APPENDIX A

DOCUMENTS VIEWED FOR THE INVESTIGATION

CONTENTS

		Page No.
	Title Page	53
	CONTENTS	54
A.1	SOURCES OF DOCUMENTS	55
A.2	GEOTECHNICAL ENGINEERING OFFICE	55
	A.2.1 Files	55
	A.2.2 Reports	56
A.3	BUILDINGS DEPARTMENT	56
A.4	ARCHITECTURAL SERVICES DEPARTMENT	57
A.5	CONSULTANTS' REPORTS	57
A.6	INFORMATION PROVIDED BY THE HONG KONG HOUSING SOCIETY AND ITS CONSULTANTS	59
A.7	GROUND INVESTIGATION REPORTS	61

A.1 SOURCES OF DOCUMENTS

All known documents relevant to the 23 July 1994 failure were reviewed during the landslide investigation. These are listed in this Appendix for reference.

The documents viewed were obtained from the following six sources :

(a) Geotechnical Engineering Office (GEO) : relevant files and internal reports.

(b) Buildings Department : relevant files.

(c) Architectural Services Department : relevant files.

(d) Consultants' Reports relevant to the site and available to the GEO.

(e) Hong Kong Housing Society and its consultants, Mott Connell Ltd and Fugro (Hong Kong) Ltd : information provided for the post-failure investigation.

(f) Ground Investigation Reports available to the GEO.

The documents are listed below under these six sources.

A.2 GEOTECHNICAL ENGINEERING OFFICE

A.2.1 Files

File Reference	Title
GCI 3/4/DH 188/74/HK	Kwun Loong Lau - I.L. 8041 Lung Wah Street (Island Division)
GCI 2/E1/11SW-A/R309	Below Block D, Kwun Loong Lau Estate (Island Division)
GCI 2/E1/11SW-A/C4	South of Block G, Kwun Loong Lau Estate (Island Division)
GCI 2/E1/11SW-A/FR21	Kwun Loong Lau Estate (Island Division)
GCI 2/E1/11SW-A/C115	Kwun Loong Lau Estate Block 'C' (Island Division)
GCI 2/E2/1985 (Part 1)	2 : Engineering. E2 Landslip Incidents. Landslip Incidents for Island Division 1985 - correspondence (Island Division)
GCI 1/1/401 (Parts 1 & 2)	Planning Area 1 - Kennedy Town (Island Division)

File Reference	Title
GCI 3/4/2026/82	Smithfield Road (Island Division)
GCI 5/3/BC	Smithfield Road (Island Division)
GCP 2/A1/11SW-A/R309	Wall below Block D, Kwun Loong Lau Estate (Planning Division)
GCD 2/A1/826	Smithfield (Design Division)
BOO GCB IN/11SW-A/R309	I.L. 8041 (20 Lung Wah St. - Below Kwun Loong Lau Estate, Block D)
BOO GCB OP7/LS/19c K	Landslide Study - Phase IID. Ka Wai Man (Sai Wan Estate) Area (11 SW-A).
Binnie & Partners Field Sheet for Wall No. 11SW-A/R309 dated February 1978	

A.2.2 Reports

Tang, K.Y. (1987). Retaining wall 11SW-A/R309 below Block D, Kwun Loong Lau Estate. Geotechnical Control Office, Hong Kong, Stage 1 Study Report no. S1R 97/87, 29 p. (Unpublished).

Cheung, R.T.K. (1992). Cut slope 11SW-A/C4 & R323 south of Block G, Kwun Loong Lau Estate. Geotechnical Control Office, Hong Kong, Stage 2 Study Report no. S2R 3/92, 33 p. (Unpublished).

A.3 BUILDINGS DEPARTMENT

File Reference	Title
BDD(B) DH188/74/HK	20 Lung Wah Street, Kwun Loong Lau, Hong Kong. I.L. 8041
BOO 1/2233/63	Kennedy Town Housing Scheme - Lung Wah St : proposed site formation
BOO 2/2233/63	Kennedy Town - site off Smithfield : proposed housing scheme for the H.K. Housing Society
BOO 3/2233/63	Site off Smithfield, Kennedy Town : proposed structural detail & cals
BOO 4/2233/63	Site off Smithfield, Kennedy Town Housing Project : proposed soil & waste system for the H.K. Housing Society

File Reference	Title
BOO 2-3/2121/77	Off Smithfield, Kennedy Town : Alterations & Additions (Canopy to Existing Access Steps). I.L 8041
BOO 1/2026/82	71-77 Smithfield. I.L. 8450
BOO 2/2026/82	71-77 Smithfield. I.L. 8450
BOO 4/2026/82	71-77 Smithfield. I.L. 8450
BOO 6/2026/82	71-77 Smithfield. I.L. 8450

A.4 ARCHITECTURAL SERVICES DEPARTMENT

File Reference	Title
ASD.PB UA-86-3069-000	Forbes Street Temporary Playground

A.5 CONSULTANTS' REPORTS

Binnie (1979a). Slope No. 11SW-A/C1 between Blocks A & F, Kwun Loong Lau Estate. Landslide Study Phase IID, Binnie & Partners (Hong Kong) for Geotechnical Control Office, Hong Kong, 58 p.

Binnie (1979b). Slope No. 11SW-A/C5 South of Block A, Kwun Loong Lau Estate. Landslide Study Phase IID, Binnie & Partners (Hong Kong) for Geotechnical Control Office, Hong Kong, 28 p.

Binnie (1979c). Slope No. 11SW-A/C129 North-east of Blocks B and C, Kwun Loong Lau Estate. Landslide Study Phase IID, Binnie & Partners (Hong Kong) for Geotechnical Control Office, Hong Kong, 28 p.

Binnie (1979d). Slope No. 11SW-A/C3 West of Block F, Kwun Loong Lau Estate. Landslide Study Phase IID, Binnie & Partners (Hong Kong) for Geotechnical Control Office, Hong Kong, 39 p.

Binnie (1979e). Slope No. 11SW-A/C4 South of Block G, Kwun Loong Lau Estate. Landslide Study Phase IID, Binnie & Partners (Hong Kong) for Geotechnical Control Office, Hong Kong, 35 p.

Binnie (1979f). Slope No. 11SW-A/C2 South of Block A, Kwun Loong Lau Estate. Landslide Study Phase IID, Binnie & Partners (Hong Kong) for Geotechnical Control Office, Hong Kong, 26 p.

Binnie (1980). Slope No. 11SW-A/C115 North of Block C and D, Kwun Loong Lau Estate. Landslide Study Phase IID, Binnie & Partners (Hong Kong) for Geotechnical Control Office, Hong Kong, 40 p.

Binnie (1982). Landslide Study - Phase IID, Sai Wan Area, General Report. Binnie & Partners (Hong Kong) for Geotechnical Control Office, Hong Kong, 11 p. plus Figures and Appendices.

Freeman Fox (1981). Geotechnical Report Proposed Development at I.L. 8450, Smithfield Road, Hong Kong, Freeman Fox & Partners (Far East), 21 p. plus Figures and Appendices.

Fugro (1983a). Geotechnical Slope Inspection Report. Kwun Loong Lau Estate, Kennedy Town. Fugro (Hong Kong) Ltd, report prepared for Hong Kong Housing Society, 6 p. plus Figures and Appendices.

Fugro (1983b). Geotechnical Report for Slope Nos. 11SW-A/C1, C2 and C5, Kwun Loong Lau Estate, Kennedy Town. Fugro (Hong Kong) Ltd, report prepared for Hong Kong Housing Society, 11 p. plus Figures and Appendices.

Fugro (1984). Supplementary Geotechnical Report for Slope No. 11SW-A/C115, Kwun Loong Lau Estate, Kennedy Town. Fugro (Hong Kong) Ltd, report prepared for Hong Kong Housing Society, 15 p. plus Figures and Appendices.

Fugro (1987). Geotechnical Slope Inspection Report. Kwun Loong Lau Estate, Kennedy Town. Fugro (Hong Kong) Ltd, report prepared for Hong Kong Housing Society, 5 p. plus Figures and Appendices.

Fugro (1988). Geotechnical Slope Inspection Report. Kwun Loong Lau Estate, Kennedy Town. Fugro (Hong Kong) Ltd, report prepared for Hong Kong Housing Society, 4 p. plus Figures and Appendices.

Fugro (1989). Geotechnical Slope Inspection Report. Kwun Loong Lau Estate, Kennedy Town. Fugro (Hong Kong) Ltd, report prepared for Hong Kong Housing Society, 4 p. plus Figures and Appendices.

John Connell (1990). Report on Annual Slope Inspection. Kwun Lung Lau Estate. John Connell & Associates Ltd, report prepared for Hong Kong Housing Society, 3 p. plus Figures and Appendices.

John Connell (1991a). Report on Annual Slope Inspection. Kwun Lung Lau Estate. John Connell & Associates Ltd, report prepared for Hong Kong Housing Society, 3 p. plus Figures and Appendices.

John Connell (1991b). Report on Annual Slope Inspection. Kwun Lung Lau Estate. John Connell & Associates Ltd, report prepared for Hong Kong Housing Society, 3 p. plus Figures and Appendices.

John Connell (1992). Report on Slope Inspection. Kwun Lung Lau Estate. John Connell & Associates Ltd, report prepared for Hong Kong Housing Society, 3 p. plus Figures and Appendices.

John Connell (1993). Study on Existing Slopes. Stage 1 - General Review, Kwun Lung Lau

Estate. John Connell & Associates Ltd, report prepared for Hong Kong Housing Society, 7 p. plus Figures and Appendices.

John Connell (1994). Report on Slope Inspection. Kwun Lung Lau Estate. John Connell & Associates Ltd, report prepared for Hong Kong Housing Society, 3 p. plus Figures and Appendices.

Mott Hay & Anderson Far East (1978). Investigation of Disused Tunnels, Additional Tunnel Network : No. 21 - Smithfield. Mott Hay & Anderson Far East, report submitted to the Geotechnical Control Office, 3 p.

Mott Hay & Anderson Far East (1984). Investigation of Disused Tunnels, Network No. 21, Smithfield, Final Report. Mott Hay & Anderson Far East, report submitted to the Engineering Development Department, 33 p. plus Appendices and Drgs.

A.6 INFORMATION PROVIDED BY THE HONG KONG HOUSING SOCIETY AND ITS CONSULTANTS

Item	Date
Letter from Fugro (Hong Kong) Ltd to Hong Kong Housing Society	13 October 1983
Letter from John Connell & Associates Ltd to Hong Kong Housing Society	23 July 1992
File Note by Senior Assistant Director (Project Management) of Hong Kong Housing Society	29 July 1992
Letter from Hong Kong Housing Society to John Connell & Associates Ltd	4 August 1992
Letter from John Connell & Associates Ltd to Hong Kong Housing Society	5 August 1992
Letter from Hong Kong Housing Society to John Connell & Associates Ltd	7 August 1992
Letter from John Connell & Associates Ltd to Hong Kong Housing Society	11 August 1992
Letter from Mott Connell Buildings Ltd to Hong Kong Housing Society	14 July 1994
Draft Tender Document for Slope Repair Works at Hong Kong Housing Society Kwun Lung Lau, 20 Lung Wah Street, Kennedy Town	19 July 1994
Letter from Mott Connell Buildings Ltd to Hong Kong Housing Society	26 July 1994
Letter from Mott Connell Ltd to Hong Kong Housing Society	27 July 1994

Item	Date
Fax from Mott Connell Ltd to GEO	27 July 1994
Letter from Hong Kong Housing Society	29 July 1994
Fax from Hong Kong Housing Society to GEO	29 July 1994
Fax from Fugro (Hong Kong) Ltd to GEO	29 July 1994
Fax from Hong Kong Housing Society to GEO	29 July 1994
Fax from Hong Kong Housing Society to GEO	30 July 1994
Fax from Hong Kong Housing Society to GEO	3 August 1994
Fax from Hong Kong Housing Society to GEO	4 August 1994
Letter from Fugro (Hong Kong) Ltd to GEO	4 August 1994
Letter from Hong Kong Housing Society to GEO	4 August 1994
Letter from Hong Kong Housing Society to GEO	4 August 1994
Fax from Fugro (Hong Kong) Ltd to GEO	8 August 1994
Fax from Hong Kong Housing Society to GEO	8 August 1994
Letter from Hong Kong Housing Society to GEO	22 August 1994
Draft drillhole logs of the ground investigation carried out under the direction of Mott Connell Ltd after the 23 July 1994 landslide	August to September 1994
Letter from Hong Kong Housing Society to GEO	2 September 1994
Letter from Hong Kong Housing Society to GEO	5 September 1994
Letter from Fugro (Hong Kong) Ltd to GEO following the meeting with GEO on 7 September 1994	23 September 1994
Fax from Hong Kong Housing Society to GEO	23 September 1994
Letter from Mott Connell Ltd to GEO in response to GEO's fax of 16 August 1994 and following the meeting with GEO on 24 August 1994	14 November 1994
Letter from Hong Kong Housing Society to GEO	15 November 1994
Letter from Mott Connell Ltd to GEO	17 November 1994

Item	Date
Letter from Hong Kong Housing Society to GEO	17 November 1994
Fax from Hong Kong Housing Society to GEO	21 November 1994
Fax from Hong Kong Housing Society to GEO	22 November 1994
Letter from Hong Kong Housing Society to GEO	23 November 1994
Letter from Mott Connell Ltd to GEO	23 November 1994
Record Books of Caretaking Staff of Hong Kong Housing Society at Kwun Lung Lau	1992 to 1994
Repair Card of Hong Kong Housing Society for Kwun Lung Lau	1973 to 1994

A.7 GROUND INVESTIGATION REPORTS

Bachy (1990). Ground Investigation : Stage 2 Study - Slope No. 11SW-A/C3, C4, R323 at Kwun Loong Lau Estate. Bachy Soletanche Group, Hong Kong, 105 p.

Enpack (1979a). Landslide Study Site Investigation for Slope No. 11SW-A/C115, Kwoon Lung Lau. Enpack (HK) Ltd, 18 p.

Enpack (1979b). Landslide Study Site Investigation for Slope No. 11SW-A/C118, Kwoon Lung Lau. Enpack (HK) Ltd, 3 p.

Enpack (1979c). Landslide Study Site Investigation for Slope No. 11SW-A/C129, Kwoon Lung Lau. Enpack (HK) Ltd, 3 p.

Enpack (1979d). Landslide Study Site Investigation for Slope No. 11SW-A/FR20, Kennedy Town Service Reservoir. Enpack (HK) Ltd, 46 p.

Oriental Boring (1977). Construction of Canopy to the Entrance Steps to Kwun Lung Lau, Kennedy Town. Oriental Boring Ltd, 3 p.

Vibro (1994). Ground Investigation Report for Landslide at Kwun Lung Lau, Smithfield Road, Kennedy Town. Vibro (Hong Kong) Ltd, 10 p. plus Figures & Appendices.

APPENDIX B

OLD TOPOGRAPHIC MAPS

CONTENTS

		Page No.
	Title Page	62
	CONTENTS	63
B.1	INTRODUCTION	64
B.2	OBSERVATIONS FROM OLD TOPOGRAPHIC MAPS	64
	LIST OF TABLES	65
	LIST OF FIGURES	69

B.1 INTRODUCTION

Old topographic survey maps kept by the Lands Department were studied to assess the development history of the landslide site. A list of the available maps which cover the landslide area is given in Table B1, and the relevant parts of the maps are reproduced in Figures B1 to B9.

B.2 OBSERVATIONS FROM OLD TOPOGRAPHIC MAPS

The dates of the available maps, together with observations relevant to the site, are summarised in Table B2.

There was little development in Kennedy Town before 1846. By 1889, Forbes Street and the lane (marked "SLAUGHTER HOUSE" in the 1901 map; denoted as 'footpath' in this report) fronting the 1994 landslide area had been constructed, and their alignments and widths were similar to those at the present time. The lane was likely to have been formed by cutting into the natural ground. It is possible that the masonry wall had been built by that time. There are also indications from the 1901 map that the masonry wall had been in place by then. The wall has been included in topographic maps published since 1959.

In the 1959 and 1960 maps, the ground where Kwun Lung Lau is presently located was shown to be occupied by squatters. Steps leading to a structure, probably a squatter hut, were present on the ground immediately above the wall which failed in the 1994 landslide. Kwun Lung Lau is shown in the 1969 map. Since that time, no major changes to the site are evident from the subsequent maps.

Based on a review of the old topographic maps, it is likely that the masonry wall was constructed some time between 1846 and 1901, and probably prior to 1889.

LIST OF TABLES

Table No.		Page No.
B1	List of Old Topographic Maps	66
B2	Observations from Old Maps	67

Table B1 - List of Old Topographic Maps

Date of Map	Map Title or No.	Scale
1846	No. HE12N	1 : 15 000
1889	No. HG29-1	1 : 1 200
1901	Victoria Hong Kong, Sheet No. 2	1 : 600
August 1957	Series L8811, Sheet No. 19	1 : 25 000
August 1959	No. 195-SE-9	1 : 600
March 1960	No. 195-SE-9	1 : 600
September 1969	No. C-195-SE	1 : 2 400
March 1970	No. C-195-SE-9	1 : 600
February 1972	No. C-195-SE-9	1 : 600
July 1974	No. C-195-SE-9	1 : 600
March 1975	No. 11-SW-11B	1 : 1 000
June 1976	No. 11-SW-11B	1 : 1 000
December 1978	No. 11-SW-11B	1 : 1 000
Note : Maps produced after 1980 are not included in this Table.		

Table B2 - Observations from Old Maps (Sheet 1 of 2)

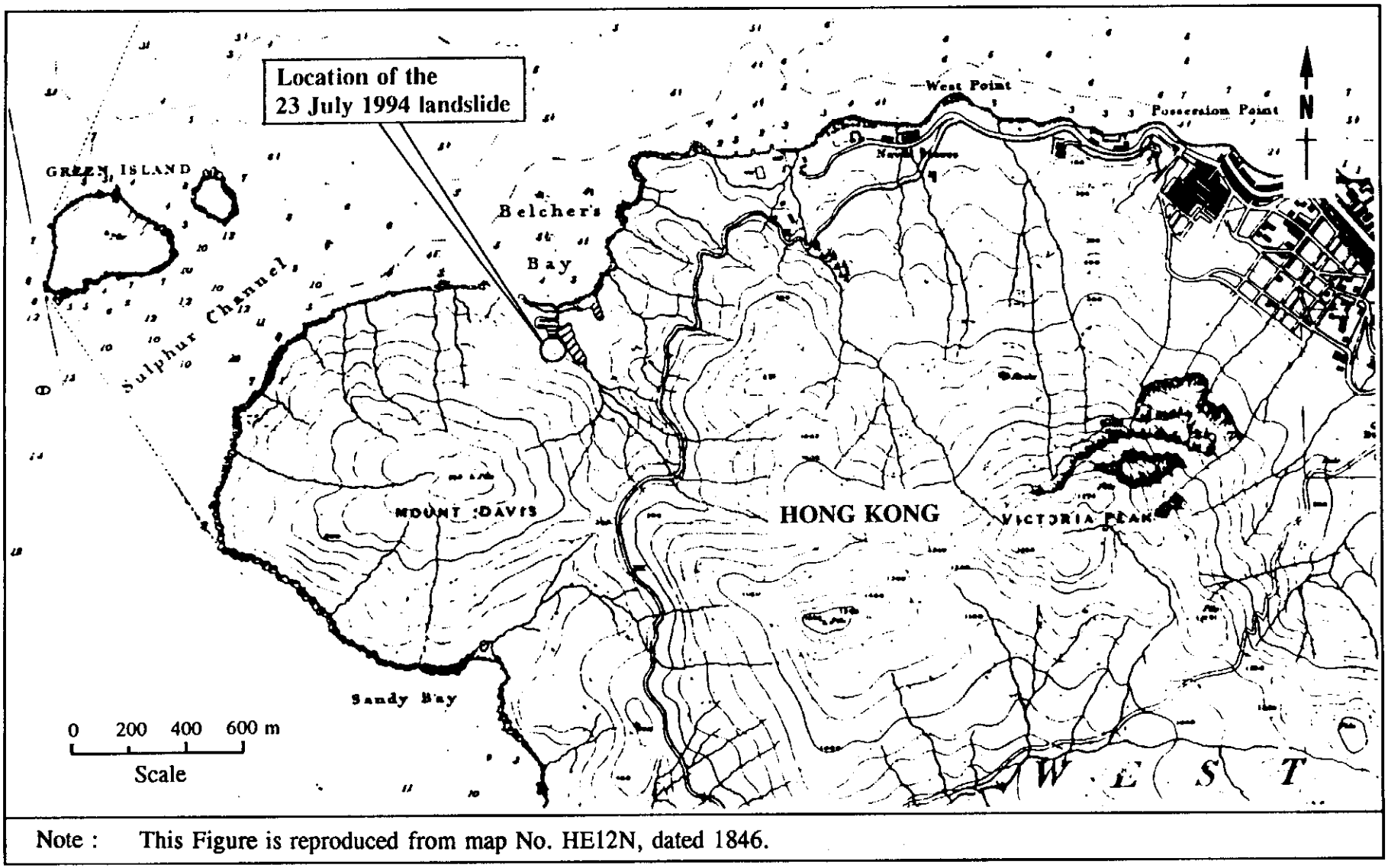
Year	Observations
1846	This is the earliest available map of the area. Belcher Bay, where the present Kennedy Town is situated, had not yet been reclaimed.
1889	Roads in Kennedy Town, such as "PRAYA" (now Kennedy Town New Praya), "CHATER STREET" (now Catchick Street), "BELCHER STREET" (now Belcher's Street) and "FORBES STREET", had been constructed. Their layout was similar to present. The lane fronting the location of the Kwun Lung Lau landslide is also shown in the map. Its alignment and width were similar to those at present. The area between Forbes Street and the lane is marked "SHEEP & PIG DEPOT". There was a recessed area shown on the southern side of the lane to the south-west of the depot. At this location, a feature probably indicating a drainage channel connected to the recessed area is shown, and further details shown on the 1901 map suggest that this was probably a stepped channel. The 1959 maps shows that a stream-course to the south was connected to the channel.
1901	The layout of the area is generally the same as that shown in the 1889 map. The lane is marked "SLAUGHTER HOUSE". Closely-spaced lines are shown along the southern side of the lane and the recessed area, extending to the western and northern sides of the area between the lane and Forbes Street. No legend is given on the plan to explain these lines. However, the alignment of the lines matches closely with that of the masonry walls in this area shown in the 1959 and 1960 maps. The eastern ends of the lines along the southern side of the lane also fit the location of the eastern end of the remaining portion of the masonry wall which failed in the 23 July 1994 landslide.
1957	The layout of the area shown on this map is generally the same as that shown in the 1889 and 1901 maps. Ground contours are shown on this map at 10 m intervals. These are plotted onto a plan showing the layout of Kwun Lung Lau in Figure B10. It can be seen that the original ground level at the landslide area along the southern side of the lane was between 20 mPD and 30 mPD, and was probably higher than 25 mPD. It is known that the crest of the masonry wall before the landslide was at about 23.5 mPD. Hence, it is likely that the lane was formed by cutting into the natural ground, and that the wall was retaining a cut face.
1959	The masonry wall that failed in the 23 July 1994 landslide is shown on the plan. A structure was present in the recessed area. Features, probably steps and squatter structures, are marked on the ground to the immediate south of the wall which failed in the landslide. Marks indicating vegetation are drawn on the ground further to the south, i.e. where the present Kwun Lung Lau is located.
1960	"SQUATTER AREA" is marked in the area to the south of the crest of the masonry wall.

Table B2 - Observations from Old Maps (Sheet 2 of 2)

Year	Observations
1969	Kwun Lung Lau is shown. There is no change to the layout of the masonry wall and the lane in front, except that the wall is shown extended by about 9 m eastward from the eastern end of the wall as shown in the 1901 map. Slope symbols are marked between the masonry wall and the Kwun Lung Lau buildings.
1970	There is no change to the layout of the masonry wall and the lane. Further details are added to the layout of the extended portion of the wall, where the present mass concrete retaining wall to the immediate east of the masonry wall is located. The structure in the recessed area is marked "Office".
1972	The layout of the masonry wall and the lane in front is the same as that shown on the 1970 map, except that the "Office" in the recessed area has been removed and the area has become part of the footway between the lane and Block D of Kwun Lung Lau.
1974 and onward	The layout of the masonry wall and the lane is the same as that shown on the 1972 map.

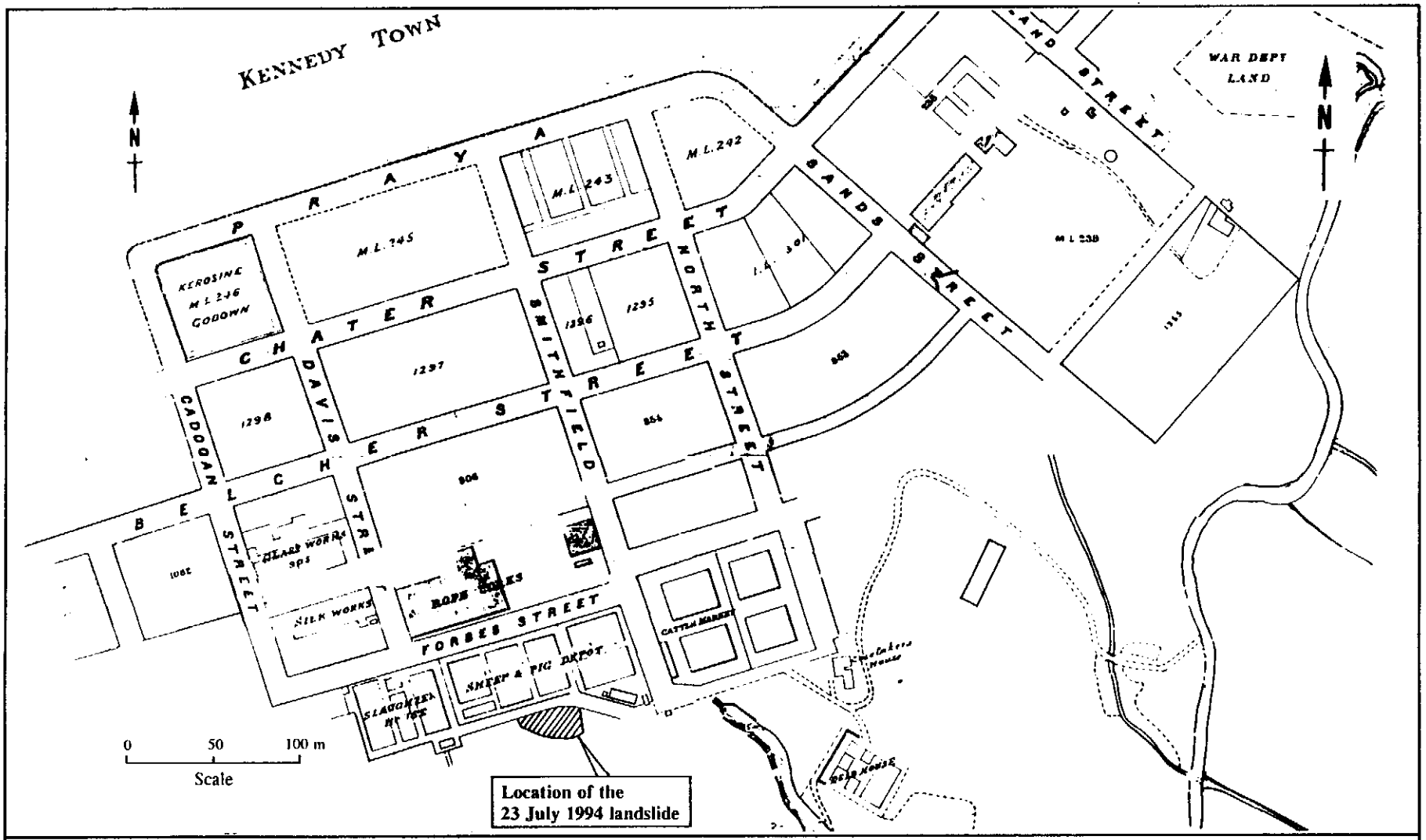
LIST OF FIGURES

Figure No.		Page No.
B1	Part of the 1846 Topographic Map	70
B2	Part of the 1889 Topographic Map	71
B3	Part of the 1901 Topographic Map	72
B4	Part of the 1957 Topographic Map	73
B5	Part of the 1959 Topographic Map	74
B6	Part of the 1960 Topographic Map	75
B7	Part of the 1969 Topographic Map	76
B8	Part of the 1970 Topographic Map	77
B9	Part of the 1972 Topographic Map	78
B10	Ground Contours Shown in the 1957 Topographic Map	79



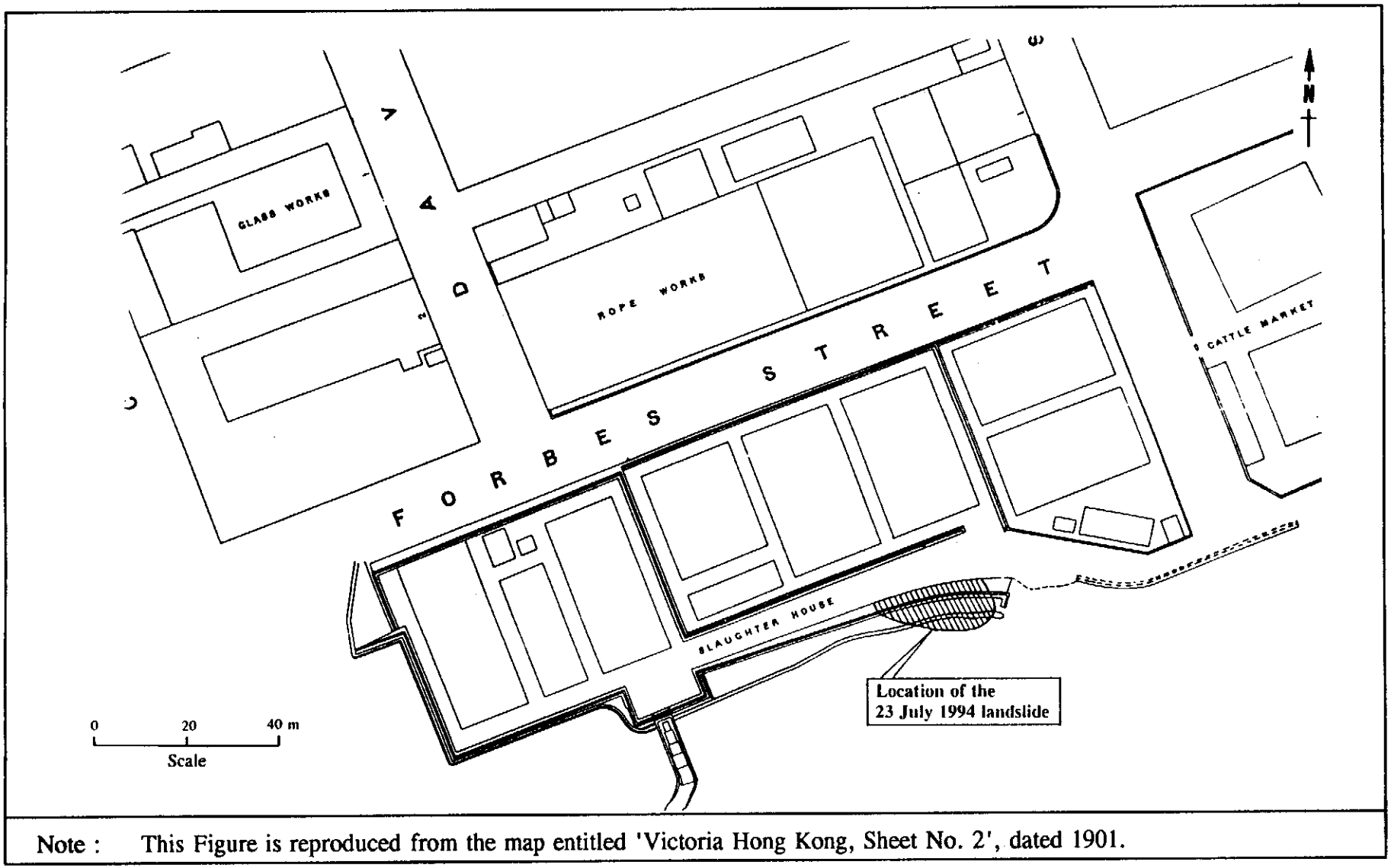
Note : This Figure is reproduced from map No. HE12N, dated 1846.

Figure B1 - Part of the 1846 Topographic Map



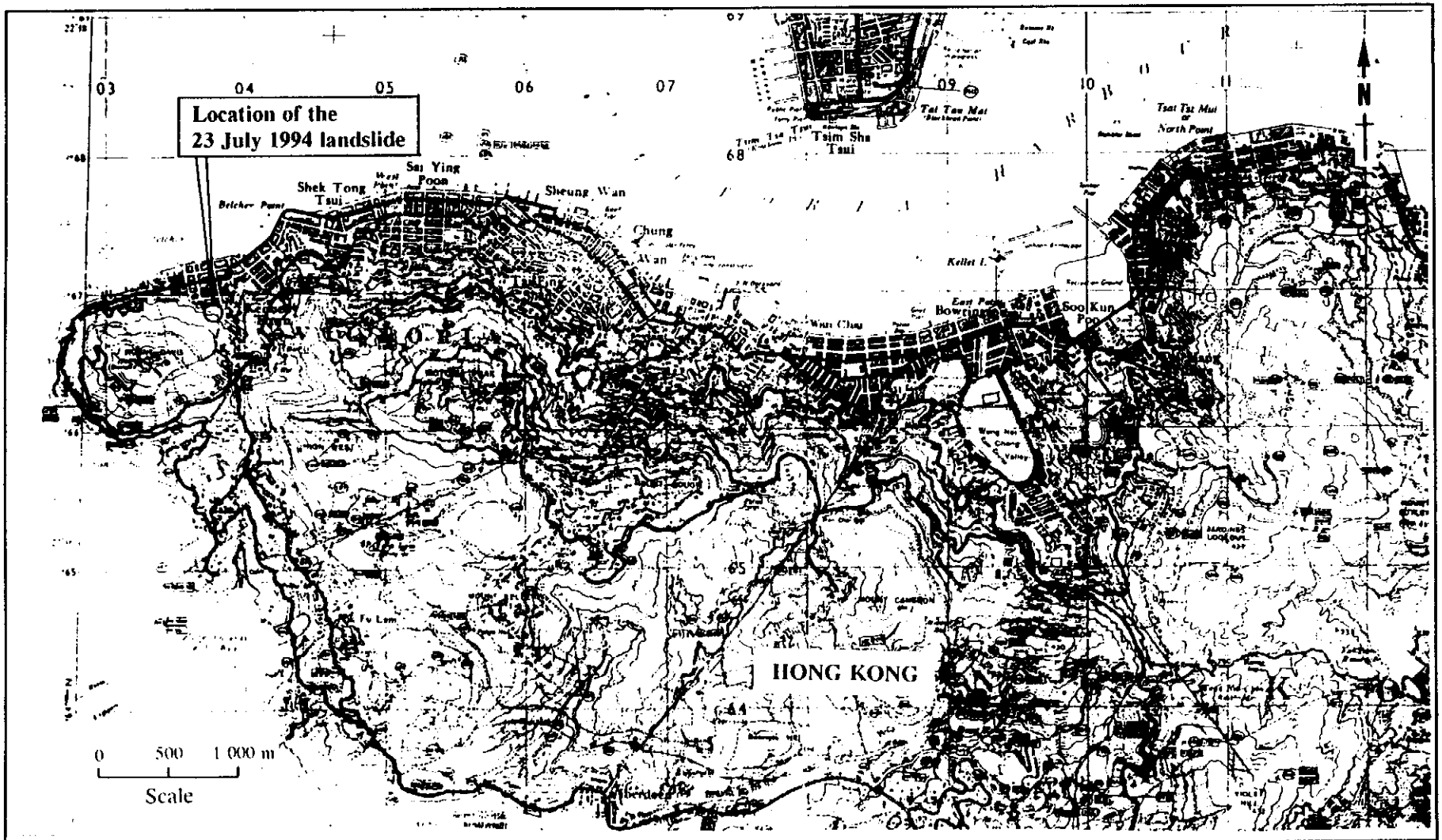
Note : This Figure is reproduced from map No. HG29-1, dated 1889.

Figure B2 - Part of the 1889 Topographic Map



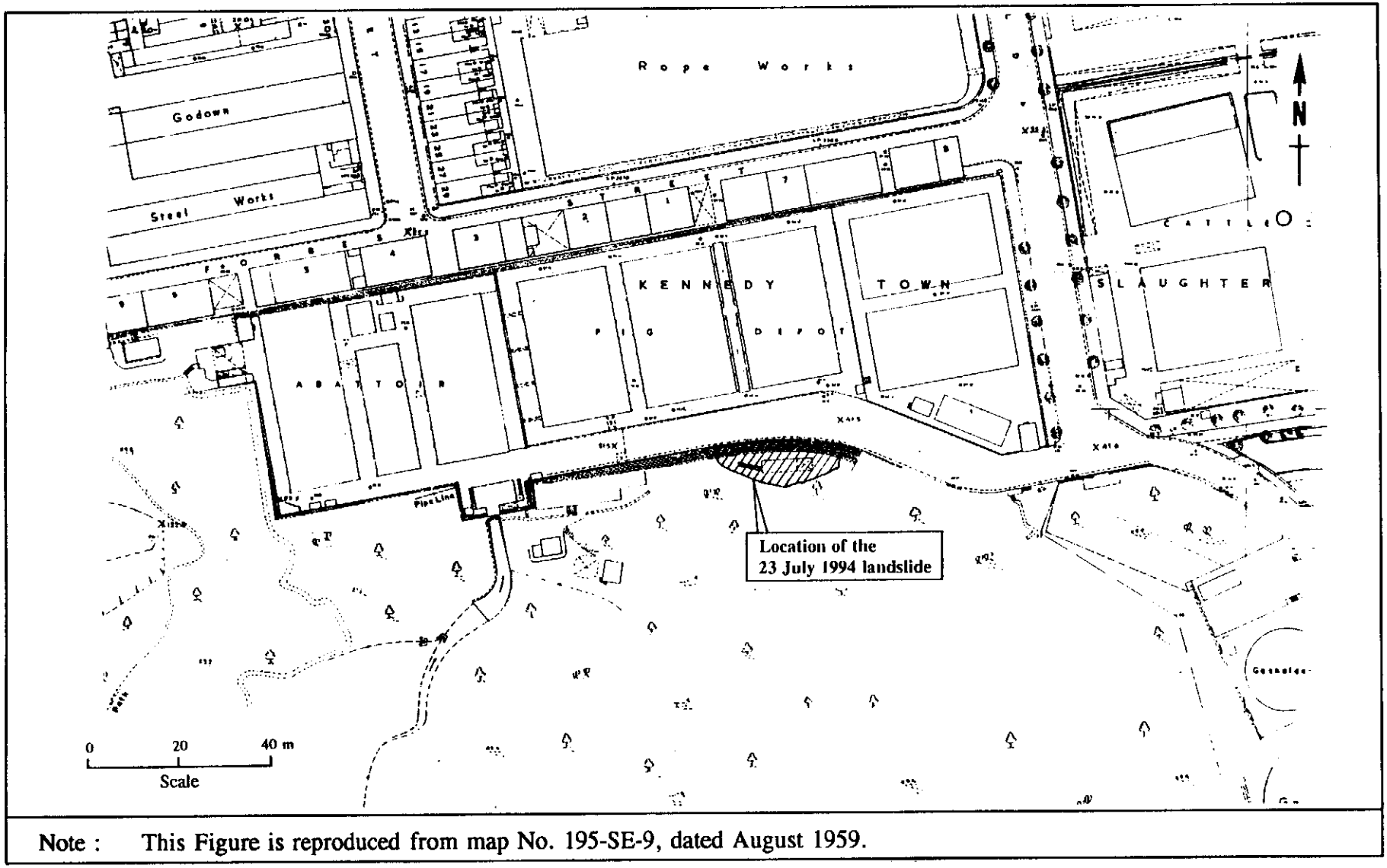
Note : This Figure is reproduced from the map entitled 'Victoria Hong Kong, Sheet No. 2', dated 1901.

Figure B3 - Part of the 1901 Topographic Map



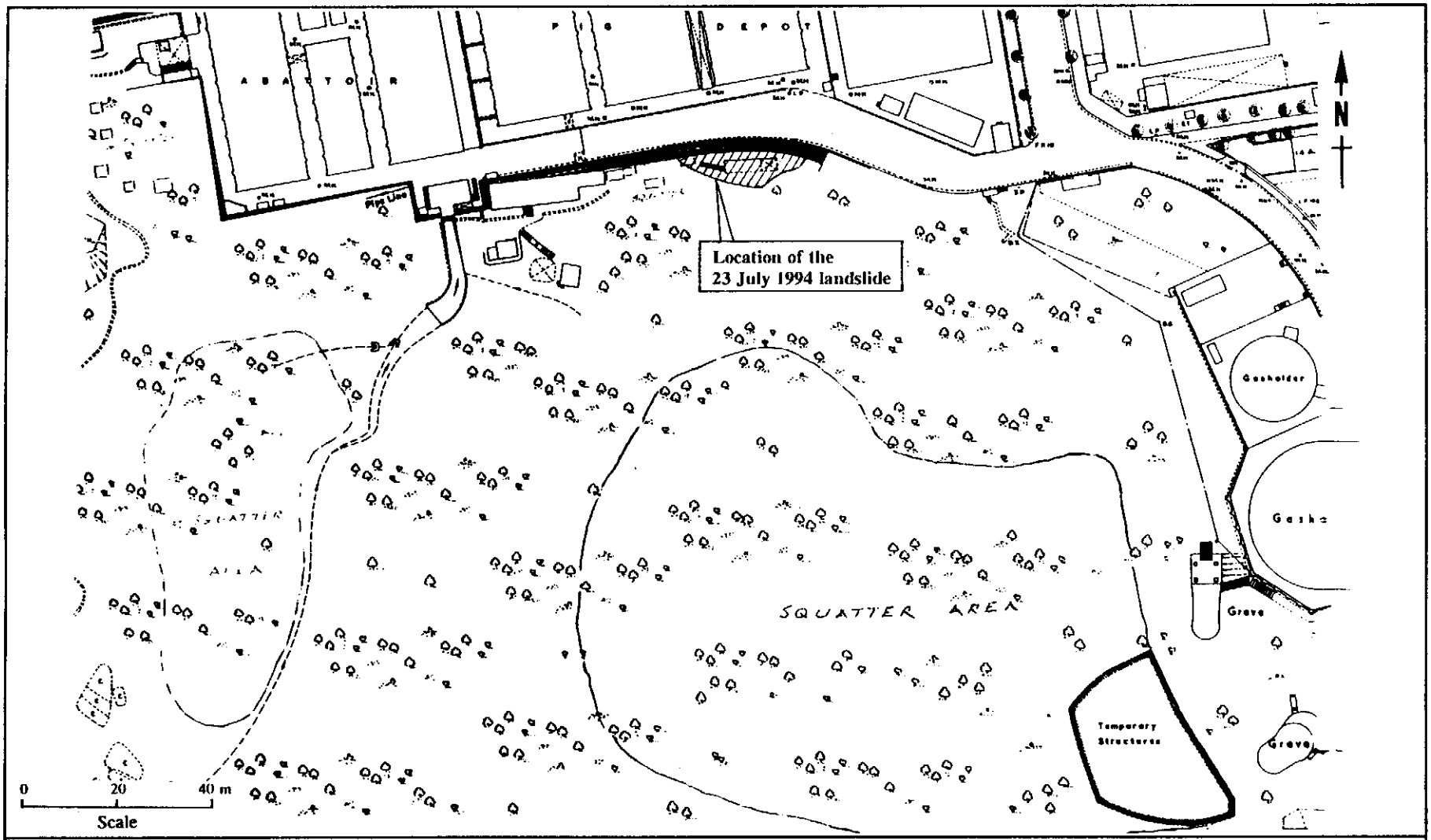
Note : This Figure is reproduced from the map referenced as Series L8811 Sheet No. 19, dated August 1957.

Figure B4 - Part of the 1957 Topographic Map



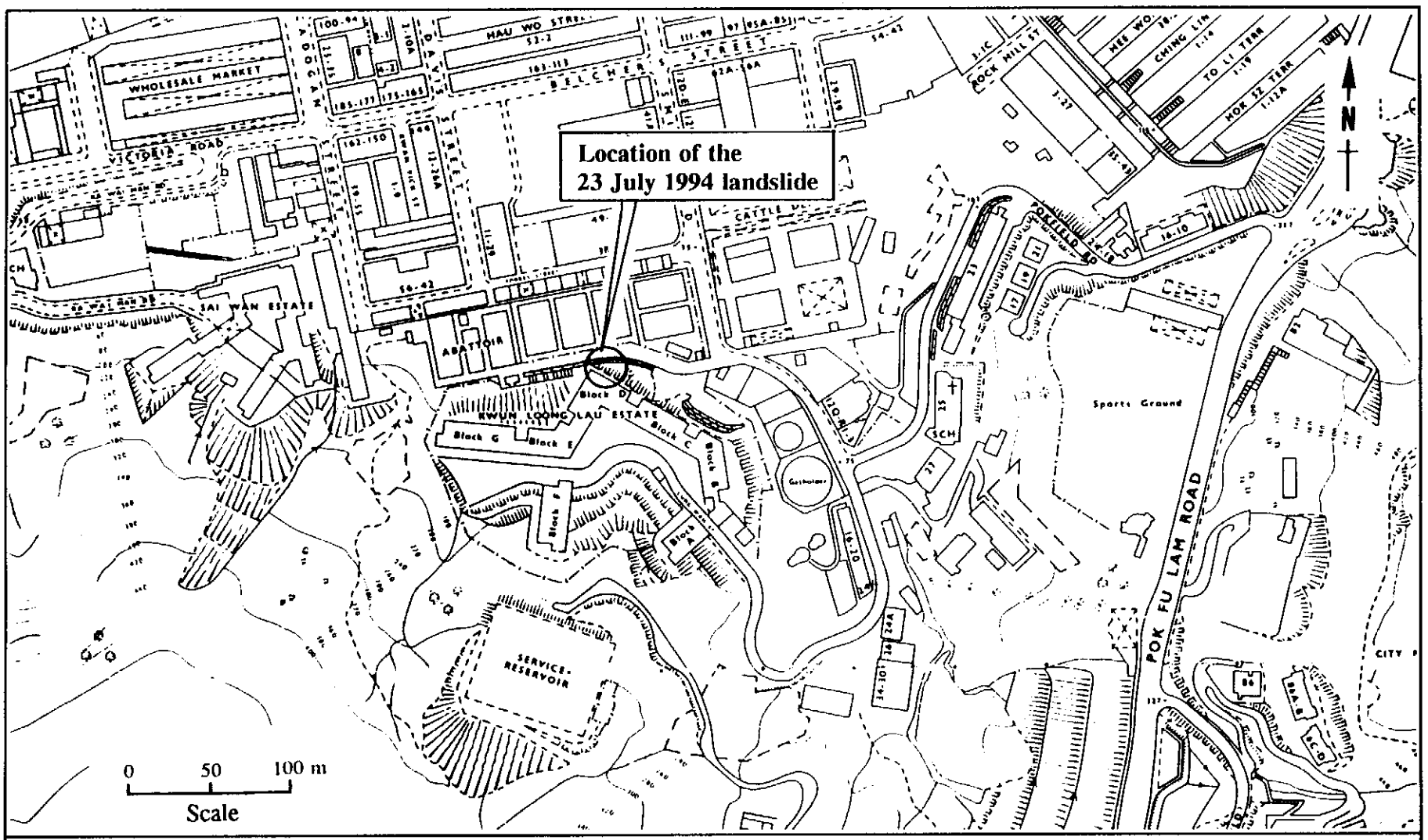
Note : This Figure is reproduced from map No. 195-SE-9, dated August 1959.

Figure B5 - Part of the 1959 Topographic Map



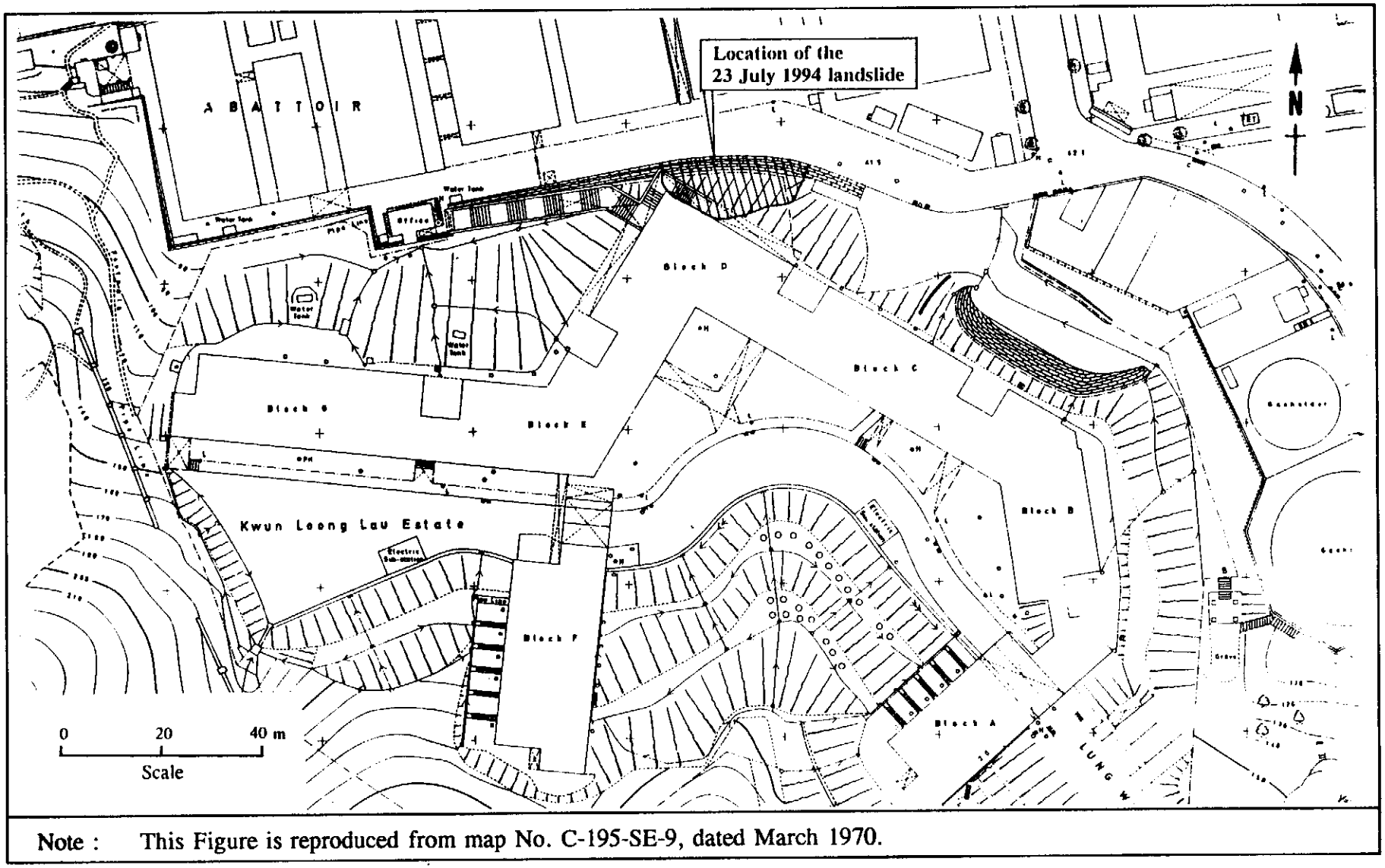
Note : This Figure is reproduced from map No. 195-SE-9, dated March 1960.

Figure B6 - Part of the 1960 Topographic Map



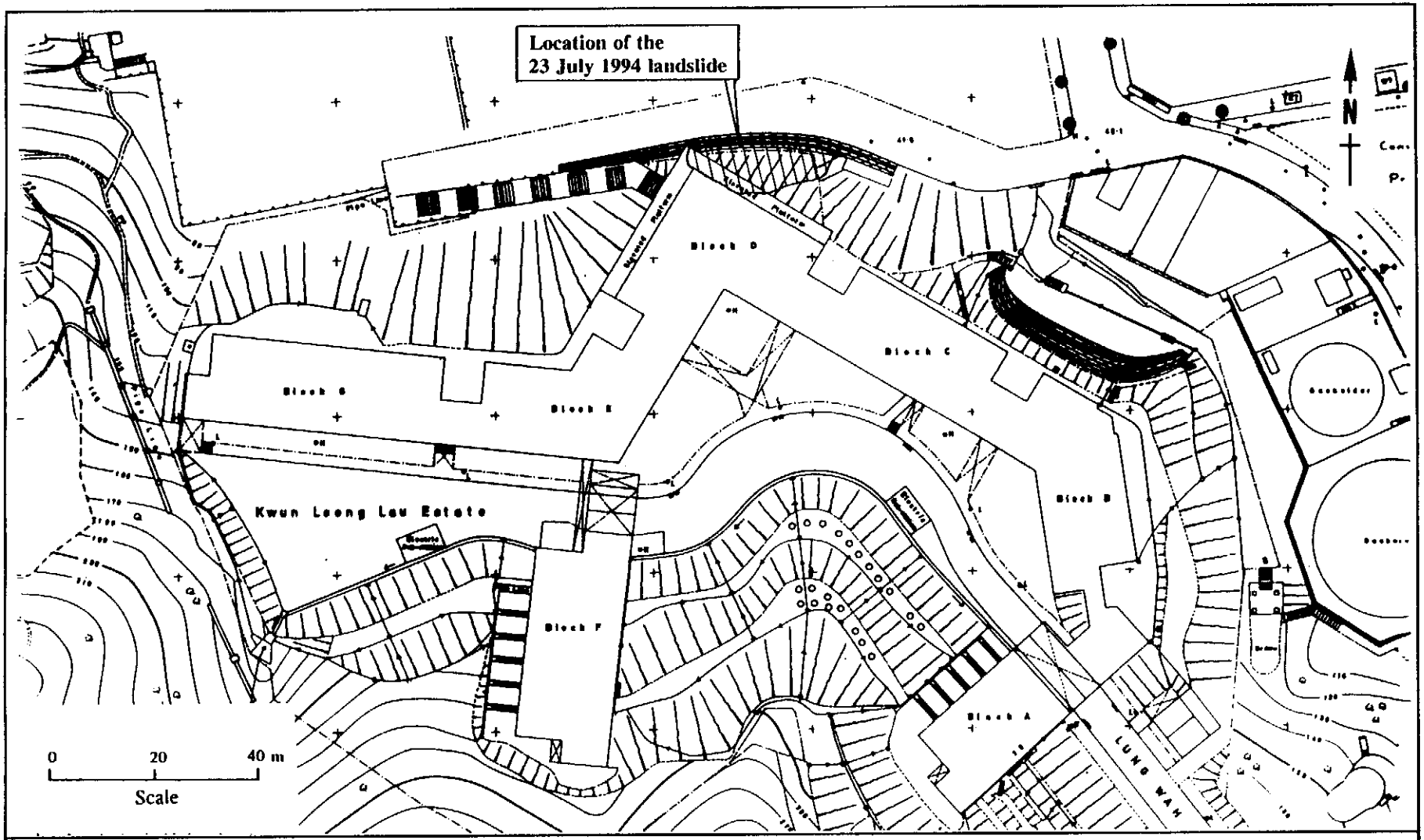
Note : This Figure is reproduced from map No. C-195-SE, dated September 1969.

Figure B7 - Part of the 1969 Topographic Map



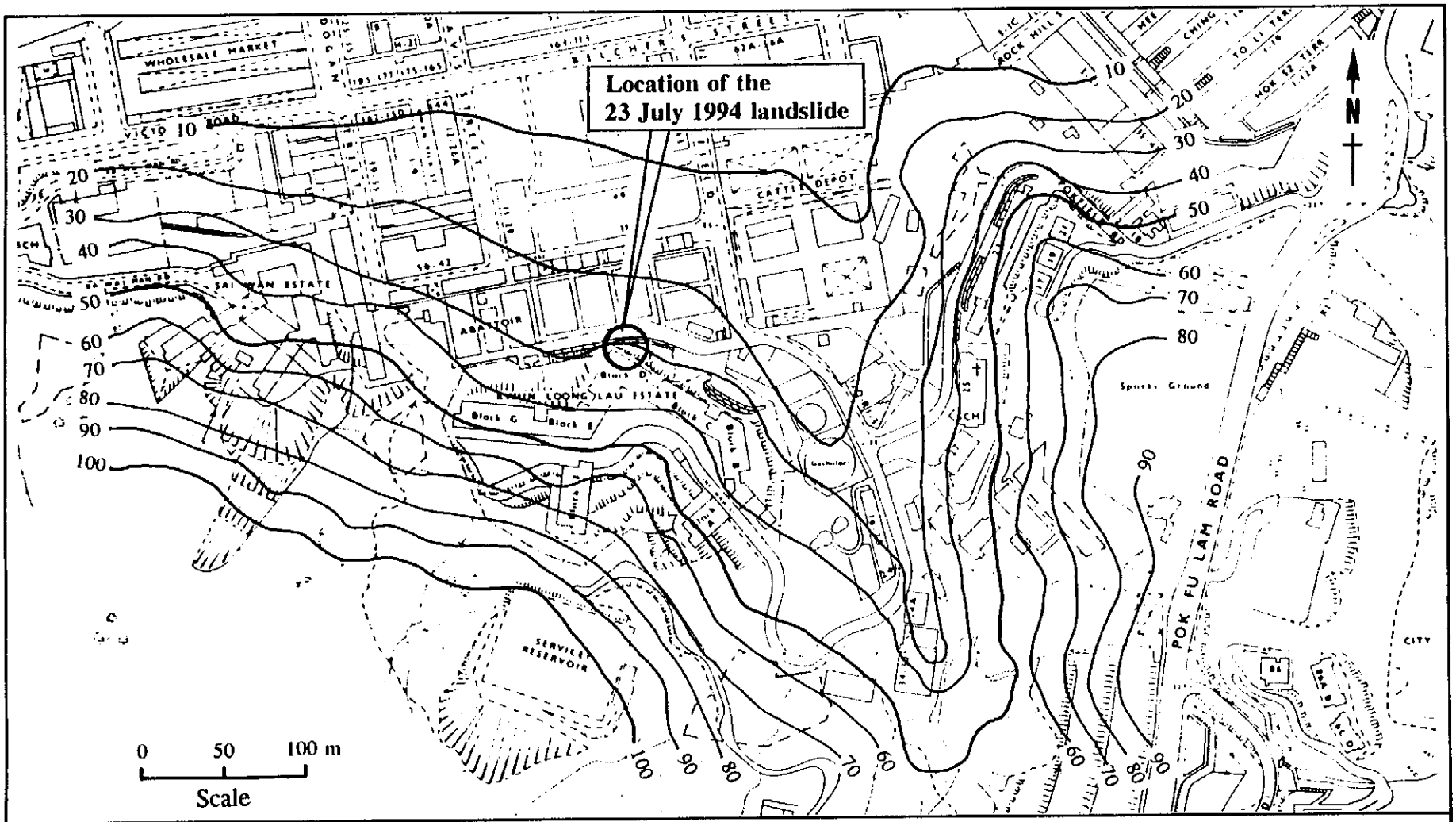
Note : This Figure is reproduced from map No. C-195-SE-9, dated March 1970.

Figure B8 - Part of the 1970 Topographic Map



Note : This Figure is reproduced from map No. C-195-SE-9, dated February 1972.

Figure B9 - Part of the 1972 Topographic Map



Note : (1) Ground contours (in mPD) are reproduced from the 1957 topographic map referenced as Series L8811 Sheet No. 19.
(2) Layout of buildings, roads, etc. is reproduced from map No. C-195-SE, dated September 1969.

Figure B10 - Ground Contours Shown in the 1957 Topographic Map

APPENDIX C

SUMMARY OF DOCUMENTARY INFORMATION

CONTENTS

		Page No.
	Title Page	80
	CONTENTS	81
C.1	INTRODUCTION	82
C.2	FINDINGS	82
C.3	REFERENCES	82
	LIST OF TABLES	83
	LIST OF FIGURES	105

C.1 INTRODUCTION

The available documentary information on the site history since the development of Kwun Lung Lau and the sequence of key events relevant to the 23 July 1994 landslide has been reviewed. The information was extracted from files and drawings kept by the various Government Departments, from reports prepared by the consultants of the Hong Kong Housing Society (HKHS), from correspondence between the HKHS and its consultants, and from the Record Books of caretaking staff of the HKHS at Kwun Lung Lau.

C.2 FINDINGS

The findings of the review of documentary information are summarised in Table C1. Items shown in parenthesis in the Table are quoted verbatim from the relevant documents.

The locations of previous landslides within Kwun Lung Lau are shown in Figure C1.

C.3 REFERENCES

Premchitt, J. (1985). Rainfall and Landslides in 1985. Geotechnical Engineering Office, Hong Kong, 115 p. plus 1 drg. (GEO Report No. 2).

LIST OF TABLES

Table No.		Page No.
C1	Summary of Site History and Sequence of Key Events	84

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 1 of 21)

Date	Key Event	Points to Note
18 Dec 1964	Letter was sent by the Building Authority (BA) to Authorised Person, W.Szeto & Partners, concerning possible effect on the masonry wall of the piling works for the building blocks.	Extracted from Buildings Ordinance Office (BOO) file ref. 3/2233/63 : "The shoring works required in para. 7 of my letter dated 28 November 1964 could be dispensed with, if great care will be exercised in the carrying out of these works and in any circumstances blasting should not be used in the area nearby the Slaughter House and retaining wall".
27 March 1965	Letter was sent by BA to W. Szeto & Partners concerning the need for precautionary measures to avoid possible landslides during the rainy season.	Extracted from BOO file ref. 2/2233/63 : "..... You are accordingly required to take precautionary measures with regard to the following areas :- a) Corner of Block D adjacent to the top of the existing 30'-0" retaining wall along Slaughterhouse Road, i.e. to the west of the abattoir manager's office. Excavation works have been carried out and are still in progress for Blocks B, C, D, E & G. As Block 'D' is at the lowest part of this excavation, the excavated area would, in the event of typhoon rain, become rivers converging on Block 'D'. The excavated soil which has been deposited between Block 'D' and the high retaining wall running parallel to the Slaughterhouse Road might be affected. Some proposals to divert the stormwater away from this area and discharge it into the existing nullah is required. The excavated earth is very soft, and even at present, does not permit walking over without sinking into it ..... ".
8 April 1965	Site Formation Plans for Kwun Lung Lau (KLL) submitted by W.Szeto & Partners on 16 March 1965 were approved by BA.	The geometry of the wall was indicated in solid lines on one of the approved drawings as a stepped masonry wall with a base width of about 4 m. The wall and the slope above were marked as "EX. RETAINING WALL" and "EX. GROUND LINE" respectively by the consultants to the Hong Kong Housing Society (HKHS), W.Szeto & Partners. No details of an investigation of, or calculations for, the masonry wall can be traced.
28 April 1965	Consent was granted by BA for site formation works in KLL.	
20 May 1965	Drainage Plans submitted by W.Szeto & Partners were approved by BA.	
22 Aug 1967	Western part of slope No. 11SW-A/C115 failed (Figure C1).	A concrete wall was subsequently constructed near the toe of the slope, and soil/cement backfill was placed on the failed slope under the direction of W.Szeto & Partners.

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 2 of 21)

Date	Key Event	Points to Note
22 Aug 1967	Western part of slope No. 11SW-A/C115 failed (Figure C1).	A concrete wall was subsequently constructed near the toe of the slope, and soil/cement backfill was placed on the failed slope under the direction of W.Szeto & Partners.
1 Oct 1968	Amendments to Site Formation Plans submitted by W.Szeto & Partners were approved by BA.	Surface and subsurface drainage provisions to the north of Building Block D were amended.
3 Oct 1968	Occupation Permit was issued by BA for Block D of KLL.	
26 Sep 1977	Plans in connection with the addition of a canopy to the existing access steps leading to Block D submitted by W.Szeto & Partners on 28 July 1977 were approved by BA.	One of the approved drawings indicated that two of the columns for the canopy at the northwest corner of Block D were to be founded on separate mass concrete bases which, as a typical detail, partially rested on the existing stepped "stone retaining wall" (drawn in dotted lines) and extended to the base of the masonry wall. The footings for these two columns were exposed after the landslide on 23 July 1994, and it transpired that they had not been constructed in accordance with the approved drawings.
9 Nov 1977	The amended plan for the proposed canopy submitted by W.Szeto & Partners on 26 September 1977 was approved by the Building Authority.	

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 3 of 21)

Date	Key Event	Points to Note
23 Feb 1978	Masonry wall was inspected by Geotechnical Control Office (GCO) consultants, Binnie & Partners (B&P), as part of the study entitled "Landslide Studies Phase 1 Reappraisal - Cut and Natural Slopes and Retaining Walls". A field sheet on the masonry wall was completed.	The masonry wall was registered as No. 11SW-A/R309 by B&P in the Catalogue of Slopes. The slope above the masonry wall was not separately registered. <u>Masonry Wall</u> Condition - "Fair" Weepholes - condition "?", flow "?" U-channels at top - condition "Good", flow "Damp" U-channels at toe - condition "Blocked" Seepage - "None visible" Sign of distress - "None visible" <u>Slope above Wall</u> Material/Construction - "Fill" Condition - "Satisfactory" Weepholes - condition "Good", flow "Dry" U-channels on slope - condition "Good", flow "Dry" U-channels at top - condition "Good", flow "Dry" U-channels at toe - condition "Good", flow "Dry" <u>Maintenance & Repair</u> "Clear shops & stores at toe of wall to allow detailed inspection" <u>Further Action</u> "Phase II - third priority, detailed study".

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 4 of 21)

Date	Key Event	Points to Note
22 June 1979	Slope No. 11SW-A/C115 was inspected by B&P as part of their Phase IID study B&P's Phase IID Study Report on slope No. 11SW-A/C115, which formed part of the Phase IID Area Study of the Sai Wan Area, was completed in January 1980.	"Close inspection of the retaining wall at the toe of the slope is not possible because of the temporary structures built against it". B&P recommended the construction of a new reinforced concrete wall at the toe of slope No. 11SW-A/C115 and that this be "continued to the west (outside the slope boundary) at least as far as the north west corner of Block D", i.e. ≈ 60% of the length of wall No. 11SW-A/R309. A discrepancy in the report is as follows : the length of the proposed new wall is only indicated as 36 m in the cost estimate, which is not consistent with the recommendation, which involved about 70 m.
20 March 1980	Memo was sent by SE(PU/CON) (i.e. seconded staff from consultants Scott Wilson Kirkpatrick & Partners, SWKP) to CGE/PU, Geotechnical Control Branch (GCB) of the Building Development Department, regarding B&P's Phase IID report on Slope No. 11SW-A/C115.	A site inspection was carried out by SWKP on 6 March 1980. "we agree in general with B&P's recommendations for the stabilization of the slope". No specific comments were made in respect of the recommended extension of the works to the north west corner of Block D.

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 5 of 21)

Date	Key Event	Points to Note
21 July 1980	Wall was inspected by GCB and B&P's field sheet was amended.	Masonry Wall Condition - "Fair" weepholes - "Plugged" U-channels at top - condition "Good", flow "Damp" U-channels at toe - condition "Blocked?" Seepage - "None visible" Sign of distress - "At west end crest. Crack along coping (probably caused by nearby tree roots)" Slope above Wall Material/Construction - "Fill (chunam covered)" Condition - "Satisfactory" Weepholes - condition "Good", flow "Dry" U-channels on slope - condition "Good", flow "Damp" U-channels at top - condition "Good", flow "Damp" U-channels at toe - condition "Good", flow "Damp" Maintenance & Repair : "Clear shops & stores at toe of wall to allow detailed inspection" Further action "G.C.B. investigation according to ranking priority"
20 May 1982	General Report on the Phase IID Study of the Sai Wan Area was submitted by B&P.	Report sub-divided features within the Sai Wan area into Category A (i.e. "significant risk-to-life") and Category B (i.e. "of lower priority"). Category A slopes in the Sai Wan area included slope Nos. 11SW-A/C1, C2, C3, C4, C5, C115 & C129. Masonry wall No. 11SW-A/R309 was not included in either category.

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 6 of 21)

Date	Key Event	Points to Note
Nov 1982 to Dec 1982	Consultants Fugro (Hong Kong) Limited (referred to as Fugro in this Appendix) were commissioned by HKHS to produce a report which "contains a description of the site geology, an appraisal of existing information, slope inspection records and recommendations for future inspections and remedial works".	Detailed inspection of Wall No. 11SW-A/R309 "is restricted by row of squatter huts along the wall".
10 Aug 1983	A Section 27A Notice (ref. DH 38/HK/83) was served on HKHS in respect of slope No. 11SW-A/C2 by BA. In the same covering letter, investigation of the stability of slope No. 11SW-A/C1 and repair and maintenance works at slope No. 11SW-A/C5 were also requested.	This action was taken on the recommendation of GCO on 13 April 1983 following a review of the B&P Phase IID reports on these slopes.
Sep 1983	"Superficial failure" occurred at the north-eastern part of Slope No. 11SW-A/C115 after Typhoon Ellen (Figure C1).	Reference to "superficial failure" was made by consultants Fugro in their Geotechnical Report on slope No. 11SW-A/C115 dated June 1984.
21 Sep 1983	Fugro inspected slope No. 11SW-A/C115 following the above failure after Typhoon Ellen.	
13 Oct 1983	Fugro wrote to HKHS proposing to include the investigation of slope No. 11SW-A/C115 as an extension to the site investigation contract that was in operation in discharging the Notice by BA dated 10 August 1983.	"We have also considered the work associated with the investigation of slope No. 11SW-A/C115 which is in need of remedial work studies as a result of recent instability".
17 Oct 1983	Fugro wrote to BA requesting existing information on slope No. 11SW-A/C115.	"slope 11SW-A/C115 (as shown coloured red on attached plan) has been recently included in our extent of investigation".
25 Nov 1983	Factual information on slope No. 11SW-A/C115 was made available to Fugro by BA.	The "unverified geotechnical information" sent to Fugro included part of the B&P's field sheet and extracts from the Phase IID report, such as history and records, plans, photos, piezometric monitoring results, trial pit logs and drillhole logs.

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 7 of 21)

Date	Key Event	Points to Note
23 Dec 1983	Fugro submitted the Geotechnical Report for slope Nos. 11SW-A/C1, C2 & C5 to BA for approval.	
27 March 1984	In response to the submission by Fugro on 23 December 1983, BA confirmed that "the contents of the report and the proposed slope remedial works are considered acceptable in principle".	
May 1984	Report entitled "Investigation of Disused Tunnels - Network 21, Smithfield, Final Report" was submitted by GCO consultants Mott Hay & Anderson Far East.	The disused tunnel was confirmed to be beneath slope No. 11SW-A/C115. Drawing No. AO/164/21/201 showed an area near the top of slope No. 11SW-A/C129 (Figure C1) as "slope repaired recently following rupture of sewer". "one of the downslope channels has been blocked by debris from a leaking sewer which has only recently been repaired" "leakage from drains and sewers running along the north side of Block C could give rise to a perched water table in the fill"
30 May 1984	Minor landslide (about 20 m^3) occurred at slope No. 11SW-A/C5 (Figure C1).	
11 July 1984	BA wrote to HKHS consultants, Fugro, following the landslide at slope No. 11SW-A/C5 in relation to Notice No. DH 38/HK/83.	"In view of the recent failure of slope No. 11SW-A/C5 you are advised to review the geotechnical report dated December 1983 submitted to me and to make formal submissions to me on the slope remedial works to the above slope as well as the slope referred to in the above captioned notice without further delay".

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 8 of 21)

Date	Key Event	Points to Note
27 July 1984	Fugro submitted the Geotechnical Report for slope No. 11SW-A/C115 and associated documents for slope Nos. 11SW-A/C1, C2 & C5, including working drawing Nos. 82118/1 to 82118/5, to BA.	Report on slope No. 11SW-A/C115 made reference to the "masonry retaining wall at the western limit of the slope", and that there were "no obvious signs of distress" observed on the masonry wall and the adjacent 5 m high mass concrete toe wall and that "their general condition is good". The report noted that "the presence of these huts restricts access to the face of existing walls, hence only limited visual inspections of the walls have been carried out in conjunction with trial pits at the wall backs". Calculations were carried out to justify the adequacy of the existing mass concrete toe wall, but no calculations were included for wall No. 11SW-A/R309. Construction of a cantilever caisson wall at slope No. 11SW-A/C115, together with slope trimming and replacement of loose fill by cement stabilised soil, were recommended. The extent of the "site boundary" of the "Phase II" works covered slope No. 11SW-A/C115, together with the north west corner of Block D (drawing No. 82118/1). Drawing no. 82118/3 shows that the recommended limit of remedial works did not extend to the north west corner of Block D but it encroached 9 m into the eastern part of wall No. 11SW-A/R309, and entailed "local trimming of existing masonry wall to match cut slope profile".
26 Sep 1984	Proposals by Fugro for Phase 1 remedial works which covered slope Nos. 11SW-A/C1, C2 & C5 approved by BA.	
23 Nov 1984	Fugro re-submitted details of the Phase II works proposals which covered slope No. 11SW-A/C115.	The submission was expanded to take account of "the presence of a disused air raid tunnel under slope 11SW-A/C115". Both the Phase 1 and Phase II works were to be combined into one remedial works contract.
24 Jan 1985	Proposals for Phase II remedial works were approved by BA.	

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 9 of 21)

Date	Key Event	Points to Note
25 June 1985	Landslide (250 m^3) occurred at slope No. 11SW-A/C129 located to the north of Blocks B & C during slope upgrading works that were being undertaken by the developers of I.L. 8450.	Description of the failure on GCO's Landslip Record Card : "Approx. 24.0 m long stone pitched fill slope collapsed probably due to leakage of services and surface drains at the crest and infiltration during heavy rainfall". The following description of the failure is given by Premchitt (1985) : "The primary causes were possibly the heavy rain which fell earlier in the day together with additional effects of leaking services and surface drainage." A portion of the pile cap of Block B was exposed as a result of the landslip. The Authorised Person for the development, Wong & Ouyang & Associates, produced a report after the failure. "During the past two weeks, we suspected that some buried sewage pipes were leaking. We found water being discharged at weep holes on the stone-pitched slopes. The quantity increased drastically during the afternoon of 25/6/1985 amid heavy rainstorm. The sewage pipe burst caused some minor damage to the slope face. Emergency works in the form of temporary pipe diversion and application of cement coats to the exposed soil face were carried out. Plastic sheets were also used to cover up the affected area. During the night of 25/6/1985 a bigger slip occurred causing another pipe burst. Parts of pile cap of Kwun Lung Lau were also exposed". No notice or advisory letter was issued by BA following the incident because the landslide involved an active construction site.
6 July 1985	Wong & Ouyang & Associates submitted to BA amended site formation plans involving "the addition of a layer of filter material and associated surface channel to intercept possible infiltrated water from Kwun Lung Lau Estate".	"The drainage system of Kwun Lung Lau appears to be in poor conditions. Following the minor slip on 25 June 1985, we noticed considerable seepage near the pile cap of the Kwun Lung Lau Estate. To avoid detrimental effects on the recompacted cement-stabilised fill slope, the addition of a filter layer is highly desirable".

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 10 of 21)

Date	Key Event	Points to Note
9 July 1985	Wong & Ouyang & Associates wrote to HKHS following the failure at slope No. 11SW-A/C129 on 25 June 1985.	"... and associated photographs show that because of broken channels and possibly some drains within your estate, water from your storm water system emerges through the slip scar close to the pile caps. Despite our efforts in putting up the remedial works in the form of a new cement-stabilized fill slope, the presence of water continues to pose a stability problem in the long term." "We are most grateful if you could co-operate in the matter by sealing up all broken channels and repairing broken drains".
23 Aug 1985	BA wrote to Fugro advising "to check and repair if necessary, the existing condition of drainage system (both subsurface & surface) at and in the vicinity of the crest of slope No. 11SW-A/C115 to avoid any adverse effect on its stability due to leaking drains".	BA's action followed the recommendation made by GCO after the landslip at slope No. 11SW-A/C129 on 25 June 1985.
10 Sep 1985	Fugro responded to BA's letter of 23 August 1985 to say that they "have recently carried out a visual inspection of the conditions of the above mentioned drainage system. Neither major cracks on the surface drainage channels nor signs of leakage of subsurface drains can be observed".	"..... As the Phase II remedial works to Slope 11SW-A/C115 are scheduled to commence on 20 September 1985, we shall carry out a detailed investigation into the condition of the existing subsurface drains". Records of such detailed investigation of the subsurface drains cannot be traced.
25 Feb 1986	BA accepted Form 21 and confirmed that Phase I slope remedial works for slope Nos. 11SW-A/C1, C2 & C5 had been completed.	
3 May 1986	Fugro submitted as-built record plans for the caissons at slope No. 11SW-A/C115 to BA.	Comments were raised by GCO concerning the differences between the approved and the as-built drawings, and concerning the reduction in cement stabilised fill quantity. These comments were subsequently resolved with Fugro.
4 Nov 1986	Clearance commenced of squatter huts along the footpath to the north of KLL by the Housing Department.	

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 11 of 21)

Date	Key Event	Points to Note
26 March 1987	Clearance of squatter huts along the footpath to the north of KLL by the Housing Department completed.	
29 May 1987	Wall No. 11SW-A/R309 was inspected by consultants Fugro who were engaged by HKHS to produce a report which "reviews the geotechnical condition of existing slopes and retaining walls within the Kwun Loong Lau Estate, Kennedy Town with the exception of slope nos. 11SW-A/C1, C2, C5 and C115". "The latter were the subject of a major remedial works contract (no. 82118) in 1984 and will be considered under separate cover".	"The wall is in fair condition" "Trees are growing on the upper portion of the wall with the roots penetrating between loose masonry blocks and causing a deterioration of the cement mortar in many locations." "Type (Retaining, Masonry)" "Movement (Cracks)" "Weepholes (Blocked, Dry, Moist, Staining)" "Seepage (Toe of wall)" <u>Maintenance</u> "Clear weepholes" "Clear drainage channels" "Remove unplanned vegetation" "Re-point the gaps between the masonry blocks with cement mortar" <u>Further Work Required</u> "Pruning of any overhanging trees to reduce load on wall"

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 12 of 21)

Date	Key Event	Points to Note
22 July 1987	Wall No. 11SW-A/R309 and the slope above was inspected by GCO as part of their Stage 1 Study. Report no. S1R 97/87 was issued in August 1987.	"No signs of distress" "pointings disappeared in a number of positions" "mature trees growing on the wall especially on the top portion" "some cracks in the coping" "the slope and the wall are generally in good condition except trees are growing in the top part of the wall" "It is therefore recommended that NO FURTHER STUDY is required under the present circumstances". "A Stage 1 Study is a preliminary stability assessment consisting of a detailed field inspection, a desk study and a geotechnical appraisal based on the available information" "Stability analyses gave adequate factors of safety" based on the following assumptions : - strength parameters recommended by Fugro for adjoining slope No. 11SW-A/C115 (i.e. $c'=12$ kPa, $\phi'=35^{\circ}$) - base width of wall assumed to be 2.4 m - no water pressure above the toe of the wall "The squatter shops and stores have been removed from the toe. The revised equivalent rank is greater than 2500".
27 May 1988	Wall No. 11SW-A/R309 was inspected by consultants Fugro who were engaged by HKHS to produce a report which "reviews the geotechnical condition of 12 existing slopes and retaining walls within the Kwun Loong Lau Estate".	"The wall is in good condition" "trees are growing on the upper portion of the wall. Gaps between the masonry blocks have recently been re-pointed." "Type (Retaining, Masonry)" "Weepholes (Dry)" <u>Maintenance</u> "None required" <u>Further Work</u> No recommendation given by the consultants

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 13 of 21)

Date	Key Event	Points to Note
4 May 1989	Wall No. 11SW-A/R309 and the slope above were inspected by consultants Fugro, who were engaged by HKHS to produce a report which "reviews the condition of 12 existing slopes and retaining walls within the Kwun Loong Lau Estate".	"The wall is in fair condition" "Trees are growing on the upper portion of the wall. Drainage channel at the retaining wall crest is severely silted/blocked by rubbish. Minor cracks and spalling appeared on the chunam surface." Soil Slope above Wall - "Slope Cover (Chunam, Trees)"; "Cracks (Surface, Spalling)"; "Drainage Channel (Silting, Blocked)" Retaining Wall - "Type (Retaining, Masonry)"; "Weepholes (Blocked, Dry)" Maintenance "Clear weepholes" "Clear drainage channels" "Remove the unplanned vegetation or at least prune trees to prevent wall collapse" Further Work Required No recommendation given by the consultants Other Remarks "inform Fugro when vegetation works to proceed so that G.E. can be in attendance"

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 14 of 21)

Date	Key Event	Points to Note
May 1990	Wall No. 11SW-A/R309 and the slope above were inspected by consultants John Connell & Associates Ltd (referred to as John Connell in this Appendix), who were engaged by HKHS to carry out "annual slope inspection" to "check the conditions of slope surface, retaining walls and drainage system and to recommend maintenance works if found necessary".	"The retaining wall is in fair condition" Soil Slope above Wall - "Slope Type (Fill)"; "Slope Cover (Chunam, Trees)"; "Drainage Channel (Silting)" Retaining Wall - "Wall Type (Masonry)"; "Drainage Channel (Silting)" Maintenance "Clear drainage channels" "Remove unplanned vegetation" Further Work No recommendation given by the consultants
30 Jan 1991	Wall No. 11SW-A/R309 was inspected by consultants John Connell, who were engaged by HKHS to carry out "annual slope inspection" to "check the conditions of slope surface, retaining walls and drainage system and to recommend maintenance works if found necessary".	"Wall in fair conditions" "Wall Type (Masonry)" "Weepholes" Maintenance "Remove unplanned vegetation" Further Work No recommendation given by the consultants

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 15 of 21)

Date	Key Event	Points to Note
29 Nov 1991	Wall No. 11SW-A/R309 and the slope above were inspected by consultants John Connell, who were engaged by HKHS to carry out "annual slope inspection" to "check the conditions of slope surface, retaining walls and drainage system and to recommend maintenance works if found necessary".	"Retaining Wall A/R309 in good condition" Soil Slope above Wall - "Slope Type (Fill)"; "Slope Cover (Chunam, Trees)"; "Drainage Channel (Silting)" Retaining Wall - "Wall Type (Masonry)"; "Drainage Channel (Silting)"; "Seepage (Toe of wall, Moist)" Maintenance "Remove unplanned vegetation" "Install 50 mm ϕ PVC weephole". (Note that the word "install" in the inspection form was changed to "clear" by hand although the main text still indicates "install".) Further Work No recommendation given by the consultants

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 16 of 21)

Date	Key Event	Points to Note
16 July 1992	Wall No. 11SW-A/R309 and the slope above were inspected by consultants John Connell, who were engaged by HKHS to produce a report to "present results of the inspection carried out by John Connell & Associates Ltd in June and July 1992 on existing slopes in Kwun Lung Lau Estate to check if there are any damages caused by the heavy rainstorms in early May 1992". "The conditions of the slope surface, retaining wall and drainage system are discussed in this report and recommendations on maintenance works are also given."	(a) Inspection : "Retaining wall A/R309 in good condition" Soil Slope above Wall - "Slope Type (Fill)"; "Slope Cover (Chunam, Trees)" Retaining Wall - "Wall Type (Masonry)"; "Seepage (Toe of wall, Trickle) Maintenance No recommendation given by the consultants Further Work "Install 50mm ϕ PVC weephole" (B) Text - Conclusions and Recommendations "There are no evidence that the rainstorm on 8 May 1992 has caused any major instability on the surface of the slopes". "However, the condition of chunam plasters of slopes should be checked to detect the extent of undermining and subsidence in the sub-soil. In addition, a detailed stability analysis of these slopes should also be performed and necessary stabilization measures have to be carried out such that the current safety standards can be achieved for these slopes".
23 July 1992	Proposed scope of engineering consultancy services in connection with the "detailed slope study" for Kwun Lung Lau was submitted by John Connell, consultants to HKHS.	

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 17 of 21)

Date	Key Event	Points to Note
4 Aug 1992	Letter was sent by HKHS to John Connell commenting on the scope of engineering services proposed by John Connell for slope stability assessment of a number of the housing estates, including Kwun Lung Lau.	
5 Aug 1992	Letter was sent to HKHS by consultants John Connell reducing the scope of engineering services subsequent to discussions with HKHS.	
7 Aug 1992	Letter was sent by HKHS to John Connell providing comments on the scope of engineering services proposed by John Connell.	
11 Aug 1992	Letter was sent by consultants John Connell to HKHS containing the revised engineering consultancy proposal for the "Stage 1 slope study".	

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 18 of 21)

Date	Key Event	Points to Note
Dec 1992	Wall No. 11SW-A/R309 and the slope above were inspected by consultants John Connell. Report entitled "Study of existing slopes - Stage 1 General review" was submitted to HKHS in January 1993. The scope of the study as given in the January 1993 report consists of the following : "i) to search for and to review slope study reports and site investigations reports available from Geotechnical Engineering Office (GEO). ii) to carry out detailed inspection on the conditions of the slopes immediately outside lot boundary and to report to Hong Kong Housing Society whether instability in such slopes may affect the housing estate. iii) to carry out a preliminary geotechnical study based on available information and findings of site inspection and to identify the need for supplementary site investigation. iv) to alert the attention of Hong Kong Housing Society if adverse conditions are in existence that may affect the stability of the existing building structures within or close to the areas of this study."	(a) Inspection : "The retaining wall is in fair condition" Soil Slope above Wall - "Slope Type (Fill)"; "Slope Cover (Chunam, Trees)"; "Drainage Channel (Silting)" Retaining Wall - "Wall Type (Masonry)"; "Drainage Channel (Silting)" Maintenance "Clear drainage channels" "Remove unplanned vegetation" Further Work No recommendation given by the consultants (b) Text - Conclusions and Recommendations : "..., we consider that it is not necessary to carry out further detailed stability study for these slopes"

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 19 of 21)

Date	Key Event	Points to Note
15 June 1994	Wall No. 11SW-A/R309 and the slope above were inspected by consultants Mott Connell Buildings Ltd. who were engaged by HKHS to carry out an inspection of the existing slopes in KLL to "check the conditions of the slope surface, retaining wall and drainage system".	(a) Inspection : "The slope is in fair condition" Soil Slope above Wall - "Slope Type (Cut)"; "Slope Cover (Chunam)"; "Deterioration (Top of slope - Subsidence, Surface, Cracks)"; "Drainage Channel (Silting)"; "Weepholes (Blocked)" Retaining Wall - "Wall Type (Masonry)"; "Drainage Channel (Silting)" Comment "Subsidence and cracks were noted near the slope crest. Unplanned vegetation on the retaining wall. Unstable tree at the toe of slope" Maintenance "clear weepholes" "clear drainage channels" "repair chunam" "remove unplanned vegetation" "reinstate subsidence and repair cracks in slope" "remove trees and vegetation from retaining wall face and reinstate voids and cracks by cement mortar" "remove tree from the toe of slope" "void in unused tree ring should be backfilled and protected with chunam plaster" (b) Text : Section 2.2 - Leakage of manhole at the western end of slope A/C115 "Dark greenish stain was noted below the manhole at the western edge of slope 11SW-A/C115 due to leakage of foul water from the manhole. It was recommended that the manhole and associated pipelines should be checked and the leaking points should be made good."

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 20 of 21)

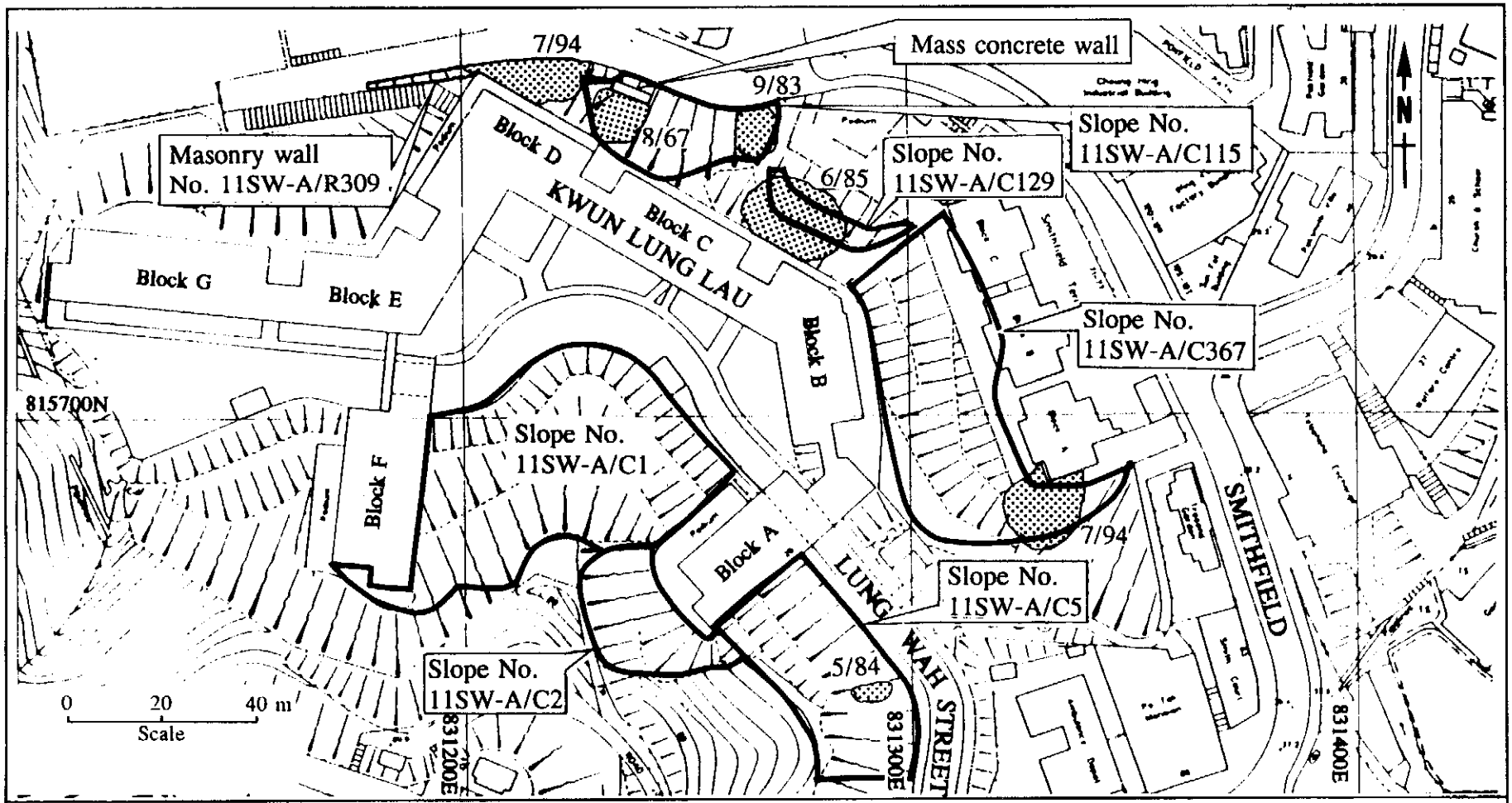
Date	Key Event	Points to Note
24 June 1994	John Connell's slope inspection report dated June 1994 was submitted to HKHS.	
14 July 1994	John Connell wrote to HKHS to clarify the recommendation given in the June 1994 report on re-surfacing of the slope above wall No. 11SW-A/R309 in response to the request by HKHS for details of new protection to eliminate the need for frequent maintenance of the old chunam.	The chunam covering to the slope above wall No. 11SW-A/R309 was recommended to be replaced with shotcrete.
19 July 1994	Tender documents for the works recommended by consultants John Connell in the June 1994 report were completed by HKHS.	This is based on information provided to GEO by HKHS on 4 August 1994.
22 July 1994	Landslip Warning was issued at 3:00 a.m. by the Royal Observatory on GEO's recommendation.	
22 July 1994	Inspections were carried out by caretaking staff of HKHS at KLL.	Translation from the Caretaker's Records Book in Chinese provided by HKHS : 8:00 a.m. - ".... A lot of mud and leaves washed to the large pump above Block G. This has been cleared by cleaners. Inspected with Tse the gullies, cleared rubbish ....." 2:00 p.m. - "Inspected at noon with Lai and Tse various slopes, carpark and the roof, and all surface channels & drainage system. The channels functioned normally during heavy rain. Small amount of rubbish was removed by us when rain was lighter. No signs of distress on the slopes during inspection."

Table C1 - Summary of Site History and Sequence of Key Events (Sheet 21 of 21)

Date	Key Event	Points to Note
23 July 1994	Inspections were carried out by caretaking staff of HKHS at KLL.	Translation from the Caretaker's Records Book in Chinese provided by HKHS : 9:20 a.m. - "Inspected and cleared surface channels & drainage system at all slopes, parking lots and the roofs in the morning". 2:00 p.m. - "..... Mr Wong reminded Ms Chu to tell all caretakers to pay attention to the slope at Block G where the transformer is located. The slope below Blocks C & D, Mr Wong and I separately inspected the roofs, carparks and gullies, and cleared rubbish".
23 July 1994	Masonry wall and the slope above failed at about 8:53 p.m.	Five people on the footpath were killed and three were seriously injured.
24 July 1994	Small-scale failure (25 m^3) occurred at the eastern end of slope No. 11SW-A/C367 (Figure C1).	
26 July 1994	Landslip Warning was cancelled at 10:00 a.m. by the Royal Observatory on GEO's recommendation.	

LIST OF FIGURES

Figure No.		Page No.
C1	Locations of Previous Landslides at Kwun Lung Lau	106



Legend :

6/85 Location of landslide dated June 1985

Notes : (1) Base map is extracted from Survey Sheet No. 11-SW-6D (scale 1:1000) dated 29 September 1992.

(2) Only recorded landslides are shown in this Figure. Landslide scars observed in aerial photographs are shown in Figure H1.

Figure C1 - Locations of Previous Landslides at Kwun Lung Lau

APPENDIX D

STATUTORY CHECKING SYSTEM FOR PRIVATE BUILDING DEVELOPMENTS

CONTENTS

		Page No.
	Title Page	107
	CONTENTS	108
D.1	STATUTORY CHECKING SYSTEM AT THE TIME OF THE DEVELOPMENT OF KWUN LUNG LAU	109
D.2	STATUTORY CHECKING SYSTEM AFTER 1972	109
D.3	REFERENCES	110

D.1 STATUTORY CHECKING SYSTEM AT THE TIME OF THE DEVELOPMENT OF KWUN LUNG LAU

Under the provisions of the Buildings Ordinance, the design of private building works has to be approved by the Building Authority (i.e. the Buildings Department).

In the 1960s, the professional staff establishment in the then Buildings Ordinance Office (BOO), now the Buildings Department, consisted of Building Surveyors (BS) and Structural Engineers (SE). Site formation submissions were checked by the BS, with the necessary structural advice being provided by the SE.

The BOO would offer no objections to an angle of slope not greater than 35° for filling and 50° for cutting. Should a steeper angle be proposed, the authorised architect had to confirm in writing to the Building Authority that he had inspected and investigated the nature of the soil and was satisfied that such slope would be stable.

Adequate protective cover and surface drains were required to be provided for formed slopes. Chunam and turfed surfaces were generally used for cut slopes, but for fill slopes, turfing was more suitable.

For cuttings exceeding 30 ft high, berms (minimum 3 ft wide) with 12 in. surface channels placed away from edges of berms were generally provided. 'Herring bone' surface drains were considered to be an effective means of intercepting surface water.

Existing retaining walls were normally accepted based on the site condition and assumptions made by the authorised architect. Only new works were approved by the Building Authority.

New retaining walls were checked by the SE against the requirements in Code of Practice No. 2 (CP2) "Earth Retaining Structures" published by the Institution of Structural Engineers (1951).

D.2 STATUTORY CHECKING SYSTEM AFTER 1972

As a result of the fatal landslides in 1972 (Hong Kong Government, 1972), including the Po Shan landslide, a Soils Section was established in the BOO in 1972 to check the geotechnical aspects of building works. Site formation submissions were required to be accompanied by detailed calculations, and these were checked by the Engineers in the Soils Section. On the recommendation of the Independent Review Panel on Fill Slopes set up following the Sau Mau Ping Landslide disaster of 1976 (Hong Kong Government, 1977), the Geotechnical Control Branch (which merged with the GCO in 1983) in the BOO and the then Geotechnical Control Office (GCO) (now the Geotechnical Engineering Office, GEO) were established. One of the principal landslip prevention duties of the GEO is the control of private and public development works through the checking of the geotechnical designs of the proposed works and the standard of site supervision. This checking system has continued up to the present time.

Guidance on technical standards for the design, construction and maintenance of site

formation works on slopes is given in the Geotechnical Manual for Slopes published by the GCO (1979, 1984). Guidance on the design of retaining walls is given in the Guide to Retaining Wall Design (GCO, 1982; GEO, 1993).

D.3 REFERENCES

GCO (1979). Geotechnical Manual for Slopes. (First edition). Geotechnical Control Office, Hong Kong, 242 p. plus 19 plates & 1 drg. (Reprinted with corrections and minor amendments, 1981).

GCO (1982). Guide to Retaining Wall Design (Geoguide 1). Geotechnical Control Office, Hong Kong, 154 p.

GCO (1984). Geotechnical Manual for Slopes. (Second edition). Geotechnical Control Office, Hong Kong, 295 p.

GEO (1993). Guide to Retaining Wall Design (Geoguide 1). (Second edition). Geotechnical Engineering Office, Hong Kong, 297 p.

Hong Kong Government (1972). Final Report of the Commission of Inquiry into the Rainstorm Disasters, 1972. Hong Kong Government Printer, 94 p. (Also published in Chinese, 99 p).

Hong Kong Government (1977). Report on the Slope Failures at Sau Mau Ping, August 1976. Hong Kong Government Printer, 105 p. plus 8 drgs. (Also published in Chinese, 92 p. plus 8 drgs).

Institution of Structural Engineers (1951). Civil Engineering Code of Practice No. 2 : Earth Retaining Structures. Institution of Structural Engineers, London, 224 p.

APPENDIX E

THICKNESS OF MASONRY RETAINING WALLS IN HONG KONG

CONTENTS

		Page No.
	Title Page	111
	CONTENTS	112
E.1	BASIS OF THE REVIEW OF WALL THICKNESS	113
E.2	FINDINGS OF THE REVIEW	113
	LIST OF TABLES	114
	LIST OF FIGURES	116

E.1 BASIS OF THE REVIEW OF WALL THICKNESS

The masonry wall at Kwun Lung Lau which partly failed in July 1994 was unusually thin. In order to judge this 'thinness' in the context of old masonry retaining walls in Hong Kong, two data sets with information on wall dimensions have been examined. The first data set was collated from reports on Stage 2 Studies carried out on retaining walls by the Geotechnical Engineering Office (GEO). The second data set comprised a collection of inspection records of old walls prepared on cards in the late 1970s when the Geotechnical Control Branch (GCB) of the Buildings Ordinance Office started an investigation of masonry walls. The GCB merged with the Geotechnical Control Office (renamed Geotechnical Engineering Office in 1991) in 1983.

The first data set could well be biased towards thinner walls, because these are more likely to have been picked out for Stage 2 Studies. The second data set should have a more random population, because the inspections were carried out on whatever walls were exposed by construction activities at that time. Two walls exposed by failures were included in the inspections, but details of their base widths were absent, and these two cases have not been included.

E.2 FINDINGS OF THE REVIEW

The wall slenderness (height/base-width, H/B) ratios are analysed in Tables E1 & E2. The wall dimensions from the two data sets are plotted in Figures E1 & E2.

The first data set covers 81 walls. There is insufficient information on the thickness of some of the walls. Of the 58 walls with known dimensions, about three-quarters have a height/base-width ratio of less than 4.0. Those with a slenderness ratio larger than 4.0 generally have some special reasons for their slenderness. In two cases, the walls are actually stone-pitching on cut slopes; two walls appear to have been constructed in stages, one retains rock, and one forms the lower part of a building wall and is therefore not a gravity retaining wall.

The second data set contains information on 19 walls, of which 13 have a slenderness ratio of less than 4.0. Of the six more slender walls, two are tied-face walls, which are known to be thin sometimes, and one is a stone pitching on a cut slope.

The masonry wall at Kwun Lung Lau had a maximum height of 10.6 m and a base-width of 0.8 m, i.e. H/B = 13.25. As can be seen from Figures E1 & E2, the wall was exceptionally slender.

LIST OF TABLES

Table No.		Page No.
E1	Slenderness Ratios of Masonry Walls Examined in GEO Stage 2 Studies	115
E2	Slenderness Ratios of Masonry Walls Determined from GCB Inspection Records	115

Table E1 - Slenderness Ratios of Masonry Walls Examined in GEO Stage 2 Studies

Slenderness Ratio	Number of Walls	Percentage of Walls
$H/B < 2$	8	14%
$2 \leq H/B < 3$	22	39%
$3 \leq H/B < 4$	12	21%
$H/B \geq 4$	15	26%
Total	57	100%

Legend :
B Base width of retaining wall
H Height of retaining wall

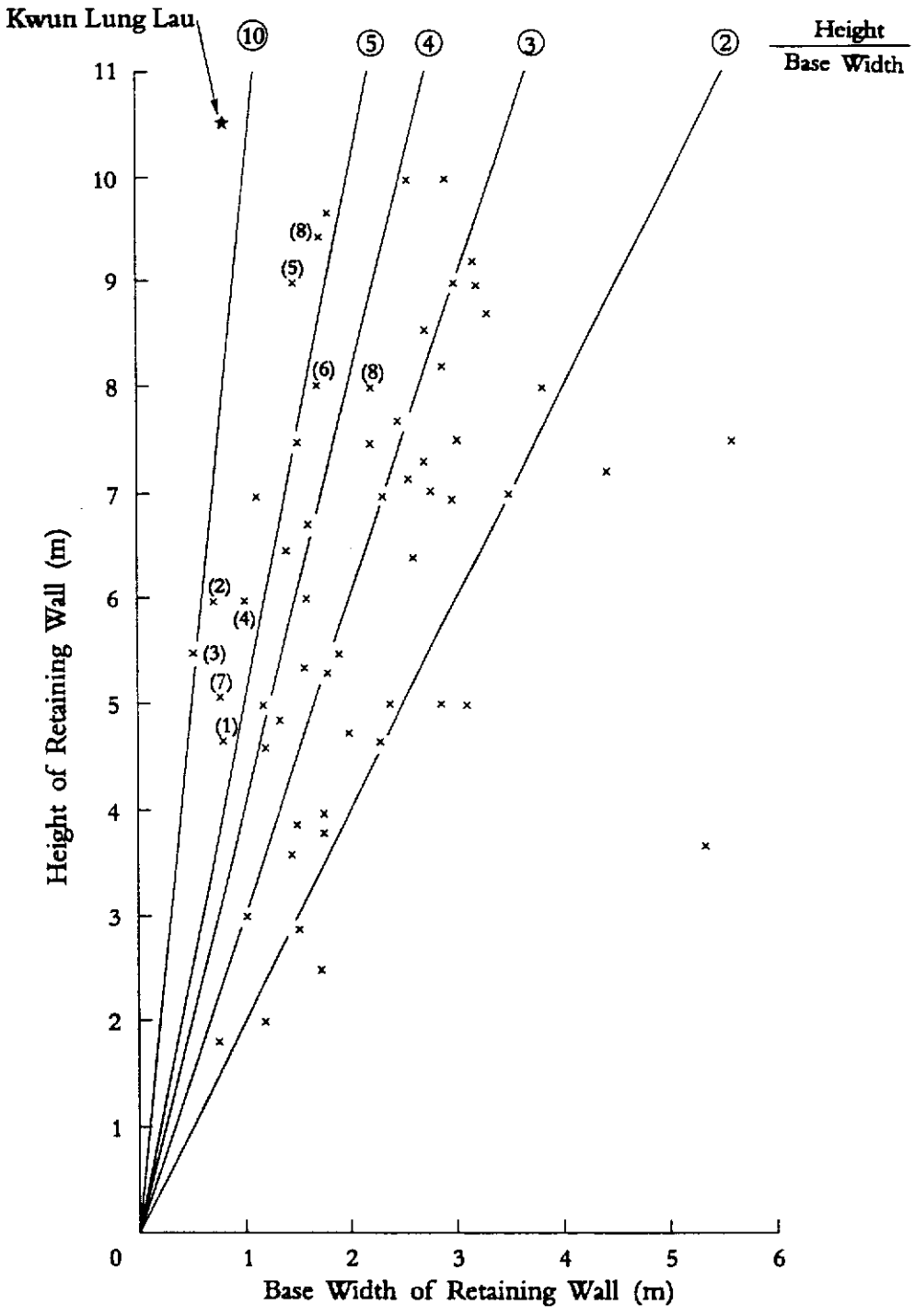
Table E2 - Slenderness Ratios of Masonry Walls Determined from GCB Inspection Records

Slenderness Ratio	Number of Walls	Percentage of Walls
$H/B < 2$	3	16%
$2 \leq H/B < 3$	5	26%
$3 \leq H/B < 4$	5	26%
$H/B \geq 4$	6	32%
Total	19	100%

Legend :
B Base width of retaining wall
H Height of retaining wall

LIST OF FIGURES

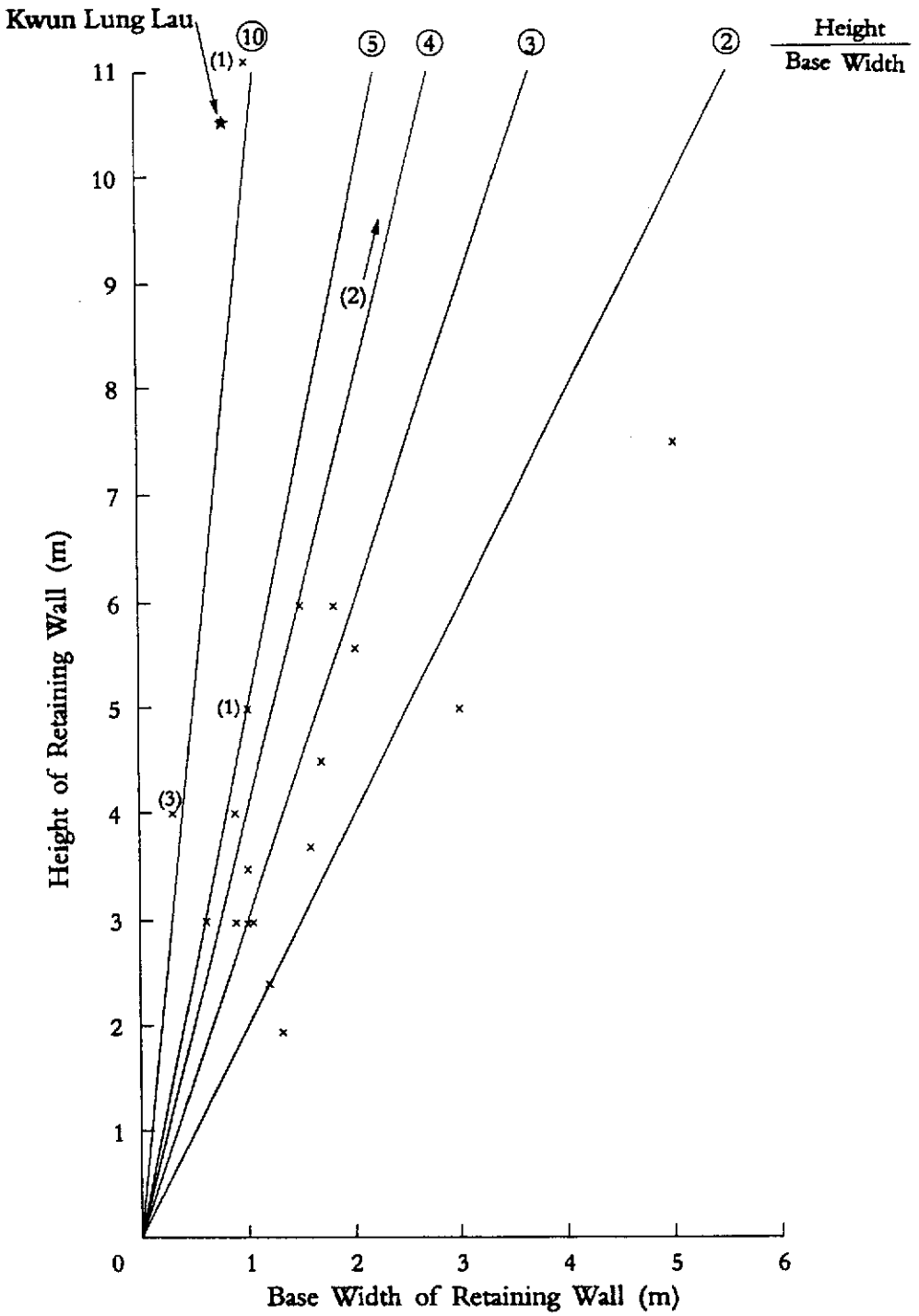
Figure No.		Page No.
E1	Dimensions of Masonry Retaining Walls Examined in GEO Stage 2 Studies	117
E2	Dimensions of Masonry Retaining Walls Determined from GCB Inspection Records	118



Notes :

(1) Very short section of wall at corner of site, concave on plan, further examination required.
(2) Recent stone-pitching wall.
(3) Stone-pitching wall on the lower two batters of a cut slope.
(4) Lower half of wall retained slightly to moderately weathered rock.
(5) Wall constructed in two stages.
(6) Retaining wall supported a building wall on top.
(7) Wall constructed in two stages, upper part in brick.
(8) Insufficient information.

Figure E1 - Dimensions of Masonry Retaining Walls Examined in GEO Stage 2 Studies



Notes : (1) Tied face walls.
(2) Height of wall = 15 m, base width of wall = 3.6 m.
(3) Stone-pitching wall on a 65° slope.

Figure E2 - Dimensions of Masonry Retaining Walls Determined from GCB Inspection Records

APPENDIX F

ACCOUNTS OF WITNESSES

CONTENTS

		Page No.
	Title Page	119
	CONTENTS	120
F.1	INTRODUCTION	121
F.2	WITNESS IDENTIFICATION	121
F.3	INFORMATION OBTAINED FROM WITNESSES	121
	F.3.1 Witness Accounts	121
	F.3.2 General Observations about the Site	122
	F.3.3 Observations before the Landslide	122
	F.3.4 Observations during the Landslide	123
	F.3.5 Flooding in the Yard Area	123
	F.3.6 Observed Flow from the Foulwater Sewer	123
	LIST OF TABLES	124
	LIST OF FIGURES	135

F.1 INTRODUCTION

Information was collected from witnesses to reconstruct the sequence of events before and during the landslide. A brief account of the actions taken by the Geotechnical Engineering Office (GEO) in identifying witnesses and a summary of the information obtained are given in this Appendix.

F.2 WITNESS IDENTIFICATION

A press statement about GEO's call-for-witnesses was released by the Information Services Department on 26 July 1994. Copies of a notice issued by the GEO calling for witnesses were posted within Kwun Lung Lau with the assistance of the Hong Kong Housing Society on 17 August 1994. Staff of the GEO also visited the residents of Kwun Lung Lau to locate potential witnesses.

With the assistance of the Hong Kong Housing Society, about 2000 questionnaires were distributed to all residents in Blocks A to G of Kwun Lung Lau on 17 August 1994. A copy of the questionnaire (translated from Chinese) is given in Figure F1. Thirty-three returns were received by the GEO.

The Royal Hong Kong Police Force referred four witnesses to the GEO, including the three people injured in the landslide.

In order to obtain further information about the site, staff of the GEO interviewed four caretakers of Kwun Lung Lau on 19 October 1994.

On 1 October 1994, staff of the GEO visited Kwun Lung Lau and interviewed the residents to estimate the number of residents who stayed awake after the landslide until the early morning of 24 July 1994, and to collect information about flooding in the yard area to the south of Block D. A total of 287 flats were visited.

F.3 INFORMATION OBTAINED FROM WITNESSES

F.3.1 Witness Accounts

Of the 33 returned questionnaires, 14 provided information about the site, and two provided direct information about the landslide. These two residents were subsequently interviewed by the GEO. Of the remainder, 16 questionnaires contained no information about the site or the landslide, and one was found to be a forgery.

A total of 22 witnesses were interviewed in person by the GEO. These included three people injured in the landslide, three other eye-witnesses of the incident, 12 people who heard the sound of the landslide or noticed unusual things before the landslide, and four caretakers of Kwun Lung Lau. Records of the interviews were prepared by the GEO and signed by the witnesses. The records are kept in the GEO. A summary of the witness statements is given in Table F1.

A brief account of the information obtained from the returned questionnaires and from the witness interviews is given below. Some important features observed by the witnesses are marked in Figure F2.

F.3.2 General Observations about the Site

Five witnesses reported that the footway had always been flooded by muddy water during heavy rains. Two other people had also observed this, as reported in their returned questionnaires.

The four caretakers of Kwun Lung Lau reported that the portion of the footway fronting the landslide area had not been flooded during heavy rains. They also reported that, in the past, they had not noticed any seepage from the masonry wall at the slope between Block D and the masonry wall which failed in the landslide.

Six witnesses indicated that trees in the masonry wall or the slope above had either been pruned or cut some time before the landslide. The time quoted ranged from a few months to three years. This was also reported by two other people in their returned questionnaires.

F.3.3 Observations before the Landslide

Seven witnesses reported that muddy water had been seeping through the weepholes within the lower part of the masonry wall. This was also reported in eight other returned questionnaires. Four of them reported seeing the seepage two days before the landslide, and the other eleven reported seeing this on the day of the failure.

The four caretakers of Kwun Lung Lau reported that they had inspected the slope above the masonry wall from the slope crest twice on the day before the landslide, and three times on the day of the landslide. The slope was last inspected about six hours before the landslide. The caretakers indicated seeing neither signs of defects nor blockage of drainage channels at the location of the inspections.

About two-and-a-half hours before the landslide, a witness reported seeing a hole in the chunam near the manhole on the slope at the eastern edge of the landslide area while walking along the footway. The hole was noted to be about 1 m in diameter, and soil was apparently exposed due to the loss of the chunam cover.

About one-and-a-half hours before the failure, a witness noticed muddy water seeping through the weepholes and joints of the masonry wall at the failure location. The seepage level was reportedly up to, and may have been higher than, five feet above the level of the footway. The seepage area was reported as about ten feet wide, which is more extensive than the seepage areas reported in the morning of the day of the landslide and two days before. About half an hour before the landslide, another witness observed that seepage of muddy water covered an extensive portion of the failure area from the wall toe to about five feet high on the masonry wall.

Within the ten-minute period before the failure, two witnesses noticed that broken strips of the metal railing on the top of the masonry wall had fallen down onto the footway, together with pieces of stone or concrete. One of the witnesses had also observed that the metal railing on the top of the wall was bent and broken.

F.3.4 Observations during the Landslide

Witnesses generally reported that the masonry wall collapsed around 8:50 p.m. on 23 July 1994. Rain was light at the time.

The three witnesses who were injured in the landslide reported that, seconds before the failure, stones had been falling from the masonry wall or the slope above. However, they were not certain about the actual location because of rain and darkness. One other witness heard a 'cracking' noise immediately before the landslide.

Six witnesses described the failure as being sudden and taking place over a very short period of time. Two witnesses described that the masonry wall burst out at about mid-height, followed by the instant collapse of the wall and the slope. One witness noticed a large amount of water gushing out from a broken pipe on the landslide scar immediately after the landslide.

F.3.5 Flooding in the Yard Area

In order to examine whether flooding had occurred in the yard area to the south of Block D, residents of 12 flats facing the yard area were interviewed. The results are shown in Table F2.

The caretakers of Kwun Lung Lau reported that the yard area had occasionally been flooded during heavy rain because of the blockage of drainage gullies by rubbish.

F.3.6 Observed Flow from the Foulwater Sewer

A large amount of water was observed flowing from a broken sewer onto the landslide scar after the failure till the early morning of 24 July 1994. The sewer carried foulwater from Blocks D, E, F & G of Kwun Lung Lau. The residents of Block D had been evacuated by that time.

Residents of Blocks E, F & G were interviewed on 1 October 1994 to estimate the number of people who stayed awake after the landslide until the early morning of 24 July 1994. The results are summarised in Table F3.

The results of the interview showed that many of the residents of Blocks E, F & G were awake in the early hours of 24 July 1994. This explained the large volume of water that was discharging from the severed foulwater sewer onto the failure scar after the landslide.

LIST OF TABLES

Table No.		Page No.
F1	Summary of Statements Given by Witnesses	125
F2	Observations on Flooding in the Yard Area during Rainstorms	134
F3	Residents Who Stayed Awake after the Landslide until 2:00 a.m. on 24 July 1994	134

Table F1 - Summary of Statements Given by Witnesses (Sheet 1 of 9)

No.	Witness		Information Provided
I. Witnesses Injured by the Landslide			
1	Ms Chan Lai-kuen	Resident of Kwun Lung Lau	At about 8:30 to 9:00 p.m. on 23 July 1994, Ms Chan was walking home with her family (a total of 4 members) along the footpath below the masonry wall. It was not raining very heavily at the time. When Ms Chan went past the front of the temporary market, she noticed some objects falling to the foot of the masonry wall. As it was too dark, she could not be certain what the objects were. The size of the objects was about 2 to 4 inches. Ms Chan therefore walked near the wire fence with her daughter. At that moment, she suddenly heard her husband shout "Run!". Before she could turn around, Ms Chan was buried by the debris up to the lower half of her body. The amount of debris was very substantial, and the duration of the incident was very short. Ms Chan recalled that a few days before the incident, while it was raining, she had noticed yellowish muddy water seeping from a weephole on the wall at a height of about 1 foot above ground level. Ms Chan had not noticed any yellowish muddy water seeping from the weepholes before that.
2	Mr Chong Sau-fung	Resident of Kwun Lung Lau	On 23 July 1994, at about 8:00 p.m., Mr Chong and his family (a total of 4 members) went past the masonry wall and noticed that falling from the masonry wall were some broken stones, which were black in colour and were in strip form about 1 inch x 2 inches in size. These could have been parts of the masonry or the mortar between masonry blocks, but Mr Chong was not sure. When he noticed there were stones falling, Mr Chong looked upwards to see what they were. He noticed the wall starting to move and heard his father shout "Run!". He immediately ran three to four steps forward and then lost consciousness. Mr Chong saw the full height of the wall toppling down in one piece. A day before the failure, Mr Chong saw that yellowish muddy water had been washed into the basketball field below Block G. However, on ordinary days, he had noticed nothing unusual about the portion of the masonry wall which had failed.

Table F1 - Summary of Statements Given by Witnesses (Sheet 2 of 9)

No.	Witness		Information Provided
3	Ms Lock Po-shan	Resident of Kwun Lung Lau	On the night of 23 July 1994, Ms Lock was walking along the footpath below the masonry wall on her way home. When she went past the entrance to the market, she noticed some objects falling from above. Ms Lock therefore walked closer to the wire fence of the football pitch. It was too dark at the time, and she could not clearly see the size of the fallen objects. When Ms Lock was near the wire fence, she looked back and found the masonry wall bursting out at the mid-height. A lot of debris instantly rushed out. Ms Lock was pushed to the ground by the debris. She could not move, as if her whole body had been buried. Ms Lock recalled that, after heavy rains, the footpath was usually flooded by yellowish muddy water. The flooding was about knee-deep.
II. Witnesses Who Saw the Landslide			
4	Mrs Poon Liu Yin-chow	Shop-worker at Kwun Lung Lau	Mrs Poon was walking from the Block D stairway towards the footpath on 23 July 1994. As she turned the corner, she heard a "da, da, da..." sound, like the cracking sound of concrete. Mrs Poon was at a distance of about 12 to 13 feet from the portion of the wall which failed, and she saw yellowish muddy water flowing from weepholes about 3 feet below the top of the wall. The water was flowing in a slightly circular motion. She then saw the top of the wall moving slightly. At that moment, she heard someone shout "The wall's collapsed!". Mrs Poon then ran back towards the staircase. In front of her was a couple holding a baby. They were able to escape in time and took cover in a pavilion. The man lost a shoe. At about 8:00 a.m. that morning, Mrs Poon also passed along the footpath but did not notice anything unusual. Mrs Poon mentioned that, on ordinary rainy days, sandy rubble and yellowish muddy water would be washed onto the footpath. However, she did not know where this material came from. There was also water flowing from weepholes in the wall, but Mrs Poon had not noticed whether or not it was yellowish muddy water.

Table F1 - Summary of Statements Given by Witnesses (Sheet 3 of 9)

No.	Witness		Information Provided
5	Mr Lee Moon-shing	Shopkeeper at Smithfield Road Temporary Market	At about 8:50 p.m. on the night of 23 July 1994, Mr Lee was at the Smithfield Road Refuse Collection Centre when he heard a "sha, sha, sha ..." sound, which seemed like the sound of falling sand. The sound then became louder and louder, so he looked upwards towards the slope near Block C and immediately noticed the masonry wall starting to collapse. The masonry wall first burst out at mid-height. The slope and the top part of the masonry wall slid down, while the lower part of the masonry wall toppled over. Mr Lee did not notice any signs of yellowish muddy water or sandy rubble at the time. Mr Lee pointed out that several large trees on the slope had been cut down about three years ago. The roots had become rotten and the soil had become loose. Mr Lee thought that cutting down the trees was the cause of the landslide.
6	Mr Wong Chun-man	Nearby resident	At the time of the failure, Mr Wong was on the football pitch playing football with several friends. It was about 9:00 p.m. Mr Wong remembered that there was heavy rain prior to the failure, and that this had subsided to a light rain for some 5 to 10 minutes before the wall collapsed. Just before the failure, Mr Wong and his friends were still playing football in the rain. Mr Wong said he first saw a big tree shaking continuously near the masonry wall. Several seconds later, he heard a loud sound like an explosion and saw the masonry blocks bursting out. The masonry wall and the slope then collapsed completely. According to Mr Wong, the tree-shaking might have been due to objects falling from above. Mr Wong could not recall the exact location of the bursting. However, his position of observation was the corner of the football pitch. He was sure that there was first a loud sound which attracted their attention. He and his friends were just able to dodge away when they saw the rubble from the masonry wall flying in their direction. Mr Wong said that there were about ten people using the footpath at the time of the failure. Before the failure, Mr Wong and his friends were playing football and did not notice anything suspicious, such as erosion or seepage from the masonry wall and the slope. Mr Wong remembered three victims being buried by the debris. Their approximate locations were at the mid-region of the collapsed portion of the retaining wall. One of the victims was a woman who, at the time, was shouting for help. A boy and a girl were also buried.

Table F1 - Summary of Statements Given by Witnesses (Sheet 4 of 9)

No.	Witness		Information Provided
III.	Witnesses Who Heard the Landslide		
7	Mr Li Chi-kwong	Nearby resident	At about 8:45 to 8:50 p.m. on the night of 23 July 1994, Mr Li and his family (including Mrs Li and their youngest daughter) suddenly heard a loud sound. Mr Li rushed to the window to see what had happened and saw that a landslide had occurred. It was not raining particularly heavily at the time. Mr Li also saw water running from the surface of the failed slope. He said that he heard only one loud sound. Mr Li also said that the footpath below the masonry wall was frequently used by people because it was the main access to Kwun Lung Lau. He had occasionally gone past the masonry wall himself, but on those occasions the masonry wall appeared to be robust, without any signs of soil erosion or seepage. He had also seen workers clearing the vegetation on the wall from time to time.
8	Mr Ma Hei-ching	Shopkeeper at Kwun Lung Lau	Mr Ma said that the footpath below the masonry wall was a compulsory route for access to Kwun Lung Lau. At about 7:50 p.m. on 23 July 1994, Mr Ma was returning to his store in Kwun Lung Lau after buying some meal boxes. He went along the footpath and did not notice anything unusual about the masonry wall. However, at about 8:50 p.m. he suddenly heard a loud sound and realised that a landslide had occurred. The masonry wall and the slope had completely collapsed. There was light rain at the time. Mr Ma did not feel any vibration at the time of the landslide.
9	Mr Lam Ho-cheong	Nearby resident	At about 8:40 p.m. on the night of 23 July 1994, Mr Lam heard a loud thunderous sound and felt some slight vibration. He therefore went to the window and found that the masonry wall and slope below Block D of Kwun Lung Lau had collapsed. There was a pipe in the landslide scar, and a lot of water was gushing out of this pipe.

Table F1 - Summary of Statements Given by Witnesses (Sheet 5 of 9)

No.	Witness		Information Provided
IV.	Witnesses Who Reported Unusual Things prior to the Landslide		
10	Mr Yam Chiu-hung	Visitor to a Kwun Lung Lau flat	On the night of 23 July 1994, at about 7:10 to 7:15 p.m., Mr Yam went along the footpath below the masonry wall on his way to his parents' home at Kwun Lung Lau for dinner. Almost every day he would go to his parents' home at this time of the day . It was raining moderately when Mr Yam walked along the footpath. He saw yellowish muddy water seeping from the joints in the masonry wall (see Figure F2 for the seepage location). The seepage area was about 8 to 10 feet wide and up to a height of between 3 and 5 feet above the ground. It was the first time that Mr Yam had seen yellowish muddy water seeping from the wall. This had not happened before. The yellowish muddy water flowed along the channel at the toe of the wall towards Smithfield Road. Mr Yam stayed at the scene for about 1 minute.
11	Mr Yip Kwok-him	District Councillor of Western District	Councillor Yip received a complaint from the residents of Kwun Lung Lau on 25 July 1994. The open space in front of Blocks C, D & E was originally covered by concrete. However, during early 1992, a project was carried out by the Hong Kong Housing Society to increase the power supply. The project was completed more than a year ago (in about 1993). The open space was then designated a 'green' area without any concrete cover. When it rained, stormwater would collect in the open space and seep into the slope. Councillor Yip thought this could possibly be one of the reasons for the landslide. Councillor Yip also mentioned receiving complaints from residents about the recent cutting of big trees on the slope (He did not know of the actual location of the trees and suggested that we approach the Hong Kong Housing Society for details). He thinks this has caused rotting of the remaining tree roots. In addition, the exposed tree rings were not backfilled by concrete. In his opinion, these two factors caused infiltration of rainwater into the slope. Councillor Yip also pointed out that many residents had complained about large quantities of yellowish muddy water seeping from weepholes in the masonry wall two or three days before the incident. The residents had also complained to the management office of the Hong Kong Housing Society about this.

Table F1 - Summary of Statements Given by Witnesses (Sheet 6 of 9)

No.	Witness		Information Provided
12	Mr Chan Chin-keung	Nearby resident	Mr Chan walked below the masonry wall at about 8:30 p.m. on 23 July 1994. He could not remember the exact time, but the landslide happened shortly after he arrived at his home in Block G. Mr Chan did not even have time to take off his shoes before he heard the rumbling sound of the landslide. When Mr Chan was walking past the masonry wall, he had noticed some yellow metallic objects and pieces of concrete falling from above. The yellow metallic objects, which were rod-like in shape, appeared to be pieces of the yellow metallic railing of the fence along the crest of the slope. A few days before the incident, when it was raining, Mr Chan had seen yellowish muddy water seeping from weepholes about 1 foot above ground level. On ordinary days, during heavy rains, there had also been yellowish muddy water flooding the footpath. Such flooding was ankle-deep.
13	Mr Yau Chi-chung	Resident of Kwun Lung Lau	Mr Yau walked under the masonry wall at about 8:30 p.m. on 23 July 1994. There was light rain at the time. He noticed that yellowish muddy water was flowing from the weepholes of the masonry wall. The extent of the seepage was similar to the width of the collapsed part of the masonry wall, and the height was from ground level to 5 feet above the ground. The lower weepholes exhibited a greater flow of yellowish muddy water. On ordinary days, Mr Yau had not noticed any yellowish muddy water seeping from the masonry wall. Mr Yau also mentioned that there had been trees growing on the masonry wall and that the Hong Kong Housing Society had trimmed or removed them every two or three months. He was not sure whether this would have affected the safety of the wall.
14	Mr Chan Kwok-leung	Resident of Kwun Lung Lau	Two or three days before the landslide (i.e. two or three days before 23 July 1994), when he went past the masonry wall, Mr Chan noticed yellowish muddy water flowing from a weephole about 8 inches above ground level (the location of the weephole is shown in Figure F2). At 6:30 p.m. on the day of the landslide, Mr Chan also went past the masonry wall and noticed yellowish muddy water flowing from the same weephole. Usually when it was raining heavily, Mr Chan did not pay attention to whether or not any yellowish muddy water was flowing from weepholes. However, there had been flooding at the entrance to the temporary market.

Table F1 - Summary of Statements Given by Witnesses (Sheet 7 of 9)

No.	Witness		Information Provided
15	Mr Yuen Chi-shing	Resident of Kwun Lung Lau	Mr Yuen was walking from Smithfield to Kwun Lung Lau on 23 July 1994 at about 6:15 p.m. and went along the footpath below the masonry wall. There was light rain at the time. He unintentionally glanced at the slope below Block C (see Figure F2 for location) and noticed a 1 m diameter hole in the slope (the hole was formed by loss of chunam cover). However, at the time, Mr Yuen did not notice any debris falling from the slope, nor was there any debris such as soil or chunam on the footpath. Mr Yuen also noticed that there was yellowish muddy water flowing from several weepholes in the masonry wall under the staircase and about 2 feet above the footpath. Usually on rainy days, only clear water would flow from the weepholes. Mr Yuen pointed out that, two or three years ago, the Urban Services Department had removed the wild trees on the masonry wall near Blocks D & E. After that, the Urban Services Department frequently cleared and removed the trees from the masonry wall and the slope.
16	Ms Chan Shuk-mui	Resident of Kwun Lung Lau	Ms Chan was walking from Welcome Supermarket to Block G of Kwun Lung Lau at about 8:40 p.m. on the night of 23 July 1994. It was not raining heavily at the time, and she felt the weather was very hot. At that moment, Ms Chan noticed some objects falling down from the masonry wall and therefore looked up towards the wall. She noticed immediately that the railing at the top of the wall was bent, and pieces of stone and broken railing were falling down. The pieces of railing that fell were about 8 inches long. On seeing the falling railings, Ms Chan immediately continued walking to get back to Kwun Lung Lau. When she reached the top of the staircase, she heard a loud sound and found the masonry wall had collapsed. Ms Chan also pointed out that, at the end of 1993, several large banyan trees on the slope near Blocks D & E were removed by the Hong Kong Housing Society. She thought this was the main cause of the failure.

Table F1 - Summary of Statements Given by Witnesses (Sheet 8 of 9)

No.	Witness		Information Provided
V. Other Witnesses			
17	Mrs Lock Leung Kwai-fong	Resident of Kwun Lung Lau	Mrs Lock usually walked along the footpath to and from her home. Usually after heavy rains, she noticed that yellowish muddy water flooded the footpath. The level of flooding was about knee-high. Mrs Lock said that the flooding was not due to a blockage of drains. At times of heavy rain, the water could not drain away quickly enough, but after a while the water would drain away.
18	Mr Cheung Chi-yuen	Resident of Kwun Lung Lau	Mr Cheung said that there had been a large banyan tree on the slope in front of Blocks D & E, and the roots of this tree spread all over the surface of the slope. The tree was planted before 1967. About two or three years ago the branches and leaves of the tree were substantially pruned so that not much was left. He thought that this was probably to achieve a more pleasant appearance and to reduce the effect during typhoons. Mr Cheung thinks that the removal of branches and leaves reduced the water absorption power and soil grasping power of the tree roots.

Table F1 - Summary of Statements Given by Witnesses (Sheet 9 of 9)

No.	Witness		Information Provided
19 to 22	Mr Wai Kam-ping Mr Lai Tin-ho Mr Wong Kwok-chu Mr Tse Wai-hei	Caretakers of Kwun Lung Lau	The caretakers of Kwun Lung Lau carried out regular inspections of slopes in the Kwun Lung Lau area once or twice a week. For the slope between Block D and the masonry wall, the inspection was carried out along the crest of the slope, and from the platform above the concrete wall to the immediate east of the masonry wall. The caretakers did not recall having seen any seepage from the masonry wall at the landslide location during heavy rains in the past. They stated that the footpath fronting the masonry wall at the landslide location was not flooded during rains. The caretakers stated that, two days before the failure, the Assistant Housing Manager of Kwun Lung Lau, Ms Margaret Choi, instructed the caretakers to inspect the slopes in the Kwun Lung Lau area more frequently because of the intense rains. The slope between Block D and the masonry wall was inspected by the caretakers at : 22 July 1994 — 9:00 a.m. — by Mr Tse and Mr Lai 2:00 p.m. — by Mr Tse, Mr Wong and Mr Lai 23 July 1994 — 9:20 a.m. — by Mr Wong 12:30 a.m. — by Mr Wong and Ms Josephine Chu (Housing Manager of Kwun Lung Lau) 2:30 p.m. — by Mr Lai and Mr Wong The caretakers reported that they did not find any signs of defect or blockage of drainage channels on the slope during the inspections. At about 11:15 a.m. on 23 July 1994, Mr Tse noticed some seepage from a weephole in the masonry wall at eye level. He recalled that the water was clear, with neither mud nor bad smell. The caretakers reported that the cracked chunam at the crest of the slope between Block D and the masonry wall was noticed by them in June 1994. They stated that similar defects had previously occurred at slopes in Kwun Lung Lau and repaired by a contractor appointed by the Hong Kong Housing Society. However, the caretakers were not certain about the time and the location of the previous chunam repairs.

Note : Unless specified otherwise, 'footpath' in this Table refers to the footpath in front of the masonry wall which failed on 23 July 1994.

Table F2 - Observations on Flooding in the Yard Area during Rainstorms

Block	Was There Usually Flooding in the Yard Area during or after a Rainstorm?			Total
	Yes	No	Not Sure	
C	1	2	2	5
D	1	2	2	5
E	1	1	2	4
Total	3	5	6	14

Note : The interviewees were residents of Kwun Lung Lau who live in flats facing the yard area.

Table F3 - Residents Who Stayed Awake after the Landslide until 2:00 a.m. on 24 July 1994

Block	Total No. of Flats in the Block	No. of Flats Visited	Percent (%) of Flats Visited	No. of Visited Residents Who Stayed Awake until 2:00 a.m.	Estimated No. of Residents Who Stayed Awake until 2:00 a.m.
E	316	133	42.1	97	230
F	218	97	44.5	79	178
G	419	57	13.6	22	162
Total	953	287	30.1	198	570

LIST OF FIGURES

Figure No.		Page No.
F1	Questionnaire Distributed to Residents of Kwun Lung Lau	136
F2	Summary of Key Observations Reported by Witnesses	137

Investigation of the 23 July 1994 Landslide
at Kwun Lung Lau, Smithfield Road, Western District

Questionnaire

The Geotechnical Engineering Office is collecting information about the landslide at Kwun Lung Lau, Smithfield Road, Western District. The information provided by you will assist the investigation. Please complete this questionnaire and return it to the Management Office of the Hong Kong Housing Society at Room 153, Block D, Kwun Lung Lau. You may also call our geotechnical engineer, Ms W.L. Chan, at telephone no. 762 5347 to provide the information.

1. Did you witness the landslide? ☐ Yes ☐ No

2. Did you pass the location of the landslide between 6:00 p.m. and the time of the landslide on the day of the failure (Saturday, 23 July 1994)?

   ☐ Yes Time _____ ☐ No

3. Did you notice anything suspicious at the masonry wall, the slope and the surrounding on the day of the failure?

   ☐ Yes _____
   ☐ No

4. Do you have any photographs of the masonry wall and the slope before the failure?

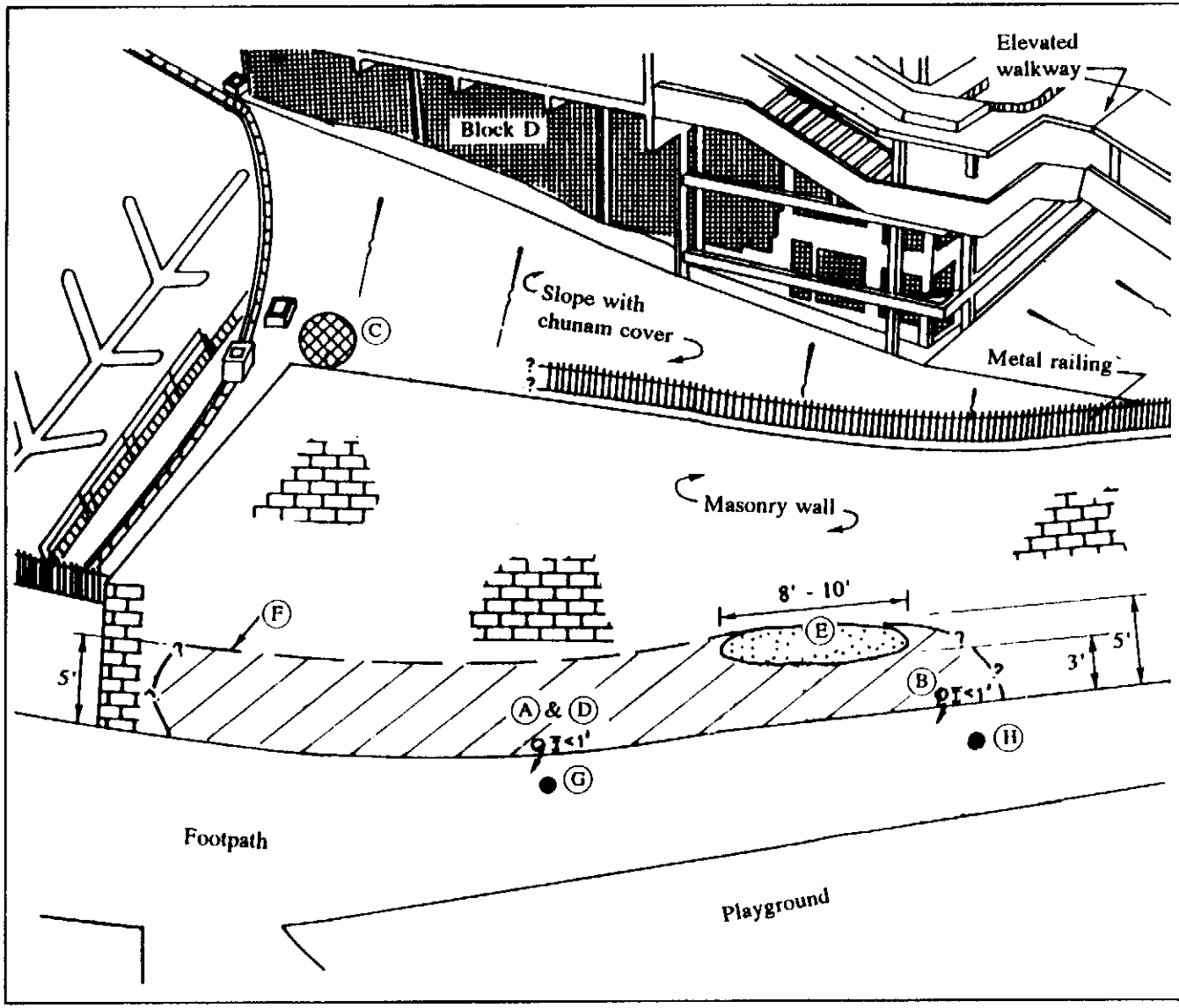
   ☐ Yes ☐ No

5. Please write down any information that you consider important.

   _____
   _____
   _____

6. Name :
   Address :
   Contact Telephone No. :
   Date :

Figure F1 - Questionnaire Distributed to Residents of Kwun Lung Lau



Observation	Time of Observation before the Landslide
(A) - Muddy water seeping from a weephole	2 days
(B) - Muddy water seeping from a weephole	2 days
(C) - 1 m diameter hole in the slope	2½ hours
(D) - Muddy water seeping from a weephole	2 hours
(E) - Muddy water seeping through joints of masonry blocks	1½ hours
(F) - Muddy water seeping from weepholes	½ hours
(G) - Fallen strips of metal railing and pieces of concrete	10 minutes
(H) - Fallen strips of metal railing and pieces of 'stone'	5 minutes

Figure F2 - Summary of Key Observations Reported by Witnesses

APPENDIX G

RAINFALL RECORDS

CONTENTS

		Page No.
	Title Page	138
	CONTENTS	139
G.1	INTRODUCTION	140
G.2	RAINFALL FROM 21 TO 23 JULY 1994	140
G.3	RAINFALL HISTORY	140
G.4	REFERENCES	141
	LIST OF TABLES	142
	LIST OF FIGURES	145

G.1 INTRODUCTION

As part of the investigation, the rainfall recorded in Hong Kong prior to the landslide was examined in detail. The pattern of rainfall at the landslide site was further analysed and compared with that recorded in major rainstorms by the automatic raingauge No. H02 since its installation in September 1978 on the roof between Blocks C & D of Kwun Lung Lau. The results of the assessment are presented in this Appendix.

G.2 RAINFALL FROM 21 TO 23 JULY 1994

The isohyets of 24-hour and 48-hour rainfalls in Hong Kong before the landslide are shown in Figures G1 and G2. During 21 to 23 July 1994, rain was heavy in the western part of Hong Kong Island where Kwun Lung Lau is located.

The hourly rainfall recorded at raingauge No. H02 from 21 to 23 July 1994 and the daily rainfall for July 1994 are shown in Figure G3. The maximum rainfall intensities for different durations for this rainstorm are shown in Table G1. The maximum one-hour and 24-hour rolling rainfalls were 101 mm and 362 mm respectively. The maximum 48-hour rolling rainfall, based on hourly rainfall records of raingauge No. H02, was 544 mm. If the 5-minute rainfall records are used, the maximum 48-hour rainfall before the landslide was 547 mm.

The return periods of the rainfall intensities for different durations assessed from historical rainfall records at the Royal Observatory are shown in Table G1. It can be seen that the 48-hour rainfall was the most severe, with an estimated return period of about 28 years.

The maximum one-hour rainfall occurred between 2:05 a.m. and 3:05 a.m. on 22 July 1994 (Table G1), about 42 hours prior to the landslide. Only 29 mm of rain were recorded by the raingauge between 11:00 a.m. on 23 July 1994 and the time of the landslide, i.e. about 95% of the 48-hour rainfall fell more than 10 hours before the landslide. Hence, the landslide was a 'delayed' failure in that it occurred several hours after cessation of intense rain.

G.3 RAINFALL HISTORY

The rainfall records of raingauge No. H02 since September 1978, when the gauge was installed, have been analysed. The monthly rainfall records are shown in Figure G4. It can be seen that July 1994 was the wettest month recorded at Kwun Lung Lau since the raingauge was installed.

Fourteen previous heavy rainstorms with daily rainfalls exceeding 150 mm were identified from the rainfall records, and the maximum rainfalls for different durations of these rainstorms were processed. The results are shown in Table G2 and Figure G5. The following are observed :

(a) The July 1994 rainstorm contained the heaviest long-

duration rainfall recorded at Kwun Kung Lau, i.e. two days or above. The long-duration rainfall intensities were significantly higher than those of the previous rainstorms.

(b) Over a 15-minute to 24-hour period, the rainfall intensities of the July 1994 rainstorm were high and were comparable to those of the major rainstorms in May 1982, May 1989 and May 1992.

(c) Over a 5-minute period, the rainfall intensity of the July 1994 rainstorm was not as high as that for the May 1992 and June 1993 rainstorms.

G.4 REFERENCES

Peterson, P. & Kwong, H. (1981). A design rain storm profile for Hong Kong. Royal Observatory, Hong Kong, Technical Note no. 58, 30 p.

LIST OF TABLES

Table No.		Page No.
G1	Maximum Rolling Rainfall at Raingauge No. H02 and Estimated Return Periods for Different Durations Preceding the 23 July 1994 Landslide	143
G2	Maximum Rolling Rainfall of Major Rainstorms at Raingauge No. H02 from 1978 to 1994	144

Table G1 - Maximum Rolling Rainfall at Raingauge No. H02 and Estimated Return Periods for Different Durations Preceding the 23 July 1994 Landslide

Duration	Maximum Rolling Rainfall (mm)	End of Period	Estimated Return Period (Years)
5 minutes	13.5	02:55 on 22 July 1994	3
15 minutes	33	03:00 on 22 July 1994	3
1 hour	101	03:05 on 22 July 1994	6
2 hours	128	04:05 on 22 July 1994	8
5 hours	172	06:50 on 22 July 1994	5
12 hours	310	13:25 on 22 July 1994	13
24 hours	362	18:30 on 22 July 1994	9
2 days	544	20:00 on 23 July 1994	28
4 days	586	21:00 on 23 July 1994	17
15 days	791	21:00 on 23 July 1994	13
31 days	941	21:00 on 23 July 1994	9

Notes : (1) Return periods were derived from the Gumbel equation based on historical rainfall records at the Royal Observatory (Peterson & Kwong, 1981).

(2) Maximum rolling rainfall was calculated based on rainfall records at :
(a) 5-minute intervals for durations of 24 hours and less,
(b) hourly intervals for durations of 2 and 4 days, and
(c) daily intervals for durations of 15 and 31 days.

Table G2 - Maximum Rolling Rainfall of Major Rainstorms at Raingauge No. H02 from 1978 to 1994

Date of Rainstorm[1]	Maximum Rolling Rainfall (mm) for Durations of :										
	5 min	15 min	1 hour	2 hours	5 hours	12 hours	24 hours	2 days	4 days	15 days	31 days
16-17 Oct 1978	-	10	32	52	100	169	254	274	287	301	651
29-30 July 1979	-	17	59	94	151	183	188	234	351	547	615
23-24 Sep 1979	-	14	48	89	163	216	232	241	342	384	438
28-29 May 1982	-	25	59	76	110	194	313	362	509	607	636
15-16 Aug 1982[2]	-	35	70	77	85	179	197	262	341	381	615
16-17 June 1983	-	26	89	119	251	316	331	332	332	392	516
29-30 May 1984	-	18	51	79	137	171	174	220	227	423	691
25-26 June 1985	-	24	61	87	138	179	215	229	244	270	397
20-21 May 1989	4.5	13	38	67	130	243	350	380	400	414	593
07-08 May 1992	22.0	34	84	145	198	321	322	377	401	487	608
28-29 June 1992	7.5	21	63	82	104	110	151	151	151	242	594
17-18 July 1992	4.5	12	40	61	103	165	180	185	185	278	473
16-17 June 1993	16.5	47	91	100	118	134	143	148	169	448	650
25-26 Sep 1993	7.5	18	43	46	84	140	250	409	541	663	747
21-22 July 1994[3]	13.5	33	101	128	172	310	362	544	586	791	941
Rainfall Records Used for Calculation of the Maximum Rolling Rainfall	15-minute rainfall records before March 1989 5-minute rainfall records after March 1989							Hourly rainfall records		Daily rainfall records	

Notes :
(1) Date of rainstorm shown refers to the period during which the maximum 24-hour rolling rainfall was recorded.
(2) Rainfall records of nearby raingauge No. H01 were used because raingauge No. H02 was out of order.
(3) Rainfall up to the time of the landslide was considered in calculating the maximum rolling rainfall intensities.

LIST OF FIGURES

Figure No.		Page No.
G1	24-hour Rainfall Distribution for the Period Ending at 19:00 on 22 July 1994	146
G2	48-hour Rainfall Distribution for the Period Ending at 20:50 on 23 July 1994	147
G3	Rainfall Records of Raingauge No. H02	148
G4	Monthly Rainfall at Raingauge No. H02 from September 1978 to July 1994	149
G5	Maximum Rolling Rainfalls at Raingauge No. H02 for Major Rainstorm	150

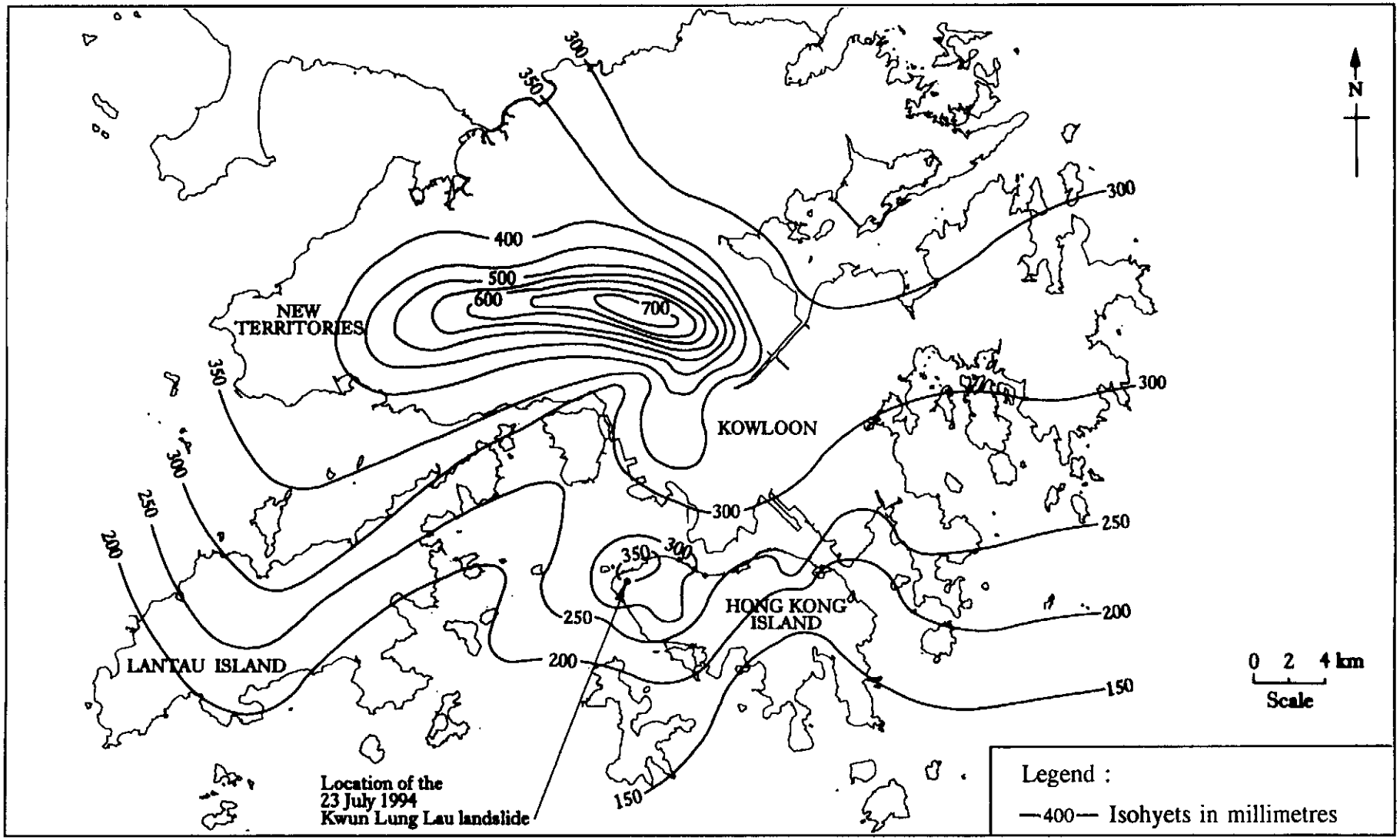


Figure G1 - 24-hour Rainfall Distribution for the Period Ending at 19:00 on 22 July 1994

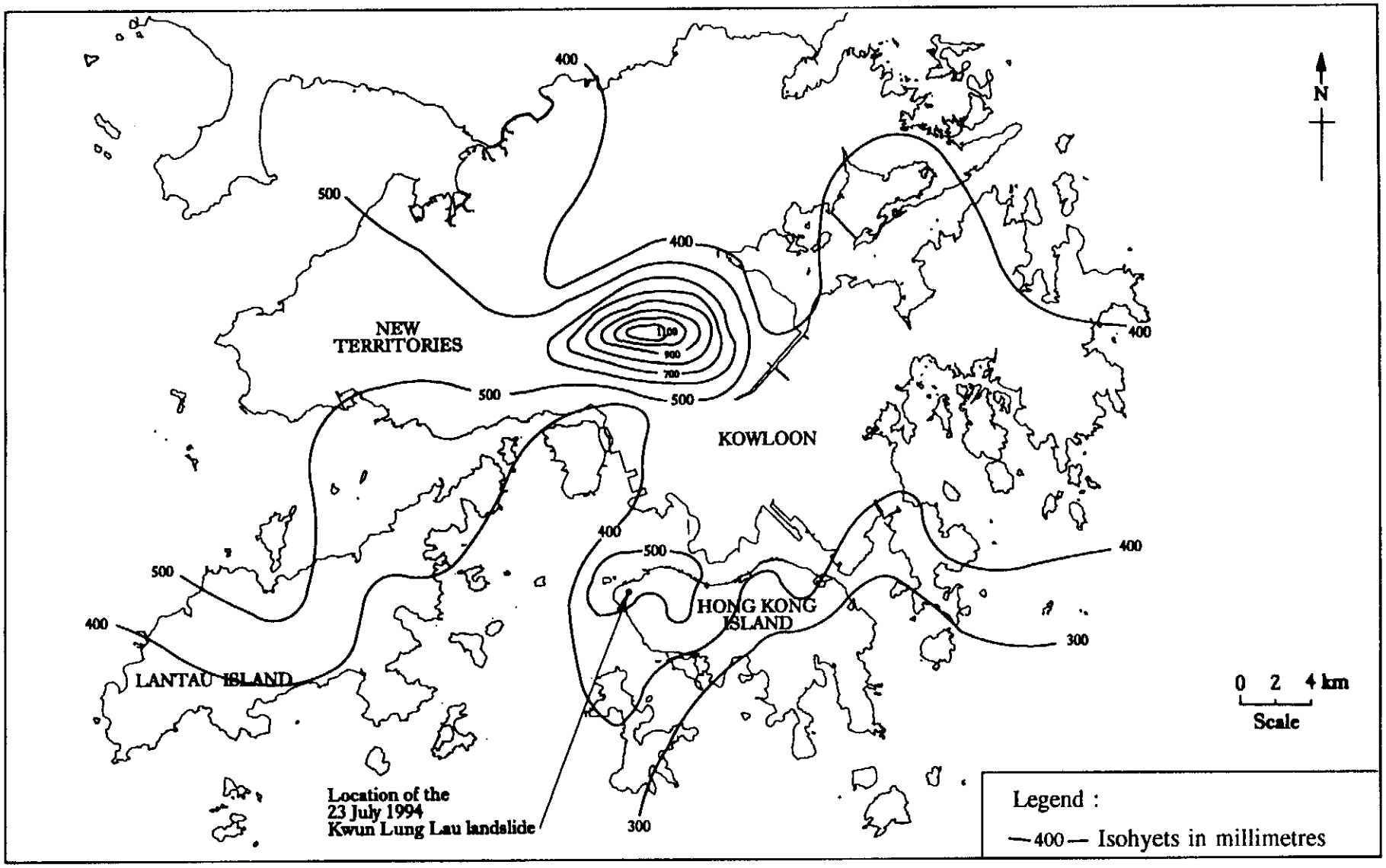
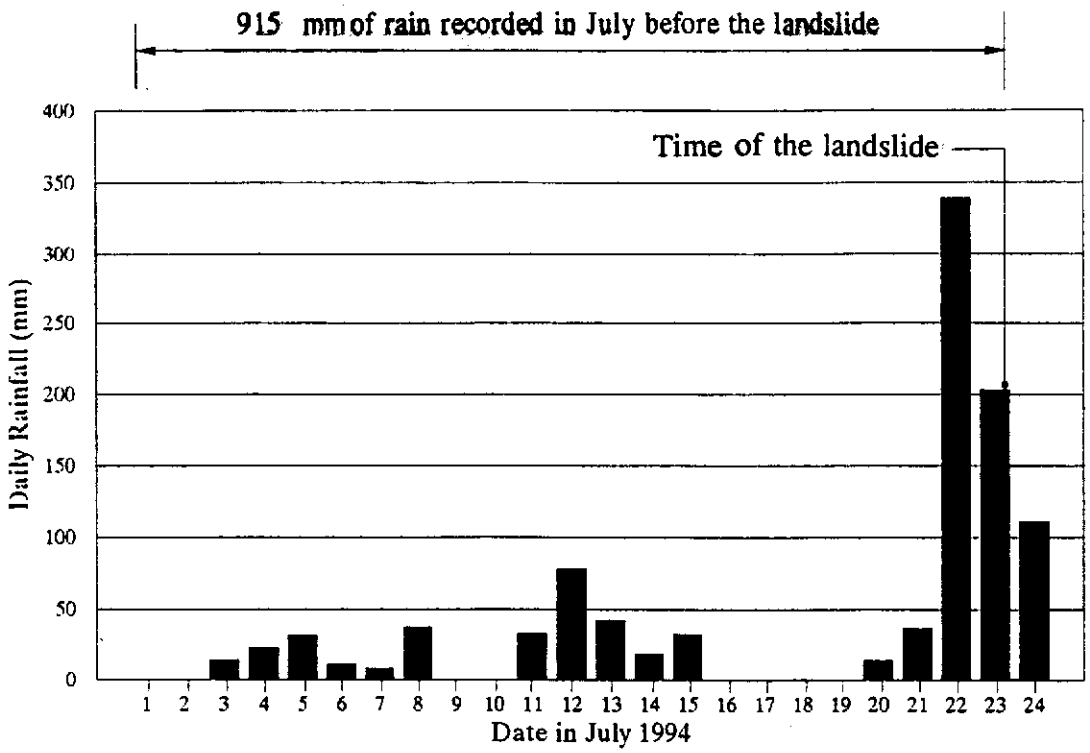
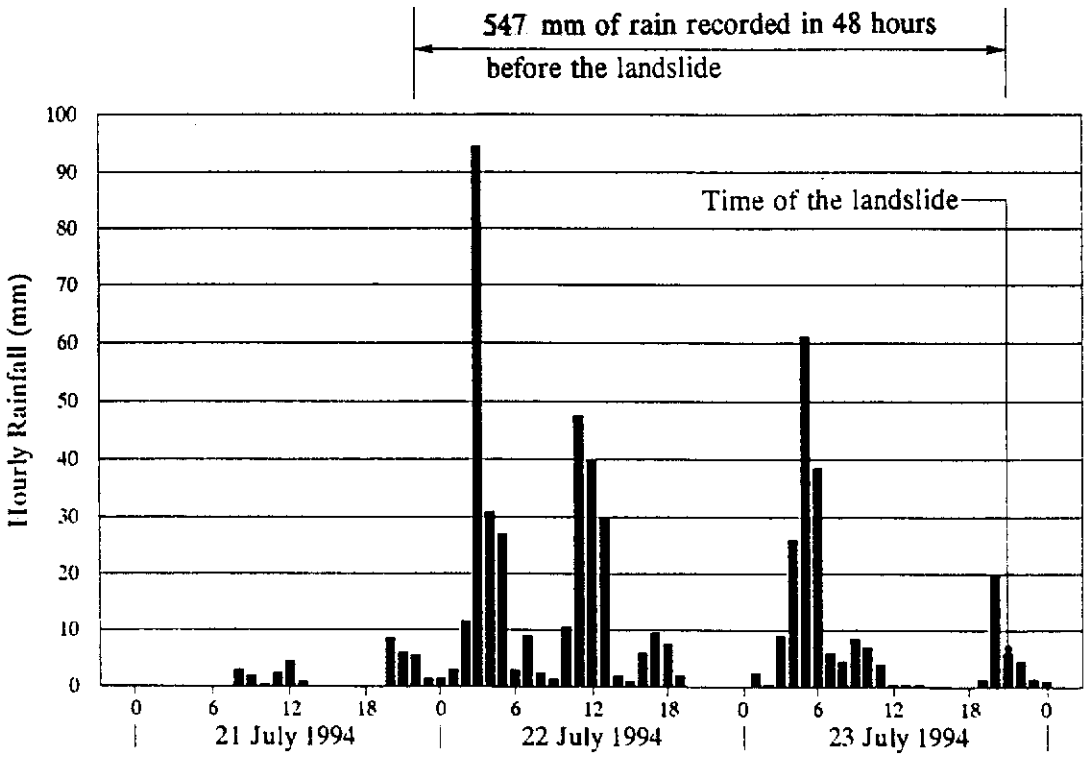


Figure G2 - 48-hour Rainfall Distribution for the Period Ending at 20:50 on 23 July 1994



(a) Daily Rainfall Intensity in July 1994



(b) Hourly Rainfall Intensity from 21 to 23 July 1994

Figure G3 - Rainfall Records of Raingauge No. H02

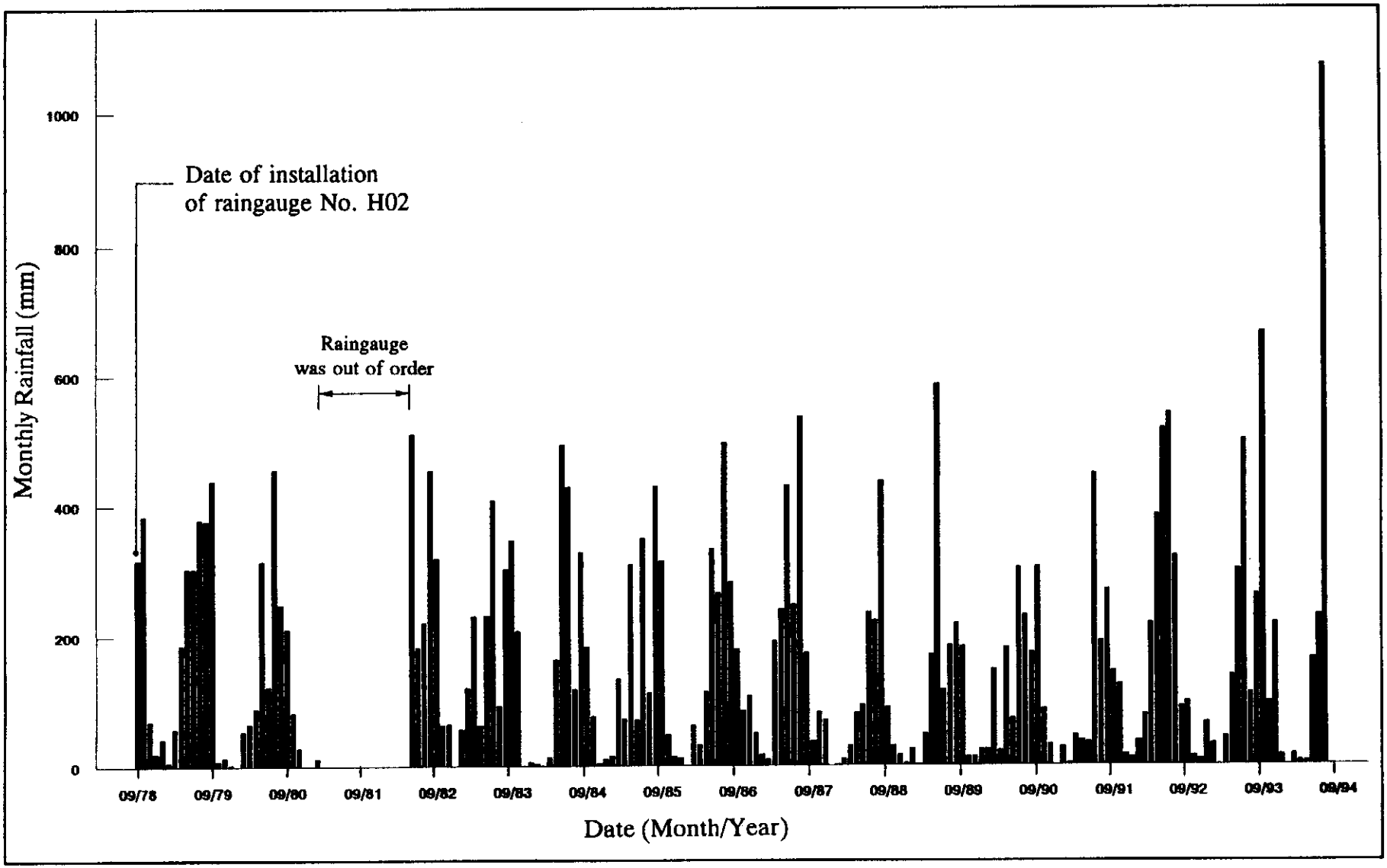


Figure G4 - Monthly Rainfall at Raingauge No. H02 from September 1978 to July 1994

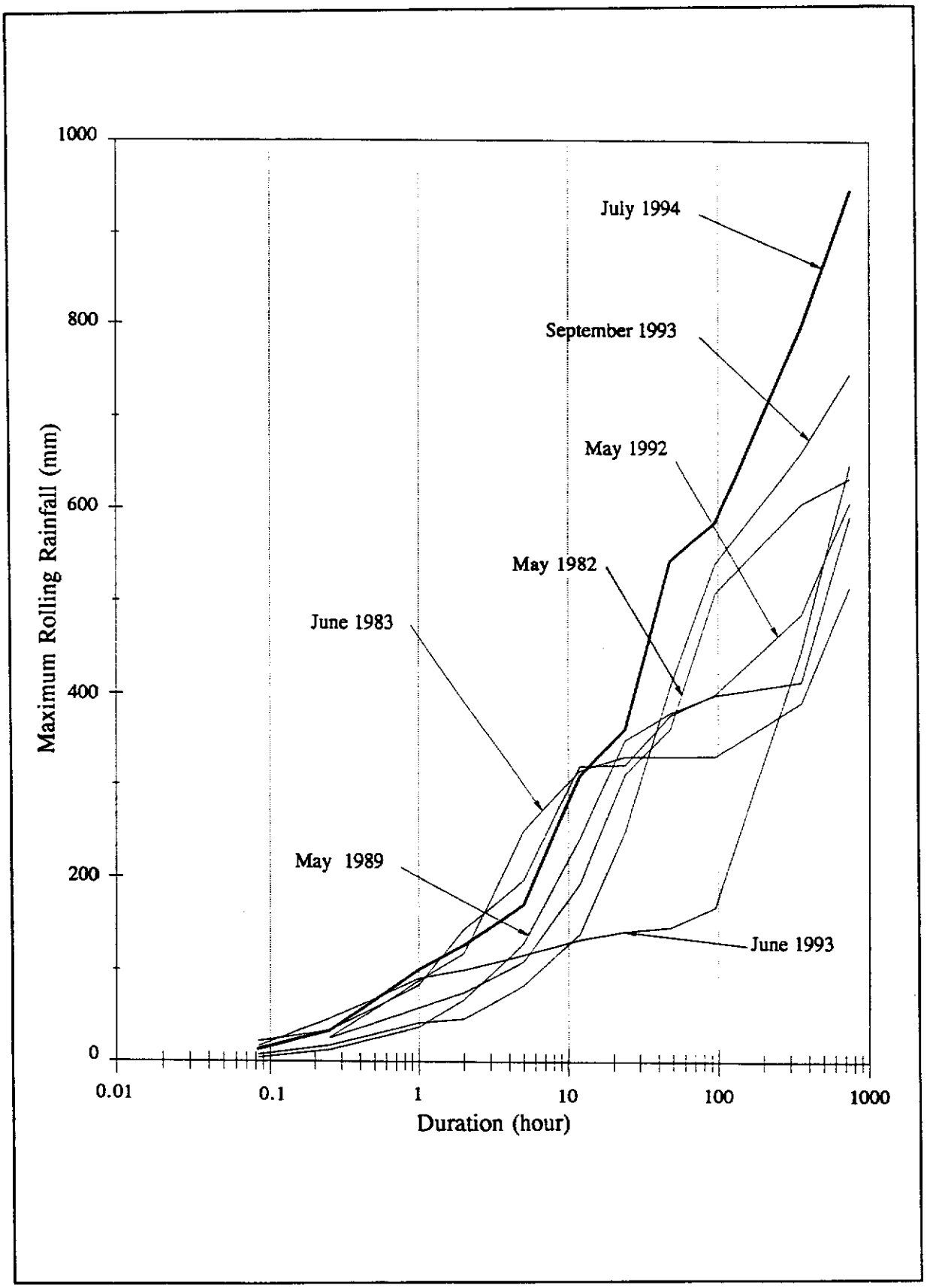


Figure G5 - Maximum Rolling Rainfalls at Raingauge No. H02 for Major Rainstorm