APPENDICES

1. Summary of the Survey and Collected Data

1-1 Geology of the Study Area

This study is original made for land condition survey, and an additional surface geology survey for supporting landform classification was conducted in order to roughly estimate the surface geology. therefore, this additional survey is not a full scale geological survey, but the geology of the study area is described based on available geological information as well as information obtained from this additional survey.

1-1-1 Outline of Geology

The study area is located on the south edge of Central Luzon Valley which was formed between the late Mesozoic and the early Cenozoic. On the east side Sierra Madre Ridge, Maruiquia Valley and Laguna de Bay Opening in the south of the valley are located, in the central part of the hill/plateau extending from Caloocan City in the north to south Taguig extends, and on the west side Manila Bay extends. The entire area has an N-S oriented landform.

The study area consists of the Cretaceous Kinabuan formation cropped out on the east edge of Sierra Madre Ridge and the hill, the pleistocene Quarternary Guadalupe formation distributing on the south-west foot of Sierra Madre Ridge and in the entire hill/plateau in the central part, and alluvium deposite in Marikina Valley and along the coast of Manila Bay. Newly formed beds are cropped out from east to west in these formations, excluding the alluvium. From a viewpoint of geological structure, there are many lineaments along Marikina Valley, and especially along the hill on the west side and on the west foot of Sierra Madre Ridge in the north-east, very clear faults exist. This suggests that Marikina Valley is a graben formed by fault. The clear fault extending in the NE-SW direction along the hill on the west side is well known as "Marikina Fault", about which many studies have been done.

1-1-2 Detailed Geology

(1) Kinabuan formation

The Kinabuan formation refers to the formation which consists of a thin bed of silty shale and medium=large limy sandstone accompanying a tuffaceous diatomaceous bed in the late Cretaceous and is cropped out along the Kinabuan channel in Tanay, Rizal Province. However, the study area is located on the south-west edge of the angat-ophiolite zone in the late Cretaceous, in which sedimentary rocks and basalt lava form alternations of strata. For this reason, "Geological Map of Manila and Quezon City Quadrangle" and "Geological Map of Montalban Quadrangle" in 1/50,000 scale prepared by the Bureau of Mines & Geo-Science named these beds as one formation called the Kinabuan formation, which is dealt with as a cretaceous formation.

Since this study is originally for land condition survey, not for geological survey, therefore, the boundary between the above mentioned ophiolite and the sedimentary rock formation was not clearly comfirmed.

Then, these beds are dealt with as the Kinabuan formation in the whole, in accordance with existing geological maps.

The Kinabuan formation in the study area extends widely in the hill/plateau in Marikina Valley, and is cropped out on the edge of the hill west of Montalban.

The rock stratum is composed of metamorphosed spilitic basalt, and red shale, sandstone, and dense tuff intercalated with the basalt. The basalt lava is the major component of the Kinabuan formation, and spreads over the entire region of this formation. The basalt lava is severly metamorphosed and crushed due to tectonic movement in many cases. NE-SW joints are prevailing in the northern area of San Mateo, while NW-SE joints develop, too, in the southern area.

The sedimentary rock formation of red shale, sandstone, and dense tuff can be seen on the road between Marikina and Antipolo and near the road between Cainta and Antipolo. It has alternations of strata with the basalt lava, and is mostly silicified. The striking direction of this sedimentary rock is NE-SW in general, and its dip angle is 8-20° SE. The basalt outcrop in the west of Montalban has intercalated shale.

This formation is the basic rock of this study area, and unconformity overlying bed is coverd on the basic rock. On the hill east of La Mesa Dam and on the roadside between Marikina and Antipolo, especially, one can see the overlying bed of the Guadalupe formation abuted and deposited.

(2) Intrusive body of gabbro

Intrusive body of gabbro which is a member of the angat/ophiolote is closely related to the basalt lava of the Kinabuan formation and it was formed at cretaceous.

The rock stratum is composed of block and stratigraphic norite and pegmetic anorthite. Its strike is not constant, but with a steep gradient of approximately 70°.

This rock body forms the hill on the right bank of Nanga river in east Marikina, stretches in the NE-SW direction in general, and has many quartz and calcite dikes along its fissures. The gabbro is very weathered, and resultantly much softer than other rocks. It is sandy and seems to be the oldest rock in this area in relation to intrusion.

(3) Guadalupe formation

The Guadalupe formation of which type place is located around Guadalupe in west Pasig is divided into two rock beds; "Alat conglomerate" consisting of bloced conglomerate, silty mudstone and tuff, and the overlying "Deliman tuff" consisting of glassy dense tuff, and molten volcanic angular conglomerate. However, study has revealed that the structure of the Guadalupe formation is more complicated, and it can be divided into at least 6 bed rocks. Each bed rock is explained here starting from the lowest one.

1) Lower dense sedimentary rock formation

This formation is composed of altanation of strata of sandstone, siltstone and dense tuff partly intercalated with old soil and volcanic conglomeratic tuff.

The distribution range is largely divided into two areas; the wide area expanding south-north around La Mesa Dam, and the hilly area south of Cainta in the south-east part of Marikina Valley on the east side of the study area. In the distribution range centering around La Mesa Dam, siltstone and coarse to extremely coarse sandstone are the major components, and the siltstone occasionally contains carbonated plants and roots. The sandstone is coarse and relatively hard in many cases, and a weak lamina develops.

In the distribution range in the south-east part of Marikina Valley, the major components are alternation of strata of dense sandstone, siltstone and dense tuff intercalated with old soil and volcanic conglomerate tuff and fossils of trees. This study found that the Guadalupe formation distributed around Cainta is the lowest bed of Pleistocine deposits formed with unconfirmity on the Kinabuan formation and is sandwiched in between the upper conglomerate bed and lower Kinabuan formation.

Therefore, this vertical relation suggests that deposits in La Mesa Dam and Cainta areas belong to the same period. It is predictable that this formation is formed under quite complicated deposition environment, through which the erosion of exposed earth surface and the deposition on the bottom of swamp occured several times repeatedly.

2) Lower conglomerate formation

This rock formation is altanation of strata composed of conglomerate, tuffaceous sandstone and silty sandstone, and is almost equavalent to the "Alat conglomerate formation" formed at Pleistocene.

Its distribution range is the hill on the east and west sides of La Mesa Dam, extending from the northern part of Quezon City to Calaocan City, and the mountain foot located east between Marikina and Cainta. The major component of this formation is well rounded igneous rock, deposited gravel and silty coarse with an average gravel size of 2-5 cm and with a maximum gravel size of 30 cm. The bed is poorly sorted and consolidated. The gravel content is approximately 60-80%. A slight difference in component of gravel type can be seen between these two areas; andesite and acid volcanic rocks are the major components with relatively less basalt in the northern part of Quezon City, basalt is predominant in the east of Marikina.

Thin strata of the tuffaceous sandstone and the silty sandstone sandwiched in between the conglomerates, and are poorly consolidated and fragile.

According to the property of the sediments in this rock formation, it seems that these were formed as former alluvial fan or deltaic fan and gravels in these two areas were supplied form slightly different place.

3) Lower volcanic pyroclastic rock formation

This formation is mainly composed of pumiceous welded tuff with a little scoria, and partially containing volcanic conglomerate tuff and sandy tuff. Its type locality is in Deliman in Quezon City, and location is lower part of "Deliman tuff" formed at Pleistocene.

This rock formation extends toward NW-SE direction on the hilly area in the south-western part of Caloocan City to Deliman in Quezon City, and generally declines to the south-west direction with gradient of 2-5°. The relation with the lower bed rock can not be identified, but the distribution form, sedimentary cycle and others suggest a possible transitional relation. Furthermore, the volcanic pyroclastic rock becomes coarsest grain in the lowest part, and outcrops of volcanic breccia in the north and the east of Deliman containing a lot of scoria boulders. Towards the upper part, the scoria breccia decreases, while pumice breccia increases. Then, fine sediments such as volcanic conglomerate tuff and sandy tuff appear. This change in gravel and grain size indicates that the volcanic activity during the period of deposition of the lowest layer was most active, followed by gradual tranquilization, and thus the one cycle of volcanic activity can be traced. However, this study failed to identify the volcano which had supplied this volcanic pyroclastic rock.

The geochronology of this rock formation is said to be Pleistocene based on yield of fossil and artificial ceramics, but its deposition environment is not cleared.

4) Upper conglometrate formation

This rock formation consists of conglometrate, volcanic conglomerate tuff, alternating strata of coarse tuff, sandy tuff, and alternating strata of dense tuff, and was included in the "Deliman tuff". However, since its base includes conglomerate and the formation has a different sedimentary cycle characterized by fine pyroclastic sediments, the formation is separated from the lower volcanic pyroclastic rock.

This rock formation extends toward west, and contacts with lower volcanic pyroclastic rock formation. It contains conglometrate on its base around the boundary between Valenzuela and Quezon City, but no conglometrate can be identified in the Quezon City. In its lower layer, alternating strata of coarse tuff and volcanic aonglometrate tuff develops. This conglometrate is composed of well-rounded igneous, sedimentary conglometrate and silty sand with an average gravel size of about 5 cm and maximum gravel size of about 15 cm. It is poorly sorted and consolidated. Its gravel content is approxiately 30-40%. Andesite and dense tuff gravels are aboundant.

This rock formation, on the whole, becomes finer and finer upwardly, in repeatedly alternating strata. In the upper layer, alternating strata of sandy tuff and dense tuff are predominant. This remarkable change in sedimentary facies suggests that it was formed as former alluvial fan or deltaic fan.

5) Upper volcanic pyloclastic rock formation

This rock formation is mainly composed of welded tuff breccia and volcanic conglomerate tuff, partically intercalates alternating strata of sandy tuff and dense tuff.

This rock formation belongs to the "Deliman tuff," and the formation as well as tuffaceous breccia in the lower volcanic pyroclastic rock formation is called "Adobe," which is well known as a housing and ornament materials. Many quarries, abandoned quarries and land created on the abandoned quarries exist all over its distribution range. It extends toward NW-SE direction along the west side of the upper conglomerate formation, from south Meycauayan to south Quezon City, but in south Quezon City the formation gets thicker locally.

In this rock formation, like the lower pyroclastic rock bed, the diameter of bureccia becomes largest in the lowest layer with more scoria bureccia. In the upper layer, pumice bureccia prevails, and its average of diameter becomes less than 1 cm. It includes volcanic conglomerate tuff. This changes in the content and diameter of conglomerate and bureccia also suggests the volcanic activity.

6) Upper fine sedimentary rock formation

This rock formation consists of layers of coarse tuff, sandy tuff, and tuffaceous sandstone from the bottom to the top in general. Dense tuff, tuffaceous conglomerate and a fine thin conglomerate beds are intercalated locally. This rock formation also belongs to the "Deliman tuff."

This rock formation distributes widely, and is cropped out on the hill/plateau extending from Valenzuela to Pasai City through the southern part of Quezon City. This formation is distributed on the hill/plateau area adjoining the alluvial plain of Manila Bay and Laguna de Bay, it has been widely developed for housing. Except the steep cliffs along the Marikina fault, there are no clear outcrops exists.

The coarse tuff is cropped out in the southern part of Quezon City. It contains a lot of small rock pieces of pumice and scoria, and contains characteristically a small amount of small pieces of obsidian. This tuff has larger rock pieces downwardly, and shifts gradually to volcanic conglomerate tuff. The sandy tuff is widely cropped out all over the distribution range, and contains pumice sub-angular to sub-rounded gravels of 1-2 mm size. Sand particles are not well rounded generally, and contain harnblende. The tuffaceous sandstone is located on the top of this rock formation. The sand particle is well rounded, becoming semi-circular to circular, and fine conglomerate and fine tuffaceous siltstone are contained locally. This vertical change in the lithofacies suggests the process in which the effect of volcanic activities decreased gradually and then volcanic pyloclastic rock was transformed to normal sediments.

The above listed 6 rock formations can be very clearly characterized in terms of properties of each sediment, sedimentary cycle, and the effect of volcanic activities, but the relation among each bed of sedimentation is unclear. However, since two rock formations have well developed conglomerate bases and a rock bed is located below these formations, it is clear that at least 3 large sedimentary cycles took place. As to volcanic activities, the presence of two volcanic pyroclastic formations shows that violent volcanic activity took place twice in the area.

The sedimentary environment of the Guadalupe formation where no aqua-biological fossil is found is not yet known. This study could not clarify the entire view, but it is very clear that a period of swamp and weathering existed at the lower part of the formation and a gradual shifted towards a deltaic fan. Twice volcanic activity took place at the period of deltaic fan and finally transited to a coastal environment.

(4) Alluvium

This formation is composed of a variety of sediments; sedimented materials of river terrace, sedimented materials of talus/alluvial fan, sedimented materials of flood plain, and sedimented materials of actual river beds distribute on the bottom of Marikina Valley. Deltaic sediments are also seen along Pasig River between Laguna de Bay and Pasig, which are considered to be sediments in the early stage of the alluvium. Landforms of coastal plain, delta (including brackmarsh and inter barnal slough) and bar develop, and their component materials are slightly different. In addition, sandy silt and sand which are containing a lot of shell at depths deeper than about 1 m are observed near the coast of this area. Each sediment is explained below by distribution range:

1) Alluvium in Marikina Valley

The alluvium in this area has deltaic sediment in the lower part, but all, excluding this deltaic sediment, were inland water sediments.

a) Deltaic sediments

These sediments are cropped out along Pasig River between Laguna de Bay and Pasig. The existing boring data shows that is it one of the sediments filling valleys distributing along Pasig River, and that there are fluvial deposits at the base. This sediment consists of sandy silt, sand and others which are containing a lot of marine shellfish. Corbiculae is overwhelmingly abundant in the outcrop, which indicates deltaic sediments.

b) Sediments of river terrace

This sediment distributes widely on the bottom of Marikina Valley, forming a low terrace (approximately 6 m relative height from the actual river bed) and a lower terrace (approximately 3 m relative height from the actual river bed).

These terraces are composed of a gravel bed and a silty fine sand bed. The lower terrace has at lest two layers of them, which suggests two sedimentary cycles. The lower terrace formed through erosion of the low terrace is considered to have been formed in the same period with the flood plain on the lower reaches. Therefore, assumedly, the low terrace was formed during regression in the early stage of the alluvial deposition, and the formation period is coincident with that of the base of the buried valleys. That is, the sedimented materials of the low terrace and fluvial deposits on the base of the buried valleys have contemporaneous heterotopic facies.

c) Sediments of talus/colluvial slope/alluvial fan

The distribution of this sediment is limited only the mountain base and the foot hills on the west side of Marikina Valley. In particular, the sediment of talus/colluvial slope distributes on the piedmont flat along the Montalban fault extending from Montalban to San Mateo. It is composed of a fault bureccia bed and podzolized clay containing a lot of basalt angular to semiangular gravel derived from the Kinabuan formation.

The alluvial fan sediments distributed thinly on the east side of Marikina Valley consists of silty sand mingled with basalt semiangular to semiround gavel, but it consists of silty fine sand on its fan foot. These sediments deposit on the low terrace surface and the flood plain.

d) Sediments of flood plain

This sediment forming the flood plain distributed on the lower reaches of Marikina River is composed of finely granulated materials such as clay, silt, sandy silt, and others. Since the flood plain is submerged during a rainy season with poor drainage, the water content in the sediment in high, and it is not faded with the resultant dark grey or dark brown color, unlike other sediments.

2) Alluvium formation in the coastal area of Manila Bay

The alluvium in this area is almost not free from effects of sea water, and even now there are many marine ponds at many places.

a) Sediments of coastal plain and delta

These sediments distributed between Bulacan to Nabotas forms coastal plains, delta, backmarshes, and inter barnal slough. The components are finely granulated, and include mainly gyttja, and silty clay. Because the distribution area has a high ground water level due to high water during a rainy season and tidal effects, the sediment is dark grey to dark bluish grey. In the inter barnal slough, it is slightly sandy.

In this distribution range, rivers meander, creaks develop well, and marine ponds distribute fairly deep to the inland. In addition, mangrove forests are left here and there along these rivers. This indicates that this area was once a mangrove forest zone.

b) Sediments of sand bar

This sediment composes the sand bar extending parallel to the shoreline, and consists of fine sand, sandy clay, sandy silt, and others.

The distribution pattern of this sand bar shows very clearly that it was formed by the counterclockwise coastal current flowing along Manila Bay.

1-1-3 Geological Structure

This study area has lineations in concentration along Marikina Valley, but very few on the hill on the west side. The Marikina fault stretching in length along the west side of Marikina Valley, and the Montaluban fault located on the north-east side are especially clear. These two faults are normal faults stretching linearly in the NE-SW direction, and Marikina Valley between Montalban and Sanmateo is relatively trough-like. The Marikina fault has been studied for a long time, and its vertical displacement is assumed to be roughly 80-120 m. Its formative period is assumed to be the late Pleistocene to the early Holocene, because the Marikina fault crosses the Guadalupe formation consisting of Pleistocene sediments with no slip on the alluvium. With respect to the Montalban fault, a fault outcrop was identified, but its displacement is not known. However, its much shorter length compared to the Marikina fault suggests a smaller displacement than that of the Marikina fault. j Its formative period seems to be nearly the same with that of the Marikina fault, because its properties are very similar to those of the Marikina fault.

The Montaluban fault and the Marikina fault are very similar in their properties, both of them form clear fault topography, and no displacement is seen on the alluvium. In addition, many lineations of NE-SW system and NW-SE system are observed. The lineations of NE-SE system appear to originate in the same faulting with the Marikina fault and the Montalban fault. The lineations of NW-SE system can be seen in the Kinaban formation composing the basement of the study area and in the lower bed of the Guadalupe formation in the north of Quezon City, and run parallel to the strike of the Guadalupe formation in general. There is a fold axis in a nearly N-S direction in the distribution range of the lower bed of the Guadalupe formation in the northern part of Quezon City, and it turns to the NW-SE direction near the Marikina fault. These facts suggest tectonic movement in the NE-SE direction in the late stage of deposition of the Guadalupe formation or just after the disposition, subsequent earth movement around the northern part of Quezon City, and NE-SW tectonic movement much later, finally to the present geological structure.

1-1-4 Geologic History

This area placed on the Cretaceous Kinaban formation, as the base, containing angat-phiolote covers an area of deposition of the Quaternary Pleistocene Guadalupe formation and alluvium.

In the Pleistocene period, fine sedimentary rock beds of the lower Guadalupe formation began to deposit on the land or marsh. At the time of deposition of the lower conglomerate bed, the sedimentary environment shifted from fan to delta. Assumedly, after this shift, two volcanic activities resulted in the formation of the lower and upper pyroclastic rock formations, and in the period of deposition of the upper fine sedimentary rock bed, the sedimentary environment gradually changed to bay and coastal via the delta. The distribution pattern of sediments indicates very clearly that at the time of the formation of the Guadalupe formation, Manila Bay and Laguna de Bay were a continual embayment.

In the late stage or after deposition of the Guadalupe formation, tectonic movement in the NW-SE direction took place around the northern art of Quezon City - Taytay - Muzon as the middle axis, followed by earth movement accompanying folding in the northern part of Quezon City.

Tectonic movement in the NE-SW direction followed, finally resulting in the formation of Marikina Valley due to the Marikina fault and the Montalban fault. This NE-SW tectonic movement might have been caused by a local difference in elevating range (Celocity) associated with the NW-SE tectonic movement. Namely, there seems to have been a fairly great difference in elevating range between the elevating zone centering around the northern part of Ouezon City and its extension south from Kainta. As a result, it appears that cracking in the NE-SW direction broke out crossing the NW-SE axis at a right angle.

The outline of Marikina Valley was formed in the late Pleistocene, followed by great regression. This regession seems to have taken place during the Wurm glaciation in the last glacial stage, and the valley landform and its fluviatile sediment buried under the Pasig river bed from Pasig to Manila Bay seem to have been formed in this period. Since then, sea water entered Laguna de Bay again through the drowned valley because of regression, and materials of delta with marine shellfish fossils deposited around Pasig. Available information from boring proves the presence of a lot of marine shellfish fossils in the deposit of the buried valley between Pasig and Manila, and thus support this fact.

After that, regression took place and the surface of the lower terrace and the alluvial plain were formed in the Marikina Valley area.

In the coastal area of Manila Bay, several sea level fluctuations after the last glacial stage lead to the development of sand bars in parallel to the shoreline. Then, soil and sand supplied from Maykawayan River and others formed sedimented materials of coastal plain, delta and others.

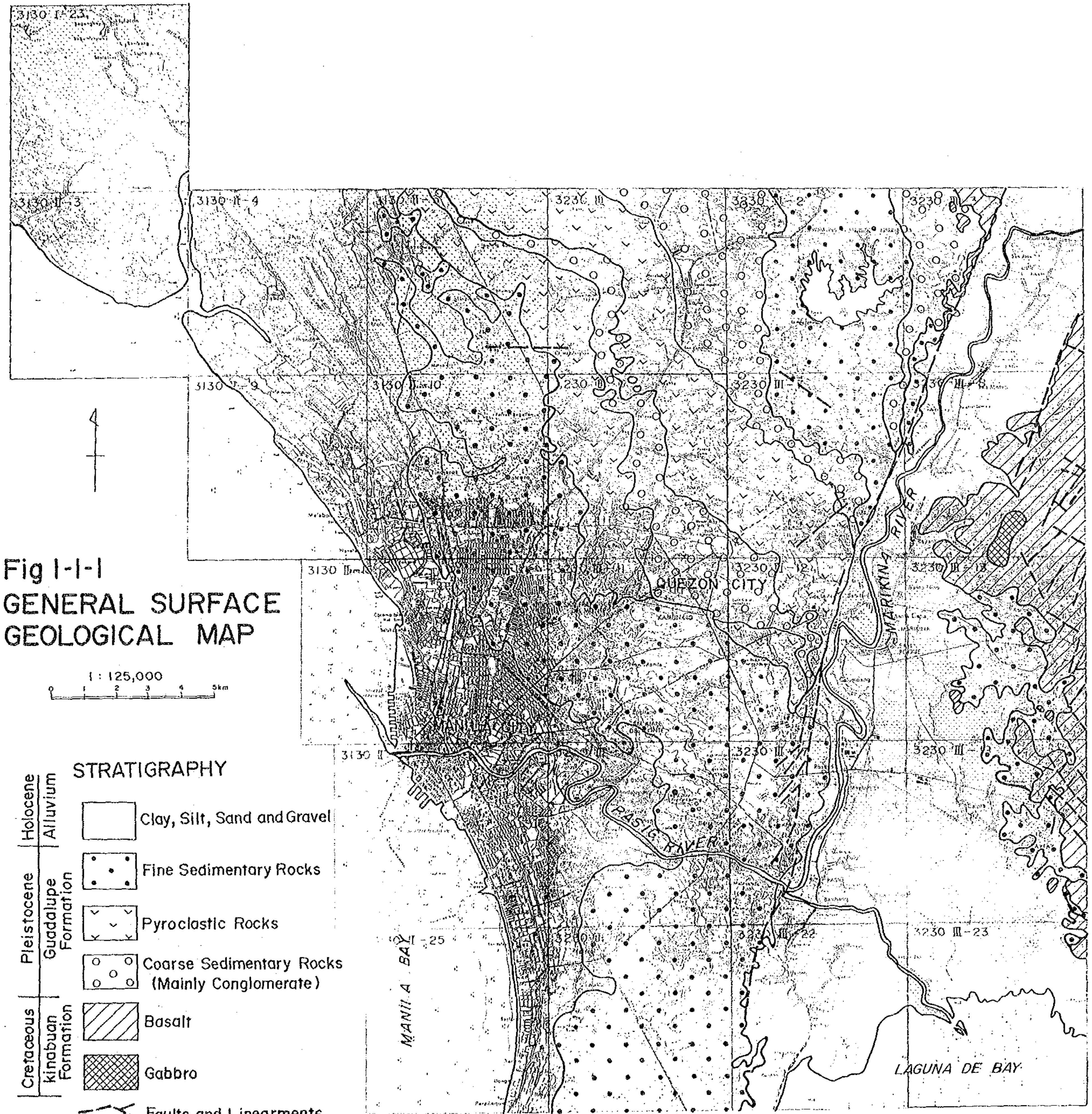


Fig 1-1-1 GENERAL SURFACE GEOLOGICAL MAP

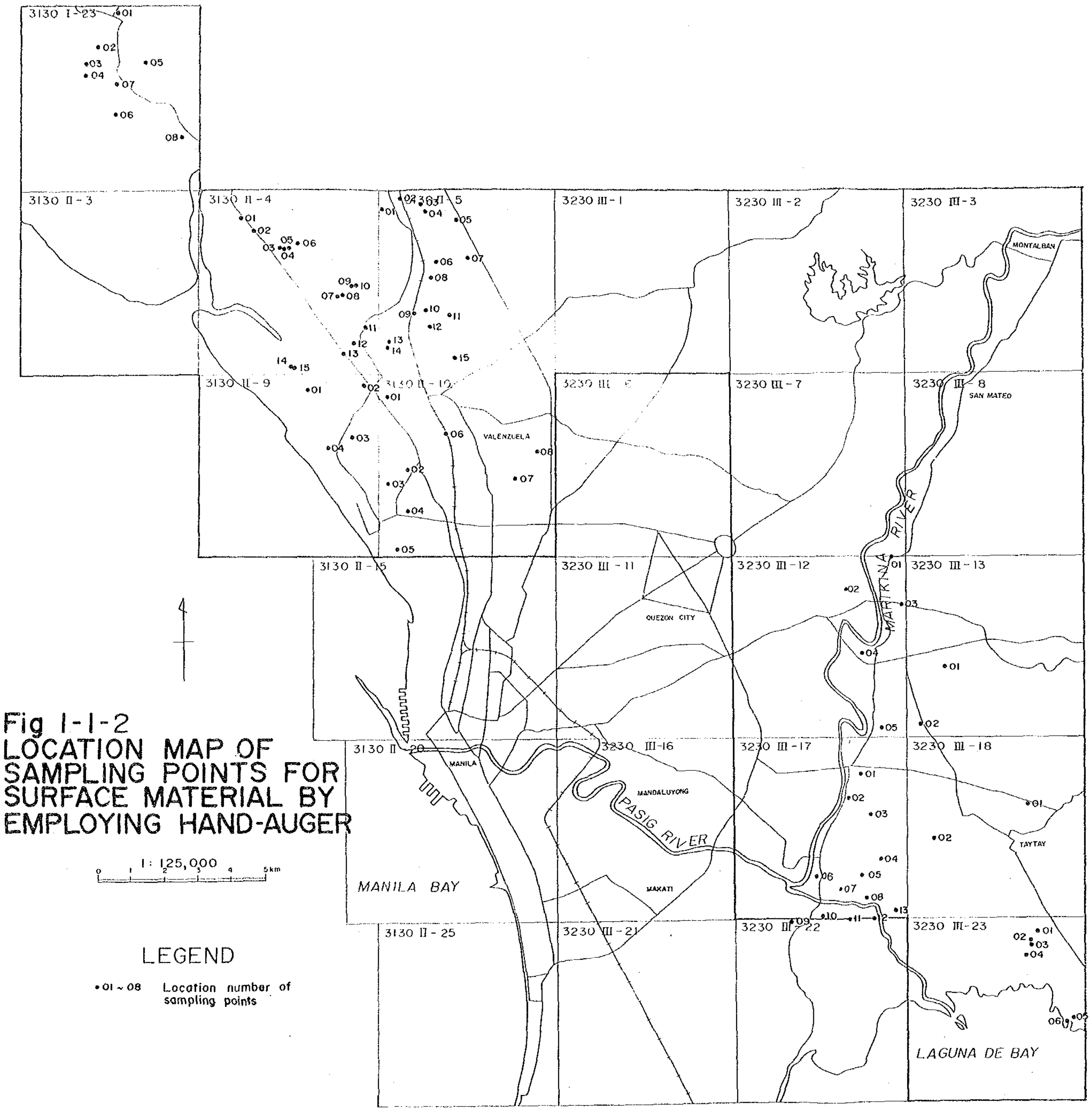


Fig 1-1-2 LOCATION MAP OF SAMPLING POINTS FOR SURFACE MATERIAL BY EMPLOYING HAND-AUGER

1 : 125,000

0 1 2 3 4 5km

LEGEND

•01 ~ 08 Location number of sampling points

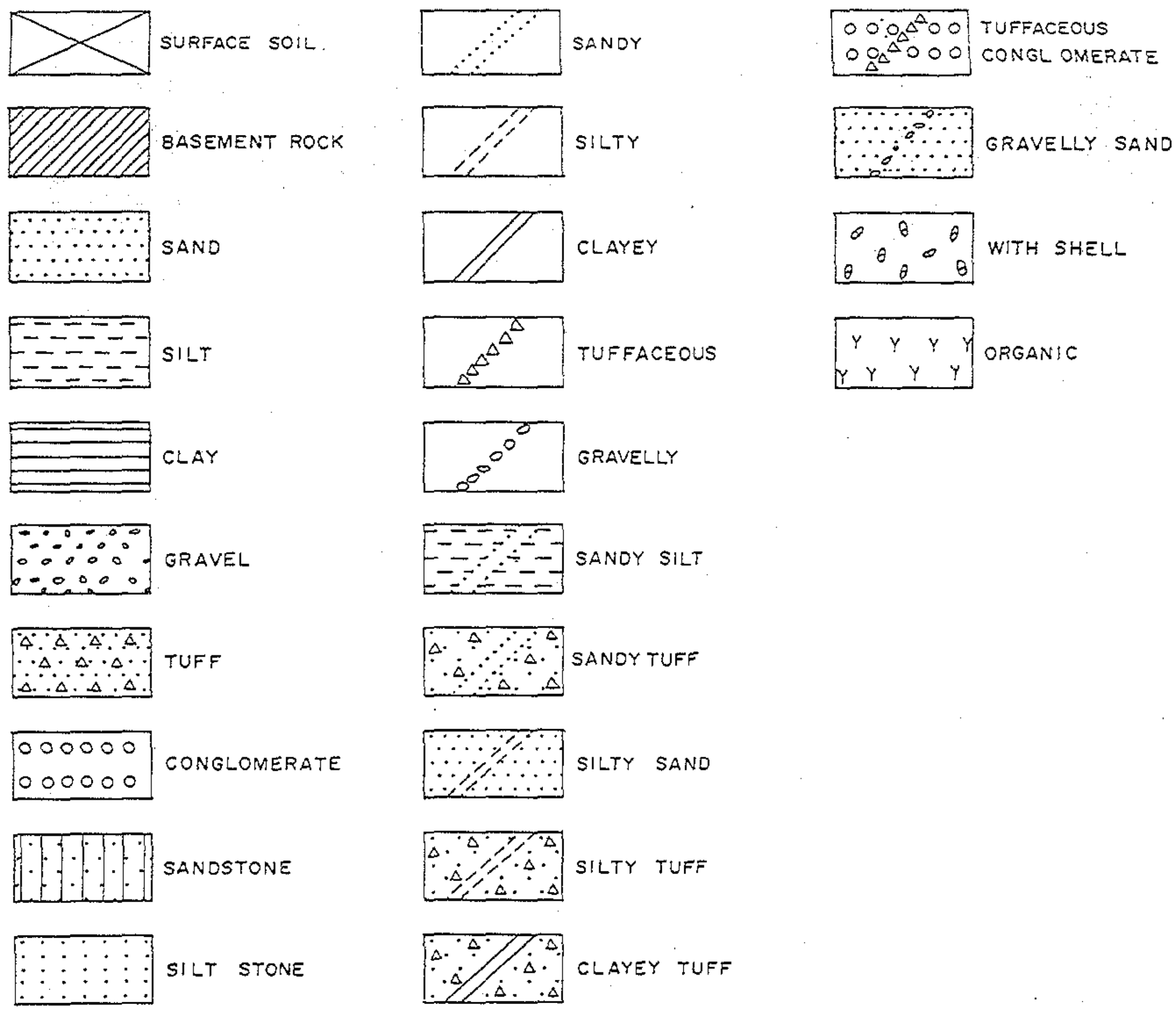


Fig. 1-1-3 Symbols used for hand-augering logs

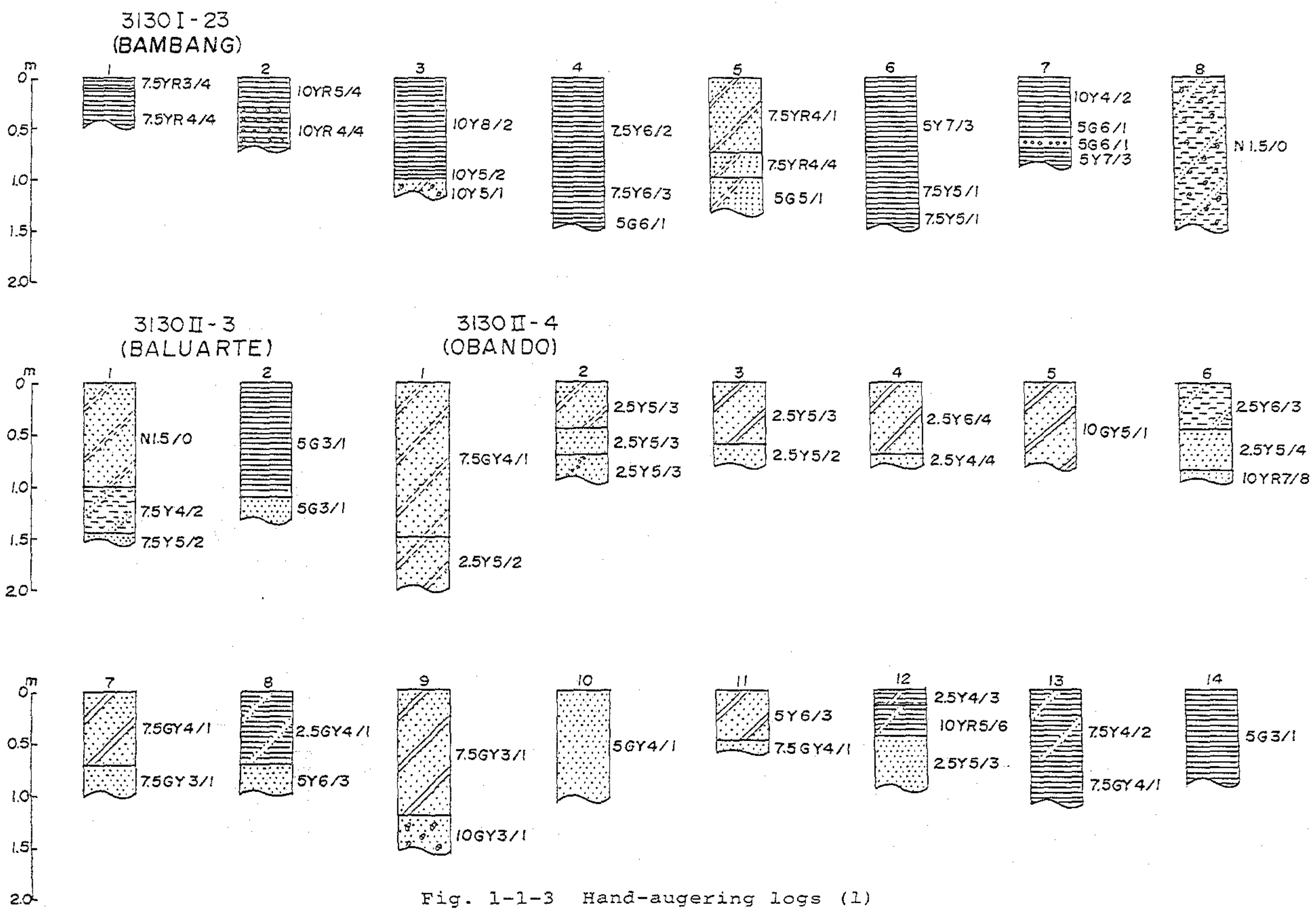


Fig. 1-1-3 Hand-augering logs (1)

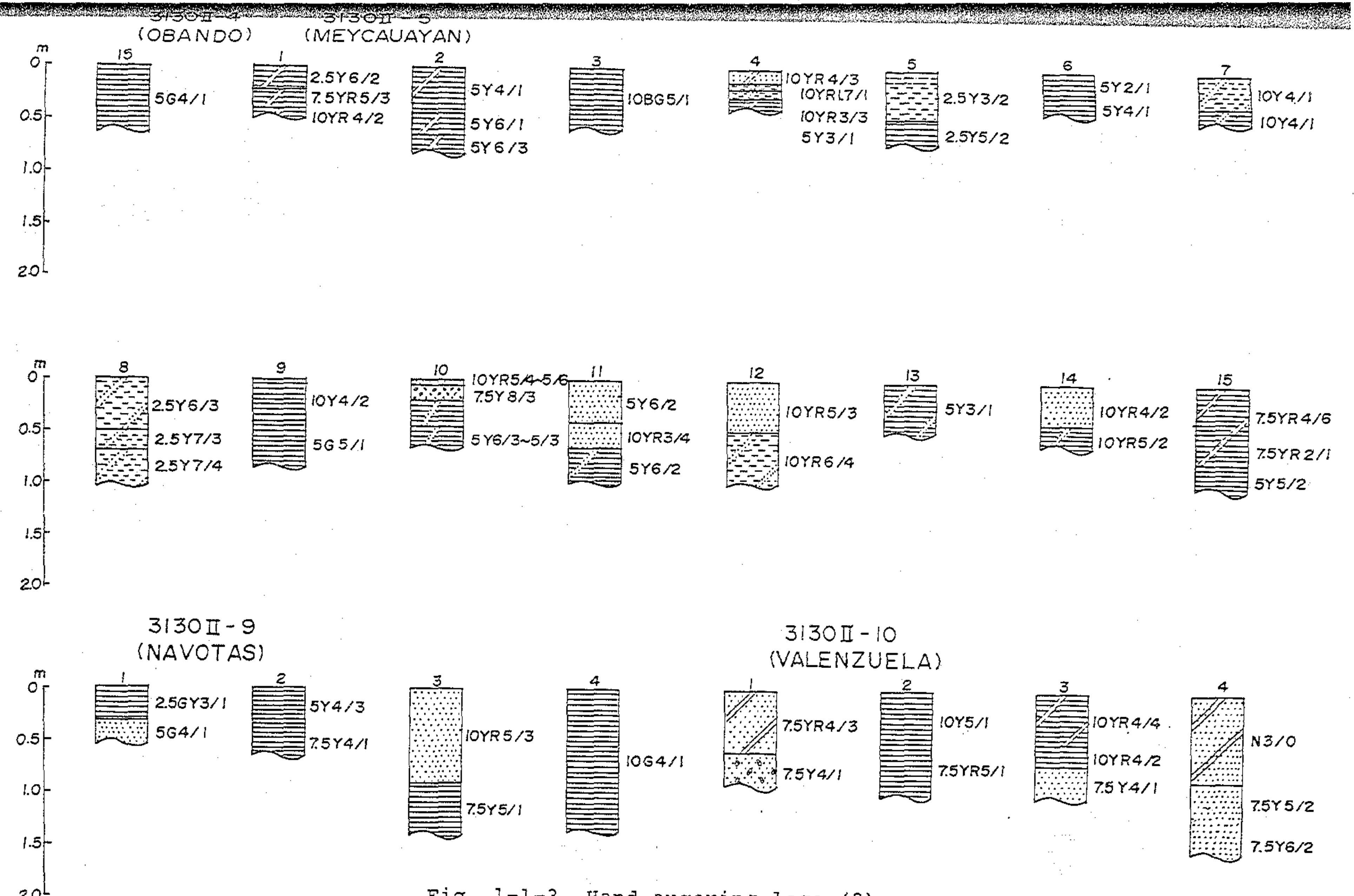


Fig. 1-1-3 Hand-augering logs (2)

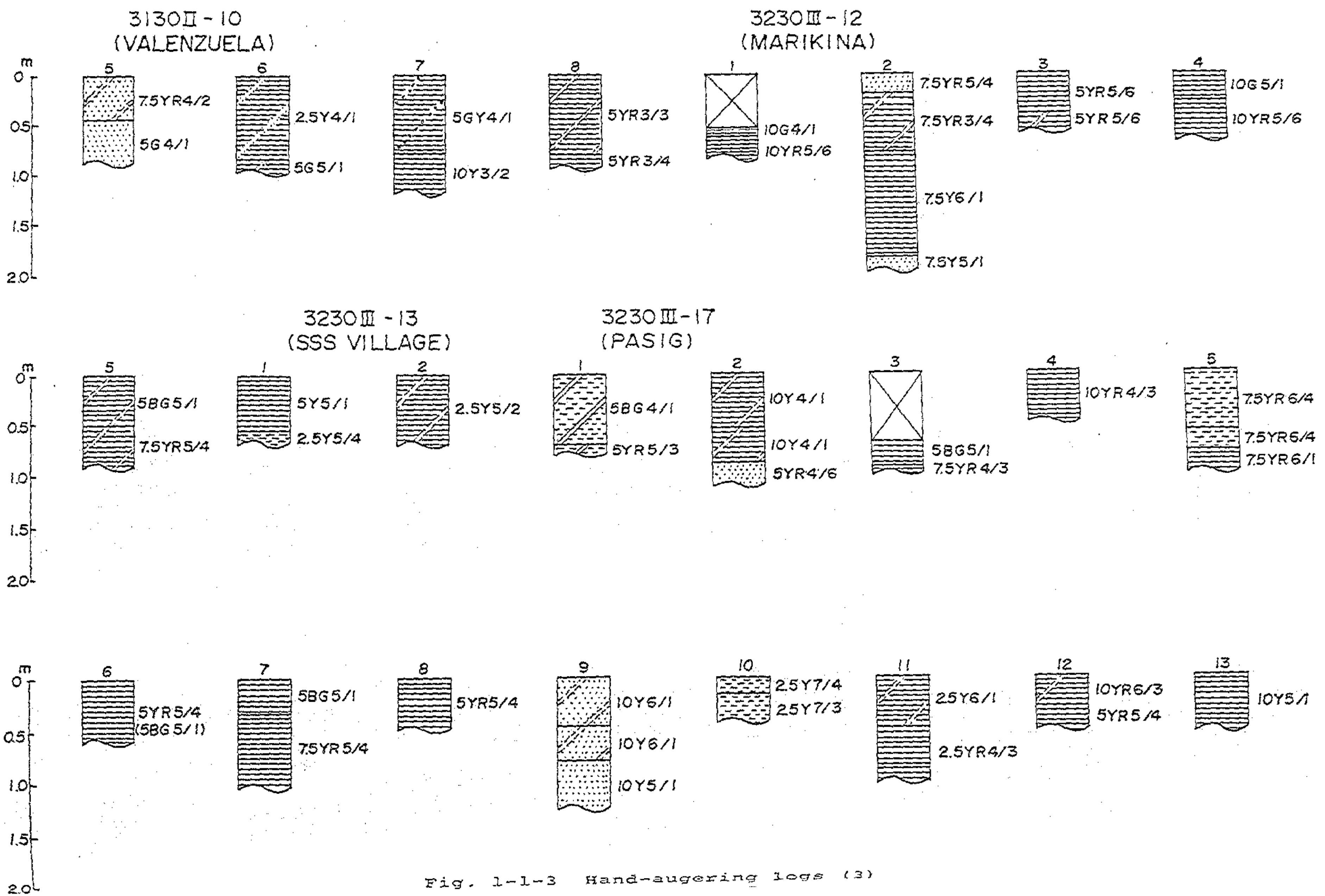


Fig. 1-1-3 Hand-augering logs (3)

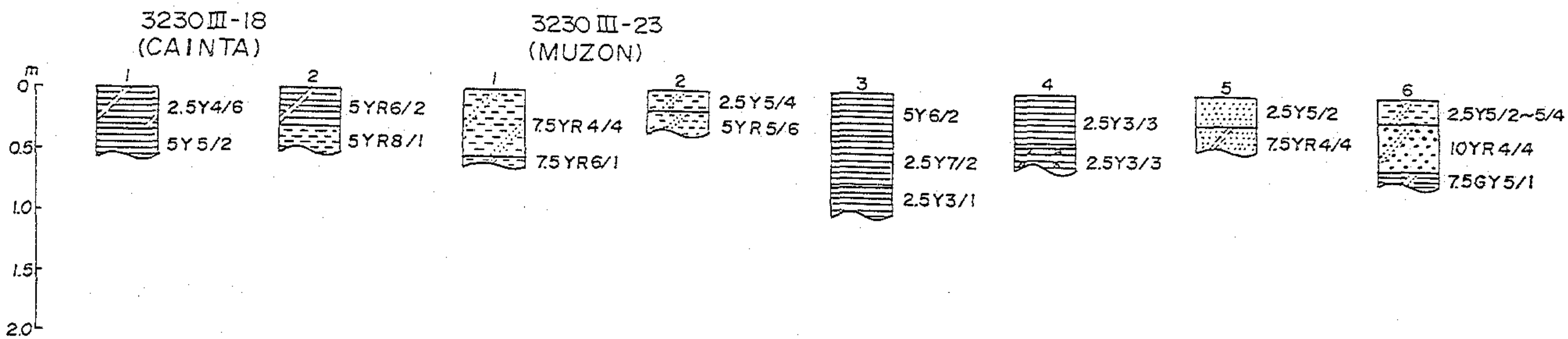


Fig. 1-1-3 Hand-augering logs (4)

Table 1-1-1 Stratigraphy of Southern Sierra Madre

Million years	Era	Period	Epoch	Age	Northern Sierra Madre: Rutland 1967	Northern Sierra Madre: BMG 1981	Southern Sierra Madre: Corby et al 1951 (Rizal-Montalban Area)	Southern Sierra Madre: Corby et al 1951 (Rizal-Teresa Area)	Southern Sierra Madre: Ocampo and Martin (1967)	Southern Sierra Madre: B.M. Pet. Div. 1975	Southern Sierra Madre: Reyes and Ordonez 1970, Hashimoto et al 1975, 1977	Southern Sierra Madre: BMG 1981
	CENOZOIC	QUATERNARY	HOLOCENE		ALLUVIUM	ALLUVIUM FAN AND DEBRIS AVALANCHE			ALLUVIUM	ALLUVIUM		QUATERNARY ALLUVIUM
.01			PLEISTOCENE	LATE	FAN DEPOSITS	DIDICAS VOLCANICS	GUADALUPE TUFF	GUADALUPE TUFF	GUADALUPE F.: DILIMAN TUFF MBR, ALAT CGL MBR.	GUADALUPE F.	GUADALUPE F.	GUADALUPE F.
				EARLY	DEBRIS AVALANCHE DEPOSITS	MT. CAGUA VOLC.		LAGUNA TUFF	LAGUNA F.			
1.8		TERTIARY	PLIOCENE	LATE	SAN JUAN F.	BUTETE F.						
				EARLY	BUTETE F.							
5.0			MIOCENE	LATE								
				MIDDLE					MADLUM F.; BUENACOP LS MBR., CLASTIC MBR.	MADLUM F.	UNNAMED F.	MADLUM F., STAINES D.
				EARLY	VILLA WAVE & BUGNAM F MAINIT F. DINGALAN F.	BUGNAM F. MAINIT F.	QUEZON F.; METAVOLCANICS SIERRA MADRE C.M., ANGAT LS.	BINANGONAN LS. TERESA TUFFACEOUS SILT	ANGAT F.	ANGAT F.		ANGAT F.
22.5			OLIGOCENE	LATE		DINGALAN F. CORONEL F. MINGAN F.			TERT. INTRUSIVES		BINANGONAN LS TERESA TUFF. SILT	BINANGONAN F.
				EARLY	CORONEL F.				MAYBANGAIN F.: CLASTIC - VOLCANIC MBR		QUARTZ DIORITE	ANTIPOLO DIORITE
38.0			EOCENE	LATE			BASEMENT COMPLEX	BASEMENT COMPLEX		MAYBANGAIN F.	MAYBANGAIN F.	
				EARLY		COASTAL BATHOLITH LUBINGAN F.			MASUNGIT LS MBR			MAYBANGAIN F.
55.0			PALAEOCENE	LATE		CARABALLO GROUP						
				EARLY	MINGAN F.	ULTRAMAFICS						
65.0	MESOZOIC	CRETACEOUS		LATE	LUBINGAN F.				KINABUAN F.	KINABUAN F.	KINABUAN F.	KINABUAN F.
				EARLY						BASEMENT COMPLEX	METAVOLCANICS	METAVOLCANICS
141		JURASSIC		LATE					BASEMENT COMPLEX			
				MIDDLE								
				EARLY								
195		TRIASSIC		LATE								
				MIDDLE								
				EARLY								
250	PALEOZOIC	PERMIAN		LATE								
				MIDDLE								
				EARLY								
280		CARBONIFEROUS										

Source: Geology and mineral resources of the Philippines (Volume one 1982)

1-2 Flood

1-2-1 Data Collection

The Republic of the Philippines is located on the east edge of the Pan-Pacific area, where the route of typhoons, like Japan. Every year several typhoons hit the country with resultant heavy damage.

Table 1-2-1 lists flood damage in Metro Manila and its surrounding areas. This table is based on 11 years of records, from 1970 to 1980. It shows several flood disasters annually.

In 1985 and 1986, when this project was in the survey phase, several floods broke out in each year, and as a result the survey was discontinued two or three times.

In the land condition survey, information concerning floods were collected for full understanding of the actual situation of floods, especially around Metro Manila.

Table 1-2-1 shows flood damage by year near Metro Manila. Even after the information collection, maps and charts showing areas inundated by floods were found to be very rare. Only two materials, shown below, were collected in the Philippines by this project team.

(1) 1985 flood in Metro Manila 1/20,000

- Ministry of Public Works and Highways -

This map illustrates submerged areas from Morobon in Metro Manila to Pasai City. The flood in 1985 was caused by a torrential rain due to successive attack of tropical depressions and typhoons over the Philippines in June 1985, especially the Typhoon Dalin which hit the middle part of Luzon on the 27th and 28th. This torrential rain caused the rise and overtopping in rivers/channels around Manila, including Pasig River and Marikina River, resulting in serious flood damage throughout Manila. This information is shown as Fig. 1-2-1.

(2) 1982-1985 Submerged area in Manila - Quezon City 1/15,000

- Office of Civil Defence -

This map, which describes submerged areas by year based on information from road patrols and contact with citizens, emphasizes more point indication.

This information is shown as Fig. 1-2-1.

Table 1-2-1 Flood Damage in Metro Manila and Suburbs

Disaster		Estimated Damage in Pesos	Affected		Casualty		
Date	Nature		Families	Persons	Dead	Injured	Missing
09-02-70	Typhoon Mading	1,085,150	9,255	56,918	18	0	0
10-11-70	Typhoon Sening	4,003,500	5,928	33,329	4	15	0
11-19-70	Typhoon Yoling	94,261,000	7,757	447,441	83	1,554	0
08-01-71	Typhoon Barang	50,000	273	1,669	0	0	0
08-11-71	Typhoon Dadang	380,000	577	3,214	0	0	0
06-25-72	Typhoon Konsing	7,756,247	7,958	45,635	8	1	2
07-17-72	Typhoon Gloring	82,400,00	81,225	482,270	94	0	3
07-07-72	Thphoon Edeng	0	238	1,428	0	0	0
10-06-73	Typhoon Luming	12,000	150	780	0	3	0
10-15-73	Typhoon Nacing	731,838	382	1,997	0	0	0
07-20-74	Typhoon Iliang	0	60	307	1	0	0
08-18-74	Typhoon Norming	132,297,500	24,504	145,305	19	0	0
11-20-74	Typhoon Bebeng	8,783,991	594	2,86	0	0	0
11-28-74	Typhoon Bedang	940,000	105	707	1	0	0
10-10-75	Typhoon Naning	930,000	92	2,765	0	0	0
05-18-76	Storm Didang	49,396,901	28,827	150,479	53	3	13
08-19-77	Typhoon Ibiang	132,000	66	383	1	0	0
11-14-77	Typhoon Unding	38,41,842	1,558	11,160	1	0	1
09-20-78	Storm Weling	2,309,745	841	4,171	1	9	0
08-23-78	Typhoon Mading	0	7	40	0	0	0
10-09-78	Typhoon Yaning	16,804,058	14,563	25,522	7	0	0
10-26-78	Storm Kading	12,500,000	55,774	281,504	3	0	0
04-13-79	Storm Begeng	2,939,607	759	3,873	0	0	0
08-11-79	Storm Mameng	0	1,718	10,053	2	0	0
07-26-80	Typhoon Osang	0	44	274	0	0	0
01-11-80	Typhoon Aring	211,522,696	1,616	7,477	603	3,170	32

Source: OCD

(3) Flood in September 1986 surveyed by this project team

When this project team encountered a typhoon during the 2nd Year field Survey, an inundation investigation was conducted after the effect of the typhoon disappeared.

The typhoon brought torrential rain mainly in Luzon Island from Aug. 31 to Sep. 1, 1986.

This project conducted an aerial survey by helicopter on Sep. 5 when the effect of the typhoon disappeared.

This survey focused on the lowland along the coast in the north-west of manila, and the lowland from Marikina River to Lagunade Bay.

Because the survey was performed 3 days after the torential rain, areas with quick drainage could not be fully identified. Therefore, submerged areas identified in this survey are ponding areas of long duration.

The ponding areas of long duration identified in this survey are as follows:

1) Coastal plain in the north-west of Manila

The coastal plain/delta area extending from Malabon to Obando and Bulacan in the survey area was submerged up to the floor level in some colonies, and the entire field and marine pond area was completely submerged only with aerial observation. In the sand bars defined by the landform classification, especially in the area of marine ponds, trunk roads were submerged and houses and trees were seen on the water surface.

2) Flood plain from lower Marikina River to Laguna de Bay

In this survey area, the ponding area spreads more widely towards the downstream, from Marikina, Cainta and Taytay. The periphery of the mangahan floodway and entire Pasig/Tagiku were innundated, leaving only houses and trees. The recent development for housing is going on very intensively from Pasig to Cainta/Marikina. In the section of filled paddy fields, water subsided, while the remaining paddy field section was still in a submerged condition.

3) Other areas

No submerged area was seen over the entire newly developed area on the hill/plateau in the north of Quezon City.

From Sanmateo to Montalban on the middle reaches of Marikina, ponding ranges concentrated along Marikina River, especially at abandoned quarries made by recent development activities. In addition, ponding ranges were obsered here and there along the trunk road on the terrace and on a paddy field surface on the terrace.

The result of this survey is shown in Fig. 1-2-3.

1-2-2 Interviewing

In the second year of this project during the land condition field survey, an interviewing about recorded floods was conducted for local people.

The contents of information received from residents is as follows:

* The maximum water level among floods experienced in the past.

* Date of the flood causing the maximum water level and the name of the typhoon.
* Ponding duration in the flood causing the maximum water level.

The inquiry survey was carried out at 147 sites within the study area, mainly about the above listed information.

Result of the survey is summarized for each figure as shown in Table 1-2-2.

Table 1-2-2 was used to summarize about the study area, as shown below:

(1) In the north-west part of Manila, even the natural levees on the microrelief sand bar where colonies spread are inundated for the most part. The ponding period, although shorter than that in the peripheral lowland, is prolonged, up to several days. The entire Obado sand bar is submerged. In the coastal plains behind the natural levees and between sand bars, the ponding duration is even longer, being several months in some cases.

(2) On the hill/plateau with good drainage, areas along the small and middle rivers engraving valleys are submerged for a short time, but in repetition.

(3) The flood plain/lower terrace along Marikina River forms a submerged range, but the water sinks rather quickly. In contrast, a ponding range with poor drainage tends to appear along the roads on the upper terrace surface.

(4) In the flood plains from Marikina River to Laguna de Bay, the area on the natural levee is hardly inundated, but the whole flood plain behind the natural levee is submerged. This area covers a lot of newly developed land for housing, but most of the land is submerged. The surrounding paddy field surface is ponded for a long time. The depth of inundation increases closer to laguna de Bay, and ponding may continue for serveral months.

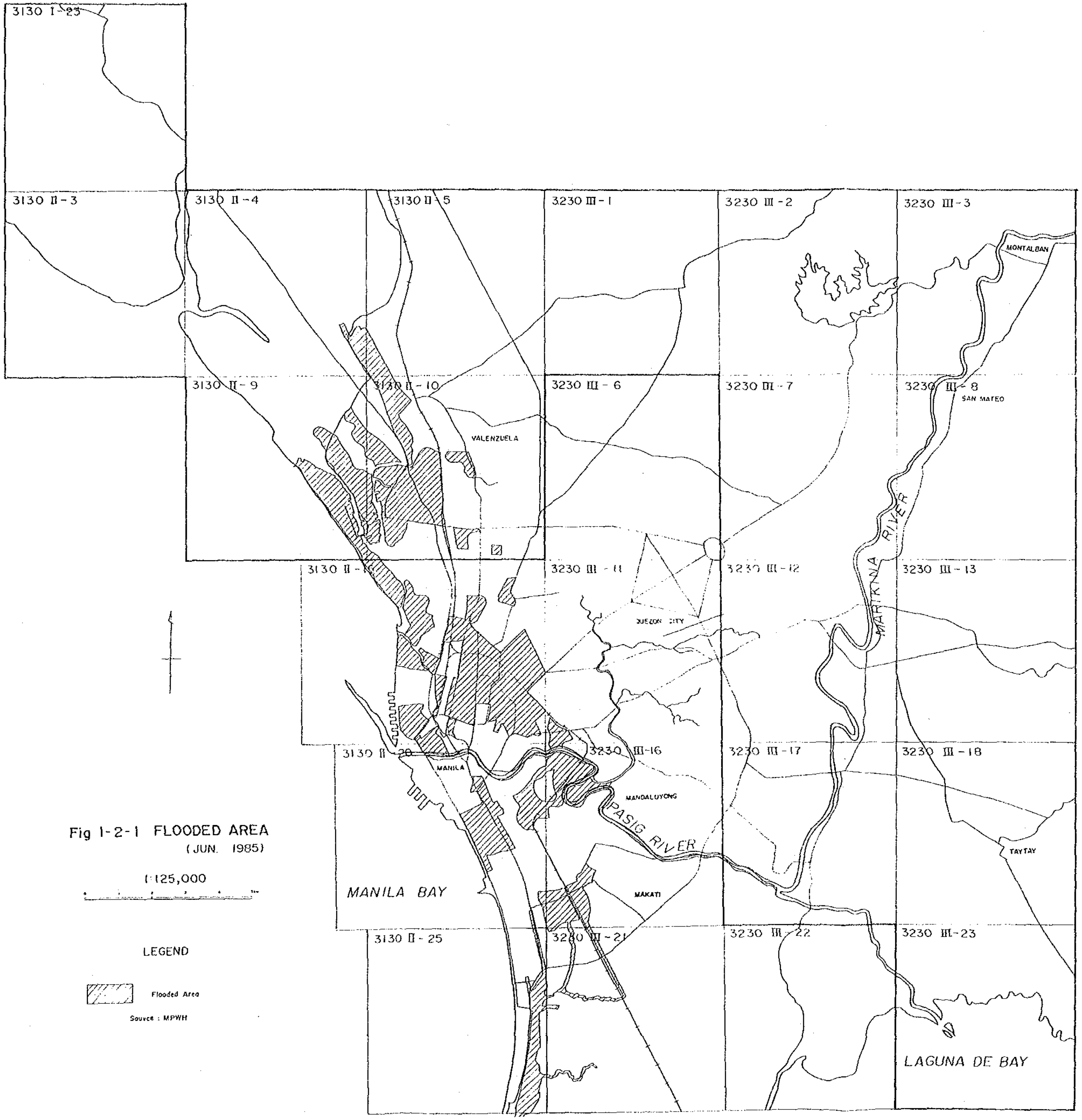


Fig 1-2-1 FLOODED AREA
(JUN. 1985)

1:125,000

LEGEND

Flooded Area

Source : MPWH

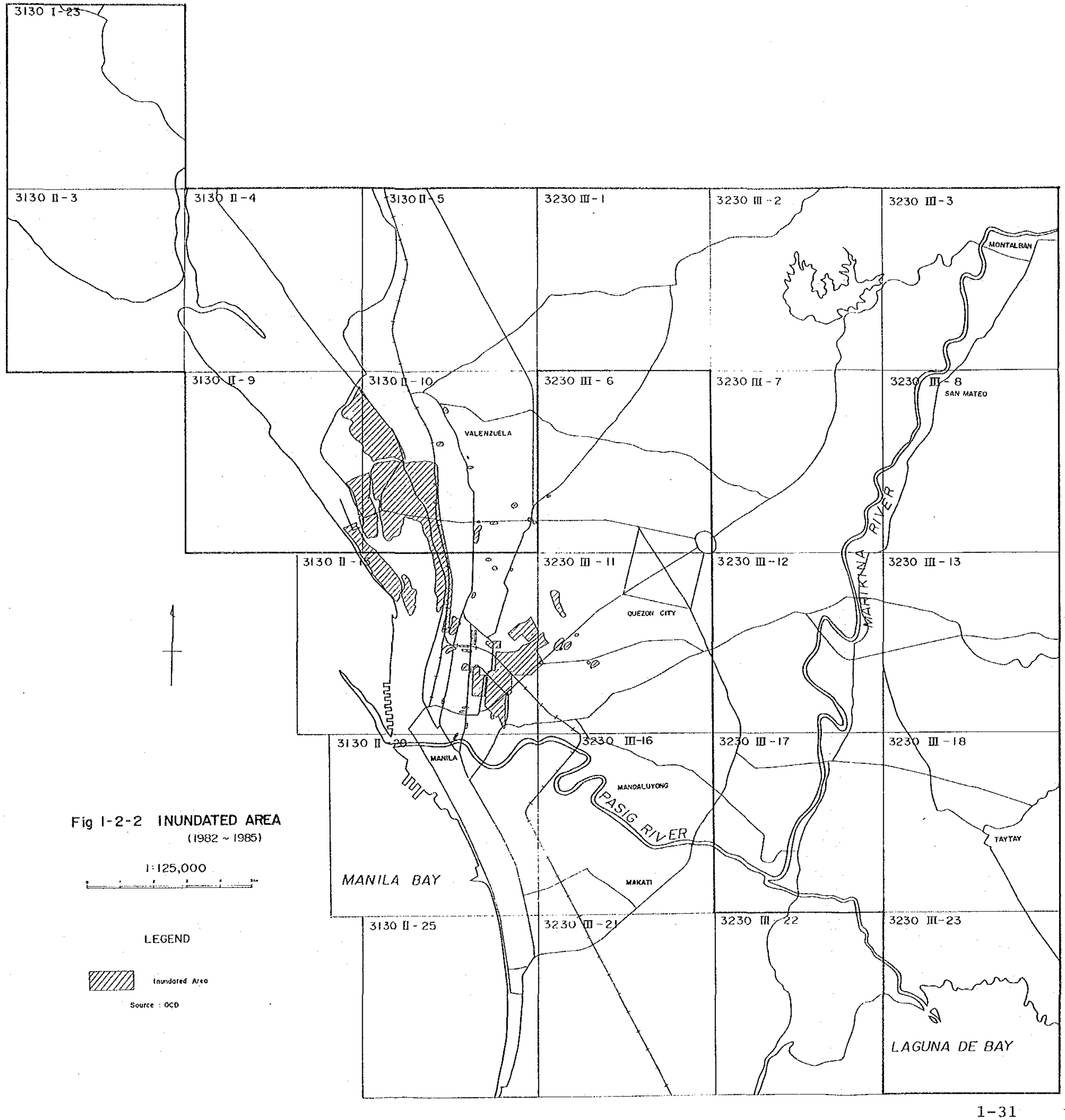


Fig I-2-2 INUNDATED AREA
(1982 ~ 1985)

1:125,000

LEGEND

Inundated Area

Source : OCD

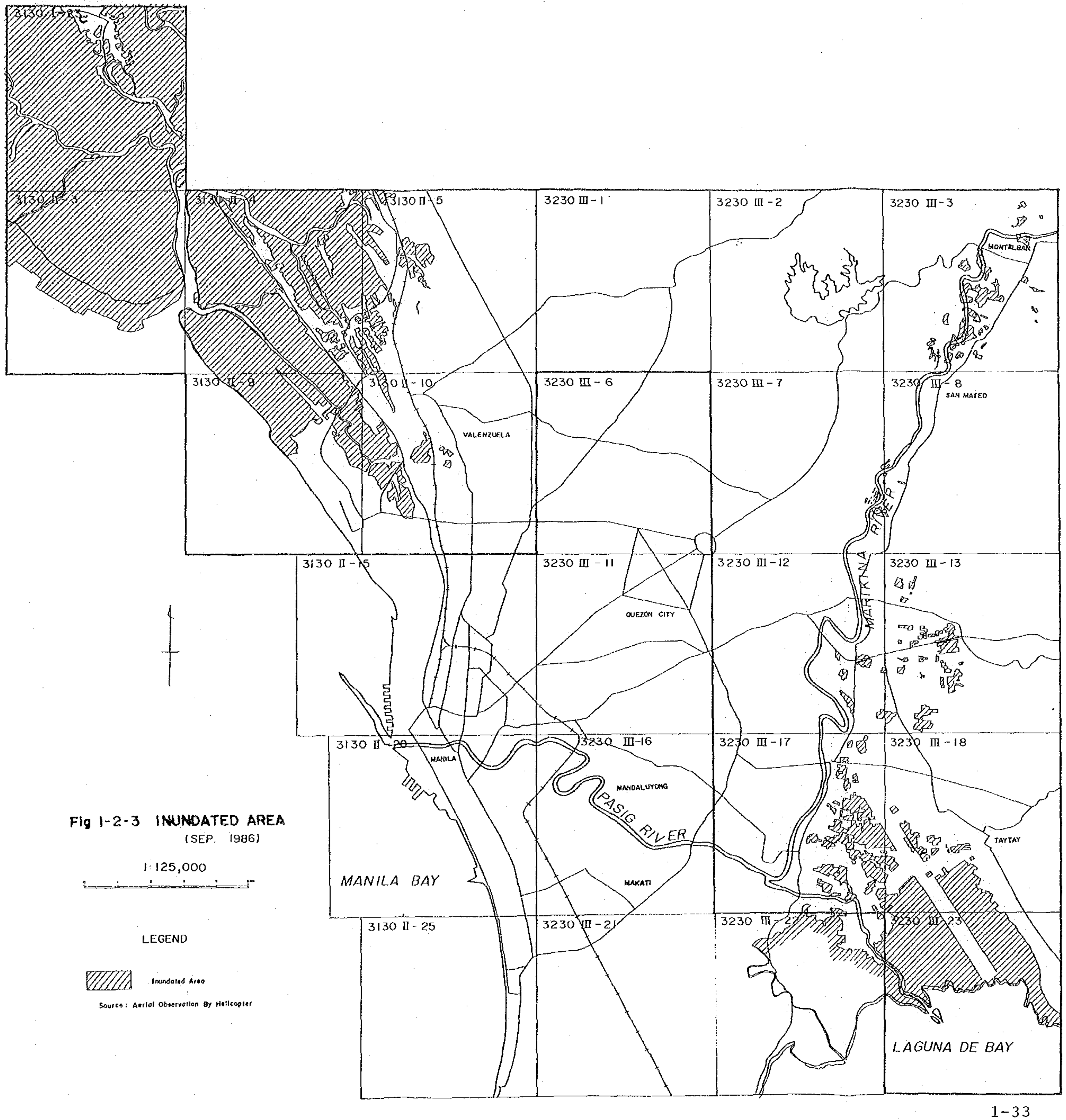


Fig 1-2-3 INUNDATED AREA
(SEP. 1986)

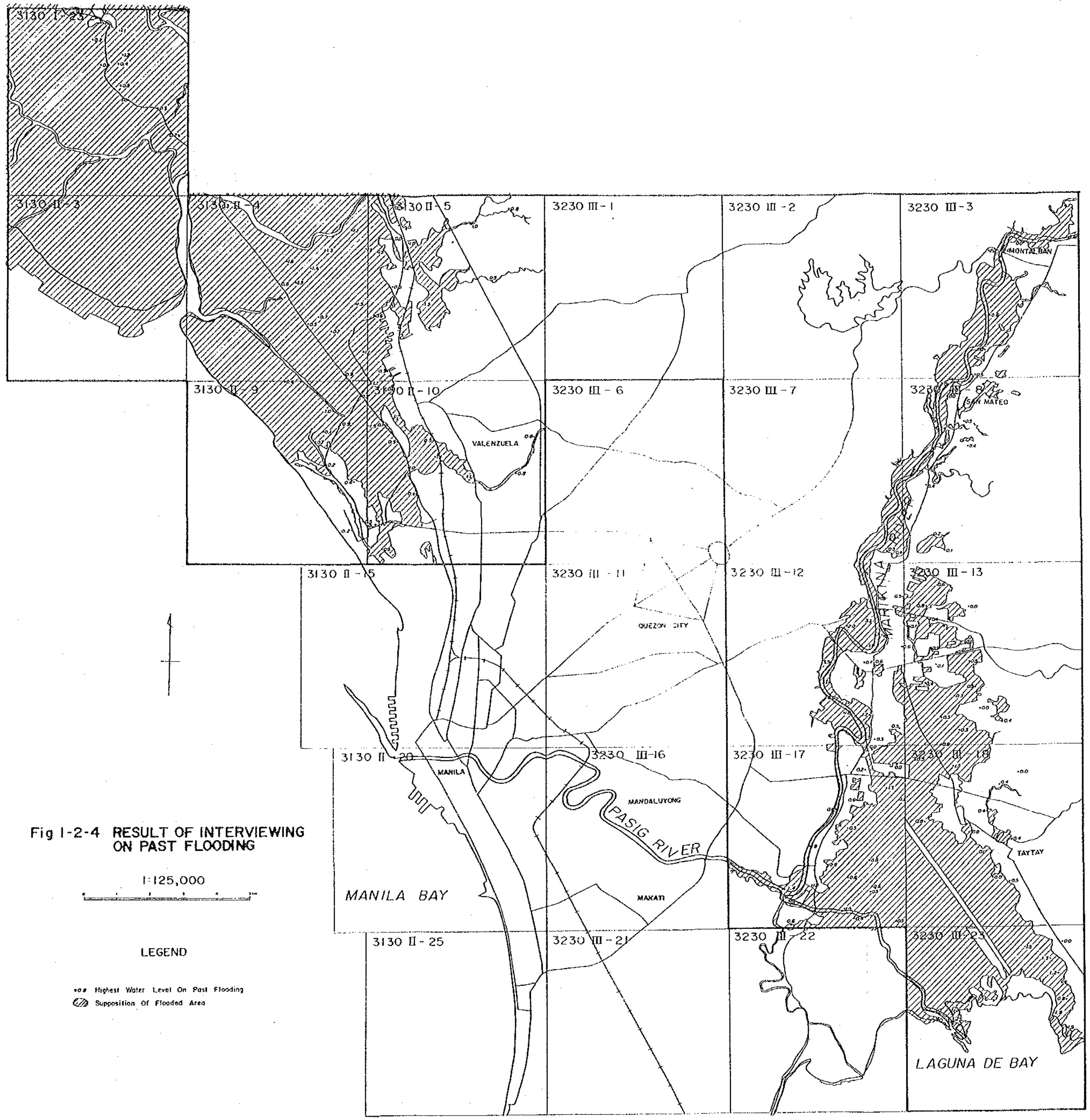


Fig I-2-4 RESULT OF INTERVIEWING ON PAST FLOODING

1:125,000

LEGEND

•0.8 Highest Water Level On Past Flooding

Supposition Of Flooded Area

Table 1-2-2 A List of Results of the Interviewing

Chart Name	Inquiry Number	Maximum Water Level (Year of Occurrence)	Inquired Average Water Level	Ponding Longest	Duration Shortest	Characteristics
3130-1-23 BAMBAMG	10	1.2 m (1985)	0.5 m	2 days	1 day	The colony in this sheet is Bulacan on a natural levee. Excluding the central part of Bulacan, the whole area is an inudated area, but because of the natural levee the average inudation depth of 0.5 m is rather shallow. The ponding duration is 1-2 days, with better drainage than other areas in the north-west of Manila City.
3130-11-4 OBANDO	14	1.6 m (1978)	1.0 m	14 days (3 months)	1 day	This sheet consists of sand bars and a coastal plain. Colonies distribute on the sand bars. The whole area is an inudated area because of the low sand bar altitude of less than 1 m. The inquired average water level of 1.0 m is deep, and the ponding duration is more than 7 days in many laces. On the whole, the area has poor drainage.
3130-11-5 MEYCAUAYAN	11	1.5 m (1985)	0.8 m	4 days	2 hours	In this sheet, the coastal plain/flood plain is on the west side, and the hill/plateau is in the east and south areas. The inundated area covers the coastal plain/flood plain. Nearly all sand bars are also submerged. The ponding duration is 4-5 days along Meycauyan River, and 1-2 days in other areas.
3230-111-1 NOVALICHES	8	1.5 m (1985)	0.7 m	1 day	1 hour	This sheet covers the hill with an altitude of 30-70 meters. The inundated areas concentrate along Novaliches River. The major river in this area, and in valleys on the hill short flooding takes place. The ponding duration is only 1-3 hours at maximum.
3130-11-9 NAVOTAS	10	1.0 m (1985)	0.5 m	7 days	1 day	This sheet covers the coastal plain along Manila Bay, and colonies concentrate in sand bars. In recent years, landfilled marine ponds have been used for housing. Poor drainage facilities has resulted in short inundation even on the sand bars. The ponding duration in the marine pond area is 3-7 days.
3130-11-10 VALENZUELA	14	1.5 m (1985)	018 m	7 days (3 months)	1 day	This sheet covers the coastal plain on the west side and the hill/plateau on the east side. The inundated area spreads over the coastal plain, and nearly all sand bars are submerged. The area along Tulahan River flowing in the hill/plateau is partly inundated. The ponding duration is 3-7 days in the coastal plain area, and 1 day along Tulahan River.
3230-111-3 MONTALBAN	7	2.0 m (1970)	1.1 m	1 day	1 hour	This sheet covers the middle reaches of Marikina River, and has the hill on the west side, the mountain on the east side, and terraces on the both banks of Marikina River. The inundated area is the flood plain and low terraces along Marikina River. On the high terraces overlaid by colonies in Montalban and Sanmateo the area surrounded by roads and its back area are submerged.
3230-111-7 DILIMAN	2	1.4 m (1986)	1.0 m	3 hours	2 hours	This sheet covers mostly the hill/plateau, with Marikina River, a lowland area on the south-east side. The inquiry survey was performed from houses in the flood plain and the low terraces along Marikina River. On the low terraces, the flooding period is 2-3 hours.

Chart Name	Inquiry Number	Maximum Water Level (Year of Occurrence)	Inquired Average Water Level	Ponding Longest	Duration Shortest	Characteristics
3230-111-8 SAN MATEO	9	2.1 m (1978)	0.7 m	7 days	1 hour	This sheet covers the hill/plateau and the lowland surrounded by the mountain along Marikina River. The inundated area extends around the flood plain along Marikina River, and also the junctions of small rivers flowing into Marikina River, the former channel on the terrace, and the shallow valley are inundated. The ponding duration is rather short along Marikina River, whole longer on the terrace.
3230-111-12 MARIKINA	17	3.3 m (1978)	1.1 m	2 days	4 hours	This sheet covers the hill/plateau overlaid by Quezon City on the west side, and the lowland with meandering Marikina River on the east side. The inundated area spreads mainly along Marikina River, and covers the lowland behind the natural levee overlaid by old colonies. The highest recorded water level is 3.3 m at the former river channel in Tanong, Marikina where the river meanders.
3230-111-13 SSS VILLAGE	10	0.9 m (1986)	0.6 m	7 days	1 hour	This sheet covers the flood plain on the west side, and the hill/mountain on the east side. The inundated area spreads over paddy fields excluding artificially deformed land for a housing site, a part of which is inundated at the depth of more than 10 cm. The inquiry survey was conducted around houses located in the artificially deformed land, and the inquired ponding duration is largely 1-2 days, but the ponding duration in the lower paddy field seems to be much longer.
3230-111-17 PASIG	17	1.8 m (1985)	0.8 m	7 days (2 months)	1 hour	This sheet consists of the hill/plateau overlaid by the urban districts of Manila City and Quezon City on the west side, and Marikina River and the lowland on the east side. The inundated area spreads over the entire lowland, excluding the area on the natural levee distributing along Marikina River. The highest water level recorded is 1.8 m in the flood plain along Marikina River, and the average inundation depth is 0.8 m in the lowland. The ponding duration is long.
3230-111-18 CAINTA	11	1.5 m (1986)	0.6 m	3 days	1 hour	This sheet covers the flood plain extending from Marikina River to Laguna de Bay on the west side, and the fan landform-hill on the east side. The inundated area is the whole flood plain and the partially enbanked deformed land. The ponding duration is mostly 1-3 days, but that on both sides of the Mangaha Channel and in the south seems to be much longer.
3230-111-23 MUZON	7	1.9 m (1972)	1.4 m	21 days (5 months)	7 days	This sheet covers the marshy lowland facing Laguna de Bay, and the fan/hill landform on the east side. The inundation level reaches 1.5 m - 2.0 m in artificially deformed land for housing side made by banking on the marshy lowland in front of the fan. Becaue of the water level rise of Laguna de Bay, the ponding duration is prolonged to several months.

1-3 Ground

1-3-1 Data Collection

In order to understand fully the ground condition of the study area in the land condition survey, boring column charts were collected mainly from soil nature surveys.

Collected materials are mainly for the central part of Metro Manila, but not so much information was available for the lowland on the north-west side of Manila and the lowland around Marikina River and Laguna de Bay within the study area.

		Collected by
(1)	The Feasibility Study for Manila Rapid Transit Railway Line No. 1	JICA
(2)	Feasibility Study on C-3 and R-4 and related Road Project	"
(3)	Radial Road R-10 Feasibility Study	"
(4)	Feasibility Study for the Metro Manila Quter Major Road Project (Northern Package): Final Report	"
(5)	Final Report - Subsurface Investigation for the Site of the Mapindan Hydraulic Control Structure	MMC
(6)	Supplementary Soils Report - Soil Investigation Proposed Southern-Pump Station and Bay Outfall, MMSP-MWSS Project, Roxas Boulevard, Metro-Manila, Volume II	"
(7)	Final Report - Subsurface Investigation for the Proposed Sites of Libertad Dumping Station and Libertad Control Gate	"
(8)	Final Report - subsurface Investigation for the Proposed Sites of Makati Pumping Station Zobel-Orbit Outfall, Zobel-Roxas Control Gate and Paco Control Gate	"
(9)	Final Report - Subsurface Investigation for Pandacan and Vitas Floodgates and Tangue Diversion Culvert	"
(10)	Final Report - Subsurface Investigatin at the site of the proposed villa anteva townhouses calumpang, Marikina, Metro Manila	GP. INC.

(11) Final Report - Subsurface Investigation Proposed Slope Stabilization Bo. Ugong, Pasig, Metro Manila "

(12) Final Report - Subsurface Investigation Site of the Proposed Mercury Drug Company Building, Santolan, Tatlong Kawayan Pasig, M.M. EG. INC

The boring points for column charts shown in the above listed reports as indicated in Fig. 1-3-1.

1-3-2 Ground Condition

Topographically, Metro Manila can be divided into the lowland along Manila Bay, the hill/plateau on its east part, and the lowland along Marikina and around Laguna de Bay. The lowland along Manila Bay being very low at 1 m to 3 m was made as a delta formed by Pasig River and other flowing into Manila Bay, and consists of alluvium.

The hill/plateau elevates gradually from the lowland of 20-30 m to the north of Quezon of 80-100 m. The 20-30 m surface forms a plateau, where the dendritic erosional valley gets deeper and deeper towards the elevated northern part shifting to rolled hilly landform. The lithography of the hill/plateau is the Quarternary Pleistocene Guadalupe formation (consisting of pyroclastic rock, siltstone, sandstone, conglomerate bed, and others).

The lowland of Marikina River/Laguna de Bay forms a wide flood plain from a 1 m altitude to almost 10 m along Laguna de Bay, and shifts to the Marikina Valley area composed of a terrace surface.

Based on the boring data collected in this survey which is mainly for the urban district of Manila, the ground condition is described for each of the above mentioned areas.

(1) Lowland along Manila Bay

In the alluvial lowland including towards Manila Bay and overlying the Guadalupe formation as the base, an alluvium mainly composed of clay and silt sand is deposited. The alluvium gets thinner towards the hill/plateau, and thicker towards Manila Bay. The deepest part of the alluvium, based on the collected boring data, is approximately 34 m near the south of the Pasig River mouth. A sandy layer of about 7 m in thickness from the ground surface and clay and silt are seen down to about 20 m under the sandy layer. The geological profile is shown in Fig.

1-3-3. The alluvium is approximately 25 m to 30 m in depth along the coast from the Pasig River mouth to Pasai City, and gets gradually deeper towards Manila Bay.

On the other hand, in the lowland from Pasig River to Nabotas in the northern area, the alluvium gets shallow suddenly at places, and drowned valleys scoring the Guadalupe formation composing the hill/plateau distribute. The buried valleys over this area are those engraved by the former Pasig River. One of the major valleys stretches north-west from the periphery of San Miguel along Pasig River to Nabotas, but its details including other buried valleys, are not known, partly because of lack of information.

The alluvium is mainly composed of silty clay with occasional intercalated sand beds, and the N value increases slightly in the sand bed, being less than 10.

A silty sand bed of the average thickness of 10 m exists, which is located under a siltyl clay bed but on the Guadalupe formation. Its N value of 10-30 shows a slightly compacted condition, and it distributes, burying the sub-merged valleys.

Pasig River forming the alluvium runs through the hill/plateau near Mandaluyong in urban district of manila, and forms delta alluvial land.

In the alluvium in this periphery, Pasig River engraves the hill/plateau gorge-like, and the depth of the alluvium at the base surface is deeper than approximately 30 m. The boring column chart is shown in Fig. 1-3-3. Its deepest part and present Pasig River slip off each other by about 1 km to the north side, and the base surface under the present river bed is around 12 to 13 m.

San Juan River running on the hill/plateau flows through the congested area in the Quezon urban district, and joins Pasig River. Along San Juan River meandering on the hill/plateau, there is a narrow and long alluvium. The alluvium is about 10 m in thickness near the San Juan Bridge, approximately 3.5 km distant from the junction with Pasig River, and mainly consists of silt clay. j Its N value of less than 5 indicates being a soft bed. The boring column chart is shown in Fig. 1-3-3.

Under the alluvium in this lowland underlying the present urban district of Manila, buried valleys formed by Pasig River exist. The alluvium appears to vary greatly in its thickness, but gets deeper uniformly towards Manila Bay.

(2) Hill/Plateau

The Guadalupe formation composing the hill/plateau, as described in details in Chapter 1-3 Lithology is roughly classified into 4 beds; bed of prevailing tuffaceous conglomerate, tufaceous sandy rock, conglomerate, and silt stone.

Each bed declines south-west at the inclination of 2-5°, and different distributions of each bed cause the difference in the present landform.

Each bed can be seen at boring holes in this area, and the N value of higher than 50 indicates a stable base.

However, the tuffaceous sandstone and siltstone in the Guadalupe formation are less consolidated and tend to change to mud when they contain water. A very thin sedimentary bed can be observed along the small and middle rivers engraving the hill/plateau and in depressions on the slope, but ony locally.

The Guadalupe formation composing this area which belongs to soft rock is good as the ground. Since recent local developments results in large scale construction works and a banked-up range is expanding owing to cutting, and special attention to the loosened ground caused by earthquakes and the necessity for drainage facilities seems to be obvious.

(3) Lowland in Marikina River/Laguna de Bay

Because of very little boring information for the lowland in Marikina River/Laguna de Bay, the entire figure of its alluvium is not clear, but fragmentary description is attempted below:

This Guadalupe formation composing the rock bed is cropped out at places on the Marikina River bed near Montalban/Sanmateo in the north-east of the study area, and its sedimentary bed consists of a gravel bed composing the terrace and a silty, extremely fine sand bed. The thickness of the sedimentary bed seems to be approximately 10 mm at maximum, judging from the altitude of the terrace. Since the alluvium consists of the gravel bed composing the terrace and the silty, extremely fine sand bd, judging from the ground condition, it is relatively compacted and stable exlucing cultivated land on the ground surface.

The neighborhood of Mariki in the middle part of this area, where Marikina River bends sharply, is subjected to spill-slooding.

The boring information on the left bank of the bending point of Marikina Rive indicate that the ground is consistent, hard and dense clay-like silt and silty sand from the top layer, with the aveage N value of 20-30. Towards the lower reches from this point, both banks of the bend in the Marikina River form nearly vertical cliffs of several meters of relative height. This suggests similar soil properties.

The boring result in the flood plain in the east of this point shows the distribution of hard and dense silty clay of approximately 10 m in thickness below less than 1 m from the surface layer. The N value of 10-20 indicates a slightly compacted condition, and the Guadalupe formation underlines it.

Therefore, the middle range of this area appears to be in a slightly compacted ground condition, excluding the surface layer.

The boring information at the point 3 km upstream from the nahindan watergate on the right bank of Marikina River indicate silty clay and slity sand with the N value of less than 10 from the ground surface down to approximately 9 m, under which the Guadalupe formation with an N value of higher than 50 lies.

Near the Sepindan watergate in the south of this area, the Guadalupe formation is observed at 2-3 m depths under the ground surface on the hill/plateau side and it sinks gradually deeper towards the Laguna de Bay area. The boring information shows that the upper surface depth of the Guadalupe formation is deeper than 50 m at the point approximately 200 m away eastward from the Napindan watergate.

The sedimentary bed above the Guadalupe formation largely consists of silty sand mingled with gravel, gravel, sand mingled with shellfish, and silty gravel; especially the sand bed with abundant medium size gravel and shellfish prevails.

The N value is 10-30 for the silty sand mingled with gravel, and 10-30 for the sand bed with gravel and shellfish, with an N value of almost 50 at places. The N value of the silty gravel is more than 50.

Since the boring information obtained in this area is limited only to those at point along Marikina River on the west side of the flood plain, the whole figure of the flood plain is not known. However, the soft bed appears to be thin on the whole, although it is rather thick locally in some parts.

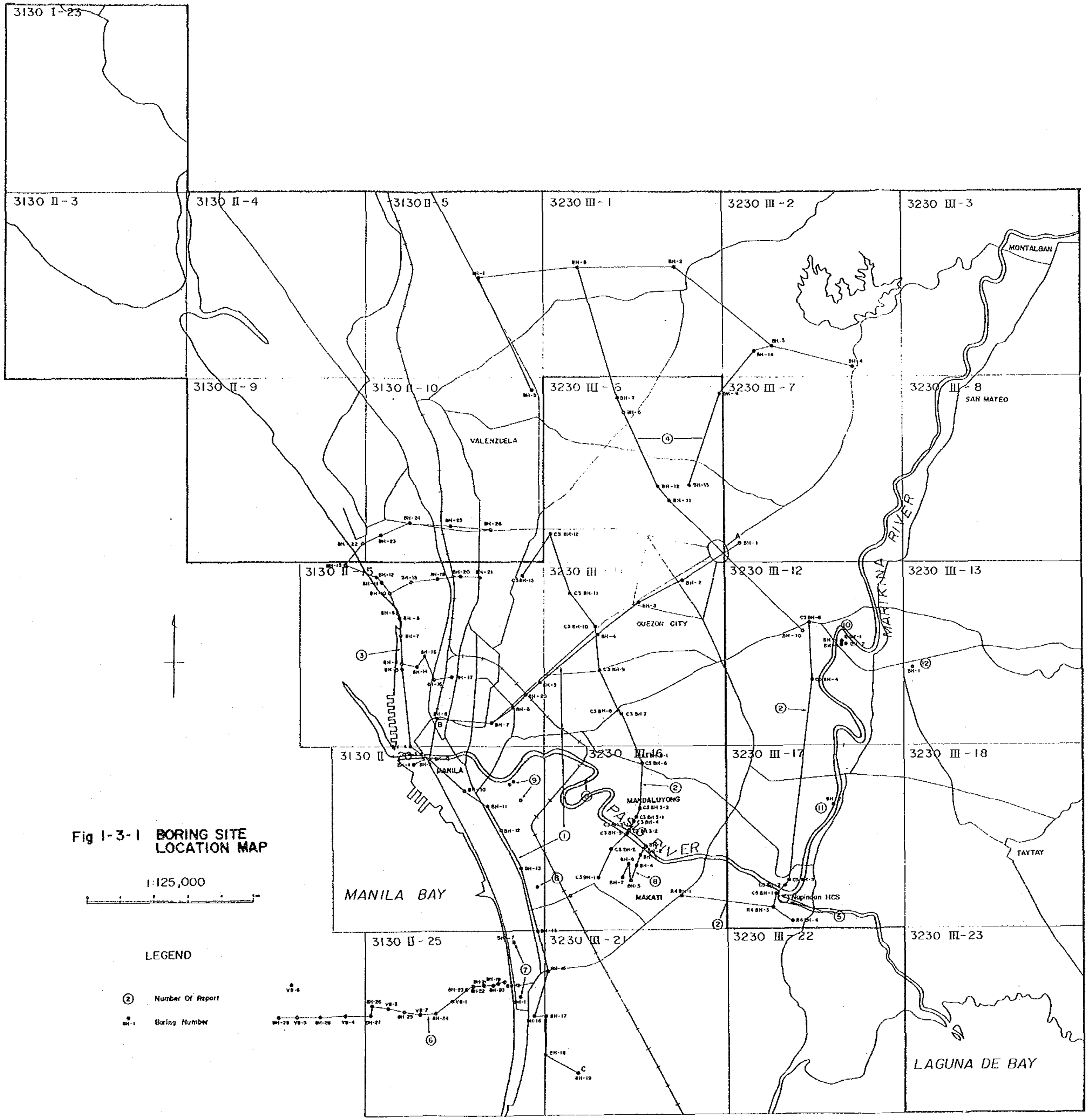


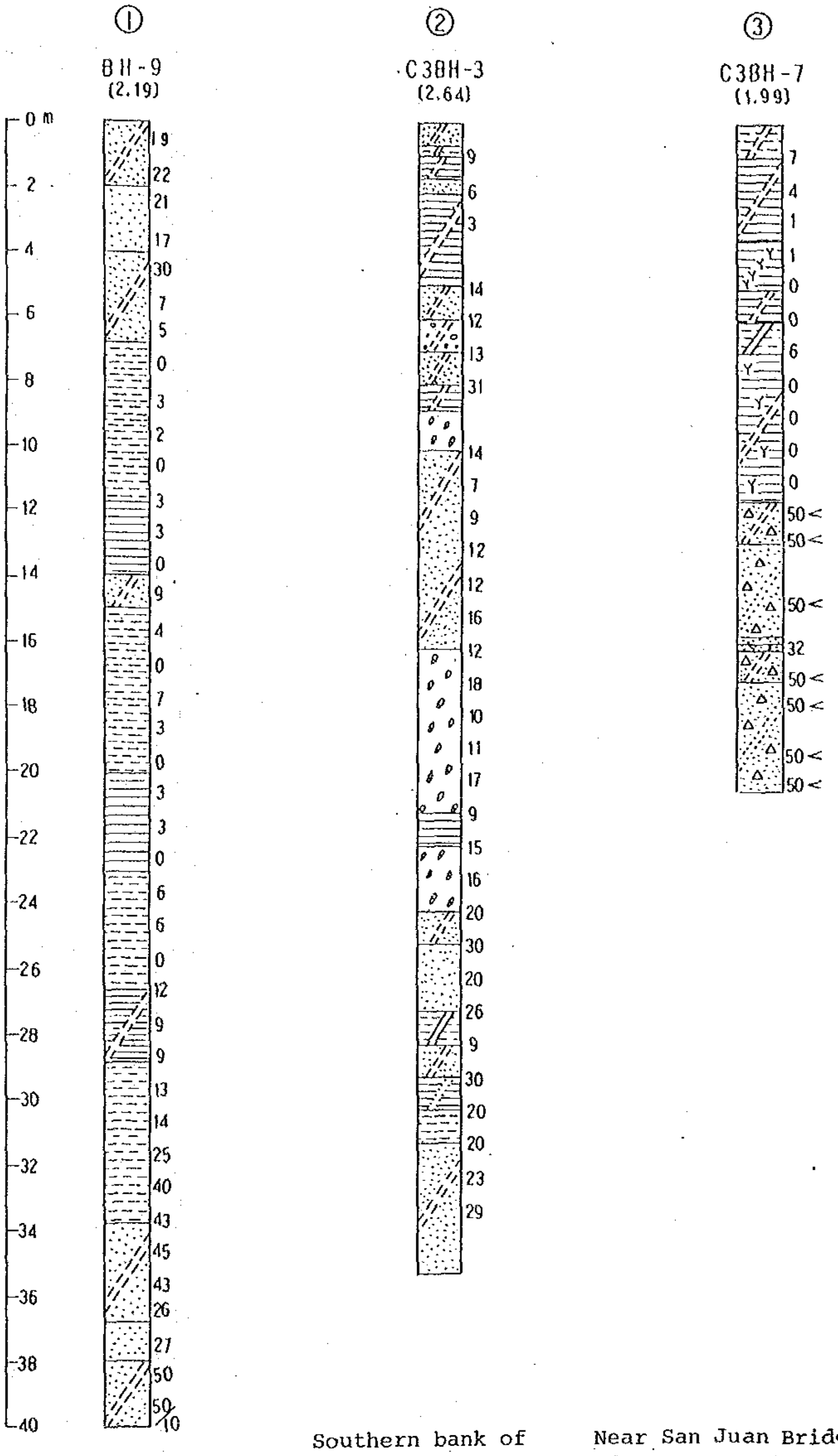
Fig I-3-1 BORING SITE LOCATION MAP

1:125,000

LEGEND

② Number Of Report

• BH-1 Boring Number



South of Pasig River mouth

Southern bank of Pasig River near Mandaluyong

Near San Juan Bridge of San Juan River (3.5 km upper point from confluence with Pasig River)

Fig. 1-3-2 Boring logs

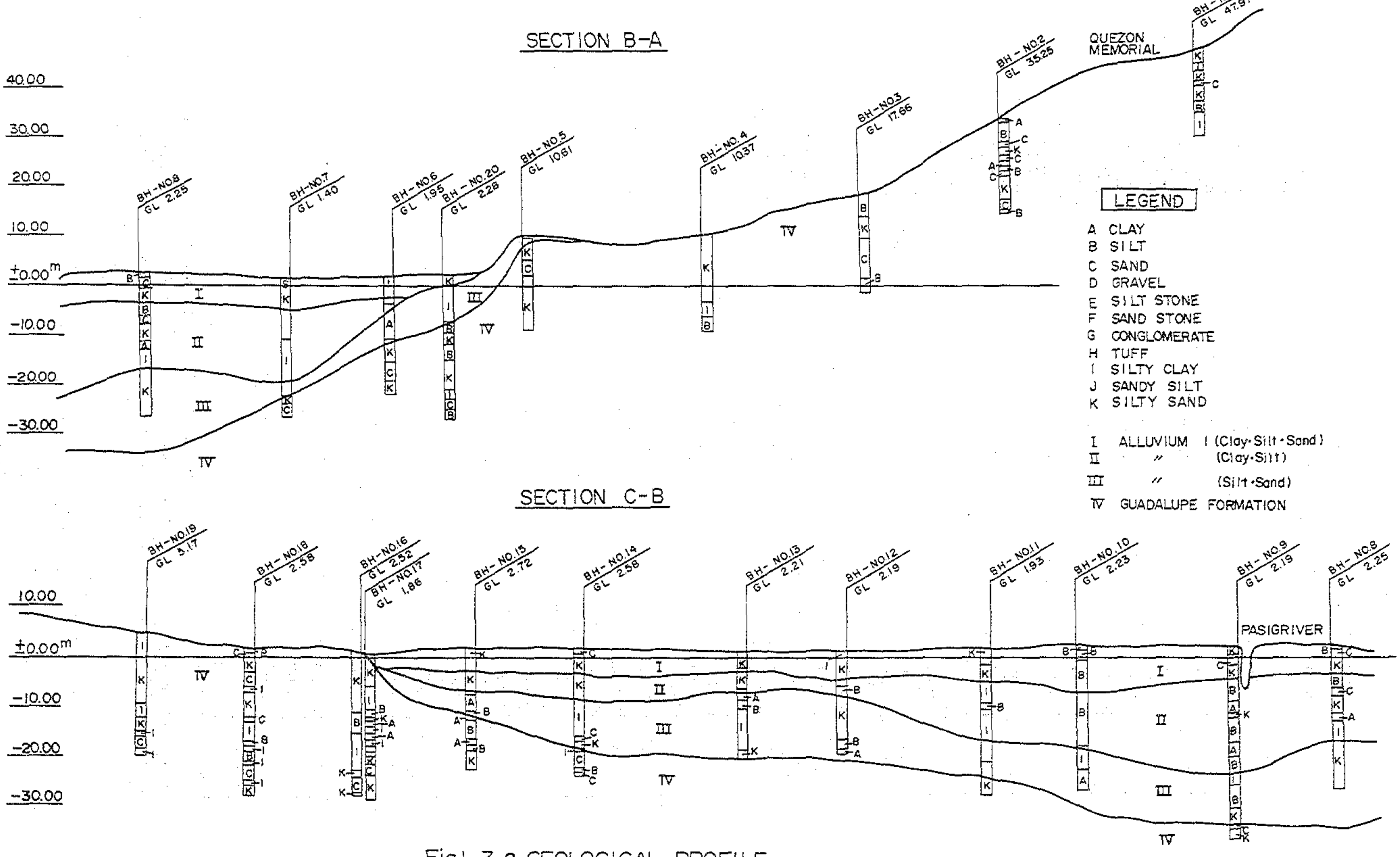


Fig1-3-3 GEOLOGICAL PROFILE

SCALE HORIZONTAL = 1/25,000
VERTICAL = 1/1,000

Source: The feasibility study for Manila rapid transit railway line No. 1.

1-4 Earthquake

The Philippines, located on the west edge of Pan-Pacific, like Japan, has many volcanoes and frequent earthquakes.

In the land condition survey of this time, information concerning earthquakes in the Philippines was collected for understanding of the local environment. The information is outlined below:

Fig. 1-4-1 is an illustration of the incidence of earthquakes from 1949 to 1979.

Areas with high incidences of earthquake are the coastal area in the middle south part of Luzon Island, and the coastal area in the east of Mindanao Island. On the east side of the Philippine Islands, the Philippine Trench and East Luzon Trench stretch along the islands, and the west side area of the trenches form a range with high earthquake incidence.

1-4-1 Recent Earthquakes around Luzon Island

This information was provided by the Philippine Institute of Volcanology and Seismology.

Table 1-4-1 - 7 lists earthquake incidences around Luzon Island.

Numerical figures in Remarks of the table refer to Rossi-Forel scale values, which are compared with Japanese scale values as follows:

Japanese scale	Rossi-Forel scale
0	1
1	2
2	3
2-3	4
3	5-6
4	7
4-5	8
5	9
5-6	10
6	10
7	10
7	10

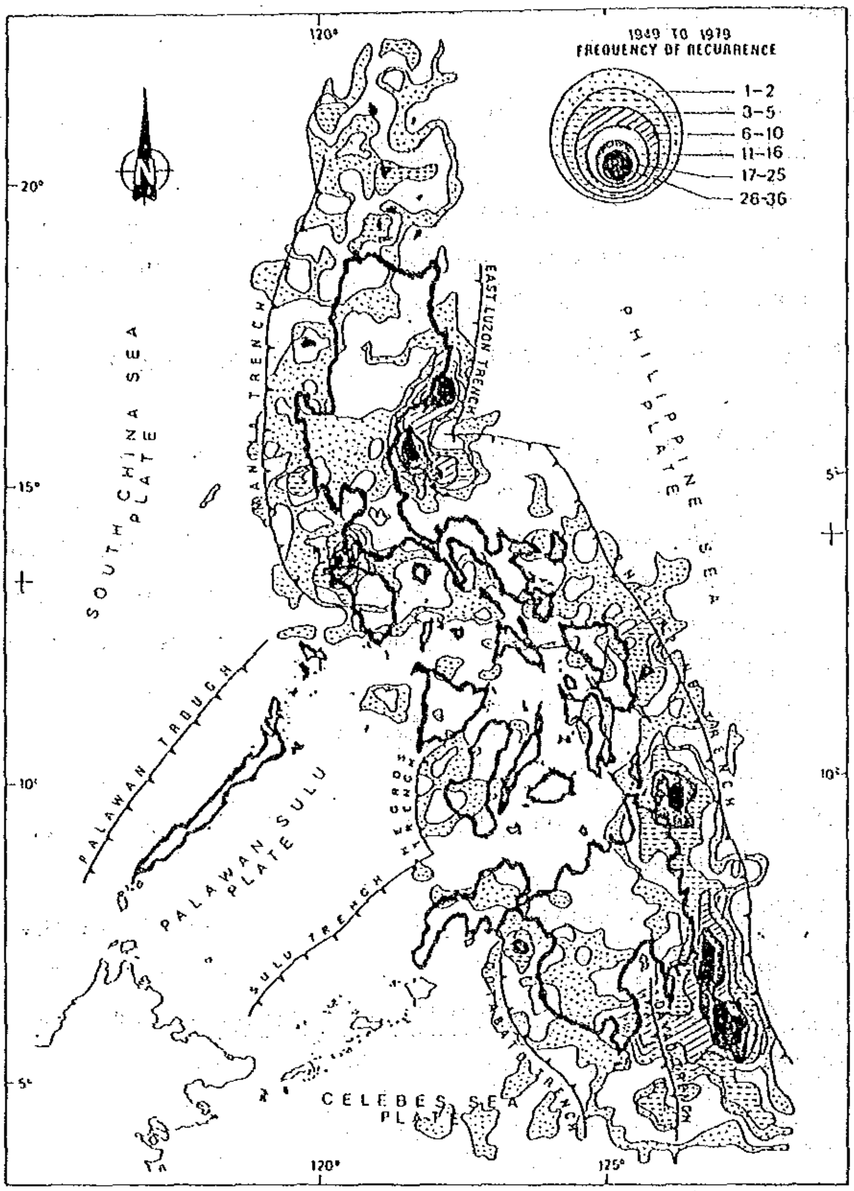


Fig. 1-4-1 Earthquake-prone areas in the Philippines
Source; PHIVOLCS

Fig. 1-4-2 is an illustration of the earthquakes in Table 1-4-1 through 7, which are classified into 3 categories based on magnitude of earthquake.

Fig. 1-4-2 also shows that points with high earthquake incidence around Luzon Island are located on the sea area. These points concentrate especially from the north sea area of Polilio Island in the est sea area to the east coast of Luzon Island. This is consistent with Fig. 1-4-1 Incidence Distribution, and the earthquake an Aug. 2, 1968 which caused serious damage in the manila urban district also occurred in this area.

Table 1-4-1 Earthquake (1)

DATE	ORIGIN TIME	COORDINATES Lat.	Long.	DEPTH	MAGNITUDE (M_B)	REMARKS
1966						
Dec. 20	18-39-59.0	14.3	122.1		5.4	Felt: Alabat RF-VI Manila - V Lucena IV Daet IV Batangas IV Aurora II Baler II Casiguran II
1967						
Jan 05	06-13-56.0	14.8	119.5		5.4	Manila RF-IV Iba IV
Jan 14	13-25-14.0	13.6	120.6		4.9	Manila III
Mar 19	05-55-24.0	13.7	120.6		4.9	Manila II
Sept 10	17-49-22.4	14.8	121.4			Manila RF-VI Quezon City VI
Sept 10	18-15-31.0	14.8	121.1			Manila III
1968						
Aug 01	20-19-21.9	16.5	122.3		7.3	Major earthquake felt widely through out the whole Is. of Luzon. More than 300 persons killed in Manila
Aug 01	20-45-43.0	15.6	122.0			Alabat V Manila III
Aug 01	23.04-57.0	15.5	122.2			Manila II
Aug 03	06-25-42.0	16.5	122.3			Manila IV Baler III Casiguran III Baguio III
Aug 06	03-16-28.7	16.2	121.9		4.8	Manila IV Infanta II Baguio II
Aug 06	14-53-04.6	15.7	121.9			Manila III Baler III Infanta III
Aug 06	23-44-34.7	15.5	121.9		5.1	Manila II Baler II Cabanatuan I
Aug 07	03-53-25.7	15.7	121.9		4.8	Manila II Infanta I

Table 1-4-1 Earthquake (2)

1968					
Aug 09	21-33-56.4	15.9	121.7	4.9	Manila II Baler II Cabanatuan II
Aug 10	16-41-25.4	15.5	121.6	5.4	Manila IV Baler IV Baguio III QC II Cabanatuan II
Aug 13	00-14-58.8	15.6	121.8	5.1	Manila II Baler II Alabat II
Aug 22	16-42-13.9	15.6	121.5	5.2	Manila IV Baler IV Tarlac III Iba III Alabat II QC II
Aug 28	02-42-13.5	15.2	122.6		Manila V Alabat V Baler V QC IV Infanta IV
Aug 29	21-08-08.8	15.9	121.7	5.2	Manila V Baler V Infanta II Alabat II Cabanatuan II
Sept 19	03-48-18.3	14.9	120.1	5.1	Manila III Iba III
Sept 22	22-02-26.4	15.7	121.9	5.3	Baler IV Manila IV QC III Cabanatuan II
Nov 22	08-59-23.1	16.3	122.3	5.3	Manila V Casiguran IV Baler IV Baguio III Infanta III QC II Aparri II Tuguegarao II Alabat II
Nov 22	09-41-16.5	16.3	122.3	5.1	Manila II
Dec 12	15-00-30.0	16.4	122.2	5.0	Manila II Casiguran II
Dec 29	07-15-50.5	13.6	120.6	5.4	Manila IV Calapan II Lucena II Alabat II Batangas II

Table 1-4-1 Earthquake (3)

1969					
Dec 23	14-08-22.0	13.8	120.6	5.3	Manila IV Batangas IV Iba III QC II
1970					
Feb 26	15-50-11.0	13.6	120.6	5.3	Talisay IV Pasay IV Manila IV Calapan III Pampanga III Baguio I QC I
Mar 04	01-17-44.5	13.5	120.4	5.2	Manila III QC III Pasay III Batangas III
Apr 07	05-34-05.6	15.8	121.7	6.4	Major earthquake felt throughout Luzon and Northern Visayas. Maximum Int. of VIII near the epicenter.
Apr 07	05-36-53.0	15.7	121.7	6.4	Manila IV QC IV
Apr 08	08-30-08.0	15.3	121.6	4.7	QC III
Apr 09	00-24-55.0	15.9	122.0	4.8	QC II
Apr 09	04-38-08.0	15.5	121.8	4.8	Manila II
Apr 09	08-43-27.0	15.5	121.8	4.6	Manila III Baguio III QC III
Apr 09	10-08-05.0	15.4	121.7	4.1	QC II
Apr 10	22-04-27.5	15.8	121.8	4.9	Manila II QC II
Apr 11	16-19-03.1	15.8	121.8	4.6	Manila III Baler III
Apr 12	04-01-44.0	15.1	122.1	5.9	Baler V Infanta V Manila V Pasay V QC IV
Apr 12	04-16-57.1	15.1	122.0	5.5	Pasay City IV Manila IV QC III Cabanatuan III Gulod, Batangas II Lucena II Iba II Alabat II Baguio II Tayabas II

Table 1-4-1 Earthquake (4)

Apr 12	04-26-38.5	15.1	122.1		QC III Cabanatuan III Baguio II Iba II Daet II Jomalig, Quezon II Gulod II
Apr 13	08-28-21.8	15.2	122.2	5.2	Manila II QC II Infanta II Daet II
Apr 13	12-52-01.3	15.3	121.6	4.6	QC I
Apr 15	13-14-21.4	15.1	122.7	5.7	Felt widely in Luzon with Intensity of V in Manila
Apr 17	08-31-06.4	15.0	122.6	4.9	QC II
Apr 17	12-37-23.6	15.6	121.8	4.4	Manila II QC II
Apr 17	13-14-55.8	15.1	122.3	4.8	QC I
Apr 17	14-33-59.2	15.0	122.4	4.1	QC I
Apr 22	13-48-53.5	15.3	121.8	5.0	Maniba III Batangas III QC II Baler II
Apr 27	09-43-09.5	15.1	122.1	4.6	QC II
May 06	02-35-17.0	15.7	121.7	5.2	Manila III QC II Pasay II Baguio II Cabanatuan II Alabat II Infanta I
Jun 16	08-09-15.4	15.4	122.0	5.1	Manila III QC III Pasay City II Infanta I
Jun 20	13-03-13.1	15.1	122.3	5.0	Manila III Baler III QC III Alabat II Infanta II Talisay II
Aug 20	14-11-00.1	15.5	121.5		Manila IV Pasay II QC II
Aug 23	09-04-13.3	14.7	120.2	4.8	Bataan I Manila I QC I
Nov 27	22-44-33.8	15.0	122.8	4.7	Manila II QC II Infanta II

Table 1-4-1 Earthquake (5)

DATE	ORIGIN TIME	COORDINATES Lat.	Long.	DEPTH	MAG. (M_L)	REMARKS	
Oct. 1975							
05	12-45-31.67	14.33	121.9	0.0		Felt: Alabat	RF-IV
						San Francisco	II
						Manila	II
08	10-27-34.31	14.02	120.11	0.0	4.4	Manila	RF-III
						Ambulong	III
						Quezon City	II
						Bagac	II
						Tayabas	II
Feb. 1976							
13	10-33-43.56	14.00	120.13	0.0	5.4	Pasay City	RF-IV
						Manila	IV
						Quezon City	IV
						Ambulong	III
						Tayabas	II
May 05	01-16-25.26	13.52	120.06	0.0	4.0	Manila	RF-II
						Quezon City	II
July 02	04.23-14.13	13.85	120.7	50.0		Manila	RF-II
						Quezon City	I
Sept. 22	09-08-55.4	13.80	120.7	50.0	4.2	Manila	RF-III
						Pasay	II
						Ambulong	II
						Quezon City	I
Nov. 27	04.1302.30	13.68	120.13	50.0	3.7	Manila	RF-III
						Quezon City	II
Jan. 08, 1977	06-40-59.32	15.29	122.16	0.0	4.6	Manila	RF-III
						Alabat	III
						Baler	III
						Baguio City	II
Feb. 13	04-06-56.52	16.00	120.47	0.0	4.3	Manila	RF-III
						Quezon City	III
Apr. 19	05-09-14.02	15.12	122.68	132.9	4.5	Manila	RF-II
						Quezon City	I
						Daet	I
Feb. 07, 1978	07-35-43.79	13.74	119.65	0.0	4.1	Manila	RF-III
						Bagac	II
						Quezon City	I
Mar. 18	04-44-26.17	15.6	121.7	69.6	4.2	Manila	RF-III
						Baguio	II
						Baler	II
						Quezon City	I

Table 1-4-1 Earthquake (6)

Mar. 31, 1978	03-22-13.16	14.63	119.62	0.0	4.5	Bagac	RF-II
						Manila	II
Apr. 17	19.14-56.06	15.17	122.06	7.5	4.4	Manila	RF-III
						Quezon City	II
Jun. 28	04-51-34.36	13.62	119.94	8.8	5.1	Manila	RF-II
						Bagac	II
Feb. 03, 1979	12-06-34.8	14.3	119.9	50.0		Manila	RF-II
						Iba	II
Aug. 11	18-25-11.10	13.66	119.86	50.0	4.6	Manila	RF-II
						Tayabas	I
Nov. 21	12-08-33.8	13.99	120.0	65.4	3.8	Alabat	RF-II
						Manila	I
						Quezon City	I
Mar. 31, 1980	12-41-47.12	16.04	121.88	50.0	5.1	Casiguran	-VI
						Manila	V
						Baguio	V
						Baler	V
						Cavite	V
						QC	IV
						Daet	IV
						Ambulong	IV
						Dagupan	IV
						Tarlac	IV
						Infanta	III
						Iba	III
						Tuguegarao	III
						Pasuquin	I
Apr. 02	18-52-15.82	16.1	122.22	96.7	4.7	Casiguran	III
						Baler	III
						Manila	III
						Bayombong	III
						QC	I
Sept. 19	08-45-48.1	13.85	120.88	50.0	4.9	Calatagan	IV
						Bagac	IV
						Manila	III
						P. Galera	II
						Quezon City	II
Apr 11, 1981	05-29-32.09	14.28	118.98	77.3	5.0	Manila	IV
						QC	III
						Pasuquin	II
						Santa, IS	I
May 01	11-54-35.91	13.25	120.61	0.0	4.3	Manila	II
						QC	I
Jul 22	18.31-35.26	14.7	119.94	49.7	5.0	Manila	IV
						Iba	IV
						Bataan	IV
						Pasay City	III
						Baler	II
						Santa, IS	II
						Pasuquin	I

Table 1-4-1 Earthquake (7)

Aug. 01, 1981	07-09-10.31	14.95	119.75	120.0	4.6	Quezon City	RF-I
Nov. 17	21-31-01.53	15.34	121.22	64.8	4.3	Calumpit	RF-IV
						QC	III
						Baler	III
						Baguio City	III
						Bagac	III
						Manila	II
						Muñoz, NE	II
Sept. 12, 1982	02-29-01.17	14.05	120.24	52.4	3.7	Manila	II
						Quezon City	II
Dec. 29	14-05-36-57	14.66	119.81	66.8	4.8	Manila	RF-V
						Bagac	V
						Subic	V
						QC	IV
						Baguio City	III
						Ambulong	II
						Alabat	II
May 28, 1983	21-25-58.51	15.49	121.8	33.0	4.1	Manila	RF-II
Apr 24, 1985	16.15-11.0	15.3	120.6		6.4	Manila	RF-IV
						Baguio	IV
						Santa, IS	IV
						Pasuquin	III
						Callao, Cagayan	III
						Quezon City	III
May 27	06-22-22.7	15.35	119.87			Manila	RF-IV
						Iba	II
						Baguio	IV
						QC	II

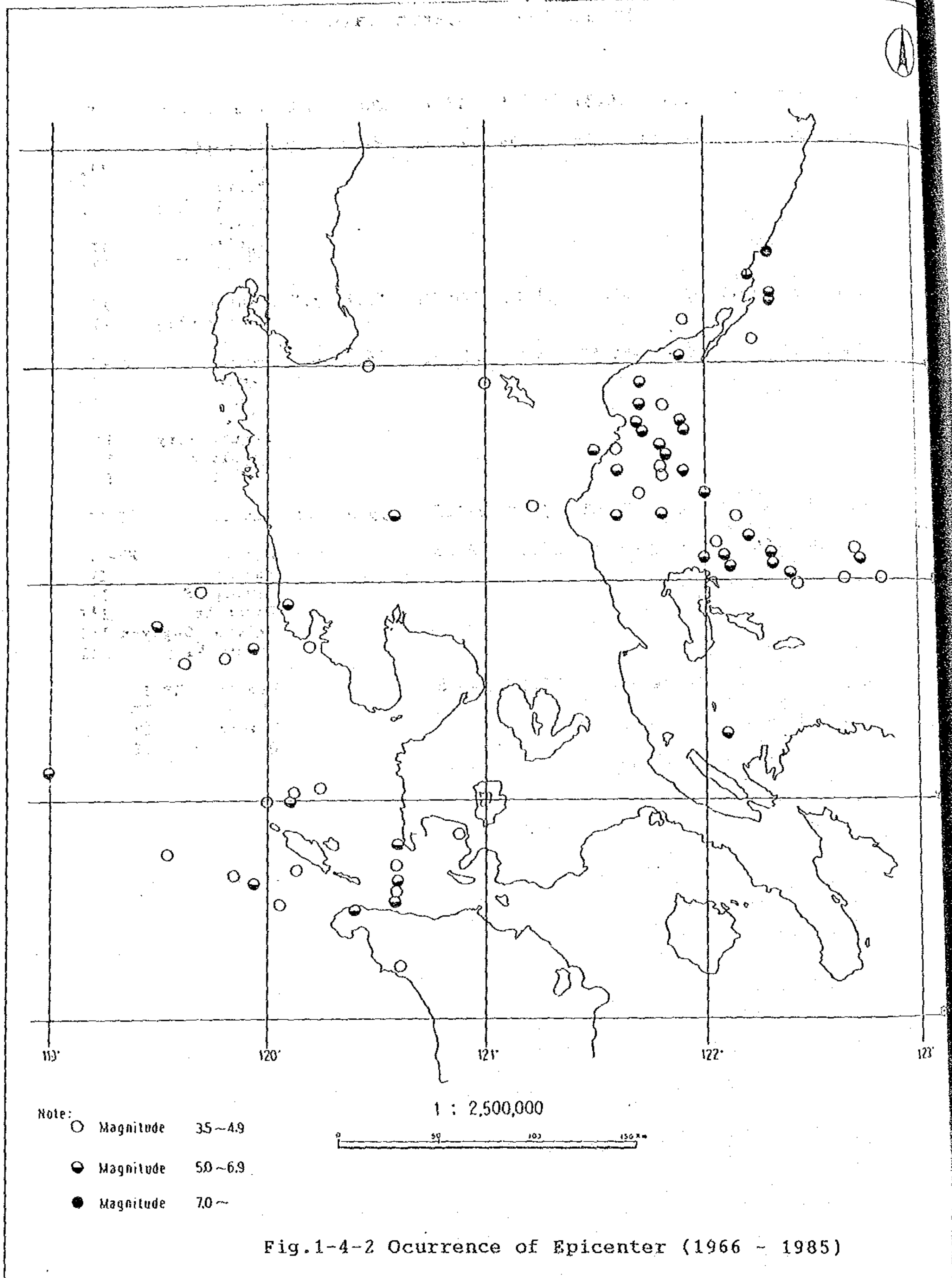


Fig.1-4-2 Ocurrence of Epicenter (1966 - 1985)

1-4-2 Earthquake of 1968

This material provided by the Office of Civil Defense is a report prepared by UNESCO just after the earthquake on Aug. 2, 1968.

Around 4:0 on Aug. 2, 1968, a violent earthquake hit Manila City. The seismic center is near Kasigren Town in Aurora Province approximately 230 cm est from Manil, and the seismic scale was Magnitude 7.3. The seismic intensity on Rossi-fores scale was 8 within 50 km radius from the seismic center, 6 in Manila 230 cm away from the epicenter, and 5 in Quezon City, Pasai City, makati and other cities in the periphery of Manila.

The seismic intensities in major cities mainly in Luzon Island are summarized in Fig. 1-4-3. The seismic damages include collapse of buildings, ground fissures, and landslides mainly in Manila and Aurora Province, at the seismic center. In Manila, especially, collapse of buildings resulted in heavy casualties.

The damages are summarized in Table 1-4-8 trough 10.

The location of Ruby Tower JApartment shown in Table 1-4-10 is given in Fig. 1-4-4.

(1) Landform/geology of the Manila urban district

The landform of the Manila urban district is flat land with an altitude of -3 m above Manila at low tide level. The elevation of the surface gets gradually higher near the suburbs on the gently sloped plateau.

The Manila Bay area which has been reclamated since 1898 has the ground water level of -1.8 m to -14 m in the dry season. The ground watr level began to drop at the time of the earthquake which hit in rainly season.

The coastal area including the Manila urban district where most severely damaged buildings were concentrated is covered with an alluvium with different of thicknesses.

In this report, too, the lithology of the coastal area is divided into the following 5 beds based on the boring information and soil property test information:

Bed I ------ Sand/silty sand containing shellfish

Bed II ----- Dark grey slity clay, and clay-like/sandy silt with shellfish

Bed III ---- Silty clay/clay with dark gey to black organiz matter. This is observed at -14 m to -25 m.

Bed IV ----- Grey consolidated silty clay/clay prevailing bed.

Bed V ------ Brown tuff and is weathered materials.

Of the beds listed above, Bed I through Bed IV are comosed a soft alluvium, which would have great impact on an earthquake. Impact of Bed IV is not know bcause only limited data is available. However, it is said that the thickness of the aluvium in this area can be determined based on the presence of Bed V.

The ground condition of this area is, as already described in 1-3 Ground; clay/slt/sand, and gravel which is sedimented material of delta located on the tuffaceous rock bed composing the plateau on the east side of the coastal area. The thickness of each bed varies locally, but roughly speaking, the area is grouped into a sand/silty sand bed several meters below the surface, a clay and clay prevailing bed of 10 m - 20 m in thickness, a silty sand bed, and an underlying tuffaceous bed rock of several meters - more than 10 m in thickness.

Buildings shown in Tale 1-4-10 which were surveyed for damage were concentrated in the estuary area covering Pasig River. This clearly indicates deposition of the thick loose and poorly consolidated clay/clay prevailing bed.

On the othr hand, damage to buildings built directly on the tuffaceous bed rock, such as in Quezon City, Macati, and Mandarin was very minor.

(2) Fault and assumed graben

Analysis of boring information at the Pasig River mouth and a field investigation at Macati District, and a photogeological survey by serial photograph was conducted to identify the fault and the graben which has been said to exist under the Manila urban district in "The geology of Greater Manila and its Bearing to the Catastrophic Earthquake of August 2, 1968 (Generosa R.OCA) Report".

The boring information of the Pasig estuary suggests sinkage of the wide and shallow tuffaceous bed rock but no sharp dip exchange point of the bed rock.

The outcrop in the macati district indicates the presence of a fault, which is assumed to start at this point or pass the point. Furthermore, slickenside and Munion structures can be seen, which prove that the horizontal movement is greater than the vertical one, but a relation with the fault of the Pasig estuary is not clear.

The photogeological survey was carried out using available serial photos, but eventually failed to discover other geological structures.

In the study area, as described in Paragraph 1-1-3, many NE-SW oriented fault and NW-SE linear structure are observed in Marikina Valley and its surrounding, and the existence of NW-SE oriented fault under Manila City can not be denied.

Future detailed analysis of ground of the Metro Manila is expected.

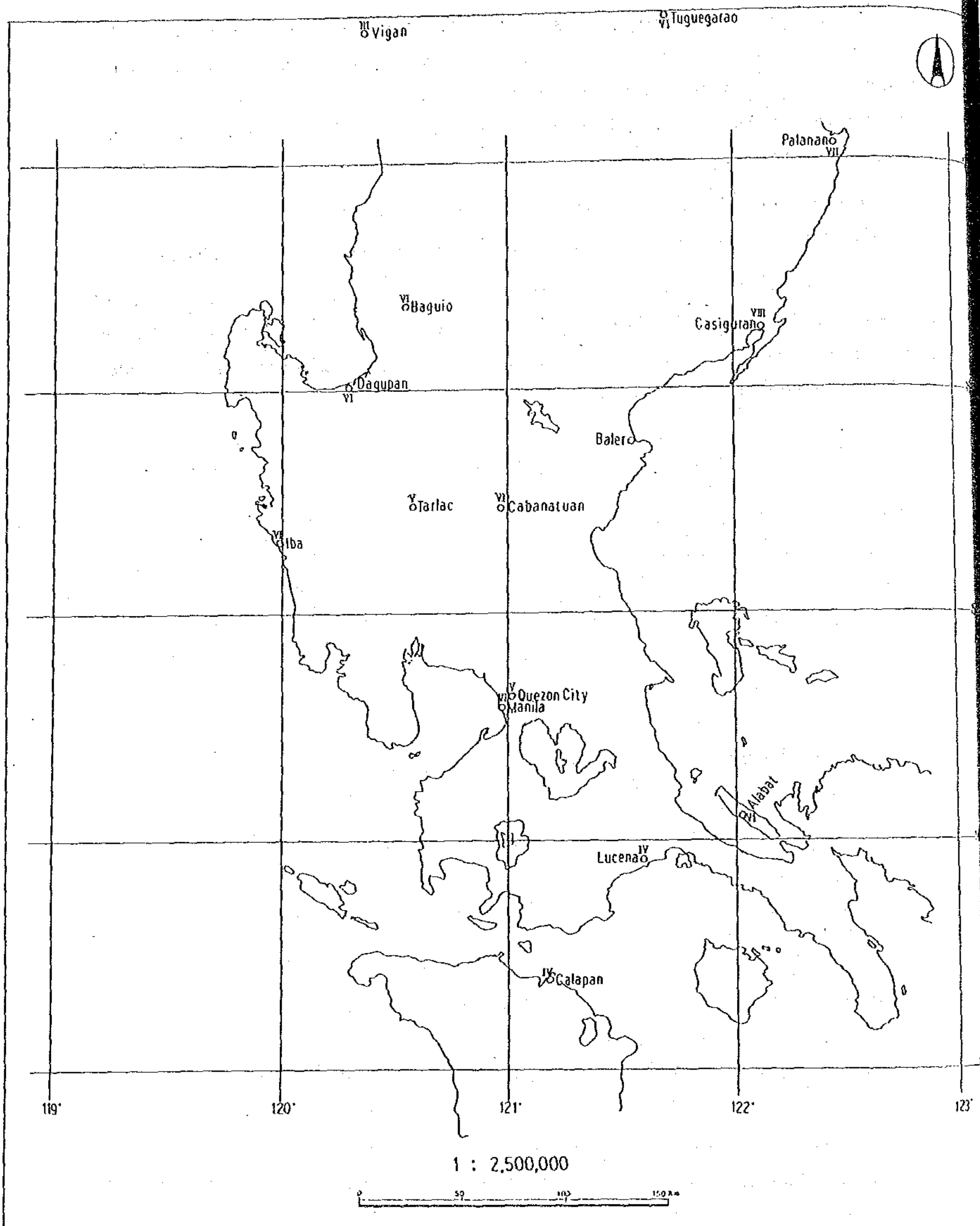


Fig.1-4-3 Seismic Intensity Map (August 2 1986)

Table 1-4-2 Disaster

Place	Number of Persons Killed	Number of Persons Injured
Manila (Ruby Towers)	268	260
Manila (Sta-Ana Tenement-Houses)		1 (Female)
Aurora Sub-province	1 (Child)	
Guagua, Pompanga	1	
Total	270	261

Table 1-4-3 Damages of Public Buildings

A. Greater Manila Area			
1. National Buildings	Costs (₱)		
Meternity and Children's Hospital	160,000.00		
National Library Building	250,000.00		
The Philippine Veterans Building	50,000.00		
Buildings for Electrical Works	52,000.00		
29 Others	163,000.00		
Damage not yet Assessed (Probable)	100,000.00	Total	775,000.00
2.			
Pier 9-passengers Terminal Bldg.	2,800,000.00		
Nine Other Items	254,000.00	Total	3,054,000.00
B. Provinces			
1. Aurora Sub-Province			
Damage to Government Bldg., Roads Bridges and Private Properties			
Damage in other Areas	460,000.00	Total	460,000.00
2. Batangas			
Abutments of Four Bridges	80,000.00		
Other Items	191,000.00	Total	271,000.00
C. Other Cities			
Cabantuan City (three bridges)	180,000.00		
Tagayatay City (Buildings and Highways)	50,000.00	Total	330,000.00

* 4.80 Pesos = ¥U.S. 1

Tale 1-4-4 Damages of Major Buildings

No.	Name	Age Yrs	Location	No. of Storeys	Bays	Damage
1.	Ruby Tower Apartments	3	D. Jose	6	11 x 7	Collapsed
2.	Philippines Bar Association	2	C. Aduana	6	6 x 3	Very Severe
3.	Aloha Theatre	1	Dasmarinas	8	-	Very Severe
4.	Tuason Bldg.	19	E. Scolta	6	5 x 4	Very Serere
5.	Trinity Bldg.	9	T.M. Kalaw	7	6 x 4	Severe Local
6.	Diamond Tower Apartments	3	Magdalena	11	11 x 2	Moderate
7.	Liwayway Hotel	33	Echague	9 (One basement)	-	Severe
8.	National Library	10	T.M. Kalaw	6-9 (H = 24 m)		Local
9.	Old Philippine National Bank	50	Muelle D.B. Nacional	7		Severe
10.	Boie Bldg.	18	Escolta	7	9 x 6	Moderate
11.	Araneta and Tuason Bldg.	9	Muelle D.B. Nacional	8	8 x 3	Moderate
12.	Development Bank of the Philippines	19	Muelle D.B. Nacional	8 (H = 34 m)	5 x 6	Moderate
13.	Phoenix Bldg.	8	Escoletos	7	12 x 4	Slight
14.	La Tondena Bldg.	1	Echague	8	1 x 5 (18m)(6.5m)	Severe Local
15.	New Philippine National Bank	2	Escolta	12	8 x 3	None
16.	Yo Chin Lim & Sons Bldg.	-	D. Jose	4	5 x 4	None
17.	Overseas Passenger Terminal	-	Pier 9	3	-	Severe Local
18.	Metropolitan Cathedial	20	C. Aduona	-	-	Damage to Cupola

No.	Name	Age Yrs	Location	No. of Storeys	Bays	Damage
19.	F.E.U. (Far Eastern University)	-	Quezon Blvd.	7	-	Moderate

The report concludes the absence of any fault or graben under te Manila urban distict.

However, as described in 1-1-3 Geological Structure, many NE-SW faults and many NW-SE lineations crossing at righ tangles are recognized mainly in Marikina Valley in the study area, and so the presence of the NW-SE fault under the Manila urban district cannot be denied. Very detailed ground survey and analysis is desilable in Metro Manila.

1-5 Ground Water

This information was excerpted from "Ground Water Development manila Water Supply II" prepared by metropolitan Waterworks and Sewerage System.

1-5-1 Conditions of Ground Water

Under natural conditions the ground water reservoirs of the Greater Manila Area (GMA) were recharged perennially by precipitation on the outcrop area which extends north, east and south of the GMA into the foothills of the enclosing mountain ranges.

The trend of ground water flow is; from the mountain foot and the plateau to Manila Bay and laguna de Bay.

The quality of natural ground water is generally inorganic and slightly alkaline. The total amount of dissolved solids (TDS) ranges between 200 mg/l and 250 mg/l. The chloride content is less than 15 mg/l. An exception is; the ground water in lowlands with shallow aquifer system TDS and the chloride content are 500-1000 mg/l and more than 200 mg/l, respectively.

The recent intensive development of the Manila Bay aquifer system has resulted in a drastic change in the ground water level.

Fig. 1-5-1 illustrates the decline of the ground water level from 1955 to 1981 in Metro Manila. The decline of the ground water level spreads over entire Metro manila; in particular, the area from Valenzuela north of Manila to the urban district of Quezon City, and the area from Sucat south of Taguig to Makai - Marikina recorded 150 - 130 m or 12 - 5 m of the annual average. However, districts in Manila where pumping of ground water and ground water supply have been discontinued for a sanitary reason are excluded.

By 1981, the ground water level of nearly all Manila Bay aquifer sytems dropped down below the sea water level, to more than 100 m in major centers where pumping is made. The decline of ground water leads ot sea water intrusion in coastal areas as a result of altered flow of ground water. This situation is very clear in result of water quality analysis.

Fig. 1-5-2 presents the chloride content in ground water in Metro Manila. The area with more than 200 mg/l in this figure is roughly grouped into two; the area along Manila Bay and the area along the north-west coast of Laguna de Bey.

The area along Manila Bay extends 1-2 km away from the sea coast over Cavite City, Las Pinas, Paranaqua, Pasay-Pasig estuary, and Malabon. Around Manila International Airport, it extends towards the indland.

The area along Laguna de Bay covers a wide range mainly around the junction of Marikina River and Pasig River, from Cainta in the north and the Makati district along Pasig River in the west, to TAguig in the south.

Another area stretches narrowly from Sakt on the bank of laguna de Bay to Manila International Airport in the north-west direction.

Fig. 1-5-3 shows the ratio of conductivity, which presents chloride density. A higher value indicates a higher chloride density.

In this figure, the area with more than 1,000 micromho/cm ratio of conductivity exists along Manila Bay and along the north-west coast of laguna de Bay, similarly to the distribution range of chloride content of more than 200 mg/l showsn in Fig. 1-5-2. The area with more than 3,000 micromho/cm is; northwardly in the area along Manila Bay, Pinas, Paranque, Pasay City- Manila South Port, and Malabon, and in the area along laguna de Bay, the junction of Markina River and Pasig River, Pasig and the pateros district.

These results prove sea water itrusion along Manila Bay and the north-west area of Laguna de Bay in Metro Manila.

Intensive pumping of ground water along Manila Bay has destroyed the natural ground water systems, resulting in sea watr intrusion into the aquifer system. This has lead to salification of the further inland area.

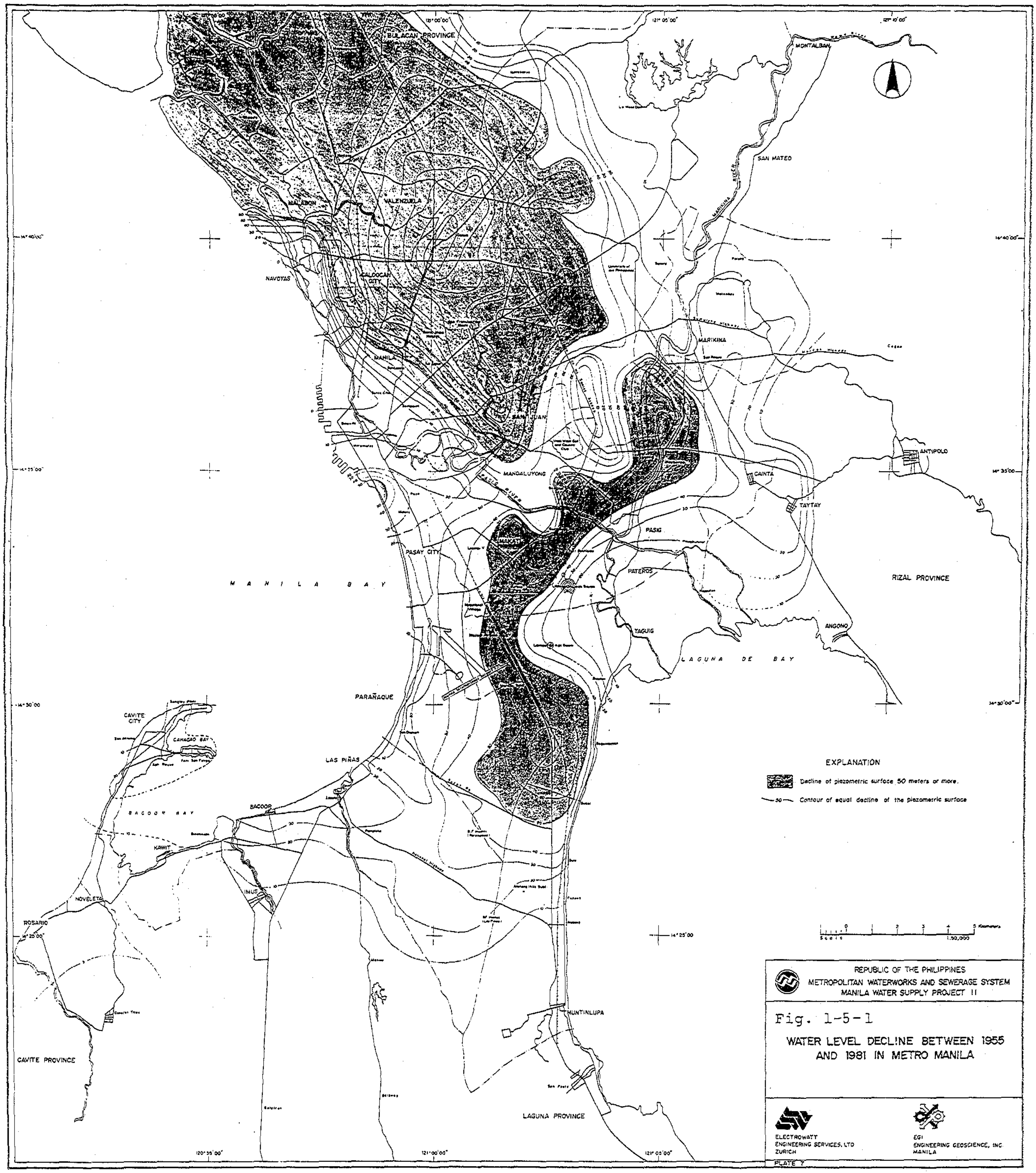
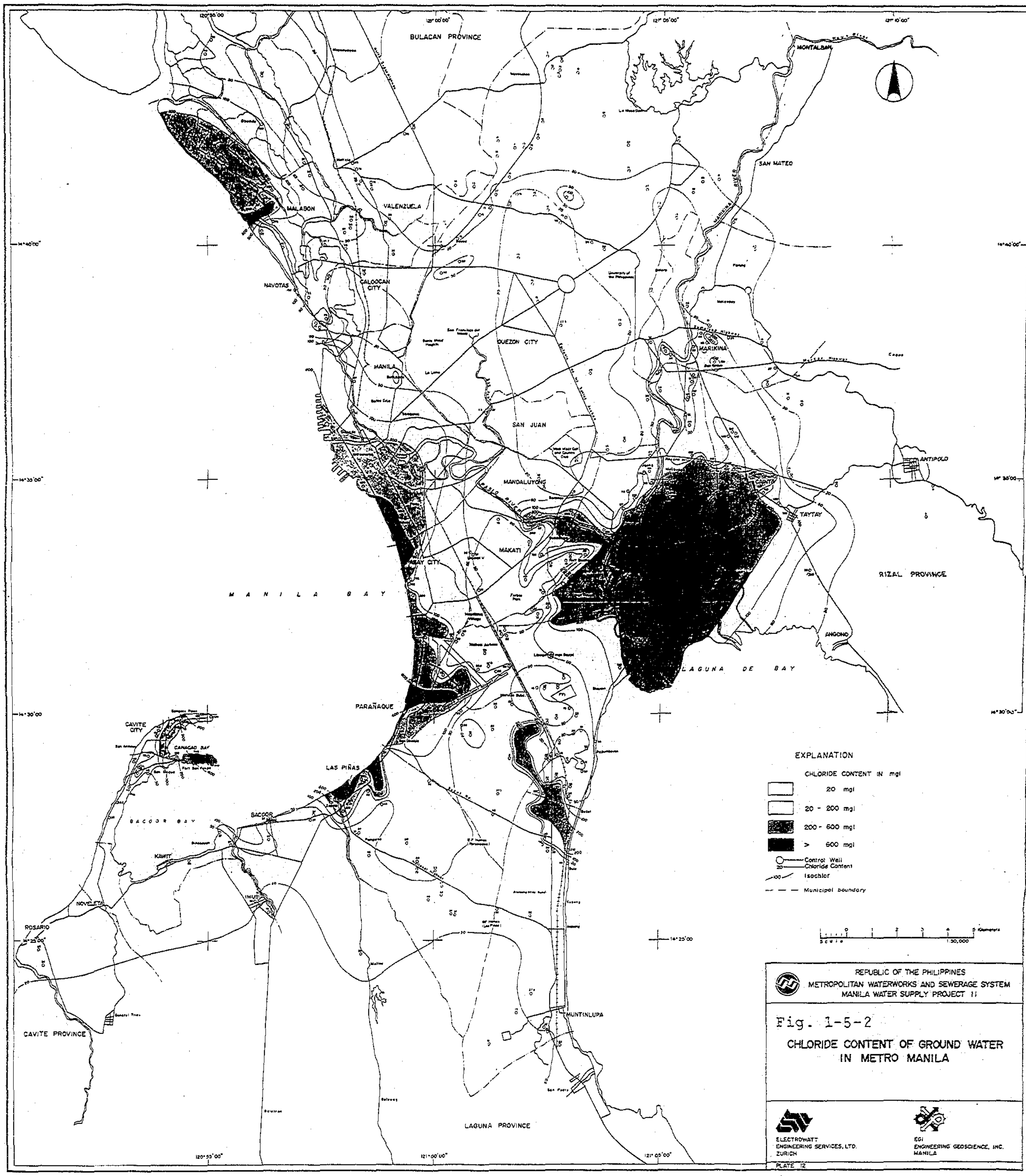


Fig. 1-5-1 WATER LEVEL DECLINE BETWEEN 1955 AND 1981 IN METRO MANILA


EXPLANATION
CHLORIDE CONTENT IN mg/l
20 mg/l
20 - 200 mg/l
200 - 600 mg/l
> 600 mg/l
Control Well
Chloride Content
Isochlor
Municipal boundary
REPUBLIC OF THE PHILIPPINES
METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM
MANILA WATER SUPPLY PROJECT II
Fig. 1-5-2
CHLORIDE CONTENT OF GROUND WATER
IN METRO MANILA
ELECTROWATT
ENGINEERING SERVICES, LTD.
ZURICH
EGI
ENGINEERING GEOSCIENCE, INC.
MANILA
PLATE 12
BULACAN PROVINCE
RIZAL PROVINCE
LAGUNA DE BAY
LAGUNA PROVINCE
CAVITE PROVINCE
MANILA BAY
BACOOR BAY
CANACAO BAY
MONTALBAN
SAN MATEO
MALABON
VALENZUELA
NAVOTAS
CALOOCAN CITY
QUEZON CITY
MARIKINA
MANILA
SAN JUAN
ANTIPOLO
MANDALUYONG
TAYTAY
MAKATI
ANGONO
PARAÑAQUE
CAVITE CITY
LAS PIÑAS
BACOOR
KAWIT
NOVELETA
IMUS
ROSARIO
MUNTINLUPA

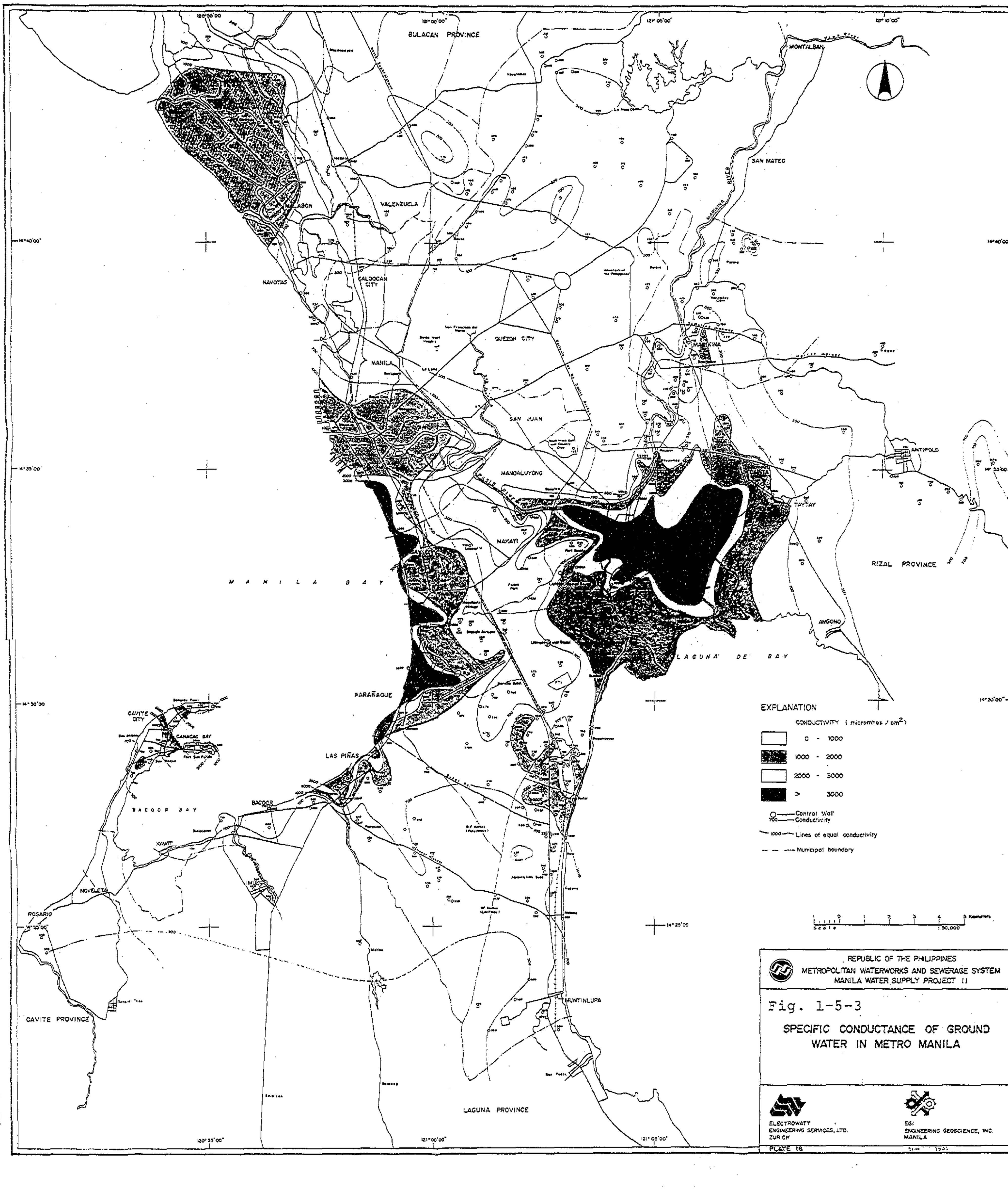


Fig. 1-5-3
SPECIFIC CONDUCTANCE OF GROUND WATER IN METRO MANILA

Salification at the junction of Marikina River and Pasig River along the north-west bank of Laguna de Bay is; both the distribution of more than 600 mg/l chloride content and that of 3,000 micromho/cm ratio of conductivity show the spred of salification from the junction of Marikina River and Pasig River to Laguna de Bay. This seems to reflect the landform/geological history of the area along Pasig River; the area along Pasig River being a former sea area was a section connecting Manila Bay and Laguna de Bay, and sedimentation and upheaving lead to the present landform, and present Pasig River is a tidal river.

The belt area stretching north-ewest from Skat in the south to Manila International airport seems to have been affected by the geological structure.

Thus, in Metro Manila, salification of ground water haw taken place in the lowland along Manila Bay and the lowland on the lower reaches of Marikina River. In other areas including Cavite Province on the hill/plateau, Quezon City and the middle to upper reaches of Marikina River, and the mountain foot/hill around Antipolo City, ground water of good quality is obtained.

The ground water of Metro Manila, mainly in lowland area, is degraded by sea water intrusion. For this problem MWSS has already programmed several countermeasures which are also necessary for future development.

Those include closing of sea water intruded wells, standardizing and guidancing of specifications for construction of wells and institutionalizing of approval for construction.

The potential users in industry, commercial and other, who have not consumed water porvided by MWSS until now, are predicted to be consumers of MWSS in future. Therefore, the main source of water that is needed in the urban area will be ground water in future.

1-6 Volcanoes

1-6-1 Distrivution of Volcanoes

The Philippines is a country hit frequently by two major geological disasters earthquakes and volcanoes.

In 1951, a catastrophic glowing could druption broke out at Tobock-Tobock Volcano in Kimigin Island, north of Mindanao, resulting in heavy casualities (500 persons killed).

This disaster led to the establishment of an organization for volcanic disaster prevention in the fiture, the present Philippine Institute of Volcanology ad Seismology.

The Philippines ha 220 Quaternary volcanoes including 21 assumedly active ones. Detuin and Liy (1982) classify the Philippine Islands into 4 major volcanic belts. (See Fig. 1-6-1.)

(1) West convex volcanic belt (the west part of Luzon Island).
(2) East convex volcanic belt (from south-east Luzon to Samar/Dabao).
(3) West volcanic belt (Negros/Panai)
(4) South-west volcanic belt

As seen in Fig. 1-5-1, these volcanic belts relate to sinkage of plates in the Manla trench, the Philippine trench, the Negros trench, the Cotabato trench, and the Sulu trench.

Among these trenches in the periphery of the Philippine Islands, the Philippine trench is subjected to the most active plate sinkage, with annual plate movement of 8 cm westwardly. Bicol Volcanic Series (east convex volcanic belt) is the most active volcanic series closely relating to this trench.

The Philippines has currently 21 active vaolcanoes, of which 5 volcanoes, Tar, Mayon, Bulsan, Caraon and Hybock-Hybock, repeat volcanic activities at relatively short intervals (8~50 years).

Recent major volcanic eruptions include Hybock-Hybock Volcano in 1952, Tar volcano in 1977, and Mayon volcano in 1984.

Of active volcanoes distributing over the whole country, Tar Volcano which is likely to have the greatest effect on Metro Manila, is described in the next section.

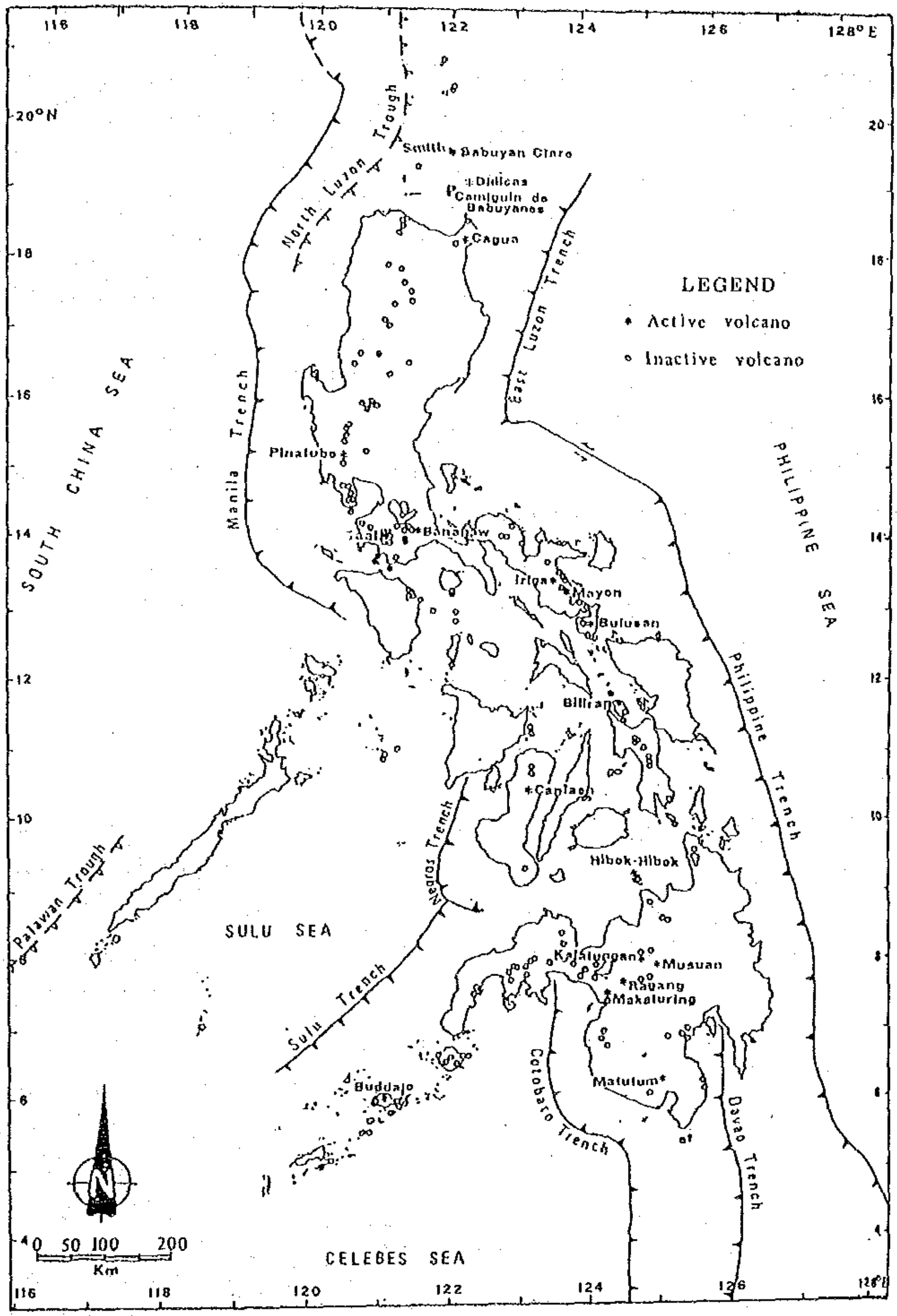


Fig. 1-6-1 Distribution of active and inactive volcanoes in the Philippines

Source; PHIVOLCS

1-6-2 TaalVolcano

(1) Volcanic landform

Taalvolcano located approximately 60 cm south of Manila has an area of 23 cm^2, surrounded by fresh water carderas (see Fig. 1-6-2).

TaalVolcano is the lowest altitude volcano in the world; the highest elevation on the south-west edge of the major crater is only 311 m above sea level.

TaalVolcano was formed through several eruptions. It consists of a least 35 cones, and has some 47 craters or concaves.

The major crater located in the center of the volcanic island has a diameter of approximately 1.9 km. Within the crater being a calm and bluish green lake, a small island of approximately 100 m^2 projects from the lake surface of the major crater.

This islad is a trace of eruption of the major crater. Past records indicate 12 eruptions of the major crater between 1749 and 1911.

The veolent reruption of 1965 around Mt. Tabaro changed the landform of this periphery by 1969 because of ejecta and lava flow (see Fig. 1-6-3).

(2) Lithology

The 35 cones composing Taal Volcano were formed through different volcanic formation processes. Of the 35 cones, 26 are tuffling cones, 5 are pyroclastic cones, and 4 are maars.

The most characteristic sediment in TaalVolcano is a wide base surge in the south-west part. Other sediments are mostly pyroclastic rock, volcanic bomb, clastics, lapilli, and volcanic ash.

The major rock composing Tar Volcano is pyroxene basalt accompanying olivine with a silica content of 51.66%.

(3) Eruption of tar volcano

As of ;1984. TaalVolcano recorded 33 eruptions since the earliest one in 1572. During this period, the most violent eruptions broke out in 1754 and 1911.

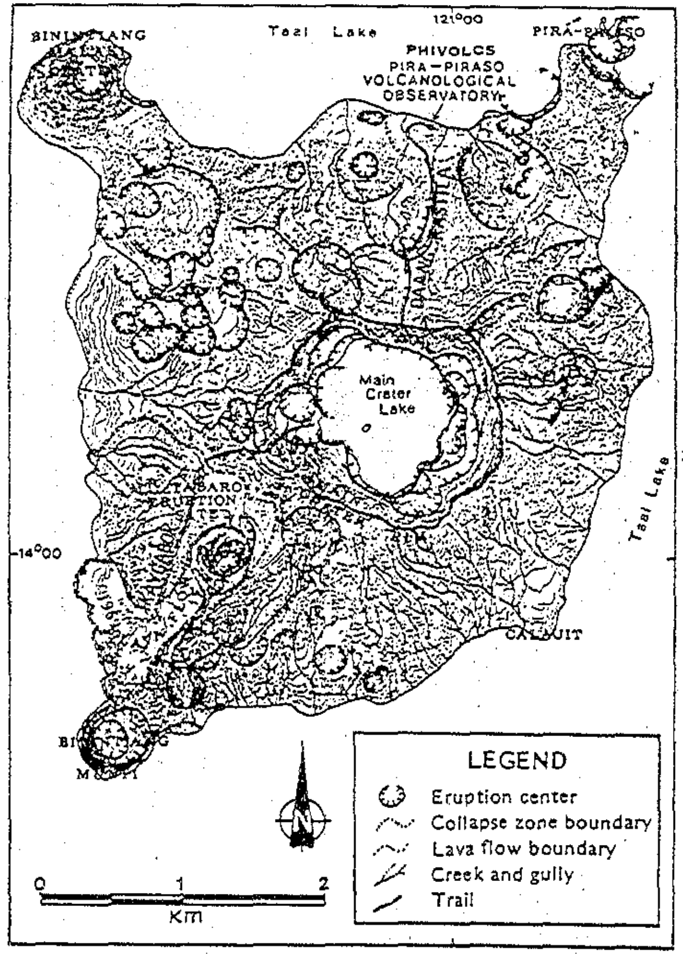


Fig. 1-6-2 Map showing eruption centers at Taal Volcano Island (R.S. Punongbayan and H.B. Ruelo, 1985). Source; PHIVOLCS

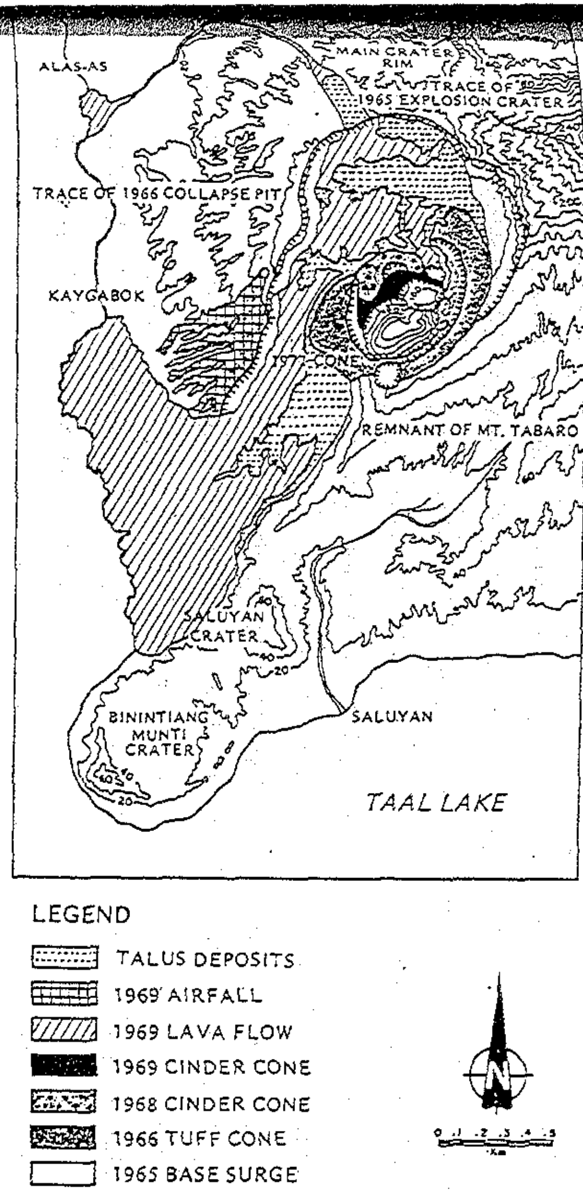


Fig. 1-6-3 Geologic map of Mt. Tabaro eruption site (H.B. Ruelo, 1983) Source; PHIVOLCS

The erupton of 1754 destroyed the old towns of Sara, Lipa, Tanauan, and Tarisai.

The eruption of 1911 destroyed the whole area of the volcanic island with 1334 killed people. Volcanic ash which erupted from the central crater reached Manila, covering an area of 2000 km^2. The form of the volcano suggests phreatic explosion or phreatomagmatic explosion.

After the eruption from the central crater calmed down, a second eruption started in Feb. 1965. Its crater was near Mt. Tabalo, about 11 m south-esat of the central crater.

The eruption around Mt. Tabalo broke out every year after 1965, and the eruption of 1968-1969 which blew up lave from several craters and from the based of the crater ws of the Stromboli type.

The eruption near Mt. Tabalo was very violent until 1969, but since then it seems to have getten gradually calmer and calmer. A very tight monitoring system is still required.

1-7 Soil

1-7-1 Soil Distribution

With respect to soil, the Bureau of Soils provided "Soils/Phisiography Repot (1980)", based on which soil distribution in the study area is briefly described.

Soil in the study area is divided into geological units called land systems confirmed in the land resources evaluation survey of Metro Manila, and illustrated in a 1/125,000 scale land system map (Fig. 1-7-1).

Landscape and soil properties are described for ech geological subdivision in the study area.

(1) Active tidal flats

The present active tidal flats include water covered or submerged marsh and soft land. In the study area, they are seen along the coast of the north-west part of Manila and in the coastal lowland in Kabaite Province south of Manila.

The soil ranges from dark greyish brown and dark greyish green to dark greyish yellow, and from clay/silty clay, sandy loam, and fine sandy loma to loamy sand, with organic matter locally.

The altitude is within the range of 0 m to 1.5 m. The land use type was previously marsh of mangrove and nipa, but presently the land has been altered to fish farms and soil beds.

(2) Former tidal flats

Former tidal flats ae slightly higher than the present tidal flats and located deeper in the land. Backmarshes and depressions of the coastal landform were formed by ocean currents and marine sediments.

The former tidal flats are slightly lower than the alluvial plain at the altitude of 2 m to 5 m, with an inclination of 0-1%.

The soil is deep and consists of clay and silty clay loam to sandy loam containing humus in the bottom layer.

The former tidal flats are poorly drained and subjected to seasonal effects of flooding. This landform includes microrelief centering around the Manila urban district, and extending from Marabon in the north and Navotas toBulacan, Pasig City in the south, and the coastal area of Kabite.

The land use of this landform was previously paddy field and cultivated land, but the recent development of the metropolitan area has lead to land development for factories and houses. At present, paddy field and cultivated land are patly left in the north of Manila.

(3) Freshwater marshes

Fresh water marshes distribue widely around Pampanga Delta in the north-west of the study area, and are also seen along Laguna de Bay within the study area.

The freshwater marshes in laguna de Bay are observed along the delta of the river flowing to Laguna de Bay.

The soil is fine loamy (silty clay loma, sandy loamy to loamy sand), and very porrly drained.

However, during dry season with low water levels rice and vegetables are cultured in small areas.

(4) Broad alluvial plain

A broad alluvial plain spreads very widely, covering nearly horizontal or gently sloped flood plains, natural levees and backmarshes. Its inclination range is 0-2%.

The broad alluvial plain is further divided into the groups shown below:

a) Landform slightly affected by flood

b) Landform moderately or fairly affected by flood

c) Landform with good drainage

d) Landform with slightly poor drainage

e) Landform with poor drainage

The classification above is applied to the aluvial plains within the study area, as follows:

1) Maycauayan area in the north of Manila

This area corresponds to (d) Landform with slightly poor drainage. The soil is clay and silty clay, and its depth is approximately 50 cm to 150 cm or a little more.

This small landform surface is slightly poor in drainage, but very fertile.

2) Montaluban/Sanmateo area in the north-east of the study area

Topographically, this area is more elevated than the present river bed, and its soil is within the range between clay silty loam and clay with the depth of 60 cm to 150 cm or a little more. This area has a very gentle inclination, and for the most part falls into (c) landform with good drainage.

3) Cainta/Taytay area in the north of Laguna de Bay

The soil is basically clay with a depth of more than 150 cm. The drainage of the soil is slightly to extremely poor, and of group (c). However, the soil is fertile.

(5) Minor alluvial plain, fan terrace, and isolated inland valley

This area distributes near Angano on the north bank of Laguna de Bay within this study area. Topographically, this area is an alluvial surface with poor drainage formed between hills. The soil is dark brown to dark grey silty clay to clay.

(6) Undulating low degrated tuffaceous plateau

This landform is composed of a slightly elevated tuffaceous plateau covered with a very shallow oil layer, and overlaid by the east part of the Manila urban district to Quezon City.

The soil of 10-15 cm in thickness is dark grey to bluish brown silty clay, and weathered volcanic tuff is observed under the soil layer. The surface of this landform has been totally urbanized because of recent development activities.

(7) Undulating slightly dissected tuffaceous plateau

This landform occupies the area extending from the northern part of Quezon City to the basin of Lamesadam Reservoir.

The soil of 10-130 cm in thickness is dark brown to reddish dark brown clay loam to clay, with a small amount of consolidated material and tuff gravel on the soil surface.

This landform with poor drainage and low fertility is slightly eroded.

The land use is forest and grassland in the basin of La Mesa Reservoir, while the remaining grassland has been very quickly developed for housing.

(8) Gently undulating moderately dissected tuffaceous lower piedmont

This landform extends from Novaliches in the north of Manila to Karaon. Topographically, it is composed of a low ridge accompanying small and middle erosional valleys and gentle slopes.

The soil is clay to silty clay, and shallow at some parts and thick at other parts (80-100 cm).

The drainage is good in general, but poor at some parts along the major rivers. In the land used for housing, there are orchards and bamboo forests on the gently undulating slopes and low ridges; the soil is shallow with low fertility.

In the gentle valleys, where the soil is thick and fertile, paddy rice is produced using rainwater to by irrigation.

(9) Lower volcanic foothills and ridges with narrow intervening valleys

This landform is the hill/mountain on the east side of the study area.

The soil is slightly shallow to deep (90-150 cm), and dark brown to dark reddish brown clay loam to clay. Outcrops are found at places on the surface. Its natural sfertility is low because of easy runoff of nutrients.

The soil is slightly acid (pH 5.0-5.4), with good drainage.

Mango is cultured in the lower foothills and ridges, where ipil-ipil and scarce second growth are found.

Grassland with bush, banana, and partial second growth is seen on the slopes.

(10) Complex volcanic mountains

This landform is the mountains on the east edge of the study area. The soil is shallow (mountain slopes) to slightly deep (foothill slopes). The soil is loam to clay accompanying clay loam and gravel, with occasional boulders.

The soil color varies greatly, from dark greenish brown to dark reddish brown.

The major landuse is primary growth/secondary growth and grassland.

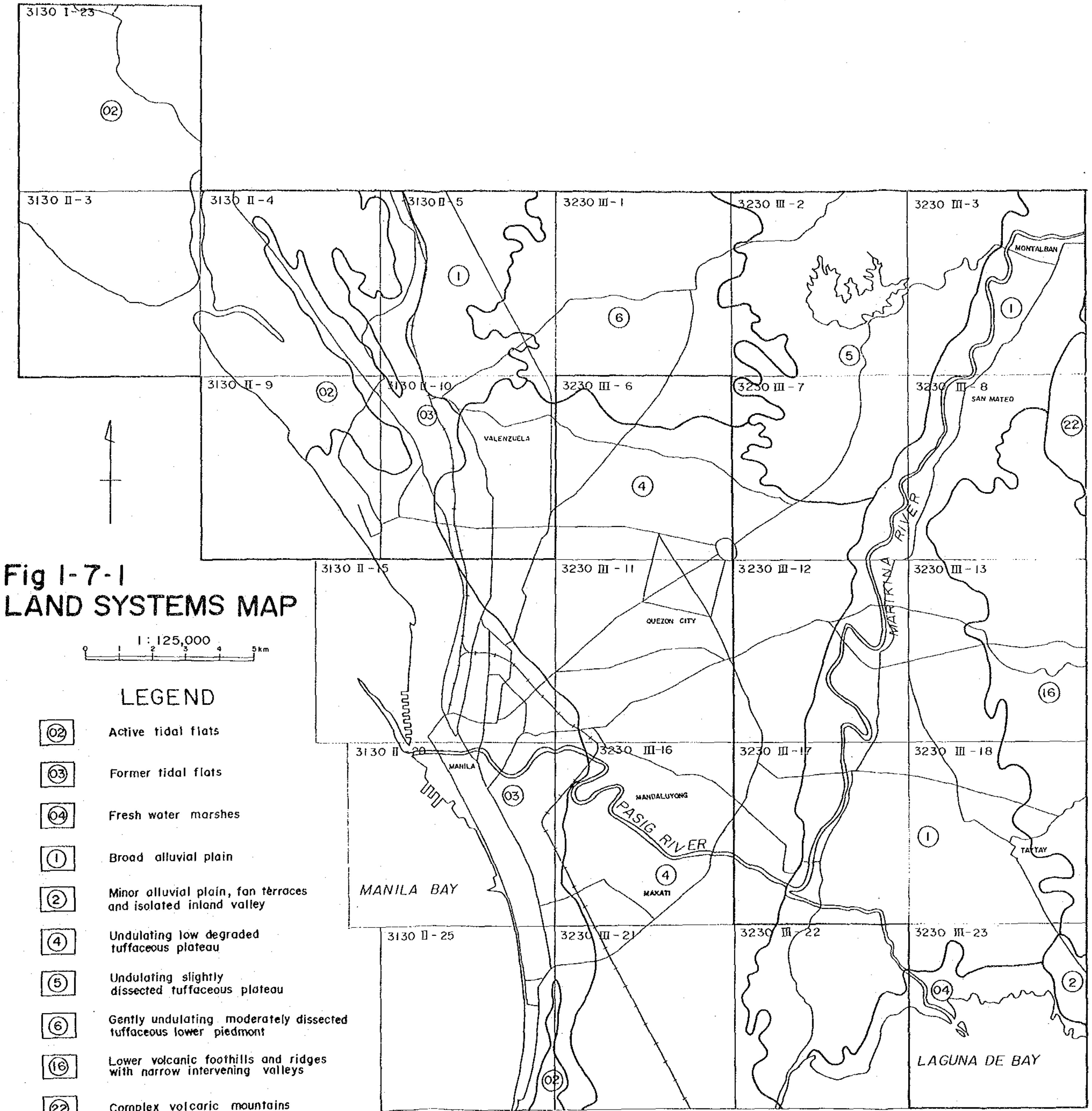


Fig I-7-I
LAND SYSTEMS MAP

1 : 125,000

0 1 2 3 4 5km

LEGEND

(02)	Active tidal flats
(03)	Former tidal flats
(04)	Fresh water marshes
(1)	Broad alluvial plain
(2)	Minor alluvial plain, fan terraces and isolated inland valley
(4)	Undulating low degraded tuffaceous plateau
(5)	Undulating slightly dissected tuffaceous plateau
(6)	Gently undulating moderately dissected tuffaceous lower piedmont
(16)	Lower volcanic foothills and ridges with narrow intervening valleys
(22)	Complex volcanic mountains

Source : BUREAU OF SOILS

2. Request by the Philippine Government and I/A

2-1 Request Letter

REPUBLIC OF THE PHILIPPINES
MINISTRY OF NATIONAL DEFENSE
Bureau of Coast and Geodetic Survey
421 BARRACA ST., SAN NICOLAS, MANILA

1372

27 March 1984

The Minister
National Economic Development Authority
Pasig, Metro Manila

Attn: The Director
External Assistance Staff

Sir:

We have worked out a project proposal to establish a graphic information base for Metro Manila with the Metro Manila Commission (MMC). This proposal will provide the Commission with plans for integration of all development projects envisioned for the area.

In this proposal our Bureau (BCGS) shall undertake the establishment/acquisition of data vital to the preparation of the resulting plans. MMC shall be the recipient of the end results, but shall closely coordinate and cooperate with BCGS during the implementation of the project. As the BCGS had already had a technical cooperation with the Japan International Cooperation Agency (JICA) and has the necessary expertise and facilities, we are proposing this project in the hope that we can contribute to the development of Metro Manila. This arrangement had already been approved by the BCGS and MMC.

In this regard, we are submitting for your approval and endorsement the attached project proposal for the "ESTABLISHMENT OF A GRAPHIC INFORMATION BASE FOR THE NATIONAL CAPITAL REGION" with assistance from the Government of Japan through the Technical Cooperation Scheme of JICA.

Respectfully yours,

ANTONIO P. VENTURA
Commodore, BCGS (Ret.)
Director

TERMS OF REFERENCE
FOR THE ESTABLISHMENT OF A GRAPHIC INFORMATION BASE
FOR THE NATIONAL CAPITAL REGION

I. BACKGROUND

The National Capital Region (NCR), which includes Metro Manila is the nation's political capital and also the economic and social center. As such, its problems are unique. Unlike other regions which have to attract both public and private investments for their growth and development, the NCR, as premier urban center, has to disperse its functions. The overall strategy is to fully develop the Regions potentials without prejudice to the growth and development of the other regions. Only those activities which the other regions are not capable of doing as yet will be undertaken by the Region. In line with the foregoing, the Metro Manila Commission (MMC) have made the ten-year Regional Development Framework Plan (RDFP) 1983 - 1992 which is an integrated physical, economic and social plan for the NCR. It shall serve as a guideline to all development plans concerning the Region. The RDFP for 1983 - 1992 indicates a general strategy for the growth and development of the Region. It necessarily has to outline detailed development guidelines for the different sectors such as Infrastructure, Services and Utilities. It is not a definitive policy document and hence must be reviewed and updated periodically.

The projects, which have been operated individually in the past years, are short of acting in concert with each other so that comprehensive programs seem not to have been conducted efficiently.

The ten-year plan must be made up of programs taking concerted action to avoid doing the fault of the past. It is then extremely desirable to use a standard information base for monitoring and achieving plans on a comprehensive visual point. Accordingly, such an information base must be kept up-to-date and technically reliable. These informations will be collated in such a way that it can compatably be inputed to a computer, once this is made available.

A great deal of merit can also be obtained by enchancing the scope of the information base for specific geographic themes. For the time being, it is desired that the following themes are separately highlighted and made to be responsive to the needs of city planning: existing conditions of buildings (purpose, structure, decrepitude), classification of land (governmental or private), administrative boundaries, existing conditions of development and other physiographic characteristics of the Region.

For the establishment of the proposed graphic information base the participation of different government agencies would be harnessed. The ground survey and the production of the graphic information plans shall be undertaken by the BCGS, in view of its previous experiences in JICA assisted mapping project at the Cagayan Valley and in the UNDP Expanded Assistance for Central Map Production.

It is the intention of the project to put together all the information for consolidation of an Office in the NCR which has close coordination with both the national government and the 17 local governments. This will ensure that the data generated will be used by different units operating in the regions for their different purposes in planning, project development andp project implementation. It is envisioned that the office of the Commission for Planning Metropolitan Manila Commission will collate and store these information for easy access and retrieval of other user agencies.

II. OBJECTIVE:

The object of this proposal is to establish a graphical information base in the National Capital Region for the use of the government and private sector.

Base Information Plan	: scale of	1:10,000
	area of	1,500 km^2
Land Use Plan	: scale of	1:10,000
	: area of	1,500 km^2
Land Condition Plan	: scale of	1:10,000
	: area of	1,500 km^2

III. SCOPE OF WORK:

1. Control Survey and Base Information Plan

Base on existing materials and control points, additional minor control points (both horizontal and vertical) survey, and field classification, the base plan preparation and printing shall be done,

Scale	1: 10,000
Size of Sheet	3' x 3'
Number of Sheets	64

2. Land use survey

Base on new plan, other source materials and field survey, actual land use plans are to be made by surveying the residential areas, commercial areas, industrial areas, agricultural areas, etc. Elements from the actual land use plans shall be scanned by automatic scanner and inputed into a new land use plan.

3. Land Condition Survey

Base on new base plan, other source materials and field survey, land use plan manuscripts are made by surveying to show the natural condition of lands, detailed elevation of terrain and other physiographic characteristics.

IV. PHILIPPINE CONTRIBUTION:

The Philippine Government will provide the survey team with the following convenience, facilities and services for the smooth and effective implementation of the project.

1. To establish principal horizontal and vertical controls in the area.
2. To supply the existing materials in the area which have already been compiled by BCGS for this project.
3. To undertake field identification and field survey in cooperation with the Japanese Survey Team when necessary.
4. To exempt from custom duties, taxes and charges of any kind with respect to equipments including vehicles, machinery, materials, personal effects and medical supplies which are deemed necessary for implementation of the project.
5. To supply available data and information related to the project.
6. To arrange for smooth transfer of data and materials to Japan and the Philippines for the purpose of executing the project.

7. To secure flight permission for aerial photography related to the project when necessary.

8. To secure permission for the use of communication facilities including transceivers and electromagnetic wave distance measuring meters (EDMs).

9. To secure permission to enter into private properties and the restricted areas and cutting of trees when necessary.

10. To secure the necessary arrangement for the safety of the survey team.

11. To arrange for hiring local staff as needed.

12. To arrange for the availability of medical facilities when necessary.

13. To provide the counterpart Philippine Government personnel consisting of a project coordinator and technical staff, when necessary.

14. To provide credentials to the members of the survey team for the execution of their activities.

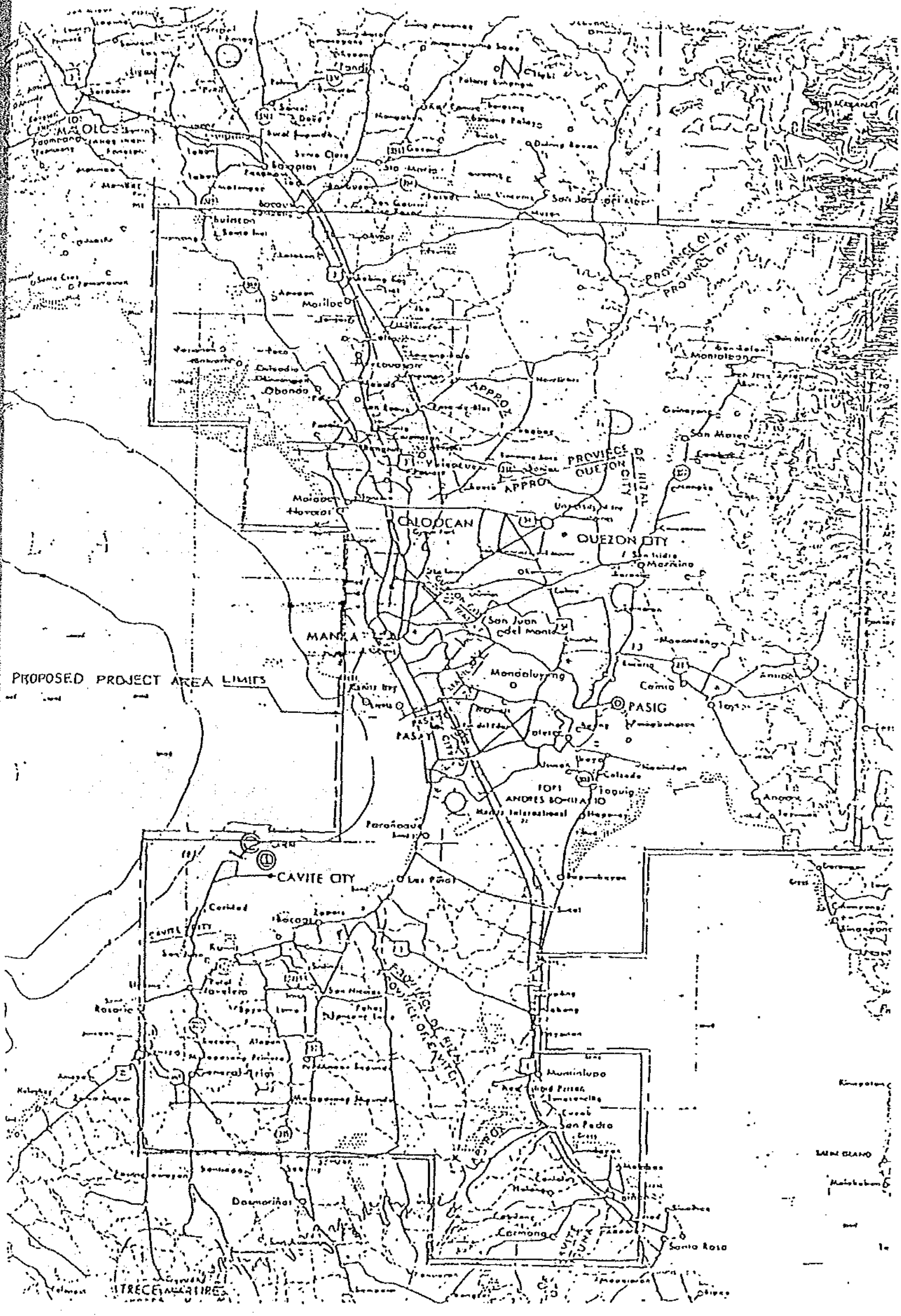
15. To gather hydrographic information of rivers and waterways.

16. To collect and provide information regarding administrative boundaries, geographical names and road classification.

17. Survey of restricted areas will be undertaken by BCGS and declassified prior to submission.

V. SCHEDULE:

	First Year	Second Year	Third Year
Base Information Plan			
Land Use Survey			
Land Condition Survey			


MALOLOS
CALOOCAN
QUEZON CITY
MANILA
San Juan del Monte
Mandaluyong
PASIG
PASAY CITY
PROPOSED PROJECT AREA LIMITS
CAVITE CITY
Muntinlupa
San Pedro
Carmona
Santa Rosa
Dasmariñas
TRECE MARTIRES

14 September 1984

Mr. YOSHITAKA MOTODA
The First Secretary
Embassy of Japan
Buendia Ave. Ext.
Makati, Metro Manila

S i r :

In connection with our telephone conversation, we are sending you the attached listing of our requirements for the Proposed Project on the Establishment of a Graphic Information Base at the National Capital Region (Metro Manila).

We hope this will be of help in the final assessment of our proposal. Please call on us anytime for any further information or data needed.

Very truly yours,

ANTONIO P. VENTURA
Commodore, BCGS (Ret.)
Director

RBF/ggg
Encl: a/s

PROJECT PROPOSAL FOR THE ESTABLISHMENT OF A GRAPHIC INFORMATION BASE FOR THE NATIONAL CAPITAL REGION

I. TECHNICAL REQUIREMENTS FROM THE GOVERNMENT OF JAPAN

1. AERIAL PHOTOGRAPHY - Aerial Photography of areas that have appreciably changed after 1982, at a scale of 1:32,000 compatible with existing photography.

2. Ground Controls - Assist the BCGS in the expansion and densification of the existing horizontal and vertical network in the National Capital Region.

3. AERIAL TRIANGULATION - Aerial triangulation and adjustment to densify ground controls which will subsequently be utilized for photogrammetric compilation.

4. Photogrammetric Compilation - Stereo plotting at scale of 1:10,000 at two (2) meter contour interval with separate plotting sheets for the following features.

   4-1 Planimetric Details Including Water Information and buildings

   4-2 Topographic Details

   4-3 Vegetation Plan

5. Field Completion - Features not delineated/drawn at the stereo compilation stage due to none presence on the photographs shall be field edited.

6. Colour Separation Drafting - Based on the compiled sheets, scribing shall be carried out for each of the following five colour separation plates:

   6-1 Red - Roads

   6-2 Blue - Coastal lines, lake coastal lines, rivers, water ways.

   6-3 Black - Buildings, contour lines (Index), works, symbols, elevation points.

6-4 Green - Vegetation delineation, swamp delineation.

6-5 Orange, Red - Contour lines, half interval contour lines, quarter interval contour lines of contour lines.

7. Printing - Press printing shall be carried out by the offset method to produce.

   7-1 Planimetric Map

   7-2 Topographic Map

8. Overprinting - Thematic data like: power line system, traffic route plan, flood control and drainage plans, institutional facilities information, housing plans, industrial and commercial zoning plan, and other varied data shall be overprinted on the Planimetric Map. This stage shall be carried out on a proofing press.

II. Instrument Requirement

1. Electronic Distance Measurements like Wild T2000 with Wild D120 distancer

2. Desktop Computer - with surveying program for ground control computation and adjustment.

3. Proofing press

III. Other Requirement

Training in Japan on the different phases of the work.

REPUBLIC OF THE PHILIPPINES
MINISTRY OF NATIONAL DEFENSE
Bureau of Coast and Geodetic Survey
421 BARRACA ST., SAN NICOLAS, MANILA

14 November 1984

Mr. YOSHITAKA MOTODA
The First Secretary
Embassy of Japan
G. Puyat Ave., Makati
Metro Manila

S i r :

We would like to submit the attached paper, which is a clarification of the proposed project proposal for the "ESTABLISHMENT OF A GRAPHIC INFORMATION BASE AT THE NATIONAL CAPITAL REGION"

As we are assessing the Project Document already submitted to your government and also our letter to you dated 14 September 1984, we feel that there are vague provisos. So, we would like to clarify some of the proposals, which can be seen on the attached paper. Also if the equipment listing as contained in our letter to you will predujice the approval of our project proposal, we are withdrawing that particular requirement.

We hope this will make matters in the proposal clearer and will be of help in its final consideration.

Very truly yours,

ANTONIO P. VENTURA
Commodore, BCGS (Ret.)
Director

ESTABLISHMENT OF A GRAPHIC INFORMATION BASE FOR THE NATIONAL CAPITAL REGION

A. Importance and Objectives

The National Capital Region (Metro Manila) comprising of four (4) cities and thirteen (13) municipalities, is the economic and social center of the Philippines. The growth of human population in this region is so explosive that the natural quality of the environment has been disturbed or even destroyed. These environmental impacts include not only population growth but also high density urbanization, industrial expansion, undesirable land-use patterns, threat to health resource exploitation, air, water and noise pollution and other consequences to the environment. These problems does not only affect the whole area of the region but now also includes the outgoing municipalities.

To eliminate or reduce these environmental problems, every development project must require indepth analysis and assessment, which must be performed by a multi-disciplinary group of agencies. As a first step to attain these objective, there is a need to prepare/produce detailed and standardized plans of all natural and physical facilities in the region. These are envisioned to be graphically presented in the form of Land Condition and Land Use Plans.

The Land Condition Plan is intended to depict the type of soil, grade or slopes, surface descriptions, water sphere and drainage and others. This plan will be of tremendous help in flood control planning, design constructions, urban planning and maintenance, rehabilitation work and other activities.

The Land Use Plan is envisioned to present the existing zoning districts (like residential, commercial and industrial) vegetations, institutional facilities (like hospital, churches, and government building) roads and others. The plan will be important and necessary in planning for urban zoning, traffic routing, sanitation (including garbage collection and disposal) public utility, and others.

B. Area Coverage

	Area (sq. km.)	No. of Sheets	Remarks
1. Planimetric Map	1500	57	Annex 1
2. Land Use Plan	823	33	Annex 2
3. Land Condition Plan	1500	57	Annex 1
4. Topographic Maps	1500	57	Annex 1

C. FINAL DELIVERY ITEMS

	Scale
1. Planimetric Map	1:10,000
2. Land Use Plan	1:10,000
3. Land Condition Plan	1:10,000
4. Topographic Map	1:10,000

D. GEODETIC CONTROLS

1. Photo Controls

   1.1 JICA shall be responsible for establishing the necessary controls required for photo-controls and aerial triangulation.

   1.2 JICA shall be responsible for supplementing the primary level lines to satisfy the requirements for aerial triangulation.

E. PLOTTING REQUIREMENTS

1. Plotting scale for the required final results shall be made at scale 1:10,000.

2. Contour lines shall be at intervals of two (2) meters and supplementary of one (1) meter on flat areas.

3. Definitions
   - 3.1 Planimetric Maps - Base maps that show the horizontal representation of features. This usually show roads, water limits, drainage, and natural features except contours and elevations. These are used as base for preparing land use and land condition plans.
   - 3.2 Topographic Maps - Maps showing the positions of natural and artificial features and their elevations above a certain datum.
   - 3.3 Overprinting - The process wherein additional information will be added to existing maps.
     The proposed idea of overprinting is that when the maps are already printed additional informations like new roads, powerlines, public utilities and others can be superimposed on the existing maps. This process will be done by BCGS after receiving the final delivery items.

4. Detail Plotting Classification shall be as follows:
   - 4.1 Planimetric map
     - a) Red - roads
     - b) Blue - coast line, lake coastal lines, rivers,, water ways.

     Topographic map
     - a) Red - roads
     - b) Blue - coast line, lake coastal lines, rivers, water ways.
     - c) Black - buildings, index contours, man made features, symbols and elevation points.
     - d) Green - vegetation delineation
     - e) Orange red - contour lines

5. Symbols
   The symbols to be used for the required maps can use the existing symbols for the 1:10,000 maps of BCGS. These symbols were adopted from the symbols

used on the 1:25,000 Cagayan Valley topographic maps prepared by JICA. Symbols of features not found on existing specifications can be designed for use of the NCR and other urban areas.

The symbols for the land use and land condition maps will be designed based on existing international standards.

F. SCHEDULE

	First Year	Second Year	Third Year
Planimetric Map Topographic Map			
Land Use Survey			
Land Condition Survey			


GRAPHIC INFORMATION
BASE FOR THE NATIONAL
CAPITAL REGION
ANNEX-1
MALOLOS
QUEZON CITY
MANILA
PASIG
CAVITE CITY
TREce MARTIRES
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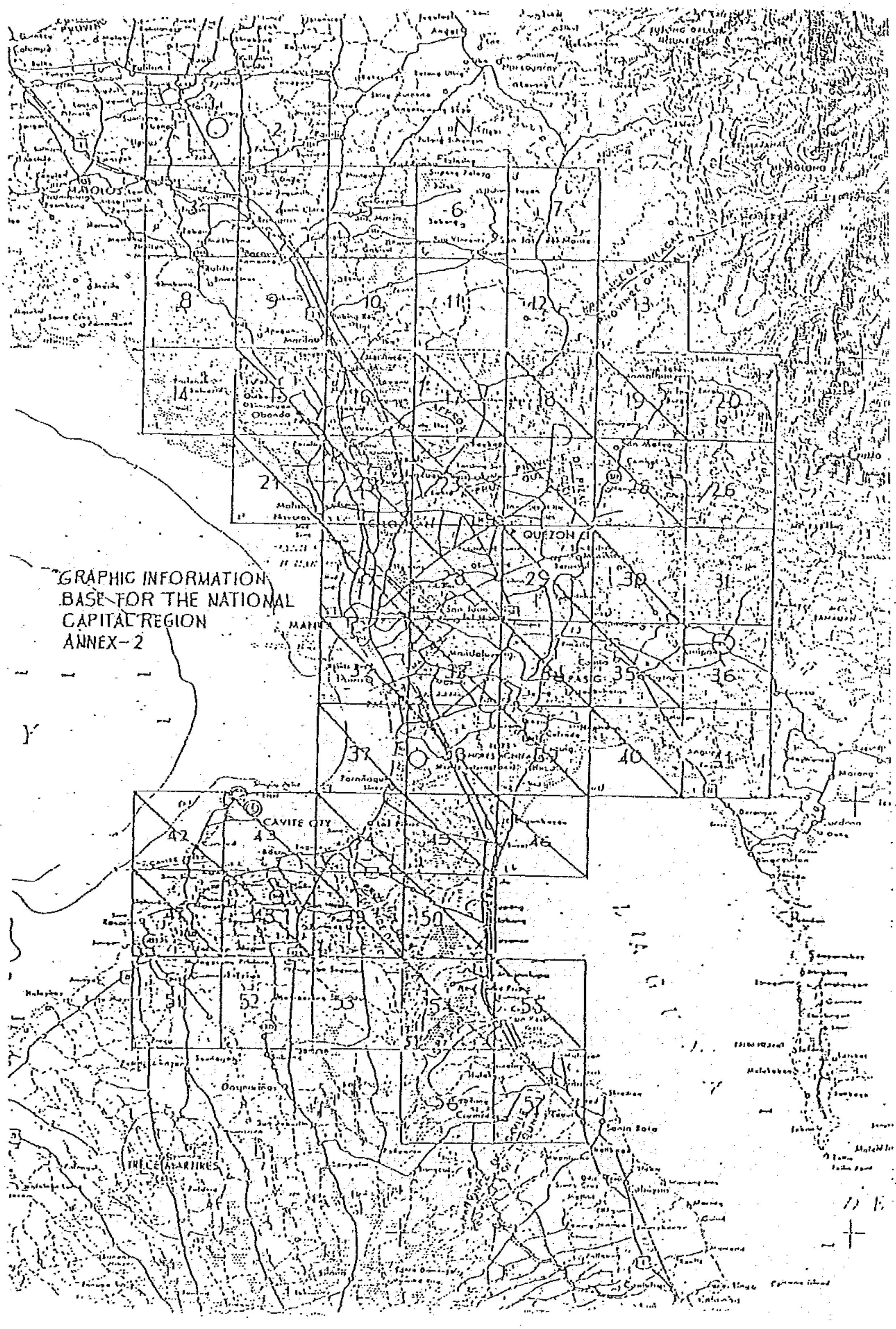
GRAPHIC INFORMATION
BASE FOR THE NATIONAL
CAPITAL REGION
ANNEX-2
QUEZON CI
PASIG
CAVITE CITY
TRECE MARTIRES