No.

REPUBLIC OF INDONESIA

THE URGENT REHABILITATION AND RECONSTRUCTION SUPPORT PROGRAM

FOR

ACEH PROVINCE AND AFFECTED AREAS IN NORTH SUMATRA

(REHABILITATION AND RECONSTRUCTION OF WEST COAST ROAD IN NORTH SUMATRA)

FINAL REPORT

JUNE 2005

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct the Study on the Urgent Rehabilitation and Reconstruction Support Program for Aceh Province and Affected Areas in North Sumatra (Rehabilitation and Reconstruction of West Coast Road in North Sumatra) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA dispatched a study team headed by Mr. MITSUMASA MITANI of Katahira & Engineers International, to the Republic of Indonesia between March 2005 and June 2005.

The team held discussion with the officials concerned in the Government of the Republic of Indonesia and conducted field surveys at the study area. Upon returning to Japan, the team prepared this report.

I hope that this report will contribute to the urgent recovery and development of the earthquake/tsunami affected Province of Nanggreo Aceh Darussalam in North Sumatra and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials of the Government and those concerned in the Republic of Indonesia for the close cooperation they extended to the study.

June 2005

Kazuhisa Matsuoka
Vice President
Japan International Cooperation Agency

MR. KAZUHISA MATSUOKA
Vice President
Japan International Cooperation Agency
Tokyo, Japan

June 2005

Dear Mr. Matsuoka

LETTER OF TRANSMITTAL

We are pleased to submit to you the report of "*The Study on the Urgent Rehabilitation and Reconstruction Support Program for Aceh Province and Affected Areas in North Sumatra (Rehabilitation and Reconstruction of West Coast Road in North Sumatra)".* The report includes the advises and suggestions of the authorities concerned of the Government of Japan and your agency as well as the comments made by the Ministry of Public Works and other authorities concerned in the Republic of Indonesia.

This report studies and analyses the damages of the West Coast Road from Banda Aceh to Meulaboh which was caused by the huge earthquake and tsunami occurred on 26 December 2004. Based on the above results as well as the review of the urgent restoration work done by the Military, the Reconstruction Plan of the West Coast Road was proposed. The preliminary design of the Rehabilitation (or Urgent Recovery) of the West Coast Road from Calang to Meulaboh which will be implemented under the Japan's Non-Project Grant Aid 2004 was also prepared. The Rehabilitation (or Urgent Recovery) Work is scheduled to be completed in early 2006.

We wish to take this opportunity to express our sincere gratitude to your agency, the Ministry of Foreign Affairs and the Ministry of Land, Infrastructure and Transport. We also wish to express our deep gratitude to the Governmental Agencies concerned in the Republic of Indonesia for the close cooperation and assistance extended to us during the Study. We hope this report will contribute to the urgent recovery and development of the earthquake/tsunami affected Province of Naggroe Aceh Darussalam in North Sumatra.

Very truly yours,

MITSUMASA MITANI
Team Leader
of the Study on the Urgent Rehabilitation
And Reconstruction Support Program for
Aceh Province and Affected Areas in North Sumatra
(Rehabilitation and Reconstruction of West Coast
Road in North Sumatra)

LOCATION MAP OF STUDY ROAD

KM 18+200

KM 20+900 Leupung Bridge

KM 23+000

KM 30+500

KM 46+480 Lam Ilie Bridge

KM 106+840

KM 92+500 Kuala Linga Bridge

KM 125+500

ROAD CONDITION DAMAGED BY TSUNAMI (1/2)

KM 155+700 Calang

KM 163+450 Sabe Bridge

KM 174+250

KM 175+000 Panga Bridge

KM 182+700 Padang Bridge

KM 184+650 Abah Bridge

KM 223+800 Siron Bridge

KM 239+950 Nibong Bridge

ROAD CONDITION DAMAGED BY TSUNAMI (2/2)

KM 14+160 Baba Bridge (bailey)

KM 27+840 Peulot Bridge (bailey+gabion protection)

KM 58+880 (causeway underconstruction)

KM 63+340 Lhok Kareung Bridge (bailey underconstruction)

KM 152+850 Lhok Buaya Bridge (appraoch restored)

KM 153+850 Batee Tutong Bridge (timber)

KM 163+450 Sabe Bridge (bailey)

KM 200+000 (re-aligned in forest)

URGENT RESTORATION WORK BY MILITARY

KM 164+540 Bakong 1 Bridge (west coast road)
(Reconstruct with concrete bridge along straight alignment)

KM 167+000 (west coast road)
(AC overley)

KM 174+250 (west coast road)
(Approach embankment and AC pavement)

KM 198+250 (re-aligned forest section)
(AC pavement)

KM 213+000 (original village road)
(AC pavement)

KM 236+183 Kureung Wayla Bridge (original village road)
(Reconstruct with concrete bridge)

KM 246+800 (original village road, flood section)
(Raise road by embankment and AC pavement)

KM 251+000 (original village road, flood section)
(Raise road by embankment and AC pavement)

CALANG - MEULABOH SECTION FOR REHABILITATION UNDER
URGENT RECOVERY OF WEST COAST ROAD (JAPAN'S NON-PROJECT GRANT AID)

SUMMARY

1. BACKGROUND OF THE STUDY

Huge earthquake with M8.9 and succeeding tsunami occurred at the offshore of Sumatra on December 26, 2004 and caused devastating damages to the coastal areas of Indonesia, Sri Lanka, Thailand and other countries facing the Indian Ocean.

The West Coast Road from Banda Aceh to Meulaboh (Total length = 247km) in North Sumatra was totally damaged. About 30 km sections were washed out and about 60 km section were severely damaged.

2. OBJECTIVES OF THE STUDY

- To collect and analyze the fundamental data and information necessary for formulation of rehabilitation and reconstruction of the West Coast Road.
- To provide technical support for the urgent recovery of the West Coast Road which will be implemented by Japan's Non-Project Grant Aid.

3. THE PROJECT ROAD

The West Coast Road from Banda Aceh to Meulaboh with a length of 247km.

4. BRIEF HISTORY RELATED TO THE STUDY

Dec. 6, 2004	:	Earthquake/Tsunami occurred
Jan. 2005	:	GOI formulated overall Rehabilitation/ Reconstruction Plan (RRRMAS)
Jan. 17, 2005	:	E/N of Japan's Non-Project Grant Aid (14,600 Million Yen) was signed.
Jan. 25 – Feb. 1, 2005	:	JICA Mission undertook the assessment of needs of rehabilitation / reconstruction.
Feb. 1, 2005	:	GOI announced the implementation organization of RRRMAS.
Mar. 10, 2005	:	This Study started.
Mar. 26, 2005	:	Urgent restoration of the West Coast Road completed by the Military.
Apr. 11, 2005	:	Goods and services to be procured under Japan's Non-Project Grant Aid and fund allocation were agreed. About 4,700 Million Yen was allocated to the urgent recovery of the West Coast Road.
Apr. 16, 2005	:	BRR NAD-NIAS was organized.
May 8, 2005	:	It was officially decided that reconstruction of the West Coast Road is implemented under the technical/financial assistance of USAID.
May 10, 2005	:	Technical support for the urgent recovery of the West Coast Road (Calang – Meulaboh Section) started.
June 22, 2005	:	Tender documents for selection of Construction for the urgent recovery from Calang to Meulaboh distributed to interested tenderers.
June 30, 2005	:	This Study completed.

5. DAMAGES OF THE WEST COAST ROAD (Refer to Figure 4.1-2)

Road Sections

• Washed out	29.6 km
• Totally damaged	60.1 km
• Medium damage	94.1 km
• Minor damage	26.0 km
Sub-total	209.8 km
• No damage	37.2 km
Total	247.0 km

Bridges

• Washed out / collapsed	76 (2,300m)
• Totally damaged	7 (118m)
Sub-total	83 (2,418m)
• No damage	59 (900m)
Total	142 (3,318m)

6. OVERALL REHABILITATION / RECONSTRUCTION PLAN OF THE PROJECT

Phase	Target Date for Completion	Objectives	Major Works	Implementing Agency
1. Urgent Restoration	By March 26, 2005	• To provide basic transport access to affected areas in order to support relief operation • To make the road possible for special vehicles such as trucks and 4WD vehicles	• To provide detour roads for washed-out sections • Urgent repair of damaged sections • To construct bailey bridges, timber bridges, pipe culverts at river crossings (some locations by portion)	Military
2. Rehabilitation (Urgent Recovery)	By the end of December 2006	• To make the road passable for all types of vehicles	• Rehabilitation to semi-permanent level of road • Paved road surface • Replace with semi-permanent bridges	Ministry of Public Works
3. Reconstruction	By the end of December 2009	• To completely improve or reconstruct the road to high level of standards for sustainable regional economic recovery and development	• To rebuild a road with ASIAN Highway Standards	Ministry of Public Works

7. URGENT RESTORATION BY MILITARY (Refer to Figure 5.4-1)

Eight (8) teams consisting of Engineering Brigade and Marine and 415 equipments were mobilized for the urgent restoration of the Project Road which was completed on March 26, 2005.

8. PRELIMINARY STUDY OF RECONSTRUCTION PLAN

Proposed Plan by the JICA Study Team

(1) Objectives of the Project

- To improve mobility as well as to provide reliable means of transportation in the region.
- To accelerate economic and livelihood recovery and obtain sustainable development of the region.

(2) Planning Concepts

Route Selection

- It was assumed that most evacuated people from tsunami disaster would come back to the original place where they were residing before tsunami.
- The original route before tsunami will be utilized as much as possible with necessary protections.
- For the washed-out road sections, new route will be selected away from the coast line, thus a buffer zone can be provided between the road and the sea. Trees are recommended to be planted in a buffer zone to reduce tsunami force.
- The route will connect original community areas each other as much as possible to recover tsunami affected people's livelihood and social and economic activities.
- Road right-of-way acquisition should be limited to required minimum.
- Natural environment should be protected as much as possible. The route which requires cutting of forest trees, high cut sections, river contamination, road structure which induces erosion, etc. should be avoided as much as possible.
- Relocation of houses should be minimized.
- A route which minimizes construction cost should be selected.

Design Standards

To improve mobility for economic recovery and regional development, ASIAN HIGHWAY STANDARDS, Class II (2-lane) was selected.

- Pavement Width 2 x 3.5 = 7.0 m
- Shoulder Width 2 x 2.0 = 4.0 m

(3) Selected Road Alignment (Refer to Figure 6.1-1)

(4) Road Planning

Ten (10) typical cross sections were prepared.

Cross Section Type			Length (km)
Section which utilize Existing Road	Type E-a	Widening (Flat)	68.4
	Type E-b	Widening (Cliff/Sea)	12.8
	Type E-c	Widening (Soft Ground)	57.7
	Type E-d	Widening (Mountainous)	30.2
	Sub-total		169.1
Sections which Re-aligned from the Existing Road (New Road)	Type R-a	New (Flat)	5.9
	Type R-b	New (Coastal)	5.0
	Type R-c	New (Soft Ground)	48.7
	Type R-d	New (Forest)	4.0
	Type R-e	New (Mountainous)	2.2
	Type R-f	New (Both Sides Coast)	1.1
	Sub-total		66.9
Now work (totally utilize existing section)			14.0
TOTAL			**250.0**

(5) Bridge Planning

Following bridges were planned to be reconstructed:

- Washed-out bridges.
- Bridges which were not damaged by tsunami, but bridges carriageway width is less than 7m.
- Bridges which were not damaged but bridge approach was washed out (bridge length was not appropriate)
- Bridges required along the re-aligned route.

A total of 67 bridges with a total bridge length of 3,631m were planned to be reconstructed.

USAID'S Reconstruction Plan (Refer to Figure 6.1-1)

The alignment of existing road is basically followed from Banda Aceh up to Km. 104 with three short realigned sections. From Km 104, totally new alignment was selected up to Meulaboh. New Alignment is located 4 to 6 km inland side from the coast. The main concept for this section is to select tsunami-free alignment, however, dense forest has to be opened up and lands for road right-of-way must be acquired.

9. PRELIMINARY DESIGN OF REHABILITATION (or URGENT RECOVERY) OF THE PROJECT ROAD

(1) Pre-determined Conditions

- The route follows those restored by the military.
- The project should be completed by the end of December 2005 which was later shifted to by the end of February 2006.
- Procurement of construction equipment, construction materials and steel portable bridges will be done separately from the civil Work contract. The Contractor will be provided these materials and equipment free of charge by the Employer.
- Later, the Ministry of Public Works preferred to procure permanent steel bridges instead of steel portable bridges. It was also agreed that bridges should not necessarily be steel bridges and concrete bridges are acceptable on the condition that construction can be completed within the specified time.
- It was also agreed that the Contractor for civil works will procure steel bridges by himself, thus the Contractor's construction schedule will not be controlled by the procurement schedule of other agency (JICS).

(2) Basic Concepts of Preliminary Design

- Road right-of-way acquisition shall be avoided.
- Relocation of people shall be totally avoided.
- To achieve above, the alignment will follow existing one. No improvement of horizontal alignment which requires ROW acquisition and resettlement of people is planned.
- Bridge structure will be as simple as possible, but strong against seismic forces.
- Road will be constructed as semi-permanent standards (about 4 years life), since reconstruction by USAID will be completed within 3 years after completion of this recovery road.
- Overlapped sections with USAID alignment (2 sections, L=6.7km) will be also rehabilitated, since this recovered road will be utilized until such time that the reconstruction road is completed.

(3) Surveys Undertaken

The JICA Study Team members could not undertake the ground survey due to security situation. Video tapes and photographs were taken from a helicopter to assess general conditions of the project road. Video tape images were captured by computer and photo-mosaic was prepared along the project road.

In order to obtain more detailed information on site conditions, local engineers were sent to the project site and undertook the following:

- Photo-taking at 250m interval
- Measure coordinates by portable GPS
- Get information on material sources
- Measure pavement width, shoulder width and bridge length
- Get information on other aspects such as flooding

(4) Road Alignment (Refer to Figure 7.4-1)

(5) Road Design

A total of 19 typical cross sections were prepared to cope with various conditions of existing road.

Proposed Pavement Width (m)	Applicable Road	Typical Cross Section Type No.	Major Works to be Implement	Applied Road Length (km)	
6.0	Coastal Road, Village Road (4), Access Road (1)	1-1	Overlay + Shoulder	9.43	52.61
		1-2	Overlay + Embank Protection	2.71	
		1-3	Overlay + Shoulder + Side Ditch (urban)	0	
		1-4	Shoulder + Side Ditch (urban)	4.52	
		2-1	Shoulder	31.17	
		2-2	Shoulder + Embank Protection	0.92	
		3-1	Bridge Approach (Low Embank)	2.25	
		3-2	Bridge Approach (High Embank)	1.61	
6.0	Re-aligned Road by Military	4	New Pavement	13.18	13.18
4.5	Village Road (2), Village Road (3), Access Road (2), Access Road (3)	5-1	Overlay + Shoulder + Side Ditch (urban)	12.54	52.49
		5-2	Overlay + Shoulder	8.68	
		6-1	New Pavement + Side Ditch (urban)	3.94	
		6-2	New Pavement + Shoulder	7.33	
		6-3	Road Re-aligned (near the river)	0.20	
		6-4	Shoulder	5.10	
		7	Flood Section (Road elevation raised by about 1m)	3.46	
		8	Flood Section (Road elevation raised by about 1.5m)	1.24	
5.0	Village Road (1)	9-1	Overlay + Shoulder + Side Ditch (urban)	2.34	2.34
		9-2	Overlay + Shoulder	0	
No Work		-	-	1.70	
TOTAL		**-**	**-**	**122.32**	

(6) Bridge Design

a) Selection of bridge type to allow fast construction

b) Bridges which is strong against earthquake

c) Bridge length and span composition

Bridges along coastal road

- Bridge length before wash-out by tsunami was basically adopted.
- Water velocity of small rivers (width of 20m or les) and at lagoon crossings was judged slow, thus even short span length can be acceptable and will not disturb water flow so much. Span length of 10 ~13.5 m was adopted.
- For medium (over 60m) and large rivers (over 100m), longer span length was judged to be required, span length of 30m was adopted.

Bridges along village road

- Existing bridges are all short bridges ranging from 10m to 30m. Slightly longer bridge length was adopted.
- Existing span length is also short, thus 10 to 12m span length was selected.

(7) Construction Planning

Construction plan was prepared in consideration of the following characteristics of the Project:

- Construction period is quite short and is about 1/3 to ¼ of normal construction period. The Contractor is required to execute the project by fast-track program. Three to four times of more equipment/plants and workers than normal construction need to be mobilized.
- Rainy season starts from September and continues up to December. Relatively high rainfalls are expected even remaining season.
- There are four flood sections where water level reaches to about 1m from the road surface, and the road becomes impassable for 3 ~ 4 days.
- Aggregate sources which are all along the rivers are limited. When water elevation of a river goes up after heavy rain, aggregate sources become under water.
- Ramadan starts from the beginning of October to beginning of November. During this period, work efficiency will be reduced, particularly Ramadan Holidays at the beginning of November, all works need to be suspended for about 10 days.
- Existing detour bridges along the coast road do not have sufficient length to span over a river and about 2/3 of a river is crossed by a causeway which may be washed out during heavy rain, resulting in suspension of construction activities.
- The contractor will be required to adopt the 2-shift working system from sunrise to sunset.

(8) Contract Packaging

It was decided that number of contract package should be one due to the following reasons:

a) In view of quite severe construction period, highly qualified and experienced contractor must be selected. If a contract package size becomes small, small and less qualified contractor may have chance to win a contract.

b) Quarry sites are limited. When more than one contractors simultaneously work in the same areas and use the same quarry site, arrangements between (or among) contractors are hard to be agreed, particularly when local contractors are selected.

c) Based on the previous experiences, the Ministry of Public Works strongly recommended that the contract package should be one.

(9) Preparation of Tender Documents

Tender documents were prepared based on the above studies.

(10) Cost Estimate

Adopting the unit price analysis method commonly used in Indonesia, cost estimate was undertaken.

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DEFINITION

In this report, definition used for Urgent Restoration, Rehabilitation (Urgent Recovery) and Reconstruction is as follows:

Urgent Restoration	:	The works undertaken by the Military to provide basic access to the tsunami affected area mainly for the support of relief operation.
Rehabilitation (or Urgent Recovery)	:	The works to rehabilitate urgently restored road by the Military to make the area accessible by ordinary vehicles. Japan's Non-Project Grant Aid Fund was allocated to Urgent Recovery of West Coast Road Banda Aceh and Meulaboh, Calang-Meulaboh Section.
Reconstruction	:	The works to reconstruct West Coast Road for economic recovery and development of the region. The JICA Study Team undertook the preliminary planning for reconstruction. In the course of the JICA Study Team, it was officially decided that USAID provides technical and financial assistance for reconstruction.

Chapter 1

INTRODUCTION

1.1. BACKGROUND OF THE STUDY

There occurred a huge earthquake of magnitude 8.9 on 26 December 2004 at about 8a.m. at the offing of Sumatra Island in Indonesia and a massive tsunami hit 12 countries located on the coast of the Indian Ocean. The tsunami caused extensive damage swallowing all houses, structures and farms along the coastal areas, and the death and missing toll climbed to about 300,000.

The road network in North Sumatra has been severely damaged with some sections entirely washed away by the tsunami waves overtopping 30m. Out of the 247km Banda Aceh – Meulaboh Section of the West Coast Road in North Sumatra, about 57 km have been washed and about 140 km have been heavily damaged.

The Government of Japan declared for support for the unheard of disaster and executed the emergency humanitarian aid. Parallel to the aid, Japan International Cooperation Agency (JICA) dispatched the Mission for assessment of restoration and rehabilitation needs and identification of necessary projects from 25 January to 1 February 2005. Base on the Findings of the mission, the Government of Indonesia requested a technical assistance from the Government of Japan for the conduct of the urgent development study on the rehabilitation and reconstruction program for Aceh Province and affected areas in North Sumatra. In response of the request, JICA has decided to conduct the study for collection and analysis of the information related to the rehabilitation and reconstruction of West Coastal Road in North Sumatra (the Study) and organized and dispatched a Study Team.

1.2 OBJECTIVE OF THE STUDY

The objective of the Study is to collect and analyze the fundamental data and information necessary for formulation of rehabilitation and reconstruction plan of Banda Aceh – Meulaboh Section of the West Coast Road in North Sumatra seriously affected by the earthquake at the offing of Sumatra Island and succeeding tsunami.

1.3 PROJECT ROAD

The Project Road Banda Aceh – Meulaboh Section of the West Coast Road in North Sumatra with a length of 247 km located in Naggroe Aceh Darussalam (NAD).

1.4 SCOPE OF THE STUDY

In order to achieve the objective mentioned above, the Study shall cover the following items:

1) Preparatory Work in Japan

2) Analysis of Present Situation

   - Collection of Relevant Data and Information
   - Site Inspection
   - Assessment of Present Situation

3) Monitoring / Observation of Emergency Restoration Works

   - Contents of Works and their Progress
   - Technical advice to Department of Public Works Naggroe Aceh Darussalam

4) Study on Rehabilitation and Reconstruction Works

   - Establishment of Design Policy
   - Preliminary Study on Route of the Sections to be Realigned
   - Preliminary Study on Structure of Road and Type of Bridge
   - Rough Estimate of Quantities of Major Construction Items
   - Preliminary Study on Construction Packaging
   - Preliminary Study on Construction

5) Technical Support for Rehabilitation Project under Japan's Non-Project Grant

   - Confirmation of Present Condition
   - Preliminary Design
   - Material Sources Survey
   - Quantity Estimate
   - Cost Estimate
   - Preparation of Tender Documents

6) Technical Advice to Executing Team for Aceh Rehabilitation and Reconstruction Planning

7) Review of Direction of Assistances from other Aid Agencies

8) Preparation of Final Report

1.5 STUDY SCHEDULE

Table 1.5-1 presents the work schedule.

1.6 COMPOSITION OF THE STUDY TEAM

The Study Team is composed of the following members:

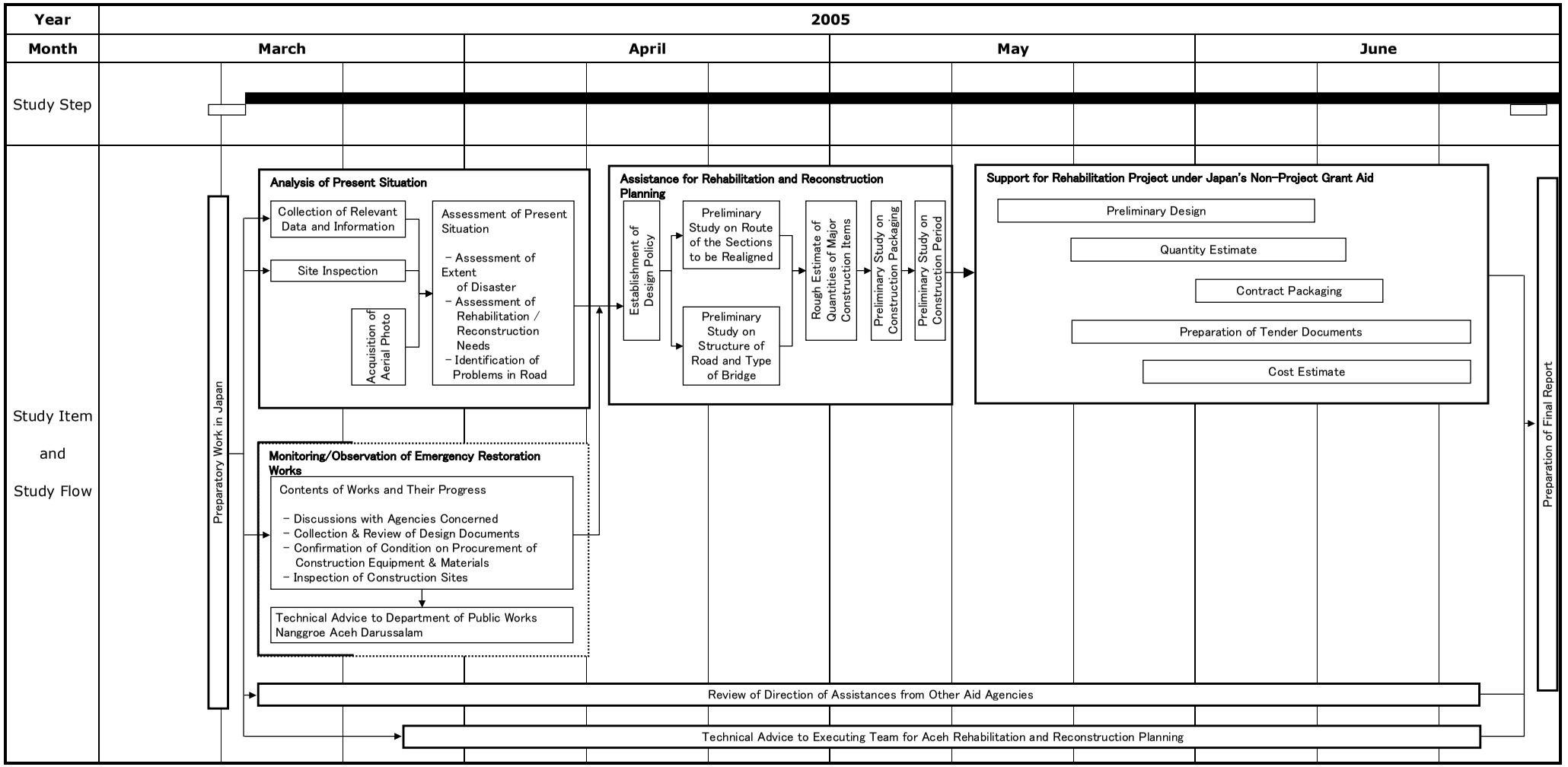
Mr. Mitsumasa Mitani	Team Leader
Mr. Kunihiko Sawano	Road and Bridge Design (I)
Mr. Mitsuo Kiuchi	Road and Bridge Design (II)
Mr. Soemu Oshita	Natural Condition Surveyor
Mr. Tsuneo Bekki	Coordinator
Mr. Takashi Okumura	Site Surveyor

TABLE 1.5-1 WORK SCHEDULE

Work Item	2005			
	March	April	May	June
1. Preparatory Work in Japan				
2. Analysis of Present Situation				
- Collection of Relevant Data / Information				
- Site Inspection				
- Assessment of Present Situation				
3. Monitoring / Observation of Emergency Restoration				
- Contents of works and their progress				
- Technical advice to Public Works Office				
4. Study on Rehabilitation / Reconstruction Works				
- Establishment of Design Policy				
- Preliminary Study on Route Selection				
- Preliminary Study on Road/Bridge Structure				
- Rough Quantity Estimate				
- Preliminary Study on Construction Packaging				
- Preliminary Study on Construction Period				
5. Support for Rehabilitation Project under Japan's Non-Project Grant Aid				
- Preliminary Design				
- Quantity Estimate				
- Contract Packaging				
- Preparation of Tender Documents				
- Cost Estimate				
6. Technical Advice to Executing Team for Aceh Rehabilitation and Reconstruction Planning				
7. Information Collection on other Donors Assistance				
8. Preparation of Final Report				

Legend : Work in Indonesia
Work in Japan

FIGURE 1.5-1 STUDY FLOW DIAGRAM



Chapter 2

PROFILE OF ACEH PROVINCE

2.1 NATURAL CHARACTERISTICS

2.1.1 Topography and Geology

The Province of Aceh locates in the most northwest part of Sumatra Island. It locates in the area between 2° and 6° N latitude and between 95° and 98° E longitude. The area is 57,366 sq. km which is bounded by Indian Ocean, Malacca Straight and Province of North Sumatra. The provincial capital is Banda Aceh City which locates at the northwestern tip of the island.

The coastal area is generally flat plain while the inland area is occupied by mountains. The highest mountain in the province is Mt. Leuser of which altitude is 3404 m. The rivers in the area are mostly small size. The longest river in the province is Geumpang River of which length is approximately 250 km.

The topography along the study road is categorized into two. The northern section from Banda Aceh to Calang (approx. 150 km) is generally mountainous. The road is located along the skirts of the steep mountains except some sections crossing river mouth plains. While the southern section from Calang to Meulaboh (approx. 100 km) is flat. The road is located along the sea coast of the alluvial plain. The most parts of the plain is covered by swampy forest.

A topographic map and a geological map are shown in **Figures 2.1-1** and **2.1-2** respectively.

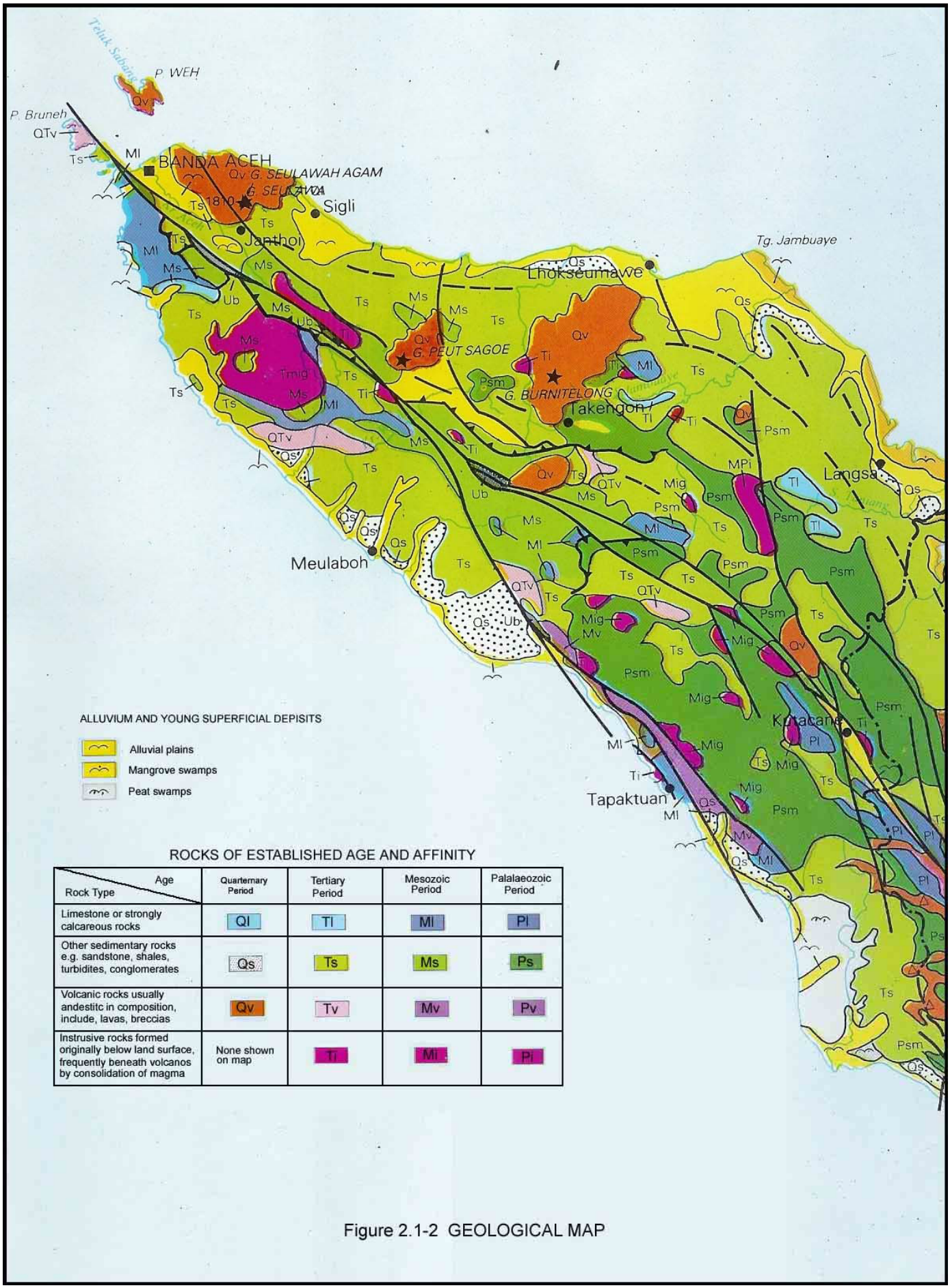
2.1.2 Meteorological Characteristics

The climate of the area is categorized as tropical rainforest. The rainfall is relatively heavy in the west coast area due to the wind from Indian Sea. The annual rainfall in the west coast area is ranging from 3,000 to 4,000 mm/year. It rains throughout the year in the area, however, between September to January is prominent. The rainfall data at Lho Nga (14 km from Banda Aceh), Calang and Meulaboh is shown in Figure 2.1-3.

The monthly average temperature range is between 21 to 34℃ in the coastal area. The maximum and minimum monthly average temperature in Banda Aceh and Meulaboh is shown in **Figure 2.1-4**. The humidity is above 75 % throughout the year in the coastal areas.

Figure 2.1-1 TOPHGRAPHIC MAP

Note: Altitudes are shown in feet.



ROCKS OF ESTABLISHED AGE AND AFFINITY

Rock Type \ Age	Quaternary Period	Tertiary Period	Mesozoic Period	Palalaeozoic Period
Limestone or strongly calcareous rocks	Ql	Tl	Ml	Pl
Other sedimentary rocks e.g. sandstone, shales, turbidites, conglomerates	Qs	Ts	Ms	Ps
Volcanic rocks usually andestitc in composition, include, lavas, breccias	Qv	Tv	Mv	Pv
Instrusive rocks formed originally below land surface, frequently beneath volcanos by consolidation of magma	None shown on map	Ti	Mi	Pi

Figure 2.1-2 GEOLOGICAL MAP