Photo 5-7-1 Gold Ridge Access Road (Maotapuku 1,2)

Photo 5-7-2 Gold Ridge Mining Site (Maotapuku 1,2)

Photo 5-7-3 Downstream Area of Intake Site of Sasa

Photo 5-7-4 Right Bank Ridge of Sasa

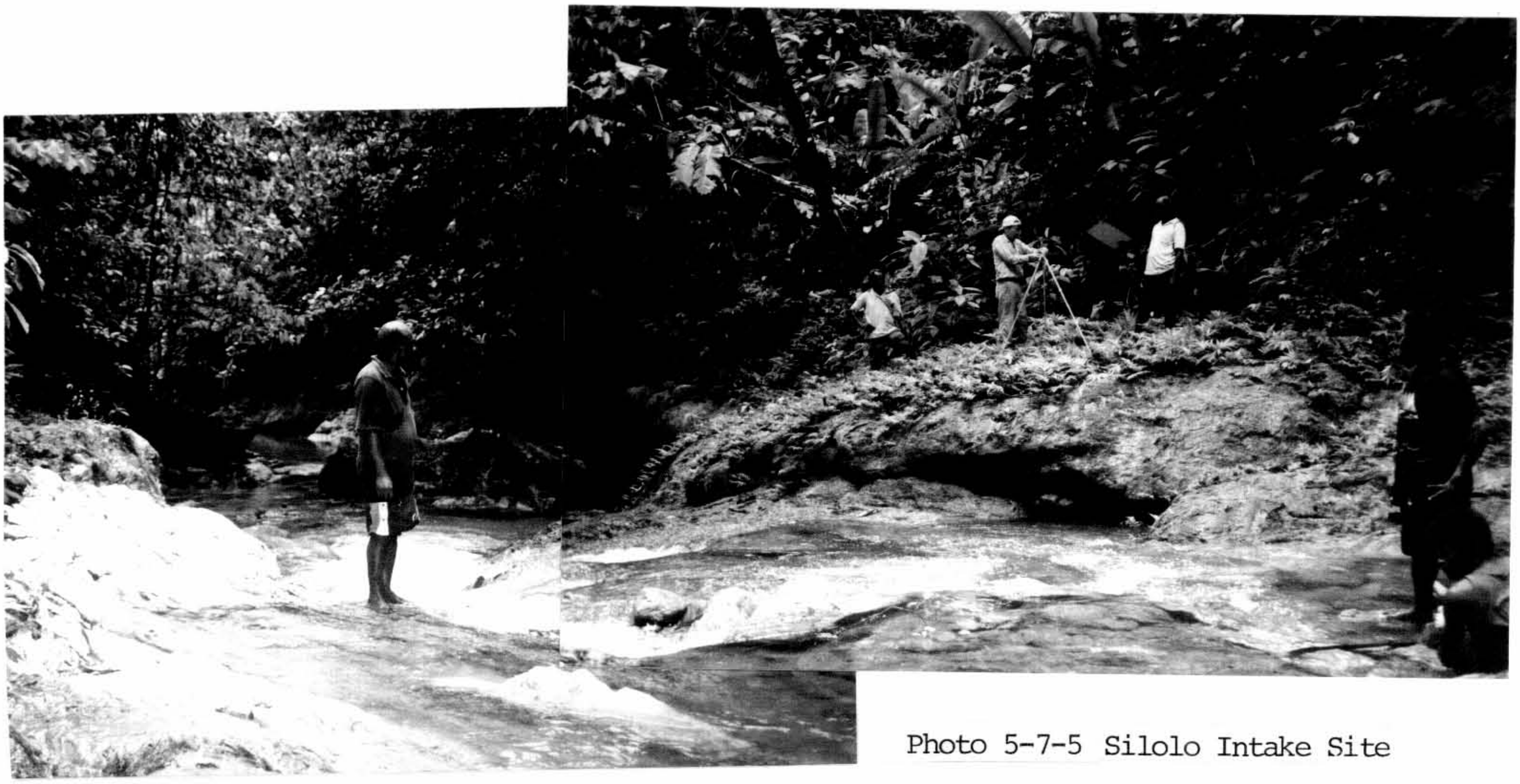

Photo 5-7-5 Silolo Intake Site

Photo 5-7-6 Talifu Waterfall at Silolo

Photo 5-7-7 Major Spring at Rori

Photo 5-7-8 Minor Spring at Rori

Photo 5-7-9 Rori Intake Site

Photo 5-7-10 Rori Powerhouse Site

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Photo 5-7-11 Kware'a Dam Site

Photo 5-7-12 Downstream Area of Kware'a Dam

Photo 5-7-13 Kubolata Spring No.1

Photo 5-7-14 Kubolata Powerhouse Site

Photo 5-7-15 Waimapuru Intake Site

Photo 5-7-16 Waimapuru Lower Waterfall

Photo 5-7-17 Sorave Intake Site

Photo 5-7-18 Sorave Waterfall

Photo 5-7-19 Luembalele Intake Site

Photo 5-7-20 Upstream Area of Powerhouse at Luembalele

CHAPTER 6

TRANSMISSION AND DISTRIBUTION FACILITIES / POWER SUPPLY SYSTEM

Chapter 6 Transmission and Distribution Facilities/Power Supply System

Eleven potential sites have been selected at the first site survey. Eight sites have been surveyed carefully at the second site survey and the remaining three sites in Guadalcanal islands could not be surveyed because of impediments arisen from ethnic tensions. Since one site, Popolo River, has been decided not suitable after the second site survey, the master plan on power network has been prepared with ten potential sites selected by the JICA M/P Team and some other sites studied by other organizations.

6.1 Summary of Transmission and Distribution Lines

Proposed power network system is as shown in Fig.6-2-1 to Fig.6-2-6. Characteristics of each transmission line are summarized below.

Table 6-1-1 Characteristics of Transmission Lines

Islands	Line Name	Voltage (kV)	Length (km)	Required Capacity (kW)	Conductor
Guadalcanal	Maotapuku 1- Maotapuku 2	33	6.5	1,600	ACSR 240mm^2
	Maotapuku 2- Lunga	33	32.5	3,000	ACSR 240mm^2
	Sasa - Honiara	11	15	500	AAC Mars 77mm^2
	New Lunga - Lunga	66	15	25,000	ACSR 240mm^2
	Komarindi - Honiara	66	25	8,000	ACSR 240mm^2
Malaita	Malu'u - Rori	33	8	300	ACSR 160mm^2
	Rori - Fausande	33	15	600	ACSR 160mm^2
	Silolo - Fausande	33	8	2,100	ACSR 160mm^2
	Fausande - Aero	33	6	2,600	ACSR 160mm^2
	Aero - Dala	33	27	2,700	ACSR 160mm^2
	Kware'a - Dala	33	14	600	ACSR 160mm^2
	Dala - Auki	33	24	3,000	ACSR 160mm^2
	Fiu - Auki	33	9	600	ACSR 160mm^2
	Auki - Ruala'e	33	13	2,500	ACSR 160mm^2
	Ruala'e - Bina	33	14	2,700	ACSR 160mm^2
	Malu'u - Silolo	33	8	300	AAC Mars 77mm^2
	Silolo - Anda'ua	11	12	100	AAC Mars 77mm^2
San Cristobal	Kirakira - Town	11	4	300	AAC Mars 77mm^2
	Huro - Kirakira	11	3	110	AAC Mars 77mm^2
	Kirakira - Waimapur	11	13	100	AAC Mars 77mm^2
	Waimapur - Nukukaisi	11	18	50	AAC Mars 77mm^2
Santa Isabel	Buala - Nareabu	11	6	100	AAC Mars 77mm^2
	Buala - Kubolata	11	2.5	200	AAC Mars 77mm^2
	Kubolata - Ghojoruru	11	15	100	AAC Mars 77mm^2
Choiseul	Sorave - 2ndary school	11	6	50	AAC Mars 77mm^2
	Sorave - Village	11	5	50	AAC Mars 77mm^2
Santa Cruz	Luembalele - Lata	11	22	50	AAC Mars 77mm^2

6.2 Power Development Plan and Transmission Line

In order to meet the growing power demand in the Solomon Islands, development of hydro power plant and associated transmission lines up to year 2015 are planned as mentioned below. With regard to the generator capacities shown in Fig. 6-2-1 to Fig. 6-2-6, amounts in parenthesis show installed capacities by June 2000 and the amounts without parenthesis are planned capacities. Diesel generator and hydro generator are denoted with letters “D” and “H”, respectively.

(1) Guadalcanal Island

No.10 diesel generator (4.2 MW) is going to be installed at Lunga P/S in 2000.

Maotapuku 1 P/S (1.6 MW) and Maotapuku 2 P/S (1.4 MW), located near the Gold Ridge, will be the most useful sites for hydropower stations. A feasibility study shall be carried out. The transmission line from Maotapuku 1 and 2 to Lunga P/S will be 33 kV and approximately 39 km long as shown in Fig. 6-2-1.

Sasa P/S (280 kW), located about 15 km West of Honiara, also require a feasibility study. The transmission line from Sasa to Honiara P/S is 11 kV, 1 circuit.

Concerning New Lunga P/S (25 MW), the Australian consultant SMEC is reviewing the feasibility study report, intending to develop it as an IPP project.

Komarindi P/S (8 MW) was designed by the Asian Development Bank (ADB). However, as 25 km of access road is needed, no plan for execution has been made.

In order to meet the power demand growth, installation of additional diesel plants as mentioned in Chapter 10 will not be avoided. The development of large hydro power stations such as New Lunga, Komarindi or other promising potential site will also be necessary.

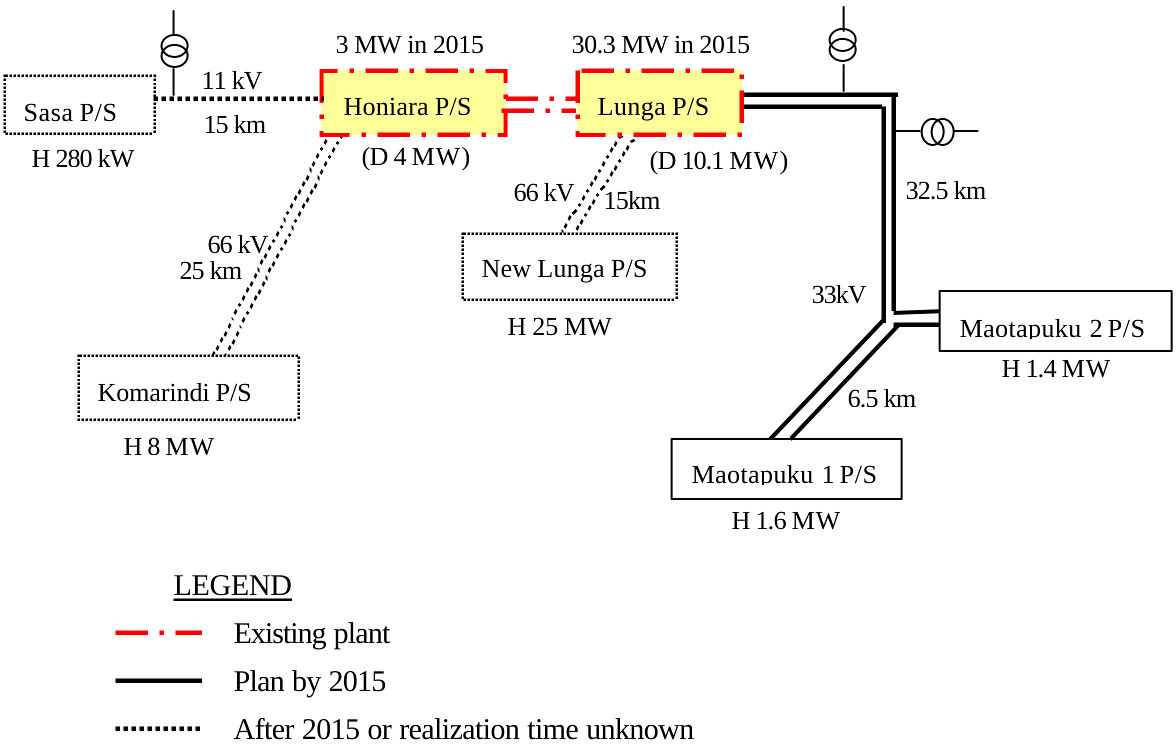


Fig. 6-2-1 Network System of Guadalcanal Island

(2) Malaita Island

Rori P/S (300 kW) shall be developed as soon as possible since it is very easy to construct at a minimum cost. It will contribute to reinforce the power supply system in North Malaita, and surplus power can be transmitted to Auki. A 33 kV transmission line between Bina and Malu'u will be installed by SIEA, financed by the World Bank. A diesel generating plant shall be installed at Bina for the supply of power to Bina project (see Fig. 6-2-4).

The next development will be Ruala'e P/S (200 kW), and then Silolo P/S (2,100 kW), Fausande switching gantry and 8 km of 33 kV transmission line between Silolo P/S and Fausande S/G. Sililo P/S also requires a feasibility study. The power from Silolo can reduce the capacity of diesel generator at Bina.

Kware'a P/S (600 kW) and Fiu P/S (560 kW) will be implemented after 2015. Manakwai P/S (300 kW) and Aero P/S (130 kW) also shall be developed in sequence.

The transmission line between Fausande S/G and Auki P/S shall be designed taking into account not only the electric power from Rori but also from Manakwai, Aero and Silolo sites.

(3) Santa Isabel Island

An 11 kV transmission line shall be installed between Buala P/S and Ghojoruru. It will be useful for the coconut crushing mill in Ghojoruru and the community school in Guguha. Though the initial cost of hydro generator is high, it shall be developed at alater stage, taking ease of maintenance and environmental impact issues into consideration. Kubolata power station has quite high head and is expected to have a capacity of 80 kW. The connection with Buala power station by an 11 kV transmission line will contribute to the decrease of operation time of the diesel generator at Buala P/S during the dry season. Refer to Fig. 6-2-5.

(4) San Cristobal Island

Kirakira P/S is going to be relocated to the outskirts of the township near the airport. Huro P/S (120 kW) shall be developed for reinforcing the power supply system in the Kirakira area. An 11 kV transmission line shall be installed from Kirakira P/S to Nukukaisi where there is a rural health clinic, and along the route power can be distributed to the coconuts crushing mill that will be installed at Kaonasugu and to the vocational school at Pamua (see Fig. 6-2-6).

The National Waimapur secondary school has diesel generators, one unit of 55 kVA and two units of 25 kVA, but considerable maintenance and repair works are required. The main load at Waimapur is for underground water pumping and for lighting, to provide essential services for 600 students and 25 teachers. The Waimapur P/S (20 kW) shall be developed together with a gravity system water supply from the Waimapur river to the secondary school in order to reduce the load.

(5) Choiseul Island

The Provincial Government has planed to develop the south side of the Sorabe River as an industrial center and to move the village from Taro Island to that center but leaving the governmental offices in Taro Island. Sorave P/S site (70 kW) is located about 200m from the logging road. Transmission lines can be constructed along the logging road, one to a secondary school where a 27 kVA diesel generator is installed and the other to a village newly developed. A diesel generating plant shall be installed in Taro Island. Refer to Fig. 6-2-2.

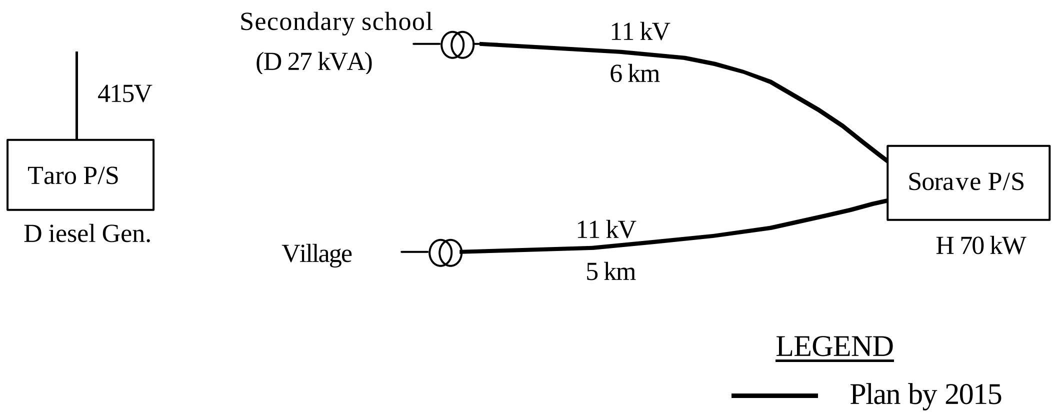


Fig. 6-2-2 Network System of Choiseul Island

(6) Santa Cruz Island

Lata power station has three units of 110 kVA diesel generators and the capacity shall be increased in the future as mentioned in Chapter 10.

The Luembalele hydro power station will contribute to decrease the load of diesel generators that use fuel transported by ship from Honiara. The transmission line will be a 22 km 11 kV line. Refer to Fig. 6-2-3.

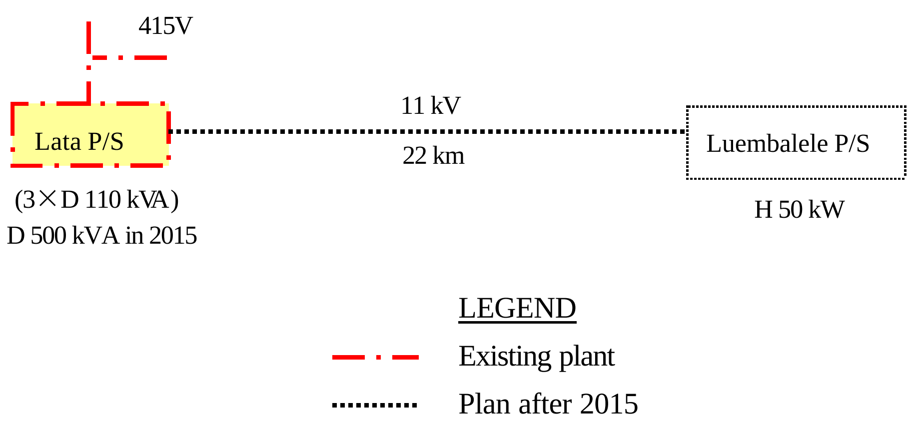


Fig. 6-2-3 Network System of Santa Cruz Island

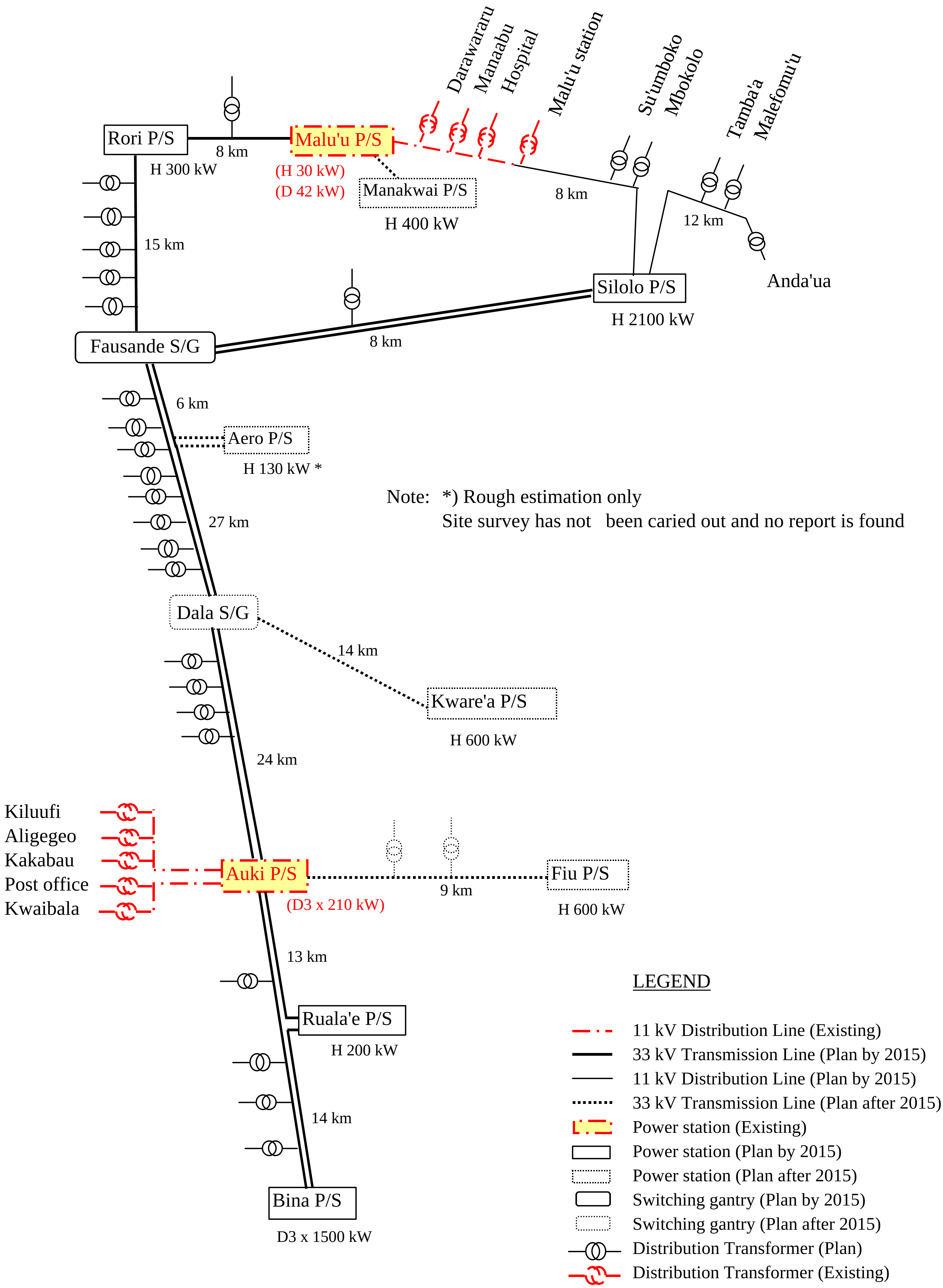


Fig. 6-2-4 Network System of Malaita Island

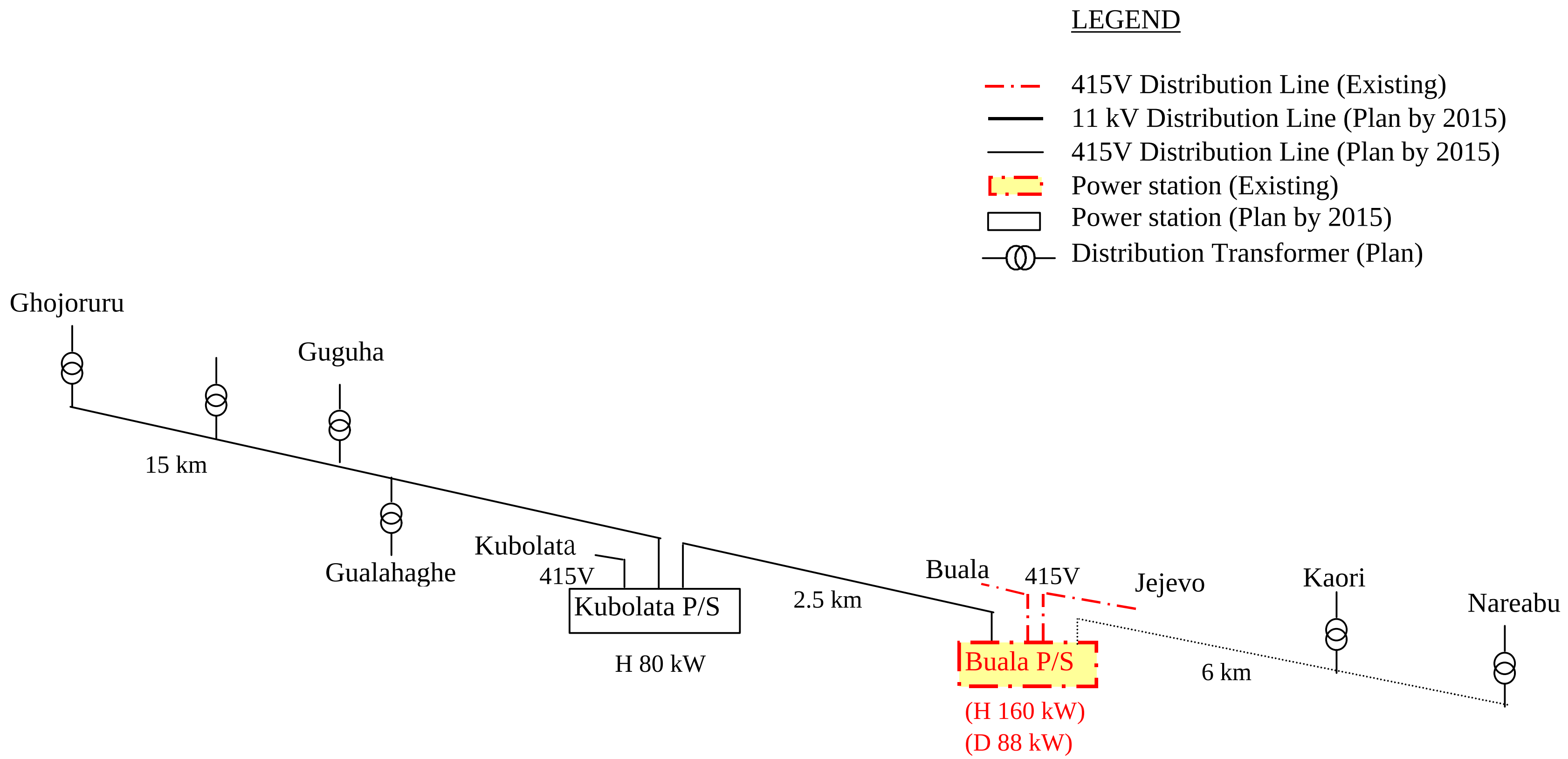
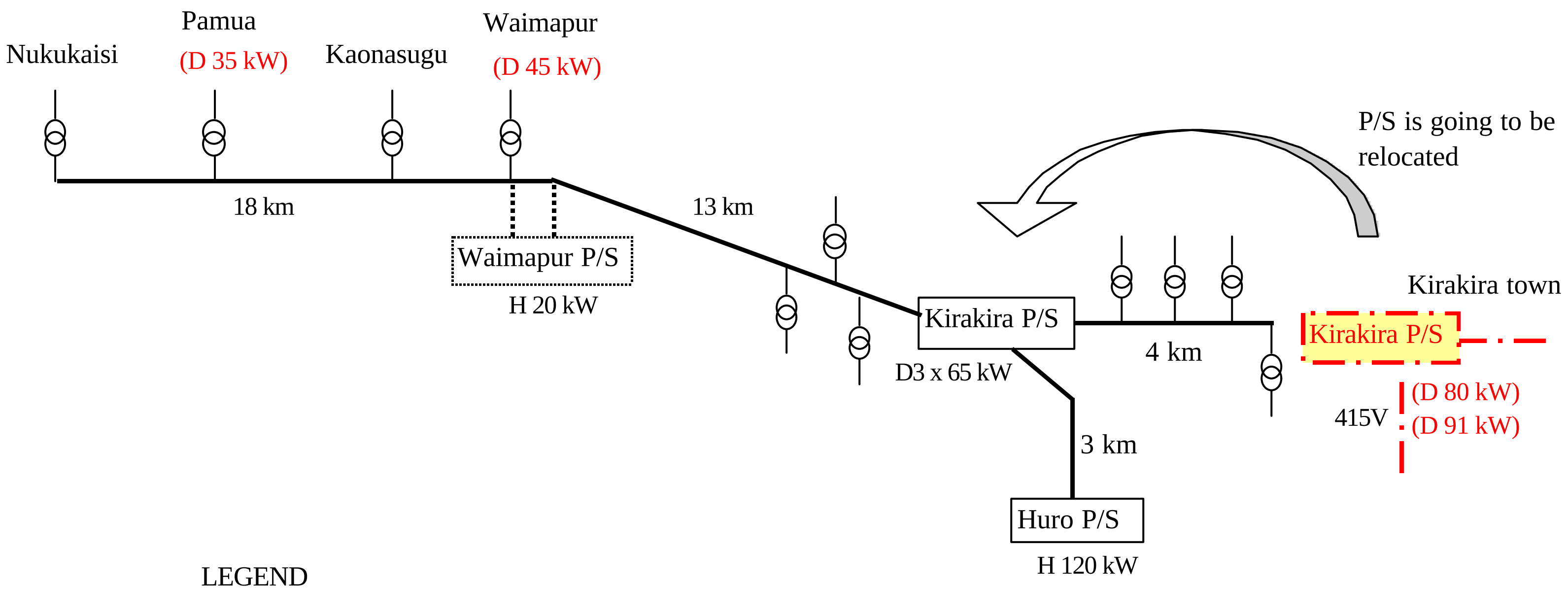


Fig. 6-2-5 Network System of Santa Isabel Island



LEGEND

- 415V Distribution Line (Existing)
- 11 kV Transmission and Distribution Line (Plan by 2015)
- 11 kV Transmission and Distribution Line (Plan after 2015)
- Power station (Existing)
- Power station (Plan by 2015)
- Power station (Plan after 2015)
- Distribution Transformer (Plan)

Fig. 6-2-6 Network System of San Cristobal Island

6.3 Profile of Transmission and Distribution Lines

The profile of transmission and distribution lines are as follows.

33 kV overhead line

	Suspension	Tension
Support type	mast	tower
Span length	250m	250m
Conductor	ACSR 240 mm^2 or ACSR160 mm^2	
Insulator	4 x 254 mm suspension insulator	

11 kV overhead line

	Suspension	Tension
Support type	steel pole	steel pole
Span length	70m	70m
Conductor	AAC Mars 77 mm^2	
Insulator	Pin post insulator	2 x 254 mm suspension insulator

415V overhead line

	Suspension	Tension
Support type	steel pole	steel pole
Span length	50m	50m
Conductor	XLPE 4 x 50 mm^2 or XLPE 4 x 95 mm^2	

Distribution transformers

Voltage ratio	33kV/415V, 11kV/415V
Capacity	20kW, 50kW, 100kW, 200kW depending on the magnitude of load

6.4 Construction Cost

Construction cost was estimated as stated below. The estimation was made based on all materials imported from Japan and manpower from Solomon Islands with some engineers from Japan. The installation of distribution transformers is included in the cost of transmission lines. The cost of distribution lines is for the section installed after the distribution transformers.

Some prices of material available in Solomon Islands and imported from Australia and other countries are listed in Appendix. 6-4-1 for reference.

Guadalcanal Island

(US$ x 1000)

Line Name	Transmission Line			415V Distribution Line	
	Voltage & ckt	Length (km)	Cost	Length (km)	Cost
Maotapuku 1-Maotapuku 2	33 kV 2 ckt	6.5	737	-	-
Maotapuku 2-Lunga	33 kV 2 ckt	32.5	3,685	6	303
Sasa - Honiara	11 kV 1 ckt	15	809	2	101

Malaita Island

(US$ x 1000)

Line Name	Transmission Line			415V Distribution Line	
	Voltage & ckt	Length (km)	Cost	Length (km)	Cost
Malu'u - Silolo	11 kV 1 ckt	8	431	5	252
Silolo – Anda'ua	11 kV 1 ckt	12	647	4	202
Silolo - Fausande	33 kV 2 ckt	8	792	-	-
Kware'a - Dala	33 kV 1 ckt	14	1,000	-	-

San Cristobal Ialand

(US$ x 1000)

Line Name	Transmission Line			415V Distribution Line	
	Voltage & ckt	Length (km)	Cost	Length (km)	Cost
Kirakira - Waimapur	11 kV 1 ckt	13	701	6	303
Waimapuru - Nukukaisi	11 kV 1 ckt	18	970	8	404

Santa Isabel Ialand

(US$ x 1000)

Line Name	Transmission Line			415V Distribution Line	
	Voltage & ckt	Length (km)	Cost	Length (km)	Cost
Buala - Kubolata	11 kV 1 ckt	2.5	135	-	-
Kubolata - Ghojoruru	11 kV 1 ckt	15	809	4	202

Choiseul Island

(US$ x 1000)

Line Name	Transmission Line			415V Distribution Line	
	Voltage & ckt	Length (km)	Cost	Length (km)	Cost
Sorave - 2ndary school	11 kV 1 ckt	6	323	-	-
Sorave - Village	11 kV 1 ckt	5	270	-	-

Santa Cruz Island

(US$ x 1000)

Line Name	Transmission Line			415V Distribution Line	
	Voltage & ckt	Length (km)	Cost	Length (km)	Cost
Luembalele - Lata	11 kV 1 ckt	22	1,186	-	-

6.5 Comparison of Overhead Line and Underground Cable

On request of SIEA, a 33 kV underground cable between Malu'u and Bina has been analyzed. Advantages and disadvantages of overhead line (OHL) and underground cable (UGC) are summarized below. Though periodical maintenance work is necessary, OHL is recommendable considering economic aspects and easiness of repair in case of line faults.

(1) Advantaget of OHL

- Construction cost will be approx. 1/5 of UGC cost
- Easy to find fault location
- Easy to replace or repair damaged conductors
- Insulation is obtained by insulators and air, easy to replace insulators
- Easy to add step down transformers to feed power to new load centers

(2) Disadvantage of OHL

- Compensation to landowners for tree cut along the line route is necessary
- Periodical site check and tree cut is necessary to prevent line fault caused by trees
- There is some possibility of conductor damage or support fall caused by cyclones

(3) Advantage of UGC

- No maintenance is necessary until insulation deterioration occurs

(4) Disadvantage of UGC

- Initial cost is high
- Special precaution is necessary for crossing wide rivers
- Cable joint is very difficult and an expert must be commissioned for maintenance works
- Difficult to find fault points
- It is difficult to anticipate faults and if they happen, it will take a long time and high cost to repair it
- It is difficult to add power feeding points in later stages

6.6 Meteorological Conditions

(1) Atmospheric Temperature

The Solomon Islands is located in a tropical rain forest region. Monthly mean temperature of maximum, mean and minimum at Honiara between 1951 and 1997 given by Solomon Islands Meteorological Service (SIMS) are 32.9°C, 26.8°C and 21.2°C, respectively (refer to Appendix 6-6-1 to 6-6-3). After data analysis, following values have been proposed by JICA M/P Team for design conditions and accepted by SIEA.

Maximum temperature	40°C
Mean temperature	27°C
Minimum temperature	20°C

(2) Wind velocity

WNW wind direction dominates during the period of westerly winds in December to March, whilst NW wind dominates in the trade wind period in April to November. Cyclones attack the Solomon Islands quite frequently during the wet season or from November to April.

The record of maximum wind gust at Vavaya Ridge Upper Air Observatory in Honiara, from January 1954 to December 1997 was summarized in Appendix 6-6-4. The return period wind velocity is obtained by the following equation.

$$V = \frac{s_v}{s_y}\left[-\ell n\left\{-\ell n\left(1-\frac{1}{T}\right)\right\}\right] + \bar{V} - \frac{s_v}{s_y}\bar{y}$$

$$y_i = -\ell n\left(-\ell n\frac{i}{n+1}\right) \qquad i = 1 \quad to \quad n$$

$$s_y = \sqrt{\frac{\sum(y_i-\bar{y})^2}{n}} \qquad s_v = \sqrt{\frac{\sum(V_i-\bar{V})^2}{n-1}}$$

Where;

V = wind velocity of T year return period

T = return period (year)

$\bar{y}$ = mean value of y_i

$\bar{V}$ = mean value of yearly maximum wind velocity V_i

n = meteorological observation period (year)

σ_y = standard deviation of y_i

σ_v = standard deviation of yearly maximum wind velocity

Calculation of the return period wind velocity was made from 21 years of data ranging from 1954 to 1974, since data from 1987 dose not reflect actual maximum wind velocity as mentioned in the foot note of the table. Calculation results are summarized below.

$\bar{y}$ = 0.525224 $\bar{V}$ = 41.19048

σ_y = 1.069377 σ_v = 11.51789

T (year)	50	100	150	300	500
V (knots)	77.6	85.1	89.5	96.9	102.5
V (km/hr)	143.7	157.6	165.8	179.5	189.8
V (m/s)	39.9	43.8	46.1	49.9	52.7

The wind velocity data in the Appendix 6-5-4 is given in knots. The wind velocity of 50-year-return period at a height of 10 m from the ground is calculated as 143.7 km/hr or 39.9 m/s.

Other sources of data available in Solomon Islands are Henderson Airport, Auki, Munda, Taro Island, and Lata. Data has been obtained at three-hour intervals. The maximum wind velocities recorded at each location are as follows:

Henderson Airport	:	less than 50 km/hr in 1975 – 1985
Auki	:	less than 61 km/hr in 1962 – 1985
Munda	:	less than 61 km/hr in 1962 – 1986
Taro Island	:	less than 61 km/hr in 1975 – 1984
Lata	:	less than 74 km/hr in 1970 – 1984

These values are lower compared to data from the Vavaya Ridge. And also the wind velocity of 50-year return period at the northeast coast in Australia is 40 to 60 m/s or 144 to 216 km/hr, according to the "Rules for Minimum Loads on Structures, SAA Loading Code Part II, Wind Forces, AS 1170 Part II 1973".

Taking into account the above mentioned facts, JICA M/P Team proposed 40 m/s as maximum gust or 30 m/s as the maximum 10 minutes mean velocity, and these values were accepted by SIEA.

(3) Earthquake

The Solomon Islands lay along the boundary between the Indo-Australian Plate and the Pacific Plate, forming part of the so called Pacific Ring of Fire, and have experienced many earthquakes due to tectonic movements of the plates and volcanic eruptions. The geographical distribution of large earthquakes and the magnitude of them are shown in Appendix 6-6-5 and 6-6-6, respectively. Considering a 7.5 magnitude earthquake, horizontal load equal to 20% of the vertical load under everyday stress (EDS) conditions shall be taken into account as seismic condition for the design of transmission lines.

6.7 Law, Regulation and Standard

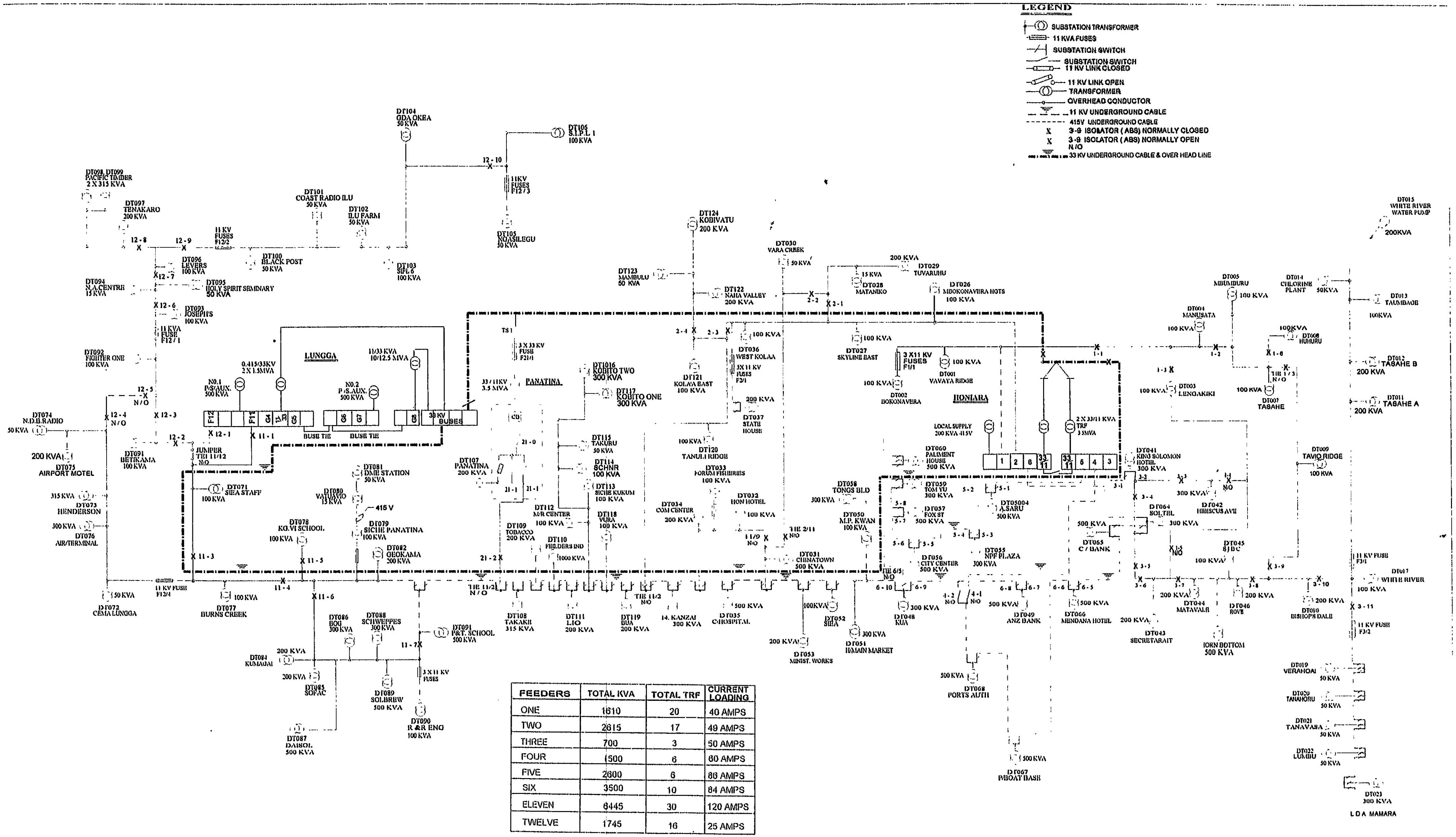
The design, manufacturing, construction, testing and operation of power systems shall conform to THE ELECTRICITY ACT 1982 (Authority of the Minister of Law), THE ELECTRICITY REGULATIONS 1993 (Minister of Natural Resources), Australian Standard AS 3000-1991 “Electrical installations-Buildings, structures and premises”, International Electrical Commission (IEC), Japanese Industrial Standards (JIS) and British Standards (BS).

6.8 Environmental Impact

From the environmental point of view, no remarkable impact has been observed for the construction of transmission and distribution lines. Since the scale of the facilities is not big, the impact to the animals and plants, soil erosion and negative influence to the social life will be small. And also historic spots and cultural heritages that will hinder from the construction of facilities have not been found along the route of the transmission lines. No serious problems will arise in the construction of transmission and distribution lines provided that the land acquisition or compensation to the land owner or village people is completed.

6.9 Diagram of Existing Power Stations

Diagrams of existing power system of Honiala and existing power stations of other locations are as shown in Fig.6-9-1 to Fig.6-9-8.



FEEDERS	TOTAL KVA	TOTAL TRF	CURRENT LOADING
ONE	1610	20	40 AMPS
TWO	2615	17	49 AMPS
THREE	700	3	50 AMPS
FOUR	1500	6	60 AMPS
FIVE	2600	6	86 AMPS
SIX	3500	10	84 AMPS
ELEVEN	6445	30	120 AMPS
TWELVE	1745	16	25 AMPS

Fig. 6-9-1 LUNGA – HONIARA NETWORK SYSTEM

SOLOMON ISLAND ELECTRICITY AUTHORITY

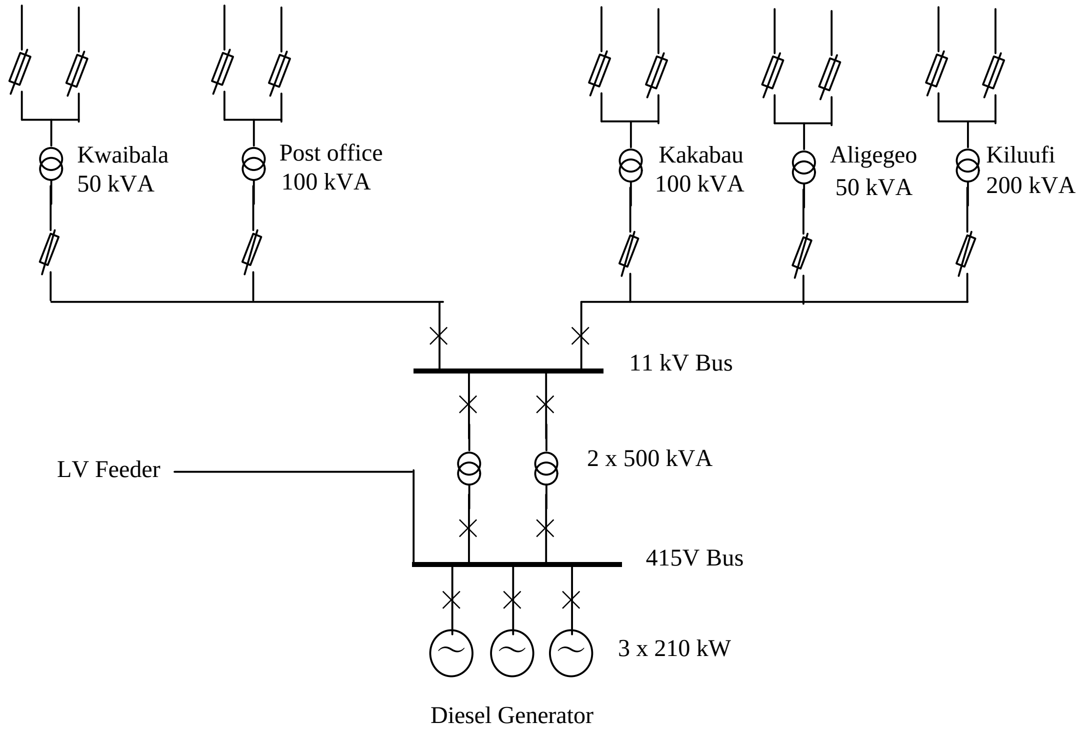


Fig. 6-9-2 AUKI POWER STATION

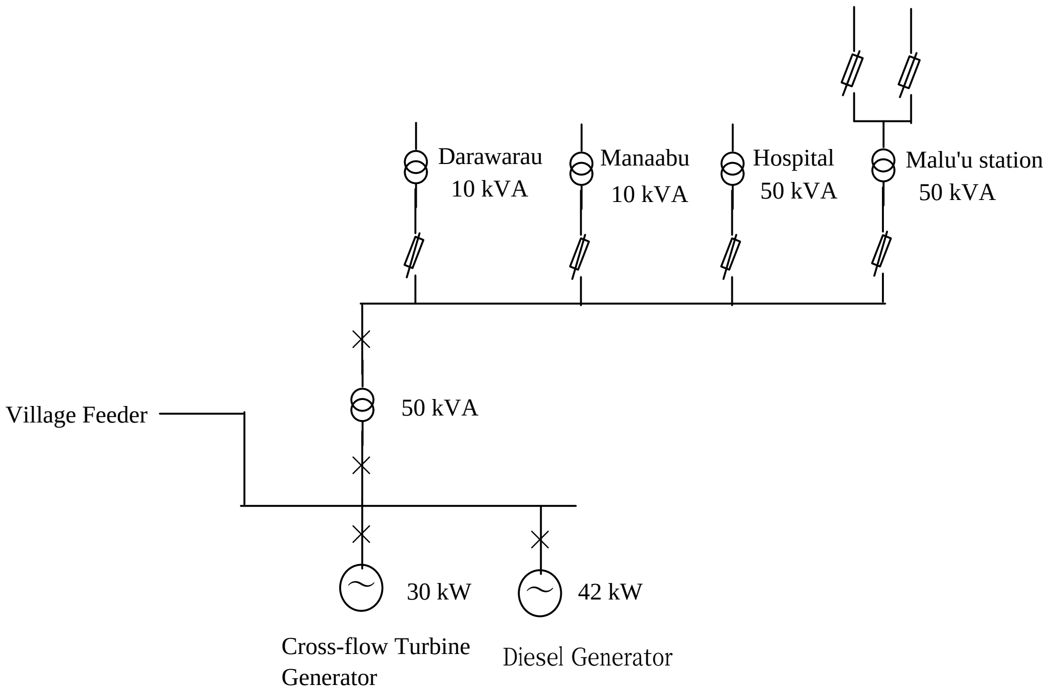


Fig. 6-9-3 MALU'U POWER STATION

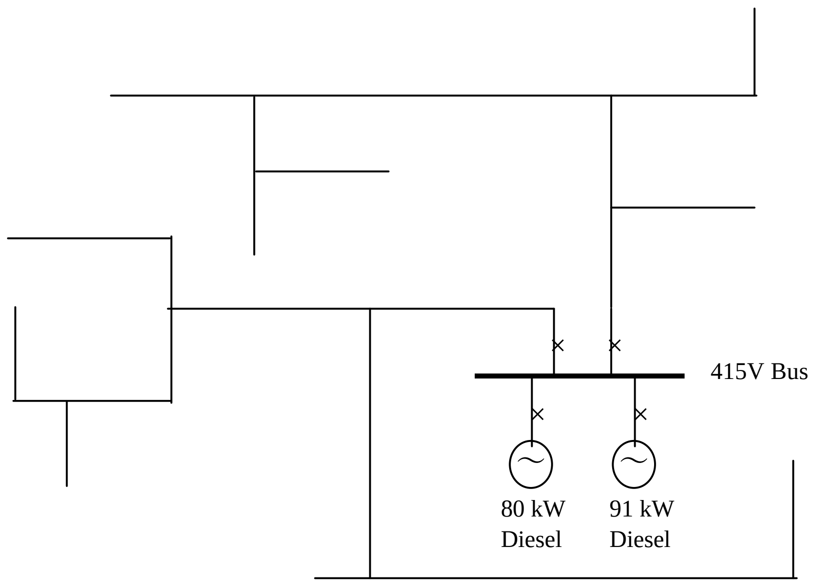


Fig. 6-9-4 KIRAKIRA POWER STATION

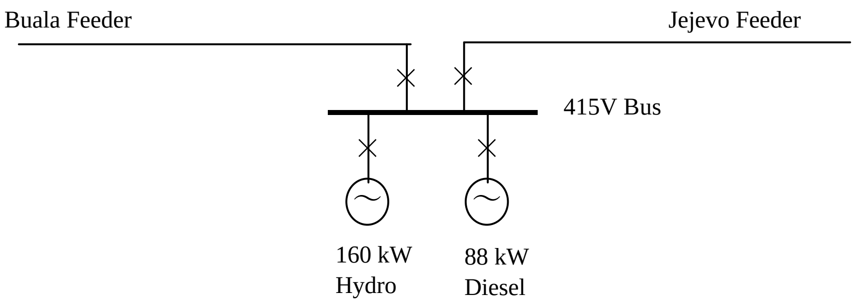


Fig. 6-9-5 BUALA POWER STATION

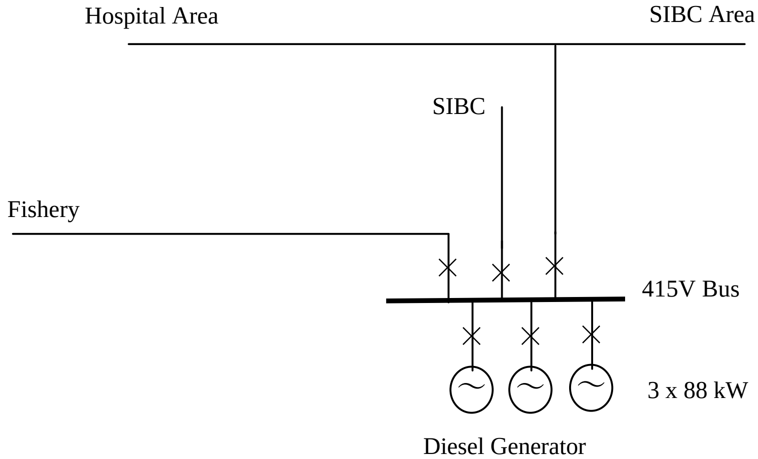


Fig. 6-9-6 LATA POWER STATION

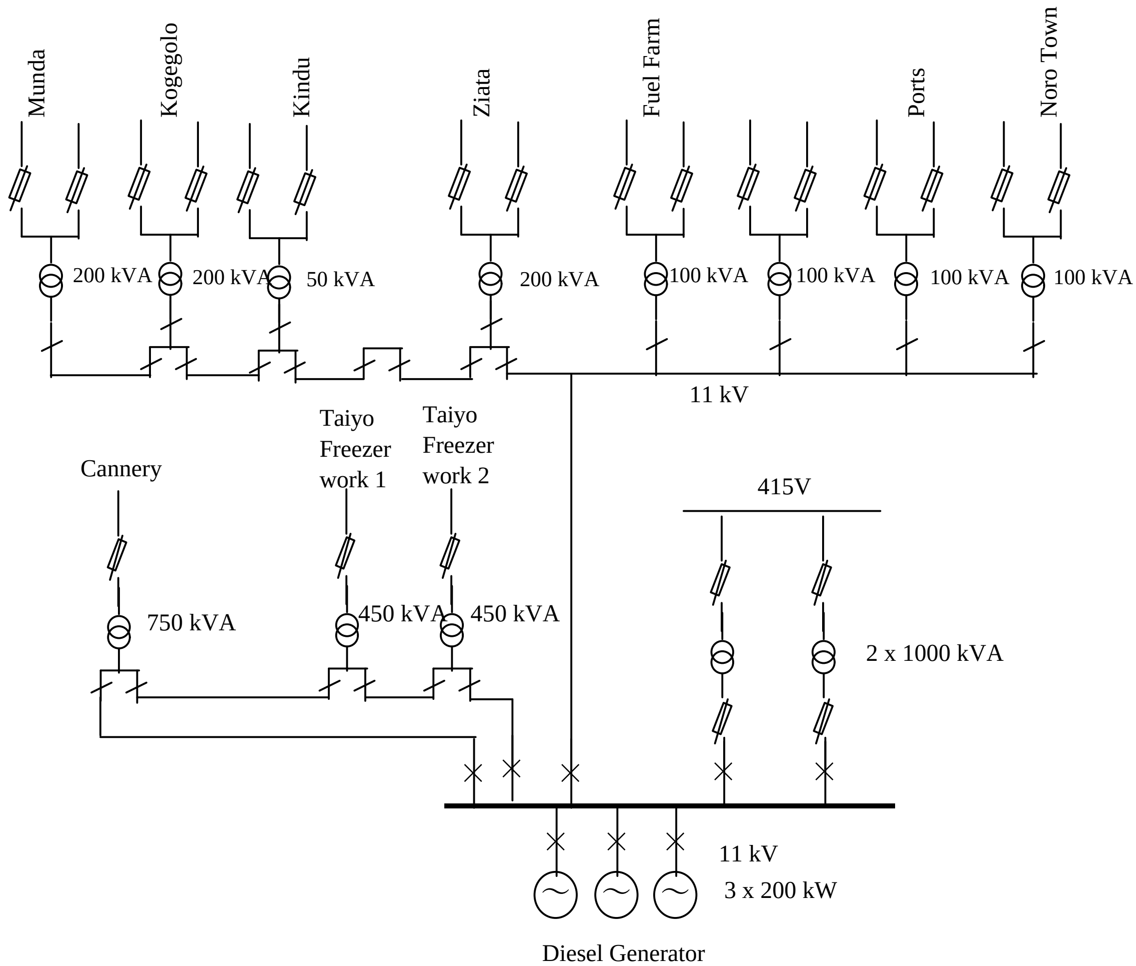


Fig. 6-9-7 NORO POWER STATION

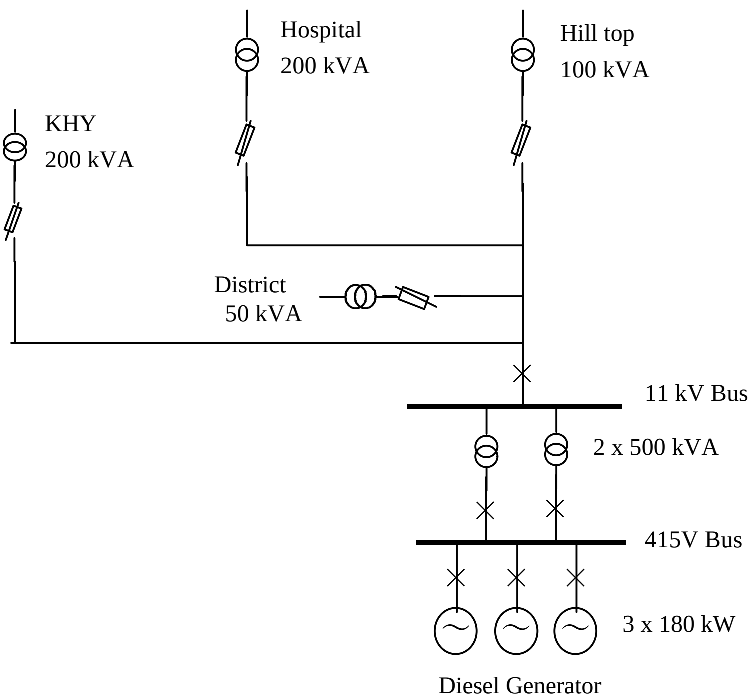


Fig. 6-9-8 GIZO POWER STATION