01520018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	Note : Housing layout from HD as of July 1996. [Occupation dates based on recommended implementation programme version 2.1]	Prepared MC	Checked PS
		Date NOV. 96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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Title :

CONCURRENT PROJECTS

Figure No.	Revision
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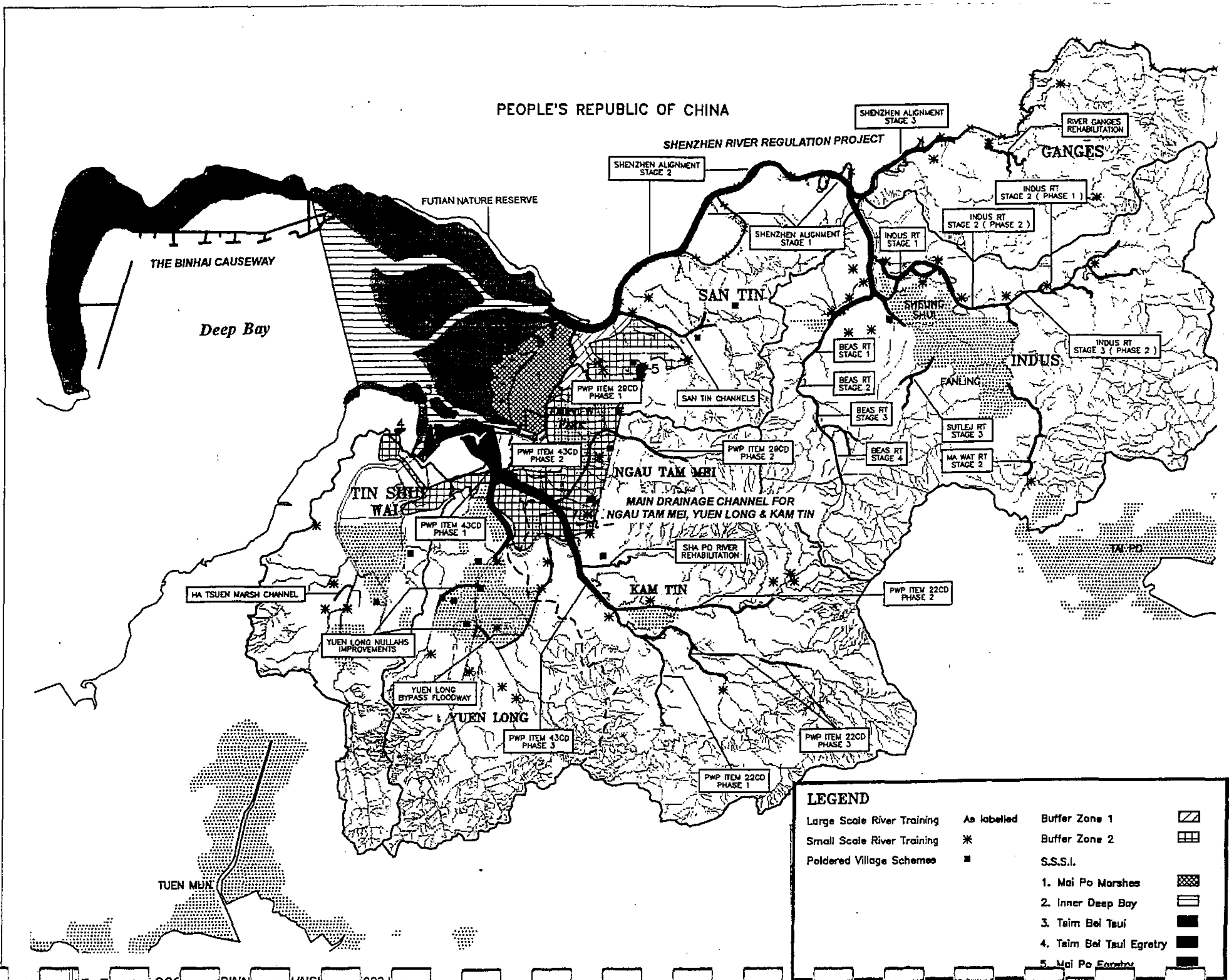
Prepared MC	Checked PS
Date NOV. 96	Scale N.T.S.



(SOURCE : TELADFLOCOSS 2 BINNIE MAUNSELL 1993)

Notes

Prepared	Checked
MC	PS

File name	Revision	Date
-	-	NOV 9

Project TIN SHUI WAI DEVELOPMENT

Contract title

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 3 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

Title

CONCURRENT PROJECT WITHIN INNER DEEP BA DRAINAGE BASIN

Figure no.	Reference no.	Scale
2.40	TELADFLOCOSS 2	NTS

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Office

新界北拓展處
NEW TERRITORIES NORTH DEVELOPMENT OFFICE

拓展署
Territory Development Department Hong Kong

3 SENSITIVE RECEIVERS AND SENSITIVE LANDUSES

3.1 Introduction

3.1.1 This section outlines the major elements and sensitive receivers of the surrounding environment which may be affected by the Project. The Study Area of 6.5 km^2 common to all environmental key issue assessments is given in Figure 3.1. Figure 3.2 shows the 9 km^2 study area for noise impact assessment which extends 300 m beyond the new roads. A wider study area has been used for ecological assessment and for some water quality studies and this is discussed in more detail in these sections.

3.1.2 The major elements and sensitive receivers that could be impacted by the Project are:

(i) the existing inhabitants within the study area;

(ii) future inhabitants within the study area;

(iii) agricultural land-uses;

(iv) all water bodies within and downstream of the Study Area;

(v) ecological receivers within a wider study zone;

(vi) fung shui elements within the Study Area.

3.2 Existing and Proposed Landuse

3.2.1 At this stage there are no residents within the RZ. Future residents will begin to occupy the RZ during various stages of the works of this Project. Table 3.1 shows the latest tentative programme for the development for individual areas on the RZ and the DZ.

3.2.2 The current and future occupation and any sensitive landuses of the DZ are defined by the Outline Zoning Plan (OZP), ref. S/TSW/1 which was issued on 21st October 1994.

3.2.3 The landuse of the areas adjacent to the RZ and DZ that fall within the study area are defined on the OZPs: S/YL-TYST/1; S/YL-PS/1; S/YL-HT/1; S/YL/2 and S/YL-LFS/1. These are summarised on Figure 3.3. The Figure defines areas zoned for Commerce (C); Comprehensive Development Area (CDA); Commercial/Residential (C/R); Residential, Group A (R(A)); Residential, Group B (R(B)); Residential, Group C (R(C)); Village Type Development (V); Industrial (I); Open Storage (OS); Government / Institution / Community (G/IC); Open Space (O); Recreation (REC); Other Specified Uses (OU); Undetermined (U); Green Belt (GB); Conservation Area (CA); Coastal Protection Area (CPA) and Sites of Special Scientific Interest (SSSI). Certain areas already zoned as potential domestic residential developments are of particular relevance to this project. Figure 3.4 shows the land uses for areas in the RZ.

3.2.4 The purpose of the OZP is to illustrate the broad principles of development and control only. It is a small scale plan and the road alignments and boundaries between the land use zones may be subject to minor alterations as detailed planning proceeds. Detailed discussions will be held with the Planning Department to ensure that all future sensitive receivers or sensitive landuses are taken into account during the detailed EIA studies. In general terms, the OZPs define the future inhabitants within the study area.

Table 3.1
Draft Development Programme for the Developments [Version 2.2]

Planning Area	Land Use	Earliest 1st Occupation*	Essential Infrastructure Available Date	Site Available Date	Population
3	HOS 3 Schools	**08/99** **08/99**	**08/99** **08/99**	Existing	19,455 -
30	RS 1 Schools	**08/99** No Programme	**08/99** **08/99**	Existing	13,020 -
31	HOS 3 Schools	**08/99** **08/99**	**08/99** **08/99**	Existing	18,488 -
33/bus & LRT termini	C/R GIC	To be confirmed	05/00	To be confirmed	8,400 -
101	PSPS 2 Schools	**03/01**	**05/00**	07/98	16,720 -
102	RS HOS 5 Schools	08/00	05/00	07/97	13,282 16,124 -
103	SC 2 Schools	**12/00** No Programme	**05/00**	04/98	12,600 -
104	R2	**12/00**	**05/00**	10/98	5,700
105	RS 1 School	**03/01**	**09/00**	10/98	15,296 -
106	HOS	**03/01**	**09/00**	10/98	7,780
107a	O	12/02	**09/00**	12/01	-
107b	O	12/02	**09/00**	12/01	-
108a	C/R	06/01	**09/00**	04/98	750
108b	C/R Hotel	07/01	**09/00**	07/98	750 1,000
109a	G/IC 1 School	06/01 No Programme	**05/00**	06/98	-
109b	G/IC 2 Schools	08/02 No Programme	06/01	03/00	-
110	HOS 2 Schools	**12/01**	06/01	12/98	15,565 -
111a	PSPS	**03/01**	**03/01**	07/98	6,232
111b	PSPS 1 School	**03/01**	**03/01**	12/98	6,232 -
112	R3	08/02	06/01	03/00	3,650
113	E 2 Schools	No programme	06/01	03/00	-
114	O	**08/01**	06/01	12/01	-
115	R3	**08/02**	06/01	12/01	2,650
116	E 2 Schools	No programme	06/01	12/01	-
117	O	**08/02**	06/01	03/00	-
118	CA	Existing	Not required	Existing	-
119	CA	Existing	Not required	Existing	-
120	G/IC	**08/02**	06/01	03/00	-
121	G/IC	08/04	08/03	02/02	-
122	GB	Existing	Not required	Existing	-
123	GB	Existing	Not required	Existing	-

* Earliest first occupation dates taking into account the completion of major highway improvement works.

3.2.5 These plans also illustrate recognised agricultural areas (AGR). Within the Study Area, fruit and vegetable agriculture is apparent to the north and west of the RZ. There are approximately 5 pig farms to the north of the RZ. The largest areas of fishponds are to the east of the RZ, with smaller areas to the north and west. The fishponds to the west of the DZ have mostly been filled in and replaced with open storage and container storage space. These latter areas have been zoned as CDA, O, U and OS in OZP S/YL-HT/1 and hence their use as container storage will decrease. Whereas, the former areas are zoned for mostly CA and GB, with some V and R(C).

3.3 Current Sensitive Receivers & Sensitive Land Uses

3.3.1 Noise Sensitive Receivers (NSRs) are defined by the *HKPSG* and *Noise Control Ordinance* as follows:

(i) all domestic premises, including temporary housing accommodation;

(ii) hotels and hostels;

(iii) offices;

(iv) educational institutions, including kindergartens, nurseries and all others where unaided voice communication is required;

(v) places of public worship and courts of law;

(vi) hospitals, clinics, convalescents homes for the aged, diagnostic rooms and wards;

(vii) amphitheatres and auditoria, libraries, performing arts centres and Country Parks.

3.3.2 In the case of air quality assessment, passive and active recreational uses are also considered. At various stages of the Project additional "current" sensitive receivers will be considered as nearby housing developments are occupied.

3.3.3 For ease of reference the Tin Shui Wai study area has been divided into a number of sections:

(a) the Reserve Zone (RZ);

(b) the Development Zone (DZ);

(c) those residents outside the RZ and DZ.

3.3.4 In order to further clarify geographical location for descriptive purposes, the study area is divided into six OZP area as shown in Figure 3.3. Sensitive receivers as well as sensitive landuses under each OZPs will be described.

Sensitive Receivers under the S/YL-LFS/1 OZP

Mong Tseng Tsuen

3.3.5 Mong Tseng Tsuen is a typical village to the north of the RZ with old and modern village houses ranging from 1 to 3 storeys high. There are a number of small agricultural fields in the vicinity of the village. Most of the fish ponds near Mong Tseng Tsuen are now abandoned. The hill north of the village is mainly used as a orchard plantation. There are a number of pig and poultry farms to the west of the village. The Lee and Cheung Ancestral Hall is located at the centre of the village. Access to the village is via the Deep Bay Road from Lau Fau Shan. The area is generally quiet with the main noise source coming from local traffic and villagers' activity.

Mong Tseng Wai

3.3.6 Mong Tseng Wai is a village located to the east of Mong Tseng Tsuen. Houses in the village range from old 1 storey village houses to modern 3 storey villas. There are a number of orchard plantations and agricultural fields scattered around the village. Some of the fishponds near the village are now left abandoned and unmanaged. The Tsim Bei Tsui egretry and the Inner Deep Bay SSSI are located to the east of the village. The Yuen Kwan Tai Temple is located in the eastern end of the village. Further east of the temple is the Mong Tseng Public Shung Yee School. This primary school is one storey high and currently has a total of 14 students and staff. The noise environment in the village is the same as Mong Tseng Tsuen which is generally quiet.

Sha Kong Wai

3.3.7 Sha Kong Wai is a village located to the west of the RZ near the roundabout at Tin Wah Road and Tin Ying Road. Houses in the village are 1 to 3 storeys high. Most of the fishponds near the village are not in use and are either filled or overgrown with grasses. To the east of the village is the Hung Shing Kung Temple. The area is generally quiet but the outer row of houses are affected by traffic noise especially from container lorries along Tin Wah Road.

Sha Kong Wai Tsai

3.3.8 Sha Kong Wai Tsai is a village located adjacent to Sha Kong Wai village. The houses are mostly 1 to 3 storeys high. There is a primary school in the village. The Sha Kong Public Luen Yick School (1 storey) has 23 students and 4 staff. The noise in the area is affected by traffic from Tin Wah Road and Lau Fau Shan Road especially from the container lorries which use these roads regularly.

Fung Lok Wai

3.3.9 Fung Lok Wai is located to the east of the RZ. The area is dominated by active fishponds. Village houses are mostly 1 storey high and can be found in scattered locations around the fishponds. A number of the fishponds are now abandoned and have been transformed into storage facilities. Because of its proximity to Deep Bay and Mai Po, flocks of water birds, mostly egrets and cormorants, can be seen in the area. Food sources from these fish ponds and the sparse human population in the area make this area attractive to water birds. The area is generally quiet with no major noise sources.

Sensitive Receivers under the S/YL-HT/1 OZP

Tung Tau Tsuen, Lo Uk Tsuen, Sik Kong Tsuen

3.3.10 These villages consists of typical 1 to 3 storey village houses. They are located to the west of the DZ near Ping Ha Road. There is a temple (Yeung Hau Temple) located in Tung Tau Tsuen. The Greenery Elderly Home which has a total of 147 elderly and staff is located in Tung Tau Tsuen near Ping Ha Road. The fishponds which were once active have now been filled and turned into container storage yards. The first row of houses which face Ping Ha Road are affected by traffic noise.

Shek Po Tsuen

3.3.11 Shek Po Tsuen is located to the west of Hung Tin Road and consists of 1 to 3 storeys village houses. The area is affected by traffic noise from Hung Tin Road.

Sensitive Receivers under the S/YL-PS/1 OZP

Ha Mei San Tsuen

3.3.12 Ha Mei San Tsuen is located east of the DZ across Tin Tsz Road. It is a typical village with 1 to 3 storey houses. Most of the fishponds to the north of the village are filled and have been turned into open storage and carparks. Only a few active fishponds are left. There are a number of small agricultural fields interspersed with village houses and used by the villagers. The village is generally quiet with major noise sources coming from traffic in Tin Tsz Road.

Sheung Cheung Wai and Hang Tau Tsuen

3.3.13 These villages are located to the south of the DZ across Ping Ha Road. It is a typical village community with 1 to 3 storey houses. Most of the fishponds in these areas have been turned into open storage and carparks. The TWGH Kwok Yat Wai Prevocational School (6 storeys) is located to the north of Sheung Chueng Wai. The dominant noise source in these villages includes traffic noise from container lorries and trucks which use the storage areas and carparks.

Hang Mei Tsuen and Tong Fong Tsuen

3.3.14 These villages consist mostly of 1 to 3 storey village houses along Ping Ha Road. Noise is dominated from traffic along Ping Ha Road.

Kiu Tau Wai

3.3.15 Kiu Tau Wai is located south of the Kiu Tau Wai Industrial Area across Ping Ha Road. It has 1 to 3 storey village houses. There is a number of container storage yards near the village. These container storage yards as well as the industrial area to the north contribute to the major noise source of the area.

Sensitive Receivers under the S/TSW/1 OZP

RZ

3.3.16 The RZ is currently vacant. Site formation works for the RZ are expected to begin in 1997. Description of the SRs in the RZ will be discussed under the future sensitive receivers section.

DZ

3.3.17 Most of the areas in the DZ have been developed or are under construction. Population intake is in progress with the gradual completion of the residential blocks.

3.3.18 The description of the SRs in the DZ will be divided into areas as shown in the OZP.

Tin Shui Estate and Tin Oi Court (Area 16)

3.3.19 Tin Shui Estate is a public housing estate consisting of 12 residential blocks of 40 storeys high. It consists of 8 harmony type housing units namely: Shui Shing House; Shui Sum House; Shui Yee House; Shui Moon House; Shui Lung House; Shui Yip House; Shui Chuen House and Shui Lam House. There are 4 Y-type housing units namely: Shui Kwok House; Shui Choi House; Shui Fai House and Shui Fung House. There are 3 schools in the estate namely: TWGH Yiu Dak Chi Memorial Primary School; MFBM Chan Lui Chung Tak Memorial College and CUHK Thomas Cheung Secondary School. All the schools are 7 storeys high and air-conditioned. There are also a number of nurseries and kindergartens on the ground floor of each building. Tin Oi Court is a Home Ownership Scheme (HOS) development with two 40 storey residential blocks: Oi Chiu House and Oi Tao House. There is a primary school near Tin Oi Court, the Lok Sin Tong Leung Kau Kui Primary School (7 storeys). Both Tin Shui Estate and Tin Oi Court are located along the WDC and the main noise source includes traffic from Tin Ying Road and local distributor roads.

Locwood Court - TSW Town Lot 1 (Area 8)

3.3.20 Locwood Court is part of the Kingswood Villas development and is located along the WDC. It consists of 14 residential blocks ranging from 30 to 38 storeys high. There are 2 schools south of Area 8, namely: Ho Ming Primary School and Pui Shing Catholic Secondary School. Both are 7 storeys high and air-conditioned. The major noise source comes from traffic on Tin Ying Road.

Chestwood Court - TSW Town Lot 3 (Area 19)

3.3.21 Area 19, Chestwood Court, is part of the Kingswood Villas development and is located just south of Area 31. It consists of 6 residential blocks 30 to 38 storeys high. The Tin Shui Wai Public Primary School (7 storeys) is located adjacent to Area 19. The area is generally quiet with noise mainly from local traffic.

District Park (Area 22)

3.3.22 Area 22 is being developed as the District Park and is located at the centre of the DZ. The first phase of the park is completed, with the second phase due for completion in 1997.

Sherwood Court - TSW Town Lot 2 (Area 11)

3.3.23 Sherwood Court is part of the Kingswood Villas development and is located opposite Locwood Court. It consists of 6 residential blocks ranging from 30 to 38 storeys high. The Ju Ching Chu Secondary School (7 storeys) is located next to Area 11. The noise in the area is mainly from local traffic.

Tin Yiu Estate and Tin Yau Court (Area 5)

3.3.24 Tin Yiu Estate consists of twelve 40 storey Y-typed public housing namely: Yiu Chak House; Yiu Lung House; Yiu Tai House; Yiu Hing House; Yiu Shing House; Yiu Man House; Yiu Fung House; Yiu Yat House; Yiu Cheong House; Yiu Foo House; Yiu Wah House and Yiu Hong House. There are a number of schools in the estate namely: Fong Yun Wah Primary School; Tin Shui Wai Government Secondary School; Yuen Long Lutheran Secondary School; Chiu Yang Primary School of Hong Kong and Queen Elizabeth School Old Students' Association Primary School. All the school are 7 storeys high and air-conditioned. Tin Yau Court is a HOS development consisting of three 40 storey residential blocks namely: Yau Tai House; Yau Ning House and Yau Hong House. Noise in the area is dominated mostly by traffic along Ping Ha Road.

TSW Town Lot 4 (Area 20 and 23)

3.3.25 The area is located south of the LRT terminus in the DZ along Tin Shing Road. It is intended to serve as a town centre providing retailing and commercial facilities for Tin Shui Wai. A hotel and office development are also proposed for these areas. Construction works are currently in progress.

Kenswood Court - TSW Town Lot 7 (Area 24)

3.3.26 Kenswood Court is part of the Kingswood Villas development and is located west of Tin Tsz Road. It consists of 14 residential blocks ranging from 30 to 38 storeys high. There is a primary school and a secondary school (7 storeys) just south of the area. Noise is generally dominated by traffic from Tin Tsz Road.

Lynwood Court - TSW Town Lot 5 (Area 27)

3.3.27 Area 27 also known as Town Lot 5 has been developed into Lynwood Court which is the fifth phase of the Kingswood Villas development. It is located just south of Tin Wah Road and consists of 10 residential blocks ranging from 30 to 38 storeys high. There are 3 school sites (7 storeys) currently under construction to the west of Lynwood Court. Noise in the area is dominated by traffic from Tin Wah Road.

Maywood Court - TSW Town Lot 6 (Area 28)

3.3.28 Maywood Court is the sixth phase of the Kingswood Villas development. It is located just south of Tin Wah Road between Lynwood Court and Kenswood Court. Construction of six 30 to 38 storey residential blocks are currently underway. Completion date is expected to be in 1997. Noise in the area is expected to be mainly from traffic along Tin Wah Road.

Area 13

3.3.29 The area is currently under construction with expected first occupation in 1997. It is located near the roundabout at Tin Tsz and Tin Fuk Road. It consists of five 40 storey and two 14 storey public rental housing estates. Noise in the area is expected to be mainly from traffic along Tin Tsz Road and Tin Fuk Road.

3.3.30 A summary of the population for each area in the DZ is tabulated in Tables 3.4 and 3.5

Sensitive Receivers under the S/YL/2 OZP

Chung Hing San Tsuen

3.3.31 Chung Hing San Tsuen consists of 3 storey houses. It is located near the Shui Ping Wai interchange facing Long Tin Road. Noise levels are particularly high especially for the houses facing Long Tin Road, Long Ping Road, Shui Pin Wai Interchange and Castle Peak Road.

Shui Pin Wai

3.3.32 Shui Pin Wai consists of 1 to 3 storey village houses. It is located to the south of Chung Hing San Tsuen. Noise in the area is dominated by traffic from Long Tin Road and Castle Peak Road. Further south of Shui Pin Wai is Yuen Long Park. South of the park is the Yuen Long Public Secondary School. The school is 7 storeys high and air-conditioned.

3.4 Future Sensitive Receivers

3.4.1 First occupation of the priority sites and the RZ will start by the end of 1999. Figures 3.5 - 3.12 show the stages of occupation for the Tin Shui Wai area from 1999-2004. They are based on the public housing digitised layout plans supplied by Housing Department (HD) as of July 1996. Some layout amendments are expected from HD in response to input from the on-going Engineering Study and traffic noise impact assessment. A description of the sensitive receivers and population in the RZ and the priority sites are summarised below in Table 3.2.

Table 3.2
Description of Sensitive Receivers in the Priority Sites and RZ in Tin Shui Wai

Area	Land Uses	Population	Description of Sensitive Receivers
3	HOS	20,617	12 nos. 40 storey HOS blocks (8 flats/floor) 4 nos. 40 storey H1 blocks (16 flats/floor) 2 nos. primary school 1 no. secondary school
30	RS	13,020	4 nos. 41 storey H1 blocks (16 flats/floor) 1 no. 21 storey new harmony annex 1 block 2 nos. 22 storey single aspect block 1 no. housing for senior citizen (HSC) - 198 bedspaces 1 no. primary school
31	HOS	18,488	4 nos. 40 storey H1 blocks (16 flats/floor) 11 nos. 40 HOS blocks (8 flats/floor) 2 nos. primary school 1 no. secondary school
101	PSPS	12,737	10 nos. residential blocks (details not available) 1 no. primary school 1 no. secondary school
102a 102b	RS HOS	15,309 15,565	5 nos. 40 storey H1 blocks (16 flats/floor) 16 nos. 40 storey HOS blocks (8 flats/floor) 3 nos. primary school 2 nos. secondary school
103	SC	12,600	sandwich class housing development (details not available) 2 nos. school sites (details not available)
104	R2	5,700	private housing development (details not available)
105	RS	15,310	6 nos. 40 storey H1 blocks (16 flats/floor) 1 no. primary school
106	HOS	8,755	9 nos. 40 storey HOS blocks (8 flats/floor)
109	G/IC	-	3 nos. school sites (details not available)
110	HOS	16,538	16 nos. 40 storey HOS blocks (8 flats/floor) 1 no. primary school 1 no. secondary school
111	PSPS	11,400	10 nos. residential blocks (details not available) 1 no. primary school 1 no. secondary school
112	R3	3,650	private housing development (details not available)
113	E	-	2 nos. school site
115	R3	2,650	private housing development (details not available)
116	E	-	2 nos. school site

3.4.2 Certain areas around Tin Shui Wai have been zoned residential and can be potential future sensitive receiver. There are areas zoned as Comprehensive Development Area (CDA) which subject to Town Planning Board approval can be developed and become potential future SRs. Table 3.3 list the zoned residential areas and CDA near the study area.

Table 3.3
Zoned Residential Areas and CDA near the Tin Shui Wai Area

Outline Zoning Plan	Schedule of Uses	Number of Storey/ Maximum Height	Location
S/YL-LFS/1	R(C)	3 storey including carport/9 m	East of Sha Kong Wai Tsai
S/YL-HT/1	CDA	3 storey including carport	South of Tin Wah Road
S/YL-HT/1	CDA	3 storey including carport	East of Tung Tau Tsuen
S/YL-HT/1	CDA	3 storey including carport	North of Fung Kong Tsuen
S/YL-HT/1	CDA	3 storey including carport	East of Fung Kong Tsuen
S/YL-HT/1	CDA	3 storey including carport	North of Hong Mei Tsuen
S/YL-PS/1	CDA	4 storey over single level carport	Near the interchange junction of Long Tin Road, Castle Peak Road and Yuen Long Highway
S/YL-PS/1	CDA	4 storey over single level carport	West of Yung Yuen Road
S/YL-PS/1	R(B)1	4 storey over single level carport/ 15 m	East of Hung Uk Tsuen
S/YL-PS/1	R(A)3	19 storey above podium	South of Shek Po Tsuen, west of Hung Tin Road
S/YL-PS/1	CDA	20 storey above podium	West of Hung Tin Road in Hung Shui Kiu
S/YL/2	R(B)	12 storey	East of Long Tin Road near Yuen Long Town Park
S/YL-TYST/1	R(B)1	4 storey over single level carpark/ 15 m	South of Castle Peak Road - Ping Shan section around Ma Fung Ling Road
S/YL-TYST/1	R(D)	2 storey/6 m	West of Shan Ha Tsuen and south of Yuen Long Highway
S/YL-TYST/1	R(B)1	4 storey over single level carpark/ 15 m	South of Yuen Long Highway near Tong Yan San Tsuen
S/YL-TYST/1	CDA	17 storey	West of Ting Shui Wai West Access (Hung Tin Road) and south of Castle Peak Road - Hung Shui Kiu section
S/YL-TYST/1	R(B)2	6 storey over single level carpark	South of Castle Peak Road - Hung Shui Kiu section next to Ho Dao College
S/YL-TYST/1	R(C)	3 storey including carpark/9 m	North of Yuen Long Highway in Tai Tao Tsuen

3.5 Population Build-up in TSW

3.5.1 The existing population currently residing in the DZ in TSW is around 119,000. Most of the areas in the DZ have been developed or are under construction. The existing population in the TSW DZ is tabulated in Table 3.4.

Table 3.4
Existing Population in the TSW DZ

Planning Area	Sensitive Receivers (Landuses) - population	Residential Population
5	Tin Yiu Estate (RS) - 31875 Tin Yau Court (HOS) - 6233 GIOU - 186 3 schools	38294
8	Locwood Court (R1) - 11969 2 schools	11969
11	Sherwood Court (R1) - 6123 1 school	6123
16	Tin Shui Estate (RS) - 29329 Tin Oi Court (HOS) - 4144 4 schools	33473
19	Chestwood Court (R1) - 5295 1 school	5295
24	Kenswood Court (R1) - 14066 2 schools	14066
27	Lynwood Court (R1) - 10149 3 schools	10149
	Existing Population in TSW DZ	**119369**

(Source : Appendix H - Sewage Flows Inventory and Build-up: *Final Investigation Report*, BCL, 3/97: Ref: 0018/ENG/R17.2).

3.5.2 Additional in-take of population of up to 82,000 is expected for the housing estate in Area 13 and the priority sites in Areas 3, 30 & 31, private housing in Area 28 & 33 and the proposed hotel in Area 20 and 23. Gradual occupation is expected to start from 1997. The future population for TSW DZ is tabulated below in Table 3.5.

Table 3.5
Future Population in the TSW DZ

Planning Area	Sensitive Receivers (Landuses) - population	Residential Population
-	Existing Population in DZ	119369
3	(HOS) - 20617 3 schools	20617
30	(RS) - 13020 1 school	13020
31	(HOS) - 18488 3 schools	18488
13	(RS) - 12543	12543
14	1 school	-
20	Hotel - 800	800
23	Hotel - 800	800
28	Maywood Court (R1) - 7804	7804
33	LRT and Bus Terminus (C/R) - 8400	8400
	Future Population in TSW DZ	**201841**

Source: - Appendix H - Sewage Flows Inventory and Build-up: *Final Investigation Report*, BCL, 3/97: Ref: 0018/ENG/R17.2
- Proposed changes to Public Housing Developments - December 1996

3.5.3 The RZ will be developed to cater for the need of the increase demand for land supply to meet future population growth. First occupation is expected to start in 2000 (Area 102) with a gradual increase until around 2004. It is expected that TSW RZ is to accommodate an additional population of around 120,000 for the development. The break down of the population in TSW RZ is shown in Table 3.6 below.

Table 3.6
Population in the TSW RZ

Planning Area	Sensitive Receivers (Landuses) - population	Residential Population
101	(PSPS) - 12737 2 schools	12737
102	(RS) - 15309 (HOS) - 15565 5 schools	30874
103	(SC) - 12600	12600
104	(R2) - 5700	5700
105	(RS) - 15310	15310
106	(HOS) - 8755	8755
108a	(C/R) - 750	750
108b	(C/R) - 750 Hotel - 1000	1750
109a	1 school	-
109b	2 schools	-
110	(HOS) - 16538 2 schools	16538
111	(PSPS) - 11400 2 schools	11400
112	(R3) - 3650	3650
113	(E) - 2 schools	-
115	(R3) - 2650	2650
116	(E) - 2 schools	-
	Population in TSW RZ	**122714**

Source: - Appendix H - Sewage Flows Inventory and Build-up: *Final Investigation Report*, BCL, 3/97: Ref: 0018/ENG/R17.2
- Proposed changes to Public Housing Developments - December 1996

3.5.4 Ultimately, the whole TSW (DZ and RZ) is expected to have a population of around 325,000.

3.6 Water Bodies

3.6.1 The water bodies upstream, downstream and within the study area are described and discussed in detail in Section 7: Water. Potential impacts as well as cumulative effects on these sensitive water bodies are assessed. The major water bodies considered sensitive with respect to the Project are:

(i) the Western Drainage Channel (WDC);

(ii) the tributary nullahs to the WDC (including the Shek Po Tsuen, the Kau Lee Uk Tsuen, the Ha Tsuen Shi and the Fung Kong Tsuen);

(iii) the Western Outfall to Inner Deep Bay;

(iv) the Eastern and Western Temporary Channels (WTC);

(v) the tributary culverts to the Eastern Temporary Channel (ETC);

(vi) the Eastern Outfall;

(vii) fishponds and associated wetlands and marshes;

(viii) Inner & Outer Deep Bay;

(ix) Old Western River; and

(x) Groundwater.

3.7 Ecological Receivers

3.7.1 Inner Deep Bay was designated as a Ramsar site in September 1995. The Ramsar site boundary shown on Figure 3.13 is currently being aligned and mapped in great detail by AFD. The final alignment may not overlap with the RZ boundary.

3.7.2 Areas recognised as having ecological value were presented in Figure 7.3 of the *Preparation of Layout Plans for Tin Shui Wai Reserve Zone* produced by Shankland Cox Limited (1995). This figure is reproduced here as Figure 3.13. Of primary importance are the SSSIs of Tsim Bei Tsui Egretry, Tsim Bei Tsui mangrove and Inner Deep Bay. The area adjacent to the study area includes Mai Po Marshes SSSI. Buffer Zones (1 and 2) have been implemented in order to protect the Bay from encroaching development. In addition, the OZPs and the Concept Plan for the area has proposed that Conservation Areas (CA), areas of Proposed Open Space, and Green Belt (GB) will provide extra protection to the ecologically sensitive area north of the RZ.

3.7.3 Figure 3.13 could be misleading as it does not emphasize the size and nature of the Inner Deep Bay SSSI. This SSSI is a mixture of mudflat and marine habitat and is of particular ecological concern. The *Deep Bay Guidelines for Dredging, Reclamation and Drainage Works (DBG)*, produced by ERL (Asia) Ltd in association with Binnie Consultants Ltd for EPD in the late 80s and finalised in 1991, gave special guidelines for the protection of this valuable area. The DBG Special Measures Zone boundary is almost identical to the current Buffer Zone 2 boundary in the vicinity of Tin Shui Wai. The DBG is now out-dated in some respects but the spirit behind the DBG and much of the mitigation suggested should be implemented as far as is practicable. The area contained within the Buffer Zone 2 boundary coincides with the Special Measures Zone boundary of the DBG in the Tin Shui Wai Area.

3.8 Representative Sensitive Receivers (RSRs)

3.8.1 RSRs have been identified from the current and future sensitive receivers (Figures 3.14 and 3.15). The RSRs will be used in the assessment of construction noise and dust as well as operational noise and air quality in this EIA report. Each RSR was selected depending on its proximity to the impact and its occupancy status.

3.8.2 Table 3.7 lists the RSRs identified.

Table 3.7
Representative Sensitive Receivers

SR	Existing, Known future, Unknown future*	General Description	No. of Storeys	Ground Level mPD	Estimated No. of Affected Dwellings/ Classrooms
1	E	village house at Mong Tseng Tsuen	2	5	1
2	E	Mong Tseng Public Shung Yee School at Mong Tseng Wai	1	5	14[a]
3	E	Special Measure Zone (SMZ)	0	3	nesting for birds
4	K	zoned R3 residential development at Area 112	N/A	5	N/A
5	K	zoned educational institution at Area 113a	7	5	30
6	K	zoned R3 residential development at Area 112	N/A	5	N/A
7	K	zoned R3 residential development at Area 115	N/A	5	N/A
8	K	zoned educational institution at Area 116a	7	5	30
9	K	zoned R3 residential development at Area 115	N/A	5	N/A
10	K	HOS residential block at Area 110	40	4.8	320
11	K	primary school at Area 110	7	4.8	30
12	K	secondary school at Area 110	7	4.8	30
13	K	HOS residential block at Area 110	40	4.8	320
14	K	HOS residential block at Area 110	40	4.8	320
15	K	HOS residential block at Area 110	40	4.8	320
16	K	PSPS residential block at Area 111	40	5.1	320
17	K	PSPS residential block at Area 111	40	5.1	320
18	K	PSPS residential block at Area 111	40	5.1	320
19	K	primary school at Area 105	7	5	30
20	K	harmony type residential block at Area 105	40	5	640

SR	Existing, Known future, Unknown future*	General Description	No. of Storeys	Ground Level mPD	Estimated No. of Affected Dwellings/ Classrooms
21	K	harmony type residential block at Area 105	40	5	640
22	K	harmony type residential block at Area 105	40	5	640
23	K	HOS residential block at Area 106 (Jul 96 layout)	40	5.3	320
24	K	HOS residential block at Area 106 (Jul 96 layout)	40	5.3	320
25	K	secondary school at Area 106** (Jul 96 layout)	7	5.3	30
26	E	no. 202B Sha Kong Wai	3	7.1	1
27	E	no. 17 Sha Kong Wai Tsai	3	5.7	1
28	U	zoned R(C) in S/YL-LFS/1 OZP	max. 3	3	N/A
29	K	secondary school at Area 101	7	5.1	30
30	K	primary school at Area 101	7	5.1	30
31	K	PSPS residential block at Area 101	40	5.1	320
32	K	PSPS residential block at Area 101	40	5.1	320
33	K	PSPS residential block at Area 101	40	5.1	320
34	K	reserved school site at Area 102 (Jul 96 layout)	7	5.6	30
35	K	HOS residential block at Area 102 (Jul 96 layout)	40	5.6	320
36	K	HOS residential block at Area 102 (Jul 96 layout)	40	5.6	320
37	K	HOS residential block at Area 102 (Jul 96 layout)	40	5.6	320
38	K	reserved school site at Area 102 (Jul 96 layout)	7	5.6	30
39	K	HOS residential block at Area 102 (Jul 96 layout)	40	5.6	320
40	K	harmony type residential block at Area 102 (Jul 96 layout)	40	5.6	640
41	K	harmony type residential block at Area 102 (Jul 96 layout)	40	5.6	640
42	K	zoned sandwich class residential development at Area 103	N/A	5.6	N/A
43	K	zoned sandwich class residential development at Area 103	N/A	5.6	N/A
44	K	zoned sandwich class residential development at Area 103	N/A	5.6	N/A

SR	Existing, Known future, Unknown future*	General Description	No. of Storeys	Ground Level mPD	Estimated No. of Affected Dwellings/ Classrooms
45	K	zoned R(2) residential development at Area 104	N/A	5.4	N/A
46	K	zoned R(2) residential development at Area 104	N/A	5.4	N/A
47	K	zoned R(2) residential development at Area 104	N/A	5.4	N/A
48	U	zoned CDA in S/YL-HT/1 OZP	max. 3	5	N/A
49	K	single aspect block at Area 30	22	6.5	321
50	K	block 1, harmony type residential block at Area 30	41	6.5	640
51	K	block 6, housing for senior citizen at 4,5,6/F on top of carpark at Area 30	3	6.5	198[b]
52	K	block 4, harmony type residential block at Area 30	41	6.5	640
53	K	primary school at Area 30	7	6.5	30
54	K	HOS residential block at Area 31	40	6.5	320
55	K	HOS harmony type residential block at Area 31	40	6.5	640
56	K	HOS harmony type residential block at Area 31	40	6.5	640
57	K	primary school at Area 31	7	6.5	30
58	K	HOS residential block at Area 31	40	6.5	320
59	K	primary school at Area 31	7	6.5	30
60	K	HOS residential block at Area 31	40	6.5	320
61	K	secondary school at Area 31	7	6.5	30
62	K	HOS residential block at Area 31	40	6.5	320
63	K	HOS residential block at Area 31	40	6.5	320
64	E	block 10, Lynwood Court, Kingswood Villas	38	6.5	304
65	K	Maywood Court, Kingswood Villas	38	6.5	304
66	E	block 1, Kenswood Court, Kingswood Villas	38	6.5	304
67	U	proposed residential development on LRT depot at Area 33	N/A	6.5	N/A
68	E	Shui Lung House, Tin Shui Estate	40	6.5	640
69	E	village house at Ha Mei San Tsuen	3	3.1	1
70	U	zoned CDA in S/YL-HT/1 OZP	max. 3	4	N/A
71	E	Oi Tao House, Tin Oi Court	40	6.5	640
72	E	Ho Ming Primary School	7	6.5	30

SR	Existing, Known future, Unknown future*	General Description	No. of Storeys	Ground Level mPD	Estimated No. of Affected Dwellings/ Classrooms
73	K	block 7, HOS residential block at Area 3	40	6.5	320
74	K	block 1, HOS residential block at Area 3	40	6.5	320
75	K	block 12, HOS residential block at Area 3	40	6.5	320
76	K	primary school at Area 3	7	6.5	30
77	K	block 14, HOS harmony type residential block at Area 3	40	6.5	640
78	K	block 16, HOS harmony type residential block at Area 3	40	6.5	640
79	K	primary school at Area 3	7	6.5	30
80	K	secondary school at Area 3	7	6.5	30
81	E	Queen Elizabeth Old Students' Association primary school	7	6.5	30
82	E	Yau Hong House, Tin Yau Court	40	6.5	640
83	E	block 3, harmony residential block at Area 13	40	6.5	640
84	E	Fong Yun Wah Primary School	7	6.5	30
85	E	Greenery Elderly Home at Tung Tau Tsuen	3	4.5	147[c]
86	E	block 7, Kenswood Court, Kingswood Villas	38	6.5	304
87	K	block 5, HOS residential block at Area 3	40	6.5	320
88	K	housing for senior citizen at 3, 4, 5/F on top of carpark at Area 102 (Jul 96 layout)	3	5.6	198[b]
89	E	TWGH's Kwok Yat Wai Prevocational School	6	3.5	N/A
90	E	village house along eastern side of Long Tin Road	1	4.5	1
91	K	block 2, Tin Tsz Estate (Area 13)	40	6.5	640
92	K	block 4, Tin Tsz Estate (Area 13)	40	6.5	640
93	K	block 4A, Tin Tsz Estate (Area 13)	14	6.5	N/A
94	K	block 3A, Tin Tsz Estate (Area 13)	14	6.5	N/A
95	E	village house along eastern side of Long Tin Road	1	6.2	1
96	E	village house along western side of Long Tin Road	2	10.4	1

SR	Existing, Known future, Unknown future*	General Description	No. of Storeys	Ground Level mPD	Estimated No. of Affected Dwellings/ Classrooms
97	E	village house in Ping Shan (south of Tin Fuk Road)	2	3.2	1
98	F	zoned village type development along eastern side of Ping Ha Road near Sheung Cheung Wai Pumping Station	3	3.5	N/A
99	E	village house at Hung Uk Tsuen along eastern side of Hung Tin Road	2	5	1
100	E	village house at Shek Po Tsuen along western side of Hung Tin Road	3	5	1
101	E	village house at Shek Po Tsuen along western side of Hung Tin Road	1	5.1	1
102	E	village house at Hung Uk Tsuen along eastern side of Hung Tin Road	1	5	1
103	E	block 8, Kenswood Court, Kingswood Villas	38	6.5	304
104	K	harmony type residential block at Area 105	40	5	640
105	K	housing for senior citizen at Area 105	N/A	5	N/A
106	K	HOS residential block at Area 106 (Jul 96 layout)	40	5.3	320
107	U	zoned C/R at Area 108a	N/A	5.8	N/A
108	U	zoned C/R at Area 108b	N/A	5.8	N/A
109	U	zoned G/IC at Area 109	N/A	5.6	N/A
110	U	zoned G/IC at Area 109	N/A	5.6	N/A
111	U	zoned G/IC at Area 109	N/A	5.6	N/A
112	will not be used				
113	U	zoned G/IC at Area 121	N/A	5.5	N/A
114	U	zoned village type development at Shek Po Tsuen along western side of Hung Tin Road	max. 3	3.5	1
115	E	Yiu Foo House, Tin Yiu Estate	40	6.5	480
116	E	Hong Kong Management Association K.C. Lo College	7	6.5	30
117	E	Tin Shui Wai Catholic Primary School	7	6.5	30
118	E	Ju Ching Chu Secondary School (Yuen Long)	7	6.5	30
119	E	Village house in Lo Uk Tsuen along Ping Ha Road	3	3.5	1
120	U	zoned R(A)3 in S/YL-PS/1 OZP along Hung Tin Road	max. 19	7.7	N/A

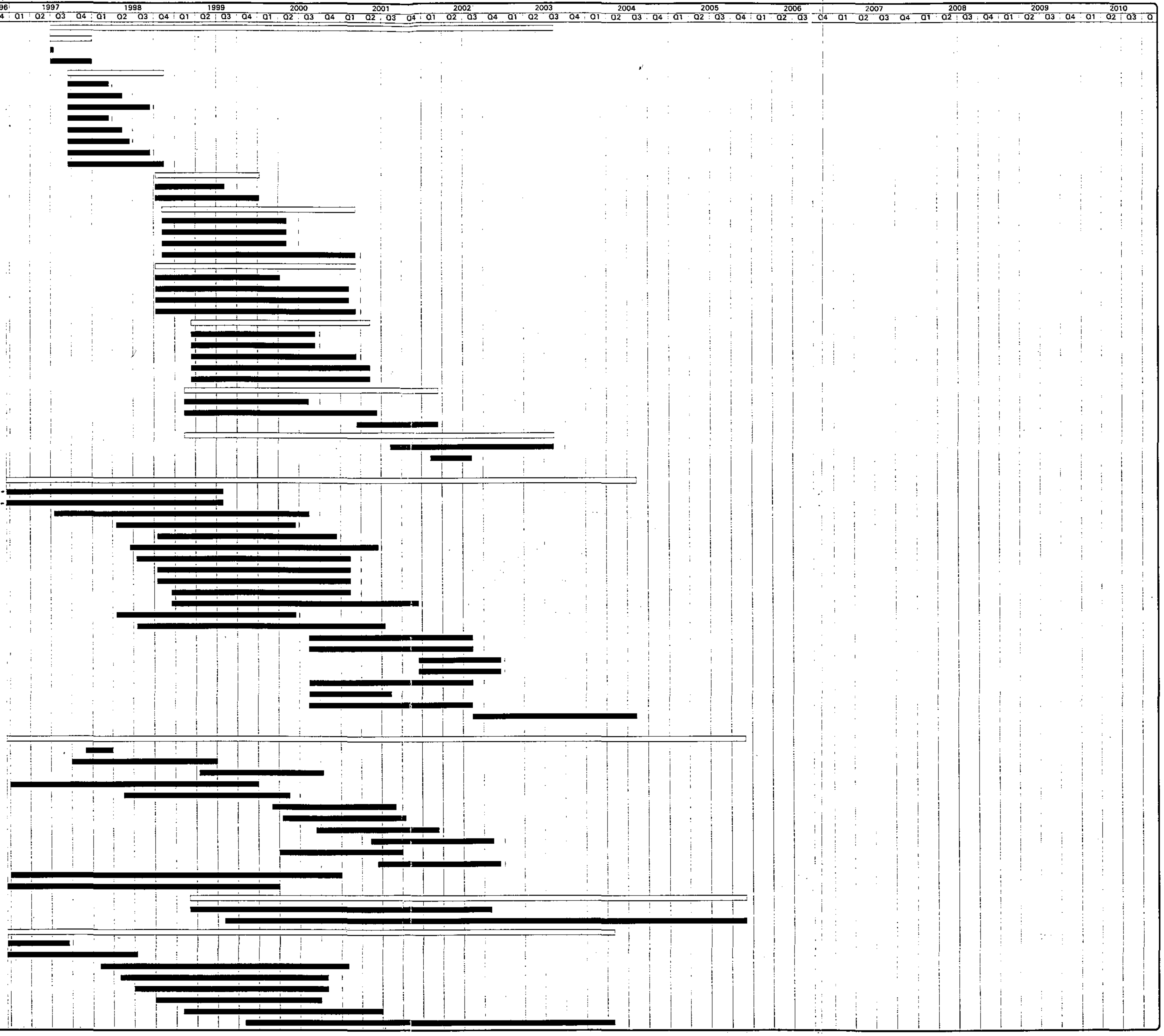
SR	Existing, Known future, Unknown future*	General Description	No. of Storeys	Ground Level mPD	Estimated No. of Affected Dwellings/ Classrooms
121	U	zoned CDA in S/YL-PS/1 OZP along Hung Tin Road	max. 20	10.0	N/A
122	U	zoned CDA in S/YL-PS/1 OZP along Long Tin Road	max. 4	5.5	N/A
123	E	village house in Chun Hing San Tsuen	1	5.0	1
124	E	village house in Chun Hing San Tsuen	3	5.0	3
125	E	village house in Tong Fong Tsuen along Ping Ha Road	3	5.6	1
126	E	village house in Hang Mei Tsuen along Ping Ha Road	2	9.0	1
127	E	Block 1, Locwood Court, Kingswood Villas	38	6.5	304
128	E	The Chinese University of Hong Kong, Federation of Alumni Association, Thomas Cheung Secondary School	7	6.5	30
129	E	Tin Shui Wai Government Primary School	7	6.5	30
130	E	Block 1, Chestwood Court, Kingswood Villas	38	6.5	304
131	E	Block 1, Sherwood Court, Kingswood Villas	38	6.5	304
132	E	Block 1, Lynwood Court, Kingswood Villas	38	6.5	304
133	E	Yiu Shing House, Tin Yiu Estate	40	6.5	720
134	E	Yiu Fung House, Tin Yiu Estate	40	6.5	720
135	E	Yiu Man House, Tin Yiu Estate	40	6.5	960
136	E	Block 14, Kenswood Court, Kingswood Villas	38	6.5	304
137	K	Maywood Court, Kingswood Villas	38	6.5	304
138	E	Block 6, Chestwood court, Kingswood Villas	38	6.5	304
139	E	Shui Shing House, Tin Shui Estate	40	6.5	640
140	K	HOS residential block at Area 3	40	6.5	320
141	K	HOS residential block at Area 3	40	6.5	320
142	K	HOS residential block at Area 3	40	6.5	320
150	K	Proposed HOS residential block at Area 102 (Dec 96 layout)	40	5.6	320
151	K	Proposed HOS residential block at Area 102 (Dec 96 layout)	40	5.6	320
152	K	Proposed HOS residential block at Area 102 (Dec 96 layout)	40	5.6	320

SR	Existing, Known, future, Unknown future*	General Description	No. of Storeys	Ground Level mPD	Estimated No. of Affected Dwellings/ Classrooms
153	K	Proposed HOS residential block at Area 102 (Dec 96 layout)	40	5.6	320
154	K	Proposed HOS residential block at Area 102 (Dec 96 layout)	40	5.6	640
155	K	Proposed HOS residential block at Area 102 (Dec 96 layout)	40	5.6	640
156	K	Proposed HOS residential block at Area 102 (Dec 96 layout)	40	5.6	640
157	K	Proposed HOS residential block at Area 102 (Dec 96 layout)	40	5.6	320
158	K	Proposed HOS residential block at Area 102 (Dec 96 layout)	40	5.6	320
159	K	Proposed multi-function building at Area 102, day nursery at 1/F, kindergarten at 2/F and 3/F and housing for senior citizen at 4/F, 5/F & 6/F (Dec 96 layout)	6	5.6	N/A
160	K	Proposed HOS residential block at Area 106 (Dec 96 layout)	40	5.3	320
161	K	Proposed HOS residential block at Area 106 (Dec 96 layout)	40	5.3	320
162	K	Proposed HOS residential block at Area 106 (Dec 96 layout)	40	5.3	320
163	K	Proposed HOS residential block at Area 106 (Dec 96 layout)	40	5.3	320
164	K	Proposed HOS residential block at Area 106 (Dec 96 layout)	40	5.3	320
165	K	Mui Fat Buddhist Monastery Chan Lui Chung Tak Memorial College	7	6.5	30

HOS Home Ownership Scheme
PSPS Private Sector Participatory Scheme
OZP Outline Zoning Plan
CDA Comprehensive Development Area
* known future sensitive receiver denotes planned development with or without detailed layout/information
unknown future sensitive receiver denotes area zoned for development but without detailed layout/information
N/A details not available
a 10 students and 4 staffs
b bedspaces for senior citizens
c a total of 119 elderly and 28 staff for all 5 blocks
C/R Commercial/Residential
G/IC Government/Institution/Community
** The secondary school previously proposed in Area 106 has now been relocated to Area 111, in order to accommodate the LRT terminus.

Figure 2.38 Programme for Works and Concurrent Projects (based on Recommended Implementation Programme - version 2.2)

Task Name	Duration
CONSTRUCTION WORKS UNDER EIA STAGE III ASSESSMENT	**73.36 m**
Contract 1	6.00 m
I - Initial Site Formation	0.50 m
II - Remaining Site Formation	6.00 m
Contract 2	14.00 m
I - Site Formation for Area 103	6.00 m
II - Site Formation for Area 109a	8.00 m
III - Site Formation for Area 104	12.00 m
IV - Remaining Works - Site Formation for Area 108a	6.00 m
V - Remaining Works - Site Formation for Areas 107a, 109a	8.00 m
VI - Remaining Works - Site Formation for Areas 101, 107b, 108b, 111a	9.00 m
VII - Remaining Works - Site Formation for Areas 105, 106	12.00 m
VIII - Remaining Works - Site Formation for Areas 110, 111b	14.00 m
Contract 3	15.00 m
I - Junction Improvement in DZ - (Tin Yiu & Tin Shui Rd & Drainage Connection)	10.00 m
II - Junction Improvement in DZ - (Remaining Works)	15.00 m
Contract 4	28.00 m
I - Sewage Pumping Station & Rising Main	18.00 m
II - Road L12(S), L13 (E), L14	18.00 m
III - LRT Outer Loop Portion A & D	18.00 m
IV - Tin Wah Rd & Tin Tsz Rd Dualling	28.00 m
Contract 5	29.00 m
I - Grade Separation of Junction W (P2/1402)	18.00 m
II -Grade Separation of Junction D & Long Tin Rd Widening	28.00 m
III - LRT Express Line (DZ)	28.00 m
IV - Grade Separation of Junction A & Hung Tin Road Widening	29.00 m
Contract 6	26.00 m
I - Road L12(N)	18.00 m
II - LRT Central Loop Western Leg	18.00 m
III - Tin Ying Road Dualling	24.00 m
IV - Road D4(N)	26.00 m
V - Western Drainage Channel Extension (WDCE)	26.00 m
Contract 7	36.99 m
I - Site Formation of Areas 109b, 112-117, 120	18.00 m
II - Road D4(S), Bridges P1/V3	28.00 m
III - Bridges P1/L1 & P1/L2	12.00 m
Contract 8	53.98 m
I - Road D3	24.00 m
II - Site Formation of Area 121	6.00 m
	0.00 m
CONCURRENT WORKS - BUILDING WORKS	***91.78 m***
Area 3	38.00 m
Areas 30, 31	43.00 m
Area 102	37.00 m
Area 103	26.00 m
Area 104	26.00 m
Area 109a	36.00 m
Areas 101, 111a	31.00 m
Area 105	28.00 m
Area 106	28.00 m
Area 111b	26.00 m
Area 110	36.00 m
Area 108a	26.00 m
Area 108b	36.00 m
Area 109b	24.00 m
Areas 117, 120	24.00 m
Area 107a	12.00 m
Area 107b	12.00 m
Areas 112, 113	24.00 m
Area 114	12.00 m
Areas 115, 116	24.00 m
Area 121	24.00 m
	0.00 m
OTHER CONCURRENT WORKS	***107.46 m***
Diversion of Existing CLP 132 kV Overhead Line	4.00 m
Tan Kwai Tsuen F/W S/R Phase I (WSD)	21.00 m
Tan Kwai Tsuen F/W S/R Phase II (WSD)	18.00 m
Substation 'B' at Area 32 (CLP)	36.00 m
Telephone Exchange in Area 109a (HKT)	24.00 m
LRT Outer Loop Portion A & D	18.00 m
LRT Outer Loop Portion C	18.00 m
Central Loop Western Leg	18.00 m
Outer Loop Portion B	18.00 m
LRT Express Line (DZ)	18.00 m
LRT Express Line (RZ)	18.00 m
West Rail Project --- (exact date to be confirmed)	48.00 m
Shenzhen River Training Project (all stages)	39.44 m
Yuen Long & Kam Tin Sewerage (Ref. DSD in PM 8/4157DS/26)	81.05 m
PWP 4157DS - Stage II (remainder)	44.07 m
PWP 4274DS - Stage III	76.03 m
Yuen Long, Kam Tin & Ngau Tam Mei - Main Drainage Channel	88.44 m
60CD, Contract B (Ref. ERM C1203\33818\CONSULT)	8.97 m
43CD	18.92 m
29CD, Phase 1	36.03 m
22CD, Phase 1	30.08 m
22CD, Phase 2	28.08 m
30CD, Pok Wai	24.04 m
30CD, Chuk Yuen/Ha San Wai	28.97 m
30CD, Mai Po Lo Wai/San Tsuen	53.99 m



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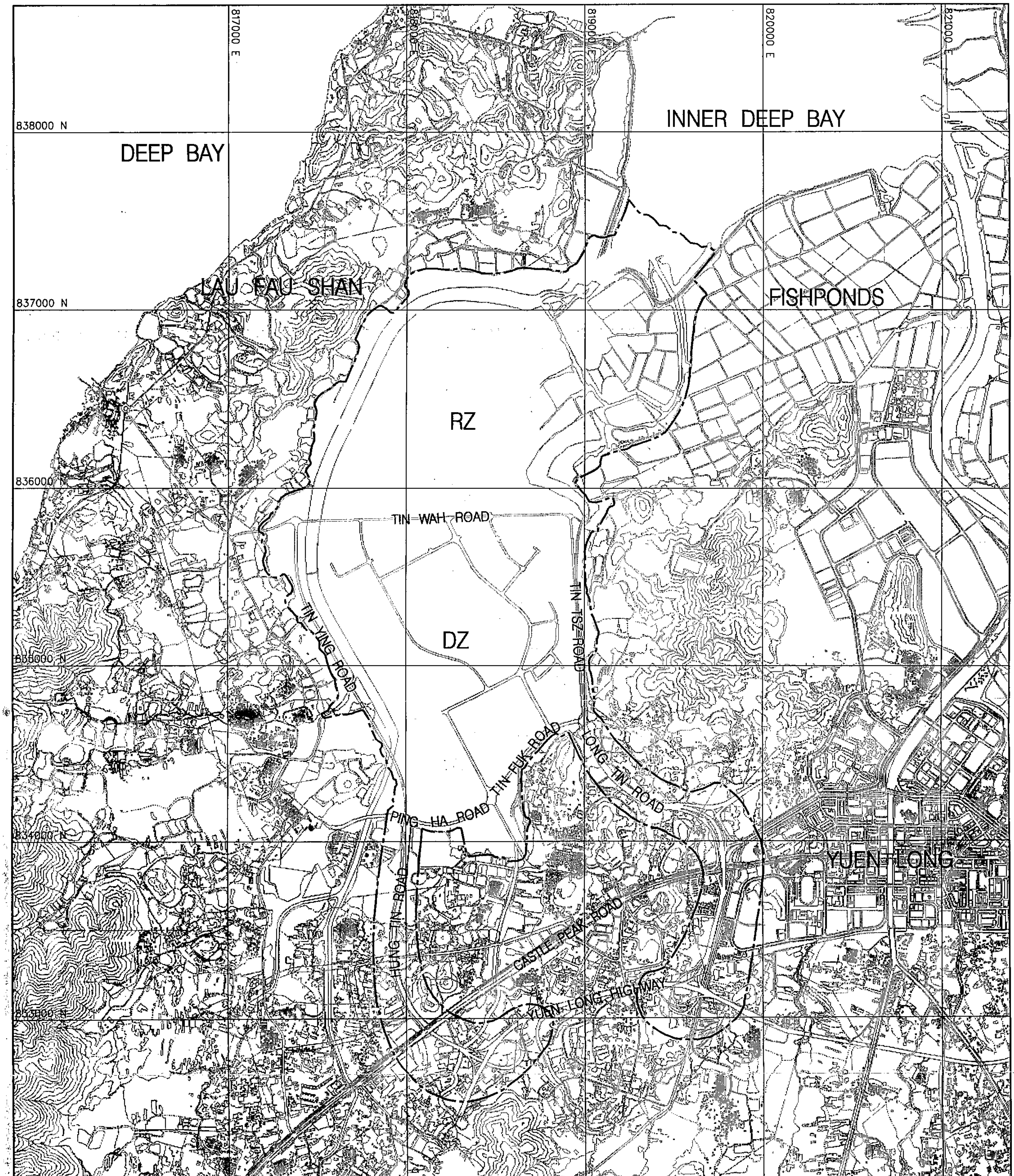
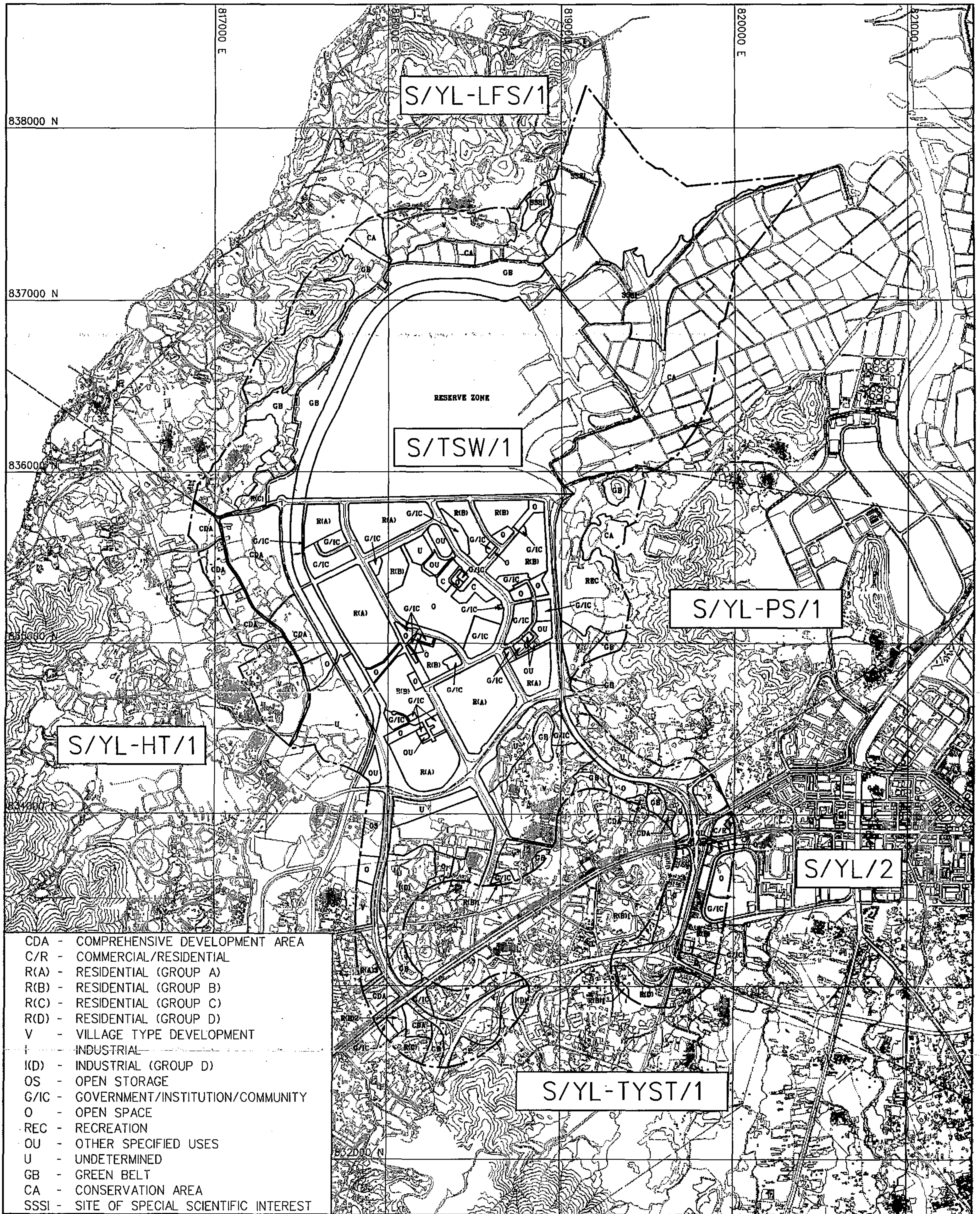
Page 1 Prepared by: MC

Milestone △ Summary
Fixed Delay



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : STUDY AREA (study area common to all EIA sub-studies)	Figure No. 3.1	Revision 0
		Reference TSW-BASE	File Name 00010018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
		Date NOV. 96	Scale 1 : 20000

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title :	Figure No. 3.2	Revision 1
	" study area " (study area specific to the noise sub-studies)	Reference TSW-BASE	File Name 02210018.C09
BINNIE CONSULTANTS LIMITED 賓尼 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS		Prepared MC	Checked PS
		Date DEC. 96	Scale 1 : 20000



CDA - COMPREHENSIVE DEVELOPMENT AREA
C/R - COMMERCIAL/RESIDENTIAL
R(A) - RESIDENTIAL (GROUP A)
R(B) - RESIDENTIAL (GROUP B)
R(C) - RESIDENTIAL (GROUP C)
R(D) - RESIDENTIAL (GROUP D)
V - VILLAGE TYPE DEVELOPMENT
~~I - INDUSTRIAL~~
I(D) - INDUSTRIAL (GROUP D)
OS - OPEN STORAGE
G/IC - GOVERNMENT/INSTITUTION/COMMUNITY
O - OPEN SPACE
REC - RECREATION
OU - OTHER SPECIFIED USES
U - UNDETERMINED
GB - GREEN BELT
CA - CONSERVATION AREA
SSSI - SITE OF SPECIAL SCIENTIFIC INTEREST

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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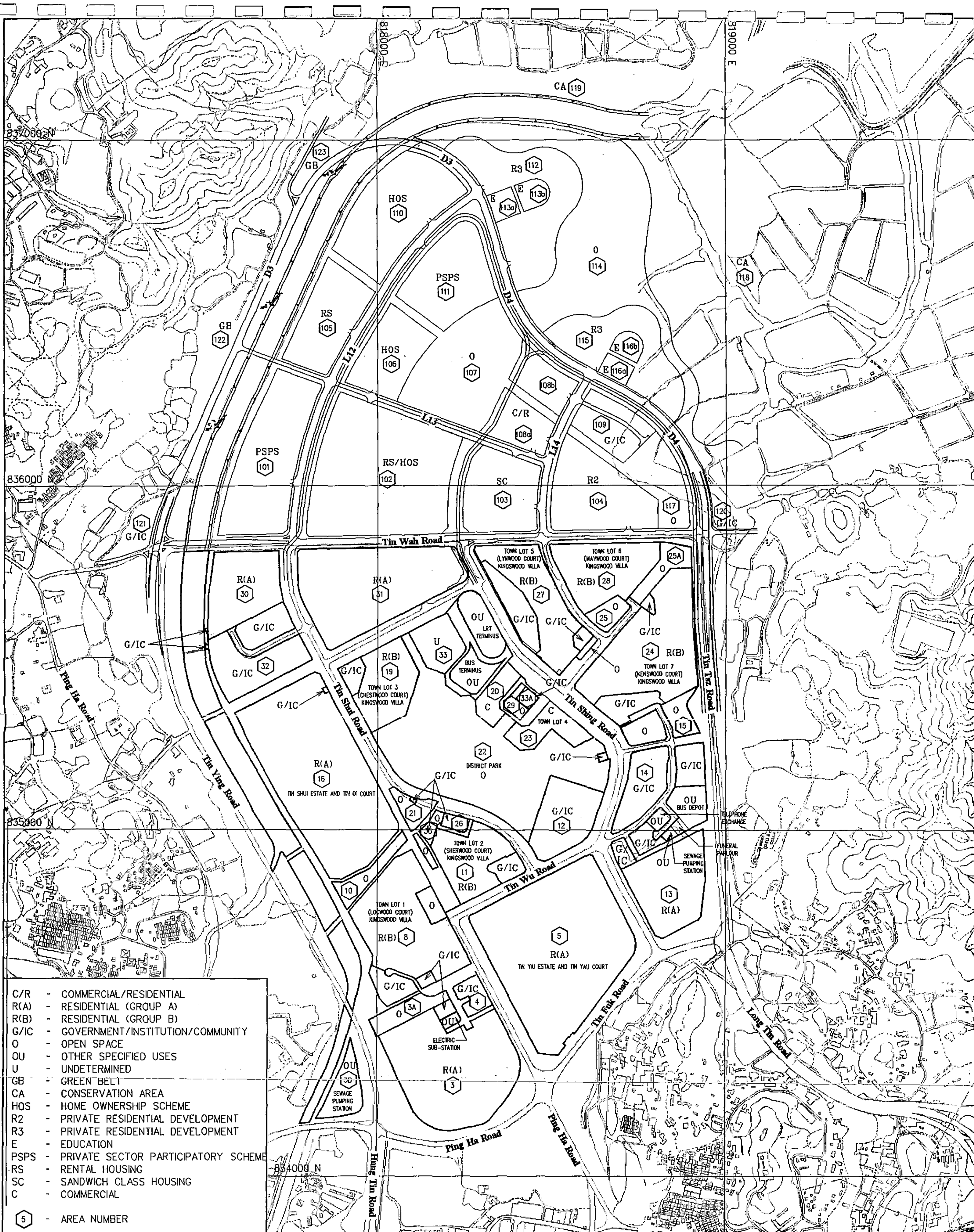
Title :

LAND USES FOR AREAS OUTSIDE RZ

Figure No. 3.3	Revision 3
Reference TSW-BASE	File Name 01050018.C09
Prepared MC	Checked PS
Date OCT. 96	Scale 1 : 20000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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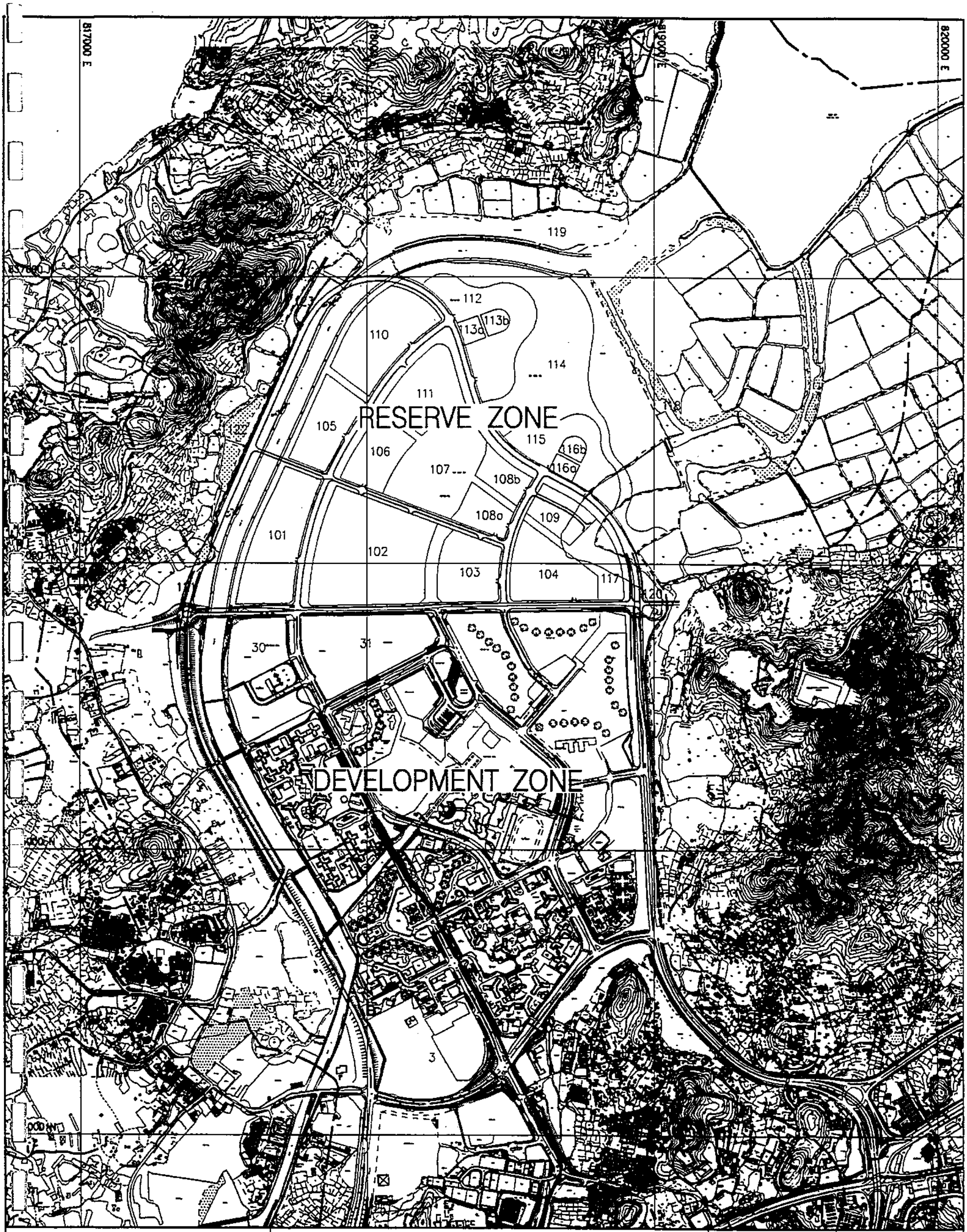
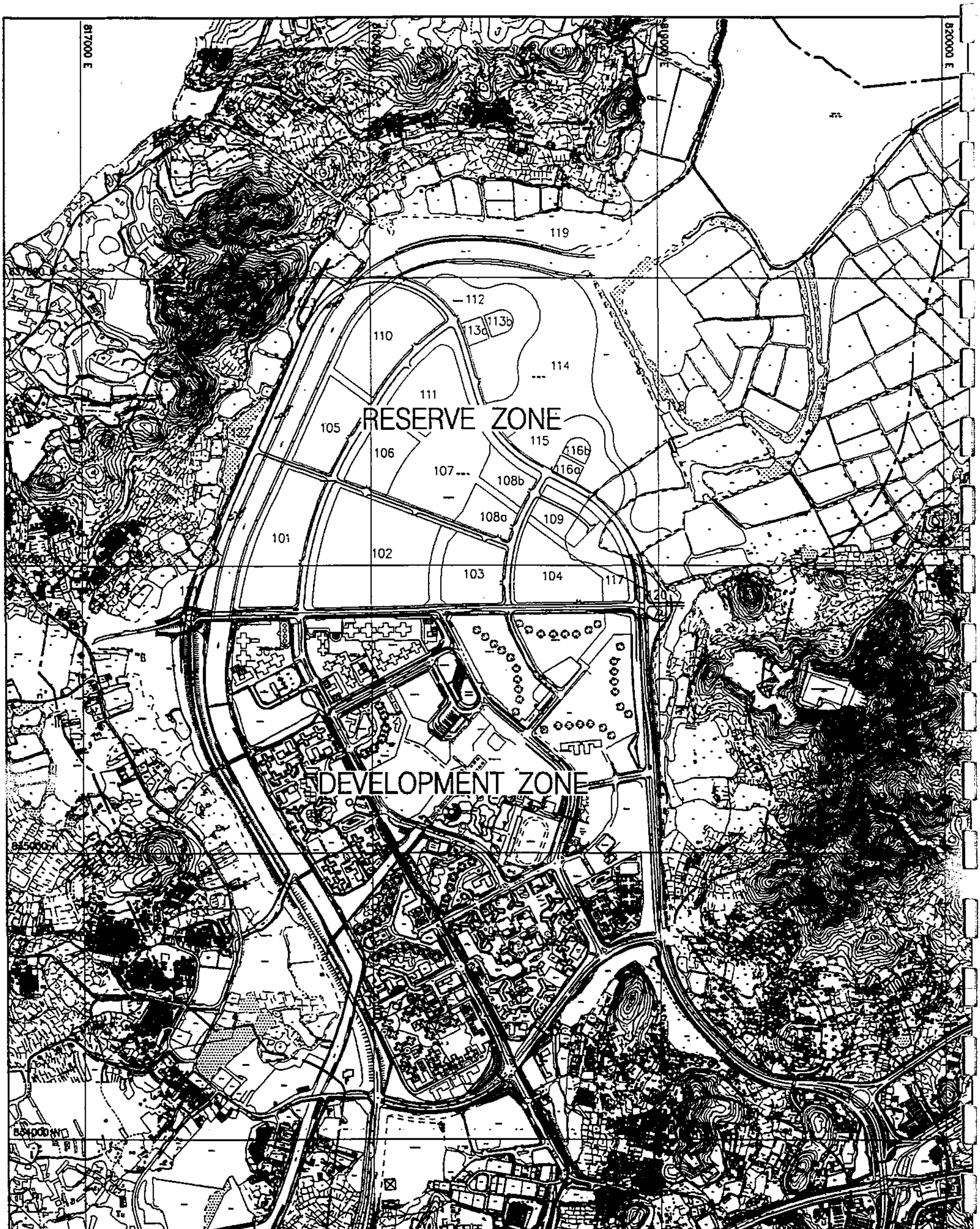
Title :

LAND USES FOR AREAS IN THE DZ AND RZ

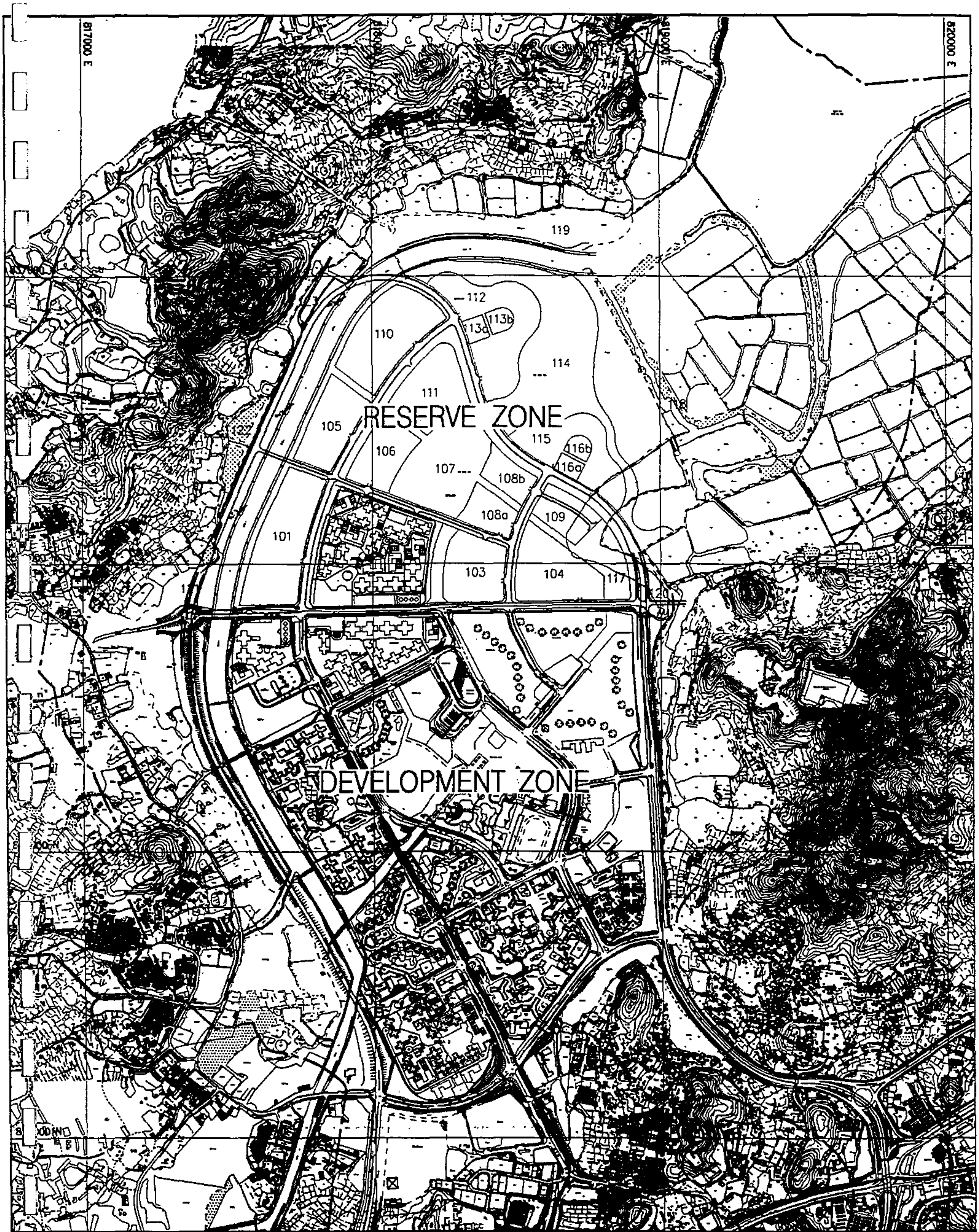
Figure No. 3.4	Revision 0
Reference TSW-BASE	File Name 02060018.C09
Prepared MC	Checked PS
Date NOV. 96	Scale 1 : 10000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title :	Figure No. 3.5	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	SENSITIVE RECEIVERS FROM 1st QUARTER OF YEAR 1999	Reference TSW-BASE	File Name 01770018.C09
		Prepared MC	Checked PS
		Date NOV. 96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SENSITIVE RECEIVERS FROM 3rd QUARTER OF YEAR 1999	Figure No. 3.6	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	Note : Housing layout from HD as of July 1996. [Occupation dates based on recommended implementation programme version 2.1]	Reference TSW-BASE	File Name 01780018.C09
		Prepared MC	Checked PS
		Date NOV. 96	Scale N.T.S.



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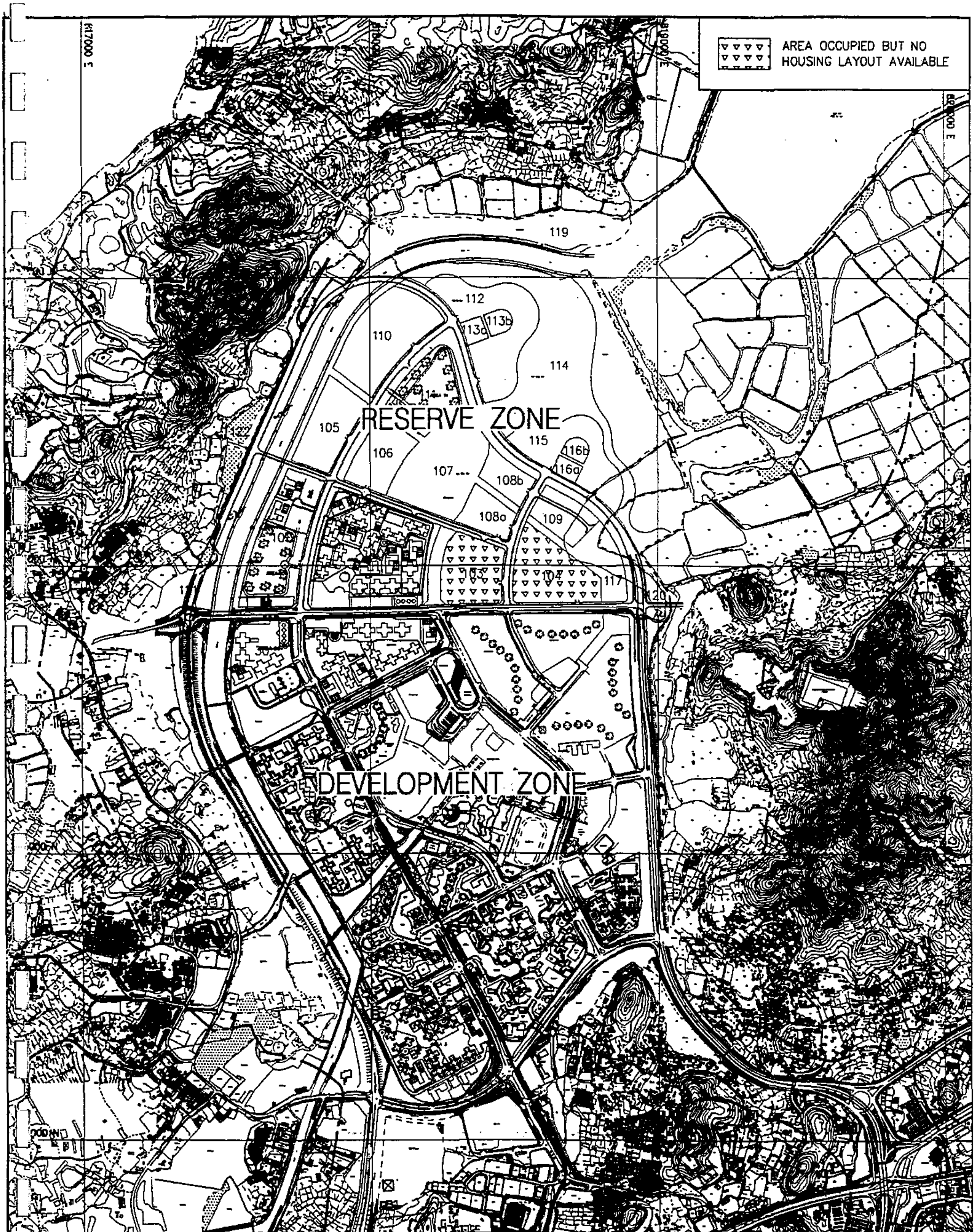
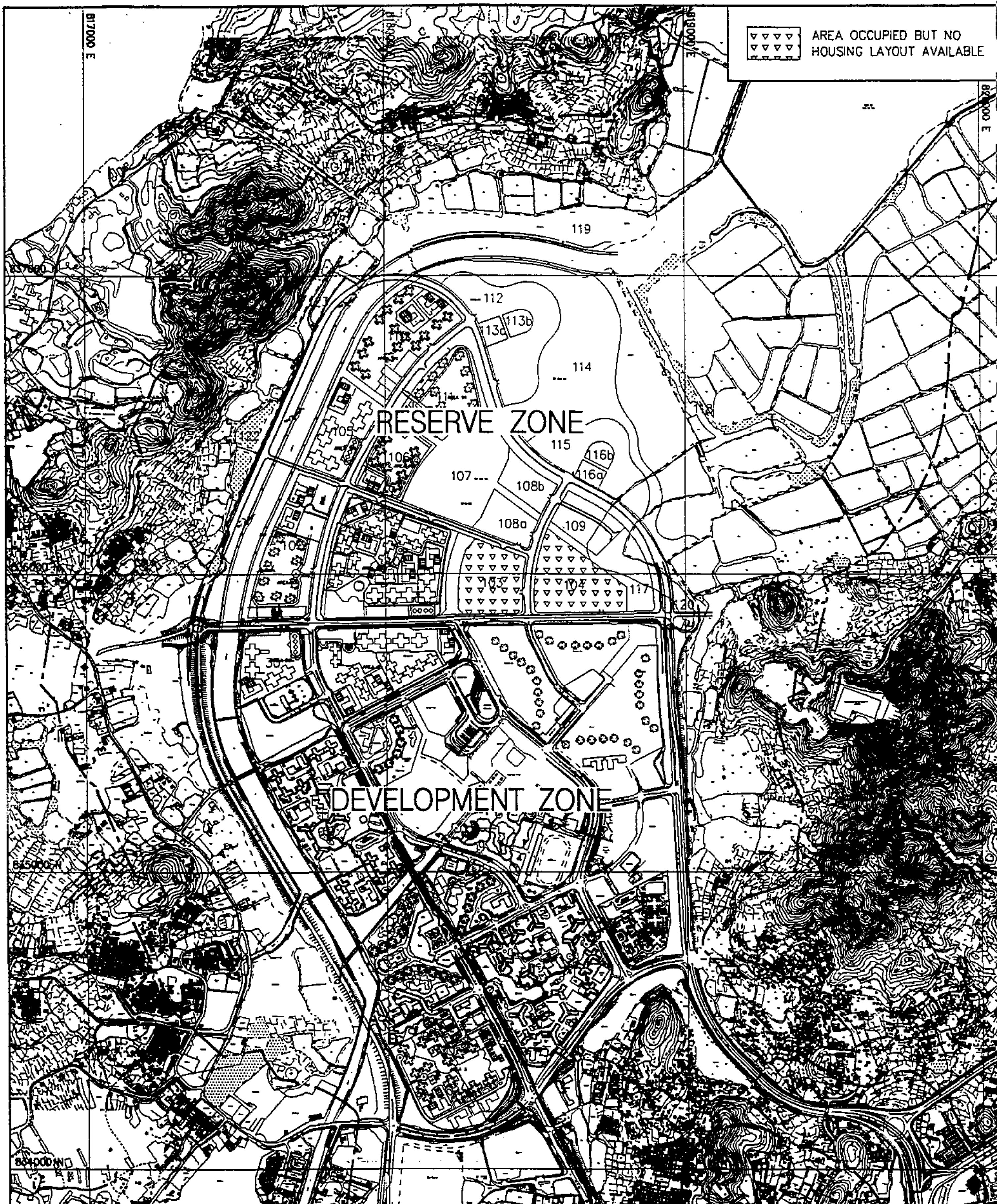
		Reference TSW-BASE	File Name 01790018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	Note : Housing layout from HD as of July 1996. [Occupation dates based on recommended implementation programme version 2.1]	Prepared MC	Checked PS
		Date NOV. 96	Scale N.T.S.

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SENSITIVE RECEIVERS FROM 1st QUARTER OF YEAR 2001	Figure No. 3.8	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	Note : Housing layout from HD as of July 1996. [Occupation dates based on recommended implementation programme version 2.1]	Reference TSW-BASE	File Name 01800018.C09
		Prepared MC	Checked PS
		Date NOV. 96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS	Title : SENSITIVE RECEIVERS FROM 3rd QUARTER OF YEAR 2001 Note : Housing layout from HD as of July 1996. [Occupation dates based on recommended implementation programme version 2.1]	Figure No. 3.9	Revision 0
		Reference TSW-BASE	File Name 01810018.C09
		Prepared MC	Checked PS
		Date NOV. 96	Scale N.T.S.



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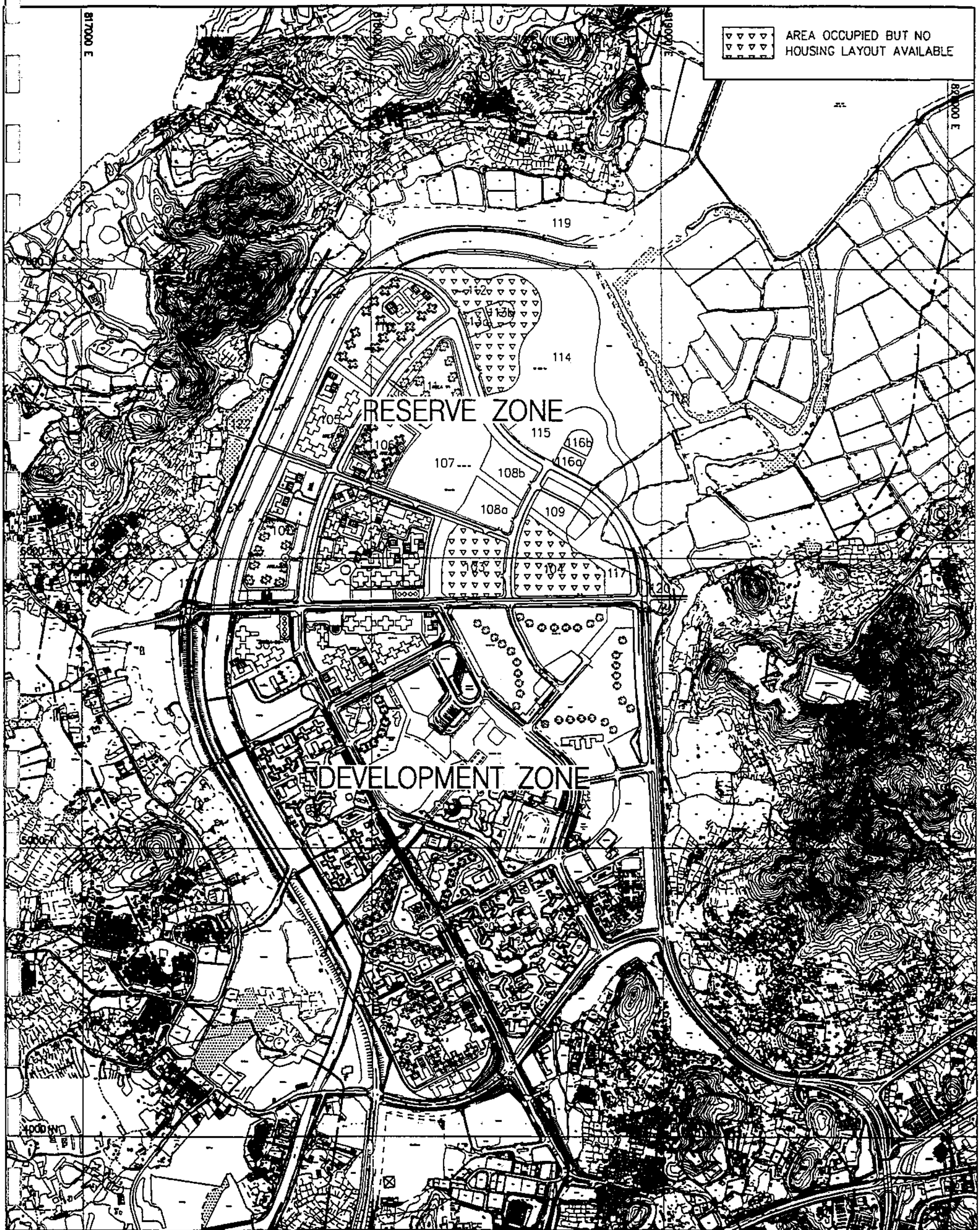
		Reference TSW-BASE	File Name 01820018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
	Note : Housing layout from HD as of July 1996. [Occupation dates based on recommended implementation programme version 2.1]	Date NOV. 96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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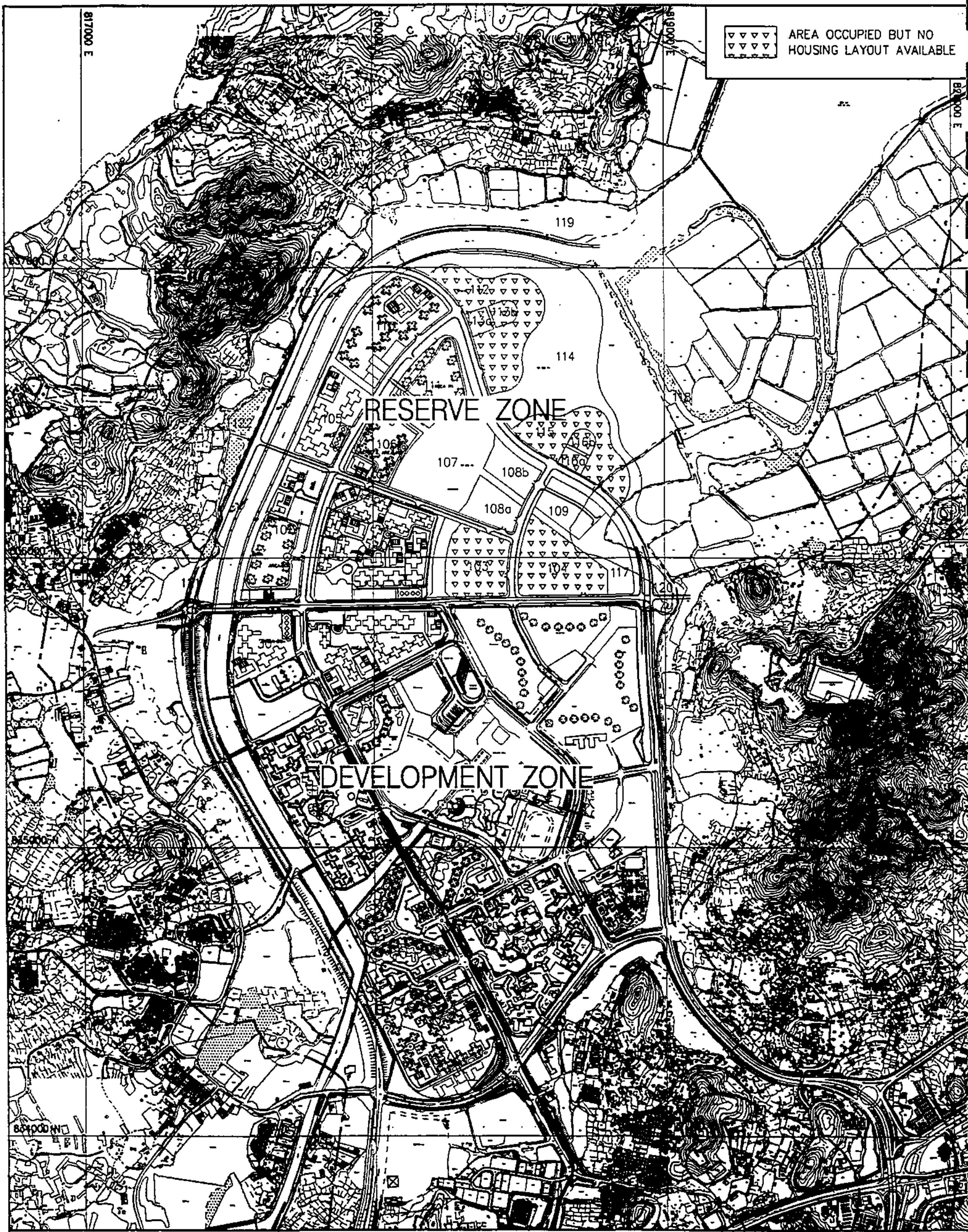
賓尼

Title :

SENSITIVE RECEIVERS FROM YEAR 2003

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No.	Revision
3.11	0
Reference	File Name
TSW-BASE	01830018.C09
Prepared	Checked
MC	PS
Date	Scale
NOV. 96	N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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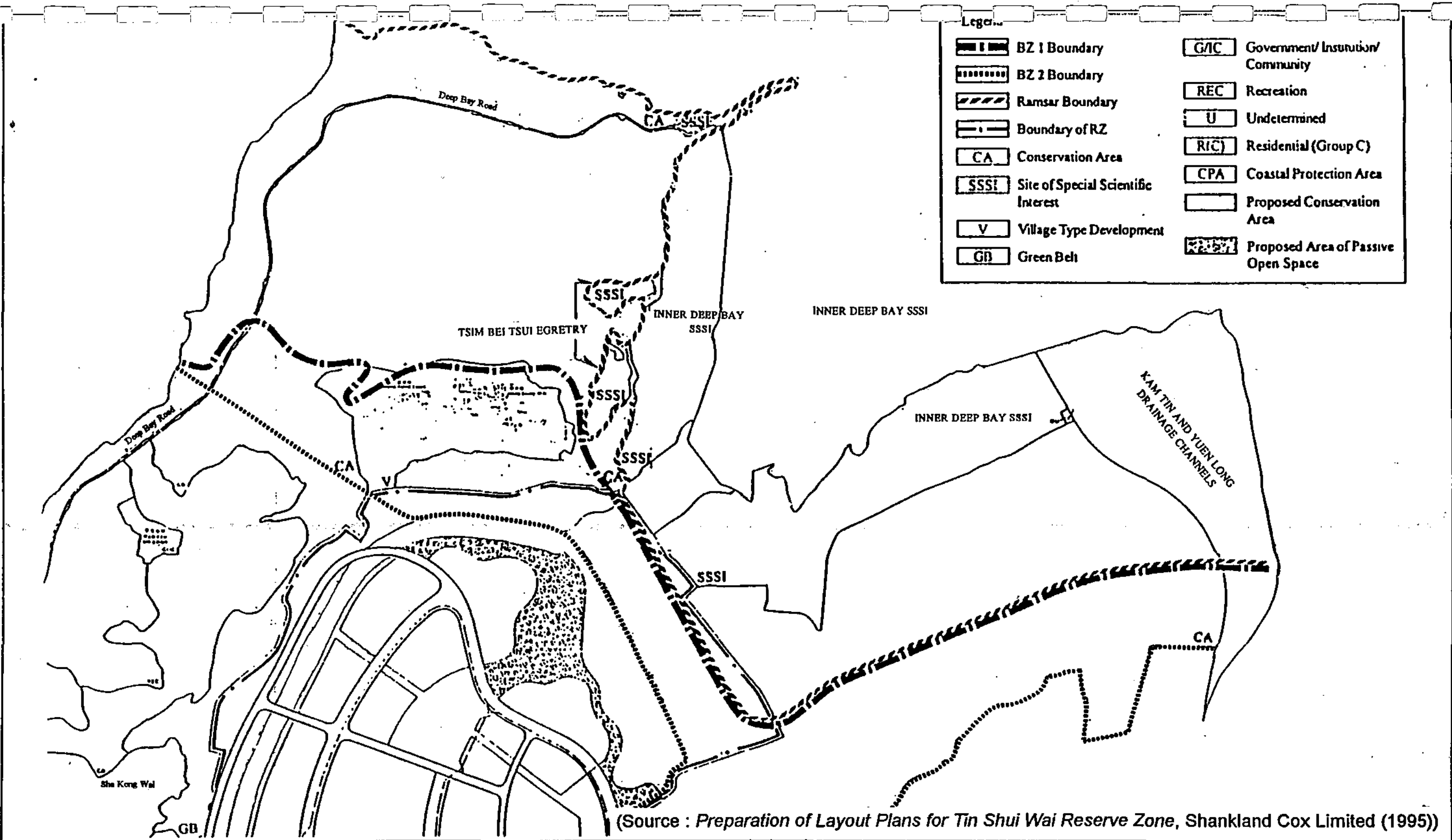
Title :

SENSITIVE RECEIVERS FROM YEAR 2004

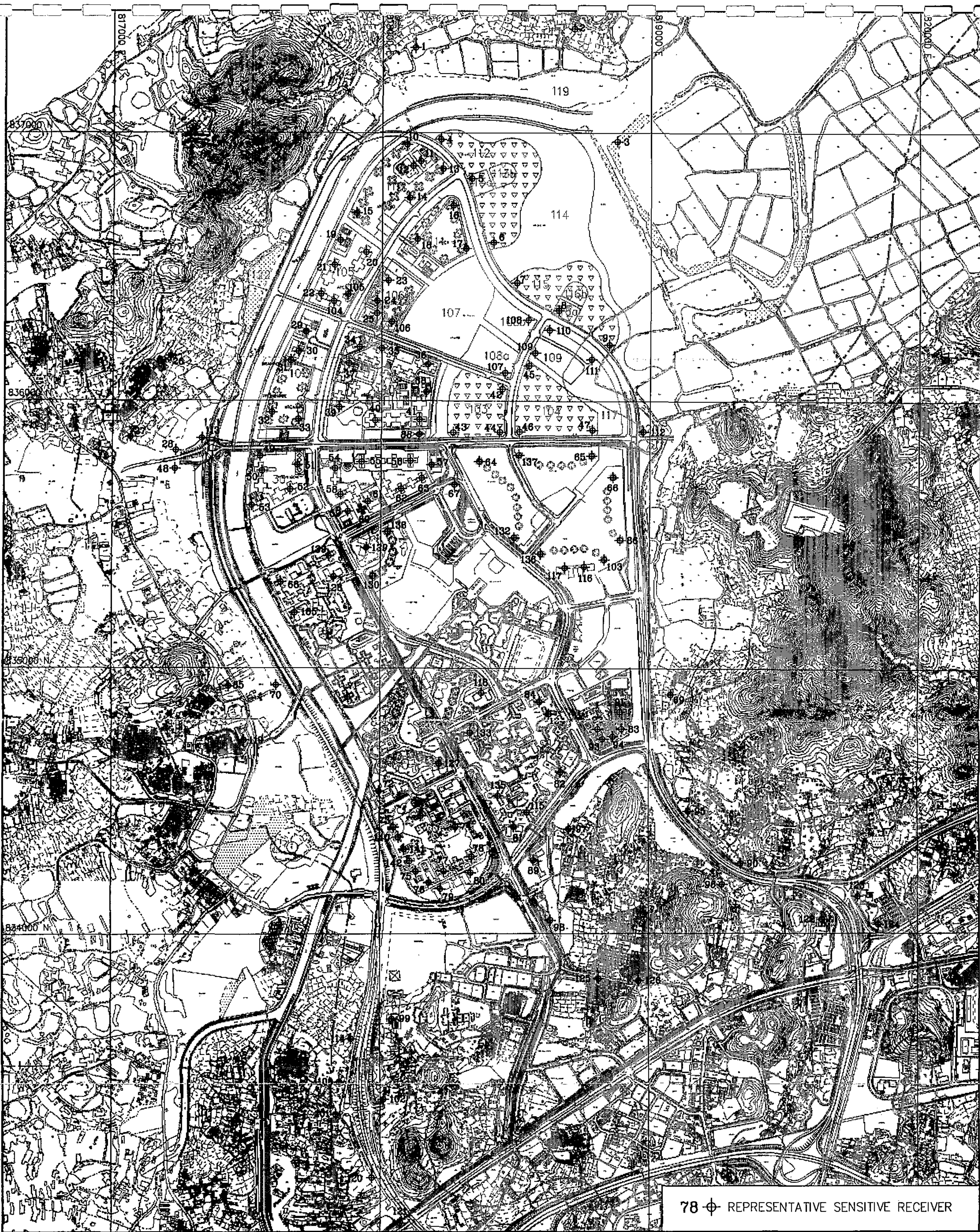
Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No. 3.12	Revision 0
Reference TSW-BASE	File Name 01840018.C09
Prepared MC	Checked PS
Date NOV. 96	Scale N.T.S.



(Source : *Preparation of Layout Plans for Tin Shui Wai Reserve Zone*, Shankland Cox Limited (1995))

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : CONSERVATION AREAS AND ECOLOGICALLY SENSITIVE SITES	Figure No. 3.13	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference No. SCS : FIG 6.3	File Name -
		Prepared SCS - MC	Checked PS
		Date MAY.96	Scale -



TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

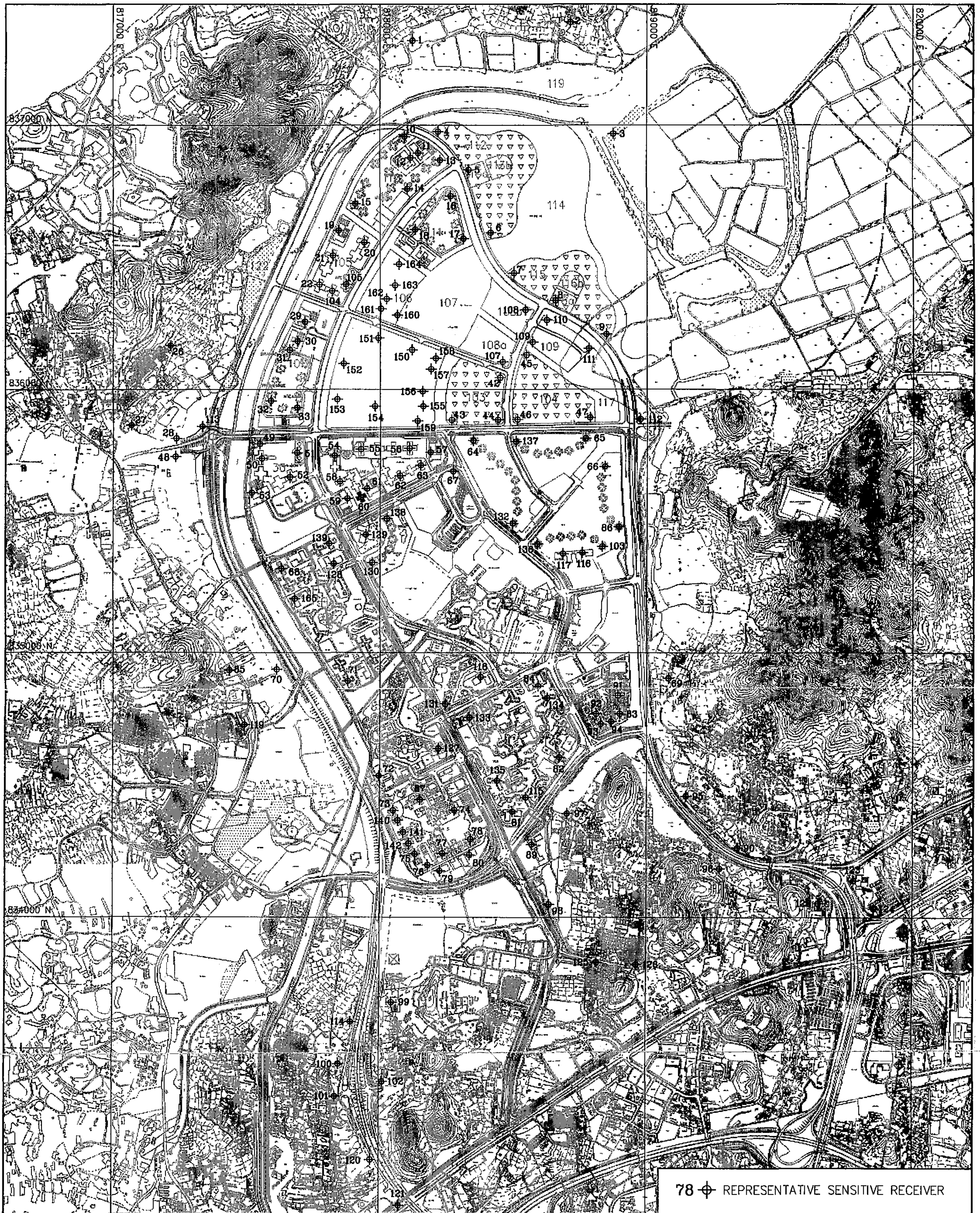
BINNIE CONSULTANTS LIMITED
賓尼工程顧問有限公司
ENGINEERS AND SCIENTISTS
賓尼

Title :

LOCATIONS OF REPRESENTATIVE SENSITIVE RECEIVER (JULY 1996 LAYOUT)

Note : Housing layout from HD as of July 1996.

Figure No.	Revision
3.14	1
Reference: TSW-BASE	File Name: 01030018.C09
Prepared: MC	Checked: PS
Date: NOV. 96	Scale: N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
賓尼工程顧問有限公司
ENGINEERS AND SCIENTISTS
賓尼

Title :

LOCATIONS OF REPRESENTATIVE SENSITIVE RECEIVER (DECEMBER 1996 LAYOUT)

Note : Housing layout from HD as of July 1996.
Area 102, 106 layout from HD as of December 1996.

Figure No. 3.15	Revision 2
Reference TSW–BASE	File Name 01030018.C09
Prepared MC	Checked PS
Date FEB. 97	Scale N.T.S.

4 NOISE IMPACT

4.1 Construction Noise

Introduction

4.1.1 In general terms, the methodology used involves the following steps:

(i) identification of the most likely worst case scenario from the construction programme;

(ii) identification of the nearest representative Noise Sensitive Receivers (NSRs) to the worksite;

(iii) calculation of the total Sound Power Level (SWL) of equipment to be used;

(iv) calculation of Predicted Noise Level (PNL) based on distance attenuation from the notional noise source point to the NSRs; and

(v) comparison of the construction noise levels with relevant standards.

4.1.2 Mitigation measures are then considered if construction noise levels are expected to exceed standards.

Noise Assessment Criteria

4.1.3 Environmental legislation and standards for construction noise are listed in Appendix A & B1. A lower day-time criterion of 72 dB(A) has been used in the assessment for some NSRs to take into account cumulative noise impact from concurrent construction works.

Construction Programme

4.1.4 A review of the construction programme (Figures 2.25 & 2.26) indicates that an overall duration of around six years is required for the construction of the various components and the Project as a whole. The programme shows construction taking place between 1997 to 2003 and is divided into packages, phases and contracts.

4.1.5 The main construction activities involve the following:

(i) site formation works;
(ii) roadworks and associated drains and sewers in the RZ;
(iii) junction improvement in the DZ;
(iv) widening and dualling of roads;
(v) bridge building/grade separation of junction;
(vi) construction of sewage pumping station;
(vii) construction of rising mains; and
(viii) Western Drainage Channel extension (WDCE).

A general description of the construction activities and works involved are given in Section 2 and Appendix B1.

Emission Inventory

4.1.6 The likely type, quantity and the SWL for each type of Powered Mechanical Equipment (PME) used for different construction activities are discussed in Appendix B1.

Representative Noise Sensitive Receivers

4.1.7 The representative NSRs (RNSRs) chosen for noise prediction are shown in Figures 4.1.1 - 4.1.11. The RNSRs used for assessment will change for each prediction, depending on the proximity of the construction works, the occupation status of the SRs and the severity of the cumulative impact on the RNSRs. A description of the sensitive receivers is tabulated in Table 3.7 of Section 3: Sensitive Receivers and Sensitive Land Uses.

Assessment Approach

4.1.8 The construction noise impact is divided mainly into two parts, the first is the noise due to the various construction activities employing PME, the second is the noise from haulage traffic. The noise levels at the RNSRs due to these two components are added together logarithmically. A facade correction of +3 dB(A) is added to this sum to account for the sound reflection from the RNSR building's surface.

4.1.9 The assessment was undertaken on the basis of the assumption that construction equipment was located on a notional noise source and is operating simultaneously at the same time. In order to avoid an overestimated PNL, a 50% on time usage of certain mobile equipment has been assumed in the calculations. Details of the assessment methodology and calculation are shown in Appendix B1.

4.1.10 Worst construction scenarios have been selected for assessment purpose. These scenarios and the associated construction activities are tabulated below in Table 4.1.1 and shown in Figures 4.1.1 - 4.1.11.

Table 4.1.1
Scenarios for Construction Noise Assessment

Scenario	Duration	Contract	Construction Activities
1	Jul-Dec 1997	1 2	- site formation of Area 102 - site formation of Areas 101, 103-109a, 110 and 111
2	Jan-Sep 1998	2	- site formation of Areas 101, 103-109a, 110 and 111
3	Oct-Dec 1998	3 4 4 4 5 5 5	- junction improvement in DZ - sewage pumping station and rising mains - road L12(S), L13(E), L14 - Tin Wah Rd and Tin Tsz Rd dualling - grade separation of junction W (P2/1402) - grade separation of junction D & Long Tin Rd widening - grade separation of junction A & Hung Tin Rd widening

Table 4.1.1
Scenarios for Construction Noise Assessment (cont'd)

4	Jan-Aug 1999	3 4 4 4 5 5 5 6 6 6 6 7 7	- junction improvement in DZ - sewage pumping station and rising mains - road L12(S), L13(E), L14 - Tin Wah Rd and Tin Tsz Rd dualling - grade separation of junction W (P2/1402) - grade separation of junction D & Long Tin Rd widening - grade separation of junction A & Hung Tin Rd widening - LRT central loop western leg - road L12(N) and road D4(N) - Tin Ying Rd dualling - Western Drainage Channel Extension - site formation of Areas 109b, 112-117 and 120 - road D4(S), bridge P1/V3
5	Sep 1999- Mar 2000	4 4 4 5 5 5 6 6 6 6 7 7	- sewage pumping station and rising mains - road L12(S), L13(E), L14 - Tin Wah Rd and Tin Tsz Rd dualling - grade separation of junction W (P2/1402) - grade separation of junction D & Long Tin Rd widening - grade separation of junction A & Hung Tin Rd widening - LRT central loop western leg - road L12(N) and road D4(N) - Tin Ying Rd dualling - Western Drainage Channel Extension - site formation of Areas 109b, 112-117 and 120 - road D4(S), bridge P1/V3
6	Apr-Sep 2000	4 5 5 6 6 6 6 7 7	- Tin Wah Rd and Tin Tsz Rd dualling - grade separation of junction D & Long Tin Rd widening - grade separation of junction A & Hung Tin Rd widening - LRT central loop western leg - road L12(N) and road D4(N) - Tin Ying Rd dualling - Western Drainage Channel Extension - site formation of Areas 109b, 112-117 and 120 - road D4(S), bridge P1/V3
7	Oct-Dec 2000	4 5 5 6 6 6 7	- Tin Wah Rd and Tin Tsz Rd dualling - grade separation of junction D & Long Tin Rd widening - grade separation of junction A & Hung Tin Rd widening - road L12(N) and road D4(N) - Tin Ying Rd dualling - Western Drainage Channel Extension - road D4(S), bridge P1/V3
8	Jan-Jun 2001	5 6 6 6 7 7	- grade separation of junction A & Hung Tin Rd widening - road L12(N) and road D4(N) - Tin Ying Rd dualling - Western Drainage Channel Extension - road D4(S), bridge P1/V3 - bridges P2/L1 & P2/L2
9	Jul-Dec 2001	7 8	- bridges P2/L1 & P2/L2 - road D3
10	Jan-Jul 2002	7 8 8	- bridges P2/L1 & P2/L2 - road D3 - site formation of Area 121
11	Aug 2002- Aug 2003	8	- road D3

4.1.11 For prediction of the worst construction noise at each of the RNSR, the different construction activities likely to affect each RNSR for each scenario will be added together.

4.1.12 Some of the construction activities will be sub-divided into different tasks. After careful study of the implementation programme, the tasks likely to affect the RNSRs during each particular scenario will be used for assessment purposes to give the worst case scenario.

Predicted Noise Levels (PNL)

4.1.13 The PNLs for the different scenario are tabulated below in Table 4.1.2 - 4.1.12 below.

Scenario 1

4.1.14 Scenario 1 consists of site formation works for Areas 101-109a, 110 and 111. The PNL for Scenario 1 is tabulated below in Table 4.1.2.

Table 4.1.2
The PNLs at the RNSRs during Scenario 1

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
66	Site formation of Areas 101-109a, 110 and 111 Dumping of materials at stockpile Dumping of materials at stockpile *Haul road traffic	124.0 120.0 120.0 67.2	300 960 680 -	71.8
64	Site formation of Areas 101-109a, 110 and 111 Dumping of materials at stockpile Dumping of materials at stockpile *Haul road traffic	124.0 120.0 120.0 69.1	120 810 650 -	78.1
138	Site formation of Areas 101-109a, 110 and 111 Dumping of materials at stockpile Dumping of materials at stockpile *Haul road traffic	124.0 120.0 120.0 66.6	390 1150 1050 -	70.1
139	Site formation of Areas 101-109a, 110 and 111 Dumping of materials at stockpile Dumping of materials at stockpile *Haul road traffic	124.0 120.0 120.0 66.0	500 1320 1250 -	68.8
27	Site formation of Areas 101-109a, 110 and 111 Dumping of materials at stockpile Dumping of materials at stockpile *Haul road traffic	124.0 120.0 120.0 64.6	590 1560 1590 -	67.3
26	Site formation of Areas 101-109a, 110 and 111 Dumping of materials at stockpile Dumping of materials at stockpile *Haul road traffic	124.0 120.0 120.0 65.5	470 1300 1300 -	68.8
1	Site formation of Areas 101-109a, 110 and 111 Dumping of materials at stockpile Dumping of materials at stockpile *Haul road traffic	124.0 120.0 120.0 65.1	400 700 950 -	69.6

* details of haul road traffic calculations are shown in Appendix B1.

Scenario 2

4.1.15 Scenario 2 consists of site formation works for Areas 101-109a, 110 and 111 excluding 102. Calculations used for Scenario 1 have been used to give a worst picture. The PNL for Scenario 2 is tabulated below in Table 4.1.3.

Table 4.1.3
The PNLs at the RNSRs during Scenario 2

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
66	Site formation of Areas 101-109a, 110 and 111	124.0	300	71.8
	Dumping of materials at stockpile	120.0	960	
	Dumping of materials at stockpile	120.0	680	
	*Haul road traffic	67.2	-	
64	Site formation of Areas 101-109a, 110 and 111	124.0	120	78.1
	Dumping of materials at stockpile	120.0	810	
	Dumping of materials at stockpile	120.0	650	
	*Haul road traffic	69.1	-	
138	Site formation of Areas 101-109a, 110 and 111	124.0	390	70.1
	Dumping of materials at stockpile	120.0	1150	
	Dumping of materials at stockpile	120.0	1050	
	*Haul road traffic	66.6	-	
139	Site formation of Areas 101-109a, 110 and 111	124.0	500	68.8
	Dumping of materials at stockpile	120.0	1320	
	Dumping of materials at stockpile	120.0	1250	
	*Haul road traffic	66.0	-	
27	Site formation of Areas 101-109a, 110 and 111	124.0	590	67.3
	Dumping of materials at stockpile	120.0	1560	
	Dumping of materials at stockpile	120.0	1590	
	*Haul road traffic	64.6	-	
26	Site formation of Areas 101-109a, 110 and 111	124.0	470	68.8
	Dumping of materials at stockpile	120.0	1300	
	Dumping of materials at stockpile	120.0	1300	
	*Haul road traffic	65.5	-	
1	Site formation of Areas 101-109a, 110 and 111	124.0	400	69.6
	Dumping of materials at stockpile	120.0	700	
	Dumping of materials at stockpile	120.0	950	
	*Haul road traffic	65.1	-	

* details of haul road traffic calculations are shown in Appendix B1.

Scenario 3

4.1.16 The PNL for Scenario 3 is tabulated below in Table 4.1.4.

Table 4.1.4
The PNLs at the RNSRs during Scenario 3

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
26	Construction of sewage P/S (foundation works) Construction of rising mains (excavation of trenches) Tin Wah Rd dualling (site clearance) Tin Wah Rd bridge - D2/VF1 (foundation works) Roadworks - Road L12(S) (laying base & sub-base)	113.8 113.8 115.2 113.8 114.5	450 460 460 380 610	63.0
65	Tin Wah Rd dualling (site clearance) Tin Tsz Rd dualling (site clearance)	115.2 115.2	70 160	74.0
66	Tin Wah Rd dualling (site clearance) Tin Tsz Rd dualling (site clearance)	115.2 115.2	135 85	73.0
118	Junction G improvement (removal of road surface) Junction A3 improvement (removal of road surface) Junction F improvement (removal of road surface)	108.6 108.6 108.6	280 60 90	69.7
83	Grade separation at junction D (foundation works) Junction C improvement (removal of road surface) Long Tin Rd dualling (site clearance)	113.8 108.6 115.2	90 150 150	71.8
99	Hung Tin Rd dualling (site clearance)	115.2	60	74.6
90	Long Tin Rd dualling (site clearance)	115.2	15	86.6

* details of haul road traffic calculations are shown in Appendix B1.

Scenario 4

4.1.17 The PNL for Scenario 4 is tabulated below in Table 4.1.5.

Table 4.1.5
The PNLs at the RNSRs during Scenario 4

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
1	Roadworks - Road L12(N) (laying base & sub-base)	114.5	540	65.4
	Roadworks - Road L13(E) (laying base & sub-base)	114.5	1060	
	Roadworks - Road L14 (laying base & sub-base)	114.5	1160	
	Roadworks - Road D4(N) (laying base & sub-base)	114.5	390	
	Site formation of Areas 109b, 112-117, 120	118.7	400	
	*Haul road A	57.7	900	
	*Haul road B	49.0	670	
	*Haul road C	54.6	460	
26	Construction of sewage P/S (foundation works)	113.8	440	66.7
	Construction of rising mains (laying of pipes)	112.1	480	
	Junction improvement - A34 (laying base & sub-base)	114.5	720	
	Tin Wah Rd dualling (laying base & sub-base)	114.5	470	
	Tin Wah Rd bridge - D2/VF1 (foundation works)	113.8	380	
	Roadworks - Road L12(S) (Laying base & sub-base)	114.5	590	
	Roadworks - Road L13(E) (Laying base & sub-base)	114.5	660	
	WDC extension (placement of inflatable dam)	109.6	340	
	Tin Ying Rd dualling (site formation works)	118.7	430	
	Site formation of Areas 109b, 112-117, 120	118.7	1340	
	*Haul road A	55.9	1380	
	*Haul road B	45.8	1400	
	*Haul road C	55.8	350	
68	Construction of sewage P/S (foundation works)	113.8	550	71.3
	Construction of rising mains (laying of pipes)	112.1	120	
	Tin Wah Rd dualling (laying base & sub-base)	114.5	530	
	Tin Wah Rd bridge (foundation works)	113.8	550	
	WDC extension (placement of inflatable dam)	109.6	290	
	Tin Ying Rd dualling (site formation works)	118.7	170	
	*Haul road C	58.2	200	
65	Construction of sewage P/S (foundation works)	113.8	1200	75.4
	Tin Wah Rd dualling (laying base & sub-base)	114.5	70	
	Roadworks - Road L12(S) (laying base & sub-base)	114.5	1020	
	Roadworks - Road L13(E) (laying base & sub-base)	114.5	430	
	Roadworks - Road L14) (laying base & sub-base)	114.5	320	
	Site formation of Areas 109b, 112-117, 120	118.7	140	
	*Haul road A	64.7	180	
	*Haul road B	48.2	810	
	*Haul road C	51.2	1000	
72	Construction of rising mains (laying of pipes)	112.1	70	74.7
	Tin Ying Rd dualling (site formation works)	118.7	115	
	Grade separation of Junction A (foundation works)	113.8	410	
	Hung Tin Rd dualling (laying base & sub-base)	114.5	630	
	*Haul road C	60.4	120	
83	Tin Tsz Rd dualling (laying base & sub-base)	114.5	100	71.7
	Grade separation of Junction D (foundation works)	113.8	120	
	Long Tin Rd dualling (laying base & sub-base)	114.5	400	
116	Tin Tsz Rd dualling (laying base & sub-base)	114.5	200	67.1
	Grade separation of Junction W (foundation works)	113.8	160	
86	Tin Tsz Rd dualling (laying base & sub-base)	114.5	60	74.2
	Grade separation of Junction W (foundation works)	113.8	210	
118	Junction G improvement (laying base and sub-base)	114.5	280	75.6
	Junction A3 improvement (laying base and sub-base)	114.5	60	
	Junction F improvement (laying base and sub-base)	114.5	90	

* details of haul road traffic calculations are shown in Appendix B1.

Scenario 5

4.1.18 The PNL for Scenario 5 is tabulated below in Table 4.1.6.

Table 4.1.6
The PNLs at the RNSRs during Scenario 5

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
1	Roadworks - Road L12(N) (laying base & sub-base)	114.5	540	65.4
	Roadworks - Road L13(E) (laying base & sub-base)	114.5	1060	
	Roadworks - Road L14 (laying base & sub-base)	114.5	1160	
	Roadworks - Road D4(N) (laying base & sub-base)	114.5	390	
	Site formation of Areas 109b, 112-117, 120	118.7	400	
	*Haul road A	57.7	900	
	*Haul road B	49.0	670	
	*Haul road C	54.6	460	
26	Construction of sewage P/S (foundation works)	113.8	440	66.5
	Construction of rising mains (laying of pipes)	112.1	480	
	Tin Wah Rd dualling (laying base & sub-base)	114.5	470	
	Tin Wah Rd bridge - D2/VF1 (foundation works)	113.8	380	
	Roadworks - Road L12(S) (Laying base & sub-base)	114.5	590	
	Roadworks - Road L13(E) (Laying base & sub-base)	114.5	660	
	WDC extension (placement of inflatable dam)	109.6	340	
	Tin Ying Rd dualling (site formation works)	118.7	430	
	Site formation of Areas 109b, 112-117, 120	118.7	1340	
	*Haul road A	55.9	1380	
	*Haul road B	45.8	1400	
	*Haul road C	55.8	350	
68	Construction of sewage P/S (foundation works)	113.8	550	71.3
	Construction of rising mains (laying of pipes)	112.1	120	
	Tin Wah Rd dualling (laying base & sub-base)	114.5	530	
	Tin Wah Rd bridge (foundation works)	113.8	550	
	WDC extension (placement of inflatable dam)	109.6	290	
	Tin Ying Rd dualling (site formation works)	118.7	170	
	*Haul road C	58.2	200	
65	Construction of sewage P/S (foundation works)	113.8	1200	75.4
	Tin Wah Rd dualling (laying base & sub-base)	114.5	70	
	Roadworks - Road L12(S) (laying base & sub-base)	114.5	1020	
	Roadworks - Road L13(E) (laying base & sub-base)	114.5	430	
	Roadworks - Road L14) (laying base & sub-base)	114.5	320	
	Site formation of Areas 109b, 112-117, 120	118.7	140	
	*Haul road A	64.7	180	
	*Haul road B	48.2	810	
	*Haul road C	51.2	1000	
72	Construction of rising mains (laying of pipes)	112.1	70	74.7
	Tin Ying Rd dualling (site formation works)	118.7	115	
	Grade separation of Junction A (structural works)	112.8	410	
	Hung Tin Rd dualling (laying base & sub-base)	114.5	630	
	*Haul road C	60.4	120	
83	Tin Tsz Rd dualling (laying base & sub-base)	114.5	100	71.3
	Grade separation of Junction D (structural works)	112.8	120	
	Long Tin Rd dualling (laying base & sub-base)	114.5	400	

Table 4.1.6
The PNLs at the RNSRs during Scenario 5 (cont'd)

116	Tin Tsz Rd dualling (laying base & sub-base) Grade separation of Junction W (concreting works)	114.5 118.1	200 160	70.1
86	Tin Tsz Rd dualling (laying base & sub-base) Grade separation of Junction W (concreting works)	114.5 118.1	60 210	74.6
51	Tin Wah Rd dualling (laying base & sub-base) Tin Wah Rd bridge - D2/VF1 (structural works) WDC extension (excavation of channel materials) *Haul road C	114.5 112.8 118.2 67.1	50 175 220 26	76.4
53	Construction of rising mains (resurfacing works) Tin Wah Rd bridge - D2/VF1 (structural works) WDC extension (excavation of channel materials) Tin Ying Rd dualling (site formation works) *Haul road C	114.5 112.8 118.2 118.7 57.8	135 245 100 200 220	75.2
75	Hung Tin Rd dualling (laying base & sub-base) Grade separation of Junction A (structural works)	114.5 112.8	325 135	66.2
73	Construction of rising mains (resurfacing works) Tin Ying Rd dualling (site formation works) *Haul road C	112.8 118.7 58.8	150 100 175	74.3
56	Tin Wah Rd dualling (laying base & sub-base) Roadworks - Road L13(E) (laying base & sub-base) Roadworks - Road L14 (laying base & sub-base) Site formation of Areas 109b, 112-117, 120 *Haul road A *Haul road B *Haul road C	114.5 114.5 114.5 118.7 58.5 47.3 50.6	60 430 370 740 750 1000 1150	73.7

* details of haul road traffic calculations are shown in Appendix B1.

Scenario 6

4.1.19 The PNL for Scenario 6 is tabulated below in Table 4.1.7.

Table 4.1.7
The PNLs at the RNSRs during Scenario 6

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
51	Tin Wah Rd dualling (resurfacing work) Tin Wah Rd bridge - D2/VF1 (concreting works) Roadworks - Road D4(N) (laying base & sub-base) WDC extension (slope foundation) Site formation of Areas 109b, 112-117, 120	113.5 118.1 114.5 113.8 118.7	50 175 1200 220 1060	75.3
53	Tin Wah Rd bridge - D2/VF1 (concreting works) WDC extension (slope foundation) Tin Ying Rd dualling (laying base & sub-base)	118.1 113.8 114.5	245 100 200	71.2
75	Hung Tin Rd dualling (resurfacing works) Grade separation of Junction A (concreting works)	113.5 118.1	325 135	70.7
73	Tin Ying Rd dualling (laying base & sub-base)	114.5	100	69.5
56	Tin Wah Rd dualling (resurfacing works) Site formation of Areas 109b, 112-117, 120	113.5 118.7	60 740	73.0
65	Tin Wah Rd dualling (resurfacing works) Roadworks - Road D4(S) (laying base & sub-base)	113.5 114.5	60 190	73.4
83	Tin Tsz Rd dualling (resurfacing works) Grade separation of Junction D (concreting works) Long Tin Rd dualling (resurfacing works)	113.5 118.1 113.5	100 120 400	73.4

Scenario 7

4.1.20 The PNL for Scenario 7 is tabulated below in Table 4.1.8.

Table 4.1.8
The PNLs at the RNSRs during Scenario 7

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
51	Tin Wah Rd dualling (resurfacing work) Tin Wah Rd bridge - D2/VF1 (concreting works) Roadworks - Road D4(N) (laying base & sub-base) WDC extension (concreting works)	113.5 118.1 114.5 116.4	50 175 1200 220	75.4
53	Tin Wah Rd bridge - D2/VF1 (concreting works) WDC extension (concreting works) Tin Ying Rd dualling (laying base & sub-base)	118.1 116.4 114.5	245 100 200	72.9
75	Hung Tin Rd dualling (resurfacing works) Grade separation of Junction A (concreting works)	113.5 118.1	325 135	70.7
73	Tin Ying Rd dualling (laying base & sub-base)	114.5	100	69.5
56	Tin Wah Rd dualling (resurfacing works)	113.5	60	72.9
65	Tin Wah Rd dualling (resurfacing works) Roadworks - Road D4(S) (laying base & sub-base)	113.5 114.5	60 190	73.4
34	Roadworks - Road L12(N) (laying base & sub-base) Roadworks - Road D4(N) (laying base & sub-base)	114.5 114.5	150 600	66.2
36	Roadworks - Road D4(S) (laying base & sub-base)	114.5	490	55.7
41	Tin Wah Rd dualling (resurfacing works)	113.5	70	71.6

Scenario 8

4.1.21 The PNL for Scenario 8 is tabulated below in Table 4.1.9.

Table 4.1.9
The PNLs at the RNSRs during Scenario 8

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
51	Roadworks - Road D4(N) (laying base & sub-base) WDC extension (concreting works)	114.5 116.4	1200 220	64.6
53	WDC extension (concreting works) Tin Ying Rd dualling (laying base & sub-base)	116.4 114.5	100 200	71.9
75	Hung Tin Rd dualling (resurfacing works) Grade separation of Junction A (concreting works)	113.5 118.1	325 135	70.7
73	Tin Ying Rd dualling (resurfacing works)	113.5	100	68.5
34	Roadworks - Road L12(N) (laying base & sub-base) Roadworks - Road D4(N) (laying base & sub-base)	114.5 114.5	150 600	66.2
36	Roadworks - Road D4(S) (laying base & sub-base)	114.5	490	55.7
47	Roadworks - Road D4(S) (laying base & sub-base) Bridge P/L2 (foundation works)	114.5 113.8	180 120	69.0
42	Roadworks - Road D4(S) (laying base & sub-base) Bridge P/L2 (foundation works)	114.5 113.8	320 470	60.8
83	Bridge P/L2 (foundation works)	113.8	60	73.2

Scenario 9

4.1.22 The PNL for Scenario 9 is tabulated below in Table 4.1.10.

Table 4.1.10
The PNLs at the RNSRs during Scenario 9

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
32	Road D3 (site formation works) Bridge L13/VCF1 (foundation works) *Haul road D	118.7 113.8 60.1	150 460 180	70.7
29	Road D3 (site formation works) Bridge L13/VCF1 (foundation works) Footbridge GP/CF1 (foundation works) Bridge D3/V1 (foundation works) *Haul road D	118.7 113.8 113.8 113.8 60.5	135 130 460 710 165	72.8
22	Road D3 (site formation works) Bridge L13/VCF1 (foundation works) *Haul road D	118.7 113.8 60.1	150 130 180	72.0
19	Road D3 (site formation works) Bridge L13/VCF1 (foundation works) Footbridge GP/CF1 (foundation works) Bridge D3/V1 (foundation works) *Haul road D	118.7 113.8 113.8 113.8 60.7	135 320 140 350 160	72.8
26	Road D3 (site formation works) Bridge L13/VCF1 (foundation works) Footbridge GP/CF1 (foundation works) Bridge D3/V1 (foundation works) *Haul road D	118.7 113.8 113.8 113.8 59.3	270 460 800 1060 220	66.6

* details of haul road traffic calculations are shown in Appendix B1.

Scenario 10

4.1.23 The PNL for Scenario 10 is tabulated below in Table 4.1.11.

Table 4.1.11
The PNLs at the RNSRs during Scenario 10

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
32	Road D3 (site formation works)	118.7	150	71.9
	Bridge L13/VCF1 (foundation works)	113.8	460	
	Site formation of Area 121	118.7	250	
	*Haul road D	60.1	180	
29	Road D3 (site formation works)	118.7	135	72.9
	Bridge L13/VCF1 (foundation works)	113.8	130	
	Footbridge GP/CF1 (foundation works)	113.8	460	
	Bridge D3/V1 (foundation works)	113.8	710	
	Site formation of Area 121	118.7	550	
	*Haul road D	60.5	165	
22	Road D3 (site formation works)	118.7	150	72.2
	Bridge L13/VCF1 (foundation works)	113.8	130	
	Site formation of Area 121	118.7	660	
	*Haul road D	60.1	180	
19	Road D3 (site formation works)	118.7	135	72.8
	Bridge L13/VCF1 (foundation works)	113.8	320	
	Footbridge GP/CF1 (foundation works)	113.8	140	
	Bridge D3/V1 (foundation works)	113.8	350	
	*Haul road D	60.7	160	
26	Road D3 (site formation works)	118.7	270	68.6
	Bridge L13/VCF1 (foundation works)	113.8	460	
	Footbridge GP/CF1 (foundation works)	113.8	800	
	Bridge D3/V1 (foundation works)	113.8	1060	
	Site formation of Area 121	118.7	300	
	*Haul road D	59.3	220	
10	Road D3 (site formation works)	118.7	240	68.7
	Bridge L13/VCF1 (foundation works)	113.8	170	
	*Haul road D	58.9	240	
15	Road D3 (site formation works)	118.7	150	72.3
	Bridge L13/VCF1 (foundation works)	113.8	400	
	Footbridge GP/CF1 (foundation works)	113.8	125	
	Site formation of Area 121	118.7	990	
	*Haul road D	60.4	170	

* details of haul road traffic calculations are shown in Appendix B1.

Scenario 11

4.1.24 The PNL for Scenario 11 is tabulated below in Table 4.1.12.

Table 4.1.12
The PNLs at the RNSRs during Scenario 11

NSR	Construction Activity (sub-task)	T. SWL (dB(A))	Distance (m)	PNL (dB(A))
32	Road D3 (laying base and sub-base) Bridge L13/VCF1 (concreting works)	114.5 118.1	150 460	66.9
29	Road D3 (laying base and sub-base) Bridge L13/VCF1 (concreting works) Footbridge GP/CF1 (concreting works) Bridge D3/V1 (concreting works)	114.5 118.1 118.1 118.1	135 130 460 710	72.6
22	Road D3 (laying base and sub-base) Bridge L13/VCF1 (concreting works)	114.5 118.1	150 130	72.0
19	Road D3 (laying base and sub-base) Bridge L13/VCF1 (concreting works) Footbridge GP/CF1 (concreting works) Bridge D3/V1 (concreting works)	114.5 118.1 118.1 118.1	135 320 140 350	72.8
26	Road D3 (laying base and sub-base) Bridge L13/VCF1 (concreting works) Footbridge GP/CF1 (concreting works) Bridge D3/V1 (concreting works)	114.5 118.1 118.1 118.1	270 460 800 1060	64.3
10	Road D3 (laying base and sub-base) Bridge D3/V1 (concreting works)	114.5 118.1	240 170	69.3
15	Road D3 (laying base and sub-base) Bridge L13/VCF1 (concreting works) Footbridge GP/CF1 (concreting works)	114.5 118.1 118.1	150 400 125	72.6

Impact Evaluation and Recommended Mitigation Measures

4.1.25 It can be seen from the above that construction noise will exceed the daytime noise criteria at most of the NSRs.

4.1.26 The principal sources of excessive construction noise at any of the NSRs occurs when :

i) vibratory pokers are in use within 100 m of any NSR;
ii) breaking equipment of any type in use within 100 m of any NSR; and
iii) the principal equipment for most activities are located closer than 50 m from any NSR.

4.1.27 Mitigation measures are required and the following forms of mitigation are recommended.

Reducing the Number of Equipment/Construction Works in Areas Close to NSRs

4.1.28 Noise can be reduced by increasing the distance between the operating equipment and the NSRs or by reducing the number of items of equipment and/or construction activity in the area at any one time. By controlling the number of items of particularly noisy equipment operating near NSRs (particularly sensitive NSRs like schools), noise levels can be reduced by about 3 dB(A).

Noise Control on Equipment

4.1.29 Equipment noise can be reduced by means of silencers, mufflers, acoustic linings or shields. Equipment such as bulldozers', excavators' and other earthmoving plants' engines generate most of the noise. Sound absorbing linings to the engine compartments; effective engine exhaust silencers; and sound baffles mounted at all openings to the engine compartments can reduce noise levels by a few dB(A)s. Cranes also create noise nuisance if they are not kept well greased and properly serviced.

Selecting Quiet Plant

4.1.30 The use of quiet plant and working methods can further reduces noise level. Quiet plant is defined as Powered Mechanical Equipment (PME) whose actual sound power level is less than the value specified in the TMs for the same piece of equipment. To allow the Contractor some flexibility to select equipment to suit his needs, it is considered too restrictive to specify which specific items of silenced equipment to be used for the construction operations. It should be noted that various types of silenced equipment can be found in Hong Kong and are readily available on the market.

Use of Temporary Noise Barrier

4.1.31 Noise can also be reduced by construction of barriers which screen the lower floors from viewing the sites. These barriers should be gap free and have a surface mass density of at least 20 kg/m^2. Materials of this density include brick, concrete and composite material comprising of minimum 50 mm thick sound absorbing lining with 10 mm thick plywood (or 1 mm thick steel) backing These barriers reduce noise by about 5 dB(A). If barriers fully screen equipment from the view of any NSR, noise reduction will be about 10 dB(A).

4.1.32 Provided the Contractor implements the recommended mitigation measures, construction noise levels can be kept to reasonable levels at all times. The noise levels before and after mitigation are shown in Table 4.1.13 - 4.1.22 and discussed below.

<u>Scenario 1</u>

4.1.33 During site formation of Areas 101-109a, 110 and 111, construction noise level is not expected to exceed day-time criteria of 75 dB(A) for all NSRs except NSR 64 (Block 10, Lynwood Court). A lower day-time criterion of 72 dB(A) have been used for assessment to take into account adjacent building works in Area 30 and 31.

4.1.34 Noise levels at RNSR 64 could approach 78 dB(A) if noise is not mitigated. The prediction is likely to be overestimated since it assumed all equipment to be located at a notional noise source and are operating all at once. By reducing the number of equipment working near RNSR 64, use of silenced equipment and additional mitigation using acoustic linings or shields on the earthmoving plant's engine plus siting haul roads away from RNSR, PNL can be reduced to acceptable level of 72 dB(A). Table 4.1.13 shows a comparison of the noise level for Scenario 1 with, and without, mitigation measures.

Table 4.1.13
Comparison of Noise Levels With and Without Specific Mitigation for Scenario 1

RNSRs	unmitigated PNL dB(A)	ANL* dB(A)	exceedance of noise criteria before mitigation dB(A)	specific mitigated PNL** dB(A)	further mitigated PNL*** dB(A)	exceedance of noise criteria after mitigation dB(A)
66	71.8	75	no	N/A	N/A	N/A
64	78.1	72	yes ≈ 6.1	76.1[a]	73.1	marginal ≈ 1.1[a]
138	70.1	72	no	N/A	N/A	N/A
139	68.8	72	no	N/A	N/A	N/A
27	67.3	72	no	N/A	N/A	N/A
26	68.8	72	no	N/A	N/A	N/A
1	69.6	75	no	N/A	N/A	N/A

* ANL 75 dB(A) for residences and 70 dB(A) for school based on EPD's ProPECC PN/2/93. ANL 72 dB(A) for RNSRs to take into account cumulative noise impact from concurrent works.
** Assuming 2 dB(A) reduction from using acoustic lining/shield, silencer or muffler on earthmoving plant's engine.
*** Assuming 3 dB(A) reduction from limiting of equipment and/or construction activity.
a Short term marginal exceedances; selection of quiet plant and working methods and moving haul road away from NSR can easily mitigate the problem.

Scenario 2

4.1.35 Scenario 2 is similar to Scenario 1 without the site formation of Area 102. Furthermore, most of the cut and fill works will be in its final stages. A few months for consolidation of fill materials will follow before the commencement of infrastructure works. Impacts from Scenario 2 will, therefore, be less significant than Scenario 1. Mitigation measures recommended for Scenario 1 will be sufficient to protect the NSRs from excessive construction noise.

Scenario 3

4.1.36 Assessment has indicated that unmitigated construction activities would cause exceedances at the NSRs.

4.1.37 For NSR 90, the use of silenced equipment, acoustic lining on excavator's engine can reduce the noise level but does not totally eliminate the problem. Further mitigation in the form of noise barrier should be constructed to protect the NSR. The barrier should be gap free with a surface mass density of at least 20 kg/m^2 and constructed around the active part of the site (i.e. where powered mechanical equipment is in use) to screen all the noise sources from stationary and preferably all quasi-stationary equipment from the sight of the NSR. Location of the noise barriers is shown on Figure 4.1.12.

4.1.38 RNSR 118 and all other schools near any junction improvement area require additional attention during construction. special attention should be taken during school examination periods (65 dB(A) ANL). The Contractor should liaise with the schools and the Examination Authority to ascertain the exact dates and times of all examination during the course of the construction works. Noisy construction activities should be avoided during this period.

4.1.39 Some schools in the DZ have been identified as having road traffic noise levels above those prescribed in HKPSG and will be recommended for mitigation measures by Education Department. It is suggested that if these schools are affected by construction noise, the implementation of mitigation measures at these schools should be implemented before the start of any construction works.

4.1.40 Table 4.1.14 shows the noise levels with and without mitigation for Scenario 3.

Table 4.1.14
Comparison of Noise Levels With and Without Specific Mitigation for Scenario 3

RNSRs	unmitigated PNL dB(A)	ANL* dB(A)	exceedance of noise criteria before mitigation dB(A)	specific mitigated PNL** dB(A)	further mitigated PNL dB(A)	exceedance of noise criteria after mitigation dB(A)
26	63.0	72	no	N/A	N/A	N/A
65	74.0	72	yes ≈ 2.0	72.0	N/A	no
66	73.0	72	yes ≈ 1.0	71.0	N/A	no
118+	69.7	70	no	N/A	N/A	N/A
83	71.8	75	no	N/A	N/A	N/A
99	74.6	75	no	N/A	N/A	N/A
90	86.6	75	yes ≈ 11.6	84.6	74.6[a]	no

+ school
* ANL 75 dB(A) for residences and 70 dB(A) for school based on EPD's ProPECC PN/2/93. ANL 72 dB(A) for RNSRs to take into account cumulative noise impact from concurrent works.
** Assuming 2 dB(A) reduction from using acoustic lining/shield, silencer or muffler on earthmoving plant's engine.
a Assuming further 10 dB(A) reduction from noise barrier.

Scenario 4

4.1.41 Assessment has indicated that unmitigated construction activities would cause exceedances at the NSRs.

4.1.42 Mitigation measures such as the limiting of equipment and construction activities plus the use of acoustic linings or shields on mobile plant's engine can reduce the noise level to acceptable levels. Special attention should be given to the schools near each construction activities especially during school examination periods. Noisy construction activities should be avoided.

4.1.43 Noise levels with and without mitigation for Scenario 4 and specific mitigation for some NSRs are shown in Table 4.1.15.

Table 4.1.15
Comparison of Noise Levels With and Without Specific Mitigation for Scenario 4

RNSRs	unmitigated PNL dB(A)	ANL* dB(A)	exceedance of noise criteria before mitigation dB(A)	specific mitigated PNL** dB(A)	further mitigated PNL*** dB(A)	exceedance of noise criteria after mitigation dB(A)
1	65.4	72	no	N/A	N/A	N/A
26	66.7	72	no	N/A	N/A	N/A
68	71.3	72	no	N/A	N/A	N/A
65	75.4	72	yes ≈ 3.4	73.4	70.4	no
72+	74.7	70	yes ≈ 4.7	72.7	69.7	no
83	71.7	75	no	N/A	N/A	N/A
116+	67.1	70	no	N/A	N/A	N/A
86	74.2	72	yes ≈ 2.2	72.2	N/A	no
118+	75.6	70	yes ≈ 5.6	73.6	70.6	marginal ≈ 0.6[a]

+ school
* ANL 75 dB(A) for residences and 70 dB(A) for school based on EPD's ProPECC PN/2/93. ANL 72 dB(A) for RNSRs to take into account cumulative noise impact from concurrent works.
** Assuming 2 dB(A) reduction from using acoustic lining/shield, silencer or muffler on earthmoving plant's engine.
*** Assuming 3 dB(A) reduction from limiting of equipment and/or construction activity.
a Short term marginal exceedances; selection of quiet plant and working methods can easily mitigate the problem.

Scenario 5

4.1.44 Assessment has indicated that unmitigated construction activities would cause exceedances at the NSRs. Table 4.1.16 shows the noise levels with and without mitigation for Scenario 5.

Table 4.1.16
Comparison of Noise Levels With and Without Specific Mitigation for Scenario 5

RNSRs	unmitigated PNL dB(A)	ANL* dB(A)	exceedance of noise criteria before mitigation dB(A)	specific mitigated PNL** dB(A)	further mitigated PNL*** dB(A)	exceedance of noise criteria after mitigation dB(A)
1	65.4	72	no	N/A	N/A	N/A
26	66.5	72	no	N/A	N/A	N/A
68	71.3	72	no	N/A	N/A	N/A
65	75.4	72	yes ≈ 3.4	73.4	70.4	no
72^+	74.7	70	yes ≈ 4.7	72.7	69.7	no
83	71.3	75	no	N/A	N/A	N/A
116^+	70.1	70	no	N/A	N/A	N/A
86	74.6	72	yes ≈ 2.6	72.6	69.6	no
51	76.4	72	yes ≈ 4.4	74.4	71.4	no
53^+	75.2	70	yes ≈ 5.2	73.2	70.2	no
75	66.2	72	no	N/A	N/A	N/A
73	74.3	72	yes ≈ 2.3	72.3	N/A	no
56	73.7	72	yes ≈ 1.7	71.7	N/A	no

+ school
* ANL 75 dB(A) for residences and 70 dB(A) for school based on EPD's ProPECC PN/2/93.
ANL 72 dB(A) for RNSRs to take into account cumulative noise impact from concurrent works.
** Assuming 2 dB(A) reduction from using acoustic lining/shield, silencer or muffler on earthmoving plant's engine.
*** Assuming 3 dB(A) reduction from limiting of equipment and/or construction activity.

Scenario 6

4.1.45 Assessment has indicated that unmitigated construction activities would cause exceedances at the NSRs. Table 4.1.17 shows the noise levels with and without mitigation for Scenario 6.

Table 4.1.17
Comparison of Noise Levels With and Without Specific Mitigation for Scenario 6

RNSRs	unmitigated PNL dB(A)	ANL* dB(A)	exceedance of noise criteria before mitigation dB(A)	specific mitigated PNL** dB(A)	further mitigated PNL*** dB(A)	exceedance of noise criteria after mitigation dB(A)
51	75.3	72	yes 3.3	73.3	70.3	no
53+	71.2	70	yes ≈ 1.2	69.2	N/A	no
75	70.7	72	no	N/A	N/A	N/A
73	69.5	72	no	N/A	N/A	N/A
56	73.0	72	yes ≈ 1.0	71.0	N/A	no
65	73.4	72	yes ≈ 1.4	71.4	N/A	no
83	73.4	75	no	N/A	N/A	N/A

+ school
* ANL 75 dB(A) for residences and 70 dB(A) for school based on EPD's ProPECC PN/2/93.
ANL 72 dB(A) for RNSRs to take into account cumulative noise impact from concurrent works.
** Assuming 2 dB(A) reduction from using acoustic lining/shield, silencer or muffler on earthmoving plant's engine.
*** Assuming 3 dB(A) reduction from limiting of equipment and/or construction activity.

Scenario 7

4.1.46 Assessment has indicated that unmitigated construction activities would cause exceedances at the NSRs. Table 4.1.18 shows the noise levels with and without mitigation for Scenario 7.

Table 4.1.18
Comparison of Noise Levels With and Without Specific Mitigation for Scenario 7

RNSRs	unmitigated PNL dB(A)	ANL* dB(A)	exceedance of noise criteria before mitigation dB(A)	specific mitigated PNL** dB(A)	further mitigated PNL*** dB(A)	exceedance of noise criteria after mitigation dB(A)
51	75.4	72	yes ≈ 3.4	73.4	70.4	no
53+	72.9	70	yes ≈ 2.9	70.9	67.9	no
75	70.7	72	no	N/A	N/A	N/A
73	69.5	72	no	N/A	N/A	N/A
56	72.9	72	yes ≈ 0.9	N/A	69.9	no
65	73.4	72	yes ≈ 1.4	71.4	N/A	no
34+	66.2	72	no	N/A	N/A	N/A
36	55.7	72	no	N/A	N/A	N/A
41	71.6	72	no	N/A	N/A	N/A

+ school
* ANL 75 dB(A) for residences and 70 dB(A) for school based on EPD's ProPECC PN/2/93.
ANL 72 dB(A) for RNSRs to take into account cumulative noise impact from concurrent works.
** Assuming 2 dB(A) reduction from using acoustic lining/shield, silencer or muffler on earthmoving plant's engine.
*** Assuming 3 dB(A) reduction from limiting of equipment and/or construction activity.

Scenario 8

4.1.47 Assessment has indicated that unmitigated construction activities would cause exceedances at some NSRs. Table 4.1.19 shows the noise levels with and without mitigation for Scenario 8.

Table 4.1.19
Comparison of Noise Levels With and Without Specific Mitigation for Scenario 8

RNSRs	unmitigated PNL dB(A)	ANL* dB(A)	exceedance of noise criteria before mitigation dB(A)	specific mitigated PNL** dB(A)	further mitigated PNL*** dB(A)	exceedance of noise criteria after mitigation dB(A)
51	64.6	72	no	N/A	N/A	N/A
53+	71.9	70	yes ≈ 1.9	69.9	N/A	no
75	70.7	72	no	N/A	N/A	N/A
73	68.5	72	no	N/A	N/A	N/A
34+	66.2	72	no	N/A	N/A	N/A
36	55.7	72	no	N/A	N/A	N/A
47	69.0	72	no	N/A	N/A	N/A
42	60.8	72	no	N/A	N/A	N/A
83	73.2	75	no	N/A	N/A	N/A

+ school
* ANL 75 dB(A) for residences and 70 dB(A) for school based on EPD's ProPECC PN/2/93. ANL 72 dB(A) for RNSRs to take into account cumulative noise impact from concurrent works.
** Assuming 2 dB(A) reduction from using acoustic lining/shield, silencer or muffler on earthmoving plant's engine.
*** Assuming 3 dB(A) reduction from limiting of equipment and/or construction activity.

Scenario 9

4.1.48 Assessment has indicated that unmitigated construction activities would cause exceedances at the NSRs. Specific mitigation for some NSRs are shown in Table 4.1.20.

Table 4.1.20
Comparison of Noise Levels With and Without Specific Mitigation for Scenario 9

RNSRs	unmitigated PNL dB(A)	ANL* dB(A)	exceedance of noise criteria before mitigation dB(A)	specific mitigated PNL** dB(A)	further mitigated PNL*** dB(A)	exceedance of noise criteria after mitigation dB(A)
32	70.7	75	no	N/A	N/A	N/A
29+	72.8	70	yes ≈ 2.8	70.8	67.8	no
22	72.0	72	no	N/A	N/A	N/A
19+	72.8	70	yes ≈ 2.8	70.8	67.8	no
26	66.6	75	no	N/A	N/A	N/A

\+ school
* ANL 75 dB(A) for residences and 70 dB(A) for school based on EPD's ProPECC PN/2/93.
ANL 72 dB(A) for RNSRs to take into account cumulative noise impact from concurrent works.
** Assuming 2 dB(A) reduction from using acoustic lining/shield, silencer or muffler on earthmoving plant's engine.
*** Assuming 3 dB(A) reduction from limiting of equipment and/or construction activity.

Scenario 10

4.1.49 Assessment has indicated that unmitigated construction activities would cause exceedances at the NSRs. ANL of 75 dB(A) has been used in this assessment since most of the building works in the RZ is completed and occupied. Specific mitigations are suggested below in Table 4.1.21.

Table 4.1.21
Comparison of Noise Levels With and Without Specific Mitigation for Scenario 10

RNSRs	unmitigated PNL dB(A)	ANL* dB(A)	exceedance of noise criteria before mitigation dB(A)	specific mitigated PNL** dB(A)	further mitigated PNL*** dB(A)	exceedance of noise criteria after mitigation dB(A)
32	71.9	75	no	N/A	N/A	N/A
29+	72.9	70	yes ≈ 2.9	70.9	67.9	no
22	72.2	75	no	N/A	N/A	N/A
19+	72.8	70	yes ≈ 2.8	70.8	67.8	no
26	68.6	75	no	N/A	N/A	N/A
10	68.7	75	no	N/A	N/A	N/A
15	72.3	75	no	N/A	N/A	N/A

+ school
* ANL 75 dB(A) for residences and 70 dB(A) for school based on EPD's ProPECC PN/2/93.
** Assuming 2 dB(A) reduction from using acoustic lining/shield, silencer or muffler on earthmoving plant's engine.
*** Assuming 3 dB(A) reduction from limiting of equipment and/or construction activity.

Scenario 11

4.1.50 Assessment has indicated that unmitigated construction activities would cause exceedances at the NSRs. ANL of 75 dB(A) has been used in this assessment since most of the building works in the RZ is completed and occupied. Table 4.1.22 shows the noise levels with and without mitigation for Scenario 11.

Table 4.1.22
Comparison of Noise Levels With and Without Specific Mitigation for Scenario 11

RNSRs	unmitigated PNL dB(A)	ANL* dB(A)	exceedance of noise criteria before mitigation dB(A)	specific mitigated PNL** dB(A)	further mitigated PNL*** dB(A)	exceedance of noise criteria after mitigation dB(A)
32	66.9	75	no	N/A	N/A	N/A
29+	72.6	70	yes ≈ 2.6	70.6	67.6	no
22	72.0	75	no	N/A	N/A	N/A
19+	72.8	70	yes ≈ 2.8	70.8	67.8	no
26	64.3	75	no	N/A	N/A	N/A
10	69.3	75	no	N/A	N/A	N/A
15	72.6	75	no	N/A	N/A	N/A

+ school
* ANL 75 dB(A) for residences and 70 dB(A) for school based on EPD's ProPECC PN/2/93.
** Assuming 2 dB(A) reduction from using acoustic lining/shield, silencer or muffler on earthmoving plant's engine.
*** Assuming 3 dB(A) reduction from limiting of equipment and/or construction activity.

Environmental Monitoring and Audit (EM&A) Requirement

4.1.51 A noise monitoring programme will be implemented during the construction period to ensure the protection of sensitive receivers and areas. The noise monitoring programme to be implemented during the construction period is outlined in Appendix F.

Mitigation Clauses

4.1.52 The following sections outline the mitigation clauses recommended for inclusion in the EM&A Manual and the Contract documents.

4.1.53 The Contractor should consider noise as an environmental constraint in the planning and execution of the Works.

4.1.54 The Contractor should comply with the *Noise Control Ordinance (Cap 400)* and with any regulations made under the Ordinance, including restrictions placed on noise from construction work and the requirements to seek CNPs. Before commencing work which requires CNPs, the Contractor should obtain these permits and display them appropriately.

4.1.55 In addition to the requirements imposed by the *Noise Control Ordinance*, to control noise generated from equipment and activities for the purpose of carrying out any construction work other than percussive piling, during the time period from 0700 to 1900 hours, on any day not being a general holiday (including Sundays), the following requirements shall also be complied with:

(a) The noise level measured at 1 m from the most affected external facade of the nearby noise sensitive receivers from the construction work alone during any 30 minute period shall not exceed an equivalent noise level (Leq) of 75 dB(A).

(b) The noise level measured at 1 m from the most affected external facade of the nearby schools from the construction work alone during any 30 minute period shall not exceed an equivalent noise level (Leq) of 70 dB(A) [65 dB(A) during school examination periods].

The Contractor shall liaise with the schools and the Examination Authority to ascertain the exact dates and times of all examination periods during the course of the contract.

(c) Maximum noise level outside the site boundary of any construction sites within the Special Measures Zone (as defined under the *Deep Bay Guidelines for Dredging, Reclamation and Drainage Works*[1]) should never exceed 60 dB(A) for all days from 0700 to 2300 hours.

(d) Should the limits stated in the above sub-clauses (a) and (b) or where applicable (c), be exceeded, the construction shall stop and shall not recommence until appropriate measures acceptable to the Engineer, that are necessary for compliance, have been implemented.

Any stoppage or reduction in output resulting from compliance with this clause shall not entitle the Contractor to any extension of time for completion or to any additional costs whatsoever.

4.1.56 The Contractor shall devise, arrange methods of working and carry out the Works in such a manner so as to minimise noise impacts on the surrounding environment, and shall provide experienced personnel with suitable training to ensure that these methods are implemented.

4.1.57 Before the commencement of any work, the Engineer may require the methods of working, equipment and sound-reducing measures intended to be used on the Site to be made available for inspection and approval to ensure that they are suitable for the project.

4.1.58 The Contractor shall ensure that all plant and equipment to be used on the Site likely to cause excessive noise be effectively sound-reduced by means of silencers, mufflers, acoustic linings or shields, acoustic sheds or screens or other means to avoid disturbance to any nearby NSRs. All hand-held percussive breakers and air compressors will comply

[1] *Deep Bay Guidelines for Dredging, Reclamation and Drainage Works* (1991), Environmental Protection Department.

with the *Noise Control (Hand-held Percussive Breakers) Regulations and Noise Control (Air Compressors) Regulations* respectively under the *Noise Control Ordinance (Ordinance No. 75/88, NCO Amendment 1992 No. 6).*

4.1.59 The Contractor shall ensure that all plant and equipment to be used on site are properly maintained in good operating condition.

4.1.60 It is recommended that construction noise should be mitigated using a suitable combination of the following measures:

(a) Noisy equipment and activities should be sited by the Contractor as far from close-proximity sensitive receivers as is practical. Prolonged operation of noisy equipment close to dwellings and the Special Measures Zone should be avoided.

(b) Noisy plant or processes should be replaced by quieter alternatives where possible. Silenced diesel and gasoline generators and power units, as well as silenced and super-silenced air compressors, can be readily obtained.

(c) Noisy activities should be scheduled to minimise exposure of nearby sensitive receivers to high levels of construction noise. For example, noisy activities can be scheduled for midday, or at times coinciding with periods of high background noise (such as during peak traffic hours).

(d) Idle equipment should be turned off or throttled down. Noisy equipment should be properly maintained and used no more often than is necessary.

(e) The power units of non-electric stationary plant and earth-moving plant should be quietened by vibration isolation and partial or full acoustic enclosures for individual noise-generating components.

(f) Construction activities should be planned so that parallel operation of several sets of equipment close to a given receiver is avoided thus reducing the cumulative impacts between operations. The numbers of operating items of powered mechanical equipment should be minimised.

(g) Construction plant should be properly maintained and operated. Construction equipment often has silencing measures built in or added on, e.g. bulldozer silencers, compressor panels, and mufflers. Silencing measures should be properly maintained and utilised.

(h) Equipment known to emit sound strongly in one direction, should, where possible, be oriented so that the noise is directed away from nearby NSRs.

(i) Material stockpiles and other structures should be effectively utilised, where practicable, to screen noise from on-site construction activities. Alternatively, noise barriers having a surface density of 20 kg/m^2 may be used to protect nearby NSRs if necessary.

4.1.61 For the purposes of the above clauses, any domestic premises, hotels, hostel, temporary housing accommodation, hospital, medical clinic, educational institution, place of public worship, library, court of law, performing arts centre or office building shall be considered a noise sensitive receiver.

4.1.62 Notwithstanding the requirements and limitations set out and subject to the clauses above, the Engineer may upon application in writing by the Contractor, allow the use of any equipment and the carrying out of any construction activities for any duration provided that he is satisfied with the application which, in his opinion, to be of absolute necessity and adequate noise insulation has been provided to the educational institutions to be affected, or of emergency nature, and not in contravention with the *Noise Control Ordinance* in any respect.

Construction Traffic Noise

4.1.63 In addition to the noise sources discussed above, traffic noise will be increased due to the volume of construction traffic outside the works boundary during the development of TSW. Construction traffic generation from site formation, infrastructure works and related building works were discussed in the Construction Traffic section of *Tin Shui Wai Development: Final Investigation Report* (ref. 0018/ENG/R17.2).

4.1.64 It can be seen from the report that, taken individually, the level of construction traffic from any given activity would not be of major significance when compared with the general traffic levels.

4.1.65 However, a number of different construction activities will be taking place at the same time at different parts of the RZ and DZ. Reference to the recommended implementation programmes (version 2.2) indicates the critical periods to be the 3rd quarter of 1999 when some of the priority sites (Area 3, 30 and 31) are occupied and a combination of construction activities are taking place.

4.1.66 The construction activities taking place are:

- Tin Wah Road, Tin Tsz Road and Tin Ying Road upgrading;
- Long Tin Road and Hung Tin Road upgrading;
- Grade separation of Junctions A and D;
- Roadworks within the RZ;
- Western Drainage Channel extension;
- Building works in Areas 101-111

4.1.67 Based on the Consultants' surveys, an estimate has been made on the number of HGV's likely to be generated by the civil and building works. As a worst case, it has been assumed that 15% of the construction traffic would be generated within the peak hour for normal traffic. It has been assumed that the average PCU factor would be 1.75. Table 4.1.23 shows the estimated construction traffic during the works.

Table 4.1.23
Estimated Construction Traffic during Construction

	Estimated Construction Traffic		
	HGV/day	HGVs in peak hour	PCU in peak hour
Civil Works Contract			
Sewerage Improvements, Roads	150	23	40
Junction A, Hung Tin Rd widening Junction D, Long Tin Rd widening	300	46	80
Road L12(N), Road D4(N) Drainage Channel, Tin Ying Rd	300	46	80
Road D4(S), Bridges, Site Formation	150	23	40
Building Works			
Area 101	430	65	114
Area 102	710	107	187
Area 103	325	49	86
Area 104	165	25	44
Area 105	340	51	89
Area 106	200	30	53
Area 108a	125	19	33
Area 108b	125	19	33
Area 110	400	60	105
Area 111	320	48	84

(Source: *Tin Shui Wai Development: Final Investigation Report* BCL (3/1997): Report Ref. 0018/ENG/R17.2)

4.1.68 A worst-case situation, when all the above activities are taking place, would involve a total construction traffic generation of the order of 1000 pcu/hr in the morning peak hour. If it was assumed that this was split 50/50 between the Long Tin Road and Hung Tin Road, there would be approximately 500 construction vehicles passing through each of the critical Junctions A and D.

4.1.69 The sensitive receivers most likely to experience an increase in noise levels as a result of the extra traffic have been identified. Temporary noise barriers are suggested for these sensitive receivers (Figure 4.1.12) in order to mitigate the expected increase in traffic noise and construction noise. Temporary noise barriers are required because of the extensive construction works in Junctions A & D and due to the amount of construction traffic passing along these two junctions and along the East Access (Long Tin Road).

Noise Impacts on Birds

4.1.70 During construction, noise level is expected to increase and have an impact on the birds living at the north and north-east of the RZ. Table 4.1.24 shows the PNL on the two representative location for each of the scenarios.

Table 4.1.24
Assessment at the Special Measures Zone (SMZ) during Construction

Scenario	Assessment points in the SMZ*	PNL dB(A)
1 & 2	1	66.6
	2	66.0
3	1	48.7
	2	51.2
4 & 5	1	62.4
	2	68.0
6	1	62.3
	2	68.0
7 & 8	1	53.8
	2	56.5
9 & 10	1	60.4
	2	54.9
11	1	60.9
	2	55.1

Note: 3 dB(A) facade correction NOT included in the calculation since assessment point is not a building.
* Location of assessment points 1 & 2 of SMZ is the same as NSRs 1 & 3 respectively as shown on Figure 3.14.

4.1.71 Results of the prediction shows that construction noise level especially during site formation works will exceed the Deep Bay Guidelines (DBG) of 60 dB(A). However, the DBG only apply to works within the SMZ and no works under this Project will occur in the SMZ. The DBG criterion has been used for indicative purposes only.

4.1.72 Mitigation measures suggested for construction noise should be adopted to protect the birds from excessive noise. The following additional mitigation measures are also suggested:

(a) The Contractor should avoid any sudden banging and clanging of materials. Sudden revving of engine on any mobile plants should also be avoided.

(b) The Contractor should warn workers to avoid disturbing the birds as far as possible.

(c) Noise close to the north of the RZ should be kept as constant as possible. Alternatively, noisy construction works close to the north of the RZ should be scheduled during the summer months to avoid the migratory season during the winter months as far as practicable.

(d) The Contractor should use quiet piling equipment and silenced equipment as far as practicable during construction works.

Impact Summary and Conclusion

4.1.73 The construction noise assessment shows that noise levels in the area will increase, starting in 1997.

4.1.74 Unmitigated noise levels could exceed EPD's recommended maximum noise levels for day-time construction work when construction activities occur in close proximity to noise sensitive receivers or when several construction works occur simultaneously.

4.1.75 Adequate mitigation measures will be necessary for the construction works to meet the criteria.

4.1.76 The use of quiet plant and working methods, reducing the number of equipment, restricting the number of works and the use of substantial noise barriers to protect the closest residences and schools has been recommended.

4.1.77 Construction traffic volume will increase during the development of TSW. Overall noise level from construction and traffic noise is expected to increase. Temporary barriers as well as the early erection of permanent barrier have been suggested to reduce excessive noise impact.

4.1.78 Construction noise is also expected to have an impact on the bird population in northern and north-eastern part of the RZ. Mitigation measures have been recommended to reduce the noise impact.

4.2 OPERATION NOISE

Introduction

4.2.1 This section addresses the long term noise impacts due to the operation of infrastructure developed under this Project.

4.2.2 Three types of operational noise impact are addressed:

(i) noise from the proposed sewage pumping station;

(ii) noise from the proposed LRT system; and

(iii) road traffic noise.

4.2.3 The December 1996 layouts for Area 102 and Area 106 has been used in this assessment. New representative NSRs have been chosen. Housing Authority has finalised the layout for Area 102 and will undertake any other changes to layout described in this report.

Noise Assessment Criteria

4.2.4 Table 4.2.1 shows the noise assessment criteria for operation noise:

Table 4.2.1
Operational noise assessment criteria

Type	Uses	Assessment Criteria
Road traffic noise, L_{10} (1 hour) dB(A) (HKPSG)	All domestic premises, hotels, offices, and temporary housing	70
	Educational establishments	65
	Hospital, clinics, convalescences and homes for aged	55
HKPSG Rail traffic Noise 1) Leq (24 hr), dB(A) 2) NCO	All of the above	65 (or L_{max} (2300-0700) = 85 dB(A) As for fixed noise source below
Fixed Noise Source 1) NCO 2) HKPSG	All of the above	The ANLs Area Rating B are 0700 to 2300: 65 dB(A) and 2300 to 0700: 55 dB(A) (a) ANL - 5 dB(A) or (b) The prevailing background noise levels, whichever is lower.

4.2.5 After exhaustion of all practicable direct measures, eligibility for indirect mitigation of road traffic noise under this Project has been determined for each NSR that still exceeds the assessment criteria after other mitigation methods have been adopted using the following criteria:

(i) the predicted overall noise level from the new road together with other traffic in the vicinity must be above the appropriate HKPSG noise standards given above in Table 4.2.1;

(ii) the predicted overall noise level is at least 1.0 dB(A) more than the prevailing noise level, i.e. the total traffic noise level existing before the works to construct the road were begun; and

(iii) the contribution to the increase in the predicted overall noise level from the new road must be at least 1.0 dB(A).

Noise from the Operation of the Proposed Sewage Pumping Station

Noise from the Sewage Pumping Station

4.2.6 Potential noise from the proposed pumping station will be caused mainly by the operation of pumps and fans. Based on the latest information from the design team (the layout obtained in July 1996), the type and number of items of equipment at the proposed sewage pumping station will be identical to those at the existing sewage pumping station situated at Area 14.

4.2.7 Leq (5 min) noise measurement at the existing sewage pumping station at Area 14 was carried out on 8th July 1996 at 3 metres from the exhaust louvres and the doorways. The noise emissions were very steady. The noise levels obtained were 60.9, 64.2, and 64.8 dB(A) respectively. The background noise level measured at a further distance from the pumping station was 60.9 dB(A). There was no other major noise source nearby.

4.2.8 After subtracting the background noise from the highest noise level, the noise level due to the operation of the sewage pumping station at 3 m distance was found to be 62.5 dB(A).

4.2.9 The equation for estimating the noise level at the worst affected NSRs is as follows:

Predicted noise level = Measured noise level - 20 log (distance of noise source from NSR / distance of noise source from measurement point) +3 dB(A)

assuming that the noise from the sewage pumping station operation is uniform in all directions and the NSR has a similar directivity factor as the measured noise.

4.2.10 This equation is derived from the method of assessing distance correction found in the *Technical Memorandum (TM) on Noise from Places Other The Domestic Premises, Public Places or Construction Sites*, adding 3 dB(A) to account for the facade reflection effect.

4.2.11 The predicted noise levels at each representative receiver are presented below in the Table 4.2.2.

Table 4.2.2
Predicted noise levels due to pumping station operation at various noise sensitive receivers

Representative noise sensitive receivers	Distance between proposed sewage pumping station and NSR (m)	Overall noise level due to the operation of pumping station dB(A)	Exceed ANL-5dB?
32a	64	38.5	No
32b	66	38.2	No
33c	112	33.5	No
51b	83	36.1	No

4.2.12 The Tin Shui Wai area comprises high rise buildings situated within a previously predominantly rural area. The background noise is naturally low. In view of this setting, it is suggested the Area Rating as stipulated in the *TM for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites* should be 'B'.

4.2.13 The corresponding Acceptable Noise Levels (ANLs) would be 65 dB(A) for 07:00 to 23:00 hours for any day including Sundays and general holidays, and 55 dB(A) for 23:00 to 07:00 hours.

4.2.14 The detailed building layout has revealed that NSR 49 is now designated as a single aspect building with noise sensitive facades situated away from roads.

4.2.15 The predicted noise levels indicate that the noise due to the operation of the sewage pumping station will be acceptable when compared with the proposed ANLs.

Noise from the Operation of the LRT System

4.2.16 A Light Rail Transit (LRT) service is proposed for the RZ and land has been reserved for the tracks, two rectifier stations and a terminus.

4.2.17 The routing is expected to travel along the roads L12, D4, L14 and P2. The rectifier stations are expected to be set up near Junction W and Area 109. There are no NSRs located close to Junction W and Area 109.

4.2.18 The operation of the extended LRT route into the RZ will therefore include the noise of LRT trains travelling along the tracks and the operational noise of the rectifiers. A number of representative noise sensitive facades have been selected for the assessment of the LRT train noise, and are listed below in Table 4.2.3. The corresponding distances between the facades and the LRT track are also included in the table.

LRT Rectifier Station and Terminus

LRT rectifier station noise

4.2.19 The nearest representative prediction points from the proposed rectifier station at Area 109 are 9b and 45a. The intervening distances are 70 m and 180 m respectively. There is no definite layout for Area 109 yet. For the second rectifier station, the nearest facade is 200 metres away, at Kenswood Court, Kingswood Villas.

4.2.20 Noise levels of an existing rectifier station in operation at Yuen Long Park was measured on 8th July 1996 for Leq (30 min) at a distance of 2.5 m away from the noisiest facade of the station. The measurements were 69.5 and 69.7 dB(A) respectively. The background noise levels were measured to be 61.3 and 60.9 dB(A) respectively. The noise from the rectifier station consists mainly of steady noise from the exhaust fan.

4.2.21 The background noise levels was approximately 10 dB(A) less than the measured source. This is low enough to be considered insignificant compared with the measured noise source. It is assumed that noise from the rectifier station is emitted uniformly. Hence, the noise measured is assumed to be 70 dB(A) at a 2.5 m distance from the station.

4.2.22 The method for calculating distance correction is the same as that used for assessing the operation noise for the sewage pumping station. The rectifier stations are considered as point sources. The equation is given in Section 4.2.9.

4.2.23 The predicted noise levels for NSR 9b and NSR 45a are 37.6 and 29.4 dB(A) respectively, with +3 dB(A) facade correction included. For the NSR at Kingswood Villa, the noise level will be lower than 29.4 dB(A) as it is 20 metres away from NSR 45a. The predicted noise levels do not exceed the ANLs as proposed in Table 4.2.1. No potential noise impact is predicted due to the operation of the rectifier stations.

LRT terminus noise

4.2.24 The potential noise levels from the proposed LRT terminus at Area 106 were assessed using the same method as that for the rectifier stations.

4.2.25 Noise levels from the existing LRT terminus in the TSW DZ and the associated background noise level were measured on the 8th July 1996 in terms of Leq (5 min). The background noise level was 55 dB(A) while the measured noise levels was 62.5, 60.3, and 59.1 dB(A) at 3 m from the terminus.

4.2.26 After subtracting the background noise, the highest noise level due to the operation of the LRT terminus is expected to be 62 dB(A) at 3 m.

4.2.27 The predicted noise levels determined in this preliminary assessment for the operation of the proposed LRT terminus at the worst affected NSRs are approximately 48 dB(A) or less. These NSRs lie 25 metres or more from the terminus as suggested in the HKPSG. A facade correction of +3 dB(A) has been added to account for the facade reflection effect.

4.2.28 However, the radius of curvature of track is much less than that of the terminus in the DZ and of the minimum curvature suggested in the HKPSG.

4.2.29 KCRC has agreed to undertake a noise assessment for the terminus when more details on LRV frequency, train etc. are known to ensure that excessive squeal noise will not occur. KCRC would be responsible for at source mitigation if required.

LRT trains

4.2.30 The peak frequency of LRT train service is estimated to be one vehicle per minute in both directions, or 60 trips per hour, between 07:00 - 23:00 hours. Between 23:00 - 02:00, the peak frequency is 0.4 vehicle per minute, or 2 vehicles every 5 minutes. Table 4.2 of the "Formation of A LRT Reserve in Yuen Long and Associated Structures, Long Ping Link Final Report (Volume 1 - Main Report), June 1991" shows the measured noise level from a train passing by along LRT track of different curvatures. A single event noise exposure level (SEL) of 81 dB(A) has been adopted for use in this assessment.

4.2.31 The following equations are used for the calculation of LRT train noise:

$$Leq = 10 * \log (1/T * N * 10^{SEL/10})$$

where Leq is the predicted equivalent continuous noise level
T is the total time period in seconds
N is the total number of the events over the period
SEL is the single event noise exposure level

4.2.32 For 07:00 - 23:00 hours, T is 1800 sec., N is 60 veh/30 min., and SEL for each vehicle pass is assumed to be 81 dB(A).

Hence, $Leq(30\ min) = 10 * \log (1/1800 * 60 * 10^{81/10})$
$= 66.2$ dB(A)

For 23:00 - 02:00 hours, T is 1800 sec., N is 12 veh/30 min., with the SEL being the same.

$Leq(30\ min) = 10 * \log (1/1800 * 12 * 10^{81/10})$
$= 59.2$ dB(A)

4.2.33 The distance correction for the propagation of LRT noise is calculated by the following equation:

Distance correction, dB(A) = $16.67 * \log (d/d_0)$

where d_0 is the distance at which the LRT noise was measured, which is 6 m in this case

4.2.34 The equation is derived from the same report as that for the SEL data. Measured data supports a decrease of 5 dB(A) for every doubling of distance. The predicted noise levels due to the LRT operation are presented below in Table 4.2.3. A +3 dB(A) correction has been added to all the predicted noise levels to account for the effect of facade reflection.

Table 4.2.3
Distance of LRT track from worst affected NSRs and Predicted noise levels due to LRT train operation

Area	Affected Facade	Perpendicular Distance of facade from LRT track (m)	Predicted noise level (07:00 - 23:00) dB(A) Leq (30 min)	Predicted noise level (23:00 - 2:00) dB(A) Leq (30 min)
30	51a+	25	59.1	52.0
	52a	51	53.8	46.8
31	54a	76	51.0	44.0
	54b	82	50.4	43.4
	57a	28	58.2	51.2
	57c	61	52.6	45.6
	59a	59	52.8	45.8
	59c	72	51.4	44.4
	62a	40	55.6	48.6
	63b	27	58.5	51.5
101	33a	71	51.4	44.4
	33b	74	51.1	44.1
102	155a	39	55.2	48.2
	155c	39	55.2	48.2
	156a	44	54.3	47.3
	156b	42	54.6	47.7
	157a	35	56.0	49.0
	157b	36	55.8	48.8
	158b	41	54.8	47.8
	158c	36	55.8	48.8
	150d	52	53.1	46.1
103	43a	31	57.5	50.4
	43b	28	58.1	51.0
105	20a	67	51.8	44.8
	20c	52	53.8	46.7
	20d	67	51.9	44.9
106	160b	158	45.0	38.1
	161b	91	49.0	42.1
	162a	82	49.8	42.8
	163a	81	49.9	42.9
	164a	52	53.1	46.1
110	14a	52	53.7	46.7
	14b	59	52.8	45.8
111	16a	34	56.1	49.1
	16b	32	56.7	49.7
	16c	33	56.5	19.5
	17a	39	55.2	48.2
	17b	40	55.0	48.0
	18b	38	55.3	48.4
	18c	40	55.0	48.0
113	5	71	51.5	44.5

\+ Fixed window design.

4.2.35 None of the predicted noise levels exceeds the acceptable noise levels for the rail traffic noise of Leq (24 hours) of 65 dB(A). The predicted noise levels are also acceptable compared with the ANLs documented in the *TM for Places Other Than Domestic Premises, Construction Sites and Public Places*, assuming an Area Rating of 'B', of 65 and 55 dB(A) for 07:00 to 23:00 and 23:00 to 07:00 hours respectively.

Summary of Noise Impact from the Operation of the LRT System

4.2.36 The operation of the LRT rectifier and station proposed for the RZ is acceptable in terms of noise impact. Table 4.2.3 shows the predicted noise levels for various components of the LRT system in operation, compared with the noise criteria. A noise assessment will be undertaken for the LRT Terminus by KCRC when more details of the operation of the terminus are known.

Road Traffic Noise

Representative Noise Sensitive Receivers

4.2.37 Representative NSRs (RNSRs) and the "study area" have been described in Section 3 (Table 3.7). Figures 4.2.1 to 4.2.3 present the locations of these RNSRs and their facades. The "study area' includes a zone 300 metres around any works to be undertaken for the Project.

4.2.38 For high rise RNSRs, noise levels have been assessed at the lowest occupied floor, at 10/F, then at every ten floors intervals up to the top floor.

4.2.39 For village type developments, schools, and other sensitive usage, noise levels have been assessed at each level occupied by residences or classrooms.

4.2.40 Existing RNSRs were identified from survey maps and site visits. For the identification of future NSRs, Outline Zoning Plan (OZPs) and preliminary layout plans from Housing Department (HD) relevant to the "study area" were used as reference material. The nearest points to the areas zoned for noise sensitive usage from the Works were selected as RNSRs. The OZPs and layout plans are given in Section 3. The preliminary layout plan for Area 102 was finalised in December 1996.

Traffic Data

4.2.41 The Brief for the Project requires that traffic noise impact assessment use the peak hour traffic flow in respect of the maximum traffic projection. The transport and traffic assessment under the assignment was required to prepare traffic flow forecasts for the design years 2001, 2006 and 2011. The morning flows are higher than the evening flows.

4.2.42 The traffic data takes into account proposed changes to Housing Authority developments within the RZ. The traffic data was produced in December 1996. The nomenclature for the road divisions based on variation in traffic flow data are given in Figure B2.1 in Appendix B2. The corresponding street names are given on Figure B2.2. All roads with a peak hour flow of more than 250 vehicles per hour have been included.

4.2.43 Traffic data for the 'do-nothing' scenario used to calculate prevailing traffic noise levels (PTNLs) are given in Table B2.1. These data have been generated from the traffic models for the year '2000' and forecast traffic flows and do not include any traffic generated by development in the RZ or Areas 3, 30 or 31.

4.2.44 The AM peak traffic data have been compared on the basis of their potential to generate the highest noise levels at any NSR. The combinations of traffic flows and heavy vehicle percentages which generate the highest calculated noise levels for each section of road have been selected.

4.2.45 The assessment of road traffic noise has been undertaken using the worst case data. The worst case data for each road segment have been chosen and used throughout the assessment. This data and its associated noise levels are given in Table B2.2.

The Study Area and the Works under the Project

4.2.46 The nature of the road building and upgrading works have been described in Section 2. New roads are to be provided in the RZ. In addition, a number of existing roads will be widened:

(i) Tin Wah Road (D2) which divides the RZ from the DZ;

(ii) Tin Ying Road (P1) and the northern part of Hung Tin Road which form the main western access;

(ii) Tin Tsz Road (P2) and the northern part of Long Tin Road which form the main eastern access; and

(iv) the northern section of a stretch of Ping Ha Road which runs parallel to Long Tin Road.

4.2.47 These major work areas are illustrated on Figure 4.2.4.

4.2.48 In addition, a number of major and minor improvements will be made to junctions. Only Junctions A, D, K, P and W are scheduled for major upgrading and these are the junctions connecting the roads listed above.

4.2.49 Within the DZ, a number of junctions will be subject to improvements which will ease traffic management. These improvements include the provision of signals, a short turning lane or better access to a bus-stop. With the possible exception of Junction B, the changes do not increase the capacity of the road network. Thus Junction B has been included as a major works area.

4.2.50 The major works include alterations of alignment; provision of new roads; provision of new elevated structures or bridges; and provision of additional lanes.

Methodology

4:2.51 Traffic noise has been calculated using the *UK Calculation of Road Traffic Noise (1988)* methodology, published by the Welsh Department of Transport.

4.2.52 Table 4.2.4 shows the assumptions used for the assessment.

Table 4.2.4
Assumptions used in the calculation of road traffic noise

Traffic speed	D2, D3 and D4	70 kmh
	P1, P2, Hung Tin Road, Long Tin Road, and Ping Ha Road	70 kmh
	All "L" roads (local distributors) and D1	50 kmh
Application of friction courses	D1, D2, D3, D4, Ping Ha Road All "L" roads (local distributors)	No
	P1, P2	Yes
	Hung Tin Road, Long Tin Road	Section due to be upgraded: Yes Existing: Yes
Road gradient	Gradients are calculated by the elevations of road segments	
Road side planter boxes	Concrete planter boxes 0.8 m high or more have been considered as barriers, as they are situated close to kerb side and above source height.	
Multiple screening effect	The effect of multiple screening is not accounted for in this assessment. At any one NSR, only the barrier with the highest screening effect is considered.	

Results

4.2.53 The maximum predicted traffic noise levels at each RNSR facade without mitigation other than that stated in Table 4.2.4 are presented in Table B2.3 in Appendix B2.

4.2.54 Table 4.2.5 is a summary of the number of NSRs likely to be affected by operation of the new roads (without mitigation except for friction course). Friction course, the special low noise surfacing material, cannot be applied to Tin Wah Road due to the presence of many traffic lights, bus-stops and other features which result in stop-start traffic. Stop-start traffic breaks up the road surfacing material very rapidly and the road surface needs very frequent replacement.

Table 4.2.5
Summary of the number of NSRs likely to be affected by the operation of the new roads (without mitigation except for friction course) (July layouts for Areas 101, 105, 110, 111)

Area	NSR (prefix s indicates it is a school)	No. of blocks / schools with similar noise impact (estimation)	Estimated number of flats / classrooms affected	Estimated population affected in whole numbers (assuming 3.3 persons per flat)
3	73	1 block, 2 flats per floor, 1/F to 3/F	4 flats	13
3	75	1 block, 5 flats per floor, 12/F to 40/F	145 flats	479
3	78	1 block, 2 flats per floor, 16/F to 25/F	20 flats	66
3	141	1 block, 2 flats per floor, 1/F to 9/F	18 flats	59
3	s76	1 school	30 classrooms	/
3	s79	1 school	30 classrooms	/
3	s80	1 school	30 classrooms	/
8	s72	1 school	30 classrooms	/
14	Position uncertain	1 school	24 classrooms	/
16	s165	1 school	30 classrooms	/
24	s116	1 school	6 classrooms	/
27	64	2 blocks: front block 4 flats per floor, 1/F to 25/F and next block, 3 flats per floor, 1/F to 25/F	175 flats	578
28	65	4 blocks: 2 blocks, 2 flats per floor for 1 block and 1 flat per floor for the other, 1/F to 35/F, and 2 blocks, 3 flats per floor, 1/F to 25/F	255 flats	842
28	137	4 blocks, 4 flats per floor for 1 block and 1 flat per floor for 1 block, 1/F to 35/F (at front) and 3 flats per floor, for 2 blocks at the back, 1/F to 25/F	325 flats	1073
30	s51	1 kindergarten at 4/F to 6/F	3 classrooms	/
30	s53	1 school	30 classrooms	/
31	s59	1 school	16 classrooms	/
102	s159	Kindergarten at 1/F to 3/F	6 classrooms	/
103	42	1 block, 2 flats per floor 1/F to 20/F	40 flats	132
103	43	3 blocks, 2 flats per floor 1/F to 18/F	108 flats	356
103	44	1 block, 2 flats per floor 1/F to 39/F	78 flats	257

Area	NSR (prefix s indicates it is a school)	No. of blocks / schools with similar noise impact (estimation)	Estimated number of flats / classrooms affected	Estimated population affected in whole numbers (assuming 3.3 persons per flat)
104	46	3 blocks, 2 flats per floor 1/F to 40/F	240 flats	792
104	47	5 blocks, 2 flats per floor 1/F to 40/F	400 flats	1320
105	104	1 block, 2 flats per floor, 1/F to 7/F	14 flats	46
105	s105	1 kindergarten, 4/F, 5/F, 6/F	6 classrooms	/
108	107	1 block, 2 flats per floor, 1/F to 12/F	24 flats	79
110	s11	1 school (3/F to 6/F)	12 classrooms	/
112	6	1 house, 2 flats per floor, 1/F to 9/F	18 flats	59
112	4	1 house, 2 flat per floor, G/F	2 flats	7
113	s5	2 schools	60 classrooms	/
115	7	1 house, 2 flats per floor, 1/F to 9/F	18 flats	59
115	9	1 house, 2 flats per floor, 1/F to 9/F	18 flats	59
116	s8	2 schools	60 classrooms	/
west of DZ and Junction K	28	Zoned R(C)	/	/
west of DZ and Junction K	48	Zoned CDA	/	/
along Hung Tin Road	99	1 block, 1 flat per floor, G/F to 1/F	2 flats	7
along Long Tin Road	90	1 block, 1 flat per floor, G/F	1 flat	3
along Long Tin Road	95	1 block, 1 flat per floor, G/F to 2/F	3 flats	10
along Long Tin Road	96	1 block, 1 flat per floor, G/F to 2/F	3 flats	10
outlying villages (planned CDA)	70	6 blocks, 2 flats per floor, G/F to 2/F	36 flats	120
along Ping Ha Road	98	6 blocks, 2 flats per floor, G/F to 2/F	36 flats	120
along Tin Fuk Road	s89	1 school	30 classrooms	/
Estimate of Total NSRs Potentially Affected by the New Roads		1,983 dwellings	403 classrooms	6,544 residents
NSRs Currently Occupied Potentially Affected by the New Roads		800 dwellings	96 classrooms	2,640 residents

4.2.55 Every NSR with potential excessive noise levels has been investigated as to the possibility of using noise barriers to mitigate noise. Table 4.2.6 summarizes those noise barriers to be implemented under this Project. Their locations are illustrated on Figures 4.2.5, 4.2.6 and 4.2.7.

4.2.56 Typical vertical cross sections of the viaducts have been examined. There are 0.8 m tall parapets flanking both sides of the viaduct P2.1 with a 0.8 m tall central divider running the whole length of road P2.1. As a result, the screening effect of these structures is already sufficient to reduce the noise levels of NSR 83 and 91 at Area 13 to the acceptable level. The parapets are functioning in the same way as a 1 m tall barrier. A number of parapets and 0.8 m planters have been added to the road design to provide noise protection.

South of the Reserve Zone

4.2.57 Table B2.3 (in the appendices), lists the facades of the RNSRs south of the RZ with maximum unmitigated predicted traffic noise levels which exceed the HKPSG together with the predicted noise levels after the application of direct mitigation.

Table 4.2.6a
Noise Barriers to be Implemented under the Project

Barrier No.	NSRs	Area protected	Locations	Length of barrier, m	Height of barrier, m	Area of barrier, m^2	On an elevated structure?
1	78, 80	3	On earth bund at Junction B	86	3	258	No
2	78, 80	3	D1	45	4.5	203	No
3	79, 80	3	D1	130	4	520	No
4	79, 80	3	D1	44	4.5	198	No
5	76, 79	3	D1	159	4	636	No
6	75, 76	3	P1 on elevated flyover	105	1.5	158	Yes
7	76	3	Hung Tin Road East - P1 Slip Road	146	3	438	No
8*	64, 43, 44	27, 103	Tin Wah Road	113	3.5	396	No
9	64	27	Tin Wah Road	50	5.5	275	No
10*+	65, 137, 46, 47	28, 104	Tin Wah Road	352	5.5	1,936	No
11	65	28	Tin Wah Road	123	5.5	677	No
12	53	30	P1	249	2	498	No
13	96	/	Long Tin Road	228	1.5	342	No
14	99	/	Hung Tin Road East	235	2	470	No

* on central mound, absorptive type to minimise noise reflection on opposite NSR.
\+ cantilevered.

Table 4.2.6b
Planter/Parapet Barrier to be Implemented under this Project

Barrier No.	NSRs	Area protected	Locations	Length of barrier, m	Height of barrier, m	Area of barrier, m^2	On an elevated structure?
15	90, 95	/	Long Tin Road East	475	1	475	No
16	97, 98	/	Ping Ha Road East	356	1	356	No
17	70, 48	CDA West of Tin Ying Road, South of Tin Wah Road	Tin Ying Road, Tin Wah Road	1130	0.8	904	No
18	165	16	Tin Ying Road	161	0.5	80.5	No
19	75, 76	3	P1, on elevated flyover, eastern side	85	1	85	Yes
20	73, 141	3	P1, slip road north east of Junction A	284	0.8	227	No

4.2.58 Schools adversely affected by the operation of the new roads will be protected by TDD. The schools protected by direct mitigation include those in Area 3 and the western side of Area 30. Indirect mitigation in the form of window insulation and air-conditioning will be provided to the affected classrooms of RNSRs s72, s89, s116 which cannot be protected by direct means. RNSR s72 is sited next to an old bridge which cannot take the additional loading of a barrier. RNSR s89 and s116 are affected by high levels of noise from existing roads not included in this Project, as well as from the new roads. Direct mitigation is not practical since mitigation must be applied to both the new road and the unaltered roads to be effective, and no work can be carried out at the latter.

4.2.59 During the course of the EIA, a number of schools within the RZ likely to experience traffic noise levels above the standard set by the HKPSG were identified. These noise levels were not due to the new roads. Housing Authority will design the schools in Area 31 such that those classrooms adversely affected will meet the HKPSG standard. The Education Department will consider the existing schools listed in Table B2.4 for protection under the *Noise Abatement Measures in Schools Programme*.

4.2.60 In order to comply with the ExCo directive *ExCo XCC (89) 157 Equitable redress for persons exposed to increased noise resulting from the use of new roads*, all RNSRs exposed to residual impacts after the implementation of direct measures should be considered for indirect measures. Eligibility for indirect measures has been tested, using the eligibility criteria described in Section 4.2.5.

Areas 3, 30 and 31

4.2.61 Area 3 is fully protected by the provision of barriers. All schools and residences have worst case predicted noise levels below the HKPSG standards.

4.2.62 A kindergarten, s51, sited within the ancillary facility block in Area 30 will be protected by Housing Authority (HA) through the provision of building design with fixed window. All other classrooms and residences within Area 30 have worst case predicted noise levels below the HKPSG standards after the implementation of direct mitigation.

4.2.63 All residences within Area 31 meet the HKPSG standards. One school within Area 31 has some classrooms which are just above the HKPSG standards. HA has incorporated a special noise protective feature within the design for this school.

West of the Development Zone

4.2.64 RNSRs 28, 48 and 70 are future sensitive receivers. Future sensitive receivers represented by RNSRs 48 and 70 will be protected through the provision of a 0.8 m concrete parapet constructed along the western edge of Tin Ying Road and along the southern boundary of Road D2.3 as far as the works extend. D2.2 and part of D2.3 form part of another project. Residences need to be set back from roads D2.2 and D2.3 at least 55 m unless mitigation is implemented under the other Project.

East of the Development Zone

4.2.65 RNSR 69 is the closest existing residence to Tin Tsz Road. The predicted noise levels at RNSR 69 comply with the HKPSG standards. Development of Ha Mei San Tsuen is planned under another project which is now in the detailed design phase. Direct mitigation to protect the future residents of Ha Mei San Tsuen has been planned under the development project.

The Reserve Zone

4.2.66 Preliminary layouts for areas within the RZ have been used in the assessments. This technique gives an indication of the feasibility of using sensible layouts as a method of ensuring future noise levels are within the HKPSG recommendations.

4.2.67 Set back distances have only been recommended as a form of noise control for residences when the required distance from the planning area boundary is less than 20 m.

4.2.68 Barriers cannot be built within 50 m of any road junction or impede the access to the LRT. They must be placed behind bus stops such that pedestrians have access to the bus stops.

4.2.69 Mitigation has been addressed whenever the RNSRs have maximum predicted traffic noise levels greater than 70 dB(A).

<u>Area 101</u>

4.2.70 Based on the preliminary layout, Area 101 does not require any noise mitigation measures.

<u>Area 102</u>

4.2.71 Based on the final layout provided by HA on 12th December, all residences and schools meet the HKPSG criteria.

Area 103 & 104

4.2.72 Areas 103 and 104 are relatively small in terms of area. The potential exceedance of HKPSG criteria at all the road junctions is significant. Kerbside noise barriers are not a practical application at Areas 103 and 104, since the 50 m clearance required at all sides of the junctions means most of them cannot be implemented for traffic safety reasons. Reduction in noise levels has been achieved along Tin Wah Road using barriers on the central median strip.

4.2.73 Several options are proposed to the potential developers to develop the areas fully, namely:

- locate commercial buildings, gardens, recreational facilities, multi-storey car parks, and other buildings insensitive to noise impact along the roads, especially at the junctions;
- sensible site layouts, eg. with blocks arranged semi-circularly in plan view leaving only the centre block closer to road; moving the buildings towards northern part of the Area 104 which is quieter;
- locate the noise sensitive facades facing away from the roads.

4.2.74 It is anticipated that by using a combination of these options that the development potential of these areas can be fully achieved and traffic noise levels will comply with the HKPSG criterion.

4.2.75 The following set-back distances are required to ensure that residential noise sensitive receivers do not receive levels of traffic noise above the standards in the *Hong Kong Planning Standards and Guidelines*. The set-back distances refer to distances from a site boundary with a total angle-of-view of the roads of 90 degrees.

Area 103

4.2.76 The set-back distance from the site boundary along Road:

D2 varies and up to 45 metres;
L13 is 0 metres; and
L14 is 30 metres.

Area 104

4.2.77 The set-back distance from the site boundary along Road:

D2 is 50 metres;
D4 is 0 metres; and
L14 is 0 metres.

Area 105

4.2.78 The preliminary layout scheme indicated that NSR 105 could have noise levels above the HKPSG. Slight set-back mitigates the excessive noise. HA has adopted these set-backs and moved NSR 105. All final predicted noise levels are within the HKPSG.

Area 106

4.2.79 All predicted noise levels are within the HKPSG noise standards.

Area 108

4.2.80 Possible excessive noise was predicted in Area 108 from the 1/F to perhaps the 6/F of NSR 107 facing Road L14. NSR 107 is a point chosen for worst case consideration only. Any adverse noise impact can be sufficiently resolved by a setback of distance of 25 m from the site boundary along Road L13. Alternatively, as this is a C/R area a commercial block could be sited at the position of NSR 107.

Area 109

4.2.81 Currently, only NSR 109 and locations to the south of the internal access road will be used for noise sensitive purposes, ie. educational establishment. The predicted noise levels indicate this use is acceptable in terms of noise planning.

4.2.82 The other NSRs are planned for non-sensitive use, such as fire station, telephone exchange, and are therefore acceptable in terms of noise planning as well.

4.2.83 Bearing in mind the Fire Service Department (FSD)'s previous concern that noise barriers are not welcomed for fear of obstruction to fire engine movements, and potential noise impact if noise sensitive buildings area to be constructed to the north of the internal access road, it is not recommended that any noise sensitive buildings should be constructed at these locations.

Area 110

4.2.84 Noise levels above the HKPSG recommendations were predicted due to Road D3 at school NSR 11. The excessive noise is easily mitigated by locating the school further south. HA has now relocated this school further south and provided further mitigation by placing a carpark block between the school and the road. Mitigated values in Table B2.3 only reflect the relocation in terms of distance and show that noise levels will comply with the HKPSG.

Area 111

4.2.85 All the noise levels are within the HKPSG recommendations.

Area 112, 113, 115, 116

4.2.86 These areas could experience excessive noise levels if layouts are planned without considering potential traffic noise levels. Several approaches could solve the potential noise problems at Areas 112, 113, 115 and 116. Areas 113 and 116 are zoned for education establishments. Areas 112 and 115 are zoned for residential purpose.

4.2.87 Barriers cannot be built to protect these areas due to the 50 m junction clearance restriction. Currently, the height of proposed buildings in these areas is not known but the area is expected to be of medium density. Barriers can only protect a small zone of Areas 112 and 115.

4.2.88 It is recommended schools should be located to the far side of the internal access roads. Furthermore, any proposed development should plan the layout of the buildings bearing in the mind the potential noise constraints. The following options can be adopted:

- have all the residential buildings set back sufficiently from the site boundary along Road D4, and have garden arrangements towards the Road D4;
- locate all the non-noise sensitive facades of the buildings to face Road D4;
- locate the buildings with noise sensitive facade towards the road to be at least 60 m away from the site boundary bordering Road D4, while the facades of the buildings closer to the road should be non-noise sensitive.

4.2.89 It is anticipated that by using a combination of these options that the development potential of these areas can be fully achieved and traffic noise levels will comply with the HKPSG criterion.

4.2.90 The following set-back distances are required to ensure that residential noise sensitive receivers do not receive levels of traffic noise above the standards in the *Hong Kong Planning Standards and Guidelines*. The set-back distances refer to distances from a site boundary with a total angle-of-view of the roads of 90 degrees.

Area 112

4.2.91 The set-back distance from the site boundary for residences along Roads:

D4.1 is 30 metres;
D3.3 is 20 metres;
L12.5 is 20 metres.

Areas 115

4.2.92 The setback distance from the site boundary for residences along Roads:

D4.1 is 30 metres;
D4.2 is 35 metres; and
L14.5 is 0 metres.

Area 120, 121

4.2.93 Area 120 is designated as a CLP substation, while Area 121 is designated for non-noise sensitive Government, Institution and Community use. It is recommended that, in view of the high noise levels likely to occur at the Area 121, it is not recommended for noise sensitive usage.

NSRs to the north and west of RZ

4.2.94 The NSRs to the north and west of the RZ include the villages Mong Tseng Tsuen, Mong Tseng Wai, and Sha Kong Wai. The noise levels at these villages are all acceptable when compared to the HKPSG recommendations.

Residual Impacts

4.2.95 A number of dwellings and classrooms (existing and planned) have been identified which were predicted to experience traffic noise levels above those recommended in the HKPSG as a result of the new roads.

4.2.96 Noise barriers have been planned for the protection of the potentially affected sensitive receivers wherever practicable. Safety requirements, particularly line-of-sight requirements, constrain barrier design at junctions and ingress points.

4.2.97 Most dwellings and classrooms (existing and planned) directly affected by the new roads are fully protected by direct means. The direct mitigation includes several kilometres of friction course, noise barriers and the inclusion in the road design elements such as concrete parapets and 0.8 m high planter boxes.

4.2.98 No existing dwellings affected by the new roads with residual noise levels predicted to be above the HKPSG standards are eligible for indirect mitigation. Set-backs and angle-of-view have been designated for planned dwellings in Areas 103, 104, 112, 113, 115 and 116. In order to maximise the development potential of these areas, developers will need to devise a combination of noise measures to ensure the dwellings meet the HKPSG criterion. The placement and orientation of schools will need special consideration.

4.2.99 During the course of the EIA, a number of schools within the DZ have been identified which are likely to exceed the HKPSG standards in the future but are not directly affected by the new roads. A list of these schools is included in Appendix B. These schools will be considered by Education Department for inclusion in the *Noise Abatement Measures in Schools Programme*.

Conclusions

4.2.100 Operational noise levels associated with the operation of the proposed sewage pumping station at Area 101 are well within the noise criteria.

4.2.101 Noise impact associated with the operation of the LRT trains and the rectifier station used for the system are predicted to be well within the noise criteria. The operation of the terminus is not expected to affect Area 106, however KCRC will undertake a noise assessment when more details of the terminus are known.

4.2.102 Potential excessive road traffic noise impact from the new roads was identified at a number of locations. Direct mitigation to be implemented by TDD includes about one and a half kilometres of noise barriers and several kilometres of special low-noise surfacing material.

4.2.103 Set back distances for planned developments in Areas 103, 104, 112, 113, 115 and 116 have been calculated. These vary from zero to sixty metres. Most of the set backs are 30 to 40 metres assuming an angle of view of 90°. A Noise Impact Assessment for the purpose of ensuring that all residences and school classrooms meet the HKPSG criterion is recommended for each development area. The planned development for Areas 112, 113, 115 and 116 should not be differentiated into residential and GIC so that schools and non-sensitive GIC uses can be sited appropriated taking into account the noise constraints.

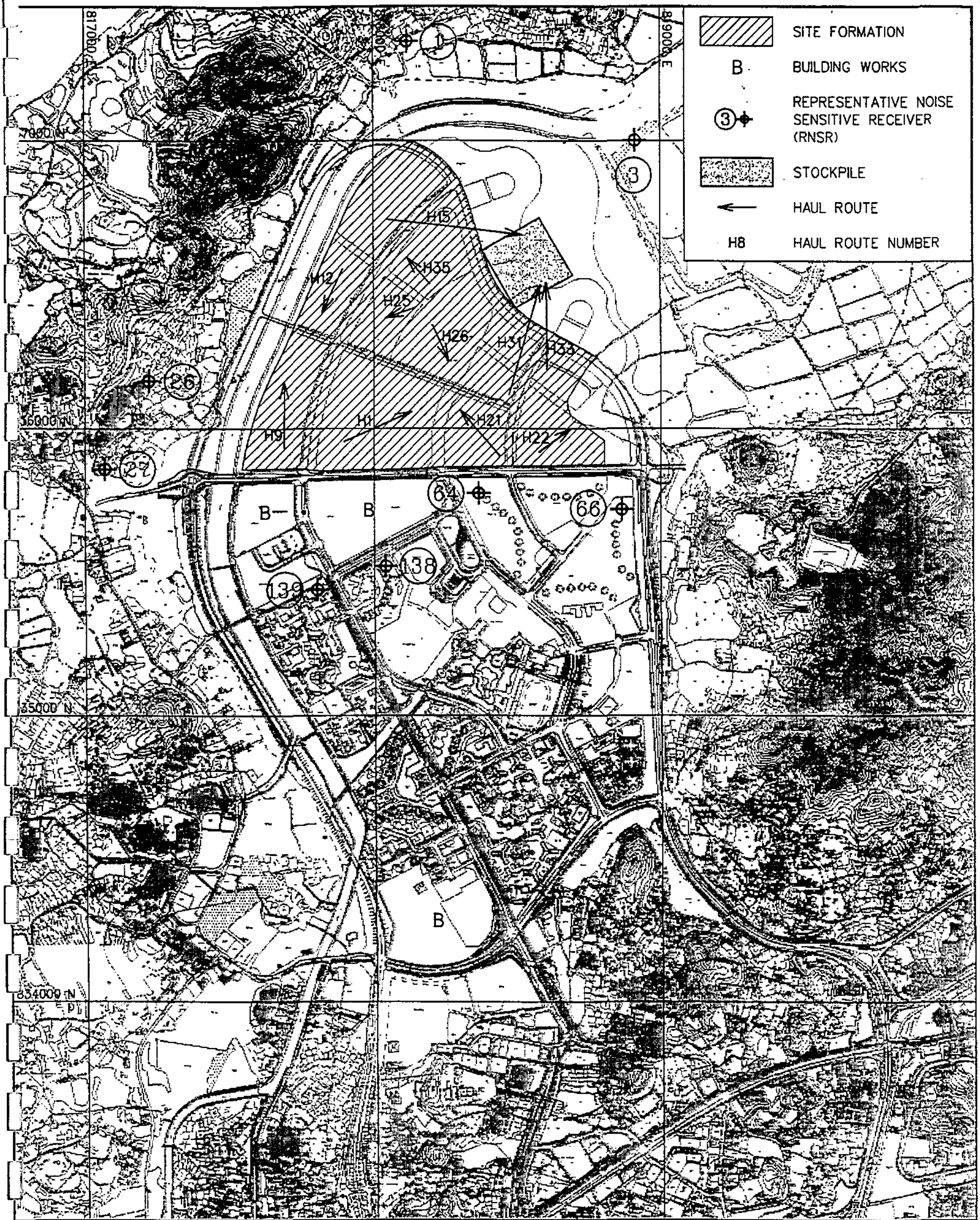
4.2.104 Table 4.2.7 below summarises the statistics, classrooms and population affected by noise levels above the HKPSG as a result of the new roads.

Table 4.2.7
Statistics Table for Future Traffic Noise Impact from the New Roads

	Dwellings		Population		Classrooms	
	Existing	Future	Existing	Future	Existing	Future
Total no. of sensitive receivers potentially affected by adverse traffic noise levels before mitigation	800	1,183	2,640	3,904	96	307
No. of sensitive receivers affected after direct mitigation	44	0*	145	0*	66	9**
No. of existing sensitive receivers eligible for indirect mitigation	0	NA	0	NA	By TDD 66	NA

* The NSRs at Areas 103, 104, 112 and 115 will be directly mitigated following the incorporation of the relevant planning constraints.
** Noise control designs to be incorporated for these classrooms by HD, ASD and others.

4.2.105 The cost of provision of noise barriers has been estimated as HK$65M.



TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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Title :

CONSTRUCTION NOISE CALCULATION
SCENARIO 1
(JUL-DEC 1997)

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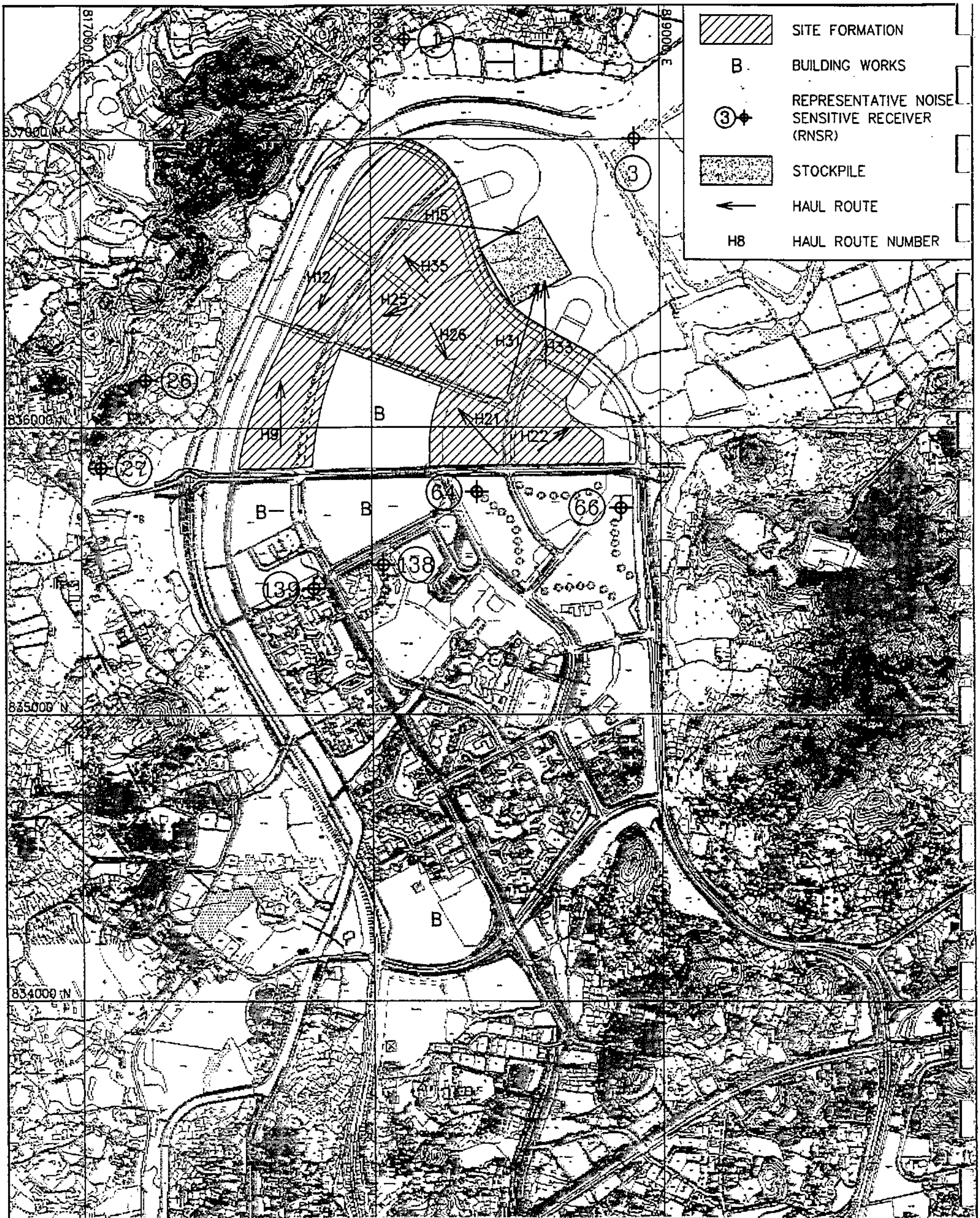
Reference TSW-BASE	File Name 02090018.C09
Prepared MC	Checked PS
Date DEC. 96	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : CONSTRUCTION NOISE CALCULATION SCENARIO 2 (JAN–SEP 1998)	Figure No. 4.1.2	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW–BASE	File Name 02100018.C09
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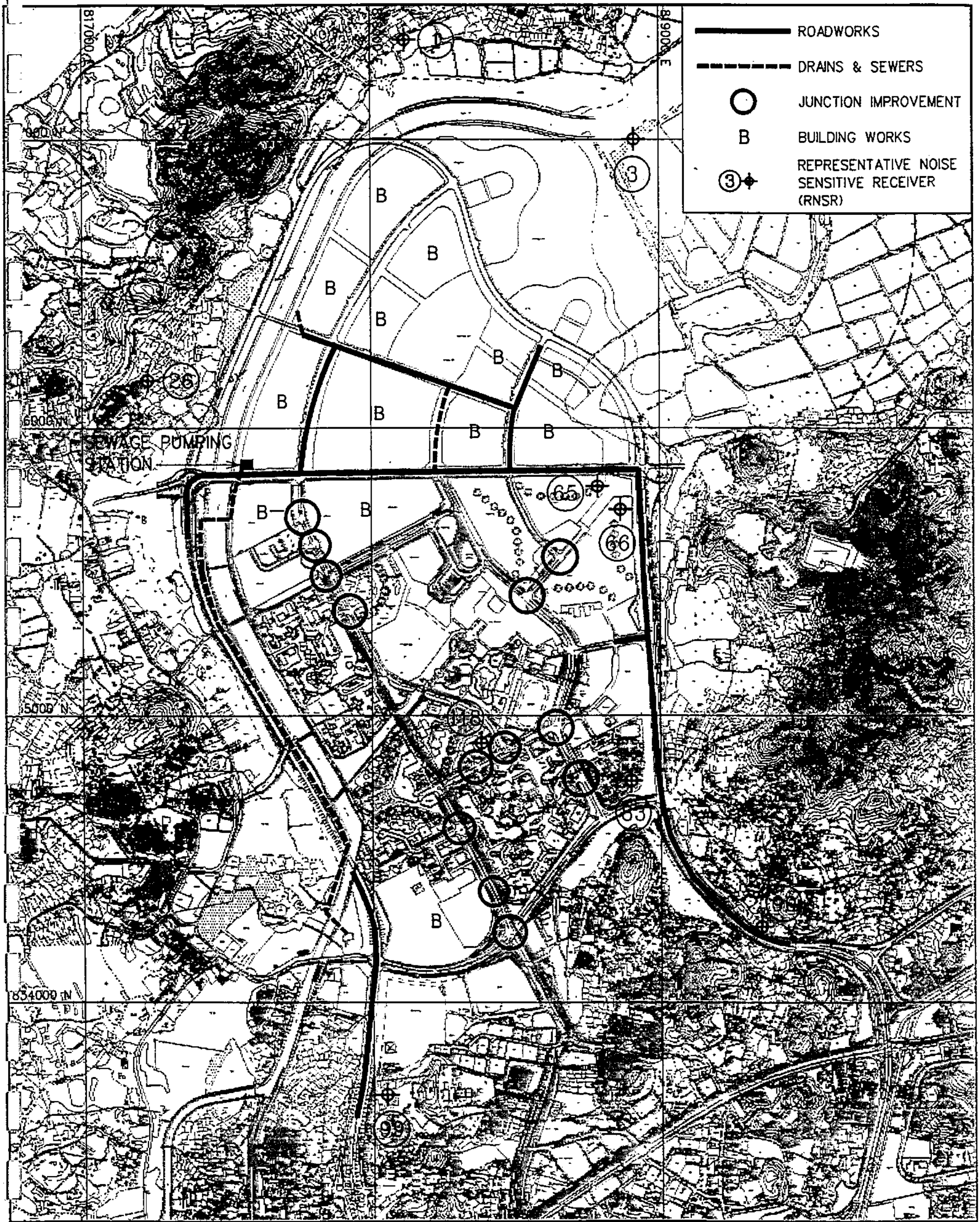

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : CONSTRUCTION NOISE CALCULATION SCENARIO 3 (OCT-DEC 1998)	Figure No. 4.1.3	Revision 0
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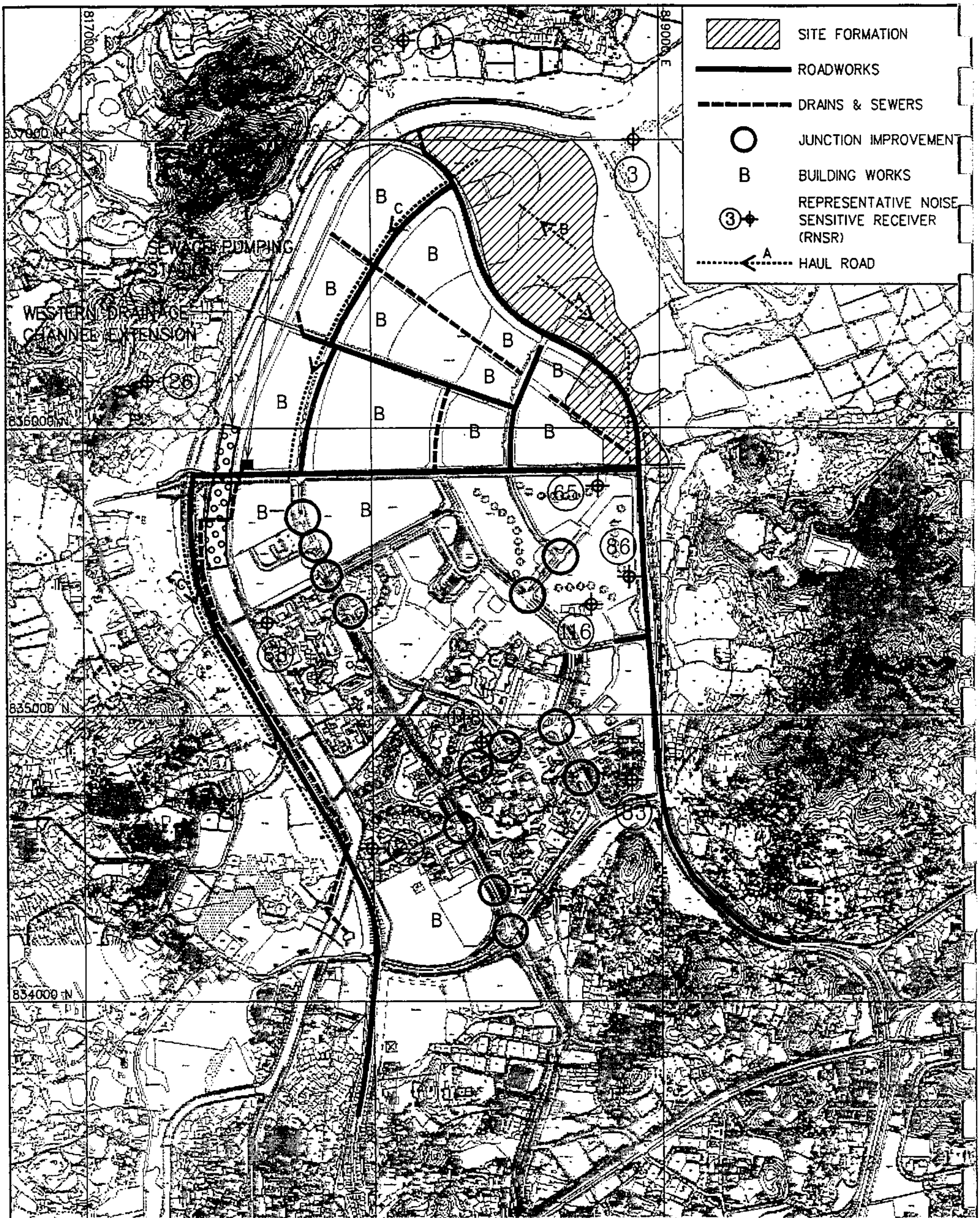
		Date DEC. 96	Scale N.T.S.



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ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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CONSTRUCTION NOISE CALCULATION SCENARIO 4 (JAN–AUG 1999)

Figure No.	Revision
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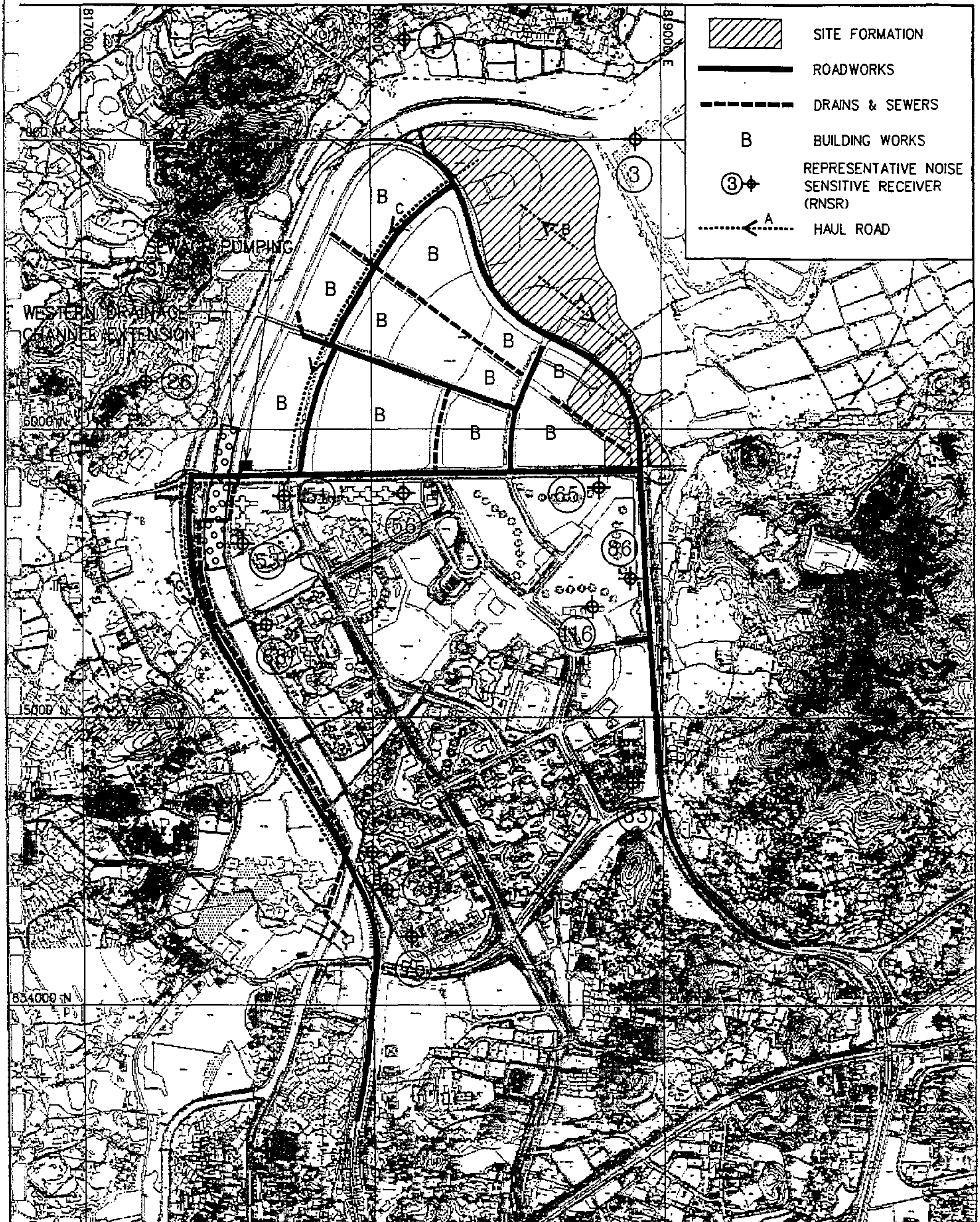

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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Title :

CONSTRUCTION NOISE CALCULATION SCENARIO 5 (SEP 1999–MAR 2000)

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No.	Revision
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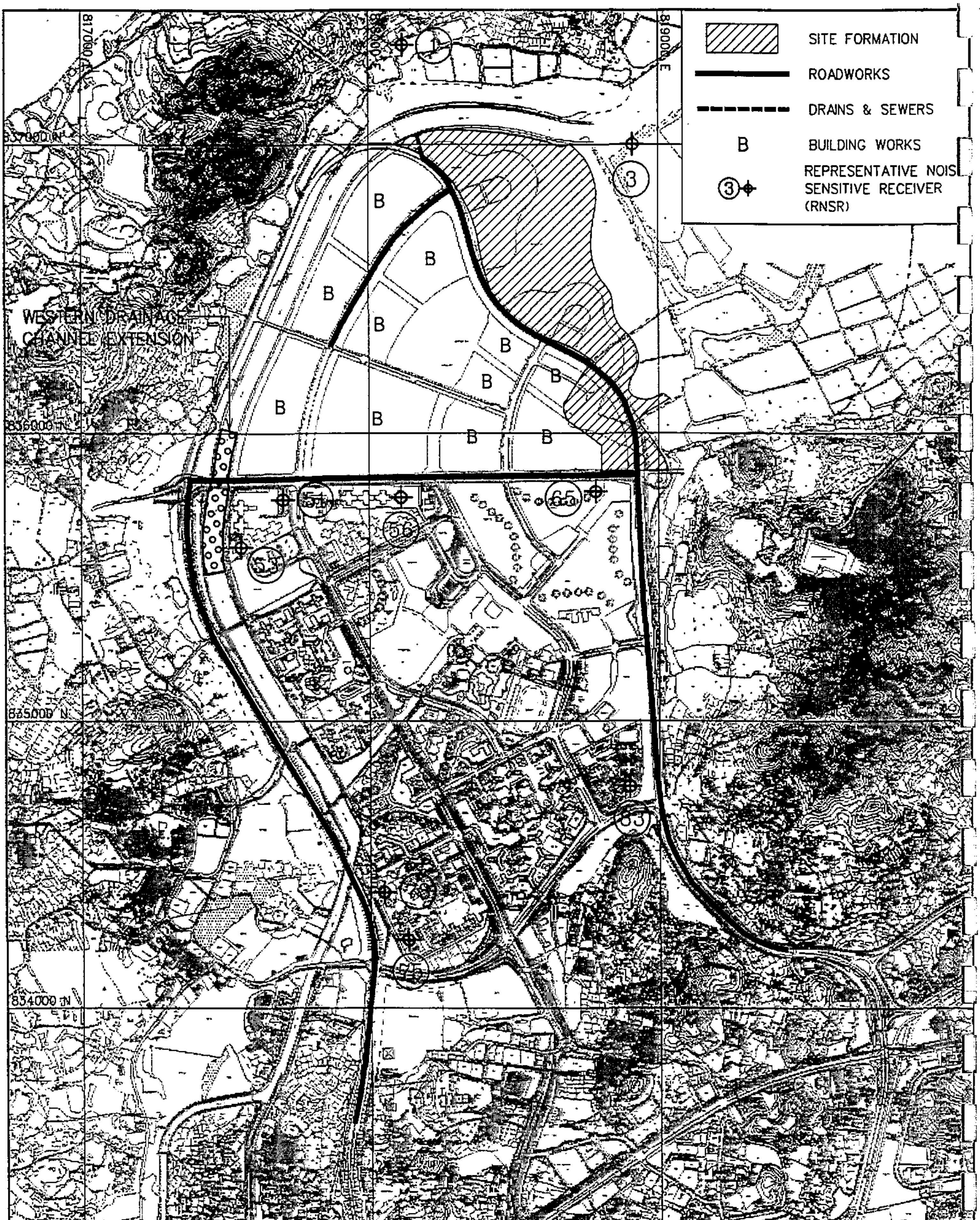
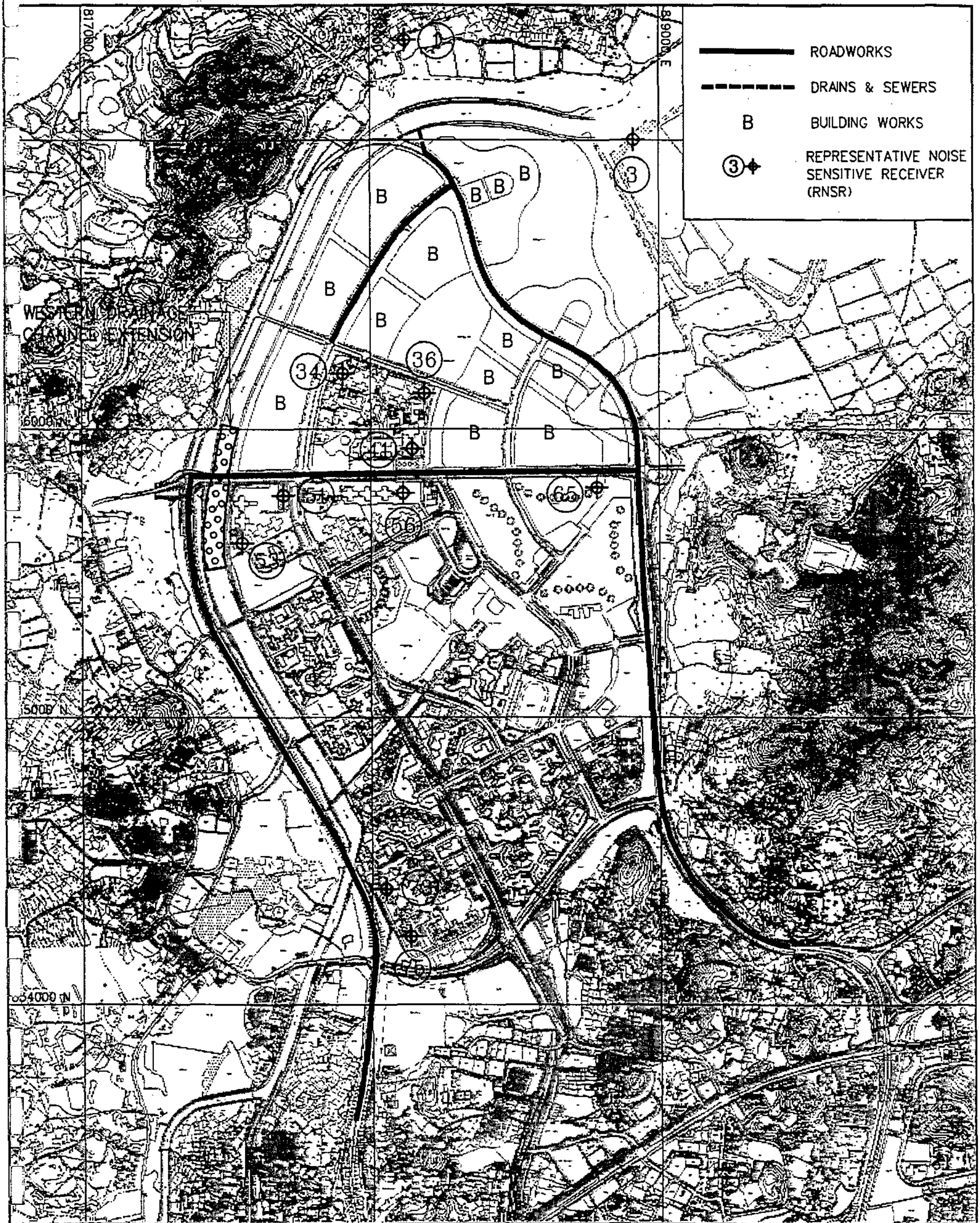
Prepared	Checked
MC	PS
Date	Scale
DEC. 96	N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95	Title :	Figure No. 4.1.6	Revision 0
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	CONSTRUCTION NOISE CALCULATION SCENARIO 6 (APR–AUG 2000)	Reference TSW–BASE	File Name 02140018.C09
		Prepared MC	Checked PS
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	Note : Housing layout from HD as of July 1996. [Occupation dates based on recommended implementation programme version 2.1]	Date DEC. 96	Scale N.T.S.



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BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	Note : Housing layout from HD as of July 1996. [Occupation dates based on recommended implementation programme version 2.1]	Reference TSW-BASE	File Name 02150018.C09
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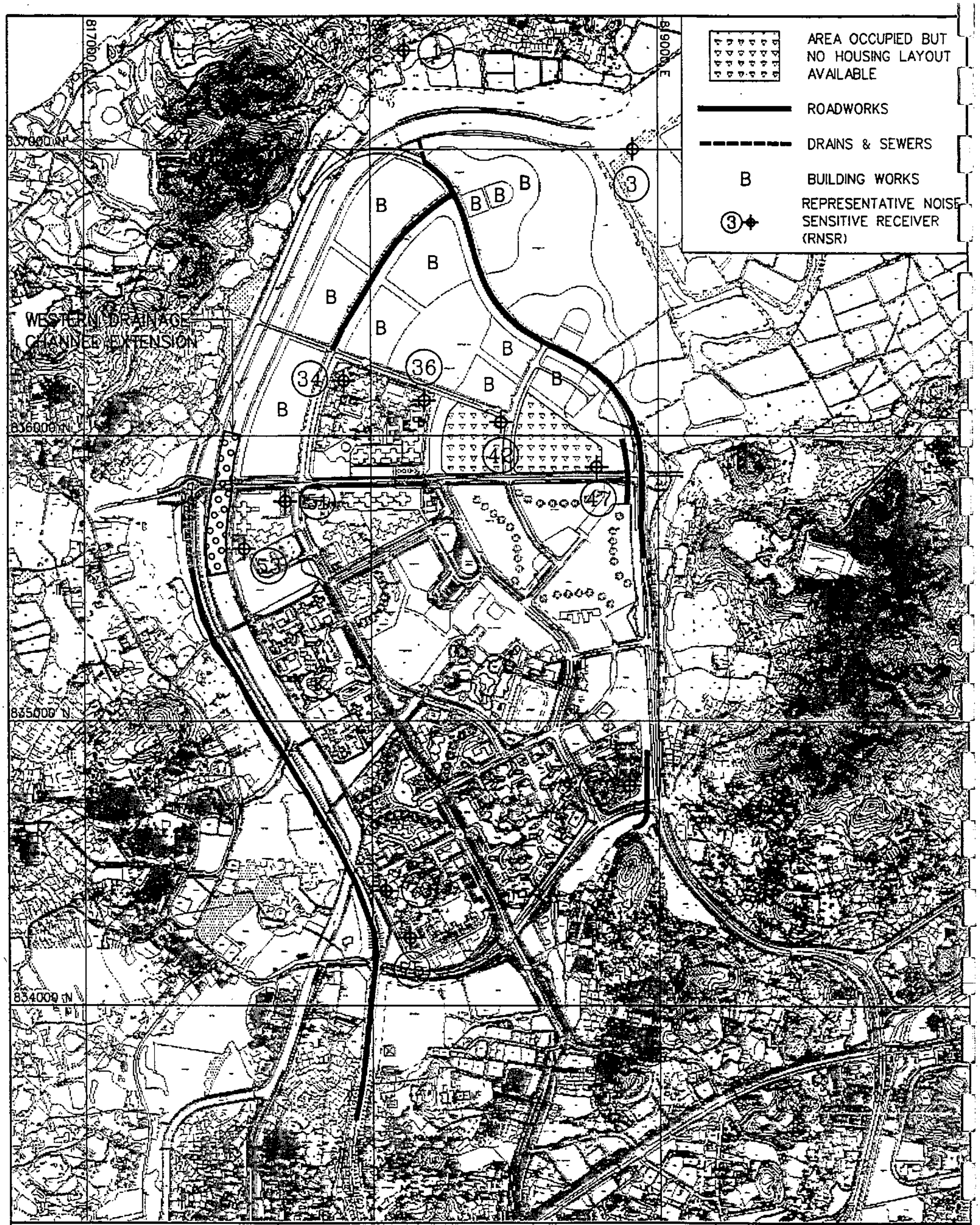

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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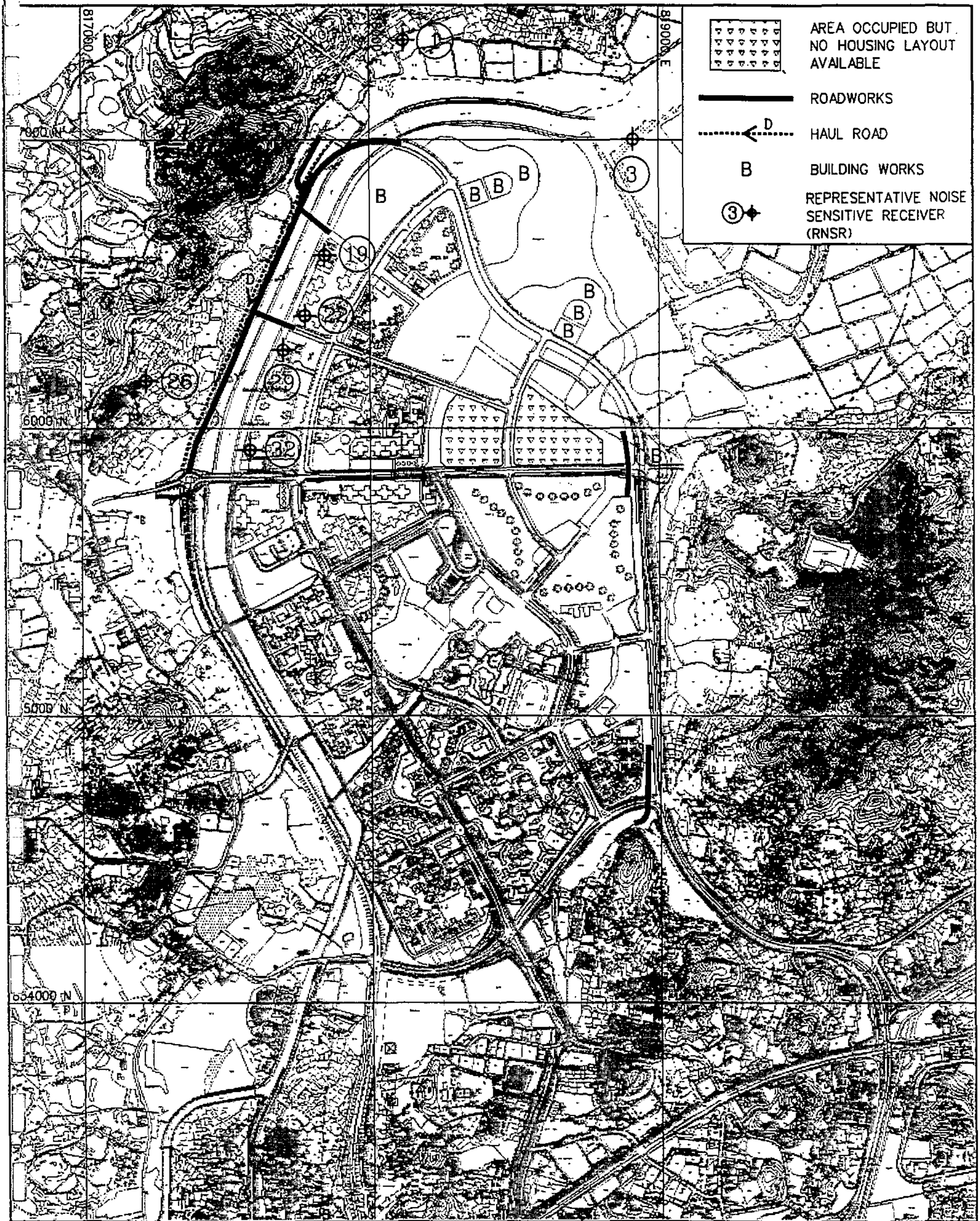
Title :

CONSTRUCTION NOISE CALCULATION SCENARIO 8 (JAN-JUN 2001)

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No.	Revision
4.1.8	0
Reference: TSW-BASE	File Name: 02160018.C09
Prepared: MC	Checked: PS
Date: DEC. 96	Scale: N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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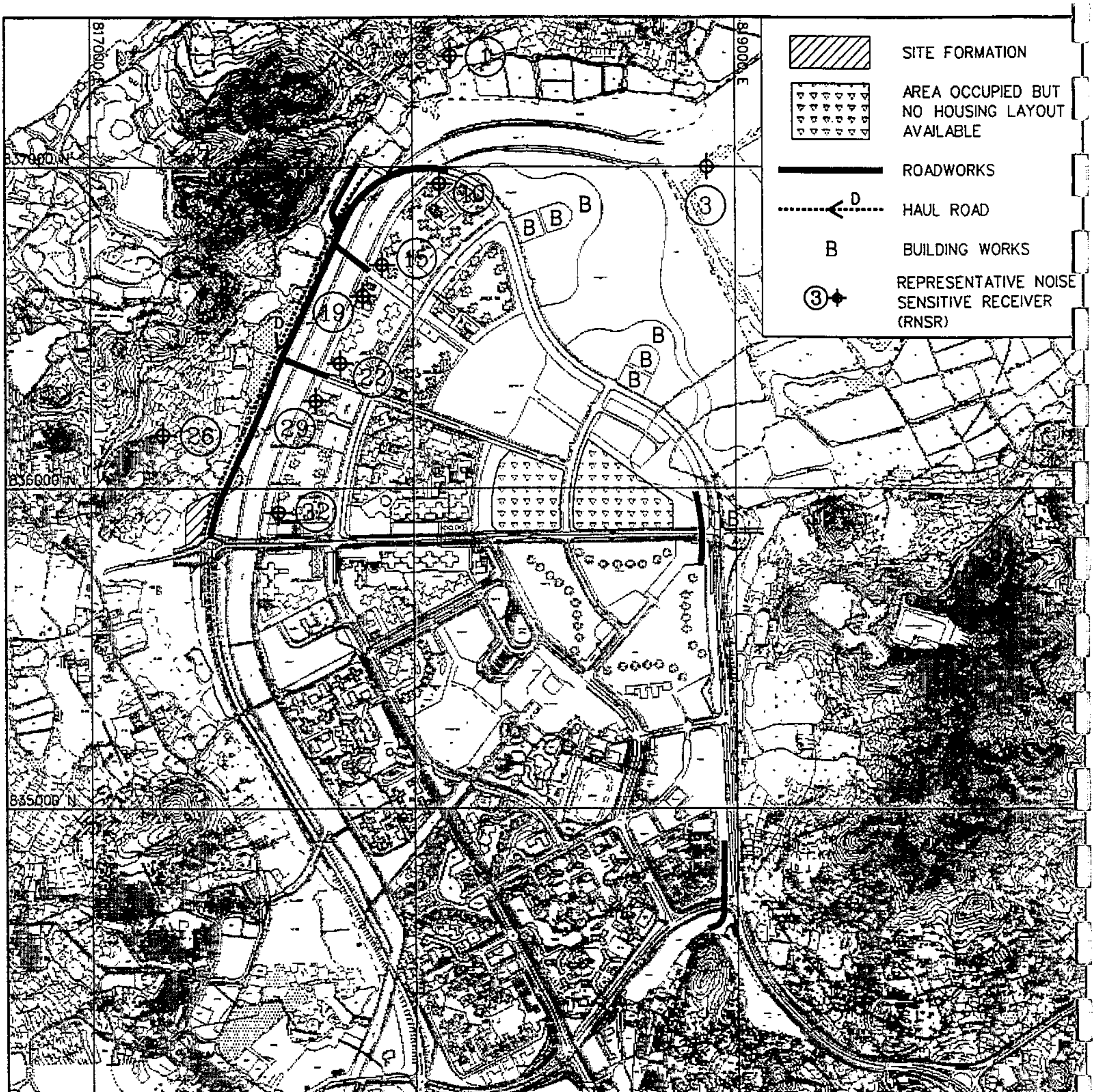
Title :

CONSTRUCTION NOISE CALCULATION SCENARIO 9 (JUL–DEC 2001)

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No.	Revision
4.1.9	0
Reference: TSW-BASE	File Name: 02170018.C09
Prepared: MC	Checked: PS
Date: DEC. 96	Scale: N.T.S.



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Title :

CONSTRUCTION NOISE CALCULATION SCENARIO 10 (JAN-JUL 2002)

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No.	Revision
4.1.10	0
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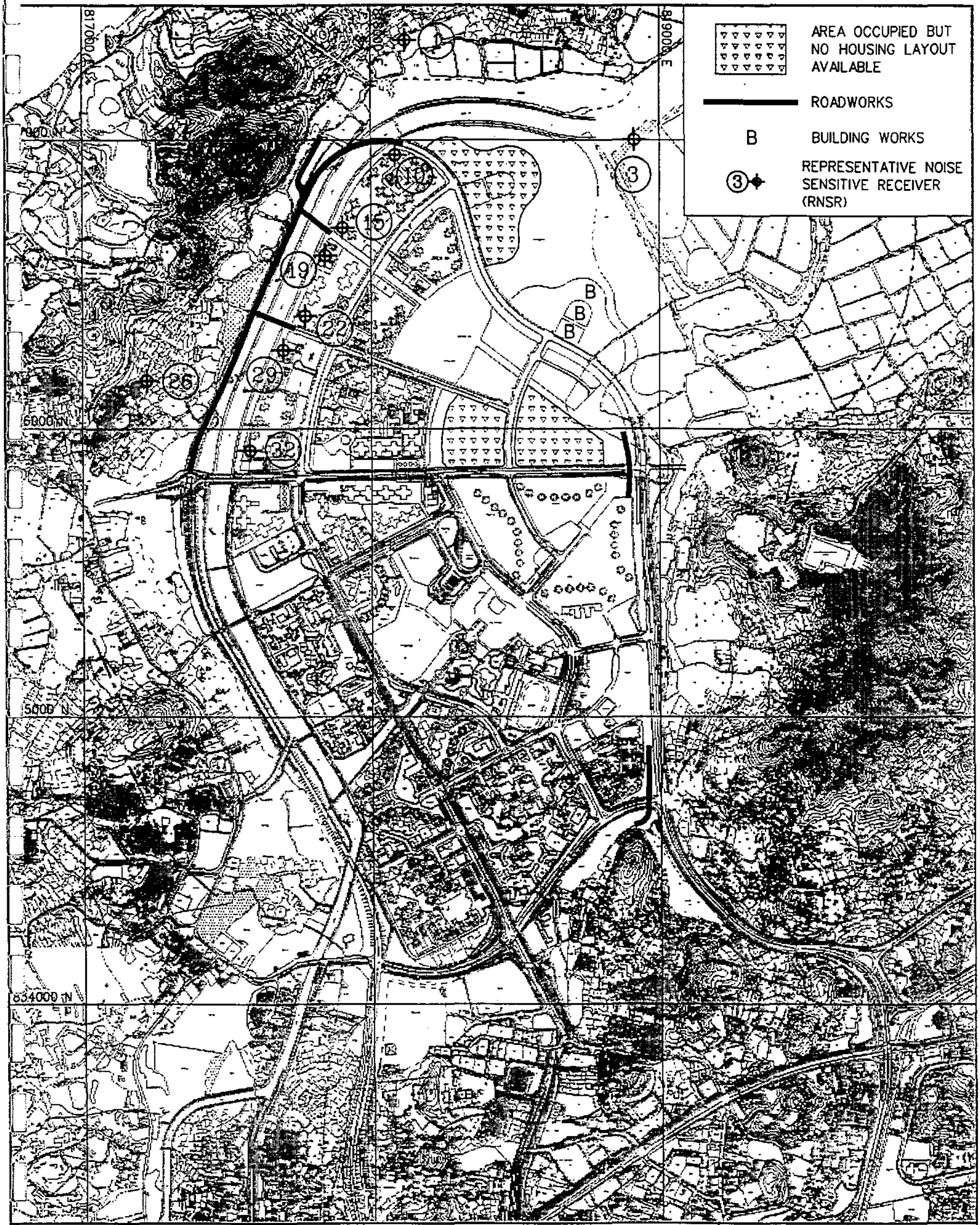
Prepared: MC	Checked: PS
Date: DEC. 96	Scale: N.T.S.



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Title :

CONSTRUCTION NOISE CALCULATION SCENARIO 11 (AUG 2002–AUG 2003)

Note : Housing layout from HD as of July 1996.
[Occupation dates based on recommended implementation programme version 2.1]

Figure No.	Revision
4.1.11	0
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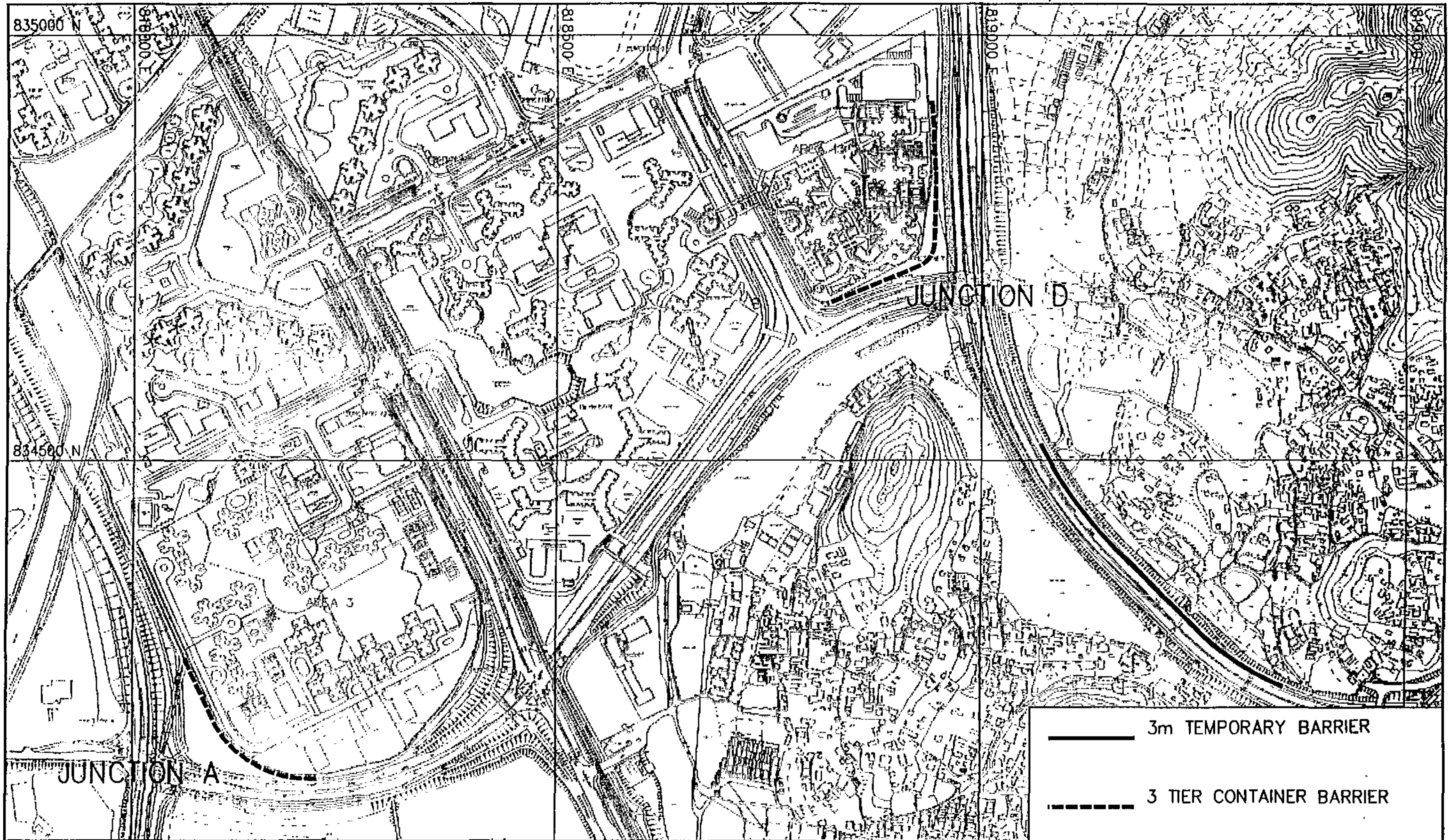
Prepared	**Checked**
MC	PS
Date	**Scale**
DEC. 96	N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
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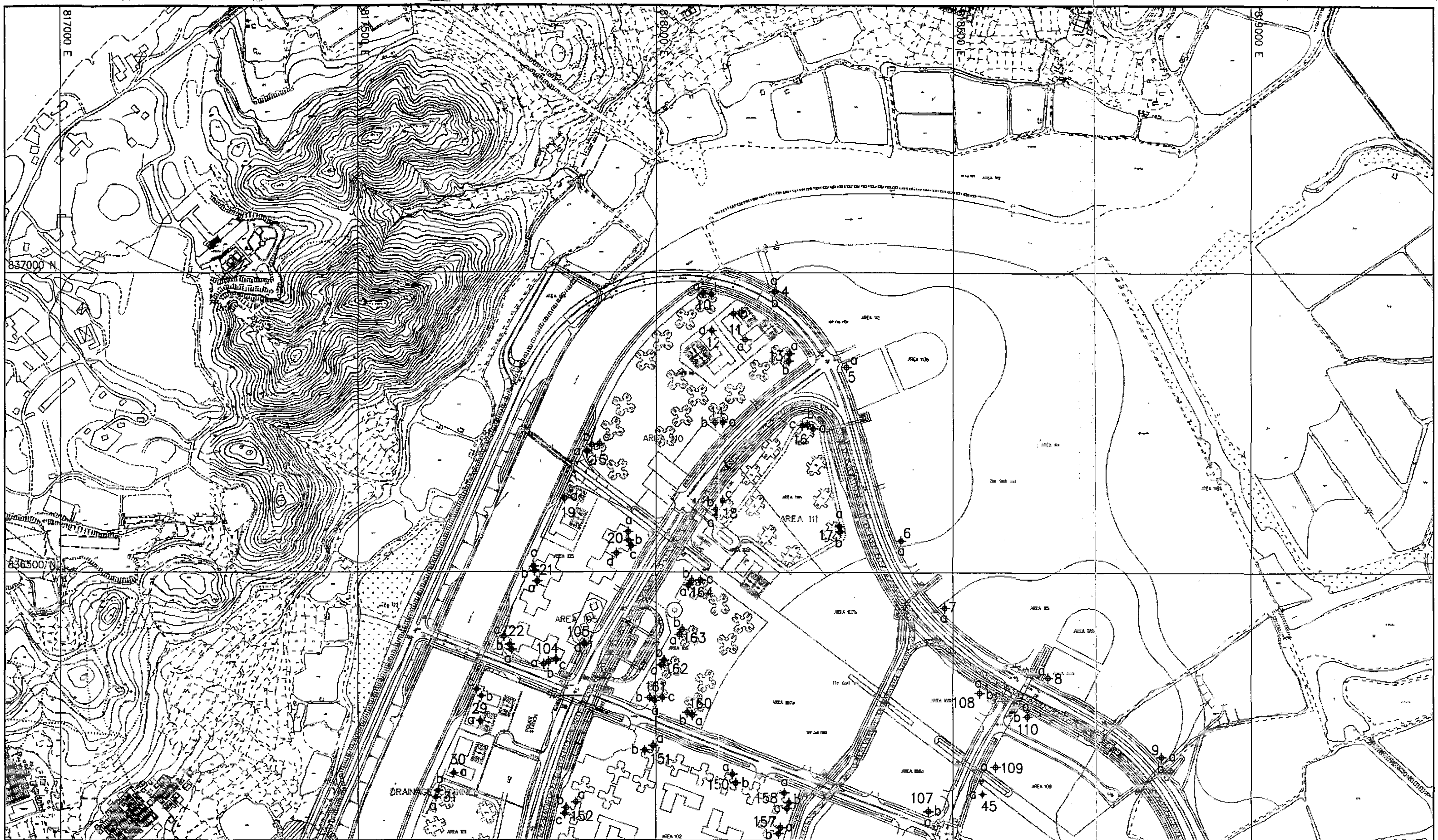
Title :

LOCATION OF NOISE BARRIERS DURING CONSTRUCTION STAGE

Figure No. 4.1.12	Revision 1
Reference TSW--BASE	File Name 01400018.C09
Prepared MC	Checked PS
Date JAN 97	Scale 1 : 6000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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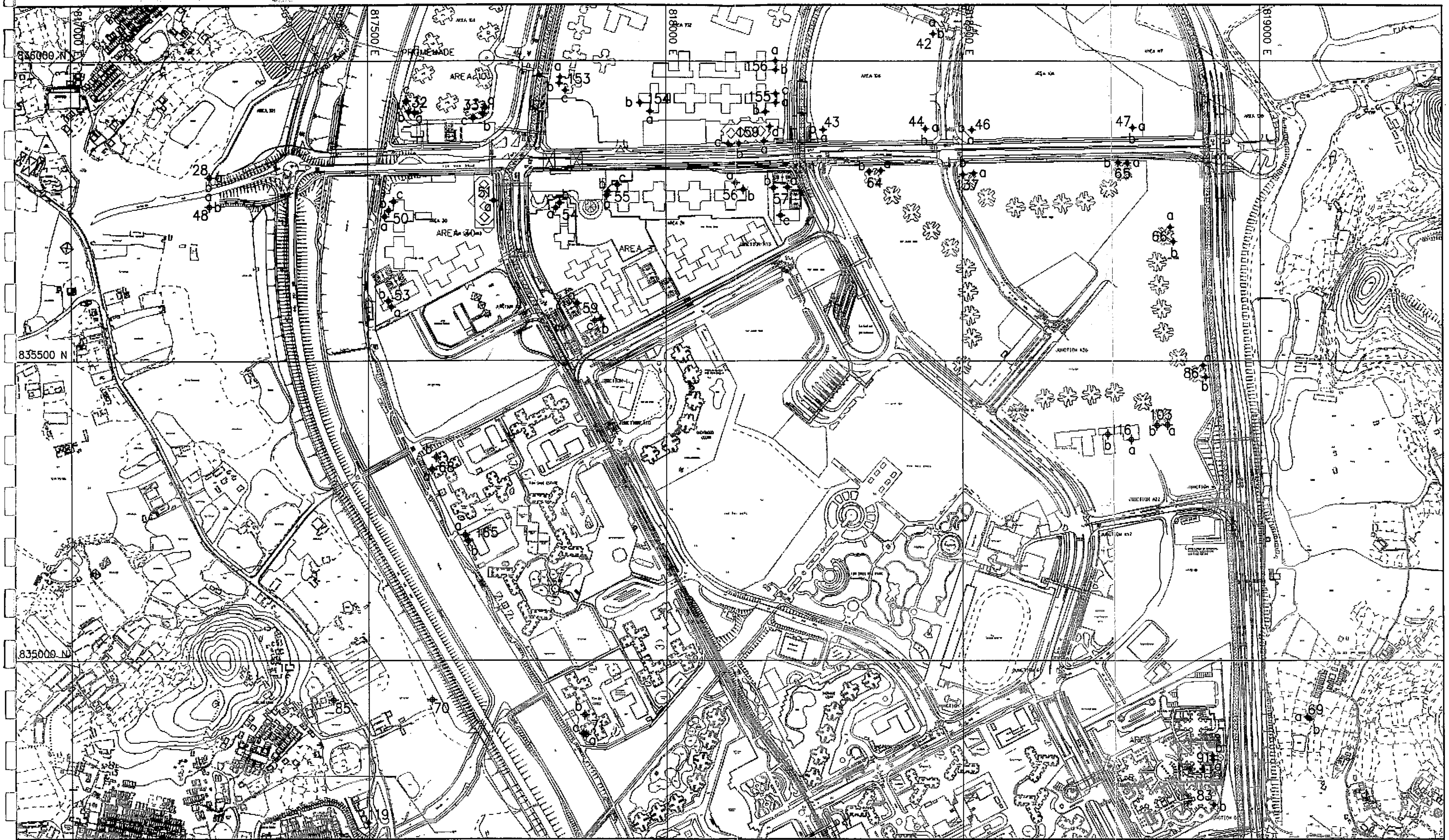
Title :

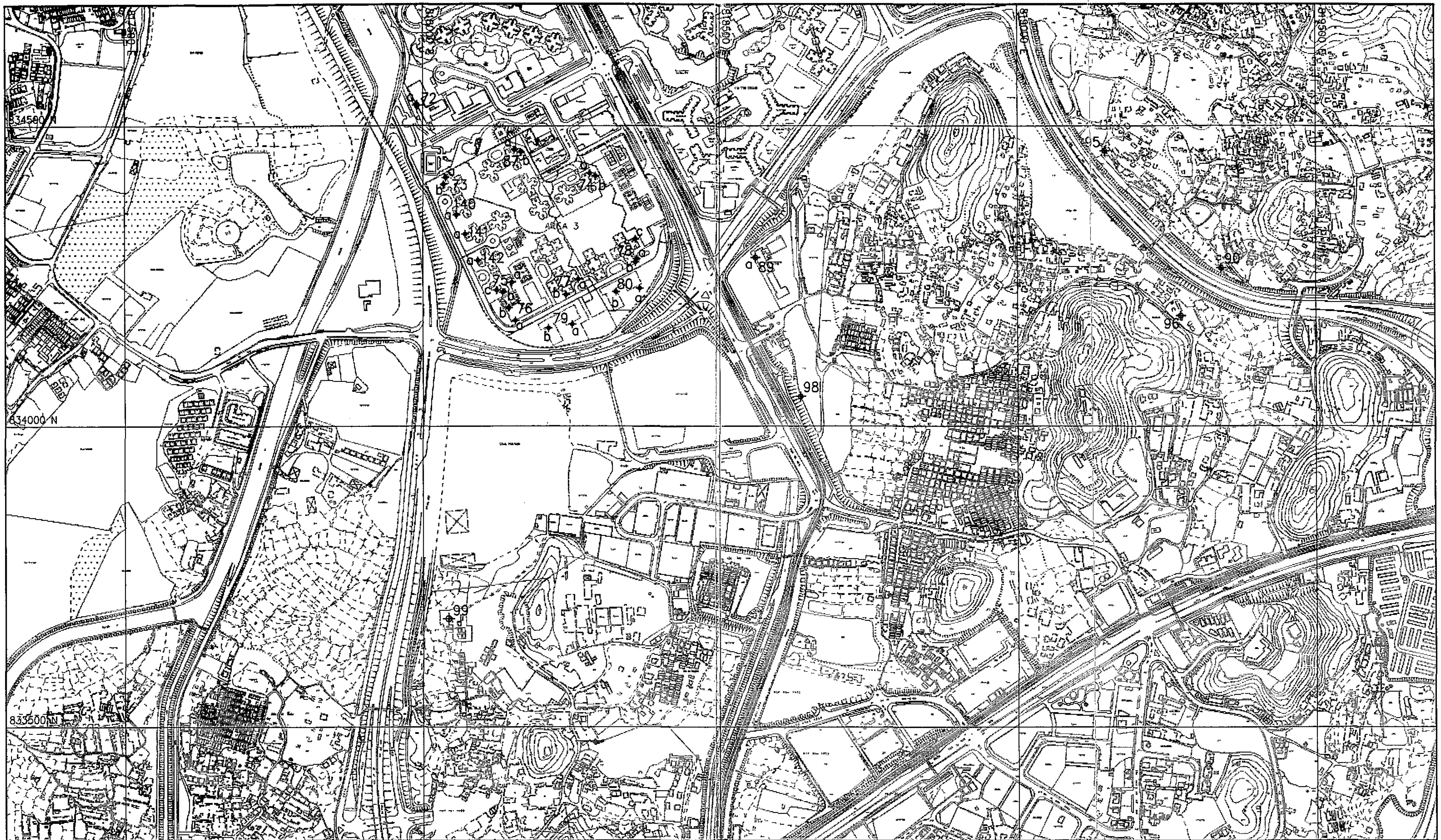
FACADE ORIENTATION OF THE REPRESENTATIVE NOISE SENSITIVE RECEIVERS – SHEET 1

Note: Housing layout from HD as of July 1996. Area 102 and 106 layout from HD as of December 1996.

Figure No. 4.2.1	Revision 0
Reference No. TSW-BASE	File Name 02380018.C09
Prepared WYC	Checked PS
Date FEB. 97	Scale: N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : FACADE ORIENTATION OF THE REPRESENTATIVE NOISE SENSITIVE RECEIVERS - SHEET 2	Figure No. 4.2.2	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 02390018.C09
		Prepared WYC	Checked PS
	Note: Housing layout from HD as of July 1996. Area 102 and 106 layout from HD as of December 1996.	Date FEB. 97	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
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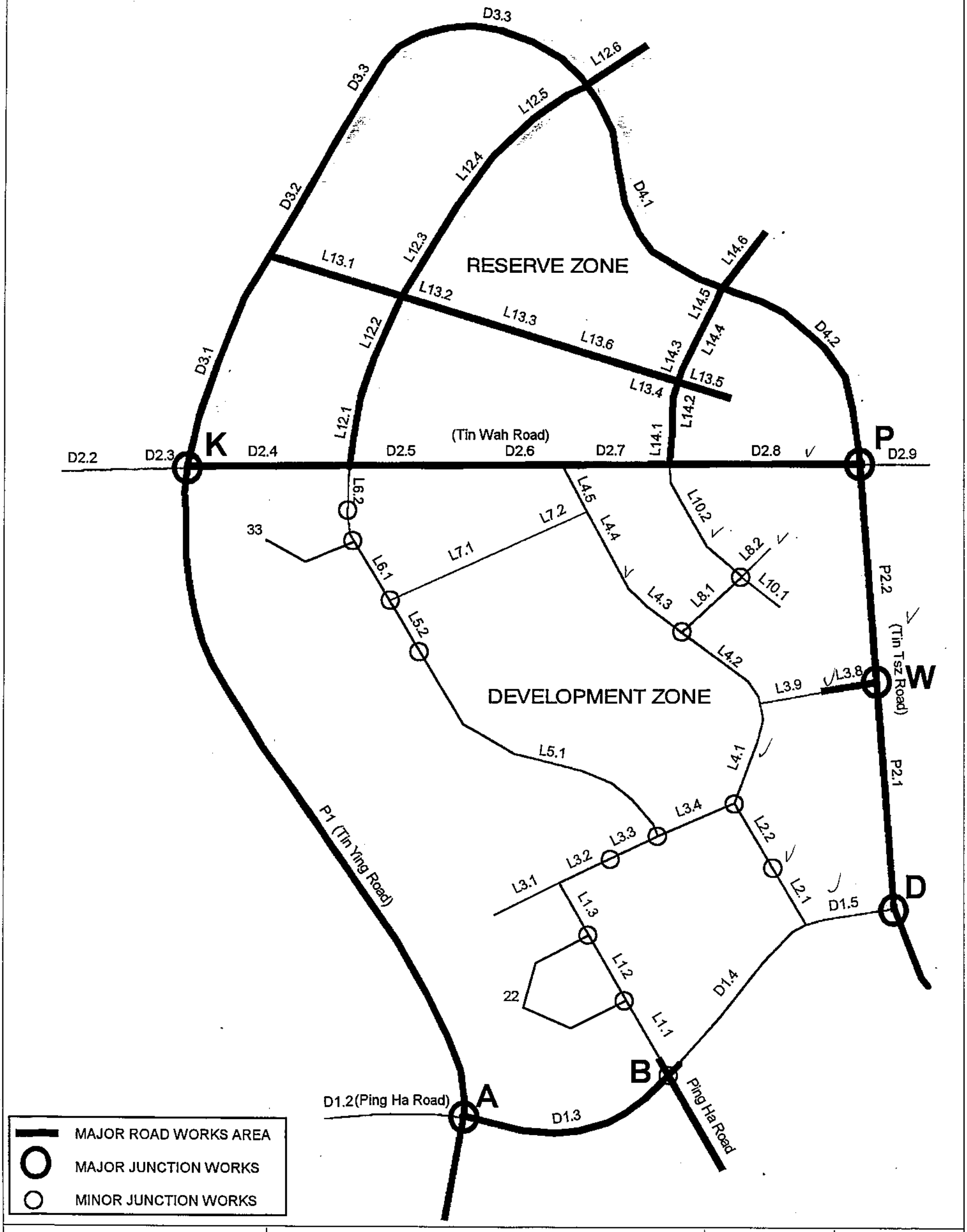
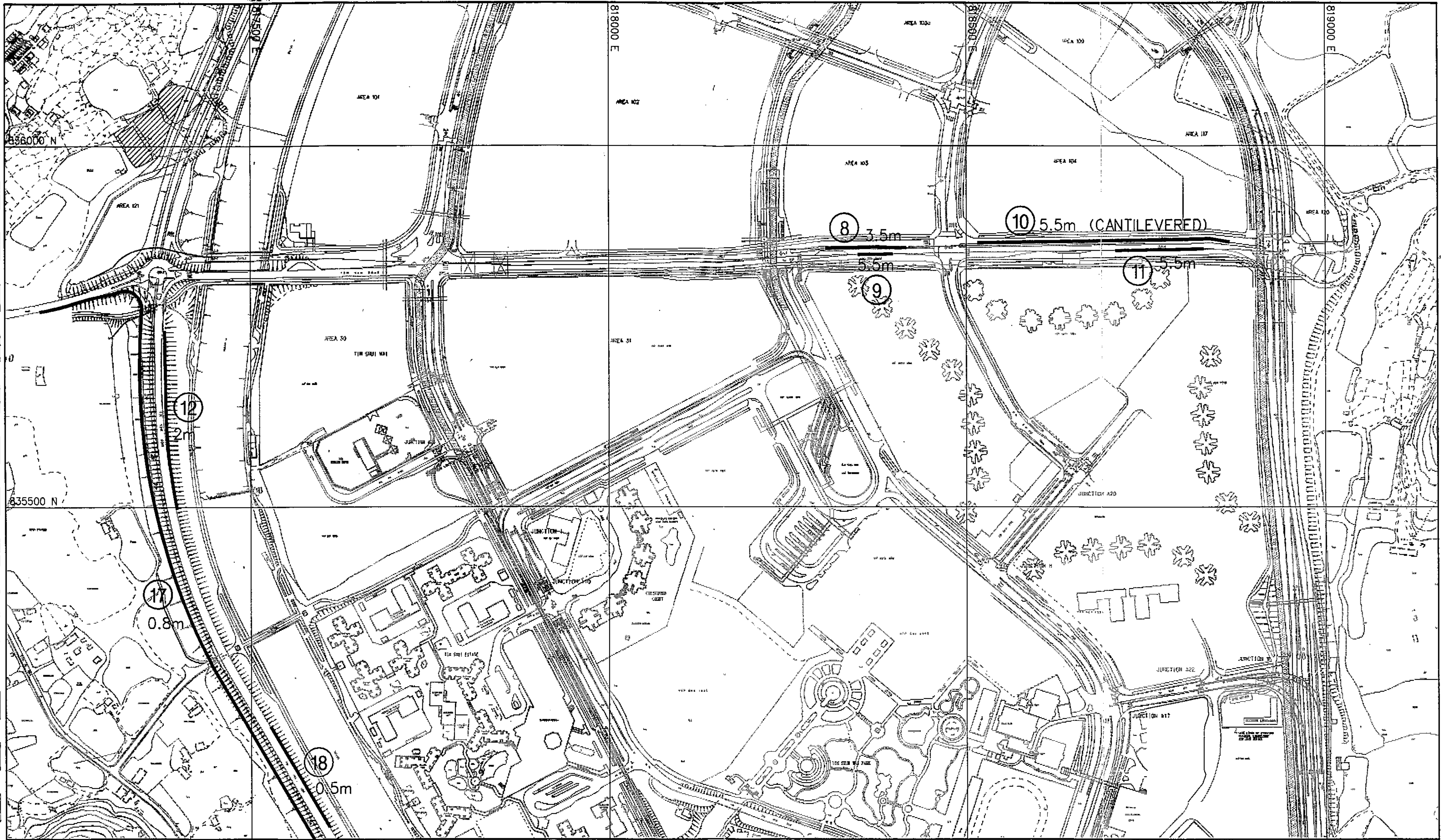
Title :

FACADE ORIENTATION OF THE REPRESENTATIVE NOISE SENSITIVE RECEIVERS – SHEET 3

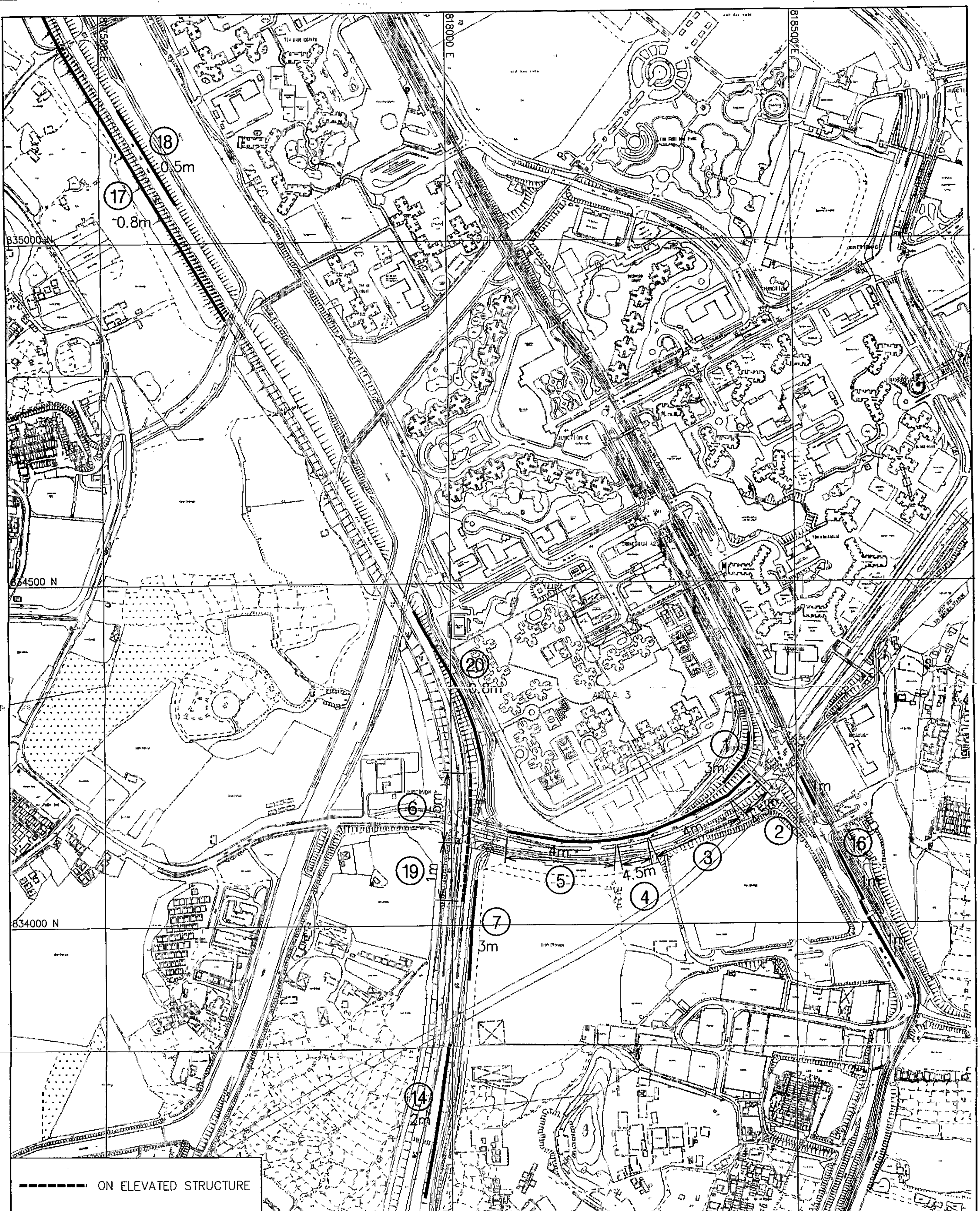
Figure No. 4.2.3	Revision 0
Reference TSW–BASE	File Name 02400018.C09
Prepared WYC	Checked PS
Date FEB. 97	Scale N.T.S.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : ROAD NOMENCLATURE AND MAJOR WORKS AREAS	Figure No. 4.2.4	Revision 1
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference No. -	File Name RD_WORK.PRS
		Prepared MC	Checked WYC
		Date JAN 97	Scale NTS



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : LOCATION AND HEIGHTS OF NOISE BARRIERS	Figure No. 4.2.5	Revision 4
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 02370018.C09
		Prepared WYC	Checked BH
		Date MAR. 97	Scale N.T.S.



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		Reference TSW-BASE	File Name 02340018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	LOCATION AND HEIGHTS OF NOISE BARRIERS	Prepared WYC	Checked BH
		Date MAR. 97	Scale N.T.S.

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : LOCATION AND HEIGHTS OF NOISE BARRIERS	Figure No. 4.2.7	Revision 5
		Reference TSW–BASE	File Name 02310018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 賓尼 ENGINEERS AND SCIENTISTS		Prepared WYC	Checked BH
		Date MAR. 97	Scale N.T.S.

5 VISUAL IMPACT ASSESSMENT

5.1 Introduction

5.1.1 This section assesses the principal visual impacts of works associated with the Project. Works and designs have not been finalized, but in order to best illustrate mitigative methods for the purposes of this EIA, each sample location is examined in detail to address any visual impact that arises during the construction stage and the operation stage based on the best information available to date. With this arrangement, any adverse impacts on visual quality can best be mitigated utilizing the combinations of various measures described throughout this section.

5.1.2 The section assesses the physical forms of the works proposals and establishes the degree to which it will be visible from the surrounding areas. By identifying affected receptors, it establishes the degree of visual impact on the local population. The section also concludes by making specific recommendations for reducing the visual impact of the Project, and improving visual compatibility with the surrounding area. The findings in this section will be taken into account during detailed design.

5.2 Methodology

5.2.1 In line with other sites investigated in Hong Kong, a 3 km radius has been taken around the site. Beyond this distance, visual impact becomes relatively insignificant. Within the 3 km radius, the zone of visual influence may be restricted by existing vegetation and buildings and the height of much of the surrounding landscape.

5.2.2 Having identified the zones of visual influence, it is possible to identify the potential visual receptors within these zones as in Plate 5.1 and assess their relative sensitivity in the context of potential visual intrusion in association with the study area. For the purpose of this study, the potential visual receptor may be grouped into five categories: (i) those who view the proposed study area from their homes; (ii) those who view the proposed study area while taking part in an outdoor leisure activity; (iii) those who view the proposed study area from their working place; (iv) those who view the proposed study area from their place of study; and (v) those who view the proposed study area while travelling along a public thoroughfare.

(i) Those who view the proposed study area from their home are considered to be the most affected by any visual intrusion associated with the Project. This is because the view from the home will have a significant effect on the home dweller's perception of quality and acceptability of their home environment, and their general quality of life.

(ii) Those who can see the proposed study area while taking part in an outdoor leisure activity, are considered more or less sensitive depending on the type of activity being enjoyed. Countryside walkers, for example, are quite concerned about the quality of their surrounding environment.

(iii) Those who view the study area from their workplace, are considered to be less affected by potential visual intrusion than those in the first two categories. This is because they are employed in activities where visual outlook plays a less important role in the perception of the working environment.

(iv) The degree of sensitivity of those who view the study area from the place of study, depends to a large extent on the time of the day. The external view will be of less significance than the first and second categories.

(v) The final category of visual receptors, comprises those who view the study area while travelling along a public thoroughfare. The degree of sensitivity of these receptors depends on the speed of travel and whether the view is continuous or occasional. Generally, the slower the speed of travel and the more continuous the viewing experience, then the greater the degree of sensitivity.

5.2.3 The significance of the visual influence on these visual receptors may vary greatly and is dependent on the complex interrelationship of a number of factors including:

(i) the nature of the study area and its context with the surrounding landscape;

(ii) the number of visual receivers;

(iii) the category or type of visual receivers as discussed above;

(iv) the distance of the visual receiver from the study area;

(v) the landscape context of the study area;

(vi) the length and duration of time the proposed development is in view;

(vii) the particular visual backdrop to the development from specific important view points; and

(viii) whether the study area blocks attractive views or screens unattractive ones.

5.3 View Analysis

5.3.1 Using the above concepts, sample Areas within the study area have been tested for visual quality from receptors. Plate 5.1 shows the locations selected for analysing the visual impact of the development. Subsequent plates illustrating a comparison between the current scenario and the artist's impression of the development are identified numerically on Plate 5.1.

5.3.2 The following Table 5.1 summarised the visual impact of the development on the previously described receptor categories, and proposes measures to mitigate the predicted impacts.

Table 5.1
Visual Impact Assessment Summary Table of the Areas/Works, Receptors and Proposed Mititgation Measures

Areas/Works	Receptor Location	Receptor Category					Mitigation Measures					
		Domestic	Leisure	Worker	Student	Commuter	Semi Transparent Barrier	Planter Type Barrier	Tall Canopy Tree	Broad Canopy Tree	Shrubs	Hydroseeding
Long Tin Road East (1 m noise barrier)	-					*		*			*	
Long Tin Road West (1.5 m noise barrier)	- Ping Shan	*		*		*	*			*	*	
Ping Ha Road East (1 m noise barrier)	- Sheung Cheung Wai - School				*	*		*			*	
Tin Yiu Road West (L1) (3 m noise barrier)	- Area 3 - Tin Yiu Estate - School in Tin Yiu Estate - School in Area 3	*			*	*	*		*		*	
Ping Ha Road North (D1) (4 m, 4.5 m noise barrier)	- Area 3 - School in Area 3 - Open storage sites	*		*	*	*	*		*		*	
Hung Tin Road East (2 m noise barrier)	- Open storage sites			*		*	*			*	*	
Hung Tin Road East (3 m noise barrier)	- Area 3 - Open storage sites	*		*		*	*		*			
Tin Ying Road East (P1) (1 m, 1.5 m noise barrier on flyover)	- Area 3 - Open storage sites	*		*		*	*					
Tin Ying Road East (P1) (2 m noise barrier)	- Area 30 - Open storage sites	*	*			*	*			*	*	

Table 5.1
Visual Impact Assessment Summary Table of the Areas/Works, Receptors and Proposed Mititgation Measures (cont'd)

Areas/Works	Receptor Location	Receptor Category					Mitigation Measures					
		Domestic	Leisure	Worker	Student	Commuter	Semi Transparent Barrier	Planter Type Barrier	Tall Canopy Tree	Broad Canopy Tree	Shrubs	Hydroseeding
Tin Wah Road (D2) (3.5 m, 5.5 m noise barrier)	- Kingswood Villas - Areas 103, 104, 117a	*				*	*			*	*	
Tin Ying Road West (P1) (0.8 m noise barrier)	- Area 30 - Area 101 - Tin Shui Estate	*			*	*		*			*	
Tin Ying Road East (P1) (0.5 m noise barrier)	- Tin Shui Estate - School at Tin Shui Estate	*			*	*		*			*	
Tin Ying Road/Ping Ha Road junction elevated flyover	- Area 3	*	*						*			
	- Area 3 School				*					*		
	- Tin Ying Road					*				*	*	
	- Open storage site (CDA)			*								
	- West Rail					*			*		*	
Widening of Tin Ying Road dual carriageway	- Tin Shui Estate	*								*	*	
	- Tin Oi Court	*								*	*	
	- Area 3	*							*			
	- Area 30	*							*			
	- Open storage sites			*						*		
Tin Ying Road/Tin Wah Road junction elevated flyover	- Area 30	*							*			
	- Sha Kong Wai	*							*			
	- Western Drainage Channel		*							*		

Table 5.1
Visual Impact Assessment Summary Table of the Areas/Works, Receptors and Proposed Mititgation Measures (cont'd)

Areas/Works	Receptor Location	Receptor Category					Mitigation Measures					
		Domestic	Leisure	Worker	Student	Commuter	Semi Transparent Barrier	Planter Type Barrier	Tall Canopy Tree	Broad Canopy Tree	Shrubs	Hydroseeding
Tin Tsz Road/Tin Wah Road junction elevated flyover	- Kingswood Villas	*							*		*	
	- Area 104	*							*		*	
	- Fung Lok Wai	*								*	*	
Site formation of Areas 101, 103 to 111 in RZ	- Tin Shui Estate	*										*
	- Kingswood Villas	*										*
	- Sha Kong Wai	*							*			*
	- Mong Tseng Tsuen	*										*
	- Mong Tseng Wai	*										*
	- Lam Tsui Shan		*									*
	- Fung Lok Wai	*										*
	- Kai Shan		*									*
	- Area 30	*										*
	- Area 31	*										*
	- Area 102	*										*
Infrastructure of Areas 101, 103 to 111 in RZ	-	*							*		*	
Elevated bridge two across WTC	- Mong Tseng Wai	*										
	- Mong Tseng Tsuen	*							*			
LRT reserve	- Areas 102-111, 117	*	*									*
Box culvert extension of ETC	- Fung Lok Wai	*								*	*	
Drainage reserve	- Kingswood Villas	*										*

5.4 Summary of Recommendations

General

5.4.1 Hydroseeding is recommended on the site formation areas, to reduce the visual intrusion and dust impacts, where works are unlikely to commence within 3 months. Tall canopy trees with shrub planting are proposed wherever practicable on the amenity strips to improve the visual quality. Planting work is also recommended around the columns of the proposed flyovers to screen these massive structures from view. Plantings would not be attached to the columns but confined to the outskirt areas to allow access to the columns by Highways Department (HyD) maintenance staff. The detailed landscaping designs for the road reserves will be discussed with HyD during the detailed design phase.

Noise Barrier

5.4.2 Where noise barriers are required to reduce the noise intrusion, then these noise barrier should blend with the surrounding environment.

5.4.3 For the high barriers, i.e. 1.5 m and above, installation of clear plexiglass panels with horizontal lines and set in a metal framework is recommended. These horizontal lines are considered unintrusive to the human population, but should be of sufficiently high visibility to avoid bird kills due to impacts in flight. Coloured glass is not recommended where the background is distant.

5.4.4 The metal frame for the noise barrier should blend in with the surrounding environment. For example, where the noise barrier is remote from sensitive receivers, the metal frame could be grey or any other suitable colour to tie in with other roadway structures and street furniture. Where the noise barrier is adjacent to planting beds, the metal frame should be coated with natural colours in sympathy with the surrounding environment. All the finishes should be non-reflective and glare-reducing.

5.4.5 Low barriers of 1.5 m and below should, as far as possible, be incorporated into the form of planter walls. Shrub planting and creeper plants will help to soften the hard edges of these planter walls.

Western Temporary Channel

5.4.6 It is recommended that trees planted along WTC be retained as far as possible in order to maintain the current aesthetic quality. The architectural form of the bridges should be similar in visual characteristics to existing bridges for continuity. Tall canopy trees with shrub planting should be designed around the abutment of the bridges to screen these massive structures from view. Smooth surfaces, and light colour finishes reflecting glare, should be avoided.

LRT Reserve

5.4.7 Particular attention should be given to hydroseeding the LRT reserve in time to limit the visual impact on the surrounding Areas.

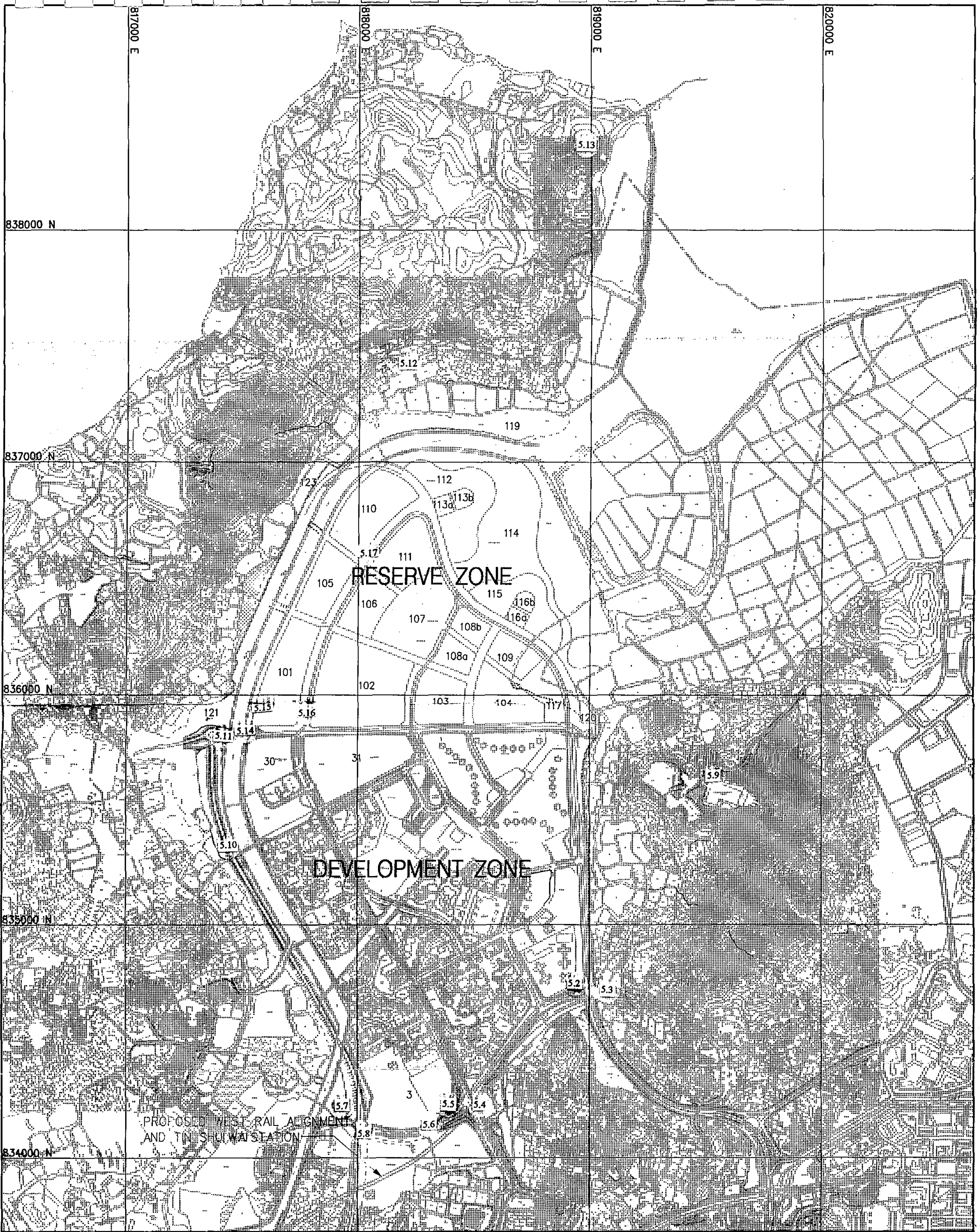
Eastern Culvert Extension

5.4.8 The embankment facing Fung Lok Wai should be planted with broad-canopy trees and shrubs to screen the structure from view.

5.4.9 An earth mound, varying from 0.5 m to 2 m in height, is proposed for the drainage reserve to provide the required visual barrier for the village of Fung Lok Wai. This is essential to compensate for the lack of tree planting on the drainage reserve.

5.5 Conclusion

5.5.1 In conclusion, the potential visual intrusion of the Project, including both the DZ and the adjoining RZ can be reduced with the adoption of the recommended mitigation methods.



TIN SHUI WAI DEVELOPMENT
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BINNIE CONSULTANTS LIMITED
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ENGINEERS AND SCIENTISTS
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Title :

LOCATION OF PHOTOMONTAGES

Key 5.2 Location of photomontage

Plate 5.1	Revision 0
Reference TSW-BASE	File Name 00770018.C09
Prepared Kenneth Ng & Associates	Checked PS
Date NOV 96	Scale 1 : 15000

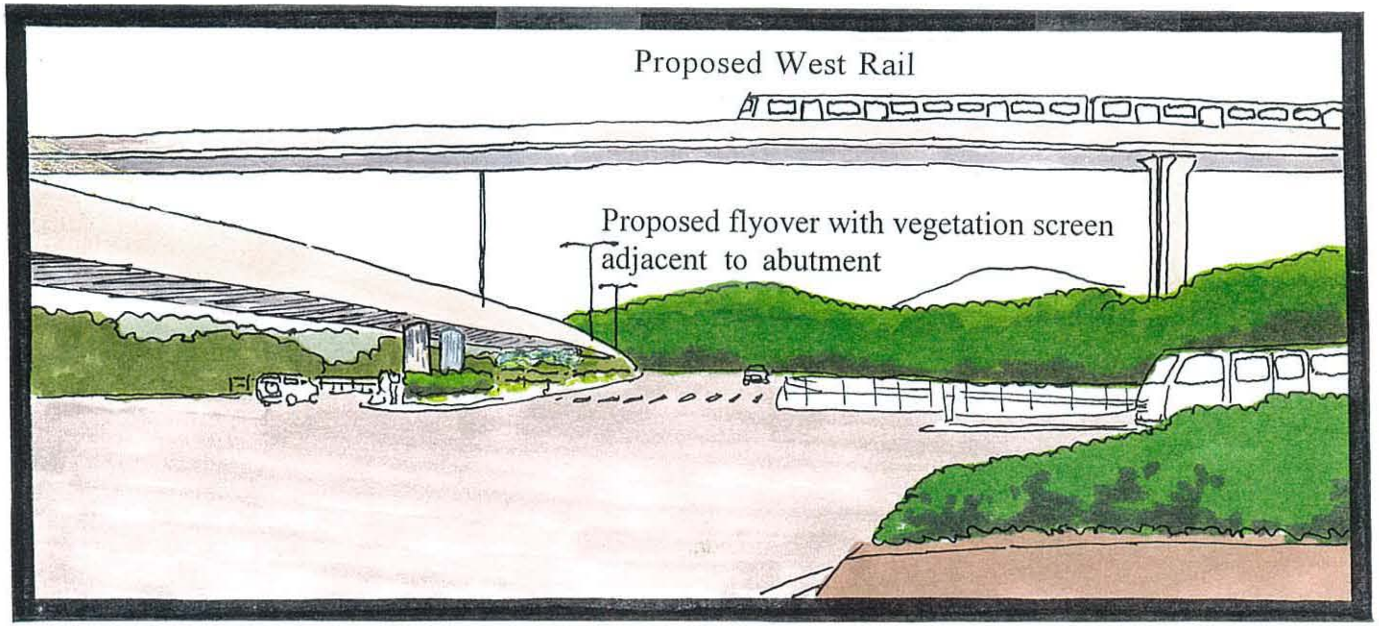


Plate 5.2 View of the flyover at the junction of Tin Fuk Road and Tin Tsz Road

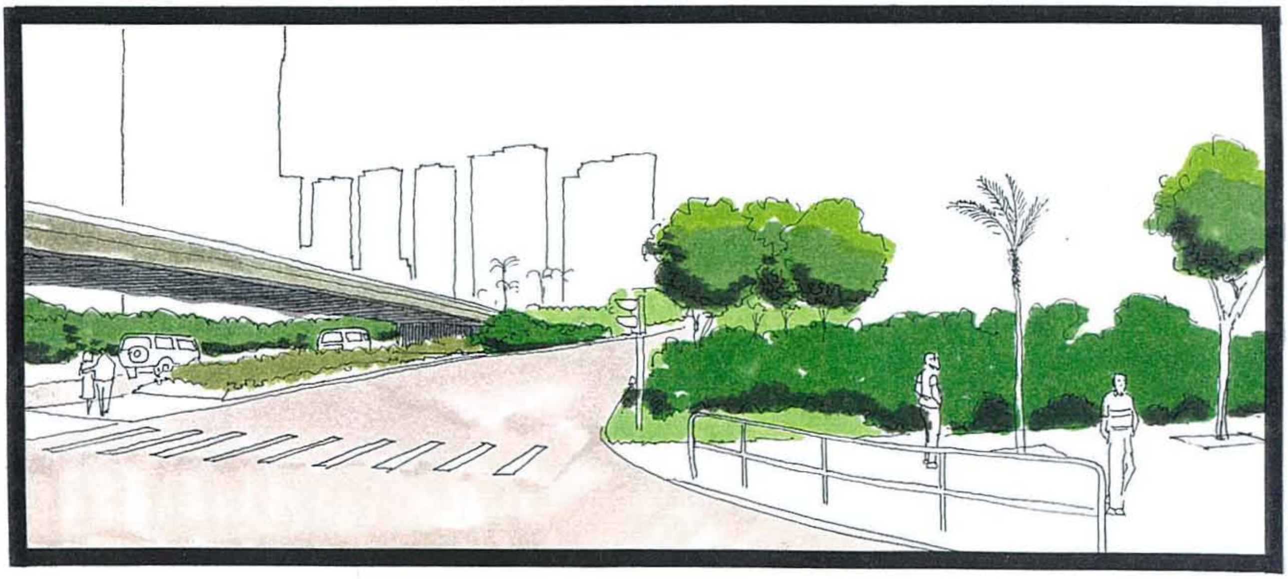


Plate 5.3 View of the proposed widened dual carriageway east of the Tin Tsz Road

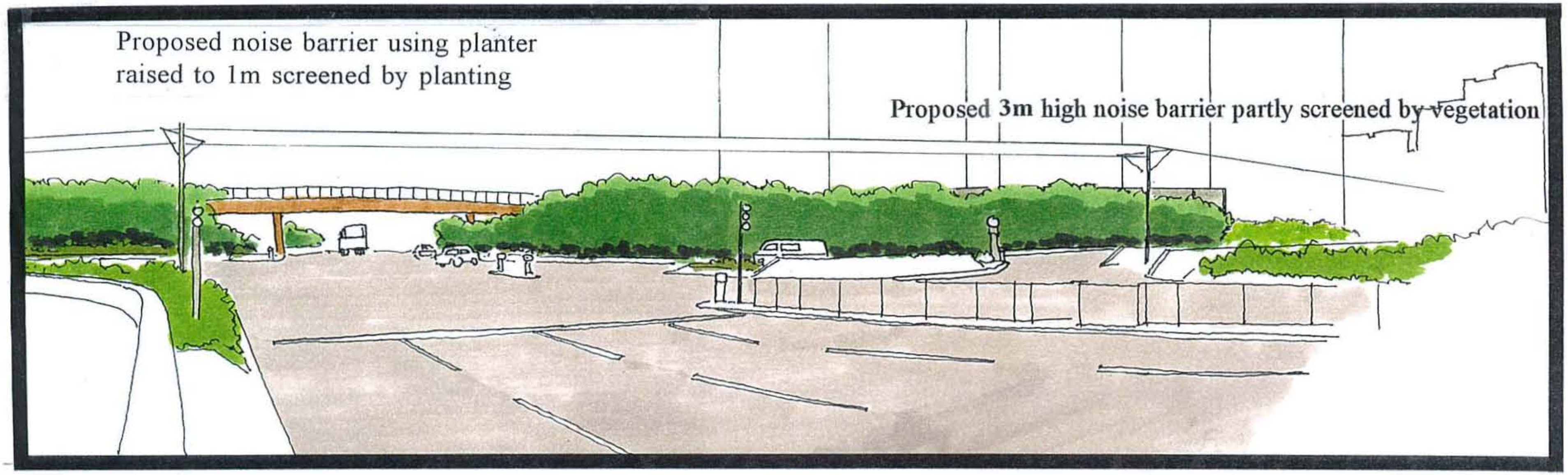


Plate 5.4 View of the proposed noise barrier along Tin Yiu Road

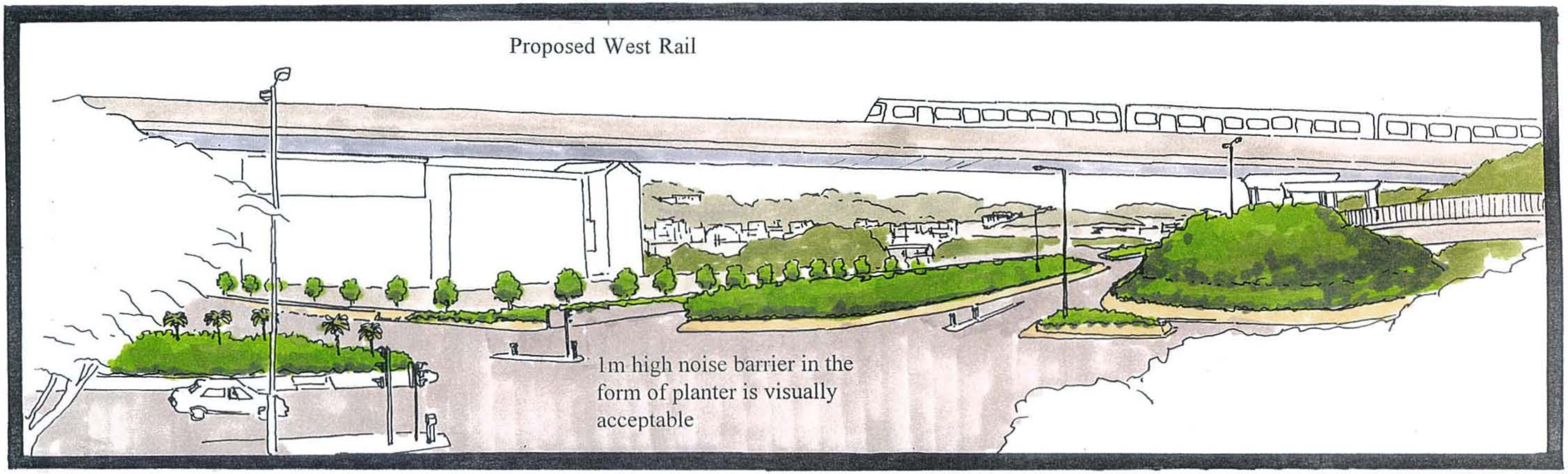


Plate 5.5 View of noise barrier along Ping Ha Road East

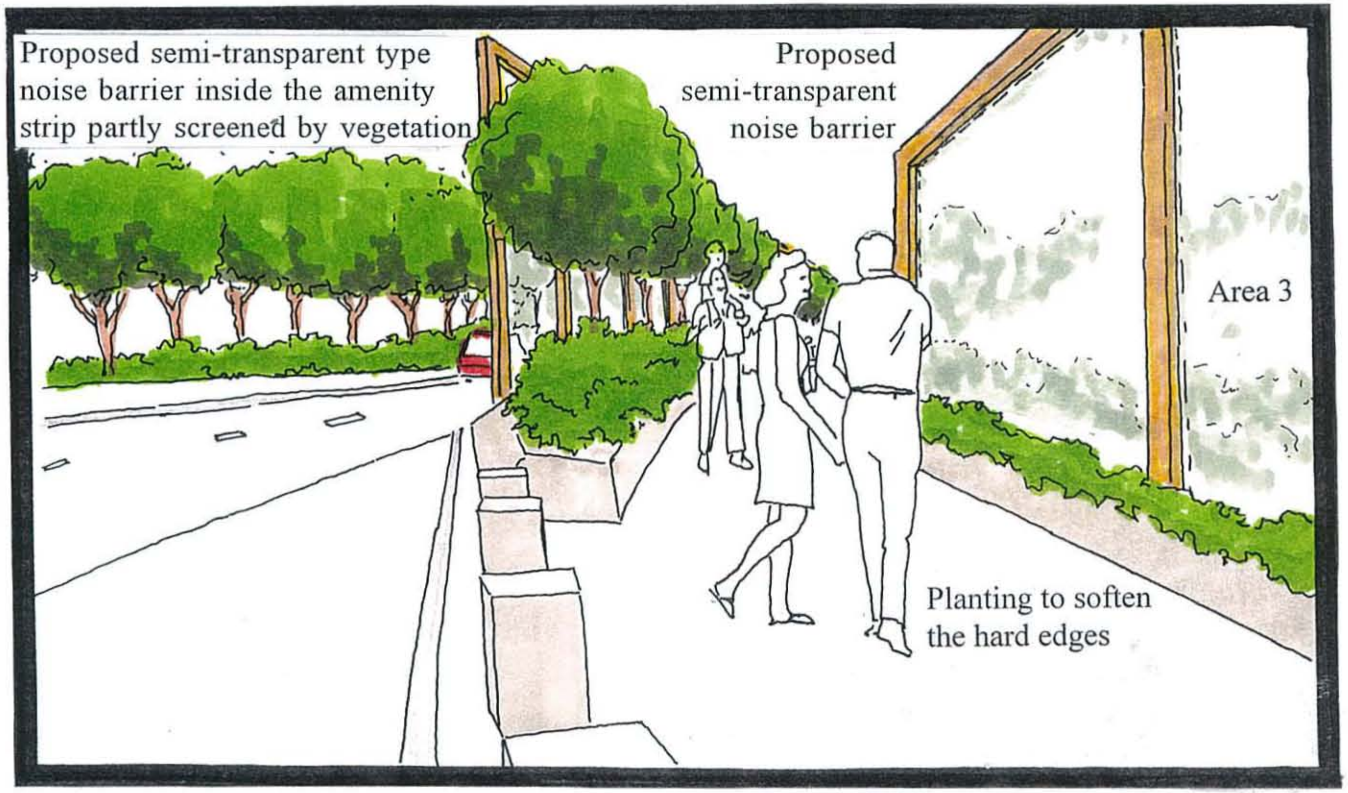


Plate 5.6 View of the proposed noise barrier along footpath of Ping Ha Road

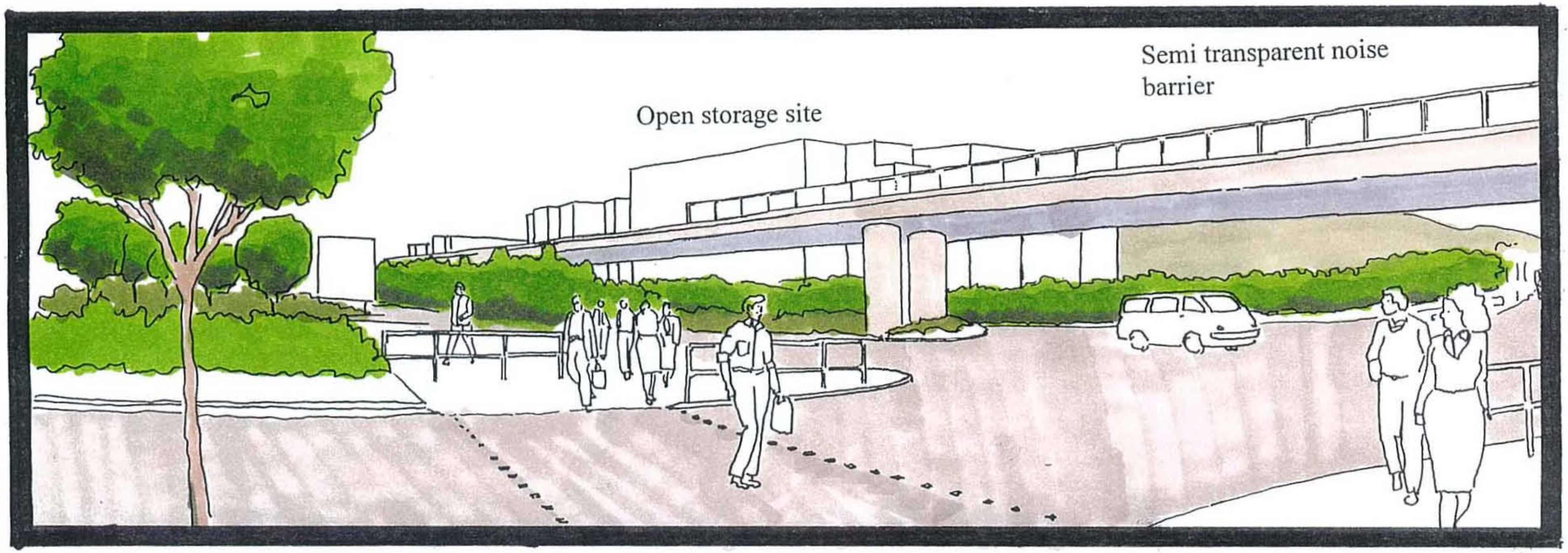


Plate 5.7 View of the widened Hung Tin Road

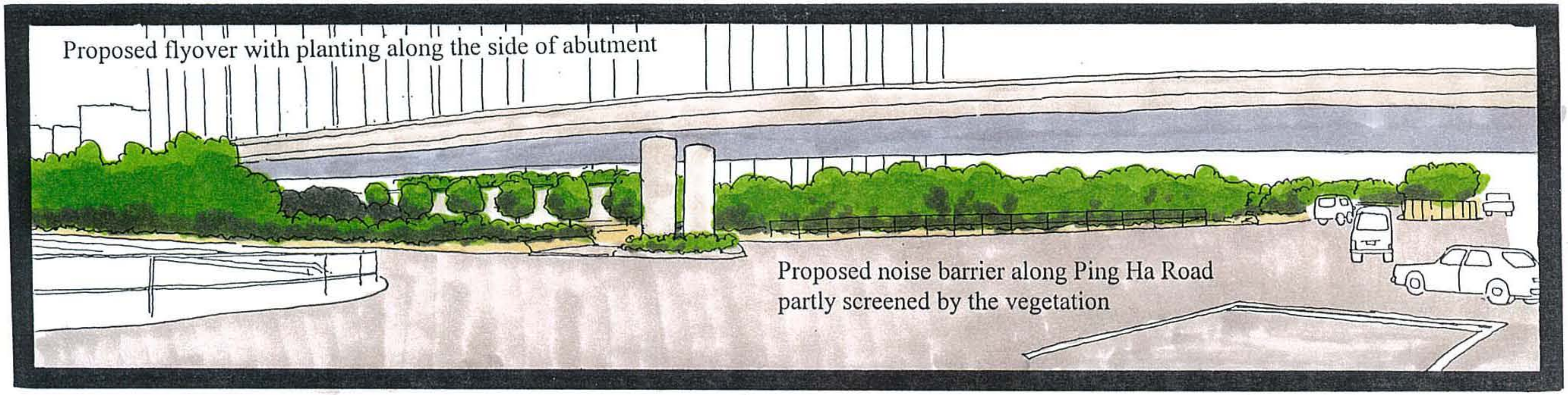


Plate 5.8 View of the flyover and the noise barrier at the junction of Ping Ha Road and Tin Ying Road

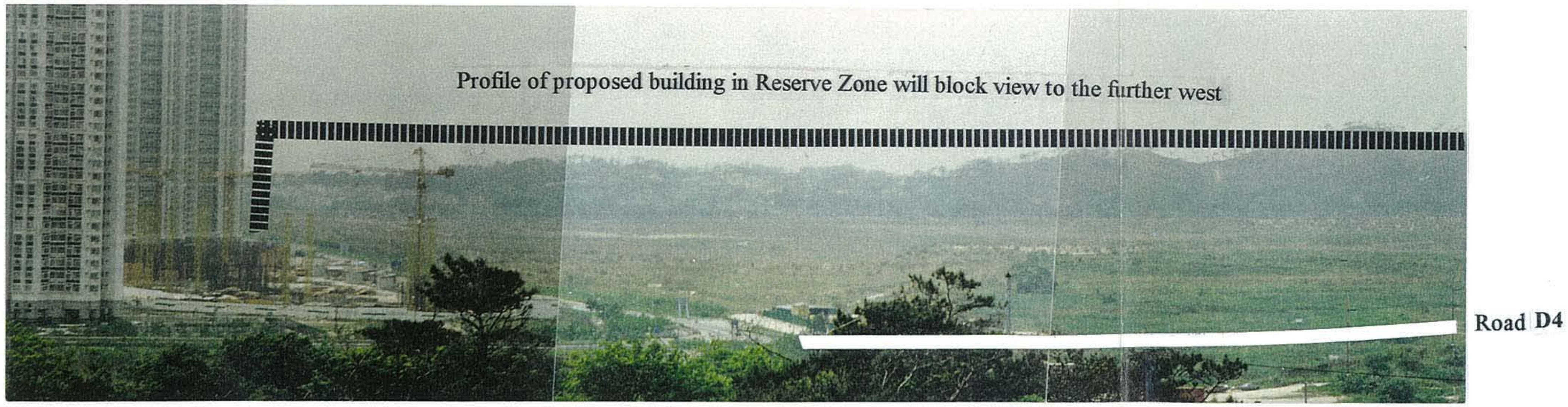


Plate 5.9 View of Reserve Zone from Kai Shan

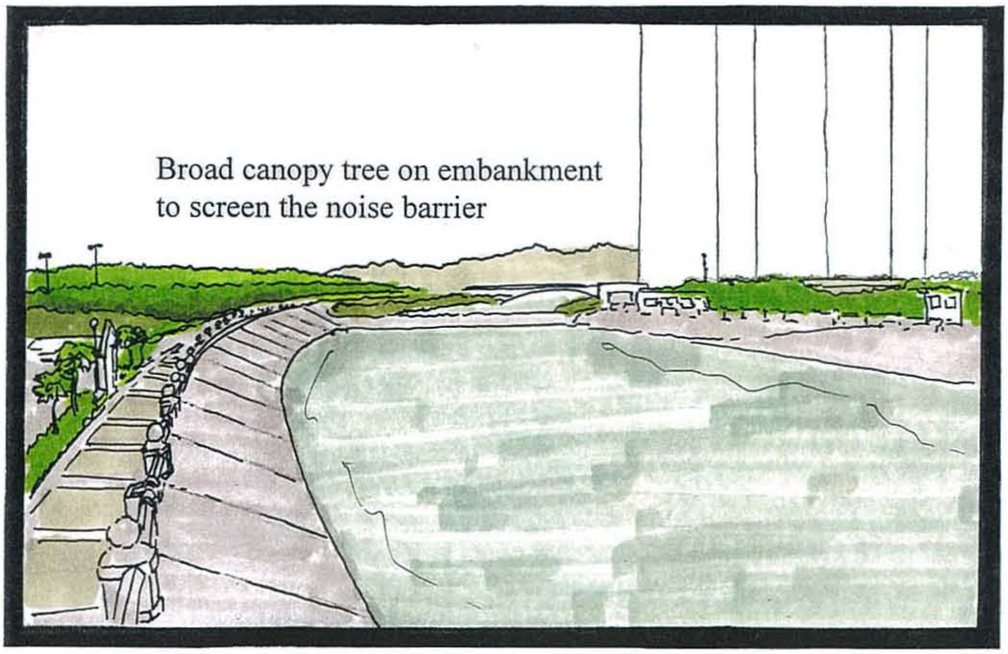


Plate 5.10 View of noise barrier along Tin Ying Road

Additional tree planting to screen Road D3 from view when built

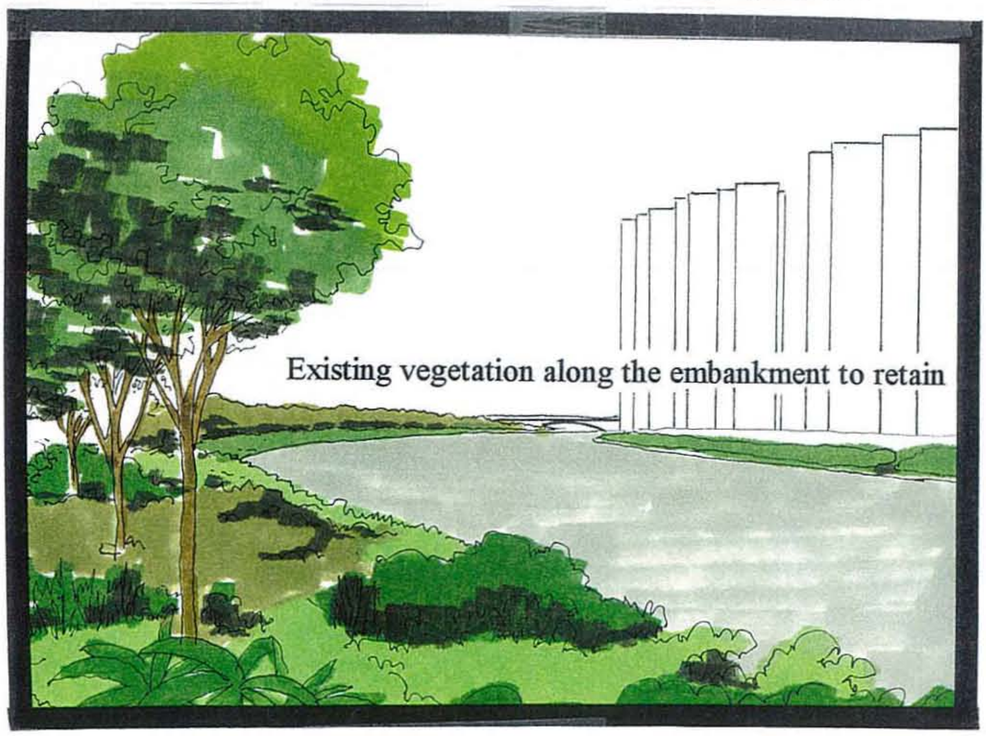


Plate 5.11 View of the Western Temporary Channel prior to Construction of Road D3

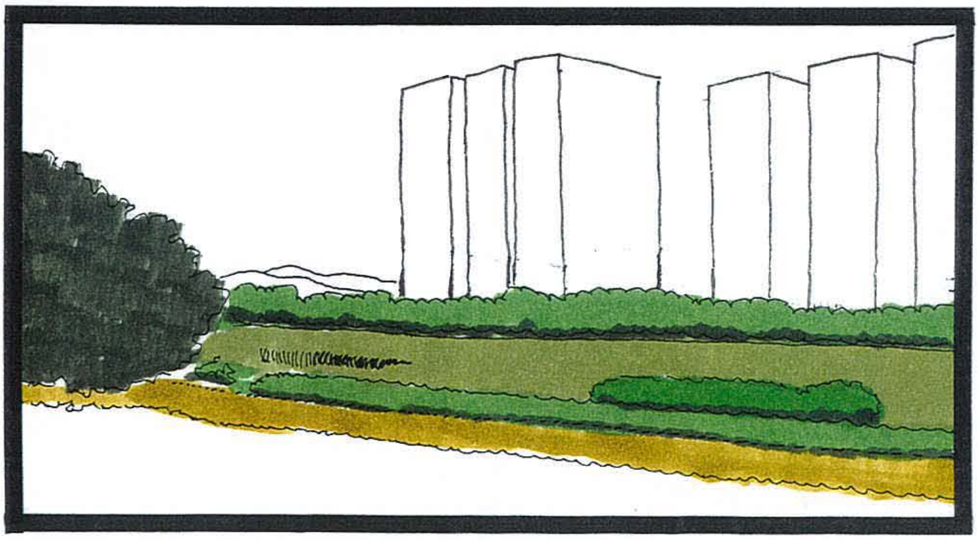
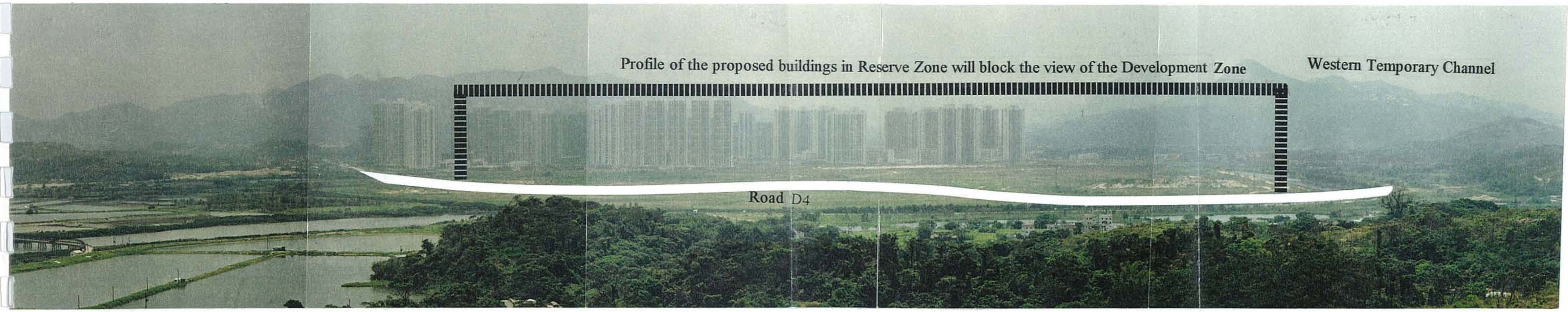


Plate 5.12 View of Reserve Zone from Mong Tseng Tsuen



Proposed bridge over Western Temporary Channel

Plate 5.13 View of Reserve Zone from Lookout Point

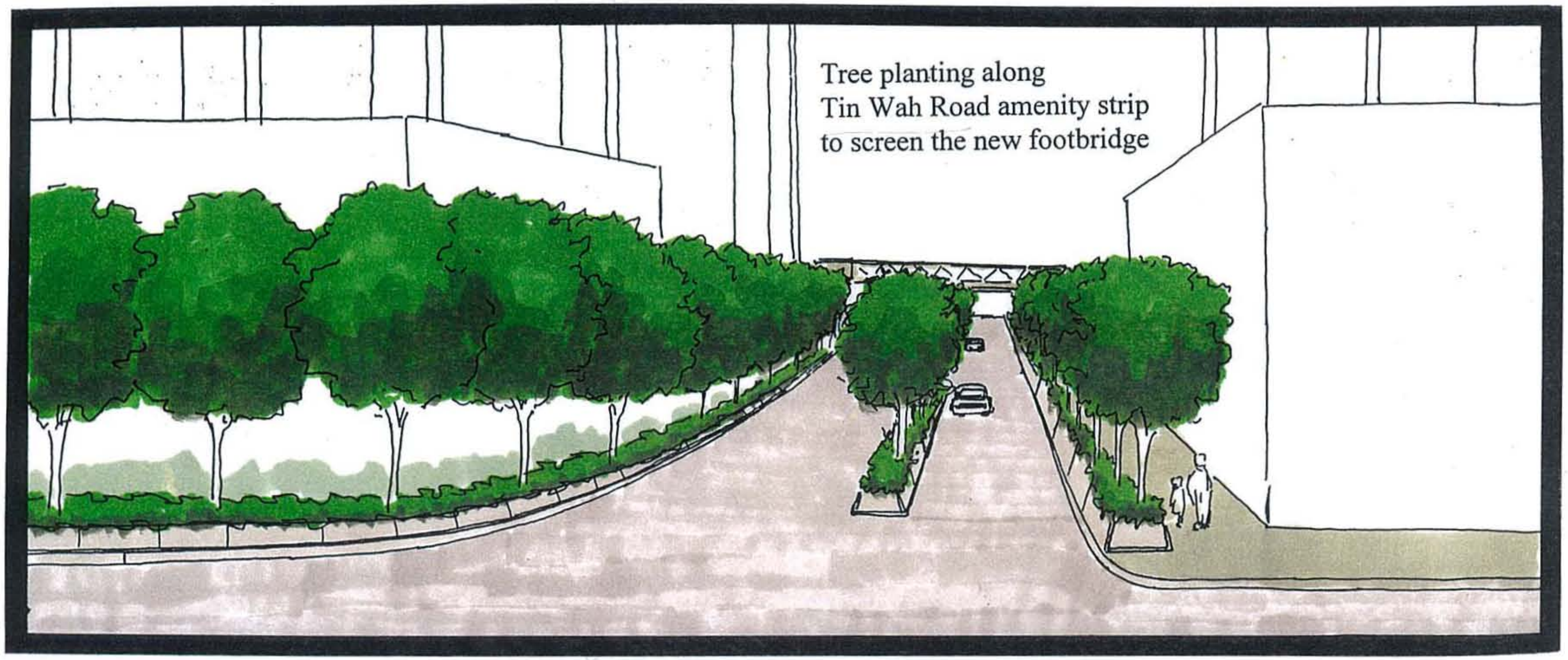


Plate 5.14 View of the new footbridge over Tin Wah Road

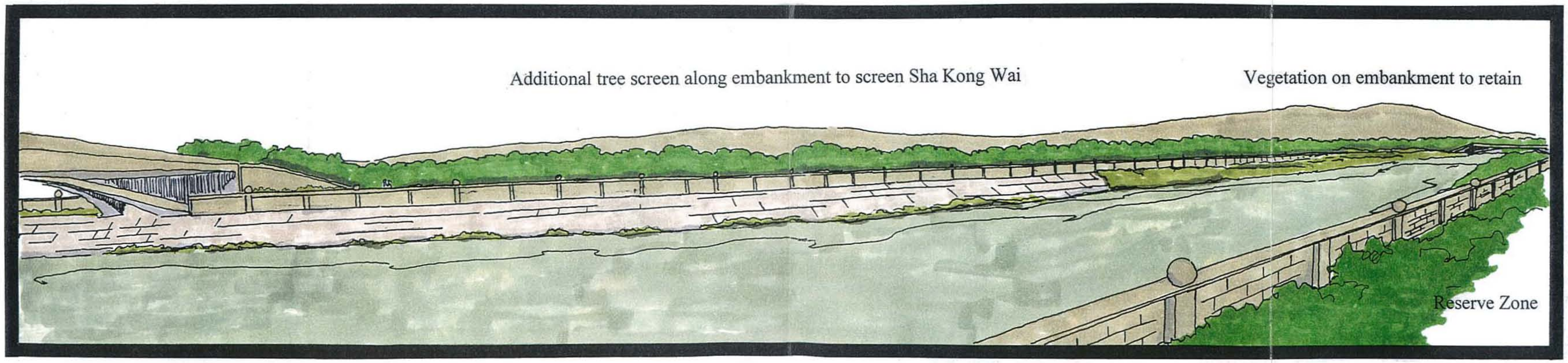


Plate 5.15 View of the new bridge over the Western Temporary Channel from Sha Kong Wai

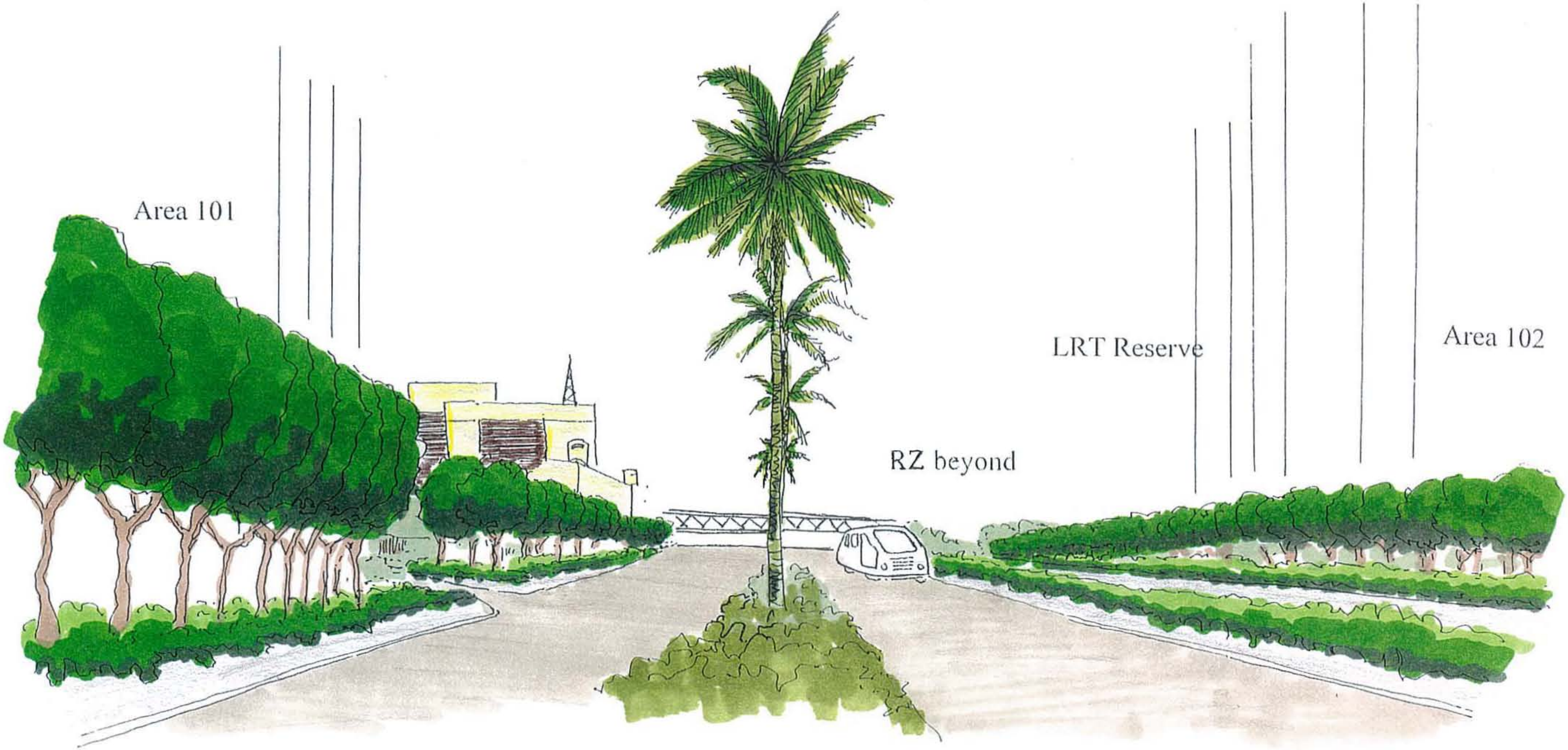


Plate 5.16 View of Reserve Zone from Road L12

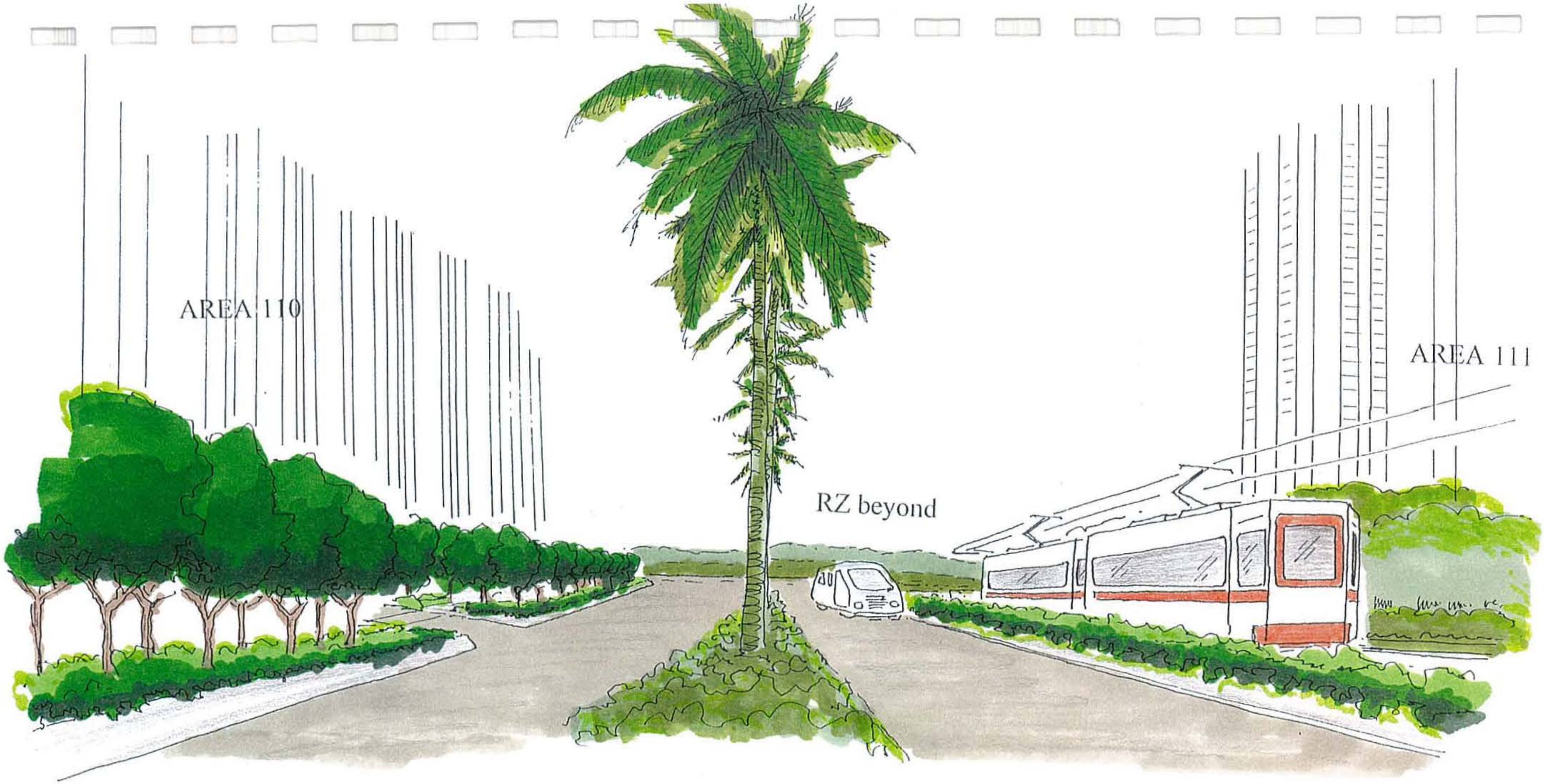


Plate 5.17 View of Reserve Zone from Road L12

6. AIR QUALITY

6.1 Introduction

6.1.1 This section presents the air quality assessments associated with the construction works and the operation of the Project. The potential air quality impacts arising from the construction works would result mainly from dust emissions. The potential sources of air pollution during the operational phase would include industrial emission and vehicle exhaust.

6.2 Air Quality Assessment Criteria

6.2.1 The principal legislation regulating air emissions in Hong Kong is the Air Pollution Control Ordinance (APCO) [Cap 311] of 1983 and its subsidiary regulations. The whole of the Territory has been covered by Air Control Zones. The Hong Kong Air Quality Objectives (AQOs) stipulate maximum acceptable concentration of air pollutants. The AQOs for 1 hour, 24 hour and annual concentrations of four major pollutants are shown in Table 6.1. Full details are given in Appendix A.

Table 6.1
Hong Kong Air Quality Objectives (AQOs)

Pollutants	Concentration in Micrograms per Cubic Metre ($\mu g/m^3$)		
	Averaging Time		
	1 hour[1]	24 hour[2,3]	1 year[3]
Nitrogen Dioxide (NO_2)	300	150	80
Sulphur Dioxide (SO_2)	800	350	80
Total Suspended Particulates (TSP)	500[5]	260	80
Respirable Suspended Particulates (RSP)[4]	-	180	55

Notes: Concentrations measured at 298K (25°C) and 101.325 kPa (one atmosphere).

1 One hour criteria not to be exceeded more than 3 times per year.
2 24 hour criteria not to be exceeded more than once per year.
3 Arithmetic means.
4 Respirable suspended particles means suspended particulates in air with a nominal aerodynamic diameter of 10 micrometre (μm) or smaller.
5 This control limit has no statutory basis but is used as a target level for limiting fugitive dust emissions generated by construction activities.

6.2.2 The Reserve Zone is bordered by the "Special Measures Zone" (SMZ) of the Deep Bay Guidelines (DBG). The boundary of the SMZ is the same as that of Buffer Zone 2 and is shown with the isopleths. Total Suspended Particulates (TSP) and Respirable Suspended Particulates (RSP) 24 hr averaged objectives are 180 $\mu g/m^3$ and 110 $\mu g/m^3$ respectively. Yearly averaged objectives are 80 $\mu g/m^3$ and 55 $\mu g/m^3$ respectively.

6.2.3 There are no statutory criteria for maximum levels of odours in Hong Kong. EPD's recommended odour nuisance criteria is 2 odour units (OUs) at the site boundary while a level of 5 OUs averaged over 5 seconds at the sensitive receiver will be used.

6.3 Air Sensitive Receivers

6.3.1 Details of the nearest air sensitive receivers that will be exposed to the construction and operational air impacts from the Project are given in Section 3: Sensitive Receivers.

6.4 Baseline Air Quality

6.4.1 Air quality in the Deep Bay Airshed is a function of the air pollutant load and the dispersive capacity of the airshed. This latter factor is determined by the topography and the micro-climate of the area.

Deep Bay Meteorology and Topography

6.4.2 Tin Shui Wai RZ lies close to the southern part of Inner Deep Bay in the northwest corner of Hong Kong. Figure 6.1 shows the topographic features surrounding Deep Bay which lead to the confinement of the Deep Bay Airshed. There are several peaks higher than 400 m in the Shenzhen area to its northeast (Wutong Mountain and Jigong Tou Mountain) and to its east (Kai Kung Leng and Tai To Yan).

6.4.3 Hong Kong has a sub-tropical maritime monsoon climate with mild weather, abundant rainfall and long periods of sunshine. Tin Shui Wai/Deep Bay area, however, has considerably less rainfall than most of Hong Kong: only about two thirds of the average of the territory and less than half of the wetter zones to the east.

6.4.4 A study by the Royal Observatory on the meteorology in the Deep Bay area indicates that the prevailing flow in the area is different from that of other locations in Hong Kong (Royal Observatory 1981). The prevailing winds in Hong Kong are north-easterly for about 70% of the year. In Deep Bay, 45-50% of the winds are from the east while about 15-20% come from the southwest direction. Only during the winter season, the dominant wind direction is northeasterly. Figure 6.2 illustrates wind conditions at Lau Fau Shan station which is very close to the RZ.

6.4.5 It is also found that the proportion of strong easterly wind is significantly less than for the rest of Hong Kong. This is probably the result of the blocking effect of hills over the western part of the New Territories. For example, the frequency of strong wind occasions at Deep Bay is less than half that at the Kai Tak Airport (Royal Observatory, 1981).

6.4.6 The wind pattern discrepancy between the Deep Bay and the rest of Hong Kong can be explained by studying the circulation pattern at Deep Bay which is complex as a result of the nearby terrain. Royal Observatory's report in 1981 describes the following circulation phenomenon at Deep Bay:

> *The hills over the New Territories are expected to have some barrier effects on winds from the east and southeast. It is likely that in a prevailing easterly airstream, a certain extent of wind channelling occurs along the Shenzhen River which is flanked by*

hills on either sides of border. Northerly winds from China are also likely to be deflected into a northeasterly airstream into Deep Bay and down the Yuen Long-Tuen Mun valley due to the presence of hills in the New Territories which are northeast-southwest oriented....Deep Bay is exposed to southwesterly winds. Because of the orientation of the range of hills extending north-northeast from Castle Peak, westerly winds are likely to be diverted into southwesterly winds in Deep Bay.

6.4.7 In addition to these wind patterns, it is also found that an inversion layer (i.e., temperature increases with height under a stable condition)[1] occurs in the morning and evening over the Deep Bay area (Royal Observatory, 1984). The stable layer associated with the inversion layer renders the area below very calm because no updraft can occur. Most air pollutant sources are near the earth's surface, being transported by eddies such as the thermal current. The inability of thermals to penetrate far into the stable layer results in the situation where the stable layer acts as a lid to the pollutants (Roland 1988). Under this circumstance, the pollutants would be trapped. During the winter season when the inversion layer stays in the area longer, this phenomenon would be prolonged. Thus Deep Bay exhibits a limited dispersive capacity.

Existing Air Quality

6.4.8 A three-week continuous background air monitoring programme has been undertaken at Mong Tseng Tsuen, Tin Shui Wai from 23 January 1996 to 13 February 1996, measuring the concentrations of sulphur dioxide (SO_2), nitrogen oxides (including nitric oxide (NO) and nitrogen dioxide (NO_2)), TSP and RSP. An additional one-week measurement of NO_2 and SO_2 was undertaken from 10 to 19 August 1996 as part of a compensation due to the breakdown of equipment during the last week of measurement. The detailed monitoring methodologies and results are given in Appendix C1. Table 6.2 summarises the results of monitoring undertaken at Mong Tseng Tsuen.

Table 6.2
Results of TSP, RSP, NO_2 and SO_2 Measurement at Mong Tseng Tsuen ($\mu g/m^3$)

Results		TSP	RSP	NO_2	SO_2
1 hr average	Mean Value	-	-	35.8	9.5
	HKAQO	-	-	300	800
24 hr average	Mean value	103*	62*	34.3	9.4
	HKAQO	260	180	150	350

Remarks: All the above data are corrected to 298 K and 101.325 kPa

HKAQO stands for Hong Kong Air Quality Objectives
- stands for not applicable
* stands for geometric mean

[1] According to the practices of the World Meteorological Organization, an inversion is defined as a layer of atmosphere with a temperature increase with height and with a thickness of at least 20 mbar.

Dust

6.4.9 The geometric means of TSP and RSP levels during the monitoring period are 103 μg/m³ and 62 μg/m³ respectively. There are obvious limitations associated with this short-term monitoring, but overall results indicate that the measured pollutant levels in Mong Tseng Tsuen are well within the Hong Kong AQOs during the winter season. In fact, the air quality within and near the Reserve Zone (RZ) is generally good except when dust-laden winds blow from Shenzhen's industrial and construction areas (Peking University, 1995).

6.4.10 It should be noted that TSP baseline monitoring results were very variable depending on wind direction, exceeding 150 μg/m³ during one third of the monitoring period and exceeded 230 μg/m³ on one occasion.

6.4.11 In order to establish a realistic background dust level for use in the EIA Study, both the Mong Tseng Tsuen data and EPD's monitoring data from Yuen Long station during the months of August and September 1995 have been utilized. The wind rose from the windgauge at WENT Landfill Site, which is located in the Western New Territories on the edge of Deep Bay, shows a predominately southerly wind during that period (Figure 6.2). The Yuen Long station monthly averages for TSP and RSP are tabulated below in Table 6.3.

Table 6.3
Monthly Particulate Concentrations at Yuen Long EPD Station (1995)

Month (1995)	Monthly Mean (μg/m³)	
	TSP	RSP
August	54	31
September	95	55

6.4.12 Comparison of the data from Mong Tseng Tsuen and Yuen Long show that the dust concentration is higher during the northeasterly winds, suggesting that the high concentration may be due to the active construction activities at Shenzhen city in southern China. High dust concentration levels under similar meteorological conditions have been previously observed during background dust monitoring at Ha Pak Nai for the WENT Landfill Project (Applied Sciences Limited 1993).

6.4.13 Averaging the data from Mong Tseng Tsuen and Yuen Long, the 24 hr average dust background data for TSP and RSP becomes 81 and 47 μg/m³ respectively. In the case of rural areas where the pollutant levels are not acute, the one hour average reading and the daily average reading are not substantially and quantitatively different; thus the one hour average can be approximated to the daily average.

6.4.14 Because of the rural nature of the Study Area, the background annual TSP level is not expected to be significant. The background annual TSP level has been approximated to 30 μg/m³. Taking 50% of the TSP level as an approximation of the RSP level gives an annual background RSP level of 15 μg/m³.

NO_2 and SO_2

6.4.15 The monthly averages for SO_2 and NO_2 from Yuen Long station are tabulated below in Table 6.4. The table shows that the SO_2 and NO_2 background concentrations in the Deep Bay area are low. It is assumed that the annual SO_2 and NO_2 background concentrations are 17 and 34 $\mu g/m^3$ respectively (the arithmetic means of the monthly average concentrations).

Table 6.4
Monthly SO_2 and NO_2 Concentrations at EPD's Yuen Long Monitoring Station

Month	Monthly Average Concentration ($\mu g/m^3$)	
	SO_2	NO_2
Apr 95	**	12
May 95	**	15
Jun 95	**	13
Jul 95	**	19
Aug 95	16	29
Sep 95	11	38
Oct 95	8	33
Nov 95	10	39
Dec 95	26	72
Jan 96	28	72
Mean	17	34

** data not yet collected.

6.4.16 As expected, NO_2 and SO_2 levels to the north of the RZ are fairly low and well within the AQOs. However, as discussed in later paragraphs of the section, air quality varies within Tin Shui Wai (TSW) depending on the direction of the prevailing wind.

Future Air Quality

6.4.17 Future air quality in the Deep Bay area will be heavily influenced by the rapid pace of development occurring in the area, in both Hong Kong and in the People's Republic of China.

6.4.18 As discussed in Section 2, many of the works under the Project will be in the construction phase at the same time and concurrently with other works not associated with the Project. Housing construction should not significantly add to current background dust levels at Tin Shui Wai despite the fact that a concrete batching plant has been already sited within Tin Shui Wai Area 13. With the exception of other possible concreting batching plants and aggregate handling, dust-producing activities associated with these concurrent works will be limited but will tend to increase overall dust levels.

6.5 Air Quality - Construction Impact Assessment

Introduction

6.5.1 The major air pollutant generated as the result of construction activities is dust which is measurable as TSP (Total Suspended Particulates) and RSP (Respirable Suspended Particulates).

6.5.2 The dust associated with the construction works is generated from the loading and unloading of material, the removal of top soil, wind erosion of exposed area, dry materials stored in stockpiles on site and lastly but most importantly the truck movement over dirt haul roads. No concrete batching plants or crushers are foreseen as necessary for the Project Works and blasting will not be required.

Scenarios

6.5.3 It has been identified that the worst case scenario will occur during the site formation for the Reserve Zone since it would involve a large quantity of earth works and frequent truck movements over dirt roads.

6.5.4 The cut and fill isopach for the RZ have been determined in the latest engineering study. The isopach are shown in Figure 6.3. Using these isopach, the material balance for the site and the amounts of material to be moved from one part of the site to another could be determined.

6.5.5 The estimated cut and fill volumes required for the site formation works of the Project were calculated using isopach data. There will be a small shortfall in the fill available under the Project works: slightly more than 150,000 m^3.

6.5.6 The site formation has already been described in Section 2. Two worst case scenarios have been chosen for the detailed assessment of dust impacts using Fugitive Dust Model (FDM):

Scenario 1 - Site formation of Area 101-108, 109a and 110-111 (Contract 1 and Contract 2 concurrently).

Scenario 2 - Site formation of Area 109b, 112-117, 120 and Tin Ying Road dualling (Contract 6 and Contract 7 concurrently).

6.5.7 The most likely haul routes for the movement of material selected for Scenario 1 are shown in Figure 6.4. The volumes of material and the truck movement associated with spoil transport along these haul routes have been calculated and are given below in Table 6.5. These have been calculated using the period of cut and fill works, that is, the main earth works, as shown in Table 6.6. Vehicle roundtrip calculations were based on a 10 hour per day, 26 day per month. The capacity of the trucks has been taken to be 6 m^3.

Table 6.5
Haul Road Transport of Materials during the Site Formation Works (Scenario 1)

Area	Works Contract	Haul Road	Volume of Materials (m^3)	Earth Movement Period (months)	Number of Vehicle Roundtrips per Hour (veh/hr)
102	1	H1	55000	4	18
102	1	H2	83000	4	28
102	1	H19	5000	4	2
102	1	H20	6000	4	2
101	2	H9	34000	4	12
103	2	H6	9000	6	2
103	2	H7	8000	6	2
103	2	H21	15000	6	4
104	2	H22	37000	2	24
104	2	H23	38000	2	26
105	2	H12	34000	6	8
105	2	H24	34000	6	8
106	2	H25	7000	6	2
107a	2	H26	15000	8	4
107b	2	H27	10000	9	2
107b	2	H28	24000	9	4
108a	2	H29	6000	6	2
108a	2	H30	14000	6	4
108b	2	H31	4000	9	2
109a	2	H32	3000	8	2
109a	2	H33	72000	8	12
110	2	H15	122000	8	20
110	2	H16	66000	8	12
110	2	H34	20000	8	4
111a	2	H35	37000	2	24
111a	2	H36	1000	2	2
111b	2	H37	26000	8	6
111b	2	H38	19000	8	4

Table 6.6
Timing for Site Formation Works (Scenario 1)

Areas Completed	Period of Cut and Fill Works (months)	Period of Consolidation Works (months)	Period for Total Site Formation Works (months)
102	4	1	6
101	4	5	10
103	6	0	6
104	2	6	12
105	6	5	12
106	6	5	12
107a	8	0	8
107b	9	0	9
108a	6	0	6
108b	9	0	9
109a	8	0	8
110	8	5	14
111a	2	5	8
111b	8	5	14

6.5.8 Similarly, the most likely haul routes for Scenario 2 have been selected and shown in Figure 4.1.4. The volumes of material and the truck movement associated with spoil transport along these haul routes are given below in Table 6.7.

Table 6.7
Haul Road Transport of Materials during the Site Formation Works (Scenario 2)

Haul Road	Volume of Material (m^3)	Earth Movement Period (month)	Number of Vehicle Roundtrips per Hour (veh/hr)
A	460,000	15	40
B	38,000	15	4
C	91,000	12	10

6.5.9 Other engineering infrastructure and road upgrading works (Contracts 3, 4 and 5), and the construction of Road D3 and the site formation of Area 121 (Contract 8), which have relatively minor impacts as compared with Scenario 1 and Scenario 2, will also be discussed later in this section.

Assessment Methodology

FDM

6.5.10 Fugitive Dust Model (FDM) which is approved by USEPA and Hong Kong EPD has been used to assess the impact of the site formation dust emissions on the surrounding area. A detailed description of the model is given by the User's Guide (TRC, 1990). Briefly, FDM, which is an atmospheric dispersion model, is specifically designed for the analysis of fugitive dust sources. The model is based on the widely used Gaussian Plume formulation for estimating pollutant concentrations, but has been adapted to incorporate a gradient-transfer deposition algorithm which accounts for the settling out of dust particles, and to include the wind dependence factor on the dust emission rates.

6.5.11 TSP (Total Suspended Particulates) and RSP (Respiratory Suspended Particulates) impacts have been evaluated. The assessment has been based on the 1994 sequential meteorological data collected at the Lau Fau Shan Station containing the hourly wind direction, wind speed, stability and temperature. The surface roughness is 10.0 cm. The Study Area has been divided into two domains and fully covers the impacts on the nearby sensitive receivers in relation to the two scenarios for dust assessment. The first domain of 39 x 30 grid covers RZ only while the second domain of 31 x 36 grid covers both RZ and DZ. Both domains have grid spacing of 100 m. The default particle distribution in FDM has been used. The fraction in each of 0-2.5, 2.5-5, 5-10,10-15 and greater than 15 μm is 0.0262, 0.0678, 0.1704, 0.1536 and 0.5820 respectively.

Dust Sources

6.5.12 The dust sources have been identified as follows:

(i) loading and unloading;
(ii) unpaved roads and haul routes;
(iii) stockpiling/aggregate storage;
(iv) top soil removal; and
(v) wind erosion of the whole exposed area.

It has been assumed in every assessment that all these activities/processes will be occurring concurrently.

6.5.13 The equations used for the calculation of emission rates for each dust source are shown in Appendix C2. The parameters used for the calculation of emission rates and the emission rates for the worst-case scenarios are summarised in Appendix C3.

6.5.14 Dust emission factors have been calculated using the latest equations in the draft 5th Edition of USEPA AP42 (1995).

Model Results

6.5.15 The predicted maximum (unmitigated and mitigated) annual, 24 hr and 1 hr average dust levels at individual sensitive receivers obtained for TSP and RSP are discussed below. It should be noted that all the tabulated results and contour figures have included the baseline dust levels.

Scenario 1

6.5.16 Table 6.8 shows the maximum 1 hour, 24 hour and annual average TSP and RSP concentrations at the sensitive receivers with and without adoption of dust suppression measures. With no mitigation, there may be exceedance of the 1 hour, 24 hour and annual TSP and 24 hour RSP at some of the sensitive receivers.

6.5.17 Dust due to the truck movement on dirt roads on the site constitutes the most dust concentrations because emission rates associated with the dirt roads account for 82% of the total dust emission rates. Other dust sources including loading and unloading, stockpiling, wind erosion and top soil removal are relatively minor. The unmitigated cumulative hourly impacts including all the dust sources plus the background dust level shows that the predicted concentration levels at all of the representative sensitive receivers will exceed the AQO. Due to their proximity to the works, they register the highest dust levels. ASR2 is the Mong Tseng Public Shung Yee School at Mong Tseng Wan.

6.5.18 Figures 6.5 to 6.9 illustrate the unmitigated dust isopleths on the RZ at pedestrian level where villages are clustered. These figures show that the highest concentrations are within the RZ.

6.5.19 Haul road traffic generates the most dust. It has been shown that watering twice a day can reduce the haul road emission rate by half, thereby lowering the dust level concentration by as much as 50% (Jutze et al, 1974). However, Figures 6.10 to 6.14 and Table 6.8 show that the dust levels resulting from 50% reduction in the dirt road dust emission rates do not comply with the AQO at all nearby residences. It is shown that Maywood Court, Lynwood Court and Kenswood Court of Kingswood Villas will experience highest dust levels.

Table 6.8
Predicted Maximum Hourly, Daily and Yearly Particulate Concentrations ($\mu g/m^3$) - Scenario 1

ASR*	Without Mitigation					With 50% Reduction of Dust Emission from Haul Roads				
	RSP		TSP			RSP		TSP		
	Daily	Yearly	Hourly	Daily	Yearly	Daily	Yearly	Hourly	Daily	Yearly
66	110	20	1075 [2]	217	42	86	18	654 [2]	164	37
64	219 [1]	53	955 [2]	454 [3]	112 [4]	154	39	592 [2]	309 [3]	81 [4]
138	145	33	566 [2]	292 [3]	68	109	26	365	213	53
139	154	32	566 [2]	313 [3]	67	113	26	379	222	53
27	139	45	616 [2]	282 [3]	94 [4]	103	33	395	200	69
26	148	52	737 [2]	300 [3]	111 [4]	108	38	468	213	79
1	116	21	605 [2]	232	43	87	19	396	168	38
2	87	18	549 [2]	162	37	71	17	356	134	34

Note:
(1) - Exceedance of the Daily RSP Limit of 180 $\mu g/m^3$.
(2) - Exceedance of the Hourly TSP Limit of 500 $\mu g/m^3$.
(3) - Exceedance of the Daily TSP Limit of 260 $\mu g/m^3$.
(4) - Exceedance of the Yearly TSP Limit of 80 $\mu g/m^3$.
* The locations of ASR are indicated in Figure 6.5.

6.5.20 It is our experience from other similar sites on Hong Kong when undertaking the Environmental Monitoring and Auditing Phase following an FDM prediction assessment that this level of mitigation can be achieved if watering is undertaken regularly and frequently. Reducing dust emissions from the haul roads by 70% is achievable and is shown in Table 6.9 that the AQOs can be met at all sensitive receivers.

6.5.21 To ensure full compliance, and to make allowance for concurrent works particularly during very dry days or worst dust situations, it is recommended that watering should be conducted every two hours. Sufficient haul road watering (every two hours) will ensure that the AQOs can be met at all sensitive receivers.

Table 6.9
Maximum Hourly, Daily and Yearly Particulate Concentrations ($\mu g/m^3$) - With 70% Reduction of Dust Emission from Haul Roads (Scenario 1)

ASR	RSP		TSP		
	Daily	Yearly	Hourly	Daily	Yearly
66	76	17	485	143	35
64	128	33	448	252	68
138	95	23	285	181	47
139	97	23	303	186	47
27	88	28	307	168	58
26	93	32	360	178	66
1	76	18	313	142	35
2	65	16	278	119	33

6.5.22 The RZ is bordered by the "Special Measures Zone" of the Deep Bay Guidelines (DBG). TSP and RSP 24 hr averaged objectives are 180 $\mu g/m^3$ and 110 $\mu g/m^3$ respectively. Yearly averaged objectives are 80 $\mu g/m^3$ and 55 $\mu g/m^3$ respectively. Figures 6.10 to 6.14 show that the mitigated dust levels associated with the site formation will comply with the DBG guidelines if 50% of the dust generated from haul road traffic is mitigated. Consequently if the human sensitive receivers are adequately protected, other species will be protected.

Scenario 2

6.5.23 As shown in Table 6.10, there could be exceedances of the AQOs at ASR1, ASR27 ASR49, ASR51, ASR54, ASR65, ASR66 and ASR85 if no mitigation measure is implemented.

6.5.24 Figures 6.15 - 6.19 illustrate the unmitigated dust isopleths at the pedestrian level. These figures show that the north-east corner of the DZ will experience unacceptably high dust levels and Table 6.10 shows that ASR65 and ASR66 will be mostly affected by the dust impacts since they are close to Area 117 in which a large quantity of filling works will be undertaken.

6.5.25 When dust suppression measures, the watering of the dirt roads twice a day, were taken into account, 1 hour and 24 hour TSP levels and 24 hour RSP levels at the sensitive receivers would be reduced by 30 - 40% in average. Table 6.10 as well as Figures 6.20 - 6.24 show that ASR65 and ASR66 may still have exceedances of the AQOs.

Table 6.10
Predicted Maximum Hourly, Daily and Yearly Particulate Concentrations ($\mu g/m^3$) - Scenario 2

ASR*	Without Mitigation					With 50% Reduction of Dust Emission from Haul Roads				
	RSP		TSP			RSP		TSP		
	Daily	Yearly	Hourly	Daily	Yearly	Daily	Yearly	Hourly	Daily	Yearly
1	117	22	701 [3]	234	46	90	20	448	173	40
27	95	38	406	187	81 [5]	73	27	252	138	57
49	122	46	531 [3]	246	99 [5]	88	32	326	170	67
51	173	54	850 [3]	360 [4]	116 [5]	114	36	477	227	76
54	125	37	522 [3]	253	79	89	27	302	173	57
65	216 [1]	36	1580 [3]	456 [4]	76	131	25	831 [3]	269 [4]	53
66	173	24	1317 [3]	360 [4]	51	110	20	699 [3]	221	40
68	92	30	332	181	63	72	23	216	135	48
71	88	24	330	172	51	69	20	215	130	41
73	85	19	458	166	39	68	17	282	126	35
85	158	56 [2]	482	325 [4]	120 [5]	106	37	296	211	78

Note:
(1) - Exceedance of the Daily RSP Limit of 180 $\mu g/m^3$.
(2) - Exceedance of the Yearly RSP Limit of 55 $\mu g/m^3$.
(3) - Exceedance of the Hourly TSP limit of 500 $\mu g/m^3$.
(4) - Exceedance of the Daily TSP limit of 260 $\mu g/m^3$.
(5) - Exceedance of the Yearly TSP limit of 80 $\mu g/m^3$.
* The locations of ARS are indicated in Figure 6.15.

6.5.26 Our experience of dust suppression programmes in Hong Kong indicates that if haul road watering is undertaken not less than three times a day, compliance with AQOs is achievable. Table 6.11 shows that reducing dust emissions from the haul roads by 75% can keep the dust levels below the AQOs.

Table 6.11
Maximum Hourly, Daily and Yearly Particulate Concentrations ($\mu g/m^3$) - With 75% Reduction of Dust Emission from Haul Roads (Scenario 2)

ASR	RSP		TSP		
	Daily	Yearly	Hourly	Daily	Yearly
1	76	18	322	143	37
27	62	22	175	114	45
49	71	25	224	133	51
51	84	27	291	161	56
54	71	22	192	133	46
65	89	20	456	175	42
66	79	17	391	151	35
68	61	20	158	112	41
71	60	18	157	109	37
73	59	16	193	107	33
85	81	27	203	154	57

6.5.27 As discussed in Section 6.5.21, to ensure full compliance and to make allowance for concurrent works, particularly, during very dry days or worst dust situations, it is recommended that watering should be conducted more frequently. Sufficient haul road watering (every two hours) will ensure that the AQOs can be met at all sensitive receivers at all times.

6.5.28 As shown in Figure 4.1.4, part of Tin Wah Road would form the haul route, so it is important that wheel washing facilities should ensure the trucks leaving the site are completely washed in order to prevent the building up of dirts on the road. The dust emission from paved road can be minimized if the road is properly cleaned.

6.5.29 Figures 6.20 to 6.24 show that the mitigated dust levels will comply with the DBG guidelines if 50% of dust emission from haul roads is reduced.

Other Engineering Infrastructure and Road Upgrading Works (Contracts 3, 4 and 5)

Construction of roads L12(S), L13(E) and L14 and the associated drains, sewers and water distribution mains

6.5.30 The major potential construction impact for the construction of the new roads L12(S), L13(E) and L14 including the associated drains, sewers and water distribution mains in the RZ is the dust arising from the site formation. The dust impact due to the site formation has been assessed above. Construction of drains, culverts, sewers and water distribution mains will require excavation of trenches. Laying this new infrastructure will be conducted street by street and a typical open cut dimension could be 20 m by 5 m; thus the quantity of the excavated material is unlikely to be large enough to cause a dust nuisance. It is anticipated that excavated material will only be stockpiled on each local works area. The duration of stockpiling will be as short as possible as most of the material will be used as backfill material for the open cut trenches. The concrete pipes are precast hence no concrete batching plants are required on site. Levelling, compacting and resurfacing of the new roads will not involve significant movement of materials, hence dust impacts will be insignificant. However proper watering of exposed dirt should be undertaken throughout the construction phase to ensure that the cumulative impacts of these and other concurrent works comply with the AQO at all times.

Junction Improvement in the DZ

6.5.31 Improvements to existing junctions B, A1, A2, E, A3, A4, F, G, H, I, A10, A17, A25 and A34 are designed to accommodate the increased traffic flow in 2011. The construction works will involve breaking of road surfaces, footpaths, and/or roundabouts, widening of road alignment, resurfacing works and diversion of utilities if required. Junctions A, D and W will require grade separation, and flyovers will be constructed. Percussive piling will be required to provide foundations for the flyovers. As the construction activities involve minor cutting and filling of materials, it is anticipated that the dust impacts to the sensitive receivers will not be significant. Any materials dropped on sealed roads will need to be cleaned up immediately to prevent any dust nuisance.

Dualling of Tin Wah Road and Tin Tsz Road (N)

6.5.32 The construction of additional carriageways for Tin Wah Road and Tin Tsz Road, which will involve some minor excavation and filling works, should not cause any significant dust impacts to the nearby sensitive receivers since no site formation works of the roads will be required.

Widening of the northern sections of Hung Tin Road and Long Tin Road

6.5.33 The filling of materials is required for the works on Hung Tin Road and Long Tin Road to form the road embankment. It is unlikely that the works will cause a significant dust nuisance provided that proper dust suppression measures are implemented.

Construction of sewage pumping station and the trunk rising mains

6.5.34 The anticipated construction programme of the pumping station is short. The pumping station is scheduled to be completed within 36 weeks. The construction works of the sewage pumping station are not extensive. The nearest sensitive receiver (SR49) is located 50 m south from the site boundary. Provided that good housekeeping practices are adhered to and dust control measures are implemented at site, no major dust impact is envisaged during the construction phase.

6.5.35 The rising mains will be built along the west bank of the West Drainage Channel (WDC). Open excavation methods will be used to lay the pipe beneath the footpath and cycle tracks of the WDC and trenchless methods will be used at locations where the rising mains cross the drainage channels. The alignment of the rising mains is about 100 m away from most of the sensitive receivers and the quantity of the excavated material is unlikely to be large, so it is expected that the dust impact will not be significant.

Road D3 and Site Formation of Area 121

6.5.36 Contract 8 will be the last contract of the Project. Since most of the fill material would be used up in the previous contracts, it is likely that an external source of fill material would be required.

6.5.37 The area and volume of fill required for the site formation of Area 121 are much smaller as compared with the site formation in Scenario 2. (Only 31,000 m^3 of fill material is required for the site formation of Area 121.) It is expected that the dust impacts associated with the site formation of Area 121 are not significant.

6.5.38 The impacts due to the construction of Road D3 would be similar to the impacts associated with Tin Ying Road dualling in Scenario 2. The major dust emission would be come from the truck movements on the unpaved haul road. The location of the haul road is shown in Figure 4.1.9.

6.5.39 It is predicted that the most affected ASRs are those at Sha Kong Wai and Sha Kong Wai Tsai. As the quantity of fill material required for the construction of Road D3 is 40% larger than the quantity required for Tin Ying Road dualling, there may be exceedances of the AQOs at the ASRs at Sha Kong Wai and Sha Kong Wai Tsai if no mitigation measure is implemented.

6.5.40 Watering of the dirt roads at least twice a day will be required to mitigate the dust impacts at the sensitive receivers. To ensure the full compliance of the AQOs, it is recommended that watering should be conducted more frequently during very dry days or worst dust situations.

Air Quality Protection - including Dust Suppression Measures

6.5.41 In view of the potential of the Site Formation Works to generate fugitive dust emissions which exceed the maximum 24-hour averaged dust level (Total Suspended Particular Concentration of 260 $\mu g/m^3$) as stipulated in the Air Quality Objectives under CAP (311), we recommend that the frequency and intensity of Site and haul road watering is a specified and priced feature of the Contracts.

6.5.42 (i) The Contractor shall undertake at all times to prevent dust nuisance as a result of his activities. Effective dust suppression measures as are necessary should be installed to ensure that the air quality, at the boundary of the site and at any sensitive receivers, complies with the Hong Kong Air Quality Objectives.

(ii) The Contractor shall frequently clean and water the Site to minimise fugitive dust emissions.

(iii) Effective water sprays shall be used during the delivery and handling of aggregate, and other similar materials, when dust is likely to be created and to dampen all stored materials during dry and windy weather.

(iv) Watering of exposed surfaces shall be undertaken at least two times a day and be exercised as often as possible depending on the circumstances. In order to meet the requirement, it is necessary to install a water refilling system so that the water refilling time should be less than ten minutes.

(v) Areas within the Site where there is a regular movement of vehicles must be regularly watered as often as is necessary for effective suppression of dust or as often as directed by the Engineer. In most instances it will be necessary to water haul roads every two hours.

(vi) Should a conveyor system be used, the Contractor shall implement the following precautionary measures. Conveyor belts shall be fitted with windboards. Conveyor transfer points and hopper discharge areas shall be enclosed to minimise dust emission. All conveyors under the Contractor's control, and carrying materials which have the potential to create dust, shall be totally enclosed and fitted with belt cleaners.

(vii) Where dusty materials are being discharged to vehicle from a conveying system at a fixed transfer point, a three-sided roofed enclosure with a flexible curtain across the entry shall be provided. Exhaust fans shall be provided for this enclosure and vented to a suitable fabric filter system.

(viii) The Contractor shall confine haulage and delivery vehicles to designated roadways inside the Site. If in the opinion of the Engineer, any motorised vehicle is causing dust nuisance, the Engineer may require that the vehicle be restricted to a maximum speed of 15 km per hour while within the site.

(ix) Wheel washing facilities shall be installed and used by all vehicles leaving the Site. No earth, mud, debris, dust and the like shall be deposited on public roads. Water in the wheel cleaning facility shall be changed at frequent intervals and sediments shall be removed regularly. The Contractor shall submit details of proposals for the wheel cleaning facilities to the Engineer prior to construction of the facility. Such wheel washing facilities shall be usable prior to any earthworks excavation activity on the Site. The Contractor shall also provide a hard-surfaced road between any washing facility and the public road.

(x) All site vehicle exhausts should be directly vertically upwards or directed away from the ground.

(xi) At the end of the works, the stockpiles should be hydroseeded.

(xii) Dust monitoring has been included in the EM&A Manual at the most critical ASRs.

Conclusions

6.5.43 The air quality assessment has addressed the dust impacts associated with the Project. The assessment has concluded that:

(i) The worst case scenario will occur during the site formation of the RZ as there would be a large quantity of earth works and frequent truck movements over dirt roads.

(ii) Without adequate mitigation, dust levels generated by the site formation works are likely to exceed the Air Quality Objectives at nearby air sensitive receivers.

(iii) The transport of material by trucks travelling over dirt haul roads is the principal source of excessive dust generation.

(iv) Mitigation measures sufficient to ensure compliance with the Air Quality Objectives has been included in the assessment.

(v) With the implementation of this mitigation, dust levels will meet the guidelines for the Special Measures Zone.

(vi) An environmental monitoring and audit programme has been formulated to ensure compliance is maintained.

6.6 Air Quality - Operational Impact Assessment

Introduction

6.6.1 During the operational phase of the Project, three major sources of air pollution have been identified in the neighbourhood of the site. The first source is emission from chimneys in the immediate area. The second source is vehicle exhaust from traffic on major roads such as Tin Wah Road, Tin Ying Road, Ping Ha Road, Hung Tin Road, Long Tin Road and Tin Tsz Road. Emissions associated with the LRT and West Rail (Western Corridor Railway) are minor and are not considered in this assessment. The third source is odour from the new sewage pumping station at Area 101.

Industrial Emission Impact Assessment

Chimneys information

6.6.2 According to EPD's inventory of chimneys information (letter ref. EP10/A10/2III), there are 178 chimneys within the vicinity of the Study Area. EPD's data set have been revised and are given in Appendix C6 in Table C6.1. Figures 6.26 and 6.27 show the locations of these chimneys. Of these chimneys, 86 consume light diesel fuel while 35 chimneys use boiler diesel oil. (Chimney nos. 18, 66 and 81 consume both light diesel fuel and boiler diesel oil.) Less than 6% of the chimneys use other fuels such as kerosene, town gas, LPG, charcoal and coke. There is no information on the fuel consumption rate for about 26% of these chimneys.

6.6.3 A recent site survey has indicated that some of the industrial estates have been turned into residential estates and the chimneys are no longer present. However, some chimneys are not identified in the current EPD records, such as the chimneys at the textile factory near the gas station at Tong Yan San Tsuen. The result of the site survey is summarized in Table 6.12.

Table 6.12
Types of Factories

Locations	Type of factory
Tai Tao Tsuen	- 14 chimneys in EPD database (chimney nos: 36, 37, 38, 39, 40, 41, 42, 43, 44, 55, 56, 57, 108 & 109) - 108 & 109 belonging to a polystyrene foam factory - 36 - 44 belonging to Pun Chun Sauce & Preserved Fruit - 55 & 56 might exist
West of Tong Yan San Tsuen Road, South of Castle Peak Road, Ping Shan Road and North of Yuen Long Highway	- the following chimneys do not exist: (chimney nos: 47, 48, 49, 50, 61, 65, 66, 67, 73, 74, 75, 76, 71, 72, 70, 69, 68, 103, 105, 104, 60, 147, 124, 126) - Several dyeing factories - Metal works factory - Ice making factory - Sodium silicate factory - Concrete plant - Tyres factory - Vegetable oil factory - 8 chimneys not in EPD database, being located San Hi Tsuen St, Ping Fuk Lan, etc (belonged to some dyeing, textile or printing factories)
Tong Yan San Tsuen	- 10 chimneys in EPD database (chimney nos: 87, 88, 89, 125, 133, 134, 131, 130, 143, 144) - 89 & 131 do not exist - 143 & 144 not used as the production has relocated to mainland China - 125 & 130 not identified yet - 133 & 134 belonging to polystyrene foam factory - 87 & 88 belonging to two dyeing factories
North-east of Tan Kwai Tsuen	- polystyrene foam factory - sauce and preserved fruit factory
Tin Shui Wai (RZ & DZ)	- 5 chimneys in EPD database (chimney nos: 21, 127, 151, 167 & 168) - only chimney 127 identified, belonging to Maxim's Restaurant
Lau Fau Shan	- no heavy industry - 2 to 3 chimneys belonging to sea-food restaurants - 9 chimneys in EPD database (chimney nos: 156, 157, 158, 159, 160, 161, 162, 163 & 166) - consumption rates of chimney 157, 159-163 & 166 being not available
Kiu Tau Wai	- 24 chimneys in EPD database (chimney nos: 15, 114, 140, 85, 84, 83, 153, 16, 139, 152, 34, 59, 115, 116, 117, 31, 32, 33, 35, 102, 101, 137, 20, 146) - 31, 32, 33, 35, 59 & 115 not existing - other belonging to small factories such as can manufacturing factory, paper mill, ironcast factory, concrete batching plant, car repair shop, container yard, dyeing factory
Tung Tau Industrial Area	- 13 chimneys in EPD database (chimneys nos: 25, 26, 27, 62, 63, 64, 79, 80, 81, 92, 106, 128 & 150) - 25, 26 & 27 belonging to abattoir - 62, 63, 64, 79, 80, 81 & 92 not existing - 106, 150 & 128 belonging to small factories in industrial buildings

Table 6.12
Types of Factories (cont'd)

Locations	Type of factory
Yuen Long Industrial Estate	- 30 chimneys in EPD database (chimney nos: 121, 122, 123, 173, 118, 119, 22, 23, 17, 18, 135, 136, 90, 138, 93, 94, 95, 107, 177, 178, 174, 19, 99, 100, 13, 14, 141, 142, 77, 78) - Petrochemical plants - Cement Plant - Building materials factory - Milk products factory - Dyeing factories - Textile factory - Printing factory - Paper factory - Brewery plant - Metal, refining and galvanizing factories - Glass works factory - Cup factory

Assessment Methodology

6.6.4 The measurable environmental parameters due to the industrial chimneys emissions have been evaluated for SO_2 and NO_2 impact by using the ISCST2 Model (Version 2.02). For this air quality assessment of the chimney emission impact, the following assumptions have been made:

1. As the industrial emissions are mainly due to the combustion of diesel fuels, the impacts due to the light diesel fuel and the boiler diesel oil have been modelled. The other minor fuels have not been considered for this assessment. Also excluded from this assessment are those chimneys whose technical information are not available and chimneys which no longer exist. Thus the number of chimneys modelled in this assessment is 84. All chimneys in the Kiu Tau Wai area have technical information and are included in the model.

2. The maximum fuel consumption has been assumed during the entire emission period. A 24 hr emission period and 140 °C exit temperature have been assumed for chimneys whose emission periods and exit temperature are not available.

3. The emission rate, efflux velocity and volumetric flow rate are calculated based on the UK's memorandum on *Method of Calculating Chimney Heights*. A diesel fuel oil with 0.5 % sulphur content (HKPSG, 1990; Appendix 3.2) has been assumed. The emission factor of nitrogen dioxide is based on AP42 (USEPA 1995; Table 1.3-1 *Criteria Pollutant Emission Factors for Uncontrolled Fuel Oil Combustion*). As the diesel fuel contains low nitrogen content, the emission factor of 0.0024 kg/litre has been used. It is assumed that 20% of nitrogen oxides emitted are NO_2. For boiler diesel fuel, the emission factor of SO_2 is based on AP42 (USEPA 1995; Table 1.3-1 *Criteria Pollutant Emission Factors for Uncontrolled Fuel Oil Combustion*).

4. Based on the USEPA's guidelines published in Section 8.2.8 of the Guideline on Air Quality Models (Revised), the urban dispersion mode has been used for modelling the chimney emissions. It is estimated that more than 50% of the land use in the areas within 3 km radius of the Kiu Tau Wai industrial area, which include the DZ and RZ, Yuen Long Industrial Estate, Yuen Long Town, Tong Yan San Tsuen and a number of villages, will be the heavy or medium industrial, commercial or multi-family residential areas in 2011. In addition, the population in the Study Area exceeds the population criteria of 21,200 (equivalent to a density of 750 people/km^2). Thus the Study Area has been reclassified as an urban area. EPD has accepted this re-classification.

5. No downwash analysis has been made. Emission rates of SO_2 and NO_2 calculated are listed in Table C6.2 and Table C6.3.

6. The Study Area has been covered by a single domain. The domain is divided into a 21 x-grid and 27 y-grid with equal grid spacing of 250 m.

7. The assessment has been based on 1994 sequential meteorological data from the Lau Fau Shan Station containing the hourly wind direction, wind speed, stability and temperature.

Industrial Emission (SO_2 and NO_2)

6.6.5 In order to provide an SO_2 and NO_2 emission impact assessment covering the whole Study Area including both the existing and future planned sensitive receivers, pollutant concentrations at sensitive receivers have been calculated at various heights, namely at pedestrian level and the 10th floor, 20th floor, 30th floor and 40th floor respectively. The contour plots at the 20th floor which represents the maximum concentration level have been generated. The baseline SO_2 and NO_2 levels have been included in the contour plots and tables.

6.6.6 It is predicted that the hourly, daily and annual SO_2 and NO_2 concentrations at the RZ and the DZ comply with the AQOs. The concentration levels would be highest near the 20th floor level. Figures 6.28 and 6.29 show the predicted NO_2 and SO_2 concentration levels at the 20th floor level respectively.

6.6.7 It is predicted that Area 3 and Tin Yiu Estate (Area 5) could be subject to higher hourly concentration levels than the other Areas in the DZ and RZ but there would not be any exceedance of the AQOs. A detailed and quantitative assessment of the air quality in the vicinity of Areas 3 and 5 has been undertaken and the modelling results are tabulated in Table 6.13. The table shows that the modelled results comply with the AQOs. The relatively higher SO_2 and NO_2 levels are due to the contribution from the industrial activities at Kiu Tau Wai which is about 250 m south of Area 3 (Figure 6.30).

Table 6.13
Predicted NO_2 and SO_2 Concentrations from Industrial Emission at the Representative ASRs in Area 3 and Tin Yiu Estate (Area 5)

ASR	Floor	NO_2 Concentration ($\mu g/m^3$)			SO_2 Concentration ($\mu g/m^3$)		
		1 hour[1]	24 hour[2]	Annual[3]	1 hour[4]	24 hour[5]	Annual[6]
75	G	48	37	35	223	52	28
75	10	51	37	35	277	65	29
75	20	52	38	35	293	68	28
75	30	46	36	34	182	46	26
75	40	43	35	34	138	26	23
77	G	48	37	35	225	57	27
77	10	49	37	35	240	59	28
77	20	51	37	35	268	61	27
77	30	46	36	34	183	42	25
77	40	44	35	34	145	28	23
78	G	46	37	35	183	51	26
78	10	48	37	35	220	53	26
78	20	51	37	34	276	52	25
78	30	46	36	34	185	40	24
78	40	43	35	34	136	28	22
79 *	G	49	37	35	245	60	28
79 *	3	49	37	35	244	60	28
79 *	6	49	37	35	244	61	28
80 *	G	46	37	35	185	55	26
80 *	3	46	37	35	186	56	26
80 *	6	46	37	35	187	57	26
81 *	G	47	36	35	203	41	26
81 *	3	47	36	35	208	41	26
81 *	6	48	36	35	217	42	26
82	G	46	36	34	192	39	26
82	10	46	36	34	191	39	25
82	20	48	36	34	210	37	25
82	30	42	35	34	124	32	24
82	40	40	35	34	90	28	23

* - School
1 - 1 hour AQOs of NO_2 : 300 $\mu g/m^3$
2 - 24 hour AQOs of NO_2 : 150 $\mu g/m^3$
3 - Annual AQOs of NO_2 : 80 $\mu g/m^3$
4 - 1 hour AQOs of SO_2 : 800 $\mu g/m^3$
5 - 24 hour AQOs of SO_2 : 350 $\mu g/m^3$
6 - Annual AQOs of SO_2 : 80 $\mu g/m^3$
Note: Background concentrations have been included.

6.6.8 The area between the Kiu Tau Wai industrial estate and Area 3 is presently undeveloped. It is unlikely that the future alignment of the West Rail or the planned Tin Shui Wai Station will result in relocation of any of the existing factories in the Kiu Tau Wai area. There is a trend for Hong Kong industrial activities to relocate to southern China but it must be assumed that the Kiu Tau Wai industrial estate will continue in operation for the foreseeable future.

6.6.9 The ISCST model indicates that the Yuen Long Industrial Estate has only a minor impact on the Study Area.

Vehicular Emission Impact Assessment

6.6.10 One of the major sources of potential air pollution is the vehicular emissions from traffic. In this assessment, the predicted traffic flows in the years 2001 and 2011 have been chosen for the detailed assessment of vehicular emission impacts using CALINE4.

6.6.11 The emissions from predicted traffic flows in the years 2001 and 2011 on the following roads have been modelled including all flyovers:

Trunk Roads - Hung Tin Road and Long Tin road
Primary Distributors - Tin Tsz Road and Tin Ying Road
District Distributors - Tin Fuk Road, Ping Ha Road and Tin Wah Road
Local Distributors (in DZ) - Tin Shui Road, Tin Shing Road, Tin Wu Road, Tin Yiu Road and Tin Wing Road
Local Distributors (in RZ) - L12, L13 and L14

6.6.12 For the year 2011, the emissions from predicted traffic flows on the following roads have also been modelled: Castle Peak Road, Long Ping Road, Wang Tat Road, Ma Wang Road, Roads D3 and D4.

6.6.13 Traffic air pollution is mainly from NO_2 and RSP. Only maximum hourly concentrations of NO_2 and RSP need assessment to check compliance with the AQOs. These have been predicted using CALINE4.

Methodology

1. The assessment has been based on the latest 2001 and 2011 traffic flows. A detailed breakdown of all types of vehicles is given in Tables C7.1 and C7.2 in Appendix C7 in terms of the percentage of passenger cars (%P.Car), public buses (%PuBus) and heavy goods vehicles (%HGV) plus the emission rates of RSP and NO_2.

2. Gases have been assumed to be inertial, and concentrations of NO_2 have been taken as 20 percent of the total NOx concentration.

3. The assumed vehicular emissions factor for pollutants such as particulates and NO_2 in 2001 and 2011 have been supplied by the Vehicle Emission Control Section of EPD. These factors originated from the USEPA MOBILE IV program.

4. Worst-case meteorological conditions have been assumed:

Wind speed	1 m/s
Wind direction	(worst case for individual receiver)
Stability Class	D

5. The latest information about the road alignments, the road elevations and the road widths has been used in the model of year 2011. It has included the complete road infrastructure covering the whole Study Area.

Vehicular Emission (NO_2 and RSP) Impacts

Year 2001

6.6.14 The traffic impact assessment shows that majority of heavy goods vehicles (HGV) within the Project Area will flow along Tin Ying Road (23.0% of HGV) and Hung Tin Road (29.3% of HGV). The percentage of HGV on Tin Wah Road and Ping Ha Road is 14.1% and 15.7% respectively. The percentage of HGV on the other roads in the DZ and RZ is less than 10%.

6.6.15 Peak-hour average pollution contours (including background NO_2 and RSP concentrations) at pedestrian level are shown in Figures 6.31-6.36. It is expected that the hourly NO_2 concentrations in Areas 3, 30 & 31 and the RZ will comply with the AQOs (Figures 6.31-6.33). However, there is no 1 hour AQOs for RSP concentration against which the findings shown in Figures 6.34-6.36 can be compared. It is notable that the peak hour RSP concentrations are well below the 24 hour AQOs for RSP and thus meet the 24 hour criteria. The predicted NO_2 and RSP concentration levels at the representative ASRs are shown in Table 6.14.

Year 2011

6.6.16 Generally, the percentage of HGV on the roads in and around the DZ and RZ in the year 2011 is lower than the percentage of HGV in the year 2001. The majority of HGV will flow along Tin Ying Road (15.7% of HGV) and Hung Tin Road (19.3% of HGV). The percentage of HGV on Tin Wah Road and Ping Ha Road (D1.3) is 10.5% and 12.6% respectively.

6.6.17 Peak-hour average pollution contours at pedestrian level are shown in Figures 6.37-6.46. The pollution contours covered the whole Study Area from the RZ and DZ and along Hung Tin Road, Ping Ha Road and Long Tin Road. The modelling results are close to the results of the year 2001. As the averaged percentage HGV is lower in the year 2011, it is expected that NO_2 and RSP concentration levels will be lower in the year 2011.

6.6.18 The predicted NO_2 and RSP concentration levels at the representative ASRs are shown in Table 6.14. It is expected that the hourly NO_2 and RSP concentrations in the whole Study Area will comply with the AQOs.

6.6.19 The air quality is better on the upper floors as the vehicular emission impact decreases when the vertical distance from the road increases.

Table 6.14
Predicted NO_2 and RSP Levels from Vehicular Emission at the Representative ASRs

ASR	Floor	Year 2001		Year 2011	
		NO_2 ($\mu g/m^3$)[1]	RSP ($\mu g/m^3$)[2]	NO_2 ($\mu g/m^3$)[1]	RSP ($\mu g/m^3$)[2]
5	G	-	-	96	61
5	3	-	-	66	54
5	6	-	-	55	51
8	G	-	-	88	59
8	3	-	-	66	54
8	6	-	-	51	51
10	G	-	-	55	51
10	10	-	-	47	50
10	20	-	-	40	48
10	30	-	-	36	47
10	40	-	-	36	47
15	G	-	-	47	50
15	10	-	-	43	49
15	20	-	-	40	48
15	30	-	-	36	47
15	40	-	-	36	47
16	G	-	-	62	53
16	10	-	-	47	50
16	20	-	-	40	48
16	30	-	-	36	47
16	40	-	-	36	47
19	G	-	-	47	50
19	3	-	-	47	50
19	6	-	-	47	49
20	G	-	-	58	52
20	10	-	-	43	49
20	20	-	-	40	48
20	30	-	-	36	47
20	40	-	-	36	47
22	G	-	-	73	56
22	10	-	-	47	50
22	20	-	-	40	48
22	30	-	-	36	47
22	40	-	-	36	47
23	G	58	53	62	53
23	10	51	51	43	49
23	20	43	49	40	48
23	30	40	48	36	47
23	40	36	47	36	47

Table 6.14 (cont'd)
Predicted NO_2 and RSP Levels from Vehicular Emission at the Representative ASRs

ASR	Floor	Year 2001		Year 2011	
		NO_2 ($\mu g/m^3$)[1]	RSP ($\mu g/m^3$)[2]	NO_2 ($\mu g/m^3$)[1]	RSP ($\mu g/m^3$)[2]
25	G	66	56	66	54
25	3	62	55	58	52
25	6	58	53	51	50
26	G	-	-	51	51
29	G	58	54	62	53
29	3	58	53	58	52
29	6	55	52	51	51
32	G	62	56	70	56
32	10	51	53	51	51
32	20	43	50	43	49
32	30	40	48	40	48
32	40	36	48	40	48
33	G	73	59	81	57
33	10	51	52	51	51
33	20	43	49	43	49
33	30	40	48	40	48
33	40	36	47	36	47
34	G	62	55	62	53
34	3	58	54	55	52
34	6	55	53	51	50
36	G	62	54	66	54
36	10	47	51	47	49
36	20	43	49	40	48
36	30	40	48	36	47
36	40	36	47	36	47
39	G	73	59	77	57
39	10	51	51	51	51
39	20	43	49	43	49
39	30	40	48	40	48
39	40	36	47	36	47
42	G	81	60	81	57
42	10	47	51	47	50
42	20	43	49	40	48
42	30	40	48	36	47
42	40	36	47	36	47
44	G	100	67	103	63
44	10	55	53	55	52
44	20	43	50	43	49
44	30	40	48	40	48

Table 6.14 (cont'd)
Predicted NO_2 and RSP Levels from Vehicular Emission at the Representative ASRs

ASR	Floor	Year 2001		Year 2011	
		NO_2 ($\mu g/m^3$)[1]	RSP ($\mu g/m^3$)[2]	NO_2 ($\mu g/m^3$)[1]	RSP ($\mu g/m^3$)[2]
44	40	36	47	36	47
45	G	70	57	70	55
45	10	47	51	47	50
45	20	40	49	40	48
45	30	40	48	36	47
45	40	36	47	36	47
46	G	96	66	96	62
46	10	55	54	55	52
46	20	43	50	43	49
46	30	40	48	40	48
46	40	36	48	36	47
47	G	81	63	85	59
47	10	58	55	55	52
47	20	47	50	43	49
47	30	40	48	40	48
47	40	36	48	40	48
48	G	-	-	92	62
49	G	92	65	85	59
49	3	58	54	51	51
49	6	43	49	43	49
51	G	100	67	85	58
51	5	66	57	61	53
53	G	-	-	57	53
53	3	-	-	54	52
53	6	-	-	49	51
55	G	73	60	73	56
55	10	55	54	51	51
55	20	43	50	43	48
55	30	40	48	40	48
55	40	36	47	36	47
57	G	66	59	66	55
57	3	66	58	62	54
57	6	62	56	58	52
59	G	62	56	66	55
59	3	58	54	58	53
59	6	55	53	51	51
64	G	62	57	67	55
64	10	51	53	49	50
64	20	47	52	42	48

Table 6.14 (cont'd)
Predicted NO_2 and RSP Levels from Vehicular Emission at the Representative ASRs

ASR	Floor	Year 2001		Year 2011	
		NO_2 ($\mu g/m^3$)[1]	RSP ($\mu g/m^3$)[2]	NO_2 ($\mu g/m^3$)[1]	RSP ($\mu g/m^3$)[2]
64	30	43	51	39	48
65	G	70	59	69	55
65	10	62	55	52	51
65	20	55	52	43	49
65	30	47	50	39	48
66	G	81	61	70	55
66	10	70	57	51	51
66	20	55	53	42	49
66	30	47	51	39	48
69	G	-	-	111	65
70	G	-	-	111	69
72	G	115	81	96	65
72	3	111	79	92	63
72	6	104	76	85	61
75	G	137	92	94	64
75	10	88	71	59	54
75	20	58	57	46	49
75	30	43	51	40	48
75	40	40	49	38	47
77	G	107	77	92	63
77	10	77	66	62	55
77	20	55	55	47	50
77	30	43	50	40	48
77	40	40	48	36	47
78	G	92	71	84	60
78	10	77	64	56	52
78	20	55	55	46	49
78	30	43	50	40	48
78	40	40	48	37	47
79	G	130	87	99	65
79	3	111	79	86	62
79	6	92	71	70	57
80	G	104	76	94	64
80	3	100	74	82	58
80	6	88	70	72	56
81	G	100	73	96	63
81	3	96	71	85	61
81	6	85	68	73	58
82	G	104	68	103	64

Table 6.14 (cont'd)
Predicted NO_2 and RSP Levels from Vehicular Emission at the Representative ASRs

ASR	Floor	Year 2001		Year 2011	
		NO_2 ($\mu g/m^3$)[1]	RSP ($\mu g/m^3$)[2]	NO_2 ($\mu g/m^3$)[1]	RSP ($\mu g/m^3$)[2]
82	10	73	62	66	55
82	20	58	56	51	51
82	30	47	52	43	49
82	40	40	49	40	48
83	G	134	77	109	65
83	10	88	63	63	54
83	20	58	56	47	50
83	30	47	52	40	48
83	40	43	50	37	47
88	G	73	61	88	60
88	5	62	57	66	55
89	G	-	-	141	76
89	3	-	-	126	72
89	6	-	-	100	65
90	G	-	-	152	75
95	G	119	75	134	70
96	G	-	-	111	65
98	G	-	-	101	66
99	G	122	86	100	66
100	G	137	91	145	80
102	G	-	-	115	70
107	G	-	-	88	59
108	G	-	-	70	54
109	G	-	-	70	55
111	G	-	-	70	55
113	G	-	-	145	79
114	G	-	-	137	77
120	G	-	-	197	96
121	G	-	-	190	94
122	G	-	-	115	67
123	G	-	-	167	81
124	G	-	-	130	74
125	G	-	-	182	92
126	G	-	-	171	88

1 Background NO_2 concentration of 35.8 $\mu g/m^3$ is included.
2 Background RSP concentration of 47.0 $\mu g/m^3$ is included.

Barrier Effect

6.6.20 The configurations of the proposed noise barriers have been presented in Section 4. The air quality associated with the 'barrier effect' i.e. the presence of noise barriers, has been assessed by assuming that the road segments with the noise barrier are elevated roads which have the same level as the barriers and has been based on the latest 2011 traffic flows.

6.6.21 The modelling results with the effect from the proposed barriers along Ping Ha Road, the southern section of Tin Ying Road and Tin Tsz Road, Long Tin Road and Hung Tin Road are tabulated in Table 6.15.

6.6.22 It is shown that the pollutant levels will slightly decrease at the ground floor level because the height of the emission source is raised by the barrier (i.e. the vertical distance from the source to the ground is increased). A slight increase of pollutant levels occurs at the level around the 6th and 10th floors depending on the height of the barrier.

6.6.23 The effect from the proposed barriers along Tin Wah Road, the northern section of Tin Ying Road and Tin Tsz Road is negligible as they are rather short and discrete while the barrier along the northern section of Tin Ying Road is also rather far away from the ASRs at Area 30. The modelling results with the barrier effect are the same as the results with the no barrier effect, so the results are not shown.

6.6.24 It is expected that the barrier effect will not be significant. The predicted NO_2 and RSP concentration levels associated with the noise barrier are well below the AQOs.

6.6.25 In December and March, new traffic data was modelled. These data take into account changes to Public Housing Developments proposed by Housing Authority. These changes have been assessed using CALINE4 for Areas 3 and 13 and along the eastern end of Tin Wah Road which are most affected by emissions from vehicular traffic and which have the most acoustic barriers nearby. This revised data is given in Tables 6.15 and 6.16 for comparison purposes. The difference in air quality between the various scenarios is minimal.

Table 6.15 Comparison of CALINE4 Modelling Results (2011) for Jul and Dec 1996 Traffic Data with and without Barrier Effect

ASR	Floor	NO2 (ug/m3)*						RSP (ug/m3)**					
		no barrier effect			with barrier effect			no barrier effect			with barrier effect		
		Jul	Dec	% difference	Jul	Dec	% difference	Jul	Dec	% difference	Jul	Dec	% difference
75	G	93.7	94.1	0.4	91.8	92.2	0.4	63.8	63.8	-0.1	63.3	63.2	-0.1
75	10	58.7	58.7	0.0	59.1	58.7	-0.6	53.6	53.2	-0.8	53.7	53.2	-0.8
75	20	46.0	47.5	3.3	46.0	47.5	3.3	49.4	49.8	0.7	49.4	49.8	0.7
75	30	40.3	41.1	1.9	40.3	41.1	1.9	48.1	48.3	0.4	48.1	48.3	0.4
75	40	37.7	38.1	1.0	37.7	38.1	1.0	47.5	47.5	0.1	47.5	47.5	0.1
78	G	83.6	86.6	3.6	83.6	86.2	3.2	60.2	59.1	-1.8	60.0	59.1	-1.5
78	10	56.5	59.5	5.3	56.5	59.5	5.3	52.0	52.8	1.5	52.0	52.8	1.5
78	20	45.6	47.1	3.3	45.6	47.1	3.3	49.3	49.7	0.8	49.3	49.7	0.8
78	30	39.6	40.3	1.9	39.6	40.3	1.9	47.9	48.0	0.3	47.9	48.0	0.3
78	40	36.9	37.3	1.0	36.9	37.3	1.0	47.3	47.3	0.1	47.3	47.3	0.1
79	G	99.0	96.7	-2.3	96.0	94.1	-2.0	65.2	64.4	-1.3	64.4	63.6	-1.2
79	3	86.2	84.7	-1.7	85.4	83.9	-1.8	61.5	60.9	-1.0	61.3	60.7	-0.9
79	6	69.6	71.1	2.2	70.0	71.1	1.6	56.8	56.5	-0.5	57.0	56.7	-0.5
80	G	93.7	94.5	0.8	91.4	93.7	2.5	63.8	62.0	-2.8	63.1	61.4	-2.7
80	3	82.0	86.9	6.0	81.7	86.9	6.4	58.4	59.3	1.5	58.4	59.2	1.3
80	6	71.5	76.4	6.8	71.9	76.4	6.3	55.7	56.7	1.8	55.7	56.8	1.8
83	G	108.7	114.4	5.2	108.4	114.4	5.6	64.5	66.4	2.9	64.5	66.4	2.9
83	10	63.2	65.5	3.6	63.2	65.5	3.6	54.1	54.5	0.8	54.1	54.5	0.8
83	20	46.7	48.2	3.2	46.7	48.2	3.2	50.0	50.2	0.4	50.0	50.2	0.4
83	30	40.3	40.7	0.9	40.3	40.7	0.9	48.3	48.3	0.1	48.3	48.3	0.1
83	40	37.3	37.7	1.0	37.3	37.7	1.0	47.5	47.5	0.0	47.5	47.5	0.0
98	G	101.2	97.5	-3.7	100.5	96.7	-3.7	66.1	64.2	-2.8	65.8	64.0	-2.8
90	G	152.4	167.4	9.9	148.6	159.9	7.6	75.0	78.6	4.8	73.9	77.3	4.7
95	G	133.6	141.1	5.6	129.8	141.1	8.7	70.1	72.9	4.0	69.8	72.4	3.7
96	G	111.0	118.5	6.8	111.0	114.8	3.4	64.6	66.8	3.3	64.5	66.6	3.3
99	G	99.7	103.5	3.8	99.7	103.5	3.8	65.9	67.2	2.0	65.8	67.1	1.9
114	G	137.3	144.8	5.5	133.6	141.1	5.6	76.6	78.7	2.7	75.8	77.8	2.6

* background concentration of NO2: 35.8 ug/m3
** background concentration of RSP: 47.0 ug/m3
Refer to Table C7.2 in Appendix C7 for calculation of vehicular emission rates - Jul 1996 traffic data.
Refer to Table C7.3 in Appendix C7 for calculation of vehicular emission rates - Dec 1996 traffic data.

Table 6.16
Effect of the Barriers along the Eastern End of Tin Wah Road on nearby ASRs (March 1997 Traffic Data)

ASR	Floor	NO_2 ($\mu g/m^3$)*			RSP ($\mu g/m^3$)**		
		no barrier	with barrier	% difference	no barrier	with barrier	% difference
44	G	111.0	111.0	0%	65.5	65.1	-0.6%
44	10	50.8	50.8	0%	50.7	50.7	0.1%
44	20	39.6	39.6	0%	47.9	47.9	0%
44	30	35.8	35.8	0%	47.2	47.2	0%
44	40	35.8	35.8	0%	47.1	47.1	0%
45	G	96.0	96.0	0%	62.1	61.7	-0.6%
45	10	50.8	50.8	0%	50.4	50.5	0.2%
45	20	39.6	39.6	0%	47.8	47.8	0%
45	30	35.8	35.8	0%	47.2	47.2	0%
45	40	35.8	35.8	0%	47.1	47.1	0%
47	G	103.5	99.7	-3.6%	64.1	63.2	-1.5%
47	10	50.8	50.8	0%	50.9	51.0	0.1%
47	20	39.6	39.6	0%	48.0	48.0	0%
47	30	35.8	35.8	0%	47.3	47.3	0%
47	40	35.8	35.8	0%	47.1	47.1	0%
43	G	77.2	77.2	0%	57.6	57.4	-0.4%
43	10	50.8	50.8	0%	51.2	51.2	0.1%
43	20	39.6	39.6	0%	48.3	48.3	0%
43	30	35.8	35.8	0%	47.3	47.3	0%
43	40	35.8	35.8	0%	47.1	47.1	0%
64	G	65.9	65.9	0%	54.2	54.1	-0.1%
64	10	47.1	47.1	0%	50.0	50.0	0%
64	20	39.6	39.6	0%	47.9	47.9	0%
64	30	35.8	35.8	0%	47.2	47.2	0%
65	G	65.9	62.1	-5.7%	54.1	54.0	-0.2%
65	10	47.1	47.1	0%	50.1	50.2	0%
65	20	39.6	39.6	0%	47.9	47.9	0%
65	30	35.8	35.8	0%	47.2	47.2	0%
137	G	77.2	77.2	0%	57.3	57.3	0%
137	10	47.1	47.1	0%	49.7	49.7	0.1%
137	20	39.6	39.6	0%	47.7	47.7	0%
137	30	35.8	35.8	0%	47.2	47.2	0%

* background concentration of NO_2: 35.8 $\mu g/m^3$ is included.
** background concentration of RSP: 47.0 $\mu g/m^3$ is included.

Cumulative Impact Assessment

6.6.26 The cumulative impact for NO_2 is generated from the chimneys and the traffic. The major contribution to the cumulative NO_2 level is from the traffic; the impact decreases as the height increases. The predicted cumulative NO_2 levels are shown in Table 6.17. It is expected that there will be no exceedance of the AQOs in the year 2001 and 2011.

Table 6.17
Predicted Cumulative NO_2 Levels at the Representative ASRs

ASR	Floor	Concentration of NO_2 ($\mu g/m^3$)				
		Industrial Impact	Traffic Impact		Cumulative Impact [*,1]	
			Year 2001	Year 2011	Year 2001	Year 2011
5	G	5	-	60	-	101
5	3	5	-	30	-	71
5	6	5	-	19	-	60
8	G	5	-	53	-	93
8	3	5	-	30	-	71
8	6	5	-	15	-	56
10	G	5	-	19	-	59
10	10	5	-	11	-	52
10	20	4	-	4	-	44
10	30	4	-	0	-	40
10	40	4	-	0	-	39
15	G	4	-	11	-	51
15	10	4	-	8	-	48
15	20	4	-	4	-	44
15	30	4	-	0	-	39
15	40	3	-	0	-	39
16	G	5	-	26	-	67
16	10	5	-	11	-	52
16	20	4	-	4	-	44
16	30	4	-	0	-	40
16	40	3	-	0	-	39
19	G	5	-	11	-	52
19	3	5	-	11	-	52
19	6	5	-	11	-	52
20	G	5	-	23	-	63
20	10	5	-	8	-	48
20	20	4	-	4	-	44
20	30	4	-	0	-	40
20	40	3	-	0	-	39
22	G	4	-	38	-	78
22	10	4	-	11	-	51
22	20	4	-	4	-	44
22	30	4	-	0	-	39
22	40	3	-	0	-	39
23	G	5	23	26	63	67

Table 6.17 (cont'd)
Predicted Cumulative NO_2 Levels at the Representative ASRs

ASR	Floor	Concentration of NO_2 ($\mu g/m^3$)				
		Industrial Impact	Traffic Impact		Cumulative Impact *,1	
			Year 2001	Year 2011	Year 2001	Year 2011
23	10	5	15	8	55	48
23	20	4	8	4	48	44
23	30	4	4	0	44	40
23	40	4	0	0	39	39
25	G	5	30	30	70	70
25	3	4	26	23	67	63
25	6	4	23	15	63	55
26	G	4	-	15	-	55
29	G	5	23	26	63	67
29	3	5	23	23	63	63
29	6	5	19	15	59	55
32	G	5	26	34	67	75
32	10	5	15	15	56	56
32	20	4	8	8	48	48
32	30	4	4	4	43	43
32	40	3	0	4	39	43
33	G	5	38	45	79	86
33	10	5	15	15	56	56
33	20	5	8	8	48	48
33	30	4	4	4	43	43
33	40	3	0	0	39	39
34	G	5	26	26	67	67
34	3	5	23	19	63	59
34	6	5	19	15	59	56
36	G	5	26	30	67	71
36	10	5	11	11	52	52
36	20	5	8	4	48	44
36	30	4	4	0	44	40
36	40	4	0	0	40	40
39	G	5	38	41	78	82
39	10	5	15	15	55	55
39	20	4	8	8	48	48
39	30	4	4	4	43	43
39	40	3	0	0	39	39
42	G	5	45	45	86	86
42	10	5	11	11	52	52
42	20	5	8	4	48	45
42	30	5	4	0	44	41
42	40	4	0	0	40	40
44	G	5	64	68	105	109
44	10	5	19	19	60	60
44	20	5	8	8	48	48

Table 6.17 (cont'd)
Predicted Cumulative NO_2 Levels at the Representative ASRs

ASR	Floor	Concentration of NO_2 ($\mu g/m^3$)				
		Industrial Impact	Traffic Impact		Cumulative Impact *,1	
			Year 2001	Year 2011	Year 2001	Year 2011
44	30	4	4	4	44	44
44	40	4	0	0	39	39
45	G	5	34	34	74	74
45	10	5	11	11	52	52
45	20	5	4	4	44	44
45	30	4	4	0	44	40
45	40	4	0	0	40	40
46	G	5	60	60	101	101
46	10	5	19	19	60	60
46	20	5	8	8	48	48
46	30	4	4	4	44	44
46	40	4	0	0	40	40
47	G	6	45	49	87	91
47	10	6	23	19	64	60
47	20	5	11	8	53	49
47	30	5	4	4	45	45
47	40	5	0	4	40	44
48	G	5	-	56	-	97
49	G	5	56	49	97	90
49	10	5	23	15	63	56
49	20	5	8	8	48	48
51	G	6	64	49	105	91
51	5	6	30	25	71	66
53	G	5	-	21	-	63
53	3	5	-	18	-	59
53	6	5	-	13	-	54
55	G	5	38	38	79	79
55	10	5	19	15	60	56
55	20	5	8	8	48	48
55	30	5	4	4	44	44
55	40	4	0	0	40	40
57	G	5	30	30	71	71
57	3	5	30	26	71	68
57	6	5	26	23	68	64
59	G	6	26	30	68	72
59	3	6	23	23	65	65
59	6	6	19	15	61	57
64	G	6	26	31	68	72
64	10	5	15	14	56	55
64	20	5	11	6	52	47
64	30	5	8	3	48	44
65	G	6	34	33	76	75

Table 6.17 (cont'd)
Predicted Cumulative NO_2 Levels at the Representative ASRs

ASR	Floor	Concentration of NO_2 ($\mu g/m^3$)				
		Industrial Impact	Traffic Impact		Cumulative Impact *,1	
			Year 2001	Year 2011	Year 2001	Year 2011
65	10	6	26	16	68	58
65	20	6	19	7	60	48
65	30	5	11	3	53	44
66	G	6	45	34	87	75
66	10	6	34	15	76	57
66	20	7	19	6	61	48
66	30	7	11	3	54	45
69	G	7	-	75	-	118
70	G	7	-	75	-	118
72	G	10	79	60	125	106
72	3	10	75	56	121	102
72	6	10	68	49	113	94
75	G	12	102	58	150	106
75	10	16	53	23	104	74
75	20	16	23	10	74	61
75	30	9	8	5	52	49
75	40	7	4	2	46	44
77	G	12	71	56	119	104
77	10	14	41	26	91	76
77	20	14	19	11	69	61
77	30	9	8	4	52	48
77	40	7	4	0	46	43
78	G	9	56	48	101	92
78	10	10	41	21	88	67
78	20	12	19	10	67	58
78	30	7	8	4	51	47
78	40	6	4	1	46	43
79	G	14	94	63	143	113
79	3	14	75	50	125	100
79	6	14	56	34	106	83
80	G	10	68	58	113	104
80	3	10	64	46	110	92
80	6	10	53	36	99	82
81	G	11	64	60	111	107
81	3	12	60	49	108	96
81	6	12	49	38	97	85
82	G	11	68	68	114	114
82	10	10	38	30	84	76
82	20	10	23	15	68	60
82	30	6	11	8	53	49
82	40	4	4	4	44	44
83	G	8	98	73	141	116

Table 6.17 (cont'd)
Predicted Cumulative NO_2 Levels at the Representative ASRs

ASR	Floor	Concentration of NO_2 ($\mu g/m^3$)				
		Industrial Impact	Traffic Impact		Cumulative Impact *,1	
			Year 2001	Year 2011	Year 2001	Year 2011
83	10	8	53	27	96	71
83	20	7	23	11	65	54
83	30	6	11	5	53	47
83	40	5	8	2	49	43
88	G	5	38	53	79	94
88	5	5	26	30	67	71
89	G	10	-	105	-	151
89	3	10	-	90	-	136
89	6	11	-	64	-	111
90	G	8	-	117	-	161
95	G	9	83	98	127	142
96	G	10	-	75	-	121
98	G	10	-	65	-	112
99	G	15	86	64	137	114
100	G	14	102	109	151	158
102	G	12	-	79	-	127
107	G	5	-	53	-	93
108	G	5	-	34	-	75
109	G	5	-	34	-	75
111	G	5	-	34	-	75
113	G	5	-	109	-	150
114	G	12	-	102	-	150
120	G	12	-	162	-	209
121	G	11	-	154	-	201
122	G	8	-	79	-	123
123	G	8	-	132	-	175
124	G	9	-	94	-	138
125	G	13	-	147	-	195
126	G	12	-	135	-	183

* - Background NO_2 concentration of 35.8 $\mu g/m^3$ is included.
[1] - 1 hour AQOs of NO_2 : 300 $\mu g/m^3$.

6.6.27 The cumulative impact for SO_2 is mainly generated from the chimneys and has been assessed to be below the AQOs. The cumulative impact for RSP is mainly generated from the traffic and has been assessed to be below the AQOs.

Odour Impact Assessment

Sewage Pumping Station

6.6.28 A new sewage pumping station is required to pump the sewage from the RZ to the Ha Tsuen pumping station. Area 101 has been proposed as the site for the sewage pumping station.

6.6.29 The proposed pumping station has been described in the report entitled *Preliminary Sewerage Assessment Report, Sewerage Proposal for Priority Sites* (Ref.0018/ENG/R4.2). In brief, the proposed pumping station will have an ultimate peak flow of 1278 l/s. The pumping station will comprise a dry well, a divided wet sump, an intake channel and loading area. The preliminary layout of the proposed pumping station is illustrated in Figure 6.47, Figure 6.48 and Figure 6.49. Its layout is similar to the existing station in Area 14.

6.6.30 The exact details of the pumping station will be discussed and agreed with DSD and EMSD during the detailed design stage.

Sensitive Receivers

6.6.31 The closest odour sensitive receiver (SR32) is the public housing about 35 metres north of the proposed pumping station.

Impact of Operational Phase

6.6.32 The principal odour generated from sewage treatment is hydrogen sulphide (H_2S) due to the anaerobic decomposition of substances containing nitrogen and sulphur. The production of odours at sewage plants depend on number of parameters namely temperature, sewage strength, velocity of sewage flow, pH, dissolved sulphide concentration and flux of H_2S.

6.6.33 The existing sewage pumping station in Area 14 contains no screening facilities which usually are the areas where most of the sewage odour is generated. As the pumping station is totally enclosed, the air inside the pumping station will be channelled through a ventilation system built inside the pumping station. The air, before emission from the pumping station, will be treated by a deodorising unit containing deactivated carbon. This treatment method has proved to be very effective with odour removal efficiency of above 95%.

6.6.34 Two odour observations (January 31st, 1996 and June 7th, 1996) were made at 3 m from the existing pumping station at Area 14 while the noise monitoring was being conducted for the pumping station. Odour was not found to be a nuisance. Thus the existing deodorising unit which is activated carbon is effective. It is anticipated that similar type of deodorising unit will be installed in the new pumping station. So all sensitive receivers are expected to comply with the EPD's odour criteria.

Mitigation Measures

6.6.35 Odour controls are needed as prevention measures against the possibility of odour nuisance. Mitigation in terms of preventing H_2S emission can be achieved by installation of deodorisation units and good housekeeping practice.

Activated Carbon

6.6.36 The proposed deodorising unit which is similar to the system used at the existing pumping station in Area 14 uses activated carbon as the absorbent for air pollutants.

Biofilter

6.6.37 Another type of deodorising units is a biofilter which achieves odour removal by the use of micro-organisms grown on an inert packing media. Odorous air passes through a soil, peat or composite bed, where odour is removed under the influence of enzymes produced by micro-organisms in the soil.

6.6.38 Despite the high odour removal efficiency rate of above 95% for either odour removal system, particular attention should be paid on the location and direction of ventilation exhausts so that they should not be allowed to face any sensitive receivers directly. Consideration should be given to the location of windows and doors at the sensitive receivers and the direction of prevailing wind.

Good Housekeeping

6.6.39 Good housekeeping practices at the pumping station can also lead to prevention of odorous emissions. The following are some of the key practices:

1. Weekly inspection of the wet wells should be conducted to check the level of the accumulation of odorous grease, oil and scum. If the accumulation of these substances are excessive, the frequency of removal and inspection should be increased.

2. To reduce the rate of accumulation of these odour-producing organic debris, regular cleaning and flushing of screens and other sewage handling equipment is required.

3. Grit stored on site should be kept in closed containers or skips with a rolling screens on top. Grit should be disposed of as soon as possible.

4. Sludge deposits in wet wells and channels should be regularly removed because sludge left in the pump and pipes can produce odorous gas. The site supervisor should ensure that only skips installed with rolling screens on top should be used to contain the sludges and are picked up by the disposal trucks. This is expected to significantly reduce the levels of odour released during the transportation of the sludge.

5. The deodorisation and ventilation systems should be regularly inspected to ensure efficient operation.

The Drainage Channels

The Western Drainage Channel (WDC)

6.6.40 Complaints have been made to various authorities about odour from the WDC. This odour arises from pollutants in the water and from sediments caught upstream of the inflatable dam.

6.6.41 The major source of these contaminants is animal wastes washed down from upstream farming industry. Currently, a system of low flow interceptors and crump weirs can divert the bulk of the contaminated low flow to sewerage provided this system is kept operating efficiently. Unfortunately, maintenance of the system has not been sufficient in the past resulting in excessive amount of solid waste in the channels and rivers and the low flow interceptors are sometimes partly or fully blocked. As a result, a significant amount of polluted low flow bypasses the interceptors and enters the channels downstream. Sediments are dropped behind the inflatable dam.

6.6.42 The sediments on the channel floor or in the water column are highly oxygen consuming and rapidly become anoxic. A range of odorous gases are formed. Hydrogen sulphide, H_2S, is particularly malodorous at very low concentrations.

6.6.43 The amount of malodorous gases present depends on factors such as the level of oxygen-consuming suspended solids, the oxygen in the water and the age of the solids. The higher the residence time, the greater the odour.

6.6.44 Two factors can reduce the odour:

(i) reduction in residence time; and
(ii) reduction in nitrogen and sulphur containing pollutants.

6.6.45 Information on the *Livestock Waste Control Scheme* and water quality data are given in Section 7 of this report. BOD levels always exceed the Water Quality Objectives particularly during the dry season. Restrictions on the amount of livestock waste discharged into the waters of the TSW drainage basin do not come into force until the 1 July 1997. These restrictions, or discharge standards will still allow 250 mg/l BOD and 250 mg/l SS to be discharged, levels which are five times the levels of BOD and suspended solids permitted after 1 July 1999.

6.6.46 As the *Livestock Waste Control Scheme* is implemented and enforced, substantial reduction in pollutant levels should occur. Theoretically this scheme should be virtually fully in operation in time for the new influx of residents to TSW.

6.6.47 It should be noted that the low-flow interceptor system does not intercept wastes from the section of the Tai Culvert, the downstream section of Lo Uk Tsuen Channel or Kiu Tau Wai channel downstream of the crump weir at Kiu Tau Wai.

6.6.48 EPD now has a 'zero discharge policy' for the Deep Bay Water Quality Control Zone which, when enforced, should result in visible and olfactory improvement in the WDC.

6.6.49 In the intervening period, it is recommended that maintenance activity associated with the low-flow interceptor system be kept at levels which ensure efficient functioning of the system at all times. The inflatable dam should be kept up except during storms so that the channel bed is kept relatively dry. The channel bed and the bed of the new low-flow channel should be kept free of accumulated sediment.

6.6.50 Dirty water should only be kept behind the inflatable dam for the minimum time possible so as to avoid bacterial breakdown of the pollutants with concomitant production of odorous volatile compounds.

6.6.51 In the long term, odour problems should not occur. In the short term they can be minimised.

Western Drainage Channel Extension

6.6.52 Once the new sewerage pumping station in Area 101 is commissioned, any contaminated water from the new low flow channel should be pumped via this station to the sewerage system. Consideration should be given to the possibility of taking away by road tanker badly polluted water in the new low flow channel during the intervening period.

6.6.53 Pollutants washed down from the catchment basins of Inner Deep Bay are diluted and carried back upstream with the tide. Once pollution in the basins is controlled, these tidal-borne pollutants will reduce.

6.6.54 The 500 m concrete extension of the WDC below the inflatable dam will enable DSD to remove any contaminated sediments which wash down from old deposits further upstream.

6.6.55 Provided the current legislation is enforced within the TSW area so that illegal discharges to the stormwater system are minimised, and the WDC is kept clean as discussed above, unacceptable odours need not be a feature of the WDCE.

Eastern Drainage Channel (EDC)

6.6.56 The drainage basin for the EDC is between 300 and 400 ha. It receives little animal wastes. Any future odour problems associated with the EDC would only arise as the result of illegal discharges to the stormwater system.

Summary and Conclusions

6.6.57 The air quality due to the chimney emissions in the RZ and the DZ will comply with the AQOs. The ISCST modelling result suggests that the NO_2 and SO_2 levels are relatively higher in Area 3 than the other Areas due to the chimney emissions from the Kiu Tau Wai industrial area but the buffer distance of about 250 m is enough to provide the acceptable air quality in Area 3. The model also indicates that the Yuen Long Industrial Estate will have minor impact on the Study Area.

6.6.58 The air quality due to the traffic emissions in the RZ and DZ will also comply with the AQOs.

6.6.59 The cumulative impact assessment concludes that the operational air quality in the DZ and RZ will be well within the AQOs.

6.6.60 During the operation of the new pumping station, odour could cause significant impact to the sensitive receivers in the vicinity. The principal odour source is H_2S emitted from the sewage in the wet well. To reduce this adverse impact, deodorisation units will be installed and good housekeeping practice employed to ensure that emissions comply with the EPD's odour criteria.

6.7 Conclusion

6.7.1 It is not likely that the air quality in the Study Area will be subjected to any significant construction or operational impacts.

6.7.2 The construction impact assessment showed that with the implementation of the mitigation measures, the air quality during the construction phase can be kept at the acceptable level.

6.7.3 To ensure that dust levels kept within EPD's guidelines and, where applicable, as closely as is practicable to the Deep bay Guidelines, appropriate Contract clauses have been recommended. A dust monitoring programme has been included in the EM&A recommendations.

6.7.4 During the operational phase, the air quality in the DZ and RZ will be at the acceptable level. The air quality in the RZ is generally better than the air quality in the DZ and the other Study Areas at the south of the DZ, as the RZ is further away from the industrial area at Kiu Tau Wai and it is not close to the major roads with relatively high traffic flow and/or high percentage of heavy vehicles, such as Tin Ying Road, Tin Tsz Road, Hung Tin Road, Ping Ha road and Long Tin Road.

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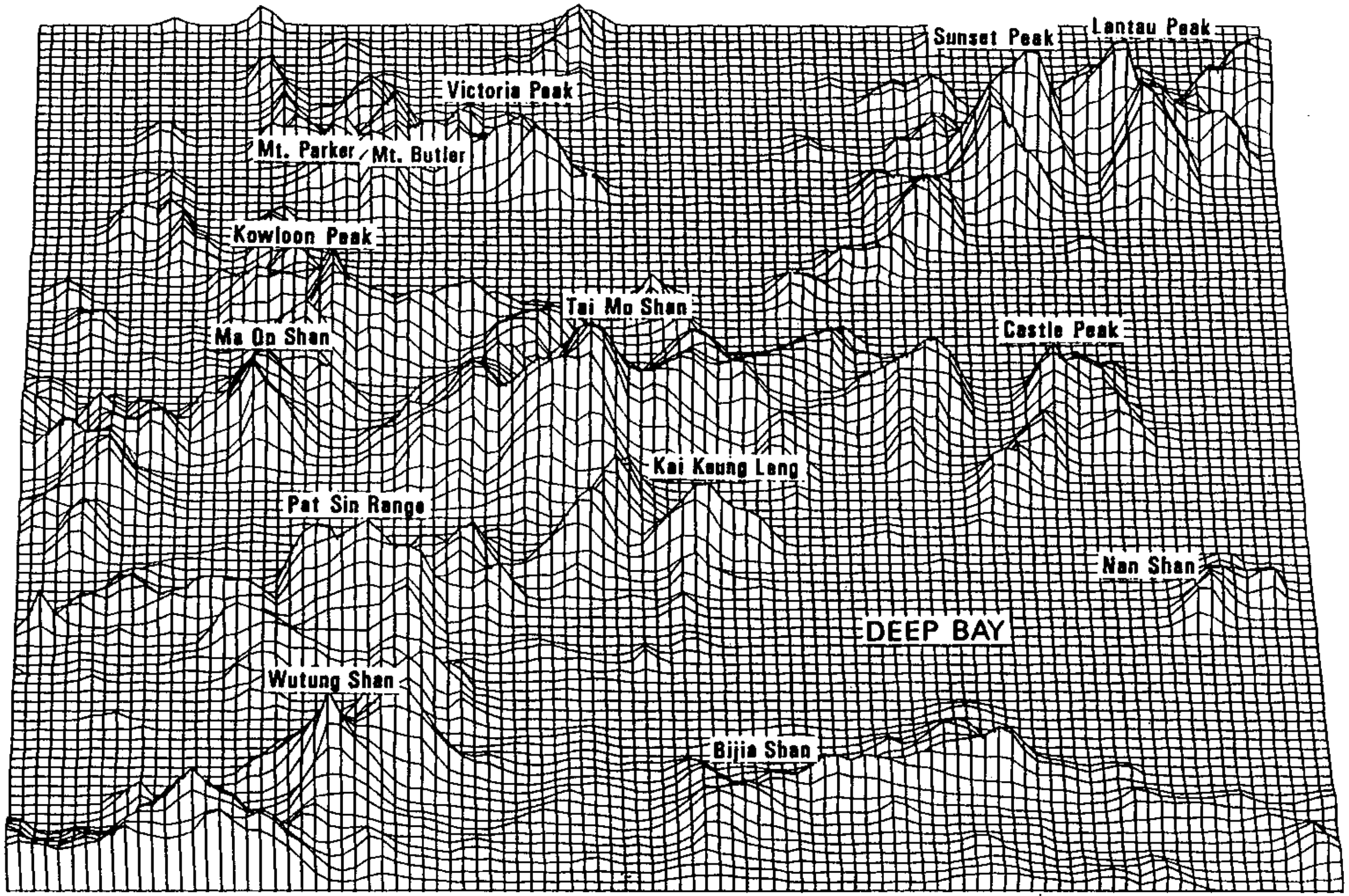
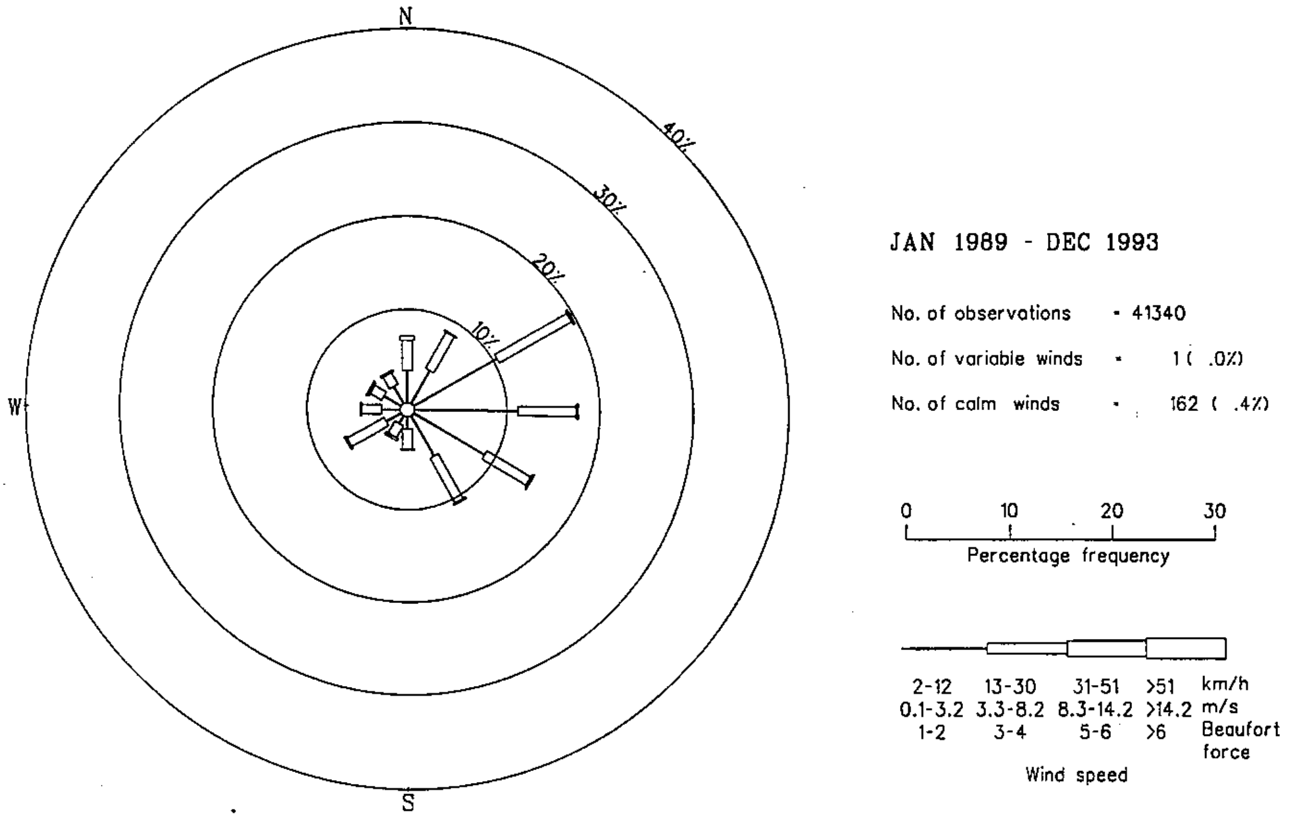


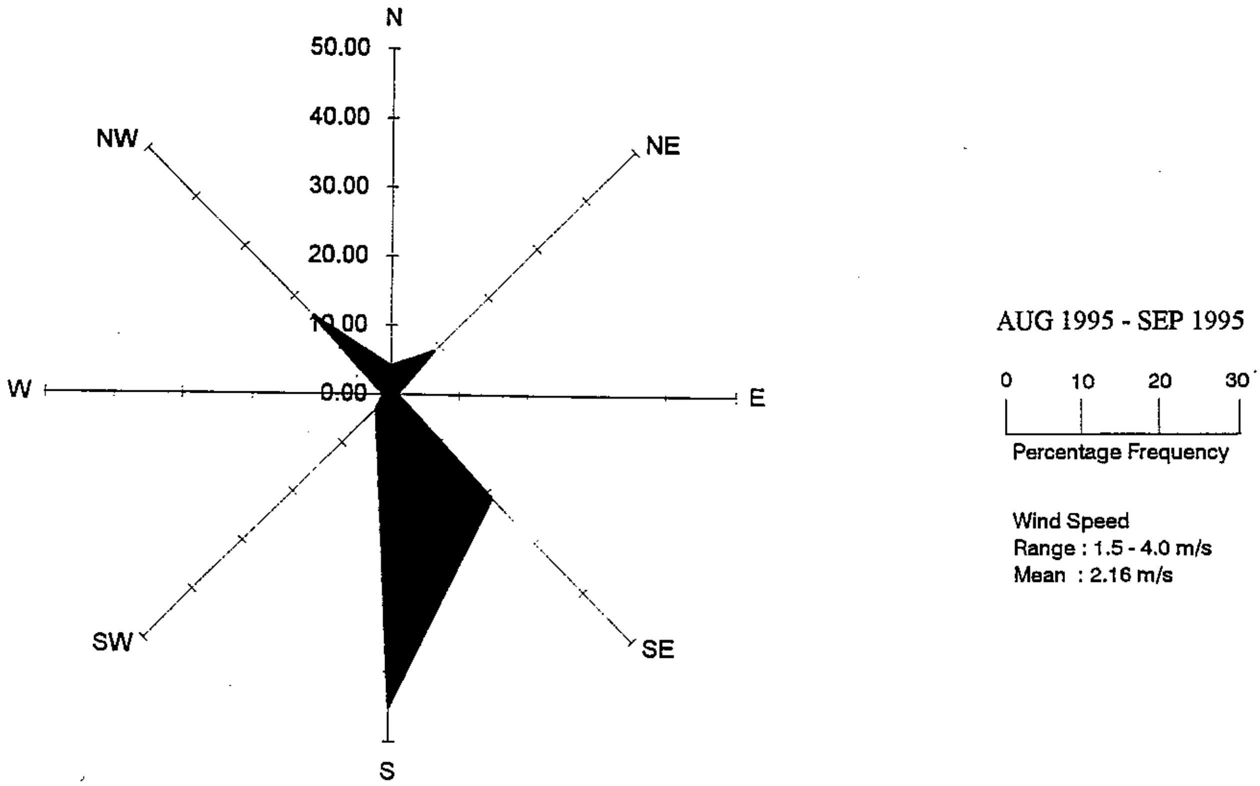
(*Source : Royal Observatory (Hong Kong), 1984*)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	Title : COMPUTER SIMULATION OF THE TOPOGRAPHIC FEATURES SURROUNDING THE DEEP BAY AIR SHED	Figure No. 6.1 Reference No. RO (HK) 1984 Prepared WKY Date FEB 96	Revision 0 File Name - Checked YWL Scale -



(Source : Royal Observatory (Hong Kong))

(a) Wind Rose for Lau Fau Shan



(Source : WENT Meteorological Data (8/95 - 9/95))

(b) Wind Rose for WENT Landfill Site

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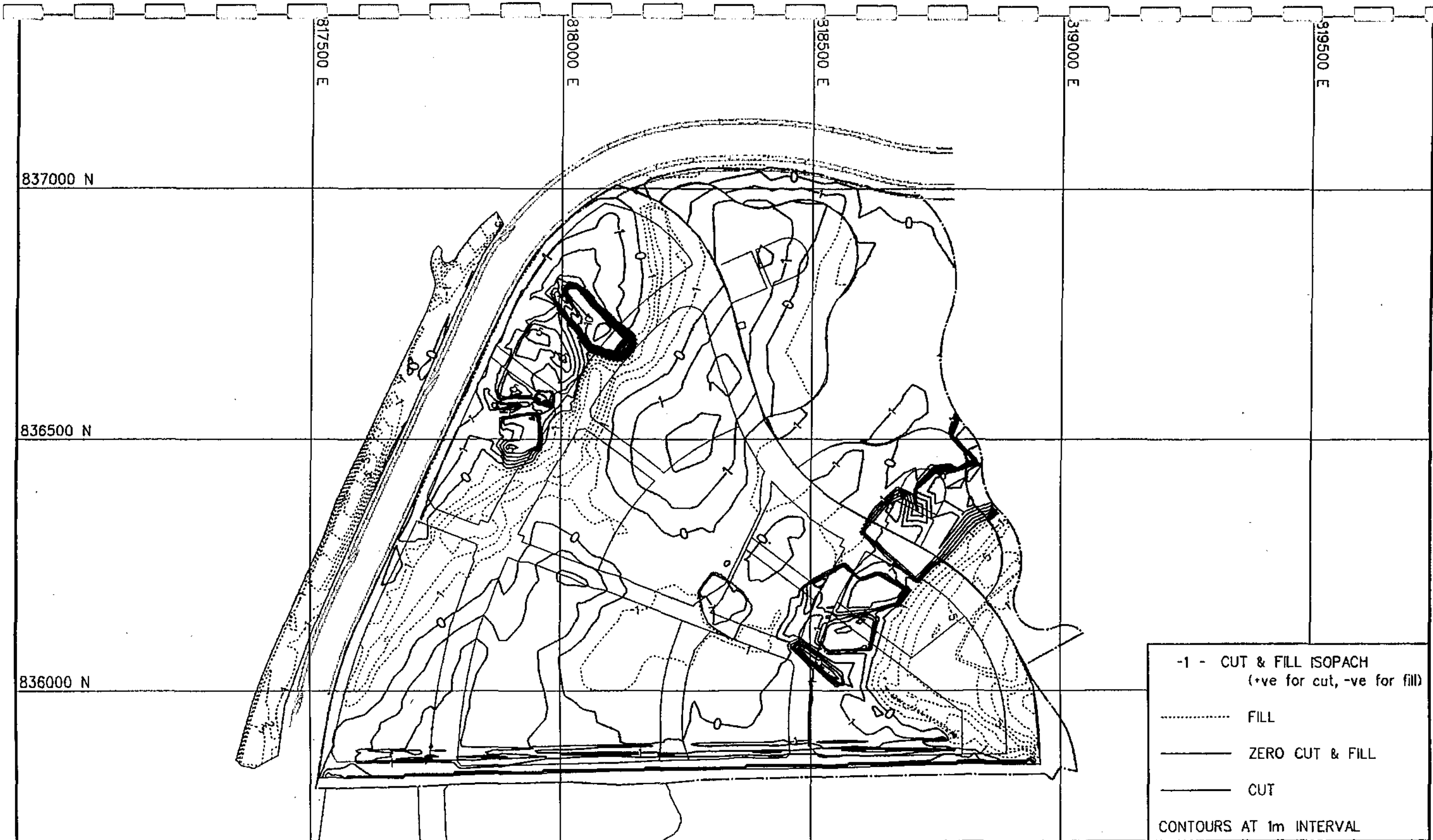
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Date FEB 96	Scale -



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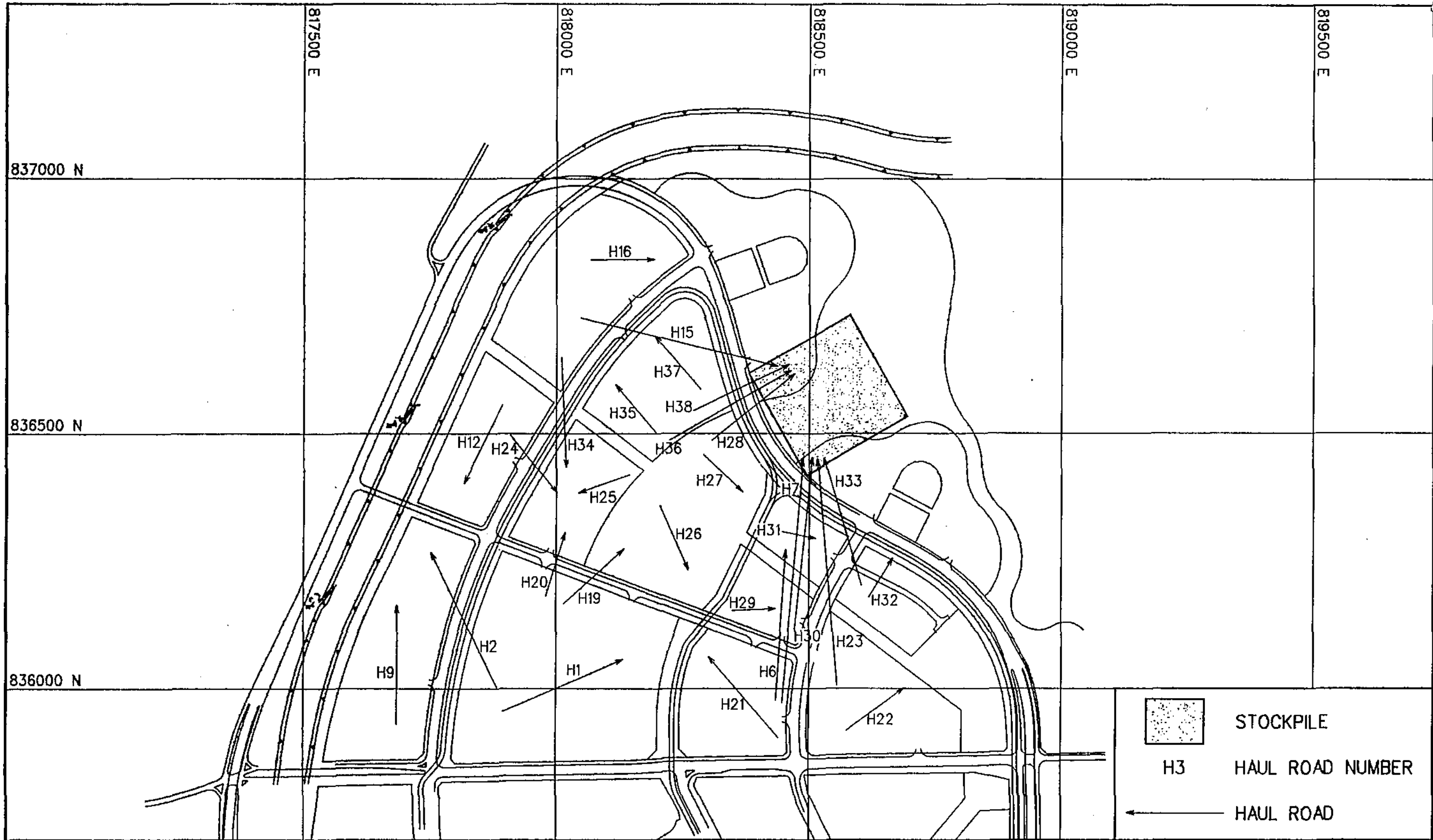

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ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼

Title :

LIKELY LOCATION OF HAUL ROADS AND STOCKPILE

Figure No.	Revision
6.4	0
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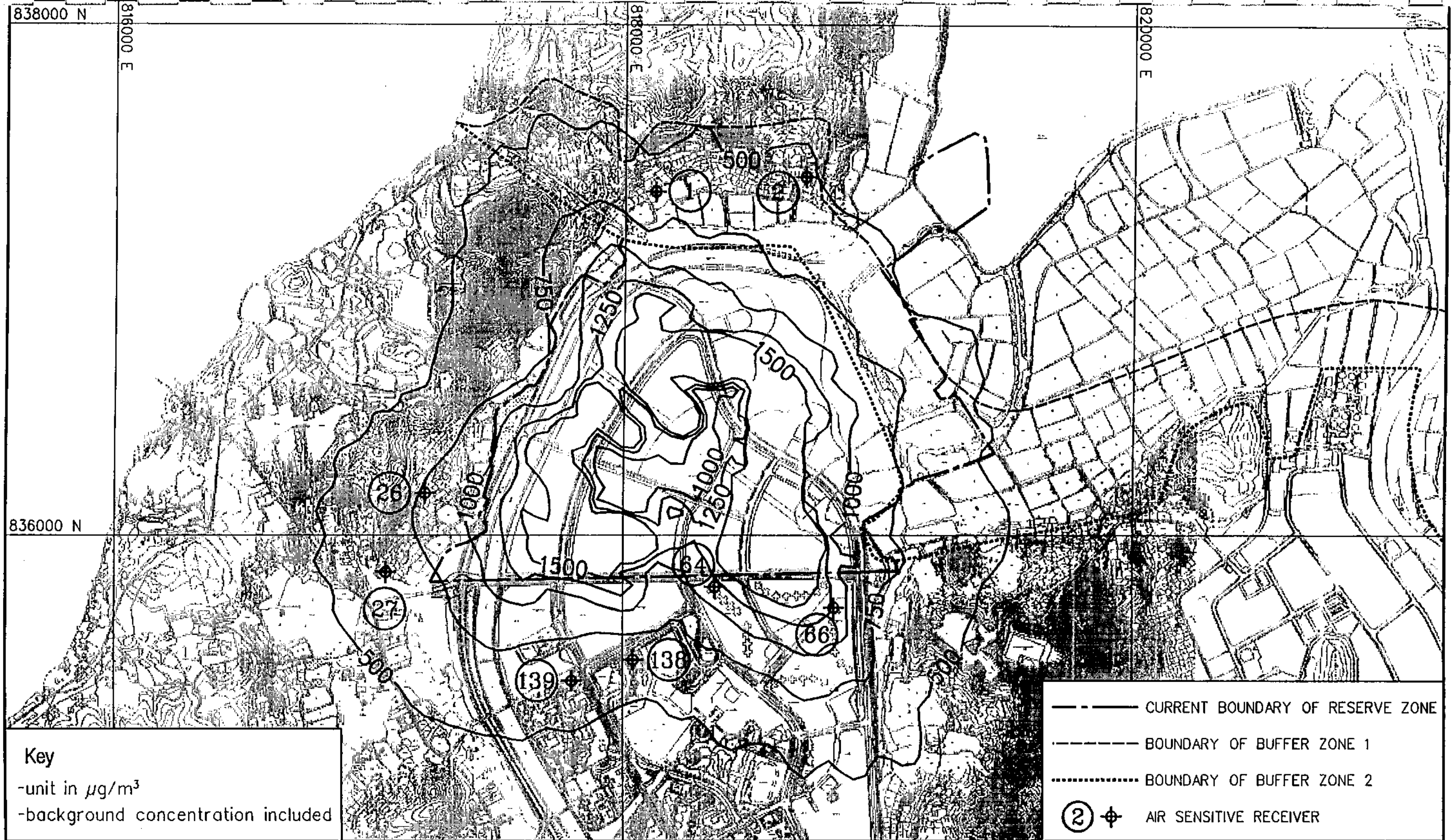
Date	Scale



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ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼

Title :

SCENARIO 1 –
MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) :
HOURLY AVERAGE (COMPLETELY UNMITIGATED)

Figure No. 6.5	Revision 0
Reference TSW-BASE	File Name 01570018.C09
Prepared HW	Checked PS
Date NOV. 96	Scale 1 : 20000

Key
-unit in $\mu g/m^3$
-background concentration included

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼

Title :

SCENARIO 1 -
MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) :
DAILY AVERAGE (COMPLETELY UNMITIGATED)

Figure No. 6.6	Revision 0
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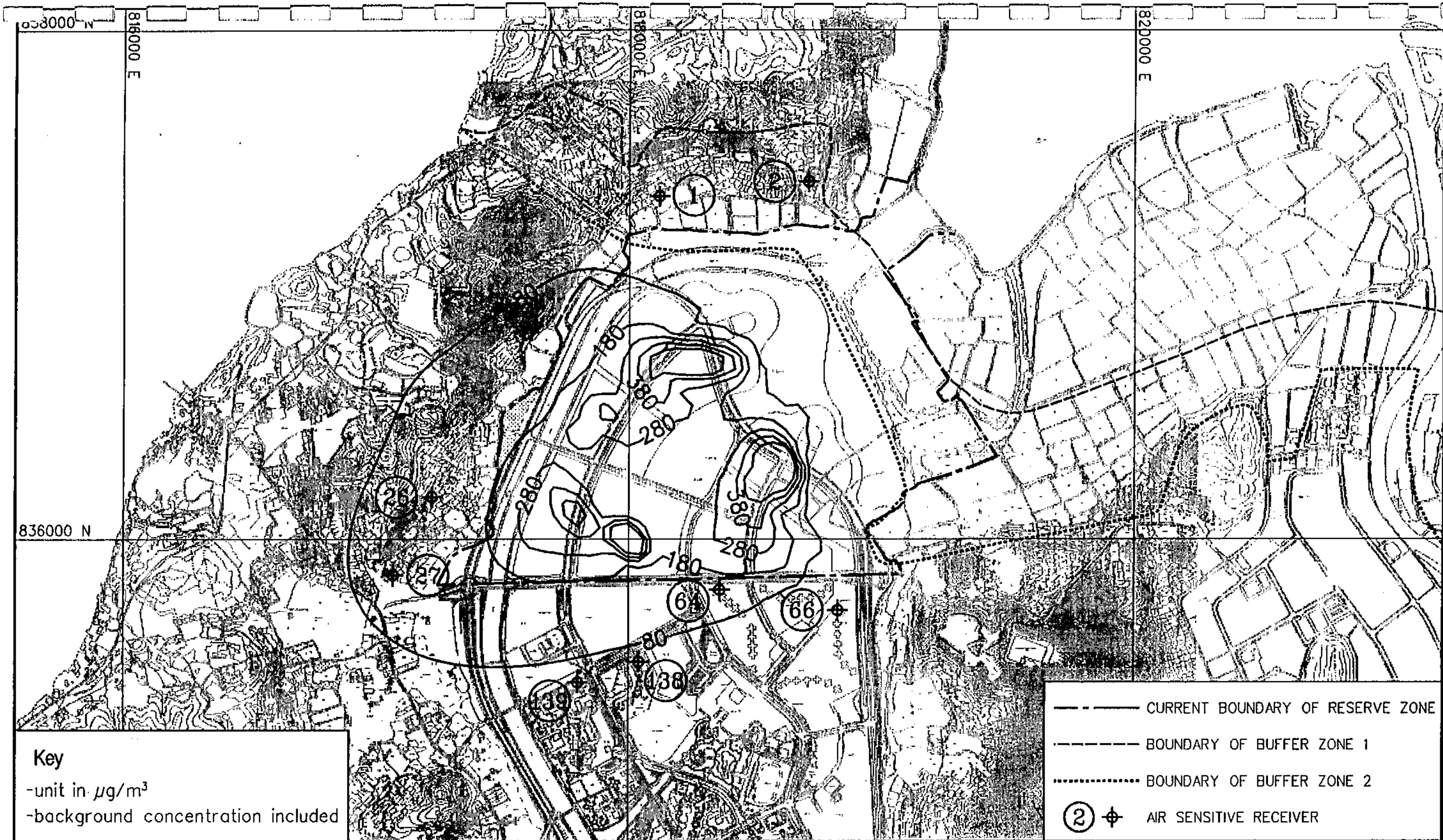
Date NOV 96	Scale 1 : 20000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SCENARIO 1 - MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) : YEARLY AVERAGE (COMPLETELY UNMITIGATED)	Figure No. 6.7	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 01590018.C09
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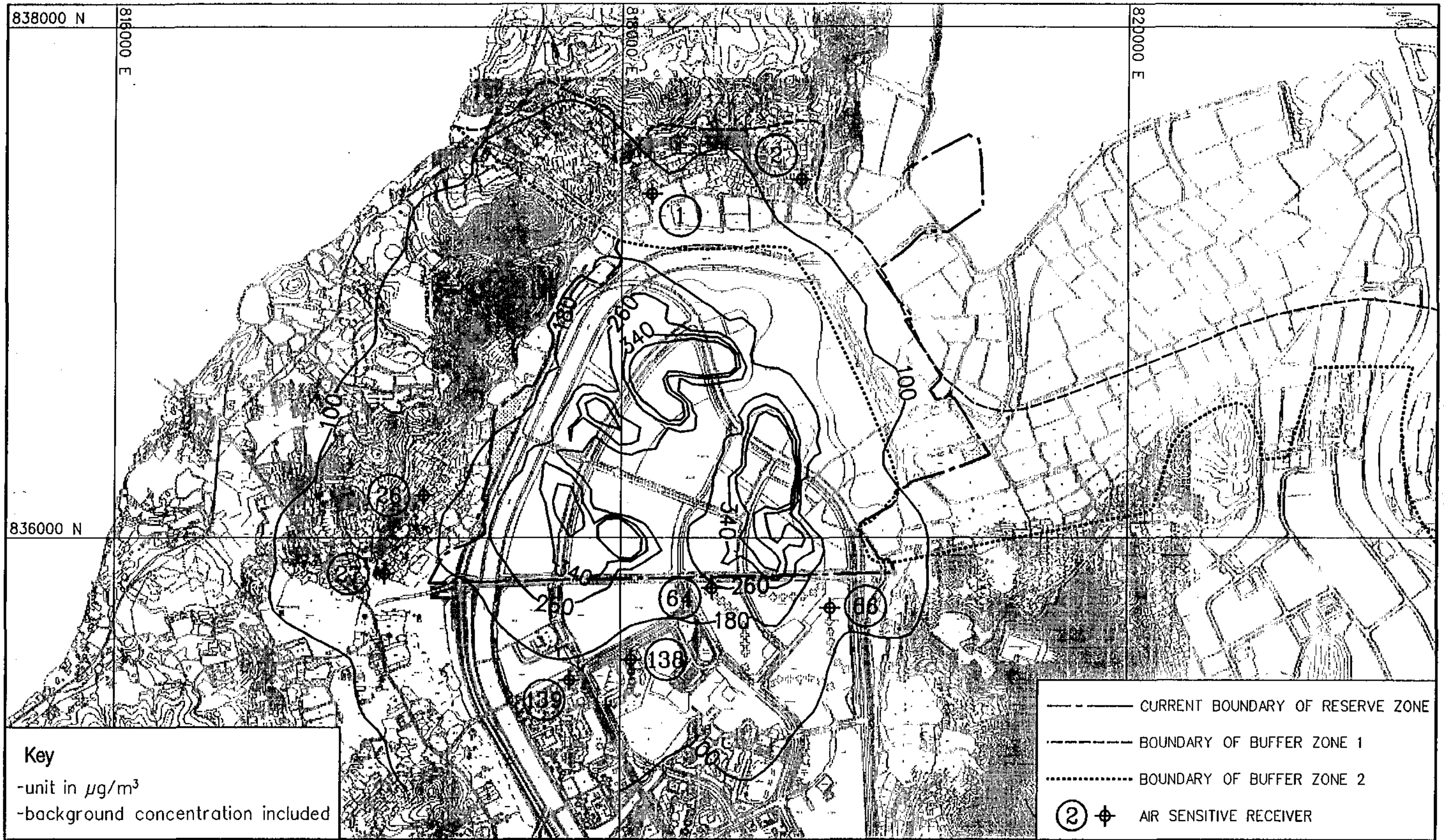

TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
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ENGINEERS AND SCIENTISTS
賓尼

Title :

SCENARIO 1 –
MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) :
DAILY AVERAGE (COMPLETELY UNMITIGATED)

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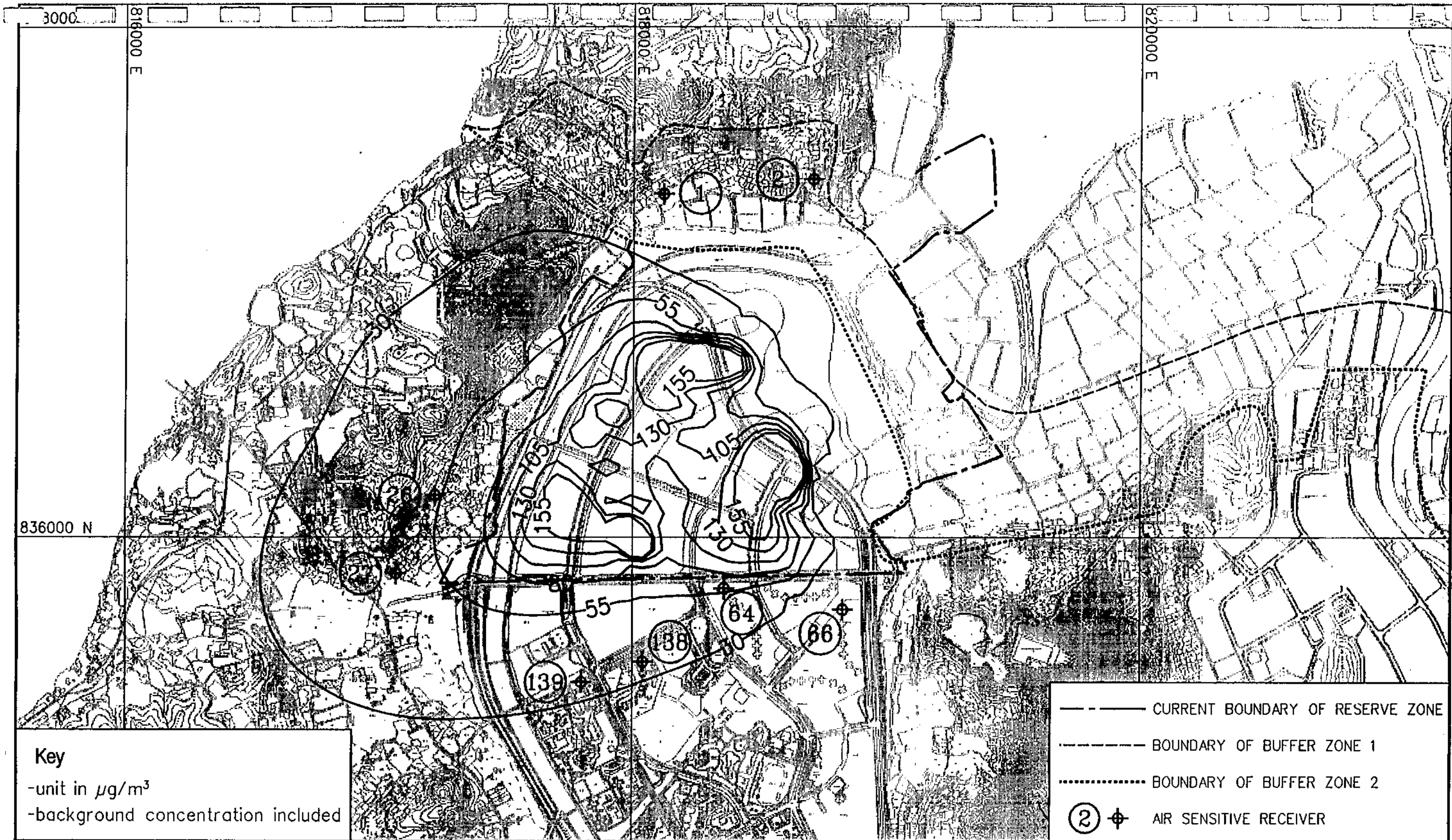

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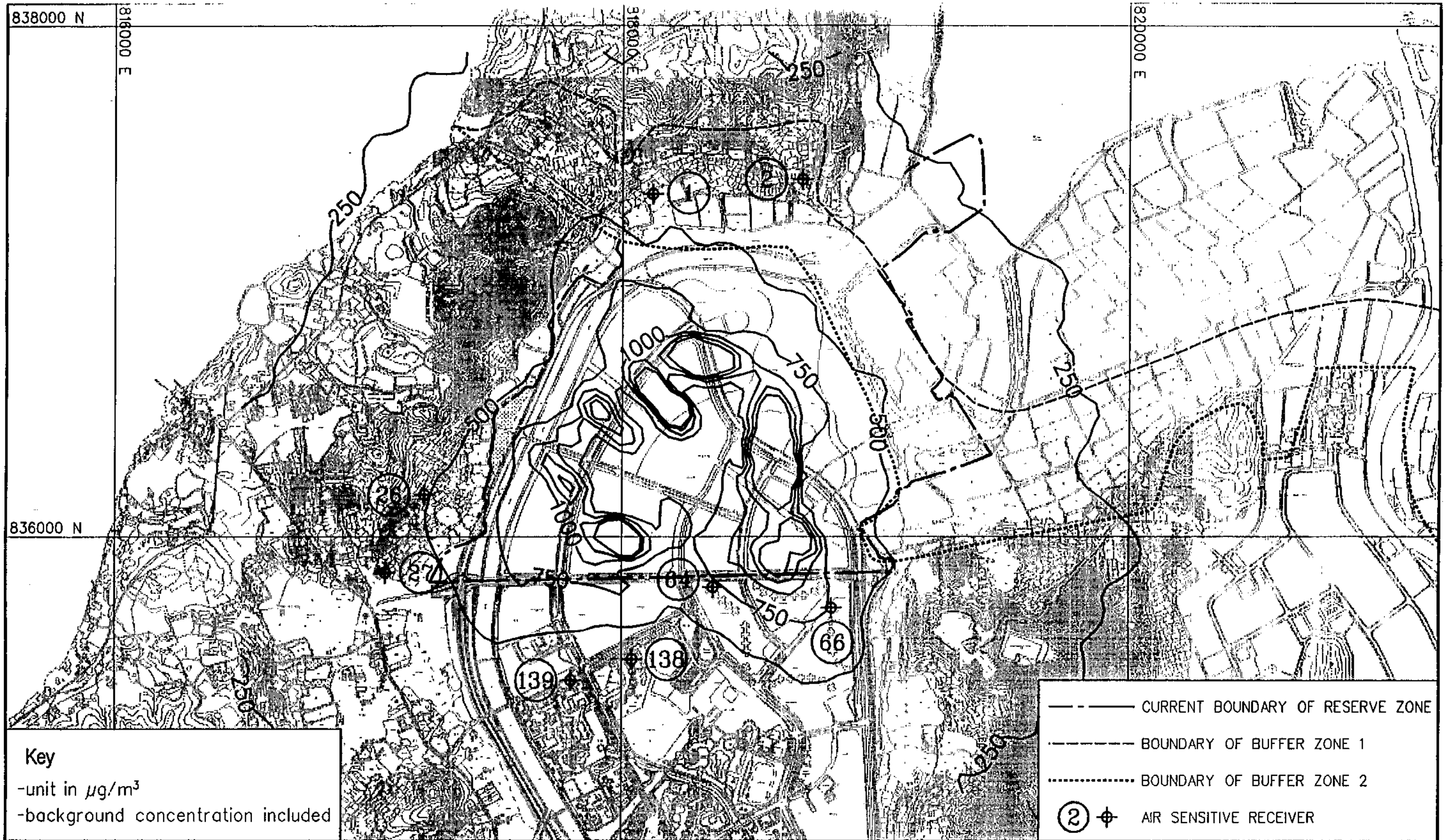

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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Title :

SCENARIO 1 –
MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) :
HOURLY AVERAGE (50% REDUCTION IN DUST FROM DIRT ROADS)

Figure No. 6.10	Revision 0
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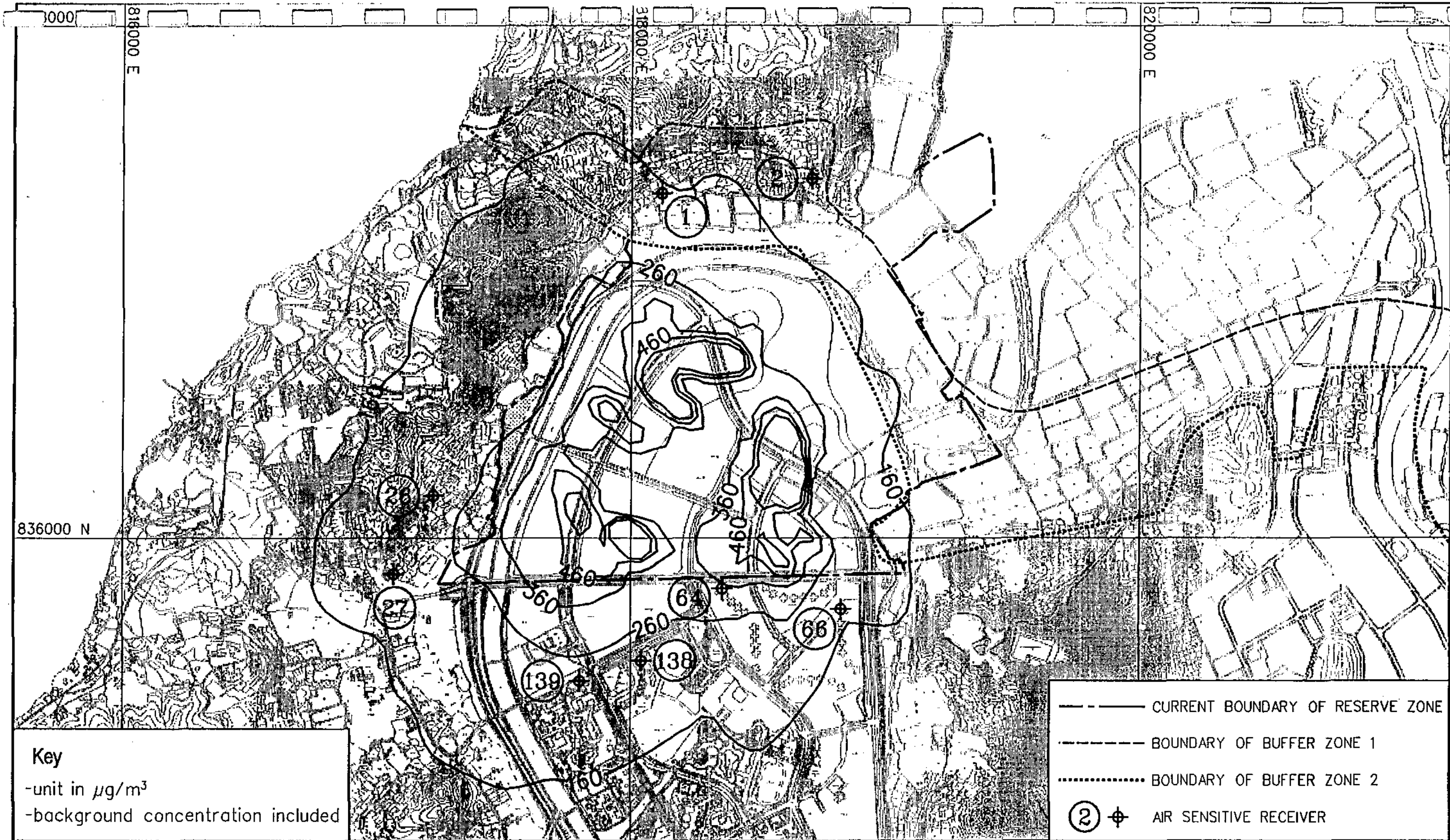
Prepared HW	Checked PS
Date NOV. 96	Scale 1 : 20000



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ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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Title :

SCENARIO 1 -
MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) :
DAILY AVERAGE (50% REDUCTION IN DUST FROM DIRT ROADS)

Figure No. 6.11	Revision 0
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Prepared HW	Checked PS
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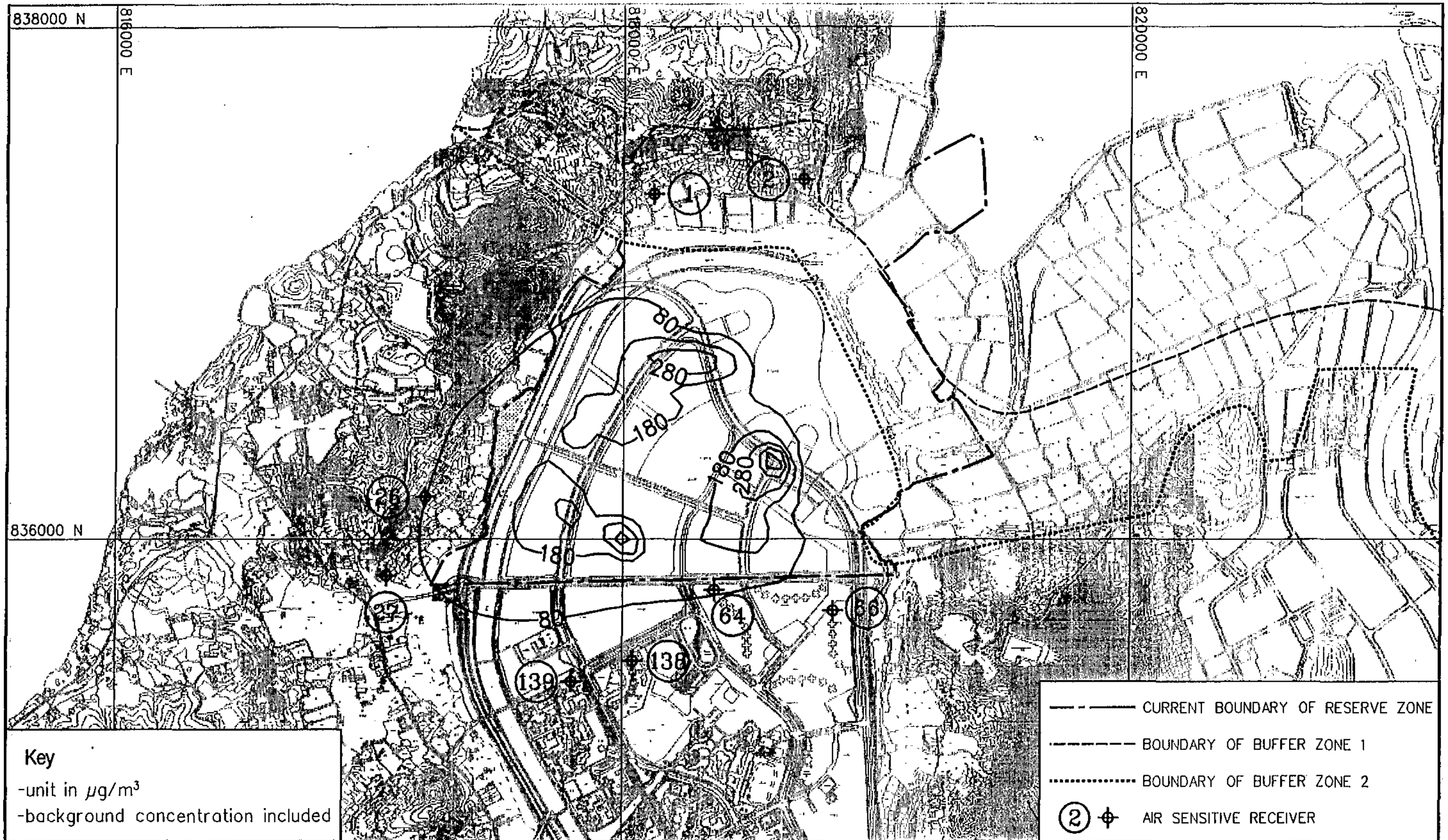

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BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 01640018.C09
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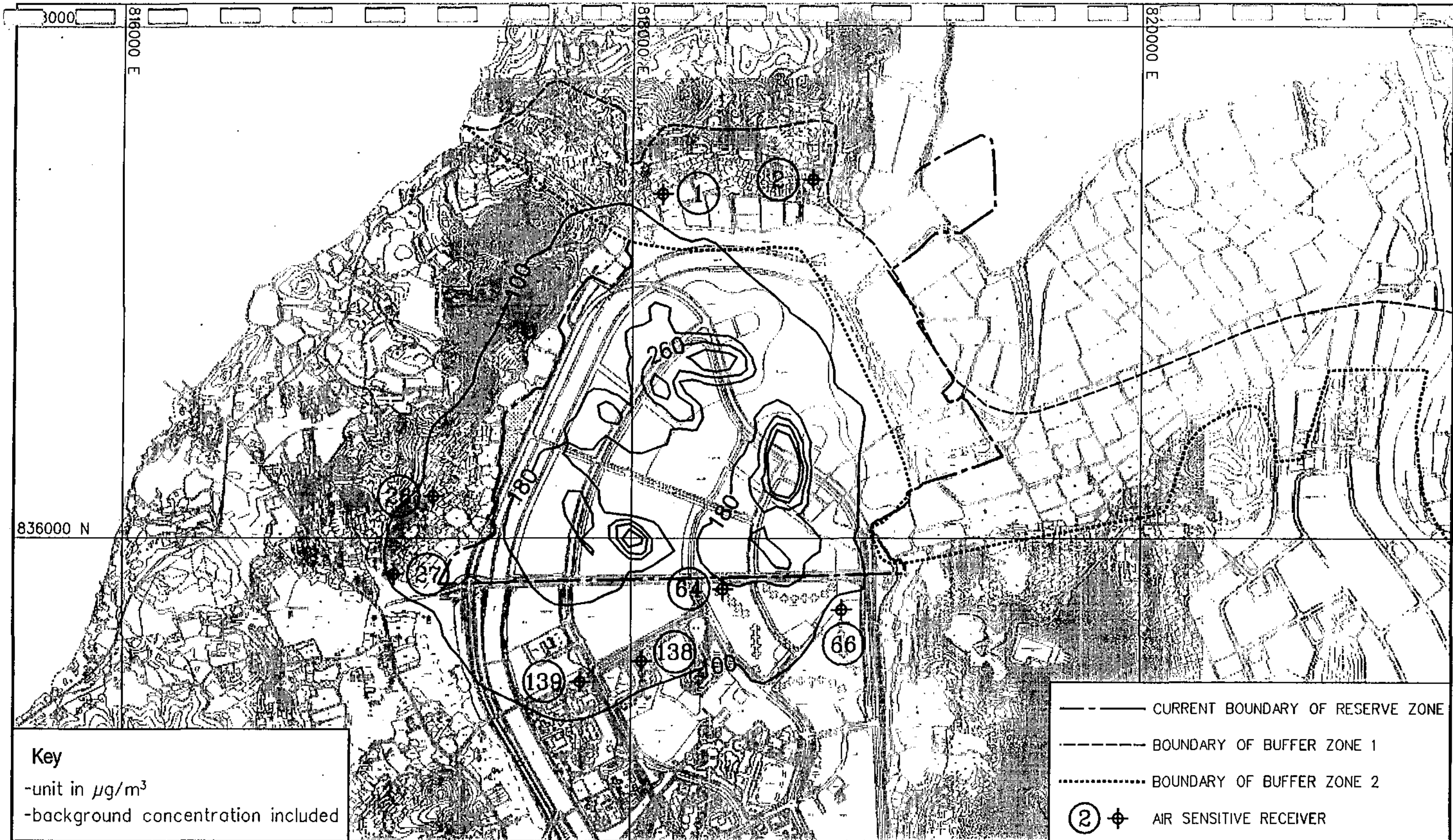

Key
-unit in $\mu g/m^3$
-background concentration included

CURRENT BOUNDARY OF RESERVE ZONE
BOUNDARY OF BUFFER ZONE 1
BOUNDARY OF BUFFER ZONE 2
② AIR SENSITIVE RECEIVER

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SCENARIO 1 – MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) : DAILY AVERAGE (50% REDUCTION IN DUST FROM DIRT ROADS)	Figure No. 6.13	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 01650018.C09
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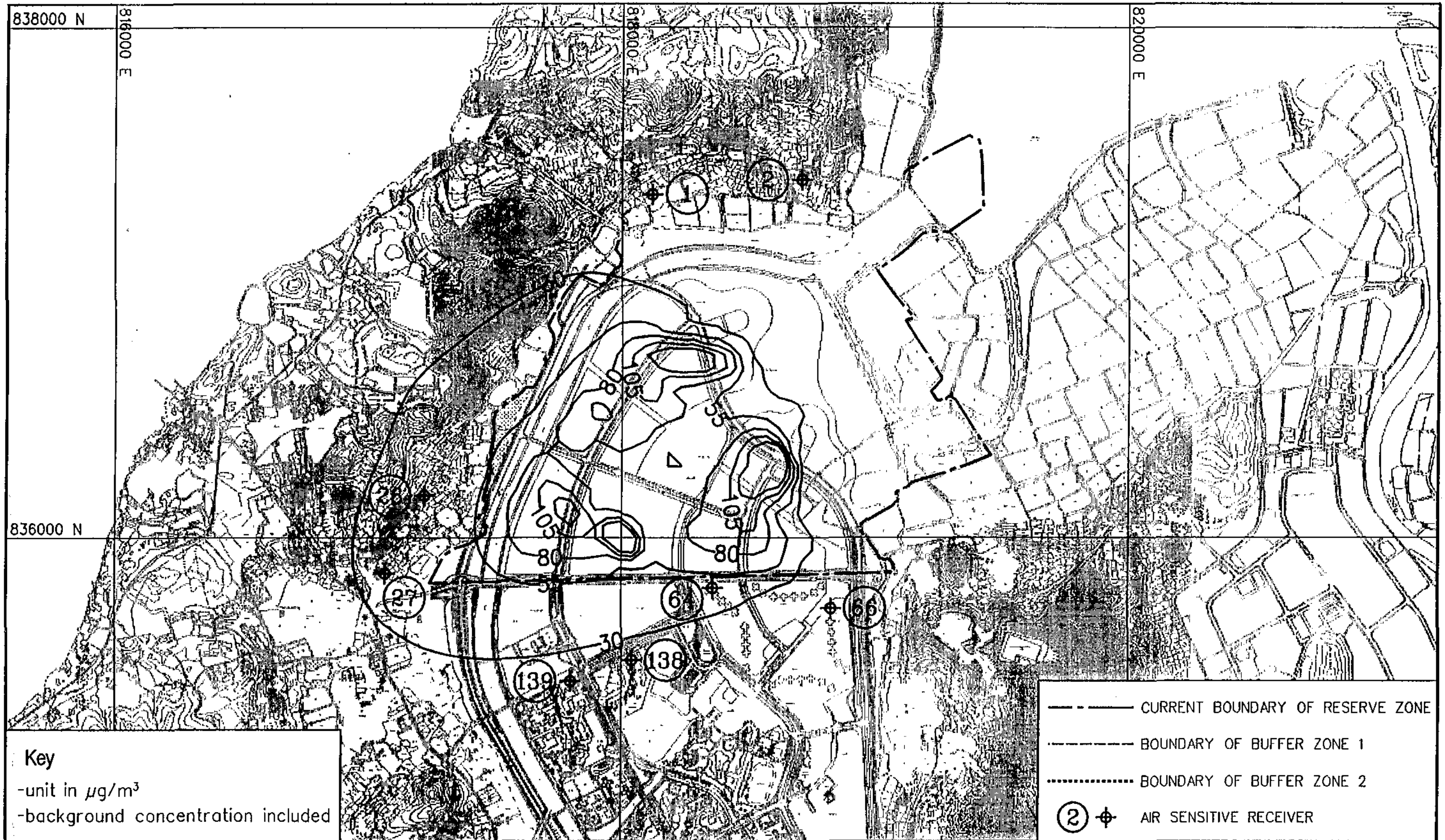

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS

Title :

SCENARIO 1 –
MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) :
YEARLY AVERAGE (50% REDUCTION IN DUST FROM DIRT ROADS)

Figure No. 6.14	Revision 0
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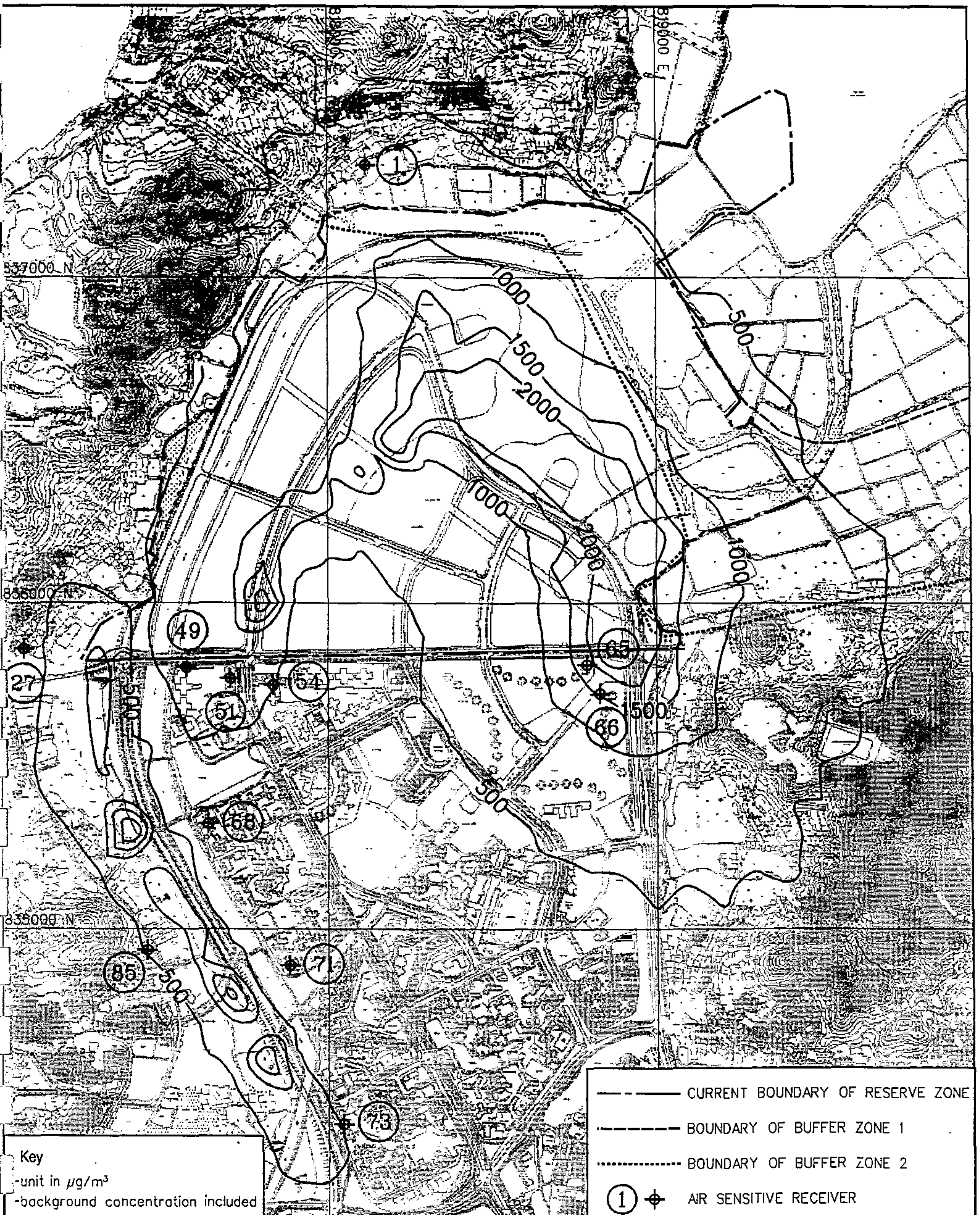
Prepared HW	Checked PS
Date NO	Scale 1 : 2



CURRENT BOUNDARY OF RESERVE ZONE
BOUNDARY OF BUFFER ZONE 1
BOUNDARY OF BUFFER ZONE 2
1 AIR SENSITIVE RECEIVER

Key
-unit in $\mu g/m^3$
-background concentration included

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SCENARIO 2 - MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) : HOURLY AVERAGE (COMPLETELY UNMITIGATED)	Figure No. 6.15	Revision 0
		Reference TSW-BASE	File Name 01670018.C09
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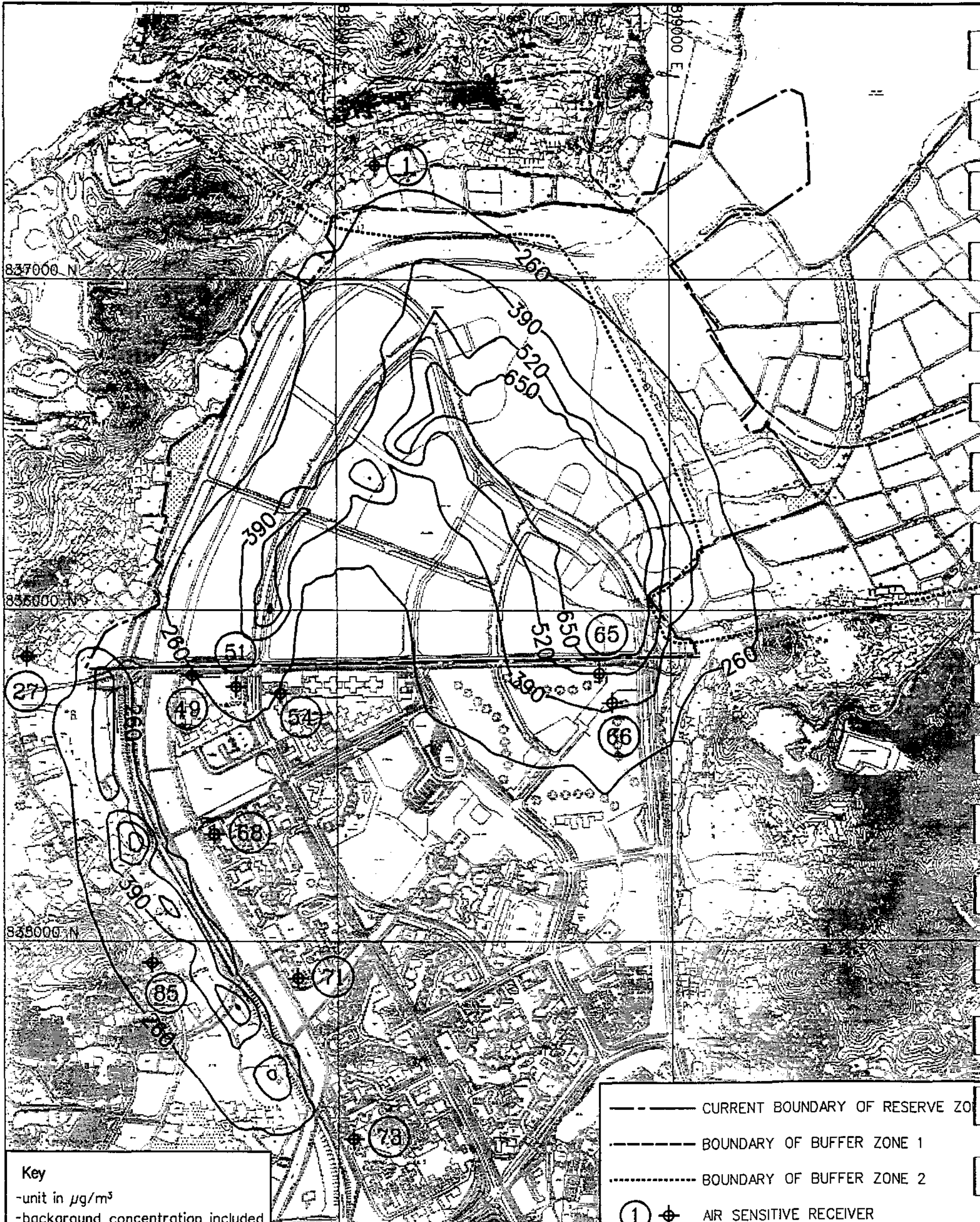

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SCENARIO 2 – MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) : DAILY AVERAGE (COMPLETELY UNMITIGATED)	Figure No. 6.16	Revision 0
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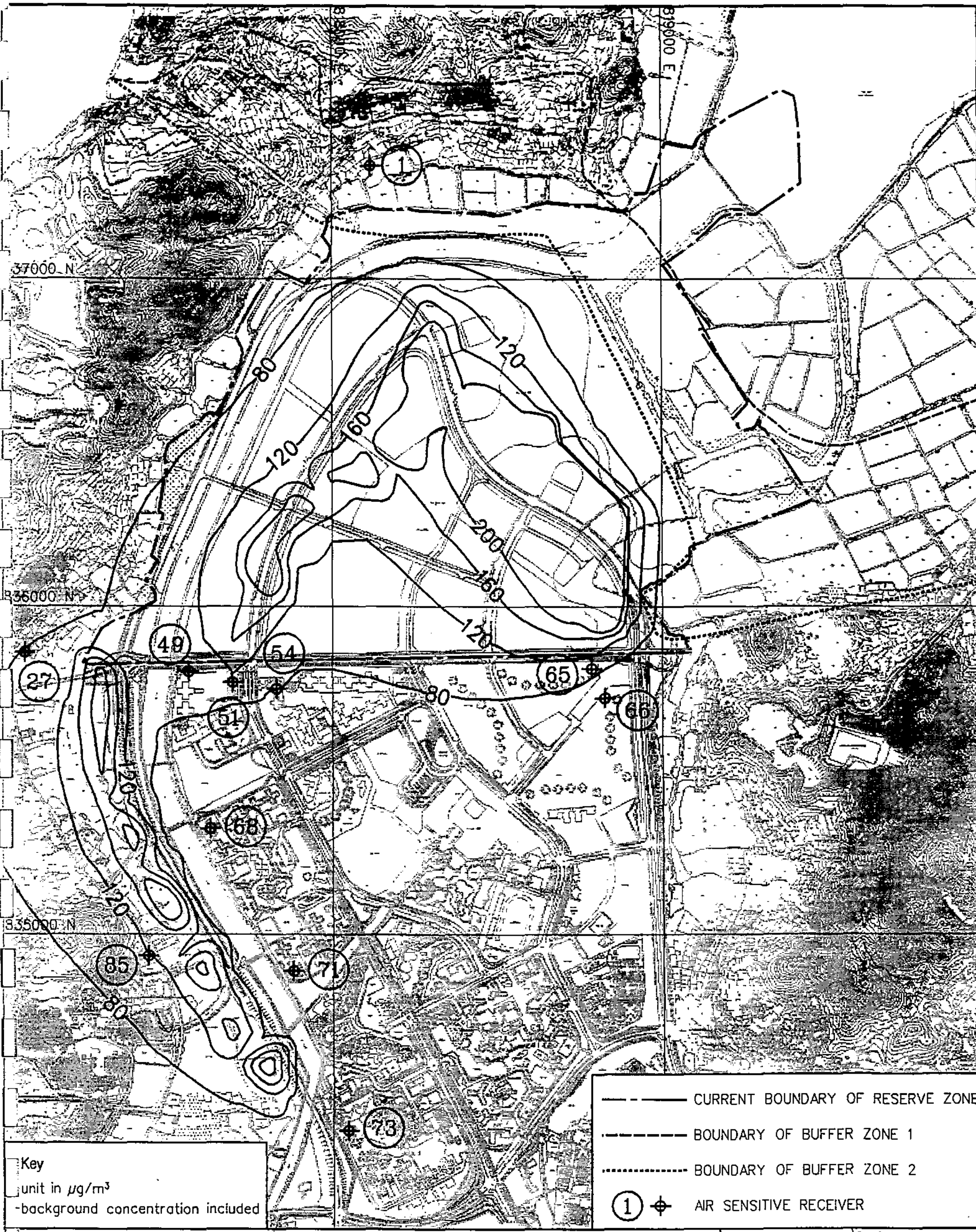
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared HW	Checked PS
		Date NOV. 96	Scale 1 : 15000



Key
unit in $\mu g/m^3$
-background concentration included

CURRENT BOUNDARY OF RESERVE ZONE
BOUNDARY OF BUFFER ZONE 1
BOUNDARY OF BUFFER ZONE 2
1 AIR SENSITIVE RECEIVER

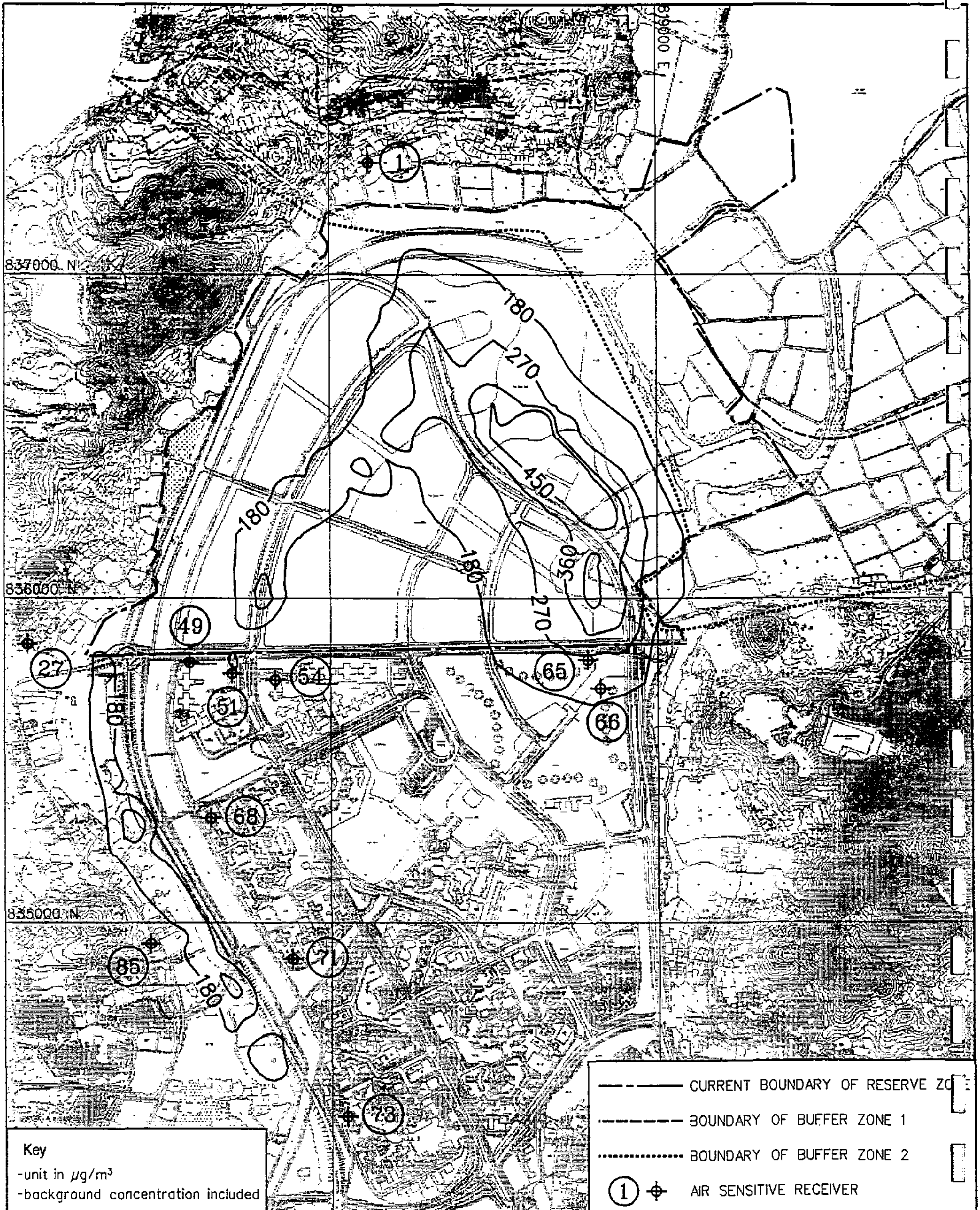
TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
賓尼工程顧問有限公司
ENGINEERS AND SCIENTISTS
賓尼

Title :

SCENARIO 2 –
MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) : YEARLY AVERAGE
(COMPLETELY UNMITIGATED)

Figure No. 6.17	Revision 0
Reference TSW-BASE	File Name 01690018.C09
Prepared HW	Checked PS
Date NOV. 96	Scale 1 : 15000

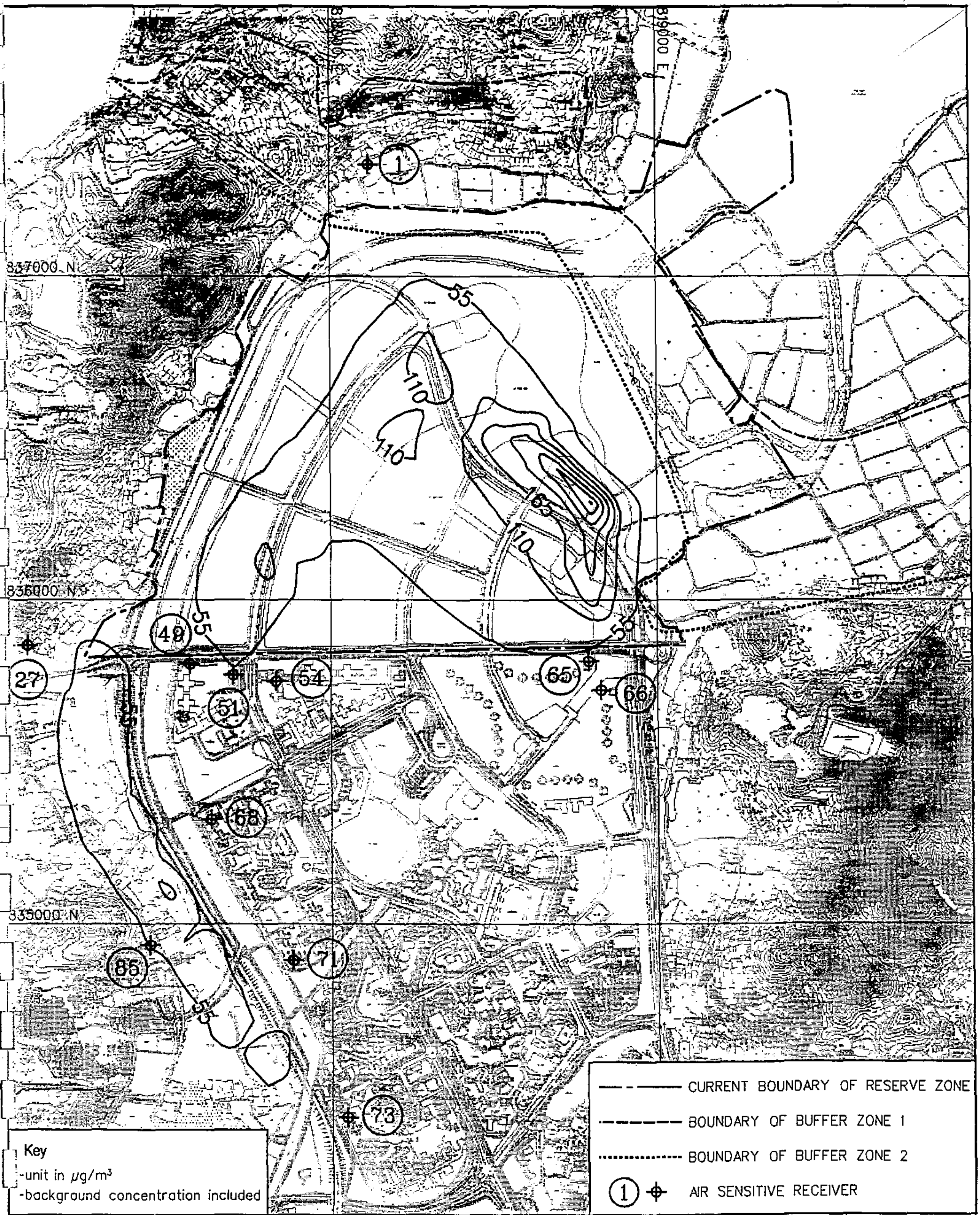


TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼

Title : SCENARIO 2 - MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground): DAILY AVERAGE (COMPLETELY UNMITIGATED)

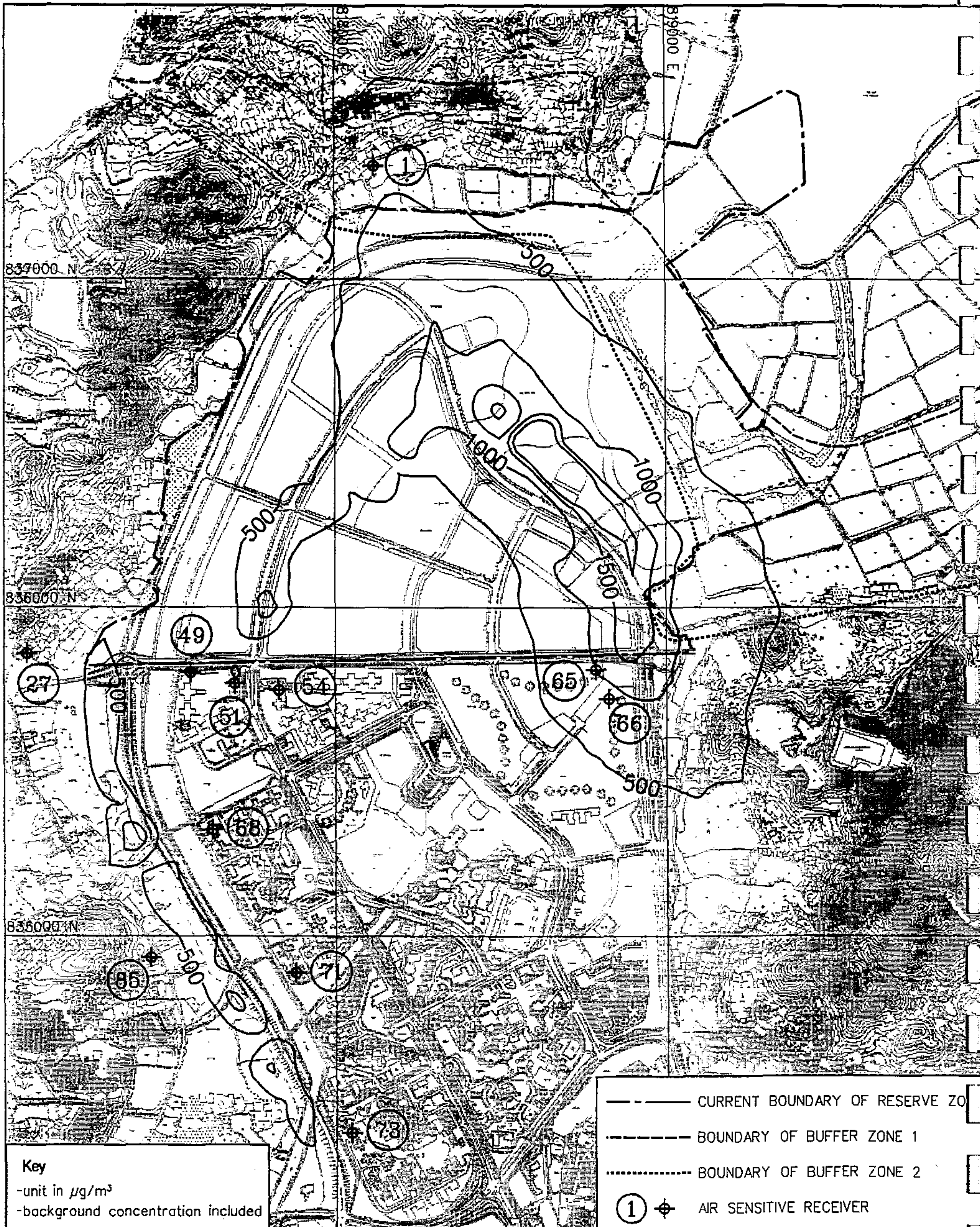
Figure No. 6.18	Revision 0
Reference TSW-BASE	File Name 01700018.C09
Prepared HW	Checked PS
Date NOV. 96	Scale 1 : 15000



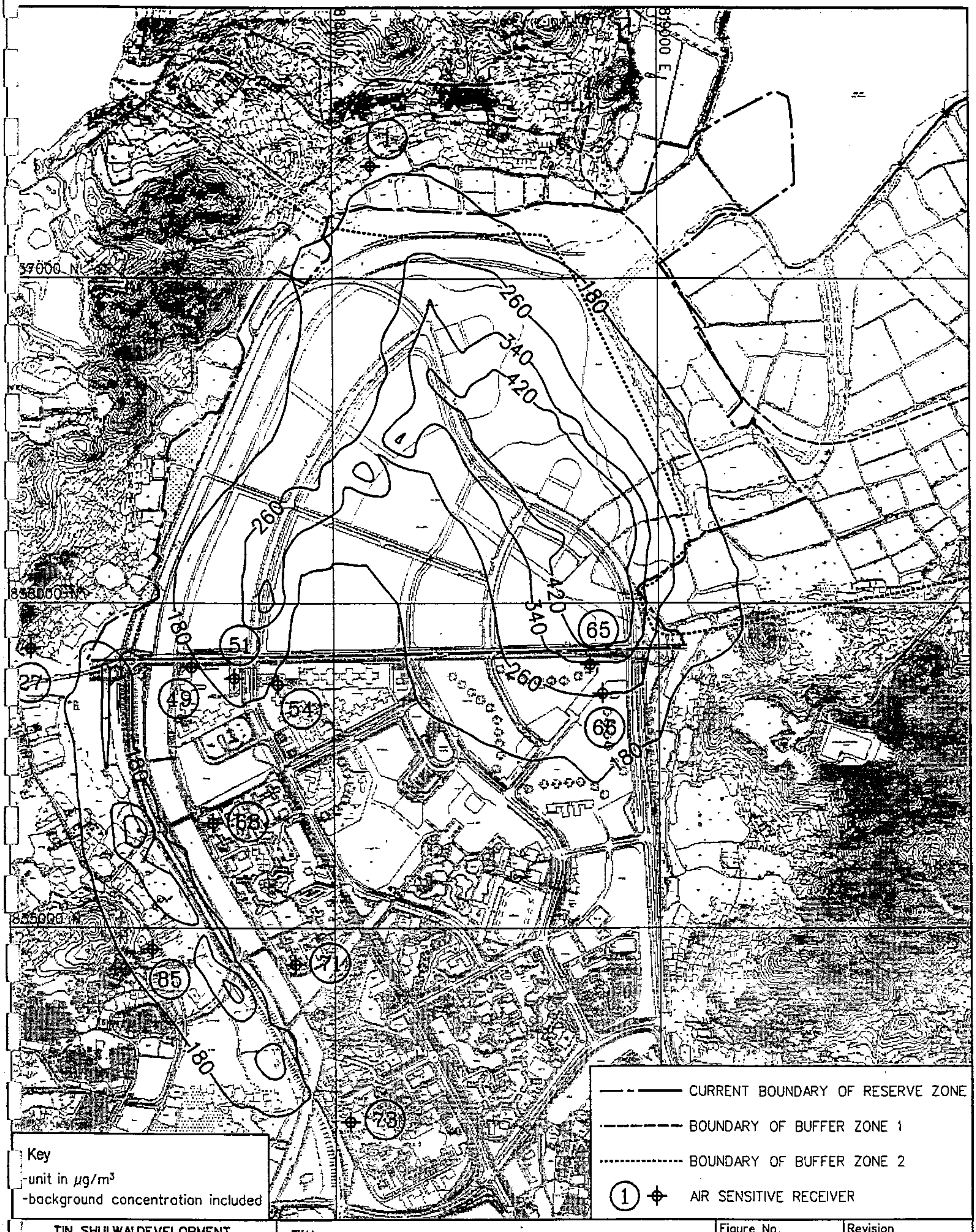
CURRENT BOUNDARY OF RESERVE ZONE
BOUNDARY OF BUFFER ZONE 1
BOUNDARY OF BUFFER ZONE 2
1 AIR SENSITIVE RECEIVER

Key
-unit in μg/m³
-background concentration included

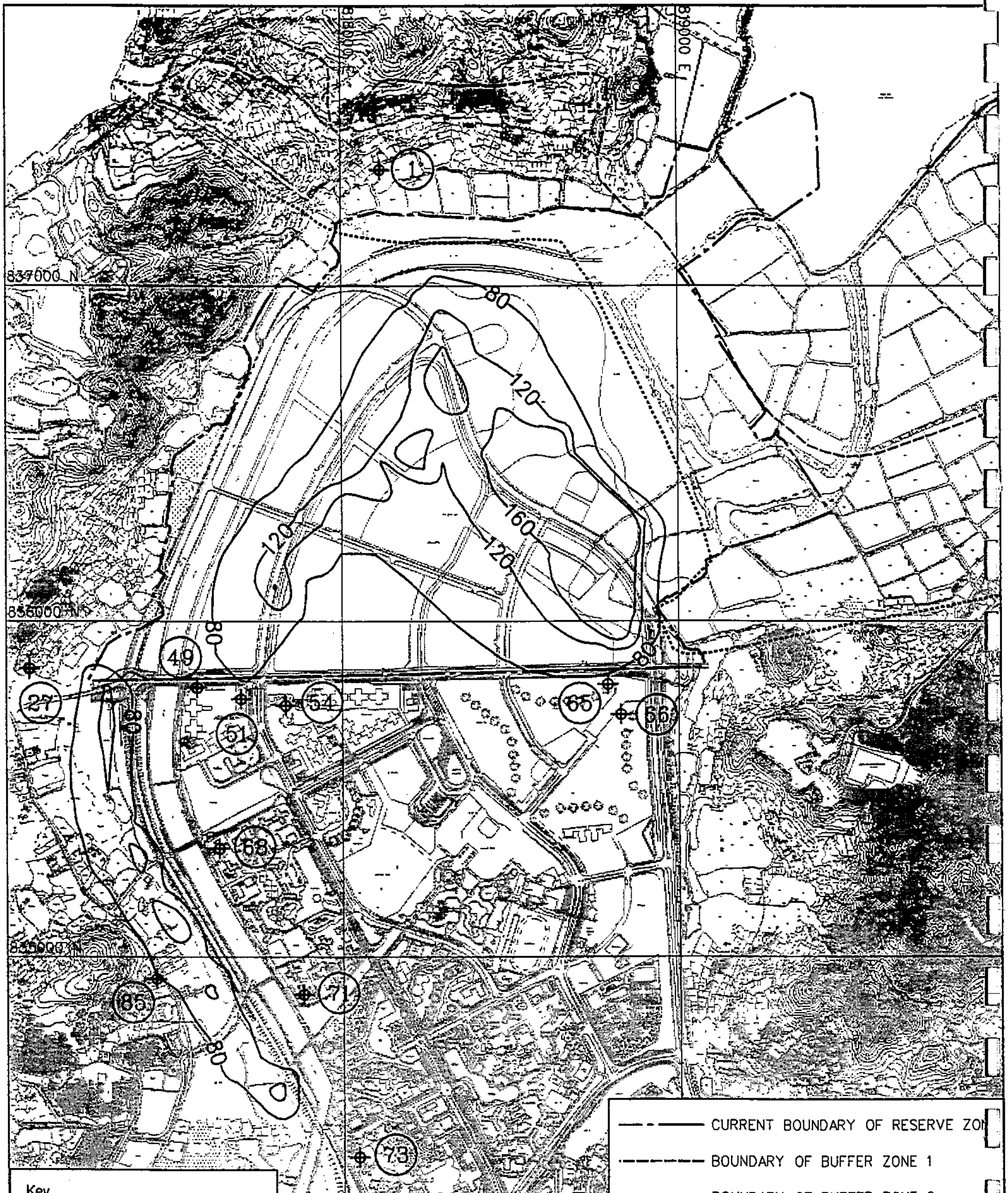
TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SCENARIO 2 – MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground): YEARLY AVERAGE (COMPLETELY UNMITIGATED)	Figure No. 6.19	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 01710018.C09
		Prepared HW	Checked PS
		Date NOV. 96	Scale 1 : 15000



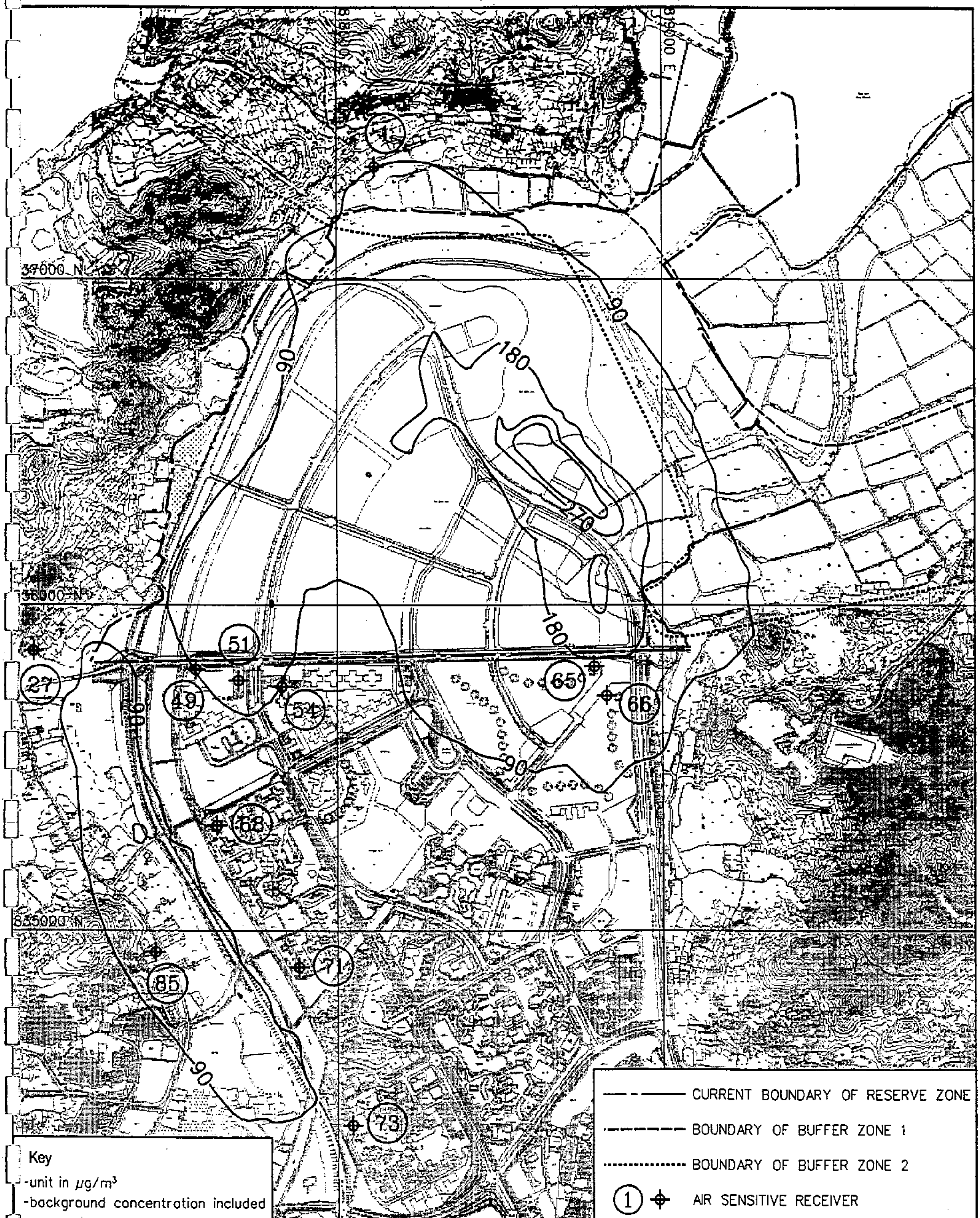
TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	Title : SCENARIO 2 - MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground): HOURLY AVERAGE (50% REDUCTION IN DUST FROM DIRT ROADS)	Figure No. 6.20	Revision 0
		Reference TSW-BASE	File Name 01720018.C0
		Prepared HW	Checked PS
		Date NOV. 96	Scale 1 : 15000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SCENARIO 2 – MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground): DAILY AVERAGE (50% REDUCTION IN DUST FROM DIRT ROADS)	Figure No. 6.21	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 01730018.C09
		Prepared HW	Checked PS
		Date NOV. 96	Scale 1 : 15000

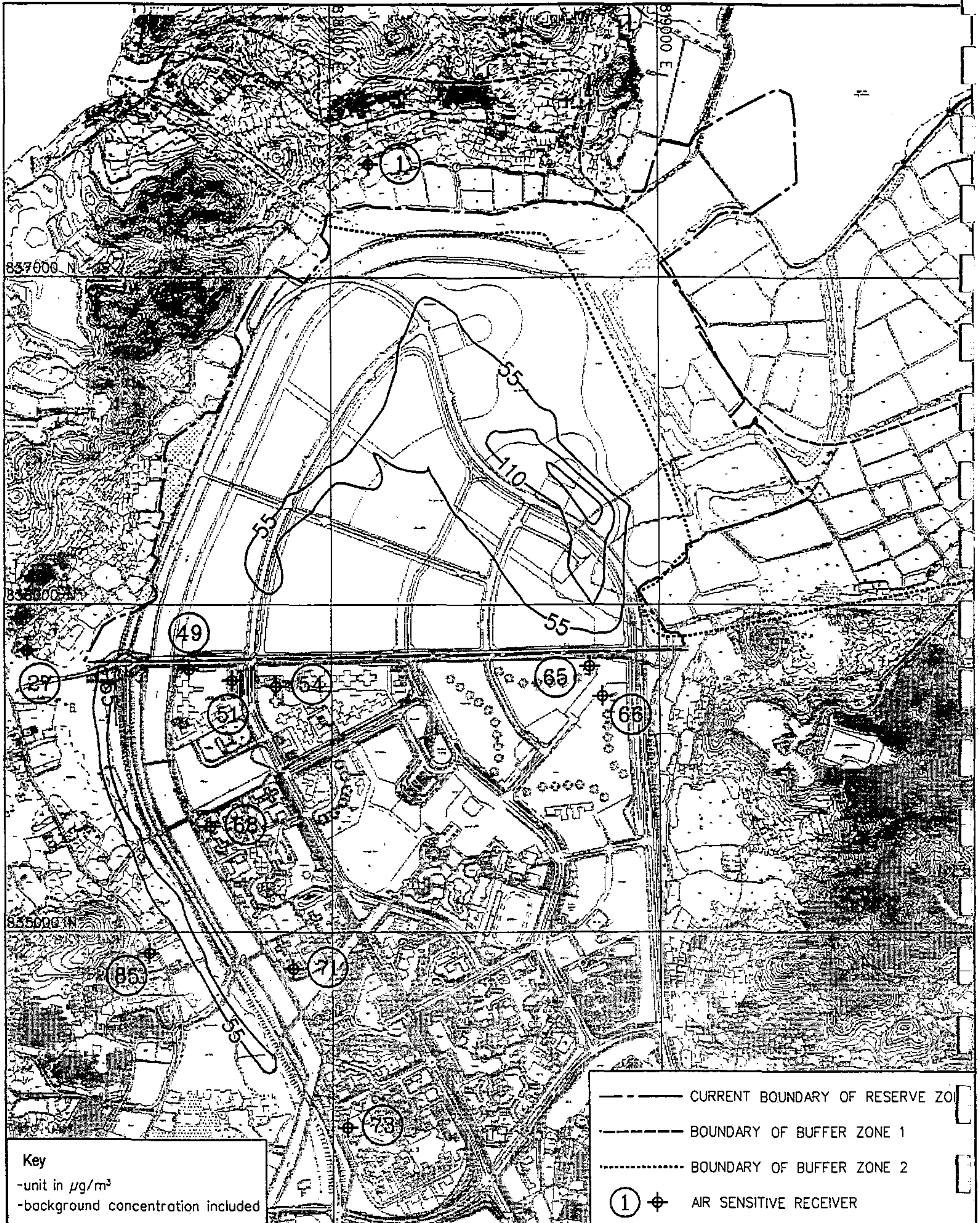


TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SCENARIO 2 – MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground): YEARLY AVERAGE (50% REDUCTION IN DUST FROM DIRT ROADS)	Figure No. 6.22	Revision 0
		Reference TSW-BASE	File Name 01740018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared HW	Checked PS
		Date NOV. 96	Scale 1 : 15000

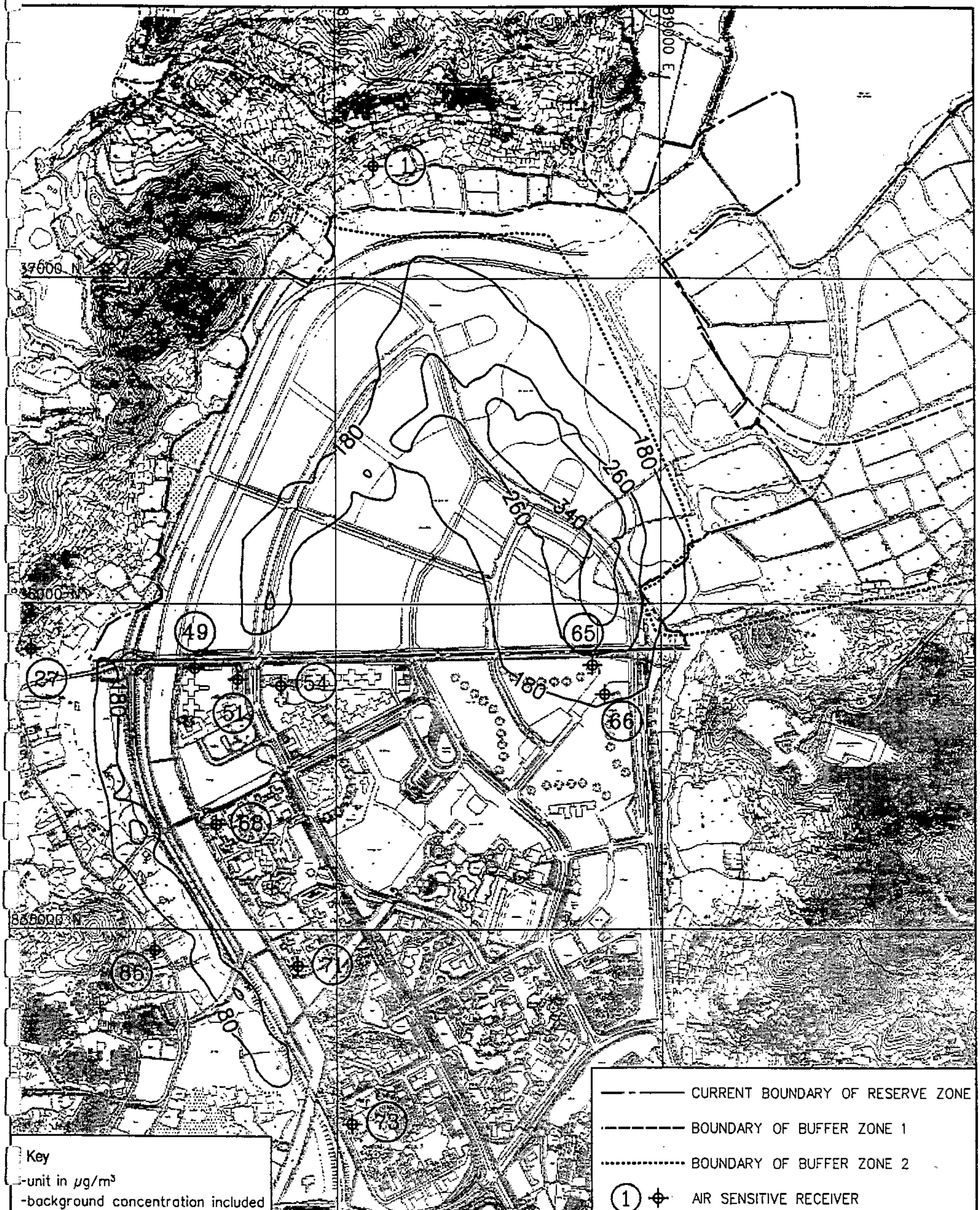


Key
-unit in $\mu g/m^3$
-background concentration included

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SCENARIO 2 - MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) : DAILY AVERAGE (50% REDUCTION IN DUST FROM DIRT ROADS)	Figure No. 6.23	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 01750018.C09
		Prepared HW	Checked PS
		Date NOV. 96	Scale 1 : 15000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SCENARIO 2 - MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground): YEARLY AVERAGE (50% REDUCTION IN DUST FROM DIRT ROADS)	Figure No. 6.24	Revision 0
		Reference TSW-BASE	File Name 01760018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared HW	Checked PS
		Date NOV. 96	Scale 1 : 15000

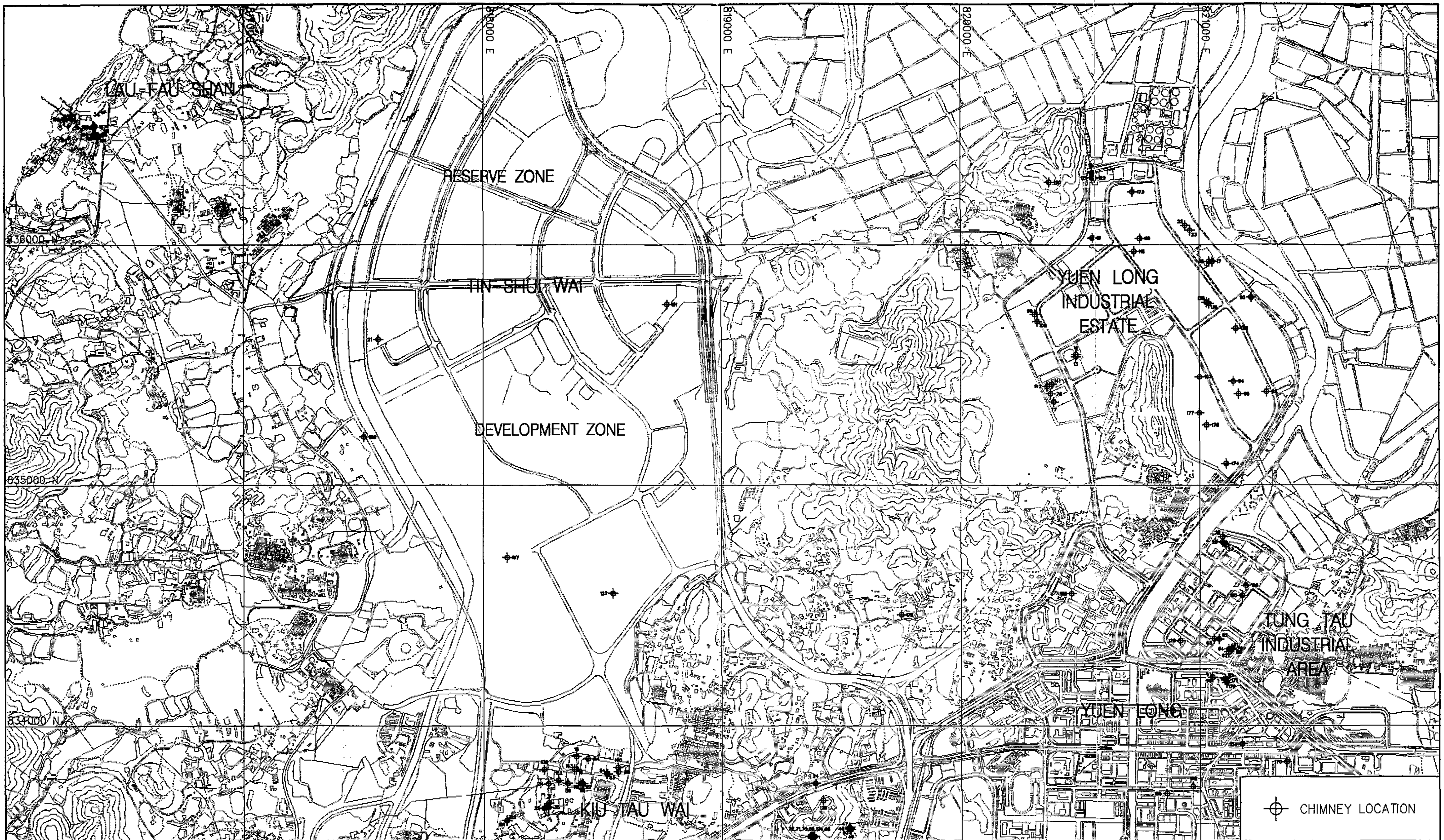


TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

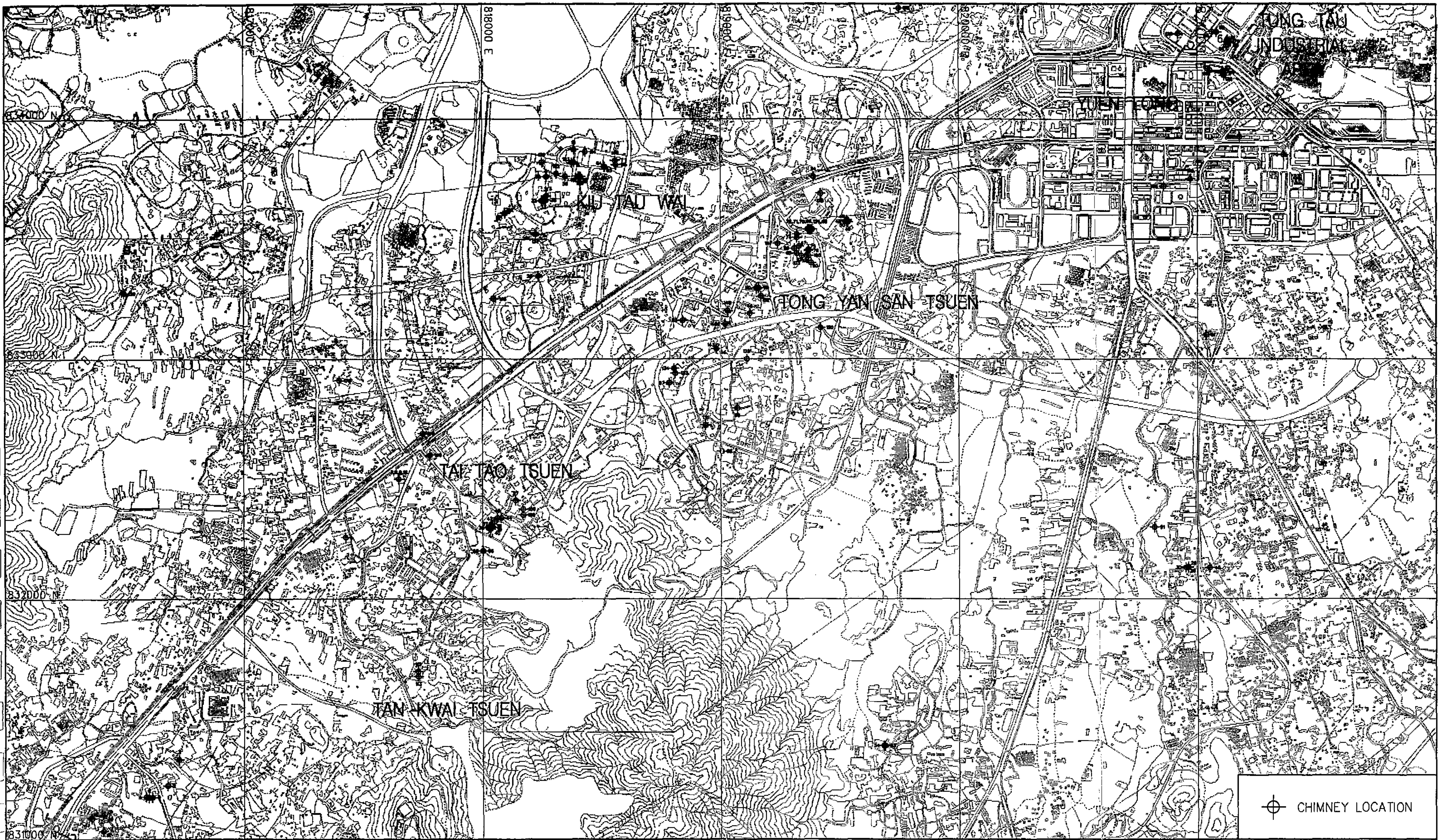
BINNIE CONSULTANTS LIMITED
賓尼工程顧問有限公司
ENGINEERS AND SCIENTISTS
賓尼

Title :
SCENARIO 2 –
MAXIMUM TSP CONCENTRATIONS AT PEDESTRIAN LEVEL (1.5m above ground) : DAILY AVERAGE
(75% REDUCTION IN DUST FROM DIRT ROADS)

Figure No. 6.25	Revision 0
Reference TSW-BASE	File Name 02030018.C09
Prepared HW	Checked PS
Date NOV. 96	Scale 1 : 15000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : LOCATIONS OF CHIMNEY IN AND AROUND TIN SHUI WAI	Figure No. 6.26	Revision 0
		Reference TSW-BASE	File Name 00840018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked YWL
		Date APR. 96	Scale 1 : 15000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title :	Figure No. 6.27	Revision 0
	LOCATIONS OF CHIMNEY IN AND AROUND TIN SHUI WAI	Reference TSW-BASE	File Name 00850018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked YWL
		Date APR. 96	Scale 1 : 15000

Keys
unit: ug/m^3
background concentration included

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
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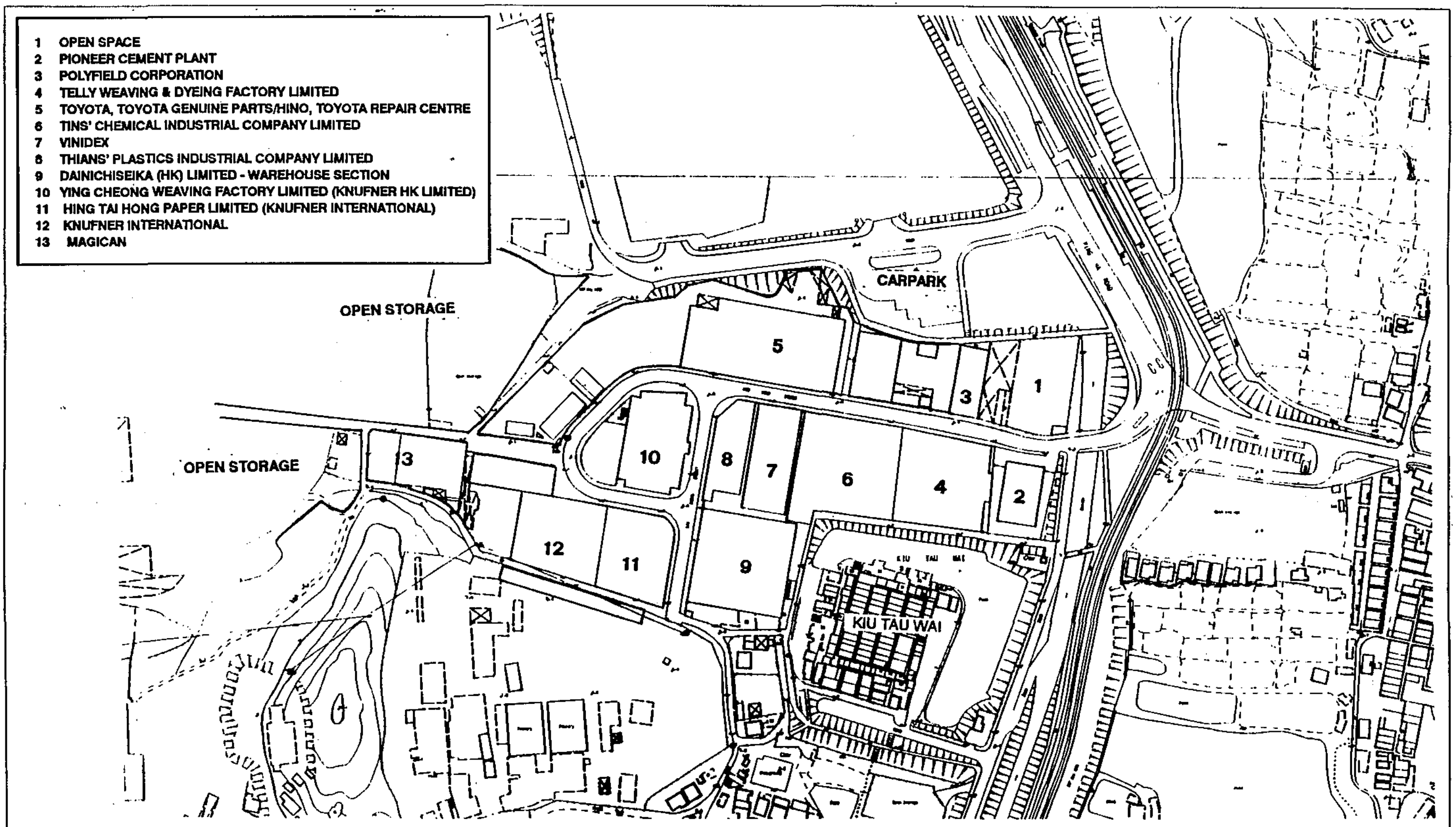
賓尼

Title :

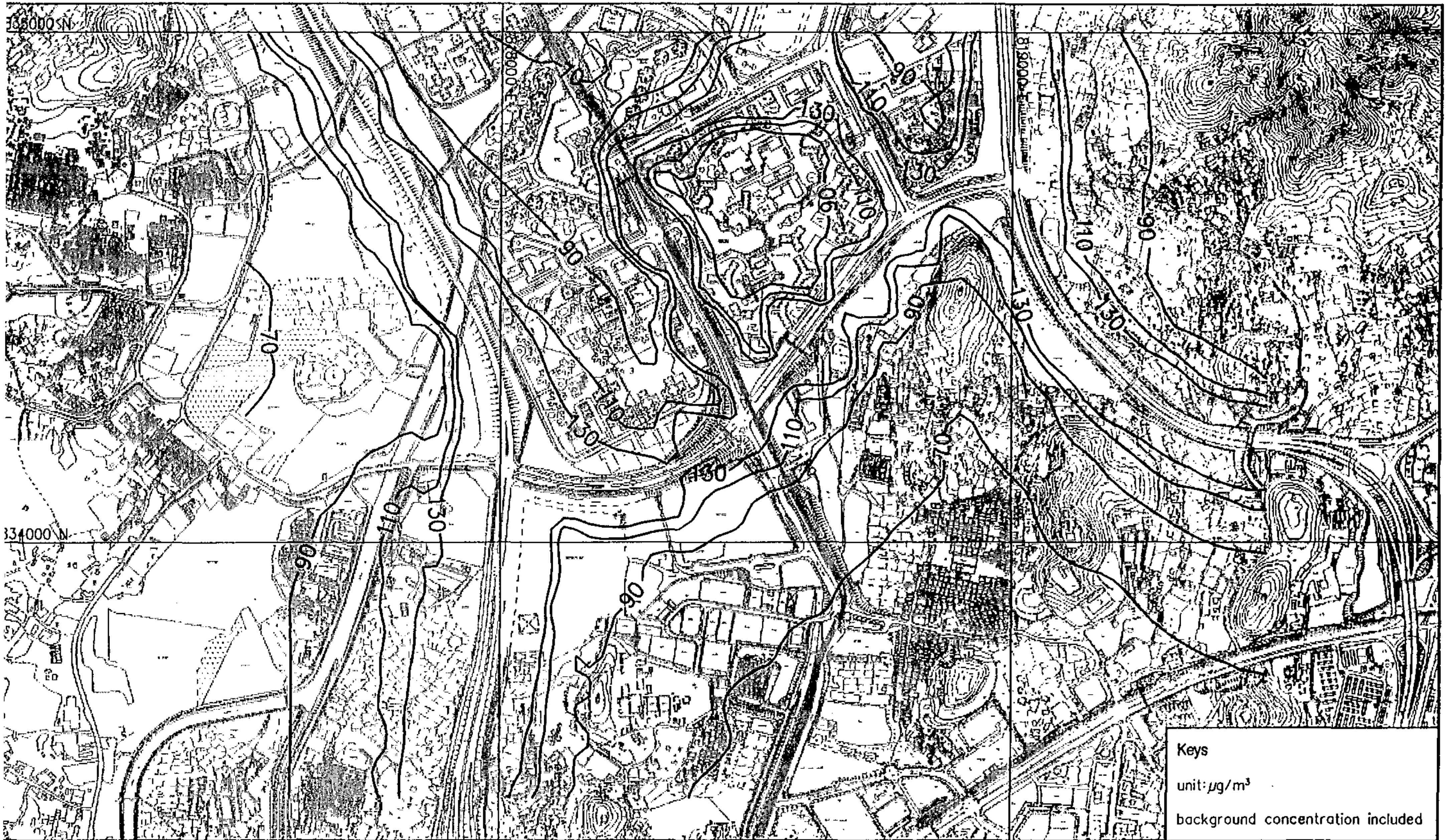
INDUSTRIAL EMISSION – NO_2 CONCENTRATIONS AT 20 / F (HOURLY AVERAGE)

Figure No. 6.28	Revision 0
Reference TSW–BASE	File Name 01850018.C09
Prepared WKY	Checked LY
Date NOV. 96	Scale 1 : 25000

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : INDUSTRIAL EMISSION - SO_2 CONCENTRATIONS AT 20 / F (HOURLY AVERAGE)	Figure No. 6.29	Revision 0
		Reference TSW-BASE	File Name 01860018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared WKY	Checked LY
		Date NOV. 96	Scale 1 : 25000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : KIU TAU WAI INDUSTRIAL AREA	Figure No. 6.30	Revision 0
		Reference No. TSW-BASE	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked YWL
		Date APR 96	Scale 1 : 3000

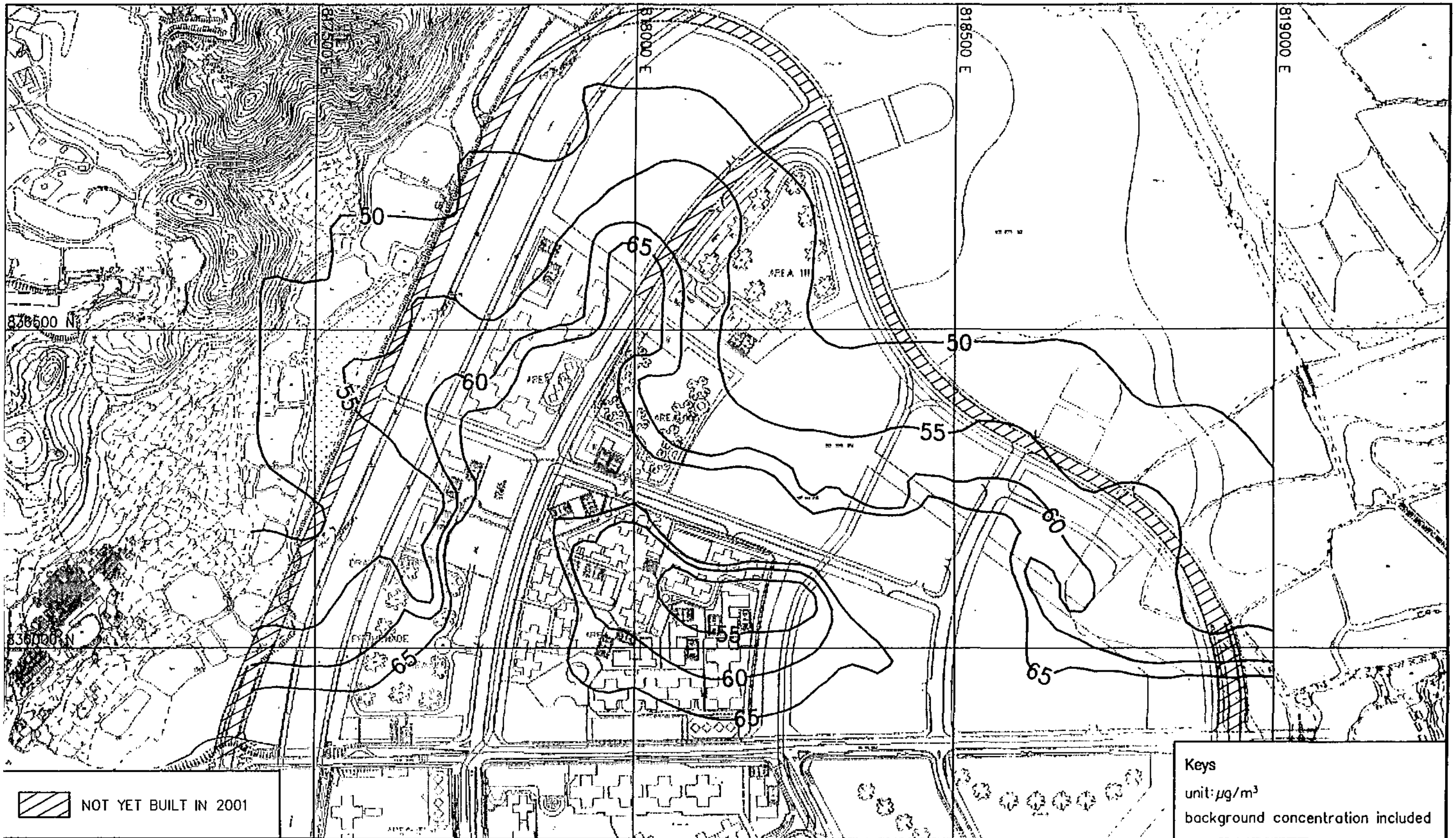


Keys

unit: $\mu g/m^3$

background concentration included

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : MAXIMUM NO_2 CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR AREA 3 IN YEAR 2001	Figure No. 6.31	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 01870018.C09
		Prepared WKY	Checked YWL
		Date NOV 96	Scale 1 : 10000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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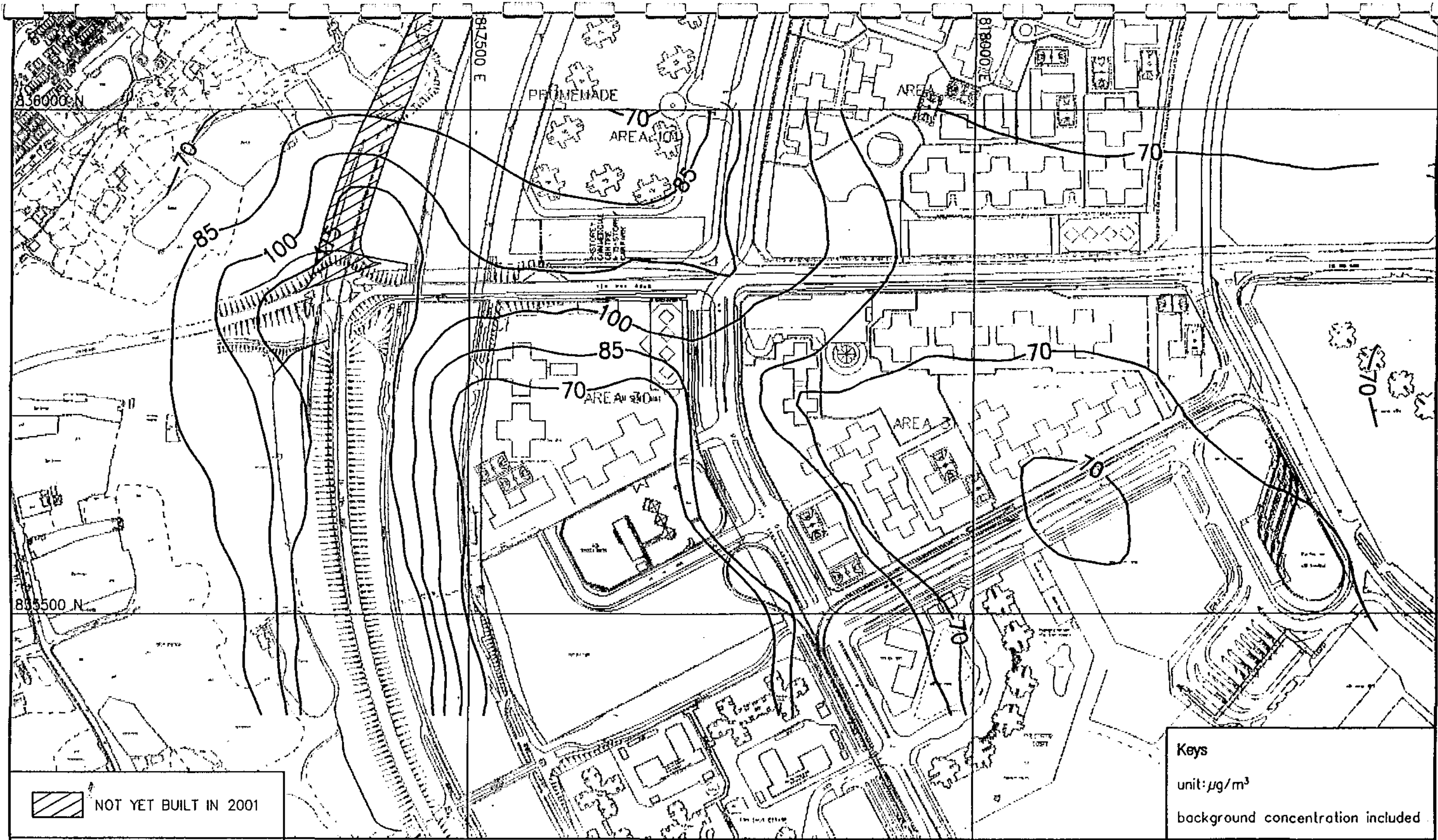
賓尼

Title :

MAXIMUM NO_2 CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR THE RESERVE ZONE IN 2001

Figure No. 6.33	Revision 0
Reference TSW-BASE	File Name 01890018.C09
Prepared WKY	Checked YWL
Date NOV. 96	Scale 1 : 8000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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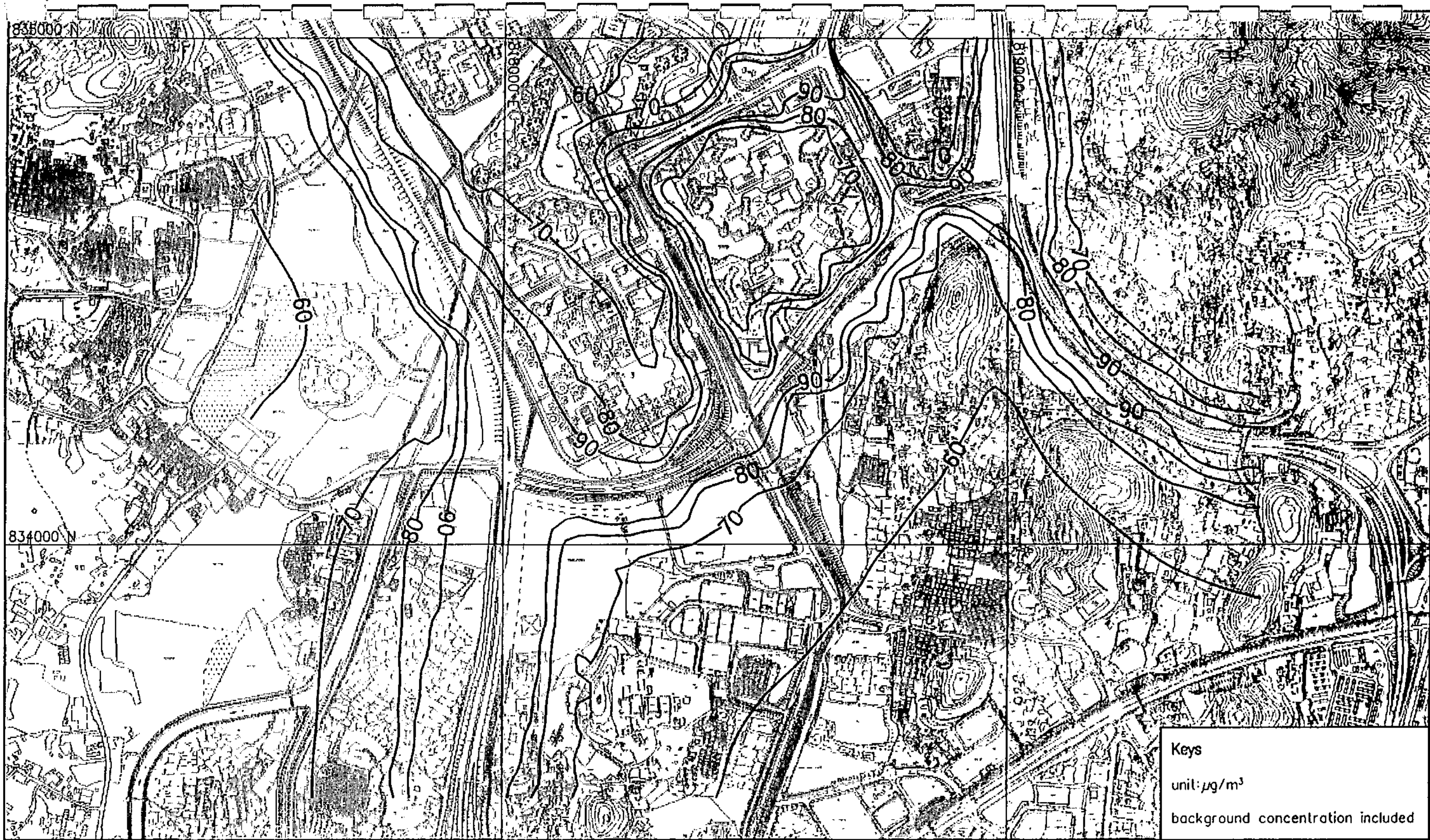
Title :

MAXIMUM NO_2 CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR AREA 30 & 31 IN YEAR 2001

Figure No. 6.32	Revision 0
Reference TSW-BASE	File Name 01880018.C09
Prepared WKY	Checked YWL
Date NOV. 96	Scale 1 : 5000



Keys

unit: $\mu g/m^3$

background concentration included

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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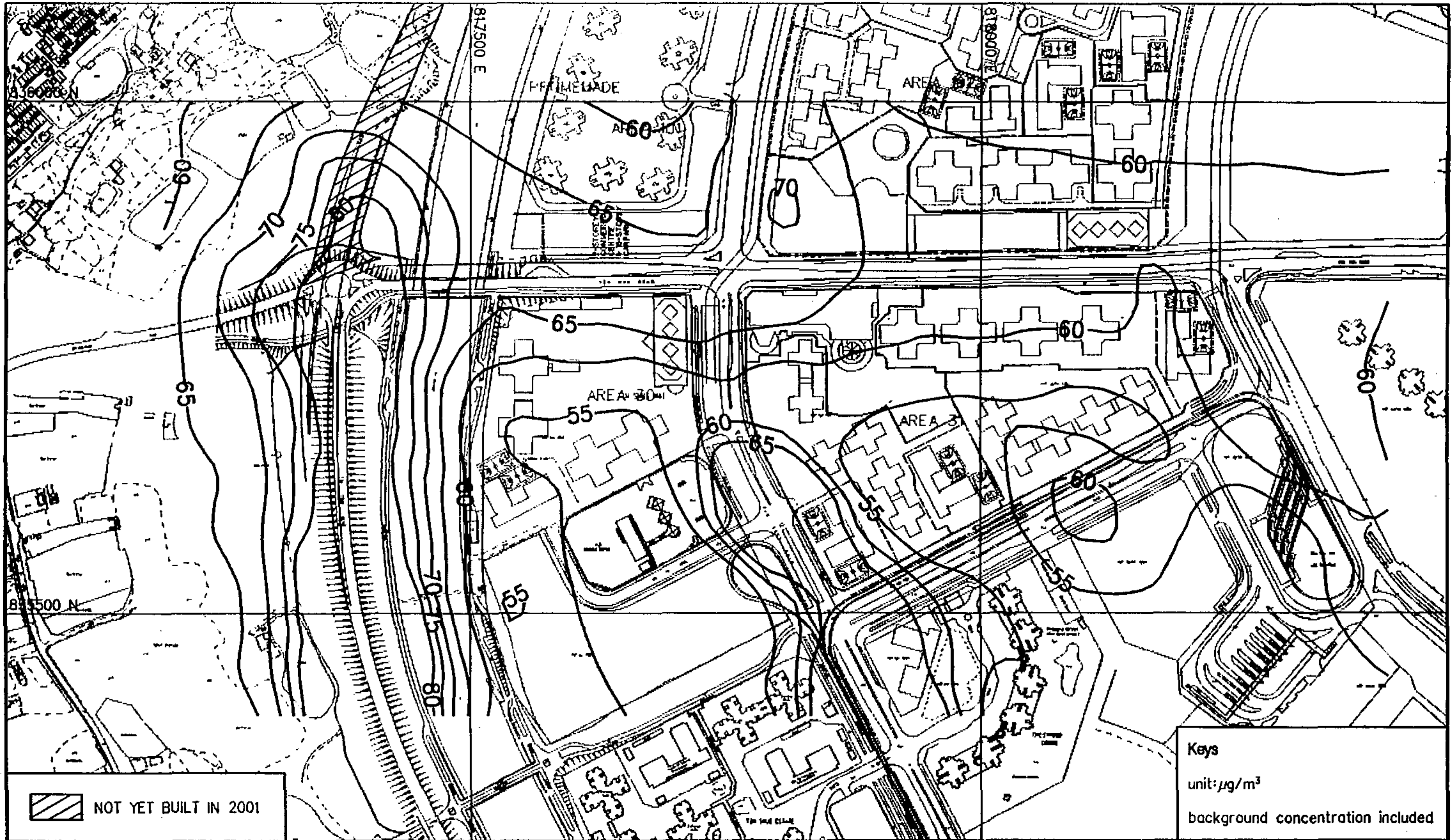
Title :

MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR AREA 3 IN YEAR 2001

Figure No.	Revision
6.34	0
Reference: TSW-BASE	File Name: 01900018.C09
Prepared: WKY	Checked: YWL
Date: NOV. 96	Scale: 1 : 10000



NOT YET BUILT IN 2001

Keys

unit: $\mu g/m^3$

background concentration included

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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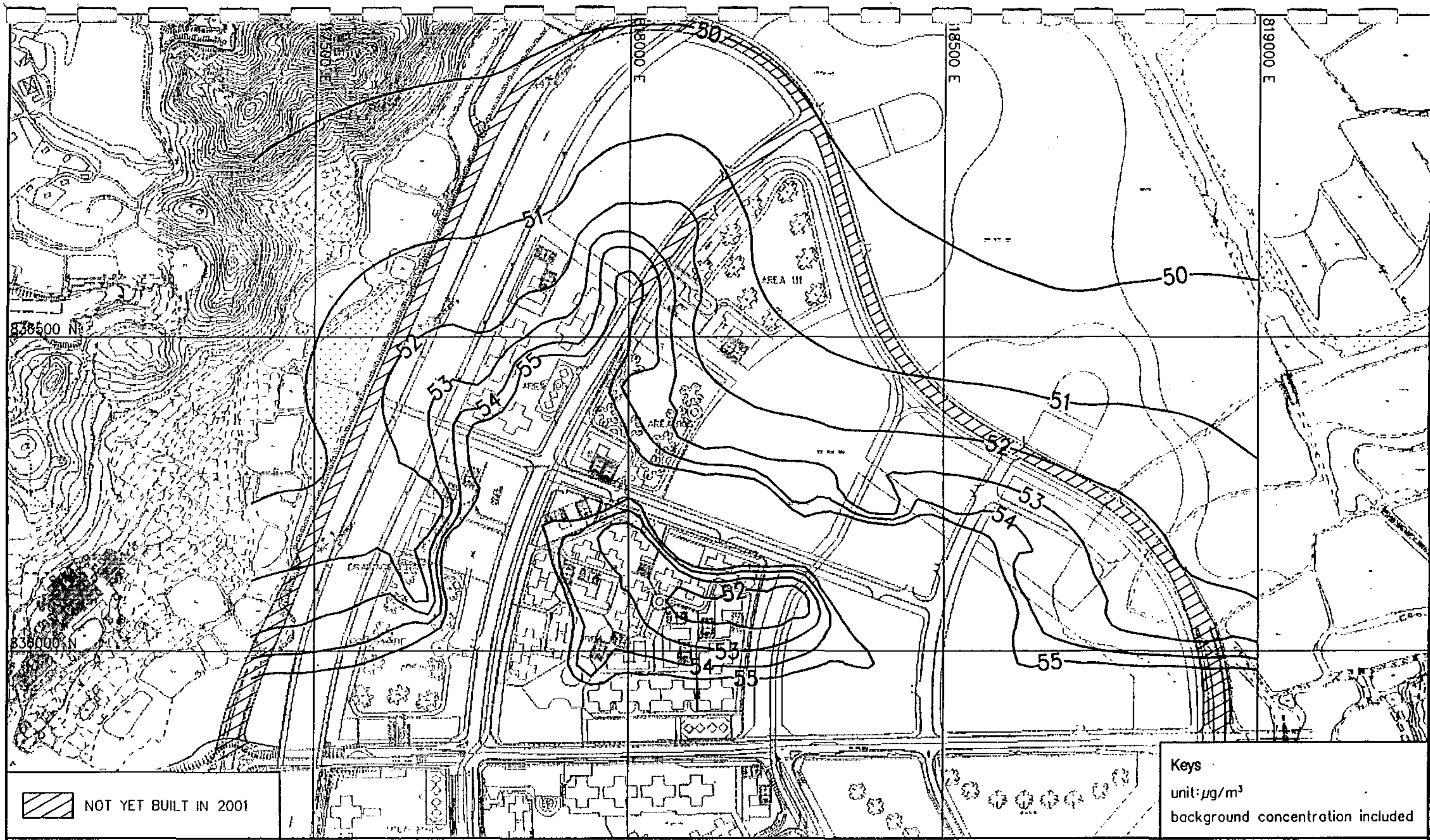
Title :

MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR AREA 30 & 31 IN YEAR 2001

Figure No. 6.35	Revision 0
Reference TSW-BASE	File Name 01910018.C09
Prepared WKY	Checked YWL
Date N[illegible]6	Scale 1[illegible]



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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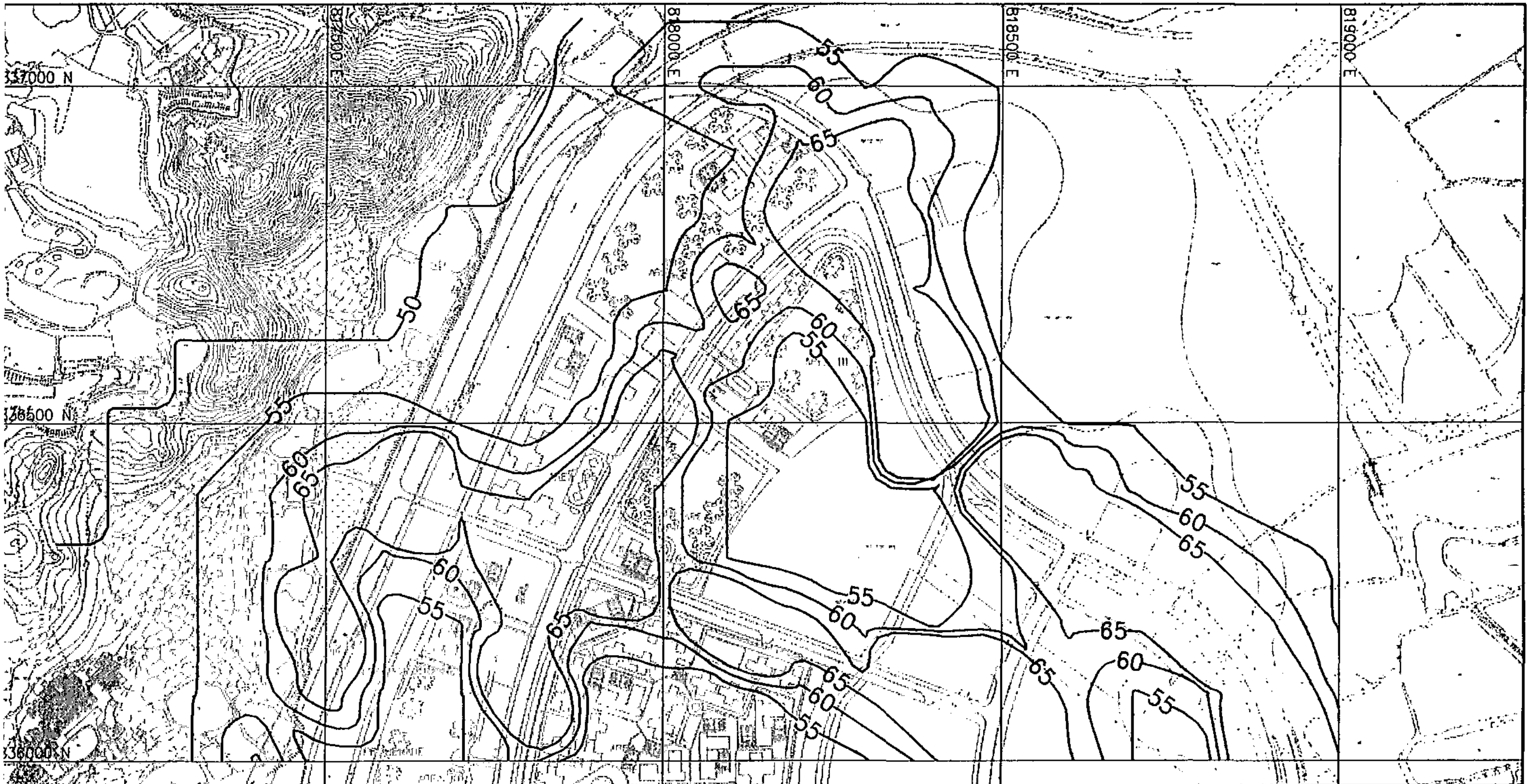
賓尼

Title :

MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR THE RESERVE ZONE IN 2001

Figure No. 6.36	Revision 0
Reference TSW–BASE	File Name 01920018.C09
Prepared WKY	Checked YWL
Date NOV. 96	Scale 1 : 8000



Keys
unit: $\mu g/m^3$
background concentration included

TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR
DEVELOPMENT OF AREAS 3, 30 & 31
OF THE DEVELOPMENT ZONE
AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
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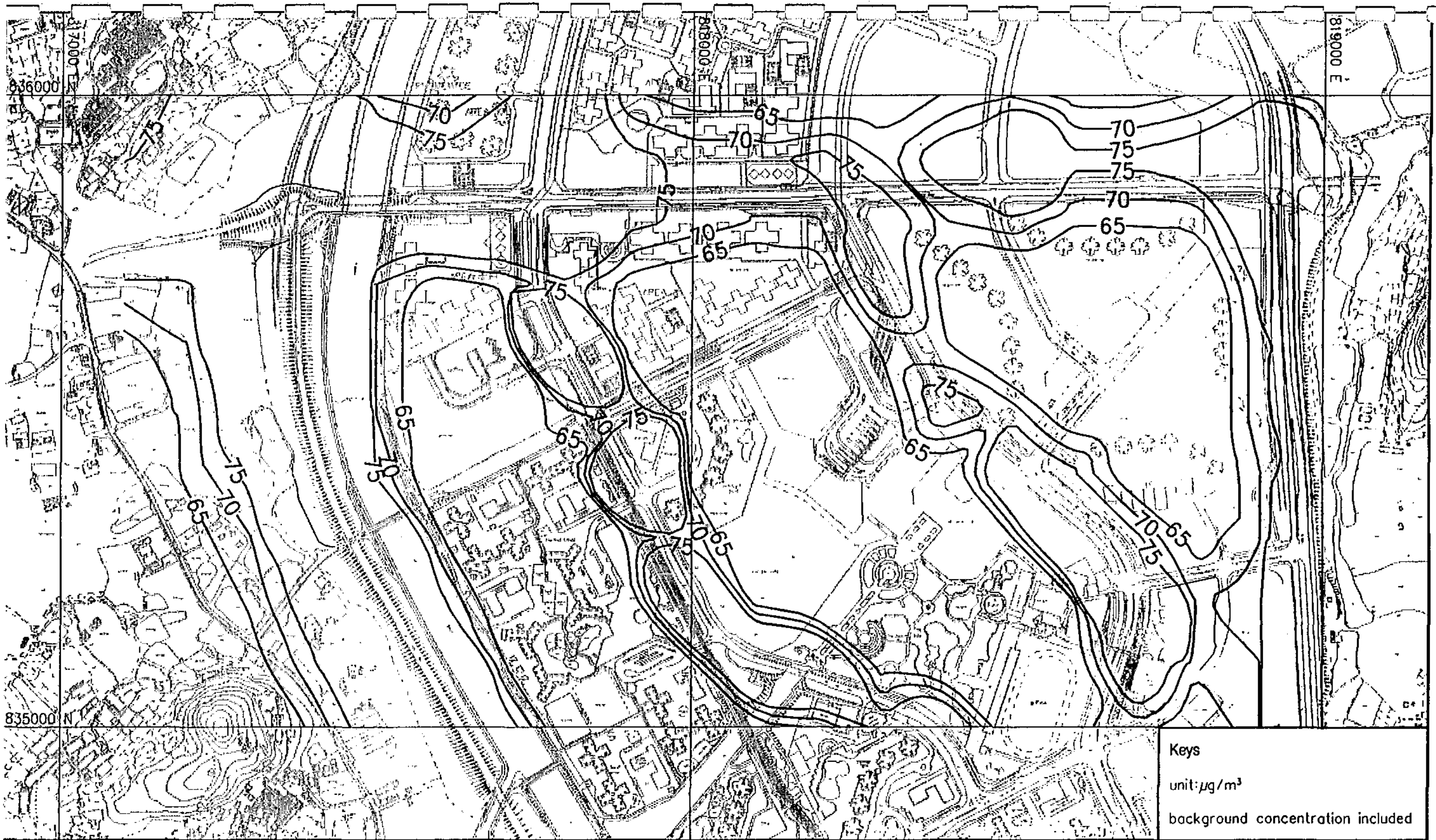
ENGINEERS AND SCIENTISTS

Title :

MAXIMUM NO_2 CONCENTRATIONS AT PEDESTRIAN LEVEL
(HOURLY AVERAGE) FOR THE RESERVE ZONE IN YEAR 2011

Figure No. 6.37	Revision 0
Reference TSW-BASE	File Name 01930018.C09
Prepared WKY	Checked YWL
Date NOV	Scale 1 : 8000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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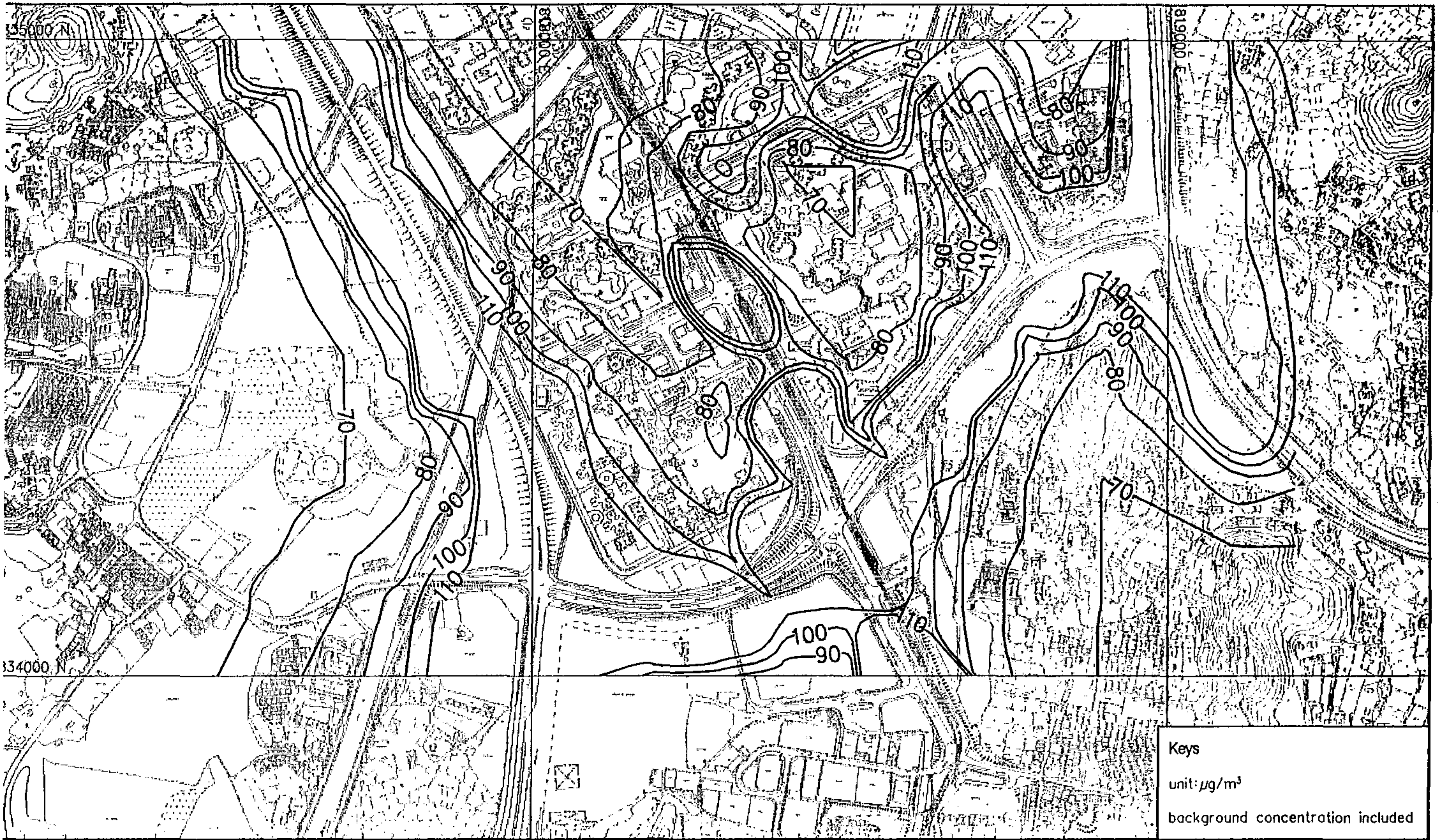
Title :

MAXIMUM NO_2 CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR AREAS 30 & 31 IN YEAR 2011

Figure No. 6.38	Revision 0
Reference TSW–BASE	File Name 01940018.C09
Prepared WKY	Checked YWL
Date NOV. 96	Scale 1 : 8000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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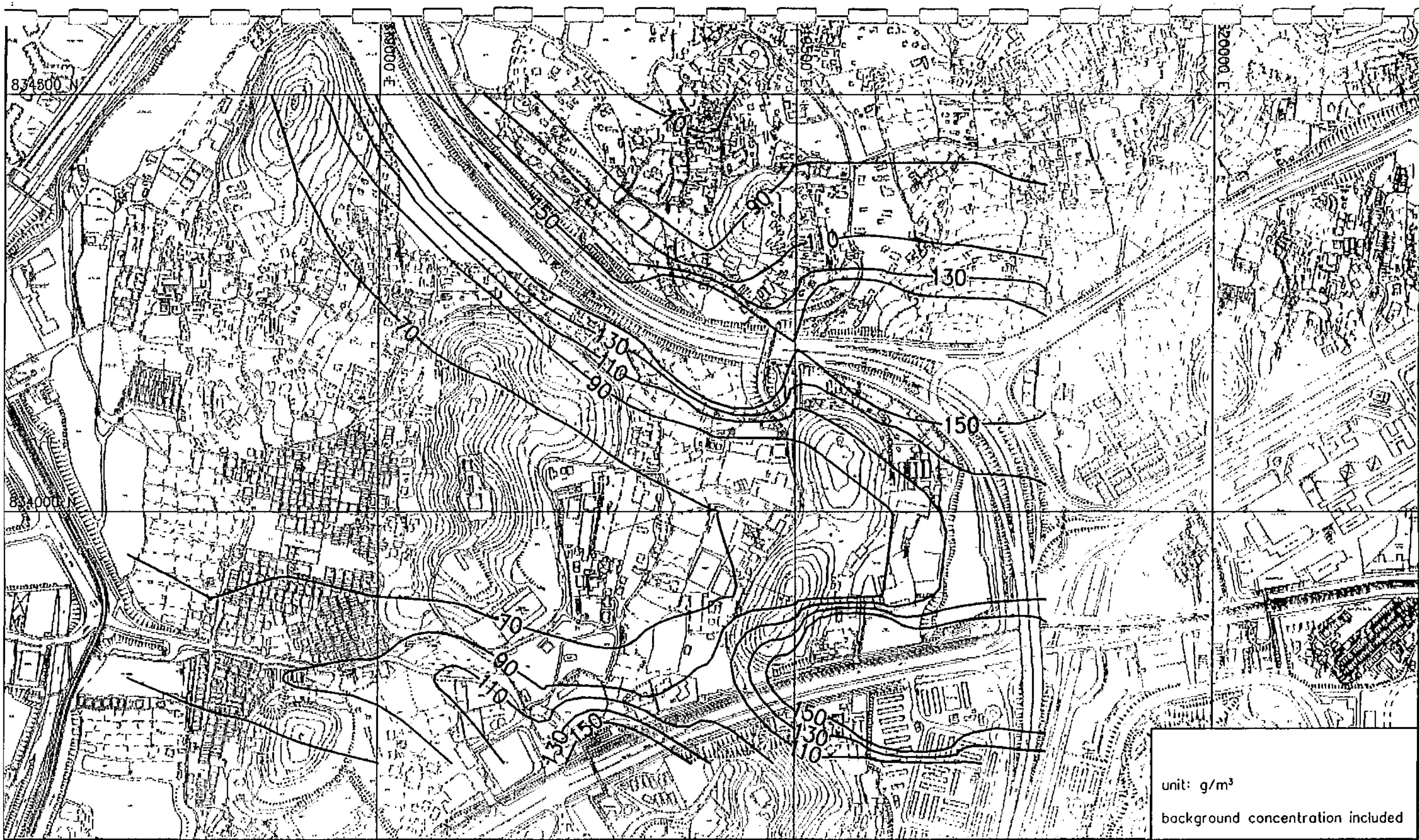
Title :

MAXIMUM NO_2 CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR AREAS 3 AND 5 IN YEAR 2011

Figure No.	Revision
6.39	0
Reference	File Name
TSW-BASE	01950018.C09
Prepared	Checked
WKY	YWL
Date	Scale
NO	1 :



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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Title :

MAXIMUM NO_2 CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) ALONG LONG TIN ROAD AND PING HA ROAD IN YEAR 2011

Figure No.	Revision
6.40	0
Reference: TSW-BASE	File Name: 01960018.C09
Prepared: WKY	Checked: YWL
Date: NOV. 96	Scale: 1 : 6000

TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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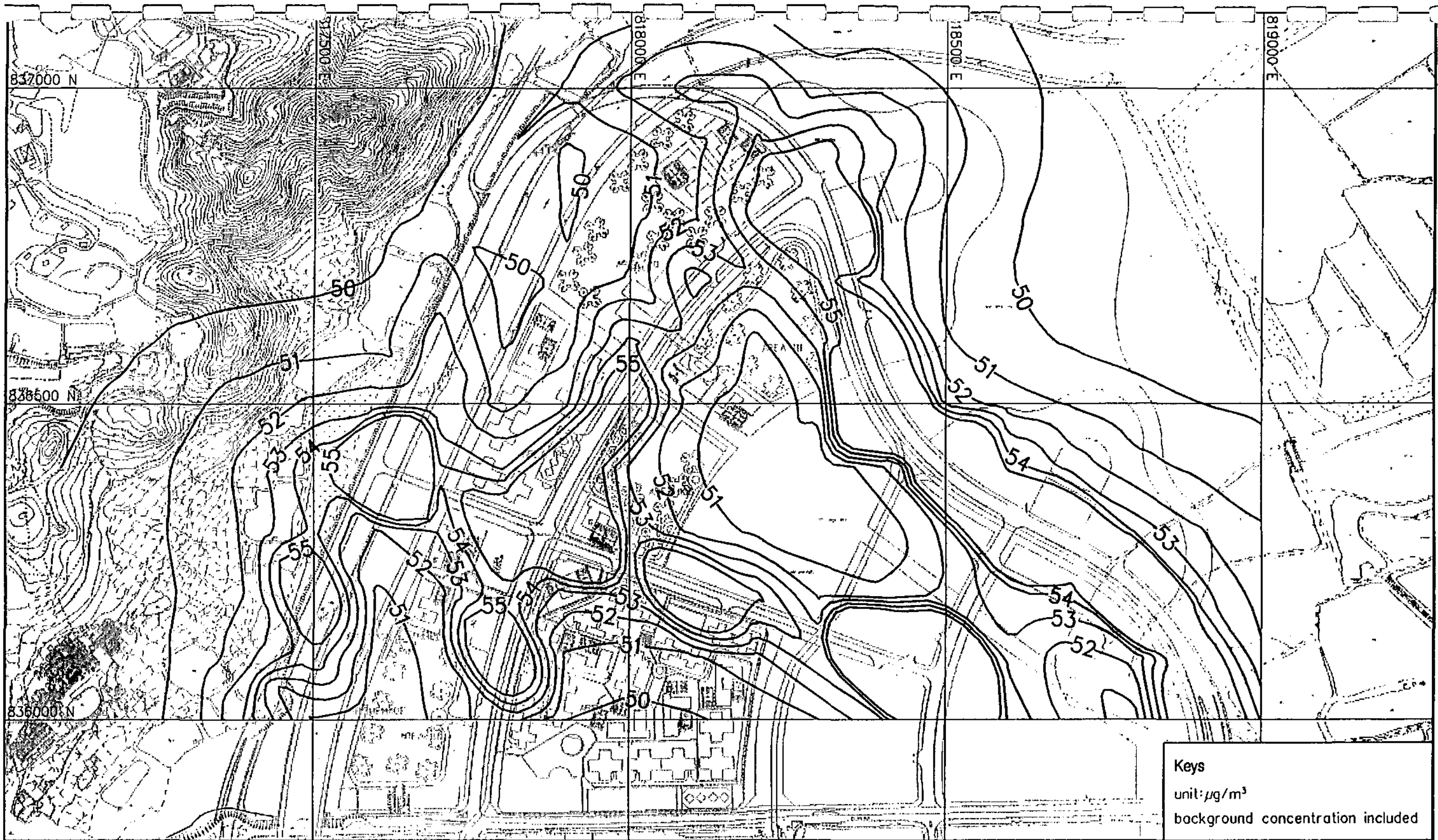
ENGINEERS AND SCIENTISTS
賓尼

Title :

MAXIMUM NO_2 CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) ALONG HUNG TIN ROAD IN YEAR 2011

Figure No. 6.41	Revision 0
Reference No. TSW-BASE	File Name 01970018.C09
Prepared WKY	Checked YWL
Date NOV 96	Scale 1 : 5000



Keys

unit: $\mu g/m^3$

background concentration included

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95

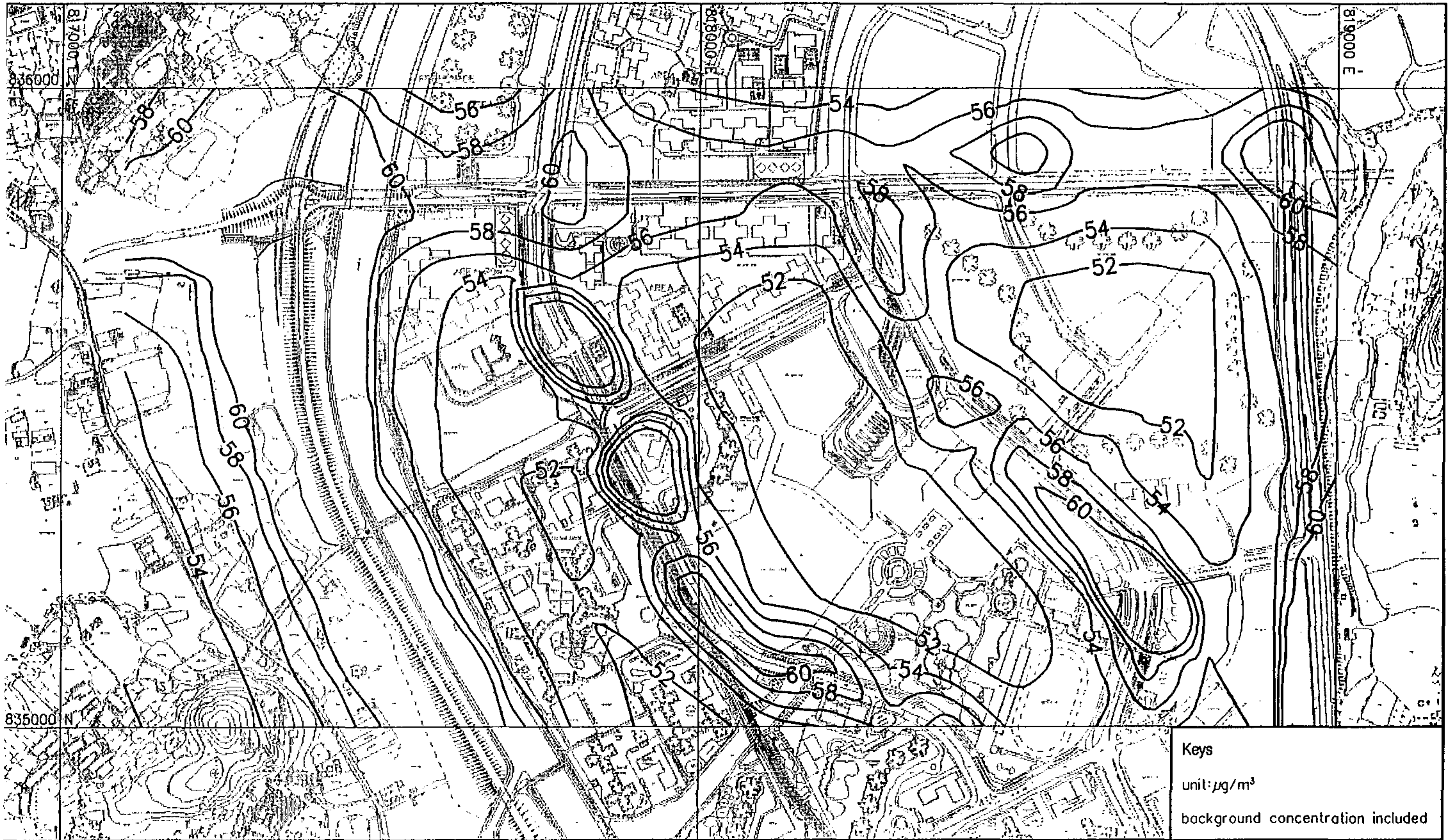
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
賓尼工程顧問有限公司
ENGINEERS AND SCIENTISTS
賓尼

Title :

MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR THE RESERVE ZONE IN YEAR 2011

Figure No. 6.42	Revision 0
Reference TSW-BASE	File Name 01980018.C09
Prepared WKY	Checked YWL
Date NOV. 96	Scale 1 : 8000



Keys

unit: $\mu g/m^3$

background concentration included

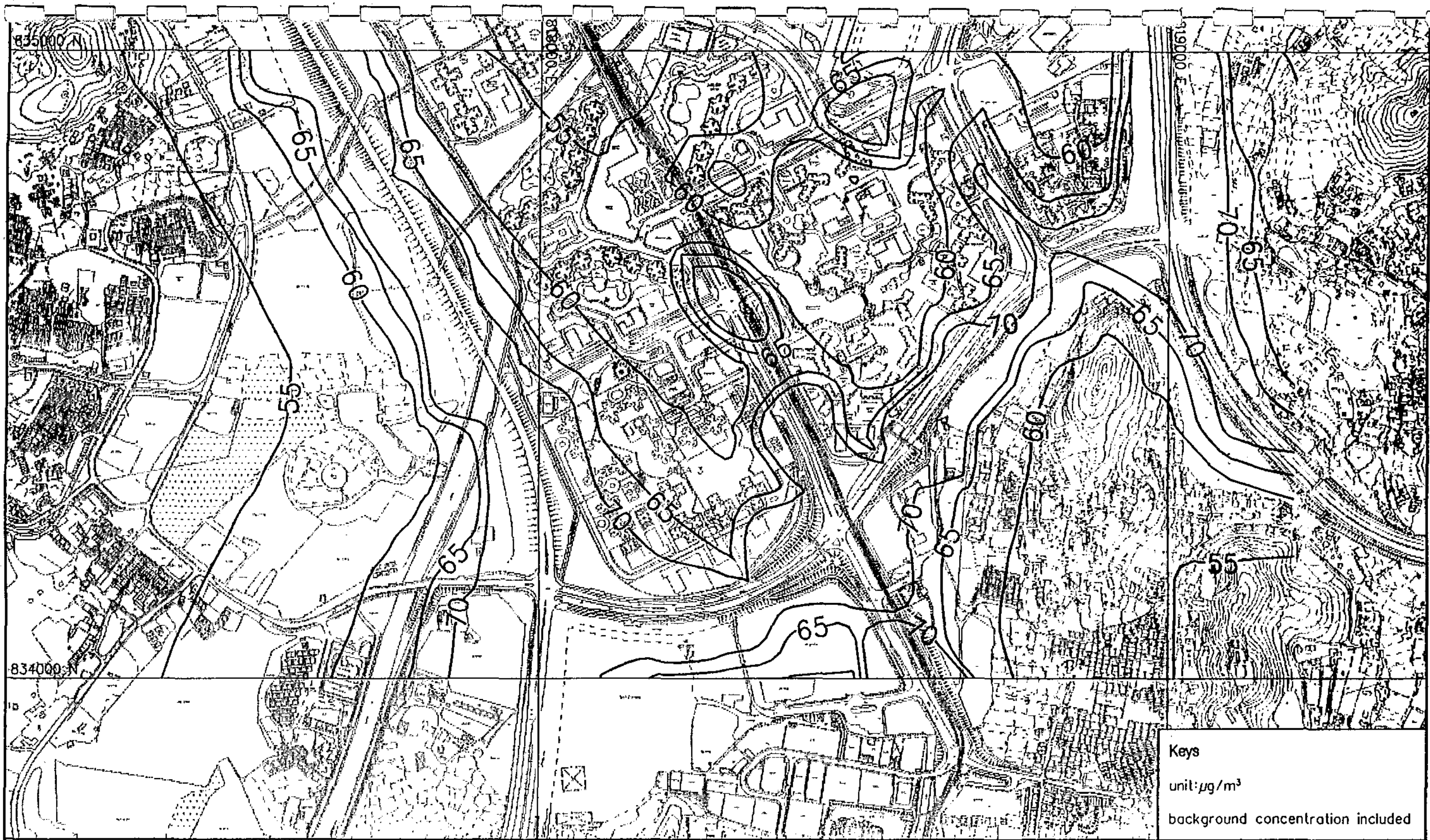
TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司

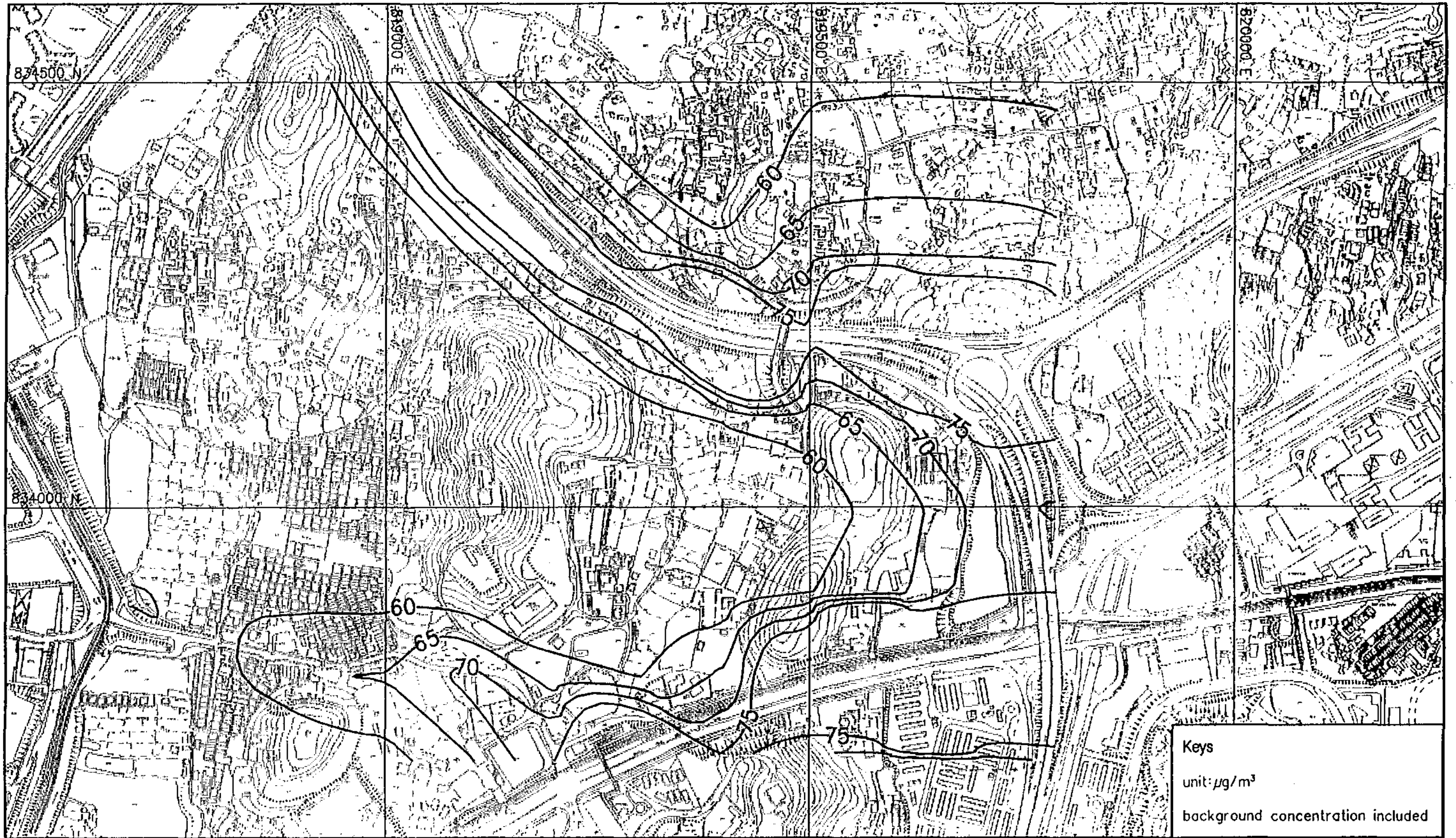
Title :

MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR AREAS 30 & 31 IN YEAR 2011

Figure No. 6.43	Revision 0
Reference TSW-BASE	File Name 01990018.C09
Prepared WKY	Checked YWL
Date NO[illegible]	Scale 1 : [illegible]



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) FOR AREAS 3 AND 5 IN YEAR 2011	Figure No. 6.44	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 02000018.C09
		Prepared WKY	Checked YWL
		Date NOV. 96	Scale 1 : 8000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

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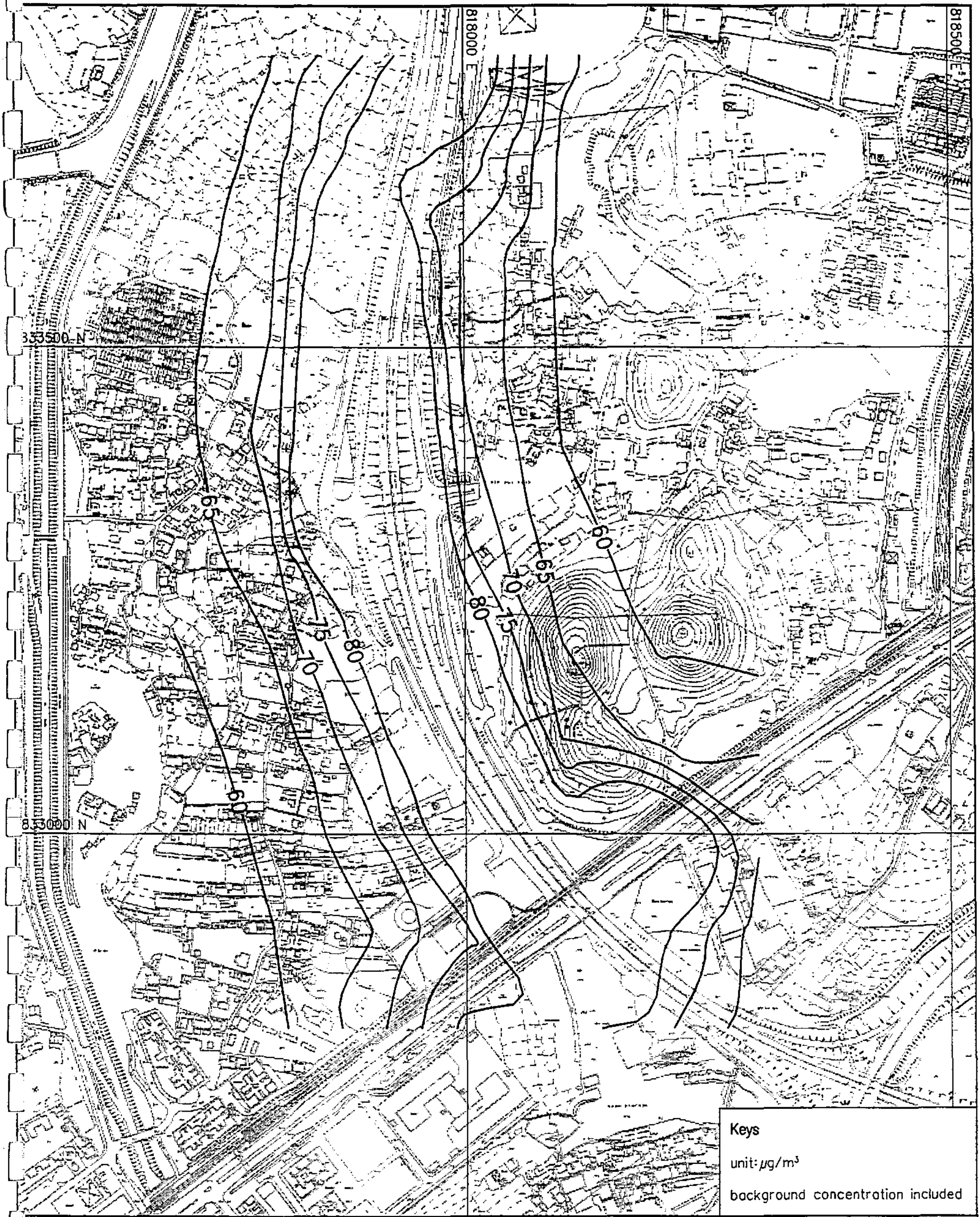
Title :

MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) ALONG LONG TIN ROAD AND PING HA ROAD IN YEAR 2011

Figure No. 6.45	Revision 0
Reference TSW-BASE	File Name 02010018.C09
Prepared WKY	Checked YWL
Date NOV 96	Scale 1 : 5000



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : MAXIMUM RSP CONCENTRATIONS AT PEDESTRIAN LEVEL (HOURLY AVERAGE) ALONG HUNG TIN ROAD IN YEAR 2011	Figure No. 6.46	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference No. TSW-BASE	File Name 02020018.C09
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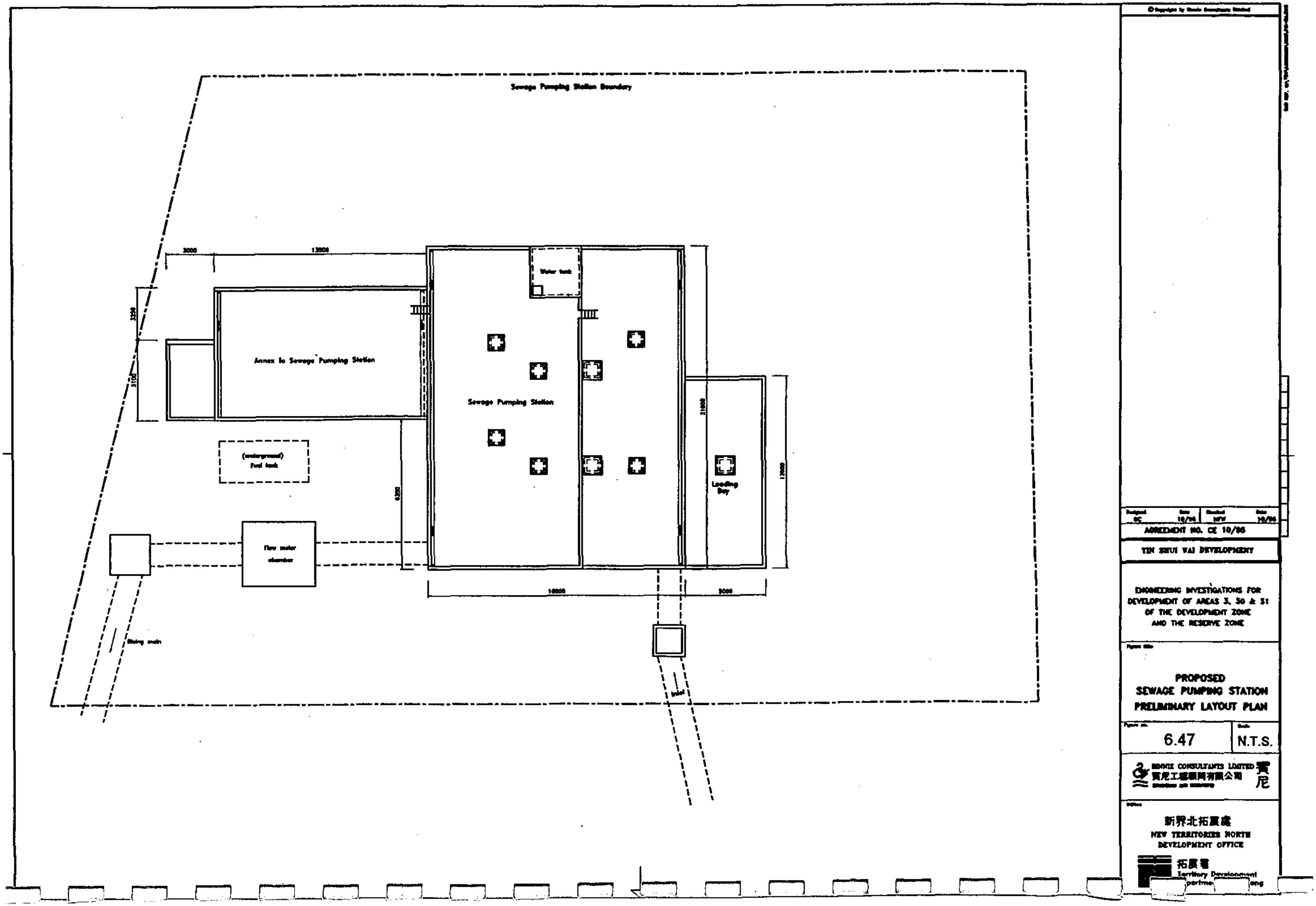
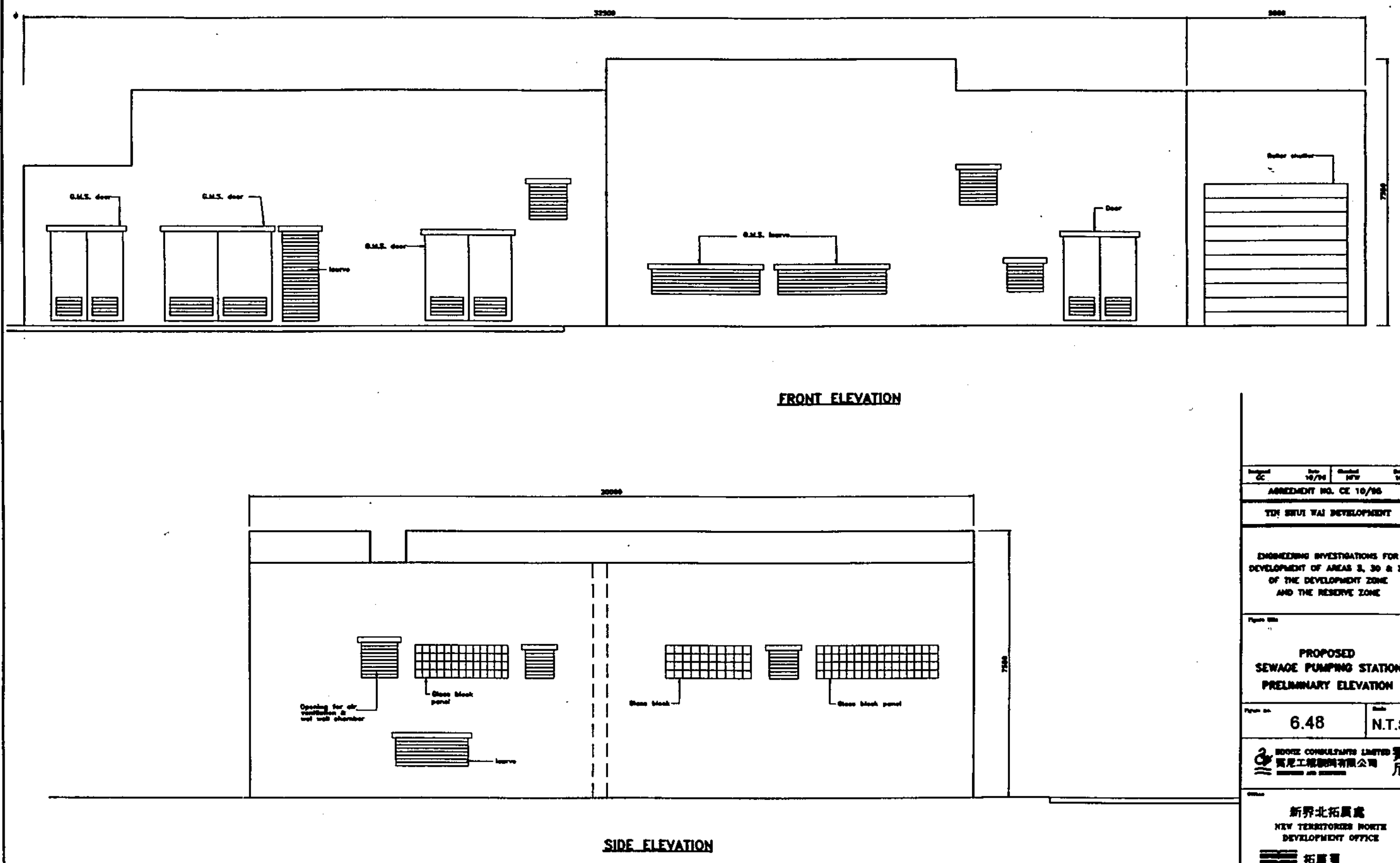
		Date NOV. 96	Scale 1 : 5000



Sewage Pumping Station Boundary
3000
13800
3250
5100
Annex to Sewage Pumping Station
Water tank
Sewage Pumping Station
(underground) Fuel tank
8300
Flow meter chamber
21800
12000
Loading Bay
18000
5000
Rising main
Inlet
Designed
Date
10/96
Checked
MFW
Date
10/96
AGREEMENT NO. CE 10/96
TIN SHUI WAI DEVELOPMENT
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE
Figure title
PROPOSED SEWAGE PUMPING STATION PRELIMINARY LAYOUT PLAN
Figure no.
6.47
Scale
N.T.S.
RENDEL CONSULTANTS LIMITED
賓尼工程顧問有限公司
賓尼
新界北拓展處
NEW TERRITORIES NORTH DEVELOPMENT OFFICE
拓展署
Territory Development Department



AGREEMENT NO. CE 10/96

TIN SHUI WAI DEVELOPMENT

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

PROPOSED
SEWAGE PUMPING STATION
PRELIMINARY ELEVATION

6.48

N.T.S.

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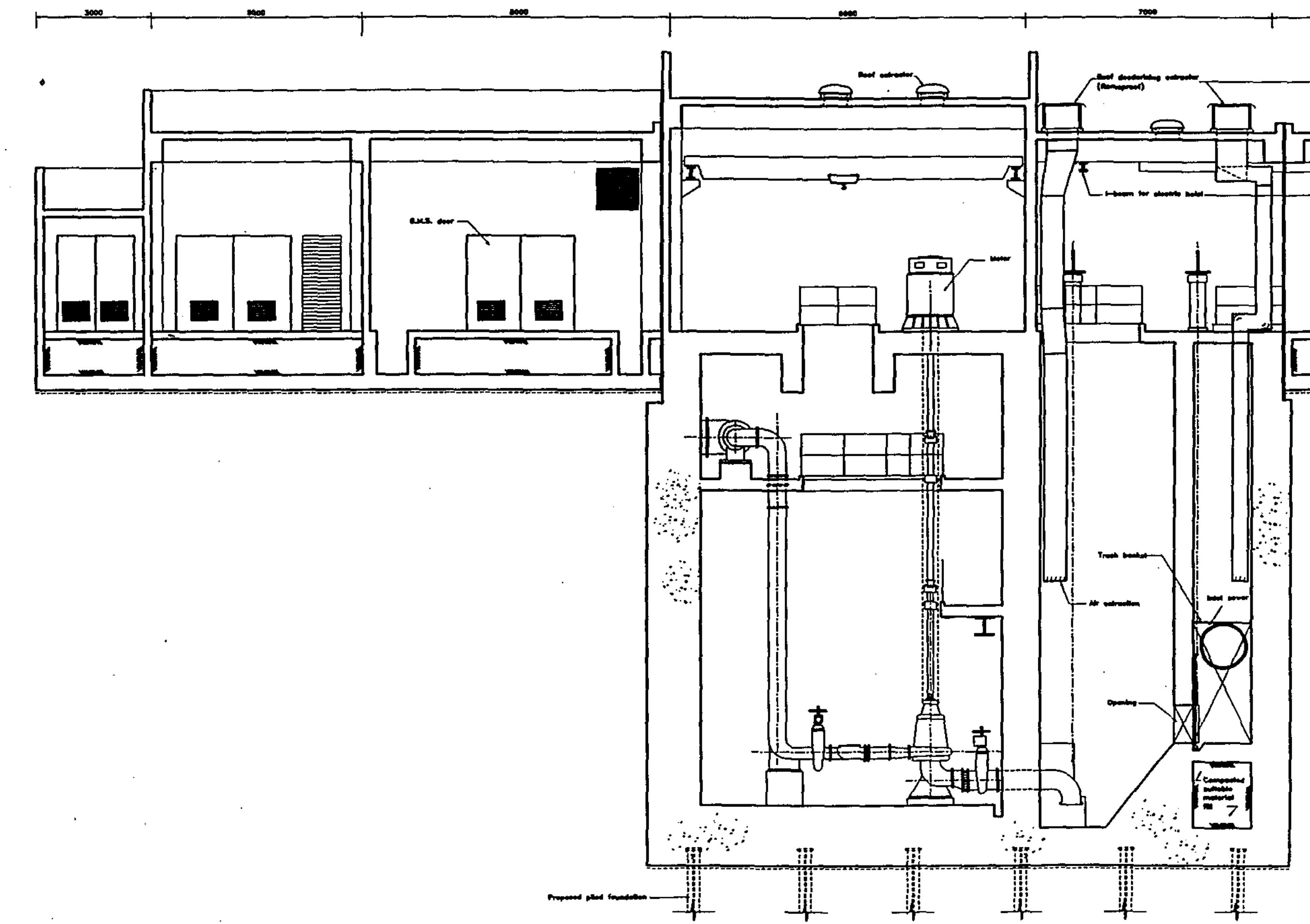
Territory Development Department, Hong Kong



AGREEMENT NO. CE 10/96

TIN SHUI WAI DEVELOPMENT

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

PROPOSED SEWAGE PUMPING STATION INTERNAL ELEVATION

6.49

N.T.S.

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司

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Territory Development Department

7 WATER

7.1 Introduction

7.1.1 The Tin Shui Wai drainage basin drains into Inner Deep Bay, an important mudflat area where invertebrate species, several of which are new to science, provide an important food resource to tens of thousands of birds both resident and migratory in this area. Several bird species are endangered and therefore any adverse impacts on them and their food supplies from development in the drainage basin must be avoided. Tin Shui Wai RZ comprises about 10% of the basin (Figure 7.1).

7.1.2 It is essential that works carried out as part of the Project do not adversely affect this valuable ecosystem or any of the current or future residents in the Tin Shui Wai area. The site formation works to be carried out on the RZ under this Project complete the land reclamation and formation works commenced in the late 1980s. At that time, 20 Mm^3 of sand was pumped into Tin Shui Wai to create the man-made platform. Fish ponds and river courses which covered the site in 1983 contained sediments 300 mm - 1,000 mm thick and these were left in place.

7.1.3 This section aims to identify the main impacts and all other issues collectively with the potential to adversely impact the water bodies within the Study Area and Inner Deep Bay as a whole. Detailed mitigation measures will be described to maintain and, where possible, improve future water quality.

Structure of this Section

7.1.4 This section is presented in sections which fulfil the objectives of the water quality impact assessment described in the Consultant's Brief (Section 6.6.15). The divisions of the impact assessment are shown in Table 7.1.

7.2 Description of Water Bodies

7.2.1 The water bodies within the Study Area are Western Temporary Channel (WTC) which, after extension of the concrete lining, is referred to as the Western Drainage Channel Extension (WDCE); the Western Drainage Channel (WDC); the Eastern Temporary Channel (ETC) which, after site formation of Areas 104, 109 and 117, will be referred to as the Eastern Drainage Channel (EDC); the Eastern Culvert; the Old Western River; the Tin Shui Wai Bund Channel, otherwise known as the TSW Creek or the Cross Channel, Inner Deep Bay and Deep Bay as a whole, the groundwater system; and fishponds and associated wetlands and marshes. These are described below and/or shown on Figure 7.2.

<u>Deep Bay</u> is a large shallow bay on the east bank of the Pearl Estuary, adjacent to the deep flood channel of Urmston Road. The Bay has a surface area of 112 km^2 and contains 330 Mm^3 of water at Mean Sea Level. The 24 km^2 catchment of the Shenzhen River provides approximately 55% of the annual runoff into the Bay.

Table 7.1
Water Quality Impact Assessment: Structure of Chapter

Description	Section	Appendix
Description of water bodies and standards which apply to sensitive receivers	7.2	
Background information about the hydrology and water quality of the catchment of each subject water body. Database of historical and existing flow regimes, stratification and mixing patterns, flushing and tidal effects, sedimentation patterns, sediment quality and water quality	7.3	D1
Current sediment quality and current water quality	7.3	D1
Identification of potential major impacts from the Project	7.4	
Assessment of all construction related impacts related to effect on hydrology of water bodies, sedimentation processes and water quality	7.5	D1
Details of mitigation measures to minimise impacts and consequential residual impacts	7.5	
Summary of Construction Phase Impacts and Mitigation Measures		
Assessment of operation related impacts related to hydrology and water quality of water bodies.	7.6	
Details of mitigation measures to minimise impacts and consequential residual impacts.	7.6	
Summary of Operation Phase Impacts and Mitigation Measures		
Impacts from and mitigation measures for key operational issue of Urban Stormwater Runoff	7.7	D2
Cumulative impacts from other projects	7.8	
Combined impacts during overlapping construction and operation periods	7.8	
Summary of Urban Stormwater Runoff Impacts and Mitigation Measures		
Summary and conclusions of impacts, and mitigation measures defined for the Project	7.9	
Section 9: Ecology describes the importance of impacts associated with water issues for the protection of surrounding ecosystem and describes the freshwater wetland area.		

Inner Deep Bay is a very shallow estuary area at the head of Deep Bay draining several rivers (the Shenzhen River being the largest). The estuary is characterised by silt and clay sediments which are exposed during low tides. The mudflat or exposed area covering 1.8 km^2 supports mangroves which host a variety of organisms which provide rich feeding grounds for thousands of migratory birds. Inner Deep Bay is an internationally recognised Ramsar site for waterfowl and other birds, and contains 4 Sites of Special Scientific Interest (Mai Po Marshes, Mai Po Egretry, Tsim Bei Tsui and Tsim Bei Tsui Egretry), as well as the nature reserve of Fu Tien to the north.

Western Drainage Channel (WDC) is a concrete lined channel, which runs along the western edge of the DZ to an inflatable dam, which controls flows downstream to the new WDCE. Low flows are directed to low flow interceptors which will ultimately pump to the sewage treatment plant.

Western Temporary Channel (WTC), later named Western Drainage Channel Extension (WDCE), flows along the western and northern boundaries of the RZ, and drains into the Western Outfall Area and Inner Deep Bay. Its total length is about 4 km. At its upstream end there is the inflatable dam controlling water flows from much of the Tin Shui Wai drainage basin. At the mouth it meets the mudflat areas of Inner Deep Bay. Currently, it is not concrete lined, however, the 500 m immediately downstream of the inflatable dam will be under this Project.

Eastern Culvert (EC) runs along the eastern edge of the DZ enclosed in a box culvert. It drains into the ETC. Construction works will later be carried out to extend this culvert which will feed into the EDC.

Eastern Temporary Channel (ETC), later named Eastern Drainage Channel (EDC), flows along the eastern edge of the RZ. It receives flows from the Eastern Central Culvert and Eastern Culvert, and drains through the Eastern Outfall via 18 tidal flap valves under the Tin Shui Wai bund. Water discharges to Inner Deep Bay via a channel between one of the gazetted dumping grounds and the fish ponds.

Tin Shui Wai Bund Channel, otherwise known as the TSW Creek or the Cross Channel, joins the WTC and the Eastern Outfall of the ETC. It is tidal in nature and heavily vegetated with mangroves. The channel is about 8 metres wide bank-to-bank with the main water channel being approximately 3 metres wide.

Old Western River flows through the western side of the RZ and joins the WTC at chainage 3000 m. This used to be the main river draining much of the Tin Shui Wai basin, meandering through fishponds. Today it only drains Areas 101,105,106, 110 and 111 of the man-made platform.

Groundwater. The old fish pond deposits underneath the Tin Shui Wai man-made platform act as a barrier between the surface waters and underlying groundwater. Groundwater (levels and quality) underlying the Tin Shui Wai Area, and the possible changes in flows, are addressed in later sections.

Water Quality Standards for the Water Bodies

7.2.2 The water quality standards established for each of these bodies of water are defined in the Water Quality Objectives for Deep Bay Water Control Zone shown in Appendix A and summarised in Table 7.2.

Table 7.2
Water Quality Objectives for Water Bodies relevant to Tin Shui Wai Development

Water Body	Criteria						
	E.coli (No./100 mL)	DO (mg/L)	pH	Temp.	Salinity	SS	Ammonia
Deep Bay Inner Deep Bay	< 610	> 4 for 90% of sampling times	6.5 - 8.5	shall not change by more than 2°C	shall not change by more than 10%	shall not change by more than 30%	< 0.021 mg/L unionized ammonia nitrogen
WDC WTC EC ETC	< 1000	> 4	6.5 - 8.5			< 20 mg/L	

Water Body	Criteria		
	BOD (mg/L)	COD (mg/L)	Toxins
Deep Bay Inner Deep Bay	-	-	waste discharges shall not cause a risk to any beneficial uses* of the aquatic environment
WDC WTC EC ETC	< 5	< 30	

* Beneficial water uses are defined in the *"Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters"* as follows:

Inland Water grouping	Beneficial use
Group A	Abstraction for potable water supply
Group B	Irrigation
Group C	Pond fish culture
Group D	General amenity and secondary contact recreation

7.2.3 Inland waters within the Tin Shui Wai Study Area are defined as Group C waters which are those "pumping through areas where there are large numbers of fishponds, especially in the Yuen Long area".

7.2.4 These water quality objectives will be considered in the assessment of construction and operation impacts on the water environment and the degree of mitigation required to maintain these standards.

7.3 Background Information on Hydrology, Sediment and Water Quality

Approach

7.3.1 This section on water quality outlines historical changes and the existing situation and presents a database of water quality and sediment related data.

Hydrology: Historical Changes and Existing Conditions

Changes in Shoreline and Watercourses

7.3.2 The shoreline of Inner Deep Bay and the watercourses that flow through the Project area have frequently altered over the decades as a result of man-made and natural changes (Figure 7.3). The coastline prior to construction of the bund wall/embankment can be identified by a ring of old villages which once lined the shoreline at sea level. Today they are far from the coast with land built up around them. The natural fate for all estuaries is to silt up and choke over thousands of years and Inner Deep Bay is no exception. However, the natural rate of siltation can be accelerated or decelerated under Man's influence.

Man-made changes

7.3.3 Shoreline: Coastlines were extended by the building of a bund wall/embankment in 1916 and the development of the land behind. Figure 7.4 shows that man-made changes and land use patterns have ranged from swamp, marsh and brackish water paddies in 1924, to predominantly *gei wais* (in 1945); to *gei wai*, fishponds and fresh water paddies (in 1963); to largely fishponds and modified *gei wai* in 1985 (Irving and Morton 1988). Development was initially to create paddy fields and fish ponds, and more recently for the New Town Development of Tin Shui Wai.

7.3.4 Watercourses: Figure 7.5 shows the watercourses and associated land uses in 1954 and 1967. Water uses associated with agricultural needs changed the flows and direction of the watercourses. In 1994 the need for these agricultural activities gave way to a greater need for housing and development. With this change of land use, fill material altered the watercourses of the development site. The Tai River was redirected into the WTC, which itself was river trained. The Old Western River although still in existence has changed its function from draining much of the Tin Shui Wai basin to now simply draining the RZ. The 'Middle' and 'Side' streams were buried along with fish ponds and local wetland areas (refer to Figure 7.6).

Natural changes

7.3.5 Shoreline: The physical nature of the Bay acts to retain deposits washed in at the mouth of the Bay. The hydrodynamics of the estuary also act to prevent much of the silts and clays from flushing out, hence, natural accretion has resulted in the shoreline being extended.

7.3.6 The natural widescale spread of mangroves has also extended coastlines and encroached on mudflat areas. This perpetuates conditions for further sediment deposition and growth of further mangroves.

7.3.7 Hyacinth increases deposition by impeding flows but it also removes pollutants, improving water quality. Water hyacinth thrives on nutrients from livestock waste in the water and dies back naturally as water quality improves, thus reducing deposition as velocities increase.

Flow Regimes

Deep Bay

7.3.8 The Deep Bay watershed is drained by the Shenzhen River from the north-east, the San Pui River and the TSW channels from the south, and a number of other smaller streams from the PRC from the north side of the Bay. The Bay in turn flows into the main Pearl River estuary which occupies an area of 8,000 km^2 and has an annual flow of around 349.2 billion cubic metres[1,2].

7.3.9 The hydrography of Deep Bay is very complex. The wet season runoff exceeds that of the dry season by a factor of four, and the seaward perimeter experiences constant changes in water quality due to the mixing of the coastal and estuarine waters in the Urmston Road area.

7.3.10 Binnie *et al.* (1985) used float tracking to define water movement. Tidal vector charts based on the dry season data produced for spring and neap tides are shown in Figure 7.7 a-d. The spring tide flows in and out of the Bay along a northeast/southwest axis. A clockwise rotation is just discernible at HHW and LHW in Inner Deep Bay. The neap tides are similar although the circulation is not apparent. In general the wet season float tracks were similar to the dry season movements.

7.3.11 In 1986, a two-dimensional flow model suggested that there were a number of small residual current circulation cells, both clockwise and anti-clockwise, in the Outer and Inner Bay areas (Binnie *et al.* 1986). Residual currents give a guide to the net movements of water as they are an integration of flows, over a tide, at a single point. The spring tide residual current pattern from the above model, shown on Figure 7.8, depicts a relatively strong clockwise cell in the region of WENT Landfill. This suggests that there is no net drift towards Inner Deep Bay. The 1986 study also indicated that the main flood and ebb flows in Deep Bay occur in the main channel, not in different areas of the Bay as previously suggested, and that the ebb tide is stronger than the flood.

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1 Chen, Z. and Wei, S. (1985). Ecological characteristics of the distribution of ichthyoplankton in the waters of the Zhujiang (Pearl River). In Wong *et al.* eds: Environmental Research in Pearl River and Coastal Areas. Guangdong Higher Education Press.

2 Fu, Y.Y., Yin, J.Q., Chen, Q.C., Hung, L.M. and Wong C.K. (1985). Distribution and seasonality of marine zooplankton in the Pearl River Estuary. In Wong *et al.* eds: Environmental Research in Pearl River and Coastal Areas. Guangdong Higher Education Press.

7.3.12 Current measurements taken as part of the dry season data for the Deep Bay Water Quality Regional Control Strategy Study (Acer 1996) at nine locations in Deep Bay are shown in Appendix D1. Currents flow faster in the outer part of the Bay, and surface and bottom flow directions sometimes differ which indicates the complexity of the Deep Bay flow regime.

Flushing and Tidal Effects

7.3.13 The flushing time for water entering Deep Bay is on average about 15 days, although the complex circulation patterns cause the actual retention time to vary considerably.

7.3.14 Water quality is related to the flushing ability, i.e. the greater the flushing, the better dispersion and dilution of the water pollutants. Flushing depends on the tidal flow in the Bay. The tidal pattern in Deep Bay is influenced by the irregular mixed diurnal tide of the South China Sea. The impact of wave action on the inter-tidal areas is extremely complex.

7.3.15 Tides effect sedimentation. In-coming tides reduce the dispersive capacity of Inner Deep Bay. Velocities of rivers flowing in drop when they meet an in-coming tide, and sediments fall out. Incoming tides also bring in marine sediments which are deposited in the WTC during the dry season and periods of low flow. In contrast, during the wet season, and at low tide, the dispersive capacity of Inner Deep Bay is vast, as rivers flowing in spread across the mudflats or along incised channels, relatively unrestricted.

7.3.16 The maximum astronomical tidal range is 2.80 m. The tidal rates of level change are also important to sedimentation. The rate of level change is directly proportional to the tidal velocity.

7.3.17 The Tin Shui Wai model that was developed for the preliminary and detailed designs of the engineered channels in TELADFLOCOSS II (1993)[3], was carried out to assess the effect of a long term sea level rise on the engineered channels of the Western Channel. Increments of 0.25 m rises show no impacts on water levels upstream of the inflatable dam, whilst downstream in the tidal region there is a significant impact. A sea level rise of 0.25 m or more would result in increased tidal sedimentation and hence increased frequencies of maintenance dredging.

Tin Shui Wai - Historical Flow Regimes

7.3.18 Prior to land reclamation of the Tin Shui Wai DZ and RZ, rivers passing through the site drained a catchment of approximately 2,100 hectares. Changes in landuse activities prior to development had already increased the flooding frequency by removing flood storage areas, and the formation of the site for the new town removed further flood storage. It was therefore essential that the subsequent drainage provisions compensated for this flood loss. Development of the site for the new town provided an ideal opportunity to improve drainage of the catchment area as a whole.

3 Binnie Maunsell Consultants, 1993, Territorial Land Drainage and Flood Control Strategy Study - Phase II.

7.3.19 The Tin Shui Wai model, which was re-run for the Tin Shui Wai DZ, simulated a catchment close to full development in the flood sensitive lowland areas, and assumed no significant flood storage area due to the infilling of most low lying areas and ponds by the Tin Shui Wai development. Most of the model comprised engineered channels designed to withstand a 1 in 50 year return period event, although a 1 in 200 year event would only just be contained.

7.3.20 Changes in the drainage strategy were to concentrate river flows in a single engineered channel on the western boundary of the site. This required diversion of the Tai River (on the eastern channel) which includes a 1.2 km culvert up to 17 m wide.

7.3.21 On 18-19 July 1992, Tropical Storm Faye gave the opportunity to check the calibration of the Tin Shui Wai (TELADFLOCOSS II) model and efficiency of the newly built drainage systems. Table 7.3 shows a comparison between the actual recorded and simulated flood levels for Tropical Storm Faye in the Western and Eastern Temporary Channel:

Table 7.3
Comparison of Recorded and Simulated Flood Levels for Tropical Storm Faye

River	Chainage (km)	Time HR:MIN	Recorded Level (mPD)	Simulated Level (mPD)	Time HR:MIN	Simulated Peak Level (mPD)
HSKC	3.132	14:25	3.35	3.70	13:08	4.02
MCDC	3.659	14:30	3.20	3.13	12:18	3.71
MCDC	4.084	10:30 15:15	3.70 2.80	2.56 2.70	12:05	3.64
MCDC	5.104	15:10	3.20*	2.46	12:05	3.44
TAI	2.506	14:15	3.45	3.41	12:18	3.80
EC	4.545	14:00	2.95	2.60	12:18	3.15
EC	5.810	13:45	2.80	2;41	12:18	3.04
PSC	2.585	14:00	3.40	3.44	12:18	3.77

* Level is inconsistent with reading taken upstream at MCDC 4.084 and also the tide level 1.76 mPD at 15:10 hours.

Source: TELADFLOCOSS II Tin Shui Wai - Binnie Maunsell Consultants 1993.

7.3.22 The levels compare reasonably well, some differences may have been due to the movement of the storm across the catchment. The water levels recorded correspond with a 1 in 10 year combined flood event. Some flooding did occur in the low lying areas but generally no significant deficiencies in the primary drainage system were reported. Poldered village schemes and non-structural measures like flood proofing were also undertaken in these low lying regions.

Existing Conditions

7.3.23 The drainage basin of approximately 23 km^2 comprises the major subcatchments of Hung Shui Hang (6 km^2), Ha Tsuen (3 km^2), Tai River (2 km^2) and Lo Uk Tsuen (2 km^2). The remaining sub catchments are less than 1 km^2. A substantial proportion of the Hung Shui Hang and the three significant tributaries now drain into the engineered WTC and ETC through the DZ and RZ.

7.3.24 Water circulation and flushing of the Temporary Channels are influenced by the tidal effect of Inner Deep Bay. It has been suggested by some studies that the water flow contribution of TSW catchment into Inner Deep Bay is minimal compared with other catchments as shown in Table 7.4. Table 7.5 demonstrates the order of magnitude difference between wet and dry season flow.

Table 7.4
Measured River Flows into Deep Bay

River	Wet Season (m^3/s) (5 months)	Dry Season (m^3/s) (7 months)
Deep Bay coast (HK)	1.1	0.19
Tin Shui Wai	0.9	0.26
Yuen Long	22.7	9.32
Shenzhen	57.4	25.30

Source: Deep Bay Integrated Environmental Management, December 1988.

Table 7.5
Measured River Flows of the Hung Shui Hang Upper Catchment of TSW sampled at the Yuen Long Highway

Year	Wet Season (m^3/s) (May - Sept)	Dry Season (m^3/s) (Oct - Apr)
Sept - Dec, 1992	0.560	0.033 - 0.058
Jan - Dec, 1993	0.040 - 0.315	0.006 - 0.054
Jan - Dec, 1994	0.015 - 0.728	0.012 - 0.065
Jan - Oct, 1995	0.014 - 0.324	0.008 - 0.980

Source : Courtesy of Acer (1996)

7.3.25 However, this viewpoint is inconsistent with the areas and nature of the various catchments. Figure 7.9 shows the drainage catchments of Deep Bay. The Yuen Long, Kam Tin, Ngau Tam Mei (YLKTNTM) drainage catchment is 90 km^2, some 8% of the Hong Kong's land area. Tin Shui Wai catchment is about 25% of the YLKTNTM drainage catchment area. However, a large percentage of the YLKTNTM basin consists of fish-ponds or uplands resulting in lower run-off rates. TSW basin is extensively urban in comparison.

7.3.26 Modelling of peak flows suggest that water volumes entering Deep Bay from the TSW basin are only slightly less than those from the YLKTNTM basin as illustrated below in Table 7.6 for the major channels for both basins.

Table 7.6
Peak Discharges Predicted under Baseline Scenarios (TELADFLOCOSS 2)

Return Period (years)	Peak Discharge (cumecs i.e. m^3/sec)	
	TSW Western Channel	San Pui River (MDC)
2	128	183
5	195	288
10	259	354
50	382	447

7.3.27 Modelling currently being undertaken for a variety of development scenarios for the *Yuen Long, Kam Tin, Ngau Tam Mei, Tin Shui Wai Master Drainage Plan* by BCL (not yet published) suggest that the San Pui River otherwise known as the Main Drainage Channel for the Yuen Long, Kam Tin and Ngau Tam Mei Basin has peak discharges only 50% more, i.e. 1½ times those of the TSW Western Channel system.

7.3.28 Part of the apparent disparity is explained if the river flows for TSW in Table 7.4 were measured at a similar location to those in Table 7.5. The Hang Shui Hang subcatchment is only 6 km^2 in total and is principally upland catchment.

7.3.29 Peak flows are dependent upon the rapidity with which rainfall can be removed from a system. Total flow or annual flow for TSW basin is probably about 1/3 of that of the YLKTNTM basin.

Sedimentation Patterns

7.3.30 Deposition has always been predominant in Deep Bay due to its physical nature. In response, the mudflats (with associated and dependant wildlife) have adapted slowly over the years. Sedimentation is a gradual positive process which can be greatly accelerated or decelerated by Man's influence.

Historical: Suspended Solids Levels

Prior to Tin Shui Wai New Town Development

7.3.31 In 1980 Binnie estimated suspended solids (SS) loadings from the Tin Shui Wai catchment as 4780 tonnes in the wet season and 480 tonnes in the dry season. This was prior to land formation of the man-made platform for Tin Shui Wai. Results of sampling at locations shown in Figure 7.10 are given in Table 7.7.

Table 7.7
Suspended Solids (SS) Levels Prior to Land Formation Works

	Suspended Solids (mg/l)		
	average	minimum	maximum
Western River	93	11	166
Middle River	101	20	233
Tai River	290	64	1345

Source: Deep Bay Water Quality 1985, Binnie & Partners International.

SS Levels Between 1988-1991

7.3.32 Suspended solids levels were recorded before, during and after the land formation works to assess the baseline levels and the overall impacts of the Project on suspended solids levels in Deep Bay.

7.3.33 Extensive monitoring by Binnie[4] between 1988-1991 around the Western outfall area, the marine borrow areas, Marine Transport Corridor and rehandling basin assessed the effects of dredging on sedimentation and possible release of pollutants from contaminated sediments.

7.3.34 A mathematical model 'SPOIL' was developed as part of the Land Preparation studies to determine the distribution of sediment disturbed from dredging activities.

4 Binnie & Partners (Hong Kong), Land Formation Working Paper No. 14 'Silt Deposition Predictive Model'.

Table 7.8
Suspended Solids Levels During Land Formation Operations of Tin Shui Wai (mg/L)

Date	Sampling locations										Deep Bay limit
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	
10.6.88	520				569	708					44
28.6.88	111	31	31	25	652	78					44
11.7.88	34	28	30	32	27	36					44
13.9.88	72	72	59	59	74	68	65	60	47	71	44
27.9.88	60	45	31	32	39	38					44
11.10.88	35	68	30	92	60	60					44
11.5.89	32	41	57	40	40	37	34	34	33	34	44
25.5.89	93	51	60	46	72	73	91	107	104	121	44
22.6.89	64	34	35	43	42	44	38	31	33	32	44
6.7.89	53	40	34	38	62	48	56	64	45	48	44
20.7.89	36	40	40	42	38	33	39	34	35	37	44
2.8.89	28	34	34	41	43	31	42	34	37	31	44
17.8.89	26	60	23	29	23	24	27	23	23	38	44
14.9.89	45	41	43	39	40	45	42	41	41	69	44
27.9.89	36	44	37	40	38	40	34	38	37	40	44
11.4.90	157	146	144	156	146	152	165	161	153	167	44
26.4.90	76	82	64	79	78	77	79	85	88	95	44
10.5.90	27	24	41	25	33	34	42	24	33	26	44
24.5.90	71	254	81	281	77	64	80	59	57	55	44
7.6.90	31	836	376	32	26	26	52	44	37	33	44
21.6.90	24	18	23	17	25	28	27	20	22	24	44
5.7.90	30	118	57	305	359	106	114	140	80	81	44
19.7.90	55	68	51	49	65	62	41	28	41	41	44
4.8.90	48	34	32	40	44	57	41	33	34	30	44
23.8.90	155	179	186	167	175	146	146	136	133	128	44
6.9.90	79	119	94	46	45	97	71	43	43	189	44
20.9.90	33	42	42	45	45	37	37	37	40	38	44
3.10.90	24	28	36	30	32	23	22	22	31	35	44
18.10.90	57	32	37	42	39	44	34	51	46	49	44
15.11.90	35	35	35	32	36	33	32	31	32	50	44
20.12.90	52	46	55	51	62	63	66	60	71	74	44
31.1.91	150	109	148	100	89	108	134	187	192	196	44
21.2.91	72	68	79	78	69	73	71	77	79	81	44
21.3.91	164	143	137	136	139	108	135	166	234	253	44
17.4.91	38	25	41	45	43	39	47	33	40	41	44
25.4.91	30	26	30	30	30	33	37	41	24	26	44
16.5.91	40	28	31	43	37	34	38	39	39	40	44
30.5.91	34	38	42	37	37	37	40	38	47	48	44

Source: Binnie & Partners and Shankland Cox Ltd.

7.3.35 The bulk of the marine fill material was dredged from Urmston Road, and Outer Deep Bay near Black Point. Table 7.8 shows suspended solids levels in the Western Outfall area during land formation. Levels generally lay within the target limits at the time of 100 mg/l, typically averaging between 30-70 mg/l, depending on season. This indicated that large quantities of sediment were not being washed into the Inner Deep Bay area. Sampling locations are shown on Figure 7.11.

7.3.36 Figures 7.12 & 7.13 compare suspended solid levels in the Western Outfall area during the land formation operations and data collected in the Inner Deep Bay area at Station W1, before, during and after land formation operations (location shown on Figure 7.10). Sampling was not carried out nearer to the mouth of the Western Outfall area (station W2) due to it being too shallow.

7.3.37 Stations W1 and W3 show levels of suspended solids ranging from 15 mg/l to well over 150 mg/l in some areas, and 377 mg/l on 7 September 1981 when Typhoon signals 1 and 3 were hoisted (refer Appendix D1 for complete data on station). These figures show suspended solids levels already existing in Deep Bay can be, and frequently are, higher than the suspended solids levels recorded in the Western Outfall area, and during the land formation activities.

7.3.38 This historical data shows that, in general, suspended solids levels in the Western Outfall are similar to those found in Inner Deep Bay prior to land formation works. Also, average suspended solids levels in the West, Middle and Tai Rivers prior to land reclamation operations, were higher than suspended solids readings from the Western River during land formation operations. This data therefore shows, that subsequent development works did not exceed the annual increase of 30% stipulated as the limit/guideline in the Water Quality Objectives. In addition, dissolved oxygen (DO) levels within the vicinity of Tin Shui Wai were gradually raised as a result of the aerating technique used for the land formation works. The sand pumped in was 'clean' and with 1 part sand to 4 part water ratio - the net effect was a flushing out of waters from the original river channels, greatly improving water quality.

Outside Influences

7.3.39 (i) During the same time period of the land formation operations, the first effects/benefits of the implementation of the Livestock Waste Control Scheme (LWCS) were realised, which may go some way to explain the reduction of the suspended solids levels despite the land formation operations. Quantitative figures on livestock waste reduction are shown later in this section. DO levels were below 1 mg/l in 1988 and were always above 4 mg/l, by 1990.

(ii) Due to the very shallow nature of Inner Deep Bay and the mudflat areas containing fine silts and clays, suspended solids are easily picked up into suspension and hence readings are naturally very high and very sensitive to wave and tidal activities.

(iii) Dredging of the WTC downstream of the inflatable dam was observed in March 1996. On 17th April 1996, extensive dredging was recorded upstream of the inflatable dam. Both activities were being carried out by DSD. These activities are outside the control and scope of the Tin Shui Wai project operations but nevertheless have an impact on turbidity and bed levels.

Deposition in the Western and Eastern Temporary Channels - Existing Situation

Western Temporary Channel

7.3.40 The tidal part of the channel, the section potentially most affected by the development of the RZ, is approx. 3.0 km long and 75 m wide with a design bed level of between 0.8 mPD and 0.0 mPD. Within 1 year of being in operation, about 1 metre of sediment accumulated. The sediment was mixed livestock waste, natural sediment and tailwater silt lost during the land formation work. Livestock waste accounted for 100% of some samples taken in March and April 1991 (TELADFLOCOSS 2 June 1993). Since then the effects of the early phases of the LWCS have been realised; a significant reduction in livestock waste has helped to reduce sediment loadings in the whole of the Western Channel. Estimates of the reduction in the quantity of sediment, based on EPD data of numbers of livestock per farm are discussed in section 7.3.91.

7.3.41 Low flow interceptors along the channel have also helped to reduce sediments reaching the tidal section of the channel (Figure 7.23, refer to 7.3.109).

7.3.42 The confrontation between terrestrial flow and marine tides in the tidal section of the WTC is seasonal. During the dry season, the deposition rate in the WTC is dominated by tidal silts, the terrestrial input being minimal as flows are generally low. Fine silts and clays easily picked up into suspension from the shallow Inner Deep Bay area are deposited in the WTC and the tides work towards an equilibrium. During the wet season, high flows overcome tidal inputs and wash out recently deposited tidal silts, to establish a new 'wet season equilibrium'. Then, during the dry season, the tide reworks sediments back into the channel until a 'dry season equilibrium' is re-established.

7.3.43 These equilibria are more affected by atmospheric weather conditions like storms whipping up Inner Deep Bay causing extreme turbidity, or by torrential rains washing out all channel deposits, than by sediments from terrestrial inputs. These conditions influence channel maintenance programmes and the need, if any, for dredging. The tolerable sedimentation level in the WTC is estimated at 0.5 m. Above this level, dredging would be required in order to avoid flooding in the event of a 1 in 50 year flood. Wet season rains are anticipated to some extent to 'self-dredge' the channel. If sedimentation levels at the end of the dry season do not exceed 0.5 m, then dredging could be avoided altogether.

7.3.44 Figure 7.14 shows water levels under different bed level scenarios and Figure 7.15 shows water levels in an unlined and lined WDCE.

7.3.45 Bed levels surveys of the WTC have been carried out by Acer Consultants (Far East) Ltd[5] in Sept/Oct 1995 in the pre- and post-wet season. The difference in bed levels gives a good indication of sedimentation rates in the channels. By simple subtraction of post- from pre-wet season bed levels, areas of deposition and scouring can easily be identified.

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[5] Information from the Phase III Sedimentation Study has been presented by courtesy of DSD and Acer Consultants (Far East) Ltd. The final reports are yet to be issued.

7.3.46 Figure 7.16a shows greatest deposition occurs in the lower reaches of the WTC between CH 2500 m and 3500 m, with a maximum of 1 m deposited between CH 3000 m and CH 3500 m as a result of dominant tidal silts being washed in from Inner Deep Bay.

7.3.47 Between CH 500 m and CH 1200 m erosion occurred up to 0.7 m.

7.3.48 Figure 7.16b shows a **net** deposition over the whole channel of 0.1 m - 0.15 m.

7.3.49 Sediment/bed levels affect water levels and in turn flood-risk.

Eastern Temporary Channel and Tin Shui Wai Creek

7.3.50 Figure 7.17 a and b show that the ETC has incurred net deposition over the whole channel area surveyed with bed levels increasing by as much as 0.75 m - 1.0 m between CH 2400 m and CH 3100 m.

7.3.51 The ETC is protected by tidal gates at its downstream end, preventing tidal flows and sediments from entering the channel. High siltation rates downstream of the hydraulic gates do not adversely affect flood levels, as bank levels are sufficiently high. Water levels higher than bank level would indicate high volume, flood situations, and hence high velocities followed by erosion.

7.3.52 Figure 7.18 a and b showing the Tin Shui Wai Creek (or 'Link' channel as referred to by Acer Consultants Far East Ltd), indicates net deposition over the whole of the channel studied.

Sediment Characteristics

Physical Sediment Characteristics

7.3.53 Sediment distribution varies around Deep Bay according to tidal flows, particle size, bathymetry and bed shear stresses. Figure 7.19 shows sediment particle size distribution in Deep Bay for clays, silts, sands including and excluding shells. These figures show the sediments at the mouth of the WTC, and the mudflats, are characterised by 60% silts, 20-30% clays and less than 5% for sand including shell fragments and less than 5% sand excluding shell fragments (Binnie & Partners and Shankland Cox 1985).

<u>Sediment particle size</u>

7.3.54 As part of the Phase III Sedimentation Study being carried out by Acer Consultants (Far East) Ltd, samples were collected at the mouth of WTC for particle size analysis. Three samples were collected from each grab location, a variety of depths were recorded to a maximum of 1100 mm and particle size analyses were carried out (refer to Appendix D1 Table D.1 and Figure 7.11 for sampling locations). All samples were dominated by particle sizes of less than 63 μm (ie. in the silts and clays bracket) and therefore would be easily picked up into suspension with low bed shear stresses.

7.3.55 Particle size analysis from sediments in Inner Deep Bay (station DS1) also show similar particle sizes to that found in the WTC sample location (refer Appendix D1 Table D.2 Source: courtesy of EPD).

7.3.56 Bed shear stresses (dependant on particle size and flow velocities) help to describe this distribution of sediments. Generally where the bed shear stress is less than 0.2 N/m^2 only coarse silt, fine sand and fluid mud may be moved. In the range of 0.2 to 0.5 N/m^2 medium sand may be mobilised, whilst a bed shear stress of 0.5 to 1.0 N/m^2 will generally move coarse sands. When bed shear stress is in the range 1.0 to 2.0 N/m^2 the very coarse sand fraction may be mobilised, whilst stresses in excess of 2.0 N/m^2 are required to move gravel fraction along the bed. The Tin Shui Wai sediments consist predominantly of the 0.02 - 0.30 μm particle size range silts and clays: presently bed shear stresses in this area are 0.3 N/m^2 (refer to Figure 7.20). A small change in flow velocities, and therefore bed shear stresses, could result in a redistribution/erosion of sediments in Inner Deep Bay. A significant change in flow velocities could result from the cumulative effect of development, causing a levelling off of deposition on the mudflat areas or even erosion of the mudflats, leading to deeper and wider incised channels.

7.3.57 In 1984 Binnie & Partners and Shankland Cox undertook a comprehensive survey during the Environmental Impact Assessment of the Land Preparation Aspects for the Tin Shui Wai Development Project. Data collected provided an adequate description of the hydrology of Deep Bay and the geochemistry of its sediments. Some of the results of the survey are given below.

7.3.58 The characteristics of the sediment in terms of particle size appear to influence the sediment chemical concentrations according to chemical type.

7.3.59 Concentrations of the heavy metals were generally lower in the sand fraction than those found in the mud fraction. It is likely that the concentrations found in the sand fraction are close to the natural levels without the influence of industrial wastes. Because of the larger surface area to unit weight ratio of the mud fraction, as compared with the sand fraction, the former fraction will have a greater capacity for absorption of heavy metals from the water column. However, complex processes such as the influence of organic matter present in the water column, variations in the behaviour of different metals, and the phase-partitioning during the transfer of metals from the rivers (or other sources) to the marine sediments also influence the fractionation of pollutants.

7.3.60 Results showed lower levels of heavy metals at greater depths in the strata. Levels of pesticides and polychlorinated biphenyls found in the sediments at greater depths were also low.

7.3.61 The mudflat areas at the Western and Eastern outfall are predominantly silts and clays and therefore would adopt the characteristics mentioned above for the mud fraction sample and hence affect the sediment quality with regard to heavy metal concentrations.

Historical Sediment and Water Quality in the Old Western River and Rivers Flowing Through the Tin Shui Wai RZ

7.3.62 Prior to the Tin Shui Wai land reclamation operations of 1988-1991 the Old Western River, along with the Middle River, Side River, Tai River (now the ETC) and upstream rivers of Hung Shui Kiu, Ha Tsuen Stream and the Lo Uk Tsuen stream drained the whole Tin Shui Wai drainage basin (Figure 7.10).

7.3.63 A study carried out in 1985 by Binnie & Partners called 'Deep Bay Water Quality' included site visits and sampling at various locations on each river (Figure 7.10).

7.3.64 A general description of the water quality of each sampling location was summarised as follows:

<u>Station A - Old Western River</u>

7.3.65 "... 100 m behind the sluice gate was choked with water hyacinth and was virtually stagnant. During high tide slight inward leakage of saline water occurred. The stream water was black, slightly turbid and had a strong odour".

<u>Station B - Middle River</u>

7.3.66 "... during sampling a decomposing pig and a number of discarded parcels, possibly of dead poultry, were seen floating amongst the water hyacinth. The water was black, slightly turbid and exhibited a strong odour".

<u>Station C - Tai River</u>

7.3.67 "... several small factories upstream of the sampling point. These included die casting, paper-processing, zinc-plating, canning and cotton-processing works. There is also a chemical factory. The water was shallow, foul-smelling, greyish, turbid and with the occasional appearance of rising pink sludge".

7.3.68 Stations D, E, F and G showed similarly black/greenish/greyish, turbid and foul smelling odours.

7.3.69 Samples were taken from all stations and analysed but for the purpose of this report only data from Station A, B and C are included. Station A reflects the Old Western River and B and C are the samples most closely representing the present ETC.

7.3.70 The Tables 7.9 and 7.10 include data from sampling carried out in 1972 and 1980 (refer Figure 7.10 for sampling locations).

7.3.71 The extensive data available in-house to the consultants shows by far the worst river was the Old Tai river, now the ETC. Local factories in the area at the time consisted of die casting, paper-processing, zinc-plating, canning and cotton-processing works. There was also a chemical factory, a major contributing factor to the water quality.

Table 7.9
Summary of Statistics for Tai and Middle River, 1972 and 1980

Water quality parameter (mg/l unless otherwise stated)	Station H5 Tin Shui Wai March 1972 (n=1-2)			Station B near Tin Shui Wai April to May 1980 (n=7)		
	Average	Min.	Max.	Average	Min.	Max.
Temperature (°C)	22	21.5	23	24.2	21	27
Colour (°Hazen)	30	-	30	-	-	-
Turbidity (silica scale)	65	-	65	-	-	-
Conductivity (micromhmos/cm)	4164	3690	4638	1536	850	2000
pH	-	8.20	9.32	-	6.9	7.3
DO	-	-	-	0	0	0
Total dissolved solids	3099	-	3099	1221	850	2199
Suspended solids at 105°C	76	-	76	101	20	233
Nitrite nitrogen as N	0.03	0.024	0.044	-	-	-
Nitrate nitrogen as N	2.52	2.25	2.80	0.15	0.1	0.4
Orthophosphate as P	0.50	-	0.50	16	10	22
Total phosphate as P	0.69	-	0.69	18	11	25
BOD (total)	33	32	34	34.7	12	110.2
Cadmium as Cd	-	-	-	-	-	-
Chromium as Cr	Nil	-	Nil	-	-	-
Copper as Cu	Nil	-	Nil	-	-	-
Lead as Pb	Nil	-	Nil	-	-	-
Manganese as Mn	0.7	-	0.7	-	-	-
Mercury as Hg	-	-	-	-	-	-
Zinc as Zn	Nil	-	Nil	-	-	-
Flow (l/s)	18.9	7.9	30.0	-	-	-

n = number of samples
Source: Deep Bay Water Quality, Binnie & Partners International 1985

Table 7.10
Summary of Statistics for Western River, 1972 and 1980

Water quality parameter (mg/l unless otherwise stated)	Station H13 Mong Tseng Wai May to June 1972 (n=1-3)			Station A near Mong Tseng Wai April to May 1980 (n=7)		
	Average	Min.	Max.	Average	Min.	Max.
Temperature (°C)	27	24.5	29	24	21	27
Colour (°Hazen)	40	-	40	-	-	-
Turbidity (silica scale)	21	-	21	-	-	-
Conductivity (micromhos/cm)	4680	1201	7504	2146	870	3500
pH	-	7.00	7.59	-	7.2	7.5
DO	-	-	-	0.08	0	0.15
Total dissolved solids	5148	-	5148	1848	693	3866
Suspended solids at 105°C	21	-	21	93	11	166
Nitrite nitrogen as N	0.1	-	0.1	-	-	-
Nitrate nitrogen as N	0.3	-	0.3	0.15*	0.06*	0.3*
Orthophosphate as P	0.70	-	0.70	14	9	19
Total phosphate as P	0.91	-	0.91	16	9	21
BOD (total)	12	10	13	25.6	7.0	57.0
Cadmium as Cd	-	-	-	-	-	-
Chromium as Cr	Nil	-	Nil	-	-	-
Copper as Cu	-	-	-	-	-	-
Lead as Pb	-	-	-	-	-	-
Manganese as Mn	0.56	-	0.56	-	-	-
Mercury as Hg	-	-	-	-	-	-
Zinc as Zn	-	-	-	-	-	-
Flow (l/s)	1822	451	4122	-	-	-

n = number of samples
* Values are organic nitrogen
Source: Deep Bay Water Quality, Binnie & Partners International 1985

7.3.72 The two main polluting factors are now under a degree of control and in some instances eliminated through the following control measures:

(i) Livestock: in 1988 the LCWS was implemented, the success of which is difficult to quantify and takes time to be realised;

(ii) Polluting industries: investigations of industries in the upstream area would be useful in determining source of pollutants and contamination whether by existing industries or by *in situ* buried contaminated sediments from historically polluting industries.

7.3.73 In addition the infill of the DZ in 1988 and the 1991 land reclamation operations isolated the Old Western River changing its function from drainage of upstream watercourses and their adjacent factories and farms, to simply draining the relatively 'clean' sandfilled area of the RZ and into the WTC at chainage 3000 m - a tidal part of the river. These measures removed the source of contamination, thus providing a possible dilution factor since 1988/89.

Current Sediment Quality

7.3.74 All unsuitable material (ie. contaminated mud, organic clay and vegetation) excavated from the site during Works within the drainage channels will be disposed of in accordance with *WBTC6/92, Fill Management* which explains how the Territory's major fill resources are managed, and defines the responsibilities of the Fill Management Committee (FMC). Under the terms of *WBTC6/92,* disposal of any volume of contaminated mud will not be considered until the need for the removal of the mud has first been demonstrated. *WBTC22/92, Marine Disposal of Dredged Mud* covers the disposal of dredged mud, whether contaminated or uncontaminated, in marine disposal grounds or exhausted marine borrow pits.

7.3.75 Sampling of the sediments in the Old Western River Channel, the ETC and WTC was undertaken to determine the extent of contaminated material present.

Sampling Locations and Parameters Measured

7.3.76 As part of the on-going environmental investigations, the channel bed sediments in both the WTC and ETC were sampled at four sets of locations:

1) TSW 1, 2, 3, 4 and 5 during February 1995 shown in Figure 7.22;

2) 60 sample locations shown in Figure 7.22;

3) Old Western River Channel (RS2 and RS3 shown in Figure 7.22);

4) 7 samples S1 to S7 shown in Figure 7.21 for elutriate analysis.

7.3.77 All samples were tested for seven priority metals (Cd, Cr, Cn, Hg, Ni, Pb, Zn) except elutriate samples from S1 to S7 which were only tested for pH, ammonia, TKN, TOC and phosphorus. In addition, 60 samples in the WTC and ETC were tested for pH and four of these samples were tested for heavy metals, pH, ammonia, TKN, TOC and phosphorus on the elutriate produced. Samples TSW1 to TSW5 were tested for PAHs and PCBs in addition to metals.

7.3.78 The sediments were classified according to the EPD's *Technical Circular No. (TC) 1-1-92* as shown in Table 7.11.

Table 7.11
Classification of Sediments by Metal Content (mg/kg dry weight)

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Class A	0.0-0.9	0-49	0-54	0.0-0.7	0-34	0-64	0-140
Class B	1.0-1.4	50-79	55-64	0.8-0.9	35-39	65-74	150-190
Class C	>1.5	>80	>65	>1.0	>40	>75	>200

All sediment results are summarised in Figure 7.22 or are in Appendix D1. Elutriate results are presented below in Tables 7.14 and 7.15.

Results

<u>Old Western River</u>

7.3.79 Samples were taken from the bed of the Old Western River in 1996 and tested for metals (refer to Figure 7.22 for locations).

7.3.80 Results for metals analysis of the samples taken from the old river bed suggest that the sediment is uncontaminated Class A material. Only 2 samples could be taken as much of the southern end of the river was covered with thick grass and reeds, making sampling near to impossible. Results are presented in Table 7.12 below.

Table 7.12
Sediment Results for the Old Western River

Sample	Cd mg/kg	Cr mg/kg	Cu mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg	Hg mg/kg	Moisture (%)
RS2	0.1	21.6	14.8	9.1	32.1	67.1	<0.2	44.0
RS3	0.1	6.3	4.3	8.4	12.4	25.4	<0.2	81.1

7.3.81 Site formation works do not require the mud from the Old Western River to be removed. In the case of contaminated ground, however, mud may need to be removed before building can proceed. The results show that the sediment in the Old Western River is not contaminated and can therefore be left in place during site formation.

Eastern Temporary Drainage Channel (ETC)

7.3.82 The current ETC, previously named the Old Tai River and subsequently the Eastern Drainage Channel (EDC) when site formation works under the current Project are complete, had the worst water quality of the old RZ watercourses and has been left relatively undisturbed during infill and land reclamation of the RZ.

7.3.83 The sediments in the ETC are nearly all Class C, contaminated with copper and zinc. Zinc results are commonly twice the Class C limit with the maximum level being 2.5 times at 580 mg/kg at station T57. Copper levels were also very high, commonly round 199 mg/kg, nearly twice the Class C limit. The area to the north by the Eastern Outfall is mainly Class B, again contaminated with copper and zinc as is the area directly by the culvert outfall. Results from TSW 4 also show Class C contamination for both lead and zinc. Results for TOC indicated only mild organic contamination with results of 2.0% TOC (see Table 7.13).

Table 7.13
Sediment Chemistry Results for Five Sampling Stations in Tin Shui Wai District (mg/kg dry weight)

	TSW1	TSW2	TSW3	TSW4	TSW5
Total Solids	55.6%	22.5%	32.0%	37.9%	40.0%
Total Organic Carbon	1.5%	4.3%	2.3%	2.0%	1.3%
Cadmium	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
Chromium	43	75	54	28	41
Copper	46	170	92	56	56
Mercury	0.2 U	0.5 U	0.3 U	0.3 U	0.2 U
Nickel	20	49	32	18	25
Lead	44	98	84	76	65
Zinc	210	740	360	250	210

Shading = Class B values
Shading/underlining = Class C values
U = undetected at the detection limit shown.

7.3.84 These sediments are left over from the original channel and the Tai Wai River and have as such been in place for many years. Pollution sources include industrial complexes including a zinc planting factory, in Kiu Tau Wai which previously drained into the Tai River. More recent sources include the runoff from car repair yards in villages to the east of the DZ and, perhaps most significantly, the livestock waste entering the channels through the low flow interceptor system.

7.3.85 The high levels of copper and zinc may be directly attributable to the activities to the south of the DZ. High levels of copper, zinc and lead are commonly associated with road runoff although the levels of lead are greatly reduced in recent years due to the introduction of un-leaded petrol. This may account for the previous Class C level for lead at TSW3 in 1995 which has now reduced to Class A. Studies (Perry et. al., 1985.) have indicated that 40-70% of metals maybe derived from highway runoff. The high levels of zinc are probably not associated with the old zinc plating works as the sediments sampled were surface sediments and therefore very recent. However, older, deeper sediment may be expected to be heavily contaminated with zinc. Animal waste can be a substantial source of copper.

7.3.86 In 1984 Binnie and Partners (HK) and Shankland Cox undertook *Evaluation of the Possible Release of Soluble Pollutants from Sediments During Dredging Operations* as *Working Paper No. 14* of the *Environmental Impact Assessment of Land Preparation Aspect* of *Tin Shui Wai Development.*

7.3.87 A number of sediments within Deep Bay and Kongsu Bank were tested according to the US Army Corp of Engineers and US EPA elutriate testing method. The tests were carried out over a wide range of salinities using standard synthetic "sea-water" and under anaerobic and aerobic conditions. Chemical analyses of each homogenised sample of sediment were undertaken as well as of the synthetic "sea-water".

7.3.88 These tests indicated clearly that considerable quantities of ammonia were released, dependent on the level of contamination of the sediment. Release of soluble organics was not measured but the contaminated sediments showed considerable absorption of oxygen particularly under aerobic conditions. Manganese was the only metal to show a significant increase in all sediments. Small increases in other metals were detected. The degree of release of ammonia from the sediments was extremely consistent through the study. Samples of sediment for testing of ammonia release must be carefully handled. For example, samples left at room temperature and not quickly tested may give misleading elutriation data.

7.3.89 Under the current study, elutriate analyses of samples S1 to S7 were carefully undertaken following the US Army Corps and USEPA elutriate method and the results are shown in Table 7.14 and 7.15 before and after blank correction. In contrast to the increase in ammonia, phosphorus decreased in most samples. Adsorption of phosphorous onto sediments is a common finding of elutriate testing. Elutriate analysis of samples T49 and T48 under the Term Contract after poor handling of the samples showed high levels of unionized ammonia (up to 9.52 mg/L at T49) while T58 also showed levels of zinc (0.06 mg/L) greater than the DBG WQO of 0.04 mg/L (ERL, BCL, 1991). These results indicated that potential ammonia and zinc pollution should be assessed for any works involving the disturbance of contaminated muds. The results of the term Contract testing can be found in Appendix D1 only as the accuracy of the results is questionable.

Table 7.14
Results of Sediment Elutriate Analysis[1]

Parameter	S1	S2	S3	S4	S5	S6	S7	Blank[2]	WQO[3]
pH (pH Units)	8.3	8.0	8.1	7.9	8.4	8.4	8.3	8.5	6.5-8.5
Salinity	8	7	8	8	7	7	6	7	--
Ammonia (mg/l As N)	18.0	25.2	20.8	12.3	14.3	12.6	13.6	9.5	--
Ammonia (Unionised mg/l)	1.76	1.31	1.34	0.51	1.73	1.52	1.35	1.40	0.02
TKN (mg/l As N)	23.0	28.4	24.6	15.6	16.0	15.1	15.7	11.4	--
TP (mg/l As P)	1.67	7.64	4.47	1.58	0.32	0.16	0.16	2.31	--

1 US Army Engineer Studies (1988) indicate that elutriate results give a conservative picture. Ammonia release may be over-estimated by an order of magnitude as compared to field studies.
2 Water taken from Eastern Temporary Channel, 1996.
3 Water Quality Objectives (Cap. 358) for Inland Waters in Study Area.

Table 7.15
Results of Sediment Elutriate Analysis - IAR Calculated Against Sample Blank

Parameter	S1	S2	S3	S4	S5	S6	S7	Blank
pH (pH Units)	-0.2	-0.5	-0.4	-0.6	-0.1	-0.1	-0.2	8.5
Salinity	-1	0	+1	+1	0	0	-1	7
Ammonia (mg/l As N)	+8.5	+15.7	+11.3	+2.8	+4.8	+3.1	+4.1	9.5
Ammonia (Unionised mg/l)	+0.36	-0.07	-0.06	-0.86	+0.43	+0.12	-0.05	1.40
TKN (mg/l As N)	+11.6	+17.0	+13.2	+4.2	+4.6	+3.7	+4.3	11.4
TP (mg/l As P)	-0.64	+5.33	+2.16	-0.73	-1.99	-2.15	-2.15	2.31

7.3.90 30% to 160% increases in ammonia in samples S1 to S7 did not necessarily indicate increases in the toxic unionized form of ammonia, due to the lowering of pH in the elutriate samples. This illustrates the importance of pH in determining the toxicity of ammonia, which is discussed later in this section. It has been noted by BCL chemists that pH has dropped in all carefully supervised elutriate tests. This is consistent with 1996 pH data for Inner Deep Bay waters (Appendix D1). The change in unionized ammonia ranged from -60% to 30%. Elutriate testing may overestimate ammonia release from sediments by an order of magnitude.

Western Temporary Channel

7.3.91 The WTC is relatively clean compared to the ETC, being polluted at only three points: on the northern bend in the RZ, at the southern most section of the RZ just below the inflatable dam and at the outfall into Inner Deep Bay by the security bund as illustrated on Figure 7.21. The main contaminants are copper, zinc and chromium, especially at the bend of the channel. One Class C lead result was recorded at T4 near the southern boundary of the RZ. TSW 5, in the Western Outfall near the security bund also had sediments of Class C for copper and zinc. Results from the 1995 survey showed high TOC levels at TSW2 with levels of 4.3% (Table 7.13). Organics in the sediment were measured at levels close to the detection limit or at levels well below those which show measurable biological effects (Appendix D1).

7.3.92 There is gross pollution above the inflatable dam in the DZ caused by discharges from the various industrial estates to the south of the DZ such as Kiu Tau Wai. A survey of the area in the 1970s (Binnie and Partners 1985) indicated several factories in the area of Kiu Tau Wai which were discharging into the Tai River, now the Eastern Temporary Drainage Culvert. A survey of the area conducted recently (1996) showed weaving factories, dyeing factories, car repair and spare parts factories, a paper mill, a canning factory and a chemical storage company which are expected to be discharging into the WDC. A zinc plating factory identified in the 1970's survey may still be in operation in 1996. Animal waste is a major source of copper.

7.3.93 Pollution near the dam may be derived from the DZ, washed over during heavy rainfall, or from pollutants carried in on the tide from Deep Bay, dropping out on the slack tide by the dam. Pollution at the outlet is almost certainly derived from Deep Bay and the Shenzhen River although there may be considerable contribution from the farms on either side of the channel. The pollution at the bend of the channel may be carried in on the tide and drop out in the relatively slow moving water on the inside of the bend or from drainage channels from the old river and from the farms on the west bank. The high levels of chromium (including one Class B lead and one Class B nickel) found only in the WTC indicates that the pollutants have a different source from those in the ETC. The high chromium may be from a tanning factory indicating that the majority of the pollution is derived from the drainage channels to the north-west.

7.3.94 As part of the Sedimentation Study conducted by Axis Environmental Consultants Ltd, core samples were taken from near the Western Outfall and analysed for metals, nutrients and organics as shown below in Table 7.16.

Table 7.16
Sediment Results of Core Samples Collected from near the Western Outfall for the Sedimentation Study

Station	Depth mm	Cd mg/kg	Cr mg/kg	Cu mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg	Hg mg/kg	NH_3 mg/kg	TKN mg/kg	TP mg/kg	TOC % w/w
11	135	0.1	21.1	13.5	2.4	42.5	53.6	<0.2	36	947	543	1
11	405	0.1	19.2	10.5	8.9	55.5	40.7	<0.2	29	589	196	0.25
11	675	0.1	19.3	14	8.7	45	39.8	<0.2	7	467	209	0.25
11	935	0.1	18.8	12	8.1	40.3	37.8	<0.2	2.5	419	157	0.2
12	135	0.6	126	115	53.5	71.5	422	<0.2	170	2,250	1,880	2.3
12	405	0.5	39.4	27.2	20	50.6	89	<0.2	129	911	662	0.9
12	675	0.05	7.5	40.8	4.3	28.1	19.3	<0.2	18	154	81	0.25
13	145	0.3	28.6	26.5	15.2	59	94	<0.2	86	905	746	1.2
13	435	0.2	21.1	15.6	11.4	49.7	56.2	<0.2	24	459	531	0.6
13	725	0.2	19.7	38.5	16.4	37.4	215	<0.2	33	449	220	0.7
13	1,005	0.1	20.3	15.4	10	43.4	51	<0.2	74	631	196	0.8
14	145	0.1	9.7	9.8	5.2	19.9	29.6	<0.2	15	201	138	0.25
14	435	0.1	19	11.6	9.36	45.4	42.4	<0.2	51	784	380	1
14	715	0.1	18.7	9.3	8.3	48.9	38.1	<0.2	37	609	179	0.1

Source: Courtesy DSD and Acer Freeman Fox, 1996.

7.3.95 The results obtained from the Sedimentation Study (Axis 1996) showed sediment samples at the Western Outfall were Class A for metals except for one sample which showed Class C for metals in the surface layer (Table 7.16). All samples were seriously contaminated with ammoniacal nitrogen, TKN and phosphorus indicating that the majority of the major pollutants in the WTC are nutrient derived. This confirmed the result of the present studies. TOCs measured for the Sedimentation Study and for this study show organic carbon levels to be fairly low but nitrogenous oxygen demand of the disturbed sediments could be very high.

7.3.96 Samples of water taken from the WTC during 1996 showed Total Kjedahl Nitrogen levels from 3 to 16 mg/l, total ammonia levels from 2 to 14 mg/l, calculated unionized ammonia levels from 0.01 to 0.54 mg/l, copper levels from 4 to 50 μg/l, zinc levels from 25 to 390 μg/l and total phosphorous levels of 1 to 4 mg/l.

7.3.97 The source of this nutrient enrichment is most probably from the farms to the west of the RZ and upstream of TSW. Levels of unionized ammonia were mostly above ecotoxic levels, with a mean value of 0.1 mg/l unionized ammonia. Chronic levels of unionized ammonia have been set by EPA as 0.035 mg/l.

7.3.98 The unionized ammonia levels in the water taken from the ETC which was very high at 1.4 mg/l unionized ammonia due to a high pH value of 8.5. Rivers and streams in the New Territories commonly have total ammonia levels in the range 5 to 20 mg/l. The source for ammonia in the ETC is unclear but is most likely to be the bottom sediments.

7.3.99 These results indicate that impacts related to ammonia should be carefully assessed for any works in the channels. Existing high ammonia levels not be much affected by dredging or other works but cumulative effects should be considered.

7.3.100 No metals were detected during extraction of the sediments which indicates that the release of toxic metals should not be a major impact during channel works (Appendix D1).

Livestock Waste Control Scheme (LWCS)

7.3.101 The Government continues to encourage livestock farmers to adopt farming practices that generate very little or no wastewater for disposal to a watercourse. In June 1988, keeping of livestock in Urban Council areas and new towns in the New Territories was prohibited under the LWCS. In addition, Phases I and II of the LWCS were completed in June 1993, covering the whole of the Northwest New Territories. Interim enforcement has resulted in a significant reduction in the number of active farms in the region (refer to Table 7.17).

7.3.102 Farmers who opt for a farming system which requires a discharge have to meet a programme of discharge standards over a specified period, namely 3 years. At the end of the three year period, effluents must meet the Technical Memorandum Standards. Within the control areas of the TSW Basin, the discharge standard will be 250 mg/L of Biological Oxygen Demand (BOD_5) and 250 mg/L of Suspended Solids (SS) from 1/7/97 to 1/7/98. This standard will be tightened to 100 mg/L of BOD_5 and 100 mg/L of SS from 1/7/98 to 1/7/99 and then finally on 1/7/99 to 50 mg/L BOD_5 and 50 mg/L of SS. Failure to comply with the control requirements will result in enforcement and prosecution action, with fines of $100,000 initially and increasing with subsequent offences.

7.3.103 Prior to the LWCS, there were some 1400 farms within the boundaries of the Tin Shui Wai drainage basin, mainly with chicken and/or pig livestock. The largest farms lie due west and northeast of the RZ in relatively close proximity.

7.3.104 By the end of December 1995, tighter controls and successful implementation of the LWCS in all areas of the New Territories resulted in many farms collecting 100% ex-gratia payments 'after the complete cessation of business'. Approximately 1152 farms are now inactive, 250 farms active, and 11 farms reactivated (Table 7.17). Some have become dilapidated and cleared, approximately 900 opting to cease business, collecting the payments offered by the Government and others struggling to comply with new legislation covering necessary waste treatment facilities.

Table 7.17
Status of Farms in North West New Territories Draining into Inner Deep Bay (1995)

	Active	Inactive	Reactivated
Tin Shui Wai	249	1152	11
Yuen Long	116	331	0 (excluding U2 and U3)
Kam Tin	445	2067	44
Fairview Park	45	98	0
STR	234	556	0
SPH	388	1641	17
RBS	11	73	2
TOTALS	1488	5918	74

Source: Data supplied by courtesy of EPD Local Control Office.

7.3.105 Using EPD data from end of December 1995 of the numbers of chickens and pigs on each farm in the Tin Shui Wai, Yuen Long and Kam Tin drainage basins, total waste production can be calculated (as shown in Table 7.18) and hence sediment reductions estimated.

Table 7.18
Livestock Waste Production for each Drainage Basin

	Active Farms			Inactive Farms		
	chickens kgs/day	pigs kgs/day	Total	chickens kgs/day	pigs kgs/day	Total
Tin Shui Wai	10,056	47,964	58,020	53,763	102,211	155,974
Yuen Long	450	1,156	1,606	5,311	9,792	15,103
Kam Tin	86,314	80,700	167,014	95,023	151,373	246,396
			226,640			417,473

Source: EPD data, December 1995

7.3.106 These figures are based on EPD figures of average rate of waste production per livestock of:

Pig	=	1.8 kg/day
Chicken	=	0.085 kg/day.

A total from all three drainage basins shows 226,640 kg/day from the active farms after December 1995 compared to 644,113 kg/day prior to this date, a 60% reduction in waste. Much of this waste finds its way into watercourses and drains into Inner Deep Bay.

7.3.107 In Tin Shui Wai at the end of December 1995, approximately 48,500 kg/day livestock waste was produced from areas west and northeast of the RZ and some 9,500 kgs/day produced from farms south of the inflatable dam in the Tin Shui Wai basin. This is a reduction of approximately 72% from the 214,000 kg/day being produced when all farms were active.

7.3.108 The *cumulative* effect of this programme will be a significant decrease in sediment load from all rivers draining into Inner Deep Bay. This will subsequently slow down deposition of sediments and alter sediment type/quality onto the mudflats. This effect, coinciding with development in the region, may have an overall neutral effect in terms of sediment from terrestrial inputs.

Interception of Low Flows

7.3.109 The heavily polluted low flows in the rivers and streams upstream of Tin Shui Wai Landholding are diverted by low flow interceptors into sewers and delivered to the Ha Tsuen Pumping Station (Figure 7.23). From Ha Tsuen Pumping Station, the low flows together with sewage are pumped to a preliminary treatment works near San Wai. The effluent is disposed of via a tunnel through the Castle Peak Range and a sea outfall into Urmston Road. During storms the capacity of the low flow system is exceeded and all flows drain directly to Deep Bay. The flow into the low flow system is controlled by penstocks at each interceptor. During rainstorms and surge tides, the system is prevented from surcharging by float-controlled flap valves which are set to close when the water level reaches +2.55 mPD. The low flow system was sized to intercept flows in the rivers and streams about 95% of the time. In practice the capacity of the low flow system will be exceeded on average 3 times in a dry season and 30 times in a year.

7.3.110 The low flow system was designed to operate automatically. The only manual operation required is the daily raking of the trash screens protecting the inlets to the low flow system. The low flow system was designed to accept a maximum inflow of 2 m^3/s.

7.3.111 At present the low flow system is inspected and maintained by DSD and RSD. RSD is required to check and remove accumulation of debris at trash screens and weir overflows. DSD is responsible for inspection and maintenance of float controlled flap valves to prevent storm flows entering and surcharging sewers. The inspection and maintenance of other components of the low flow system are also carried out by DSD.

7.3.112 The low flow system installed in the upstream region of the Tin Shui Wai drainage basin is observed to function effectively provided maintenance is adequate (see end of Section 6.6).

Amenity Water Scheme

7.3.113 The amenity water scheme was designed to reduce the visual impact of the wide Western Drainage Channel (WDC) upstream of the inflatable dam by covering the drainage channel with amenity water which would be suitable for secondary contact (not for swimming), be of low turbidity to improve its appearance, and would not harbour mosquitoes which could create a nuisance and health hazard.

7.3.114 Several design options were considered and the selected option was to retain the existing amenity water scheme, without extension into the WTC.

Ecotoxicology of Ammonia-nitrogen

Introduction

7.3.115 This section provides a summary of information presented in the US Environmental Protection Agency document "Ambient Water Quality Criteria for Ammonia (Saltwater) - 1989" (US EPA 1989).

7.3.116 Ammonia is of relatively high toxicity to aquatic organisms and can enter aquatic systems through discharges from industrial, municipal and agricultural activities. In aqueous media, the ammonium ion dissociates to un-ionized ammonia and the hydrogen ion. The equilibrium equation can be written:

$$H_2O + NH_4^+ \rightleftarrows NH_3 + H_3O \qquad (1)$$

7.3.117 The total ammonia concentration is the sum of the unionized form (NH_3) and the ionized form (NH_4^+). Ammonia-nitrogen (NH_3-N) is a form of total ammonia that is measured analytically in aqueous solution.

7.3.118 The toxicity of aqueous ammonia to aquatic organisms is primarily attributable to the un-ionized form, the ammonium ion being less toxic (Armstrong et al. 1978; Chipman 1934; Tabata 1962; Thurston et al. 1981; Wuhrmann et al. 1947; Wuhrmann and Woker 1948). It is necessary, therefore, to know the percentage of total ammonia which is in the un-ionized form in order to establish the corresponding total ammonia concentration toxic to aquatic life. The percentage of un-ionized ammonia (%UIA) in aqueous solution can be calculated based on Whitfield's (1974) stoichiometric model if the salinity, temperature and pH are known, using the following equation:

$$\%UIA = 100[1 + 10\ (X + 0.0324\ (298\text{-}T) + 0.0415\ P/T - pH)]^{-1} \qquad (2)$$

where

P = pressure = 1 ATM for all toxicity testing reported here
T = temperature (degrees Kelvin)
X = pK^s_a or the stoichiometric acid hydrolysis constant of ammonium ions in saline water based on I,
I = $19.9273\ S\ (1000 - 1.005109\ S)^{-1}$

where

I = molal ionic strength of the sea water
S = salinity (g/kg or ppt)

7.3.119 The major factors influencing the degree of ammonia dissociation are pH and temperature, which both correlate positively with un-ionized ammonia. Salinity, the least influential of the three water quality factors that control the fraction of un-ionized ammonia, is inversely correlated. Ammonia is therefore less toxic in marine waters.

7.3.120 Using data derived from its own ammonia toxicity studies and that from other investigations, the US EPA developed national water quality criteria for ammonia in salt water. They established guidelines which takes into account both short-term (acute) and longer-term (chronic) toxicity test results on a variety of test organisms (US EPA 1986). These acute and chronic toxicity test results are summarized in the following sections.

Acute and Chronic Toxicity to Marine Organisms

7.3.121 Toxicity to aquatic life generally is expressed in terms of acute (short term) and chronic (long term) effects. Acute toxicity refers to effects occurring in a short time period: often death is the endpoint. Acute toxicity can be expressed as the lethal concentration (LC) for a stated percentage of organisms tested (e.g., the LC50 is the concentration lethal to 50% of the test organisms), or the reciprocal, which is the tolerance limit of a percentage of surviving organisms. Acute toxicity for aquatic organisms generally has been expressed for 24 to 96-hour exposures (US EPA 1986).

7.3.122 Chronic toxicity refers to effects through an extended time period. Chronic toxicity may be expressed in terms of an observation period equal to the lifetime of an organism or to the time span of more than one generation. Some chronic effects may be reversible, but most are not (US EPA 1986).

7.3.123 The US EPA water quality criteria document cites numerous studies of the acute toxicity of ammonia to a variety of saltwater animals, including crustaceans, bivalve molluscs and fish. The winter flounder, *Psuedopleuronectes americanus*, is the most sensitive species, with a mean acute LC50 of 0.492 mg/L. The mean acute sensitivity of 88 percent of the species tested is within a factor of 10 of that for the winter flounder. Fishes and crustaceans are well represented among both the more sensitive and more resistant species; molluscs are generally resistant.

7.3.124 Chronic toxicity data for ammonia cited in the US EPA water quality criteria document include tests on both freshwater and saltwater species of aquatic organisms. In the mysid *Mysidopsis bahia* life-cycle test, adverse effects were observed at 0.331 mg un-ionized NH_3/L but not at 0.163 mg/L. In the early life-stage test with inland silversides, *Menidia beryllina* adverse effects were observed at 0.074 mg un-ionized NH_3/L but not at 0.050 mg/L.

US EPA National Water Quality Criteria for Ammonia

7.3.125 EPA's water quality criteria for ammonia specify concentrations which, if not exceeded, are expected to support an organic ecosystem suitable for the higher uses of water. Water quality criteria are not intended to offer the same degree of protection for survival and propagation at all times to all organisms within a given ecosystem. Rather, they are intended to ensure a reasonable degree of safety for those more sensitive species that are important to the functioning of the aquatic ecosystem even though data on the response of such species to the constituent under consideration may not be available.

7.3.126 Because toxicity data typically are available only for a representative array of test organisms, a substantial safety factor is employed in setting water quality criteria to protect all life stages of the test organism in waters of varying quality, as well as associated organisms that have not been tested and that may be more sensitive to the test constituent. Application factors have been used to provide the degree of protection required. For ammonia, application factors applied to the above toxicity data resulted in an acute criteria value of 0.233 mg un-ionized NH_3/L and a chronic criteria value of 0.035 mg un-ionized NH_3/L.

7.3.127 These criteria are formally stated as follows:

"Except where a locally important species is very sensitive, saltwater aquatic organisms should not be affected unacceptably if the four day average concentration of un-ionized ammonia does not exceed 0.035 mg/L more than once every three years on the average and if the one-hour average concentration does not exceed 0.233 mg/L more than once every three years on the average."

7.3.128 It is important to note that the above criteria are expressed in terms of un-ionized ammonia concentrations. If expressed as total ammonia nitrogen, calculations must be made which requires that pH, temperature and salinity be specified, as the un-ionized fraction will vary as a function of these three parameters (as explained in paragraph 4.4). For example, at a pH of 8.4, a temperature of 30°C and salinity of 10 ppt, the US EPA one-hour average criteria value of 0.233 mg un-ionized NH_3/L corresponds to a total ammonia-nitrogen concentration of 1.16 mg/L as NH_3-N.

7.3.129 At a pH of 7.5 and a temperature of 20°C at the same salinity, conditions which could occur in the winter in Hong Kong, the 0.233 criteria value corresponds to 18.37 mg/L NH_3-N.

7.3.130 A summary table of the effect of pH and temperature on unionized ammonia concentrations is shown below:

Table 7.19
Percentage of Ammonia Un-ionized in Distilled Water

Temperature	Percentage Un-ionized at Given pH								
	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
5	0.01	0.04	0.11	0.40	1.1	3.6	10	27	54
10	0.02	0.06	0.18	0.57	1.8	5.4	15	36	64
15	0.03	0.08	0.26	0.83	2.6	7.7	21	45	72
20	0.04	0.12	0.37	1.2	3.7	11	28	55	80
25	0.05	0.17	0.51	1.7	5.1	14	35	63	84
30	0.07	0.23	0.70	2.3	7.0	19	43	70	88

* APHA, AWWA. Standard Methods for the Examination of Water and Wastewater (18th Edition, 1992).

7.3.131 This discussion shows that the levels of unionized ammonia in the channels are already above ecotoxic levels e.g. 1.40 mg/l in the water sample collected and used for elutriate tests. Dredging or other disturbance of the mud need not result in adverse impact if increases in pH levels from other works are avoided.

7.3.132 Levels of PAHs and PCBs (shown in Appendix D1) in the ETC (location TSW4) are mostly near to the detection limit or unreliable due to the variable duplicate results. Those PAHs which are detectable (Fluorene and Phenanthrene) are far below the values associated with biological effects (640 and 1380 µg/kg respectively).

Hong Kong Standards for Ammonia Levels

7.3.133 A Water Quality Objective (WQO) of 0.021 mg/l for ammonia nitrogen in the unionized form has been adopted for most waters, marine and inland, in Hong Kong. In some instances other WQOs have been used such as 0.5 mg/l of total-ammonia nitrogen for the water-courses of Tolo Harbour.

7.3.134 These WQOs are similar to those formulated for the UK Department of the Environment in 1986 and were based principally on ecotoxicological data for fish. Fish can be very sensitive to free ammonia but they are highly mobile. Extremely few studies have been undertaken on worms of any sort. It has normally been assumed that worms are less susceptible than fish. For example the nermertine worm *Cerebratulus fuscus* dies in less than two hours if exposed to concentrations of 2.3 mg of free (unionized) ammonia/l.

Current Water Quality in the Study Area

7.3.135 Deep Bay has a surface area of some 112 km^2 and a catchment of 312.5 km^2. It is shallow with an average depth of 2.9 m and is nowhere deeper than 6 m at low tide. It is an area of predominantly estuarine water with a maximum tidal range of about 2.8 m. An estimated 1.8 km^2 of intertidal mudflats are exposed at spring low tide lying on the border between Hong Kong and the People's Republic of China (PRC). Deep Bay is a complex ecosystem and probably unique in Hong Kong territorial waters, which are of commercial and ecological importance.

7.3.136 Inner Deep Bay is a spur-shaped bay east of the Pearl River Estuary, highly protected from wind and wave actions. Deep Bay receives water and sediment directly from the Dasha River in the north, from the Shenzhen River in the northeast and from the Tin Shui Wai catchment and Shan Pui River/Kam Tin River in the southeast. There is also a considerable inflow of water from the Pearl River (Figure 7.9).

7.3.137 Owing to the influence of the Pearl River discharge which varies seasonally, the salinity of the outer part of Deep Bay exhibits prominent seasonal variation. It is subject to stratification during the wet season as a result of the complex mixing occurring in the area of the Kongsu Bank described in previous studies (Binnie and Partners, 1983). The freshwater discharge from the Pearl River was periodically observed overlaying the denser waters moving north through Urmston Road resulting in stratification at the mouth of Deep Bay (EPD, 1995).

7.3.138 Inner Deep Bay is extremely shallow with good mixing characteristics and stratification is unlikely to occur in this area (Binnie and Partners 1986). This was confirmed by EPD year round monitoring data of water temperature and salinity level at surface and bottom layers. The bottom layer salinity and water temperature levels of monitoring station DM1 (Figure 7.24) were only measured in April 1987 and October 1988, as shown in Table 7.19. Inner Deep Bay remained reasonably well mixed in the wet season although the average level of salinity was less than 50% of that measured in the dry season (BCL, 1986). Salinity was fairly uniform in the main channel and dropped steadily towards the shore. EPD monitoring data from Deep Bay shows the progressive increase in salinity away from the Shenzhen river mouth, even in the dry season (Appendix D1).

Table 7.20
Water temperature and Salinity of EPD monitoring station DM1

Water Depth	April 1987		October 1988	
	Water Temp. (°C)	Salinity (ppt)	Water Temp. (°C)	Salinity (ppt)
Surface	25.7	17.93	25.0	25.07
Bottom	25.5	18.52	24.9	25.04

7.3.139 Inner Deep Bay is a semi-enclosed embayment where there is generally weaker current and hence little turbulent mixing compared to Outer Deep Bay. After the surface water is heated up by the hot air and strong sunlight, it is not readily dispersed or mixed with the cooler bottom water or the water from Outer Deep Bay, resulting in higher surface seawater temperatures. The surface seawater temperature in the enclosed embayment of Inner Deep Bay is slightly warmer than the area close to Outer Deep Bay. This trend is seen in EPD monitoring data (Appendix D1). This represents a fairly homogeneous water body without temperature stratification. A near horizontal temperature gradient is observed from Inner to Outer Deep Bay (see Appendix D1).

7.3.140 Inner Deep Bay water quality is strongly affected by the pollutants carried down the Dasha River, the Shenzhen River, the San Pui River and TSW Western channel. According to the Hong Kong - Guangdong Environmental Protection Liaison Group[6], Deep Bay received a daily load of more than 94 tonnes of pollutants in 1989 consisting of about 32 tonnes from Shenzhen and 62 tonnes from Hong Kong. The pollutants from Shenzhen include mainly commercial, industrial and domestic discharges while 70% of the pollutants from Hong Kong arose from livestock waste.

7.3.141 Table 7.21 show the BOD pollution loading. TSW catchment was apparently the source of 10% of the BOD loading from agricultural sources in 1989 and about 7-8% of the total BOD loading.

Table 7.21
Pollution Loadings Entering Deep Bay from Its Catchments (1989)[6]

Catchment	Pollution Loading, BOD (kg/day)				
	Industrial	Commercial	Agricultural	Domestic	Total
South West Catchment	0	-	2,512	467	2,979
Tin Shui Wai Catchment	129	-	5,258	1,689	7,076
Yuen Long - Kam Tin Catchment	753	-	17,121	6,355	24,229
Shenzhen River Catchment (Hong Kong side)	1,699	-	22,115	4,651	28,465
Shenzhen River Catchment (Shenzhen side)	322	11,860	-	7,740	19,922
North West Catchment	678	6,540	-	5,160	12,378

7.3.142 As part of its role in monitoring and protecting the marine environment, EPD has carried out routine water quality surveys throughout the Territory's waters since 1970s. Water quality monitoring of Inner Deep Bay commenced in 1976 in three monitoring locations (Figure 7.24). The EPD water quality database for the years 1976 to 1996 have been analyzed and presented graphically in Appendix D1.

6 *EPD Technical Report on the Environmental Protection of Deep Bay and its Catchments,* December 1992.

7.3.143 EPD has also regularly monitored river water within the TSW basin at TSR1 and TSR2. TSR1 lies in the amenity water scheme area, upstream of the inflatable dam but downstream of the major crump weir. TSR2 lies on the Hung Shui Hang where it crosses the Yuen Long Highway.

7.3.144 In addition to EPD's data, a data-base for water quality has been collected from this and other concurrent studies in the study area. Data in Appendix D1 include river water data collected in Hong Kong and China during 1996 for EPD's Deep Bay Modelling Study, and marine water quality data collected over two tidal cycles during the wet and dry seasons at six stations in Deep Bay and 3 stations nearby simultaneously. Water quality data in the TSW WTC were also collected under DSD's Sedimentation Study.

7.3.145 Tables 7.22 to 7.24 summarize 1995 and 1996 data in the water-bodies of most concern under this EIA.

7.3.146 The ecological studies undertaken for this assignment indicated that a very severe decline in organisms which form the food supplies for birds using the Inner Day mudflats occurred in 1996. At the end of 1996, these organisms were at extremely low levels (Section 9: Ecology, Figures 9.5 to 9.10).

7.3.147 The corresponding water quality data was not available until very late in the EIA study period. It indicates a serious deterioration in water quality in Inner Deep Bay during 1996.

7.3.148 Dissolved oxygen (DO) levels at EPD's marine water quality monitoring station DM1 were below 1 mg/l for 3 consecutive sampling occasions in 1996, in June, July and August. DO levels often drop at DM1 about this period of the year but these were long sustained periods with the lowest readings recorded as a sequence since data has been available i.e. 1986.

7.3.149 The annual average 5-day Biochemical Oxygen Demand (BOD) at DM1 was 9 mg/l in 1996. This is more than double the annual average in any year since 1976 with the exception of 1982 (5½ mg/l).

7.3.150 At DM2, water quality is normally better than DM1 but the same patterns were seen. DO levels of less than 2 mg/l have only been recorded 3 times since 1986, once in 1990 and twice in 1996. The annual average BOD was 4 mg/l in 1996. The annual averages for BOD have fluctuated between 1-3 mg/l for every other year since 1976.

7.3.151 Total Inorganic Nitrogen (TIN) levels at DM1 average 7½ mg/l over 1996. From 1986-1995 TIN levels hovered between 3 to 4 mg/l. Most of the TIN was ammoniacal nitrogen. The annual average for ammonia was 7¼ mg/l, almost double the average of any year since data has been collected, i.e. 1986.

7.3.152 *E. coli* levels were six times higher than any annual average since 1985, as might be expected from the Pearson Rosenberg curve. DM1 site offshore of the western point of the Mai Po mudflat and is principally affected by the Shenzhen River, the Main Drainage Channel for the Basin and by TSW WC. Most of the water from the Shenzhen River passes DM1. DM2 lies downstream of DM1 on the ebb tide.

Table 7.22 Summary Statistics of 1996 Water Quality of Inner Deep Bay and TSW-Western Channel*

		Inner Deep Bay at Station DM1 1996			Inner Deep Bay at Station DM2 1996			Inner Deep Bay at Station DM3 1996		
		Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Depth	(m)	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
Temperature	(°C)	16.4	24.5	31.4	16.5	23.9	31.3	17.3	24.1	31.1
Current	(m/s)	-	-	-	-	-	-	-	-	-
Salinity	(ppt)	2.00	13.71	26.71	2.00	17.53	28.90	2.55	19.71	32.10
Conductivity	(uS/cm)	-	-	-	-	-	-	-	-	-
Turbidity	(NTU)	10.0	69.4	350.0	3.0	30.0	151.0	5.6	23.9	96.2
pH		7.04	7.37	7.93	7.05	7.55	7.93	6.79	7.80	8.76
D.O.	(mg/L)	0.12	3.48	8.30	0.59	4.71	8.63	3.58	6.98	10.25
D.O.%	(%)	1.8	43.6	119.0	8.4	59.6	105.9	41.9	91.2	139.0
SS	(mg/L)	11.0	97.2	320.0	5.0	49.3	150.0	7.6	25.0	91.0
BOD_5	(mg/L)	1.4	9.0	19.8	0.1	4.1	12.6	0.3	2.3	7.2
COD	(mg/L)	-	-	-	-	-	-	-	-	-
Total $NH_4(N)$	(mg/L)	2.40	7.28	13.00	1.70	4.47	8.40	0.12	1.22	3.70
Free NH_3 (calc)	(mg/L)	0.03	0.09	0.15	0.03	0.10	0.27	0.01	0.04	0.14
$NO_3(N)$	(mg/L)	0.01	0.20	0.57	0.03	0.32	0.61	0.16	0.43	0.98
$NO_2(N)$	(mg/L)	0.01	0.08	0.17	0.03	0.14	0.20	0.03	0.16	0.48
Total Oxidised N	(mg/L)	-	-	-	-	-	-	-	-	-
TKN-sol.	(mg/L)	2.40	8.79	15.00	2.00	5.62	10.00	0.28	1.52	4.40
TKN-total	(mg/L)	2.4	10.0	18.0	2.1	6.5	11.0	0.4	1.9	6.2
TN	(mg/L)	2.8	10.3	18.0	2.7	6.9	11.3	0.9	2.5	7.2
TIN	(mg/L)	2.8	7.6	13.0	2.3	4.9	8.5	0.5	1.8	4.7
TOC	(mg/L)	-	-	-	-	-	-	-	-	-
TIC	(mg/L)	-	-	-	-	-	-	-	-	-
TC	(mg/L)	-	-	-	-	-	-	-	-	-
SiO_2	(mg/L)	0.1	7.7	13.0	1.8	5.6	9.5	0.2	2.9	8.2
TS	(mg/L)	-	-	-	-	-	-	-	-	-
TVS	(mg/L)	1.4	14.9	32.0	1.0	8.5	29.0	1.4	4.6	18.0
$PO_4(P)$	(mg/L)	0.25	0.82	1.60	0.25	0.58	0.90	0.04	0.18	0.51
TP-sol.	(mg/L-P)	0.26	0.96	1.60	0.27	0.67	0.95	0.07	0.26	0.65
TP	(mg/L-P)	0.48	1.50	2.40	0.34	0.97	1.90	0.10	0.38	1.10
Chlorophyll-a	(mg/m^3)	-	-	-	-	-	-	-	-	-
E.coli	(No./100ml)	1500	318067	1100000	700	69933	430000	4	904	6500
F.coli	(No./100ml)	2000	410358	1300000	800	93733	530000	5	1153	9000
B	(ug/L)	-	-	-	-	-	-	-	-	-
Secchi Disc	(m)	0.1	0.3	0.7	0.2	0.5	1.0	0.3	0.7	1.5
Chy	(ug/L)	1.2	12.1	48.0	1.0	29.8	170.0	0.5	33.6	180.0
Phea.	(ug/L)	2.90	17.92	84.00	1.60	19.26	67.00	0.90	16.17	77.00
WQI		-	-	-	-	-	-	-	-	-
TCYN	(mg/L)	-	-	-	-	-	-	-	-	-
Detergent	(mg/L)	-	-	-	-	-	-	-	-	-
Oil	(mg/L)	-	-	-	-	-	-	-	-	-
Sulp.	(mg/L)	-	-	-	-	-	-	-	-	-
H_2S	(mg/L)	-	-	-	-	-	-	-	-	-
SSP	(mg/L)	-	-	-	-	-	-	-	-	-
F^-	(mg/L)	-	-	-	-	-	-	-	-	-
Cl^-	(mg/L)	-	-	-	-	-	-	-	-	-
Dissolved Cu	(ug/L)	-	-	-	-	-	-	-	-	-
Total Cu	(ug/L)	-	-	-	-	-	-	-	-	-
Fe	(ug/L)	-	-	-	-	-	-	-	-	-
Cd	(ug/L)	-	-	-	-	-	-	-	-	-
Pb	(ug/L)	-	-	-	-	-	-	-	-	-
Zn	(ug/L)	-	-	-	-	-	-	-	-	-
Cr	(ug/L)	-	-	-	-	-	-	-	-	-
Mn	(ug/L)	-	-	-	-	-	-	-	-	-
Al	(ug/L)	-	-	-	-	-	-	-	-	-
As	(ug/L)	-	-	-	-	-	-	-	-	-
Ni	(ug/L)	-	-	-	-	-	-	-	-	-
Hg	(ug/L)	-	-	-	-	-	-	-	-	-
Ag	(ug/L)	-	-	-	-	-	-	-	-	-

*These statistics have been prepared for the EIA from data supplied by courtesy of EPD

Table 7.22 (cont'd) Summary Statistics of 1996 Water Quality of Inner Deep Bay and TSW-Western Channel*

		Station TSR 1 in Western Channel near Area 16 1996			Station TSR 2 in upstream end of Western Channel near Yuen Long Highway 1996		
		Minimum	Mean	Maximum	Minimum	Mean	Maximum
Depth	(m)	-	-	-	-	-	-
Temperature	(°C)	20.4	26.8	33.5	18.0	28.3	35.6
Current	(m/s)	-	-	-	-	-	-
Salinity	(ppt)	-	-	-	-	-	-
Conductivity	(uS/cm)	318	590	1536	94	243	470
Turbidity	(NTU)	11.0	31.3	55.0	9.0	42.5	120.0
pH		7.39	7.90	9.07	7.78	8.46	9.59
D.O.	(mg/L)	0.33	5.22	15.58	4.01	10.01	18.14
D.O.%	(%)	4.4	65.5	219.0	49.3	132.4	265.4
SS	(mg/L)	21.0	78.8	260.0	9.9	49.2	140.0
BOD_5	(mg/L)	8.2	41.2	100.0	2.3	14.6	62.0
COD	(mg/L)	27.0	75.1	340.0	7.0	20.0	49.0
Total NH_4(N)	(mg/L)	2.70	10.76	21.00	0.30	5.72	29.00
Free NH_3 (calc)	(mg/L)	-	-	-	-	-	-
NO_3(N)	(mg/L)	0.0	0.2	0.7	0.00	1.10	2.30
NO_2(N)	(mg/L)	0.0	0.1	0.3	0.02	0.08	0.17
Total Oxidised N	(mg/L)	-	-	-	-	-	-
TKN-sol.	(mg/L)	3.6	14.7	38.0	0.5	9.4	51.0
TKN-total	(mg/L)	5.1	18.5	48.0	0.8	9.9	54.0
TN	(mg/L)	-	-	-	-	-	-
TIN	(mg/L)	-	-	-	-	-	-
TOC	(mg/L)	7.0	16.1	32.0	3.0	8.3	26.0
TIC	(mg/L)	-	-	-	-	-	-
TC	(mg/L)	-	-	-	-	-	-
SiO_2	(mg/L)	9.9	14.8	18.0	4.7	13.3	17.0
TS	(mg/L)	250.0	422.0	910.0	140.0	221.1	350.0
TVS	(mg/L)	64	108	240	54.00	73.67	110.00
PO_4(P)	(mg/L)	1	2	4	0	1	2
TP-sol.	(mg/L-P)	0.7	2.1	5.3	0	1	3
TP	(mg/L-P)	1.1	2.9	11.0	0	1	5
Chlorophyll-a	(mg/m^3)	-	-	-	-	-	-
E.coli	(No./100ml)	220000	2026667	4800000	17000	2471700	23000000
F.coli	(No./100ml)	360000	2463333	5800000	20000	2616000	24000000
B	(ug/L)	130.0	1766.4	5900.0	50.00	187.78	560.00
Secchi Disc	(m)	-	-	-	-	-	-
Chy	(ug/L)	-	-	-	-	-	-
Phea.	(ug/L)	-	-	-	-	-	-
WQI		10	13	15	7	10	14
TCYN	(mg/L)	0	0	0	0.01	0.01	0.01
Detergent	(mg/L)	0.2	0.3	0.7	0.1	0.2	0.5
Oil	(mg/L)	0.5	14.2	92.0	1	1	6
Sulp.	(mg/L)	0	0	0	0.0	0.0	0.0
H_2S	(mg/L)	0.0	0.0	0.0	0.0	0.0	0.0
SSP	(mg/L)	0	0	3	0	0	0
F^-	(mg/L)	0	1	1	0.3	0.5	0.7
Cl^-	(mg/L)	30	53	73	10	21	44
Dissolved Cu	(ug/L)	-	-	-	-	-	-
Total Cu	(ug/L)	8.0	23.5	58.0	2.0	4.1	10.0
Fe	(ug/L)	490	1021	2000	280	478	850
Cd	(ug/L)	0.1	0.2	0.8	0.1	0.1	0.3
Pb	(ug/L)	1	6	18	2	6	13
Zn	(ug/L)	20	116	360	10	33	110
Cr	(ug/L)	1	18	110	1	1	2
Mn	(ug/L)	90	185	270	50	150	500
Al	(ug/L)	150	416	990	190	388	790
As	(ug/L)	1	2	4	1	1	2
Ni	(ug/L)	12	65	320	1	3	9
Hg	(ug/L)	1	1	1	1	1	1
Ag	(ug/L)	1	1	1	1	1	1

*These statistics have been prepared for the EIA from data supplied by courtesy of EPD

Table 7.23 Summary Statistics of 1995 Water Quality of Inner Deep Bay and TSW-Western Channel*

		Inner Deep Bay at Station DM1 1995			Inner Deep Bay at Station DM2 1995			Inner Deep Bay at Station DM3 1995		
		Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Depth	(m)	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
Temperature	(°C)	16.3	23.7	31.3	16.5	23.4	30.9	16.9	23.3	30.7
Current	(m/s)	-	-	-	-	-	-	-	-	-
Salinity	(ppt)	3.53	15.92	25.10	7.08	17.02	27.82	9.33	20.68	30.93
Conductivity	(uS/cm)	-	-	-	-	-	-	-	-	-
Turbidity	(NTU)	8.8	32.2	70.0	3.5	29.8	160.0	3.5	19.3	80.0
pH		7.27	7.50	7.91	7.36	7.61	8.19	7.69	7.87	8.20
D.O.	(mg/L)	0.48	3.39	6.12	2.25	4.56	7.03	4.75	6.42	8.44
D.O.%	(%)	6.8	41.6	67.8	33.0	56.9	79.0	66.1	82.0	97.3
SS	(mg/L)	20.0	47.7	87.0	8.6	34.0	130.0	9.0	25.9	100.0
BOD_5	(mg/L)	1.0	1.8	2.9	0.5	1.3	3.5	0.4	0.9	1.3
COD	(mg/L)	-	-	-	-	-	-	-	-	-
Total NH_3(N)	(mg/L)	1.80	3.58	5.00	1.20	2.29	3.30	0.05	0.50	1.30
Free NH_3 (calc)	(mg/L)	0.03	0.05	0.10	0.02	0.04	0.05	0.00	0.01	0.04
NO_3(N)	(mg/L)	0.130	0.327	0.640	0.14	0.44	0.76	0.15	0.47	0.85
NO_2(N)	(mg/L)	0.08	0.18	0.38	0.06	0.21	0.54	0.02	0.10	0.27
Total Oxidised N	(mg/L)	-	-	-	-	-	-	-	-	-
TKN-sol.	(mg/L)	2.40	4.26	5.40	1.20	2.79	3.70	0.08	0.69	1.70
TKN-total	(mg/L)	3.1	4.9	6.2	1.3	2.9	4.0	0.2	0.8	1.9
TN	(mg/L)	3.5	5.4	6.6	2.0	3.6	4.6	0.7	1.4	3.0
TIN	(mg/L)	2.7	4.1	5.4	1.4	2.9	3.7	0.4	1.1	2.4
TOC	(mg/L)	-	-	-	-	-	-	-	-	-
TIC	(mg/L)	-	-	-	-	-	-	-	-	-
TC	(mg/L)	-	-	-	-	-	-	-	-	-
SiO_2	(mg/L)	1.3	6.8	14.0	1.0	5.9	14.0	1.2	4.1	9.4
TS	(mg/L)	-	-	-	-	-	-	-	-	-
TVS	(mg/L)	2.9	6.9	11.0	1.0	4.9	12.0	1.5	4.2	10.0
PO_4(P)	(mg/L)	0.22	0.43	0.59	0.14	0.30	0.48	0.04	0.09	0.18
TP-sol.	(mg/L-P)	0.22	0.47	0.65	0.19	0.34	0.48	0.05	0.13	0.25
TP	(mg/L-P)	0.32	0.56	0.82	0.23	0.40	0.61	0.06	0.16	0.32
Chlorophyll-a	(mg/m^3)	-	-	-	-	-	-	-	-	-
E.coli	(No./100ml)	900	20750	170000	210	1675	4000	15	863	3400
F.coli	(No./100ml)	900	26958	210000	290	2364	6100	20	1071	4000
B	(ug/L)	-	-	-	-	-	-	-	-	-
Secchi Disc	(m)	0.2	0.4	0.5	0.2	0.6	1.0	0.3	0.8	1.2
Chy	(ug/L)	0.2	3.8	14.0	0.2	2.3	8.9	0.4	1.9	6.1
Phea.	(ug/L)	0.50	2.57	7.50	0.20	1.85	8.00	0.20	1.38	6.20
WQI		-	-	-	-	-	-	-	-	-
TCYN	(mg/L)	-	-	-	-	-	-	-	-	-
Detergent	(mg/L)	-	-	-	-	-	-	-	-	-
Oil	(mg/L)	-	-	-	-	-	-	-	-	-
Sulp.	(mg/L)	-	-	-	-	-	-	-	-	-
H_2S	(mg/L)	-	-	-	-	-	-	-	-	-
SSP	(mg/L)	-	-	-	-	-	-	-	-	-
F^-	(mg/L)	-	-	-	-	-	-	-	-	-
Cl^-	(mg/L)	-	-	-	-	-	-	-	-	-
Dissolved Cu	(ug/L)	-	-	-	-	-	-	-	-	-
Total Cu	(ug/L)	-	-	-	-	-	-	-	-	-
Fe	(ug/L)	-	-	-	-	-	-	-	-	-
Cd	(ug/L)	-	-	-	-	-	-	-	-	-
Pb	(ug/L)	-	-	-	-	-	-	-	-	-
Zn	(ug/L)	-	-	-	-	-	-	-	-	-
Cr	(ug/L)	-	-	-	-	-	-	-	-	-
Mn	(ug/L)	-	-	-	-	-	-	-	-	-
Al	(ug/L)	-	-	-	-	-	-	-	-	-
As	(ug/L)	-	-	-	-	-	-	-	-	-
Ni	(ug/L)	-	-	-	-	-	-	-	-	-
Hg	(ug/L)	-	-	-	-	-	-	-	-	-
Ag	(ug/L)	-	-	-	-	-	-	-	-	-

*These statistics have been prepared for the EIA from data supplied by courtesy of EPD

Table 7.23 (cont'd) Summary Statistics of 1995 Water Quality of Inner Deep Bay and TSW-Western Channel*

		Station TSR 1 in Western Channel near Area 16			Station TSR 2 in upstream end of Western Channel near Yuen Long Highway		
			1995			1995	
		Minimum	Mean	Maximum	Minimum	Mean	Maximum
Depth	(m)	-	-	-	-	-	-
Temperature	(°C)	14.6	22.9	31.5	15.4	22.9	32.6
Current	(m/s)	-	-	-	-	-	-
Salinity	(ppt)	-	-	-	-	-	-
Conductivity	(uS/cm)	88	461	2500	32	150	308
Turbidity	(NTU)	14.0	44.0	90.0	13.0	87.6	260.0
pH		7.33	7.56	8.02	7.48	7.78	8.95
D.O.	(mg/L)	1.47	4.86	8.91	4.94	7.23	8.97
D.O.%	(%)	16.7	57.3	102.1	54.9	87.5	111.5
SS	(mg/L)	3.4	46.8	170.0	9.0	82.5	290.0
BOD_5	(mg/L)	5.4	23.2	57.0	1.8	33.1	110.0
COD	(mg/L)	11.0	39.4	140.0	6.0	39.8	110.0
Total $NH_4(N)$	(mg/L)	1.00	6.83	19.00	0.26	7.50	24.00
Free NH_3 (calc)	(mg/L)	-	-	-	-	-	-
$NO_3(N)$	(mg/L)	0.00	0.78	4.00	0.00	1.28	9.50
$NO_2(N)$	(mg/L)	0.00	0.11	0.24	0.00	0.13	0.71
Total Oxidised N	(mg/L)	-	-	-	-	-	-
TKN-sol.	(mg/L)	1.70	8.93	20.00	0.60	11.27	32.00
TKN-total	(mg/L)	2.1	10.1	25.0	0.8	12.6	36.0
TN	(mg/L)	-	-	-	-	-	-
TIN	(mg/L)	-	-	-	-	-	-
TOC	(mg/L)	3.0	15.7	74.0	2.0	15.5	40.0
TIC	(mg/L)	-	-	-	-	-	-
TC	(mg/L)	-	-	-	-	-	-
SiO_2	(mg/L)	9.7	13.5	20.0	4.5	12.0	18.0
TS	(mg/L)	120.0	278.3	490.0	56.0	254.7	650.0
TVS	(mg/L)	20.0	86.6	220.0	11.0	92.3	270.0
$PO_4(P)$	(mg/L)	0.20	0.93	2.10	0.07	0.69	1.90
TP-sol.	(mg/L-P)	0.24	1.07	2.30	0.09	0.94	3.00
TP	(mg/L-P)	0.38	1.49	4.00	0.13	1.71	5.70
Chlorophyll-a	(mg/m^3)	-	-	-	-	-	-
E.coli	(No./100ml)	140000	1464167	4400000	60000	4089667	12000000
F.coli	(No./100ml)	300000	2173333	5800000	100000	5450000	14000000
B	(ug/L)	50.0	770.8	2800.0	50.00	218.33	1200.00
Secchi Disc	(m)	-	-	-	-	-	-
Chy	(ug/L)	-	-	-	-	-	-
Phea.	(ug/L)	-	-	-	-	-	-
WQI		6	11	15	3	9	13
TCYN	(mg/L)	0.0	0.0	0.2	0.01	0.01	0.02
Detergent	(mg/L)	0.05	0.25	1.40	0.05	0.22	0.68
Oil	(mg/L)	0.50	2.05	15.00	0.50	1.14	4.70
Sulp.	(mg/L)	0.02	0.02	0.05	0.02	0.02	0.05
H_2S	(mg/L)	0.0	0.0	0.0	0.01	0.01	0.01
SSP	(mg/L)	0	0	1	0.02	0.04	0.09
F^-	(mg/L)	0.3	0.4	0.6	0.30	0.46	0.70
Cl^-	(mg/L)	21.0	41.6	62.0	10.00	19.00	39.00
Dissolved Cu	(ug/L)	-	-	-	-	-	-
Total Cu	(ug/L)	1.0	16.8	66.0	2.0	8.3	25.0
Fe	(ug/L)	130	776	1600	50	413	1700
Cd	(ug/L)	0.1	0.3	0.6	0.1	0.2	0.4
Pb	(ug/L)	3	10	22	2	14	52
Zn	(ug/L)	30	121	300	10	60	130
Cr	(ug/L)	1	2	4	0	1	2
Mn	(ug/L)	80	193	380	70	178	280
Al	(ug/L)	90	397	830	80	380	1200
As	(ug/L)	1	2	3	1	1	4
Ni	(ug/L)	3	20	120	1	5	21
Hg	(ug/L)	1	1	1	1	1	1
Ag	(ug/L)	1	1	1	1	1	1

*These statistics have been prepared for the EIA from data supplied by courtesy of EPD

Table 7.24 Summary Statistics of 1996 Water Quality from All Other Sources+

		Eastern Culvert (E.C.) Jan 96 - Mar 96	Eastern Central Culvert (E.C.C.) Jan 96 - Mar 96	TSW-E.T.C. (E.C.&E.C.C. Water) Mar-96	TSW-W.T.C. (4 sampling points over a number tidal of cycles) Mar 96, Apr 96, Aug 96		
					Minimum	Mean	Maximum
Depth	(m)	-	-	-	-	-	-
Temperature	(°C)	20.5	20.7	-	20.7	22.4	24.2
Current	(m/s)	-	-	-	0.023	0.118	1.230
Salinity	(ppt)	-	-	7.00	5.80	8.88	12.40
Conductivity	(uS/cm)	1900	600	-	1620	4359	12810
Turbidity	(NTU)	45.5 (11.0 - 121.0)	44.7 (25.0 - 70.0)	-	-	-	-
pH		6.6	7.35	8.50	7.00	7.44	7.90
D.O.	(mg/L)	6.5	8.0	-	0.13	0.28	0.49
D.O.%	(%)	-	-	-	1.5	3.2	5.7
SS	(mg/L)	110.0	45.0	-	7.0	55.3	184.0
BOD_5	(mg/L)	5.0	6.0	-	4.0	14.9	42.0
COD	(mg/L)	-	-	-	14.0	46.0	91.0
Total NH_3(N)	(mg/L)	2.3	0.4	9.5	1.70	8.35	14.10
Free NH_3 (calc)	(mg/L)	0.004	0.004	1.4	0.01	0.10	0.54
NO_3(N)	(mg/L)	-	-	-	0.010	0.132	0.840
NO_2(N)	(mg/L)	-	-	-	0.01	0.02	0.13
Total Oxidised N	(mg/L)	-	-	-	0.01	0.05	0.36
TKN-sol.	(mg/L)	-	-	-	-	-	-
TKN-total	(mg/L)	3.9	0.4	11.4	3.2	9.6	16.4
TN	(mg/L)	-	-	-	3.5	9.7	16.4
TIN	(mg/L)	-	-	-	-	-	-
TOC	(mg/L)	15.0	7.0	-	4.0	9.9	19.0
TIC	(mg/L)	23	17	-	13	36	54
TC	(mg/L)	38	24	-	19	46	68
SiO_2	(mg/L)	-	-	-	6.2	9.9	14.5
TS	(mg/L)	-	-	-	-	-	-
TVS	(mg/L)	-	-	-	-	-	-
PO_4(P)	(mg/L)	-	-	-	0.47	2.04	3.42
TP-sol.	(mg/L-P)	-	-	-	-	-	-
TP	(mg/L-P)	1	0.24	2.31	0.91	2.82	4.42
Chlorophyll-a	(mg/m^3)	-	-	-	3	17	80
E.coli	(No./100ml)	49000	13000	-	-	-	-
F.coli	(No./100ml)	-	-	-	-	-	-
B	(ug/L)	-	-	-	-	-	-
Secchi Disc	(m)	-	-	-	-	-	-
Chy	(ug/L)	-	-	-	-	-	-
Phea.	(ug/L)	-	-	-	-	-	-
WQI		-	-	-	-	-	-
TCYN	(mg/L)	-	-	-	-	-	-
Detergent	(mg/L)	-	-	-	-	-	-
Oil	(mg/L)	5.0	5.0	-	-	-	-
Sulp.	(mg/L)	-	-	-	-	-	-
H_2S	(mg/L)	-	-	-	-	-	-
SSP	(mg/L)	-	-	-	-	-	-
F^-	(mg/L)	-	-	-	-	-	-
Cl^-	(mg/L)	-	-	-	12	1269	5620
Dissolved Cu	(ug/L)	-	-	-	1.0	24.0	50.0
Total Cu	(ug/L)	-	-	-	4.0	29.6	50.0
Fe	(ug/L)	-	-	-	-	-	-
Cd	(ug/L)	-	-	-	25.0	25.0	25.0
Pb	(ug/L)	-	-	-	250	250	250
Zn	(ug/L)	-	-	-	25	83	390
Cr	(ug/L)	-	-	-	25	25	25
Mn	(ug/L)	-	-	-	-	-	-
Al	(ug/L)	-	-	-	-	-	-
As	(ug/L)	-	-	-	-	-	-
Ni	(ug/L)	-	-	-	50	50	50
Hg	(ug/L)	-	-	-	500	500	500
Ag	(ug/L)	-	-	-	-	-	-

+Data from this EIA, Interim Data from DSD's: "Sedimentation Study" and Interim Data from EPD's: "Deep Bay Water Quality Regional Control Strategy Study".
Sampling points shown on Figure 7.24.

Table 7.24 (cont'd) Summary Statistics of 1996 Water Quality from All Other Sources+

		Inner Deep Bay (variation over two tidal cycles) Station 10 Dry Season (Mar-1996)			Inner Deep Bay * (variation over two tidal cycles) Station 8 Wet Season (Aug-1996)		
		Minimum	Mean	Maximum	Minimum	Mean	Maximum
Depth	(m)	-	-	-	-	-	-
Temperature	(°C)	21.0	21.5	22.0	28.8	29.0	29.1
Current	(m/s)	-	-	-	-	-	-
Salinity	(ppt)	19.00	23.54	27.00	7.40	9.80	11.00
Conductivity	(uS/cm)	-	-	-	1360	1697	1870
Turbidity	(NTU)	-	-	-	13.5	30.2	57.0
pH		7.60	7.94	8.50	7.69	7.90	8.10
D.O.	(mg/L)	4.50	5.00	5.50	4.60	5.25	5.90
D.O.%	(%)	-	-	-	-	-	-
SS	(mg/L)	18.0	52.0	158.0	8.0	16.9	24.8
BOD_5	(mg/L)	1.3	2.3	4.5	-	-	-
COD	(mg/L)	-	-	-	15.3	19.4	22.2
Total NH_4(N)	(mg/L)	-	-	-	0.51	1.44	2.43
Free NH_3 (calc)	(mg/L)	-	-	-	0.02	0.08	0.20
NO_3(N)	(mg/L)	-	-	-	0.742	0.853	0.957
NO_2(N)	(mg/L)	-	-	-	0.23	0.28	0.30
Total Oxidised N	(mg/L)	-	-	-	-	-	-
TKN-sol.	(mg/L)	-	-	-	-	-	-
TKN-total	(mg/L)	3.0	4.2	6.5	0.7	1.7	2.6
TN	(mg/L)	3.8	4.9	7.0	1.9	2.8	3.6
TIN	(mg/L)	-	-	-	-	-	-
TOC	(mg/L)	4.2	4.8	5.2	3.5	4.0	4.6
TIC	(mg/L)	-	-	-	-	-	-
TC	(mg/L)	-	-	-	-	-	-
SiO_2	(mg/L)	4.0	5.0	6.5	3.5	4.0	4.6
TS	(mg/L)	-	-	-	-	-	-
TVS	(mg/L)	-	-	-	-	-	-
PO_4(P)	(mg/L)	0.38	0.75	1.20	0.14	0.27	0.42
TP-sol.	(mg/L-P)	-	-	-	-	-	-
TP	(mg/L-P)	0.50	0.83	1.22	0.21	0.42	0.70
Chlorophyll-a	(mg/m^3)	1	3	6	9	19	36
E.coli	(No./100ml)	-	-	-	-	-	-
F.coli	(No./100ml)	-	-	-	-	-	-
B	(ug/L)	-	-	-	-	-	-
Secchi Disc	(m)	-	-	-	-	-	-
Chy	(ug/L)	-	-	-	-	-	-
Phea.	(ug/L)	-	-	-	-	-	-
WQI		-	-	-	-	-	-
TCYN	(mg/L)	-	-	-	-	-	-
Detergent	(mg/L)	-	-	-	-	-	-
Oil	(mg/L)	-	-	-	-	-	-
Sulp.	(mg/L)	-	-	-	-	-	-
H_2S	(mg/L)	-	-	-	-	-	-
SSP	(mg/L)	-	-	-	-	-	-
F^-	(mg/L)	-	-	-	-	-	-
Cl^-	(mg/L)	-	-	-	6900	8318	9570
Dissolved Cu	(ug/L)	4.0	6.0	8.0	1.3	2.6	4.2
Total Cu	(ug/L)	8.0	10.9	18.0	2.8	5.6	9.2
Fe	(ug/L)	-	-	-	-	-	-
Cd	(ug/L)	-	-	-	-	-	-
Pb	(ug/L)	-	-	-	-	-	-
Zn	(ug/L)	-	-	-	-	-	-
Cr	(ug/L)	-	-	-	-	-	-
Mn	(ug/L)	-	-	-	-	-	-
Al	(ug/L)	-	-	-	-	-	-
As	(ug/L)	-	-	-	-	-	-
Ni	(ug/L)	-	-	-	-	-	-
Hg	(ug/L)	-	-	-	-	-	-
Ag	(ug/L)	-	-	-	-	-	-

+Data from this EIA, Interim Data from DSD's: "Sedimentation Study" and Interim Data from EPD's: "Deep Bay Water Quality Regional Control Strategy Study".
*Same position as Station 10 in Dry Season
Sampling points shown on Figure 7.24.

7.3.153 Graphs illustrating this data in Appendix D1 show annual means for the monthly analyses and the highest and lowest analyses for the year. Figures 7.25 to 7.29 show monthly plots for selected parameters.

7.3.154 Figures 7.25 to 7.28 present data plotted for each month for DO, BOD, ammonia-N and *E. coli* at Stations DM1 and DM2. Unionized ammonia-N has been calculated but care is needed in the interpretation of the data. An increase in pH of 0.2 units doubles the free ammonia. Apparent spikes of unionized ammonia-N were recorded in 1996 (Figures 7.28 and 7.29).

7.3.155 Most of the river water quality data for the period 1992-1996 is presented graphically in Appendix D1 for the Western Channel. Graphs of DO, pH, BOD, ammonia-N, copper (Cu), zinc (Zn) and oil and grease are shown in Figures 7.30 to 7.32. There is an obvious seasonal variation in the data and with the exception Zn and *E. coli* do not show any trend towards improvement. Oil and grease data show a marked deterioration in levels in recent years.

7.3.156 Dissolved oxygen levels (DO) are critical to aquatic ecosystems. DO should normally be maintained above 4 mg/l. 2 mg/l is a critical level for the survival of marine waters in Hong Kong (Reports for the Environmental Protection Office at West Kowloon - BCL 1992-1996). However the fish found in the ETC survive by using their buccal cavities to gulp and absorb atmospheric oxygen. Benthic organisms of the mud-flats can survive for a period by burying into the mud or gulping atmospheric air. Lowered DO levels are principally the result of increases in BOD (or COD) which occur from new loads of pollutants or from the release of pollutants during the resuspension of old wastes. BOD arises to a large extent from organics in livestock waste and sewerage augmented by restaurant wastes or other industries with organic waste. Oxygen demand is also created by reduced forms of nitrogen which are oxidised by micro-organisms. Nitrogenous oxygen demand has historically been considered an interference in the determination of BOD. Nitrogenous oxygen demand is almost identical to total ammonia levels. Like BOD, ammonia arises principally from livestock waste and sewerage and can be freed from sediments during their resuspension.

7.3.157 Inner Deep Bay, despite high nutrient levels, has a low frequency of red tide occurrences. The ratio of organic-N to inorganic-N can be used to estimate the active transformation of inorganic-N to organic-N by algal organisms. The 1996 ratios do not suggest the occurrence of such events in Inner Deep Bay. Chlorophyll-a data is not available for Inner Deep Bay. However benthic field staff did note the presence of higher levels than normal of green algae on the Mai Po mudflats in autumn.

7.3.158 The WC river data does suggest that eutrophic events occurred, a not unusual event, in the upper parts of the TSW drainage basin during 1996.

7.3.159 The deterioration of water quality in the Study Area in 1996, it makes critical that all potential sources of deteriorating water quality be controlled as quickly.

7.3.160 Fortunately, resuspension of ammonia laden sediments do not have much effect on toxic, free ammonia levels. Indeed, because pH goes down, levels of free i.e. unionized ammonia, may even drop. However, this situation is quickly reversed by the presence of concrete washings and can be very destructive to the Inner Deep Bay ecosystem.

7.3.161 The following sections discuss the main water quality parameters in terms of their current and past levels and potential importance in relation to works under the Project or as part of the further development of TSW.

Dissolved Oxygen (DO)

Inner Deep Bay

7.3.162 Data for DO levels in Inner Deep Bay area available for EPD's monitoring stations on a monthly basis since 1986 (Figures 7.25, 7.26 and Appendix D1). As for all parameters, DM3 has the best water quality and DM1 the worst. DM1 is most affected by discharges from Hong Kong's rivers but is not as diluted by sea-water influences as is DM2. DM3 is relatively well diluted by cleaner marine waters.

7.3.163 DO levels at DM1 do not comply with the WQOs. The annual averages hover around 4 mg/l but levels between 2½ and 4 mg/l are recorded several times every year. Levels below 2 mg/l are detected in some years, most commonly in the summer months.

7.3.164 Annual average DO levels at DM2 are always above 4 mg/l. In most years, DO levels almost comply with the WQOs. In 1996, DO levels fell well below 2 mg/l on 2 occasions with 5 readings below 4 mg/l. These are the lowest readings recorded since 1986.

7.3.165 DO levels at DM3 have always been above 4 mg/l since 1986, well within the WQOs. However, although 10% of readings can be below 4 mg/l for compliance with the WQOs, the first reading ever recorded below 4 mg/l was made in December 1996. Lower readings are more usual during the hotter months.

Western Channel

7.3.166 DO levels were principally either very low in 1996 or a very high indicating eutrophic events (Figure 7.30). A DO of 18 mg/l was recorded in 1996 at TSR2, the highest recorded since September 1992. As in 1994, when these high DO values are recorded at TSR2, DO levels downstream at TSR1 fall below 2 mg/l.

7.3.167 Against this backdrop of fluctuating DO levels, it would be difficult to assess when works under the Project and/or Development affect DO levels. However it will be essential to monitor DO levels throughout the works both in the marine environment nearby and in the two channels.

7.3.168 As the livestock waste scheme is progressively implemented, the fluctuations should diminish considerably. Lowered levels of SS and BOD arising from livestock farms should result in vastly improved DO levels. However, excessive disturbance of existing sediments, with resultant increases in BOD, COD or/and SS loads from the works coupled with similar increases from other projects in Deep Bay could result in damage to the ecosystem downstream and should be avoided.

BOD

Inner Deep Bay

7.3.169 The high BODs at DM1 in 1996 can only be due to increases in livestock waste and/or from the resuspension of sediments during the major river training works and with concomitant increase in levels of organics. A WQO of 5 mg/l has been set for the inland waters. The marine waters normally have BODs below 5 mg/l. In 1996, the annual average BOD_5 at DM1 was 9 mg/l as compared to less than 2 mg/l in 1995. The maximum BOD reading was 20 mg/l in 1996 as compared to 3 mg/l in 1995. BOD_5 levels were also comparatively high at DM2 and DM3.

Western Channel

7.3.170 It is disturbing to note that BOD_5 levels averaged 40 mg/l in 1996 at TSR1 with a maximum of 100 mg/l (Figure 7.30). This compares with an annual average of 23 mg/l in 1995 with a maximum of 57 mg/l. During 1996, the way in which the amenity water scheme was operated was changed many times and quantities of sediment were either removed from the dry channel bed or dredged.

7.3.171 Upstream at TSR2 the situation was reversed with an average of 15 mg/l in 1996 with a maximum of 62 mg/l. This compares with an average of 33 mg/l in 1995 with a maximum of 110 mg/l. TSR2 only represent a fraction of the waters received at TSR1.

7.3.172 The data for TSR1 during 1996 may be uninterpretable as corresponding information on the use of the inflatable dam and the state of the interception system is not available.

7.3.173 Consequently any measurements of BOD_5 taken for the Project need to ensure sufficient data is collected about the state of the amenity water scheme. Sufficient stations will be necessary for differentiation of sources of contamination.

TIN, Ammonia and pH

Inner Deep Bay

7.3.174 Fortunately pHs at DM1, DM2 and DM3 were generally lower in 1996 probably reflecting the drops in pH found on resuspension of ammonia-rich sediment. However, it should be noted that a pH of nearly 9.0 was recorded at DM3.

7.3.175 TIN levels were raised at all stations in 1996 (Figure 7.27, 7.28 and Appendix D1). The WQO of 0.7 mg/l is never achieved in Inner Deep Bay. However 1996 has the worst annual averages on record at all stations being 50% to 100% greater than any other annual average since 1986 at both DM1 and DM2. The TIN is made up almost entirely of ammonia. The pattern of ammonia and TIN are very similar as would be expected.

7.3.176 Unionized ammonia levels have been calculated from data on pH, total ammonia, salinity and temperature. Levels of unionized ammonia were much higher at all stations in 1996 than had been the case in 1995. However, free (or unionised) ammonia levels have probably fluctuated considerably at DM1 over the years. In 1996, DM1 recorded the longest ever recorded sustained period, 5 months, of free ammonia levels above 0.1 mg/l. In 1996, at DM2, 2 consecutive months above 0.1 mg/l were recorded, the only time since 1986. The calculated free ammonia levels were 0.23 and 0.27 mg/l, much higher levels than previously recorded. At DM3, levels above 0.1 mg/l were recorded twice in 1996. Only one other level above 0.1 mg/l has been recorded at DM3 since 1986.

7.3.177 Of great concern is the fact that levels of BOD, TIN, ammonia and free ammonia were all raised for the last set of data available for each parameter.

Western Channel

7.3.178 As would be expected, there is a marked seasonal pattern in total ammonia levels at TSR1 (Figure 7.31). Ammonia levels in 1996 were of a similar pattern to previous years. Levels start to increase in October each year reaching about 20 mg/l in January or February and then declining about June to under 5 mg/l in a good year to 5-10 mg/l in a poorer year.

7.3.179 These patterns are similar for the Shui Piu river. All the rivers have occasional readings well over 20 mg/l. Ammonia levels at TSR1 in autumn this year were double or more of those of the previous three years.

7.3.180 Monitoring and assessment of the Project should evaluate ammonia, pH and free ammonia. TIN measurements are redundant.

Turbidity and Suspended Solids (SS)

7.3.181 These parameters, while relatively high in 1996, do not appear to correlate well with ecological damage (Appendix D1). Their field of influence is relatively isolated. SS readings do not differentiate between suspension of inert material and material with high levels of soluble pollutants.

7.3.182 Both parameters however could be increased during works such as site formation and do give a measure of the degree of disturbance caused by construction works.

E. coli

7.3.183 *E. coli* levels were grossly elevated during 1996 in Inner Deep Bay (Figures 7.25, 7.26 and 7.28). This has serious implications for the food industries associated with Deep Bay such as fishing, prawn farming and oyster farming.

Heavy Metals

7.3.184 Data is not available from the EPD stations within Inner Deep Bay. Cu levels measured for the Deep Bay Modelling Study reached a maximum of 8 μg/l for dissolved copper (Cu) and 18 μg/l for total Cu in both the wet and dry seasons at the closest stations to TSW.

Western Channel

7.3.185 Cu and Zinc (Zn) can be high in the Western Channel (Figure 7.31). These metals are just below preferred levels from an ecotoxicological perspective. During channel works, their levels are likely to be slightly raised during resuspension of contaminated sediments. Their inclusion in the EM&A programme is optional.

Oil and Grease

7.3.186 Oil and grease contamination of the Western Channel was considerable in 1996 (Figure 7.32). Upstream of the TSW DZ, the water is malodorous with spots of oil and grease, especially the tributaries of the WDC where open storage areas and lorry parking exist adjacent to the watercourses. The tributary which flows through San Lee Uk Tsuen and Ha Tsuen is particularly bad.

Water Quality of Other Rivers flowing into Inner Deep Bay

7.3.187 River water quality data was collected for all the major rivers flowing into Deep Bay for the EPD's *Deep Bay Water Quality Regional Control Strategy Study* (The Deep Bay Modelling Study) in March and August 1996. The data is provided in Appendix D1, Table D.11. The Ganges River was the most polluted river.

7.3.188 Virtually all the data in Table D.11 from these rivers lie within the range found for the TSW-WC at EPD's routine monitoring stations TSR1 and TSR2. Differences in concentrations are in part due to the differences in degree of dilution by marine waters.

The Ecological Importance of Inner Deep Bay

7.3.189 The Ramsar Convention defines wetlands as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres." Thus all wetland habitats in the Deep Bay area, including man-made fish ponds and *gei wais*, mangroves, inter-tidal flats and open water areas of Deep Bay are "wetlands" under the Ramsar definition.

7.3.190 In September 1995 the Hong Kong Government designated the Mai Po/ Inner Deep Bay area as a Ramsar site. The core of the wetland is the Mai Po Nature Reserve and the Futian-Neilinding National Nature Reserve, together with 4 SSSIs within the Study Area. These areas support a variety of plants and animals (at least 19 invertebrate species new to science have been identified) and provide important habitats for waterfowl and migratory birds including a number of rare, threatened or endangered species.

7.3.191 The wetland ecosystem of Deep Bay consists of the shallow bay, mudflats, *gei wais*, mangroves and fish ponds. The wetland is of international importance and is one of the most important in the South China region. Deep Bay also supports one of the largest areas of reed beds in Southern China. The intertidal mudflats of Inner Deep Bay are fringed along the landward side by mangroves. The mangrove area, which covers some 220 ha, is the largest in Hong Kong and is one of the largest areas of protected mangrove remaining in China and is of regional conservation importance.

7.3.192 Deep Bay supports internationally important numbers of at least 18 bird species which visit the area, either during winter months, or to use the site to rest and feed during their migrations. The intertidal flats of Deep Bay are of particular importance to long-distance migratory birds as they provide rich feeding grounds which permit birds to accumulate fat quickly during stop-over periods. Disruption to feeding patterns through changes to the area and richness of the mudflat may affect the ecological value of the Bay.

7.3.193 The intertidal mudflats provide food resources for tens of thousands of migratory waterfowl to fuel their movements between breeding grounds as far north as Siberia, and wintering areas as far south as New Zealand. Numbers of birds increase and new species arrive every year.

7.3.194 Water pollution due to urbanisation, industrialisation and livestock rearing surrounding Deep Bay has threatened habitat loss and the ecological roles of the Bay.

Fish Ponds

7.3.195 Fish ponds surrounding the Study Area are an integral part of the wetland in Deep Bay. They are recognised as "wetlands" under the definition in the Ramsar Convention and can be regarded as inland habitats.

7.3.196 There has been a dramatic loss of fish ponds in the Deep Bay area during the past decade. The area of fish ponds in Deep Bay area has declined by some 34% over the past 16 years due to extensive development from 1,830 ha in 1979 (ERL, Deep Bay Management Study 1989) to 1,200 ha in 1995 (AFD).

7.3.197 A substantial reduction in fish pond area can be expected in the Deep Bay region in future, based on current development proposals by both Government and private sector. There appears to be the potential for loss of about 40% of the fish ponds on both sides of Deep Bay and this would have severe impacts on waterfowl and other wildlife, which use this habitat for feeding and breeding.

7.3.198 As a result of the Tin Shui Wai Development, some abandoned fish ponds in Area 122 and Area 123, along the WDCE will be lost due to the dualling of Road D3.

7.3.199 In response to these direct losses of habitat and the general encroachment on fish pond areas around Inner Deep Bay, this Project provides mitigation to creatively compensate by construction of a wetland in Areas 114 & 118, providing new habitats for wetland vegetation, insects and associated wildlife.

Groundwater and Geology

7.3.200 In 1984 as part of the Land Preparation Aspects over 100 wells in the region were sampled, water levels recorded and water quality tests carried out. These are compared to sampling undertaken within this EIA in 14 wells to the west and north of the RZ. In general water quality has improved in the wells sampled over the past 12 years.

7.3.201 Water quality data from groundwater samples collected in 1984 and 1996 from well locations shown in Figure 7.2 are presented in Figures 7.33 and 7.34.

7.3.202 Groundwater parameters measured before the original land formation works do not significantly differ from the same parameters measured in 1996. Sampling in each case was undertaken in March - April in both 1984 and 1996.

7.3.203 Improvements in colour, turbidity and DO can probably be attributed to the fact that most wells are now disused and probably have not been used for a number of years. The exceptions are wells 33, 34, 111 and 132 which are only partially used for washing vegetables or very small scale irrigation.

7.3.204 Survey results suggests that water levels have slightly decreased to the west of the RZ and generally increased to the north. It is anticipated that many of the wells to the east of the RZ may now have dried up with the diversion of most of the waters of the Old Tai River into the western channel. The wells outside the site area to the east have been buried by stockpiling activities and are therefore unavailable for assessment.

7.3.205 It is therefore assumed that local changes such as frequency of use and whether wells are covered are factors having more influence on groundwater levels and quality than the original land reclamation operations and changes in level which appear to be minor. The 1984 studies showed some very high *E.coli* levels in the wells with bad colour and turbidity. The practices which probably caused this pollution to appear to have mostly ceased.

7.3.206 The site is underlined by weak and highly compressible marine deposits, alluvium and rock weathered to considerable depths. Within the ponds the marine deposits are overlain by "pond deposits", the detritus from the fish and duck farming operation. The surficial material within the river courses comprised recent sediments which are generally highly polluted by agricultural wastes.

7.3.207 The pond deposits were about 300 mm to 1,000 mm thick depending on the time that had elapsed since the farmer had cleaned out the pond (generally every three or four years). The thickness of the recent river sediments was similar to the pond deposits.

7.3.208 The marine deposits, comprising silts and clays with occasional sand partings and lenses, are present over 90% of the site. The thickness of the marine stratum varies substantially across the site. In pre-existing valleys along the eastern side of the site and from west to east across the middle of the site the marine materials are up to 9 m thick and typically 5 m thick.

7.3.209 Today the RZ is covered with sand fill material dredged from Deep Bay. Checks on settlement carried out in 1992 indicated that most of the RZ had achieved 95% consolidation.

7.4 Potential Major Issues of the Project

7.4.1 The Potential Major Issues for this Project have been identified as:

1) Eastern Culvert Extension and infilling of the ETC;
2) Western Temporary Channel and Construction of Western Drainage Channel Extension; and
3) Urban Stormwater runoff.

7.5 Construction Phase Impacts and Mitigation

7.5.1 The Major Issues with potentially the most impact on water will be discussed first (as shown in Table 7.25), followed by all other construction activities anticipated to have minor impacts but which without appropriate mitigation could escalate to become major issues (Table 7.26).

Table 7.25
Summary of Potential Major Issues for Construction Phase Impacts

Major Issues	Works to be carried out	Impact	Contract(s)	Date - Duration
Eastern Culvert Extension (ECE)	Eastern Culvert Extension under road D4 south, partially infilling ETC in Areas 104, 109 and 117	Areas potentially impacted will be the TSW Creek and Inner Deep Bay, via the water column of the ETC, affecting benthos and consequently birdlife in the area.	2	Sept 1997 - Sept 1998 1 year
	75% of ETC will be filled during this period	ETC sediments are of Class C contamination. Impacts on water quality are potentially very heavy dependent on construction methodology with release of ammonia and oxygen consuming substances.	7	Apr 1999- Apr 2001 2 years
Western Temporary Channel	Paving of 500 m of the WTC immediately downstream of the inflatable dam for maintenance purposes	Impacts on water quality are potentially heavy dependent on construction methodology. Large scale disturbance of channel sediments will increase turbidity/SS and decrease dissolved oxygen levels, affecting water quality and ecology downstream; Without tight mitigation there is potential for site runoff, concrete washings or accidental spill to affect water quality; Permanent loss of benthos in construction site area.	6	Mar 1999- May 2001 2 years 2 months
Freshwater Wetland Habitat	Wetland habitat will be created in Areas 114 and 118. Deepening of ETC and construction of diversion dams and wetland channels	Increase in pH levels, suspended solids, pollutants from disturbed sediments	8	2 years 2 months Aug 2001 - Aug 2003

Table 7.26
Summary of Other Construction Impacts resulting from the Project

Minor Issues	Work to be carried out	Impact	Contract	Date - Duration
Site Formation	Levelling of RZ and relocation of stockpile material	Increase in suspended solids runoff in the receiving water bodies, affecting the hydrology and ecology of the WTC and ETC.	All contracts	Jul 1997 - Aug 2003 6 years 1 month
Site runoff	all construction works	Potential impact on all water bodies	All contracts	Jul 1997 - Aug 2003
Eastern Culvert Re-alignment	Construction of new section of Eastern Culvert under Road P2 at Junction P and removal of redundant Culvert in ETC	Potentially minor impacts during final connection of re-aligned section of culvert with the ETC	4	Oct 1998 - Feb 2001 28 months (fewer months with potential impact)
Bridge Construction	WTC vehicle bridges D3/V1 and L13/VCF1 and footbridge WC/CF5 to be constructed	Minor impact on water quality when channel sediments are disturbed. Channel sediments are Class A and therefore not expected to yield metal pollutants	8	Aug 2001 - Aug 2003 24 months
Installation of rising mains and new sewage pumping station	Installation of rising mains on the western side of the WDC and WTC. Crossing the WDC and two tributaries, by 'no-dig' method, to link new and old pumping stations	Impacts on WDC and WTC, runoff from construction activities, increasing turbidity decreasing DO.	4	Oct 1998 - Apr 2000 1 year 6 months
Construction and upgrading of roads, junctions and flyovers	Construction works related to development of road infrastructure in Study Area.	Increase in pH levels from concrete washings which affects dissociation of ammonia and hence its ecotoxicity.	3 to 8	Sept 1998 - Aug 2003 4 years 11 months
Construction of permanent drainage culverts	3 culverts will be built, 2 draining into the WDCE, and one into the ETC	Increase in pH levels and suspended solids from runoff	4 6	Oct 1998 - Apr 2000 1 year 6 months Mar 1999 - May 2001

7.5.2 Major Issues 1 and 2 are Construction Phase Impacts are discussed in Section 7.5. Major Issue 3 - Urban Stormwater Impact Assessment, is discussed under Section 7.7.

7.5.3 A description of the impacts from the construction phases of the Project will be followed by details of appropriate mitigation measures to minimise the impacts.

Eastern Culvert Extension

7.5.4 The works carried out in the Eastern Temporary Channel include the extension of the Eastern Culvert, site formation of Areas 104, 109b and 117, construction of Road D4, and construction of the North Eastern Culvert (NEC).

7.5.5 The Eastern Culvert Extension will be built as part of the engineering infrastructure (drains and sewers) for the new road D4(S) under Package II works, which forms part of the eastern perimeter of Areas 109 and 117.

7.5.6 The construction process will involve the excavation and removal of 1 to 2 metres of soft mud of varying contamination levels from Class A to C to form a trench, both within the depression that forms the ETC, and in the intermediate area.

7.5.7 The maximum volume of material to be excavated is estimated to be about 6,000 m^3. About two thirds of this material comes from the ETC, the rest is a mixture of sand fill material and marine clays. Further testing will be undertaken to confirm the volumes involved.

7.5.8 Removal of this sediment has a potential ecological impact in terms of (i) possible release of soluble pollutants; (ii) deposition of sediment downstream and in Inner Deep Bay; (iii) increase in turbidity; and (iv) decrease in DO.

7.5.9 Elutriate tests showed that metals released from disturbed sediment are negligible. Existing total ammonia levels could potentially cause serious water quality impacts, exceeding acute and chronic toxic levels in its unionized form[7]. The present quality of the ETC water is poor, with high levels of unionized ammonia having been measured (1.4 mg/l) and further increases could have serious ecological consequences. Any increase in pH due to construction washings would increase the toxicity of any ammonia present. Thus increases in total ammonia by the Project should be minimised.

7.5.10 Mitigation against toxic levels of ammonia involve reducing ammonia levels and/or reducing pH. From an evaluation of the effects of pH (Section 7.3) on unionized ammonia levels, pH runoff levels should be kept below 8.5, which is a more stringent requirement than required by the Group C or Group D inland waters standards in the TM. This mitigation is essential to protect aquatic life in the TSW channels.

7.5.11 Previous data and elutriation tests from dredging in Deep Bay (discussed in detail in BCL EIA 1984) have shown that dredging during the land reclamation works did not release environmentally significant levels of pollutants from metals to the water column.

[7] EPA 1989. Ambient Water Quality Criteria for Ammonia.

7.5.12 During much of the construction, water will continue to flow along its present course in the ETC, naturally settling out disturbed sediments from the bank works. The final section of culvert crossing the channel connecting the extension to the re-aligned culvert will require a diversion of flow. This section of the existing channel will be blocked and flows will be redirected to the downstream sections of the channel or recently constructed culvert extension. This will inevitably cause sediments to be resuspended but these will settle out in the remainder of the channel before passing through the tidal valves.

7.5.13 The work should be carried out during the dry season to ensure that high water levels due to heavy rains do not flood excavations and that contaminated mud is not washed into the surrounding watercourses. All excavation should be undertaken behind a cofferdam and precautions taken to ensure that the water and sediment behind the dam do not spill over into the remainder of the channel.

7.5.14 A major mitigation measure designed into the Project to reduce the water quality impact such as increased ammonia release has been the minimisation of the volume of sediment to be removed. An original estimated total volume of over 300,000 m^3 has been reduced by 90% through engineering design.

7.5.15 Additional mitigation involves the selection of construction methodology. With suitable removal methods, machinery and timing programmes (preferably dry season and periods of low flow) impact on the water bodies such as turbidity/sediment generation can be kept to a minimum. Most sediment disturbed through construction activities in this channel will be rapidly re-deposited close to the release point because of the low flow or dry conditions.

Infilling of the Eastern Temporary Channel

Area 104

7.5.16 The formation of Area 104 under Package I works, requires the construction of a toe slope in the ETC.

7.5.17 This involves the excavation of the relatively low shear strength soft marine clays before sand fill material is placed to act as a toe weight.

7.5.18 Fabric reinforcement is then used to cover the soft marine clays. At this stage, we estimate that about 2,000 m^3 needs to be excavated.

7.5.19 Sand fill will then be placed on top of the reinforced fabric to form a working platform for the plant and subsequent fill deposits and compaction to form the toe slope.

7.5.20 Impacts from the formation of toe slopes include sediment runoff into the cross channel leading to Deep Bay, increasing turbidity of the waters and potentially impacts on marine life. The extent of this impact was evaluated with reference to previous data.

7.5.21 Suspended solids levels during the original land reclamation operations in 1988-91 discussed earlier in this section were consistently within government Water Quality Objectives, namely less than 30% increase of ambient turbidity within Inner Deep Bay.

7.5.22 It is therefore not anticipated that construction activities in the ETC will increase suspended solids or turbidity in Inner Deep Bay by this amount as the ETC in Area 118 would act as a sedimentation pond.

7.5.23 Providing removal of contaminated mud is carried out in the dry season, there will be no impact on the ETC channel adjacent to this Area.

7.5.24 EPD has agreed in principle that this material should be taken to East Sha Chau.

7.5.25 Care taken in the removal of contaminated mud must be matched by care in the transportation of contaminated material to a dumping site. Routing of transportation vehicles shall avoid sensitive receivers in the area, as described in the Waste Chapter, Section 8.1.

7.5.26 Sensitive receivers in the area include waterbodies which are ecologically valuable such as freshwater wetlands and small water courses where the water flow is minimal and therefore dilution will not reduce the impact.

7.5.27 Loads should be covered, and seals on the tailgate of the lorries maintained in good order to prevent leakage of liquid from the mud onto the roads.

7.5.28 Disposal of the contaminated mud at East Sha Chau mud pits must follow the required operational practices for barge loading and pit dumping which are described in Works Branch Technical Circular No. 22/92 on *Marine Disposal of Dredged Mud.*

7.5.29 As part of the EM&A, additional ammonia and suspended solids sampling should be carried out downstream of work activities in the ETC during toe slope and landfill and culvert extensions, in addition to sampling stations that will be monitored throughout the Project regardless of activity.

<u>Areas 109b and 117</u>

7.5.30 Muds beneath Areas 109b, 117b and 115 will require excavation of about 5,000 m^3 of material to be disposed of at East Sha Chau.

7.5.31 Removal of contaminated mud could cause sufficient disturbance to release ammonia into the water column, potentially to ecotoxic levels. This could impact the ecological environment of the ETC and hence impact the cross channel in the absence of adequate mitigation.

7.5.32 Providing this work is carried out in the dry season, there will not be any impact on the channel into which the ETC flows. However, great care is needed during mud removal to ensure that ammonia rich leachate is not allowed to flow into the ETC, but should be allowed to drain into the landbank. This work should be undertaken behind cofferdams.

7.5.33 Impacts from removal of this mud are comparable with the impacts already described for removal of mud from the ETC.

7.5.34 Should geotechnical investigations show that the removal of mud is required, the mud should be handled with extreme care to avoid release of ammonia rich leachate into ecologically sensitive areas downstream of the ETC.

7.5.35 Good dredging practices have been described to minimise resuspension of suspended solids, including carrying the works out in the dry season when overflow into the channel can be prevented.

7.5.36 In all works involving removal of contaminated mud, the primary mitigation measures is to avoid disturbance of the mud by minimising the volumes to be removed.

North Eastern Culvert

7.5.37 Impacts from the construction of the North Eastern Culvert (NEC) under Road D4 will also require removal of a small volume (about 2,000 m^3) of mud.

7.5.38 Mitigation against potentially harmful impacts on the ecologically sensitive receiving waters from increased suspended solids and ammonia levels from the mud, combined with high pH values which may result from construction washings, include the measures described in previous sections.

Western Drainage Channel Extension

500 m paving downstream of the inflatable dam

7.5.39 The Package II works on the WDCE includes the dredging (of 0.5 m depth) and paving of 500 m of the Channel downstream from the inflatable dam. This work will involve no major structural changes to the WTC; no realignment, no change in channel shape, no change in bed level or side gradients. However it is expected that about 4,000 m^3 of mud will be excavated from the Channel most of which has been shown to be of Class A metals levels. This will involve removal of mud with potential impacts downstream of resuspended solids and release of pollutants from possibly contaminated material.

7.5.40 In particular, an increase in pH from concrete workings, will increase the toxic component of ammoniacal nitrogen, i.e. the unionized ammonia fraction. Release of ammonia from contaminated mud could potentially impact ecological resources, through a decrease in DO and a direct toxic effect from unionized ammonia.

7.5.41 Mitigation against potential impacts involves working behind a coffer dam for small stretches of the channel and on alternate sides of the channel to enable diversion of the water flow from upstream during the works. Water which gathers behind the coffer dam may be pumped out into the main channel providing pH is below 8.5, otherwise neutralization is required before pumping. Pumping water slowly into the main channel will minimise any potential impact and minimise sediment disturbance.

Site Formation Works

7.5.42 Land preparation activities produced large quantities of SS runoff as evident from tailwater monitoring. However, the contribution of dilution and settling out in the channels as well as the large quantities of seawater (1 sand to 4 water) pumped in with the sand fill material, gave rise to acceptable suspended solids levels in the Western Outfall area. This aerating technique flushed out poorer water quality with typical DO levels of 1 and 2 mg/l, to levels of consistently over 4 mg/l after land reclamation activities.

7.5.43 Today it is not acceptable for the channels to act as a settlement area for site formation runoff. This highlights the importance of mitigation and monitoring of this project for the following reasons:

- The area is generally more valuable ecologically than 10 years ago. Water quality in the WTC especially is much improved today, providing an even richer and more favourable environment than some of the Mai Po area for egrets and other birdlife to rest and forage for food;

- The potential cumulative effects on Inner Deep Bay from large and especially small construction site activities around the Bay and upstream are considerable. Uncontrolled impacts from the development of Tin Shui Wai could result in the ecosystem becoming overstressed.

7.5.44 In general, the silt content of the man-made platform is estimated at <6% averaging about 2-3% and hence run-off from all site formation works throughout construction should not contain high sediment concentrations. Before runoff is allowed to enter the adjacent watercourses of the Western and Eastern Channels, the majority of the suspended solids can be removed by settlement using silt traps or sedimentation ponds. In most instances, the runoff will seep directly into the Land Bank.

7.5.45 Mitigation measures therefore involve construction of silt traps and sedimentation ponds to trap sediment in runoff. Maintenance of these ponds is essential to ensure their effective functioning.

7.5.46 Sedimentation ponds should be made by widening temporary drainage channels to about 2 m, and deepening them to about 2 m for at least 6 m.

Infill of Old Western River

7.5.47 Site formation of Areas 101, 105-108, 110 and 111 involves redistribution of material already within the RZ so that the whole area is formed to the required levels for infrastructure works and development. This means completely infilling the Old Western River with the addition of many wick drains which feed into the upper section of the WTC.

Sediment quality in Old Western River bed

7.5.48 In accordance with the 'Contaminated Land Assessment and Remediation' EPD Paper[8], a site assessment to determine whether the bed of the Old Western River is contaminated has been carried out.

7.5.49 The sources of contamination no longer exist as local industries, such as zinc-plating, dye casting, paper, canning and cotton processing, in the Tin Shui Wai drainage area closed years ago with the original reclamation operations of the DZ. The Old Western River's function changed from draining much of the Tin Shui Wai basin to presently draining the man-made platform area of the RZ.

7.5.50 Sediment samples from the bed have been taken to determine the extent, if any, of the contamination. Due to the extreme difficulty of obtaining samples because of the dense reed growth only two samples were taken.

7.5.51 To assess these levels, the results of quality of the sediment samples in the Old Western River bed are compared to the 'Dutch List' for soil and groundwater criteria used in The Netherlands for Contaminated Land (Table 7.27).

Table 7.27
Comparison of Old Western Channel Sediments with the 'Dutch List' Guidelines for Assessing the Significance of Contaminated Land

Component	Soil mg/kg dry soil			Old Western River (mg/kg)	
	A	B	C	RS2	RS3
Chromium	100	250	800	21.6	6.3
Nickel	50	100	500	9.1	8.4
Copper	50	100	500	14.8	4.3
Cadmium	1	5	20	0.1	0.1
Mercury	0.5	2	10	<0.2	<0.2
Lead	50	150	600	32.1	12.4
Zinc	200	500	3000	67.1	25.4

A-level = unpolluted,
B-level = pollution present and further investigation required,
C-level = significant pollution present and cleanup (preferably back to A-level) required.
Source: Contaminated Land Assessment and Remediation, ProPECC PN 3/94.

7.5.52 Works to be carried out on the site of the Old Western River involve construction of high rise housing developments. The Old Western River bed is not contaminated by any substance of the full 'Dutch List'.

8 ProPECC PN 3/94.

Re-alignment of Eastern Culvert

7.5.53 The re-alignment of the Eastern Culvert will have minimal impact on the water quality of the ETC. The new alignment does not encroach onto the ETC wet bed, except possibly for the final connection stage at the northern end of the culvert (see Figure 2.4 in Section 2). The section of Eastern Culvert made redundant from the re-alignment will be removed.

7.5.54 A maximum of 500 m^3 of soft contaminated material will be removed from the ETC as a result of the Eastern Culvert re-alignment.

7.5.55 Impacts from removal of contaminated mud on the ammonia concentration of the surrounding water have already been described in Section 7.3. The quantity of water in the ETC is already poor. However, certain mitigation measures should be incorporated into the Works. Workings should be undertaken behind a coffer dam where possible draining water from the works onto the landbank to avoid further contamination of the adjacent water body. The realignment works should be carried out during the dry season or periods of low flow to minimise contaminated runoff and generation of high suspended solids levels from excavated material and the removal of the redundant Eastern Culvert.

7.5.56 It is not anticipated that these construction activities in the ETC will increase suspended solids or turbidity in Inner Deep Bay above the Water Quality Objectives due to the small nature of the works. An in-built mitigation device in the form of the ETC, acting as a sedimentation pond will remove sediment before water is discharged to Inner Deep Bay through tidal flap valves.

7.5.57 As part of the EM&A, additional ammonia and suspended solids sampling should be carried out downstream of work activities in the ETC during culvert alterations, in addition to sampling stations that will be monitored throughout the Project regardless of activity.

Permanent Drainage Works

7.5.58 Permanent Outfall drainage pipes will be constructed at three points along the south bank downstream of the WDCE (Figure 2.14, Section 2) and at one location on the west bank of the EDC.

7.5.59 Construction of these outfalls will involve some disturbance of channel sediments causing small increases in turbidity levels and SS levels.

7.5.60 Mitigation involves construction of an earth bund (of clays and silt material) across the outfall area, during construction to contain runoff from the site area. The earth bund will then be removed. Silty clays & silts will re-settle causing minimum adverse sedimentation effects downstream or in Inner Deep Bay.

7.5.61 Impacts from ammonia released from disturbed sediment will be enhanced by the release of concrete washings during construction. Ammonia is more toxic at a high pH due to the increased dissociation into the more toxic, unionized form. Mitigation measures include minimisation of the volume of sediment to be disturbed, and channelling of any ammonia rich leachate and concrete washings onto the landbank where infiltration reduces the environmental impact.

7.5.62 There are 4 proposed permanent drainage box culverts to be constructed within the RZ to cater for the further development and the subsequent runoff generated (Figure 2.16, Section 2 and Table 7.28). Storm waters are collected into larger culverts/storage areas before discharge to either the Western or Eastern Drainage Channels.

Table 7.28
Proposed Drainage Culverts within RZ

Proposed Culvert	Location	Discharge Point	Sub-catchment
Garden South Culvert (GSC)	Along Road L13	WDCE	Areas 101(N), 105(S), 106(S), 107(S), 102(N), Roads L12, L13
Garden Path Culvert (GPC)	Garden path	WDCE	Areas 105(N), 106(N), 110(S), 111a, 107b, Garden Path Roads L12, L13
Northern Culvert (NC)	Along Road D4	WDCE	Areas 110(N), 111b, 112, 113, Road D4
Northeastern Culvert (NEC)	Along Road D4	EDC	Areas 108b, 109, Roads D4, L14

Notes: 101(N) denotes northern part of Area 101.
105(S) denotes southern part of Area 105.

Bridge Construction

7.5.63 The construction of the GP/CF1 footbridge and L13/VCF1 vehicle bridge across the channel downstream of the WDCE (shown on Figure 2.3) will involve some disturbance of channel sediments. Sediments sampled in these areas by BCL in early 1996 were found to be predominantly Class A (Figure 7.22).

7.5.64 Potential construction impacts from bridge construction include an increase in suspended solids levels and turbidity and a decrease in dissolved oxygen levels downstream. Release of contaminants such as heavy metals is expected to be minimal from chemical testing results. However, ammonia levels may increase and in the presence of high pH, these can reach ecotoxic levels.

7.5.65 Vehicle bridges D3/V1 and D2/VF1 will be constructed in stretches of the WTC where sampling has shown the sediment to fall into Class B and C categories.

7.5.66 D2/VF1 will have a relatively minor impacts because the design does not require the construction of central concrete piles in the channel. Piles will be constructed on the banks of the channel as part of the arched support of the main carriageway. Potential impacts of increased suspended solids levels will be relatively minor if appropriate mitigation measures are implemented.

7.5.67 Potential impacts from construction of vehicle bridge D3/V1 include disturbance of contaminated sediment with resultant increases in suspended solids levels and ammonia, possibly in an ecotoxic form.

7.5.68 Mitigation measures to reduce the amount of suspended solids passing downstream include the use of silt curtains during construction. With these measures, it is anticipated that resuspended sediments will result in the channel downstream of the WDCE and not cause any adverse effects on the lower reaches of the channel or the mudflats of Deep Bay.

7.5.69 Increase in ammonia in the water column are more difficult to mitigate against because the contaminant is soluble. Ammonia becomes more toxic as pH increases which will occur where construction materials are being used.

7.5.70 Impacts from ammonia on the ecological resources of the channel can be minimised through the following mitigation measures. Disturbance to the sediment should be carried out when high flows are measured in the channel, to enhance dilution of the ammonia. The use of construction materials in the river channel should be delayed until ammonia levels in the water have been reduced through tidal dilution or river flow.

7.5.71 The EM&A programme includes additional monitoring of suspended solids, ammonia and pH before, during and after construction activities in water bodies. Levels of unionized ammonia should be monitored especially closely against known acute and toxic levels to marine life.

7.5.72 Monitoring of ammonia and suspended solids levels downstream of the works should be carried out during construction works.

Installation of Rising Mains and New Sewage Pumping Station

7.5.73 The new pumping station in Area 101 will be connected by a rising main to the Ha Tsuen Pumping Station. This will involve crossing the WDCE, a small tributary stream and the Hung Shui Kiu channel. Construction methods will be of a 'no-dig' type, i.e. pipe jacking. Direct impacts on the WDCE are therefore expected to be minor.

Construction and Upgrading of Roads, Junctions and Flyovers

7.5.74 Construction and upgrading of roads, junctions and flyovers will affect runoff volumes and water quality. pH levels may be increased from concrete washings which in turn affects the dissociation of ammonia and hence its ecotoxicity.

7.5.75 Impacts should be minimised by reduction in the amount of runoff into adjacent water courses where marine life may be harmed. Runoff should be diverted onto the landbank where infiltration minimises the harmful effects on the marine ecosystem.

Fresh-water Wetland Habitat

7.5.76 Construction of the wetland habitat will be undertaken in such a manner that contact with the two channels is avoided for most of the works. Initially, clean sand will be removed and used for site formation works elsewhere on the site. The remaining material will be shaped to form channels and banks for the wetland (Section 9).

7.5.77 The greatest potential impact on water quality will arise when the remaining ETC area is deepened to form a sedimentation pond and when the diversion dams are built. These works should be undertaken during the dry season. Cofferdams will be used to isolate sections of the works. Increases in pH due to concreting works will be avoided by the use of cofferdams and testing and neutralisation of any washings with a pH above 8.5.

General Site Runoff

Runoff from Site Compounds

7.5.78 The Tin Shui Wai site including the RZ was formed over low permeability marine mud and underlying fish pond mud. Pollutants tend to remain in the surface water system and are unlikely to pollute the groundwater except via the main drainage channels.

7.5.79 Construction sites can be the source of a variety of polluting substances. The most common of these are derived from oils and greases, concrete/cement washings and wheel-washing wastes.

7.5.80 There is potential for oil, grease and fuels to be spilled which would directly impact water quality and ecosystems. This should not be allowed to happen.

7.5.81 Site runoff from haulage roads will contain contaminants from traffic runoff. Sand traps located at strategic collecting culverts will help to reduce contaminants reaching the watercourses.

7.5.82 Sand traps are essential at the drainage outfall areas i.e. three in the channel downstream of the WDCE and one at the EDC.

7.5.83 Cement washings can have high alkalinity (pH), suspended solids, turbidity, COD and calcium. They can arise from flushing or washing down of spills, equipment, or new works.

7.5.84 Lime is the primary ingredient of cement that will raise the pH value in water. Concrete or cement runoff could lead to water quality impacts on sensitive receivers, particularly in relation to increase in ammonia toxicity.

7.5.85 Mitigation measures to be implemented to minimise these impacts are based on the principle of good management practice. These measures include a temporary drainage system and settlement ponds to encourage infiltration of water instead of runoff.

7.5.86 Temporary drainage arrangements will be required from the start of any works.

7.5.87 Drainage from the construction works area shown on Figure 2.1 in Section 2 will be channelled through ditches to settlement ponds constructed on the RZ initially.

7.5.88 Overflows from these ponds will soak into the permeable sand platform that makes up the RZ or drain along the preferential drainage lines incorporated in the original design of the man-made platform. Channels should be widened to about 2 m and deepened to about 2 m for at least 6 m to form a settlement pond.

7.5.89 During the intermediate stage, temporary drainage channels will be chunam-lined and provided with sand traps as shown on Figures 2.11 and 2.12. The channels will be modified wherever practicable as shown in Section 10.

7.5.90 Oil interceptors should be provided in site compounds and regularly emptied to prevent release of oils and grease into the surface water drainage system after accidental spillages. The interceptor should have a bypass to prevent flushing during periods of heavy rain. Oil and fuel bunkers should be bunded to prevent discharge due to accidental spillages or breaching of tanks.

7.5.91 Maintenance of these temporary drainage systems and interfaces is important for their efficient functioning.

Major Concurrent Projects

7.5.92 Occurring simultaneously with works under this Project (which have been described in Section 2), a number of works within Inner Deep Bay and Tin Shui Wai will impact on water quality within the Tin Shui Wai study area. The works with the greatest potential to impact on Inner Deep Bay water quality are:

(i) Shenzhen River Regulation Project;

(ii) works on the main drainage channels for Ngau Tam Mei, Yuen Long, and Kam Tin;

(iii) works undertaken in the People's Republic of China (PRC); and

(iv) the further development of TSW with provision of housing in the RZ.

7.5.93 In addition many other works will affect water quality in the study area such as the Livestock Waste Control Scheme, construction of the low flow channel for the WDC and works within the NWNT Sewerage Catchment System.

7.5.94 Their locations are shown on Figure 7.1 and start dates and duration shown in the Works Programme in Section 2.

Main Drainage Channel, Ngau Tam Mei, Yuen Long & Kam Tin

7.5.95 Under this project there will be deepening, widening and lining of the San Pui River and tributary streams that flow into Inner Deep Bay. Estimated time scales for all works coincides with the 'Project' covered in this report. Upstream of Castle Peak Road the channel will be lined, downstream it will not. All works however, especially those downstream and close to the channel mouth, will impact on the mudflat area in terms of suspended solids, water quality and hydrodynamics. Ammonia release from mud disturbance is of particular concern because of the increase in toxicity in the presence of raised pH, which can occur during construction works without careful drainage measures.

7.5.96 The Tin Shui Wai WDCE and downstream channel is tidal and as such is sensitive to activities in Inner Deep Bay. Sediments are washed into the channel, bed levels are altered and the equilibrium between channel and mudflat reaches new levels. It is inevitable that some effects of the Main Drainage Channels of Ngau Tam Mei, Yuen Long & Kam Tin will influence the water quality in Inner Deep Bay particularly near the mouth of the WDCE channel which in turn impacts the Tin Shui Wai WDCE.

Shenzhen River Regulation Project

7.5.97 The Shenzhen River Training Scheme Stages 1 and 2 is the largest project in this area and can be used as a yard stick or worst case scenario to compare and measure the ecological impacts of developments on Inner Deep Bay.

Flow regimes - Shenzhen River Project

7.5.98 The EIA of Stage 1 and 2 River Training Works of the Shenzhen River used models to predict changes in hydrology and sediment flux. These are important in the assessment of ecological impacts of a Project and conclusions found for the neighbouring Shenzhen River Project can be compared to the Tin Shui Wai Project.

7.5.99 Firstly however, the greater size of the Shenzhen Project must be emphasised. The Tin Shui Wai Project is not building new channels but developing around existing channels with minor modifications to the channel itself. In light of this the conclusions from the Shenzhen Project discussed below are of greater magnitude than that expected from the development of the RZ in Tin Shui Wai. The total length of the Shenzhen River Project is 13.6 km, compared with the WDCE and channel downstream: 3.96 km, the Eastern channel: 2.13 km and the ECC: 0.5 km (total area adjacent to RZ approx. 1.0 km).

7.5.100 Results from Shenzhen River Training EIA:

(i) No significant changes in hydrodynamics of the Shenzhen River and Deep Bay were predicted as a result of the Stage 1 Works (removal of meanders in the lower parts of the river). However, after Stage 2 Works the water levels were expected to decrease by 1.2 metre at the lower end of the river mouth due to channel widening (total reduction in river length was 3.3 km)

(ii) No significant differences in the hydrodynamics of Deep Bay were predicted by modelling results except for an increase in the tidal exchange and a local increase of the tide velocities in the river mouth area.

7.5.101 In the Tin Shui Wai basin there are several drainage improvement schemes and infrastructure activities.

7.5.102 The cumulative effect of all these projects is to increase runoff, concentrate flows and more importantly in terms of sediments, increase peak maximum velocities.

7.5.103 Similarly to Tin Shui Wai, the main channel and tributaries from the whole Shenzhen basin will deepen and widen due to increased velocities and result in erosion of mudflat areas during the wet season.

Sedimentation flux - Shenzhen River Project

7.5.104 The EIA of the Shenzhen River Training Stages 1 and 2 Works (Peking University, Axis Environmental Consultants and CES Ltd 1995) highlights several points regarding sediment flux, sedimentation patterns which can also be compared to the Tin Shui Wai Project. Models used to assess the ecological impacts of the works in terms of sediment transportation produced the following results:

(i) A slight increase in sediment flux from the Shenzhen River was expected during construction of Stage 1. More sediment was predicted to be resuspended during Stage 2 dredging than Stage 1. The suspended sediment contents in the river mouth were expected to reach 150 mg/l on average compared with baseline conditions of 80 mg/l.

(ii) More sediment upstream would be deposited in the trained channel after the Project and maintenance dredging of the channel would be required. Sediment flux in other parts of Deep Bay would decrease significantly.

Tin Shui Wai: This characteristic would not apply to the Western Drainage Channel as the upstream inflatable dam reduces approximately 3/4 of the sediments trapping them upstream and enabling dry dredging. Channel dredging is fast becoming a routine part of river system management and this may apply to the Western and Eastern Drainage Channels and Channel Extensions affected by the Reserve Zone but probably with a greater interval between dredging years.

(iii) Sedimentation rates due to Stage 1 Works were predicted to increase from 16.4 mm/yr to 18.8 mm/yr for the Futian and from 17.0 mm/yr to 19.5 mm/yr for Mai Po during Stage 2 Works when the lower reach of the channel was dredged. The sedimentation rate in Futian and Mai Po mudflat was expected to increase from 16.4 mm/yr to 22.5 mm/yr and from 17.0 mm/yr to 21.0 mm/yr respectively. Within a small area adjacent to the river mouth, a relatively large increase from 86.6 mm/yr to 115 mm/yr was predicted.

Tin Shui Wai: In Tin Shui Wai the Project does not involve any major river training works and the disruptive operations that go with it, therefore a significantly smaller sedimentation rate is expected as a result of this Project.

Data of rates of sedimentation from the Shenzhen River Training Stages 1 and 2 Works show that the levels are below those which benthic organisms can bury up through.

(iv) Following completion of Stage 2 sediment deposition rates were expected to drop from 17.0 mm/yr to 13.0 mm/yr in Mai Po and from 16.4 mm/yr to 12.0 mm/yr in Futian respectively, as much of the sediment flow energy will be concentrated in a deep channel.

Tin Shui Wai: Sediment deposition rates may also drop marginally after the completion of construction works as greater flow velocities around the mouth deepen mudflat channels and carry sediment further into Deep Bay.

7.5.105 The impacts of the River Training Project on sediment flux before, during and after construction, shows an overall reduction in suspended solids in the long term. Often short term increases during construction have to be endured or sustained in order to have long term benefits, reducing the rate of deposition on the mudflats.

7.5.106 The maximum discharge rate predicted during flood events could result in localised erosion at the Shenzhen River mouth but there will continue to be net deposition. Reduction of sedimentation rate around the mouth of the river is expected to reduce by approximately 60% of the current rate of 86.6 mm. As a result in the Mai Po and Futian areas a decrease in sedimentation deposition is expected of 22.2% and 26.8% respectively from the 1995 levels. Sediment loads can be expected to be further reduced by the full implementation of the LWCS discussed in Section 7.3.91.

7.5.107 As the Shenzhen River Training Project appears to result in a relocation of erosion and deposition areas and ultimately reducing deposition rates as a whole after the Project, it is anticipated that a cumulative impact of the Shenzhen River Training Project and the Tin Shui Wai Project will slow the increased rate of deposition compared to the trend immediately prior to the construction works. The overall sedimentation pattern will still be one of nett deposition but the rates will reflect that of the early 1980s before large scale urbanisation.

7.5.108 Finally the EIA of the Shenzhen River Training Project stated that minor changes in hydrodynamics, sediment flux and erosion-sedimentation should have no unacceptable influence to the ecosystem of the River and Inner Deep Bay systems. The changes would not exceed those experienced in a natural fluctuation such as a typhoon, storm, flooding etc. It is therefore anticipated that due to the similarity of the Shenzhen Project to the Tin Shui Wai Project and both draining into the sensitive receiver area of Inner Deep Bay, the effects albeit of a smaller nature will also be that of *'no unacceptable influence to the ecosystem'*.

Comparison with surrounding drainage basins

7.5.109 Sediments received from the main drainage basins: Tin Shui Wai, Yuen Long/Kam Tin/Ngau Tam Mei, San Tin, Indus, Ganges and Shenzhen, flowing into Deep Bay are generally comprised of:

(i) livestock waste
(ii) natural sediment from erosion
(iii) construction waste
(iv) tidal silts

7.5.110 Tables 7.29 and 7.30 show sedimentation summaries for non-tidal channels in the five drainage basins. Sediments from Tin Shui Wai make up approximately 20% of the total sediment entering the Bay from Hong Kong. Of this amount of sediments, approximately 67% are settled out above the inflatable dam and dredged during the dry season, minimising sediment deposited downstream and in Inner Deep Bay.

Table 7.29
Sedimentation Rates for Main Drainage Basins in Deep Bay Region

Drainage Basin	Sedimentation rate (tonnes/day)	m^3/annum
Tin Shui Wai	17,000	11,300
Yuen Long/Kam Tin/Ngau Tam Mei	40,000	26,700
San Tin	6,000	4,000
Indus	17,000	11,300
Ganges	5,000	3,300

(It is assumed that the density of the settled natural deposits is 1.5 t/m^3.) (TELADFLOCCOS II, Binnie & Partners 1993)

Table 7.30
Average Level of Suspended Solids over Deep Bay

Location	Representative samples	Avg. level of suspended solids (mg/l)		
		wet season	dry season	12 months
Mouth of Shenzhen River	W1	33	83	66
Mouth of San Pui River	W2	44	75	64
Outfall of TSW streams	W6	42	57	54
Inner Deep Bay	W3, 4 & 5	35	51	44
Lau Fau Shan foreshore	W9 & 11	27	48	44
Outer Deep Bay	W7, W8, W10, W1, W13 & W14	29	46	39
Whole Bay	A11	32	53	44

Note: Suspended solids levels include all samples except those which had extreme levels which were rejected on the grounds that the samples were not representative (Source: Binnie & Partners, Shankland Cox 1985).

Long Term Erosion/Deposition Patterns

7.5.111 Long term deposition and erosion depends on several factors:

(i) effective enforcement of legislation
(ii) rate of urban growth
(iii) maintenance of channels/dredging techniques

7.5.112 The predicted reduction in sedimentation rates following the completion of the Project should result in a reduction in the rate of mangrove encroachment on the mudflat area. Loss of intertidal mudflats to mangroves is becoming of increasing importance in terms of essential foraging areas for migratory birds. Present mangrove encroachment is estimated at approximately 3.5 m/yr and therefore a reduction in sedimentation could be beneficial to birdlife dependent on these intertidal mudflats.

7.5.113 However, as a result of current policies and legislations (such as LWCS, WCPO, WDO) along with more stringent mitigation measures, development may very effectively alter the water quality and sediment loadings entering Deep Bay in the future. In future years a constant supply of millions of m^3 of 'fresh' water (carrying less sediments, with higher volumes and velocities, more runoff, less seepage) from all the drainage basins may <u>erode</u> sediments in Deep Bay possibly having an adverse effect on the mudflats and hence the diverse wildlife it supports.

7.5.114 Re-introduction of sections of the Livestock Waste Control Scheme phased in over 1996-1999 in this area will greatly reduce maintenance dredging commitments by controlling livestock waste effluent discharges to watercourses.

<u>Water Quality Impacts During the Construction Phase</u>

7.5.115 The EIA concluded that there would be no direct influence on water quality of the Shenzhen River and Deep Bay during the construction phase of the Project, simply because pollution load will not be directly altered by the construction itself. Water quality during the operation period was predicted to result in a slight improvement in water except during maintenance dredging. However, this impact was expected to be less than that of the Stage I construction works.

7.5.116 The EIA recognised that the dredging operation of the Stage I and II works would indirectly affect water quality through the resuspension and release of pollutants from the heavy contaminated bottom sediments.

7.5.117 Elutriate testing was undertaken using river water and sea-water at dilutions of 1:100 and 1:1000. The logic behind the dilution ratios was based on modelled SS levels. The contamination found was further diluted due to final dilution of expected SS levels at the river mouth. These assumptions are partially invalid for soluble substances. SS levels near a dredger are high allowing most of the potential elutriated materials to pass into the water body and they do not drop out as the suspended solids drop out. Hence there is a likelihood that total loadings of soluble pollutants may be substantially increased by these training works. Silt screens will block suspended material but will not prevent soluble pollutants from passing down the river. However, any method used to reduce the percentage of overburden or unnecessary disturbance of the bottom sediments will reduce soluble pollutant levels resulting from the works. Works undertaken behind cofferdams as in the case of much of the Stage I works will have far less impact.

7.5.118 Calculations of the impact on water quality from the Ngau Tam Mei, Yuen Long and Kam Tin construction works (ERM, 1995). also assumed that soluble pollutant levels would drop as SS levels drop with distance from a dredger. A doubling of soluble pollutant levels within a river channel can result in a major increase of pollutants in Inner Deep Bay. The ratios of dilution from river mouth to any point in Inner Deep Bay remain alike with or without dredging as is exemplified by the water quality data of DM1, DM2 and DM3.

The Provision of Housing in the RZ

7.5.119 As illustrated in the section on Urban Stormwater Runoff (7.7), the construction of housing and related amenities in Areas 3, 30, 31 and the RZ could have a marked effect on water quality in the two channels and in Inner Deep Bay if building site runoff, particularly concrete washings, enter the drainage system. Many of the new storm-water drainage culverts will be completed early in the Project works programme, speeding the discharge of these effluents to the channels.

7.5.120 Standard contract clauses prevent Contractors from depositing such wastes on their own sites. Theoretically such wastes should be collected, settled and neutralised. In practice, neutralisation is rarely undertaken and once washings are deposited in storm drains, the problem is no longer easily visible.

7.5.121 The protection of downstream water quality and ecological systems require the implementation of this standard mitigation. It is recommended that strong environmental control be maintained during the further development of TSW. It would be better for contractors to dump their cement washings on their sites than to be tempted to flush concrete washings down the drains. "Out-of-sight is out-of-mind". Assistance with neutralisation, which is easy to implement, would have a major effect on the reduction of potential cumulative impacts from the TSW area.

Low Flow Channel in WDC

7.5.122 In view of the odour nuisance created from low flowing polluted liquid in the WDC, DSD will construct a 400 m long 1 m deep x 2.5 m wide low flow channel in the WDC upstream of the existing dam to facilitate maintenance work as well as solve the odour problem. The length of the channel will be reviewed depending on its effectiveness. The construction of this low flow channel is considered an appropriate interim measure to improve the water quality in the WDC before the effective operation of the existing low flow intercepting system.

7.5.123 After the Water Pollution Control Ordinance and the Livestock Waste Control Scheme are fully implemented, water entering the Tin Shui Wai Amenity Water Scheme will then be relatively clean and at the acceptable standard for discharge into the WDCE.

Livestock Waste Scheme

7.5.124 In the medium term, the Livestock Waste Scheme will markedly improve water quality. However, despite the decrease in the number of farms operating in Hong Kong, there has been a recent increase in the total number of pigs.

Table 7.31
Recent Estimates of Pigs in Hong Kong
(Courtesy EPD ref. EP 60/L5/4, 1997)

Year	All Areas in HK	Control Area No. 18 (TSW Area)
1996	340,000	62,000
1995	196,000	24,600
1994	218,000	25,000

7.5.125 The increase in the TSW area is very considerable and suggests an increase of 150%, i.e. 2½ times in total livestock waste produced. The increase in all areas of Hong Kong is over 50%. If this waste has been allowed to enter Inner Deep Bay part of the decrease of water quality in Inner Deep Bay can be explained. The remainder of the decreases in water quality have probably resulted from the major drainage projects.

Mitigation Measures

7.5.126 Tables 7.32 and 7.33 below summarise the mitigation measures for the Major Issues and all other minor issues resulting from the Project. Contract Clauses to implement these measures are described in Section 10 and adopt mitigation measures contained in the ProPECC Note 1/94 on construction site drainage.

Table 7.32
Summary of Mitigation for Major Issues related to Construction Impacts

Major Issues	Works to be carried out	Mitigation	Contract	Date - Duration
Eastern Culvert Extension (ECE)	Eastern Culvert Extension under road D4 south partially infilling ETC in Areas 104, 109 and 117	The Contractor must use a coffer dam during works within or near the channel.	2	Sept 1997 - Sept 1998 1 year
	A figure showing the areas of contaminated mud to be removed is given in Section 8: *Waste* (Figure 8.1)	ETC sediments are of Class C contamination therefore works should be carried out during the dry season or periods of low flow in the channel. Design of ECE shall ensure that the amount of contaminated mud removed is minimised to avoid water quality impacts. Diversion of flow during the final section of culvert must be carried out with minimal disturbance of bed sediments and impact on water quality. EM&A should include monitoring of downstream water sampling locations for ammonia levels which can worsen ecotoxic levels with elutriate from this mud. In addition, pH levels of runoff should be kept below 8.5 to protect aquatic life in the channel and in Inner Deep Bay. pH should be checked and neutralisation undertaken as necessary.	7	Feb 1999-Jun 2001 2 years 4 months
Western Temporary Channel	Paving of 500 m of the WTC immediately downstream of the inflatable dam for maintenance purposes	Works should be carried out during the dry season or periods of low flow in the channel in order to minimise affects on water quality downstream. The Contractor must use a silt curtain or preferably a coffer dam during works within the channel. The EM&A programme will incorporate a fixed monitoring station just downstream of the proposed works to monitor for suspended solids and ammonia. This will act as a warning signal to check Contractor procedures. In addition, pH levels of runoff should be kept below 8.5 to protect aquatic life in the channel and in Inner Deep Bay.	6	Mar 1999-May 2001 2 years 2 months

Table 7.33
Summary of Principal Mitigation for Minor Issues resulting from the Project

Minor Issues	Work to be carried out	Principal Mitigation	Contract	Date - Duration
Site Formation	Levelling of RZ and relocation of stockpile material	Silt traps or sedimentation ponds to settle out sediment in runoff. Ponds also encourage infiltration instead of runoff.	All contracts	Jul 1997 - Aug 2003 6 years 1 month
Site runoff	All construction works	Each work site shall have a temporary drainage ditch draining to a sedimentation pond; Hard standing compounds shall drain via an oil interceptor; All oil interceptors shall be drained and oil exposed of in a appropriate manner.	All contracts	Jul 1997 - Aug 2003 6 years 1 month
Eastern Culvert Re-alignment	Construction of new section of Eastern Culvert under Road P2 at Junction P and removal of redundant Culvert in ETC	Recommended final connection of re-aligned section of culvert with the ETC to take place during the dry season or period of low flow in the ETC. Cofferdams to be used.	4	Nov 1998 - Mar 2001 28 months (fewer months with potential impact)
Bridge Construction	WTC vehicle bridge D2/VF1	Use of silt curtains or cofferdam to ensure minor impact on water quality when channel sediments are disturbed. Channel sediments under L13/VCF2 and GP/CF1 are Class A and therefore not expected to yield metal pollutants.	4	Nov 1998 - Mar 2001 28 months
Bridge Construction	WTC vehicle bridges D3/V1 and L13/VCF1 and footbridge GP/CF1 to be constructed	Class C sediments under D3/V1 require careful handling and monitoring of ammonia levels to minimise impacts. Avoid high pH levels and ammonia release through engineering programme design.	8	Aug 2001 - Aug 2003 24 months
Installation of rising mains	Installation of rising mains on the western side of the WDC and WTC. Crossing the WDC and two tributaries, by 'no-dig' method, to link new and old pumping stations	Impacts on WDC and WDCE from runoff from construction activities can be minimised by the diversion of drainage water through sediment ponds.	4	Nov 1998 - May 2000 1 year 6 months
Construction of permanent drainage culverts	3 culverts: the Northern, Garden Path and Garden South, will be built, two draining into the WDCE and one into the EDC	An earth-bund of clays and silts or a cofferdam will be built to prevent runoff from the construction of the culverts from entering the channel. Earth bund will then be removed.	4 6	Nov 1998 - May 2000 1 year 6 months Mar 1999 - May 2001 2 years 2 months
Construction and upgrading of roads, junctions and flyovers	Construction works related to development of road infrastructure in Study Area	Minimising runoff, particularly in area of potential ammonia toxicity from contaminated runoff. Settlement ponds to settle out sediment in runoff. Ponds to encourage infiltration instead of runoff.	3 to 8	Oct 1998 - Aug 2003 4 years 10 months
Fresh water wetland	Deepening of ETC and construction of diversion dams and wetland channels	Dry season workings. Use of coffer dams, pH testing of waters.	8	Aug 2001 - Aug 2003

7.5.127 The EM&A Manual presents a programme of water quality monitoring procedures, locations and frequencies and appropriate actions to be undertaken should there be any exceedance of the stated water quality criteria for the Project.

7.5.128 The water quality monitoring programme is one component of an integrated environment monitoring strategy designed to ensure that the site formation and subsequent Project works within the RZ take place with a minimum of adverse impact on the ecology of Inner Deep Bay and surrounding areas. The water quality monitoring programme will detect deterioration of water quality due to concurrent projects.

Conclusion of Construction Impacts

7.5.129 The main impact will be the possible release of pollutants such as ammonia and other soluble oxygen depleting substances from the works carried out in the ETC and during the paving of the WDCE. Changes in pH could result in increasing levels of toxic, free ammonia.

7.5.130 Provided that the requirements of this report and the EM&A Manual are strictly observed, the site formation and construction activities can be carried out with a minimum adverse impact on the environment, to the benefit of the complex and sensitive ecology of the Inner Deep Bay area.

7.6 Operational Impact and Mitigation

Operational Impact Assessment

7.6.1 The major operational impacts are shown in Table 7.31. Due to the importance of the urban stormwater runoff issue, as identified in the Brief, this is addressed separately in Section 7.6.

Table 7.34
Identification of Potential Operational Impacts from the Project

	Works to be carried out	Impacts	Contract	Date - Duration
Urban Stormwater Runoff	Creation of infrastructure, housing and other developments which reduce infiltration and increase surface runoff cover 65% of the RZ	Impacts potentially severe with proven cases of high levels of pollutants in urban stormwater runoff from similar urban areas in the USA. Water quality and associated wildlife in receiving water bodies could be adversely affected in the long term.	All contracts	Occupation starts Aug 1999 - ongoing
Maintenance Dredging	Dredging in the WDCE and EDC	Dredging removes channel sediments and therefore benthos living within. Also bank reeds and mangroves are removed which provide foraging and resting areas for many birds. Sediments disturbed during dredging have potential to affect water quality.	-	In the long term once every 10 years or more
Sewage	Increased population of Tin Shui Wai, leading to requirement for sewage collection and disposal in RZ	Increase in volume of sewage to be conveyed to pumping station and ultimately to discharge outfall. Accidental discharge of sewage into drainage channels resulting from failure of pumping station.	-	First occupation - Aug 1999 - ongoing

7.6.2 The TSW Project has no potential to have any impacts on the shoreline, the water circulation patterns, stratification, flushing, mixing patterns or tidal regime in Inner Deep Bay.

7.6.3 There will be an increase in runoff volume as a result of completed development covering approximately 65% of the RZ and the whole of Areas 3, 30, 31 and 33 with concrete. The remaining 35% of the RZ will be retained as green belt or conservation areas.

7.6.4 The river training works in the Tin Shui Wai basin have been designed to allow for extensive development in the basin. The modelling conducted for TELADFLOCOSS II demonstrated that the existing trained river channels could convey the flows arising from full development of the Tin Shui Wai landholding. No adverse impacts will therefore arise from paving the filled areas in Areas 3, 30, 31 and 33 and the RZ for development.

7.6.5 Also, the RZ lies at the most downstream end of the Tin Shui Wai drainage basin. The peak runoff from the RZ will therefore be discharged well before the runoff from the drainage basin as a whole reaches its peak. The peak and the time to peak of the runoff hydrograph for the whole drainage basin will therefore be about the same as before development.

7.6.6 Most of the flood loss mitigation measures comprising river training and poldered village schemes in the drainage basin have been completed. The remaining works comprise completion of the village flood protection schemes at Sheung Cheung Wai and Ha Mei San Tsuen and minor river training works on the secondary drainage system to resolve local flooding problems which are to be recommended in the Yuen Long, Kam Tin, Ngau Tam Mei and Tin Shui Wai DMP Study. Flooding problems persist only in low-lying areas which cannot drain by gravity during floods. These flooding problems will not be aggravated by the proposed Developments within the Tin Shui Wai Landholding. Therefore no flood mitigation measures are necessary for the proposed Developments as long as they are formed to levels above the floodwater levels.

7.6.7 Flood flows may be encouraged, by means of constructive embanking, to flood Area 118, creating flood storage as well as feeding wetlands and related ecological habitats.

7.6.8 The ETC and the future EDC are not tidal. The Tin Shui Wai bund with its 18 flap valves acts as a barrier controlling flow velocities and suspended solids loadings entering Inner Deep Bay. Therefore the extension of and the building of the Eastern Culvert (EC) and the North Eastern Culvert (NEC) respectively will not impact Inner Deep Bay providing mitigation measures described in Section 7.5 are implemented.

7.6.9 In the WTC sedimentation patterns are dominated by the tide particularly in the dry season, and any changes in channel design will not affect this controlling factor.

7.6.10 A 500 m section immediately downstream of the inflatable dam will be paved to create the WDCE. This is for maintenance purposes only and will not affect the hydrology in this channel and therefore the mud flat area. This enables the retention of the rest of the channel in its natural state. Sediment settles out as this point from both tidal inflows as well as from water passing over the inflatable dam enabling DSD to remove contaminated sediments thus improving the water quality of the remaining channel.

7.6.11 The Amenity Water Scheme will not be extended to the channel downstream of the WDCE as was originally proposed. This measure minimises the impact on water quality and ecological resources downstream. The inflatable dam will be left in place containing the existing Amenity Water Scheme upstream.

Maintenance Dredging

7.6.12 Extensive bed level surveys carried out by Acer Consultants (Far East) Ltd 1996 provides pre- and post-wet season data for the Sept/Oct 1995 period discussed in Section 7.3. Simple subtraction of the post- and pre-wet season bed levels determines where accumulation of sediment and where scouring is taking place. Also as built bed levels were compared to present bed levels surveyed.

7.6.13 In general there is an overall net deposition in the Western and Eastern Temporary Channels as well as the Tin Shui Wai Creek. Deposition is greater in the lower reaches of the WTC due to the strong influences of the tide bringing in marine sediments. It is believed that dredging the upper reaches has little impact on water levels and therefore would not be effective.

7.6.14 Similarly dredging in the channel areas around the mouth may be an ineffective measure of flood control because water levels in this region are controlled by the tide.

7.6.15 The frequency of dredging depends on the rate of siltation.

7.6.16 Maintenance dredging would be best targeted to particular lengths of the channels where it would be most effective.

7.6.17 Estimations on present sedimentation rates predict some dredging of the Western and Eastern Drainage Channels and Channel Extensions over the next 4-5 years and at longer intervals with the increased reduction of sediments from the LWCS and the anticipated 'self dredging' during the wet season. This interval is expected to be 10 years or longer.

7.6.18 Impacts from dredging include the generation of low levels of turbidity and data suggests that most of the released sediment is rapidly redeposited close to the release point.

7.6.19 Dredging in the Western and Eastern Drainage Channels and Channel Extensions could have a short-term detrimental environmental impact in terms of released pollutants from sediments on the ecology downstream. However, ammonia levels could potentially cause significant impacts, particularly if pH levels are raised as a result of construction related runoff. As the Livestock Waste Scheme progresses, ambient ammonia levels will decline and ammonia levels in the sediments will decline reducing potential impact.

7.6.20 Mitigation measures to minimise the impact from disturbance of sediments include the use of silt curtains which reduce sedimentation impacts, especially around the mouth of the channel during low tides and flows.

7.6.21 Previous studies[9] have shown that the combination of an appropriate dredger with a silt screen can greatly reduce the extent of plumes resulting from dredging activities. Selection of a dredging method at the detailed design stage should therefore be carefully

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9 ERL (Asia) Ltd and Binnie Consultants Ltd (1991), *Deep Bay Guidelines for Dredging, Reclamation and Drainage Works* (1991). For EPD.

BCL in association with Dredging Research Ltd, Applied Geology Ltd (1993), *The Use of Acoustic Doppler Current Profiles to Monitor Suspended Sediment Concentrations During Dredger Operations*. Fill Management Study - Phase II, Investigation & Development of Marine Borrow Areas. For CED & GEO.

BCL (1994), *South of Ninepins Borrow Area Environmental Impact Assessment*. Fill Management Study - Phase IV, Investigation & Development of Marine Borrow Areas. For CED & GEO.

Mott MacDonald Hong Kong Ltd. (1991), *Contaminated Spoil Management Study*. Final Report (Agreement CE 30/90). For EPD.

considered to minimise the impact on the river ecosystem. With these mitigation measures, no resuspended sediments are expected to reach Inner Deep Bay, however monitoring downstream should be carried out during the works.

7.6.22 As far as the sensitive receivers are concerned, no significant increase in suspended solids during the maintenance dredging of marine muds in the Drainage Channels is expected when compared to the natural range of conditions in Inner Deep Bay. If maintenance dredging is required then it is recommended the most upstream end be dredged first and work towards the mouth. Recolonization by benthic organisms will be more rapid if only one side of the channel is dredged at a time. If only short lengths of the channel are dredged, no such mitigation would be necessary.

Sewerage

Existing Regional Sewerage Facilities

7.6.23 Tin Shui Wai is within the NWNT Sewerage System Catchment. The existing NWNT Sewerage System comprises the following key facilities:

(i) Ha Tsuen Pumping Station;

(ii) San Wai Sewage Treatment Works;

(iii) a sewer tunnel beneath Castle Peak Range; and

(iv) a submarine outfall discharging to the waters at Urmston Road.

7.6.24 Ha Tsuen Pumping Station is situated at the southwestern part of Tin Shui Wai and is the nearest sub-regional pumping station to the Priority Sites. According to the North West New Territories Strategy Studies, it is designated to serve the Yuen Long Peripheral Areas, Tuen Mun/Yuen Long Corridor, Tin Shui Wai, Au Tau/Long Ping and Kam Tin. However, no provision has been made for the present development at the Priority Sites and the remainder of the RZ.

7.6.25 The present capacity of the pumping station is about 123,000 m^3/d (DWF). Land is available within the pumping station compound for expansion. The pumping station is linked to San Wai Sewage Treatment Works about 1.5 km to the west via two 1200 mm diameter pumping mains with provision for a third.

Existing Sewerage Network in Tin Shui Wai Development Zone

7.6.26 The sewage generated at the DZ is presently collected and conveyed by a system of gravity sewers with sewage head raised at the intermediate by a sewage pumping station in Area 14 of the DZ. The system discharges to Ha Tsuen Pumping Station via a trunk sewer beneath Ping Ha Road at the southern periphery of the DZ.

7.6.27 The gravity sewers are constructed of precast concrete pipes of diameters ranging from 225 mm to 2100 mm with concrete manholes provided at intervals not greater than 50 m. They run primarily beneath carriageways, but some are provided beneath footpaths, cycle tracks or drainage reserves.

7.6.28 The DZ sewerage network has been designed in accordance with the requirements of the Civil Engineering Manual Volume VI with dry weather flows determined from the total water consumption calculated from data in WSD's revised Provisional Standing Order No. 1309 dated July 1985. The method used in determining designed flows has been superseded by the Sewerage Manual published by DSD in May 1995. Re-calculating the designed flows in accordance with the new method indicates that larger spare capacities are available in the sewers and in the Area 14 sewage pumping station. The results of re-calculation based on the revised Sewage Flow Inventory for Tin Shui Wai prepared in February 1996 are presented in the Interim Final Investigation Report, Appendix D (Ref. 0018/ENG/R8.1).

Planned Sewerage Facilities and On-going Studies

7.6.29 A sewerage master plan has been formulated for the NWNT sub-region under the Yuen Long and Kam Tin Sewerage Master Plan (SMP) Study. The study was completed in December 1991 before a definitive plan to develop the RZ was endorsed. No provision has been made in the SMP to cater for the developments at the RZ or for any revised developments at the DZ.

7.6.30 The sub-regional sewerage strategy adopted by the SMP is to discharge sewage collected from the Yuen Long, Kam Tin and Tin Shui Wai areas through the NWNT sewerage system to the tidal channel at Urmston Road. The SMP has included a comprehensive network of new trunk sewers and sewage pumping stations to achieve this strategy. Implementation has been underway since 1992.

7.6.31 A number of the SMP trunk sewers have been proposed to run within Tin Shui Wai. Their preliminary layouts are described and the key data are summarised in Table 7.35. These proposed provisions are currently under review.

Table 7.35
Proposed SMP Trunk Sewers within Tin Shui Wai

Proposed Trunk Sewer	Diameter (mm)	Alignment within Tin Shui Wai	Implementation Programme
A pumping main/gravity sewer to transfer sewage from Ping Shun Street Pumping Station to the existing trunk sewer immediately upstream of Ha Tsuen Pumping Station	1000 (rising main) 1200 (gravity sewer)	Along Tin Fuk Road and Ping Ha Road	1995-1997 under construction
Two pumping mains to transfer sewage from Yuen Long Sewage Treatment Works to the sewer tunnel beneath Castle Peak Range	1200/1200	Along Tin Wah Road and eastern side of Western Drainage Channel	2000 - 2003 under review
Two pumping mains to serve Sha Kong Wai and Lau Fau Shan	200/250	Along western side of Western Drainage Channel	1999 - 2001 under review
One pumping main to serve Mong Tseng Tsuen and Mong Tseng Wai	150	Along western side of Western Drainage Channel (Extension)	2001 - 2003 under review

7.6.32 Concurrent with this engineering investigation for the RZ and related developments, a separate study entitled "Review of Yuen Long and Kam Tin Sewerage and Sewage Treatment Requirements" was commissioned by EPD in December 1995 to review the sewerage facilities in a sub-regional context taking account of the latest development forecasts. Its completion is presently scheduled for December 1996. One of the objectives of the review is to assess whether all sewage flows from the latest Tin Shui Wai development could be discharged to Ha Tsuen Pumping Station or part of the sewage flows would have to be discharged directly to San Wai Sewage Treatment Works. Technical Note No. 1 of the review issued in February 1996 indicates that Ha Tsuen Pumping Station has sufficient capacity to receive all sewage flows from the ultimate Tin Shui Wai development.

7.6.33 The Average Dry Weather Flows (ADWF) generated from the Priority Sites are summarised in Table 7.36. These data are consistent with those contained in the final Preliminary Sewerage Assessment Report issued in April 1996 under the Assignment.

Table 7.36
Estimated Sewage Flows Generated from Priority Sites

Planning Area	Land Use	Total ADWF (m^3/d)
3	HOS	4872
30	Rental	2320
31	HOS	4688
102	Rental/HOS	6542
103	SC	3411
104	R2	2145

Notes:
HOS Home Ownership Scheme
SC Sandwich Class Housing
R2 Residential Zone 2

Sewerage Plan

Priority Sites

7.6.34 A preliminary sewerage assessment was conducted in the earlier part of the Assignment to investigate sewerage options for the Priority Sites. The findings and recommendations are contained in the final Preliminary Sewerage Assessment Report issued in April 1996. The report has been discussed at working group and steering group meetings for the Assignment and a sewerage plan selected.

7.6.35 The sewerage plan entails discharging sewage generated from the Priority Sites to Ha Tsuen Pumping Station via the existing sewerage network in the DZ and constructing a new sewage pumping facility on the western fringe of TSW under a 2-stage implementation programme.

7.6.36 Stage I utilizes the existing TSW sewerage network as an interim arrangement to meet the early population intakes of the development at Areas 3, 30 and 31. The interim arrangement will last for about two years until the final sewerage scheme under Stage II is complete. A short section (approximately 500 m) of the trunk sewer beneath Tin Shing Road will be surcharged but still have adequate factor of safety against overflow. In assessing the surcharged condition, sewage from Area 33 has been excluded in view of the high priority of the development at Areas 3, 30 and 31 and the unconfirmed status of the Area 33 development. Additional provision will be required if first occupation of the development at Area 33 takes place before completion of Stage II.

7.6.37 Stage II involves constructing new gravity sewers beneath Roads L12, L13 and L14 and Tin Wah Road, a new sewage pumping station at Area 101 and a pair of rising mains along the Western Drainage Channel to convey sewage generated from Areas 102, 103 and 104 to Ha Tsuen Pumping Station. In order to dispense with the surcharge condition caused under Stage I to the existing TSW sewerage system, provision will be made under Stage II to re-route sewage from receiving points 27a, 31b and 33b for Areas 27, 31 and 33 respectively to the proposed trunk sewer beneath Tin Wah Road. After re-routing of the sewerage, the existing TSW sewerage network will be reverted to normal flow condition with no surcharge.

Remainder of Development

7.6.38 The recommended sewerage network for the Developments, expanded from that for the Priority Sites, is shown on Figure 7.25. Sewage from the whole RZ, except Area 121 will be discharged through a network of gravity sewers in carriageways discharging to the proposed sewage pumping station at Area 101 which will in turn discharge to Ha Tsuen Pumping Station. All sewage installations including the sewage pumping station at Area 101 and the associated rising mains provided for the Priority Sites will be designed for the ultimate flows of the Developments and therefore no re-construction will be required.

7.6.39 It is proposed that sewage from Area 121 will be discharged via a gravity sewer to the proposed SMP pumping station.

7.6.40 No sewage is expected, as established in the sewage flows inventory, to be generated at Areas 118, 119, 122 and 123 which have been designated as Conservation Areas or Green Belts in the Report on Preparation of Layout Plans for Tin Shui Wai Reserve Zone. No sewerage provision is therefore proposed for these Areas.

7.6.41 This plan is in line with the current findings of the Review of Yuen Long and Kam Tin Sewerage and Sewage Treatment Requirements to discharge sewage generated from the whole of the Tin Shui Wai development to Ha Tsuen Pumping Station.

7.6.42 Considerable attention to the acceptability of Urmston Road as a receiving water and alternative routes for transport of NWNT sewage to Urmston Road involving variations and combinations of a tunnel through the Castle Peak Range and a pipeline along the Deep Bay coast were considered in the *Further Study North West New Territories Sewerage Scheme*. The outfall has been designed to disperse the effluent so that there is minimum impact on the receiving water body and environs of the Urmston Road tunnel.

7.6.43 A potential impact on the water quality in the area would be the failure of the sewage pumping station. In this event, large volumes of sewage would flow into the WDCE, causing extensive organic pollution with potentially devastating consequences on the wildlife in the channel and downstream in Inner Deep Bay. Thus the pumping station has been designed with standby pumps and emergency generators.

7.6.44 It is recognised that adequate preventative maintenance should be carried out in the pumping station.

Summary of Mitigation

7.6.45 The following table summarises the mitigation measures for the operational impacts:

Table 7.37
Mitigation for Operational Impacts

Operational Impact	Mitigation	Frequency
Urban Stormwater Runoff (see section 7.7 for details)	Preliminary devices ie. grass verges swales, porous pavements etc. Settlement pond at the EDC outfall Formation of Constructed wetland (see Section 7.6 for details)	Dredge settlement pond approx. every 3 years or less frequently depending on sedimentation rate
Dredging in WDCE	Dredging in the WDCE should take place in a split and section fashion to allow for speedy recolonisation	Dredging is anticipated to be once every 10 years on present sedimentation rates for the WDCE and the EDC. On one bank should be dredged first and the opposite bank 5 years later if extended lengths of the channel is to be dredged.
Increase in sewage volumes	Standby pumps and emergency generators Frequent checking and good preventative maintenance	

Conclusion of Operational Impacts

7.6.46 The operational impacts from dredging in the channels is considered minimal as impacts are only encountered approximately once every 10 years. There are adequate facilities for the increase in sewage generated from the RZ and therefore this operational impact can be contained.

7.7 Urban Stormwater Runoff Impact Assessment

Introduction

7.7.1 "when a city takes a bath, what do you do with the dirty water?"[10]

7.7.2 The Brief for the TSW EIA stipulated that an Urban Stormwater Runoff Impact Assessment be undertaken in a qualitative manner with a limited amount of quantitative backup. The purpose of the study was to assess the impacts of the urban activities and surface runoff of the proposed Development and Engineering Infrastructure/Upgrading Works upon environmentally sensitive Inner Deep Bay. Recommendations of cost-effective measures to minimise the impacts "shall include but not be limited to source and planning control, careful infrastructure design and cautious construction methods".

7.7.3 Any water-related impact arising from water transported through drains or culverts to be constructed under the Project can be seen as an operational impact of the Project. As is accepted practice in Hong Kong for noise impacts arising from infrastructure works or upgrading works, the degree of responsibility for mitigation should be dependent upon the degree of change resulting from the works and the actual extent of the works. The meaning of "proposed Development" includes Areas 3, 30 and 31 and the whole of the RZ.

7.7.4 Currently housing is available for about 110,000 people on the DZ. Housing in Areas 13 and 28 (Lot 6) have been under construction during the period of the EIA study. These areas will soon be occupied by another 20,000 people. Applications for private developments in the DZ for an additional 10,000 people are in process. Areas 3, 30 and 31 will provide residences for another 51,000 people. The final total residential population of the DZ will be between 190,000 and 200,000.

7.7.5 Thus at the time of the Urban Stormwater Study the population of the DZ was about half of its final population. The stormwater infrastructure studies, however, indicate that the current culvert system is adequate in capacity and no upgrading is necessary.

7.7.6 Apart from the culverts under Tin Wah Road, the stormwater infrastructure for the RZ is completely undeveloped and the current population is zero. The final residential population for the RZ is projected to be almost 120,000 people.

7.7.7 Thus at the current time, TSW has less than a third of its ultimate population. The commercial/recreational facilities for the existing population, although adequate, are still being extended.

Approach to the Assessment

7.7.8 Urban stormwater runoff and its associated impacts are not normally addressed as key impact studies in Hong Kong environmental assessments. The environmental effects of urban stormwater are becoming increasing recognised elsewhere and a variety of

[10] Field R.A., Lager, T.A., Urban runoff pollution control - State-of-the-art. J. Environ. Eng. Div. ACSE 101, EE-1, 107-125 (1975).

legislation and code of practices are now in operation overseas. Runoff from rainfall, especially in urban areas, washes pollutants out of the air and off the land into the oceans via the receiving waters.

7.7.9 This assessment reviews the current status of the relevant Hong Kong legislation and discusses the US Environmental Protection Agency (USEPA) approach and experience. The standards for the European Community are very varied, but in general rapidly proceeding towards increased protection of water-bodies downstream of urban centres.

7.7.10 This assessment then identifies the potential impacts from urban stormwater and presents the results of a small quantitative study conducted on stormwater quality associated with the DZ.

7.7.11 The water quality results from the DZ are compared to stormwater quality in the United States. Measures found to be effective and practical elsewhere in the world for the mitigation of urban stormwater impacts are presented.

7.7.12 Finally, measures to be implemented in the proposed development in TSW are presented.

Current Legislation and Standards

7.7.13 In Hong Kong, there is no legislation in place that deals specifically with urban stormwater runoff.

7.7.14 The *Water Pollution Control Ordinance (WPCO) [Cap. 358], 1981* is the principal legislation for the control of water pollution and water quality. TSW basin falls within the Deep Bay Water Control Zone. The Technical Memorandum (TM 1991) gives standards for effluents discharged into drainage and sewerage systems, inland and coastal waters. The standards do not apply to discharges controlled by the *Waste Disposal (Livestock Waste) Regulations* nor to dredging, dumping for land formation or solid waste disposal.

7.7.15 It is recognised in the TM that most stormwater drains discharge directly into inland or coastal waters.

> *The Authority will not normally allow effluents to them. If exceptionally, he does so, effluents to them must meet the standards for the next receiving waters downstream.*

7.7.16 The standards for discharges to inland waters vary according to the beneficial end-use which in the case of TSW is the Ramsar Site. The TM standards are designed for point effluent discharges. Consequently it is to be expected that urban stormwater runoff should be cleaner than that required for point effluent discharges. Throughout the remaining text the standards adopted for discussion are those of Group D, the least stringent, which are usually adopted for those waters draining urban and semi-urban areas and Group B that which should be adopted for discharges ultimately draining to the Ramsar Site (Appendix A). Due to the toxic levels of ammonia in the drainage channels the adoption of a limit of pH 10 as per Group D Standards is particularly inappropriate. A maximum pH of 8.5 as per that for Group B waters and the *Deep Bay Guidelines (DBG)* is essential until livestock waste pollutant levels are much lower.

7.7.17 To date, it has not been normal practice to assess stormwater effluents according to the TM. There has been a tacit assumption that contaminated stormwater arises in Hong Kong as the result of illegal expedient connections or illegal discharges.

7.7.18 Construction site runoff, with the exceptions noted above, is considered a discharge and is governed by the TM standards.

7.7.19 Cap. 358 section 8 makes it an offence to discharge waste or polluting matter or any matter leading or likely to lead to a substantial aggravation of pollution into waters of Hong Kong and inland waters. However, it excludes discharges which are made by way of a communal drain or discharges of unpolluted water.

7.7.20 The Deep Bay Guidelines (DBG) were formulated to protect the Special Measures Zone, now the Ramsar Site, and give water quality objectives for the waters of Inner Deep Bay. In some cases, these standards are more stringent that the Water Quality Objectives under the WPCO. WQO are usually more stringent than TM Standards as dilution of fixed source discharges is expected as the result of mixing with storm water and marine water. Details of the standards are given in Appendix A.

7.7.21 Cap. 358 Section 9 makes it an offence to discharge any matter into a communal drain other than "unpolluted water". "Unpolluted water" means:

(a) rainwater from any part of a building, including any area appurtenant to a building;

(b) water which does not contain any poisonous noxious or polluting matter.

However Section 9 does not apply to "water used for the cleansing of streets, thoroughfares, and other areas".

7.7.22 The HKPSG requires that the requirements of the beneficial uses of water bodies be considered to ensure that proposed land use will not be in conflict with the beneficial uses. These uses include such purposes as sources of food; navigation and shipping; and recreation as well as SSSIs.

7.7.23 In the United States, the *National Water Quality Inventory, 1988 Report to Congress* concluded that pollution from diffuse sources such as runoff from urban areas is the leading cause of water quality impairment and in 1987 congress passed the Water Quality Act of 1987 (WQA). On November 16, 1990 the USEPA promulgated the final stormwater regulations establishing requirements for stormwater permit allocations. The US now requires, via federal legislation, that all major populated areas develop programmes to effectively reduce such pollution and requires all municipalities to obtain National Pollution Discharge Elimination System (NPDES) Permits for their stormwater discharges.

7.7.24 Federal regulations are adopted in various ways by the state authorities. This has led to a very complex approach to water quality control. The common practice is that for municipalities over a certain size, commonly 100,000 people, a general stormwater permit may be required. The stormwater quality requirements are established as conditions of the general permit on a case-by-case basis. This system has led to clean-up of stormwater particularly where the stormwater discharges into natural waters with beneficial uses sensitive to water quality.

7.7.25 The following criteria are typical of those applied for the protection of aquatic life:

Criteria for Protection of Aquatic Life
(10 CSR_{20-7} - Clean Water Commission - 31/10/96)

Chlorine (total residual)	10 µg/l
Hydrogen sulphide (un-ionized)	2 µg/l
Dissolved oxygen minimum	5 mg/l
Oil and grease	10 mg/l
Arsenic	20 µg/l
Beryllium	5 µg/l
Cadmium	9 µg/l
Chromium	62 µg/l
Copper	19 µg/l
Iron	1 mg/l
Lead	9 µg/l
Mercury	0.5 µg/l
Nickel	360 µg/l
Selenium	5 µg/l
Silver	3.5 µg/l
Zinc	241 µg/l

7.7.26 These criteria for metals are less stringent than those of the DBG water quality objectives (Appendix A) but more stringent than the TM standards as would be expected as a fundamental difference between water quality objectives and standards for point effluent discharges.

7.7.27 In addition to criteria like those above which are applied to classified waters, many other criteria apply such as:

a) Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.

b) Waters shall be free from substances in sufficient amounts to cause unsightly colour or turbidity, offensive odour or prevent full maintenance of beneficial uses.

c) Waters shall be free from substances or conditions in sufficient amounts to result in toxicity to human, animal or aquatic life.

d) Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community.

7.7.28 In cases where the water quality is better than the criteria, further degradation is not allowed unless it is deemed, after due consideration, that lowered water quality is necessary to allow important economic and social development to take place. The evaluation process must show that all cost-effective and reasonable best management practices for nonpoint source control have been applied before any lowering of water criteria can be considered.

Potential Impacts from Urbanization

7.7.29 At the present time, the RZ and parts of the DZ are typical of undeveloped land in that very little rainwater enters the nearby channels during or soon after a storm. The majority of the rain falling on undeveloped lands is lost through evapotranspiration, canopy interception and soil infiltration.

7.7.30 During the further development of TSW, the area will be extensively urbanised with the majority of the built-up area being covered with concrete. Developed areas have increased surface runoff due to the increase in impervious surfaces such as roads, pavements, car parks etc. This results in high stormwater runoff coefficients of around 0.70 to 0.95 (WEF/ASCE 1992) causing the majority of the stormwater to run off the land in the first few hours after the storm and very little, being lost due to soil infiltration. Wet weather discharges will increase whilst dry weather discharges may either increase or decrease depending upon localised conditions. In general, the increased urbanisation of TSW will result in increased wet-weather runoff with the stormwater drainage system conveying the water much more readily than the previous natural surfaces.

7.7.31 Groundwater can also be affected by the changes in stormwater runoff characteristics (Pitt et al. 1994). Prior to urbanization, groundwater is recharged by rainfall-runoff infiltrating through the pervious natural surfaces including grass lands and woodlands. This infiltrating water is relatively uncontaminated. Urbanization, however, reduces the permeable soil surface area through which groundwater is recharged.

7.7.32 Much research has been conducted on stormwater runoff (WEF/ASCE 1992) and the typical effects of urbanisation of the RZ, excluding possible effects on groundwater, can be summarised thus:

(i) the total runoff will be greater after urbanisation due to decrease in infiltration and depression storage

(ii) the runoff will occur more rapidly due to greater flow velocities in the drainage system, and

(iii) the peak discharge will be greater due to the larger runoff volume occurring over a shorter time.

7.7.33 Urbanisation will also have a greater impact on frequent storm events than on rare events.

7.7.34 The stormwater runoff from the RZ may be expected to contain significant concentrations of pollutants which will vary depending upon the point source of the runoff (ie, residential, commercial, carparks etc). Sources of pollutants in urban runoff include atmospheric fallout, vegetation and leaf litter, land surface erosion, oil and chemical spills, pavement wear, car and truck emissions, airborne materials that have settled to the surface or have been washed out of the air by precipitation, rubber particles from vehicle tyres, asbestos fibres from brake linings, animal and bird droppings, pesticides and fertilizers, leaves and grass clippings, building erosion and plastic or other such persistent litter.

7.7.35 The most common forms of pollution identified in the US (USEPA, 1983) are suspended sediment, heavy metals, organics including oil & grease, oxygen-demanding substances and bacteria including *E.coli*. Canadian studies (Internet Document) have also indicated that there can be an expected increase in phosphorus and other nutrients and PAHs have also been identified as a pollutant of concern (Marsalek 1986). Generally the input of petroleum hydrocarbons to the marine environment from urban runoff can be 3.8% compared to 3.1% from refineries (Oil Spill Intelligence Report 1985).

7.7.36 In order to determine the likely degree of pollutants in stormwater runoff from TSW, a limited amount of stormwater pollutant monitoring was conducted on the DZ during March 1996 as described below.

Urban Stormwater Runoff Water Analyses

Methodology

7.7.37 To assess the potential pollutants in urban stormwater runoff from the RZ, samples of runoff were taken from TSW DZ. In total, 11 stormwater sampling stations were identified on the DZ: 7 stormwater drains and 4 stormwater culverts. Each sampling location being representative of a different land use, such as public housing, private housing, bus depots, markets, construction sites and other various activities. The 11 stations are shown on Figure 7.36 and are labelled A-K.

7.7.38 Due to expectations that pollutant levels in the stormwater runoff from the DZ would be fairly dilute, it was decided that if possible, early flush data should be collected. The DZ has no expedient connections; the buildings and infrastructure are all less than five years old; no obvious malpractices or illegal practices occur and the area is either covered in clean paved areas, landscaped or still undeveloped.

7.7.39 Due to the nature of the weather in Hong Kong, where most of the early storms are flashfloods lasting only a few hours, it was realised that it would not be feasible to mobilise and collect samples during the rainstorm. In order to catch the first rains of the season, and hence contaminated runoff, it was decided to place sample bottles in the stormwater drains and leave them in place with the hope that the runoff would fill the drain sufficiently to fill the sampling bottles which were then retrieved as soon as the monitoring staff could be mobilised during or after the storm. During retrieval, additional samples were taken including *in situ* analysis of temperature, dissolved oxygen, turbidity and pH.

7.7.40 Large, 5-litre precleaned HDPE sample bottles were provided and positioned in the storm-drains such that they would collect water when the drains were flowing at half capacity thus collecting representative samples for the rainstorm event. The bottles were labelled C_1, D_1, E_1, F_1, J_1 and K_1.

7.7.41 The bottles were put in place on 28th March 1996. The first heavy rainstorm of the year occurred the following morning (60 mm), 29th March 1996 from 6 a.m. to 11 a.m. Samples were collected between 1-4 p.m. on 29th March 1996.

7.7.42 During collection of the bottles additional samples were taken together with samples from the culverts. These samples were labelled A_2 to K_2.

7.7.43 The parameters tested were:

a) In situ Analysis

DO, Turbidity, pH, Temperature, Conductivity;

b) Laboratory Analysis

Suspended Solids, BOD, Oil and Grease, TP, TKN, Ammonia, *E.coli*, TOC and TC.

Results

7.7.44 Of the 7 bottles left in place, 4 filled with water and 3 remained empty. During the *in situ* sampling, 3 locations had insufficient flow. A few samples had insufficient volume for all laboratory analyses to be undertaken. A summary of the sample collection is given below in Table 7.38. The drainage areas for each sampling point are given in Table 7.39.

Table 7.38
Summary of Stormwater Sample Collection

Station	Bottle Left in Place	In situ Sampling
A Culvert (EC)	N/A	Sampling conducted
B Culvert (ECC)	N/A	Sampling Conducted
C	Bottle Filled - Sample sent to laboratory	Sampling Conducted
D	Bottle Empty	Sampling Conducted
E	Bottle Empty	No Water Flow
F	Bottle Filled - Sample sent to laboratory	No Water Flow
G Culvert	N/A	Sampling Conducted
H	Bottle Filled - Sample sent to laboratory	No Water Flow
I Culvert	N/A	Sampling Conducted
J	Bottle Empty	Sampling Conducted
K	Bottle Filled - Sample Sent to laboratory	Sampling Conducted

Table 7.39
Land Uses and Areas Associated with Each Sample Point

	Main Land Uses	Approx. Area Drained (ha).
A	High density and low density residential, open space, G/IC, upland, fishponds, vehicles parks, small farms, road runoff, construction site and unused, bare land.	45
B	High density private residential, site for future construction, LRT Depot, road runoff.	34
C	Open space, indoor recreation area.	3
D	Principally open space park area, some high density residential.	18
E	Small open area.	< 1
F	High density residential, commercial.	5
G	High density residential, district open space, road runoff.	17
H	Small area of high density residential and refuse collection point.	1
I	Includes runoff from high density residential and open space. Road runoff.	7
J	High density residential, open space, road runoff, small market.	6
K	Private residential including construction of buildings in Area 28.	6

7.7.45 The results generally showed considerable contamination by *E.coli*, suspended solids, and nutrients such as TKN, ammonia and phosphorus. The parameters TOC and BOD indicated gross organic pollution at Station D. There was no measurable oil and grease found at any of the sampling stations. These results, except for the oil and grease, seem to confirm those found in the US as discussed in later sections. Further sampling and analysis is recommended to build up greater knowledge of the types of pollutants expected, their sources and the expected quantities.

7.7.46 Dissolved oxygen levels for all samples were all within acceptable ranges, varying from 5.7 to 8.0 mg/l. pH for all samples was also acceptable, in the range of 6.60 to 8.25 pH units except station K which had a pH of 12.03. This station was directly next to a construction site and the runoff is therefore indicative of construction site runoff that could occur on the RZ. In addition to the high pH, the turbidity and the suspended solids levels were also extremely high. Suspended solids measured 38,700 mg/l in the first runoff and 13,900 mg/l in the second runoff with turbidity readings of >10,000 NTU for both first and second runoffs. The water quality at Station K illustrates the degree of pollution that could be caused during the further development of TSW if disposal of concrete washings is undertaken carelessly.

7.7.47 High *E.coli* results were recorded at stations A, F, G, H, I and J with station H recording levels of 130,000 CFU/100 ml. Station H is in a new private housing estate which also contains the refuse collection and transfer station which could account for the high *E.coli* levels.

7.7.48 The results are given in Table 7.40.

Table 7.40 Results of Stormwater Runoff Analysis

Station	Comment	Insitu Analysis					Laboratory Analysis									
		DO mg/l	pH	temp °C	Conductivity mS/cm	Turbidity NTU	E.Coli CFU/ 100 ml	SS mg/l	NH3 mg/l	TKN mg/l	TP mg/l	TOC mg/l	TIC mg/l	TC mg/l	Oil & Grease mg/l	BOD mg/l
WQO - Deep Bay WQCZ[1]		4	6.5-8.5	--	--	--	1,000	--	--	--	--	--	--	--	--	<5
TM - Inland Waters Group D		--	6-10	<30	--	--	1,000	<30	<20[2]	--	5-10	--	--	--	<10	<20
TM - Inland Waters Group B		-	6.5-8.5	<30	-	-	100	< 30	< 5	5-10	--	--	--	--	<10	<20
A2	Culvert	6.5	6.60	20.5	0.6	**121**	**49,000**	**110**	2.3	3.9	0.66	15	23	38	<5	5
B2	Culvert	8.0	7.35	20.7	1.9	**70**	**13,000**	45	0.4	0.4	0.24	7	17	24	<5	6
C1	1st Runoff	--	--	--	--	19.5	790	**980**	0.1	0.1	0.42	7	14	21	<5	3
C2	2nd Runoff	7.3	6.11	22.4	0.3	31.3	**2,200**	**115**	<0.1	0.2	0.25	4	16	20	--	5
D1	1st Runoff	Bottle Empty - No Sample Collected					Bottle Empty - No Sample Collected									
D2	2nd Runoff	7.7	6.83	23.1	0.0	**144**	**1,700**	**320**	--	--	--	**225**	14	**239**	--	**744**
F1	1st Runoff	--	--	--	--	**599**	**49,000**	**620**	2.8	2.8	**1.83**	4	8	12	<5	9
F2	2nd Runoff	No Flow - No Insitu Analysis					No Flow - No Sample Collected									
G2	Culvert	6.2	8.25	25.4	0.5	**172**	**110,000**	**95**	3.3	--	0.62	14	17	31	<5	8
H1	1st Runoff	--	--	--	--	10.2	**130,000**	**170**	<0.1	<0.1	0.19	9	21	31	<5	2
H2	2nd Runoff	No Flow - No Insitu Analysis					No Flow - No Sample Collected									
I2	Culvert	5.7	7.70	23.2	0.6	**135**	**79,000**	**90**	4.3	**5.8**	0.65	17	21	38	--	10
J1	1st Runoff	Bottle Empty - No Sample Collected					Bottle Empty - No Sample Collected									
J2	2nd Runoff	7.2	7.20	21.1	0.1	**58.4**	**70,000**	**135**	0.7	3.4	0.63	19	15	34	--	**36**
K1	1st Runoff	--	--	--	--	**>10,000**	<2	**13,900**	2.3	2.3	<0.01	14	<1	14	<5	13
K2	2nd Runoff	7.7	**12.03**	23.9	3.1	**>10,000**	<2	**38,700**	--	--	--	--	--	--	--	7

1st Runoff	Sample bottle left in-place to catch first stormwater runoff
2nd Runoff	Sample collected at the same time as insitu analysis and retrieval of 1st runoff bottles
DO	Dissolved Oxygen
SS	Suspended Solids
NH3/TKN	Ammonia/Total Kjeldahl Nitrogen
TOC/TIC/TC	Total Organic, Total Inorganic and Total Carbon
TP	Total Phosphorus
BOD	Biological Oxygen Demand
1	Yuen Long & Kam Tin Subzone
2	<2 mg/l for Group C waters

7.7.49 Metal analyses were also undertaken on a limited number of samples. These results are given below in Table 7.41.

Table 7.41
Concentration of Metals in Urban Stormwater Runoff

Parameter µg/l	Deep Bay Guidelines	C1	F1	H1	K1
Cd	1	<0.2	<0.2	<0.2	<0.2
Cr	15	<1	1	7	<1
Cu	5	1	3	20	2
Ni	30	1	12	3	<1
Pb	10	<1	<1	14	<1
Zn	40	10	60	<10	50

7.7.50 The TM Standard for Group D Inland Waters is less stringent than the Water Quality Objectives and is normally applied to "polluted" discharges not "unpolluted" stormwater discharges. Consequently, it seemed reasonable to expect that stormwater from the DZ should meet the TM, otherwise the "polluted" waters from industry etc. would be diluting the "unpolluted" stormwater. Point effluent discharges often run continuously in contrast to storm water. However illegal discharges made to storm-water drains can occur during dry periods.

7.7.51 The discharges analyses were from the first major rains but not the first flush discharges. The DZ is relatively clean. The development on the DZ will double in the next few years. Viewed in these contexts the levels of some pollutants were high. With the possible exception of location K, pollution levels similar to those measured are likely in the long term particularly as first flushes. The data can be used to estimate 'worst case scenario' loadings.

7.7.52 *E.coli* levels were up to 100 times those stipulated as maximum by the TM. All SS levels exceeded the TM and most samples exceeded the TM many fold. The weighted average SS level for all sites was 1,200 mg/l. Omitting samples from location K, suspended solids levels still averaged at a very high 148 mg/l. The two culverts discharging directly into the WDC had SS levels of about 90 mg/l.

7.7.53 Assuming TSW to have an area of 4 km^2 (TELADFLOCOSS 2) and an annual average rainfall of 2,000 mm then the annual stormwater is approximately 40 million m^3 for the TSW drainage basin and 8 million m^3 for TSW itself. The average runoff for TSW is equivalent to 22,000 m^3/day which exceeds discharges rates tabulated in the TM. Discharge levels from industry which exceed the TM such as the cooling waters from the power stations are normally given more stringent standards than those within the TM tables.

7.7.54 A simple prediction for sediment loading in TSW urban stormwater based on the above data and including location K is 9,600 tonnes per year or, excluding location K, 1,184 tonnes per year. This is about 1/8 or 1/30 of the estimated loadings of livestock waste for the TSW basin made in TELADFLOCOSS 2.

7.7.55 The weighted average BOD was 103 mg/l. Location D showed a level of over 700 mg/l. Excluding Location D, the average BOD was 7 mg/l. This gives an annual BOD loading of 560 tonnes BOD based on the weighted average, 5,600 tonnes BOD based on Location D levels alone and 72 tonnes based on the weighted average excluding Location D BOD levels.

7.7.56 The average ammonia concentration was 1.7 mg/l as compared to 2 mg/l as the maximum in the TM for Group C Inland Waters. Group C is for waters used for fish pond culture. More estimates of loadings etc. are presented later in this section under the heading: "Parameters and their Associated Impacts".

7.7.57 Many questions arise from this data. Are these levels of pollutants normal for stormwater? Where do they arise? Are they serious impacts in the context of the current project? What mitigation can be undertaken?

7.7.58 These questions are addressed in the following sections.

Potential Sources of Pollutants in Stormwater Runoff

7.7.59 Potential sources of pollutants can be divided into two categories:

(i) non-stormwater sources; and

(ii) runoff related sources.

7.7.60 Stormwater drains are designed primarily to remove rainwater from storm events. However, materials from other sources may find their way into the stormwater system and ultimately be discharged along with the stormwater runoff into the receiving waters, in this case the WDCE and downstream channel, the EDC and Inner Deep Bay. These additional pollutants may include heavy metals, nutrients, oil & grease, organics and pathogens. The major potential sources of non-stormwater discharges from TSW are outlined below:

Non-Stormwater Sources

Improper Disposal

7.7.61 Materials that are improperly (or illegally) disposed of either into the ground or directly into the stormwater system can be a major cause of stormwater contamination. Improper disposal usually occurs due to the public's mistaken belief that disposal to street drains is an environmentally acceptable and sound practice. Materials commonly disposed of include oil and grease, including cooking oils and wastes from restaurants, toxic household chemicals, general litter and construction wastes such as cement-truck washing although all of these activities are in fact illegal in Hong Kong.

7.7.62 Dog faeces contribute to the organic load, but this impact can be reduced through public education, regular street cleaning with proper disposal of the collected waste and control of the stray dog population.

Spills

7.7.63 Spilled materials have a high potential for entering the stormwater system, then quickly passing to Inner Deep Bay. Materials may be spilled during transport, transfer and use. The materials spilled could include:

(i) petrol, fuel oils and diesel oils;
(ii) hazardous chemicals being transhipped through the area;
(iii) cement for construction sites; and
(iv) solvents used in cleaning or on construction sites.

The chance of a spill occurring increases with the volume of material handled. Item (i) above has the largest volumes handled while (ii) includes highly toxic materials.

'Expedient' Connections

7.7.64 Expedient connections to the stormwater system usually consist of residential sewers and industrial sewers being cross connected either illegally or in the mistaken belief that the waste is going to a foul sewer acting as overflow devices. In newer systems, cross connections may be designed when the hydraulic capacity of the sewage system exceeds the designed capacity. As TSW is a new residential area, the likelihood of any unplanned cross connections is very slight.

Interactions with Foul Sewage Systems

7.7.65 Sewage infiltration usually occurs only in older systems due to deterioration of the pipes, manholes and joints and is not expected to be a problem on TSW. However, such problems may arise in the future.

Malfunctioning septic tanks and contaminated groundwater infiltration

7.7.66 Due to the nature of the TSW site, there is little likelihood of contamination from septic tanks and there are no nearby villages. Contaminated groundwater infiltration usually occurs in industrialised areas and should pose no threat in Tin Shui Wai.

Discharge from off-site sources

7.7.67 Various areas, not directly connected with the RZ, may nevertheless discharge or drain into the RZ stormwater system and associated receiving waters. These areas include farms and factories to the north and west of the RZ which may drain into the WTC and areas to the east and south which drain into the ETC. There is an industrial estate at Kiu Tau Wai which drains into the WDC upstream of the inflatable dam. This estate has numerous factories including plating, canning, dyeing and metal works, a paper mill, a weaving factory and chemical storage companies.

7.7.68 The ETC is fed by two culverts, the Eastern Central Culvert from the DZ which feeds into the Eastern Culvert (formerly the Tai River) and the North-eastern Culvert to be constructed under the Project. The Eastern Culvert carries discharge and stormwater runoff from the villages to the south-east and east of the DZ which contain some car repair yards and a large vehicle park.

Construction Site Runoff

7.7.69 During the early stages of the development of the RZ, the majority of the runoff will be from various construction sites. Construction site runoff is considered a polluting discharge by EPD and advice on handling and disposal of construction site discharges, including site runoff and contaminated wastewaters, is provided in the ProPECC Paper (PN1/94) on Construction Site Drainage. The discharges from the construction sites are controlled by the Water Pollution Control Ordinance (WPCO) and governed by the Deep Bay Water Quality Objectives. The major pollution problems associated with construction site runoff, as identified in the ProPECC paper are:

(i) siltation in storm drains caused by excessive sand and silt in the storm runoff;

(ii) visual nuisance and hazard to aquatic life caused by discharge of muddy water into streams or the sea;

(iii) pollution caused by improper handling and disposal of other types of construction site wastewater such as sewage for site toilets.

7.7.70 Construction site runoff is usually limited to suspended solids, cement waste, oil and grease. Other pollutants present in smaller amounts include solvents and human waste from the on-site construction crews. In order to reduce suspended solids runoff into lower Deep Bay, with associated hazards for the benthic community, all construction sites should be equipped with sediment traps in stormwater drains and stock piles of sand, cement and other construction material should be kept covered when not being used.

7.7.71 Cement is composed primarily of lime with some clay or sand used in smaller amounts. The water pollutants associated with cement runoff, consist of high pH, high dissolved solids and suspended solids, high levels of alkalinity, potassium,and sulphate. Cement waste runoff should be controlled to reduce the impact on the aquatic environment. This is particularly important when ammonia levels are high.

7.7.72 Waste oils and other chemicals are controlled by regulations for chemical waste under the *Waste Disposal Ordinance* and must be disposed of at the Government Chemical Treatment Centre at Tsing Yi or at other licensed disposal sites.

Industrial Runoff

7.7.73 Tin Shui Wai will be primarily residential with no industrial waste runoff.

Runoff Related Sources

General Runoff

7.7.74 Dusts gather in any household every day. They arise in a diffuse manner from pollutants in the air, from clothing and bedding, from the goods used, cooking and so on. Consequently, we choose to wash ourselves and our clothes frequently and dust, vacuum and wash our households. This water is considered relatively dirty water or 'grey' water and forms part of our sewage input.

7.7.75 In a similar manner, 'dirt' collects in our urban environments and is washed away by the rain. Just as occurs in households, the more intense the activity and the more populated an area, the dirtier the stormwater is likely to be. These pollutants are also flushed to sensitive downstream environments faster with increasing use of concrete culverts.

7.7.76 Pollution from residential and commercial lands has been extensively investigated particularly in the US with the most notable study being the Nationwide Urban Runoff Program (NURP) which evaluated data collected from 81 different sites between 1978 and 1983 as shown in Table 7.42. Although the urban and commercial environment in Hong Kong is different to that in the US, the data collected in this study can be used as a guideline for assessing whether the pollutants levels measured in the limited quantitative studies are consistent with other urban stormwater discharges potential pollutants and their concentrations.

Table 7.42
Typical Water Quality Characteristics of Runoff from Residential and Commercial Areas of the US as Compared to those Measured on the DZ

Parameter	Average[1] Concentration for Residential or Commercial Site	Weighted Mean[1] Concentration for Residential or Commercial Site	NURP[1] Recommendations for Load Estimates	Weighted[4] Averages Measured in this Study
TSS	239 mg/l	180 mg/l	180-548 mg/l	148 or 1200 mg/l
BOD	12 mg/l	12 mg/l	12-19 mg/l	7 or 103 mg/l
COD	94 mg/l	82 mg/l	82-178 mg/l	-
Total P	0.5 mg/l	0.42 mg/l	0.42-0.88 mg/l	0.5 mg/l
Sol.P	0.15 mg/l	0.15 mg/l	0.15-0.28 mg/l	-
TKN	2.3 mg/l	1.9 mg/l	1.90-4.18 mg/l	2.0
NO3 + 3-N	1.4 mg/l	0.86 mg/l	0.86-2.2 mg/l	-
Cu	53 μg/l	43 μg/l	43-118 μg/l	4 (20[2]) μg/l
Pb	238 μg/l	182 μg/l	182-443 μg/l	2 (14[2]) μg/l
Zn	353 μg/l	202 μg/l	202-633 μg/l	42 (46[2]) μg/l
E.coli	27,000/100 ml [3]			42,000

1 Results of nationwide urban runoff program, NURP, Vol, NTIS PB 84-185552, USEPA, 1983.
2 Highest value from 4 points, C, F, H and K.
3 Faecal coliforms.
4 Please note that only limited sampling and testing of urban stormwater was undertaken during this study during one rainfall incident only.

7.7.77 Suspended solids levels, BOD, total phosphorous and total nitrogen levels show a great deal of correspondence between the US data collected from 81 sites and the data collected for the DZ under this study.

7.7.78 Notably, metal levels are much lower. However, many positive steps have been taken in many parts of the world including Hong Kong which reduce metal levels in the environment. For example plastic piping is commonly used instead of metal pipes. Lead levels in fuels have been drastically cut since the NURP study.

Runoff from Parks and Recreational areas

7.7.79 The RZ will contain a large central park or open area at Area 107 with additional open areas at Areas 114 and 117. Potential pollutants resulting from these open spaces will consist mainly of fertilizers, vegetation waste such as leaves and cut grass, and litter discarded by the public. Regular cleaning and proper disposal of the rubbish collected will considerably reduce this pollution. Parkland has the advantage of providing an infiltration area for runoff prior to it entering the stormwater system.

Runoff from Roads and Carparks

7.7.80 The concentrations of pollutants in the runoff from roads is usually higher than those found in the runoff from residential areas. The major pollutants include oil, fuel oil and diesel, hydraulic fluids, coolants, incomplete combustion of fuel, clutch and brake lining wear, particulate exhaust emissions and debris from vehicles such as rust, dirt, metals, plastics and glass. Indeed, one recent study suggests that the primary source of petroleum hydrocarbons in urban runoff is derived from used crankcase oil, either from washoff of oil deposited by cars and/or from direct disposal of used oil into the stormwater drains (Latimer et.al.). Further studies (Perry et. al., 1985.) have also indicated that in some areas, 50% of solids, 40-70% of metals and 70% of total PAHs can be derived from highway runoff. High levels of lead, copper and zinc (from car tyres) are also associated with road runoff although the levels of lead are declining due to the increased use of un-leaded petrol. Inevitably many of these pollutants will be washed into the stormwater system. Table 7.43 gives values for typical road surface pollutants associated with various particle sizes.

Table 7.43
Street Surface Pollutants associated with various particle sizes
(Source: Sartor and Boyd 1972, U.S. EPA. 1976)

Pollutant	Particle Size	Percentage Composition by Weight
Total Solids	<43 μm 43 μm-246 μm >246 μm	5.9 37.5 56.5
BOD5	<43 μm 43 μm-246 μm >246 μm	24.3 32.5 43.2
COD	<43 μm 43 μm-246 μm >246 μm	22.7 57.4 19.9
Volatile Solids	<43 μm 43 μm-246 μm >246 μm	25.6 34.0 40.4
Phosphates	<43 μm 43 μm-246 μm >246 μm	56.2 36.0 7.8
Nitrates	<43 μm 43 μm-246 μm >246 μm	31.9 45.1 23.0
Kjeldahl Nitrogen	<43 μm 43 μm-246 μm >246 μm	18.7 39.8 41.5
Heavy Metals	<43 μm-145 μm 145->246 μm	51.2 48.7
Pesticides	<43 μm-145 μm 145->246 μm	73 27
PCBs	<43 μm-145 μm 145->246 μm	34 66

Parameters and Their Associated Impacts

General Impacts

7.7.81 Stormwater impacts can usually be divided into three general classes:

(i) Short-term
(ii) Long-term
(iii) Physical impacts

7.7.82 Receiving waters with low flushing such as those found at Tin Shui Wai are generally more sensitive to long-term changes and physical impacts such as sedimentation. The large volumes of water flushed into the receiving waters during storm events also pose short-term problems. Inner Deep Bay water quality is such that eutrophic events are highly likely with even small changes to the conditions.

Sensitive Receivers

7.7.83 The sensitive receivers for the stormwater runoff include the following:

(i) the Western Drainage Channel and the channel downstream of inflatable dam;
(ii) the Eastern Drainage Channel;
(iii) The TSW mudflats: the Ramsar site; and
(iv) the remainder of the Ramsar site.

7.7.84 The effect of the various identified pollutants associated with urban stormwater runoff on sensitive receivers are outlined below. It must be emphasized that all data applies to the first rain and hence is the worst case scenario. The true averages and loadings will be much lower.

Suspended Sediment and Turbidity

7.7.85 Suspended Sediment (SS) is the most common form of stormwater pollution, with average figures recorded in the US an order of magnitude greater than that commonly found in discharges from sewage treatment plants offering secondary treatment. Results from the DZ indicated SS levels as high as 40,000 mg/l and turbidity readings of >10,000 NTU in runoff from a construction site at station K emphasizing the importance of control of construction site runoff.

7.7.86 Increase in SS levels has a potentially damaging impact on the hydraulics of Deep Bay and the benthic organisms of the sensitive receiver areas. The major potential physical impacts are:

(i) loss of benthic habitat from smothering of the benthic organisms, including eggs and other immature forms of free-swimming organisms;

(ii) reduction in oxygen exchange and oxygen levels due to oxygen demanding pollutants attached to sediment particles;

(iii) decrease in light penetration resulting in reduced photosynthesis and a loss of aquatic vegetation used as habitat and food.

7.7.87 Pollutants bound to the sediment particles, although initially bound and therefore biologically unavailable, may be re-mobilised and enter the food chain.

7.7.88 Increased SS could also potentially pose a problem by depositing sediments in the drainage channels, requiring more frequent maintenance dredging and affecting the overall hydraulics of the channels.

7.7.89 The weighted average loading can be used to predict daily loading. Omitting station K, the predicted loading for the whole of TSW is 3,200 kg/day. With station K it becomes 26,000 kg/day.

7.7.90 The average SS concentration of 148 mg/l omitting station K is nearly double the 1996 average SS measured at TSR1 in the WDC near Area 16. As TSW is about 20% of the TSW drainage basin, an SS level of 148 mg/l would raise the SS level in the WDC by up to 20%.

Organics and Oxygen Demanding Substances

7.7.91 Aquatic biota, including fish, water living insects, eggs, immature forms of free swimming organisms and benthic organisms require minimum levels of dissolved oxygen to survive. Oxygen demanding substances,i.e. decomposing vegetation and other organic matter, can cause oxygen sags which could result in death or lead to anoxic conditions accompanied by foul-smelling odours. This is of particular concern in the shallow, slow moving channels of the RZ which are close to housing developments.

7.7.92 Oxygen levels within the samples measured would not have had any adverse effect on oxygen levels in the channels or Deep Bay. Indeed the currently poor DO levels in the channels would be improved.

7.7.93 BOD levels measured from the large open space in the centre of the DZ (manhole D) were very high at 744 mg/l. Without runoff from this area, BOD levels averaged 7 mg/l (weighted mean). BOD levels at TSR1 averaged 41 mg/l with a minimum reading of 8 mg/l. With predicted BOD levels of 103 mg/l, the weighted mean including runoff from Station D, the open space area, BOD levels in the channels could rise by up to 20%.

7.7.94 The BOD daily loading estimate is 150 kg without station D and 2000 kg including station D. TOC levels averaged 40 mg/l. This gives a maximum predicted loading of TOC from TSW of 800 kg/day.

Pathogens

7.7.95 Pathogens can enter the drainage system through various means, such as cross-connections, leaking sewers or by animal faeces being washed into the system during a storm or during street cleaning. These water-borne pathogens can be transmitted to man and animals through contact with the receiving waters or by consumption of fish, prawns or shell fish caught or raised in the receiving waters. The highest levels recorded appears to be associated with a refuse collection point.

7.7.96 The weighted mean *E. coli* level was 42,000/100 ml. The 1996 yearly mean at TSR1 was 2 million/100 ml.

pH, Temperature and Ammonia

7.7.97 Small changes in pH cause ionized ammonia to become the unionized form which is high toxic to aquatic fauna. The concrete washings registered at location K were of great concern as any significant volume of these could cause major destruction of aquatic organisms. During the building of most of the residences for the development, the potential exists for changes in pH well out into Inner Deep Bay.

7.7.98 The detection of a pH of 12 was of considerable concern. However, this was due to activities in contravention of the law and normal contractual practice. For as long as total ammonia levels are high in the channels and Inner Deep Bay, even relatively small changes in pH in the two channels should be avoided.

7.7.99 Ammonia levels averaged 1.7 mg/l and hence storm water would dilute ammonia levels in the channel waters. The levels measured in urban stormwater are within the TM standards.

Toxic Substances

7.7.100 Substances, such as heavy metals, PAHs, PCBs, oil and grease and inorganics can exhibit toxicity to various organisms, including Man. Many of these toxic substances accumulate in the sediment of channels such as the EDC and WDCE and downstream channel, accumulating in benthic organisms and upwards through the food chain. Changes in pH, temperature and dissolved oxygen affect the mobilisation of these substances. Heavy metal levels and oil and grease levels were fairly low.

Nutrients

7.7.101 Excessive nutrients can result in the accelerated growth of aquatic plants and algae resulting in eutrophication, low oxygen levels and unpleasant odours. Algal blooms block light and result in drastic reductions in oxygen levels, particularly after the death of the algae. Algal blooms can also result in shellfish poisoning, a major health problem due to the popularity of oyster farming in Inner Deep Bay and Lau Fau Shan.

7.7.102 A bloom from excessive nutrients would be of most concern in the receiving waters of Inner Deep Bay and Tsim Bei Tsui.

7.7.103 Total nitrogen averaged 2 mg/l. Thus the maximum predicted total nitrogen loading from TSW is 4.4 kg/day. This is considerably lower than the current levels entering Deep Bay.

7.7.104 Total phosphorus averaged 0.5 mg/l giving a maximum predicted total phosphorus loading from TSW of 11 kg/day.

Temperature

7.7.105 Temperature changes can affect the concentration of dissolved oxygen that can be carried by the water and may affect the various life cycles of the aquatic organisms. Temperature is not considered to be a major problem at Tin Shui Wai.

Flotables, Plastics and Litter

7.7.106 Degradation of the stormwater system by litter can degrade the aesthetic quality of the receiving waters and pose a hazard to wildlife. Litter should be minimised.

Animal Wastes

7.7.107 Animal waste, most notably dog excrement, can be a significant pollutant contributing organics, nutrients and pathogens to the runoff from the drainage channels into Inner Deep Bay. The levels of nutrients, BOD and pathogens were discussed above.

Mitigation Measures for Urban Stormwater Adopted Elsewhere

7.7.108 Mitigation of urban stormwater runoff is a difficult and involved process, often referred to as more of an art than an exact science. Many countries recognise the need to adopt an holistic approach to the problem and often employ Best Management Practices (BMP) or Best Practical Means (BPM) process to achieve these ends. Over the years however, a few standard empirical rules have been adopted (WEF/ASCE 1992) and can be summarised as:

(i) reduction of runoff peak and volume;
(ii) runoff retention;
(iii) settling of pollutants;
(iv) recovery of floating refuse; and
(v) treatment of dissolved pollutants.

7.7.109 There are two main categories of stormwater control, source control and site control, often referred to as preventative measures and control measures respectively (Phillip, 1992; Schueler, 1987; Arnold *et al*, 1993).

7.7.110 Preventive measures, or source controls, are techniques designed to reduce exposure of materials to stormwater, hence limiting the amount of pollutants picked up by water. However, public use of chemicals is difficult to control. Education is central in the implementation of preventive measures which are very cost-effective in terms of land use.

7.7.111 Site controls generally attempt to reduce the runoff rate and volume from the affected site and include the use of infiltration devices, the use of porous surfaces, silt traps, catch pits and oil & grease traps.

7.7.112 Due to the variation in loadings and volumes of urban stormwater increasing use is being made of wetland technologies for the treatment of pollutants.

7.7.113 A short description of some of the various mitigation methods are given below.

Preventative Measures

<u>Animal Waste Collection</u>

7.7.114 Animal wastes can be best controlled through education which should provide guidance on proper disposal of animal wastes. Regular road cleaning and sweeping with proper disposal of the waste will also help to reduce animal waste loads.

<u>Kerb Elimination</u>

7.7.115 Many countries have found that the elimination of kerbs reduces pollution entering the aquatic environment. Kerbs function as channels for the stormwater, carrying with it sediment and other pollutants. By replacing kerbs with porous filter strips, verges and grass swales, runoff can be spread over large vegetated areas, the velocities reduced and pollutants can settle out and be taken up by plants or soils.

7.7.116 These measures are most suitable in areas of light traffic flow. Any area selected must have good drainage to ensure infiltration of the runoff. These measures are not suitable for large, busy carriageways.

Debris Removal

7.7.117 Floating litter, leaf trash and other waste materials that are not immediately broken down can clog inlets, catch basins, and outlets, lead to overflows, erosion and unintended flooding. Whilst grates on inlets and outlets must prevent entry by children they should be easily cleaned by maintenance crews. Regular road cleaning and sweeping will help reduce the level of waste that enters the system.

Education Programmes

7.7.118 Education programmes can and should play an important part in the cleanup of stormwater runoff. A disproportionate amount of pollution enters the environment through carelessness or ignorance. Methods of informing the public, including public presentations, school programs and pamphlets aimed at children and adults have been shown to be effective in increasing environmental appreciation. The implementation of this will be discussed in more detail in Section 9. With Mai Po Nature Reserve so close, the public at Tin Shui Wai should be encouraged to appreciate their natural environment.

Exposure Reduction

7.7.119 Minimising the exposure of stormwater to pollutants is the most effective control measure. Construction materials should be covered, roads and pavements regularly cleaned and litter disposed of appropriately.

Landscaping

7.7.120 The use of fertilizers and pesticides by professional landscaping services to remove unwanted growth should be replaced by the use of mechanical techniques.

Buffer Zones

7.7.121 Buffer zones are strips of vegetation, either natural or planted, around water bodies which help reduce the impact of surface runoff by trapping sediment and sediment-bound pollutants, encouraging infiltration, and by slowing and spreading stormwater flows over a wide area. Buffer zones incorporated into the design of the RZ should be considered one of the most important aspects of pollution control in addition to providing natural habitat for local fauna.

7.7.122 Disadvantages of vegetated buffer zones may include erosion, sedimentation and nutrient enrichment of the downstream water courses.

Minimization of Pollutants

7.7.123 Substantial reduction in potential for spills of contaminants can be achieved by keeping petrol filling stations and chemical storage areas out of the new TSW development areas.

7.7.124 Practices to remove potential pollutants from hazardous waste and general waste include the use of recycling centres and implementation of contract requirements on construction sites for the correct disposal of oils and chemicals including paints and solvents.

Car Parks and Road Cleaning

7.7.125 Road sweeping and cleaning is usually performed to improve the appearance of streets and access roads; however, it also significantly reduces the level of pollutants in runoff through the collection and proper disposal of fine particle size material to which pollutants are attached, and collection of litter from runoff outlets.

Sanitary Waste Management

7.7.126 Certain areas targeted as disproportionate contributors to the water resource of nutrients, bacteria, or organics such as restaurants should be considered for installation of sanitary sewers or special requirements for on-site waste disposal systems.

Control Measures

Infiltration (Exfiltration) Devices

7.7.127 Infiltration devices are areas of porous material which allow soaking of water into the ground. They include trenches dug into the ground and filled with porous materials to facilitate drainage into the groundwater. Basins are shallower areas which impound stormwater and allow drainage into the porous soil areas beneath at a slower rate. Dry wells are small areas near buildings which are pervious and capture runoff from roofs and other impervious surfaces.

7.7.128 Infiltration devices can be very effective in the removal of pollutants through adsorption onto soil particles, and biological and chemical conversion in the soil (Scheler 1987, Schueler *et al* 1992, US EPA 1990; Philips 1992; Birch *et al* 1992). Infiltration basins with long detention times and grass bottoms enhance pollutant removal by allowing more time for settling. Disadvantages of these devices include the requirement for frequent maintenance through cleaning, to avoid nuisance problems especially with insect breeding, odours and soggy ground.

Porous Pavement and Carparks

7.7.129 Porous pavements have excellent potential for use on streets (Niemczynowicz, 1990) and pathways. Properly constructed, they can have load-bearing strengths (although heavy vehicles must be excluded) and longevity comparable to regular pavements whilst greatly reducing imperviousness and consequently minimising surface runoff. Porous pavements are only feasible in areas where the soil is permeable, flat and the water table is deep.

7.7.130 Porous pavement may be designed in one of two ways. Asphalt or concrete is laid over a thick base of granular material. Alternatively, porous pavement is formed with modular, interlocking open-cell cement blocks laid over a base of coarse gravel. A geo-textile fabric underlying the gravel prevents the migration of soil upward into the gravel bed. Both designs typically include a reservoir of coarse aggregate stone beneath the pavement for stormwater storage prior to exfiltration into surrounding soils.

7.7.131 Porous pavement systems have been shown to have high removal rates for sediment, nutrients, organic matter, and trace metals. These rates are largely due to the reduction of mass loadings of these pollutants through transfer to groundwater (Schueler *et al*, 1992).

7.7.132 The major disadvantage of porous pavement is that sites have a high failure rate without proper maintenance, due to clogging either from improper construction, accumulated sediment and oil, or resurfacing. Excessive sediment will cause the pavement to rapidly seal and become ineffective (Urbonas and Stahre, 1993). The modular, interlocking, open-cell concrete block type tends to remain effective for considerably longer than asphalt or concrete porous pavement. Quarterly vacuum sweeping and/or jet hosing is needed to maintain porosity, and this may constitute one to two percent of the initial construction costs (Schueler et al., 1992).

Emergency Spill Response Valves

7.7.133 Emergency valves are installed at the mouth of culverts and drains entering a natural water channel to prevent the passage of spilt oil or chemicals which could have a devastating impact on the environment. These valves are electrically operated and require substantial maintenance to ensure their proper working, which makes them an expensive site control option.

Oil and Grease Traps

7.7.134 Oil and grease from restaurants, petrol stations and bus depots should pass into the sanitary sewage system, but some will inevitably be washed into the stormwater system. Underground catch basins should be installed to remove oils, grease, other floating substances and sediment from stormwater before the pollutants enter the storm water drainage system. These devices are relatively small and inexpensive, but can only detain stormwater for short periods. However, they are effectively used as a first stage of treatment to remove oil and sediment from stormwater.

7.7.135 Advantages of catch basins are their easy installation, and they create few aesthetic problems. However, apart from oil and grease and sediment, pollutant removal is low and odours can cause a problem. Oil and grease trap catch basins require regular inspection and cleaning at least twice a year to remove sediment, accumulated oils and grease, floatables, and other pollutants.

Filter Strips and Grass Swales

7.7.136 Filter strips and grass swales are one of the oldest forms of stormwater treatment devices. Filter strips are strips of land planted with vegetation, usually tough grasses, planted between the source and the receiving waters whereas swales are in effect grassed waterways and are used primarily at the outlet of road culverts and as motorway medians.

7.7.137 Filter strips remove sediment, organic matter and many trace metals by the filtering action of the vegetation, infiltration and sediment deposition. The addition of trees can greatly increase the effectiveness by increasing uptake and long-term retention.

7.7.138 Both devices have low pollutant removal efficiency but they can be effective when combined with other devices as part of the stormwater management system.

Use of Existing Natural Wetlands

7.7.139 Natural wetlands vary widely in their pollutant removal capabilities, but can effectively remove a number of contaminants (Bastian and Hammer, 1993; Bingham, 1994; Brix, 1993; Corbitt and Bowen, 1994) as shown in Table 7.44.

Table 7.44
Summary of Nutrient Removal from Natural Wetlands (USEPA 1988)

Project	Flow m^3/d	Wetland Type	Percentage Removal			
			TDP[a]	NH_3-N	NO_3-N	TN[b]
Brillion Marsh, WI	757	Marsh	13	-	51	-
Houghton Lake, MI	379	Peatland	95	71	99[c]	-
Wildwood, FL	946	Swamp/ Marsh	98	-	-	90
Concord, MA	2,203	Marsh	47	58	20	-
Bellaire, MI	1,136[d]	Peatland	88	-	-	84
Coots Paradise, CA	-	Marsh	80	-	-	60-70
Whitney Mobile Park, FL	227	Cypress Dome	91	-	-	89

a Total Dissolved Phosphorus
b Total Nitrogen
c Nitrate and Nitrite
d May-November Only

7.7.140 The most important removal processes associated with wetlands are the purely physical processes of sedimentation via reduced velocities and filtration by hydrophytic vegetation resulting in the removal of suspended solids, the particulate fraction of organic matter (particulate BOD), and sediment-attached nutrients and metals. Oils and greases are effectively removed through impoundment, photodegradation, and microbial action. Similarly, pathogens show good removal rates via sedimentation and filtration, natural die-off, and UV degradation. Dissolved constituents such as soluble organic matter, ammonia and ortho-phosphorus tend to have lower removal rates although these increase if the wetland also combines detention ponds such as the EDC.

7.7.141 Soluble organic matter is largely degraded aerobically by bacteria in the water column, plant-attached algal and bacterial associations, and microbes at the sediment surface. Ammonia is removed largely through microbial nitrification (aerobic)-denitrification (anaerobic), plant uptake, and volatilization, while nitrate is removed largely through denitrification and plant uptake. In both cases, denitrification is typically the primary removal mechanism. The microbial degradation processes are relatively slow, particularly the anaerobic steps, and require longer residence times which favour the use of the ETC and its associated wetlands above the WTC.

7.7.142 Phosphorus is also removed more effectively in the detention ponds mainly through soil sorption processes and plant assimilation Metals are removed largely through adsorption and complexation with organic matter.

7.7.143 Natural wetlands generally achieve pollutant removal rates similar to constructed wetlands, however, both are greater than that for wet pond detention alone as shown in Table 7.45.

Table 7.45
Comparison of Pollutant Removal Efficiencies in Different Types of Wetland

Pollutant	Estimated Removal Efficiencies		
	Natural Wetland	Constructed Wetland	West Detention Ponds
Plant Nutrients Total Phosphorous Total Nitrogen	High Moderate	High Moderate	Moderate to High
Sediment Total suspended solids	Very High	Very High	High
Metals Trace Metals (sediment-bound)	High	High	High Moderate
Organic Matter Biological Oxygen Demand (BOD)	Moderate	Moderate	Moderate
Oil and Grease	Very High	Very High	High
Bacteria	High	High	High

Compiled from Schueler 1987; Schueler et al. 1992; USEPA 1990; Phillips 1992; Birch, etc al. 1992.

Constructed Wetlands and Wet Detention Ponds

7.7.144 Much work has been done on constructed wetlands, both in the US and the UK, and interest has been steadily increasing over the last two decades in the use of natural physical, biological, and chemical aquatic processes for the treatment of polluted waters. Natural treatment processes have been recognised as being both cost effective when compared to conventional treatment processes and being beneficial to the community and a haven for local wildlife.

7.7.145 The efficiency of constructed wetlands in removing pollutants is similar to that of natural wetlands as shown in Table 7.41 (USEPA 1993). Studies in California have indicated metals removal of 99%, 97% and 99% for Cu, Zn, and Cd respectively with residence times of 5.5 days (Gersberg 1985). Coliform bacteria have been shown to have a 99% removal rate (Gersberg 1985) and 98.3% removal rates for viruses have also been reported using the same residency times (Gearheart 1982). A summary of the removal rates of various pollutants is given in Table 7.46 below:

Table 7.46
Summary Nutrient Removal from Constructed Wetlands

Project	Flow m_3/d	Wetland Type	BOD_5 (%)	Suspended Solids (%)	Hydraulic Surface Loading Rate m^3/ha-d
Listowel Canada	17	FWS	82	93	-
Santee CA	-	SFS	75	90	-
Sydney, Australia	240	SFS	86	92	-
Arcata, CA	11,350	FWS	64	28	907
Emmitsburg, MD	132	SFS	71	73	1,543
Gustine CA	3,785	FWS	84	86	412

FWS Free Water Surface System
SFS Subsurface Flow System

7.7.146 The nutrient removal efficiencies of detention ponds are lower than other wetland types but can be excellent for the initial removal of suspended materials.

Mitigation to be Implemented or Recommended for TSW

7.7.147 There is no absolute requirement for mitigation to be undertaken under the current laws of Hong Kong for the impacts of urban stormwater runoff. However, under Hong Kong's obligations as a signatory to the Ramsar Convention and under the recommendations of the HKPSG, reasonable effort should be made to minimise pollutant loadings from development. Government has a policy of *zero addition pollution loading* in the Deep Bay Catchment.

7.7.148 Consequently, a number of Government Departments will implement measures on TSW which will aid in the minimisation of impact from stormwater runoff.

Territory Development Department

7.7.149 TDD will provide the following measures:

(i) gulley-pots along all new carriageways;

(ii) infiltration devices as shown in Figure 7.37;

(iii) planters and planter strips along carriageways and the LRT tracks;

(iv) soft landscaping along carriageways; and

(v) over 16 ha of fresh-water wetland (Sections 9.4 and 9.5). This will effectively clean up water from a similar catchment area to the further development area of TSW.

Agriculture and Fisheries Department

7.7.150 AFD will operate and maintain the fresh-water wetland.

DLO and Planning Department

7.7.151 These departments will ensure that:

(i) oil interceptors are stipulated in lease conditions to be installed and maintained by the developers of the bus termini in Areas 101, 110 and 108a;

(ii) all petrol stations and chemical storage areas are excluded from the Tin Shui Wai area.

Environmental Protection Department

7.7.152 EPD will enforce the prohibition on the illegal discharge of construction site runoff, restaurant wastes and leachate from solid waste collection points to stormwater. EPD is also responsible for the enforcement of the *Livestock Waste Control Scheme*.

Regional Services Department

7.7.153 RSD will:

(i) maximise the "green" areas within parks and open spaces;

(ii) ensure efficient footpath and streetcleaning; and

(iii) maintain landscaped areas in the road and LRT reserves.

Housing Authority

7.7.154 Housing Authority

(i) will maximise landscaped areas within their sites;

(ii) is currently researching methods of minimising urban stormwater runoff impacts for their new TSW developments; and

(iii) will collect leachate from their refuse collection centres.

Maintenance of Stormwater Drainage System

7.7.155 A number of departments are involved with the maintenance of the stormwater drainage system as summarised in the table below:

Table 7.47
Maintenance of Stormwater Drainage System and Natural Stream Courses under Normal Weather Condition

Category of Storm Drainage System or Natural Stream Course		Routine Inspection	Clearance	Minor Repair Work	Remarks
1.	All drains and streams within allocated Government land or within Government project limits	Client Department or Project Office			
2.	All public stormwater drains, trained rivers and engineered sections of drainage channels other than those described under category 1, 3 & 4	DSD	DSD	DSD	RSD to assist DSD by clearing refuse, etc. from non-roadside inlet baffles, grilles and sand traps.
3.	Exclusive Road Drainage Installations:				
(a)	Gully pits	HyD	RSD HyD	HyD	See Note (1)
(b)	Gully connections, down pipes from elevated highway structures	HyD	DSD HyD	HyD	See Notes (1) & (2)
(c)	Roadside slope drainage, roadside open channels, catchpit open connections	HyD	HyD	HyD	See Note (3)
(d)	Roadside catchpit piped connections, cross road drains connecting open channels	HyD	DSD HyD	HyD	See Notes (1) & (2)
(e)	Internal drainage and pump sumps in subways, tunnels and vehicular underpasses	HyD	DSD HyD	HyD	See Note (5)
4.	Village drains, natural streams in unallocated Government land	Shared by several Departments DSD, RSD, LD, TDD, HAD & AFD			See Note (4)

Note:

(1) Clearance of pump sumps, gully pits and connections within the boundary of high speed roads will be carried out by HyD.

(2) Overall responsibility for exclusive road drainage lies with HyD. DSD will provide service for clearance on request.

(3) HyD is only responsible for the maintenance of surface channels and catchpits on roadside slopes where the slope itself is maintained by HyD.

(4) Responsibility is shared among DSD, LD, RSD, HAD and AFD as described in paragraphs 3 and 4 of the Works Branch Technical Circular No. 10/88.

(5) HyD is responsible for pumping the water out of the highway structure and to co-ordinate follow-up action by DSD and EMSD. DSD will provide service for clearance of chokages on request. EMSD is responsible for maintenance of electrical and mechanical installation in the subways.

Wetland

7.7.156 Mitigation measures including the implementation of a new 16.5 ha freshwater wetland are recommended in Section 9: Ecology. As indicated earlier in this section, wetland has the ability to effectively remove many pollutants from urban stormwater or other water streams.

7.7.157 Thus the freshwater wetland has been designed such that it will be constructed and maintained to gain the possible advantages from a water quality view point.

7.7.158 The advantages of constructing a wetland are given below. Design and maintenance criteria relevant to water quality are given below.

7.7.159 Advantages of constructing wetland include:

- effective removal of up to 97% of metals, suspended solids and other pollutants;
- hydrological reduction of stormwater runoff peak discharges;
- can handle the variations in loading which occur in stormwater discharges.

Design Criteria for Wetland Construction from a Water Quality Perspective

7.7.160 There are several design criteria to be taken into consideration with the construction of a wetland in respect of clean-up of urban stormwater runoff, as listed below:

- the flowrate of water through the wetland determines the dimensions of the constructed wetland and therefore its location and size;
- distribution of the inflow over the wetland should be maximised;
- a residence time of 5.5 days removes over 97% of metals and bacteria (Gersberg 1985);
- a settlement area upstream of the wetland and a suitable flowrate are required to ensure the majority of the sediment particles settle out before entering the vegetated area of the wetland;
- local plants must be chosen that can withstand the pollutant loading and the frequent fluctuation in water depth;
- anaerobic sediment conditions should be ensured to allow for long-term burial of organic matter and phosphorous;
- one way valves are necessary to prevent saline water intrusion, the ETC already has 18 flap valves which prevent Inner Deep Bay waters from entering the ETC;
- a controlled rate of discharge is required.

7.7.161 Maintenance of a constructed wetland is essential to ensure efficiency of nutrient removal and requires:

- regular inspection including inspection of water movement and quality;
- supplementing water flows during dry periods to maintain optimal flows;
- vegetation establishment checking;
- maintenance of structures;
- periodic removal of accumulated sediment;
- removal of opportunistic species (particularly water hyacinth) to appropriate landfill disposal.

7.7.162 Maintenance frequency can be minimised by preventative measures such as the removal of sediment upstream of the constructed wetland by widening and deepening the initial section of the constructed wetland to trap sediments prior to entering wetland areas which will be more difficult to maintain.

7.7.163 In the plan shown in Section 9, sedimentation will be achieved by widening and deepening of the EDC. During the dry season sediments can be removed by a digger via the planned DSD access route.

7.7.164 Assuming a sedimentation rate of 0.5 m/10 years, from the dredging frequency for optimal flood conveyance in the ETC it can be calculated that approximately 2,300 m^3/yr of sediment settles out in the area of the ETC which will be removed by the Project. Settlement of this sediment in the remaining part of the channel, the EDC, would increase the required dredging frequency to once every 2 years. Detailed design of the wetland must incorporate dredging access at key points for removal of sediment and excessive vegetation growth.

7.7.165 Calculations relating to the wetland are given in Appendix D2.

Summary and Conclusions

7.7.166 A holistic approach has been adopted towards stormwater management and mitigation. This approach includes implementing a system of both preventative and control measures aiming to reduce the exposure of pollutants to the stormwater and hence the amount of pollutants picked up by the water and to reduce the levels of pollutants in the stormwater that has been exposed to pollutant sources.

Further Studies

7.7.167 It is recommended that further investigation be carried out to determine the identity, source and possible loading of the pollutants in urban stormwater run-off in Hong Kong. For example, continued investigation of the DZ would enable closer estimation of the types and quantities of the pollutants in Hong Kong stormwater. A series of stormwater monitoring stations have already been identified on the TSW DZ and monitoring could continue at these locations. The analysis of additional parameters, such as COD and organics could be included. A series of monitoring stations could be established in the RZ to monitor both the construction phases and the operation phases of the site. In addition to the water analysis, a site walkover should be conducted to determine the quantities of floatable materials and the general aesthetic appearance.

7.7.168 The data collected from the additional monitoring should be used to calibrate a Source Loading and Management Model which would be used for long-term investigation of the effects of the stormwater and the associated pollutants.

Specific Mitigation

7.7.169 Tables 7.48 and 7.49 summarise the specific mitigation measures which will be implemented or are recommended to minimise the potential impacts from the Project.

Table 7.48
Summary of Urban Stormwater Runoff Mitigation - Preventive Measures to be Implemented

Preventative Mitigation	Primary measures to reduce runoff peak, total volume and pollutants reaching the Western and Eastern Drainage Channels using: Best Management Practices - animal waste collection - debris removal - education programmes - landscaping - road sweeping - infiltration devices will trap first flush material and illegal dry flow pollutants (e.g. Figure 7.37) - oil and grease traps - gulley pots - frequent inspection of stormwater drains ProPECC recommendations, WQOs and TM limits to be closely enforced. Chemical and oil waste products should be disposed of at licensed disposal sites. Housing Authority is currently researching methods of reducing urban storm-water impact.

Table 7.49
Summary of Urban Stormwater Runoff Mitigation - Recommended Control Measures

Controlled Mitigation	
	Initial Concept for Construction of Wetland
Settlement Pond	At the point at which the ECE enters the EDC, the channel will be deepened to encourage initial settling out of suspended solids. This area can be easily dredged via a planned access route and will be carried out by DSD. Sediments will then be appropriately disposed of to landfill or East Sha Chau, depending on the degree of contamination. Settling of sediments in this area will help to reduce the dredging requirements of the less accessible areas of the constructed wetland. Fine particles however will be carried into the wetland and will be removed in the low flow system.
Constructed Wetland	The water will be directed into the proposed wetland channel by a low weir which will prevent overflow during periods of low flow, but will allow overflow under storm conditions, to prevent flooding of the RZ. The proposed wetland channel comprises a convoluted channel 2.7 km long, averaging 30 m wide and with an average depth of 1 m. Low weirs will be constructed at intervals to prevent sediment passage throughout the wetland and also to separate deep areas from shallower areas. Maintenance of the wetland is essential for its proper functioning. Under normal flowrate conditions, the constructed wetland will remove up to 99% of the following: 1 - Suspended solids, particulate fraction of organic matter and-sediment-attached nutrients and metals, via reduced velocities and infiltration by hydrophytic vegetation; 2 - Oils and greases are effectively removed through impoundment, photodegradation, and microbial action; 3 - Pathogens via sedimentation and filtration, natural die-off and UV degradation; 4 - Dissolved constituents such as soluble organic matter, ammonia and ortho-phosphorous have increased removal rates if the wetland is combined with detention/settlement ponds such as the ETC; 5 - Soluble organic matter is degraded aerobically by bacteria in the water column, plant-attached algal and bacterial association, and microbes at the sediment surface; 6 - Ammonia is removed by microbial nitrification (aerobic)-denitrification (anaerobic), plant uptake, and volatization, nitrate:by denitrification and plant uptake; 7 - Phosphorous is also removed in the detention/settlement pond via soil sorption processes and plant assimilation; and 8 - Metals are removed by adsorption and complexation with organic matter.
WDCE and channel downstream	The banks of the channel downstream from the WDCE must be retained to encourage the growth of wetland plants at the channels' edge. These plants can remove some pollutants as described above.

already in place

7.8 Residual Impact of the Project on Water Quality after Implementation of Mitigation

7.8.1 The greatest residual impact of the Project activities on water quality is on the ETC. This water body is partially removed and culverted as a result of site formation activities.

7.8.2 The concreting of 500 metres of the WTC to form the WDCE will cause minimal residual impacts during the construction phase provided the recommended mitigation is fully implemented. In the medium term, the provision of this concreted area will allow DSD to keep the channel much cleaner of deposited sediment. This sediment arises to a large extent from animal waste sources. The removal of this sediment will improve water quality in the remainder of the channel.

7.8.3 Sediment disturbance during road and bridge construction, extension of the Eastern Culvert, and during the dredging works in the operational phase create a residual impact in the EDC and WDCE and downstream channel. This is minimal providing the recommended mitigation measures are implemented as described (Table 7.50).

7.8.4 Urban stormwater runoff has the potential of increasing loadings of pollutants entering Deep Bay in the long term. A holistic approach has been taken to mitigation. Stormwater runoff from an area equivalent to the area to be developed within TSW will pass through the fresh-water wetland to be implemented under this Project. Most of the runoff comes from TSW itself.

7.8.5 The design of the wetland is such that very high removal rates of SS are to be expected. A 90% removal rate has been assumed in Table 7.51. BOD removal rates should be optimal in all but flood situations when BOD levels should be low. Up to 500 kg of BOD/day could be removed in the planned wetland area. A predicted average removal rate of BOD of about 80% has been assumed in Table 7.51. Similar rates of removal of total nitrogen and phosphorus are likely.

7.8.6 The residual worst case scenario loading of the waters discharged to Inner Deep Bay can be estimated using the limited data available under this study. These estimates are given in Table 7.51. The mitigation to be implemented under this Project will assist in the eventual achievement of the Water Quality Objectives for Inner Deep Bay. Removal rates of 50% for heavy metals have been assumed for the TSW RZ values. In practice, the removal rates are likely to be far higher. Removal rates of at least 97% are commonly achieved.

Table 7.50
Residual Impacts during the Construction Phase of the Project

Activity	Construction Phase								
Water Bodies	Site Formation	Site Runoff	Bridge Construction	Installation of rising mains & pumping station	Infrastructure works; roads etc	Eastern Culvert Re-alignment	Eastern Culvert Extension	WDCE	Construction of Wetland
Deep Bay									
Inner Deep Bay		-	(-)		(-)				
WDC		-		(-)	(-)				
WTC/WDCE		-	(-)	(-)	(-)			(- -)	(-)
ETC/EDC	- -	-			(-)	(-)	(-)		(- -)
Old Western River	- -								
Groundwater									

\+ beneficial impacts (all long term benefits)
\- adverse impacts

N.B ( ) denotes short term impacts only
An empty cell indicates no impacts
The scale is 1 to 5.

Table 7.51
Estimated 'Worst-Case' Residual Loadings in Urban Stormwater Runoff on Discharge from the Fresh-water Wetland Area to Inner Deep Bay

Parameter	NURP Weighted Mean Concentrations for Residential or Commercial Site (USEPA 1983)	TSW RZ Weighted Mean Concentrations (1996)	Assumed Clean-up Rate	Estimated Residual Concentration for NURP Weighted Means	Estimated Residual Loading for TSW RZ Weighted Means	Water Quality Objectives
SS (mg/l)	180	148	90%	18	15	20(1)
BOD (mg/l)	12	7(2)	80%	2.4	1.4	5(3)
Total N (mg/l)	1.9	2.0	80%	0.4	0.4	0.7(4)
Total P (mg/l)	0.42	0.5	80%	0.1	0.1	NA (5)
Cd (μg/l)		<0.2	50%	-	<0.1	1(6)
Cr (μg/l)		1.5	50%	-	1	15(6)
Cu (μg/l)	43	4	90%	4	2(7)	5(6)
Ni (μg/l)		5.5	50%	-	3	30(6)
Pb (μg/l)	182	2.1	95%	9	1(7)	10(6)
Zn (μg/l)	202	41.8	80%	40	20(7)	40(6)
E.coli (counts/100 ml)	27,000	42,000	99%	270	420	1,000

(1) WQO for Inland Waters. WQO for marine waters is no more than 30% above ambient. SS levels at DM1 in 1996 averaged 97 mg/l and at DM3 averaged 25 mg/l.
(2) Omitting Station D. With Station D becomes 103 mg/l.
(3) WQO for Inland waters.
(4) WQO for Inner Deep Bay.
(5) No WQO stipulated. Common TM standards is 5-10 mg/l.
(6) DBG WQO.
(7) Assuming 50% clean-up rate only.

7.8.7 Table 7.52 shows the net loading of suspended solids and BOD resulting from the further development of TSW i.e. the development of Areas 3, 30, 31 and the RZ. These loadings have been based on the worse case situation of no mitigation within TSW before the storm-water enters the channels and is based on an average rainfall of 2 m/year.

Table 7.52
Residual Loadings Estimated for the Further Development of TSW (tonnes/yr)

	Loading from Further Development Area within TSW	Loading Removed by Wetland[1]	Residual Loading from New Development	Loading Removed by Low Flow Infiltration Chambers[2]	Potential Loading Removed by Measures currently being Researched by Housing Authority[3]
Area (ha)	236	323	-	33	168
SS loading based on NURP weighted average (180 mg/l)	850	1047	-197	59	121
SS loading based on EIA studies in TSW (148 mg/l)	699	860	-161	49	99
BOD loading based on NURP weighted average (12 mg/l)	57	62	-5	4	8
BOD loading based on EIA studies in TSW (7 mg/l)	33	36	-3	2	5

1 Assumes 90% removal of SS and 80% removal of BOD.
2 Assumes 50% removal.
3 Assumes 20% removal.

7.8.8 Mitigation measures in themselves, have residual impacts as shown in Table 7.52, all of which are beneficial to the environment. In particular, the constructed wetland will improve water quality in the brackish waters leading to Inner Deep Bay, and the Amenity Water Scheme will improve the visual impact of the WDC.

7.8.9 Concurrent projects which are being carried out include the channel works for the YLKTNTM Drainage Basin and the Shenzhen River Training project, both of which have a potential impact on Inner Deep Bay, the WDCE and EDC due to increased pollutant loadings during construction. However, after completion of these projects and implementation of suitable mitigation measures, water quality in these water bodies, particularly in relation to reduced sedimentation, will improve (Table 7.53).

7.8.10 The implementation of the *Livestock Waste Control Scheme* (LWCS) will benefit water quality in all water bodies covered in this Project through reduction in sedimentation and organic pollution.

Table 7.53
Residual Impacts during Operational Phase of the Project and Concurrent Projects

Activity	Operational Phase				Concurrent Projects			
Water Bodies	Urban stormwater runoff	Dredging	Sewage	Construction of Wetland	Increased Maintenance of Low Flow Interceptors and Amenity Water Scheme	Livestock Waste Control Scheme (LWCS) in TSW Basin	Ngau Tam Mei River Training Projects	Shenzhen River Project
Deep Bay				+ +		+ +		
Inner Deep Bay	-			+ + +	(+)	+ + +	(- - - - -) +	(- - - - -) +
WDC	-				(+ + +)	+ + + + +	(- -)	(- -)
WDCE	- -	-			(+ +)	+ + + + +	(-)	(-)
EDC	- -	-		+ +		+ +		
Old Western River								
Groundwater	-			+		+		

\+ beneficial impacts (all long term benefits)
\- adverse impacts

N.B ( ) denotes short term impacts only
An empty cell indicates no impacts
The scale is 1 to 5.

Combined Construction and Operation Impacts

7.8.11 The period of this Project up to August 1999 involves construction activities only from both the Project and the construction of Housing Authority buildings. After this period, the Priority Sites will be occupied and impacts will be a combination of construction and operation activities. The overlap of activity programmes year by year are shown in Figure 2.28 in Section 2.

7.8.12 As described in the Impact Assessment Sections, all of these activities have the potential to impact water quality. More importantly the cumulative impact from each stage and activity, coupled with concurrent projects outside the Study Area will have a greater potential for adverse ecological impacts.

7.8.13 Implementation of mitigation measures is especially important during the period 1999 to 2001 when the majority of the construction works are occurring, concurrent with occupation of the first residential blocks, giving rise to operation impacts.

7.8.14 Table 7.54 shows that the major combined impacts are on WDCE and EDC from site formation and runoff, sediment disturbance, during construction and dredging, and urban stormwater runoff. Mitigation measures against potential impacts in these water bodies are especially important because of the subsequent impact on Inner Deep Bay.

Table 7.54
Overlap of Construction and Operational Potential Impacts

Period	Activities		Main impacts
	Construction	Operation	
July 1997 - August 1999	Site formation	-	Site runoff Release of ammonia from contaminated mud
August 1999 - August 2003	Site formation Infrastructure including road construction and bridge construction Rising main installation Realignment of Eastern Culvert Extension of Eastern Culvert Paving of 500 m section of WDCE	Urban stormwater runoff including cement washings from concurrent building works passing down the Project drains. Sediment removal in WDC. Sediment removal in EDC. Sewage	Site runoff Sediment disturbance and removal of contaminated sediment - release of ammonia Polluted stormwater runoff Concrete washings from construction increasing pH of water
August 2003 and onwards	-	Urban stormwater runoff Dredging in WDCE Dredging in EDC Sewage	Polluted stormwater runoff Disturbance of sediments

Summary of Potential Impacts from Construction and Operation Phases and Mitigation Measures

7.8.15 The Major potential impacts identified from this Project can be summarised as:

(i) Eastern Culvert Extension;

(ii) 500 m paving of WTC to construct the WDCE; and

(iii) Urban Stormwater Runoff.

7.8.16 Additional construction activities associated with the Project with minor potential impacts on the water environment are:

(iv) Site formation Works;

(v) Re-alignment of the Eastern Culvert;

(vi) Permanent drainage works;

(vii) Bridge construction across the channel downstream of the WDCE;

(viii) Installation of rising mains connecting new and old sewage pumping stations; and

(ix) General site runoff (including temporary drainage works and runoff from site compounds).

Summary and Conclusions for Mitigation for Potential Impacts

Major Potential Impacts

<u>Eastern Culvert Extension</u>

7.8.17 The ETC is heavily polluted with copper and zinc, reaching Class C levels at the bend of the centre section. The mud removed from the ETC for the culvert works will require disposal at East Sha Chau.

7.8.18 Liquid from sediment removed during the works should be allowed to drain into the landbank. Works will be carried out in the dry season and behind cofferdams.

7.8.19 The toxicity of ammonia is a factor of pH, temperature and salinity, although pH has the greatest effect. The toxic fraction of ammonia (unionized ammonia) increases with pH. Table 7.55 shows two examples of the condition under which toxicity to aquatic organisms occurs.

Table 7.55
Examples of Effect of Ammonia

Total ammonia (mg/l)	pH	Temperature (°C)	Unionised ammonia (mg/l)	Effect on organism*
10	7.5	25	0.17	Chronic effect on less pollution-tolerant organisms
	8.5	25	1.4	Acute effect on less pollution-tolerant organisms
	9.0	25	3.5	Chronic effect on more pollution-tolerant organisms
20	7.5	25	0.34	Acute effect on less pollution-tolerance organisms
	8.5	25	2.8	Chronic effect on more pollution-tolerant organisms
	9.0	25	7.0	Acute effect on more pollution-tolerant organisms, death of all aquatic organisms

* See Table 7.56 for detailed description of effects.

Table 7.56+
Effects on Aquatic Organisms at Different Ammonia Concentrations

Unionized ammonia (mg/l)	Effect	Impact on aquatic organisms
0.035	Chronic	Reduction in growth, reproduction, mobility of the least pollution-tolerant organisms, ultimately leading to death
0.233	Acute	Death of least pollution-tolerant organisms
1-2	Chronic	Reduction in growth, reproduction, mobility of more pollution-tolerant organisms, ultimately leading to death
Above 5	Acute	Death of nearly all aquatic life

\+ USEPA (1989), *Ambient Water Quality Criteria for Ammonia (Saltwater).*

7.8.20 Total ammonia levels in the channels commonly fluctuate between 5 and 20 mg/l. The examples in the tables show that a small change in pH can have a significant change on ammonia toxicity. Concrete washings from construction works on development sites can readily exceed pH 9.0, which would be lethal to existing organisms in the ETC.

7.8.21 Ammonia concentrations measured in the ETC indicate that to protect aquatic life, the pH of runoff water must not exceed 8.5. Mitigation measures which must be carried out by the contractor responsible for runoff include settlement of concrete and cement washings in ponds, to encourage infiltration into the ground, or, if runoff is unavoidable, pH adjustment to 8.5.

7.8.22 The significance of an increase in pH is shown by the fact that ammonia levels are doubled by an increase of 0.2 pH units. Concrete washings which run off the development sites of Tin Shui Wai therefore have a significant potential impact on water quality in all water bodies of concern under this Project.

7.8.23 Ammonia and pH levels should be monitored closely during construction related activities.

<u>500 m paving of Western Temporary Channel</u>

7.8.24 The WTC shows some metal contamination (Class C) at the far north by the security bund, the far south by the DZ and at the bend in the channel. Pollution is to Class C level with copper (from livestock waste), zinc and chromium (from industrial discharges to the west of the DZ). Nutrient enrichment near the Western Outfall is probably from farm runoff west of the channel, while DZ stormwater runoff may contribute to the pollution at the inflatable dam.

7.8.25 Coffer dams will be used to reduce washing of disturbed sediment downstream, and avoiding release of pollutants into the water from liquid drained from sediment removed during the works.

7.8.26 In order to avoid releasing high pH washings into the water downstream of the WDCE concrete piling will be done on a dry stream bed.

Minor Potential Impacts

7.8.27 Sedimentation and pollutant runoff from the RZ during site formation will be minimised through the use of sedimentation ponds and oil interceptors. Similar mitigation measures will be employed during installation of the rising main on the Western side of the WDC and WDCE.

7.8.28 During works in water bodies, such as bridge and road construction, and construction of permanent drainage culverts, coffer-dams or clay earth bunds will be used to minimise sediment washing downstream.

Urban Stormwater

7.8.29 A holistic approach to urban stormwater management and mitigation will achieve effective control of pollutant discharge. Preventative measures such as incorporation of infiltration devices, and use of porous areas (grass areas and porous pavements) aims to reduce the exposure of pollutants to the stormwater and to reduce the levels of pollutants in stormwater that has already been exposed to pollutant sources.

7.8.30 Control measures include education programmes, regular road and pavement cleaning, installation of sediment and oil and grease traps, enforcement of the ProPECC recommendations and EM&A contractual obligations.

7.8.31 The impacts from major chemical or oil spills will be avoided by the elimination of sources of contamination on the RZ, such as chemical storage areas and petrol stations.

Further Studies

7.8.32 Further investigations are recommended for future environmental studies under other Projects to determine the identity, source and possible loading of pollutants in Hong Kong Urban Stormwater.

7.8.33 The data collected from the additional monitoring could be used to calibrate a Source Loading and Management Model (SLAMM) which could then be used for long-term investigation of the effects of the stormwater and the associated pollutants.

Urban Stormwater Treatment

7.8.34 A holistic approach has been taken to mitigation of urban stormwater runoff impacts. One of the main mitigation measures to be implemented is the formation of a freshwater wetland in Areas 114 and 118 (Section 9: Ecology). This wetland will also mitigate impacts from urban stormwater runoff before it is discharged into Inner Deep Bay. This would treat all waters from the Eastern Culvert and the North Eastern Culvert which drain a substantial part of the DZ and the RZ plus areas outside of TSW and should result in removal of pollutant loadings substantially greater than those generated by the new developments.

7.8.35 The banks of the channel downstream of the WDCE will remain untouched to encourage the growth of wetland plants at the channel's edge. This serves the dual function of increasing the aesthetic value of the area and removing pollutants from stormwater passing through it. The areas close to the mouth of the Western Channel will be extensively planted with native woodland trees.

Conclusions

7.8.36 The Project has no potential to have any impacts on the shoreline, the water circulation patterns, stratification, flushing, mixing patterns or tidal effects on Inner Deep Bay.

7.8.37 The further development of TSW, i.e. the further urbanisation of TSW, will lead to additional runoff but due to the geography of the basin, this additional runoff will not affect peak flows. Any small changes noted in future years in sedimentation and erosion patterns will be due to implementation of the Livestock Waste Control Scheme.

7.8.38 Provided mitigation is fully implemented and sensible construction methods are used, the construction works under the Project should have minimal adverse impact on the water quality in the two channels and virtually no impact on Inner Deep Bay. Due to the current variability and poor quality of water in the channels, changes in water quality due to Project works may be almost undetectable.

7.8.39 The existing high ammonia levels in the channels could create damage to the ecosystems in the channels and even into Inner Deep Bay if construction site runoff from concurrent building works in TSW is not controlled. Small increases in pH could lead to large increases in levels of the toxic, unionized form of ammonia. Mitigation is simple to implement and the discharge of concrete washings to storm-drains is illegal under the Water Pollution Control Ordinance. The concurrent construction works for the further development of TSW can be undertaken with minimal impact on water quality in the channels.

7.8.40 Urban stormwater runoff from the further development of TSW has the potential to increase loadings of a range of pollutants entering Inner Deep Bay. A holistic approach to mitigation has been adopted. This approach includes control of pollution at source, and ensuring that the fresh-water wetland to be implemented as a mitigation measure for ecological impacts of the Project is designed such that the wetland also serves to diminish pollutant loadings entering Deep Bay. The residual impact of the measures is such that Water Quality Objectives for Inner Deep Bay can be assured in the future.

7.8.41 It is recommended that the major developers should prepare an environmental management plan for their construction phase to ensure that all necessary mitigation measures are implemented.

7.8.42 A two-tier approach has been taken for the EM&A programme for water quality: at source control; and a combined water quality and ecological checking system in the channels and the neighbouring part of Inner Deep Bay. This latter system will ensure that cumulative impacts from the Project, both temporally and spacially, are acceptable. This is particularly important in the case of this Project as construction and operational phase impacts of the Project are concurrent.

7.8.43 The further development of TSW can be carried out with minimum adverse impact on the aquatic environment, to the benefit of the complex and sensitive ecology of the Inner Deep Bay area.

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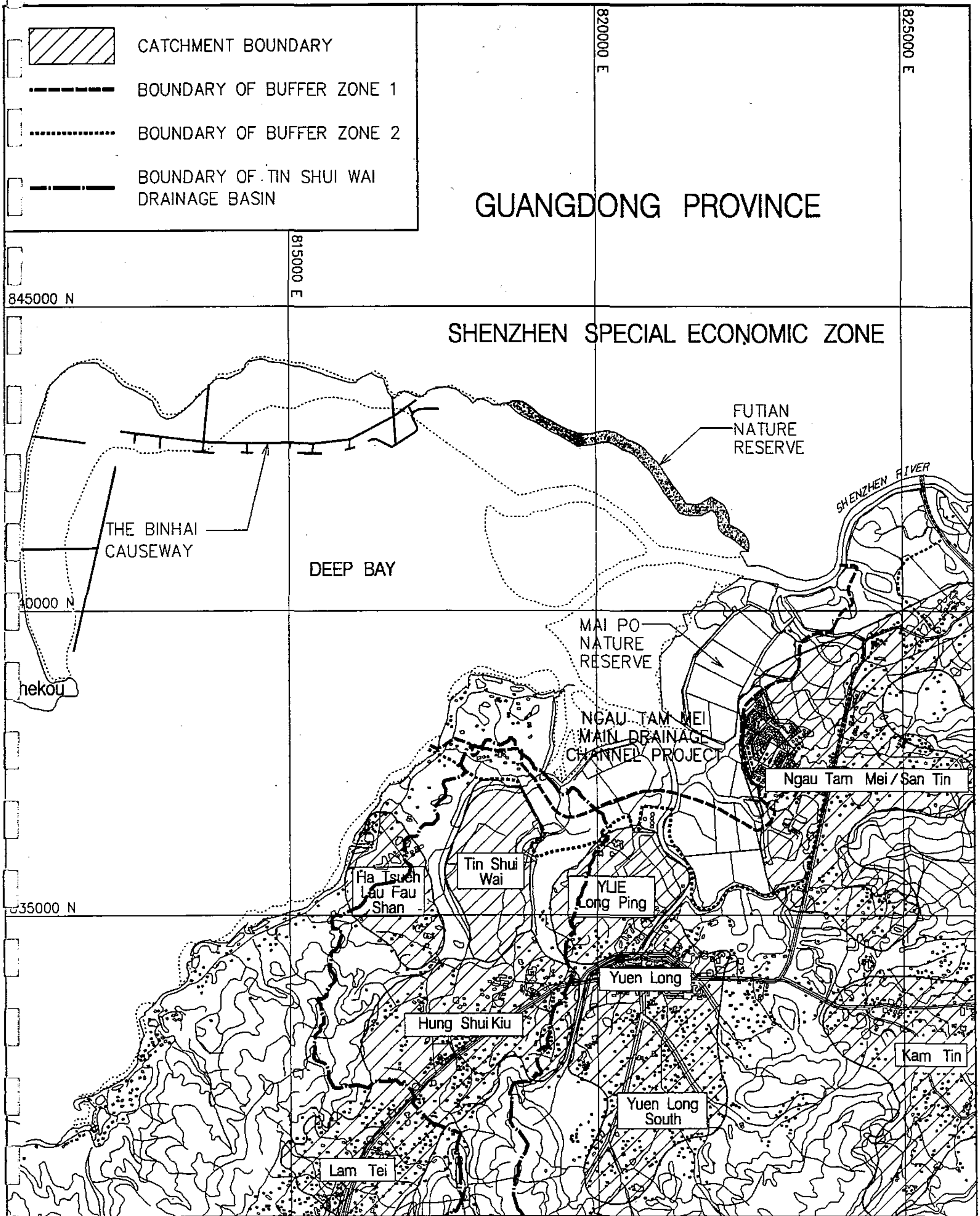

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		Reference TSW-BASE	File Name 00760018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
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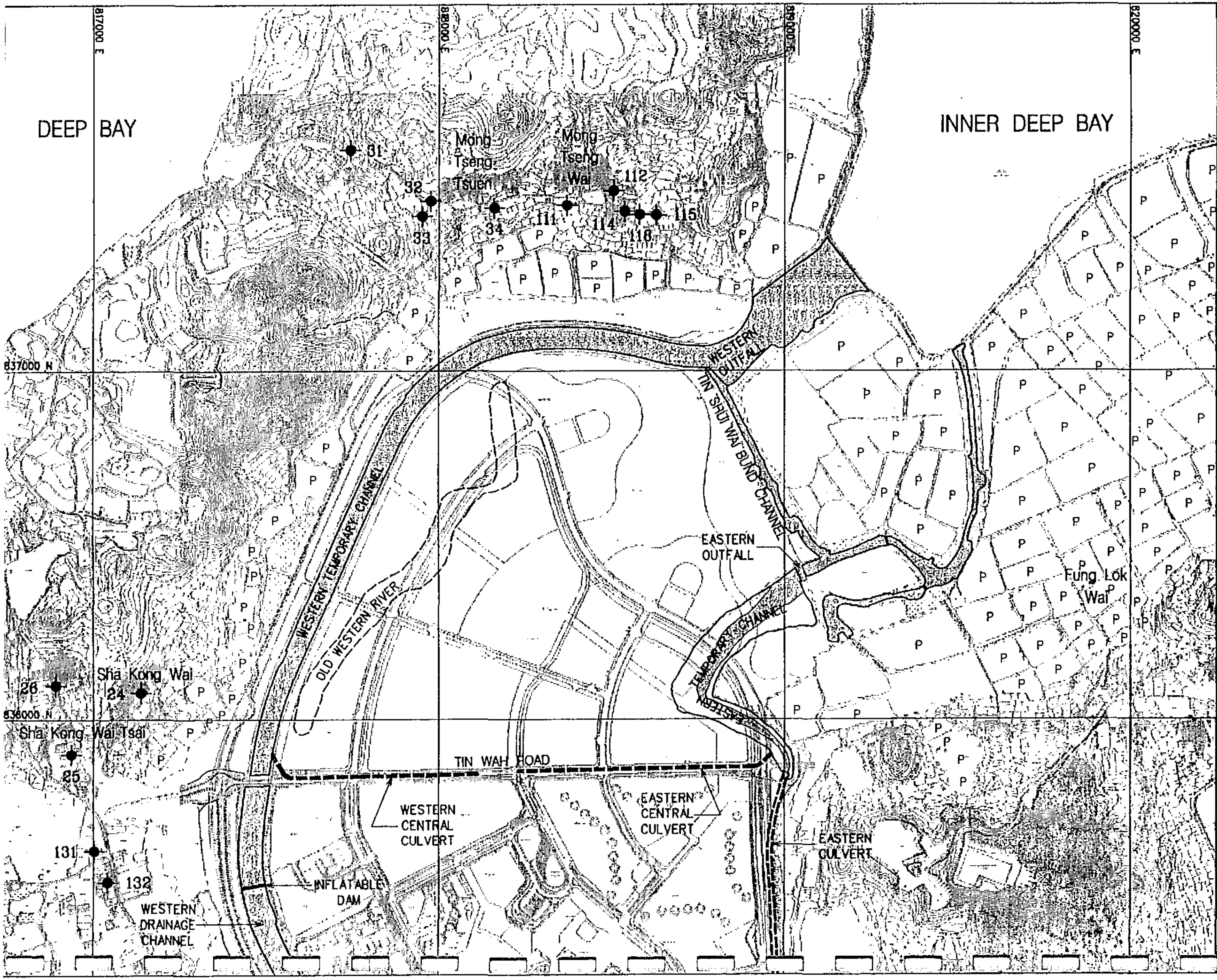

Notes

P - ACTIVE FISH POND

34 - EXISTING WELLS MONITORED

- WATER BODY AREA WITHIN CHANNEL

Prepared	Checked	
MC	LS	
File name	Revision	Date
00690018.C09	1	OCT. 96

Project TIN SHUI WAI DEVELOPMENT

Contract title

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

Title

PRINCIPAL WATER BODIES

Figure no.	Reference	Scale
7.2	TSW-BASE	N.T.S.

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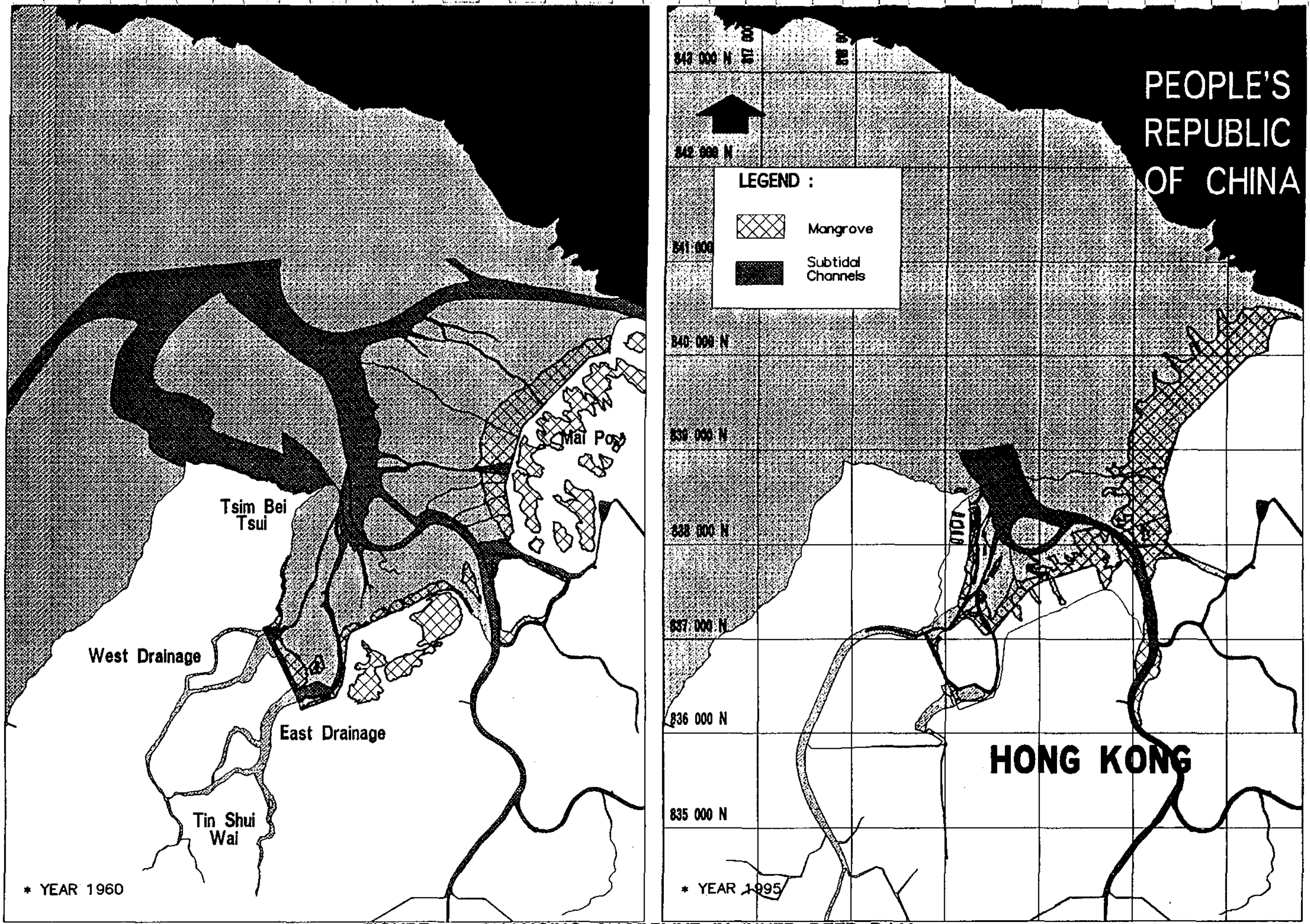
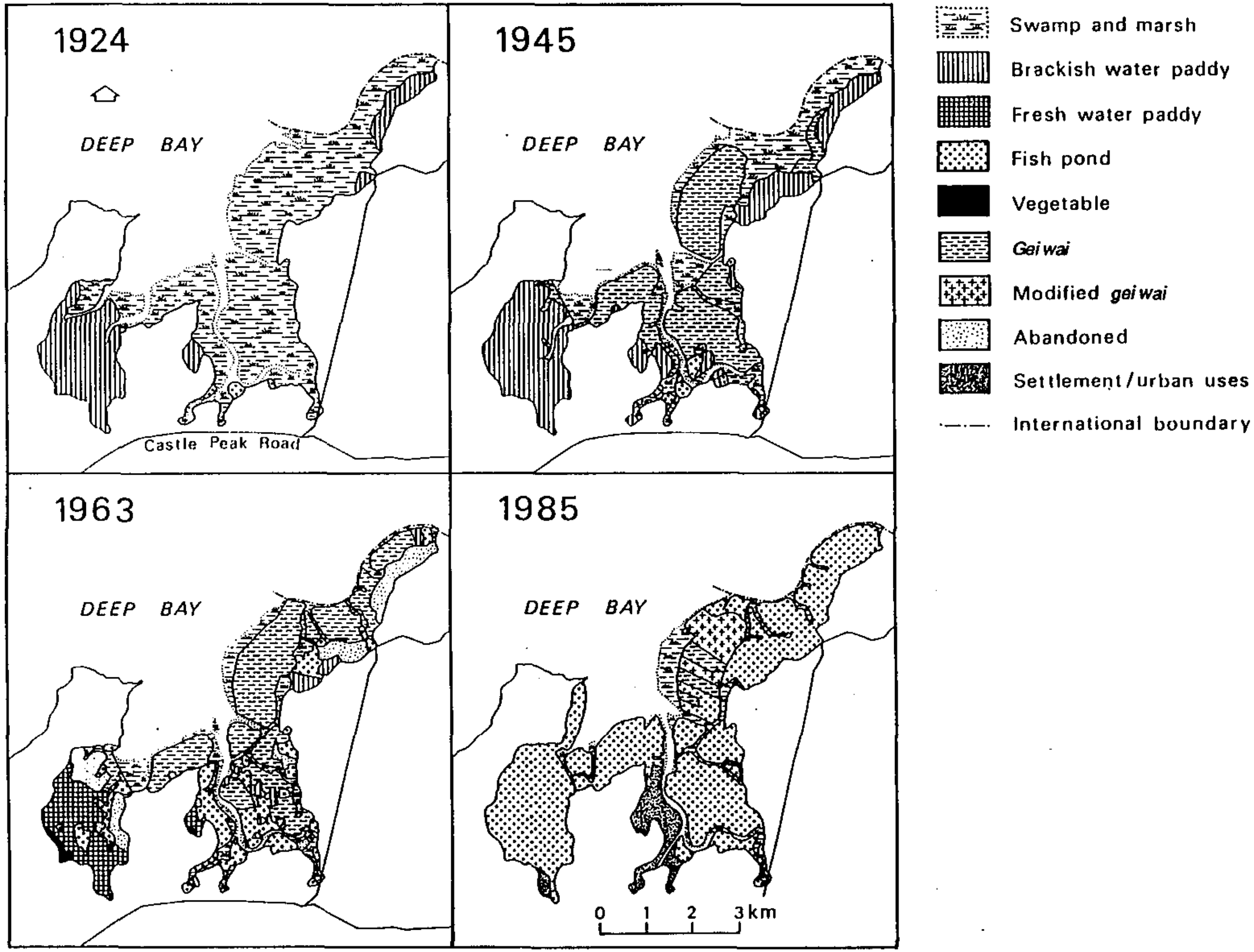


FIGURE 7.3 CHANGING SHORELINE IN INNER DEEP BAY



(SOURCE : A GEOGRAPHY OF THE MAI PO MARSHES : IRVING & MORTON, WWF HK 1988)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title:	Figure No. 7.4	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼	MAN-MADE CHANGES AND LAND USE PATTERNS IN DEEP BAY, 1924-1985	Reference No. WWF HK 1988	File Name -
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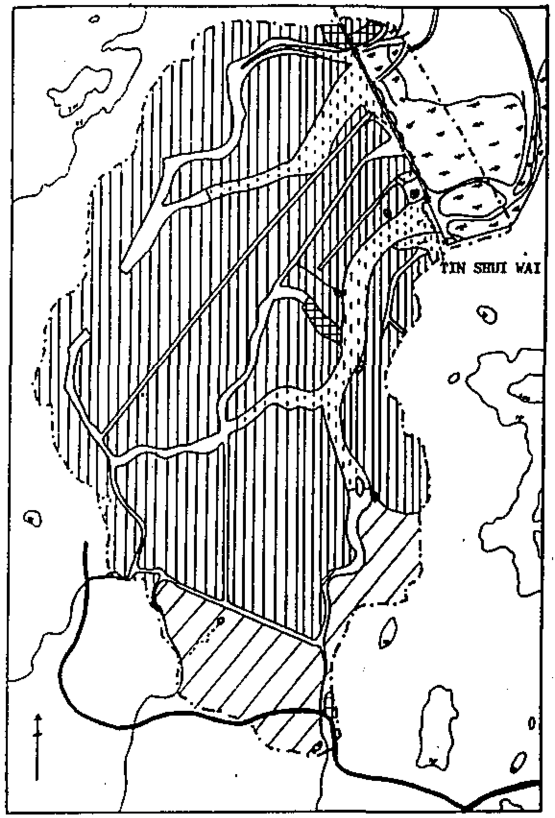

Source : R. A. F. airphotos — 19/10/1954.
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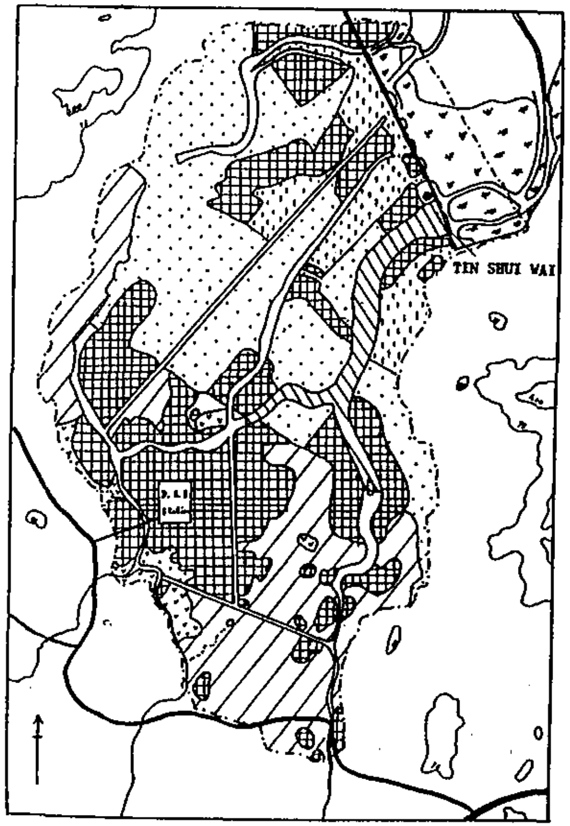
Mile ¼ 0 ¼ ½ ¾ 1 Mile

height in feet

- brackish-water paddy
- slightly brackish-water fish pond
- tambaks
- fresh-water paddy
- mangrove swamp
- approximate boundary of Tin Shui Wai



Source : R. A. F. airphotos — 16/5/1967.
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Mile ¼ 0 ¼ ½ ¾ 1 Mile

height in feet

- fallowed land
- tambaks
- slightly brackish-water fish pond
- stream screening pond
- vegetable
- fresh-water paddy
- mangrove swamp
- approx. boundary of Tin Shui Wai

(SOURCE : THE CHANGING LANDUSE PATTERN IN TIN SHUI WAI : CHAN (DISSERTATION), 1970)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : HISTORICAL CHANGES IN WATER COURSES THROUGH THE TIN SHUI WAI DEVELOPMENT AND RESERVE ZONES	Figure No. 7.5	Revision 0
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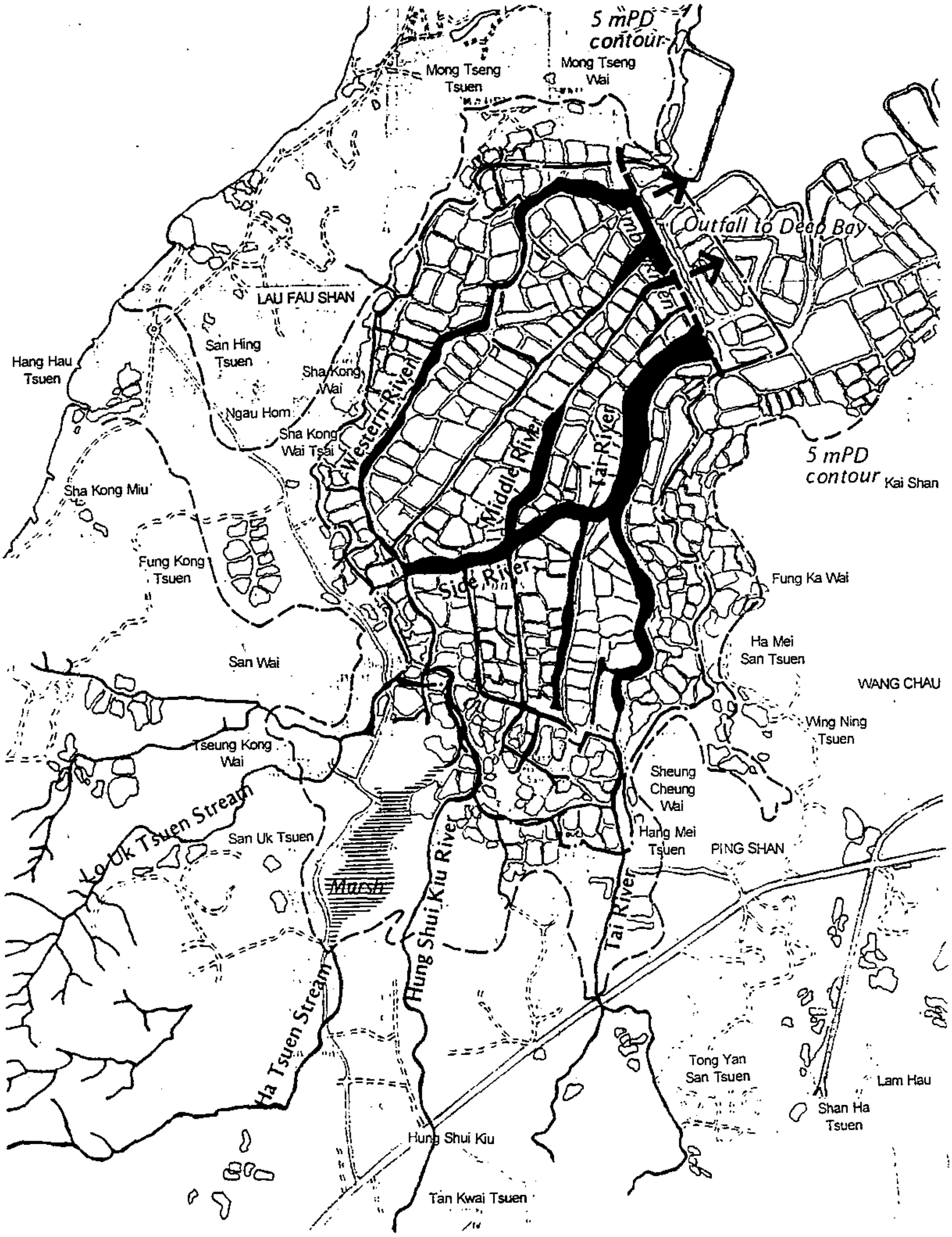

(SOURCE : TIN SHUI WAI DEVELOPMENT - LAND FORMATION DESIGN : BCL, 5/1992)

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BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 賓尼 ENGINEERS AND SCIENTISTS		Reference No. BCL 5/1992	File Name -
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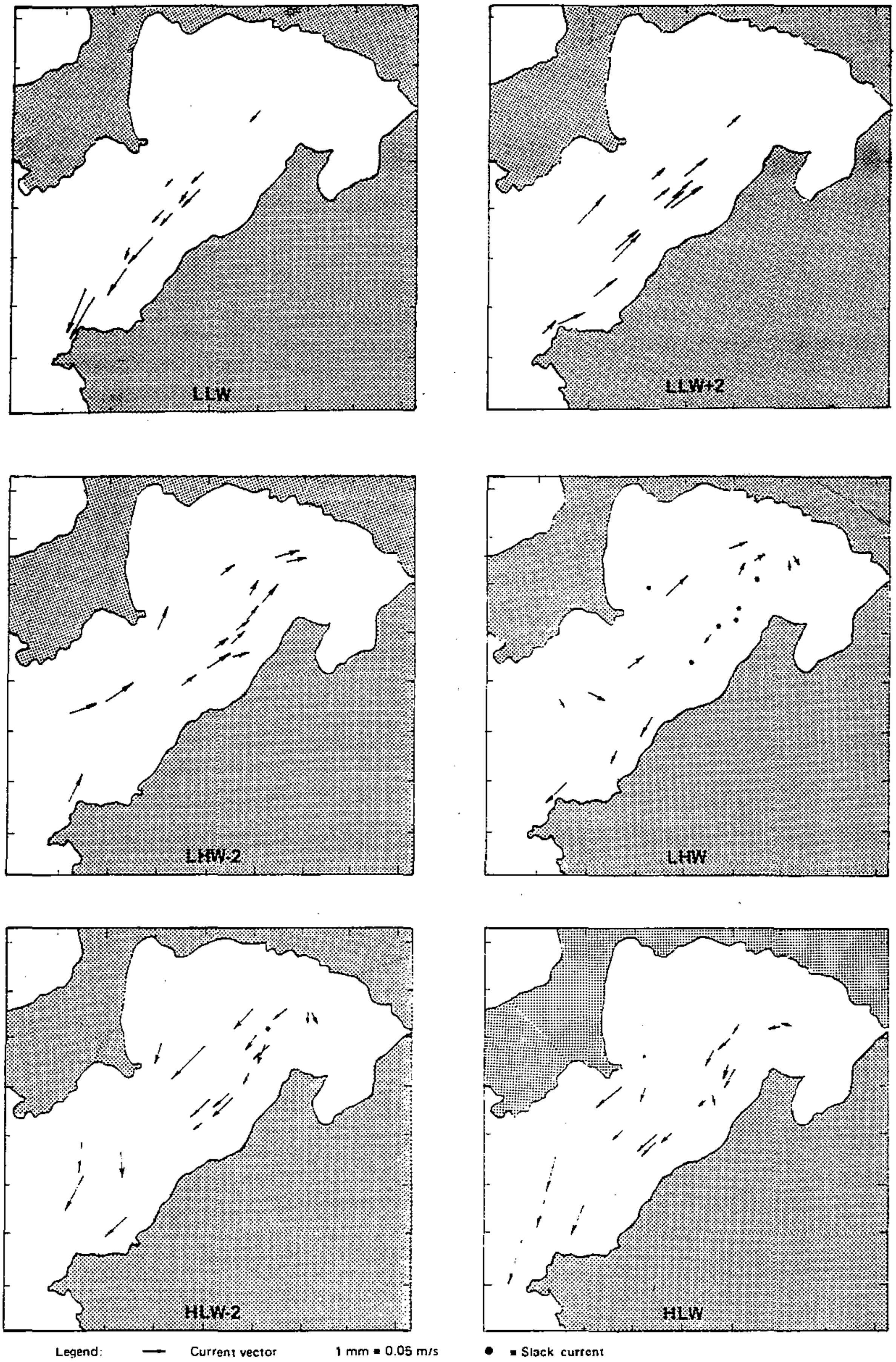

(SOURCE : TIN SHUI WAI DEVELOPMENT - EIA OF LAND PREPARATION ASPECTS : BINNIE AND SHANKLAND COX, 2/1985)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : DEEP BAY - SPRING TIDE CURRENT VECTORS	Figure No. **7.7a**	Revision 0
		Reference No. BINNIE & SHANKLAND COX 2/1985	File Name -
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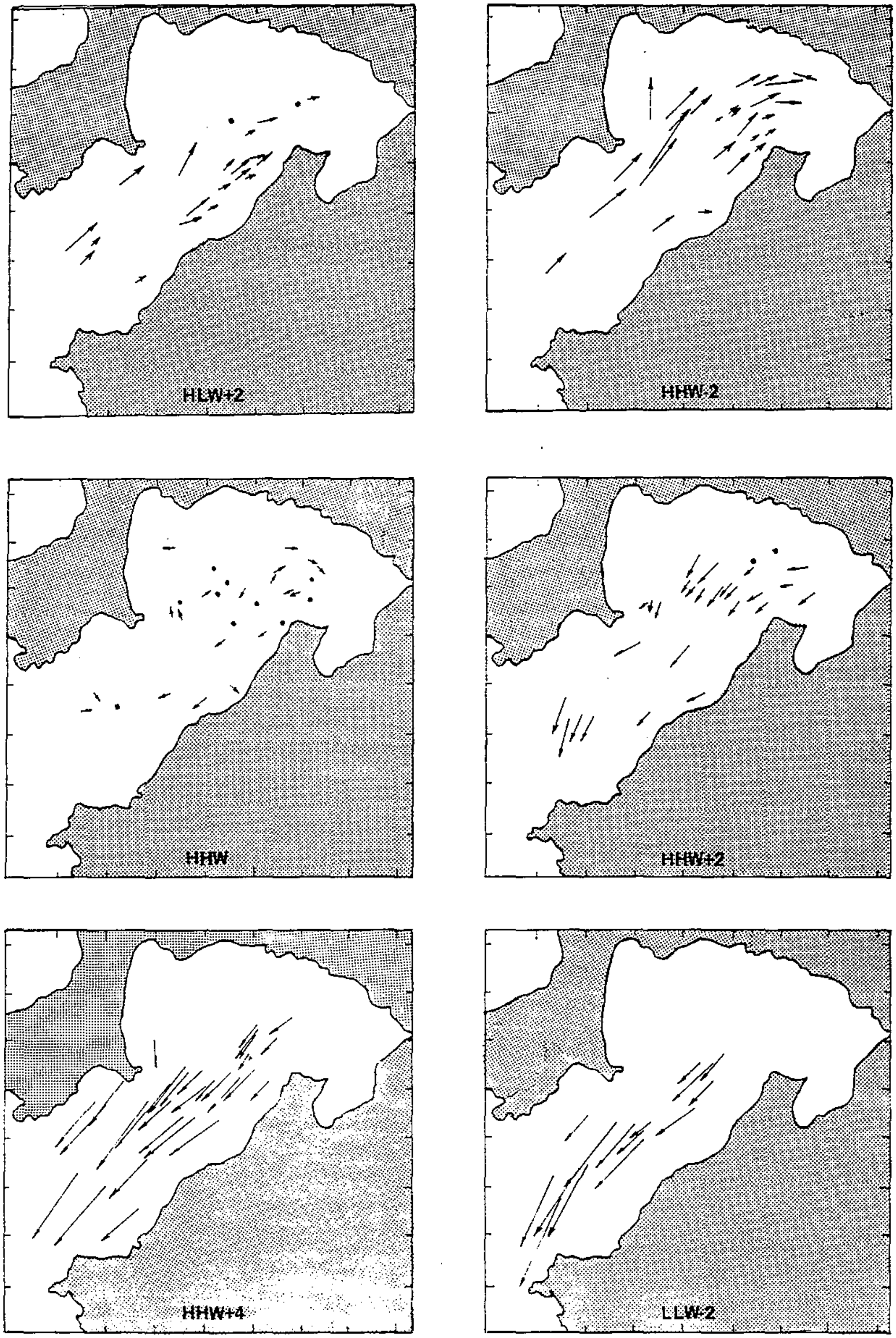

Legend — Current vector 1 mm = 0.05 m/s ● = Slack current

(*SOURCE : TIN SHUI WAI DEVELOPMENT - EIA OF LAND PREPARATION ASPECTS : BINNIE AND SHANKLAND COX, 2/1985*)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : DEEP BAY - SPRING TIDE CURRENT VECTORS	Figure No. **7.7b**	Revision 0
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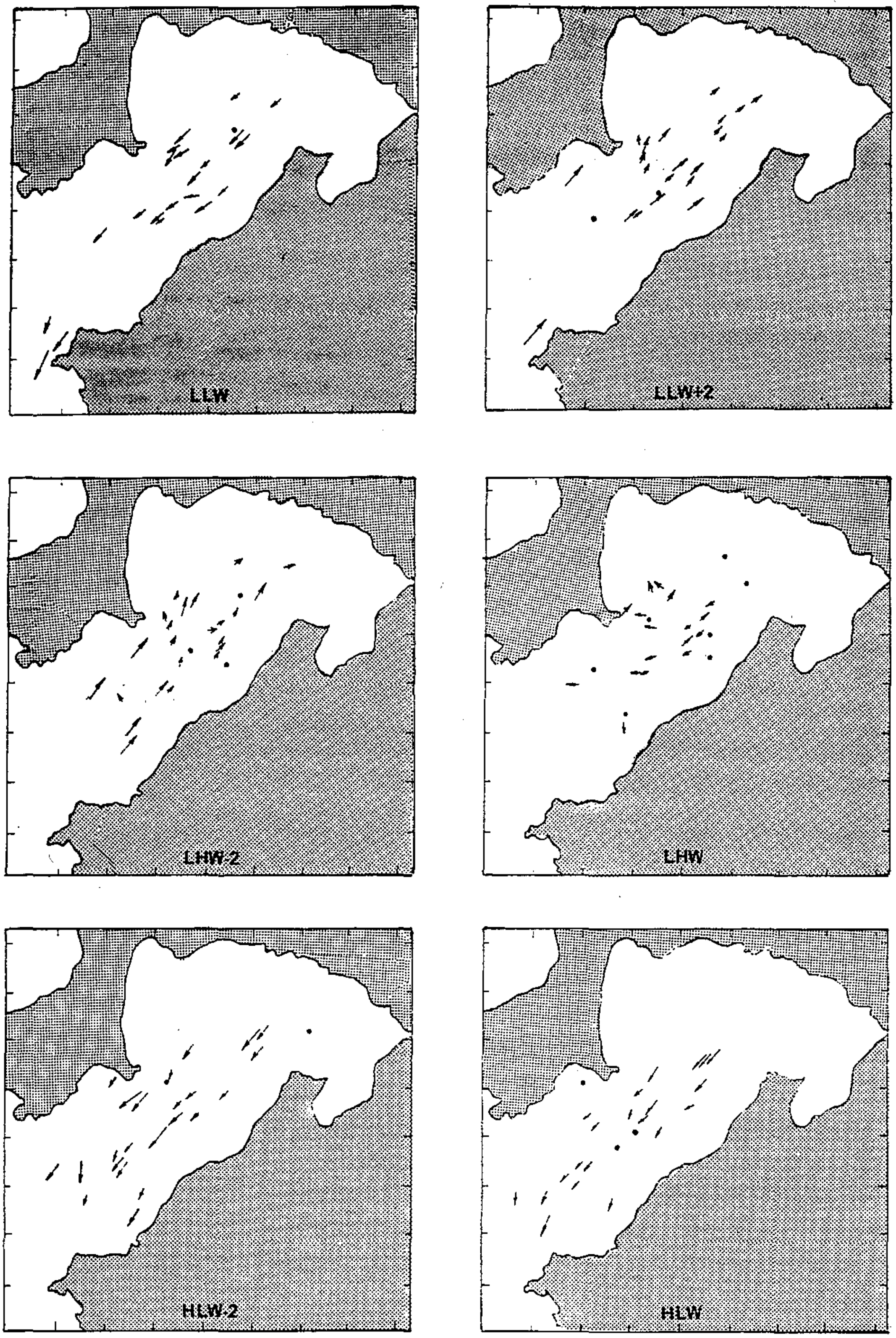

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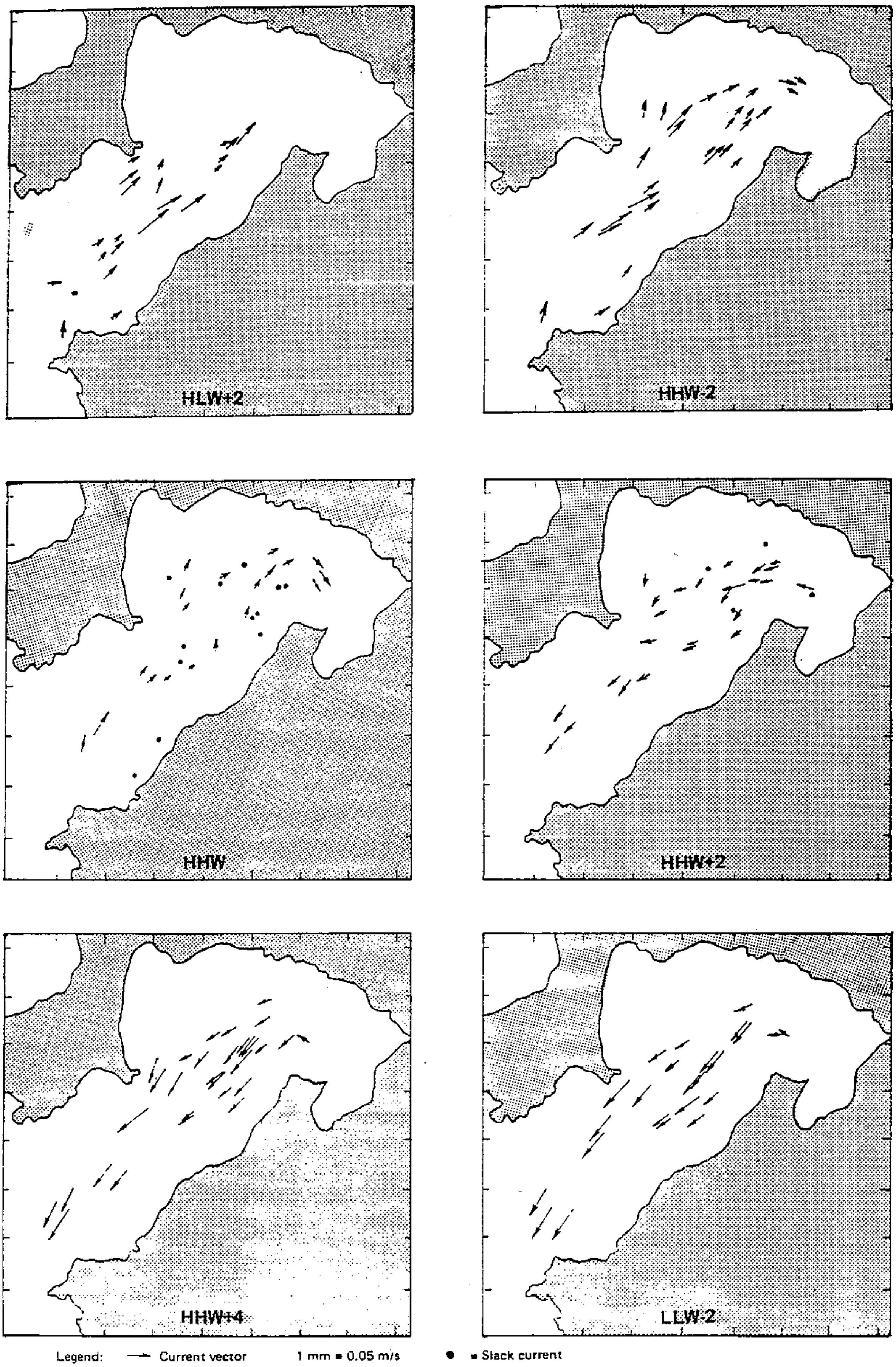

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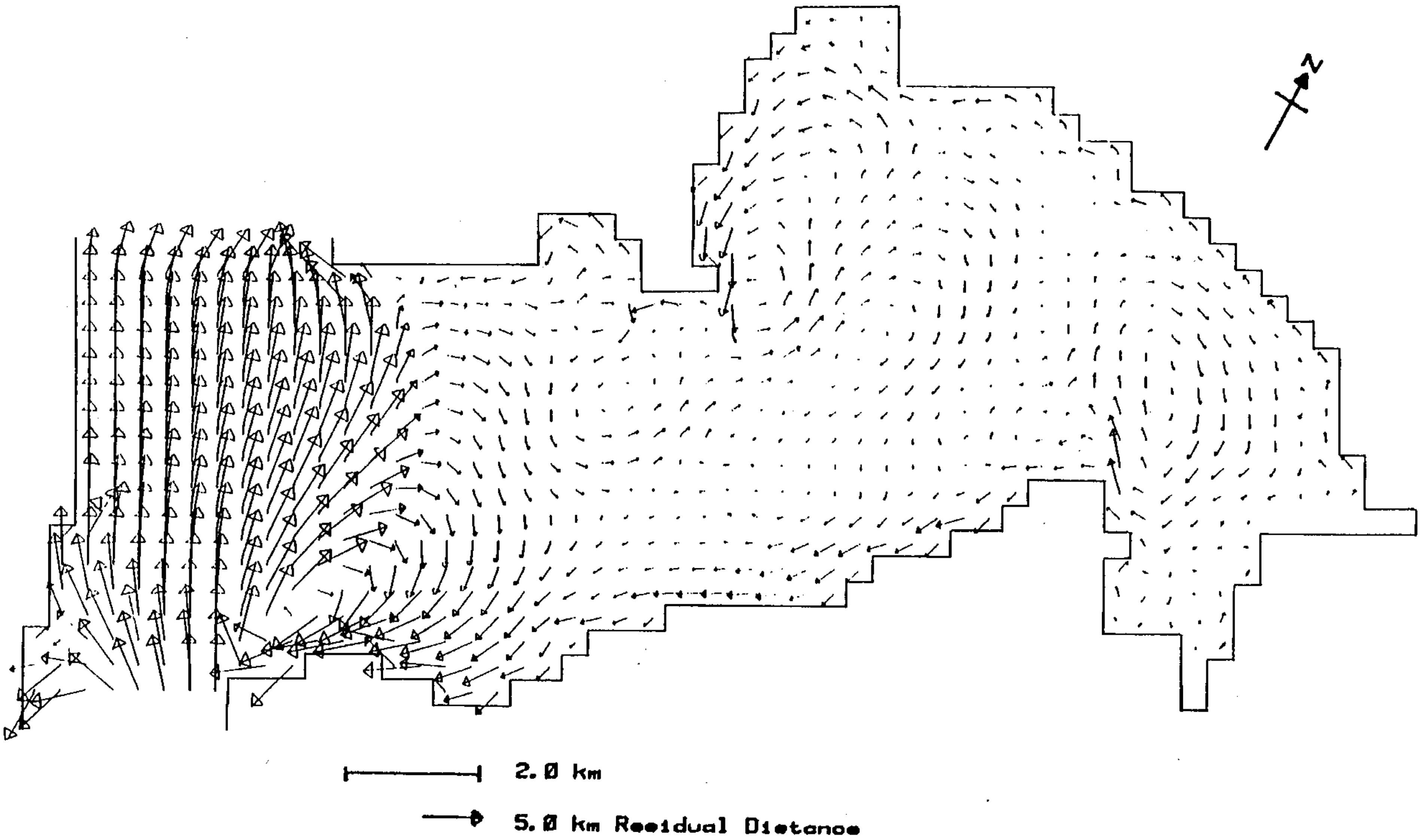

(SOURCE : TIN SHUI WAI DEVELOPMENT : LAND FORMATION WORKING PAPER NO. 12 : BINNIE & PARTNERS, 9/1986)

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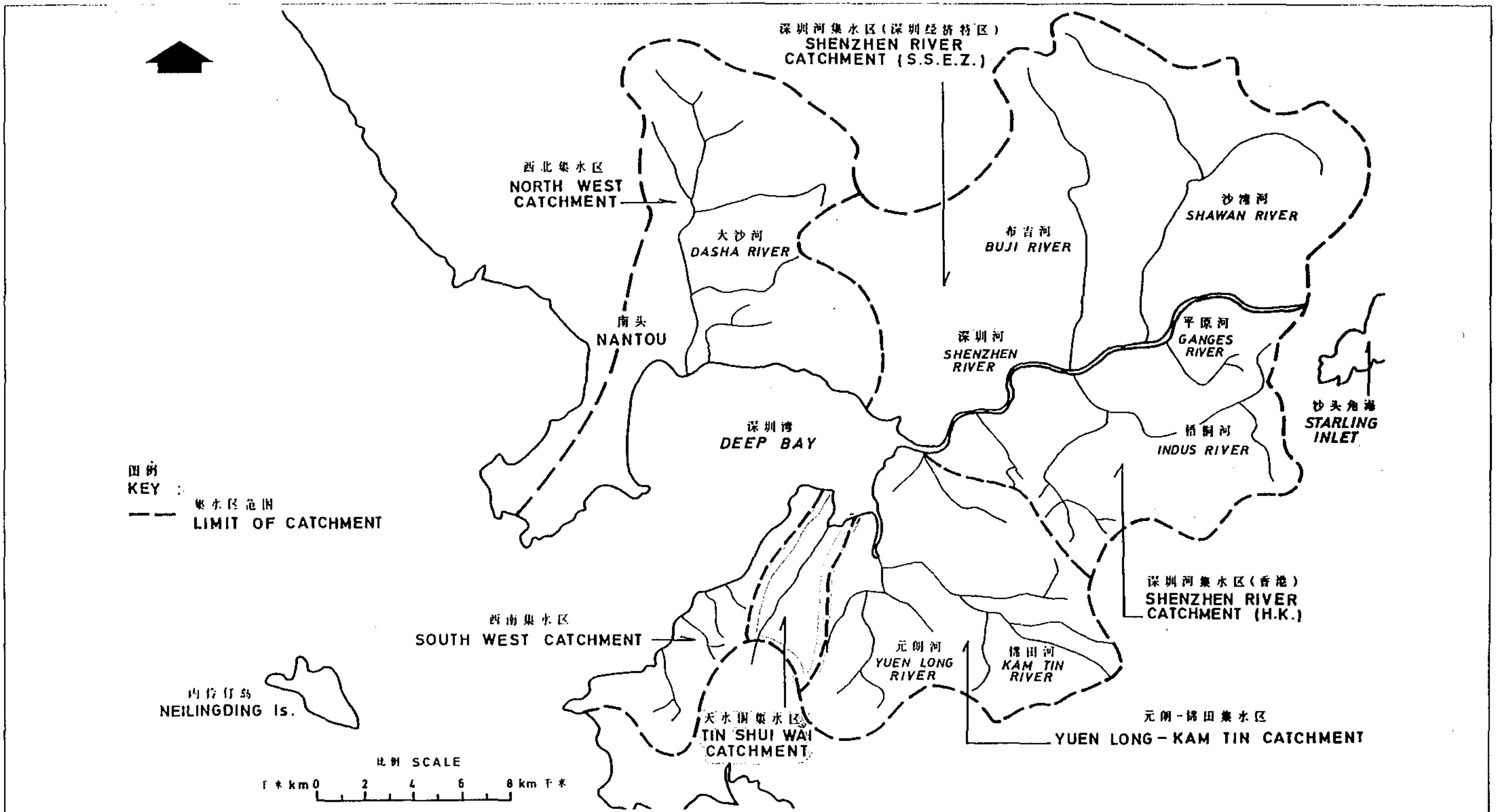

(SOURCE : TECHNICAL REPORT ON THE ENVIRONMENTAL PROTECTION OF DEEP BAY & ITS CATCHMENTS : HK-GUANGDONG ENVIRONMENTAL PROTECTION LIAISON GROUP - TECHNICAL SUB-GROUP, DECEMBER 1992)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : DRAINAGE CATCHMENTS OF DEEP BAY	Figure No. 7.9	Revision 0
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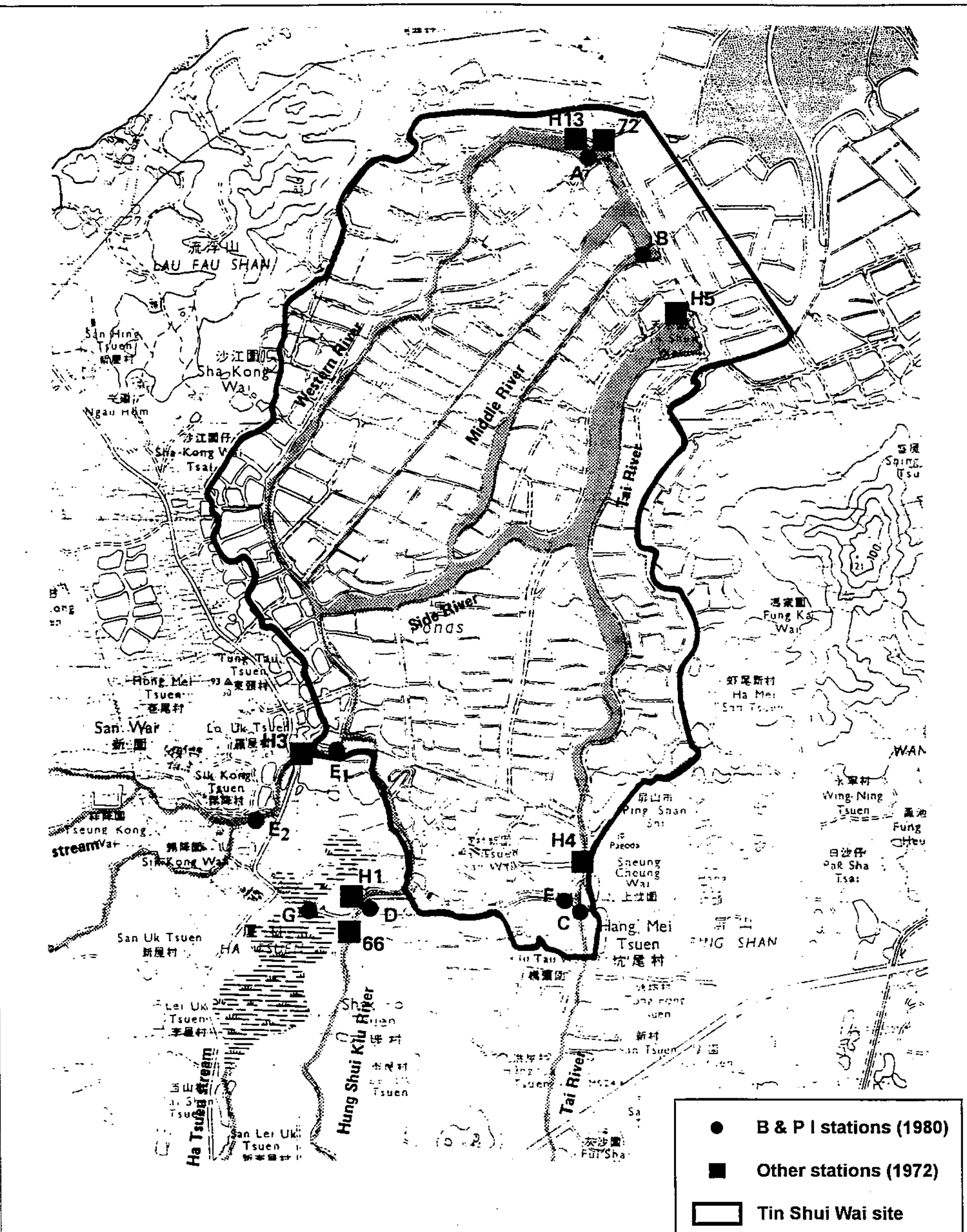
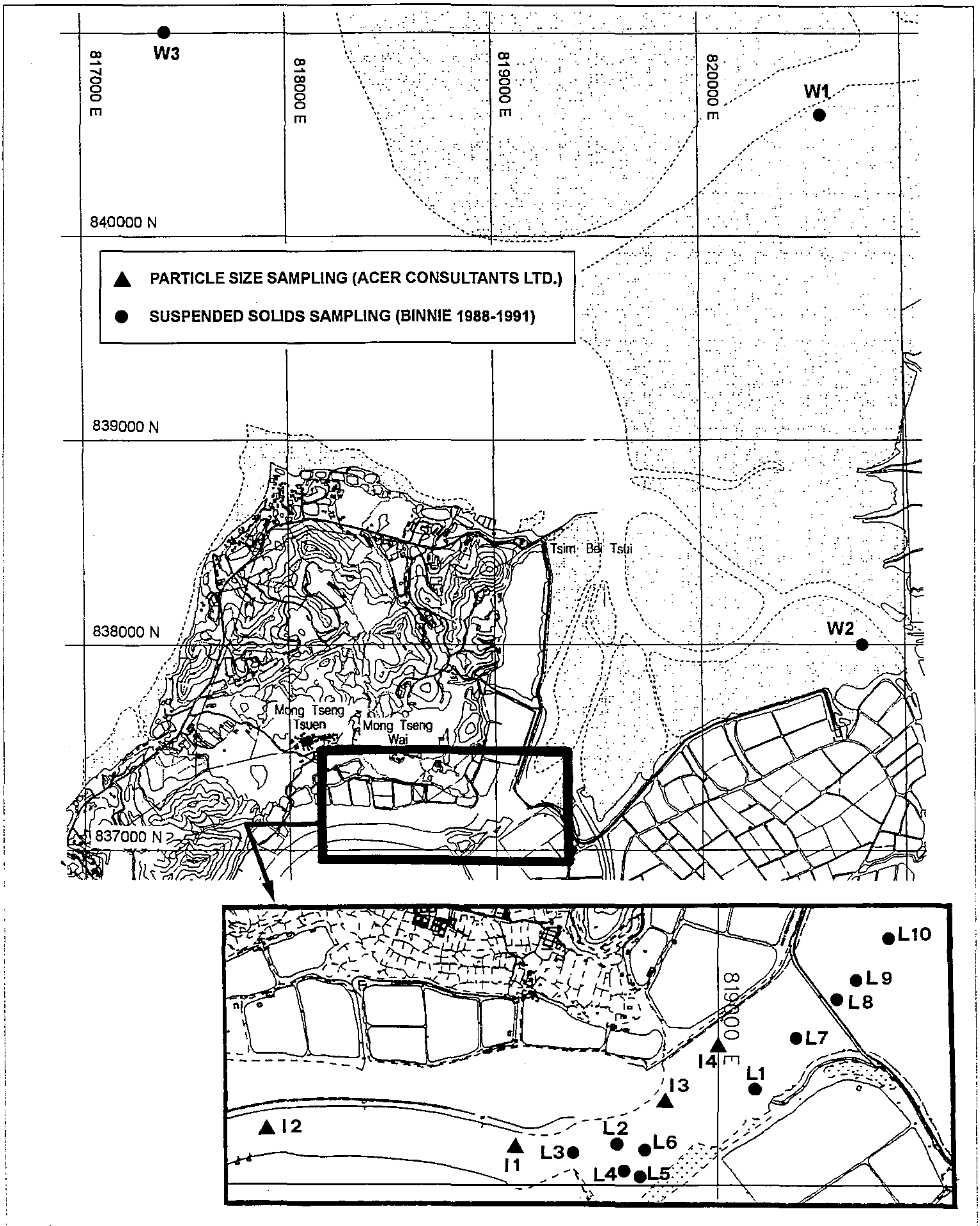


(SOURCE : DEEP BAY WATER QUALITY : BINNIE & PARTNERS INTERNATIONAL, 1985)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : LOCATIONS OF STREAM SAMPLING STATIONS IN 1972 & 1980	Figure No. 7.10	Revision 0
		Reference No. BINNIE 1985	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked JC
		Date APR 96	Scale NTS



(SOURCE : RIVER SEDIMENT SURVEY - PHASE 2 : ACER CONSULTANTS (FAR EAST) LIMITED / BINNIE ARCHIVE DATA)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SUSPENDED SOLIDS & PARTICLE SIZE SAMPLING LOCATIONS	Figure No. 7.11	Revision 0
		Reference No. ACER / BINNIE DATA	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS		Prepared MC	Checked JC
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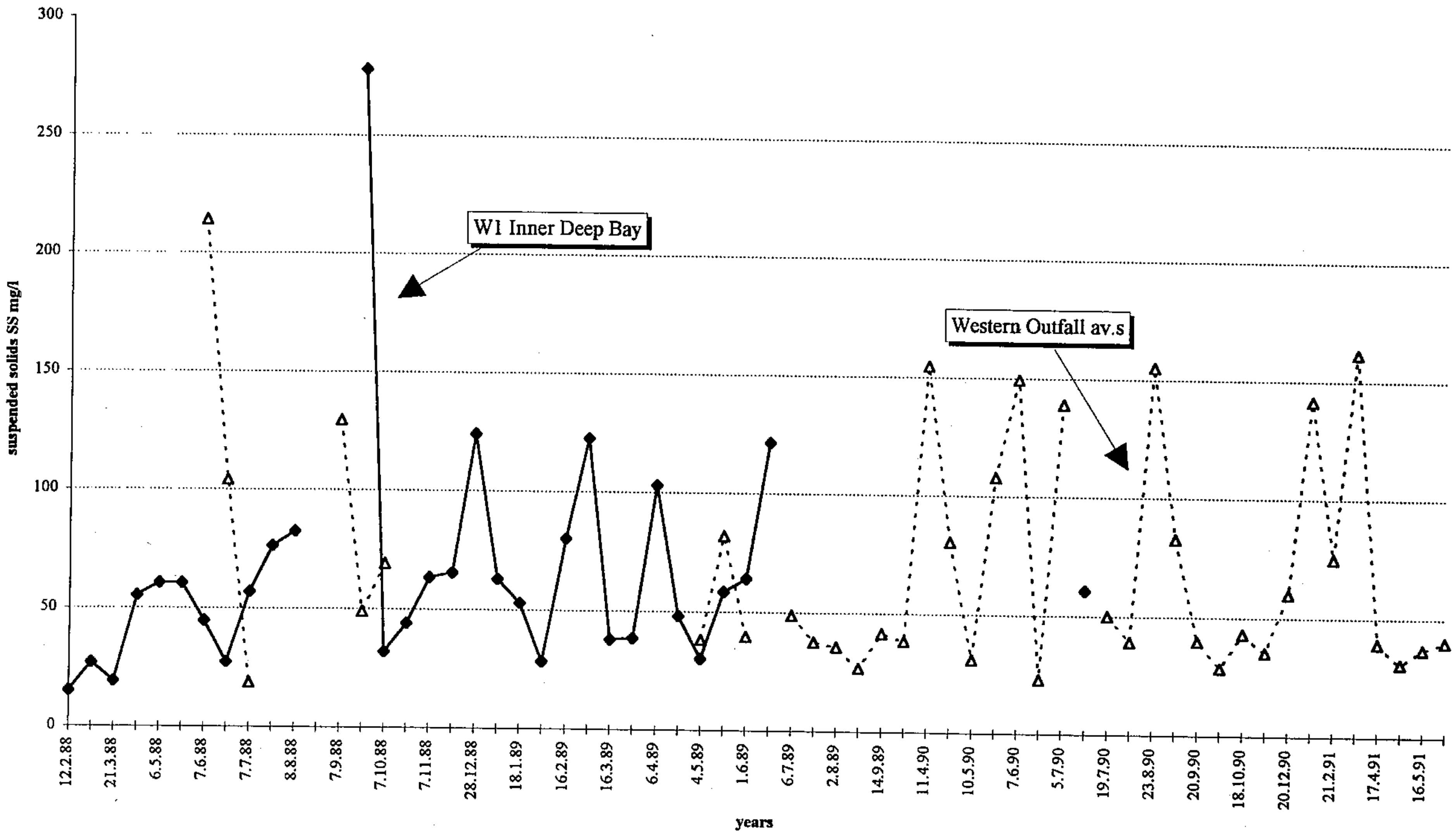

(SOURCE : BINNIE & PARTNERS AND SHANKLAND COX ARCHIVE DATA)

TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR
DEVELOPMENT OF AREAS 3, 30 & 31
OF THE DEVELOPMENT ZONE
AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
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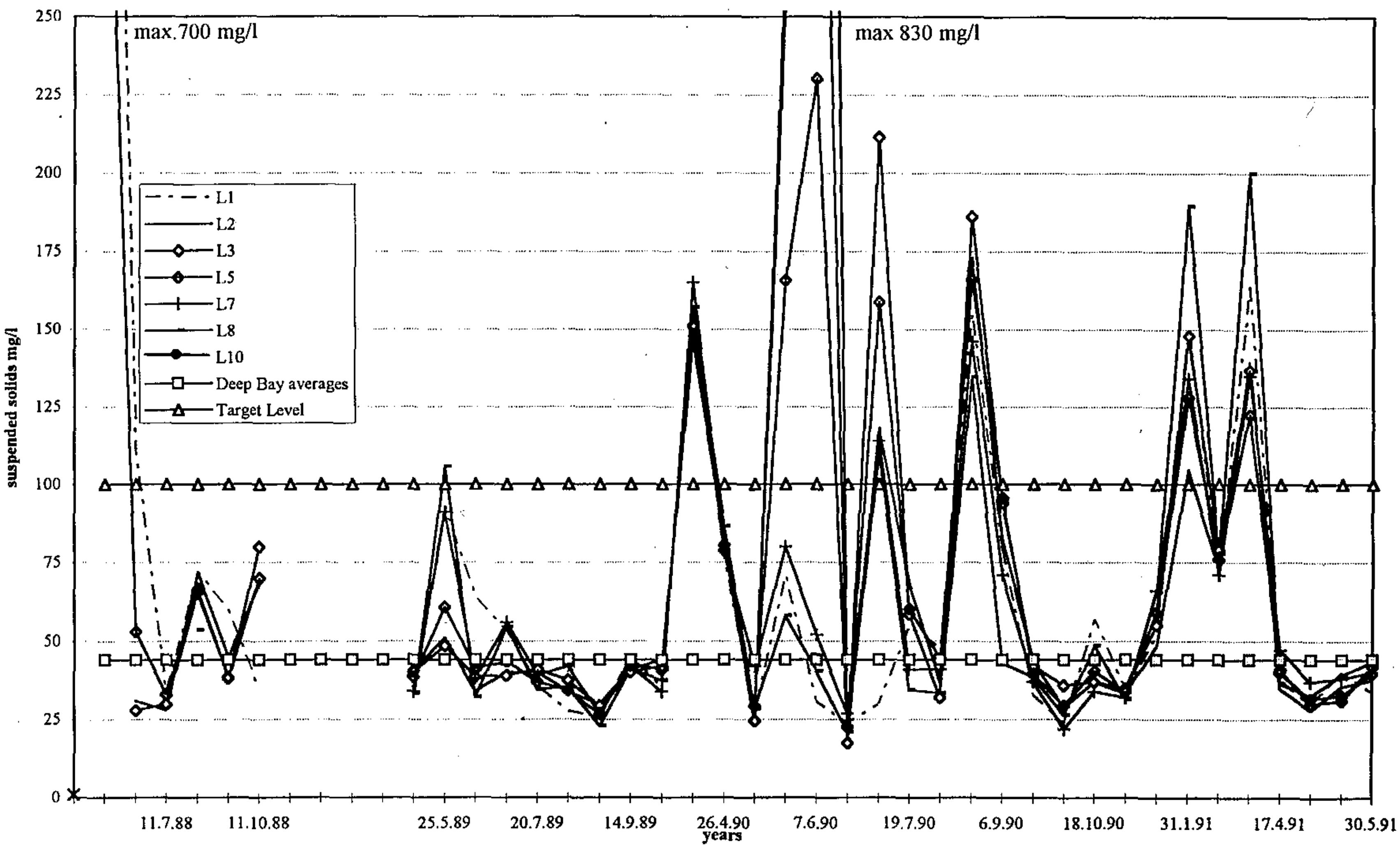
Title :

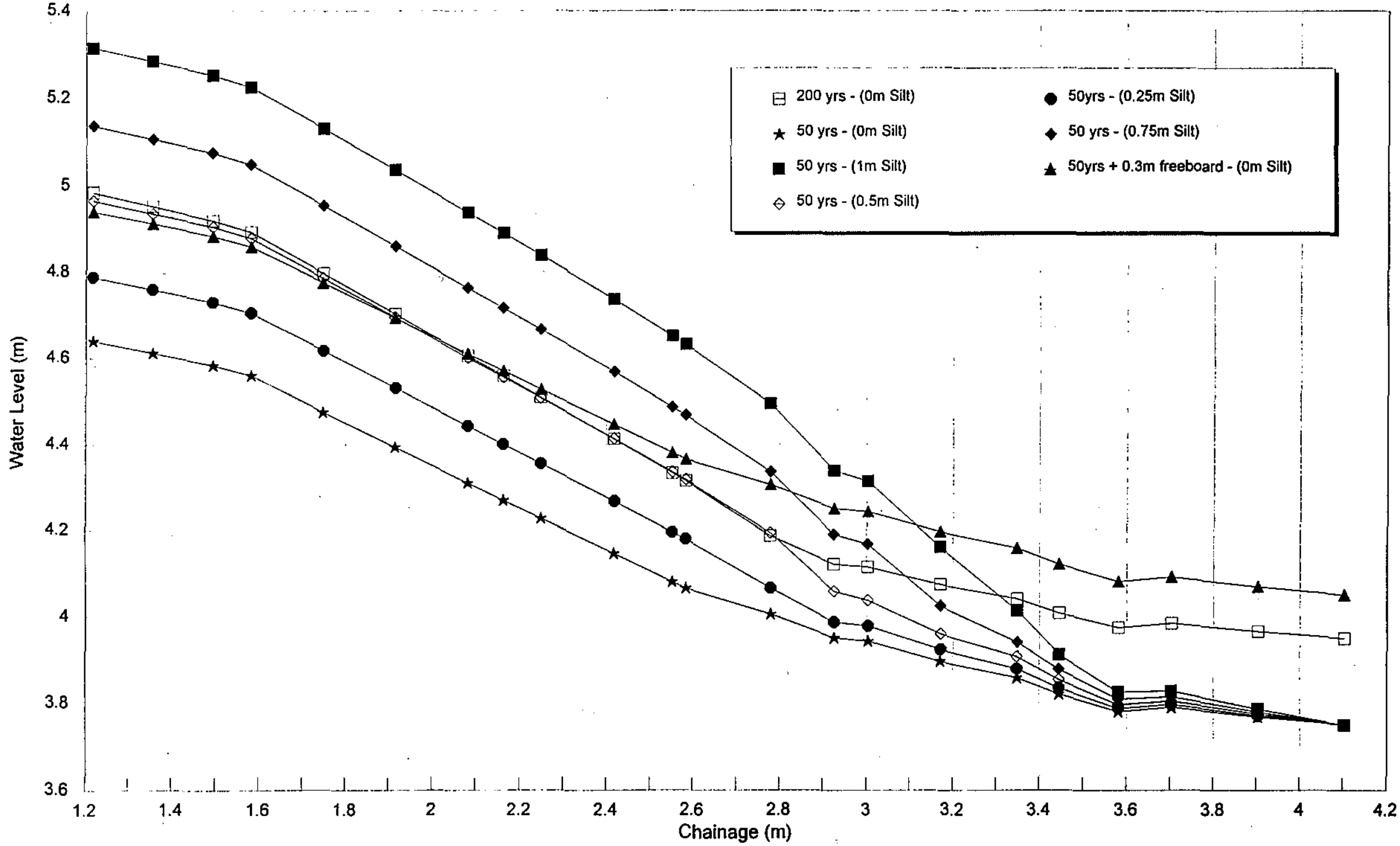
A COMPARISON OF SUSPENDED SOLIDS IN WESTERN OUTFALL AND INNER DEEP BAY DURING LAND FORMATION WORKS - TIN SHUI WAI

Figure No. 7.12	Revision 0
Reference No. BINNIE & SHANKLAND COX DATA	File Name -
Prepared MC	Checked JC
Date APR 96	Scale AS SHOWN



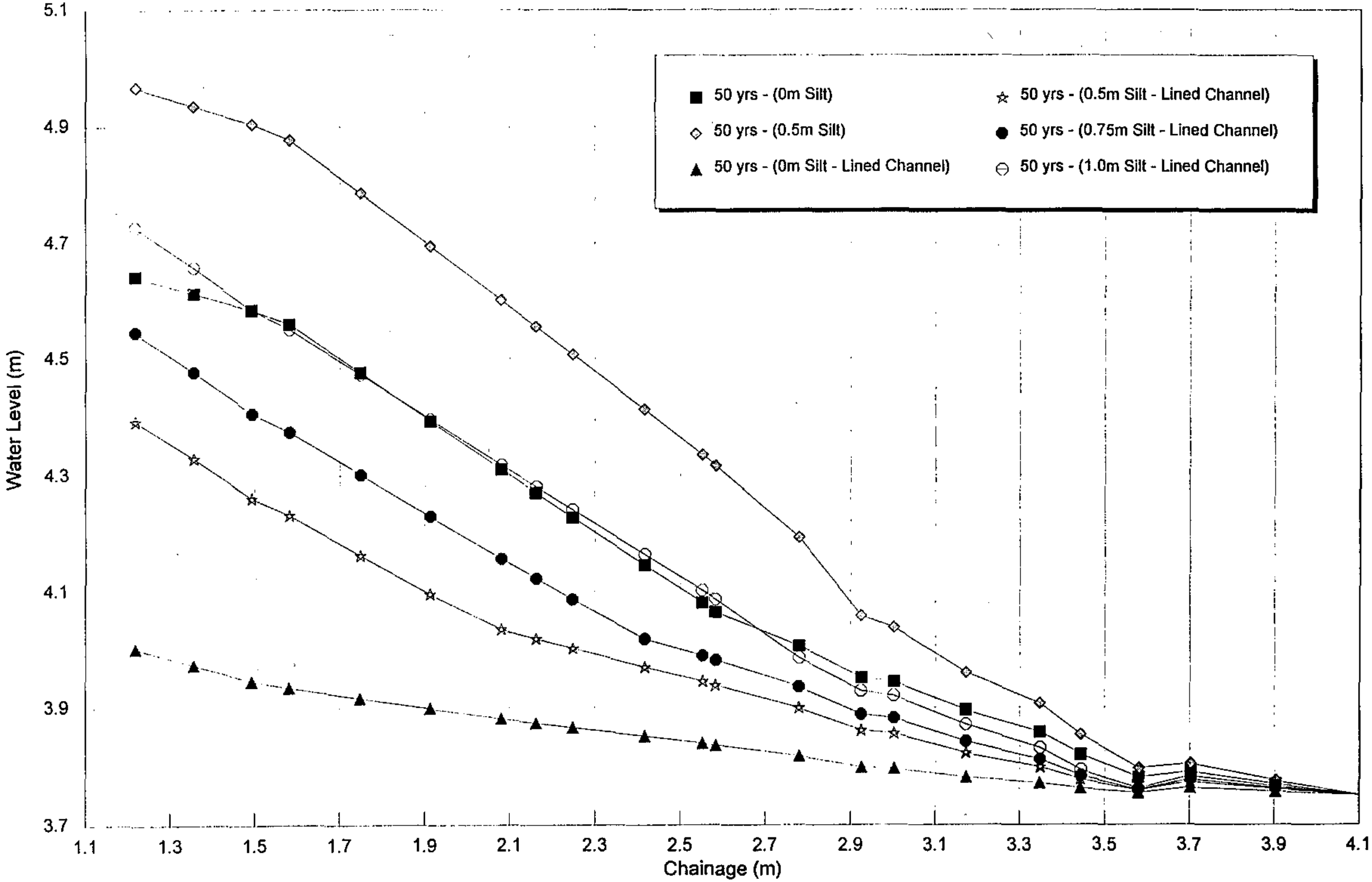
(SOURCE : BINNIE & PARTNERS AND SHANKLAND COX ARCHIVE DATA)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SUSPENDED SOLIDS IN WESTERN OUTFALL DURING LAND FORMATION WORKS - TIN SHUI WAI	Figure No. 7.13	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS		Reference No. BINNIE & SHANKLAND COX DATA	File Name -
		Prepared MC	Checked JC
		Date APR 96	Scale AS SHOWN



(SOURCE : TIN SHUI WAI DEVELOPMENT - FINAL INVESTIGATION REPORT (Ref. 0018/ENG/R17.2) : BCL, 3/97)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : COMPARISON OF MAXIMUM WATER LEVELS WITH DIFFERENT DEPTH OF SILTATION IN WESTERN DRAINAGE CHANNEL EXTENSION	Figure No. 7.14	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference No. PKL / MIKE 11 MODEL	File Name -
		Prepared MC	Checked JC
		Date FEB 97	Scale AS SHOWN



(SOURCE : TIN SHUI WAI DEVELOPMENT - FINAL INVESTIGATION REPORT (Ref. 0018/ENG/R17.2) : BCL, 3/97)

TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
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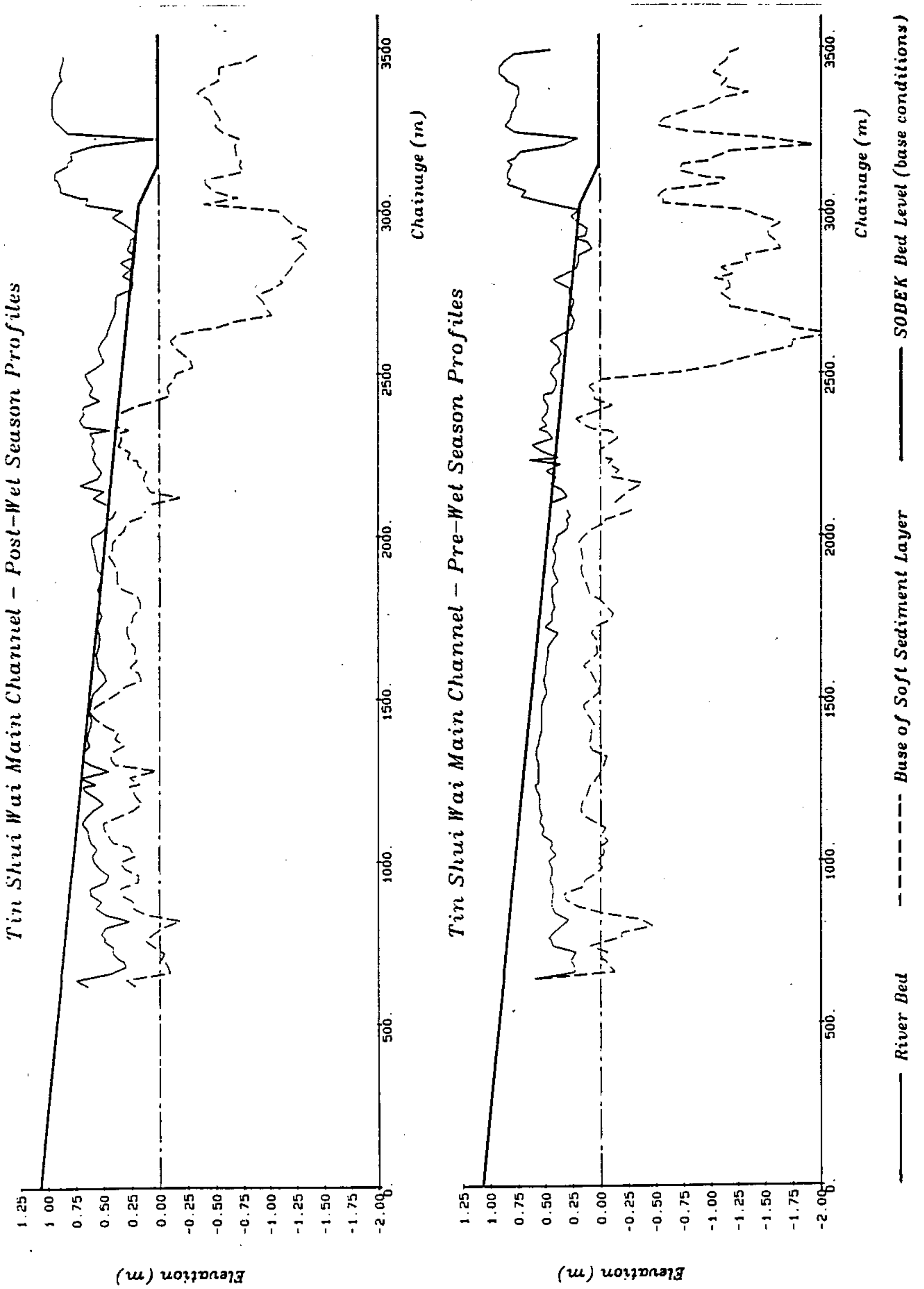
賓尼

Title :

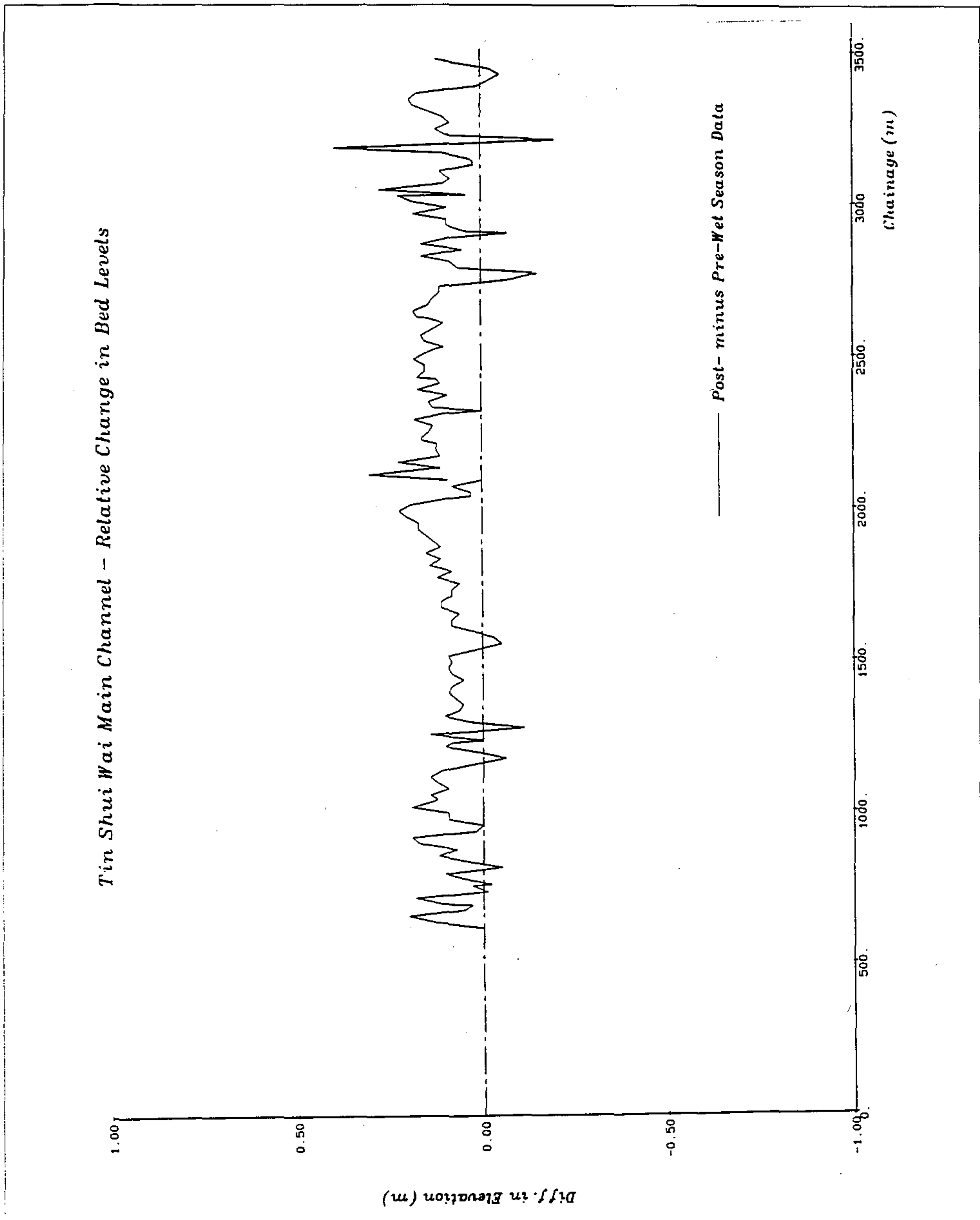
COMPARISON OF MAXIMUM WATER LEVELS IN WESTERN DRAINAGE CHANNEL EXTENSION WITH LINED AND UNLINED CASES

Figure No. 7.15	Revision 0
Reference No. PKL / MIKE 11 MODEL	File Name -
Prepared MC	Checked JC
Date FEB 97	Scale AS SHOWN



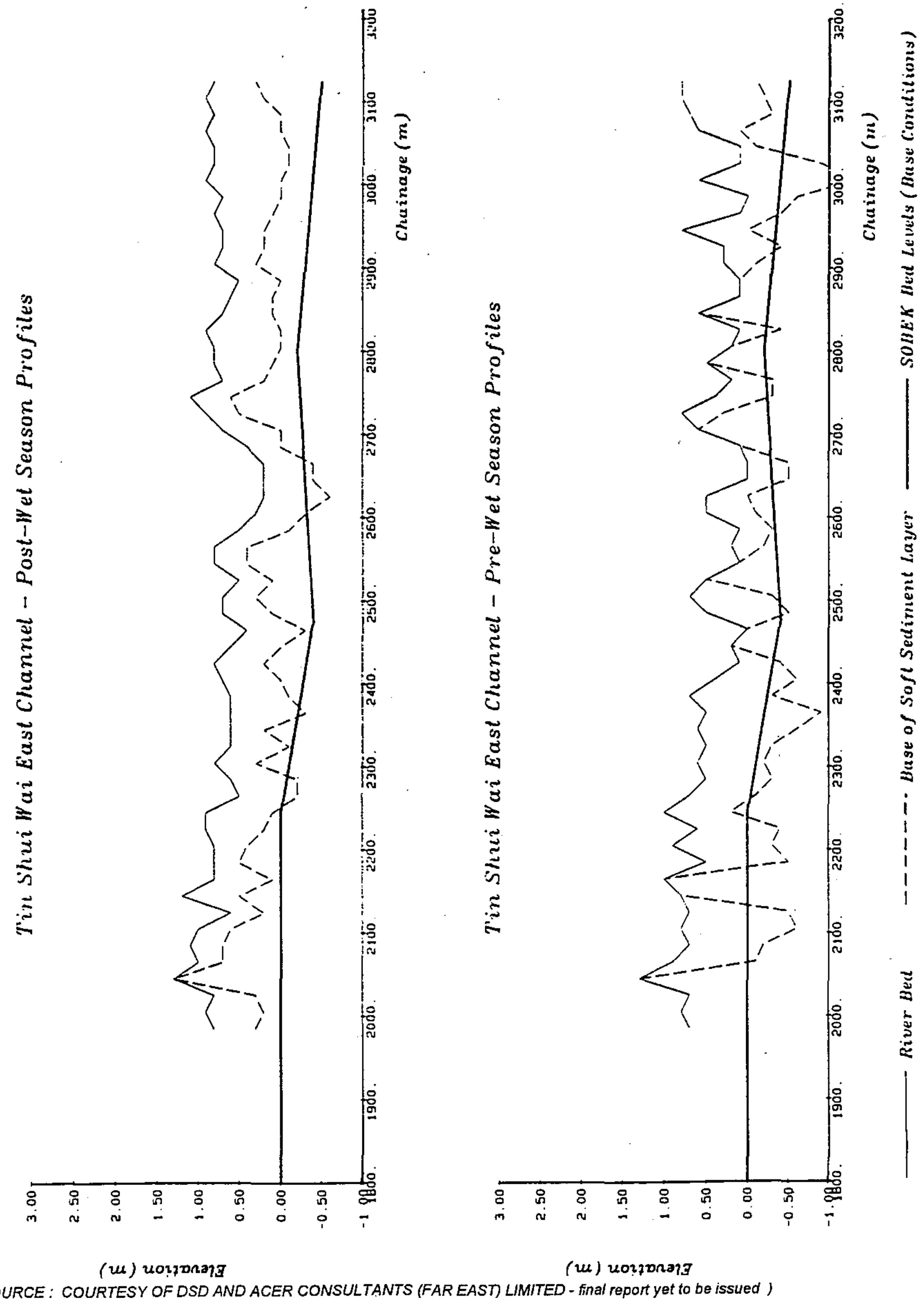
(SOURCE : COURTESY OF DSD AND ACER CONSULTANTS (FAR EAST) LIMITED - final report yet to be issued)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SEDIMENTATION STUDY (BED LEVEL SURVEY) Tin Shui Wai Channels Mid-Channel Longitudinal Section Tin Shui Wai Main Channel	Figure No. 7.16a	Revision 0
		Reference No. ACER DATA	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked JC
		Date APR 96	Scale NTS



(SOURCE : COURTESY OF DSD AND ACER CONSULTANTS (FAR EAST) LIMITED - final report yet to be issued)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SEDIMENTATION STUDY (BED LEVEL SURVEY) Tin Shui Wai Channels Mid-Channel Longitudinal Section Tin Shui Wai Main Channel	Figure No. **7.16b**	Revision 0
		Reference No. ACER DATA	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked JC
		Date APR 96	Scale NTS



(SOURCE : COURTESY OF DSD AND ACER CONSULTANTS (FAR EAST) LIMITED - final report yet to be issued)

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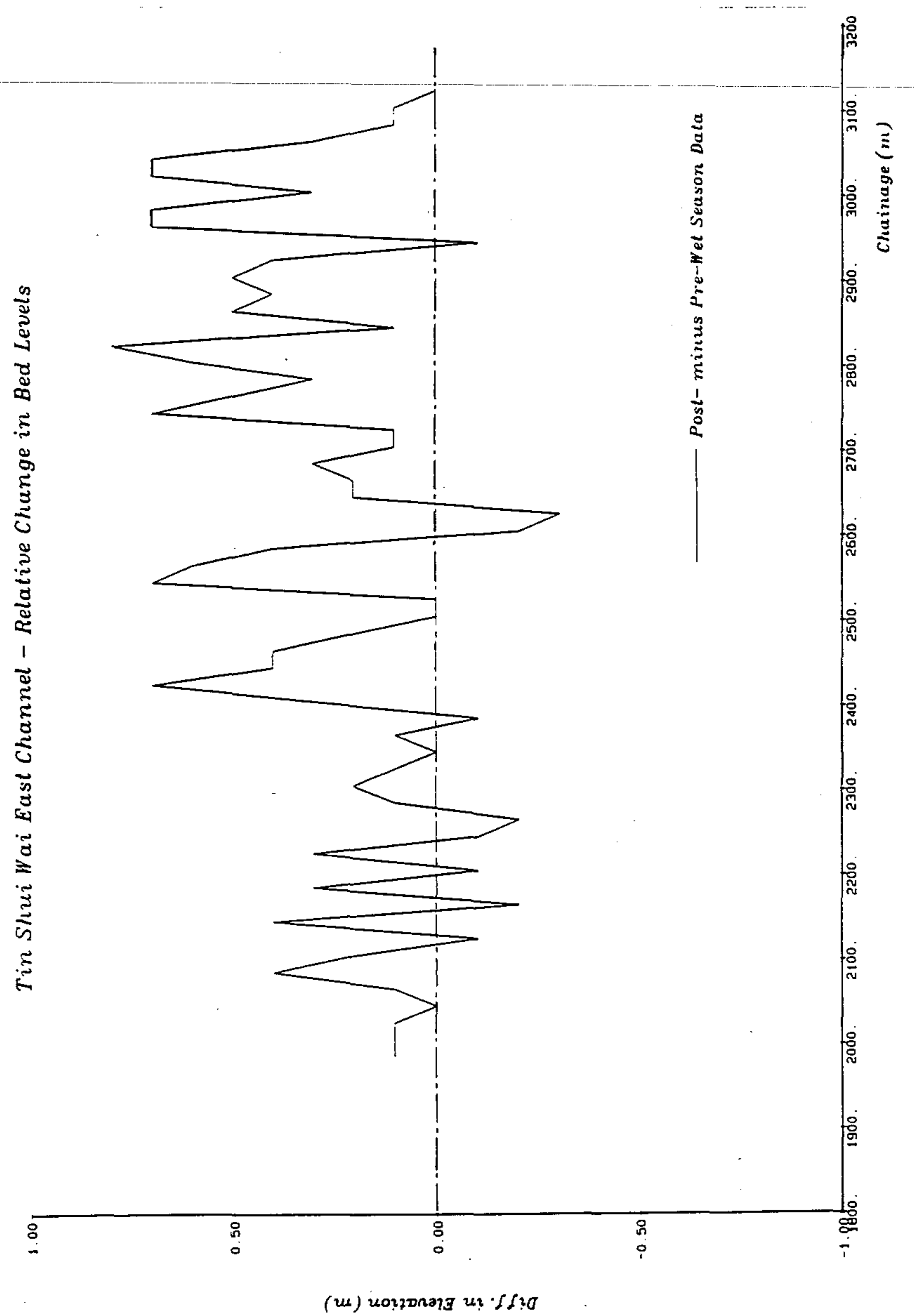
		Reference No. ACER DATA	File Name
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked JC
		Date APR 96	Scale NTS



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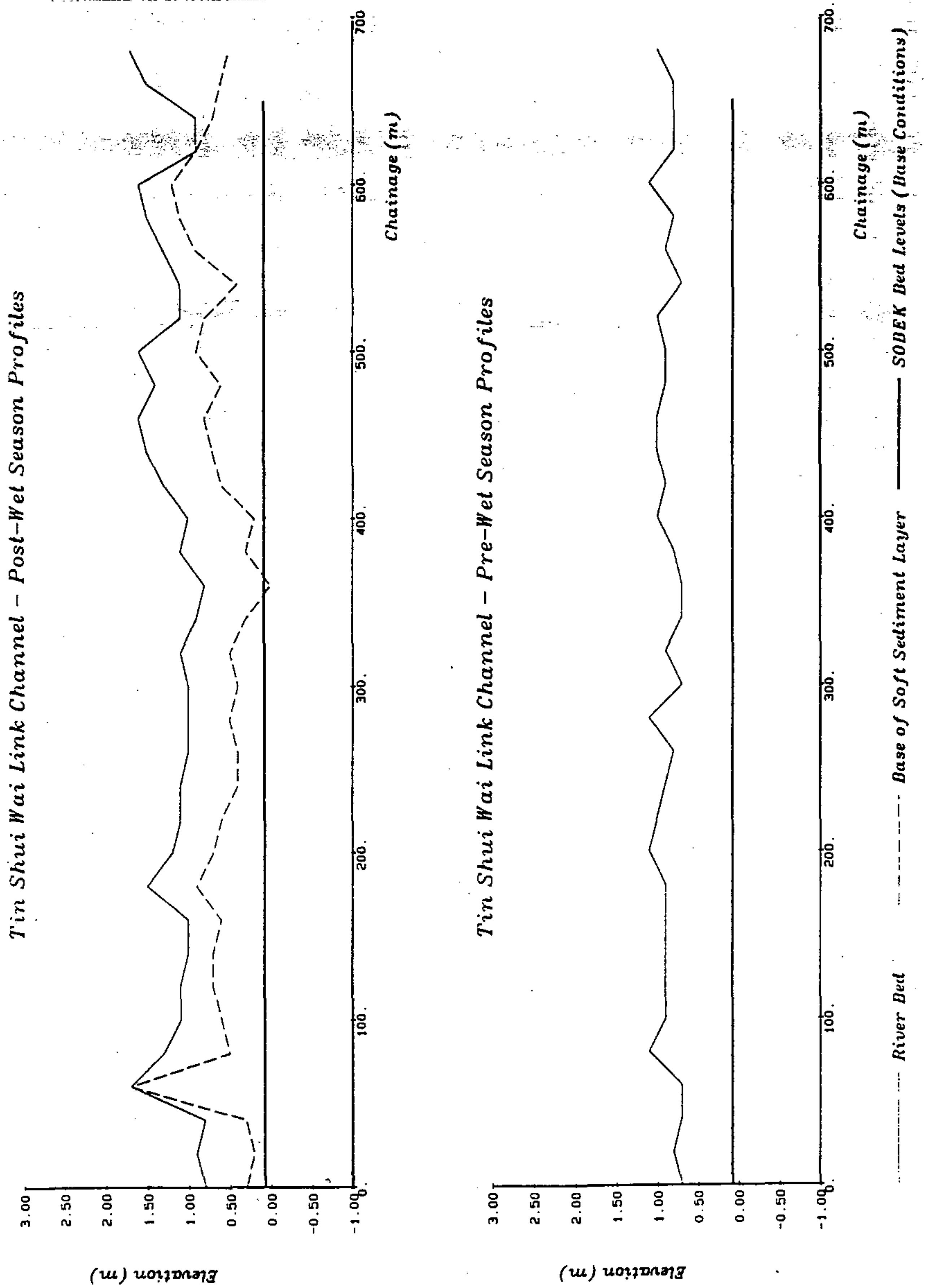
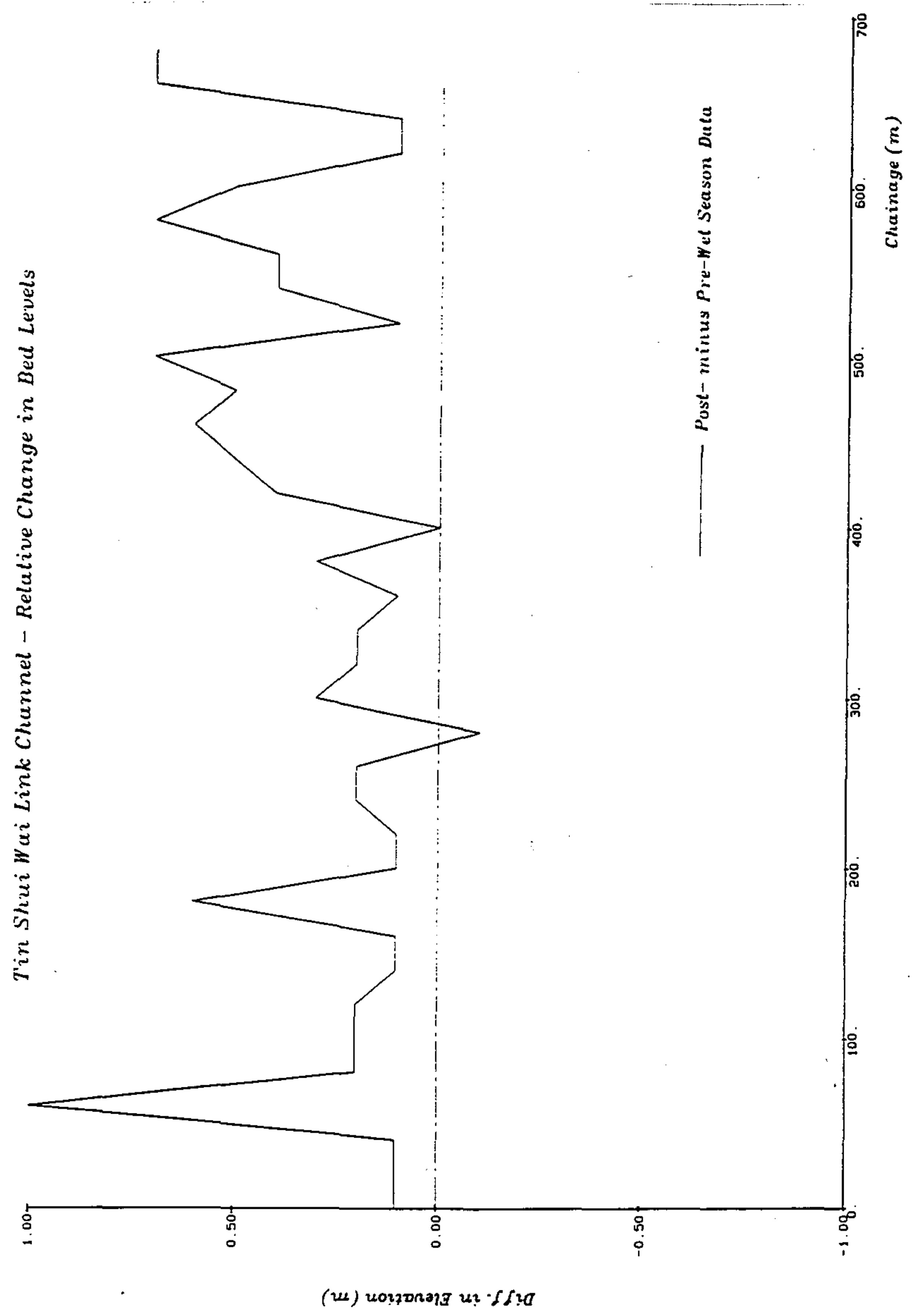
		Reference No. ACER DATA	File Name
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked JC
		Date APR 96	Scale NTS



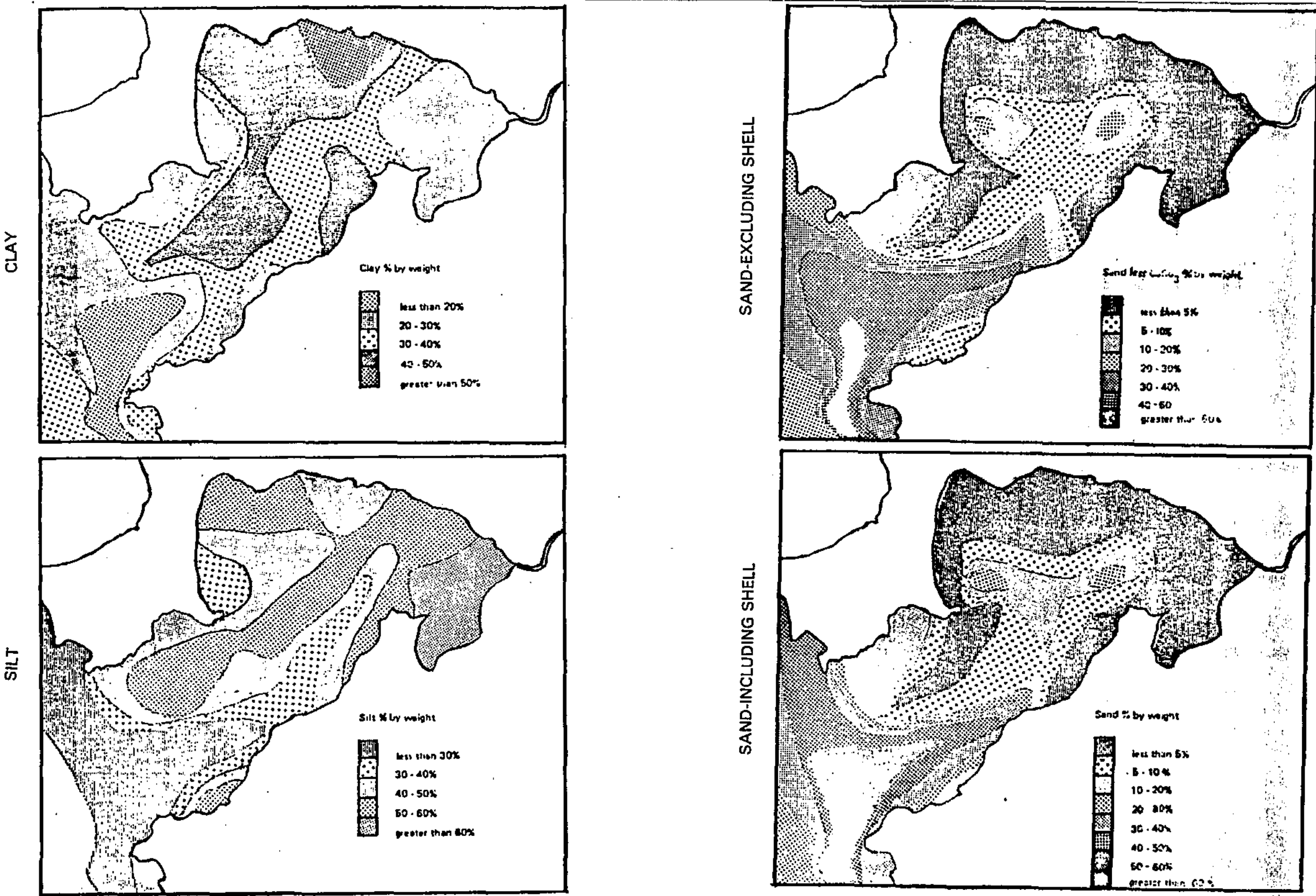
(SOURCE : COURTESY OF DSD AND ACER CONSULTANTS (FAR EAST) LIMITED - *final report yet to be issued*)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SEDIMENTATION STUDY (BED LEVEL SURVEY) Tin Shui Wai Channels Mid-Channel Longitudinal Section Tin Shui Wai Link Channel (Tin Shui Wai Creek)	Figure No. **7.18a**	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference No. ACER DATA	File Name -
		Prepared MC	Checked JC
		Date APR 96	Scale NTS



(SOURCE : COURTESY OF DSD AND ACER CONSULTANTS (FAR EAST) LIMITED - final report yet to be issued)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : SEDIMENTATION STUDY (BED LEVEL SURVEY) Tin Shui Wai Channels Mid-Channel Longitudinal Section Tin Shui Wai Link Channel (Tin Shui Wai Creek)	Figure No. **7.18b**	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference No. ACER DATA	File Name -
		Prepared MC	Checked JC
		Date APR 96	Scale NTS



TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
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DEVELOPMENT OF AREAS 3, 30 & 31
OF THE DEVELOPMENT ZONE
AND THE RESERVE ZONE

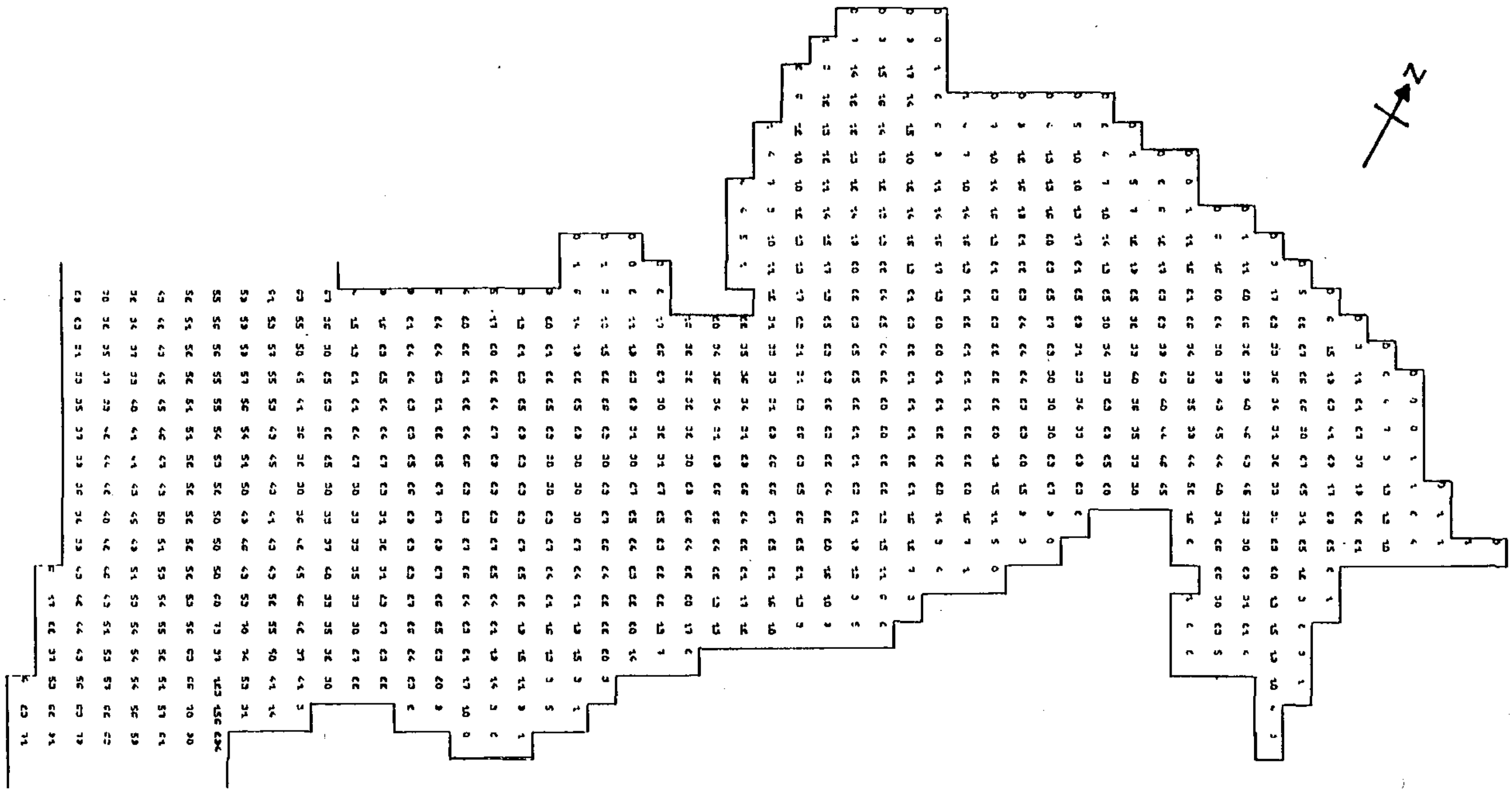
BINNIE CONSULTANTS LIMITED
賓尼工程顧問有限公司
ENGINEERS AND SCIENTISTS
賓尼

Title :

SEDIMENT PARTICLE SIZE DISTRIBUTION IN DEEP BAY

(SOURCE : TIN SHUI WAI DEVELOPMENT - EIA OF LAND PREPARATION ASPECTS : BINNIE & SHANKLAND COX, 2/1985)

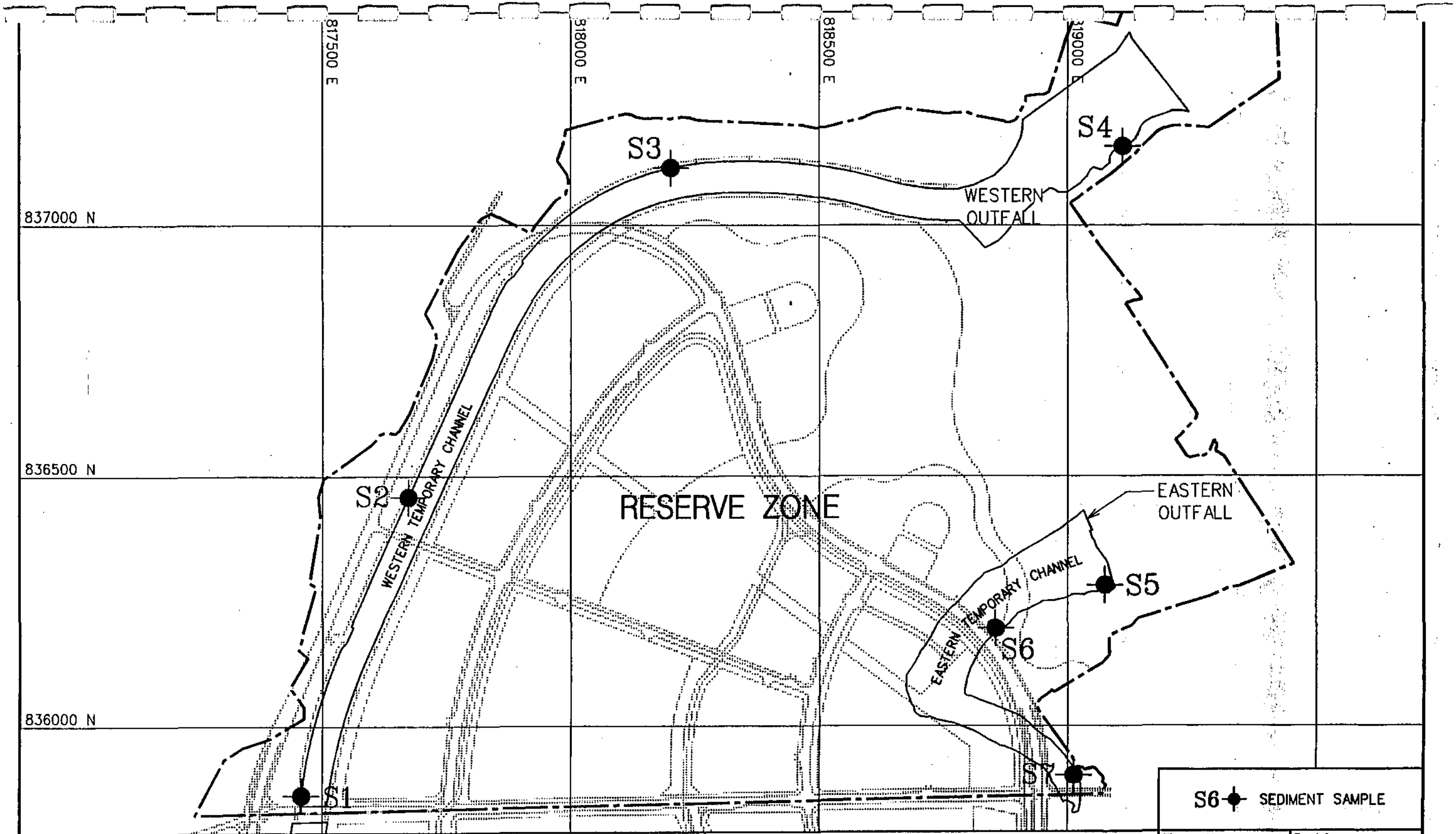
Figure No. 7.19	Revision 0
Reference No. BINNIE & SHANKLAND COX 1985	File Name -
Prepared MC	Checked JC
Date APR 96	Scale NTS



Plotted Values are Max Shear Stress (N/m^2) x 100

(SOURCE : TIN SHUI WAI DEVELOPMENT : LAND FORMATION WORKING PAPER NO. 12 : BINNIE & PARTNERS, 9/1986)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : NEAP TIDE MAXIMUM BED SHEAR STRESS	Figure No. 7.20	Revision 0
		Reference No. BINNIE 9/1986	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked JC
		Date APR 96	Scale AS SHOWN



TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
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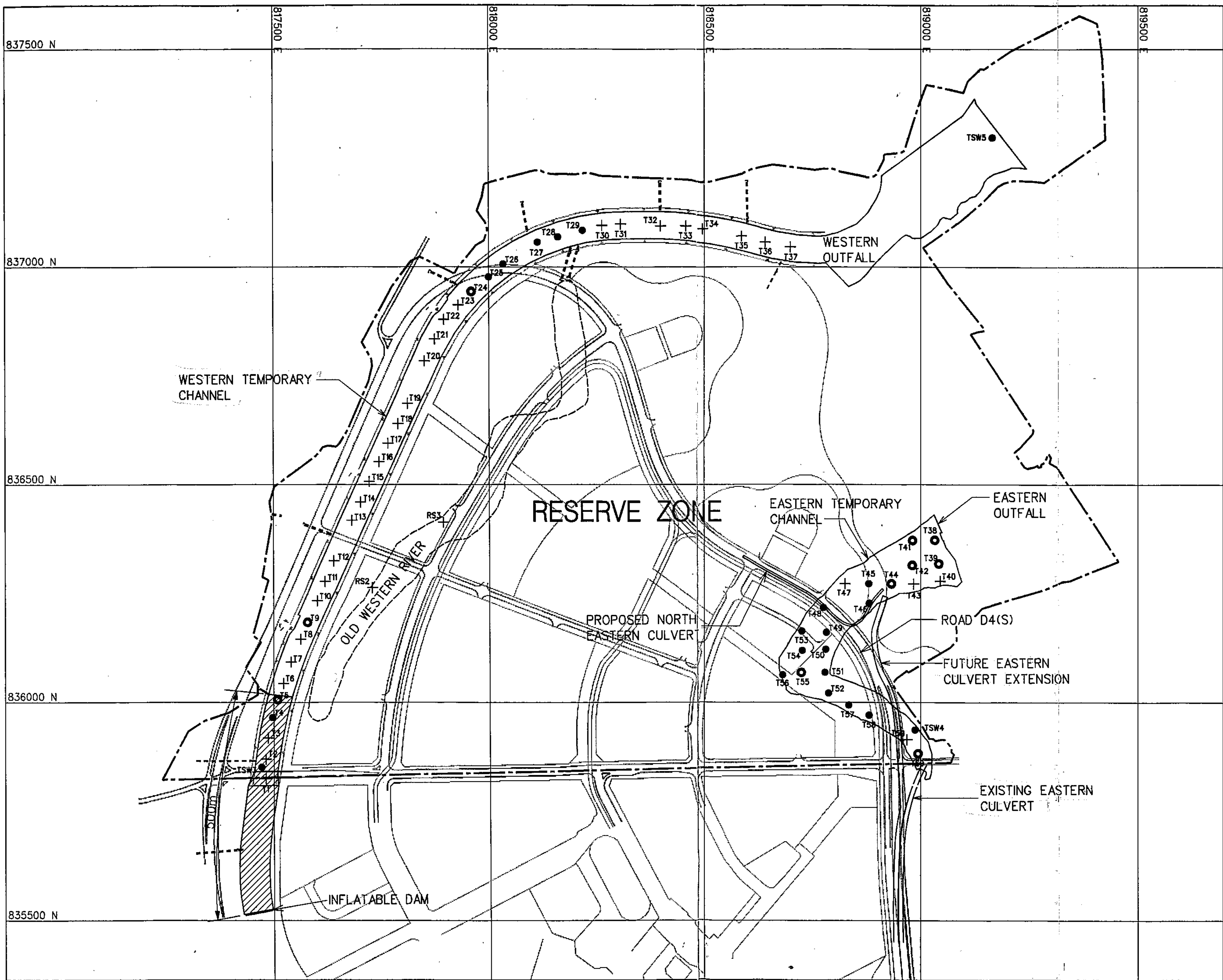
Title :

SEDIMENT LOCATIONS FOR ELUTRIATE ANALYSIS

Figure No. 7.21	Revision 0
Reference No. TSW-BASE	File Name 00700018.C09
Prepared PS	Checked MC
Date APR. 96	Scale 1 : 10000



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Notes

+	- CLASS A
○	- CLASS B
●	- CLASS C
- - -	- OUTFALL
(hatched)	AREA TO BE PAVED

Prepared	Checked
MC	AMP

File name	Revision	Date
01040018.C09	1	OCT. 96

Project TIN SHUI WAI DEVELOPMENT

Contract title

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

Title

SEDIMENT SAMPLING LOCATIONS UNDER TERM CONTRACT

Figure no.	Reference	Scale
7.22	TSW-BASE	1 : 8000

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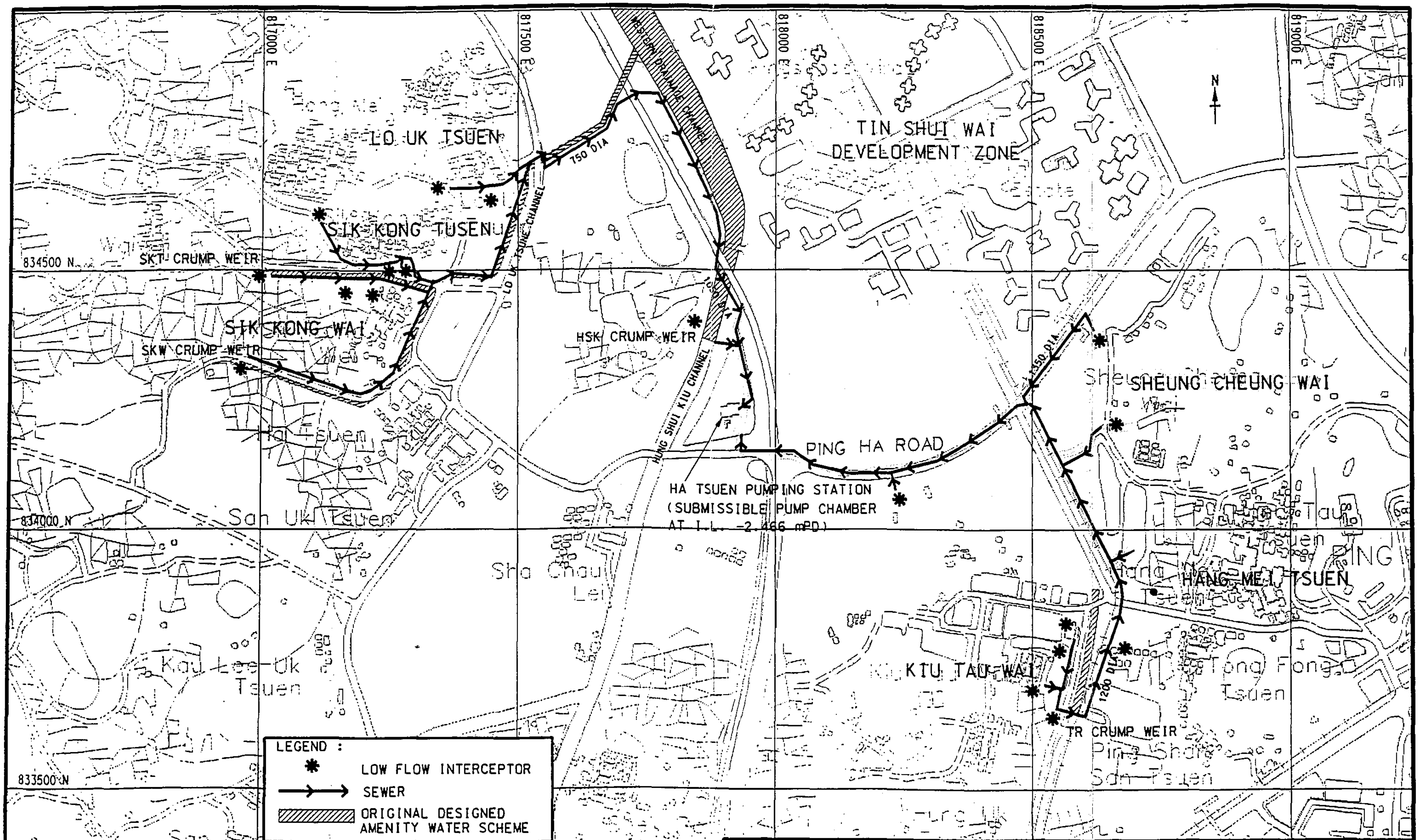
Office

新界北拓展處
NEW TERRITORIES NORTH DEVELOPMENT OFFICE

拓展署
Territory Development Department, Hong Kong

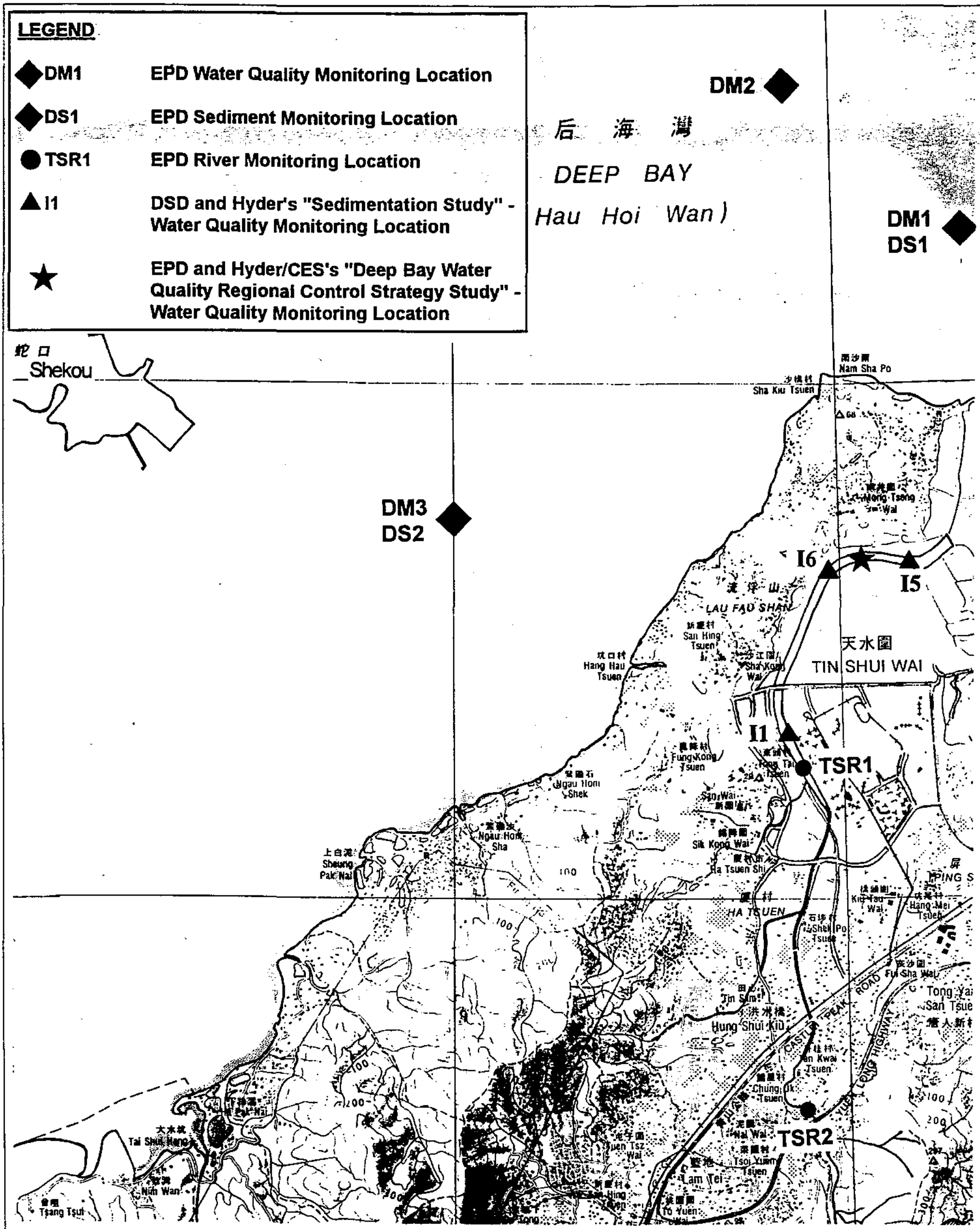


TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3.30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED 賓尼土程顧問有限公司

LAYOUT OF EXISTING AMENITY WATER SCHEME AND LOCATIONS OF LOW FLOW INTERCEPTORS

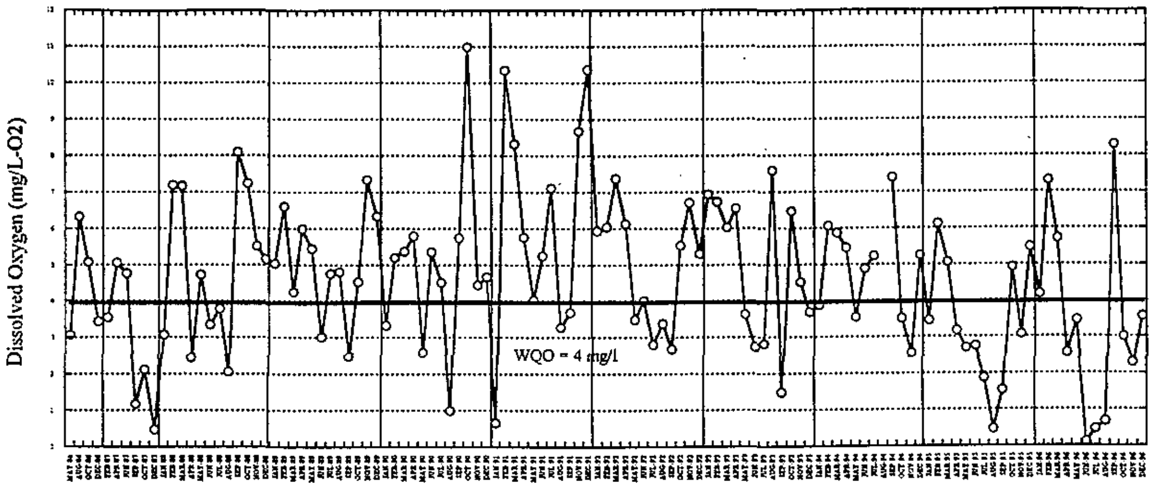
Figure no.	7.23
Prepared PKL	Checked CYH
Date 10/96	Scale N.T.S.



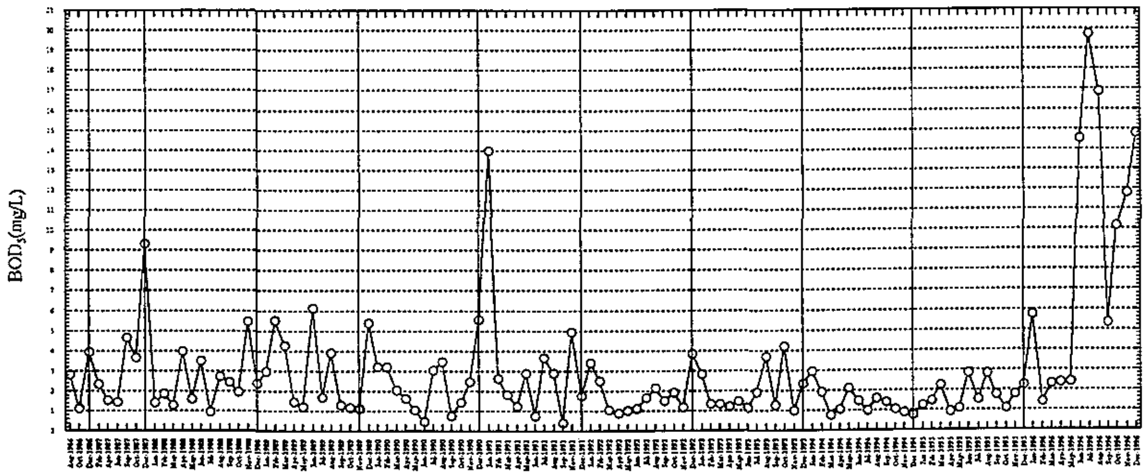
(SOURCE : EPD WATER QUALITY MONITORING REPORTS ; HYDER'S "SEDIMENTATION STUDY" - INTERIM REPORT ; HYDER/CES'S "DEEP BAY WATER QUALITY REGIONAL CONTROL STRATEGY STUDY" - INTERIM REPORT.)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : WATER QUALITY MONITORING STATIONS	Figure No. 7.24	Revision 0
		Reference No. -	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
		Date FEB 97	Scale 1 : 50000

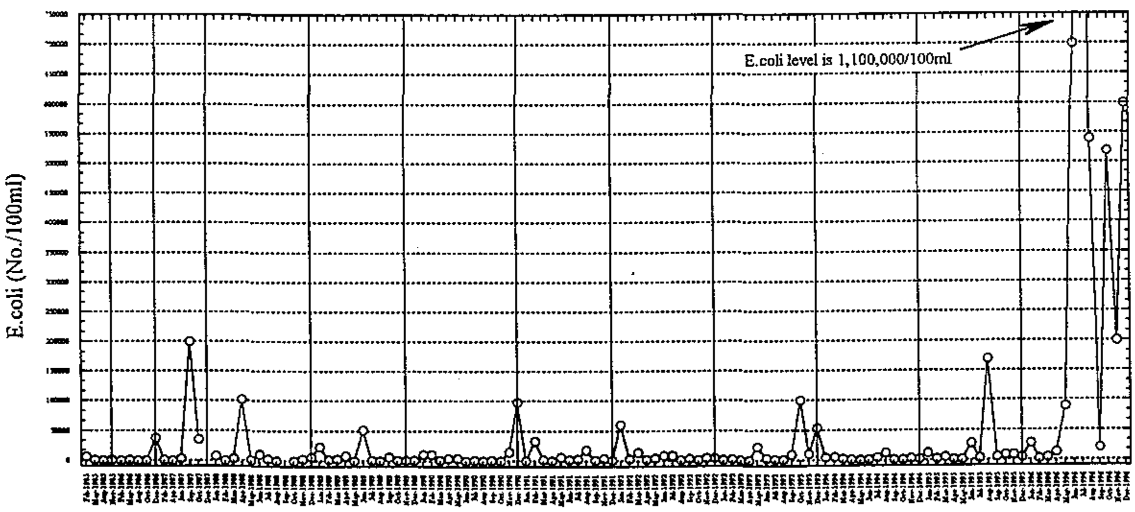
Dissolved Oxygen Levels of Inner Deep Bay at Station DM1 from 1986 to 1996



5-Day Biochemical Oxygen Demand Levels of Inner Deep Bay at Station DM1 from 1986 to 1996



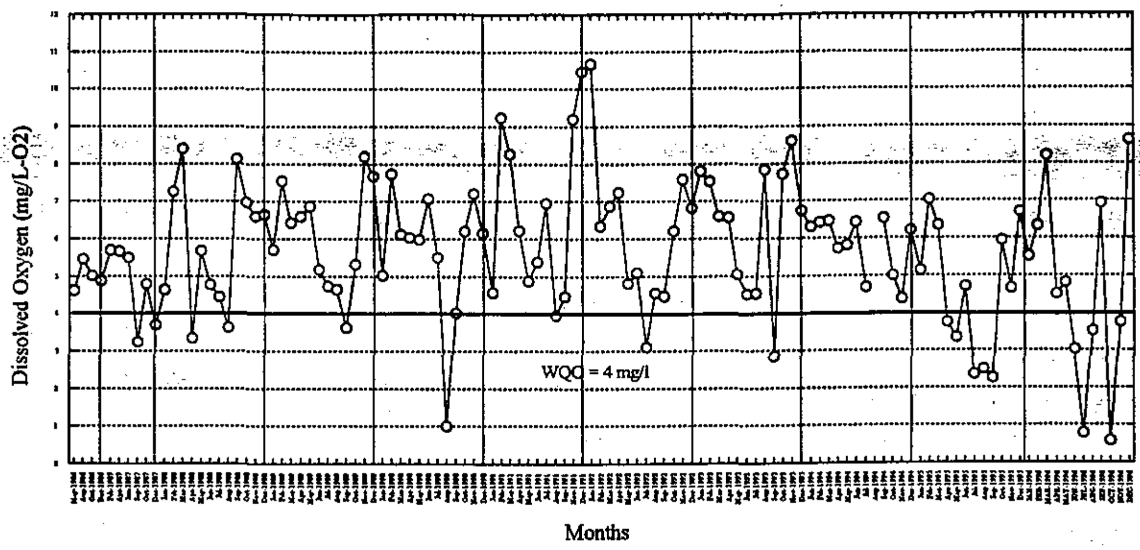
Escherichia coli Levels of Inner Deep Bay at DM1 from 1985 to 1996



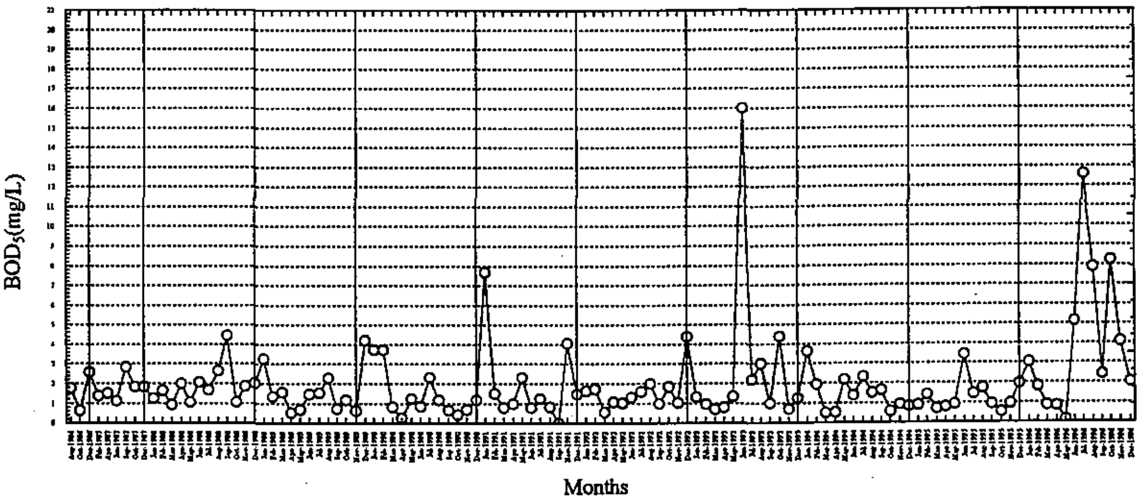
(SOURCE : WATER QUALITY MONITORING DATA COURTESY OF EPD)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : DISSOLVED OXYGEN, 5-DAY BOD AND *ESCHERICHIA COLI* LEVELS OF INNER DEEP BAY AT STATION DM1 FROM 1985 TO 1996	Figure No. 7.25	Revision 0
		Reference No. EPD DATA	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
		Date FEB 97	Scale NTS

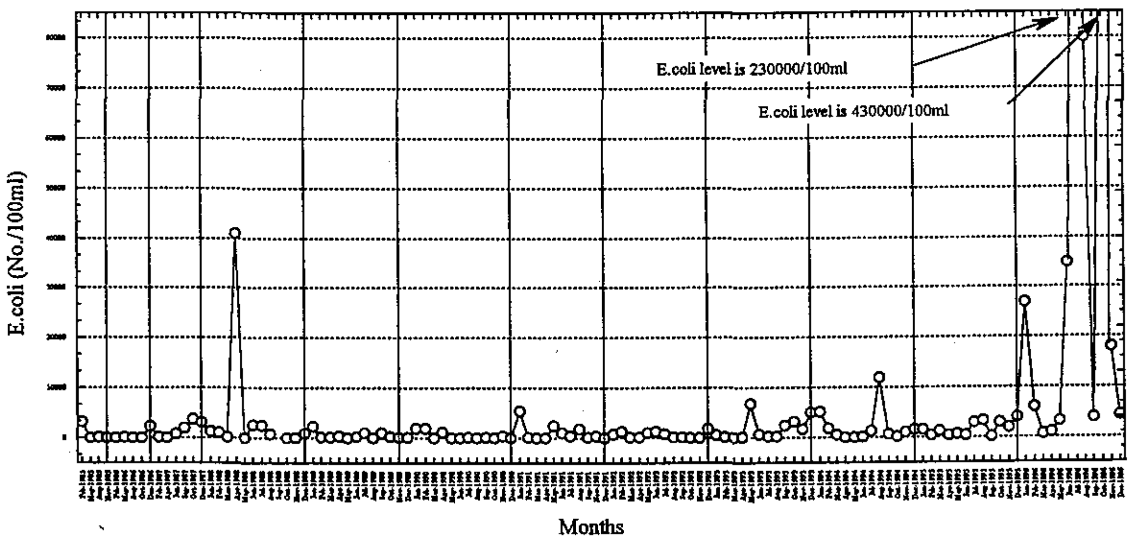
Dissolved Oxygen Levels of Inner Deep Bay at Station DM2 from 1986 to 1996



5-Day Biochemical Oxygen Demand Levels of Inner Deep Bay
at Station DM2 from 1986 to 1996



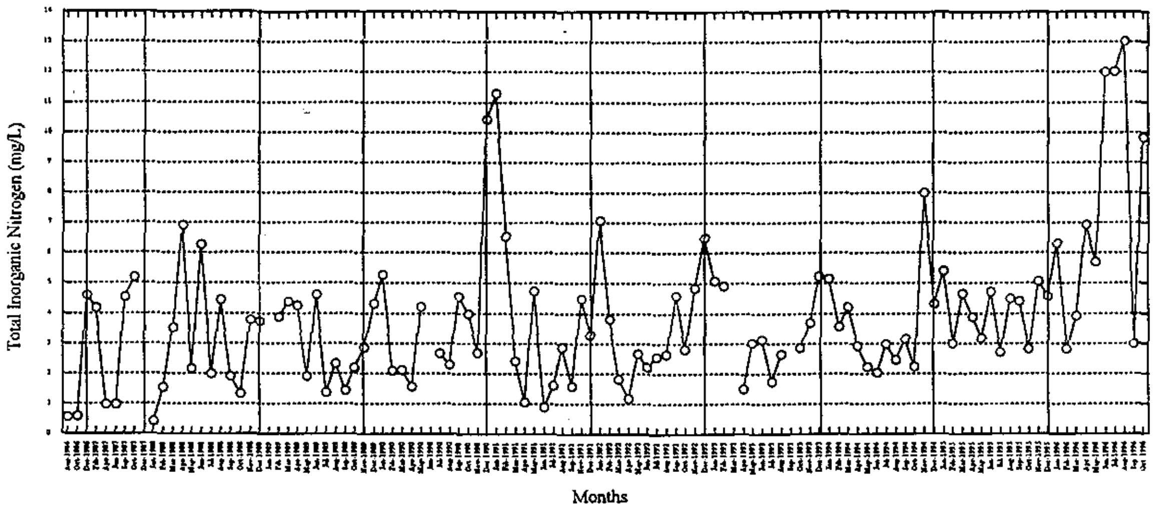
Escherichia coli Levels of Inner Deep Bay at DM2 from 1985 to 1996



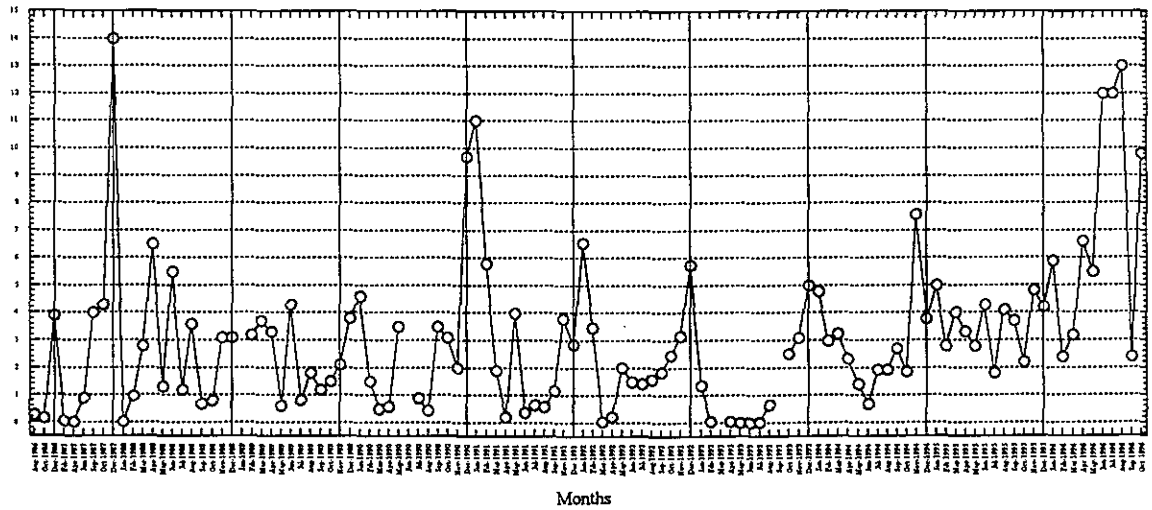
(SOURCE : WATER QUALITY MONITORING DATA COURTESY OF EPD)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : DISSOLVED OXYGEN, 5-DAY BOD AND *ESCHERICHIA COLI* LEVELS OF INNER DEEP BAY AT STATION DM2 FROM 1985 TO 1996	Figure No. **7.26**	Revision 0
		Reference No. EPD DATA	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
		Date FEB 97	Scale NTS

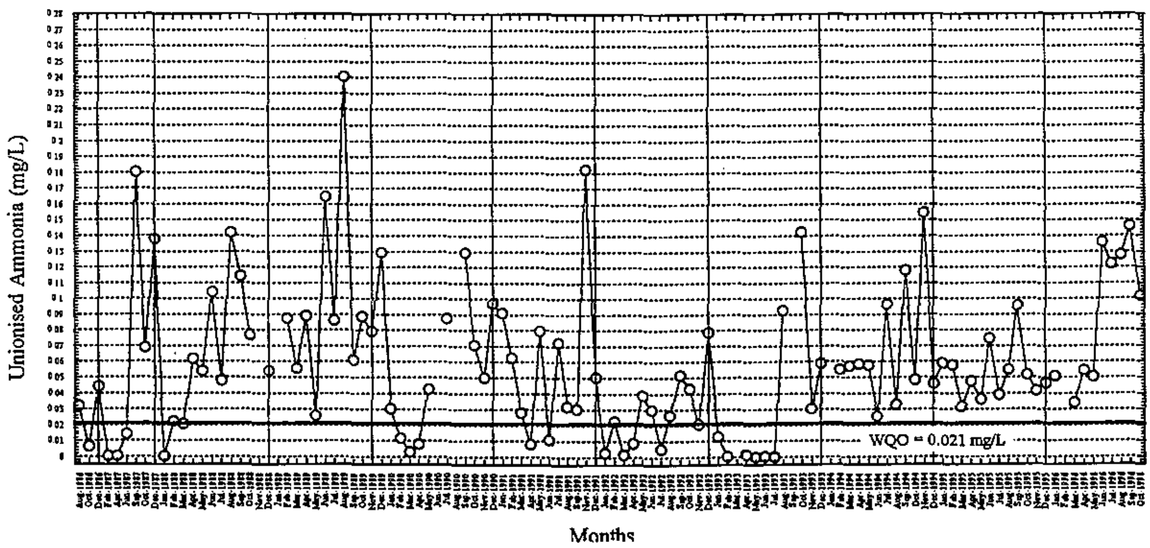
Total Inorganic Nitrogen Levels of Inner Deep Bay
at Station DM1 from 1986 to 1996



Ammoniacal-Nitrogen Levels of Inner Deep Bay
at Station DM1 from 1986 to 1996



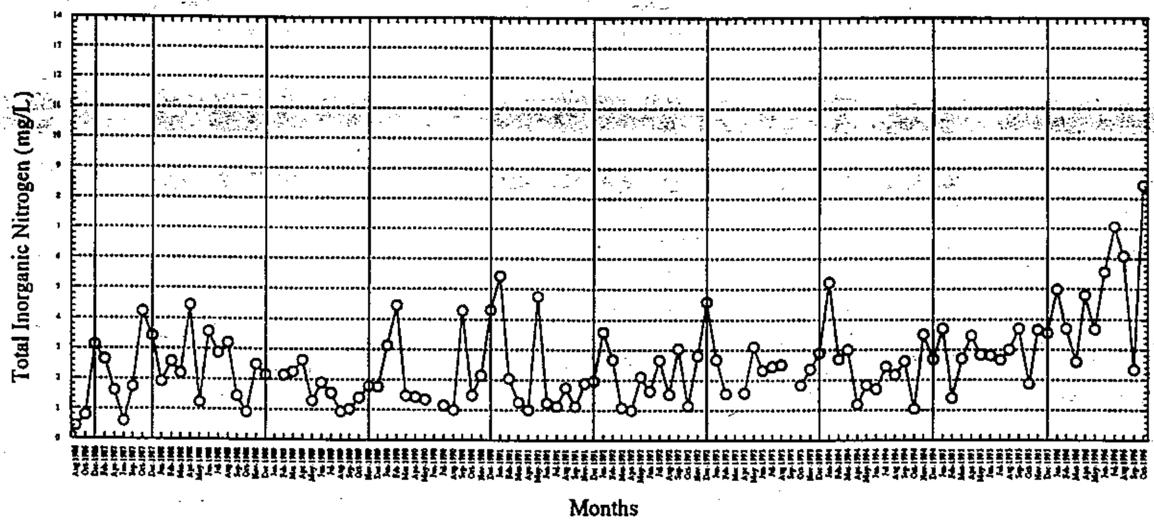
Unionised Ammonia Levels of Inner Deep Bay at Station DM1 from 1986 to 1996



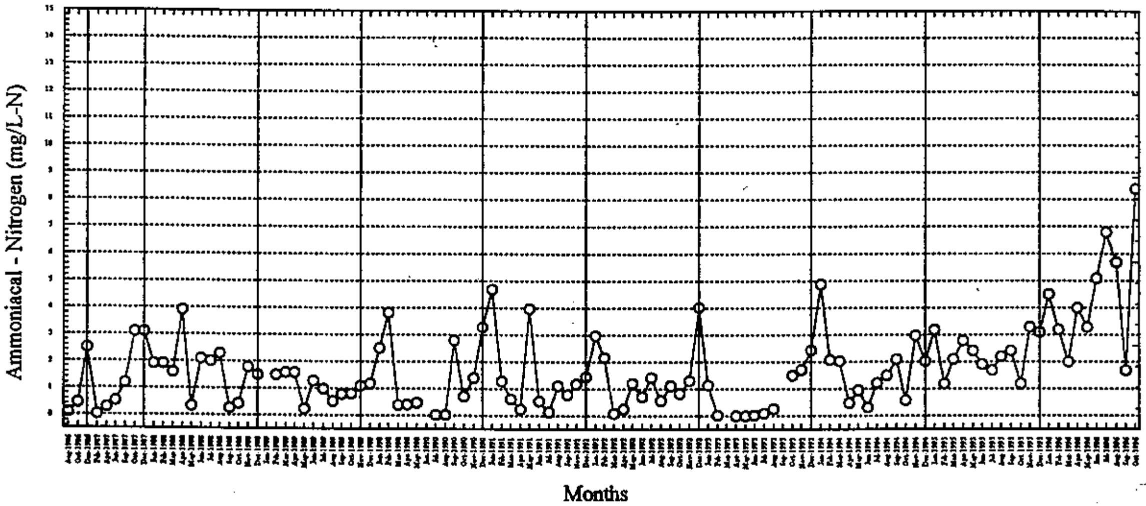
(SOURCE : WATER QUALITY MONITORING DATA COURTESY OF EPD)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : TOTAL INORGANIC NITROGEN, AMMONIACAL NITROGEN & UNIONISED AMMONIA LEVELS OF INNER DEEP BAY AT STATION DM1 FROM 1986 TO 1996	Figure No. 7.27	Revision 0
		Reference No. EPD DATA	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
		Date FEB 97	Scale NTS

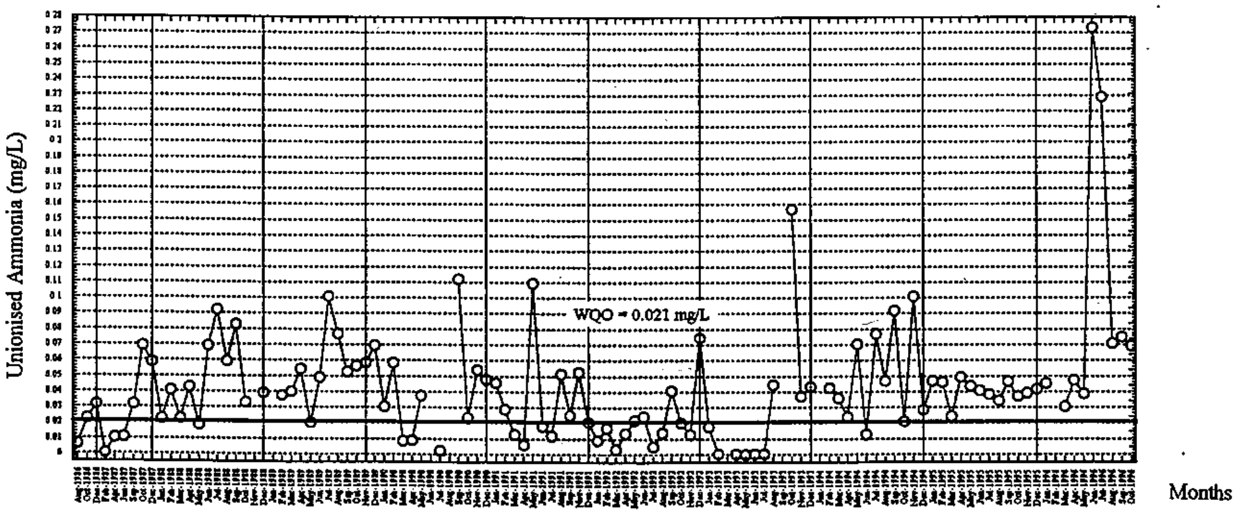
Total Inorganic Nitrogen Levels of Inner Deep Bay
at Station DM2 from 1986 to 1996



Ammoniacal-Nitrogen Levels of Inner Deep Bay
at Station DM2 from 1986 to 1996



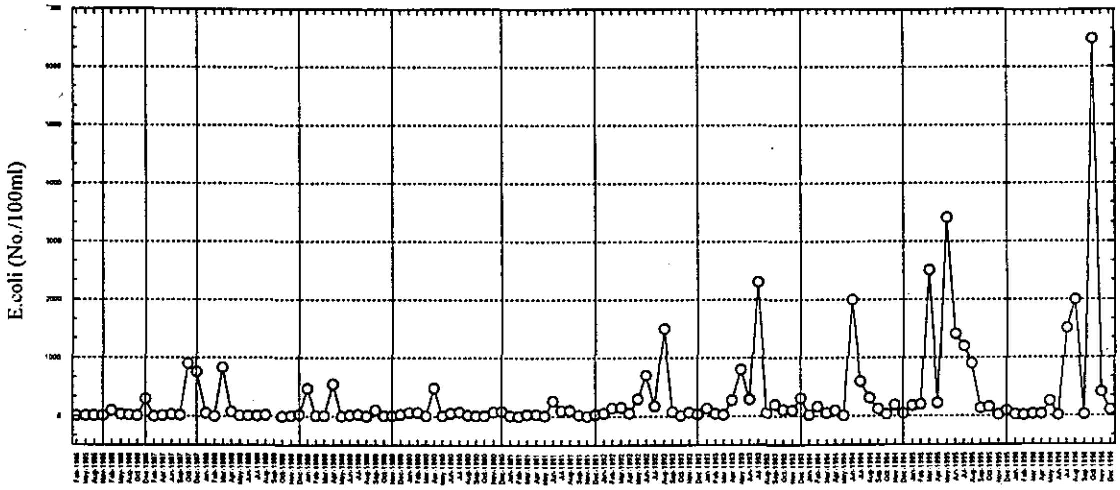
Unionised Ammonia Levels of Inner Deep Bay at Station DM2 from 1986 to 1996



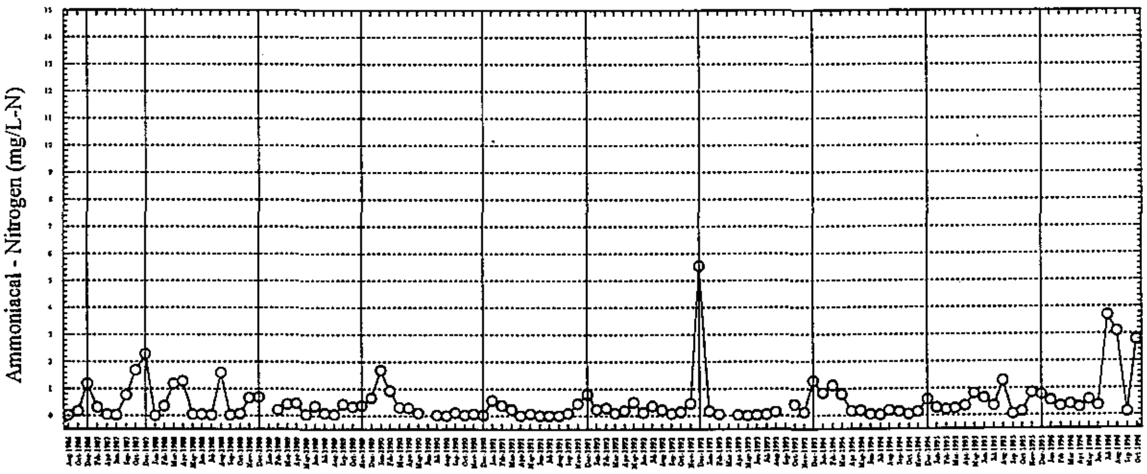
(SOURCE : WATER QUALITY MONITORING DATA COURTESY OF EPD)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : TOTAL INORGANIC NITROGEN, AMMONIACAL NITROGEN & UNIONISED AMMONIA LEVELS OF INNER DEEP BAY AT STATION DM2 FROM 1986 TO 1996	Figure No. 7.28	Revision 0
		Reference No. EPD DATA	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 賓尼 ENGINEERS AND SCIENTISTS		Prepared MC	Checked PS
		Date FEB 97	Scale NTS

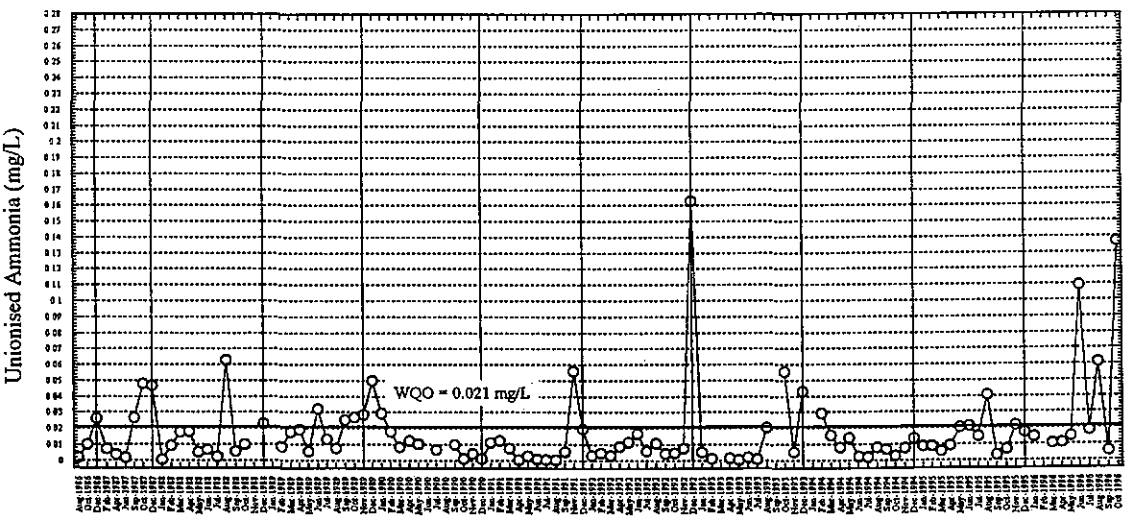
Escherichia coli Levels of Inner Deep Bay at DM3 from 1985 to 1996



Ammoniacal-Nitrogen Levels of Inner Deep Bay at Station DM3 from 1986 to 1996



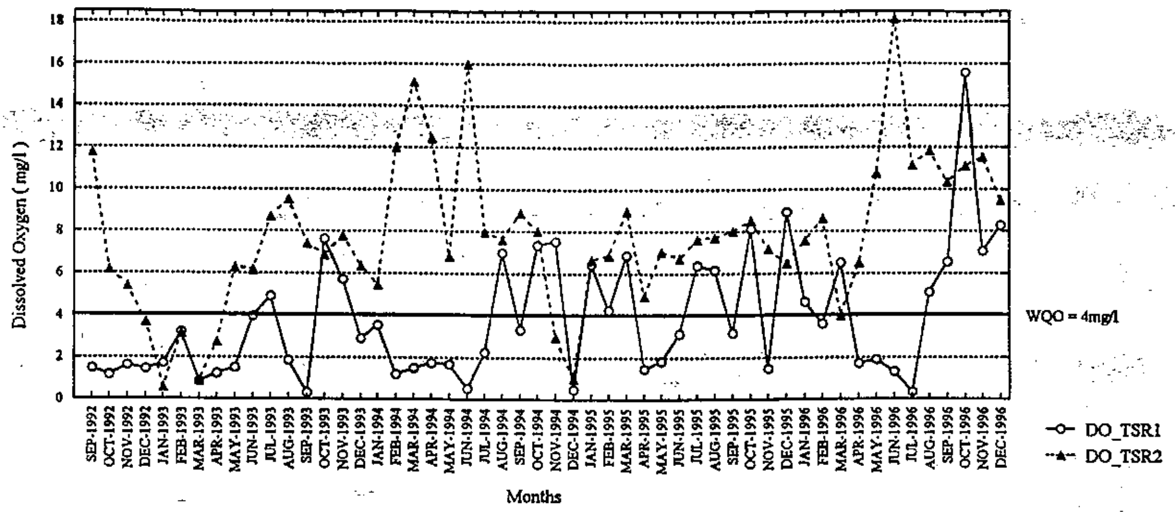
Unionised Ammonia Levels of Inner Deep Bay at Station DM3 from 1986 to 1996



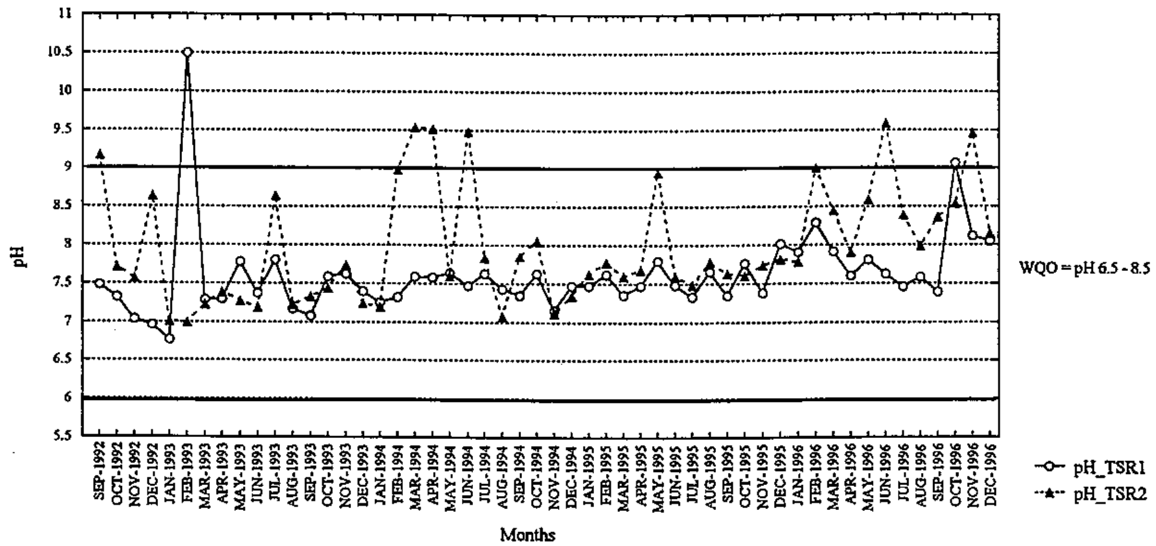
(SOURCE : WATER QUALITY MONITORING DATA COURTESY OF EPD)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : *ESCHERICHIA COLI,* AMMONIACAL NITROGEN & UNIONISED AMMONIA LEVELS OF INNER DEEP BAY AT STATION DM3 FROM 1986 TO 1996	Figure No. **7.29**	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference No. EPD DATA	File Name -
		Prepared MC	Checked PS
		Date FEB 97	Scale NTS

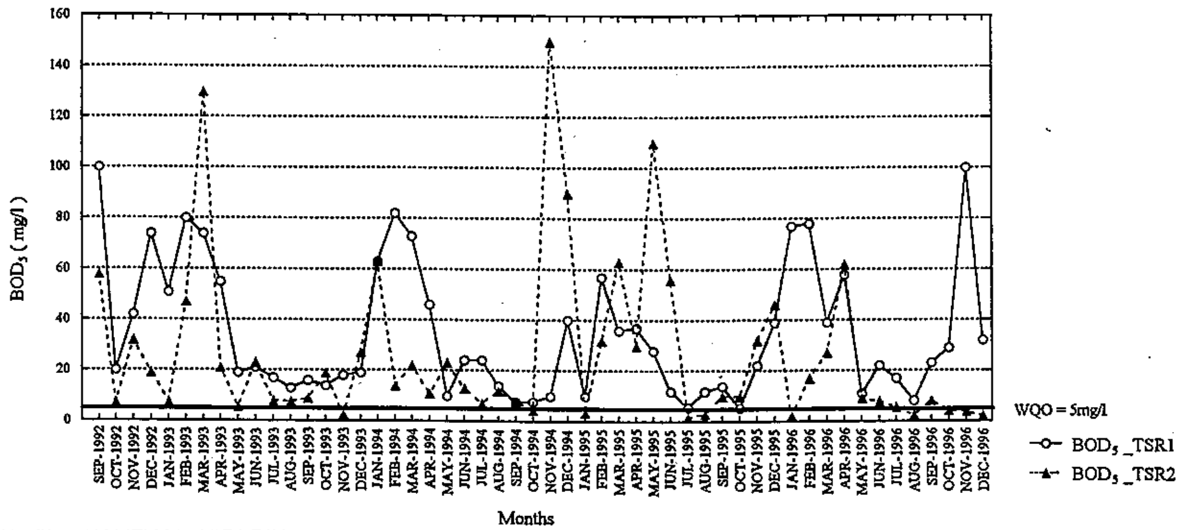
Dissolved Oxygen Levels of TSW-Western Channel
at Stations TSR1 & TSR2 from 1992 to 1996



pH Levels of TSW-Western Channel at Stations TSR1 & TSR2 from 1992 to 1996

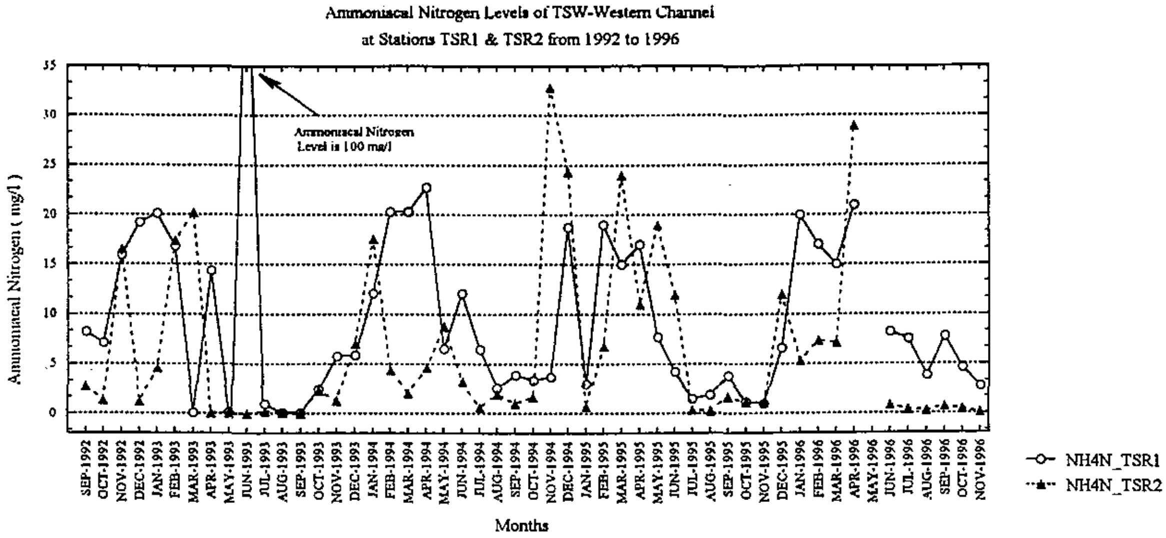


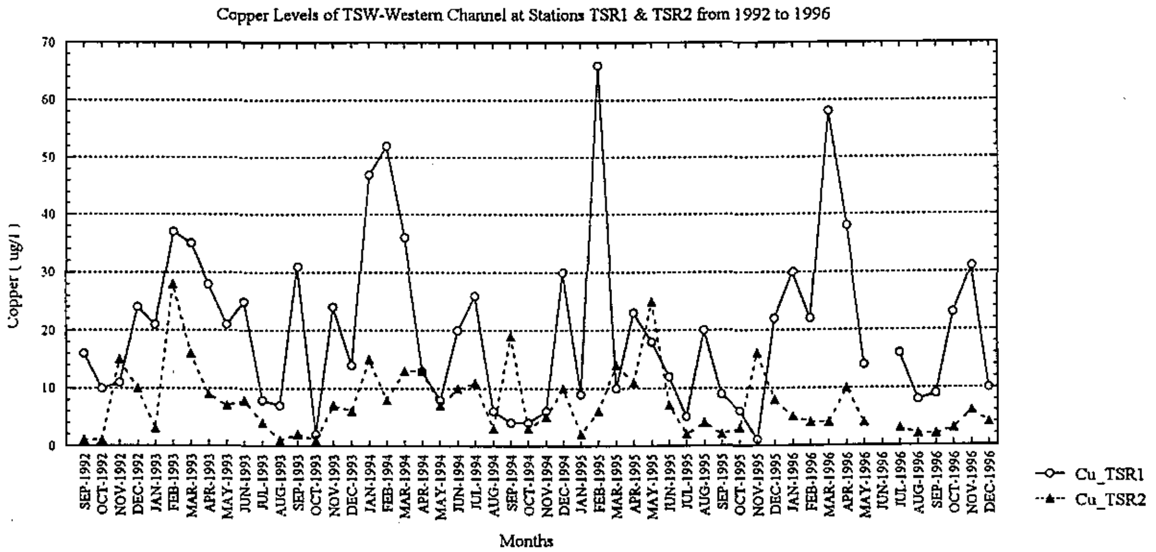
Biochemical Oxygen Demand Levels of TSW-Western Channel
at Stations TSR1 & TSR2 from 1992 to 1996

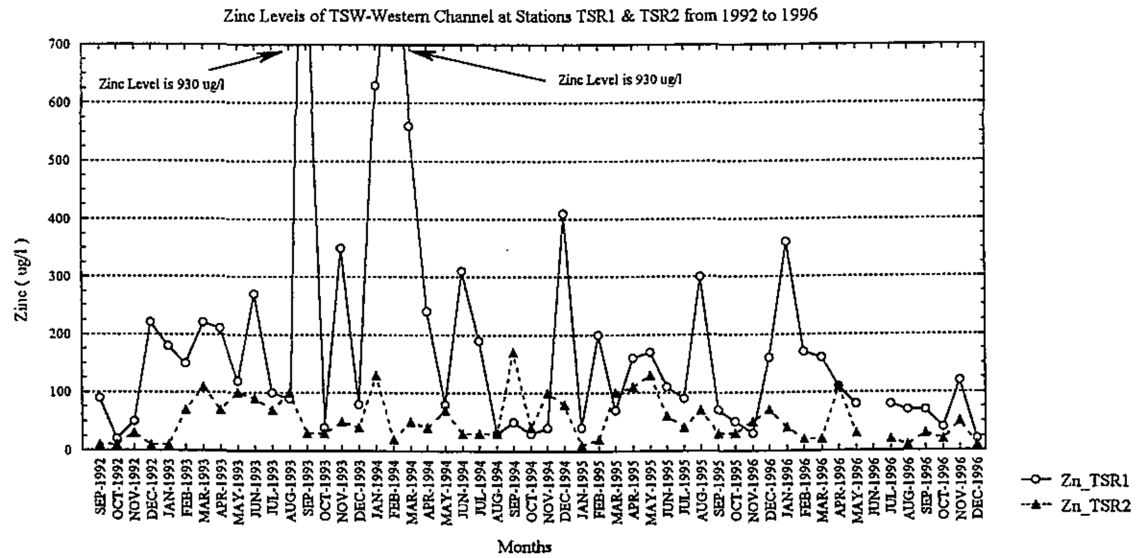


(SOURCE : WATER QUALITY MONITORING DATA COURTESY OF EPD)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : DISSOLVED OXYGEN, pH & BIOCHEMICAL OXYGEN DEMAND LEVELS OF TSW - WESTERN CHANNEL AT STATIONS TSR1 & TSR2 FROM 1992 TO 1996	Figure No. 7.30	Revision 0
		Reference No. EPD DATA	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 賓尼 ENGINEERS AND SCIENTISTS		Prepared MC	Checked PS
		Date FEB 97	Scale NTS

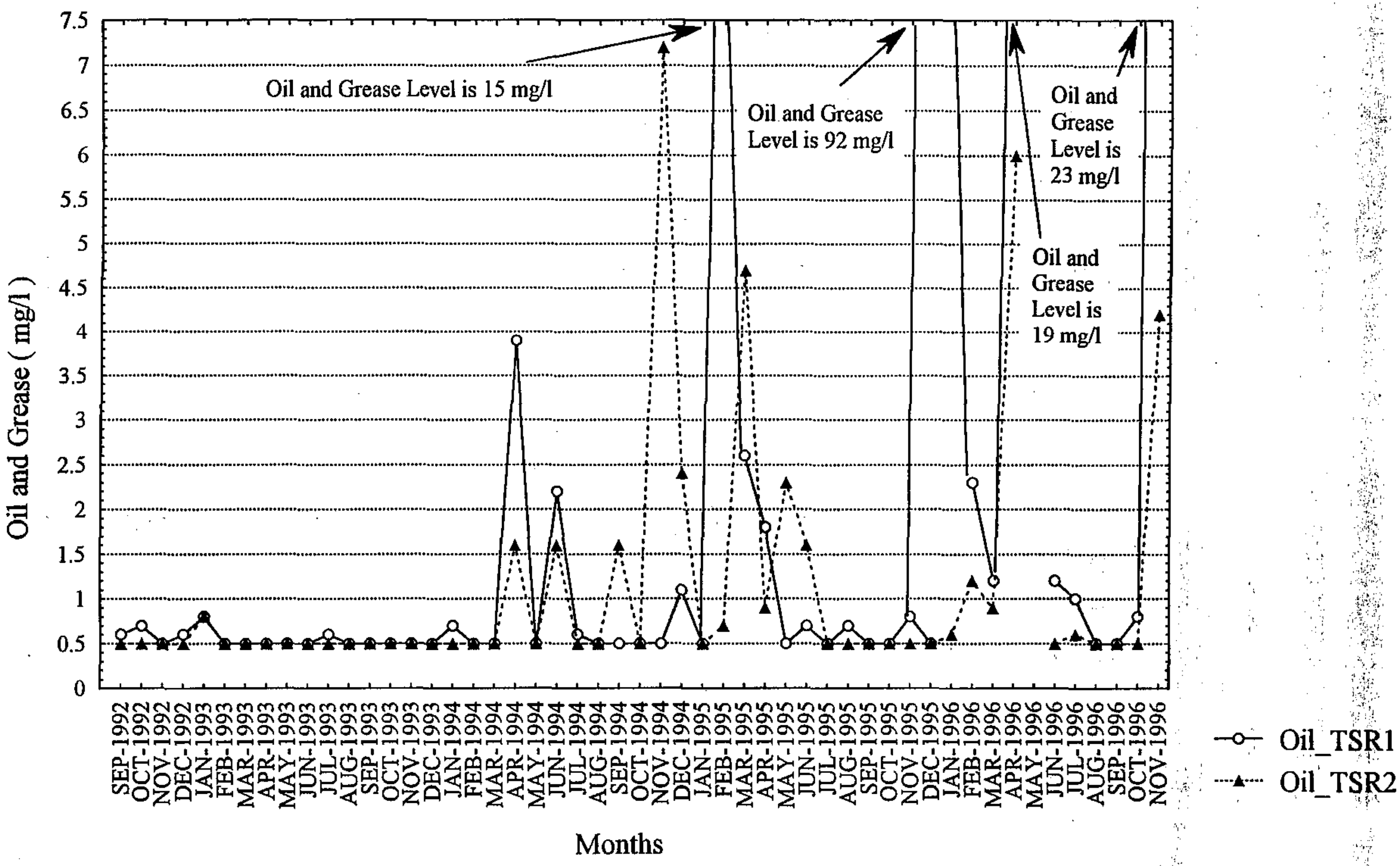






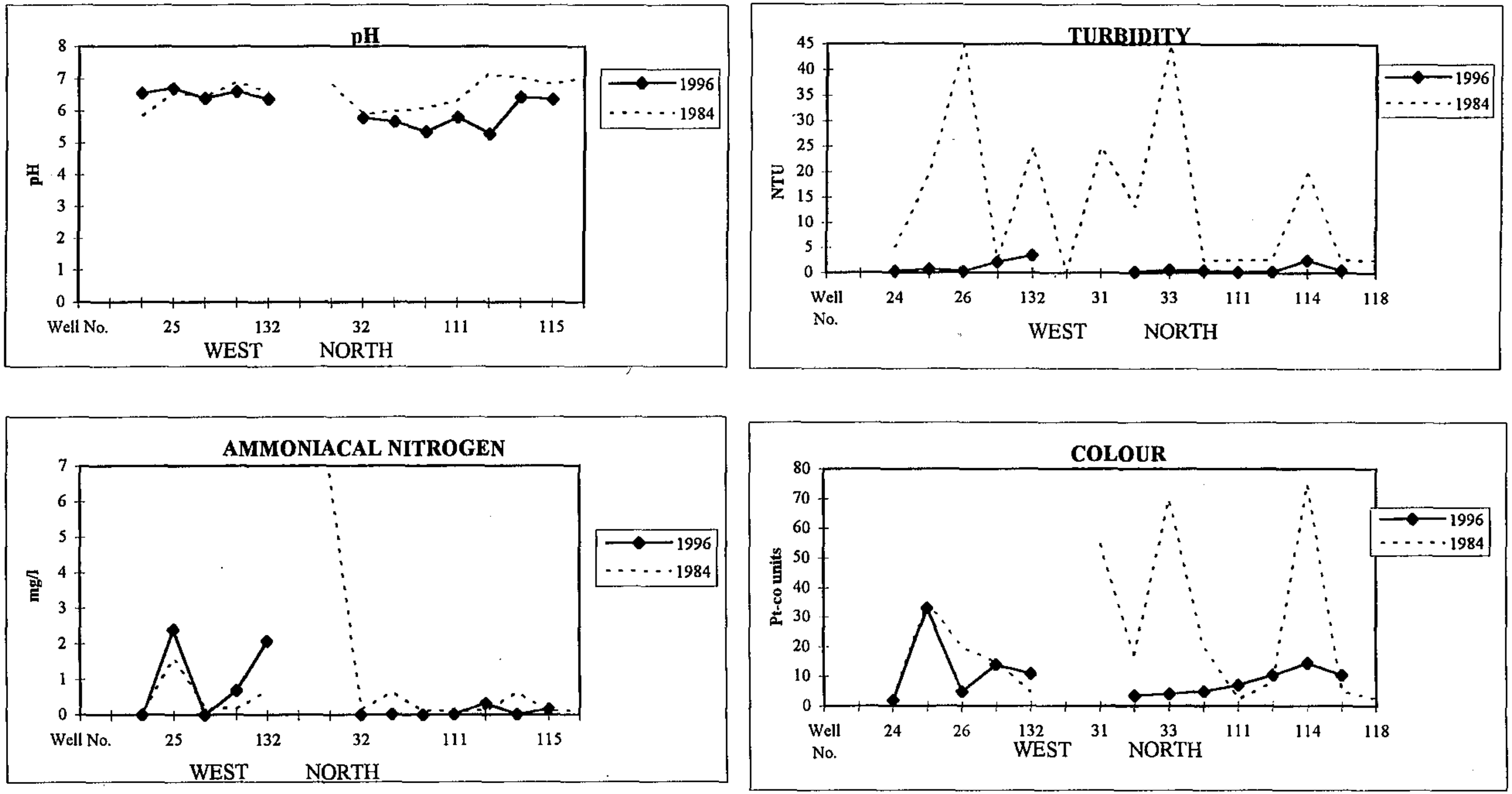
(SOURCE : WATER QUALITY MONITORING DATA COURTESY OF EPD)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : AMMONIACAL NITROGEN, COPPER AND ZINC LEVELS OF TSW - WESTERN CHANNEL AT STATIONS TSR1 & TSR2 FROM 1992 TO 1996	Figure No. **7.31**	Revision 0
		Reference No. EPD DATA	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
		Date FEB 97	Scale NTS



(SOURCE : WATER QUALITY MONITORING DATA COURTESY OF EPD)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 賓尼 ENGINEERS AND SCIENTISTS	Title : OIL AND GREASE LEVELS OF TSW - WESTERN CHANNEL AT STATIONS TSR1 & TSR2 FROM 1992 TO 1996	Figure No. 7.32 Reference No. - Prepared MC Date FEB 97	Revision 0 File Name - Checked PS Scale -



(SOURCE : BINNIE ARCHIVE & MONITORING DATA)

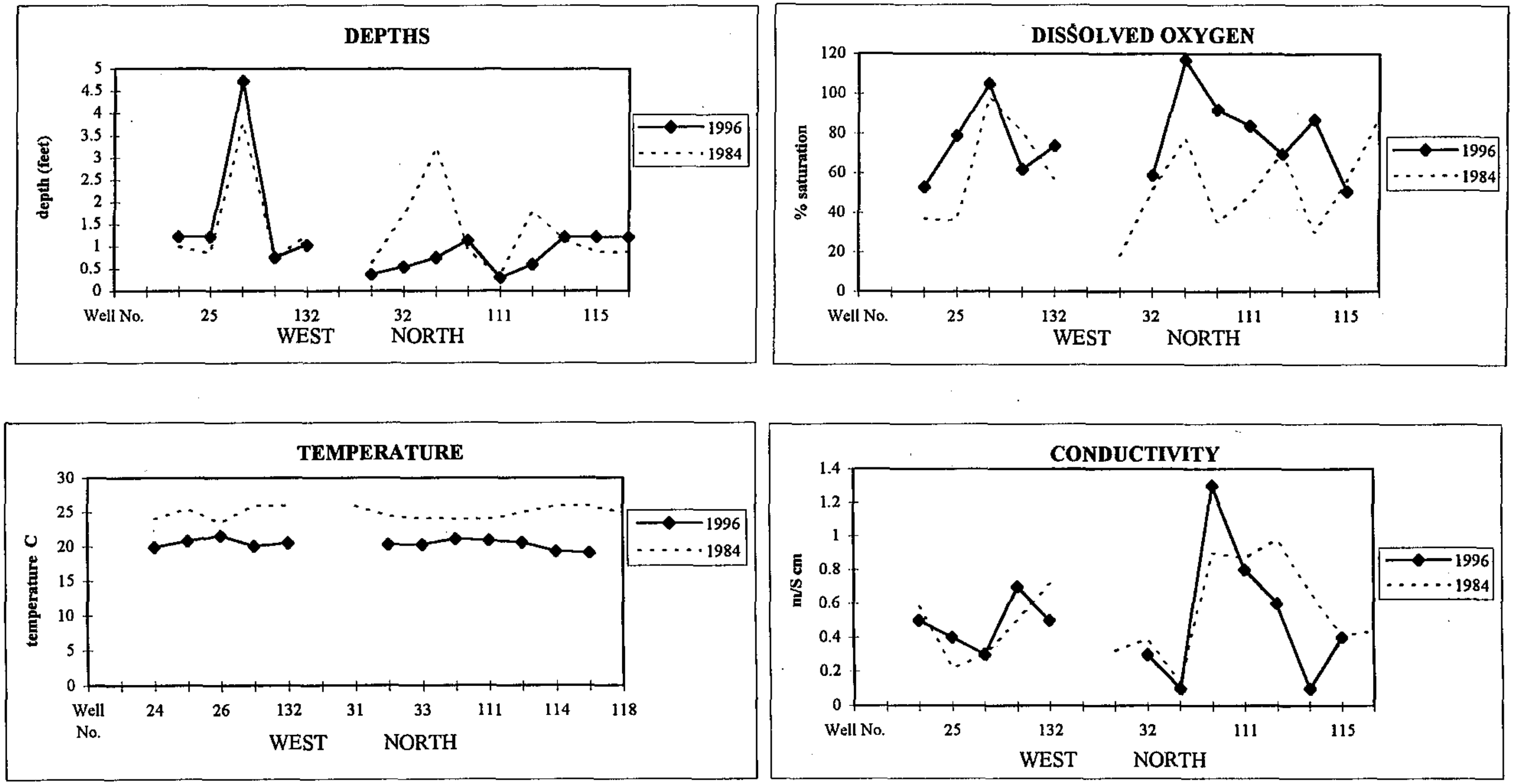
TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR
DEVELOPMENT OF AREAS 3, 30 & 31
OF THE DEVELOPMENT ZONE
AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
賓尼工程顧問有限公司 賓尼

Title :

GROUNDWATER QUALITY COMPARISON IN TIN SHUI WAI AREA - 1984 & 1996

Figure No. 7.33	Revision 0
Reference No. BINNIE ARCHIVE & MONITORING DATA	File Name
Prepared MC	Checked JC
Date APR 96	Scale NTS



(SOURCE : BINNIE ARCHIVE & MONITORING DATA)

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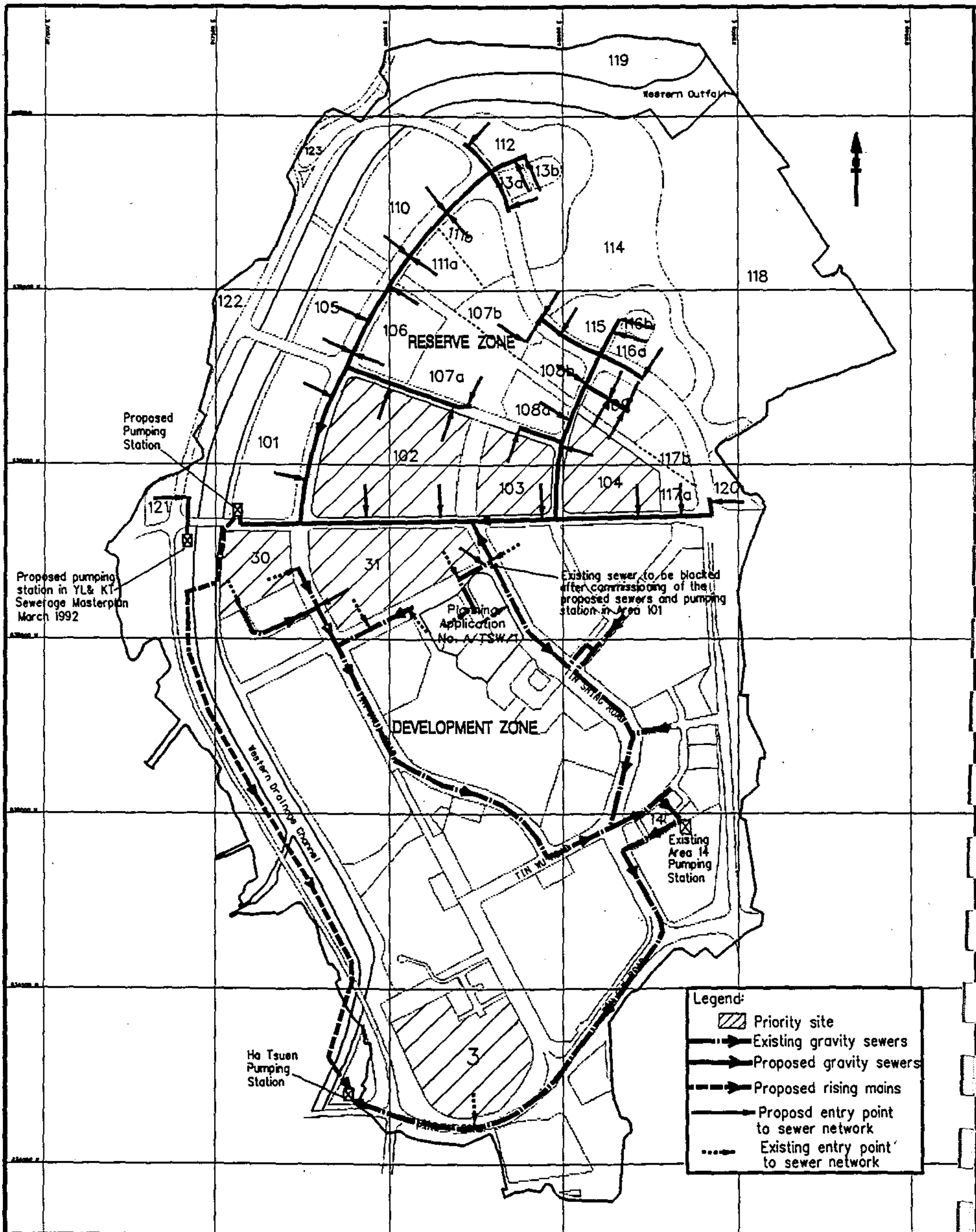
		Reference No. BINNIE ARCHIVE & MONITORING DATA	File Name
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked JC
		Date APR 96	Scale NTS



TIN SHUI WAI DEVELOPMENT
AGREEMENT NO. CE 10/95
ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

BINNIE CONSULTANTS LIMITED
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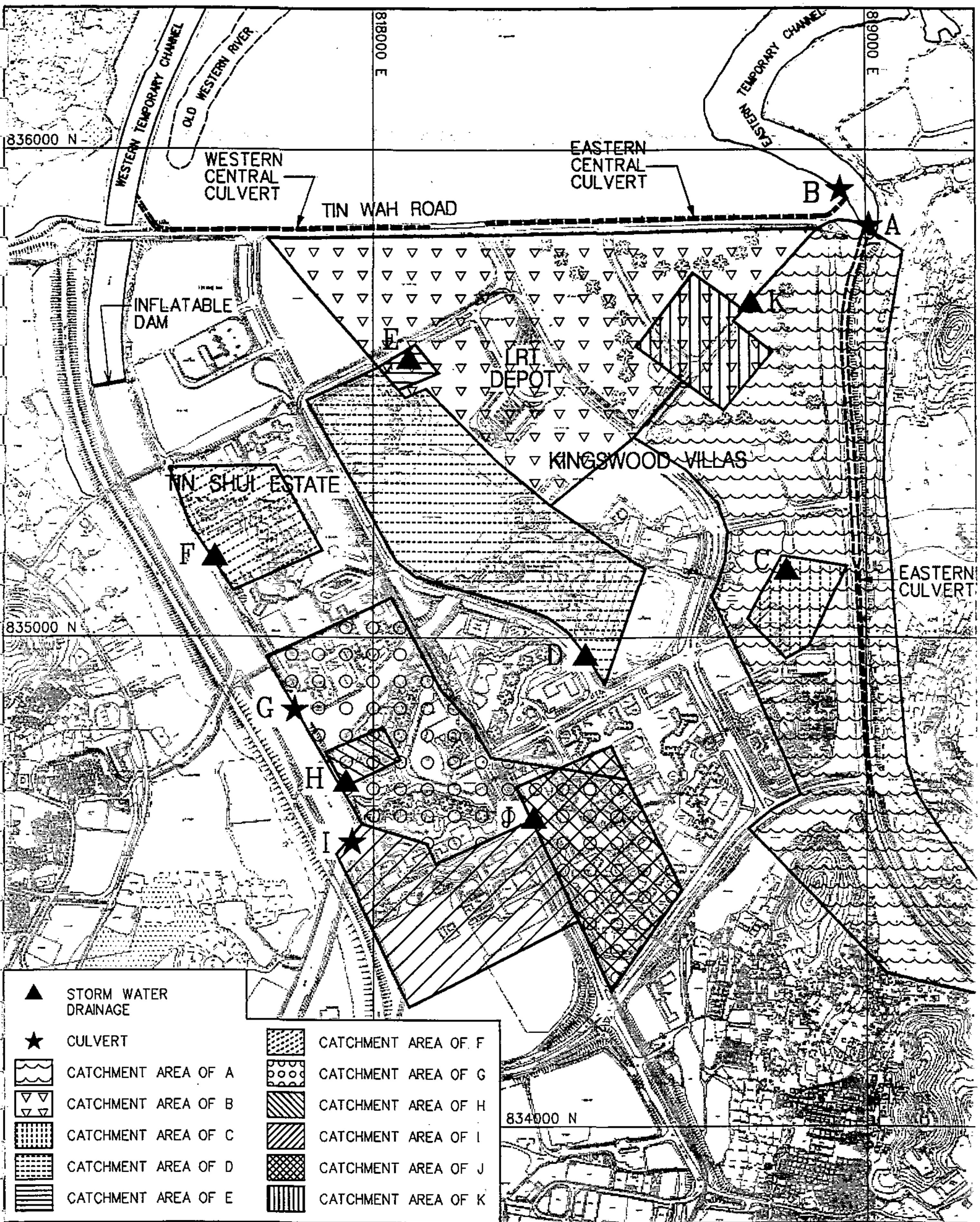
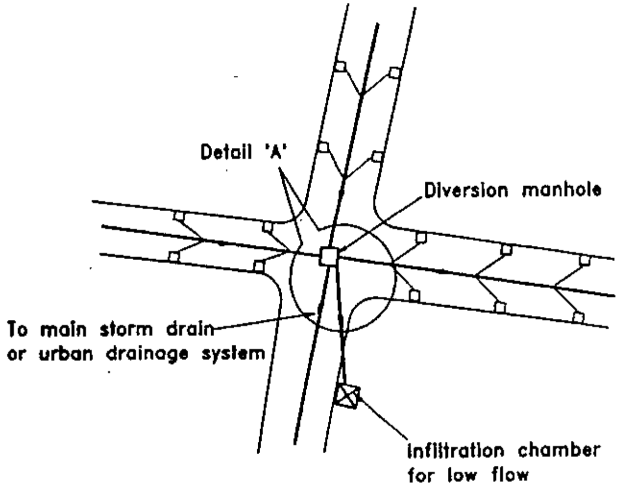
ENGINEERS AND SCIENTISTS

RECOMMENDED SEWERAGE NETWORK FOR THE DEVELOPMENTS

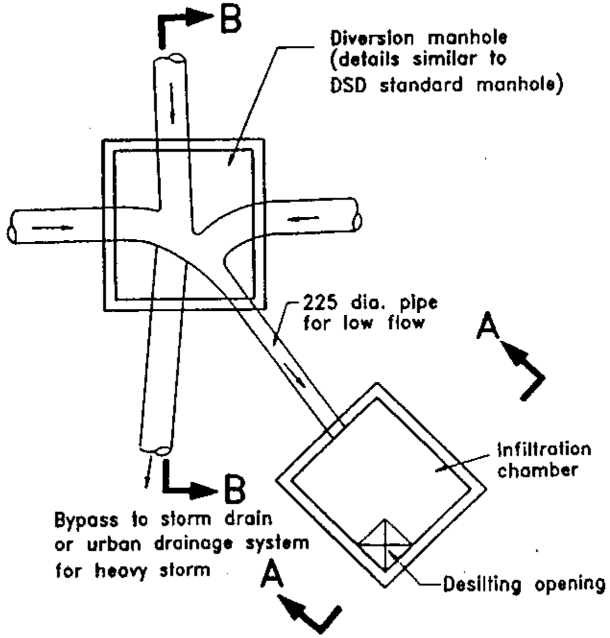
Figure No.	7.35
Prepared GC	Checked CYH
Date 10/96	Scale N.T.S.



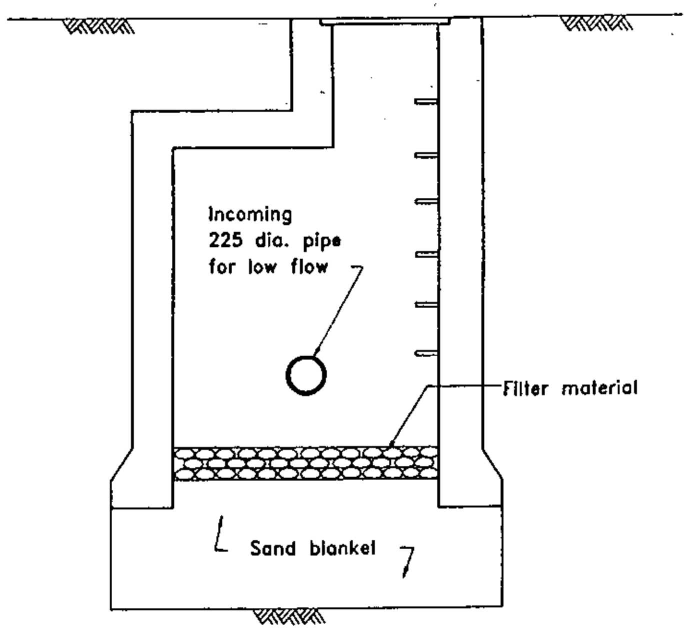
TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : LOCATIONS OF URBAN STORM DRAIN SAMPLING STATIONS & CATCHMENT AREAS	Figure No. 7.36	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference TSW-BASE	File Name 02410018.C09
		Prepared MC	Checked FNW
		Date FEB. 97	Scale N.T.S.



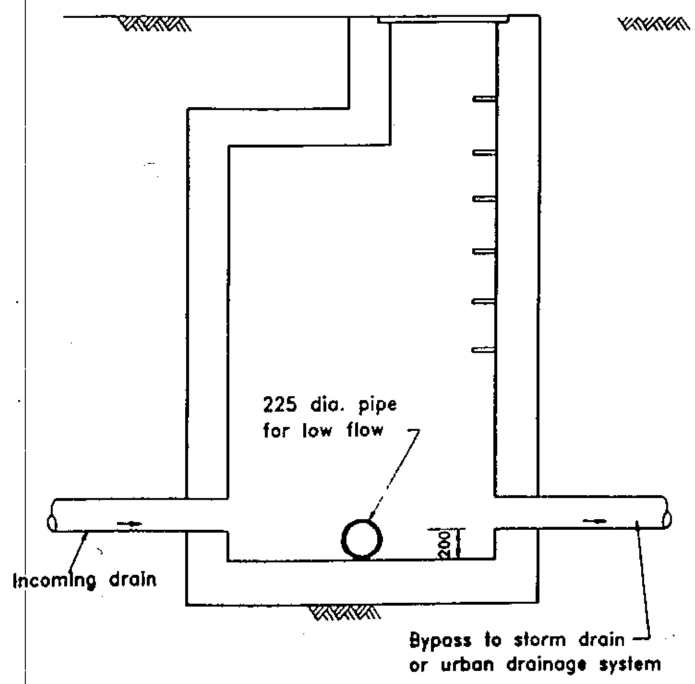
GENERAL LAYOUT



DETAIL 'A'



SECTION A – A



SECTION B – B

Note:

1. The low flow is the flow of which not exceeded by about 3 times in a dry season and 30 times in a year. As the Yuen Long and Tin Shui Wai catchments contain similar landuse and have similar effect on flow data, the 14 years data recorded by WSD for Yuen Long 'A' gauge station are therfore adopted.

   The low flow in m^2/s for an infiltration chamber =
   catchment area upstream of the chamber in ha x 1.09/702

2. The dimensions of infiltration chamber shall be determined with reference to EPD Drawing no. EP 50/D1/5/01.

3. For a typical chamber of 3m(W) X 3m(L), each chamber could serve a catchment area of 0.62 ha.

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3,30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	INFILTRATION CHAMBER FOR STORMWATER LOW FLOW	Figure No. 7.37	
		Prepared HFW	Checked SCM
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司		Date 11/96	Scale N.T.S.

8 WASTE MANAGEMENT

8.1 Construction Waste

Introduction

8.1.1 This section examines the timing, quality and quantity of potential sources of wastes arising from the construction phase of the Project. In order to minimise waste production, the potential for reuse and recycling has been considered.

8.1.2 The EIA Study has:

(i) identified the sources, volumes, quality and timing of wastes arising from the construction activities;

(ii) recommended a construction waste management strategy and control measures/routings (including final disposal sites) in accordance with the current legislative and administrative requirements for the disposal of construction waste, including consideration of waste reduction, reuse and recycling, for inclusion into contract documents; and

(iii) assessed the disposal of inert materials and wastes.

Sources of Construction Waste

8.1.3 Careful calculation of waste quantities, and the speed of their generation has allowed the formulation of plans for their efficient removal and disposal, with the aims of minimal disruption to traffic flow and maximum environmental protection.

8.1.4 Waste generation arising from construction activities will include:

(i) *Excavated material*: resulting from the cutting of trenches and foundations, this includes the potentially contaminated mud resulting from the installation of the culvert in the ETC and works for the WDCE, volumes of soft material unsuitable for building will be utilized in landscaping works;

(ii) *Concrete waste*: there will inevitably be a small excess of concrete arising from each of the construction activities throughout the project, with the peak being between 1999 and 2001;

(iii) *General works waste*: including the generation of wooden material waste, chemical waste, aqueous waste, and domestic, municipal waste and sewage from the establishment of site offices, works compounds and canteens, and day to day activities.

8.1.5 The overall principles of construction waste management are the minimisation of waste generation, coupled with the maximum reuse of construction materials. The legislation and guidelines relating to these issues are highlighted in Appendix A to this report. During the course of this investigation, the engineers and environmental assessors have closely liaised to reduce the volumes of contaminated muds requiring removal and final disposal from 314,000 m^3 to less than 30,000 m^3.

8.1.6 Within the framework of the building development programme, site formation and engineering infrastructure have been grouped into the two packages outlined in Tables 8.1 and 8.2 below. The construction waste impact assessment has been undertaken with reference to the *Waste Disposal Ordinance [Cap 354]* and the subsequent Waste Disposal Plan[1].

8.1.7 The various types of waste arising from the Project works are described in this section, and options for disposal outlined in each case. Responsibilities for disposal and, where possible, recycling, are discussed.

8.1.8 Volumes and types of solid waste are discussed in Section 8.2 and the planned refuse collection system for housing estates described. Mechanisms for the recycling of paper, cans and bottles within this system are outlined.

[1] *Waste Disposal Plan for Hong Kong (1989)*, Environmental Protection Department.

Table 8.1
Wastes Arising as a Result of Package I Works

Major Activities	Works Description	Waste Type	Disposal
Site Formation	Areas 101-111, excluding 109b	contaminated mud	Up to 10,000 m^3 to East Sha Chau (ESC)[a]
Infrastructure for Priority Sites	- Garden South culvert, Hung Tin Road culvert realignment and Eastern culvert realignment near Junction P	concrete waste wooden waste steel contaminated mud	- To public dump (Tseung Kwan O) - Reuse or to landfill - Recycle - 500 m^3 to ESC[b]
	- construction of Roads L12, L13 & L14 including associated drains, sewers and water reticulation system; - roadbridge D2/V1 over WDCE, footbridge D2/CF1 over Junction M, subways L13/S1, L14/S1, P1/S1, - construct grade separated interchanges at Junctions A, D & W, and associated utility and drainage diversion; - construction of roadbridges P1/V1 at Junction A, P2/V1 at Junction D and P2/V2 at Junction W; footbridge P2/CF1 across Road P2	concrete waste wooden waste steel	- Public dump - Reuse or to landfill - Recycle
	formation of LRT reserve adjacent to Tin Tsz Road, L12 and Central Path;	concrete waste wooden waste steel	- Public dump - Reuse or to landfill - Recycle
Interim Road Upgrading Works	- including junction widening of DZ junctions; provision of additional lanes - dualling of Tin Wah Road and widening of Junction K; - dualling of Tin Tsz Road; - widening of Long Tin Road and Hung Tin Road to 3-lane dual carriageway	concrete waste wooden waste steel	- Public dump - Reuse or to landfill - Recycle
Trunk sewer from RZ to NWNT Sewerage Scheme	- rising mains from sewage pumping station in Area 101 to Ha Tsuen Pumping Station; - construction of Area 101 pumping station,	concrete waste wooden waste steel	- Public dump - Reuse or to landfill - Recycle
General Site Activities		sewage wastes domestic wastes packaging materials chemical waste waste oil	- sewage treatment - landfill - landfill - CWTP - licensed contractor

(a) Contract 2
(b) Contract 4

Table 8.2
Wastes Arising as a Result of Package II Works

Major Activities	Works Description	Waste Type	Disposal
Site Formation	- site formation of Areas 109b, 112 to 117, 120 and 121	@ 5000 m^3 (a) contaminated mud from Areas 109b, 114, 115, 117 & 120	- to East Sha Chau
Infrastructure	- construction of Road L12, D4, D3 and 1231 and associated drains, sewers and water reticulation system; - construction of footbridges L12/CF1 at Junction S; D4/F1 at Junction T; subways L12/S1 across Road L12; D4/S1 across Road D4; Garden Path culvert; and the Northern culvert - construction of roadbridge P2/V3 at Junction P; footbridge D4/CF2 at Junction V; subway D4/S2 across Road D4 - construction of roadbridges P1/V2 and P1/V3; subway extensions P1/S2 and P2/S3 - construction of roadbridge D3/V1; road/footbridge L13/VCF1; footbridge WC/CF5	- concrete waste - wooden waste - steel	- Public dump - Reuse or to landfill - Recycle
	Northeastern culvert; Eastern culvert extension; - river training of 500m of WDCE Formation of LRT reserve next to Roads L12 and D4	- @ 2000 m^3 (a) contaminated mud from excavations Northeastern culvert - @ 6000 m^3 (a) contaminated mud arising from Eastern Culvert under Road D4; - @ 4000 m^3 (b) contaminated mud from WDCE	- to East Sha Chau
Road Upgradings	Dualling of Tin Ying Road between Junctions A-K including associated sewers and drains	concrete waste wooden waste steel	- Public dump - Reuse or to landfill - Recycle
General Site Activities		sewage wastes domestic wastes packaging materials chemical waste waste oil	- sewage treatment - landfill - landfill - CWTP - licensed contractor

(a) Contract 7
(b) Contract 6

Collection, Storage & Handling

Provision of Refuse Collection Points

8.1.9 It has been assumed that domestic wastes generated by the proposed developments will be collected from approved refuse collection points (RCPs) by RSD. RCPs will be constructed at appropriate locations within the proposed developments in accordance with the guidelines set out in HKPSG, Chapter 9.

Material from the Eastern & Western Temporary Channels

Eastern Temporary Channel

8.1.10 The formation of Area 104 under Package I works, requires the construction of an edge slope in the ETC. The low shear strength of the soft sediment and marine clay layer presents a major stability problem. The preferred option for solving this situation involves using a fabric reinforcement underneath the fill to stabilize the edge slope. It is estimated, in the worst case scenario, that up to 10,000 m^3 needs to be excavated for ground levelling before the installation of the fabric reinforcement.

8.1.11 In future, the ETC will be contained by re-routing and extending the existing Eastern Culvert. This culvert will be built as part of the engineering infrastructure (drains and sewers) for the new road D4(S) under Package II works, which forms part of the eastern perimeter of Areas 109 and 117. The construction process will involve the excavation and removal of 1 to 2 metres of soft mud of varying contamination levels from Class A to C (Section 7 Tables 7.9 and 7.10 and Figure 7.22) to form a trench, both within the depression that forms the ETC, and in the intermediate area. The maximum volume of material to be excavated is estimated to be 6,000 m^3. About two thirds of this material comes from the ETC, the rest is a mixture of sand fill material and marine clays. Further testing will be undertaken to confirm the volumes involved. It is a recommendation of this report that, where scheduling permits, this work should be carried out during the dry season, in order to ensure that high water levels due to heavy rains do not flood the excavations and that contaminated mud is not washed into the surrounding watercourses.

8.1.12 A culvert, known as the North Eastern Culvert (NEC), will be constructed under Road D4. This will discharge into the ETC. The construction of the NEC will involve the excavation of muds with various levels of contamination, including Class C, which will require disposal. The total amounts will be confirmed during detailed design but volumes would appear to be small, of the order of 2,000 m^3 or less.

8.1.13 Based on the available site investigation and laboratory test results, the soft materials in the ETC are proposed to be left in place and consolidated under the fill. However, it may be necessary to remove the bed of the ETC under Areas 109b, 117b and 115 should the detailed design consider otherwise to ensure geotechnical stability and strength, and to ensure consolidation. This would require excavation of about 3 metres of material. Surface sampling and testing of this material indicates that the majority of this material is heavily contaminated material high in zinc (Zn), copper (Cu) and ammonia (NH_3).

8.1.14 Elutriate testing (Section 7: Tables 7.9, 7.10 and Figure 7.22) on the mud from the ETC shows high ammonia levels produced by the sediments. Metal levels in the elutriates are low or at worst, probably marginal.

8.1.15 If these sediments were placed in Area 114 just to the north-east of Road D4 between Areas 112 and 115, the resulting leachate could be treated by the constructive reed-bed suggested in Section 7.6 for the mitigation of urban stormwater run-off.

Western Drainage Channel Extension

8.1.16 The Package II works on the WDCE will probably include the dredging (of 0.5 m depth) and paving of 500 m of the Channel downstream from the inflatable dam. Sediment testing will be carried out in this stretch of the river bed before any works commence. The volumes and methods involved have yet to be finalized, but around 4,000 m^3 of mud is expected to be excavated from the Channel. The ecological impacts of disturbance from dredging are described in Section 9.2. Selection of a dredging method at the detailed design stage should be carefully considered to minimise the impact on the river ecosystem. Previous studies[2] have shown that the combination of an appropriate dredger with silt screen can greatly reduce the extent of plumes resulting from dredging activities.

Contaminated Mud Disposal

8.1.17 All unsuitable excavated material (ie. contaminated mud, organic clay and vegetation), will be disposed of in accordance with *WBTC 6/92, Fill Management* and *WBTC 22/92, Marine Disposal of Dredged Mud.*

8.1.18 The FMC normally requires the testing of material for heavy metals, and occasionally for pollutants such as PAHs and PCBs. As part of an on-going testing, the channel bed sediments in both the WTC and the ETC were sampled at five sites (TSW 1-5), and laboratory tested in February 1995. Grab samples have been taken (60 along both channels) for sets of heavy metal content and pH value tests. The results of these tests are discussed in the Water Quality Section of this Report (Section 7.3).

8.1.19 The sediments were classified according to the EPD's *Technical Circular No. (TC) 1-1-92* as shown in Table 8.3.

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[2] ERL (Asia) Ltd and Binnie Consultants Ltd (1991), *Deep Bay Guidelines for Dredging, Reclamation and Drainage Works* (1991). For EPD.

BCL in association with Dredging Research Ltd, Applied Geology Ltd (1993), *The Use of Acoustic Doppler Current Profiles to Monitor Suspended Sediment Concentrations During Dredger Operations.* Fill Management Study - Phase II, Investigation & Development of Marine Borrow Areas. For CED & GEO.

BCL (1994), *South of Ninepins Borrow Area Environmental Impact Assessment.* Fill Management Study - Phase IV, Investigation & Development of Marine Borrow Areas. For CED & GEO.

Mott MacDonald Hong Kong Ltd. (1991), *Contaminated Spoil Management Study.* Final Report (Agreement CE 30/90). For EPD.

Table 8.3
Classification of Sediments by Metal Content (mg/kg dry weight)

	Class A	Class B	Class C
Cd	0.0-0.9	1.0-1.4	1.5+
Cr	0-49	50-79	80+
Cu	0-54	55-64	65+
Hg	0.0-0.7	0.8-0.9	1.0+
Ni	0-34	35-39	40+
Pb	0-64	65-74	75+
Zn	0-140	150-190	200+

8.1.20 The Class B and C samples revealed by the testing are shown on Figure 8.1. It is necessary for the concentration of only one metallic element to be exceeded for sediments to be identified as falling within a particular class.

8.1.21 Sample stations in both the WTC and the ETC can be seen from the results to contain levels for some metals in excess of Class C minimum parameters. The concentration of PAHs and PCBs were either negligible or below the limit of detection.

8.1.22 CED and EPD are currently reassessing the classification system and the disposal of contaminated material. One of the possible recommendations of the report may be the designation of a new testing system whereby highly contaminated mud will be subject to more rigorous ecological testing and may require non-marine disposal.

8.1.23 CED and EPD are discussing additional testing requirements which will include ecotoxicity tests of the sediment and elutriate. However, the details of these tests have not yet been finalised and current disposal requirements, based on metal levels, continue to apply.

8.1.24 EPD has agreed in principle that the Class C material arising from the site formation works of Package I can be dumped at East Sha Chau. The disposal of contaminated material arising under Package II works has yet to be confirmed.

8.1.25 Under the *Dumping at Sea Ordinance [Cap 466] 1995*, a dumping licence will be required for the disposal of contaminated sediment. Application will be made to the Director of Environmental Protection (DEP), or his representatives, together with a sediment quality testing report. Once the application has been approved by the DEP, a dumping ground will be allocated by FMC.

8.1.26 During Area 104 formation work, great care needs to be exercised to limit the disturbance of contaminated or unsuitable muds and minimise the resuspension of the particles. In practice, the dredged mud can be air dried to reduce its volume and prevent spillage during haulage by truck to Tuen Mun Public Pier for loading onto barges. Similarly, in other Areas/works (Eastern Culvert extension, Northeastern Culvert and WDCE), where contaminated mud or unsuitable materials are issues, great care should be taken over the handling and eventual disposal of those materials.

8.1.27 Class C material must be excavated and transported with great care. It cannot be dumped in the gazetted marine disposal grounds, and must be effectively isolated from the environment upon final disposal, for example to contaminated mud pits at East Sha Chau. Any vehicles leaving the Site carrying unsuitable excavated material, should have their loads covered and be routed, so far as possible, to avoid sensitive receivers in the area. It would be desirable to restrict routes to and from the site to the main East and West accesses from Tin Shui Wai onto the Yuen Long Highway.

Fill Material

8.1.28 No surplus fill material is expected to be removed from the site, as this material will be stockpiled for use elsewhere in the RZ.

8.1.29 From the material balance for site formation, there is a deficit of fill material. However, during construction of housing and other buildings, fill will be excavated during piling works. This fill material should be stockpiled in a designated location from where it can be utilized for further site formation works as required.

Concrete Waste

8.1.30 Concrete is the major construction material likely to be used in the installation of the permanent stormwater drainage culverts, flyovers and all other infrastructure involved in the development of Tin Shui Wai. Of the volume of concrete supplied, it is assumed that approximately 3-5% of the concrete used will be lost to waste. Dry concrete waste will be sorted out from the other wastes and recycled for reuse or sorted for disposal at the public dump e.g. to Tseung Kwan O.

General Works Waste

Wooden Materials

8.1.31 Different kinds of wooden materials are essential to the construction project, such as wooden boards for formwork, erection of site boundaries, as well as bamboo for scaffolding. Wooden materials are important and valuable resources. Options for the reuse and recycling of discarded wooden waste are discussed below.

Formwork

8.1.32 Wood is generally used as formwork for concrete structures, although reusable steel shutters are an alternative. In order to estimate the waste volume of wooden boards and shutter ply, which may be required if steel shutters are not used, the following assumptions have been made:

(i) wooden boards are assumed to be 0.02 m thick;

(ii) it is assumed that the wooden boards can be reused five times, therefore the wastage rate of the wooden boards is assumed to be 20%.

8.1.33 All wooden materials used on site should be kept separate from other wastes. Wooden boards can be reused on site although the reusability and quantity of final waste depends on the shape and quality of the boards. Timber which cannot be reused should be sorted and stored separately from all inert waste before being disposed of to landfill. On-site incineration of wooden waste requires a permit from EPD. A number of private contractors will collect used formwork materials for local reuse or export to China.

8.1.34 Reusable steel shutters can be used as a preferred alternative.

Site fencing

8.1.35 Site fencing may be necessary to separate the construction works from the public and to reduce construction nuisance such as noise to nearby sensitive receivers.

8.1.36 In this case, it is likely that metal fencing or building panels will be used to provide site fencing. Building panels are cement structures with a lightweight concrete core. The material provides good sound and thermal insulation, as well as being both waterproof and fire resistant. These panels are easily recycled and reduce wastage of timber. However, wooden panels may be used and the following data can be utilised in calculating waste.

8.1.37 It is assumed that wooden fencing used would be 0.02 m thick with a height of 2 m. The volume of waste generated from this source is often assumed to be 20% of the total volume.

8.1.38 This type of wooden board is valuable for reuse on other construction sites and should not therefore be disposed of to landfill. On completion of the construction phase, the boards should be sorted and grouped then distributed to other construction sites.

8.1.39 Under *Section 43* of the *Air Pollution Control Ordinance (Cap. 311), Open Burning Regulation (1995)*, a permit is required from EPD to burn any waste emanating from, or located at, a construction site.

Chemical Waste

8.1.40 Where the construction processes produce chemical waste, the Contractor must register with EPD as a Chemical Waste Producer. Wastes classified as chemical wastes are listed in the *Waste Disposal (Chemical Waste) (General) Regulation*. These wastes are subject to stringent disposal routes. EPD requires information on the particulars of the waste generation processes including the types of waste produced, their location, quantities and generation rates. A nominated contact person must be provided.

8.1.41 The major chemical waste types arising from the construction sites are likely to be oils, lubricants, paints and solvents. Oil waste may be in the form of raw waste, or as sundries such as spent oil filters, or materials used to absorb oil leaks. Storage and disposal of these wastes are discussed below.

8.1.42 Hard standing surfaces draining via oil interceptors shall be provided in works area compounds. Interceptors will be regularly emptied to prevent release of oils and grease into the surface water drainage system after accidental spillages. The interceptor should have a bypass to prevent flushing during periods of heavy rain. Oil and fuel bunkers should be bunded to prevent discharge due to accidental spillages or breaches of tanks. Waste collected from any grease traps should be collected and disposed of by a licensed contractor.

8.1.43 Any construction plant which is likely to leak oil, should have absorbent inert material eg. sand, placed beneath it. This material should be replaced on a regular basis and the contaminated material should be stored in a designated, secure place. Such relatively inert material is suitable for landfill disposal and can be disposed of via the normal waste stream.

8.1.44 Lubricants and waste oils are likely to be generated from the maintenance of vehicles and mechanical equipment. Used lubricants will be collected and stored in individual containers which are fully labelled. The containers should be stored in a designated secure place. If possible such waste should be sent to oil recycling companies; there are also companies which collect empty oil drums for reuse or refill.

8.1.45 Oil and lubricant wastes are classified as chemical wastes, and if not recycled, should be treated at the Chemical Waste Treatment Centre, Tsing Yi, or other sites licensed for the disposal of waste oil. A trip ticket system operates to control the movement of such chemical waste and tickets have to be produced upon the request of EPD.

8.1.46 Some paints and solvents are classified as chemical waste and, if used on site, will be subject to the stringent requirements of the *Waste Disposal (Chemical Waste) (General) Regulation.* Empty paint cans should be recycled or collected as waste. Any dry paint waste should be swept up and collected in containers for disposal.

8.1.47 No lubricants, oils, solvents or paint products should be allowed to discharge into water courses, either by direct discharge, or as contaminants carried in surface water runoff from the construction site.

Aqueous Wastes

8.1.48 Requirements designed to protect against surface runoff include the use of sediment traps, settlement ponds, special drainage channels and bunding. Discharges from concrete batching must be settled and possibly treated. Oil interceptors must have a bypass. Landtake under stockpiles or open working areas must be minimised wherever practicable such as the road upgrading works. Stockpiles are to be fenced and bunded and treated to reduce erosion and sediment release. The water must be collected and settled. Solids accumulated in the sand traps, settlement tanks, manholes, and streambeds must be cleared out regularly.

8.1.49 All discharged waters, including sewage and site runoff, should comply with the appropriate standards in the *TM on Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*, prior to discharge. Advice on the handling and disposal of construction site discharges, including site runoff and contaminated wastewaters, is provided in the *ProPECC Paper (PN1/94), Construction Site Drainage.*

8.1.50 Refuse floating in the channels, emanating from the works, should be collected using refuse booms and disposed of appropriately.

8.1.51 The permanent, concrete, stormwater drainage culverts for the RZ development will be installed during these stages.

8.1.52 All vehicles leaving the RZ will pass through the wheelwash at the eastern Site access/exit. If, at any time, further entry/exit points are created, they will be provided with similar facilities. The wheelwash requires regular cleaning to remove sediment, and may also produce a large volume of wastewater. To prevent excess sedimentation, and possible contamination of local streams and water courses, these wastewaters should be directed into settlement ponds as far as practicable. The wastewater can then be reused on Site. The maintenance of the wheelwash will be the responsibility of the Contractor undertaking the site formation works.

Sewage

8.1.53 Sewage is characterised by high BOD and suspended solids, and is enriched with nutrients and high bacteriological counts. Domestic sewage generated from the site toilets, washing facilities and any temporary canteen provided for construction workers will need to be collected separately and disposed of or appropriately treated to comply with Government requirements. It is the responsibility of the contractor to ensure that sewage disposal complies with the standards set out in the *TM on Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters.*

Municipal Waste

8.1.54 Solid and liquid wastes will be generated by the construction workers during the clearance/construction period. The number of site staff per Area is estimated to be 45 persons. If the quantity of municipal waste generated is estimated[3] to be 1.29 kg/employee/day, then the total generation per Area will be around 58 kg/day. A temporary refuse collection station will be set up by the Contractor. Municipal waste will be collected regularly in black refuse bags and delivered to, and disposed of at, an approved landfill as required by the Regional Services Department (RSD).

Site Clearance

8.1.55 Site clearance waste includes used materials such as packaging materials, used wooden blocks and boards, debris etc. All construction waste should be sorted on site into inert and non-inert materials. Non-inert materials such as wood, and materials such as glass, plastics, steel or other metals should be disposed of at landfill. Other non-inert materials such as soil, sand, concrete, rubble etc should be kept separate and disposed of at public dumps which are operated by CED. Construction waste with only a small amount of inert material (not more than 20% by volume) will be allowed for disposal at landfill. In the case of reinforced concrete, steel rods should be separated from concrete rubble by mechanical means, and disposed of separately.

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3 *Monitoring of Municipal Solid Waste 1991, 1992* (1993) Environmental Protection Department.

Recycling or Re-use Facilities

8.1.56 As a result of the large variety of wastes which will be generated during the development of Tin Shui Wai during formation, construction and operation of the site, the establishment of an efficient collection system is required to achieve environmental objectives. The system should also allow for recycling of certain materials and proper disposal of other materials as detailed in Table 8.4.

Table 8.4
Waste types and their potential for recycling or re-use

Waste type	Works generating waste	Volumes lost as waste	Potential re-use or recycling	Disposal Options
Fill material	Site Formation	None	Material balance in deficit for site formation, and excess fill material produced during piling activities will be used to balance the deficit	No disposal considered - all fill will be used
	Construction of buildings*	None		
Concrete	Road building Construction of buildings*	3-5%	Needs to be separated; re-useable material needs to be crushed	To public dump
Wood formwork, fencing	Road building Construction of buildings*	20%	Used as lower grade shuttering or fencing on-site or other sites	To public dump
Reinforcing steel, steel cable and shutters	Road building Construction of buildings*	1%	Most material can be re-used after cleaning	To public dump
Chemical waste	General site activities	Small amounts	Recycling/disposal firms will collect chemicals or waste oil, or refill oil containers	Chemical waste, including paints disposed of to treatment facility - REQUIRES LICENSE
Oil waste				Oil can be removed for recycling or soaked up by sand for disposal to landfill.
Grease trap waste				Grease trap waste collected and disposed of to licensed contractor.
Wheel wash waste	Vehicle use during general works	Total volume when replaced	Recycling through filter until replacement of water is required	Onto sand area where natural filtration occurs, and oils can be retained before landfill disposal.
Domestic waste	General site activities	Putrescible waste, wet paper, fabrics	Cans, bottles, dry paper	To landfill

* These works are under Housing Authority control.

8.1.57 Responsibilities for recycling, re-use or disposal of waste materials are divided between the contractors generating the waste, the management of the Tin Shui Wai development, RSD, the Fill Management Committee (FMC) and the management of the receiving dump sites. These responsibilities are described in Table 8.5.

8.1.58 Under present practices, contractors handle their own wastes, often without separating different types of waste resulting in incorrect disposal of wastes. Under the proposed scheme, contractors would be required to separate wastes to ensure maximum reuse of materials and minimise adverse impact on the environment.

Concrete

8.1.59 The waste concrete generated during construction can be transported directly to the public dump by the contractor. Separation is essential to enable separated concrete to be processed, for example, by crushing at the disposal site, and used as fill at other sites.

Wood formwork and steel

8.1.60 Only waste material need be taken to the public dump. It should be separated from recyclable concrete. Contractors are responsible for storage of re-useable materials on site.

8.1.61 The ease of disposal of concrete and wood waste to public dump and their operation as processing centres for concrete depends on the location of the dump. This is the subject of a Territory-wide study on Public Dumping.

Chemical wastes and oil wastes

8.1.62 Contractors are responsible for obtaining licenses for the disposal of chemical and oil wastes. A storage area should be designated as a pre-disposal containment area to prevent environmental impacts from spilt chemicals.

Wheel wash waste

8.1.63 Areas of sand for absorbing oily wash water should be set up by contractor. Liaison with RSD is essential for correct disposal.

Domestic waste

8.1.64 Provision and collection of skips for different types of recyclable waste is the responsibility of the contractor. Arrangements should be made directly with the recycling companies, for example, the paper merchants, to collect the waste as required.

8.1.65 While fulfilling the responsibilities described above, each contractor is required to maintain their work area in compliance with environmental requirements. The generation of dust and noise from concrete and other waste collection must be minimised in compliance with Quality Objectives. Maintenance of a clean and tidy environment is essential to minimise adverse environmental and visual impact.

Table 8.5
Responsibilities for waste collection, recycling and disposal

Waste type	Responsibility for collection of waste	Responsibility for transport of waste off-site	Responsibility for recycling	Responsibility for disposal
Contaminated mud	Contractor to use care in handling of waste. Any stockpiles to be bunded	Contractor - in contractor's vehicles to Tuen Mun	N/A	Contractor - may be a joint arrangement with DSD
Fill material	Construction contractors required to stockpile excess fill for use elsewhere	Not applicable	Recycled on site	Not applicable
Concrete	Contractor - directly at source of waste generation Separation of re-useable and waste concrete should be carried out at source by contractor	Contractor - in contractor's vehicles to public dump Disposal of re-useable and waste concrete in different areas of dump as required	FMC defines suitable dumpsites. Project proponent at public dump site Project proponent to provide different areas for re-useable and waste concrete as required	FMC defines suitable dumpsites. Project proponent responsible at public dump site
Wood formwork, fencing	Contractor - directly at source of waste generation where volumes are large Separation of waste wood and concrete should be carried out at source by contractor	Contractor - transported in contractor's vehicles to public dump	Contractor - at source	FMC defines suitable dumpsites. Project proponent responsible at public dump site
Reinforcing steel, steel cable and shutters	Contractor - directly at source of waste generation where volumes are large Separation of waste steel and concrete should be carried out at source by contractor	Contractor - transported in contractor's vehicles to public dump	Contractor - at source	FMC defines suitable dumpsites. Project proponent responsible at public dump site
Chemical waste Oil waste Grease trap waste	Contractor - separate bunded area required for storage prior to collection	Contractor - liaison with chemical waste and waste oil collection firms	Chemical waste collection firms or oil recycling firms	Contractor through chemical waste collection firms or oil recycling firms. Contractor REQUIRES LICENCE
Wheel wash waste	Contractor - on solid sand trap or as liquid for disposal	Contractor - contaminated sand to landfill, or liquid waste to foul water system	Contractor - during wheel washing activity No recycling applicable after collection on sand trap	Contractor - if liquid waste to foul water system RSD if sand trap waste disposed of to landfill
Domestic waste	Contractor - provision of skips and sorting of recyclable wastes into separate skips	Contractor - liaison with recycling companies	Recycling firms	RSD - to landfill

Summary

8.1.66 Waste will inevitably be produced during the construction period. The quantity of waste should be minimised and materials should be recycled as far as practicable, in order to minimize the disposal requirement.

8.1.67 No major waste impacts are predicted to arise as a result of the site formation process (as long as good environmental practices are observed), as no surplus material is expected.

8.1.68 The formation of Area 104, the extension to the Eastern Culvert and the extension to the WDC will involve the excavation of soft, contaminated mud and the removal of this contaminated material. It is recommended that this work should be carried out during the dry season as far as practicable, in order to reduce the possibility of runoff from the contaminated excavations reaching the water column. Any stockpiles must be surrounded by bunds. Class C material must be excavated and transported with great care. It cannot be dumped in the gazetted marine disposal grounds. The material must be effectively isolated from the environment upon final disposal, for example to contaminated mud pits at East Sha Chau. Transloading of contaminated mud at the barging point must be undertaken so as to prevent runoff/leachate from polluting nearby sensitive receivers. At the current time, it is planned that the muds are transloaded and disposed of using existing handling facilities in Tuen Mun.

8.1.69 Any vehicles leaving the Site carrying unsuitable excavated material should have their loads covered and be routed, so far as possible, to avoid sensitive receivers in the area.

8.1.70 Water and liquid waste products arising on site should be collected and removed from the site and disposed of at a location and in a manner that should not cause pollution or a public health hazard. The Contractor shall be responsible for the adequate maintenance and clearance of drainage channels and gullies.

8.1.71 Contract requirements should include the responsibilities of the contractor for waste collection and disposal. Suitable facilities should be provided, for example, an accessible dump site with processing capabilities to ensure maximum utilisation of waste materials.

8.1.72 Correct storage of and, where possible, recycling of chemical and oil wastes is required to minimise environmental impacts.

8.1.73 In order to maximise re-use of materials and minimise the cumulative impact of waste products on the environment, facilities should be set up for the separation of recyclable material from domestic waste for collection by recycling companies.

8.1.74 Provided that there is strict control of wastes from construction works and all arisings are stored, transported and disposed of using approved methods as described previously, no significant impacts are predicted.

8.2 Solid Waste

Introduction

8.2.1 This section of the report assesses the solid waste impact of the development of Tin Shui Wai Areas 3, 30 & 31, the private development in Area 33 and the RZ. This includes, wherever possible:

(i) a characterisation and quantification of the waste generated by the proposed Developments;

(ii) the identification of feasible means for the collection, storage and handling of waste generated from the proposed Developments for the purpose of disposal of the waste to the existing and committed waste management facilities outside the Developments, or to other such facilities that may be proposed by EPD;

(iii) the identification and proposal of mitigation measures to ameliorate environmental impacts associated with the construction and/or operation of any means identified above.

Characterisation of Waste

8.2.2 Hong Kong's solid waste is categorised by EPD[4] as: domestic/public cleansing; industrial/commercial; and, construction waste. The composition of the first two categories of wastes is illustrated in Figure 8.2 and 8.3, and the regional variations in Figure 8.4. The categories are defined as follows:

(i) *Domestic/Public Cleansing Waste*: Household waste refers to waste generated from residential premises in the course of normal daily activities, and to bulky wastes such as discarded furniture and domestic appliances, which are collected separately and can be identified easily at the disposal sites. Refuse collected in public cleansing includes dirt and litter from street cleansing and litter bins by USD and RSD, and litter collected from country parks. Some commercial/trade wastes are mixed with these wastes in those Refuse Collection Points (RCPs) in the urban areas and business districts with interfaces of residential and commercial premises. The majority of this waste is disposed of to landfill.

(ii) *Commercial Waste*: arises from all forms of commercial activity such as markets, shops, restaurants, hotels and offices, but not factories. It is collected mainly by private contractors, but a small portion is collected by USD and RSD, and is disposed of to landfill, with a limited quantity being delivered to incinerators.

(iii) *Industrial Waste*: includes solid wastes arising from all manufacturing (except chemical and construction waste). Collection and transportation of this waste is carried out either by private contractors or by direct labour from the industries, and is disposed of to landfill.

(iv) *Construction Waste*: arising from any land excavation, formation, civil/building construction, roadwork, renovation or demolition activities. Waste include various types of building debris, rubble, earth, concrete, timber and mixed site clearance materials. Collection and disposal is carried out entirely by the private sector, and disposal may be to public dumps, reclamations, marine spoil grounds or landfills, according to category.

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[4] EPD, (1993), *Monitoring of Municipal Solid Waste, 1991-1992 and 1993-1994.* Hong Kong Govt.

Quantities of Solid Waste

8.2.3 The waste generation per capita/day, and per employee/day for Yuen Long District, the New Territories and the whole Territory for the years 1991-94 is given in Table 8.6. From Table 8.6 it can be seen that although domestic waste generation is below the Territorial average, commercial/industrial waste generation is above the Territorial average. A comparison of waste composition in urban areas and the New Territories is shown in Figure 8.4.

Table 8.6
Geographical Variations in Waste Arisings

District	Domestic Waste (kg/capita/day)				Commercial & Industrial Waste (kg/employee/day)			
	1991	1992	1993	1994	1991	1992	1993	1994
Yuen Long District	0.9	0.91	0.89	0.99	3.2	4.27	3.72	3.75
New Territories Average	0.8	0.84	0.85	0.93	1.99	2.24	2.69	3.02
Territorial Average	0.98	1.01	1.02	1.04	1.09	1.29	1.44	1.38

8.2.4 Hong Kong's domestic, commercial and industrial waste arisings continue to increase due to the growth in population and increasing *per capita* waste generation rate. The increase in generation rate of domestic waste has established an historical trend of 3.5% per annum[5] (simple) and simple growth rate of commercial/industrial waste arisings of 6.3% per annum. EPD predicts the quantities of waste for Yuen Long District, the New Territories and the Territory as a whole as presented in Table 8.7. Figures 8.2 and 8.3 show the composition of domestic, and commercial and industrial wastes for 1993 and 1994.

Table 8.7
Forecast Arisings of Waste Quantities (Tonnes/Day)

District	Domestic Waste			Commercial & Industrial Waste			Construction Waste			Total		
	2001	2006	2011	2001	2006	2011	2001	2006	2011	2001	2006	2011
Yuen Long District	391	468	540	127	207	234	1,154	1,172	882	1,672	1,847	1,656
New Territories	3,158	3,739	4,312	1,287	2,093	2,365	9,008	9,147	8,879	13,453	14,979	15,556
Territorial Total	7,970	9,335	10,732	3,250	3,841	4,341	25,879	26,279	25,514	37,098	39,456	40,617

8.2.5 From Table 8.8 the generation rate of domestic waste in the Yuen Long district may be projected to reach around 1.58 kg/capita/day in 2011. This year may be taken as the likely date for full occupation of the residential developments. This rate is applied uniformly (without regard to variation within socio-economic groups) to the RZ and Areas 3, 30, 31 and 33 on an area-by-area basis in Table 8.8.

[5] EPD, *Monitoring of Municipal Solid Waste, 1991-1992* and *1993-1994*. Hong Kong Govt.

Table 8.8
Projected Quantities of Domestic Waste Arising from RZ and Areas 3, 30, 31 and 33 (for 2011)

Areas in order of occupation	Landuse	Final Population	Projected Domestic Waste (t/day)
3	HOS	20,617	32.6
30	RS	13,020	20.6
31	HOS	18,488	29.2
33	C/R G/IC	8,400	13.3
102a	RS	15,309	24.2
102b	HOS	15,565	24.6
		30,874	48.8
101	PSPS	12,737	20.1
103	SC	12,600	19.9
104	R2	5,700	9.0
106	HOS	8,755	13.8
107a	O	-	-
108a	C/R	750	1.2
111a	PSPS	6,232	9.8
117a	O	-	-
121	OU(G/IC)	-	-
105	RS	15,310	24.2
107b	O	-	-
108b	CR	750	1.2
109	G/IC	-	-
110	HOS	16,538	26.1
111b	PSPS	11,400	18.0
117b	O	-	-
120	OU(G/IC)	-	-
112	R3	3,650	5.8
113	E	-	-
115	R3	2,650	4.0
116	E	-	-
114	O	-	-
118	CA	-	-
119	CA	-	-

RS	Rental Housing	G/IC	Government Institution and Community
HOS	Home ownership scheme	E	Educational
PSPS	Private sector participation scheme	O	Open space
SC	Sandwich class housing	CA	Conservation area
R2	Residential zone 2	GB	Green belt
R3	Residential zone 3	A	Amenity area
C/R	Commercial/residential	OU	Other specified Uses

8.2.6 If the projected per capita figure for Yuen Long domestic waste arising is applied to the total Tin Shui Wai RZ population (and Areas 3, 30, 31 and 33) of 176, 216 this will result in around 300 tonnes/day of domestic refuse requiring disposal.

Table 8.9
Projected Quantities of Commercial/Industrial Waste Arising from RZ and Areas 3, 30, 31 & 33 (for 2011)

Areas in order of occupation	Landuse	Assumed No. of Employees*	Projected Waste Generated (t/day)
3	HOS	311	0.9
30	RS	9	0
31	HOS	477	1.4
33	C/R G/IC	1,698	4.9
102a	RS	249	0.7
102b	HOS	302	0.9
101	PSPS	211	0.6
103	SC	1,075	3.1
104	R2	1,500	4.3
106	HOS	292	0.8
107a	O	-	-
108a	C/R	1,400	4.0
111a	PSPS	229	0.7
117a	O	-	-
121	OU(G/IC)	200	0.6
105	RS	9	0
107b	O	-	-
108b	CR	400	1.1
109	G/IC	450	1.3
110	HOS	290	0.8
111b	PSPS	-	-
117b	O	-	-
120	OU(G/IC)	300	0.9
112	R3	2,025	5.8
113	E	-	-
115	R3	1,475	4.2
116	E	-	-
114	O	-	-
118	CA	-	-
119	CA	-	-

* This figure is based on the number of employees predicted (or calculated on the basis of the average number of employees per hectare where such information is unknown)[6].

[6] BCL, (1996). *Sewage Flow Inventory.*

8.2.7 Table 8.9 is calculated on the basis of the Territorywide 1.38 kg/employee/day commercial and industrial waste arisings (1994) growing to 2.86 kg/emp/day by 2011. The total arising will be around 37 tonnes/day from Table 8.9.

Collection, Storage & Handling

Provision of Refuse Collection Points

8.2.8 At present, domestic wastes generated by private developments are collected from approved refuse collection points (RCPs) by RSD. RCPs are constructed at appropriate locations within developments in accordance with the guidelines set out in *HKPSG, Chapter 9 (Section 6)*, a summary of which is included in Appendix A. The guidelines suggest two bases on which to provide RCPs: one per 20,000 persons or at a spacing to limit walking to 500 metres. The actual provision for private developments is likely to feature at least one RCP per Area (no single area exceeds 20,000 persons or 500 m at its longest dimension) with more RCPs included at the developer's discretion in Areas 33, 103, 104, 108, 112 and 115.

8.2.9 The public housing estates designated for Areas 3, 30, 31, 101, 102 (a & b), 105, 106, 110 and 111 (a & b) are subject to separate provision standard and design criteria for refuse collection. The criteria are summarized in Table 8.10 and described in detail in Appendix A: "Guidelines for Refuse Collection in Public Housing Estates". These guidelines aim to regularize the approach to be adopted for refuse collection and provide the necessary design data to ensure an acceptable provision in all public housing estates.

Table 8.10
Summary of Public Housing Refuse Collection Requirements

Provision	Standard
Refuse Storage Chamber (RSC)	One to each block with sufficient space for daily storage. One bin, with a minimum floor area of 2.0 m^2, should be provided per 35 flats.
Refuse Storage Area (RSA)	To store bins awaiting collection, within the shortest distance practicable from the domestic blocks they serve. Minimum floor allowance of 2.5 m^2/bin.
Refuse Collection Point (RCP)	Estate of ≤ 3,000 flats require one RCP; Estate of > 3,000 flats requires two RCPs; Minimum height 8 m.
Junk Collection Point (JCP)	Estate of ≤ 2,500 flats requires one JCP of at least 20m^2; estate of > 2,500 flats requires two 20m^2 JCP or one 40m^2 JCP; Not more than 180 m from domestic blocks.

8.2.10 Application of these criteria to the public housing Areas results in the requirements laid out in Tables 8.11 and 8.12 for the DZ and RZ respectively.

Table 8.11
Public Housing Refuse Collection Requirements for the DZ

Area (No. of flats)*	Provision	Requirement
3 (6400)	RSC RSA RCP JCP	- 1 RSC per block (layout N/A) - 183 bins will require 366 m^2 of RSA space - Two RCPs - Two areas of 20 m^2 or one area of 40 m^2
30 (3720)	RSC RSA RCP JCP	- 1 RSC per block - 107 bins will require 214 m^2 of RSA space - Two RCPs - Two areas of 20 m^2 or one area of 40 m^2
31 (6080)	RSC RSA RCP JCP	- 1 RSC per block (layout N/A) - 174 bins will require 348 m^2 of RSA space - Two RCPs - Two areas of 20 m^2 or one area of 40 m^2

* *Source : Housing Branch Fax (23/9/96) M.L. Wan to C.L. Ng (PM/NTN, TDD)*

Table 8.12
Public Housing Refuse Collection Requirements for the RZ

Area (No. of flats)*	Provision	Requirement
101 (4000)	RSC RSA RCP JCP	- 1 RSC per block (layout N/A) - 115 bins will require 230 m^2 of RSA space - Two RCPs - Two areas of 20 m^2 or one area of 40 m^2
102a (3795) 102b (5304)	RSC RSA RCP JCP RSC RSA RCP JCP	- 1 RSC per block (layout N/A) - 109 bins in total will require 218 m^2 of storage space - Two RCPs - Two areas of 20 m^2 or one area of 40 m^2 - 1 RSC per block (layout N/A) - 152 bins will require 304 m^2 of RSA space - Two RCPs - Two areas of 20 m^2 or one area of 40 m^2
105 (4511)	RSC RSA RCP JCP	- 1 RSC per block (layout N/A) - 129 bins will require 258 m^2 of RSA space - Two RCPs - Two areas of 20 m^2 or one area of 40 m^2
106 (2560)	RSC RSA RCP JCP	- 1 RSC per block (layout N/A) - 74 bins will require 148 m^2 of RSA space - Two RCPs - Minimum area of 20 m^2
110 (5120)	RSC RSA RCP JCP	- 1 RSC per block (layout N/A) - 147 bins will require 294 m^2 of RSA space - RCPs - Two areas of 20 m^2 or one area of 40 m^2
111a (2050) 111b (2050)	RSC RSA RCP JCP RSC RSA RCP JCP	- 1 RSC per block (layout N/A) - 59 bins will require 118 m^2 of RSA space - Two RCPs - Minimum area of 20 m^2 - 1 RSC per block (layout N/A) - 59 bins will require 118 m^2 of RSA space - Two RCPs - Minimum area of 20 m^2

* *Source : Housing Branch Fax (23/9/96) M.L. Wan to C.L. Ng (PM/NTN, TDD)*

<u>Potential Impacts from Solid Waste Collection</u>

8.2.11 The provision of RCPs to serve the population of Tin Shui Wai generates environmental impacts, namely noise, odour and visual nuisance.

8.2.12 Noise impact is inevitable because RCVs will need to visit the sites on a regular basis to empty the containers. Each facility is likely to be visited by two to three RCVs per day, with the maximum number of visits to the largest RCPs being around five per day. From site observations, each transfer operation takes around 5 to 10 minutes.

8.2.13 Odour can be generated in poorly maintained RCP facilities when litter, leachate or dirty water is allowed to accumulate within and around the RCP under the following conditions:

(i) where waste is spilled during delivery or whilst being transferred to the RCV during the container emptying operation;

(ii) where there are either too few suitable sealed containers or the containers are emptied infrequently, leading to containers being overfilled;

(iii) where drainage of the facility is inadequate.

8.2.14 As recommended in HKPSG, waste reception and transfer facilities should be located and designed to minimise nuisance to the public and people living and working nearby, and sited to minimise disruption to traffic or the creation of pedestrian or vehicular traffic safety hazards.

Mitigation Measures to Minimise Potential Impacts

8.2.15 In a well managed RCP, noise, odour and visual nuisance can be minimised by good design, operation and management of the unit. Design of the RCP should incorporate enclosure of the unit to minimise the noise impact from the container emptying operation.

8.2.16 Visual nuisance can also be minimised by design and management, enclosing the facility and maintaining a clean, litter-free environment in and around the site can both contribute to a less negative public image. Where feasible, architectural design of RCPs should incorporate landscaping to 'disguise' the facility.

8.2.17 Storage of municipal wastes in sealed containers which are regularly removed from site, and prompt and efficient clean up of spilt litter and leachate reduces the generation of odour to a minimum.

8.2.18 Each RCP should be fitted with a water point and high pressure hose for cleansing operations. Drainage from the RCPs should be connected to the foul sewerage system. Where RCPs are serving markets and cooked food stores, adequately maintained grease traps must be installed to prevent blockage of the sewers.

8.2.19 Plates 8.1 to 8.4 show existing RCPs serving public housing, commercial and private housing areas within Tin Shui Wai.

Bulky Waste

8.2.20 Large items of waste, such as furniture, should be disposed of at Junk Collection Points (JCPs) which are areas within or adjacent to selected RCPs. Those wastes should be removed from the sites on a regular basis.

Planned Refuse Disposal System in Housing Estates

8.2.21 One option being considered for dealing with refuse collection in Tin Shui Wai public housing estates is the installation of a centralised RCP in lieu of several RSAs to serve a whole estate.

8.2.22 The system is designed to overcome the problem of an incompatible layout for the storage of refuse collection bins and to minimise the pedestrian/refuse collection vehicle conflict which currently exists.

8.2.23 Currently, refuse is collected on each floor by estate management personnel and disposed of down a chute within a refuse collection room. Access to this room is limited to authorised estate management personnel for safety reasons.

8.2.24 At the base of the chute, bags of rubbish fall directly into refuse collection containers which are stored within a RSC in each block.

8.2.25 Daily collection of the refuse containers removes them to a RCP which allows entry of the RCV for collection and transport to disposal sites.

8.2.26 Large waste items are stored separately and delivered to a JCP for separate collection.

8.2.27 Under the new proposal, the chute in each building will be connected to a pipework system which leads underground to a centralised RCP for "dewatering" in a rotating cyclone separator followed by compaction and transport in a container to landfill.

8.2.28 The chute and associated pipework are under vacuum which ensures suction of the waste through to the centralised RCP. The layout of the scheme is shown in the guidelines in Appendix A.

8.2.29 Two pilot schemes are presently being operated to determine the best design and layout of the system for Tin Shui Wai. In Fanling, the Swedish Centralsug system has been installed, while at Shek Yam East Phase I, the American Transvac system is being tested.

8.2.30 The major difference between the two systems is in the chute within each building. In the Centralsug system this section of the chute is not under vacuum. The rubbish bags are dropped down the chute until they reach the discharge valve. At intervals, the valve opens and the refuse is transported by suction through the conveying pipes to the central containers.

8.2.31 In the Transvac system, the whole chute is under vacuum which reduces the amount of storage time within the chute. There are several advantages of this central and vacuum operated system compared with that in current use, as shown in Table 8.13.

Table 8.13
Advantages of Vacuum Collection System for Domestic Waste

1)	Waste is contained within a closed system of pipework until it reaches the central collection area
2)	There is no need for refuse collection vehicles or containers to go to a Transfer Station, they can be transferred directly to landfill
2)	The system dispenses with the requirement for vehicle access to each block.
3)	Odour is reduced because open refuse collection containers are not stored in each block.
4)	Public hygiene is improved.
5)	Noise is reduced within the central RCP.
6)	Liquid is removed from the waste, reducing the amount of leachate transported with the waste.

8.2.32 Potential problems and associated mitigation measures which need to be addressed in the system design are described below:

a) Odours may arise from the chutes when rubbish is not completely transferred to the central RCP. Chute doors need to be properly sealed to minimise the odour problem.

b) A concentration of refuse collection vehicles around the central RCP requires consideration of safety of pedestrian access.

c) Removal of leachate from the waste through the use of a cyclone requires a disposal route for waste liquid, preferably to the foul water system.

d) The system does not encourage the recyling of domestic waste. Further consideration is given to this in Section 8.2.43.

8.2.33 Noise and odour from the centralised RCP will be dealt with by noise baffles and dust filters/deodorizers within the system. Careful locating of the collection point will minimise noise and odour impacts on local residents.

8.2.34 A backup is provided in the case of breakdown of this automated system which involves retention of the refuse collection chamber at the base of each building and the ability to remove the terminal part of the chute to allow reversion of the system to the traditional mode of collection of the waste in refuse collection containers.

<u>Refuse Collection Vehicles</u>

8.2.35 The Refuse Collection Trucks for the proposed refuse collection system are of similar dimensions to the RCVs currently utilised by RSD.

8.2.36 From the current Yuen Long population it can be deduced that 238 tonnes/day of domestic waste is generated. Data from RSD indicates that they operate 21 RCVs in Yuen Long district. On the present productivity figure, the projected 300 tonnes/day would require an increase in the fleet of 25 RCVs. This more than doubles the current number of RCVs assigned to Yuen Long district.

8.2.37 Clearly, the increase would be accommodated between now and 2011, but at some stage, the capacity of RSD's vehicle depot in Tin Shui Wai will be exceeded and alternative/supplementary provision will need to be made.

8.2.38 After compaction of the waste into RCVs at the centralised RCP, the vehicle can transport the waste directly to the landfill without intermediate delivery to a Refuse Transfer Station. The increase in traffic from this arrangement would be compensated for by the saving of time in eliminating waste transfer requirements.

8.2.39 Existing refuse collection arrangements in the Yuen Long district will be facilitated by operation of the proposed North West New Territories Refuse Transfer Station, planned for south of Ping Ha Road. The precise catchment for this facility and its design capacity depend on the implementation of the proposed refuse collection system and direct haulage of wastes to landfill.

Waste Recycling

8.2.40 Domestic waste recycling is stated to be one of the main requirements to achieve the objectives of the Waste Reduction Study for Hong Kong.

8.2.41 The present environmental policy of the Housing Department incorporates the following features:

1) recycling of surplus excavated materials which are temporarily stockpiled;

2) reuse of metals as construction materials, such as metal hoarding;

3) provision of waste paper collection bins in several housing estates. This will be extended to other housing estates in the future;

4) campaigns for waste paper recycling, plastic bag reduction and "sort and recycle" of waste materials.

8.2.42 The last two items can be incorporated into the design of a refuse collection system in the TSW DZ and RZ.

8.2.43 Refuse collection points are required to be sited and managed in the TSW DZ and RZ in accordance with criteria laid out in the *HKPSG* Chapter 9 (Section 6) and the *Guidelines for Refuse Collection in Public Housing Estates*. The most appropriate arrangement for location of the collection points for recyclable material would be close to the refuse collection areas, such as the Junk Collection Point, so that collection of domestic waste and recyclable materials can be combined.

8.2.44 There is little provision at the present time for collection and recycling of waste paper, aluminium cans and cardboard from housing estates, except through individual members of the community.

8.2.45 Recyclable waste collection points must be initially incorporated into the design of public housing blocks, which are the responsibility of the Housing Department and individual developers respectively. A workable recycling system must establish facilities and responsibilities as described below:

(i) Residents will be required to separate out their newspaper waste and cans into separate bags/boxes;

(ii) The cleaners/staff will dispose of the non-recyclable waste down the chutes and take the recyclable waste separately into the service lift by which the material can be transported straight down to the waste collection point;

(iii) At the refuse collection chamber (which is retained as a backup in the case of breakdown of the automated refuse collection system), the paper and cans will be put into the separate containers provided for these items;

(iv) Separate transport will be required to take these containers to the JCP where a Recyclable Waste Collection Point can be established;

(v) Arrangements should be made with paper merchants and other recycling companies who will collect the goods from the JCP.

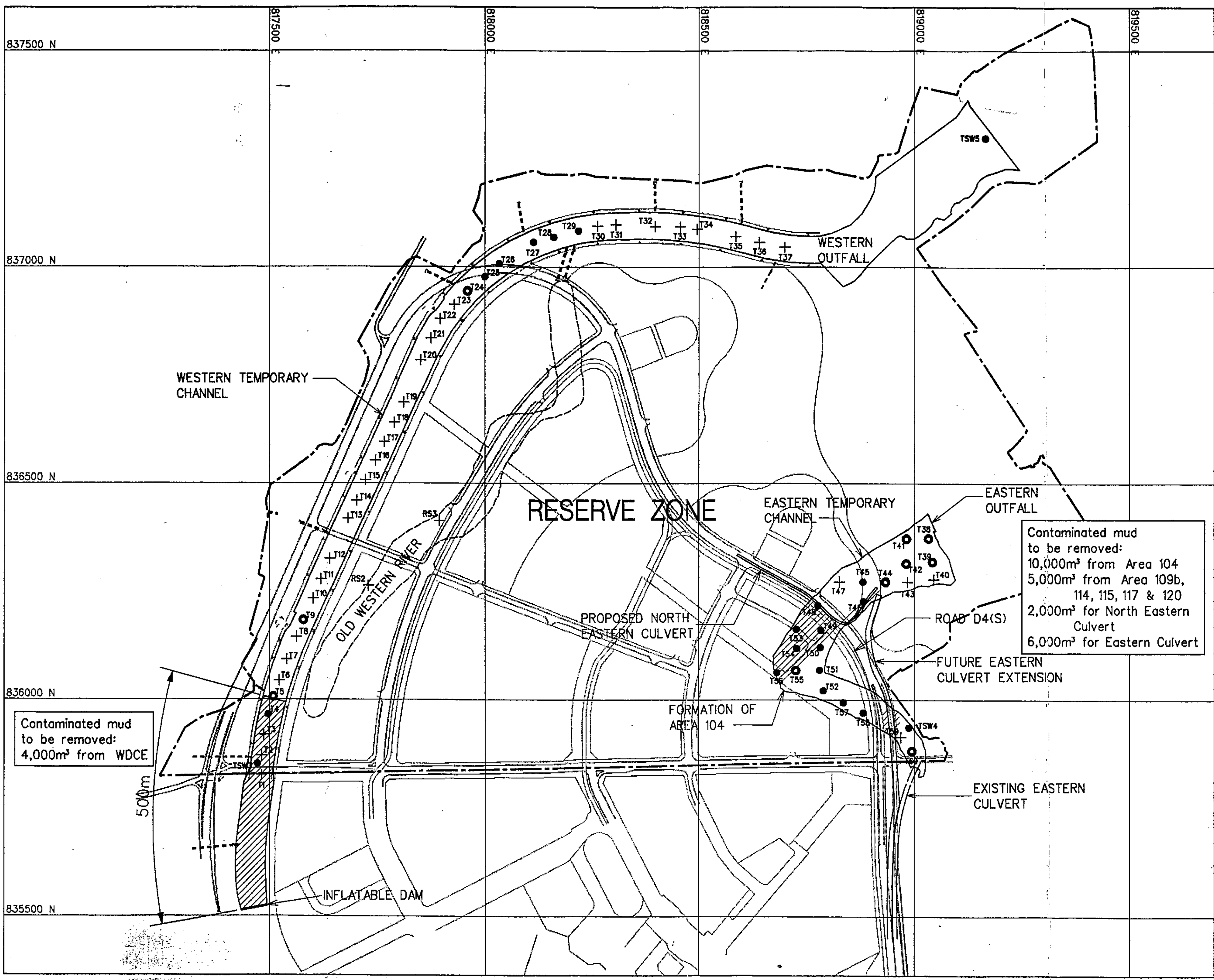
8.2.46 The success of such a project depends on the co-operation of several parties:

- contractors who generate waste during development activities will be required to separate waste for recycling;
- housing development contractors, public and private, who need to incorporate areas for recycling into the design of housing blocks;
- public cooperation in separating waste materials at source.

Summary

8.2.47 Adequate provision of facilities for the collection, storage and disposal of municipal wastes within the Tin Shui Wai area is essential. Provided that these facilities are suitably sited, designed, maintained and regularly served by RCVs, only minimal adverse impact from these facilities is anticipated.

8.2.48 Facilities for recycling domestic waste should be established at an early stage, with the requirement to separate wastes by contractors working on site. Development of housing and RCPs needs to take consideration of the separation of recyclable material at source. Public cooperation is a major factor in the success of a recycling scheme.



Notes

+ - CLASS A

○ - CLASS B

● - CLASS C

- - - OUTFALL

AREA OF CONTAMINATED MUD TO BE REMOVED UNDER THE PROJECT

Prepared	Checked	
MC	AMP	
File name	Revision	Date
00680018.C09	2	FEB. 97

Project TIN SHUI WAI DEVELOPMENT

Contract title

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

Title

CONTAMINATED MUD AREAS IMPACTED BY CONSTRUCTION

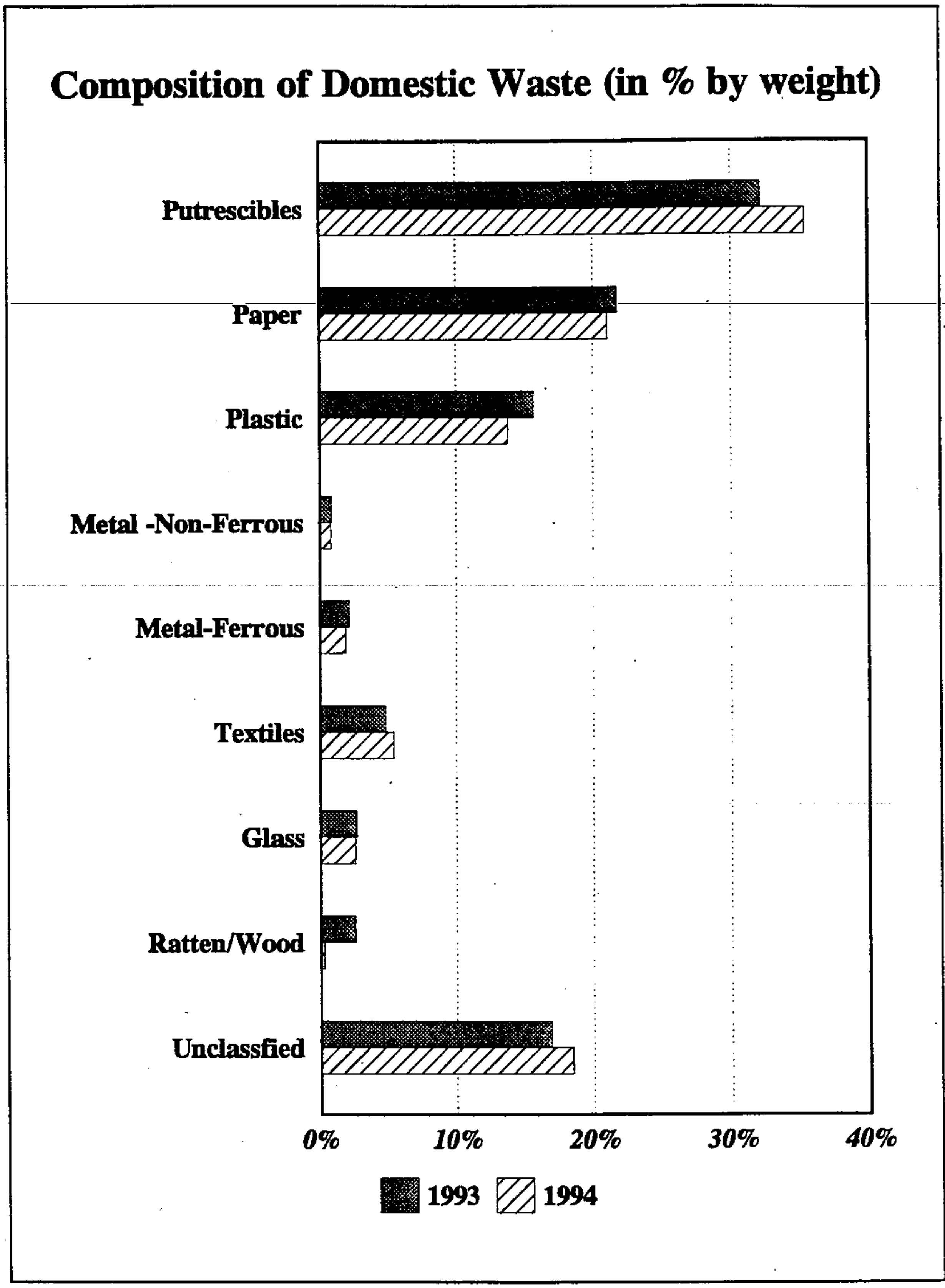
Figure no.	Reference	Scale
8.1	TSW-BASE	1 : 8000

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼

Office

新界北拓展處
NEW TERRITORIES NORTH DEVELOPMENT OFFICE

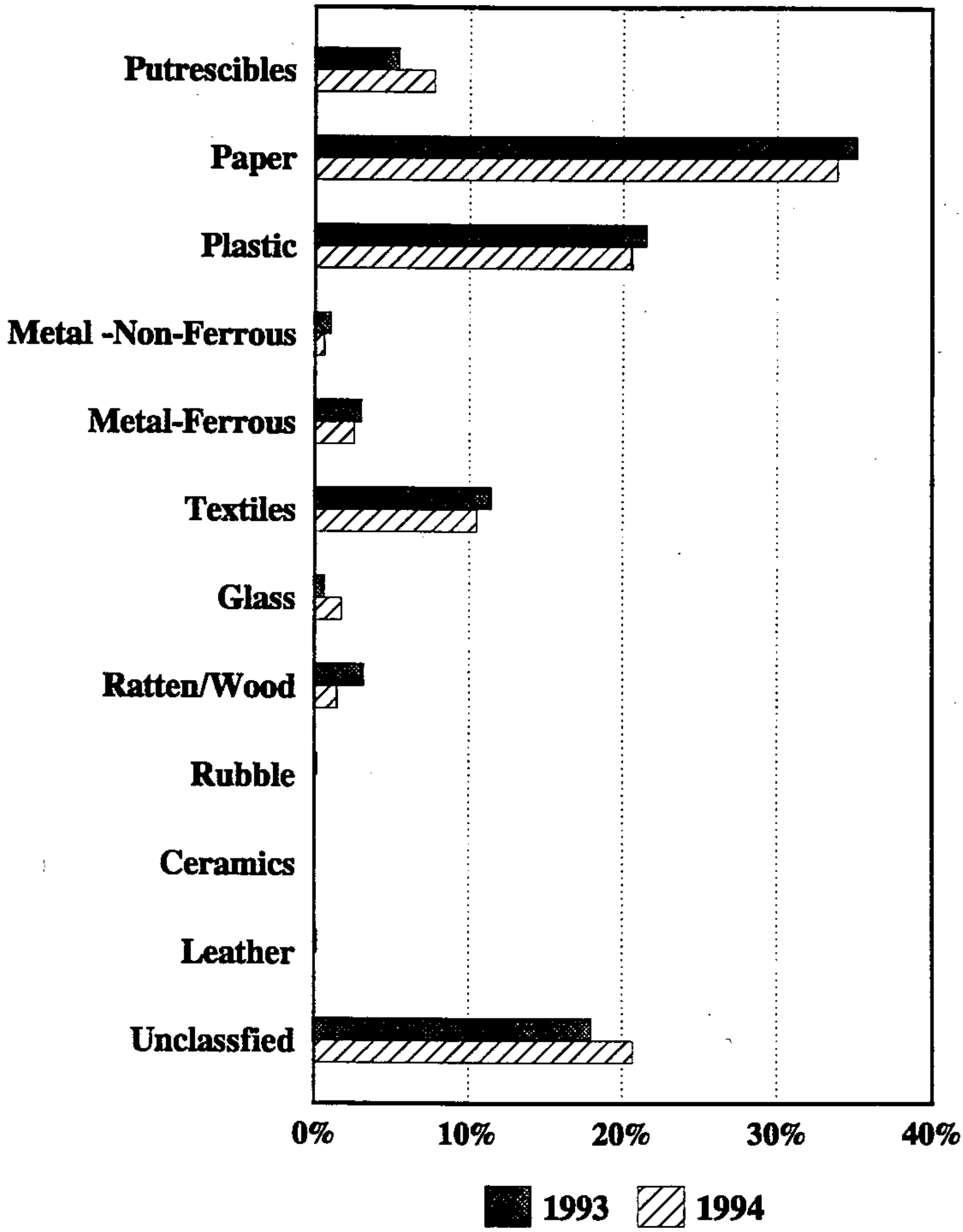
拓展署
Territory Development Department, Hong Kong



(SOURCE : MONITORING OF MUNICIPAL SOLID WASTE 1993 AND 1994, EPD)

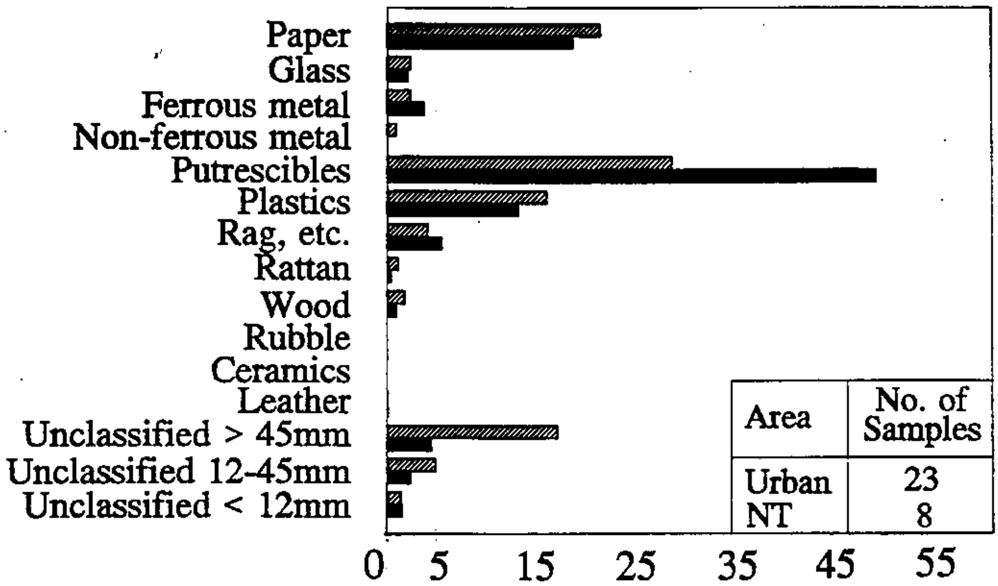
TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : COMPOSITION OF DOMESTIC WASTE IN 1993 AND 1994 (in % by weight)	Figure No. 8.2	Revision 0
		Reference No. EPD /TR/3/95	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked AMP
		Date NOV 96	Scale NTS

Composition of Commercial & Industrial Waste (in % by weight)

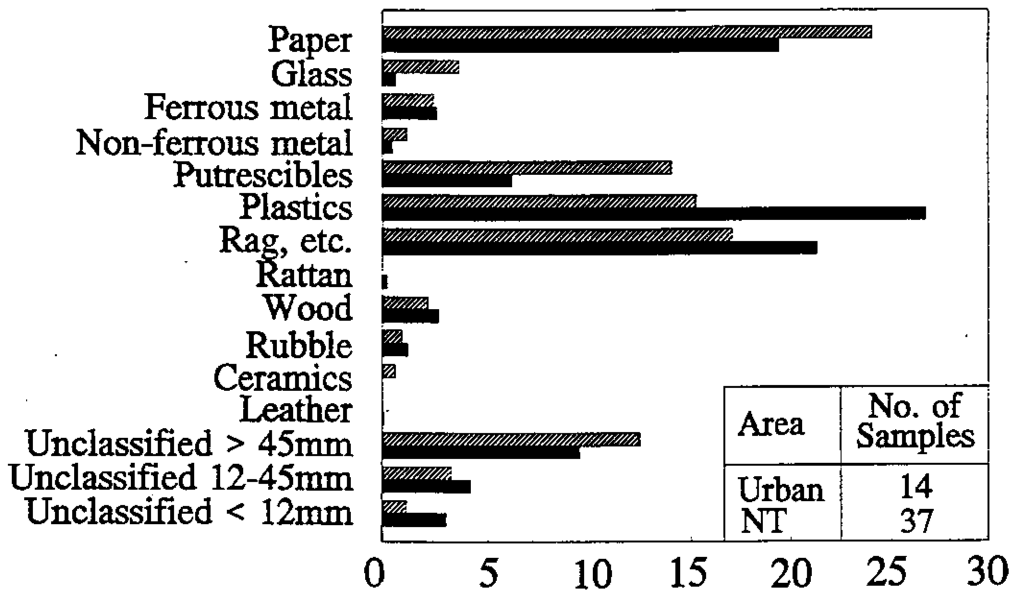


(SOURCE : MONITORING OF MUNICIPAL SOLID WASTE 1993 AND 1994, EPD)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : COMPOSITION OF COMMERCIAL AND INDUSTRIAL WASTE IN 1993 AND 1994 (in % by weight)	Figure No. 8.3	Revision 0
		Reference No. EPD /TR/3/95	File Name -
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked AMP
		Date NOV 96	Scale NTS



Composition of Domestic Waste (in % by weight)



Composition of Commercial & Industrial Waste (in % by weight)

Urban Area NT

Note : As determined at waste disposal sites.

(SOURCE : MONITORING OF MUNICIPAL SOLID WASTE 1991 - 1992, EPD)

TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : COMPARISON BETWEEN WASTE COMPOSITION IN THE URBAN AREA AND THE NEW TERRITORIES IN 1992 (in % by weight)	Figure No. 8.4	Revision 0
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Reference No. EPD /TR/5/93	File Name -
		Prepared MC	Checked AMP
		Date NOV 96	Scale NTS

9 ECOLOGY

9.1 Introduction

9.1.1 This chapter describes the ecological resources of the Tin Shui Wai area which are potentially impacted by the Project, assesses the significance of the impacts in terms of the ecological value of the resources and defines the required mitigation measures to prevent or minimise impacts. Where residual impacts are unavoidable, the nature and extent of the residual impacts are evaluated.

9.1.2 The Study Area includes a range of ecologically important habitats including fish nursery grounds, intertidal mudflats, fishponds, freshwater wetlands (including fishponds, reedbeds, and marshes), gei wai, grassland, shrubland and native woodland. Many species of animals and plants are protected under Hong Kong legislation. The Study Area is shown in Figure 9.1.

9.1.3 The ecological value of the area has been recognised by governments for over twenty years. China created the Fu Tien National Bird and Mangrove Reserve on the north-eastern shore of Inner Deep Bay. The Hong Kong Government designated Inner Deep Bay a Site of Special Scientific Interest (SSSI) in 1976. An SSSI is generally recognised as a prime example of a natural feature, in this case, a natural wetland and intertidal mudflat area. Subsequently, Government has supported the World Wide Fund for Nature - Hong Kong's management of the core area Mai Po Marshes Nature Reserve since 1983.

9.1.4 In September 1995, the Hong Kong Government designated the Mai Po/Inner Deep Bay area as a Wetland of International Importance under the Ramsar Convention. China is one of the contracting parties to the Ramsar Convention. The Deep Bay Ramsar site has been further designated by Government as an essential wetland in the East Asian-Australasian Shorebird Reserve Network launched at the Ramsar Convention of Parties in March 1996. This wetland network has sites distributed between Siberia and Australia, providing stepping stones for waterbirds on their annual migrations. The location of SSSIs, the Ramsar Site and Buffer Zones is shown in Figure 9.2.

Requirements of the Brief

9.1.5 The Brief for the proposed development of the RZ as part of Tin Shui Wai requires a 12-month Ecological Impact Assessment (Eco-IA) to be carried out as part of the overall EIA. The Brief states that the 12-month ecological study shall focus on:

(i) description of the physical environmental background and habitat characterisation of the sites to be affected by the Project;

(ii) investigation of the existing flora/fauna likely to be affected;

(iii) identification and quantification as far as possible of any direct/indirect and onsite/offsite impacts that lead to the destruction, displacement or adverse effect on flora and fauna (such as, loss of shelter and food, reduced species diversity, loss of breeding grounds, loss of wetland, loss of fisheries, species extraction, loss of carrying capacity); and

(iv) evaluation of the impacts and proposals for mitigation measures.

9.1.6 The objectives of the Ecological Study are listed below, together with the section of this chapter in which each objective is addressed:

Objective of Study	Relevant Section of Chapter	Relevant Appendix
a) To describe the existing conditions of the Study Area with reference to:		
i) relevant legislation	9.1	A
ii) fauna and flora studies	9.2	E1, E2, E3, E4
b) To identify and quantify the impacts during site formation, infrastructure provision and operation on the ecological resources of the Study Area	9.2	E4
c) To evaluate the importance of each impact on the ecology in terms of the value of the ecological resources	9.3	
d) To describe mitigate measures which should be implemented to minimise the environmental impacts of the Project works	9.4, 9.5	
e) To describe residual impacts after mitigation measures have been implemented, and any impacts of the mitigation measures themselves, in order to enable an assessment of the acceptability of the Project to be made	9.6	

Relevant Conventions, Legislation, Regulations, and Guidelines

International Conventions

9.1.7 Deep Bay and its associated wetlands have been recognised to be of conservation importance by the governments of the People's Republic of China and Hong Kong. Hong Kong, currently through the United Kingdom, is a Party to several international conventions relevant to the Mai Po region.

- *The Convention on Wetlands of International Importance especially as Waterfowl Habitat* (the Ramsar Convention)
- *The Convention on the Conservation of Migratory Species of Wild Animals* (the Bonn Convention)

The Ramsar Convention

9.1.8 The Ramsar Convention states several criteria that qualify a wetland as a wetland of international importance. Based on the occurrence of the following five species (Peking University (PU) 1995) in numbers which constitute 1% or more of their respective world populations (Table 9.1), Mai Po/Inner Deep Bay fulfil this Ramsar Treaty criterion.

Table 9.1 Species in Deep Bay with Densities Exceeding the Threshold that Warrants Ramsar Designation

Common name	Species name	% of world total
Dalmatian Pelican	*Pelecanus crispus*	1%
Black-faced Spoonbill	*Platalea minor*	30%
Asiatic Dowitcher	*Limnodromus semipalmatus*	1%
Spotted Greenshank	*Pelecanus crispus*	10%
Saunders' Gull	*Larus saundersi*	5%
Black-tailed Godwit	*Limosa limosa*	1%

9.1.9 The Ramsar Convention also requires that wise use should be made of wetlands to ensure "their sustainable utilisation for the benefit of mankind in a way compatible with the maintenance of natural properties of the ecosystem"

The Bonn Convention

9.1.10 Hong Kong is also party to the Bonn Convention. Animals listed in Appendix I of the Bonn Convention require signatories to provide strict protection for species which are in danger of extinction, through conservation or restoration of their habitats, particularly in relation to their migration passage. In Deep Bay, the Appendix I list applies to the following species:

Dalmatian pelican	*Pelecanus crispus*
Chinese Egret	*Egretta eulophotes*
Oriental White Stork	*Ciconia boyciana*
Relict Gull	*Larus relictus*
Saunders' Gull	*Larus saundersi*

Hong Kong Guidelines and Statutes

9.1.11 The importance of this area from an ecological viewpoint has resulted in the establishment of Buffer Zones as shown in Figure 9.2, which are bands of land designated to protect the internationally recognised wetland habitat of Deep Bay. The original concept for buffer zones arose from the Integrated Management Plan for Deep Bay formulated in 1988. It was officially adopted in 1993 in the *TPB Guidelines for Applications for Development within the Deep Bay Buffer Zones* under Section 16 of the *Town Planning Ordinance*. In addition, legislation and guidelines have been established in Hong Kong to protect the flora and fauna of ecologically valuable areas including the Study Area.

1. *The Forests and Countryside Ordinance* (Cap 96) which protects both natural and planted forests, including mangroves
2. *The Forestry Regulations*, which provide for the protection of specified local wild plant species
3. *The Town Planning Ordinance* (Cap 131) which, under Section 16, controls developments within the Deep Bay Buffer Zones.
4. *The Wild Animals Protection Ordinance* (Cap 170) which provides for protection of all wild animals (excluding fish and marine invertebrates) by prohibiting the hunting or the disturbance, taking or removal of such nests or eggs, unless a special permit is obtained.
5. *Livestock Waste Control Scheme*, which is currently being implemented to control the volume of waste disposed of into watercourses in the New Territories.

9.1.12 The Guidelines which are relevant to this project include:

1. *The Hong Kong Planning and Standards and Guidelines*
   Chapter 9: Environment
   Chapter 10: Conservation states and expands on four principles to be adopted for the practical pursuit of conservation in land use planning.

2. *The Deep Bay Guidelines for Dredging, Reclamation and Drainage Works* which are intended to ensure that dredging and associated works carried out in Deep Bay respect the environmental value and sensitivity of the area, including mangroves and mudflat habitats supporting a bird population of international importance.

9.1.13 Chapter 9 of the *Hong Kong Planning Standards and Guidelines* (HKPSG) states that Nature Reserves and SSSIs "should be adequately protected from the effects of pollution". Under the *Town Planning Ordinance*, a formally zoned SSSI will have planning protection.

9.1.14 In addition to Hong Kong Regulations, China has entered into bilateral agreements for the protection of migratory birds with both Japan and Australia. Birds passing through the Deep Bay area are known to migrate to/from these countries (Melville and Galsworthy 1993).

Agriculture and Fisheries Department Fish Pond Categories

9.1.15 Hong Kong fish ponds have been categorised by the AFD into three grades depending on the size of ponds, proximity to other ponds, quality of management, security from development, and access. Although this system is not contained within any body of regulation relative to conservation or development, it is a useful guide for assessing the nature of fish ponds in specific areas within Hong Kong as shown in Table 9.2.

Table 9.2 AFD Categorisation of Fish Ponds

Grade	Classification Criteria
A	Well established pond fish culture areas with good potential for further development. Substantial amount of fish pond is actively operated and well managed. Access to the site is good.
B	Established pond fish culture areas with small numbers of fish ponds most of which are actively operated and well managed. Further development is limited either by the remoteness of the site, availability of suitable land or vulnerability to flooding. Access to the site is fairly good.
C	Areas with scattered small fish ponds. They are subject to high development pressure due to their close proximity to development as are those under Grade D.
D	Idle or filled small scattered ponds.

9.1.16 Relevant portions of these statutes, guidelines and conventions are described in detail in Appendix A.

9.2 Existing Ecological Conditions and Assessment of Potential Impacts

Approach to Study

Methodology for Eco-IA

9.2.1 Identification of the types of habitat present within the Study Area was carried out by means of several studies as shown in Table 9.3. Initially, habitat mapping was carried out to determine the range of habitats present. Within each habitat, the Eco-IA identified and evaluated the fauna and flora present. The techniques selected to collect data during the Eco-IA were designed to achieve two objectives.

9.2.2 First, sufficient information is required in order to evaluate the ecological value of the habitat and to assess the vulnerability of the habitat to Project impacts. A comparison can also be made with similar areas of recognised ecological value (e.g. SSSIs, MPNR, Fu Tien NR).

Table 9.3 Studies carried out for the Ecological Assessment

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TERRESTRIAL													
habitat mapping	*				*					*			
mammals					*							*	
birds										*			*
amphibians										*			
fish					*								
odonates										*			
ESTUARINE													
waterbirds		*			*			*			*		
benthic infauna	*		*				*					*	
epifauna		*			*			*			*		
mangroves					*								
seabed					*								

Note * = Completed

9.2.3 Second, the techniques have proven capability of distinguishing project impacts from natural variation. Natural variation is inevitable in the mosaic of plant and animal assemblages within an environmental framework. It is essential to have a thorough understanding of natural variation in order to be able to distinguish potential project-related impacts.

9.2.4 Details of the methodology used in carrying out the Eco-IA are provided in Appendix E.2.

Division of Habitats for Study

9.2.5 The habitat maps produced during the Eco-IA cover two seasons, dry and wet, as shown on Figures 9.3 and 9.4. Figure 9.3 includes dry season habitat studies from December 1995 to April 1996, while Figure 9.4 shows the site in the wet season, September 1996. The Study Area was divided into two main habitats: terrestrial and estuarine, each of which include a range of ecologically important species groups.

9.2.6 The terrestrial habitat includes the man-made sandy land bank of the RZ. Two drainage channels were left on the land bank along the courses of the Old Western River and the Tai River, now the Eastern Temporary Channel (ETC). These areas are wetlands. While these drainage channels were originally estuarine and tidal, flap valves were installed on the downstream end of both channels to prevent inflow of tidal water, and the habitat has now become freshwater wetland. In addition, two abandoned fishponds remain in Area 122 on the west bank of the Western Temporary Channel (WTC), and four partially-filled abandoned fishponds remain in Area 118.

9.2.7 The estuarine environment comprises the sub-tidal and seabed ecosystems of Deep Bay, and the intertidal area around Mai Po marshes and Tsim Bei Tsui. Intertidal mudflat areas are present along the section of WTC adjacent to the Ramsar site and Inner Deep Bay SSSI. Mangrove stands are present along sections of the WTC, the Eastern Outfall Channel, the cross channel connecting the two, and the landward fringe of the adjacent Ramsar site. The subtidal habitat is present as the Western and Eastern Outfall channels, and the waters below the low tide line in Inner Deep Bay.

9.2.8 The Study Area is also divided into on-site and off-site areas, which are generally subject to direct and indirect Project impacts respectively. Reference to "on-site" includes the area within the site boundary and also the areas subject to land resumption (fish ponds in Area 122) and the road reserves south of the RZ.

Initial Identification of Potential Impacts of Project on Ecological Resources

9.2.9 Potential impacts on the ecological resources of the site include:

- direct and indirect impacts
- short-term and long-term impacts
- cumulative impacts

9.2.10 At the beginning of the EIA Study, several major potential impacts on the ecological environment at Tin Shui Wai were identified. These included the extension of the Western Drainage Channel (WDCE) as a concrete lined channel as far down as the mouth of the present WTC. This proposal has been dramatically reduced to a 500 m stretch downstream of the inflatable dam, thereby averting destruction of the benthos inhabiting this tidal channel. The WDCE works and potential water quality impacts are described in section 7.5.

9.2.11 A second potentially harmful impact would be the removal of substantial volumes of contaminated mud from the ETC during site formation works and subsequent infrastructure development. Considerable effort has been made to minimise the amount of mud to be removed through consideration of the geotechnical properties of the mud. Initial estimates of the volume of mud to be removed was over 300,000 m^3. This has been reduced to less than one-tenth of this figure and will be reduced further where engineering studies show this is possible.

<u>Direct Impacts</u>

9.2.12 The terrestrial habitat is most vulnerable to direct, on-site impacts, the major impacts being:

(i) loss of habitat including the grasslands and freshwater wetlands on the RZ, and the freshwater marshes (abandoned fishponds) in Area 122.
(ii) noise and human disturbance from the works or maintenance dredging and through increased density and close proximity of site workers, residents, visitors, and by increased site lighting at night;
(iii) fires caused by site activities such as disposal of waste or welding.

9.2.13 The landbank will be affected most severely, with lesser impacts occurring in the Tsim Bei Tsui headland and the habitats around the perimeter of the site.

Indirect Impacts

9.2.14 The estuarine habitat is more vulnerable to indirect, off-site impacts, chiefly the potential deterioration in water quality as a result of run-off during site formation and infrastructure works. This may include:

(i) changes in water quality and sediment dynamics due to dredging activities, in particular the removal of contaminated mud from the ETC;
(ii) changes in water quality due to stormwater run-off or accidental discharge of polluting liquids, such as sewage;
(iii) impacts of noise and dust on roosting, feeding or breeding animals.

9.2.15 The greatest potential impact will be on the intertidal mudflats within the tidal channels (WDCE and the cross channel), while the impacts in Inner Deep Bay and Deep Bay will be greatly reduced through dilution effects.

Short-term Impacts

9.2.16
- disturbance from building activities;
- sediment and stormwater run-off during site formation;
- erosion of sediment during storm run-off periods;
- water pollution through removal of contaminated mud.

Long-term Impacts

9.2.17
- loss of habitat;
- pollutant run-off from urban stormwater;
- water quality deterioration and changes in hydrology;
- operational noise, human disturbance.

Cumulative Impacts

9.2.18 The third type of potential impact is cumulative impacts of all developments occurring within Deep Bay and its watershed. The impacts of each separate project may be judged to be acceptable on an individual basis, but the cumulative effect of these small impacts might cause unacceptable changes to the ecological habitats of the area.

Existing Ecological Conditions and Potential Impacts

9.2.19 The habitats present in the Study Area are shown in Figures 9.3 and 9.4, and Table 9.4. The potential impacts on the ecological environment can be divided into impacts related to Site Formation and Infrastructure Works, and those related to Operation of the Tin Shui Wai Development. These impacts are summarised in Table 9.5.

9.2.20 The extent of each habitat in relation to the total in Hong Kong is shown in Table 9.6. The severity of Project impacts on each habitat will be discussed in terms of both the degree of influence from Project activities, and the value of the ecological resource.

Table 9.4 Ecological habitats and resources

Terrestrial Habitats	*Grassland with bare patches* landbank breeding and feeding birds mammals amphibians abandoned agricultural birds mammals amphibians insects *Freshwater wetlands* fishponds breeding and feeding birds insects fish reedbeds and marshes *Phragmites* beds breeding birds migrant and resident birds mammals insects fish ephemeral amphibians *Woodlands* native birds mammals plantation, including orchards birds mammals amphibians insects *Cultivated land* birds mammals amphibians insects
Estuarine-type Habitats	*Mudflat* benthic infuana epifauna foraging waterbirds *Mangrove* roosting, breeding and feeding birds fishery nursery mammals *Seabed* fishery

Table 9.5 Potential Impacts on Ecological Resources from Project Works

Period of Works		Potential Impacts	Ecological Resource potentially impacted	
			Direct impact	Indirect Impact
Site Formation including infilling of the Eastern Temporary Channel and Old Western River channel	Levelling of landbank for site formation	Increase in sedimentation	Mudflats - Benthic infauna - Benthic epifauna - mangroves	Mudflats - Waterbirds
		Loss of ecological habitat	Freshwater wetland in Old Western River/ETC - insects - fish	Freshwater wetland in Old Western River/ETC - birds - mammals
			Grassland - insects	Grassland - birds - mammals
		Noise and human disturbance and creation of dust	Birds and mammals utilising mudflats, freshwater and grassland habitat	
	Removal of mud from ETC	Increase in levels of pollutants from removal of contaminated mud	Freshwater wetland within ETC - benthic fauna - fish	Mudflats - Waterbirds
			Mudflats in receiving channels - Benthic infauna - Benthic epifauna	
		Noise and human disturbance	Birds and mammals utilising this area for feeding	
Infrastructure Works	General construction of temporary drainage system, permanent culverts, roads, sewage mains, utilities	Deterioration in water quality due to increased pH from concrete washings	Mudflats - benthic infauna - benthic epifauna - mangroves	Mudflats - waterbirds
		Noise and human disturbance	Mudflats - waterbirds	
			Birds and mammals on RZ	

Table 9.5 Potential Impacts on Ecological Resources from Project Works (cont'd)

Period of Works		Potential Impacts	Ecological Resource potentially impacted	
			Direct impact	Indirect Impact
	Construction of WDCE	Increase in sedimentation Loss of sediment habitat	Mudflats - benthic infauna - benthic epifauna - mangroves	Mudflats - waterbirds
	Construction of road bridges	Deterioration in water quality due to increased pH from concrete washings Physical disturbance of banks Noise and human disturbance	Mangroves Mudflats - waterbirds Birds and mammals on RZ	
Operation	Urban stormwater run-off	Contamination of water courses through increased heavy metals in run-off from roads and covered areas	Mudflats - benthic infauna - benthic epifauna	Mudflats - waterbirds
	Waste production	Contamination of water courses through run-off	Mudflats - benthic infauna - benthic epifauna	Mudflats - waterbirds
	Noise barriers	Increased obstacles	Residential and migrating birds and mammals	
	Residences	Noise and increased lighting	Residential and migrating birds and mammals	
	Human presence	Noise and human disturbance	Residential and migrating birds and mammals	
	Accidental spills Malfunction of sewage pumping station and discharge of untreated sewage	Contamination of receiving water bodies	Mudflats - benthic infauna - benthic epifauna	Mudflats - waterbirds
	Maintenance dredging of WDCE and EDC	Increase in sedimentation	Mudflats - benthic infauna - benthic epifauna - mangroves	Mudflats - waterbirds

Table 9.6 Areas of Habitat types on site as a percentage of total areas in Hong Kong

Major habitat	Approximate Area of habitat on site* (ha)	Area of habitat throughout Territory (ha) (Ashworth *et al* 1993)	% of HK total for habitat
Intertidal mudflats	15	2700*[4]	0.6
Mangroves	16	276	0.6
Fishpond*[1]	3	1,376*[3]	0.2
Freshwater wetland (marshes, reedbeds)	17.5^{+}	≥325	≤5.4
Grassland	135^{+}	57,000	0.2
Native woodland*[2]	5	8,630	0.0006
Government plantation	44	2,775	1.6

* "site" includes the fishponds within the land resumption area of Area 121 during building of road D3 (*[1]) and land which is affected by the road reserves south of the Development Zone (*[2]). *[3] Wilson, 1995. *[4] McChesney 1996 for Deep Bay.

\+ These areas were classified by Ashworth et al as high density urban area.

Terrestrial Habitat

9.2.21 Habitat mapping (Figures 9.3 and 9.4) revealed that the terrestrial portion of the Study Area can be subdivided into four main types: grasslands with bare patches, freshwater wetlands, woodlands, and cultivated land. (Table 9.4). Each type is further subdivided, and the ecological resources for each habitat have been identified during this Eco-IA. Seasonal variation was only recorded in terms of emergence and flowering. The survey maps presented show the details of the surveys in September/October when flowering and emergence was at its peak.

Grassland with Bare Patches

9.2.22 Habitat mapping has differentiated two subtypes of this habitat type: the landbank which is hydroseeded with a mixture of grasses and herbs, and abandoned agricultural fields that have become overgrown with grasses and herbs.

Landbank

9.2.23 The man-made platform areas of the RZ were hydroseeded following the original land formation. The bulk of the RZ is now covered in opportunistic grasses dominated by *Brachiaria* sp., and *Rhynchelytrum repens*, with clumps of *Neyraudia reynaudiana*, and herbs such as *Sesbania* sp. and *Conyza* sp. These are of little botanical interest or conservation value. Wetland areas with *Phragmites* and *Eichornia* are discussed in Section 9.2.55.

9.2.24 Although the grassland area is not a natural habitat, it has become an area for bird courtship, breeding, and feeding, with breeding success recorded for Oriental Skylark, Little-Ringed Plover and Savannah Nightjar. The habitat is also used by passage migrant Wagtails, Pipits and Warblers.

Breeding Birds

9.2.25 The presence of breeding birds on the RZ was reported in the Environmental Review Paper (BCL 1996). Since then the locations of nesting and courting areas of Oriental Skylark, Savannah Nightjar, and Little Ringed Plover have been confirmed with data from the Hong Kong Bird Watching Society, and other local experts. Two additional bird species likely to be breeding within the Study Area are the White Breasted Kingfisher on the RZ, and the Black-shouldered Kite within the Deep Bay mangroves. We do not consider that the Black-shouldered Kite breeds on site. The field observations providing evidence for these species breeding is presented next. Unpublished field data cited in the form of personal communications is considered highly reliable.

Oriental Skylark

9.2.26 Tin Shui Wai currently supports a resident population of Oriental Skylark (M. Leven, pers. comm). The species seems to require grassland, but in Hong Kong it is not found in upland grassland areas, and has been confined to breeding sites at Kai Tak airport (Viney and Phillips 1986) and currently at Tin Shui Wai (M. Leven, pers comm).

9.2.27 The areal extent of the grassland habitat on the RZ may be the essential element for the successful breeding of Oriental Skylark. Smaller areas of reclamation along the Tolo Highway between Sha Tin and Tai Po, for example, hold breeding Richard's Pipit populations but Oriental Skylark is absent (Leven pers. comm.). In Pakistan, breeding pairs hold territories of 2-3 ha in fields of lucerne (Roberts 1965). The height of the grass seems to be a factor determining breeding in Hong Kong (P. Leader pers. comm., G. Carey, pers. comm.). Grass needs to be long enough to provide cover, yet not too long to prevent adequate visibility from the nest to permit early detection of the approach of predators, or inhibit the ability to run quickly between tussocks to capture insects, and to pick up fallen seeds (Roberts 1965).

9.2.28 Birds are likely to be discouraged from occupying suitable habitat at Chek Lap Kok because of the need to reduce birdstrike hazard, and therefore displaced Oriental Skylark individuals are unlikely to move there. The species may occupy other suitable reclamation sites in the region, which tend to lie unoccupied for a period of time after formation, with low disturbance and potential for ground-breeding birds. The advent of these sites is inherently unpredictable, and their duration unsustainable.

Savannah Nightjar

9.2.29 Breeding was recorded at TSW on Area 118 in April 1996, where chicks were ringed (M. Leven, pers. comm.). Several other areas, including frequently disturbed grasslands, were known as probable breeding locations in Hong Kong prior to the TSW location. Breeding probably occurred at Mong Tseng adjacent to the RZ, at Mai Po, Lok Ma Chau, Kai Tak, the Sai Kung Peninsula, at Chau Tau (where fires are frequent), and at the Shek Kong airstrip (Chalmers 1986) prior to the construction of the Vietnamese camp, where the grassland adjacent to the runway was frequently mowed.

9.2.30 Savannah Nightjar is recorded year round in Hong Kong (Chalmers 1986, Leven pers. comm.), and is reported to display in several areas of the New Territories (Melville pers. comm.). Birds breeding further north may pass through on migration, temporarily increasing numbers. This species is an urban bird in Jakarta where it breeds on rooftops in the city, but it is not known to occupy similar habitat in Hong Kong.

9.2.31 At least four individual Savannah Nightjars were recorded flying and probably feeding on aerial insects around the Old Western River during a night survey of the RZ during the current Eco-IA.

Little Ringed Plover

9.2.32 In Hong Kong, Little Ringed Plover (*Charadrius dubius*) have bred on reclaimed land in the northeast and west New Territories (Chalmers 1986, Leven and Carey 1993, Hong Kong Bird Watching Society Data unpublished), and appear very tolerant of human disturbance, successful breeding having been recorded adjacent to operating heavy equipment (Leven pers. comm.). The breeding behaviour of Little Ringed Plover on reclamation sites makes the species widely regarded as a pioneering species (e.g. Spaans 1994, Cramp and Simmons 1977). Favourable habitat conditions for successful breeding include natural gravel islands (Enderlein, 1994), and bare or scarcely vegetated newly constructed islands (Spaans, 1994).

<u>Other Bird Species Breeding, or Likely to be Breeding, on site</u>

9.2.33 Horizontal burrows recorded in sand stockpiles on the RZ are suitable breeding habitat for the White-breasted Kingfisher (Viney *et al.* 1994). Swallow and Chinese Starling were recorded breeding on or immediately adjacent to the RZ in 1993. (HKBWS Breeding Bird Survey unpublished data).

9.2.34 Black-shouldered Kite (*Elanus caeruleus*) have been seen in the Study Area in every month of the year and probably breed in the Deep Bay mangrove (M. Chalmers pers. comm.). These birds probably feed on the RZ, where small diameter burrows are abundant, probably utilised by rodents and shrews. Birds of the same genus (*Elanus*) in Australia are specialised rodent hunters (Baker-Gabb 1989), and Black-shouldered Kites in Hong Kong have twice been observed capturing rats in agricultural-grassland habitats at Long Valley (P.J. Leader, in prep.).

Bird Species Protected under Bilateral PRC Treaties

9.2.35 29 species of birds protected under bilateral migratory bird agreements between the PRC and either Japan or Australia have been recorded on the RZ both including this Eco-IA, and from birdwatchers' reports (Table 9.7a and b).

9.2.36 Chestnut-eared Bunting has been seen on the TSW reclamation (M. Leven pers. comm.). Previous reports have listed dried rice paddy as winter habitat for this species, and now the RZ provides a substitute habitat.

Resident and Migratory Birds

9.2.37 Pipits, wagtails, buntings and warblers increase substantially during migration, and many spend winter in Hong Kong (Chalmers 1986). Birds recorded during terrestrial surveys on the RZ for the Eco-IA are listed in Table 9.8.

Mammals

9.2.38 Mammal surveys carried out showed the presence of Javan Mongoose, bats, rodents and shrews on the RZ. Javan Mongooses now use the hydroseeded landbank portion of the RZ as part of their range.

9.2.39 Burrows of rodents and shrews, as well as shrew scat and unconfirmed civet cat droppings have also been recorded on the hydroseeded landbank portion of the RZ, indicating the use of this area by these mammals for feeding and breeding. During the Eco-IA, small bats (pipistrellids) were recorded flying and presumably feeding over the landbank, both above the Old Western River and several hundred meters from wetland areas.

Amphibians

9.2.40 More than six individuals of *Bufo melanostictus* (Common Toad) were recorded during night-time surveys on the RZ in September. In addition, single individuals or a few individuals of 4 other species Marbled Pigmy Frog (*Microhyala pulchra*), Brown Tree Frog (*Polyedates leucomystax*), Gunther's Frog (*Rana guentheri*) and Paddy Frog (*R. limnocharis*) were recorded in rain puddles on the RZ. This will be discussed in Section 9.2.83 on freshwater wetlands.

Impacts from the Project

9.2.41 An area of approximately 200 ha of sparse grassland will be lost as a direct result of site formation works. During this period, increased dust and noise due to operating machinery, the presence of site workers, residents and visitors, and accidental and deliberate fires occurring in the grassland will impact wildlife on the RZ.

9.2.42 Breeding birds, such as the Oriental Skylark, Little-Ringed Plover and Savannah Nightjar, will be deterred in the area with the onset of construction activities. The length of time for which they remain in the area will depend on the degree to which they can adapt to human disturbance and the availability of alternative habitats for recolonisation.

Table 9.7a
Occurrence in the Study Area of Waterbird and Raptor Species Protected under Bilateral Migratory Bird Agreements

Common name	Scientific name		Recorded on-site	Recorded off-site
Black-necked Grebe	*Podiceps nigricollis*	J		3
Great Crested Grebe	*Podiceps cristatus*	AJ		3
Lesser Frigatebird	*Fregata ariel*	AJ		
Bittern	*Botaurus stellaris*	J		
Cattle Egret	*Bubulcus ibis*	J		1
Reef Egret	*Egretta sacra*	AJ		
Great Egret	*Egretta alba*	AJ		2
Yellow Bittern	*Ixobrychus sinensis*	AJ	1	
Schrenck's Bittern	*Ixobrychus eurhythmus*	J		
Little Green Heron	*Butorides striatus*	J	1	
Intermediate Egret	*Egretta intermedia*	J		1
Night Heron	*Nycticorax nycticorax*	J	1	
Purple Heron	*Ardea purpurea*	J	1	
Black Stork	*Ciconia nigra*	J		
Glossy Ibis	*Plegadis falcinellus*	A		
White Spoonbill	*Platalea leucorodia*	J		
Black-faced Spoonbill	*Platalea minor*	J		1,3
Ruddy Shelduck	*Tadorna ferruginea*	J		
Shelduck	*Tadorna tadorna*	J		1
Pintail	*Anas acuta*	J		1
Teal	*Anas acrecca*	J	1	
Baikal Teal	*Anas formosa*	J		3
Falcated Teal	*Anas falcata*	J		1
Mallard	*Anas platyrhychos*	J		
Gadwall	*Anas strepera*	J		
Wigeon	*Anas penelope*	J	1	
Garganey	*Anas querquedula*	AJ		1
Shoveler	*Anas clypeata*	J		1
Common Pochard	*Aythya ferina*	J		3
Baer's Pochard	*Aythya baeri*	J		
Tufted Duck	*Aythya fuligula*	J		3
Scaup	*Aythya marila*	J		3
Red-breasted Merganser	*Mergus serrator*	J		3
White-bellied Sea-eagle	*Haliaeetus leucogaster*	A		
Marsh Harrier	*Circus japonica*	J		1
Hobby	*Falco subbuteo*	J	1	
Watercock	*Gallicrex cinerea*	J		3
Moorhen	*Gallinula chloropus*	J	1	
Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	A		
Painted Snipe	*Rostratula benghalensis*	AJ		
Little Ringed Plover	*Charadrius dubius*	A	1	
Ringed Plover	*Charadrius hiaticula*	A		
Lesser Sand Plover	*Charadrius mongolus*	AJ		1
Greater Sand Plover	*Charadrius leschenaultii*	AJ		1
Oriental Plover	*Charadrius veredus*	A		
Lapwing	*Vanellus vanellus*	J		
Grey Plover	*Pluvialis squatarola*	A		1
Pacific Golden Plover	*Pluvialis fulva*	AJ		1
Little Whimbrel	*Numenius (borealis) minutus*	A		3
Whimbrel	*Numenius phaeopus*	J		1
Curlew	*Numenius arquata*	AJ		1

Table 9.7a
Occurrence in the Study Area of Waterbird and Raptor Species Protected under Bilateral Migratory Bird Agreements (cont'd)

Common name	Scientific name		Recorded on-site	Recorded off-site
Australian Curlew	*Numenius madagascariensis*	AJ		1
Black-tailed Godwit	*Limosa limosa*	AJ		1
Bar-tailed Godwit	*Limosa lapponica*	AJ		1
Spotted Redshank	*Tringa erythropus*	J		1
Redshank	*Tringa totanus*	AJ	1	
Marsh Sandpiper	*Tringa stagnatilis*	AJ	1	
Greenshank	*Tringa nebularia*	AJ	1	
Green Sandpiper	*Tringa ochropus*	J	1	
Wood Sandpiper	*Tringa glareola*	AJ	1	
Nordmann's Greenshank	*Tringa guttifer*	J		3
Common Sandpiper	*Tringa hypoleucos*	AJ	1	
Grey-rumped Sandpiper	*Tringa brevipes*	AJ		
Terek Sandpiper	*Xenus cinereus*	AJ		1
Turnstone	*Arenaria interpres*	AJ		1
Swinhoe's Snipe	*Gallinago megala*	AJ		
Pintail Snipe	*Gallinago stenura*	A		
Common Snipe	*Gallinago gallinago*	J	1	
Woodcock	*Scolopax rusticola*	J		
Asiatic Dowitcher	*Limnodromus semipalmatus*	A		1
Red Knot	*Calidris canutus*	AJ		1
Great Knot	*Calidris tenuirostris*	AJ		1
Red-necked Stint	*Calidris ruficollis*	AJ		1
Long-toed Stint	*Calidris subminuta*	AJ		
Temminck's Stint	*Calidris temminckii*	J		1
Sharp-tailed Sandpiper	*Calidris acuminata*	AJ		1
Dunlin	*Calidris alpina*	AJ		1
Curlew Sandpiper	*Calidris ferruginea*	AJ		1
Sanderling	*Calidris alba*	AJ		1
Spoon-billed Sandpiper	*Eurynorynchus pygmaeus*	J		3
Broad-billed Sandpiper	*Limicola falcinellus*	AJ		1
Ruff	*Philomachus pugnax*	AJ		1
Black-winged Stilt	*Himantopus himantopus*	J		1
Avocet	*Recurvirostra avosetta*	J		1
Red-necked Phalarope	*Phalaropus lobatus*	AJ		3
Grey Phalarope	*Phalaropus fulicarius*	AJ		
Oriental Pratincole	*Glareola maldivarum*	AJ		
Common Gull	*Larus canus*	J		
Herring Gull	*Larus argentatus*	J		1
Slaty-backed Gull	*Larus schistisagus*	J		
Black-headed Gull	*Larus ridibundus*	J		3
Black-legged Kittiwake	*Rissa tridactyla*	J		
Common Tern	*Sterna hirundo*	AJ		
Little Tern	*Sterna albifrons*	AJ		
Ancient Auk	*Synthliboramphus antiquus*	J		

Birds occurring in the Deep Bay area protected under bilateral migratory bird agreements between China and Australia/Japan (from Peking University 1995)

Key:
1 - Species recorded during this Eco-IA.
2 - Species recorded during HKBWS mid-winter waterfowl counts 1995-96.
3 - Undocumented reports to HKBWS bird hotline.

Table 9.7b
Occurrence of Terrestrial Bird Species Protected under Bilateral Migratory Bird Agreements

Common name	Scientific name		Recorded on-site	Recorded off-site
Japanese Quail	*Coturnix coturnix*	J	1	
Oriental Cuckoo	*Cuculus saturatus*	AJ		
Short-eared Owl	*Asio flammeus*	J		
White-throated Needletail	*Hirundapus caudacutus*	AJ		3
Pacific Swift	*Apus pacificus*	AJ	1	1
Little Swift	*Apus affinis*	J		
Sand Martin	*Riparia riparia*	J		
Barn Swallow	*Hirundo rustica*	AJ	1	1
Red-rumped Swallow	*Hirundo daurica*	AJ		1
Asian House Martin	*Delichon dasypus*	J		3
Forest Wagtail	*Dendronanthus indicus*	J		3
Yellow Wagtail	*Motacilla flava*	AJ		
Citrine Wagtail	*Motacilla citreola*	AJ	3	3
White Wagtail	*Motacilla alba*	AJ	1	1
Richard's Pipit	*Anthus richardi*	J	1	1
Olive-backed Pipit	*Anthus hodgsoni*	J		1
Pechora Pipit	*Anthus gustavia*	J		3
Red-throated Pipit	*Anthus cervinus*	J	1	1
Water Pipit	*Anthus spinoletta*	J		
Ashy Minivet	*Pericrocotus divaricatus*	J		
Tiger Shrike	*Lanius tigrinus*	J		
Brown Shrike	*Lanius cristatus*	J		
Black-naped Oriole	*Oriolus chinensis*	J		1
Chestnut-cheeked Starling	*Sturnus philippensis*	J		3
Red-tailed Robin	*Luscinia sibilans*	J		
Siberian Rubythroat	*Luscinia calliope*	J		
Siberian Blue Robin	*Luscinia cyane*	J		
Red-flanked Bluetail	*Tarsiger cyanurus*	J	1	
Daurian Redstart	*Phoenicurus auroreus*	J		
Stonechat	*Saxiocola torquata*	J	1	
Siberian Thrush	*Zoothera sibiricus*	J		
White's Thrush	*Zoothera dauma*	J		
Grey-backed Thrush	*Turdus hortulorum*	J		
Grey Thrush	*Turdus cardis*	J		
Pale Thrush	*Turdus pallidus*	J		
Eye-browed Thrush	*Turdus obscurus*	J		
Dusky Thrush	*Turdus naumanni*	J		
Short-tailed Bush Warbler	*Urosphena squameiceps*	J		
Middendorf's Grasshopper Warbler	*Locustella ochotensis*	J		3
Lanceolated Warbler	*Locustella lanceolata*	J	1	
Great Reed Warbler	*Acrocephalus orientalis*	AJ	1	1
Black-browed Reed Warbler	*Acrocephalus bistrigiceps*	J		

Table 9.7b
Occurrence of Terrestrial Bird Species Protected under Bilateral Migratory Bird Agreements (cont'd)

Common name	Scientific name		Recorded on-site	Recorded off-site
Yellow-browed Warbler	*Phylloscopus inornatus*	J		
Arctic Warbler	*Phylloscopus borealis*	AJ	1	
Pale-legged Leaf Warbler	*Phylloscopus tenellipes*	J		
Eastern Crowned Warbler	*Phylloscopus coronatus*	J		
Yellow-rumped Flycatcher	*Ficedula zanthopygia*	J		
Narcissus Flycatcher	*Ficedula narcissina*	J		
Mugimaki Flycatcher	*Ficedula mugimaki*	J		
Blue-and-White Flycatcher	*Cyanoptila cyanomelana*	J		
Sooty Flycatcher	*Muscicapa sibirica*	J		
Grey-streaked Flycatcher	*Muscicapa griseisticta*	J		3
Brown Flycatcher	*Muscicapa latirostris*	J		3
Japanese Paradise Flycatcher	*Terpsiphone atrocaudata*	J		
Ruddy Sparrow	*Passer rutilans*	J		
Brambling	*Fringilla montifringilla*	J		
Siskin	*Carduelis spinus*	J		
Black-tailed Hawfinch	*Eophona migratoria*	J		
Yellow-breasted Bunting	*Emberiza aureola*	J		
Black-faced Bunting	*Emberiza spodocephala*	J		
Japanese Yellow Bunting	*Emberiza sulphurata*	J		3
Chestnut-eared Bunting	*Emberiza fucata*	J	1	
Rustic Bunting	*Emberiza rustica*	J		
Little Bunting	*Emberiza pusilla*	J		
Tristram's Bunting	*Emberiza tristrami*	J		
Pallas's Reed Bunting	*Emberiza pallasi*	J		3
Reed Bunting	*Emberiza schoeniclus*	J		3

Birds occurring in the Deep Bay area protected under bilateral migratory bird agreements between China and Australia/Japan (from Peking University 1995)

Key:
1 - Species recorded during this Eco-IA.
2 - Species recorded during HKBWS mid-winter waterfowl counts 1995-96.
3 - Undocumented reports to HKBWS bird hotline.

Table 9.8
Birds Observed at Tin Shui Wai Reserve Zone

English Name	Scientific Name
Cormorant	*Phalacrocorax carbo (sinensis)*
Grey Heron	*Ardea cinerea*
Great Egret	*Egretta alba*
Reef Egret	*Egretta sacra*
Little Egret	*E. garzetta*
Chinese Pond Heron	*Ardeola bacchus*
Black-crowned Night Heron	*Nycticorax nycticorax*
Chinese Little Bittern	*Ixobrychus sinensis*
White-breasted Waterhen	*Amaurornis phoenicurus*
Curlew	*Numenius arquata*
Avocet	*Recurvirostra avosetta*
Little-ringed Plover	*Charadrius dubius (curonicus)*
Common Snipe	*Gallinago gallinago*
Common Redshank	*Tringa totanus*
Common Greenshank	*Tringa nebularia*
Green Sandpiper	*Tringa ochropus*
Common Sandpiper	*Actitis hypoleucos*
Wigeon	*Anas penelope*
Green-winged Teal	*Anas crecca*
Northern Pintail	*Anas acuta*
Spotbill Duck	*Anas poecilorhyncha*
Northern Shoveler	*Anas clypeata*
Common Shelduck	*Tadoma tadoma*
Coot	*Fulicra atra*
Moorhen	*Gallinula chloropus*
Little Grebe	*Tachybaptus ruficollis (poggei)*
Rufous Turtle-dove	*Streptopelia tranquebarica*
Spotted Dove	*S. chinensis*
Greater Coucal	*Centropus sinensis*
Lesser Coucal	*C. bengalensis*
Savanna Nightjar	*Caprimulgus affinis*
White-breasted Kingfisher	*Halcyon smyrnensis*
Common Kingfisher	*Alcedo atthis*
Barn Swallow	*Hirundo rustica (gutturalis)*
House Swift	*Apus nipalensis*
Pipit & Wagtail sp.	*Motacillidae*
Pipit	*Anthus sp.*
Richard's Pipit	*Anthus richardi*
Grey Wagtail	*Motacilla cinerea*
White Wagtail	*M. alba*
Koel	*Eudynamis scolopacea*
Oriental Skylark	*Alauda gugula (coelivox)*
Tree Sparrow	*Passer montanus (saturatus)*

Table 9.8
Birds Observed at Tin Shui Wai Reserve Zone (cont'd)

English Name	Scientific Name
Black-faced Laughing Thrush	*Garrulax perspicillatus*
Crested Bulbul	*Pycnonotus jocosus*
Red-vented Bulbul	*Pycnontus aurigasta*
Chinese Bulbul	*Pycnonotus sinensis*
Chat & Thrushes	*Turdidae*
Siberian Stonechat	*Saxicola maura (stejnegeri)*
Plain Prinia	*Prinia inornata (extensicauda)*
Yellow-bellied Prinia	*P. flaviventris*
Old World Warbler	*Sylviidae*
Oriental Reed Warbler	*Acrocephalus orientalis*
Fantail Warbler	*Cisticola juncidis (tinnabulans)*
Chinese Bush Warbler	*Cettia canturians*
Dusky Warbler	*Phylloscopus fuscatus*
Masked Bunting	*Emberiza spodocephala*
Rufous-backed Shrike	*L. schach*
Drongo	*Dicrurus sp.*
Black Drongo	*Dicrurus macroercus*
Hair-crested Drongo	*D. hottentottus*
Starling	*Sturnidae*
Black-necked Starling	*Sturnus nigricollis*
Crested Myna	*Acridotheres cristatellus*
Magpie	*Pica pica*
Magpie Robin	*Cosychus saularis*
Jungle Crow	*Corvus macrorhynchus*
Collared Crow	*Corvus torquatus*
Eurasian Hoopoe	*Upupa epops*
Black-winged Cuckoo-shrike	*Coracina melaschistos*
Quails	*Phasianidae*
Japanese Quail	*Coturnix japonica*
Kestrel	*Falco tinnunculus*
Peregerine Falcon	*Falco peregrinus*
Hobby	*Falco subbuteo*
Marsh Harrier	*Circus spilonotus*
Japanese Sparrowhawk	*Accipter gularis*
Black-eared Kite	*Milvus lineatus*

9.2.43 Successful relocation of the bird populations currently utilising the RZ requires similar, available habitat elsewhere, preferably close to the Tin Shui Wai area. Absence of alternate habitat may lead to the loss of this population of breeding bird species. However, loss of this population will not lead to loss of these species. They are not endangered.

9.2.44 Holes suitable for Kingfisher nests have been observed in the stockpiles on the RZ grassland. Relocation of the stockpiles will destroy these burrows. The species is not threatened and alternate habitats in the Territory are more likely to be available than large grassland tracts.

9.2.45 The loss of grassland habitat on the landbank of the RZ may reduce feeding opportunities for Black-shouldered Kites, which could affect their ability to breed successfully in the adjacent Ramsar site.

9.2.46 Migratory birds including raptors and insectivorous warblers will be affected through the reduction of the large open area.

9.2.47 Mammals will be subject to disturbance from increased noise and human activities on the RZ which will deter them from feeding in this area, thereby limiting the extent of their feeding and sheltering habitat. Site formation works will result in the direct loss of their habitat, food source and shelter.

9.2.48 Amphibians will be affected in a similar way, although these species use the ephemeral wetlands on the grasslands opportunistically, and are expected to find alternate habitat in the surrounding area.

9.2.49 The insect community is also an essential part of the ecological foodweb in the terrestrial sphere and changes in the population have ensuing effects on the bird population which feeds on them. Disturbance from human activities and construction works will have minimal impact on the insect population.

9.2.50 The importance of the loss of this area of grassland on the RZ must be evaluated with reference to the ecological value of the area. The following factors will be taken into account in the assessment of the ecological value of this habitat (section 9.3).

- this grassland does not support any rare or endangered species;
- it is not a habitat under general threat in Hong Kong;
- it is man-made and most species which inhabit the area are opportunistic species which have moved in since the construction of the landbank;
- the breeding bird species have been observed breeding or are considered likely to breed in other parts of the Territory, even in areas of relatively high disturbance.

9.2.51 Grassland habitat, although not under threat in Hong Kong, will be under increasing pressure from the cumulative impacts from other projects, with the result that this habitat will decrease in total area.

Table 9.9 Summary of impacts on grassland habitats on site

Habitat	Ecological resources	Major potential impacts of the Project
Grassland	breeding birds migratory birds insects mammals	Loss of habitat under site formation, leading to: - loss of breeding and feeding sites for birds - loss of insect production - increased disturbance from noise and human activity, deterring mammals, amphibians and birds - cumulative impact from other projects, increasing value of this ecological habitat elsewhere in Hong Kong

Abandoned Agricultural Habitat

9.2.52 Abandoned agricultural fields are present in the upland areas to the west of the site. The presence of a damp, compacted soil layer slows down the process of tree succession and leads to a vegetation rich in a variety of grasses and herbs. This supports a diverse fauna including several species of odonata (Dudgeon and Corlett 1994).

9.2.53 There are no direct impacts from the Project works on this habitat. Indirect impacts include noise, human disturbance and dust, which potentially affect birds and mammals using the habitat for feeding and breeding. The distance from the site suggests that these impacts are very minor compared with those on the RZ.

Freshwater Wetlands

9.2.54 Freshwater habitats in the Study Area comprise fishponds, marshy areas and ephemeral wetlands. Existing freshwater wetland habitat on the RZ site includes the Old Western River, the ETC (a 7.8 ha area of impounded water), abandoned fishponds/freshwater marsh in Areas 122 (2.2 ha) and 118 (1.4 ha), and the WTC. The Old Western River (6.1 ha of freshwater reedbed) is of high ecological value, as evidenced by the presence of *Rhodothemis rufa*, a dragonfly indicator species of excellent wetland quality collected during field work by K. Wilson, AFD.

9.2.55 The fishponds found on site in Areas 118 and 122 are presently unused. However, a range of wildlife utilises the ponds for feeding and breeding. For example, abandoned fish ponds have been reported in the literature to provide good numbers of the common asian dragonfly species. Permanent freshwater ponds or lakes are stated to be in very short supply in Hong Kong (Wilson 1996). The ETC comprises a 7.8 ha area of impounded water which drains a large area around the site, including discharges from several industries. Despite the build up of contaminants in the sediment over time, the channel supports feeding and breeding birds which inhabit the RZ. Water hyacinth dominates the vegetation, thriving in organically contaminated environments. Three fishponds need to be resumed between Areas 121 and 122 to allow construction of road D3. However, in late 1996 these ponds have been filled by others.

9.2.56 The following plant species were particularly noted during the field surveys of the freshwater wetland habitats (marshes, reedbeds, fishponds) on the RZ.

grass and reeds:
Reedgrass *Phragmites* sp.
Brachiatia mutica
Pennisetum purpureum
Mikania micrantha
Water Hyacinth *Eichhornia crassipes*
Cyclosorus interruptus
Scirpus subulatus
Cyperus polystachyos
Fimbristylis ferruginea

9.2.57 The submerged roots of water hyacinth in Hong Kong have been shown to provide habitat for over 90 species of gastropod, dragonfly and damselfly larvae, heteroptean bugs, beetles, etc (Dudgeon and Corlett 1994).

9.2.58 Ephemeral wetlands are shallow depressions and tyre ruts that fill up with rainwater. Similar habitats are called vernal wetlands in other places (Schilling 1996). These areas are particularly valuable for breeding amphibians because they lack resident fish.

Amphibians

9.2.59 The individuals and species of amphibians were recorded mainly during the night surveys in the ephemeral wetlands of the RZ (Table 9.10).

Table 9.10
Amphibians Recorded on the Reserve Zone

Asiatic Common Toad	*Bufo melanostictus*
Marbled Pygmy Frog	*Microhyala pulchra*
Brown Tree Frog	*Polypedates leucomystax*
Gunther's Frog	*Rana guentheri*
Paddy Frog	*R. limnocharis*

Fish

9.2.60 A gill netting survey for fish in the Reserve Zone was conducted in April 1996. One net was placed across the Western Temporary Channel (WTC) mouth just upstream of the security bund bridge, and another net was drawn through the ETC. The survey yielded four talapia from the ETC and no fish from the WTC. In addition, an individual snakehead *Ophiocephalus maculatus* was seen being taken by anglers from the abandoned fishponds in Area 122.

9.2.61 During other field surveys on the RZ, fishermen were seen hand-cast netting in the ETC. Their catch included:

Snakehead	*Ophiocephalus maculatus*
Grass-carp	*Carassius auratusgibetio*
Catfish	*Clarias fuscus*

9.2.62 A dead snakehead was found beside the old Western River. The water body(ies) of the old Western River are very difficult to access.

Endangered and Breeding Birds

9.2.63 Fishponds also provide feeding habitat for egrets and herons which breed and feed in the region. Banded Rail and White-breasted Waterhen have bred in fishpond habitat adjacent to the RZ (Hong Kong Bird Watching Society unpublished data). Coots, rails, and grebes have bred in fishpond habitat as well (Bhushan *et al.* 1993), and the fringes of the ETC were judged as suitable breeding sites for these species during field work for this Eco-IA (K. Wilson pers. comm.). No evidence for breeding pairs of these species using this habitat was recorded during the Eco-IA.

9.2.64 Savannah Nightjar, which breeds on the RZ, have been seen flying above the Old Western River channel, probably feeding on insects.

9.2.65 Purple Heron (*Ardea purpurea*) were present during field surveys, and have been regularly sighted near the reedbeds along the Old Western River on the RZ (K. Wilson, pers. comm.). During the Eco-IA, three Purple Herons, including one juvenile, were flushed from this site in October, and may have bred there, although birds passing through Hong Kong on migration could also account for the presence of this group of individuals.

9.2.66 Prinia spp. are known to breed in reedbed habitat and on grasslands throughout the Territory.

Migrant and Resident Birds

9.2.67 In winter, Cormorants roost and loaf on fishponds and feed on small individuals of fish, although Deep Bay is probably their main feeding ground (Walthew 1995).

9.2.68 Styan's Grasshopper Warblers have been recorded in reedbed and mangrove habitat in the Study Area, and on the RZ (Hong Kong Bird Watching Society bird-watcher's hotline). Deep Bay is the only location where this species has been recorded in winter in Deep Bay (D.S. Melville, pers. comm.), although it almost certainly winters elsewhere as well.

9.2.69 Large numbers of migrant warblers have been recorded in reedbeds along the Old Western River during bird traverses for the current Eco-IA in the spring and fall migratory seasons.

9.2.70 A list of all the birds recorded during the field surveys of the Eco-IA apparently utilizing the freshwater wetland habitats of the RZ follows:

Little Grebe *Tachybaptus ruficollis*
Cormorant *Phalacrocorax carbo*
Grey Heron *Ardea cinerea*
Purple Heron *Ardea purpurea*
Great Egret *Casmerodius albus*
Little Egret *Egretta garzetta*
Chinese Pond Heron *Ardea bacchus*
Black-crowned Night Heron *Butorides striatus*
Wigeon *Anas penelope*
Green-winged *Teal Anas*
Yellow-nib Duck *Anas poecilorhyncha*
Northern Shoveler *Anas cylpeta*
Northern Pintail *Anas acuta*
Black-eared Kite *Milvus lineatus*
Marsh Harrier *Circus spilonotus*
Rail sp. Rallidae
White-breasted Waterhen *Amaurornis phoenicurus*
Coot *Fulica atra*
Common Snipe *Gallinago gallinago*
Common Sandpiper *Actitis hypoleucos*
Green Sandpiper *Tringa ochropus*
Rufous Turtle-dove *Streptopelia chinensis*
Spotted Dove *Streptopelia orientalis*
Greater Coucal *Centropus sinensis*
Koel *Eudynamis scolopacea*
White-breasted Kingfisher *Halcyon smymensis*
Common Kingfisher *Alcedo atthis*
Barn Swallow *Hirundo rustica*
House Swift *Apus nipalensis*
Tree Sparrow *Passer montanus*
Grey Wagtail *Motacilla cinerea*
White Wagtail *Motacilla alba*
Black-faced Laughing Thrush *Garrualx perspicillatus*
Crested Bulbul *Pycnonotus jocosus*
Chinese Bulbul *Pycnonotus sinensis*
Red-vented Bulbul *Pycnonotus aurigaster*
Magpie Robin *Copsychus saularis*
Fantail Warbler *Cisticola juncidis*
Plain Prinia *Prinia inornata*
Yellow-bellied Prinia *Prinia flaviventris*
Oriental Reed Warbler *Acrocephalus orientalis*
Dusky Warbler *Phylloscopus fuscatus*
Rufous-backed Shrike *Lanius schach*
Black Drongo *Dicrurus macrocercus*
Hair-crested Drongo *Dicrurus hottentotus*
Magpie *Pica pica*

Jungle Crow *Corvus macrorhynchus*
Collared Crow *Corvus torquatus*
Black-necked Starling *Sturnus nigricollis*
Crested Myna *Acridotheres cristatellus*
Masked Bunting *Emberiza spodocephala*

Mammals

9.2.71 In September, bats (pipistrellids) were observed flying over and presumably feeding on insects above the Old Western River channel. The roost site location for these individuals is unknown.

9.2.72 The Javan Mongoose *Herpestes javanicus* was trapped near the old Western River during the EIA field studies. Otter spraint has been recorded within reedbeds as well as mangroves at Mai Po Marshes Nature Reserve (L. Young, 1994). However, evidence of the presence of otters was not recorded at TSW during the field studies.

Insects and other Invertebrates

9.2.73 During the Eco-IA, K. Wilson provided expert advice and identification of odonates. He identified 15 species of dragonfly and damselfly from the RZ (Table 9.11). Four of these are typical fishpond species (K. Wilson, pers. comm.).

9.2.74 Two endangered species of Odonate (dragonflies and damselflies)(Groombridge 1993) *Mortonagrion hirosei* and *Orthretum poecilops* are present in Hong Kong. They are endangered because their ranges are limited by fragmentation and declining habitat. *M. hirosei* was the 12th most common aerial insect collected in malaise traps in reedbeds at Mai Po Marshes Nature Reserve (Reels 1994) and is confined to dense stands of *Phragmites* reed beds. *O. poecilops* is present at Nam Chung in Hong Kong where a fresh water stream discharges into a mangrove (Wilson 1995). Very similar habitat occurs in the RZ where the ETC discharges fresh water into a mangrove.

9.2.75 Neither species was observed during an afternoon survey of the ETC and the Old Western River with Keith Wilson in September 1996. However, the occurrence of a teneral male *Rhodothemis rufa* along the Old Western River channel indicated the high quality of the reedbed there, and *Mortonagrion hirosei* is expected to occur there (K. Wilson, pers. comm.). The absence of *O. poecilops* on the RZ during the Eco-IA surveys may be explained by the fact that the discharge of fresh water from the ETC into the mangrove zone passes into standing water, while the habitat supporting *O. poecilops* at Nam Chung is characterised by a freshwater stream flowing through the mangrove exposed at low tide but inundated at high tide.

9.2.76 The ETC was completely choked with water hyacinth (*Eichornia crassipes*) in September 1996. Samples of roots of plants near the edge yielded gastropods, flat worms, and two families of polychaetes (nereids and cirratulids). Fishponds can be very productive for Chironomid midges. Chironomid midges have been the most abundant flying insect trapped at Mai Po (Reels 1994).

Table 9.11 Odonates observed on RZ in September 1996

Area within site	Species found on site
Within and adjacent to ETC:	*Agriocnemis pygmaea* *A. femina* *Ceriagrion auranticum ryukyuanum* *Ischnura senegalensis* *Pantala flavescens* *Neurothemis tullia* (paddy field indicator species) *Zyxomma petiolatum* (pollution tolerant)
Freshwater marshy area in area 118:	*Pantala flavescens* *Brachydiplax chalybea flavovittat* (fishpond species) *Orthetrum sabina* (fishpond species) *Brachythemis contaminata* (pollution tolerant)
Old West River Channel:	*Pantala flavescens* *Diplacodes trivialis* *Acisoma panorpoides* *Crocothemis servilia* (fishpond species) *Rhodothemis rufa* (indicator of good wetland quality) *Anax guttalus* (fishpond species)

Impacts of the Project

9.2.77 As much as five percent of the area of freshwater wetland in Hong Kong (Ashworth *et al.* 1993) will be lost during site formation (Table 9.6). The freshwater habitats on site are subdivided into fishponds and impound-water wetlands, and reedbeds.

9.2.78 75% of impounded water in the ETC will be lost during site formation. This will result in a loss of feeding and potential breeding habitat for birds. During the development of Tin Shui Wai RZ, the area of fishpond loss is small. Five more fishponds are vulnerable to filling due to the provision of infrastructure. The cumulative impact from several projects in the region is increasing the significance of loss of this type of habitat (Peking University 1995).

9.2.79 Fishponds provide feeding habitat for migratory Black-faced Spoonbills and reed warblers in the form of benthic invertebrates, fish, or crustaceans. Twenty-five to 33% of the world's population of the critically endangered Black-faced Spoonbill winter in the Deep Bay area and have been seen feeding in drained fishponds (Peking University 1995). There is no evidence from this Eco-IA that Black-faced Spoonbills regularly use or depend on the fishponds or impounded water on site. Resident herons and egrets also use fishpond habitat for feeding.

9.2.80 The loss of the Old Western River reedbed during site formation represents a loss of as much as 16% of the reedbeds in the Territory (Young 1995). The quality of the Old Western River reedbeds is high, as indicated by the presence of the high-wetland quality indicator odonate *Rhodothemis rufa*. The likely loss of the abandoned fishpond marshes in Area 122 during the provision of infrastructure for the Project means that all the freshwater marsh area remaining on the RZ will be lost as a result of this Project.

9.2.81 As the Territory probably hosts the largest stands of reedbeds in the region (Peking University 1995 citing Gao Yu Ren *in litt.* to L. Young), the loss of as much as 16% of these reedbeds is a significant impact. These reedbeds are high quality wetland and probably host the endangered odonate *Mortonagrion hirosei* (K. Wilson, personal communication).

9.2.82 These reedbeds and mangroves in Deep Bay are the only known area for wintering of Styan's grasshopper Warbler (*Locustella pleski*), although this species almost certainly winters elsewhere, the locations as yet unknown.

9.2.83 Otters, which are protected, have been seen within the Study Area and are known to be adversely affected by increased human disturbance. Deterioration in water quality, particularly an increase in inorganic pollutants, as a result of site activities, would have a potential impact on their survival.

9.2.84 Large mammal burrows have been found on marshy sections of the RZ but none have been sighted within the areas directly affected by the works. Small diameter burrows have been recorded throughout the RZ indicating the presence of rodents and shrews. Scats likely from both shrews and civet cats have been noted on the RZ. Mammal trapping adjacent to the Old Western River shows that this area is a habitat for Javan mongoose.

9.2.85 Many of the bird and insect individuals depending on the area could be lost unless they can recolonise similar habitat elsewhere. None of the species are rare or endangered with the exception of one or two dragonfly species. Freshwater habitat replacement will reduce the residual impact.

9.2.86 The main concern about the loss of this habitat is that freshwater wetland habitat is becoming increasingly uncommon in Hong Kong. Mitigation measures, to be proposed later in the chapter (Sections 9.4 and 9.5) will include habitat replacement as compensation for the loss.

9.2.87 Most amphibians were found in puddles remaining after rain on grassland. The potential impact of the Project on amphibians is expected to be small because they readily utilise similar habitats in surrounding areas.

Table 9.12 Summary of Impacts on Wetland Habitats on Site

Habitat	Ecological resources	Major potential impacts of the Project
Marshes, Reedbeds, fishponds and abandoned fishponds	breeding birds migratory birds insects mammals	Loss of substantial proportion (5%) of Hong Kong freshwater wetlands, leading to: - loss of feeding habitat for many bird species - loss of habitat for insects which include possible endangered species - loss of wintering habitat for birds - loss of breeding habitat for mammals
Ephemeral wetlands	amphibians	Loss of area in which amphibians breed

Woodlands

9.2.88 Woodlands within the Study Area are of two types: native woodland and plantation woodland. Both can have substantial ecological value with a variety of vegetation types, and provision of food and shelter for breeding animals. Native woodlands usually have a more complex structure than plantation woodlands (Ashworth *et al.* 1993).

Native Woodlands

9.2.89 Few native woodlands in Hong Kong are greater than 40 years old, with the exception of fung shui woodlands (Ashworth *et al.* 1993). Woodland is the natural vegetation cover of Hong Kong, and would be expected to host a great diversity of fauna, but widespread deforestation and changing land use since the arrival of humans 6000 years ago has eliminated many animal species specialised to forests (Ashworth *et al.* 1993). Native woodland contains many trees that are rarely or never found in younger woodlands, and hosts civets, wild boar, barking deer, porcupine, pangolin (Marshall 1967), and birds including thrushes and flycatchers.

Plantation Woodlands

9.2.90 Plantation woodlands on site are dominated by exotic *Eucalyptus* and *Casuarina* spp. These species have little value to local birdlife (M. Leven, pers. comm.). The structure of the plantation in Area 118 provides roosts for large numbers of common starlings and mynas (Black-necked Starling and Crested Myna) at night (P. Leader, pers. comm.). Resident birds such as the Greater Coucal and Japanese Sparrowhawk have been recorded within the plantation woodlands during the Eco-IA. Mammals are present in the plantations as evidenced by successful trapping of mongoose, and the presence of shrew droppings. Plantations provide shelter. Older plantations in the Study Area could have increased value as habitat, because they can contain an understorey developed from native trees and shrubs (Ashworth *et al.* 1993).

Impacts of the Project

9.2.91 There are no areas of native woodland on the RZ. Native woodland adjacent to the site on Lau Fau Shan and on the hills above Mong Tseng are not going to be directly impacted by the Project. Patches of woodland adjacent to the Long Tin Road are unlikely to be directly impacted by scheduled road dualling associated with infrastructure provision in the Project as they are well outside the site works area. No direct impacts will occur on the plantation woodlands within the site from the Project.

9.2.92 Indirect impacts of the Project on these off-site areas include noise, dust, human disturbance and fire. The mitigation measures for noise and dust impacts of the Project, and contractual provisions in the control of fire hazards during construction are expected to protect the ecological resources from such impacts in the native woodlands.

Table 9.13 Summary of impacts on woodland habitats on site

Habitat	Ecological resources	Minor potential impacts of the Project
Native Woodland	mammals birds	Noise, human disturbance and dust from construction activities in road reserves outside the Site boundary. Temporary disturbance to animals inhabiting woodlands
Plantations	mammals birds	

Farms

9.2.93 There is no farmland on site, and only 6 ha has been recorded during habitat mapping (Figures 9.3 and 9.4). Farmland tends to have reduced insect populations because of pesticide use, and the diversity of ecological resources is expected to be low. Farmland habitat elsewhere in the Territory does provide some cover for migratory passerines, such as buntings, and marshbirds, such as Snipe, at Long Valley.

Impacts of the Project

9.2.94 There are no areas of farmland on the RZ. Farmland adjacent to the site near Mong Tseng will not be directly impacted by the Project. Indirect impacts of the Project on these off-site areas of farmland include noise and dust. The mitigation measures for noise and dust impacts of the Project are likely to protect the limited ecological resources.

Table 9.14 Summary of impacts on farm habitats on site

Habitat	Ecological resources	Minor potential impacts of the Project
Farmland	birds	Noise, human disturbance and dust from Project activities which will temporarily disturb fauna in this habitat

Estuarine

9.2.95 The estuarine habitats on site are directly linked by water to the habitats comprising the core of the Ramsar site. The estuarine habitats have therefore been a focus of assessment effort. The habitat comprises mudflats, mangrove, and seabed (Table 9.4).

Mudflat

9.2.96 This habitat type is present on-site along the banks of the WTC and the Eastern Outfall. Mudflats within the Ramsar site lie immediately downstream. The special ecological resources identified during the Eco-IA include waterbirds, benthic infauna, and epifauna.

Waterbirds and Raptors

9.2.97 Raptors are grouped with waterbirds in this Eco-IA for consistency with other local studies. Raptors are included in HKBWS mid-winter waterfowl counts.

Endangered and Vulnerable Species

9.2.98 The critically endangered (Groombridge 1993) Black-faced Spoonbill (*Platalea minor*) were recorded during Eco-IA fieldwork in April, when 17 individuals flew over the waterbird monitoring location at Tsim Bei Tsui. Several unconfirmed sightings of endangered, threatened, or vulnerable waterbird species were reported from Tsim Bei Tsui (Lewthwaite 1996a, 1996b, 1996c), the area immediately downstream of the WTC mouth. The endangered Baikal Teal, Oriental White Stork, and Chinese Egret, near-threatened Black Ibis, and vulnerable Dalmatian Pelican were reported there during the Eco-IA.

Species Protected under Bilateral PRC Treaties

9.2.99 During the studies for this Eco-IA, 16 species of waterbirds and raptors protected under bilateral migratory bird agreements between the PRC and either Japan or Australia have been recorded on the RZ (Table 9.7a). Most of these species have been recorded from the intertidal area of the WDC, where ducks, herons and egrets were feeding, or from the ETC and outfall, a feeding habitat for egrets and herons (see Results of Terrestrial Bird Surveys, Appendix E4).

Impacts on Waterbirds

9.2.100 The waterbird community is one of the most important ecological resources in the Study Area, this being the main reason for establishing the Ramsar Site. The impacts on them include direct habitat loss, disturbance due to site formation and infrastructure provision, and from human disturbance (Table 9.5). Indirect impacts include habitat deterioration, through any changes in sedimentation and water quality which then impact the benthic community, their main source of food.

9.2.101 Direct habitat loss removes potential feeding areas, thereby increasing pressure on other feeding grounds in the area.

9.2.102 Noise created during the construction works and operation may cause increased disturbance to some bird species which are used to a quiet environment. The degree to which they can adapt to increased levels of human disturbance will affect the final impact of this Project on the waterbird community. Many bird species are not particularly sensitive to noise (Melville 1991).

9.2.103 The Deep Bay Guidelines (DBG) for noise levels do not strictly apply to works within the RZ. However due to the proximity of Inner Deep Bay to the RZ, consideration has been given to the levels of noise expected in the Special Measure Zone due to construction activities.

9.2.104 Noise impact levels during the construction phase are discussed in the section on Construction Noise: 4.1. During operation, noise patterns are more continuous, and adaptation of the birds is expected.

9.2.105 Dust levels within the Special Measures Zone will be kept below the DBG recommendations except under certain meteorological conditions. When winds blow from the north or north east, DBG recommendations may be exceeded. However these excessive dust levels do not arise from this Project or any other part of the development of TSW. Moderate levels of dust are not expected to affect waterbirds. For example, waterbirds remained on their nests at the new egretry at the mouth of the Shan Pui River in 1995, and returned there to breed in 1996, despite construction activities within 30 m (M. Leven pers. comm.). The relative numbers before and after the construction are, however, unknown. Dust mitigation will be undertaken for the residents of the Tin Shui Wai area which will bring dust levels to within the DBG. Dust levels from the Project are not expected to adversely affect birds.

9.2.106 Most waterbird species feed on the benthic organisms in intertidal mud. Any impact on benthic numbers or size will indirectly affect organisms, including waterbirds, at higher trophic levels. The most serious potential impacts on the benthos are changes in water quality, direct disturbance of the sediment, increasing foraging by the birds themselves and change in habitat type. These are described in more detail in the next section.

Infauna

9.2.107 Benthic infauna are an essential component in the ecological foodweb of mudflats and therefore any impact on these organisms will impact other species at a higher trophic level. Capitellid polychaete worms are the pollution tolerant worm group (Pearson and Rosenberg 1978). The proportion of these worms to other less pollution tolerant worms is high at the TSW Western Channel mouth site in February and June (Figure 9.6), and the ratio is high at all of the sites in November.

9.2.108 The polychaete *Dendronereis pinnaticirrus* remains as the largest worm sampled. Its large body size makes it an important food source for large-bodied birds that forage by capturing individual prey. The capitellids remain individually very small, but their high abundance forms a food resource capable of feeding birds which forage with a dabbling style, such as ducks. The Sabellid polychaete worms provided the greatest biomass at the WTC site throughout the year and formed the only significant resource in November. Sabellidae also show some tolerance to pollution. Compared to previous surveys undertaken using the same sampling methodology including sample dimensions (e.g. Peking University 1995, McChesney 1996) the abundance of the large-bodied nereid polychaete *Dendronereis pinnaticirrus* at Mai Po during this survey has shown a significant decline (Figure 9.5, Table 9.15). This November, the abundance of the nereid polychaetes *D. pinnaticirrus* and other nereids is low. The density now is about 0.33 per sample (Table E4.6), compared to 7-10 per sample in November, 1993. This polychaete is a large-bodied worm utilized as food by most waterbird species at Mai Po (McChesney 1996). The results of the benthic infaunal studies in the Eco-IA show that food resources for migratory and resident waterbirds are unevenly present across all three monitoring areas. Figures 9.6 and 9.7 show a significant decline across all sites in both the abundance and numbers of worms, and their biomass during 1996.

Table 9.15 Change in Abundance of Benthic Species (important as food to waterbirds at Mai Po)

Species	Date	Mean ± SD (per 10 cm diam. x 20 cm long core)	Significance level (Mann-Whitney U test)
Dendronereis pinnaticirrus	Jan 1994	16.75±2.5	p=0.005
	Feb 1996	8±4.3	
	May 1994	14.8±5.8	p=0.001
	June 1996	0.63±0.7	

9.2.109 The analysed results can be summarised as follows:

(i) Nearly all benthic data collected in 1996 show that the abundance of organisms (i.e. the food supply for birds), is lower at Mai Po throughout 1996 than in previous years (see Figure 9.5). At Mai Po, the biomass of worms in June was only about 5% of the February value (Figure 9.6). The latest results indicate that the November biomass at Mai Po is lower than in June.

(ii) The biomass of all worms in February 1996 was approximately equal between TSW Western Channel mouth and Mai Po, but low at Tsim Bei Tsui.

(iii) In June 1996, the biomass of worms was the same, or greater than in February at Tin Shui Wai and Tsim Bei Tsui. By November, all sites had low worm biomass.

9.2.110 The component species in the benthic assemblage at each site change in size and abundance. The importance of the WTC site adjacent to the RZ is illustrated by the currently higher biomass at the site. The benthic infaunal assemblage at the WTC mouth is numerically dominated by the capitellid polychaete group. These animals are organic-pollution tolerant, and numerical dominance of a site by this group indicates highly polluted conditions (Pearson and Rosenberg 1978). A breakdown of the abundance and biomass of each worm group is given in Figures 9.8 and 9.9. The overall decline in food supplies from polychaete worm is summarised in Figure 9.10.

Impacts on Infauna

9.2.111 The main, direct impacts on the intertidal benthic community are associated with water quality, sedimentation and erosion processes. The existing benthos derives its nutrient supply from the organic matter in the surrounding water and sediments. A change in the water quality will affect the food source for the benthic population.

9.2.112 Organic enrichment has been shown to increase the densities of pollution-tolerant benthic species, although diversity is reduced, leading to large numbers of a few pollution-tolerant species, generally smaller in size than before. This situation provides an increased food supply for selected waterbird species, those that can prey on small-bodied organisms.

9.2.113 As water quality decreases further, fewer species can tolerate the low oxygen conditions and species diversity reduces further until conditions deteriorate to the point where no organisms can survive except for large numbers of small bacteria.

9.2.114 Water quality in the WTC tends to deteriorate upstream towards sources of organic inputs when polluted water passes over the deflated dam. Samples of sediment from the WTC taken from downstream of the dam during this Eco-IA were afaunal. Benthic samples from other highly polluted rivers (Shan Pui River, Lee 1995; Shenzhen River, McChesney, unpublished) were similarly afaunal.

9.2.115 The Pearson and Rosenberg (1978) model predicts that increasing organic loading in areas already stressed will cause a collapse of the benthic community. Any further increase in organic loading in the WTC would likely increase the defaunated intertidal area in the WTC and if pollution levels are high enough, even in the mudflats of Inner Deep Bay.

9.2.116 The introduction of the Livestock Waste Control Scheme (LWCS) will reduce the volume of organic material entering the watercourses around Tin Shui Wai and pollution levels are expected to decrease.

9.2.117 Urban stormwater runoff is an operational impact of the further development of TSW and an operational impact of the infrastructure works under this Project. Water quality impacts from the Project will arise from run-off from site activities, albeit on a small scale. The major source of organic pollution in the short term is livestock waste creating conditions where further deterioration of water quality will potentially impact the benthic community. Urban stormwater run-off does add to pollutant loadings but in an insignificant manner in the short-term. In the long term, pollution from urban storm-water runoff should be minimised to optimise the ecological value of Inner Deep Bay (section 7.6). Release of untreated urban stormwater carrying high organic loads or alkali loads from illegal sources into the intertidal area adjacent to the WTC could significantly impact the benthic community.

9.2.118 Accidental discharges of sewage or wastewater will temporarily raise organic pollution levels with short-term impacts on the benthic community. The decrease in dissolved oxygen concentrations will depend partly on the temperature of the water. In summer months, high temperatures exacerbate the impact, although this may be partially off-set by the increased water flow during the wet season which will dilute potential impacts.

9.2.119 Disturbance of mud in the ETC during construction works may raise BOD levels, metal levels and ammonia levels in the surrounding water body, the toxicity of the ammonia depending on the water pH. The extent of these impacts depends on the period of the discharge and the pollutant concentrations present. Short-term impacts are unlikely to have a significant impact. However, long-term discharges will change the composition of the infaunal community. Engineering design has enabled the volume of contaminated mud requiring removal to be minimised, thereby reducing the potential impact. In addition, most of the works will be undertaken using 'dry' methodologies such as using cofferdams.

9.2.120 Operational dredging of sediments in the formed EDC and WDCE channels has a potential physical impact on the benthic population, destroying the benthos in the removed sediment. This is a short-term impact, as it is expected that the area will be colonised rapidly as sediment builds up, providing water quality conditions remain unchanged.

9.2.121 Changes in the particle size of the sediment may result in a change in the benthic community structure. Little work has been done on the particle size of sediments in urban stormwater, but it is expected that some sediments are coarser than the fine muds on the mudflats.

9.2.122 In section 7.5, which discusses the potential impacts from the construction works on water quality in the Study Area, sedimentation impacts were assessed to be very minimal. During land formation, large quantities of suspended solids were present in the run-off from the landbank, however, the low silt content caused a rapid deposition of the sediment particles. Sediment run-off during site formation works is expected to be minor because of the sandy nature of the RZ material, the presence of natural sedimentation ponds, such as the ETC, and constructed sedimentation and silt traps.

9.2.123 Assessment of environmental impacts from concurrent projects (Peking University 1995) considered deposition events unlikely to reach the depth at which benthos are adversely affected (an acute deposition event of 5 cm was shown to severely impact the benthic community in studies by Anderson (in prep.). In comparison with this major river training scheme, a significantly smaller sedimentation rate is expected from the present Project. However, suspended solids monitoring should be carried out during the Project works to confirm this conclusion, particularly in view of the observation in the REMOTS study, which was conducted for the seabed assessment of this Eco-IA, that deposition events occurred near the mouth of the WTC of between 2.5 and 8 cm (Technical Appendix E.4).

9.2.124 Erosion of the sediment can also have an impact on the benthic community. Most benthos in Deep Bay mudflat sediments are found in the top 4 cm of the sediment (McChesney 1996). Substantial erosion of this layer will destroy the benthic community, but gradual erosion has minimal impact because the benthos can probably burrow deeper, provided that the anoxic conditions evidenced by black mud (REMOTS results in Appendix E.4) are inhabitable.

9.2.125 Gradual changes in the height of the sediment layer will change the length of time, as well as the rate, of exposure and inundation over the tidal cycle. Changes in mudflat elevation due to sedimentation are expected to be long term. Any erosion is expected to be a short-term impact, because sedimentation processes that dominate an estuary would infill eroded areas.

9.2.126 Indirect impacts on the benthic community include factors affecting the encroachment of mangroves onto the mudflats. Mudflats and mangroves have very different benthic communities. Mangroves thrive in intertidal areas and may reduce the extent of the habitat available for the mudflat benthos population.

9.2.127 The number of birds feeding on the mudflats reduces the abundance and affects the diversity of the benthic community. The abundance and biomass of the benthic community affects the locations selected by foraging birds (Goss-Custard 1970). Loss of intertidal habitat in one area displaces foraging birds, and exerts extra pressure on other areas of mudflat.

Epifauna

9.2.128 The epifaunal population on the estuarine mudflat habitat of Deep Bay is dominated by crabs and mudskippers. Within the mangrove and along its edge the fiddler crab predominates (*Uca* spp.). The mudflat hosts a varied assemblage of crabs, including *Macrophthalmus* and *Metaplax* spp. Mudskippers, which inhabit both mangrove and mudflat areas include *Periophthalmus cantonensis, Boleophthalmus pectinirostris* and *Scartelaos viridis*.

9.2.129 Epifaunal mudflat crabs *Macrophthalmus* and *Metaplax* seem to be the preferred food for larger waterbirds (Curlew: McChesney 1996), while mudskippers are the main food source for Chinese Pond Heron (Young 1993), when they are available. Availability appears to be strongly temperature dependent, with epifauna remaining in their burrows during cooler weather.

9.2.130 Epifauna are harvested as a fishery resource to a limited extent by local residents trapping crabs and mudskippers in Deep Bay, and farming oysterbeds.

Impacts of the Project

9.2.131 In a similar way to the impacts on benthic fauna, water quality and sediment quality are important factors determining crab and mudskipper survival. Poor water quality, particularly evidenced by low DO levels, during high tide will potentially impact the epifaunal population. However, the behaviour of some epifauna (*Uca* crabs) reduces the impact of poor water quality (Lee 1995). Lee's study (1995) demonstrated that *Uca* isolate themselves from polluted water by burrowing at high tide. At low tide, they emerge to forage on the mudflats. This suggests that *Uca* are not very sensitive to polluted water.

9.2.132 With the implementation of the LWCS, organic pollution in the drainage channels will greatly reduce. However urban stormwater runoff has the potential to contribute to the pollution load. From data presented in section 7.5, increased sedimentation rates are not expected to be an impact during site formation. However, in section 7.5, pollutants transported by or released from sediment are of potentially greater concern. Potential impacts from the release of pollutants in contaminated mud during workings in the ETC have been minimised through good engineering design and the use of mitigative construction methodologies.

9.2.133 Increased pressure from displaced waterbirds feeding on mudflats away from any Project impacts will potentially reduce numbers of crabs and mudskippers. The results of the Eco-IA studies have shown a decline in mudskipper density by 90% at Mai Po compared with previous studies (Chan 1990) (Figure 9.5). The same decreasing trend at Mai Po is also observed for the density of fiddler crabs (0.2-1.6 crabs.m^{-2} in the present study compared with 5-15 crabs.m^{-2} in previous work (Choi 1991)). Although some of the difference may be attributed to different sampling methods, communication with Mai Po Nature Reserve has confirmed that the density of crabs on the mud flat in Mai Po is exceptionally low (particularly in September) this year. These results are consistent with the decline in infaunal abundance (Figure 9.5 and Table 9.15).

9.2.134 The overall food supply at Tin Shui Wai mudflats is higher than at Mai Po and hence due to loss of food adjacent to Mai Po, the mudflats adjacent to the WTC mouth have become increasingly important this year. The mean numbers of egrets present during studies for this Eco-IA at the WTC site and TBT are higher than at Mai Po, which may be explained by the much higher density of mudskippers at the WTC site (0.9 - 2.0 • m^{-2}) and TBT (1.6 - 2.5 • m^{-2}) compared with Mai Po (0.3 - 0.4 • m^{-2}).

9.2.135 In summary, the overall food supply at Tin Shui Wai is higher than at Mai Po which is currently very low.

Table 9.16 Summary of Impacts on Estuarine Habitats on Site

Habitat/Resource	Species	Major potential impacts of the Project
Waterbirds	resident herons and egrets migratory shorebirds (stilts, avocets, plovers, sandpipers) ducks gulls	Noise, dust and disturbance from human activities during the Project. Loss of habitat along the WDCE. Indirect impacts of additional pressure on adjacent mudflats. Impacts on benthos have consequential impacts on waterbirds feeding on them.
Infauna	worms, clams, snails, crustaceans	Deterioration in water quality. Sedimentation impacts are not expected to be significant although pollution associated with sediment is a potential impact on infauna and epifauna survival. Indirect impacts include increased foraging pressure from waterbirds on remaining habitat when other habitat has been lost.
Epifauna	crabs and mudskippers	

Mangrove habitat

9.2.136 Mangroves flourish on protected tropical shores, and are an important habitat for wildlife, particularly as a nesting and roosting site for birds. Certain epifauna, such as crabs *Chiromanthes bidens* also depend on mangrove leaf litter as a food source (Lee 1989, Peking University 1994). The Mai Po mudflats represent one of the six largest mangrove stands remaining in China, and are part of some of the most northern stands in Asia.

9.2.137 Mangroves line the intertidal banks of the WTC and the cross channel between the WTC and the Eastern Outfall. They form the high-shore habitat of the Ramsar site immediately downstream of the Project.

Associated Endangered and Vulnerable Species

9.2.138 Chestnut-cheeked Starling (*Sturnus phillipensis*) and Silky Starling (*S. sericeus*) are considered near-threatened species ("Birds to Watch - the World List of Threatened Birds", Collar *et al* 1994). Large starling roosts formed in the mangrove adjacent to the mouth of the WTC during the winter of 1995-1996, and have been observed again in October 1996. The Chestnut-checked Starling and Silky Starling have been reported at Tsim Bei Tsui during the autumn of 1996 (P. Leader, pers. comm.). There are also reports of Chinese Starlings (*Sturnus chinensis*) at Tsim Bei Tsui (Lewthwaite 1995), which is a species that formerly bred widely across Hong Kong but is now confined to only a few villages (Viney *et al.* 1994). A complete listing of rare, unusual and/or threatened bird species reported in the Study Area, during the last year, can be found in Tables E4.7 and E4.8.

9.2.139 Five-toed footprints with claw marks were observed adjacent to the mangrove edge on the mudflats beneath the Security Bund bridge during benthic sampling in June 1996. These footprints possibly belong to the Crab-eating Mongoose (*Herpestes urva*), or Javan Mongoose (*H. javanicus*). Otter spraints have been observed along the WWF-HK floating boardwalk through the mangrove at Mai Po (Young 1994), indicating the importance of the mangrove habitat to these mammals.

Breeding and Migratory Birds

9.2.140 The Tsim Bei Tsui SSSI egretry hosted breeding Little Egret and Great Egret in 1994 (Hong Kong Bird Watching Society Data unpublished), and these birds, as well as Night Herons and Cattle Egrets, have subsequently bred in the new egretry located in the mangrove near the mouth of the Shan Pui River in 1995 (ERM 1996). This Eco-IA study documented their breeding at this site in 1996.

9.2.141 Black-shouldered Kites (*Elanus caeruleus*) have been seen in every month of the year in the area, and several sightings have been made from the RZ. This species is likely to be breeding in the Deep Bay mangrove (M. Chalmers pers. comm.).

9.2.142 Styan's Grasshopper Warbler (*Locustella pleski*) migrates from breeding grounds in NE Asia and to southeast China (Viney *et al.* 1994) and has been recorded in both reedbeds and mangroves in Deep Bay. Deep Bay is the only known wintering area for this species although it must certainly winter elsewhere at sites not yet located.

Fishery Nursery

9.2.143 In a survey comparing the roles of the Mai Po mudflats, mangroves, and intertidal channels to the Deep Bay fishery (Vance in press), the largest numbers of juvenile commercial prawn species (*Metapenaeus ensis* and *M. affinis*), and juvenile fish were caught in mangrove sites at Mai Po.

Impacts on Mangrove

9.2.144 The loss of areas of mangrove resulting from construction of road bridges across the WDCE removes areas of mangrove cover important to some species (e.g. White-breasted Waterhen, Little Egret, Great Egret, Chinese Pond Heron, Grey Heron). This impact is regarded as minor because of habitat removed (estimated to be 0.3 ha) and because the mangroves in this area are young, small and thin.

9.2.145 We do not consider there are any Black-shouldered Kites nesting in mangroves that will be impacted by the Project. The small mangrove areas along the WTC are newly established and probably unattractive nesting sites to this species. There are no recognised breeding grounds for rare or endangered birds or mammals recorded in the WTC. The egretry at the Shan Pui River mouth is unlikely to be directly impacted by works on the RZ, which are 1.25 km or more from this egretry. A cumulative impact of all development projects in the area, however, includes the reduction of fishpond habitat used for feeding by these birds.

9.2.146 Construction work will have a minimal direct impact on the mangrove community, except for a 500 m section of the WDCE which will be concrete lined for maintenance purposes, and several small areas where bridges will be constructed across the WTC. Concrete lining will be along the base of the channel. Construction of the bridge footings requires the removal of small areas of the mangroves on either side of the channel.

9.2.147 The percentage of mangrove lost is very small. However, the cumulative destruction of mangrove in the Deep Bay area is a cause of concern because it has several important functions in the environment. However examination of aerial photographs of TSW area have shown increased area of mangroves in the TSW area not related to plantings undertaken in the early 90s.

9.2.148 Mangroves can act as important nutrient sinks for the ecosystem and they may act as important buffers against pollution impacts. The removal of any robust vegetation from river banks has the potential to increase erosion which will weaken the riverbank for remaining vegetation, additionally increasing sedimentation from run-off.

9.2.149 During site formation, sediment run-off is unlikely to cause a significant increase in total sedimentation (Section 7). However, pollutant loadings could potentially increase as a result of urban stormwater run-off during operation. The recruitment rate of young mangroves can be affected during floods.

9.2.150 Established mangrove stands provide stability for the channel banks during the passage of peak flow and any adverse impacts on the development of the mangrove community will encourage erosion and instability during storm events.

Table 9.17 Summary of impacts on mangrove habitats on site

Habitat/Resource	Minor Potential Impacts of the Project
Mangroves	Small loss of habitat through WDCE and bridge construction leading to: - loss of cover for some bird species - removal of mangrove as nutrient sink - removal of means of stabilising channel banks - deterioration in water quality from urban stormwater run-off - increased run-off velocity

Waterbird Feeding Ecology

9.2.151 The intertidal estuarine habitat supports benthos which are used as a food source by internationally important numbers of waterbirds. This section describes the feeding ecology relationships that link these estuarine resources.

9.2.152 The WTC mouth is noted for the large concentration of waterbirds, particularly duck (Peking University 1995). The diet for duck in Deep Bay has not been determined, but their behaviour suggests that they harvest food from the mudflats when the tide ebbs and floods, and roost on the mudflat when the tide is low (Peking University 1995). The high concentration of ducks along the WTC can take advantage of the relatively high biomass of invertebrates measured here during this Eco-IA. The final benthic sampling event in November showed that duck density was high, corresponding with the relatively high densities of capitellids and sabellids (Figure 9.9).

9.2.153 Food resources with a high-energy value per item, for example, mudskippers, are selected by herons and egrets in Deep Bay (Young 1993), and elsewhere in Hong Kong (L. Young, pers. comm.). The higher mean numbers of egrets present during studies for this Eco-IA at the WTC site (1.9 - 33.0 birds) and TBT (6.4 - 66.5 birds), compared to Mai Po (3.4 - 14.2 birds) may be explained by the much higher density of mudskippers at the WTC site (0.9 - 2.0 • m^{-2}) and TBT (1.6 - 2.5 • m^{-2}) compared with Mai Po (0.3 - 0.4 • m^{-2}). The highest densities (birds • m^{-2}) were recorded at the WTC site.

9.2.154 In April, the highest mean number of Little Egret (8.8 birds) occurred at Mai Po. In April, Little Egrets would be expected to be tending nests. As shown by several workers in Deep Bay (Wong 1991, Crosby 1991, Young 1993), egrets feeding on fishponds do so most intensely in the early morning and evening, because dissolved oxygen is low and prey are near the surface of the water, and therefore easy to catch. The time of day at which observations reported here were made was generally between 10:00 and 16:00, when feeding opportunities were low at fishponds and egrets may have stayed in the egretry.

9.2.155 High foraging rates as measured by prey swallowed per unit time and by percentage of birds in flocks foraging, may indicate that optimal prey are lacking and so waterbirds are foraging on less-optimal (e.g. smaller) prey. Under these circumstances, foraging intensity (% foraging) would necessarily be higher in order to satisfy the energy demands.

9.2.156 Four observations at Mai Po indicate the ecological relationships between favoured prey density and predator behaviour in Deep Bay:

- Low numbers of mudskippers are present at Mai Po versus the other two sampling locations.
- Low numbers of Little Egret tend to be present at Mai Po.
- A high proportion of the Little Egrets that are present at Mai Po are foraging.
- The foraging Little Egrets have high intake rates.

9.2.157 The high foraging intensity and high intake rate of the egrets may be explained by the low density of high-energy food resources present at Mai Po during these surveys.

9.2.158 The highest densities of large-bodied nereid polychaetes measured during this study to date were at Mai Po . These large-bodied prey are suitable for larger birds, while the small prey size of the capitellids that numerically dominated the benthos at the mouth of the WTC (Figure 9.5) is suitable for the smaller-bodied ducks that forage with a dabbling style. The highest total biomass measured during this study to date was at the WTC in June, when sample biomass was dominated by sabellid polychaetes, which are a sedentary, tube-dwelling species that retreats rapidly into its burrow upon disturbance. The Little Egret at Mai Po have been observed harvesting red polychaete worms, the nereid polychaetes.

Seabed

9.2.159 The seabed habitat occupies most of outer Deep Bay. A REMOTS seabed-profiling survey was conducted at fifteen subtidal sites as close to the WTC mouth as possible (see Appendix E.4). Sites were located along a deeper-water channel that remains flooded even at low tide. This channel is dredged to permit barges to travel at all tidal heights.

9.2.160 The subtidal habitat in this area was determined to be extremely degraded, with black anoxic sediments generating methane or hydrogen sulfide gas in places. REMOTS images indicated the presence of few macroinfaunal worms, and dominated by surface-dwelling tube-building capitellid or spionid worms. Despite large improvements in the water quality in the WTC since the early 1980's, organic loads continue to be high in the area probably due to pig farming near Mong Tseng, and to the proximity of the highly polluted Shan Pui River (Lee 1995).

9.2.161 The subtidal habitat hosts benthic and demersal fauna. The benthic fauna may provide a food resource for grazing demersal predators which constitute a fishery resource. Oysterbeds once extended across large areas of the Deep Bay intertidal and shallow subtidal, but the oysterbed fishery has been declining strongly in the last decade, due in part to severely deteriorating water quality. Oyster production dropped from 160 tonnes in 1988 to 100 tonnes in 1993 (AFD, 1994). The capture fishery in Deep Bay comprised 63 vessels under 15 feet in length that harvested 70.5 tonnes, not including the harvest of shrimp trawlers and hang trawlers (Applied Sciences Limited 1993). Gei Wai shrimp farming in Deep Bay is confined to the gei wai operated by WWF-HK at the Mai Po Nature Reserve.

Impacts of the Project

9.2.162 The seabed of Inner Deep Bay supports a benthic community which appears to be of low diversity and biomass due to long term effects of organic pollution entering Deep Bay.

9.2.163 This could be further impacted by increases in pollution associated with sediment run-off (although this is expected to be very minimal) and deterioration in water quality for any reason.

9.2.164 The impacts from this Project are expected to be minor because of the distance from the site. However, cumulative impacts from concurrent projects could have potentially major impacts on the benthic community in this habitat.

Table 9.18 Summary of impacts on seabed habitat

Habitat/Resource	Major potential impacts of the Project
Seabed	Cumulative water quality impacts from the Project works, urban storm-water runoff, other works for the further development of TSW with water quality deterioration associated with river training and/or reclamation works in Inner Deep Bay will be reduced through dilution with distance from site Cumulative impacts will increase pollution long-term

Cumulative impacts

9.2.165 Concurrent projects in the Deep Bay area include river training projects, transportation infrastructure construction, housing, sanitary landfilling, and port development (Young and Melville 1993). Several large scale river training projects are underway within the catchments of the major streams draining into Deep Bay: the Shenzhen River and the Shan Pui River. These are shown on Figure 9.11. Modelling work predicted potentially minimal impacts from the Shenzhen River Training Project, however, the cumulative effect of several projects on the total benthic resources in Deep Bay could be extreme.

9.2.166 Loss of wetland habitat is one of the main impacts of the current Project, and is also an impact created by several other development projects in the region. Developments close to the Ramsar site are of particular concern and continued encroachment on the previously remote mudflats and fishponds puts further pressure on these essential habitats.

9.2.167 Water quality in Inner Deep Bay has seriously deteriorated in 1996 (Section 7) and is undoubtedly the cause of the serious deterioration in food supplies for birds on the mudflats of Inner Deep Bay this year. This year's winter waterbird count has dropped by over 5%. This is by far the largest decrease since counts began in 1979. The annual waterbird count has been steadily increasing by nearly 20% per year (Melville D.S. WWF - personal communication and L. Young, 1995).

9.2.168 Water quality is a very serious issue in Deep Bay which receives sewage, construction and industrial wastes . Pollution from livestock waste should soon be a decreasing impact due to the implementation of the LWCS.

9.2.169 Urban stormwater is of long term concern because of the potential presence of high levels of pollutants particularly from illegal sources which may have a negative impact on the intertidal benthic population. As developments expand in the region, the nature of the run-off may change from the previously organic loads entering Deep Bay (from livestock) to less biodegradable pollution (including heavy metals and pesticides).

9.2.170 Noise levels and the degree of human disturbance will also increase in the area and the legislation applying to the area will become less strict as the area rating changes.

Summary of Ecological Conditions and Potential Impacts

9.2.171 The ecological resources in the Study Area for the Tin Shui Wai Development have been classified for the purposes of this Eco-IA into terrestrial and estuarine habitats which have been further subdivided into the ecological resources within each habitat

9.2.172 The terrestrial environment comprises grassland, freshwater wetland (fishponds, impounded areas of water, marshes and reedbeds), and woodlands (native and plantation). The estuarine environment is composed of intertidal mudflats, mangroves and the subtidal environment of Deep Bay.

9.2.173 These ecological habitats are subject to direct and indirect, short-term and long-term, and cumulative impacts, with varying degrees of severity. A summary of potential impact on each ecological resource is shown in Table 9.19. Each of these impacts has been carefully assessed. The most critical impacts are loss of habitat and poor water quality.

9.2.174 It is evident that one of the most significant impacts of the Project is the loss of habitat under the Project. The percentage loss of each habitat as a percentage of both the total on the site and the total in Hong Kong is shown in Table 9.20.

9.2.175 The degree of mitigation required is determined by the ecological value of the habitat and its resources. This section has reviewed the knowledge about each habitat and the extent of the impacts to enable an assessment of the value to be made.

9.2.176 The most serious potential ecological impact on the ecology of Deep Bay is a cumulative one as indicated by the deterioration of water quality and ecological resources in Inner Deep Bay in 1996. The ultimate survival of the Ramsar Site is dependent upon the minimisation of any adverse water quality impacts either short or long term from the Project works, the further development of TSW and other concurrent works which have already severely affected water quality. The continuation of current levels of pollution would not allow the re-colonization and re-establishment of Inner Deep Bay ecological resources.

Table 9.19 Potential Impacts on Ecological Resources Assessed

Habitat type	Potential Impacts of Project	Flora/Fauna group Affected
Sparsely vegetated grassland	Loss of significant proportion of habitat under site formation; loss of courtship, breeding and feeding area for resident and migratory birds, loss of feeding habitat and shelter for mammals, amphibians and insects	Oriental Skylark - courtship area
		Oriental Skylark - nesting area
		Savannah Nightjar
		Little Ringed Plover
		Migrant birds
		Amphibians
		Mammals -Javan Mongoose
		Bats
		Insects
Stockpiles	Destruction of nesting areas	Kingfisher
Woodlands - AFD plantations and native woodlands	Loss of plantation through habitat replacement; impacts on native woodlands during infrastructure provision	AFD plantations
		Native woodlands
Eastern Temporary Channel (ETC), marsh, fishponds Abandoned fishponds in Area 122	Loss of substantial proportion of channel and Old Western River under site formation, loss of benthic, insect and bird populations, loss of breeding and feeding habitat for birds, loss of feeding area for mammals	Water hyacinth
		Reedbeds
		Benthic insects
		Aerial insects
		Fish
		Waterbirds
		Songbirds
		Mammals

Table 9.19 Potential Impacts on Ecological Resources Assessed (cont'd)

Habitat type	Potential Impacts of Project	Flora/Fauna group Affected
ETC, Western Temporary Channel (WTC) and cross channel	Increased disturbance due to proximity of development	Waterbirds - WTC
		Waterbirds - ETC outfall
		mammals, mongooses
	Water quality impacts during construction works associated with the Project	Intertidal mangrove and benthic fauna - WTC
		Intertidal mangrove and benthic infauna - EC outfall
	Water quality impacts during dredging and stormwater run-off in the operational phase	Intertidal benthos - EC outfall
	Loss of young individuals of colonising species	Mangroves
	Loss of habitat during concreting of WDCE	Intertidal benthic fauna
Inner Deep Bay	Water quality impacts during construction works associated with the Project	Infauna
		Epifauna
		Mangrove
	Water quality impacts during dredging and stormwater run-off in the operational phase	Infauna
		Epifauna
		Mangrove
	Accidental spills if they were to occur	Infauna
		Epifauna
		Mangrove
	Increased human disturbance through light, noise, human presence	Waterbirds
Deep Bay seabed	Increase in pollution loadings from stormwater run-off particularly from illegal sources discharged into Project drainage system	Subtidal benthos
		Fisheries

Table 9.20 Habitat lost by Project Site Formation and Provision of Infrastructure

Habitat	Estimated Area Lost (ha)	Approximate area of habitat on site (ha)	% lost (of on-site total)	% lost (of total in Hong Kong)
Intertidal Mudflats	3.1	15	20	0.1
Mangroves	0.3	16	19	0.1
Fishpond (Area 121)	3	3	100	0.2
Freshwater wetlands: ponds, marsh, reedbed	17.5	20.4	86	< 5.4
Grassland	130	135	96	2.3
Native woodland	0	5	0	0
Government plantation	44+	44	100	1.6

\+ Principally as a result of mitigation measures described later in this section.

9.3 Assessment of Ecological Value of Resources and Potential Impacts

9.3.1 The assessment of ecological value is an important issue in evaluating the impact of an activity on the environment and the need for mitigation of the impact. The significance of each habitat type in terms of the proportion it represents in Hong Kong is shown in Table 9.20.

9.3.2 Ecological value is a complex evaluation which requires consideration of several criteria. The criteria recommended in the Draft EIA Technical Memorandum were used to carry out the assessment of habitats in this Eco-IA.

Assessment Criteria

9.3.3 Naturalness — Habitats formed by natural succession processes tend to be valued higher than plantations. Intertidal mudflat and native woodlands are the most natural habitats in the areas, followed by freshwater habitats. Hydroseeded grassland and plantations are the least natural habitats.

Fragmentation — Entire areas are valued higher than fragmented areas. Intertidal mudflat is the least fragmented habitat, in contrast to fung shui woodlands which are native woodland split up into smaller units.

Size — Larger areas are valued more highly than smaller areas. Grassland on the RZ covers a large area relative to other habitats; fishponds and native woodlands cover the smallest area. Intertidal mudflats are a relatively small area on site compared with freshwater habitats on site.

Nativeness	Habitats comprising or dominated by native species are valued more highly than areas dominated by exotics. Native woodland, by nature, is native, whereas plantations comprise mainly exotic species.
Rarity	Species concerned are of rare and/or endangered status; habitat type is limited in the region. Freshwater, grassland and intertidal habitats host several rare species of either insects, birds or mammals.
Scarcity	Scarce habitats are more valuable than common habitats. In Hong Kong, freshwater wetland habitats are particularly scarce.
Location	Proximity to the Mai Po Ramsar site places a higher value on an area. The intertidal areas are closest to the Ramsar site, followed by freshwater habitats.
Re-creatability	This criterion has been marked with reference to the ease of colonisation by displaced flora and fauna. Easier re-creation makes the conservation less critical. Woodland habitats are particularly complex habitats, the features of which are difficult to create until enough time has elapsed for succession.
Nursery/Breeding	Habitat that provides nursery or breeding ground, food or cover for special ecological resource species are valued more highly. Freshwater, intertidal and native woodland habitats are rated highly in this category.
Diversity	A greater diversity of the species or habitat type enhances the diversity of a region, thereby increasing its value. Grassland and plantation are the least diverse habitats compared with freshwater and intertidal areas.
Potential Value	Areas may develop increased ecological value with time, through natural succession or management.
Age	Older habitats are usually more highly valued than recent ones.
Protected Species	The occurrence of protected species is more significant than the occurrence of unprotected species. The legal protection status ought to be considered from a local and regional point of view.
Species Range	Species which are endemic are highly valued, and species with ranges restricted to local or regional distributed are generally more highly valued than wide-ranging species.

9.3.4 The assessment of each habitat for its ecological value is shown in Table 9.21. From this assessment, the most valuable habitats within the Study Area are freshwater wetland (particularly reedbeds), intertidal mudflats and native woodland. This indicates that these three types of habitat should be given priority protection or, if impacts are unavoidable, mitigation measures to replace lost habitat should be implemented.

9.3.5 The prime issue in terms of the assessment of ecological impacts is whether short-term and long-term changes in area of habitat, hydrology, water quality and sedimentation will have any significant impact on the ecological system.

9.3.6 Consideration of the severity of the impacts on each habitat type (Table 9.19) shows that the reedbed within the Old Western River will be completely destroyed as a result of Site Formation Works as will most of the ETC freshwater wetland habitat.

9.3.7 Intertidal mudflats will be subject to lesser impacts in terms of habitat loss. The proximity of the area to the Ramsar site enhances the importance of potential impacts on the intertidal community.

9.3.8 No native woodland is expected to be directly impacted under this Project.

9.3.9 Low values were derived from the assessment of fishponds and grasslands on the site (Table 9.21). These habitats are among those diminishing in area as the result of development in Hong Kong. They support a variety of wildlife. Mitigation of the loss of these habitats has been considered but is of relatively low priority..

9.3.10 In summary, the results show the following classification:

High Priority Habitats:	intertidal mudflats, freshwater marshlands, native woodlands
Low Priority Habitats:	fishponds, grasslands, Government plantations

Table 9.21 Assessment of Relative Ecological Value of Habitats

Attribute of value	Habitat					
	Grassland	Fishponds	Freshwater - reedbed, marshes, impounded wetland	Intertidal mudflat including mangrove	Government Plantations	Native woodland
Naturalness	1	2	4	4	1	5
Fragmentation	3	1	4	5	1	1
Size	5	1	4	2	1	1
Nativeness	1	2	4	5	0	5
Rarity	2	3	5	5	2	3
Scarcity	2	3	5	3	2	3
Location	1	3	3	5	1	1
Difficulty of re-creation	1	1	3	1	2	4
Breeding	2	4	5	3	2	5
Diversity	1	2	4	3	2	5
Potential Value	2	3	4	5	2	3
Age	2	2	3	2	3	4
Protected Species	3	2	5	5	2	4
Range	2	3	4	3	2	4
TOTALS	28	32	57	51	23	48

\+ Scale of 0-5 increasing with increasing value.

9.4 Mitigation

9.4.1 This study has identified a number of key impacts on the ecological resources as a result of the Project activities. The key impacts are the loss of habitat and detrimental changes in the water quality. This section presents the measures required to mitigate these key impacts.

Mitigation for Loss of Habitat and other Major Impacts

9.4.2 The ecological value of each type of habitat in the Study Area was assessed in section 9.3, resulting in a prioritisation of the value of the habitats present. Table 9.20 also showed the amount of each type of habitat lost as a percentage of the total on the site.

9.4.3 These analyses demonstrated the importance of the loss of freshwater habitat due to this Project, because of the fauna it supports and the relative scarcity of the habitat in Hong Kong.

9.4.4 Intertidal habitat was also shown to be important ecologically by these analyses. A relatively small area is directly lost under the Project. This area is currently very degraded and lies just upstream of the inflatable dam. Human disturbance will limit the use of parts of the ETC by ducks. Birds like egrets adapt more readily to the presence of people. The grassland lost under site formation is considered to be less important than other habitat types under the current Project.

9.4.5 Habitat replacement and enhancement through management are measures by which to mitigate against impacts. One of the main mitigation measures to be used in minimising the ecological impact of this project is the replacement of lost habitat. Habitat management is becoming a major part of planning future developments in Hong Kong, particularly in the Northwest New Territories. Studies of importance include the AFD's Study: *Development of a Comprehensive Conservation Strategy and a Management Plan in Relation to the listing of Mai Po and Inner Deep Bay as a Wetland of International Importance under the Ramsar Convention* and AFD. Planning Department's Study: *Study of the Ecological Value of Fishponds in the Deep Bay Area.*

9.4.6 Mitigation aims to quantitatively replace lost habitat at a ratio of 1:1 or greater. An additional consideration is qualitative replacement in which the value of the ecological habitat lost is evaluated, and replaced with habitat of a greater ecological value.

9.4.7 There is a limited area on site for quantitative replacement of habitat. The demands of different ecological habitats have been evaluated to determine the most ecologically beneficial use of the land. Reference to the ecological value of the habitats will be taken into account as habitat replacement measures are described.

9.4.8 The plan for the provision of a fresh-water wetland and the upgrading of the nearby areas to form an integrated scheme for mitigation associated with the Project and a buffer for the protection of the Ramsar Site is shown in Figure 9.12.

Terrestrial Habitat Mitigation

<u>Freshwater Wetland Habitat Replacement</u>

9.4.9 Freshwater wetland on site includes reedbeds, impounded water, and ephemeral habitat. The main mitigation measure for the loss of freshwater wetland is replacement with similar habitat. The locations on site where this could take place are limited to Areas 114, 118, and 119. Area 119 and a portion of Area 118 were contaminated mud dumping grounds when the original land formation works for TSW landbank were undertaken. This material is best left undisturbed.

9.4.10 Damp ground already exists on the landbank in portions of Area 114 and 118, which can be enhanced and expanded. This wetland is currently similar in ecological characteristics to the wetland of the Old Western River, which will be lost under the site formation works. Replacement for freshwater reedbed habitat loss involves increasing the size of the area of this damp ground. The loss of fishponds on the western side of the WDCE adds a small proportion to the overall loss of wetlands from the Project.

9.4.11 The plan for replacement wetland involves a channelled flow regime and ponds. The channel will direct water from the eastern culvert through a series of wetland areas planted with reeds and other vegetation types. A range of vegetation types will promote colonization by different benthic infauna and epifauna communities, and can support a wide range of animals displaced from the RZ (Figure 9.12).

9.4.12 Amphibians are also a component of the wetland ecosystem. These organisms are expected to readily utilize ephemeral wetland areas which will be incorporated as part of the replacement habitat for loss of the wetlands on the RZ.

9.4.13 The plan for the replacement wetland habitat is described in detail in section 9.5. Possible future access routes for the public have been considered to enable maximum interest to the visitors while minimising the disturbance to wildlife, particulary waterbirds which can be very sensitive to disturbance by human presence.

<u>Mitigation for impacts on grassland habitat</u>

9.4.14 The grassland area has been assessed to be of less importance in this Project than the freshwater and intertidal habitats as summarised in Table 9.21 with a low score. The availability of alternative grassland habitats in Hong Kong is much greater than for wetlands. The large area of grassland to be lost compared to the area available on-site for replacement means that quantitative replacement of the habitat is therefore not feasible, and individuals of the species utilizing this habitat will be impacted.

9.4.15 Work to be carried out in the Oriental Skylark nesting area on the north-east of the RZ must be avoided during the breeding season (April to August, Viney *et al.* 1994) and the drain leading from the stockpile located in the north-east of the RZ must be sited to avoid the nests of Oriental Skylark, or permits obtained. If suitable release sites are available, trapping and relocation of these birds will be undertaken.

9.4.16 Kingfishers are likely to be nesting in horizontal holes recorded in the stockpiles on the RZ grassland. Works relating to the movement of these stockpiles must avoid the breeding season (March to July, Viney *et al.* 1994) or a permit obtained from AFD.

9.4.17 The impact on the mammal population will be minimised by carrying out an inspection prior to the commencement of site formation and relocation of the individuals where required.

<u>Mitigation for impacts on woodland habitat</u>

9.4.18 The Project will cause the loss of government plantations on the RZ by upgrading them to native woodland habitat. The government plantations comprise exotic species not considered of high ecological or monetary value.

9.4.19 Native woodland is considered to be a valuable ecological resource on the basis of its age and the diversity of species which it supports. Native woodland areas are unlikely to be directly impacted through loss of habitat, but increased human disturbance levels and risk of fire will impact on these areas in the long term.

9.4.20 Native woodland has been identified as one of the more valuable ecological resources in the Study Area. It provides shelter, food and even nesting sites for birds and mammals. It has the effect of diminishing the impact of human disturbance on these animals. The existing Government plantations in Areas 118 and 119 could be extensively upgraded through the provision of top-soil and native plantings assisting in the provision of a buffer area between the TSW development and the Ramsar Site. Native woodland of varying density will soften the interface between the two areas providing a pleasant environment for both people and wildlife. Native species will include those of particular value to birds as an extension of food supplies and as roosting places.

Estuarine Habitat Mitigation

9.4.21 Intertidal habitat comprises mudflats, mangrove, and the seabed in this Eco-IA. These habitats have been identified as valuable by the assessment analyses in Section 9.3. Impacts of the Project are both direct, through habitat loss during drainage channel extension and disturbance during infrastructure construction, and indirect, through changes in water quality. Maintenance of a healthy benthic population is important for the health of the waterbird community. Mitigation measures to maintain a good water quality are also necessary for other trophic levels of the ecological community.

<u>Mitigation for Impacts on Mudflat</u>

9.4.22 The direct loss of intertidal habitat is not considered to be overly significant because the area lost is very small during the current Project. However, maintenance dredging of the soft-bottomed channel needs to be mitigated through scheduling.

9.4.23 When maintenance dredging of the bottom end of the channel is necessary for other than essential flood mitigation it is best scheduled for the period March/April. If relatively large sections are to be dredged then dredging should be undertaken in smaller sections allowing time for recolonization of benthic organisms to occur before the next section is dredged. Alternatively, dredging should be undertaken on one side of the channel, the other side being dredged after recolonization has occurred. This will take a year or so.

9.4.24 Dense woodland plantings will be made in Area 119 and in the sections of Area 114 and 118 close to the downstream end of the Western Channel. This will encourage waterbirds to continue to utilise the intertidal mudflats at the downstream end by the channel.

<u>Mitigation for Impacts on Mangroves</u>

9.4.25 It is not considered necessary to mitigate the loss of mangroves from the western shore of the WDCE because of the already widespread colonisation of these plants.

9.4.26 Removal of mangroves during bridge construction will, however, have potential erosion impacts on the banks of the channel which should be prevented. This can be achieved by stabilising the bank during construction and preventing sediment run-off. These works should be carried out during the dry season to minimise the impact on the water environment and the benthos.

Mitigation for Impacts on Seabed

9.4.27 The potential impacts on the Deep Bay seabed from the Project have been assessed to be very minimal. Mitigation measures aimed at protecting water quality (Section 7) are effective in mitigating any potential impacts on the Deep Bay seabed. However, of greater concern is the cumulative impacts from all Projects in the area, which cannot be mitigated through this Project alone.

9.4.28 Water quality is expected to improve from the Hong Kong watershed into Deep Bay in the future through the implementation of the LWCS which will eliminate the passage of livestock waste into the river channels in the New Territories, and ultimately to Deep Bay. Sewage improvement schemes in Shenzhen are similarly expected to eventually result in improved water quality, but the timing of the implementation of these schemes is less certain.

Summary

9.4.29 A summary of the mitigation measures to be implemented to minimise potential impacts from the Project is shown in Table 9.22.

Table 9.22 Mitigation Measures for Potential Impacts on Ecological Resources

Habitat type	Potential Impacts of Project	Mitigation measures
Sparsely vegetated grassland	Loss of significant proportion of on-site habitat under site formation; loss of courtship, breeding and feeding area, loss of feeding habitat and shelter for mammals, amphibians and insects	Amphibians are expected to inhabit puddles found elsewhere within the mitigation area. Site should be inspected for mammals before site formation and individuals relocated as required. Stockpile drain should be aligned to avoid nesting areas, or permits obtained if drain built in breeding season.
Stockpiles	Destruction of Kingfisher nesting areas	Check stockpiles for Kingfisher burrows. Either obtain permit from AFD or avoid grading of stockpiles in breeding season (March - July).
Woodlands - AFD plantations	Loss of plantation through habitat replacement	Habitat replacement not considered necessary for AFD plantations. Native trees to be planted within mitigation area particularly those useful for wildlife and which are attractive for human visitors.
Eastern Temporary Channel (ETC), marsh, fishponds Old Western River	Loss of substantial proportion of channel and all of Old Western River under site formation, loss of benthic, insect and bird populations, loss of breeding and feeding habitat for birds, loss of feeding area for mammals	Provision of freshwater wetland habitat as part of development of mitigation areas. Works for construction of mitigation area, in particular the wetland, will be scheduled to occur during Contract 7 or 8. Site should be inspected for mammals before site formation and individuals relocated as required.
Western Temporary Channel and cross channel	Increased disturbance due to proximity of development	Use of woodland plantings, control of public access away from sensitive areas.
	Increased run-off into channels.	Installation of sediment traps during site formation, installation of oil interceptors and stormwater treatment facilities.
	Water quality impacts during dredging and stormwater run-off	See Section 7. Use of cofferdams etc.
	Loss of young individuals of colonising species	Maintenance dredging on one side of the channel at a time.
	Loss of habitat during concreting of WDCE	
Inner Deep Bay	Increased run-off into channels	Installation of sediment traps, silt traps.
	Water quality impacts during dredging and stormwater run-off	Installation of oil interceptors and stormwater treatment facilities.
	Accidental spills	Minimise storage of hazardous waste on site, ensure sufficient maintenance of the sewage pumping station.
	Increased human disturbance through light, noise, human presence	Adherence of DBG for noise, use of barrier planting, control of public access away from sensitive areas.
Deep Bay seabed	Increase in pollution loadings from stormwater run-off	Section 7. Water pollution reduction ability of replacement freshwater wetland.

Environmental Monitoring & Audit

9.4.30 The information obtained during the current assessment is a valuable database of background information indicating the natural trends in the ecological systems over a 12 month period. An on-going monitoring programme is essential to evaluate the effectiveness of the mitigation measures which have been implemented and to aid as an early warning of unacceptable levels of cumulative impact.

9.4.31 The proposed EM&A programme will monitor noise, dust, water quality and ecological parameters during each phase of the development and compare data with defined lower limits which warn of impending change and upper limits which initiate action. These limits will be established through evaluation of trends during collection of baseline data.

9.4.32 The impacts of water quality on many aspects of the ecosystem indicate the importance of a water quality monitoring programme. However, sampling cannot be continuous and pollution events which occur between water sampling events may pass unnoticed. Ecological monitoring may serve as a back up to water quality monitoring. The former will pick up any deterioration in water quality affecting the biological community including any intermittent deterioration between samplings or long term cumulative effects.

9.4.33 In the ecological environment, the parameters which should be monitored are not well established. This assessment has shown the importance of the benthic community as a barometer of the health of the intertidal ecosystem.

9.4.34 The REMOTS Study carried out in this assessment showed a highly degraded benthic environment with few infauna, a result of organic pollution. The dependency of birds, epifauna and bottom feeding fish on the infauna community indicates that monitoring of benthic infauna is an important measure of ecological health.

9.4.35 The EM&A results obtained depend to a large extent on the events immediately preceding sampling. The EM&A team will need to carefully consider all relevant information. For example, a storm can wash away the top layers of the sediment along with its associated benthic communities. Seasonal fluctuations also affect the data.

9.4.36 Although the significance of an impact is difficult to define, the density, size and diversity of the benthic community should continue to be studied because of the increasing pressure on the intertidal habitat by resident and migratory birds feeding on the food resources. The number of birds feeding from season to season should be carefully monitored, but the use of this as an ecological monitoring tool is difficult because of the variability of the population. Consequently, lists of species abundance as recorded by the Bird Watching Society will be reported.

9.5 Schemes for Habitat Replacement and Upgrading of the Conservation Area

9.5.1 The concept of a conservation area as a buffer area between TSW and Inner Deep Bay thus mitigating the effect of development was first presented in the Preferred Concept Plan (Shankland Cox 1995) for the Development of TSW. This assessment has developed this idea to enable the mitigation to remove potential interface problems between areas for people and areas for conservation. The principal functions of the scheme described in this section is as replacement habitat and to act as a buffer area for the Ramsar Site. By designing the wetland replacement area such that it creates a linkage between people and the Ramsar Site, the replacement habitat can achieve a number of additional functions: recreation; education; water quality control as well as habitat diversification in the area.

9.5.2 The wetland area can achieve the principal aims. Establishment of the habitats will require detailed design studies for the engineering and planting schedules. One of the many useful functions of wetland is its ability to improve the quality of water before entering Deep Bay. The scheme presented here has been designed as mitigation for ecological impacts but has also been designed to ensure beneficial long-term improvement of water quality (Section 7).

9.5.3 A schematic version of the design is shown in Figure 9.12. The area comprises a constructed freshwater wetland as well as areas of open woodland and dense woodland.

Responsibility for the Scheme

9.5.4 TDD would be responsible for implementing the habitat areas with assistance from AFD, or alternatively TDD may entrust the works to a works agent of AFD, if any.

9.5.5 The ongoing management is recommended to be under one authority. The site is adjacent to the Ramsar Site and AFD is responsible for matters related to the Ramsar Site. The EIA therefore has strongly recommended that AFD takes up the subsequent management subject to availability of resources. Advice on water quality would be obtained from DEP.

9.5.6 Dredging of the large sedimentation pond will be undertaken by DSD.

Replacement of Lost Habitat

9.5.7 Construction of the freshwater wetland in Areas 114 and 118 has been triggered by the loss, due to Project activities, of areas of wetland on the RZ (such as the Old Western River and the Eastern Temporary Channel) which represents a habitat under increasing threat from development in Hong Kong. As a result of its rarity, the ecological value of freshwater wetland is high.

9.5.8 In order to enhance the ecological value of the wetland area, several microhabitats will be created. A greater diversity of species will be supported in such a habitat, allowing for a greater chance for establishment of species which require specific environmental conditions. These microhabitats will be made smallest and most attractive on the southern side of the wetland area which will have most public visitation.

Upgrading of the Conservation Area

9.5.9 The scheme will also provide protection from human disturbance of the mudflat area in the downstream area of the Western Channel. Area 119 is currently Government plantation which is considered to be of relatively low value in this Project.

9.5.10 The old dumping grounds in the conservation area in Area 118, currently supports Government plantations of exotic trees on higher ground. The western area will be retained as a raised area for observation of the surrounding ecological sites. The plantations should be replaced with densely planted native woodland in the lower areas and grassland and open native plantings on raised ground. The current soil in these areas is poor and was originally unusable material. Top soil should be provided.

Requirements for Success

9.5.11 In order to reduce the maintenance requirements of the wetland, sediment should be removed from the water flow before it enters the wetland. A natural sedimentation pond, the EDC, is already present into which the ECE will flow.

9.5.12 Sediment settled out in the EDC should be removed at appropriate intervals by DSD to prevent sediment washout in a storm. Determination of the frequency of dredging requires regular inspection of the channel. Easy access for equipment should be provided such as concrete ramps etc. The frequency of dredging has been predicted by the *Territorial Land Drainage and Flood Control Strategy Study - Phase III* otherwise known as DSD's Sedimentation Study as being very infrequent. This study by Hyder Consulting is not yet complete.

9.5.13 Water containing very low suspended solids levels will flow into the wetland which comprises a 2.7 km long channel, with an average width of 30 m. The depth of the channel will vary between 0.5 m and 2.0 m due to the incorporation of a series of shallow and deep pools, separated by weirs for flow control.

9.5.14 Design criteria for the function of wetland as a pollutant removal device were described in Section 7.6 and general dimensions were assigned to the wetland to illustrate its treatment capability.

9.5.15 Maintenance of the wetland is essential to ensure efficient removal of sediment and pollutants. The wetland should be regularly inspected to ensure the water is not becoming odorous and foul. This may occur if high levels of nutrients and contaminants are entering the system and the treatment is not effective. Pumping additional water from the reservoir to increase flow may alleviate any temporary anoxic conditions.

9.5.16 The efficiency of treatment can be increased by monitoring the rate of growth of vegetation and removal of excess or older vegetation, to provide space for additional plants to grow and uptake nutrients. Particularly fast growing plants (such as water hyacinth) may tend to block channels , resulting in overflow of the water from the channel. Water hyacinth can be controlled to some extent by stocking the wetland with herbivorous grazers such as grass carp (*Ctenopharygodon idellus*).

9.5.17 Water hyacinth and plants such as phragmites planted in the upstream section of the wetland should be regularly harvested and sent to landfill. Many pollutants will be trapped or taken up by these plants. If they are allowed to die or become overwhelmed by pollutants these pollutants will be returned to the water body. Through regular harvesting, pollutants such as oil and grease and heavy metals are removed from the system.

9.5.18 Paths along the sides of the channel must be constructed to enable maintenance vehicles to gain access to all areas of the wetland. These access routes must be well maintained.

9.5.19 The value of this area from an ecological stance has been described in Section 9.4. It partially replaces a freshwater wetland lost under site formation and, with good management, will provide a more ecologically diverse habitat than that which was lost. It is important to select appropriate vegetation to ensure management of the area can be kept to a minimum and the wetland can fulfill its function of a treatment system and an area of ecological diversity. The staff maintaining the wetland should be encouraged to keep a small plant nursery so that plantings can be replaced on a planned basis.

9.5.20 In 'dirty' and 'clean' areas at both ends of the channel, on the margins and shallow water, the Phragmites should be replaced in 3 to 5 year cycles. Older stands are less attractive in appearance. Three year old stands have the highest abundance of Odonates. The vegetation will be dominated by *Phragmites*. Diversification of the habitat can be provided by planting other grasses and sedges. This habitat will provide good shelter and spawning ground for fish, and promote insects such as dragonflies (Hodgkiss 1978). Fishponds are well-known for the production of chironomids and other flying insects, which are the staple food of birds such as nightjars and warblers (Viney *et al.* 1994).

9.5.21 Deepened sections of the channel will likely be dominated by water hyacinth, which needs to be managed carefully because it is a highly opportunistic species and will readily displace other vegetation. Diversification of the deeper water can be achieved with water lilies, floating duckweed, and submerged pondweed. The ecological roles of these plants will be as shelter and food for fish and insects, that will provide food for birds.

9.5.22 Other bird species which are expected to visit and benefit from this wetland include herons, egrets, rails and crakes, ducks, stints, snipe. Feeding insectivorous mammals are likely to attract birds of prey.

9.5.23 Consideration should be given to keeping a few waterfowls particularly in the southern channel of the freshwater wetland. These birds will have the effect of encouraging other birds to visit and aid in overcoming the effects of human disturbance. If the bridges are shut at dusk it is likely that great flocks of birds will fly in and out at dawn and dusk particularly if some feed for the captive waterfowl available. This effect will be visible from areas accessible to the public and can be quite spectacular.

9.5.24 In addition to the freshwater wetland, the conservation area will include areas of intertidal mudflat, on the northern shore of the WDCE where egrets, herons, ducks, and shorebirds will feed. This could be viewed from observation towers and viewing areas.

9.5.25 Other freshwater wetland areas will be developed. This will be an entirely shallow marshland which will support a *Phragmites* reed bed and associated insect species. Amphibians will also be able to utilize ephemeral wetlands in this area.

9.5.26 If storm overflows are not allowed to bypass the wetland area, flooding of the adjacent land may occur. The design incorporates low-flow weirs to divert most storms into the wetland, and allow flood water to bypass the wetland via the Eastern Outfall.

9.5.27 The flowrate through the wetland and the type of vegetation planted will affect the efficiency of water clean-up and should be considered in the detailed wetland design (Appendix D2).

9.5.28 Poor treatment can also lead to algal blooms. Maintaining an adequate flow through the wetland can be achieved by pumping water from a deep reservoir at the outlet of the wetland to recirculate water back to the inlet of the wetland.

9.5.29 Rotting vegetation should always be removed to avoid further contribution of nutrients from the plants which are initially carrying out the pollutant removal. The wetland areas and park areas closest to housing areas should be adequate gardening. By comparison the outer observation area should be comparatively wild. All areas should be kept free of rubbish.

9.5.30 Low flowrate wetland areas are an ideal habitat for mosquitoes to breed which will create a public nuisance for residents of Tin Shui Wai. Maintaining an adequate flowrate through the system will help reduce mosquitos. Stocking the wetland with mosquito fish (*Gambusia affinis*) or Guppy (*Poeceilia reticulata*) will also help reduce this nuisance. Dragonfly nymphs and adults also prey efficiently on mosquitos.

9.5.31 The TSW wetland conservation area can provide a means to focus public access into an area from which the Ramsar site can be viewed. Increasing public awareness is an important aspect of conservation. To do this, the public must be given access to experience the importance of the resources available. Access must be balanced with the requirement to maintain an undisturbed environment for the organisms being conserved. The areas of access and those areas to which access is restricted must be clearly defined in order to meet the management objectives.

9.5.32 Access for the public has been considered in the design of the scheme. The raised ground in Area 118 could provide a general viewpoint for any visitors. Any footpaths and bridges built for maintenance purposes should be low maintenance structures.

Impacts from Construction of the Wetland Replacement Scheme

9.5.33 The potential short-term impacts which will arise during the necessary construction works associated with forming the replacement habitat areas are heavily outweighed by the long term benefits. The same mitigation measures and standards applicable to works on the ETC and the site formation works within Area 114 apply to these works.

9.5.34 Disturbance generated from the construction of the wetland, and site formation works adjacent to the area, will deter birds from using the area for feeding or breeding unless they adapt to the changed environment. The Savannah Nightjar may be successful in adapting to the environment because it is night feeding and has been observed to occupy other areas where considerable disturbance occurs (Melville, pers. comm.).

9.5.35 About 2 m of good quality sand fill would be removed from the areas within the wetland. About 300,000 m^3 of fill would be released for the Project resulting in a cost benefit.

9.5.36 The old dumping grounds would be given a 300 mm or so coating of landscaping quality soil and landscaped with suitable native species. Landscaping and landscaping soil is also needed in the areas closest to the development in order to avoid interface impacts between the development and the wetland area while providing pleasant environment for people visiting the area.

9.5.37 The EDC would be deepened through the removal up to 70,000 m^3 of unsuitable material to form a settlement pond and water storage area. This material would go to public dump.

9.5.38 The material remaining in the main wetland area would be used to roughly form the channels and the banks. This would cost approximately $1 million. A minimal amount of good quality landscaping soil may be required.

9.5.39 About 50% of the wetland planting should be Phragmites which is readily available and fairly opportunistic. The remainder of the wetland species plantings are dependent upon the final detailed design and the availability of stocks.

9.5.40 The works will be undertaken during the period of the main Project works (Contracts 7/8).

Attribute	Impact
Construction noise and dust	Minimal dust impact. Short-term impact from construction noise
Mangal-intertidal mudflat	Occurrence within Area 118 maintained
Contaminated material	Left in place
Quality sandfill released	300,000 m^3
Water Quality	Minimal during construction phase
Cost	Most cost-effective of options examined
Visual Impact	Beneficial impact during operational phase. A view is given in Figure 9.13

Costs

9.5.41 A broadbrush costing at today's prices is given below. Further information is given in the Final Investigation Report. The costs are based on the provision and maintenance of the scheme as (i) ecological replacement habitat areas and (ii) water quality control area between the development and the Ramsar site.

1. Freshwater Wetland and Pond Areas: HK$26 million.

2. Woodland Areas: HK$25 million.

3. Associated facilities including maintenance area and facilities, bridges, roads, paths, fences, weirs and pump-house: HK$25 million.

4. Preliminary (15%) + Safety (2%) + Contingency (30%) on capital cost before savings: HK$36 million.

5. Ongoing Maintenance Costs including staff requirement: $3 million per annum (Ref. WWF experience at Mai Po Nature Reserve for basic maintenance).

9.5.42 Maintenance of the area as ecological replacement habitats includes tasks such as tending, replacement planting, nursery for stock and replanting. Maintenance of the wetland as a water treatment area includes monitoring of water quality and water levels, use and maintenance of pumps and weirs as necessary, regular replacement of certain species of plants and clearing of unwanted materials. These functions would be mainly undertaken by field assistant/skilled workmen/gardeners under the supervision of a manager and two sub-managers with specialist knowledge of wetland functions and the care of fauna and flora.

9.5.43 The statistics of the scheme are shown in Table 9.23.

Table 9.23
Statistics of the Scheme

Freshwater wetland channel area	16.4 Ha
Sediment pond	0.7 Ha
Deep pond areas	0.9 + 2.0 Ha
Open woodland areas	9.6 Ha
Remote dense woodland areas	15.5 Ha
Maintenance area	1.0 Ha
Length of fence	3.6 km
Length of footpath	2.1 km
Length of road	1.3 km
Number of small bridges	4
Total area upgraded	46 Ha
Untouched area	19 Ha
Total Area (including EDC)	65 Ha

9.6 Residual Impacts from Project Activities

9.6.1 The mitigation measures described in Sections 9.4 and 9.5 reduce the impacts on the ecological system. It has been shown that full quantitative compensation, in terms of complete habitat replacement and retention of all animal and plant populations, cannot be achieved. Where appropriate, qualitative mitigation measures have been described.

9.6.2 As a result, residual impacts exist and the acceptability of the residual impacts (as shown in Tables 9.24 and 9.25) determines the overall acceptability of the Project.

Table 9.24 Residual Impacts on Habitat Loss after Mitigation

Habitat	Estimated Area Lost due to the Project (ha)	Area of Replacement Habitat (ha)	Residual change (ha)
Intertidal Mudflats	3.1	0	-3.1
Mangroves	0.3	0	-0.3
Fishpond	3	0	-3
Freshwater wetland: ponds, marshes, reedbed	17.5	18.5	+1
Grassland	135	0	135
Native woodland	0	+15	+15
Government plantation	44	0	-44

Table 9.25 Residual Impacts on Ecological Resources from Project

Habitat type	Major Impacts of Project	Residual Impacts after implementation of Mitigation Measures
Freshwater wetland	Loss of significant portion of ETC and associated populations of insects, fish, water birds, songbirds, amphibians, mammals and vegetation.	After construction of replacement habitat, no residual impacts are expected. Disturbance from noise cannot be completely mitigated and some residual noise impact exists for some bird species. Replacement of habitat for wetland leads to destruction of grassland/plantation areas on Areas 118 and 119 (considered to be of lower ecological value than freshwater wetland). Construction of wetland area has positive impact because of enhanced ecological value of created habitat. <u>Residual Impact</u>: <u>Minimal.</u>
	Potential for deterioration in water quality and changes in hydrology through urban stormwater runoff	Changes in hydrology will not result in increased erosion/ sedimentation. No adverse residual impact on water quality from the further development of TSW.
	Human disturbance during site formation, infrastructure and operation stages of Project.	Loss of remote intertidal and terrestrial habitats. Residual impacts of disturbance are acceptable providing mitigation measures are implemented.
Intertidal habitat	Small loss of waterbird feeding habitat, small loss of mangrove which acts as bird roosting area, potential water quality and sedimentation impacts	After installation of sediment traps, and successful construction and maintenance of the replacement freshwater wetland area, no residual impacts are expected on water quality and sedimentation. Water quality will not deteriorate if correct construction practices are followed as discussed in Section 7. Disturbance on waterbird community is a residual impact.
	Works in WTC will remove benthic population.	Disturbance of sediment benthos and mangrove as a temporary impact is acceptable.
	Works in ETC may impact water quality downstream.	Very minimal with water quality mitigation measures planned. <u>Residual Impacts</u>: <u>Minimal.</u>
	Potential for deterioration in water quality and changes in hydrology through urban stormwater runoff	Changes in hydrology will not result in increased erosion/ sedimentation. No residual impact on water quality with implementation of stormwater mitigation. Water quality will improve markedly with the disappearance of livestock wastes from the water.

Table 9.25 Residual Impacts on Ecological Resources from Project (cont'd)

Habitat type	Major Impacts of Project	Residual Impacts after implementation of Mitigation Measures
	Human disturbance during site formation, infrastructure and operation stages of Project.	Loss of remote intertidal and terrestrial habitats. Mitigation to reduce impact to be implemented. Residual impacts of disturbance are acceptable providing mitigation measures are implemented. Concurrent projects are expected to have residual impacts of increased sedimentation and reduction in water quality during construction. These may not be acceptable on intertidal and subtidal benthic community, but cannot be mitigated under this Project because the impact does not arise from the Project.
Grassland	Loss of significant portion of grassland under site formation; loss of insects, mammals, songbirds associated with habitat. Destruction of kingfishers breeding sites.	Loss of habitat for breeding, feeding, nesting of songbirds, and for mammals and amphibians. <u>Residual impacts</u>: <u>Minimal</u> providing songbirds can colonize similar areas elsewhere in Territory or are successfully relocated and mammals and amphibians successfully relocate to other areas. The songbirds are not endangered species.
Woodlands	Loss of plantations under creation of replacement habitats. Erosion problems where woodland removed.	Residual impact is loss of AFD plantations. Beneficial residual impact on native woodland because of additional plantings. <u>Residual impacts</u>: <u>Minimal</u> because of low ecological value of AFD plantations and positive due to provision of native woodland.

Residual Loss of Habitat

Freshwater Wetland

9.6.3 The major mitigation measure described in this study is the constructed wetland to compensate for loss of freshwater wetland on the RZ and the fishponds alongside road D3. An area of 20.5 ha, which amounts to less than 6% of the Territory's freshwater wetlands, will be lost under site formation. The replacement wetland area encompasses 16.5 ha, and another 6.2 ha of fishponds is provided as mitigation in other areas on site.

9.6.4 The extent of the residual impacts resulting from incomplete mitigation, is minimised through habitat enhancement. Wetland construction design has incorporated areas of deep and shallow water to encourage diversity of flora and fauna as well as provide aesthetic appeal for visitors. These attributes will increase the ecological value of the habitat in comparison to the area lost.

9.6.5 Ephemeral marshy patches which form ideal habitat for amphibian breeding will be created within the wetland replacement scheme and these organisms are expected to successfully utilise suitable habitat.

9.6.6 Despite the successful implementation of the habitat replacement scheme, residual impacts will exist. The territorial demands of avifauna and mammals will likely result in a loss of part of their populations. None of the birds recorded using the habitats to be lost are endangered. However, freshwater wetland habitat is one of the habitat types under most threat in Hong Kong at the present time.

Intertidal Wetland

9.6.7 The loss of the remote character of intertidal habitat cannot be fully mitigated because of the increased disturbance which will ensue from the operation of the Tin Shui Wai development. Addition of barrier native woodland areas and restriction of public access to the mudflats can only partially compensate for the impact on the waterbirds which utilise this environment. The long-term benefits of children educated as to the value of the Ramsar Site and wetlands far outweighs the loss of remoteness of this piece of wetland.

Grassland

9.6.8 The acceptability of the grassland habitat loss depends on the success of recolonisation of the species elsewhere in the Territory. Studies of the Little Ringed Plover have shown its ability to adapt to areas of substantial human and operational disturbance (Leven, pers. comm.), and the presence of breeding Savannah Nightjars is likely to be confirmed in the hills at Lau Fau Shan adjacent to the Site (Melville pers. comm.). However, breeding Oriental Skylark seems to be restricted to relatively undisturbed, lowland grasslands in Hong Kong (Leven pers. comm.). Deep Bay is currently the only known wintering ground for Styan's Grasshopper Warbler and its relocation ability is another aspect of the acceptability of this impact.

9.6.9 The success of recolonisation in other areas will depend on the degree to which birds can adapt to human disturbance and the availability of alternative habitats for recolonization.

9.6.10 None of the bird species currently inhabiting the RZ is endangered.

9.6.11 Destruction of the stockpiles on the RZ will not be mitigated. However, the residual impacts are expected to be minor because of the likely ability of the kingfisher inhabitants to find alternative locations for nesting.

Woodlands and Plantations

9.6.12 Native woodland replacement through planting along roads and in the habitat replacement areas is multi-function serving as a visual/noise barrier, enhancing the native woodland population in the area and providing shelter and a variety of additional food sources for birds.

Water Quality in Inner Deep Bay

9.6.13 The water quality impacts resulting from the development of the Tin Shui Wai RZ will have little effect on the hydrology and water quality of the receiving water channels provided the mitigation planned is implemented.

9.6.14 Due to the temporary nature and degree of the construction phase impacts, these residual impacts should be acceptable. Monitoring of the health of benthic community is essential to provide early warning if food resources are being impacted, and should be carried out as part of the EM&A programme to ensure that any impacts on the benthos are sufficiently small in time and space to avoid impacts on the bird populations.

9.6.15 The implementation of mitigation measures to prevent accidental spills and incorrect disposal of wastes will eliminate residual impacts from these activities (Section 7.7).

9.6.16 However, it should be noted that both the temporal and spatial cumulative impacts from all concurrent Projects impacting on Inner Deep Bay could continue to be very severe if not controlled.

9.7 Conclusion

9.7.1 The project area for the proposed development comprises mainly of newly reclaimed land now covered by grasses. Some areas left untouched since the works in the early 1990s have become habitats for the feeding and breeding of some species. More valuable habitats are mainly found at the northern periphery of the TSW Reserve Zone. These include woodlands, mangroves, intertidal mud flats and other wetlands. The most important one is the mud flat at Inner Deep Bay which was designated as a Ramsar Site in 1995.

9.7.2 The major impacts of the proposed development to the sensitive ecological environment are the loss of habitats, potential for deterioration of water quality and disturbance from human activities. Provided water quality is controlled within acceptable levels as discussed in Section 7, the mudflats at Inner Deep Bay would not be adversely affected by the future development of TSW. The conservation areas to the north of TSW will be upgraded to replace lost habitats and act as a buffer to the Ramsar Site. The needs of the residents and visitors of TSW have been paramount in the suggested design to ensure that interface problems are minimized.

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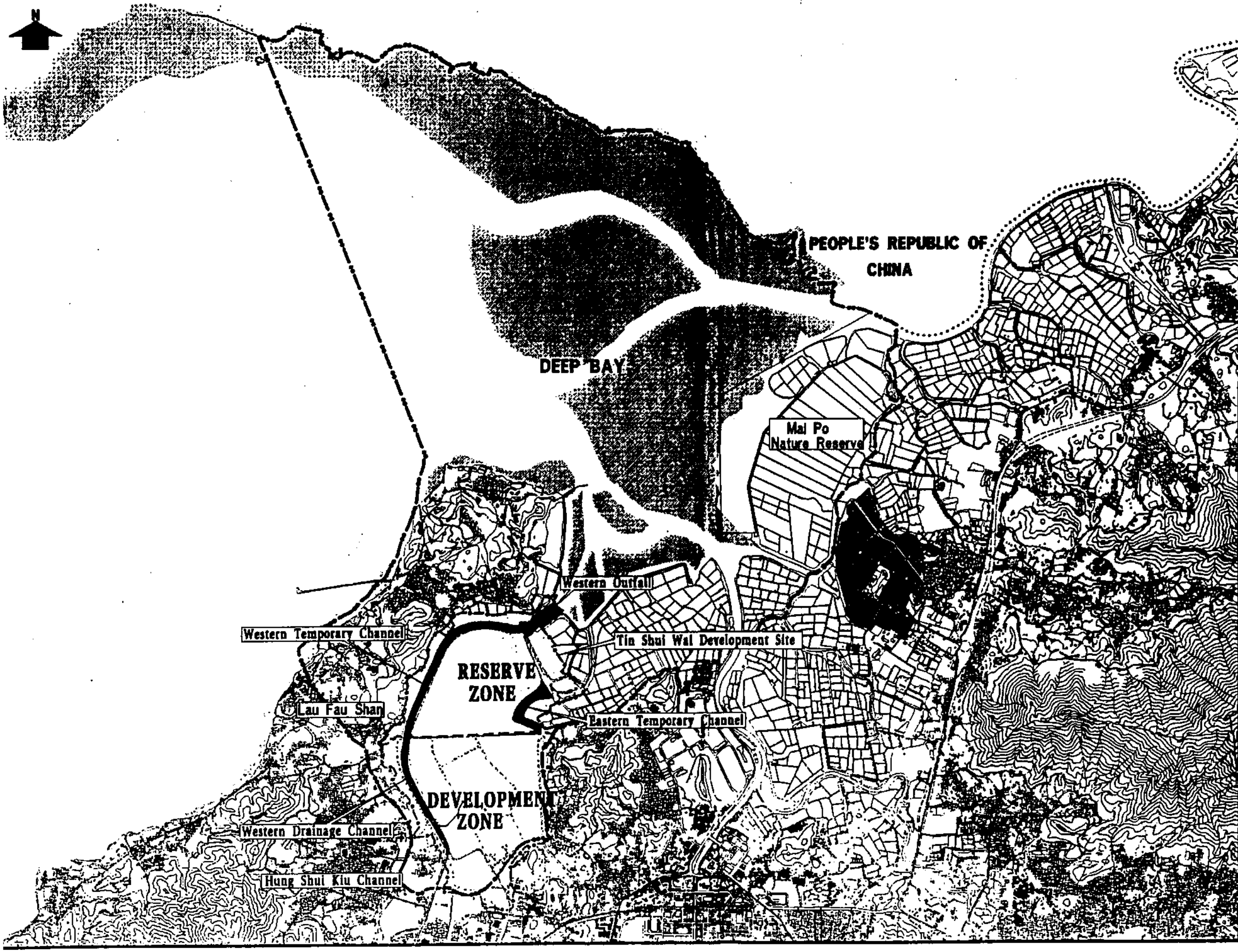


Limit Of Study Ar[ea]

TIN SHUI WAI DEVELOPMENT

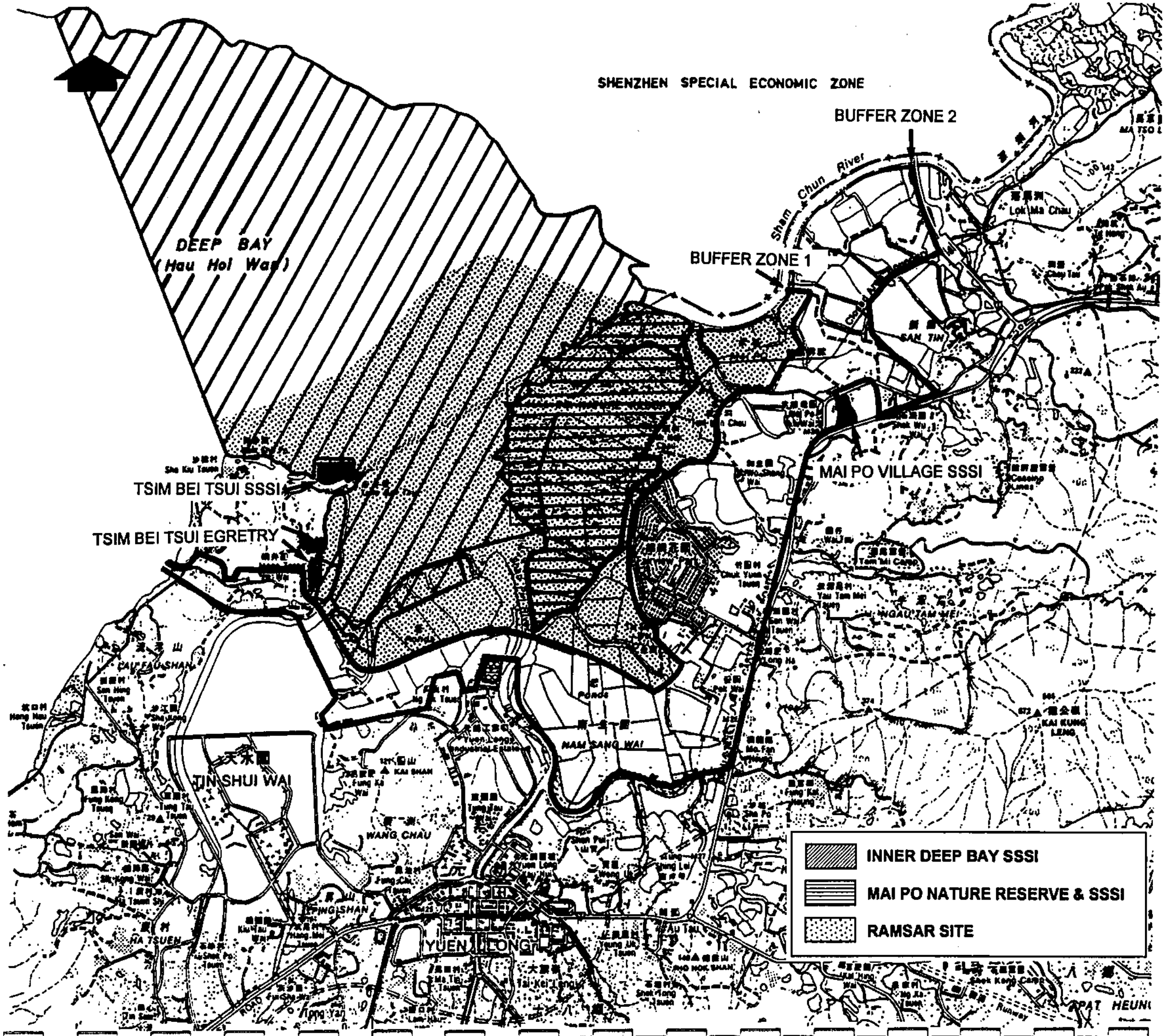
A MAP OF ECOLOGICAL STUDY AREA

Figure no.	Reference no.	Scale
9.1		NTS

賓尼

新界北拓展處
NEW TERRITORIES NORTH DEVELOPMENT OFFICE

拓展署
Territory Development Department, Hong Kong



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TIN SHUI WAI DEVELOPMENT

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

TIN SHUI WAI PROJECT AREA SHOWING SSSIs, RAMSAR SITE AND BUFFER ZONES

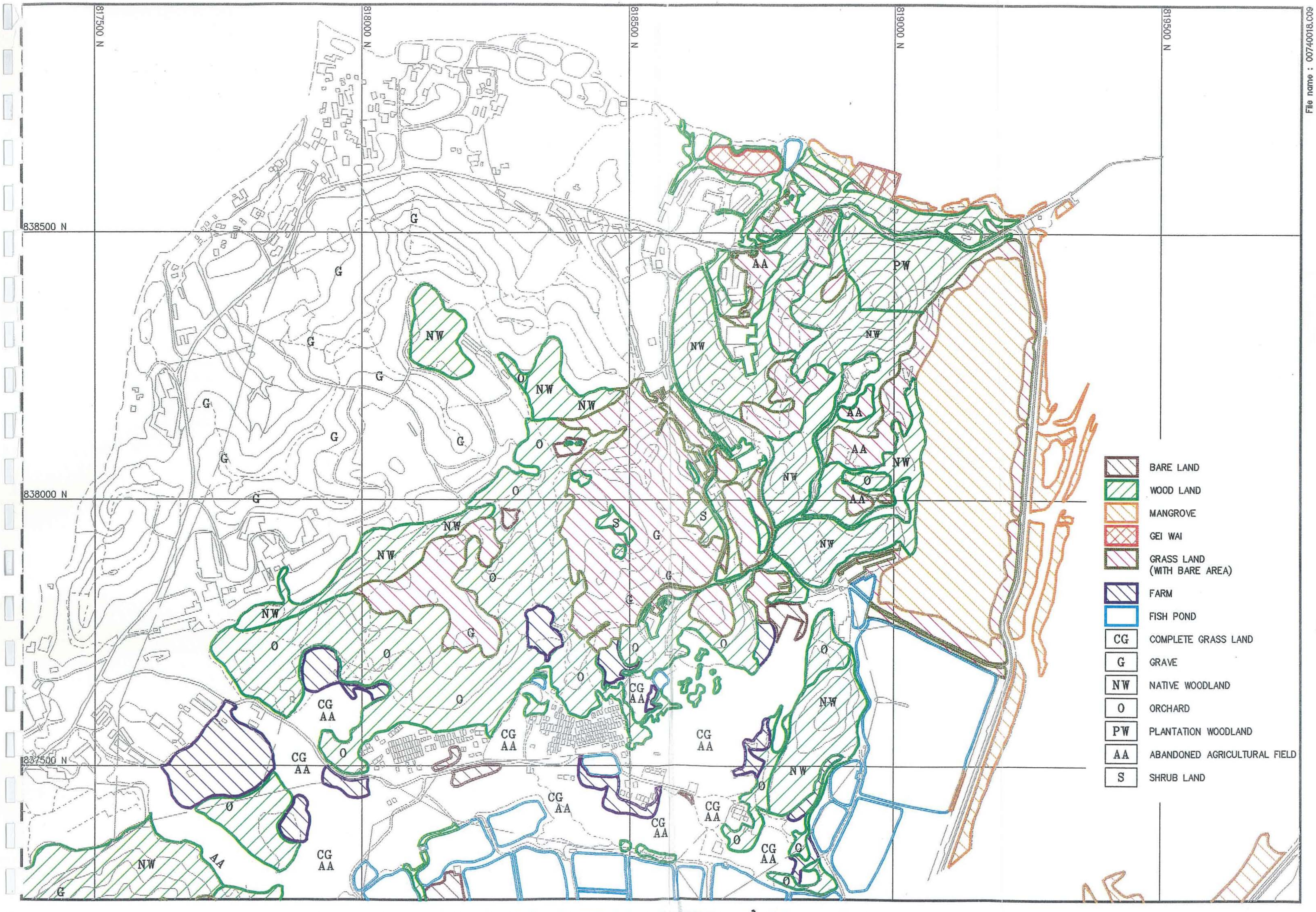
9.2	-	NTS

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼

新界北拓展處
NEW TERRITORIES NORTH DEVELOPMENT OFFICE

拓展署
Territory Development Department, Hong Kong

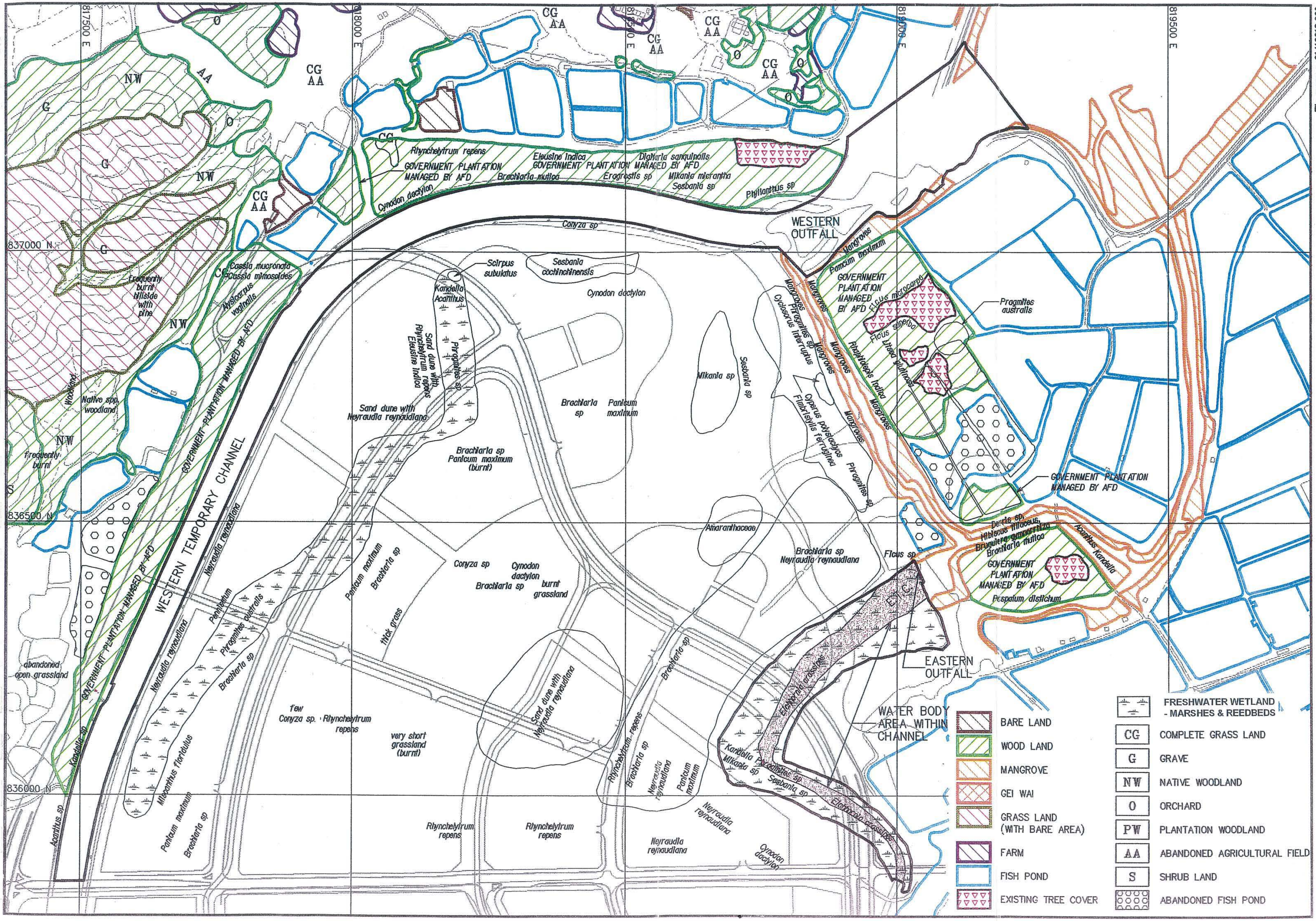
Plates 8.1 and 8.2 (above) show the commercial and public housing RCP at the Tin Shui Estate, which can be compared with the landscaped RCP for the commercial and private housing estate of Kingswood Villas (Plates 8.3 and 8.4, below), also in the DZ.



* DATE OF SURVEY APRIL 1996.

Figure : 9.3 ECOLOGICAL HABITAT MAP (APRIL) - SHEET 1 Scale : 1 : 6000

Prepared : TC Checked : SMC



DATE OF SURVEY SEPT/OCT 1996. Figure : 9.4 ECOLOGICAL HABITAT MAP (OCTOBER) – SHEET 2 Scale : 1 : 6000 Prepared : TC Checked : SMC

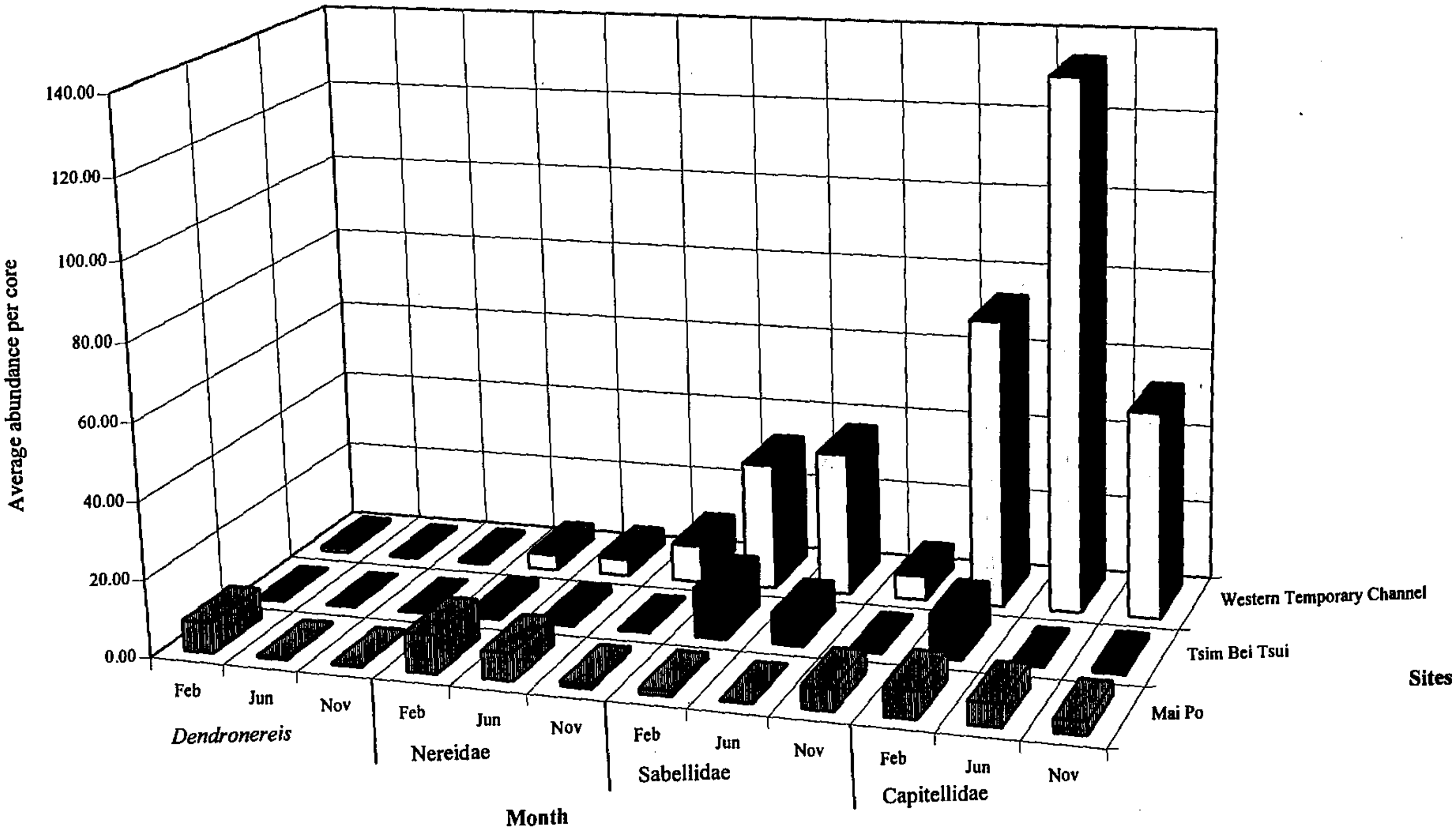


Fig. 9.9 Benthic Infauna: Abundance of Each Benthic Group

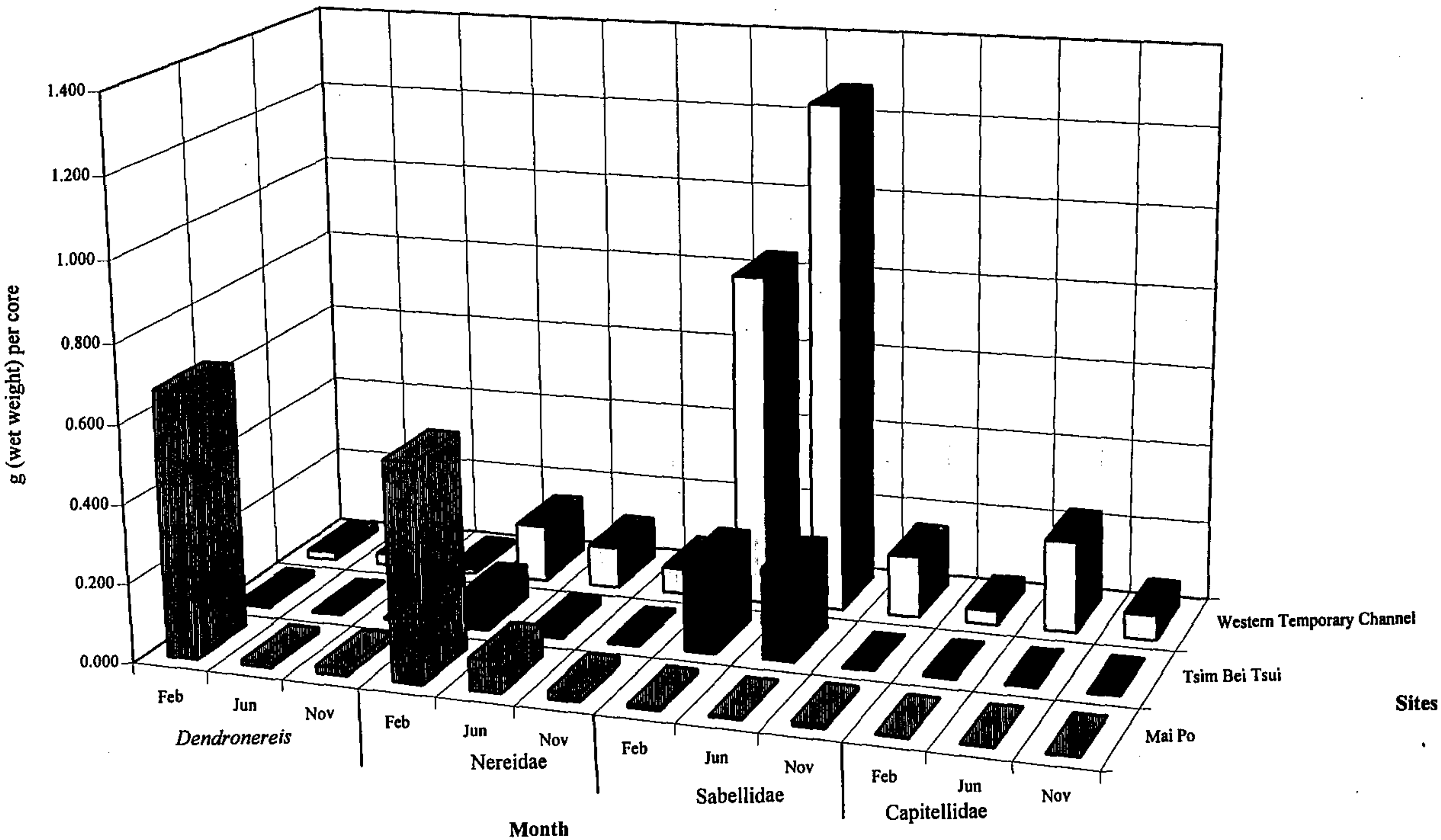


Fig. 9.8 Benthic Infauna: Biomass of Each Benthic Group

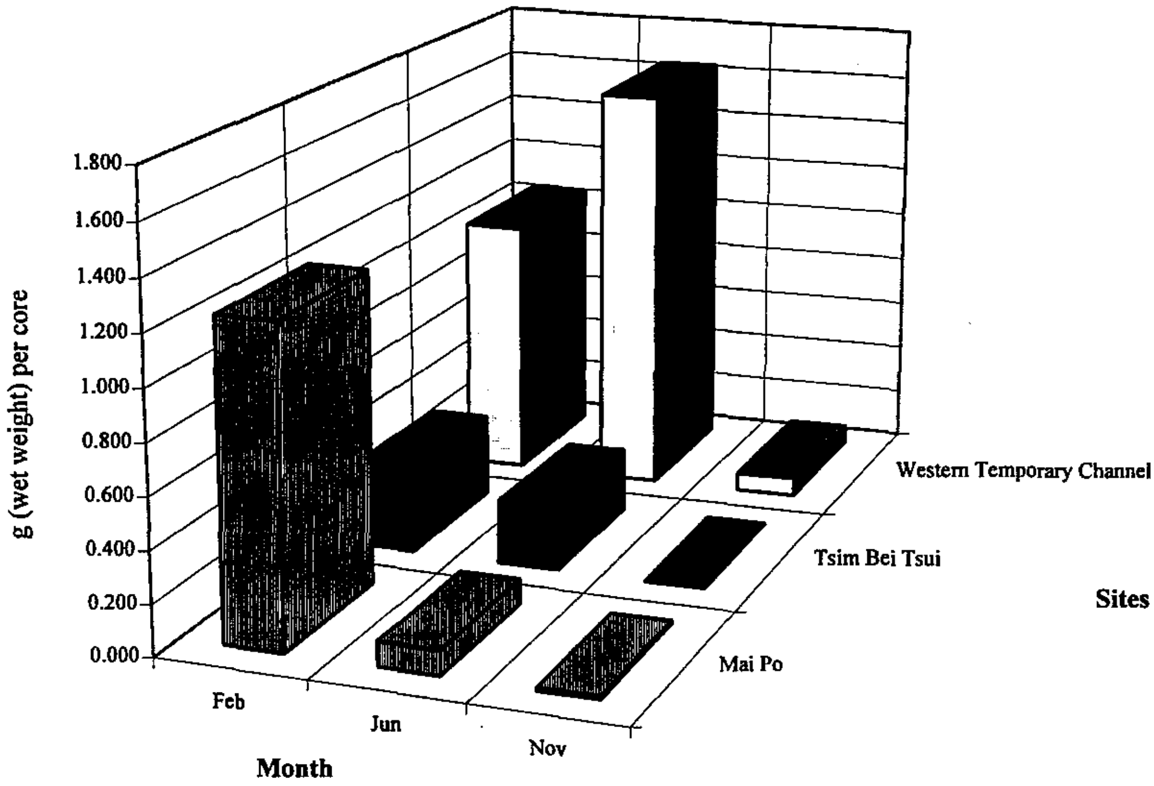


Fig. 9.6 Benthic Infauna - Biomass Distribution

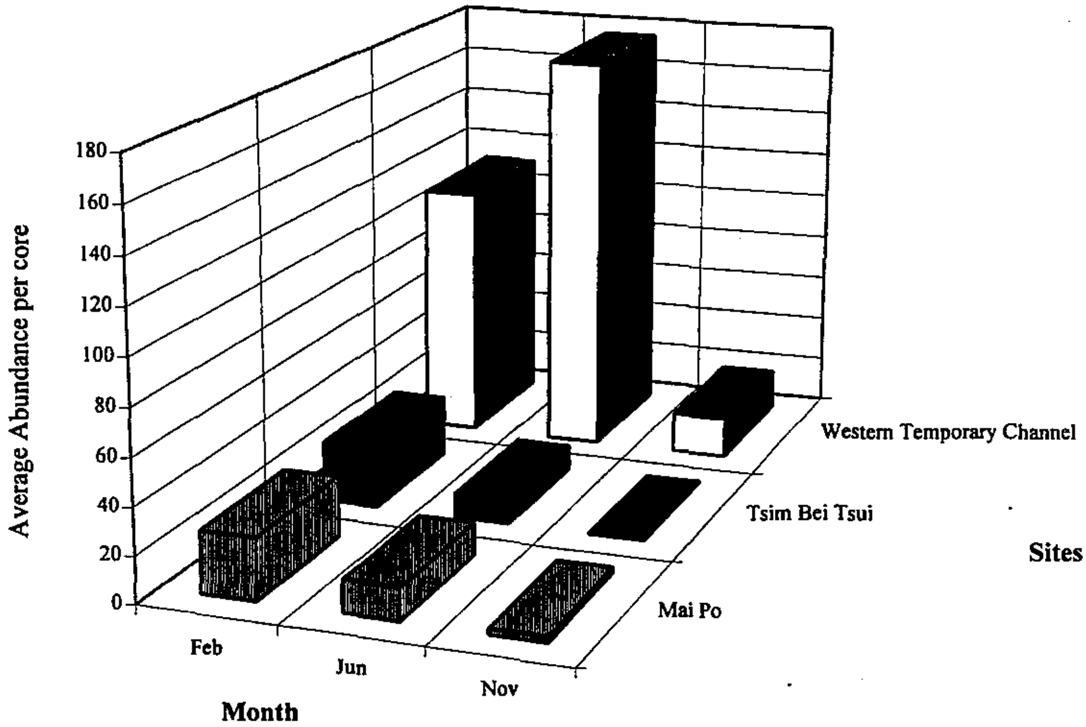


Fig. 9.7 Benthic Infauna - Abundance Distribution

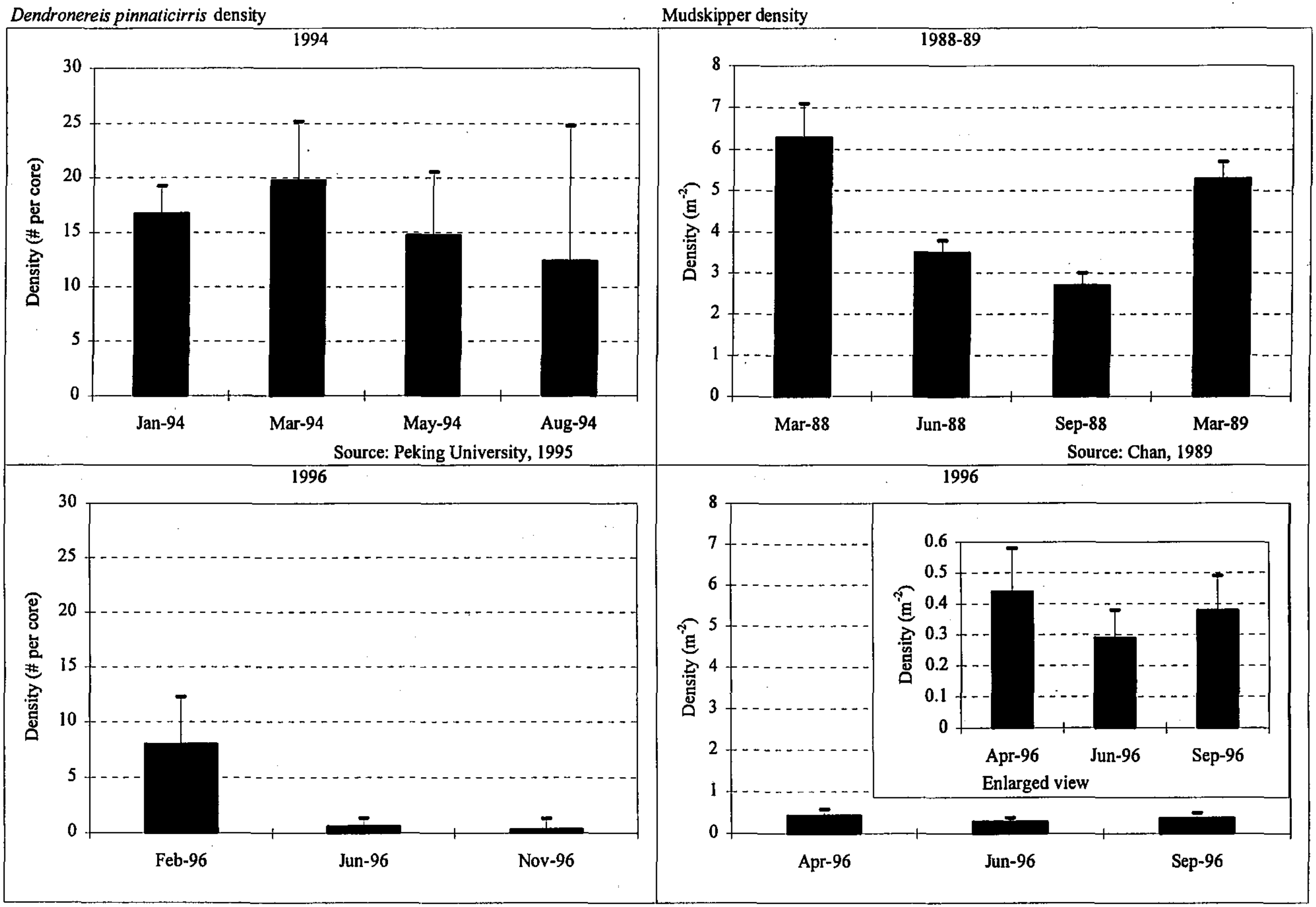
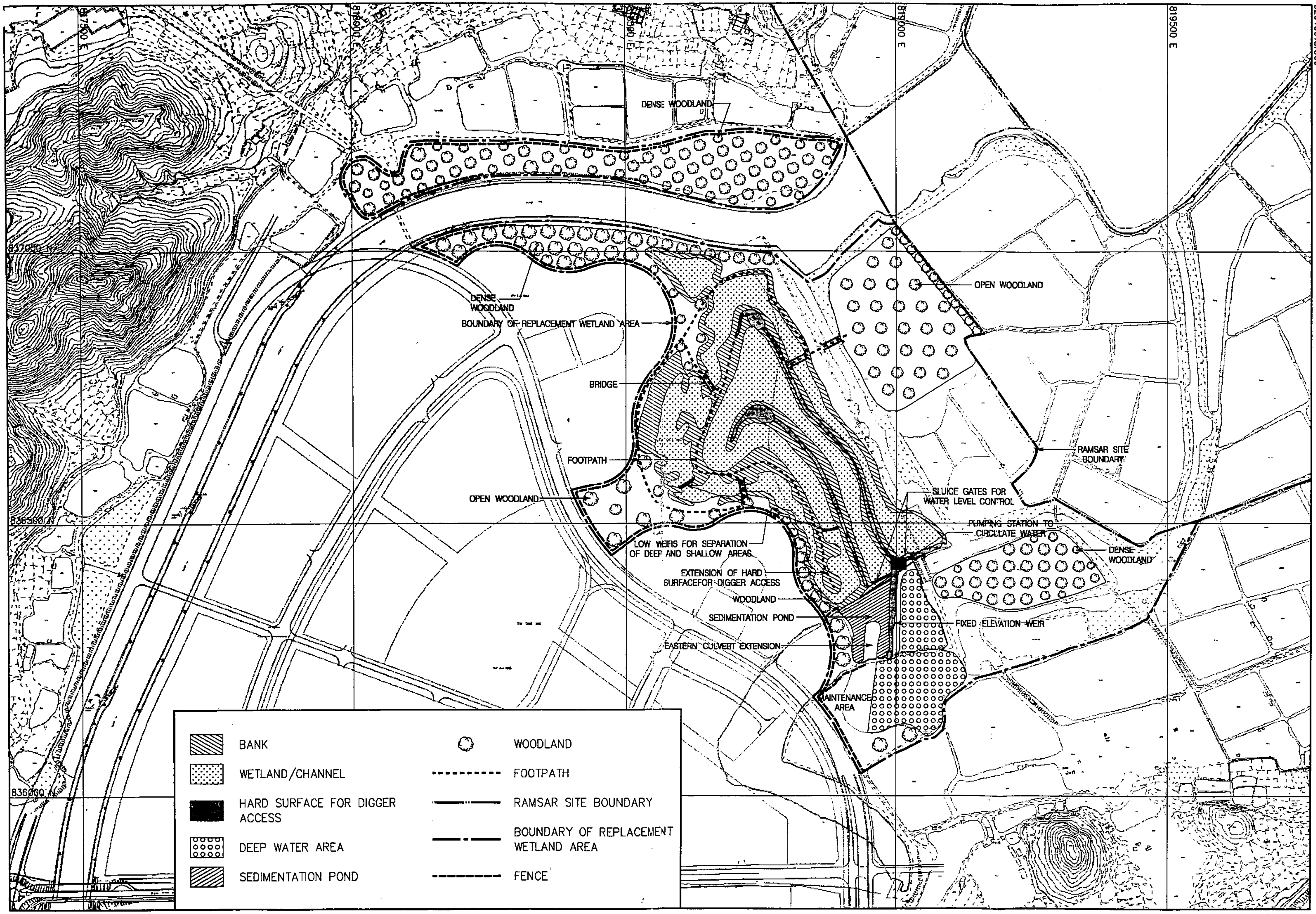


Figure 9.5 Decreased Abundance of Benthos at Mai Po



Date : FEB. 97 Figure : 9.12 PLAN FOR REPLACEMENT WETLAND AND BUFFER AREA. Scale : 1 : 6000 Prepated : SMc/LS Checked : PS

Figure 9.13 View of the Ecological Replacement Areas from Area 114 just north of Road D4

Kenneth Ng & Associates Ltd
Landscape & Environmental Consultants

10 IMPACTS SUMMARY AND RECOMMENDATIONS

10.1 Introduction

EIA Study Requirements

10.1.1 The requirements for the EIA Study are detailed in Section 5.3 'Environmental Study Brief' of the Consultancy Brief. This report fulfils these requirements which are summarized below:

(i) describe the processes/activities carried out under the Project and the corresponding implementation programme;

(ii) identify the processes/activities which may result in environmental impacts, in particular in the ecological aspect;

(iii) describe the major elements and sensitive receivers of the surrounding environment which may be affected by the processes/activities;

(iv) assess and evaluate the environmental impacts and cumulative effect arising from the Project with particular reference to those issues of key concern during the construction and operation of the Project;

(v) describe measures to minimise environmental impacts and/or enhance the environment, and evaluate the residual impacts of the Project activities after mitigation;

(vi) define measurable environmental parameters and environmental features likely to be affected by the Project and identify the environmental monitoring programmes which are required both to provide a baseline profile of existing environmental conditions and to monitor impacts and compliance during construction and operation of the Project;

(vii) define the environmental audit requirements for compliance and post-project audit, which shall include a review of the monitoring data both to identify compliance with regulatory requirements, policies and standards and to define any remedial works required to redress unanticipated or unacceptable consequential environmental impacts;

(viii) describe the agreed schedules and programmes for monitoring and audit requirements;

(ix) define the specification for detailed design, construction and operation requirements of the Project. Actions to restore and/or rehabilitate sites to an acceptable level are addressed;

(x) provide an impacts summary, which details the study findings, conclusions, recommendations and a mechanism for implementation.

Environmental Studies

10.1.2 Potential impacts have been predicted and quantified in terms of short-term, long-term, direct and indirect effects of the Project on sensitive receivers. Mathematical models have been and where appropriate and assessments carried out with reference to HKPSG and other statutory requirements.

10.1.3 Mitigation measures are defined with consideration of practicality of enforcement, cost-effectiveness and compliance with environmental standards of pollution, disturbance and nuisance, in order to reduce adverse impacts to acceptable levels.

10.1.4 A programme of environmental monitoring and auditing has been provided as a stand alone document which specifies the monitoring and auditing required to ensure implementation and effectiveness of environmental protection and pollution control measures adopted.

10.2 Noise Impact

Construction Impact Summary

10.2.1 Unmitigated noise levels could exceed EPD's recommended maximum noise levels for day-time construction work when construction activities occur in close proximity to noise sensitive receivers or when several construction works occur simultaneously.

10.2.2 Adequate mitigation measures will be necessary for the construction works to meet the criteria.

10.2.3 The use of quiet plant and working methods, reducing the number of equipment, restricting the number of works and the use of substantial noise barriers to protect the closest residence and schools has been recommended.

10.2.4 Construction traffic volume will increase during the development of TSW. Overall noise level from construction and traffic noise is expected to increase. Temporary barriers as well as the early erection of permanent barrier have been suggested to reduce excessive noise impact.

10.2.5 Construction noise is also expected to have an impact on the bird population in the northern and north-eastern part of the RZ. Mitigation measures have been recommended to reduce the noise impact.

10.2.6 An environmental monitoring and audit programme has been formulated to ensure compliance is maintained at sensitive receivers and to ensure the effectiveness of mitigation measures.

Operational Noise

10.2.7 Operational noise levels associated with the operation of the proposed sewage pumping station at Area 101 are well within the noise criteria.

10.2.8 Noise impact associated with the operation of the LRT trains and the rectifier station used for the system are predicted to be well within the noise criteria. The operation of the terminus is not expected to affect Area 106, however KCRC will undertake a noise assessment when more details of the terminus are known.

10.2.9 Potential excessive road traffic noise impact from the new roads was identified at a number of locations. Direct mitigation to be implemented by TDD includes over two kilometres of noise barriers and four kilometres of special low-noise surfacing material.

10.2.10 Set back distances for planned developments in Areas 103, 104, 112, 113, 115 and 116 have been calculated. Most of the set backs are 30 to 40 metres assuming an angle of view of 90°. A Noise Impact Assessment is recommended for each development area. The planned development for Areas 112, 113, 115 and 116 should be not differentiated into residential and GIC so that schools and non-sensitive GIC uses can be sited appropriately taking into account the noise constraints.

10.2.11 Table 10.1 below summarises the statistics, classrooms and population affected by noise levels above the HKPSG as a result of the new roads.

Table 10.1
Statistics Table for Future Traffic Noise Impact from the New Roads

	Dwellings		Population		Classrooms	
	Existing	Future	Existing	Future	Existing	Future
Total no. of sensitive receivers potentially affected by adverse traffic noise levels before mitigation	800	1,183	2,640	3,904	96	307
No. of sensitive receivers affected after direct mitigation	44	0*	145	0*	66	9**
No. of sensitive receivers eligible for indirect mitigation	0	NA	0	NA	By TDD 66	NA

* The NSRs at Areas 103, 104, 112 and 115 will be directly mitigated following the incorporation of the relevant planning constraints.

** Noise control designs to be incorporated for these classrooms by HD, ASD and others.

10.2.12 The cost of provision of noise barriers has been estimated as HK$65M.

10.3 Air Impact

Construction Impact Summary

10.3.1 During site formation, the main dust producing activities have been identified as:

(i) loading and unloading;
(ii) unpaved roads and haul routes;
(iii) stockpiling/aggregate storage;
(iv) top soil removal;
(v) wind erosion of the whole exposed area.

10.3.2 Two of the 'worst case scenarios' modelled during the EIA studies to calculate the TSP and RSP values within the RZ and DZ of Tin Shui Wai during site formation works are presented.

10.3.3 Without adequate mitigation, dust levels generated by site formation works are likely to exceed the Air Quality Objectives for TSP and RSP at nearby sensitive receivers in the report.

10.3.4 The transport of material by trucks travelling over dirt haul roads is the principal source of excessive dust generation.

10.3.5 The main mitigation measure required to reduce dust levels to below AQO levels is watering of exposed surfaces, especially where there is regular movement of vehicles. A watering frequency of every 2 hours is recommended. This frequency will also enable the guidelines to be met for the Special Measures Zone under the worst circumstances, i.e. dry weather, heavy vehicle traffic, peak construction period and windy conditions.

10.3.6 Other mitigation measures to reduce dust levels from other sources include water sprays for the handling of aggregate, windboards fitted to conveyor belts, and wheel washing facilities for use by all vehicles leaving the Site.

10.3.7 An environmental monitoring and audit programme has been formulated to ensure compliance is maintained at sensitive receivers and to monitor the effectiveness of mitigation measures.

Operational Impact Summary

10.3.8 Air quality at the sensitive receivers on the RZ and DZ within Tin Shui Wai is impacted by industrial emissions, traffic emissions and noise barriers (a mitigation measure against noise impacts). The extent of each impact was modelled under worst case conditions.

10.3.9 No exceedance of the AQO limits for nitrogen dioxide or sulphur dioxide occurred from industrial chimney emissions at the most sensitive locations within the Study area.

10.3.10 Similarly, nitrogen dioxide levels and RSP levels from traffic emissions were below the Air Quality Objectives. Air quality on the RZ is expected to be better than that in the DZ because of its greater distance from the industrial area of Kiu Tau Wai and major roads with relatively high traffic flow. In the presence of noise barriers, the values for NO_2 and RSP showed no significant change. No mitigation measures are required for operational activities related to the Project

10.3.11 The cumulative impacts were assessed and showed that levels of NO_2, SO_2 and RSP will be below the Air Quality Objectives.

Sewage Pumping Station

10.3.12 The principal odour generated from sewage treatment is hydrogen sulphide (H_2S), the level of odour depending on a number of environmental parameters including temperature, sewage strength and velocity of sewage flow.

10.3.13 Mitigation measures to reduce the odour to acceptable levels for nearby residents consist of enclosing the pumping station and channelling the air through a ventilation system prior to emission. The air will be treated by a deodorizing unit containing deactivated carbon, a treatment method with removal efficiency of over 95%.

10.3.14 No residual impacts should occur from construction and operation impacts if mitigation measures are carried out as described. The existing pumping station in Area 14 which has an identical design to the proposed unit.

10.4 Visual Impact Summary

General

10.4.1 Hydroseeding is recommended on the site formation areas, to reduce the visual intrusion and dust impacts, where works are unlikely to commence within 3 months. Tall canopy trees with shrub planting are proposed wherever practicable on the amenity strips to improve the visual quality. Planting work is also recommended around the columns of the proposed flyovers to screen these massive structures from view. Tall canopy trees with shrub planting should be designed around the abutment of the bridges to screen these massive structures from view. Plantings would not be attached to the columns to allow access to the columns by Highways Department (HyD) maintenance staff. The detailed landscaping designs for the road reserves will be discussed with HyD during the detailed design phase.

Noise Barriers

10.4.2 Where noise barriers are required to reduce the noise intrusion, then these noise barrier should blend with the surrounding environment. Where the noise barrier is adjacent to planting beds, the metal frame should be coated with natural colours in sympathy with the surrounding environment. All the finishes should be non-reflective and glare-reducing. Low barriers of 1.5 m and below should, as far as possible, be incorporated into the form of planter walls. Shrub planting and creeper plants will help to soften the hard edges of these planter walls.

Conclusion

10.4.3 In conclusion, the potential visual intrusion of the Project, including both the DZ and the adjoining RZ can be reduced with the adoption of the recommended mitigation methods.

10.5 Waste

Construction Waste

10.5.1 Waste will inevitably be produced during the construction period. The quantity of waste should be minimised and materials should be recycled as far as practicable, in order to minimize the disposal requirement.

10.5.2 No major waste impacts are predicted to arise as a result of the site formation process (as long as good environmental practices are observed), as no surplus material is expected.

10.5.3 Mitigation measures have been designed to reduce the volumes of waste produced and to encourage re-use and recycling wherever possible. During the course of this investigation, the engineers and environmental assessors have closely liaised to reduce the volumes of contaminated muds requiring removal and final disposal from 314,000 m^3 to less than 30,000 m^3. Contaminated muds sent to the East Sha Chau Contaminated Mud Disposal Area will be isolated from the environment.

10.5.4 The works such as the formation of Area 104, the extension to the Eastern Culvert and the extension to the WDC will involve the excavation of soft, contaminated mud and the removal of this contaminated material. It is recommended that this work should be carried out during the dry season as far as practicable, in order to reduce the possibility of runoff from the contaminated excavations reaching the water column. Class C material must be excavated and transported with great care. It cannot be dumped in the gazetted marine disposal grounds. The material must be effectively isolated from the environment upon final disposal, as is best taken to the contaminated mud pits at East Sha Chau.

10.5.5 Any vehicles leaving the Site carrying unsuitable excavated material should have their loads covered and be routed, so far as possible, to avoid sensitive receivers in the area.

10.5.6 Water and liquid waste products arising on site should be collected and removed from the site and disposed of at a location and in a manner that should not cause pollution or a public health hazard. The Contractor shall be responsible for the adequate maintenance and clearance of drainage channels and gullies during construction.

10.5.7 Contract requirements should include the responsibilities of the contractor for waste collection and disposal. Suitable facilities should be provided, for example, an accessible dump site with processing capabilities to ensure maximum utilisation of waste materials.

10.5.8 Correct storage of and, where possible, recycling of chemical and oil wastes is required to minimise environmental impacts.

10.5.9 In order to maximise re-use of materials and minimise the cumulative impact of waste products on the environment, facilities should be set up for the separation of recyclable material from domestic waste for collection by recycling companies.

10.5.10 Provided that there is strict control of wastes from construction works and all arisings are stored, transported and disposed of using approved methods as described in Section 8, no significant impacts are predicted.

Solid Waste

10.5.11 Adequate provision of facilities for the collection, storage and disposal of municipal wastes within the Tin Shui Wai area is essential. Provided that these facilities are suitably sited, designed, maintained and regularly served by RCVs, only minimal adverse impact from these facilities is anticipated.

10.5.12 Facilities for recycling domestic waste should be established at an early stage, with the requirement to separate wastes by contractors working on site. Development of housing and RCPs needs to take consideration of the separation of recyclable material at source. Public cooperation is a major factor in the success of a recycling scheme.

10.5.13 Projection of Yuen Long's per capita figures for domestic and commercial and industrial waste arising indicate that Areas 3, 30, 31 and 33 and the RZ will produce 300 tonnes/day and around 37 tonnes/day respectively.

10.5.14 In a well managed RCP, noise, odour and visual nuisance can be minimised by good design, operation and management of the unit. Design of the RCP should incorporate enclosure of the unit to minimise the noise impact from the container emptying operation.

10.5.15 Each RCP should be fitted with a water point and high pressure hose for cleansing operations. Drainage from the RCPs should be connected to the foul sewerage system. Where RCPs are serving markets and cooked food stores, adequately maintained grease traps must be installed to prevent blockage of the sewers.

10.5.16 As recommended in HKPSG, waste reception and transfer facilities should be located and designed to minimise nuisance to the public and people living and working nearby, and sited to minimise disruption to traffic or the creation of pedestrian or vehicular traffic safety hazards.

10.5.17 Existing refuse collection arrangements in the Yuen Long district will be facilitated by operation of the proposed North West New Territories Refuse Transfer Station, planned for south of Ping Ha Road. The precise catchment for this facility and its design capacity depend on the implementation of the proposed refuse collection system and direct haulage of wastes to landfill.

10.5.18 Private developments are likely to feature at least one RCP per Area, whereas public housing estates will conform to standard provision and design criteria as laid out in HKPSG, Chapter 9 (Section 6).

10.5.19 During operation, the main wastes produced will be sewage and domestic refuse.

10.6 Water Impacts

10.6.1 The potential impacts of this Project on the water environment are separated into construction and operational impacts. These can be divided into major and minor impacts, determined by the degree of impact on the environment.

Construction Related Impacts

10.6.2 The most important impacts on water quality during construction (Table 10.4) are related to the release of ammonia from dredged mud and runoff of concrete washings with a high pH value, which will increase the toxicity of ammonia.

10.6.3 The ETC is heavily polluted with copper and zinc, reaching at least Class C levels at the bend of the centre section. The mud removed from the ETC will require disposal at East Sha Chau.

10.6.4 Ammonia is already at levels in the WTC and the ETC (5-20 mg/l) which are toxic to many aquatic organisms.

10.6.5 The toxicity of ammonia is a factor of pH, temperature and salinity, although pH has greatest effect. The toxic fraction of ammonia (unionized ammonia) increases with pH. Table 10.2 shows two examples of the conditions under which toxicity to aquatic organisms occurs. Ammonia levels are doubled by an increase in 0.2 pH units.

Table 10.2
Examples of effect of pH on ammonia

Total ammonia (mg/l)	pH	Temperature (°C)	Unionized ammonia (mg/l)	Effect on Aquatic Organisms*
10	7.5	25	0.17	Chronic effect on less pollution-tolerant organisms
	8.5	25	1.4	Acute effect on less pollution-tolerant organisms
	9.0	25	3.5	Chronic effect on more pollution-tolerant organisms
20	7.5	25	0.34	Acute effect on less pollution-tolerant organisms
	8.5	25	2.8	Chronic effect on more pollution-tolerant organisms
	9.0	25	7.0	Acute effect on more pollution-tolerant organisms.

* Effects are described in Table 10.3.

Table 10.3+
Effects on aquatic organisms at different ammonia concentrations

Unionized ammonia (mg/l)	Effect	Impact on aquatic organisms
0.035	Chronic	Reduction in growth, reproduction, mobility of the least pollution tolerant organisms, ultimately leading to death
0.233	Acute	Death of least pollution-tolerant organisms
1-2	Chronic	Reduction in growth, reproduction, mobility of more pollution tolerant organisms, ultimately leading to death.
above 5	Acute	Death of nearly all aquatic life

\+ USEPA (1989), *Ambient Water Quality Criteria for Ammonia (Saltwater).*

10.6.6 These examples show that a small change in pH can have a significant change on ammonia toxicity. Concrete washings from construction works on development sites can readily exceed pH 9.0, which could have a significant potential impact on water quality and aquatic life in the channels in the presence of ammonia at levels above about 2 mg/l.

10.6.7 To protect aquatic life, the pH of runoff water must not exceed 8.5. Mitigation measures which must be carried out by the contractor responsible for runoff include settlement of concrete and cement washings in ponds, to encourage infiltration into the ground, or if runoff is unavoidable, pH adjustment to 8.5. Concrete paving should be done on a dry stream bed. No water should be allowed onto the area until it is sufficiently dry that high pH washings will not be released.

10.6.8 Removal of contaminated mud could release additional ammonia into the water, which would increase the toxic, unionized ammonia levels. Liquid from sediment should be allowed to drain into the landbank wherever possible and must not enter the channels downstream of the ETC. Works should be carried out in the dry season.

Table 10.4
Potential Impacts from Construction Works during the Project

Area of Works	Works to be carried out	Potential impact(s)
Eastern Culvert Extension (ECE)	Eastern Culvert Extension under Road D4 south partially infilling ETC in Areas 104, 109 and 117	Areas potentially impacted will be the TSW Creek and Inner Deep Bay, via the water column of the ETC, affecting benthos and consequently birdlife in the area. ETC sediments are of Class C contamination. Impacts on water quality are potentially very heavy dependent on construction methodology with release of ammonia and oxygen consuming substances.
Western Temporary Channel	Paving of 500 m of the WTC immediately downstream of the inflatable dam for maintenance purposes	Impacts on water quality are potentially heavy dependent on construction methodology. Large scale disturbance of channel sediments will increase turbidity/SS and decrease dissolved oxygen levels, affecting water quality and ecology downstream; Without tight mitigation there is potential for site runoff, concrete washings or accidental spill to affect water quality; Permanent loss of benthos in construction site area.
Site Formation	Levelling of RZ and relocation of stockpile material	Increase in suspended solids runoff in the receiving water bodies, affecting the hydrology and ecology of the WTC and ETC.
Site runoff	All construction works	Potential impact on all water bodies.
Eastern Culvert Re-alignment	Construction of new section of Eastern Culvert under Road P2 at Junction P and removal of redundant Culvert in ETC	Potentially minor impacts during final connection of re-aligned section of culvert with the ETC.
Bridge Construction	WTC vehicle bridges D3/V1 and L13/VCF1 and footbridge WC/CF5 to be constructed	Minor impact on water quality when channel sediments are disturbed. Channel sediments are Class A and therefore not expected to yield metal pollutants.
Installation of rising mains and new sewage pumping station	Installation of rising mains on the western side of the WDC and WTC. Crossing the WDC and two tributaries, by 'no-dig' method, to link new and old pumping stations	Impacts on WDC and WTC, runoff from construction activities, increasing turbidity decreasing DO.
Construction and upgrading of roads, junctions and flyovers	Construction works related to development of road infrastructure in Study Area	Increase in pH levels from concrete washings which affects dissociation of ammonia and hence its ecotoxicity.
Construction of permanent drainage culverts	3 culverts will be built, 2 draining into the WDCE, and one into the ETC	Increase in pH levels and suspended solids from runoff.
Freshwater Wetland Habitat	Wetland habitat will be created in Areas 114 and 118. Deepening of ETC and construction of diversion dams and wetland channels	Increase in pH levels, suspended solids, pollutants from disturbed sediments.

10.6.9 Mitigation measures to minimise the effect of these impacts and the residual effects after implementation of the mitigation are summarised in Table 10.5.

Table 10.5
Mitigation Measures and Residual Impacts for Construction Works during the Project

Works to be carried out	Mitigation to minimise impacts	Residual Impacts
Eastern Culvert Channel Extension (ECE)	The Contractor must use a cofferdam during works within or near the channel. ETC sediments are of Class C contamination therefore works should be carried out during the dry season or periods of low flow in the channel. Design of ECE shall ensure that the amount of contaminated mud removed is minimised to avoid water quality impacts. Diversion of flow during the final section of culvert must be carried out with minimal disturbance of bed sediments and impact on water quality. EM&A should include monitoring of downstream water sampling locations for ammonia levels which can worsen ecotoxic levels with elutriate from this mud. In addition, pH levels of runoff should be kept below 8.5 to protect aquatic life in the channel and in Inner Deep Bay. pH should be checked and neutralisation undertaken as necessary.	Minimal residual impact should occur if removal of mud is carried out following the defined procedures.
Western Temporary Channel Extension	Works should be carried out during the dry season or periods of low flow in the channel in order to minimise affects on water quality downstream. The Contractor must use a silt curtain or preferably a cofferdam during works within the channel. The EM&A programme will incorporate a fixed monitoring station just downstream of the proposed works to monitor for suspended solids and ammonia. This will act as a warning signal to check Contractor procedures. In addition, pH levels of runoff should be kept below 8.5 to protect aquatic life in the channel and in Inner Deep Bay.	Minimal residual impacts should occur if mitigation measures are implemented.
Site Formation	Silt traps or sedimentation ponds to settle out sediment in runoff. Ponds also encourage infiltration instead of runoff.	Minimal residual impacts should occur if sedimentation ponds are constructed and adequately maintained.

Table 10.5 (cont'd)
Mitigation Measures and Residual Impacts for Construction Works during the Project

Works to be carried out	Mitigation to minimise impacts	Residual Impacts
Site runoff	Each work site shall have a temporary drainage ditch draining to a sedimentation pond; Hard standing compounds shall drain via an oil interceptor; All oil interceptors shall be drained and oil exposed of in a appropriate manner.	Minimal residual impacts should occur on water quality if mitigation measures are implemented. However, the hydraulics of the runoff will be altered with the increase in impermeable surfaces.
Eastern Culvert Re-alignment	Recommended final connection of re-aligned section of culvert with the ETC to take place during the dry season or period of low flow in the ETC. Cofferdams to be used.	Minimal residual impacts should occur if mitigation measures are implemented.
Bridge Construction	Use of silt curtains or cofferdam to ensure minor impact on water quality when channel sediments are disturbed. Channel sediments under L13/VCF2 and GP/CF1 are Class A and therefore not expected to yield metal pollutants. Class C sediments under D3/V1 require careful handling and monitoring of ammonia levels to minimise impacts. Avoid high pH levels and ammonia release through engineering programme design.	Minimal residual impacts should occur if mitigation measures are implemented.
Installation of rising mains	Impacts on WDC and WDCE from runoff from construction activities can be minimised by the diversion of drainage water through sediment ponds.	Minimal residual impacts should occur if mitigation measures are implemented.
Construction of permanent drainage culverts	An earth-bund of clays and silts or a cofferdam will be built to prevent runoff from the construction of the culverts from entering the channel. Earth bund will then be removed.	Minimal residual impacts should occur if cofferdam construction is carried out properly.
Construction and upgrading of roads, junctions and flyovers	Minimising runoff, particularly in area of potential ammonia toxicity from contaminated runoff. Settlement ponds to settle out sediment in runoff. Ponds to encourage infiltration instead of runoff.	Minimal residual impacts should occur as long as runoff can be minimised. During wet season works, increases in pH from runoff will lead to an increase in ammonia toxicity, especially in ETC where sediment elutriate ammonia levels are high. Further mitigation is required to prevent potentially toxic waters from entering the receiving channel.
Fresh water wetland	Dry season workings. Use of cofferdams, pH testing of waters.	Minimal residual impacts should occur if mitigation measures are implemented.

Operation Related Impacts

10.6.10 Potential impacts associated with the operation of Tin Shui Wai following its development under the Project are shown in Table 10.6.

Table 10.6
Potential Impacts from Operation under the Project

Activity	Consequences of activity	Potential impacts
Creation of infrastructure, housing and other developments	Reduction in infiltration due to 65% of RZ being covered in concrete. Increased urban stormwater runoff.	Impacts potentially severe with proven cases of high levels of pollutants in urban stormwater runoff from similar urban areas in the USA. Water quality and associated wildlife in receiving water bodies could be adversely affected in the long term.
Maintenance & Dredging	Dredging in the WDCE and EDC every 10 to 15 years	Dredging removes channel sediments and therefore benthos living within. Also bank reeds and mangroves are removed which provide foraging and resting areas for many birds. Sediments disturbed during dredging have potential to affect water quality.
Sewage	Increased population of Tin Shui Wai, leading to requirement for sewage collection and disposal in RZ	Increase in volume of sewage to be conveyed to pumping station and ultimately to discharge outfall. Accidental discharge of sewage into drainage channels resulting from failure of pumping station.

10.6.11 Mitigation measures which should be implemented to minimise these impacts and the residual impacts which exist are described in Table 10.7.

Table 10.7
Mitigation Measures and Residual Impacts for Operation Works Resulting from the Project

Activity	Mitigation to minimise impact	Residual impacts
Creation of infrastructure, housing and other developments	Reduction in contaminated runoff will be achieved through the following Best Management Practices: - silt and sand traps, infiltration devices, catchpits, road sweeping, debris removal, oil and grease traps, maintenance of stormwater drains. Proper collection and disposal of chemical and oil wastes. ProPECC recommendations, and TMs closely enforced. HA is currently researching methods of reducing urban storm-water impact. Treatment of polluted stormwater by replacement wetland. The banks of the channel downstream of WDCE should be retained to encourage growth of vegetation through which stormwater runoff can infiltrate with partial pollutant removal.	Hydraulic increase in runoff is expected as a result of increased impermeable cover of RZ and hence any pollutants will be carried rapidly downstream. Minimal adverse residual impacts should occur on water quality with proposed mitigation.
Dredging in WDCE and EDC	Dredging in the WDCE should take place in a split and section fashion to allow for speedy recolonisation. Frequency of dredging is expected to be once every 10 years although this requirement should be monitored. The passage of sediment downstream should be minimised. pH and ammonia levels should be monitored during dredging activities to ensure minimal impact on the receiving water environment.	Temporary residual impact will occur on benthos in dredged sediment. No long term residual impact should occur on water quality if mitigation measures are implemented.
Increase in sewage volumes	Ha Tsuen Pumping Station has sufficient capacity to receive all sewage flows from the final TSW development. Construction of pumping station in Area 101 and rising main connecting new and old pumping stations. Frequent checking and good preventative maintenance.	Minimal residual impact on water quality should occur if mitigation measures are implemented at the programmed time.

10.6.12 In general, the construction and operational phase impacts are mitigatable with good site management and implementation of defined measures. During the period from the handover of sites to Housing Authority under the Project until the completion of construction works under the Project, construction and operational impacts will occur concurrently.

10.6.13 Mitigation measures implemented separately for construction and operation impacts are generally adequate to minimise impacts and avoid residual impacts. However, the combined impacts of high pH from concrete washings during construction and operation and potential increases in ammonia from urban stormwater runoff will increase unionized ammonia levels which are potentially toxic to aquatic life.

10.6.14 Mitigation during combined construction and operation phases should include either neutralisation of high pH washings or reduction in ammonia levels.

10.6.15 All discharged waters, including sewage and site runoff, should comply with the appropriate standards in the *TM on Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*, prior to discharge. Advice on the handling and disposal of construction site discharges, including site runoff and contaminated wastewaters, is provided in the *ProPECC Paper (PN1/94), Construction Site Drainage.*

10.6.16 Concurrent projects which are being carried out and which have potential impacts on the water quality in the channels and on the mudflats around Tin Shui Wai include the Ngau Tam Mei Drainage Channel and the Shenzhen River Training projects. Impacts include increased sedimentation during construction, increases in ammonia levels and increases in pH although after completion of construction and implementation of appropriate mitigation measures, water quality is expected to improve.

10.6.17 The implementation of the Livestock Waste Control Scheme (LWCS) will benefit water quality in all water bodies covered in this Project through reduction in sedimentation and organic pollution. However, in the interim period, flow of livestock waste into the WDCE will increase ammonia levels and decrease DO in this channel,with potentially damaging effects on the aquatic fauna.

10.6.18 Urban stormwater runoff has the potential of increasing loadings of pollutants entering Deep Bay in the long term. A holistic approach has been taken to mitigation. Stormwater runoff from an area equivalent to the area to be developed within TSW will pass through the fresh-water wetland to be implemented under this Project. Most of the runoff comes from TSW itself.

10.6.19 The design of the wetland is such that very high removal rates of SS are to be expected, of the order of 90%. BOD removal rates should be optimal in all but flood situations when BOD levels should be low. Up to 500 kg of BOD/day could be removed in the planned wetland area. Predicted average removal rates of BOD of about 80% are to be expected. Similar rates of removal of total nitrogen and phosphorus are likely.

10.6.20 The residual worst case scenario loading of the waters discharged to Inner Deep Bay can be estimated using the limited data available under this study. These estimates are given in Table 10.8. The mitigation to be implemented under this Project will assist in the eventual achievement of the Water Quality Objectives for Inner Deep Bay. Removal rates of 50% for heavy metals have been assumed. In practice, the removal rates is likely to be far higher.

Table 10.8
Estimated 'Worst-Case' Residual Loadings in Urban Stormwater Runoff on Discharge from the Fresh-water Wetland Area to Inner Deep Bay

Parameter	Estimated Residual Loading	Water Quality Objectives
SS	15 mg/l	20[1] mg/l
BOD	2[2] mg/l	5[3] mg/l
Total N	0.4 mg/l	0.7[4] mg/l
Total P	0.1 mg/l	NA [5]
Cd	< 0.1 μg/l	1[6] μg/l
Cr	1 μg/l	15[6] μg/l
Cu	2 μg/l	5[6] μg/l
Ni	3 μg/l	30[6] μg/l
Pb	1 μg/l	10[6] μg/l
Zn	20 μg/l	40[6] μg/l

(1) WQO for Inland Waters. WQO for marine waters is no more than 30% above ambient. SS levels at DM1 in 1996 averaged 97 mg/l and at DM3 averaged 25 mg/l.
(2) Omitting Station D. With Station D becomes 21 mg/l.
(3) WQO for Inland waters.
(4) WQO for Inner Deep Bay.
(5) No WQO stipulated. Common TM standards is 5-10 mg/l.
(6) DBG WQO.

10.6.21 Installation of sandtraps and gullies for the carriage of urban stormwater will be carried out by TDD. Installation and maintenance of oil intercepters and chemical storage areas is the responsibility of DLO and Planning Department.

10.6.22 RSD will be responsible for street cleaning and maximising and maintaining "green" areas while the Housing Authority will maximize landscaped areas within their sites and is currently researching methods of minimising urban stormwater drainage.

10.6.23 Maintenance of the stormwater drainage system is summarized in Table 7.43 in the Water Section, and is predominantly the responsibility of DSD and Highways Department.

10.7 Ecology Impacts

10.7.1 The major impacts of the Project on the ecological resources are habitat loss, deterioration in water quality and disturbance from noise or human presence.

10.7.2 These impacts are described in relation to the habitats at risk (Table 9.4) which are assessed for their ecological value in Section 9.3. This assessment showed that the most valuable ecological resources are the freshwater wetlands and intertidal mudflats, due to their importance in the ecological web of flora and fauna and their increasing rarity as a result of development in the New Territories.

10.7.3 Flora and fauna groups impacted directly and indirectly are shown in Table 10.9. Mitigation measures to minimise impacts are shown in Table 10.10 along with residual impacts, where they exist.

10.7.4 One of the major mitigation measures is the formation of a constructed wetland as replacement habitat for the wetland lost under site formation. It will also serve as a water treatment facility for polluted stormwater runoff which will improve water quality in the receiving watercourses and benefit the faunal community.

10.7.5 Mitigation measures which can be implemented under the current Project are sufficient to minimise residual impacts. However, impacts from concurrent projects occurring in the region, including the Shenzhen River Training project and Ngau Tam Mei Channel construction include increases in sedimentation during construction phases and decrease in water quality from released pollutants. Long term residual impacts from the Project are expected to be minimal providing mitigation measures under the Project are implemented.

10.7.6 Water quality impacts from discharge of livestock waste into the channels will continue to affect freshwater and marine fauna in the receiving channels. The potential for high concentrations of ammonia should be considered in relation to the discharge of high pH concrete washings during the construction period of the Project and the construction period of the development phase: the operational phase of the Project.

10.7.7 From the period of the first handover of a site to Housing Authority until the end of the construction works under the Project, impacts from construction and operation will overlap. Implementation of mitigation measures will minimise the majority of the combined impacts. However, high pH runoff from construction washings combined with high concentrations of ammonia require additional mitigation to avoid ecotoxic levels of ammonia in the watercourses. Water quality should be monitored throughout this period. Infiltration of water into the landbank should be encouraged wherever possible.

10.7.8 Environmental monitoring and audit should include monitoring of the ecological resources most likely to be impacted at each stage of the works. Correlation of ecological findings with water quality is essential to identify the cause of any significant changes.

Responsibilities for Implementation of Mitigation Measures

10.7.9 The construction of a wetland as habitat replacement will be carried out by TDD under the current Project. It is recommended that on-going management should be the responsibility of AFD. Advice on water quality would be obtained from EPD.

Table 10.9
Potential Impacts of the Project on Ecological Resources

Period of Works	Potential Impacts
<u>Site Formation</u>	
Levelling of landbank	Project activities related to road building and site formation result in the loss of freshwater wetlands including the Old Western River and part of ETC. Reedbed habitat lost under the Project. Faunal impacts include loss of feeding, courtship and breeding habitat for freshwater and grassland insects, birds, mammals and amphibians. Potential increase in sedimentation from movement of sand around landbank during site formation, which will impact freshwater fauna, marine infauna and epifauna, and mangroves. Noise and disturbance impacts on birds and mammals.
Removal of mud from ETC	Potential impacts on water quality from increases in ammonia resulting from disturbance of sediment in channel. This will impact freshwater and marine fauna. Noise and disturbance during works will impact birds and mammals.
<u>Infrastructure Works</u>	
Construction of drainage, sewerage and utilities	Potential impacts on water quality from increase in pH from concrete washings entering the channel. In the presence of high concentrations of ammonia, freshwater and marine fauna will be subjected to ecotoxic levels of un-ionized ammonia. Noise and disturbance during works will impact birds and mammals. Covering of vegetated areas with an impermeable surface will increase hydraulic runoff, with potential increases in erosion and sedimentation.
Construction of WDCE and construction of road bridges	Potential impacts of increased sedimentation and loss of sediment habitat for benthic fauna. Loss of mangrove habitat on site. Potential deterioration in water quality due to increased pH from concrete washings. Noise and human disturbance during works will impact birds and mammals.
<u>Operation</u>	
Urban stormwater runoff; waste production	Potential contamination of water courses, impacting freshwater and marine fauna in receiving waters.
Accidental spills including discharge of untreated sewage	
Presence of residences and increased population	Noise and disturbance impacts on birds and mammals inhabiting the area.
Maintenance dredging of WDCE and EDC	Potential increase in sedimentation which will impact the benthic infauna and epifauna of the receiving water.

Table 10.10
Mitigation Measures and Residual Impacts of the Project on Ecological Resources

Impact	Mitigation	Residual Impact
Loss of grassland habitat under site formation	Replacement cannot be achieved within the site under this Project.	Loss of 133 ha of grassland which is habitat for breeding, feeding and nesting of songbirds, mammals and amphibians. This impact is minimal providing recolonization is successful elsewhere.
Loss of freshwater habitat under site formation	Creation of freshwater wetland habitat as part of the Project in Areas 114 and 118. Works for construction of habitat will be scheduled for Contract 8.	Minimal residual impacts should occur providing habitat rehabilitation is successful.
Loss of habitat for mammals, amphibians and breeding birds	Site should be inspected for mammals before site formation and individuals relocated as required. Stockpile drain should be aligned to avoid nesting areas and grading of stockpiles where nests occur should be avoided in the breeding season.	Minimal residual impact should occur providing mitigation measures are implemented.
Loss of intertidal habitat, including disturbance of feeding area for waterbirds in WTC	Native woodland planting will isolate part of channel from human disturbance.	Minimal residual impact should occur as area lost is small and degraded. Mangroves colonize replacement habitat.
Deterioration in water quality during construction (increase in pH)	Minimise runoff to avoid impacts of raised pH or SS levels on receiving water environment.	Some residual impact from increased pollutants in runoff, however, ecological impact will be minimal if mitigation implemented.
Impacts on birds and mammals from increased noise and disturbance during construction	Little mitigation is planned because of temporary nature of impact.	Short term residual impact on birds and mammals in construction area.
Impacts on birds and mammals from increased noise and disturbance during generation	Barrier planting and sensitive areas e.g. replacement wetland areas, control of public access in these areas. Adherence to DBG for noise levels.	Residual impacts of increased noise are inevitable, however birds and mammals in adjacent areas are expected to adapt to the additional disturbance.
Impacts on freshwater and marine fauna from deterioration in water quality during operational urban stormwater runoff	Installation of sediment and silt traps on site, oil interceptors and constructed wetland to treat polluted runoff.	Minimal residual impacts should occur if mitigative devices are well designed, constructed and maintained.
Accidental spills	No hazardous installations will be constructed on site. Good preventative maintenance will be carried out in sewage pumping station.	No residual impacts should occur if mitigation measures are implemented.
Maintenance dredging of WDCE and EDC	Dredge one side of channel at a time, to allow for recolonization of dredged mud if extended lengths of channel need dredging.	Temporary residual impact of loss of benthos in dredged mud.

Conclusion

10.7.10 The project area for the proposed development comprises mainly of newly reclaimed land now covered by grasses. Some areas left untouched since the works in the early 1990s have become habitats for the feeding and breeding of some species. More valuable habitats are mainly found at the northern periphery of the TSW Reserve Zone. These include woodlands, mangroves, intertidal mud flats and other wetlands. The most important one is the mud flat at Inner Deep Bay which was designated as a Ramsar Site in 1995.

10.7.11 The major impacts of the proposed development to the sensitive ecological environment are the loss of habitats, deterioration of water quality and disturbance from human activities. Provided water quality is controlled within acceptable levels as discussed in Section 7, the mudflats at Inner Deep Bay would not be adversely affected by the future development of TSW. The conservation areas to the north of TSW will be upgraded to replace lost habitats and act as a buffer to the Ramsar Site. The needs of the residents and visitors of TSW have been paramount in the suggested design to ensure that interface problems are minimized.

10.8 Recommended Environmental Monitoring and Audit Programme

10.8.1 The EM&A Programme has been designed to monitor the potential impacts of the Project on noise levels, air quality, water quality, waste quantities and ecological resources in and around Tin Shui Wai. The data from the programme will be used to:

(i) provide a baseline database of "ambient", or pre-development conditions;

(ii) monitor and interpret conditions with respect to acceptance criteria during construction in order to provide an early indication that any of the environmental control measures or construction practices are failing to achieve the required standards;

(iii) provide data to determine the effectiveness of any mitigation or control measures implemented through changes in working practice undertaken if acceptance criteria are exceeded;

(iv) provide a database of conditions during and prior to the construction period for the assessment of the extended effects of construction and for the post-project audit;

(v) assess compliance with contractual or legislative environmental standards;

(vi) assess the validity of the action and limit levels (AL levels) set for the event/action plans;

(vii) ensure that only acceptable environmental impact impinges upon nearby sensitive uses and receivers with the aim of minimising adverse impact upon the surrounding environs.

10.8.2 The environmental audit system is intended to check methodically that the activities of the project are complying with previously defined environmental requirements and that the necessary measures have been identified to remedy any unacceptable or unforeseen environmental impacts. Environmental auditing is a check to reassure management and regulatory agencies that the development is being operated in an environmentally acceptable manner. It also enables a post project analysis to be carried out to examine the accuracy of the original EIA.

10.8.3 The Environmental Monitoring and Auditing Programme is described in a separate document, in which details of the monitoring required at each stage are defined.

10.9 Recommended Contract Clauses

Avoidance of Nuisance

10.9.1 (i) The Contractor shall comply with and observe all Ordinances, bye-laws, regulations and rules for the time being in force in Hong Kong governing the control of any form of pollution, including air, noise, water and waste pollution, and for the protection of the environment, and shall implement all pollution control measures to the satisfaction of the Engineer and the Director of Environmental Protection.

(ii) All works are to be carried out in such a manner as to cause as little inconvenience as possible to nearby residents, property and to the public in general, and the Contractor shall be held responsible for any claims which may arise from such inconvenience.

(iii) The Contractor shall be responsible for the adequate maintenance and clearance of channels, gullies, etc. and shall also provide and maintain such pedestrian and vehicular access as shall be directed within the Site.

(iv) Water shall be used to prevent dust rising and the Contractor shall take every precaution to prevent the excavated materials from entering into the public drainage system.

(v) Water and liquid waste products arising on Site shall be collected and removed from the Site by a suitable and properly designed temporary drainage system and should be disposed of at a location and in a manner that shall not cause pollution or a public health nuisance.

(vi) Waste collected from grease traps shall be collected and disposed of by a licensed contractor.

(vii) The Contractor shall construct, maintain, remove and reinstate temporary drainage works and shall take other precautions necessary to avoid damage by flooding and by material washed down from the Site. Adequate precautions shall be provided to ensure that spoil or debris is not allowed to be pushed, washed down, fall or be deposited on land or in the watercourses adjacent to the Site.

(viii) In the event of any spoil or debris from the Site being deposited on adjacent land or streambed or any silt being washed down to any area, the EMT shall be informed immediately. If the spoil or debris is found to be contaminated, special precautions shall be taken during removal of the material to ensure that the environmental impacts and minimized. After removal of the spoil, debris or material and silt, the affected land or streambed areas shall be restored to their natural state by the Contractor to the satisfaction of the Engineer and the EMT.

(ix) The Contractor shall make provision for the disposal from the Site of all solid waste products such that pollution and nuisance are not caused; the manner and location of disposal shall be as agreed by the Engineer.

(x) The use of access roads shall be kept to a minimum.

(xi) The Contractor shall ensure that no earth, rock or debris is deposited on public or private rights of way as a result of activities, including any deposits arising from the movement of plant or vehicles.

Air Quality Protection - including Dust Suppression Measures

10.9.2 In view of the potential of the Site Formation Works to generate fugitive dust emissions which exceed the maximum 24-hour averaged dust level (Total Suspended Particular Concentration of 260 $\mu g/m^3$) as stipulated in the Air Quality Objectives under CAP (311), we recommend that the frequency and intensity of Site and haul road watering is a specified and priced feature of the Contract.

10.9.3 (i) The Contractor shall undertake at all times prevent dust nuisance as a result of his activities. Effective dust suppression measures as are necessary should be installed to ensure that the air quality, at the boundary of the site and at any sensitive receivers, complies with the Hong Kong Air Quality Objectives.

(ii) The Contractor shall frequently clean and water the Site to minimise fugitive dust emissions.

(iii) Effective water sprays shall be used during the delivery and handling of aggregate, and other similar materials, when dust is likely to be created and to dampen all stored materials during dry and windy weather.

(iv) Watering of exposed surfaces shall be undertaken at least two times a day and be exercised as often as possible depending on the circumstances. In order to meet the requirement, it is necessary to install a water refilling system so that the water refilling time should be less than ten minutes.

(v) Areas within the Site where there is a regular movement of vehicles must be regularly watered as often as is necessary for effective suppression of dust or as often as directed by the Engineer. In most instances it will be necessary to water haul roads every two hours.

(vi) Should a conveyor system be used, the Contractor shall implement the following precautionary measures. Conveyor belts shall be fitted with windboards. Conveyor transfer points and hopper discharge areas shall be enclosed to minimise dust emission. All conveyors under the Contractor's control, and carrying materials which have the potential to create dust, shall be totally enclosed and fitted with belt cleaners.

(vii) Where dusty materials are being discharged to vehicle from a conveying system at a fixed transfer point, a three-sided roofed enclosure with a flexible curtain across the entry shall be provided. Exhaust fans shall be provided for this enclosure and vented to a suitable fabric filter system.

(viii) The Contractor shall confine haulage and delivery vehicles to designated roadways inside the Site. If, in the opinion of the Engineer, any motorized vehicle is causing dust nuisance, the engineer may require that the vehicle be restricted to a maximum speed of 15 km per hour while within the Site.

(ix) Wheel washing facilities shall be installed and used by all vehicles leaving the Site. No earth, mud, debris, dust and the like shall be deposited on public roads. Water in the wheel cleaning facility shall be changed at frequent intervals and sediments shall be removed regularly. The Contractor shall submit details of proposals for the wheel cleaning facilities to the Engineer prior to construction of the facility. Such wheel washing facilities shall be usable prior to any earthworks excavation activity on the Site. The Contractor shall also provide a hard-surfaced road between any washing facility and the public road.

(x) All site vehicle exhausts should be directly vertically upwards or directed away from the ground.

(xi) At the end of the works, the stockpiles should be hydroseeded.

Noise Control

10.9.4 (i) The Contractor shall consider noise as an environmental constraint in the planning and execution of the Works.

(ii) The Contractor shall comply with the *Noise Control Ordinance (Cap 400)* and with any regulations made under the Ordinance, including restrictions placed on noise from construction work and the requirements to seek Construction Noise Permits. Before commencing work which requires Construction Noise Permits, the Contractor should obtain such permits and display these appropriately.

(iii) In addition to the requirements imposed by the *Noise Control Ordinance*, to control noise generated from equipment and activities for the purpose of carrying out any construction work other than percussive piling during the time period from 0700 to 1900 hours on any day not being a general holiday (including Sundays), the following requirements shall also be complied with:

(a) The noise level measured at 1 m from the most affected external facade of the nearby noise sensitive receivers from the construction work alone during any 30 minute period shall not exceed an equivalent sound level (Leq) of 75 dB(A).

(b) The noise level measured at 1 m from the most affected external facade of any nearby schools from the construction work alone during any 30 minute period shall not exceed an equivalent sound level (Leq) of 70 dB(A) [65 dB(A) during school examination periods].

The Contractor shall liaise with the schools and the Examination Authority to ascertain the exact dates and times of all examination periods during the course of the contract.

(c) The noise level measured at a point 100 m outside the Site boundary within the Special Measures Zone (as defined under the *Deep Bay Guidelines for Dredging, Reclamation and Drainage Works*[1]) should never exceed 60 dB(A) for all days 0700 to 2300 hours.

(d) Should the limits stated in the above sub-clauses (a) and (b) or, where applicable, (c) be exceeded, the construction shall stop and shall not recommence until appropriate measures acceptable to the Engineer that are necessary for compliance have been implemented. If two contractors working under this Project are both working close to the same NSR, both contractors may be required to reduce the noise level from their individual contract to 3 dB(A) less than the levels stipulated above so that the combined noise level does not exceed these limits.

Any stoppage or reduction in output resulting from compliance with this clause shall not entitle the Contractor to any extension of time for completion or to any additional costs whatsoever.

(iv) The Contractor shall devise, arrange methods of working and carry out the works in such a manner as to minimise noise impacts on the surrounding environment, and shall provide experienced personnel with suitable training to ensure that these methods are implemented.

(v) Before the commencement of any work, the Engineer may require the methods of working, equipment and sound-reducing measures intended to be used on the Site to be made available for inspection and approval to ensure that they are suitable for the project.

1 *Deep Bay Guidelines for Dredging, Reclamation and Drainage Works* (1991), Environmental Protection Department.

(vi) The Contractor shall ensure that all plant and equipment to be used on the Site likely to cause excessive noise effectively sound-reduced by means of silencers, mufflers, acoustic linings or shields, acoustic sheds or screens or other means to avoid disturbance to any nearby noise sensitive receivers (NSRs). All hand-held percussive breakers and air compressors will comply with the *Noise Control (Hand-held Percussive Breakers) Regulations and Noise Control (Air Compressors) Regulations* respectively under the *Noise Control Ordinance (Ordinance No. 75/88, NCO Amendment 1992 No. 6)*.

(vii) The Contractor shall ensure that all plant and equipment to be used on Site are properly maintained in good operating condition.

(viii) It is recommended that construction noise should be mitigated using a suitable combination of the following measures:

(a) Noisy equipment and activities should be sited by the Contractor as far from close-proximity sensitive receivers as is practical. Prolonged operation of noisy equipment close to dwellings should be avoided.

(b) Noisy plant or processes should be replaced by quieter alternatives where possible. Silenced diesel and gasoline generators and power units, as well as silenced and super-silenced air compressors, can be readily obtained.

(c) Noisy activities should be scheduled to minimise exposure of nearby sensitive receivers to high levels of construction noise. For example, noisy activities can be scheduled for midday, or at times coinciding with periods of high background noise (such as during peak traffic hours).

(d) Idle equipment should be turned off or throttled down. Noisy equipment should be properly maintained and used no more often than is necessary.

(e) The power units of non-electric stationary plant and earth-moving plant should be quietened by vibration isolation and partial or full acoustic enclosures for individual noise-generating components.

(f) Construction activities should be planned so that parallel operation of several sets of equipment close to a given sensitive receiver is avoided. The numbers of operating items of powered mechanical equipment should be minimised.

(g) Construction plant should be properly maintained and operated. Construction equipment often has silencing measures built in or added on, e.g. bulldozer silencers, compressor panels, and mufflers. Silencing measures should be properly maintained and utilised.

(h) Acoustic barriers should be used to protect nearby noise sensitive receivers if necessary. Barriers can be made of mounds of fill or any material having a surface density of 20 kg/m^3.

(ix) Acoustic barriers shall be constructed as indicated in Figure 10.1 from the beginning of the construction of infrastructure works (end of 1998).

(x) Mitigation measures should be adopted to protect birds from excessive noise.

(a) The Contractor should avoid any sudden banging and clanging of materials. Sudden revving of engine on any mobile plants should also be avoided.

(b) The Contractor should warn workers to avoid disturbing the birds as far as possible.

(c) Noise close to the north of the RZ should be kept as constant as possible. Alternatively, noisy construction works close to the north of the RZ should be scheduled during the summer months to avoid the migratory season during the winter months as far as practicable.

(d) The Contractor should use quiet piling equipment and silenced equipment as far as practicable during construction works.

(xi) For the purposes of the above clauses, any domestic premises, hotels, hostel, temporary housing accommodation, hospital, medical clinic, educational institution, place of public worship, library, court of law, performing arts centre or office building shall be considered a noise sensitive receiver.

(xii) Notwithstanding the requirements and limitations set out in clause (iv) above and subject with clauses (v), (vi) and (viii) above, the Engineer may upon application in writing by the Contractor, allow the use of any equipment and the carrying out of any construction activities for any duration provided that he is satisfied with the application which, in his opinion, to be of absolute necessity and adequate noise insulation has been provided to the educational institutions to be affected, or of emergency nature, and not in contravention with the *Noise Control Ordinance* in any respect.

Water Quality

10.9.5 (i) The Contractor shall be aware of and comply with the *Buildings Ordinance*, the *Water Pollution Control Ordinance* and the *Technical Memorandum Standards for Effluent Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters.*

(ii) The Contractor shall not discharge directly or indirectly (by runoff) or cause or permit or suffer to be discharged into any public sewer, storm-water drain, channel, stream-course or sea any effluent or foul or contaminated water or cooling or hot water without the prior consent of the Engineer and the EMT who may require the Contractor to provide, operate and maintain at the Contractor's own expense, within the premises or otherwise, suitable works for the treatment and disposal of such effluent or foul or contaminated or cooling or hot water. The design of such treatment works shall be submitted to the Engineer for approval not less than one month prior to the commencement of construction or as agreed by the Engineer.

(iii) Surface run-off from the Site shall be discharged into storm drains via adequately designed sand/silt removal facilities such as sand traps, silt traps and sediment basins. Channels or earth bunds or sand bag barriers should be provided on Site to properly direct stormwater to such silt removal facilities. Perimeter channels at the Site boundaries shall be provided where necessary to intercept storm run-off from outside the Site so that it will not wash across the Site. Catchpits and perimeter channels shall be constructed ~~in advance of site~~ formation works and earthworks.

Before any site formation works commence in any area including stockpile areas, temporary drainage systems must be set up with at least the following capacity. A metre high bund must surround each site works area. A channel about 1 metre deep and 1 metre wide shall be formed just inside these bunds leading to the discharge points. Drains in nesting areas should be built during the non-breeding season. Existing drains should be re-aligned away from nesting sites. Before each outlet or discharge point the channels shall be widened to at least 1.5 metres and deepened to at least 1.5 metres for at least a length of 6 metres to form a settlement pond except that for the main stockpile the settlement pond should be 12 m long. These ponds and the channels and bunds must be kept in good working order at all times until they are replaced by the more permanent temporary drainage systems. The system must be adapted as site works proceed to take the changing ground levels into account.

(iv) The chunam-lined channels designated for the intermediate drainage systems should be implemented such that infiltration of run-off can occur wherever a solid bed to a channel is not essential. The base of the channel should be formed of granular material (Figure 10.2).

(v) Ensuring that works within the Eastern Temporary Channel in Area 104 take place in the dry season as far as practicable or else additional temporary works such as cofferdam or temporary earth bund will be required.

(vi) Works within the ETC and the WTC should be concentrated to dry periods as much as practicable. Temporary works such as cofferdams and temporary earth bunds should be used to minimise runoff and pollution from the works entering the water column. Water collecting behind the cofferdam shall be either pumped onto the land-bank or collected, settled and pH adjusted to 8.5 or less before being allowed to enter the channels.

(vii) The Contractor shall take all reasonable measures to minimise adverse impacts resulting from construction activities associated with dredging and spoil disposal. These measures shall include ensuring that all plant and equipment and working methods meet the following criteria. The Engineer may monitor any or all vessels transporting material to ensure that loss of material does not take place during transportation. The Contractor shall:

- utilise a floating silt curtain to contain excessive suspended solids upon instruction by the Engineer;
- minimise disturbance of the channel bed while dredging;
- minimise leakage of dredged material during lifting;
- use closed grabs: mechanical grabs shall be designed and maintained to avoid spillage and seal tightly while being lifted;
- prevent the overflowing of any hopper or barge;
- not fill any barge or hopper to a level that can cause overflowing;
- not wash out any hopper or barge while dredging and loading;
- ensure that any barge or any sediment transport vessel is fitted with tight fitting seals to the bottom openings to prevent leakage of material;
- ensure that bottom openings are properly closed when vessels are full and on their way to the disposal site;
- ensure that bottom-openings are properly closed when empty and returning to the site;
- remove any excess dredged material from the decks and exposed fittings of barges before the vessel is moved;
- cause no visible foam, oil, grease, scum, litter or other objectionable matter to be present on the water within the Site or dumping grounds;
- use vessels of such a size that adequate clearance of the vessel with the seabed is maintained at all stages of the tide thereby minimising turbidity generation by vessel movement or propeller wash;
- repair all pipe leakages immediately;
- keep the decks of all vessels tidy and free of oil and any other substances or articles which may be washed overboard. Rubbish shall not be dumped in the sea;
- control the loading of barges or hopper so as to prevent splashing or spillage of dredged material to the surrounding water;
- prevent the unacceptable deterioration of marine water; and
- take any reasonable measures, as directed by the Engineer.

(viii) The disposal of dredged material will comply with the following:

- The Contractor shall be responsible for disposing of all dredged material. All material shall be dumped within the designated marine dumping ground;

- The Contractor shall apply for the necessary licence from the Director of Environmental Protection (DEP) for the marine disposal of material, and shall at all times comply with his requirements. All fees in respect of applications for disposal permits shall be borne by the Contractor. A copy of the disposal licence held or obtained by the Contractor shall be given to the Engineer and no disposal may be carried out until a licence permitting such disposal has been obtained;

- The Contractor shall properly locate and fix the boundaries of the dumping area to ensure that the material is dumped at the correct location. The Contractor shall dump material in uniform layers over the dumping area under the agreed schedule such that no high spots are formed;

- Before commencing the dumping works, the Contractor shall provide, through the Engineer, to the Director of Environmental Protection (DEP) and the Secretary of the Fill Management Committee (FMC), a programme for the approval of the dumping works. Dumping works shall only be carried out in accordance with the approved programme which may be amended from time to time with the approval of DEP and FMC;

- The Contractor shall provide, through the ER, the DEP and FMC, a schedule containing details of the work included in, and the frequency of, the dumping works, on a monthly basis. A return showing the number of barge loads and the estimated quantity of surplus mud dumped within the mud disposal site shall be submitted to the DEP and FMC within one week after completion of the dumping works.

(ix) In the event of dredging of contaminated mud the following applies:

- The Contractor shall ensure that all contaminated mud is dredged, transported and placed in approved special dumping grounds in accordance with the provisions in Works Branch Technical Circular No. 22/92 and in such a manner to minimise the loss of material to the water column. THE classification on the contamination levels shall comply with the EPD TC No. 1-1-92.

- The Contractor shall be responsible for securing a licence for the disposal of contaminated marine mud to a disposal works area. The Contractor shall submit to the Director of Environmental Protection (DEP) a method statement covering the disposal of contaminated mud and this method statement must be approved before a licence to dump can be issued.

- The Contractor shall place the contaminated mud at a location and in a manner as stipulated in the disposal licence and as directed by the Engineer. The Contractor shall proceed with the disposal operation in accordance with the relevant sections in the Management Scheme for Contaminated Mud Disposal Pits at East Sha Chau - Guidance Notes for Dumping which may be modified from time to time. The Contractor shall not carry out any dumping without the permission of the Engineer.

- Flushing of the hopper is not permitted within the disposal works area.

- The Contractor shall maintain detailed daily records of the number of the vessels transporting dredged material to the disposal works area, including details of the vessels capacities, the approximate volumes of material transported, the vessels' registration numbers, and the location, time and duration of all disposal operations. The daily records shall be submitted to the Engineer's Representative on the following day.

(x) When dredging, transporting and disposing of contaminated mud, the Contractor shall implement additional special procedures for the avoidance of pollution which shall include but not be limited to the following:

- Dredging of contaminated marine mud shall only be undertaken by a suitable grab dredger using a closed watertight grab.

- Transport of contaminated marine mud from Tuen Mun to East Sha Chau shall be by split barge of not less than 750 m^3 capacity, well maintained and capable of rapid opening and discharge at the disposal works area.

- Discharge from split barges shall be placed in the contaminated mud disposal pit by bottom dumping, at a location within the pit to be specified, from time to time, by the Secretary of the Fill Management Committee (FMC) and Geotechnical Engineering Office of Civil Engineering Department.

- The dumping vessel shall be stationary throughout the dumping operation. Discharge shall be undertaken rapidly and the hoppers shall remain closed until the barge next returns to the disposal works area.

- Any substance which is found dumped by the Contractor outside the contaminated mud disposal pit shall be removed by the Contractor at his own cost.

- The Contractor shall install an automatic self monitoring device on the dumping barges as required by the Director of Environmental Protection. The device should be maintained functional at all times, and the equipment together with its stored record should not be tampered with.

(xi) The Contractor shall not permit any sewage, waste water or effluent containing sand, cement, silt or any other suspended or dissolved material to flow from the Site onto any adjoining land or allow any waste matter or refuse to be deposited anywhere within the Site or onto any adjoining land and shall have all such matter removed from the site.

(xii) The Contractor shall be liable for any damages caused to adjoining area through his failure to comply with clause 3.5 (iv).

(xiii) The Contractor shall be responsible for adequately maintaining any existing Site drainage system at all times including removal of solids in sand traps, manholes and stream beds. Dredging of water courses shall be carried out only after informing the ER and EMT.

(xiv) Silt removal facilities, channels and manholes shall be maintained and the deposited silt and grit shall be removed regularly, at the onset of, and after each rainstorm to ensure that these facilities are functioning properly at all times. Disposal of material shall be carried out properly and with the knowledge and approval of the ER and EMT.

(xv) Temporary access roads shall be protected by crushed stone or gravel, particularly during the rainy season. Intercepting channels shall be provided to prevent storm runoff from washing across exposed soil surfaces. Arrangements shall always be in place to ensure that adequate surface protection measures can be safely carried out well before the arrival of a rainstorm.

(xvi) Earthworks final surfaces shall be well compacted. Appropriate drainage such as intercepting channels shall be provided where necessary.

(xvii) Open stockpiles of construction materials (e.g. aggregates, sand and fill material) on site shall be protected from erosion during rainstorms. Measures shall be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.

(xviii) Discharge of surface run-off into foul sewers must always be prevented in order not to unduly overload the foul sewerage system.

(xix) The Contractor shall furnish, for the Engineer's information, particulars of the Contractor's arrangements for ensuring that material from any earthworks does not wash into the drainage system. If at any time such arrangements prove to be ineffective the Contractor shall take such additional measures as the Engineer and EMT shall deem necessary and shall remove all silt which may have accumulated in the drainage system whether within the Site or not.

(xx) Precautions to be taken at any time of year when rainstorms are likely, actions to be taken when a rainstorm is imminent or forecast and actions to be taken during or after rainstorms are summarized in the following:

(1) Precautions to be taken at any time of year when rainstorms are likely

(a) Silt removal facilities, channels and manholes should be maintained and the deposited silt and grit should be removed regularly.

(b) Temporary access roads should be protected by crushed stone or gravel.

(c) Intercepting channels should be provided (e.g. along the crest/edge of excavation) to prevent storm runoff from washing across exposed soil surfaces.

(2) Actions to be taken when a rainstorm is imminent or forecast

(a) Silt removal facilities, channels and manholes should be checked to ensure that they can function properly.

(b) Open stockpiles of construction materials (e.g. aggregates, sand and fill materials) on Site should be surrounded by suitable bunds and temporary channels.

(3) Actions to be taken during or after rainstorms

(a) Silt removal facilities, channels and manholes should be checked and maintained to ensure satisfactory working conditions. Attention should be given to safety when carrying out this work.

(xxi) All vehicles and plant shall be cleaned before they leave the Site to ensure no earth, mud, debris and the like is deposited on roads. A wheel washing bay shall be provided at every Site exit and wash-water shall have sand and silt settled out or removed before discharging into the site drainage system. The section of construction road between the wheel washing bay and the public road shall be paved to reduce vehicle tracking of soil and to prevent site run-off from entering public road drains.

(xii) The transport of sediment to the environment shall be minimised by the installation of appropriate sediment traps within the drainage system. Sediment traps shall be designed with adequate capacity and constructed within the surface water drainage systems at appropriate locations.

(xiii) Any stockpile of spoil or fill materials shall be treated to reduce erosion of the stockpile and sediment release. A separate settlement system for a large stockpile will be provided as necessary to collect contaminated surface water prior to release to the works area drainage system.

(xiv) All compounds in works areas shall be located on areas of hardstanding with provision of drainage channels and settlement ponds where necessary to allow interception and controlled release of settled/treated water; and provision of bunding for all potentially hazardous materials on Site including fuels. The Contractor shall establish emergency procedures in the event of any spills of hazardous materials.

(xv) Oil interceptors shall be provided in Site compounds and regularly emptied to prevent release of oils and grease into the surface water drainage system after accidental spillages. The interceptor shall have a bypass to prevent flushing during periods of heavy rain. Oil and fuel bunkers shall be bunded to prevent discharge due to accidental spillages or breaching of tanks.

(xvi) If any office, works area canteen or toilet facilities are erected, foul water effluent should be directed to a foul sewer or to a sewage treatment facility either directly or indirectly by means of pumping or other means approved by the Engineer.

(xvii) Wastewater generated from the washing down of mixer trucks and drum mixers and similar equipment should wherever practicable be recycled. The discharge of wastewater should be kept to a minimum.

(xviii) To prevent pollution from wastewater overflow, the pump sump of any water recycling system should be provided with an on-line standby pump of adequate capacity and with automatic alternating devices.

(xxix) Any waters entering the storm drains must have a pH less than 8.5. Under normal circumstances, surplus wastewater may be discharged into foul sewers after treatment in silt removal and pH adjustment facilities (to within the pH range of 6 to 9). Disposal of wastewater into storm drains will require more elaborate treatment. Surface run-off should be segregated from the concrete batching plant and casting yard area as much as possible, and diverted to the stormwater drainage system. Surface run-off contaminated by materials in a concrete batching plant or casting yard should be adequately treated before disposal into stormwater drains.

(xxx) Bentonic slurries used in diaphragm wall and bore-pile construction should be reconditioned and reused wherever practicable. If the disposal of a certain residual quantity cannot be avoided, the used slurry may be disposed of at the marine spoil grounds subject to obtaining a marine dumping licence from EPD on a case-by-case basis.

(xxi) If the used bentonite slurry is intended to be disposed of through the public drainage system, it should be treated to the respective effluent standards applicable to foul sewers, storm drains or the receiving waters as set out in the WPCO Technical Memorandum on Effluent Standards.

(xxxii) The Contractor is reminded that all discharges into any drainage or sewerage systems, or inland or coastal waters within a Deep Bay Water Control Zone are controlled under the *Water Pollution Control Ordinance* (WPCO), except the discharge of domestic sewage into foul sewers or the discharge of unpolluted water into storm drains or into the waters of Hong Kong. Construction site discharges are controlled under the WPCO.

(xxxiii) Discharges controlled under the WPCO must comply with the terms and conditions of a valid WPCO licence.

(xxxiv) The WPCO licence application form (Form A) can be obtained from any EPD office or from District Offices. The applicant should include in the application, inter alia, information on the various points of discharge of storm run-off and wastewater, and the corresponding maximum (or range of) volume of discharge expected on a dry day. The application form, which can be filled in by the Owner, the Authorized Person, the Consulting Engineer or the Contractor, should be submitted to EPD as early as possible before the commencement of any discharge. In general, assuming adequate information has been provided together with the licence application, EPD would need at least 20 days for the processing of a licence for a discharge, and in the case of a discharge directly into any waters of Hong Kong, EPD would need at least 50 days to allow time for public notification as required by the WPCO.

Spoil & Waste Management

10.9.6 (i) The Contractor shall be aware of, and comply with, the *Waste Disposal Ordinance*, the *Public Health and Municipal Services Ordinances*, the *Water Pollution Control Ordinance* and the *Waste Disposal (Chemical Waste) (General Regulation)*.

(ii) The excavation of soft, contaminated mud and its removal must, as far as is practicable, be carried out in the dry and during the dry season.

(iii) The Contractor's attention is drawn to *A Guide to the Chemical Waste Control Scheme*; *A Guide to the Registration of Chemical Waste Producers*; and the *Code of Practice on the Packing, Labelling and Storage of Chemical Wastes*.

(iv) The Contractor shall segregate all inert construction waste material suitable for reclamation or land formation and shall dispose of such material at public dumping areas or at a location agreed in advance by the FMC and EPD.

(v) All non-inert construction waste material deemed unsuitable for reclamation or land formation and all other waste material shall be dumped at public landfill.

(vi) The Contractor shall comply with and complete the procedures in WBTC No. 22/92 and/or EPD's ProPECC PN 3/94 regarding marine or land-based disposal of dredged mud, prior to the commencement of Works.

(vii) The new *Air Pollution Control (Open Burning) Regulation* came into effect on 26th February 1995. This regulation prohibits open burning for the disposal of construction waste or the clearance of a site in preparation for construction work. Certain other types of open burning are allowed under permits issued by the EPD.

(viii) Fossil fuel and used lubricants for trucks and machinery are classified as chemical wastes. The Contractor shall register with EPD as a chemical waste producer and observe all the requirements under the storage, labelling, transportation and disposal of chemical waste.

(ix) The Contractor shall prevent fuel and lubricating oil leakage from plant and storage sites from contaminating the construction site. All compounds in works areas shall be located on areas of hardstanding with provision of drainage channels and settlement lagoons where necessary to allow interception and controlled release of settled water; and provision of bunding for all potentially hazardous materials on Site including fuels. The Contractor shall prepare a spill action plan and keep suitable clean-up materials on-site.

(x) Care must be taken to prevent spillages:

(a) the storage area for fuels and lubricants shall be isolated from working areas and kept secure;

(b) use of fuels and lubricants shall be carried out with care;

(c) any spillage problem due to any truck and machinery shall not be ignored;

(d) emulsifier and absorbent shall be available on Site, so that immediate action can be taken when there is minor spillage;

(e) all containers shall be stored so as to prevent any spillage of the contents and disposed of carefully; and

(f) concepts of 'Site cleanliness' shall be introduced to workers, to gather and store construction waste in an appropriate manner.

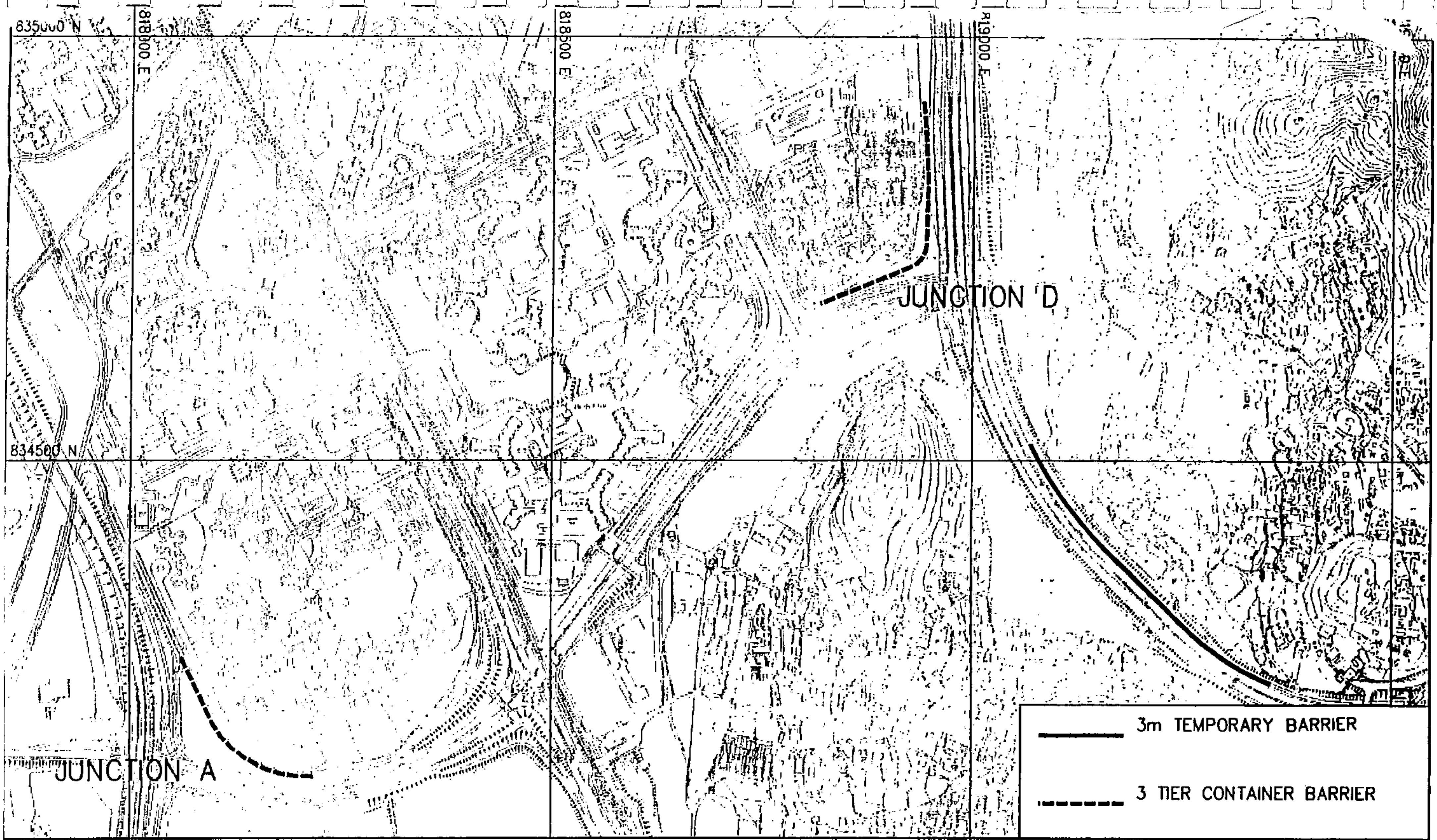
(xi) Temporary waste facilities shall be set up by the Contractor. Municipal waste shall be collected in black refuse bags and delivered to, and disposed of at, an approved landfill.

Ecology

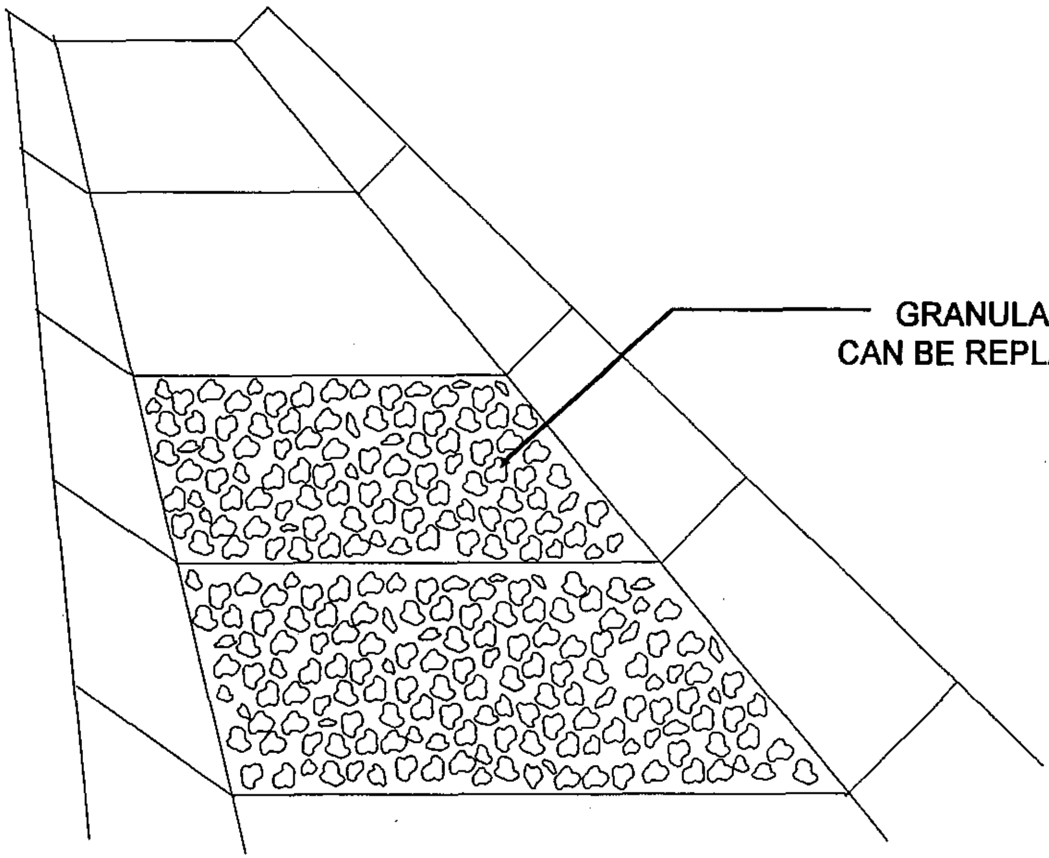
10.9.7 A survey of mammals and burrowing activities shall be undertaken along the edge of each Area immediately prior to commencement of Works. Areas of particular importance for mammals are wetland areas and marshy ground. In the event that either leopard cats, otters, or active burrows are detected, then relocation shall be undertaken in discussion with AFD.

10.9.8 A survey for nesting birds shall be undertaken for Areas 110, 112, 113 and 114 if works are to be undertaken during the nesting season, i.e. March to July and if the area has not been worked for three months. If nesting birds are found, advice should be sought from AFD. AFD will issue a permit or recommend other measures. Trapping and relocation of birds will be undertaken if a suitable release site is available. Kingfishers were nesting in the stockpile within Areas 105 and 110 in 1996.

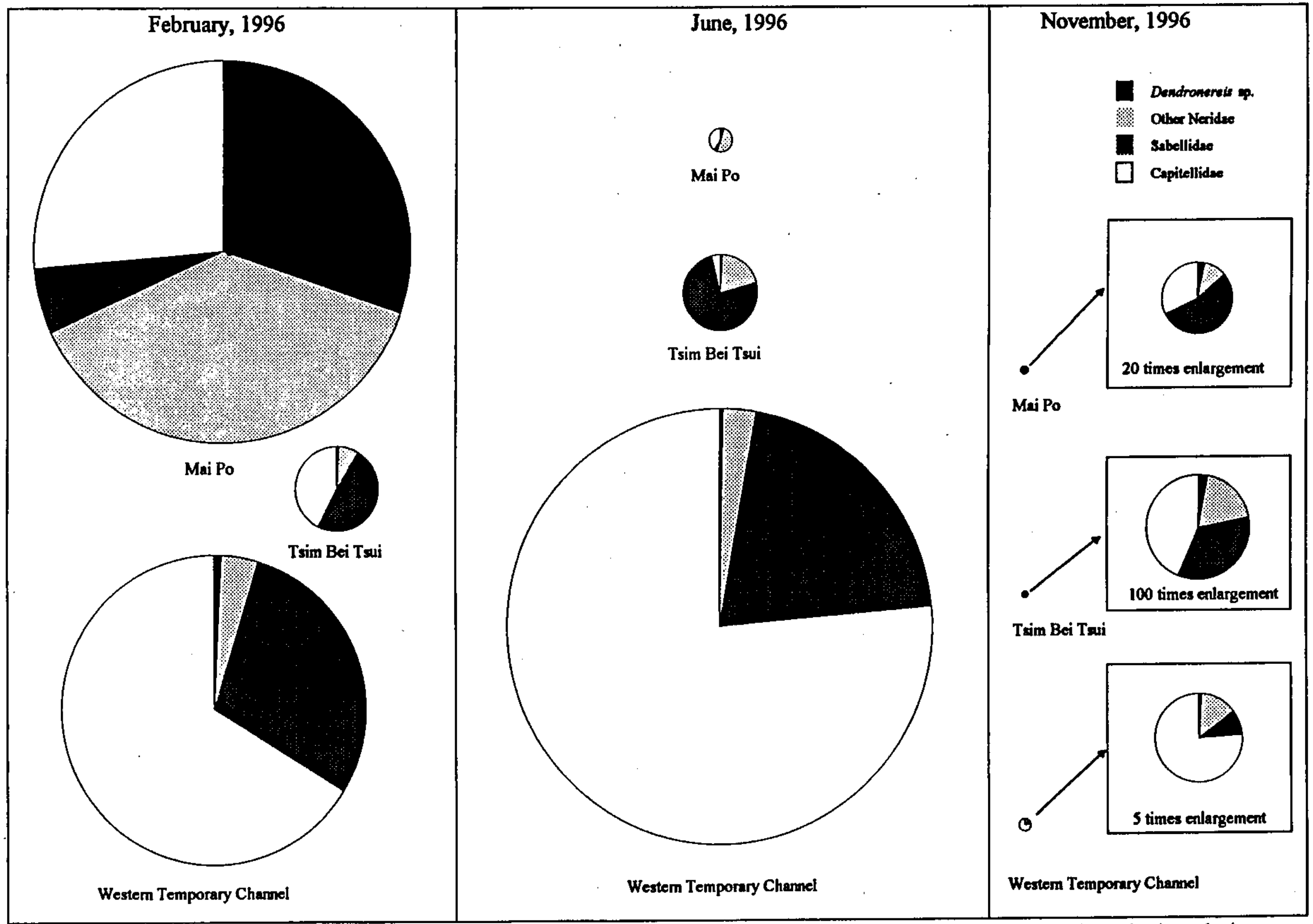
10.9.9 Contractors should ensure their staff minimise disturbance to wildlife in areas adjacent to the Works. Unwanton destruction of wildlife such as birds, bats and larger mammals is illegal.



TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title :	Figure No. 10.1	Revision 1
	LOCATION OF NOISE BARRIERS DURING CONSTRUCTION STAGE	Reference TSW-BASE	File Name 01400018.C09
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 ENGINEERS AND SCIENTISTS 賓尼		Prepared MC	Checked PS
		Date JAN. 97	Scale 1 : 6000

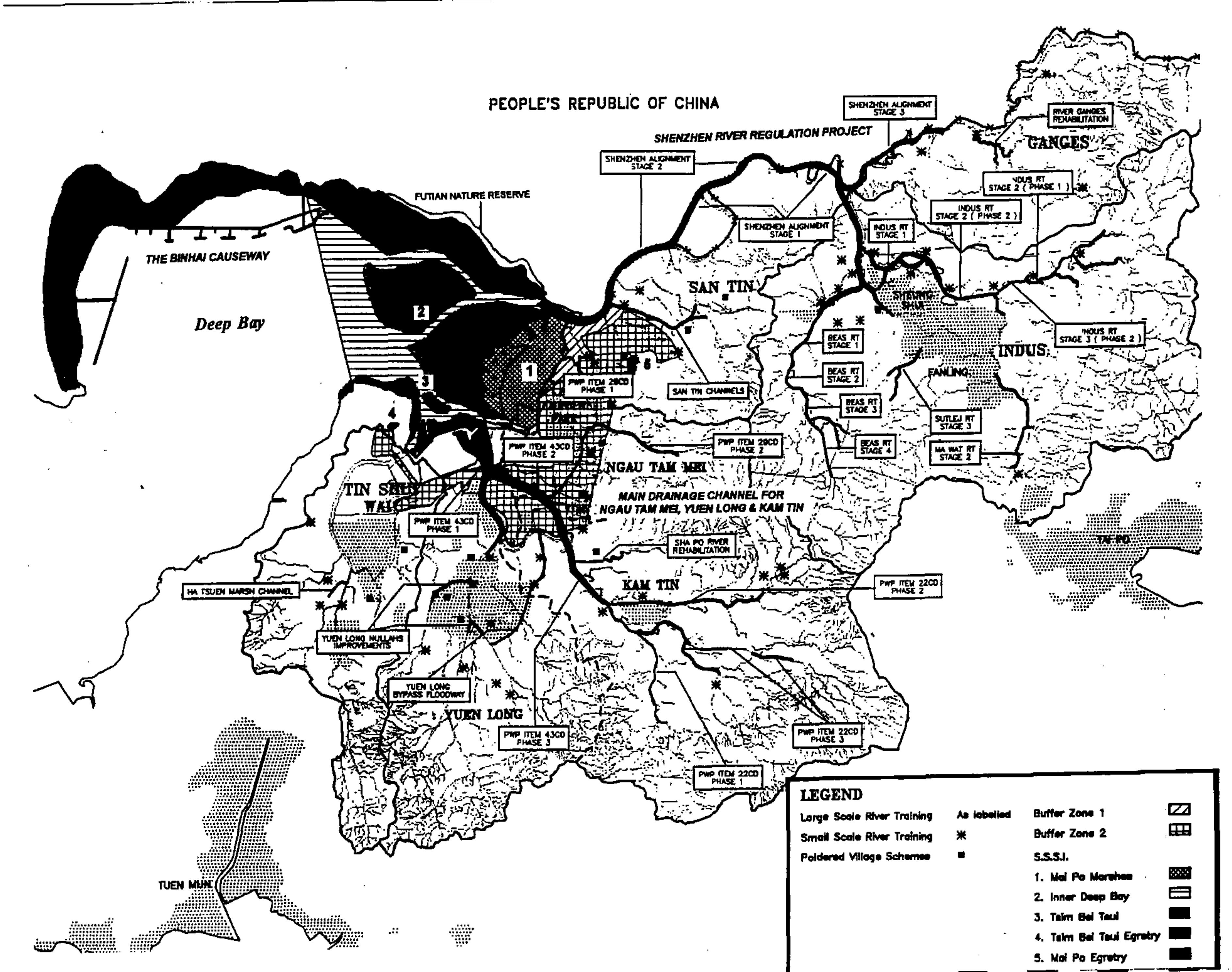


TIN SHUI WAI DEVELOPMENT AGREEMENT NO. CE 10/95 ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE	Title : INFILTRATION CHANNEL	Figure No. 10.2	Revision 0
		Reference No. -	File Name MC:\TSW..INFIL2.PRS
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 賓尼 ENGINEERS AND SCIENTISTS		Prepared MC	Checked PS
		Date NOV 96	Scale NTS



The diameter of the pie is proportional to the biomass. Proportion of the total abundance of each of the four species is shown by the wedge in each pie. The wedges do not show the proportion of biomass of each benthic group.

Figure 9.10 Composition of Benthic Assemblages and the Average Biomass at each Study Site.



Notes

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-		-	NOV 96

Project: TIN SHUI WAI DEVELOPMENT

ENGINEERING INVESTIGATIONS FOR DEVELOPMENT OF AREAS 3, 30 & 31 OF THE DEVELOPMENT ZONE AND THE RESERVE ZONE

Title:

CONCURRENT PROJECTS WITHIN INNER DEEP BAY DRAINAGE BASIN

Figure no.	Reference no.	Scale
9.11	TELADFLOCCOSS	NTS

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Territory Development Department, Hong Kong

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