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# BASIC DESIGN STUDY REPORT

# ON

# THE PROJECT

# FOR

# CONSTRUCTION OF NEW KAWASOTI SUBSTATION

# IN

# THE KINGDOM OF NEPAL

MAY 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

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# PREFACE

In response to a request from His Majesty's Government of Nepal, the Government of Japan decided to conduct a basic design study on the Project for Construction of New Kawasoti Substation in the Kingdom of Nepal and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Kingdom of Nepal a study team from November 9 to December 6, 2005.

The team held discussions with the officials concerned of His Majesty's Government of Nepal, 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 Kingdom of Nepal 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 His Majesty's Government of Nepal for their close cooperation extended to the teams.

May 2006

Masafumi KUROKI
Vice-President
Japan International Cooperation Agency

May 2006

## Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Construction of New Kawasoti Substation in the Kingdom of Nepal.

This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from October, 2005 to May, 2006. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of the Kingdom of Nepal and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

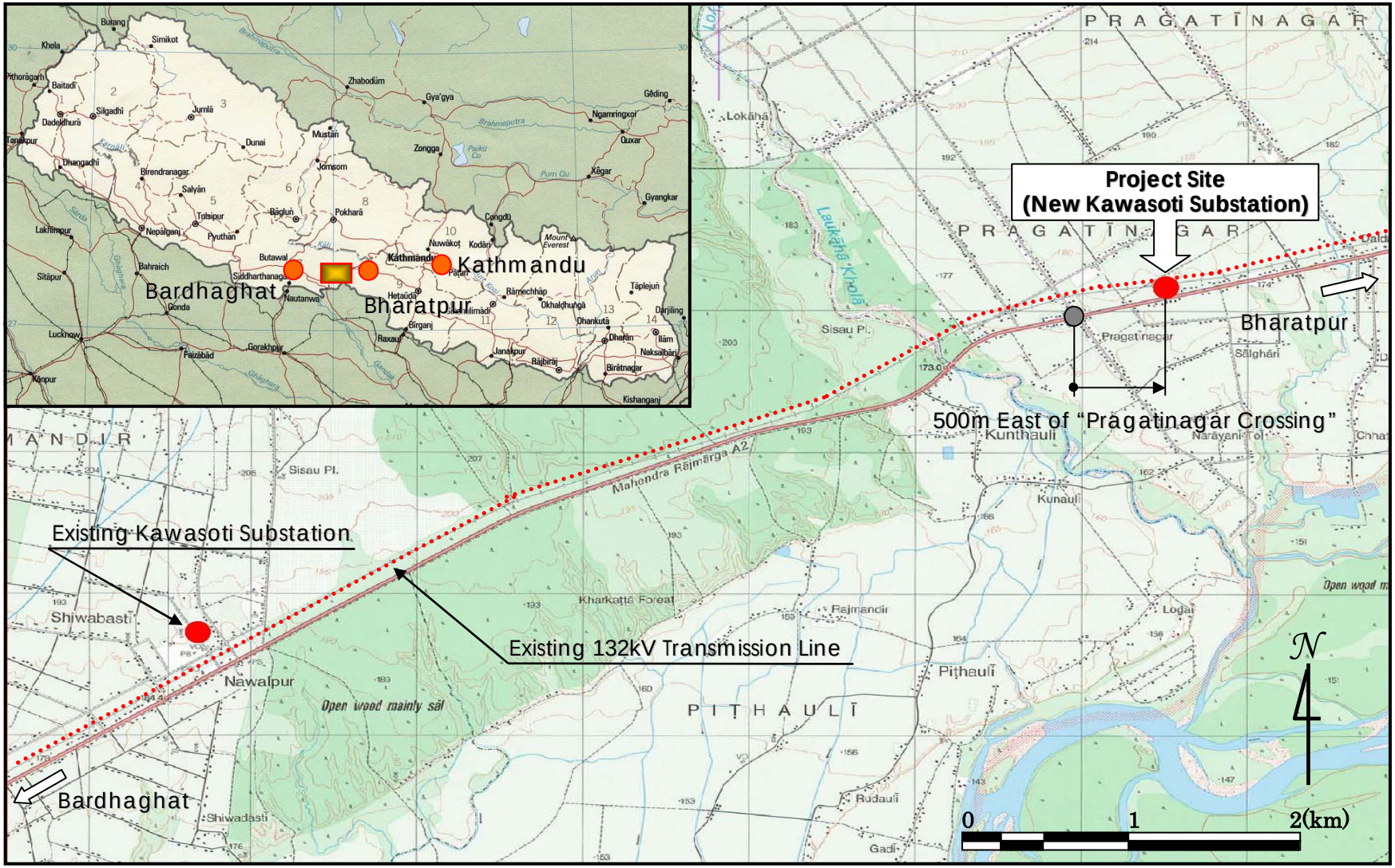
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

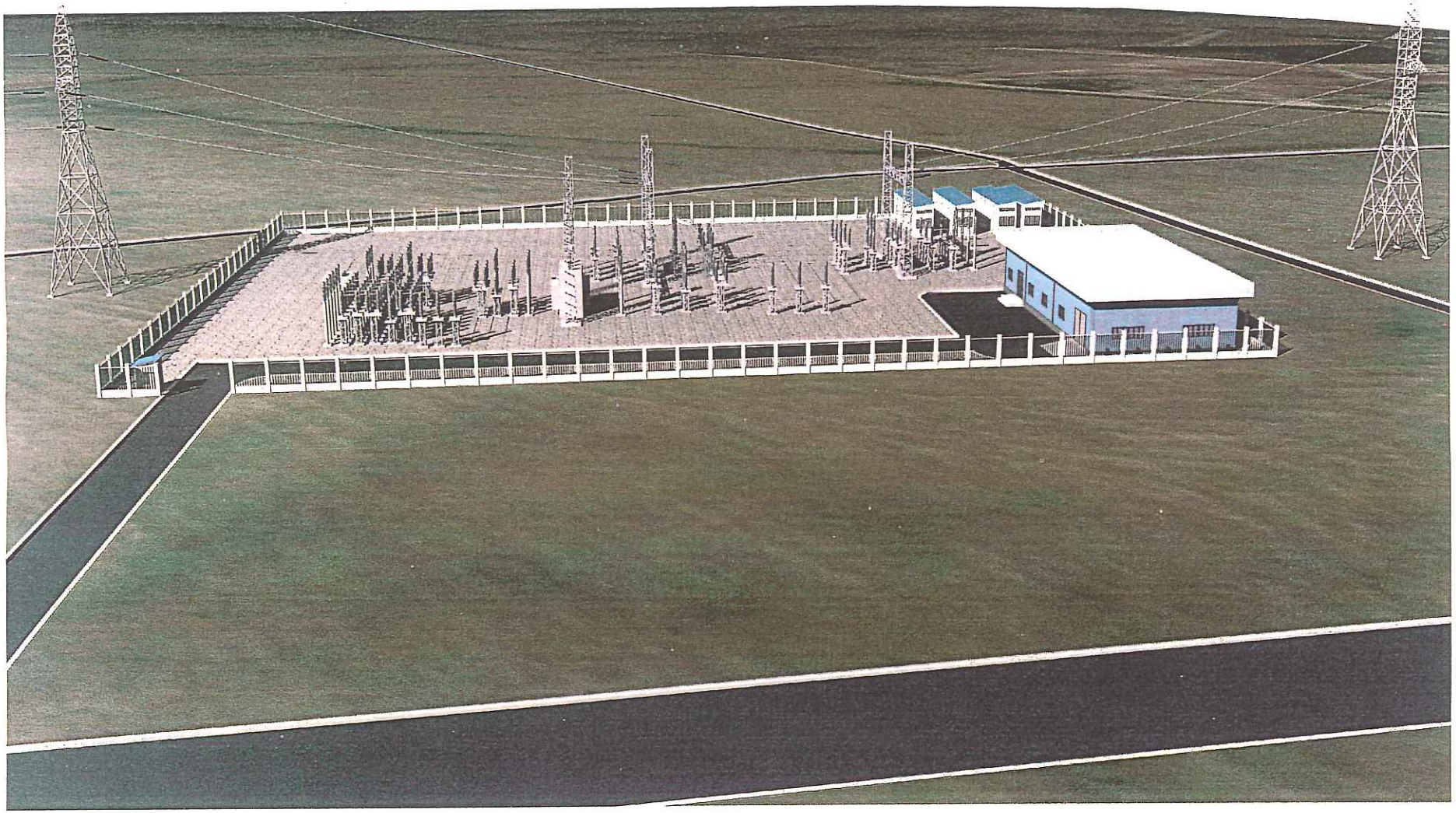
Hiroyuki MORITA

Chief Consultant,
Basic design study team on
The Project for Construction of
New Kawasoti Substation
In the Kingdom of Nepal
Nippon Koei Co., Ltd.


Location Map




Location Map



PERSPECTIVE

## *Summary*

# SUMMARY

His Majesty's Government of Nepal (hereinafter referred to as "HMG/N") is trying to reduce poverty, especially economical disparities between urban and rural areas. This is one of the most important issues for HMG/N's policy stated in the 10th five-year development plan (2002–2007). Promotion of the rural electrification is one of the measures that has been selected to stimulate economic growth in rural areas.

In the past, the largest problem in the power sector in Nepal has been the lack of generating capacity. However, this situation has been improved by the construction of new hydropower stations such as Kimtikhola (60 MW, completed in 2000) and Kali Gandaki A (144 MW, completed in 2002). While the long-term problem of generation is being solved, weaknesses in the power transmission and distribution system are being disclosed. At present, the average ratio of electrification in the whole country is low, just 23.9%, and this means that much more rural electrification is clearly needed. This also means that the extension of the existing power transmission and distribution facilities cannot fully keep up with the electrical demand due to the rapid growth of the population in isolated industrial areas like Kawasoti. The poor condition of the transmission and distribution facilities causes power failures caused by ground faults and results in an unreliable power supply. In addition, there are so many domestic consumers left without being connected to the distribution lines because the priority for connection is placed on industrial/commercial consumers.

The targeted area of the Project, Kawasoti, is located in the district of Nawalparasi, and it is in the middle west of the country 120 km west-southwest from the city of Kathmandu. The Nawalpalasi district has a huge area of fertile fields called the "Terai", and various kinds of agricultural products are available there. This area is a new settlement area and factories are being set up because the area is close to the Indian border, offering many chances of trade. Infrastructure in the area is being arranged. As a result, economic growth is underway. People coming from the mountain areas can provide inexpensive labour forces and such peoples attract the factories to gather there. The area itself is well on the way to seeing a reduction in poverty. The population of the area is increasing drastically and the power supply system cannot afford the sudden increase in demand. The rapid increase in electrical demand, mainly by the industries, hinders the electrical supply even to domestic consumers who used to have access to a reliable electrical supply. This poor condition of the electrical supply disturbs the improvement of living standards of the inhabitants.

The present power supply to the target area is made in the following way. The power of 132 kV is transmitted from Bardhaghat Substation to Bharatpur Substation located 70 km to the east of Bardhagat Substation via 132 kV transmission line. At Bharatpur Substation, the power is transformed into 33 kV and then transmitted to the existing Kawasoti Substation through 33 kV transmission line with 35 km length. The power is transformed from 33 kV into 11 kV at the existing Kawasoti Substation and then distributed to each consumer. The transmission capacity of the existing transmission system is too small. Due to this poor system, the voltage drop at the receiving end of the 33 kV transmission line (Existing Kawasoti Substation) exceeds 5%; the national regulations stipulate that the voltage drop shall be less than 5%. Also the transmission loss is remarkable. Regarding the reliability of the power supply, the long distances of the 33 kV transmission line and the 11 kV distribution line result in frequent interruptions by

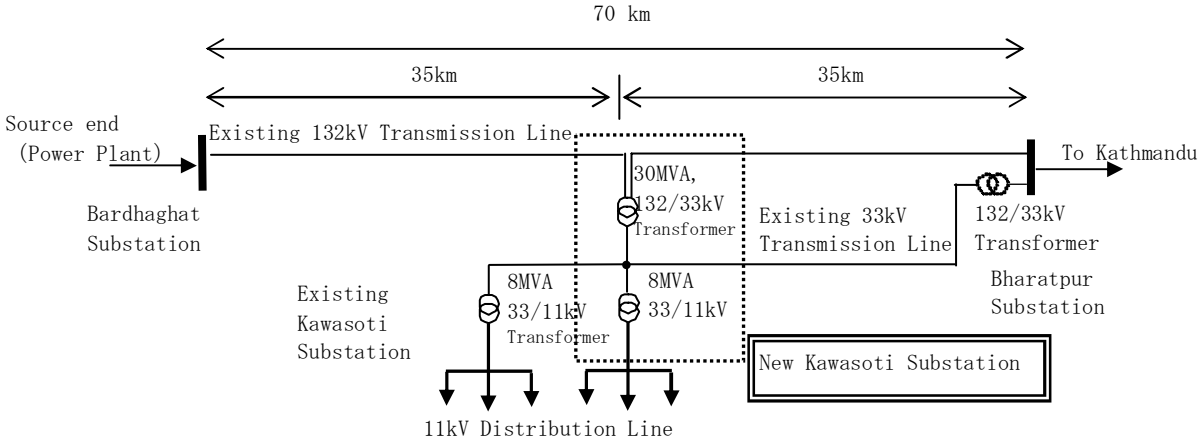
earth fault. This fact makes the electrical supply to consumers totally unreliable.

Under such circumstances, HMG/N requested a grant aid from the Government of Japan for construction of the new Kawasoti Substation. In reply to HMG/N's request, the Government of Japan decided to conduct the basic design study for the Project. JICA sent to Nepal a study team from November 9 to December 6, 2005. The study team had a series of discussions with the Nepalese side. Through these discussions, the details of the request were confirmed and then the socioeconomic situation in the target area, electrical demand, conditions of the existing transmission/distribution system, and location of the new substation were surveyed. The study team continued the basic design in Japan based on the results of the study at the project site. The basic design in Japan confirmed that implementation of the grant aid was justified and confirmed the scope of the Project. From March 25 to March 29, 2006, JICA again dispatched the team to Nepal to explain the basic design and the obligations of the Nepalese side. The explanation was agreed to by the Nepalese side.

The location of the new substation was selected to be in the center of electrical demand. This will eliminate the voltage drop and transmission loss efficiently. Consideration of environmental effects were made to minimize the environmental impact such as involuntary removal of the inhabitants or on public facilities such as roads. The transmission and distribution system was designed so that the benefits of the system will be efficiently passed on to the beneficiaries (domestic consumers and factories) along the east-west highway by utilizing both 132 kV and 33 kV transmission lines. The largest effect at minimum cost was sought in the design. The transformer capacity was determined by considering the trends in electrical demand in the targeted area and expected increase in demand. Thus, the overloading on the existing transformer that would otherwise occur in the near future can be avoided.

Hence, the scope of the Project was determined as shown below.

(1) Transmission/distribution System



(2) List of Equipment/materials etc.

| Classification | Item | Quantities |
|---|---|---|
| 132/33 kV Transformer | 132/33kV Transformer | 1 set |
| | 145 kV Circuit Breaker | 4 sets |
| | 145kV Disconnector | 7 sets |
| | 145kV Current Transformer | 9 sets |
| 33/11 kV Transformer | 33/11kV Transformer | 1 set |
| | 36kV Circuit Breaker | 4 sets |
| | 36kV Disconnector | 7 sets |
| | 36kV Current Transformer | 12 sets |
| Control Equipment/ Auxiliary Equipment/ Materials | Control panel for 132/33kV Transformer | 1 set |
| | Control panel for 132kV Transmission Line | 2 sets |
| | Control panel for 33/11kV Transformer | 1 set |
| | Control panel for 33kV Transmission Line | 1 set |
| | 110V Battery | 1 set |
| | 11kV Cubicles | 1 lot |
| | 33 kV & 11 kV XLPE cable | 1 lot |
| Building | Control building | 340 $m^2$ |

If the Project is implemented under the Japanese grant aid, the estimated project cost is 922 million Japanese yen (Japanese side: ¥ 846 million, Nepalese side: ¥ 76 million). The estimated period of implementation of the Project is 19 months from the exchange of notes between HMG/N and the Government of Japan.

After completion of the Project, the substation is to be operated by Nepal Electricity Authority (NEA). NEA has adequate experience in completing various Japanese grant aid projects in the past. The electrical facilities provided through those past projects are well maintained, so the technical and financial capabilities of NEA are good enough to maintain the New Kawasoti Substation. The required maintenance cost for operation of the New Kawasoti Substation is estimated at only 0.02% of the entire annual operation and maintenance budget of NEA. Hence, the cost of maintenance for the new substation can be easily met.

After implementation of the Project, the following direct and indirect positive effects can be realized. The population to benefit consists of the residents of the district of Nawalparasi and the number of people concerned would be approximately 190,000.

(1) Direct Effects

1) Capacity of the transformers for the target area is to be increased
(Total capacities of the new transformers : 8 MVA→38 MVA)
2) Transmission loss is to be decreased
(Bardhaghat Substation - Existing/New Kawasoti Substation : 297 MWh→7 MWh)
3) Period of power outage due to transmission line faults will be shortened
(Bardhaghat Substation - Existing/New Kawasoti Substation : 25 hour/year→to be less)

(2) Indirect Effects

1) The Project will contribute to the activation of socioeconomic activities in the target area by the provision of a reliable power supply
2) The Project will contribute to basic human needs in the target area (hospitals, schools etc.)

The Project will provide a reliable electrical supply to the newly developing settlement area in a rural district. This fact will promote small scale industries and enhance the living standards of residents, resulting in a reduction in poverty and economic disparity. Hence, the implementation of the Project under Japanese grant aid would have a fruitful outcome and is strongly recommended.

Basic Design Report

on

The Project for Construction of New Kawasoti Substation

in

The Kingdom of Nepal

## CONTENTS

**[DRAWINGS]**



**[APPENDICES]**



**[TABLE]**

**[FIGURE]**

## Abbreviations

| | | |
|---|---|---|
| ADB | : | Asian Development Bank |
| ANSI | : | American National Standards Institute |
| ASTM | : | American Society for Testing and Materials |
| BHN | : | Basic Human Needs |
| BS | : | British Standard Institution |
| CB | : | Circuit Breaker |
| CT | : | Current Transformer |
| CV | : | Cross-linked polyethylene insulated and polyvinyl chloride sheathed power cable |
| CVV-S | : | Polyvinyl chloride insulated and sheathed control cable with shield |
| D/L | : | Distribution Line |
| DS | : | Disconnecting Switch |
| EIA | : | Environmental Impact Assessment |
| GDP | : | Gross Domestic Product |
| GWh | : | Gigawatt-hour |
| HMG/N | : | His Majesty's Government of Nepal |
| HV | : | High Voltage (132, 66, 33, and 11 kV) |
| IEC | : | International Electrotechnical Commission |
| IEE | : | Initial Environmental Examination |
| IPP | : | Independent Power Producer |
| IS | : | Indian Standards |
| ISO | : | International Organization for Standardization |
| ITU | : | International Telecommunication Union |
| JBIC | : | Japan Bank for International Cooperation |
| JCS | : | Japanese Cable Maker’s Association Standard |
| JEC | : | Japanese Electromechanical Committee |
| JEM | : | Japanese Electrical Commission |
| JICA | : | Japan International Cooperation Agency |
| JIS | : | Japanese Industrial Standard |
| LDC | : | Load Dispatching Center |
| MW | : | Megawatt |
| NEA | : | Nepal Electricity Authority |
| S/S | : | Substation |
| T/L | : | Transmission Line |
| TR | : | Transformer |

# *Chapter 1*
# *Background of the Project*

# Chapter 1 Background of the Project

The district of Nawalparasi, which contains the targeted area of the Project, Kawasoti, is a newly industrialized area where new factories are being constructed, infrastructure being developed, and the inhabitants are working to eliminate economic disparity. The commerce and industries in the area show steady growth, which is attracting people to the area and increasing the population. The new arrivals, with expectations of economic growth, then demand a reliable electricity supply.

The present power supply to the targeted area is provided in the following way. The power of 132 kV is transmitted from Bardhaghat Substation to Bharatpur Substation located 70 km to the east of Bardhagat Substation via 132 kV transmission line. At Bharatpur Substation, the power is transformed into 33 kV and then transmitted to the existing Kawasoti Substation through 33 kV transmission line of 35 km length. The power is transformed from 33 kV into 11 kV at the existing Kawasoti Substation and then distributed to each consumer. The transmission capacity of the existing transmission system is too small to accommodate the recent drastic growth in the number of consumers. Due to the poor system, the voltage drop at the receiving end of the 33 kV transmission line exceeds 5% while the national regulations stipulate such voltage drop shall be less than 5%. Also the transmission loss is remarkable. Regarding the reliability of the power supply, the long 33 kV transmission line and 11 kV distribution line are frequently interrupted by earth faults. This fact makes the electrical supply to the consumers in this area totally unreliable. Hence, the Project for the construction of the new Kawasoti Substation is necessary. The new substation will receive power from the 132 kV transmission line, having more capacity than the 33 kV transmission line. The new substation will reinforce the transmission capacity of the existing 33 kV transmission line. The new substation will have new transformers with large capacity to reinforce the distribution capacity of the existing substation.

Under such circumstances, in June 2004 His Majesty's Government of Nepal (hereinafter referred to as "HMG/N") requested a grant aid from the Government of Japan for construction of the new Kawasoti Substation. The contents of this request were revised during the site visit in November 2005. The details of this revision are described in Clause 2.2.2 - (1).

# *Chapter 2*
# *Contents of the Project*

# Chapter 2 Contents of the Project

## 2.1 Basic Concept of the Project

(1) Overall Target and Project Objectives

HMG/N has an overall target of eliminating poverty from rural areas and this goal is stated in the Tenth of Five Years Development Plan. Terai, where the project target area is located, is a wide and fertile agricultural area that produces many kinds of agricultural products. Especially the economical growth of the Kawasoti area in recent years is conspicuous because the area is close to India where there are many opportunities for business and trading. Residents in the mountains are moving in to the area to look for jobs and the standard of living is increasing. The people in the whole area seem to be starting to enjoy economic growth. The whole area is built on the momentum of raising their standard of living. Meanwhile, the capacity of the electrical supply system is still small and is still hampering the economic growth of the area. The poor capacity of the electrical facilities hinders the growth in living standards.

The purpose of the project to improve the electrical supply system is to enhance and continue the improvement of living standards of the residents of the Kawasoti area and to reduce poverty and minimize the difference in living standards between cities and rural areas, which are being hindered by the poor electrical system.

(2) Outline of the Project

The exponential growth of power demand in the Kawasoti area has risen as a result of the industrial and commercial development caused by the diverse influx of settlers over a period of 5 years up to 2004. Existing power supply to the Kawasoti area is by 33 kV sub-transmission line from Bharatpur Substation and by 11 kV distribution lines, which extend as one (1) circuit from each existing 33/11 kV Kawasoti Substation and substations at the both ends of the Kawasoti area, the Bharatpur substation and Bardhaghat Substation. But the installed capacities of the existing 33 kV and 11 kV facilities are not sufficient for the actual power demand. The 33 kV sub-transmission line in this area has an excessive voltage drop beyond the value of 5% specified in the regulations for the country. There are frequently accidental blackouts on the 33 kV sub-transmission lines and the 11 kV distribution lines and the power supply has therefore become unstable. The transformer capacities of the existing substations will soon be below the required capacity.

Under the Project, a new 132/33/11 kV Kawasoti substation will be constructed with a transformer of 132/33 kV, 30 MVA. The new substation will receive power from a higher capacity 132 kV transmission line with greater reliability than the existing 33 kV sub-transmission line. The 132 kV transmission line will be connected to the 33 kV transmission line system through the transformer to reinforce the 33 kV transmission line. As the result, there will be a drastic reduction in the voltage drops, power outages, and transmission line loss.

## 2.2 Basic Design of the Requested Japanese Assistance

### 2.2.1 Design Policy

(1) Basic Policy

HMG/N is making a strong effort to realize industrial development for the correction of rural economic disparity. The Nawarparasi, including Kawasoti area, and surrounding areas have been targeted for the promotion of immigration and enhancement of industry by HMG/N. Nawarparsi has been requesting a stable power supply in response to the rapidly increasing population by solid growth of commerce and industry. For the design of electrical equipment for the realization of stable power supply, the present situation of Kawasoti area, where economic growth is highly expected as one of the largest settlement areas in Nepal, shall be considered. The long term sustainability of the project and maximum benefit from the implementation of the project is aimed at by keeping the cost to a reasonable level.

The site of the new substation is to be adjacent the 132kV transmission line power source and transmission line work will be minimized. The substation is to be constructed at the load center so that the decreasing voltage drop and transmission losses can be realized efficiently. Involuntary removal of inhabitants and public facilities shall be avoided as much as possible.

Regarding the composition of the substation, the existing 33kV transmission line grid will be connected to the 132kV grid to create the distribution system and make it possible to extend the area to benefit along the east-west highway to the maximum extent.

Transformer capacity will be determined so as to cover electricity demand for at least 10 years after 2005. The confirmation of transformer capacity, which is the main equipment to be supplied by the Project, shall be made after sufficient analysis and study of recent trends in electricity demand of Kawasoti Substation and the demand forecast made by Nepal Electricity Authority (NEA).

(2) Policy on Natural Condition

This clause verifies the data collected at Rampur weather station located 10 km east side of Kawasoti.

1) Temperature

Rampur has a wider temperature range than Kathmandu, especially maximum temperature reaches more than 40 ℃. Nepalganj, which is located on the Terai plain like Kawasoti, recorded 43.8 ℃ instantaneous maximum temperature in 1996 according to the NEPAL YEARBOOK[*1]. While NEA standard concerning maximum design temperature is 45.0℃. Hence, applying the NEA standard to

[*1] Institute for Integrated Development Studies, 1999

the Project is reasonable.

2) Humidity

The humidity in Rampur is comparatively high. Humidity of more than 80% is experienced on most of days exclusive of March to May as shown in Table 2-1. Therefore, a space heater inside to eliminate moisture is needed for the closed equipment such as cubicles.

Table 2-1 Monthly Average Humidity in Rampur（Unit: %）

| Year | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Ave. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2000 | Morning | 98.4 | 91.6 | 73.9 | 63.8 | 78.1 | 83.2 | 86.8 | 86.9 | 84.8 | 82.7 | 96.6 | 99.7 | 85.5 |
| | Evening | 73.7 | 60.2 | 42.5 | 47.9 | 67.5 | 74.8 | 80.5 | 83.3 | 84.1 | 77.7 | 82.7 | 78.4 | 71.1 |
| 2001 | Morning | 99.1 | 94.7 | 71.1 | 57.8 | 74.4 | 84.8 | 84.7 | 87.0 | 87.9 | 85.4 | 95.4 | 99.4 | 85.1 |
| | Evening | 72.3 | 61.5 | 41.4 | 40.8 | 64.9 | 76.2 | 80.0 | 80.7 | 83.8 | 81.5 | 83.0 | 82.5 | 70.7 |
| 2002 | Morning | 99.0 | 95.6 | 79.4 | 70.9 | 78.9 | 78.0 | 89.0 | 83.5 | 84.7 | 84.5 | 94.0 | 98.3 | 86.3 |
| | Evening | 76.3 | 67.6 | 52.7 | 58.5 | 67.9 | 73.2 | 81.4 | 79.4 | 81.3 | 78.7 | 82.6 | 85.7 | 73.8 |
| 2003 | Morning | 97.8 | 98.9 | 84.5 | 69.6 | 65.7 | 86.3 | 85.3 | 85.6 | 85.3 | 87.9 | 94.9 | 99.0 | 86.7 |
| | Evening | 83.7 | 72.5 | 62.2 | 56.5 | 58.0 | 77.6 | 80.8 | 76.8 | 81.0 | 77.9 | 82.0 | 79.2 | 74.0 |
| 2004 | Morning | 98.8 | 98.9 | 81.1 | 74.1 | 74.2 | 79.7 | 86.6 | 85.1 | 86.9 | 84.9 | 92.1 | 99.3 | 86.8 |
| | Evening | 79.7 | 67.6 | 50.9 | 58.5 | 61.0 | 71.6 | 82.2 | 82.1 | 82.1 | 78.1 | 77.4 | 78.4 | 72.5 |

Source: Department of Hydrology & Meteorology, Ministry of Environment, Science & Technology

3) Precipitation

Table 2-2 shows average monthly precipitation in Rampur. Rampur receives a relatively large amount of precipitation, about 2,000–2,700 mm per year. It has 100–500 mm as average monthly precipitation. Such precipitation does not affect the design of the equipment procured under the Project. However, inland transportation, excavation and concrete work are recommended to be avoided during the rainy season in June to August as much as possible.

Table 2-2 Monthly Precipitation in Rampul（Unit: mm）

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2000 | 0.8 | 9.8 | 24.9 | 73.0 | 315.8 | 520.8 | 558.3 | 333.2 | 206.9 | 6.4 | 0.0 | 0.0 | 2,049.9 |
| 2001 | 1.6 | 18.6 | 0.8 | 67.4 | 246.9 | 386.3 | 644.8 | 548.2 | 376.8 | 28.3 | 20.4 | 0.0 | 2,340.1 |
| 2002 | 31.9 | 28.3 | 45.6 | 57.7 | 391.9 | 600.9 | 853.3 | 303.3 | 263.7 | 22.7 | 44.6 | 0.0 | 2,643.9 |
| 2003 | 35.1 | 59.4 | 62.0 | 101.0 | 99.9 | 473.2 | 930.0 | 548.9 | 292.2 | 81.1 | 0.0 | 10.7 | 2,693.5 |
| 2004 | 62.7 | 0.0 | 0.0 | 180.2 | 111.4 | 472.5 | 495.5 | 214.3 | 417.7 | 75.7 | 12.0 | 0.0 | 2,042.0 |

Source: Department of Hydrology & Meteorology, Ministry of Environment, Science & Technology

4) Wind Scale

The average monthly wind velocity in Rampur was less than 1 m/sec in the period 1991–1998. For reference, the maximum wind speed velocity is 26.75 m/sec observed at Kathmandu airport meteorological observatory in 1994. Therefore, no special conditions will be applied for the equipment design.

(3) Policy on Conditions of Socio-economy

To protect the equipment/materials from theft or vandalism, the materials transported from Kolkata should be kept in the site yard of Kawasoti substation or the existing Bharatpur substation. And, it is important to create a framework for smooth communication between local police, the NEA, the Consultant and Contractor. It should also be considered to request the authorities to provide security for transportation.

(4) Policy of Material Procurement and Construction

1) Environment

According to the Environmental Protection Act, 2053 and Environmental Protection Regulation (EPR) 1997, execution of an initial environment examination (IEE) or environmental impact assessment (EIA) is mandatory prior to any project implementation. As mentioned in the above Environmental Protection Act and EPR 1997, the need for an EIA for a normal substation project depends on the capacity of its transformers. Substation projects installing transformers of more than 6 MVA require EIA[1]. Therefore, the Project is required to carry out EIA. According to the results of confirmation through the Site Survey, EIA has been started by NEA in accordance with the schedule as shown in Figure 2-1.

| No. | Activities | Schedule in Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2005 | | | 2006 | | | | | | | | |
| | | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. |
| **1** | **Scoping and ToR Stage** | | | | | | | | | | | | |
| 1.1 | Literature Collection and Review | ■ | | | | | | | | | | | |
| 1.2 | Preparatory Work & Publication of Scoping Notice | ■ | | | | | | | | | | | |
| 1.3 | Field Visit for Scoping and ToR | | ■ | | | | | | | | | | |
| 1.4 | Collection of Muchulka and Concerns of VDC | | ■ | | | | | | | | | | |
| 1.5 | Preparation & Submission of Scoping and ToR Report | | ■ | | | | | | | | | | |
| 1.6 | Approval of Scoping Report & ToR | | | ■ | ■ | | | | | | | | |
| **2** | **EIA Stage** | | | | | | | | | | | | |
| 2.1 | Desk Study and Preparatory Work | | | | ■ | | | | | | | | |
| 2.2 | Field Investigation | | | | | ■ | | | | | | | |
| 2.3 | Data Encoding and Analysis | | | | | | ■ | | | | | | |
| 2.4 | Draft Report Preparation | | | | | | ■ | ■ | | | | | |
| 2.5 | Preparation & Implementation of Public Hearing Program | | | | | | | | ■ | | | | |
| 2.6 | Collection of Recommendation of VDCs | | | | | | | | ■ | | | | |
| 2.7 | EIA Report Preparation and Submission | | | | | | | | ■ | | | | |
| 2.8 | Report Approval | | | | | | | | | ■ | ■ | ■ | ■ |

Figure 2-1 EIA（Environmental Impact Assessment）Schedule

[1] EPR Schedule 2.c.2

2) Construction

NEA stated that a Construction License is necessary for the substation construction work prior to commencement of the work. It is confirmed that the Construction License is provided by NEA prior to commencement of the work. NEA also stated that the License is able to be issued within a few weeks after approval of the EIA final report, and it may be issued smoothly. It is reported that a few 11 kV distribution line posts are only found near the access road of the project area, and there are no public facilities to be moved for this project.

3) Land

It is confirmed that NEA is responsible for procuring the site. NEA will provide special reserves in the budget for procuring the site. Compensation for the land is made after due consultation between NEA Regional Office and the land owner. Because NEA stated that it has already received general acceptance of the land owner, there is no problem expected in procuring the site.

The process for estimating the cost for the project premises for the substation and compensation proceedings are shown in Figure 2-2.

4) Applicable Standard

Basically, world class standards, such as IEC, JIS, BS, ASTM, etc., should be applied for the substation equipment to be supplied under this Project. But regarding the details of minor matters that are not stipulated in international standards or NEA's standards, e.g. configuration of cubicle, thickness of steel plate of boards, etc, JEM (Japan Electric Machine Industry Association) standards should be applied to complement the IEC.

Major applicable standards and items to be applied are shown in Table 2-3.

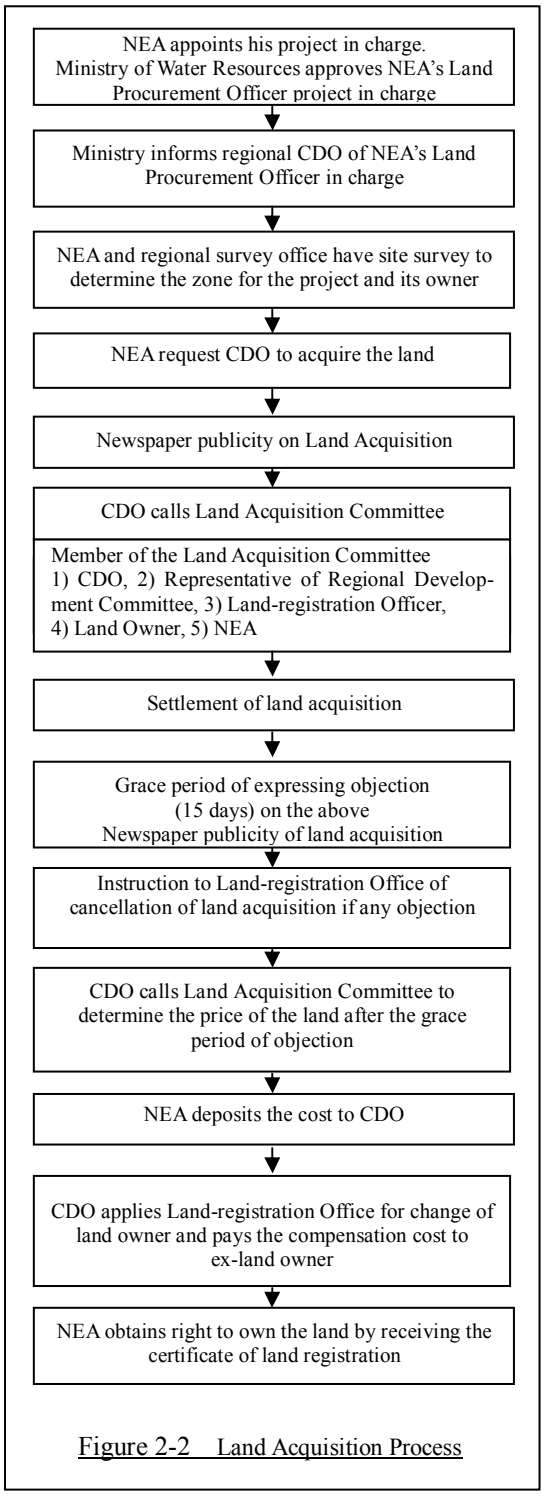



Figure 2-2 Land Acquisition Process

Table 2-3 Major Applicable Standard

| Item | Major Applicable Standard |
|---|---|
| Transformer, Outdoor Switchyard Equipment | IEC |
| Control Board, Cubicle | IEC、JEM |
| Cable, Wire | IEC、BS、JCS |
| Design and Material of Construction | BS、ASTM、JIS、IS |
| Other Equipment such as Angle for Support, Insulator, etc. | ANSI、ISO、BS |

5) Quality of Local Labor and Materials

The quality of local labor is already known from past similar projects to be sufficient provided there is instruction from Japanese experts. For construction planning, therefore, local currency portion should be applied for hiring local labor. Considering the quality and reliability, local materials should be used as much as possible. Civil and architectural materials may be allowed to be used for this project.

6) Policy on Local Contractor Utilization

Past results of grant aid projects shows that local contractors with enough technical ability, given proper instructions and supervision, are available for civil/architectural construction work and for electrical work for the distribution lines. Positive use of such local contractors could be made. Therefore, it is planned that local contractors will construct the buildings for the new Kawasoti Substation under the control of the Japanese contractor.

Regarding installation of the equipment, it is planned that Japanese experts will take part in important works, such as switchgear installation, cable joint work, final check of control cable connections, etc., and other works will be undertaken by local labor.

It is also planned that local civil engineers be employed to supervise civil and architectural work.

7) Policy on Operation and Maintenance capability of Implementation Agency

The borrower's implementation agency for this project is the Transmission Lines and Substations Construction Department of the Transmission and System Operation. About 10 efficient engineers, who have experience working with foreign engineers, are in the department. A project team is established within the Transmission Line and Substation Construction Department for each project as the implementation unit. After completion, the Butwar Grid Operation Office of the Transmission and System Operation will take care of operation and maintenance of New Kawasoti Substation. Butwal Grid Operation Office is taking care of the existing Bardhaghat Substation. Bharatpur substation, a substation next to the new Kawasoti Substation, is taken care by the Hetauda Grid Operation Office. Operation and maintenance of the network of the 33 kV lines and below connected to the new Kawasoti substation will be undertaken by the West Region Office of the Distribution and Customer Service Agency.

Many staff members of the technical departments of NEA have a lot of experience in technical transfer as engineers and/or counterparts from previous Japanese Grant Aid distribution line projects in the Kathmandu Valley. The Japanese ODA has contributed heavily to raising the technical level of NEA's staff. In addition, experiences in operation and maintenance gained through projects under the WB and ADB will also contribute to the effective operation and maintenance of the new Kawasoti substation.

8) Selection of Grade of Plant and Materials

Major equipment of the substation, i.e. main transformer, 132 kV and 33 kV switchgears, are classified into high grade system such as GIS (Gas Insulated Switchgear) and normal grade of conventional type. And 11 kV cubicles and control & protection boards are also classified into high grade of hermetically-sealed type (high grade IP or Gas Insulated type) and normal grade type. Normal grade plant and materials should be selected for this project because there is no necessity to use high grade types.

The substation buildings in this project will function simply as a container for the control, protection, and housing of auxiliary equipment of the substation. Because there is no heavy or vibrating facilities in the substation building, materials of normal grade for the building are enough for this project; such materials are available locally to minimize the construction cost.

Construction and procurement for this substation are quite standard. Generally, there are no special features to be considered in the civil work, except that the foundation work for the heavy facilities, such as main transformer, in the rainy season shall be avoided.

### 2.2.2 Basic Plan

(1) Total Plan

The scope of work for the Project is construction of 132kV substation including the following items. Meanwhile, detailed verification of the contents of the application form are shown on the next page.

| | | |
|---|---|---|
| a) | 132/33kV, 30MVA Main Transformer | 1 unit |
| b) | 33/11kV, 8/6MVA Transformer | 1 unit |
| c) | 132kV Outdoor Switchyard Equipment | 1 lot |
| d) | 33kV Outdoor Switchyard Equipment | 1 lot |
| e) | 11kV Indoor Cubicle | 1 lot |
| f) | Communication, Control and Protection Equipment | 1 lot |
| g) | Installation Work for above Equipment | 1 lot |
| h) | Cable Connection Work<br>from 132kV Transmission Line to New Kawasoti Substation | 1 lot |
| i) | Cable Connection Work<br>from 33kV Transmission Line to New Kawasoti Substation | 1 lot |
| j) | Cable Connection Work<br>from 11kV Distribution Line to New Kawasoti Substation | 1 lot |

1) System Configuration

The contents of the Japanese Grant Aid requested by HMG/N in June 2004 was the construction of a 132/11kV, 15MVA Substation. Since this original request plan is to increase the reliability of power supply suitable for increasing electricity demand by separating the load supplied by the existing 33/11kV substation, a new 132/11kV substation is planned to be constructed in Kawasoti area being fed from 132 kV transmission line as shown in Figure 2-3. However, HMG/N requested a change to the original plan during the site survey for the basic design in November to December 2005, as shown in Figure 2-4. The contents of the additional request plan were: 1) to change the secondary voltage of the transformer to 33kV, 2) to change the capacity of the 132kV transformer to 30MVA, 3) to add a 33/11kV, 8MVA transformer, and 4) to add 33kV switchgear equipment associated with the above changes.

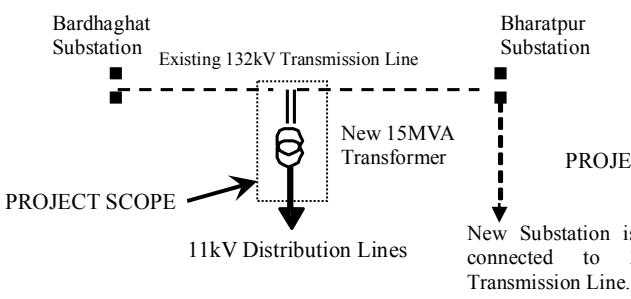



Figure 2-3 Original Plan in Application

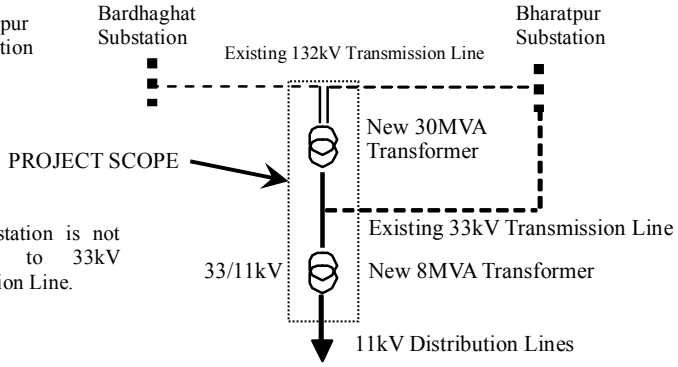


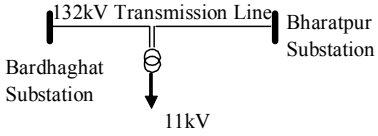
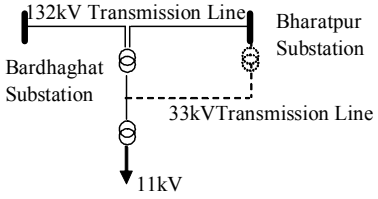
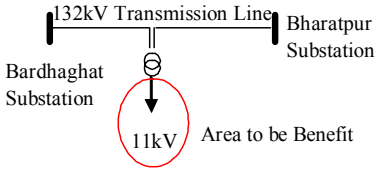
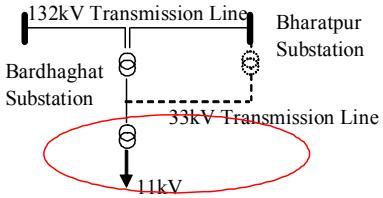

Figure 2-4 Additional Request Plan

Table 2-4 shows a comparison of the original request and the additional request.

Figure 2-5 shows the area that would benefit from the additional request.

As a result of the review, the additional request was applied to the Project due to superiority from the point of view of future expandability and wider coverage area of production of the Project effect. The existing 132kV transmission line will therefore be connected to the existing 33kV transmission line through a 132/33kV, 30MVA transformer. The original application can not supply stable power to such a wide area in the future.

Table 2-4 Comparison of Original and Additional Request Plans

| Comparing Item \ Plan | | Using 132/11kV Main Transformer | Using 132/33kV Main Transformer and 33/11kV Transformer |
|---|---|---|---|
| | | Plan A | Plan B |
| | | Original Request Plan | Additional Request Plan |
| Contents of Coorperation | System Configulation |  |  |
| | Specification of Main Equipment | Transformer Voltage: 132/11kV<br>Transformer Capacity: 15MVA x 1 unit | Transformer Voltage: 132/33kV<br>Transformer Capacity: 30MVA x 1 unit<br><br>Transformer Voltage: 33/11kV<br>Transformer Capacity: 8MVA x 1 unit |
| Project Cost | Project Cost | ○<br>100%<br>Amount of the equipment is minimum. | △<br>138 %<br>2 units of transformer and associated switchgear equipment are needed. |
| Sustainability of Operation | Maintenance | ○<br>Easy | △<br>A little bit cumbersome than Plan A because the number of Equipment more than Plan A |
| Expandability of System | Expandability | ×<br>There is no expandabirity because of nothing 33kV system. | ○<br>There is expandability to use 33kV system. |
| Voltage Drop, Loss, Power Failure | Improvement of Voltage Drop and Loss | ×<br>Improvement area is a part of 11kV Distribution line in Kawasoti area. | ○<br>Wide area will be improved by 33kV and 11kV distribution line. |
| | Affect by Existing 33kV and 132kV Transmission Line Failure | △<br>There is no affect by 33kV line failure. But there is no alternative line when 132kV line fairure happened. | ○<br>Power failure can be recovered because all transmission line without failure line can be used. |
| Expression of Effect | Area to be Benefit | ×<br>  | ○<br>  |
| Difficulty to Implementation | Construction Schedule | ○<br>100% | △<br>110% |
| | Land Acquisition | ○<br>Easy | ○<br>Easy |
| Effect on the Environment | Cutting of Tree | ○<br>No effect to environment except construction site | ○<br>No effect to environment except construction site |
| Judgement (Priolity) | | × | ○ |

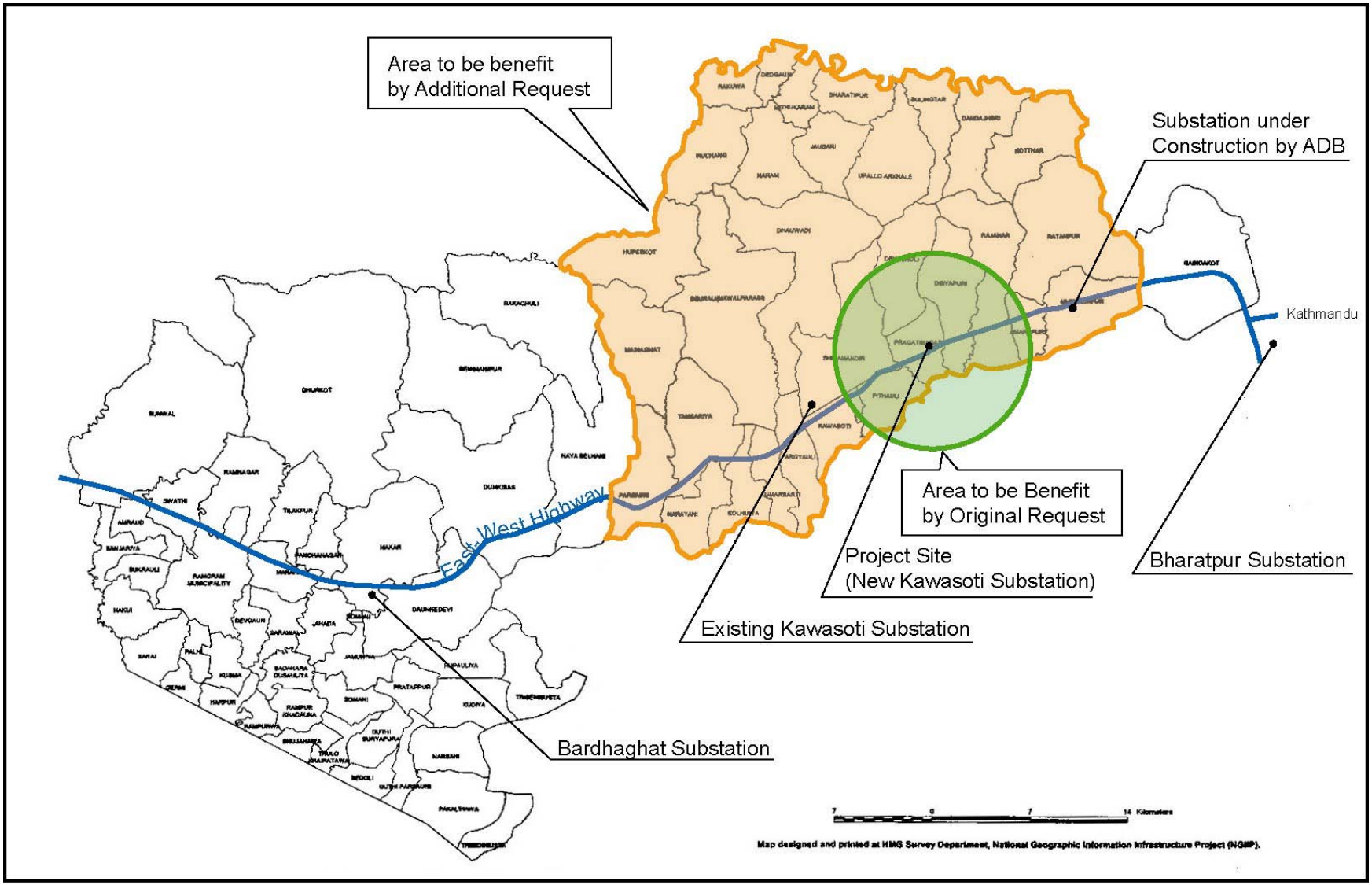



Figure 2-5 Area to be Benefit by Original and Additional Request Plan

2) Location of the New Substation

The location of the substation site relative to the transmission line affects land acquisition and construction cost in the design of the new substation and to issues beyond the Project. In other words, if the selected substation site is located far from the transmission line, the construction cost for new transmission line is increased through difficult land acquisition for the transmission line. The substation is also better to be located near a main road considering accessibility during the construction period.

The substation site was selected from three candidate sites adjacent the east-west highway and with the necessary area of approximately 7,000 $m^2$ to enable future expansion. These candidate sites were compared from the point of view of the impact on society, site conditions, and power supply surface (technical surface), etc. As a result of the above, and after discussion with NEA, candidate site 1 was judged to have high superiority and is very suitable for a substation. Table 2-5 shows a comparison of the three candidate sites. Figure 2-6 shows the locations of the three candidate sites.

Figure 2-7 shows an electricity demand map for the Kawasoti area. As a result, candidate site 1 was confirmed as being located in the center of electricity demand.

■Candidate Site 1


■Candidate Site 2

There is a plan to construct a 33/11kV substation and distribution center by ADB loan. The land was already reserved.

■Candidate Site 3

Photo 2-1 Three Candidate Sites

Table 2-5 Comparison with Three Candidate Sites

| Item 1 | Item 2 | Site 1 | Site 2 | Site 3 |
|---|---|---|---|---|
| Impact on the society | Distance to Private Residence | ○ | △ | △ |
| | Involuntary Relocation of Residents | ○ | △ | ○ |
| | Relocation of Public Facilities | ○ | △ *1 | ○ |
| Locational Conditions | Cost of Land Acquisition | △ *2 | △ | ○ *3 |
| | Future Expandability | ○ *4 | ○ | △ |
| | Ground Level | ○ | × *5 | ○ |
| | Accessibility from Main Road | ○ | ○ | △ *6 |
| | Distance to Existing 13 2kV Transmission Line | ○ | ○ | × |
| Power Supply | Response to Customer in Kawasoti Area (Decrease of Transmission Losses and Voltage Drop) | ○ *7 | ○ | × *8 |
| | Stability and Reliability of 11kV System | ○ *9 | ○ | × |
| Judgments | | ○ | △ | × |

Note:

*1 There is a possibility to shift an existing farm road.
*2 Site 1 is little bit cheaper than Site 2.
*3 Land acquisition was already completed.
*4 Site 1 is easy to expand additional transformer, etc. because it is not located near houses, unlike Site 3.
*5 Site 2 is located near paddy. There is a possibility of flooding because the ground level is low.
*6 Site 3 is located in a residential block far from the main road. Therefore, carrying the Equipment would need to pay attention to low-hanging power and telephone lines.
*7 After construction of the Mukundapur 33 kV substation under ADB funds, the other consumers not benefited by that substation will benefit through elimination of the transmission line loss and voltage drop.
*8 Since the construction of Mukundapur 33 kV substation under ADB fund is determined, the consumers in this area will be covered and the construction of the new 132 kV substation will have no advantage.
*9 Because the new substation is constructed far from the existing Bharatpur Substation, the 132kV transmission line will cover power failure by ground fault failure of the 33kV transmission line and 11kV distribution line.

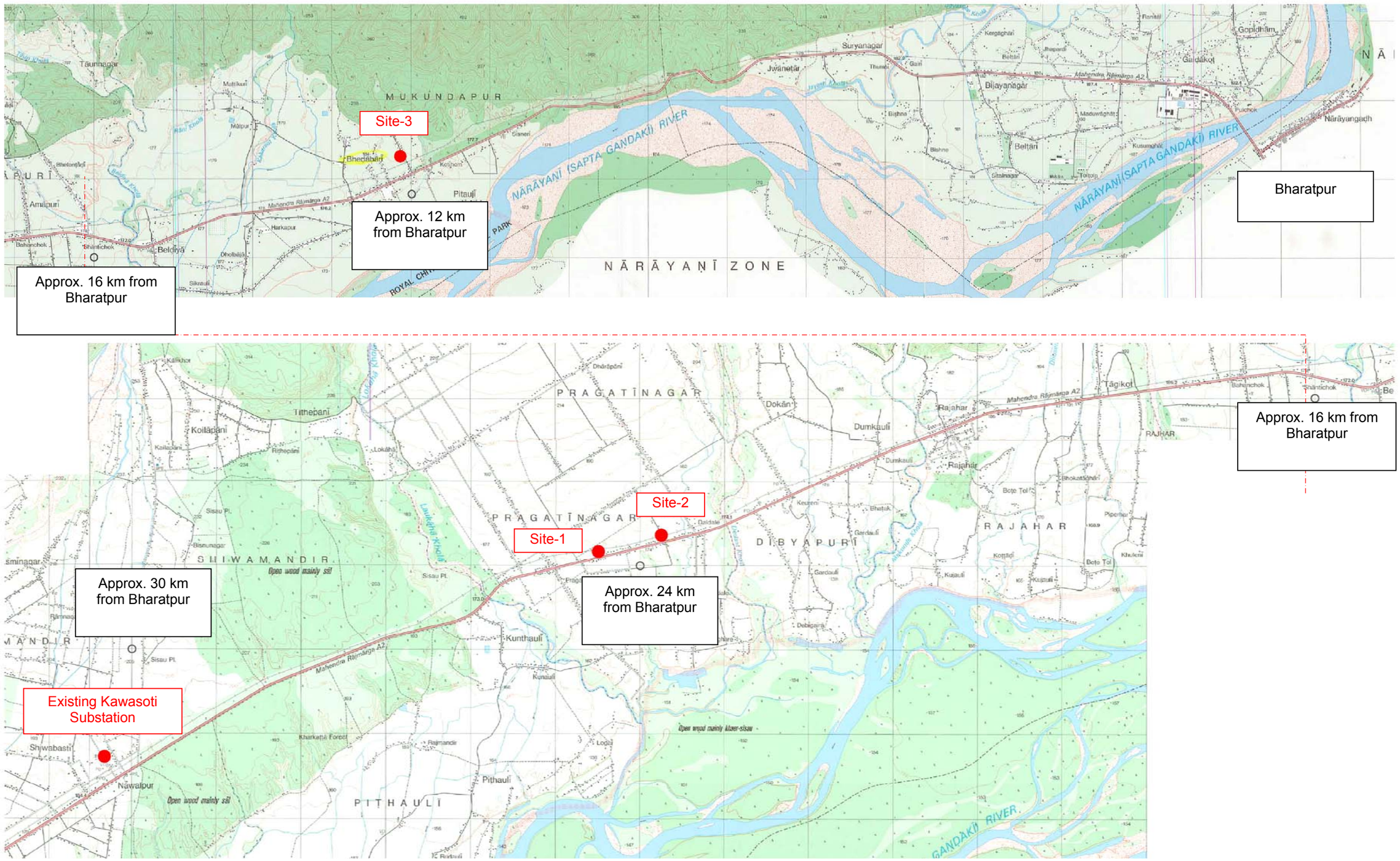



Figure 2-6 Location Map of Candidate Sites

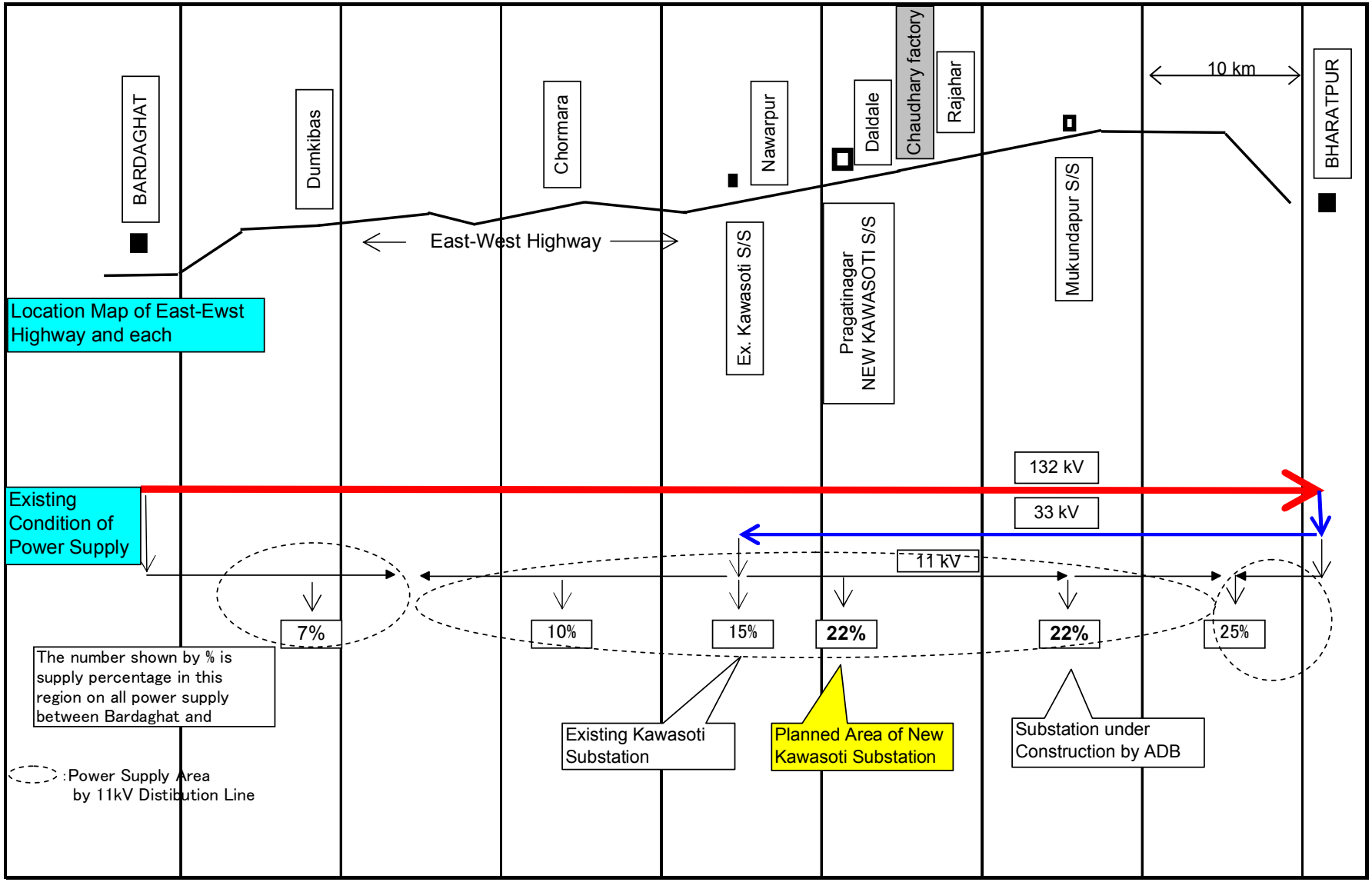



Figure 2-7 Electricity Demand Map in Kawasoti Area

(2) Substation Equipment

a) Adoption of 30MVA Transformer

Table 2-6 shows the increasing demand for electricity as energy sold.

Table 2-6 Electricity Demand in Recent 5 Years (GWh)

| Sales Energy | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Rate |
|---|---|---|---|---|---|---|---|
| Whole of Country (GWh) | 1,269.3 | 1,407.1 | 1,534.3 | 1,696.8 | 1,795.2 | 1,964.4 | 9.1% |
| Kawasoti Area (GWh) | 13.67 | 15.58 | 30.58 | 31.39 | 34.44 | 34.73 | - |
| (Year on Year Growth rate) | - | 14.1% | 96.3% | 2.6% | 9.7% | 0.8% | 24.7% |

Source: NEA

The year on year growth rate of energy sold in the Kawasoti area from 2000 is 24.7%. The maximum load in 2005 can be estimated from the energy in Kawasoti area and the data received from NEA, a load factor of 54%, and power factor of 85%, as follows;

34.73 GWh / 365 days / 24 hours/ 0.54 / 0.85 =8.6 MVA

On the other hand, the average growth rate of the said area over the last 5 years is 24.7%. The reason for such a high average growth rate is from the drastic increase from construction of the Kawasoti substation (3MVA → 8MVA) in 2001. (A 96.3% average growth rate was recorded in 2002) Although it is not realistic to predict the same growth rate in future years, it is expected that a higher growth rate than the total Nepalese average (9.1%) could be applied. The following preconditions were used to verify the said growth rates shown in Table 2-7.

[Preconditions]

| Item | Value |
|---|---|
| 1) Maximum load of Kawasoti area | 8.6 MVA |
| 2) Average growth rate | 24.7%, 15.0%, 9.1% |

Time forecasting of maximum load of 30 MVA by the above preconditions are estimated in Table 2-7.

Table 2-7 Time forecasting of maximum load of 30 MVA

| Average growth rate | Time period up to 30 MVA |
|---|---|
| 24.7% : Actual data of Kawasoti area over last 5 years | 6 years |
| 15.0% : Predicted value with high possibility | 9 years |
| 9.1% : Actual data of all Nepal over last 6 years | 14 years |

In case the average growth rate is 15.0%, which has a high possibility of occurring in the Kawasoti area, a 30 MVA transformer would be overloaded at 9 years after 2005 as follows.

$8.6 \text{ MVA} \times 1.15^9 = 30 \text{ MVA}$

Hence, a transformer capacity of 30 MVA is suitable.

The maximum electricity of transmission lines and distribution lines supplied from the Bharatpur Substation, Bardhaghat Substation and existing 33/11kV Kawasoti Substation to the Kawasoti area were studied, and the total capacity is 12.5 MVA. Therefore, the calculated maximum electricity (MW) calculated from energy sales in 2005, 8.6MVA, is appropriate.

The exponential increase in electricity demand is a common phenomenon in developing countries. Especially, the areas of rural electrification have ever-increasing new customers, and it is impossible to cancel the contract of those benefiting from electricity. Therefore, the yearly average growth rate is likely to be approximately 15%, considerably higher than the whole country.

b) Additional 33/11 kV 8MVA Transformer

Because the transformer of the existing 33/11 kV substation has no spare capacity for growth in demand, a plan for installation of additional 33/11 kV 8MVA transformer to the new substation is reasonable. By the assumption of a yearly growth in demand of 15%, it is estimated that a shortage in total capacity of 33/11 kV transformers (16MVA), including the new transformer provided by this project, will occur after 5.1 years. From past actual performance of NEA, it is judged that one additional 8 MVA transformer bank could be provided from NEA's own budget.

c) 132 kV Branch Line Work to the Substation

The existing 132 kV transmission line crosses over the planned substation premises. A dead end tower is constructed just under the transmission line and a branch line is tapped from the existing tower straight to the gantry beam of the substation. In this way, shutdown of related transmission lines could be minimized. The suspension tower next to the new Kawasoti substation should be replaced with a tension tower.

d) Arrangement Plan of Compound and Facilities

The planned construction site of Kawasoti substation is a dry field located near the east-west highway that has no obstructions to access and has few changes in elevation. As shown in the Plan of the Substation Premises in clause 2.3, although there are a few houses and village roads around the premises, land acquisition based on the design without restrictions is possible. Involuntary removal of residents is not necessary.

① View from East-West Highway ② View from Planned Site to East-West Highway

Photo 2-2 Planned Construction Site of New Kawasoti Substation

e) Substation building construction

The 132/33 kV transformer, 132 kV switchgear, 33/11 kV transformer and 33 kV switchgear will be installed outdoors. Because the space for the substation is wide enough, a cubicle room, control room and other auxiliary facilities will be arranged on the same floor and the building design is of simple one-story. Space for future extension, especially for additional 132/33 kV transformer, 33/11 kV transformer and 33 kV feeders, is considered in the initial building design .
The total floor space will be 340 $m^2$. The major rooms of the new Kawasoti substation building are shown in Table 2-8 below.

Table 2-8 New Kawasoti Substation Building Configuration of Rooms

| Name of Room | Purpose | Area |
|---|---|---|
| 1) Communication Room | Installation space of control board and cubicles | 202.5 $m^2$ |
| 2) Battery Room | Installation space of battery | 11.5 $m^2$ |
| 3) Refreshment Room | Catnap space for operator | 11.5 $m^2$ |
| 4) Store Room | Store room for spare parts and tools | 9.1 $m^2$ |
| 5) Manager Room | Private room for manager | 23.1 $m^2$ |
| 6) Office | Office space | 23.1 $m^2$ |
| 7) Toilet, Kitchen, Lobby, etc. | | 58.7 $m^2$ |
| Total | | 340 $m^2$ |

f) Geological Survey

Even though the substation site is the stable dry field, the bearing capacity of the soil was confirmed by the local geological surveyors. According to the results of the drilling, it was judged that, at the 1 m below the ground surface for the foundation of the substation equipment or building, the capacity of 12 ton/$m^2$ can be expected, while at the 3 m below the ground surface for the transmission line

tower foundation, the capacity of 50 ton/$m^2$ can be expected. Special foundations such as piles are not necessary even for the heaviest facilities of 132/33 kV transformer.

Table 2-9 shows a summary of the specifications of the main equipment for the substation.

Table 2-9 Summary of Specifications of Main Equipment for New Kawasoti Substation

| Equipment | Qty | Specification | Purpose |
|---|---|---|---|
| 1) 132/33kV Transformer | 1 | 24/30MVA(ONAN/ONAF), 50Hz,<br>3-phase type<br>Rated Voltage: 132/33kV<br>Oil-immersed type<br>(Accessories)<br>Conservator, Radiator, OLTC (On Load Tap Changer), BCT (Bushing type Current Transformer) | To transform the voltage of 132kV to 33kV for distribution<br>Most important equipment of the substation |
| 2) 33/11kV Transformer | 1 | 6/8MVA (ONAN/ONAF), 50Hz,<br>3-phase type<br>Rated Voltage: 33/11kV<br>Oil-immersed type<br>(Accessories)<br>Conservator, Radiator, OLTC (On Load Tap Changer), BCT (Bushing type Current Transformer) | To transform the voltage of 33kV to 11kV for distribution |
| 3) 145kV Circuit Breaker | 3 | Rated voltage: 145kV<br>Rated current: 1,250A<br>Breaking current: 31.5kA<br>3-phase type, Motor spring operation<br>Single phase automatic reclosing/Three phase automatic reclosing | To switch the electric power of 132kV and to break the fault current if accidents affect the transmission line and transformer |
| 4) 36kV Circuit Breaker | 4 | Rated voltage: 36kV<br>Rated current: 2,000A<br>Braking current: 6.3kA<br>3-phase type, Motor spring operation<br>Single phase automatic reclosing/Three phase automatic reclosing | To switch the electric power of 33kV and to break the fault current if accidents affect the transmission line and transformer |
| 5) 145kV Disconnector | 7 | Rate voltage: 145kV<br>Rated current: 1,250A<br>Braking current: 31.5kA<br>3-phase type, Center single break<br>with/without Earthing switch | To switch 132 kV circuit for maintenance |
| 6) 36kV Disconnector | 7 | Rated voltage: 36kV<br>Rated current: 2,000A<br>Braking current: 6.3kA<br>3-phase type, Manual operation<br>with/without Earthing switch | To switch 33 kV circuit for maintenance |
| 7) 145kV Current Transformer | 9 | Rated primary current: 400-200A<br>Rated secondary current: 1A<br>Rated burden: 40VA, Single phase | To transform the current for meter and relay |

| Equipment | Qty | Specification | Purpose |
|---|---|---|---|
| 8) 36kV Current Transformer | 12 | Rated primary current: 300-200A<br>Rated secondary current: 1A<br>Rated burden: 40VA, Single phase | To transform the current for meter and relay |
| 9) 132kV Potential Transformer | 9 | Rated primary voltage: 132/√3kV<br>Rated secondary voltage: 0.11/√3kV<br>Rated thirdly voltage: 0.11/√3kV<br>Rated burden: 100VA, Single phase | To transform the voltage for meter and relay |
| 10) 33kV Potential Transformer | 9 | Rated primary voltage: 33/√3kV<br>Rated secondary voltage: 0.11/√3kV<br>Rated thirdly voltage: 0.11/√3kV<br>Rated burden: 100VA, single phase | To transform the current for meter and relay |
| 11) 120kV Lightning Arrester | 9 | Rated voltage: 120kV<br>Discharge current: 10kA<br>Single phase, Gapless type | To protect the equipment from abnormal voltage such as lightning, etc. |
| 12) 33kV Lightning Arrester | 12 | Rated voltage: 33kV<br>Discharge current: 10kA<br>Single phase, Gapless type | To protect the equipment from abnormal voltage such as lightning, etc. |
| 13) Control Panel for 132/33kV Transformer | 1 | (Component)<br>Switches and meters to operate 132/33kV transformer<br>Relays to protect 132/33kV transformer | To operate 132/33kV transformer, and to protect 132/33kV transformer |
| 14) Control Panel for 33/11kV Transformer | 1 | (Component)<br>Switches and meters to operate 33/11kV transformer<br>Relays to protect 33/11kV transformer | To operate 33/11kV transformer, and to protect 33/11kV transformer |
| 15) Control Panel for 132kV Transmission Line | 2 | (Component)<br>Switches and meters to operate 132kV switchyard equipment<br>Relays to protect 132kV switchyard equipment | To operate 132kV transmission line bay, and to protect 132kV transmission line bay |
| 16) Control Panel for 33kV Transmission Line | 1 | (Component)<br>Switches and meters to operate 33kV switchyard equipment<br>Relays to protect 33kV switchyard equipment | To operate 33kV transmission line bay, and to protect 33kV transmission line bay |
| 17) AC Low Voltage Cubicle | 1 | Metal enclosed type | To supply low voltage AC power to control panels, relays, 11kV cubicles and station service auxiliary power circuits<br>To operate/protect the auxiliary power circuit such as lighting |
| 18) DC cubicle | 1 | Rated voltage: 110V<br>(Component)<br>Distribution panel | To supply uninterruptible DC power source for control circuits such as control panels, etc.<br>To protect DC circuits |

| Equipment | Qty | Specification | Purpose |
|---|---|---|---|
| 19) 110V Batteries | 1 | Valve type lead-acid battery<br>Rated voltage: DC110V | To supply uninterruptible DC power source for control circuits such as control panels, etc. |
| 20) Battery Charger | 1 | Rated voltage: DC110V | To supply uninterruptible DC power source for control circuits such as control panels, etc. |
| 21) Remote Terminal Unit (RTU) | 1 | Terminal unit for tele-control | Terminal unit for tele-control |
| 22) 11kV Switchgear (Cubicles) | 1 | (Component)<br>Circuit breaker cubicle: 2 nos.<br>PT cubicle: 1 no.<br>Station service transformer cubicle: 1 no. | To switch the electric power of 11kV, and to break the fault current if accident affects the transmission line and transformer |
| 23) 132 kV Line Trap | 4 | Rated current: 1250A | To communicate by transmission line |
| 24) Underground Cable for 33 kV and 11 kV | 1 | 33kV CV, 90mm2 x 3core<br>11kV CV, 200mm2 x 3core | To connect from existing 33kV line/11kV line to New Substation |

### 2.2.3 Basic Design Drawings

The basic design drawings are attached hereto and a list of those drawings is shown in Table 2-10.

Table 2-10 List of Basic Design Drawings

| ID | Drawing No. | Title |
|---|---|---|
| 1 | Fig. S - 2 | Kawasoti S/S Plan |
| 2 | Fig. S - 1 | Kawasoti S/S Single Line Diagram |
| 3 | Fig. C - 1 | Kawasoti S/S Floor Plan |
| 4 | Fig. C - 3 | Kawasoti S/S Front View (West Side) and Rear View (East Side) |

### 2.2.4 Implementation Plan

#### 2.2.4.1 Implementation Policy

Procurement and construction policy to be implemented by the Project by Japanese Grant Aid are as follows.

(1) Implementation Agency of Recipient Country

The Nepalese implementation agency for the Project is Nepal Electricity Authority (NEA), and the department in charge is the Transmission Line/Substation Construction Department of the Transmission & System Operation. NEA managing director at the recommendation of this department selects a project manager who establishes a project team for each project, and the project team carries out the project. Management of operation after completion of the project and distribution section is transferred to

respective division of Grid Operation Department. Meanwhile, all projects of the Transmission Line/Substation Construction Department are managed directly by head office. Therefore, all items concerning project cost and important technical items on the Contract will be carried out through discussion, judgment, decision, and approval by the project manager under direction of the Transmission Line/Substation Construction Department. Most of the detailed design study will therefore be undertaken in Kathmandu, while the concerned parties will have many opportunities to hold meetings in Kathmandu.

The Project site is located in the Terai plain, far from the Capital city of Kathmandu, and therefore, the Project shall proceed with attention to important items to be settled by NEA head office, especially formalities of importation and mobilization of equipment and matters concerning land, through close communication with concerned parties.

(2) Source of Procurement and Transportation Route

Equipment and materials to be procured under the Project are those necessary for the construction of the substation and transmission line, and most of the materials would be procured from Japan except equipment for the foundation work and building work which would be procured from Nepal. The route for transportation of imported goods to Kawasoti is as follows.

Japan – Ocean Transport – India (Kolkata) – Inland Transportation – Nepal (Kawasoti)

Customs clearance by the Nepal side will be at the Birgunj border crossing between Nepal and India. Inland transportation from Birgunj to Kawasoti can be made by utilizing flat paved road on the Terai plain without limitation of season because there is no possibility of rock fall and landslides in the rainy season.

(3) Necessary of Foreign Technical Supervisor

Construction of the substation is composite work including many building works, foundation work, assembly work for the gantry structure, installation work for the equipment, adjustment and testing of the installed equipment, etc. in a limited period. Moreover, the work is required to be carried out skillfully, safely and efficiently to avoid interruption of the existing transmission line network. Therefore, a foreign technical supervisor who can manage and instruct the Project work is required to perform effective work, safety control and oversee the overall work. Of course, procurement of construction material and inspection and acceptance of imported equipment are important.

Regarding the substation equipment, because the of the importance of accurate assembly, prevention of contamination of the equipment, and the original technical know-how of the manufacturer, engineers from the manufacturer, such as substation construction engineers and technicians, will be required for assembly, alignment, and testing.

(4) Utilization of Contractor and Local Contractor

According to the Japanese Grant Aid scheme, the procurement of material and installation work are to be

carried out by a Contractor that is a Japanese corporation selected by open tendering.

Construction of the New Kawasoti Substation can be carried out by a local contractor under the management of a Japanese contractor. Installation of substation equipment can also be carried out by a local contractor or local semi-skilled labor under the management of a Japanese contractor.

#### 2.2.4.2 Implementation Condition

(1) Implementation Condition on Construction

The substation to be constructed by the Project is a new structure, and few adjustments to existing systems are necessary to provide connections from the 132kV transmission line to the new substation. Especially, the function of the central load dispatching center shall be retained. The construction work does not require the operation of existing equipment to be suspended, so there will be no power interruption. However, the 132kV transmission line between Bharatpur and Bardhaghat will be required to stop operation to charge the equipment after installation and for adjustments and tests. The work schedule for suspension of operations of the 132kV transmission line to be requested by the Contractor will be verified by the Consultant, and the work will be carried out after adjustment of the schedule with NEA.

Work to connect the transmission line will be carried out before installation of switchgear equipment, and the transmission line will be required to hold the gantry structure installed in the substation at the appropriate time. Installation, adjustment, and testing of switchgear equipment will require a short suspension of operation of the transmission line by carrying out a temporary reconnection to avoid a long term stoppage, although the work for holding transmission line can be carried out in about 1–2 days.

(2) Implementation Condition on Procurement

1) Equipment Design

The substation to be constructed by the Project is a new structure, and the protection equipment for the transmission line and communication equipment will be required to interface with existing systems, although few adjustments to the existing power supply equipment are needed. Especially, the function of the central load dispatching center shall be retained.

2) Procurement Management

Implementation of the Project without any delay to the schedule of site work will require smooth transportation of equipment, including inland transportation, to the site. Transportation from Japan to Kawasoti is divided into marine transportation from Japan to Kolkata in India, inland transportation from Kolkata to the Birgunj border, and inland transportation from Birgunj to Kawasoti after customs clearance at Birgunj, and the transportation period from Japan to Kawasoti is estimated to require about 1.5 months. Therefore, meticulous equipment procurement management, including design,

procurement of material, manufacturing, assembly, testing, and packing for importation is required. Especially, inland transportation in India carried out by Indian transportation company is requested to manage and instruct meticulously for rough handling.

3) After-Sales Service

After completion of the Project, after-sales service such as the supply of spare parts by the Contractor, especially the manufacturer is important. Therefore, preparing an instruction manual, a list of spare parts, and communication system after taking over the equipment must be given adequate attention.

### 2.2.4.3 Scope of Works

Table 2-11 shows the scope of works, regarding the construction, procurement and installation for the Japanese side and Nepalese side.

Table 2-11 Scope of Works for Japanese Side and Nepalese Side

| Work Item/Procured Item | | Scope | Note |
|---|---|---|---|
| 1. Procurement | | | |
| | 1. 132kV and 33kV Transformer | Japan | |
| | 2. 132kV and 33kV Outdoor Switchyard Equipment | Japan | |
| | 3. 11 kV Indoor Cubicle | Japan | |
| | 4. Control and Protection Panel | Japan | |
| | 5. Associated Equipment and Materials for the above | Japan | |
| | 6. Material for Foundation and Building | Nepal | |
| 2. Construction and Installation | | | |
| | 1. Installation, Adjustment and Test for the above | Japan | |
| | 2. Foundation Work for the Equipment | Japan | |
| | 3. Building Construction Work | Japan | |
| | 4. Cabling Work | Japan | |
| | 5. Connection Work from existing 33kV and 11kV line to new Substation | Japan | |
| | 6. Miscellaneous Work such as Parking and Approach Road | Japan | |
| | 7. Leveling | Nepal | |
| | 8. Gate and Fences | Nepal | |
| | 9. Connection of telephone trunk line to the distribution system (MDF) of the control building | Nepal | |
| | 10. General furniture for the control building | Nepal | |
| | 11. Operators' quarter, stores, and guard house | Nepal | |

Boundary point of responsibility between Japan and Nepal is a post of 33 kV sub-transmission line and 11 kV distribution line. Nepal side should have responsibility for the point to load side, in other words, operation and maintenance for the 33 kV sub-transmission line and 11 kV distribution line. NEA has many experiences on the said operation and maintenance work.

#### 2.2.4.4 Consultant Supervision

(1) Basic Policy

The following are the basic policies of consultant supervision for the Project.

1) In accordance with Japan's grant aid scheme, the Consultant will organize the project supervision team to execute smooth implementation of the Project based on the purpose of the basic design.

2) The Consultant will supervise the Contractor to ensure the performance and quality of the equipment indicated in the contract and punctual completion of the works of the Project within the scheduled period. The Consultant will also supervise the Contractor to execute the site works in safety.

(2) Consultant's Obligations

A Japanese consulting firm will conclude a consultancy agreement with the Government of Nepal in accordance with Japan's grant aid scheme. The major obligations of the Consultant to be included in the agreement are as follows:

1) Detailed Design and Preparation of the Tender Documents

(i) Detailed Design

Based on the results of the basic design study, the Consultant will execute the detailed design for the Project through additional site survey and will discuss with NEA to confirm the Project costs and obligations of the Nepal side. Prior to preparation of the Tender Documents, the Consultant will confirm the equipment design, estimate the Project costs, and formulate the implementation program.

(ii) Preparation of the Tender Documents

Especially issuing technical matter, the Consultant will support NEA, if necessary.

(iii) Works for Tender

On behalf of NEA, the Consultant will announce the tender, prepare clarifications, open the tenders, evaluate tenders, negotiate the contract with successful tenderers and assist with the conclusion of the Contract for the Project.

2) Project Supervision

(i) Project Supervision

The Consultant will supervise the Project through a kick-off meeting, checking of shop drawings and specifications of the equipment, factory inspection before shipment, supervision of installation work at the site, preparation of several reports, issuing the intermediate

performance certificate, commissioning tests, etc. to ensure smooth execution of the Project.

(ii) Works on and after Completion of the Project

On completion of the Project, the Consultant will issue a completion certificate, handover the equipment, and prepare a completion report. One year later, the Consultant will carry out inspections of the equipment after the defect liability period.

(3) Staffing Schedule of the Consultant

Staffing schedule of the Consultant to conduct the above works is as follows:

1) Staffing Schedule for the Detailed Design and Preparation of Tender Documents

The following staff of the Consultant will be necessary for the detailed design and preparation of the Tender Documents.

Table 2-12 Staffing Schedule for Detailed Design and Preparation of the Tender Documents

| Position | Works in Charge |
|---|---|
| Project Manager | Detailed design, Preparation of Tender Documents, Overall management regarding the Tender, Reviewing the Equipment Plan |
| Substation Engineer | Design of the substation equipment and associated equipment including transformer |
| Transmission Line Engineer | Design of the transmission line |
| Civil Engineer | Design of the building |
| Building Equipment Engineer | Design of the building equipment |
| Cost Estimate | Cost estimation |

2) Staffing Schedule of the Project Supervision

The following staff of the Consultant will be necessary for the Project supervision.

Table 2-13 Staffing Schedule for Project Supervision

| Position | Works in Charge |
|---|---|
| Project Manager | Overall management of the Project |
| Substation Engineer (on-site engineer) | Supervision of the works at site, payment procedure, management of the procurement of the equipment, control of the Project schedule, quality control and safety control |
| Transmission Line Engineer | Supervision of the installation work for transmission line |
| Civil Engineer | Supervision of the construction work for substation building |
| Inspection Engineer-1 | Checking the shop drawings and specifications |
| Inspection Engineer-2 | Attendance to the factory tests and commissioning tests |
| Inspection Engineer-3 | Attendance to the inspection before shipment |
| Inspection Engineer-4 | Attendance to the commissioning inspection |

### 2.2.4.5 Procurement Plan

(1) Quality Control of Materials

Quality control of materials will be achieved by checking and approval of shop drawings, witnessing of shop inspections before shipping, witnessing of day-to-day inspection during construction, and commissioning tests.

(2) Scope of Spare Parts

Spare parts for components that are absolutely imperative for operation will be supplied to maintain the effect of the Project continuously. Spare parts will be categorized as "consumables" and "spare parts for repair". In the Project, consumables such as lamps, fuses, trip coils of circuit breaker, etc., and spare parts for repair to be replaced or re-filled promptly in case of failure such as SF6 gas, relays, meters, etc., will be supplied. The quantity of spare parts will be for about 2 years operation.

(3) Defect Liability Period

The defect liability period is 1 year.

(4) Transportation Plan

Equipment procured in Japan will be unloaded at Kolkata port, transported to Nepal by truck or trailer by land, given custom clearance at Birgunj, and transported to the site in Nepal. No other route is recommended because the transportation company might not be familiar with it.

### 2.2.4.6 Implementation Schedule

The estimated period of the implementation schedule for the Project is approximately 19 months from the exchange of notes between HMG/N and the Government of Japan to the completion of the Project and approximately 13.5 months from verification of the Contract between HMG/N and the Contractor to the completion of the Project as shown in Table 2-8.

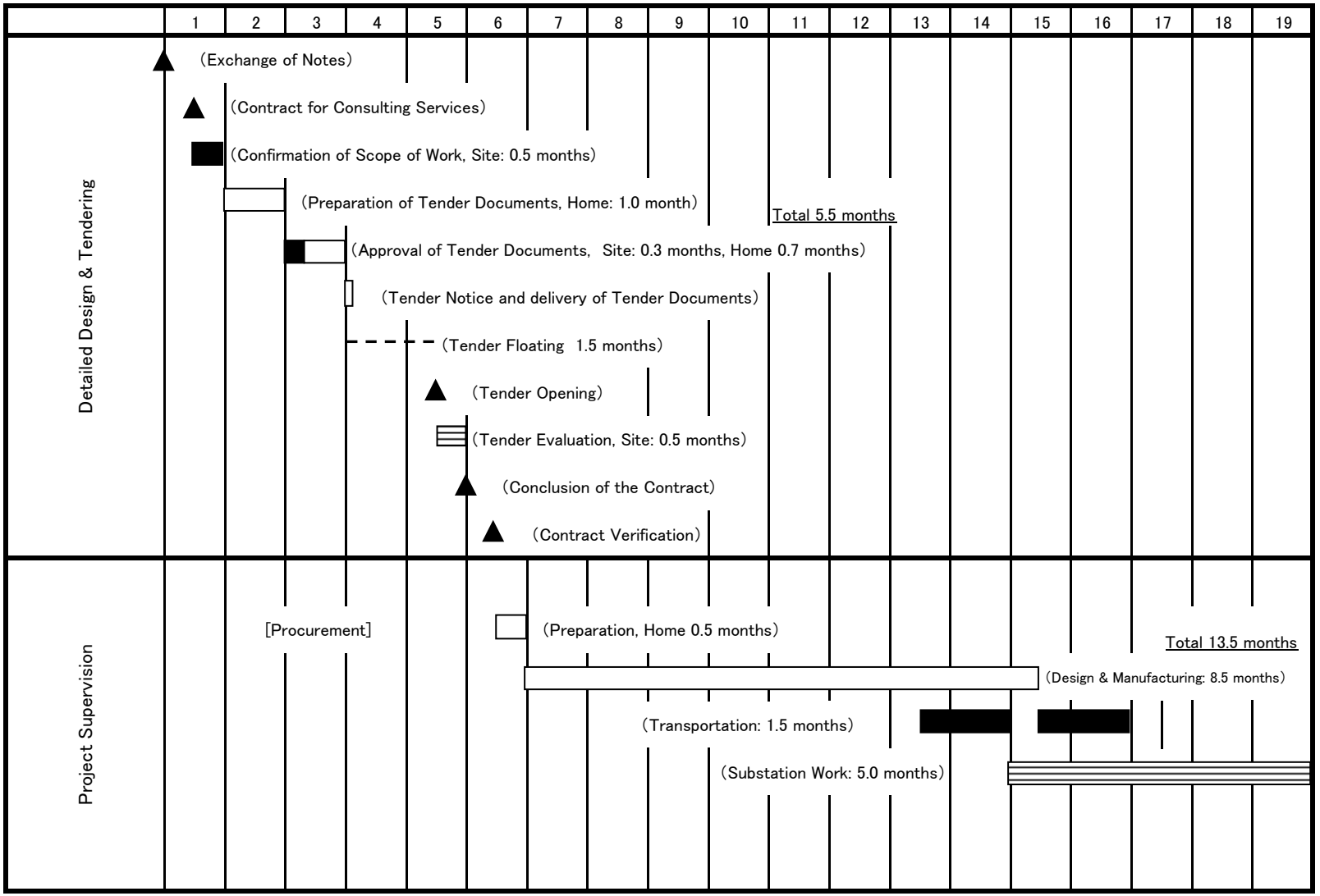



Figure 2-8 Implementation Schedule

## 2.3 Obligations of Recipient Country

In the implementation of this Grant Aid project, HMG/N (NEA) is required to undertake such necessary measures as the following:

(1) Programmed power shutdown on the existing 132 kV transmission and 33 kV sub-transmission lines for the new substation construction

Because the plan is the construction of a new substation, construction work items, such as installation of switchgears, control building work and installation of indoor equipment, are able to be carried out freely and without power shutdown of the existing power transmission and distribution system. However, some work items, such as connecting the 132 kV feeder line to the new substation, initial charging test of 132 kV switchgears, etc., require a programmed shutdown of the existing 132 kV transmission lines from Bharatpur and Bardhaghat Substations. Therefore, upon request for power shutdown by the contractor and consultant, NEA should arrange the programmed power shutdown responsibly.

(2) Other formal requirements of Nepal

a. To ensure prompt customs clearance of the products purchased under the Grant Aid at the Nepal-India border.

b. Banking Arrangements (B/A) and Authorization to Pay (A/P)

To open an account in the name of HMG/N at a bank in Japan.

To bear an advising commissions for Authorization to Pay and payment commissions to the Bank,

c. To exempt products purchased under the Grant Aid from customs duties and internal taxes,

d. To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed on services to be provided under the Verified Contracts,

e. To arrange necessary permissions for construction,

f. To secure land for the new substation and temporary yard,

g. To clear, level, and reclaim the site,

h. To construct fences, gate, and planting of the Kawasoti Substation, if Nepalese side judge necessary,

i. To provide facilities for the distribution of electricity, water supply and drainage, telephone line and other incidental facilities in and around the site,

j. To arrange the fixtures and furniture for use in the Kawasoti Substation, and

k. Other all items to be done for this project but not covered by the Japanese Grant Aid.

## 2.4 Project Operation Plan

(1) Operation and Maintenance Personnel

After completion of this project, i.e., at the operation and maintenance stage, the substation will be operated by the Butwal Grid Operation Division of the Grid Operation Department. The Butwal Grid Operation Devision has jurisdiction over the Bardhaghat substation. Bharatpur substation which is next to the Kawasoti substation is controlled by the Hetauda Grid Operation Division.

The 33 kV sub-transmission lines, 11 kV distribution lines, and low voltage distribution lines will be operated and maintained by the Butwal Regional Office of Distribution and Customer Service business group.

For the New Kawasoti substation 2-3 resident operators in a 3-shift system and 2 additional standby operators will be applied. The main duties of the operators are as follows.

a) Data Logging: at each 30 min., to log voltage, current, power flow, etc. in the logging sheet.

b) Operation of System Switching: to operate switchgear in accordance with the order of the Load Dispatching Center (LDC),

c) Counter Measures for Trouble: Emergency operation to recover the Kawasoti substation. In the case of trouble on the transmission lines, wait for orders from the LDC. In case of heavy trouble, LDC will plan and order the recovery work.

d) Operation and Check: To carry out the daily and periodical maintenance and check.

It is judged that the NEA can provide and manage the above operators without difficulty.

(2) Maintenance and Check Work

The daily maintenance and check work is described below.

Maintenance and check work consists of daily perambulation and periodical check (3 months – 5 years). Items of daily perambulation and periodical check are shown in Table 4-1.

Table 2-14 Items of daily maintenance and check work

| Equipment | Daily Perambulation | Periodical Check (3 months interval, if not mentioned) |
|---|---|---|
| Main Transformer | -Abnormal noise/vibration<br>-Temperature rise<br>-Insulation oil level<br>-Oil leakage | -Silica gel check & replace<br>-$N_2$ gas pressure check<br>-Oil deterioration test (1 year) |
| Control/Relay Boards | -Meters & Indication lamps | -Cleaning<br>-Relay function test (3-5 years) |
| 11 kV Cubicles | -Abnormal noise/vibration<br>-Meters & Indication lamps | -Cleaning<br>-Circuit breaker operation test<br>-Relay function test (3-5 years) |
| Batteries | -Deformation of terminals and cell cases | -Voltage measurement<br>-Equalizing charge |

These perambulations and checks including corrective maintenance work can be technically and financially carried out by NEA.

## 2.5 Estimated Project Cost

### 2.5.1 Estimated Project Cost

In case the Project is implemented under Japan's Grant Aid, the total project cost is estimated to be approximately 922 million Japanese Yen (Japanese side: approx. ¥846 million, Nepalese side: approx. ¥76 million). The cost breakdown based on the scopes of works between the Japanese and Nepalese sides is outlined in the following sections (1) and (2), under the conditions described in the section (3).

This cost estimate, however, is provisional and would be further examined by the Government of Japan for approval of the Grant.

(1) Japanese Portion

Table 2-15 Estimated Cost of Japanese Portion

| Items | | Estimated Cost | |
|---|---|---|---|
| Procurement | Transformers, substation equipment, and other materials | 707 million Yen | 790 million Yen |
| Installation | Building, and equipment foundations | 83 millionYen | |
| Detailed Design and Construction Supervision | | | 56 million Yen |
| TOTAL | | | **846 million Yen** |

(2) Nepalese Portion

Table 2-16 Estimated Cost of Nepalese Portion

| | Items | Estimated Cost |
|---|---|---|
| ① | Procuring land for substation | NRs. 17,000,000. (27.2 mil. Yen) |
| ② | Fences and gate | NRs. 10,000,000. (16 mil. Yen) |
| ③ | Furniture and telephone connection | NRs. 180,000. (0.3 mil. Yen) |
| ④ | Operators' quarter, stores, and guard house | NRs. 20,000,000. (32 mil. Yen) |
| TOTAL | | NRs. 47,180,000. **(75.5 mil. Yen)** |

(3) Conditions of Estimation

① Date of Estimation November 2005

② Exchange Rate US$ 1 = JPY 113.51
NRs. 1 = JPY 1.6

③ Project Period As per clause 2.2.4.6

| | |
|---|---|
| ④ Others | The Project will be implemented in accordance with the Guidelines for Japan's Grant Aid Cooperation |

### 2.5.2 Operation and Maintenance Cost

Table 2-17 shows the yearly estimated O&M cost after completion of the Project.

Table 2-17 Yearly O&M Cost (NRs)

| Maintenance Cost (Purchase of Spare Parts) | Manpower Cost | Total Cost |
|---|---|---|
| 200,000 | Operator<br>5 people x 3 shifts x 12 months x 11,250<br><br>Guard<br>2 people x 3 shifts x 12 months x 10,000 | 2,945,000 |

Maintenance cost is purchasing cost of spare parts to be expected for one year. In this estimation, NEA will pay maintenance cost from second year after completion of the Project.

O&M cost for the equipment to be procured under the Project accounts only 0.02% of the total yearly budget of NEA's operation and maintenance in 2004/2005 (approximately NRs. 11,859.4 million). Therefore, the payments of budget can be judged possible.

# *Chapter 3*
# *Project Evaluation and Recommendations*

# Chapter 3 Project Evaluation and Recommendation

## 3.1 Project Effect

The main objective of the Project is to realize drastic reduction in the voltage drops, power outages, and transmission line loss in the targeted area so that the quality and reliability of the electrical supply in the area will be much improved. Such improvement will be made through the construction of the 132/33/11 kV New Kawasoti substation with a transformer of 132/33 kV, 30 MVA. The new substation will interconnect 132 kV transmission line with the 33 kV transmission line system so as to improve the transmission capacity of the 33 kV transmission line. Under the Project, the following direct and indirect positive effects can be expected.

### (1) Direct Effect

Direct effects by the implementation of the Project are as follows.

a) Capacity for power distribution will be increased.
(New transformers capacity in total : 8 MVA→38 MVA)

b) Transmission loss up to the target area will be reduced.
(Bardhaghat Substation - Existing/New Kawasoti Substation : 297 MWh→7 MWh)

c) Power outage due to 33 kV transmission line ground fault will be reduced.
(Bharatpur Substation - Existing/New Kawasoti Substation : 25 hour/year→to be reduced)

The beneficiaries by the Project will be the residents of the eastern part of the district of Nawalparasi, and their numbers will be approximately 190,000.

Table 3-1 summarizes the direct effects of the Project.

Table 3-1 Direct Effects of the Project

| Current Status & Issues | Countermeasures | Direct Effects |
|---|---|---|
| Capacity of the existing 33/11kV, 8MVA transformer in Existing Kawasoti Substation will soon be overloaded.<br><br>This may cause scheduled long power outage. | Capacity of the 33/11 kV transformer will be reinforced by 8MVA new transformer in New Kawasoti Substation<br><br>In addition, the new 30 MV, 132/33 kV will interconnect 132kV system and 33kV system and reinforce the transmission capacity of 33kV transmission line. | Scheduled long power outage to be occurred in future due to overloading of the 33/11 kV transformer can be avoided.<br><br>In addition, 33kV transmission line capacity is to be reinforced by the interconnection. |
| The existing 33kV transmission line of 35km between Bharatpur - Existing/ New Kawasoti Substation is causing excessive voltage drop and transmission line loss. | 33kV transmission line will be interconnected to 132kV transmission line. | Excessive voltage drop and transmission line loss will be minimized. (Estimated value : 297MWh→7MWh) |
| Power outage due to 33kV transmission line fault occurred frequently. | Existing 33kV transmission line can be by-passed by New Kawasoti Substation. | Power outage due to the 33kV transmission line fault (25 hours/year) will be reduced. |

### (2) Indirect Effect

Indirect effects by the implementation of the Project are as follows.

a) The Project will contribute to vitalization of the socio-economical activities in the target area, through reliable electrical power supply.

b) The Project will contribute to the Basic Human Needs (Reliable electrical power supply to Hospital, Schools etc.).

For reference, the numbers of the public facilities that will receive the power from the New Kawasoti Substation are ;

| | | |
|---|---|---|
| - | School | 554 |
| - | School (Campus) | 4 |
| - | Hospital | 2 |
| - | Clinic | 264 |

## 3.2 Recommendations

To maximize and maintain the positive effects of the Project and to ensure the long-term operation of the New Substation, the Nepalese side is requested to meet the following requirements after completion of the Project.

### (1) Periodical Maintenance and Check of Equipment

To maintain the equipment's functions and to discover the technical faults in time, the periodical perambulation and check are needed by NEA. NEA is requested to schedule the periodical perambulation and check, and to prepare the budget/manpower, and to execute such works.

### (2) Extension of 33kV Transmission Line and 11kV Distribution Lines

NEA is requested to extend 11kV distribution line, and also 33kV transmission lines to distribute the electrical power to the waiting consumers, so that the ratio of the electrification can be increased. Also the power through New Kawasoti Substation can be efficiently distributed through the extended lines. NEA is requested to prepare the budget/manpower to do this work.

# *Drawings*

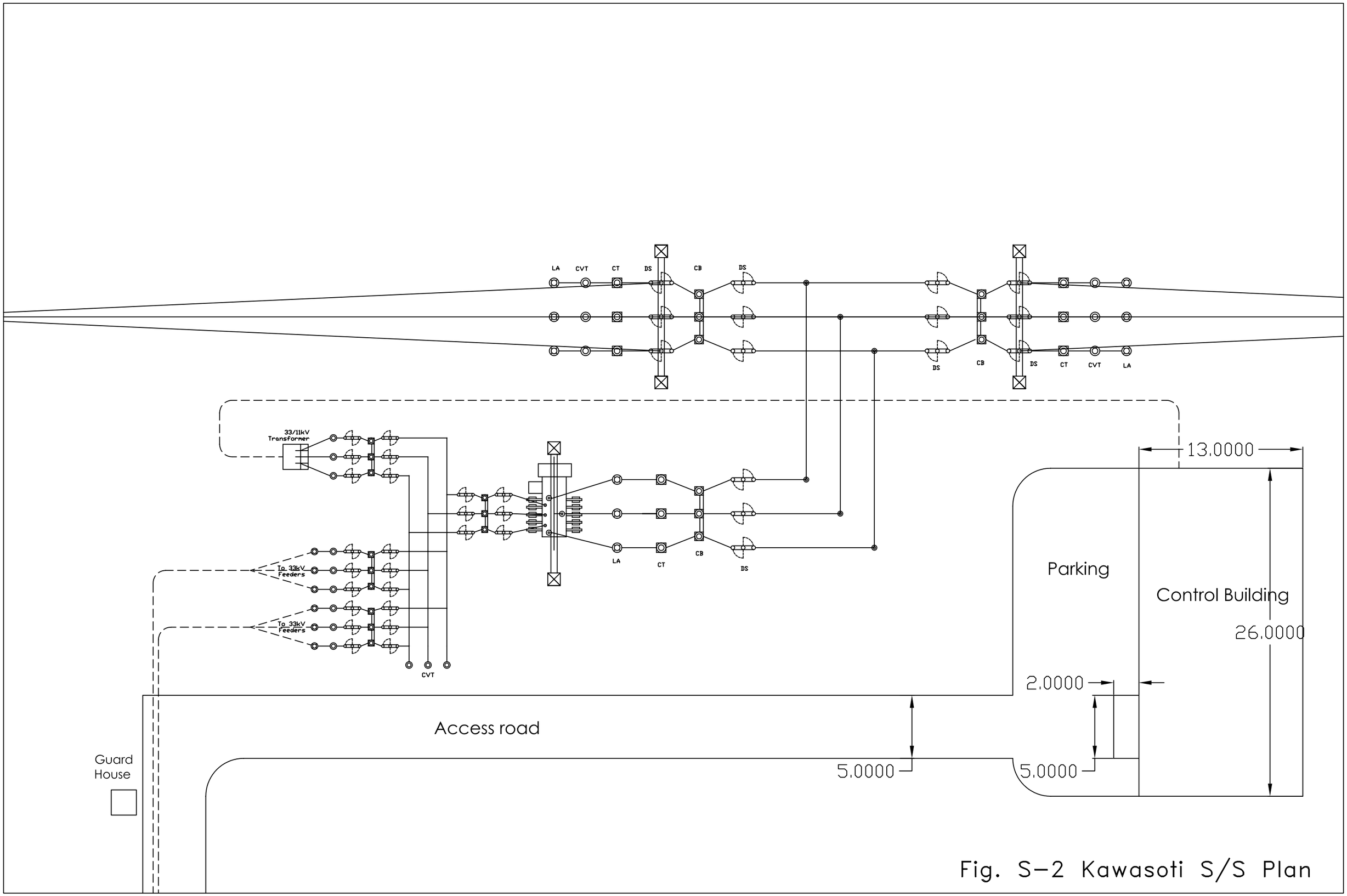



Fig. S-2 Kawasoti S/S Plan

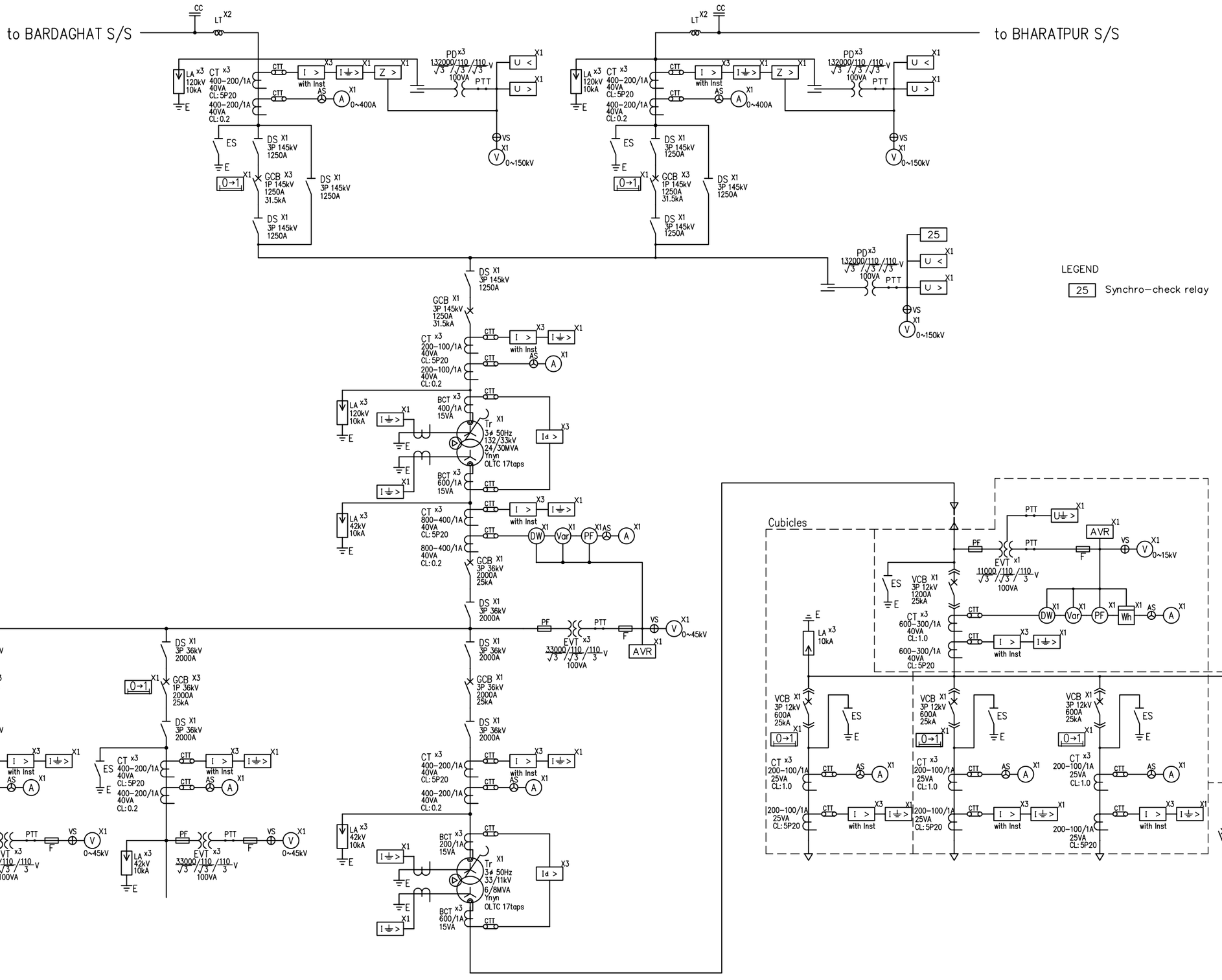
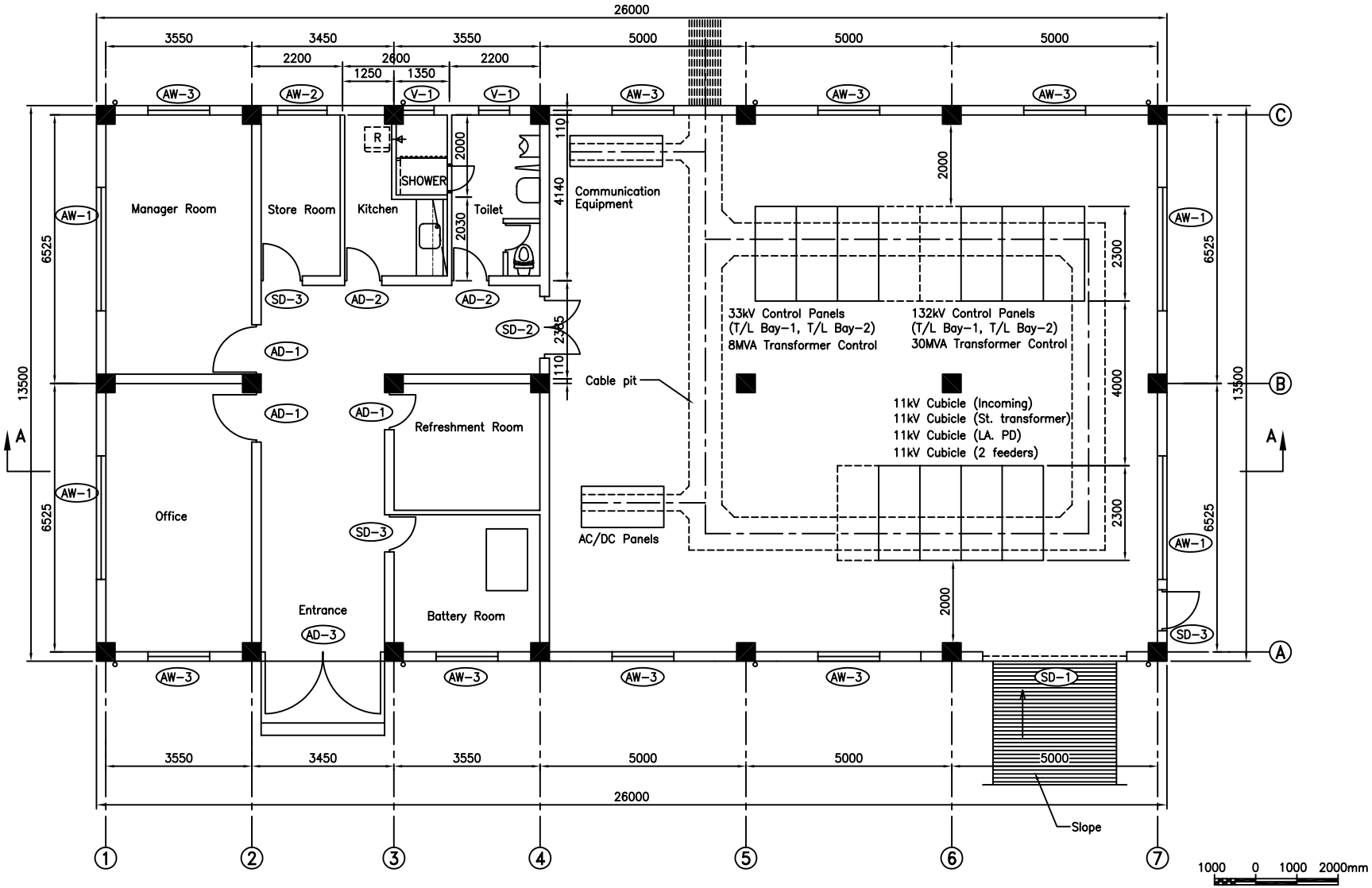
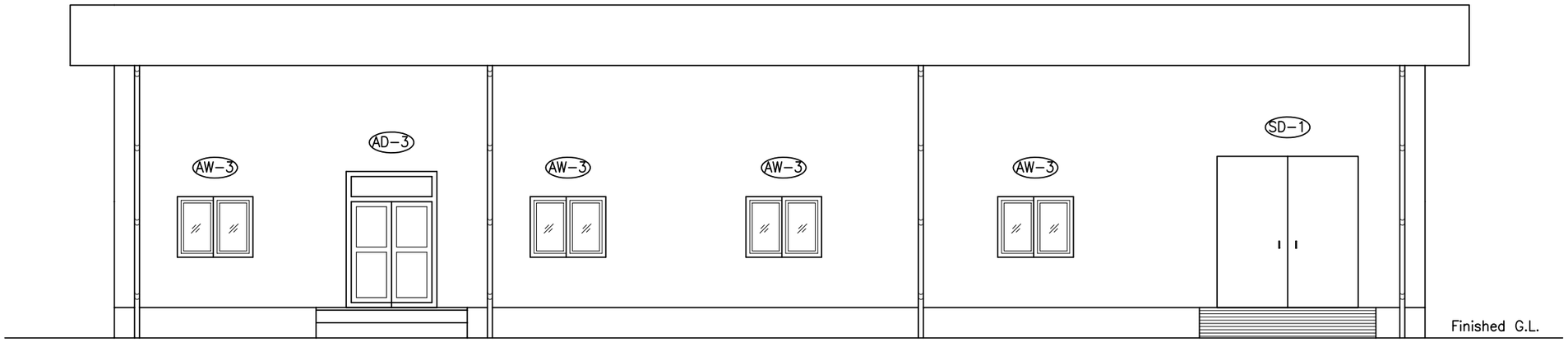



Fig. S-1 Kawasoti S/S Single Line Diagram

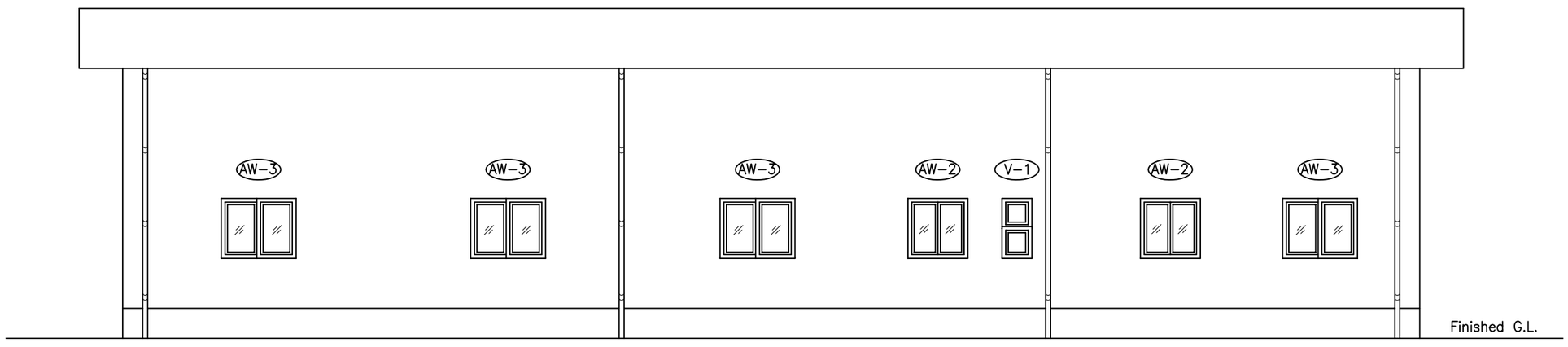



Substation Floor Plan

Fig. C-1 Kawasoti S/S Floor Plan




West Elevation




East Elevation

1000 0 1000 2000mm

Fig. C-3 Kawasoti S/S Front View (West Side) and Rear View (East Side)