CHAPTER 4: CURRENT ENVIRONMENTAL AND SOCIAL CONDITIONS

4.1 Current Situation of Surrounding Environment of Project Area

Myanmar International Terminals Thilawa is located in plot 5 to 9 of Thilawa port area. MITT is a multi-purpose container terminal located at Thilawa near the mouth of the Yangon River. There exists Myanmar Integrated Port Limited terminal (MIPL) on the right of MITT, left by plot 10 which is open area with shrubs/bushes and trees and inland location, behind of MITT is Thilawa SEZ Zone A. Thilawa SEZ Zone A and nearest village are 1.5 miles and 2.5 miles away from MITT respectively. The surrounding area of MITT is shown in Figure 4.1-1.

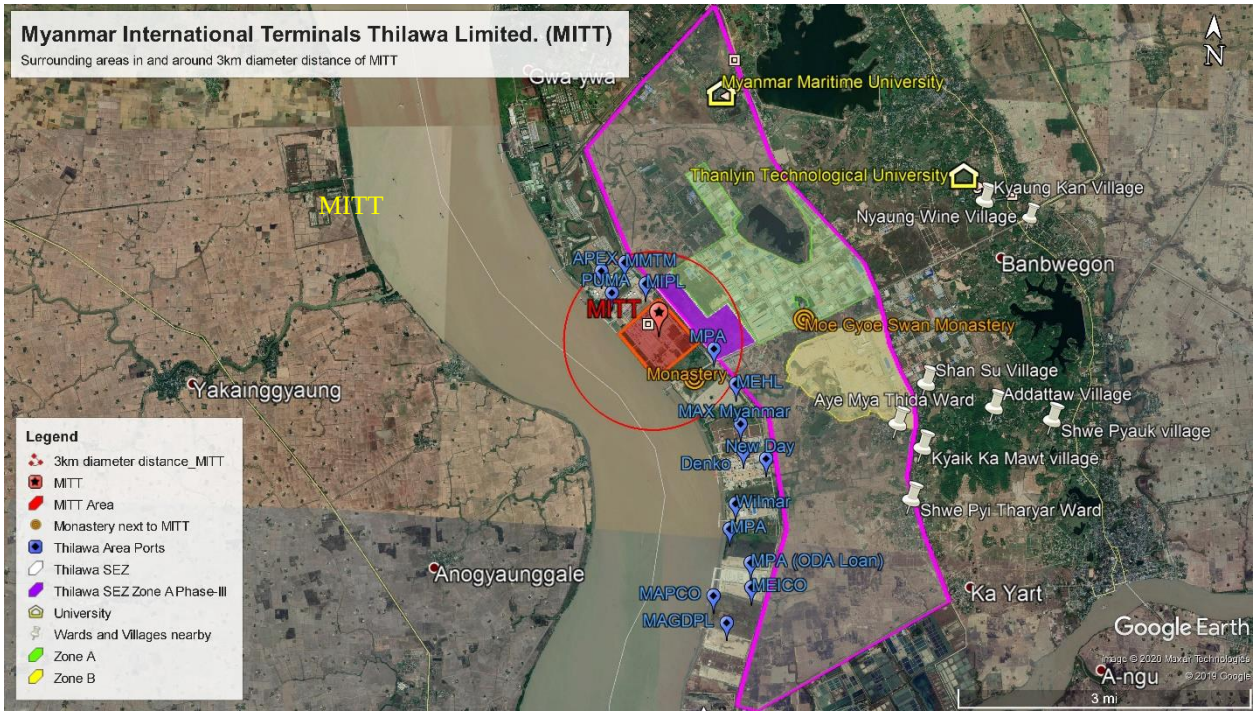


Figure 4.1-1 Location of MITT and surrounding area

4.2 Natural Environment

4.2.1 Meteorology

There are three seasons defined in Greater Yangon: the summer season starts from March till May, the rainy season starting from June till October and the winter starts from November till February. The Kaba-aye Meteorological Station, which is managed by the Department of Meteorology and Hydrology (DMH) in the Ministry of Transport and Communications (MOTC), has been observing meteorological conditions of Greater Yangon since 1968. The location of the Kaba-aye Station is shown in Figure 4.2-1.

Source: EMP Study Team

Figure 4.2-1 Location of Meteorology Station in the Yangon Area

Greater Yangon has a tropical monsoon climate characterized by altering the rainy season (from May to October) and the dry season (from November to April). Table 4.2-1 shows the amount of monthly rainfall mean temperature averaged from 2009 to 2018 observed at the Kaba-aye Meteorological Station, which is the nearest station from Thilawa.

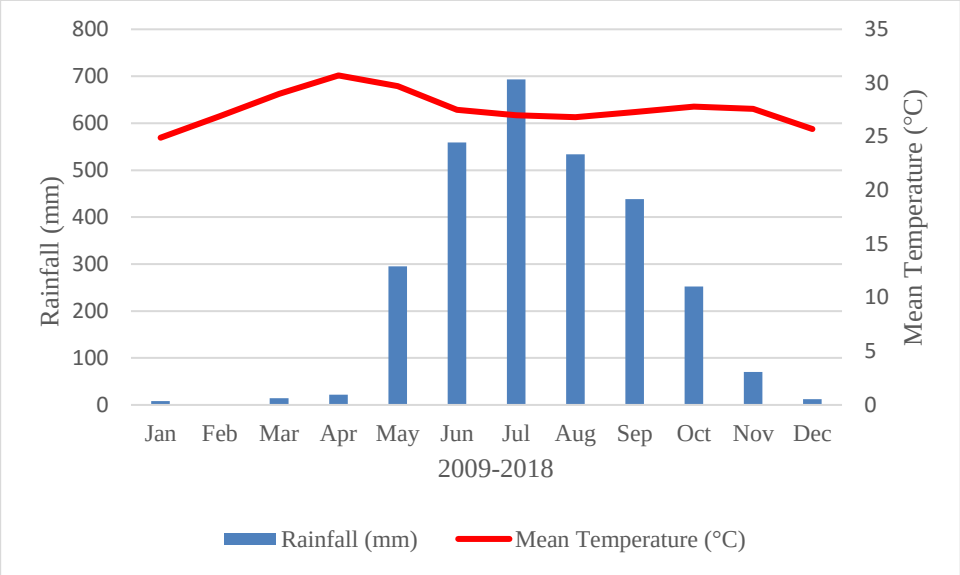
Temperature and Rainfall

From 2009 to 2018 the mean annual temperature is 27.6 °C. The mean monthly temperature is highest in April at 30.7 °C and lowest in January at 24.9 °C. Except in January, the monthly mean temperature is above 25.0 °C. The southwest monsoon wind is the main source of rain, and the Yangon area receives rain during the period from May to October. The average annual amount of rainfall is 241.42 mm. Rainfall sharply decreases from November and continues to be less than 30 mm from December to April as shown in Table 4.2-1 and Figure 4.2-2. According to Koppen's climate classification, the type of climate is Tropical Monsoon (am), which is characterized by alternating wet and dry seasons. The average relative humidity in Yangon is 76% during 2009-2018.

Table 4.2-1 Monthly Mean Temperatures, and Rainfall at Kaba-aye Station in Yangon City (2009-2018)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Mean Temp. (°C)	24.9	26.9	29.0	30.7	29.7	27.5	27.0	26.8	27.3	27.8	27.6	25.7	27.6
Rainfall (mm)	8	0	14	22	295	559	693	534	438	252	70	12	241.42

Source: Data of the Department of Meteorology and Hydrology, Kaba-aye Station, Yangon in the Statistical Year Book (2019)



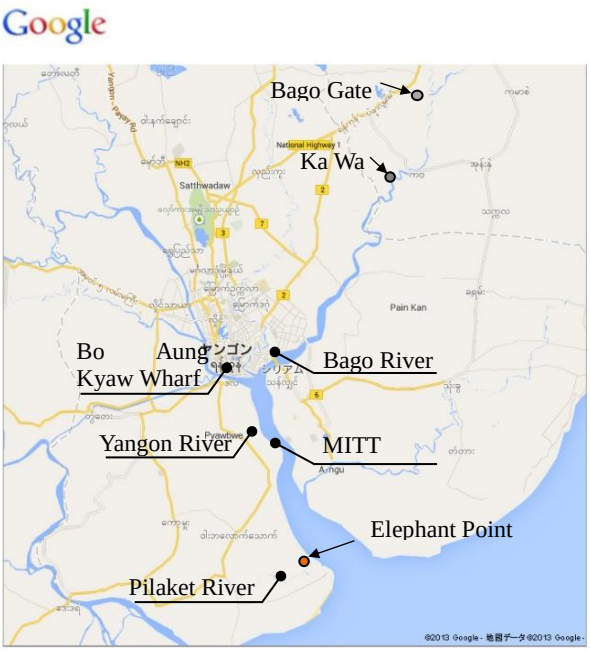
Source: Data of the Department of Meteorology and Hydrology, Kaba-aye Station, Yangon in the Statistical Year Book (2019)

Figure 4.2-2 Temperature and Rainfall in Yangon (2009-2018 Average)

4.2.2 Hydrological Situations

The proposed project will be located adjacent to the Yangon River in Kyauktan Township. The Yangon River is formed by the confluence of the Bago River and Myitmaka River in Myanmar. Yangon River estuary flows into the Gulf of Martaban of the Andaman Sea. The channel is navigable by ocean-going vessels playing an important role in the economy of Myanmar. The largest tidal range at Yangon River is 6.81 meters to 22.3 meters. Current velocity of Yangon River is 4 to 6 knots.

The data on the tide levels of the Yangon River as observed at elephant point (see Figure 4.2-3) by the Myanma of Port Authority (MPA) are shown in Table 4.2-2.The elephant point is located at the mouth of the Yangon River, 32 km south from the Yangon Port. The data of MPA are converted in accordance with Myanmar's standard sea level.



Source: JICA Preparatory Study on Thilawa SEZ Infrastructure Development in the Republic of the Union of Myanmar (March 2014)

Figure 4.2-3 Location of Rivers and Elephant Point

Table 4.2-2 Hydrological Data on the Yangon River

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

Source: JICA Preparatory Study on Thilawa SEZ Infrastructure Development in the Republic of the Union of Myanmar (March 2014)

4.2.3 Tophography

The coastal zone exists on the southern and South-eastern part of Thanlyin and Kyauktan township (see Figure 4.2-4). These coastal zone structures are from Mibya, Zwebagon, Shan Chaung, and Sinmakwe villages to the southern part up to Mottama sea. Large swampy lowlands are found in the lower part of the coastal region where Hmawwun river, Kondon creek and Kawdaun creek flow into Yangon river. The drain empties very slowly. Thus, this part is unsuitable for agriculture and fishing industries. The western portion of these townships is drained by a lot of tidal rivers and creeks. The main drainage is Hmawwun river which flows from east to west and drains into Yangon River. Some creeks flow into Yangon river, some into Hmawwun river and some directly into the Gulf of Mottama (e.g., Kanaung, Myagaing, Tummyaung, etc.).

1) Ridges

The dominant physical features of the region where the project is located are the three ridges namely: the Yangon Ridge in the northern part, the Thanlyin Anticlinal Ridge in the eastern part, and the Kawhmu Ridge in the western part of the region. Other parts are flat lowlands. These ridges are the southern continuation of the Pegu Yoma. The Yangon-Mingaladon Ridge is an anticlinal ridge but morphologically it looks like a homoclinal ridge. The highest elevation is about 68 m above sea level with 30 m base height and the regional slope is towards the south. The Thanlyin Ridge is also an anticlinal ridge and covered with thick lateritic soil. The highest elevation of the entire region is about 50 m mean sea level (msl) and base height is about 21 m above sea level. The Kawhmu Ridge is a dome shaped and covered with thick lateritic soil. The highest point is about 60 m and the basement of this ridge is about 20 m. This ridge is wide at about 34 km from the north of Twantay Town to the south of Kawhmu Town. Further in the western part along the Thanlyin-Kyauktan Highway and the western part of Nyaungwine Village Tract, Shwebyauk Village, Thanlyin Township, and Kyauktan Township are situated. The elevation of the ridges is above 17

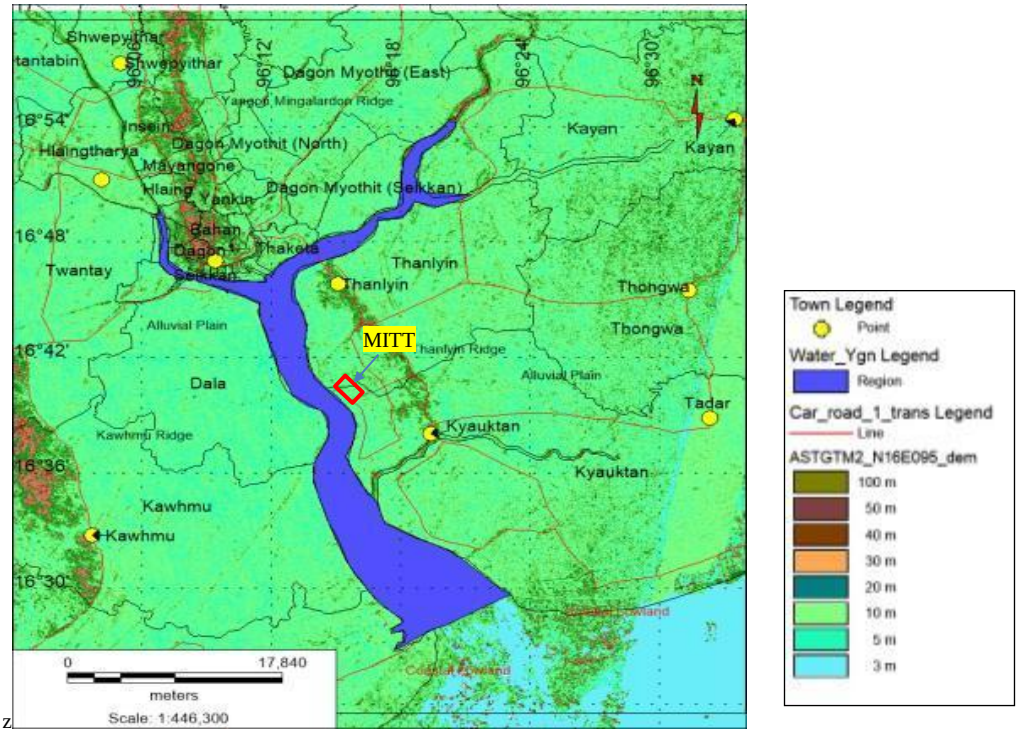
m and is located at the border of Thanlyin Township and Kyauktan Township along the road between Ahle Village of Thanlyin Township and Thilawa Village of Kyauktan Hmawwun by the side of Thilawa Road. The ridges are covered with dense forest vegetation and boundaries and are composed of laterite. These ridges are gently sloping southward.

2) Alluvial Plain

The alluvial plain is widespread and a vast agricultural land is found in the study area. This plain is built up with alluvial deposits from the Hlaing and Bago rivers. The general elevation of the alluvial plain is generally less than 6.6 m above mean sea level. In the rainy season, the plain is usually flooded, thus, it permits old alluvial soil to be deposited in its banks. The plain is rather swampy in some places.

3) Costal Lowland

The coastal zone exists in the southern and southeastern parts of Thanlyin Township and Kyauktan Township. These coastal zone structures are from Mibya, Zwebagon, Shan Chaung, and Sinmakwe villages in the southern part up to the Mottama Sea. Large swampy lowlands are found in the lower part of the coastal region where the Hmawwun River, Kondon Creek, and Kawdaun Creek flow into the Yangon River. The drain empties very slowly, thus, this part is unsuitable for agriculture and fishing industries. The western portion of these townships is drained by a lot of tidal rivers and creeks. The main drainage is the Hmawwun River, which flows from east to west and drains into the Yangon River. Some creeks flow into the Yangon River, some into the Hmawwun River, and some directly into the Gulf of Mottama (e.g., Kanaung, Myagaing, and Tummyaung). Figure 4.2-4 shows physiographic features in Yangon area.



Note: Scale is not applicable
Source: Resource Environmental Myanmar Ltd

Figure 4.2-4 Physiographic Features in the Yangon Area

4.2.4 Geographical Features

The regional geomorphic features of the entire area include ridges and deltaic lands lying south of the Pegu Yoma between the Sittaung River in the east and the Irrawaddy River in the west.

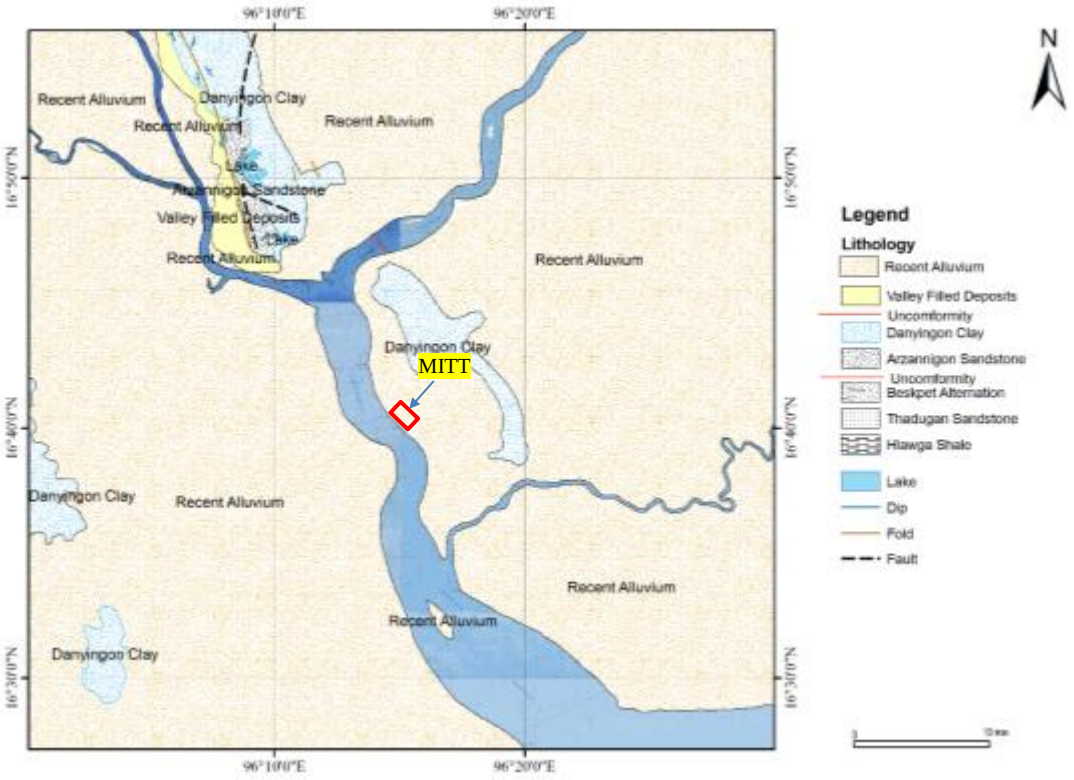
This area is in a north-south trending sedimentary basin containing thick sedimentary deposits from the Tertiary to Quaternary periods. The Tertiary deposits are strongly folded into narrow echelon anticlinal folds such as the Yangon Ridge, the Thanlyin-Kyauktan Ridge, and the Twantay-Kawhmu Ridge. All these

ridges are trending south towards the Gulf of Martaban. Rocks of the Tertiary Period contain well consolidated marine sandstone and shale of the Pegu Group and semi-consolidated, continental deltaic and marginal marine deposits of the Irrawaddy Formation. The synclinal valley or through west of the Yangon Anticlinal Ridge is filled with unconsolidated deposits from the Quaternary Period. There forms a wedge-shaped alluvial accumulation, ranging in thickness from a few feet near the ridge up to 100 m in the synclinal valley. The wedge-shaped form of these sediments extends both in the east-west and north-south directions and shows thickening toward the south and west. These sediments include clay, silt, sand, and very coarse-grained gravel. Table 4.2-3 shows geological survey of the region located in and around Yangon area and Figure 4.2-5 shows geological map in and around Yangon area.

Table 4.2-3 Geological Survey of the Region located in and around the Yangon Area

Lithostratigraphic Units	Geological Age	Physical Parameter
Recent Alluvial	Recent	Clay and silt with trace sand
Valley-filled Deposits	Pleistocene	Clay, silt, sand, and very coarse-grained gravel
Danyingon Clay	Pliocene	Reddish brown, grey to blue, laminated clays, with interbedded sand-rocks
Arzanigon Sand-rock		Yellowish grey to bluish grey sand-rock, fine to coarse-grained, sometimes very coarse-grained, sometimes very coarse to gritty with intercalated clay and mudstone/siltstone
Besapet Alternation	Miocene	Alternation of shale and argillaceous sandstone
Thadugan Sandstone		Well consolidated, jointed argillaceous sandstone
Hlawga Shale	Oligocene	Generally indurated shale

Source: Data from the Geology Department



Note: Scale is not applicable
Source: Data from the Geology Department

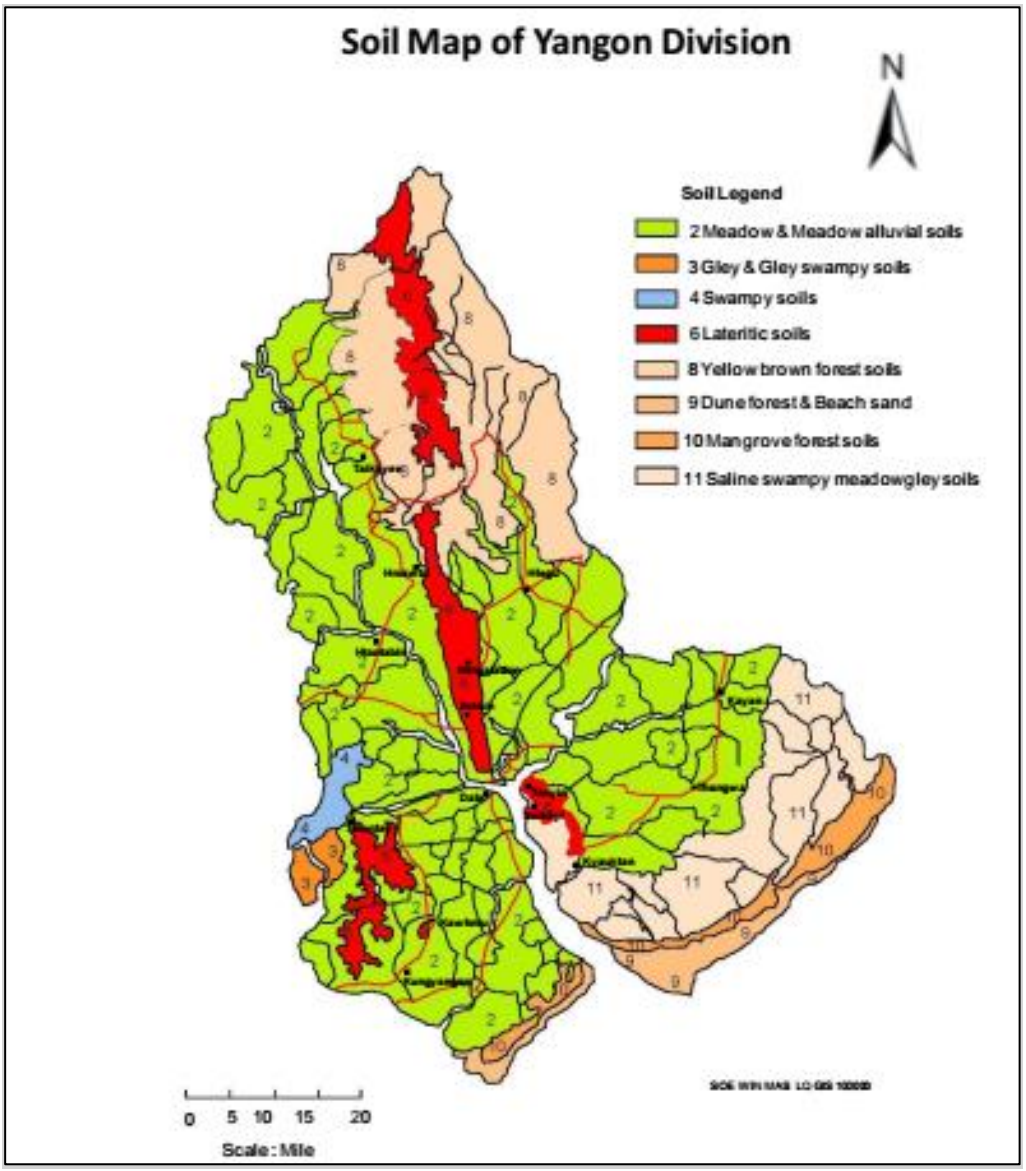
Figure 4.2-5 Geological Map in and around the Yangon Area

The project site is located on the left bank of the Yangon River, and on the elbow point of the river and always subject to erosion. There are two creeks on both north and south sides of the project area.

4.2.5 Soil Erosion

The main types of soil are Ferrosols, Gleysols, Solovechaks, and Arenesols. Ferrosols (plinthic) or lateritic soils are found on low hills along Thanlyin-Kyauktan. The soil is good for growing rubber and vegetables and for gardening. Gleysols (dystric) or meadow gley soils occupy much of the area in this township as shown in

Figure **4.2-6**. About 90% of these soils are composed of silt and clay, but humus content varies from place to place. These soils are favorable for paddy cultivation. The main problem, however, is the poor drainage and water-logged conditions. Meadow Solonchak are usually found in lowlands under impeded drainage. In the rainy season, they are covered with flood water. Because of the high content of clay, these soils become very dry and crack in the dry season. Solonchaks (gleyic) or saline swampy gluey soils are found along the coastal area. These soils develop from sediments transported and deposited in the estuaries of the Yangon River.



Note: Scale is not applicable
Source: Data from the Land Use Division, Myanmar

Figure 4.2-6 Soil Map of Yangon Area

4.2.6 Flora/Fauna and Biodiversity

According to the results of Flora and Fauna Survey in 2015[1], 158 flora species, 71 butterflies, 4 dragonflies, 67 birds, 7 mammals, 13 reptiles and amphibians, and 22 fish species were observed or recorded through interview with the local people in the project site and the surrounding area. Most species were classified as Not Evaluated (NE), Data Deficient (DD), and Least Concern (LC) under the IUCN Red List of Threatened Species (2015-4 Version 3.1). There were 1 threatened species (1 reptile) and 5 near threatened species (2 birds and 3 fishes) recorded in the area.

Table 4.2-4 Identified Species of Flora & Fauna in Thilawa SEZ Zone B

	Number of Species					
	Total	IUCN Red List				
		NE	DD	LC	NT	VU
Flora	158	139	3	16		
Butterfly	71	68		3		
Dragonfly	4			4		
Birds	67	1		64	2	
Mammals	7			7		
Reptilian & amphibian species	13	8		4		1
Fish	22	5	1	13	3	
Total	342	221	4	111	5	1

Note: NE: Not Evaluated; DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable;
Source: EIA Report for the Thilawa SEZ Zone B Industrial Area Development Project (May 2016)

Table 4.2-5 Threatened and Near Threatened Species Recorded during Field Survey

No.	Scientific Name	Common Name	Family	IUCN (2015-4 Ver. 3.1)	Type of Species
A. Threatened Species (CR: Critically Endangered, EN: Endangered, VU: Vulnerable)					
1.	*Ophiophagus hannah*	King Cobra	Elapidae	VU	Reptile
B. Nearly Threatened Species (NT)					
1.	*Anhinga melanogaster*	Oriental Darter	Anhingidae	NT	Bird
2.	*Ploceus hypoxanthus*	Asian Golden Weaver	Ploceidae	NT	Bird
3.	*Ompok bimaculatus*	Indian Butterfish	Siluridae	NT	Fish
4.	*Oreochromis mossambicus (Tilapia mossambica)*	Mozambique Tilapia	Cichlidae	NT	Fish
5.	*Wallago attu*	Wallago	Siluridae	NT	Fish

Note: NT: Near Threatened; VU: Vulnerable; EN: Endangered
Source: EIA Report for the Thilawa SEZ Zone B Industrial Area Development Project (May 2016)

4.2.7 Emergency Risk

Natural Hazard

The "Hazard Profile of Myanmar" prepared by the five government ministries and departments of Myanmar and four non-governmental agencies in July 2009 describes the nine types of disasters in Myanmar, as follows: 1) Cyclone, 2) Drought/Dry Zone, 3) Earthquake, 4) Fire, 5) Flood, 6) Forest Fire, 7) Landslide, 8) Storm, and 9) Tsunami. Among these, some notable natural hazards are described as follows:

(1) Flood

Flood in Greater Yangon can be classified into three types: i) river flood; ii) localized flood inundation in urban areas due to the combination of factors such as cloudburst, poor infiltration rate, poor drainage infrastructure (possibly due to climate change, heat island phenomenon); and in rural areas due to decrepit dams, dikes and levees, and iii) flood due to cyclone and storm surge.

Past major flood events from 1997 to 2007 are described in the "Hazard Profile of Myanmar", but there are only a few flood events recorded in and around Greater Yangon as shown in Table 4.2-6.

[1] EIA Report for Industrial Area of Zone B (May 2016)

Table 4.2-6 Past Major Floods in Yangon Region (1997-2007)

Location	Date	No. of Affected Households	Affected Population	Deaths	Remark
Kayan Township	7 June 1997	1,189	5,878	0	North part of the region
Hta/16 Ward, Shwe Pyi Thar Township	8 September 2002	886	4,541	0	Along the left bank of the Hlaing River in Greater Yangon

Source: Hazard Profile of Myanmar, July 2009

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. However, small-scale floods happen every year due to the poor drainage system and the influence of high tide at lowland areas near the Yangon River. According to the result of the interview survey on flooding targeting households living in Thilawa conducted from 17 to 20 September 2012 under the JICA Study[2], 35% of the population have experienced flood at least once as shown in Table 4.2-7.

Table 4.2-7 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 Preparatory Study on Thilawa SEZ Infrastructure Development in the Republic of the Union of Myanmar (March 2014)

Table 4.2-8 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 one day. In addition, 26% of the residents answered that the duration of inundation is from one to three days, and 28% experienced more than three days of inundation.

Table 4.2-8 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 Preparatory Study on Thilawa SEZ Infrastructure Development in the Republic of the Union of Myanmar (March 2014)

(2) Cyclone

Cyclones that originate from the Bay of Bengal generally move westward to India and then turn toward Bangladesh and Myanmar. Severe cyclones tend to occur either during the pre-monsoon season from April to May or the post-monsoon season from October to November.

Cyclones have three destructive forces, namely: i) storm surge, ii) heavy rainfall, and iii) strong winds. According to the "Hazard Profile of Myanmar", 1,248 tropical storms formed in the Bay of Bengal during the period from 1887 to 2005, of which 80 storms (6.4% of the total) hit Myanmar's coast. In total, 12 cyclones caused severe damage in Myanmar mainly due to the accompanying storm surge, and the highest death or missing toll was at 138,373 caused by Cyclone Nargis in May 2008.

Cyclone Nargis also hit Greater Yangon and floodwater spread on a number of townships around Yangon City. Most of the inundated areas during Cyclone Nargis were the Dala, Twantay, Htantabin, and Hlegu areas.

[2] JICA Preparatory Study on Thilawa SEZ Infrastructure Development in the Republic of the Union of Myanmar (March 2014)

(3) Earthquake

In the Bay of Bengal, west of Myanmar, there is the Andaman Trench, where the Indian Plate is moving northward and subducting underneath the Burma Plate from west to east. In east Myanmar, there is the Sagaing Fault, which is the boundary between the Burma Plate and Sunda Plate. Hence, magnitude 7.0+ class earthquake has occurred more than 16 times, and six earthquakes of around magnitude 7.0 hit the main cities along the Sagaing Fault such as Yangon, Bago, and Mandalay from 1930 to 1956. Significantly, Yangon experienced six huge earthquakes around the 1930s and large earthquake has not occurred for this 80 year. Greater Yangon apparently faces a potential risk of significant earthquake disaster although it is not easy to predict the time and magnitude of future earthquakes in the area. In August 2016, a 6.8 magnitude earthquake hit central Myanmar, damaging pagodas in the ancient city of Bagan and killed at least one person.

Table 4.2-9 Major Earthquake Records around Greater Yangon

Date	Location	Magnitude	Remarks
868	Bago	-	Shwemawdaw Pagoda fell down
875	Bago	-	Shwemawdaw Pagoda fell down
13th Sep. 1564	Bago	-	Pagodas including Shwemawdaw and Mahazedi fell down
1567	Bago	-	Kyaikko Pagoda fell down
1582	Bago	-	Umbrella of Mahazedi Pagoda fell down
9th Feb. 1588	Bago	-	Pagodas and other buildings fell down
30th March 1591	Bago	-	The Great Incumbent Buddha destroyed
4th June 1757	Bago	-	Shwemawdaw Pagoda damaged
27th Dec. 1768	Bago	-	Ponnyayadana Pagoda fell down
24th Aug. 1858	Pyay	-	Collapsed houses and tops of pagodas at Pyay, Henzada and Thayetmyo Felt with some damages in Innwa, Sittwe, Kyaukpyu and Yangon
8th Oct. 1888	Bago	-	Mahazedi Pagoda collapsed
10th Sep. 1927	Yangon	-	-
17th Dec. 1927	Yangon	7.0	Impacts extended to Dedaye
5th May 1930	Near Kayan, Yangon and Bago Region	7.3	Collapsed houses and other buildings in Yangon and Bago Regions. Death person in Bago and Yangon Regions were approximately 500 and 50, respectively.
27th Mar. 1931	Yangon	-	-
16th May 1931	Yangon	-	-
21st May 1931	Yangon	-	-

.

Table 4.2-10 Major Disasters in Yangon

Natural Disaster	Affected Place	Affected Year	Affected Facilities	Affected Living Things	Value Loss
Fire	Taikkyi T/S in Yangon[1]	February, 2004	Apyauk Oil Well No. 13		
	Hlaing T/S in Yangon[1]	2005		Victim: 9,145	80 million Kyats
Flood	Across Myanmar[2]	August, 2012	Damaged houses, roads, bridges and over 136,000 acres of farmlands	Victim: 287,000	
	Yangon Region and 11 other regions & states	July, 2015 - September 2015	Destroyed houses, inundated farmlands, roads, rail tracks, bridges. landslides	Affected population: 1.01 million Loss of life: 125	
Wind	Bago and Yangon (7.3)[1]	May, 1930	Damaged Houses and Pagoda	Loss of life: 550	
	Northern Myanmar (6.8)[2]	November, 2012	Houses: 400, Schools: 65, Religious building: 100	Loss of life: 16 Injury: 52	
Tsunami Earthquake (9.0) and flood	Ayeyarwady Region, Tanintharyi Region, Rakhine State and Yangon Region[1]	26th Dec, 2004	Houses: 601	Victim: 2,592, Loss of life: 61	1,585.56 million kyats
Cyclone	Yangon Region and Delta Region Areas	2nd May 2008	Damaged houses, roads, bridges, trees, power lines, communication poles, etc.	Loss of life and missing: 138,373	USD 10 billion (2008 USD)

Source: Hazard Profile of Myanmar, July 2009 and Myanmar Information Management Unit (MIMU)

Table 4.2-11 No. of Natural hazards in Yangon from 2015 to 2017

		Fire	Flood	Storm	Earthquake	Riverbank Erosion	Landslide	Thunder lightining stroke	Others	Total
2015-2016	Case	15	6	3	-	-	-	1	-	25
	Death (Person)	-	-	-	-	-	-	1	-	1
	Victims (Household)	121	3,761	117	-	-	-	-	-	3,999
	Victims (Person)	535	14,2246	555	-	-	-	-	-	15,336
2016-2017	Case	26	5	11	1	6	-	3	-	55
	Death (Person)	10	1	-	-	-	-	3	-	14
	Victims (Household)	279	1,957	123	6	97	-	-	4	2,466
	Victims (Person)	1,455	6,221	518	29	422	-	-	113	8,758
2017-2018	Case	37	2	10	-	12	1	4	6	72
	Death (Person)	2	-	-	-	-	-	5	-	7
	Victims (Household)	370	103	447	-	242	1	-	-	1,163
	Victims (Person)	1,576	374	2,297	-	983	6	-	29	5,265

(5) Climate Change

In the Republic of the Union of Myanmar, relatively underdeveloped, and with large parts of the country having only irregular use of electricity, if at all, Myanmar has a very low rate of carbon dioxide emissions per capita, at 0.1 metric tons per person in 1990, and rising gradually to 0.21 metric tons per person in 2004. This is in spite of the tropical climate, and the heavy use of air conditioners in the cities. Myanmar has its own oil industry, with petrol and gas used to generate electricity. Approximately 83 % of the country's electricity comes from fossil fuels, with the remainder from hydropower. As a result, liquid fuels make up 57 % of carbon dioxide emissions, and gaseous fuels make up another 39 %. The remainder comes from solid fuels and from the manufacture of cement. About 36 % of the carbon dioxide emissions in the country come from transportation, 30 % from the generation of electricity, and 15 % from manufacturing and construction. The main effect of global warming and climate change on Myanmar has been the increased risk of flooding, especially at the mouth of the Irrawaddy. The Boxing Day Tsunami in 2004 led to serious flooding of this region. The Myanmar government took part in the United Nations Framework Convention on Climate Change signed in Rio de Janeiro in May 1992. They accepted the Kyoto Protocol to the UN Framework Convention on Climate Change on August 13, 2003, and it took effect on February 16, 2005.

4.3 Social Conditions

4.3.1 Population

Myanmar International Terminals Thilawa is located across Thanlyin and Kyauktan townships in Yangon Region. As the GAD list of 2018, there are about 250,430 people in Thanlyin Township and 168,106 in Kyauktan Township as shown in Table 4.3-1.

Table 4.3-1 Population of Thanlyin and Kyauktan Townships

Township	Total (Male/Female)			Total (Urban/Rural)		Households
	Male	Female	Total	Urban	Rural	
Thanlyin	121,940	128,490	250,430	81,768	168,662	58,349
Kyauktan	82,599	85,507	168,106	44,568	123,538	42,521

Source: Thanlyin Township Administrative Offices Data (2018) and Kyauktan Township Administrative Offices Data (2018)

4.3.2 Ethnicity

The races residing in Thanlyin and Kyauktan townships are shown in Table 4.3-2. Most of the people who live in Thanlyin Township are Bamar, followed by Kayin and Rakhine. In Kyauktan Township, most of people are Bamar, followed by Kayin and Rakhine.

Table 4.3-2 Races in Thanlyin and Kyauktan Townships (2018)

No.	Race	Township	
		Thanlyin	Kyauktan
1	Kachin	20	3
2	Kayar	-	2
3	Kayin	579	224
4	Chin	26	12
5	Mon	28	8
6	Bamar	238,814	167,764
7	Rakhine	500	90
8	Shan	23	3
9	Indian/Chinese	10,440	4536
Total		250,430	172,642

Source: Thanlyin Township Administrative Offices Data (2018) and Kyauktan Township Administrative Offices Data (2018)

4.3.3 Religion

The different kinds of religion present in Thanlyin and Kyauktan townships are shown in Table 4.3-3. More than 90% of the people living in the two townships are Buddhists. There are more Hindus and Christian living in Kyauktan Township than in Thanlyin Township.

Table 4.3-3 Religion in Thanlyin and Kyauktan Townships

Township	Religion	Buddhist	Christian	Hindu	Muslim	Total
Thanlyin	Number	239,814	605	5,504	4,507	250,430
	(%)	95.8	0.2	2.2	1.8	100.0
Kyauktan	Number	163,028	1,221	3,264	594	168,116
	(%)	96.9	0.7	1.9	0.4	100.0

Source: Thanlyin Township Administrative Offices Data (2018) and Kyauktan Township Administrative Offices Data (2018)

4.3.4 Local Economy and Livelihood

The main sources of livelihood in the two townships are service staff, agriculture, livestock, trade, industry and official employment in the government (see Table 4.3-4). More than 20% of livelihoods in Thanlyin Township are earning for trade and odd job, while about 30% of livelihoods are earning from other livelihoods activities in Kyauktan Township.

Table 4.3-4 Existing Status of Local Livelihoods in Thanlyin and Kyauktan Townships (2018)

Township	Type of Workers (Person)								
	Government Staff	Service Staff	Agriculture	Livestock	Trade	Industry	Odd Job	Others	Total
Thanlyin	3,947 (2.7%)	18,530 (12.6%)	11,980 (8.2%)	670 (0.5%)	32,337 (22%)	25,128 (17.1%)	35,000 (23.8%)	19,225 (13.1%)	146,817 (100.0%)
Kyauktan	2274 (2.2%)	11,130 (10.7%)	11,290 (10.9%)	9,638 (9.3%)	8,593 (8.29%)	5,543 (5.3%)	20,307 (19.6%)	34,115 (32.9%)	103,632 (100.0%)

Source: Thanlyin Township Administrative Offices Data (2018) and Kyauktan Township Administrative Offices Data (2018)

4.3.5 Social Infrastructure and Service

Access Road

Public transportation modes in Kyauktan township are bus and inland water transportation. There are 3 bus line within 115 vehicles servicing the Kyauktan township. Figure 4.3-1 shows the current main roads that connect Yangon City to Thilawa Area, i.e., the road that passes through Thanlyin Bridge (Bridge No. 1) and the road that passes through Dagon Bridge (Bridge No. 2). The peripheral road of Thilawa Area is paved with concrete while the road between Thanlyin Bridge and Thilawa Area is paved with asphalt.

Majority of the pavement is made with concrete because concrete is relatively inexpensive there while there are insufficient asphalt factories which provide good-quality asphalt. On the other hand, most of the roads connected into the villages are still unpaved. Currently, the expansion of connection road from Thanlyin Bridge to Thilawa SEZ has been planned under the support of JICA.

Source: Preparatory Study on Thilawa SEZ Infrastructure Development in the Republic of the Union of Myanmar (2014)

Figure 4.3-1 Present Conditions of the Main Roads to Thilawa Area

Water Storage Reservoirs

In the region, there are 3 main reservoirs, including Zarmani Reservoir and Thilawa Reservoir in the northeast and Bant Bwaykone Reservoir in the east of Myanmar International Terminals Thilawa (MITT). Since water right for surface water belongs to the Ministry of Agriculture and Irrigation (MOAI), the Zarmani Reservoir and Bant Bwaykone Reservoir are managed by MOAI. On the other hand, the water right of Thilawa Reservoir belongs to the Ministry of Industry (MOI) and the Ministry of Construction (MOC). The location of the above reservoirs is presented in Table 4.3-5 and Table 4.3-6 shows the outline and situation of utilization of the three reservoirs.

The purpose of these major water reservoirs are as follows:

i) Zarmani Reservoir: It is a reservoir for agricultural purposes and the it serves mainly for irrigation. In addition, the reservoir water is sold as drinking and domestic water to the nearby industrial area and port.
ii) Bant Bwaykone Reservoir: It is a reservoir for agricultural purposes. The reservoir water is supplied for irrigation and sold to Kyauktan Township. A small portion is sold as drinking and domestic water to a nearby port.
iii) Thilawa Reservoir: This reservoir's water is supplied to nearby factories and is used for irrigation, and sold to a nearby port.

Table 4.3-5 Existing Three Reservoirs in and around Thilawa SEZ

No	Content	Bant Bwaykone	Zarmani	Thilawa
1	Location (Township)	Kyauktan	Thanlyin	Thanlyin

No	Content	Bant Bwaykone	Zarmani	Thilawa
2	Name of Source Creek	Par Da	Myayaryoe	-
3	Catchment Area (km^2)	2.25	7.25	0.93
4	Gross Storage Capacity	2,140	6,616	1,363
5	Full Water Level (EL m)	7.92	7.01	9.75
6	Completion Year	June 1994	June 1995	1986

Source: Preparatory Study on Thilawa SEZ Infrastructure Development in the Republic of the Union of Myanmar (2014), and JICA/Sanyu Consultants Inc., Data Collection Survey on Water Resources Potential for Thilawa Special Economic Zone and Adjoining Areas Final Report, September 2014

Table 4.3-6 Utilization of Three Reservoirs in and around Thilawa SEZ (2003-2011)

Unit: 1,000 m^3/year

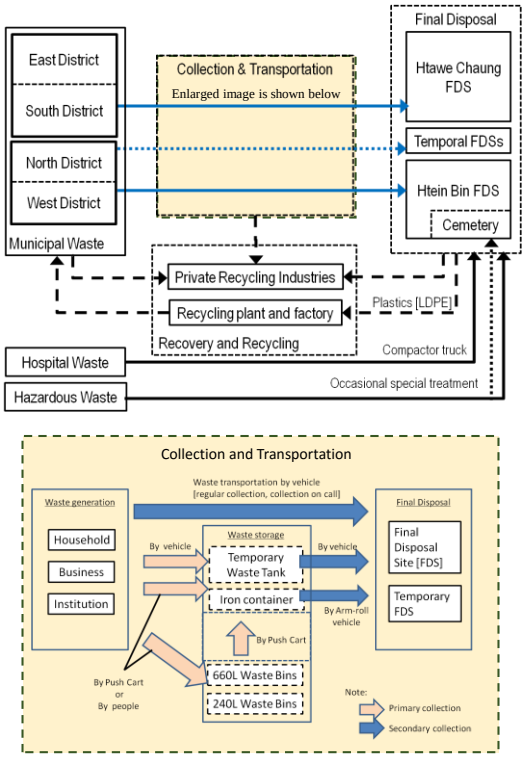
	Bant Bwaykone	Zarmani	Thilawa
1. Irrigation Water (average)	1,299	2,455	The amount of irrigation, domestic, and drinking water (2007-2011): 1,371
Maximum (1999-2011)	2,620	5,222	
Minimum (1999-2011)	1,023	752	
2. Domestic, Drinking Water (average: - 2011) *1	37	9	
(average: 2002 - 2003) *2	2,187	23,719	
Average water consumption (1+2) (average: - 2011) *3	1,336	2,464	1,371

*1: The average except from 2002 to 2003.
*2: The water from Zarmani and Bant Bwaykone was supplied to a nearby construction project in 2002-2003; it was different from the normal year.
*3: In the Thilawa Reservoir, the operational record before 2006 did not remain with the administrator (SHESAKA Factory).
Source: JICA/Sanyu Consultants Inc., Data Collection Survey on Water Resources Potential for Thilawa Special Economic Zone and Adjoining Areas Final Report, September 2014

Solid Waste Management

(1) Solid Waste Management in Yangon City

The Pollution Control and Cleansing Department (PCCD) of YCDC is in charge of solid waste management of 33 townships in Yangon City. The flow of solid waste from generation to final disposal in Yangon City is illustrated in below picture.



Source: The Project for the Strategic Urban Development Plan of the Greater Yangon (JICA) 2014

Figure 4.3-2 Flow of Solid Waste Management in Yangon City

The waste collection system in Yangon City is a combination of primary waste collection method, waste temporary storage and secondary waste collection (waste transportation). The PCCD personnel collects

solid waste directly from waste generation sources such as households, shops and businesses using push carts or trucks. The PCCD also collect waste from waste bins placed on the corner of the street in which waste generator discharge. In addition, there is another type of collection, so-called "on call". Waste generators make a phone call for waste collection to a township office or a district office. A PCCD truck goes and collects waste directly from large amount waste generators such as industries, embassies, and institutions.

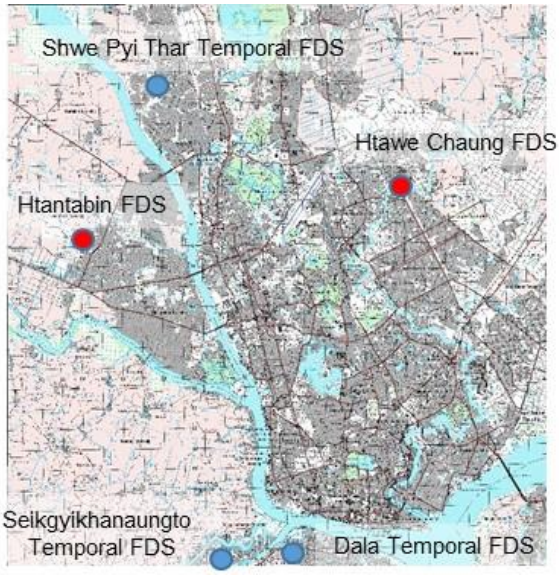
There are two main final disposal sites (FDS) operated by the PCCD. One is Htantabin final disposal site and the other one is Htawe Chaung final disposal site. These two FDSs are open and receive wastes for 24 hrs./day. Additionally, some small and temporary landfill sites are operated.

Table 4.3-7 outlines the existing final disposal sites in Yangon city, while Figure 4.3-3 shows these locations. All final disposal sites are currently operated as open dumping sites. No soil covering on the dumped waste, collection/treatment of leachate, nor control of landfill gas have been carried out.

Table 4.3-7 Existing Final Disposal Site in Yangon City

Name	Township/District	Area [ha]	Year of Starting Service
Disposal site			
Htanbin	Hlaing Tharyar/ West	61	2002
Htawe Chaung	North Dagon/ East Dagon	60	2004
Temporal site			
Shwe Pyi Thar [Kyun Chaung]	Shwe Pyi Thar/ West	1	1998
Seikgyikhanaungto	Seikgyikhanaungto / South	0.1	1962-
Dala	Dala/ South	1	1950

Source: YCDC



Source: EIA Report for the Thilawa SEZ Zone B Industrial Area Development Project (May 2016) (based on information from PCCD)

Figure 4.3-3 Location of the Existing Disposal Sites in Yangon City

As for the infectious waste, the PCCD has collected them separately by compactor trucks and then incinerated them at the furnace equipped in the cemetery located at the nearby Htantabin FDS. The furnace of Htantabin Crematorium is used for infectious wastes every afternoon after completion of funerals.

As for management of disposed hazardous materials, the PCCD has treated and disposed waste which are recognized and classified as hazardous wastes like the expired medicines, residual paints and mercury. In most cases, these materials are sealed into concrete containers or encapsulated and placed into a protected deep trench. Since hazardous wastes have not been regulated by legislation in Myanmar, responsibility of treatment and disposal as well as method for treatment is not clear.

(2) Solid Waste Management in Thanlyin and Kyauktan Townships

Solid waste management facilities in Thanlyin and Kyauktan townships are shown in Table 4.3-8. In Thanlyin Township, the Sanitary Department is in-charge of waste management and collects waste from all

wards. On the other hand, the Sanitary Section of the Administration Department is in-charge of waste management in Kyauktan Township. As shown in Figure 4.3-4 and Figure 4.3-5, each of the two townships has operated its own final disposal site as open dumping.

Table 4.3-8 Solid Waste Management in Thanlyin and Kyauktan Townships

Township	Department in Charge of Solid Waste Management	Waste Collection Amount [t/d]	Equipment [Vehicles, Machinery]	Collection Area	Area of Present Disposal Site [ha]
Thanlyin	Sanitary Department	60	Truck: 7 (3.5 to 4.0-ton truck)	16 of 17 wards and 2 villages	1.6
Kyauktan	Sanitary Section of the Administration Department	5	Truck: 2 (1-ton truck) Push cart: 3	6 of 9 wards	2.0

Source: Thanlyin Township Administrative Offices Data (2018) and Kyauktan Township Administrative Offices Data (2018)

Source: EIA Report for the Thilawa SEZ Zone B Industrial Area Development Project (May 2016)

Figure 4.3-4 Location of the Existing Disposal Site in Thanlyin and Kyauktan Townships

Final Disposal Site in Thanlyin Township

Final Disposal Site in Kyauktan Township

Source: EIA Report for the Thilawa SEZ Zone B Industrial Area Development Project (May 2016)

Figure 4.3-5 West Dumping Condition in Thanlyin and Kyauktan Townships

(4) Electricity

Three substations, namely: Thanlyin Substation, Thaketa Substation, and Kamarnat Substation are located in the surrounding area of Thilawa SEZ as shown in Table 4.3-9. Among them, the Thanlyin Substation is the closest one from Thilawa SEZ about 10 km to the north.

Table 4.3-9 Grid Substation near Thilawa Grid 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)
Thilawa Substation	2	230/33/11 kV	300 MVA (100 MVA x 3 units)

Source: Preparatory Study on Thilawa SEZ Infrastructure Development in the Republic of the Union of Myanmar (2014)

Table 4.3-10 shows the number of conventional households by main source of lighting in Thanlyin and Kyauktan townships according to the result of the census in 2014. Around 47.7% and 33.1% of households use electricity in Thanlyin and Kyauktan townships, respectively.

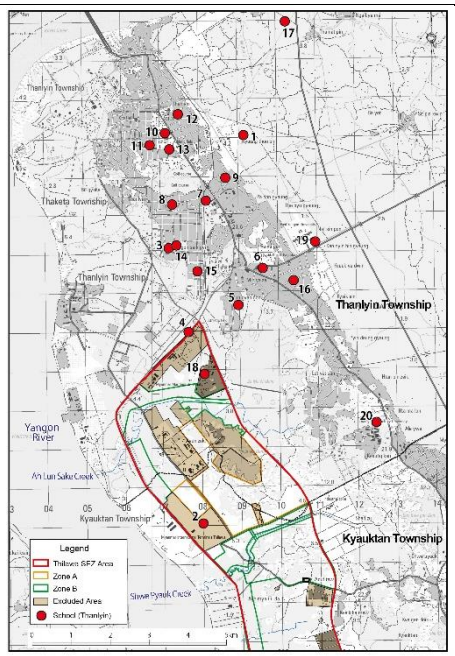
Table 4.3-10 Conventional Households by Main Source of Lighting

	Total	Electricity	Kerosene	Candle	Battery	Generator (Private)	Water Mill (private)	Solar System/ Energy	Other
Thanlyin	61,597	29,199	2,784	5,689	16,023	5,710	81	1,723	388
Kyauktan	32,976	10,914	4,617	4,436	8,218	2,057		1,793	928

Source: Department of Population, Ministry of Immigration and Population "The 2014 Myanmar Population and Housing Census–The Union Report- Census Report Volume 2" May 2017

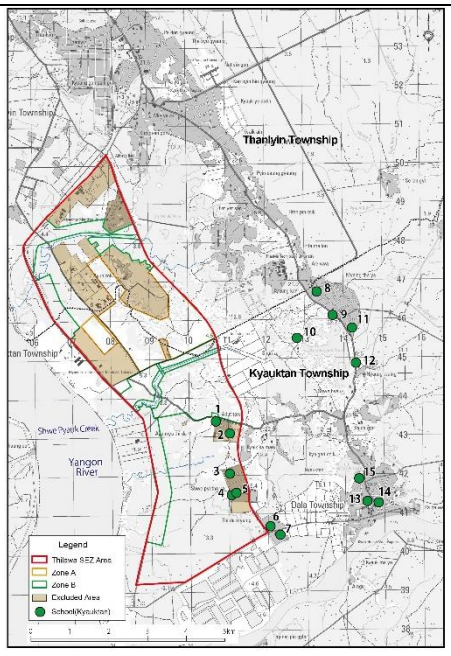
(5) School

Location of major schools, i.e. basic education primary school (B.E.P.S.), basic education middle school (B.E.M.S), basic education high school (B.E.H.S) and university, near Thilawa SEZ in Thanlyin and Kyauktan townships are shown in Figure 4.3-6 and Figure 4.3-7, and the name and the located village tract/ ward of schools are described in Table 4.3-11 and Table 4.3-12.



Source: EIA Report for the Thilawa SEZ Zone B Industrial Area Development Project (May 2016)

Figure 4.3-6 Location of Major Schools near Thilawa SEZ in Thanlyin Township



Source: EIA Report for the Thilawa SEZ Zone B Industrial Area Development Project (May 2016)

Figure 4.3-7 Location of Major Schools near Thilawa SEZ in Kyauktan Township

Table 4.3-11 List of Major Schools near Thilawa SEZ in Thanlyin Township

Sr. No.	Name of School	Location
1	Co-operative University	Nyaung Thone Pin Village Tract
2	B.E.H.S (Branch) Jamar	Seikkyi Village Tract
3	Su Htoo Pan Monastery School	Aye Myitta Ward
4	B.E.P.S Phan Chat	Phan Chat Ward

Sr. No.	Name of School	Location
5	B.E.P.S (146) Battalion School	Pha Yar Kone Village Tract
6	B.E.H.S Kyauk Yay Twin	Hpa Yar Kone Village Tract
7	B.E.P.S Jamar	Aung Chan Thar Ward
8	B.E.M.S (Branch) Htaw Watt	Aung Chan Thar Ward
9	B.E.M.S (Branch) Nyaung Thone Pin	Ah Mhu Htan Ward
10	B.E.H.S (2) Thanlyin	Myo Thit (East) Ward
11	B.E.H.S (3) Thanlyin	Htan Pin Kone Ward
12	B.E.H.S (1) Thanlyin	Oke Hpo Su Ward
13	B.E.H.S (4) Thanlyin	Bago Su Ward
14	B.E.H.S (Branch) Kyaung Kone Seik Gyi	Kyaung Kone Seik Gyi Village Tract
15	B.E.P.S Aye Thit Sar	Aye Thit Sar Ward
16	B.E.M.S Kun Chan Kone	Kun Chan Kone Village Tract
17	B.E.P.S Nga/ Pa	Nga/ Pa Village Tract
18	Myanmar Maritime University	Hpa Yar Kone Village Tract
19	East Yangon University	Hpa Yar Kone Village Tract
20	Technological University	Let Yet San Village Tract

Source: EIA Report for the Thilawa SEZ Zone B Industrial Area Development Project (May 2016)

Table 4.3-12 List of Major Schools near Thilawa SEZ in Kyauktan Township

Sr. No.	Name of School	Location
1	B.E.P.S Phan Lan	Aye Mya Thi Dar Ward
2	B.E.M.H Battalion (7)	Aye Mya Thi Dar Ward
3	B.E.P.S Shwe Pyi Thar Yar No.2	Shwe Pyi Thar Yar Ward
4	B.E.P.S Shwe Pyi Thar Yar No.3	Shwe Pyi Thar Yar Ward
5	B.E.P.S Shwe Pyi Thar Yar No.1	Shwe Pyi Thar Yar Ward
6	B.E.P.S Ka Yat	Thi Tar Myaing Ward
7	B.E.P.S Gway Pin	Thi Tar Myaing Ward
8	B.E.P.S Banbwe Kone No.1	Myaing Thar Yar Ward
9	B.E.M.S Myaing Thar Yar (Branch)	Myaing Thar Yar Ward
10	B.E.P.S Shan Su	Myaing Thar Yar Ward
11	B.E.P.S Banbwe Kone No.2	Myaing Thar Yar Ward
12	B.E.P.S Nyaung Wyne	Myaing Thar Yar Ward
13	B.E.H.S (1) Kyauktan	San Chein Hmi Ward
14	B.E.M.S Myo Ma	Ah Lel Paing Ward
15	B.E.H.S (2) Thaw Ka School	San Chein Hmi Ward

Source: EIA Report for the Thilawa SEZ Zone B Industrial Area Development Project (May 2016)

(6) Medical Facilities/Services

Location of major medical facilities and service near Thilawa in Thanlyin and Kyauktan townships are shown in below figure and the name and located village tract/ward of hospitals are described in Table 4.3-13.

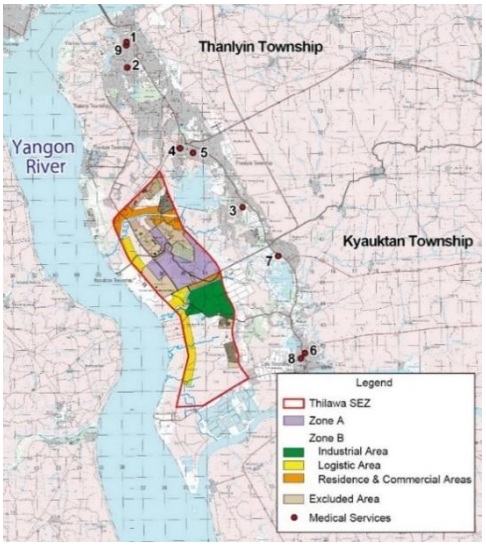


Figure 4.3-8 Location of Medical Services near Thilawa SEZ in Thanlyin and Kyauktan Townships

Table 4.3-13 List of Medical Facilities near Thilawa Area in Thanlyin and Kyauktan Townships

Sr. No.	Name of Hospital	Location
1	Chan Myae Myitta Private Hospital	Thanlyin Township
2	Thanlyin General Hospital	Thanlyin Township
3	Rural Health Department	Lat Yat San Village Tract, Thanlyin Township
4	Rural Health Department	Hpa Yar Gone Village Tract, Thanlyin Township
5	Rural Health Department	Ka La We Village Tract, Thanlyin Township
6	Rural Health Department	Yone Thapaykan Village Tract, Thanlyin Township
7	Rural Health Department	Dil Zet Village Tract, Thanlyin Township
8	Kyauk Tan General Hospital	Kyauktan Township
9	Rural Health Department (Myaing Thar Yar)	Nyaung Wine Village Tract, Kyauktan Township
10	Mother & Child Care	Ah Lal Ward Village Tract, Kyauktan Township
11	Mother & Child Care	San Chain Mhee Ward, Kyauktan Township

Source: Thanlyin Township Administrative Offices Data (2018) and Kyauktan Township Administrative Offices Data (2018)

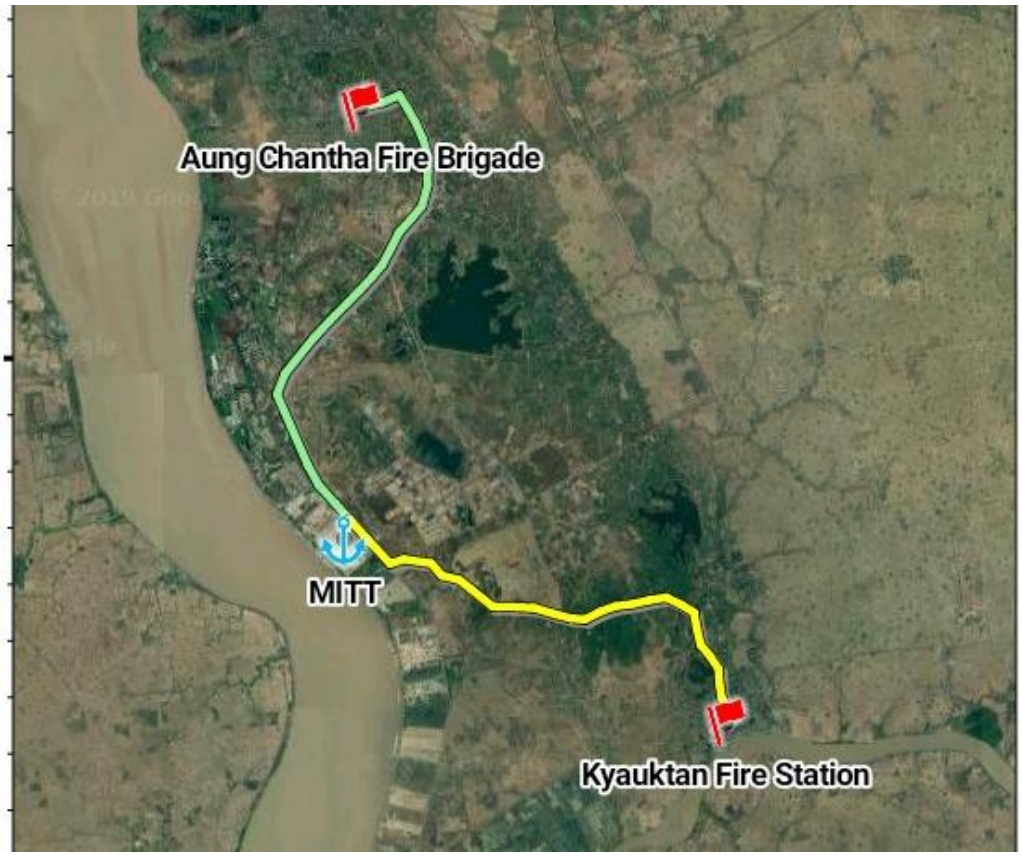
(7) Fire Station

In the region, there are 2 fire stations, including Aung Chantha Fire Brigade in Thanlyin township and Kyauktan Fire Station in Kyauktan township. The estimated distance between the project area and fire station and the estimated duration are described in Table 4.3-14. The relevant locations are shown below figure.

Table 4.3-14 Fire Stations in Thanlyin and Kyauktan Townships

From	To	Distance (miles)	Duration (minute)
Aung Chantha Fire Brigade	Project Area	about 6.82 miles	about 24 minutes
Kyauktan Fire Station	Project Area	about 6.21 miles	about 19 minutes

Source: EMP Study Team



Source: EMP Study Team

Figure 4.3-9 Location of Fire Stations in Thanlyin and Kyauktan Townships

4.3.6 Public Health

Table 4.3-15 shows the morbidity and mortality of diseases and accidents in Thanlyin and Kyauktan townships in 2018. It shows high morbidity of Acute Respiratory Infections (ARI) under 5-year-old and diarrhea disease in both townships.

Table 4.3-15 Morbidity and Mortality of Disease and Accidents

Disease/Accident	Thanlyin Township		Kyauktan Township	
	Morbidity	Mortality	Morbidityta	Mortality
Malaria	-	-	2	-
Diarrhea	246	-	1620	-
TB (Sputum+)	222	16	439	9
Dysentery	54	-	691	-
Hepatitis	-	-	42	-

Source: Thanlyin Township Administrative Offices Data (2018) and Kyauktan Township Administrative Offices Data (2018)

According to the Township Health Profile (2015) of Thanlyin and Kyauktan townships, most immunization rates for the major diseases cover more than 90% and some exceed 100% in both townships as shown in Table 4.3-16.

Table 4.3-16 Expanded Program on Immunization (2015)

	Thanlyin Township	Kyauktan Township
BCG	103	100.8
DPT (Diphtheria, Pertussis, Tetanus) 3 or Penta 1	101	100.7
OPV (Oral Polio Vaccine) 3	97	101.1
Hepatitis B3 or Penta 3	97	-
Measles 1 or 2	92	88.5
TT (Tetanus Toxoid) 1 or 2	100	97.1

Source: Township Health Profile 2016 of Thanlyin and Kyauktan Townships

Health Impact Indicators of both townships show that mortality rate in 2015 declines from that in 2013, except Under 5 mortality rates (U5 MR) in Kyauktan Township and maternal mortality rate (MMR) in both townships. On the other hand, population growth rate also decreases in both townships as shown in Table 4.3-17 below.

Table 4.3-17 Health Impact Indicator

	Thanlyin Township		Kyauktan Township	
	2013	2015	2013	2015
Population Growth (%)	1.79	1.2	0.87	0.7
Infant Mortality Rate (IMR)/1,000 Live Birth	14.4	7	14	5
Under 5 Mortality Rate (U5 MR)/1,000 Live Birth	17.3	4.3	2.9	12.8
Maternal Mortality Rate (MMR)/1,000 Live Birth	0.9	1.3	0.04	1.4

Source: Township Health Profile 2016 of Thanlyin and Kyauktan Townships

Other parameters related to public health in both townships are summarized in Table 4.3-18.

Table 4.3-18 Other Parameters related to Public Health (2015)

	Thanlyin Townships	Kyauktan Township
Nutrition		
Underweight Children (<1 yr.) (%)	1.7	-
Underweight Children (<5 yr.) (%)	0.5	1.4
Reproductive Health		
% of home deliveries (Basic Health Staff: BHS)	24.8	25.2
% of home deliveries (Auxiliary Midwife: AMW)	2	5.53
% of deliveries at Rural Health Centre (RHC) delivery room	71	22.62
Law birth weight (%)	1.4	2.47
School Health		
Coverage of students examined (%)	100	91.7

	Thanlyin Townships	Kyauktan Township
Coverage of schools with sanitary latrine (%)	100	100
Coverage of schools with safe water supply (%)	100	100
Environmental Health		
Coverage of sanitary latrines (%)	95.4	98

Note1: data in 2014

Source: Township Health Profile 2016 of Thanlyin and Kyauktan Townships

National Tuberculosis Prevention Program

Immunization Program for Measles and Polio

Figure 4.3-10 Major National Programs for Prevention of Infectious Disease

According to the information of Ministry of Health, the National Tuberculosis (TB) Program has been implemented for 2011-2015 in order to control expansion of TB in the whole of Myanmar. Currently, government supports TB patients free of charge treatment by distributing medicine in clinics and hospitals. In addition, prevention program of the Measles and Polio has been conducted by targeting children under 5 years old. The posters for these national programs are shown in Figure 4.3-10.

4.3.7 Cultural Heritage

Cultural heritage of Thanlyin and Kyauktan Township is shown in. The famous ancient pagodas are Kyaik Khauk pagoda, Ye Le Kyauk Tan pagoda in Thanlyin and Kyauktan Township. There are not found significant sites of cultural heritage or archaeological interest in the direct impact zone of the project. there is one old monastery (Thilawa YwaOo) near the project area. Furthermore, Ah Lwan Sok Pagoda, Ah Lwan Sok Monastery, one Roman catholic church and one Hindu Temple are found in Ah Lwan Sok village.

Table 4.3-19 Cultural Heritage in Thanlyin and Kyauktan Township in 2018

	Type of Cultural Heritage						
	Pagoda	Buddhist Temple	Church	Mosque	Hindu Temple	Chinese Temple	Total
Kyauktan	66	294	2	2	8	1	218
Thanlyin	146	278	5	10	32	2	473

Source: Thanlyin Township Administrative Offices Data (2018) and Kyauktan Township Administrative Offices Data (2018)

4.3.8 Landscape and Land Use

The project site and its surrounding area are composed of flat plains and typical rural landscapes of urban neighborhood.

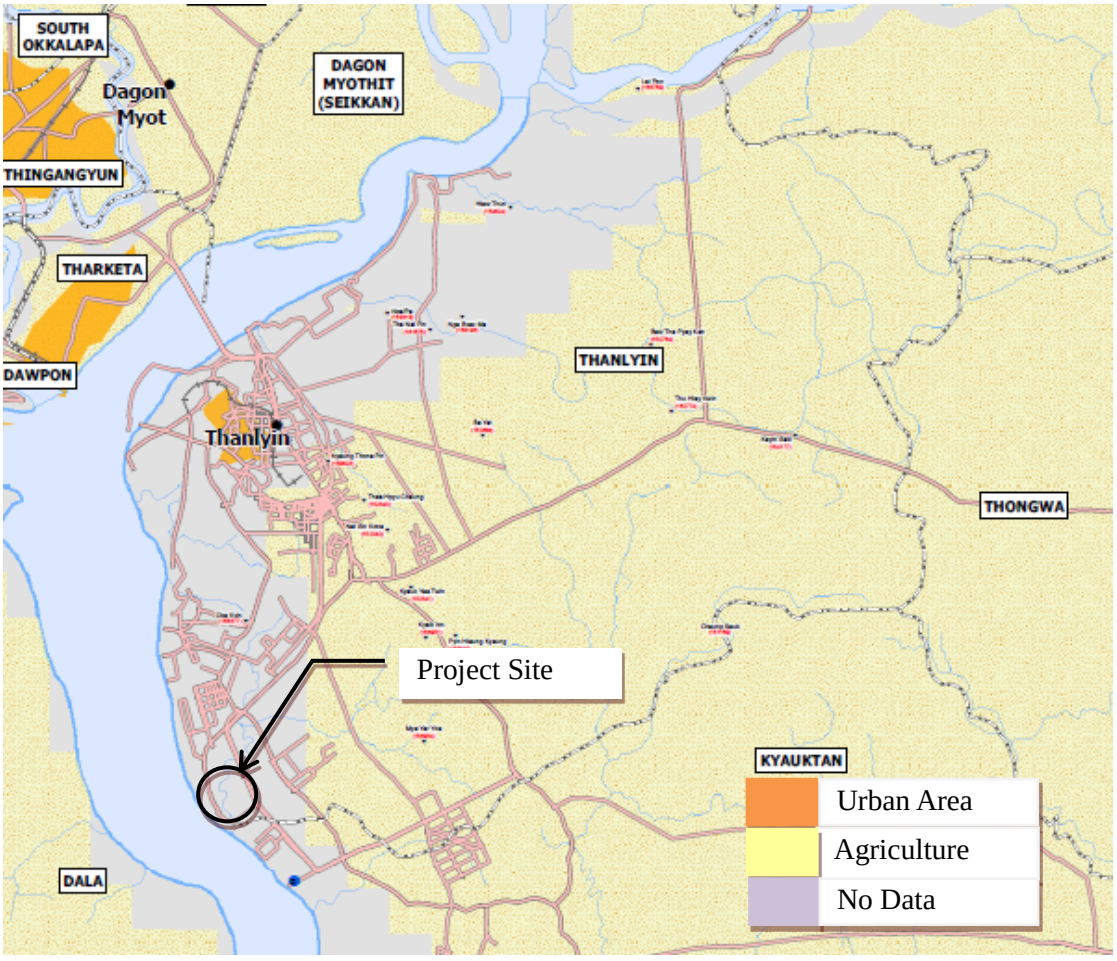
Land use in Thanlyin and Kyauktan townships are shown in Table 4.3-20. Both townships mainly use its land for agriculture followed by water area. In Thanlyin Township, settlement land covers 10.6 % (3,936 ha) which is comparatively large. It is considered that Thanlyin Township is a kind of bed-town for laborers who go to Yangon to work.

Table 4.3-20 Land Use of Thanlyin and Kyauktan Townships (2012/2013)

Land Category	Thanlyin		Kyautan	
	ha	%	ha	%
Agricultural Land	24,762.3	66.4	62,882.9	74.5
Forest and Natural Area	51.4	0.1	225.4	0.3
Road and Railway	803.7	2.2	1,097.5	1.3
Water Area	5,064.6	13.6	12,087.2	14.3
Industrial Land	2,108.0	5.7	794.4	0.9
Settlement Land	3,936.0	10.6	3,840.9	4.6
Other	565.3	1.5	3,442.7	4.1
Total Area	37,291.3	100.00	84,371.0	100.00

Source: JICA/Sanyu Consultants Inc., Data Collection Survey on Water Resources Potential for Thilawa Special Economic Zone and Adjoining Areas Final Report, September 2014.

Statistical data for land use in Thanlyin and Kyauktan Township is summarized and opened to the public by Myanmar Information Management Unit (MIMU) based on the statistics of Ministry of Home Affairs (MOH). According to the data, there are 17 Urban Wards and 28 Village Tracts in Thanlyin Township, and there are 17 Urban Wards and 28 Village Tracts in Kyauktan Township. Almost whole land is used for agricultural purposes and small remaining land represents the urban area as shown in Figure 4.3-11 and Figure 4.3-12.



Source: Myanmar Information Management Unit (MIMU)

Figure 4.3-11 Land Use in Thanlyin Township

Source: Myanmar Information Management Unit (MIMU)

Figure 4.3-12 Land Use in Kyauktan Township

4.4 Environmental Baseline Situation

4.4.1 Air Quality

Survey Items

The parameters for air quality survey were NO_2, SO_2, Ozone, $PM_{2.5}$ and PM_{10} and the parameters for meteorology survey were wind speed and wind direction.

Survey Location

The location of air quality survey point is shown in Table 4.4-1. The detail of the survey point is described below. The location of the air quality survey point is shown in Figure 4.4-1.

Table 4.4-1 Location of Air Quality Field Survey

Survey Point	Coordinates	Description of Survey Point
AQ-1	N: 16° 39'57.22", E: 96° 15'15.43"	Inside the compound of Myanmar International Terminals Thilawa (MITT)

Source: EMP Study Team

Source: EMP Study Team

Figure 4.4-1 Location of Air Quality Survey at AQ-1

AQ-1

AQ-1 is located inside the compound of Myanmar International Terminals Thilawa Limited. It is situated in the west of Thilawa Special Economic Zone. The surrounding area are Ah Lun Soke village in the northeast, Shwe Pyauk village and Dagon-Thilawa Road in the southeast respectively. Yangon River is situated in the west of MITT. The surrounding area inside MITT near AQ-1 are DG (Dangerous Goods) container/car yard in the west, vacant land in the east and the temporary staff housing in the northeast.

Source: EMP Study Team

Figure 4.4-2 Status of Air Quality Monitoring Point

Survey Period

Air quality and meteorology survey were conducted 1 day from 29 November 2019 – 30 November 2019.

Survey Method

Survey of meteorology and air quality (NO_2, SO_2, Ozone, $PM_{2.5}$ and PM_{10}) were conducted by referring to the recommendation of the United States Environmental Protection Agency (U.S. EPA). The Haz-Scanner EPAS was used to collect ambient air pollutants. The EPAS measures automatically every one minute and directly reads and records onsite for NO_2, SO_2, Ozone, $PM_{2.5}$ and PM_{10}.

Survey Results

The daily average value of air quality monitoring results of NO_2, SO_2, Ozone, $PM_{2.5}$ and PM_{10} are described in Table 4.4-2. Comparing with the guideline values of NO_2, SO_2, Ozone, $PM_{2.5}$ and PM_{10} prescribed in the National Environmental Quality (Emission) Guidelines (NEQG), one day average concentration of $PM_{2.5}$, PM_{10} and SO_2 were higher than the guideline value. In addition, hourly average concentration of NO_2 measured results for seven hours and concentration of Ozone measured results for five hours were exceeded than the guideline value.

Table 4.4-2 Air Quality Survey Result (Daily Average)

Date	NO_2 [3)4)]	$PM_{2.5}$	PM_{10}	SO_2 [3)]	Ozone
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
29 ~ 30 Nov, 2019	115.651	52.024	67.205	75.021	35.764
1 Day Average Value	115.651	52.024	67.205	75.021	35.764
NEQG Guideline Value[2)]	200 (1-hour)	25 (24-hours)	50 (24-hours)	20 (24-hours)	100 (8-hours)

Note: 1) The value in red color shows the value which is higher than NEQG
2) NEQG- National Environmental Quality Emission Guideline, Myanmar (Dec, 2015)
3) The value of NO_2 and SO_2 were converted to µg/m³ units from ppb per day at 1 atm condition.
4) The value of NO_2 is 24 hours average.
Source: EMP Study Team

Wind direction and wind speed were measured at AQ-1. Hourly average values of measured wind direction and wind speed data are described in Appendix-1. Status of air quality monitoring point and wind direction are described in Figure 4.4-3. Depending on the wind direction, it is assumed that the wind came from Northwest (NW), West-Northwest (WNW), West (W) and West-Southwest (WSW) were from the DG (Dangerous Goods) container yard. The wind came from Southwest (SW), South-Southwest (SSW), South (S), South-Southeast (SSE) and Southeast (SE) were from the vacant land inside MITT compound. The wind came from East-Northeast (ENE), East (E) and East-Southeast (ESE) ere from the temporary staff housing. The wind came from North-Northwest (NNW), North (N), North-Northeast (NNE) and Northeast (NE) were from MITT main office, canteen, operation main gate and Containers storage area. Moreover, the wind from outside of the Project area, where Dagon-Thilawa road, Thilawa SEZ and the Yangon River can also affect the air quality around AQ-1. According to the wind direction, the exceeded hours for NO_2, $PM_{2.5}$ PM_{10}, Ozone and SO_2 during the MITT operation period are shown in Table 4.4-5, Table 4.4-6, Table 4.4-7 and Table 4.4-8. Most of the wind directions come from East-Southeast (ESE), North-Northwest (NNW) and North-Northeast (NNE). The MITT is in 24 hours operation and its main operation activities are vehicles (cargo trucks/container trucks) in and out of MITT. The operation activities of MITT are described in Table 4.4-3.

Table 4.4-3 MITT Operation Activities

	General Cargo Truck		Container Trucks	
	Gate In	Gate Out	Gate In	Gate Out
29/11/2019 30/11/2019	27	313	378	475

Gate in Total	405
Gate out Total	788
Grand Total	1193

Source: MITT

Figure 4.4-3 Status of Air Quality Monitoring Point and Wind Direction

Remark: **N** *North* **NNE** *North-Northeast* **NE** *Northeast* **ENE** *East-Northeast* **E** *East* **ESE** *East-Southeast* **SE** *Southeast* **SSE** *South-Southeast* **S** *South* **SSW** *South-Southwest* **SW** *Southwest* **WSW** *West-Southwest* **W** *West* **WNW** *West-Northwest* **NW** *Northwest* **NNW** *North-Northwest*

Table 4.4-4 Summary of Total Exceeded Hours

Day	Parameters	Total Exceeded Hours
29 - 30 Nov, 2019	NO_2	6
	$PM_{2.5}$	15
	PM_{10}	12
	SO_2	7
	Ozone	5

Source: EMP Study Team

Table 4.4-5 Wind Direction of NO_2 Exceeded Hours

Day	Time	NO_2	Wind Direction
30 Nov, 2019	1:00 ~ 1:59	226.038	SW
	2:00 ~ 2:59	229.175	NNW
	3:00 ~ 3:59	224.036	NNW
	4:00 ~ 4:59	226.978	WSW
	5:00 ~ 5:59	222.155	SE
	6:00 ~ 6:59	209.198	NNE

Note: Time Duration when NO_2 Values are exceeded over NEQG Guideline Value (200 µg/m3)
Source: EMP Study Team

Table 4.4-6 Wind Direction of $PM_{2.5}$ Exceeded Hours

Day	Time	$PM_{2.5}$	Wind Direction
29 Nov, 2019	16:00 ~ 16:59	29.529	SSE
	17:00 ~ 17:59	39.200	SSE
	18:00 ~ 18:59	51.308	ESE
	21:00 ~ 21:59	27.056	W
	22:00 ~ 22:59	57.883	E
	23:00 ~ 23:59	72.633	NNW
30 Nov, 2019	0:00 ~ 0:59	103.200	WSW

Day	Time	$PM_{2.5}$	Wind Direction
	1:00 ~ 1:59	80.217	SW
	2:00 ~ 2:59	72.917	NNW
	3:00 ~ 3:59	105.750	NNW
	4:00 ~ 4:59	143.250	WSW
	5:00 ~ 5:59	154.604	SE
	6:00 ~ 6:59	133.000	NNE
	7:00 ~ 7:59	59.517	NNE
	8:00 ~ 8:59	27.767	NNE

Note: Time Duration when $PM_{2.5}$ Values are exceeded over NEQG Guideline Value (25 μg/m^3)
Source: EMP Study Team

Table 4.4-7 Wind Direction of PM_{10} Exceeded Hours

Day	Time	PM_{10}	Wind Direction
29 Nov, 2019	18:00 ~ 18:59	55.08	ESE
	22:00 ~ 22:59	65.50	E
	23:00 ~ 23:59	76.28	NNW
30 Nov, 2019	0:00 ~ 0:59	116.98	WSW
	1:00 ~ 1:59	90.55	SW
	2:00 ~ 2:59	80.72	NNW
	3:00 ~ 3:59	128.88	NNW
	4:00 ~ 4:59	179.30	WSW
	5:00 ~ 5:59	202.08	SE
	6:00 ~ 6:59	164.26	NNE
	7:00 ~ 7:59	82.10	NNE
	8:00 ~ 8:59	59.85	NNE

Note: Time Duration when PM_{10} Values are exceeded over NEQG Guideline Value (50 μg/m^3)
Source: EMP Study Team

Table 4.4-8 Wind Direction of SO_2 Exceeded Hours

Day	Time	SO_2	Wind Direction
29 Nov, 2019	13:00 ~ 13:59	371.6638	ESE
	14:00 ~ 14:59	351.2183	ESE
	15:00 ~ 15:59	327.3683	SE
	16:00 ~ 16:59	154.1925	SSE
	17:00 ~ 17:59	32.20257	SSE
30 Nov, 2019	11:00 ~ 11:59	110.4568	E
	12:00 ~ 12:59	230.1763	SSW

Note: Time Duration when SO_2 Values are exceeded over NEQG Guideline Value (20 μg/m^3)
Source: EMP Study Team

Table 4.4-9 Wind Direction of Ozone Exceeded Hours

Day	Time	Ozone	Wind Direction
29 Nov, 2019	13:00 ~ 13:59	119.94	ESE
	14:00 ~ 14:59	102.25	ESE
30 Nov, 2019	10:00 10:59	100.50	NNE
	11:00 ~ 11:59	145.42	E
	12:00 ~ 12:59	169.35	SSW

Note: Time Duration when Ozone Values are exceeded over NEQG Guideline Value (100 μg/m^3)
Source: EMP Study Team

Overall summary of total exceeded hours for 1 Day during for NO_2, Ozone, $PM_{2.5}$ PM_{10} and SO_2 are shown in Table 4.4-4. The wind direction for NO_2, Ozone, $PM_{2.5}$ PM_{10} and SO_2 exceeded hours are shown in Table 4.4-5, Table 4.4-6, Table 4.4-7, Table 4.4-8 and Table 4.4-9. Average hourly values of measured air quality data are described in Table 4.4-10.

For NO_2, hourly results are compared with 1-hour guideline value from NEQG. Based on the summary table of total exceeded hours for NO_2, the total exceeded hours were 6 hours. After detailed analyzing the NO_2 exceeded time according to the wind direction, all exceeded hours are come from Southwest (SW), North-Northwest (NNW), West-Southwest (WSW), Southeast (SE) and North-Northeast (NNE) directions which are from DG (Dangerous Goods) container yard, the vacant land of MITT and MITT main office, canteen, operation main gate and Containers storage area.

For $PM_{2.5}$, there is no 1-hour guideline value in Myanmar and nearby ASEAN Countries. Thus, hourly results are compared with 24 hours guideline value. Based on the summary table of total exceeded hours for $PM_{2.5}$, the total exceeded hours were 15 hours. After detailed analyzing the $PM_{2.5}$ exceeded time according to the wind direction during, all exceeded hours are come from East(E), East-Southeast (ESE), North-Northwest (NNW), Southeast (SE), South-Southeast (SSE), Southwest (SW), West (W), West-Southwest (WSW) and North-northeast (NNE) directions which are from the DG (Dangerous Goods) container yard, vacant land inside MITT compound, the temporary staff housing and MITT main office, canteen, operation main gate and Containers storage area.

For PM_{10}, there is no 1-hour guideline value in Myanmar and nearby ASEAN Countries. Thus, hourly results are compared with 24 hours guideline value. Based on the summary table of total exceeded hours for PM_{10}, the total exceeded hours were 12 hours. After detailed analyzing the PM_{10} exceeded time according to the wind direction during, all exceeded hours are come from East-Southeast (ESE), East(E), North-Northwest (NNW), Southwest (SW), West-Southwest (WSW), Southeast (SE), North-Northeast (NNE) directions which are from the DG (Dangerous Goods) container yard, vacant land inside MITT compound, the temporary staff housing and MITT main office, canteen, operation main gate and Containers storage area and Dagon-Thilawa road.

For SO_2, there is no 1-hour guideline value in Myanmar. For a detailed understanding, 1-hour average value is compared with Vietnamese Standard value (350 $\mu g/m^3$ on QCVN 05/2013/ BTNMT) as an example of an ASEAN Country. As compared with the 1-hour average value of SO_2 with Vietnamese Standard, total exceeded hours for SO_2, were 2 hours. After detailed analyzed the SO_2 exceeded time according to the wind direction, all exceeded hours are come from East-Southeast (ESE) direction which is from vacant land inside MITT compound and Dagon-Thilawa road.

For Ozone, hourly results are compared with 8-hour guideline value from NEQG. Based on the summary table of total exceeded hours for Ozone, the total exceeded hours were 5 hours. After detailed analyzing the Ozone exceeded time according to the wind direction, all exceeded hours are come from East-Southeast (ESE), North-northeast (NNE), East (E) and South-southwest (SSW) directions which are from the vacant land of MITT, temporary staff housing and MITT main office, canteen, operation main gate and Containers storage area.

Possible emission sources of $PM_{2.5}$ and PM_{10} are affected from natural origin such as dust from unpaved land area inside MITT compound and transportation in and around the monitoring area and Dagon-Thilawa road.

Possible emission sources of SO_2 are affected from the combustion of fuel for vehicles from nearby Dagon-Thilawa road.

Possible emission sources for NO_2 are affected from motor vehicles exhaust from MITT operation area and nearby Dagon-Thilawa road.

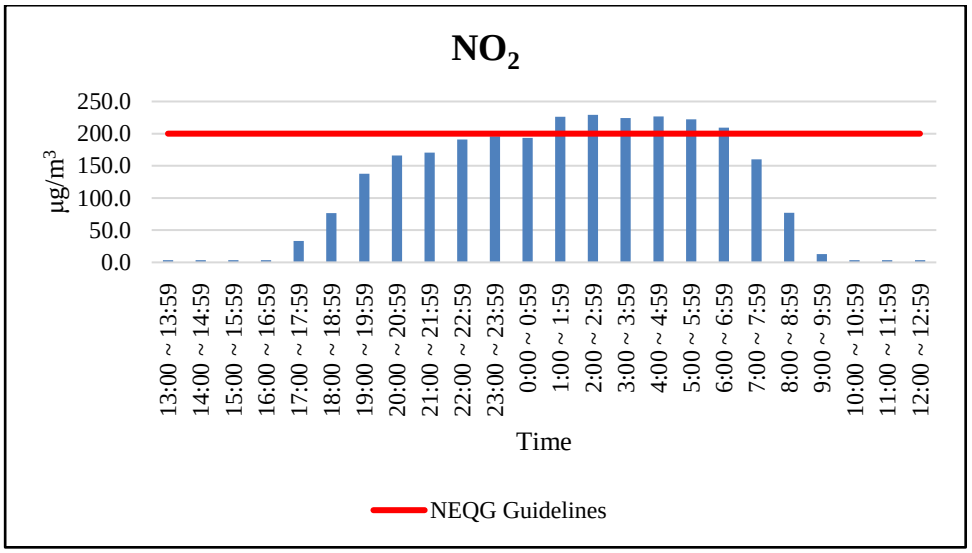
Ozone which is not emitted directly into the air. However, it is created by chemical reactions between oxides

of Nitrogen (NOx) and Volatile Organic Compounds (VOC). Possible emission sources for Ozone are affect from the combustion of fuel for vehicles and ozone pollution occur during periods of sunny weather.

As for future subject for air quality monitoring in MITT, the following action may be taken to achieve the target level:

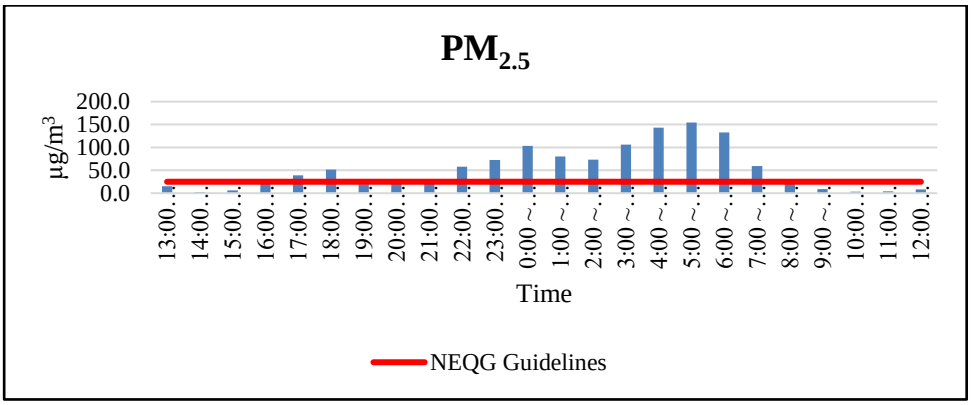
1) To control the speed limit of all machinery & vehicle in the project area to avoid excessive dust creation and to minimize air pollution by the exhaust fumes.
2) To conduct the proper operation (stop idling while no operation).
3) To implement the regular maintenance of machine used for operation activities.
4) To give awareness training to workers on machinery.
5) To check and maintain the generator regularly.

The periodical monitoring will be necessary to grasp the environmental conditions in the port operation stage of MITT. The mitigation measures for environmental management will be considered in collected periodical environmental data and has to be reviewed in future.



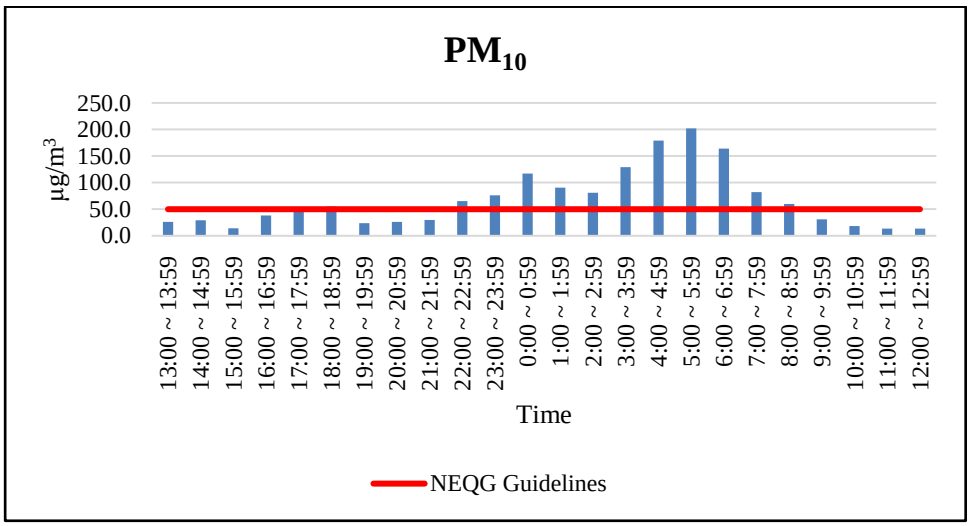
Source: EMP Study Team

Figure 4.4-4 NO_2 Values



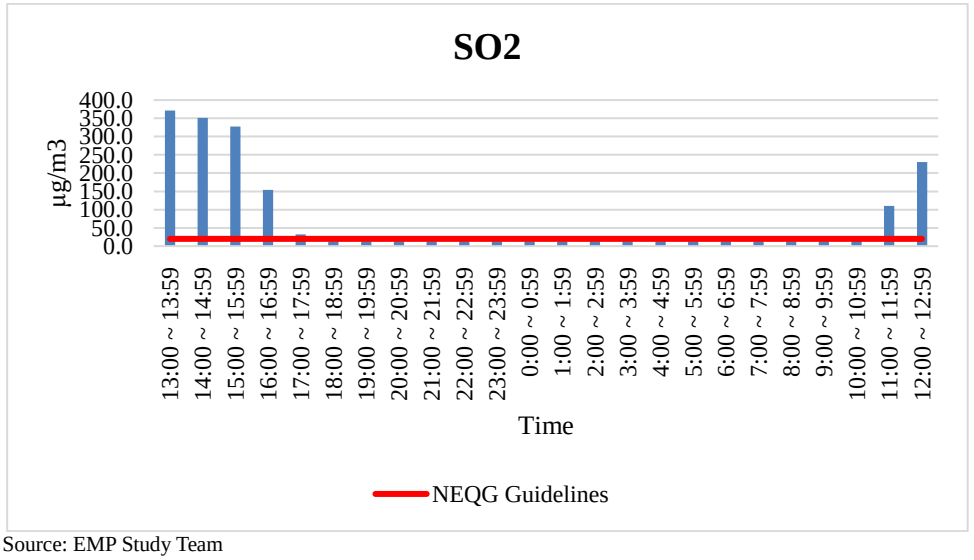
Source: EMP Study Team

Figure 4.4-5 $PM_{2.5}$ Values



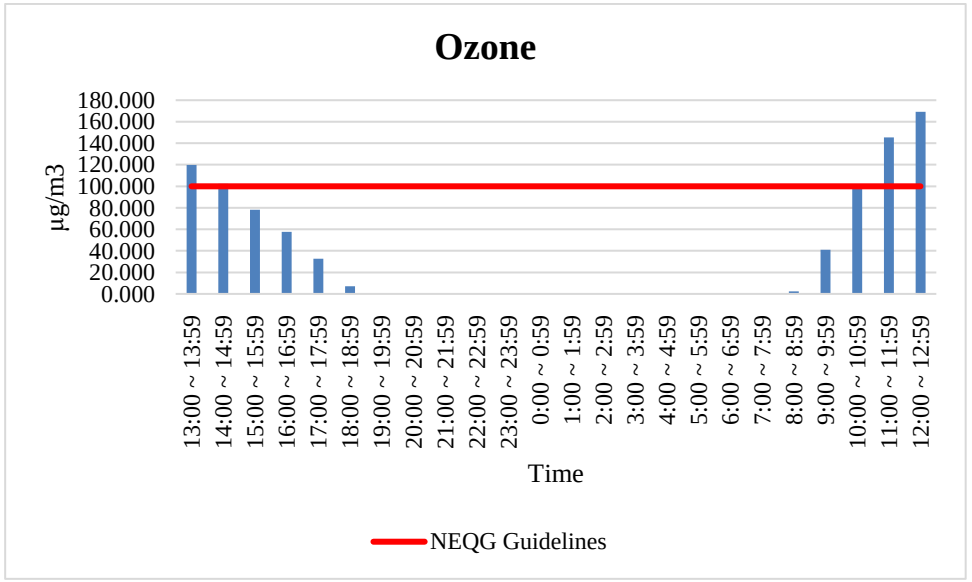
Source: EMP Study Team

Figure 4.4-6 PM_{10} Values



Source: EMP Study Team

Figure 4.4-7 SO_2 Values



Source: EMP Study Team

Figure 4.4-8 Ozone Values

Table 4.4-10 Hourly Air Quality Results

Date	Time			NO_2	$PM_{2.5}$	PM_{10}	SO_2	Ozone	Wind Speed	Wind Direction	
				µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	kph	Deg.	Direction
				Hourly	Hourly	Hourly	Hourly	Hourly	Hourly	Hourly	Hourly
29 Nov, 2019	13:00	~	13:59	3.387	15.273	26.455	371.664	119.935	2.47	106.00	ESE
29 Nov, 2019	14:00	~	14:59	3.382	2.371	29.429	351.218	102.248	2.42	105.50	ESE
29 Nov, 2019	15:00	~	15:59	3.392	5.800	13.950	327.368	78.207	2.68	144.00	SE
29 Nov, 2019	16:00	~	16:59	3.403	29.529	38.294	154.192	57.743	2.62	164.83	SSE
29 Nov, 2019	17:00	~	17:59	33.497	39.200	47.000	32.203	32.716	1.37	148.67	SSE
29 Nov, 2019	18:00	~	18:59	76.711	51.308	55.077	13.024	7.011	0.48	111.33	ESE
29 Nov, 2019	19:00	~	19:59	137.562	19.278	23.833	13.020	0.684	1.05	215.33	SW
29 Nov, 2019	20:00	~	20:59	165.899	24.133	25.950	13.000	0.479	1.13	286.75	WNW
29 Nov, 2019	21:00	~	21:59	170.416	27.056	29.917	13.013	0.348	0.75	263.50	W
29 Nov, 2019	22:00	~	22:59	190.876	57.883	65.500	13.080	0.205	0.52	86.33	E
29 Nov, 2019	23:00	~	23:59	196.090	72.633	76.283	13.046	0.000	0.92	331.67	NNW
30 Nov, 2019	0:00	~	0:59	193.503	103.200	116.983	13.104	0.000	0.73	237.33	WSW
30 Nov, 2019	1:00	~	1:59	226.038	80.217	90.550	13.079	0.000	0.67	232.33	SW
30 Nov, 2019	2:00	~	2:59	229.175	72.917	80.717	13.087	0.000	0.95	331.17	NNW
30 Nov, 2019	3:00	~	3:59	224.036	105.750	128.883	13.101	0.000	1.13	348.67	NNW
30 Nov, 2019	4:00	~	4:59	226.978	143.250	179.300	13.131	0.000	1.17	243.67	WSW
30 Nov, 2019	5:00	~	5:59	222.155	154.604	202.075	13.145	0.000	1.10	133.00	SE
30 Nov, 2019	6:00	~	6:59	209.198	133.000	164.262	13.160	0.000	1.12	30.83	NNE
30 Nov, 2019	7:00	~	7:59	160.282	59.517	82.100	13.100	0.000	2.00	29.33	NNE
30 Nov, 2019	8:00	~	8:59	76.865	27.767	59.850	13.013	2.459	2.33	13.83	NNE
30 Nov, 2019	9:00	~	9:59	12.646	9.067	31.017	12.931	41.029	2.30	32.67	NNE
30 Nov, 2019	10:00	~	10:59	3.390	3.033	18.550	14.196	100.497	2.27	26.00	NNE
30 Nov, 2019	11:00	~	11:59	3.377	3.783	13.500	110.457	145.415	1.65	82.83	E
30 Nov, 2019	12:00	~	12:59	3.371	8.017	13.450	230.176	169.354	0.88	199.00	SSW

Max	229.175	154.604	202.075	371.664	169.354
Avg	115.651	52.024	67.205	75.021	35.764
Min	3.371	2.371	13.450	12.931	0.000

4.4.2 Water Quality

Survey Items

Sampling points and parameters for water quality survey are determined so as to cover the environmental monitoring plan of the EMP report. Survey items and sampling points are summarized in Table 4.4-11.

Table 4.4-11 Survey Items for Water Quality

No.	Parameters	SW-1	SW-2	DW-1	Remarks
1	Water Temperature	○	○	○	On-site measurement
2	pH	○	○	○	On-site measurement
3	BOD (5)	○	○	○	Laboratory analysis
4	Dissolved Oxygen	○	○	○	On-site measurement
5	COD (Cr)	○	○	○	Laboratory analysis
6	Total Nitrogen	○	○	○	Laboratory analysis
7	Suspended Solids	○	○	○	Laboratory analysis
8	Total Coliform	○	○	○	Laboratory analysis
9	Total Phosphorous	○	○	○	Laboratory analysis
10	Zinc	-	-	○	Laboratory analysis
11	Arsenic	-	-	○	Laboratory analysis
12	Chromium	-	-	○	Laboratory analysis
13	Cadmium	-	-	○	Laboratory analysis
14	Selenium	-	-	○	Laboratory analysis
15	Lead	-	-	○	Laboratory analysis
16	Copper	-	-	○	Laboratory analysis
17	Nickel	-	-	○	Laboratory analysis
18	Free and Total Cyanide	-	-	○	Laboratory analysis
19	Phenols	-	-	○	Laboratory analysis
20	Total Residual Chlorine	-	-	○	Laboratory analysis
21	Cyanide	-	-	○	Laboratory analysis
22	Ammonia	-	-	○	Laboratory analysis
23	Fluoride	-	-	○	Laboratory analysis
24	Sulphides	-	-	○	Laboratory analysis
25	Silver	-	-	○	Laboratory analysis
26	Oil and Grease	○	○	○	Laboratory analysis
27	Iron	-	-	○	Laboratory analysis
28	Mercury	-	-	○	Laboratory analysis

Source: EMP Study Team

Survey Location

The location of sampling points are mentioned in Table 4.4-12. The photos of conducting field survey at each sampling points are mentioned in Appendix-2.

Table 4.4-12 Location of Sampling Points

No.	Station	Detailed Information
1	SW-1	**Coordinate** - N - 16°39'54.52", E - 96°14'37.00" **Location** - Upstream of the Yangon River before discharged point and 500m from the end of the jetty **Survey Item** – Surface water sampling
2	SW-2	**Coordinate** - N - 16°39'38.90", E - 96°15'13.62" **Location** – Downstream of the Yangon River after discharged point and at the end of the jetty **Survey Item** – Surface water sampling

No.	Station	Detailed Information
3	DW-1	**Coordinate-** N - 16°39'56.47", E - 96°15'2.66"
		Location – Middle discharged point of the MITT
		Survey Item – Discharged water sampling

Source: EMP Study Team

Figure 4.4-9 Location of Sampling Points of Water Quality Survey

SW-1

SW-1 was collected at the upstream of Yangon river which is 500m from discharged point at the end of the jetty. The Yangon River is situated in the west of MITT. The water quality of this survey point has been influenced by the surrounding area such as nearby Terminals and jetty.

Source: EMP Study Team

Figure 4.4-10 Surface Water Sampling and Onsite Measurement at SW-1

SW-2

SW-2 was collected at the downstream of the Yangon River which is close discharged point of the jetty. The Yangon River is situated in the west of MITT. The water quality of this survey point has been influenced by the surrounding area such as MITT and jetty.

Source: EMP Study Team

Figure 4.4-11 Surface Water Sampling and Onsite Measurement at SW-2

DW-1

DW-1 was collected at the middle-discharged point of MITT. The Yangon River is situated in the west of the MITT. The water quality of this survey point has been influenced by the wastewater from the MITT.

Source: EMP Study Team

Figure 4.4-12 Discharged Water Sampling and Onsite Measurement at DW-1

Survey Period

Water quality and water flow rate survey was conducted on 2 December 2019. The sampling time is shown in Table 4.4-13.

Table 4.4-13 Sampling Time of Each Station

No.	Station	Sampling Time
1	SW-1	2/12/2019 10:32
2	SW-2	2/12/2019 10:49
3	DW-1	2/12/2019 09:50

Source: EMP Study Team

Survey Method

All water samples were collected with cleaned sampling bottles and analyzed by the following standard method as shown in Table 4.4-14. All samples were kept in iced boxes keeping at 2-4° C and were transported to the laboratory. Among the parameters; water temperature, pH and DO were measured by the on-site instrument “Horiba, U-52.

Table 4.4-14 Analytic Method for Water Quality

No.	Parameter	Method
1	Water Temperature	Instrument Analysis Method (Horiba, U-52, Multi Water Quality Checker)
2	pH	Instrument Analysis Method (Horiba, U-52, Multi Water Quality Checker)
3	Dissolved Oxygen (DO)	Instrument Analysis Method (Horiba, U-52, Multi Water Quality Checker)
4	Suspended Solids	APHA 2540 D (Dry at 103-105°C Method)
5	BOD (5)	APHA 5210 B (5 Days BOD Test)
6	COD (Cr)	APHA 5220D (Close Reflux Colorimetric Method)
7	Oil and Grease	APHA 5520B (Partition-Gravimetric Method)
8	Total Nitrogen	HACH Method 10072(TNT Persulfate Digestion Method)
9	Total Phosphorous	APHA 4500-P E (Ascorbic Acid Method)
10	Ammonia	HACH Method 10205 (Silicylate TNT Plus Method)
11	Sulphide	HACH 8131 (USEPA Methylene Blue Method)
12	Cyanide	HACH 8027 (Pyridine-Pyrazalone Method)
13	Phenols	USEPA Method 420.1 (Phenolics (Spectrophotometric, Manual 4-AAP With Distillation))
14	Zinc	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
15	Chromium	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
16	Arsenic	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
17	Copper	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
18	Mercury	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
19	Cadmium	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
20	Selenium	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
21	Lead	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
22	Nickel	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
23	Iron	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
24	Silver	APHA 3120 B (Inductively Coupled Plasma (ICP) Method)
25	Fluoride	APHA 4110 B (Ion Chromatography with Chemical Suppression of Eluent Conductivity)
26	Total Coliform	APHA 9221B (Standard Total Coliform Fermentation Technique)
27	Total Residual Chlorine	APHA 4500-CL G (DPD Colorimetric Method)
28	Free and Total Cyanide	

Source: EMP Study Team

Survey Results

Results of water quality survey are summarized in Table 4.4-15. Water quality analysis report from the laboratory are described in Appendix-2.

The water quality results were compared with the guideline value of effluent water quality discharging to water body stipulated in the National Environmental Quality (Emission) Guidelines (NEQG) in Myanmar.

Results of Water Quality at the Upstream and Downstream of Surface Water Points in the Yangon River and Discharged Water Point

As comparison with the NEQG Guideline value, the results of suspended solids, total nitrogen, ammonia, iron and total coliform exceeded than the guideline values.

The temperature of downstream receiving water body at Yangon River (SW-2) is 29.65°C and the temperature of upstream (SW-1) and middle discharged point (DW-1) are 29.25°C and 28.05°C respectively. Thus, the temperature difference is 0.4°C and 1.6°C respectively. According to NEQG guideline temperature difference between the discharge point and receiving water body is less than 3°C. Thus, the result is within the range.

As for the result of suspended solids, the results at (SW-1), (SW-2) and (DW-1) exceeded the guideline value due to expected reasons; i) by natural characteristic of the Yangon River and ii) soil erosion in the upstream basin and iii) surface water run-off from the surrounding area.

As for the result of total nitrogen, the results at (SW-2) and (DW-1) exceeded the guideline value. The potential reason for exceeding the guideline value at discharged point of (DW-1) might be due to the nature of wastewater and they do not have the treatment system for Nitrogen. The possible reason for exceeding the guideline value at surface water monitoring point in the Yangon River (SW-2) due to the wastewater from upstream area (DW-1) to downstream area (SW-2).

As for the result of ammonia, the results at the discharged water monitoring point (DW-1) exceeded the guideline. The potential reason for exceeding the guideline value at (DW-1) might be due to ammonia which has been used in the water treatment systems.

As for the result of iron, the result at the discharged water monitoring point (DW-1) exceeded the target value. The possible reason may be due to the influence of natural origin (iron can reach out from soil by run-off). In Yangon, soil is naturally rich in iron. Japan set effluent standards for two items as follows; i) health item and ii) living environment item. In the health item, there is no standard value for iron. On the other hand, for the living environment item, the standard value for soluble iron level is 10 mg/l. As the comparison with the living environment standard value in Japan, iron result in (DW-1) is lower than the standard value. Therefore, it can be considered that there is no significant impact on the living environment.

As for the result of total coliform, the results at (SW-2) and (DW-1) exceeded the guideline value due to expected reasons. The potential reason for exceeding the guideline value at surface water monitoring point in the Yangon River (SW-2) might be natural bacteria existed in the Yangon River because there are various kinds of vegetation and creature such as birds, and small animals along the River, and wastewater from the upstream area and delivered from surrounding area by tidal effect. A possible reason for exceeding the guideline value at the outlet of (DW-1) might be due to domestic wastewater and rain water discharge to the drain.

As for future subject for water quality monitoring in MITT, the following action maybe taken to achieve the guideline values for suspended solids, total nitrogen, ammonia, iron and total coliform:

1) To monitor Escherichia Coli (E coli) level to identify health impact by coliform bacteria,
2) To install post treatment system to reduce the total nitrogen and ammonia value

Table 4.4-15 Water Quality Survey Results for Surface Water and Discharged Water

No.	Parameters	Unit	SW-1	SW-2	DW-1	NEQG Guideline Value (Reference Value for Self-Monitoring)
1	Water Temperature	˚C	29.25	29.65	28.05	<3
2	pH	-	8.1	8.1	8.1	6~9
3	Dissolved Oxygen (DO)	mg/L	5.60	5.09	5.42	-
4	Suspended Solids	mg/L	264.00	2240.00	98.00	50
5	BOD (5)	mg/L	3.26	3.62	6.60	50
6	COD (Cr)	mg/L	9.5	15	24	250
7	Oil and Grease	mg/L	< 3.1	<3.1	<3.1	10

No.	Parameters	Unit	SW-1	SW-2	DW-1	NEQG Guideline Value (Reference Value for Self-Monitoring)
8	Total Nitrogen	mg/L	2.4	11.1	13.9	10
9	Total Phosphorous	mg/L	< 0.050	<0.050	1.480	2
10	Ammonia	mg/L	-	-	15.800	10
11	Sulphide	mg/L	-	-	0.005	1
12	Cyanide	mg/L	-	-	<0.002	0.1
13	Phenols	mg/L	-	-	0.007	0.5
14	Zinc	mg/L	-	-	0.012	2
15	Chromium	mg/L	-	-	≤0.002	0.5
16	Arsenic	mg/L	-	-	≤0.01	0.1
17	Copper	mg/L	-	-	≤0.002	0.5
18	Mercury	mg/L	-	-	≤0.002	0.01
19	Cadmium	mg/L	-	-	≤0.002	0.1
20	Selenium	mg/L	-	-	≤0.01	0.1
21	Lead	mg/L	-	-	≤0.002	0.1
22	Nickel	mg/L	-	-	0.007	0.5
23	Iron	mg/L	-	-	4.770	3.5
24	Silver	mg/L	-	-	≤0.002	0.5
25	Fluoride	mg/L	-	-	0.216	20
26	Total Coliform	MPN/100ml	350	1600	>160000	400
27	Total Residual Chlorine	mg/L	-	-	0.1	0.2
28	Total Cyanide	mg/L	-	-	0.032	1

Note: The value in red color shows the value which is higher than NEQG.
Note: NEQG- National Environmental Quality Emission Guideline, Myanmar (Dec, 2015)
*Note: Based on the water utilization at discharged creek, water quality C of quality standard for water baths in Japan, (Ministry of Environment, 1997) is set as a reference value for self-monitoring of E. coli for surface water monitoring. However, due to limitation of capacity for analytical laboratory in Myanmar, the method to analyze the "Colony Forming Unit (CFU)" is not available in Myanmar. Therefore, the results of “Most Probable Number (MPN)” are assumed similar to CFU values and compared with reference values. Once the method to analyze the CFU will be available in Myanmar, the analytical method will be changed.
Source: EMP Study Team

4.4.3 Soil and Sediment Quality

Survey Items

Sediment quality sampling was carried out at one location. Survey items and sampling points are summarized in Table 4.4-16.

Table 4.4-16 Survey Items for Sediment Quality

No.	Parameters	SQ-1	Remarks
1	Water Content	○	Laboratory analysis
2	Arsenic	○	Laboratory analysis
3	Cadmium	○	Laboratory analysis
4	Lead	○	Laboratory analysis
5	Chromium	○	Laboratory analysis
6	Copper	○	Laboratory analysis
7	Zinc	○	Laboratory analysis

Source: EMP Study Team

Survey Location

The outline of sampling points is mentioned in Table 4.4-17. The photos of conducting field survey at each sampling points are mentioned in Figure 4.4-13.

Table 4.4-17 Outline of Sampling Points

Category	Station	Detailed Information
Sediment	**SQ-1**	**Coordinate**- N- 16°39'38.90", E- 96°15'13.62"
		Location – downstream from the discharged point
		Survey Item – Sediment sampling

Source: EMP Study Team

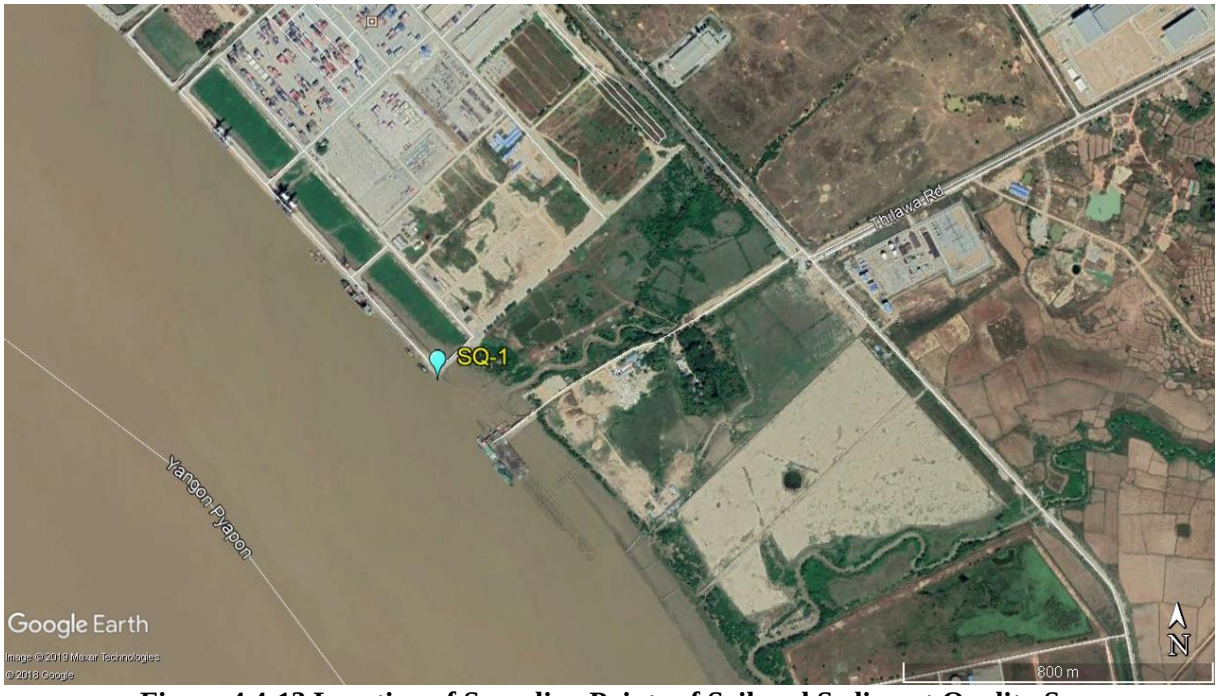


Figure 4.4-13 Location of Sampling Points of Soil and Sediment Quality Survey

SQ-1

SQ-1 was collected at the end of the jetty which is in the downstream of the Yangon river and is close to discharged point of MITT. The Yangon River is situated in the west of MITT. The sediment quality of this survey point has been influenced by the surrounding area such as MITT and jetty.

Source: EMP Study Team

Figure 4.4-14 Sediment Sampling and Onsite Measurement at SQ-1

Survey Method

Sediment sampling were taken in strict accordance with recognized standard procedures. Sediment samples were collected by using a hand-held device called as Sediment Wildco Sampler. The samples were transferred from the sampling device to a sample container with appropriate size, inert material and complied with the analyses requested. In this sampling, cleaned plastic bags were use as container for transferring to the laboratory. Chemical preservation of samples was not applied because it is generally not recommended by standard method. Samples were preserved by cooling to 4^{o}C which is usually the best approach, supplemented by the appropriate holding time for the analyses requested.

Table 4.4-18 Analytic Method for Soil Quality

No.	Parameter	Method
1	Water Content	Soil sampling and method of analysis (70.2 gravimetric with oven drying)
2	Arsenic	APHA 3120 B (Inductively Coupled Plasma (ICP))
3	Cadmium	APHA 3120 B (Inductively Coupled Plasma (ICP))
4	Lead	APHA 3120 B (Inductively Coupled Plasma (ICP))
5	Chromium	*SM 2012:3120B ICP-OES
6	Copper	*SM 2012:3120B ICP-OES
7	Zinc	Atomic Absorption Spectroscopy (AAS)

Source: EMP Study Team

Survey Period

Sediment quality survey was conducted on 2nd December 2019 and sampling time is shown in Table 4.4-19.

Table 4.4-19 Sampling Time of Each Station

No.	Station	Sampling Time

1	SQ-1	2/12/2019 10:55

Source: EMP Study Team

Survey Results

The result of soil and sediment quality analysis was presented in Table 4.4-20. As the comparison with the target value, all parameters found far lower than the target value. The soil qualities of project surrounding area are good condition.

Table 4.4-20 Results of Soil Quality Survey at SQ-1

No.	Parameter	Unit	SQ-1	Reference Value
				Environmental Standard in Japan
	Date	-	2-December-19	
	Time	-	10:55	
	Weather	-	Sunny	
1	Water Content	%	54.35	
2	Arsenic	mg/kg	≤0.34	150
3	Cadmium	mg/kg	≤0.034	150
4	Lead	mg/kg	10.438	150
5	Chromium	mg/kg	32.6	250
6	Copper	mg/kg	24.0	-
7	Zin	ppm	1.76	-

Source: Ministry of Environment, Government of Japan (2002) "Regulation for implementing the Law on Soil Contamination Countermeasures"
Source: EMP Study Team

4.4.4 Noise and Vibration Level

Survey Items

The noise and vibration level survey items are shown in Table 4.4-21.

Table 4.4-21 Survey Parameters for Noise and Vibration Level

No.	Item	Parameter
1	Noise	A-weighted loudness equivalent (L_{Aeq})
2	Vibration	Vibration level, vertical, percentile (L_{v10})

Source: EMP Study Team

Survey Location

The location of noise and vibration level points is shown in Table 4.4-22. The detail of each survey point is described below. The location of the noise and vibration survey points are shown in Figure 4.4-15.

Table 4.4-22 Location of Noise and Vibration Survey Station

Survey Point	Coordinates	Description of Survey Point
NV-1	N: 16° 40'13.25", E: 96° 15'10.43"	Inside of the MITT which is nearest place to the main gate

Source: EMP Study Team

Figure 4.4-15 Location of Noise and Vibration Level Survey Points

NV-1

NV-1 is located in the north of the MITT compound. It is near to the operation main gate where the containers and other vehicles passed. The surrounding area inside MITT near NV-1 are the main operation gate in the northeast, office compound in the north and container yards in the south respectively.

Source: EMP Study Team

Figure 4.4-16 Status of Noise and Vibration Level Survey

Survey Period
Noise and vibration level survey were conducted 24 hours from 29 Nov 2019 – 30 Nov 2019.

Survey Method
Noise level was measured by "Rion NL-42 sound level meter" and automatically recorded every 10 minutes in a memory card. The vibration level meter, VM-53A (Rion Co. Ltd., Japan), accompanied by a 3-axis accelerometer PV-83C (Rion Co. Ltd.), was placed on solid soil ground. Vertical vibration (Z axis), L_v, was measured every 10 minutes within the adaptable range of (10-70) dB at NV-1 recorded to a memory card.

The measurement period of noise and vibration was 24 hours for each survey point. The status of the noise and vibration level survey on NV-1 is shown in Figure 4.4-16.

Survey Result

Noise Measurement Results

Noise measurement results are separated daytime (07:00 to 22:00) and night time (22:00 to 07:00) time frames respectively for NV-1. Noise measurement was carried out for one location on a 24-hour basis. The survey results are summarized in Table 4.4-23. Hourly noise level survey results for NV-1 are shown in Table 4.4-24. Figure 4.4-17 showed the results of noise level (LAeq) at NV-1. Comparing with the guideline value of noise level prescribed in NEQG Guidelines value, the results of NV-1 were under the guideline values.

Table 4.4-23 Results of Noise Levels (LA_{eq}) Survey at NV-1

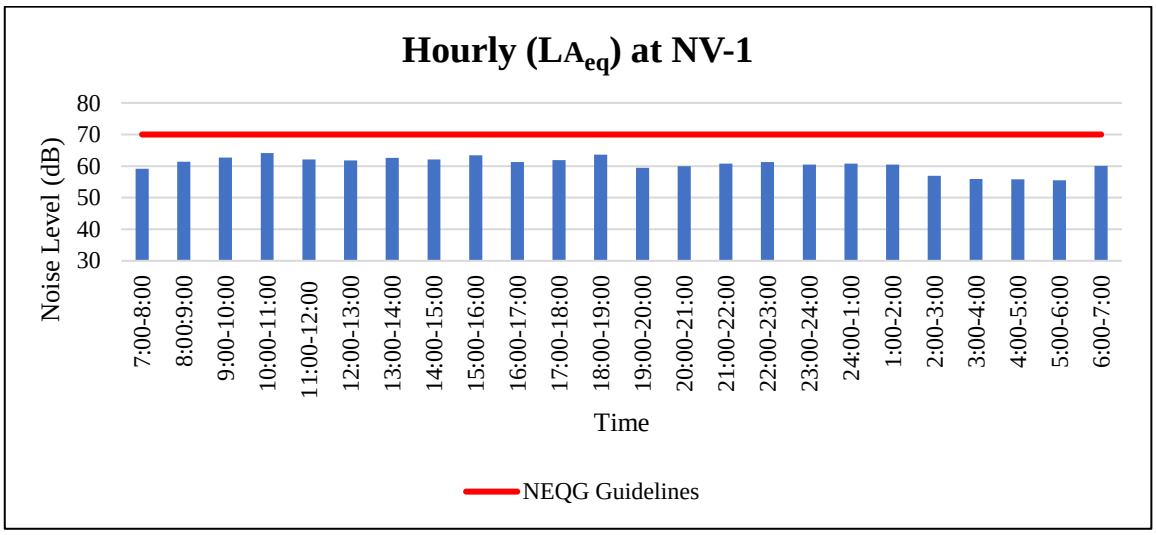
Date	(Industrial, Commercial) Equivalent Noise Level (LA_{eq}, dB)	
	Day Time (7:00 AM – 10:00 PM)	Night Time (10:00 PM – 7:00 AM)
29 – 30 Nov, 2019	62	59
NEQG Guideline value	70	70

Note: Target value is applied to the noise level in the NEQG Guideline (Dec, 2015), Myanmar
Source: EMP Study Team

Table 4.4-24 Hourly Noise Level (LA_{eq}) Survey Results at NV-1

Date	Time	(LA_{eq}, dB)	(LA_{eq}, dB) Each Category	(LA_{eq}, dB) Target Value	Remark
29 – 30 Nov, 2019	7:00-8:00	59	62	70	
	8:00:9:00	61			
	9:00-10:00	63			
	10:00-11:00	64			
	11:00-12:00	62			
	12:00-13:00	62			
	13:00-14:00	63			
	14:00-15:00	62			
	15:00-16:00	63			
	16:00-17:00	61			
	17:00-18:00	62			
	18:00-19:00	64			
	19:00-20:00	59			
	20:00-21:00	60			
	21:00-22:00	61			
	22:00-23:00	61	59	70	
	23:00-24:00	60			
	24:00-1:00	61			
	1:00-2:00	60			
	2:00-3:00	57			
	3:00-4:00	56			
	4:00-5:00	56			
	5:00-6:00	56			
	6:00-7:00	60			

Source: EMP Study Team



Source: EMP Study Team

Figure 4.4-17 Results of Noise Levels (LA_{eq}) Survey at NV-1

Vibration Measurement Results

Vibration monitoring results are separated daytime (07:00 to 19:00), evening time (19:00 to 22:00) and night time (22:00 to 07:00) time frames respectively for NV-1. Vibration measurement was carried out for one location on a 24-hour basis. The results of vibration level (L_{v10}) monitoring at NV-1 is shown in Table 4.4-25 .Results of hourly vibration level survey for NV-1 is summarized in Table 4.4-25 and Table 4.4-26. There is no guideline value for vibration level in Myanmar's NEQG as well as Southeast Asia and International organizations such as WHO and IFC. Therefore, the value of vibration level is compared with the target value of Thilawa Special Economic Zone B which is set based on the Japanese standard. By comparing with the target vibration level in operation stage in EIA report for Thilawa Special Economic Zone development project Zone B, all of results were under the target values.

Table 4.4-25 Results of Vibration Levels (L_{v10}) Survey at NV-1

Date	(Commercial and Industrial areas) Equivalent Vibration Level (L_{v10}, dB)		
	Day Time (7:00 AM – 7:00 PM)	Evening Time (7:00 PM – 10:00 PM)	Night Time (10:00 PM – 7:00 AM)
29 – 30 November, 2019	53	52	49
Target Value	70	65	65

Note: Target value is applied to the vibration level during the operation stage in the EIA Report for Thilawa SEZ Development Project (Industrial Area of Zone B).

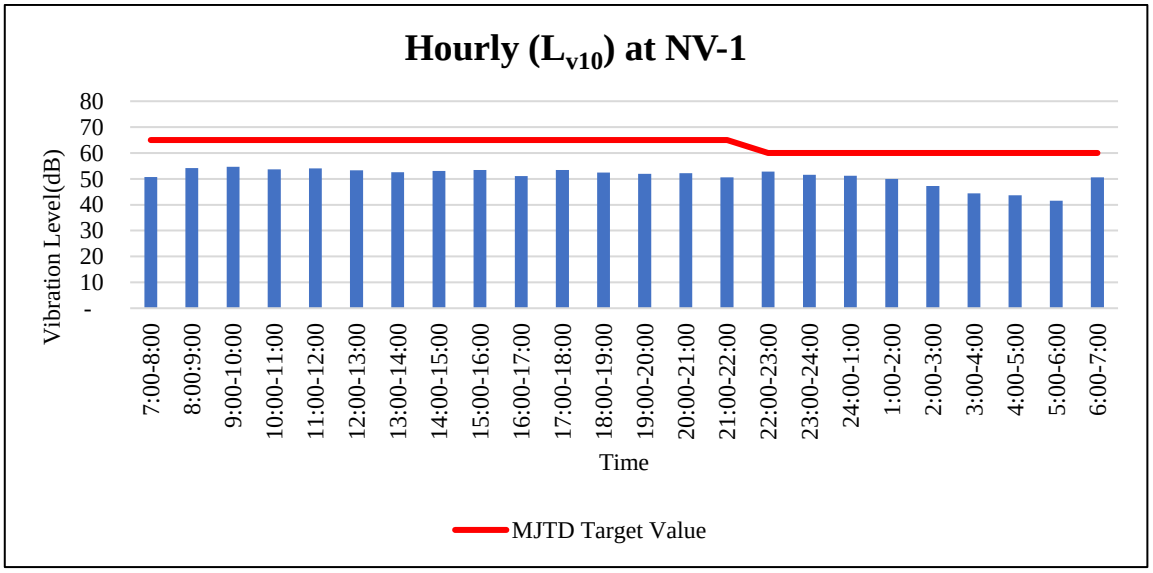
Source: EMP Study Team

Table 4.4-26 Results of Hourly Vibration Levels (L_{v10}) Survey at NV-1

Date	29-30 November 2019	(L_{v10}, dB) Each Category	(L_{v10}, dB) Target Value	Remark
Time	L_{v10}			
7:00-8:00	51	53	70	
8:00:9:00	54			
9:00-10:00	55			
10:00-11:00	54			
11:00-12:00	54			
12:00-13:00	53			
13:00-14:00	53			

Date	29-30 November 2019	(L_{v10}, dB) Each Category	(L_{v10}, dB) Target Value	Remark
Time	**L_{v10}**			
14:00-15:00	53			
15:00-16:00	53			
16:00-17:00	51			
17:00-18:00	53			
18:00-19:00	52			
19:00-20:00	52			
20:00-21:00	52	52	65	
21:00-22:00	51			
22:00-23:00	53			
23:00-24:00	52			
24:00-1:00	51			
1:00-2:00	50			
2:00-3:00	47	49	65	
3:00-4:00	44			
4:00-5:00	44			
5:00-6:00	42			
6:00-7:00	51			

Source: EMP Study Team



Source: EMP Study Team

Figure 4.4-18 Results of Vibration Levels (L_{v10}) Survey at NV-1

The vehicle usage record of MITT during the noise and vibration survey period is shown in Table 4.4-27.

Table 4.4-27 Vehicle Usage Record during Noise and Vibration Survey Period

	General Cargo Truck		Container Trucks	
	Gate In	Gate Out	Gate In	Gate Out
29/11/2019 30/11/2019	27	313	378	475

Gate in Total	405
Gate out Total	788
Grand Total	1193

Source: Myanmar International Terminals Thilawa

4.4.5 Weather Monitoring

Weather monitoring system with Japanese technology and water level sensor were installed by MJTD since June 2017. Weather monitoring system was installed at Thilawa SEZ and water level sensor for surface water (Yangon River) was installed at terminal port of Myanmar International Terminals Thilawa Limited (MITT).

Weather monitoring systems provides total seven parameters information of wind direction, wind speed, precipitation, air pressure, temperature, humidity and water levels in the Thilawa area. Hourly data transmission will also provide real-time observation for forecast verification and weather monitoring. All these systems are to help disaster risk reduction (DRR) which is needed to minimize the human damage and economic losses, to maximize the effectiveness of economic development and investment and to protect the safety and security of people's lives. Calculation and analyzing the data provides early warning to prepare for the negative impact of extreme weather and natural disasters, including the need for a potential evacuation. The monthly result of weather data is shown in Table 4.4-28.

Table 4.4-28 Monthly Weather Monitoring Result

Month	Retention Pond Water Level	Precipitation	Temperature	Humidity	Air Pressure	Wind Direction	Wind Speed	Discharged Cannel Water Level
Jun-17	3.14	3.14	27.32	92.97	1006.44	173.42	2.40	3.14
Jul-17	3.30	3.30	26.48	96.40	1006.48	187.82	1.79	3.30
Aug-17	3.01	3.01	26.54	96.57	1006.61	181.71	1.53	3.01
Sep-17	2.98	2.98	27.40	94.00	1007.94	173.63	1.37	2.96
Oct-17	3.01	3.01	26.86	93.59	1009.12	142.12	1.41	3.10
Nov-17	2.61	2.61	27.46	83.62	1010.05	133.99	1.66	2.44
Dec-17	2.73	2.73	25.75	73.02	1012.49	120.63	2.01	2.37
Jan-18	3.08	3.08	25.33	71.65	1010.48	186.41	1.64	2.43
Feb-18	2.90	2.90	26.18	68.38	1012.02	192.21	1.48	2.92
Mar-18	3.01	3.01	27.74	74.14	1009.97	192.83	1.84	2.91
Apr-18	3.69	3.69	29.84	72.33	1008.95	204.38	2.29	2.93
May-18	3.37	3.37	28.75	82.89	1008.33	176.26	2.15	2.99
Jun-18	3.23	3.23	26.98	93.93	1006.11	189.02	2.44	3.24
Jul-18	3.53	3.53	26.27	97.53	1005.35	195.22	1.72	3.54
Aug-18	3.44	3.44	26.10	97.12	1005.56	198.86	2.18	3.45
Sep-18	3.07	3.07	27.17	93.19	1008.63	181.41	1.65	3.08
Oct-18	2.74	2.74	27.93	87.90	1011.05	153.48	1.29	2.85
Nov-18	2.87	2.87	27.55	79.28	1012.04	164.22	1.79	2.50
Dec-18	4.05	4.05	4.05	76.62	1012.47	161.71	2.04	*
Jan-19	4.42	4.42	25.57	71.74	1013.75	151.58	2.02	2.40
Feb-19	3.00	3.00	26.77	69.96	1012.83	195.04	1.49	2.44
Mar-19	2.62	2.62	27.72	73.45	1011.02	207.79	1.93	2.52
Apr-19	2.68	2.68	30.07	74.33	1008.82	206.74	2.31	2.65
May-19	2.74	2.74	29.74	80.98	1008.19	218.87	2.06	2.72
Jun-19	2.68	2.68	27.52	93.30	1006.83	180.31	2.17	2.58
Jul-19	2.79	2.79	26.44	95.91	1008.01	184.63	1.94	2.75
Aug-19	2.81	2.81	26.48	96.73	1006.74	213.03	85.69	2.87

Source: https://www.mjtd.com.mm/weather-monitoring-system-thilawa-sez

Contents