The Feasibility Study of the Flood Control Project for
the Lower Cagayan River in the Republic of the Philippines
Final Report
Supporting Report

ANNEX III : GEOLOGY

THE FEASIBILITY STUDY OF
THE FLOOD CONTROL PROJECT FOR THE LOWER CAGAYAN RIVER IN
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

Volume III-1 SUPPORTING REPORT

ANNEX III GEOLOGY

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CHAPTER 1 INTRODUCTION

In the Cagayan valley, Northern Luzon, Philippine inhabitants are suffering from severe and frequent flood by heavy rain and typhoon every rainy season so that flood control structures and river channel improvement are required.

In connection with it, this project, "The Feasibility Study for the Lower Cagayan River Flood Control", is being carried out by Japan International Cooperation Agency (JICA) cooperating with GOP, DPWH, NIA and NAPOCOR from March 1999. The geological investigation has been executed at two terms namely (1) from March-June 1999, and (2) July-October 2000.

The main purposes in the geological survey are as follows:

(1) To collect existing data and reports from government agencies concerned,
(2) To carry out field reconnaissance survey for General geological condition of the basin,
(3) To explore the geotechnical conditions for the prospective river channel widening at Magapit and Nassiping narrows,
(4) To explore the geotechnical conditions for the foundation of the prospective flood control structures in Tugegarao,
(5) To explore the availability of construction materials for levees in Tugegarao and Cabagan.

CHAPTER 2 DATA COLLECTION

During the course of the field work, the Study Team visited various offices concerned, exchanged view with officials and collected data. Main data are the regional geological map by Mines and Geoscience Bureau (MGB), and the construction material sources (sand and gravel pits) maps and boring records along the Philippines –Japan Friendship road by DPWH.

The publications by MGB furnished rather detailed information with regard to the geology of the Study area. The corrected data are as listed in Table 2.1.1.

CHAPTER 3 GENERAL GEOLOGY

3.1 General Geology of the Philippines

The Philippine Archipelago forms a part of the Circum-Pacific volcanic and seismic belt and defined by island arcs marginal basins. It has a maximum North-South length of 1600 km and an average width of 400 km.

The region is characterized by lithologies and regional structure developed during Cretaceous-Tertiary period. During this period there was an extensive ultramatic intrusion tectonism, andesitic and dacitic volcanism and the sediments are diverse including sandstone, conglomerate, tuffs, siltstone, shale, reef limestone and coal. Diorite, quartzdiorite and andesitic stocks were intruded at various times. The oldest rocks found in the region are Cretaceous spilite, shale, greywacke and chert.

The present geologic features of the Philippines are recognized as a model for an actively developing archipelago. These geologic features are divided into four zones as follows:

1. Stable zone (Palawan and Sulu region)
2. Mobile Belt zone (covers Luzon, part of Visaya and Mindanao)
3. Manila Trench
4. Mindanao and East Luzon Trench

The Stable zone includes Palawan, Cuyo islands Sulu sea, Southern Mindanao and Zamboanga. This region is characterized by less seismicity, reduced Tertiary activity, and prevalence of quartzose and alkalirich sedimentary rocks.

The Mobile belt extends longitudinally through Luzon, Visaya and Mindanao. It is characterized by pronounced earthquake activity, active and recently active volcanoes, prevalence of Mesozoic to Tertiary igneous rocks and greater rocks deformation and metamorphism.

The Mindanao and East Luzon Trench separates the east and south of the belts from the Philippine sea and Manila Trench separates Luzon from the South China sea. (Refer to Figure 3.1.1).

3.2 General Geology of Northern Luzon

(1) Physiography

Northern Luzon proper belongs to the mobile belt of the Philippines and four major physiographic and structural provinces are recognized in this region. These are l) Ilocos basin, 2) Cordillera Central, 3) Sierra Madre and Caraballo range and 4) Cagayan basin. (Refer to Figure 3.2.1).

The Ilocos basin forms the coastal folded belt of Northern Luzon and extends north and south between the high Cordillera Central and South China Sea. Structurally this region is characterized by intensely folded and faulted north-trending anticlines. The major fault trends are north-south and northwest-southeast with a secondary fault system trending generally northeast-southwest.

The Cordillera Central is located along the east side of the Cagayan valley and is composed of intermediate to mafic plutonic masses with great thickness of bedded volcanics and metasediments (basalt and greywacke) along the marginal areas. Silicic intrusive and extrusive are known in this area. In Cordillera Central major lineaments have a north-south orientation essentially parallel with the trends in the mountains. Infolded and down-dropped blocks of Miocene carbonates and clastics occur at many places.

Sierra Madre and Caraballo mountains form the eastern and southern margins, respectively, of the Cagayan valley. They are composed of intermediate (andesitic) igneous rocks in their cores with early Tertiary bedded metavolcanics and metasediments along their margins, and coarse crystalline diorite intrusive are also known to occur at various places.

The Cagayan basin is a sedimentary trough whose sedimentary rock is dated late Paleogene to Recent. The thickness was calculated to be more than 7,000 m. Rocks in the basin are predominantly sedimentary clastics with interformational limestone. Volcanic and volcano clastics constitute the next widely distributed rocks in the area. A Cretaceous to Paleogene volcanic and sedimentary rocks form the basement upon which the sediments were deposited. Rocks within the basin also include intrusive, consisting mainly of diorite and granodiorite distributed generally at the core of the mountain ranges.

(2) Faults

Numerous faults are also present in Northern Luzon. They are generally persistent over long distances and oriented parallel to the longitudinal direction of the

Cordillera Central. The most prominent of these faults are; l) the Kabugao Fault in Apayao, 2) the Vigan-Vintar Fault in Ilocos province, 3) the Hapao-Kalinga Fault at the eastern part of Cordillera and 4) the Baloy-Abra Faults wherein the Baloy fault transects the mid-section of the lower half of the Cordillera while the Abra fault runs parallel to the Abra river.

(3) Seismicity of Northern Luzon

In Northern Luzon, many earthquakes are experienced yearly. The epicenters according to magnitude are shown in Figure 3.2.2. Significant seismic area is off the Manila Bay and west coastline; which corresponds to eastward subduction of Manila Trench, and southeastern coast; which corresponds to westward subduction of East Luzon Trench. And relatively fewer earthquakes occurred within Cagayan Valley, but nevertheless of significant intensities. On the whole, intense earthquakes is assumed to be tectonic origin and rarely of volcanic nature.

The major earthquake occurred in July 16, 1990 about 70 km south of Santa Fe. The epicenter of this earthquake was located at 15.68ºN latitude and 121.17ºE longitude. The magnitude of this earthquake was recorded at 7.8 in Richter scale. This earthquake injured seriously stability of the mountain slopes in the south-western watershed area and has been causing the serious debris sediment problem in the tributaries of the Cagayan river in this area.

The earthquake was decidedly of tectonic origin due to readjustments of rock strata within the earth’s crust. No volcanic action occurred in connection with this earthquake.

(4) Structure

In the Master Plan Study, the false-colored landsat image of Northern Luzon (1983) was analyzed for interpretation of the lineament structure. The photograph covers the whole part of northern Luzon from 16ºN to 20ºN. (Refer to Figure 3.3.3)

Many major lineaments interpreted, lie in the south-western part of Northern Luzon and decrease in north and east. These major lineaments occupy the Cordillera mountain region, west of the Cagayan basin.

Generally, lineaments trend north and braches into north-east and north-west direction. West of the Cagayan basin, the intensity of lines is higher in comparison to the eastern region.

Strong and clear lineaments are traceable for a about a hundred kilometer long and continue more as many small lineaments of several kilometers from major lines.

The trends, distribution and extent of interpreted lineaments correspond to the major elements in Northern Luzon. In Cordillera region, these lines represent the infolded and faulted of Miocene rocks, and, in Sierra Madre and Caraballo region, these represent NE-SW normal faults. In Magat and Chico rivers area, these lineaments comprise the faulted and folded belt of the region.

The most strong and clear lineaments, that lie in the west-southern part of Northern Luzon, were interpreted as part of the Philippine Fault Zone which runs from Lingayen Gulf through Dingalan Bay.

3.3 General Geology of Cagayan River

(1) Physiography

The Cagayan river basin is a north-south trending asymmetrical trough circumscribed by a channel in the north and major mountain ranges along the south, east and west sides. The basin measures about 240 km long and 85 km wide. It underlies an area of approximately 20,000 km^2. It is gently sloping and shallow along the eastern side but deep and highly disturbed along the western flank. The basin can be divided into two main physiographic regions namely the mountainous regions and highs are composed of great mountain ranges: Central Cordillera, Sierra Madre and Caraballo Mountains.

(2) Stratigraphy

The stratigraphy of the whole Cagayan valley is not necessarily unified at present, because rock facies vary show considerable lateral variation. Thus, stratigraphy is mainly adopted from Darkee and Pederson.

Rocks in Cagayan basin are represented by a thick sequence of pre-Tertiary metamorphic and plutonic rocks. These were uplifted by igneous intrusions during the Late Tertiary and Quaternary. An Oligocene to Pliocene Marine section occupies the main basin area. It is up to 9,000 m thick along the flanks but attains a maximum thickness of over 12,000 m at the center of the basin. The Oligocene section consists of basic lava flows, metamorphosed conglomerate, tuff breccia and tuffaceous sandstone and siltstone. Late Pleistocene to Recent sands, silts, gravels and pyroclastics are found generally in the central basin area and the sequence is entirely non-marine.

Rocks exposures in the area are divided into West side and East side of the Cagayan valley and they are classified according to rock formation.

From top to bottom they are:

West Side	East Side
Holocene Deposit	Holocene Deposit
Awiden Mesa Formation	Awiden Mesa Formation
Ilagan Formation	Ilagan Formation
Mabaca River Croup	Callao Limestone
Sicalao Limestone	Gatangan Creek Formation
Basement Complex	Basement Complex

HOLOCENE DEPOSIT

Holocene deposit consists of alluvium, volcanic material and terrace gravel. Alluvium materials are gravel, sand, clay and other fluviatiles, they are generally found along the river channel and flood plains. Terrace gravels are particularly well developed along the Chico river at Tabuk, Kalinga where at least three levels of terraces demonstrate recent isostatic adjustment or changes in base level. Other terraces occur near Butigui on the Siffu river, along the Magat river at Oscariz Isabela and of Jones Isabela.

AWIDEN MESA FORMATION

Awiden Mesa Formation is nearly equivalent to Tabuk Formation on the geological map the Figure 3.3.4. This formation is distributed in the central plain of Cagayan Valley.

This formation is composed of welded tuffs and tuffaceous sediments of a dacitic type. It is characterized by the presence of bipyramidal quartz phenocrysts (generally less than 5%) and euhedra of hornblends and sodic feldspar. The tuffaceous sediments are various shades of tan and gray and show variable clast sizes and rounding, though they maintain their homogeneity of composition. The quartz euhedra commonly form an erosional residue with a sparkling appearance to the surface of the ground where the formation is present.

The Awiden Mesa Formation is overlain by Holocene deposit and uncomformably overlies folded strata of Tertiary age in the type area. The maximum thickness is found at Awiden Mesa, 6 km northwest of Lubuangan, Kalinga sub-Province, Mountain Province. Scattered sections of the formation in Kalinga show that it is a valley-filling deposit unconformable on an irregular surface of deformed Miocene rocks. At Awiden Mesa, the tuff beds attain a thickness of at least 300 m.

ILAGAN FORMATION

Ilagan Formation extends on the hilly lands which make a margin to the central plain of the Cagayan valley.

This formation is commonly seen as rock exposures along the Ilagan river. This formation is sandstone which exhibits the typical fluviatile depositional nature. No detailed description of the formation is given because great lateral lithological variations occur in short distances. The best exposures occur along the Tao Tao, Siffu and Mallig rivers. A very good exposure is also present on the flanks of the Pangul anticline, which is breached to the Buluan formation. The uppermost units of the Ilagan are well exposed on the Enrile and Tumauini anticlines.

MABACA RIVER CROUP

Mabaca River Croup is nearly equivalent to Lubuagan Formation which makes a mountainous zone extending over the outer margin of Cagayan valley.

This group represents all strata occurring west of (below) the Ilagan Formation escarpment near the mouth of the Mabaca river and east of (above) the Sicalao Limestone. This formation is a thick terrigeneous sequence of lutites and interbedded arenites and locally some pyroclastics. The rocks of the Mabaca River Group could be subdivided, from top to bottom, into:

Buluan-Formation
Balbalan-Formation
Asiga - Formation

BULUAN FORMATION

The Buluan Formation consists mostly of siltstones while part of it is a shaly structure. Finely grained intercalated sandstones, and small pebble conglomerates occur. The individual beds do not exceed 50 cm at the bottom of the formation, and 15 cm on the upper part. Depending on the degree of lithification, the silt/claystones can further be divided into resistant and non-resistant units with regard to weathering and erosion.

BALBAIAN FORMATION

The Balbalan Formation is a greywacke, sandstone/siltstone sequence, with a thickness of 1,165 m at its type locality. The sandstones range from fine to coarse-grained, with inclusions of pebble zones. Few conglomerates occur with pebble size mafic igneous clasts. Sandy claystone, with sandstone intercalations, form the transition to the overlying Buluan formation. Occasionally, well-indurated claystones can also be found in the lower part. From the Macaba river to the south of the Chico river region, the Balbalan Formation contains more conglomerates than in a typical section. The fraction of sandstone decreases respectively. Claystone, siltstone, and sandy siltstone layers occur more frequently, however, they are not as well indurated, and thus prone to loose their strength when exposed to the surface. Although the Balbalan Formation is a mappable unit throughout the eastern part of Kalinga, its upper and lower boundaries are difficult to distinguish by their facies changes. Broader transition zones occur to the south, which can often be misinterpreted as the underlying Asiga, or the overlying Buluan Formation

ASIGA FORMATION

The Asiga Formation, partially overlying the basement, forms the oldest unit of the Mabaca River Group. It is distinguished by its high claystone portion of 60%, with the remaining 40% being arenites. The lithogic beds are thinly stratified. They are best exposed along the Pasil river, from Ableg to the east, and in the western part of the region. Detailed investigation at the Pasil river bridge determined that this part is not the upper portion of the Asiga Formation. Despite the alternation of siltstone/sandstone layers, the siltstone content including all siltstone laminae in sandstone beds, does not exceed 15%.

SICALAO LIMESTONE

Sicalao Limestone is rather continuously scattered at western and southern-southeastern margin of Cagayan valley. This is called Ibulao Limestone at the southern portion of Lagawe.

This limestone is a massive-bedded calcarenites and calcirudites. With the Cagayan valley, the Sicalao Limestone is correlative with the Callao Limestone on the margins of the Baggao embayment, along the north flank of the Casiggayan nose, and the northeast peninsula of Luzon. The formation can be traced nearly continuously along the west margin of the Cagayan valley from Luna, Apayao, near the north coast, southward to the vicinity of Salegseg, Kalinga. In the latter region the formation is absent because of Miocene faulting and erosion and subsequent Neogene tectonic activity. North of the Saltan river at Salegseg is a large gently east-dipping limestone mass (Mt. Kilkilang), and in the Saltan river at the south and the Mabaca river at the north there is no limestone present.

CALLAO LIMESTONE

Callao Limestone is distributed at the east margin of the Cagayan valley.

The type area for the Callao Limestone is at Barrio Callao, Cagayan. The section described here was measured at Callao Canyon in which right bank, there are significant cave formations like the Callao Cave, along the Pinacanauan de Tuguegarao river. The formation is a calcarenite, it is thin-bedded at the top and becoming more poorly bedded and thicker-bedded in lower part. The Callao limestone south of the type area is the age equivalent of the middle part of the

Mabaca river group of the west of the valley and the Baggao embayment. The basal part of the limestone, which migrates downward across the time lines north of the type area toward the Baggao embayment, is the age equivalent of progressively lower and lower units of the Mabaca River Croup, until the Callao Limestone of Intal river region on the south margin of the Baggao embayment is the age equivalent of the Sicalao Limestone of the west margin of the Cagayan valley.

GATANCAN CREEK FORMAT I ON

Gatangan Creek Formation is distributed at the outer margin of Cagayan valley, and it is the age nearly corresponding to lower section of Lubuagan Formation.

The Gatangan Creek formation is composed of greywacke sand-stone and layers of claystone. It is overlain by the Callao limestone and underlain by andesite flows of the basement complex. Exposures along the Gatangan Creek are excellent and nearly continuous and the formation is 1,010 m thick. The Gatangan Creek formation is the age equivalent of the Asiga and Balbalan formation of the lower Mabaca River Group. It is lithologically similar to the Asiga formation in some respects but has a greater percentage of coarse clastics.

BASEMENT COMPLEX

Basement complex is distributed over the mountainous land surrounding the Cagayan valley.

Basement complex is composed of some type indistinctly bedded mafic agglomerates, or an interbedded sequence of pyroclastics and indurated sedimentary rocks. The anticlinal peninsula area southeast of Capoe Engano contains an estimated thickness of 2,440 m of interbedded pyroclastics and "metasediments". Along the western margin of the valley mafic flows, agglomerates, some thin indurated greywackes and conglomerates occur in the basement complex beneath sedimentary section. These rock types are exposed in every major drainage feature, such as the Abulug, Matalag, Mabaea, Saltan and Pasil rivers. In the southwestern margin of the Cagayan valley and around the isolated outcrops of sedimentary rocks of the fault-preserved Kiangan-Ibulao Gato area, the mountains are composed of metasediments and interbedded igneous rocks.

In most places it was also observed that the indistinctly bedded basement rocks have a similar structural attitude to the overlying clastics or carbonates of the sedimentary section. Some exceptions to this general conformity were found along the south side of the Baggao embayment (Intel river) where there is nearly a right-angle convergence of strikes between the basement and the overlying limestones.

(3) Folding

Folding, faulting, and intrusion by igneous rocks are well displayed in the Kalinga foothills and the Cagayan anticlinal belt. The intensity of folding in these areas decreases from west to east. The folds of the Kalinga foothills are very large, in part nearly isoclinal, and much broken by normal and strike-slip faults. Andesite-diorite stocks are present. It is not improbable that these folds are slightly older than those on the east within the Cagayan Anticlinal belt.

The folds of the Cagayan anticlinal belt form three general groups.

The folds of the Cagayan anticlinal belt form three general groups. The western trend extends from Butigui anticline northward to Camcamalog anticline. These folds have weak west flanks and in the case of Camcamalog some asymmetry in the west is present. The next trend on the east, extending from the Tumauini anticline N30ºW to the Tuao fold, consists of folds 15-20 km long with vertical closures of 700-1,300 m on beds within the Ilagan formation. The folds of this trend are characterized by high-angle reverse faults along their east flanks. The component folds of this trend are arranged en echelon from southeast to northwest either by folding (Tumauini-South Tumauini) or epi-anticlinal strike-slip faulting (Dagupan-North Dagupan).

The third group includes all folds in the northern and eastern third of the Cagayan anticlinal belt. The easternmost folds of this area are asymmetrical toward the east, e.g., Enrile anticline, whose west flank dips 5º - 10º and whose east limb is vertical. The Piat anticline in the western part of this area is asymmetrical toward the west as opposed to the eastward asymmetry of the Faire anticline, which is separated from Piat anticline by the Tabang syncline. This is the area where the fold trends change in direction from north south to east-northeast.

(4) Intrusions

Along a trend bearing N 20ºW in the Kalinga Foothills are six andesite-diorite intrusives. West of the Pasunglao ferry on the Chico river are three intrusives. They seem to bear no or Nanong intrusive has a diameter of about 3,000 m and is emplaced within the northwest-dipping limb of the Tappao syncline. Northeast of and associated with this stock is a well-defined group of radial tension faults. The Mambucayan intrusive on the east is about 1,000 m in diameter and is located in the axial region of the isoclinal beds of the Mambucayan nose. The position of this stock may be only fortuitous and its true relation may be that both it and the small Dalimuno intrusive (750 m in diameter), the middle one of the three, may be located along a radial tension fracture which extended eastward from the Nanong intrusive. Metamorphic aureoles do not extend beyond 50 m into the sediments adjacent to the intrusives.

Another large intrusion is present along the Mabaca river west of Asiga, Kalinga. Southward, intrusions have been recognized in the Pinto nose and three small intrusives are located at Cordon, Nueva Vizcaya. All of these intrusives lie on the general trend of N 20ºW.

(5) Faults

The major faults of the Cagayan valley are shown in Figure 3.3.4. In general, there are two major zones of faulting. One of these extends along the west margin of the valley from the vicinity of Aglipay, Nueva Vizcaya, northward to Talifugo, Apayao. There this fault zone narrows, leaves the sedimentary region, and continues north-northwest in the basement rocks for 80 km or more. The second important trend of faulting is along the south margin of the Sicalao-Casiggayan high. The faults of these two major zones of importance are either wrench faults, or a combination of the two different types of movement at different periods of time.

The Dummun river fault zone along the south margin of the Casiggayan nose is one of the most important ruptures, as it separates the Sicalao-Casiggayan high and Aparri Plain block from the southern part of the Cagayan valley. This fault is defined by surface mapping and is characterized by some hot springs along its trace. It is indicated on Aerial photographs by prominent lineaments that continue eastward across the Sierra Madre to the east coast. Bathymetric data support the supposition that this zone continues north and east into the Pacific for a short distance. This east-west trend is approximately in the same latitude as the eastward offset in the coastline of northeastern Luzon. This suggests that the offset is the manifestation of right-lateral movement along the Dummun river fault zone which may have begun in late Miocene time and had recurrent movement in Pleistocene time.

This fault possibly had its origin as a normal fault in middle or late Miocene as demonstrated by seismic data that indicate possibly 1,000 m or more of late Miocene strata on the downthrown (south) side of the fault near Gattaran, Cagayan. The change in anticlinal trend, from north-south in the latitude of Tuguegarao to northeast-southwest in the Paret river area suggests some possible drag effect in late Pliocene time of the southern Cagayan valley block against the Aparri Plain block along the Dummun river fault zone.

Of the faulting along the west margin of the Cagayan valley, the fault systems in the Kalinga Foothills are most accessible, best exposed, and because of the maximum amount of Miocene rocks known to occur in this region, it is probably the most important region to consider relative to the faulting along the west side. One of theses fault zones, the Cogowi Creek fault is 3 km wide in the Mallig river area, being comprised of much distorted, faulted, and triturated Miocene sediments. It is in this zone that numerous small oil and gas emanations are found. This faultzone separated the Kalinga Foothills from the Cagayan anticlinal belt. At the Pasunglao ferry near Tabuk, Kalinga, this zone has about 4,000 m of throw and indirect evidence indicates a strike-slip component of more than 6 km as demonstrated by offset in anticlinal axes and Ilagan formation outcrops of the Tuga nose and Tapac anticline. The total length of the Cogowi Creek fault zone is about 50 km and it is upthrown on the west.

The western part of the Kalinga Foothills has two major fault zones that trend north-south, of which the northernmost is the Kalinga fault zone and the southern one is the Chico river fault zone. The combined length of these two zones exceeds 80 km. The west side is upthrown along both zones. In the Pasil river bridge area, north of Lubugan, Kalinga, an imbricate anastomosing relation occurs between these two zones. Combined strike-slip movement on the faults has offset (left-lateral) the syncline at Lubugan town by 10 km. In general, the Kalinga Foothills region appears to have moved up and north relative to the Cagayan anticlinal belt.

CHAPTER 4 GEOTECHNICAL AND MATERIAL INVESTIGATION

4.1 General

In order to clarify the geotechnical properties of the Magapit and Nasiping narrows, where excavation of the original ground is prospective for widening of the present river channel, the core boring was carried out. In the bore holes, the standard penetration test and field permeability test were carried out and the undisturbed samples were taken for the laboratory soil test.

In order to clarify the foundation bed condition in Tuguegarao, where some flood control structures are prospective, three core borings of 20 m depth each were carried. In the bore holes, the standard penetration test and field permeability test were carried out and the undisturbed samples were taken for the laboratory soil test.

In order to locate the candidates of the borrow pits for the levee embankment material, each five test pits of 3 m depth were excavated in Tuguegarao and Cabagan, where the embankment levees are prospective, to clarify the subsurface condition and to examine availability of the earth material for the levee embankment. From the each test pit, the samples were taken for the laboratory soil test.

The quantity of the investigation is shown in Table 4.1.1.

Other than the investigation mentioned above, the material sources for concrete aggregates and boulders were investigated mainly with the data prepared by the Revision I Office of DPWH. Some of the material sources were reconnoitered.

4.2 Geotechnical Properties of Magapit and Nasiping Narrows

4.2.1 Magapit Narrow

The geology of Magapit narrow area consists of the alluvial plane of clay and sand and the hills of the marl and mudstone.

Two (2) core borings of 50 m depth each were sunk at the locations as shown on Figure 3.6.1. The boring logs are shown on Figure 3.7.1.

At the bore hole MB-1, the clay layer is distributed from the ground surface to the depth of 22 m, the soft rock of marl is distributed from 22 m depth to 38 m and the fresh and hard mudstone is distributed below the marl. At the bore hole MB-2, the clay layer is distribute from the ground surface to the depth of 18 m, the fine sand layer is distributed from 18 m depth to 34 m and the fresh and hard weathered marl is distributed below the fine sand.

The N-values of the clay layer range from 6 to 35 and most of them are higher than 8 which is generally the boundary between the medium-hard layer and the stiff layer as shown on Table 4.2.1. Therefore no serious problem is foreseen in the cut slope for widening of the river channel. The N-values of fine sand layer ranges from 6 to 44 and 70% of them are less than 20 which is the boundary between the medium layer and the dense layer. If this layer becomes the objective of the excavation, some slope stability measures will be required. This layer, however, is situated at the deeper portion and accordingly the slope stability measures will be limited to this section. The further investigation, however, will be necessary in order to clarify the distribution status of this layer in the detailed design stage.

The permeability coefficients of the clay layer range from 10^{-4} to 0 cm/sec and those of the sand layer from 10^{-2} to 10^{-5} cm/sec as shown in Table 4.2.2. These permeability coefficients are reasonable and no trouble is judged to occur in the cut slope.

The laboratory soil test result is shown in Table 4.2.3. The index property test result is judged to be reasonable. With regard to the triaxial compression test result of the consolidated-undrained and consolidated-drained conditions, however, the cohesions are judged to be to high. For the design values of the design in the feasibility study stage, the following values are recommended.

Condition	Cohesion	Internal friction degree
Uncosolidated-undrained	80 kPa	5 degrees
Consolidated-undrained	10 kPa	25 degrees
Consolidated-drained	0 kPa	30 degrees

The rock test result is shown in Table 4.2.4. Most of the bulk densities range from 2.06 to 2.386 ton/m^3 and judged to be reasonable. For the design value, 2.30 ton/m^3 is recommended. Absorptions ranges from 5.05 to 9.39% and judged to be reasonable from the compression strength. The unconfined compression strengths range from 38.8 to 141.7 kPa and this rock is judged to be excavated without blasting. The rock distributed in the hilly area, however, is judged to be necessary for blasting for excavation. Some blasting is recommended to be taken into account for channel widening excavation although the amount will depend on the alignment of the channel widening. The elastic moduli range from 4,480 to 10,345 kg/cm^2 and are judged to be too high from the compression strength. For the design value, 2,000 kg/cm^2 is recommended from the compression strength.

The Poisson’s ratios range from 0.26 to 0.40 and most of them are reasonable and 0.35 is recommended for the design value.

4.2.2 Nasiping Narrow

The geology of the Nasiping narrow area consists of clay, silt and sand in the alluvial plane and marl and mudstone in the hills.

Five (5) core borings of 50 m depth each were sunk at the locations as shown on Figure 3.6.2. The boring logs are shown on Figure 3.7.2.

At the bore hole NRB-1, the clay layer is distributed from the ground surface to the depth of 7 m and the fine sand layer is distributed from the depth of 7 m to the depth of 50 m (the bore hole bottom). At the bore hole NLB-1, the decomposed mudstone is distributed from the ground surface to the depth of 3 m, the moderately-highly weathered mudstone is distributed from 3 m depth to 16 m and the decomposed mudstone is distributed below the weathered mudstone intercalated with the weathered mudstone of a few meters thickness. At the bore hole NLB-2, the silty sand layer is distributed from the ground surface to the depth of 2 m, the fine sandy/clayey silt layer is distributed from 2 m depth to 40 m and the fine silty sand is distributed below the silt layer. At the bore hole NLB-3, the clay layer is distributed from the ground surface to the depth of 30 m and the alternation of decomposed marl and mudstone is distributed below the clay layer. At the bore hole NLB-4, the fine silty sand layer is distributed from the ground surface to the depth of 3 m, the sandy clay layer from 3 m depth to 11 m, the sandy silt layer from 11 to 20 m, the sandy clay from 20 to 32 m and the and silty/clayey sand layer from 32 to 50 m (the bore hole bottom).

The N-values of the decomposed rock layer is more than 30 and judged to be hard as shown on Table 4.2.1. The N-values of the clay layer range from 3 to 30 and most of them are higher than 8 which is generally the boundary between the medium-hard layer and the stiff layer. The N-value of 3 is recorded at 10 m depth and judged to be caused by insufficient cleaning of the temporary bore hole bottom. Therefore no serious problem is foreseen in the cut slopes for widening of the river channel. The N-values of fine sand layer except at depths of 7 ~ 14 m in the bore hole NRB-1 and 0 ~ 3 m in the bore hole NLB4 are more than 20 and no serious stability problem will occur except erosion problem. The low N-values in the bore hole NLB-4 is not a serious problem since they are judged to have been measured at the quite limited deposit. The low N-values in the bore hole NRB-1, however, is judged to have the potential to cause some serious slope stability problem when it is exposed as an unsupported cut slope. If this layer becomes the objective of the excavation, some slope stability measures will be required. This layer, however, is situated at the deeper portion and accordingly the slope stability measures will be limited to this section. The further investigation, however, will be necessary in order to clarify the distribution status of this layer in the detailed design stage. The N-values of the silt layers range from 4 to 31. The low N-values are judged to have been caused by the insufficient cleaning of the temporary hole bottom since all of them are recorded at considerably deep points. Therefore, no serious stability problem will occur in the cut slope in the silt layer.

The permeability coefficients of the clay layer range from 10^{-3} to 0 cm/sec, those of the sand layer from 10^{-3} to 10^{-5} cm/sec, those of the silt layer 10^{-2} to 0 cm/sec, and those of the decomposed/weathered rock 10^{-3} as shown in Table 4.2.2. Most of these permeability coefficients are reasonable and no trouble is judged to occur in the cut slope.

The laboratory soil test result is shown in Table 4.2.3. The index property test result is judged to be reasonable. With regard to the triaxial compression test result of the consolidated-undrained and consolidated-drained conditions, however, the cohesions are judged to be to high. For the design values of the design in the feasibility study stage, the following values are recommended.

Condition	Cohesion	Internal friction degree
Uncosolidated-undrained	80 kPa	5 degrees
Consolidated-undrained	10 kPa	25 degrees
Consolidated-drained	0 kPa	30 degrees

The rock test result is shown in Table 4.2.4. The bulk densities range from 1.87 to 2.08 ton/m^3 and judged to be reasonable. For the design value, 2.00 ton/m^3 is recommended. Absorptions ranges from 13.9% to 18.4% and judged to be reasonable for the compression strength. The unconfined compression strengths range from 10.5 to 29.4 kPa and this rock is judged to be excavated without blasting. The rock distributed in/nearby the hilly area, however, is judged to be necessary blasting for excavation. Some blasting is recommended to be taken into the account in the channel widening excavation though it is dependent on the alignment of the channel widening. The elastic moduli range from 1,190 to 6,024 kg/cm^2 and are judged to be too high from the compression strength. For the design value, 1,200 kg/cm^2 is recommended for the compression strength. The Poisson's ratios range from 0.22 to 0.30 and most of them are reasonable and 0.30 is recommended for the design value.

4.3 Properties of Foundation Bed in Tugegarao

The geology in and around Tuguegarao consists of the clayey soil in the hilly area and the sand and sand/gravel in the alluvial plain. The sand/gravel is distributed along the Tuguegarao river and the right bank of the Cagayan river at the vicinity of the confluence with the Tuguegarao river.

Three core borings of 20 m depth each were carried out at the location as shown on Figure 3.8. The boring logs are shown on Figure 3.9.

At the bore hole TBH-1, the sandy clay layer is distributed from the ground surface to 1.5 m depth, the sand and gravel layer with some cobble from 1.5 m to 8 m and the sand layer from 8 m to 20 m (the hole bottom). At the bore hole TBH-2, the silty clay layer is distributed from the ground surface to 20 m depth (the hole bottom) and the silty sand and gravel layer with cobble and boulders is intercalated from 0.6 m depth to 1.7 m. At the bore hole TBH-3, The silty clay layer is distributed from the ground surface to 2 m depth and the fine sand layer from 2 m to 20 m (the hole bottom).

The N-values of the sand layer ranges from 9 to 29, the most of them are more than 15 and there are no problem for the foundation of the levee embankment as shown on Table 4.2.1. Depending on the load intensity, however, the foundation piles or some special foundation structures will be required for the concrete structures. N-values of the clay range mainly from 11 to 22 and judged to be the stiff base. The clay layer also is judged to be sufficient to support the levee embankment but the foundation piles or some special foundation structures may be required for the heavy structures although it depends on the load intensity.

The permeability coefficients of the sand and sand/gravel layers range from 10^{-3} to 10^{-4} cm/sec as shown on Table 3.4 and is judged to be reasonable. No seepage measure will be generally required for the foundation. Those of the clay layer range from 10^{-3} to 10^{-5} cm/sec and are judged to be too high since a considerable numbers of them are on the order of 10^{-3} cm/sec. This is judged to have been caused by lack of water-tightness between the casing pipe and the original ground. No seepage measure will be generally required for the foundation.

The laboratory soil test result is shown in Table 4.2.3. The index property test result is judged to be reasonable. With regard to the triaxial compression test result of the consolidated-undrained, however, the cohesions are judged to be to high. For the design values of the design in the feasibility study stage, the following values are recommended.

Condition	Cohesion	Internal friction degree
Uncosolidated-undrained	80 kPa	5 degrees
Consolidated-undrained	10 kPa	27 degrees

4.4 Properties of Embankment Materials in Tuguegarao and Cabagan

4.4.1 Tuguegarao

Six (6) test pits of 3 m depth each were excavated at the locations as shown in Figure 3.10.1. The logs of the test pit are shown on Figure 3.11.1

In all the test pits except the test pit TP-T2, the clay layer, which is suitable for the levee embankment, is distributed. Among them, the material at TP-T4 is the best since it contains the sand and gravel. The soil distributed around the TP-T2 also is judged to be usable for the levee embankment with some erosion measures since it is classified to the non-plastic silt which is vulnerable to erosion.

The laboratory test result is shown in Table 4.4.1. The test result, except the triaxial compression test under the unconsolidated-undrained condition, is judged to be acceptable since most of the cohesions and some of the internal friction angles are judged to be too high from our experience. For the design parameters, the following values are recommended.

Condition	Cohesion	Internal friction degree
Uncosolidated-undrained:	each test values	
Consolidated-undrained:	10 kPa	25 degrees

Abundant fine sand is distributed along the river. This sand is recommended to be used inside of the levee embankment to save the amount of the expensive clay material because of the long distance required for transportation of the higher levee embankment. The minimum width of the clayey material is recommended to be 5 m on the river side and 3 m on the land side.

4.4.2 Cabagan

Six (6) test pits of 3 m depth each were excavated at the locations as shown on Figure 3.10.2. The logs of the test pit are shown on Figure 3.11.2

In all the test pits except the test pit TP-C2, the clay layer, which is suitable for the levee embankment, is distributed. Among them, the material at TP-C1 is the best since it contains the sand and gravel. The soil distributed around the TP-T2 is also judged to be usable for the levee embankment with some erosion measures since it is classified as non-plastic silt which is vulnerable to erosion.

The laboratory test result is shown in Table 4.4.1. The test results, except the triaxial compression test under the unconsolidated-undrained condition, are judged to be acceptable since most of the cohesions and some of the internal friction angles are judged to be too high from our experience. For the design parameters, the following values are recommended.

Condition	Cohesion	Internal friction degree
Uncosolidated-undrained:	each test values	
Consolidated-undrained:	10 kPa	25 degrees

Abundant fine sand is distributed along the river. This sand is recommended to be used on the inside of the higher levee embankment. The minimum width of the clayey material is recommended at 5 m on the river side and 3 m on the land side.

4.5 Material Sources for Aggregate and Boulder

The material source map for the concrete aggregate and boulders prepared by DPWH Region 2 Office are shown on Figures 3.12.1 and Figure 3.12.2. On the figures, the available quantity is presented. Some of them have already been consumed. According to the site reconnaissance, however, it appears that the materials are being supplied by the floods every year and there is an abundant amount of the materials.

Tables

Tabe 2.1.1 List of Data Collected

Geological Map

Geological Map of Cagayan River Basin (Scale: 1/500,000)
Geological Map of Aparri Quadrangle (Scale: 1/50,000)
Geological Map of Buguey Quadrangle (Scale: 1/50,000)
Geological Map of Gattaran Quadrangle (Scale: 1/50,000)
Geological Map of Tumauini Quadrangle (Scale: 1/50,001)
Geological Map of Illagan Quadrangle (Scale: 1/50,002)
Geological Map of Mallig Quadrangle (Scale: 1/50,003)
Geological Map of Loxas Quadrangle (Scale: 1/50,004)
Geological Map of Cabatuan Quadrangle (Scale: 1/50,005)

Geological Investigation Repor

Soil Investigation/Proposed San Pablo Bridge ISABERA
Soil Investigation/Proposed Naguilian Bridge ISABERA
Soil Investigation/Proposed Tuguegarao Submerged Bridge CAGAYAN (1)
Soil Investigation/Proposed Tuguegarao Submerged Bridge CAGAYAN (2)

Boring Log

Marana II Bridge
Santa Bridge
Aguiguican Bridge
Cansan Bridge
Carig III Bridge
Malabbac Bridge
Iguig Bridge
Bobogan Bridge
Baculud Amulong Bridge
Baculi Bridge
Nalbo Bridge
Balasig Bridge

Material (Concrete Aggregates) Source Ma

Package VI A (Upstream Area)
Package VII A (Midstream Area)
Package VIII A (Downstream Area)
Cagayan Province
Isabela Province
Directory of Mines and Quarries in Regeon 02

Land Use Map

Barangay Carig Norte Tuguegarao City
Barangay Carig Sur Tuguegarao City

Table 4.1.1 Summary of Geotechnical Investigation Work Quantity

Work Item		Cut Slope		Foundation	Embankment Material	
		Magapit	Nasiping	Tuguegarao	Tuguegarao	Cabagan
Field Works	Core Boring	50 m x 2 = 100 m	50 m x 5 = 250 m	20 m x 3 = 60 m	-	-
	Test Pit Excavation	-	-	-	3 m x 6 = 18 m	3 m x 6 = 18 n
	Standard Penetration Test (nos)	72	193	54	-	-
	Field Permeability Test (nos)	19	135	50	-	-
	Perforated Pipe Installation (m)	100	250	-	-	-
	Undisturbed Sampling (nos)	4	10	5	-	-
	Sampling of Disturbed Soil	-	-	-	6	6
Laboratory Soil Test	Specific Gravity (nos)	4	10	6	6	6
	Noisture Content (nos)	4	10	6	6	6
	Grain Size Analysis (nos)	4	10	6	6	6
	Plastic/Liquid Limits (nos)	4	10	6	6	6
	Proctor Test (Compaction) (nos)	-	-	-	6	7
	Unconfined Compression (nos)	4	10	5	-	-
	Triaxial Compression (UU*) (nos)	3	10	5	6	6
	Triaxial Compression (CU**) (nos)	1	3	1	6	6
	Triaxial Compression (CD***) (nos)	1	2	-	-	-
	Consolidation	-	-	6	-	-
Laboratory Rock Test	Bulk Density & Absorption (nos)	6	6	-	-	-
	Unconfined Compression**** (nos)	6	6	-	-	-

Note:

UU*: Uncosolidated- Undrained Condition
CU**: Cosolidated- Undrained Condition
CD***: Cosolidated- Drained Condition
****: with measurement of Elastic Moduli and Poisson's Ratio

Table 4.2.1 Record of Standard Penetration Test

Depth (m)	Nasiping					Magapit		Tuguegarao		
	NBR 1 N	NLB 1 N	NBL 2 N	NLB 3 N	NLB 4 N	MB 1 N	MB 2 N	TBH1 N	TBH2 N	TBH3 N
0.70 ~ 1.00	10	29	16	20	3	11	16			
1.70 ~ 2.00	12	46	12	26	5	12	9	10	14	11
2.70 ~ 3.00	12	40	15	14	8	12	16		22	9
3.70 ~ 4.00	12		14	16	12	24	9		16	11
4.70 ~ 5.00	11		12	7	11	22	18		14	13
5.70 ~ 6.00	12		13	5	9	23	11		11	14
6.70 ~ 7.00	12		20	7	9	8	4		13	15
7.70 ~ 8.00	12		24	8	9	6	10		17	17
8.70 ~ 9.00	12		34	8	10	9	10	20	13	20
9.70 ~ 10.00	12		33	3	9	10	11	22		22
10.70 ~ 11.00	15		28	6	21	9	7	20	14	19
11.70 ~ 12.00	16	35	48	6	6	7	7	17	12	21
12.70 ~ 13.00	17	78	105	10	12	8	12	19	15	23
13.70 ~ 14.00	20	67	55	7	17	9	9	18	17	23
14.70 ~ 15.00	21	64	65	8	5	9	8	15	16	24
15.70 ~ 16.00	21		5	11	4	10	40	16	6	24
16.70 ~ 17.00	20		24	11	6	6	15	16	3	25
17.70 ~ 18.00	22		26	18	7	6	44	17	7	27
18.70 ~ 19.00	21		28	17	20	7	12	19	8	28
19.70 ~ 20.00	23		17	14	19	6	10	19	17	29
20.70 ~ 21.00	23	84	19	29	24	35	7			
21.70 ~ 22.00	24	77	15	12	24	113	25			
22.70 ~ 23.00	26	86	18	63	6		11			
23.70 ~ 24.00	28		30	8	16		16			
24.70 ~ 25.00	31		25	35	9		12			
25.70 ~ 26.00	30		28	30	14		7			
26.70 ~ 27.00	28		19	14	31		11			
27.70 ~ 28.00	26		16	23	10		10			
28.70 ~ 29.00	27		10	28	18		12			
29.70 ~ 30.00	28		13	22	16		6			
30.70 ~ 31.00	30		12	85	55		10			
31.70 ~ 32.00	30		7		56		52			
32.70 ~ 33.00	37		12	70	32		36			
33.70 ~ 34.00	42		17	85	40		39			
34.70 ~ 35.00	43		31		80		122			
35.70 ~ 36.00	47		36		50		72			
36.70 ~ 37.00	44		58		54		77			
37.70 ~ 38.00	49		62		27		125			
38.70 ~ 39.00	49		75		41		67			
39.70 ~ 40.00	54		58		38		84			
40.70 ~ 41.00	55		51		47		46			
41.70 ~ 42.00	61		53		46		98			
42.70 ~ 43.00	73		60		60		74			
43.70 ~ 44.00	70		38		71		80			
44.70 ~ 45.00	85		42		52		83			
45.70 ~ 46.00	78		63		34		70			
46.70 ~ 47.00	80		40		26		65			
47.70 ~ 48.00	81		27		28		60			
48.70 ~ 49.00	84		31		28		81			
49.70 ~ 50.00	88		35		32		74			

Table 4.2.2 Field Permeability Test Result (unit: cm/sec)

	Nasiping					Magapit		Tuguegarao		
Depth (m)	NRB 1	NLB 1	NLB 2	NLB 3	NLB 4	MB 1	MB 2	TBH1	TBH2	TBH3
1	0.00E+00	1.03E-03			7.00E-05			.		0.00E+00
2	0.00E+00	5.57E-04			5.50E-05			2.19E-03		1.05E-04
3	0.00E+00	3.47E-04			1.21E-04					2.00E-04
4	0.00E+00	2.85E-05	1.70E-04		1.80E-05					3.80E-04
5	0.00E+00			0.00E+00	7.00E-06	0.00E+00	8.20E-05			5.45E-04
6	3.80E-04				6.00E-06				6.10E-05	3.63E-04
7	9.52E-04				5.40E-05			1.52E-04	3.84E-04	3.80E-04
8	1.14E-03				4.80E-05			7.90E-05	1.45E-03	4.00E-04
9	2.38E-03				9.60E-05			7.90E-05	1.25E-03	1.05E-04
10	9.52E-04		1.35E-03	2.17E-03	4.80E-05	0.00E+00	0.00E+00	5.50E-05	1.34E-03	1.24E-03
11	2.60E-03				4.50E-05			7.10E-05	1.10E-03	1.77E-03
12	4.09E-03	1.67E-04			2.40E-04			5.40E-04	7.42E-04	1.39E-03
13	5.71E-03	3.46E-05			4.80E-05			3.40E-05	1.18E-03	1.80E-03
14	9.04E-03	6.10E-05			3.80E-05			6.90E-05	8.88E-04	1.78E-03
15	8.76E-03	2.50E-05	1.60E-03	1.36E-03	4.90E-05	0.00E+00	6.30E-04	1.36E-04	4.44E-04	2.50E-03
16	7.84E-03	2.60E-04			6.00E-06			4.50E-05	4.00E-04	2.40E-03
17	7.59E-03				3.00E-06			6.80E-05	1.15E-03	2.90E-03
18	7.29E-03				6.00E-06			7.40E-05	4.12E-04	2.40E-03
19	7.13E-03				6.30E-05			5.40E-05	3.52E-04	3.20E-03
20	7.15E-03	8.58E-05	5.80E-04	3.08E-04	3.10E-05	5.40E-04	5.43E-05	7.40E-05	3.19E-04	3.22E-03
21	6.35E-03	2.46E-04			8.40E-05					
22	6.33E-03	3.84E-04			1.70E-05					
23	5.75E-03	3.07E-04			6.00E-06					
24	5.54E-03				6.00E-06					
25	9.54E-03		0.00E+00	9.00E-05	6.00E-06		1.04E-02			
26	5.04E-03				6.00E-06					
27	5.18E-03				3.40E-05					
28	5.27E-03				1.70E-05					
29	5.42E-03				1.00E-05					
30	5.51E-03		0.00E+00	7.30E-05	3.40E-05	2.17E-03	5.06E-04			
31	5.60E-03				1.70E-05					
32	5.73E-03				3.40E-05					
33	5.82E-03	1.48E-04			6.80E-05					
34	5.87E-03				3.40E-05					
35	5.98E-03		4.00E-04		6.80E-05	2.53E-03	1.58E-02			
36	8.43E-03				6.80E-05					
37	4.97E-03				1.05E-04					
38	5.26E-03				1.05E-04					
39	9.10E-03				3.50E-05					
40	8.97E-03		5.75E-04	7.02E-04	7.00E-05	2.02E-03	1.53E-03			
41	9.22E-03				1.05E-04					
42	8.89E-03				7.00E-05					
43	7.71E-03	1.40E-04			1.05E-04					
44	7.69E-03				1.05E-04					
45	9.16E-03		0.00E+00	1.10E-03	1.05E-04	2.00E-03	9.18E-03			
46	8.51E-03				1.05E-04					
47	5.89E-03				3.50E-05					
48	7.54E-03	1.57E-04			3.50E-05					
49	8.09E-03				1.70E-05					
50	8.00E-03		1.64E-03	1.14E-03	1.70E-05	1.78E-03	1.91E-02			

Table 4.2.3 Summary of Laboratory Test on Undisturbed Samples taken from Bore Hole

LOCATION	Boring N0.	Depth (m)	Gs	Gradation			Consistency			NMC	Consolidation			Unconfined Compression		Triaxial Compression				
																UU		CU		
				gravel (%)	sand (%)	silt/clay (%)	LL (%)	PL (%)	PI (%)	(%)	e_0	Pc (kPa)	Cc	e_f (%)	q_u (kPa)	c_{uu} (kPa)	ϕ_{uu} (deg.)	c' (kPa)	ϕ' (deg.)	(k
MAGAPIT	MB-1A	2.00	2.67	0	4	96	66	28	38	53	-	-	-	10.75	111.4	84	5	67	23	
	MB-1B	3.00	2.73	0	5	95	44	31	13	49	-	-	-	9.33	66.5	80	3			
	MB-2A	2.00	2.58	0	67	33	36	26	10	22	-	-	-	5.23	128.1	71	8			
	MB-2B	3.00	2.69	0	60	40	38	27	11	24	-	-	-	8.30	60.0					
NASIPING	NLB-1A	2.00	2.61	0	9	91	41	28	13	14	-	-	-	7.69	135.4	64	6			
	NLB-1B	3.00	2.62	0	11	89	54	34	20	17	-	-	-	4.15	133.5	69	4	48	25	
	NLB-2A	2.00	2.59	0	59	41	39	28	11	18	-	-	-	8.57	35.3	87	6			
	NLB-2B	3.00	2.63	0	58	42	37	27	10	27	-	-	-	9.79	42.0	90	5			
	NLB-3A	2.00	2.56	0	75	25	35	25	10	12	-	-	-	6.51	32.9	74	6			
	NLB-3B	3.00	2.52	0	68	32	38	27	11	18	-	-	-	5.80	39.7	68	7	27	29	
	NLB-4A	2.00	2.62	1	23	76	40	29	11	29	-	-	-	9.54	96.5	72	8	44	27	
	NLB-4B	3.00	2.61	0	23	77	43	30	13	16	-	-	-	7.76	85.2	75	6			
	NRB-1A	2.00	2.61	0	12	88	57	35	22	33	-	-	-	6.79	124.9	68	4			
	NRB-1B	3.00	2.71	0	8	92	66	30	36	38	-	-	-	9.55	128.2	78	8			
TUGUEGARAO	TBH-1A	0.55 ~ 1.00	2.60	0	60	40	42	29	13	35	1.164	17.0	0.345	9.66	32.36	62	4			
	TBH-1B	1.50 ~ 2.00	2.57	0	88	12	NP			9	0.944	19.0	0.323							
	TBH-2A	5.50 ~ 6.00	2.68	3	3	94	65	29	36	49	1.322	12.5	0.363	16.78	17.02	70	2			
	TBH-2B	9.50 ~ 10.00	2.65	0	1	99	70	30	40	54	1.321	13.0	0.389	9.86	33.73	74	3			
	TBH-3A	0.55 ~ 1.00	2.69	0	3	97	59	35	24	37	1.158	12.5	0.363	10.50	31.41	80	2	44	27	
	TBH-3B	1.50 ~ 2.00	2.72	0	2	98	67	28	37	34	0.722	16.5	0.231	9.06	45.82	72	4			

Table 4.2.4 Summary of Laboratory Rock Test Result

Area	Location	Depth (m)	Bulk Density (ton/m^3)	Absorption (%)	q_u (kg/cm^2)	E (kg/cm^2)	ρ
Magapit	MB1	22 ~ 23	2.060	9.39	38.8	5,882	0.35
	MB1	25 ~ 26	2.236	5.65	141.7	4,480	0.26
	MB1	26 ~ 27	1.439	5.06	74.6	10,345	0.31
	MB1	27 ~ 28	2.276	5.30	53.4	5,263	0.36
	MB1	28 ~ 29	2.275	6.65	71.4	7,065	0.36
	MB1	29 ~ 30	2.386	4.41	54.8	6,868	0.40
Nasiping	LNB1	4 ~ 5	1.974	18.37	16.5	2,370	0.22
	LNB1	5 ~ 6	1.866	17.59	10.5	1,190	0.30
	LNB1	6 ~ 7	2.094	14.08	24.4	1,330	0.22
	LNB1	7 ~ 8	1.873	14.94	29.4	3,030	0.29
	LNB1	8 ~ 9	1.902	13.91	27.7	6,024	0.30
	LNB1	9 ~ 10	2.080	15.30	24.4	3,683	0.24

Note

$q_{u:}$ Unconfined compressive strength
E: Elastic moduli
ρ: Poisson's ration

Table 4.4.1 Summary of Laboratory Test on Embankment Material

Boring N0.	Depth (m)	Gs	Gradation			Consistency			NMC	Proctor		Triaxial Compression			
												UU		CU	
			gravel	sand	silt/clay	LL	PL	PI		OMC	MDD	c	ϕ	c'	ϕ'
			(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(t/m^3)	(kPa)	(deg.)	(kPa)	(deg.)
TPT-1	0.00 ~ 3.00	2.763	0	3	97	45	29	16	37	25.0	1.53	100	13	130	21
TPT-2	0.00 ~ 3.00	2.791	0	8	92	NP	NP	NP	25	20.0	1.57	92	13	52	35
TPT-3	0.00 ~ 3.00	2.773	0	3	97	67	21	46	32	25.5	1.45	81	11	60	30
TPT-4	0.00 ~ 3.00	2.875	18	19	63	39	23	16	14	19.0	1.67	76	14	45	37
TPT-5	0.00 ~ 3.00	2.665	0	1	99	76	27	49	35	26.0	1.33	90	5	71	26
TPT-6	0.00 ~ 3.00	2.797	8	35	56	67	29	38	29	23.0	1.42	95	10	60	31
TPC-1	1.85 ~ 3.00	2.667	2	27	71	38	16	22	19	17.0	1.74	70	20	70	27
TPC-2	0.00 ~ 1.70	2.665	0	47	53	NP	NP	NP	15	15.0	1.78	68	16	37	38
TPC-2	1.70 ~ 3.00	2.654								15.0	1.66				
TPC-3	0.00 ~ 3.00	2.779	0	1	99	51	25	26	38	26.0	1.47	78	12	57	32
TPC-4	0.00 ~ 3.00	2.703	11	28	61	40	20	20	15	18.5	1.68	87	13	40	36
TPC-5	0.00 ~ 3.00	2.706	0	28	72	38	17	21	22	16.0	1.65	87	11	38	33
TPC-6	0.00 ~ 3.00	2.743	0	3	97	51	22	29	31	25.0	1.43	100	10	35	33

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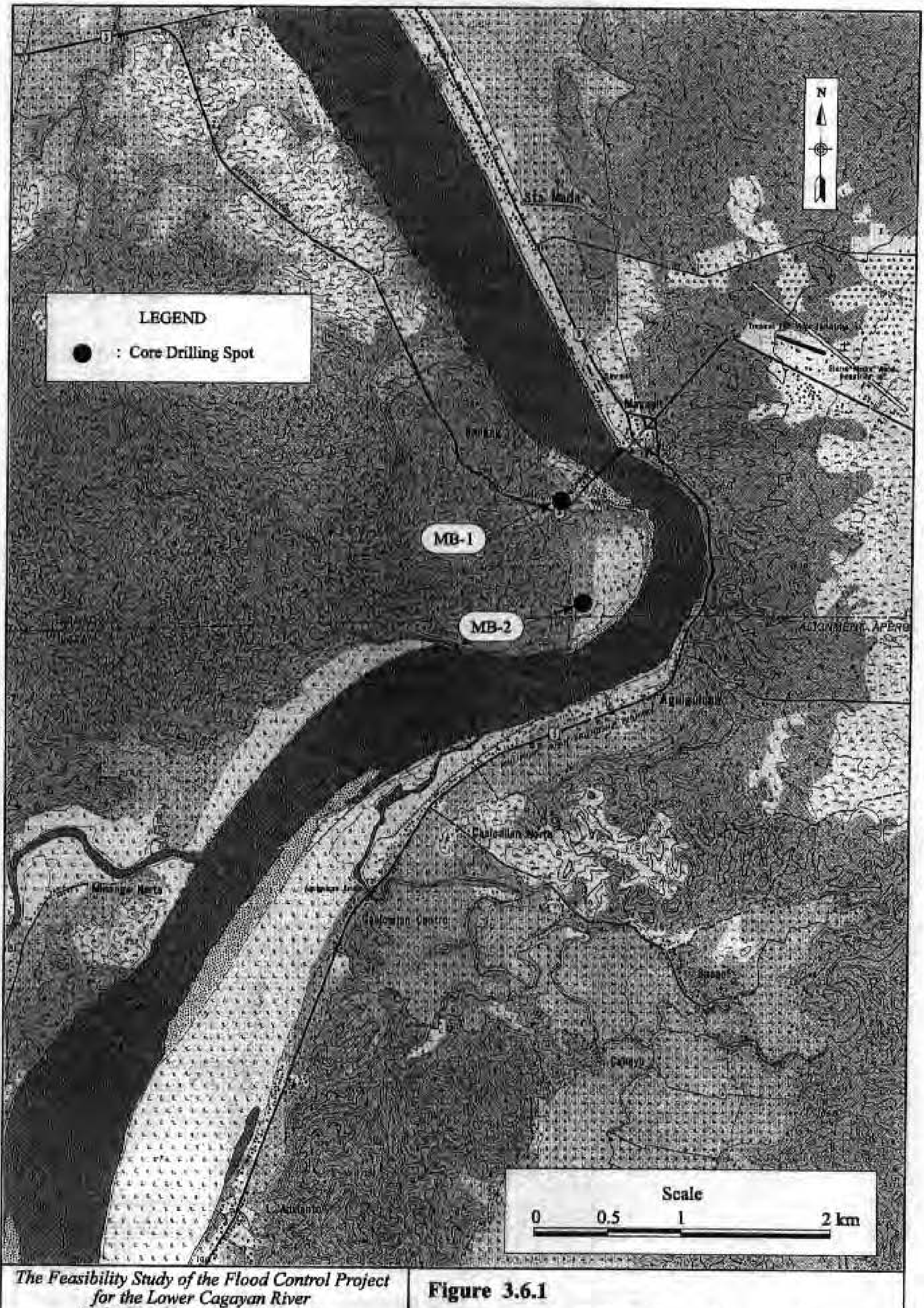
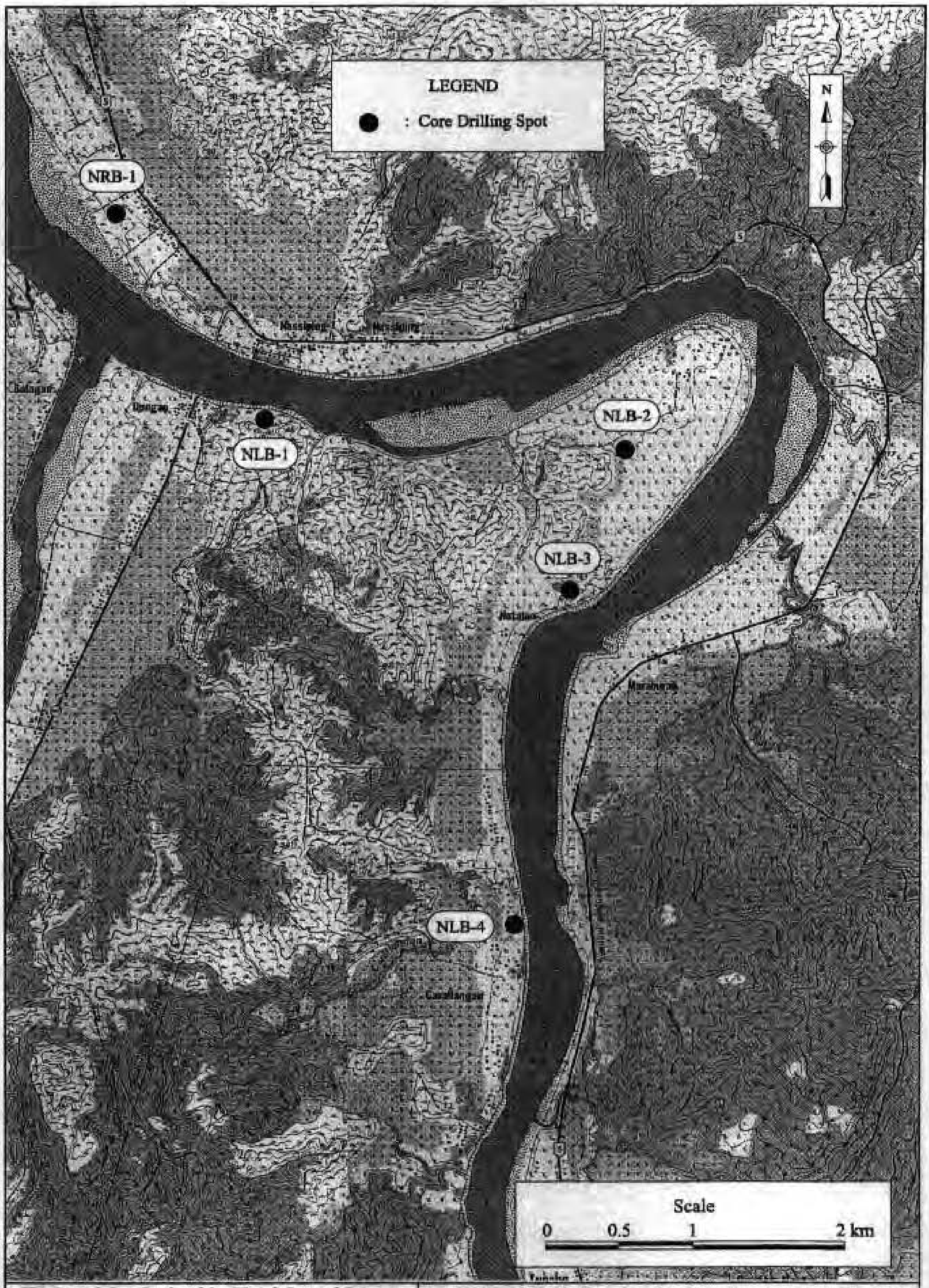
Figures



The Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines	**Figure 3.6.1**
JAPAN INTERNATIONAL COOPERATION AGENCY	**Location Map of Boring in Magapit Narrow**



The Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines

JAPAN INTERNATIONAL COOPERATION AGENCY

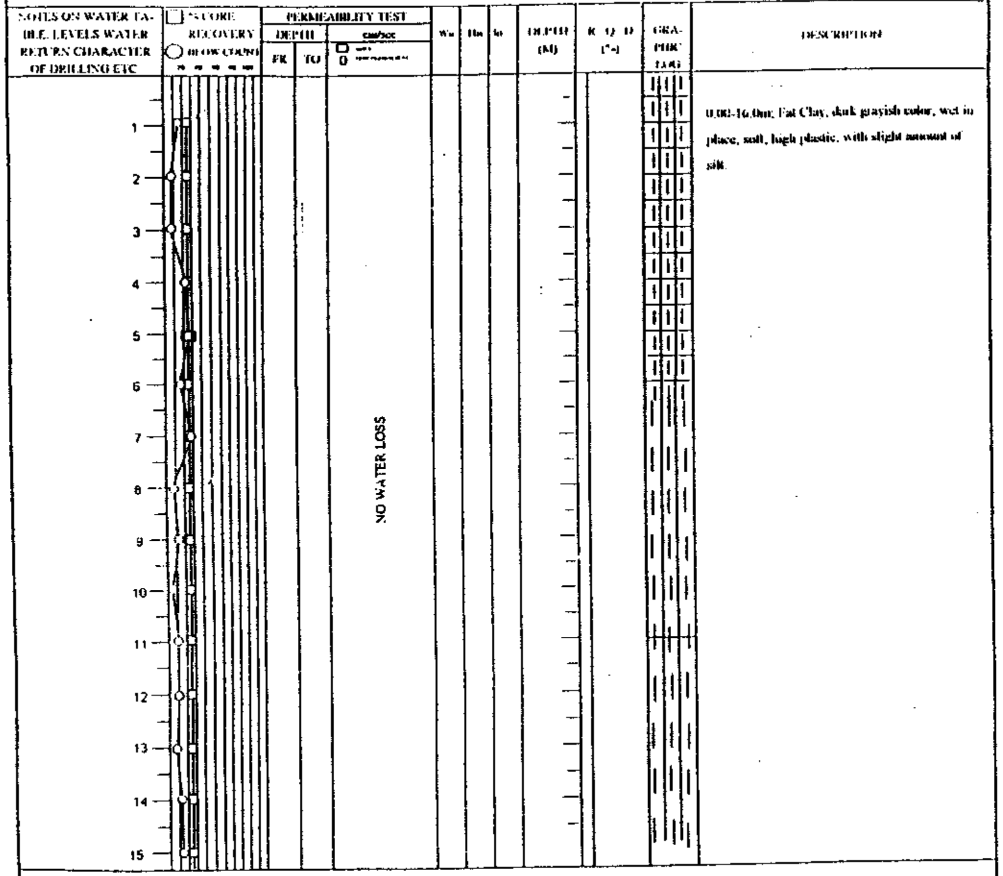
Figure 3.6.2

Location Map of Boring in Nasiping Narrow

MB-1

GEOLOGIC LOG OF DRILL HOLE

FEATURE: PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: LAL-LO, CAGAYAN
HOLE NO. MB-1 COORDINATES N 2,004,294.75 E 570,733.13 GROUND ELEVATION 7.22 M INCLINATION VERTICAL
BEGUN 5/26/00 FINISHED 6/4/00 DEPTH OF OVERBURDEN 21.76 M RIG MINDRILL F-20
TOTAL DEPTH 50.00 m ELE. OF WATER TABLE: 2.60 M LOGGED BY WJL CONTRACTOR ICI



0.00-16.0m; Fat Clay, dark grayish color, wet in place, soft, high plastic, with slight amount of silt.

HOLE NO. MB-1 SHEET NO. 1 of 4

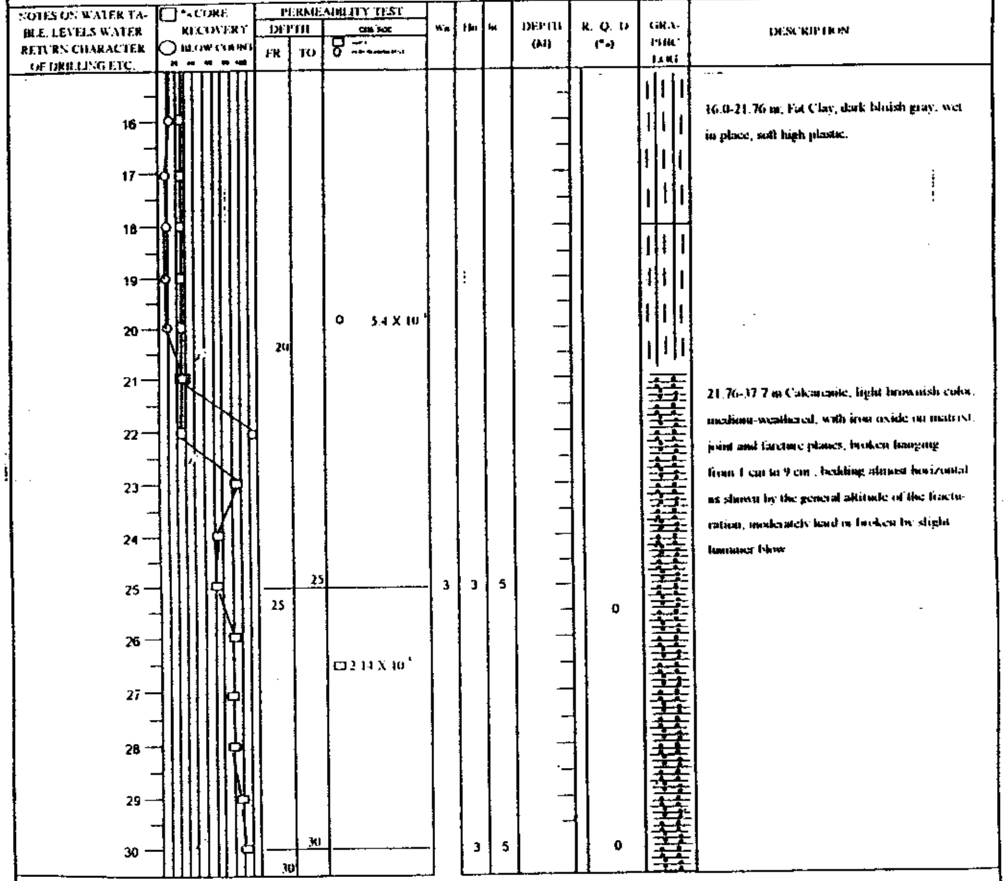
EXPLANATION

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.1 (a) Boring Log of MB-1 (1)

GEOLOGIC LOG OF DRILL HOLE

FEATURE: PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: LAL-LO, CAGAYAN
HOLE NO: MB-1 COORDINATES N 2,004,294.75 E 570,733.13 GROUND ELEVATION 7.22 M INCLINATION VERTICAL
BEGUN 5/26/00 FINISHED 6/4/00 DEPTH OF OVERBURDEN 21.76 M RIG MINDRILL F-20
TOTAL DEPTH 50.00 m ELE. OF WATER TABLE: 2.60 M LOGGED BY WJL CONTRACTOR ICI



16.0-21.76 m; Fat Clay, dark bluish gray, wet in place, soft high plastic.

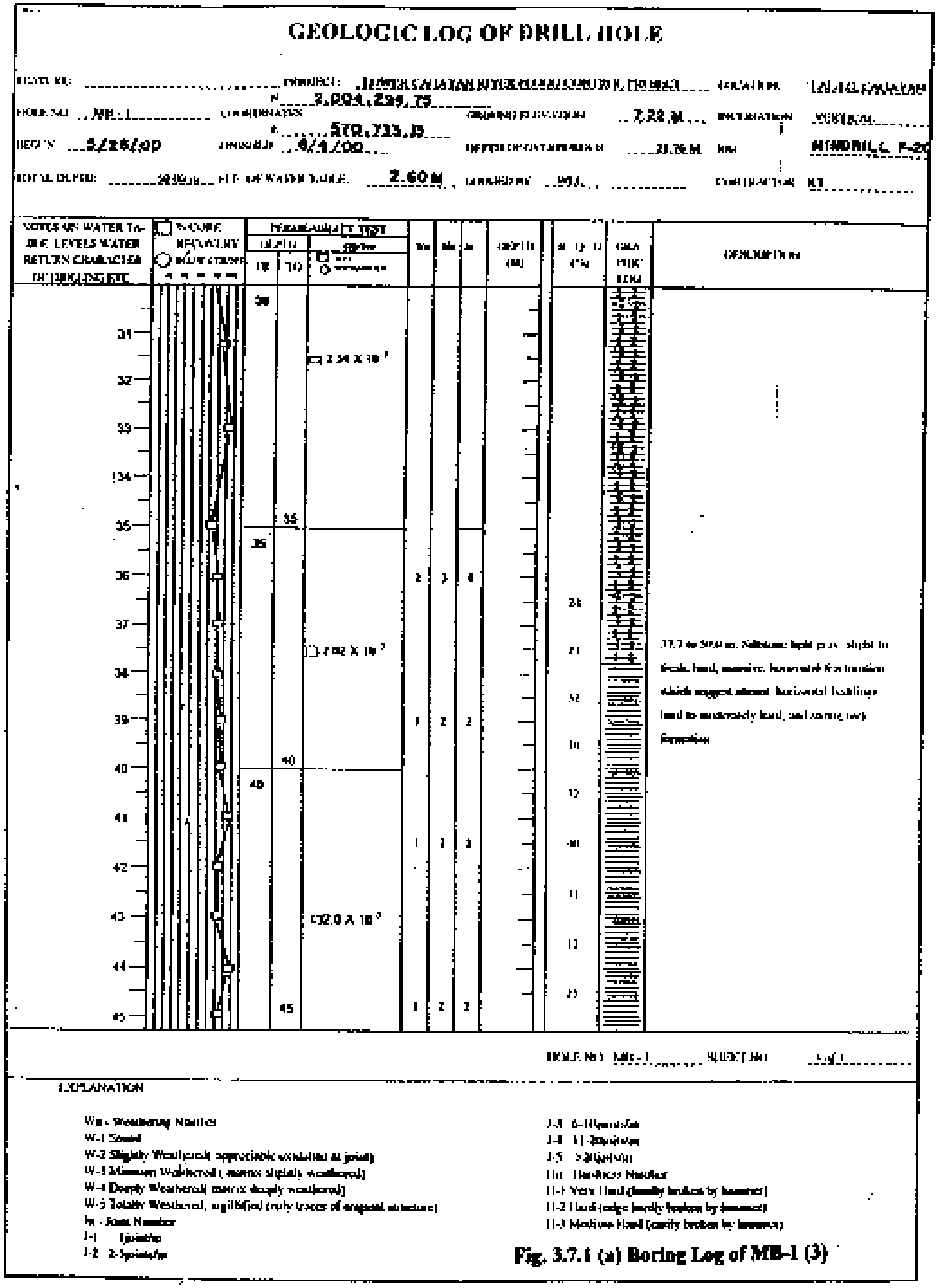
21.76-37.7 m Calcarenite, light brownish color, medium-weathered, with iron oxide on matrix, joint and fracture planes, broken hanging from 1 cm to 9 cm , bedding almost horizontal as shown by the general altitude of the fracturation, moderately hard or broken by slight hammer blow

HOLE NO. MB-1 SHEET NO. 2 of 4

EXPLANATION

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.1 (a) Boring Log of MB-1 (2)



GEOLOGIC LOG OF DRILL HOLE

PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: LAL-LO, CAGAYAN
HOLE NO. MB-1 COORDINATES N 2,004,294.75 E 570,735.15 GROUND ELEVATION 7.22 M INCLINATION VERTICAL
BEGUN 5/26/00 FINISHED 6/4/00 DEPTH OF OVERBURDEN 21.76 M RIG MINDRILL F-20
TOTAL DEPTH 50.00 m ELEV. OF WATER TABLE 2.60 M CONTRACTOR KT

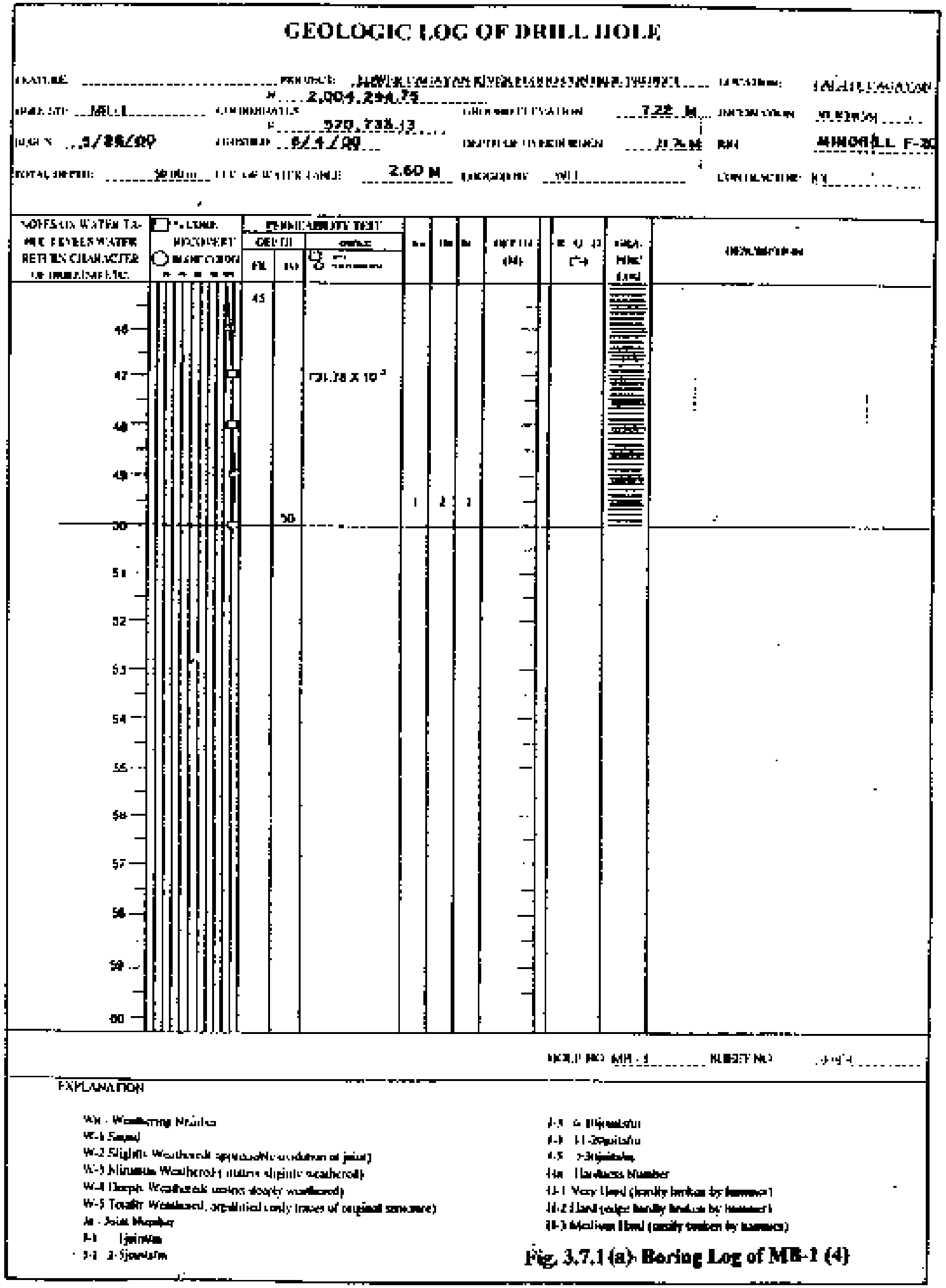
37.7 to 50.0 m. Siltstone: light gray, slight to fresh, hard, massive, horizontal fine lamination which suggest almost horizontal beddings, hard to moderately hard, and strong rock formation

HOLE NO. MB-1 SHEET NO.

EXPLANATION

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered(matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joints/m
J-5 >20joints/m
Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.1 (a) Boring Log of MB-1 (3)



GEOLOGIC LOG OF DRILL HOLE

PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: LAL-LO, CAGAYAN
HOLE NO. MB-1 COORDINATES N 2,004,294.75 E 570,735.13 GROUND ELEVATION 7.22 M INCLINATION VERTICAL
BEGUN 5/26/00 FINISHED 6/4/00 DEPTH OF OVERBURDEN 21.76 M RIG MINDRILL F-20
TOTAL DEPTH 50.00 m ELEV. OF WATER TABLE 2.60 M CONTRACTOR KT

HOLE NO. MB-1 SHEET NO.

EXPLANATION

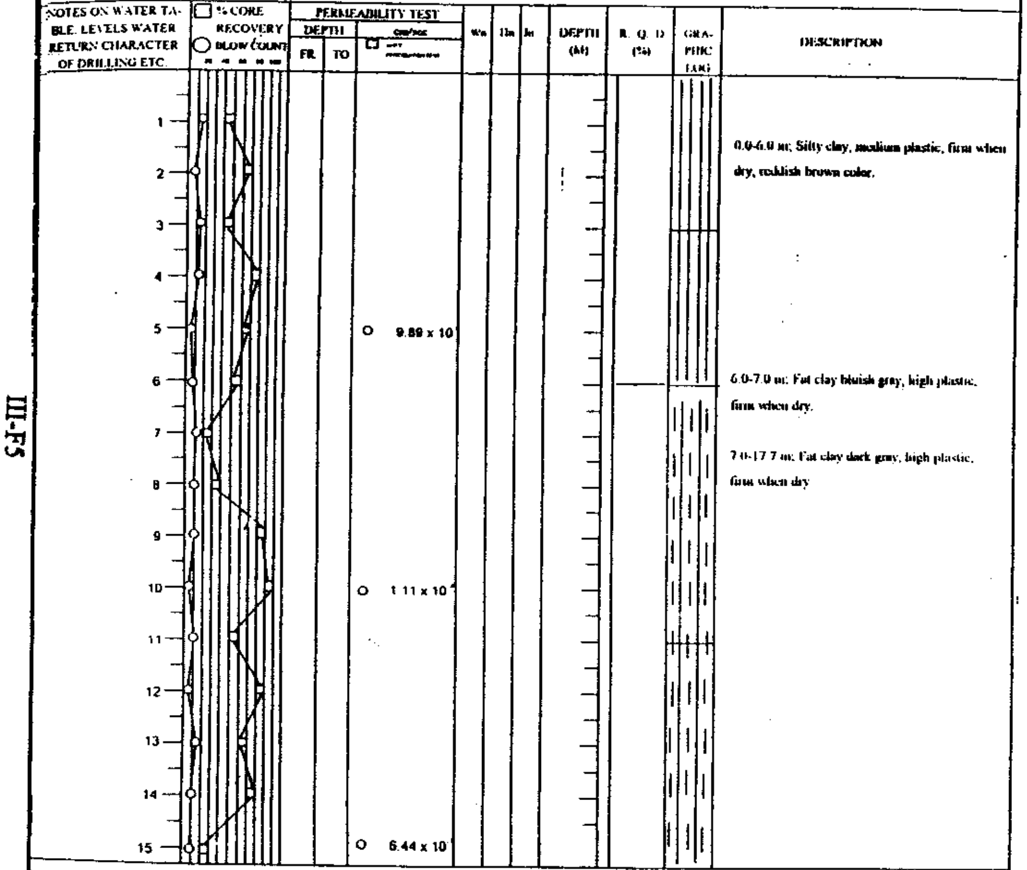
Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered(matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joints/m
J-5 >20joints/m
Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.1 (a) Boring Log of MB-1 (4)

MB-2

GEOLOGIC LOG OF DRILL HOLE

FEATURE: PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: LAL-LO, CAGAYAN
HOLE NO: MB - 2 COORDINATES N 2,003,885.91 E 571,071.5 GROUND ELEVATION: 10.42 M INCLINATION: VERTICAL
BEGUN: 5/28/00 FINISHED: 6/4/00 DEPTH OF OVERBURDEN: 50.0 M RIG: TONE THS-5
TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 6.93 M LOGGED BY: WJJ CONTRACTOR: ICI



0.0-6.0 m: Silty clay, medium plastic, firm when dry, reddish brown color.

6.0-7.0 m: Fat clay bluish gray, high plastic, firm when dry.

7.0-17.7 m: Fat clay dark gray, high plastic, firm when dry

HOLE NO. MB - 2 SHEET NO. 1 of 4

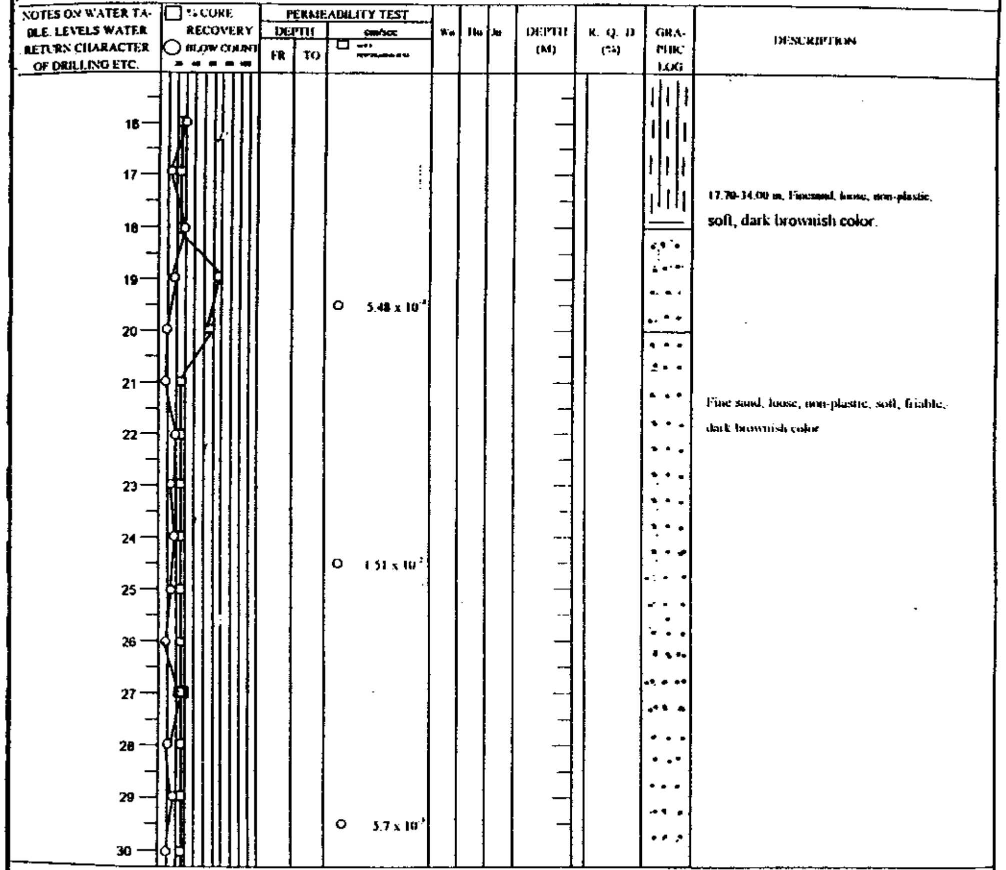
EXPLANATION.

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.1 (b) Boring Log of MB-2 (1)

GEOLOGIC LOG OF DRILL HOLE

FEATURE: PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: LAL-LO, CAGAYAN
HOLE NO: MB - 2 COORDINATES N 2,003,885.91 E 571,071.54 GROUND ELEVATION: 10.42 M INCLINATION: VERTICAL
BEGUN: 5/28/00 FINISHED: 6/4/00 DEPTH OF OVERBURDEN: 50.0 M RIG: TONE THS-5
TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 6.93 M LOGGED BY: WJJ CONTRACTOR: ICI



17.70-34.00 m, Finesand, loose, non-plastic, soft, dark brownish color.

Fine sand, loose, non-plastic, soft, friable, dark brownish color

HOLE NO. MB - 2 SHEET NO. 2 of 4

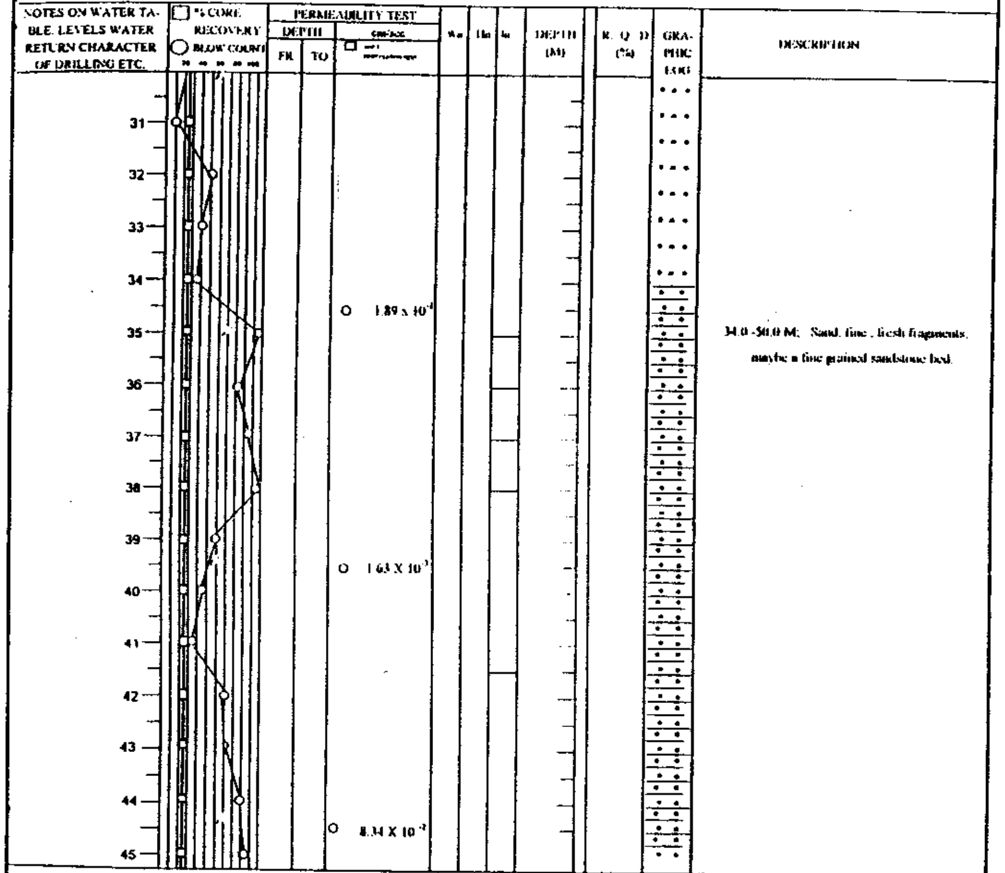
EXPLANATION.

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.1 (b) Boring Log of MB-2 (2)

GEOLOGIC LOG OF DRILL HOLE

EATURE: ______ PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: LAL-LO, CAGAYAN
HOLE NO. MB-2 COORDINATES N 2,003,885.91 E 571,071.54 GROUND ELEVATION 10.42 INCLINATION VERTICAL
BEGUN: 5/26/00 FINISHED 6/4/00 DEPTH OF OVERBURDEN 50.0 M RIG: ZONE THS-5
TOTAL DEPTH 50.00 m ELE. OF WATER TABLE: 6.93 M LOGGED BY WLL CONTRACTOR ICI



34.0 -50.0 M; Sand, fine, flesh fragments, maybe a fine grained sandstone bed.

HOLE NO MB-2 SHEET NO 3 of 4

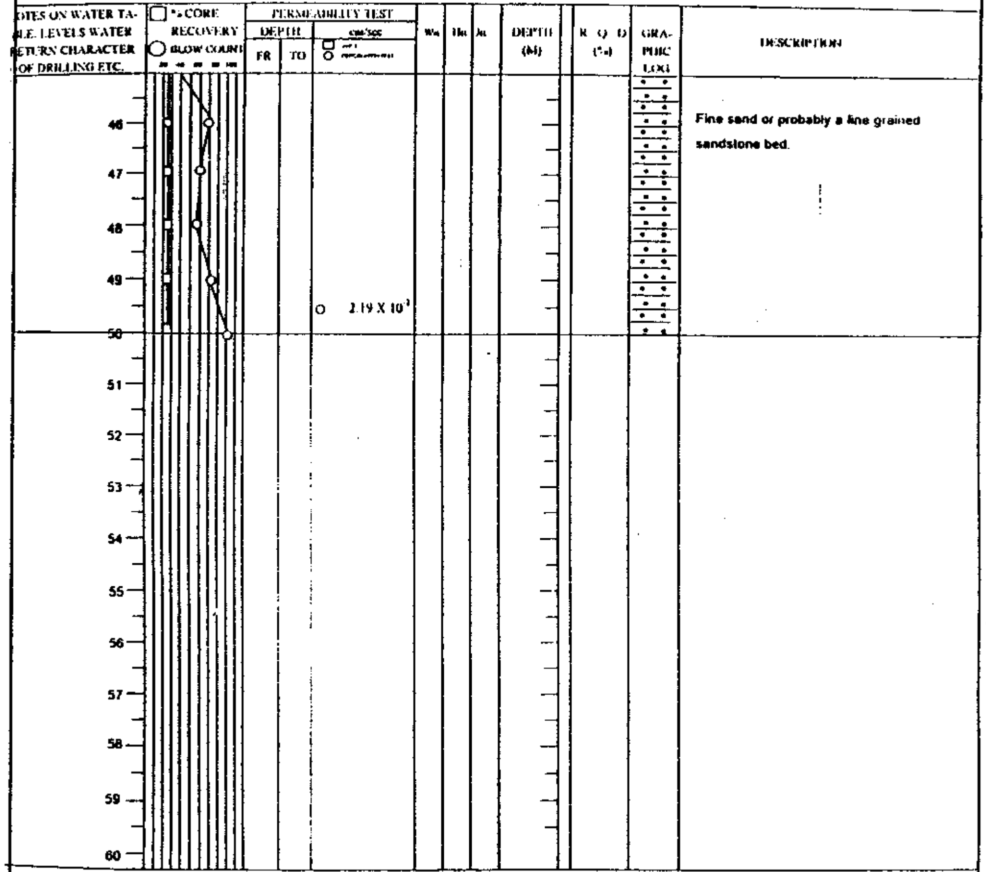
EXPLANATION

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.1 (b) Boring Log of MB-2 (3)

GEOLOGIC LOG OF DRILL HOLE

ATURE ______ PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: LAL-LO, CAGAYAN
LE NO MB-2 COORDINATES N 2,003,885.91 E 571,071.54 GROUND ELEVATION 10.42 M INCLINATION VERTICAL
GUN 5/26/00 FINISHED 6/4/00 DEPTH OF OVERBURDEN 50.0 M RIG: ZONE THS-5
TAL DEPTH 50.00 m ELE. OF WATER TABLE 6.93 M LOGGED BY WLL CONTRACTOR ICI



Fine sand or probably a fine grained sandstone bed.

HOLE NO MB-2 SHEET NO. 4 of 4

EXPLANATION

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.1 (b) Boring Log of MB-2 (4)

NRB-1

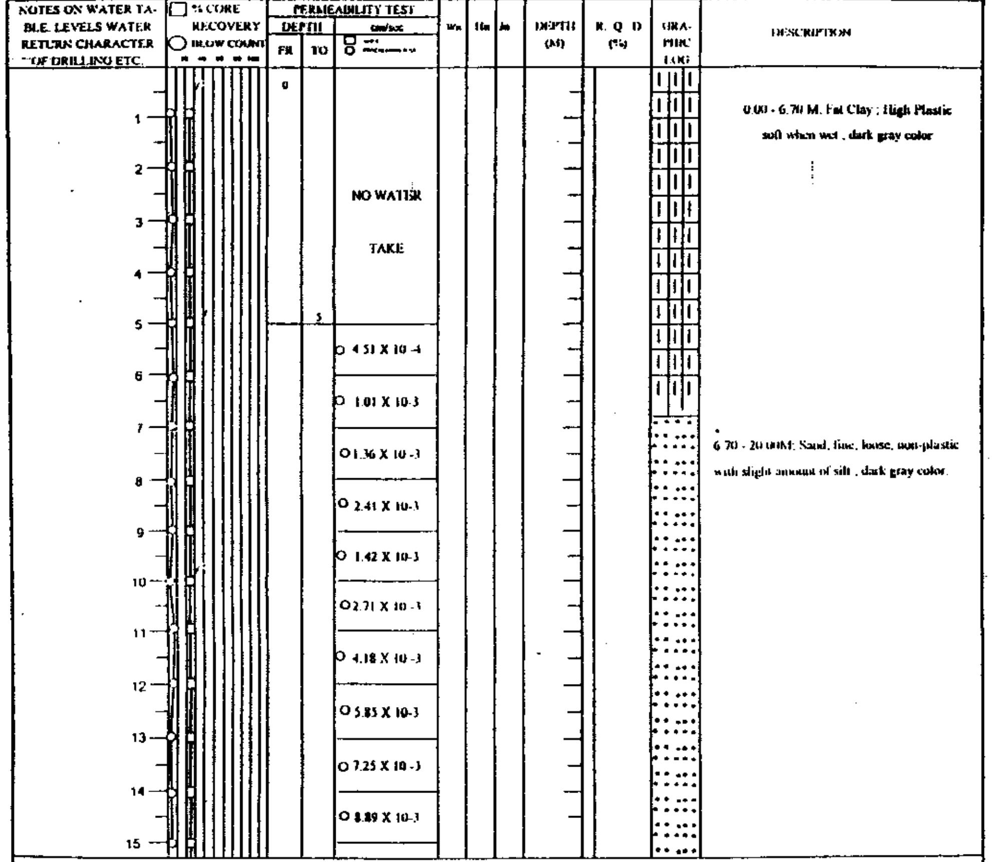
GEOLOGIC LOG OF DRILL HOLE

FEATURE: PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: GATTARAN, CAGAYAN

HOLE NO: NRB - 1 COORDINATES N 1,987,758.62 E 564,768.73 GROUND ELEVATION: 11.45 M INCLINATION: VERTICAL

BEGUN: 5/9/00 FINISHED 5/10/00 DEPTH OF OVERBURDEN 30.0 M RIG: TONE THS-5

TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 6.40 M LOGGED BY: WJJ CONTRACTOR: ICI



PERMEABILITY TEST DEPTH FR	TO	cm/sec	DESCRIPTION
0	5	NO WATER TAKE	0.00 - 6.70 M. Fat Clay ; High Plastic soft when wet , dark gray color
		○ 4.51 X 10 -4	
		○ 1.01 X 10-3	
		○ 1.36 X 10 -3	6.70 - 20.00M: Sand, fine, loose, non-plastic with slight amount of silt , dark gray color.
		○ 2.41 X 10-3	
		○ 1.42 X 10-3	
		○ 2.71 X 10 -3	
		○ 4.18 X 10 -3	
		○ 5.85 X 10-3	
		○ 7.25 X 10 -3	
		○ 8.89 X 10-3	

HOLE NO. NRB - 1 SHEET NO. 1 of 4

EXPLANATION

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (a) Boring Log of NRB-1 (1)

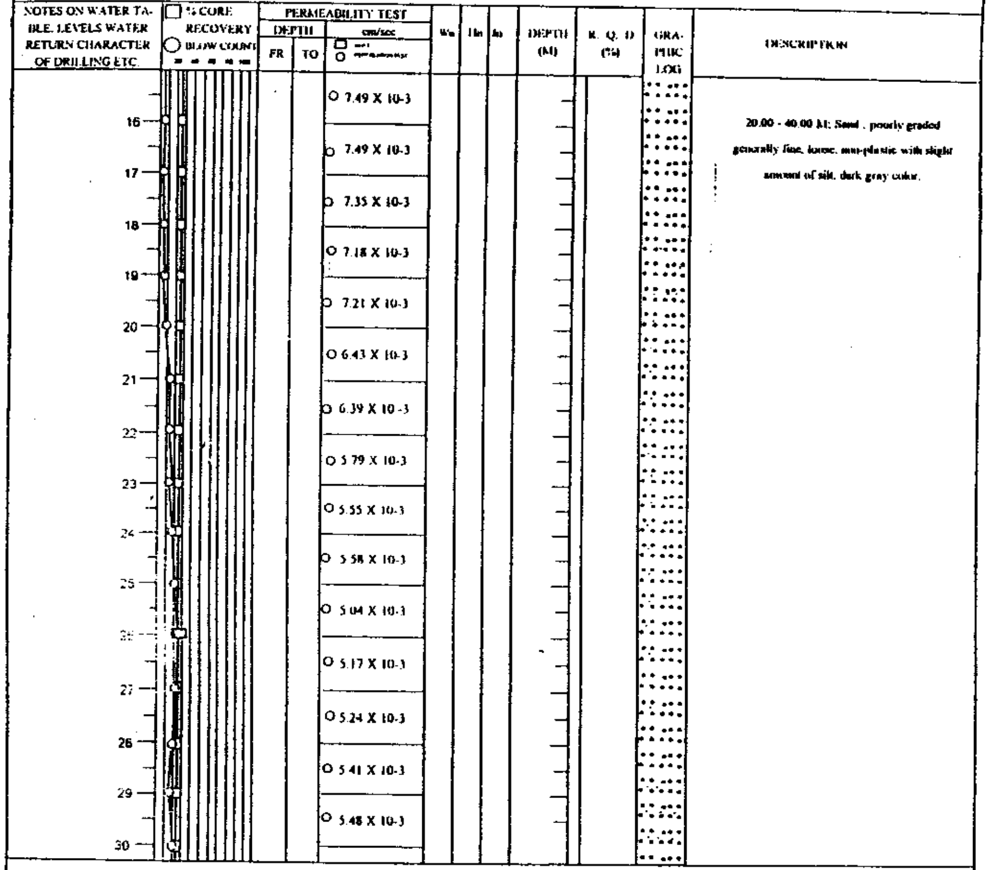
GEOLOGIC LOG OF DRILL HOLE

FEATURE: PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: GATTARAN, CAGAYAN

HOLE NO: NRB - 1 COORDINATES N 1,987,758.62 E 564,768.73 GROUND ELEVATION: 11.45 M INCLINATION: VERTICAL

BEGUN: 5/9/00 FINISHED 5/18/00 DEPTH OF OVERBURDEN 30.0 M RIG: TONE THS-5

TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 6.40M LOGGED BY: WJJ CONTRACTOR: ICI



PERMEABILITY TEST DEPTH FR	TO	cm/sec	DESCRIPTION
		○ 7.49 X 10-3	20.00 - 40.00 M: Sand , poorly graded generally fine, loose, non-plastic with slight amount of silt, dark gray color.
		○ 7.49 X 10-3	
		○ 7.35 X 10-3	
		○ 7.18 X 10-3	
		○ 7.21 X 10-3	
		○ 6.43 X 10-3	
		○ 6.39 X 10 -3	
		○ 5.79 X 10-3	
		○ 5.55 X 10-3	
		○ 5.58 X 10-3	
		○ 5.04 X 10-3	
		○ 5.17 X 10-3	
		○ 5.24 X 10-3	
		○ 5.41 X 10-3	
		○ 5.48 X 10-3	

HOLE NO. NRB - 1 SHEET NO. 2 of 4

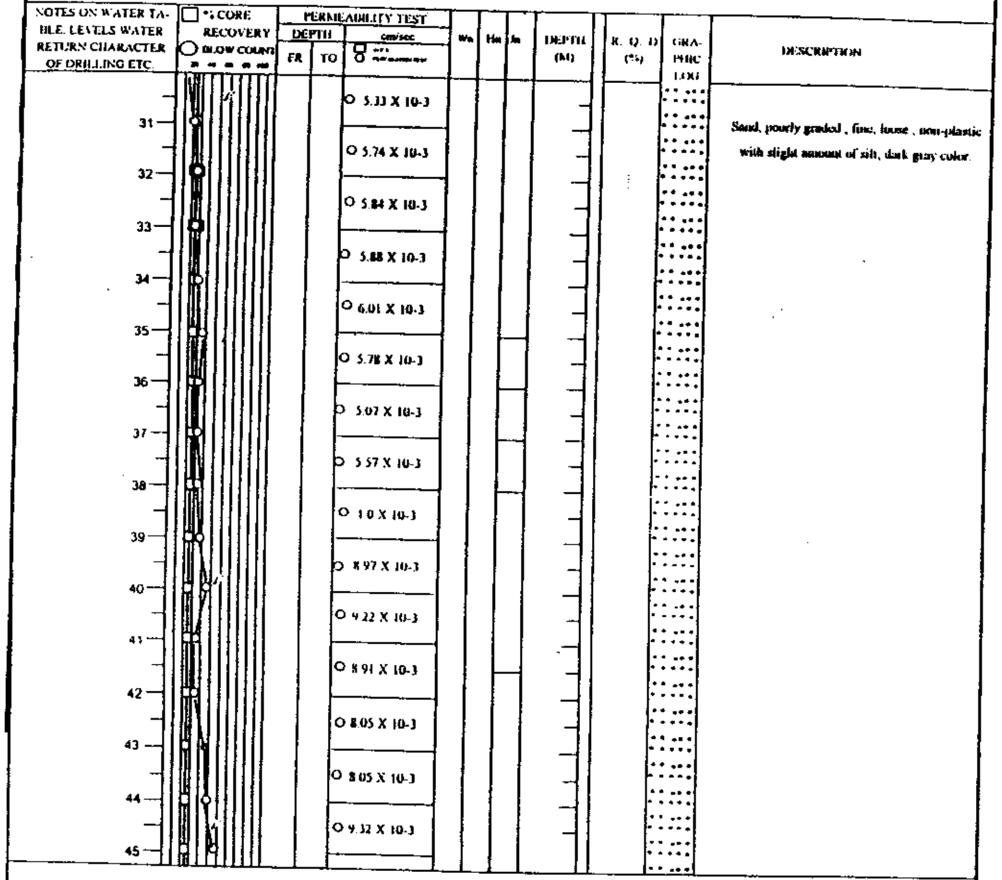
EXPLANATION

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (a) Boring Log of NRB-1 (2)

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: GATTARAN, CAGAYAN
HOLE NO: NRB-1
COORDINATES N 1,987,758.62 E 564,768.73
GROUND ELEVATION: 11.45 M
INCLINATION: VERTICAL
BEGUN: 5/9/00
FINISHED: 5/18/00
DEPTH OF OVERBURDEN: 50.0 M
RIG: TONE THS-5
TOTAL DEPTH: 50.00 m
ELE. OF WATER TABLE: 6.40 M
LOGGED BY: WIJ
CONTRACTOR: KCI



PERMEABILITY TEST cm/sec
○ 5.33 X 10-3
○ 5.74 X 10-3
○ 5.84 X 10-3
○ 5.88 X 10-3
○ 6.01 X 10-3
○ 5.78 X 10-3
○ 5.07 X 10-3
○ 5.57 X 10-3
○ 1.0 X 10-3
○ 8.97 X 10-3
○ 9.22 X 10-3
○ 8.91 X 10-3
○ 8.05 X 10-3
○ 8.05 X 10-3
○ 9.32 X 10-3

DESCRIPTION: Sand, poorly graded, fine, loose, non-plastic with slight amount of silt, dark gray color.

HOLE NO. NRB-1 SHEET NO. 3 of 4

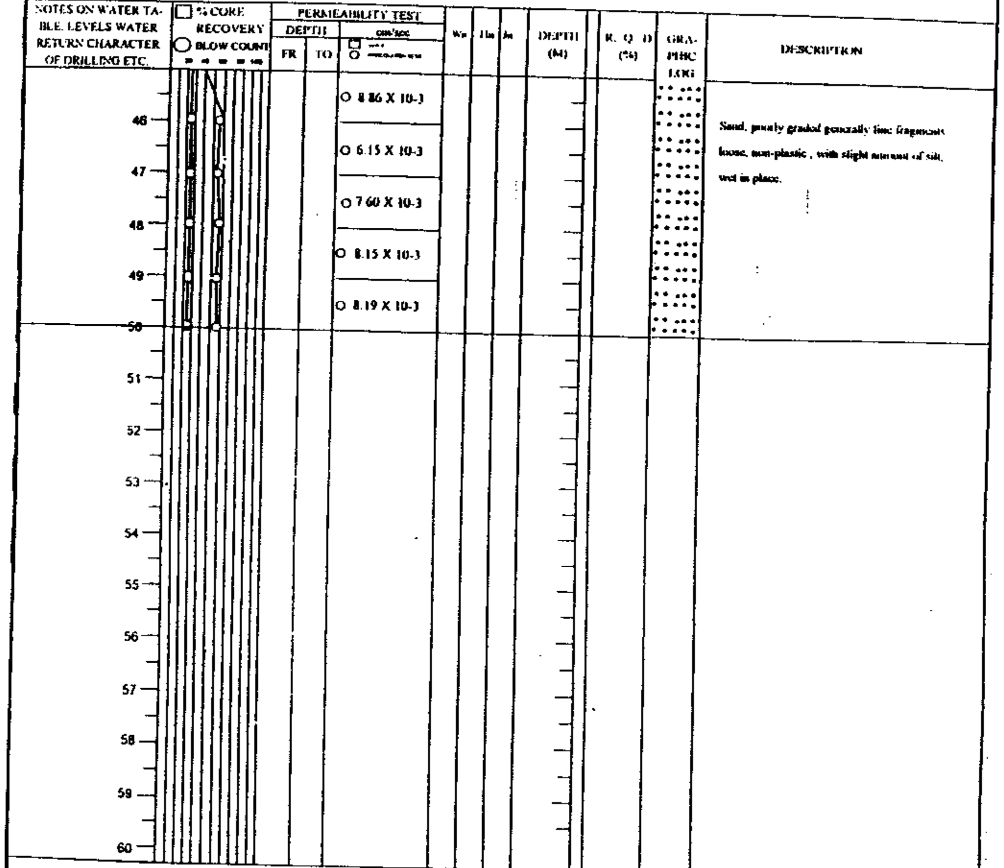
EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joints/m
J-5 >20joints/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (a) Boring Log of NRB-1 (3)

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: GATTARAN, CAGAYAN
HOLE NO: NRB-1
COORDINATES N 1,987,758.62 E 564,768.73
GROUND ELEVATION: 11.45 M
INCLINATION: VERTICAL
BEGUN: 5/9/00
FINISHED: 6/18/00
DEPTH OF OVERBURDEN: 50.0 M
RIG: TONE THS-5
TOTAL DEPTH: 50.00 m
ELE. OF WATER TABLE: 6.40 M
LOGGED BY: WIJ
CONTRACTOR: KCI



PERMEABILITY TEST cm/sec
○ 8.86 X 10-3
○ 6.15 X 10-3
○ 7.60 X 10-3
○ 8.15 X 10-3
○ 8.19 X 10-3

DESCRIPTION: Sand, poorly graded generally fine fragments loose, non-plastic, with slight amount of silt, wet in place.

HOLE NO. NRB-1 SHEET NO. 4 of 4

EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

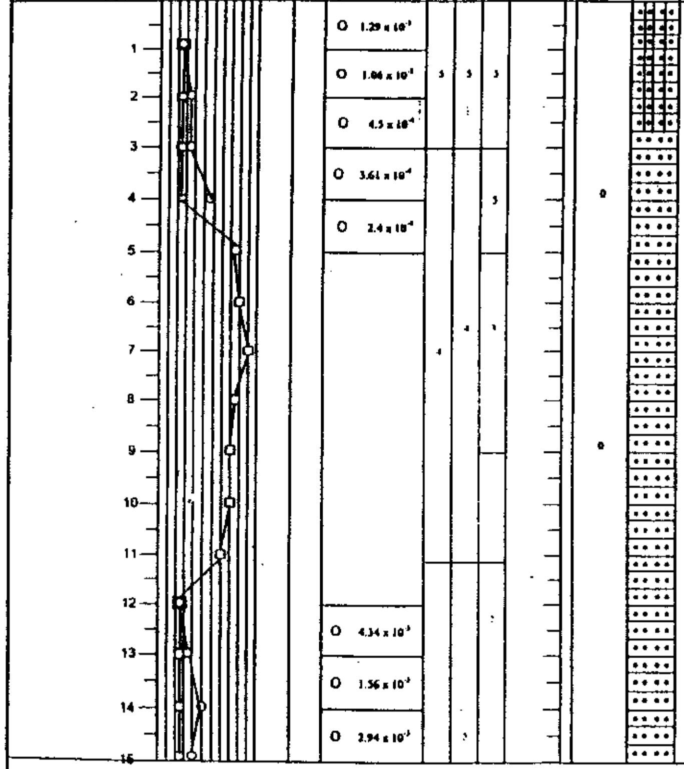
Fig. 3.7.2 (a) Boring Log of NRB-1 (4)

NLB-1

GEOLOGIC LOG OF DRILL HOLE

FEATURE: ______ PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: STO. NIÑO CAGAYAN
HOLE NO: NLB-1 COORDINATES N 1,986,632.12 E 565,777.74 GROUND ELEVATION: 9.73 M INCLINATION: VERTICAL
BEGUN: 4/28/00 FINISHED 5/1/00 DEPTH OF OVERBURDEN: 30 M MODEL: TONE THS-5
TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 4.90 m LOGGED BY: WLL CONTRACTOR: ICI

NOTES ON WATER TABLE LEVELS WATER RETURN CHARACTER OF DRILLING ETC. | ☐ % CORE RECOVERY ○ BLOW COUNT | PERMEABILITY TEST: DEPTH FR TO, cm/sec | Wn | Hn | Jn | DEPTH (M) | R. Q. D (%) | GRAPHIC LOG | DESCRIPTION



0.00-3.00 m: Totally weathered Sandstone, Friable and loose

3.00-16.00 m: sandstone, moderate to highly weathered, 2-5° dip of beds, with leanes of siltstone at the depth of 6.54-6.40 m, extremely weathered at the depth of 11-16 meters.

HOLE NO. NLB-1 SHEET NO. 1 of 4

EXPLANATION:

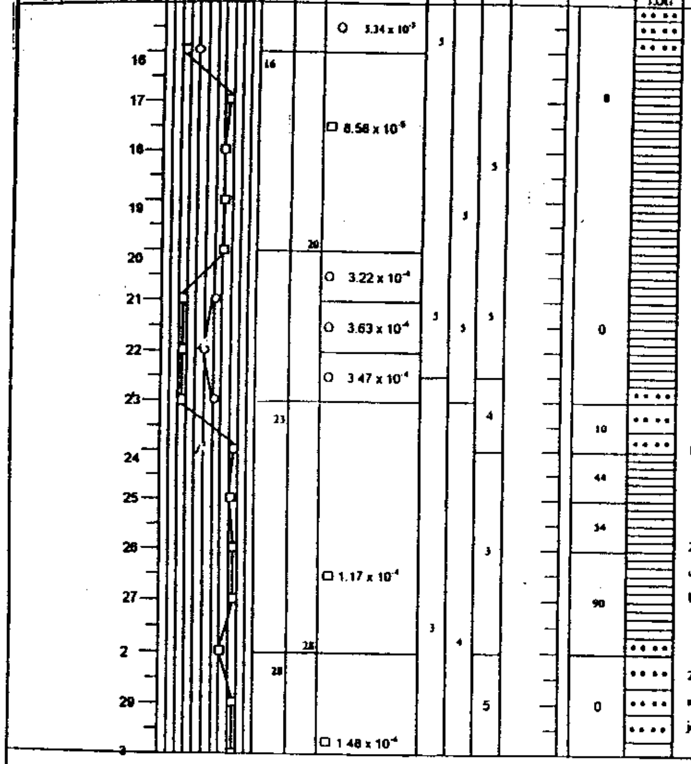
Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (b) Boring Log of NLB-1 (1)

GEOLOGIC LOG OF DRILL HOLE

FEATURE: ______ PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: STO. NIÑO CAGAYAN
HOLE NO: NLB-1 COORDINATES N 1,986,632.12 E 565,777.74 GROUND ELEVATION: 9.73 M INCLINATION: VERTICAL
BEGUN: 4/28/00 FINISHED 5/1/00 DEPTH OF OVERBURDEN: 30 M MODEL: TONE THS-5
TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 4.90 m LOGGED BY: WLL CONTRACTOR: ICI

NOTES ON WATER TABLE LEVELS WATER RETURN CHARACTER OF DRILLING ETC. | ☐ % CORE RECOVERY ○ BLOW COUNT | PERMEABILITY TEST: DEPTH FR TO, cm/sec | Wn | Hn | Jn | DEPTH (M) | R. Q. D (%) | GRAPHIC LOG | DESCRIPTION



16.00-22.70: Mudstone, extreme to totally weathered mudstone, soil or easily broken by finger pressure.

22.70-24.00 m; Sandstone Moderately weathered slightly hard or broken by finger pressure.

24.00-27.70 m; Mudstone, moderate to deeply weathered, slightly hard or broken by finger pressure.

27.70-32.00 m; Sandstone, medium-grained, medium weathered, with iron oxides along joint/fracture plane.

HOLE NO. NLB-1 SHEET NO. 2 of 4

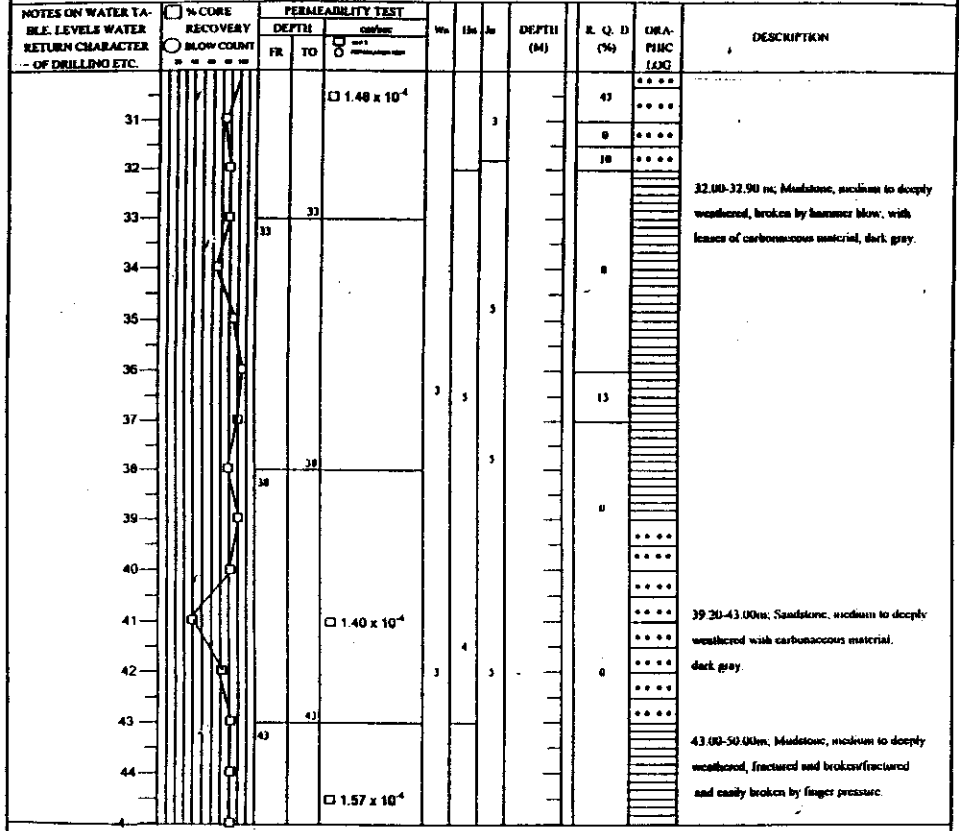
EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (b) Boring Log of NLB-1 (2)

GEOLOGIC LOG OF DRILL HOLE

FEATURE: ____ PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: STO. NIÑO CAGAYAN
HOLE NO: NLB-1 COORDINATES N 1,986,832.12 E 565,777.74 GROUND ELEVATION: 9.73 M INCLINATION: VERTICAL
BEGUN: 4/28/00 FINISHED 5/1/00 DEPTH OF OVERBURDEN: 30 M MODEL: TONE THS-5
TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 8.90 m LOGGED BY: WLL CONTRACTOR: ICI



32.00-32.90 m; Mudstone, medium to deeply weathered, broken by hammer blow, with leases of carbonaceous material, dark gray.

39.20-43.00m; Sandstone, medium to deeply weathered with carbonaceous material, dark gray.

43.00-50.00m; Mudstone, medium to deeply weathered, fractured and broken/fractured and easily broken by finger pressure.

HOLE NO. NLB-1 SHEET NO. 3 of 4

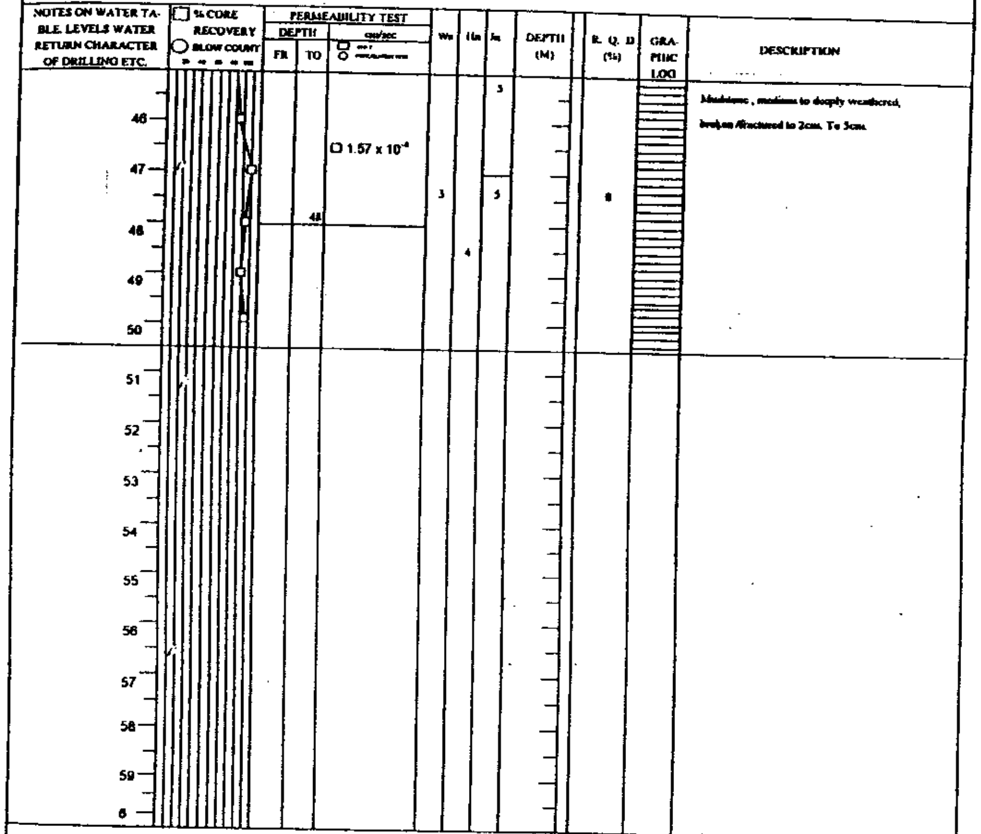
EXPLANATION:

Wn - Weathering Number	J-3 6-10joints/m
W-1 Sound	J-4 11-20joits/m
W-2 Slightly Weathered(appreciable oxidation at joint)	J-5 >20joits/m
W-3 Minimum Weathered (matrix slightly weathered)	Hn - Hardness Number
W-4 Deeply Weathered(matrix deeply weathered)	H-1 Very Hard (hardly broken by hammer)
W-5 Totally Weathered, argillified (only traces of original structure)	H-2 Hard (edge hardly broken by hammer)
Jn - Joint Number	H-3 Medium Hard (easily broken by hammer)
J-1 1joint/m	
J-2 2-5joints/m	

Fig. 3.7.2 (b) Boring Log of NLB-1 (3)

GEOLOGIC LOG OF DRILL HOLE

FEATURE: ____ PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: STO. NIÑO CAGAYAN
HOLE NO: NLB-1 COORDINATES N 1,986,832.12 E 565,777.74 GROUND ELEVATION: 9.73 M INCLINATION: VERTICAL
BEGUN: 4/28/00 FINISHED 5/1/00 DEPTH OF OVERBURDEN: 30 M MODEL: TONE THS-5
TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 8.90 m LOGGED BY: WLL CONTRACTOR: ICI



Mudstone , medium to deeply weathered, broken /fractured to 2cm. To 5cm.

HOLE NO. NLB-1 SHEET NO. 4 of 4

EXPLANATION:

Wn - Weathering Number	J-3 6-10joints/m
W-1 Sound	J-4 11-20joits/m
W-2 Slightly Weathered(appreciable oxidation at joint)	J-5 >20joits/m
W-3 Minimum Weathered (matrix slightly weathered)	Hn - Hardness Number
W-4 Deeply Weathered(matrix deeply weathered)	H-1 Very Hard (hardly broken by hammer)
W-5 Totally Weathered, argillified (only traces of original structure)	H-2 Hard (edge hardly broken by hammer)
Jn - Joint Number	
J-1 1joint/m	
J-2 2-5joints/m	

Fig. 3.7.2 (b) Boring Log of NLB-1 (4)

NLB-2

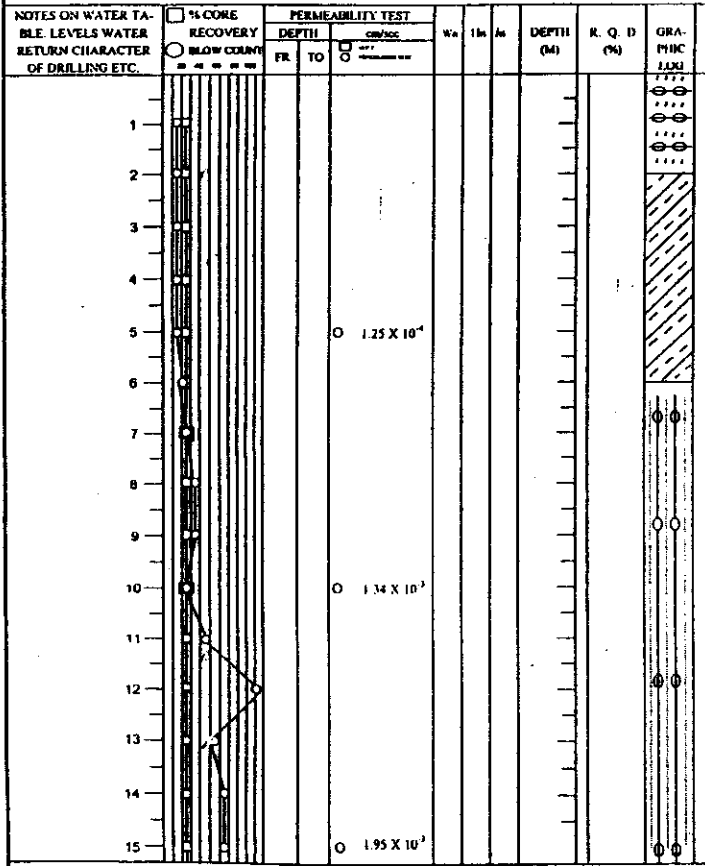
GEOLOGIC LOG OF DRILL HOLE

FEATURE: ______ PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: CABALLANGAN, ALCALA, CAGAYAN

HOLE NO: NLB-2 COORDINATES N 1,987,068.97 E 568,389.75 GROUND ELEVATION: 12.86 M INCLINATION: VERTICAL

BEGUN: 6/2/00 FINISHED 6/10/00 DEPTH OF OVERBURDEN: >20.0 M RIG USED: KY-20

TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 14.10 LOGGED BY: WLL CONTRACTOR: ICI



DESCRIPTION

0.00-2.00 m; Silty sand, non-plastic, friable, loose, dark brown color.

2.0-6.0 m; Clayey silt, slightly plastic, soft, redish brown color.

6.00-15.0 m; Silty sand, non-plastic, loose, dark gray color.

15.00-30.0 m; Clayey/sandy silt, slight to non-plastic, soft dark bluish gray color.

HOLE NO. NLB-2 SHEET NO. 1 of 4

EXPLANATION:

Wn - Weathering Number	J-3 6-10joints/m
W-1 Sound	J-4 11-20joits/m
W-2 Slightly Weathered(appreciable oxidation at joint)	J-5 >20joits/m
W-3 Minimum Weathered (matrix slightly weathered)	Hn - Hardness Number
W-4 Deeply Weathered(matrix deeply weathered)	H-1 Very Hard (hardly broken by hammer)
W-5 Totally Weathered, argillified (only traces of original structure)	H-2 Hard (edge hardly broken by hammer)
Jn - Joint Number	H-3 Medium Hard (easily broken by hammer)
J-1 1joint/m	
J-2 2-5joints/m	

Fig. 3.7.2 (c) Boring Log of NLB-2 (1)

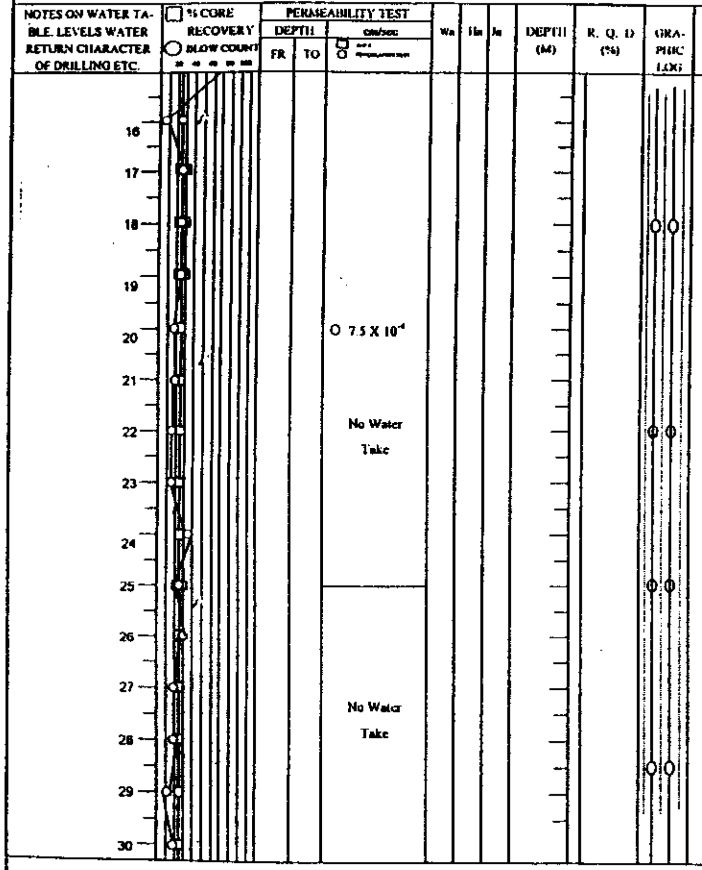
GEOLOGIC LOG OF DRILL HOLE

FEATURE: ______ PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: CABALLANGAN, ALCALA, CAGAYAN

HOLE NO: NLB-2 COORDINATES N 1,987,068.97 E 568,389.75 GROUND ELEVATION: 12.86 M INCLINATION: VERTICAL

BEGUN: 6/2/00 FINISHED 6/10/00 DEPTH OF OVERBURDEN: >20.0 M RIG USED: KY-20

TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 14.10 M LOGGED BY: WLL CONTRACTOR: ICI



DESCRIPTION

Clayey / Sandy silt, slight to non-plastic, dark bluish color.

HOLE NO. NLB-2 SHEET NO. 2 of 4

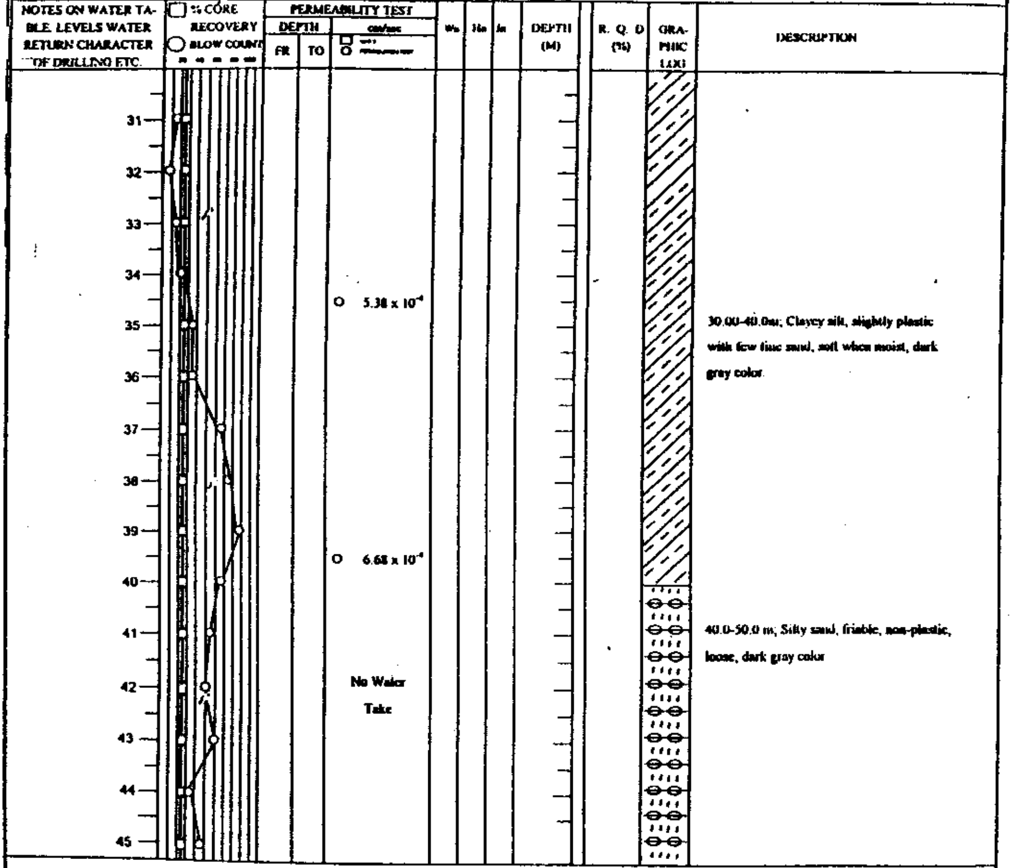
EXPLANATION:

Wn - Weathering Number	J-3 6-10joints/m
W-1 Sound	J-4 11-20joits/m
W-2 Slightly Weathered(appreciable oxidation at joint)	J-5 >20joits/m
W-3 Minimum Weathered (matrix slightly weathered)	Hn - Hardness Number
W-4 Deeply Weathered(matrix deeply weathered)	H-1 Very Hard (hardly broken by hammer)
W-5 Totally Weathered, argillified (only traces of original structure)	H-2 Hard (edge hardly broken by hammer)
Jn - Joint Number	H-3 Medium Hard (easily broken by hammer)
J-1 1joint/m	
J-2 2-5joints/m	

Fig. 3.7.2 (c) Boring Log of NLB-2 (2)

GEOLOGIC LOG OF DRILL HOLE

FEATURE: ______ PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: CABALLANGAN, ALCALA, CAGAYAN
HOLE NO. NLB-2 COORDINATES N 1,987,068.97 E 560,389.75 GROUND ELEVATION: 12.86 M INCLINATION: VERTICAL
BEGUN: 6/2/00 FINISHED 6/10/00 DEPTH OF OVERBURDEN: >20.0 M RIG USED: KY-2D
TOTAL DEPTH: 50.00 m ELE. OF WATER TABLE: 14.10 M LOGGED BY: WJJ CONTRACTOR: KCI



30.00-40.0m; Clayey silt, slightly plastic with few fine sand, soft when moist, dark gray color.

40.0-50.0 m; Silty sand, friable, non-plastic, loose, dark gray color

HOLE NO. NLB-2 SHEET NO. 3 of 4

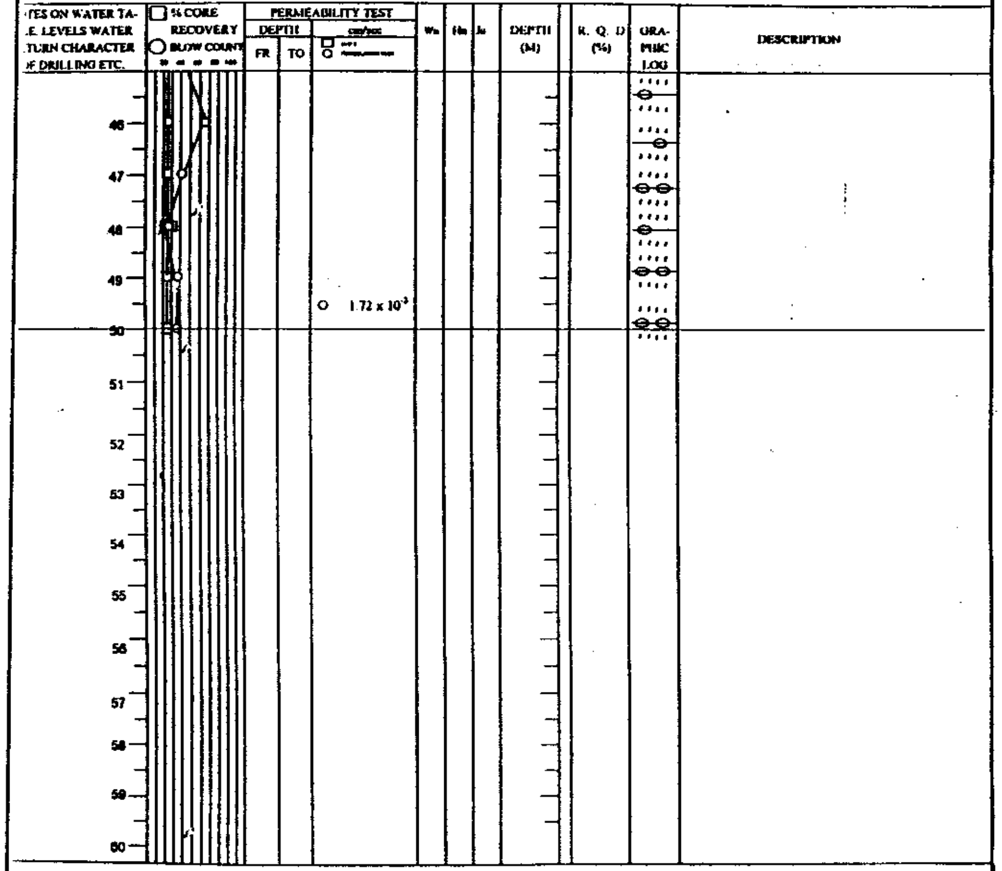
EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joints/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (c) Boring Log of NLB-2 (3)

GEOLOGIC LOG OF DRILL HOLE

URE: ______ PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: CABALLANGAN, ALCALA, CAGAYAN
E NO: NLB-2 COORDINATES N 1,987,068.97 E 560,369.75 GROUND ELEVATION: 12.86 M INCLINATION: VERTICAL
N: 6/2/00 FINISHED 6/10/00 DEPTH OF OVERBURDEN: >20.0 M RIG USED: KY-2D
L DEPTH: 50.00 m ELE. OF WATER TABLE: 14.10 M LOGGED BY: WJJ CONTRACTOR: KCI



HOLE NO. NLB-2 SHEET NO. 4 of 4

EXPLANATION:

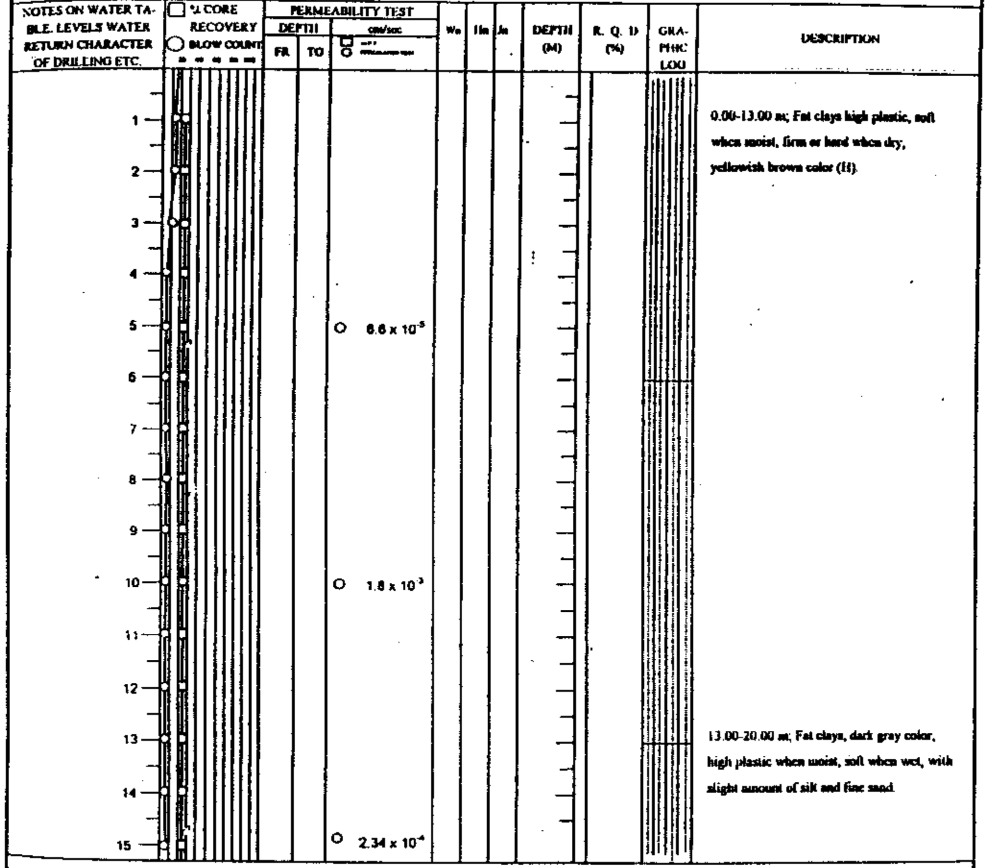
Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (c) Boring Log of NLB-2 (4)

NLB-3

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: STO. NIÑO, CAGAYAN
HOLE NO: NLB-3
COORDINATES N 1,966,016.06 E 567,988.00
GROUND ELEVATION: 18.95 M
INCLINATION: VERTICAL
BEGUN: 5/28/00
FINISHED 6/4/00
DEPTH OF OVERBURDEN: 35.00 M
BEARING: KSK-BLG
TOTAL DEPTH: 50.00 m
ELE. OF WATER TABLE: 16.05M
LOGGED BY: WJJ
CONTRACTOR: ICI



Depth	Permeability (cm/sec)
5	○ 6.6×10^{-5}
10	○ 1.8×10^{-3}
15	○ 2.34×10^{-4}

0.00-13.00 m; Fat clays high plastic, soft when moist, firm or hard when dry, yellowish brown color (H).

13.00-20.00 m; Fat clays, dark gray color, high plastic when moist, soft when wet, with slight amount of silt and fine sand.

HOLE NO. NLB-3 SHEET NO. 1 of 4

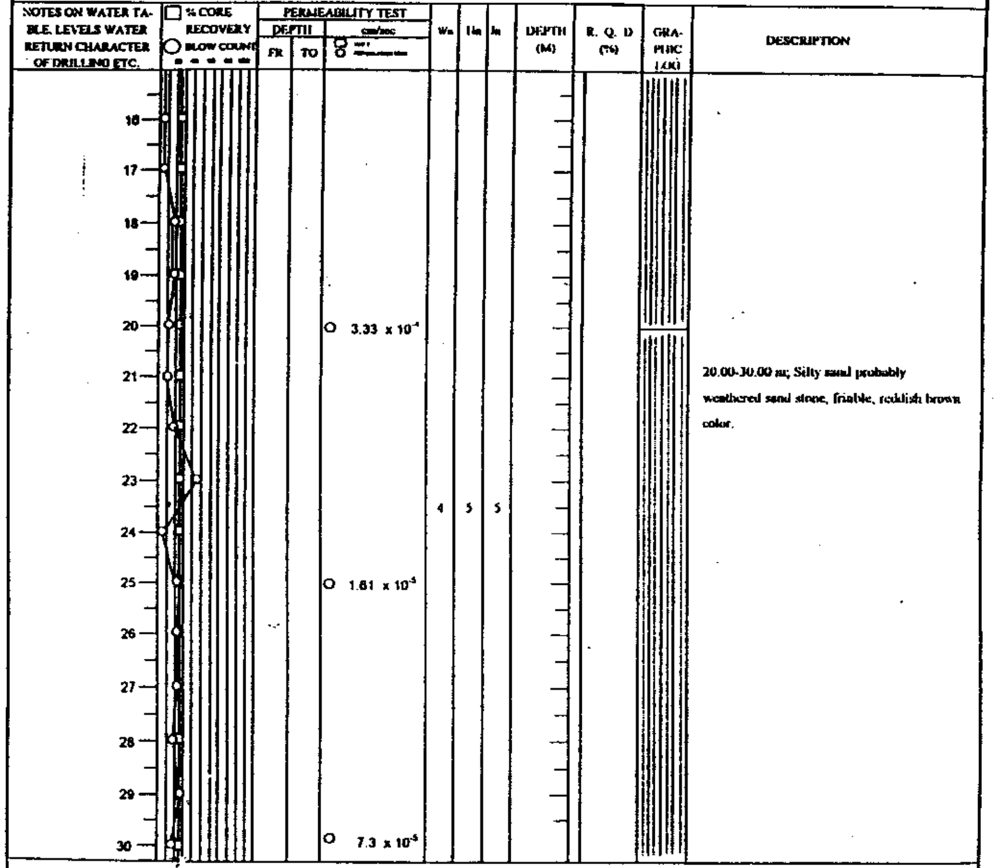
EXPLANATION:

Wn - Weathering Number	J-3 6-10joints/m
W-1 Sound	J-4 11-20joits/m
W-2 Slightly Weathered(appreciable oxidation at joint)	J-5 >20joits/m
W-3 Minimum Weathered (matrix slightly weathered)	Hn - Hardness Number
W-4 Deeply Weathered(matrix deeply weathered)	H-1 Very Hard (hardly broken by hammer)
W-5 Totally Weathered, argillified (only traces of original structure)	H-2 Hard (edge hardly broken by hammer)
Jn - Joint Number	H-3 Medium Hard (easily broken by hammer)
J-1 1joint/m	
J-2 2-5joints/m	

Fig. 3.7.2 (d) Boring Log of NLB-3 (1)

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: STO. NIÑO, CAGAYAN
HOLE NO: NLB-3
COORDINATES N 1,986,016.06 E 567,988.00
GROUND ELEVATION: 18.95 M
INCLINATION: VERTICAL
BEGUN: 5/28/00
FINISHED 6/4/00
DEPTH OF OVERBURDEN: 35.00M
BEARING: KSK-BLG
TOTAL DEPTH: 50.00 m
ELE. OF WATER TABLE: 16.05 M
LOGGED BY: WJJ
CONTRACTOR: ICI



Depth	Permeability (cm/sec)
20	○ 3.33×10^{-4}
25	○ 1.61×10^{-5}
30	○ 7.3×10^{-5}

Wn	Hn	Jn
4	5	5

20.00-30.00 m; Silty sand probably weathered sand stone, friable, reddish brown color.

HOLE NO. NLB-3 SHEET NO. 2 of 4

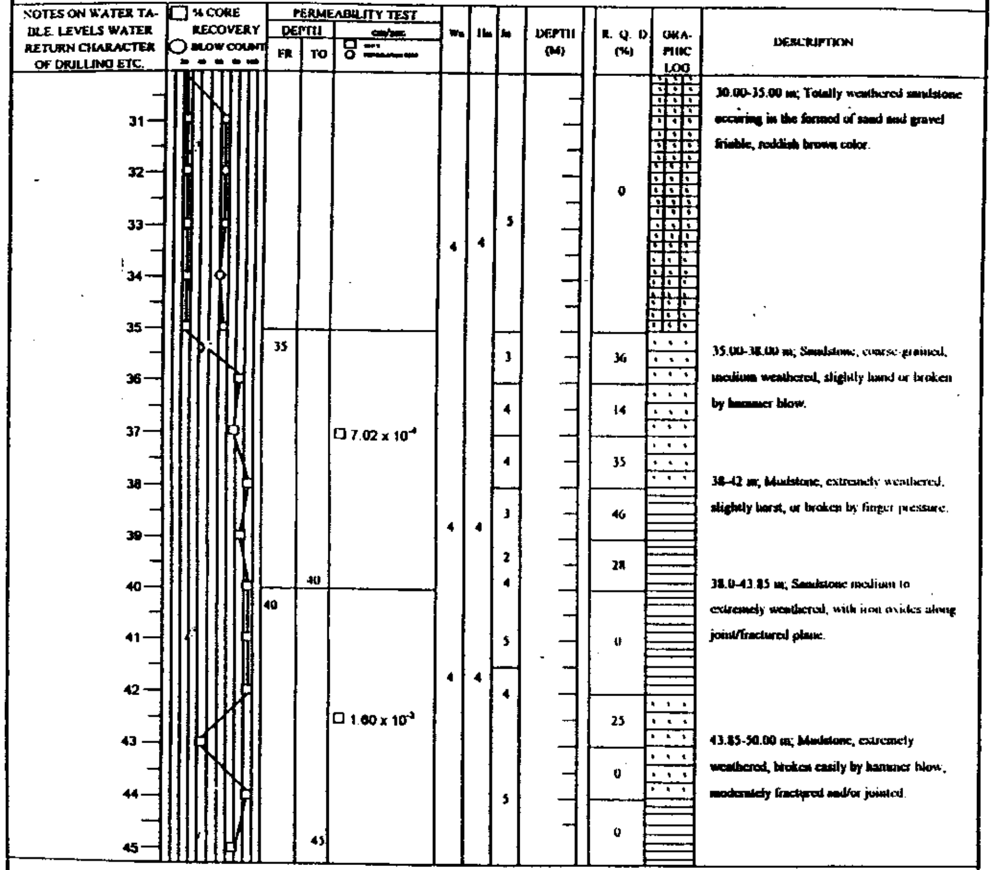
EXPLANATION:

Wn - Weathering Number	J-3 6-10joints/m
W-1 Sound	J-4 11-20joits/m
W-2 Slightly Weathered(appreciable oxidation at joint)	J-5 >20joits/m
W-3 Minimum Weathered (matrix slightly weathered)	Hn - Hardness Number
W-4 Deeply Weathered(matrix deeply weathered)	H-1 Very Hard (hardly broken by hammer)
W-5 Totally Weathered, argillified (only traces of original structure)	H-2 Hard (edge hardly broken by hammer)
Jn - Joint Number	H-3 Medium Hard (easily broken by hammer)
J-1 1joint/m	
J-2 2-5joints/m	

Fig. 3.7.2 (d) Boring Log of NLB-3 (2)

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: STO. NIÑO, CAGAYAN
HOLE NO: NLB-3
COORDINATES N 1,986,016.06 E 567,988.00
GROUND ELEVATION: 18.95 M
INCLINATION: VERTICAL
BEGUN: 5/28/00
FINISHED 6/4/00
DEPTH OF OVERBURDEN: 35.00 M
BEARING: KSK-BLG
TOTAL DEPTH: 50.00 m
ELE. OF WATER TABLE: 16.05 M
LOGGED BY: WJJ
CONTRACTOR: KI



30.00-35.00 m; Totally weathered sandstone occuring in the formed of sand and gravel friable, reddish brown color.

35.00-38.00 m; Sandstone, coarse-grained, medium weathered, slightly hand or broken by hammer blow.

38-42 m; Mudstone, extremely weathered, slightly harst, or broken by finger pressure.

38.0-43.85 m; Sandstone medium to extremely weathered, with iron oxides along joint/fractured plane.

43.85-50.00 m; Mudstone, extremely weathered, broken easily by hammer blow, moderately fractured and/or jointed.

HOLE NO. NLB-3 SHEET NO. 3 of 4

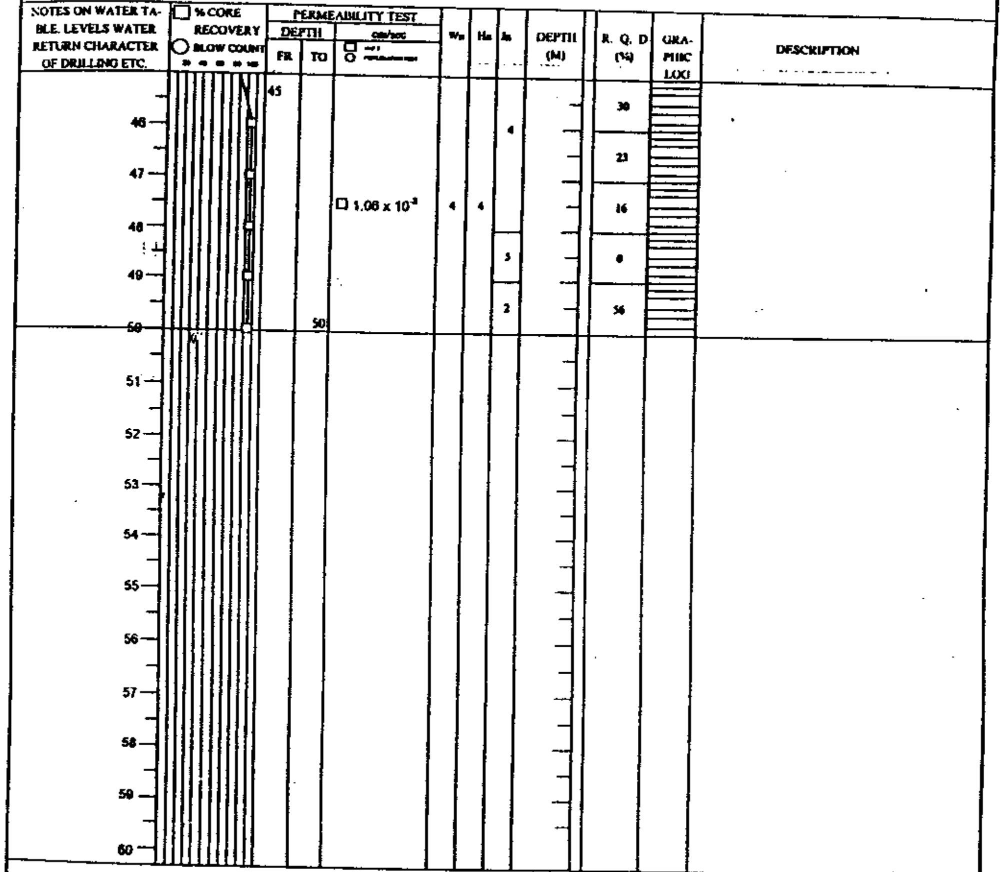
EXPLANATION:

Wa - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Ja - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Ha - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (d) Boring Log of NLB-3 (3)

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: STO. NIÑO, CAGAYAN
HOLE NO: NLB-3
COORDINATES N 1,986,016.06 E 567,986.00
GROUND ELEVATION: 18.95 M
INCLINATION: VERTICAL
BEGUN: 5/28/00
FINISHED 6/4/00
DEPTH OF OVERBURDEN: 35.00 M
BEARING: KSK-BLG
TOTAL DEPTH: 50.00 m
ELE. OF WATER TABLE: 16.05 M
LOGGED BY: WJJ
CONTRACTOR: KI



HOLE NO. NLB-3 SHEET NO. 4 of 4

EXPLANATION:

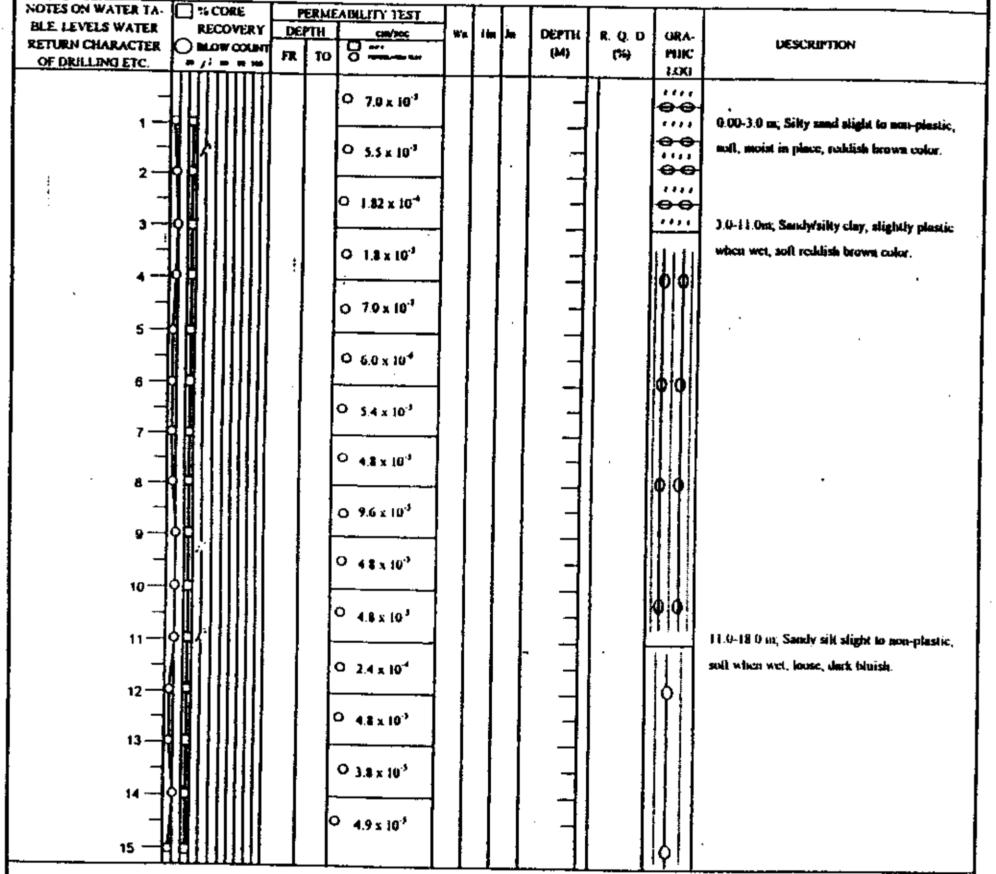
Wa - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Ja - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Ha - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (d) Boring Log of NLB-3 (4)

NLB-4

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: CABALLANGAN, ALCALA, CAGAYAN
HOLE NO: NLB-4
COORDINATES N 1,983,151.65 E 567,422.06
GROUND ELEVATION: 15.27 M
INCLINATION: VERTICAL
BEGUN: 5/3/00
FINISHED 6/9/00
DEPTH OF OVERBURDEN: >50.0 M
RKI: KSK-BLQ
TOTAL DEPTH: 50.00 m
ELE. OF WATER TABLE: 11.33 M
LOGGED BY: WJJ
CONTRACTOR: ICI



0.00-3.0 m; Silty sand slight to non-plastic, soft, moist in place, reddish brown color.

3.0-11.0m; Sandy/silty clay, slightly plastic when wet, soft reddish brown color.

11.0-18.0 m; Sandy silt slight to non-plastic, soft when wet, loose, dark bluish.

HOLE NO. NLB-4 SHEET NO. 1 of 4

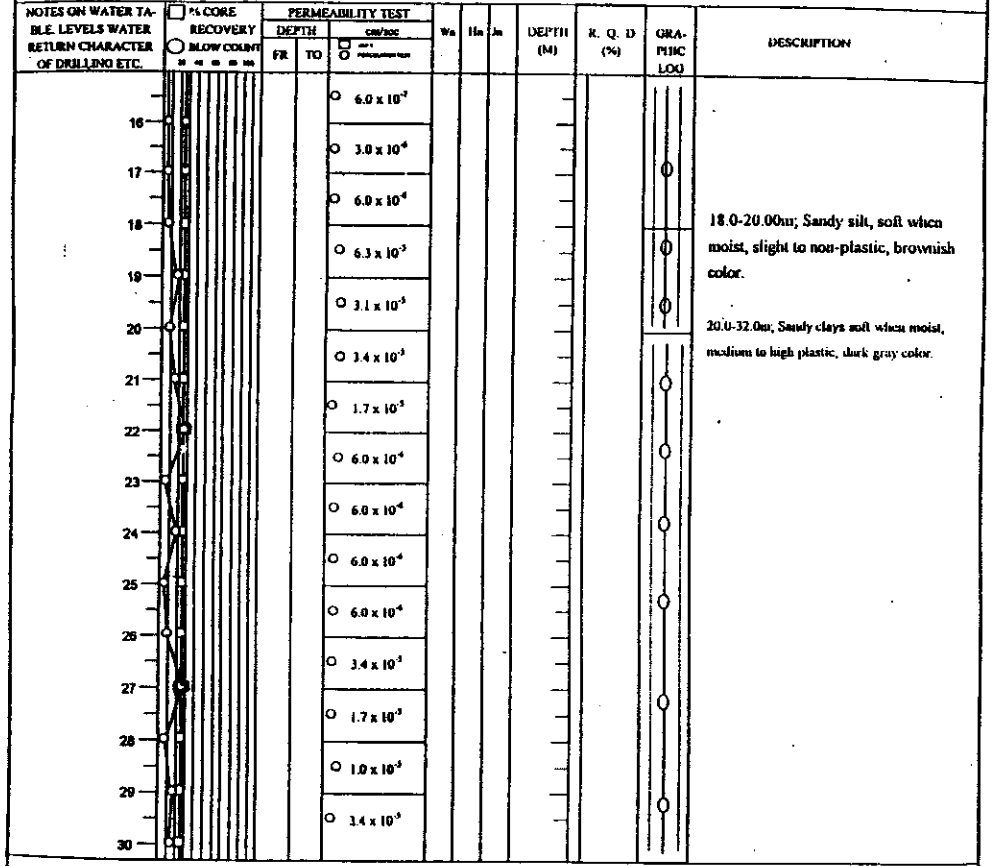
EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (e) Boring Log of NLB-4 (1)

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: CABALLANGAN, ALCALA, CAGAYAN
HOLE NO: NLB-4
COORDINATES N 1,983,151.65 E 567,422.06
GROUND ELEVATION: 15.27 M
INCLINATION: VERTICAL
BEGUN: 5/3/00
FINISHED 6/9/00
DEPTH OF OVERBURDEN: >50.0 M
RKI: KSK-BLQ
TOTAL DEPTH: 50.00 m
ELE. OF WATER TABLE: 11.33 M
LOGGED BY: WJJ
CONTRACTOR: ICI



18.0-20.00m; Sandy silt, soft when moist, slight to non-plastic, brownish color.

20.0-32.0m; Sandy clays soft when moist, medium to high plastic, dark gray color.

HOLE NO. NLB-4 SHEET NO. 2 of 4

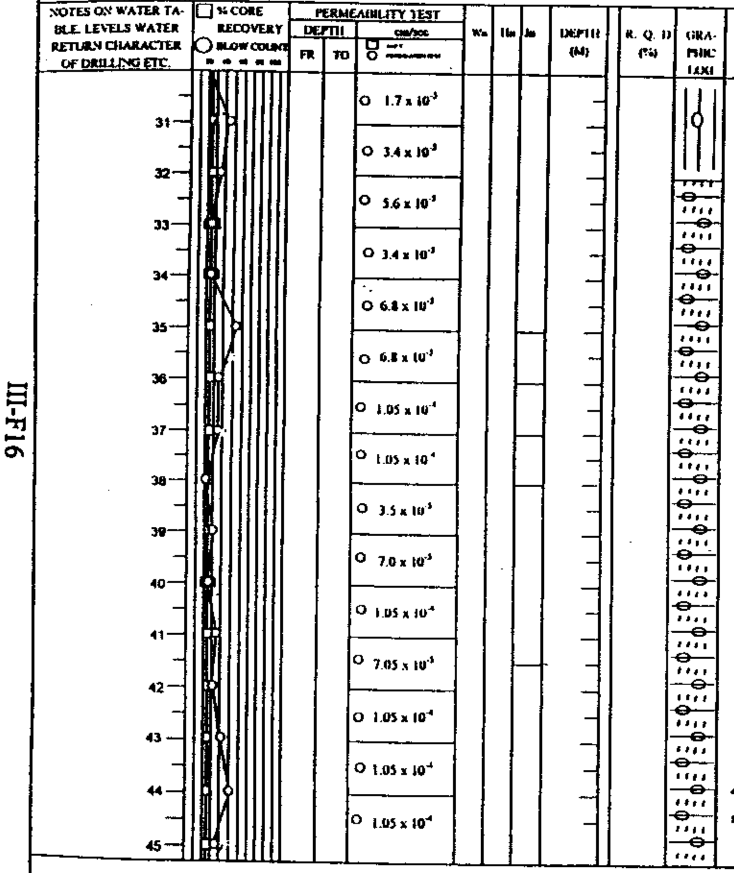
EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (e) Boring Log of NLB-4 (2)

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: CABALLANGAN, ALCALA, CAGAYAN
HOLE NO: NLB-4
COORDINATES N 1,203,151.95 E 567,422.06
GROUND ELEVATION: 15.27 M
INCLINATION: VERTICAL
BEGUN: 5/ 8/00
FINISHED 5/ 9 /00
DEPTH OF OVERBURDEN: 50.0 M
RIG: SSK-ULU
TOTAL DEPTH: 50.00 m
ELE. OF WATER TABLE: 11.33 M
LOGGED BY: WJJ
CONTRACTOR: ICI



PERMEABILITY TEST cm/sec
○ 1.7 x 10^{-5}
○ 3.4 x 10^{-5}
○ 5.6 x 10^{-5}
○ 3.4 x 10^{-5}
○ 6.8 x 10^{-5}
○ 6.8 x 10^{-5}
○ 1.05 x 10^{-4}
○ 1.05 x 10^{-4}
○ 3.5 x 10^{-5}
○ 7.0 x 10^{-5}
○ 1.05 x 10^{-4}
○ 7.05 x 10^{-5}
○ 1.05 x 10^{-4}
○ 1.05 x 10^{-4}
○ 1.05 x 10^{-4}

DESCRIPTION

32.0-45.0 m; Silty sand non-plastic to slightly plastic, soft when moist, dark gray color.

45.0-50.0 m; Clayey sand, non-plastic to slightly plastic, dark gray color.

HOLE NO. NLB-4 SHEET NO. 3 of 4

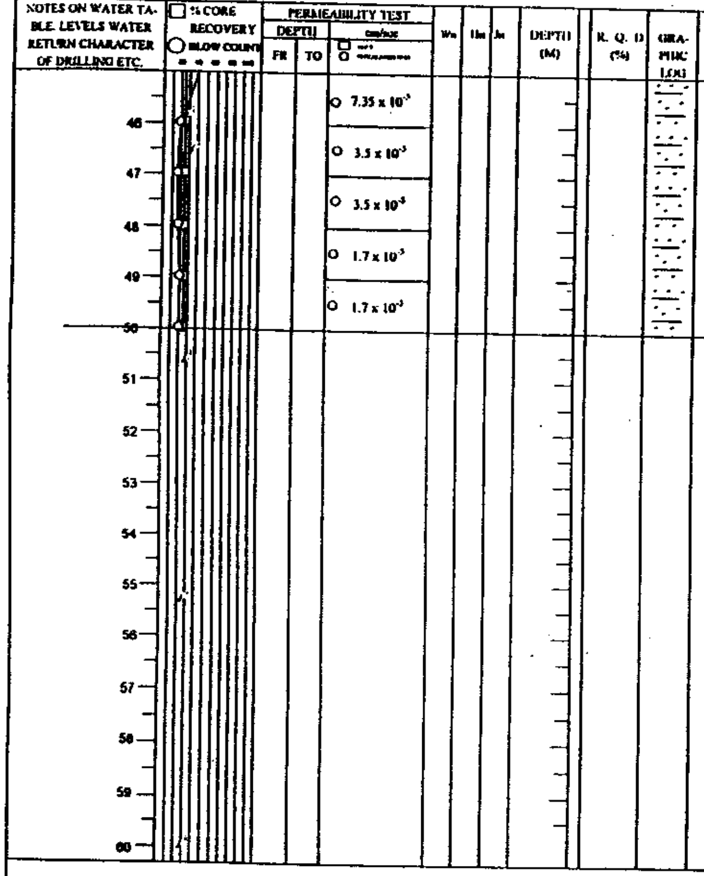
EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joints/m
J-5 >20joints/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (e) Boring Log of NLB-4 (3)

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: CABALLANGAN, ALCALA, CAGAYAN
HOLE NO: NLB-4
COORDINATES N 1,203,151.95 E 567,422.06
GROUND ELEVATION: 15.27 M
INCLINATION: VERTICAL
BEGUN: 5/ 8 /00
FINISHED 5/9 /00
DEPTH OF OVERBURDEN: 50.0 M
RIG: SSK-ULU
TOTAL DEPTH: 50.00 m
ELE. OF WATER TABLE: 11.33 M
LOGGED BY: WJJ
CONTRACTOR: ICI



PERMEABILITY TEST cm/sec
○ 7.35 x 10^{-5}
○ 3.5 x 10^{-5}
○ 3.5 x 10^{-5}
○ 1.7 x 10^{-5}
○ 1.7 x 10^{-5}

DESCRIPTION

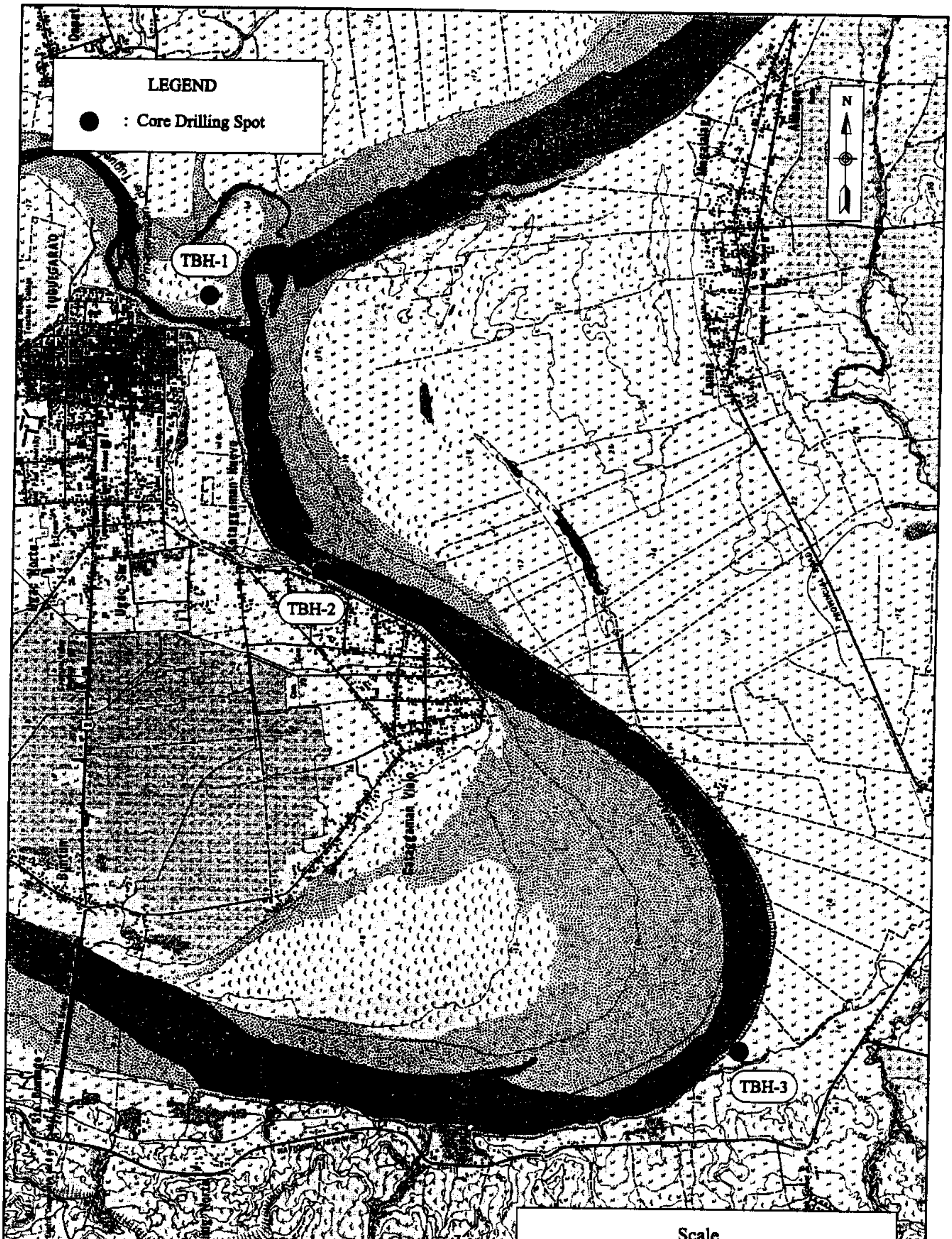
Clayey Sand, non-plastic to slightly plastic, dark gray color.

HOLE NO. NLB-4 SHEET NO. 4 of 4

EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joints/m
J-5 >20joints/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.7.2 (e) Boring Log of NLB-4 (4)



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JAPAN INTERNATIONAL COOPERATION AGENCY

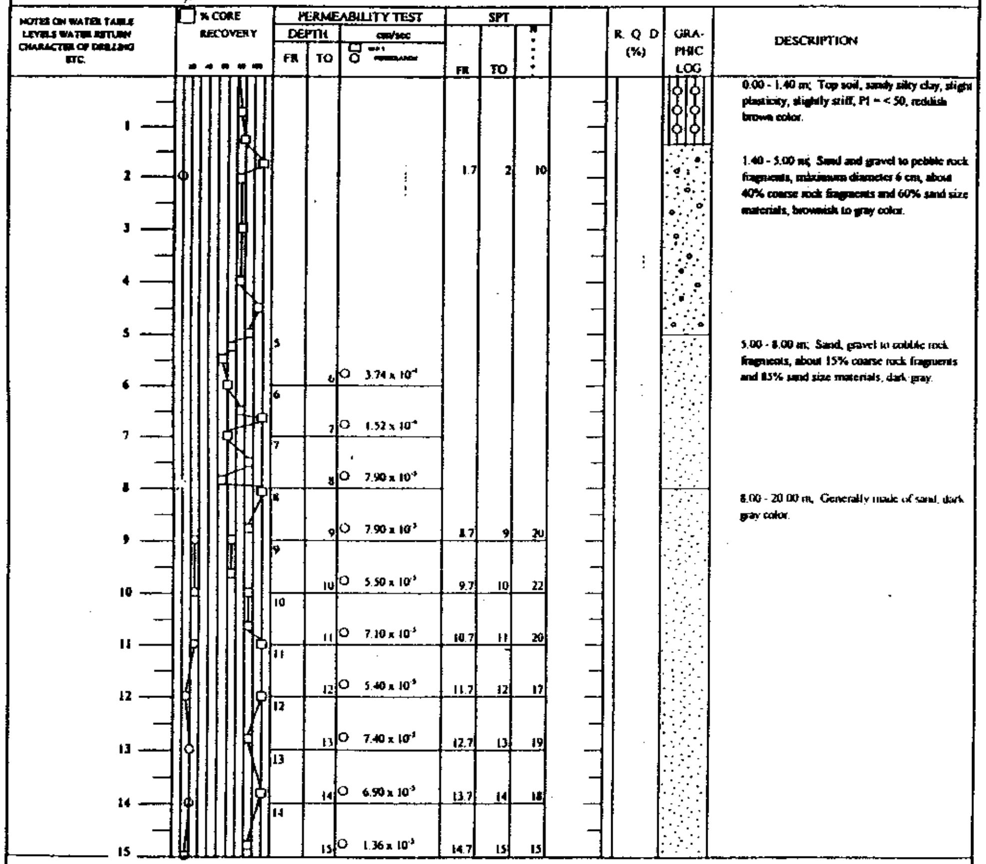
Figure 3.8.1

Location Map of Boring in and around Tuguegarao

TBH-1

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: Brgy. [illegible]
HOLE NO. TBH - 1
COORDINATES N E
GROUND ELEVATION:
INCLINATION :
BEGUN: 8/19/00
FINISHED 8/26/00
DEPTH OF OVERBURDEN > 20.00 m
MODEL TONE THS 5
TOTAL DEPTH: 20.00 m
ELE. OF WATER TABLE: 2.00 m
LOGGED BY: W.L.L.
CONTRACTOR: ICI



PERMEABILITY TEST DEPTH FR	TO	cm/sec	SPT FR	SPT TO	N
			1.7	2	10
5	6	○ 3.74 x 10⁻⁴			
6	7	○ 1.52 x 10⁻⁴			
7	8	○ 7.90 x 10⁻⁵			
8	9	○ 7.90 x 10⁻⁵	8.7	9	20
9	10	○ 5.50 x 10⁻⁵	9.7	10	22
10	11	○ 7.10 x 10⁻⁵	10.7	11	20
11	12	○ 5.40 x 10⁻⁵	11.7	12	17
12	13	○ 7.40 x 10⁻⁵	12.7	13	19
13	14	○ 6.90 x 10⁻⁵	13.7	14	18
14	15	○ 1.36 x 10⁻⁵	14.7	15	15

DESCRIPTION

0.00 - 1.40 m; Top soil, sandy silty clay, slight plasticity, slightly stiff, PI = < 50, reddish brown color.

1.40 - 5.00 m; Sand and gravel to pebble rock fragments, maximum diameter 6 cm, about 40% coarse rock fragments and 60% sand size materials, brownish to gray color.

5.00 - 8.00 m; Sand, gravel to cobble rock fragments, about 15% coarse rock fragments and 85% sand size materials, dark gray.

8.00 - 20.00 m, Generally made of sand, dark gray color.

HOLE NO. TBH - 1 SHEET NO. 1 of 2

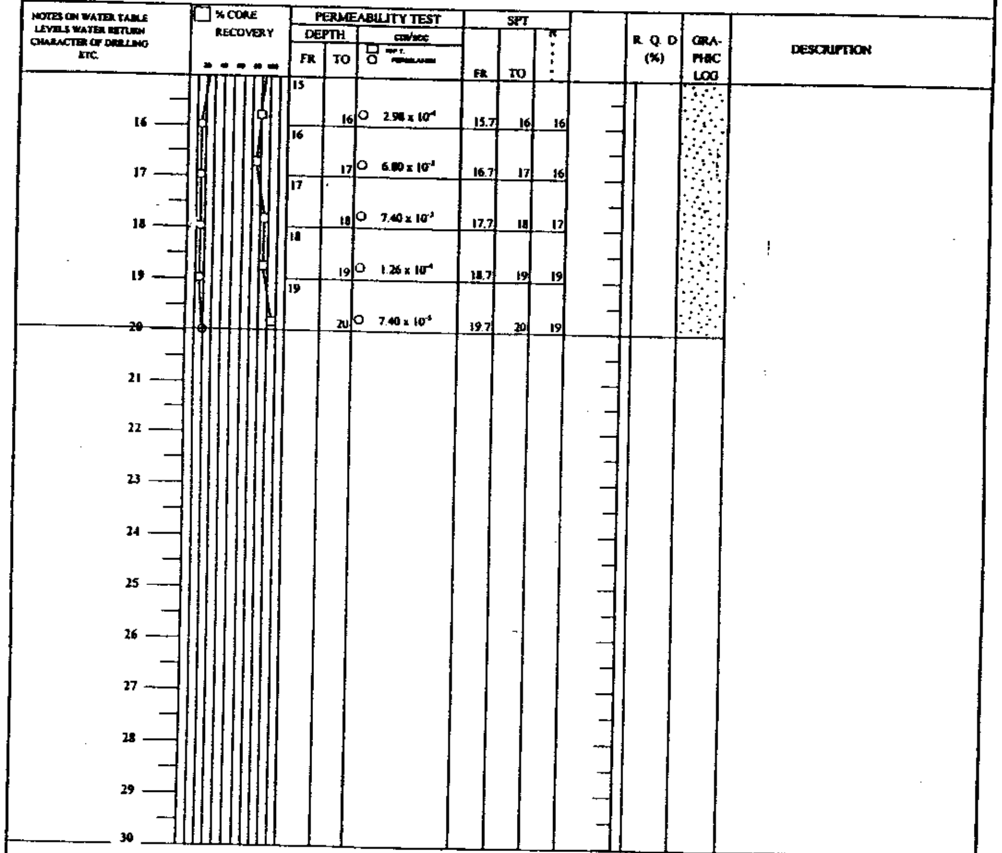
EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.9 (a) Boring Log of TBH-1 (1)

GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: Brgy. [illegible]
HOLE NO. TBH - 1
COORDINATES N E
GROUND ELEVATION:
INCLINATION :
BEGUN: 8/19/00
FINISHED 8/26/00
DEPTH OF OVERBURDEN: > 20 m
MODEL : TONE THS 5
TOTAL DEPTH: 20.00 m
ELE. OF WATER TABLE: 2.00 m
LOGGED BY: W.L.L.
CONTRACTOR: ICI



PERMEABILITY TEST DEPTH FR	TO	cm/sec	SPT FR	SPT TO	N
15	16	○ 2.98 x 10⁻⁴	15.7	16	16
16	17	○ 6.80 x 10⁻⁵	16.7	17	16
17	18	○ 7.40 x 10⁻⁵	17.7	18	17
18	19	○ 1.26 x 10⁻⁴	18.7	19	19
19	20	○ 7.40 x 10⁻⁵	19.7	20	19

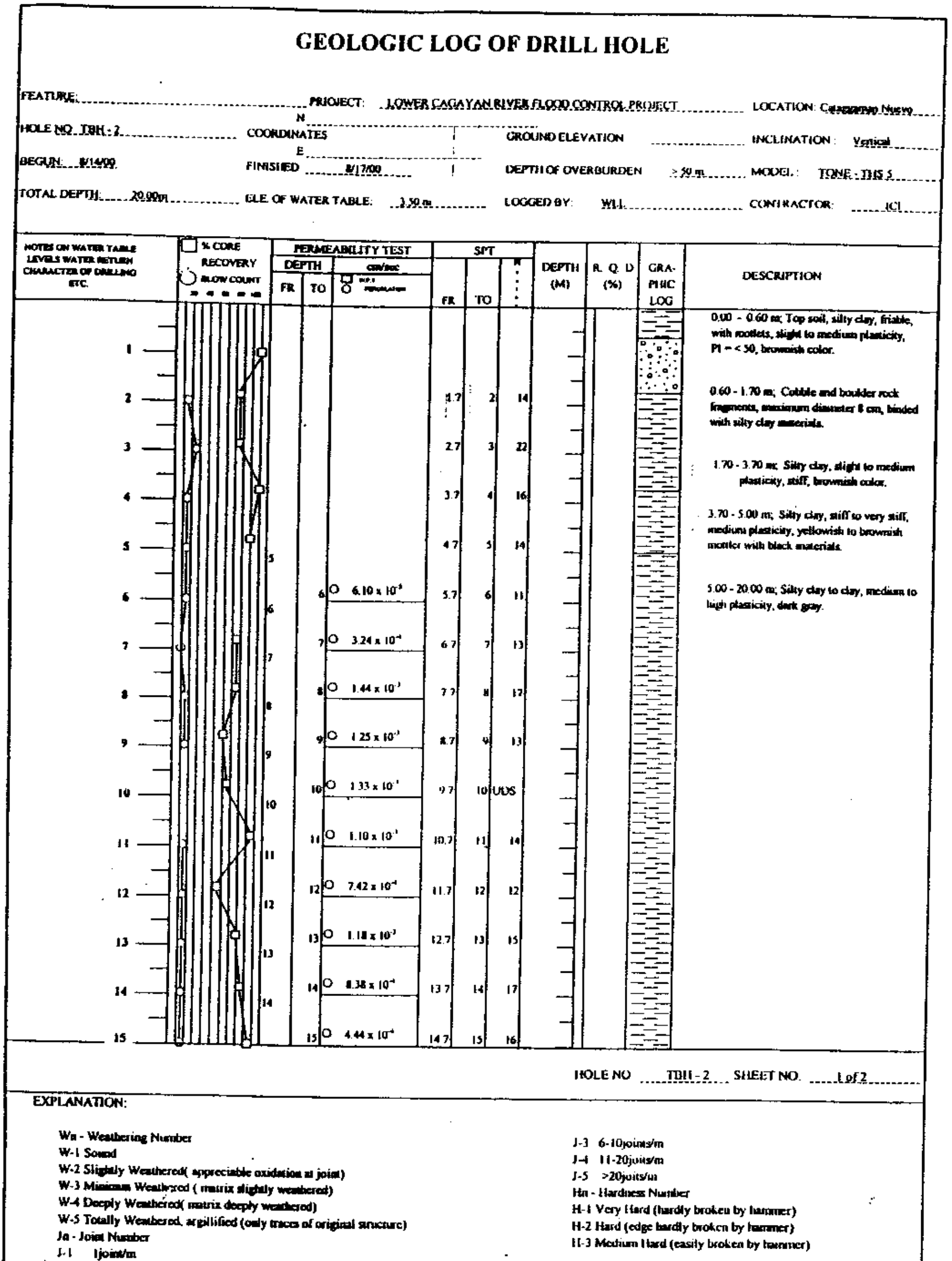
HOLE NO. TBH - 1 SHEET NO. 2 of 2

EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.9 (a) Boring Log of TBH-1 (2)

TBH-2



GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT
LOCATION: Cataggaman Nuevo
HOLE NO. TBH - 2
COORDINATES N / E
GROUND ELEVATION
INCLINATION: Vertical
BEGUN: 8/14/00
FINISHED 8/17/00
DEPTH OF OVERBURDEN > 50 m
MODEL: TONE - THS 5
TOTAL DEPTH: 20.00m
ELE. OF WATER TABLE: 3.50 m
LOGGED BY: WLL
CONTRACTOR: ICI

NOTES ON WATER TABLE LEVELS WATER RETURN CHARACTER OF DRILLING ETC.

☐ % CORE RECOVERY ○ BLOW COUNT

PERMEABILITY TEST DEPTH FR	TO	cm/sec ☐ ○ PERMEATION	SPT FR	TO	N
			1.7	2	14
			2.7	3	22
			3.7	4	16
			4.7	5	14
5	6	○ 6.10 x 10^{-4}	5.7	6	11
6	7	○ 3.24 x 10^{-4}	6.7	7	13
7	8	○ 1.44 x 10^{-3}	7.7	8	17
8	9	○ 1.25 x 10^{-3}	8.7	9	13
9	10	○ 1.33 x 10^{-3}	9.7	10	UDS
10	11	○ 1.10 x 10^{-3}	10.7	11	14
11	12	○ 7.42 x 10^{-4}	11.7	12	12
12	13	○ 1.18 x 10^{-3}	12.7	13	15
13	14	○ 8.38 x 10^{-4}	13.7	14	17
14	15	○ 4.44 x 10^{-4}	14.7	15	16

DEPTH (M) | R. Q. D (%) | GRAPHIC LOG | DESCRIPTION

0.00 - 0.60 m; Top soil, silty clay, friable, with rootlets, slight to medium plasticity, PI = < 50, brownish color.

0.60 - 1.70 m; Cobble and boulder rock fragments, maximum diameter 8 cm, binded with silty clay materials.

1.70 - 3.70 m; Silty clay, slight to medium plasticity, stiff, brownish color.

3.70 - 5.00 m; Silty clay, stiff to very stiff, medium plasticity, yellowish to brownish mottler with black materials.

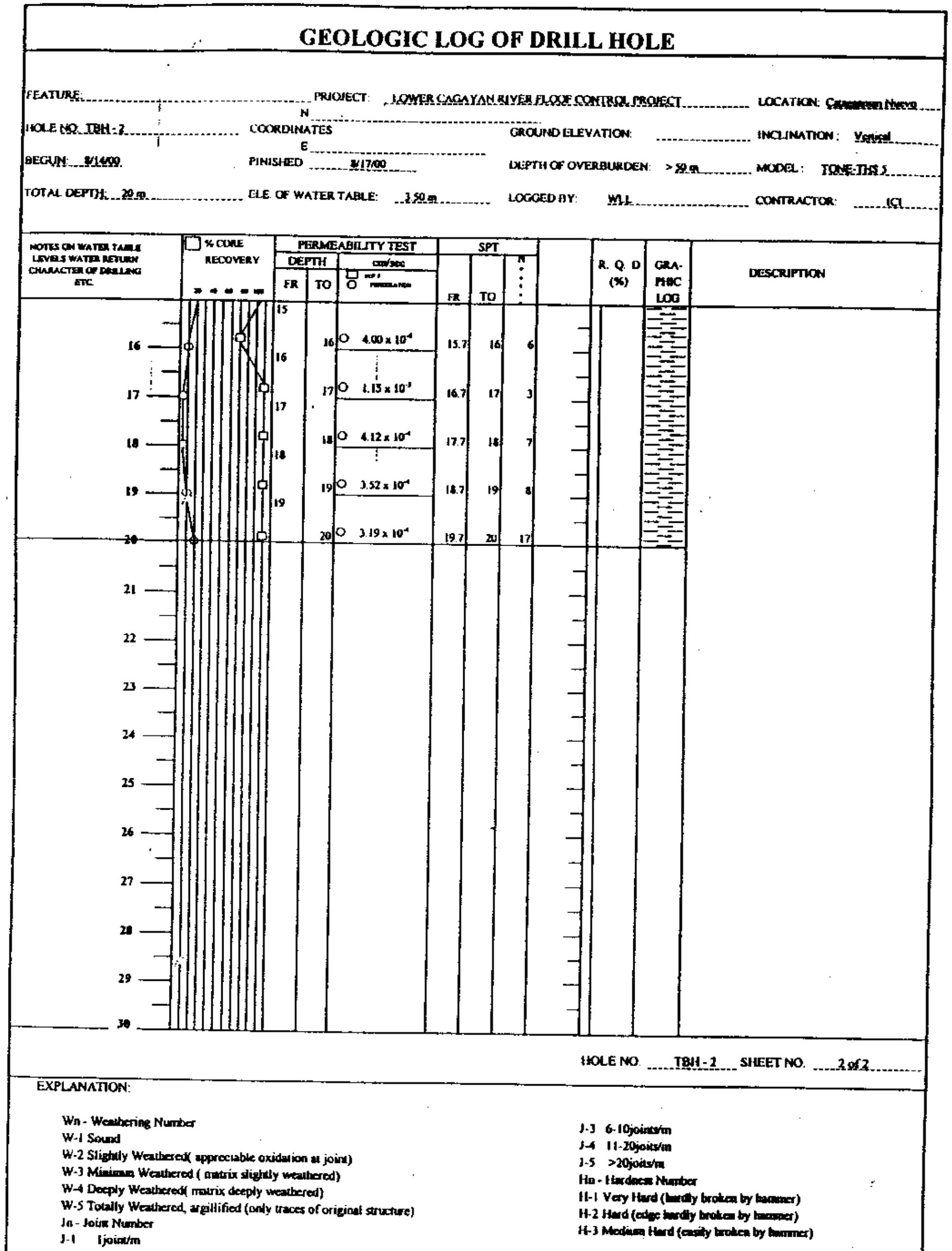
5.00 - 20.00 m; Silty clay to clay, medium to high plasticity, dark gray.

HOLE NO TBH - 2 SHEET NO. 1 of 2

EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.9 (b) Boring Log of TBH-2 (1)



GEOLOGIC LOG OF DRILL HOLE

FEATURE:
PROJECT: LOWER CAGAYAN RIVER FLOOF CONTROL PROJECT
LOCATION: Cataggaman Nuevo
HOLE NO. TBH - 2
COORDINATES N / E
GROUND ELEVATION:
INCLINATION: Vertical
BEGUN: 8/14/00
PINISHED 8/17/00
DEPTH OF OVERBURDEN: > 50 m
MODEL: TONE-THS 5
TOTAL DEPTH: 20 m
ELE. OF WATER TABLE: 3.50 m
LOGGED BY: WLL
CONTRACTOR: ICI

NOTES ON WATER TABLE LEVELS WATER RETURN CHARACTER OF DRILLING ETC.

☐ % CORE RECOVERY

PERMEABILITY TEST DEPTH FR	TO	cm/sec ☐ ○ PERMEATION	SPT FR	TO	N
15	16	○ 4.00 x 10^{-4}	15.7	16	6
16	17	○ 1.15 x 10^{-3}	16.7	17	3
17	18	○ 4.12 x 10^{-4}	17.7	18	7
18	19	○ 3.52 x 10^{-4}	18.7	19	8
19	20	○ 3.19 x 10^{-4}	19.7	20	17

R. Q. D (%) | GRAPHIC LOG | DESCRIPTION

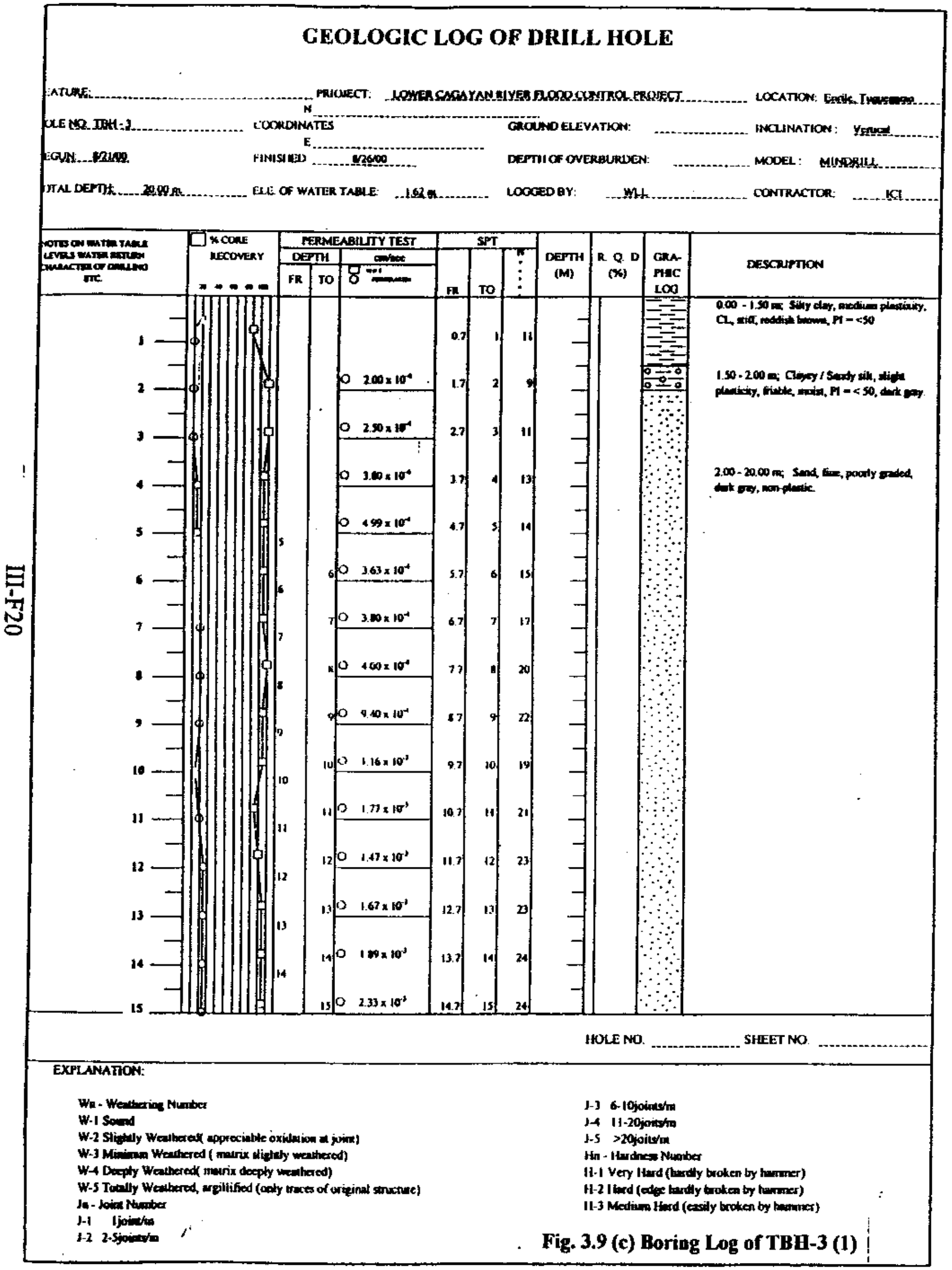
HOLE NO. TBH - 2 SHEET NO. 2 of 2

EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.9 (b) Boring Log of TBH-2 (2)

TBH-3



GEOLOGIC LOG OF DRILL HOLE

FEATURE: PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: Enrile, Tuguegarao
HOLE NO. TBH - 3 COORDINATES N E GROUND ELEVATION: INCLINATION: Vertical
BEGUN: 8/21/00 FINISHED 8/26/00 DEPTH OF OVERBURDEN: MODEL: MINDRILL
TOTAL DEPTH: 20.00 m. ELE. OF WATER TABLE: 1.62 m LOGGED BY: WLL CONTRACTOR: ICI

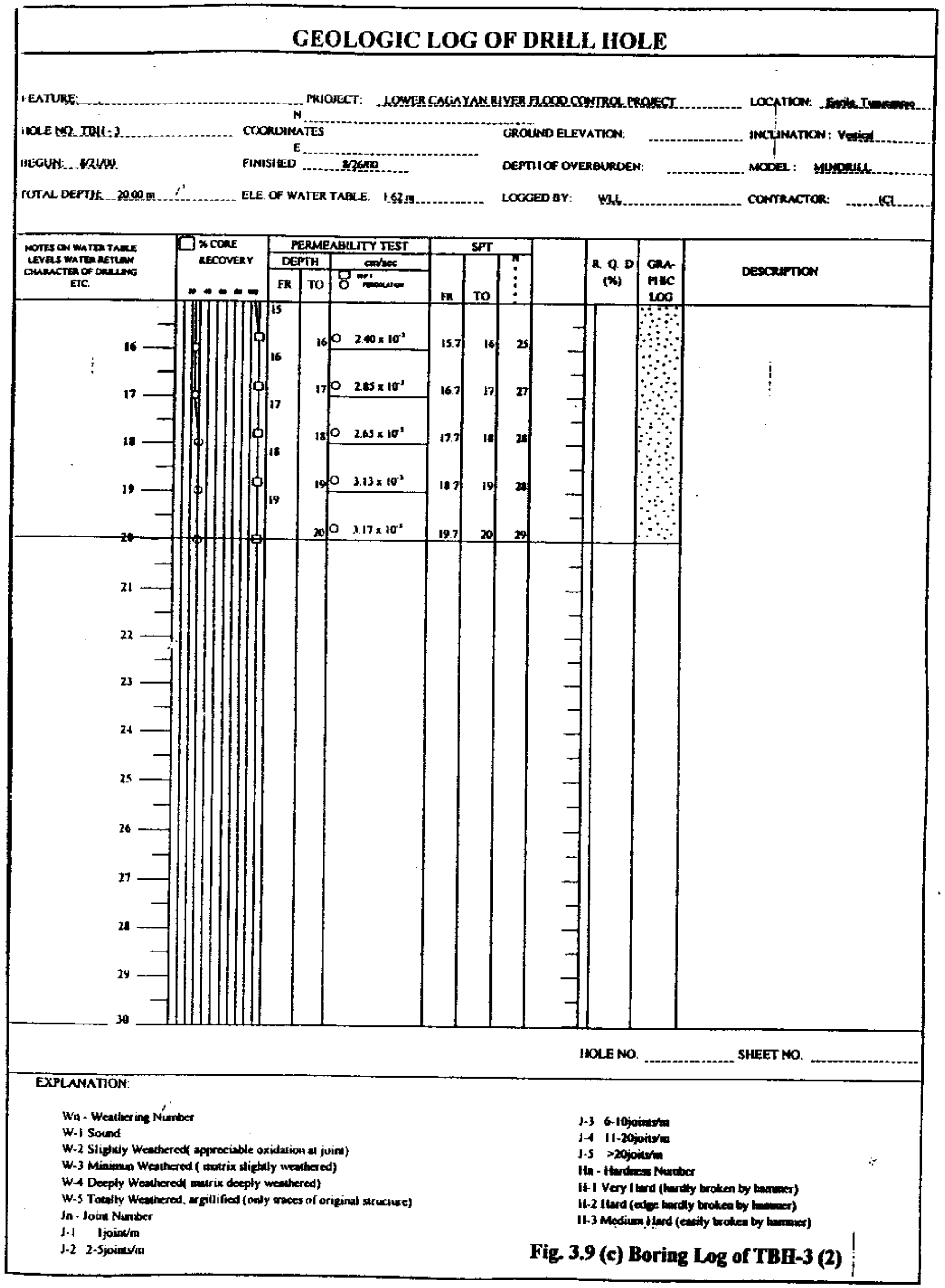
NOTES ON WATER TABLE LEVELS WATER RETURN CHARACTER OF DRILLING ETC.	PERMEABILITY TEST DEPTH FR	TO	cm/sec	SPT FR	TO	N	DEPTH (M)	R. Q. D (%)	DESCRIPTION
1				0.7	1	11			0.00 - 1.50 m; Silty clay, medium plasticity, CL, stiff, reddish brown, PI = <50
2			2.00 x 10⁻⁴	1.7	2	9			1.50 - 2.00 m; Clayey / Sandy silt, slight plasticity, friable, moist, PI = < 50, dark gray
3			2.50 x 10⁻⁴	2.7	3	11			
4			3.80 x 10⁻⁴	3.7	4	13			2.00 - 20.00 m; Sand, fine, poorly graded, dark gray, non-plastic.
5			4.99 x 10⁻⁴	4.7	5	14			
6	5	6	3.63 x 10⁻⁴	5.7	6	15			
7	6	7	3.80 x 10⁻⁴	6.7	7	17			
8	7	8	4.60 x 10⁻⁴	7.7	8	20			
9	8	9	9.40 x 10⁻⁴	8.7	9	22			
10	9	10	1.16 x 10⁻³	9.7	10	19			
11	10	11	1.77 x 10⁻³	10.7	11	21			
12	11	12	1.47 x 10⁻³	11.7	12	23			
13	12	13	1.67 x 10⁻³	12.7	13	23			
14	13	14	1.89 x 10⁻³	13.7	14	24			
15	14	15	2.33 x 10⁻³	14.7	15	24			

HOLE NO. SHEET NO.

EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.9 (c) Boring Log of TBH-3 (1)



GEOLOGIC LOG OF DRILL HOLE

FEATURE: PROJECT: LOWER CAGAYAN RIVER FLOOD CONTROL PROJECT LOCATION: Enrile, Tuguegarao
HOLE NO. TBH - 3 COORDINATES N E GROUND ELEVATION: INCLINATION: Vertical
BEGUN: 8/21/00 FINISHED 8/26/00 DEPTH OF OVERBURDEN: MODEL: MINDRILL
TOTAL DEPTH: 20.00 m ELE. OF WATER TABLE. 1.62 m LOGGED BY: WLL CONTRACTOR: ICI

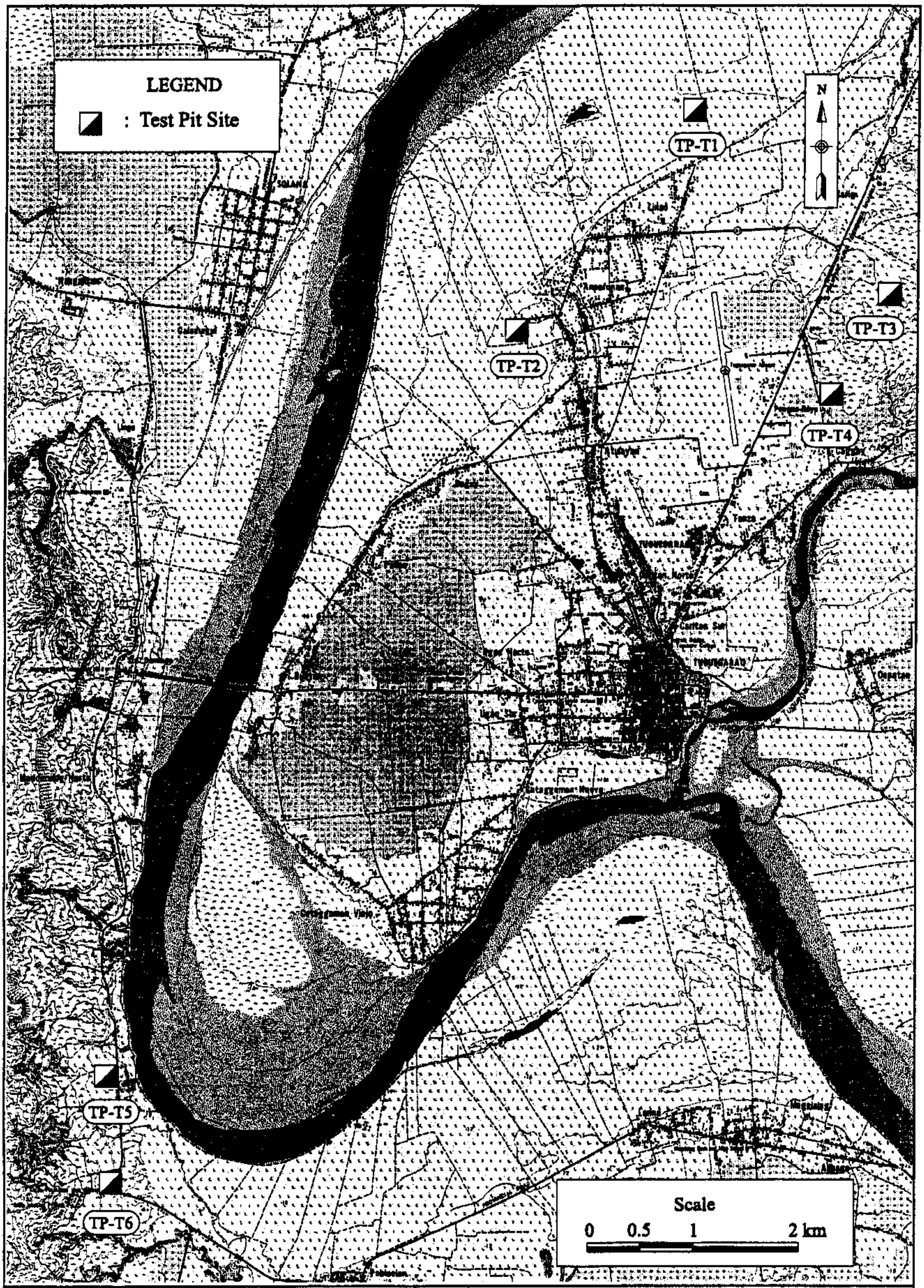
NOTES ON WATER TABLE LEVELS WATER RETURN CHARACTER OF DRILLING ETC.	PERMEABILITY TEST DEPTH FR	TO	cm/sec	SPT FR	TO	N	R. Q. D (%)	DESCRIPTION
16	15	16	2.40 x 10⁻³	15.7	16	25		
17	16	17	2.85 x 10⁻³	16.7	17	27		
18	17	18	2.65 x 10⁻³	17.7	18	28		
19	18	19	3.13 x 10⁻³	18.7	19	28		
20	19	20	3.17 x 10⁻³	19.7	20	29		
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

HOLE NO. SHEET NO.

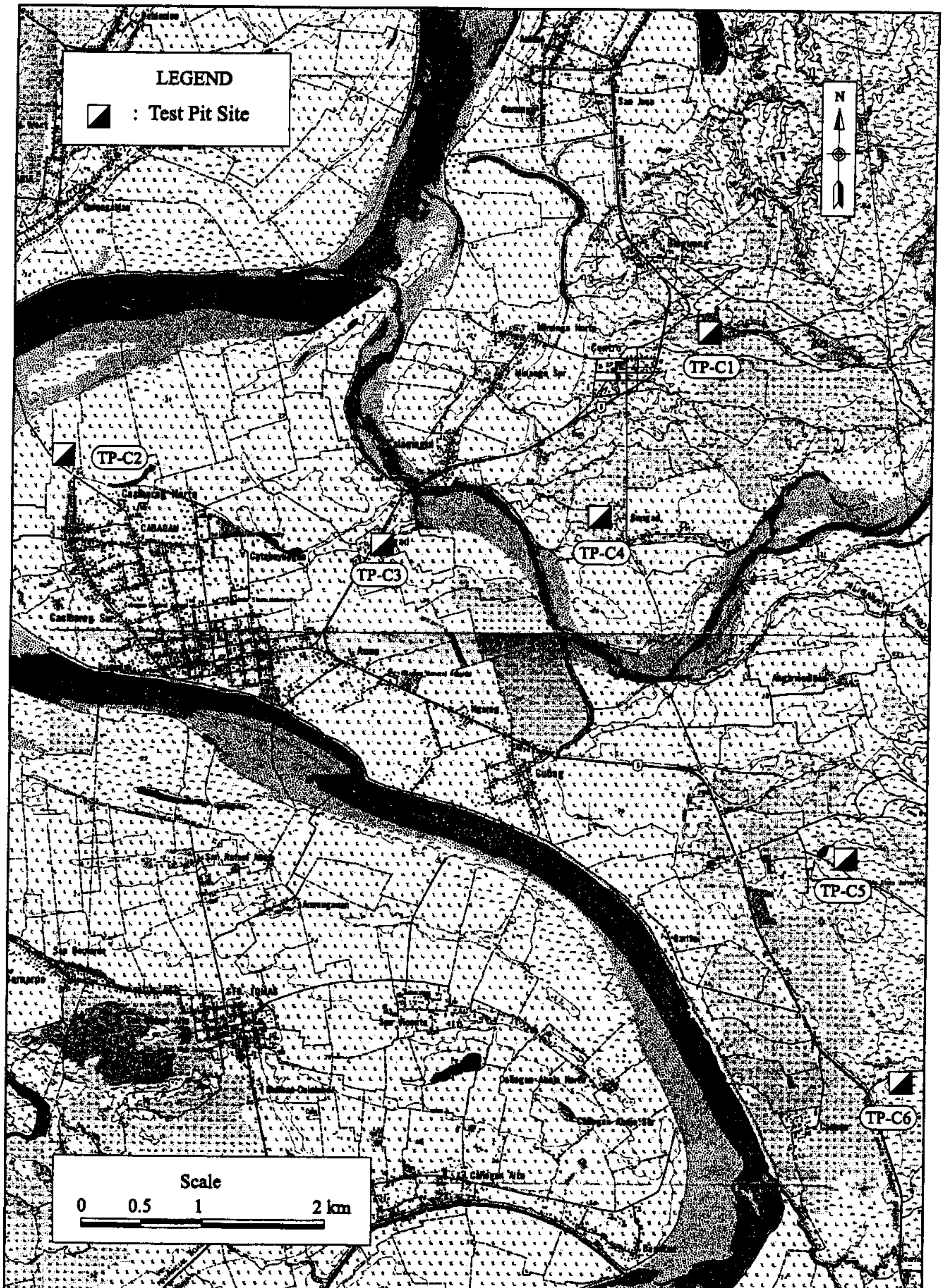
EXPLANATION:

Wn - Weathering Number
W-1 Sound
W-2 Slightly Weathered(appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered(matrix deeply weathered)
W-5 Totally Weathered, argillified (only traces of original structure)
Jn - Joint Number
J-1 1joint/m
J-2 2-5joints/m
J-3 6-10joints/m
J-4 11-20joits/m
J-5 >20joits/m
Hn - Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (easily broken by hammer)

Fig. 3.9 (c) Boring Log of TBH-3 (2)



The Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines	**Figure 3.10.1**
JAPAN INTERNATIONAL COOPERATION AGENCY	**Location Map of Test Pit in and around Tuguegarao**



The Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines

JAPAN INTERNATIONAL COOPERATION AGENCY

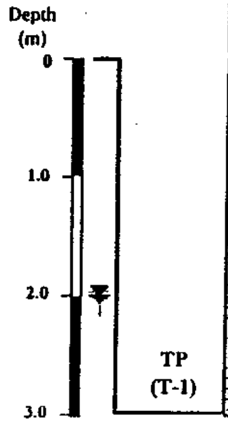
Figure 3.10.2

Location Map of Test Pit in and around Cabagan

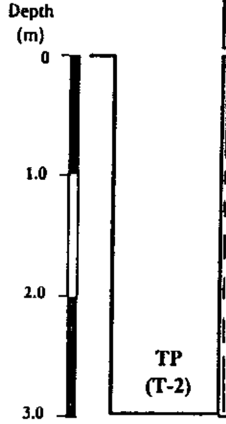
TP-T1 & TP-T2

TEST PITS PROFILE

(Embankment - Tuguegarao)



Symbol	Description	Atterberg Limits			Other test results
		LL	PL	PI	
	(0-3.0 m) Brown clayey SILT, medium plastic, traces of fine sand. ML, (A-7-6) (11). **Note :** Water table encountered at 2.00 m.	45	29	16	*NMC = 37.11 %*

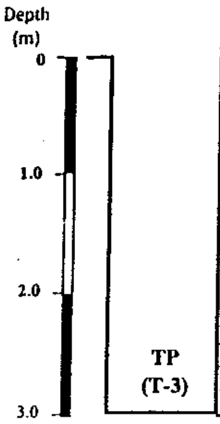


Symbol	Description	Atterberg Limits			Other test results
		LL	PL	PI	
	(0-3.0 m) Brown non-plastic SILT, traces of fine sand. ML, (A-4) (8).	NP	NP	NP	*NMC = 25.29 %*

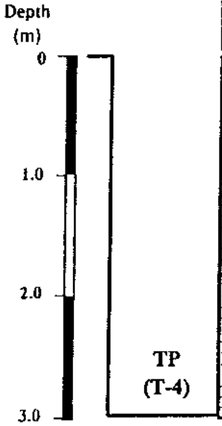
Fig. 3.11.1 (a) Log of Test Pit TP-T1 & TP-T2

TEST PITS PROFILE

(Embankment - Tuguegarao)



Symbol	Description	Atterberg Limits			Other test results
		LL	PL	PI	
	(0-3.0 m) Dark gray CLAY, high plastic, traces of fine sand. CH, (A-7-6) (20).	67	21	46	*NMC = 32.21 %*



Symbol	Description	Atterberg Limits			Other test results
		LL	PL	PI	
	(0-3.0 m) Reddish brown silty CLAY, medium plastic, little amount of fine sand and gravel. CL, (A-6) (8).	39	23	16	*NMC = 13.71 %*

Fig. 3.11.1 (b) Log of Test Pit TP-T3 & TP-T4

TEST PITS PROFILE

(Embankment - Tuguegarao)

Depth (m): 0, 1.0, 2.0, 3.0

TP (T-5)

Symbol	Description	Atterberg Limits			Other test results
		LL	PL	PI	
▤	(0-3.0 m) Gray to Yellowish brown CLAY, high plastic, traces of fine sand. CH, (A-7-6) (20).	76	27	49	*NMC = 34.64 %*

Depth (m): 0, 1.0, 2.0, 3.0

TP (T-6)

Symbol	Description	Atterberg Limits			Other test results
		LL	PL	PI	
▤	(0-3.0 m) Gray to Yellowish brown sandy CLAY, high plastic, traces of gravel. CH, (A-7-6) (14).	67	29	38	*NMC = 29.02 %*

Fig. 3.11.1 (c) Log of Test Pit TP-T5 & TP-T6

TEST PITS PROFILE

(Embankment - Cabagan)

Depth (m): 0, 1.0, 2.0, 3.0

TP (C-1)

Symbol	Description	Atterberg Limits			Other test results
		LL	PL	PI	
▤	(0-3.0 m) Yellowish brown silty CLAY, medium plastic, some fine sand, traces of fine gravel. CL, (A-6) (12).	38	16	22	*NMC = 19.05 %*

Depth (m): 0, 1.0, 2.0, 3.0

TP (C-2)

Symbol	Description	Atterberg Limits			Other test results
		LL	PL	PI	
▥	(0-1.70 m) Brown non-plastic SILT, with fine sand. ML, (A-4) (4).	NP	NP	NP	*NMC = 15.02 %*
▒	(1.7-3.0 m) Gray fine SAND, some non-plastic silt. SM, (A-2-4) (0).	NP	NP	NP	*NMC = 48.09 %*

Fig. 3.11.2 (a) Log of Test Pit TP-C1 & TP-C2

TEST PITS PROFILE

(Embankment - Cabagan)

Depth (m)
0
1.0
2.0
3.0

TP (C-3)

Symbol	Description	Atterberg Limits LL	PL	PI	Other test results
	(0-3.0 m) Dark brown CLAY, medium plastic, traces of fine sand. CH, (A-7-6) (17).	51	25	26	*NMC = 38.05 %*

Depth (m)
0
1.0
2.0
3.0

TP (C-4)

Symbol	Description	Atterberg Limits LL	PL	PI	Other test results
	(0-3.0 m) Grayish brown silty CLAY, medium plastic, some sand, little amount of fine gravel. CL, (A-6) (9).	40	20	20	*NMC = 14.70 %*

Fig. 3.11.2 (b) Log of Test Pit TP-C3 & TP-C4

TEST PITS PROFILE

(Embankment - Cabagan)

Depth (m)
0
1.0
2.0
3.0

TP (C-5)

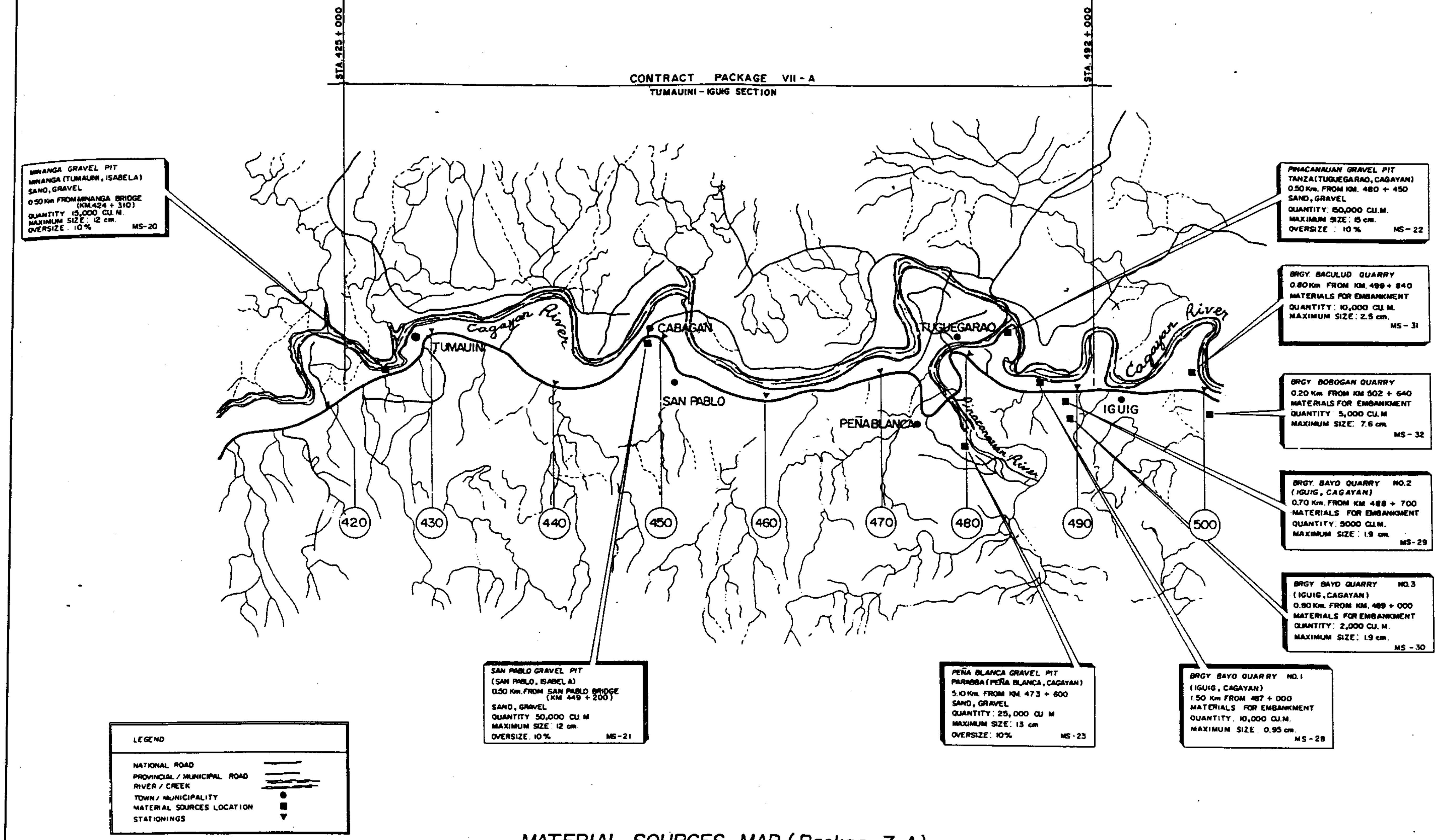
Symbol	Description	Atterberg Limits LL	PL	PI	Other test results
	(0-3.0 m) Yellowish brown silty CLAY, medium plastic, some fine sand. CL, (A-6) (12).	38	17	21	*NMC = 22.33 %*

Depth (m)
0
1.0
2.0
3.0

TP (C-6)

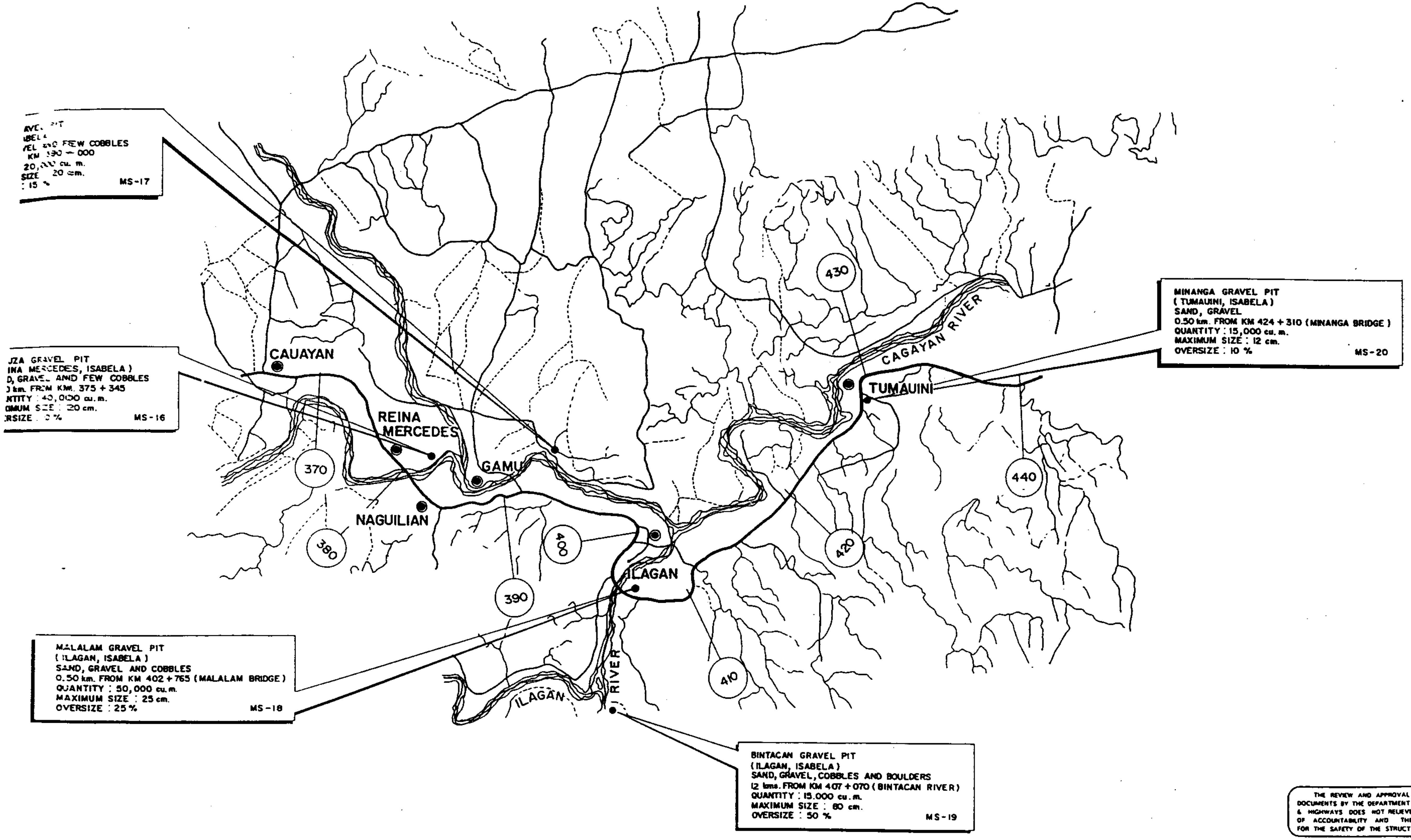
Symbol	Description	Atterberg Limits LL	PL	PI	Other test results
	(0-3.0 m) Yellowish brown CLAY, medium plastic, traces of fine sand. CH, (A-7-6) (18).	51	22	29	*NMC = 30.77 %*

Fig. 3.11.2 (c) Log of Test Pit TP-C5 & TP-C6



MATERIAL SOURCES MAP (Package 7-A)

The Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines	**Figure 3.12.1** **Location Map of Material Sources for Aggregate and Boulders (1)**
JAPAN INTERNATIONAL COOPERATION AGENCY	



MATERIAL SOURCES MAP (PACKAGE VI-A)

Figure 3.12.2
Location Map of Material Sources for Aggregate and Boulders (2)