Chapter 3
BASELINE ENVIRONMENTAL CONDITIONS

3.1 ENVIRONMENTAL STUDY AREA

The Environmental Study Area (ESA) is delineated to determine and situate the potential impacts of the project at various stages of development. This establishes the impact zones that are most likely to be directly or indirectly affected by the development. The various impact zones are as follows:

(1) Direct Impact Area (DIA)

The DIA covers the area within 500 m from the center line to both sides of the North South Road, East West – Daang Hari Extension, the CALA Expressway and the Toll Road from SLEX to Muntinlupa.

(2) Indirect Impact Area (IIA)

This refers to the barangays and towns where the various segments of the proposed road alignments will pass through. The East-West road alignment will cover 19 barangays: 2 in Bacoor; 4 in Gen. Trias; 6 in Imus; 5 in Tanza; and 2 in Muntinlupa City.

The North-South Road will go through 27 barangays: 3 in Silang; 3 in Imus; 9 in Dasmariñas; and 12 in Bacoor.

The CALA expressway on the other hand will cover 21 barangays in Cavite (4 in Dasmariñas, 4 in Gen. Trias, and 13 in Silang) and 7 barangays in Laguna (4 in Biñan and 3 in Sta. Rosa).

Figure 3.1 shows the proposed road alignment in relation to the identified impact areas.

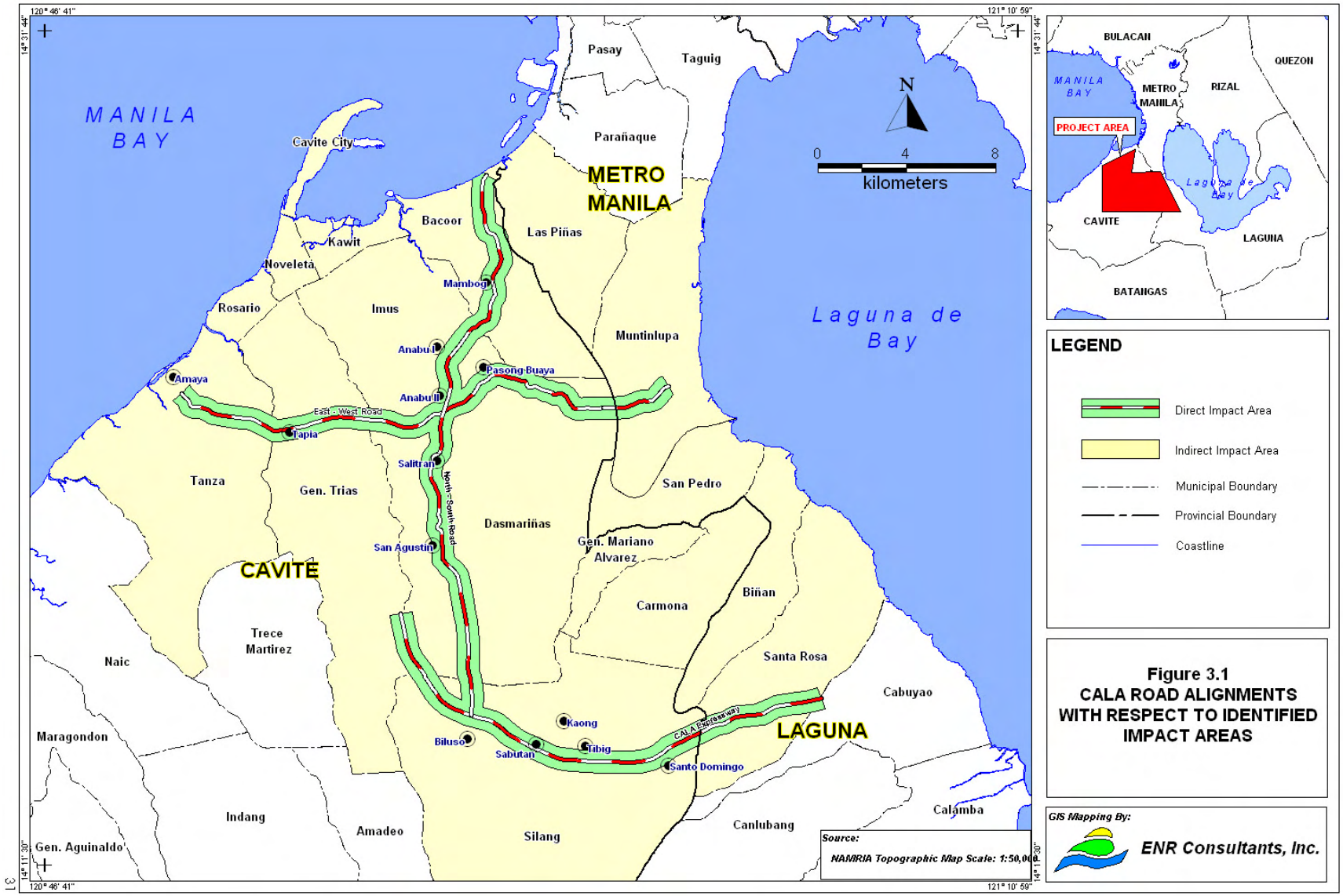
3.2 PHYSICAL ENVIRONMENT

The physical environment of the project area is described in terms of geologic and topographic setting, soils and land use, air and water resources.

3.2.1 Geology

(1) Methodology

This module focused on the geological characteristics and natural hazards of the area in relation to the development and operation of a new and upgraded road system through the provinces of Cavite and Laguna. Evaluation was done in terms of foundation suitability and the susceptibly of the road project to such hazards such as earthquakes, erosion and mass movements using secondary data and several walkover surveys through the project area in January and February 2006. The secondary correspond to published and unpublished reports as well as maps from the Mines and Geo-Sciences Bureau (MGB-DENR) and the Philippine Institute of Volcanology and Seismology (PHIVOLCS) and the works done by other agencies and the private sector in both Cavite and Laguna.


MANILA BAY
Cavite City
Pasay
Taguig
Parañaque
METRO MANILA
Las Piñas
Bacoor
Kawit
Noveleta
Rosario
Imus
Mamboog
Anabu
Anabu II
Pasong Buaya
Amaya
East - West Road
Tapia
Salitran
North - South Road
Muntinlupa
Laguna de Bay
Tanza
Gen. Trias
San Pedro
Dasmariñas
San Agustin
Gen. Mariano Alvarez
CAVITE
Carmona
Biñan
Trece Martirez
Naic
Santa Rosa
Cabuyao
Kaong
Biluso
Sabutan
Tibig
CALA Expressway
Santo Domingo
LAGUNA
Maragondon
Indang
Amadeo
Silang
Canlubang
Calamba
Gen. Aguinaldo
N
0 4 8
kilometers
120° 46' 41"
121° 10' 59"
14° 31' 44"
14° 11' 30"
Source:
NAMRIA Topographic Map Scale: 1:50,000
BULACAN
QUEZON
MANILA BAY
METRO MANILA
RIZAL
PROJECT AREA
CAVITE
LAGUNA
BATANGAS
LEGEND
Direct Impact Area
Indirect Impact Area
Municipal Boundary
Provincial Boundary
Coastline
Figure 3.1
CALA ROAD ALIGNMENTS WITH RESPECT TO IDENTIFIED IMPACT AREAS
GIS Mapping By:
ENR Consultants, Inc.

(2) Regional Geology and Tectonic Setting

1) Tectonic Setting

The island of Luzon, which is situated at the western margin of the Circum-Pacific region, is bounded by 3 offshore structures. These are the eastward-dipping Manila trench on the west[1], and the incipient, northward-propagating, westward-dipping east Luzon trench[2] along the east and the active Lubang Fault to the southwest. On shore structures include the West Marikina Valley Fault System to the east and the 1,300 km long Philippine Fault farther east.

Volcanic landforms in the region including those in the Cavite – Laguna area form part of the southern extension of the north-south trending West Luzon volcanic arc associated with subduction of the South China Sea plate along the Manila Trench[3]. Figure 3.2 shows the major tectonic features of Luzon Island.

2) Physiography/Geomorphology

The Cavite Laguna area regionally falls at the Southwest Luzon Uplands (*Figure 3.3*), a regional landscape unit within the Central Luzon Sub province which in turn belongs to the Central Physiographic province[4]. The northern portion of the Southwest Luzon Uplands essentially corresponds to the CALA project area. It is characterized by a gently sloping terrain which grades towards Manila Bay and dissected by a sub parallel network of streams emanating from the northern edge of the Tagaytay highlands. It is bounded to the east by the Laguna de Bay and to the south by the Tagaytay escarpment and farther south by Taal Lake.

The 1977 Geomorphologic Map of Cavite on the other hand classifies the project area under the Taal Ignimbrite Field, term derived from the underlying sequence of Quaternary pyroclastic deposits (Figure 3.4).

3) Slope

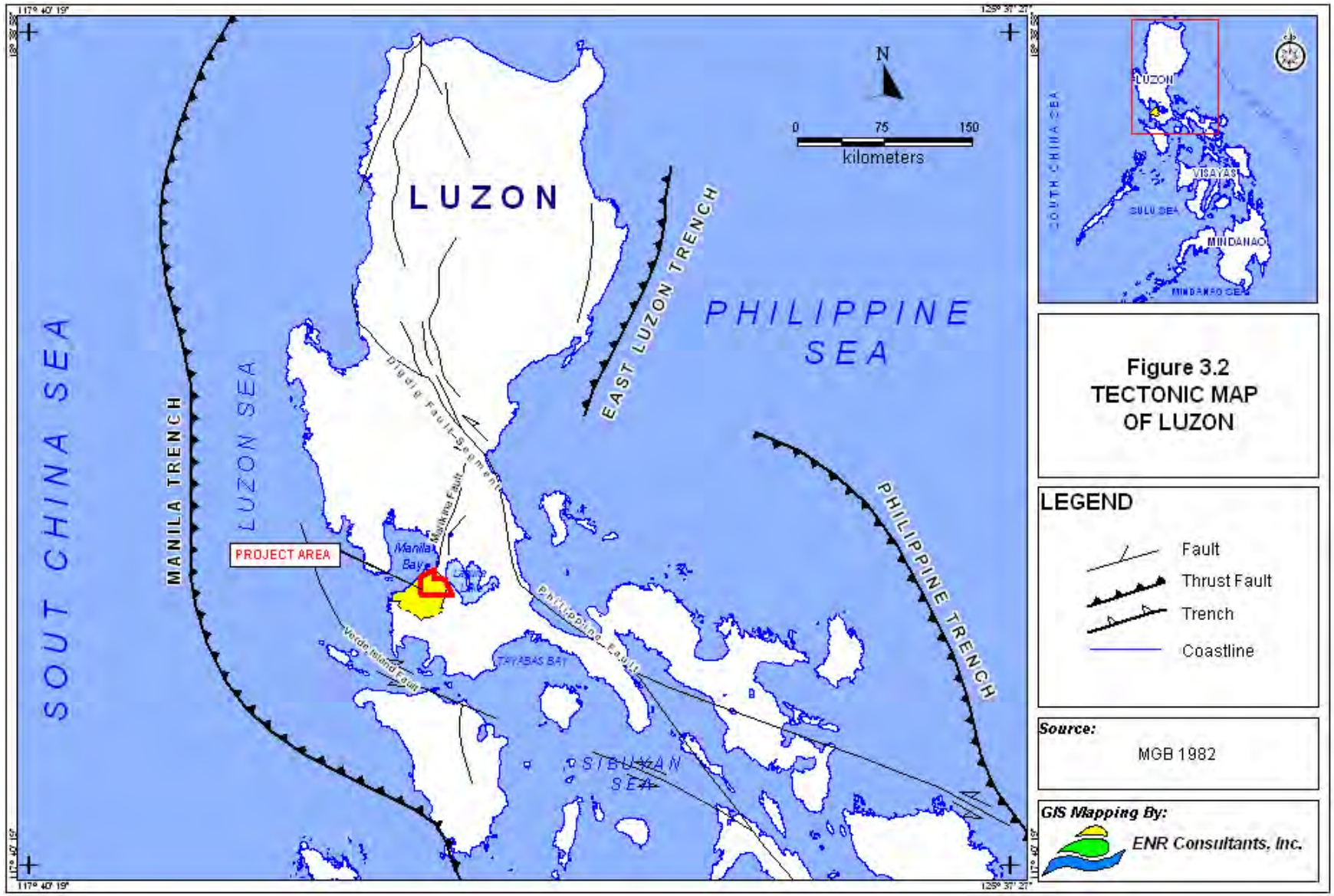
Figure 3.5 shows the slope types, which have been traversed by the various road sections of the CALA project.

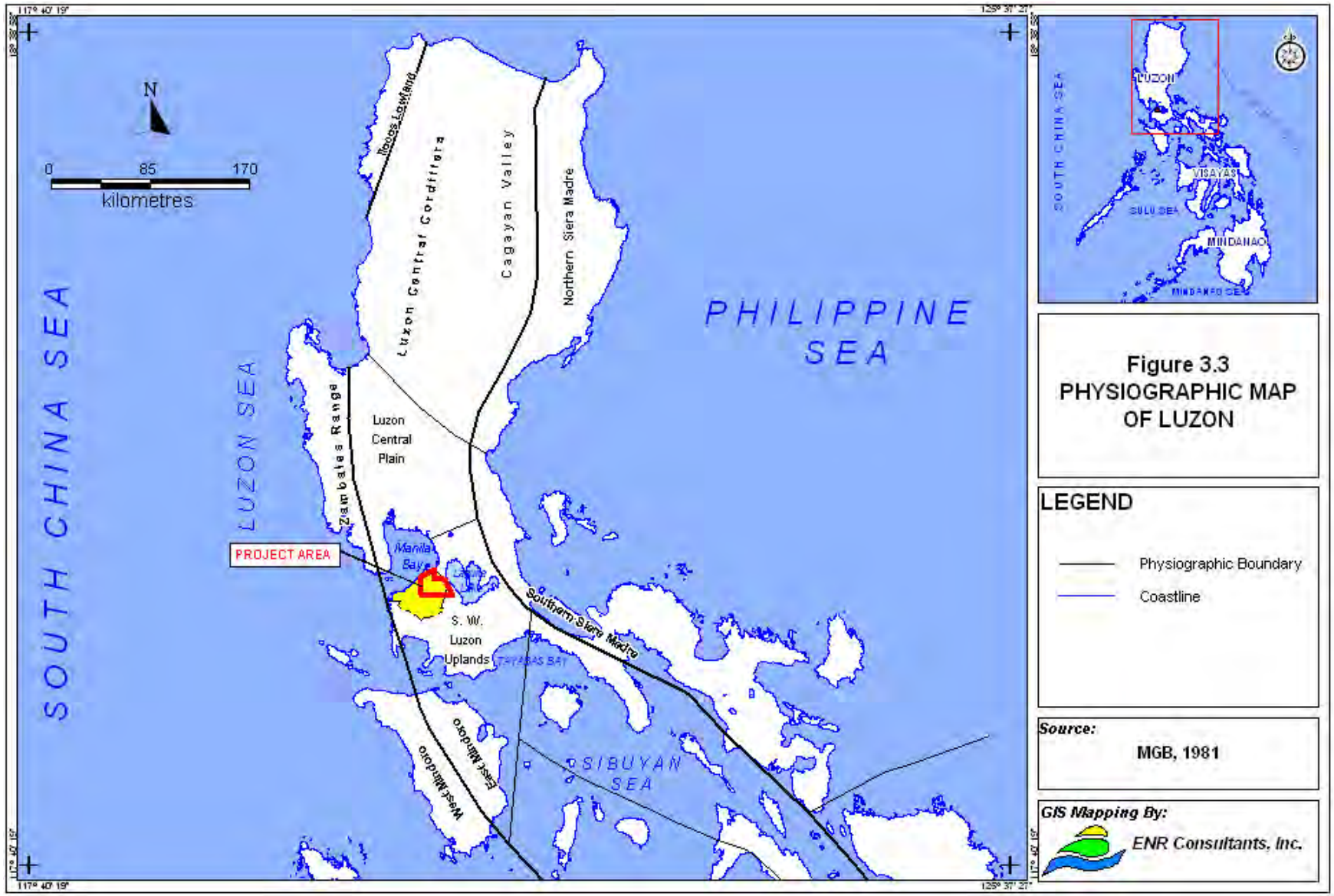
ALT-1C of the East-West has 6.4 km of road, which will be constructed through a level to nearly level area (0-3%) corresponding to the segment from General Trias to Tanza. About 5 km of ALT-1C will pass through a gently sloping to undulating (3-8%) terrain.

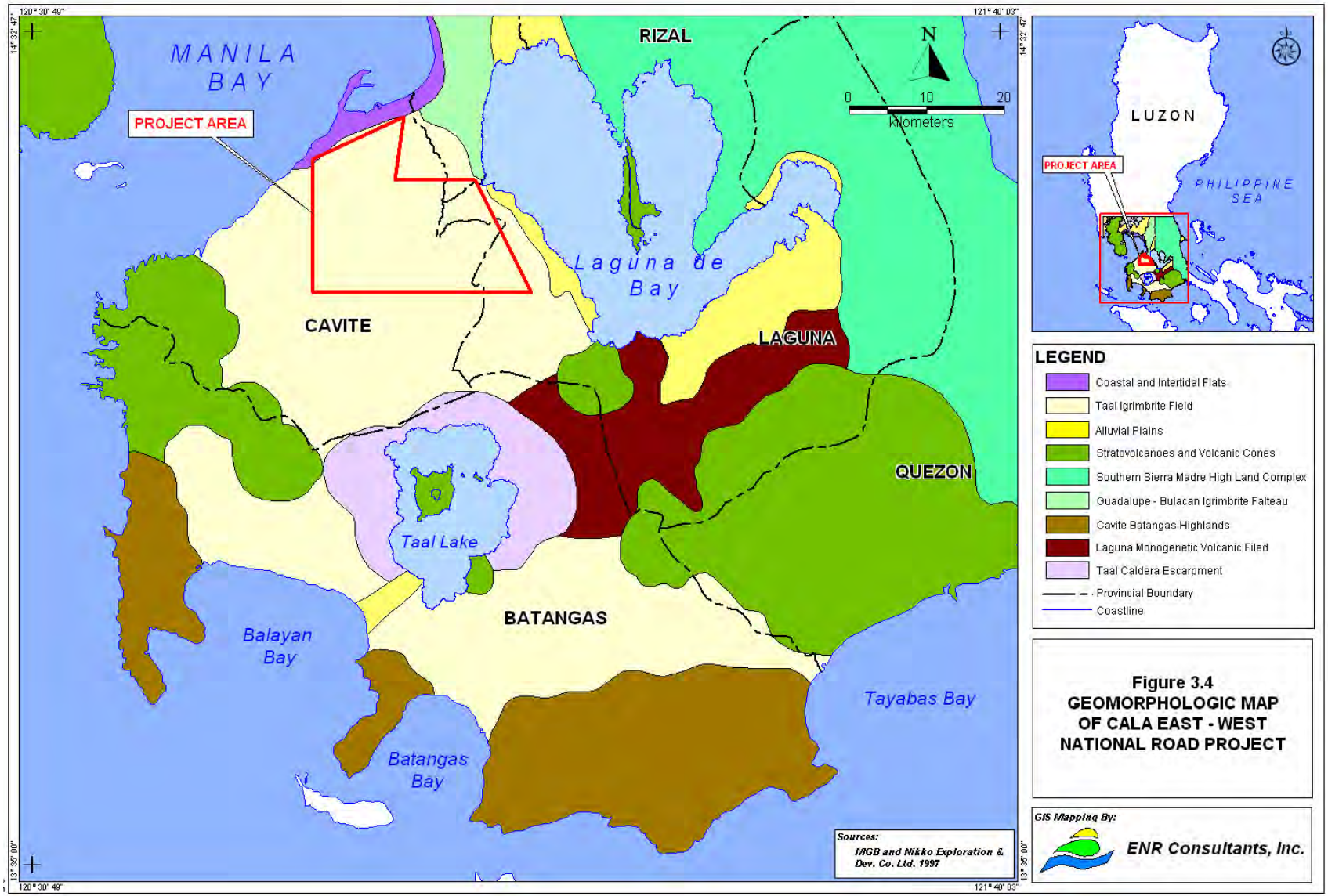
ALT-1B of the North-South road will have 3.1 km on a level to nearly level area (0-3%), 10.6 km on a gently sloping to undulating (3-8%) terrain and 6.94 km of road located on an undulating to rolling area (8-18%).

Most of the segments of the CALA Expressway are in areas, which are undulating to rolling. The final alternative route (ALT-2) will have 15.2 km of road on an undulating to rolling (8-18%) area, 5.0 km on a rolling to moderately steep (18-30%) area, 2.1 km on a gently sloping to undulating (3-8%) area, and 1.3 km situated on a level to nearly level area (0-3%).

[1] Ludwig and others, 1967; Fitch and Molnar, 1970; Cardwell and others, 1980
[2] Cardwell and others, 1980; Hamburger and others, 1983; Taylor and Hayes, 1983
[3] Cardwell and others, 1980; Wolf and Self, 1983
[4] The Bureau of Mines and Geo-Sciences (1981) divided the Philippine archipelago into four physiographic units, namely: Palawan, Western, Central, and Eastern physiographic Provinces.


LUZON
PHILIPPINE SEA
SOUT CHINA SEA
LUZON SEA
MANILA TRENCH
EAST LUZON TRENCH
PHILIPPINE TRENCH
PROJECT AREA
Manila Bay
TAYABAS BAY
SIBUYAN SEA
Philippine Fault
Verde Island Fault
Digdig Fault Segment
Marikina Fault
N
0 75 150
kilometers
VISAYAS
SULU SEA
MINDANAO
MINDANAO SEA
SOUTH CHINA SEA
Figure 3.2
TECTONIC MAP
OF LUZON
LEGEND
Fault
Thrust Fault
Trench
Coastline
Source:
MGB 1982
GIS Mapping By:
ENR Consultants, Inc.


N
0
85
170
kilometres
SOUTH CHINA SEA
LUZON SEA
PHILIPPINE SEA
SIBUYAN SEA
Ilocos Lowland
Luzon Central Cordillera
Cagayan Valley
Northern Sierra Madre
Zambales Range
Luzon Central Plain
PROJECT AREA
Manila Bay
S. W. Luzon Uplands
TAYABAS BAY
Southern Sierra Madre
West Mindoro
East Mindoro
LUZON
VISAYAS
MINDANAO
SULU SEA
MINDANAO SEA
Figure 3.3
PHYSIOGRAPHIC MAP OF LUZON
LEGEND
Physiographic Boundary
Coastline
Source:
MGB, 1981
GIS Mapping By:
ENR Consultants, Inc.


MANILA BAY
PROJECT AREA
RIZAL
Laguna de Bay
CAVITE
LAGUNA
QUEZON
Taal Lake
BATANGAS
Balayan Bay
Batangas Bay
Tayabas Bay
N
0 10 20
Kilometers
120° 30' 49"
121° 40' 03"
14° 32' 47"
13° 35' 00"
Sources:
MGB and Nikko Exploration & Dev. Co. Ltd. 1997
LUZON
PROJECT AREA
PHILIPPINE SEA
LEGEND
Coastal and Intertidal Flats
Taal Igrimbrite Field
Alluvial Plains
Stratovolcanoes and Volcanic Cones
Southern Sierra Madre High Land Complex
Guadalupe - Bulacan Igrimbrite Falteau
Cavite Batangas Highlands
Laguna Monogenetic Volcanic Filed
Taal Caldera Escarpment
Provincial Boundary
Coastline
Figure 3.4
GEOMORPHOLOGIC MAP
OF CALA EAST - WEST
NATIONAL ROAD PROJECT
GIS Mapping By:
ENR Consultants, Inc.

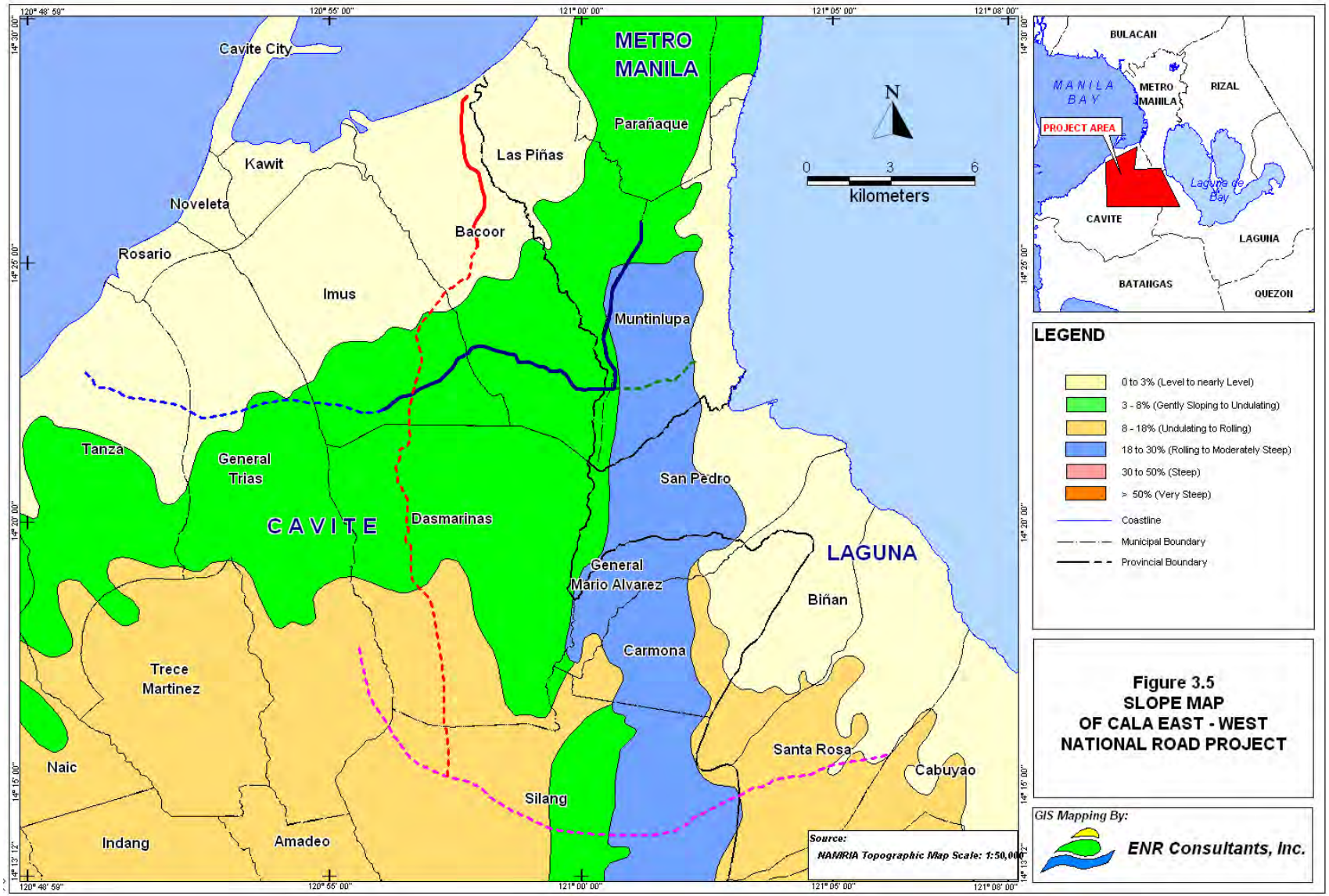


Figure 3.5
SLOPE MAP
OF CALA EAST - WEST
NATIONAL ROAD PROJECT

4) Lithology

Within the project area, 2 major rock formations have been mapped (Figure 3.6). These are the Quaternary Alluvium (QAL) and the Quaternary Volcanic Pyroclastics (QVP). The alluvium refers to the unconsolidated deposit of sands, silts, clays and boulders in varying proportion and degrees of consolidation. These have been mapped in previous studies along the northern coast of Cavite and the western edge of Laguna de Bay. The pyroclastics consists of interlayers of tuff, ash and tuffaceous sedimentary rocks and have known to underlie the gently sloping to hilly sections of the project area. This rock formation is deemed capable of supporting the proposed road structures.

Table 3.1 shows the spatial distribution of the rock formations with respect to the 3 alignments of the project.

Table 3.1 Length of Road Segments vs. Rock Formation

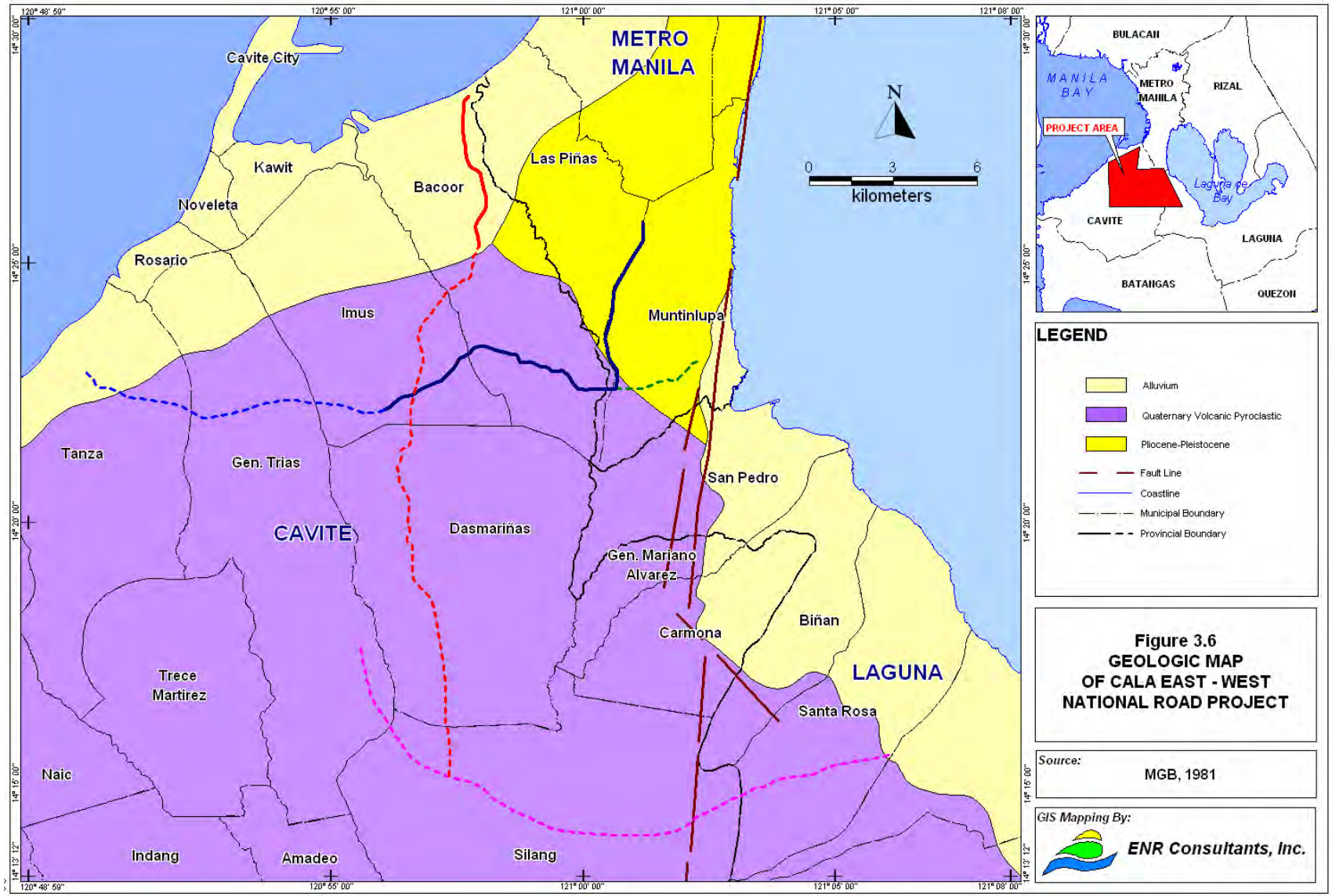
Rock formation	Road Segment	Length (km)
Quaternary Alluvium	East-West Road (ALT-1C)	1.59
	North-South Road (ALT-1B)	0.41
	CALA Expressway (ALT 2)	0.14
Quaternary Volcanic Pyroclastics	East-West Road (ALT-1C)	9.75
	North-South Road (ALT-1B)	20.22
	CALA Expressway (ALT 2)	23.41

5) Structures

The Valley Fault System (VFS) located east - northeast of the project area is considered by PHIVOLCS as active or is an earthquake generator. The VFS consists of two main north-northeast trending faults – the East Valley Fault (EVF) and the West Valley Fault (WVF). Repeated movements along the VFS greatly influenced the present morphology of the area wherein the Marikina Valley was downthrown relative to the Diliman-Pasig and Montalban-San Mateo-Antipolo areas on the west and east, respectively.

The EVF was mapped as far north as San Rafael, Rodriguez and south just north of Marvi Hills Subdivision and Modesta Village for a distance of 8 km. The northern terminus of the EVF has not been fully mapped while its southern extent is poorly-defined as most of the area has been greatly modified by present-day development. Among areas transected by the EVF are the following: San Rafael north of Wawa River, eastern San Rafael, Gloria Vista Subdivision, eastern San Mateo, and northwestern Antipolo. Extension of the EVF from northwestern Antipolo to Angono, Rizal is inferred or is concealed by the Quaternary and Recent alluvial deposits of the Marikina Valley.

Of greater interest in relation to the proposed development is the WVF. The WVF runs from Ridriguez, Rizal on the north to Muntinlupa City and as far south as Silang, Cavite. The northern section of the WVF has been mapped for a distance of at least 23 km from Lower Macabod, Rodriguez in the north down to the vicinity of the Philsports Arena (formerly ULTRA) in Pasig City. This section of the WVF, whose trace is marked by young, fault-related landforms, corresponds with earthquakes of magnitude 6-7 (Nelson et al., 2000). Landforms suggesting repeated rupture of the WVF southward beyond the Pasig River have yet to be identified.


METRO MANILA
Cavite City
Kawit
Noveleta
Bacoor
Las Piñas
Rosario
Imus
Muntinlupa
Tanza
Gen. Trias
CAVITE
Dasmariñas
San Pedro
Gen. Mariano Alvarez
Carmona
Biñan
LAGUNA
Santa Rosa
Trece Martirez
Naic
Indang
Amadeo
Silang
N
0 3 6
kilometers
BULACAN
MANILA BAY
METRO MANILA
RIZAL
PROJECT AREA
Laguna de Bay
CAVITE
LAGUNA
BATANGAS
QUEZON
LEGEND
Alluvium
Quaternary Volcanic Pyroclastic
Pliocene-Pleistocene
Fault Line
Coastline
Municipal Boundary
Provincial Boundary
Figure 3.6
GEOLOGIC MAP
OF CALA EAST - WEST
NATIONAL ROAD PROJECT
Source:
MGB, 1981
GIS Mapping By:
ENR Consultants, Inc.

Road developments that will traverse across the WVF are the east-west routes of E/W 1 (Daang Hari) and the CALA Expressway (Alternatives 1 and 2). A comparison by PHIVOLCS of the WVF with Digdig Fault and the Aglubang Fault indicated that if the vertical to lateral movement ratio is similar to ratios (1:2 to 1:8) measured along scarps on the DigDig fault in northern Luzon soon after the magnitude 7.8 1990 earthquake and the Aglubang River fault in Mindoro during the magnitude 7.1 1994 earthquake, vertical separations of 20-40 cm that probably occurred during individual surface-faulting events on fault strands and the stream exposure suggest lateral slip of about 1-2 m during each event.

Figure 3.7 shows the major seismic zones of the Philippines as defined in the Geology Volume of the Geology and Mineral Resources of the Philippines (1982). The project area belongs to an unclassified strip between Seismic Zone I to the east and Seismic Zone VI to the west. The non classification of the area is attributed to the near absence of earthquakes in the area as shown in *Figure 3.8*. Most of the quakes in the Cavite area are clustered at the southwest coast along a trace parallel to the active Lubang Fault.

6) Hazards

The project area is susceptible to varying degrees to the natural processes of erosion, siltation, mass movement, flooding, volcanic and seismic related hazards. It will also be susceptible to foundation related hazards brought about by the reported presence of paleosols and expansive clays.

Geomorphologic processes within the project area include the usual process of erosion along weathered rock exposures, scouring along the streams and rivers and mass movements involving mainly the residual and colluvial materials which mantle the slopes.

Scouring and bank erosion are deemed not significant due to the essentially good compaction of the pyroclastics in most of the river channels traversing the area.

Based on the erosion map prepared by the Bureau of Soils and Water Management (BSWM), 4 erosion classes were identified in the project area (Figure 3.9. The most widespread category is the No Apparent Erosion. This prevails along the final alternative route (ALT-1C) of the East – West Road. About 13.7 km of the North-South final alternative route (ALT-1B) will be built through a No Apparent Erosion area. The remaining 6.9 km will be situated in a Slight Erosion Area. The final alternative route ALT-2 of the Expressway will pass through 18.2 km under the Slight Erosion category with the remaining 5.3 km of road to be situated on a No Apparent Erosion area.

The coastal section from Kawit to Las Piñas where the North–South Road originates is susceptible to tidal flooding (Figure 3.10).

Most of the project area is deemed not vulnerable to liquefaction, settlement and lateral spreading. This is attributed to the location of very short segments of the road on the alluvial deposits at near the coastal road of Cavite and along the western shores of Laguna de Bay. Considering the more than 25 km distance of the project area to Taal Volcano, it is unlikely that it will be directly and adversely affected by eruption-related volcanic hazards such lava flows, lahars and pyroclastic flows if the scale of eruptions were of similar magnitude to those of historic times. The proposed road segments though will be affected by air fall and volcanic quakes which will not have significant impacts on the structures.

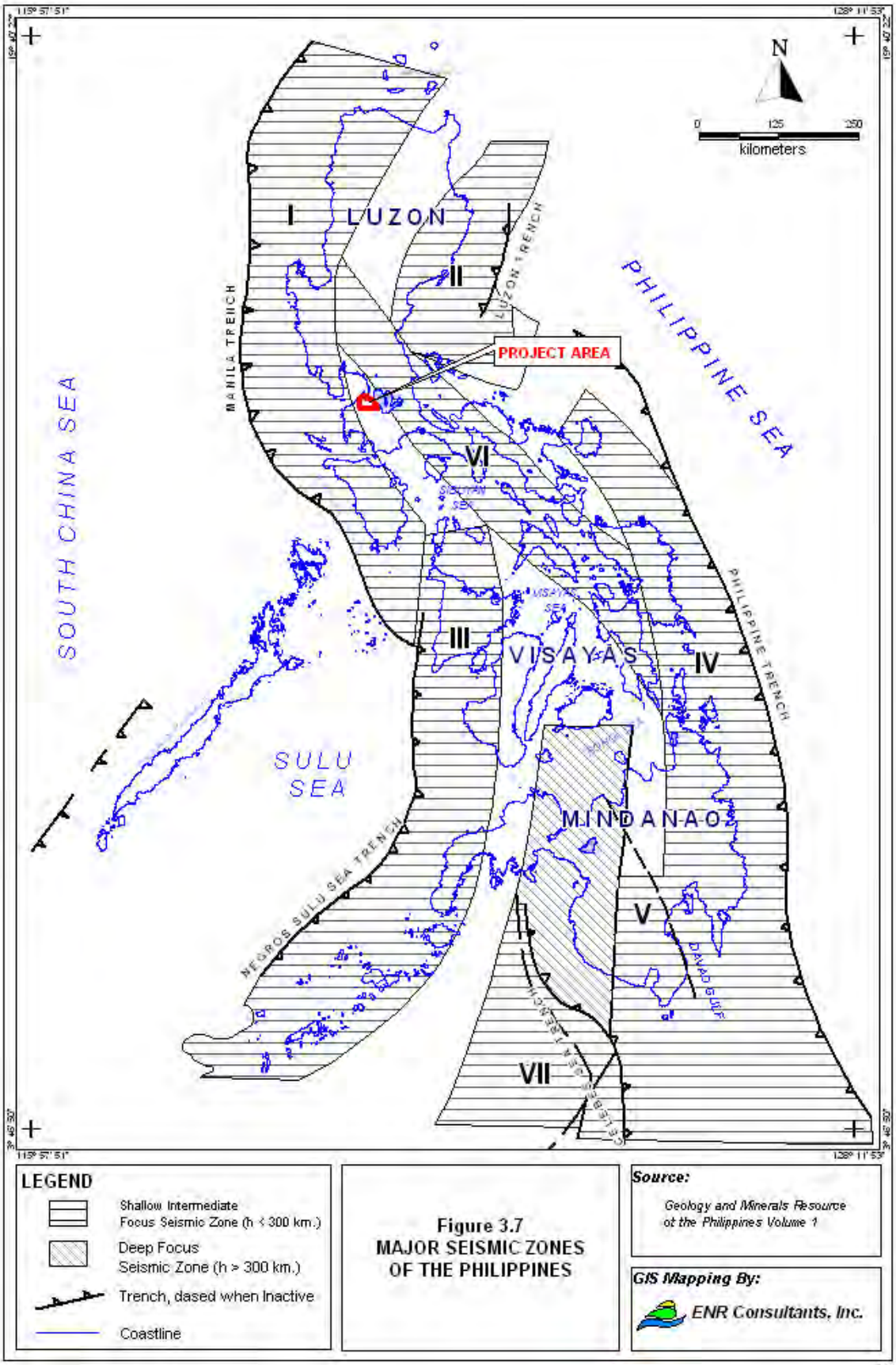
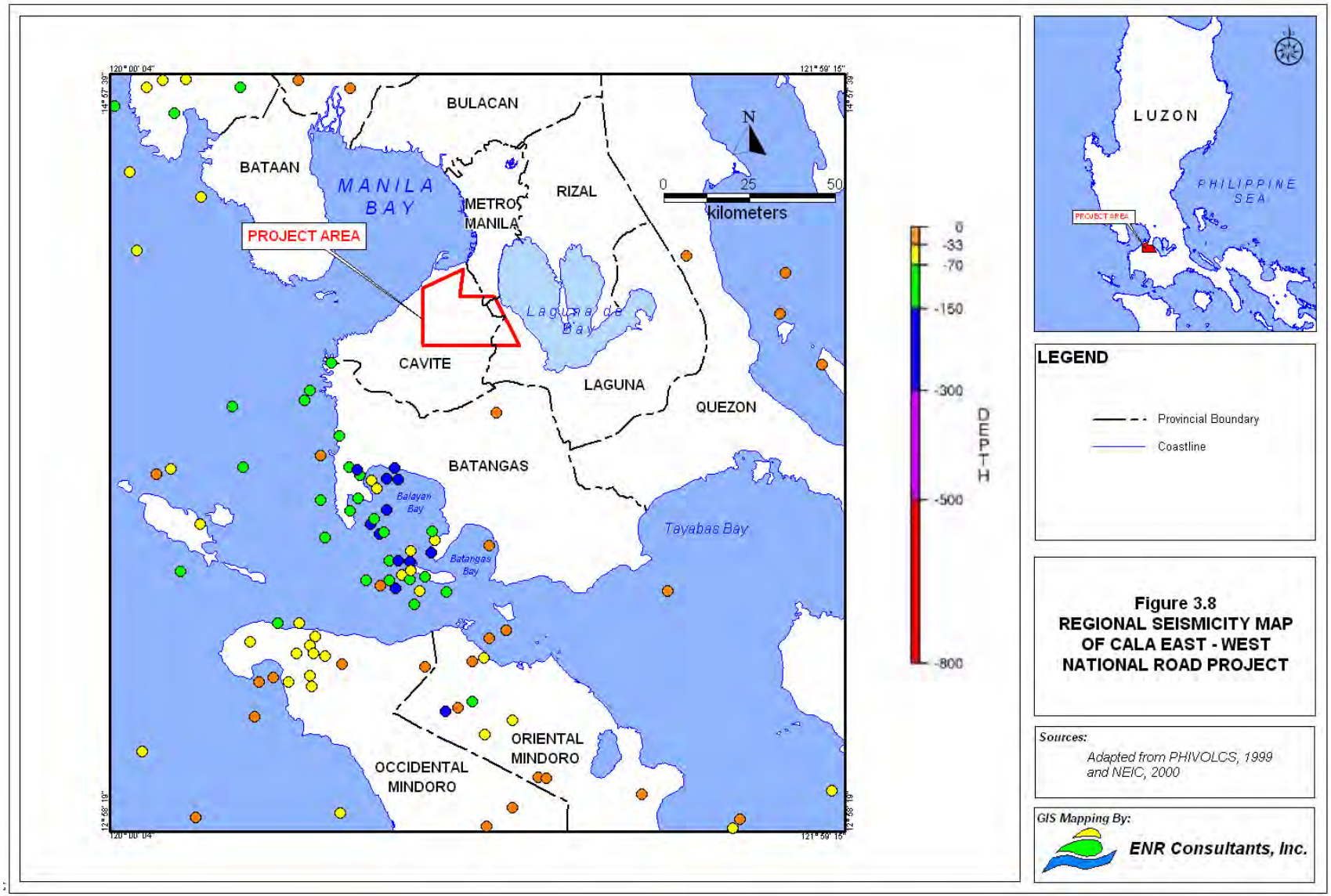
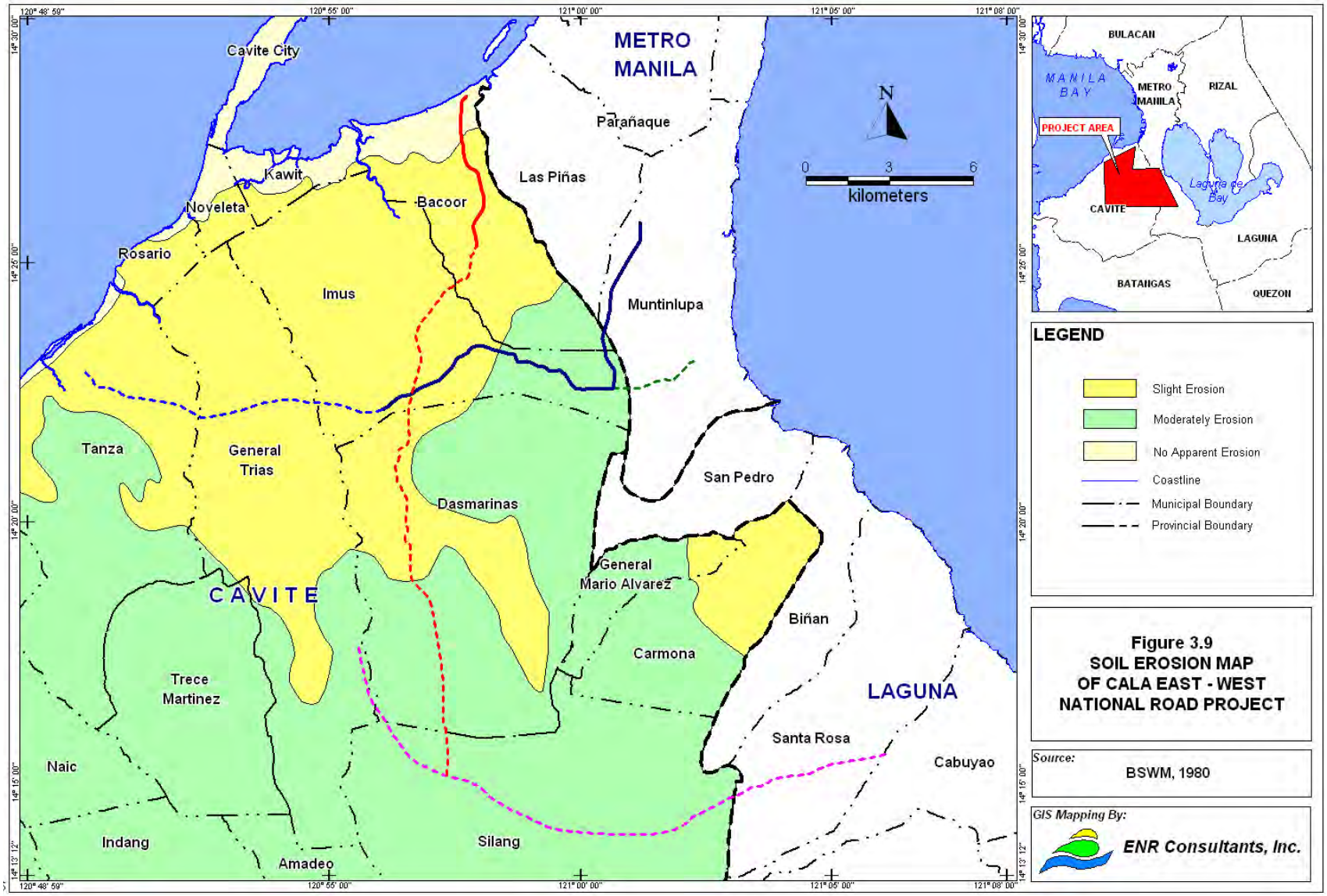
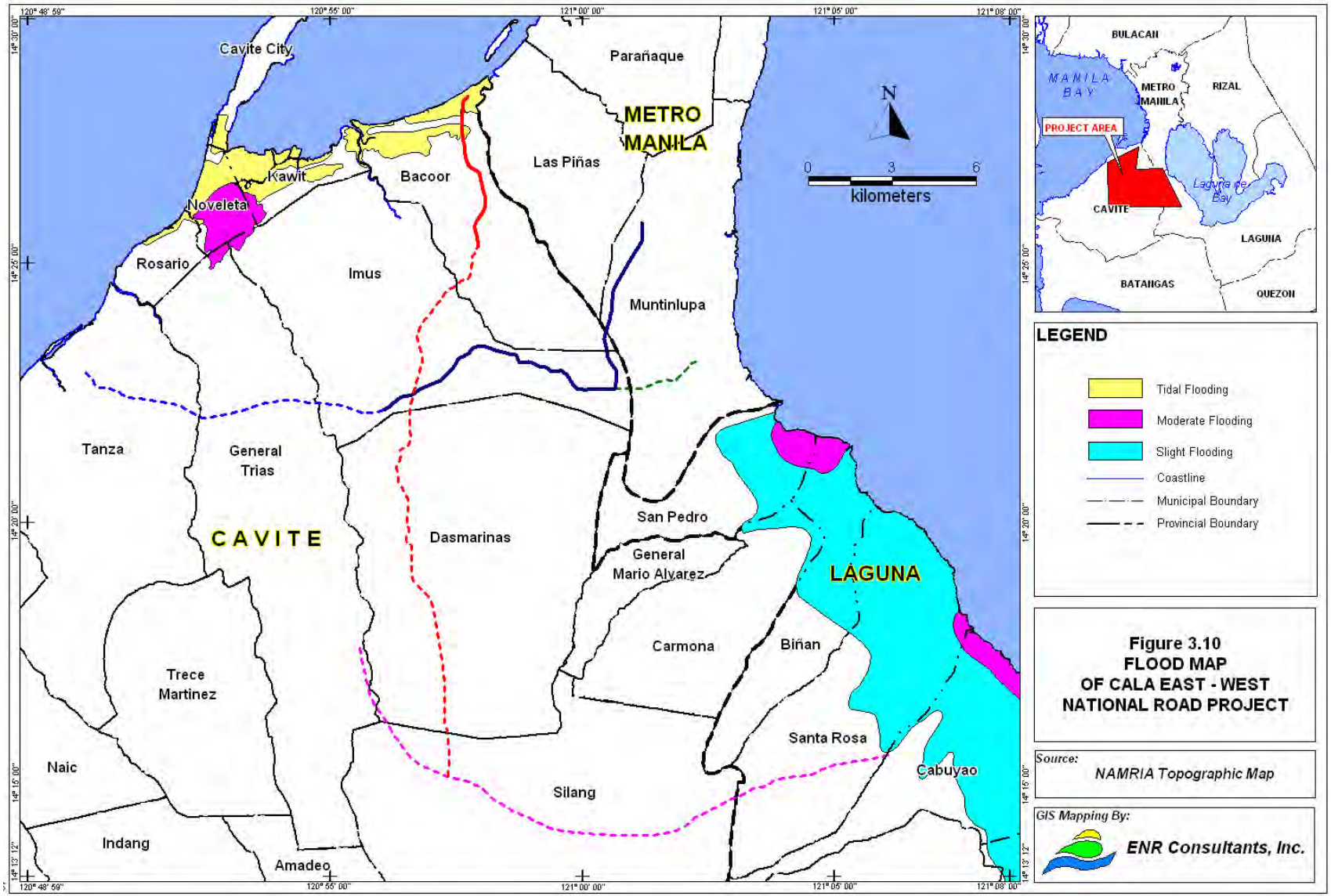


Figure 3.7
MAJOR SEISMIC ZONES
OF THE PHILIPPINES


BULACAN
BATAAN
MANILA BAY
METRO MANILA
RIZAL
PROJECT AREA
Laguna de Bay
CAVITE
LAGUNA
QUEZON
BATANGAS
Balayan Bay
Batangas Bay
Tayabas Bay
ORIENTAL MINDORO
OCCIDENTAL MINDORO
N
0
25
50
kilometers
DEPTH
0
-33
-70
-150
-300
-500
-800
LUZON
PHILIPPINE SEA
PROJECT AREA
LEGEND
Provincial Boundary
Coastline
Figure 3.8
REGIONAL SEISMICITY MAP
OF CALA EAST - WEST
NATIONAL ROAD PROJECT
Sources:
Adapted from PHIVOLCS, 1999
and NEIC, 2000
GIS Mapping By:
ENR Consultants, Inc.


METRO MANILA
Cavite City
Parañaque
Las Piñas
Kawit
Noveleta
Bacoor
Rosario
Imus
Muntinlupa
Tanza
General Trias
Dasmarinas
San Pedro
General Mario Alvarez
CAVITE
Biñan
Carmona
Trece Martinez
LAGUNA
Santa Rosa
Cabuyao
Naic
Indang
Amadeo
Silang
N
0 3 6
kilometers
BULACAN
MANILA BAY
METRO MANILA
RIZAL
PROJECT AREA
Laguna de Bay
CAVITE
LAGUNA
BATANGAS
QUEZON
LEGEND
Slight Erosion
Moderately Erosion
No Apparent Erosion
Coastline
Municipal Boundary
Provincial Boundary
Figure 3.9
SOIL EROSION MAP
OF CALA EAST - WEST
NATIONAL ROAD PROJECT
Source:
BSWM, 1980
GIS Mapping By:
ENR Consultants, Inc.


Cavite City
Parañaque
METRO MANILA
Las Piñas
Kawit
Bacoor
Noveleta
Rosario
Imus
Muntinlupa
Tanza
General Trias
CAVITE
Dasmarinas
San Pedro
General Mario Alvarez
LAGUNA
Carmona
Biñan
Trece Martinez
Santa Rosa
Cabuyao
Naic
Silang
Indang
Amadeo
N
0 3 6
kilometers
BULACAN
MANILA BAY
METRO MANILA
RIZAL
PROJECT AREA
Laguna de Bay
CAVITE
LAGUNA
BATANGAS
QUEZON
LEGEND
Tidal Flooding
Moderate Flooding
Slight Flooding
Coastline
Municipal Boundary
Provincial Boundary
Figure 3.10
FLOOD MAP
OF CALA EAST - WEST
NATIONAL ROAD PROJECT
Source:
NAMRIA Topographic Map
GIS Mapping By:
ENR Consultants, Inc.

The major geologic structures in the region could generate seismic activity which could bring about ground shaking. A study conducted by Thenhaus, Hanson and Algermissen of the United States Geological Survey and the Philippine Institute of Volcanology and Seismology (1995) estimated peak ground horizontal accelerations that have a 10% probability of being exceeded in 50 years for medium soil and soft soil conditions in the Philippines (Figures 3.11 and 3.12). The results indicate peak ground accelerations of 0.39 ***g***[5] and 0.70 ***g*** for the pyroclastics and alluvial deposits, respectively.

Paleosol horizons have been reported to occur in between pyroclastic layers in the Cavite – Laguna area. These horizons represent buried, usually soft residual clays derived from the weathering and alteration of volcanic materials, which were subsequently buried by another sequence of volcanic deposits. If found in sufficient thickness below the final grade level of he proposed road, these deposits could settle due to the additional load imposed by the structure and dynamic load of the passing vehicles.

Settlement can also take place if the final grade level happens to coincide with the soft residual clays found near the present ground surface.

Expansive soils may be present in the pyroclastic layers which underlie the project area. These soils, which originated from the alteration of the volcanic rocks swell and shrink with the presence and absence of water. As water is initially introduced into the soil (by rainfall or watering), an expansion takes place. If dried out, the soil will contract, often leaving small fissures or cracks. This behavior could affect the integrity of the pavement which may be founded don these materials.

7) Hydrogeology

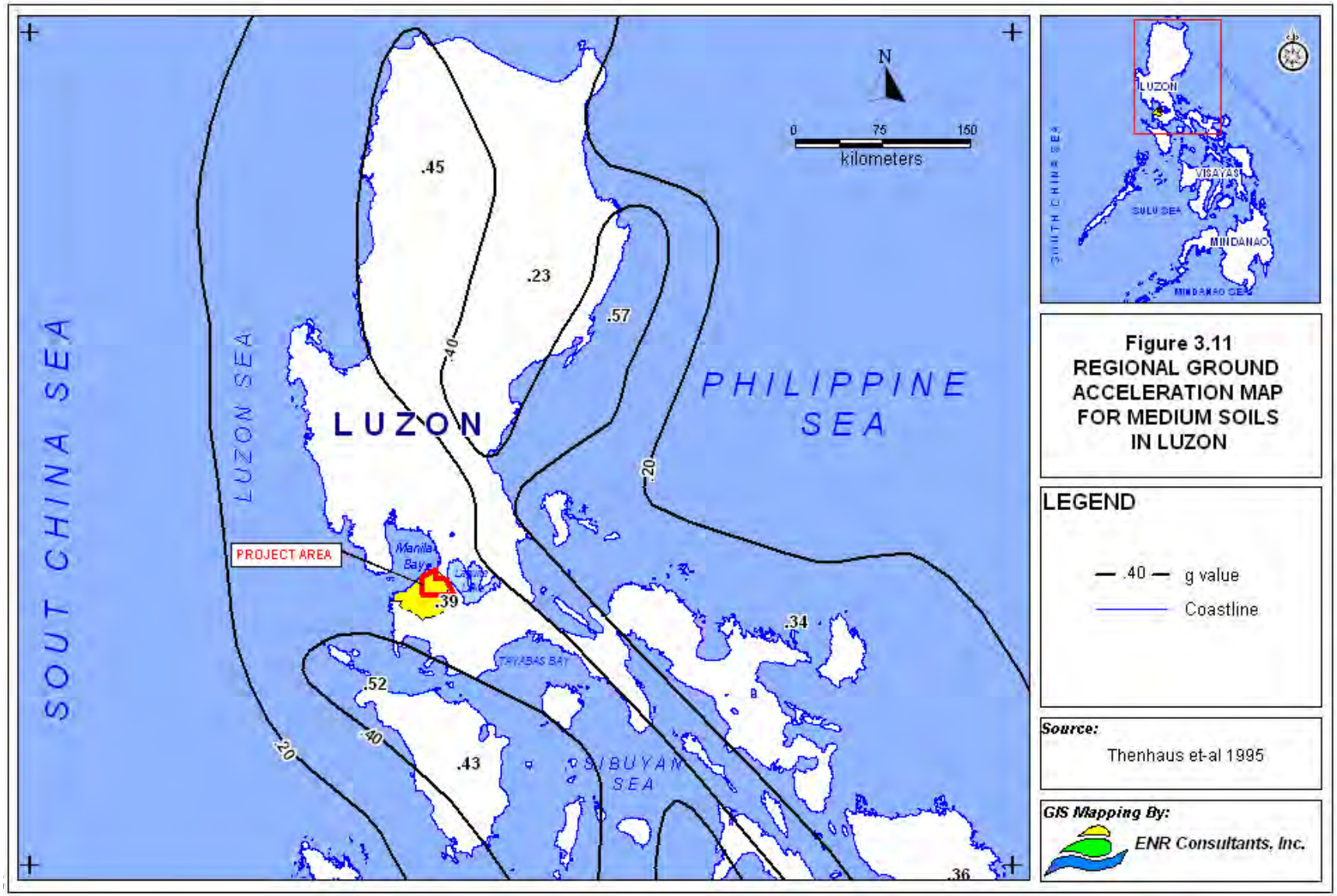
The hydrogeologic units of the project area essentially coincide with the 2 major rock formations. The Quaternary Alluvium form simple unconfined aquifers with shallow water tables. Well yields are mostly about 2 liters per second (lps) but as high as 20 lps in some sites (MGB, 1997). The Quaternary Volcanic Pyroclastics form either unconfined or confined aquifers. Known production yields are mostly about 20 lps but as high as 60 lps in some areas (MGB, 1997).

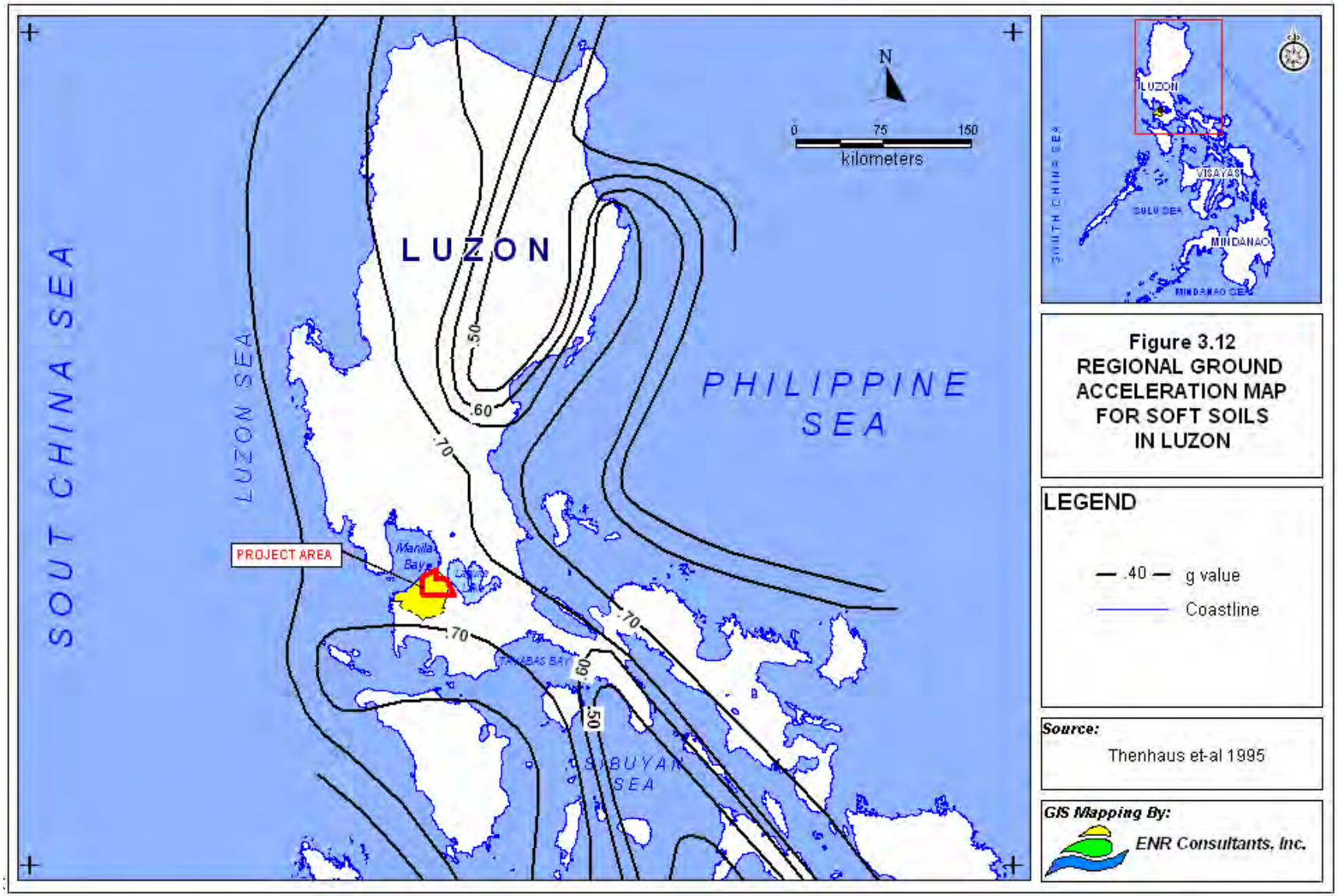
Figure 3.13 shows the depth to groundwater level map for the year 2004 prepared by CEST Inc. The map indicates groundwater depths ranging from 60 m to 100 m below ground surface (mbgs).

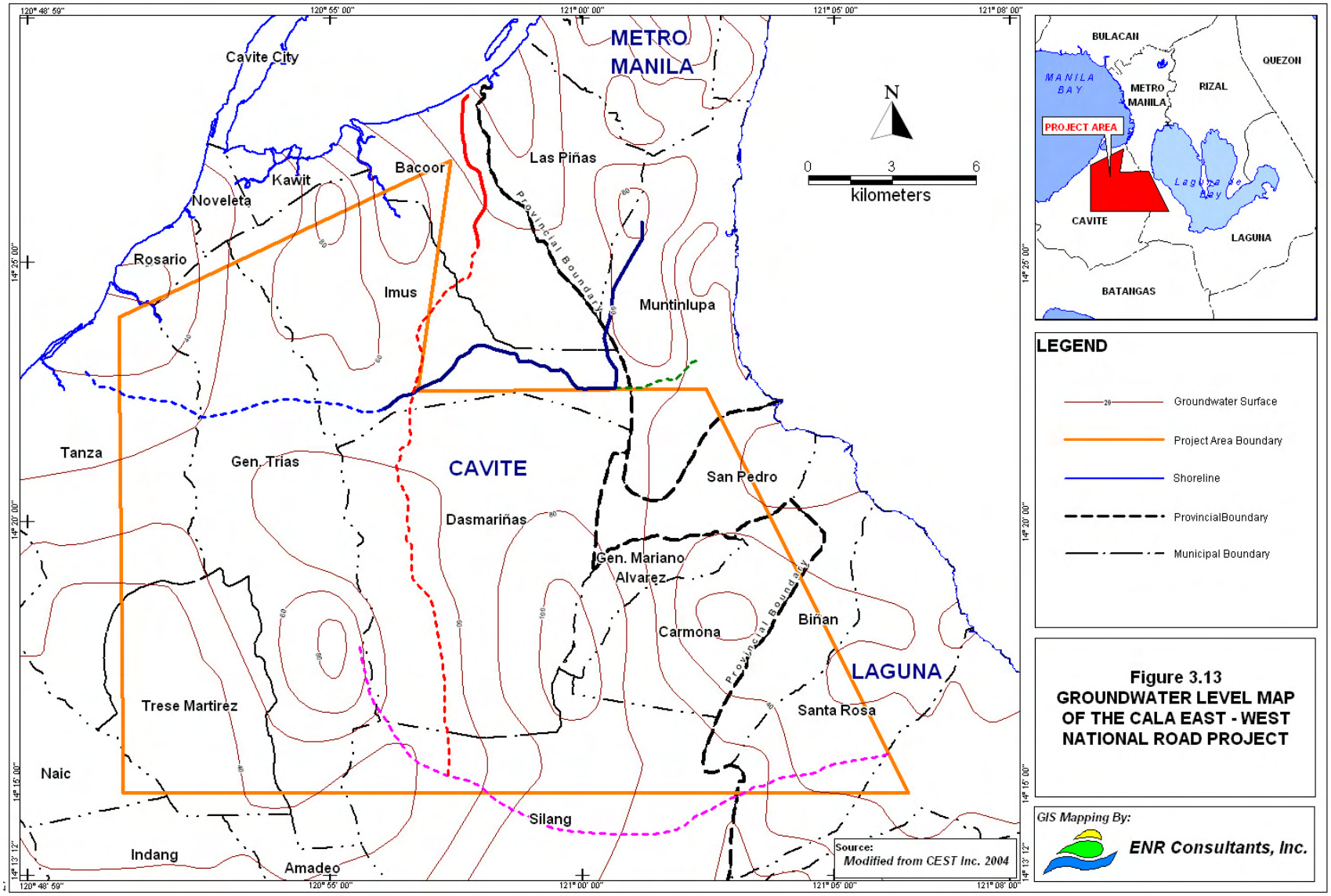
3.2.2 Soils

The soils within the project area were derived from the residual weathering of the Quaternary Volcanic Pyroclastics and were further categorized by the BSWM in accordance with the hierarchal system of soil classification following the basic guidelines of soil classification provided by the USDA Soil Taxonomy System (Figure 3.14). Table 3.2 shows the four soil types traversed by the proposed road project.

[5] Refers to the force of gravity equal to 9.8m/sec/sec


N
0
75
150
kilometers
.45
.23
.57
.40
.20
LUZON
PHILIPPINE SEA
SOUT CHINA SEA
LUZON SEA
PROJECT AREA
Manila Bay
.39
.34
TAYABAS BAY
.52
.40
.20
.43
SIBUYAN SEA
.36
LUZON
VISAYAS
SULU SEA
MINDANAO
SOUTH CHINA SEA
MINDANAO SEA
Figure 3.11
REGIONAL GROUND ACCELERATION MAP FOR MEDIUM SOILS IN LUZON
LEGEND
.40 g value
Coastline
Source:
Thenhaus et-al 1995
GIS Mapping By:
ENR Consultants, Inc.


SOUT CHINA SEA
LUZON SEA
LUZON
PHILIPPINE SEA
SIBUYAN SEA
PROJECT AREA
Manila Bay
TAYABAS BAY
.50
.60
.70
N
0
75
150
kilometers
LUZON
VISAYAS
MINDANAO
SULU SEA
SOUTH CHINA SEA
MINDANAO SEA
Figure 3.12
REGIONAL GROUND
ACCELERATION MAP
FOR SOFT SOILS
IN LUZON
LEGEND
.40 g value
Coastline
Source:
Thenhaus et-al 1995
GIS Mapping By:
ENR Consultants, Inc.


METRO MANILA
Cavite City
Las Piñas
Bacoor
Kawit
Noveleta
Rosario
Imus
Muntinlupa
Provincial Boundary
N
0 3 6
kilometers
Tanza
Gen. Trias
CAVITE
San Pedro
Dasmariñas
Gen. Mariano Alvarez
Carmona
Biñan
LAGUNA
Santa Rosa
Trese Martirez
Naic
Silang
Indang
Amadeo
Source:
Modified from CEST Inc. 2004
BULACAN
QUEZON
MANILA BAY
METRO MANILA
RIZAL
PROJECT AREA
Laguna de Bay
CAVITE
LAGUNA
BATANGAS
LEGEND
Groundwater Surface
Project Area Boundary
Shoreline
ProvincialBoundary
Municipal Boundary
Figure 3.13
GROUNDWATER LEVEL MAP OF THE CALA EAST - WEST NATIONAL ROAD PROJECT
GIS Mapping By:
ENR Consultants, Inc.

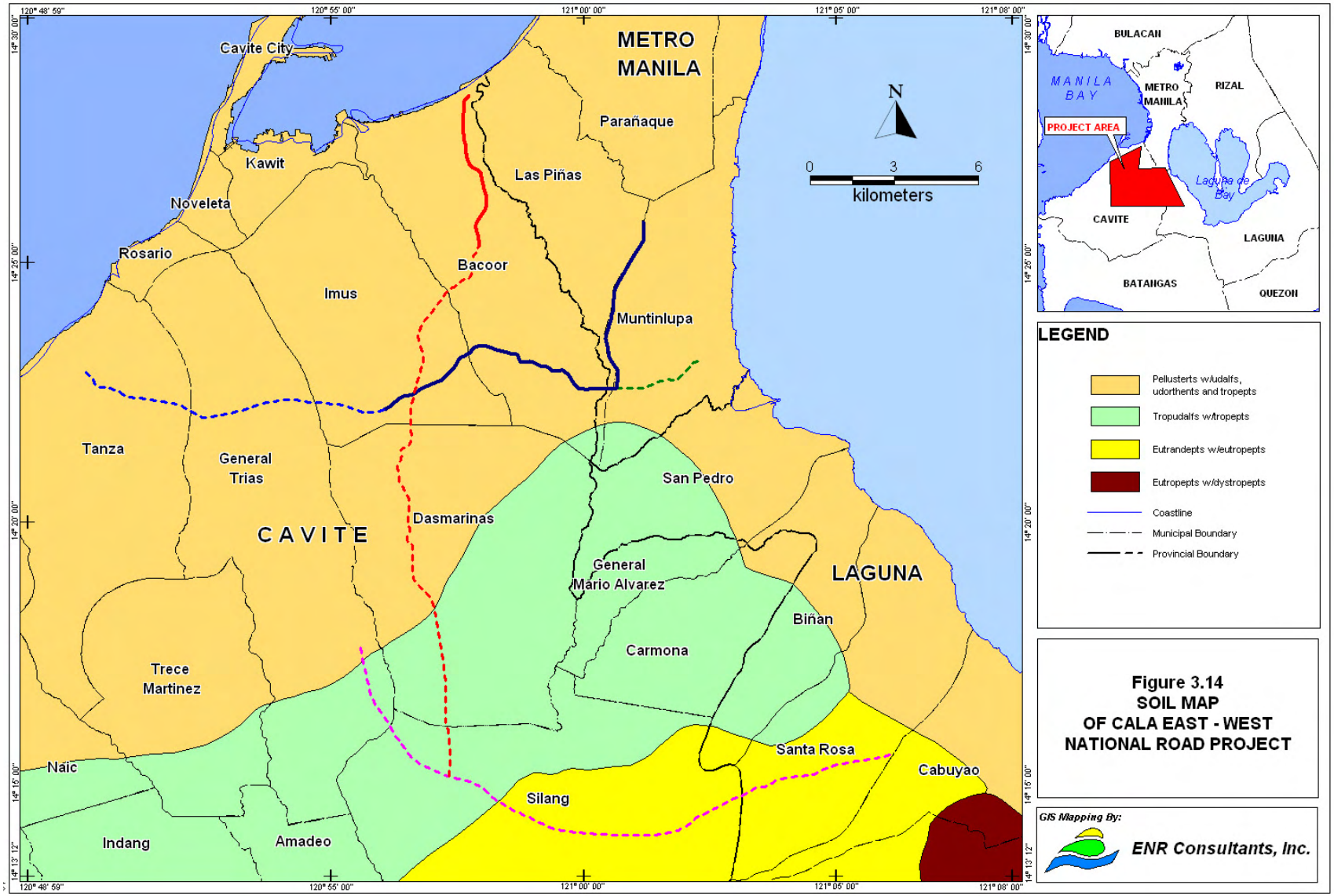

METRO MANILA
Cavite City
Kawit
Noveleta
Rosario
Parañaque
Las Piñas
Bacoor
Imus
Muntinlupa
Tanza
General Trias
CAVITE
Dasmarinas
San Pedro
General Mario Alvarez
LAGUNA
Biñan
Carmona
Trece Martinez
Naic
Indang
Amadeo
Silang
Santa Rosa
Cabuyao
N
0 3 6
kilometers
BULACAN
MANILA BAY
METRO MANILA
RIZAL
PROJECT AREA
Laguna de Bay
CAVITE
LAGUNA
BATANGAS
QUEZON
LEGEND
Pellusterts w/udalfs, udorthents and tropepts
Tropudalfs w/tropepts
Eutrandepts w/eutropepts
Eutropepts w/dystropepts
Coastline
Municipal Boundary
Provincial Boundary
Figure 3.14
SOIL MAP
OF CALA EAST - WEST
NATIONAL ROAD PROJECT
GIS Mapping By:
ENR Consultants, Inc.

Table 3.2 Soil Types Traversed by the CALA Road Project

Soil Series	Soil Taxonomic Classification	Location	Road Alignment
Guadalupe clay	Fine clay, Typic Ustropepts, 0-2% slopes, no apparent flooding	Bgys. Malagasang and Anabu 11, Imus; Dasmariñas	East-West Road North-South Road
Guadalupe silt loam	Fine Aquic Ustropepts, 25-40% slopes, moderately eroded	Eastern and western portions of General Mariano Alvarez; Bgy. Paliparan, Dasmariñas	North-South Road
Guadalupe clay adobe	Fine clay, Lithic Tropaquepts, 2-5% slopes, no erosion	Southwestern & southeastern portions of Tanza; northern portion of Dasmariñas; Imus and Bacoor up to Cavite-Rizal provincial boundary.	East-West Road North-South Road
Guadalupe clay loam	Very fine clay, Lithic Tropaquepts, 2-5% slopes, no erosion	Sloping southwestern part of Tanza; Northeastern portion of Dasmariñas down to Imus and Bacoor extending to the Cavite-Rizal provincial boundary	East-West Road North-South Road
Magallanes loam	Very fine, Typic Hapludalfs, 5-8% slopes, no apparent erosion	Bgys. Tubuan, Luksuhin, Munting Ilog, Kalubkub, all of Silang extending towards General Trias and Amadeo	CALA Expressway
Carmona clay loam	Very fine, Typic Haplustalfs, 5-8% slopes, moderately eroded	Southern part of Silang and Dasmariñas through the Cavite-Rizal provincial boundary	North-South Road CALA Expressway

1) Guadalupe Clay

The soils of this mapping unit are found at Barangays Malagasang and Anabu II, Imus extending towards the municipality of Dasmariñas. The soil is mostly planted with non-irrigated paddy rice with limited patches of vegetables and diversified crops. Industrial establishments and housing Projects are also observed although in limited extent.

2) Guadalupe Silt Loam

This soil is found at eastern and western part of General Mariano Alvarez going towards to Barangay Paliparan, Dasmariñas. Areas on the lower slopes are principally utilized for pineapple production. Other areas are used for diversified crops such as root crops, cassava, and sweet potato. High elevation areas are occasionally planted with upland rice, sugarcane and fruit trees.

The Guadalupe Clay and Guadalupe Silt Loam correspond to moderately deep-to-deep, well drained, brown to dark brown, grayish brown, dark grayish brown and very dark grayish brown clay. The basic difference is the occurrence of the former on flat to gentle areas while the latter is found on moderately sloping ground.

The surface soils, 15-20 cm thick, are dark grayish brown, very dark grayish brown and brown to dark brown clay with matrix hue color of 10YR. Soil structure is weak and medium to moderate angular blocky breaking to sub angular blocky. Soil consistency is sticky, plastic when wet and firm when moist. Soil reaction ranges from 5.3 to 6.3.

The cambric B horizons, 20-100 cm thick, are grayish brown, dark grayish brown and very dark grayish brown clay loam to clay. Soil structure is fine medium to moderate angular to sub angular blocky; consistency is sticky and plastic when wet and firm when moist. Few small hard pebbles and soft iron manganese concretions are occasionally observed in this horizon. Presence of few partially and highly weathered probably volcanic tuff fragments is also observed in increasing depth. Soil reaction varies from 5.6 to 6.6.

The substratum below 60-110 cm deep are dark grayish brown clay loam with few to common partially and highly weathered yellowish brown and dark yellowish brown probably volcanic rock fragments. This horizon is underlain by hard tuff.

The soils are moderately well drained with estimated permeability and infiltration rates are moderate.

3) Guadalupe Clay Adobe

This soil is extensively found on the gently sloping southwestern and southeastern portion of Tanza going towards the northern portion of Dasmariñas extending towards Imus and Bacoor up to Cavite-Rizal provincial boundary. This unit is dominantly utilized for irrigated and non-irrigated paddy rice. Some other areas are planted with diversified crops with limited patches of fruit trees.

4) Guadalupe Clay Loam

This soil is extensively mapped in the sloping southwestern portion of Tanza, northeastern portion of Dasmariñas down to Imus and Bacoor extending to the Cavite-Rizal provincial boundary. It is normally used for irrigated and non-irrigated paddy rice with patches of open grassland and diversified crops. Industrial establishments and housing Projects were observed in the soil mapping unit.

Both the Guadalupe Clay Adobe and Guadalupe Clay Loam occur on level to nearly level topography of low-lying broad alluvial plain/residual terraces having a slope ranging from 0-8%. Elevation ranges from 10-80 m above mean sea level. These soils have an ochric epipedon and a cambric subsurface horizon with a shallow lithic contact encountered at a depth of 50 cm.

Lithic Tropoaquepts have a solum thickness ranging from 10-35 cm thickness. The ochric epipedon varies from 10-15 cm thick, dark gray, dark grayish brown, very dark grayish brown and dark yellowish brown clay with few to common yellowish red, dark yellowish brown and dark gray mottles. Soil structure is moderate; consistency is sticky, plastic when wet and firm when moist. Occasional occurrence of few small and hard probably volcanic cinders is observed in this horizon. Soil reaction varies from 5.1 to 5.8.

The cambric B horizon ranges from 10 to 35 cm thick; gray and dark gray clay with yellowish brown and greenish gray mottles. Few to common iron manganese concretions and common partially and highly weathered volcanic fragments usually occur in this horizon. Few to common soft and hard probably volcanic cinders and thin patches of slickensides are also occasionally present in this horizon. Soil reaction varies from 5.3 to 6.9.

The substratum is usually gray, dark gray and grayish brown clay with moderately strong sub angular blocky structure. Consistency is similar to that of subsurface horizon. Many

partially and highly weathered olive and light olive gray volcanic fragments are present. Soil reaction varies from 5.4 to 6.9.

Both soils are poorly to somewhat poorly drained. The permeability and the basic infiltration rates are estimated to be slow to moderately slow.

5) Magallanes Loam

This soil is found in Bgys. Tubuan, Luksuhin, Munting Ilog, and Kalubkub in Silang. This mainly planted to coffee, coconut, fruit trees and diversified crops as well as patches of shrubs and grasses. It corresponds to moderately deep, well drained soils occurring on undulating to rolling volcanic tuff materials. The slope ranges from 2-18% with an elevation ranging from 200 to 500 m above mean sea level. Soil structure is moderately weak to moderately weak strong medium angular and sub angular and sub angular blocky with few to common discontinuous thin clay cutans. They are extensively identified on undulating to hilly landscapes next to the mountainous areas.

Solum thickness ranges from 15-120 cm. The A horizon is dark brown, brown to dark brown and very dark grayish brown clay with occasional strong brown mottles. Soil structure is moderately weak to moderately strong medium angular to sub angular blocky. Consistency is sticky, plastic when wet and firm when moist. Few tubular open pores within ped faces and few slightly and partially weathered brownish yellow probably volcanic tuff fragments are present. Soil reaction ranges from 5.0 to 5.8.

The argillic B horizon, 25-100 cm thick, are brown to dark brown, dark brown and dark reddish brown clay. Soil structure is moderately strong medium angular to sub angular blocky. Consistency is sticky, plastic when wet and firm when moist. Common to many patchy thin clay cutans within tubular open pores and ped faces are present. Volcanic cinders are occasionally observed in this horizon. Partially and highly weathered brownish yellow and yellowish brown probably volcanic tuff fragments are also present. Soil pH ranges from 4.9 to 5.8.

The substratum is generally brown and reddish brown and has texture similar to the overlying horizon. Consistency is sticky, plastic when wet and firm when moist. The horizon usually contains partially and highly weathered yellowish brown materials are probably volcanic tuff fragments. Soil pH ranges from 5.3 to 6.0.

The Magallanes Loam is a well drained soil. The permeability and basic infiltration rates are moderately slow and moderate, respectively.

6) Carmona Clay Loam

This soil is found in the southern part of General Trias extending towards the municipalities of Silang and Dasmariñas through the Cavite-Rizal provincial boundary. This unit is planted to sugarcane, corn, banana, papaya, pineapple, diversified crops, fruit trees, sweet potato, cassava and upland rice. It corresponds to moderately deep, well drained soils that occur on undulating to rolling volcanic landscapes derived from pyroclastic materials. The slope ranges from 2-25% and elevation varies from 50 to 340 m above mean sea level. These soils are similar to Typic Hapludalfs having ochric epipedon and argillic diagnostic subsurface horizons. The only difference is that the Typic Haplustalfs lack available moisture in more than three months a year while the Typic Hapudalfs is only dry in shorter period. Soil structure is moderately weak to

moderately strong medium angular to sub angular blocky with few to common patchy thin cutans within the tubular open pores and ped faces.

Solum thickness ranges from 15-110 cm. The surface horizons are brown to dark brown, dark brown, very dark brown and dark grayish brown clay. Soil structure is moderately weak to moderately strong medium angular to sub angular blocky breaking to granular structure. Consistency is sticky, plastic when wet and firm when moist. Presence of krotovinas and few tubular open pores within ped faces is observed. Soil reaction varies from 5.1 to 6.3.

The argillic B horizons, 25-100 cm thick, are brown to dark brown, dark grayish brown, dark brown and grayish brown clay. Soil structure is moderately strong medium angular to sub angular blocky; consistency is sticky, plastic when wet and firm when moist. Presence of common to many tubular open pores with patchy thin cutans in between ped faces is observed. Few small soft and hard black probably iron manganese concretions are occasionally present. Soil pH varies from 5.0 to 6.3.

The substratum is generally dark brown and dark grayish brown clay, almost similar to the overlying horizon. Soil consistency is sticky, plastic when wet and firm when moist. This horizon usually contains partially and highly weathered yellowish brown materials probably volcanic rock fragments. Soil reaction ranges from 5.5 to 6.0.

The Carmona Clay Loam is a well drained soil. The estimated permeability and the basic infiltration rates are moderate.

3.2.3 Land Use

This study represents a combination of the review of available secondary data from various agencies and local government agencies and the brief walkover surveys of selected segments of the project area.

Traditionally, Cavite is predominantly an agricultural province. About 74% of the total land area is devoted to agriculture. Major crops are rice, corn, vegetable, fruits, root crops, coffee and coconut. Built-up areas consist 16%, forestlands account for 9%, and wetlands comprise only 1%.

At present, there are 8 industrial estates being developed in terms of infrastructure support and facilities. There are also 74 industrial establishments engaged in a variety of agri-business processing and manufacturing activities.

Laguna's land use is almost similar to that of Cavite. Approximately 49% is devoted to agriculture. Forestlands comprise about 28% while built-up areas account for 23%.

Figure 3.15 shows the landuse map of Cavite and parts of Laguna as compiled by the JICA Study Team. It shows the changes in the landuse that has taken place over the last 20 years. Most of the areas originally utilized for agricultural purposes have been converted to or planned to be changed to agro-industrial or residential areas.

The proposed CALA project will pass mostly though what used to be designated as agricultural areas but are now currently developed and or earmarked for agro industrial development.

The East-West road will mostly pass through agricultural area. The final alternative route (ALT-1C) of the East-West road will pass through 7 landuse categories namely; agricultural land, forestland, low density residential, medium density residential, industrial, grassland, and open space. The Proposed PNCC Project which will traverse the New Bilibid Prison Compound, will cover the following landuse categories; agricultural land, forestland, water body, low density residential, and religious and cemetery. The Proposed PNCC Project will mostly cover agricultural lands and forestlands. The final alignment will pass through Stateland Subdivision in Brgy. Malagasang, Imus Cavite. The road will not only traverse the subdivision but it will also go through on a number of informal settlers beside the subdivision. The East-West road will also cover houses located opposite the entrance of Stateland Subdivision. There are also 2 identified houses along Tanza-Trece Martirez City Road that will be affected with the construction of the East-West road.

The North-South Road will successively pass through 11 land use categories, namely; agricultural land, grassland, low density residential, medium density residential, high density residential, forestland, industrial, open space, health and welfare, commercial and business, and educational and cultural. Common land use categories to be covered by the North-South road are agricultural lands, forestlands, grasslands, and low density residential areas.

The construction of new roads at the western end of the Manila-Cavite Expressway will entail the relocation of informal settlers. The succeeding segment will pass through a heavily built-up area in Molino, Bacoor thence through an area previously designated as agricultural which are now converted to residential lots. This will start at the southern end of Molino Boulevard and will traverse CITA ITALIA subdivision in Brgy. Mambog III (Bacoor).

Thereafter, the road alignment will successively pass through an area mapped as agricultural land, grassland, forestland, and residential. Within these collective segments, the road will go through the barangay halls of Buhay na Tubig (Imus) and Salitran II (Dasmariñas), Day Care Center (Buhay na Tubig), and MTC Academy (along La Salle road). Commercial establishments that the road will go through are located in Brgy. Buhay na Tubig (Bacoor) and establishments that are adjacent MTC Academy (Brgy. Burol Main).

CALA Expressway's final alternative route (ALT-2) will pass through agricultural lands, forestland, grassland, industrial, low density residential, commercial and business, and parks and recreational. Agricultural lands, forestlands, and grasslands are the common land uses the expressway will pass through. Around 14.8 km alone of the expressway will stretch thru agricultural areas. The expressway will pass through a residential area in Brgy. Sabutan, Silang, Cavite. A portion of a poultry farm in Brgy. Tibig (Silang) and a resort along the Silang Bypass road are some of the commercial areas the CALA Expressway will go over.

Table 3.3 summarizes the length of each road segment with relation to the different land use categories it will pass through.

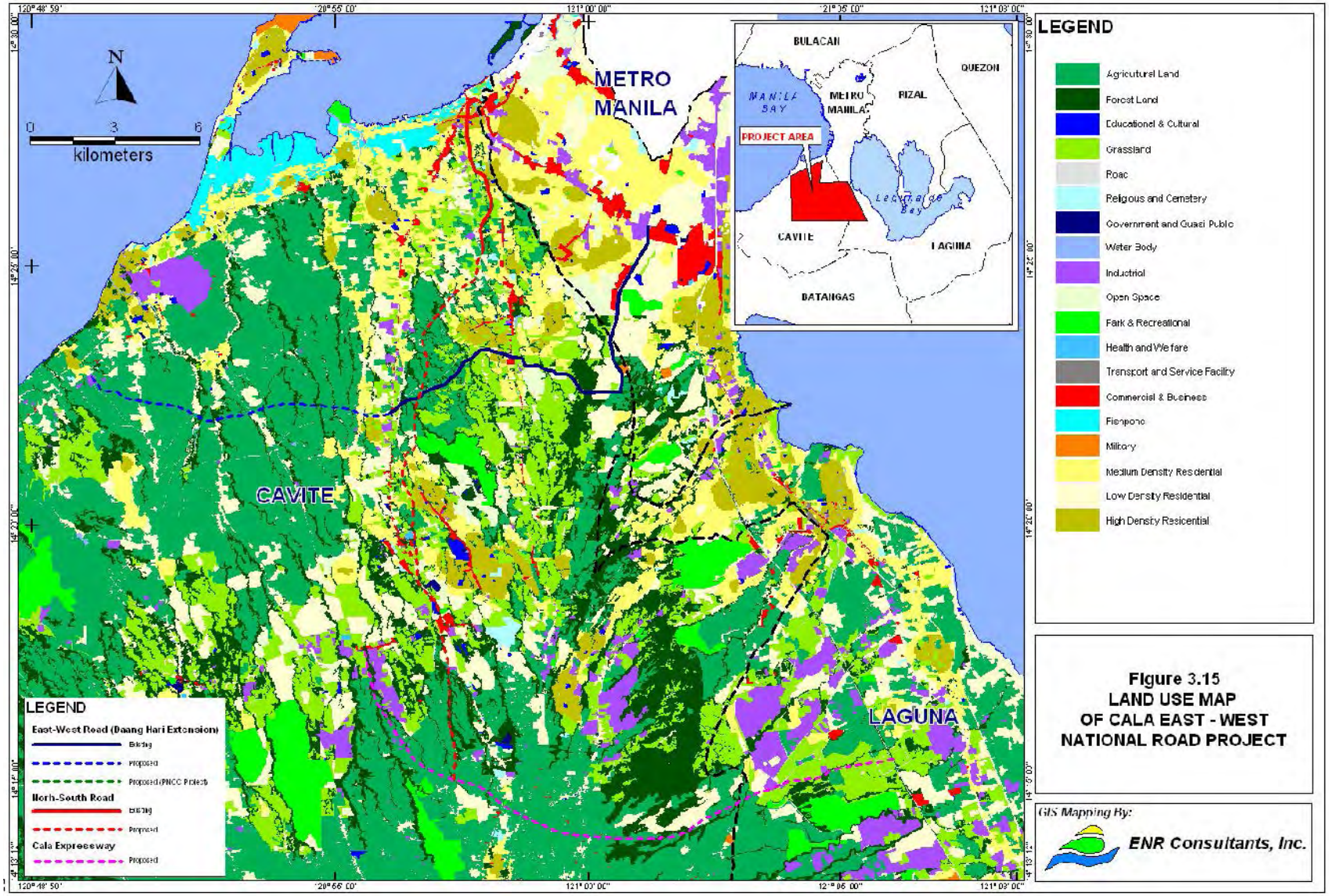
Table 3.3 Land Use Categories Traversed by the CALA East-West National Road Project

Land Use Categories	CALA Final Road Alignments (in km)			
	EW	PNCC Proposed	NS	CE
Agricultural Land	8.75	1.65	7.28	14.80
Forestland	0.86	1.34	4.40	3.19
Low Density Residential	0.24	0.08	2.16	1.11
Medium Density Residential	0.66	-	1.95	-
High Density Residential	-	-	0.07	-
Industrial	0.41	-	0.14	0.43
Grassland	0.31	-	2.34	3.84
Open Space	0.14	-	0.85	-
Religious and Cemetery	-	0.08	-	-
Water Body	-	0.08	-	-
Parks and Recreational	-	-	-	0.15
Commercial and Business	-	-	1.01	0.05
Health and Welfare	-	-	0.12	-
Educational and Cultural	-	-	0.31	-
TOTAL	**11.36**	**3.23**	**20.63**	**23.56**

The East-West road will mostly pass through agricultural. The final alternative route (ALT-1C) of the East-West road will pass through 4 landuse categories namely, non-agricultural, expansion area, built-up area and paddy rice. The non-agricultural segment will traverse the area currently occupied by the New Bilibid Prison. Farther west and up to boundary with Muntinlupa and Cavite, the road will pass through an expansion area which corresponds to the subdivision areas on the ground. The remaining segment will pass through alternating zones of rice paddies, built-up and non-agricultural areas. The latter 2 correspond to the strip along the existing roads which are bordered by a mixture of commercial and residential establishment. The final alignment will pass through Stateland Subdivision in Brgy. Malagasang, Imus Cavite. The road will not only traverse the subdivision but it will also go through on a number of informal settlers beside the subdivision. Houses located opposite the entrance of Stateland Subdivision will also be covered by the East-West road. There are also 2 identified houses along Tanza-Trece Martirez City Road that will be affected with the construction of the East-West road.

The North-South road will successively pass through 7 land use categories, namely; fish ponds occupied by informal settlers, built-up area, paddy rice, irrigable land, rice irrigated paddies, unclassified and agro industrial lands.

The construction of new roads at the western end of the Manila-Cavite Expressway will entail the relocation of informal settlers which occupy the area designated as fishponds. The succeeding segment will pass through a heavily built-up area in Molino, Bacoor thence through an area previously designated as rice paddies which are now converted to residential lots. This will start at the southern end of Molino Boulevard and will traverse CITA ITALIA subdivision in Brgy. Mambog III (Bacoor).


LEGEND
Agricultural Land
Forest Land
Educational & Cultural
Grassland
Road
Religious and Cemetery
Government and Quasi Public
Water Body
Industrial
Open Space
Park & Recreational
Health and Welfare
Transport and Service Facility
Commercial & Business
Fishpond
Military
Medium Density Residential
Low Density Residential
High Density Residential
METRO MANILA
CAVITE
LAGUNA
BULACAN
QUEZON
RIZAL
PROJECT AREA
BATANGAS
0 3 6
kilometers
LEGEND
East-West Road (Daang Hari Extension)
Existing
Proposed
Proposed (PNCC Project)
North-South Road
Existing
Proposed
Cala Expressway
Proposed
Figure 3.15
LAND USE MAP
OF CALA EAST - WEST
NATIONAL ROAD PROJECT
GIS Mapping By:
ENR Consultants, Inc.