THE REPUBLIC OF THE UNION OF MYANMAR
THILAWA SEZ MANAGEMENT COMMITTEE

PREPARATORY STUDY ON THILAWA SPECIAL ECONOMIC ZONE INFRASTRUCTURE DEVELOPMENT IN THE REPUBLIC OF THE UNION OF MYANMAR

FINAL REPORT

MARCH 2014

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)
NIPPON KOEI CO., LTD.

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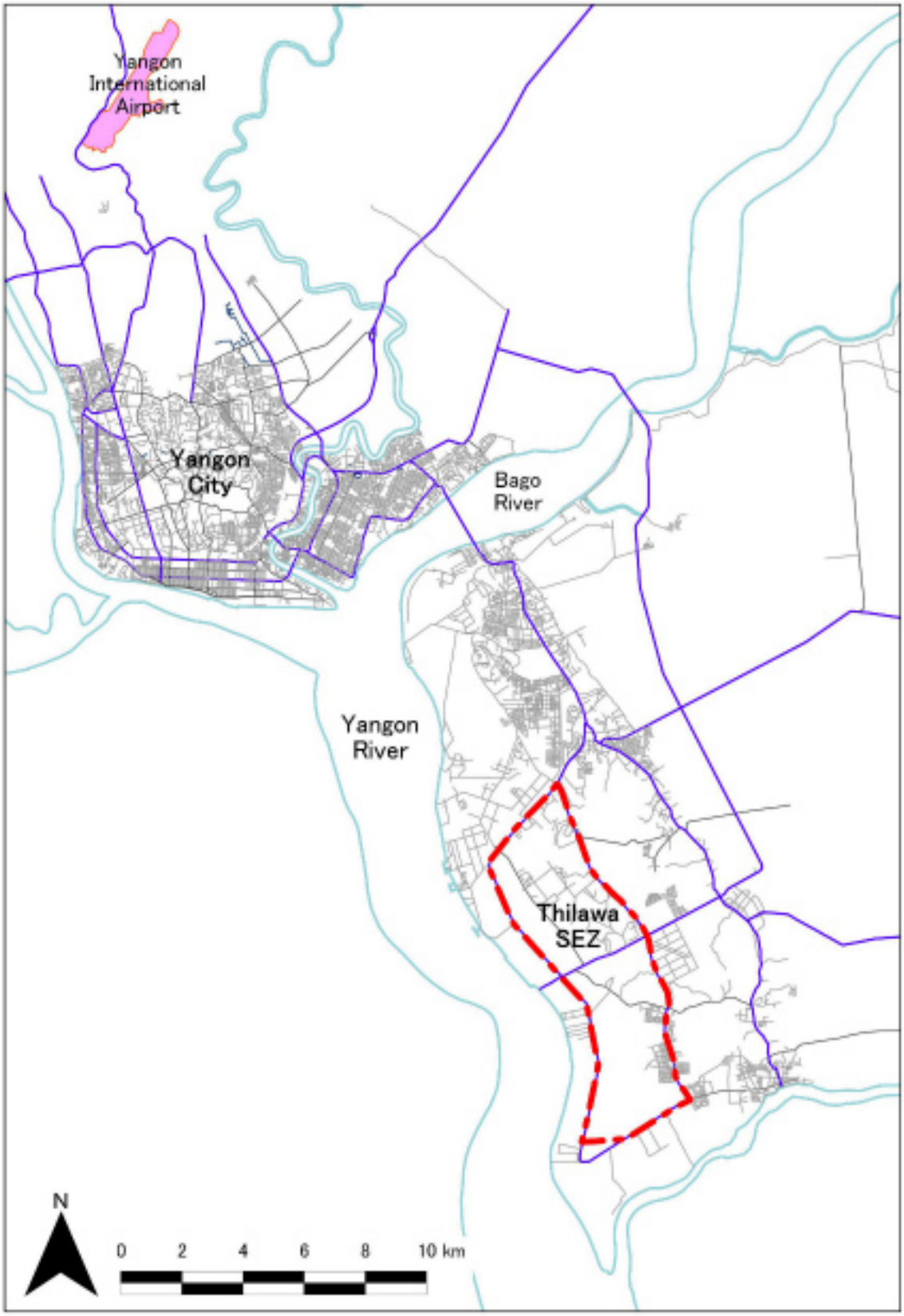
(2013.October)

Location Map



FINAL REPORT
Executive Summary

1. INTRODUCTION

1.1 Background of the Study

The Myanmar government places priority on foreign direct investment (FDI) in order to achieve economic development, especially in Thilawa, Dawei, and Kyaukphyu, which are being developed as special economic zones (SEZs). Under these circumstances, the Ministry of Economy, Trade and Industry (METI) of Japan started the METI Pre-Feasibility Study on the Thilawa SEZ Development (hereinafter referred to as "METI-FS") in March 2012. This preparatory study (hereinafter referred to as "the Study") has been started in preparation for a more detailed study on infrastructure development related to Thilawa SEZ.

1.2 Objective of the Study

The objective of the Study is to prepare a feasibility study (F/S) on the necessary infrastructure for the realization of Thilawa SEZ. The Study will review the demand, identify necessary projects, and recommend project details, including costs, implementation roadmap as well as environmental and social considerations.

1.3 Study Area

Thilawa SEZ is located beside the towns of Thanlyin and Kyauktan, about 20 km from the southeast side of Yangon City as shown in Figure 1.3.1. The Study covers Thilawa SEZ, which has an area of about 2,400 ha, and its surrounding area, but the focus is on the basic infrastructure that is required for the phase I development (tentatively 420ha).

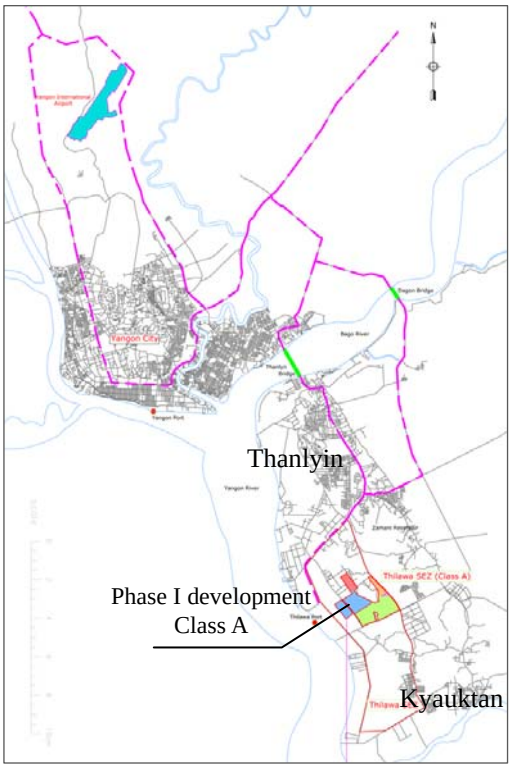


Figure 1.3.1 Study Area

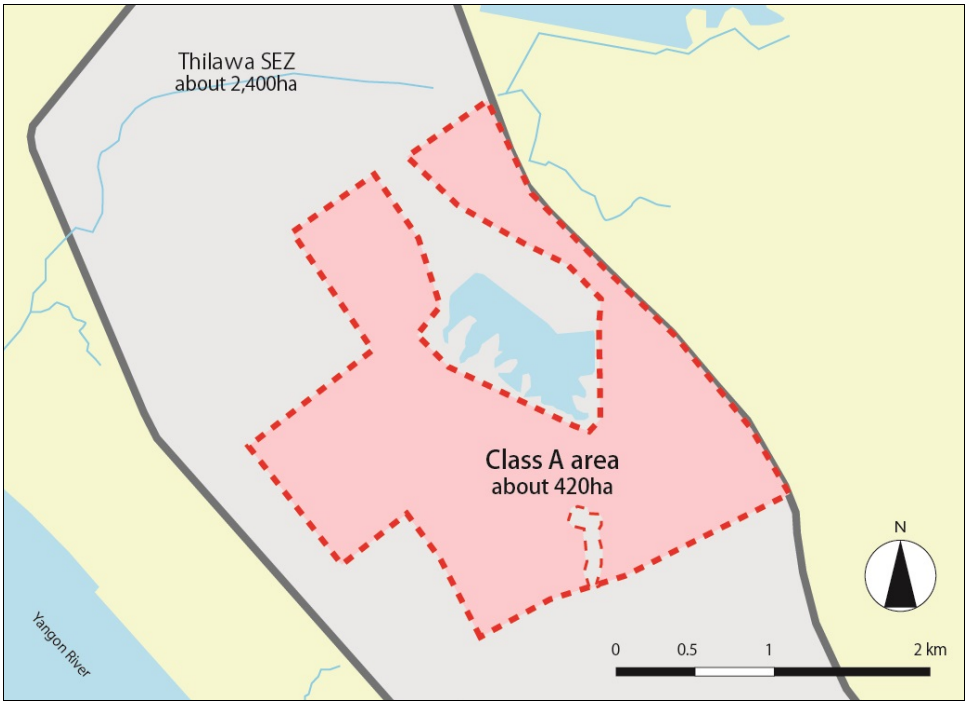
1.4 Related Studies

1) Project for Promoting Export of Infrastructure System (Study on the Possibility of Implementing Smart-Community in Myanmar) (METI-FS)
2) Feasibility Study for Thilawa Special Economic Zone (SEZ) Class A Development
3) The Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area (Phases 1, 2, and 3)

1.5 Summary of Class A Area

(1) Introduction of Class A Area

The layout of first phase development area (Class A, 420ha) is planned as shown in Figure 1.5.1. Since the location of Class A area is close to the main road and has an existing high ground elevation, which is easy for embankment, this area has been selected as the development priority area.



Source: JICA Study Team

Figure 1.5.1 Layout Plan of Class A Area

(2) Demand Forecast of Infrastructure in the Thilawa SEZ Area

According to METI-FS, when the Class A area (about 420 ha) starts operating, about 60,000 new workers will be entering the Thilawa area.

Demand forecast of infrastructure for Class A area (in year 2037 when industrial land is expected to be sold out) is shown below:

a. Electricity: 180 MVA/day
b. Water: 42,000 m^3/day
c. Sewerage : 29,400 m^3/day
d. Solid Waste : 930 t/day

2. REVIEW OF THE METI STUDY FOR THILAWA SEZ

2.1 Outline of the Study

(1) Land Use Plan

The land use plan of the SEZ is summarized in Table 2.1.1.

Table 2.1.1 Land Use Proposed by METI Study

Land Use	Area (ha)
1. Manufacturing Area	1,560 ha
2. Logistics Area	20 ha
3. IT Software and R&D Area	100 ha
4. Commercial Area	40 ha
5. International Wholesale Area	10 ha
6. Residential Area	220 ha
7. Healthcare and Hospital Area	10 ha
8. Education Area	5 ha
9. Open Space and Recreation Area	200 ha
10. Administration Area	5 ha
11. Infrastructure	230 ha
TOTAL	**2,400 ha**

Source: METI-FS

(2) Development Framework (for the Whole Thilawa SEZ Area)

- Labor : 208,000
- Residents: 156,000
- Water supply needs: 117,000 m^3/day
- Sewage: 82,000 m^3/day
- Solid waste: 3,300 t/day
- Power supply : 800 MW

2.2 Development Method

The scale of Thilawa SEZ 2,400ha is extremely large, and the infrastructure needs to be constructed in a phased manner based on the actual progress of development and its demands. Regarding to Thilawa SEZ development, huge investments would be required for new infrastructure development due to a significant shortage of existing infrastructure supply. Public-private partnership would be essential since this budget would be difficult to be covered only by public sector.

3. PRESENT CONDITION AND DESIGN OF THILAWA SEZ-RELATED INFRASTRUTURE

3.1 Natural Conditions and Embankment Plan

(1) Natural Conditions

1) Geological Survey

a. Geological survey in the Thilawa SEZ Area

A geological survey for the project was conducted for two months, from 8th October 2012 to 7th December 2012. The results of the survey are provided in Table 3.1.1.

Table 3.1.1 Summary of the Geological Survey (Thilawa SEZ)

Survey Point	North and Surrounding Areas of Class A	South Area of Class A
Feature	The ground surface from the ground level (GL) to 10 m is composed of stiff clayey soil, which have N-values of 8 to 30. Depth of more than 10 m from GL, the composition of sand or silty sand is spread.	The ground surface from GL to 15 m is composed of soft clayey soil which has N-values of less than 4. This includes composition of soft ground and needs improvement to prevent land subsidence. Depth of more than 15 m from GL, the composition of sand or silty sand is spread.
Judgment	It may not be necessary to develop foundation for building factories.	It may be necessary to improve foundation or soil stabilization.

Source: JICA Study Team

b. Geological Survey of Access Road

Geological survey for the project was conducted for one month, from 22nd August 2013 to 27th September 2013. The results of the survey are provided in Table 3.1.2.

Table 3.1.2 Summary of the Geological Survey (Access Road)

Survey Point	North and Surrounding Area of Class A	South Area of Class A
Feature	From the ground level (GL) to 7 m is composed of coarse sand, which has N-values of 11 to 30. From GL to 7 m-15 m, medium layer is composed of medium density sand. Depth of more than 15 m from GL, high density sand is spread.	From GL to 17 m is composed of clayey soil where N-value ranges from 13-23. Depth of more than 16 m from GL, the composition of silt sand is spread.
Judgment	Soft ground which causes settlement does not exist.	

Source: JICA Study Team

2) Topographic Survey

The area with the lowest elevation is located on the northwest side wherein a creek crossing from east to west of the SEZ. The elevation of the land along the creek is 2.5~3.0 m, which is

less than 1 m higher than the elevation of the creek. On the other hand, the elevation around Thilawa Rreservoir is the highest throughout the whole area. The elevation is about 8.5 m higher than the lowest point. In general, the topography of the area has an incline that is sloping gently down from north to south and from east to west. The elevation of the creek mentioned above is about 2.0 m and it does not change throughout the east and west sides. The east landside of the area has rough undulations within 5.5~10.5 m of the elevation. There is almost no undulation along the central road, which stretches from west to east of the flat plain.

3) Borehole Development Survey

8 wells were selected as Test Well (TW) from 10 surveyed points and TW-6, TW-7A, TW-7B and TW-10 were selected as Production Well (PW). Water production test were carried out in these Production Wells (PW1=TW-7A, PW-2=TW-10, PW-3=TW-7B ,PW4=TW6).
The following issues are recommended for operation of the four tube wells:

a. PW2/TW-10 and PW3/TW-7B are useful for industrial and domestic purposes in terms of water quality.

b. PW1/TW-7A and PW4/TW-6 are useful only for industrial purposes due to the high values of EC and total dissolved solids (TDS).

c. To avoid drying up of the wells, the pump operation pattern is recommended as follows: 6 hr operation and 2 hr standby (three shifts per day).

d. The total water production of the four wells was estimated at 3,000 m^3/d. Combined production of PW2/TW-10 and PW3/TW-7B was estimated at 1,360 m^3/d. The production values are indicated in Table 3.1.3.

Table 3.1.3 Pump Operation Pattern and Production

Tube Well No.	Pumping Ratio (L/s)	Daily Pump Operation Pattern			Production (m^3/d)
		On (hr)	Off (hr)	Shift (times)	
PW1/TW-7A	20	6	2	3	1,296
PW4/TW-6	6	6	2	3	389
				Subtotal	1,685
PW2/TW-10	6	6	2	3	389
PW3/TW-7B	15	6	2	3	972
				Subtotal	1,361
				Total	3,046

Source: JICA Study Team

4) Flooding Survey

Flooding experience hearing survey was conducted from 17th to 20th September 2012. The results of the survey are shown as following:

a. 35% of respondents experienced flood, and 65% of them had no flooding experience.

b. Among the respondents, 10% of them experienced every year, 2% of them experienced every 6~10 years, flooding about 30 minutes. Remaining 88% of them experience flood once only in the past.

c. Among these respondents who experienced flood once only, 46% of them had duration of flood below one day, 26% of them had duration of flood between 1-3 days, and 28% had more than 3 days.

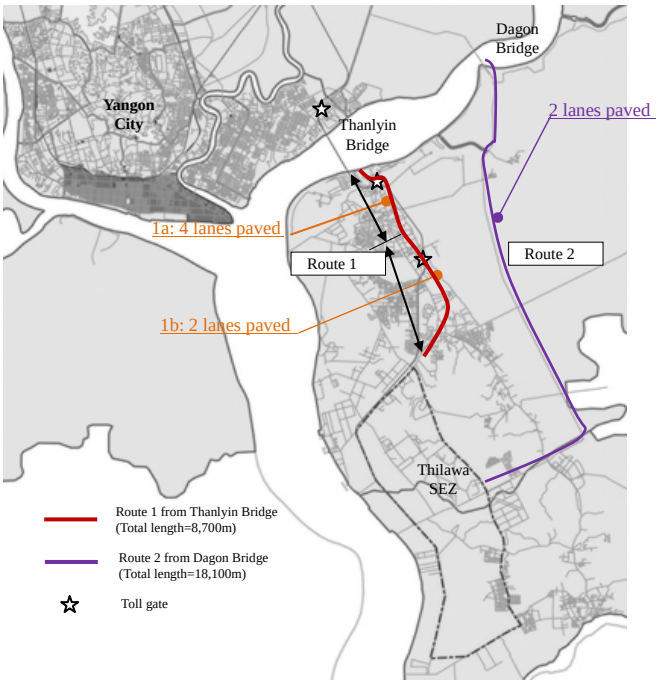
d. it is confirmed that flood occurred every year at the existing creek and several part inside the SEZ site.

In the development planning stage, ground levels need to be set high and drainage systems need to be improved. The installation of embankments, pump stations, and gates are also desired in the areas with high probabilities of flooding.

3.2 Present Conditions of the Road Network

(1) Present Conditions of the Access Road Network to Thilawa SEZ

1) Road network



Source: JICA Study Team

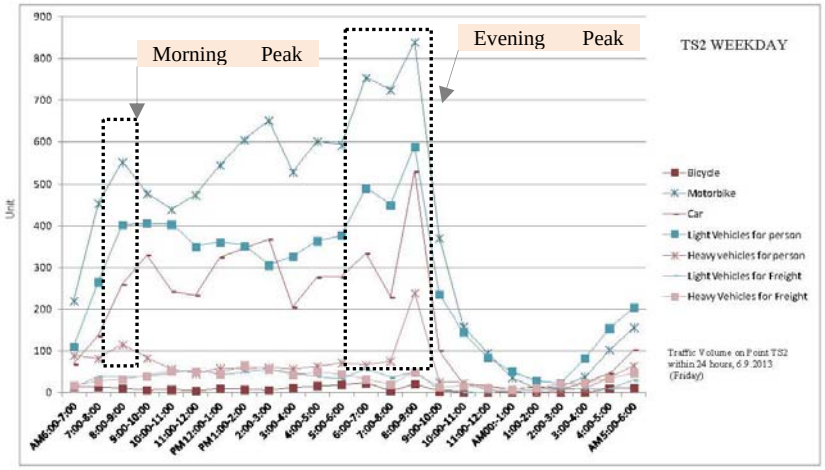
Figure 3.2.1 Present Conditions of the Road Network to Thilawa SEZ

There are two ways of accessing Thilawa SEZ from Yangon City. The first is the route that passes through Thanlyin Bridge (Route 1: 8,700 m), and the second is the route that passes through Dagon Bridge (Route 2: 18,100 m). Route 1 is mainly used for commuters between Yangon and Thanlyin area. This is because the length of the route is short and heavy vehicles

are not able to pass through the route due to a weight limitation (weight of vehicle more than 20t are forbidden to pass through Route 1). Route 2 is used for cargo transportation.

The traffic volume is concentrated from 8:00 to 9:00, and the peak time period in the afternoon is concentrated from 20:00 to 21:00. Traffic volume in both time periods exceeds 1,000 pcu/hour.

Even in present situation, there is certain level of traffic volume from Thanlyin to Thilawa. Buses, trucks and motorbikes pass through the road, and overtaking occurs frequently. When the traffic volume increased, if the road situation remains the same as current condition, it can be predicted that accident will increase.



Source: JICA Study Team

Figure 3.2.2 Traffic Volume Survey Data on Route 1 (Center of Thanlyin Access Road)

2) Existing Infrastructure Survey

a. Power Distribution System

The Yangon City Electricity Supply Board (YESB) manages power distribution systems to the Yangon area, including Thilawa and Thanlyin. Currently, the overhead power distribution systems along the road from Thanlyin Bridge to Thilawa SEZ supply primarily from the 230/33 kV-100 MVA Thanlyin Main Substation and Ba Yar Gone Substation through overhead lines.

b. Street Lighting and Traffic Signal System

The existing streetlights are installed along the road near Thanlyin Bridge, and made of around 30 lamps (sodium type) at 10 m high concrete poles.

c. Existing Telecommunications System

The Yangon Division Office under Myanmar Post and Telecommunications (MPT) manages telecommunications systems to Thanlyin and Kyauktan. There are two types of telecommunications cables from Thanlyin Exchange Station (underground and overhead).

Underground copper cables are buried at the depth of 0.6m and at about 1m distance from existing houses. For overhead telecommunication cables, both optic fiber and copper cables are used.

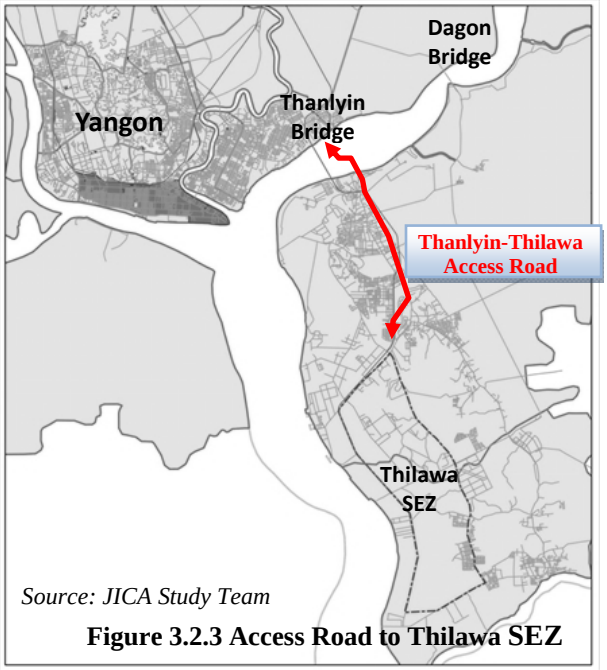
(2) Necessary priority project for access road

The traffic volume from Thanlyin Bridge to Thilawa SEZ will increase around 2 times more than the current traffic volume after full development of Thilawa SEZ (after 2040); therefore, traffic jam during rush time and the safety of people using transportation (pedestrian, bicycle, motorbike) shall be considered. Because motorbike use is not prohibited in Thilawa area, along with recent economic growth, the number of motorbike users has been increasing rapidly, and traffic accidents have been a serious concern.

With the above mentioned reasons, the study proposes to expand the road from Thanlyin Bridge to Thilawa SEZ not only to improve driving comfort but also to ensure safe transportation of people, and environmental protection by reducing traffic congestions (CO_2 emission).

(3) Basic Concept

The design standard is based on Japanese road design regulations (by Japan Road Association). Thilawa SEZ access road is the main road which will connect Yangon City and Thilawa SEZ. Therefore, based on evaluation of development condition of the existing road conditions and prediction of the increase of future traffic volume, appropriate function and road width shall be designed. Expansion plan shall maximum use the existing road, and make sure the new road alignment should be located inside the MOC-ROW. Land acquisition shall be avoided.



Source: JICA Study Team

Figure 3.2.3 Access Road to Thilawa SEZ

(4) Outline of Road Plan

Outline of the road is summarized in Table 3.2.1.

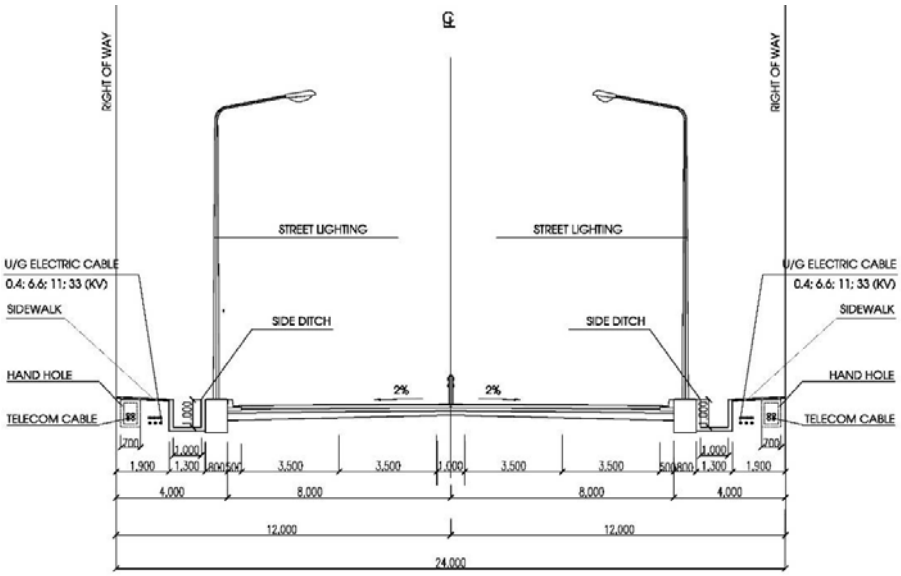
Table 3.2.1 Summary of Road

Length	Number of Additional Lanes	Width of Lanes	Width of Median	Sidewalk	ROW	Paved Material
8,700 m	2 lanes each	16 m	1 m	4 m (both sides)	24.0 m*	Asphalt

Note: ROW = Right-of-way
**Note: In order to avoid the existing structure, part of ROW is set at 22 m.*
Source: JICA Study Team

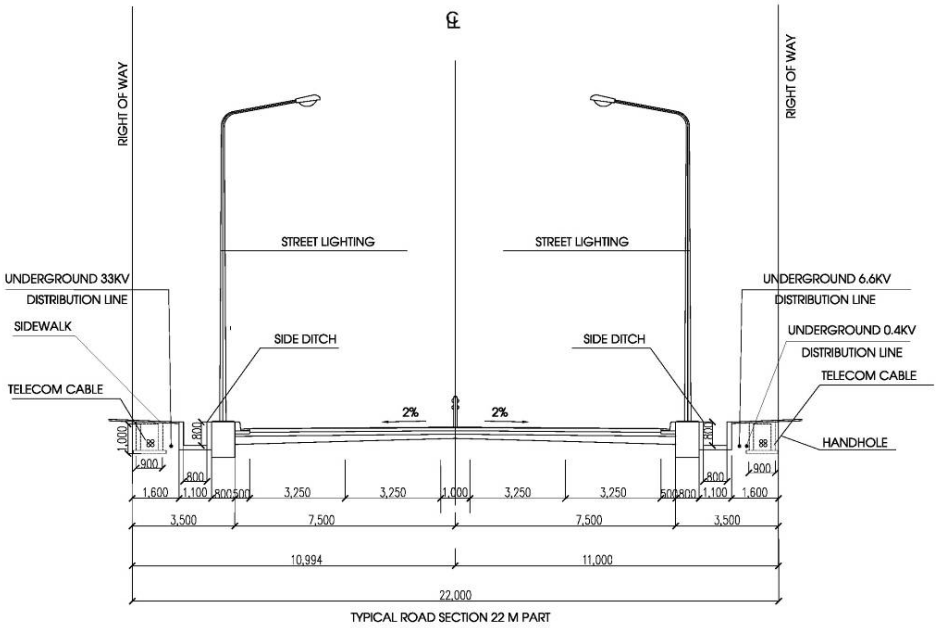
Typical road cross section has been designed based on the following conditions:

a. Required space for the necessary infrastructure is considered (side ditch, streetlight/traffic signal, power supply and telecommunications cable).
b. Referring to the results of traffic volume estimation, smooth traffic for commuters with different transportation means and sidewalk for pedestrian are considered during cross section design.



Source: JICA Study Team

Figure 3.2.3 Typical Cross Section (24 m)

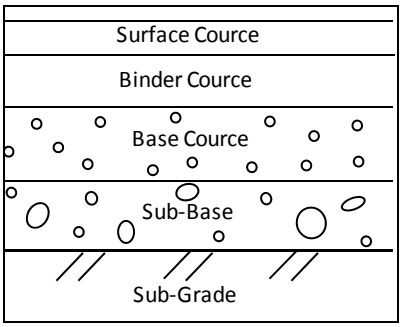


Source: JICA Study Team

Figure 3.2.4 Typical Cross Section (22 m)

3) Pavement Design

Pavement structures were designed in accordance with Figure 3.2.5 and Table 3.2.2 below.



Source: JICA Study Team

Figure 3.2.5 Pavement Design

Table 3.2.2 Proposed Asphalt Pavement

	Structure of Asphalt Pavement	**Conversion Factor***	**TA value**
Asphalt course	5 cm	1.00	5
Binder course	7 cm	1.00	7
Base course	20 cm	0.35	7
Sub-course	30 cm	0.25	7.5
		Total	26.5 >25.4cm

Source: JICA Study Team

3.3 Present Conditions of Power Supply System

3.3.1 Present Conditions

(1) Myanmar Power Supply Status

1) Myanmar Power Demand

The peak power demand in Myanmar was estimated at approximately 1,850 MW by MEPE. Meanwhile, actual generation was recorded at 1,622 MW during peak time on 24 September 2012 (wet season). Accordingly, the shortage of electricity supply in the whole of Myanmar was assumed at around 230 MW in September 2012. Besides, the generation of hydropower stations during the dry season is extremely lower than during the wet season. The shortage of electricity may further increase to about 400 MW, depending on reservoir operations of hydropower stations in the northern and central parts of Myanmar. Insufficient power supply of 230 MW-400 MW at peak time is a critical problem of unstable and low quality of power supply in Myanmar.

2) Power Generation in Myanmar

The total installed capacity in Myanmar was estimated at 3,421 MW as of March 2012. However, the available generation capacity is estimated to have been reduced to about 46% of the installed capacity due to inefficiency brought about by aging generation facilities, decrease in water sources for hydroelectric power generation and shortage of gas supply.

3) Transmission Line Network in Thanlyin and Thilawa Area

Existing transmission lines near Thanlyin area, as shown in Table 3.3.1 below.

Table 3.3.1 Existing Power Transmission Lines Connected to Thanlyin Substation

Section	No. of Circuit	Voltage	Line Length	Conductor Size (Single Phase)	Capacity (1 Circuit)
Thanlyin to Thaketa	1 (2)*	230 kV	Approx. 10 km	ACSR765MCM (400 mm^2) x2	500 MVA
Thanlyin to Kamarnat	1	230 kV	Approx. 98 km	ACSR765MCM (400 mm^2) x2	500 MVA

**Note Thanlyin – Thaketa: Conductors for two circuits are installed already, but only one circuit is used at the moment.*
Source: JICA Study Team

The technical specifications of these three substations (Thanlyin Substation, Thaketa Substation and Kamarnat Substation) are summarized in Table 3.2.2.

Table 3.3.2 Grid Substations near Thilawa

Substation	No. of 230 kV Feeder Bay	Substation Voltage	230 kV Transformer Capacity
Thanlyin Substation	2	230/33/11 kV	100 MVA (100 MVA x 1 unit)
Thaketa Substation	2	230/33/11 kV	300 MVA (100 MVA x 3 units)
Kamarrnat Substation	5	230/33/11 kV	100 MVA (100 MVA x 1 unit)

Source: JICA Study Team

4) Fuel Supply Condition for the Yangon Region

a. Natural Gas Supply

More than 1,000 million standard cubic feet per day (1,000 MMSCFD) of natural gas was exported to Thailand in 2011-2012, accounting for nearly 80% of the total supply. Meanwhile, 270 MMSCFD was supplied to domestic users in the same year. Among domestic consumption of natural gas, 157 MMSCFD (58%) are being used for electricity generation.

b. Diesel Oil (alternative fuel for Gas turbine)

Diesel oil is mostly imported from foreign countries for domestic market supply. Diesel oil, which is normally used for diesel generators in Myanmar, can be used for gas turbine generators when natural gas is not available.

(2) Necessary Priority Project for Power Supply

In recent years, the urban development of Yangon is rapidly moving forward and a higher demand for electricity has been observed as more people use air conditioning and personal computers. On the other hand, the expansion or maintenance of facilities for supplying electricity is not keeping pace with the pace of demand.

Under such conditions, a stable power supply to Thilawa SEZ is expected to be difficult. Power situation in Thilawa SEZ area is already poor and it may be worsen in later years. Moreover, the migrant workers resulting from SEZ development may put additional strain on the existing infrastructure in the surrounding communities by creating higher demand.

Due to the above reasons, for convenience and also for safety reasons (supply of lights during nighttime), power supply development is listed as a priority public project.

(3) Basic Concept

The proposed design standards for the power supply system within the area are as follows:

a. To apply the following regulations and standards:

- Basic Master Plan for Thilawa August 2012, Ministry of Economy, Trade and Industry of Japan
- International Electrotechnical Commission (IEC)
- Environmental Conservation Law, July 2012, the Republic of the Union of Myanmar

- Ministry of Electric Power (MOEP) Regulation
- Yangon City Electric Supply Board (YESB) Technical Standards
- Japanese Industrial Standards (JIS)
- Other local electrical rules and regulations

b. To consider the reliable power supply without any power interruption,

c. To take adequate measures in line with the local conditions so as to conserve the landscape and water environment, and protect the site from natural disaster such as floods,

d. To extend the power supply facilities, step by step, (such as substations and power plants) in accordance with the power demand forecast of SEZ, and

e. To use the Myanmar Electric Power Enterprise's (MEPE's) national grid to secure the stable power supply in the future.

(4) Outline of Power Supply System Plan

According to METI-FS, electric power load after all tenants in the whole SEZ area (2,400ha) starts operation is estimated to be grown to 800 MVA. The development scenario of power supply facilities for Thilawa is proposed as followings. Stage 1 and Stage 2 will be developed with priority as the development plan of power supply facilities for the Thilawa area.

Stage1: Supply of 20 MW through 33 kV double circuit distribution line from Thanlyin Substation

- 33kV double circuit distribution line
- Modification of Thanlyin Substation: 33 kV switch bay for cconnection of 33 kV distribution line
- Construction of 33 kV bus and switchgear in Thilawa Substation

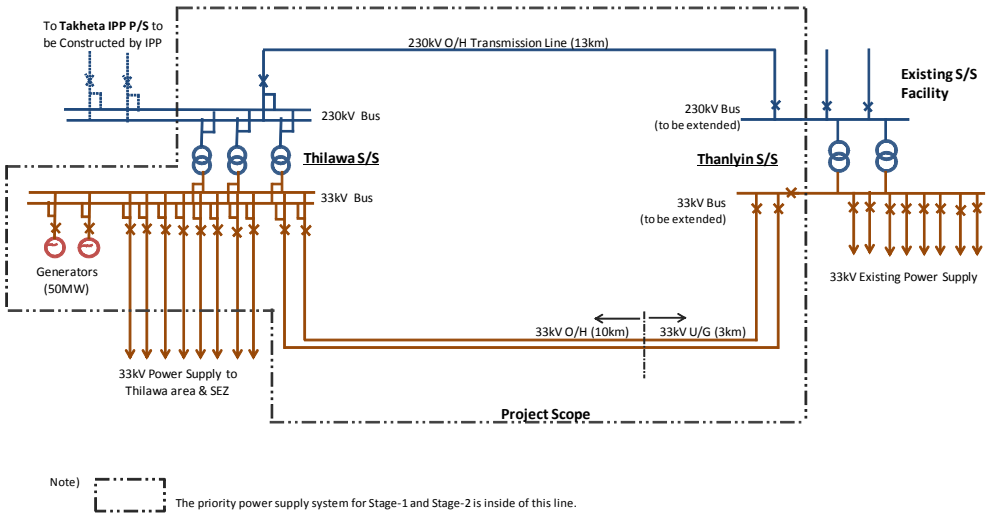
Stage2: Supply of 50 MW generated by dual fuel generators

- 50 MW dual fuel generators
- 230 kV transmission line from Thilawa Substation to Thanlyin Substation
- Thilawa 230/33 kV substation
- Modification of 230 kV switchyard for connection of 230 kV transmission line in Thanlyin Substation

Stage3: Supply of another 168 MW from Thaketa IPP

Stage4: Supply of more than 218 MW from the national gird

The priority power supply system plan for Thilawa is illustrated in Figure 3.3.1.



Source: JICA Study Team

Figure 3.3.1 Summary of Priority Power Supply System (for Stage1 and Stage 2)

3.4 Environmental and Social Considerations

(1) Issues on Environmental and Social Considerations for Power Supply Facilities Upgrading Project

As of July 2013, environmental impact aassessment (EIA) is not required because an EIA law does not exist in Myanmar. On the other hand, as the Ministry of Environmental Conservation and Forestry (MOECF) is drafting the EIA procedure as a kind of EIA regulation in Myanmar, an official EIA process may be required when the EIA procedure is issued earlier than the detailed design stage. However, the necessity of submitting the required documents in accordance with the EIA procedure will be judged by MOECF. Therefore, it is better for MEPE (Project Proponent) to confirm with MOECF about the necessity of undergoing the EIA procedure at the time of defining the specifications of the transmission line and substation during the detailed design stage.

It is desirable to implement detailed investigation on the following elements which may cause environmental impacts to the project at the time of defining the specifications of the transmission line, power plant and substation in the detailed design stage:

- Impact assessment on air quality, noise, and water quality, mitigation, and development of more detailed monitoring plan

(2) Summary of Stakeholder Meeting for the Road Expansion Project

The stakeholders meeting was held on 22nd September 2013 at the Department of Construction Office in Thanlyin Township. In addition with the aforementioned 12 vendors, MOC also invited representatives from concerned wards and villages, as well as representatives of

Thanlyin Township. In the meeting, MOC and local consultant of the JICA Study Team explained not only social considerations on relocation and reassembly but also the results of baseline survey, expected mitigation measures, and monitoring plan as shown below:

a. Introduction of the project outline (project description, results of the baseline survey, expected mitigation measures, monitoring plan, etc.),
b. Explanation of support (relocation and ressembling) by MOC, and
c. Feedback from project-affected households (PAHs) and representatives from concerned wards and villages.

As a results of the meeting, representative from Township and villages presented their positive feedback to the project, and offered to cooperate with the Project to MOC during construction.

4. MEASURES TO ACCELERATE PROJECT IMPLEMENTATION

4.1 Major Premises for Project Implementation

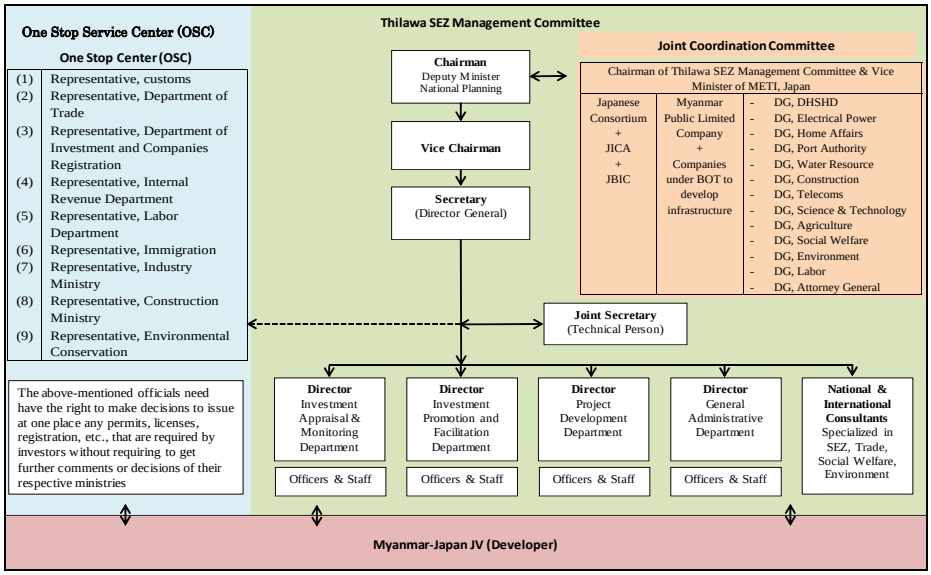
a. Based on the memorandum between Government of Japan (GOJ) and Government of Myanmar (GOM), development of on-site infrastructure and facilities inside SEZ is expected to be implemented by Japan-Myanmar joint venture (JV) as a zone developer of Thilawa SEZ.

b. Development of supporting off-site infrastructure outside SEZ is assumed to be implemented by Myanmar government as public works.

c. Commercial operations of Thilawa SEZ will commence in 2015.

4.2 Organization Structure of Thilawa SEZ Development Project

The organizational structure should have the following four key components: Thilawa SEZ Management Committee, Joint Coordination Committee, Myanmar-Japan JV (Developer), and One-stop Service Center (OSC).



Source: Thilawa SEZ Management Committee

Figure 4.2.1 Organization Structure of Thilawa SEZ Development Project

4.3 Institutional Measures

(1) Policy and Legal System for Investment Promotion

Industrial Policy: The industrial policy of Myanmar has been drafted by the Industrial Development Committee (IDC) chaired by the Union Minister under the Office of the President,

although the policy has not been finalized and disclosed yet.

Revised Law on Foreign Investment: An amendment to the Foreign Investment Law was issued on 2 November 2012.

Revised Law on Special Economic Zone: The Law on Special Economic Zone is the legal basis for the development of Thilawa SEZ as well as of other SEZs. The Revised Law on Special Economic Zone has been drafted but amendments are still required. The draft should preferably be examined from the viewpoint of investors so as to make the law practical. The revised law needs to be finalized and promulgated as soon as possible. (The law was issued in January 2014)

(2) Institutional Measures to Accelerate the Project

Investment Promotion Activity: It is necessary to organize various business seminars and missions in Myanmar in order to introduce the business climate and investment opportunities to Japanese investors in cooperation with GOM, Japanese government-related organizations such as the Japan External Trade Organization (JETRO), ASEAN Japan Center (AJC), and the Organization for Small and Medium Enterprises and Regional Innovation of Japan (SME Support of Japan).

One-Stop Service Center: One-Stop Service Center (OSC) is required to be established inside SEZ in order to have efficient and smooth process in issuing permits, licenses, and registration.

Improvement of Worker Quality: Public vocational training schools are recommended to be established inside Thilawa SEZ, with the participation of foreign investors, in order to develop a practical training program which can provide system of employment promotion for neighborhood residents and priority employment for graduates of the schools.

4.4 Project Implementation Structure for Priority Infrastructure Development

(1) Priority Infrastructure Development Projects

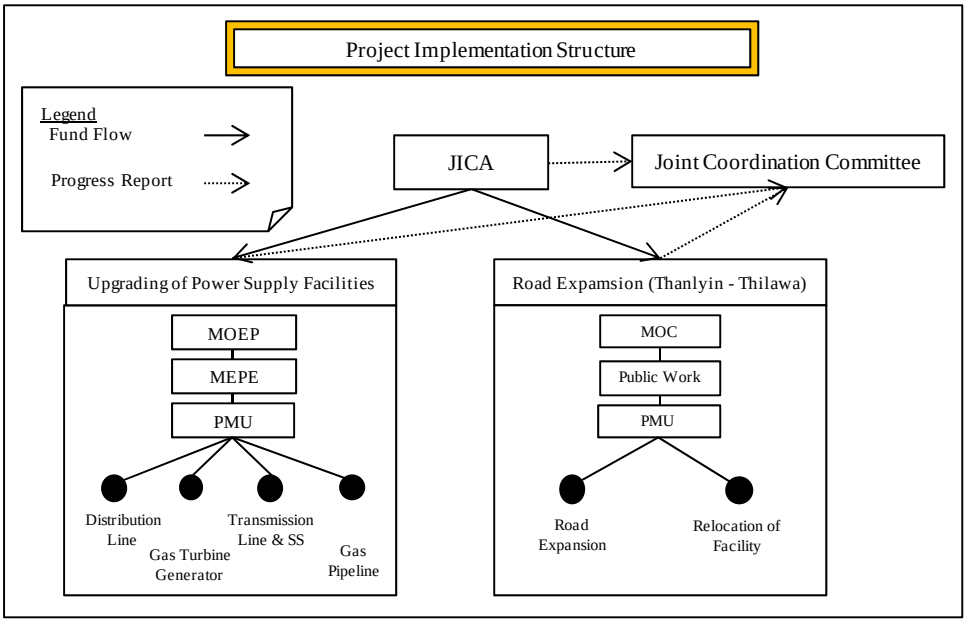
The following supporting infrastructure projects are proposed to be implemented under public works:

1. Power Supply Facilities Upgrading Project
2. Road Expansion Project between Thanlyin Bridge and Thilawa SEZ

(2) Proposed Project Implementation Structure

The priority projects for power supply and road expansion will be implemented on a sector-by-sector basis as shown in Figure 4.4.1. The progress of project implementation would

be reported to the Joint Coordination Committee by JICA and the executing agencies of individual sectors.



Source: JICA Study Team

Figure 4.4.1 Proposed Project Implementation Structure

(3) Proposed Establishment of PMU

In order to assistance project implementation, PMU are proposed to be set up with the function as following: Planning, Management of preparation for project implementation, Bidding and contract management, Financial and asset management, and disbursement, Administration, information provision, and coordination, Monitoring, evaluation, and reporting of project implementation, Handover and financial settlement of projects.

4.5 Proposed Organization for Priority Projects

(1) Power Supply Facilities Upgrading Project

Executing Agency: Ministry of Electric Power (MOEP)

Project Objective: The project aims to improve and upgrade the existing power supply facilities by installing 33 kV distribution lines between Thanlyin and Thilawa, new gas turbine generators, a transmission line for Thilawa Substation, and gas pipeline in order to achieve stable power supply to Thilawa.

Organization for Project Implementation: In implementing the project, a PMU is expected to be set up under the Yangon Electricity Supply Board (YESB).

Organization for O&M: Organization including 63 staff for power supply facilities and 23 staff for Thilawa SEZ substation are proposed for O&M. MOEP will hand over the completed gas

pipeline for gas turbine generator to the Myanma Oil and Gas Enterprise (MOGE), which is under the Ministry of Energy (MOE), for operation.

(2) The PMU for the Thanlyin-Thilawa Road Expansion Project

Executing Agency: Ministry of Construction (MOC)

Project Objective :The project is aimed at expanding the road between Thanlyin Bridge and Thilawa SEZ. The project is also aimed at relocating facilities along the road so as to improve transportation between Yangon and Thilawa SEZ.

Organization for Project Implementation: For implementing the project, a PMU is expected to be set up at MOC which includes at least10 staff..

Organization for O&M: After completing the road construction, MOC will be responsible for the O&M of the expanded road. Meanwhile, MOC will hand over the relocated facilities to the original organization in charge so that they can carry out the O&M of the facilities

PREPARATORY STUDY
ON
THILAWA SPECIAL ECONOMIC ZONE
INFRASTRUCTURE DEVELOPMENT
IN
REPUBLIC OF THE UNION OF MYANMAR

FINAL REPORT

LOCATION MAP

EXECUTIVE SUMMARY

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Abbreviation

AMSL	Above Mean Sea Level	MOC	Ministry of Construction
BOD	Biochemical Oxygen Demand	MOECF	Ministry of Environment Conservation and Forestry
CDMA	Code Division Multiple Access	MOEP	Ministry of Electric Power
DAWF	Daily Average Water flow	MOGE	Myanma Oil and Gas Enterprise
DHSHD	Department of Human Settlement and Housing Development	MONRE	Ministry of Natural Resource and Environment
DMH	Department of Meteorology & Hydrology	MITT	Myanmar International Terminals Thilawa
DMWF	Daily Maximum Water flow	MPA	Myanmar Port Authority
EPD	Energy Planning Department	MPPE	Myanmar Petroleum Products Enterprise
FDI	Foreign Direct Investment	MPT	Myanmar Posts and Telecommunications
FTTB	Fiber-to-the-Building	MPTA	Myanmar Petroleum Trade Association
FTTC	Fiber-to-the-Curb/Cabinet	NGN	Next Generation Network
FTTH	Fiber-to-the-Home	PCCD	The Pollution and Cleaning Department
GOM	Government of Myanmar	PTD	Post and Telecommunications Department
GSM	Global System for Mobile Communication	RBD	The Road and Bridge Department
GTG	Gas Turbine Generator	SEZ	Special Economic Zone
HMWF	Hourly Maximum Water flow	SLRD	Settlement and Land Records Department
IEC	International Electro-technical Commission	SPT	Standard Penetration Test
ID	Irrigation Department	S/S	Substation
ITMC	International Transmission Maintenance Center	TDMA	Time Division Multiple Access
JICA	Japan Cooperation International Agency	TES	Thanlyin Earth Station
JIS	Japanese Industrial Standard	TKDC	Thanlyin - Kyauktan Development Company
JPY	Japanese Yen	TKIZ	Thanlyin - Kyauktan Industrial Zone
KTDC	Kyauktan Township Development Committee	TSMC	Thilawa SEZ Management Committee
MCIT	Ministry of Communications, Information Technology	TSSC	Thilawa SEZ Supporting Committee
MCPT	Ministry of Communications, Posts and telegraphs	TTDC	Thanlyin Township Development Committee
MDA	Ministry of Development Affairs	UMFCCI	Union of Myanmar Federation of Chambers of Commerce and Industry
MEPE	Myanmar Electric Power Enterprise	USD	US Dollar
METI	Ministry of Economy, Trade and Industry (of Japan)	WWTP	Waste-Water Treatment Plant
MITT	Myanmar International Terminals Thilawa	YCDC	Yangon City Development Committee
MMK	Myanmar Kyat	YESB	Yangon City Electricity Supply Board
MOAI	Ministry of Agriculture and Irrigation		

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Myanmar government places priority on foreign direct investment (FDI) in order to achieve economic development, especially in Thilawa, Dawei, and Kyaukphyu, which are being developed as special economic zones (SEZs). Under these circumstances, the Ministry of Economy, Trade and Industry (METI) of Japan started the METI Pre-Feasibility Study on the Thilawa SEZ Development (hereinafter referred to as "METI-FS") in March 2012. This preparatory study (hereinafter referred to as "the Study") has been started in preparation for a more detailed study on infrastructure development related to Thilawa SEZ.

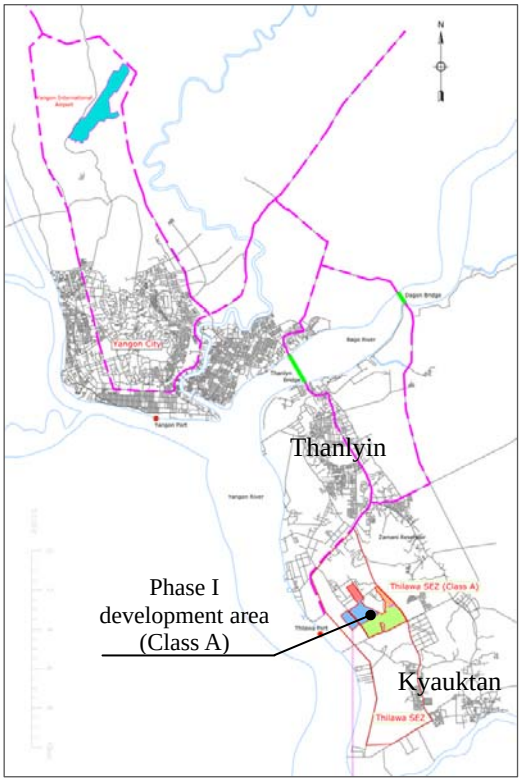
1.2 Objective of the Study

The objective of the Study is to prepare a feasibility study on the necessary infrastructure for the realization of Thilawa SEZ. The Study will review the demand, identify necessary projects, and recommend project details, including costs, implementation roadmap as well as environmental and social considerations.

1.3 Study Area

Thilawa SEZ is located beside the towns of Thanlyin and Kyauktan, about 20 km from the southeast side of Yangon City as shown in Figure 1.3.1. The Study covers Thilawa SEZ, which has an area of about 2,400 ha, and its surrounding area, but the focus is on the basic infrastructure that is required for the phase I development (tentatively 420ha).

It is surrounded by a ring road and adjacent to the container ports along the Yangon River that have a capacity of 360,000 TEU per year (as of November 2013).



Source: JICA Study Team

Figure 1.3.1 Study Area

1.4 Related Studies

Regarding the development of Thilawa SEZ, there have been four studies implemented, as summarized in Table 1.4.1 below.

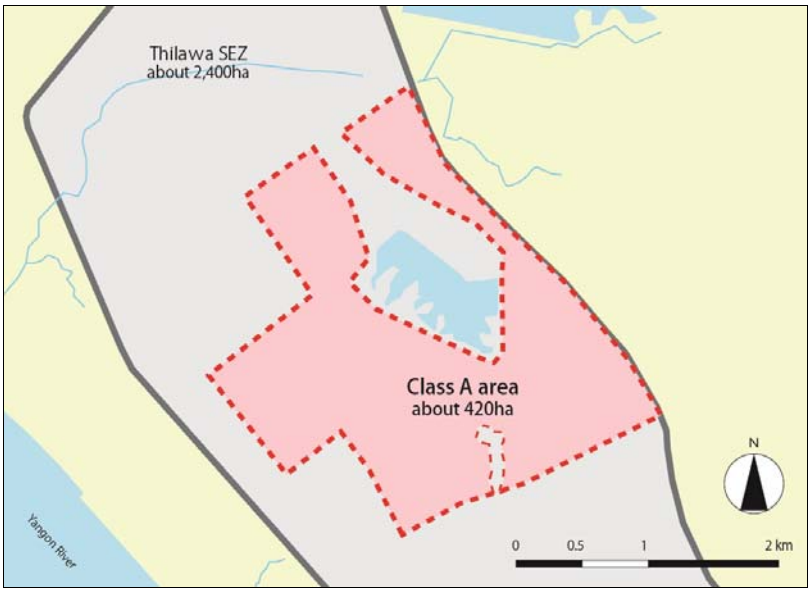
Table 1.4.1 Summary of Thilawa Studies

No.	Project	Study Area	Description
1	Project for Promoting Export of Infrastructure System (Study on the Possibility of Implementing Smart-Community in Myanmar) (METI-FS)	2,400 ha	General plan of the whole Thilawa SEZ (2,400 ha)
2	Feasibility Study for Thilawa Special Economic Zone (SEZ) Class A Development	420 ha	A joint venture is executed between Japanese and Myanmar consortiums.
3	Preparatory Study on Thilawa Special Economic Zone Infrastructure Development in the Republic of the Union of Myanmar	2,400 ha and its surrounding area	It is necessary to identify required infrastructure to develop first phase (Class A) area as priority area.
4	The Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area(Phases 1, 2, and 3)	Thilawa Port	800 m x 750 m (Phases 1, 2, and 3)

** No. 3 is this Study.*
Source: JICA Study Team

1.5 Summary of First Phase Development Area (Class A)

The layout of first phase development area (Class A, 420ha) is planned as shown in Figure 1.5.1. Since the location of Class A area is close to the main road and has an existing high ground elevation, which is easy for embankment, this area has been selected as the development priority area.



Source: JICA Study Team

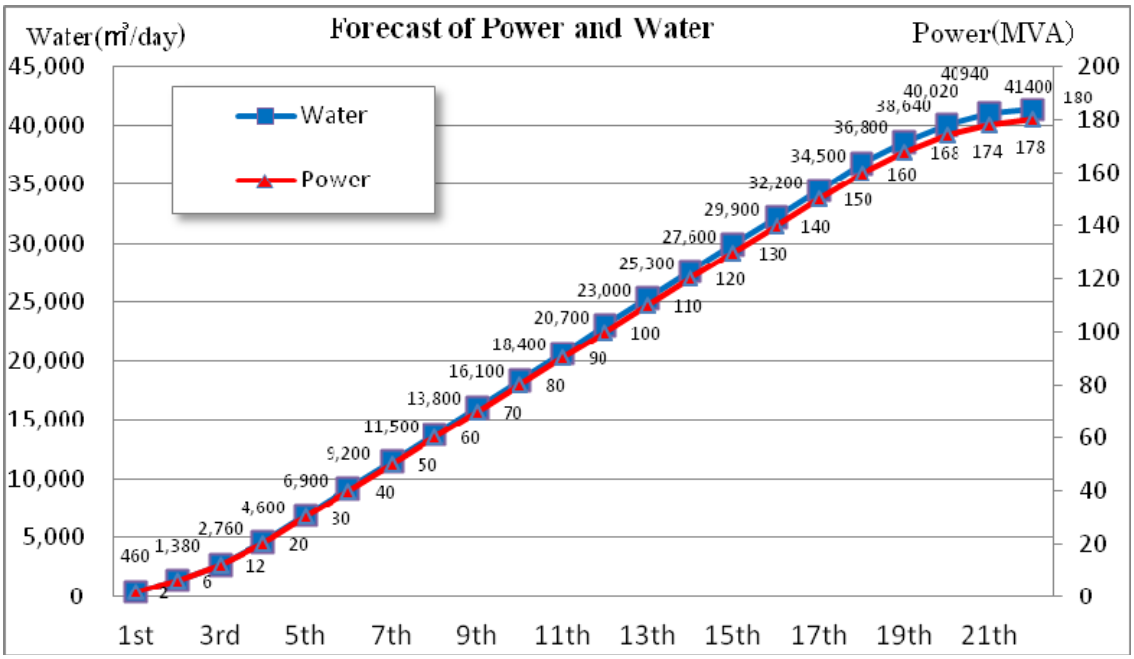
Figure 1.5.1 Layout Plan of Class A Area

The Japanese consortium assumed that tenant lots of 20 ha per year will be sold to investors based on past experiences in other Asian countries. In accordance with this marketing plan, the demands for water and power have been forecasted as presented in Table 1.5.1.

Table 1.5.1 Demand Forecast of Water and Power Supply

Year	1st	2nd	3rd	4th	5th	10th	15th	20th	22th
Accumulated Sales Area (ha)	20	40	60	80	100	200	300	360	360
Area of Factory Operation (ha)	4	12	24	40	60	160	260	348	360
Water Demand (m^3/day)	460	1,380	2,760	4,600	6,900	18,400	29,900	40,940	41,400
Power Demand (MVA/day)	2	6	12	20	30	80	130	174	180
Water Demand Intensity (m^3/day/ha)	23.0	34.5	46.0	57.5	69.0	92.0	99.7	111.2	115.0
Power Demand Intensity (m^3/day/ha)	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5

Note: Water (110 m^3/ha/day), Power (0.5 MVA/ha)
Source: Feasibility Study for Thilawa SEZ Class A Development



Source: JICA Study Team

Figure 1.5.2 Demand Forecast of Power and Water Supply

1.6 Definition of the Center of Yangon

The urban area of Yangon was originally developed around Shwedagon Pagoda (largest pagoda in the city area) and areas along the Yangon River, which until now serves as the city center of Yangon. This area, commonly known as the central business district (CBD), is faced with high densities of houses and shops. Urban central functions including administration, banking, and commerce etc. are located in the CBD, as shown in Figure 1.6.1. In this report, the city center of

Yangon is defined as the CBD. The distances from the CBD and the Yangon International Airport to Thilawa SEZ are given in Table 1.6.1 below.

Source: JICA Study Team

Figure 1.6.1 Location of the CBD of Yangon

Table 1.6.1 Distances to Thilawa SEZ from Major Spots

No.	Major Spot	Distance to Thilawa SEZ	
		Bridge No.1 (Thanlyin Bridge)	Bridge No.2 (Dagon Bridge)
1	Center of Yangon City	19 km	36 km
2	Yangon International Airport	30 km	47 km

Source: JICA Study Team

CHAPTER 2 BACKGROUND OF THE THILAWA SEZ DEVELOPMENT

2.1 Background of the Thilawa SEZ Development

In 1996, the Thanlyin-Kyauktan Development Company (TKDC) was formed to develop and manage the 1,230 ha Thanlyin-Kyauktan Industrial Zone (TKIZ), which will be the economic center of the region. Consequently, this development scheme was suspended due to lack of related laws and participators.

Thereafter, TKIZ was handled by several foreign firms as Thilawa SEZ, and subsequently, feasibility studies have been carried out in order to realize the SEZ development. However, due to several reasons, including political and social issues and Myanmar's domestic economic climate, launching the implementation of the SEZ development faced difficulties.

2.2 Objective of the Thilawa SEZ Development

The objective of Thilawa SEZ is to serve as "A Trigger for the Future of Myanmar" in order to enhance economic development and contribute to the improvement of people's livelihood. Acquisition of substantial foreign currency and jobs creation at Thilawa SEZ will contribute to the development of the Yangon region and upliftment of the economy.

2.3 Thilawa SEZ Development Contexts

The Thilawa SEZ development is based on the following contexts:

1. To promote and implement various economic activities (manufacturing, distribution, commerce, service, etc.) for sustainable and substantial economic development.
2. To accumulate foreign direct investment (FDI), not only for financial purposes but also for knowledge acquisition to consolidate the economic fundamentals.
3. To develop sufficient infrastructure and business climate at the international level in order to invite major investors from overseas and develop Myanmar's brand in the global market.

2.4 Thilawa SEZ Development Progress

Currently (November 2013), there is not much development progress in Thilawa SEZ. Only one office for the Thilawa SEZ Supporting Committee and several roads have been constructed. The existing roads in Thilawa SEZ are listed in Table 2.4.1 below.

Table 2.4.1 Road in Thilawa SEZ

Road	Description
External Ring Road	Two-way concrete pavement, one lane each way.
Center Main Road	Two-way concrete pavement, two lanes each way with median and drains.

Source: JICA Study Team

CHAPTER 3 REVIEW OF THE METI STUDY FOR THILAWA SEZ

3.1 Outline of the Study

3.1.1 Land Use Plan

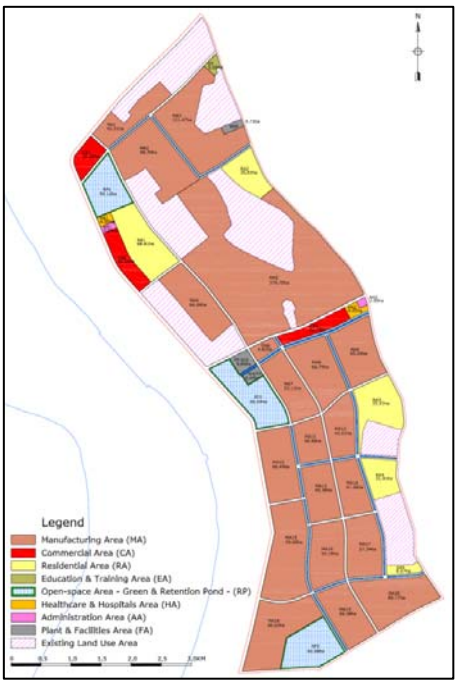
According to METI-FS, Thilawa SEZ was not planned to be used for a single function only, but to be developed as an industrial satellite city with functional use. Therefore, with regard to the land use plan, all necessary functions to enrich the investment climate were proposed.

The land use plan of the SEZ is shown in Table 3.1.1 and Figure 3.1.1 below.

Table 3.1.1 Land Use Proposed by METI Study

	Land Use	Area (ha)	Ratio
1	Manufacturing Area	1,560	65.0 %
2	Logistics Area	20	0.8 %
3	IT Software and R&D Area	100	4.2 %
4	Commercial Area	40	1.6 %
5	International Wholesale Area	10	0.4 %
6	Residential Area	220	9.2 %
7	Healthcare and Hospital Area	10	0.4 %
8	Education Area	5	0.2 %
9	Open Space and Recreation Area	200	8.4 %
10	Administration Area	5	0.2 %
11	Infrastructure	230	9.6 %
	TOTAL	**2,400**	**100.0 %**

Source: METI-FS



Source: JICA Study Team

Figure 3.1.1 Land Use Plan (Alternative)

3.1.2 Development Framework

In METI-FS, based on the abovementioned land use plan, the population and required infrastructure have been estimated, as shown in Table 3.1.2. In addition to this, the infrastructure needs forecasted in the Study are shown in Figure 3.1.3.

Table 3.1.2 Population Forecast

Land Use	Thilawa SEZ Total (people)
1. Labor	
a) manufacture	208,000
b) commercial	7,000
2. Resident	156,000

Source: METI-FS

Table 3.1.3: Infrastructure Demand Estimates

Infrastructure	Total
1. Water Supply	117,000 m^3/d
2. Wastewater	82,000 m^3/d
3. Solid Waste	3,300 t/d
4. Electricity	800 MVA

Source: METI-FS

3.2 Review of the Study

The scale of Thilawa SEZ is extremely large to be developed all at once considering the huge amount of investments required. Since the development will be carried out by zone, the infrastructure also needs to be constructed in a phased manner based on the actual progress of development.

Actual infrastructure demand will occur when activities such as the manufacturing process and settlement of inhabitants have started. Usually, there is a time gap between the occurrence of demand (usage) and implementation of supply (infrastructure development). If infrastructure development will be conducted by the private sector, it is common that they would start the implementation after the demand occurs in order to reduce investment risks. When the private sector develops infrastructure before the occurrence of the demand, it is common that the public sector will guarantee the investment in order to reduce the risk for advance implementation.

For Thilawa SEZ, due to a considerable shortage of the existing infrastructure supply compared with the demand after the development of SEZ, a large amount of investment would be needed for new infrastructure development. This will become a key issue for developing Thilawa SEZ smoothly. It would be difficult for public works to cover the large amount of investment; therefore, infrastructure development must be carried out through partnerships between the public and private sectors.

CHAPTER 4 PRESENT CONDITIONS OF THILAWA SEZ AND ITS RELATED INFRASTRUCTURES

4.1 Natural Condition

4.1.1 Geological Survey

(1) Geological Survey in the Thilawa SEZ Area

1) Scope of Works

Geological survey for the Thialwa SEZ area was conducted for two months, from 8 October to 7 December 2012. The scope of the survey works is shown in Table 4.1.1.

Table 4.1.1 Scope of Geological Survey Works (Thilawa SEZ)

Work Item	Work Volume
1. On-site Investigations Core boring Standard penetration test (SPT) In situ permeability test	Depth of 30 m at three points Depth of 2 m for each borehole One test for each borehole
2. Laboratory Tests	Soil particle density, moisture content test, grain size analysis, wet density test, permeability test, consolidation test, California bearing ratio (CBR) test

Source: JICA Study Team

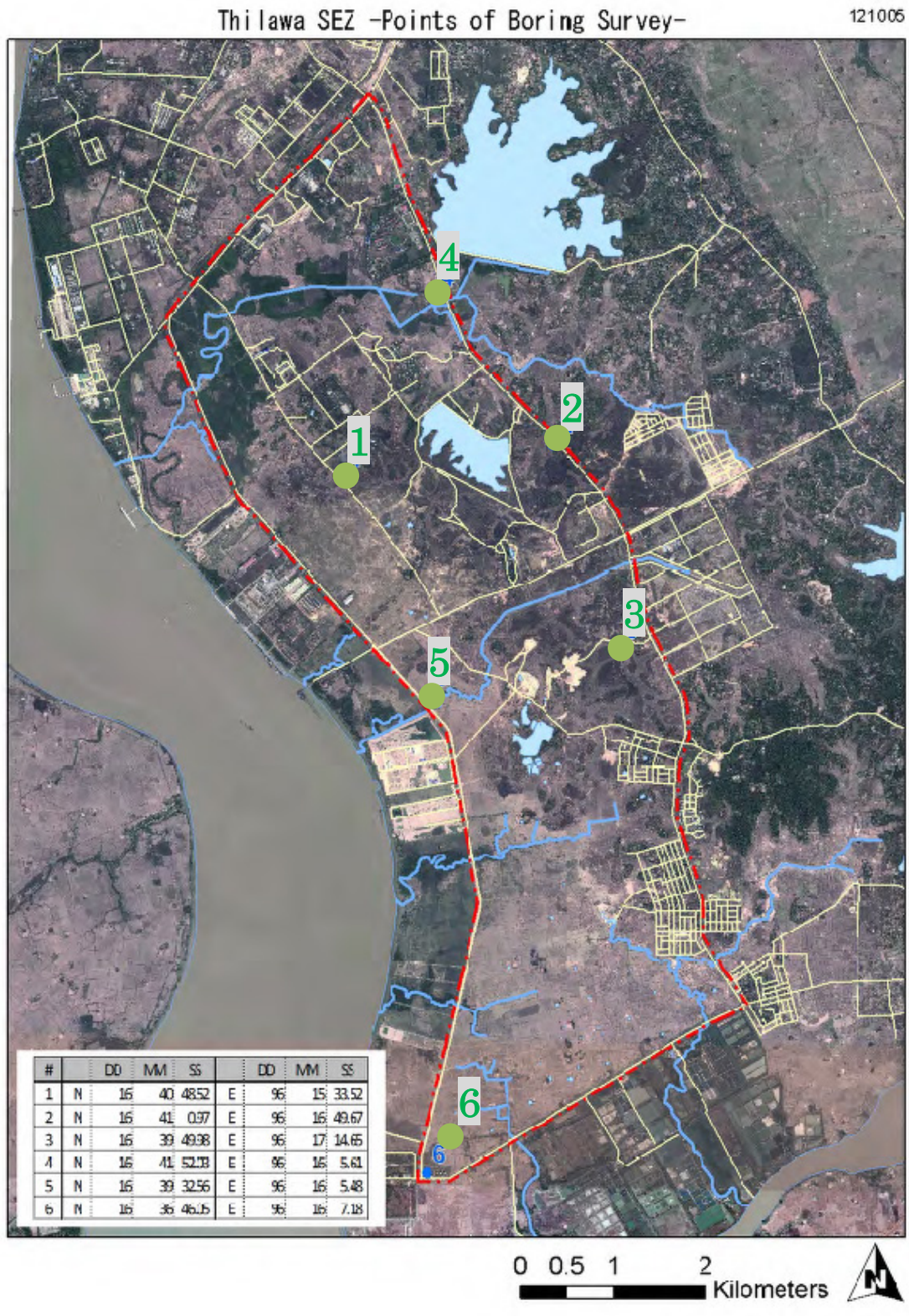
2) Survey Points

The locations of the six survey points are shown in Figure 4.1.1. The purpose for selecting these points in the survey area is shown in Table 4.1.2.

Table 4.1.2 Purpose for the Selection of Survey Points (Thilawa SEZ)

Survey Point	Purpose	Remarks
1	The site proposed for Class A development	North side of the SEZ
2	The site proposed for Class A development	North side of the SEZ
3	The site proposed for Class A development	South side of the SEZ
4	Planned site for expansion and repair of bridge	North side of the SEZ
5	The site proposed for the pump station	South side of the SEZ
6	The site proposed for sewage disposal plant	South side of the SEZ

Source: JICA Study Team



#		DD	MM	SS		DD	MM	SS
1	N	16	40	48.52	E	96	15	33.52
2	N	16	41	0.97	E	96	16	49.67
3	N	16	39	49.38	E	96	17	14.65
4	N	16	41	52.13	E	96	16	5.61
5	N	16	39	32.56	E	96	16	5.48
6	N	16	36	46.6	E	96	16	7.18

Source: JICA Study Team

Figure 4.1.1 Geological Survey Points (Thilawa SEZ)

3) Results of the Survey

From the results of the geological survey, it was found out that existing ground conditions in Thilawa SEZ can be summarized into the following two groups:

a. North and Surrounding Area of Class A

b. South Area of Class A

The results of the geological survey are as shown in Table 4.1.3.

Table 4.1.3 Summary of the Geological Survey (Thilawa SEZ)

Survey Point	North and Surrounding Area of Class A	South Area of Class A
Boring Number	Nos. 1, 2, 3, and 4	Nos. 5 and 6
Feature	The ground surface from the ground level (GL) to 10 m is composed of stiff clayey soil, which has N-values of 8 to 30. From Deeper than 10m from GL, the composition of sand or silty sand is spread.	The ground surface from GL to 15 m is composed of soft clayey soil which has N-values of less than 4. This layer may need countermeasure to prevent consolidation settlement. Deeper than 15m from GL, the composition of sand or silty sand is spread.
Judgment	When a standard factory is planned to be built, it may not be necessary to require pile foundation design.	When a structure is planned, it may be necessary to require pile foundation design.

Source: JICA Study Team

Based on the results above, there is a trend that the bearing capacity of existing surface soil in the north area is better than that in the south area of Thilawa SEZ.

(2) Geological Survey of Access Road

1) Scope of Works

Geological survey for the project was conducted from 22nd August to 27th September 2013. The scope of the survey works is shown in Table 4.1.4.

Table 4.1.4 Scope of Geological Survey Works (Access Road)

Work Item	Work Volume
1. On-site Investigations Core boring Standard penetration test (SPT) In situ permeability test Dynamic cone penetration test (DCPT)	Depth of 30 m at four points Depth of 2 m for each borehole One test for each borehole 9 points (About 1 km, 1 point)
2. Laboratory Tests	Density of soil particles, moisture content test, grain size analysis, wet density test, permeability test, consolidation test, CBR test

Source: JICA Study Team

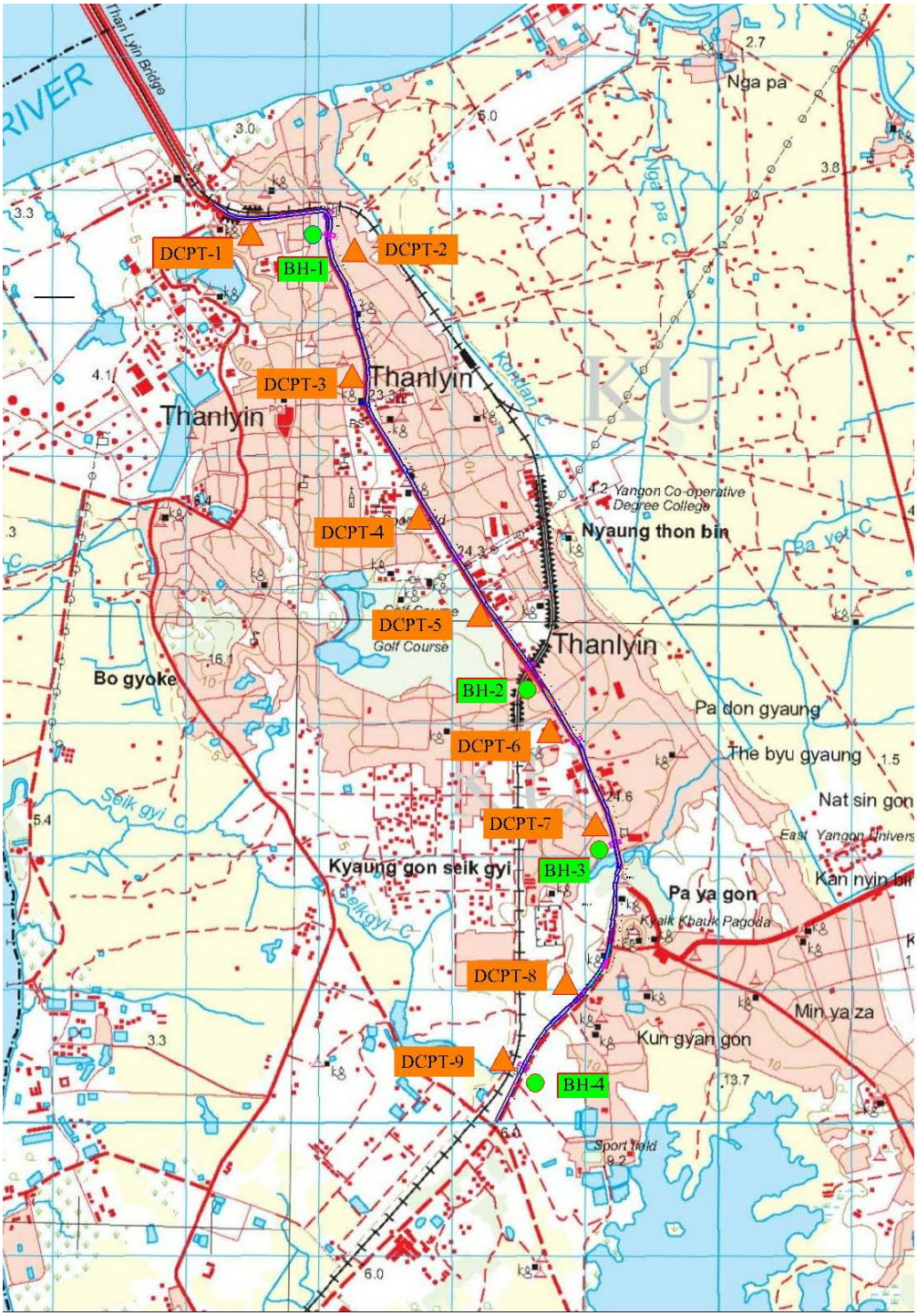
2) Survey Points

The locations of the four survey points are shown in Figure 4.1.2. Table 4.1.5 below shows the purpose for selecting these points in the survey area.

Table 4.1.5 Purpose for the Selection of Survey Points (Access Road)

Survey Point	Purpose	Remarks
BH-1	Reconstruction of box culvert, BC-1	West side of access road
BH-2	Reconstruction of box culvert, BC-4	East side of access road
BH-3	Reconstruction of box culvert, BC-5	West side of access road
BH-4	Widening of bridge, BR-2	East side of access road

Source: JICA Study Team



Source: JICA Study Team

Figure 4.1.2 Geological Survey Points (Access Road)

3) Results of the Survey

・Boring survey

The results of the geological survey are as shown in Table 4.1.6.

Table 4.1.6 Summary of the Geological Survey (Access Road)

Survey Point	North and surrounding Area of Class A	South Area of Class A
Boring Number	Nos. 1, 2, and 3	Nos. 4
Feature	From the ground level (GL) to 7 m is composed of coarse sand, which has N-values of 11 to 30. From GL to 7 m-15 m, medium layer is composed of medium density sand. Deeper than 15m from GL, high density sand is spread.	From GL to 17 m is composed of clayey soil where N-value ranges from 13-23. Deeper than 16m from GL, the composition of silt sand is spread.
Judgment	Soft ground which causes settlement does not exist.	

Source: JICA Study Team

・DCPT survey results

Based on the laboratory test, the CBR of the roadbed in this area is from 2.2 to 6.9, and the average CBR in nine locations is around 4.6.

4.1.2 Topographic Survey

(1) Scope of Works

Topographic survey for the project was conducted for two months, from 8th October to 7th December 2012. Topographic maps of the area were drawn with a map scale of 1:2,500, and the satellite image of the area was used as the background of the map. Contour lines are indicated at every 0.5 m interval with some spot level. The scope of the survey works is shown in Table 4.1.7.

Table 4.1.7 Scope of Topographic Survey Works

Work Item	Quantity
1. Benchmark Survey	
1) Benchmark	5 points
2) Auxiliary Benchmark Installation	35 points
3) GPS Survey	40 points
4) Leveling Survey	85 km
2. Grid Height Measurement	
1) Ortho Photo Contour Map (Block A)	15 km^2 (1,500 ha)
2) Ortho Photo Contour Map (Block B)	15 km^2 (1,500 ha)

Source: JICA Study Team

(2) Survey Area

The survey area is shown in Figure 4.1.3

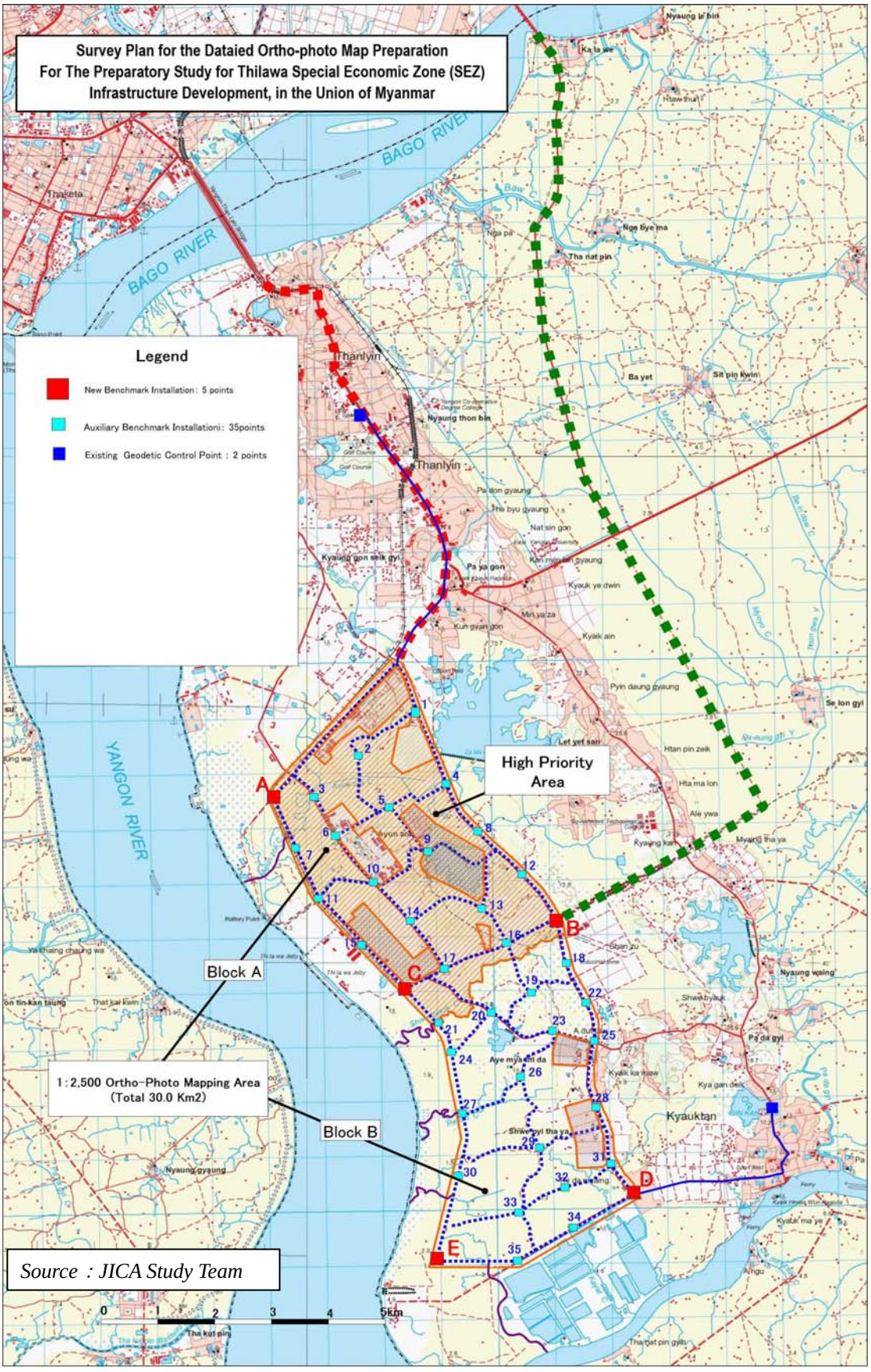


Figure 4.1.3 Topographic Survey Points

(3) Results of the Survey

1) Land Height and Incline

The area with the lowest elevation is located on the northwest side where a creek crosses from east to west of the SEZ. The elevation of the land along the creek is 2.5-3.0 m, which is less than 1 m higher than the elevation of the creek. On the other hand, the elevation around the Thilawa Reservoir is the highest throughout the whole area. The elevation is about 8.5 m higher than the lowest point.

In general, the topography of the area has an incline that gently slopes down from north to south and from east to west. The elevation of the creek mentioned above is about 2.0 m and it does not change throughout the east and west sides.

2) Undulations

The east landside of the area has rough undulations within 5.5-10.5 m of the elevation. There is almost no undulation along the central road, which stretches from west to east of the flat plain.

4.1.3 Borehole Development Survey

The borehole development survey was conducted from 1st October 2012 to 15th February 2013. The results of the survey are summarized below.

(1) Outline of the Survey

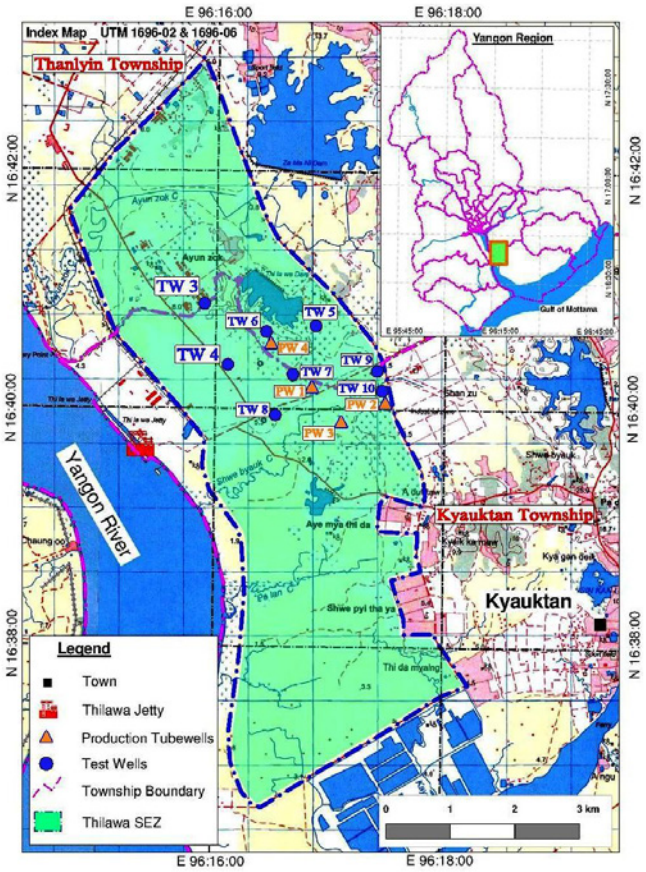
The survey was conducted at ten sites in the entire development area of Thilawa SEZ, as shown in Figure 4.1.4. The survey covered the work items shown in Table 4.1.8.

Table 4.1.8 Outline of Borehole Development Survey

Work Item	Schedule	Remarks
1. Site reconnaissance 2. Kickoff meeting with Thilawa SEZ Supporting Committee	27 September 2012	Ten sites were selected for the geoelectric resistivity survey.
3. Geoelectric resistivity survey	1 to 19 October 2012	Eight sites were selected for the trial drilling work.
4. Trial drilling works and water quality tests (Test Well: TW)	20 October to 2 November 2012	Four sites were selected for the production borehole (TW-6, 7A, 7B, 10).
5. Production borehole development (Production Well: PW) ・ Drilling works ・ Five-step pumping test ・ Consecutive pumping test ・ Recovery test	17 November to 17 December 2012	Casings and screens were installed (PW-1, 2, 3, and 4)
6. Water quality analysis	Completed on 7 February 2013	-
7. Borehole Development Survey Final Report	Submitted on 15 February 2013	-

Source: JICA Study Team

The location of survey points and production wells are shown in Figure 4.1.4.



Source: JICA Study Team

Figure 4.1.4 Location Map of Survey Points and Production Wells

(2) Results of Borehole Development

Casings and screens were installed and pumping tests were conducted at four wells. The status of the four production tube wells is summarized in Table 4.1.9. The pumping water level at PW-4/TW-6 is the deepest at around 38 m, while at other locations is around 20 m. The estimated pumping ratios at PW-1/TW-7A and PW-3/TW-7B are around 20 L/s and 15 L/s, respectively. They are more than as compared to other locations, and the pumping water level is not deep, which means they can be used easily.

Table 4.1.9 Status of Tube Wells

Description		PW-1/TW-7A			PW-2/TW-10		PW-3/TW-7B		PW-4/ TW-6
Estimated Pumping Ratio (L/s)		20			6		15		6
Depth of Well (m)		68			70		68		86
Casing	Position (m)	0-33	55-61		0-36	52-58	0-27		0-52
	Diameter (in)	10	8		10		10		10
Slot Screen	Position(m)	33-49	50-55	61-66	36-52	58-59	27-33	34-66	52-85
	Diameter (in)	10	8	8	8		10	8	10
Size of Slot (mm)		1			1		1		1
Pumping Water Level (m)		20			24		18		38
Pump Installation Position (m)		27.5			33.5		25.9		48.7

Source: JICA Study Team

A typical borehole section with column diagram and casing program is presented in Figure 4.1.5.

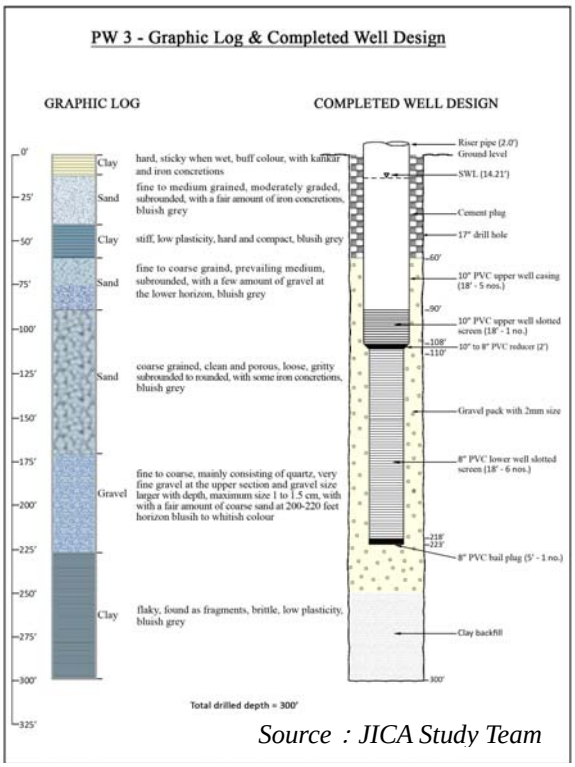


Figure 4.1.5 Geographic Log and Borehole Section of PW3/TW-7B

(3) Water Quality Analysis Compared with Myanmar's Drinking Water Standards

The results of the water quality analysis of production wells are presented in Table 4.1.10. The water quality is generally satisfy the Myanmar drinking water standard. Even though Turbidity, Manganese, Total Coliform is higher than the standard value, but by using some simple countermeasure including chlorine sterilization method, water from these wells can be used as drinking water.

Table 4.1.10 Results of Water Quality Analysis of Production Wells

No.	Test Items	Unit	PW-1	PW-2	PW-3	PW-4	Myanmar's Standards		WHO Guidelines
			(TW-7A)	(TW-10)	(TW-7B)	(TW6)	Present	2011 Draft	
1	pH Value	-	8.80	8.21	8.06	8.72	6.5-9.2	6.5-8.5	Preferably less than 8
2	Turbidity	NTU	2.70	27.60	-	-	20.00	5.00	5.00
3	Color	Unit	7.50	17.50	-	-	5~50	15.00	15.00
4	Aluminum (Al)	mg/L	<0.10	<0.10	<0.10	<0.10	0.20	0.20	0.20
5	Arsenic (As)	mg/L	<0.01	<0.01	0.01	<0.01	0.05	0.05	0.01
6	Calcium (Ca)	mg/L	18.80	14.00	16.40	34.40	75~200	100.00	-
7	Chloride (Cl)	mg/L	132.07	8.25	41.27	412.73	200~600	250.00	250.00
8	Copper (Cu)	mg/L	<1.00	<1.00	<1.00	<1.00	1.00	2.00	1.00
9	Cyanide (CN2)	mg/L	<0.05	<0.05	<0.05	<0.05	0.05	0.07	0.07
10	Hardness	mg/L	90.00	65.00	70.00	95.00	500.00	500.00	-
11	Iron (Fe)	mg/L	0.10	0.40	ND	ND	0.5~1.5	1.00	0.30
12	Manganese (Mn)	mg/L	0.90	0.70	0.25	0.60	0.30	0.30(0.1)	0.10

No.	Test Items	Unit	PW-1	PW-2	PW-3	PW-4	Myanmar's Standards		WHO Guidelines
			(TW-7A)	(TW-10)	(TW-7B)	(TW6)	Present	2011 Draft	
13	Lead (Pb)	mg/L	<0.01	<0.01	<0.01	<0.01	0.05	0.01	0.01
14	Magnesium (Mg)	mg/L	20.90	43.00	95.00	13.85	30~150	500.00	-
15	Nitrate (NO_3)	mg/L	<0.10	<0.10	0.52	0.49	10 (as N)	50.00	-
16	Sulfate	mg/L	25.51	20.58	ND	15.00	400.00	250.00	250.00
17	Total Dissolved Solids (TDS)	mg/L	702.00	139.00	274.00	996.00	1000.00	1000.00	1000.00
18	Zinc (Zn)	mg/L	2.00	2.50	<1.00	<1.00	5~15	3.00	3.00
19	Total Coliform	Number /100 mL	>16.00	5.10	>16.00	16.00	0.00	0.00	0.00
20	E. Coli	Number /100 mL	NI	NI	NI	NI	0.00	0.00	0.00

ND=Not Detected NI=Not Isolated

Source: JICA Study Team

(4) Results of Tube Well Survey

The following issues are recommended for operation of the four tube wells:

a. PW2-/TW-10 and PW-3/TW-7B are useful for industrial and domestic purposes in terms of water quality.

b. PW-1/TW-7A and PW-4/TW-6 are useful for industrial purposes only due to the high values of EC and TDS.

c. To avoid drying up of wells, the pump operation pattern is: 6 hr operation and 2 hr standby (at three shifts per day).

d. The total water production of the four wells was estimated at 3,000 m^3/d. In case of using only two tube wells without salinity, the combined production of PW-2/TW-10 and PW-3/TW-7B was estimated at 1,360 m^3/d. The production values are indicated in Table 4.1.11.

Table 4.1.11 Pump Operation Pattern and Production

Tube Well No.	Pumping Ratio (L/s)	Daily Pump Operation Pattern			Production (m^3/d)
		On (hr)	Off (hr)	Shift (times)	
PW-1/TW-7A	20	6	2	3	1,296
PW-4/TW-6	6	6	2	3	389
				Subtotal	1,685
PW-2/TW-10	6	6	2	3	389
PW-3/TW-7B	15	6	2	3	972
				Subtotal	1,361
				Total	3,046

Source: JICA Study Team

4.1.4 Flooding Survey

Flooding survey was conducted from 17th to 20th September 2012.

(1) Outline of Flooding Survey

The survey method involved personally interviewing residents by means of questionnaires in order to grasp the sanitation conditions and flood damages in the Thilawa SEZ area. Sampling was conducted along the existing roads of Thilawa SEZ as shown in Figure 4.1.6. The total

number of samples is 140, and the average dwelling period of the samples is about 18 years, as shown in Table 4.1.12.

Table 4.1.12 Dwelling Period

Dwelling Years	Number of Samples	Percentage (%)
Less than 1 year	18	13%
1-5 years	24	17%
6-10 years	21	15%
11-20 years	25	18%
21-30 years	19	14%
31-40 years	16	11%
41-50 years	9	6%
More than 50 years	8	6%
Total	140	100%

Source: JICA Study Team

(2) Survey Results

The results of the survey are summarized in Table 4.1.13 and Figure 4.1.6. Figure 4.1.6 also indicates the frequency of flooding on the existing road. The survey answers indicated that the northwest, southeast, and central west parts have experienced flood once in the past. In addition, residents who answered that flood occurs every year are mainly living along Route G.

Table 4.1.13 Flood Experience of Residents

Frequent Flooding Experiences	Number of Samples	Percentage (%)
Yes	49	35
(1) Every year	5	10
(2) Sometimes (every 6-10 years or more)	1	2
(3) Only once as far as they know	43	88
No	91	65
Total	140	100

Source: JICA Study Team

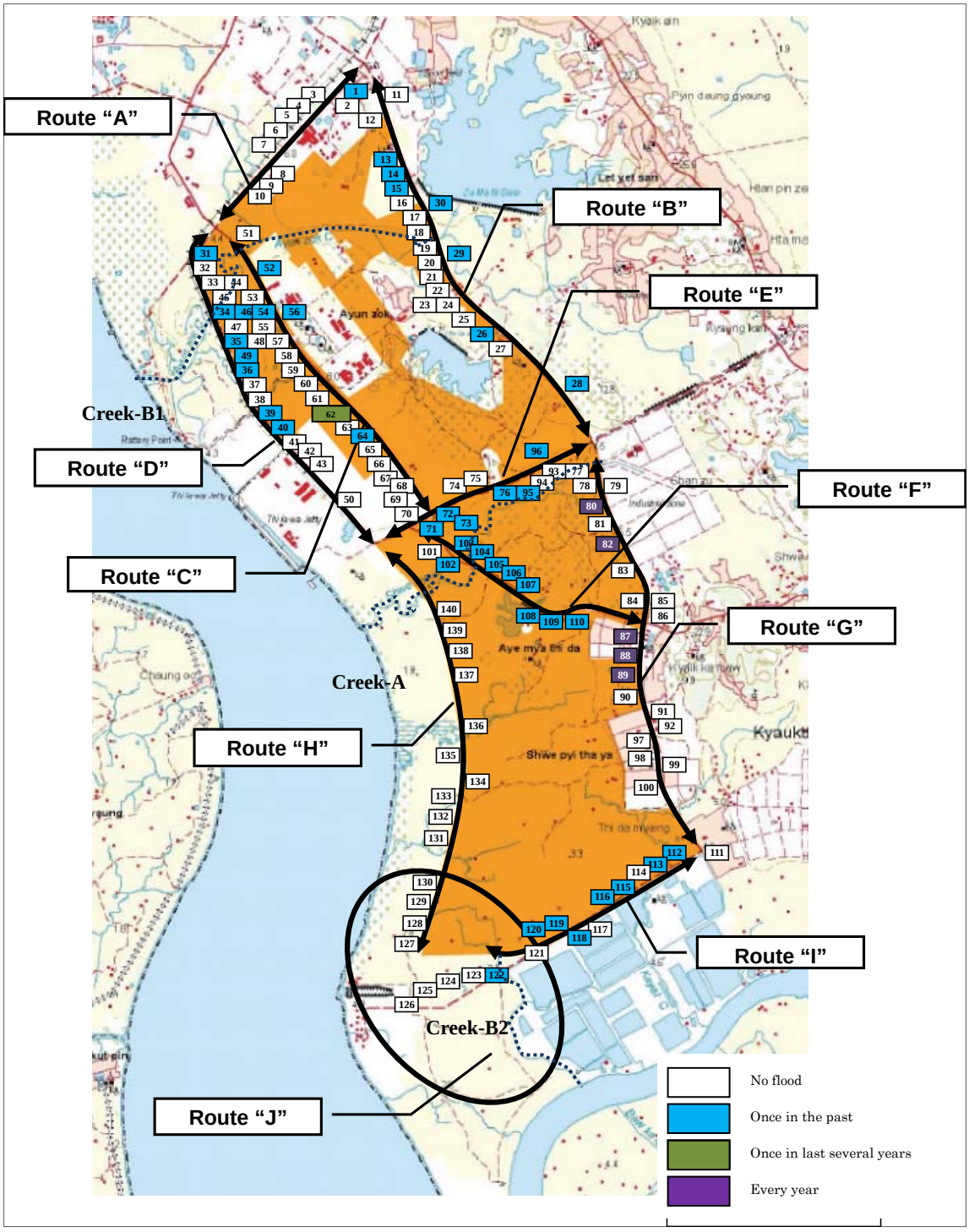
Table 4.1.14 shows the duration of inundation. The residents who answered that flooding occurred every year reported that the duration of inundation is below 30 min. For the residents who answered that they experienced flooding once a year, 46% of them answered that the duration of inundation is 1 day. In addition, 26% of the residents answered that the duration of inundation is within 1 to 3 days, and 28% experienced more than 3 days of inundation.

Table 4.1.14 Inundation Duration Report of Residents Who Experienced Flooding Only Once

Duration of Inundation	Number of Samples	Percentage (%)
30 min to 1 hour	6	14%
More than 1 hour	1	2%
Half day to 1 day	13	30%
1 to 3 days	11	26%
3 to 5 days	7	16%
More than 6 days	5	12%
Total	43	100%

Source: JICA Study Team

Even though quantitative data are not available in hearing survey, but existing creek A and south part of Route E inside of SEZ site, it is confirmed that flood occurred every year.



Source: JICA Study Team

Figure 4.1.6 Flooding Survey

(3) Flood Countermeasure

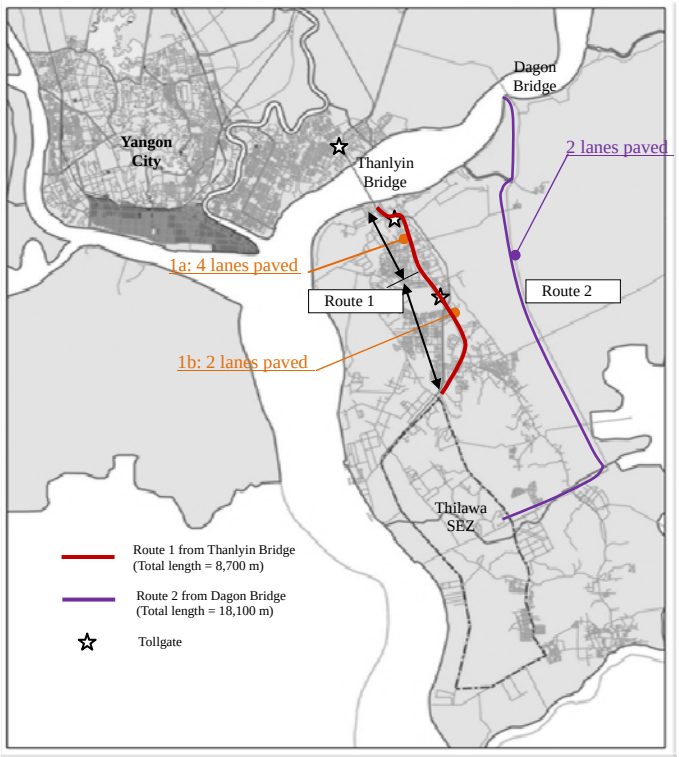
In the development planning stage, ground levels need to be set high and drainage systems need to be improved. The installation of embankments, pump stations, and gates are also desired in the areas with high probabilities of flooding.

4.2 Present Conditions of the Road Network

4.2.1 Present Conditions of the Access Road Network to Thilawa SEZ

There are only two ways of access going to Thilawa SEZ from Yangon City. The first is the route that passes through Thanlyin Bridge (Bridge No. 1), and the second is the route that passes through Dagon Bridge (Bridge No. 2). The road network is presented in Figure 4.2.1.

The peripheral road of Thilawa SEZ is paved by concrete while the road between Thanlyin Bridge and Thilawa SEZ is paved by asphalt. The majority of pavement is made by concrete because of cheaper price of concrete and shortage of high-quality asphalt factories. On the other hand, most of the roads connecting villages are still not paved.



Source: JICA Study Team

Figure 4.2.1 Present Conditions of the Road Network to Thilawa SEZ

4.2.2 Present Condition of Road Usage

(1) Route 1 (Thanlyin Bridge to Thilawa SEZ)

1) Pavement and Roadside Conditions

Route 1, which is from Thanlyin Bridge to Thilawa SEZ, is entirely paved by asphalt. However, the width of the paved part is not fixed. Some sections of the road are widely paved, having four lanes in total. In other sections, the road only has two asphalt lanes, though there are some spaces left on the shoulders of the road. This road is owned by the Ministry of Construction (MOC), but its operation and maintenance has been assigned to the private company, Max Myanmar Company.

For the right-of-way (ROW) of the road, the MOC owns 75 ft of each roadside from the road center (total of 150 ft = 45.72 m). The present conditions on the development of the access road are shown in Table 4.2.1.

Table 4.2.1 Present Conditions of Road 1 Surface

No.	Road Condition	Road Length
(1a)	Two-lane road	3.0 km
(1b)	One-lane road	5.7 km
	Total	8.7 km

Source: JICA Study Team

Since the asphalt has been repeatedly paved only on the existing roadway, there are some places where the difference in level between the pavement and ground surface are noticeable. The maximum difference in level is around 40 cm, as shown in Figure 4.2.2.

Side ditches for drainage are partially developed along the roadside, especially at places where inhabitants are concentrated such as house fronts and shops. Most of the ditches were developed by manual digging without the use of machines and concrete covering (Figure 4.2.3).

Source: JICA Study Team

Figure 4.2.2 Difference in Road Level Between the Pavement and Side Road

Source: JICA Study Team

Figure 4.2.3 Side Ditches Along the Access Road

2) Current State of the Thanlyin Bridge

Thanlyin Bridge, built in 1993, has a total length of 1,800 m with one lane at each side (total of two lanes), and is used for both vehicles and trains. Although it has only been 20 years old, most of the structure have corroded. The road holding is in bad condition because the road surface has been poorly maintained. When the bridge was constructed, the weight limit was set to 36 t.

However, the weight limit was reduced to 20 t in 2009. Therefore, heavy container trucks are unable to cross the bridge using Route 1.

Source: JICA Study Team

Figure 4.2.4 Thanlyin Bridge

3) Current Issues on Road Usage

Currently traffic volume of the access road is within allowable levels, except during the peak hours, there is temporary traffic congestion in specified locations such as bus stop etc. However, different types of vehicles pass through this access road (not only cars, buses and trucks, but also motorcycles, bicycles, carts, carriages, etc.). The velocity of each vehicle also varies, therefore, overtaking of vehicles by crossing over the opposite lane occurs frequently. Moreover, small traffic jams and vehicle overtaking are often caused by bus stops and places where trucks are being loaded. Based on the future demand forecast, the road plan for improving safety by widening the road and securing the width of the lane is necessary to be developed.

Source: JICA Study Team

Figure 4.2.5 Overtaking on Narrow Roads

Source: JICA Study Team

Figure 4.2.6 Various Types of Traffic Vehicles

(2) Route 2 (Dagon Bridge to Thilawa SEZ)

1) Pavement and Roadside Conditions

The width of the road connecting Dagon Bridge and Thilawa SEZ (Route 2) is about 7 m for each lane. This road is owned by the MOC, but operation and maintenance has been assigned to the private company Max Myanmar Company (13.2 miles/21.2km including Dagon Bridge,) same as for Route 1.

The ROW owned by the MOC is 100 ft from the center line of the existing road to each side (total of 200 ft = 60.9 m). The elevation of paved road is raised higher than the surrounding agricultural land elevation. However, the unpaved areas are mostly kept as of the present ground elevation. The road extends from the east corner of Route 2 to the middle of Thilawa SEZ. It has four lanes (two lanes on each side), and there are also street lights installed along the median.

Source: JICA Study Team

Figure 4.2.7 Road Conditions of Route 2

Source: JICA Study Team

Figure 4.2.8 Road Extended to the Middle East of Thilawa SEZ

2) Current State of the Dagon Bridge

Dagon Bridge, a prestressed concrete bridge built in 2007, has a total length of 836 m and three lanes on each side (total of six lanes). Its weight limit is 60 t. All heavy vehicles coming from Thilawa Port pass on this bridge to carry goods into Yangon City. Although the road holding and maintenance of Dagon Bridge are better than of Thanlyin Bridge, there is a gap between the bridge and the approach road due to land subsidence.

Source: JICA Study Team

Figure 4.2.9 Dagon Bridge

3) Current Issues of Road Usage

Since heavy loaded vehicles are restricted to use Route 1, it is expected that Route 2 would be used by freight cars for transportation. This road has little traffic volume and is not being utilized for public transportation because the route does not pass through town area. As a result, there is a safety issue which arises from the overspeeding of heavy vehicles.

4.2.3 Present Condition of Toll Fee

(1) Route1 (Thanlyin Bridge to Thilawa SEZ)

As shown in Figure 4.2.1, there are three tollgates currently located in the access road from Yangon to Thilawa SEZ (Kyaik Khauk Pagoda Road). The toll fee is collected by Max Myanmar Company. Although a standard toll fee exists, the collection of fees is unclear, such that vehicles are not weighed and vehicle types are not classified accurately. The actual toll rates currently used are shown in Table 4.2.2 and Table 4.2.3.

Table 4.2.2 Toll Fee for Thanlyin Bridge

JPY 1 = MMK 10

No	Type of Vehicle	Toll Fee (MMK)
1	Motorbikes	50
2	Vehicles below 2 t	100
3	School ferries	100
4	Buses (small)	100
5	Buses (big)	200
6	Vehicles between 2 t to 5 t	300
7	Vehicles between 5 t to 10 t	700
8	Vehicles between 10 t to 29 t	1,000

Note: Starting from 1 October 2012
Source: Max

Table 4.2.3 Toll Fee for Route 1 (Kyaik Khauk Pagoda Road)

JPY 1 = MMK 10

Weight of Vehicle	Toll Fee (MMK)
5 t and above	500
3 t and above	300
1 t and above	200
Below 1 t	100

Note: Vehicles weighing 12 t and above are prohibited. Noted, March 2013
Source: Max

(2) Route 2 (Dagon Bridge to Thilawa SEZ)

Route 2 has only one tollgate, which is located at the foot of Dagon Bridge of Thanlyin and Thilawa. The toll fee includes bridge fee, road fee, and city tax. The road fees going to Thilawa SEZ from Yangon (one way) are as listed in Table 4.2.4; however, there are times that the actual price is not the same as the toll fee listed in the table. It can be observed that the operations need some improvement for the better management.

Table 4.2.4 Toll Fee of Dagon Bridge and Access Road

JPY 1 = MMK 10

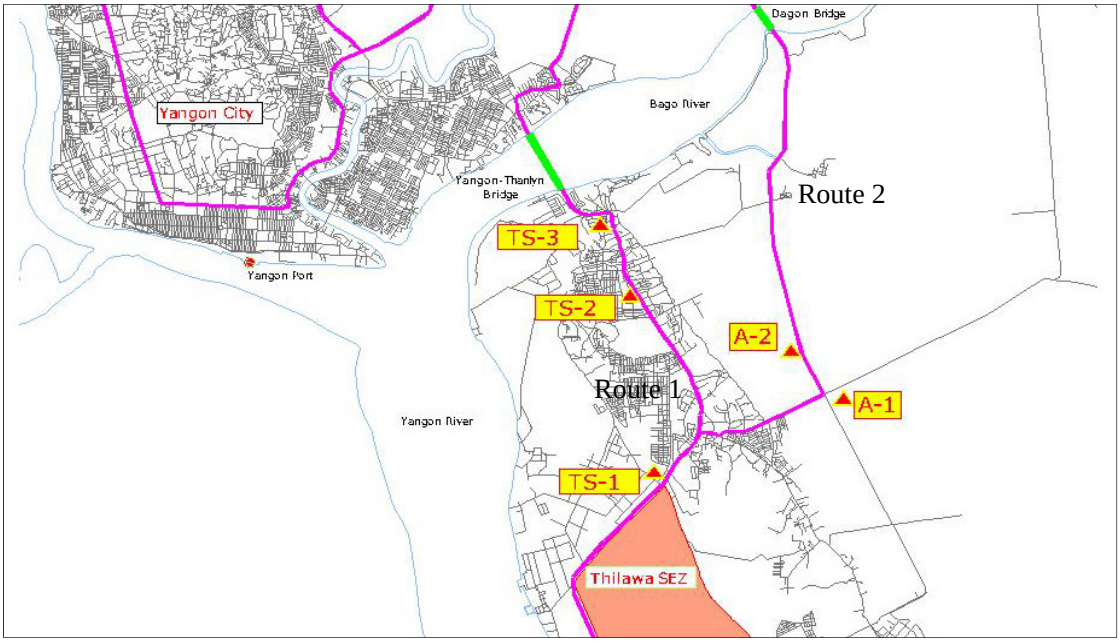
No.	Type of Toll Fee	Toll Fee (MMK)
1	Bridge Usage fee	
	- Motorbike	50
	- Motorbike with three wheels	100
	- Vehicle, Bus	300
	- Six-wheeler light truck (below 4 t)	600
	- Six-wheeler truck (below 10 t)	1,500
	- Eight-wheeler large truck (below 21 t)	1,800
2	Road Usage fee	
	- Motorbike	50
	- Vehicle (below 4 t)	100
	- Vehicle, bus (below 10 t)	150
	- Medium size truck (below 12 t)	200
	- Large size truck (below 16 t)	300
3	City tax	100

Source: Max

4.2.4 Present Traffic Volume Conditions

(1) Location of Traffic Survey Point

In order to estimate the present traffic volume, a traffic survey was carried out in three locations along Route 1 and two locations along Route 2.



Source: JICA Study Team

Figure 4.2.10 Traffic Survey Locations

(2) Route 1 (Thanlyin Bridge to Thilawa SEZ)

The traffic survey was carried out in three locations along Route 1. The categories of vehicles are based on the Japan Bus Association and the Safety Standards for Road Transportation Vehicles of Japan. The traffic survey was carried out during weekdays and weekends involving

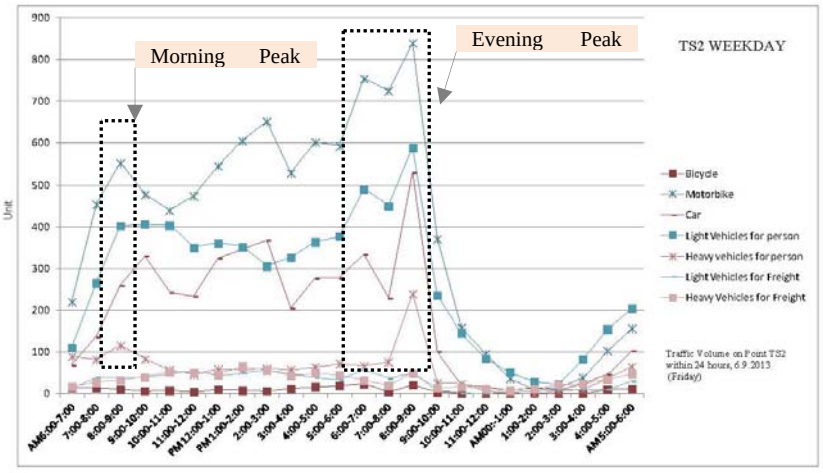
seven types of vehicles, as shown in Table 4.2.5. According to the traffic survey results, traffic in TS1 (near Thilawa SEZ) is very few; therefore, the average traffic volumes in TS2 and in TS3 (in city area of Thanlyin) were used for the Study. Traffic volumes in TS2 and in TS3 (both weekdays and weekends) are more than about 20,000 pcu/day.

Table 4.2.5 Results of the Traffic Volume Survey (Route 1)

Location	Date	Bicycle	Motor bike	Car	Mini bus	Medium-Large Bus	Light Freight Trucks	Heavy Freight Trucks	
TS1	8.9.2013(Sun)	153	5,080	402	414	197	109	404	
	9.9.2013 (Mon)	256	4,570	1,404	880	506	153	554	
TS2	6.9.2013 (Fri)	193	9,435	4,483	6,553	1,380	702	798	
	7.9.2013 (Sat)	237	9,105	3,892	5,998	1,165	764	743	
TS3	1.9.2013 (Sun)	245	2,193	4,942	9,686	2,144	764	647	
	2.9.2013 (Mon)	283	2,254	5,267	9,750	2,529	961	1,343	
TS2 and TS3 Average	Weekend	241	5,649	4,417	7,842	1,655	764	695	
	Weekdays	238	5,845	4,875	8,152	1,955	832	1,071	
	PCU Factor	0.2	0.5	1	1	2	1	2	Total
	Weekend (pcu)	48	2,825	4,417	7,842	3,309	764	1,390	20,595
	Weekday (pcu)	48	2,922	4,875	8,152	3,909	832	2,141	22,878
	Ratio (PCU)	0.2%	12.8%	21.3%	35.6%	17.1%	3.6%	9.4%	

Source: JICA Study Team

Also, the observed traffic volume for Route 1 by time period is presented in Figure 4.2.11, i.e., i) the traffic peak hour is concentrated from 8:00 to 9:00; and ii) the peak time in the afternoon is concentrated from 20:00 to 21:00. Traffic volume in both time periods exceeds 1,000 pcu/hour.



Source: JICA Study Team

Figure 4.2.11 Traffic Volume Survey Data in TS2 (Center of Thanlyin Access Road)

(3) Route 2 (Dagon Bridge to Thilawa SEZ)

The traffic volume in Route 2 is shown in Table 4.2.6. The average traffic volume during weekdays of only 2,000 pcu/day remarkably shows the low frequency of road usage of Route 2.

Table 4.2.6 Results of the Traffic Volume Survey (Route 2)

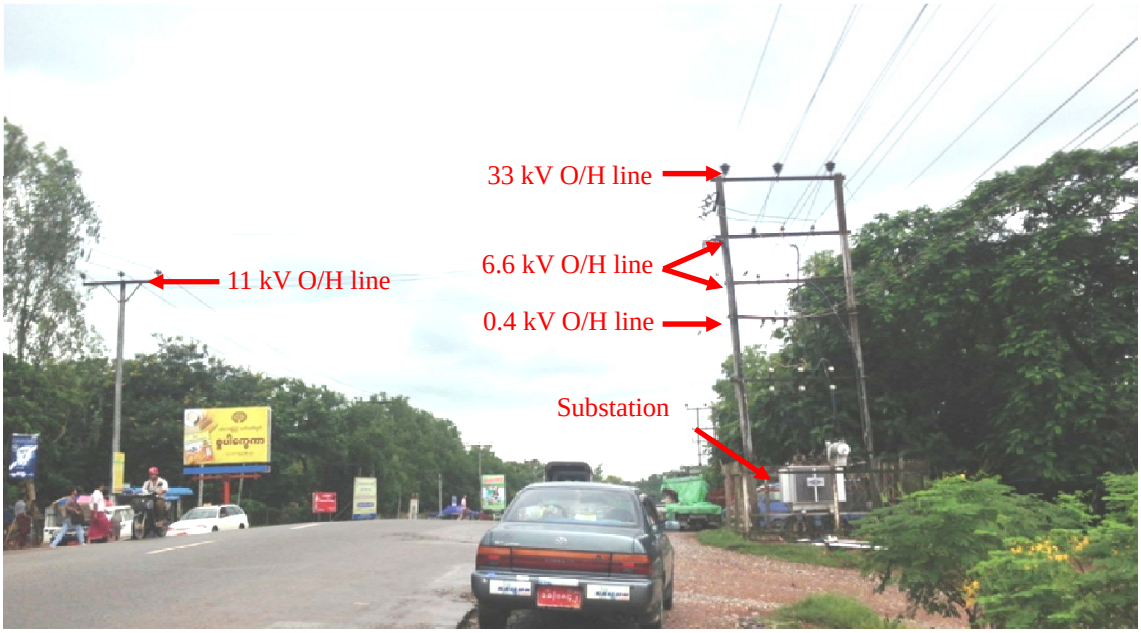
Location	Date	Bicycle	Motor bike	Car	Mini bus	Heavy Bus	Light freight trucks	Heavy freight trucks	
A1	13.9.2013 (Fri)	77	721	213	180	119	54	257	
	14.9.2013 (Sat)	58	969	233	302	92	139	289	
A2	15.9.2013 (Sun)	81	1153	278	384	231	109	338	
	16.9.2013 (Mon)	75	1248	195	293	104	97	246	
A1 and A2 Average	Weekend	70	1,061	256	343	162	124	314	
	Weekday	76	985	204	237	112	76	252	
	PCU Factor	0.2	0.5	1	1	2	1	2	Total
	Weekend (pcu)	14	531	256	343	323	124	627	2,217
	Weekday (pcu)	15	492	204	237	223	76	503	1,749

Source: JICA Study Team

4.2.5 Existing Infrastructure Survey

(1) Power Distribution System

The Yangon City Electricity Supply Board (YESB) manages power distribution systems to the Yangon area, including Thilawa and Thanlyin. Currently, power distribution system along the road from Thanlyin Bridge to Thilawa SEZ supplies primarily from 230/33 kV-100 MVA Thanlyin Main Substation and Ba Yar Gone Substation through overhead line.



Source: JICA Study Team

Figure 4.2.12 Typical Picture of Existing Power Distribution System along the Road

The existing overhead line was installed with concrete poles. The height of poles ranges from 8 m to 20 m. The distance from the current pole to the center line of the road is approximately 5 m. The existing power distribution lines confirmed are given in Table 4.2.7.

Table 4.2.7 Existing Power Distribution Lines along the Road

No.	Type of Power Distribution Line	No. of Feeders	Total Line Length
1	33 kV O/H line	9	23.4 km
2	11 kV O/H line	1	3.8 km
3	6.6 kV O/H line	6	19.3 km
4	0.4 kV O/H line	9	8.1 km

Source: JICA Study Team

The existing transformer was installed on the existing pavement. The substation was built as outdoor type and is air-insulated. The dimensions of a typical existing transformer are 3.5 m (width), 3.5 m (length), and 10 m (height). The existing distribution substations along the road are shown in Table 4.2.8.

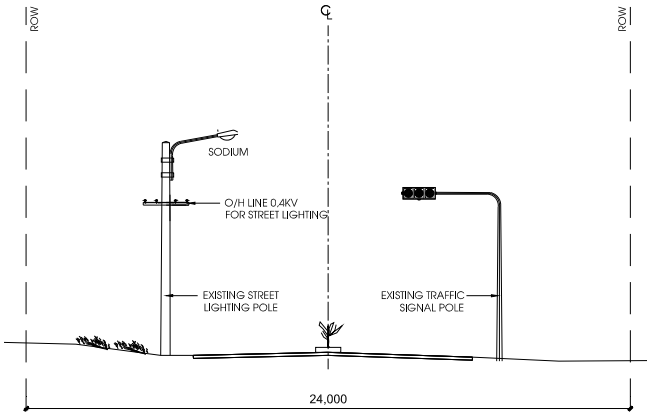
Table 4.2.8: Existing Distribution Substation along the Road

No.	Name of Substation	No. of Transformers	Voltage	Capacity
1	Thaut Taw Kwin (1+2)	2	6.6/0.4 kV	2 x 315 kVA
2	Nann Thar Kone	1	6.6/0.4 kV	1 x 500 kVA
3	Ah Mu Htan	1	6.6/0.4 kV	1 x 500 kVA
4	Yone Taw Kwat	1	6.6/0.4 kV	1 x 500 kVA
5	Forestry Park	1	6.6/0.4 kV	1 x 315 kVA
6	Miyarmiee	1	6.6/0.4 kV	1 x 315 kVA
7	Aung Chan Thar (3)	1	6.6/0.4 kV	1 x 500 kVA
8	GSM	1	6.6/0.4 kV	1 x 50 kVA
9	Pyi Khaing Pyo	1	6.6/0.4 kV	1 x 50 kVA

Source: JICA Study Team

(2) Street Lighting and Traffic Signal System

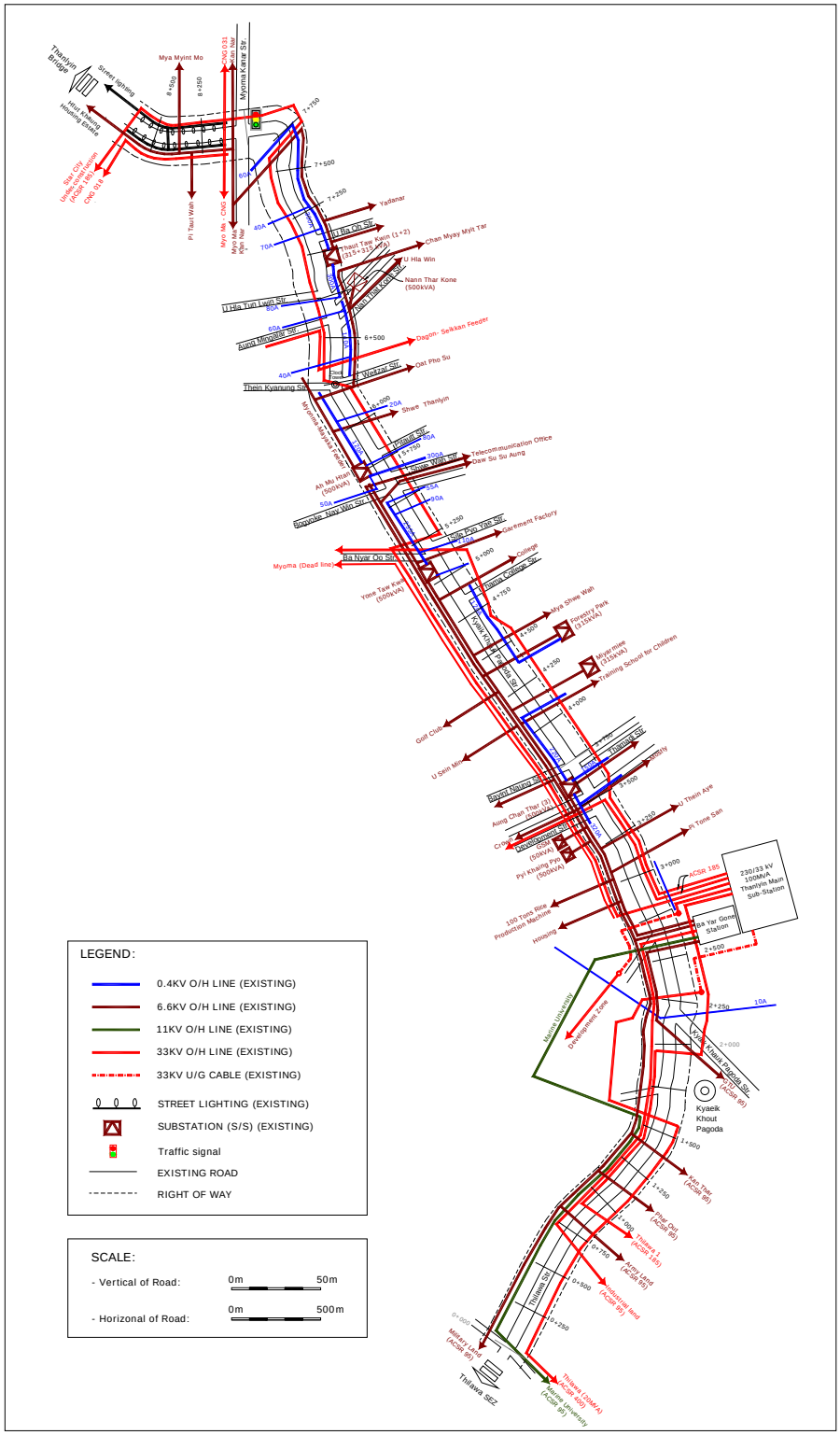
The existing streetlights are installed along the road near Thanlyin Bridge, and made of around 30 lamps (sodium type) at 10 m high concrete poles. There is only one traffic signal system at the intersection of Kyaik Khauk Myoma Kanar Street and Pagoda Street.



Source: JICA Study Team

Figure 4.2.13 Typical Section of Existing Street Lighting and Traffic Signal System

The locations of the existing power supply lines, streetlights, and traffic signals are shown in Figure 4.2.14.

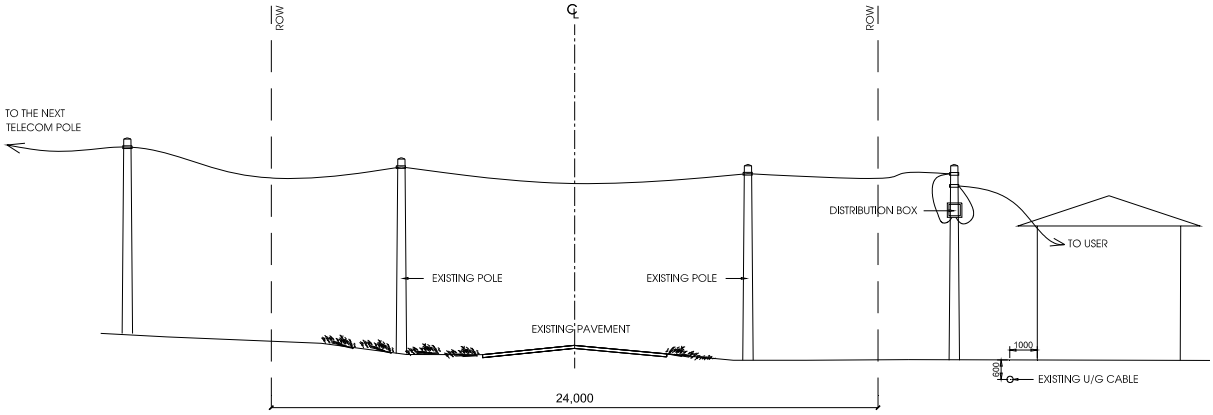


Source: JICA Study Team

Figure 4.2.14 Existing of Power Distribution System, Street Lighting, and Traffic Signal System

(3) Existing Telecommunications System

The Yangon Division Office under Myanmar Post and Telecommunications (MPT) manages telecommunications systems to Thanlyin and Kyauktan. There are two types of telecommunications cables from Thanlyin Exchange Station (underground and overhead). Underground copper cables are buried at the depth of 0.6m and at about 1m distance from existing houses. For overhead telecommunication cables, both optic fiber and copper cables are used. The existing telecommunications cables and systems are summarized in the figures and tables below.



Source: JICA study team

Figure 4.2.15 Existing Telecommunications System

Table 4.2.9 Existing Underground Telecommunications Cable

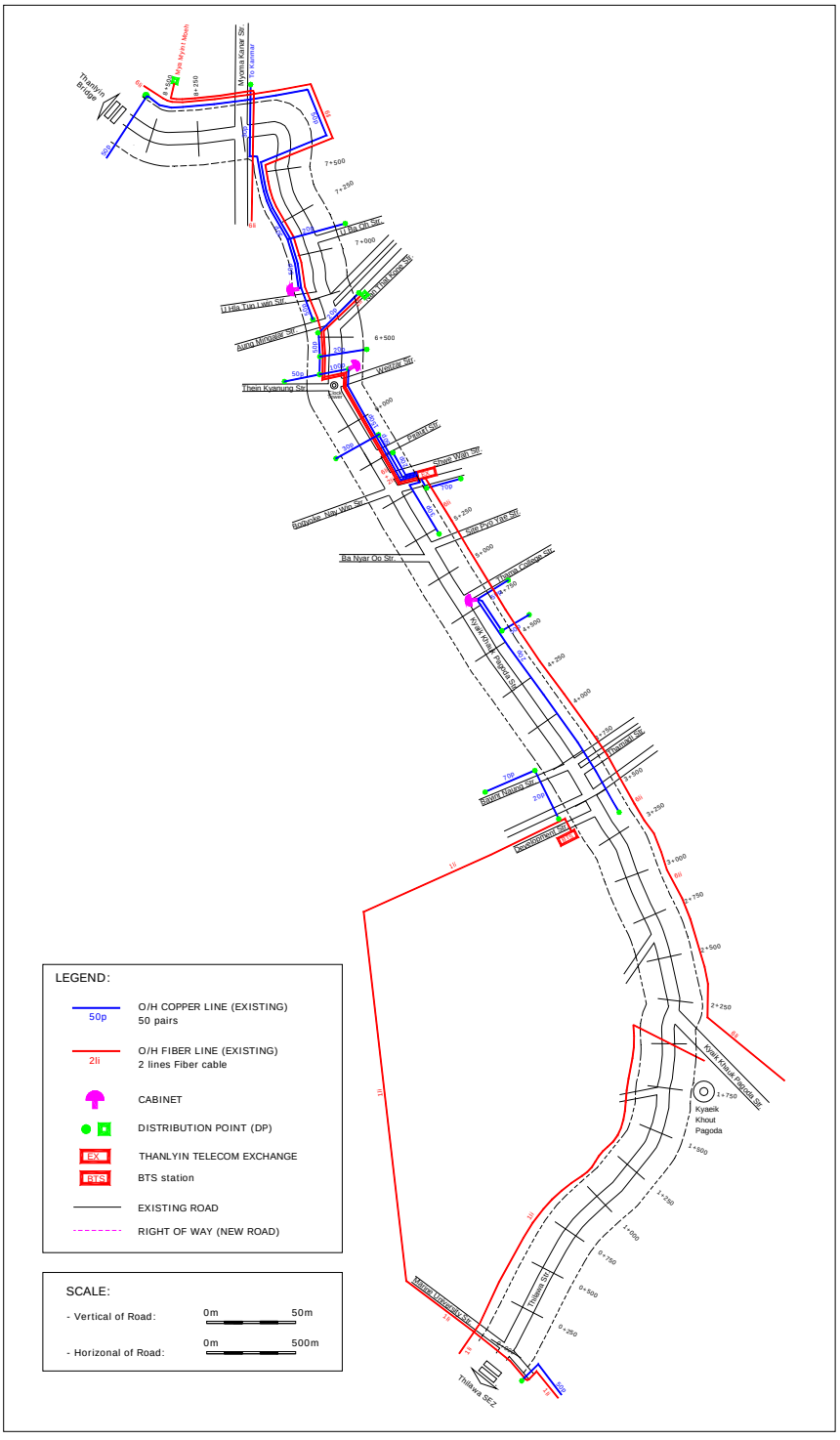
No.	Type of Underground Telecommunications Cable	No. of Feeders	Total Line Length (km)
1	Copper cable 300*2*0.4 mm^2	3	4.5
2	Copper cable 200*2*0.4 mm^2	9	19.5
3	Copper cable 150*2*0.4 mm^2	1	1
4	Copper cable 100*2*0.4 mm^2	5	0.8

Source: JICA Study Team

Table 4.2.10 Existing Overhead Telecommunications Cable

No.	Type of Overhead Telecommunications Cable	No. of Feeders	Total Line Length (km)
1	Copper cable 200*2*0.4 mm^2	1	0.2
2	Copper cable 150*2*0.4 mm^2	1	0.8
3	Copper cable 100*2*0.4 mm^2	1	0.2
4	Copper cable 50*2*0.4 mm^2	7	4.4
5	Copper cable 30*2*0.4 mm^2	3	1.5
6	Copper cable 20*2*0.4 mm^2	4	2.1
7	Fiber cable 6 lines	2	4.8
8	Fiber cable 2 lines	1	1.4
9	Fiber cable 1 line	1	2.3

Source: JICA Study Team



Source: JICA Study Team

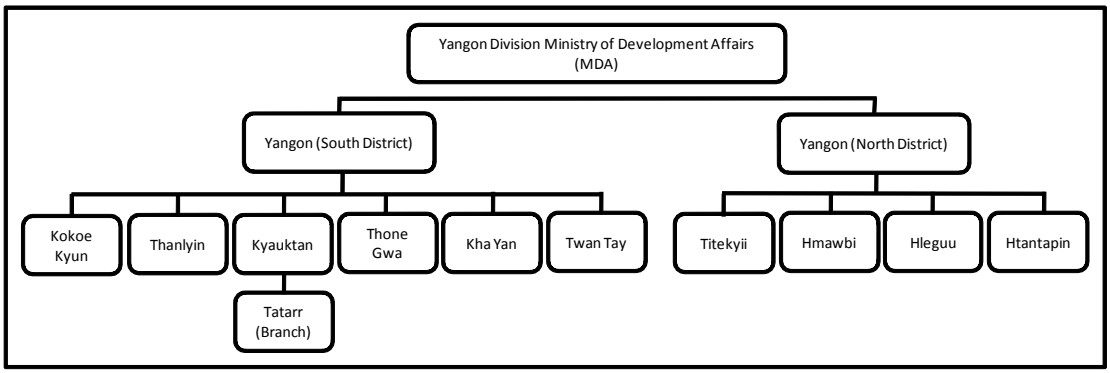
Figure 4.2.16 Existing of Telecommunications System (Location Map)

4.3 Present Conditions of the Drainage and Flood Control System

4.3.1 Institutional Aspects Related to the Drainage Sector

Thilawa SEZ is located at Thanlyin Township and Kyauktan Township. Development committees in both townships carry out public services, such as cleaning of drainage facilities and septic tanks, water supply, and solid waste collection.

Two township development committees belong to Ministry of Development Affairs (MDA), Yangon South Division. The organizational chart of MDA is shown in Figure 4.3.1.



Source: MDA

Figure 4.3.1 Organizational Chart of MDA

4.3.2 Drainage and Flood Control

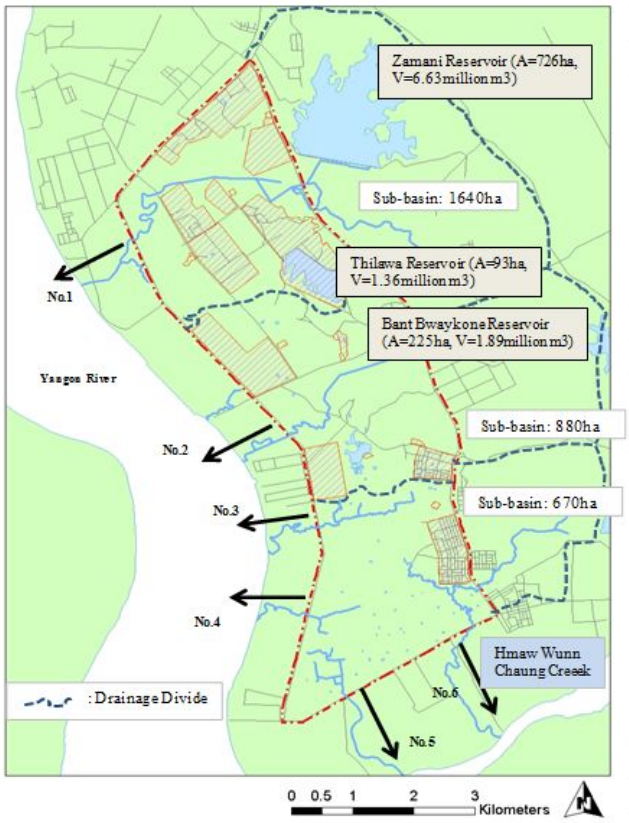
There are no stations that conduct meteorological and hydrological observations in the Thilawa area. The Kaba-Aye Station under the Department of Meteorology and Hydrology (DMH) is the nearest station to Thilawa. The DMH has been recording daily rainfall for more than 40 years, although they do not observe rainfall duration. According to the maximum daily rainfall data provided by DMH, the heaviest daily rainfall observed in the past 20 years (1992-2011) was 242 mm, which was recorded at the Kaba-Aye Station on 22 September 2007.

The main water channels in Thilawa SEZ are the Yangon River and Hmaw Wunn Chaung Creek. Thilawa SEZ is surrounded by Yangon River at west side, Bago River at north side, and Hmaw Wunn Chaung Creek at south side. Hmaw Wunn Chaung Creek is a tributary of the Yangon River which discharges at the southern part of Kyauktan Township.

Stormwater in Thilawa SEZ and the eastern sub-basins is collected by drainage facilities consisting of culverts and canals constructed along the road network and irrigation system. The water then flows into the Yangon River through existing creeks as shown in Figure 4.3.2. For the collection of stormwater and wastewater, a combined sewer system is adopted. This is because sewerage systems are not yet fully established therein.

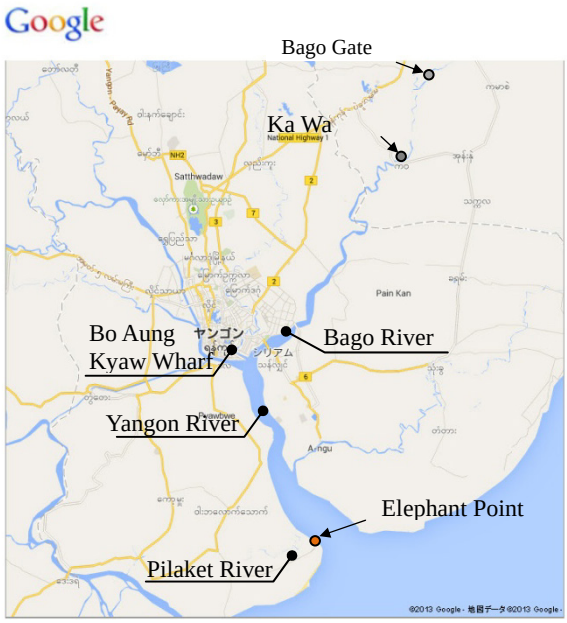
Three water storage reservoirs, namely Zamani, Thilawa, and Bant Bwaykone, have a retention function in the Thilawa area. Existing creeks do not function properly as discharge canals due to

the lack of flow capacity in case heavy rainfall and high tide arise at the same time; however, the Yangon River has enough flow capacity to discharge stormwater to the ocean. The allowable flow of the Yangon River was tentatively estimated to be greater than 226,000 m^3/s based on the sounding data of the Myanmar Port Authority (MPA).



Source: JICA Study Team

Figure 4.3.2 Existing Drainage System in the Thilawa SEZ Area



Source: JICA Study Team

Figure 4.3.3: Location of existing rivers and elephant point

Data on the tide levels of the Yangon River as observed at elephant point (Figure 4.3.3) by MPA are shown in Table 4.3.1. The elephant point is located at the mouth of the Yangon River, 32km south from the Yangon Port. The data of MPA's are converted in accordance with Myanmar's standard sea level.

Table 4.3.1 Hydrological Data on the Yangon River

Description	Datum of Sounding at Elephant Point (m)
Highest HWL (September 1930)	+4.390
MWL at Bo Aung Kyaw Wharf	+0.856
MWL at Pilaket Creek	+0.591
Zero of Tide Gauge at Yangon	-2.265
Lowest LWL (February 1888)	-2.265
High Tide Duration	1.2 hr

Source: MPA

It was reported by DMH that the high water level and low water level in 2011-2012 at the gauge station located at Bago gate of the Bago River, 50km upstream from the mouth of the Yangon River which are 6.63 m and 0.14 m, respectively.

Table 4.3.2 Design Elevation of Myanmar International Terminals Thilawa (MITT)

Description	Design Elevation at MITT (m)
Highest HWL	+4.24
HWL at High Tide	+3.04
Jetty Floor Level	+4.54
Ground Level of MITT	+5.04
Outlet Level	+0.87

Source: MITT

The hydrological data in Tables 4.3.1 and 4.3.2 above are adopted for planning the drainage system in Thilawa SEZ since the flood water level of the Yangon River and the probable rainfall corresponding to each return period have not yet been studied. Large-scale floods rarely happen since the area is protected due to the construction of banks along the Yangon River and the Bago River. The bank elevation is more than 3.83 m. Small-scale floods inside the SEZ happen every year due to the poor drainage system and the influence of high tide at lowland areas near the Yangon River. Areas with elevations of less than 4.5 m are the ones which are mostly flooded based on the results of the inundation interview survey.

4.3.3 Rainfall Intensity

Rainfall intensity formula has not yet been established in Myanmar. The Study on Drainage System of Mingalar Taung Nyunt Area (Drainage Study) has been conducted by Fukken Co., Ltd in cooperation with the Yangon City Development Committee (YCDC) in November 2002. Based on the probable rainfall proposed by the Drainage Study, Talbot's formula, as given below, was used for the analysis of storm rainfall intensities for varying durations. The Drainage Study's formula (YCDC formula) was developed based on the analysis of 31 years of rainfall from 1968 to 2001. The YCDC formula is as follows:

$$I = \frac{K}{t^n}$$

Where, I : Rainfall intensity (mm/hr)

t : Duration (min)

n, K : Constants to be determined for each return period (Talbot Constant)

The results of calculation are summarized in Table 4.3.3.

Table 4.3.3 Rainfall Intensity Obtained Using the YCDC Formula

Return Period	K	n	I
5	1,115	0.7	63
10	1,249	0.7	71
20	1,382	0.7	79
50	1,785	0.7	102
100	1,918	0.7	109

Source: The Study on Drainage System of Mingalar Taung Nyunt Area

Even though the probable rainfall intensity has been proposed, the YCDC formula has not been officially acknowledged. Therefore, the validity of the YCDC formula is examined below.

Tentative Examination Based on Heaviest Rainfall Data in the Recent 20 Years (1992-2011)

Examination of the rainfall intensity (I) was tentatively conducted using the Gumbel formula, as presented in Table 4.3.4. The rainfall intensities obtained by using the YCDC formula were greater than the values from the Gumbel formula. Therefore, the YCDC formula shows safer standards.

Table 4.3.4 Rainfall Intensity

Return Period	2 years	5 years	10 years	20 years	50 years	100 years
I (mm/hr)	42	56	65	74	85	94

Source: JICA Study Team

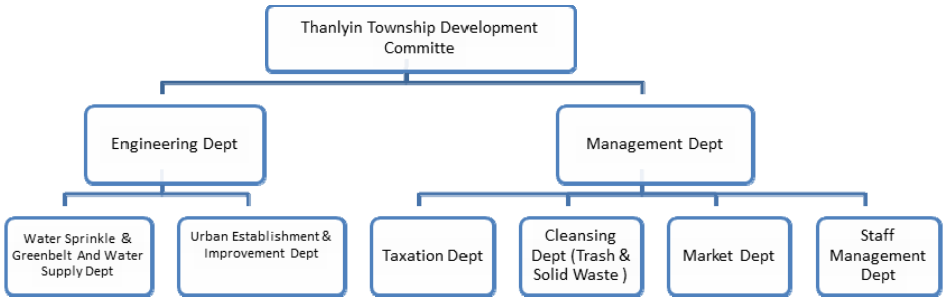
Appropriateness of the YCDC Rainfall Intensity Formula

Whenever there is promotion to invest in Thilawa SEZ, investors have always taken special attention to flood issues due to the recent flooding in Thailand. It is recommended to use the YCDC rainfall intensity for drainage works in road design and land reclamation, because it is in the safe side.

4.4 Present Conditions of the Water Supply System

4.4.1 Institutional Aspects Related to the Water Sector

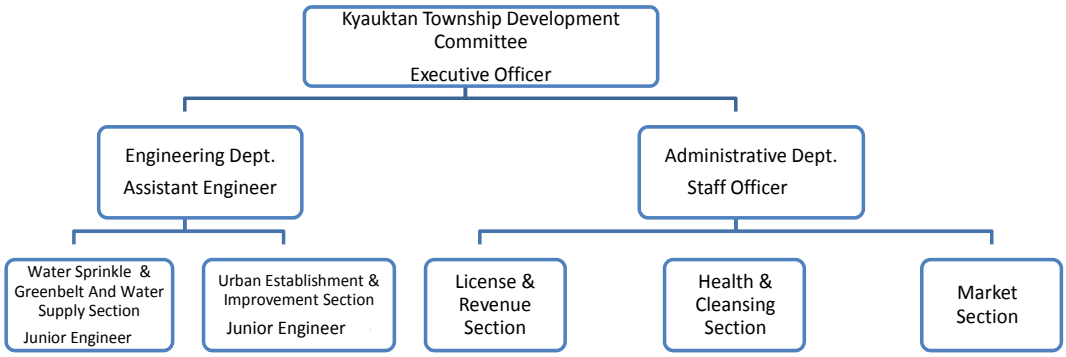
In the Yangon region, the Engineering Department (Water and Sanitation) of YCDC is responsible for the daily management of urban water supply and sanitary facilities in the Yangon City. In Thilawa area township developer committees of Thanlyin and Kyauktan is responsible for water supply and sanitary facilities. The organizational chart of Thanlyin Township is presented in Figure 4.4.1.



Source: Thanlyin Township

Figure 4.4.1 Organizational Chart of Thanlyin Township Development Committee

The organizational chart of Kyauktan Township is shown in Figure 4.4.2.



Source: Kyauktan Township

Figure 4.4.2 Organizational of Kyauktan Township Development Committee

4.4.2 Present Conditions of Water Source and Water Supply

Reservoir (Water Resource)

At present, water sources for the Thilawa area include underground water and surface water which are stored by three water storage reservoirs, namely, Zamani, Thilawa, and Bant Bwaykone, which are located in Thanlyin and Kyauktan Townships, as shown in Figure 4.4.3. In principle, the water right of the river in Myanmar belongs to the Ministry of Agriculture. Zamani Reservoir is used for irrigation only. Thilawa and Bant Bwaykone reservoirs are normally used for water supply, but in the dry season, priority is given to irrigation purposes.

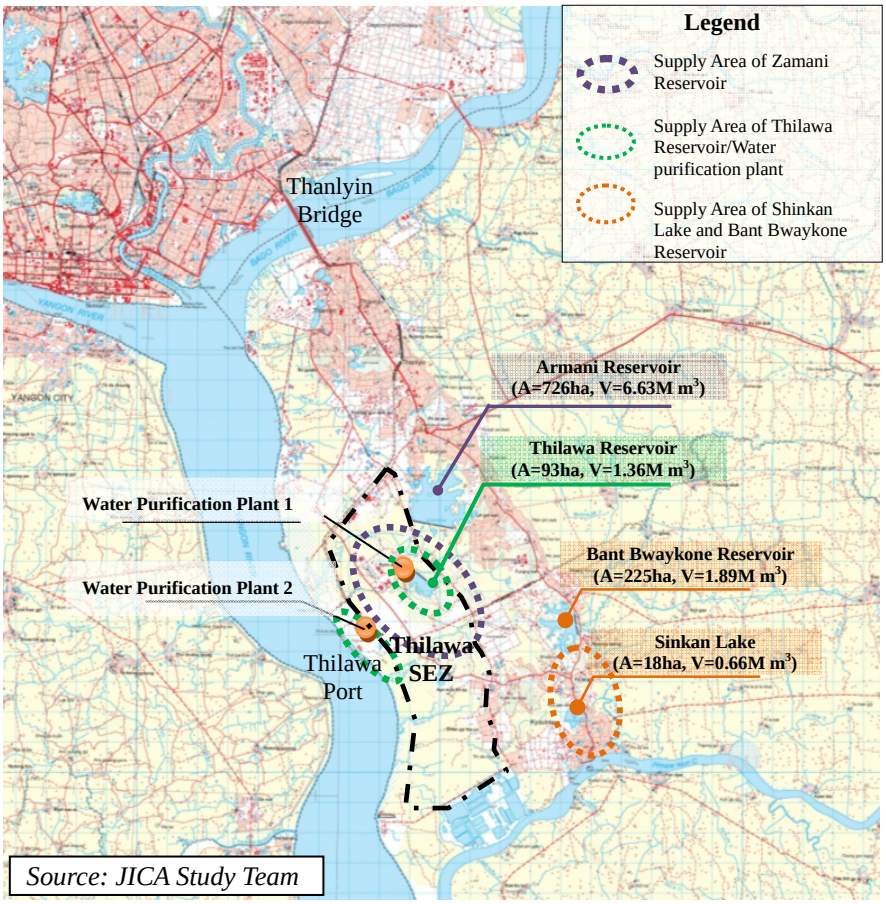


Figure 4.4.3 Location Map of Existing Utilities and Water Resources

The outlines of the three reservoirs are presented in Table 4.4.1.

Table 4.4.1 Existing Water Storage Reservoirs

No.	Description	Bant Bwaykone	Zamani	Thilawa
1	Location	Kyauktan	Thanlyin	Thanlyin
2	Name of Creek	Par Da Creek	Myayaryoe	-
3	Catchment Area (m^2)	2,245,974	7,255,912	930,764
4	Annual Average Rainfall (cm)	254	254	254
5	Annual Average Water Volume (m^3)	4,859,851	11,261,532	N.A.
6	Type of Reservoir	Earth dam	Earth dam	Earth dam
7	Height of Reservoir (m)	7.32	5.79	6.71
8	Height of Embankment (m)	9.75	8.84	10.97
9	Length of Reservoir (m)	N.A	2,316.48	1,341.12
10	Storage Volume (m^3)	1,890,000	6,630,000	1,360,000
11	Dead Storage Volume (m^3)	190,000	410,000	10,000
12	Daily Water Consumption (m^3/d)	6,400	17,045	5,000
13	Completion Year	June 1994	June 1995	1986
14	Construction Cost (MMK Million)	19.86	44.80	4.47
15	Responsible Agency	Ministry of Agriculture and Irrigation (MOAI)	Ministry of Agriculture and Irrigation (MOAI)	Ministry of Industry (MOI), and Ministry of Construction (MOC)

Source: MDA

Regarding to Thilawa Reservoir, MOAI transferred water right to MOC and MOI for operation. The purification plants being managed by Thilawa Water Supply Industry are supplying water to five locations, namely Andawar, Myitta Mon, Myanmar International Terminals Thilawa (MITT), Myanmar International Port Authority (MIPA), and Thilawa Cement & Building Materials (TCBM). The purification plants managed by the MOI are supplying water to five factories, namely Shwe Sahar Company, Kyaw Thau Company (paper packing product factory), TRISTAR Iron Sheet Factory, and Myanmar Garment Factories No.18 and No.19.

The water supply facility of MITT provided by the Thilawa Water Supply Industry is as follows:

- Supplying water area: 750 m * 1,000 m
- Current water consumption: 150 m^3/day
- Plan water consumption: 1,221 m^3/day (when fully developed)
- Underground tank with capacity of 1,000 m^3: one unit
- Water supply RCC tower with 200 m^3 capacity, 40 m height: one unit
- Pump room: one unit

According to an interview with MITT, there has been almost no problem during its 16 years of operations, but only one case of water shortage during the dry season. Water for Thanlyin Kyauktan Industrial Zone which is next to Thilawa SEZ (refer to Figure 4.4.4) was supplied by the own facility below utilizing water from Bant Bwaykone Reservoir

- Ground tank with a capacity of 2,000 m^3: one unit
- RCC Elevated tank with 300 m^3 capacity and 20 m height: one unit
- Pump house: one unit
- Centrifugal pump: three units (30 kW x 1.8 m3/min x 61 m head)
- Distributions: 12” pipeline, 10”, 8”, 6” and 4” PVC Pipelines
- Water price: MMK 300/m^3

The Kyauktan Township Development Committee (KTDC) supplies water to Kyauktan center using a water purification plant with a capacity of 1,000 m^3/day. The served population was estimated at 34,718. Kyauktan’s main water source is the Sinkan Lake. KTDC adds raw water to the plant from the Bant Bwaykone Reservoir of MOAI at a charge of MMK 0.5/m^3.

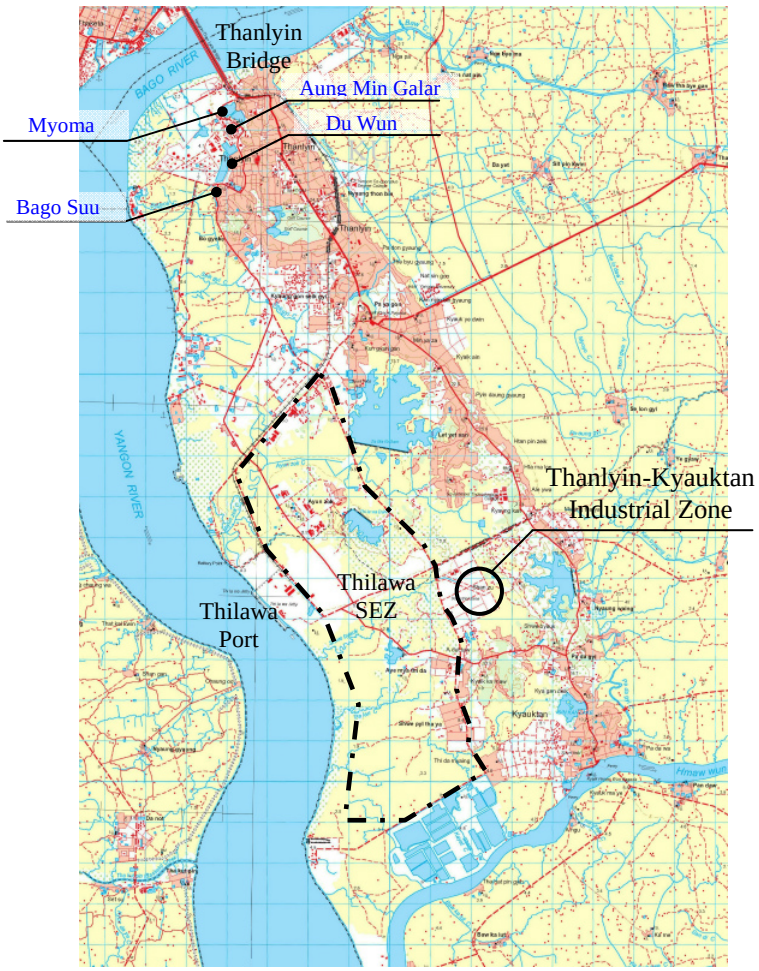
Underground Water Source

The water right of groundwater belongs to different townships. Currently there are four deep wells, as shown in Table 4.4.2, belonging to Thanlyin Township and are supplying water to the city area.

Table 4.4.2 Existing Tube Wells in Thanlyin

	Name of Tube Well	Casing Diameter (in)	Pump Discharge (m3/day)	Depth (m)
1	Duu Wun Street	6	55	85
2	Myo Ma	10	109	90
3	Aung Mingalar	4	55	104
4	Bago Suu	4	55	116

Source: TTDC



Source: JICA Study Team

Table 4.4.4 Location of Thanlyin's Existing Wells

Water Tariff

The monthly water charge for domestic use of Thanlyin Township is fixed at MMK 1,000/household. For other usage, the prices are listed in Table 4.4.3.

Table 4.4.3 Water Tariff of Thanlyin

	Category	Rate by Meter	Fixed Rate
1	Governmental Use		
(a)	Offices, Organizations and Housing	MMK 1.14/gal	-
(b)	Plants and Factories	MMK 1.14/gal	-
2	Public Use		
(a)	Domestic Usage		
	・ Separate Compound, Housing	-	MMK 1,000
	・ Houses and Apartments	-	MMK 1,000
(b)	Commercial		
	・ Factory	MMK 1.14/gal	MMK 20.16

Source: TTDC

The monthly water charge for domestic use in Kyauktan Township is at a fixed price of MMK 2,500/household. Unlike in Thanlyin Township, the price is not different for other uses

and is fixed at MMK 2,500/household. The Thilawa Water Supply Industry of DHSHD collects water fee based on a rate of USD 0.8/m^3. The water tariff rates in Yangon City (YCDC) are shown in Table 4.4.4.

Table 4.4.4 Water Tariff of YCDC

Sr.	Category	Rate by Meter	Meter Unequipped	Fixed Rate
1	Governmental Use			
(a)	Offices, Organizations and Housing	MMK 0.25/gal	Charged based on the estimated amount of usage of water per day	-
(b)	Plants and Factories	MMK 0.35/gal	Charged based on the estimated amount of usage of water per day	-
2	Public Use			
(a)	Domestic Usage			
	Separate Compound, Housing	MMK 0.25/gal	Per month	MMK 1,875
	Houses and Apartments	MMK 0.25/gal	Count per month Collect the charges with invoice per three months	MMK 1,125
(b)	Commercial			
	Construction Industry	MMK 0.35/gal	Count per month	MMK 20.16
	・Businesses invested with local currency	MMK 0.35/gal	Collect the charges with invoice per three months (based on the estimated amount of water usage per ft^2)	

Water tariff for respective industries collected in foreign currency, USD

Sr.	Kind of Industry	Rate by Meter	Fixed Rate
1	Hotels and inns invested with foreign currency	USD 4/1,000 gal	USD 0.5/visitor/day
2	Plants, factories, shopping malls, superb buildings	USD 4/1,000 gal	
3	Separate compound rent in foreign currency, buildings and residents	USD 2/1,000 gal	USD 25/month

Source: YCDC 4.4.3

4.4.3 Water Quality of Sources and Maximum Permissible Level

The water qualities of the Yangon River, the Bago River and the Hmaw Wunn Chaung Creek are presented in Table 4.4.5.

Table 4.4.5 River Water Quality and Maximum Permissible Level

Parameter	Unit	Yangon River*1 Date: 06/04/05	Bago River*2 Date:14/10/05	Hmaw Wunn Chaung Creek*3 Date: 31/05/05	Maximum Permissible Level*4
Appearance		Turbid	Rusty, Turbid	Rusty, Turbid	-
Color	Unit	450.0	1300.0	500.0	50
Turbidity	NTU	990.0	176.0	2,750.0	25
pH		8.0	7.8	7.9	6.5 to 9.2
Total Solids	mg/L	12,742	334.0	3,0784.0	1,500
Total Hardness (CaCO3)	mg/L	1,195	68.0	3,240.0	500
Total Alkalinity	mg/L	90.0	20.0	83.0	-
Calcium (Ca)	mg/L	105.6	15.2	392.0	200
Magnesium (Mg)	mg/L	260.6	8.7	632.8	150
Chloride (Cl)	mg/L	3,245.0	14.2	5,369.0	600
Sulfate (SO4)	mg/L	79.6	38.4	38.4	400
Total Iron	mg/L	25.6	8.8	41.6	1.0
Arsenic (As)	mg/L	-	-	-	0.05

Note: *1: near Thilawa Port, *2: near Ka Wa (figure 4.4.3), *3: 1 mile upstream from Kyauktan, *4: Ministry of Health

Source: DHSHD

Due to the severe saltwater intrusion in the Yangon River and the Hmaw Wunn Chaung Creek, it is not recommended that these two rivers are used as water resources. On the other hand, although having a high turbidity, it is possible for Bago River to be used as water resource referring to the above lab test results. One issue of concern is that because the downstream of the Yangon River and the Hmaw Wunn Chaung Creek have already been intruded by saltwater, it is highly possible that the Bago River has also been intruded by saltwater.

The water quality of the three reservoirs and one lake in the Thilawa area, and their maximum permissible levels are presented in the Table 4.4.6. All water quality parameters satisfy the maximum permissible limits to be water resources.

Table 4.4.6 Water Quality of Reservoirs and Maximum Permissible Level

Parameter	Unit	Bant Bwaykone Date: 30/07/04	Zamani Date: 30/07/04	Thilawa Date: 30/08/04	Sinkan Lake Date: 11/02/10	Maximum Permissible Limit
Appearance		Slightly Turbid	Rusty	Rusty	-	-
Color	Unit	54.0	30.0	14.0	25.0	50
Turbidity	NTU	8.8	2.2	2.2	10.0	25
pH		7.0	6.5	8.7	7.3	6.5 to 9.2
Total Dissolved Solids	mg/L	252.0	90.0	104.0	308.0	1,500
Total Hardness (CaCO3)	mg/L	16.0	14.0	27.0	56.0	500
Total Alkalinity	mg/L	14.0	13.0	20.0	-	-
Calcium (Ca)	mg/L	2.4	2.4	6.4	8.0	200
Magnesium (Mg)	mg/L	2.8	2.2	3.1	10.1	150
Chloride (Cl)	mg/L	130.4	58.4	44.0	18.5	600
Sulfate (SO4)	mg/L	11.5	5.8	18.2	15.4	400
Total Iron	mg/L	1.4	1.6	1.0	1.0	1.0
Arsenic (As)	mg/L	-	-	-	0.002	0.05

Source: DHSHD

The water quality of 4 tube wells at Thanlyin and their maximum permissible levels are presented in Table 4.4.7 below.

Table 4.4.7 Water Quality of Tube Wells and Maximum Permissible Limit

Parameter	Unit	Duu Wun 17/07/2007	Myoma 17/07/2007	Bago Suu 17/07/2007	Aung Mingalar 17/07/2007	Maximum Permissible Limit
PH	mg/L	6.95	6.93	6.82	6.93	6.5 to 8.5
Total Hardness ($CaCO_3$)	mg/L	90	75	0	10	500
Total Dissolved Solvents (TDS)	mg/L	228	198	60	80	1,000
Turbidity	NTU	20	80	5	40	5.0
Electrical Conductivity	µs/cm	384	344	105	147	1,500.0
Fluoride (F)	mg/L	0.5	0.55	0.3	0.35	-
Nitrate (NO_3)	mg/L	0.063	0.051	0.032	0.043	-
Iron (Fe)	mg/L	2.53	2.21	0	2.08	1.0
Arsenic (As)	mg/L	0	0	0	0	0.05

Source: TTDC

These wells are already used as water source. Iron content is high, but water quality has no problems in particular.

4.4.4 Drinking Water Standards

The drinking water standards of Myanmar basically follow the WHO standards as presented in Table 4.4.8.

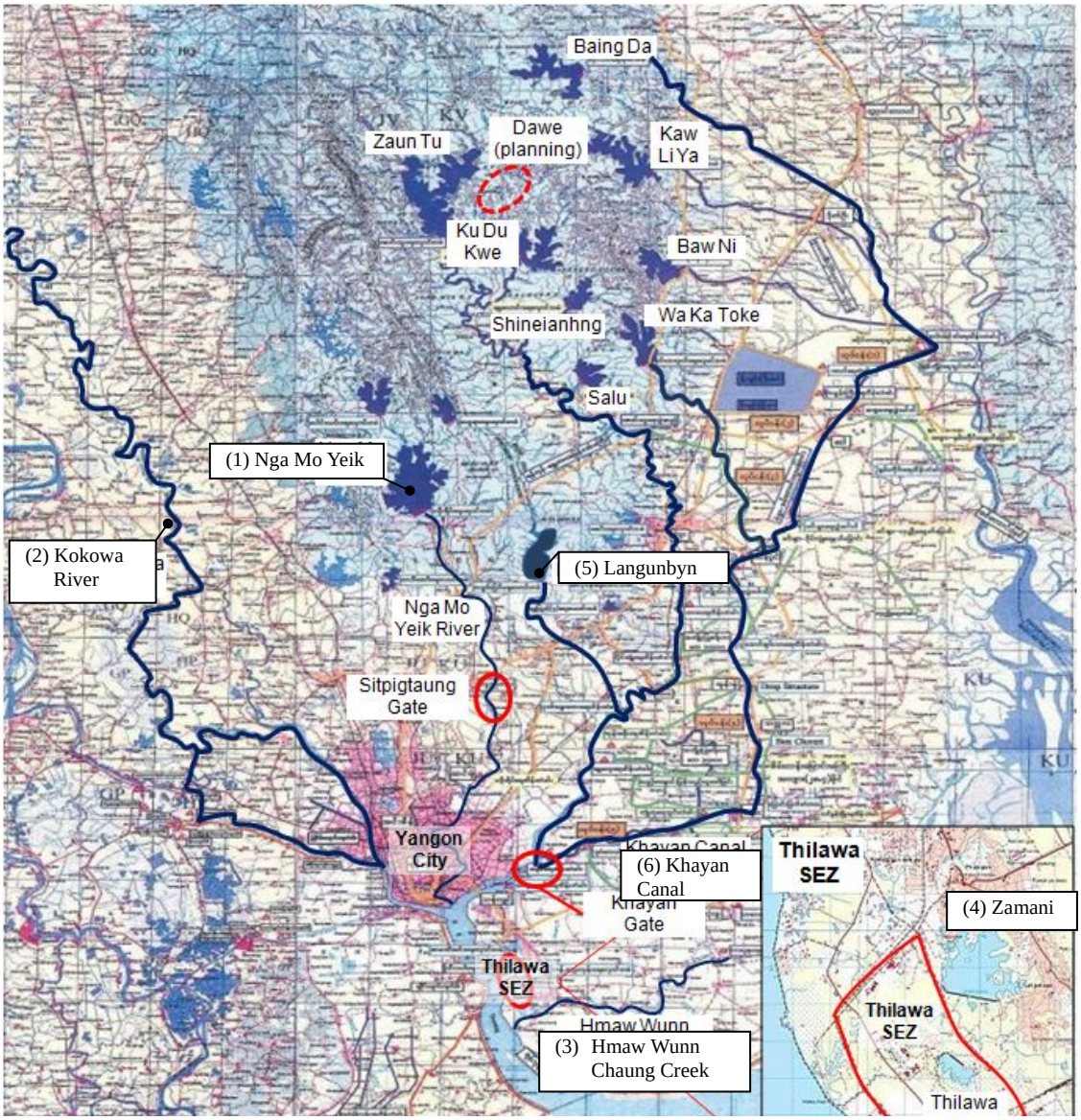
Table 4.4.8 Drinking Water Standards

No.	Items	Unit	Myanmar Standard		WHO Guidelines (The 4th Version)
			Present	2011 Revised Draft	
1	pH Value	-	6.5-9.2	6.5-8.5	Preferably less than 8
2	Turbidity	NTU	20.00	5.00	5.00
3	Color	Unit	5-50	15.00	15.00
4	Aluminum (Al)	mg/L	0.20	0.20	0.20
5	Arsenic (As)	mg/L	0.05	0.05	0.01
6	Calcium (Ca)	mg/L	75-200	100.00	-
7	Chloride (Cl)	mg/L	200-600	250.00	250.00
8	Copper (Cu)	mg/L	1.00	2.00	1.00
9	Cyanide (CN2)	mg/L	0.05	0.07	0.07
10	Hardness	mg/L	500.00	500.00	-
11	Iron (Fe)	mg/L	0.5-1.5	1.00	0.30
12	Manganese (Mn)	mg/L	0.30	0.3(0.1)	0.10
13	Lead (Pb)	mg/L	0.05	0.01	0.01
14	Magnesium (Mg)	mg/L	30-150	500.00	-
15	Nitrate (NO3)	mg/L	10(as N)	50.00	-
16	Sulfate	mg/L	400.00	250.00	250.00
17	Total Dissolved Solids (TDS)	mg/L	1,000.00	1,000.00	1000.00
18	Zinc (Zn)	mg/L	5-15	3.00	3.00
19	Total Coliform	Number/100 mL	0.00	0.00	0.00
20	E. Coliform	Number/100 mL	0.00	0.00	0.00

Source: YCDC

4.4.5 Water Sources

Candidate water sources have been mentioned in discussion with related organizations. The brief information is described in Figure 4.4.5.



Source: ID/YCDC

Figure 4.4.5 Candidate Water Sources for Thilawa

(1) Nga Mo Yeik Reservoir

The Sitpigtaung intake located at the Nga Mo Yeik River in the northeast of the Yangon region shall be constructed by YCDC. Its intake is expected to start its operation in 2016. The capacity of water supply is approximately 204,600 m^3/day. YCDC intends to utilize the Nga Mo Reservoir for the water supply of Yangon City only, since Yangon City has been confronted with severe water shortage.

(2) Kokowa River

The Kokowa River is a tributary of the Yangon River located in the western part of the Yangon region. The Kokowa River is expected that it has not yet been intruded by saltwater. Allowable exploitation of raw water from the river is estimated at 405,000 m^3/day according to the YCDC Water Supply M/P. The Kokowa River water supply scheme is expected to be implemented by

2025. When the Kokowa River water supply scheme is completed, YCDC shall be allowed to supply water to Thilawa SEZ area including Thanlyin Township and Kyauktan Township.

(3) Surface Water and Underground Water at the Hmaw Wunn Chaung Creek Area

Surface water and groundwater of the Hmaw Wunn Chaung Creek have high potential for water resources development according to MOAI. However, due to salt pollution, water quality should be seriously concerned. Therefore, further water source survey along the Hmaw Wunn Chaung Creek area would be necessary to be carried out.

(4) Zamani Reservoir and Underground Water in the Thilawa Area

MOAI has approved to extract water from the Zamani Reservoir at a design raw water supply rate of 3,000 m^3/day in order to meet the water requirements for the short-term development of Class A. The water purification plant (WPP) will be constructed by a Class A developer. Currently, regarding underground water development, four boreholes have been developed by the JICA Study Team with a design pump rate of 3,000 m^3/day. It is necessary to carry out studies on the effect of continuous pumping on aquifers.

(5) Langunbyn Reservoir

The MOAI has approved to extract water from the Langunbyn Reservoir at a design raw water supply rate of 52,500 m^3/day in order to meet the water demand of Class A (42,000 m^3/day). WPPs and water transmission pipelines shall be constructed by YCDC. Water supply from the Langunbyn Reservoir has the most prospective scheme in securing a stable and safe Class A water source.

(6) Khayan River Irrigation Route

The Khayan intake is located near Chaung Wa Village in Thanlyin Township, 25 km east of Thilawa SEZ, as shown in Figure 4.4.3. The Khayan sluice gate was constructed in 2006 for inundation protection, running of seawater and provision of domestic water and irrigation water. The water source of the Khayan River is the Wa Ka Toke Reservoir, which is located 100 km upstream of the Bago River from the Khayan gate. The reservoir has a capacity of 40 million m^3 and according to the Khayan river gate manager, there is no salt pollution. Summary of the Khayan River gate is as follows:

a. Location : Chaung Wa Village, Thanlyin Township
b. Name of River : Khayan River
c. Catchment Area : 367.62 km^2
d. Size of RC Sluice Gate : 1.8 m width x 4.9 m height x 40 units
e. Served Area : 121.4 km^2
f. Implementation Period : 2003 to 2006
g. Project Cost : MMK 1,659 million

Source: JICA Study Team

Figure 4.4.6 Langunbyn Reservoir

Source: JICA Study Team

Figure 4.4.7 Khayan River and Gate

MOAI intends to connect the Khayan River with three upper reservoirs, which have a total capacity of 145 million m^3, according to the Irrigation Master Plan for East of Bago River Region and Yangon Region (2004, MOAI). The construction is expected to be completed in 2016. Additionally, MOAI has four other reservoirs (Zaun Tu, Ku Du Kwe, Shineianhng, and Salu), which have a total capacity of 264 million m^3. The total capacity of the seven reservoirs supplying to the Khayan River shall be 405 million m^3.

General Issues

The most practical method is to use Zamani Reservoir (which has proper water quality and does not require to water right adjustment) as a short-term water resource, and Langunbyn Reservoir as a medium-term water resource. It is necessary to carry out further studies regarding the long-term water resource considering the water management plan in the whole Yangon region and economic factors.

4.5 Present Conditions of the Sewerage System

4.5.1 Institutional Aspects

For Yangon City, the Engineering Department (Water and Sanitation) of YCDC is responsible for the daily management of urban sewerage system; although both Thanlyin and Kyauktan township development committees have yet to organize a responsible sector for sewerage. The cleansing department of Thanlyin Township conducts cleaning of septic tanks and pit latrines in response to requests from residents.

4.5.2 Present Condition

Wastewater and separate sewerage systems have not been established yet even in Yangon City. There is one wastewater treatment plant (WWTP) in Yangon City. However, currently it is not well functioned due to inadequate operation and maintenance. Similarly, Domestic and commercial wastewater are not well controlled. Although wastewater is disposed to individual

septic tanks and pit latrines, raw sewerage is often discharged directly to ditches and combined culverts without proper treatment.

Source: YCDC

Figure 4.5.1 Location of Yangon WWTP

4.5.3 Industrial and Municipal Wastewater Effluent Standard

Shown in Table 4.5.1 are the industrial wastewater effluent standards as determined by MOI. Factories shall conform with the effluent standards for certification on their discharge of sewage and process wastewater.

Table 4.5.1 Industrial Wastewater Effluent Standard

No	Items	Allowable Rate	Unit	Remarks
1.	BOD (5 days at 20ºC)	Max. 20-60	ppm	Depending on geography of waste discharging point.
2.	Suspended Solids	Max. 30	ppm	-
3.	Dissolved Solids	Max. 2,000	ppm	-
4.	COD Permanganate Value	Max. 60	ppm	-
5.	Sulphide (as HS)	Max. 1	ppm	-
6.	Cyanide (as HCN)	Max. 0.2	ppm	-
7.	Oil and Grease	Max. 5	ppm	-
8.	Tar	None	-	-
9.	Formaldehyde	Max. 1	ppm	-
10.	Phenols and Cresols	Max. 1	ppm	-
11.	Free Chlorine	Max. 1	ppm	-
12.	Zinc	Max. 5	ppm	-
13.	Chromium	Max. 0.5	ppm	-
14.	Arsenic	Max. 0.25	ppm	-
15.	Copper	Max. 1.0	ppm	-
16.	Mercury	Max. 0.005	ppm	-
17.	Cadmium	Max. 0.03	ppm	-
18.	Barium	Max. 1.0	ppm	-
19.	Selenium	Max. 0.02	ppm	-
20.	Lead	Max. 0.2	ppm	-
21.	Nickel	Max. 0.2	ppm	-
22.	Insecticides	None	-	-
23.	Radioactive Materials	None	-	-

No	Items	Allowable Rate	Unit	Remarks
24.	Temperature	Max. 40	ºC	-
25.	Color and Odor	-	-	Not objectionable when mixed in receiving water.

Source: MOI

Shown in Table 4.5.2 are the municipal wastewater discharge standards as determined by MOAI.

Table 4.5.2 Municipal Wastewater Effluent Quality Standards

Pollutant or Parameter	Unit	Limit
pH	–	9-6
BOD	mg/L	50
COD	mg/L	250
Oil and grease	mg/L	10
TSS	mg/L	50
Metals		
Heavy metals, total	mg/L	10
Arsenic	mg/L	0.1
Cadmium	mg/L	0.1
Chromium		
Hexavalent	mg/L	0.1
Total	mg/L	0.5
Copper	mg/L	0.5
Iron	mg/L	3.5
Lead	mg/L	0.1
Mercury	mg/L	0.01
Nickel	mg/L	0.5
Selenium	mg/L	0.1
Silver	mg/L	0.5
Zinc	mg/L	2
Cyanide		
Free	mg/L	0.1
Total	mg/L	1
Ammonia	mg/L	10
Fluoride	mg/L	20
Chlorine, total residual	mg/L	0.2
Phenols	mg/L	0.5
Phosphorus	mg/L	2
Sulfide	mg/L	1
Coliform bacteria	MPN/100 mL	<400
Temperature increase		<3 °C

Source: Irrigation Department, MOAI

4.5.4 Regulations on Pretreatment for Factories

Mingaladon Industrial Park (MIP) in Yangon stipulates the wastewater discharge standard in the lease contract as presented in Reference 1: Additional Condition for Lease of Mingaladon Industrial Park below.

Reference-1 "Additional Condition for Lease of Mingaladon Industrial Park"

Chapter IIV Utilities Codes
D. Waste Water

a) Sewerage of the Waste Water shall be by concrete pipes or PVC pipes.
b) The quality of the Waste Water discharged from the Land shall be properly monitored by both the Lessee and the Lessor by means of routine sampling.
c) Connection to the sewer line:
i) The Lessee shall submit an application, in writing, together with drawings, to the Lessor;
ii) The quantity and quality of the Waste Water to be discharged and proposed connection date shall be mentioned in such application.
d) Other provisions:
i) Any Lessee producing Waste Water that has not fulfilled the Waste Water quality standards required by the MIP, as specified in the Attachment 9 contained in the Conditions, and utilizing the Waste Water Treatment Plant of the MIP, shall be obliged to construct a Primary Waste Water Treatment Plant at its own cost in the Land in order that the Waste Water discharged by the Lessee fulfills the quality standards of the MIP.
ii) The construction of the Primary Waste Water Treatment Plant by the Lessee must follow the system specified in Attachment 2.
iii) Any violation of the Waste Water quality, as determined by the MIP and/or the Government, shall result in the temporary closure of the Lessee's Industrial Water Supply and Waste Water outlet. Such closure shall be carried out after the Lessee' s failure to meet the quality standards, notwithstanding having been sent three (3) warning letter by the Lessor. All consequences and /or losses resulting from such closure shall be the full responsibility of the Lessee.
iv) The temporary closure of the Lessee's Industrial Water supply and Waste Water outlet shall be lifted only after the Lessee has taken all necessary measures to comply with all the Waste Water quality standards mentioned above.

Mingaladon Industrial Park
Additional Condition

ATTACHMENT 9

WASTE WATER QUALITY CRITERIA

PARAMETER		UNIT	MAXIMUM ALLOWABLE LIMIT
PHYSICAL			
Temperature		°C	35
Dissolved Solids		mg/l	1,000
Suspended Solids		mg/l	200
CHEMICAL			
pH		units	6-9
Iron	(Fe)	mg/l	5
Manganese	(Mn)	mg/l	0.5
Zinc	(Zn)	mg/l	5
Copper	(Cu)	mg/l	0.5
Chromium Hexav.	(Cr^{6})	mg/l	0.1
Cadmium	(Cd)	mg/l	0.01
Total Mercury	(Hg)	mg/l	0.005
Boron	(B)	mg/l	1
Nickel	(Ni)	mg/l	0.1
Phosphate	(PO_4-P)	mg/l	1
PCB		mg/l	0.003
Lead	(Pb)	mg/l	0.1
Arsenic	(As)	mg/l	0.05
Selenium	(Se)	mg/l	0.01
Cyanide	(CN)	mg/l	0.02
Sulphur	(S)	mg/l	0.01
Fluorine	(F)	mg/l	1.5
Chlorine	(Cl_2)	mg/l	1
Chloride	(Cl)	mg/l	600
Sulphate	(SO_4)	mg/l	400
Free Ammonia	(NH_3-N)	mg/l	0.5
Nitrate	(NO_3-N)	mg/l	10
Nitrite	(NO_2-N)	mg/l	1
Oxygen Demand			
Biology	(BOD)	mg/l	240
Chemical	(COD)	mg/l	500
Blue Active Compound Methylene (Mixed Active Methyl Blue)		mg/l	0.5
Phenol		mg/l	0.002
Vegetable Oil & Fats		mg/l	30
Mineral Oil (Hydrocarbon)		mg/l	10
MBAS (Detergent)		mg/l	0.5
Radioactivity*			

Note: 1. Radioactivity* concentration follows the valid regulations.
2. No substances constituting an obstacle to the biological treatment process shall be included.

4.6 Present Condition of Solid Waste Management

4.6.1 Current Solid Waste Management in Greater Yangon

(1) Responsible Organization and Related Regulations

The Pollution Control and Cleansing Department (PCCD) of YCDC is responsible for solid waste management within Yangon region. PCCD handles most of the waste collected from industries. Solid waste generated in wards of townships outside of YCDC, such as Thanlyin and Kyauktan, are collected by township development committee. In some townships, waste collection services are not provided to all wards. People outside of the service area of the development committee have to dispose their wastes by themselves as well as rural villages.

The bylaws of YCDC (Pollution Control and Cleansing Law, Order No.10/99) stipulate seven waste categories as shown in Table 4.6.1 below. Since PCCD in Thanlyin and Kyauktan are not operated well, it is difficult for them to deal with industrial waste. The Thilawa SEZ management committee decided to rely on PCCD of YCDC for solid waste collection.

It is recognized that industrial waste is included in factory waste. Solid waste other than normal waste is not allowed to be put into waste bins and placed on roadsides in the city. Such waste must be deposited in waste bins which have been designated by YCDC.

Table 4.6.1 Solid Waste Categories as Defined in YCDC Bylaws

Waste Category	Definition
Normal waste	Kitchen and other waste, apart from garden waste, factory waste, construction waste, and commercial waste.
Garden waste	Waste from pruning/cutting trees, grass, bushes within compound and broken parts of house and furniture.
Factory waste	Waste materials thrown away from factory.
Construction waste	Waste materials thrown away from construction sites.
Commercial waste	Waste materials thrown away from commercial businesses.
Filthy waste	Dead animals, muck from animals, blood, liquid or dirt.
Hospital waste	Waste materials thrown away from state-owned hospitals, organization-owned hospitals, private-owned hospitals and clinics

Source: Pollution Control and Cleansing Law, Order No.10/99

The Ministry of Environment Conservation and Forestry (MOECF) issued the Environment Conservation Law in March 2012. While the law gives the basic policy for environmental protection, the detailed rule will be decided by the Environmental Conservation Rules, which are being prepared by MOECF. The types of industrial waste including hazardous materials and the classifications of hazardousness will be defined in the rules.

This law also mentions that the entity or the person running a business or a factory in industrial zones or SEZs shall financially contribute to waste management and sanitation.

(2) Solid Waste Management by YCDC

PCCD of YCDC implements waste collection and transportation for residence and business entities in YCDC area as public service. Waste is disposed at dumping sites after transportation.

There are several collection methods in the city, which include 1) door-to-door collection by push cart or truck, 2) a collection point method using temporary waste tank placed in a certain area, and 3) curbside collection by waste bins placed on roadsides of populated areas.

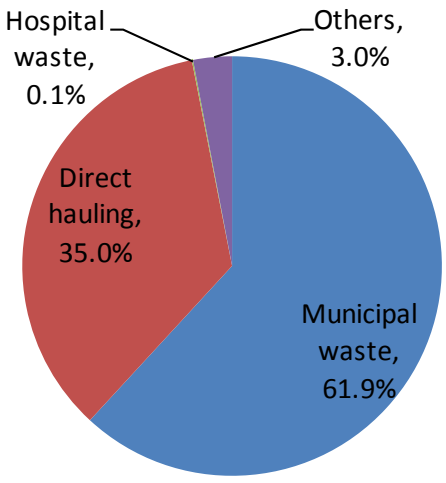
There are two major dump sites, namely the Htein Bin and Htawe Chaung dump sites, and five temporary dump sites. All of these are open dump sites without any environmental protection measures. The amount of waste collected and disposed in 2007-2011 was 1,250-1,400 t/day.

PCCD in Thanlyin does not carry out appropriate final waste treatment. PCCD just simply uses one truck to collect garbage in the city and dispose wastes at the disposal area in the Bago River.

On the other hand, PCCD in Kyauktan owns the final disposal area in the Hmaw Wunn Chaung Creek, but there is no garbage collection vehicle. Therefore, for large garbage collection works, Kyauktan's PCCD subcontract the works to Thanlyin's PCCD.

(3) Industrial Solid Waste Management System

According to YCDC data, while there is a category of factory waste in the bylaws of YCDC, the amount of its generation is still unclear. The ratio of disposed waste amounts is shown in Figure 4.6.1.



Source: YCDC

Figure 4.6.1 Ratio of Waste Disposal

1) Non-hazardous Waste

Wastes generated in factories are collected by PCCD's "on-call system", which is operated by request basis from waste generators. Direct waste hauling to dump sites by waste generators is also practiced. Non-hazardous factory waste can be disposed at dump sites without distinguishing it from municipal waste, such as normal waste and commercial waste.

The ratio of direct hauling industrial waste (non-hazardous) to final disposal site in 2011 was 35% which is about 460 t/year.

2) Hazardous Industrial Waste

Though there is not much regulation on hazardous waste, PCCD occasionally treats and disposes materials recognized as hazardous.

Hazardous industrial wastes treated and disposed between 2005 and 2011 are shown in Table 4.6.2. It is understood that the materials that can be treated by YCDC are very limited because of their low capability and lack of appropriate facilities.

Table 4.6.2 Records of Disposal of Hazardous Waste

	Year	Type of Waste	Disposed (t)	Method
1	2005	Expired Medicine	4.55	Deep Well
2	2006	Expired Medicine	2.27	Deep Well
3	2007	Paint Residue	2.00	Deep Well
		Melamine Milk Powder	88.00	Incinerator
4	2008	Expired Medicine	36.85	Deep Well
5	2009	Paint Residue	18.02	Deep Well
		Expired Medicine	15.21	Deep Well
6	2010	Expired Medicine	18.70	Deep Well
7	2011	Damaged Sulfur	150.00	Deep Well
		Paint Residue	2.20	Deep Well
		Expired Medicine	14.90	Deep Well
		Total	352.70	
		Average	approx. 50	t/yr
			approx. 0.14	t/d

Source: PCCD, YCDC

(4) Solid Waste Management in the Industrial Zone

Most of the waste generated in the existing industrial zones is disposed of at dump sites operated by YCDC. The methods for waste collection and transportation may vary at each industrial zone.

Temporary waste tanks are placed in small-scale zones. Wastes that are deposited in the tanks are regularly collected by PCCD. In case that a certain amount of waste is generated at once in factories, these factories should request PCCD to collect their waste as “on-call”. There is also a managing committee assigned to an industrial zone which is responsible for the vehicles for collection and transportation of waste generated from factories to final disposal site within the zone.

For large-scale industrial zones, the managing committee requires each factory to be responsible for its own waste management. Temporary waste tanks shall not be provided in the zone and PCCD shall not collect their waste. Factories may either request on-call collection or transport their waste using their own trucks. It was said that waste from some factories are being used for land reclamation. A summary of industrial waste management is shown in Table 4.6.3.

Table 4.6.3 Waste Management in the Industrial Zone

Body	Collection and Transportation	Final Disposal
Managing committee, factories	-By owned trucks	-Direct hauling to PCCD’s dump sites -Land reclamation in low area of zone
YCDC upon request by factories	-On-call -Regular collection to temporary waste tank located in the industrial zone	-Final disposal at PCCD’s dump sites

Source: JICA Survey Team

(5) Waste Service Fee

1) Tariff of YCDC

The tariff for waste management of YCDC is shown in Table 4.6.4. For the on-call system which is not shown in this table, waste generators have to pay MMK 30,000/trip (for government agencies), or MMK 35,000/trip (for private entities). In the case of direct hauling, waste generators have to pay MMK 5,000/t to YCDC.

A managing committee contract for the use of vehicle for waste transportation costs about MMK 50,000/trip. Private companies which specifically operate waste collection do not exist, since waste collection business has not been developed yet in Yangon City. Some management committees expect that YCDC shall provide stable services for the collection and transportation of waste to industrial zones.

Table 4.6.4 Solid Waste Collection Charge in YCDC

Category	Collection Charge
Domestic	MMK 300–600/month/household
Business Activities	MMK 500–400,000 per time
Guesthouse or Mini Hotel	MMK 6,500–250,000 per time
Hotel	More than MMK 10,000 per time
Foreign Financed Hotel	USD 67–300 per time
Hospital	MMK 1,200–19,500 per time

Source: YCDC

2) Tariff of Thanlyin and Kyauktan Townships

The tariff for waste management of Thanlyin and Kyauktan townships are shown in Tables 4.6.5 and 4.6.6, respectively.

Table 4.6.5 Solid Waste Collection Charges in Thanlyin Township

Type of Building	Collection Charge
Concrete Structure (2–3 stories)	MMK 25,000–30,000/yr/household
Brick Structure (1–3 stories)	MMK 6,000–15,000/yr/household
Brick and Wooden Structure (1–2 stories)	MMK 2,500–4,500/yr/household
Wooden Structure (1–2 stories)	MMK 1,440–1,800/yr/household
Wooden and Bamboo Structure	MMK 810–1,080/yr/household
Others	MMK 300–600/yr/household
Night Soil	MMK 3,000 per time

Source: TTDC

Table 4.6.6 Solid Waste Collection Charges in Kyauktan Township

Type of Building	Collection Charge
Concrete Structure (3–5 stories)	MMK 3,000–3,600/yr/household
Concrete Structure (1–2 stories)	MMK 900–2,400/yr/household
Concrete and Wooden Structure (1–2 stories)	MMK 780–1,800/yr/household
Brick Structure (1–2 stories)	MMK 900–1,200/yr/household
Brick and Wooden Structure (1–2 stories)	MMK 210–540/yr/household
Wooden and Bamboo Structure (1–2 stories)	MMK 120–360/yr/household
Others	MMK 90/yr/household

Source: KTDC

4.6.2 Benchmarking Survey for Solid Waste Management

(1) Purpose of Survey

In order to consider and recommend an appropriate industrial solid waste management system for Yangon city, a benchmark survey targeting Hanoi City, the capital city of Vietnam, was used as reference. In Hanoi, as well as Thilawa SEZ class A, Thang Long Industrial Park is being operated, where international factories by foreign capital including Japan are doing business.

(2) Laws and Regulations on Industrial Solid Waste in Vietnam

Vietnam has issued various decrees, directives of the Prime Minister, and decisions for solid waste management including hazardous waste. These legislations can be used as reference to establish them in Myanmar.

In Vietnam, the Law on Environmental Protection and Government Decree No. 59/ND-CP defines the differences between municipal and industrial wastes. Municipal authorities are responsible for the disposal of municipal solid waste (MSW). Likewise, waste generators are responsible for the disposal of their industrial waste.

With regard to the disposal of hazardous solid waste, the Government of Vietnam issued Decision No. 23/2006 under the Ministry of Natural Resource and Environment (MONRE) containing the list of hazardous wastes. Also, Circular No. 12/2006/TT-B-TNMT dated 26 December 2006 was issued containing guidelines and procedures for application preparation, registration, license granting to practice, and the issuance of the code for hazardous waste management. However, Vietnam does not have a particularly strict standard which is imposed on the final disposal of sludge and slag containing mercury, cadmium and other harmful substances.

Vietnam has detailed the technical standards and requirements on solid waste disposal technology. Vietnam has issued landfill technical standards TCVN 6696: 2000 and TCXDVN 261: 2001 on domestic landfill waste design and requirements. TCVN 6706: 2000 and TCXDVN 320: 2004 are technical standards and requirements regarding hazardous waste landfill design.

The case of Vietnam will be used as reference for the preparation of laws and regulation related to industrial waste management in Myanmar because the legislations of Vietnam are more advanced than that of Myanmar. However, it is to be noted that regulations in developed countries such as Japan should also be referred to since regulations on some important parameters such as dioxin emission from incinerator have not yet been developed in Vietnam.

(3) Industrial Waste Management by Hanoi URENCO

The Hanoi Urban Environmental Company (Hanoi URENCO) is one of the companies which collect and treat industrial waste generated in Hanoi City. Hanoi URENCO belongs to the Hanoi

People Committee and is in charge of environmental sanitation such as waste collection, transportation, and treatment in Hanoi City. Hanoi URENCO consists of 14 group companies that each have specific roles and responsibilities in the solid waste management field.

Among 14 companies, URENCO-10 and URENCO-11 are in charge of collection, transportation, treatment, and disposal of hazardous and infectious materials. Both companies are licensed for operating these works by MONRE.

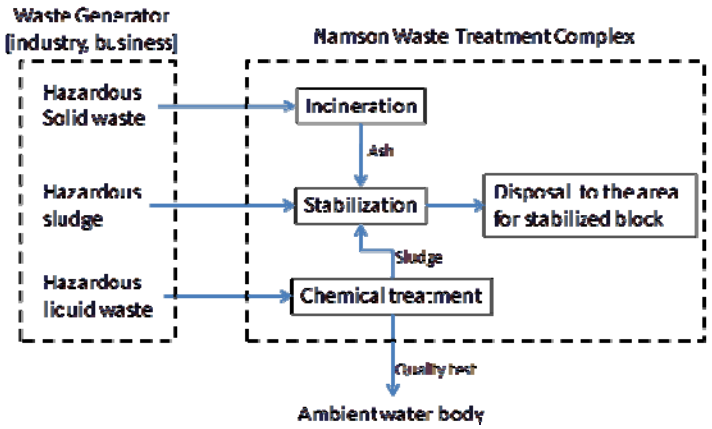
Treatment facilities for hazardous waste are located at the Namson Waste Treatment Complex. About 5 ha out of the 83 ha complex is allotted for hazardous waste treatment facilities, and it develops and operates the relating facilities.

The complex accepts both solid and liquid wastes. These wastes are treated by the methods shown in Table 4.6.7 below. Incineration is adopted for solid waste (hazardous and infectious) and chemical treatment of effluent is for liquid waste. Figure 4.6.2 illustrates the treatment flow practiced in Hanoi City and Namson Waste Treatment Complex.

Table 4.6.7 Treatment Methods of Hazardous Waste Adopted at the Namson Waste Treatment Complex in Hanoi City, Vietnam

Treatment method	Target Waste
Incineration	Hazardous and infectious solid waste
Chemical treatment	Industrial effluent and liquid waste
Solidification	Incineration ash and hazardous sludge

Source: Hanoi URENCO



Source: JICA Study Team

Figure 4.6.2 Treatment Flow of Hazardous Waste at the Namson Waste Treatment Complex in Hanoi City, Vietnam

(4) Incinerators Operated by Hanoi URENCO

Hanoi URENCO currently operates four incinerators for waste treatment. Two out of four incinerators are located in the Namson complex. The treatment capacity and operating conditions of incinerators are shown in Table 4.6.8. These two incinerators are manufactured by a Vietnamese company and operated under similar conditions. One of the four incinerators was manufactured by an Italian company.

Table 4.6.8 Incinerators Under Operation at the Namson Waste Treatment Complex in Hanoi City, Vietnam

Treatment capacity	200 kg/hr	2,000 kg/hr
Established year	2005	2011
Operation condition	6 days for non-stop operation, 2-day maintenance	(under test operation)
Incineration temperature Primary furnace Secondary furnace	 800 °C 1,100-1,200 °C	 800 °C 1,100-1,200 °C
Manufacturer	Vietnamese company	Vietnamese company

Source: Hanoi URENCO

(5) Treatment Fee for Hazardous Waste by Hanoi URENCO

The treatment fees charged by Hanoi URENCO to their customers are given in Table 4.6.9.

Table 4.6.9 Waste Treatment Fee of Hazardous Solid Waste by Hanoi URENCO

Treatment Method	Waste Treatment Fee
Incineration	VND 10 million/t (USD 480)
Chemical treatment	VND 4 million/m^3 (USD 190)
Solidification	VND 3 million/t (USD 140)

Source: Hanoi URENCO

4.6.3 Solid Waste Generation and Facilities in Greater Yangon

(1) Waste Generation Rate and Waste Composition

YCDC conducted survey in January 2012. Generated and stored solid wastes were sampled from households in all of the 33 townships, which accounted to more than 7% of the population in the city. Wastes stored for a day at each household were used for the sampling. One day generated waste was used for sampling. As a result, the generation rate of domestic waste is 0.396 kg/day/person.

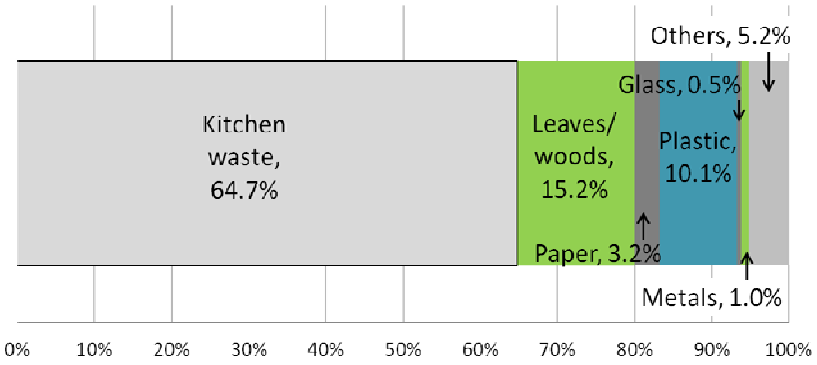
PCCD has conducted such waste generation surveys five times in the last 12 years (see Table 4.6.10). The survey results show fluctuation in generation rates. The rates were 0.267-0.396 kg/day/person. The survey on the waste generation rate and physical composition of waste were not carried out in Thanlyin and Kyauktan townships.

Table 4.6.10 Waste Generation Rate in Yangon City

2001-2002	2003-2004	2006-2007	2010-2011	2011-2012
0.395	0.312	0.287	0.267	0.396

Unit: kg/person/day
Source: PCCD, YCDC

The percentage of each category of waste are shown in Figure 4.6.3, and kitchen waste accounted for 65% of the total solid waste generated in Yangon city.



Source: JICA Study Team

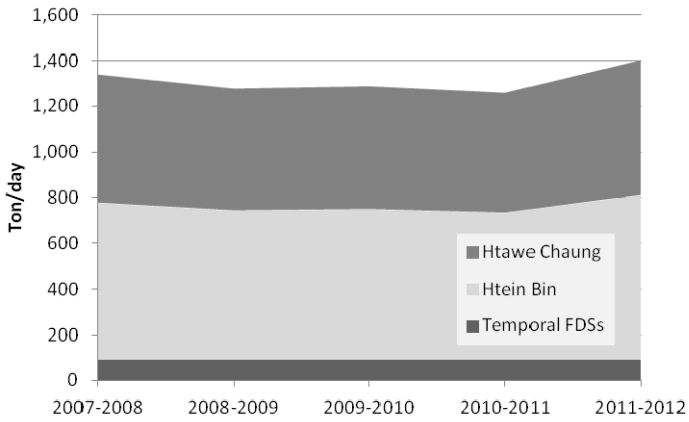
Figure 4.6.3 Physical Composition of Solid Waste

(2) Waste Amount

The amount of solid waste disposed at final disposal sites (Htawe Chaung, Htein Bin, and temporal final disposal sites (FDSs)) in the last five years in Yangon City was about 1,250-1,400 t/day (see Figure 4.6.4). While the amount was following a declining trend from 2007 to 2010, it increased from 2010 to 2011. According to monthly records on waste amount, the largest figure was observed during April, the month in which "New Year" is held in the country. The month with the second largest collected waste is October to November, when the religious holiday season is held.

Table 4.6.11 shows the amount of waste collected in 2011 by waste type. The amount of domestic waste is dominant among the four types including both municipal and hazardous wastes.

The amounts of waste collected in Thanlyin and Kyauktan townships were estimated by the township development committee at about 7 t/d and 5 t/d, respectively. These amounts are quite small compared to that of YCDC.



Note: It is assumed that waste amount hauled to temporal FDSs is constant.
Source: JICA Study Team

Figure 4.6.4 Amount of Solid Waste Collected in Yangon City

Table 4.6.11 Collected Solid Waste by Type in YCDC (2011)

Category	Types of Wastes	Amount (t/day)
Municipal waste	Domestic waste	870
	Other municipal wastes	533
	Total	1,403
Hazardous waste	Industrial waste (hazardous)	0.14*
	Infectious wastes from hospitals	1.4
	Total	1.54

Note*: Average amount of collected solid waste for the last seven years.
Source: PCCD, YCDC

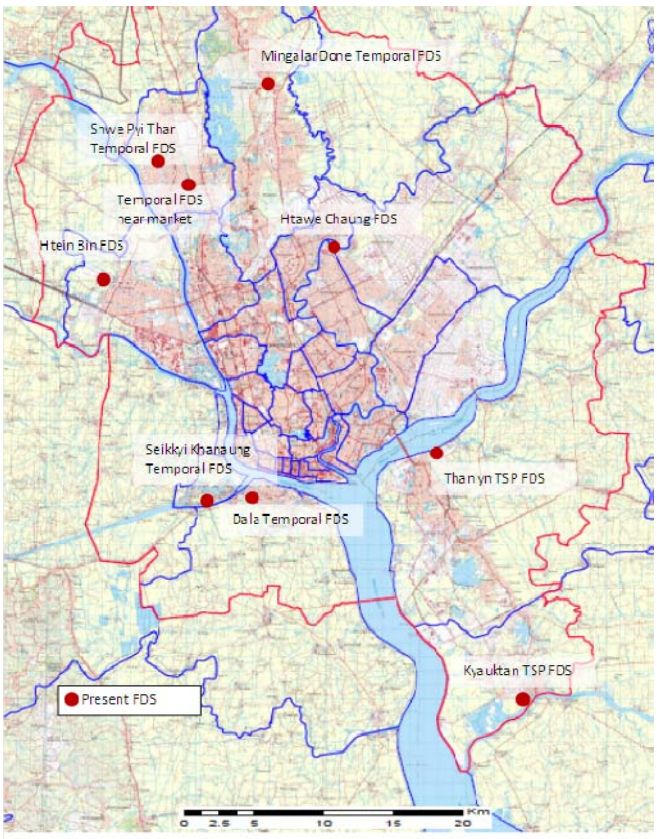
(3) Final Disposal Sites

There are two main FDSs operated by the PCCD. One is the Htein Bin FDS and the other is the Htawe Chaung FDS. These two FDSs are open and receive waste 24 hr/day. Township offices of the PCCD supervise and operate five other temporal FDSs located far from the two main FDSs or physically separated by the Yangon River. Thanlyin and Kyauktan townships each have their own dump sites with areas of about 1.6 ha and 2 ha, respectively. Table 4.6.12 outlines the existing FDSs in Yangon City. The locations of the FDSs are shown in Figure 4.6.5.

Table 4.6.12 Existing FDSs

Name	Township/District	Potential usable Area [ha]	Assumed service period of existing facility	Present Condition
Disposal site				
Htein Bin	Hlaing Tha Yar/ West	61	2002-2021	28 ha area are being used, which can be used until 2021 (assumed)
Htawe Chaung	North Dagon/ East	60	2004-2015	19 ha area are being used, which can be used until 2015 (assumed)
Temporal site				
Shwe Pyi Thar [Kyun Chaung]	Shwe Pyi Thar/ West	1	1998-2015	Two separate sites are in operation within the area for rainy and dry season.
Mingalardon	Mingalardon / North	1	2003-2012	Fence is set along the main road. A candidate site for future landfill.
Seikgyikhanaungto	Seikgyikhanaungto / South	0.1	1962-n.a.	
Dala	Dala/ South	1	1950-n.a.	A candidate site for future landfill.
Damyingone Train Station, Vegetable Market	Shwe Pyi Thar / North	5	2009-2012	Dumping is accepted for land reclamation. No fence at the site. This site is used in the dry season.

Source: PCCD, YCDC



Source: JICA Study Team

Figure 4.6.5 Locations of Existing FDSs (Including Thanlyin and Kyauktan)

4.7 Present Condition of Power Supply System

4.7.1 Institutional Aspects Related to the Power Sector

(1) Ministry of Electric Power (MOEP)

The Ministry of Electric Power (MOEP) of Myanmar was established in 1997. In 2006, MOEP was divided into two ministries, namely: the Ministry of Electric Power 1 (MOEP-1), which manages hydropower stations, and the Ministry of Electric Power 2 (MOEP-2), which manages power transmissions, thermal power stations and distribution systems. In September 2012 MOEP-1 and MOEP-2 were again merged to form a new MOEP.

The subsidiary organization of MOEP and their major tasks are summarized in Table 4.7.1 below. In these organizations, the Myanmar Electric Power Enterprise (MEPE) and Yangon City Electricity Supply Board (YESB) are take part in providing power supply to the Yangon area, including Thilawa and Thanlyin. MEPE is responsible for planning, operation, and maintenance of power transmission lines, substations and gas turbine power stations nationwide; while YESB is responsible for the operations and maintenance of distribution line systems in the Yangon area. The MOEP organization after integration of MOEP-1 and MOEP-2 is shown in Table 4.7.2, but the main work items have not yet been revealed.

Table 4.7.1 MOEP Organization before Integration

Name of Department		Items of main work
MOEP-1: Ministry of Electric Power 1	DHPP: Department of Hydro Power Planning	. Development plan of hydro power station . Administration for all MOEP1
	DHPI: Department of Hydro Power Implementation	. Construction of hydro power station . Procurement of equipment and machinery . Maintenance and repairing of hydro power stations
	HGPE: Hydro Power Generation Corporation	. Operation of hydro power stations . Operation of Tee Gyit coal fired steam turbine power station .
MOEP2: Ministry of Electric Power 2	DEP: Department of Electric Power	. Planning basic electrical policies . Coordination with all related ministries of departments . Planning electrical system (with MEPE)
	MEPE: Myanmar Electric Power Enterprise	. Operation of electrical transmission system . Construction and operation of gas turbine power stations . All electrical operating system
	YESB: Yangon City Electricity Supply Board	. Electrical supply for Yangon city area . Electrical distribution (less than 33KV) . Construction and operation of 66/33KV substation . Tariff collection
	ESE: Electricity Supply Enterprise	. Electrical supply for the area except Yangon city . Electrical distribution (less than 33KV) . Construction and operation of 66/33KV substation . Tariff collection

Source: Report by official survey team, published in 2010

Table 4.7.2 MOEP Organization after Integration

Name of department	
MOEP	Department of Hydropower Planning
	Department of Electric Power
	Department of Hydropower Implementation
	Hydropower Generation Enterprise
	Myanmar Electric Power Enterprise
	Electric Supply Enterprise
	Yangon City Electricity Supply Board

Source: Myanmar Government

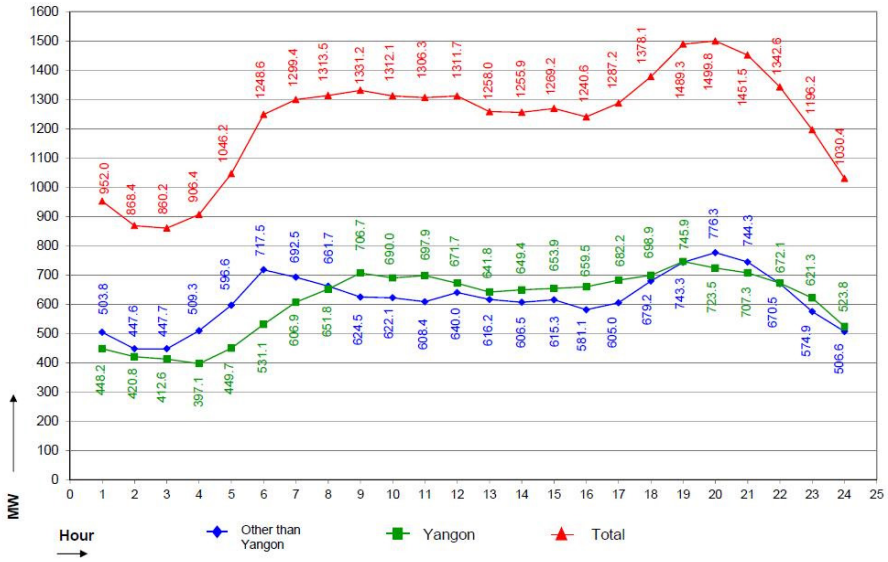
(2) Ministry of Energy (MOE)

The Ministry of Energy (MOE) is in charge of the development, importation and exportation of petroleum and natural gas, and production in the domestic market. Fuel for gas turbine power stations operated by MEPE is provided by Myanma Oil and Gas Enterprise (MOGE) under MOE.

4.7.2 Present Conditions

The peak power demand in Myanmar was estimated at approximately 1,850 MW by MEPE. Meanwhile, actual generation was recorded to achieve 1,622 MW at peak time on 24 September 2012 (wet season). Accordingly, the shortage of electricity supply in the whole of Myanmar was estimated at around 230 MW in September 2012. Besides, the generation of hydropower stations during the dry season is extremely lower than during the wet season. The shortage of electricity may further expand the capacity to about 400 MW, depending on reservoir operations of hydropower stations in the northern and central parts of Myanmar. Insufficient power supply of 230 MW-400 MW at peak time is a critical problem of unstable and low quality of power supply in Myanmar. Figure 4.7.1 shows the daily load curves recorded on 12 March 2012.

The daily load curves in Myanmar on 12 March 2012 are given in Figure 4.7.1.



Source: MEPE

Figure 4.7.1 Daily Load Curves (on 12 March 2012)

The graph above also shows the daily load curves of Yangon and other townships. From the graph, the load patterns and peak loads seem to be approximately similar in values. On the other hand, although there is no quantitative data, actual peak load is expected to be higher than the recorded daily load curve mentioned above due to the implementation of planned power outage. The current peak load of Yangon was about half of Myanmar whole country peak load, therefore, it was estimated at 925 MW (1,850 MW/2) as of 2012 by MEPE.

4.7.3 Power Generation

(1) Power Generation in Myanmar

The total installation capacity in Myanmar was estimated at 3,421 MW as of March 2012. These power sources consist of hydropower (76%), gas turbine (16%), steam turbine (4.5%), and coal thermal (3.5%). However, the ratio of available generation capacity is estimated to have been reduced to about 46% of the installation capacity due to inefficiency brought about by aging generation facilities, decrease in water source for hydraulic power, shortage of gas supply, and decrease in calorific values of natural gas because of change of gas fields. The installed and available generation capacities in Myanmar are summarized in Table 4.7.3.

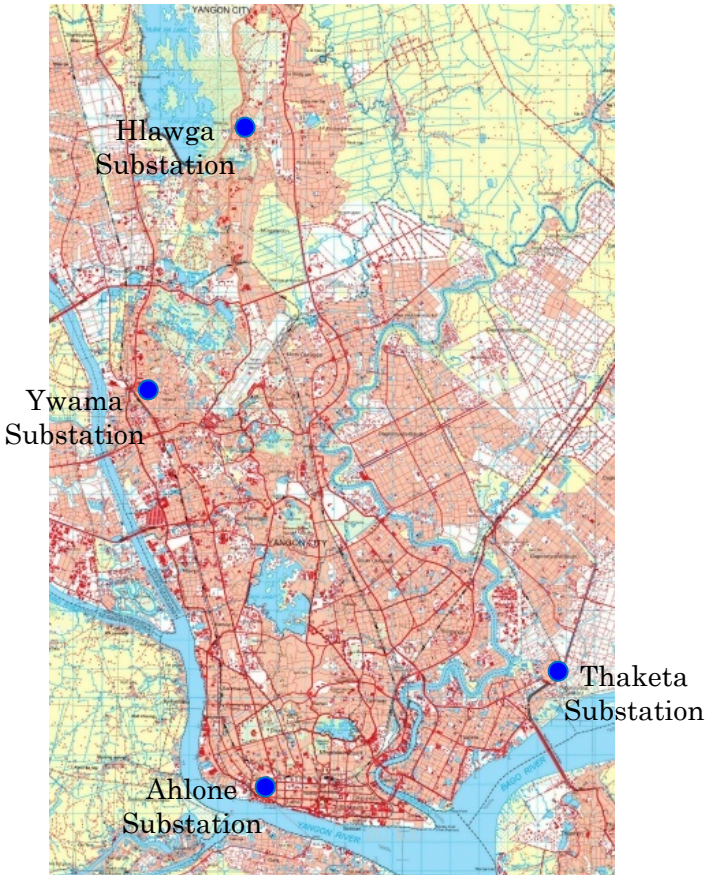
Table 4.7.3 Installation and Available Capacity of Power Generation in Myanmar

Type of Power Generation	No. of Power Stations	Installed Capacity (A)	Available Capacity (B)	Ratio of Available Capacity (C)=(A)/(B)
Hydropower	57	2,586 MW	1,237 MW	48%
Coal Thermal	33	835 MW	345 MW	41%
Total	90	3,421 MW	1,582 MW	46%

Source: MEPE

(2) Power Supply in Yangon City

In Yangon City, four gas turbine combined cycle power stations namely Hlawgar, Yawma, Ahlon and Thaketa are currently in operation (refer to Figure 4.7.2). These power stations supply power as base load, corresponding to 31% of the peak load in the Yangon area. The sum of the available capacities of the above four power plants in Yangon City was estimated at only 235 MW, whereas, the peak demand in Yangon City was estimated at 925 MW as discussed in Section 4.7.3. Therefore, the remaining demand of 690 MW (= 925 MW – 235 MW) will be supplied by hydropower stations through the national power grid outside Yangon. However, the available generation capacity in Myanmar is still insufficient to cover the peak load of the whole country, and power transmission lines from hydraulic power stations are still undeveloped, thus, undermining a stable power supply in Yangon City at the moment.



Source: JICA Study Team

Figure 4.7.2 Location of Power Stations

4.7.4 Transmission and Distribution Line System

(1) Power Grid in Myanmar

The location map and single line diagram of the (existing and future) national power grid in Myanmar is shown in Figure 4.7.3. The voltage system of the national grid and organizations of jurisdiction consist of the following classes:

a. Transmission lines under MEPE control: 500 kV (future plan), 230 kV, 132 kV, and 66 kV.

b. Distribution lines under YESB control: 33 kV (to be upgraded to 66 kV in the future), 11 kV, 6.6 kV (to be upgraded to 11 kV in the future), and 0.415-0.24 kV.

According to YESB, transmission and distribution losses in the whole country were estimated at 25%. In Myanmar, power transmission losses amount to 7%, while distribution losses are at 18%. These values are relatively high when compared with power losses in other Southeast Asian countries.

In order to reduce transmission and distribution losses, the upgrading of voltage system is planned in which the 33 kV and 6.6 kV distribution systems will be replaced by 66 kV and 11 kV, respectively, by YESB in the future. In addition, since most hydropower stations are located in the northern area, MEPE plans to construct a 500 kV transmission line to feed power to the demand center of Yangon.

(2) Transmission Line Network in Thanlyin and Thilawa Area

1) Existing Transmission and Distribution Network

There are two existing transmission lines near Thanlyin SEZ, as shown in Table 4.7.4.

Table 4.7.4 Existing Power Transmission Lines Connected to Thanlyin Substation

Section	No. of Circuit	Voltage	Line Length	Conductor Size (Single Phase)	Capacity (1 Circuit)
Thanlyin to Thaketa	1 (2)*	230 kV	Approx. 10 km	ACSR765MCM ($400mm^2$) x2	500 MVA
Thanlyin to Kamarnat	1	230 kV	Approx. 98 km	ACSR765MCM ($400mm^2$) x2	500 MVA

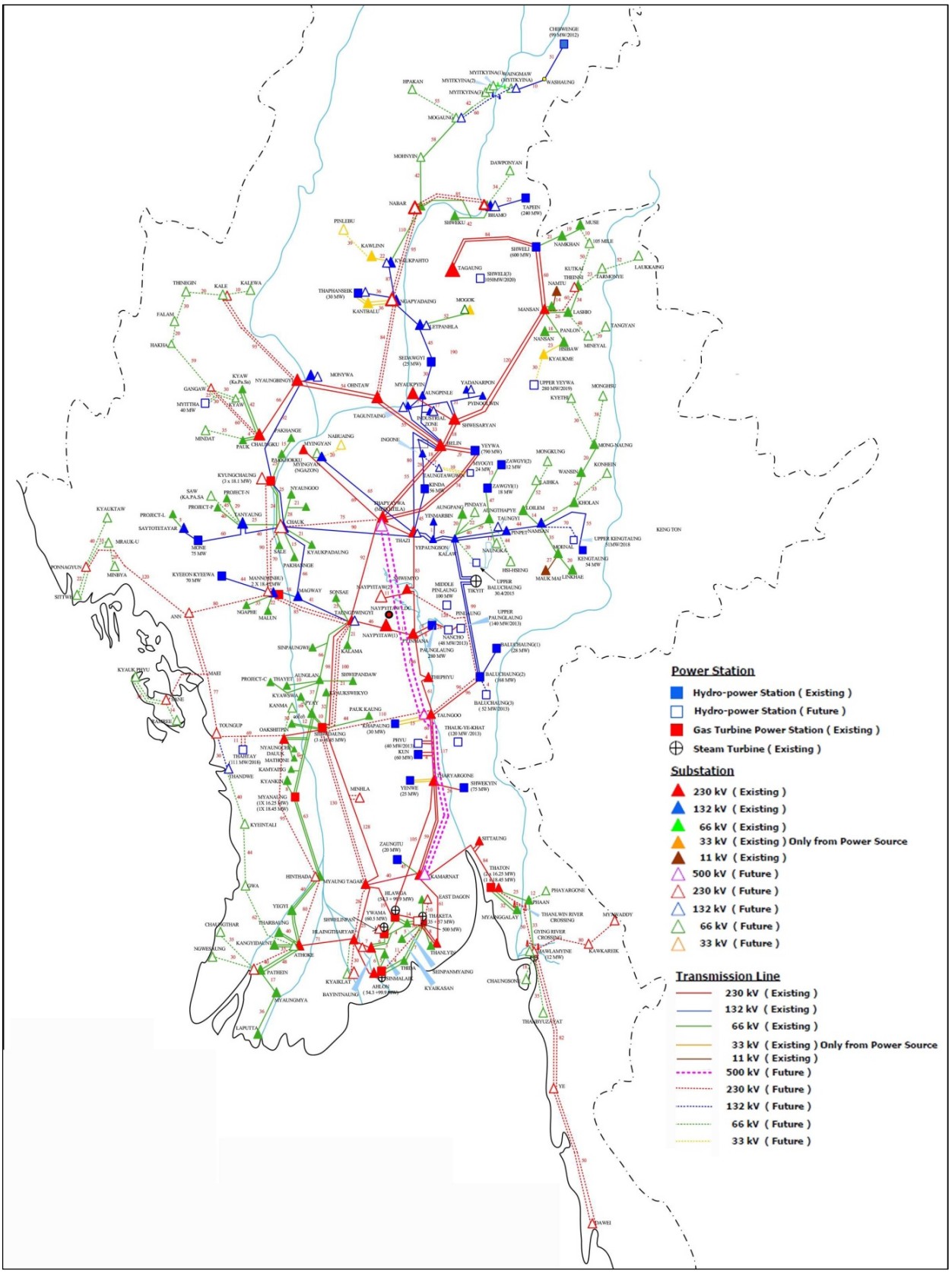
*Note) Thanlyin – Thaketa: Conductors for two circuits are installed already, but only one circuit is used at the moment.

Source: JICA Study Team

Thanlyin Substation, located 10 km north of the center of the SEZ, is the nearest grid substation to the Thilawa area. There is a 230 kV double-circuit overhead transmission line from Thanlyin to Thaketa using double-conductor ACSR 400 m^2. The line has a transmission capacity of approximately 500 MVA per circuit. These transmission lines currently function to feed power (approximately 100 MVA) to Yangon from hydropower stations in the north area according to substation records in October 2011.

Even though there is a 230/33 kV substation in Thanlyin (as shown in Figure 4.7.4), there is no 230 kV or 132 kV substation in Thilawa area. The power supply of Thilawa area including Kyauktan is currently covered by 33 kV double circuit distribution lines and Thilawa distribution substation (33/11 kV) which is located in the same area. The maximum capacity of this distribution line is 20 MVA for each circuit.

Figure 4.7.3 describes the national power grid in Myanmar.



Source : MEPE

Figure 4.7.3 The National Power Grid in Myanmar (as of September 2012 including Future Plan)

Note: Green-colored line: 230kV transmission line between Thaketa-Thanlyin
Pink-colored line: 230kV transmission line from Kamarnat to Thanlyin
Yellow-colored line: Border of Thilawa SEZ
Source: JICA Study Team

Figure 4.7.4 230 kV Transmission Lines to Thanlyin Substation

2) Existing Grid Substations near Thilawa

The technical specifications of the three substations (Thanlyin, Thaketa and Kamarnat) are summarized in Table 4.7.5 below.

Table 4.7.5 Grid Substations near Thilawa

Substation	No. of 230 kV Feeder Bays	Substation Voltage	230 kV Transformer Capacity
Thanlyin Substation	2	230/33/11 kV	100 MVA (100 MVA x 1 unit)
Thaketa Substation	2	230/33/11 kV	300 MVA (100 MVA x 3 units)
Kamarnat Substation	5	230/33/11 kV	100 MVA (100 MVA x 1 unit)

Source: JICA Study Team

The technical specifications of major items of the existing 230 kV substations are listed as follows:

a. Main transformer: 230/33/11 kV, oil immersed, fan-cooling type (single phase x three units)
b. Circuit breaker: 245 kV, 1600 A, 31.5 kA
c. Disconnecting switch: 245 kV, 1600 A, 31.5 kA
d. Lightning arrestor: 198 kV, 10 kA
e. Phase modifying equipment: Capacitor and reactor
f. Busbar system (in the case of the Thaketa power station switchyard)
   - 230kV: Single bus
   - 66kV: Double bus

- 33kV: Single bus
- 11kV: Single bus

g. Supervisory control system: Not available

Supervisory control and data acquisition (SCADA) systems are not applied in the existing systems of the substations. The monitoring and operations of the substations and generating equipment are manually controlled by technical engineers and staff of MEPE at the power stations or substations.

4.7.5 Development Plan

MOEP has planned for the development of several hydropower projects with a total generating capacity of 25.5 GW by 2030. MEPE has also planned the development of new transmission lines, including the construction of a 500 kV transmission line from Thapyaywa to Kamarnat (total length of 263 miles). The construction of new gas turbine power plants (total capacity of more than 1,500 MW) at existing power plants in Yangon is also being planned.

In addition, YESB is now in progress of a five year plan (2010/11 to 2015/16) for improving the existing power distribution system for end-consumers in Yangon City. The plan shall be subjected according to the policies listed below.

a. Construction of upgraded substations;
b. Upgrading of voltage transmission/distribution lines from 33 kV to 66 kV;
c. Replacement of small size cables to large transmission/distribution lines;
d. Replacement of bare wire to insulated wire;
e. Replacement of consumption meter from mechanical type to electrical type;
f. Installation of capacitor bank in substation for improvement of power factor;
g. Cutting of trees which interfere with the overhead wire; and
h. Investigation of illegal connections.

4.7.6 Electricity Tariff

The electricity tariff in Myanmar was revised in January 2012, as shown in Table 4.7.6. The electricity rate has increased by as much as 140% for residential consumers and 150% for industrial consumers, when compared with the previous tariffs.

Table 4.7.6 Electricity Tariff (as of January 2012)

Classification	Metered Charge (MMK/kWh)	Basic Charge (MMK/month)	Previous Charge (MMK/kWh)
General domestic	35	1,000 (single phase), 3,000 (three phase)	25
Streetlight	35	1,000 (single phase), 3,000 (three phase)	25
Industry	75	1,000 (single phase), 3,000 (three phase)	50
Commerce	75	1,000 (single phase), 3,000 (three phase)	50
Large consumer	75	1,000 (single phase), 3,000 (three phase)	50

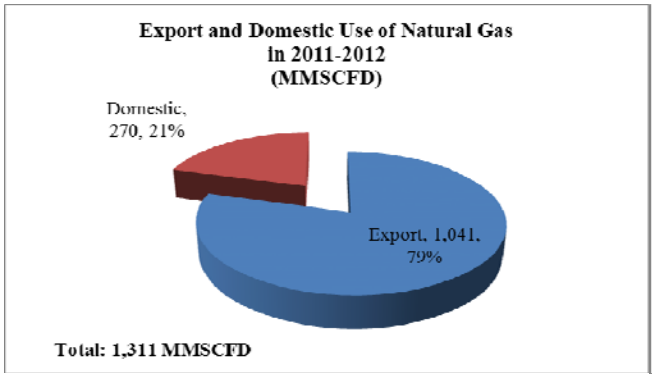
Source: YESB

4.7.7 Fuel Supply Condition for the Yangon Region

(1) Natural Gas Supply

1) Natural Gas Supply for Export and Domestic Use

More than 1,000 million standard cubic feet per day (MMSCFD) of natural gas was exported to Thailand in 2011-2012, accounting for nearly 80% of the total supply. Meanwhile, 270 MMSCFD was supplied to domestic users in the same year.

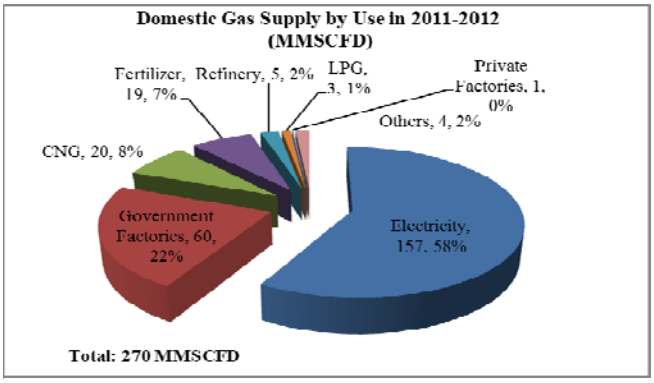


Source: MOGE

Figure 4.7.5 Export and Domestic Use of Natural Gas

2) Domestic Consumption of Natural Gas by Application

Among domestic consumption of natural gas, 157 MMSCFD (58%) are being used for electricity generation, followed by government factories (60 MMSCFD, 22%), and as compressed natural gas (CNG) fuel for use of buses and taxis (20 MMSCFD, 8%).



Source: MOGE

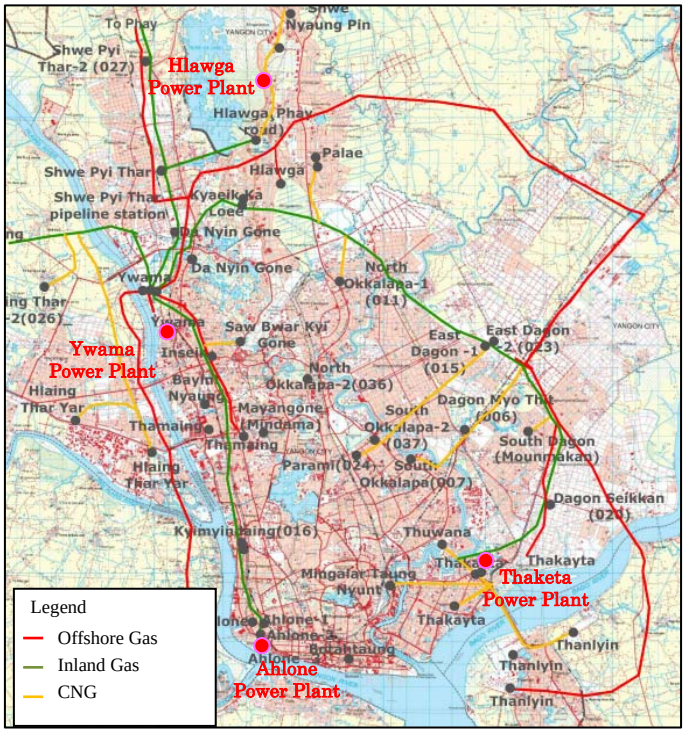
Figure 4.7.6 Domestic Natural Gas Use by Application

3) Supplier of Natural Gas

MOGE is a state-owned enterprise under MOE. MOGE is mainly responsible for the supply of domestic natural gas through its own pipelines.

4) Natural Gas Pipeline Network in the Yangon Region

In the Yangon region, there are three kinds of natural gas pipelines owned and operated by MOGE, as shown in Figure 4.7.7. The offshore gas pipelines supply gas from Yadana to the four gas power plants at Hlawga, Yawma, Ahlon and Thaketa, and to government factories. The inland gas pipelines and CNG pipeline supply gas to 40 CNG filling stations for buses and taxis.



Source: MOGE

Figure 4.7.7 Gas Pipelines in the Yangon Region

5) Properties of Offshore Gas

Table 4.7.7 shows the properties of offshore gas. Offshore gas has less amount of heat than inland gas due to its higher content (more than 25%) of nitrogen which has no heat.

Table 4.7.7 Properties of Offshore Gas

Component	Concentration (%)
Methane	69.221
Ethane	0.937
Propane	0.173
i-Butane	0.018
n-Butane	0.031
n-Pentane	0.004
i-Pentane	0.007
neo-Pentane	0.003
Hexane and heavier	0.020
CO_2	4.125
N_2	25.458
H_2S	0.002
H_2O	0.001
Total	100.000
Molecular Weight	20.5
Higher Heating Value	733 BTU/SCF
Lower Heating Value	653 BTU/SCF

BTU: British Thermal Unit
SCF: Standard Cubic Feet
Source: MOGE

6) Future Plan for Gas Supply

According to MOGE, 100 MMSCFD of offshore gas will be supplied to MOEP until the end of 2013. MOEP intends to distribute them to newly constructed and future expanding power plants as fuel.

(2) Diesel Oil

1) Alternative Fuel for Gas Turbine Generator

Diesel oil is mostly imported from foreign countries for domestic market supply. Diesel oil, which is normally used for diesel generators in Myanmar, can be used for gas turbine generators when natural gas is not available. Meanwhile, high speed diesel (HSD) is suitable for diesel-powered automobiles. HSD can also be used for gas turbine generators in terms of quality, but is not recommended as its price is higher than that of diesel oil.

2) Supplier of Diesel Oil

The Myanma Petroleum Products Enterprise (MPPE) is a state-owned enterprise under MOE. It is responsible for the distribution of motor gasoline and diesel oil in the domestic market. MPPE at first had monopoly of this kind of business in Myanmar, until the ban on the private sector to participate in such business was lifted in 2010. After the participation of the private sector was allowed, 25 private companies that are affiliated with the Myanmar Petroleum Trade Association (MPTA), under the Union of Myanmar Federation of Chambers of Commerce and Industry (UMFCCI), participated in this business. These private companies are now distributing petroleum products to private sector users. Meanwhile, MPPE distributes only to government sector users.

3) Specifications of Diesel Oil

Table 4.7.8 shows the specifications of diesel oil.

Table 4.7.8 Diesel Oil Specifications

No.	Characteristic	Unit	Test Method	Specification
(a)	Color	-	ASTM D1500	2.0 Max.
(b)	Density at 15ºC,	kg/L	ASTM D1298	0.82 – 0.87
(c)	Distillation ºC,	90% Recovery	ASTM D86	370 Max.
(d)	Cetane Index	-	ASTM D976	48 Min.
(e)	Flash Point,	ºC	ASTM D93	66 Min.
(f)	Sulfur,	mass %	ASTM 1P336	0.5 Max.
(g)	Copper Corrosion	(3 hr @ 100ºC)	ASTM D130	Category 1 Max.
(h)	Ash,	mass %	ASTM D482	0.01 Max.
(i)	Viscosity at 40ºC,	cst	ASTM D445	1.7-5.5
(j)	Pour Point,	ºC	ASTM D97	9 Max.
(k)	Conradson Carbon Residue,	%mass	ASTM D189	0.1 Max.
(l)	Water and Sediment,	%volume	ASTM D2709	0.05 Max.

Source: New Day Energy

4.8 Present Conditions of the Telecommunications System

4.8.1 Overview of Telecommunication System

Policies on telecommunications in Myanmar are put in effect by Ministry of Communications, Posts, and Telegraphs (MCPT) and The Post and Telecommunications Department (PTD) under MCPT law which regulates postal service, telecommunications service, and broadcasting. The Myanma Posts and Telecommunications (MPT) is an organization which provides telecommunications including internet services as an operator. MCPT changed its name to the Ministry of Information Technology and Communication (MITC) in the beginning of November 2012.

Present laws on telecommunications were based on the Myanmar Telegraph Act and the Myanmar Wireless Telegraph Act enacted in 1885 and 1934, respectively. These acts have been updated several times in accordance with changes in the social environment and technology.

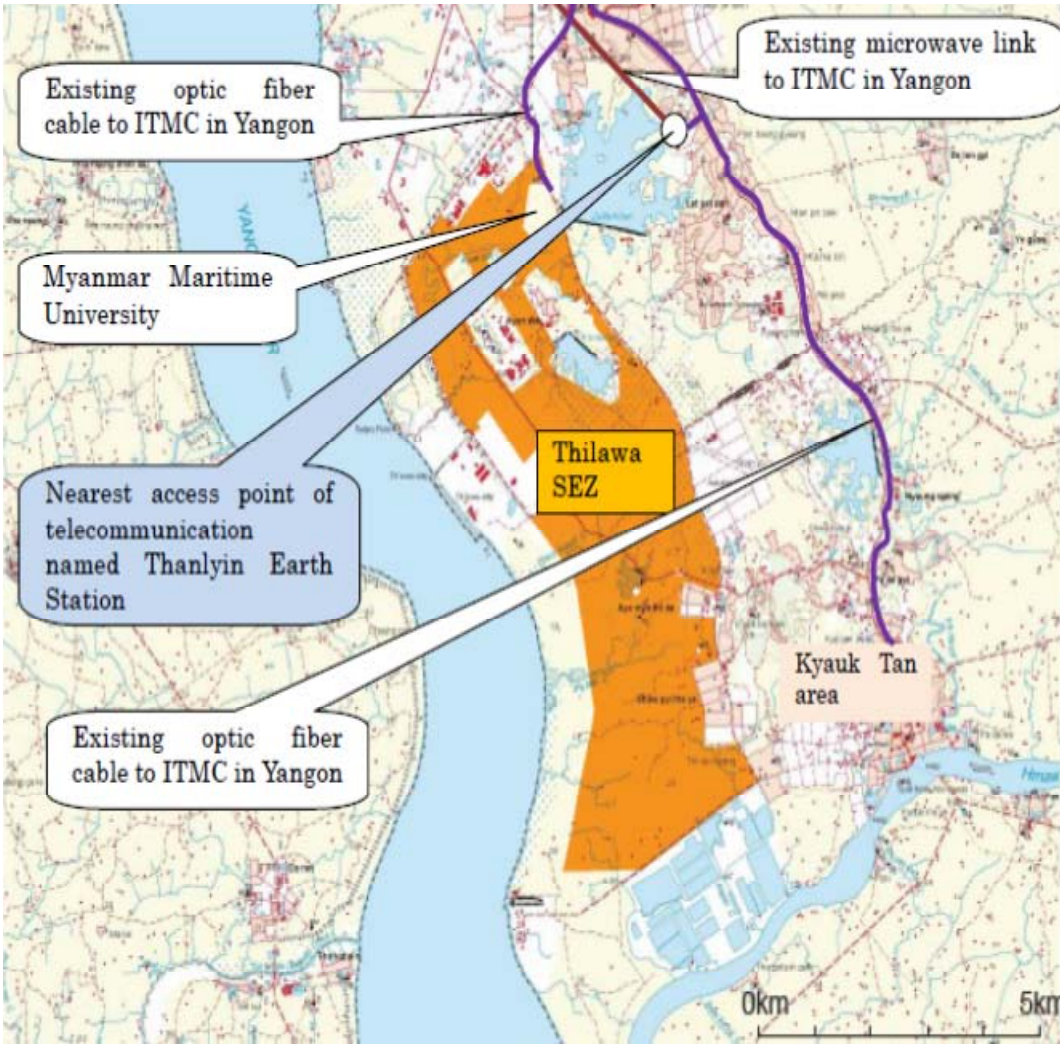
Fixed communication services are being provided by MPT. The penetration ratio on fixed telecommunications services for the entire Myanmar in 2010 was 1.3%. In terms of telecommunications, there exists a huge gap between cities and rural areas. Mobile communication services are also provided by MPT with different types of Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Global System for Mobile Communications (GSM) and wideband CDMA (W-CDMA). The number of subscribers using mobile communications has grown rapidly, reaching 1.43 million in 2010. In order to catch up with the demand, MPT plans to increase its line capacity by adding another 30 million mobile lines from 2011 to 2015.

Internet services are being provided by MPT and Yatanarpon Teleport. Several other internet service providers (ISPs) run their businesses by leasing transmission lines from MPT. The number of internet users has reached 380,000 in March 2011, with most of its users concentrated in Yangon and Mandalay. MPT started its internet service named Sky Net via satellite in 2010. Now, Worldwide Interoperability for Microwave Access (WiMAX) has been introduced in the country with a maximum speed of 1 Mbps.

4.8.2 Present Status of Telecommunications in Thilawa SEZ

There is no trunk telecommunications access to Thilawa SEZ. It is isolated from telecommunications. Figure 4.8.1 shows the present access conditions in the vicinity of Thilawa SEZ. As shown in the figure, the nearest telecommunications port from Thilawa SEZ is the Thanlyin Earth Station (TES), which belongs to MPT. TES is connected by both optical fiber cable and microwaves with the International Transmission Maintenance Center (ITMC), which functions as an international gateway for telecommunications in Yangon. In addition, the existing optical fiber cables are connected to the Myanmar Maritime University (MMU). Since

November 2012, antennas have also been mounted on the rooftops of MMU to provide 3G services to mobile users.



Source: JICA Study Team

Figure 4.8.1 Present Telecommunications Access in Thilawa SEZ

The specifications of the two existing radio and cable links are shown in Table 4.8.1.

Table 4.8.1 Specifications of Possible Existing Connections to Thilawa SEZ

Type of Transmission	Specifications
Microwave Radio	PDH, frequency of 4.7 GHz, capacity of 8E1 (voice), 28 km approximate distance, installed in 1994.
Optical Fiber Cable	ITU-T G.652, aerial type, single mode with 12 cores, 50 km approximate distance, installed in 2005.

Source: JICA Study Team

4.8.3 Present Issues on Telecommunications in Thilawa SEZ

The issues on telecommunications development in Thilawa SEZ are as follows:

a. No trunk communications access to/from Thilawa SEZ;
b. No local access network in Thilawa SEZ;
c. Insufficient transmission capacity of existing microwave between TES and ITMC; and
d. Insufficient transmission capacity of ITMC to handle international lines.

4.9 Environmental and Social Considerations

Environmental and social considerations will be a key issue in development of Myanmar for various sectors in the next decade to create sustainability in planning and implementing development projects. In order to take steps toward ecologically and socially responsible development in Myanmar, this project will be one of the first actual steps for Myanmar to have a sound policy framework on environmental protection and sustainable development.

The purpose of this section is to understand the system, related laws and regulations, and their tasks and issues from the viewpoint of environmental and social considerations and to clarify difference from the JICA Guidelines.

4.9.1 Institutions regarding Environmental and Social Considerations

(1) Institutional Setting

Myanmar has 31 ministries under the Office of the President. The leading organization in charge of environmental and social considerations is the Department of Environmental Conservation under MOECF which was established in September 2011.

(2) Legislative System Related to Environmental Considerations in Myanmar

1) Fundamental Laws and Regulations

There are 18 legislations pertinent to the natural and social environment of Myanmar. They are as follows:

a. Forestry Law (1992)
b. Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law 1994
c. Public Health Law (1972)
d. Factory Act (1951)
e. Territorial Sea and maritime Zone Law (1977)
f. National Environment Policy (1994)
g. Draft Environment Law (2000)
h. Mines Law (1994)
i. Freshwater Fisheries Law (1991)
j. Marine Fisheries Law (1990)
k. Law on Aquaculture (1989)
l. Irrigation Laws and Regulations (1982)
m. The Conservation of Water Resources and Rivers Law *(*October 2006)
n. Myanmar Special Economic Zone Law (2011)
o. Environmental Conservation Law (2012)
p. Draft Environmental Conservation Rules (under legislation, February 2013)
q. Draft EIA Procedures (under process)

<u>Environmental Provisions in the 2008 Constitution</u>

In the new 2008 Constitution, it is stated that the government “shall protect and conserve the natural environment” (Chapter 1, Section 45). The national legislature can, but does not need to, enact laws to protect the environment and help restore areas degraded or damaged by mining

and forestry activities; or those that have experienced the destruction of plants, wildlife, and habitat (Chapter 4, Section 96). In addition, every citizen has the duty to assist the government in carrying out environmental conservation (Chapter 8, Section 390).[1]

With regard to environmental protection, the 2008 Constitution does not guarantee the people the right to a clean and healthy environment, although many other national constitutions provide such right. The constitution does not have any clear language on sustainable development and recognition of the rights of civil society, such as freedom of information, participation in natural resource management, customary land ownership, information in local languages, and equitable benefit sharing.[2]

Protection of Wildlife and Conservation of Natural Areas Law (1994)

This law is under the jurisdiction of the MOECF and defines conservation of wildlife and natural environment, implementation of government policy, and implementation of related studies. Moreover, it is lacking in actual numerical criterion to protect the natural environment.[3]

Conservation of Water Resources and Rivers Law (2006)

Other than the regulation on conserving water resources and river itself, this law describes and regulates about conservation and protection of the systems of water resources and rivers for beneficial utilization of the public.

However, this law is under the jurisdiction of the Ministry of Transport, not MOECF. This law puts its strength on transportation safety and its development. Also, it is lacking in actual numerical criterion for natural environment.

Environmental Conservation Law (2012)

The updated Environmental Conservation Law prepared by MOECF (established on September 2011) was passed on 30 March 2012. The Environmental Conservation Law contains 14 chapters that define the rights and responsibilities of MOECF, environmental standards, environmental conservation, management in urban areas, conservation of natural and cultural resources, process for businesses to apply for permission to engage in an enterprise that has the potential to damage the environment, prohibitions, offenses and punishments.

Based on this law Environmental Conservation Rules was drafted by MOECF on February 2013 and currently (by February 2013), it is under approval procedure at this moment.

2) EIA System in Myanmar

[1] *Constitution 2008, The Republic of the Union of Myanmar*, 2008
[2] *Burma's Environment: People, Problems, Policies*, The Burma Environmental Working Group (BEWG), June 2011
3 "Housing, Land And Property Rights In Burma, : The Current Legal Framework", Scott Leckie & Ezekiel Simperingham, Displacement Solutions & The HLP Institute, 2009

Regulation on investment sector that EIA becomes the condition on authorization was stipulated in new foreign investment law (January 2013). With respect to this, procedures regarding to EIA are under formulation as of April 2013.

3) Environmental Standards in Myanmar

Though the environmental standard is to be stipulated by the Environmental Conservation Law in Myanmar, the Environmental Conservation Rules have not been established. However, standards for measuring are regulated by ministries and government offices as necessary. For example, Yangon city specifies water quality of sewage discharge, and MOI regulates the standard on industrial waste water and gas discharge.

4) Comparison and Verification of Consistency between Myanmar's System and the JICA Guidelines

Table 4.9.1 below shows the consistency between the draft EIA system in Myanmar (as of April 2013) and the JICA guidelines.

Table 4.9.1 Comparison between the EIA System in Myanmar and the JICA Guidelines

Major Requirements / Key Points of the JICA Guidelines	System in Myanmar
Integration of environmental and social considerations into planning and decision making process	-The Draft EIA System stipulates that in the stage of EIA Scoping, stakeholder's opinion shall be involved, and at the stage of draft EIA report stage, stakeholder meeting shall be carried out.
Availability of EIA-related documents prepared in understandable language	-The Draft EIA System stipulates that depends on the scale of the project, it is obligated to prepare EIA report , IEE report, EMP report (environment management, monitoring plan).
Categorization of the proposed project	- The Draft EIA System classifies a project based on project type and scale. The detail for project type and scale are still being discussed.
Examination of various impacts and measures	- EIA procedures in The Draft EIA System stipulates the regulation for examination of impacts and measures in scoping stage. But guidelines for the detail impact analyses, evaluation method are not provided.
Information disclosure and stakeholder consultation	- EIA procedures in The Draft EIA System, ensures information disclosure and public consultation with description of types of group. But regarding to the EIA report disclosure, there is no description.
Consideration of socially vulnerable groups, involuntary resettlement, etc.	- EIA procedures in The Draft EIA System includes weak people and forced resettlement, but there are not included in the detail consideration in each project in charged by related government organizations.
Monitoring after project implementation	- EIA procedures in the Draft EIA system, it stipulates that an environment monitoring shall be carried out

Source: JICA Study Team

4.9.2 Initial Study for Land Acquisition and Resettlement

There are currently no regulations on land acquisition and resettlement in Myanmar. When projects on infrastructure development are implemented by ODA loan in Myanmar,

implementation of land acquisition and resettlement must follow the standards of international organization such as JICA.

(1) Organization

In this Study, land acquisition and resettlement related items are the responsibility of related government offices.

(2) Legislative System for Land Acquisition and Resettlement in Myanmar

Myanmar is one of the rare countries to have laws and regulations regarding land acquisition and resettlement in the early stage of its history (as early as the 19th century). However, these laws have been out-of-date with not enough countermeasures to solve resettlement problems in the present changing conditions. The formulation of the New Land Law has been an issue and is now under deliberation.

In the present situation of Myanmar, land is categorized as either 1) agricultural land, or 2) non-agricultural land. Agricultural land refers to cultivable land at the disposal of the state, and land occupied for the purposes of agriculture such as paddy (rice land), *ya* (dry land), *kaing* (alluvial land), and garden. Non-agricultural land refers to land not used for agricultural purposes. If agricultural land is not used for cultivation, all buildings built on agricultural land can be removed by the authorities. Furthermore, whoever uses agricultural land for purposes other than its intended use can be vacated and penalized under the 1894 Land Tenancy Law. After that, the Farm Land Law issued in 2012 clearly defined land use rights. In this law, together with the regulations for land use right authorization for farmers, the rights to sell, exchange, and lease are allowed.

(3) Fundamental Laws and Regulations

1) Constitution (1974)

It is stipulated in Article 18 that “the State is the ultimate owner of all natural resources above and below the ground, above and beneath the waters and in the atmosphere, and also of all lands”.

2) Provisions in the 2008 Constitution

It is mentioned in the 2008 Constitution that “the Union is the ultimate owner of all lands and all natural resources above and below the ground, above and beneath the water and in the atmosphere in the Union”.

(4) Resettlement System in Myanmar

Despite the fact that land acquisition and resettlement have been considerable issues in Myanmar due to its ethnic diversity, the country does not have a comprehensive involuntary resettlement policy.

(5) Comparison and Verification of Consistency between Myanmar's System for Land Acquisition and Resettlement and the JICA Guidelines

As described in table 4.9.2, the law corresponding to land acquisition and resettlement is not developed. Due to this, implementation of land acquisition and resettlement should be followed by the standards of international organization such as JICA guidelines.

Table 4.9.2 Comparison and Verification between Myanmar's System and the JICA Guidelines

	Policies in the JICA Guidelines	Regulation in Myanmar	Comparisons
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.	The government has no clear policy or procedure.	Section 4 of the draft EIA procedures comments on the necessity of appropriate action plan for the project which might create involuntary resettlement. However, there are no procedures outlined in detail.
2	When, after such an examination, avoidance is proved not feasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the affected people.	1894 Land Tenancy Law, Section 3	Section 3 of the Land Tenancy Law entitles compensation to land owners. However, there are no procedures outlined in detail.
		2012 Farm Land Law, Section 26	Section 26 of the Farm Land Law comments on the appropriate compensation procedures on farm land acquisition for public use.
		2012 Farm Land Law, Section 64	Section 64 of the Farm Land Law also regulates the appropriate compensation procedures on farm land acquisition for public use.
3	People who will be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents, etc. in a timely manner.	1894 Land Tenancy Law, Section 23	Section 23 of the Land Tenancy Law regulates the compensation procedures with regard to damaging farm products, forests, land, buildings, as well as for the loss of opportunities for economic activities. However, it does not concern about the improvement or restoration of the quality of life of involuntary settlers.
4	Prior compensation, at full replacement cost, must be provided as much as possible.	1894 Land Tenancy Law. Section 23	In Section 23 of the Land Tenancy Law, the full replacement cost is not guaranteed, but the compensation of the market driven land acquisition price is entitled to the land owners.
5	The compensation or support must be provided before the resettlement.	1894 Land Tenancy Law. Section 34	The Land Tenancy Law does not specify the compensation to be made before the resettlement. However, Section 34 comments that extra compensation can be added when the payment is not made before the resettlement.
6	For projects that will result in large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public.	The government has no clear policy or procedure.	There is no regulation which mandates the preparation of a resettlement action plan. Meanwhile, the Ministry of Internal Affairs, GAD, explained that the large size development plan needs a land acquisition and resettlement action plan to be accepted by the GAD.
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	The government has no clear policy or procedure.	Same as above
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected	The government has no clear policy or procedure.	Same as above

	Policies in the JICA Guidelines	Regulation in Myanmar	Comparisons
	people.		
9	Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood.	The government has no clear policy or procedure.	Same as above
10	In addition, appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	1894 Land Tenancy Law, Section 5A and Section 18	Section 5A of the Land Tenancy Law entitles the land owners of the project site with the right to object the advancement of the project within 30 days since the announcement of the project. Section 18 allows land owners to proclaim to the court if the land compensation is not acceptable to them.

Source: JICA Study Team

4.10 Review of Organization for Project Implementation

This section reviews the situation of government agencies that are possible to implement the supporting off-site infrastructures projects, as of September 2012.

4.10.1 Situation of the Thilawa SEZ Management Committee

The Thilawa SEZ Management Committee (TSMC), which is stipulated under the existing SEZ Law, is still in the process of organizational formation. According to Section 13 of the existing SEZ Law, the functions and duties of TSMC are as follows:

a. To submit the SEZ development plan.
b. To arrange and enable the operation of investment businesses to be carried out in the SEZ.
c. To supervise and inspect the matters on implementation of investment and establishment plans, land use, environmental conservation, waste management, health, education, finance and taxation, development, transport, communications, security, electricity, energy and water supply, etc., and coordinate with the relevant government departments and organizations.
d. To coordinate with the relevant government departments and organizations as may be necessary to give protection to the property, profits, and other rights of the investor in conformity with the existing laws.
e. To coordinate with the relevant government departments and organizations as may be necessary to obtain entry visa and residency for foreign investors and their employees, technicians, and staff working in the SEZ.
f. To coordinate and facilitate the Central Bank of Myanmar as may be necessary, in implementing financial management, supervising foreign currency exchange and financial businesses for investors in the SEZ and in communicating with banks permitted to do foreign banking businesses in Myanmar.
g. To coordinate with the developers, investors, and companies that will take responsibility to construct the infrastructure in the SEZ, give permission to do so in accordance with the stipulation, and supervise their activities.
h. To carry out one-stop service related to the works within the authority of the management committee in accordance with the existing law.
i. To scrutinize and approve the construction works and designs in accordance with the main plan of the SEZ.
j. To supervise the natural environmental conservation and protection in the SEZ in accordance with the existing laws, to scrutinize the disposal system of industrial wastes, and, if it is not

in conformity with the stipulations, to make the developer or investor perform in line with them.

k. To carry out the functions and duties specifically assigned by the government and the central body.

4.10.2 Situation of the Thilawa SEZ Supporting Committee

The Thilawa SEZ Supporting Committee (TSSC) is being formed to provide support for TSMC's works in Thilawa SEZ. Table 4.10.1 shows the status of TSSC member assignment as of mid-September 2012.

It seems that the government established TSSC having the features of a cross-ministry organization, wherein 19 members are from 12 ministries or government organizations. Among the 19 members, two members are from the Settlement and Land Records Department (SLRD) of the Ministry of Agriculture and Irrigation. Another two members are from DHSHD of MOC. As of mid-September 2012, the chairman and secretary have already been assigned on a full-time basis, and a few members are working on a part-time basis.

Table 4.10.1: Status of TSSC Member Assignment (as of mid-September 2012)

Assigned Person		Post at TSSC	Original Post	Status of Assignment
1	Maung Maung San	Chairman	Director General, Administration Department, Ministry of Home Affairs	Assigned
2	Khin Maung Soe	Secretary	Assistant General Manager, Myanmar Agricultural Product Trading, Ministry of Commerce	Assigned
3	Undisclosed	Member	Assistant Director, Settlement and Land Records Department (SLRD), Ministry of Agriculture and Irrigation	Not Yet
4	Undisclosed	Member	Chief Officer, Immigration and National Identification Card Registration Department, Ministry of Immigration and Population	Not Yet
5	Undisclosed	Member	Assistant Civil Engineer Officer, Myanmar Port Authority, Ministry of Transportation	Not Yet
6	Undisclosed	Member	Assistant Director , Union of Lawyer Office	Not Yet
7	Undisclosed	Member	Assistant Director, Taxation Department, Ministry of Finance and Revenue	Not Yet
8	Undisclosed	Member	Assistant Director, Directorate of Trade, Ministry of Commerce	Not Yet
9	Undisclosed	Member	Chief Officer (Administration 3), Labor Administration Department, Ministry of Labor	Not Yet
10	Undisclosed	Member	Assistant Director , Transportation Administration Department, Ministry of Transportation	Not Yet
11	Undisclosed	Member	Assistant Director, Department of Human Settlement and Housing Development (DHSHD), Ministry of Construction	Not Yet
12	Undisclosed	Member	Chief Engineer, YCDC(Thanlyin), Ministry of Border Area, National Races and Development Affairs	Not Yet
13	Undisclosed	Member	Myanmar Police Group, Ministry of Home Affairs	Not Yet
14	Undisclosed	Member	Assistant Director, Directorate of Investment and Company Administration, Ministry of National Planning and Development	Not Yet
15	Undisclosed	Member	Assistant Director, Department of Human Settlement and Housing Development (DHSHD), Ministry of	Not Yet

Assigned Person		Post at TSSC	Original Post	Status of Assignment
			Construction	
16	Undisclosed	Member	Assistant Director, Department of Human Settlement and Housing Development (DHSHD), Ministry of Construction	Not Yet
17	Undisclosed	Member	Assistant Director, Settlement and Land Records Department (SLRD), Ministry of Agriculture and Irrigation	Not Yet
18	Undisclosed	Member	Assistant Director, Settlement and Land Records Department (SLRD), Ministry of Agriculture and Irrigation	Not Yet
19	Undisclosed	Member	One of the Representatives from Member of Government Officer	Not Yet

Source: Thilawa SEZ Supporting Committee

4.10.3 Situation of Department of Human Settlement and Housing Development

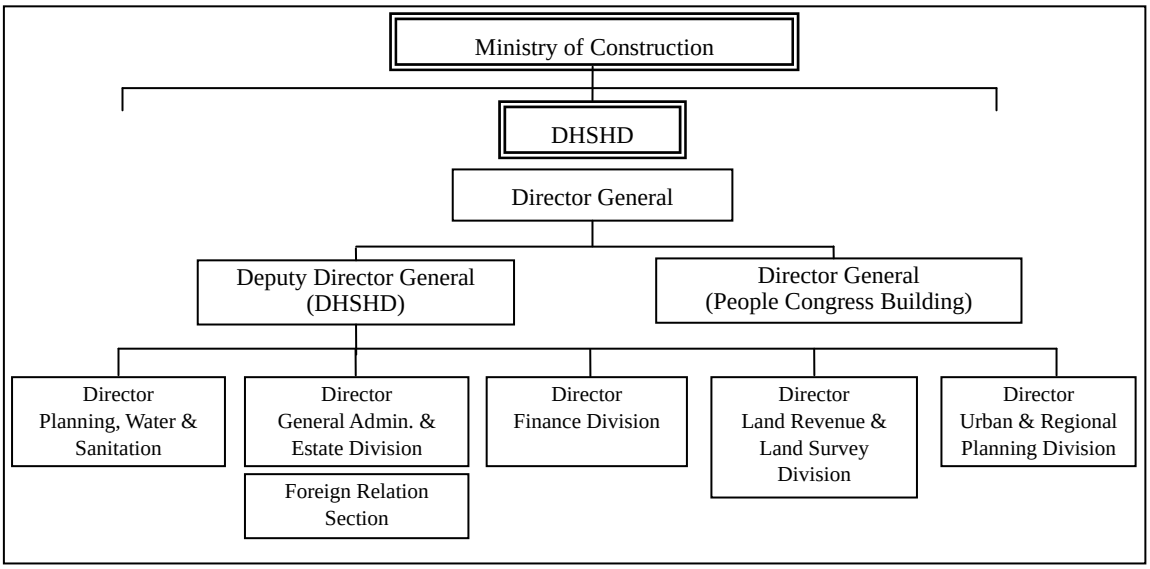
The DHSHD has extensive experience in planning and implementation of industrial estate projects. To utilize such experience, DHSHD is expected to be involved in the Thilawa SEZ development project. One possible way of DHSHD's involvement is to transfer its staff to TSMC and/or TSSC. Another possible way of its involvement is to act as an external infrastructure developer. Of course, its involvement should be determined under the responsibility of TSMC.

The DHSHD has five major functions as enumerated as following.

- Planning and implementation of urban development projects
- New town development
- Management and development of land owned by the government
- Planning and implementation of industrial estate development projects
- Investment by joint venture companies

As illustrated in Figure 4.10.1, DHSHD is one of the departments under MOC. There are five divisions under the authority of the Director General of DHSHD.

Approximately 2,000 staff are working at offices mainly in Nay Pyi Taw, Yangon, and Upper Myanmar. In addition, some staff are working in townships.



Source: DHSHD

Figure 4.10.1 Organizational Chart of DHSHD

The following are the survey results on DHSHD's experience in industrial estate projects.

(1) Industrial Estate Developed by DHSHD

There are three types of industrial estates in the Yangon region, as follows:

a. Local industrial zones developed by DHSHD,

b. Local industrial estates developed by private developers under the supervision of DHSHD, and

c. International industrial estates developed by joint venture between DHSHD and foreign investors.

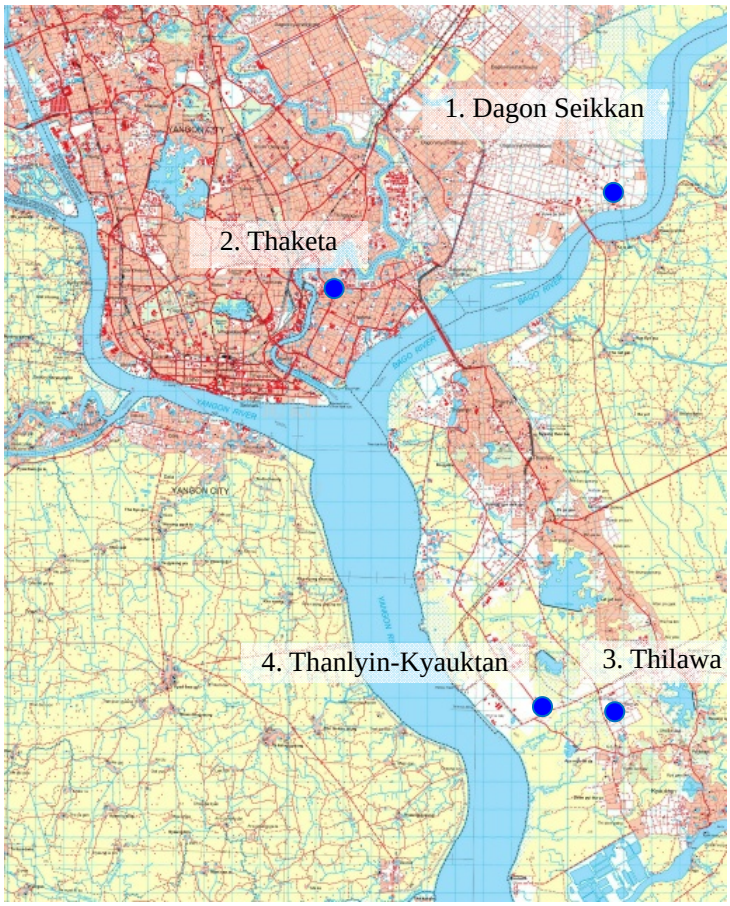
In the Yangon region, DHSHD has participated in 25 industrial estate development projects with a total land area of 5,560 ha. Among the 25 industrial estates, four industrial estates are near the Thilawa SEZ area.

1. Dagon Seikkan 490 ha, operating
2. Thaketa 81 ha, operating
3. Thilawa 175 ha, operating
4. Thanlyin-Kyauktan 100 ha, international industrial estate under construction jointly developed by DHSHD and Shinmardev International Pte. Ltd. of Singapore

Table 4.10.2 Status of Industrial Estates in the Yangon Region (as of the End of August 2012)

	Type of Industrial Estate	No. of Industrial Estates	Total Land Area (ha)
1	Local industrial estates developed by DHSHD	17	4,033
2	Local industrial estates developed by private developers under supervision of DHSHD	6	1,338
3	International industrial estates developed by joint venture between DHSHD and foreign investors	2	189
	Total	25	5,560

Source: DHSHD



Source: JICA Study Team

Figure 4.10.2 Location of Industrial Parks

(2) Infrastructure Status of Existing Industrial Parks

In the case of local industrial zones, water is self-supplied from investors' tube wells, although wastewater treatment facilities are not provided. On the other hand, in MIP, an international industrial estate, the developer supplies water from their own tube wells to investors and also treats discharged wastewater from the investors through a wastewater treatment facility.

(3) Implementation Method of Industrial Estate Development Project

The three divisions of DHSHD play important roles on the development of industrial estate projects.

The Land Revenue and Land Survey Division takes charge of land issues including land acquisition, relocation, and resettlement. In case that a local developer implements an industrial estate development project, this division shall at once acquire the land from the land owner and sell it to the private developer.

The Urban and Regional Planning Division plays a central role in the development of industrial estate projects. The division performs planning and design works, including master plan and detailed design.

The Planning, Water Supply, and Sanitation Division takes charge of construction supervision of industrial estate development projects. DHSHD calls for bids for contractor selection under the supervision of its director general.

(4) Investment Promotion

Investment promotion is not necessary for local industrial estates, according to DHSHD. In the case of MIP, the representative of the developer and the foreign relations representative of DHSHD are the contact persons of foreign investors. All land lots of MIP have already been sold-out. Therefore, land lots are no longer available to foreign investors.

(5) Operations and Maintenance of Industrial Estates

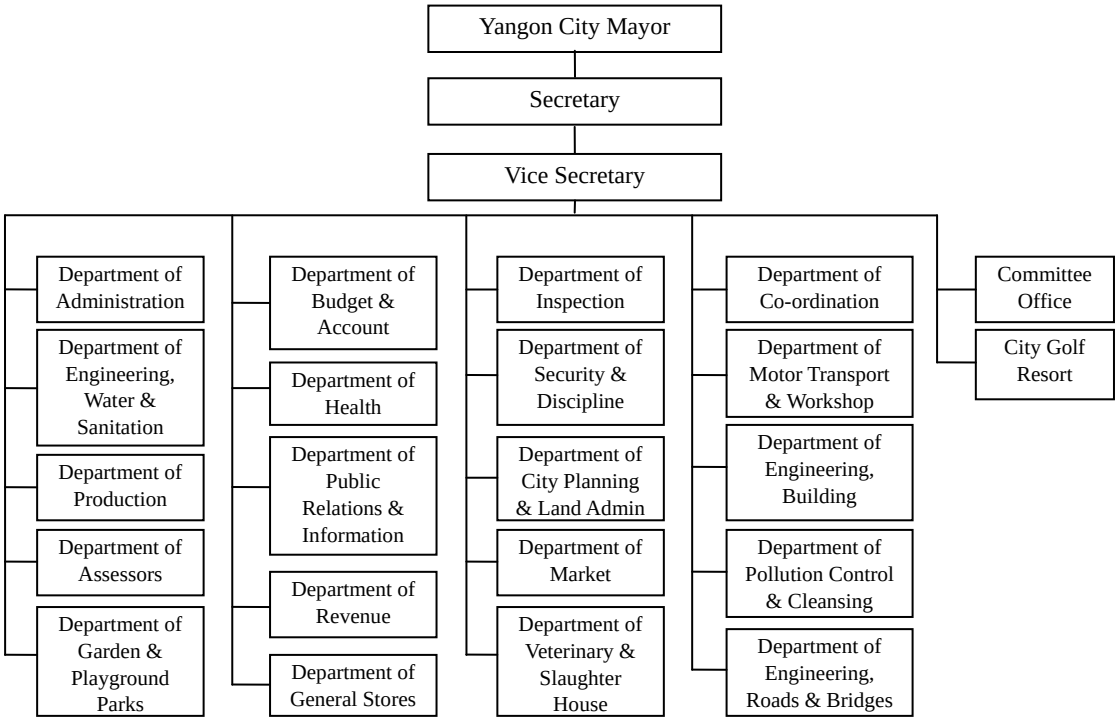
In the case of local industrial estates, after all the land lots have been sold, the facilities are then handed over from DHSHD to the Industrial Zone Management Committee. The committee members are composed of investors from industrial estates. The committee members jointly carry out the operations and maintenance of industrial estates by using the management fees collected from their members. In case of MIP, the joint venture company continues to carry out its operations and maintenance.

Individual investors directly pay electric tariff to YESB, telephone tariff to MPT, and solid waste disposal tariff to YCDC.

4.10.4 Situation of Yangon City Development Council Committee

Thilawa SEZ is located in the suburbs of Yangon City. Yangon City is one of the three cities with an authorized city development council, i.e., YCDC. The jurisdiction of YCDC is expected to be expanded in the future, although at present it is still limited to Yangon City. Thanlyin and Kyauktan townships in which Thilawa SEZ will be developed are not under YCDC's jurisdiction at present.

The YCDC has 20 departments under the supervision of the Mayor, Secretary, and Vice Secretary of Yangon City, as illustrated in Figure 4.10.3.



Source: YCDC

Figure 4.10.3 Organizational Chart of YCDC

The YCDC is the responsible agency for controlling and managing of capacity development for the members. However, insufficient human resources and experience limit its ability to respond to various urban issues at present. In addition, YCDC has no experience in developing industrial estates.

4.10.5 Ministries and Agencies Relevant to Infrastructure Development

This Study is being conducted in conjunction with various ministries and agencies, as shown in Table 4.10.3 below.

Table 4.10.3 Ministries and Agencies Relevant to Infrastructure Development of Thilawa SEZ

Infrastructure		Relevant Ministry or Agency
1	Road	Ministry of Construction (MOC)
2	Electricity	Myanmar Electric Power Enterprise (MEPE)
3	Sewage Disposal	Ministry of Construction (MOC)
4	Communication	Ministry of Communication, Posts and Telegraphs (MCTP)
		Myanmar Posts and Telecommunication (MPT)
5	Water Supply	Ministry of Construction (MOC)
		Ministry of Agriculture and Irrigation (MOAI)
		Yangon City Development Committee (YCDC)
6	Drainage	The Ministry of Construction (MOC)
		The Ministry of Agriculture and Irrigation (MOAI)

Source: JICA Study Team

4.11 Issues on Existing Infrastructure

The issues on existing infrastructure are summarized in Table 4.11.1.

Table 4.11.1 Issues on Existing Infrastructure

Sector		Issues
4.2	Road	1) Together with the development of the Class A area in Thilawa SEZ, Thilawa Port and related residential area development, traffic to the nearby city area (including Thanlyin, Yangon) is predicted to increase. 2) Accordingly, driving comfort and safety shall be concerned in the existing two-lane access road from Thanlyin to Thilawa.
4.3	Drainage	1) Development of the Class A area in Thilawa SEZ and the upstream industrial park is ongoing, but the corresponding drainage system has not yet been organized, thus, flood in the downstream area is concerned. 2) Drainage system in the basin (land outside of development land) need to be implemented by public works, but the Class A and city areas located in Thanlyin, drainage route and industrial park located in Kyauktan, furthermore, drainage routes are under the management of the Irrigation Department. The drainage work will become projects for one ministry with two townships.
4.4	Water supply	1) Water supply is a necessary infrastructure for regional development, especially in attracting investment companies to Thilawa SEZ. However, the prospect of the whole needs for ongoing development have not yet been established. 2) Although the short- to medium-term water supply needs have been estimated, large-scale water resources development for predicted long-term development has not yet been set.
4.5	Sewage	1) It is necessary to develop sewage system following water supply project step-by-step. 2) Currently, septic tank for SEZ, port, housing, etc. is necessary. In the future, sewage system for the whole area shall be managed by public works.
4.6	Waste management	1) Existing wastes are managed as part of public works. In the future, waste management will apply the same policy, and be operated by related government authorities. 2) Toxic waste generated in the Class A area shall be treated by the developer first, and then transferred to the final public treatment plant.
4.7	Power supply	1) In the present situation, although Thanlyin Substation can supply 20 MVA electricity, which is enough for Thilawa SEZ, Thilawa Port, and the new city area, it is forecasted that, together with economic growth, household appliance ratio would increase and there would be electricity shortage. 2) MOEP plans to construct a new power plant (500 MVA) in Yangon by build-operate-transfer (BOT) scheme. However, considering the uncertainty of private projects, the rapid increase of electricity needs in Yangon, and the scarcity of gas fuel, it is difficult to supply electricity to Thilawa area with priority. 3) In order to obtain stable power supply, it is necessary to take countermeasures such as construction of power plants in the Thilawa area and procurement of fuel.
4.8	Telecommunications	1) There is no main transmission line from/to Thilawa SEZ. 2) There is no subscriber network in Thilawa SEZ. 3) Transmission capacity of existing microwave telecommunication facility between TES and ITMC is limited. 4) Transmission capacity of international circuit used by ITMC is small. 5) Regarding telecommunications system, main networks improvement will be implemented as part of public works. Following that, same as the current situation, it is recommended for private companies to develop related systems/facilities depending on the actual needs.

Source: JICA Study Team