Initial Environmental Examination

April 2017

Myanmar: Third GMS Corridor Town Development Project
“Mon State” (Part 1 of 4)

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Abbreviations & Acronyms

3Rs	Reduce, Reuse, Recycle
AAGR	Annual Average Growth Rates (Population)
ADB	Asian Development Bank
AH 1	Asian Highway 1
APCF	Asia Pacific Carbon Fund
BATNEEC	Best Available Techniques Not Entailing Excessive Costs
BOI	Thai Board of Investment
BOI	Thai Board of Investment
BOO	Build - Own - Operate
BOOT	Build–Operate–Own–Transfer
C:N	Carbon-Nitrogen (ratio)
cap	Capita (= 1 person)
CBO	Community-Based Organization
CBP	Capacity Building Program
CC	Climate Change
CDIA	Cities Development Initiative for Asia
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CH_4	Methane
CO_2	Carbon Dioxide
CPCS	Centre for Peace and Conflict Studies
DDI	Domestic Direct Investment
DFR	Draft Final Report
DHSHD	Department for Human Settlement Housing Development (DUHD)
DMF	Design and Monitoring Framework
DUHD	Department of Urban Housing Development (MOC)

EA	Executing Agency
EA	Environmental Assessment
ECC	Environmental Compliance Certificate
ECD	Environmental Conservation Department
EIA	Environmental Impact Assessment
EHS	Environment, Health and Safety
EMP	Environmental Management Plan
EWEC	East – West Economic Corridor
FDI	Foreign Direct Investment
GAD	General Administration Department
GHG	Greenhouse Gas
GMS	Greater Mekong Sub-Region
GNP	Gross National Product
GoM	Government of Myanmar
HDPE	High Density Polyethylene
IA	Implementing Agency
IEE	Initial Environmental Examination
IFI	International Finance Institution
INC	Initial National Communication
IPNS	Integrated Plant Nutrient System
ISWM	Integrated Sustainable Waste Management
JICA	Japan International Cooperation Agency
m^3	cubic meter
MaT-DAC	Mawlamyine Township Development Affairs Committee
MaT-DAO	Mawlamyine Township Development Affairs Office
MoECAF	Ministry of Environment Conservation and Forests
MoNREC	Ministry of Natural Resources and Conservation (ex-MoECAF)
MHA	Ministry of Home Affairs
MMK	Myanmar Kyat

MOA	Ministry of Agriculture
MOC	Ministry of Construction
MOE	Ministry of Energy
MOSB	Myanmar Offshore Supply Base
MRF	Material Recovery Facility
MS-DA	Mon State Development Affairs
MS-DAC	Mon State Development Affairs Committee
MS-DAO	Mon State Development Affairs Office
MSE	Micro- and Small enterprises
MSG	Mon State Government
MS-GAD	Mon State General Affairs Department
MST-DAC	Mon-State Township-level Development Affairs Committees
MSW	Municipal Solid Waste
MTDC	Mawlamyine Town Development Committee
MW	Megawatt
NAPA	National Adaptation Programs of Actions
NECC	National Environmental Conservation Committee
NEDA	Neighbouring Countries Economic Development Cooperation Agency, Ministry of Finance, Thailand
NGO	Non-Government Organization
NMSP	New Mon State Party
NPK	Nitrogen, Phosphorous, And Potassium
NSAG	Non-State Armed Groups
ODA	Overseas Development Assistance
PCU	Project Coordination Unit
PET	Poly-ethylene Terephthalate
PIU	Project Implementation Units
PPP	Public–Private Partnership
PPTA	Project Preparatory Technical Assistance
SEZ	Special Economic Zone
SLEDP	Strategic Local Economic Development Plans

SPC	Special Purpose Company
SPS	Safeguard Policy Statement
TA	Technical Assistance
TAO	Township Administration Office
UMTA	Union of Myanmar Travel Association
UNDP	United Nations Development Programme
WOP	Water Operator Partnership (WOP)
WWTP	Waste Water Treatment Plant
YCDC	Yangon City Development Committee
YHT	Yangon Heritage Trust

EXECUTIVE SUMMARY (ENGLISH)

The Third GMS Corridor Town Development Project focuses on the town of Mawlamyine in Mon State. The Project intends to significantly improve the environmental conditions in Mawlamyine and the quality of life of its population through the improvement of water supply and solid waste facilities.

Water supply is presently insufficient in terms of serviced areas, service duration, quantities supplied and water quality. The Project beneficial impacts are the followings:

- Improvement of the water supply efficiency by the improvement of KhinPonChong reservoir water resource mobilisation;
- Improvement of public safety through the construction of a water treatment plant based on rapid sand filtration process with disinfection by chlorine;
- Improvement of water supply security by increasing the water supply storage capacity through (i) the construction of a new 4,000 m^3 new water storage, located next to the proposed water treatment plant and (ii) the rehabilitation of the 3 existing storages of Kan Thone Kan;
- Improvement of distribution networks and extension over the whole town of Mawlamyine (except the 12 wards in the North that would be managed by Thai Tap Water Company);
- Improvement of quality of life and reduction of public health risks related to water.

Solid waste management is a major environmental issue in Mawlamyine where only 50% of the solid wastes are collected at present. The remaining 50% are dumped all over the city where the waste either decay with unpleasant smells and proliferation of insects or is burnt by the residents with emission of unpleasant and dangerous smokes as materials like plastics are also burnt. The collected waste is disposed in a large dumping site where it is regularly burnt in dry season and from where untreated leachates are discharged into the surface water bodies. Large quantities of waste are dumped into the storm drainage networks, clogging the drains and creating localized flooding during the rainy season.

The solid waste component beneficial impacts include:

- Improvement of quality of life and public health by (i) increasing the collection rate of solid waste in the city and (ii) improving collection points facilities;
- Improvement of storm drainage efficiency by reducing the amount of waste dumped in the drains and clogging the system;
- Optimization of waste transport costs to landfill by the construction of a transfer station;
- Reduction of water pollution load by improved collection rate and construction of a sanitary landfill with leachate collection and treatment;
- Reduction of air emissions and particularly GHG through (i) construction of a composting plant on the landfill site and (ii) collection of landfill gas and flaring;

- Improvement of waste recycling efficiency resulting in secondary beneficial environmental impacts through significant avoidance of GHG emission;
- Reduction of public health risk particularly among the population of waste pickers through the construction of an incinerator facility for the treatment of medical waste from the several hospitals and clinics and presently disposed in the dumping site without any precautionary measure.

The proposed acquisition of private land (3.7 acres or 1.5 ha) to build the future sanitary landfill near MuYong Village in Kyaikmayaw is only involving agricultural land. Then it will affect no household.

The only affected households are the wastepickers living in the existing dump site area that will be closed. Details regarding their affectation are available in resettlement plan report.

The buildings heritage in Mawlamyine is represented by Mon buildings dating from several centuries ago up to the British colonial era, with most of the latter in very poor condition. The project intends to stimulate the rehabilitation of such buildings with the objectives to:

- improve the general urban landscape and city beautification;
- stimulate the returns from the development of tourism;

None of the building heritage Project components requires land acquisition as the proposed pilot study is located on Mon Government land and involves mostly internal works with some paving of an outside courtyard.

None of the Project components involves significant forest clearing or encroachment into wetland or other conservation area.

The project will support innovation with the construction of the first composting plant in Myanmar, attached to the landfill and will equipped the proposed new landfill with a system of gas collection and flaring. When compared with the situation without project, the solid waste component of the Third GMS in Mon State shall reduce the annual emissions of GHG from generated waste by more than 42,000 t CO_2-eq/year in 2020 and even by 132,000 t CO_2-eq/year in 2040 when compared to a situation without Project. From 2016 to 2040, the reduction of cumulated GHG emissions shall be reduced by more than 2 million tons CO_2-eq.

The IEE also considered climatic trends at the national, regional and local scale in Myanmar and more specifically in Mawlamyine for which long term climatological data is available. Both temperature and rainfall show increasing trends in Mawlamyine along the last 50 years of observations, in line with MONREC trend analysis for Mon State. Annual rainfall increased by 500 mm over a 50 years period, or a raise of about 100 mm/decade. The month of July shows the highest raise during the 50 years period, about 300 mm, followed by May with 120 mm. Other months are almost stable or show only slight increase.

Temperature also increased over the same period. The average annual maximum temperature rose by 1.1°C over the last 48 years, or an increase of about 0.23°C per decade, a value significantly higher than what is considered in the Mon State (0.14°C increase per decade). July and November are the months showing the highest raise over the period, about 2°C. According to IPCC, sea level rise could reach 0.82 m by the end of the century. The present project

considers a safety over-elevation of 1 meter as a design criteria for concerned project components, to avoid long term flooding risk.

The results of AWARE were considered in the preparation of the IEE Report. In this connection, climate change and natural hazards considerations had been incorporated in the IEE. AWARE was used by ADB to undertake an initial climate risk screening exercise. The results had rated the project as MEDIUM RISK and have identified flooding and landslide as a high level risk factor as the project is located in a region which has experienced recurring flood events in the recent past. However, the effective risk level is dependent on local geographical factors. On this basis, due to the location of Mawlamyine in a flat or smoothly undulating area, the risk for landslide may be considered as low. Mawlamyine experiences infrequent flooding mainly localized next to the Thanlwin River which may affect the strand road, but hardly more of the urban area as the elevation raises quickly by several meters. None of the Project sub-component is localized in flood prone area. The WTP, located next to the KhinPonChong reservoir is designed to be higher than the maximum elevation of water in the reservoir. The Project components shall not be affected or put at risk by climate change.

A screening carried out during the Interim phase of the Project confirmed that environmental impacts raised by the project were either very beneficial or mainly related to the risks of nuisances during the construction phase and easily controllable by appropriate construction site supervision and conventional mitigation measures. Consequently, the proposed categorization of the Project was B, involving the preparation of the present IEE. The conclusions of the present report confirm this initial categorization as category B Project.

Aside from the several and undisputable beneficial impacts of the Project in Mawlamyine, some potential risks of limited impacts are still to be considered should the management program anticipated be deficient:

- Appropriate operation and maintenance of the incinerator, particularly of the furnace temperature and of the stacks filters is required to ensure no hazardous air contamination results from the process. The EMP recommends long term monitoring of air emissions as part of the routine O&M activities.
- Most of the anticipated environmental and social impacts are related to nuisances which may happen during the construction activities. Because of the project located in an urban environment, risk of nuisances is higher: traffic congestion, temporary alienation of access, temporary disruption of community facilities, noise and engine gas and dust release may temporarily disturb the nearby communities. However, recommendations formulated in the present EMP combined with a solid environmental contractual framework and an effective inspection and supervision of construction sites will definitely reduce these risks to acceptable levels.

The EMP also emphasizes the low level of consideration for occupational health and safety (OHS) in Myanmar but also in Mawlamyine nowadays. Construction sites generally ignore safety signals, personal or collective protections for workers, safety belts, EHS awareness training, public safety measures for activities in populated areas etc. This situation is not compliant with the EHS requirements of international lending organisations as the ADB. For that reason, the EMP emphasises (i) the need for EHS capacity building for MTDC, the PMO and the PIU staff, (ii) the need for very strict and detailed EHS specifications for the tender documents and (iii) the need for strict EHS enforcement through monitoring of construction activities.

EXECUTIVE SUMMARY (MYANMAR)

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- Chlorine
- 50%
- 50%

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(ii) [illegible]

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(C& M activities)

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EMP

EMP … EHS

[illegible] ADB [illegible] EMP [illegible] (i) MTDO , PMG [illegible] PIO [illegible] (ii) [illegible] EMS [illegible] (iii) [illegible] EHS [illegible]

1 INTRODUCTION

1.1 Project Categorization

A preliminary screening exercise of the proposed Project components, based on the latest applicable Rapid Environmental Assessment (REA) Checklists proposed by the ADB (REA Urban Development, REA Water Supply, REA Sewage Treatment and REA Solid Waste Management), was initially carried out by the ADB in June 2014. The screening was updated in 2015 and presented in the Project Interim Report (August 2015) and led to the following conclusions:

- The Project will provide major improvements regarding urban environment and quality of life of the residents;
- Projects components are not anticipated to significantly affect water, soil or air quality in the Project area;
- No detrimental impacts are anticipated on the long term. Most critical period will be the construction period, as many of the works will occur in densely urbanized areas. However, impacts can be strongly minimized, even avoided if good environmental practices are integrated in the Construction EMP and in the EHS specifications for construction contractors, and effectively enforced on sites through a solid and efficient monitoring. These requirements are described in the present IEE-EMP.
- The Project will have limited land acquisition and resettlement implications, as most of the project components have already been designed in order to avoid/minimize land acquisition and resettlement.

Applicable ADB REA Checklists are presented in **Appendix 3**.

Considering (i) the major beneficial impacts on the urban environment of Mawlamyine, (ii) the anticipated limited environmental impacts from the Project components and (iii) the limited potential impacts on land acquisition and resettlement, the present Project was classified as an ADB category. This categorization has been confirmed during the preparation of this IEE as discussed later.

This IEE is complemented (i) by a Resettlement Plan (RP) to address in details land acquisition and resettlement issues and (ii) by a full EMP encompassing construction and operation period with a particular focus on the construction period, recognizing that many of the construction activities will be located within sensitive urbanized areas.

Considering the Burmese environmental regulations, the study level also complies with the regulatory requirement of the draft EIA Procedures (6th edition).

1.2 Purpose of EIA/IEE

This report gives an account of the Environmental Impact Assessment (EIA) of the proposed Third GMS Corridor Towns Development Project. The EIA was conducted as part of the Project preparation with the following purposes:

- To ensure the environmental soundness and sustainability of the project;

- To support the integration of environmental as well as climate change and natural hazards considerations into the project decision-making process;
- To identify early potential impacts and risks arising from the proposed Project components on the physical, biological, socio-economic and cultural environment;
- To identify measures to avoid, minimize, mitigate or compensate for adverse impacts and enhance positive impacts, and
- To lead to overall environment improvements in the project area of influence.

The present EIA was carried out in compliance with the Safeguard Policy Statement (SPS, June 2009) of the Asian Development Bank (ADB) and with reference to the Draft Procedure for Environmental Assessment (6th edition) prepared by the Burmese Government under the 2012 Environmental Conservation Law.

1.3 Report Organization

The Initial Environmental Examination follows a conventional layout for this type of report and integrates an Environmental Management Plan (EMP).In addition to this introduction the reader will find the following sections in this report:

- The Executive Summary;
- This introduction with the project rationale (Section 1)
- The applicable Institutional and Regulatory Framework (Section 2);
- The description of the proposed Project components (Section 3);
- The Baseline Situation (Section 4);
- The Impact Analysis (Section 5);
- The Alternative Development options (Section 6);
- The Public Consultation activities (Section 7);
- The Grievance and Redress Mechanism proposed (Section 8)
- The Environmental and Social Management Plan (Section 9)
- Conclusions & Recommendations (Section 10)
- Appendices (see separate volume)

2 POLICY, INSTITUTIONAL & LEGAL FRAMEWORK

2.1 Myanmar Environmental Laws, Regulations and Standards

2.1.1 HISTORICAL BACKGROUND

National Commission on Environmental Affairs (NCEA) was formed in 1990 with the purposes of setting environmental standards and creating environmental policies for utilizing natural resources and controlling environmental pollutions. It was organized as a division under the Ministry of Foreign Affairs in April 1992. NCEA has

adopted a National Environmental Policy (NEP) in 1994 to ensure the incorporation of environmental concerns in planning for economic development. The NEP emphasizes "the responsibility of the State and every citizen to preserve its natural resources in the interest of present and future generations". In 2005, NCEA was transferred under the Ministry of Forestry.

The Ministry of Forestry was upgraded in September 2011 as the Ministry of Environmental Conservation and Forestry (MOECAF) and then Ministry of Natural Resources and Conservation (MONREC) in 2016, the focal and coordinating agency for the overall environmental management in Myanmar

The Environmental Conservation Department (ECD), one of the six departments under the MOECAF is responsible for implementing National Environmental Policy and to manage natural resources conservation and pollution control on water, air and land. The main ECD responsibilities include:

- Development of legislation related to environmental regulations, guidelines and procedures;
- Coordination of environmental conservation activities;
- Development of plans on climate change mitigation and adaptation, on desertification control and ozone layer protection;
- Preparation of national report in relation with international agreements.

When the MOECAF was created, the NCEA disappeared and its members were transferred to the ECD. The National Environmental Conservation Committee (NECC) was then established in April 2011 by ECD which selected representatives from most Ministries to participate to this committee.

On March 17th, 2016, the newly seated Pyihtaungsu Hluttaw announced an important reorganization of the Union Ministries, reducing the overall number from 36 ministries to 21. A total of 10 ministries have been merged. The Ministry of Environmental Conservation and Forestry (MOECAF) has been merged with the Ministry of Mines (MOM) to create the new **Ministry of Natural Resources and Environmental Conservation (MONREC).**

2.1.2 BACKGROUND OF LAWS AND REGULATIONS

Myanmar has already legislation and regulations which relate to natural environmental aspects dating prior to its independence. For instance, the Forest Act and the Burma Wildlife Protection Act have been enacted respectively in 1902 and 1936 for the sustainability of the forest products. Amended versions of such earlier act and newly promulgated one give a perspective on the existing legal and administrative framework concerning the environmental affairs in Myanmar.

The Myanmar Agenda 21 was formulated in 1997 in response to the call of the Earth Summit to develop national strategies to implement the Global Agenda 21. The Myanmar Agenda 21 made recommendations for the drafting and promulgation of a framework law which can further promote the integration of environmental and developmental concerns in the decision making processes of the country.

Present major laws and regulations with relation to environmental management are summarized in **Table 2-1**.

Table 2-1: Applicable Environmental, Health and Safety (EHS) Laws & Regulations in Myanmar

Laws and Regulations	Year	Purpose/Description
Environmental Conservation Law	2012	This law provides the basis for the conservation and protection of the natural environment of Myanmar including the marine environment. The ECL provides the common principles of environmental conservation and for other environmental laws and policy. The Environmental Conservation Committee (ECC) within the Ministry of the Natural Resources and Environmental Conservation (MONREC) was formed to oversee implementation, enforcement, and further development of the ECL including providing education and assistance to government agencies and proponents with the requirements of the ECL. The ECC also plays a lead role in managing environmental disputes.
Myanmar Environmental Conservation Rules	2014	These place responsibility on the Government to establish and adopt the necessary programs for the conservation and enhancement of environment, protection, control and reduction of pollution in environment, and conservation. Articles 52, 53 and 55 of the Rules states that all Projects and Project expansions undertaken by any ministry, government department, organization, corporation, board, development committee and organization, local government or authority, company, cooperative, institution, enterprise, firm, partnership or individual (and/or all Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses identified by the Ministry, which may cause impact on environmental quality and are required to obtain Prior Permission in accordance with Article 62 of the Rules) having the potential to cause Adverse Impacts, are required to undertake IEE or EIA or to develop an EMP, and to obtain an ECC from MONREC.

Laws and Regulations	Year	Purpose/Description
Environmental Impact Assessment Procedures	2015	The EIA procedures state that all projects undertaken by a ministry, government department, organization, corporation, board, development committee, local government or authority, company, cooperative, institution, enterprise, firm, partnership or individual that could cause significant adverse environmental or social impacts are subjected to screening for either an IEE or EIA, and ultimately require an Environmental Compliance Certificate (ECC) from MONREC before being allowed to proceed. The EIA process involves (i) screening, (ii) scoping for EIA, (iii) EIA/IEE preparation and review, (iv) EIA/IEE approval, and (v) appeal. The procedures include project categorization which helps determining whether such project or activity will be required to conduct an IEE, an EIA or an EMP. The article 13 of the procedures states that the appropriate public consultation is required through all phases of the IEE and EIA. Regarding the Resettlement and Indigenous People, in the article 7, chapter 2 of the procedures states that projects that involve Involuntary Resettlement or which may potentially have an Adverse Impact on Indigenous People shall comply with specific procedures separately issued by the responsible ministries. Prior to the issuance of any such specific procedures, all such Projects shall adhere to international good practice (as accepted by international financial institutions including the World Bank Group and Asian Development Bank) on Involuntary Resettlement and Indigenous Peoples.
Conservation of Water Resources and Rivers Law	2006	To conserve and protect the water resources and rivers system for beneficial utilization by the public; to protect environmental impacts for the abuse use of water resources. Law strictly prohibits disposal of engine oil, chemical, poisonous material and other which may cause damage, or dispose of explosives from the bank or from a vessel.
Forest Law	1992	The Forest Law, 1992 highlights forest protection, environmental and biodiversity conservation, and extended set-up of the permanent forest estates (PFE) and protected areas system (PAS). It provides opportunities for the promotion of private sector involvement in reforestation and timber trade, and decentralizes management responsibilities. It encourages community participatory approach in managing forest resources, particularly to satisfy the basic needs of the rural people. It demonstrates a shift from the concept of revenue generation and restriction to motivation and share of management responsibility with people.
Protection of Wildlife and Wild Plants	1994	To protect wildlife, wild plants and conserve natural areas, to contribute towards works of natural scientific research, and to establish zoological gardens and botanical gardens.

Laws and Regulations	Year	Purpose/Description
and Conservation of Natural Areas Law		The Law highlights habits maintenance and restoration, protection of endangered and rare species of both fauna and flora, establishment of new parks and protected areas, and buffer zone management.
National Environmental Policy	1994	To ensure sound environmental policies in the utilization of water, land, forest, mineral resources and other natural resources in order to conserve the environment and prevent its degradation.
Law of Mon State Development Affair	2012	It provides information on the policy, regulations on the solid waste management and drainage facilities management, and includes supervision of construction, renovation and extension of a building.
Law of Kayin State Development Affair	2013	It provides information on the policy, regulations on the solid waste management and drainage facilities management, and includes supervision of construction, renovation and extension of a building.
Protection and Preservation of Cultural Heritage Regions Laws	1998	To implement the protection and preservation policy with respect to perpetuation of cultural heritage that has existed for many years; to protect and preserve the cultural heritage regions and the cultural heritage. New project in such sensitive areas is required to get prior approval from the Culture
The Underground Water Act	1930	This Act provides the requirement for systematic use of ground water toward sustainable purpose.
Public Health Law	1972	For promoting and safeguarding public health and to take necessary measures in respect of environmental health.
Prevention and Control of Communicable Diseases Law	1995 Revised in 2011	The Law highlights the functions and responsibilities of health personnel and citizens in relation to prevention and control of communicable diseases. It also describes measures to be taken in relation to environmental sanitation, reporting and control of outbreaks of epidemics and penalties for those failing to comply. The law also authorizes the Ministry of Health to issue rules and procedures when necessary with approval of the government
Factory Act	1951	For effective management in every factory for disposal of waste and effluent, and matters on health, cleanliness and precaution against danger.
Agricultural Land Law	2012	To protect the rights of the people working on the farmland
National Biodiversity Strategy and Action Plan	2012	The NBSAP acts as the major guiding document for planning biodiversity conservation in the country, following its goal to provide a strategic planning framework for the effective and efficient conservation and management of biodiversity and natural resources based on greater transparency, accountability and equity.
Myanmar Investment Law	2012	This Law makes sure not to cause environmental pollution or damage in accord with existing laws in respect of investment.

Laws and Regulations	Year	Purpose/Description
Myanmar Investment Rules	2013	The Myanmar foreign investment rules contain several elements dealing with environmental protection, including: Art. 33. Proposals for economic activities that are considered capital intensive by the Commission, and that are prescribed to undergo environmental impact assessment by the Ministry of Environmental Protection and Forestry have to be submitted along with Environmental and Social Impact Assessment. Art. 54. The promoter or investor shall: (a) comply with Environmental Protection Law in dealing with environmental protection matters related to the business; Art. 123. If it is scrutinized and found out that the investor has carried out business that causes environmental pollution or has not taken action to minimize environmental pollution at the land for which he is entitled to lease or use, or if it is scrutinized and found that the work carries out causes nuisance to the persons who reside around such place due to noise or by culture and if relevant persons officially object, the Commission may terminate the lease or tendering right to use after making necessary inquiry. Art. 125. The investor, for operating any business, does not have the right to lease and develop the following lands: (a) religious lands; (b) cultural heritage and natural heritage regions designated by relevant Ministries; (c) lands restricted for Union defence and security; (d) lands under litigation; (e) lands restricted by the State from time to time; (f) lands where exists place or building which may cause situations such as impact on public environment noise, pollution, impact on culture within urban residential area due to the business of the investor.
National Sustainable Development Strategy	2009	This strategy concerns the sustainable management of natural resources, integrated economic development, and sustainable social development.
Conservation of Water Resources and Rivers Law (2006)	2006	This Law aims to conserve and protect the water resources and river systems for beneficial utilization by the public, to smooth and enhance safety of waterways navigation along rivers and creeks, to contribute to the development of State economy through improving water resources and river systems, and to protect environmental impact.
Enacted Laws related to Labour and Safety	Mainly 2011-2016	Laws and Rules applicable for the construction and operation of the projects: Labour Organization Law & Rules (2011) Settlement of Labour Dispute Law & Rules(2012) Edited Settlement of Dispute Law(September, 2014) Social Security Law (2012) Social Security Rule (2012) Minimum Wages Law (2013)

LAWS AND REGULATIONS	YEAR	PURPOSE/DESCRIPTION
		Minimum Wages Rule Employment and Skill Development Law Leave and Holiday Law (1951) Amended Law for Leave and Holiday Law 1951(July 2014) Payment of Wages Law (Jan 2016)

2.1.3 APPLICABLE ENVIRONMENTAL STANDARDS

In December 2015 MONREC released Myanmar Environmental Quality (Emission) Guidelines. The guidelines cover both water and atmosphere emissions related to a wide range of production industries. Most of the proposed standards refer to the Environmental, Health and Safety Guidelines of the IFC (2007). Concerning treated wastewater discharges (Section 1.2), proposed standards refer also to IFC EHS guidelines. Emission guidelines related to leachate discharges from municipal solid waste landfills and emissions from incinerators are presented in following Tables. With respect to drinking water standards the MONREC guidelines refer to the National Drinking Water Guidelines recently introduced by the National Water Council and based on WHO Guidelines and Standards for drinking water.

Table 2-2: Emission Quality Standards applicable to treated municipal wastewater effluents

Parameter	Unit	Maximum Concentration
Biological oxygen demand	mg/L	30
Chemical oxygen demand	mg/L	125
Oil and grease	mg/L	10
pH	S.U.	6-9
Total coliform bacteria	MPN[a]/100 ml	400[b]
Total nitrogen	mg/L	10
Total phosphorus	mg/L	2
Total suspended solids	mg/L	50

[a] MPN = Most Probable Number

[b] Not applicable to centralized, municipal wastewater treatment systems

Table 2-3: Emission Quality Standards applicable to leachate from municipal waste landfills

PARAMETER	UNIT	DAILY MAXIMUM	MONTHLY AVERAGE
5-day Biochemical oxygen demand	mg/l	140	37
Ammonia	mg/l	10	4.9
Aniline		-	-
Arsenic	mg/l	-	-
alpha Terpineol	mg/l	0.033	0.016
Benzoic Acid	mg/l	0.12	0.071
Chromium (total)	mg/l	-	-
Naphthalene	mg/l	-	-
p-Cresol	mg/l	0.025	0.014
pH	S.U.	6-9	6-9

Phenols	mg/l	0.026	0.015
Pryridine	mg/l	-	-
Total suspended solids	mg/l	88	27
Zinc	mg/l	0.2	0.11

2.1.4 NATIONAL EIA REQUIREMENTS AND FRAMEWORK

In accordance with the recommendations of the 2012 Environmental Conservation Law, MONREC has prepared a procedure for the Environmental Assessment (EA) of development projects. This procedure is still in a draft form (version 42 latest) but is already virtually enforced by MONREC.

From the information gathered from the draft procedure, the PPTA Consultant has prepared a tentative flowchart depicting the various stages of the procedure and the formal review/approval steps by MONREC.

MONREC should be solicited 3 times during the preparation process of a local EIA/IEE:

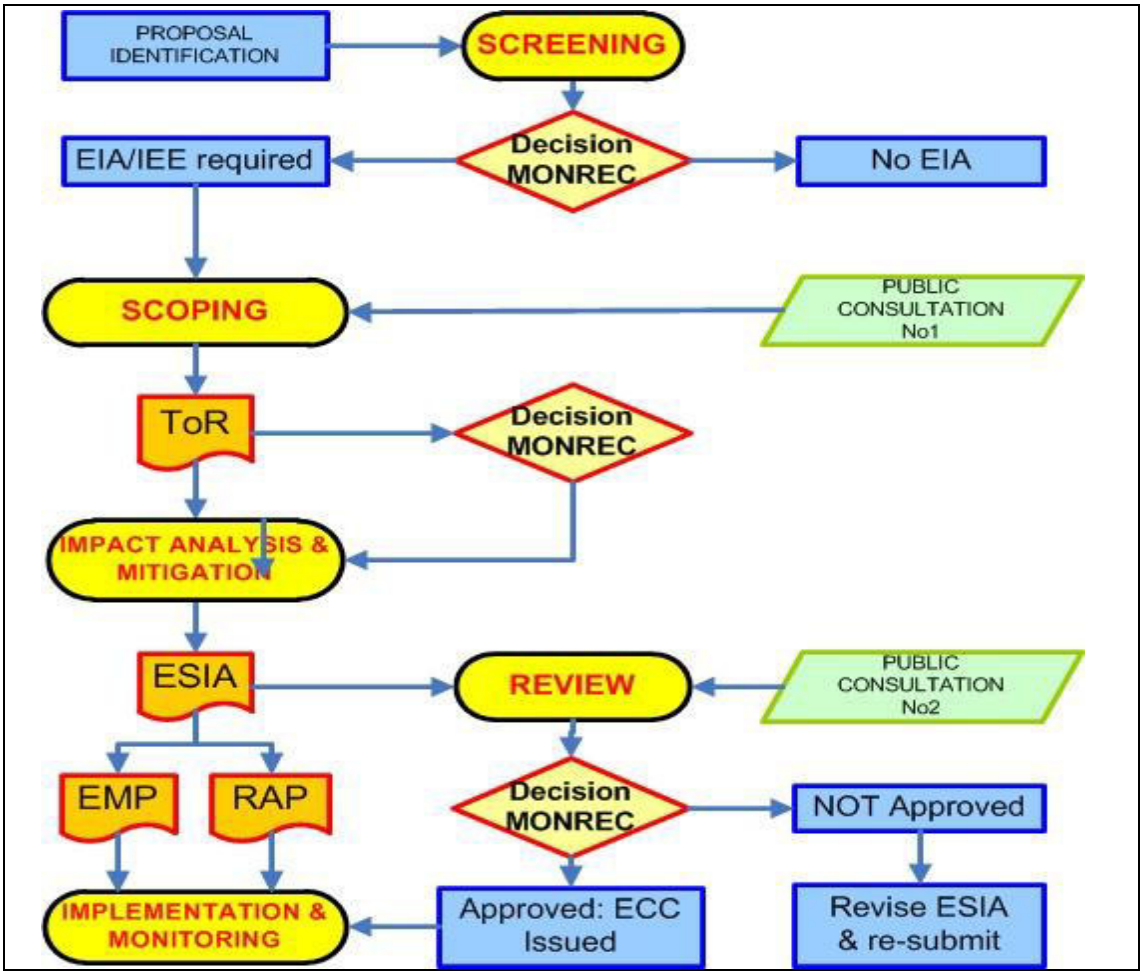
- at project proposal stage (screening), to decide if EIA or IEE is required or not
- before the start of the EIA study to approve (i) the Terms of Reference for the EIA and (ii) the qualification of the Consultant proposed for carrying out the EIA;
- at submission stage of the EIA draft report for comments and then issuance of the ECC.

Two public consultations are also considered. This process, as shown in **Figure 2-1** is quite comparable with ADB requirements regarding the EA main process stages.

In parallel to the preparation of the IEE documentation by the PPTA Consultant for ADB, it is required by the national procedure on EA that a local EIA report is submitted to MONREC. In order to avoid delay in the eventual implementation of the project, the required EA steps have been undertaken by the Executing Agency in parallel with the progress of the PPTA IEE, benefiting fully from the work done by the PPTA Consultant.

In terms of report content, the EIA requirement for Myanmar covers both environmental and social while for ADB SPS, these come separately in the EIA/IEE for environment and the RAP (and other types of documents) for the social aspects (baseline, resettlement, livelihood restoration). Compilation of information for reporting to MONREC relied on these documents from PPTA.

Figure 2-1: Draft Process for Environmental Assessment in Myanmar



Source: PPTA Consultant based on Myanmar EIA Procedures
Note: ECC=Environmental Compliance Certificate

Table 2-4: Coordination between ADB and MONREC requirements

STEPS IN MYANMAR EA PROCEDURE	LINKS WITH ADB PPTA EIA/IEE	SCHEDULE
Submission of Project proposal	Project proposal to be submitted to MONREC by the Proponent (MSG) must be based on the final list of project components approved by proponent following PPTA Interim report and workshop	MONREC is required within 15 days of receiving a project proposal to perform screening and determine the type of environmental assessment (EIA, IEE or none) required.
Preparation of EIA Scoping and ToR	ToR may partly rely on the ADB ToR related to the Environmental and Social tasks of the PPTA, and be complemented as necessary by any	MONREC is required to provide decision on firm's qualification within 7 days, and to provide approval of scoping and EIA ToR within 15 days

Steps in Myanmar EA Procedure	Links with ADB PPTA EIA/IEE	Schedule
	issue identified during the public consultation activities. Project proponent must appoint a consultant registered/qualified to prepare scoping and ToR.	upon submission of documents by proponent
Preparation of EIA report	Preparation of the EIA/IEE report will be based on the EIA/IEE and RAP reports prepared by the PPTA Consultant.	Report preparation to start when PPTA EIA/IEE is submitted to or approved by ADB
Public Consultations	Myanmar EA procedure requires 2 public consultations. ADB SPS requires minimum of 2 consultations for category A project (with full EIA) and minimum 1 for category B (with IEE)	Public consultation activities of PPTA Consultant to be fully considered in EIA report for MONREC

In order to achieve the proposed project implementation plan, the timeline for securing the applicable MONREC approval are as **Table 2-5**:

Table 2-5: Timeline for MONREC Approval

Activities	2016				2017			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Detailed design								
Procurement of goods and services								
Permits and Clearances								
Scoping and Approval of TOR (with MONREC)								
Local EIA Preparation (from ADB IEE)								
MONREC approval								

2.1.5 INTERNATIONAL TREATIES

Myanmar has also made commitments to the following international agreements and protocols on environmental, social, safety and occupational issues as shown in **Table 2-6**.

Table 2-6 International Agreements on Environment, Social and Safety

International Agreement	Date of Signature	Date of Ratification	Date of Membership	Cabinet Approval	Relevance to Project
United Nations Framework Convention on	11/06/1992	25/11/1994 (Ratification)	-	41/94 (09/11/1994)	Yes (GHG reduction)

International Agreement	Date of Signature	Date of Ratification	Date of Membership	Cabinet Approval	Relevance to Project
Climate Change, New York, 1992 (UNFCCC)					
Convention on Biological Diversity, Rio de Janeiro, 1992	11/06/1992	25/11/1994 (Ratification)	-	41/94 (09/11/1994)	Yes but limited as urban environment
International Tropical Timber Agreement (ITTA), Geneva, 1994	06/07/1995	31/1/1996 (Ratification)	-	-	No
Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985	-	24/11/1993 (Ratification)	22/2/1994	46/93	No
Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1987	-	24/11/1993 (Ratification)	22/2/1994	46/93	No
London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London, 1990	-	24/11/1993 (Ratification)	22/2/1994	46/93	No
The Convention for the Protection of the World Culture and Natural Heritage, Paris, 1972	-	29/4/1994 (Acceptance)	-	6/94	Yes in Mawlamyine

International Agreement	Date of Signature	Date of Ratification	Date of Membership	Cabinet Approval	Relevance to Project
United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and / or Desertification, Particularly in Africa, Paris, 1994 (UNCCD)	-	02/01/1997(Accession)	02/04/1997	40/96 (4-12-96)	No
Convention on International Trade in Endangered Species of Wild Fauna and Flora, Washington, D.C., 1973; and this convention as amended in Bonn, Germany,1979 (CITES	-	13/6/1997 (Accession)	11/09/1997	17/97 (30-4-97)	No
ASEAN Agreement on the Conservation of Nature and Nature Resources, Kuala Lumpur, 1985	16/10/1997	-	-	-	No
Cartagena Protocol on Biosafety, Cartagena, 2000	11/5/2001	-	-	13/2001 (22-03-2001)	No
ASEAN Agreement on Transboundary Haze Pollution	10/06/2002	13/3/2003 (Ratification)	-	7/2003 (27-02-2003)	No
Kyoto Protocol to the Convention on Climate Change, Kyoto, 1997	-	13/8/2003(Accession)	-	26/2003 (16-07-2003)	Yes

International Agreement	Date of Signature	Date of Ratification	Date of Membership	Cabinet Approval	Relevance to Project
Stockholm Convention on Persistent Organic Pollutants (POPs), 2001	-	18-4-2004 (Accession)	18/7/2004	14/2004 (01-04-2004)	No
Sendai Framework for Disaster Risk Reduction, UNISDR, 2015	-	-	2015	-	?

2.2 ADB Environmental Safeguards Policy

In 2005, the Asian Development Bank embarked on a review process of its three safeguard policies on the environment, involuntary resettlement and Indigenous Peoples. The 2009 Safeguard Policy Statement (SPS) is the result of this four-year process. NGO Forum on ADB's network members was heavily involved in monitoring and commenting the review process.

The new Safeguard Policy Statement (SPS) became effective in January 2010. It replaced the ADB's previous separate policies on each of these areas: Policy on Indigenous People (1998), Involuntary Resettlement Policy (1995) and Environment Policy (2002). Key documents related to the new Policy include:

- ADB, 2009. Safeguard Policy Statement, Manila.
- ADB, 2012. Environment Safeguards, a Good Practice Sourcebook, Draft Working Document, Manila.

The standards contained in the ADB's SPS have far-reaching impacts. They determine the ADB's environmental and social obligations for its annual and rising lending volume and influence emerging national legal frameworks in Asia. Due to the Bank's increasing support for private sector operations, the Safeguard Policy Statement also determines how private financing, supported by the ADB, operates in Asia.

The overarching statement on ADB's Commitment and Policy Principles (Chapter V) says that the ADB's safeguards have the following objectives (SPS, p 15): i) avoid adverse impacts of projects on the environment and affected people, where possible; ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and iii) help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

2.2.1 GENERAL REQUIREMENTS

The Policy Delivery section (Chapter V B, paras. 53–64) lists general requirements that the ADB is obliged to follow in regard to: project screening and classification, information disclosure, consultation and participation, due diligence, monitoring and reporting, local grievance redress mechanisms and the Bank's Accountability Mechanism.

- Project screening and classification: The Policy stipulates that the ADB will undertake project screening as early as possible to i) determine the significance of adverse impacts; ii) identify the level of assessment and institutional resources required; iii) determine disclosure requirements (para. 50).
- Information disclosure: In line with the ADB's Public Communications Policy, the Policy requires (para. 53) that for environment Category A projects, draft environmental impact assessments must be posted on the ADB's website 120 days before project approval. For draft environmental assessment and review frameworks, draft resettlement frameworks and/or plans and draft Indigenous Peoples planning frameworks and/or plans, the Policy only stipulates that these documents must be provided by the borrower/ client and posted on ADB's website before project appraisal, as follows: i) final or updated environmental impact assessments and/or initial environmental examinations, resettlement plans, and Indigenous Peoples plans upon receipt (by the ADB), and ii) environment, involuntary resettlement and Indigenous Peoples monitoring reports submitted by borrowers/clients during project implementation upon receipt (by the ADB).
- Consultation and participation: The general provisions on consultation and participation are mostly phrased as aspirations. The Policy states that the ADB "is committed to working with borrowers/ clients to put processes of meaningful consultation and participation in place." Meaningful participation is defined as: i) beginning early in the project preparation stage and being carried out on an on-going basis throughout the project cycle; ii) providing timely disclosure of relevant and adequate information that is accessible to affected people; iii) being free of intimidation and coercion; iv) being gender inclusive and responsive; and v) enabling the incorporation of all relevant views of affected people and other stakeholders in decision-making (para. 54).
- Due diligence and review of safeguard assessments and plans: Due diligence refers to the ADB's process of assessing safeguard issues through field visits and desk reviews as well as through examining relevant safeguard documents (such as environmental impact assessments, resettlement plans, Indigenous Peoples' plans). Through its due diligence processes, the ADB confirms that all potential environmental and social risks are identified. If they cannot be avoided, it ensures that appropriate mitigation measures are identified (SPS, para. 56).
- Monitoring and reporting: The monitoring obligations are merely required to be "commensurate with the project's risks and impacts". For highly complex and sensitive projects, the ADB requires the borrower/client to "engage an independent advisory panel" (SPS, para. 57).
- Local grievance redress mechanisms: The Policy requires the borrower/client to set up and maintain a grievance redress mechanism at project level (SPS, para. 59). This mechanism does not replace the ADB's accountability mechanism, but is intended to solve grievances at the local level. Affected people can also take complaints to the ADB's Accountability Mechanism. The Accountability Mechanism Policy merely requires complainants to demonstrate that they have sought to address their complaint with management.

2.2.2 ENVIRONMENTAL REQUIREMENTS

More precisely as environment aspects are concerned, the objective of the Policy is to "ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-

making process" (SPS, p. 17). The main Environmental Safeguard requirements are the followings:

- **Categorization and information disclosure:** The Policy uses a categorization system to reflect the significance of a project's potential environmental impacts. "A project's category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence" (SPS, para. 50). Final or updated EIAs and/or initial environmental examinations must be made available upon receipt on the ADB's website. The following categories exist:
  - **Category A**: significant adverse environmental impacts that are irreversible, diverse or unprecedented. Category A projects requires a full-scale Environmental Impact Assessment (EIA). A draft EIA, including the Environmental Management Plan, must be made available on the ADB's website at least 120 days prior to Board approval.
  - **Category B**: less adverse environmental impacts that are site specific, few of which are irreversible, and mitigation measures that can be designed more readily than for Category A projects. Category B projects require an initial environmental evaluation.
  - **Category C**: minimal or no adverse environmental impacts. Category C projects require further environmental assessment actions/documents.
  - **Category FI**: projects involving ADB funds to, or through, a financial intermediary. Category FI projects require an Environmental and Social Management System.
- **Assessment process:** Environmental impacts must be determined in consultation with affected people and concerned non-government organizations (NGOs). For category A projects, the borrower/client is required to undertake an assessment of options that looks at alternatives to the project's location, design, technology and components. The options assessment will also examine the "no project" alternative. The borrower/client must present the rationale for selecting the particular project details, including a cost-benefit analysis that takes into account environmental costs and benefits of the various alternatives considered (SPS, Appendix 1, para. 4).
- **Type of impacts:** The types of impacts related to the environment include physical, biological, cultural and socioeconomic impacts. These can relate to occupational health and safety; community health and safety; vulnerable groups; gender issues; and impacts on livelihoods and physical cultural resources (SPS, Appendix 1, para. 5).
- **Project site/scope:** The project site covered by the environmental safeguard provisions in the Policy is defined as: "the primary project site(s) and related facilities that the borrower/client (including its contractors) develops or controls, such as power transmission corridors, pipelines, canals, tunnels, access roads, borrow pits and disposal areas, and construction camps". This definition also includes: associated facilities that are not funded as part of the project, but "whose viability and existence depends exclusively on the project"; "areas and communities potentially affected by cumulative impacts from further planned development of the project"; and predictable impacts caused by the project "that may occur later or at a different location" (SPS, Appendix 1, para. 6).
- **Transboundary impacts:** The environmental assessment process must identify potential transboundary effects, such as air pollution and increased use

or contamination of international waterways. It must also identify global impacts, such as the impact of greenhouse gases and impacts on endangered species and habitats (SPS, Appendix 1, para. 7).

- **Environmental planning and management:** If environmental impacts are identified, the borrower/ client is required to prepare an environmental management plan describing how potential impacts and risks will be addressed (SPS, Appendix 1, para. 12).
- **Consultation and participation, grievance mechanism:** The consultation process and grievance mechanism process follows the same provisions as laid out in the general requirements (see above) (SPS, Appendix 1, paras. 19 and 20).
- **Reporting and monitoring:** The Policy states that "the extent of monitoring activities will be commensurate with the project's risks and impacts" (SPS, Appendix 1, para. 21). For Category A projects, the borrower/client is required to retain qualified external experts or qualified NGOs to verify its monitoring information. The minimum requirement is semi-annual report during construction for projects with significant impacts and which become annual during operation. For other projects, periodic reports are required. Monitoring reports must be posted in a location accessible to the public (SPS, Appendix 1, paras. 21 & 22).
- **Unanticipated environmental impacts:** If unanticipated impacts occur during project implementation, the borrower/client is required to update the environmental assessment and environmental management plan or prepare a new assessment and plan (SPS, Appendix 1, para. 23).
- **Biodiversity conservation and sustainable natural resource management:** This section (SPS, Appendix 1, paras. 24 – 49) contains requirements regarding the following issues: modified habitats; natural habitats; critical habitats; legally protected areas; invasive alien species; management and use of renewable resources;
- **Pollution prevention and abatement** (resource conservation, energy efficiency, waste, hazardous materials, pesticide use and management, greenhouse gas emissions);
- **Health and safety** (occupational health and safety and community health and safety); and
- Physical cultural resources (SPS, Appendix 1, para. 24).

3 PROJECT DESCRIPTION

3.1 Project Proposals for Mawlamyine

The Project in Mon State concerns 3 main components related to water supply improvement, solid waste management and cultural heritage conservation. The project components are presented in Error! Reference source not found..

Figure 3-1: Proposed Third GMS Project Components in Mawlamyine

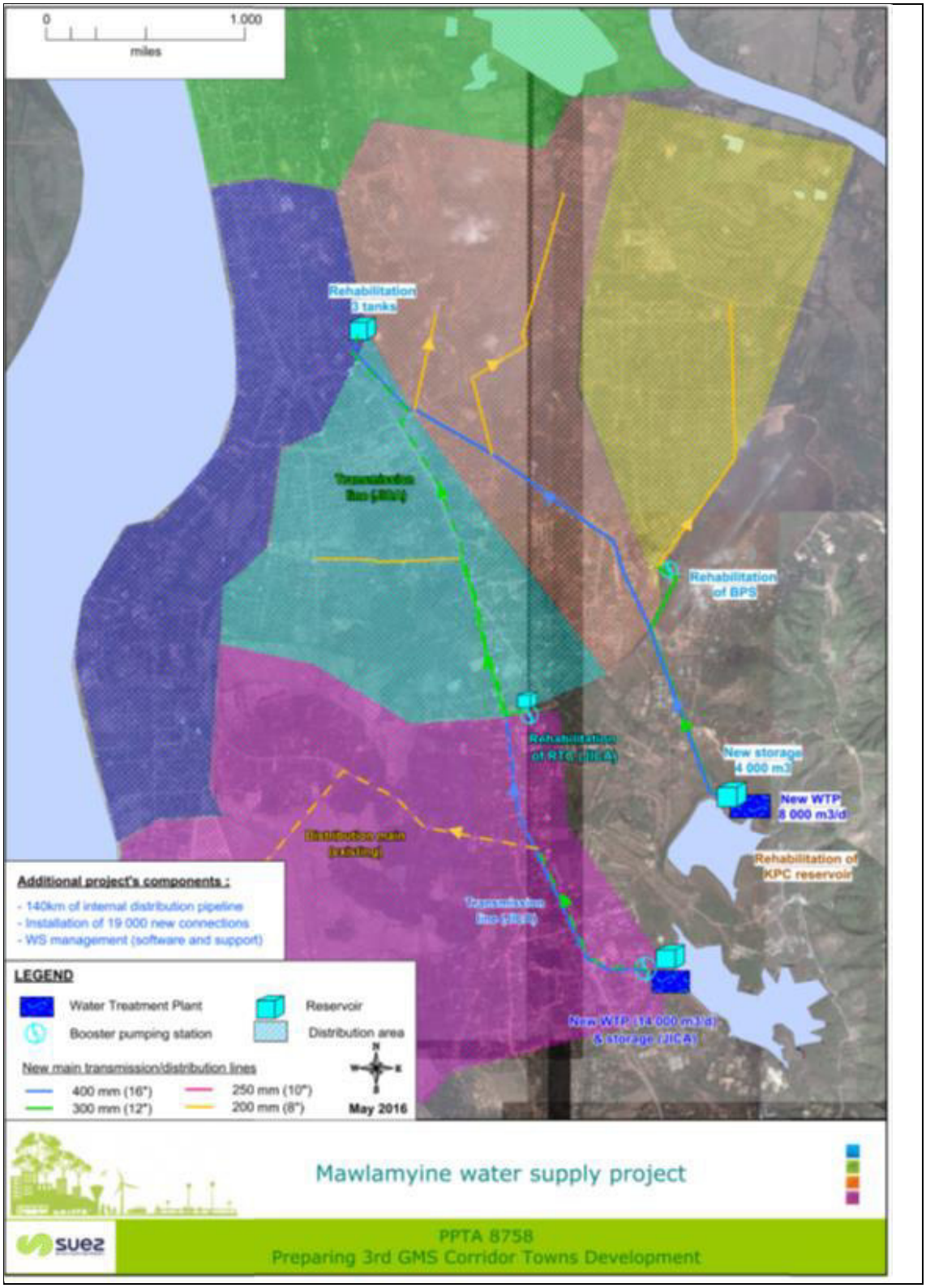
3.2 Water Supply project

The proposed project consists of four major elements as depicted spatially on **Error! Reference source not found.**.

- Rehabilitation of the KhinPonChong dam and creation of a new treatment plant. Rehabilitation of the KPC dam recognises that this forms part of the unique cultural heritage of Mawlamyine and will therefore be undertaken to preserve the main features of the existing dam most notably the existing intake structure. The treatment plant would have a capacity of 8,000 m3/day. The process would include remineralisation, rapid sand filtration, disinfection and sludge treatment.
- Rehabilitation and extension of the existing storage facilities (3 Tanks Reservoir) and creation of a new storage facilities at KhinPonChong (4,000 m3);
- Transmission lines and distribution lines including 13 km of transmission lines and main networks (diameters from 200-400 mm) and 140.2 km of distribution system (including tertiary networks < 100 mm). The project would also include a fund to finance approximately 19000 new connections.
- Improved Operation & Management covering asset management, GIS, billing and customer management, NRW control. These latter aspects will be procured as part of a management contract.

The outline designs of the proposed networks have been analysed using hydraulic modelling techniques. The results demonstrate that maximum velocities and pressures are acceptable for both the short and long term requirements.

Figure 3-2: Proposed Water Supply Project in Mawlamyine

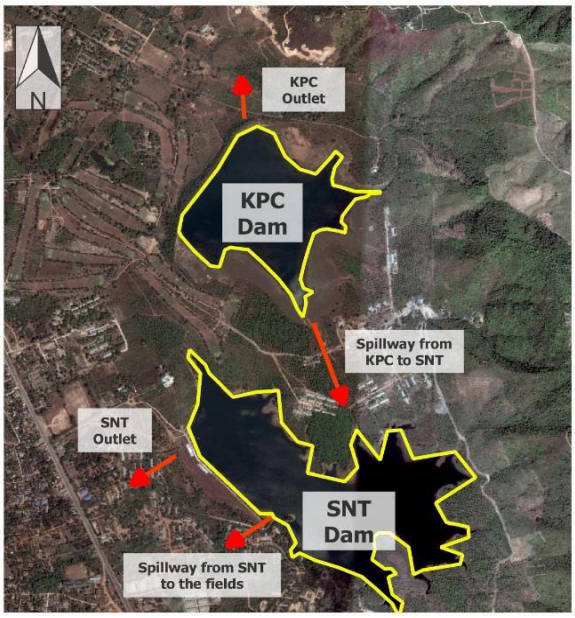


3.2.1 EXISTING WATER RESOURCES

In terms of the existing public water supply, Mawlamyine is served by three distinct resources namely:

- Water from the KhinPonChong reservoir created in 1904 together with an old distribution system which is still supplying 24/7 water by gravity to the main storage reservoirs and thereafter distributing to parts of the city;
- A newer reservoir, ShweNatTaung reservoir which supplies by pumping to the main storage reservoirs in the downtown area;

Figure 3-3: View of existing reservoirs and interactions



Main characteristics of the two reservoirs are summarized in the table below:

Table 3-1: Main characteristics of the reservoirs

Reservoir	Type	Construction date	length of the dam (m)	Maximum storage capacity (m3)	Current use	Managed by
KhinPonChong	Earth dam	1904	1200	3.08 M	Public and private water supply	Mawlamyine TDC
ShweNatTaung	Earth dam	1996	460	6.47 M	Public and private water supply Irrigation	Irrigation Department

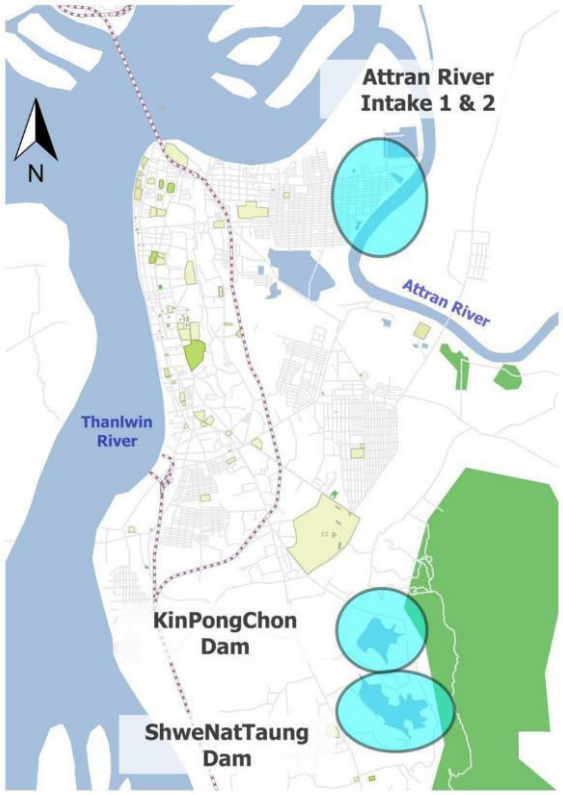
Reservoir	Catchment area (km²)	Max level (mASL)	Min Level (mASL)	Spillway elevation (mASL)	Water surface at spillway level (km²)	Remark
KhinPonChong	1.78	39.1	32	39.1 (+0.7)*	0.54	No resource protection plan No regular monitoring
ShweNatTaung	2.35	36.6	20.6 (intake level)	33.5	0.63	No resource protection plan

**Spillway level is regularly increased by TDC (see hydrological report in appendix of FSR)*

***Given the age of these structures little details are available concerning the design of these structures.*

Two water intakes from the Attran River, which shall be replaced in the future by one intake and associated treatment plant under a proposed PPP (see chapter 3.2.4).

Figure 3-4: View of existing resources in Mawlamyine



Inhabitants supplement these water resources via shallow groundwater (tubewells and wells), rainwater during rainy season and also via bottled water and boxer trucks.

Existing information concerning the quality of these resources is extremely sparse. To supplement this the PPTA Consultant undertook a series of measurements during September 2015. The main findings of these surveys are summarised below:

- The KhinPonChong water resource presents a very low mineralisation (EC=22.5 µS), which is in line with its origin: only rain water with a limited run-off due to the small size of the catchment, so with limited opportunity to be enriched with soil minerals. Organic pollution is low, in relation to the small size of the catchment and the absence of major pollution sources. All parameters are compatible for its use as drinking water after treatment. Similar conclusions apply to the ShweNatTaung dam water quality.
- The high salinity of tube well N°1 located along the Thanlwin river bank reflects the influence of the sea and the salinity of the water in the estuary. Turbidity and TSS values are high for underground resources, probably reflecting the inappropriate design of the tube wells or the fine sediment at the level of the pumping. All wells are contaminated, as a result of discharges from septic tanks representing the predominant sanitation system of Mawlamyine.
- Turbidity of the Attran river intakes is high and also there is evidence of salinity related to the proximity of these intakes to the Thanlwin estuary. The turbidity of water from Attran intakes 1 and 2 is reduced by sedimentation in ponds before

reaching the households. This is the only purification process in Mawlamyine water supply system.

OPTION ANALYSIS AND CONCLUSION

In terms of water resources the following different sources have been considered, in accordance with above information:

- Groundwater;
- Surface water dams and reservoirs;
- Surface water from the Attran River

With regard to groundwater, available information indicates that this is either polluted by septic tank effluents (shallow groundwater) or saline (deeper tubewells). Given also the limitation with respect to yield, existing resources should be discontinued.

Turning to possible dams/reservoirs, we have not considered the development of new dams/reservoirs but focused on identifying existing dams which could be eventually used for domestic water supply. Available hydrological information would indicated that the water resources of the ShweNatTaung are abundant and not limiting due to the large storage capacity and catchment basin. Resources in the KhinPonChong appeared to be more limited especially at the end of the dry season and also in relation to known leakages associated with this reservoir. Nevertheless, this resource is strategic due to its quality, elevation and location. Hydrological analysis of the dam has been performed looking at different scenarios, as presented in Water Supply Appendix 1.2. Main results indicate that considering the present project described hereafter, 8 000 m3/d could be abstracted safely throughout the year.

The current Attran intakes are close to the Thanlwin estuary. Studies undertaken by the PPTA Consultant indicate that these resources are highly likely to be saline in the short to medium term related to changes in the upstream hydrological regime (linked to operation of future dams) and also due to the sea level changes. In addition being located downstream of the main city, these intakes are subject to pollution from both wastewater systems and solid waste leachate discharges. In order to abstract water from the Attran river, intake should be implemented upstream of the city, preventing salinity and urban pollution.

Finally, it has to be noticed that none of the resources has a protection plan for environmental protection purpose as well as preservation, to prevent from pollution or undesirable/illegal uses.

3.2.2 DESCRIPTION AND ANALYSES OF THE PRESENT SITUATION

CONTEXT

The Township of Mawlamyine is the capital of Mon State and is located at the estuary of the Thanlwin (Salween) River, one of the longest rivers of Myanmar. Mawlamyine Township comprises 28 urban wards and 13 rural villages with a total population of 289,388 inhabitants as recorded by the 2014 Census. The largest ethnic group in Mawlamyine according to the General Administration Department (GAD) data is the Bamar whereas the Mon comprise the third largest group in the township, most of

whom live in rural areas of the township. Annual rainfall average over the period 1965-2014 (50 years) period is 4864 mm of which 82% falls from June to September, the 4 wettest month of the South-west monsoon.

The 2014 census records the sources of drinking water and water for other uses as reported by households in Mawlamyine. Mawlamyine data indicates a high use of bottled/purified water in the city compared to general bottle water consumption in the State. In addition, Mawlamyine residents rely more heavily on tap water/piped water and tubewells than other state residents although protected wells/springs are an important source of non-drinking water in general.

Concerning water borne sanitation, almost 95% of the population of Mawlamyine has access to improved toilet facilities (sealed latrines 92% and flush toilets 2%). Only a small portion of the population (<5%) does not have access to sanitation facilities. In the main urban area, septic tanks and sealed latrines are emptied by trucks with septage disposed near to the existing landfill.

According to the Mon State Health Dept., dengue outbreaks are a common occurrence with reported cases ranging between 8 cases in 2000 and 1114 cases in 2001 with reported deaths at zero in some years to a high of 9 (2001). The general incidence of dengue ranges between 138 (2011) with another spike of 819 cases in 2013. In addition, the GAD figures identify tuberculosis as having the highest prevalence, followed by diarrhoea and malaria.

ORGANIZATION AND GENERAL INFORMATION

The provision of urban environmental services in Mawlamyine Town is the responsibility of the Mawlamyine Town Development Committee (MTDC) which covers a service area of 28 wards with a total urban population of 253 734.

Residents of Mawlamyine City are getting water from different resources:

- ✓ **Water supply system managed by TDC comprises several facilities based on surface water which includes both reservoirs and river.**
- ✓ **Private tubewells (among them are some unregistered/illegal ones),**
- ✓ **Public wells and communal taps**
- ✓ **During the dry season water is supplied with water boxer (2.7-3.6 m3) through and out the city**

Most of households have elevated water tank, ground water tank or drums as water storage for 2 to 3 days usage and this is the practice throughout the country.

The original piped water supply system was constructed under the British Empire based on the use of KhinPonChong Dam supplying 3 tanks reservoir and then the city area under gravity conditions. Since then, the water supply system has been significantly reinforced in order to increase the coverage of the city with the inclusion of:

- ✓ **Shwe Nat Taung reservoir and distribution system including RTC reservoir**

- ✓ **Attran 1 & 2 systems distributing water from the river for the northern part of the city : two surface treatment plants based on sedimentation process**

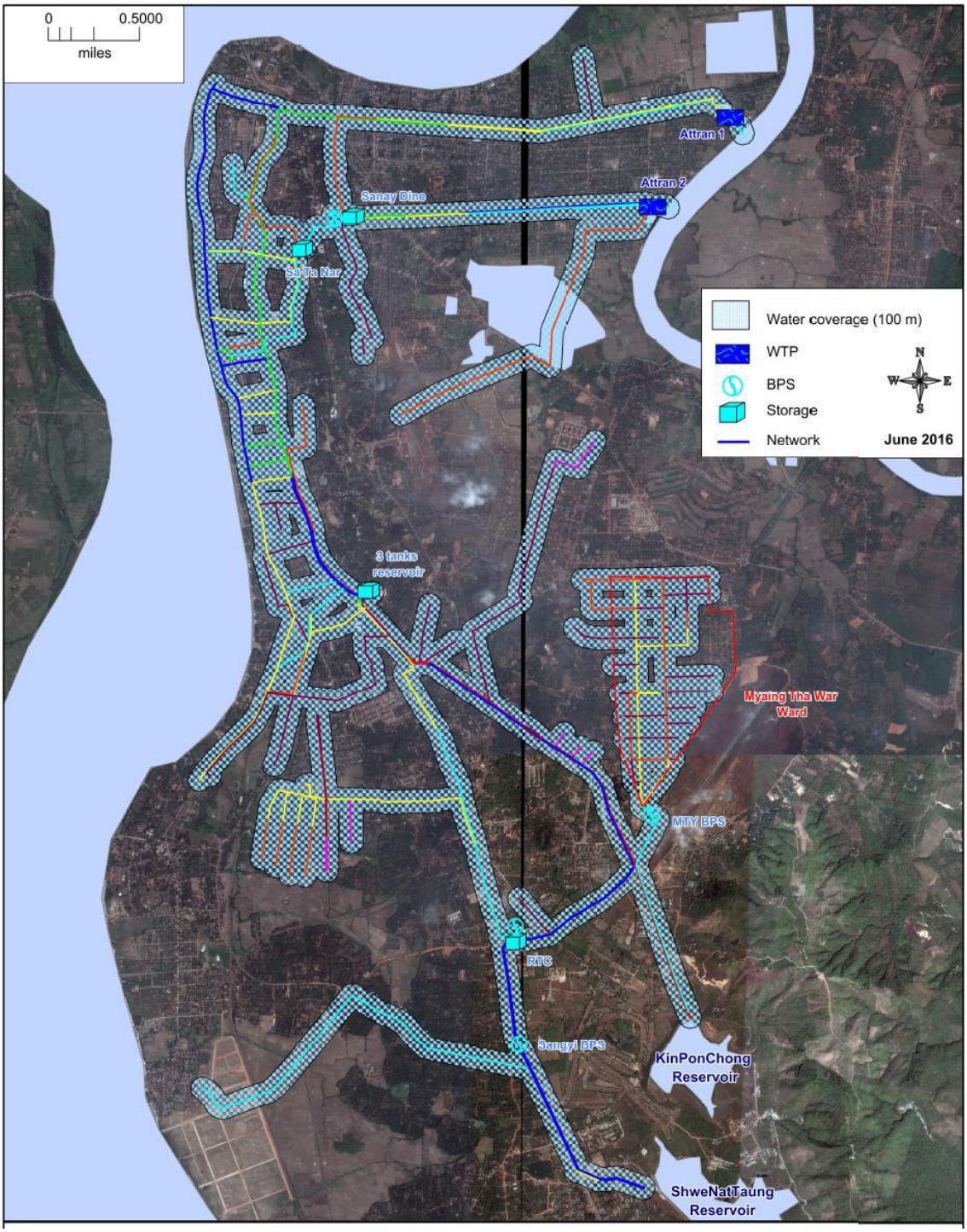
During this period, the main network has also been extended significantly, in order to improve the coverage in the city, particularly in the Northern and Southern areas. Indeed, the network length has increased to nearly 110km as on date.

It is supposed that nearly 26% of Mawlamyine urban population which means nearly 50 000 inhabitants are supplied through the public network. The number of water meters is currently 9 250.

The current coverage of the water supply system is presented in the figure below based on the maximum distance of 100m from the distribution network. The overall covered area is nearly 14km².

Besides, it has to be noticed that water supply in MyaingThaYar Ward is managed by a ward committee, getting water from KhinPonChong reservoir.

Figure 3-5: Map of water supply system and coverage in Mawlamyine



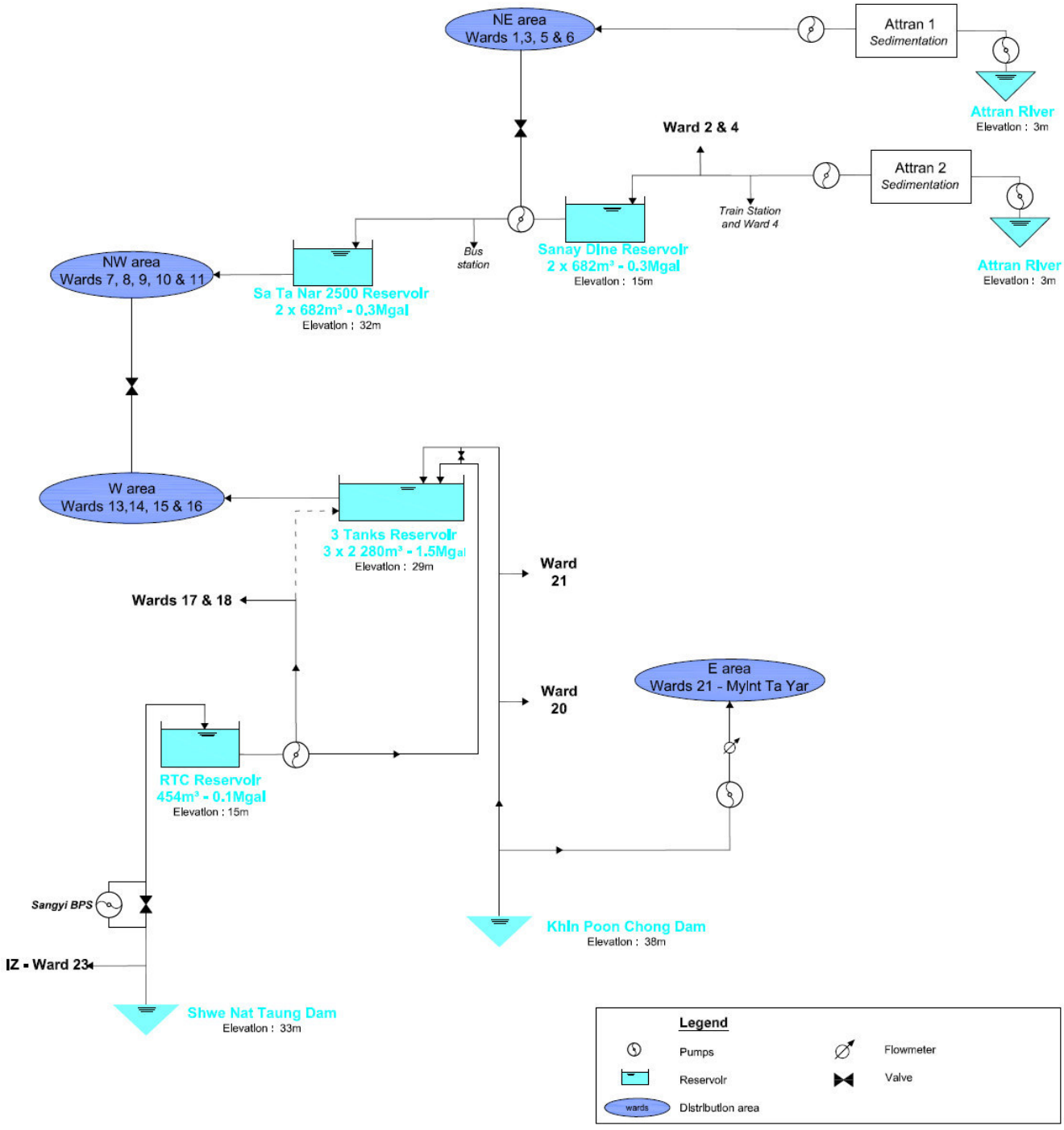
KEY FIGURES

- ✓ Service area coverage : about 14 km²
- ✓ 26% of the population covered with piped water
- ✓ Unsteady functioning with intermittent supply for some areas
- ✓ About 50 000 people supplied with nearly 9 250 installed water meters
- ✓ 2 reservoirs : KhinPonChong and Shwe Nat Taung
- ✓ 2 Treatment plants and intakes on the Attran River
- ✓ Amount of supplied water : ~ 25 000 to 30 000 m3/d
- ✓ 107 Km pipe lines : -
  - Transmission& distribution mains: 16 km
  - Internal network :91 km
- ✓ 4 storage : RTC, 3 tanks Reservoir, SanayDine and SaTaNar
- ✓ 3 booster pumping stations : RTC, SanayDine and Maing Tha Yar
- ✓ 10 000 m^3 storage => 8 to 10 hours autonomy of current production
- ✓ NRW : >80**%** (estimation including commercial losses)
- ✓ No treatment apart from sedimentation process

DESCRIPTION OF THE SYSTEM

The figure below summarizes the functioning of the existing water supply system and distribution areas. In addition, description of the existing facilities is presented in Water Supply Appendix 1.3, together with additional information of the existing system (functioning hours, quality analysis from TDC…)

Figure 3-6: Flow diagram of the existing system



ANALYSIS OF THE SYSTEM

The main conclusions regarding the water supply system in Mawlamyine as included in the complementary modelling report (Water Supply Appendix 2) are as follows:

- **Production & treatment**: None of the existing facilities treat the water apart from natural sedimentation process. Hence, only raw water is distributed with

regular presence of bacteria. The age of some facilities, limited capacity and lack of maintenance limit their use in the immediate future. The existing dams are a major asset since they benefit from a significant elevation and good water quality. Water from the dam has the advantage to have a low turbidity throughout the year compared to the Attran river sources.

- **Transmission & Storage**: some transmission lines, especially from KhinPonChong Dam, are in very bad condition due to their age (nearly 100 years) and material (grey cast iron). In addition, many of these lines are now under-sized in relation to increasing demand of the service area. Hence, rehabilitation as well as strengthening shall be undertaken to ensure the transfer of future water production.

Concerning the storage and focusing on the southern area in connection with the project's boundaries two reservoirs exist:

- RTC reservoir presents a limited capacity, leakages and overflow as indicated by the measurement campaign. Accordingly, the rehabilitation of this key facility shall be considered, as well as the rehabilitation and resizing of the pumps.
- 3 tanks reservoir is a strategic facility located close to the downtown area and functioning under gravity. Available storage capacity is considerable with 1.5 Mgal (~ 6 800m^3). Separation into 3 different tanks allows higher flexibility. However, due to its age (nearly 80 years old), the reservoir should be rehabilitated and secured. Existing connexions appear to be also in bad conditions because of the age of the installation and lack of maintenance.

In the northern area two tanks are used to distribute the water from the Attran River. Attran 2 supplies the tank of SanayDine, from which water is pumped to the distribution system (North West Area) and to the second storage of SaTaNar. This second tank is operating under gravity condition to supply the northern part of the downtown area.

Table 3-2 : Reservoirs' description

	Volume (m3)	Description	Elevation (m)	Distribution Area
3 tanks	6 820	3 similar square ground tanks	29	Wards 13 to 16
RTC	450	Ground tank	15	Wards 17&18 and 3 tanks
SanayDine	1365	2 similar ground tanks	15	Wards 1 to 6 (with Attran 1&2)
SaTaNar	1365	2 similar ground tanks	32	Wards 7 to 11
TOTAL	**10 000**	**-**	**-**	**-**

- **Distribution:** Existing distribution network represents a total length of nearly 90km with the oldest cast iron pipes laid almost 100 years ago in the downtown area. Presently, the number of connections estimated to be around 9 250, mainly

equipped with poor quality water meters with questionable accuracy. The coverage for the urban area is quoted as only 27%. Clearly rehabilitation of the existing network is necessary together with improvement of service coverage.

Table 3-3 : Length of network

Length (km)	Ø < 80	Ø 80	Ø 100	Ø 150	Ø 200	Ø 250	Ø 300	Ø 400	Total
Transmission lines	-	-	-	-	-	-	10.7	5.3	**16**
Distribution lines	1.9	18.1	15.9	21.4	17.6	7.1	8.9	-	**90.9**
Total	**1.9**	**18.1**	**15.9**	**21.4**	**17.6**	**7.1**	**19.6**	**5.3**	**106.8**

- **Operation and management**: limited human and technical resources have been identified. As a consequence, a lack of planning is noticeable as well as the absence of NRW management. Indeed, both commercial and physical losses are high, with a total amount of NRW estimated at over 70%. Specific focus on NRW is presented in the following chapter. In addition, limited capacity does not allow a sufficient maintenance and operating of the facilities.

3.2.3 FOCUS ON NRW

NRW IN MAWLAMYINE

Based on available data and measurements a tentative water balance has been established during the study. Accuracy of the analysis remains highly limited due to the lack of accessible data of the system and some assumptions were necessary to perform the water balance. Nevertheless, it is clear that the amount of NRW is extremely high with a large share of real/physical losses.

Table 3-4: Tentative water balance for Mawlamyine

<table>
<tr><td rowspan="6">System Input Volume
30 000 m³/d</td><td rowspan="3">Authorized Consumption
7 931 m³/d</td><td rowspan="2">Billed Authorized Consumption
2 931 m³/d</td><td>Billed Metered Consumption
2 580 m³/d</td><td rowspan="2">Revenue Water
2 931 m³/d
10%</td></tr>
<tr><td>Billed Unmetered Consumption
381 m³/d</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
5 000 m³/d</td><td>Unbilled Metered Consumption
0 m³/d</td><td rowspan="5">Non – Revenue Water
27 069 m³/d
90%</td></tr>
<tr><td>Unbilled Unmetered Consumption
5 000 m³/d</td></tr>
<tr><td rowspan="3">Water Losses
22 069 m³/d</td><td rowspan="2">Commercial losses
800 m³/d</td><td>Unauthorized Consumption
500 m³/d</td></tr>
<tr><td>Customer metering inaccuracies
300 m³/d</td></tr>
<tr><td>Physical losses
21 269 m³/d</td><td>Leakage on mains
Leakage and overflows at storages
Leakage on services connections up to the customer metering</td></tr>
</table>

The level of billed consumption or revenue water is very low. Unbilled authorized consumption cannot be defined precisely but is estimated to be high with a large use of "free water" for institution, monasteries and administrative buildings. Besides, commercial is likely to be significant due to the oldness and poor quality of water meters and possible billing errors in absence of proper customer data base.

On the basis of these estimates the tentative leakage index is estimated at 253 m3/d/km or 2900 l/day/connection. These figures confirm a very high level of NRW. Translating them using the chart below and giving the low pressure of the system, it can be appreciated that the system is in Category D corresponding to "Very inefficient use of resources" there is clearly therefore significant further room for improvement to bring losses down to around 150-200 l/connection/day, thereby liberating a precious amount of water of spare production capacity.

Figure 3-7: Categorization of Water Company Performance in terms of NRW

Technical Performance Category		ILI	Real Losses in Litres/Connection/Day (when the system is pressurised); at an average pressure of:				
			10 m	20 m	30 m	40 m	50 m
Developed Countries	A	1 - 2		< 50	< 75	< 100	< 125
	B	2 - 4		50 - 100	75 - 150	100 - 200	125 - 250
	C	4 - 8		100 - 200	150 - 300	200 - 400	250 - 500
	D	> 8		> 200	> 300	> 400	> 500
Developing Countries	A	1 - 4	< 50	< 100	< 150	< 200	< 250
	B	4 - 8	50 – 100	100 - 200	150 - 300	200 - 400	250 - 500
	C	8 - 16	100 - 200	200 - 400	300 - 600	400 - 800	500 - 1000
	D	> 16	> 200	> 400	> 600	> 800	> 1000

A Further loss reduction may be uneconomic unless there are shortages

B Possibilities for further improvement

C Poor leakage management, tolerable only if resources are plentiful and cheap

D Very inefficient use of resources, indicative of poor maintenance and system condition in general

Source: World Bank Institute NRW Training Module 6: performance Indicators

3.2.4 OTHER PROJECTS

JICA PROJECT: PHASE 1 & 2

JICA's project is part of an overall JICA loan agreement with the Union of Myanmar covering several towns, including Mawlamyine. This project in Mawlamyine is proposed to include 2 phases. This paragraph describes the scope of work based on available data and documents.

First phase of the project consists in a 1M US$ loan which aims to increase the production capacity. This project is supposed to include two main components:

- Creation of a new production facility near ShweNatTaung dam which outflow is set at 3.12 Mgal/d (~ 14 000m3/d) using Slow Sand Filter Process. This project consists in intake structure from ShweNatTaung Dam, the WTP using slow sand filters and the associated storage.
- Implementation of a transmission line from RTC to 3 Tanks Reservoir: it is proposed to lay a 300mm pipe (PVC) between the two facilities.

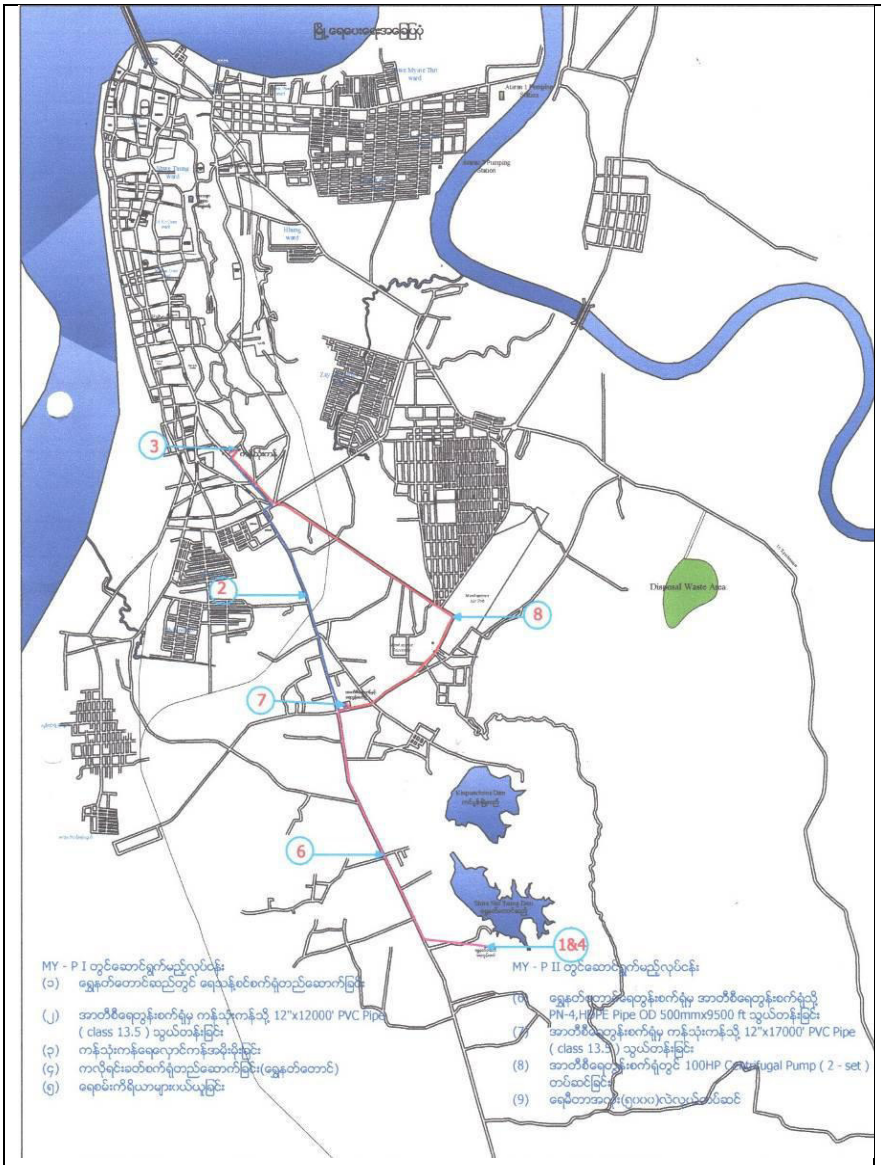
Besides some rehabilitation works of 3 tanks reservoir are also planned, including the construction of a roof.

In addition, a second phase is planned by JICA which is supposed to complement the functioning of ShweNatTaung system (the following components are currently under discussion between TDC, DUHD and JICA, and have not been approved yet):

- Implementation of a transmission line from SNT to RTC Reservoir: it is proposed to lay a 400mm pipe between the two facilities.
- Renewal of RTC pumping station and reservoir and extension of the storage
- Installation of 5 000 water meters
- Implementation of an additional pipeline from RTC to 3 tanks Reservoir: it is proposed to lay a 300mm pipe between the two facilities.
- Main distribution line for RTC distribution area (250mm) to wards 17 &18

Consequently, the overall project would cover the entire system from SNT and provide up to 14 200m3/d to the western part of the city, including 3 tanks reservoir. Overall scope of the project has been summarized in the following map (source TDC). However, it has to be noticed that at this stage, final scope of Phase 2 has not been approved yet.

Figure 3-8: Components of proposed JICA's project – phase 1 & 2 *(source TDC)*



PHASE 1

1. SNT Water Treatment Plant & Reservoir.
2. Transmission line from RTC to 3 Tanks
3. Construction of a Roof at 3 tanks reservoir.
4. Chlorination plant
5. Equipment

PHASE 2

6. Transmission line from SNT to RTC
7. Renewal of RTC BPS
8. Transmission line from RTC to 3 tanks
9. Renewal of 5000 water meters

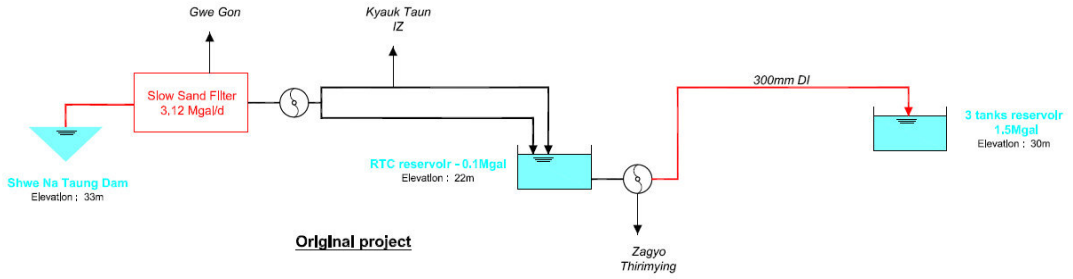
In addition, it is proposed to install a main distribution line (250mm) from RTC to wards 17&18.

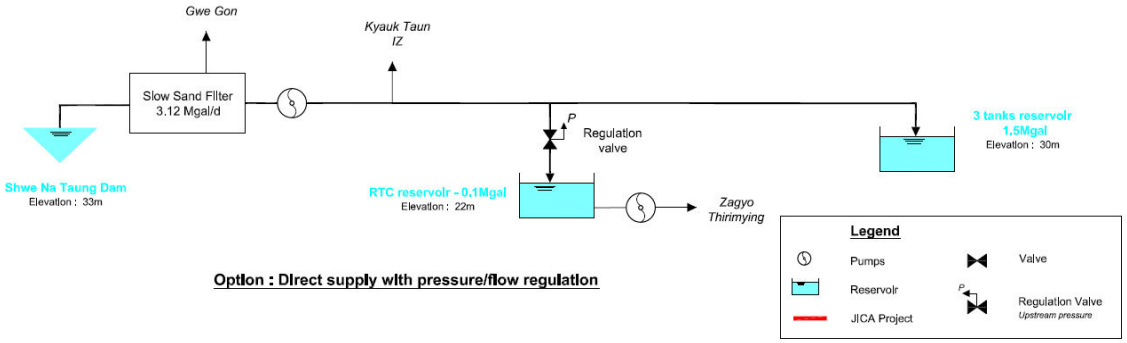
Comments : *While reviewing the design associated with these projects few comments have been made to ensure the overall consistence and adequacy since the systems as a whole need to function together. All components of the proposed project are necessary and consideration of the ShweNatTaung system as a whole is fundamental.*

Firstly it is clear that proposed theoretical production of 14 200 m3/d (or 3.12 Mgal/d) is necessary to cope with the water demand. Treatment process relies on slow sand filtration which appear to be adequate but questionable in some aspects (high capital expenditure, land requirements, specific operating…). Considering a usual velocity in the filter of 0.2 m/h and 20h/d functioning, production volume would require a filtration surface not less than 3 500m² or 0.85acre (while available documents suggest an filtration surface of 8 filters x 21 m x 14 m = 2350 m², notwithstanding the fact that 2 of the 8 filters are assumed to be spare ones). It is also reminded that slow sand filtration is a specific biological treatment which needs a skillful operating different from rapid sand filtration (which operation is usually assisted by automatic devices). Regarding the chlorination process, use of similar process for all treatment facility would ease the overall operation of the system and procurement of chemicals. Besides, it is noticed that the issue of low mineralization of the raw water is not addressed in the design.

Regarding the distribution, it seems consistent to have different independent distribution areas used as DMAs (as explained hereafter and presented on Figure 3-11), including one for each following areas: ShweNatTaung, RTC and 3 tanks. Under this consideration, storage and pumping infrastructure should be designed accordingly. Indeed, water would then be directly distributed to the surrounding area of ShweNatTaung from the new WTP facility which would require sufficient storage for both transfer to RTC and 3 tanks, and distribution. Accordingly, a storage capacity of nearly 4 000m³ would appear adequate (approximately 25% of the daily production capacity). Actual capacity of the storage currently under construction appears much lower.

Besides, transmission system from ShweNatTaung to RTC and 3 tanks reservoirs is a key components. Current plan would supply from WTP to RTC from which water would be transferred again to 3 tanks. Opportunity to have a direct supply from WTP to 3 tanks with a connection to RTC (equipped with a regulation system) would lower energy consumption (only one pumping) and reduce the pressure on RTC which storage capacity is highly limited. The following flow diagrams describes both functioning:





Water Supply project Mawlamyine - JICA's Proposal

The proposed ADB project described hereafter will need to function in a complementary manner to the one financed by JICA. The scope of works of the two projects has been studied in details to prevent from overlapping. In particular, ShweNatTaung system (production, storage and transmission) will be under JICA's project whereas ADB project will include the distribution (network and connections).

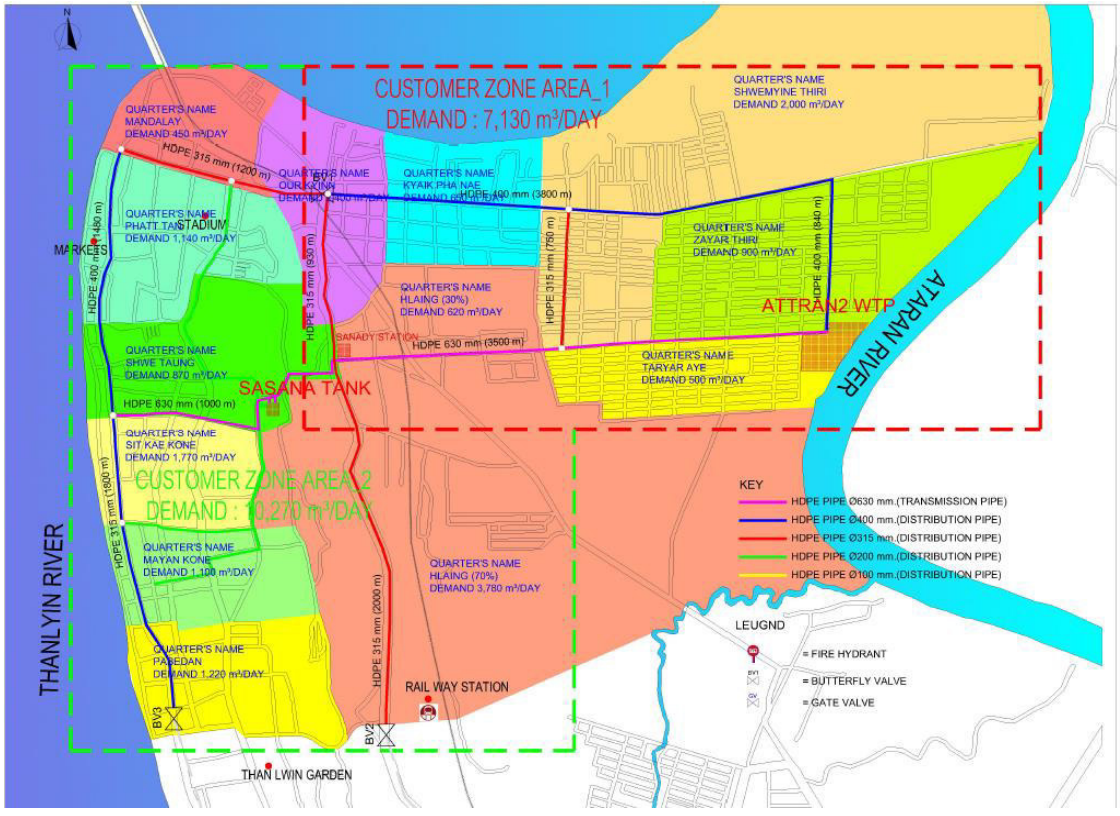
PPP PROJECT WITH THAI TAP WATER COMPANY (TTW)

A PPP project from Thai Tap Water Company is currently being studied. This projects aims to construct a new WTP in the North-Eastern part of the city and replace existing facilities Attran 1&2. The project area would cover the 12 northern wards of Mawlamyine (see figure Figure 3-9).

The proposed project includes:

- Construction of a WTP using rapid sand filter process together with clarifiers and chlorination. Overall capacity is proposed to be 30 000m3/d with expandable structure to reach 40 000m3/d.
- Clear water tank (3000m3) and BPS at the WTP
- Main transmission and distribution lines
- Additional storage (2000m3) for the western area

Figure 3-9: Project area of PPP project from Thai Tap Water Company *(source: TTWC)*



The proposed treatment process would consist in rapid sand filtration with a pre-treatment using clarifiers (pre-chlorination, coagulation/flocculation) and a final chlorination. This process is assumed to comply with WHO standard.

It has to be noticed that none internal distribution network neither connection are included in this project and NRW is expected to be 50%. Hence water sales are estimated to be nearly 15 000m3/d in the covered area. Consequently, volume of production is rather high with 30 000m^3/d.

Considering this PPP and under the current circumstances, it is assumed that the northern part of the city (wards 1 to 12) are covered by the PPP and is not part of the project area. Nevertheless, an alternative scenario is presented hereafter covering the eventuality where an agreement would not be reached and the PPP not push through.

leading to the definition of a water supply project.

3.2.5 WATER SUPPLY STRATEGY

The water supply project of Mawlamyine meets the following targets:

- **Increase water coverage : *"Water for All"***

One of the main objectives of the project is to increase the service coverage of the water supply system in the project area together with the production. Alongside of this project, this water coverage is supposed to be completed by the PPP project for the Northern part of the city, supplying treated water from the Attran River.

The objective is to connect 75% of the urban population in short term by the end of the project. As assumed to complete the water coverage in long term (2040), it is proposed to consider 95 % of coverage for the city. At that time, almost all the population living in the urban area will be connected to the network.

According to the following table and calculation and considering the project area only, the estimated impacts of the project are following looking at population to be served by the network for the two main horizons:

- **By 2020: Nearly 120 000 inhabitants in the project area, that is to say 95 000 more than current situation with more than 19 000 expected new connections.**
- **By 2040: over 240 000 inhabitants within the urban area.**

- **Continuous service : 24/7 water supply**

As previously described in the diagnosis phases, the level of service is unequal in the city. Most inhabitants are supplied only few hours per day. The target is to reach a good level of service for all the citizens of Mawlamyine: a continuous water service, 24h/d and 7d/week together with an appropriate monitoring system. Besides continuous supply and pressurized network is a prerequisite to enable satisfactory water quality and prevent pollution in the network.

Reduction of NRW through the definition and application of an action plan is also a necessity to improve the quality service. It will also have an impact on the financial

sustainability of the system limiting expenditures (CAPEX and OPEX) and increasing incomes.

- **Improve water quality**

A continuous service would not be completely efficient without improvement in water quality. The project proposal aims to ensure good water quality everywhere in the network from the production to the consumers' taps. Using existing assets, in particular the reservoirs, water can be easily treated and distributed. Improvements of the water quality are also highly necessary to improve public health and limit waterborne diseases. Treated water must comply with WHO and upcoming national standards in terms of quality. The table below shows objectives on treated water quality.

Table 3-5: water quality objectives

Parameters	National drinking water standard	WHO drinking water standard	Treatment objectives
Turbidity	5 NFU	< 5 NFU**	1 NFU
pH	6.5 - 8.5	6.5 - 9.5	6.5 - 8.5
Iron	1 mg/l	0,3 mg/l**	0.2 mg/l
Aluminium	-	0.2 mg/l	0.2 mg/l
Ammonia	0.02 mg/l	-	0.1 mg/l
Chlorine	2 - 10 mg/l	-	1 - 2 mg/l
E. Coli	-	0 (99%)**	0 /100 ml
Parasites*	-	-	0 /100 ml

* Gardia and Cryptosporidium ** Expected

- **Enhance resilience and sustainability of the system**

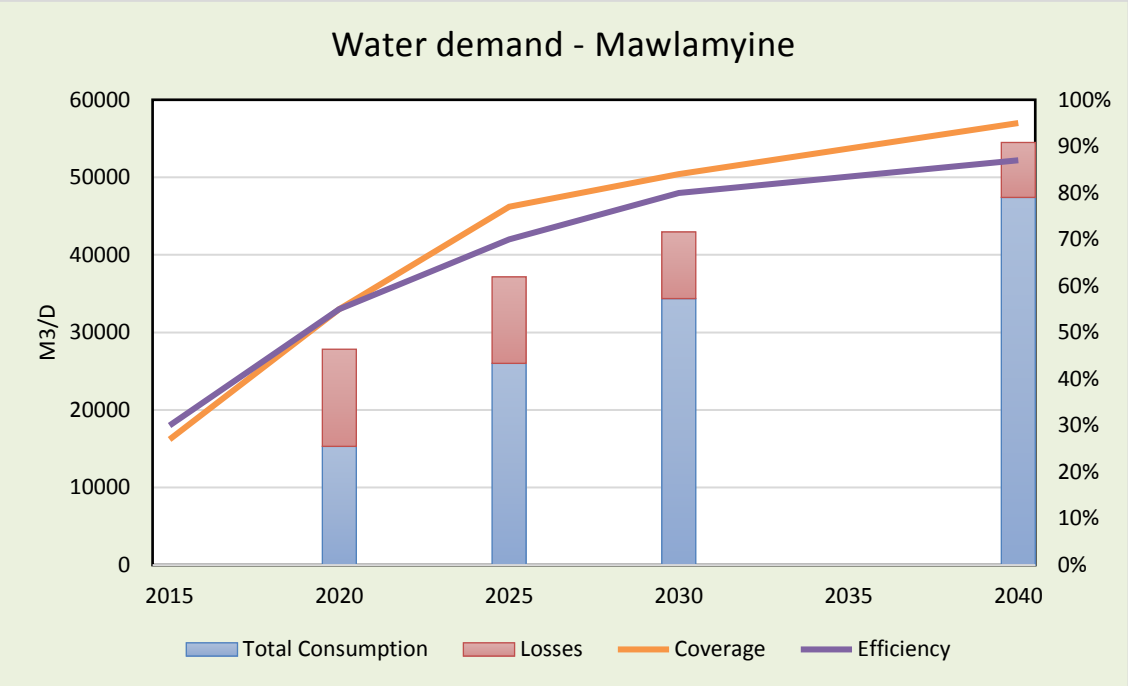
Based on existing assets, the strategy is to improve the current system with a stepwise modernization and reinforcement of the capacities. From a technical point of view the strategy is to build upon existing system with reinforcement and rehabilitation of existing assets together with new infrastructure. Furthermore improvement of the management and system will only come with a specific capacity building plan focusing on people, and with a financial strategy leading toward long term sustainability and development.

3.2.6 FUTURE REQUIREMENTS

The requirements for future water supply provision are based upon the concept plans developed by DUHD which the population is set to grow at around 2.0% per annum reaching almost 360,000 by 2025 and 485,000 by 2040. On the basis of these plans and projections, water demand for future horizons up to 2040 has been estimated covering the urban area and surrounding villages.

The projections as included in the FSR indicate a requirement of approximately 37,000 m3/day for the urban area by 2025. This would increase to almost 55,000 m3/day in the long term (2040). The way that water consumption is planned to increase together with service coverage and overall system efficiency (reduction of physical losses) is shown in **Figure 3-10**.

Figure 3-10: Mawlamyine Water Supply and Demand to 2040



Looking at the entire city and as indicated above, water supply coverage from the TDC system is planned to increase from 27% to 77% in the short term (focusing firstly on the urban area) and up to 95% in the long term. Connections will increase to 47,000 by 2025 and 86,000 by 2040. Population served will increase to almost 235,000 in the short term and 430,000 in the long term considering the accessible villages surrounding the urban area to be connected in long term. In addition water supplies will all be treated and provided continuously (i.e. 24/7 supplies).

3.2.7 OPTION ANALYSIS

The previous analysis confirmed the need for large increases in production capacity, treatment facilities (currently inexistent) and associated networks to improve service coverage in water supply together with improved operational and financial management.

As part of the interim report, two options were studied consisting of providing water supply from primarily the existing reservoirs and secondly from a combination of the reservoirs and the Attran resource. As a result of the different technical-economic analysis undertaken it was shown that separate systems for each service area was the most economic option. Indeed, the existing dams are a major asset since they benefit from a significant elevation and good water quality; water from the dam has the advantage to have a low turbidity throughout the year compared to the Attran river sources. Implementation of new production facilities able to treat water from these resources would enable to fulfil the short and medium term requirements for Mawlamyine considering the southern part of the city.

In addition, during the Interim and Final phases of the assignment further details of two associated projects presented above have been obtained allowing to refine the Project and ensure their consistency and complementarity. Consequently, it is assumed that JICA project will cover the entire production and transmission line from Shwe Nat Taung to 3 tanks reservoir, including RTC reservoir while PPP is supposed to cover the Northern part of the city (wards 1 to 12), as summarized in Figure 3-11. As mentioned previously, JICA project for Mawlamyine city includes the

implementation of a new water treatment plant at ShweNatTaung dam. Theoretical capacity is supposed to be 3.12 Mgal/d, that is to say 14 200 m3/d, with possibilities for further extensions. Considering future water demand spatial distribution, implementation of this facility is highly necessary to fulfil the water need.

Further analysis of the proposed Project during the final phase of this assignment focused on the identification of an appropriate site for the intake and treatment plant at KhinPonChong and the preliminary design of the network facilities. In accordance with resource analysis, SWOT analysis and previous conclusions, it is proposed the creation of a new water treatment plant with a nominal capacity of 8 000m3/d (16h/day functioning). Capacity has been set according to the hydrological analysis of KhinPonChong. Together with ShweNatTaung system, this capacity will fulfill the water need within the project area. It has to be noticed that rehabilitation of the dam is also necessary, including measure to reduce water losses from the dam, secure and optimize the storage capacity. Produced water from KhinPonChong will supply the same areas as existing conditions plus future extensions under this project towards the Eastern part of the city.

An upgrade of the storage facilities appears necessary in order to increase the autonomy of the system and to promote water supply under gravity thereby saving on operating cost. As an initial approach it is advised a minimum storage capacity of half day per distribution area or system. Consequently, sufficient storage shall be implemented at KhinPonChong. Besides, existing 3 tank reservoir presents a significant storage capacity with a strategic location allowing gravity distribution to the city center. It is proposed to keep the functioning of this key system which need to be secured and rehabilitated. This storage could be supplied from both KhinPonChong and Shwe Nat Taung systems for a higher flexibility and security purpose. Consequently two inflows will be made available according to water needs and distribution across the system: gravity flow from KhinPonChong and transfer from ShweNatTaung (BPS).

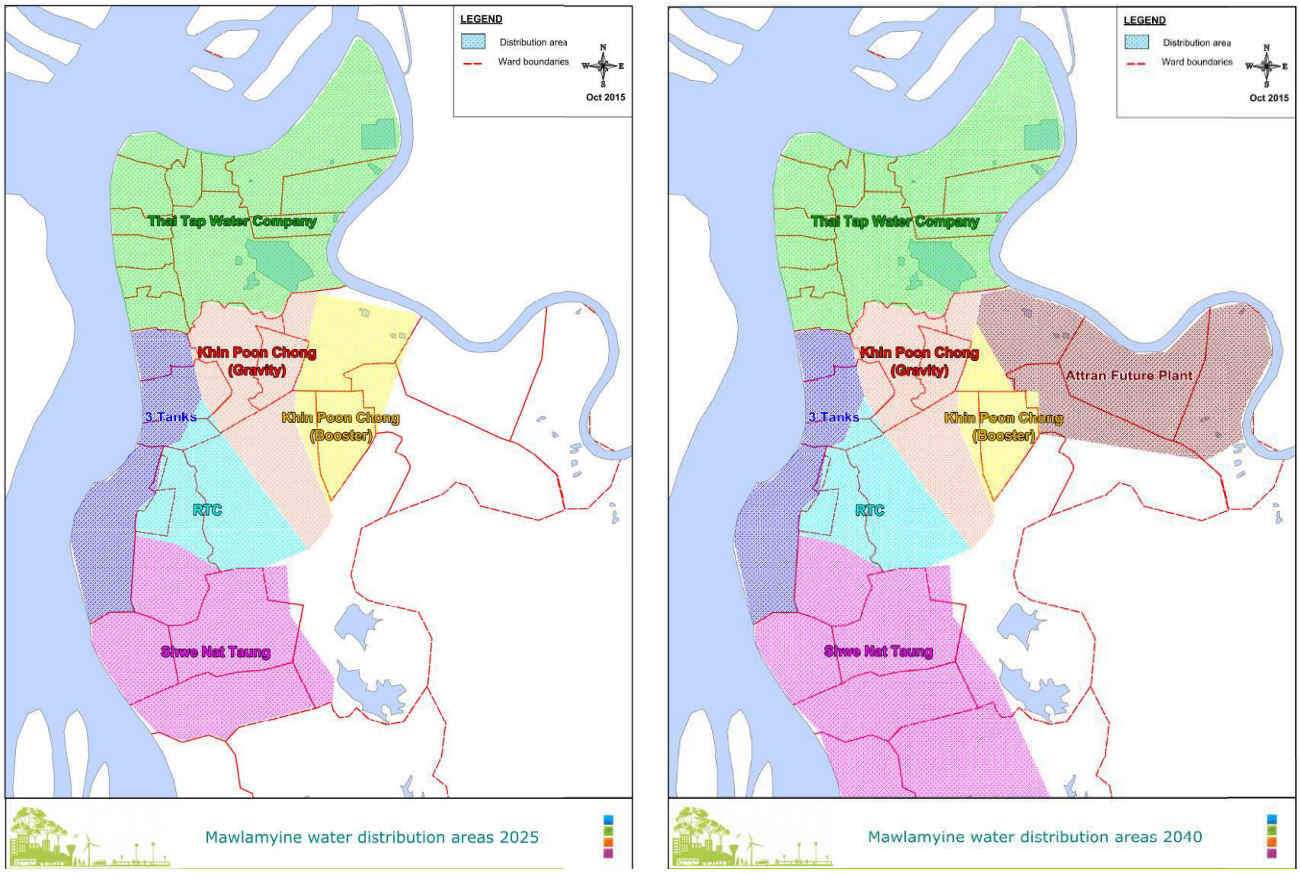
To distribute the treated water and extend the coverage, a large amount of pipe will have to be newly installed, whereas existing network will have to be rehabilitated and strengthened to ensure reliable supply in the covered areas. Installation of the internal distribution system remains in the scope of ADB project for the entire project area.

Apart from TTW area (outside project perimeter), 5 distribution areas can be identified, each of them can be easily metered as part of NRW strategy. The distribution strategy is based on the existing functioning. Among them: two are only supplied from KhinPonChong, two other from ShweNatTaung whereas both resources can supply 3 tanks area. Looking at longer term and requirements, the development of the Eastern zone will require a new distribution area which resource could be the Attran River. Whereas Shwe Nat Taung system will cover the West Southern development and extension. Related distribution areas can be identified in the figure below. In addition, interconnections between the systems would secure the overall functioning and ensure higher flexibility of the system (ex: 3 tanks reservoir shall keep available supply from both dams.

In addition, **reduction of NRW will be one of the focal point regarding both commercial and physical losses.** The objective of the proposed action plan is tackle current high level of NRW and to counterbalance in long term the entropic tendency of the losses to increase. From an existing network efficiency estimated to be 30%, it assumed that efficiency shall raise up to 70% by 2025 and 95% for longer term. Alongside with infrastructure, capacity building and new methodologies shall

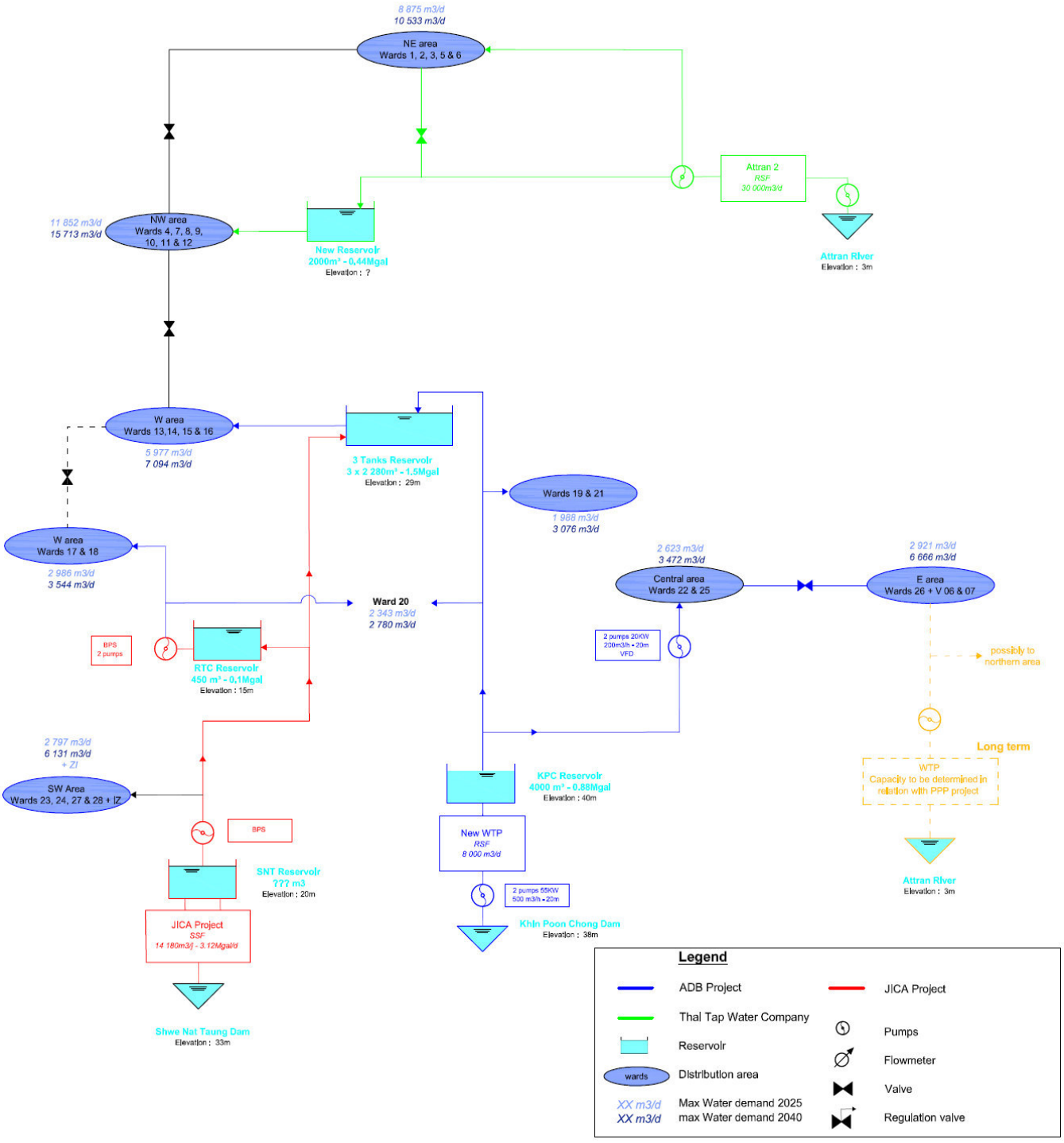
be implemented to reduce commercial losses in particular regarding the customer management and billing activities. This component shall be supported by the use of modern tools, particularly software & support (GIS, customer & billing management software…).

Figure 3-11: Distribution areas for short and long terms



Summary and repartition of the works of each projects are summarized in the figure below.

Figure 3-12: Mawlamyine project flow diagram



Notes

In case the PPP project is not commissioned, an alternative strategy would need to be implemented to supply the Northern area of Mawlamyine. Considering that availability of surface water from the two reservoirs is limited and would not be sufficient to cover the entire city, it is suggested to use surface water from the Attran River.

Under this consideration, a treatment facility using Rapid Sand filtration in line with the raw water quality would be necessary. Such facility would then be concomitant with long term requirements which suggest a production facility for the South-Western part of the city. Consequently, treatment facility could be constructed in short term and then extended for longer term. Nevertheless, it is strongly recommended to abstract water upstream of the city and potential effluent from the landfill. In addition of potential pollution, this would prevent from salted water intrusions toward Attran river estuary which is likely to increase in connection with climate change. On initial examination, a nearly 20 000m3/d facility would be required to be extended to 30 000m3/d for long term requirements.

Apart from production facility, it would also be necessary to implement new infrastructure building upon existing assets and facilities (SanayDine and SaThaNar tanks). This would include: storage (total 10 000m^3 for half day autonomy) and transmission towards the supplied area, as well as distribution network. Furthermore, in order to reduce NRW and ensure the sustainability of the system, it would also be recommended to apply the same strategy as the project area, implementing a NRW and asset management strategy, including renewal of some existing assets.

3.2.8 PROPOSED PROJECT

In line with previous objectives and strategy the proposed project consists of four major elements as described below.

- Production and treatment
- Increase and secure storage
- Expand distribution system
- Reduce NRW, improved Operation & Management covering asset management, GIS, billing and customer management.

PRODUCTION AND TREATMENT

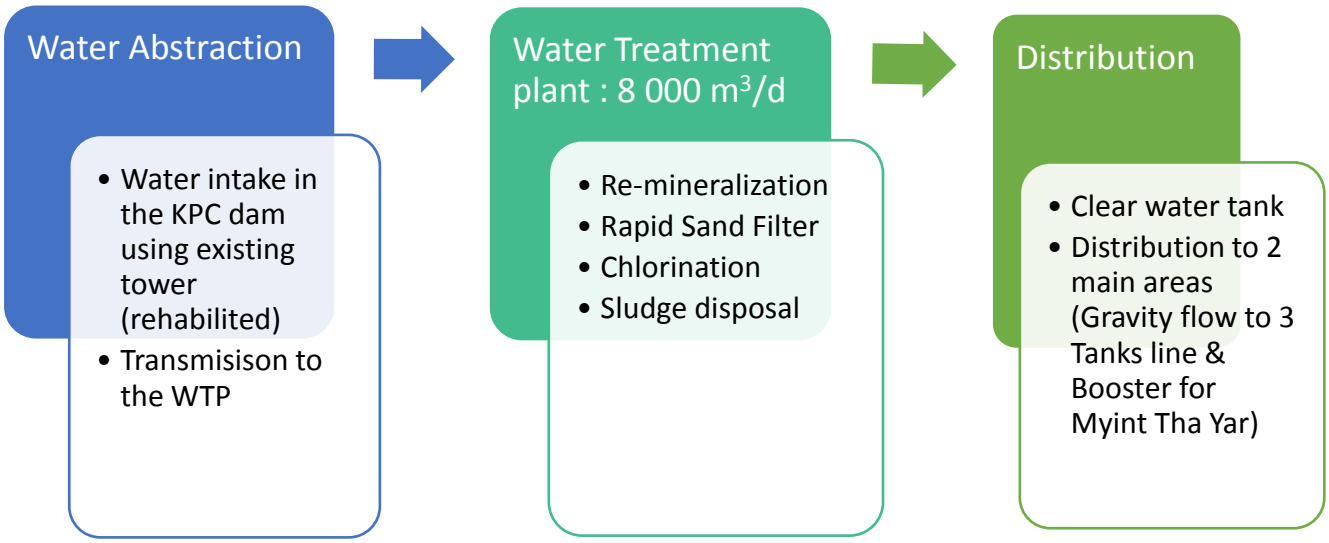
Increase production capacity is a crucial component to cope with future water demand considering the urban growth. In order to achieve this objective in a

sustainable and secured manner, it is proposed to optimize and upgrade existing resources by treating the water thanks to a new water treatment plant at Kin Pong Chong, whereas ShweNatTaung system is under JICA project.

It is firstly proposed to rehabilitate the reservoir of KhinPonChong. Necessary surveys shall be conducted first to gather additional information of the dam (topography, soil analysis…). According to the results, rehabilitation of the dam should include measure to secure the infrastructure, reduce water losses and seepages and optimize the storage.

It is proposed the creation of a new water treatment plant with a nominal capacity of **8 000m3/d** (16h/day functioning). Capacity has been set according to available data regarding the hydrology of the dam considering its rehabilitation. This capacity will fulfil the water need within the dedicated area (average daily need).

Overall functioning is summarized below:



For more details, proposed treatment process consists in:

1. Water abstraction using the existing water tower which need to be rehabilitated. Intake includes the installation of pumps and transmission line to the WTP equipped with a flowmeter and pilot line to control pumps from the treatment site. The transmission line is expected to measure nearly 300 meter long with 400mm diameter pipe.

2. Re-mineralization process as a pre-treatment would be preferable since low mineralization has been identified in KhinPonChong Dam. If confirmed the adopted treatment process would need to consider this parameter in order to prevent the water supply system from possible damages due to aggressive water (corrosion and colored water, possible deterioration of DI pipes, civil work… leading to leakages). Different process could be used is re-mineralization is necessary depending on detailed chemical composition of the water (for instance: injection of CO_2 + lime).

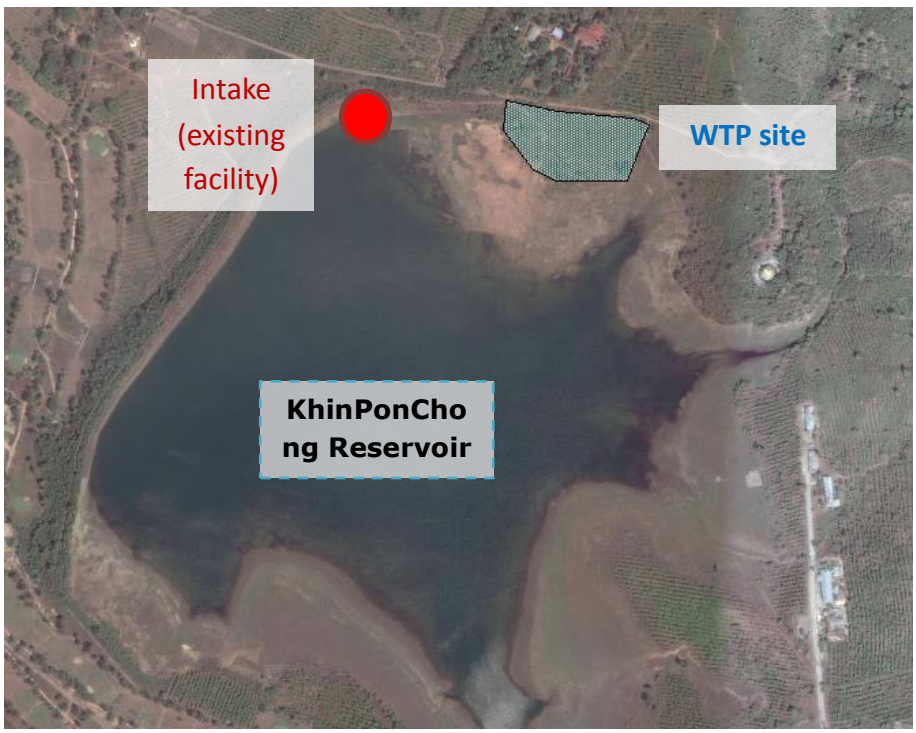
3. Filtration step with a battery of 3 open type gravity sand filters (alternatively pressurized filters could be considered), with the associated backwash, air scour and control facilities. Filters are upstream and constant level type and each of them will be equipped with one independent filter control system (easier operation). Using rapid sand filters, depth of sand shall not be less than 0.9 m (exclusive of all supporting layers). The filter media will be hard grain silica sand, having a NES (Nominal Effective Size) between 0.9 mm and 1.2 mm and a UC (Uniformity Coefficient) below 1.8. An overall filtration surface of nearly 60m² would be necessary (3 x 20m²).

4. Final chlorination into a clear water tank prior to distribution mainly for its microbial disinfection power. Disinfection could be based on different process to produce chlorine with a possibility to have a common production for all WTP (use of chlorine bleach or chlorine gas, or production on site with electro-chlorination…). Chlorine, whether in the form of chlorine gas or sodium hypochlorite, dissolves in water to form hypochlorous acid (HOCl) and hypochlorite ion (OCl^-).

5. Transmission under gravity conditions

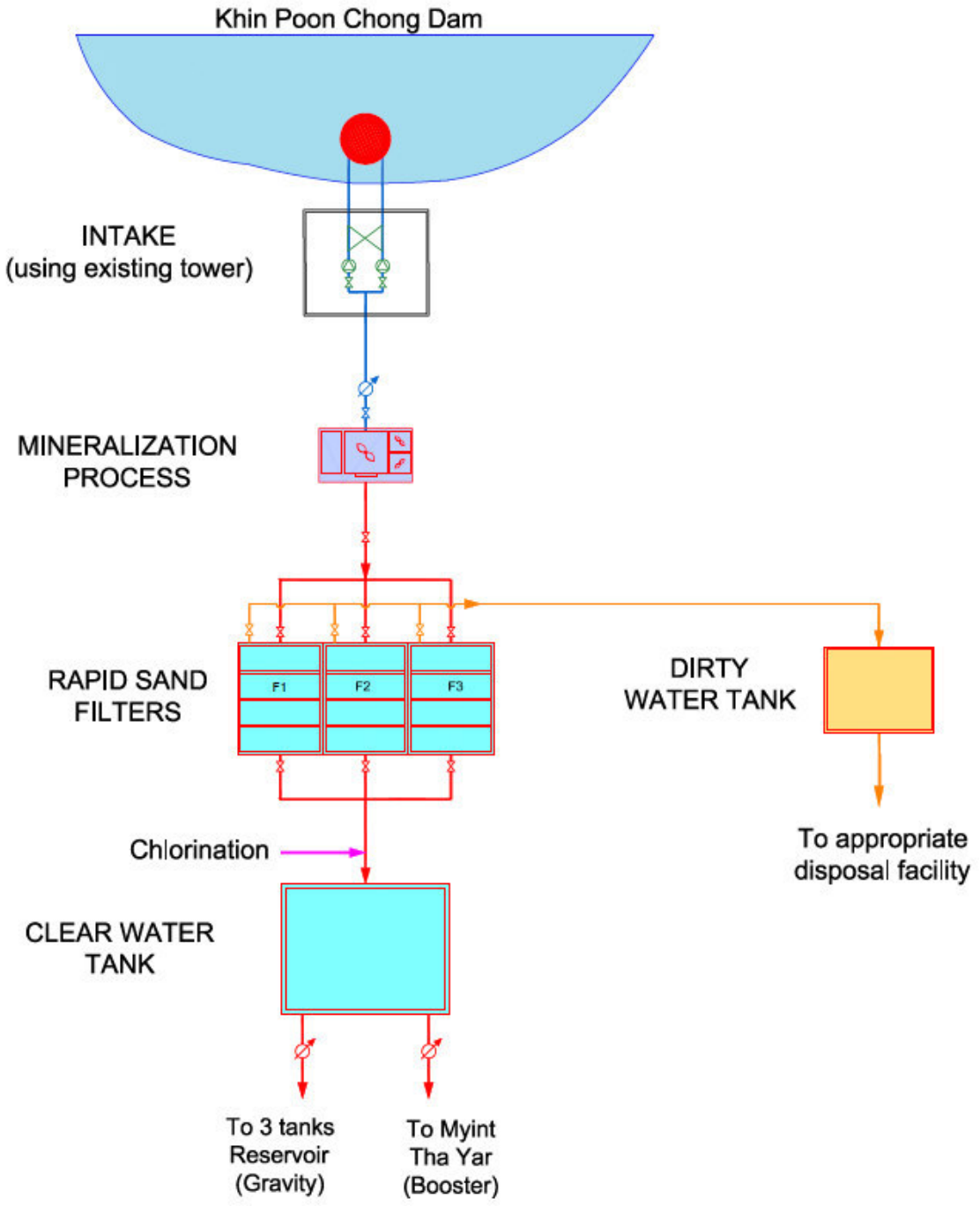
The new facility will also include buildings and annex devices, in particular: operation building, electricity buildings, chlorination plant, air production… In addition, sludge resulting from filters washing will have to be properly disposed. Nevertheless, the amount of sludge is expected to be limited due to the low raw water characteristics.

Figure 3-13 : Site location of WTP



The proposed process is able to ensure an appropriate water quality and relatively easy to operate since it can be assisted and automatic. It is a compact and robust system able to treat a large amount of water in a limited space. In connection with the low turbidity of the raw water, coagulation/flocculation and use of chemicals would not be required. The process diagram below shows the global system which is proposed.

Table 3-6: Mawlamyine KPC system



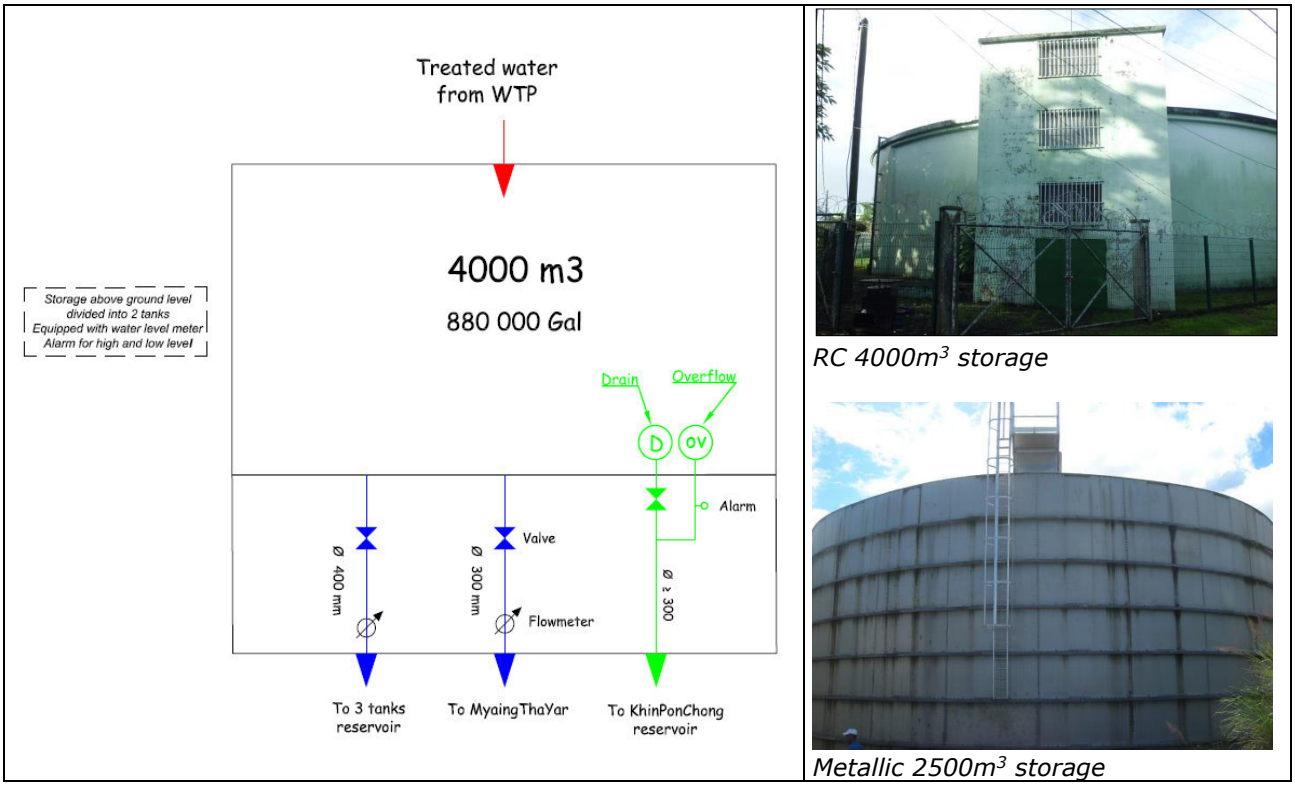
Finally, protection plan will have to be set up introducing protection perimeters and environmental policy around the water resources, in particular the 2 reservoirs. Such plan will serve multiple purposes: prevent pollution, control water usage, centralization of data (hydrologic and climatic information) updating estimates of water resource availability, adoption of an integrated water management approach and possibility to develop action plan for water conservation and promote public information.

STORAGE

In line with previous considerations treated water storage capacity needs to be increased. The following components are proposed to cope with the objectives and requirements:

- Construction of a new reservoir for the new WTP at KhinPonChong with a storage capacity of 4000m3 (i.e. 0.88 Mgal). This capacity corresponds to half of the daily treatment capacity and is necessary to ensure the good functioning of the system under gravity conditions and supply the peak demand. This facility should be constructed next to the WTP and above the ground (elevation > 40m) to enhance gravity flow and prevent under-pressure from groundwater along the dam. To ease operation and regular cleaning, this storage should be divided into two compartmented tanks. Geotechnical analysis on this site will be required for both WTP and storage. Finally, each outlet will be equipped with flowmeter (x2).

Figure 3-14: general layout of KhinPonChong storage



RC 4000m³ storage

Metallic 2500m³ storage

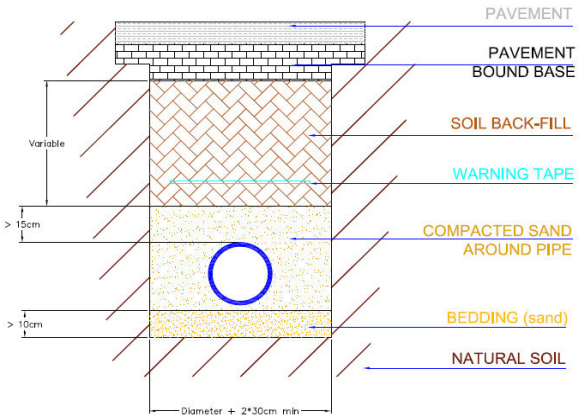
- Rehabilitation of 3 Tanks reservoir which capacity is sufficient in regard with its distribution area (>1 day autonomy) and benefit from sufficient head to supply most of downtown area. Works shall ensure the quality of treated water and secure the facility. It has to be notices that a roof is already under construction at the time of this report production. Hence, it is suggested to improve drainage system, refurbish the tanks and connections (inlets/outlets), secure the site with fences and install measurement equipment (water level sensor, alarm…).

DISTRIBUTION

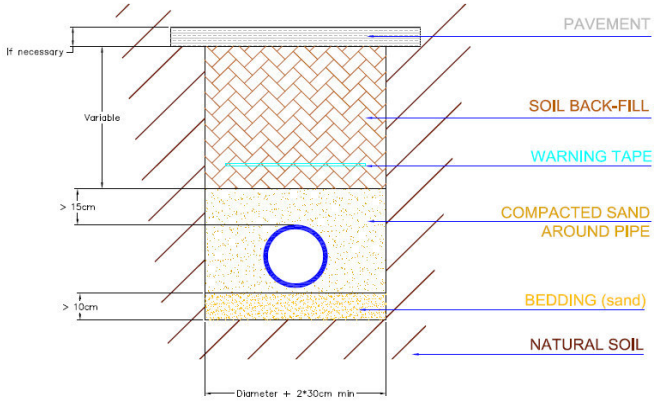
To distribute treated water and increase water coverage, a large amount of pipeline will be newly installed. The network is organized and structured based on the main distribution lines from which some need to be strengthened or replaced. The outline designs of the proposed networks have been analysed using hydraulic modelling techniques. The results demonstrate that maximum velocities and pressures are acceptable for both the short and long term requirements. Results of this analysis are presented in Water Supply appendix 2.

Pipelines will generally be installed using trench method. A specific care will be given for the installation of pipeline to prevent leakages and premature wear. Consequently, pipeline will be installed according to international standards as presented in the typical trench drawing below. Nature of backfilling can depend on the soil condition and quality. Furthermore, typical drawings for pipe and equipment installation are presented in Water Supply Appendix 1.6.

Figure 3-15: Pipe installation and trench description



Typical trench drawing
National / AH Roads



Typical trench drawing
Secondary Road

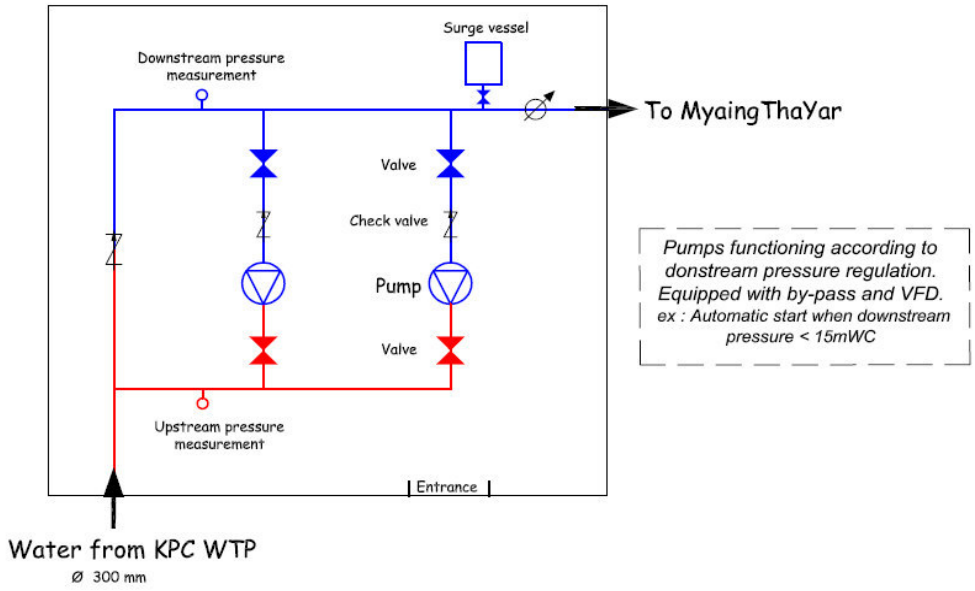
- **Transmission and main distribution**

In order to meet increasing water demands and future extensions, strengthening of both transmission and main distribution pipes and laying of new main distribution lines is proposed. This shall also permit to finally achieve equitable distribution of water supply and to limit head losses. This network will consist of pipelines from 200mm diameter up to 400mm and has been sized based on system modelling looking at medium and long terms requirements. This structural network includes:

- Replacement of old transmission line from KhinPonChong to 3 tanks reservoir. Following the existing route a new 400mm pipeline is proposed. The corresponding longitudinal profile is following:

- Replacement and strengthening of MyaingThaYar main distribution line with a 300mm pipeline. Strengthening of this line will limit the head losses and ensure a suitable supply and pressure to MyaingThaYar ward. Existing BPS may become optional due to higher static head. Nevertheless, it is proposed to include its rehabilitation in the project to have the possibility to increase pressure if necessary, especially during peak demand and/or for medium term. Existing BPS could be rehabilitated implementing a new booster with downstream pressure control (variable frequency drive) and by-pass. In case connections are made upstream of MyaingThaYar (in particular supply to military camp), relocation of the BPS at the production point (next to the tank) could be considered.

Figure 3-16: General layout of MTY BPS



- Some new main distribution lines 200mm to cover the wards #19 to #22.

Proposed total length of new transmission and main distribution network per diameter is as following, location is presented in the summary map below. In regards with the strategic importance of this structural system and local constraints, it is proposed to install ductile iron pipeline.

Table 3-7: Length of transmission and main distribution lines

	200 mm	250 mm	300 mm	400 mm	TOTAL
Length (m)	**5 570**	**0**	**2 230**	**5 160**	**12 960**

Besides, some existing main distribution lines recently installed will be used even if some may need to be strengthened for long term requirements. And it has to be reminded that an additional transmission lines will be installed from ShweNatTaung system under JICA project.

- **Internal distribution**

As presented previously, it is proposed to increase the network coverage step by step, based on the population forecasts and future water demand 77% by 2025 and 95% by 2040 (long term). Consequently, the length of internal network to be installed for the project area by 2025 is estimated to be nearly 140km, in addition of existing distribution network (~ 53km) among which many pipes are likely to need

renewal. Then, the proposed breakdown of pipe length per size for Mawlamyine is following:

Table 3-8: Length of internal distribution network

Diameter (mm)	≤ 80mm	100 mm	150 mm	200 mm	TOTAL
Breakdown	40%	35%	20%	5%	**100%**
Length (km)	56	49	28	7	**140**

At this stage, for durability and economic considerations, it is proposed to install ductile iron pipeline; alternatively HDPE could be considered for internal network.

Following map is a draft design of tentative future internal distribution network which shall be further detailed during the next steps of the Project:

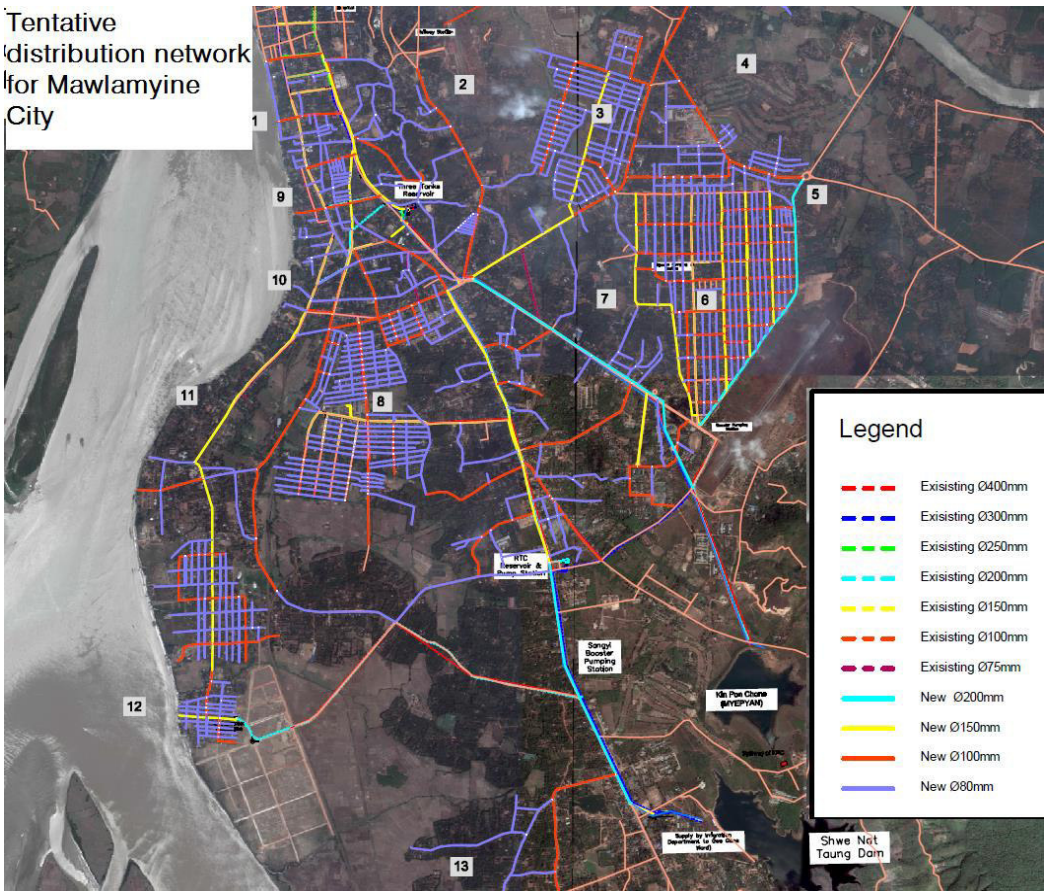


Figure 3-17 : Tentative drawing of Mawlamyine future internal distribution system

Together with the coverage extension and distribution network installation, new connections will be made. The number of new connections is estimated to be nearly 19 160 by 2025 assuming that 24 200 households will be connected in the project area (47 300 for the entire city). New connections shall be implemented according to international standards with a define procedure (material, maximal, length, registration…), and equipped with high quality water meters: certified class B or ideally class C.

NRW STRATEGY

It is proposed to have a full strategy to fight, control and reduce losses, from a macro scale to a household level, according to the objectives presented above. It is based on:

- The quantification of losses,
- The localisation of leakages,
- The proposition to start an asset management plan.

Control of leakages cannot be permanently maintained if leakage detection is not accompanied by an asset management plan. Indeed, part of the network infrastructure is aging since oldest part of the network is nearly 100 years old. Consequently, it is proposed the rehabilitation of 50 % of the existing network in the project area (that is to say around 26 km pipes). This is a first step to implement an asset management plan that must be tracked and used in the future.

3.3 Solid Waste Project

At the moment the waste collection and disposal in Mawlamyine town is inadequate and create health risks, safety risks and environmental hazards for the population. This is an unacceptable situation and unsustainable and therefore needs urgent improvements. Several options have been investigated for implementation of an Integrated Solid Waste Management (ISWM) system.

The proposed new ISWM system for Mawlamyine consists of:

- Improving primary collection system in the town and secondary transport system to the landfill and composting site;
- More Efficient separation and collecting of recyclables e.g. like ferro, plastic bottles, glass, aluminium cans and paper, both through the informal sector and formal sector;
- Introducing source separating organics (SSO) system for diverting large amounts of organic waste to the new planned Composting Plant;
- Upgrading of the existing dumpsite to a Controlled Landfill with bottom liner and leachate collection and treatment.

Above measures are included in the investment plans of the town and proposed for ADB financing.

Table 3-9: Solid Waste sub-components for Mawlamyine

DESCRIPTION	SUBDIVISION	NUMBER TO PURCHASE
Primary Collection		
Small containers 240 ltr in 3 different colours for the three different separation waste streams: for each ward two collection points (28 Wards)	Green colour containers for organics; Blue colour containers for recyclables Yellow colour containers for the reject waste	56 56 56
Aluminium containers 1100 ltr for siting at small size collection points. Two different containers for separating organics and rejected waste. It is assumed that most of the recyclables are already removed by the informal sector	Aluminium container with large text on site: ORGANICS Aluminium container with large text: ONLY REJECTS WASTE Aluminium container with large text: ONLY RECYCLABLES	28 28 28
Transport containers content 3 m3 for collecting with hooklift trucks	Steel containers 3 m3 hook lift system	28
Collection trucks for above containers	Small trucks with lift system for 240 l and 1100 l containers Hook lift Truck for 3m3 steel containers	2 2
Recycling		
Formal sector: Introducing at schools, township offices and other official buildings the separation and recovery of recyclables using 3 different colour containers	recyclables (“dry waste”): 240 l containers Blue compost (“wet waste”): 240 l containers Green reject waste: 240 l containers Yellow	28 28 28
Adding aluminium containers 1,100 l at specific collection Points in town for deposit recyclables by the public	Additional Recycling containers 1100 l, 1 in each ward	28
Adding some extra 3m3 containers in the most populated wards of town	Additional containers 3m3 hook lift system in most populated wards	15

DESCRIPTION	SUBDIVISION	NUMBER TO PURCHASE
Composting		
Construction of a composting plant of 65 tons/day capacity	Sorting area Composting Pad Maturing Pad Storage Area Mechanical Equipment Area	500 m² 4,000 m² 1,600 m² 4,000 m² 2,000 m²
Landfilling		
Upgrading of existing dumpsite into a controlled landfill with bottom liner and leachate collection over 16.8 ha including 5 cells (only 1 cell constructed under this Project Phase, others scheduled in 2024, 2028, 2032, 2036)	Landfill Infrastructures area (access, office, storage) Environmental monitoring wells Weighbridge 50 tons Bulldozer 248 HP Small 4x4 drive truck tractor	14.6 ha 2.2 ha 6 1 1 1
Leachate treatment: anticipated production is 23,000 m3 per sub-cell during 5 months of wet season	Recirculation into landfill passive evaporation from holding ponds in dry season. On-site physical & biological treatment	3000 m² pond and leachate treatment plant

Source: PPTA Consultant, Solid Waste FSR, 2015

Total CAPEX is estimated at 14 million USD for the first phase of project implementation.

Required labour is estimated as 18 employees for landfill operation and 14 employees for compost plant operation. Total OPEX for waste collection, controlled landfill, compost plant and medical waste treatment is estimated at 460,000 USD/year.

3.3.1 DIAGNOSIS SOLID WASTE MANAGEMENT

COLLECTION

- Mawlamyine Town Development Committee (MTDC) provides solid waste collection services to 23 of the 28 wards (covering about 90% of the total population).
- The MTDC has only 7 waste vehicles for 23 Wards and they have no possibility to include the other 5 wards to incorporate in the SWMS (Solid Waste Management System). Normally waste is collected twice/week.
- Assuming a population of 258,809 with a waste generation of 0.55/kg/capita/day, results in about 142 ton/day. Initial observations estimate that about 50% of waste is collected and dumped at the designated dump site.

For instance, Nhaing Tae Ward is not covered by solid waste collecting system of Mawlamyine Town and the community had to deal with their own waste management system. Mostly they dump the waste into the stream near the village which flows into the Attran River. This small stream flows in the north of the ward, while the Attran river flows north-east of the ward. The households away from the stream and from Kyaikmayaw road burn their waste on the street or on their yard.

Inadequate and uncontrolled waste disposal causes groundwater pollution, unpleasant odour and air pollution by unauthorised burning of the waste, drain clogging and spreading of mosquitoes. This has a negative impact on the city's health and environment.

- While the majority of the city is generally kept well clean, there are often accumulations of solid waste in drains which are washed down to the sea front and accumulate near to the promenade area.
- Most of the activities are operated by MTDC, but there is one ward (MyaingThaYar) which is actively undertaking a community based collection system.

Cleansing Program executed by the Cleansing Department

Sweeping, collecting and transporting the waste from roads and streets in the townships is by four means:

- Daily determined sweep routes, collection routes, and the garbage carried by hand to "carry" waste bins; every morning sweeping duties are done by 41 workers. The daily workers from the Market Department do their cleansing duties inside and outside market places in evening sessions.
- **Door to door collection:** Bell ringing and collecting of waste in the town area is an effective and systematic way of waste collection system. By hearing the bell ringing, the community know easily that the waste collection truck is coming into the streets; they can prepare for the disposal of their waste to the waste truck in time.

Figure 3-18: People queuing at bell ringing dumper venue

- **Cart and trash bin collection points**: Collecting of waste from the waste collection tanks, waste bins and waste carts kept for waste collection in the selected streets. Some carts are hitched to a jeep and sent directly to the dump site. Users throw their waste on the ground until the cart is back to the collection point. The other carts are emptied by labourers into dumper truck.

Figure 3-19: Waste Collection points (big one with Cart and small one with trash bin)

- Waste from town parks, town landscapes, town areas cleaning plan, daily collected by truck.

In each garbage truck one driver and three workers are assigned. In the morning section waste from waste collection tanks, waste bins and waste carts are collected and disposed to the dump site. In the afternoon and evening section the waste will be collected via the bell ringing system.

Markets Cleansing Program executed by the Market Department

The MTDC Market & Slaughter House Department have their own cleansing program according to **Table 3-10**.

Table 3-10: Markets Cleansing Program Mawlamyine

No.	Name of Market	Address	Collecting System
1.	No (1) Market	PhetTan Ward Lower Main Street	Between 5-8 p.m direct loading, 3 ton waste truck, 1 trip every day
2.	No (2) Market	PhetTan Ward Lower Main Street`	Between 5-8 p.m direct loading, 3 ton waste truck, 1 trip every day
3.	MyineYaDaNar Market & Vegetable Market	PhetTan Ward Upper Main Street	Between 5-8 P.M direct loading, 3 ton waste truck, 2 trips every day
4.	MinGaLar Market	SitKaeKone Ward Upper Main Street	Between 5-8 p.m direct loading, 3 ton waste truck, 1 trip every day, Small market ½ load truck

No.	Name of Market	Address	Collecting System
5.	ThiriMyine Market	ThiriMyine Ward Shwe Street	(15' x 10') Waste collection tank, between 5-8 P.M, 3 ton waste truck, 1 trip every day
6.	DaingWunKwin Market	Kyaikene Ward Lower Main Street	(15' x 10') Waste collection tank, between 5-8 P.M, 3 ton waste truck, 1 trip every day
7.	ShweMyineThiri Market	ShweMyineThiri Ward Lower Main Street	Waste collecting system bell ringing & direct loading to the truck, 1 trip every day
8.	ThanLwin Market	BoKone Ward Lower Main Street	Waste collecting system bell ringing & direct loading to the truck, 1 trip every day
9.	MaungNgaing Market	MaungNgaing Ward Lower Main Street	Waste trailer kept for waste collecting, early morning every day one trip waste trailer plus waste truck
10.	PharOut Market	PharOut Village	(20'x20') Waste collection tank. Alternate 3 days one truck one trip
11.	MyaingThaYar Market	MyaingThaYar Ward ThaMeinBaYan Street	(15'x10') Waste Collection Tank. Alternate 3 days one truck one trip

Cleansing Program by the Communities in Wards

MyaingThaYar Ward, which is situated within the area covered by the cleansing program of MTDC, has its own community solid waste system with one garbage truck. The MTDC Cleansing Section collects only waste from the outer parts of the MyaingThaYar Ward. The inner parts of the Ward areas are collected by the ward community itself with its own garbage truck and transported to the dump site.

Existing Recyclable Waste Operators in Mawlamyine

The existing recyclables waste traders in Mawlamyine, considered the 'informal sector' for recyclables are shown in **Table 3-11**.

Table 3-11: Mawlamyine Recyclables Waste traders

Materials Type	Recyclable Means
Paper-Newsprint Paper exercise books	Sent to Mawlamyine Industrial Zone. They are mixed and grind and made it to pulp, and made it to paper again. Some as tissue papers.

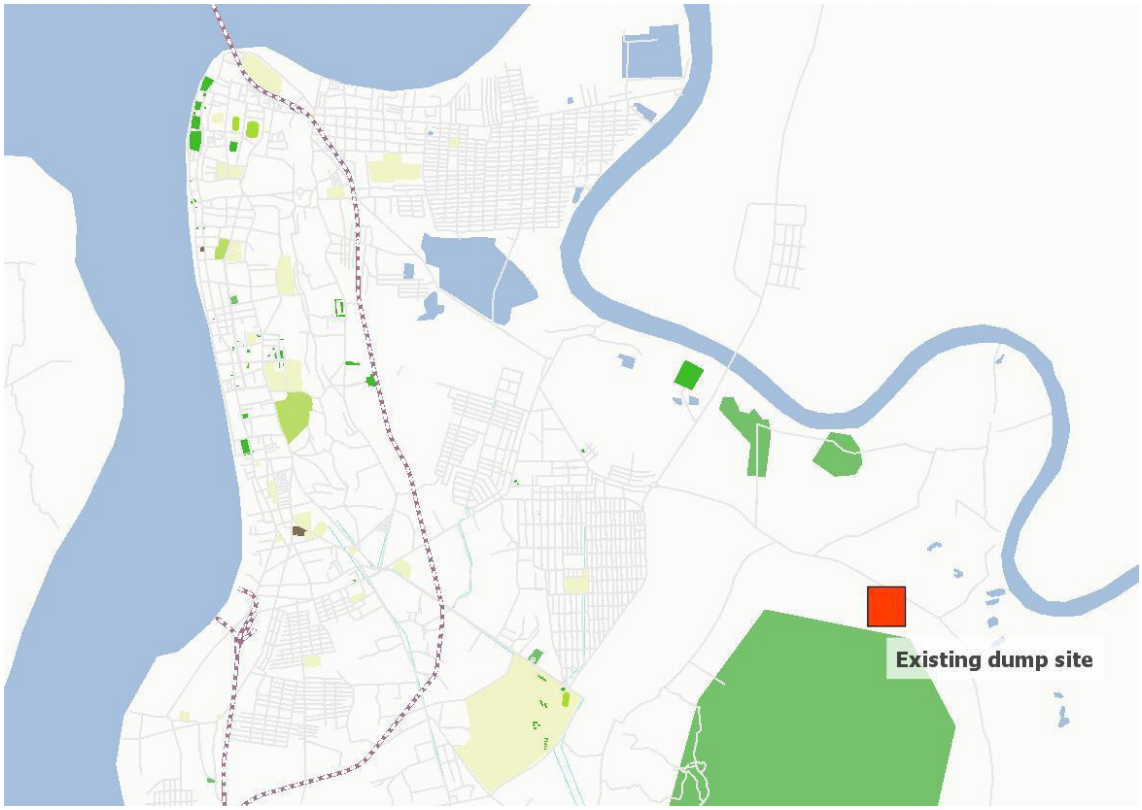
Materials Type	Recyclable Means
Metal (iron) Metal (hard) (Car Engines and so on) Metal (soft) (Aluminium pots and so on) Metal (Copper) (Coils from electric wires)	Iron are directly sent to MyaungDaKar Industrial Zone, in MhawBi Township, Yangon Region. Sent to SawBwarGyi Gone, Yangon Region Sent to SawBwarGyi Gone, Yangon Region. Sent to SawBwarGyi Gone, Yangon Region. If the coils were burnt less value, if not burnt higher value.
Cardboard containers	Sent to ShwePyithar Industrial Zone, Yangon Region. Then mixed, grinded and made to pulp rolls.
Rubber slippers	Coloured rubber slippers are bought and sent to Yangon. (No black rubber slippers!). Made to plastic pallets for other usage.
Batteries	Sent to SawBwarGyi Gone.
Glass bottles (Myanmar liquor Co. use their own branded bottle. Other brand bottles (e.g. oil and fish sauce bottles)	Sent to Yangon for further recycling Recycled by the companies brand
Other brand bottles	overseas liquor bottles are not traded

The recyclable wastes were not only traded from Mawlamyine Town. The traders get also recyclables from Mudon, Kyaikmayaw, Yae and Dawei.

DUMPSITE

Solid waste is dumped at a site to the east of the main city and upstream of the two river water supply intakes as shown on **Figure 3-20**. There is a clear risk of contamination of these water resources by leachate from the dump site.

Figure 3-20: Dumpsite location in Mawlamyine



Burning of waste takes place at the dump site to reduce waste volumes; this is a clearly a health hazard to the waste pickers and also is a matter of complaints from the nearby village (MuYaung Village) and the Sports Academy. During the site visit (May 2015) the dump area was completely covered in smoke (Figure 3-21).

Figure 3-21: Leachates and waste burning at the dumpsite Mawlamyine

On the dumpsite there are 8 to 10 waste pickers / scavengers as shown in Figure 3-22. Several individuals collect directly some types of recyclables and arrange their own transport (for recycling) to Yangon by truck.

Figure 3-22: Scavengers at Mawlamyine dumpsite

Mawlamyine TDC often uses open fires to reduce the volume of waste. They try to burn only downwind of dwellings, however this is uncontrollable. Burning waste creates significant quantities of smoke (see pictures) and other fire hazards, especially when several fires lit simultaneously. Waste should not be burned anywhere, normally waste should be covered with soil once disposed. The MuYaung Village and Sports Academy, which are close to the Dump Site area, are complaining about the smoke and smells of the open fires from the dumpsite.

3.3.2 SOLID WASTE PROJECTIONS & STRATEGY

The graph in **Figure 3-23** shows the quantities (in tonnes per day) in Mawlamyine with separation of recyclables and biodegradable waste from the total waste generated for the next 25 years.