BASIC DESIGN STUDY REPORT

ON

THE PROJECT
FOR
IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM (PHASE II)
IN
THE REPUBLIC OF THE PHILIPPINES

MARCH, 2002

JAPAN INTERNATIONAL COOPERATION AGENCY
JAPAN WEATHER ASSOCIATION

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Earthquake and Volcano Monitoring System (Phase II) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team from September 17 to October 19, 2001.

The team held discussions with the officials concerned of the Government of the Republic of the Philippines, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to the Philippines in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the teams.

March, 2002

Takao KAWAKAMI
President
Japan International Cooperation Agency

March, 2002

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Improvement of Earthquake and Volcano Monitoring System (Phase II) in the Republic of the Philippines.

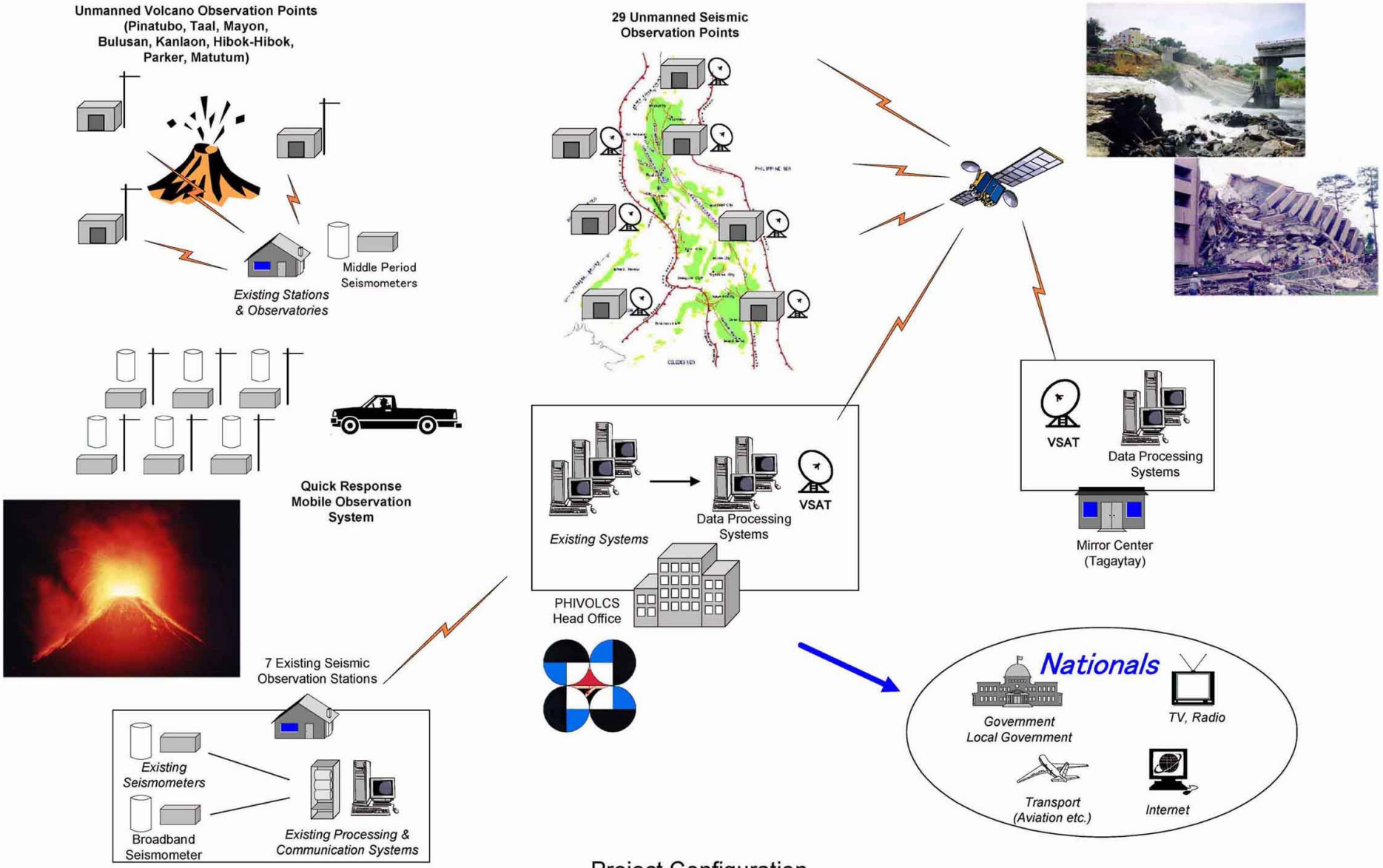
This study was conducted by Japan Weather Association, under a contract to JICA, during the period from September, 2001 to March, 2002. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of the Philippines and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Kunio AKATSU
Project Manager
Basic design study team on the Project for Improvement of Earthquake and Volcano Monitoring System (Phase II) in the Republic of the Philippines

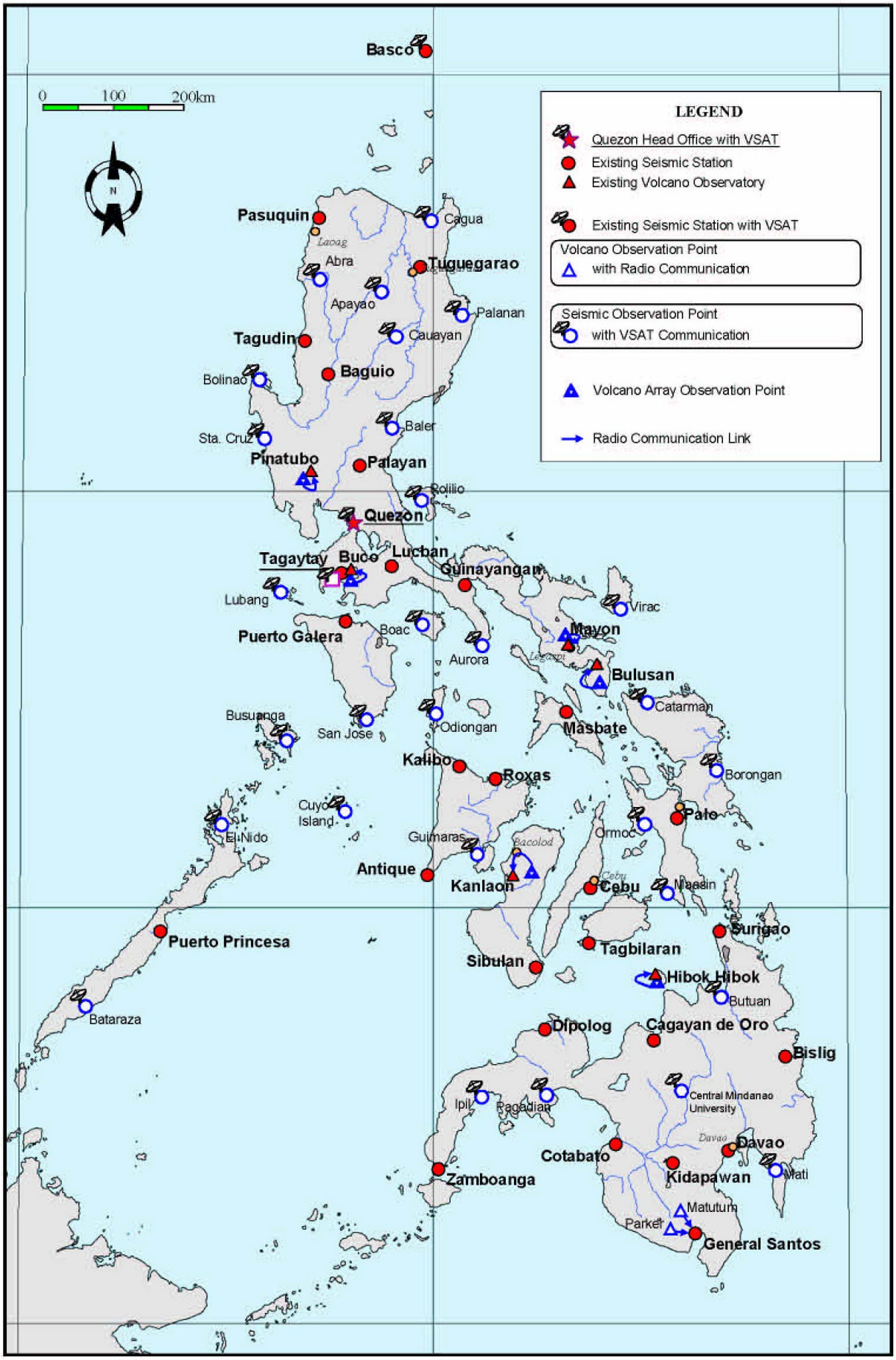
Japan Weather Association



Project Configuration

Project for Improvement of Earthquake and Volcano Monitoring System (Phase II)
in the Republic of the Philippines

Map of the Philippines



Location Map of Seismic and Volcano Observation Stations in Phase I & II

Contents

Chapter 1 Background of the Project

The Philippines

The Philippines, which is located in the Western Pacific Ocean, consists of 7107 islands. Out of this total, only 200 are inhabited. Luzon and Mindanao are by far the largest islands, and comprise roughly 66% of the country's total land area. Only about 1000 islands are larger than one sq km and 2500 are unnamed. The archipelago, like that of Japan, is characterized by subduction-related volcanic belts with many active volcanoes and experiences frequent seismic activity. The Philippine Archipelago belongs to the Circum-Pacific Ring of Fire and as such is prone to hazards related to geotectonic activities. It is sandwiched by two sets of opposing subduction systems and dissected by many active faults. The most active earthquake generator is the Philippines Fault Zone whose trace extends over 1,600km from Luzon to Mindanao.

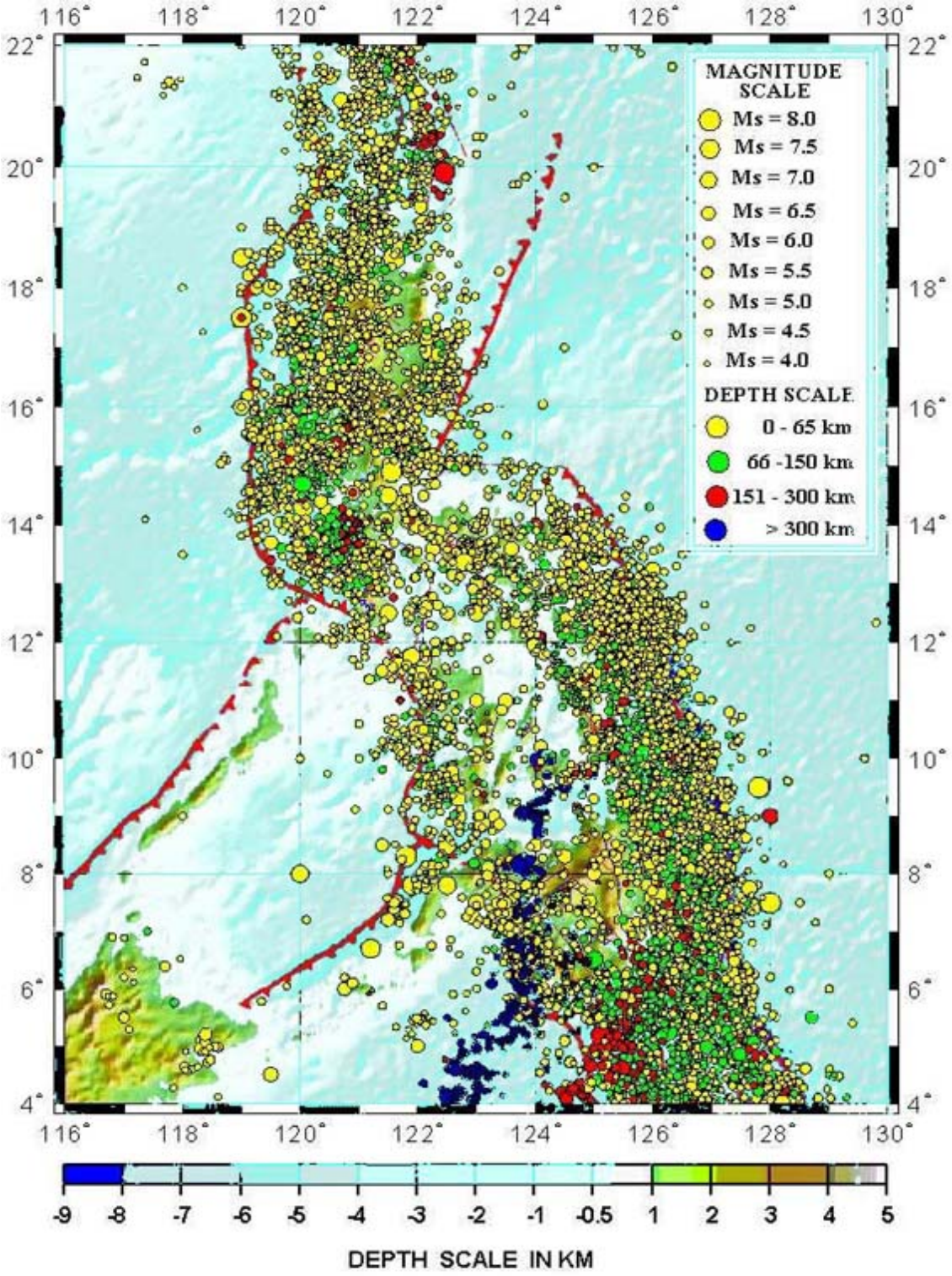
Natural hazards such as earthquakes, tsunamis, landslides and volcanic eruptions are common occurrences in the country and the mitigation of disasters and reduction of loss of lives and damages to properties are parts of the major concerns of the Philippine government.

The earth's crust is a mosaic of separate plates which are continuously moving relative to each other. Volcanoes and earthquakes occur in zones where these plates interact. The Philippines, being situated in a zone where at least three lithospheric plates coalesce, hosts more than 200 volcanoes distributed in five volcanic belts intimately related to subduction/convergent processes and at least 5 imperceptible to perceptible earthquakes occur everyday. In the past, several large magnitude earthquakes and major volcanic eruptions have occurred and caused considerable loss of lives and damage to properties. In addition, undersea large earthquakes have brought about several tsunami disasters in the coastal areas fronting them and caused the collapse of many buildings and damage to infrastructures in built-up areas. Also, pyroclastic flows and lahars from erupting volcanoes have caused extensive damage. In recent years, the Philippines has been affected seriously by the eruptions of Pinatubo, Mayon, Taal and Hibok-Hibok and by earthquakes in Luzon, Mindoro, Samar, Panay, Bohol and Mindanao Islands. These areas carry the highest potential for loss of life and property, and have suffered serious economic losses.

Earthquakes on the Western Pacific active plate margin continually threaten the socio-economic development of seventy million Filipino people. Manila alone, with a

population of over ten million, is one of the world's mega-cities at risk to adverse impacts of large magnitude earthquakes. During the last forty years, there were about six damaging earthquakes (magnitude greater than 7.0) which occurred within 200km of Manila.

Faults and Trenches in the Philippines Region



Earthquake distribution in the Philippines Region for period 1608 -1999

Violent volcanic eruptions also pose a threat to the well being of the Filipino population. At present, twenty two volcanoes are regarded as active. On average over the last forty years, there has been an eruption every fourteen months. The 1991 eruption of Pinatubo Volcano resulted in long-term social change to many communities and caused a major setback in the economy of the country.

The Philippines is vulnerable to devastating impacts of rapid-onset geologic phenomena. It is affected seriously by the frequent occurrence of earthquakes, tsunamis and volcano eruptions which carry the highest potential for loss of life and property. Regrettably, the extensive damage from earthquakes, tsunamis and volcanic eruptions is the determining factor for significant set back of national economy and development activities of the Philippines. Under these circumstances, the Government of Philippines prepared *the Project for Improvement of Earthquake and Volcano Monitoring System, Phase II* (hereinafter referred to as "the Project Phase II").

The Project Phase II aims to upgrade the quality of geophysical monitoring and other geologic hazard studies which are being undertaken by the Philippine Institute of Volcanology and Seismology (hereinafter referred to as "PHIVOLCS") to understand why, where and how natural disasters of volcanic and seismic origins occur in the Philippines and also aims to provide the PHIVOLCS the capability to establish a reliable data base from which preparedness plans for disaster mitigation arising from volcano eruptions and earthquakes can be developed/formulated. The Project Phase II is in line with the objectives of the latest Medium-Term Philippine Development Plan on disaster mitigation which provides for the enhancement of disaster preparedness and management.

Justification for Necessity of the Project Phase II *(The Project Phase II aims at mitigating the adverse effects of earthquake and volcanic hazards faced by the 70 million people of the Philippines.)*

- *The Project for Improvement of Earthquake and Volcano Monitoring System (Phase I)*

Phase I of this project financed by Japan's Grant Aid Assistance was completed in March 2000. In Phase I, instrumentations in existing 34 volcano and seismic monitoring stations of PHIVOLCS were upgraded. Old and dilapidated analog seismographs were replaced by modern digital seismic instruments. The provision of this modern instrumention setup has put PHIVOLCS somewhat at par with international seismological research institutions. The new digital setup not only improve the quality of data obtained from the network but will also enhance the processing and transmission time of data from field stations to the main office in Quezon City. This results in timely and prompt provision of

earthquake information and warning to the public and concerned government institutions. The present upgraded setup is, however, sensitive only to moderate sized and large magnitude earthquakes. The 34 stations that PHIVOLCS presently operate are considered inadequate in number to effectively monitor microearthquakes origination from the many active faults and subduction zones and from the 22 active volcanoes of the country.

- *Seismic Monitoring*

In order to improve the earthquake detection capability of the Philippine network up to microearthquake level, the Project Phase-II is planned to be implemented. Although Phase-I provided for 34 modernized stations, more are necessary to increase the detection capability.. For example, Japan, an equally seismically and volcanically active country like the Philippines, has a total of around 800 seismic stations belonging to Japan Meteorological Agency, governmental organizations concerned with disaster preparedness and universities. Taiwan is only one and a half times bigger than Mindoro, also has about 61 seismic stations which are only real-time seismic data transmission stations to Tai-pei.

The main aim of the Project Phase-II is the densification of the existing network through the establishment of satellite telemetered seismic observation points in strategic locations. The Project Phase-II will provide 29 new unmanned seismic observation points for seismic monitoring in the vicinity of presently unmonitored active faults and volcanoes and in other plans to widen the aperture of the seicmic network. This will push the total number of seismic observation points to more than 60 capable of accurately determining the parameters of more than 6,000 earthquake events per year. The generation of a bigger and accurate hypocentral database will enable the Institute to fully understand the complicated seismotectonic setting and determine the earthquake generating potentials of less known active structures in the archipelago. Unknown or hidden active faults can be precisely delineated and mapped. The above will provide for accurate delineation and characterization of seismic source zones in the country and this will be very useful in long term forecasting of seismic hazards in the country such as in the generation of a comprehensive seismic hazard zonation maps.

Most importantly, the additional seismic stations that will form the Project Phase II network will contribute to the earthquake alert data collected at the PHIVOLCS head office in Quezon City. By using varied communication methods, more data has a better chance of being quickly transmitted to PHIVOLCS, even in the event of a devastating earthquake, where most lines of communication will be disrupted. This information can

then be used in the appropriate deployment of emergency services to the affected area, which may not be able to communicate its needs. Also, the increased density of the seismic network will aid in more accurate earthquake locations, which is important when assets (people, towns and other infrastructure) are congregated as close as they are in the Philippines.

Rapid, appropriate response is required after major earthquakes, and the more effectively this can be performed through the better knowledge of earthquake location, the more lives can be saved. It is critical that victims are reached within 72 hours of an earthquake to minimize loss of life, and at present the network could not locate all damaging earthquakes (those above approximately magnitude 4) with sufficient accuracy to confidently assign emergency services to the most badly affected areas.

Aftershock monitoring is also an important function in that it can indicate the safety of rescue operations. Determining aftershock locations can also give a better idea of the fault zone and possibly indicate what assets may be at risk from future events. Learning the mechanism and location of active faults is also very important in determining earthquake hazard for an area and contributes to the understanding of the regions seismicity.

In addition to the seismic monitoring equipment, the communication network is very important for an effective earthquake alarm system. After a major event, land telephone lines may be cut, which can also affect the mobile telephone network operation and capability. If an event is strong enough, it may even affect radio telemetry, so alternative methods, such as satellite communications, must be considered as part of a reliable earthquake alarm system.

- *Volcano Monitoring*

In those countries around the world with a record of active volcanism, volcano monitoring systems are an essential element of the government policy seeking to mitigate the effects of eruptions. The Government policy usually includes:

1) Providing alerts and warnings of heightened volcanic activity by deploying appropriate monitoring networks.

2) Reducing the loss of life during an eruption by having well-trained emergency services personnel capable of handling a crisis situation.

3) Minimizing the damage to buildings and service infrastructure (roads, bridges, electricity grids, hospitals, water supplies, etc.) from an eruption by implementing appropriate urban and rural planning policies.

4) Minimizing the financial impact of eruptions on the national and regional economies by employing long-term risk management strategies.

Volcano monitoring addresses the first issue: alerts and warnings of heightened volcanic activity. The other three issues must be addressed by the Government long-term planning, administrative procedures and policy guidelines.

The Philippines has twenty-two active volcanoes but only five of these are with observatories and equipped to monitor regional earthquakes with digital seismic equipment installed during Phase I. The Project Phase II is to install small volcano array network monitoring systems at six active volcanos and link them to an existing volcano observatory. These systems will provide more accurate and timely alerts of abnormal activity in a volcano and enable the PHIVOLCS volcanologists to provide critical advice to the civil and emergency authorities at the local and national levels.

Having a dense network will also allow for the early detection of impending abnormal activities of the presently unmonitored active volcanoes. With increasing population density and the fact that previously uninhabited places around volcanoes are now slowly being occupied by more people, the risk has increased around these unmonitored active volcanoes. Assuming there are at least 50,000 inhabitants in each of the 22 active volcanoes, then with the new setup the PHIVOLCS would be able to give assurance that it can provide timely warning to at least 1 million residents around volcanoes. The primary system for volcano monitoring is a local seismic network of 3-6 seismic stations that measures changes in seismic ground tremor and small earthquake activity, indicators of magma movement within the volcano. Such a network can be established using radio telemetry links from seismic sensors on the volcano to an observatory/office that may be 5-15 km away. Magma movement within the volcano also causes ground deformation that may be a precursor to an eruption. Other monitoring instruments that should be added to a seismic network could include ground deformation monitors such as tilt meters and Differential Global Positioning Satellite (DGPS) receivers for tracking possible magma ascent.

Phase-I has demonstrated that the introduction of digital seismic methods to the PHIVOLCS has provided the Philippines with a firm technological foundation for future seismic monitoring. It has improved the PHIVOLCS capability to provide reliable and

accurate real-time geo-hazard information to Government authorities and the public. The Project Phase-II will build on that firm foundation and provide modern monitoring techniques to all active volcanoes in the Philippines. This will enable the PHIVOLCS to greatly improve their volcanic activity/alert system for advising emergency services and the public, and to provide long-term advice to government on the patterns and nature of volcanic activity.

The Project Phase II is designed to provide PHIVOLCS with very important data in order to understand and assess the earthquake potential of less known active seismic source zones (particularly blind faults) and eruption potential of all potentially active volcanoes. This can be achieved through the establishment of additional stations which are remotely sited in strategic places in order to detect the weak seismicity of active earthquake source zones and volcanoes which is not detectable by the existing upgraded network. The increased detection capability that can be achieved by the implementation of the Project Phase II will enable PHIVOLCS to detect impending big earthquakes and volcanic crises and will provide for ample time for the deployment of a more dense network of mobile instruments to deeply study an impending geologic upheaval. The high resolution database that will be generated thru the deployment of a dense network of remote and mobile instruments will allow PHIVOLCS to make accurate and reliable forecasts of volcanic eruptions and intelligent assessment of ongoing seismic crises. Hence, in order to successfully realize the goal of PHIVOLCS and to minimize geologic disasters in the Philippines, the Project Phase II is very essential and indispensable.

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

The Philippines is prone to a wide range of natural disasters and hazards that threaten lives, properties and food supplies, and whose effects are particularly adverse on the poor and disadvantaged sectors.

In accordance with the Medium Term Plan of the Department of Science and Technology based on the Medium Term Philippine Development Plan 1999-2004, it is essential that the PHIVPLOCS will thus continue to provide timely information, monitoring and prediction services on earthquakes, volcano eruptions and related natural phenomena. It will also conduct studies such as hazard identification and mapping and vulnerability and risk assessment of potentially active volcanoes, faults and lahars as a target of the PHIVOLCS.

To be able to respond quickly and effectively to emergency situations and the people's demand, the PHIVOLCS will continuously upgrade its prediction capability, warning system and quick response mechanisms. It will also establish back-up service center of the Head Office in strategically located areas of the country and maintain as well as enhance its national-wide network of seismic and volcano monitoring stations through implementation of the Project Phase II.

Phase I of the project was basically intended to upgrade the instrumentation in the 34 existing seismic monitoring stations of PHIVOLCS in order for the network to be at par with state-of-the-art instrumentation of developing countries in the field of seismology. The Phase I was able to greatly improve the quality of seismic recording and increase efficiency and promptness of data transmission to PHIVOLCS Head Office. The completion of Phase I enabled the PHIVOLCS to effectively provide prompt warning and information on earthquake occurrences to the public. With regards to the effectiveness of the Phase I, it was considered to be very effective in providing PHIVOLCS with a firm technological foundation for future seismic monitoring. Despite this, however, a mere 34-station seismic network that relies on conventional telecommunication technology might not be able to respond promptly to a sudden, large magnitude earthquake. The number of station is also not enough to capture small magnitude earthquakes which is necessary for building earthquake database and detecting foreshocks of large magnitude earthquakes. Therefore, the implementation of the Phase II of the project is very important to reap the fruits of the improved seismic and volcano network of the Philippines and to conform with the requirement of the Medium Term Plan of the country.

The main objective of the Project Phase II is to further increase the detection capability of the network up to microearthquake level by establishing remote stations in strategic sites and to communicate seismic data to the PHIVOLCS Head Office in Quezon City using satellite technology. The enhanced network will allow for the detection of very small earthquakes which may serve as precursors to big, damaging earthquakes. Phase II will therefore support the research program of PHIVOLCS geared at developing earthquake prediction tools by providing an appropriate network for generating suitable data for earthquake prediction research. Furthermore, the Project Phase II is designed to provide the PHIVOLCS with very important data in order to understand and assess the earthquake potential of less known active seismic source zones (particularly blind faults) and eruption potential of all potentially active volcanoes. This can be achieved through the establishment of additional observation points which are remotely sited in strategic places in order to detect the weak seismicity of active earthquake source zones and volcanoes which is not detectable by the existing upgraded network by the Phase I. The increased detection capability that can be achieved by the implementation of Phase II will enable PHIVOLCS to detect impending big earthquakes and volcanic crises and will provide for ample time for the deployment of a more dense network of mobile instruments to deeply study an impending geologic upheaval. The high resolution database that will be generated thru the deployment of a dense network of remote and mobile instruments will allow the PHIVOLCS to make accurate and reliable forecasts of volcanic eruptions and intelligent assessment of ongoing seismic crises.

In order for the PHIVOLCS to effectively perform its role as the national volcano and seismic institute, the following aims are targeted during the implementation of the Project Phase II.

- ✧ To improve the earthquake detection capability of the national seismic monitoring network to a minimum magnitude of 4.0, which is the lower level for damaging earthquakes in the country. The expanded network will also allow the PHIVOLCS to confidently identifying arrival time of secondary waves and improve hypocentral location of events. The present PHIVOLCS earthquake detection capability is at magnitude 4.7 – 5.0 which is achieved during the upgrading in the Phase I.
- ✧ To establish volcano array observation network in each of the six most active volcanoes in the Philippines (Pinatubo, Kanlaon, Taal, Mayon, Hibok-Hibok and Bulusan) and two volcano observation points in two presently unmonitored volcanoes for locating and characterizing volcanic earthquakes and for detecting onsets of volcanic unrest.

- ✧ To strength capability of the Quick Response Team by supply of the mobile monitoring systems.
- ✧ To minimize seismic information preparation time at the Head Office between occurrence of an event and information dissemination from 45 minutes to 10 - 15 minutes.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy for the Basic Design of the Project Phase II

- To satisfy with the targets of detection capability with minimum number of the observation points/stations.
- To minimize the time for data receiving, processing and issuing seismic information.
- To enable flexible utilization of the Equipment for special monitoring of aftershocks and volcano activities.
- To be consistent with observation system established under the Phase I.
- To consider the PHIVOLCS institutional capacity to be required for the Project's implementation.
- To evaluate the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view.
- To minimize the recurrent cost of PHIVOLCS for operation & maintenance of the Equipment.

(2) Basic Policy for the Equipment

- To design all the Equipment to conform operation and maintenance on technical capabilities of the PHIVOLCS.
- To make appropriate compatibility and suitability between the Equipment supplied under the Phase I and to be supplied under the Project Phase II.
- To take reliability and durability into account in the selection of the Equipment to make them more suitable for severe natural condition in the Philippines (high temperature and humidity, typhoon, heavy rain, etc.).
- To implement appropriate selection of the Equipment for easy procurement and replacement of spare parts and consumables.
- To consider structure of operation & maintenance of the PHIVOLCS for the Equipment to be supplied.

- To minimize recurrent costs of operation & maintenance of the Equipment to be borne by the PHIVOLCS.
- To ensure provisions in the basic design against any damage and disappearance for the Equipment.
- To further improve data processing, analysis and archiving.
- To design in order to achieve low power consumption.
- To include suitable power back-up devices (battery, UPS, solar array, etc.) for uninterrupted operation.
- To design automatic data receiving and processing from the seismic and volcano observation points.
- To consider future network expansion in the design of the Equipment, data processing, analysis and archiving systems.
- To consider software which are adopted internationally standardized technology, fully tested and continuously being developed. Simplicity and user-friendliness, less time-consuming and less laborious should be the main factors in choosing the software.
- To consider necessary surge and lightning protection measures for the Project Phase II.
- To consider the security conditions of the Project Sites.
- To consider time schedules for procurement and delivery of the Equipment.

2-2-2 Basic Plan

2-2-2-1 Major Components

In accordance with several discussions with the PHIVOLCS and also results of the field survey and data analysis during the Basic design Study period in Japan and the Philippines, major components of the Project Phase II has been decided. Comparison between components requested by the Government of the Philippines to the Government of Japan and components decided for the Project Phase II is shown below as *"Comparison Table of Major Components between the Official Request (Application Form) of the Government of the Philippines and the Project Phase II"*.

Comparison Table of Major Components

between the Official Request (Application Form) of the Government of the Philippines and the Project Phase II

Components requested by the Government of the Philippines		Components for the Project Phase II	
- Seismic Observation Points (1-component) with Data Communication Systems	19	- Seismic Observation Points (3-component, Convertible-type) with Satellite Communication Systems (VSAT)	29
- Volcano Observation Points (Vertical Component) with Data Communication Systems	13	- Volcano Observation Points (3-component, Convertible-type) with Data Communication Systems (including Repeater Points)	2
- Volcano Array Observation Points (3-component) with Data Communication Systems	18	- Volcano Array Observation Network (each network: 3 observation points, 3-component, Convertible-type) with Data Communication Systems (including Repeater Points) for 6 most active volcanoes (3 observation points x 6 volcanoes = 18 points)	6
- Data Processing & Analyzing Systems at Sub-Centers (Tuguegarao, Baguio, Cebu and Davao)	4		
		- Satellite Hub Data Communication System, Pre-processing and Data Storage Systems at the Head Office Mirror Center in Tagaytay Existing Seismic Observation Station	1
- Data Processing Systems at the Existing Volcano Observatories	6	- Data Processing & Analyzing Systems at the Existing Volcano Observatories	6
- Data Processing Systems in Quezon City Head Office	1	- Satellite Hub Data Communication System and Data Management & Processing Systems in Quezon City Head Office	1
		- Satellite Data Communication System at Basco Existing Seismic Observation Station	1
- Relay Stations	9		
- Middle-period Seismic Sensors (3-component) with Recording Systems at the Existing Stations	35	- Middle-period Seismic Sensors (3-component) with Recording Systems at the Existing Volcano Observatories	6
- Long-period Seismic Sensors (3-component) with Recording Systems at the Existing Seismic Stations	4	- Broadband Seismic Sensors (3-component) with Recording Systems at the Existing Seismic Stations	7
- Short-period Seismic Observation System with Recording Systems at Buco Existing Volcano Observatory	1	- Short-period Seismic Observation System (3-component) and Strong Motion Observation System (3-component) with Recording Systems at Buco Existing Volcano Observatory	1
- Displacement-type Seismic Recording Systems	35		
- Mobile Monitoring Systems		- Quick Response Mobile Monitoring Systems	
Short-period Seismic Sensors (3-component)	20	Short-period Velocity-type Seismic Sensors (T0=1 sec, 3-component, Convertible-type)	30
		Short-period Velocity-type Seismic Sensors (T0=20 sec, 3-component)	5
Accelerometers (3-component)	10	Accelerometers (3-component)	10
Mobile Data Recorders	30	Mobile Seismic Data Recorders (9-channels)	30
		Tiltmeters with Data Logging Function	10
		GPS Deformation Monitoring Systems with Data Logging Function	10
		Data Communication Systems (with 10 repeater systems)	30
		Data Processing Systems with Satellite Data Link and Satellite Phone	2
- Pick-up Vehicles	3	Pick-up Vehicles (Pick-up Trucks)	3
		- Back-up Power Supply Systems	
- Spare Parts and Consumables		- Spare Parts and Consumables	
- Motorcycles	9		

2-2-2-2 Highlight Topics of Major Components of the Project Phase II

• Function and Role of the Head Office Mirror Center

In lieu of the envisioned requested 4 sub-centers, a Head Office Mirror Center has been included to minimize maintenance and operation cost, avoid unnecessary increase in personnel, ensure continuous operation in case the Head Office is adversely affected by a large magnitude earthquake and ensure continuous provision of critical earthquake information to the public, decision makers and responding agencies. This mirror center will only serve as a data receiving and storage hub with data processing capability similar to the Head Office.

• Unmanned Volcano Observation Points

The number of requested unmanned volcano observation points (with 3-component convertible sensors) has been decreased to minimize maintenance and operating costs. Most of the unmonitored active volcanoes do not require yet continuous surveillance. In the event of volcanic unrest in these active volcanoes, a Quick Response Team will be dispatched using the mobile monitoring systems. Such reduction resulted in the increase of the number of seismic observation points and increase in the number of mobile monitoring systems.

• Unmanned Seismic Observation Points

Such reduction of the number of requested unmanned volcano observation points as described above resulted in the increase of the number of seismic observation points and increase in the number of mobile monitoring systems. Selected seismic observation points to be furnished with data communication systems will be equipped with 3-component convertible sensors to confidently identify arrival time of secondary waves for improving hypocentral location of events.

• Volcano Array Observation Networks

Volcano Array Observation Network consisting of 3 observation points (with 3-component convertible sensors) with centralized recording systems will be established in each of the six most active volcanoes for locating and characterizing volcanic earthquakes and for detecting onsets of volcanic unrest though continuous monitoring. Data repeater points will be established as required. It is decided that in lieu of continuous monitoring of all active volcanoes in the country, a surveillance activity on an as-required basis would be sufficient. This means that if a volcano in the Philippines becomes active, then a number of seismic sensors and their required ancillary equipment would be brought to the affected sites to obtain the needed data. The reason

for this scheme is to avoid unnecessary exposure of the Project Phase II components to wear and tear, man-made and animal disturbances and to ease maintenance and operating costs by deploying only required equipment at critical times.

• Data Processing & Analyzing Systems at the Existing Volcano Observatories
The provision of data processing and analyzing capabilities including archiving capability to the existing volcano observatories will ensure near real-time analysis of volcanic information and timely issuance of warnings to the public.

• Middle-period and Broadband Seismographs
Only the six (6) existing volcano observatories will be equipped with middle-period sensors (three-component) with recording systems. These systems are highly sensitive to detecting low-frequency volcanic tremors associated with magmatic intrusion and ascent. The remaining proposed twenty-nine middle-period sensors will be replaced by seven broadband seismic sensors (three-component) with recording systems. The broadband sensors will be provided with thermal insulating and temperature stabilizing measures.

• Quick Response Mobile Monitoring Systems
- Thirty (30) short-period velocity sensors (To=1sec, three-component, convertible-type) will be provided for the monitoring of aftershocks and seismic swarms and the periodic and emergency monitoring of active volcanoes without observatories.
- Five (5) short-period velocity sensors (To=20sec, three-component) will be provided for the effective detection of low-frequency volcanic quakes that indicate magma ascent and for site response analysis during aftershock survey.
- Ten (10) accelerometers (three-component) will be used in characterizing strong ground-motion site response in areas affected by large magnitude earthquakes.
- Thirty (30) mobile data recorders (nine-channel) would allow for simultaneous data-acquisition using two types of three-component velocity sensors and three-component accelerometer.
- Ten (10) tiltmeters with data logging function and ten (10) GPS deformation monitoring systems with data logging function will be provided and the networks to be consisted by tiltmeters and GPS deformation monitoring systems will be deployed during emergencies to monitor ground deformation associated with volcanic and seismic crises.
- Thirty (30) telemetry systems with ten (10) repeater systems will be added all the mobile monitoring systems for transmission of data from and seismic networks to Quick Response temporary central station.

• Quick Response Mobile Data Processing Systems with Satellite Data Link and Satellite Phones

Two (2) sets of data processing systems with satellite data link and two (2) satellite phones will be used in the event of two crises occurring at the same time. With the provision of these sets of equipment, on-site processing of acquired data from mobile monitoring networks and immediate data transmission to Head Office will be possible.

• Data Management and Processing Capability of Head Office

Simple, user-friendly, less laborious, systematic and event-oriented data acquisition, processing and archiving system using internationally accepted data format will be designed for the Head Office.

• Spare Parts and Consumables

Spare units/parts and troubleshooting/testing equipment will be required to ensure proper operation and minimize down time beyond warranty period.

• Provision of Vehicles

The vehicles will allow for the immediate dispatch of Quick Response Teams with mobile monitoring equipment during earthquake and volcanic crises.

2-2-2-3 Justifications on Selection and Location of the Project Sites

• Seismic Monitoring Network

In order to establish the national seismic monitoring network for detecting minimum of approximately 4.0 magnitude earthquakes in the Philippines, necessary number and locations of seismic observation points have been decided in consideration at an interval of about 100 km among observation points and the existing observation stations for uniformly covering the whole regions of the Philippines.

• Volcano Array Monitoring Network

For establishing volcano array monitoring networks, the six most active volcanoes (Taal, Pinatubo, Mayon, Bulusan, Kanlaon and Hibok Hibok) in the Philippines have been nominated for locating and characterizing volcanic earthquakes and for detecting onsets of volcanic unrest. Each volcano array monitoring network is consisted with three observation points with necessary number of repeater points. Three observation points have been decided to encircle the highest potential erupt-able area of each selected volcano as the consequence of the field survey.

• Volcano Monitoring Network

For establishing volcano monitoring networks, two geologically new volcano mountains as a potentially active volcano (Parker and Matutum) in Mindanao island have specially been selected due to the following reasons.

Observational data from each remote observation point at Parker and Matutum volcanoes will be relayed and recorded at the existing volcano and seismic station in General Santos City.

❖ *Matutum Volcano*

Located in Cotabato Province in southern Mindanao, Matutum is an andesitic stratovolcano rising 2,300 meters asl. From its geology, there is evidence of explosive and Plinian eruptions. These deposits form a pyroclastic plain that reaches beneath General Santos City and interfinger with lahar deposits of Parker Volcano. Matutum Volcano is a cause of concern because the crater lies only 30 kilometers from General Santos City.

Based on the young appearance of deposits and from the gross morphology of the cone, thermal springs issuing from the volcano, it is evident that Matutum is active. Its latest activity in 1911 also strongly suggest the possibility of future eruption. It is also evident that should Matutum Volcano reactivate, the major city of General Santos will be severely affected because there are no topographic barriers in between. Since General Santos City is a major contributor to the country's commerce and industry, which includes an international airport and seaport, it is very important to provide a suitable warning system so that assets of this city as well as its residents, are given a reasonable chance against the ill effects of volcanic eruption.

❖ Parker Volcano

This is another active volcano with a 2-kilometer diameter caldera lake, located some 30 kilometers northwest of General Santos City. In many physical aspects, Parker Volcano resembles Pinatubo and it is also evident from the dacite pyroclastic flow deposits and cone morphology that this volcano erupted in recent history. Carbon dates of charred tree trunks embedded in these pyroclastic flow deposits indicate that Parker Volcano erupted about 400-500 years ago in manner very similar to explosive eruptions of Pinatubo in 1991. Archives from early Dutch and German explorers also indicate a possible eruption in the 17th century. If such measurements and accounts are accurate, then risks to present-day surrounding communities, including General Santos City are significant, considering that pyroclastic flow deposits and lahar plains reaches out to about 40 kilometers from the crater.

The need to monitor Parker Volcano is underscored in the recent crater-lake breakout in September 1995. Flashfloods caused by this crater rim breach killed over 100 persons. It was reported by the Provincial Government of South Cotabato and the town of T'Boli that a series of local earthquakes were felt a few days prior to the failure of the crater rim. Detection of such earthquakes, therefore, may provide some kind of warning should the crater rim become unstable in the future.

A seismic observation point at Paker Volcano is therefore very important to detect and monitor precursors for public safety. Data from a seismometer located on the slope of Parker will be relayed to an existing volcano-seismic station in General Santos City.

- Head Office Mirror Center

Head Office Mirror Center is proposed to ensure continuous operation in case the Head Office is adversely affected by a large magnitude earthquake. Candidate sites for the mirror center are Baguio, Pinatubo (in Clark Air Force Base) and Tagaytay existing seismic observation stations. Tagaytay existing seismic observation station in Southern Luzon has been nominated due to the following judgment.

	Direct Distance	*Land and facility owner*	*Accessibility from Quezon*	*Space for equipment installation*	*Judgement*
Baguio	approx. 190 km	PHIVOLCS	Difficult (mountainous area)	Available	-
Pinatubo	approx. 80 km	Air Force	Easy	Available	-
Tagaytay	approx. 60 km	PHIVOLCS	Easy	Available	Ok

- Result of noise level survey

As a consequence of the back-ground noise level studies at several number of the proposed sites for seismic observation points by short-period velocity sensor system (vertical, 2Hz), the back-ground noise level has been confirmed to be much smaller than 1×10^{-6} cm/sec. Due to a result of the study, it is expected all the proposed sites for seismic observation points have the similar back-ground noise level. Thereby, it is possible to establish the national seismic monitoring network for detecting minimum of approximately 4.0 magnitude earthquakes in the Philippines as scheduled in the Project Phase II.

- Calculation of Detection Ability

・ Required detecting ability of the national seismic monitoring network: minimum of approximately 4.0 magnitude earthquakes (M = 4.0)

・ Interval among observation points and the existing observation stations of the national seismic monitoring network of : about 100 km (Δ = 100 km)

Magnitude calculation formula of Japan Meteorological Agency (JMA)

JMA 67 Type Seismometer (T0=1sec.): $M = \log Av + 1.64 \log \Delta + 0.22$

JMA 76 Type Seismometer (T0=1sec.): $M = \log Av + 1.64 \log \Delta + 0.44$

Av: Maximum velocity in vertical component (10^{-6} cm/sec)

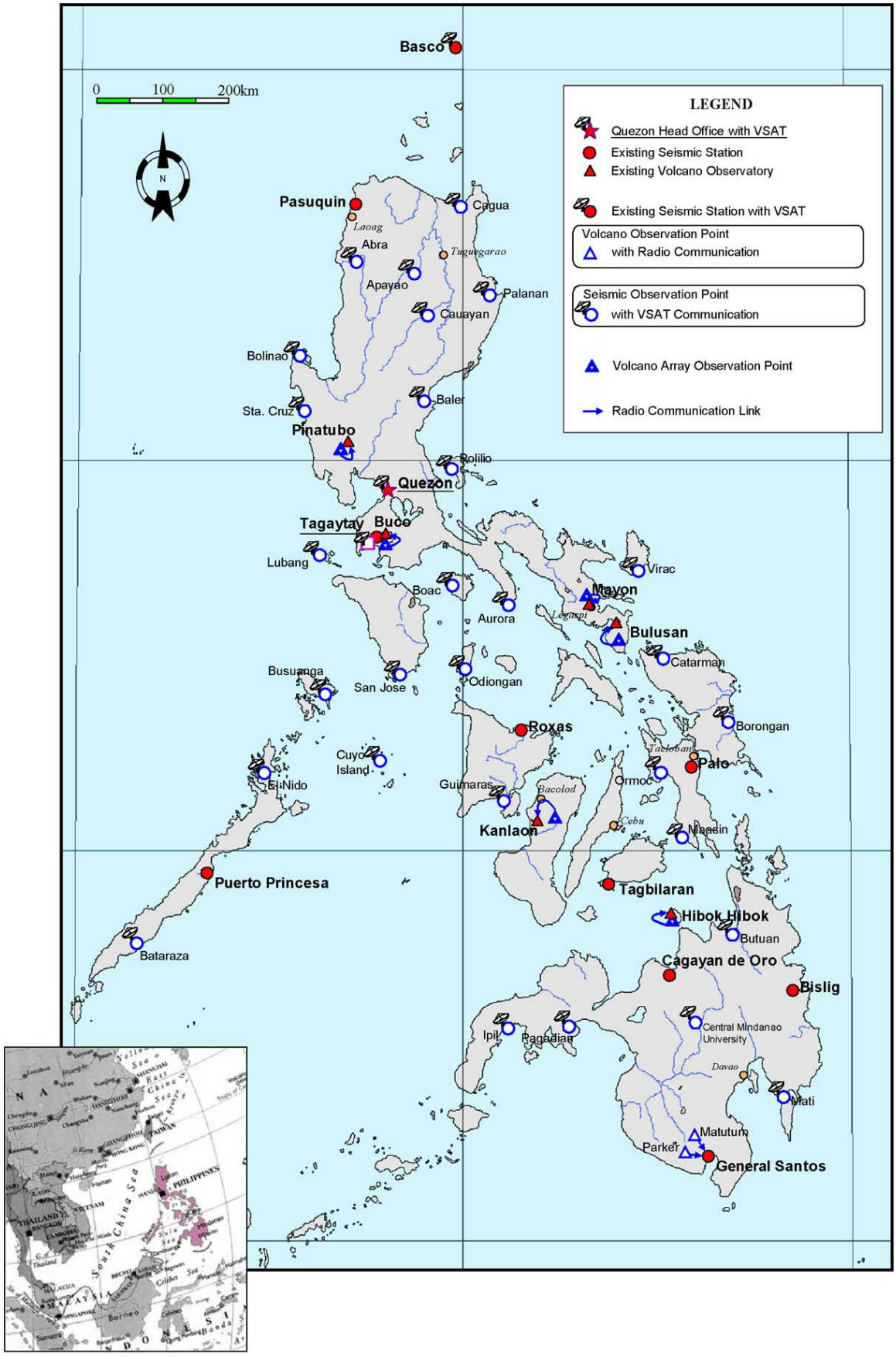
Δ : Epicenter distance (km)

$Av = 1.9 – 2.3 \times 10^{-6}$ cm/sec

- Consequence of the calculation -

If each observation point can obviously distinguish seismic signal of $1.9 – 2.3 \times 10^{-6}$ cm/sec, the national seismic monitoring network to be established under the Project Phase II can surely detect minimum of approximately 4.0 magnitude earthquakes.

All the seismic and volcano observation points to be established under the Project Phase II and the existing observation stations & observatories are shown in a map of *"Location Map of the Project Sites"* attached herewith.



Location Map of the Project Sites

2-2-2-4 Justification and Necessity of Planned Major Components

(1) Establishment of National Seismic Monitoring Network by Satellite Data Communication

A total of twenty nine (29) new unmanned seismic observation points and Basco Existing Seismic Observation Station are designed to be linked to the central hub receiving station in Quezon city and to the mirror center in Tagaytay using satellite data communication system. "*Comparison Table between Satellite Data Communication and GSM Data Communication"* are attached herewith.

Comparison Table between Satellite Data Communication and GSM Data Communication

Item		*Continuous Transmission by GSM Data Communication*		*GSM Data Communication to be operated by Trigger Level*		*Satellite Data Communication*	
Capital Budget for Network Establishment		Approx. 40 Million Japanese Yen	○	Approx. 40 Million Japanese Yen	○	Approx. 180 Million Japanese Yen	△
Recurrent Cost for Communication	At least 6 of 30 points require satellite data communication system due to no other communication solutions.	Approx. 90 Million Japanese Yen	−	Approx. 20 Million Japanese Yen	○	Approx. 20 Million Japanese Yen	○
System Reliability against Seismic Disaster	This Project is for contributing to mitigation of seismic and volcano disasters, thereby, seismic observation network must provide PHIVOLCS with the whole waveform of a three-component system on very near real time basis even when large scale of earthquake occurs.	After a strong earthquake, ordinary telephone land line and GSM systems are usually damaged or congested by heavy calls from of the inquiring public. A large scale of earthquake will render the GSM telephone system inoperable for a long time due to damage to some ground facilities and also due to heavy traffic from the inquiring public.	−	After a very strong earthquake, ordinary telephone land line and GSM systems are usually damaged or congested by heavy calls from the inquiring public. A large scale of earthquake will render the GSM telephone system inoperable for a long time due to damage to some ground facilities and also due to heavy traffic from the inquiring public.	−	Serious affection by a larger scale of earthquake is not expectable.	○
Very Near Real Time Basis Data Communication	Very near real time basis communication is necessary for seismic observation.	Communication cost is very high as described above	○	Very near real time data communication is inoperable.	△	Complete waveform data of earthquake events will be available at the Head Office on very near real time basis for more detailed and prompt analysis.	◎
Transmission of Short-period 3-componet Waveform Data	For detecting minimum of approximately 4.0 magnitude earthquakes, a three-component data recording of all the observation points will be required solution for the Project.	The use of GSM system wherein only a single component (usually vertical component) and a small part of the waveform data can be transmitted to the Head Office.	−	Only a single component (usually vertical component) and a small part of waveform data more than selected trigger level can be transmitted to the Head Office.	−	The wider bandwidth of satellite communication system will easily allow to transmit 3-component seismic data with a higher data sampling rate.	○
Detecting Capability	It is planned to establish the national seismic monitoring network for detecting minimum of approximately 4.0 magnitude earthquakes in the Philippines as the project target.	Possible to satisfy the project target, however communication cost will be very high as described above.	◎	Possible to satisfy the project target, however seismic network detecting capability depends on selecting trigger level.	○	There is no problem to satisfy the project objective. Satellite data communication will be upgrading detecting capability of PHIVOLCS very much.	◎
Contribution to Tsunami Monitoring in the Pacific Region		Additional system in PHIVOLCS will be required to provide Tsunami information and warnings to neighboring countries facing to the Pacific Ocean	△	Additional system in PHIVOLCS will be required to provide Tsunami information and warnings to neighboring countries facing to the Pacific Ocean.	△	It is possible to provide Tsunami information and warnings of PHIVOLCS to neighboring countries including Japan facing to the Pacific Ocean due to required international arrangements.	○
Data Analysis for Earthquake		Difficult, because GSM only allow to transmit a small part of the waveform data and limited volume of single component.	−	Difficult, because GSM only allow to transmit a small part of the waveform data and limited volume of single component.	−	A big advantage in getting the whole 3-component record of the earthquake is that secondary phase (S-wave) arrival is more clearly recorded and identified on the 2 horizontal components than only on the vertical component. Determination of a more accurate S-wave arrival time gives the better and accurate location of the focus of the earthquake event.	○
Synthesis Judgement		−		△		○	

- Reasons on Nomination of Satellite Data Communication

Satellite data communication has nominated for establishment of the seismic monitoring network over other systems such as radio telemetry, GSM and landline telephone system because of the following reasons:

a. Ordinary telephone land line and GSM systems are usually damaged or congested by heavy calls from the inquiring public after a very strong earthquake. This will make transmission of seismic data from seismic stations using telephone lines to the Head Office very difficult. The Ms 7.8 Luzon earthquake of July 16, 1990 rendered the telephone system inoperable for several hours due to damage to some lines and also due to heavy traffic from the inquiring public. Fortunately, the PHIVOLCS was not yet highly dependent on public telephone system at that time and many of its manned stations were equipped with a dedicated communication system like a single side band (SSB) radio. Verbal transmission of manually processed data from manned stations using SSB radios to the Head Office was not adversely affected and earthquake parameters were determined and disseminated to the public on time. Unlike public telephone and GSM system, dedicated communication systems such as the use of satellite communication is more stable and less affected by large earthquakes and will therefore ensure the continuous flow of critical earthquake information and warning to the public. The desire to modernize and speed up the data processing capability of the PHIVOLCS makes the use of satellite communication system imperative.

b. The use of satellite communication is considered to be the most efficient and fastest method of transmitting large volume of digital data. The wider data transmission bandwidth possible with the use of satellite communication will ensure the availability of the complete waveform data of earthquake events to the Head Office on very near real time basis for more detailed and prompt analysis. Unlike with the use of GSM and landline telephone system wherein only a single component (usually vertical component) and a small part of the wave form data can be efficiently transmitted to the Head Office, the wider bandwidth of satellite communication system will not limit the volume of data acquired and will allow for the use of a three component seismic sensors and the use of a digital data acquisition system with a higher data sampling rate. The whole waveform of a three-component system can be received at the Head Office on very near real time basis. There is a big advantage in getting the whole three-component record of the earthquake. One is that secondary phase arrival is clearly recorded on the two horizontal components which is usually less clear on the vertical component. A more accurate secondary phase (S-wave) arrival time can therefore be obtained and this will contribute for the better and accurate location of

the focus of the earthquake event. S-wave arrival times are usually very difficult to identify and it requires a skill-full and experienced seismic observer to pick accurate S-wave arrival times. Most of the time, S-wave arrival times picked by station seismic observers need to be rechecked after the initial run of the hypocentral location software to reduced the time residuals of the phases and refine the solution. The simultaneous processing and viewing of the complete waveforms from many observation points using a seismic signal processing software at the Head Office will enable an easy checking and re-picking of phase arrivals times and quick recalculation of earthquake parameters. This will normally takes a longer time to do if the complete waveform data are not available at the central processing station. Head Office operators will have to request field operators to re-pick and re-transmit data of later phases such as S-wave arrival times.

Moreover, a three-component record will facilitate amplitude analysis/comparison between vertical and horizontal components and this can be useful in inferring tsunamigenic earthquakes. For very large magnitude earthquakes, most of the stations will have saturated amplitudes and the only measurement that can be used for estimating the magnitude is the total duration of the waveform.

The immediate availability of all waveforms from unmanned seismic observation points with the satellite communication systems will make archiving more efficient. Earthquake waveforms can be archived as they occur and there is no need to wait for the station personnel to send in their monthly data which are very time consuming and very laborious to collate and archive.

c. Some of the planned twenty nine (29) unmanned seismic observation points will be located close to and around Metro Manila. This metropolis is the largest economic center in the country and is the seat of the Philippines government. It is rapidly growing and developing and has a present population of around 9 Million. Many active earthquake generating structures are located in and around it. Several large historical earthquakes have affected Metro Manila and have caused considerable loss of lives and damage to properties. The objective of the satellite communication network for the planned unmanned seismic observation points in the surrounding area of Metro Manila is to augment and increase the earthquake detection capability of the existing 4-station radio telemeterd micro earthquake monitoring network of Metro Manila. The immediate availability at the Head Office and prompt processing of the complete waveform data from several stations around the metropolis will result in timely detection of foreshock swarms which may indicate impending big earthquakes. This will subsequently facilitate timely dissemination of critical information and warning to Metro Manila residents.

d. Security of the unmanned seismic observation points setup and ease of access for maintenance is one of the basic considerations in selecting the station location. Unlike radio telemetered systems for seismic monitoring, satellite communication systems can be located easily in more secured sites since line of sight from the receiving point is not required for data transmission. The only requirement is to have an open sky for satellite visibility. The observation point can be sited in a safe place free from theft and vandalism. Radio telemetered systems will require the points to be located on high grounds such as peaks of the mountains to provide for lines of sight to the receiving point. At longer distances over a rugged terrain, this will require more repeater points to connect to the receiving point. Therefore, it is suitable for volcano observation, not for seismic monitoring. The difficult accessibility to reach the remote and repeater points plus the many number of repeater points required will make a radio telemetered network more difficult and more expensive to maintain for seismic monitoring.

- Required conditions for establishment of the National Seismic Monitoring by Satellite Data Communication

  - Name of required Satellite: Agila II
    (Space Segment Provider in the Philippines: Mabuhay Philippines Satellite Corporation, MPSC)
  - Band: Ku-band
  - Bandwidth: at least 300kHz
  - Each Site: Open Sky for Satellite Visibility (Approximate Azimuth 118 º and Elevation 56 º)

(2) Establishment of Head Office Mirror Center

A mirror center is planned to be established in Tagaytay in Southern Luzon to duplicate basic PHIVOLCS Head Office monitoring functions such as data receiving, data archiving, data processing and information dissemination. The mirror center will ensure continuous flow of valuable earthquake and volcano information to the public in the event that the PHIVOLCS Head Office at Quezon City becomes incapacitated by a large magnitude earthquake or by some other natural or manmade phenomena. The movement of an active fault dissecting the Metro Manila may generate very strong ground motion that may damage the PHIVOLCS building and facilities in Quezon City. The provision of a redundancy in the form of a mirror center located at a safe distance from faults that can affect the Head Office in Quezon City is very important and logical. During normal times, this mirror center will serve as a backup data receiving and storage hub. The mirror center will also be provided with basic data processing and communication systems very similar to that of the Quezon City Head Office to maintain familiarity with equipment and

procedures when Head Office personnel are abruptly relocated from the Head Office to the mirror center during times of emergencies. When the Head Office is incapacitated, this will function as the central receiving center and will take the responsibility of processing, interpretation and dissemination of critical information and warning to the public, decision makers and responding agencies.

(3) Installation of Broadband Seismic Sensors

Typical short-period seismographs are for capturing high frequency signals from earthquakes. To understand better the faulting mechanisms of large magnitude and damaging earthquakes, seismologists use broadband seismographs to detect and record a wide range of periods that could come from these events. The long period energy content of large magnitude earthquakes which are outside the frequency detection capability of inexpensive short period recorders could be efficiently detected by broadband seismographs since these were designed to detect a wide-range of frequency content. The recording of the broad frequency content of earthquakes will allow for the use of a more reliable and non saturated magnitude scale such as Moment Magnitude (Mw). The resulting broadband digital data is highly suitable for mathematical modeling leading to the understanding of the rupture process of large events which is very crucial in understanding the seismotectonics of the Philippine region. In addition, broadband seismic sensor can also effectively detect earthquakes of distant origin which have very dominant low frequency energy content. The generation of sufficient quality teleseismic data will enable the PHIVOLCS to participate actively in international seismic data exchange and will immensely contribute to the global efforts of studying earthquakes and exploring the deep structures of the earth.

(4) Supply of Quick Response Mobile Monitoring Systems

Under the Project Phase II, a number of sensors, required data recorders, telemetry equipment and data processing system with satellite links have been included as part of a "Quick Response Mobile Monitoring System". The Quick Response Mobile Monitoring System is intended to supplement other sensors during times of volcanic and earthquake crises. Due to the fact that the number of volcanoes and earthquake prone areas far outnumber the sensor stations in the country, there is a need to place additional but temporary sensors in strategic sites during a volcanic or earthquake crisis. The idea is that the numbers of seismic and related equipment for permanent deployment will be kept to the minimum for economy, ease of maintenance and to reduce exposure to possible vandalism. However, when a volcanic crisis develops, for example, additional seismic and ground deformation sensors shall be deployed to enable the monitoring networks to gather the necessary data. After the crisis, equipment from the Quick Response Mobile

Monitoring System will be returned to their designated storage for maintenance and future use. So that all the Quick Response Mobile Monitoring System will be located the Head Office for flexibility for deployment and centralized safekeeping.

A primary objective of the Quick Response Mobile Monitoring System is to rapidly deploy a set of seismic and ground deformation instruments so that the PHIVOLCS can issue timely and appropriate warnings in times of volcanic and earthquake crises. The Quick Response Package is designed to supplement the volcano seismic monitoring networks to be established as well as the regional earthquake monitoring system. The Quick Response Mobile Monitoring System allows a minimum number of sensors to be permanently deployed so that economy and efficiency of operating the seismic and related networks around the country is enhanced. Cognizant that permanent and simultaneous monitoring of all active and potentially active volcanoes and earthquake prone areas in the country is not economically feasible, the Quick Response Mobile Monitoring System is one proposal to ensure that all areas will be investigated on an as-needed basis. Thus, when a volcano becomes active, the required number of sensors can be deployed and will be temporarily integrated into the regular volcano or regional seismic monitoring system of that particular area. Likewise, if a hazardous fault is interpreted to be the loci of large-magnitude earthquakes, then the Quick Response Mobile Monitoring System will allow a sufficient array of seismometers for locating earthquakes and, therefore, help decision makers identify hazardous areas.

- Volcano Monitoring -

It is important to note that in the Project Phase II, establishment of Volcano Array Observation Networks consists of 3 observation points are included for each of the six identified active volcanoes. This arrangement was made under the assumption that three observation points at each volcano is minimum number of observation points required for earthquake location. However, under this scheme, very accurate calculation of hypo-centers and other critical earthquake parameters determined from earthquake position data cannot be undertaken. For reasonable accuracy, six observation points should be deployed around the target volcano. This number of observation points assumes that all stations detect a particular earthquake. Because volcanic earthquakes are usually small-magnitude, there are instances when not all stations will detect a particular event, especially those most distant from the epicenter. Thus, additional sensors and related equipment from the Quick Response Mobile Monitoring System are required to bring the number of instruments to the desired capability.

- Regional Earthquake Monitoring -

There are times when earthquake monitoring requires more seismometer sites than already installed. For practical reasons, the required number of seismometers should be kept to a

minimum but it is likewise desirable to maximize the number of sensors in earthquake prone areas or in areas where significant seismic gaps occur. Also aftershock monitoring will require a dense array of seismometers because the magnitude of these events may be small and, hence, require closely spaced sensor distribution. In areas of geological complexity in the Philippines, it is necessary to deploy seismometers because local geology may modify site response so that data from many sensors can discriminate between local effects from that of larger, more hazardous earthquake generators.

Mobile Short Period Velocity-type Seismic Sensors

Volcano Related Crisis: Assuming that a volcano anywhere in the country other than that with an existing seismic network reactivates will show signs of possible eruption, then the PHIVOLCS will need to initially deploy a minimum of 5 sets of 1-second (T0=1second) short period seismometers. This preliminary deployment will attempt to determine the general area where seismicity is occurring. In general, volcanic seismicity may involve crustal adjustments to magmatic intrusions, or perhaps fluid movement. In many cases, the seismic activity is high-frequency type and may involve rock breaking as a response to intrusion or perhaps micro-fracturing. If deformation response occurs over a broad or large area, then the aperture or area to be monitored should be large as well. These conditions require an additional package of 5 sensors for a total of 10 seismometers. Because some movements are very local, as a result of intrusion, then it may be required to adjust the spacing of sensors or to add some seismometers to fully cover the area affected by the seismic crisis.

Event	Action	Purpose
A volcano shows potent of eruption.	Initially deploy a minimum of 5 sets of 1-second (T0=1second) short period seismometers	To determine the general area where seismicity is occurring
Deformation response occurs over a broad or large area.	Additionally deploy 5-10 sensors (a total of 10-15 seismometers)	To adjust the spacing of sensors or to add some seismometers to fully cover the area affected by the seismic crisis

There is no set rule as to how to deploy the seismometers and how many to deploy because such a strategy must consider local and regional geologic conditions in which there are variable site response and path effects to seismic waves. However, it is the experience of the PHIVOLCS that at least 15 seismometers should be in place to adequately monitor, for example, a volcano such as Taal Volcano (35 km^2) in which volcanic activity can occur anywhere in this area.

For detecting magma movement, possibly originating from deep sources and to detect the variable types of seismic signatures related to fluid movements at shallow sources (magma, gaseous emission, etc.) in volcanic systems, five (5) sets of short period (T0=20seconds) seismometer sets are also required. This is because the frequency range of volcanic signals

is actually broader than traditionally thought. In recent years, the PHIVOLCS used only 1-second (T0=1second) short-period sensors in volcano monitoring. But it has become evident that the use of longer-band seismometers (T0=20seconds) in volcano monitoring is useful in defining the true spectral frequency of volcanic events. This has led to better interpretation of volcanic signals and the type of activity (hence, possible explosivity). For example, volcanic earthquakes recorded as high-frequency type quakes by 1-second short period seismometers become attenuated as a function of radial distance from the source. Thus, the proper recognition or interpretation of such events at far-field stations (as dictated by difficult access) is difficult using only 1-second period seismometers but such events are better recorded using broader-band seismometers. This capability to detect such events even at farther distances from the volcano is important, as it brings attention to possible activity that may otherwise go unnoticed.

Mobile Accelerometer

Ten sets of strong motion instruments (accelerometers) will be useful for monitoring strong aftershock activities after every large earthquakes. When deployed in the affected built-up areas, mobile accelerometers will generate very important information that can be used in seismic site response evaluation and seismic microzonation of the affected areas. Plausible explanation for the damage pattern and distribution can be derived using strong motion data measured at different locations in the affected areas. These generated information will serve as additional guide in planning for immediate recovery and reconstruction efforts which will be make heavily affected areas safe from future earthquakes.

Tiltmeter

Tiltmeters are extremely useful sensors that supplement earthquake detection in active volcanoes. As their name implies, these instruments detect minute shifts in ground angle or tilt, usually applied for determining intrusion of magma into the volcano edifice. As magma exerts pressure in the volcanic conduit or passageway, the pressure induces a corresponding outward movement of the ground. Thus, even when seismic slips have not yet occurred perhaps due to elastic behavior of the volcanic cone, such deformation may be detected by tiltmeters and provide an important early warning of impending eruption. This is especially true for volcanoes with “open” magmatic systems (volcanoes that frequently erupt) in which the conduit is well lubricated from recent eruptions and hence, rock breakage or oscillations induced by magma squeezing through cracks does not occur. Examples of volcanoes with effective tiltmeter and ground deformation networks are those in Sakurajima Volcano in Kyushu, Usu Volcano in Hokkaido, Japan.

In volcanoes where the magma is very fluid and relatively degassed, volatile pressure is not sufficient to induce internal explosions that are readily detected by seismometers. In

such cases, tiltmeters play an important role in detecting ground swelling that may accompany magma transport en route to the surface. In volcanoes that do not erupt frequently, pressure induced by ascending magma usually trigger a large number of earthquakes. Such cases are also frequently accompanied by large ground deformation so that tilt data become important co-indicators of precursors. In general, volcano monitoring using tiltmeters, when properly employed, is able to define reasonable to very good timing indicators of an eruption because rapid ground accelerations that frequently precede an eruption are readily detected by tiltmeters.

The Quick Response Mobile Monitoring System includes ten (10) Biaxial-type precision tiltmeters with data logging function. In a single active volcano, the PHIVOLCS considers it a minimum to deploy an array of three (3) tiltmeters on one flank distributed;

i) at the lower elevation,
ii) middle elevation and
iii) upper elevation.

Then on the other side an additional three (3) tiltmeter sets will be placed if the topography and access permits. Other tiltmeters are desired on or near the summit where maximum ground displacements occur. With this arrangement, the ascent of magma may be tracked as it passes through the lower part of the edifice and through upper stations. Through time, the acceleration of deformation can be well defined and a possible window of high probability of eruption might be determined.

Ground Positioning Satellite Receiver (GPS) Deformation Monitoring Systems

In recent years, GPS deformation monitoring systems have been employed at some active volcanoes around the world because significant horizontal shifts in ground positions accompany volcanic activity. Detection of such ground movements is therefore used as aids in volcano eruption prediction. GPS data from multiple stations deployed around an active volcano can indicate relative rates of motion of the volcanic edifice and thus suggest location of active pressure source/s. In Taal Volcano, for example, where the active volcanic center can be anywhere in the vicinity of the island, location of deformation sources may indicate the position of an impending eruption. This is especially important when seismic events are diffused and do not indicate a particular active structure.

For earthquake monitoring, GPS deformation monitoring systems can be useful to determine horizontally-dominated movement along faults, either as fault creep or rapid movement along a fault plane. This is useful when the active structure is not very evident to the eye so that the GPS deformation monitoring systems can detect an accumulated strain over a large area even when no fault rupture has taken place. GPS data can be

subjected to a wide range of processing techniques that may be appropriate for rapid warning, such as time-series plots of ground movement or for mapping purposes to determine differing degrees of risk along large tracts of land transected by faults.

Mobile Data Processing Systems with Satellite Links and Satellite Phones

With data from various quick response mobile monitoring systems deployed at critical sites during emergencies, it is necessary to reduce the data for analysis and processing. While data logging functions are made on site, there is a need to collate and integrate data so that analysis is possible and decision-makers both on field and in the PHIVOLCS Head Office can interpret the data and make a collective decision for issuing the appropriate warnings. To achieve rapid information dissemination, two sets of data and voice satellite links are included in the Project Phase II so that such information can be sent any time of day and anywhere in the country. The latter is especially important because during volcanic and earthquake crises, communication links are often disabled by the crises or because commercial communication lines are saturated by existing users. Two sets of satellite phones will allow voice communication within the quick response team for installation of the quick response mobile monitoring systems to confirm a line of the site for data transmission.

(5) Data Communication Systems for Quick Response Mobile Monitoring Systems, Volcano Array Observation Networks and Volcano Observation Points

In order to make easy spare parts procurement by the PHIVOLCS and standardization of system interfaces to be furnished with all of the equipment, the data communication systems to be supplied under the Project phase II will be unified.

1) Requirements of the Data Communication Systems

Due to the following requirements and conditions, digital spread spectrum system of 2.4GHz Band has been selected for Quick Response Mobile Monitoring Systems and Volcano Array Observation Networks ant it can satisfy all the followings. In addition, in order to measure the existing interference around an observation point, 2 sets of spectrum analyzers will be furnished with data communication systems for the Quick Response Mobile Monitoring Systems to be used and measured receiving disturbance intensity and direction before the installation.

- Requirements -

- Data Observation points and repeater points located at very remote and dense forest areas: High reliability
- Data transmission: Uninterrupted and continuous real time transmission

- Availability of commercial power supply: No available at all the points
- Power consumption: Low power consumption
- Communication cost: Free communication cost
- Minimum transmission speed for observational data of 3-component: 9600bps
- Power supply: Solar-power system with battery(s)
- Weight: Lightweight and handy carry type for quick response mobile system
- Installation method: Easy and simple installation
- Maintenance: Easy maintenance
- Extension of the system: Easy and simple expandable system
- Interface flexibility: Easily connectable to PC and other digital devices

2) Advantage of the Spread Spectrum System

a. No communication charge is required
b. Very high-speed data traffic (11Mbps)
c. Specifications and modulation standard of spread spectrum radio equipment is based on International Standard IEEE802.11b (IEEE: the Institute of Electrical and Electronic Engineers under International Telecommunication Union, ITU)
d. The equipment has "10Base-T Ethernet Interface (IEEE802.3)" for unification of all the equipment digital signal interfaces to be communicated by TCP/IP as a global standard of PC network for easy networking and wider expansion
e. The system has two-way communication function for data collection and remote control & monitoring of the system
f. In case of link-error occurred, data re-transmission by the re-try function is available
g. Due to employing microwave, antenna is a high gain antenna which is smaller and lighter than normal yagi antenna
h. The system is very expandable to connect the plural number of the same systems
i. Rain attenuation of radio signal is 0.01dB per 1 km under more than 100mm/h raining (system design available as no attenuation by rain)
j. The system has security function in accordance with IEEE802.11 of Wired Equivalent Privacy Algorithm (WEP) using Media Access Control ID (MAC) and Extended Service Set ID (ESS)
k. The system has Comparatively high antenna power. The antenna power of transmitter is prescribed in the frequency band 1MHz in the case of spread spectrum system. The spectrum is speeded in 20MHz band. So that, the total antenna power of transmitter is equivalent approximate 100mW
l. By adopting the Spread Spectrum communication method, it can be built the communication system which is strong for interference radio wave and noise. Even if 40dB bigger interference wave is existing in the side channel, the system

does not receive influence. It can estimate the greatest distance that it gives interference to with 40db

m. The antenna power of a yard radio station is maximum 300mW, and a low power radio station is maximum 10mW. The antenna gain is admitted to the greatest 20dBi both, so that it can estimate the greatest distance that it gives interference to with 40m

n. It is equipped with data transmission and reception error monitor function on communication protocol in IEEE802.11b. Accordingly, this protocol guarantees high reliability of data communication between Spread Spectrum method equipment

3) Channel Frequencies of the Spread Spectrum System

The channel frequencies of digital spread spectrum system of 2.4GHz Band (2400～2483.5MHz) are specified by IEEE802.11b.

4) Output power of the Spread Spectrum System: 10mW/MHz or less

5) Antennas of the Spread Spectrum System: 19 dBi high gain Yagi antenna for long distance communication

6) Comparison between Analog Radio Link and Digital Spread Spectrum Radio Link

Comparison Table

Items	Radio Link (Analogue)		Spread Spectrum Radio Link	
1.Data Transmission Rate	1200bps	×	11Mbps	◎
2. Economical Communication Distance	20-30km	◎	10-20km	○
3. Power Consumption	＜20W	×	＜3W	◎
4. Communication Fee	Free	◎	Free	◎
5. Calling System	Polling System	○	CDT	◎
6. Equipment Cost	Small	◎	Small	◎
7. Expandability	Easy	◎	Easy	◎
8. Frequency Interference	High Possibility	×	Low Possibility	◎
9. Maintenance	Easy	◎	Easy	◎

(6) Supply of Vehicles for Quick Response Mobile Monitoring System

The idea of a Quick Response Mobile Monitoring System for volcano and earthquake monitoring requires a delivery system to deploy such instruments. Thus, it is required that one of major components of the Project Phase II be allocated for vehicles.

4 Wheel Drive (4WD) Pickup Vehicles

Three 4-wheel Drive Pickup vehicles are also required. They will stand by at the Head Office in Quezon City for quick deployment anywhere in the country during times of emergency to transport heavier equipment and more personnel. Deployment of the Quick Response Mobile Monitoring Systems, together with heavy batteries, solar panels and ancillary equipment far from existing observatories or stations can only be achieved efficiently through 4-wheeled vehicles that are designed for rough terrain.

Remote stations are geographically situated in isolated areas where public transport vehicles do not go due to bad road conditions. Only private and hired special vehicles could assess these areas. Hiring is expensive and requires long negotiation period to schedule a special trip especially during the rainy season. Therefore, even if capable personnel and spare parts are available, hiring of vehicles will delay maintenance and repair work, and would prolong the interruption of operation of the instrument. In this case, additional vehicles (4-wheel and motorcycles) to conduct the necessary maintenance of instruments deployed in the field should be considered.

2-2-2-5 Equipment List for Planned Major Components

In connection with all the equipment and systems as described above, the basic design study and investigation have been held in the Philippines and Japan. In accordance with the result of the study, the Project Phase II has been designed to consist of two packages as A and B-Packages. The major components of each package are described below.

A-Package

(1) Installation of Middle-period Seismic Sensors (3-component) at the 6 Existing Volcano Observatories
(2) Installation of Broadband Seismic Sensors (3-component) with Recording Systems at the 7 Existing Seismic Observation Stations
(3) Establishment of Short-period Seismic Observation System (3-component) and Strong Motion Observation System (3-component) with Recording Systems at Buco Existing Volcano Observatory
(4) Establishment of 2 Volcano Observation Points (3-component, short period convertible-type) with Data Communication Systems (including Repeater Points): Mt. Parker and Mt. Matutum
(5) Installation of Data Management and Processing Systems at the PHIVOLCS Head Office
(6) Installation of Satellite Hub Data Communication System at the PHIVOLCS Head Office
(7) Installation of Satellite Communication System at Basco Existing Seismic Observation Station
(8) Supply of Quick Response Mobile Observation Systems:
    - T0=1sec. Short-period Velocity-type Seismic Sensors (3-component, Convertible-type): 30 sets
    - T0=20sec. Short-period Velocity-type Seismic Sensors (3-component): 5 sets
    - Accelerometers (3-component): 10 sets
    - Mobile Data Recorders (9-channel): 30 sets
    - Tiltmeters with Data Logging Function: 10 sets
    - GPS Deformation Monitoring Systems with Data Logging Function: 10 sets
    - Data Communication Systems (with 10 repeater systems): 30 sets
    - Mobile Data Processing Systems with Satellite Data Link and Satellite Phones (each 2 sets)
(9) Necessary Power Supply Systems
(10) Supply of Vehicles (pick-up trucks)

B-Package

(1) Establishment of 29 Seismic Observation Points (each point: vertical/3-component, short period convertible-type) with Satellite Communication Systems

(2) Establishment of 6 Volcano Array Observation Networks (each network consisting of 3 observation points with 3-component, short period convertible-type sensors) with Data Communication Systems (including Repeater Points): Mt. Taal, Mt. Pinatubo, Mt. Mayon, Mt. Bulusan, Mt. Kanlaon and Mt. Hibok Hibok

(3) Installation of Data Processing & Analyzing Systems at the 6 Existing Volcano Observatories

(4) Establishment of Satellite Hub Data Communication System, Pre-processing and Data Storage Systems at the Head Office Mirror Center, Tagaytay

(5) Necessary Power Supply Systems

Major Components for the Project Phase II

A-Package

Pinatubo, Mayon, Bulusan, Kanlaon and Hibok-Hibok Existing Volcano Observatories			
Equipment	**Specification**	**Quantity**	**Purpose**
Middle-period Seismic Sensor (3-component)	・ Transducer type: force balance ・ 50 or longer seconds to 0.02 second (frequency range 0.02 to 50 Hertz)	1 set	For detecting low-frequency volcanic tremors associated with magmatic intrusion and ascent
GPS Timing System	・ GPS signal syncronization ・ Timing accuracy for signal receiving: better than 100 microseconds	1 set	For timing control of the seismic equipment and system by GPS signals
Data Recorder	・ 6 channels, gain adjustable input amplifiers suitable for accepting the outputs of seismometer ・ 24 bit AD converter, 200sps for each channel ・ Removable solid state memory ・ Digital interface: 10 Base-T	1 set	For digital data recording of 3 components of seismic motion
Power Supply	・ DC power supply: 1 ・ AVR (5kVA): 1 ・ Lead acid battery (65AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system

Pasuquin, Roxas, Palo, Puerto Princesa, Tagbilaran, Cagayan de Oro and Bislig Existing Seismic Observation Stations			
Equipment	**Specification**	**Quantity**	**Purpose**
Broadband Seismometer (3-compornent)	・ Transducer type: force balance (feedback type with automatic mass position adjustment) ・ Three orthogonal components vertical, north/south and east/west ・ 360 or longer seconds to 0.02 second (frequency range 0.0027 to 50 Hertz)	1 set	For understanding better the faulting mechanisms of large magnitude and damaging earthquakes For detecting a wide range of periods and a wide-range of frequency content
GPS Timing System	・ GPS signal syncronization ・ Timing accuracy for signal receiving: better than 100 microseconds	1 set	For timing control of the seismic equipment and system by GPS signals

Data Recorder	• 6 channels, gain adjustable input amplifiers suitable for accepting the outputs of seismometer • 24 bit AD converter, 200sps for each channel • Removable solid state memory • Digital interface: 10 Base-T	1 set	For digital data recording of 3 components of seismic motion
Data Processing & Analyzing Unit for Broadband Seismometer	• Pentium IV 2GHz processor • 512 Mbytes Memory, 40Gbytes hard drive • CD-RW drive, DVD RAM, 17' monitor • LAN interface: 10BASE-T/100BASE-TX • Data processing & analyzing software	1 set	For data processing and analy for broadband seismometer
Power Supply	• DC power supply: 1 • Isolation Transformer (5kVA): 1 • AVR (5kVA): 1 • Lead Acid Battery (65AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system

Basco Existing Seismic Observation Station			
Equipment	**Specification**	**Quantity**	**Purpose**
Satellite Transceiver	• Receive frequency: 10.95GHz to 11.7GHz • Transmit frequency: 14.0GHz to 14.5GHz • Receiving data rate: 32kbps at 1/2 FEC • Transmission Modulation: QPSK • Transmission data rate: 38.4kbps at 1/2 FEC rate • Receiving Demodulation: BPSK/QPSK	1 set	For transmitting observational data of short period seismic motion and communicating with the Head Office and the Mirror Center
Parabolic Antenna (1.8m) with Support structure	• Frequency range: 10.95 – 14.5GHz • Transmit gain : 46dBi at 14.25GHz	1 set	
Satellite GPS Timing System	• Synchronization of transmitted carrier frequency • Timing accuracy: 100 microseconds	1 set	For timing control of the satellite equipment and system by GPS signals
Satellite Seismic Data Recorder	• 6 channels • 24 bit AD converter , 200sps for each channel • Periodic logging of state of health information for performance analysis • Digital buffering: one day for six ADC inputs continuously sampled at 100Hertz	1 set	For recording observational data of short period seismic motion (3 components) to transmit through satellite communication system to the Head Office and the Mirror Center
Power Supply	• DC power supply: 1 • Charger Unit: 1 • Connection Terminal Switch: 1 • Isolation Transformer (5kVA): 1 • AVR (5kVA): 1 • Lead Acid Battery (420AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system

Buco Existing Volcano Observatory			
Equipment	**Specification**	**Quantity**	**Purpose**
Data Processing & Analyzing Unit	• Pentium IV 2GHz processor • 512 Mbytes Memory, 40Gbytes hard drive • CD-RW drive, DVD RAM, 17' LCD monitor • LAN interface: 10BASE-T/100BASE-TX • Data processing & analyzing software	2 sets	For seismic observational processing and analyzing as existing station
Peripheral Equipment	• Inkjet Printer (A4): 1 • Modem: 2 • Automatic Telephone Line Switch, Phone Line Protection, Fax Machine: 1 for each	1 set	For computing system
Communication Control Intelligent Switch	• Backbone LAN interface: IEEE802.3 Ethernet (CSMA/CD), 100Base-FX • LAN interface: 100Base-TX/10Base-T • Ethernet switching features: Store-and-forward	1 set	For data frame switching
T0=1sec Short Period Seismometer (3-compornent)	• Transducer type: Moving coil • Three-Component: east/west & north/south motions and vertical (up/down) short period motions • 0.5 - 20Hertz (period 2 - 0.05 seconds)	1 set	For observation of 3 components of short period seismic motion

Middle-period Seismic Sensor (3-component)	• Transducer type: force balance • 50 or longer seconds to 0.02 second (frequency range 0.02 to 50 Hertz)	1 set	For detecting low-frequency volcanic tremors associated with magmatic intrusion and ascent
Accelerometer (3 components)	• Transducer type: force balance orthogonally oriented • Three-Component: acceleration of seismic motions of east/west & north/south motions and vertical (up/down) • Maximum acceleration capability: 2G • Frequency range: DC to 50 Hertz • Seismic Intensity Indicating Function	1 set	For using in characterizing strong ground-motion site response in areas affected by large magnitude earthquakes
Data Recorder	• 6 channels, gain adjustable input amplifiers suitable for accepting the outputs of seismometer • 24 bit AD converter, 200sps for each channel • Removable solid state memory • Digital interface: 10 Base-T	3 sets	For digital data recording of 3 components of seismic motion
Drum Recorder	• Recording capacity: 24 hours/sheet of paper • Recording media: curvilinear ink pen • Seismic and pen amplifier input: differential or single-ended	3 set	For analog data recording of 3 components of seismic motion
GPS Timing System	• GPS signal syncronization • Timing accuracy for signal receiving: better than 100 microseconds	1 set	For timing control of the seismic equipment and system by GPS signals
Power Supply	• DC power supply: 1 • Power Distribution Board: 1 • Surge Diverter: 1 • UPS (1.0kVA): 2 • AVR (5kVA): 1 • Lead Acid Battery (65AH, 12V): 4	1 set	For uninterrupted and suitable power supply to the equipment and system

Equipment	Specification	Quantity	Purpose
PHIVOLCS Head Office			
Master Satellite Transceiver	• Receive frequency: 10.95GHz to 11.7GHz • Transmit frequency: 14.0GHz to 14.5GHz • Receiving data rate: 64kbps at 1/2 FEC • Transmission modulation: BPSK/QPSK • Transmission data rate: 38.4kbps at 1/2 FEC rate • Interface for connection with computers: 10BASE-T • Satellite Signal Frequency Analyzer	1 set	For communicating with all the unmanned seismic observation points in the seismic observation network and mirror center as Hub Center
Parabolic Antenna (3.8m) with Support structure	• Frequency range: 10.95 – 14.5GHz • Transmit gain : 53dBi at 14.25GHz	1 set	
Satellite GPS Timing System	• Synchronization of transmitted carrier frequency • Timing accuracy: 100 microseconds	1 set	For timing control of the satellite equipment and system by GPS signals
Satellite Communication Network Master Control Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 17’ color monitor • LAN interface: 10BASE-T/100BASE-TX • Satellite communication network control software	1 set	For controlling all the satellite communication systems at the unmanned seismic observation points as the Hub Center
Communication Control Intelligent Switch	• Backbone LAN interface: IEEE802.3 Ethernet (CSMA/CD), 100Base-FX • LAN interface: 100Base-TX/10Base-T • Ethernet switching features: Store-and-forward	1 set	For data frame switching
Data Archiving Server	• Pentium III 1.2GHz processor • 512 Mbytes memory, 80 Gbytes hard drive • CD-RW drive, DVD RAM, 17’ color monitor • LAN interface: 10BASE-T/100BASE-TX • Data archiving software	2 sets	For seismic observational data arching
Seismic Data Processing & Analyzing Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 21’ color monitor • LAN interface: 10BASE-T/100BASE-TX • Seismic data analysis & plotting software	1 set	For seismic data processing and analyzing

Deformation Data Analysis & Plotting Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 21' color monitor • LAN interface: 10BASE-T/100BASE-TX • Scientific data analysis and visualization software • Deformation data analysis & plotting software	1 set	For deformation data analyzing and plotting
Volcano Data Receiving Server	• Pentium III 1.2GHz processor • 512 Mbytes memory, 80 Gbytes hard drive • CD-RW drive, DVD RAM, 17' color monitor • LAN interface: 10BASE-T/100BASE-TX • Data storage software • Volcano data receiving software	1 set	For data receiving and serving
Volcano Waveform Data Analysis & Plotting Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 21' color monitor • LAN interface: 10BASE-T/100BASE-TX • Scientific data analysis and visualization software • Volcano waveform data analysis & plotting software	1 set	For volcano waveform data analyzing and plotting
Peripheral Equipment	• Laser Printer (A3), Inkjet Printer (A3): 1 for each • Scanner (A3): 2 • Plotter, Digitizer: 1 for each • Modem, Automatic Telephone Line Switch, Phone Line Protection: 1 for each	1 set	For the computing system
Power Supply	• Generator Change-over Switch: 1 • Isolation Transformer (10kVA): 1 • AVR (10kVA): 1 • Engine Generator (5kVA): 1 • UPS (1.0kVA): 4 • UPS (1.5kVA): 3	1 set	For uninterrupted and suitable power supply to the equipment and system

Quick Response Mobile System			
Seismic Sensors			
Equipment	**Specification**	**Quantity**	**Purpose**
T0=1sec Short Period Seismometer (Convertible Type, 3-compornent)	• Transducer type: Moving coil • Three-Component: east/west & north/south motions and vertical (up/down) short period motions • Convertible: horizontal and vertical (up/down) • Frequency range: 0.5 - 20Hertz (period 2 - 0.05 seconds)	30 sets	For either regional earthquake or volcano monitoring and for an emergency survey of two simultaneous crises (1 volcano related and one tectonic earthquake related)
T0=20sec Short Period Seismic Sensor (3-component)	• 3-component (Up-Down, North-South and East-West) • Transducer type: force balance (feedback type with automatic mass position adjustment) or equivalent • Three orthogonal components vertical, north/south and east/west • 20 or longer seconds to 0.02 second (frequency range 0.05 to 50 Hertz)	5 sets	For the effective detection of low-frequency volcanic quakes that indicate magma ascent
Accelerometer (3 components)	• Transducer type: force balance orthogonally oriented • Three-Component: acceleration of seismic motions of east/west & north/south motions and vertical (up/down) • Maximum acceleration capability - 2g • Frequency range: DC to 50 Hertz	10 sets	For using in characterizing strong ground-motion site response in areas affected by large magnitude earthquakes
Data Recorder	• 6 channels, gain adjustable input amplifiers suitable for accepting the outputs of seismometer • 24 bit AD converter, 200sps for each channel • Removable solid state memory • Digital interface: 10 Base-T • Waterproof	30 sets	For recording observational data of the mobile monitoring systems
GPS Timing System	• GPS signal syncronization • Timing accuracy for signal receiving: better than 100 microseconds	30 sets	For timing control of the seismic equipment and system by GPS signals
Tiltmeter	• Platform type with biaxial sensors, suitable for geophysical/volcanological application • Resolution: 0.1 microradian • Repeatability: 1 microradian (static) • Linearity: 2% of full span • Time Constant: 0.5 second • Switch-able gain (Hi & Low)	10 sets	For detecting minute shifts in ground angle or tilt, usually for determining intrusion of magma into the volcano edifice

	• Mounting: Three adjustable invar legs • Power supply: approximately 11 to 15Volts DC • Scale core: Ks = +0.05%/°C typical • Digital Tiltmeter Balance Unit (1 set for all)		
Tiltmeter Data Logger	• 9 channels • Data sample rate: 1sps for each channel • Removable solid state memory • Digital interface: 10 Base-T • Waterproof	10 sets	For recording observational data of the tiltmeter
Laptop Data Processing Unit for Tiltmeter	• Mobile Pentium III 1GHz processor • 256 Mbytes memory, 20Gbytes hard drive • CD-RW drive, DVD RAM, 14' color monitor • LAN interface: 10BASE-T/100BASE-TX • Data processing & analyzing software • Mobile Inkjet Printer (A4)	2 sets	For observational data of tiltmeter processing at a site
Mobile Satellite Transceiver	• Receive frequency: 10.95GHz to 11.7GHz • Transmit frequency: 14.0GHz to 14.5GHz • Receiving data rate: 32kbps at 1/2 FEC • Transmission Modulation: QPSK • Transmission data rate: 38.4kbps at 1/2 FEC rate • Receiving Demodulation: BPSK/QPSK	2 sets	For communicating with the Head Office Hub Center and the Mirror Center and for data transmission to the Head Office to interpret the data and make a collective decision for issuing the appropriate warnings
Parabolic Antenna (1.2m) with Support structure	• Frequency range: 10.95 – 14.5GHz • Transmit gain : 46dBi at 14.25GHz	2 sets	
Satellite GPS Timing System	• Synchronization of transmitted carrier frequency • Timing accuracy: 100 microseconds	2 sets	For timing control of the satellite equipment and system by GPS signals
Communication Control Intelligent Switch	• Backbone LAN interface: IEEE802.3 Ethernet (CSMA/CD), 100Base-FX • LAN interface: 100Base-TX/10Base-T • Ethernet switching features: Store-and-forward	1 set	For data frame switching
Mobile satellite Communication Laptop Data Processing Unit	• Mobile Pentium III 1GHz processor • 256 Mbytes memory, 20Gbytes hard drive • CD-RW drive, DVD RAM, 14' color monitor • LAN interface: 10BASE-T/100BASE-TX • Data processing & analyzing software	2 sets	For processing observational data from various quick response mobile monitoring systems deployed at critical sites during emergencies
Accessories	• Satellite Phone • SIM Card • Mobile Inkjet Printer (A4)	2 sets	For the mobile satellite communication data processing unit and for voice communication from anywhere
GPS Deformation Receiver Kit	• Tracking channels: 20 L1/L2 channels • High Precision • GPS groundplane antenna (Frequency GPS L1 and L2, antenna gain: 50dB)	10 sets	For determine horizontally-dominated movement along faults, either as fault creep or rapid movement along a fault plane and for detecting an accumulated strain over a large area even when no fault rupture has taken place
GPS Deformation Radio Communication Unit	• Transmission distance: 10km • Transmission data rate: 9,600bps (Digital) • Omni directional antenna	10 sets	
GPS Antenna/Receiver Tripod with Adapter	• Light weight, hand-carried type • Leg length extendable	10 sets	
GPS Antenna/Receiver Mount Pole	• Light weight, hand-carried type • RTK antenna	2 sets	
Receiver and Data Controller	• RTK GPS Data logging • Data exchange with GPS Deformation Processing & Analyzing Mobile Unit • Continuous RTK surveying feature • RS-232C, 38,400bps: 1 port	2 sets	For receiving and controlling observational data of GPS deformation system
10Base-T Real-time Converter	• Serial interface: RS-232C, 9,600bps: 1 • LAN interface: 10Base-T	10 sets	For converting from serial data to IP packets

Portable Battery with Charger for GPS Deformation System	• Input power: AC 220Volts, 60Hz • Output power: DC 10-36Volts • Battery capacity: 6AH	10 sets	For uninterrupted and suitable power supply to the equipment
GPS Deformation Processing & Analyzing Mobile Unit	• Mobile Pentium III 1GHz processor • 256 Mbytes memory, 20Gbytes hard drive • CD-RW drive, DVD RAM, 14' color monitor • LAN interface: 10BASE-T/100BASE-TX • GPS deformation processing & analyzing software	2 sets	For processing and analyzing observational data of GPS deformation system at a site
Power Supply	• AVR (5kVA): 2 • Generator Change-over Switch: 2 • Engine Generator (1kVA): 2	1 set	For uninterrupted and suitable power supply to the equipment and system
Mobile Carrying Case	• Weather-proof	For each system	For carrying the quick response mobile system

Quick Response Mobile System			
25 Sets of Data Communication Principle-I Systems			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	• Frequency range: 2.4GHz ISM band • Tx/Rx radio standard: IEEE802.11b • Transmission power: 10mW/MHz or less • Wire connection interface: 10 BASE-T • Supervising function of instruments health & setting	1 set	For transmitting and receiving observational data
High Gain Yagi Antenna	• Frequency range: 2.4GHz ISM band • Gain: 19 dBi • Portable Mast (3m)	1 set	
Communication Control Unit	• Interface: IEEE 802.3 Ethernet • Access method: CSMA/CD • Wire connection IF: 10Base-T	1 set	For data exchange and flow control
Power Supply	• Connection Terminal Switch: 2 • Solar Power Controller: 2 • Solar Panel (100W): 2 • Mobile Solar Panel Frame: 2 • Lead Acid Battery (140AH, 12V): 2	1 set	For uninterrupted and suitable power supply to the equipment and system
Mobile Carrying Case	• Weather-proof	For each system	For carrying the quick response mobile system

Quick Response Mobile System			
5 Sets of Data Communication Principle-II Systems			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	• Frequency range: 2.4GHz ISM band • Tx/Rx radio standard: IEEE802.11b • Transmission power: 10mW/MHz or less • Wire connection interface: 10 BASE-T • Supervising function of instruments health & setting	1 set	For transmitting and receiving observational data
High Gain Yagi Antenna	• Frequency range: 2.4GHz ISM band • Gain: 19 dBi • Portable Mast (3m)	1 set	
Communication Control Unit	• Interface: IEEE 802.3 Ethernet • Access method: CSMA/CD • Wire connection IF: 10Base-T	1 set	For data exchange and flow control
Uninterrupted Data Storage	• Internal data capacity: 1 week data of all 3-channel, 100sps continuous waveform data from 3 Volcano Array Observation Points • Input: Continuous 3-channel 100sps data in a compressed format from 3 Volcano Array Observation Points/a Volcano Observation Point • Digital interface: 10 Base-T	1 set	For receiving and saving volcano observational data transmitted by each unmanned observation point

Power Supply	• Connection Terminal Switch: 1 • DC Power Supply: 1 • Solar Power Controller: 1 • Solar Panel (150W): 1 • Lead Acid Battery (210AH, 12V): 1 • AVR (1kVA) • Generator Change-over Switch: 1 • Engine Generator (1kVA): 1	1 set	For uninterrupted and suitable power supply to the equipment and system
Laptop Mobile Data Receiving Server	• Mobile Pentium III 1GHz processor • 256 Mbytes memory, 20Gbytes hard drive • CD-RW drive, DVD RAM, 14' color monitor • LAN interface: 10BASE-T/100BASE-TX • Mobile data receiving software	1 set	For data receiving and storage at a site
Mobile Carrying Case	• Weather-proof	For each system	For carrying the quick response mobile system

Quick Response Mobile System			
10 Sets of Data Communication Repeater Systems			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	• Frequency range: 2.4GHz ISM band • Tx/Rx radio standard: IEEE802.11b • Transmission power: 10mW/MHz or less • Wire connection interface: 10 BASE-T • Supervising function of instruments health & setting	2 sets	For transmitting and receiving observational data
High Gain Yagi Antenna	• Frequency range: 2.4GHz ISM band • Gain: 19 dBi • Portable Mast (3m)	2 sets	
Communication Control Unit	• Interface: IEEE 802.3 Ethernet • Access method: CSMA/CD • Wire connection IF: 10Base-T	1 set	For data exchange and flow control
Power Supply	• Connection Terminal Switch: 2 • Solar Power Controller: 2 • Solar Panel (110W): 2 • Mobile Solar Panel Frame: 2 • Lead Acid Battery (150AH, 12V): 2	1 set	For uninterrupted and suitable power supply to the equipment and system
Mobile Carrying Case	• Weather-proof	For each system	For carrying the quick response mobile system

Quick Response Mobile System			
Instrumentation Tool Kit			
Equipment	**Specification**	**Quantity**	**Purpose**
Instrumentation Tool Kit	• High Gain Yagi Antenna • Antenna Tripod • Power ATT • Multimeter • Spectrum Analyzer • Personal Computer • Software Packages • Maintenance Tool • Carrying Case (weather-proof)	2 sets	For maintaining and setting the mobile spread spectrum data communication systems

Mt. Matutum and Mt. Parker Observation Network			
General Santos Existing Seismic Observation Station			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	• Frequency range: 2.4GHz ISM band • Tx/Rx radio standard: IEEE802.11b • Transmission power: 10mW/MHz or less • Wire connection interface: 10 BASE-T • Supervising function of instruments health & setting	2 sets	For transmitting and receiving observational data
High Gain Yagi Antenna	• Frequency range: 2.4GHz ISM band • Gain: 19 dBi	2 sets	
Multi Communication Control Unit	• Interface: IEEE 802.3 Ethernet • Access method: CSMA/CD • Wire connection IF: 10Base-T	1 set	For data exchange and flow control
Network Management Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 17' LCD monitor • LAN interface: 10BASE-T/100BASE-TX • Network supervising software • Network management software	1 set	For supervising and managing the volcano observation array network
Power Supply	• Connection Terminal Switch: 1 • Charger Unit: 1 • DC Power Supply: 1 • Isolation Transformer (5kVA): 1 • AVR (5kVA): 1 • UPS (1.0kVA): 3 • Generator Change-over Switch: 1 • Engine Generator (5kVA): 1 • Lead Acid Battery (420AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system
Uninterrupted Data Storage	• Internal data capacity: 1 week data of all 3-channel, 100sps continuous waveform data • Input: Continuous 3-channel 100sps data in a compressed format from a Volcano Observation Point • Digital interface: 10 Base-T	1 set	For receiving and saving volcano observational data transmitted by each unmanned volcano observation point
Drum Recorder	• Recording capacity: 24 hours/sheet of paper • Recording media: curvilinear ink pen • Seismic and pen amplifier input: differential or single-ended	2 set	For analog recording of volcano observational data transmitted by each unmanned volcano observation point
GPS Timing System	• GPS signal syncronization • Timing accuracy for signal receiving: better than 100 microseconds	1 set	For timing control of the seismic equipment and system by GPS signals
Volcano Data Archiving Server	• Pentium III 1.2GHz processor • 512 Mbytes memory, 80 Gbytes hard drive • CD-RW drive, DVD RAM, 17' LCD monitor • LAN interface: 10BASE-T/100BASE-TX • Volcano data archiving software	1 set	For volcano data archiving
Volcano Data Processing Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 17' LCD monitor • LAN interface: 10BASE-T/100BASE-TX • Volcano data processing software • Scientific data analysis and visualization software	1 set	For volcano data processing
Peripheral Equipment	• Inkjet Printer (A4): 1 • Modem, Automatic Telephone Line Switch, Phone Line Protection: 1 for each	1 set	For computing system
Guyed Mast	• 30m	1	For mounting spread spectrum high gain yagi antenna

Unmanned Volcano Observation Points of of Mt. Parker and Mt. Matutum Observation Networks			
Bagong Silang Observation Point (Mt. Parker) and Alnamang Observation Point (Mt. Matutum)			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	• Frequency range: 2.4GHz ISM band • Tx/Rx radio standard: IEEE802.11b • Transmission power: 10mW/MHz or less • Wire connection interface: 10 BASE-T • Supervising function of instruments health & setting	1 set	For transmitting and receiving observational data
High Gain Yagi Antenna	• Frequency range: 2.4GHz ISM band • Gain: 19 dBi	1 set	
Communication Control Unit	• Interface: IEEE 802.3 Ethernet • Access method: CSMA/CD • Wire connection IF: 10Base-T	1 set	For data exchange and flow control
Self Support Pole	**Mt. Parker**		For mounting spread spectrum high gain yagi antenna
	• Bagong Silang Observation Point: 4m	1	
	Mt. Matutum		
	• Alnamang Observation Point: 6m	1	
T0=1sec Short Period Seismometer (Convertible Type, 3-compornent)	• Transducer type: Moving coil • Three-Component: east/west & north/south motions and vertical (up/down) short period motions • Convertible: horizontal and vertical (up/down) • Pulse Calibrator • 0.5 - 20Hertz (period 2 - 0.05 seconds)	1 set	For observation of 3 components of short period seismic motion
Data Recorder	• 6 channels, gain adjustable input amplifiers suitable for accepting the outputs of seismometer • 24 bit AD converter, 200sps for each channel • Removable solid state memory • Digital interface: 10 Base-T	1 set	For digital data recording of 3 components of seismic motion
GPS Timing System	• GPS signal syncronization • Timing accuracy for signal receiving: better than 100 microseconds	1 set	For timing control of the seismic equipment and system by GPS signals
Power Supply	• Connection Terminal Switch: 1 • Solar Power Controller: 1 • Solar Panel (200W): 1 • Lead Acid Battery (280AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system

Unmanned Volcano Repeater Points of Mt. Parker and Mt. Matutum Observation Networks			
San Jose Repeater Point (Mt. Parker) Upper Klinan Repeater Point and Silway Repeater Point (Mt. Matutum)			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	• Frequency range: 2.4GHz ISM band • Tx/Rx radio standard: IEEE802.11b • Transmission power: 10mW/MHz or less • Wire connection interface: 10 BASE-T • Supervising function of instruments health & setting	2 sets	For transmitting and receiving observational data
High Gain Yagi Antenna	• Frequency range: 2.4GHz ISM band • Gain: 19 dBi	2 sets	
Communication Control Unit	• Interface: IEEE 802.3 Ethernet • Access method: CSMA/CD • Wire connection IF: 10Base-T	1 set	For data exchange and flow control
Self Support Pole	**Mt. Parker**		For mounting spread spectrum high gain yagi antenna
	• San Jose Repeater Point: 4m	1	
	Mt. Matutum		
	• Upper Klinan Repeater Point: 4m	1	
	• Silway Repeater Point: 4m	1	
Power Supply	• Connection Terminal Switch: 1 • Solar Power Controller: 1 • Solar Panel (180W): 1 • Lead Acid Battery (265AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system

PHIVOLCS Head Office			
Equipment	**Specification**	**Quantity**	**Purpose**
Spare Parts	・Data Modulation/Demodulation Module and Splitter & Combiner for Master/Mirror Satellite Transceiver, Satellite Seismic Data Recorder: 1 for each ・Satellite Communication Network Master Control Unit: 1 ・Solar Panel (100W), (110W), (150W), (180W): 1 for each ・High Gain Yagi Antenna: 2 ・Receiver Unit, Transmitter Unit, 10Base-T Interface Unit, Power Unit for Spread Spectrum Transceiver: 3 for each ・Surge Diverter: 1 ・Main Board for Data Recorder, Digitizing Board for Data Recorder, Power Board for Data Recorder: 6 for each ・T0=1sec Short Period Seismometer (3-compornent, convertible type): 3 ・Pulse Calibrator for Convertible Type Short Period Seismometer: 3	1 set	Necessary spare parts for all of the equipment in A-Package

PHIVOLCS Head Office			
Equipment	**Specification**	**Quantity**	**Purpose**
Vehicles	・Four-wheel drive (4WD) model pick-up truck vehicle ・Double Cab model seats five adults ・Diesel engine (Available type in the local market) ・Transmission type: 5-Speed Manual Transmission/Part-Time 4WD (5 speed manual floor shift, 2/4-wheel gear shifter)	3	For deployment of the Quick Response Mobile Monitoring Systems, together with heavy batteries, solar panels and ancillary equipment far from existing observatories or stations and for maintenance of the equipment

B-Package

Unmanned Seismic Observation Points			
Cagua, Abra, Apayao, Palanan, Cauayan, Baler, Bolinao, Sta. Cruz, Polilio, Lubang, Boac, Aurora, Virac, San Jose, Tablas, Busuanga, Cuyo Island, Guimaras, Ormoc, Catarman, Borongan, Maasin, Butuan, Ipil, Pagadian, Central Mindanao University, Mati, Bataraza and El Nido			
Equipment	**Specification**	**Quantity**	**Purpose**
Satellite Transceiver	・ Receive frequency: 10.95GHz to 11.7GHz ・ Transmit frequency: 14.0GHz to 14.5GHz ・ Receiving data rate: 32kbps at 1/2 FEC ・ Transmission Modulation: QPSK ・ Transmission data rate: 38.4kbps at 1/2 FEC rate ・ Receiving Demodulation: BPSK/QPSK	1 set	For transmitting observational data of short period seismic motion and communicating with the Head Office and the Mirror Center
Parabolic Antenna (1.8m) with Support structure	・ Frequency range: 10.95 – 14.5GHz ・ Transmit gain : 46dBi at 14.25GHz	1 set	
Satellite GPS Timing System	・ Synchronization of transmitted carrier frequency ・ Timing accuracy: 100 microseconds	1 set	For timing control of the satellite equipment and system by GPS signals
Satellite Seismic Data Recorder	・ 6 channels ・ 24 bit AD converter, 200sps for each channel ・ Digital interface: 10 Base-T ・ Periodic logging of state of health information for performance analysis ・ Digital buffering: one day for six ADC inputs continuously sampled at 100Hertz	1 set	For recording observational data of short period seismic motion (3 components) to transmit through satellite communication system to the Head Office and the Mirror Center
T0=1sec Short Period Seismometer (Convertible Type, 3-compornent)	・ Transducer type: Moving coil ・ Three-Component: east/west & north/south motions and vertical (up/down) short period motions ・ Convertible: horizontal and vertical (up/down) ・ 0.5 - 20Hertz (period 2 - 0.05 seconds)	1 set	For observation of 3 components of short period seismic motion
Power Supply	・ Connection Terminal Switch: 1 ・ Solar Power Controller: 1 ・ Solar Panel (380W): 1 ・ Lead Acid Battery (420AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system

Mt. Taal Array Observation Network Buco Existing Volcano Observatory			
Mt. Mayon Array Observation Network Mayon Existing Volcano Observatory			
Mt. Bulusan Array Observation Network Bulusan Existing Volcano Observatory			
Mt. Hibok-Hibok Array Observation Network Hibok-Hibok Existing Volcano Observatory			
Mt. Pinatubo Array Observation Network Pinatubo Existing Volcano Observatory			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	・ Frequency range: 2.4GHz ISM band ・ Tx/Rx radio standard: IEEE802.11b ・ Transmission power: 10mW/MHz or less ・ Wire connection interface: 10 BASE-T ・ Supervising function of instruments health & setting	2 sets	For transmitting and receiving observational data
High Gain Yagi Antenna	・ Frequency range: 2.4GHz ISM band ・ Gain: 19 dBi	2 sets	
Multi Communication Control Unit	・ Interface: IEEE 802.3 Ethernet ・ Access method: CSMA/CD ・ Wire connection IF: 10Base-T	1 set	For data exchange and flow control

Network Management Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 17' LCD monitor • LAN interface: 10BASE-T/100BASE-TX • Network supervising software • Network management software	1 set	For supervising and managing the volcano observation array network
Power Supply	• Connection Terminal Switch: 1 • Charger Unit: 1 • DC Power Supply: 1 • Isolation Transformer (5kVA): 1 • AVR (5kVA): 1 • UPS (1.0kVA): 3 • Generator Change-over Switch: 1 • Engine Generator (5kVA): 1 • Lead Acid Battery (420AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system
Uninterrupted Data Storage	• Internal data capacity: 1 week data of all 3-channel, 100sps continuous waveform data from 3 Volcano Array Observation Points • Input: Continuous 3-channel 100sps data in a compressed format from 3 Volcano Array Observation Points • Digital interface: 10 Base-T	1 set	For receiving and saving volcano observational data transmitted by each unmanned volcano observation point
Drum Recorder	• Recording capacity: 24 hours/sheet of paper • Recording media: curvilinear ink pen • Seismic and pen amplifier input: differential or single-ended	3 set	For analog recording of volcano observational data transmitted by each unmanned volcano observation point
GPS Timing System	• GPS signal syncronization • Timing accuracy for signal receiving: better than 100 microseconds	1 set	For timing control of the seismic equipment and system by GPS signals
Volcano Data Archiving Server	• Pentium III 1.2GHz processor • 512 Mbytes memory, 80 Gbytes hard drive • CD-RW drive, DVD RAM, 17' LCD monitor • LAN interface: 10BASE-T/100BASE-TX • Volcano data archiving software	1 set	For volcano data archiving
Volcano Data Processing Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 17' LCD monitor • LAN interface: 10BASE-T/100BASE-TX • Volcano data processing software • Scientific data analysis and visualization software	1 set	For volcano data processing
Peripheral Equipment	• Inkjet Printer (A4): 1 • Modem, Automatic Telephone Line Switch, Phone Line Protection: 1 for each	1 set	For computing system
Self Support Pole	**Mt. Taal Array Observation Network**		For mounting spread spectrum high gain yagi antenna
	• Buco Existing Volcano Observatory: 4m	1	
	Mt. Mayon Array Observation Network		
	• Mayon Existing Volcano Observatory: 2m	1	
	Mt. Bulusan Array Observation Network		
	• Bulusan Existing Volcano Observatory: 4m	1	
	Mt. Hibok-Hibok Array Observation Network		
	• Hibok-Hibok Existing Volcano Observatory: 4m	1	
	Mt. Pinatubo Array Observation Network		
	• Pinatubo Existing Volcano Observatory: 10m	1	

Mt. Kanlaon Array Observation Network Kanlaon Existing Volcano Observatory			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	• Frequency range: 2.4GHz ISM band • Tx/Rx radio standard: IEEE802.11b • Transmission power: 10mW/MHz or less • Wire connection interface: 10 BASE-T • Supervising function of instruments health & setting	3 sets	For transmitting and receiving observational data
High Gain Yagi Antenna	• Frequency range: 2.4GHz ISM band • Gain: 19 dBi	3 sets	

Multi Communication Control Unit	• Interface: IEEE 802.3 Ethernet • Access method: CSMA/CD • Wire connection IF: 10Base-T	1 set	For data exchange and flow control
Network Management Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 17' LCD monitor • LAN interface: 10BASE-T/100BASE-TX • Network supervising software • Network management software	1 set	For supervising and managing the volcano observation array network
Power Supply	• Connection Terminal Switch: 1 • Charger Unit: 1 • DC Power Supply: 1 • Isolation Transformer (5kVA): 1 • AVR (5kVA): 1 • UPS (1.0kVA): 3 • Generator Change-over Switch: 1 • Engine Generator (5kVA): 1 • Lead Acid Battery (420AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system
Uninterrupted Data Storage	• Internal data capacity: 1 week data of all 3-channel, 100sps continuous waveform data from 3 Volcano Array Observation Points • Input: Continuous 3-channel 100sps data in a compressed format from 3 Volcano Array Observation Points/a Volcano Observation Point • Digital interface: 10 Base-T	1 set	For receiving and saving volcano observational data transmitted by each unmanned volcano observation point
Drum Recorder	• Recording capacity: 24 hours/sheet of paper • Recording media: curvilinear ink pen • Seismic and pen amplifier input: differential or single-ended	3 set	For analog recording of volcano observational data transmitted by each unmanned volcano observation point
GPS Timing System	• GPS signal syncronization • Timing accuracy for signal receiving: better than 100 microseconds	1 set	For timing control of the seismic equipment and system by GPS signals
Volcano Data Archiving Server	• Pentium III 1.2GHz processor • 512 Mbytes memory, 80 Gbytes hard drive • CD-RW drive, DVD RAM, 17' LCD monitor • LAN interface: 10BASE-T/100BASE-TX • Volcano data archiving software	1 set	For volcano data archiving
Volcano Data Processing Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 17' LCD monitor • LAN interface: 10BASE-T/100BASE-TX • Volcano data processing software • Scientific data analysis and visualization software	1 set	For volcano data processing
Peripheral Equipment	• Inkjet Printer (A4): 1 • Modem, Automatic Telephone Line Switch, Phone Line Protection: 1 for each	1 set	For computing system
Self Support Pole	**Mt. Kanlaon Array Observation Network**		For mounting spread spectrum high gain yagi antenna
	• Kanlaon Existing Volcano Observatory: 10m	1	

Mt. Taal Array Observation Network Binintiang Munti Hill Observation Point, Taal Main Crater Observation Point and Calauit Observation Point			
Mt. Mayon Array Observation Network Upper Anoling Observation Point, Upper Santa Misirecordia Observation Point and Mayon Rest House Observatory			
Mt. Bulusan Array Observation Network Upper Inlagadian Hill Observation Point, Upper Mayonpayong Hill Observation Point and Upper San Roque Observation Point			
Mt. Hibok-Hibok Array Observation Network Mt. Vulcan Peak Observation Point, Upper Slope Observation Point and Mainit Observation Point			
Mt. Kanlaon Array Observation Network Santo-Bama Observation Point, Canlaon District Hospital Observation Point and Manghumay Observation Point			
Mt. Pinatubo Array Observation Network CRAZ Observation Point and FNGZ Observation Point			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	・ Frequency range: 2.4GHz ISM band ・ Tx/Rx radio standard: IEEE802.11b ・ Transmission power: 10mW/MHz or less ・ Wire connection interface: 10 BASE-T ・ Supervising function of instruments health & setting	1 set	For transmitting and receiving observational data
High Gain Yagi Antenna	・ Frequency range: 2.4GHz ISM band ・ Gain: 19 dBi	1 set	
Communication Control Unit	・ Interface: IEEE 802.3 Ethernet ・ Access method: CSMA/CD ・ Wire connection IF: 10Base-T	1 set	For data exchange and flow control
T0=1sec Short Period Seismometer (Convertible Type, 3-compornent)	・ Transducer type: Moving coil ・ Three-Component: east/west & north/south motions and vertical (up/down) short period motions ・ Convertible: horizontal and vertical (up/down) ・ 0.5 - 20Hertz (period 2 - 0.05 seconds)	1 set	For observation of 3 components of short period seismic motion
Data Recorder	・ 6 channels, gain adjustable input amplifiers suitable for accepting the outputs of seismometer ・ 24 bit AD converter, 200sps for each channel ・ Removable solid state memory ・ Digital interface: 10 Base-T	1 set	For digital data recording of 3 components of seismic motion
GPS Timing System	・ GPS signal syncronization ・ Timing accuracy for signal receiving: better than 100 microseconds	1 set	For timing control of the seismic equipment and system by GPS signals
Power Supply	・ Connection Terminal Switch: 1 ・ Solar Power Controller: 1 ・ Solar Panel (200W): 1 ・ Lead Acid Battery (280AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system
Self Support Pole	**Mt. Taal Array Observation Network**		For mounting spread spectrum high gain yagi antenna
	・ Binintiang Munti Hill Observation Point: 2m	1	
	・ Taal Main Crater Observation Point: 2m	1	
	・ Calauit Observation Point: 2m	1	
	Mt. Mayon Array Observation Network		
	・ Upper Anoling Observation Point: 2m	1	
	・ Upper Santa Misirecordia Observation Point: 2m	1	
	・ Mayon Rest House Observatory: 6m	1	
	Mt. Bulusan Array Observation Network		
	・ Upper Inlagadian Hill Observation Point: 4m	1	
	・ Upper Mayonpayong Hill Observation Point: 4m	1	
	Mt. Hibok-Hibok Array Observation Network		
	・ Mt. Vulcan Peak Observation Point: 2m	1	
	・ Upper Slope Observation Point: 2m	1	
	・ Mainit Observation Point:4m	1	
	Mt. KanlaonArray Observation Network		
	・ Santo-Bama Observation Point: 2m	1	
	・ Canlaon District Hospital Observation Point: 2m	1	
	・ Manghumay Observation Point: 10m	1	
	Mt. Pinatubo Observation Network		
	・ CRAZ Observation Point: 6m	1	

	• FNGZ Observation Point: 6m	1
Guyed Mast	**Mt. Mayon Array Observation Network**	
	• Upper San Roque Observation Point: 20m	1

Mt. Pinatubo Array Observation Network PI2Z Observation & Repeater Point			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	• Frequency range: 2.4GHz ISM band • Tx/Rx radio standard: IEEE802.11b • Transmission power: 10mW/MHz or less • Wire connection interface: 10 BASE-T • Supervising function of instruments health & setting	2 sets	For transmitting and receiving observational data
High Gain Yagi Antenna	• Frequency range: 2.4GHz ISM band • Gain (Isopropic): 19 dBi	2 sets	
Communication Control Unit	• Interface: IEEE 802.3 Ethernet • Access method: CSMA/CD • Wire connection IF: 10Base-T	1 set	For data exchange and flow control
T0=1sec Short Period Seismometer (Convertible Type, 3-compornent)	• Transducer type: Moving coil • Three-Component: east/west & north/south motions and vertical (up/down) short period motions • Convertible: horizontal and vertical (up/down) • 0.5 - 20Hertz (period 2 - 0.05 seconds)	1 set	For observation of 3 components of short period seismic motion
Data Recorder	• 6 channels, gain adjustable input amplifiers suitable for accepting the outputs of seismometer • 24 bit AD converter, 200sps for each channel • Removable solid state memory • Digital interface: 10 Base-T	1 set	For digital data recording of 3 components of seismic motion
GPS Timing System	• GPS signal syncronization • Timing accuracy for signal receiving: better than 100 microseconds	1 set	For timing control of the seismic equipment and system by GPS signals
Power Supply	• Connection Terminal Switch: 1 • Solar Power Controller: 1 • Solar Panel (230W): 1 • Lead Acid Battery (335AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system
Self Support Pole	**Mt. Pinatubo Observation Network**		For mounting spread spectrum high gain yagi antenna
	• PI2Z Observation & Repeater Point: 6m	1	

Mt. Taal Array Observation Network Daan Kastila Repeater Point and Tagbakin Repeater Point			
Mt. Mayon Array Observation Network Tabaco Municipal Building Repeater Point and Mt. Bariw Repeater Point			
Mt. Bulusan Array Observation Network Salvacion Slope Repeater Point			
Mt. Hibok-Hibok Array Observation Network Napo Repeater Point, Baylao Repeater Point and Lawigan Repeater Point			
Mt. Kanlaon Array Observation Network Calvary Hill Repeater Point, Mansalanao Hill Repeater Point and Pinamintigan Hill Repeater Point			
Mt. Pinatubo Array Observation Network ODNZ Repeater Point, Malasa Repeater Point, Tarukan Repeater Point, Nabuklod Repeater Point, Porac Repeater Point and Sapang Bato Repeater Point			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	• Frequency range: 2.4GHz ISM band • Tx/Rx radio standard: IEEE802.11b • Transmission power: 10mW/MHz or less • Wire connection interface: 10 BASE-T • Supervising function of instruments health & setting	2 sets	For transmitting and receiving observational data
High Gain Yagi Antenna	• Frequency range: 2.4GHz ISM band • Gain: 19 dBi	2 sets	

Communication Control Unit	• Interface: IEEE 802.3 Ethernet • Access method: CSMA/CD • Wire connection IF: 10Base-T	1 set	For data exchange and flow control
Power Supply	• Connection Terminal Switch: 1 • Solar Power Controller: 1 • Solar Panel (180W): 1 • Lead Acid Battery (265AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system
Self Support Pole	**Mt. Taal Array Observation Network**		For mounting spread spectrum high gain yagi antenna
	• Daan Kastila Repeater Point: 4m	1	
	• Tagbakin Repeater Point: 4m	1	
	Mt. Mayon Array Observation Network		
	• Tabaco Municipal Building Repeater Point: 2m	1	
	• Mt. Bariw Repeater Point: 4m	1	
	Mt. Bulusan Array Observation Network		
	• Salvacion Slope Repeater Point: 6m	1	
	Mt. Hibok-Hibok Array Observation Network		
	• Napo Repeater Point: 6m	1	
	• Baylao Repeater Point: 4m	1	
	Mt. KanlaonArray Observation Network		
	• Calvary Hill Repeater Point: 4m	1	
	• Mansalanao Hill Repeater Point: 4m	1	
	• Pinamintigan Hill Repeater Point: 2m	1	
	Mt. Pinatubo Observation Network		
	• ODNZ Repeater Point: 6m	1	
	• Malasa Repeater Point: 6m	1	
	• Tarukan Repeater Point: 6m	1	
	• Nabuklod Repeater Point: 6m	1	
	• Porac Repeater Point: 6m	1	
	• Sapang Bato Repeater Point: 6m	1	
Guyed Mast	**Mt. Hibok-Hibok Array Observation Network**		
	• Lawigan Repeater Point: 30m	1	

Mt. Taal Array Observation Network Napayung Repeater Point			
Mt. Mayon Array Observation Network Upper Santo Domingo Repeater Point			
Mt. Bulusan Array Observation Network Mt. Jormajam Repeater Point			
Mt. Hibok-Hibok Array Observation Network Mt. Vulcan Peak Repeater Point			
Equipment	**Specification**	**Quantity**	**Purpose**
Spread Spectrum Transceiver	• Frequency range: 2.4GHz ISM band • Tx/Rx radio standard: IEEE802.11b • Transmission power: 10mW/MHz or less • Wire connection interface: 10 BASE-T • Supervising function of instruments health & setting	3 sets	For transmitting and receiving observational data
High Gain Yagi Antenna	• Frequency range: 2.4GHz ISM band • Gain: 19 dBi	3 sets	
Communication Control Unit	• Interface: IEEE 802.3 Ethernet • Access method: CSMA/CD • Wire connection IF: 10Base-T	1 set	For data exchange and flow control
Power Supply	• Connection Terminal Switch: 1 • Solar Power Controller: 1 • Solar Panel (220W): 1 • Lead Acid Battery (315AH, 12V): 1	1 set	For uninterrupted and suitable power supply to the equipment and system
Self Support Pole	**Mt. Taal Array Observation Network**		For mounting spread spectrum high gain yagi antenna
	• Napayung Repeater Point: 10m	1	
	Mt. Mayon Array Observation Network		
	• Upper Santo Domingo Repeater Point: 15m	1	
	Mt. Bulusan Array Observation Network		
	• Mt. Jormajam Repeater Point: 15m	1	
	Mt. Hibok-Hibok Array Observation Network		
	• Mt. Vulcan Peak Repeater Point: 2m	1	

Mirror Center			
Tagaytay Existing Seismic Observation Station			
Equipment	**Specification**	**Quantity**	**Purpose**
Mirror Satellite Transceiver	• Receive frequency: 10.95GHz to 11.7GHz • Transmit frequency: 14.0GHz to 14.5GHz • Receiving data rate: 64kbps at 1/2 FEC • Transmission modulation: BPSK/QPSK • Transmission data rate: 38.4kbps at 1/2 FEC rate • Interface for connection with computers: 10BASE-T • Satellite Signal Frequency Analyzer	1 set	For communicating with all the unmanned seismic observation points in the seismic observation network as the Mirror Center
Parabolic Antenna (3.8m) with Support structure	• Frequency range: 10.95 – 14.5GHz • Transmit gain : 53dBi at 14.25GHz	1 set	
Satellite GPS Timing System	• Synchronization of transmitted carrier frequency • Timing accuracy: 100 microseconds	1 set	For timing control of the satellite equipment and system by GPS signals
Satellite Communication Network Mirror Control Unit	• Pentium IV 2GHz processor • 512 Mbytes memory, 40 Gbytes hard drive • CD-RW drive, DVD RAM, 17' color monitor • LAN interface: 10BASE-T/100BASE-TX • Satellite communication network control software	1 set	For controlling all the unmanne seismic observation points in th seismic observation network as Head Office Mirror Center
Communication Control Intelligent Switch	• Backbone LAN interface: IEEE802.3 Ethernet (CSMA/CD), 100Base-FX • LAN interface: 100Base-TX/10Base-T • Ethernet switching features: Store-and-forward	1 set	For data frame switching
Data Archiving Server	• Pentium III 1.2GHz processor • 512 Mbytes memory, 80 Gbytes hard drive • CD-RW drive, DVD RAM, 17' color monitor • LAN interface: 10BASE-T/100BASE-TX • Data archiving software	2 sets	For seismic observational data archiving
Peripheral Equipment	• Inkjet Printer (A4): 1	1 set	For computing system
Power Supply	• Generator Change-over Switch: 1 • Isolation Transformer (5kVA): 1 • AVR (5kVA): 1 • Engine Generator (5kVA): 1 • UPS (1.0kVA): 1 • UPS (1.5kVA): 2	1 set	For uninterrupted and suitable power supply to the equipment and system

PHIVOLCS Head Office			
Equipment	**Specification**	**Quantity**	**Purpose**
Spare Parts	• Data Modulation/Demodulation Module and Splitter & Combiner for Master/Mirror Satellite Transceiver: 1 for each • Satellite Seismic Data Recorder: 3 • Satellite Communication Network Master Control Unit: 1 • Satellite Transceiver for Unmanned Observation Points: 3 • Satellite GPS Timing System: 3 • Solar Panel (100W) (110W) (150W): 3 for each • Solar Panel (180W): 2 • High Gain Yagi Antenna: 2 • Receiver Unit, Transmitter Unit, 10Base-T Interface Unit, Power Unit for Spread Spectrum Transceiver: 3 for each • Main Board for Data Recorder, Digitizing Board for Data Recorder, Power Board for Data Recorder: 5 for each • T0=1sec Short Period Seismometer (3-compornent, convertible type), Pulse Calibrator for Convertible Type Short Period Seismometer: 2 for each	1 set	Necessary spare parts for all of the equipment in B-Package

All the specifications describe minimum requirements of each component.

2-2-3 Basic Design Drawing

The basic design drawings of the Project Phase II are as follows.

Unmanned Seismic Observation Points

- Site Development Plan, Vicinity Map and Location Map of Proposed Sta. Cruz Seismic Observation Point 1/24
- Site Development Plan, Vicinity Map, Elevation Showing Slope and Location Map of Proposed Boac Marinduque Seismic Observation Point 2/24
- Site Development Plan, Vicinity Map, Elevation Showing Slope and Location Map of Proposed Borongan, Eastern Samar Seismic Observation Point 3/24
- Site Development Plan, Vicinity Map and Location Map of Proposed Ormoc Seismic Observation Point 4/24
- Site Development Plan, Vicinity Map, Sectional Elevation Showing Slope and Location Map of Proposed Odiongan Romblon Seismic Observation Point 5/24
- Site Development Plan, Vicinity Map and Location Map of Proposed San Jose Seismic Observation Point 6/24

- Site Development Plan, Vicinity Map, Elevation Showing Slope and Location Map of Proposed El Nido Seismic Observation Point 7/24

Taal Volcano Array Observation Network

Taal Observation & Repeater Points 8 and 9/24

Mayon Volcano Array Observation Network

Mayon Observation & Repeater Points 10 and 11/24

Bulusan Volcano Array Observation Network

Bulusan Observation & Repeater Points 12 and 13/24

Kanlaon Volcano Array Observation Network

Kanlaon Observation & Repeater Points 14, 15 and 16/24

Hibok-Hibok Volcano Array Observation Network

Hibok-Hibok Observation & Repeater Points 17 and 18/24

Pinatubo Volcano Array Observation Network

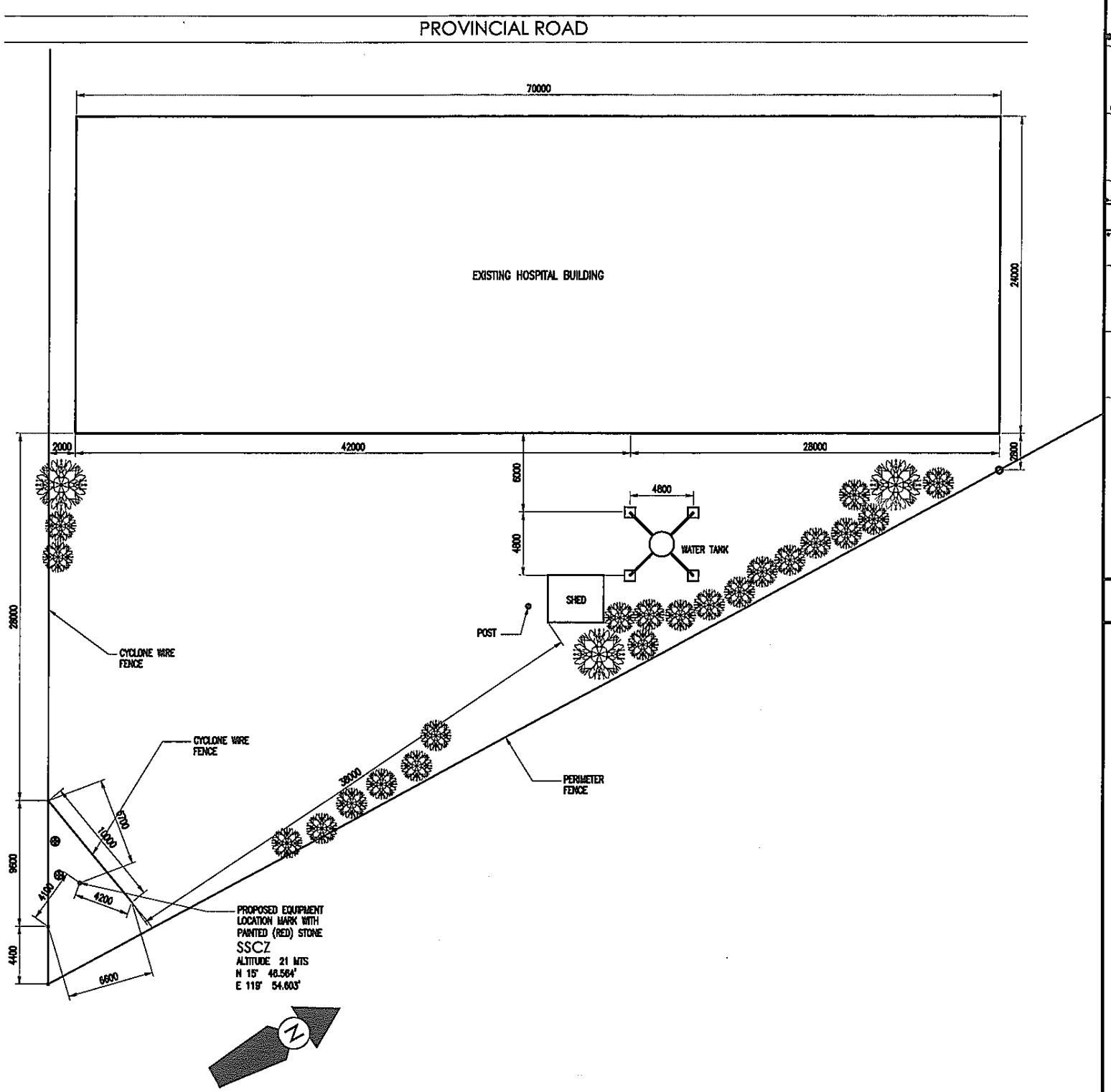
Pinatubo Observation & Repeater Points 19/24

PHIVOLCD Head Office (VSAT Parabolic Antenna)

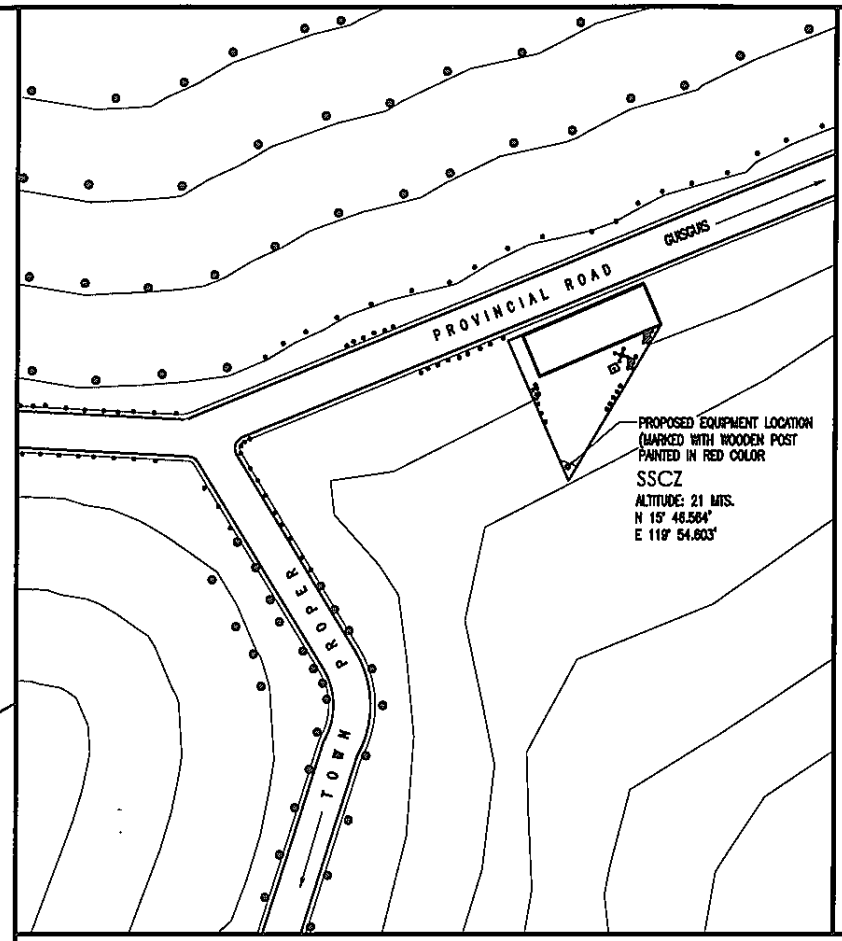
Site Development Communication Cable & Power Cable Layout	20/24
Ground Floor Communication Cable & Power Cable Layout	21/24
First Floor Communication Cable Layout	22/24
Second Floor Communication Cable Layout	23/24
Third Floor Communication Cable Layout	24/24

Civil Work

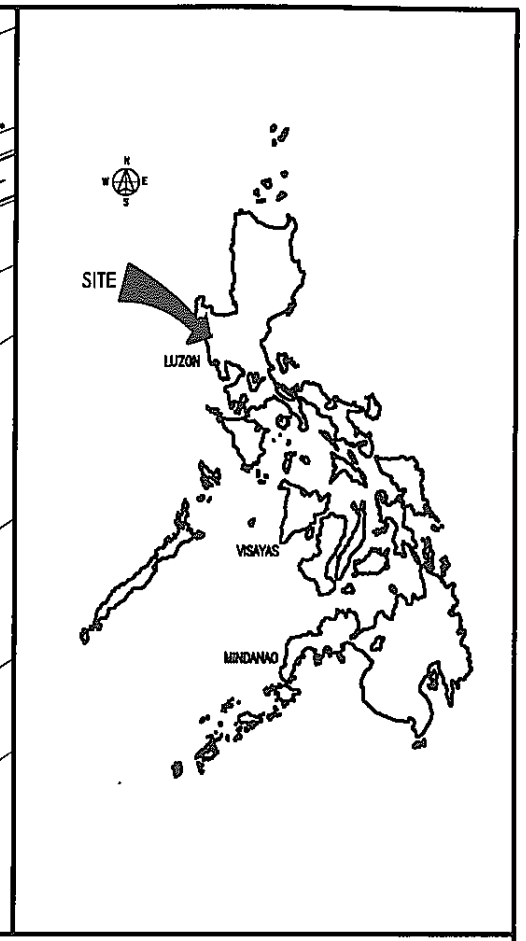
• Short Period Sensor Shelter (Plans, Elevations and Sections)	C-01
• Broadband Sensor Shelter (Plans, Elevations and Sections)	C-02
• Repeater Shelter (Plans, Elevations and Sections)	C-03



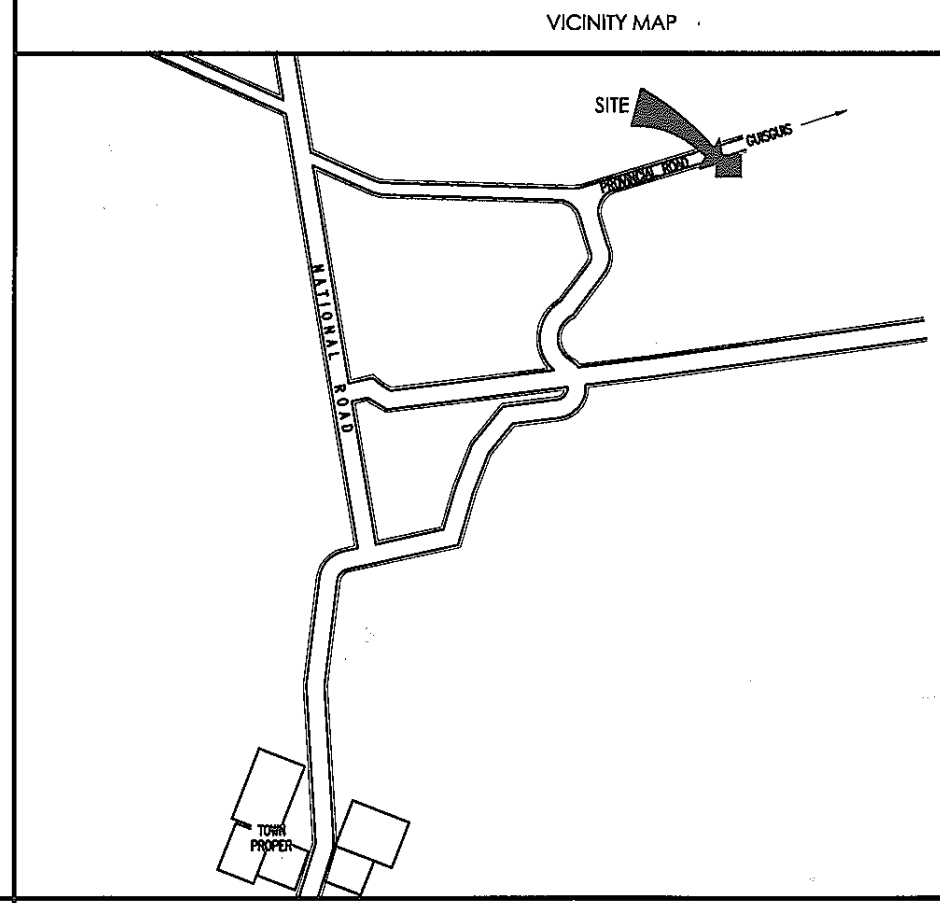
SITE DEVELOPMENT PLAN



VICINITY MAP



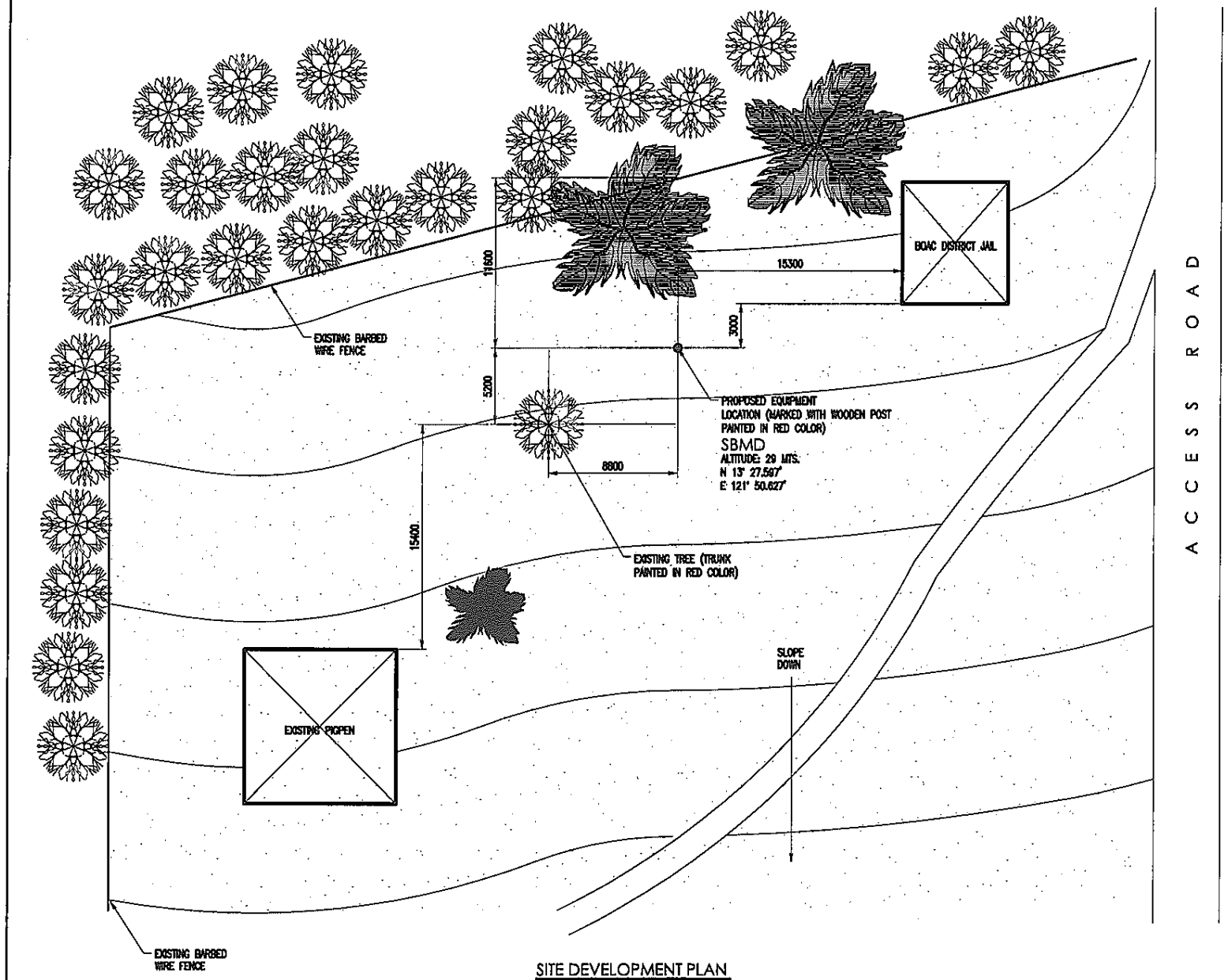
VICINITY MAP



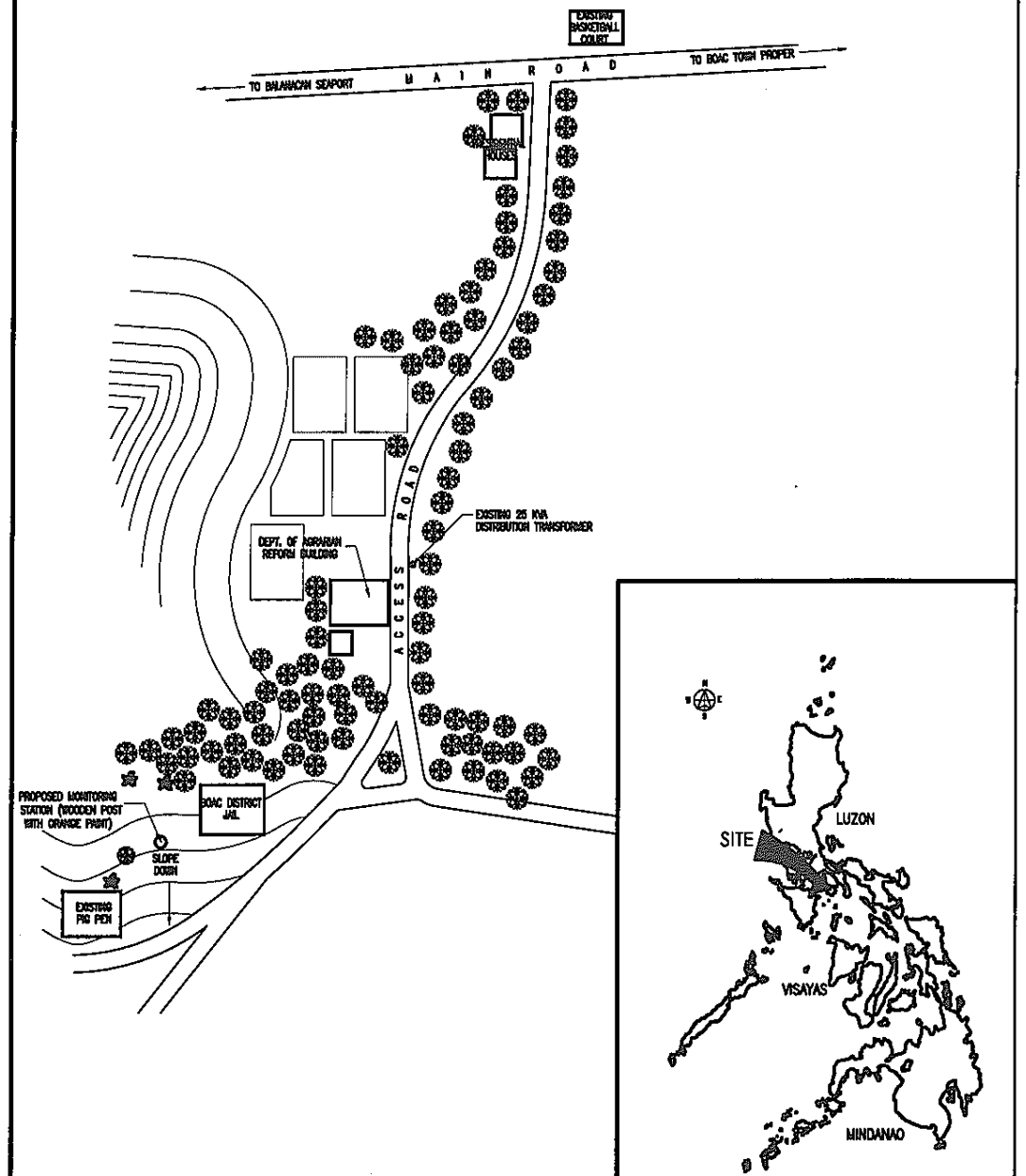
LOCATION MAP

Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

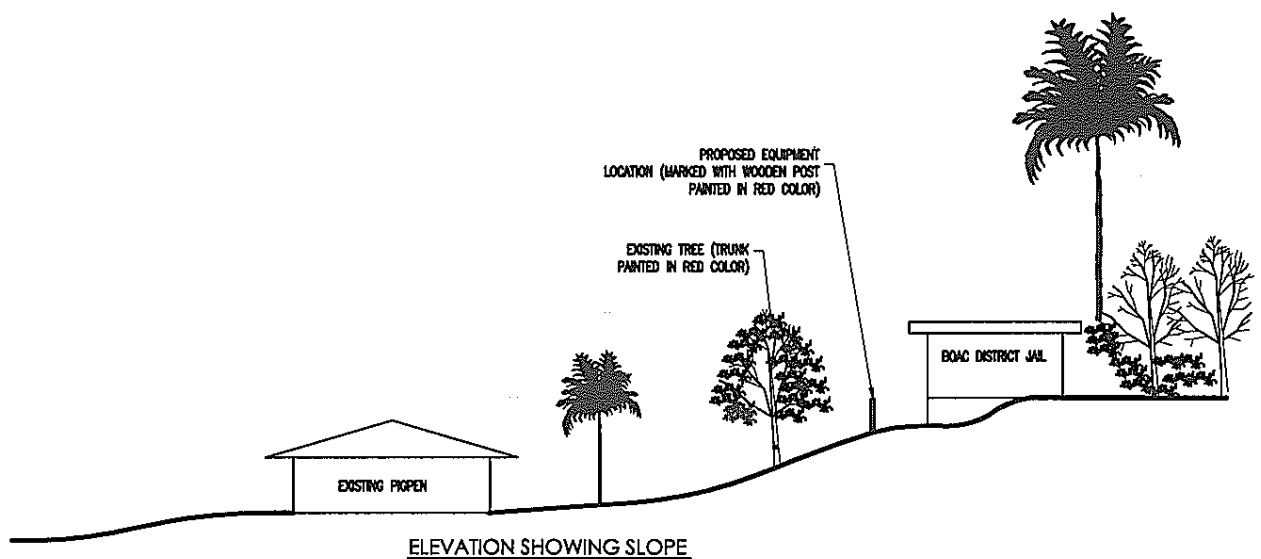
PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED STA. CRUZ OBSERVATION POINT LOCATION : OSPITAL NG STA. CRUZ, BARANGAY POBLACION NORTH, STA. CRUZ, ZAMBALES	SITE DEVELOPMENT PLAN VICINITY MAP LOCATION MAP	1/24



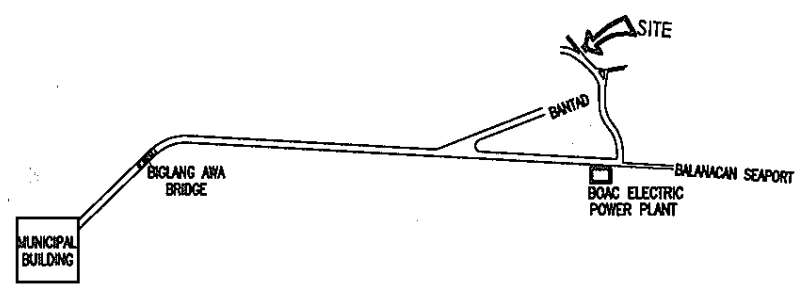
SITE DEVELOPMENT PLAN



VICINITY MAP



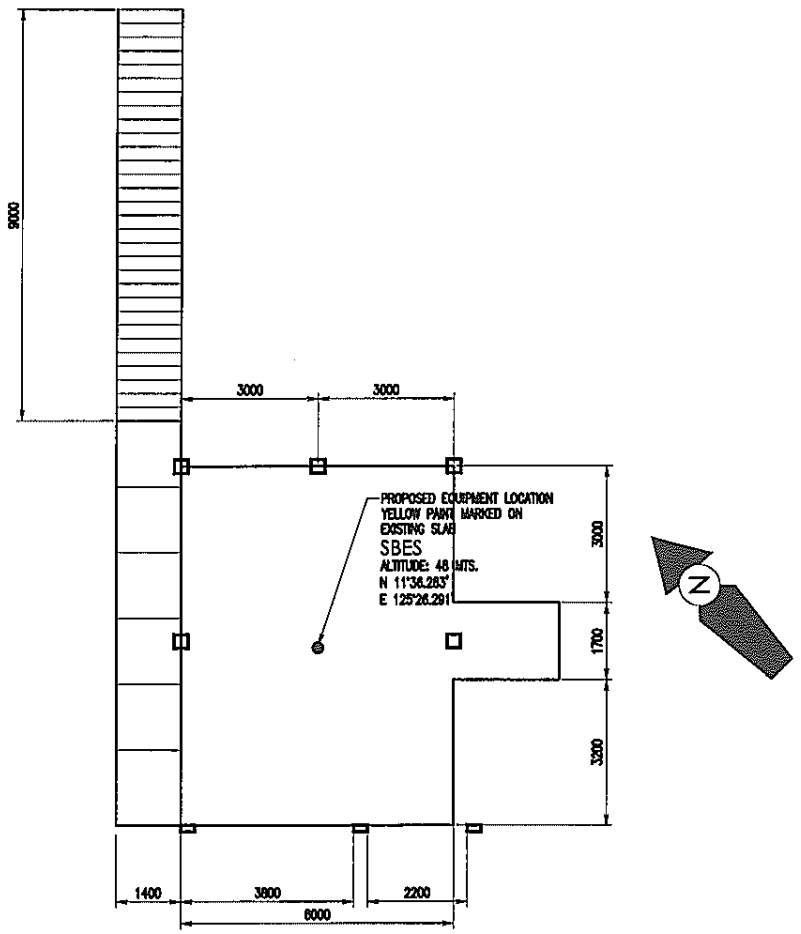
ELEVATION SHOWING SLOPE



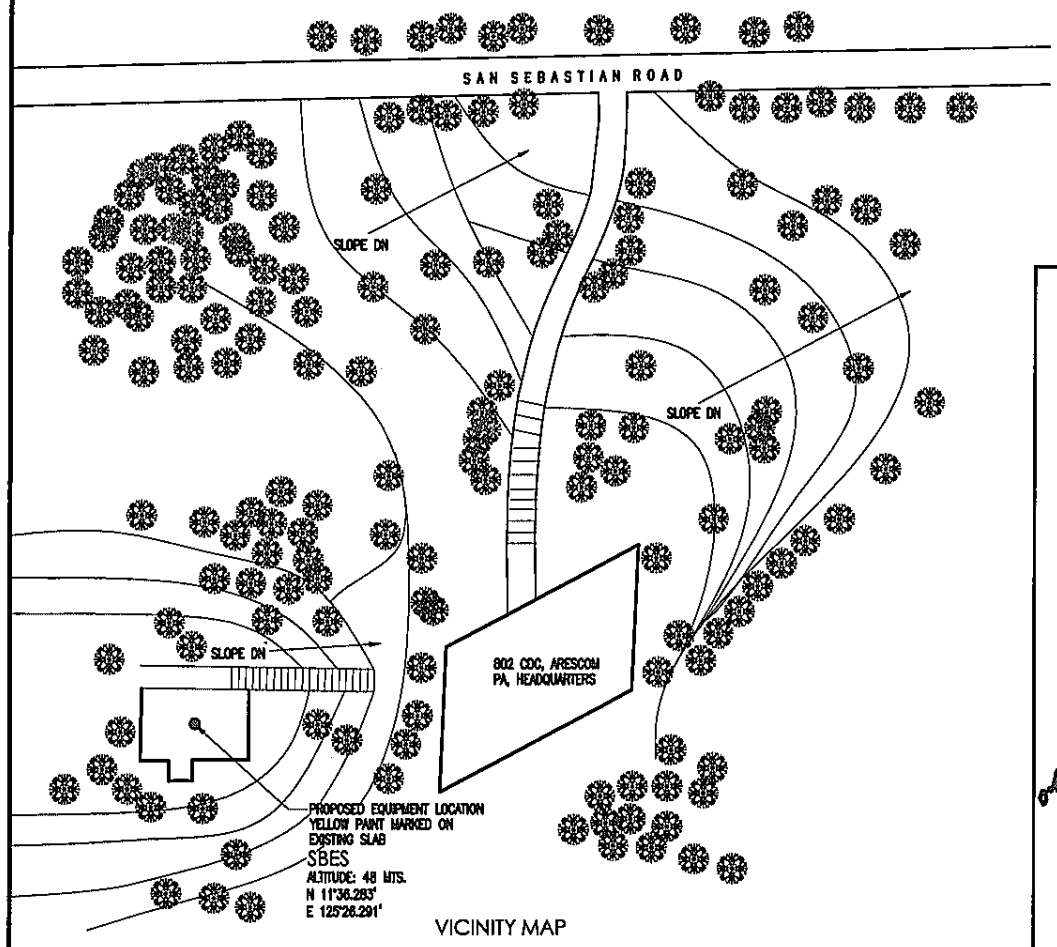
LOCATION MAP

Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

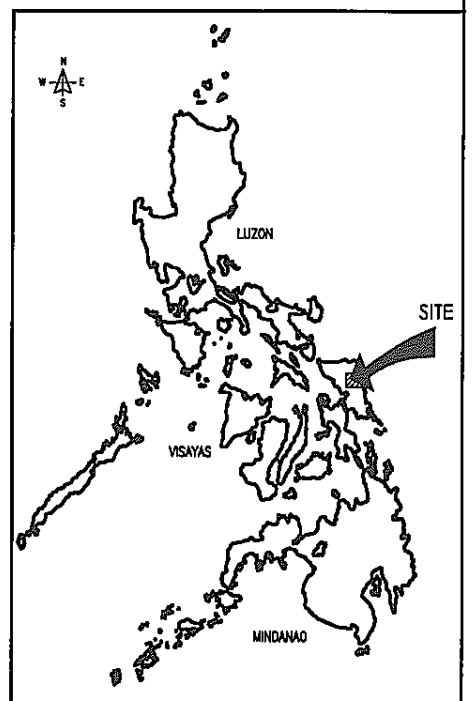
PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED BOAC MARINDUQUE OBSERVATION POINT LOCATION : BOAC DISTRICT JAIL BARANGAY TANZA, BOAC MARINDIQUE	SITE DEVELOPMENT PLAN ELEVATION LOCATION MAP	2/24

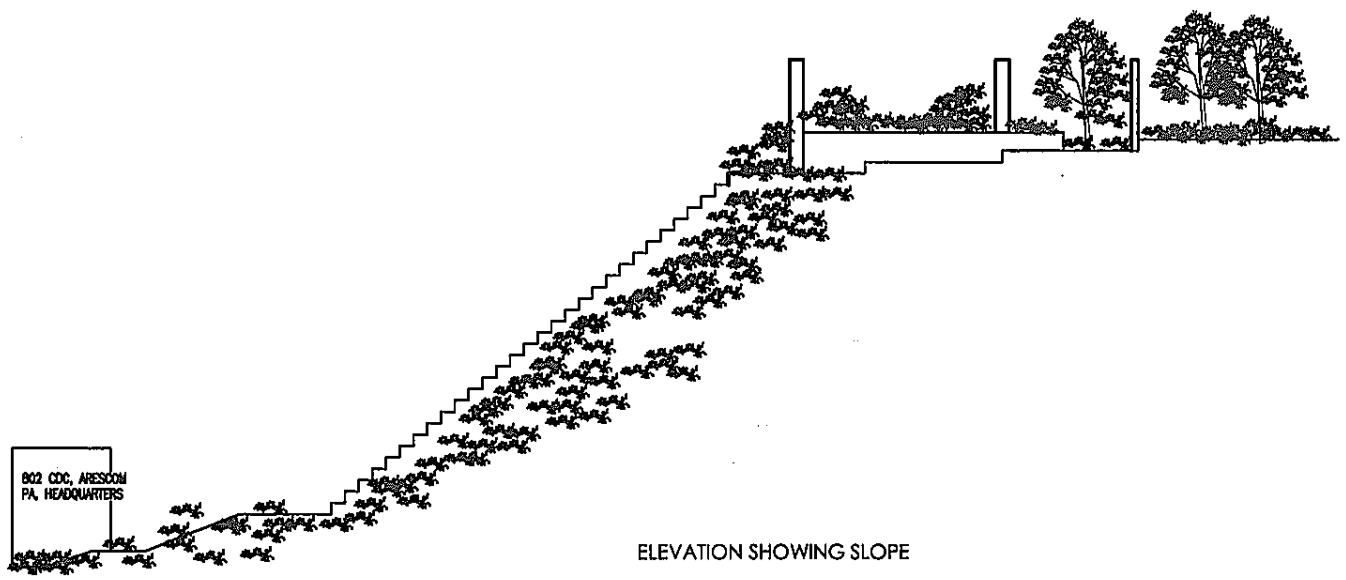


SITE DEVELOPMENT PLAN

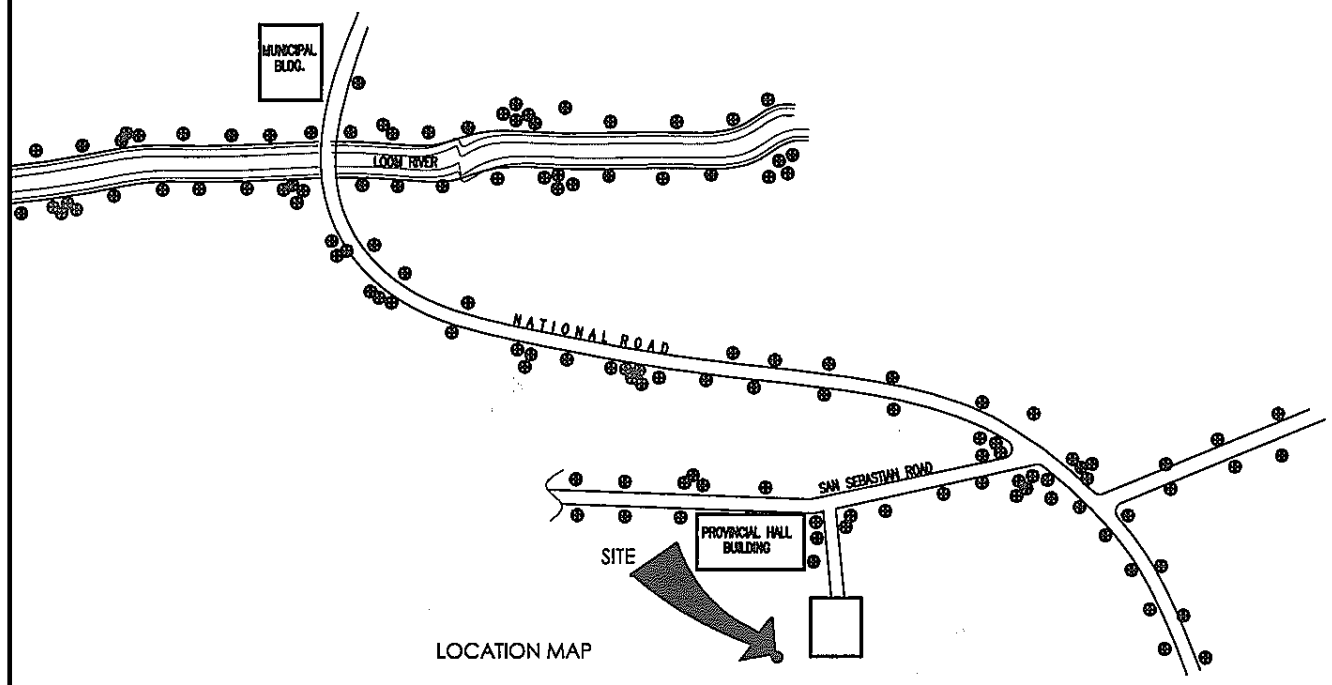


VICINITY MAP





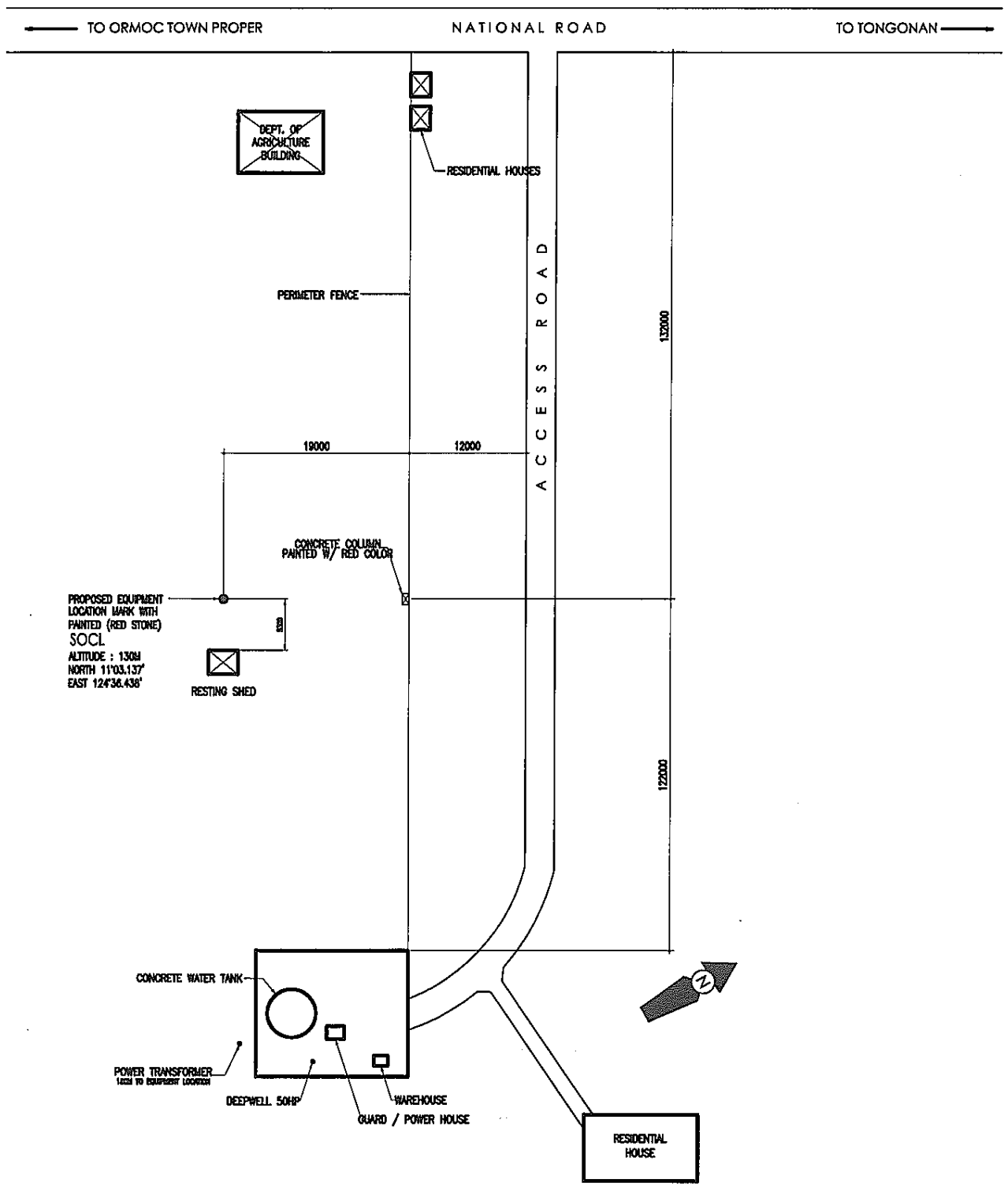
ELEVATION SHOWING SLOPE

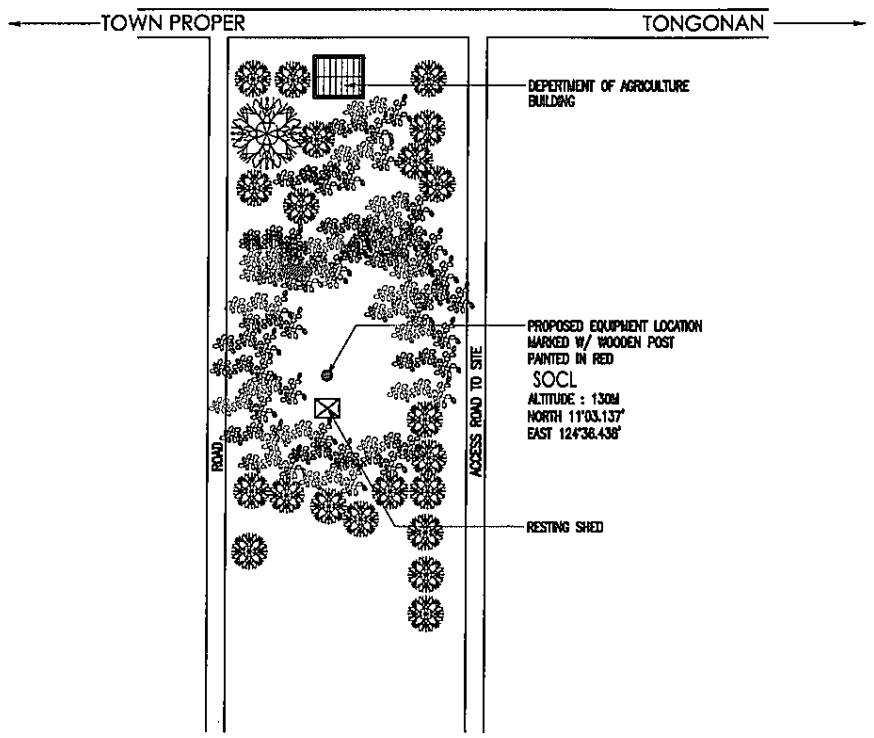


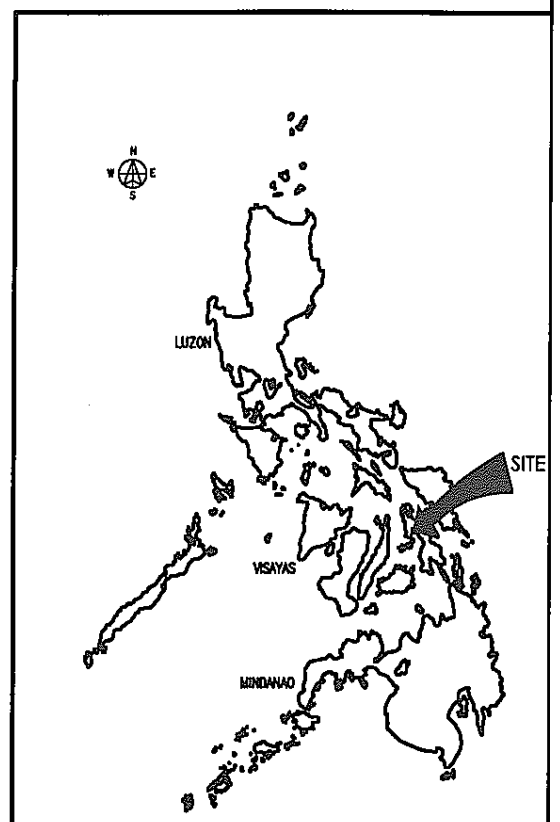
LOCATION MAP

Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162	PROJECT TITLE : THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	DRAWING TITLE PROPOSED BORONGAN, EASTERN SAMAR OBSERVATION POINT LOCATION : 802 CDC, BRCDC, ARESCOM, PA. HEADQUARTERS BARANGAY ALANG ALANG, BORONGAN, EASTERN SAMAR	SHEET CONTENTS : SITE DEVELOPMENT PLAN ELEVATION SHOWING SLOPE VICINITY MAP LOCATION MAP -	DRAWING No. 3 24

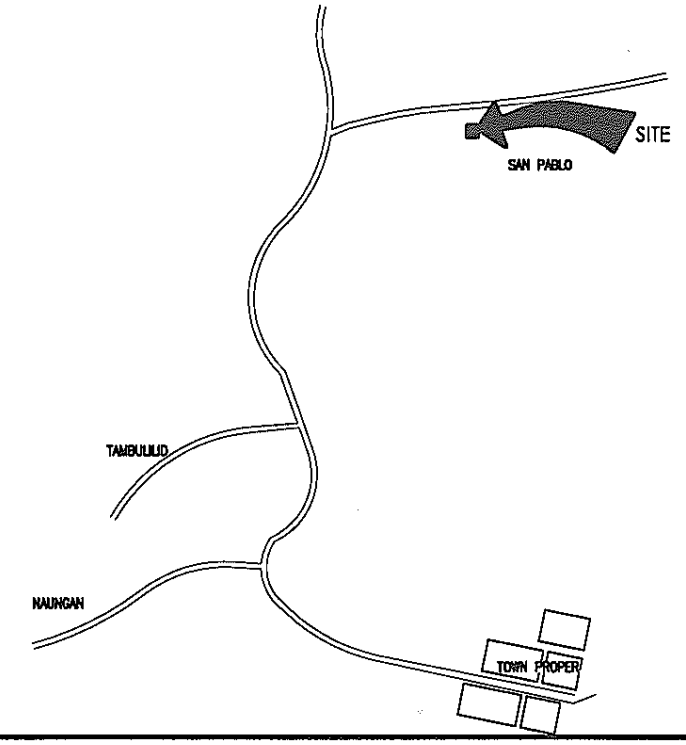
SITE: ORMOC OBSERVATORY STATION
ADDRESS: BRGY. SAN PABLO, ORMOC CITY





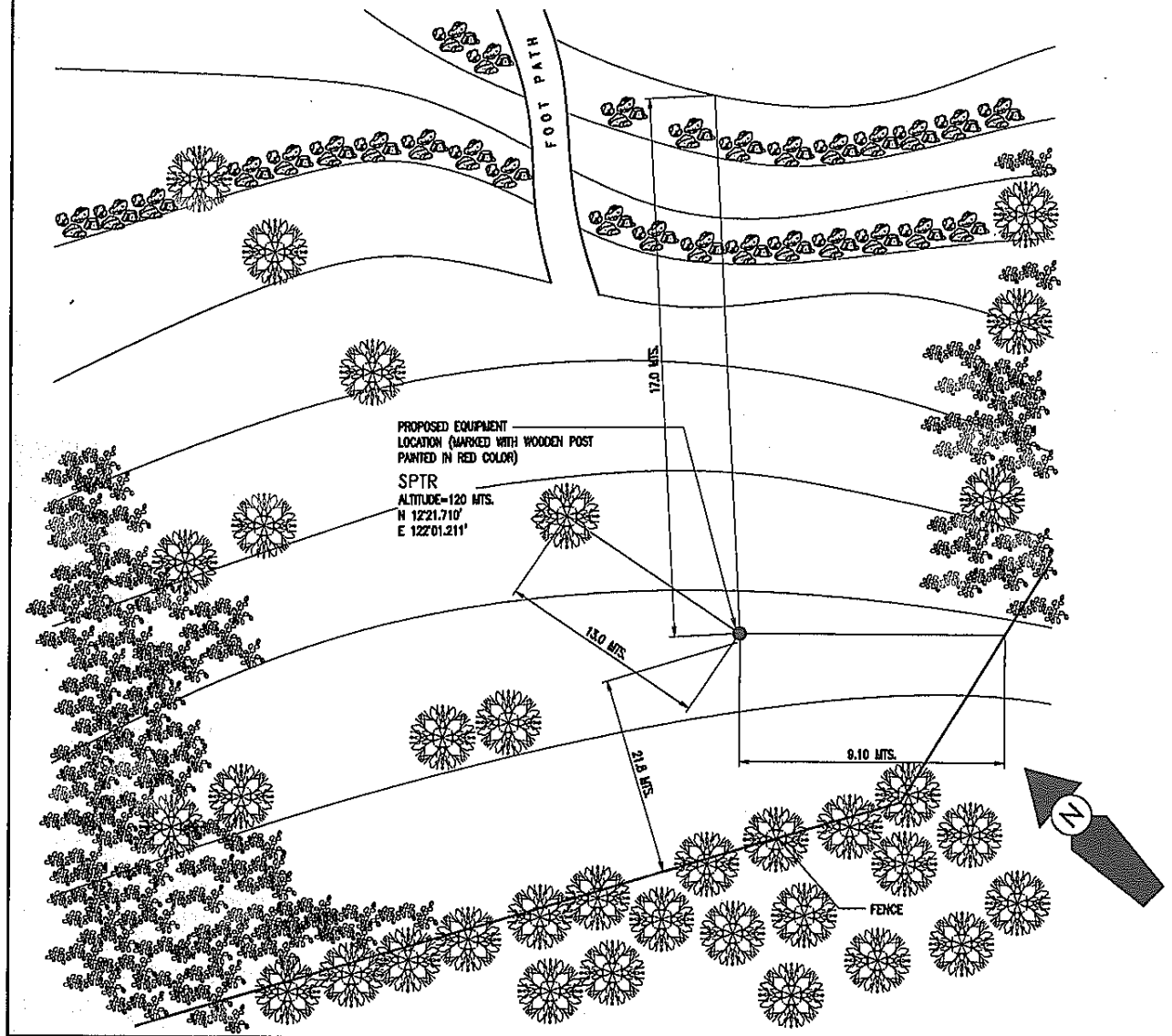


VICINITY MAP

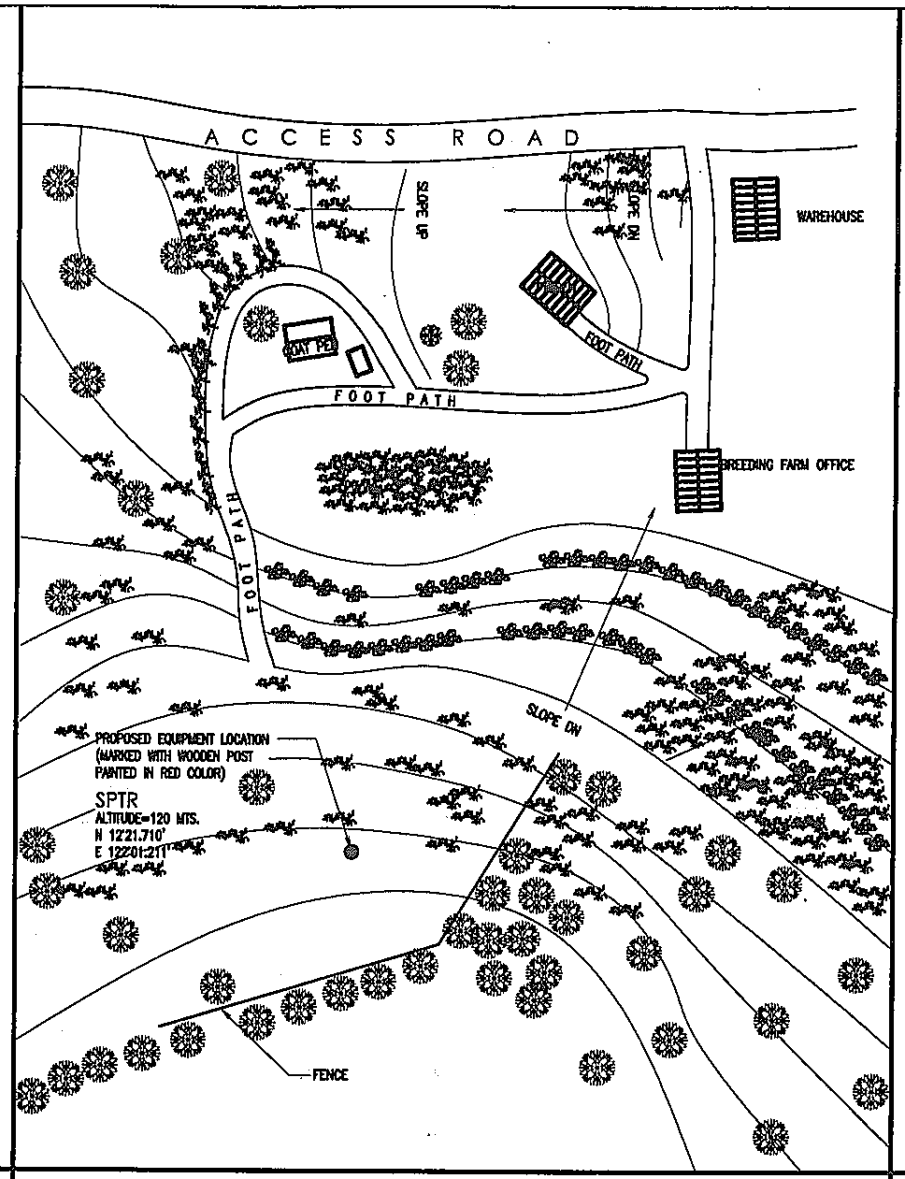


LOCATION MAP

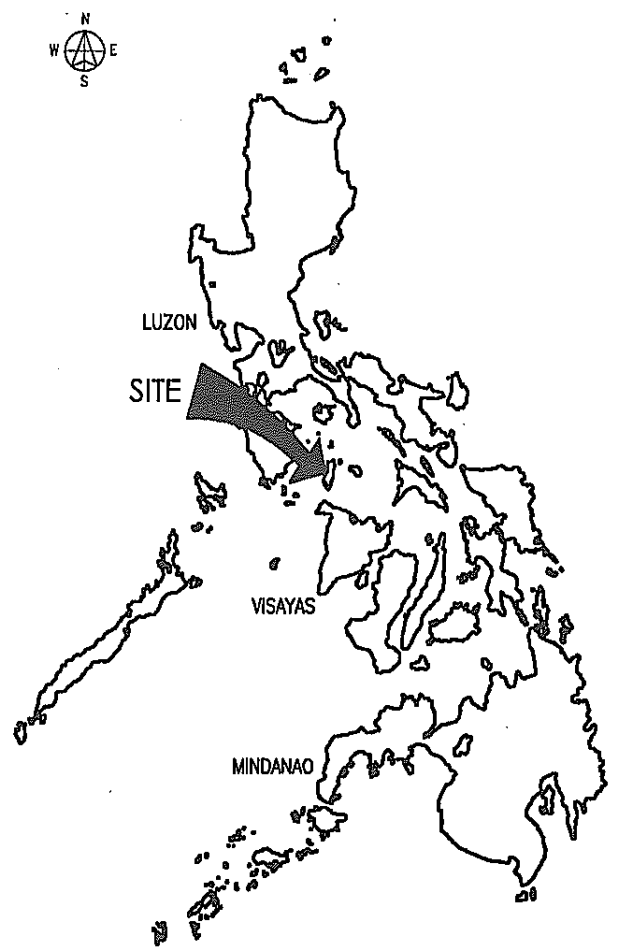
Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162	PROJECT TITLE : THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	DRAWING TITLE PROPOSED ORMOC OBSERVATION POINT LOCATION : DEPARTMENT OF AGRARIAN REFORM COMPOUND BARANGAY SAN PABLO , ORMOC CITY	SHEET CONTENTS : SITE DEVELOPMENT PLAN VICINITY MAP LOCATION MAP	DRAWING No. 4/24

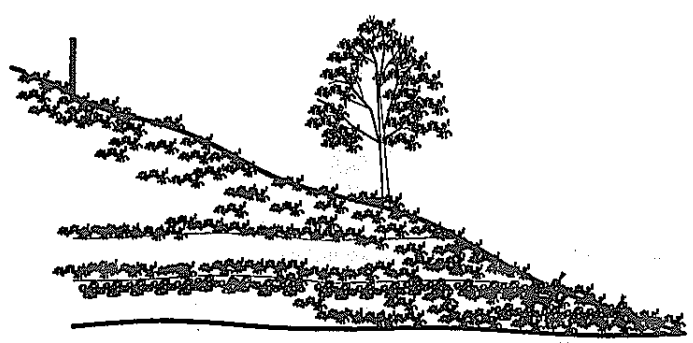


SITE DEVELOPMENT PLAN

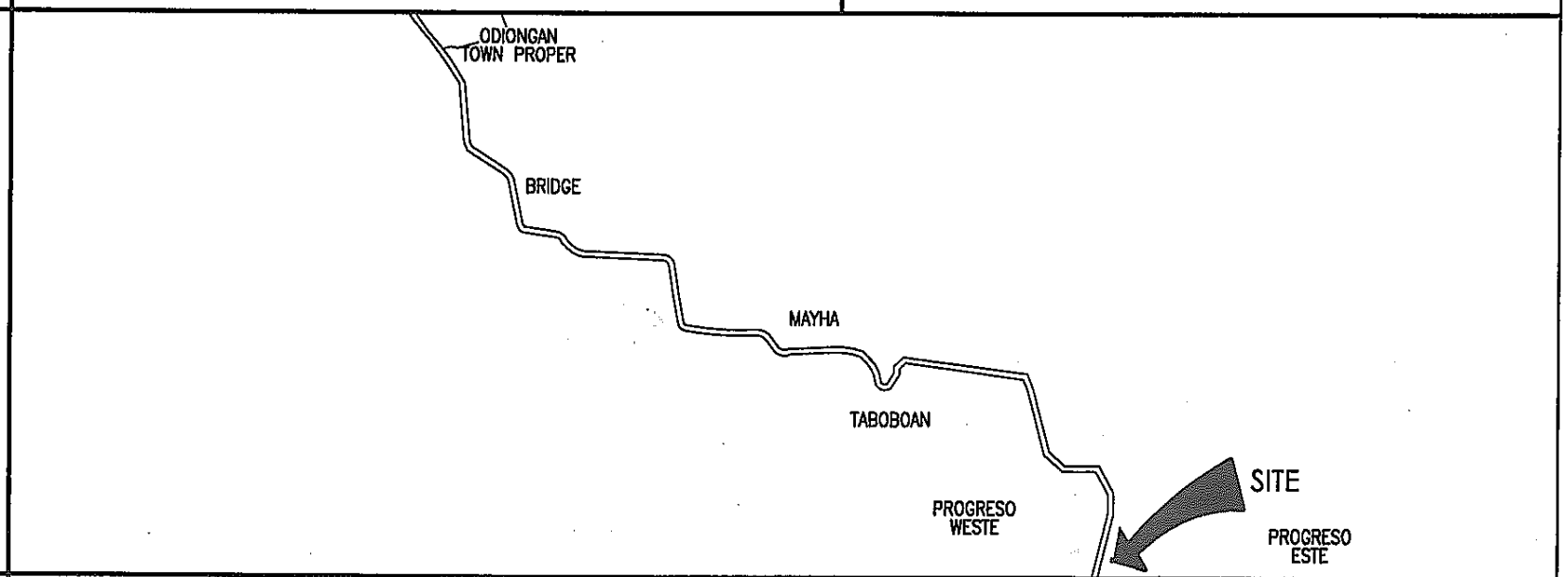


VICINITY MAP





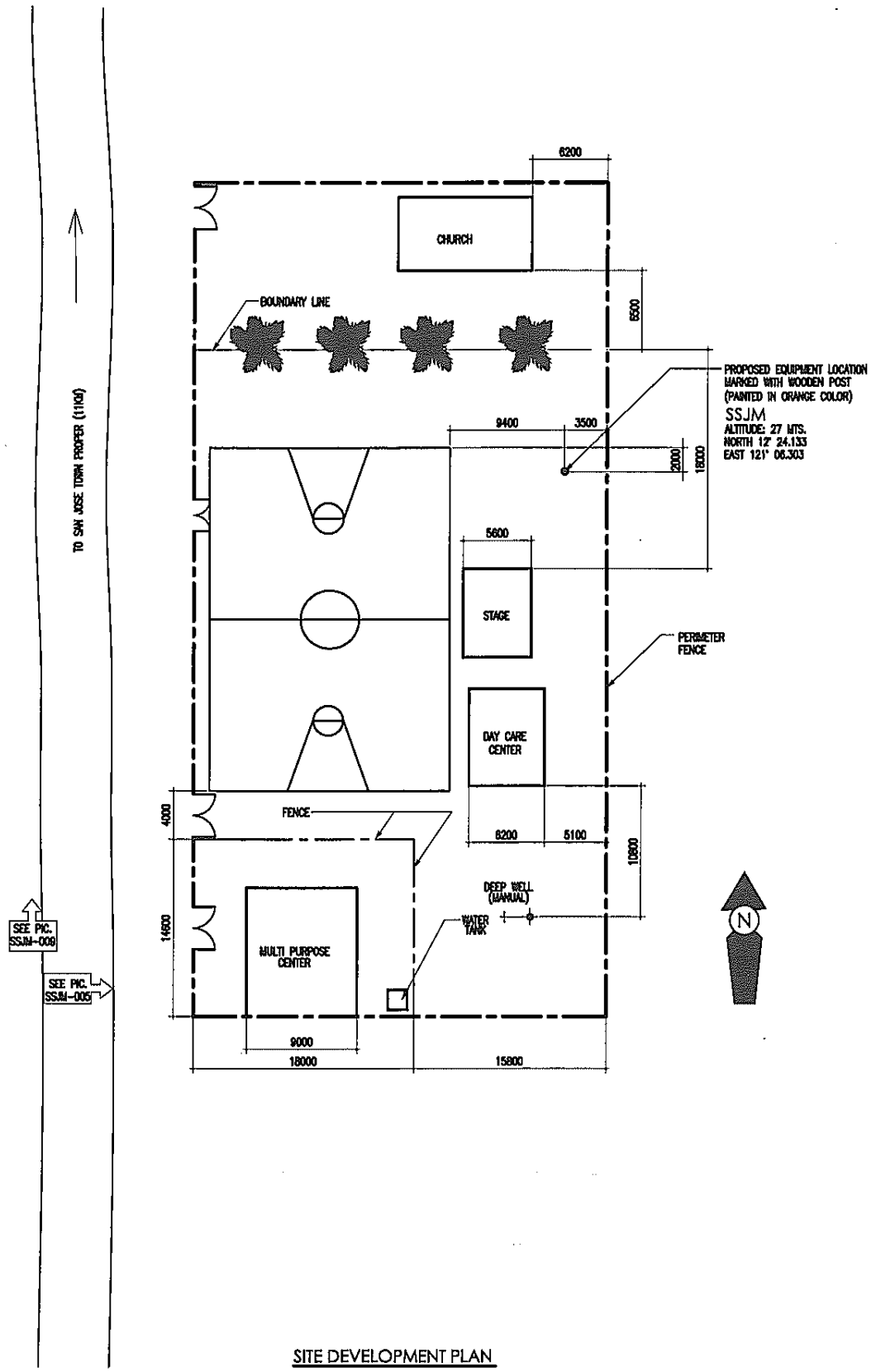
SECTIONAL ELEVATION SHOWING SLOPE



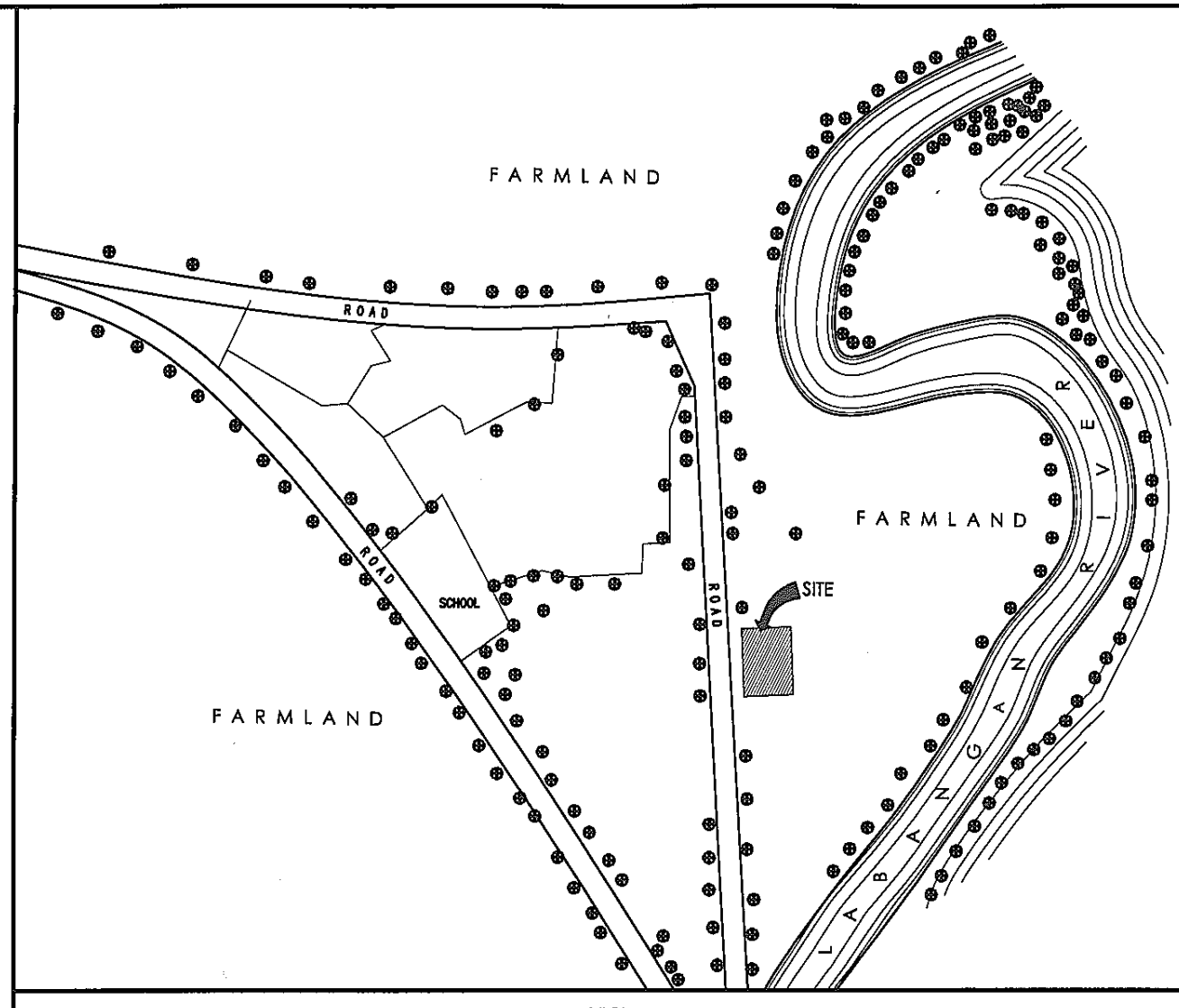
LOCATION MAP

JWA Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

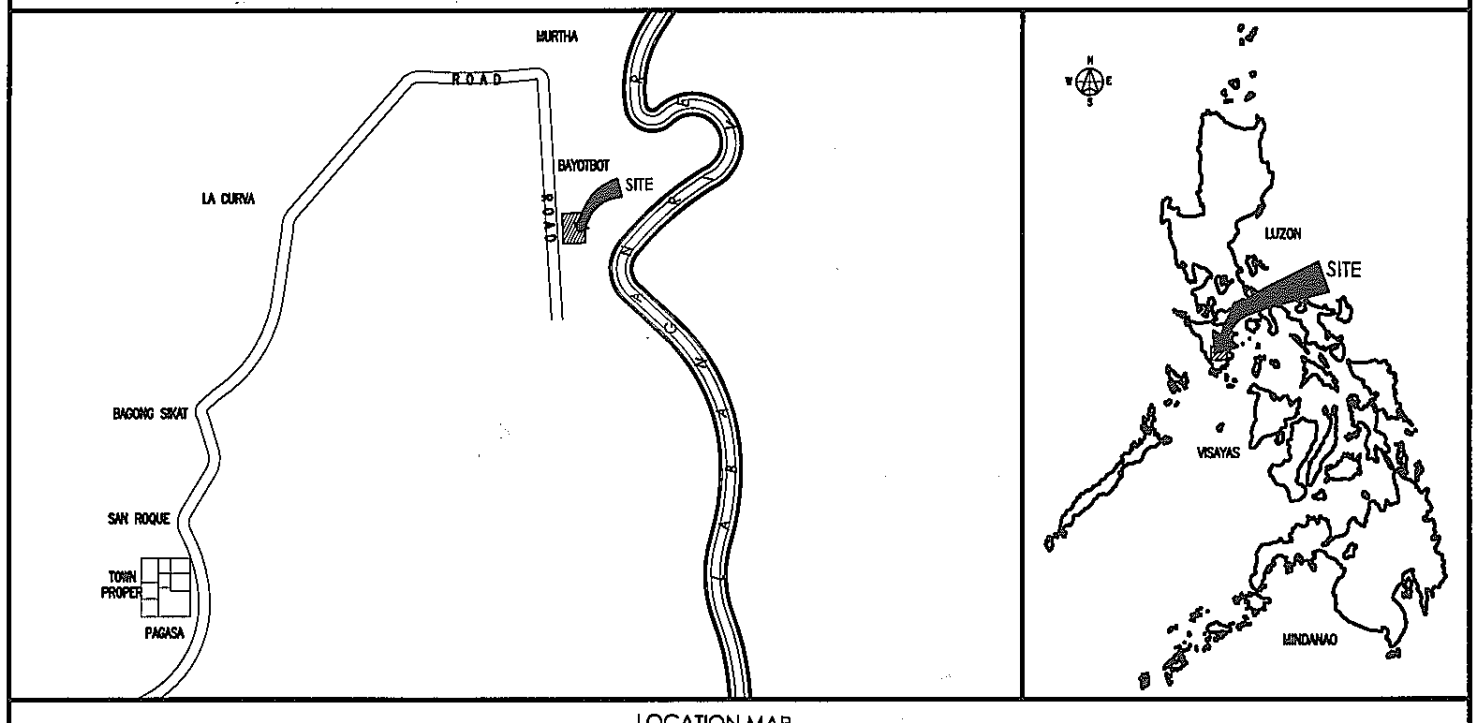
PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED ODIONGAN ROMBLON OSERVATION POINT LOCATION : BREEDING CENTER COMPOUND BARANGAY TUGIS , ODIONGAN , ROMBLON	SITE DEVELOPMENT PLAN VICINITY MAP SECTIONAL ELEVATION SHOWING SLOPE LOCATION MAP	5/24



SITE DEVELOPMENT PLAN

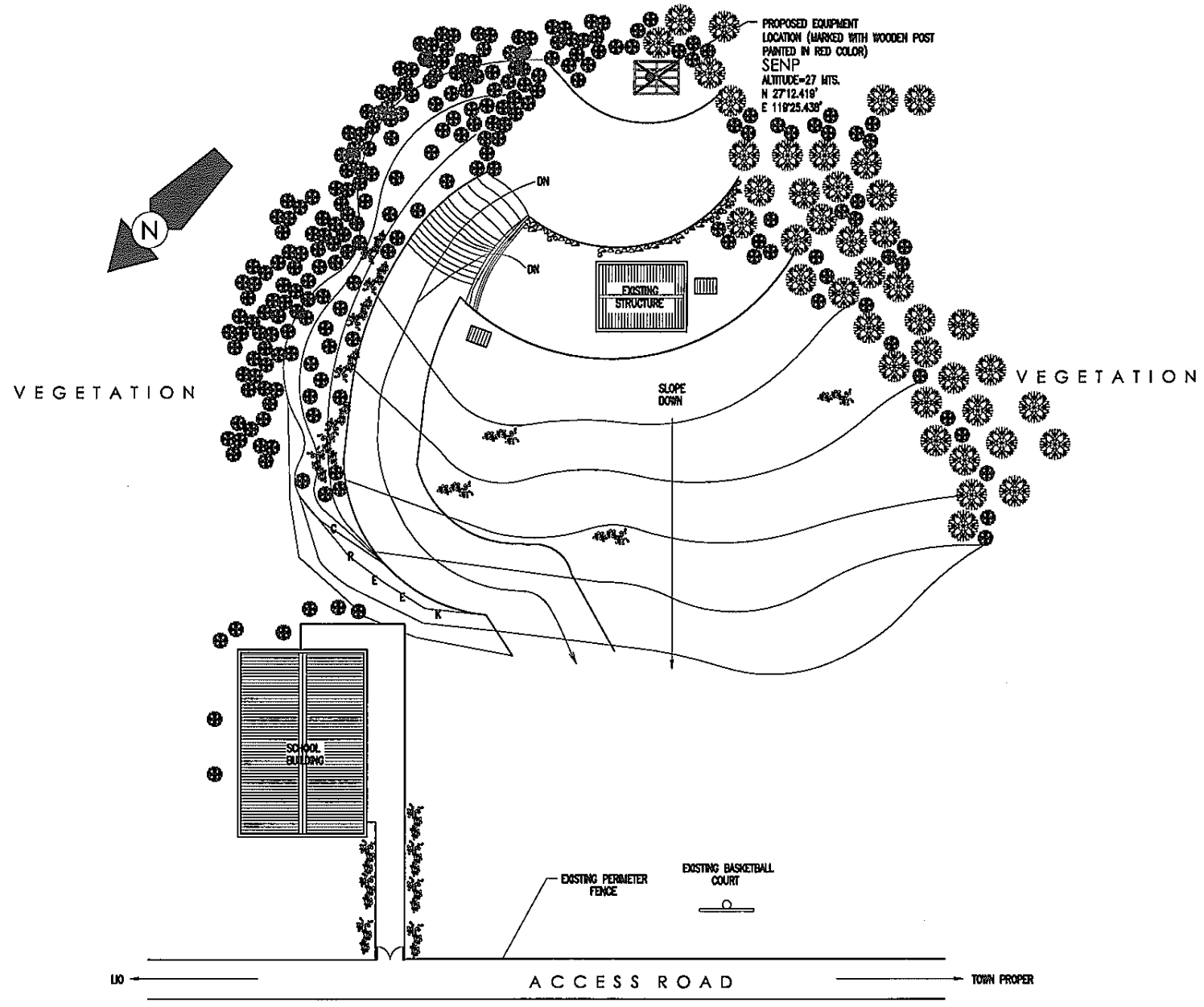


VICINITY MAP

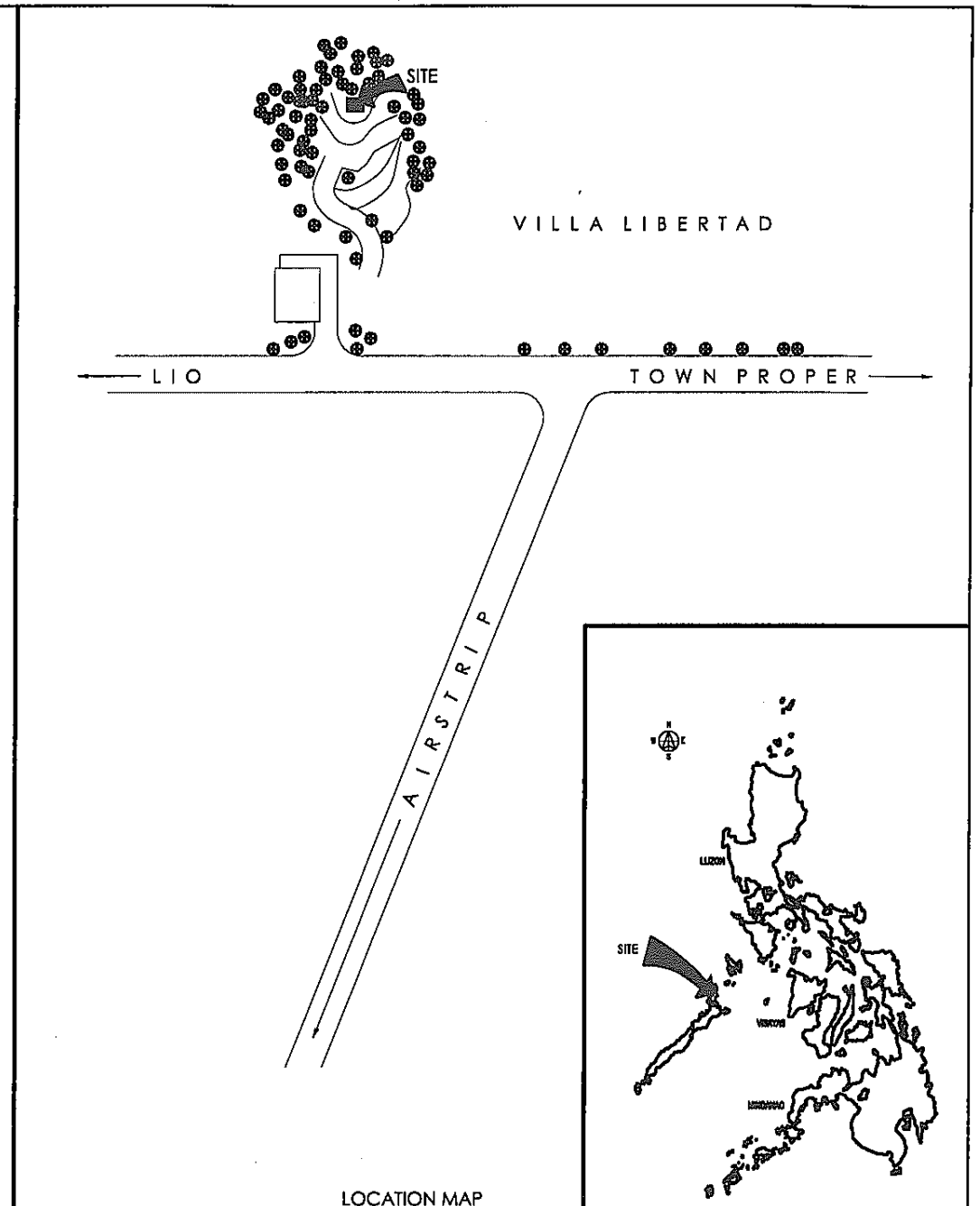


LOCATION MAP

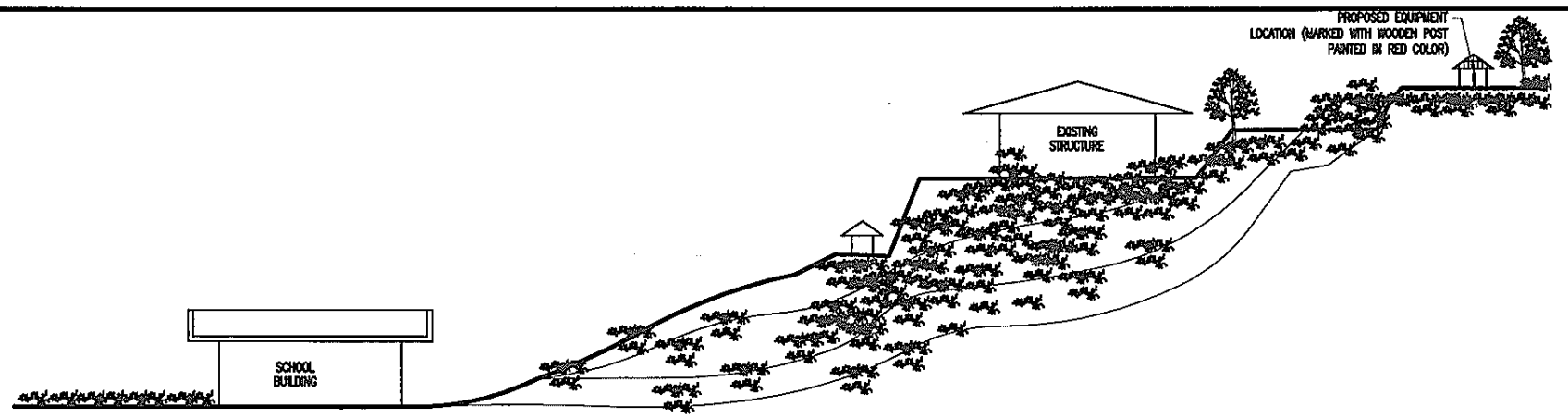
Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162	PROJECT TITLE : THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	DRAWING TITLE PROPOSED SAN JOSE OBSERVATION POINT LOCATION : MULTI-PURPOSE CENTER COMPOUND BARANGAY BAYOTBOT, SAN JOSE, OCCIDENTAL MINDORO	SHEET CONTENTS : SITE DEVELOPMENT PLAN VICINITY MAP LOCATION MAP	DRAWING No. 6/24



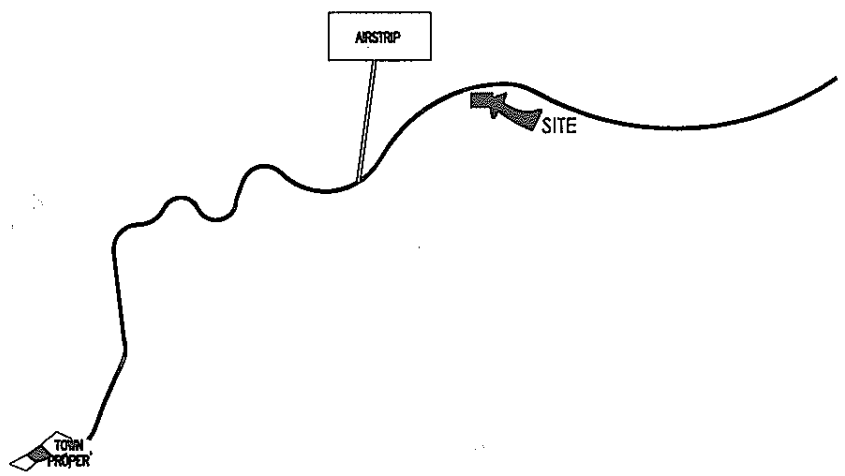
SITE DEVELOPMENT PLAN



LOCATION MAP



ELEVATION SHOWING SLOPE



VICINITY MAP

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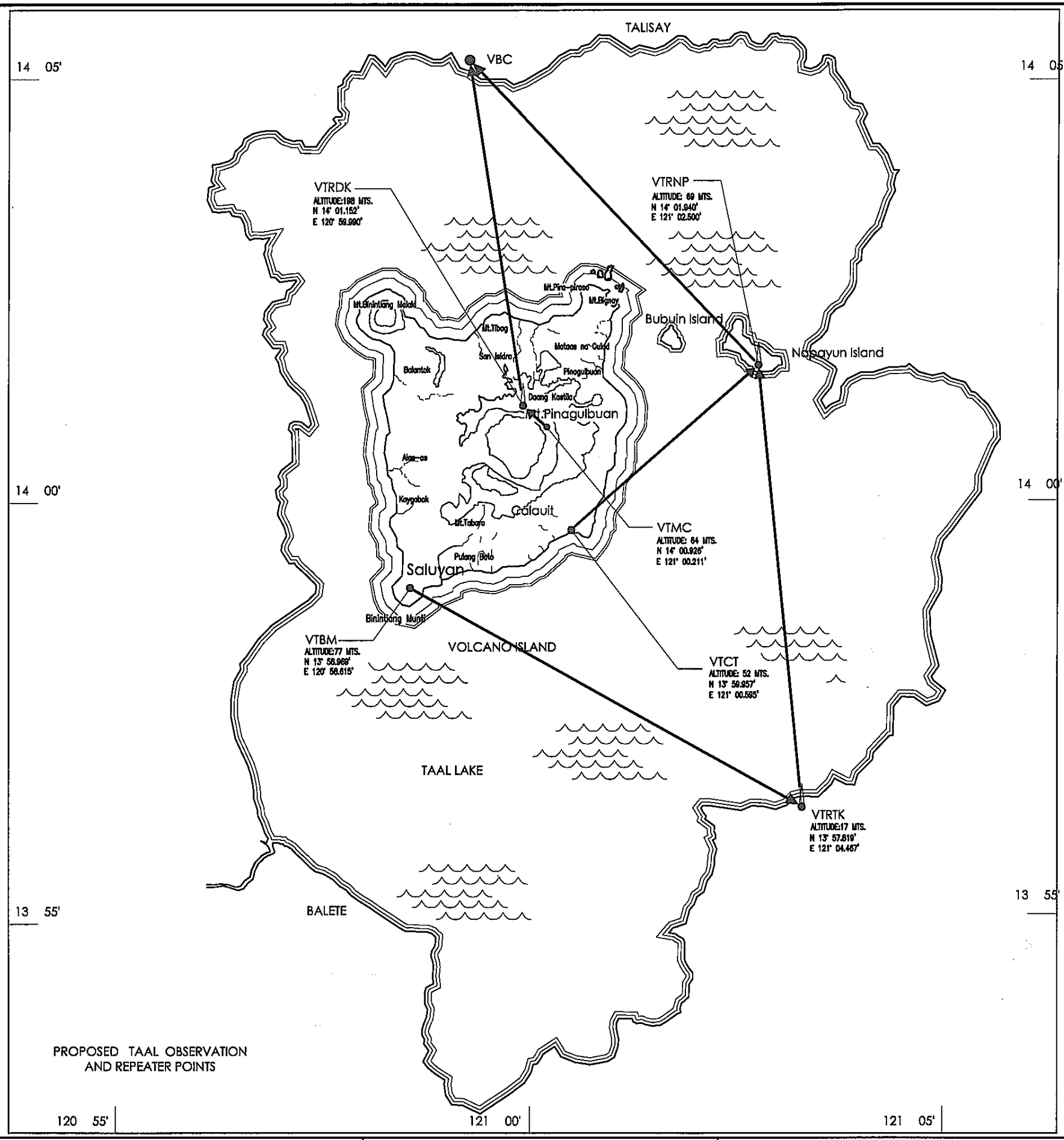
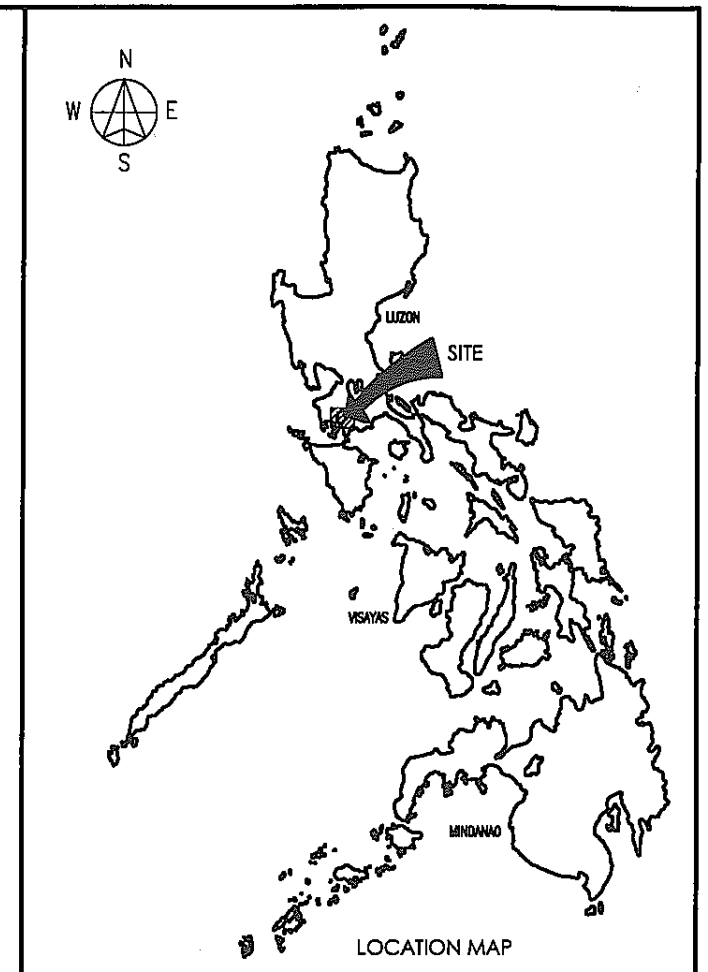
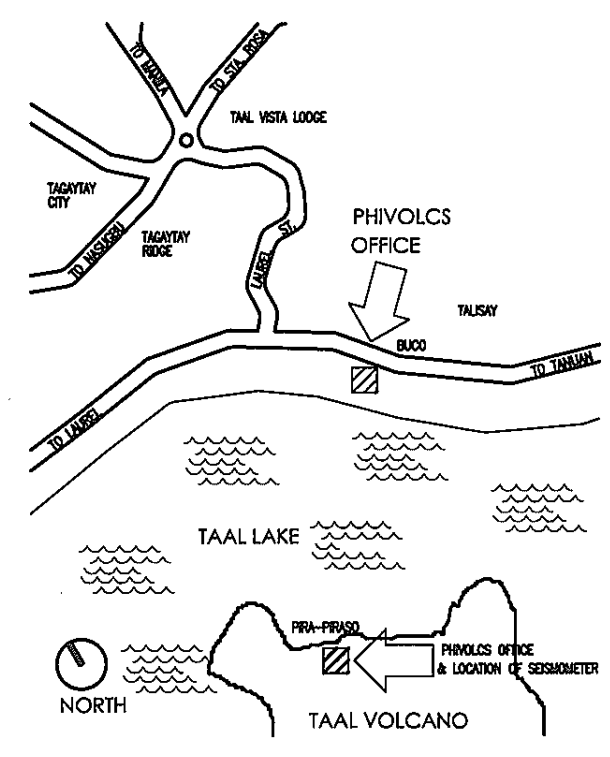
170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED EL NIDO OBSERVATION POINT LOCATION : STATE POLYRTECHNIC COLLEGE OF PALAWAN COMPOUND BARARNGAY VILLA LIBERTAD , EL NIDO PALAWAN	SITE DEVELOPMENT PLAN LOCATION MAP ELEVATION SHOWING SLOPE VICINITY MAP	7/24



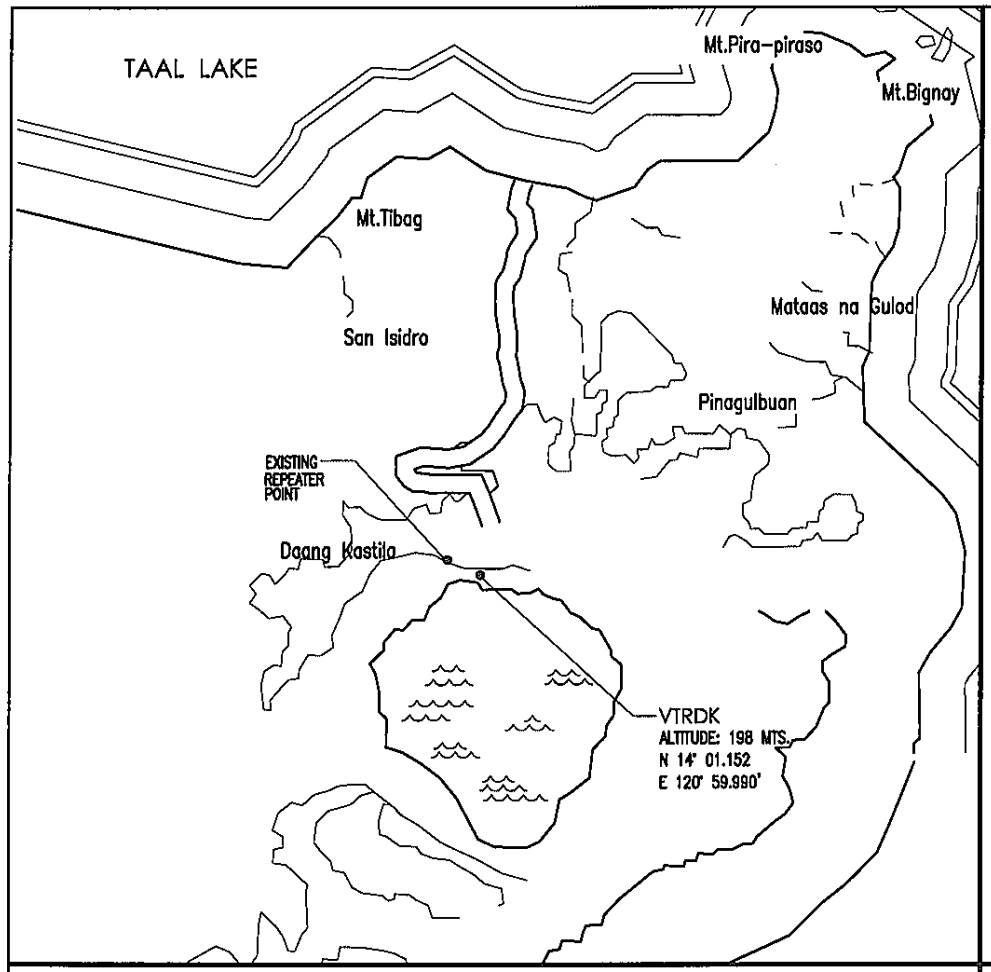


LOCATION MAP

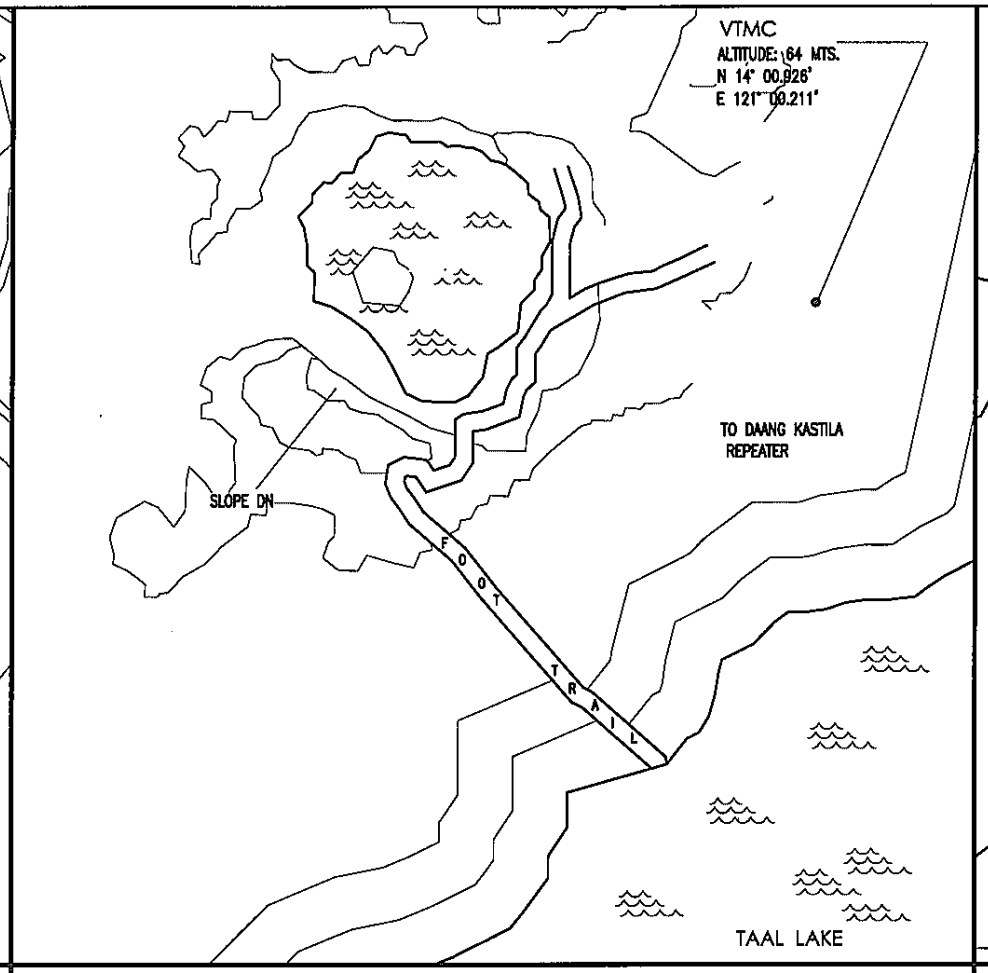


SITE LOCATION MAP (PHIVOLCS OFFICE)

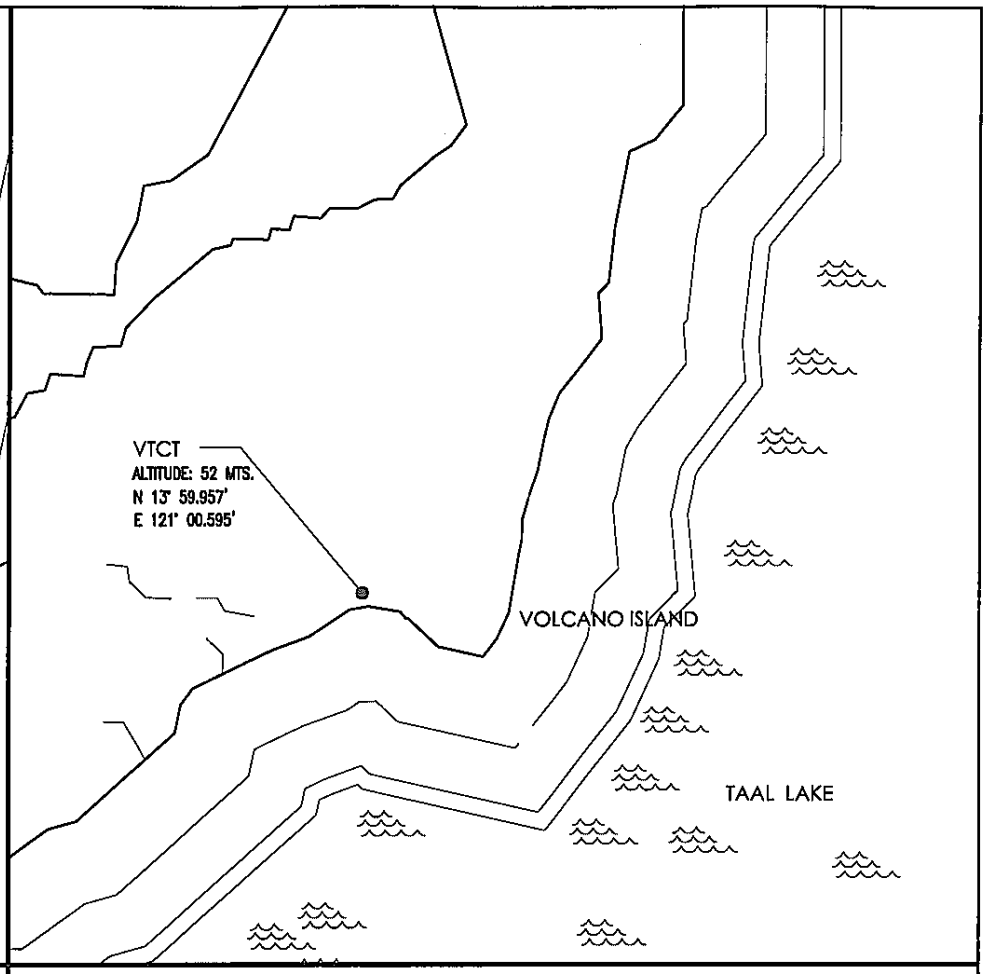
Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162	PROJECT TITLE : THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	DRAWING TITLE PROPOSED TAAL OBSERVATION & REPEATER POINTS LOCATION : TAAL VOLCANO, PHILIPPINES	SHEET CONTENTS : LOCATION MAP SITE LOCATION MAP (PHIVOLCS OFFICE) TAAL OBSERVATION AND REPEATER POINTS	DRAWING No. 8/24



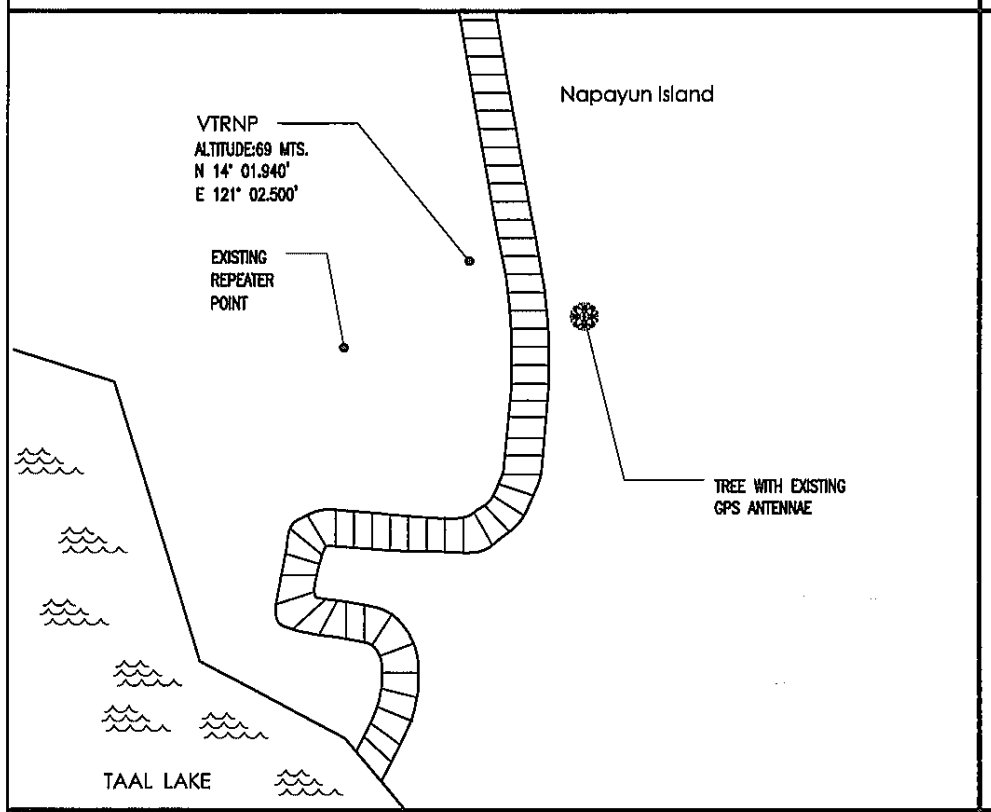
DAANG KASTILA REPEATER POINT



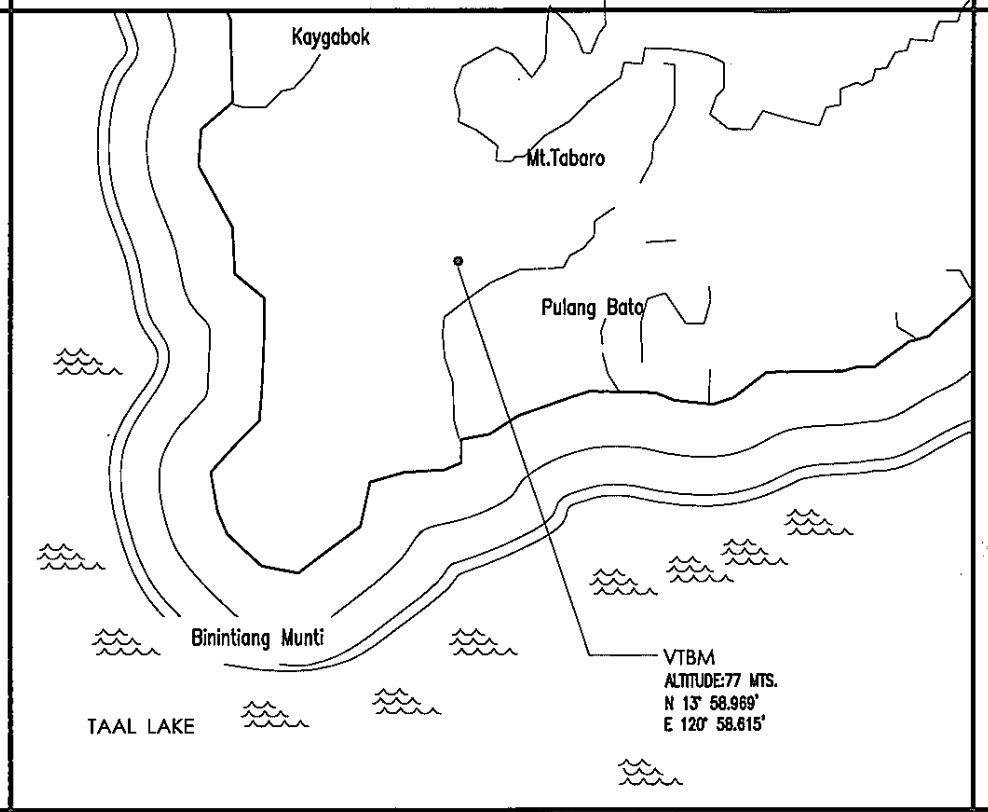
TAAL MAIN CRATER OBSERVATION POINT



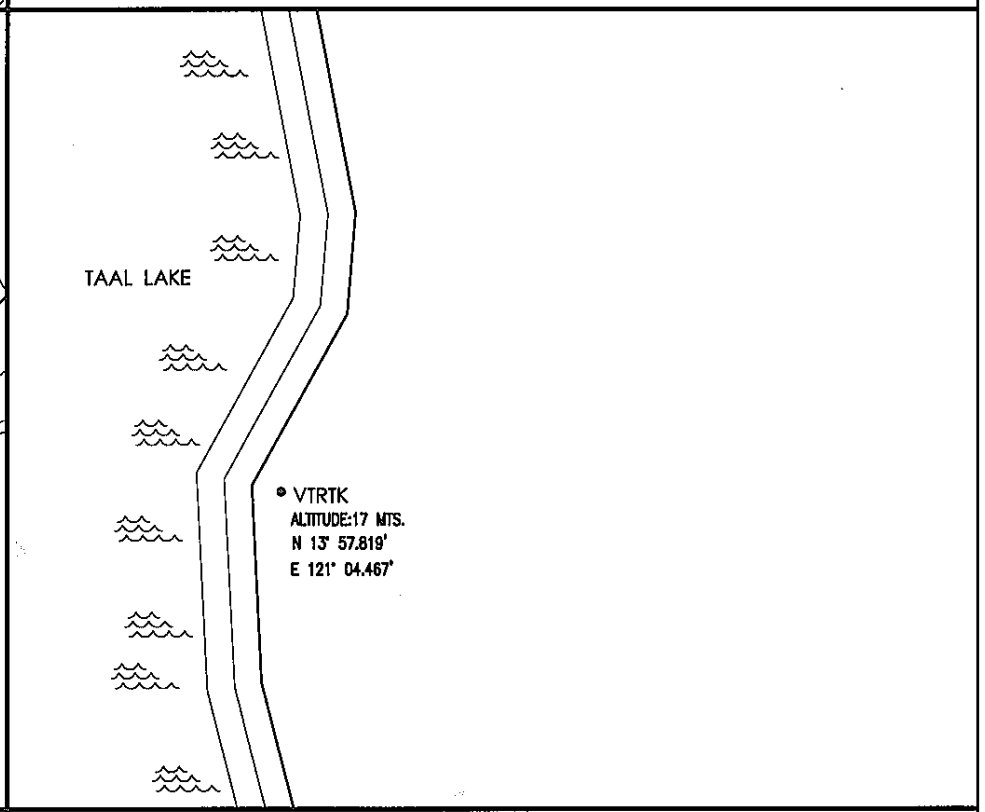
CALAUIT OBSERVATION POINT



NAPAYUN REPEATER POINT



BININTIANG MUNTI HILL OBSERVATION POINT



TAGBAKIN REPEATER POINT

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PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED TAAL OBSERVATION & REPEATER POINTS LOCATION : TAAL VOLCANO, PHILIPPINES	TAGBAKIN REPEATER POINT BININTIANG MUNTI HILL OBSERVATION STATION NAPAYUN REPEATER POINT CALAUIT OBSERVATION STATION DAANG KASTILA REPEATER POINT, TAAL MAIN CRATER OBSERVATION STATION	9 / 24

123 30' 123 35' 123 40' 123 45'

13 20' 13 15' 13 10' 13 06'

VMRTM
ALTITUDE= 10 MTS.
N 13°21.653'
E 123°43.762'

VMRH
ALTITUDE= 790 MTS.
N 13°17.179'
E 123°40.178'

VMSM
ALTITUDE= 441 MTS.
N 13°15.201'
E 123°43.719'

VMRSD
ALTITUDE= 278 MTS.
N 13°15.036'
E 123°40.562'

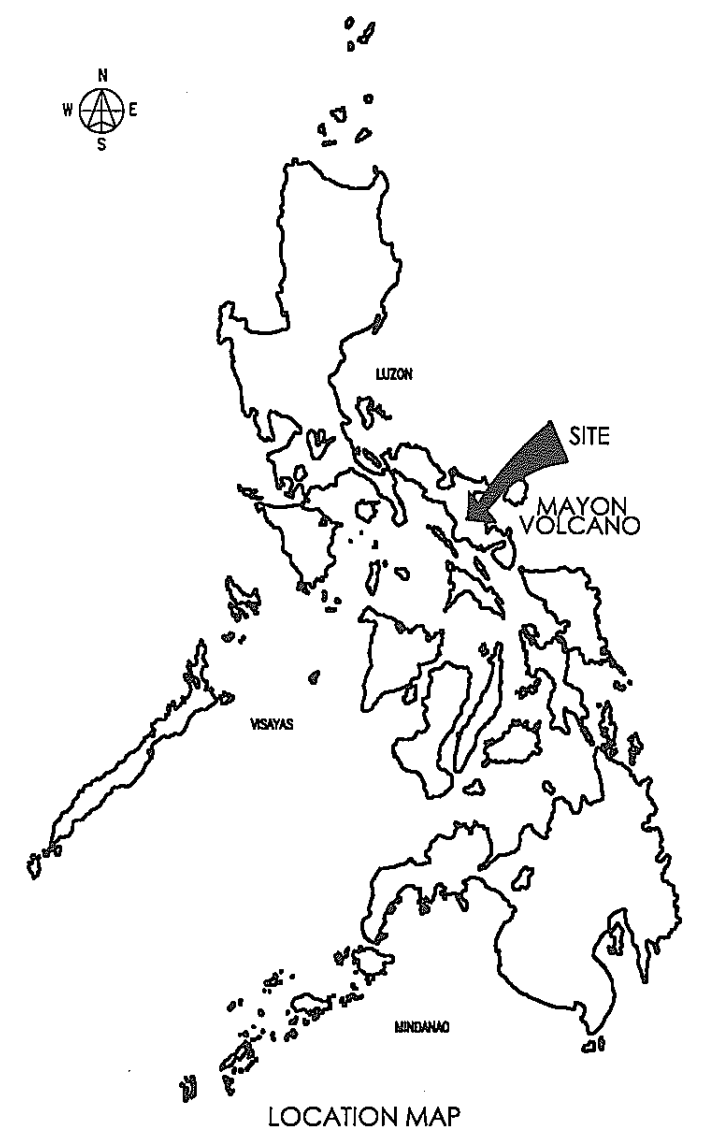
VMAN
ALTITUDE= 749 MTS.
N 13°13.884'
E 123°40.339'

VMR
ALTITUDE= 111 MTS.
N 13°09.664'
E 123°43.588'

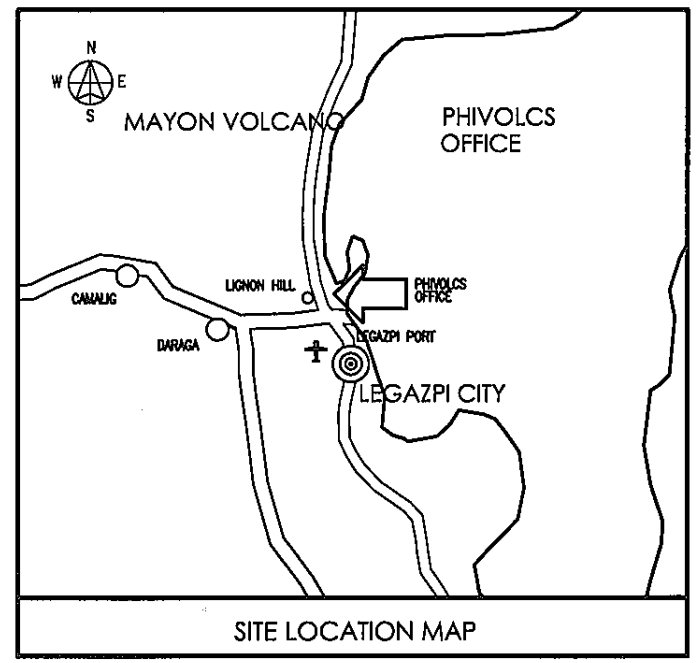
VMRMB
ALTITUDE= 255 MTS.
N 13°07.045'
E 123°43.405'

TABACO
TABACO BAY
MALILIPOT
BACACAY
SANTA MISERICORDIA
SANTO DOMINGO
UPPER ANOLING
GUINOBATAN
CAMALIG
LIGNON HILL
ALBAY GULF
DARAGA
LEGAZPI CITY
LEGAZPI PORT DISTRICT

PROPOSED MAYON VOLCANO MONITORING NETWORK



LOCATION MAP



SITE LOCATION MAP

Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

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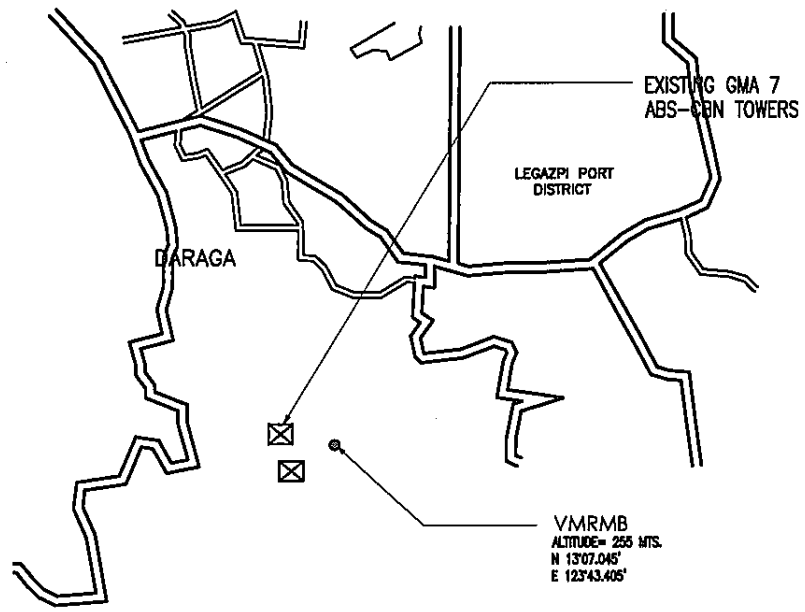
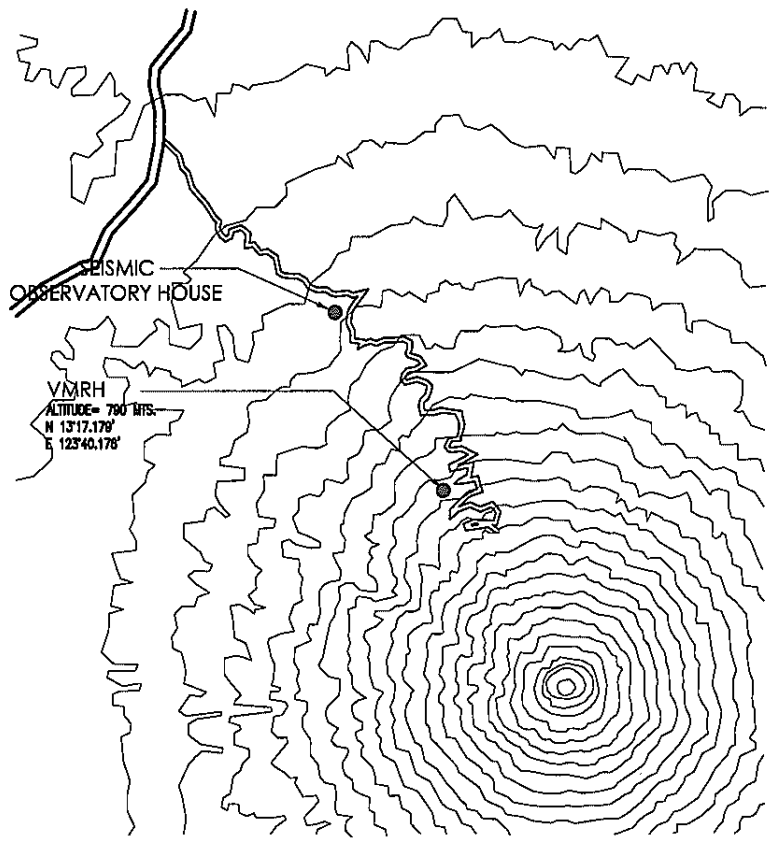
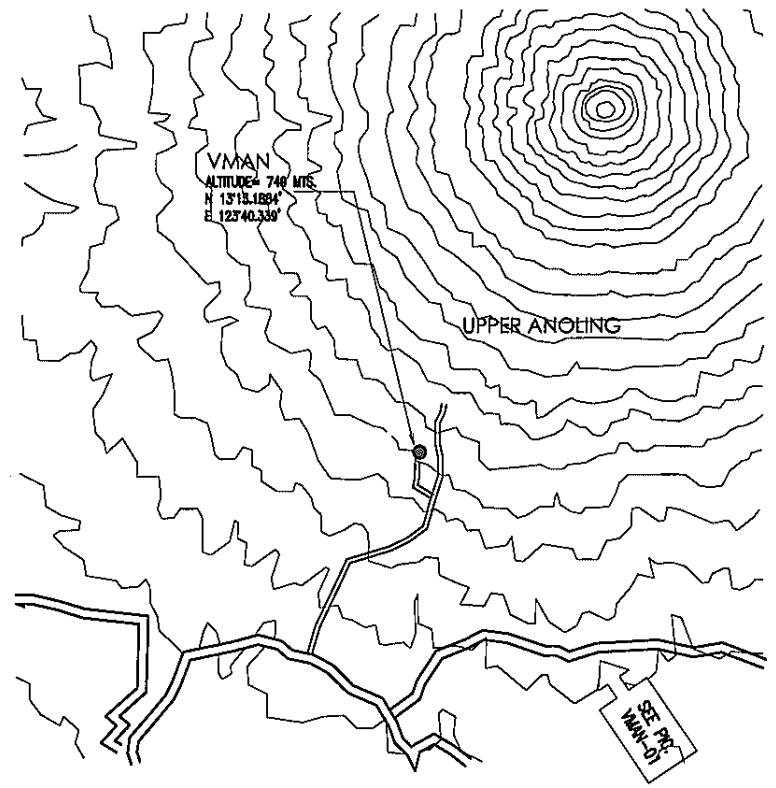
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED MAYON OBSERVATION & REPEATER POINTS LOCATION : ALBAY , BICOL , PHILIPPINES	PROPOSED MAYON VOLCANO MONITORING NETWORK LOCATION MAP SITE LOCATION MAP (PHIVOLCS OFFICE)	10 / 24



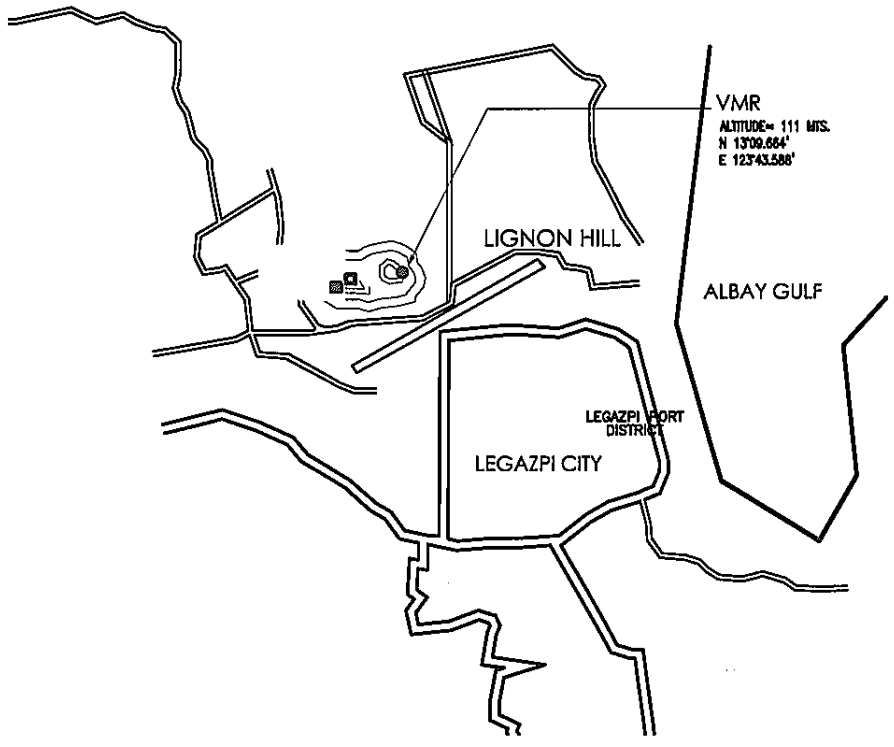
MT. BARIW REPEATER POINT



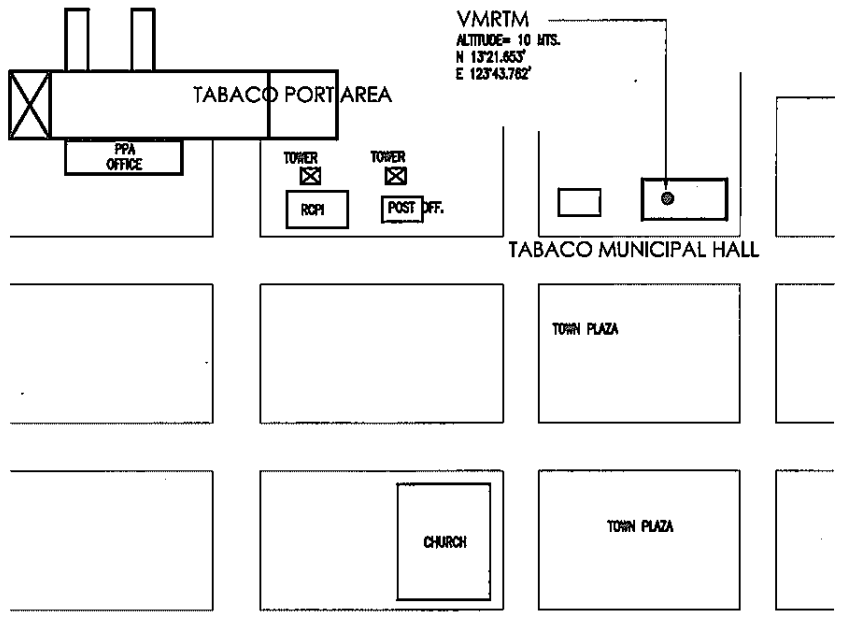
MAYON REST HOUSE OBSERVATORY STATION



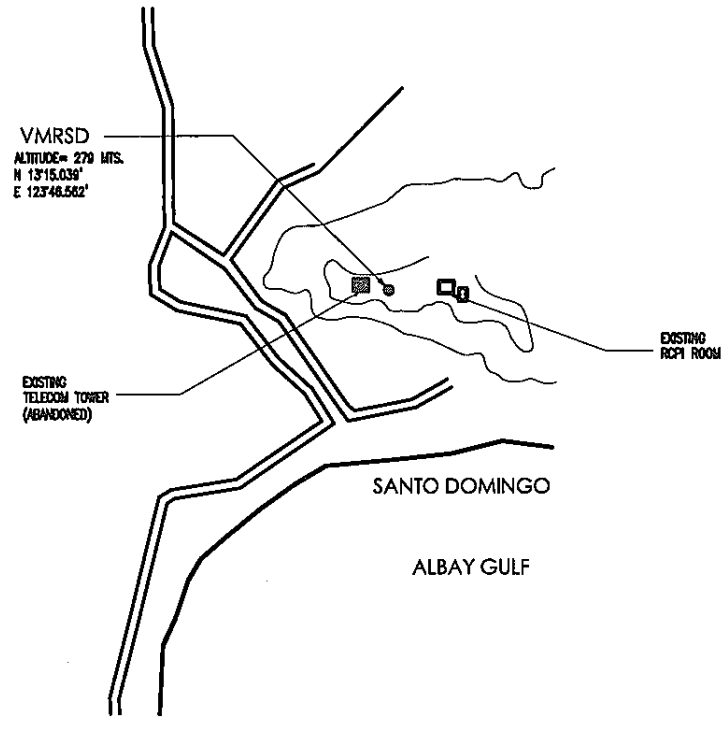
UPPER ANOLING OBSERVATION POINT



LIGNON HILL VOLCANO OBSERVATORY



TABACO MUNICIPAL BUILDING REPEATER POINT



UPPER SANTO DOMINGO REPEATER POINT

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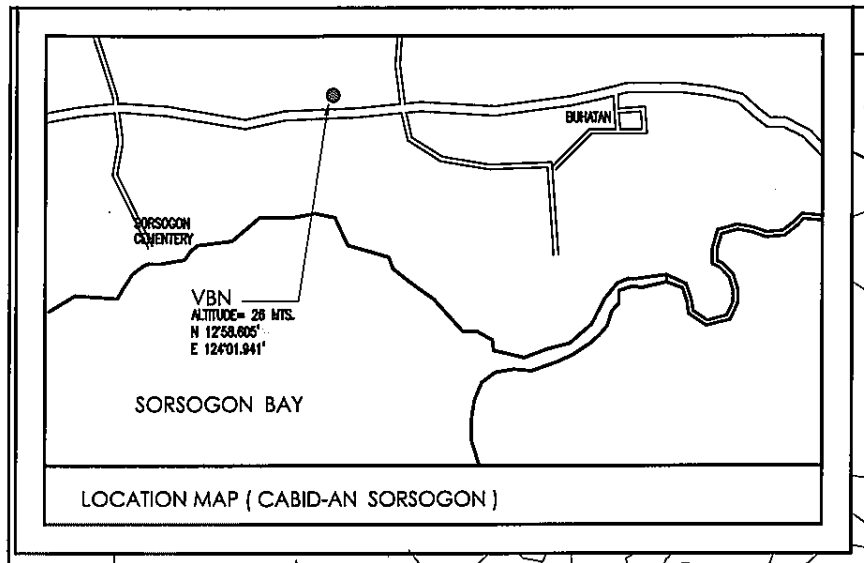
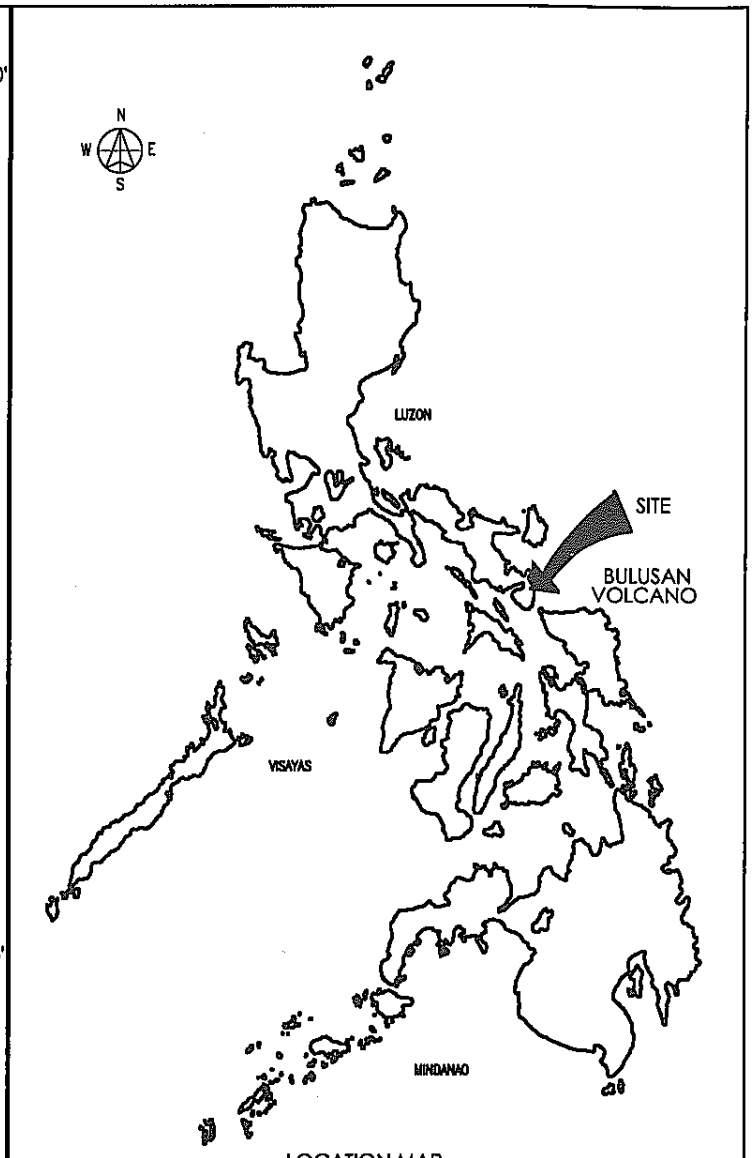
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo,
170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED MAYON OBSERVATION & REPEATER POINTS LOCATION : ALBAY , BICOL , PHILIPPINES	MT BARIW REPEATER POINT LINGNON HILL OBSERVATORY MAYON RESTHOUSE OBSERVATORY STATION TABACO SEAPORT & MUNICIPAL BUILDING REPEATER POINT UPPER ANULING & SANTO DOMINGO REPEATER POINT	11 / 24

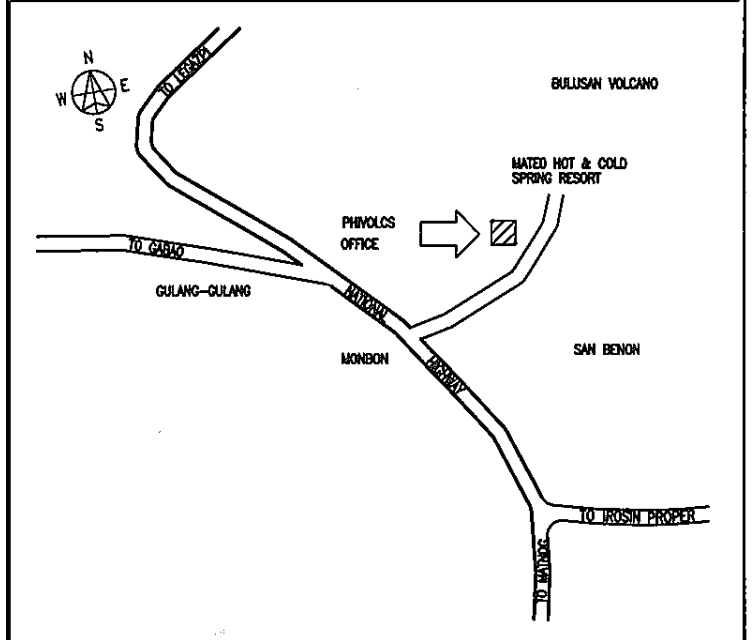


LOCATION MAP (CABID-AN SORSOGON)

PROPOSED BULUSAN OBSERVATION AND REPEATER POINTS



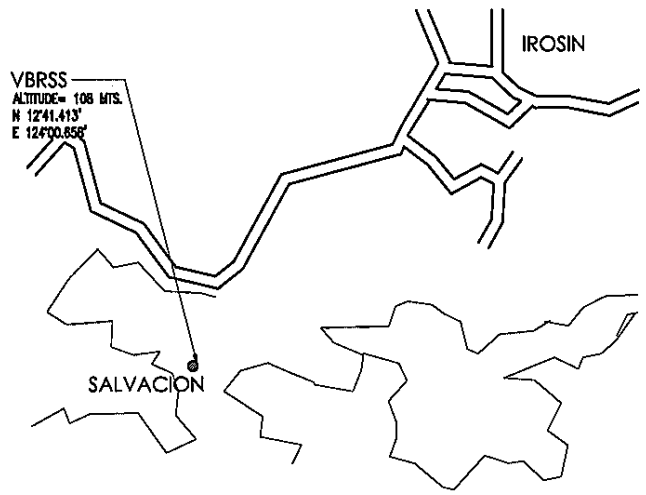
LOCATION MAP



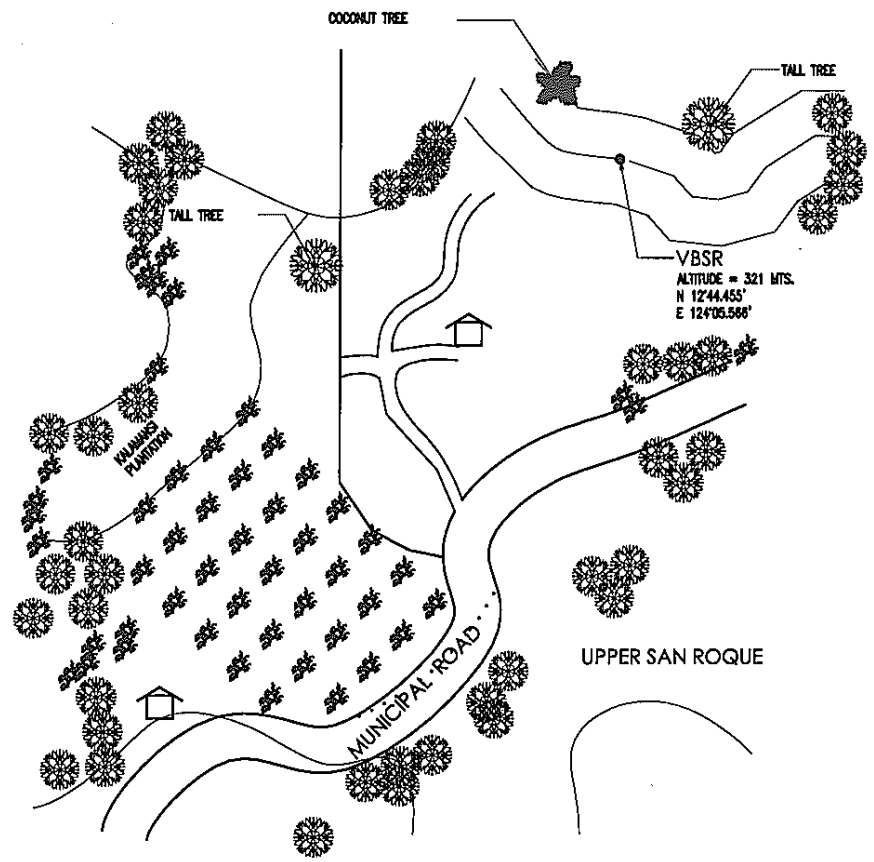
SITE LOCATION MAP (PHIVOLCS OFFICE)

Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

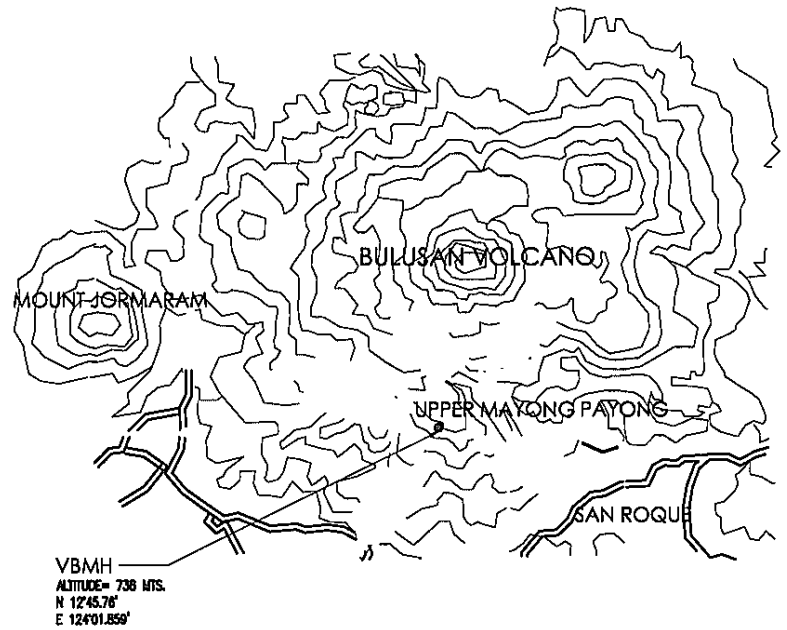
PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED BULUSAN OBSERVATION & REPEATER POINTS LOCATION : BULUSAN,SORSOGON,PHILIPPINES	BULUSAN OBSERVATION & REPEATER POINTS LOCATION MAP LOCATION MAP (CABID-AN SORSOGON) SITE LOCATION MAP (PHIVOLCS OFFICE)	12/24



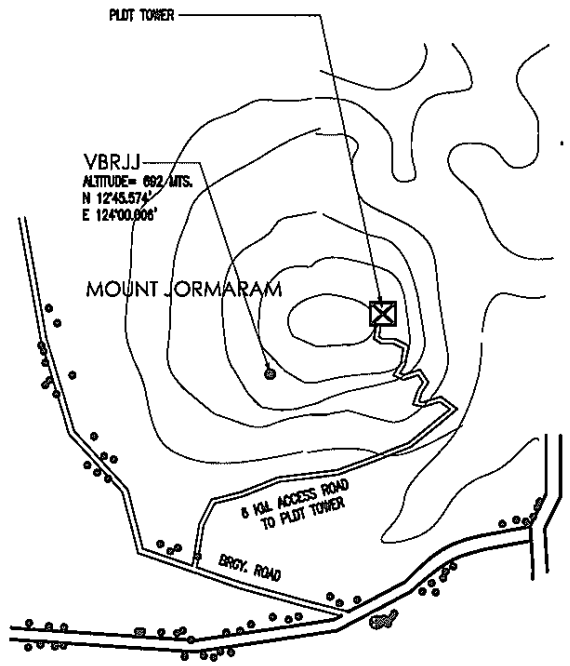
SALVACION SLOPE REPEATER POINTS



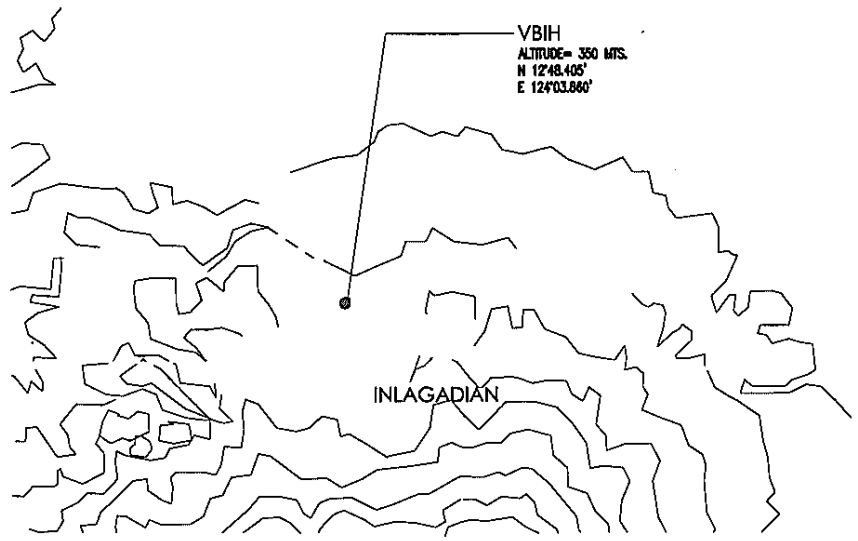
UPPER SAN ROQUE OBSERVATION POINT



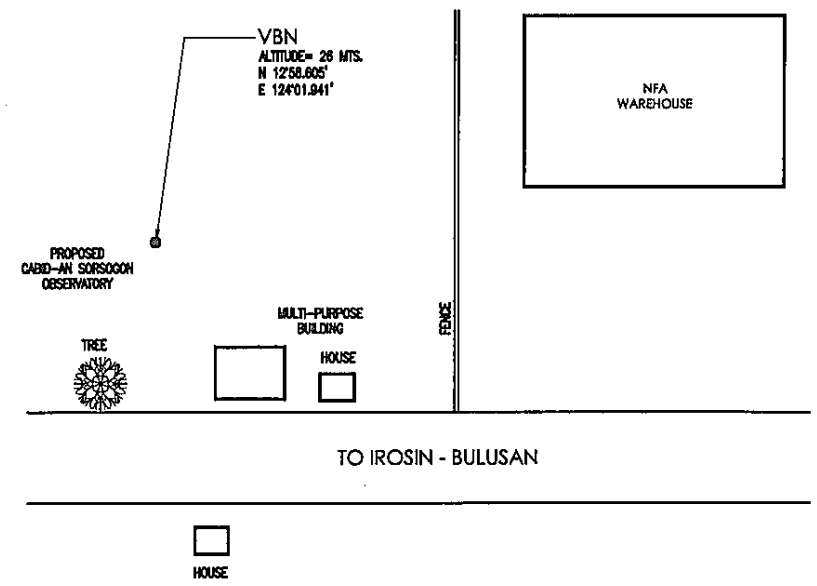
UPPER MAYONG PAYONG HILL REPEATER POINT



MT. JORMARAM REPEATER POINT



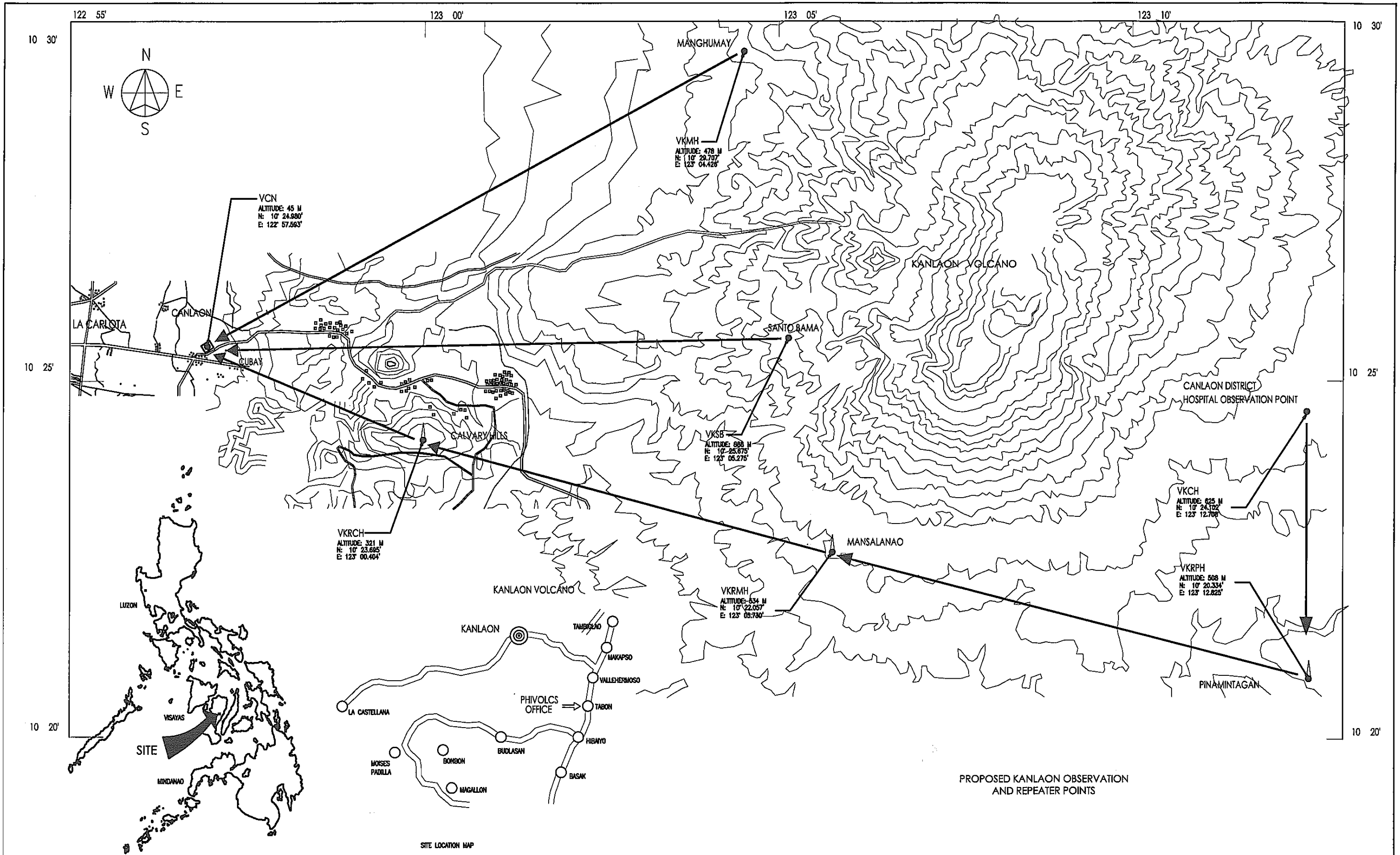
UPPER INLAGADIAN HILL OBSERVATION POINT



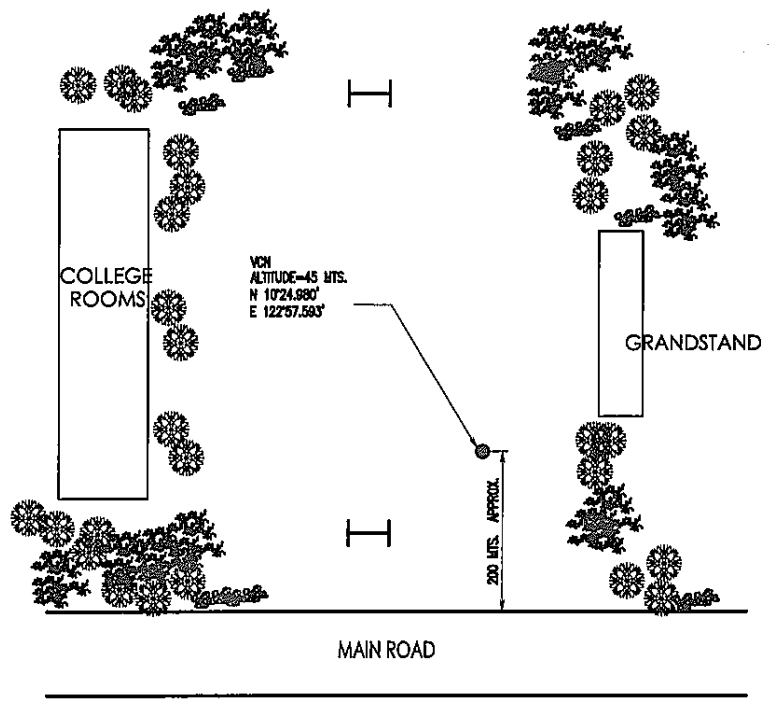
CABID-AN SORSOGON OBSERVATORY STATION

Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

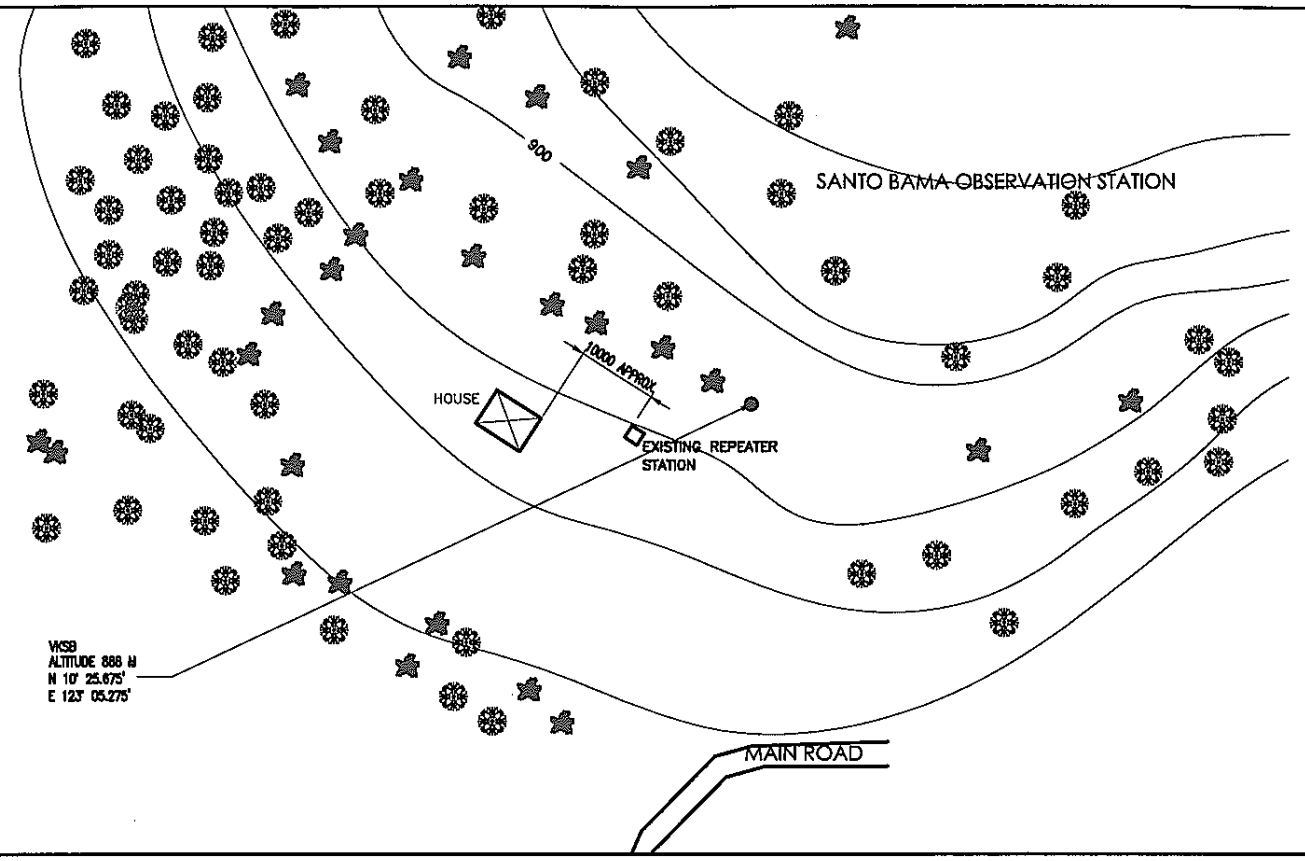
PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED BULUSAN OBSERVATION & REPEATER POINTS LOCATION : BULUSAN,SORSOGON,PHILIPPINES	SALVACION SLOPE REPEATER POINT UPPER SAN ROQUE REPEATER POINT UPPER MAYONG PAYONH HILL REPEATER POINT MT. JORMARAM REPEATER POINT / UPPER INLAGADIAN HILL REPEATER POINT CABID-AN SORSOGON OBSERVATORY STATION	13 / 24



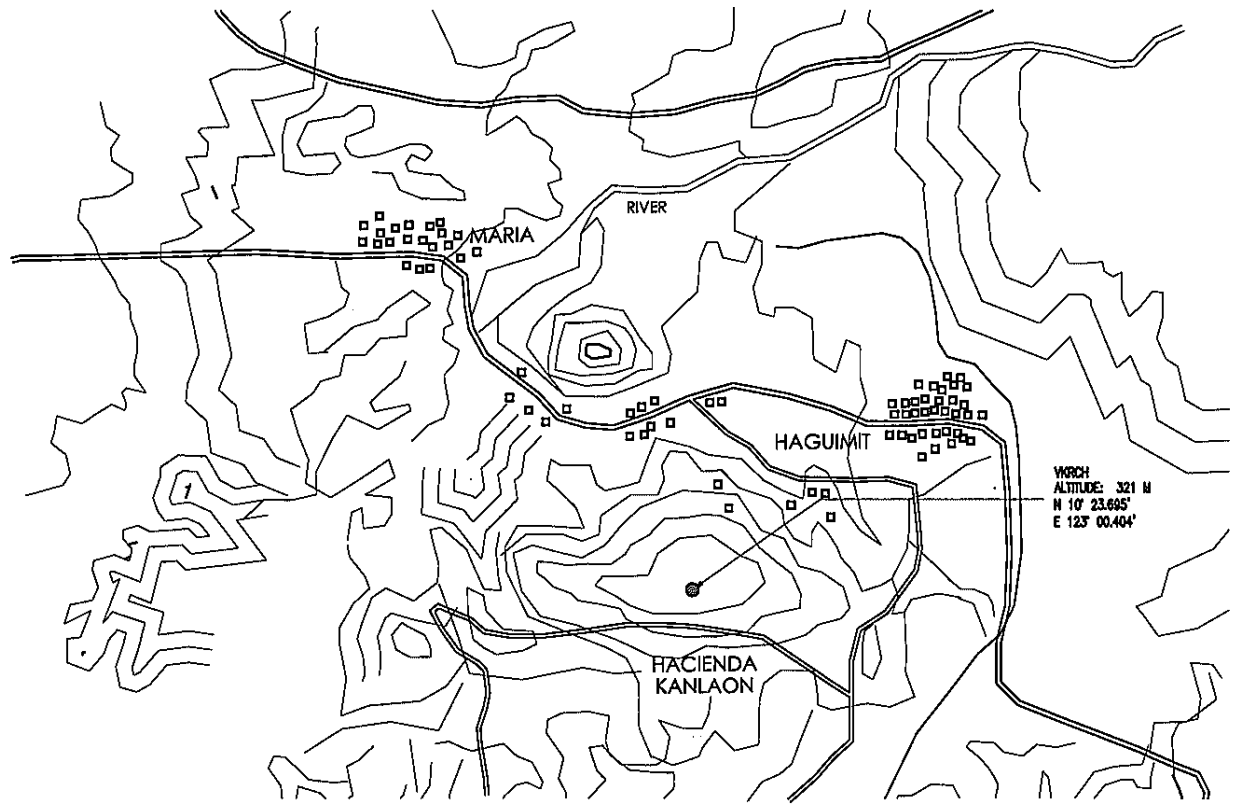
Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukura, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162	PROJECT TITLE : THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	DRAWING TITLE PROPOSED KANLAON OBSERVATION & REPEATER POINTS LOCATION : KANLAON, NEGROS OCCIDENTAL, PHILIPPINES	SHEET CONTENTS : PROPOSED KANLAON OBSERVATION & REPEATER POINTS SITE LOCATION MAP LOCATION MAP	DRAWING No. 14/24



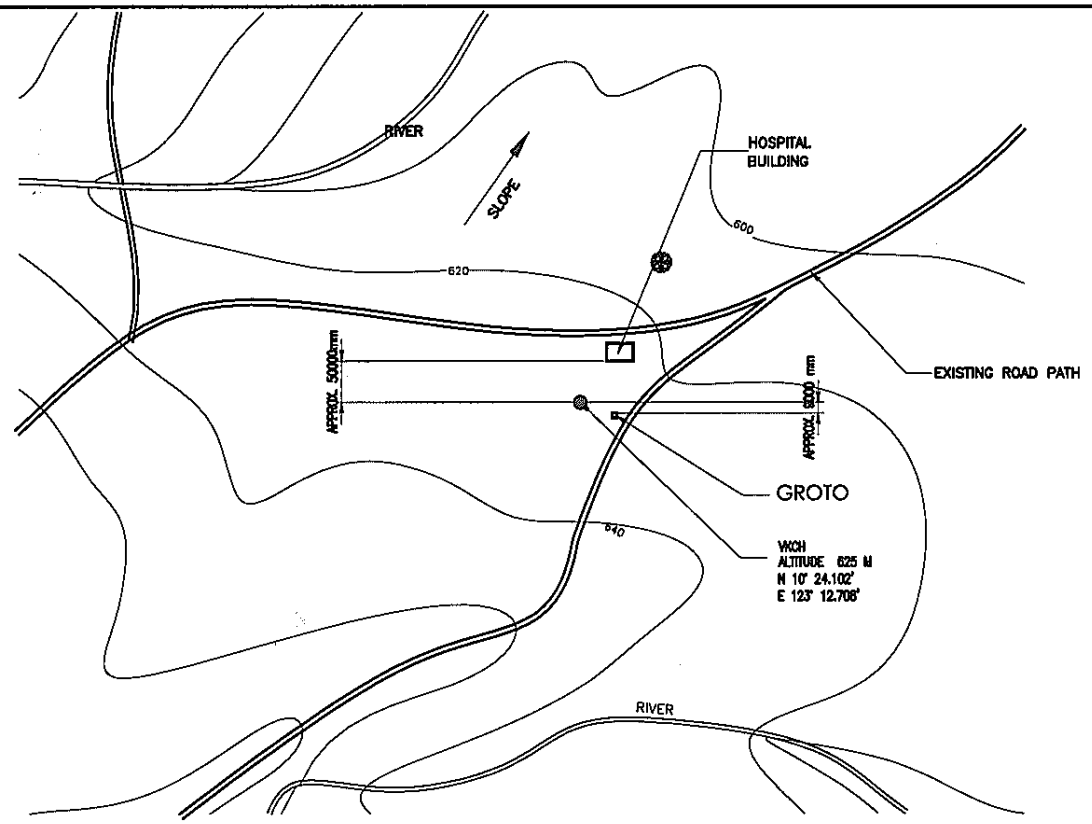
KANLAON VOLCANO OBSERVATORY
(LA CARLOTA CITY COLLEGE)



SANTO BAMA OBSERVATION POINT



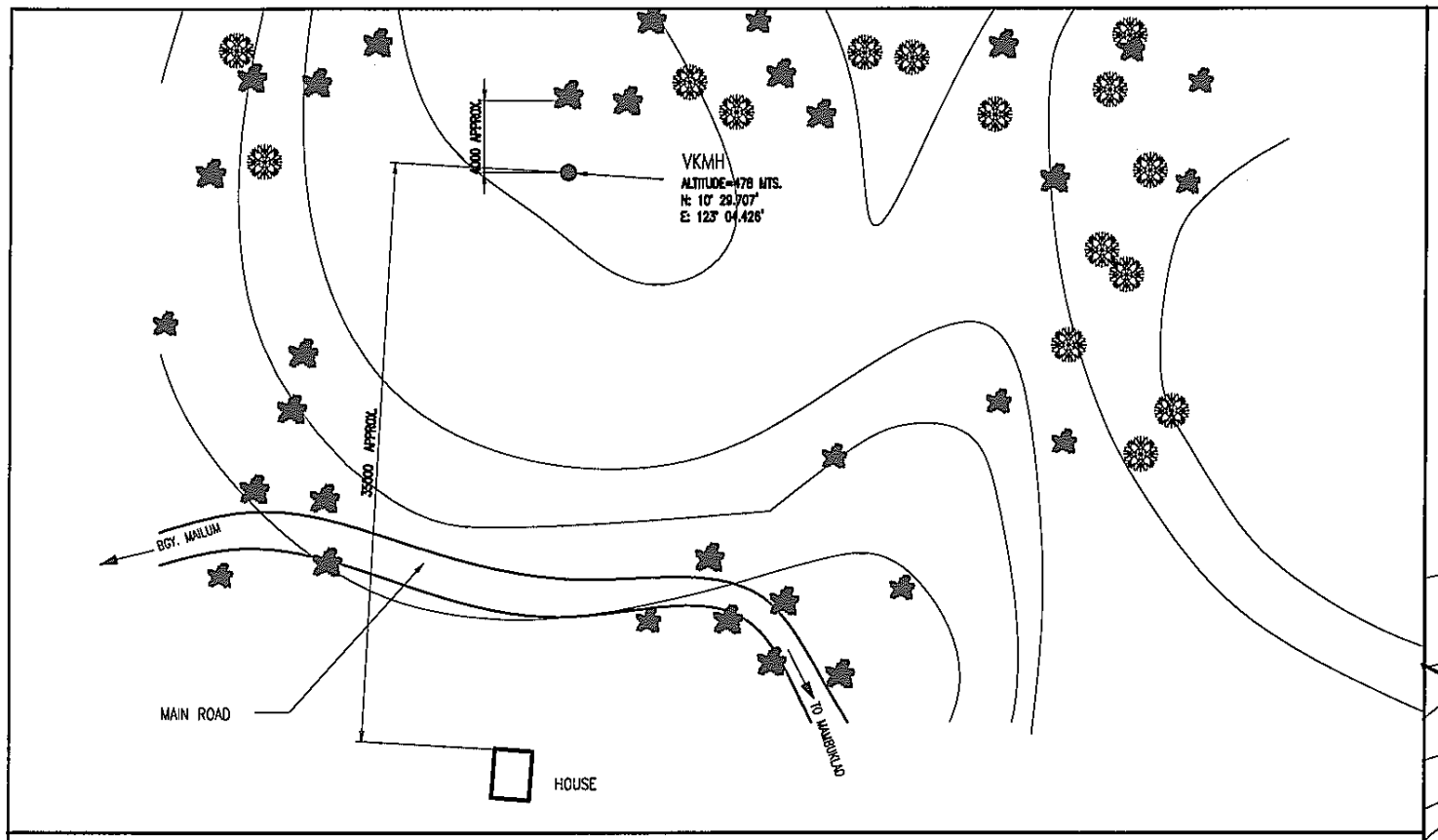
CALVARY HILL REPEATER POINT



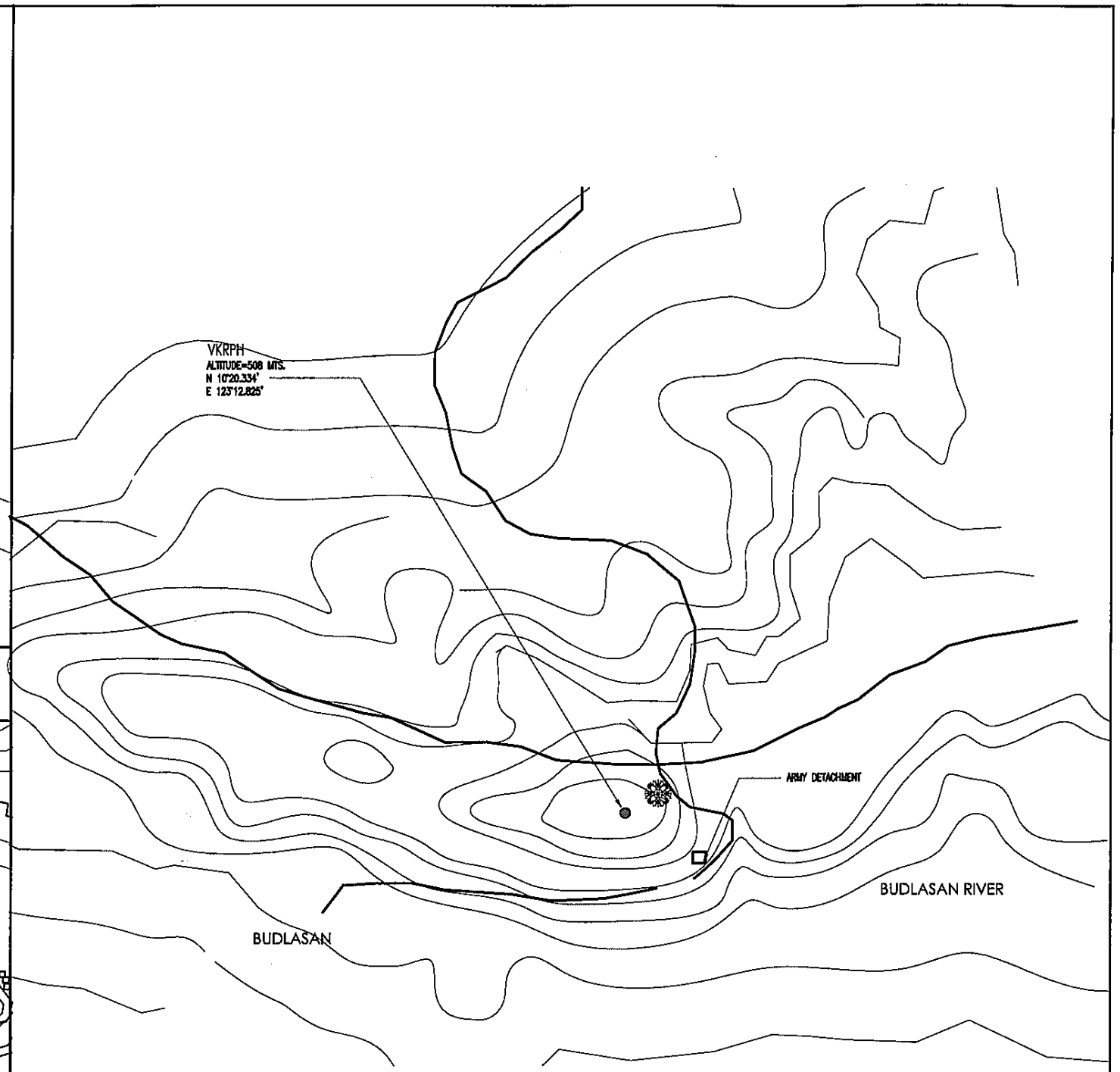
CANLAON DISTRICT
HOSPITAL OBSERVATION STATION

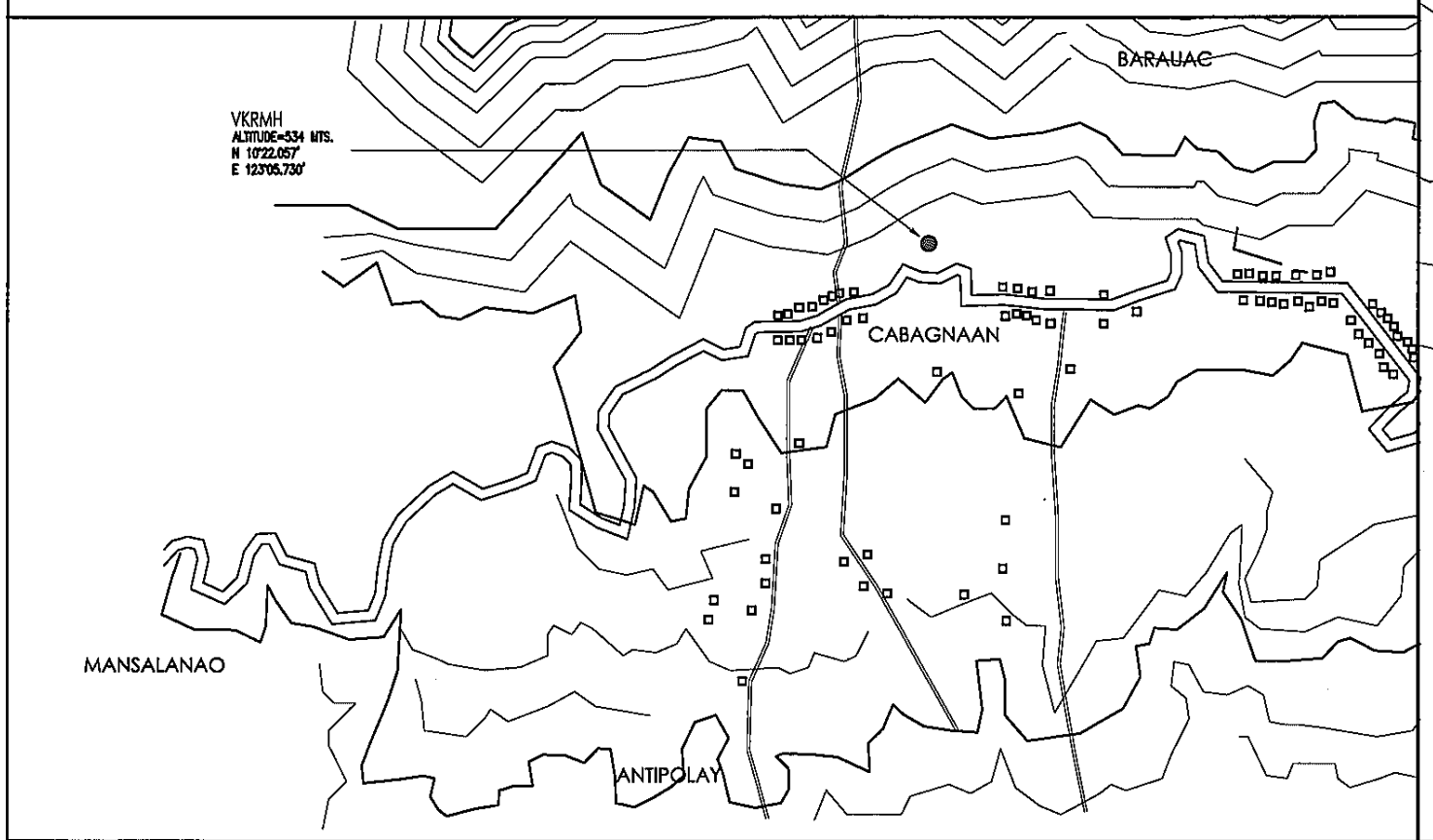
Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo,
170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED KANLAON OBSERVATION & REPEATER POINT LOCATION : KANLAON, NEGROS OCCIDENTAL, PHILIPPINES	CANLAON OBSERVATORY STATION CALVARY HILL REPEATER POINT SANTO BAMA OBSERVATORY STATION KANALON DISTRICT HOSPITAL OBSERVATION STATION	15 / 24



MANGHUMAY OBSERVATION POINT





MANSALANAO HILL REPEATER POINT

PINAMINTAGAN REPEATER POINT

Japan Weather Association
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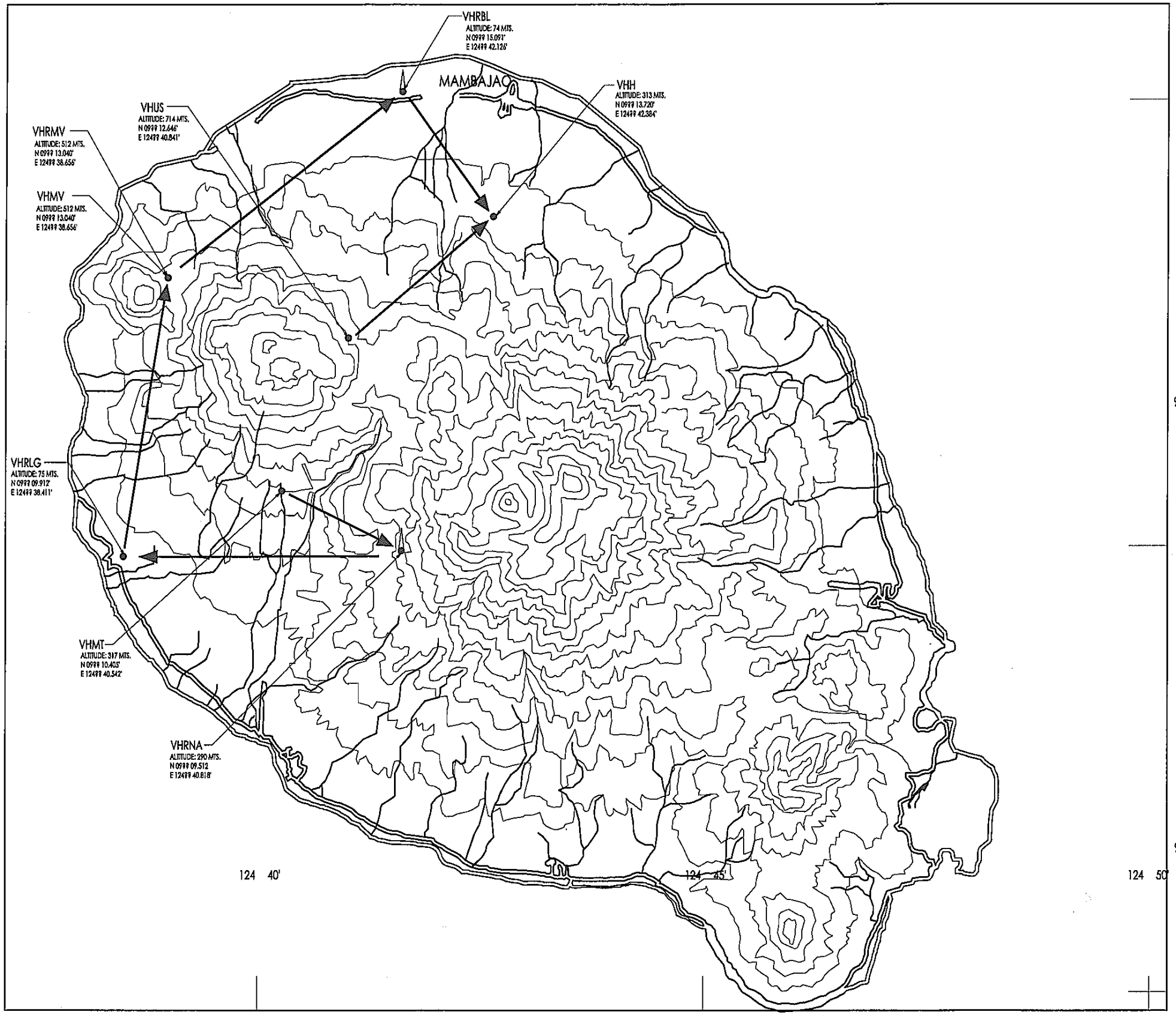
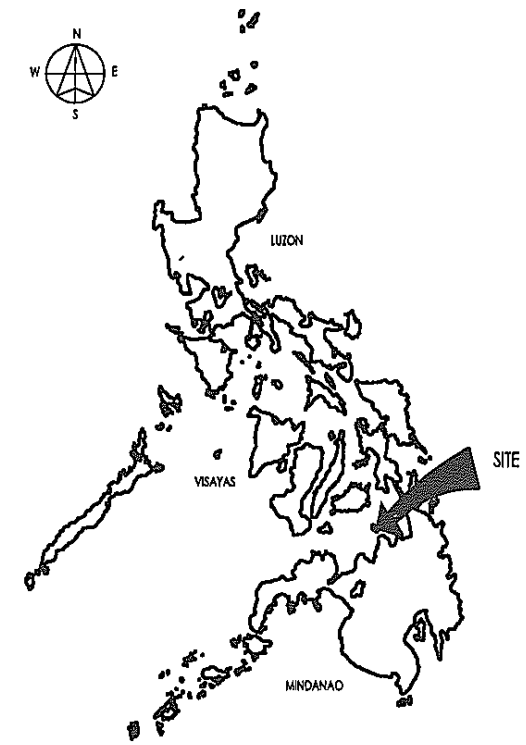
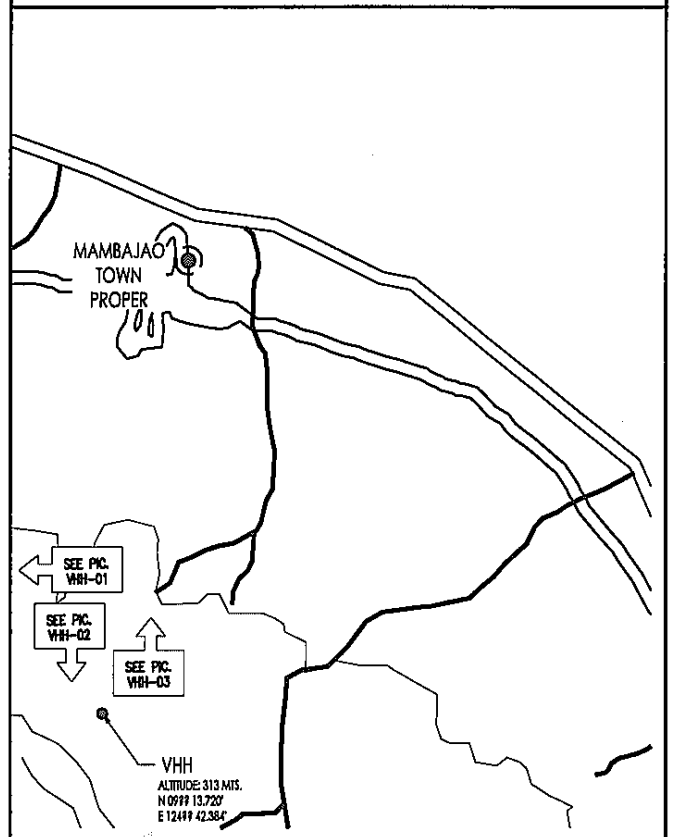
PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED KANLAON OBSERVATION & REPEATER POINTS LOCATION : KANLAON, NEGROS OCCIDENTAL, PHILIPPINES	MANGHUMAY OBSERVATION STATION MANSALANAO HILL REPEATER POINT PINAMINTAGAN REPEATER POINT	16 / 24



PROPOSED HIBOK-HIBOK OBSERVATION & REPEATER POINTS



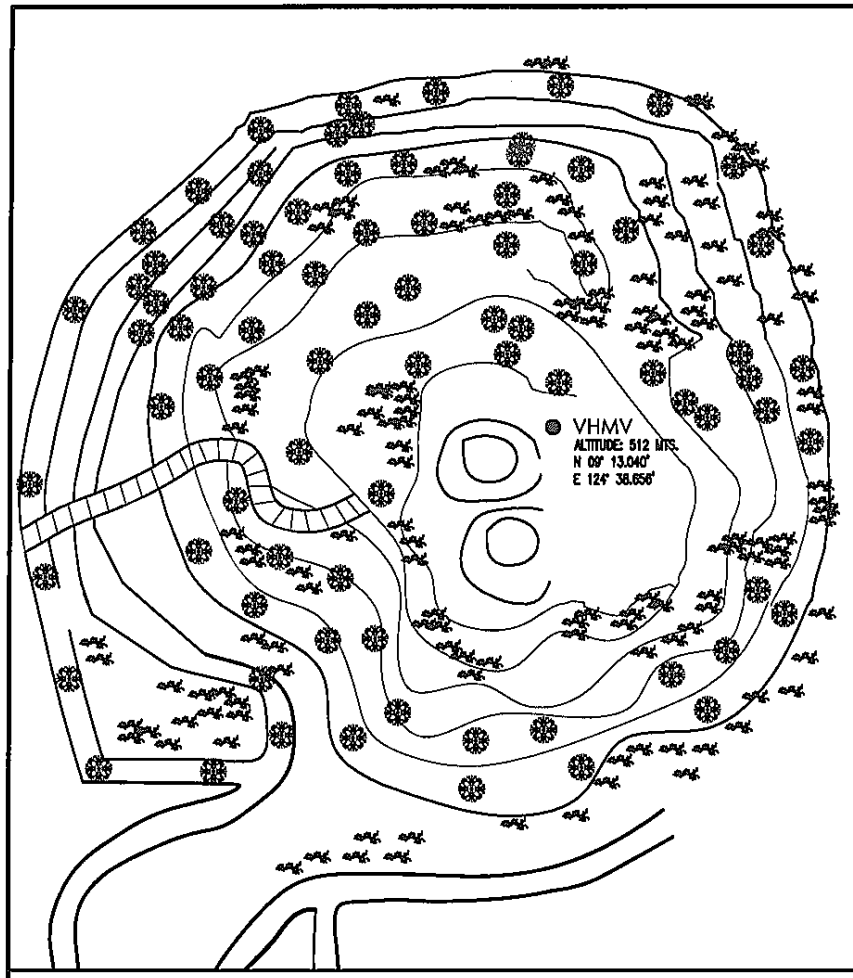
LOCATION MAP



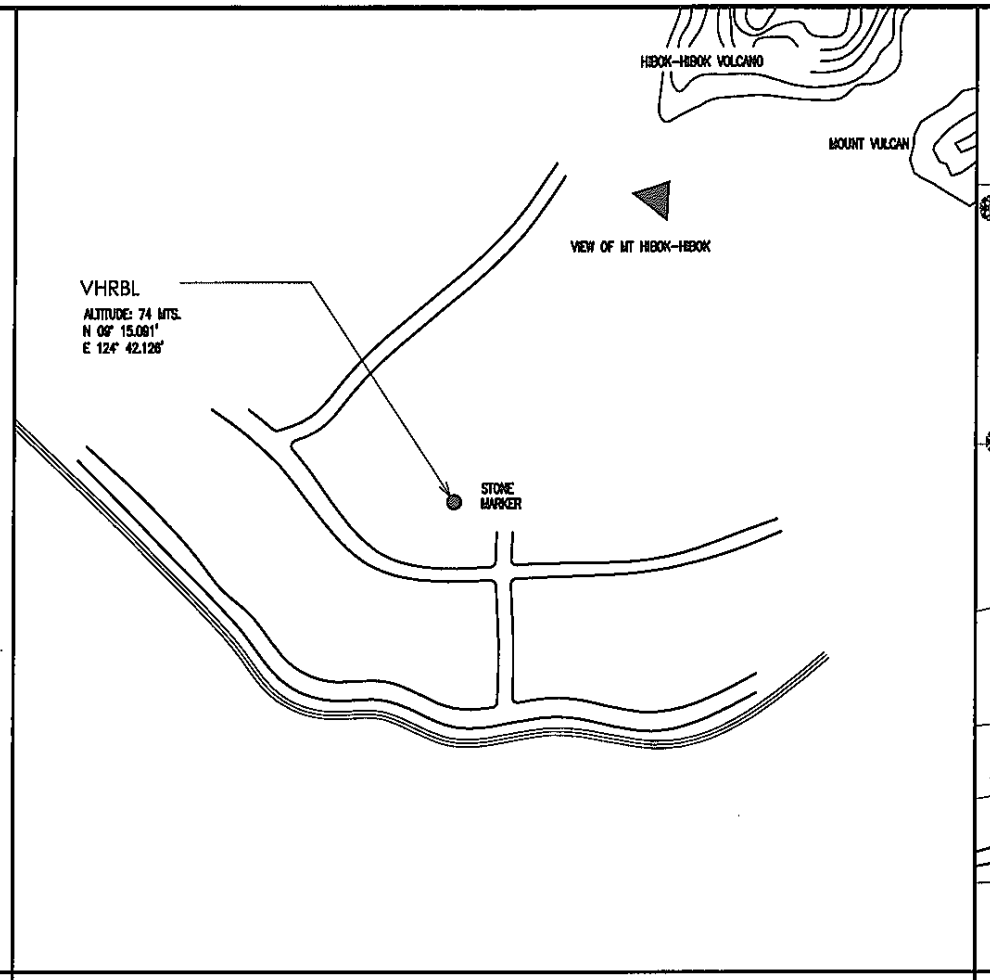
HIBOK-HIBOK VOLCANO OBSERVATORY

Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo,
170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

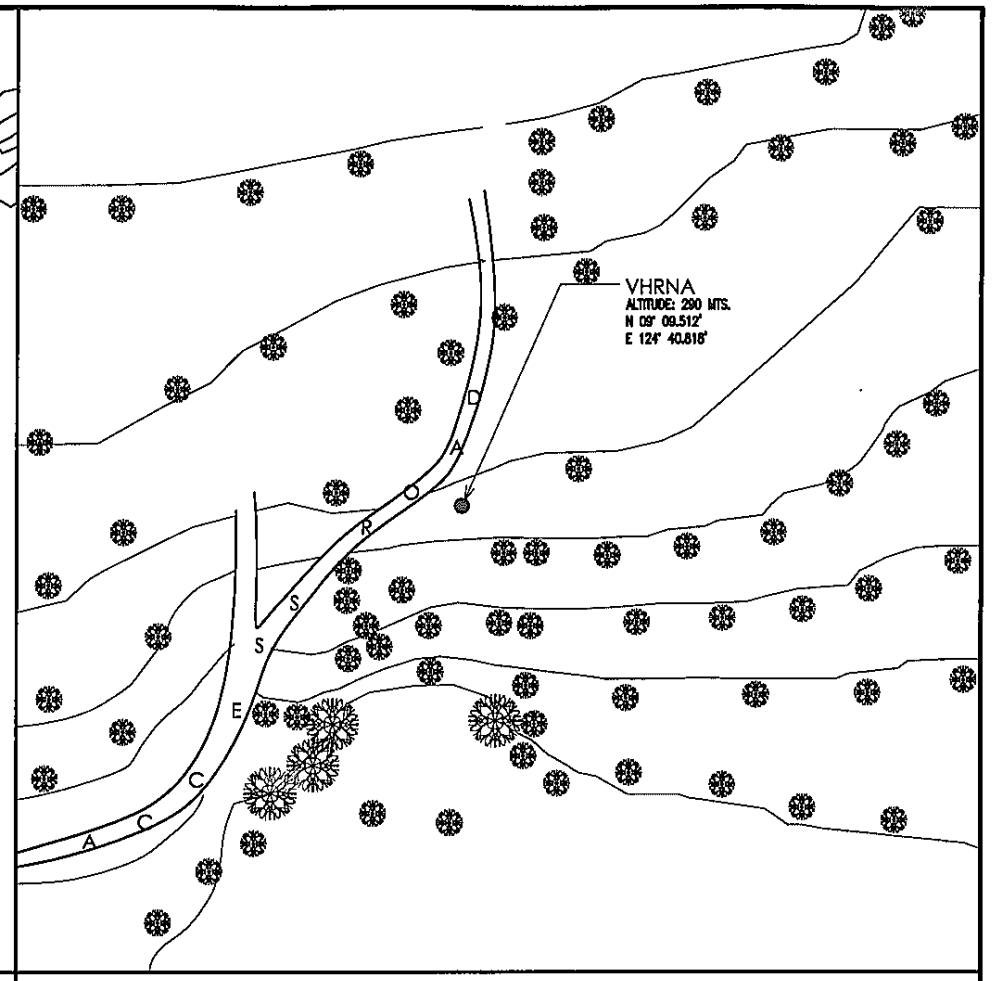
PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED HIBOK-HIBOK OBSERVATION & REPEATER POINTS LOCATION : HIBOK-HIBOK CAMIGUIN	HIBOK-HIBOK OBSERVATION & REPEATER POINTS LOCATION MAP SITE LOCATION MAP	17/24



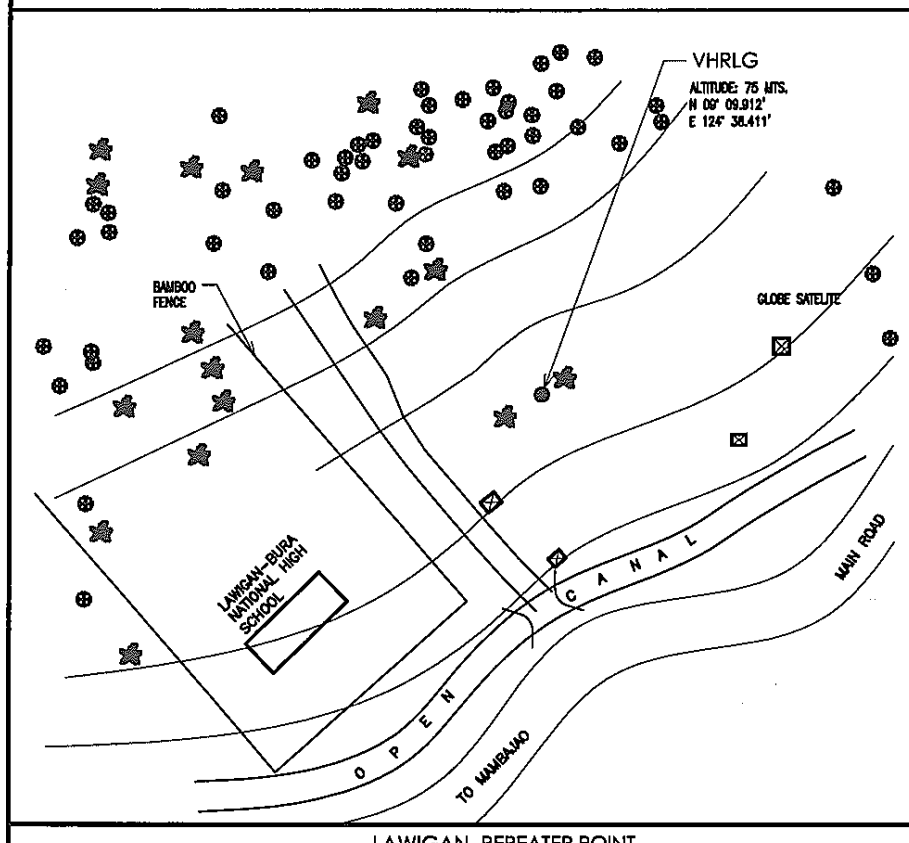
MOUNT VULCAN PEAK OBSERVATION POINT



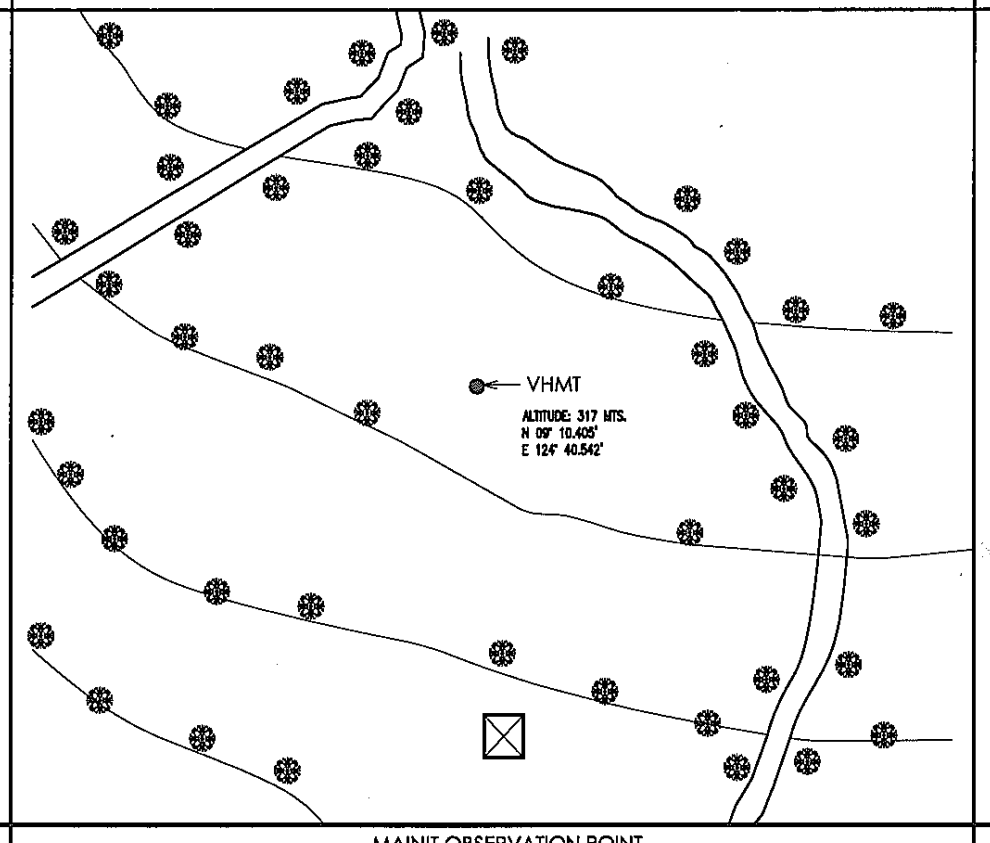
BAYLAO REPEATER POINT



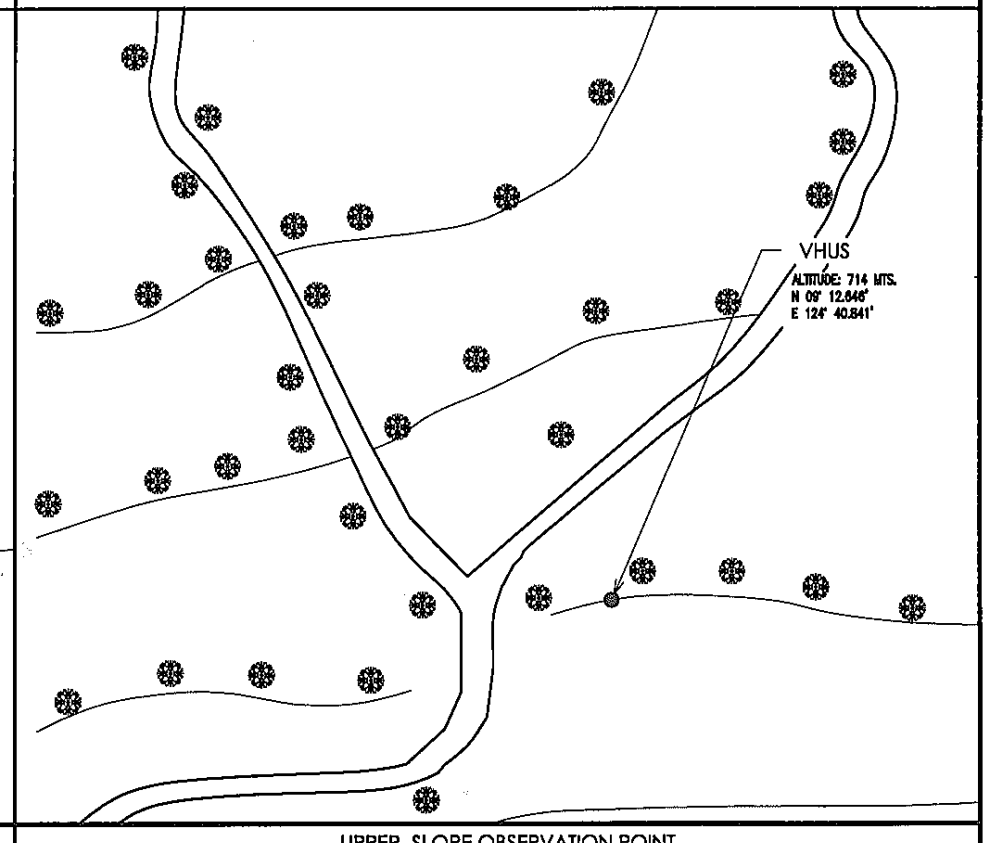
NAPO REPEATER POINT



LAWIGAN REPEATER POINT



MAINIT OBSERVATION POINT



UPPER SLOPE OBSERVATION POINT

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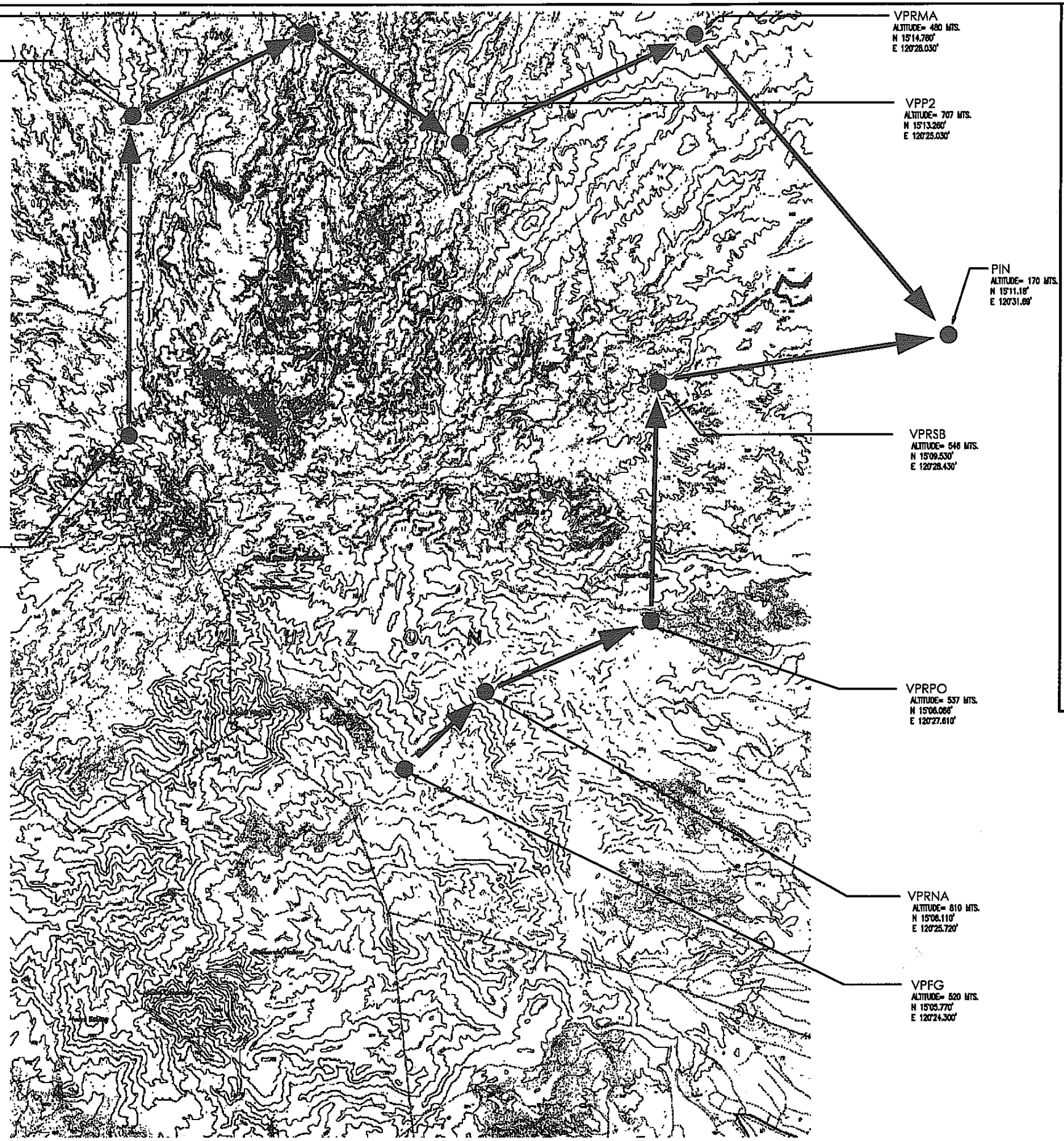
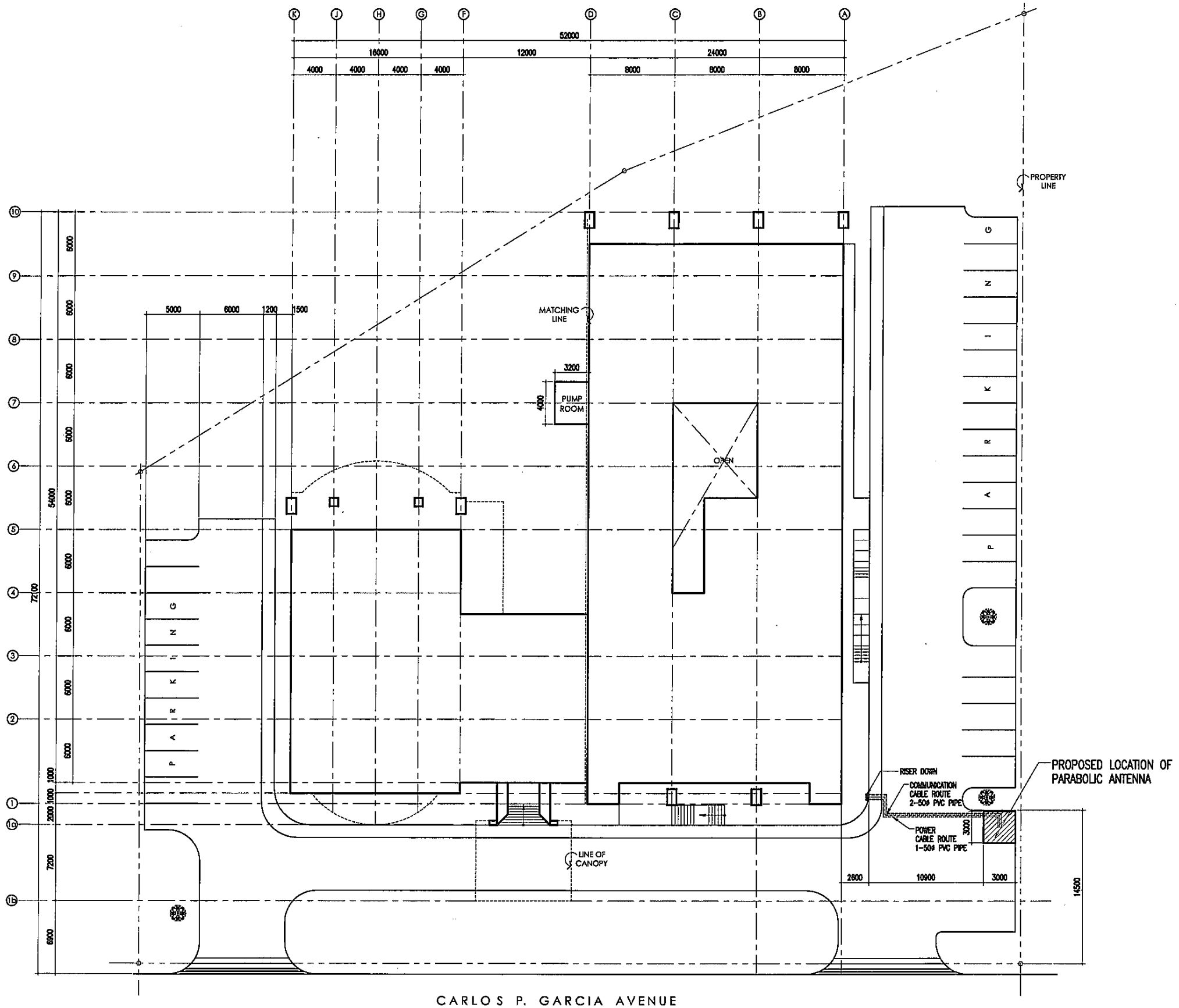
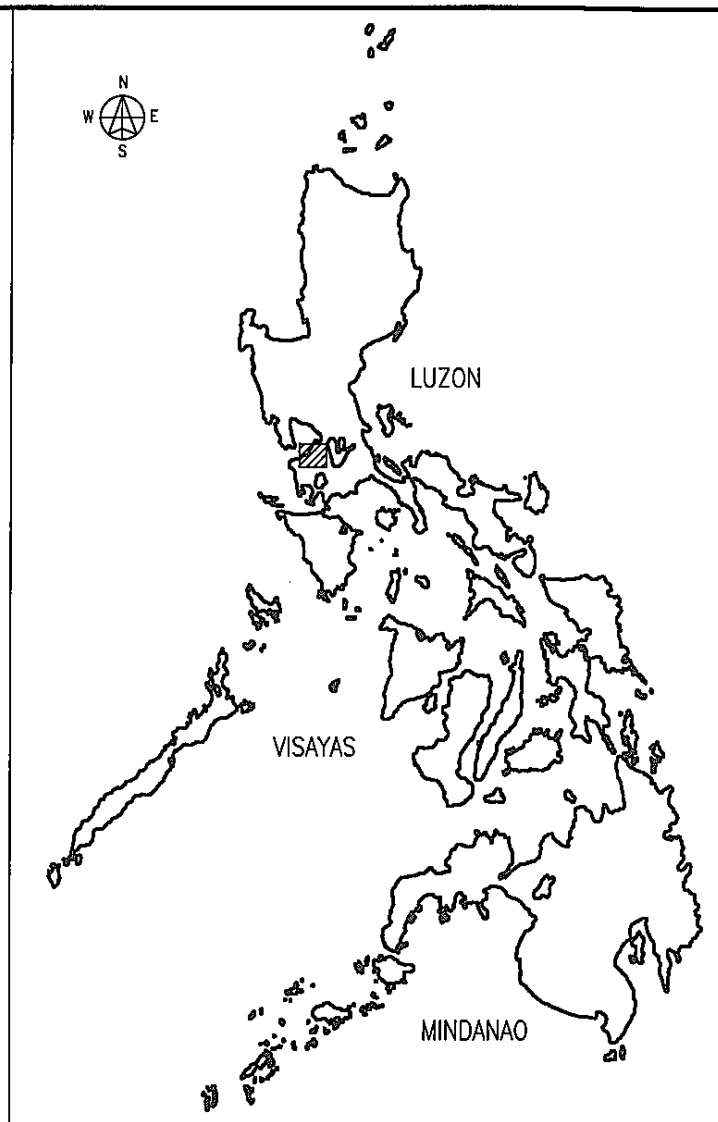
PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED HIBOK-HIBOK OBSERVATION & REPEATER POINTS LOCATION : HIBOK-HIBOK CAMIGUIN	MOUNT VULCAN PEAK OBSERVATION POINT BAYLAO REPEATER STATION HIBOK-HIBOK VOLCANO OBSERVATORY LAWIGAN REPEATER STATION,NAPO REPEATER STATION USOP OBSERVATION POINT, MAINIT OBSERVATION POINT	18 / 24

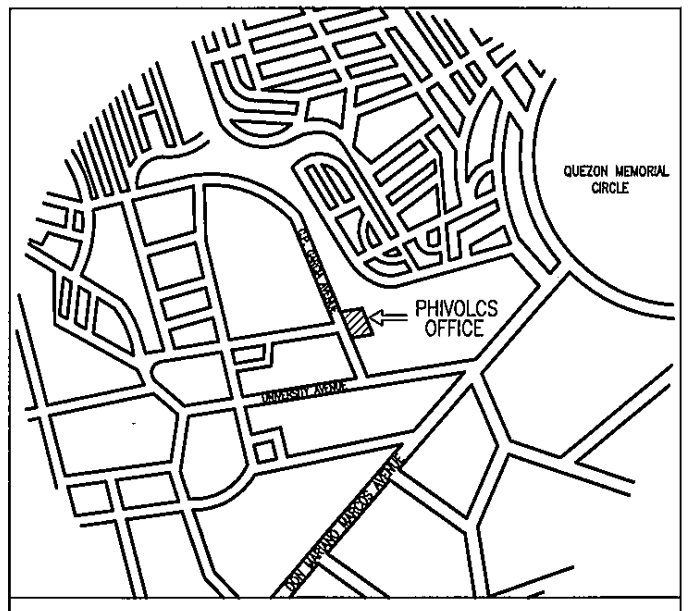


Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162	PROJECT TITLE : THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	DRAWING TITLE PROPOSED PINATUBO OBSERVATION & REPEATER POINTS LOCATION : PINATUBO , ZAMBALES , PHILIPPINES	SHEET CONTENTS : PROPOSED PINATUBO VOLCANO MONITORING NETWORK LOCATION MAP SITE LOCATION MAP (PHIVOLCS OFFICE)	DRAWING No. 19/24



SITE DEVELOPMENT COMMUNICATION CABLE & POWER CABLE LAYOUT
SCALE 1:400

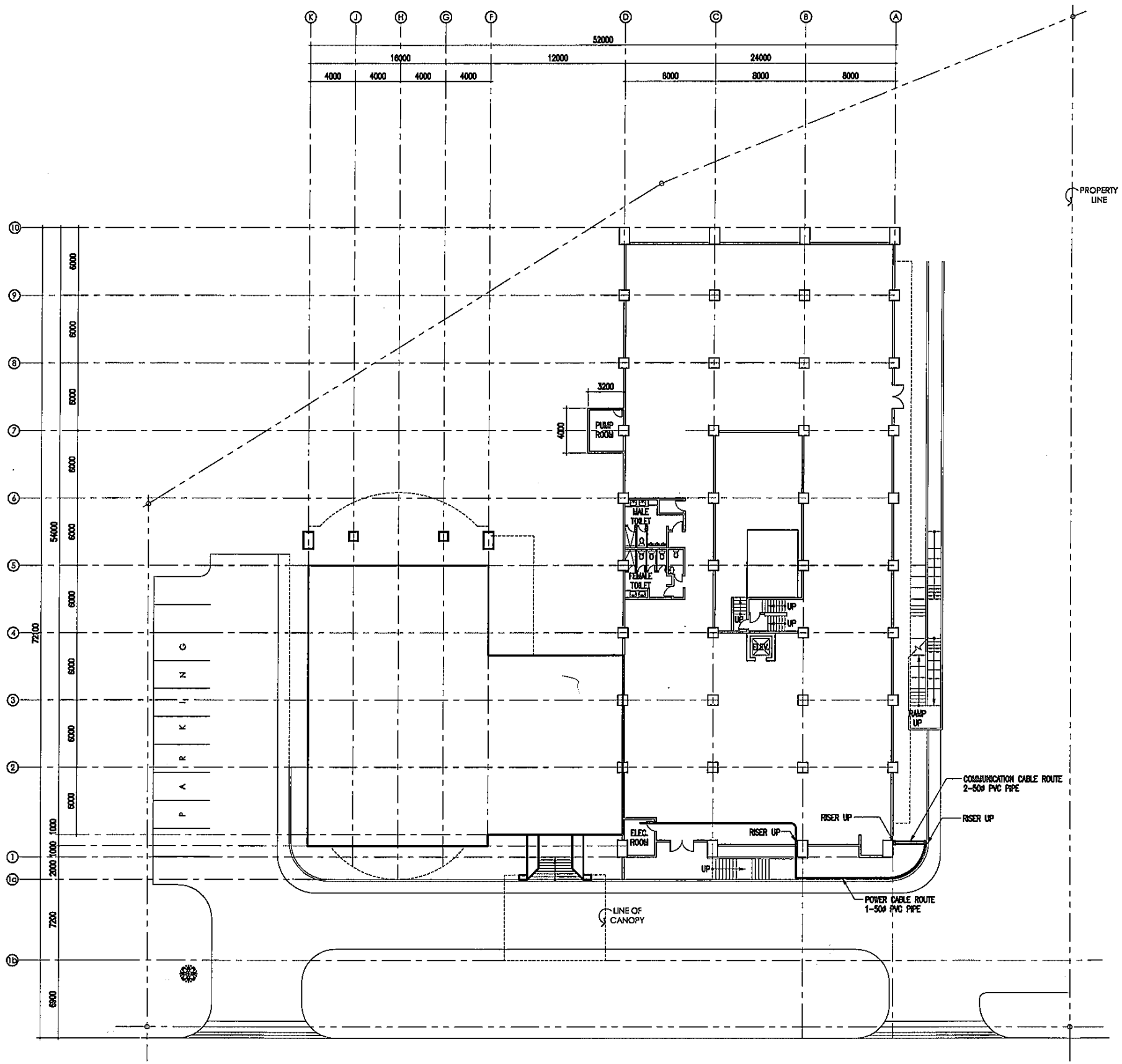




VICINITY MAP

Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

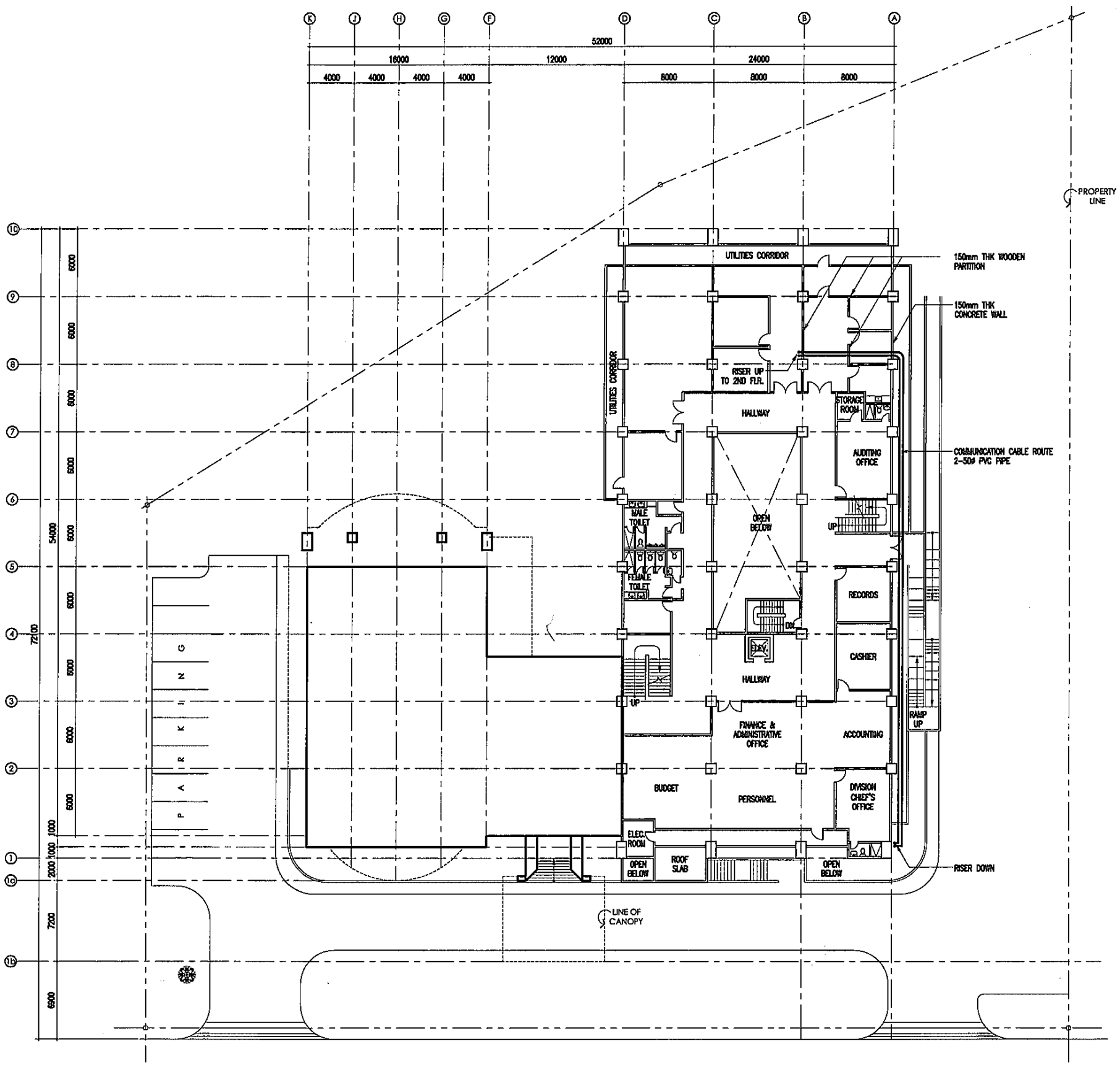
PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED PARABOLIC ANTENNA AT PHIVOLCS HEAD OFFICE LOCATION : C.P. GARCIA AVE. UP CAMPUS, DILIMAN, QUEZON CITY	SITE DEVELOPMENT COMMUNICATION & POWER CABLE LAYOUT	20/24



GROUND FLOOR COMMUNICATION & POWER CABLE PLAN
SCALE 1:400

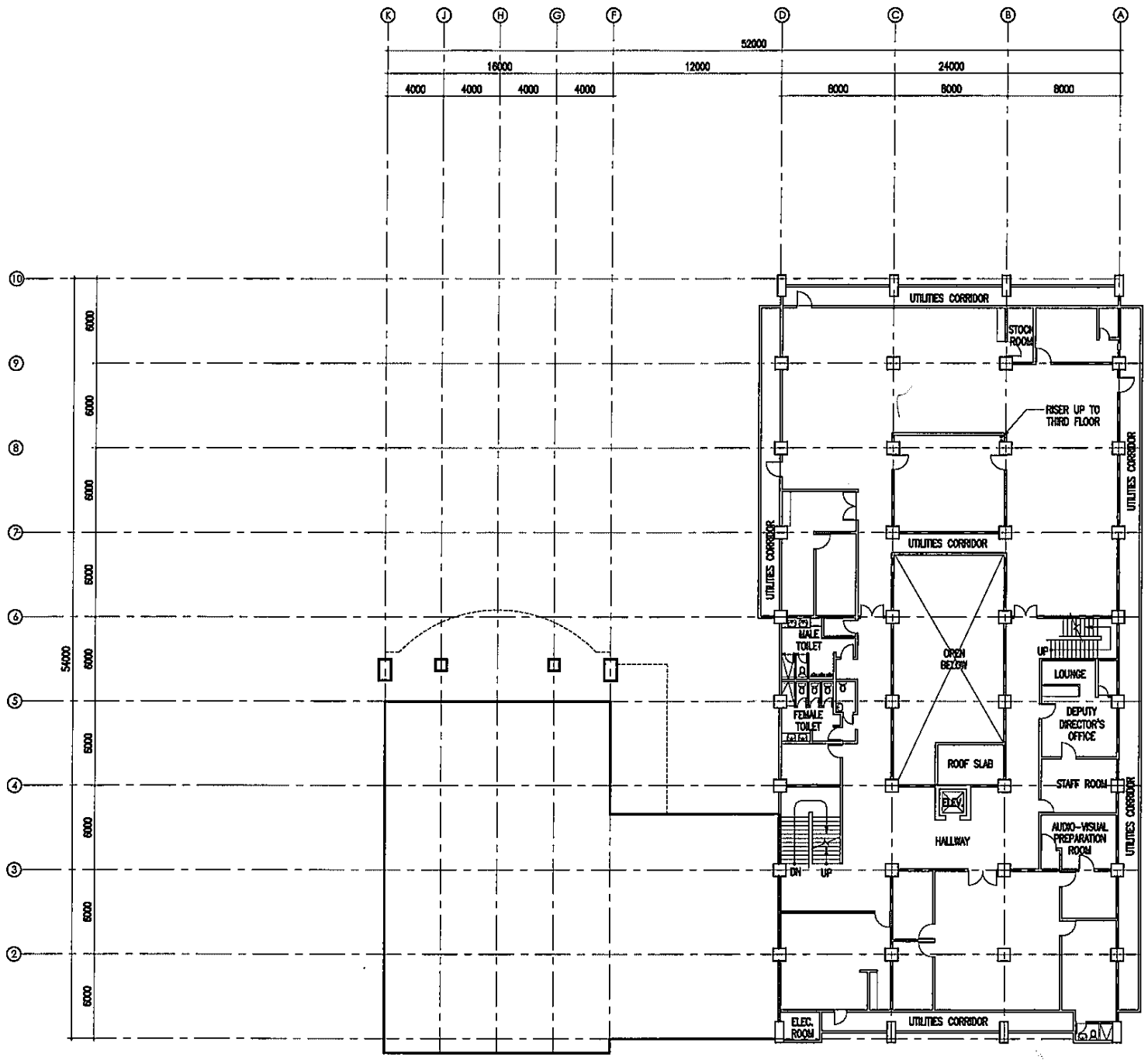
Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

PROJECT TITLE :	DRAWING TITLE	SHEET CONTENTS :	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	PROPOSED PARABOLIC ANTENNA AT PHIVOLCS HEAD OFFICE LOCATION : C.P. GARCIA AVE. UP CAMPUS, DILIMAN, QUEZON CITY	GROUND FLOOR COMMUNICATION & POWER CABLE LAYOUT	21/24



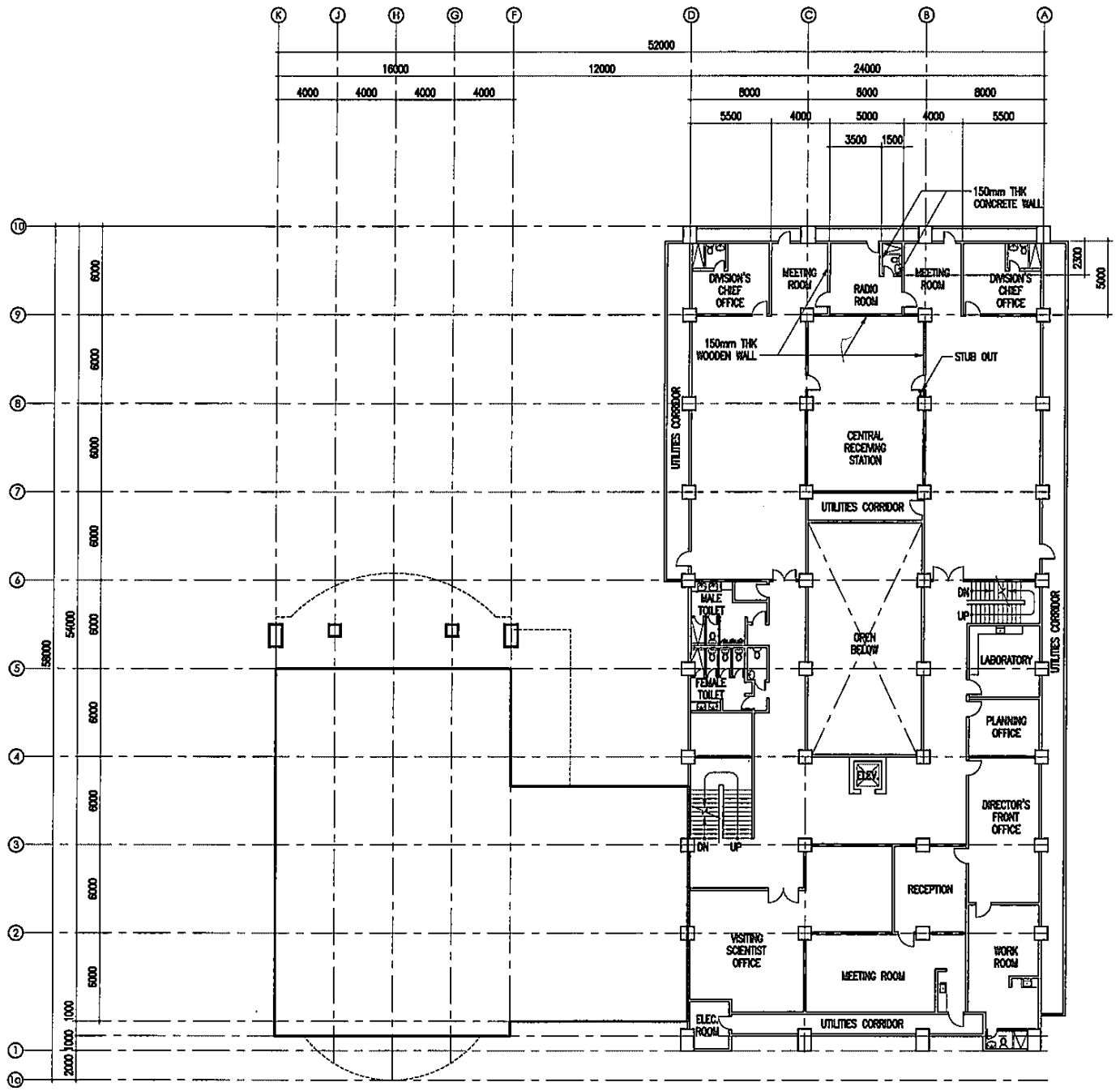
FIRST FLOOR COMMUNICATION CABLE LAYOUT
SCALE 1:400

Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162	PROJECT TITLE : THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	DRAWING TITLE PROPOSED PARABOLIC ANTENNA AT PHIVOLCS HEAD OFFICE LOCATION : C.P. GARCIA AVE. UP CAMPUS, DILIMAN, QUEZON CITY	SHEET CONTENTS : FIRST FLOOR COMMUNICATION CABLE LAYOUT	DRAWING No. 22/24



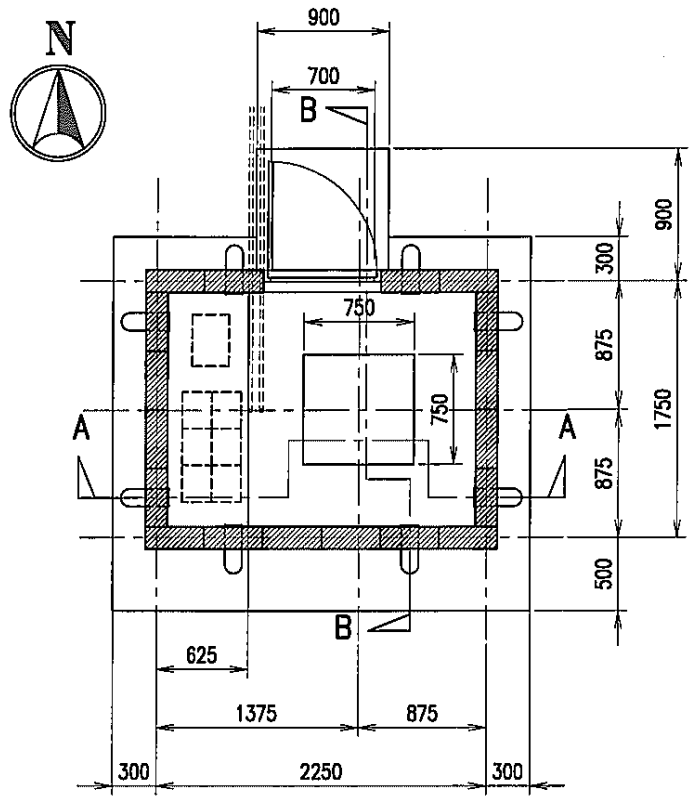
SECOND FLOOR COMMUNICATION CABLE LAYOUT
SCALE 1:400

Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162	PROJECT TITLE : THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	DRAWING TITLE PROPOSED PARABOLIC ANTENNA AT PHIVOLCS HEAD OFFICE LOCATION : CP GARCIA AVE., UP CAMPUS, DILIMAN, QUEZON CITY	SHEET CONTENTS : SECOND FLOOR COMMUNICATION CABLE LAYOUT	DRAWING No. 23 24

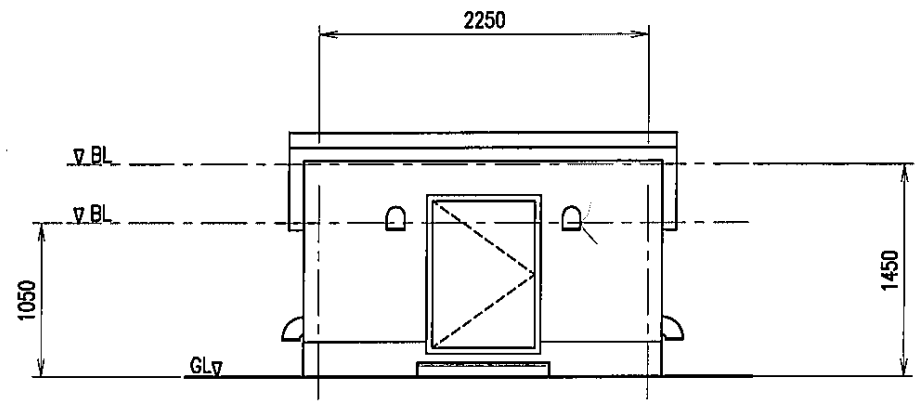


THIRD FLOOR COMMUNICATION CABLE LAYOUT
SCALE 1:400

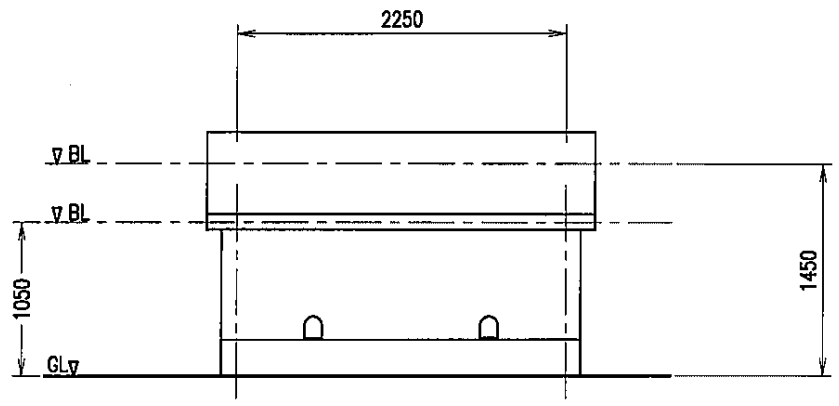
Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162	PROJECT TITLE : THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	DRAWING TITLE PROPOSED PARABOLIC ANTENNA AT PHIVOLCS HEAD OFFICE LOCATION : C.P. GARCIA AVE. UP CAMPUS, DILIMAN, QUEZON CITY	SHEET CONTENTS : THIRD FLOOR COMMUNICATION CABLE LAYOUT	DRAWING No. 24 24



FLOOR PLAN
SCALE 1:50



NORTH ELEVATION
SCALE 1:50



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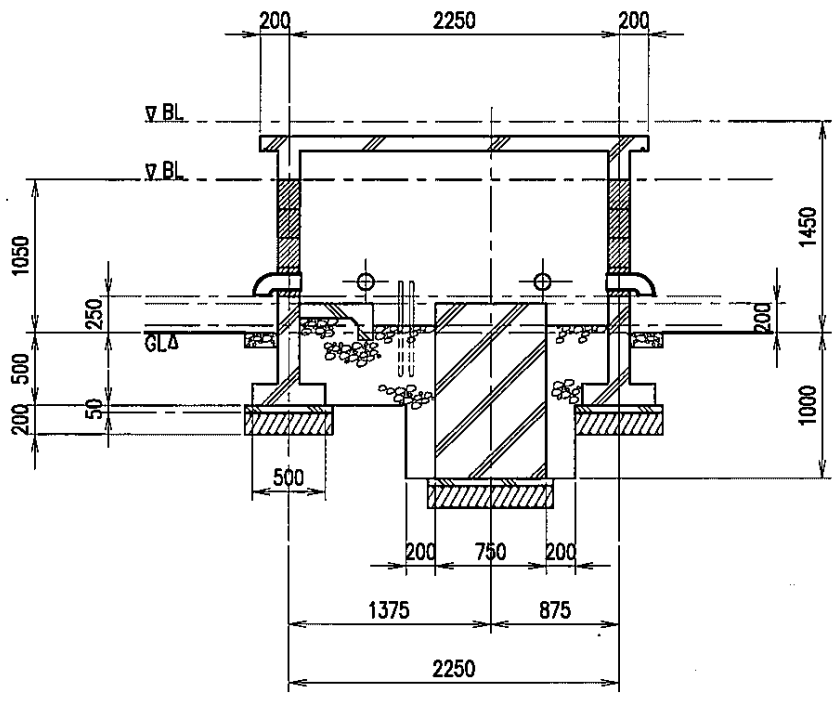

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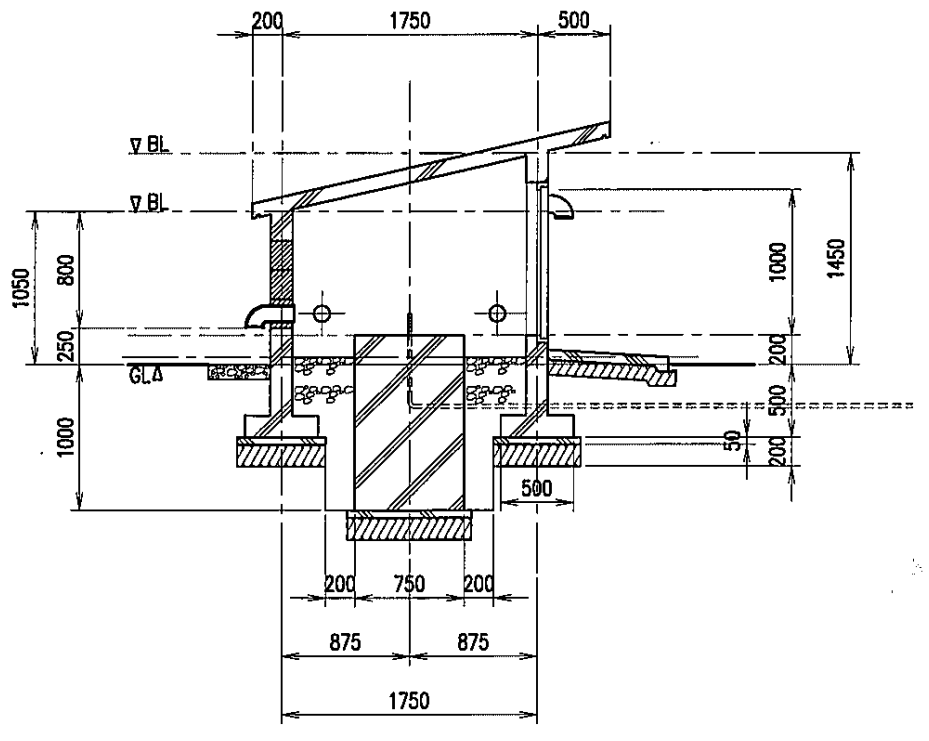

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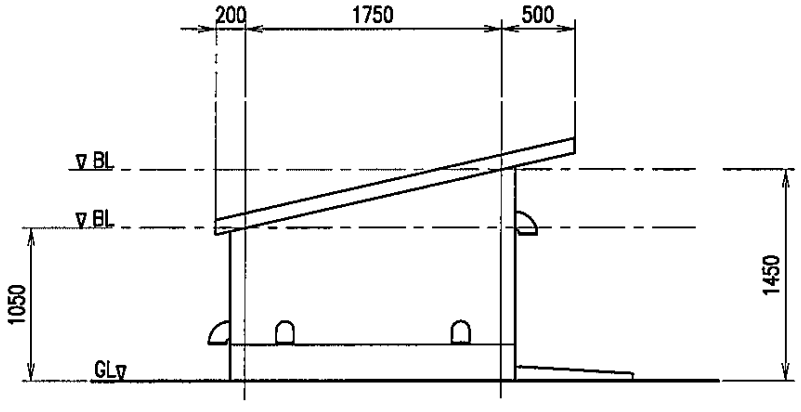
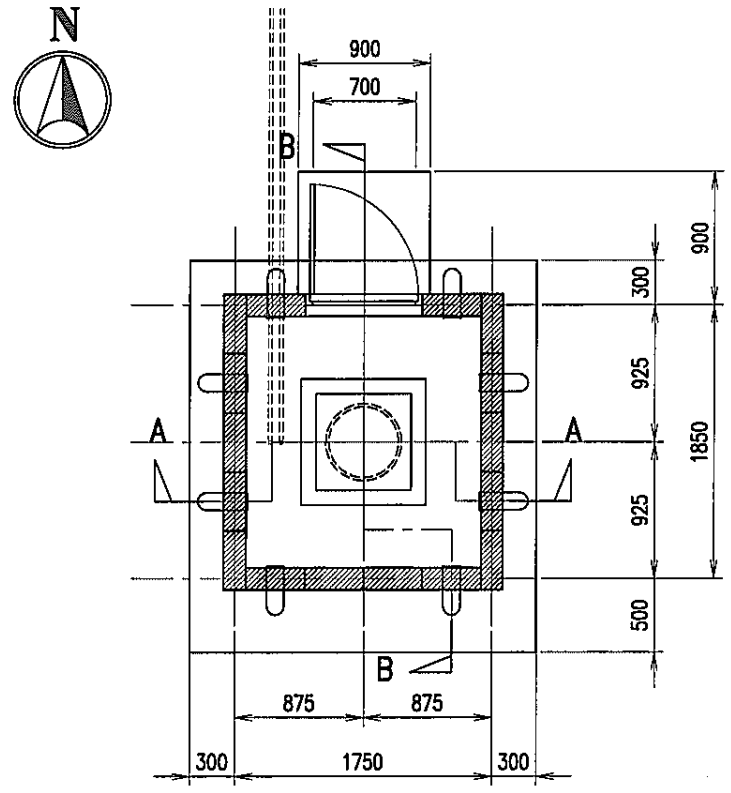


EAST & WEST ELEVATION
SCALE 1:50

Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162	PROJECT TITLE: THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	DRAWING TITLE: Short Period Sensor Shelter	SHEET CONTENTS: PLAN ELEVATIONS SECTIONS	DRAWING No. C-01



FLOOR PLAN
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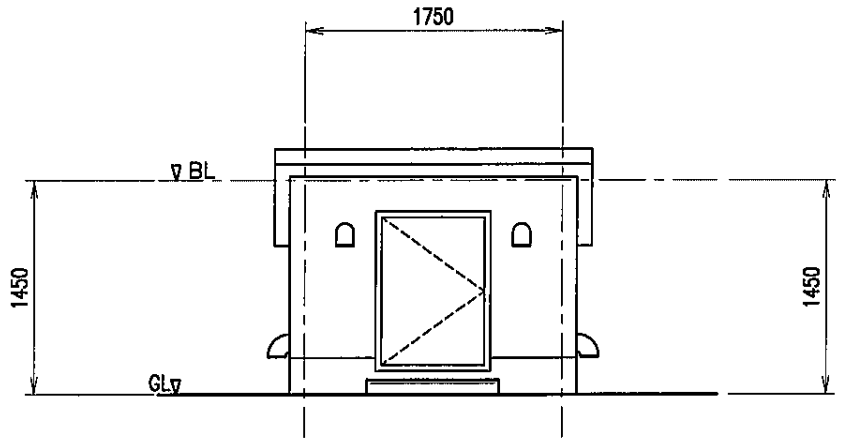

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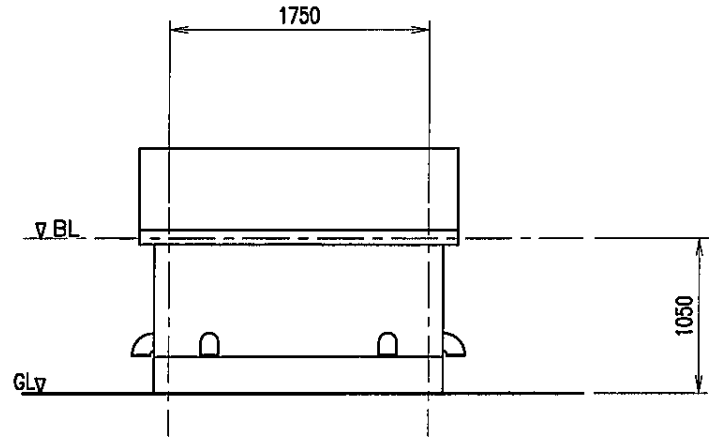

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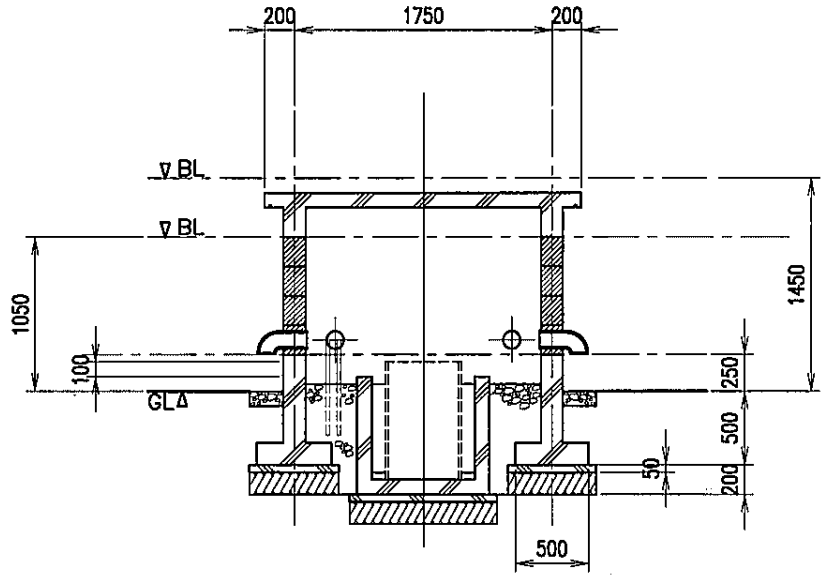

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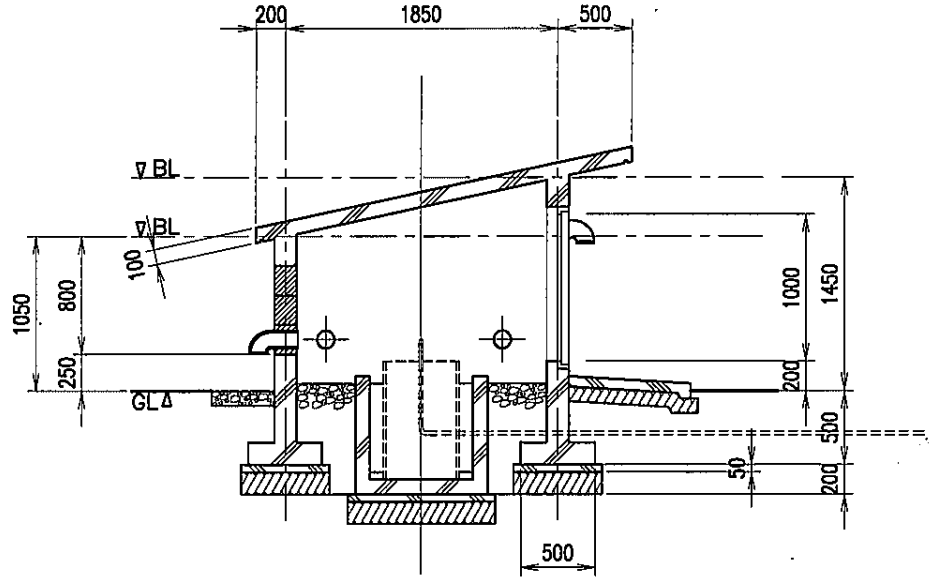

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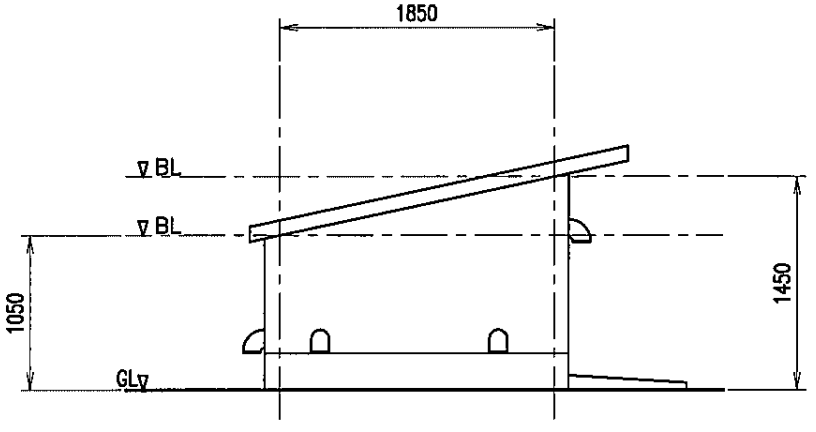

EAST & WEST ELEVATION
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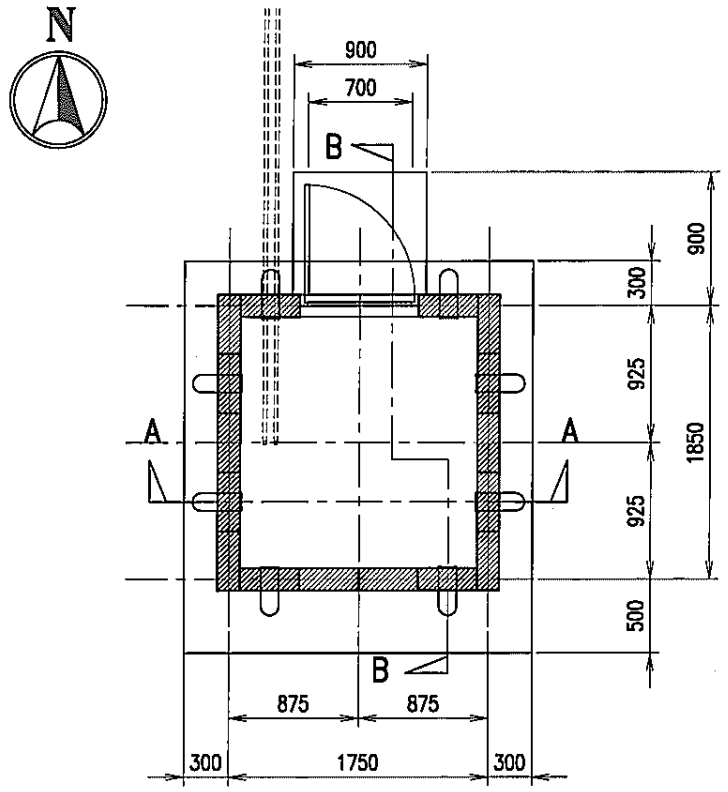
Japan Weather Association
Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162

PROJECT TITLE:	DRAWING TITLE:	SHEET CONTENTS:	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	Broadband Sensor Shelter	PLAN ELEVATIONS SECTIONS	C-02



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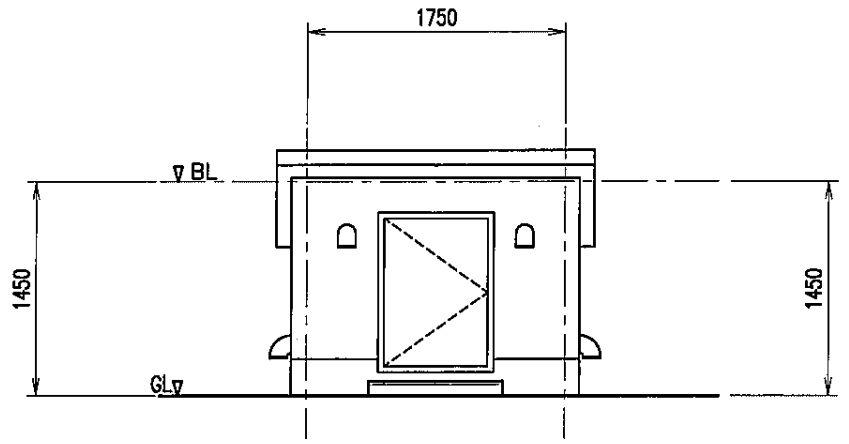

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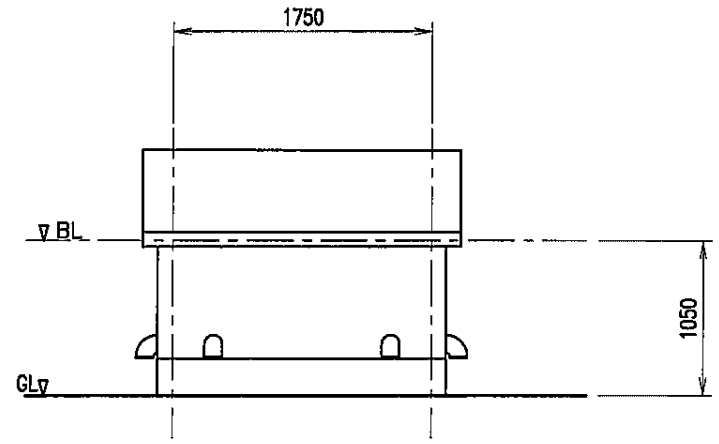

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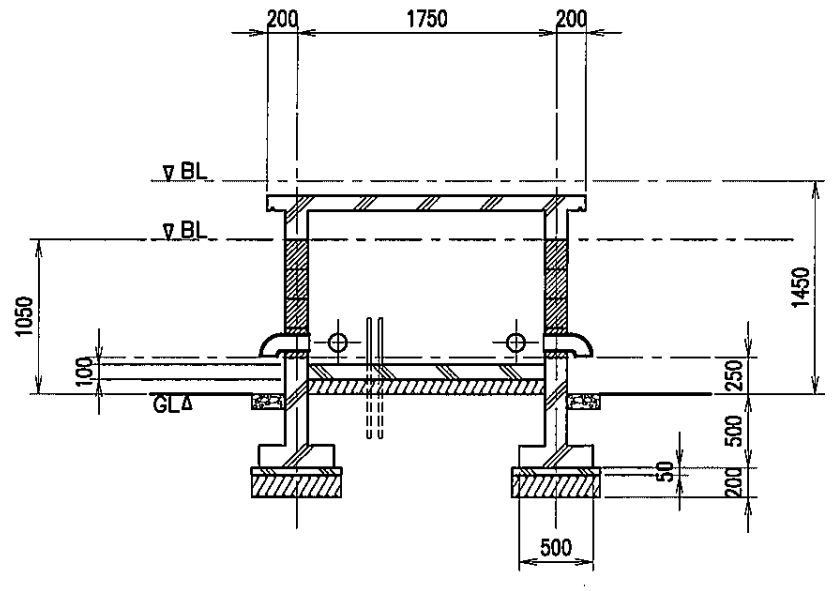

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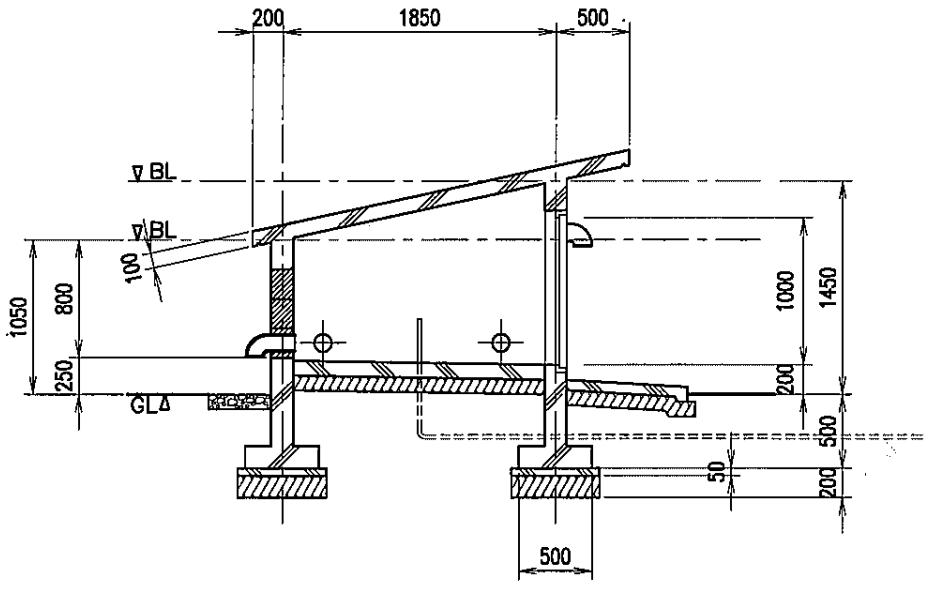

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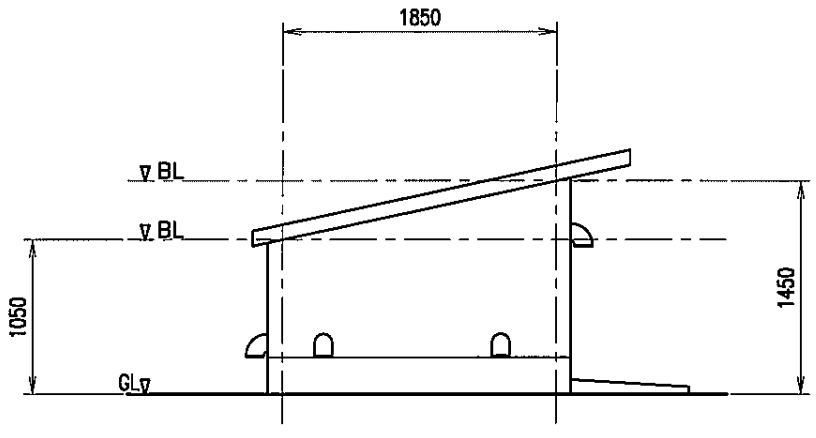

EAST & WEST ELEVATION
SCALE 1:50

Japan Weather Association
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PROJECT TITLE:	DRAWING TITLE:	SHEET CONTENTS:	DRAWING No.
THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES (PHASE II)	Repeater Shelter	PLAN ELEVATIONS SECTIONS	C-03

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The coordination among related implementation works for completion of the Project Phase II will be necessary, because the Project concerns systematically many fields such as volcanology, seismology, communication, civil engineering, etc. The acquisition and deployment of volcanic and seismic equipment is time constrained because these manufacturing take time. Thereby, time schedule management should be given particular attention.

(1) Executing agency of the Project

The responsible governmental agency of the Philippines for the implementation of the Project Phase II is the PHIVOLCS under supervision of Department of Science and Technology (hereinafter referred to as "DOST") and it will be a signer of Consultant Agreement and Contract as the Client.

(2) Consultant

After signing of the Exchange of Notes (E/N) for the Project Phase II between the Government of the Philippines and the Government of Japan, it is very significant to conclude an Agreement of the Consulting Services for the Project as early as possible. The Agreement of the Consulting Services will be signed by and between the PHIVOLCS and a consulting firm duly organized and existing under the laws of Japan, having its principal office in Japan and recommended by JICA.

(3) Contractor

A contractor (a trading company) duly organized and existing under the laws of Japan, having its principal office in Japan, with necessary qualifications, will be selected by an open public tender in accordance with the tender documents prepared by the Consultant in accordance with the JICA guide line and approved by the PHIVOLCS.

(4) Local Sub-contractors

Generally in the Philippines, the technical skills and levels of the major private local contractors are relatively sufficient and suitable for civil work and installation work of the equipment installation work together with engineers of the contractor. Local firms may participate in the Project Phase II as sub-contractors but must be not responsible for the whole or the main part of the work. The prime contractor will be responsible for any problem that may arise as a result of the non-compliance of the local sub-contractor to the technical specification.

(5) Procurement of the Equipment

Some of seismic and volcano monitoring equipment including software in seismology and volcanology are not available in Japan and the Philippines and also some of the equipment from member countries of Organization for Economic Cooperation and Development (hereinafter referred to as "O.E.C.D.") are cheaper than Japanese products. In connection with easy procurement of spare parts, maintaining levels of sophisticated equipment, it will be essential to procure such components from member countries of Organization for Economic Cooperation and Development (hereinafter referred to as "O.E.C.D.") including Japan.

(6) Schedule of the Project Phase II

The Project Phase II will be divided into 2 packages as A and B due to the implementation schedule of the Project Phase II.

(7) Separation of the Tender

In A Package, 7 sets of broadband seismometers are included. However, broadband seismometers are produced by only a few manufacturers in the world. In order to conduct fare tendering and to widely invite bidders, the Tender of A Package will be consisted with two (2) lots as Lot-1 and Lot-2. Lot-1 is 7 sets of broadband seismic observation systems including necessary delivery and installation works and Lot-2 is all the remaining components of A Package.

(8) Equipment Delivery and Installation Work in Mindanao Islands

The PHIVOLCS will be responsible for delivery and installation works of the equipment for some of the project sites in Mindanao islands located in the rural areas having security problem at his expense.

2-2-4-2 Implementation Conditions

Seismic & volcano monitoring equipment, computing equipment and other sophisticated equipment will be installed at unmanned observation points to be established under the Project Phase II. Thus, power back-up equipment (battery, solar panel, UPS, etc.) for these equipment are indispensable for uninterrupted operation. In accordance with the implementation schedule, dispatch of specialized engineers are required at the time of the installation, adjustment and wiring for the equipment and power supply back-up equipment. In addition to these dispatch mentioned above, specialized high skilled engineers for installation, adjustment and commissioning works of seismic & volcano monitoring equipment, data communication equipment (VSAT), computing equipment and

other sophisticated equipment are necessary for keeping high precision and quality of the installation work for. Such high precision and quality are necessary for accurate monitoring.

Furthermore, personnel of the Consultant and the contractor to perform their obligations under the verified contract. Cautious consideration should be given in making appropriate arrangements for the delivery and installation of the equipment and systems and in taking necessary measures on security for the personnel against any force majeures and dangerous factors through discussions with the PHIVOLCS and study in the Philippines.

2-2-4-3 Scope of Works

Scope of works to be undertaken by the Japan side and the Philippines side for the implementation of the Project are as follows.

- Scope of works to be undertaken by the Japan's Grant Aid Assistance
  a. Procurement of required equipment
  b. Transport of the equipment to the various project sites
  c. Installation work for the equipment
  d. Adjustment work for the equipment
  e. Commissioning for the total system

- Scope of works to be undertaken by the Philippine side
  a. Securing the required project sites
  b. Securing necessary frequency for the data communication systems
  c. Movement and relocation of the existing obstructive facilities on the sites, if required
  d. Necessary measures against any damage and disappearance for the equipment & systems
  e. Securing necessary permission and certificate for the construction of shelters and guyed masts & self support poles
  f. Fencing work for unmanned observation points, if required
  g. Access roads work for unmanned observation points
  h. Delivery and installation works for the equipment for some of the project sites having security problem in Mindanao island
     - Existing Seismic Observation Station: Bislig (only installation work)
     - Unmanned Seismic Observation Points: Butuan, Mati, Ipil, Pagadian and Central Mindanao University

・ Unmanned Volcano Observation Points: Parker and Matutum including required repeater points for data transmission

2-2-4-4 Consultant Supervision

(1) Principal Guidelines

1) To take a responsibility for expeditious project implementation and supervision for the project in accordance with the guidelines of Japan's Grant Aid Assistance and the basic design.
2) To communicate closely with responsible organizations and personnel of both countries, and complete the Project Phase II in time in accordance with the implementation schedule.
3) To provide appropriate advise and direction to personnel of the contractor.
4) To provide necessary instructions on installation methods and techniques to local contractors.
5) To provide instructions for construction and installation methods and technique to the PHIVOLCS's staff and local contractors as technology transfer so as to maximize the project effect.
6) Support the contractor to conduct on-the-job training and guidance to the PHIVOLCS to ensure smooth operation and maintenance of all the equipment.

(2) Consultant Supervision

1) The Consultant will dispatch at least one responsible personnel to the Philippines at each implementation stage in the Project Phase II.
2) For the construction works for concrete piers and guyed masts & self support poles, a consultant architectural engineer will be dispatched to the Philippines.
3) With respect to installation and adjustment works of seismic & volcano monitoring equipment, data communication equipment, computing equipment and system software, specialized engineers of the Consultant are necessary to dispatch to the Philippines for timely installation guidance, inspection, etc. for each equipment.
4) The Consultant will attend performance test at a factory, adjustment, inspection for seismic & volcano monitoring equipment, data communication equipment and computing equipment instead of PHIVOLCS.
5) Final test, commissioning of the systems and data reception & transmission test in the Philippines will be conducted by the contractor under supervision of the Consultant.

(3) Scope of Work for Supervision

1) The Consultant in coordination with the PHIVOLCS will prepare the form of the contract in accordance with JICA standard and select a Japanese prime contractor through tendering, and also recommend the nominated contractor to the Government of the Philippines.
2) The Consultant will inspect and confirm shop-drawings, system drawings & diagrams and material samples submitted by a contractor as well as performance and function of all the equipment and systems.
3) Based on a review of the implementation schedule, the Consultant will provide instructions to a contractor and submit progress reports on the implementation of the Project Phase II to the PHIVOLCS, Embassy of Japan, JICA local office, etc.
4) The Consultant will cooperate in certification of payment, such as through examination of notice of approval and invoices in connection with implementation cost to be disbursed during the implementation period and upon completion of the Project Phase II.
5) As required during the implementation period, the Consultant will perform inspections at each stage of the work based on confirmation of completion and fulfillment of the contract conditions. The Consultant will be present at the handing over of the equipment and systems, at which point its tasks will be completed, with the approval of the PHIVOLCS. Reports will also be made to concerned personnel in the Government of Japan on all required items, such as progress reports during the implementation period, payment procedures, completion and handing over.

2-2-4-5 Procurement Plan

(1) Equipment Procurement

None of the equipment to be supplied through the Project Phase II is being produced in the Philippines. In addition, major satellite data communication equipment specially for seismic data transmission widely using in many international seismic and volcano institutes and organizations are not a Japanese one. Japan, of course, has companies that can manufacture the required devices. Furthermore, some of major seismic and volcano equipment manufactures have local agents in the Philippines. In view of the future maintenance aspect of these highly specialized pieces of equipment by the PHIVOLCS, it is advantageous to have suppliers that are available within the same region of the Philippines and/or in friendly developed countries including Japan. Thus, in connection with quality and maintaining levels of sophisticated equipment, it will be absolutely essential to procure such components from member countries of Organization for Economic Cooperation and Development (hereinafter referred to as “O.E.C.D.”) including

Japan. For quality control of each system, procurement of the equipment from member countries of O.E.C.D. will be easier than other countries. It is sure that procurement from member countries of O.E.C.D. would surely be advantageous to the PHIVOLCS in consideration of durability & reliability of the systems and easy procurement of spare parts, operating procedures and maintenance techniques of the equipment.

Procurement features on seismic and volcano monitoring equipment for the Project Phase II are classified as follows.

Name of equipment				Remark
	Japan	Philippines	Third Countries	
T0=1sec Short Period Sensor (Convertible Type)			Yes	OECD Countries
T0=20sec Short Period Sensor			Yes	OECD Countries
Accelerometer			Yes	OECD Countries
Middle Period Sensor			Yes	OECD Countries
Broadband Sensor			Yes	OECD Countries
Satellite Communication System for seismology			Yes	OECD Countries
Tiltmeter with Data Logging Function			Yes	OECD Countries
GPS Deformation Monitoring System with Data Logging Function			Yes	OECD Countries
Data Recorder			Yes	OECD Countries
Drum Recorder			Yes	OECD Countries
Software			Yes	OECD Countries
Telemeteing System with Repeater systems (Spread Spectrum Transceiver)	Yes			
Computing Equipment	Yes		Yes	OECD Countries
Power Supply System	Yes	Yes		
Pick-up Truck		Yes		

(2) Civil Work Material Procurement

1) Cement

Supply is relatively stable. However, careful quality checks will be required during civil work.

2) Concrete aggregate

Concrete aggregate uses mainly either crushed or natural stone. Local supplies are stable and able to meet current demand in terms of both quantity and quality.

3) Reinforced bars

Reinforced bars can be locally manufactured, and a reliable intensity value can be confirmed from the mill sheet obtained of the reinforcing bars.

4) Paint

The paints both for indoor and exterior are available in a wide variety of colors and in terms of quantity, color, and base (oil, emulsion, vinyl) in the local market.

As noted above, almost all the civil work materials for shelters and concrete foundations of guyed masts & self support poles are generally available in the Philippines, with quality presenting no particular problem.

(3) Transport Routing

The principal port in the Philippines is Manila. Thus, the equipment and systems shipped by sea to the Philippines from member countries of O.E.C.D. including Japan will be unloaded at Manila and shipped or airlifted or trucked to each project site.

1) Air service
   In the Philippines, there are approximately 75 routes of domestic flight. And also international cargo & mail statistics are airlifted by the international scheduled airlines at Manila, Cebu and Davao international airports.
2) Shipping service
   There are many scheduled shipping between the Manila seaport (the biggest in the Philippines) and major overseas seaports. Most of cargo are handled and cleared at the Manila seaport. Due to the geographic condition of the Philippines, the shipping service is quite popular and active.

Approximate duration of shipping to Manila

From Japan	: 2 weeks
From U.S.A	: 2 – 3 weeks
From Canada	: 2 – 3 weeks
From Europe	: 4 – 5 weeks
From Australia	: 3 weeks
From New Zealand	: 3 weeks

(4) Security

Careful consideration should be given in making arrangement for the domestic transport and taking appropriate measures against any damage and disappearance during the delivery of the sophisticated equipment and in ensuring safety of the Project Phase II implementation. Some of the project sites in Mindanao islands are located in the rural areas having security problem, therefore, the PHIVOLCS will take necessary measures on security of the contractor and the Consultant to perform their obligations against any force

majeures. As for Ipil, Pagadian, Parker, Matutum, Mati, Central Mindanao University, Butuan and Bislig, the contractor can not deliver the Equipment (excluding Bislig) and not implement any works at these sites above mentioned. Besides, the contractor will delivered the Equipment for these sites to General Santos, Cagayan de Oro, Davao and Bislig existing seismic observation stations, and delivery work for the Equipment from the General Santos, Cagayan de Oro and Davao existing seismic observation stations to these sites and the installation work for the Equipment will be made by the PHIVOLCS.

(5) Broadband Sensor

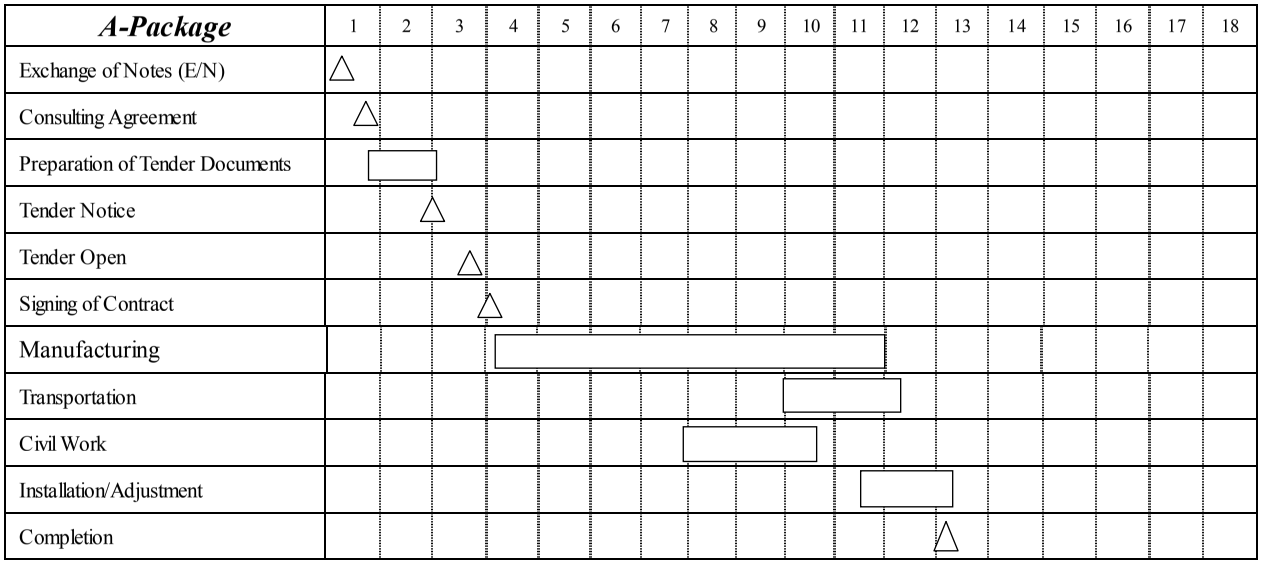
Only some of specialized seismic equipment manufactures in the Europe produce the broadband sensors. The Broadband Sensor is very sophisticated and absolutely sensitive and delicate. In order to keep it's very high sensitivity and sophistication, air transport from the Europe to Manila is indispensable. In addition to this, it is also necessary to use air transport for domestic equipment delivery from Manila to the nearest domestic airports located from the project sites.

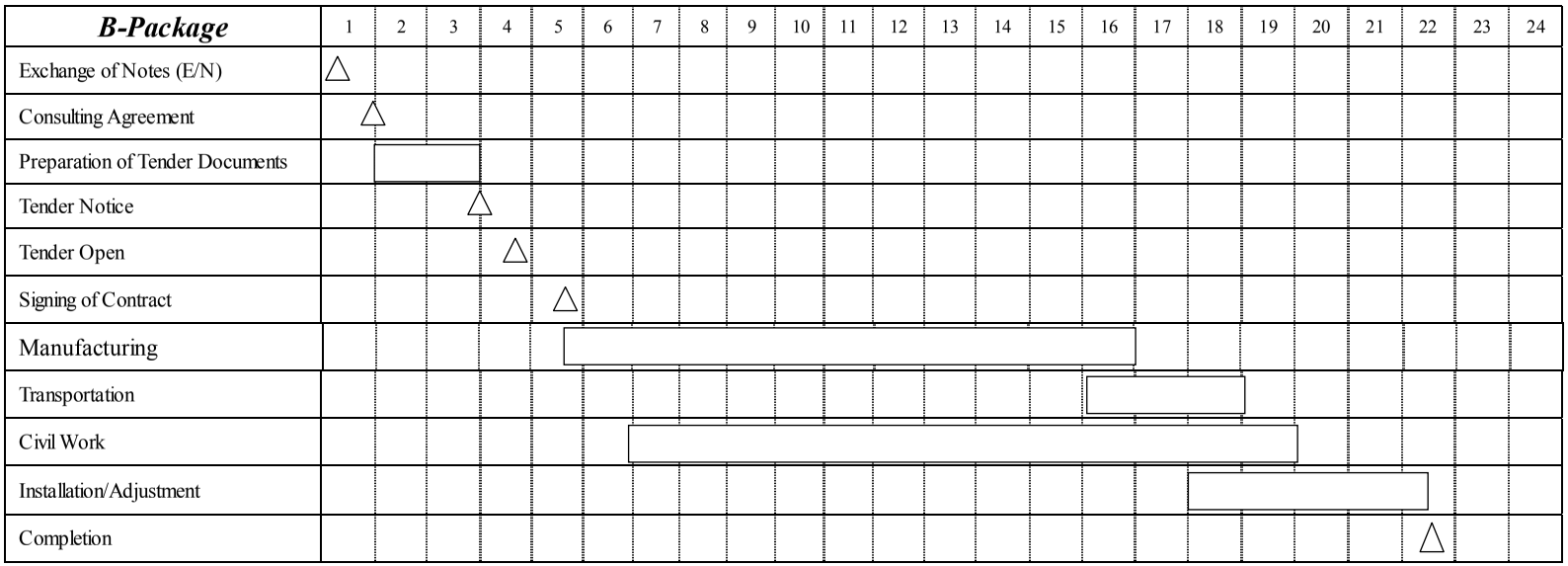
2-2-4-6 Implementation Schedule

The Project Phase II will be divided into 2 package as A and B. The work of each package is to commence after signing of the contract between the contractor and the PHIVOLCS.

A-Package will require approximately 9 months and B-Package will require approximately 17 months to complete.

Implementation Schedule of the Project for Improvement of Earthquake and Volcano Monitoring System (Phase Ⅱ) in the Republic of the Philippines





2 - 3 Obligations of Recipient Country

2-3-1 PHIVOLCS Obligation for smooth implementation of the Project Phase II

The PHIVOLCS shall ensure to undertake the following necessary measures for the Project Phase II.

(1) General Obligations

1. To secure land necessary for the sites and to clear the land prior to commencement of the Project Phase II.
2. To provide facilities for distribution of electricity, telephone and other incidental facilities to the project sites, if required.
3. To secure effective spaces at the existing facilities and to shift or remove the existing equipment and facilities for installation of the equipment to be supplied, if required.
4. To take care of all legal, administrative and documentary requirements in the Philippines.
5. To bear commissions to a bank in Japan for the banking services based upon Banking Arrangement.
6. To obtain tax exemption (especially local VAT refunding to the contractor) and to take necessary measures for customs clearance of the materials and equipment brought for the Project Phase II at the port of disembarkation.
7. To accord personnel whose services may be required in connection with the supply of products and the services under the verified contract such facilities as may be necessary for their entry into the Philippines and stay therein for the performance of their work.
8. To take necessary measures on security for personnel as described above to perform their obligations under the verified contract against any force majeures.
9. To establish proper and effective maintenance and utilization procedures for the equipment purchased under the Grant Aid.
10. To undertake incidental outdoor works such as fencing, gates and exterior lighting in and around the site, if necessary.
11. To take appropriate measures against any damage and disappearance of the equipment to be supplied.

(2) Special Obligations

1. To make the access roads and/or paths to the sites prior to commencement of the Project, if necessary.
2. To provide necessary spaces at the Head Office for the Consultant and the contractor for the implementation.
3. To provide necessary radio frequencies and space segments for data communication systems to be established.
4. To make necessary procedures for obtaining registration of the vehicles.
5. To implement the required site survey and all necessary installation and inspection works at some of the project sites having security problem in Mindanao islands on his responsibility and at his expense.
6. To provide counterparts of the PHIVOLCS on his responsibility and at his expense for the Consultant and the contractor to guide all the selected observation and repeater points during survey time and installation time to be conducted by the contractor.
7. To provide trainees of the PHIVOLCS during the installation period of the equipment on his responsibility and at his expense for on-the-job training to be implemented by the contractor.

2-3-2 Capital Cost Estimation for undertaking to be borne by the PHIVOLCS

At the time of implementation of the Project Phase II under Japan's Grant Aid Assistance, the following estimated capital costs for the major undertaking of the PHIVOLCS are required as follows.

A-Package

- Power line intake cost at Buco Existing Volcano Observatory Peso40,000

- Telephone line intake cost at Buco Existing Volcano Observatory Peso6,000

- Burglar fencing Peso 250,000
  For unmanned volcano observation and repeater points: 5
  Size of burglar fencing: 6m × 4m (length: 20m)
  5 sites × 20m × Peso 2,500/m = Peso 250,000

- Installation Work

  a. Mt. Parker
     - Seismic sensor shelter Peso 157,000

- Foundation of self support pole Peso 124,000
  4m self support pole: 2 × Peso 62,000 = Peso 124,000
- Equipment delivery Peso 110,000
  From General Santos Existing Seismic Observation Station to each point by a truck and porters
  2 × Peso 55,000 = Peso 110,000
- Equipment installation Peso 72,000
  2 sites × Peso 36,000 = Peso 72,000

b. Mt. Matutum
- Seismic sensor shelter Peso 157,000
- Foundation of self support pole Peso 297,000
  4m self support pole: 1 × Peso 62,000 = Peso 62,000
  6m self support pole: 1 × Peso 85,000 = Peso 85,000
  10m self support pole: 1 × Peso 150,000 = Peso 150,000
- Equipment delivery Peso 165,000
  From General Santos Existing Seismic Observation Station to each point by a truck and porters
  3 × Peso 55,000 = Peso 165,000
  Equipment installation Peso 108,000
  3 sites × Peso 36,000 = Peso 108,000

c. Bislig
- Broadband sensor shelter Peso93,000
- Equipment installation Peso 36,000

Total Capital Cost on A-Package (approximate) Peso 1,615,000

B-Package

- Burglar fencing Peso 3,835,000

For unmanned volcano observation and repeater points: 39
Size of burglar fencing: 6m × 4m (length: 20m)
39 sites × 20m × Peso 2,500/m = Peso 1,950,000

For unmanned seismic observation points: 29
Size of burglar fencing: 9m × 4m (length: 26m)
29 sites × 26m × Peso 2,500/m = Peso 1,885,000

・ Installation Work

a. Ipil, Pagadian, Central Mindanao University, Butuan and Mati

・ Seismic sensor shelter Peso 525,000

5 sites × Peso 105,000 = Peso 525,000

・ Satellite antenna foundation pad Peso 235,000

5 sites × Peso 47,000 = Peso 235,000

・ Equipment delivery Peso 431,000

From General Santos Existing Seismic Observation Station to Ipil and Pagadian seismic observation points by a boat

Ipil: Peso 110,000 Pagadian: Peso 110,000

From Cagayan de Oro Existing Seismic Observation Station to Central Mindanao University and Butuan seismic observation points by a truck

Central Mindanao University: Peso 81,000 Butuan: Peso 75,000

From Davao Existing Seismic Observation Station to Mati seismic observation points by a truck

Mati: Peso 55,000

・ Equipment installation Peso 180,000

5 sites × Peso 36,000 = Peso 180,000

Total Capital Cost on B-Package (approximate)	Peso 5,206,000
Sub-total	Peso 6,821,000
Miscellaneous (2% of Sub-total)	Peso 136,000
Grand total (approximate)	Peso 6,957,000

Furthermore, due to the ODA regulation, commissions to the Japanese foreign exchange bank for the banking services based upon Banking Arrangement will be required. Such commissions and taxes such as Value Added Tax (VAT) and import taxes levied by the Government of the Philippines on any goods and services which will be purchased and/or imported by the contractor shall additionally be borne by the Government of the Philippines.

2 - 4 Project Operation Plan

2-4-1 Operation work being done by the PHIVOLCS

Most of the field personnel operating the existing stations have engineering degrees and have been previously trained on the use of computers and digital data processing software. The PHIVOLCS also has a group of well trained instrumentation personnel who are in charge with repair and maintenance of the instruments. Each station is operated and manned on a 24-hour basis and at least two personnel take turns in operating the station. A regular check-up of the instrument health and calibration is also being done by the station operators.

One special feature of the system installed in the Phase I is the capability for automatic picking and transmission of phase date to the Head Office. Appropriate software and hardware are installed in every existing station with available phone lines. At the Head Office, a corresponding computer setup anticipates and receives the automatically transmitted data. Another computer setup will automatically evaluate the received date and discriminates if an earthquake event has occurred. If an event is declared, automatic location of epicenter and magnitude calculation is done and a bulletin for that earthquake is automatically generated and made available to the Fax-on-Demand system for easy downloading by the public.

Expected operation plans for cases of occurrence of earthquake and volcano eruption are attached herewith.

CASE: Occurrence of Earthquake

Existing Seismic Stations	Waveform Data (via public telephone line) ⇨			**PHIVOLCS Head Office** Data Analysis & Processing Determination of Hypocenter and Magnitude Estimation of Scale of Disaster	⇨ Earthquake Bulletins Tsunami Warnings	Governmental Agencies Local Government	⇨ - Municipality - Police - Fire Dept. - Media	- People - International Organizations
Unmanned Seismic Observation Points	Waveform Data (by VSAT) ⇨						⇨ Disaster Relief Task Force	- Lifesaving - Prevention of Second Disaster - Rehabilitation
Quick Response Team with Mobile Observation System (at Head Office)	⇨ Vehicles	Deployment of Observation Equipment	Observation Data (by VSAT) ⇨					

CASE: Volcano Eruption/Eruption Portent

Volcano Array Observation Network Unmanned Volcano Observation Points	Waveform Data ⇨ (by Spread Spectrum Transceiver)	Existing Volcano Observatories	- Observation Data - Volcano Information ⇨ (by PSTN/VSAT)	**PHIVOLCS Head Office** Data Analysis & Processing	⇨ Volcano Bulletins Evacuation Alert	Governmental Agencies Local Government	⇨ - Municipality - Police - Fire Dept. - Media	- People - International Organizations
Quick Response Team with Mobile Observation System (at Head Office)	⇨ Vehicles	Deployment of Observation Equipment					⇨ - Evacuation Support - Disaster Relief Task Force	- Evacuation - Lifesaving - Prevention of Second Disaster - Rehabilitation

2-4-2 Maintenance work being done by the PHIVOLCS

In connection with equipment maintenance, consideration must be given to the following matters.

- Staff training
- Establishment of countermeasures against system troubles
- Schedule of a regular check-up for the instrument health and calibration
- Report of spare parts and consumables replacement records
- Strengthening of maintenance structure in the PHIVOLCS
- Establishment of frequent scheduled parts & consumables replacement and overhauls
- Preparation for expectable frequency of system failure occurrence

Maintenance Plan

Equipment Location	Responsible Personnel
Unmanned seismic and volcano observation points and data repeater points	Care-taker at each point to be employed by the PHIVOLCS (watching equipment against disappearance, cutting glass, etc.)
Regular check-up for the equipment at the existing seismic stations/volcano observatories	Staff of each existing seismic station/volcano observatory
Regular check-up for the equipment at unmanned seismic and volcano observation points and data repeater points	Staff of the nearest existing seismic station/volcano observatory from each point
spare parts and consumables replacement for the equipment at the existing seismic stations/volcano observatories	Staff of each existing seismic station/volcano observatory (after receiving spare parts and consumables from PHIVOLCS Head Office)
spare parts and consumables replacement for the equipment at unmanned seismic and volcano observation points and data repeater points	Staff of the nearest existing seismic station/volcano observatory from each point (after receiving spare parts and consumables from PHIVOLCS Head Office)
Trouble shooting, special replacement of spare parts and consumables, major repairing work	Staff of Quick Response Team at PHIVOLCS Head Office

In order for each responsible person to be able to perform appropriately and effectively his duty to avoid any failure, provision of installation, operation and maintenance manuals are indispensable. In addition, on-the-job training through actual installation works together with the contractor's engineers and actual use of the equipment should be conducted to as long as possible by the PHIVOLCS staff in accordance with these manuals.

The PHIVOLCS must have the special consideration on implementation of appropriate operation & maintenance procedures will lead to the minimization of consumption and cut down on operation cost. In addition, standardization and selection of the most durable & reliable equipment should be undertaken as much as possible. Such a policy will

contribute positively to reducing financial burden of future procurement of spare parts and consumables as well as reduce overall maintenance expenditures.

2-4-3 Required Staff Allocation for Operation & Maintenance

The PHIVOLCS has sufficient qualified personnel who are assigned for the operation and maintenance of the instruments of the Project Phase I and II. After completion of the Project Phase II, the following personnel assignments will be required for appropriate and effective operation and maintenance of the equipment and systems to be supplied. In case of a major technical problem occurred, it will be necessary to dispatch some of high skilled engineers in the quick response team located in the Head Office for repairing and for making solution.

Required Additional Personnel for Phase-II of the Project

In the Quick Response Team (PHIVOLCS Head Office)		
For Data Communication Systems (VSAT and Spread Spectrum)	:	4 staff
Sub-center		
Mirror Center in Tagytay (two staff per team)	: 2 staff × 2 teams =	4 staff
	Total of Phase II	8 staff

The required 8 staff can be arranged from the existing personnel of the PHIVOLCS. Maintenance capabilities of the PHIVOLCS have been amply confirmed on the basis of its experience and performance. The technical skill levels of the engineers and technicians in the PHIVOLCS are quite sufficient for maintenance of the equipment and systems.

2-4-4 Budgetary Aspects

A table showing *"PHIVOLCS BUDGET"* is described below. In this table, the budgets between 1997 and 2002 are actual allocations and the budgets between 2003 and 2006 are estimated as expectable allocations.

The budgetary consideration for the required equipment delivery and all necessary installation work in Mindanao islands as obligations of the PHIVOLCS has been made already and reflected in the estimated annual budgets as "Project for Japan's Grant Aid Assistance". The estimated expense of the equipment delivery and installation work are included in 2002 and 2004.

PHIVOLCS BUDGET

(In thousand pesos)

	As per General Appropriation Act						Estimates			
	1997	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***
*Personal Services	24,633	34,652	37,647	36,696	36,522	45,830	66,570	66,570	66,570	66,570
Maintenance & Other Operation Expense	35,344	38,624	35,524	40,332	34,658	36,153	41,888	48,214	54,863	56,624
Project of Japan's Grant Aid Assistance	-	-	7,750	7,480	5,679	6,133	8,404	9,302	9,505	9,700
Capital Outlay	41,209	47,000	4,410	17,650	450	7,867	13,476	15,168	17,000	20,000
Total	101,186	120,276	85,331	102,158	77,309	95,983	130,338	139,254	147,938	152,894

*Personal Services is increased from 2001 to 2002:

Due to difference accounts mainly in the payment of "*Magna Carta Benefits*" for the PHIVOLCS employees and terminal leave benefits of compulsory retirees.

Magna Carta: provision of allowances in the form of subsistance allowance, laundry allowance, hazards pay, longevity pay as provided under the Republic Act No.8439

The PHIVOLCS, in case of inadequate funding, will defer implementation of its other regular projects in order to give way to accomplish the set objectives of the Project Phase II and the PHIVOLCS will also utilize whatever savings generated from other regular projects to segment the available existing fund for the Project Phase II.

2-4-5 Estimation of Additional Expenditure for the Project Phase II

1) Rental Cost for Satellite Space Segment of 300kHz bandwidth (Ku-band): US$17,376/year (US$1,448×12months)

The annual rental cost for satellite space segment estimated by Mabuhay Philippines Satellite Corporation is US$17,376/year which is approximately Pesos 887,000/year.

2) Local caretaker employment cost : Pesos 690,000/year

For cleaning and securing the equipment and systems to be installed at unmanned observation points, employment of local caretaker will be required.

- Seismic observation points: 29 points
- 6 volcano array observation networks: 12 points
- 2 volcano observation points: 5 points

- Necessary number of the caretakers:46

46 caretakers×Pesos800/month×13month/year (including a bonus) = 478,400 = Pesos 479,000

3) Land lease cost: Pesos205,000/year

The land lease cost will be available due to some of unmanned observation points and data repeater points selected for the Project Phase II are belonging to private properties.

Number of the volcano observation points in private properties: 12 points
12 points × 900/month × 12monts = Pesos129,600/year

Number of the seismic observation points in private properties: 7 points
7 points × 900/month × 12monts = Pesos75,600/year

4) Electricity charge: Pesos 30,000/year

The electricity charge in 2000 of the Head Office and the existing volcanic & seismic stations is approximately Pesos 300,000/year. Based on the expenditure of the existing situation, additional electricity charge can be roughly expected as 10 percents of the electricity charge in 2000.

5) Transportation services charge (courier service, mail, etc.): Pesos 17,000 / year

The transportation services charge in 2000 of the Head Office and the existing volcanic & seismic stations is approximately Pesos 870,000/year. Based on the expenditure of the existing situation, additional transportation services charge can be roughly expected as 2 percents of the transportation services charge in 2000.

6) Travelling expenses: Pesos1,420,000/year

The travelling expenses in 2000 of the volcanic & seismic divisions is approximately Pesos 5,555,000/year. Based on the expenditure of the existing situation, additional travelling expenses can be roughly expected as 20 percents of the travelling expenses in 2000 and plus consideration of increasing rate for the last 3 years (2% / year).
5,555,000 × 0.20 × 1.02 = Pesos1,133,220 = Pesos1,135,000

It is expected that travelling expenses from 1st year to 3rd year will be lower than 1,135,000 pesos because there will be less chances to repair the new equipment. On the other hand, PHIVOLCS staff will have to visit the Project Sites more times in between 6th year and 8th year so as to replace the batteries.

1st Year: 1,135,000×0.2 = Pesos 227,000
2nd Year: 1,135,000×0.5 = Pesos 568,000
3rd Year: 1,135,000×0.6 = Pesos 681,000
4th & 5th Year: Pesos 1,135,000
6th Year: 1,135,000×1.2 = Pesos 1,362,000

7th Year: 1,135,000×1.6 = Pesos 1,816,000
8th year: 1,135,000×1.2 = Pesos 1,362,000

7) Supplies and materials cost (spare parts procurement): Pesos 720,000/year
The office supplies cost in 2000 is approximately Pesos 7,216,000/year.
Based on the expenditure of the existing situation, additional office supplies cost can be roughly expected as 10 percents of the office supplies cost in 2000.

It is expected that there will be less chances to repair the new equipment during the first 4 years, and annual supplies and materials cost is estimated as follows;

1st Year: 720,000×0.1 = Pesos 72,000
2nd Year: 720,000×0.3 = Pesos 216,000
3rd Year: 720,000×0.5 = Pesos 360,000
4th Year: 720,000×0.8 = Pesos 576,000

8) Repair/maintenance of the government's vehicles cost: Pesos 530,000/year
The repair / maintenance of the government's vehicles cost in 2000 is approximately Pesos 520,000/year. Based on the expenditure of the existing situation, additional repair / maintenance of the government's vehicles cost can be roughly expected as 100% of the repair / maintenance of the government's vehicles cost in 2000 and can be included 2% of the cost escalation for the last 3 years.
520,000×1.02 = Pesos 530,000/year

It is expected that there will be less chances to repair the new equipment during the first 4 years, and annual repair / maintenance of the government's vehicles cost is estimated as follows;

1st Year: 0
2nd Year: 530,000×0.4 = Pesos 212,000
3rd Year: 530,000×0.5 = Pesos 265,000
4th Year: 530,000×0.8 = Pesos 424,000

9) Gasoline & oil cost of the government's vehicles : Pesos 71,000/year
Under this Project, supply of 3 pick-up vehicles are scheduled at the Project Phase II.

・ Diesel oil: Pesos15/liter

3 Pick-up vehicles: 6 liters/day (50km drive/day)×Pesos15/liter×20days/month×12month/year×3 Pick-up vehicles×1.1 (engine oil, etc.) = 71,280 = Pesos71,000

10) Replacement of batteries

All of the seismic and volcano monitoring equipment will be furnished with battery(s) for uninterrupted power supply. The battery is free maintenance and sealed type. Lifetime of the battery is expected approximately 6 – 8 years, so that replacement of batteries will be required as follows.

Total price of a batteries for the Project Phase II: approx. Pesos7,000,000.

Expectable replacement cycle from completion of the Project Phase II
After 6 years: 20% of all the batteries = Pesos 1,400,000.
After 7 years: 60% of all the batteries = Pesos 4,200,000.
After 8 years: 20% of all the batteries = Pesos 1,400,000.

2-4-6 Additional Expenditure and Time Sequence

As a consequence of the above conditions, the additional expenditure for regular operation & maintenance after completion of the Project Phase II will be needed in addition to the present expenditure of operation and maintenance cost. The additional expenditure and time sequence are indicated in next page of "*Table of Additional Expenditure and Time Sequence*".

Much more than the required additional budget for Phase-I was secured in the 2000 and 2001 annual budgets of the PHIVOLCS. In addition, 2002 annual budgets of the PHIVOLCS including the required additional budget for the Project Phase II has been already scheduled to be allocated without any problem.

Due to the present economical situations of the Philippines, the Government of the Philippines instructed to all the governmental departments/agencies to curtail of their annual expenditures. However, this has no direct effect to budget allocation of the PHIVOLCS because disaster management is one of the top priority aspects in the country and the Government recognizes the necessity of supporting PHIVOLCS and importance of the development and maintenance of its facilities.

Table of Additional Expenditure and Time Sequence

(Unit: Peso)

	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year
Rental Cost for Satellite Space Segment	887,000.	887,000.	887,000.	887,000.	887,000.	887,000.	Ps 887,000.	Ps 887,000.
Local caretaker employment cost	479,000.	479,000.	479,000.	479,000.	479,000.	479,000.	479,000.	479,000.
Land lease cost	205,000	205,000	205,000	205,000	205,000	205,000	205,000	205,000
Electricity charge	0,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Transportation services	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000
Travelling expenses	227,000	568,000	681,000	1,135,000	1,135,000	1,362,000	1,816,000	1,362,000
Supplies and materials cost	72,000	216,000	360,000	576,000	720,000	720,000	720,000	720,000
Repair/maintenance of the government's vehicles cost	0	212,000	265,000	424,000	530,000	530,000	530,000	530,000
Gasoline & oil cost of the government's vehicles	71,000	71,000	71,000	71,000	71,000	71,000	71,000	71,000
Replacement of batteries	0	0	0	0	0	1,400,000	4,200,000	1,400,000
Total (A)	1,988,000	2,685,000	2,995,000	3,824,000	4,074,000	5,701,000	8,955,000	5,701,000
Budget for Maintenance & Other Operation Expense of PHIVOLCS (B)	48,214,000	54,863,000	56,624,000					
(A) / (B) (%)	4.12	4.89	5.29					

Chapter 3 Project Evaluation and Recommendation

3 - 1 Project Effect

After completion of the Project Phase-II, all observed data will be transmitted to the PHIVOLCS Head Office and data ingestion time will be greatly minimized. In addition, the PHIVOLCS will be able to improve the seismic detection capability minimum of approximately magnitude 4.0 in the whole region of the Philippines for obtaining accurate hypocenter and focal depth determination and also will be able to accurately and speedily make detection and warning for reduction of natural disasters and recommending prompt disaster response actions. In case of emergency and an evacuation warning of volcano eruption and tsunami required to the general public, the PHIVOLCS will be able to announce the warning immediately by the systems to be established under the Project.

The Project Phase II makes the following objectives and the Philippines will benefit from the Project Phase II as the project effect.

1) Mitigation of natural disasters resulting from earthquakes, tsunamis and volcanic eruptions.

2) Prompt and necessary action of civil defense and relief for minimizing extensive loss and damage which are the determining factor for significant set back of national economy and development activities of the Philippines.

3) Improvement of safety of the aviation operation and of people's life & property by providing more accurate and timely information for the general public around the clock.

4) Preparation and enforcement of standard, regulation and other necessary rules on structure, civil defense, relief action, operation of transports, etc. for appropriate and efficient loss reduction action plans.

After the completion of the Project, Phase I and Phase II, the national monitoring network of the PHIVOLCS will be greatly improved. Thus the PHIVOLCS will be capable of contributing effectively to the mitigation of natural disasters resulting from volcanic eruption, earthquake and tsunami and will enhance relief action and civil defense activity of the Philippines.

In addition, the accuracy and the reliability of volcano eruption detection & warning and seismic monitoring for the mitigation of natural disasters will be improved. It is expected that with this the PHIVOLCS can contribute to the reduction of volcanic and seismic disasters in the country. At the same time, overall standard of volcanic and seismic information will be greatly improved, and the PHIVOLCS will thus be able to contribute in a greater perspective to reduction of natural disasters generated by volcanic eruptions and earthquakes. Further, the improvement of the volcano & seismic monitoring network in this Project will highly enhance capabilities of the PHIVOLCS and will put it in a better position to play an active role in supporting the economic development of the Philippines.

Volcano eruption detection & warning, tsunami forecasts and various kinds of volcanic and seismic information are provided to the general public of the Philippines through mass-media. Volcanic and seismic information is also provided to the other users, such as, Office the President, government agencies (Office of Civil Defense, National Disaster Coordinating Council, Department of Social Welfare, Air Transport Office, Department of Public Works & Highways, etc.), Philippine National Red Cross, foreign embassies and international institutions. Thus, when the Project will be completed, it will have a high publicity profile. Thereby, the national volcanological & seismological network is an essential facility for the government of the Philippines to be able to develop successful risk mitigation strategies at an affordable cost.

The national network should have a mix of seismographs so that both small and large earthquakes can be recorded without distortion both near to and far from the epicenter. In addition, a central monitoring facility receiving data telemetry from each station of the network in near-real-time is necessary so that the location can be done quickly and an appropriate warning sent to seismologists and then to clients including emergency managers, decision makers, policy makers, media and public. It is necessary to quantify the hazard throughout the Philippines so that appropriate land planning decisions can be made and so that appropriate building codes can be developed. It is also necessary to be able to determine the location and size of an earthquake quickly and accurately so that national and local emergency units can respond effectively following damaging earthquakes. Emergency managers need also to be advised of the likelihood of damaging tsunamis following a large local or distant earthquake. The introduction of inadequate building regulations could result in building collapse and fatalities and be very expensive while unnecessarily severe building regulations could also be very expensive. However, it is widely accepted that rapid warning systems and disaster preparedness can greatly mitigate the disastrous effects of these natural occurrences especially in the reduction in human injuries/losses and damage to properties.

The expected project effects to be generated by the Project Phase II are as follows.

- The PHIVOLCS will be able to supply information of volcano eruption detection and earthquake and other necessary information to agencies concerned with the reduction of natural disasters (Office of Civil Defense, National Disaster Coordinating Council, Department of Social Welfare and Development, Philippine National Red Cross, civil aviation sector and other information users) for formulating appropriate measures and making prompt relief action.

- The national volcanological & seismological network that will be improved and enhanced under the Project will ensure continuous flow of necessary information on geologic phenomena to PHIVOLCS and this will result in accurate and speedy detection and warning to other agencies concerned with rescue and relief operations.

- In case of an emergency wherein an evacuation warning due to an impending volcanic eruption is required to be conveyed to the concerned public, the PHIVOLCS will be able to announce the warning immediately to the appropriate governmental agencies and mass media.

- The PHIVOLCS will be able to conduct research & development on the physical and socio-economic impact of volcanic eruption, earthquake and other related geologic phenomena and recommend appropriate measures for the mitigation of impacts and rehabilitation of affected areas.

- By understanding the mechanism of geologic phenomena, the PHIVOLCS will be able to adapt and develop technologies on volcanic eruption, earthquake prediction, volcano and seismic monitoring and disaster mitigation.

- The PHIVOLCS will be able to improve its seismic detection capability to a minimum of approximately magnitude 4 in the whole regions of the Philippines as well as obtaining accurate hypocenter and focal depth determination.

- The PHIVOLCS will be able to release information to the public in about 10 to 15 minutes after the occurrence of an earthquake. (Before the project implementation, it used to be from one to one and a half hour.)

- The provision of a bigger and accurate earthquake database that will be realized through the implementation of this project will enable the PHIVOLCS to effectively estimate the hazards and risks due to earthquakes and will be able to recommend safe

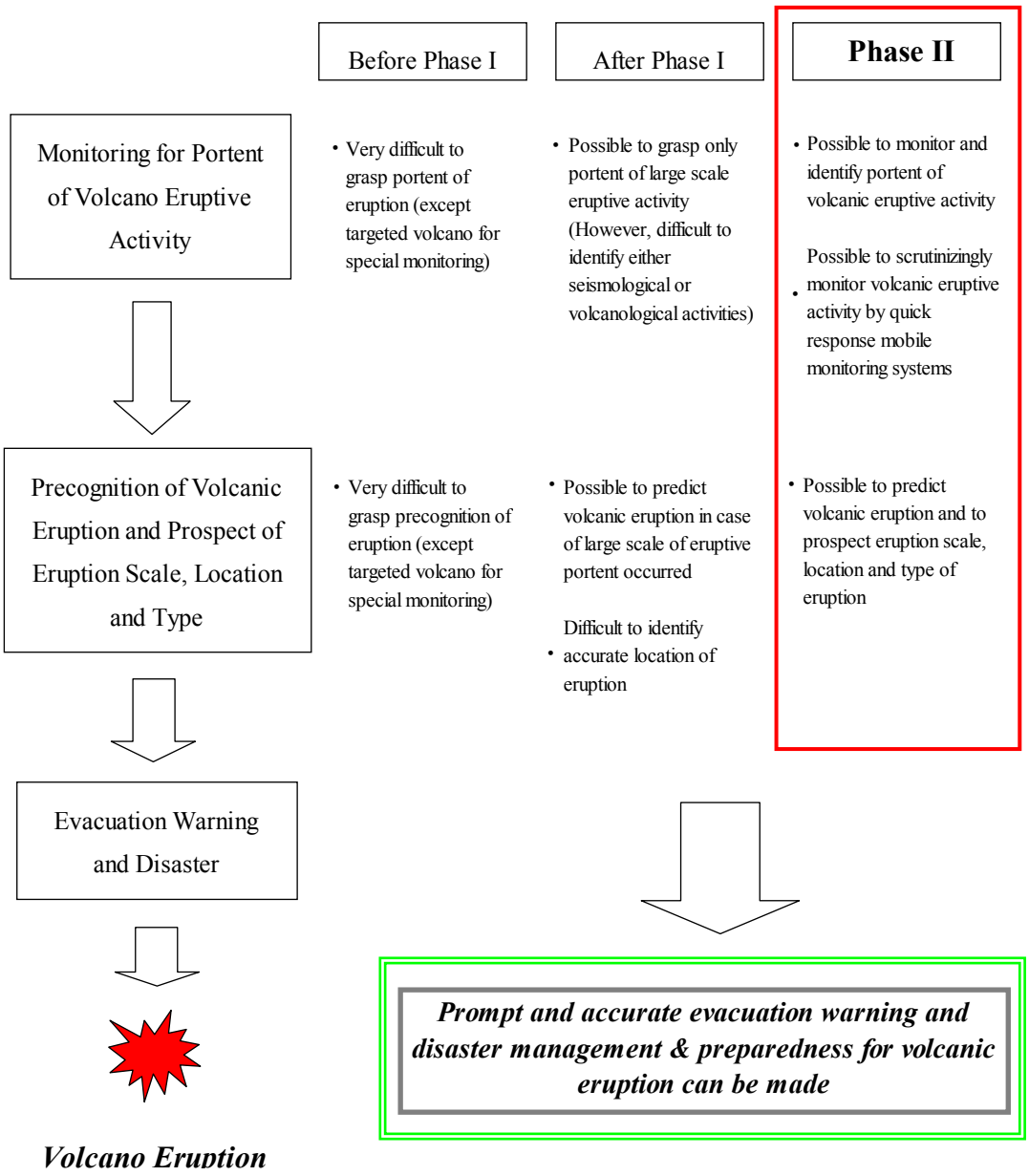
building standards and designs to minimize extensive damage to buildings and infrastructures in future strong earthquakes.

- The PHIVOLCS will be able to conduct more in-depth researches to increase the level of understanding/knowledge about volcanoes, volcanic eruptions and terranes, earthquake zones and mechanism, faulting, along with other related geologic phenomena.

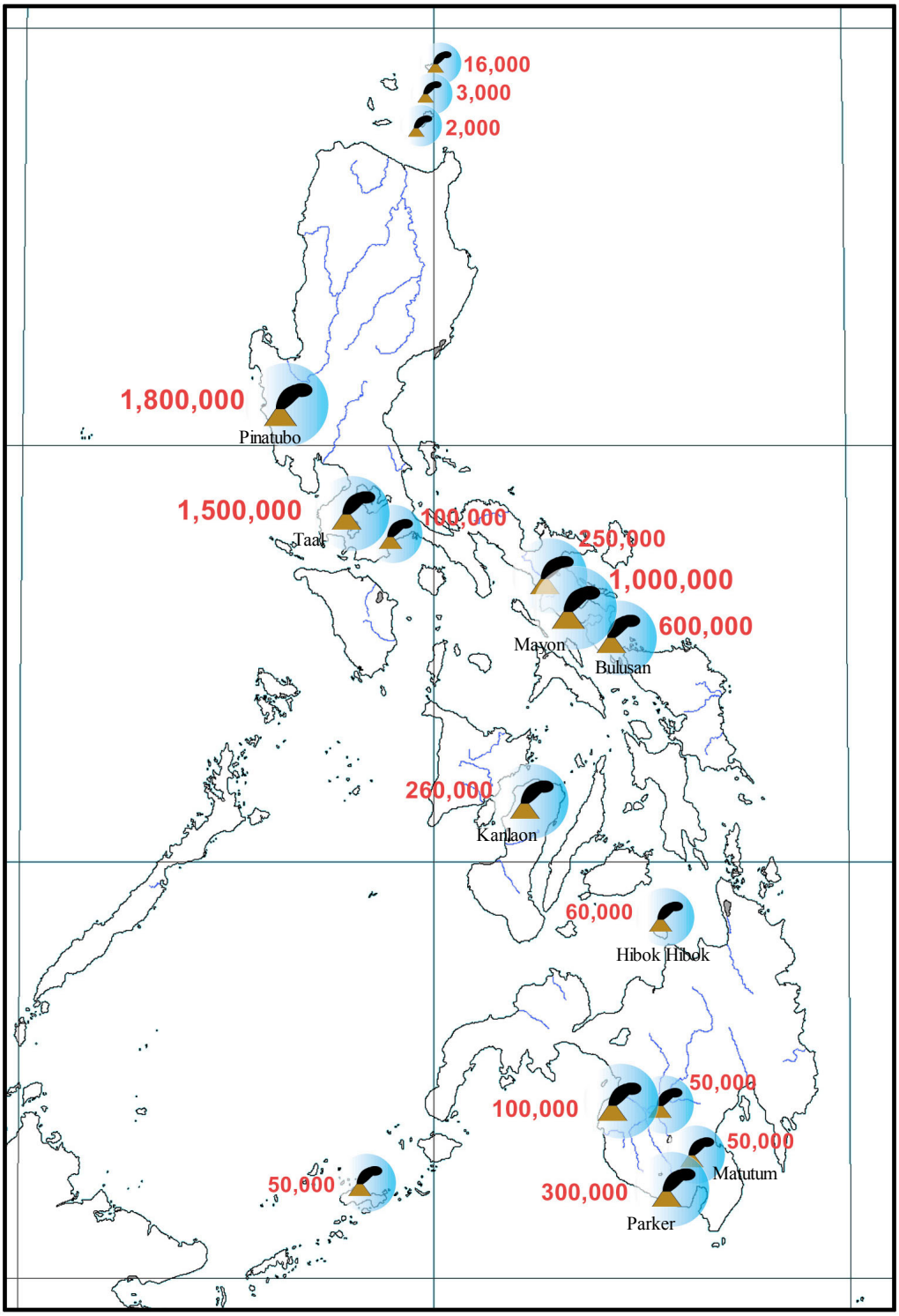
- The PHIVOLCS will be able to implement an aggressive science & technological information processing and dissemination program to promote public awareness on the significance of volcanic activity, earthquakes and related geotectonic processes and their threats and possible benefits to the people.

- The PHIVOLCS will be able to identify, evaluate and characterize volcanic materials and energy products and generate/adapt technologies for their utilization for the people of the Philippines.

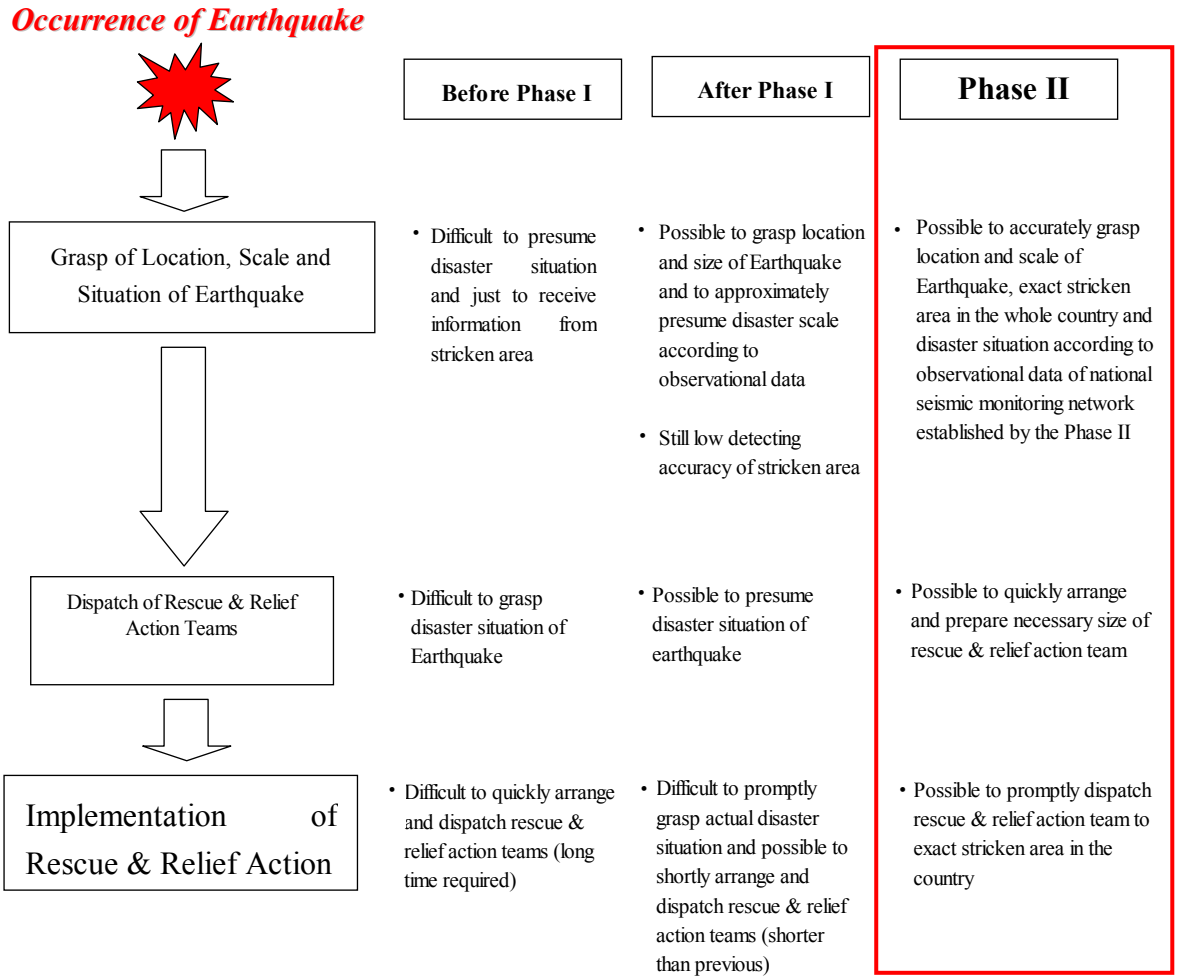
Comparison Flow Chart of Project Effect
on Volcano Monitoring Network established by the Project Phase I and II



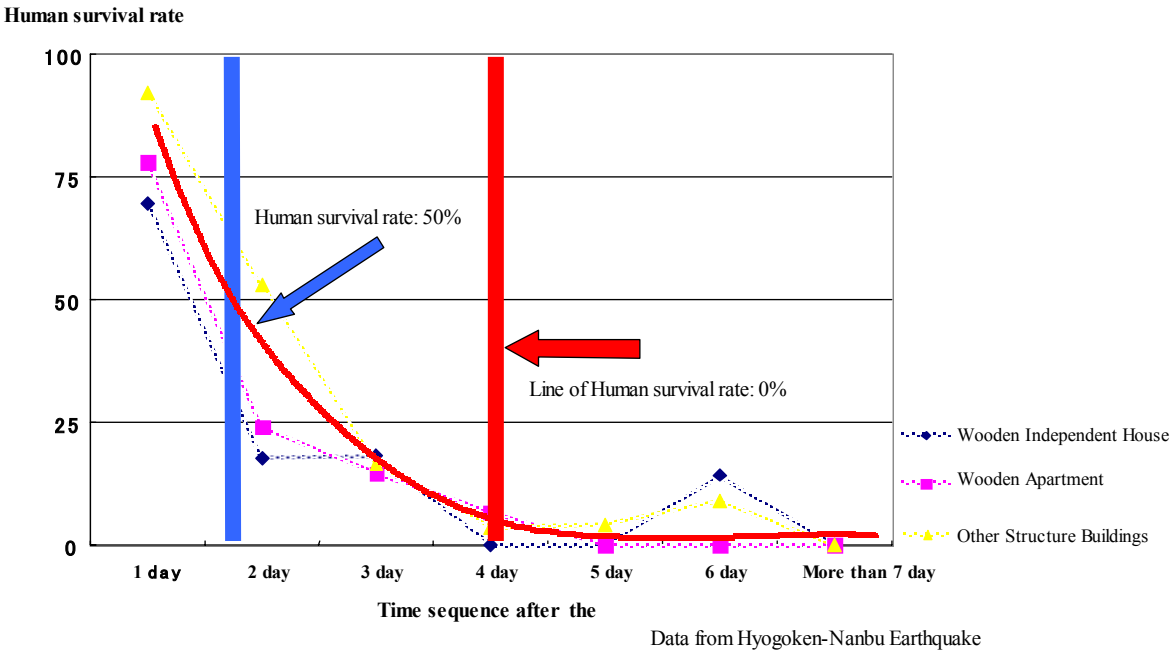
Indicative Populations at Risk from Volcanic Eruption in the Philippines



Comparison Flow Chart of Project Effect on Seismic Monitoring Network established by the Project Phase I and II



The following table shows linkage between time sequence from occurrence of earthquake and human survival rate. In case that rescue and relief action start very immediately after the event, human survival rate is still high. However, after 48 hours from the even, human survival rate becomes less than 50%.



Data from Hyogoken-Nanbu Earthquake

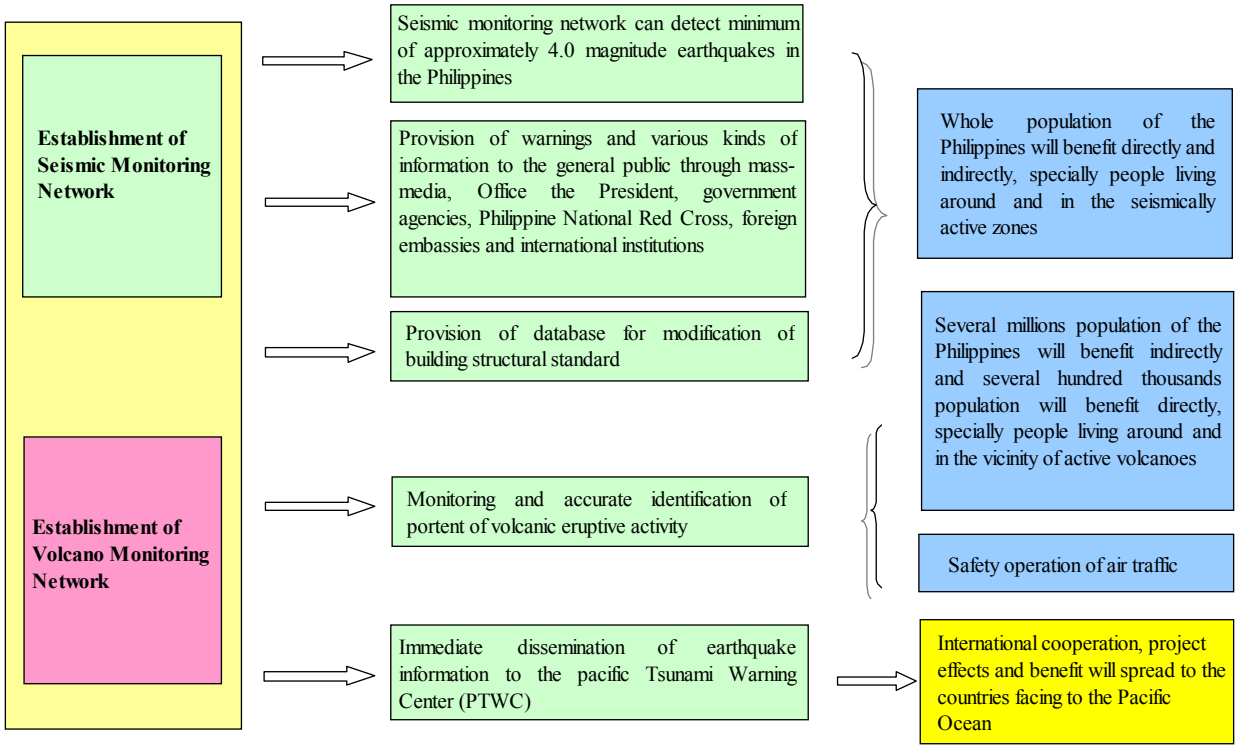
Rescue and relief action can be made immediately and exactly to the stricken area, it is surly possible to reduce number of casualties.

Human survival rate;
Rescue and relief action can be implemented;
after 3 days from the event: approx. 20%
after 2 days from the event: approx. 40%
after 1 days from the event: more than 75%

↓

Upgrading Accuracy of Earthquake Monitoring can contribute reduction of earthquake disaster

Flow Chart of the Project Effect and Benefit



3 - 2 Recommendation

The Project Phase II is expected to produce the considerable benefits as mentioned above. The Project Phase II would substantially contribute to the development of the basic human needs in the people of the Philippines, the appropriateness of carrying out this Project under a grant-aid has been amply confirmed. Therefore, the implementation of the Project Phase II is inferred to be truly significant.

- To develop of more qualified technical personnel.

- To secure necessary financial measures for appropriate operation & maintenance and also procurement of spare parts & consumables for the whole equipment and systems to be supplied under the Project Phase II.

- To take appropriate measures against any damage and disappearance of the equipment.

- To make very close communication and association with the governmental agencies and international institutions as the governmental organization obtained a special obligation of mitigation of the natural disaster.

- To disseminate the information on volcano eruptions, earthquakes and tsunami more speedily and accurately to the general public, the governmental agencies and other organizations concerned with natural disaster mitigation.

- To develop and maintain effective networks of volcanological, seismological and geophysical stations and facilities for monitoring, Research & Development purposes and disaster mitigation;

- To develop the capability to repair, upgrade and fabricate instruments used in volcano and seismic monitoring and R&D activities;

- To conduct research to increase the level of understanding/knowledge about volcanoes, volcanic eruptions and terranes, earthquake zones and mechanism, faulting, along with other related geotectonic phenomena;

- To adapt and develop technologies for volcanic eruption and earthquake prediction, volcano and seismic monitoring and disaster mitigation;

- To conduct Research & Development on the impact of volcanic eruption, earthquake and other related geotectonic phenomena on the physical and socio-economic environment and recommend appropriate measures for the mitigation of impacts and

rehabilitation of affected areas;

- To implement an aggressive S&T information processing and dissemination program to promote public awareness on the significance of volcanic activity, earthquakes and related geotectonic processes and their threats and possible benefits to man; and

- To identify, evaluate and characterize volcanic materials and energy products and generate/adapt technologies for their utilization.

Appendix 1. Member List of the Survey Team

(1) Basic Design Survey Team

Mr. Akira NAKAMURA	Leader	Deputy Director, Project Monitoring and Coordination Division, Grant Aid Management Department, Japan International Cooperation Agency (JICA)
Mr. Toru FUJISHIRO	Grant Aid Cooperation	Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs
Mr. Takeshi KOIZUMI	Technical Advisor	Senior Scientific Officer, Earthquake Prediction Information Division, Seismological and Volcanological Department, Japan Meteorological Agency (JMA)
Mr. Kunio AKATSU	Chief Consultant / O&M Planner	Japan Weather Association
Mr. Nobuo ARAI	Earthquake and Volcano Monitoring Planner / Disaster Prevention Planner	Japan Weather Association
Mr. Yoshihisa UCHIDA	Equipment Planner I	Japan Weather Association
Mr. Hiroaki MIZUKAMI	Equipment Planner II	Japan Weather Association
Mr. Masaharu IDO	Procurement Planner / Cost Estimator	Japan Weather Association
Mr. Takuya ISHII	Project Coordinator	Japan Weather Association

(2) Explanation of Draft Report

Mr. Akira NAKAMURA	Leader	Deputy Director, Project Monitoring and Coordination Division, Grant Aid Management Department, Japan International Cooperation Agency (JICA)
Mr. Kenji MURATA	Coordinator	Third Project Management Division, Grant Aid Management Department, Japan International Cooperation Agency (JICA)
Mr. Takeshi KOIZUMI	Technical Advisor	Senior Scientific Officer, Earthquake Prediction Information Division, Seismological and Volcanological Department, Japan Meteorological Agency (JMA)
Mr. Kunio AKATSU	Chief Consultant / O&M Planner	Japan Weather Association
Mr. Nobuo ARAI	Earthquake and Volcano Monitoring Planner / Disaster Prevention Planner	Japan Weather Association
Mr. Yoshihisa UCHIDA	Equipment Planner I	Japan Weather Association

Appendix 2. Study Schedule

(1) Basic Design Study

Study Schedule			Governmental Member			Consultant Member					
			Mr. Akira NAKAMURA	Mr. Toru FUJISHIRO	MR. Takeshi KOIZUMI	Mr. Kunio AKATSU	Mr. Nobuo ARAI	Mr. Yoshihisa UCHIDA	Mr. Hiroaki MIZUKAMI	Mr. Masaharu IDO	Mr. Takuya ISHII
	2001		Leader	Grant Aid Cooperation	Technical Advisor	Chief Consultant/O&M Planner	Eathquake and Volcano Montoring/Disaster Prevention Planner	Equipment Planner I	Equipment Planner II	Procurement Planner/Cost Estimator	Project Coordinator
1	17 Sep.	Mon	Narita→Manila, Courtesy Call on JICA Philippine Office, Meeting with concerneed JICA staff								
2	18 Sep.	Tue	Courtesy Call on Embassy of Japan, Courtesy Call on NEDA, Courtesy Call on PHIVOLCS and discussion with PHIVOLCS								
3	19 Sep.	Wed	Discussion with PHIVOLCS								
4	20 Sep.	Thu	Site visit to Baguio Seismic Station						Manila→Sta. Cruz, Sta.Cruz Site Survey		
5	21 Sep.	Fri	Site visit to Bolinao Seismic Observation Point						Sta. Cruz Site Survey, Sta.Cruz→Manila		
6	22 Sep.	Sat	Site visit to Mt. Pinatubo Volcano Observatory			Site visit to Mt. Pinatubo Observatory, Clark→Buco→Taal			Manila→Buco→Taal, Taal Volcano Site Survey		
7	23 Sep.	Sun	Internal Meeting			Taal Volcano Site Survey, Taal→Manila					
8	24 Sep.	Mon	Discussion with PHIVOLCS								
9	25 Sep.	Tue	Site visit to Buco Observatory and Tagaytay Station			Data Collection for Preparation of Basic Design					
10	26 Sep.	Wed	Discussion with PHIVOLCS, Signing of the Minutes of Discussion								
11	27 Sep.	Thu	Report to JICA Philippine Office								Narita→Manila
12	28 Sep.	Fri	Manila→Narita			Manila→Legaspi→Mayon, Mayon Volcano Site Survey				Manila→Lucena→Balanacan, Boac Site Survey	
13	29 Sep.	Sat				Mayon Volcano Site Survey				Boac Site Survey, Boac→Balanacan→Lucena→Manila	
14	30 Sep.	Sun				Mayon Volcano Site Survey				Internal Meeting	
15	1 Oct.	Mon				Mayon Volcano Site Survey, Mayon→Bulusan, Bulusan Volcano Site Survey				Meeting with PHIVOLCS	
16	2 Oct.	Tue				Bulusan Volcano Site Survey				Manila→Tacloban→Borongan, Borongan Site Survey	
17	3 Oct.	Wed				Bulusan Volcano Site Survey, Bulusan→Legaspi				Borongan→Ormoc, Ormoc Site Survey	
18	4 Oct.	Thu				Legaspi→Manila				Ormoc Site Survey, Tacloban→Manila	
19	5 Oct.	Fri				Manila→Bacolod→Canlaon, Kanlaon Vplcano Site Survey				Manila→(Looc)	
20	6 Oct.	Sat				Kanlaon Vplcano Site Survey				Odiongan Site Survey, Looc→(Manila)	
21	7 Oct.	Sun				Kanlaon Vplcano Site Survey, Canlaon→Bacolod				(Looc)→Manila	
22	8 Oct.	Mon				Bacolod→Manila				Manila→San Jose, San Jose Survey	
23	9 Oct.	Tue				Manila→Cagayan de Oro→Hibok-Hibok, Hibok-Hibok Volcano Site Survey				San Jose→Manila	
24	10 Oct.	Wed				Hibok-Hibok Volcano Site Survey				Manila→El Nido, El Nido Site Survey	
25	11 Oct.	Thu				Hibok-Hibok Volcano Site Survey				El Nido Site Survey	
26	12 Oct.	Fri				Hibok-Hibok→Cagayan de Oro→Manila				El Nido→Manila	
27	13 Oct.	Sat				Internal Meeting					
28	14 Oct.	Sun				Data & Information Collection		Existing Frequency Survey at Mt. Pinatubo Observatory		Data & Information Collection	
29	15 Oct.	Mon				Meeting with PHIVOLCS					
30	16 Oct.	Tue				Meeting with PHIVOLCS					
31	17 Oct.	Wed				Taal Volcano Site Survey			Data & Information Collection	Taal Volcano Site Survey	Data & Information Collection
32	18 Oct.	Thu				Meeting with PHIVOLCS, Reporting to Embassy of Japan and JICA Philippine Office					
33	19 Oct.	Fri				Manila→Narita					

Appendix 2. Study Schedule

(2) Explanation of Draft Report

Study Schedule 2002			Governmental Member			Consultant Member		
			Mr. Akira NAKAMURA	Mr.Kenji MURATA	MR. Takeshi KOIZUMI	Mr. Kunio AKATSU	Mr. Nobuo ARAI	Mr. Yoshihisa UCHIDA
			Leader	Project Coodinator	Technical Advisor	Chief Consultant/O&M Planner	Eathquake and Volcano Montoring/Disaster	Equipment Planner I
1	10 Jan.	Thu	Narita→Manila, Courtesy Call on JICA Philippine Office, Meeting with concerned JICA staff					
2	11 Jan.	Fri	Courtesy Call on Embassy of Japan, Courtesy Call on PHIVOLCS and discussion with PHIVOLCS, Visit to Public Investment Staff, NEDA					
3	12 Jan.	Sat	Internal Meeting					
4	13 Jan.	Sun	Visit to Tagbilaran and Cebu Existing Seismic Observation Stations			Data Collection for Preparation of Basic Design		
5	14 Jan.	Mon	Visit to Proposed Seismic Observation Point in Guimara and Roxas Existing Seismic Observation Stations			Discussion with PHIVOLCS		
6	15 Jan.	Tue	Discussion with PHIVOLCS					
7	16 Jan.	Wed	Discussion with PHIVOLCS					
8	17 Jan.	Thu	Discussion with PHIVOLCS, Signing of the Minutes of Discussions, Report to Embassy of Japann and JICA Philippine Office					
9	18 Jan.	Fri	Manila →Narita			Discussion with PHIVOLCS		
10	19 Jan.	Sat				Discussion with PHIVOLCS		
11	20 Jan.	Sun				Internal Meeting and Data Collection for Preparation of Basic Design		
12	21 Jan.	Mon				Manila →Narita		

Appendix 3. List of Party Concerned in the Recipient Country

- *Department of Science and Technology (DOST)*

Dr. Estrella F. Alabastro	Secretary

- *National Economic and Development Authority (NEDA)*

Mr. Librado F. Quitoriano	Director III, Intrastructure Staff
Ms. Ameta Benjamin	Senior Economic Development Specialist, Public Investment Staff
Ms. Joanne Tolentino	Economic Development Specialist, Public Investment Staff

- *Philippine Institute of Volocanology and Seismology (PHIVOLCS)*

Dr. Raymundo S. Punongbayan	Director
Dr. Ernesto G. Corpuz	Chief, Volcano Monitoring and Eruption Prediction Division
Dr. Bartolome C. Bautista	Chief, Seismological Observation and Earthquake Prediction Division
Ms. Nanette V. A. Melosantos	Chief, Finance and Administrative Division
Mr. Delfin C. Garcia	Planning Officer
Mr. Ismael C. Narag	Supervising Science Research Specialist
Mr. Arnaldo A. Melosantos	Senior Science Research Specialist, Engineering and Instrumentation Section
Mr. Gemme F. Ambubuyog	Precision Instrument Specialist
Ms. MA. Leonila P. Bautista	Assistant Scientist
Mr. Erlinton Antonio B. Olavere	Science Research Specialist I
Mr. Melquiades S. Figueroa II	Instrumentation Engineer
Mr. Benjamin Tanatan	Science Research Assistant
Mr. Eduardo Lauerta	Resident Volcanologist, Mayon Volcano Observatory, Senior Science Research Specialist

Mr. Elmer Giabinete	Science Research Specialist II
Mr. Wencelito M. Gelido	Science Research Specialist I
Mr. Joel Marilla	Science Research Specialist I
Mr. Rudy Lacson	Science Research Specialist I
Mr. Alejo Baloloy	Science Research Analyst
Mr. Jesus R. Puertollano	Senior Research Specialist
Mr. Nelson Mondia	Science Research Assistant
Mr. Crispolo Diolata Jr.	Science Research Assistant
Mr. Luisito Samgsugan	OIC Hibok-Hibok Volcano Observatory
Mr. Arturo Jardin	Science Research Assistant
Mr. Alan Loga	Resident Volcanologist, Taal Volcano Observatory
Mr. Orlando Guardacasa	Science Research Specialist
Mr. Ramses Valerio	Science Research Specialist II
Mr. Danny Alejandro Martinez	Science Research Specialist I
Mr. Bong Artemio Luis Jr.	Science Research Analyst
Mr. Joel Arellano	Science Aide

- *National Telecommunication Committee (NTC)*

Mr. James C. Panefa	Communication Development Officer II, Frequency Management Division

- *Municipal, Santa Cruz, Zambales*

Mr. Ding Magsaysay	Governor of Zambales
Ms. Consolacion Marty	Municipal Mayor

- *Municipal, Boac, Marinduque*

Mr. Dante Marquez	Municipal Vice Mayor

- *Municipal, Borongan,Eastern Samar*

Mr. Fidel Anacta	Municipal Mayor

- *Municipal, Ormoc City*

Mr. Beinvenido Matiga	Minicipal Administrator
Mr. Darlito Pareja	Tax Mapper IV

- *Municipal, Odiongan, Romblon*

Mr. Ed Musca	Municipal Administrator

- *Municipal, San Jose, Occidental Mindoro*

Mr. Gaudencio Espiritu	Municipal Mayor
Mr. Ricard Obana	Barangay Kagawad

- *Municipal, El Nido, Palawan*

Ms. Leonor Corral	Municipal Vice Mayor

- *Municipal, La Carlota, Negros*

Mr. Joseph V. Emboltorio	City Administrator
Dr. Rex R. Jalando-on	Vice Mayor
Hon. Deme C. Honrado	City Councilor
Mr. Ismael Salvacion	NGO

Appendix 4. Minutes of Discussion

MINUTES OF DISCUSSIONS ON BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM (PHASE Ⅱ) IN THE REPUBLIC OF THE PHILIPPINES

In response to a request from the Government of the Republic of the Philippines (hereinafter referred to as "the Philippines"), the Government of Japan decided to conduct a Basic Design Study on the Project for Improvement of Earthquake and Volcano Monitoring System (Phase Ⅱ) (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA dispatched to the Philippines the Basic Design Study Team (hereinafter referred to as "the Team"), which is headed by Mr. Akira Nakamura, Deputy Director of Project Monitoring and Coordination Division, Grant Aid Management Department, JICA, and scheduled to stay in the country from September 17 to October 19, 2001.

The Team held discussions with officials concerned of the Government of the Philippines and conducted a field survey at the study area.

In the course of discussions and field survey, both parties confirmed the main items described in ATTACHMENT Ⅰ. The Team will proceed with further works and prepare the draft report.

Quezon, September 26, 2001

Akira Nakamura
Leader
Basic Design Study Team
JICA

Raymundo S Punongbayan
Director
Philippine Institute of Volcanology and Seismology

ATTACHMENT I

1. Objective

The objective of the Project is to contribute to the following points through improving the Earthquake and Volcano Monitoring System of the Philippine Institute of Volcanology and Seismology (hereinafter referred to as "PHIVOLCS"):

(1) Reduction of natural disasters resulting from earthquakes, tsunamis and volcanic eruptions

(2) Prompt and necessary action of civil defense and relief for minimizing extensive loss and damage, which are determining factor for significant set-back of national economy and development activities of the Philippines.

(3) Improvement of safety of the aviation operation and of people's life & property by providing more accurate information for the general public around the clock.

(4) Formulation of hazards reduction and disaster avoidance strategies needed in the preparation and enforcement of standards, regulations and other necessary rules on structure, civil defense, relief action, operation of transports, etc. for appropriate and efficient development of the Philippines.

2. Project Site

The project sites are located as shown in Annex-1.

3. Responsible and Implementing Organization

The Responsible and Implementing Organization of the Project is PHIVOLCS. The organization chart of PHIVOLCS is shown in Annex-2.

4. Items requested by the Government of the Philippines

After discussions with the Team, the items described in Annex-3 were finally requested by the Philippine side. JICA will assess the appropriateness of the request and will recommend to the Government of Japan for approval.

5. Japan's Grant Aid Scheme

(1) The Philippine side understands the Japan's Grant Aid scheme explained by the Team, as described in Annex-4.

(2) The Philippine side will take the necessary measures, as described in Annex-5, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6. Schedule of the Study

(1) The consultants will proceed with further studies in the Philippines until October 19, 2001.

(2) JICA will prepare the draft report in English and dispatch a team to the Philippines in order to explain its contents around January, 2002.

(3) In case that the contents of the report are accepted in principle by the Government of the Philippines, JICA will complete the final report and send it to the Government of the Philippines by May, 2002.

7. Other Relevant Issues

(1) The Philippine side will provide the team with data and information necessary for the study when requested.

(2) The Philippine side will take possible measures to secure the safety of the Team.

(3) In areas deemed having security problems, the Philippine side will implement necessary site surveys at these sites at PHIVOLCS' expense.

(4) The Philippine side will obtain all necessary permission and frequency for the data communication system to be provided under the project.

(5) The Philippine side will secure the personnel and budget necessary for implementation of the Project and for operation/maintenance of the equipment and facilities.

(6) The Philippine side will complete the procedure to obtain a re-approval of Investment Coordinating Committee (ICC) by the end of January, 2002.

(7) The Philippine side will exempt Japanese nationals engaged in the Project from customs duties, internal taxes including VAT, and other fiscal levies which may be imposed in the Philippines for the supply of products and services under the verified contracts.

(8) The Philippine side will complete the procedure to secure the land necessary for the observation facilities before the tender notice of the Project.

(9) The Team shall examine the reliability of the data transmission on cellular phone network by sending e-mail with attached file to the director's e-mail address of PHIVOLCS. As the consultants will be able to cover some thirty (30) percent of the target points, PHIVOLCS is responsible for the check of the remaining points by

sending e-mail on a cellular phone.

(10) All items especially data communication systems will be determined considering cost-effectiveness as well as technical appropriateness.

(11) The Philippine side explained to the Team that the equipment procured under Phase I have been fully utilized to strengthen the activities of PHIVOLCS with proper operation and maintenance, and with timely issuance of earthquake information to the public.

(12) Highlight of discussion for the project component

a. Function and Role of the Head Office Mirror Station

In lieu of the envisioned three sub-centers, a Head Office Mirror Station is proposed to minimize maintenance and operation cost, avoid unnecessary increase in personnel, ensure continuous operation in case the Head Office is adversely affected by a large magnitude earthquake and ensure continuous provision of critical earthquake information to the public, decision makers and responding agencies. This mirror station will only serve as a data receiving and storage hub with basic data processing capability. Candidate sites for the mirror station are Baguio and Pinatubo in Northern Luzon and Tagaytay in Southern Luzon.

b. Unmanned Seismic and Volcano Observation Points

The number of unmanned volcano observation points has been decreased to minimize maintenance and operating costs. Most of the unmonitored active volcanoes do not require yet continuous surveillance. In the event of volcanic unrest in these active volcanoes, a Quick Response Team will be dispatched using the proposed mobile monitoring systems. Such reduction resulted in the increase of the number of seismic observation points and increase in the number of mobile monitoring systems.

Selected seismic observation points to be furnished with satellite communication systems will be equipped with three-component sensors to confidently identify arrival time of secondary waves for improving hypocentral location of events.

c. Volcano Satellite observation points

Three satellite observation points (each equipped with three-component convertible type sensors) will be established in each of the six most active volcanoes for locating and characterizing volcanic earthquakes and for detecting onsets of volcanic unrest. Data

relay stations will be established as required.

The provision of data processing capability to the existing volcano observatories will ensure near real-time analysis of volcanic information and timely issuance of warnings to the public.

d. Middle-period and Broadband Seismographs

Only the six existing volcano observatories will be equipped with middle-period sensors (three-component) with recording systems. These systems are highly sensitive to detecting low-frequency volcanic tremors associated with magmatic intrusion and ascent. The remaining proposed twenty-nine middle-period sensors will be replaced by seven broadband seismic sensors (three-component) with recording systems.

e. Mobile Monitoring Systems

Thirty short-period velocity sensors (To=1 sec, three-component convertible-type) will be provided for the monitoring of aftershocks and seismic swarms and the periodic and emergency monitoring of active volcanoes without observatories. Five short-period velocity sensors (To=20 sec, three-component) will be provided for the effective detection of low-frequency volcanic quakes that indicate magma ascent. Ten accelerometers will be used in characterizing strong ground-motion site response in areas affected by large magnitude earthquakes. Thirty mobile data recorders (nine-channel) would allow for simultaneous data-acquisition using two types of three-component velocity sensors and three-component accelerometer.

Thirty telemetry systems with ten repeater systems will be added for transmission of data from ten tiltmeters with data logging function, ten GPS with data logging function and seismic networks to Quick Response temporary central station. GPS and tiltmeter networks will be deployed during emergencies to monitor ground deformation associated with volcanic and seismic crises.

Two sets of data processing systems with satellite data link will be used in the event of two crises occurring at the same time. With the provision of these sets of equipment, on-site processing of acquired data from mobile monitoring networks and immediate data transmission to Head Office will be possible.

f. Power Supply

All power supplies should be regulated and should have sufficient lightning protection to ensure instrument longevity and continuous operation of all monitoring equipment.

g. Timing System

GPS timing system will be required for all recording systems to ensure absolute time during recording of crucial events.

h. Data Management and Processing Capability of Head Office

Simple, user-friendly, less laborious, systematic and event-oriented data acquisition, processing and archiving system using internationally accepted data format will be designed for the Head Office.

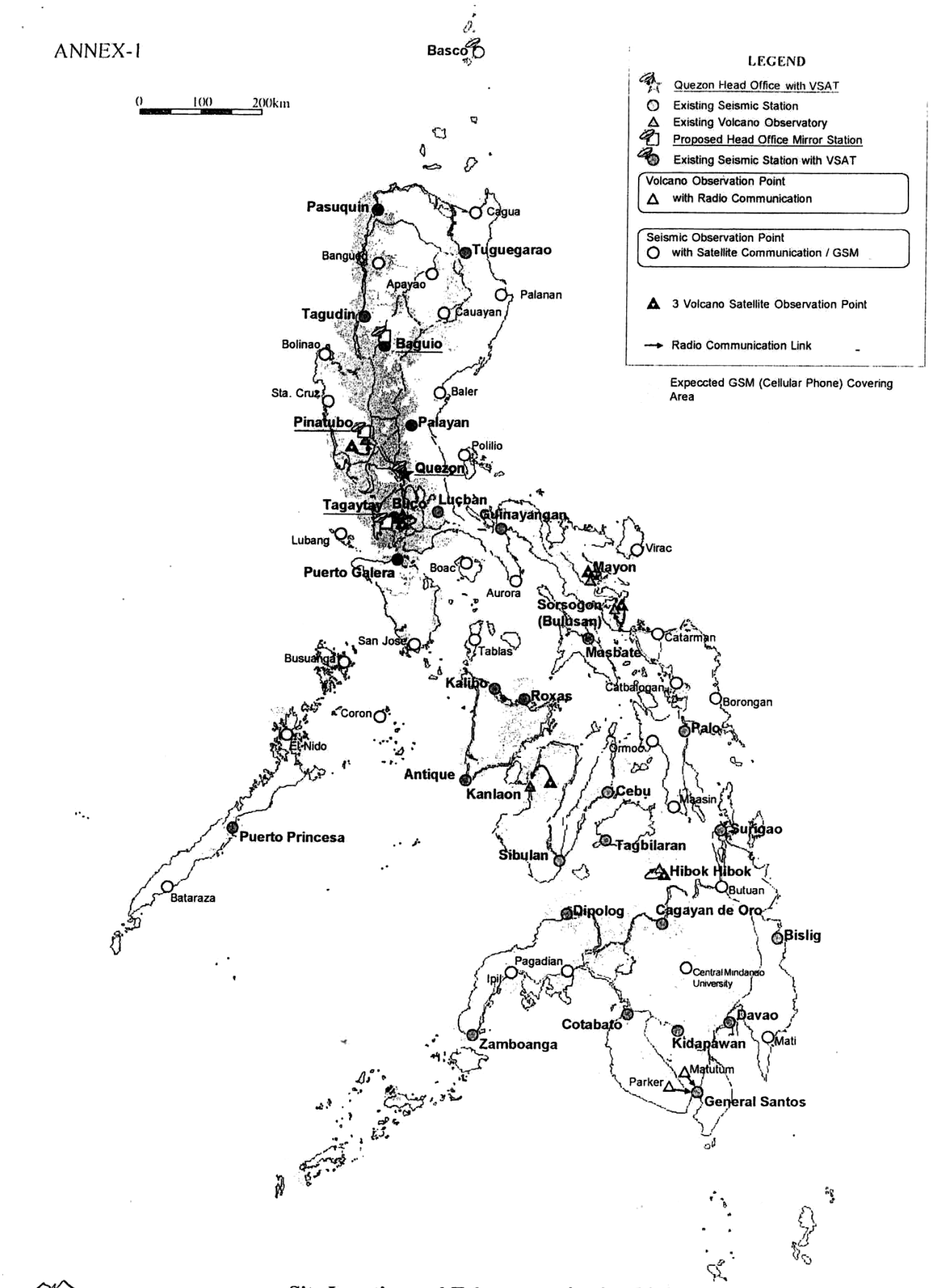
i. Spare Parts

Spare units/parts and troubleshooting/testing equipment will be considered to ensure proper operation and minimize downtime beyond warranty period.

j. Provision of Vehicles and Motorcycles

The proposed vehicles will allow for the immediate dispatch of Quick Response Teams with mobile monitoring equipment during earthquake and volcanic crises. Motorcycles will allow PHIVOLCS technical staff to access hard-to-reach sites during equipment deployment and to conduct rapid damage assessment due to earthquakes and volcanic eruptions. Motorcycles will also aid in the repair and maintenance of remote stations inaccessible to four-wheel vehicles.

ANNEX-I



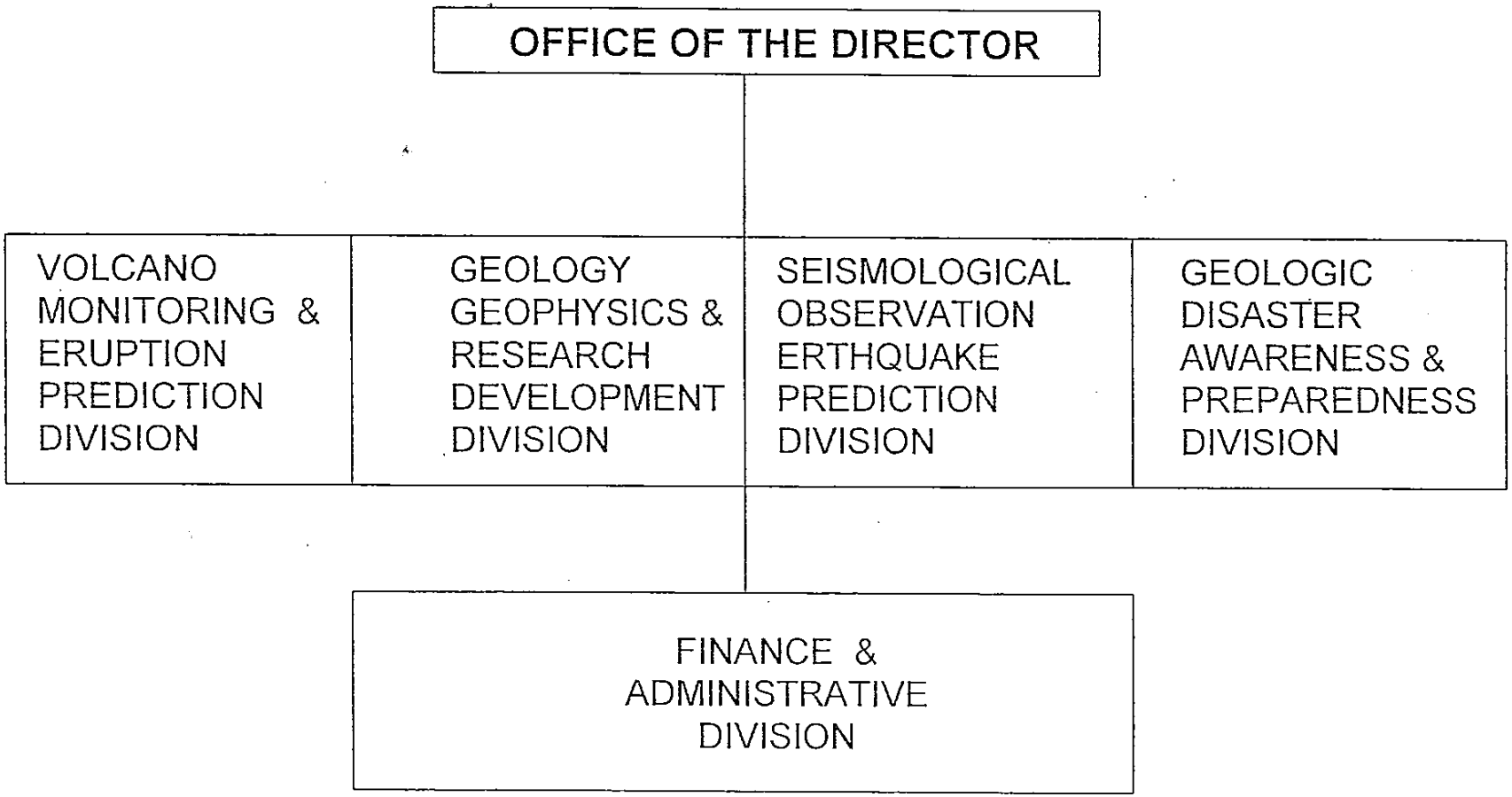
Site Location and Telecommunication Link

The Project for Improvement of Earthquake and Volcano Monitoring in the Republic of the Philippines (Phase-II)

ANNEX-2

ORGANIZATIONAL STRUCTURE OF THE

Philippine Institute of Volcanology and Seismology



ANNEX-3

Requested components in the Application Form submitted to the Government of Japan		Revised proposal and components newly requested by PHIVOLCS		Components to be studied by JICA Basic Design Study Team	
Main Components		**Main Components**		**Main Components**	
- Seismic Observation Points (1-component) with Data Communication Systems	19	- Seismic Observation Points (1-component) with Data Communication Systems	24	- Seismic Observation Points (Vertical / 3-component) with Data Communication Systems	29
- Volcano Observation Points (Vertical Component) with Data Communication Systems	13	- Volcano Observation Points (Vertical Component) with Data Communication Systems	15	- Volcano Observation Points (Vertical Component) with Data Communication Systems	2
- Volcano Satellite Observation Points (3-component) with Data Communication Systems	18	- Volcano Satellite Observation Points (3-component) with Data Communication Systems	18	- Volcano Satellite Observation Points (3-component, Convertible-type) with Data Communication Systems (including Relay Stations, if required)	18
- Data Processing & Analyzing Systems at Sub-Centers (Tuguegarao, Baguio, Cebu and Davao)	4	- Data Processing & Analyzing Systems at Sub-Centers (Baguio, Cebu and Davao)	3		
				- Data Receiving, Pre-processing and Storage Systems at the Head Office Mirror Station (Proposed site: Baguio, Pinatubo or Tagaytay)	1
- Data Processing Systems at the Existing Volcano Observatories	6	- Data Processing Systems at the Existing Volcano Observatories	6	- Data Processing Systems at the Existing Volcano Observatories	6
- Data Processing Systems in Quezon City Head Office	1	- Data Processing Systems in Quezon City Head Office	1	- Data Processing Systems in Quezon City Head Office	1
- Relay Stations	9	- Relay Stations	4		
- Middle-period Seismic Sensors (3-component) with Recording Systems at the Existing Stations	35	- Middle-period Seismic Sensors (3-component) with Recording Systems at the Existing Stations	34	- Middle-period Seismic Sensors (3-component) with Recording Systems at the Existing Volcano Observatories	6
- Long-period Seismic Sensors (3-component) with Recording Systems at the Existing Stations	4	- Broadband Seismic Sensors (3-component) with Recording Systems at the Existing Seismic Stations	4	- Broadband Seismic Sensors (3-component) with Recording Systems at the Existing Seismic Stations	7
- Short-period Seismic Observation System with Recording Systems at Buco Existing Station	1	- Short-period Seismic Observation System (3-component) with Recording Systems at Buco Existing Station	1	- Short-period Seismic Observation System (3-component) with Recording Systems at Buco Existing Station	1
				- Strong Motion Observation System (3-component) with Recording Systems at Buco Existing Station	1
- Displacement-type Seismic Recording Systems	35				
- Mobile Monitoring Systems		- Mobile Monitoring Systems		- Mobile Monitoring Systems	
Short-period Seismic Sensors (3-component)	20	Short-period Seismic Sensors (3-component)	20	Short-period Velocity-type Seismic Sensors (T0=1 sec, 3-component, Convertible-type)	30
				Short-period Velocity-type Seismic Sensors (T0=20 sec, 3-component)	5
Accelerometers (3-component)	10	Accelerometers (3-component)	10	Accelerometers (3-component)	10
Mobile Data Recorders	30	Mobile Data Recorders	30	Mobile Seismic Data Recorders (9-channel)	30
		Tiltmeters with Telemetering Systems	9	Tiltmeters with Data Logging Function	10
		Mobile Geochem Mini-laboratory	1		
		Correlation Spectrometers (COSPECs)	3		
		Electronic Distance Meters	3		
		GPS (Deformation Monitoring System)	6	GPS Deformation Monitoring Systems with Data Logging Function	10
				Telemetering Systems (with 10 repeater systems)	30
				Data Processing Systems with Satellite Data Link	2
		Infrared Cameras	3		
		High Precision Gravimeter	1		
		- Satellite Data Communication Systems	11	- Satellite Data Communication Systems / GSM Data Communication Systems	32
		- GSM Data Communication Systems	24		
				- Back-up Power Supply System	
- Pick-up Vehicles	3	- Pick-up Vehicles	3	- Pick-up Vehicles	3
- Motorcycles	9	- Motorcycles	9	- Motorcycles	9

Japan's Grant Aid

The Grant Aid scheme provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

Japan's Grant Aid Scheme is executed through the following procedures.

Application	(Request made by a recipient country)
Study	(Basic Design Study conducted by JICA)
Appraisal & Approval	(Appraisal by the Government of Japan and Approval by Cabinet)
Determination of Implementation	(The Notes exchanged between the Governments of Japan and the recipient country)

Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for the Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using Japanese consulting firms.

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Scheme, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes (E/N) signed by the Governments of Japan and the recipient country.

Finally, for the smooth implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

2. Basic Design Study

(1) Contents of the Study

The aim of the Basic Design Study (hereinafter referred to as "the Study"), conducted by JICA on a requested project (hereinafter referred to as "the Project"), is to provide a basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows:

- Confirmation of the background, objectives, and benefits of the requested Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation.

- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view.

- Confirmation of items agreed upon by both parties concerning the basic concept of the Project.

- Preparation of a Basic Design of the Project.

- Estimation of cost of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Study, JICA uses registered consulting firms. JICA selects firms based on proposals submitted by interested firms. The firms selected carry out a Basic Design Study and write a report, based upon terms of reference set by JICA.
The consulting firms used for the Study are recommended by JICA to the recipient country to also work on the Project's implementation after the Exchange of Notes, in order to maintain technical consistency.

3. Japan's Grant Aid Scheme

(1) Exchange of Notes (E/N)
Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

(2) "The period of the Grant Aid" means the one fiscal year which the Cabinet approves the project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with consulting firms and contractors and final payment to them must be completed.
However, in case of delays in delivery, installation or construction due to unforeseen factors such as natural disaster, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

(3) Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However, the prime contractors, namely consulting, constructing and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

(4) Necessity of "Verification"
The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

(5) Undertakings required to the Government of the recipient country
In the implementation of the Grant Aid project, the recipient country is required to undertake such necessary measures as the following:

1) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction,
2) To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites,

3) To secure buildings prior to the procurement in case the installation of the equipment,
4) To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid,
5) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the verified Contracts,
6) To accord Japanese nationals, whose services may be required in connection with supply of the products and services under the verified contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

(6) "Proper Use"
The recipient country is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

(7) "Re-export"
The products purchased under the Grant Aid should not be re-exported from the recipient country.

(8) Banking Arrangement (B/A)
1) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the verified contracts.

2) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to Pay (A/P) issued by the Government of recipient country or its designated authority.

(9) Authorization to Pay (A/P)
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions to the Bank.

ANNEX - 5

Major Undertakings to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To bear following commissions to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	Payment commission		●
2	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	Marine (Air) transportation of the products from Japan the recipient	●	
	Tax exemption and custom clearance of the products at the port of disembarkation		●
	Internal transportation from the port of disembarkation to the project site	(●)	(●)
3	To accord Japanese nationals, whose service may be required in connection with the supply of the products and the services under the verified contract, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
4	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts		●
5	To maintain and use properly and effectively the facilities contracted and equipment provided under the Grant Aid		●
6	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for the transportation and installation of the equipment		●

MINUTES OF DISCUSSIONS
ON BASIC DESIGN STUDY
ON THE PROJECT FOR IMPROVEMENT OF EARTHQUAKE AND VOLCANO MONITORING SYSTEM (PHASE II) IN THE REPUBLIC OF THE PHILIPPINES
(EXPLANATION ON DRAFT REPORT)

In September 2001,the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a Basic Design Team on the Project for Improvement of Earthquake and Volcano Monitoring System (Phase II) (hereinafter referred to as "the Project") to the Republic of the Philippines (hereinafter referred to as "the Philippines"), through discussion, field survey, and technical examination of the results in Japan, JICA prepared a draft report of the Study.

In order to explain and to consult the Government of the Philippines on the components of the draft report, JICA sent to the Philippines the Draft Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. AKIRA NAKAMURA, Deputy Director of the Planning Division, Grant Aid Management Department, JICA from January 10 to 21, 2002.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Quezon City, January 17, 2002

Akira Nakamura
Leader
Draft Report Explanation Team
Japan International Cooperation Agency

Raymundo S. Punongbayan
Director
Philippine Institute of Volcanology and Seismology

ATTACHMENT

1. Components of the Draft Report

The Philippine side agreed and accepted in principle the components of the draft report as prepared and explained by the Team. Main components of the Project are shown in ANNEX-1 as a result of the discussion. JICA will assess the appropriateness of the components and will recommend to the Government of Japan for approval.

2. Japan's Grant Aid Scheme

The Philippine side understands the Japan's Grant Aid scheme and the necessary measures to be taken by the Philippine side as explained by the Team and described in ANNEX-4 and ANNEX-5 of the Minutes of Discussions signed by both parties on September 26, 2001.

3. Schedule of the Study

JICA will complete the final report in accordance with the confirmed components and send it to the Philippine side by the end of April, 2002.

4. Other Relevant Issues

(1) The PHIVOLCS shall use all the equipment procured under Japan's Grant Aid properly and effectively.

(2) Both sides confirmed that Satellite Data Communication System (VSAT) is suitable for transmitting seismic data.

(3) The Philippine side shall secure personnel and budget necessary for implementation of the Project and for operation and maintenance of all Japan's Grant Aid equipment and facilities.

(4) The Philippine side shall obtain all necessary permits and frequency allocations for the VSAT at their expense.

(5) Both sides reconfirmed that the Philippine side should complete the procedure to obtain the re-approval of Investment Coordinating Committee (ICC) for the Project by the end of January, 2002.

(6) The Team handed one copy of the draft-detailed specifications of the equipment to the PHIVOLCS. Both sides agreed that these draft specifications were confidential and should not be duplicated or released to any other outside parties in order to secure the fairness and competitiveness of the tender of the Project.

(7) The Philippine side will exempt Japanese nationals engaged in the Project from all duties, and related fiscal charges which may be imposed in the Philippines with respect to the import of the products and services supplied under the verified contracts.

(8) The Philippine side will assume all fiscal levies and taxes imposed in the Philippines on Japanese nationals with respect to the payment carried out for and the income accruing from the supply of the products and services under the verified contracts.

(9) Both sides reconfirmed that the Philippine side should complete the procedure to secure the land necessary for the observation facilities before the tender notice of the Project.

(10) Both sides confirmed that the three (3) pick-up trucks procured under Japan's Grant Aid should be stationed in the PHIVOLCS' Head Office and operated and maintained properly, and also used for urgent and/or regular mobile monitoring, educational campaign regarding earthquakes and volcanic activities, etc.

(11) In areas deemed having security problems, the Philippine side will shoulder inland transportation, installation, any and all relative works of equipment at the PHIVOLCS' expense. After installation of all equipment in such areas, the PHIVOLCS' Head Office shall confirm successful installation of the equipment by receiving the data from each observation point, and shall inform JICA of the result in writing within one (1) month after completion of the Project.

(12) The Philippine side requested for inclusion of isolation transformers for lightning protection. The Team understood their necessity and will consider the possibility of their inclusion.

(13) The Philippine side requested a modification of the design of the seven stations that will be provided with broadband instruments in order to simplify the design for easy maintenance and ease of operation.

(14) The Team visited several stations where the equipment were installed under Phase I, and confirmed that they are properly operating and well-maintained. The Team also visited one of the proposed sites for unmanned seismic observation point, and confirmed suitability for seismic observation and satellite data transmission.

Comparison Table of Major Components

between the Official Request (Application Form) of the Government of the Philippines and the Project Phase II

Components requested by the Government of the Philippines		Components for the Project Phase II	
- Seismic Observation Points (1-component) with Data Communication Systems	19	- Seismic Observation Points (3-component, Convertible-type) with Satellite Communication Systems (VSAT)	29
- Volcano Observation Points (Vertical Component) with Data Communication Systems	13	- Volcano Observation Points (3-component, Convertible-type) with Data Communication Systems (including Repeater Points)	2
- Volcano Array Observation Points (3-component) with Data Communication Systems	18	- Volcano Array Observation Network (each network: 3 observation points, 3-component, Convertible-type) with Data Communication Systems (including Repeater Points) for 6 most active volcanoes (3 observation points x 6 volcanoes = 18 points)	6
- Data Processing & Analyzing Systems at Sub-Centers (Tuguegarao, Baguio, Cebu and Davao)	4		
		- Satellite Hub Data Communication System, Pre-processing and Data Storage Systems at the Head Office Mirror Center in Tagaytay Existing Seismic Observation Station	1
- Data Processing Systems at the Existing Volcano Observatories	6	- Data Processing & Analyzing Systems at the Existing Volcano Observatories	6
- Data Processing Systems in Quezon City Head Office	1	- Satellite Hub Data Communication System and Data Management & Processing Systems in Quezon City Head Office	1
		- Satellite Data Communication System at Basco Existing Seismic Observation Station	1
- Relay Stations	9		
- Middle-period Seismic Sensors (3-component) with Recording Systems at the Existing Stations	35	- Middle-period Seismic Sensors (3-component) with Recording Systems at the Existing Volcano Observatories	6
- Long-period Seismic Sensors (3-component) with Recording Systems at the Existing Seismic Stations	4	- Broadband Seismic Sensors (3-component) with Recording Systems at the Existing Seismic Stations	7
- Short-period Seismic Observation System with Recording Systems at Buco Existing Volcano Observatory	1	- Short-period Seismic Observation System (3-component) and Strong Motion Observation System (3-component) with Recording Systems at Buco Existing Volcano Observatory	1
- Displacement-type Seismic Recording Systems	35		
- Mobile Monitoring Systems		- Quick Response Mobile Monitoring Systems	
Short-period Seismic Sensors (3-component)	20	Short-period Velocity-type Seismic Sensors (T0=1 sec, 3-component, Convertible-type)	30
		Short-period Velocity-type Seismic Sensors (T0=20 sec, 3-component)	5
Accelerometers (3-component)	10	Accelerometers (3-component)	10
Mobile Data Recorders	30	Mobile Seismic Data Recorders (9-channels)	30
		Tiltmeters with Data Logging Function	10
		GPS Deformation Monitoring Systems with Data Logging Function	10
		Data Communication Systems	30
		Repeater Systems for Data Communication Systems	10
		Data Processing Systems with Satellite Data Link and Satellite Phone	2
		- Back-up Power Supply Systems	
- Spare Parts and Consumables		- Spare Parts and Consumables	
- Pick-up Vehicles	3	- Pick-up Vehicles (Pick-up Trucks)	3
- Motorcycles	9		

Appendix. 5. Cost Estimation Borne by the Recipient Country

The following major undertakings to be borne by the Philippines side (PHIVOLCS) are necessary for the implementation under Japan's Grant Aid Assistance.

- Prior to commencement of the Project

1) Cost for securing all necessary lands for the sites of the Project including clearing, leveling and reclaiming the lands
2) Cost for making the access roads and/or paths to the sites
3) Commission for obtaining appropriate frequencies for telemeter systems

- During the Project Implementation

4) Civil work, equipment delivery and installation work costs for some of the project sites having security problem (Mindanao islands, etc.)
5) Cost for a required space segment (band width) for satellite data communications

- During the Project Implementation or after completion of the Project

6) Fencing for protection of the equipment and systems at the unmanned Project sites
7) Personnel expenses for caretakers for unmanned observation points

Due to the ODA regulation, commissions to the Japanese foreign exchange bank to be borne by the Government of the Philippines for the banking services based upon Banking Arrangement will be required. In addition to this, taxes such as Value Added Tax (VAT) and import taxes levied by the Government of the Philippines on any goods and services to be purchased and/or imported by the contractor will also be borne by the Government of the Philippines.

Appendix 6. References

1. Annual Report ’99, Philippine Institute of Volcanology and Seismology

2. Annual Report ’98, Philippine Institute of Volcanology and Seismology

3. Annual Report ’97, Philippine Institute of Volcanology and Seismology

4. Annual Report ’96, Philippine Institute of Volcanology and Seismology

5. Annual Report ’95, Philippine Institute of Volcanology and Seismology

6. Nomination Form 2001 of United Nations Sasakawa Award for Disaster Reduction, 2001

7. Quick Refference Notes(Mayon, Pinatubo, Hibok-Hibok,Kanlaon, Bulusan,Taal), PHIVOLCS

8. The Philippine Road Guide, M&L Licudine Enterprises,

9. The Philippine Atlas, Philippine Guides, Inc.,

10. Philippines Travel Atlas, United Tourist Promotions,

11. Earthquake Bulletin Data (1996-Spt 2001), PHIVOLCS

12. Medium-Term Philippine Development Plan, 1999-2004, Angat Pinoy 2004

13. The Medium Term Term Plan of the Department of Science and Technology (1999-2004)