Initial Environmental Examination

April 2015

Myanmar: Mandalay Urban Services Improvement Project

Prepared by Mandalay City Development Committee for the Asian Development Bank.

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ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
BOD5	Biochemical oxygen Demand (5 days)
CC	Climate Change
DES	Director Environment & Social (MCDC PMU)
DOC	Department of Construction
EA	Executing Agency
EHSC	Environment, Health & Safety Coordinator (Contractor)
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GDP	Gross Domestic Product
GIS	Geographic Information System
IA	Implementing Agency
IEE	Initial Environmental Examination
IPCC	Inter -Governmental Panel on Climate Change
MCDC	Mandalay City Development Committee
MOECAF	Ministry of Environment Conservation and Forest
PIC	Project Implementation Consultant
PMU	Project Management Unit
PPTA	Project Preparation technical Assistance
RAP	Resettlement Action Plan
SE	Supervision Engineer
SEA	Strategic Environmental Assessment
UN	United Nations
WB	World Bank

0. EXECUTIVE SUMMARY

The first phase of the Mandalay Urban Services Improvement Project (MUSIP 1) will significantly improve the environmental conditions in Mandalay City and the quality of life of its population through the following results:

- Improvements in water supply: increasing the access of the population of Mandalay to improved water supply services. The project aims to increase the population receiving 24/7 water supplies from an estimated 105,000 to over 670,000 during the project while achieving significant efficiencies gains in water supply operations and ensuring financial sustainability. This will be achieved by a variety of measures, notably: Non-Revenue Water Management and associated system rehabilitation (reducing NRW from an estimated 52% to 35%); Rehabilitation and extension of the existing water supply production facilities (increasing production from a little under 100,000 m3/day to 170,000 m3/day); Reinforcement and extension of the existing water supply distribution system.
- Major improvement of wastewater collection and treatment, through the implementation of interceptors along major creek and canals. Immediate improvement of surface drainage water with major beneficial impacts on surface water quality of receiving water bodies, on public health for population living along drainage systems and on the general quality of life of the population. Domestic pollution to water bodies will be reduced by 12 tons per day thanks to the first development stage of a wastewater treatment plant located at the south of the city and providing enhanced primary treatment. Pollution load to the environment will also be reduced by the improvement of night soil collection and treatment.
- Reduction in flood frequency and damages through a variety of measures. The cleaning or dredging of major creek and canals (Thingaza creek and Shwe Ta Chaung and Mingalar canals) associated with the rehabilitation of pumping station and the development of a water level monitoring system for the canals and lakes will improve general drainage conditions in the city and reduce seasonal flooding particularly around Thingaza creek and Taung Tha Man Lake. Cleaning of the creek and canals will also beneficially impact the quality of the urban environment and the quality of life of its residents. These will be associated with increased pumping capacities in key locations.
- Improved solid waste collection: Solid waste is another major issue in Mandalay city, with a significant part of the domestic waste produced finding its way into the drainage system. Due to budget constraints, the anticipated improvement of collection through new vehicles and the creation of 12 collection points with the closure of existing points (over 70) will most probably be considered under phase 2 of the Project (MUSIP2). When implemented, it will strongly improve the general urban landscape, the cleanliness of the streets and drains, the efficiency of the drainage and the general quality of life of the residents. Only a pilot collection point is anticipated under MUSIP1.
- Following the principles of Green Cities, MUSIP 1 will support innovation: a co-generation project will be developed with the WWTP in order to digest the sludge from the WWTP and use the gas for electricity production. It is anticipated the WWTP to be carbon neutral and at least 50% energy self-sufficient. Sludge from the digester will be stabilized for potential re-use in agriculture and/or material reuse with cement works (dependent on sludge quality). Also, part of the drainage canal improvement is proposed as SUDS (Sustainable Urban Drainage System) pilot scheme in new development areas, a pilot project which will demonstrate the interest of the system and provide several hectares of green urban space in a densely populated area.

A screening carried out during the Interim phase of the Project confirmed that impacts raised by the project were mainly related to land acquisition while impacts on natural environment were all very limited, mainly related to the construction phase and easily controllable by appropriate and conventional mitigation measures. Consequently, the proposed categorisation of the Project was B, involving the preparation of the present IEE.

Aside from the several and undisputable beneficial impacts of the MUSIP, some limited negative impacts are anticipated:

- Land acquisition outside the main urban area of Mandalay city for the WWTP and minor temporary displacement of buildings in the densest areas along the drainage canals where interceptors are going to be laid. Inside the main city area, the design of MUSIP has already integrated constraints and most of the facilities are implemented either in MCDC property land or in public zones. This includes notably the works associated with WTPN°8 wherein the rehabilitation and extension of the plant will take place within land wholly owned by MCDC. Interceptors for Thingaza have occasionally been implemented along streets to avoid any monastery or temple but are mainly located within the beds of the creek and canals. Similarly there will be minor temporary impacts associated with the laying of water supply pipelines and network extensions. Temporary resettlement will mainly be required very locally for access to the construction sites. These aspects are detailed in the Resettlement Plan prepared simultaneously to this IEE.

- Dredging of canals for hydraulic improvement will result in the production of an estimated 100,000 m^3 of sediment. It is considered the reuse of this sediment as fill for the reclamation of the presently floodable land to be used for the development of the WWTP. The site will accommodate more than this expected production. The sediment, dominantly sand type, shows limited contamination by heavy metals and can be used for fill purpose. Dredging of Thingaza creek, which sediment consist mainly of silt, inappropriate as fill, is not considered within MUSIP1. Only the cleaning of the creek by removal of the solid waste accumulated on its shore will be carried out. The waste will be disposed to the existing solid waste disposal site.

- The Water Treatment Plant extensions will involve the production of large quantities of sludge; as part of the feasibility study alternative disposal solutions were investigated. It was concluded to discharge water treatment sludge to the wastewater network and to thereafter treat these discharges in the proposed wastewater treatment plant.

- The WWTP will discharge treated effluent in the Ayeyarwaddy river. The discharge point will represent a concentration point for pollution load, as the effluent is expected to satisfy in its first stage the target of 60 mg BOD/l. Due to the high discharge of the river and the mainly organic pollution load of the effluent, major impacts are not anticipated as no residence or water usage nearby is observed. However, a long term monitoring of the water quality in the area is proposed in the EMP to ensure the impact remains insignificant.

- Most of the anticipated potential environmental 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 loss of access, temporary disruptions in operation of community facilities, noise, engine exhaust gas and dust release may temporarily disturb the nearby communities. However, recommendations formulated in the EMP combined with a solid environmental contractual framework and an effective inspection of construction sites will definitely reduce these risks to an acceptable level.

The IEE also identifies the extremely low level of consideration for occupational health and safety (OHS) in Myanmar and particularly in Mandalay nowadays. Construction sites generally ignore safety signals, personal or collective protections for workers, safety belts, EHS awareness training etc. This situation is not compatible with the implementation of a project supported by international lenders as ADB and AFD. For that reason, the EMP emphasizes the need for EHS capacity building for MCDC-PMO, the need for very detailed EHS specifications for the tender documents, the need for a strict EHS monitoring of construction activities.

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1. INTRODUCTION

1.1. PROJECT RATIONALE

Mandalay is the second city and capital of the central dry region and is considered by many to be the capital of Myanmar culture and the Buddhist religion. It is the second largest city in Myanmar with a population of approximately 1.25 million and is on the crossroads of routes linking Laos, Cambodia, Thailand and Vietnam to India and is also on the link between China and the Andaman Sea. Growth is very fast in Mandalay at just under 3 percent per annum since 1990. Mandalay District is a district of the Mandalay Division in central Myanmar. Though the district used to consist of two cities, Mandalay and Amarapura, today, with the urban sprawl of Mandalay capturing Amarapura and Patheingyi, the district and the city of Mandalay have become effectively one and the same. However, according to MCDC documents they are currently responsible for providing urban services in 6 of the 7 townships excluding Patheingyi

It is within this context that the Union of Mandalay together with the ADB has placed the Mandalay Urban Services Improvement Project within the current lending programme. The proposed project is in line with the ADB's medium-term goal in Myanmar as outlined in the interim country partnership strategy to promote sustainable and inclusive economic growth in support of the government's objectives of poverty reduction and national reconciliation. As outlined in the Terms of References: The impact of the project will be the improved urban environment and public health in Mandalay. The outcome will be improved access to sustainable urban services. Climate change resilient designs will be introduced in infrastructure construction and upgrading. The indicative outputs will include (i) water supply system improvements, (ii) wastewater management and urban drainage, (and (iii) institutional capacity strengthening and public awareness raising.

The indicative project cost is estimated at $130 million of which ADB proposes to provide a loan of $60.00 million from the Asian Development Fund (ADF); other co-financing source (the AFD) and the government will provide €40 million and $13.00 million respectively. Capacity building will be financed by grant funds managed by both ADB and AFD currently estimated at $4 million and €6 million respectively.

The expected impact of the project will be the improved urban environment and public health in Mandalay. The outcome will be improved access to sustainable urban services. The outputs will include (i) water supply system improvements, (ii) drainage and flood protection, (iii) wastewater management, (iv) solid waste management and (iv) institutional capacity strengthening and public awareness raising. Climate change resilient designs will be introduced in infrastructure construction and upgrading.

1.2. PROJECT CATEGORIZATION

A 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 presented in the Interim Report (September 2014) 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 most 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 will be discussed in the 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. Only the WWTP site may involve some agricultural land acquisition. The main sewer to the WWTP may locally require the removal of some structures (pig shelter, low income bamboo houses), but still to be confirmed as design adjustments may totally avoid such disturbances.
- Dredging of Thingaza creek and canals could raise a potential risk of water pollution, should the sediment to handle be highly polluted and the way to dispose it inappropriate. However, such risk can be easily avoided by appropriate management and disposal measures.

Applicable ADB REA Checklists are presented in Appendix 2.

Considering (i) the major beneficial impacts on the urban environment of Mandalay, (ii) the anticipated limited environmental impacts from the Project components and (iii) the limited potential impacts on land acquisition and resettlement, it is recommended that the classification of the present Project as an ADB category B be confirmed. Thus the preparation of an IEE should suffice.

However, this IEE is complemented (i) by a full RP to address in details land acquisition and resettlement issues and (ii) by a full EMP focusing particularly on the construction period, recognizing that most of the implementation activities are located within sensitive urbanized areas.

Considering the Burmese environmental regulations, the study level will also comply with the regulatory requirement.

1.3. PURPOSE OF EIA/IEE

This report gives an account of the initial environmental examination (IEE) of the proposed Mandalay Urban Services Improvement Project. The IEE was conducted as part of the Project preparation to primarily:

(i) To ensure the environmental soundness and sustainability of the project;

(ii) To support the integration of environmental as well as climate change and natural hazards considerations into the project decision-making process and promote the integration of Green Cities principles;

(iii) To identify early potential impacts and risks arising from the proposed Project components on the physical, biological, socio-economic and cultural environment;

(iv) To identify measures to avoid, mitigate, and compensate for adverse impacts, and enhance positive impacts, and

(v) To lead to overall environment improvements in the project area of influence.

The present IEE 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 prepared by the Burmese Government under the 2012 Environmental Conservation Law.

1.4. 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 Chapters in this report:

- The executive summary;
- The introduction with the project rationale (Chapter 1)
- The applicable institutional and regulatory framework (Chapter 2);
- The description of the Project proposed components (Chapter 3);

- The baseline situation (Chapter 4);
- The impact analysis (Chapter 5);
- The alternative development options (Chapter 6);
- The public consultation activities (Chapter 7);
- The grievance and redress mechanism proposed (Chapter 8)
- The environmental and social management plan (Chapter 9)
- Conclusions & Recommendations (Chapter 10)
- Appendices

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2. POLICY, INSTITUTIONAL & LEGAL FRAMEWORK

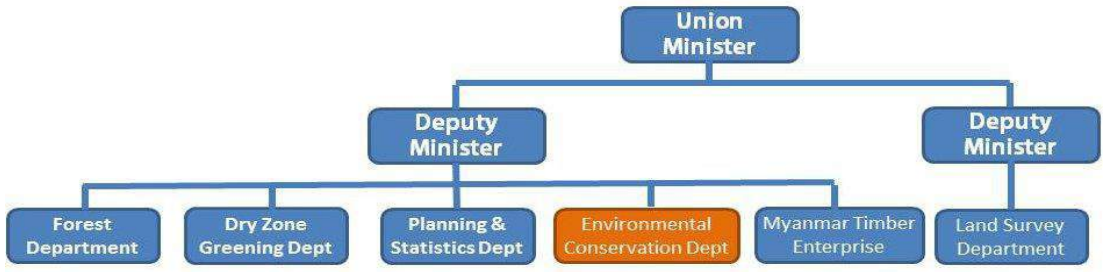
2.1. MYANMAR ENVIRONMENTAL LAWS, REGULATIONS & STANDARDS

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), the focal and coordinating agency for the overall environmental management in Myanmar. The organization is presented in the following Figure [1] .

Figure [1] ORGANIZATION STRUCTURE OF MOECAF



Source: MOECAF

The Environmental Conservation Department, 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.

ECD has presently 156 officers and 247 staffs under the supervision of the Director General at the Head Office in Nay Pyi Taw and in 14 states of the Union. One office is located in Mandalay.

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. There is at present one NECC but the Government has the objective, since 2013, to establish one such committee per Province of the Union. Different ministries involved in dealing with environmental issues also have their own policies, capacities, processes, legislations, and budgets for the environmental issues they have to address. Capacity and institution building in the short and medium term is being carried out by each ministry separately on their own budgets.

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 the following Table [1].

Table [1] APPLICABLE ENVIRONMENTAL LAWS & REGULATIONS IN MYANMAR

LAWS AND REGULATIONS	YEAR	PURPOSE/DESCRIPTION
Environmental Conservation Law (ECL)	2012	To implement National Environmental Policy; to set up basic principles and guidelines for sustainable development and systematic integration of environmental conservation; to conserve the clean environment, natural and cultural heritage for present and future generation, to prevent degradation of natural resources and for sustainable use, to build up public understanding on environmental awareness.
Myanmar Environmental Conservation Rules	2014	The Rules reinforce the obligation for project developers to submit an EIA or an IEE. It aims to establish and adopt the necessary programmes for the conservation and enhancement of environment, protection, control and reduction of pollution in environment, and conservation.
Myanmar Investment Law	2012	This Law provides elements on foreign investments in Myanmar. Art. 17: The duties of the investor are as follow: (f) making no alteration of topography or elevation of the land obviously on which he is entitled to lease or use without the approval of the Commission; (h) carrying out not to cause environmental pollution or damage in accord with existing laws in respect of investment business;
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.

LAWS AND REGULATIONS	YEAR	PURPOSE/DESCRIPTION
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	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. This law strictly prohibits disposal of engine oil, chemical, poisonous material and other materials which may cause environmental damage, or dispose of explosives from the bank or from a vessel.
Conservation of Water Resources and Rivers Procedure	2012	Chapter 3 on Prevention of water pollution and Environmental Conservation in its Para (7 C) mentions the wastewater produced from any factories and industries nearby the rivers, channels and ports should be treated before discharge. Monitoring is required. Para (8E) states that everyone must take preventive measures in accordance with international standards in order to prevent the leakage/discharge of waste water and sewage into the rivers. Para (9) states that cost for pollution abatement is supported by the polluter
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 and Conservation of Natural Areas Law	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. 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.
Environmental Conservation and Cleaning Rules & Regulations, Mandalay City Development Council	2009	It provides information on the policy, regulations on the solid waste management and drainage facilities management.
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)	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 Water Policy	Draft 1, Aug. 2013	Provide general policy principles on water framework directive, uses of water, adaptation to climate change, enhancement of water availability, demand side management and efficiency of use, pricing principles, conservation of river corridors and water bodies, management of flood and drought, water supply and sanitation, institutional arrangements, transboundary rivers, research and capacity development, implementation of national water policy.

While there is no specific pollution law enacted, the Environmental Conservation Law 2012 has significant provisions that relate to both pollution and its control, referring to pollutants, waste and noise pollution.

2.1.3. APPLICABLE ENVIRONMENTAL STANDARDS

2.1.3.1. PRESENT SITUATION

Until very recently, there were no country wide national standards for wastewater effluent discharges in Myanmar. For this reason, and following the recommendations of the 2012 Environmental Conservation Law, several Ministries or Agencies proposed environmental emission standards to be used for the projects developed under their respective authority, as summarized in the following table. There is no actual consistency between all these standards as they apply to various sources of pollution. These existing standard tables are presented in Appendix 5.

Table [2] DRAFT STANDARDS PROPOSED BY MINISTRIES

MINISTRY	ENVIRONMENTAL QUALITY STANDARDS
Ministry of Health	Air quality, noise & vibration
Ministry of Electrical Power	Air pollutants, noise & vibration (from coal power plants), air quality standards, wastewater for general industries
Ministry of Industry	Ambient air quality, wastewater quality
Ministry of Mines	Surface water quality, ground water quality, air quality, dust, wastewater
MCDC	Drinking Water Quality (based on WHO standards)
YCDC	Drinking water quality, liquid effluents quality

Several key wastewater quality standards have already been proposed by Yangon City Development Committee, the Ministry of Industry and the Ministry of Electrical Power and are presented in the following Table [3].

Very recently (16 December 2014) MOECAF released draft Myanmar Environmental (Emission) Quality Guidelines. The draft guidelines cover both water and atmosphere emissions and cover a wide range of production industries. A large part of the proposed standards come from the Environmental, Health and Safety Guidelines of the IFC (2007). Concerning treated sanitary discharges (Section 1.2), proposed standards refer to IFC EHS guidelines. Key parameters for wastewater are also presented in following Table [3].

Table [3] KEY PARAMETERS FOR WASTEWATER QUALITY STANDARDS

POLLUTANTS	UNIT	YCDC	MIN. OF INDUSTRY	MIN. ELECTRICAL POWER	MOECAF (16/12/14)
pH	pH	6-9	5-9	6-9	6-9
Total Solids	ppm	<2000	-	-	-
Total Suspended Solids	ppm	<500	<30	<50	<50
BOD_5	ppm	20-60	20-60	<50	<30
COD	ppm	<200	-	<250	<125
Oil & Grease	ppm	-	<5	<10	<10
Coliforms	MPN/100ml	-	-	<400	<400(1)

(1) Not applicable to centralized, municipal wastewater treatment plant

2.1.3.2. RECOMMENDED STRATEGY FOR MUSIP

Given the absence of an enacted over-arching national standard, it is proposed to adopt a MCDC provisional standard for wastewater effluent standards. This could conveniently adopt similar standards as those of YCDC but taking into account notions of the receiving water's assimilative capacity and functional use (as considered in the existing system prevailing in China) and economic considerations (as considered in the EU Water Framework Directive). Indeed, the standard proposed by MOECAF in its draft form is extremely strict considering the prevailing situation of wastewater management in Myanmar and looks hardly applicable except investing in the most advanced treatment systems available in the world. In this respect, YCDC proposed standards are far more realistic and reflect an achievable target for simple treatment technologies.

In this respect, the FSR for the Wastewater component of MUSIP1 proposes to adopt a low wastewater discharge standard in the first phase (akin to the Class 3 level of the Chinese standard) with gradual improvements taking place in order to protect local water resources (mainly agricultural water uses) and potential future water resources in the mixing zone of the Ayeyarwaddy downstream of Mandalay (industrial, agricultural and potentially domestic at Myotha). In the long term it would be desirable to encourage the reuse of wastewater; in this context more stringent wastewater discharge standards will be required limiting BOD in the range 10 to 20 mg/l dependent on the reuse option.

On the basis of the FSR analysis of the issue, provisional effluent discharge criteria are proposed for consideration as part of MUSIP1. It is proposed to refer to YCDC standards in the short term, which criteria are compatible with the first stage treatment of the WWTP and then to refer to the National Environmental Quality Standards when implementing the second stage of treatment of the WWTP. The short and longer term criteria are presented below in Table [4]. Dependent on the particular future treated effluent re-use these standards may require adaptation.

Table [4] PROPOSED MCDC WASTEWATER DISCHARGE STANDARDS FOR MUSIP (MG/L)

NO.	PRIMARY CONTROLLING POLLUTANTS	UNIT	SHORT TERM (YCDC CRITERIA)	LONG TERM (NATIONAL STANDARDS)
1	Chemical Oxygen Demand (COD)	mg/l	**125**[(1)]	**125**
2	Biochemical Oxygen Demand (BOD5)	mg/l	**60**	**30**
3	Total Suspended Solid (TSS)	mg/l	**50**	**50**
4	Oil & Grease	mg/l	**20**	**10**
5	Total Nitrogen (as N)	mg/l	N/A	10
6	Ammonia Nitrogen (as N)	mg/l	N/A	8
7	Total phosphorus (as P)	mg/l	5	2
8	PH	pH unit	6 – 9	6 – 9
9	Total coliform	MPN/100 ml	N/A	N/A

(1) Initial criteria from YCDC is more stringent (120 mg/l) than the draft national criteria (125 mg/l). The national criteria may be considered directly on the short term.

The proposed short term criteria could be established by MCDC as a MCDC Regulation. It is suggested to start the process for approval not later than mid-2015, to ensure the MCDC Regulation promulgated by the end of 2015.

2.1.4. INTERNATIONAL TREATIES

Myanmar has also made commitments to the following international agreements and protocols on environmental, social, safety and occupational issues as shown in the following table.

Table [5] INTERNATIONAL AGREEMENTS ON ENVIRONMENT, SOCIAL AND SAFETY

INTERNATIONAL AGREEMENT	DATE OF SIGNATURE	DATE OF RATIFICATION	DATE OF MEMBERSHIP	CABINET APPROVAL
United Nations Framework Convention on Climate Change, New York, 1992 (UNFCCC)	11/06/1992	25/11/1994 (Ratification)	-	41/94 (09/11/1994)
Convention on Biological Diversity, Rio de Janeiro, 1992	11/06/1992	25/11/1994 (Ratification)	-	41/94 (09/11/1994)
International Tropical Timber Agreement (ITTA), Geneva, 1994	06/07/1995	31/1/1996 (Ratification)	-	-
Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985	-	24/11/1993 (Ratification)	22/2/1994	46/93
Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1987	-	24/11/1993 (Ratification)	22/2/1994	46/93

INTERNATIONAL AGREEMENT	DATE OF SIGNATURE	DATE OF RATIFICATION	DATE OF MEMBERSHIP	CABINET APPROVAL
London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London, 1990	-	24/11/1993 (Ratification)	22/2/1994	46/93
The Convention for the Protection of the World Culture and Natural Heritage, Paris, 1972	-	29/4/1994 (Acceptance)	-	6/94
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)
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)
ASEAN Agreement on the Conservation of Nature and Nature Resources, Kuala Lumpur, 1985	16/10/1997	-	-	-
Cartagena Protocol on Biosafety, Cartagena, 2000	11/5/2001	-	-	13/2001 (22-03-2001)
ASEAN Agreement on Transboundary Haze Pollution	10/06/2002	13/3/2003 (Ratification)	-	7/2003 (27-02-2003)
Kyoto Protocol to the Convention on Climate Change, Kyoto, 1997	-	13/8/2003(Accession)	-	26/2003 (16-07-2003)
Stockholm Convention on Persistent Organic Pollutants (POPs), 2001	-	18-4-2004 (Accession)	18/7/2004	14/2004 (01-04-2004)

2.1.5. MYANMAR EIA REQUIREMENTS AND FRAMEWORK

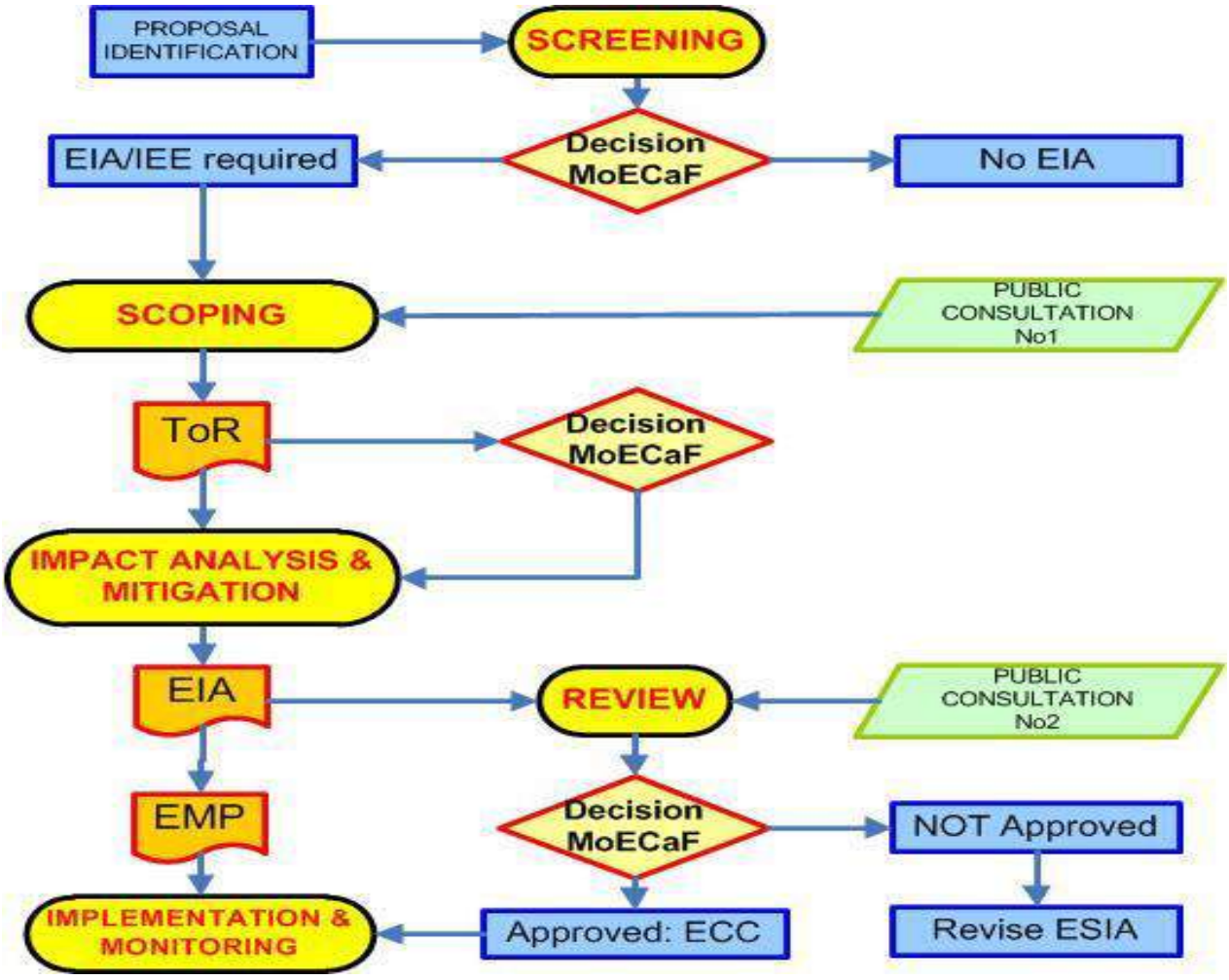
In accordance with the recommendations of the 2012 Environmental Conservation Law, the ECD of MOECAF has prepared a procedure for the Environmental Assessment (EA) of development projects. This procedure is still in a draft form (version 42 latest) but is already virtually enforced by MOECAF. From the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

MOECAF should be solicited 3 times during the process:

- at project proposal stage (screening), to decide if EIA or IEE is required or not;
- before the start of the EIA study to approve (1) the Terms of Reference for the EIA and (2) the qualification of the Consultant proposed for carrying out the EIA;
- at submission of the EIA draft report for comments and then issuance of the ECC.

Two public consultations are also considered. This process is quite comparable with ADB requirements regarding the EA main stages and is illustrated in the following Figure [2] .

Figure [2] DRAFT PROCESS FOR ENVIRONMENTAL ASSESSMENT IN MYANMAR



Source: PPTA Consultant
Note: ECC=Environmental Compliance Certificate

In terms of EIA/IEE report content, the requirement in Myanmar covers both environmental and social within the same document while ADB SPS requires separate documents for environment and social: EIA/IEE for environmental impacts and RAP (and any other related document) for the social aspects (baseline, resettlement, livelihood restoration). EIA report for Myanmar will be prepared by MCDC (the project proponent) who will rely on the IEE and RP documents prepared under the present PPTA.

The following Table [6] introduces the EA steps required by Myanmar in relation to those required by ADB Safeguard Policy Statement (SPS) 2009.

Table [6] CORRELATION BETWEEN ADB AND MOECAF REQUIREMENTS

STEPS IN MYANMAR EA PROCEDURE	LINKS WITH ADB PPTA EIA/IEE	SCHEDULE
Submission of Project proposal	Project proposal to be submitted to MOECAF by the Proponent (MCDC) must be based on the final list of project components approved by MCDC following PPTA Interim report and workshop	MOECAF is required to, within 15 days of receiving a project proposal, determine the type of environmental assessment (EIA, IEE or none) required
Screening	Screening will be based on the environmental screening presented by the PPTA Consultant in the Interim Report.	

STEPS IN MYANMAR EA PROCEDURE	LINKS WITH ADB PPTA EIA/IEE	SCHEDULE
Preparation of EIA Scoping and ToR	ToR to partly rely on the ADB ToR related to the Environmental and Social tasks of the PPTA, and be complemented as necessary by any issue identified during the public consultation activities. Project proponent must appoint a consultant registered/qualified to prepare scoping and ToR.	MOECAF is required to provide decision on firm's qualification within **7 days**, and to provide approval of scoping and EIA ToR within **15 days** upon submission of documents by proponent
Preparation of EIA report	Preparation of the EIA/IEE report will be based on the EIA/IEE and RP reports prepared by the PPTA Consultant.	Report preparation to start when PPTA IEE and RP are submitted to and approved by ADB. To be considered the 90 days required by MOECAF to provide its response.
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 MOECAF

In order to achieve the proposed project implementation plan, the timeline for securing the applicable MOECAF approval are as follows:

ACTIVITIES	2015				2016			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Detailed design								
Procurement of goods and services								
Permits and Clearances								
Scoping and Approval of TOR (with MOECAF)								
EIA Preparation								
MOECAF approval								

2.2. ADB ENVIRONMENTAL SAFEGUARDS POLICY

In 2005, the Asian Development Bank (ADB) initiated a review process of its three safeguard policies on the environment, involuntary resettlement and indigenous peoples. The 2009 Safeguard Policy Statement 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.

In July 2009, the ADB approved its new Safeguard Policy Statement (SPS), which became effective in January 2010. The new Safeguard Policy Statement replaces 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 Safeguard Policy Statement 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 ongoing 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 examination.

✓ 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 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 requirements are semi-annual reports during construction for Category B projects, and quarterly monitoring reports during construction for Category A reports. For projects with likely ongoing impacts during operation, annual monitoring is 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).

2.2.3. ADAPTATION TO FUNDING OPTION

In recent years, the ADB has increased its use of different forms of finance modalities, such as programme lending, sector lending and multi-tranche finance facilities. The common feature of these lending modalities is that they consist of upfront lending, usually in large amounts, and that the project details and subprojects are not always known at the time of Board approval. The Safeguard Policy Statement contains provisions for each of these types of lending:

- Program lending: For program loans, the borrower/client is required to evaluate any potential safeguard impacts in regard to the environment (also resettlement and/or Indigenous Peoples) and to identify appropriate mitigation measures. The borrower/client must prepare a matrix of potential impacts of each policy action, with the corresponding mitigation measures (SPS, Appendix 4, para. 2).
- Sector lending: For sector investments with any likely safeguard impacts, the borrower/client must agree on an environmental assessment and review framework (also resettlement framework and/or an Indigenous Peoples planning framework) before project approval is given by the ADB (Annexes 1 to 3 of Appendix 4 describe the components of these frameworks). One or more sample subprojects must be identified and appraised prior to approval of the sector project. For these subprojects, the borrower/client must prepare relevant documentation, including: environmental and social impact assessment reports, environmental management plans, resettlement plans and Indigenous Peoples plans. All the Policy's safeguard requirements apply to all subprojects and their components (SPS, Appendix 4, paras. 3 – 8).
- Multi-tranche finance facilities: For multi-tranche finance facility projects with any safeguard impacts, the same process applies as for sector projects (SPS, Appendix 4, paras 9–10). Multi-tranche finance facilities are loans which are disbursed in several tranches. At the time of Board approval, only the details of the first tranche are available, and subprojects of the multi-tranche finance facilities are often only identified later in the investment cycle.
- Emergency assistance loans: The Policy stipulates that in cases where preparation of safeguard documents, such as an EIA, resettlement plan and/or Indigenous Peoples plan, is deemed not possible before Board approval, frameworks, such as those required for sector or multi-tranche finance facility loans, must be prepared (SPS, Appendix 4, para. 11).
- Financial intermediaries: Where financial intermediary (FI) projects are likely to have safeguard impacts, the financial intermediary is required to "have in place or establish an appropriate environmental social management system (ESMS) to be maintained as part of

their overall management system to meet national laws and/or ADB's requirements for FI projects" (SPS, Appendix 4, para. 13). An ESMS must include the financial intermediary's: (i) environmental and social policies; (ii) screening, categorisation and review procedure; (iii) organisational structure and staffing, including skills and competencies in environmental and social areas; (iv) training requirements; and (v) monitoring and reporting processes (SPS, para. 66). Where subprojects financed by the financial intermediary are likely to have environmental or social impacts, the financial intermediary must ensure that the subprojects meet the ADB's relevant safeguard requirements including the submission of relevant safeguard documents (EIA, resettlement plan and Indigenous Peoples plan) according to the Policy requirements (SPS, Appendix 4, para. 15).

2.2.4. STRENGTHENING AND USE OF COUNTRY SAFEGUARD SYSTEMS

The Policy states that the ADB is committed to strengthening and using country safeguard systems (CSS). This means that the borrowing country's legal and institutional framework would be applied in regard to the social and environmental impacts of a project instead of the ADB's safeguard policy requirements.

The approach taken by the ADB to using country safeguard systems has two key components:

- First, in order to apply the country system, the ADB must conduct an "equivalency assessment" which evaluates the country's provisions against ADB safeguard requirements. Only if the country's provisions are found to be equivalent to that of the ADB can the country system be applied.
- Second, the borrowing country must be found to have the implementation practice, track record, and the capacity and commitment to implement the applicable regulations. This provision is referred to as the "acceptability assessment".

The Policy states that "to the extent possible, the proposal for the strengthening and use of the CSS, together with its justification, is presented in the country partnership strategy or in country partnership strategy progress reports" (SPS, Appendix 6, para. 14). In addition, the Policy commits the ADB to hold in-country consultations with stakeholders, including governments and NGOs, on the equivalency and acceptability assessments. The final equivalency and acceptability assessments must be disclosed on the ADB's website upon completion (Appendix 6, para. 14).

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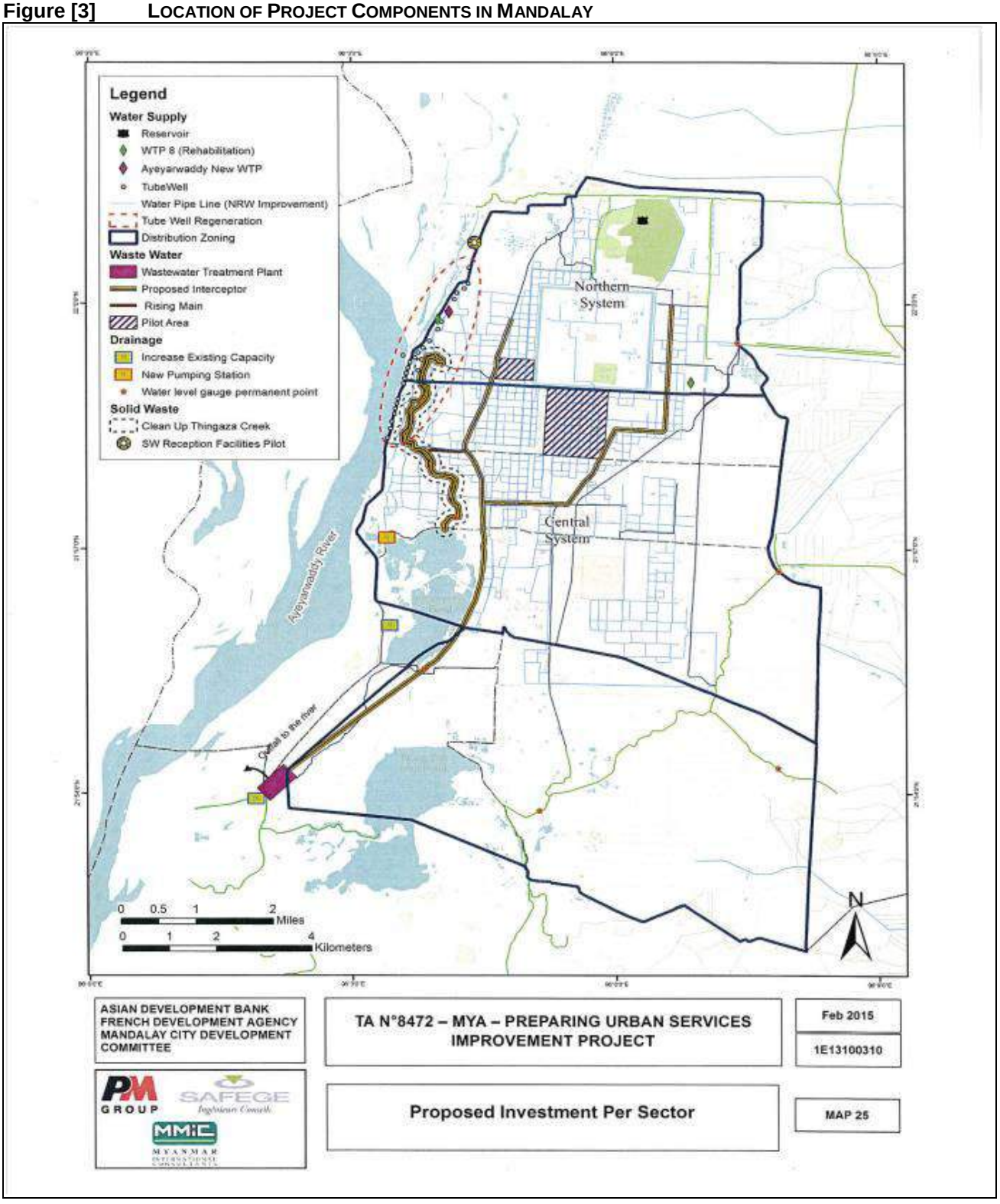
3. PROJECT DESCRIPTION

3.1. PROJECT COMPONENTS LOCATION

The Project is located in Mandalay City in Mandalay Region, Myanmar, a city which is home to approximately 1.25 million inhabitants. The Project covers 6 Townships within Mandalay City itself; project components are also found inside the township of Patheingyi currently outside of the jurisdiction of Mandalay City (see Figure [3] below). Mandalay is the second city of Myanmar and capital of the central dry region and is considered by many to be the capital of Myanmar culture and the Buddhist religion. It is the second largest city in Myanmar with a population of approximately 1.25 million and is on the crossroads of routes linking Laos, Cambodia, Thailand and Vietnam to India and is also on the link between China and the Andaman Sea. Growth is very fast in Mandalay at just under 3 percent per annum since 1990. Mandalay District is a district of the Mandalay Division in central Myanmar. Though the district used to consist of two cities, Mandalay and Amarapura, today, with the urban sprawl of Mandalay capturing Amarapura and Patheingyi, the district and the city of Mandalay have become effectively one and the same.

Figure [3] LOCATION OF PROJECT COMPONENTS IN MANDALAY



Source: PPTA Consultant, 2015

3.2. OUTPUT 1: IMPROVED WATER SUPPLY SYSTEMS

This component is aimed at increasing the access of the population of Mandalay to improved water supply services. The project aims to increase the households receiving 24/7 water supplies from an estimated 19,000 to approximately 124,000 during the project while achieving significant efficiencies gains in water supply operations and ensuring financial sustainability.

This will be achieved by a variety of measures, notably:

- Non-Revenue Water Management and associated system rehabilitation
- Rehabilitation and extension of the existing water supply production facilities
- Reinforcement and extension of the existing water supply distribution system

These measures will be associated with management and financial/policy measures notably involving the corporatisation of water supply services across Mandalay and the reform of tariffs to achieve financial cost recovery and demand management (both of MCDC's water supply service and also the use of groundwater).

There are a number of complementary investments underway to improve the water supply system of Mandalay, which can be viewed to complement the proposed project, most notably:

- The support of the AFD for the township of Amarapura providing extensions of the water supply system to approximately 11,200 residents via a water supply network linked to BPS7 of the existing MCDC system;
- The support of JICA for the township of Pyigidagun financed by a grant of approximately $20 million covering water supply facilities (3 tubewells, conveyance, storage and distribution systems with an average capacity of 8249m^3/day) covering 51919 inhabitants at the horizon 2020 (30% of the township's population)
- Again the support of JICA via a twinning partnership with the City of Kitakyushu which apart from capacity building support is providing for disinfection of existing resources across the city (production of chlorine at BPS1 and WTP N°4 with remaining sites receiving chlorine from these locations)
- And finally with support from Waterlinks (partially financed by the ADB), the Dutch water company Vitens & Evides is providing support to improve the operation of WTPN°8 potentially to raise it's capacity to approximately 1000 m3/hr by the end of 2015.

In addition, MRG and MCDC is considering a BOT arrangement for the provision of water intake, production and conveyance facilities for the southern townships of Pyigyidagun and Amarapura. This latter project is no longer linked to the current project as MUSIP no longer covers the two southern townships.

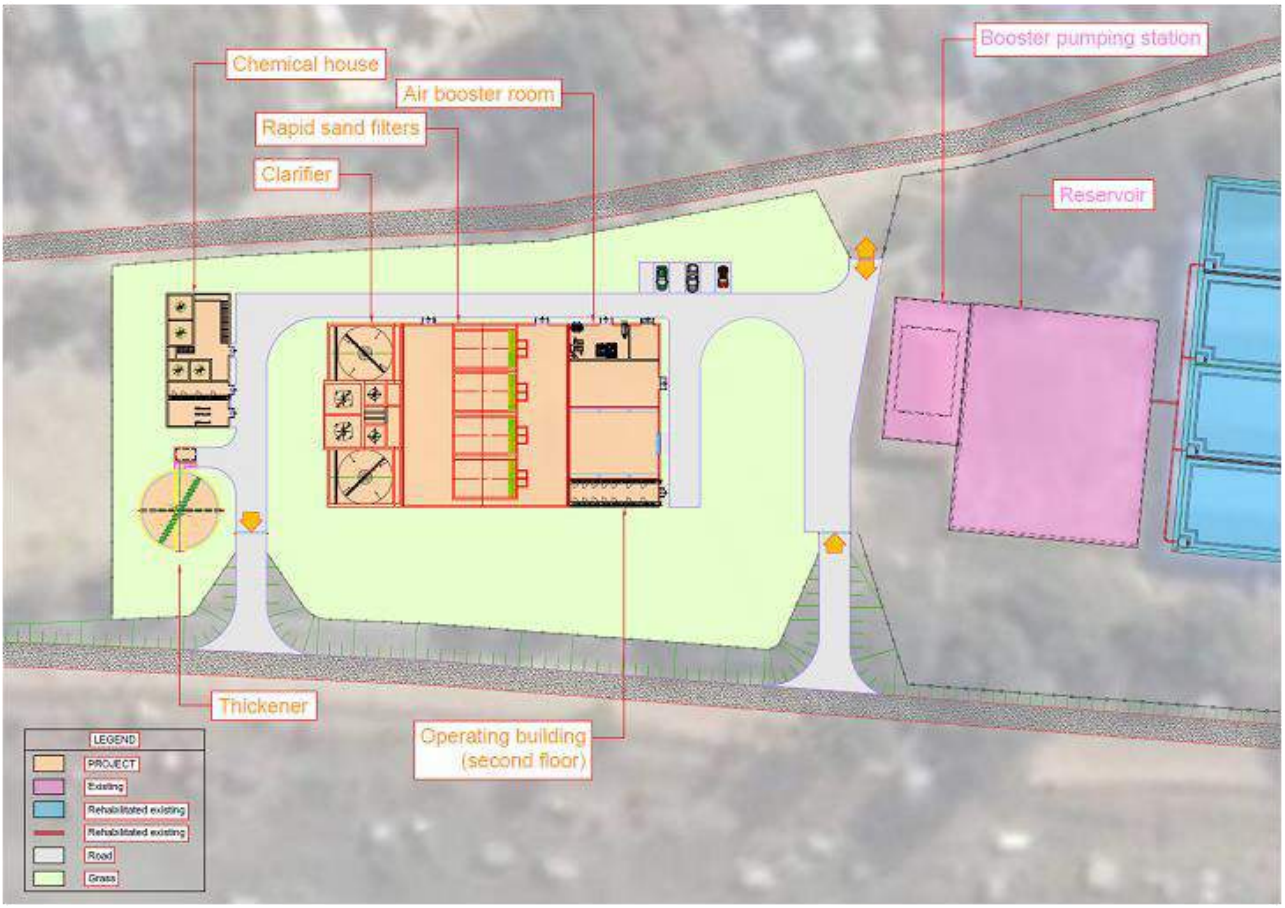
3.2.1. COMPONENT 1: REHABILITATION OF EXISTING PRODUCTION FACILITIES

This component will involve the rehabilitation of water treatment plant N°8 together with the improvements of the existing tubewellls recharged by the Ayerarwaddy. The objective will be to increase overall production capacity by approximately 30,000 m^3/day.

WTP N°8 treatment facilities will be extended by the inclusion of a pre-treatment facility upstream of the existing slow sand filters (currently under renovation). This will ensure that the plant will be able to treat effectively the higher turbidity observed on the surface water as well as some heavy metal concentrations noted in Section 4.7.1.

This rehabilitation will be complemented by an extension of the current plant by 38,000 m3/day by a new facility on MCDC owned land adjacent to the original plant. This new plant will use conventional treatment technology involving pre-treatment, coagulation, sedimentation, rapid sand filtration and disinfection.

Figure [4] SITE LAYOUT OF WTP N° 8 EXTENSION



3.2.2. COMPONENT 2: REHABILITATION OF NETWORKS AND REDIUCTION OF NON REVENUE WATER

This component is aimed at reducing NRW currently estimated at 52% (almost 52,000 m^3/day) to 25% (40,000 m^3/day) by improvements of both physical and commercial losses. It is estimated that approximately 11,000 m^3/day of physical/real losses will be reduced through replacement of water meters and connections (25%) and pipelines and valves (5%) in the distribution system.

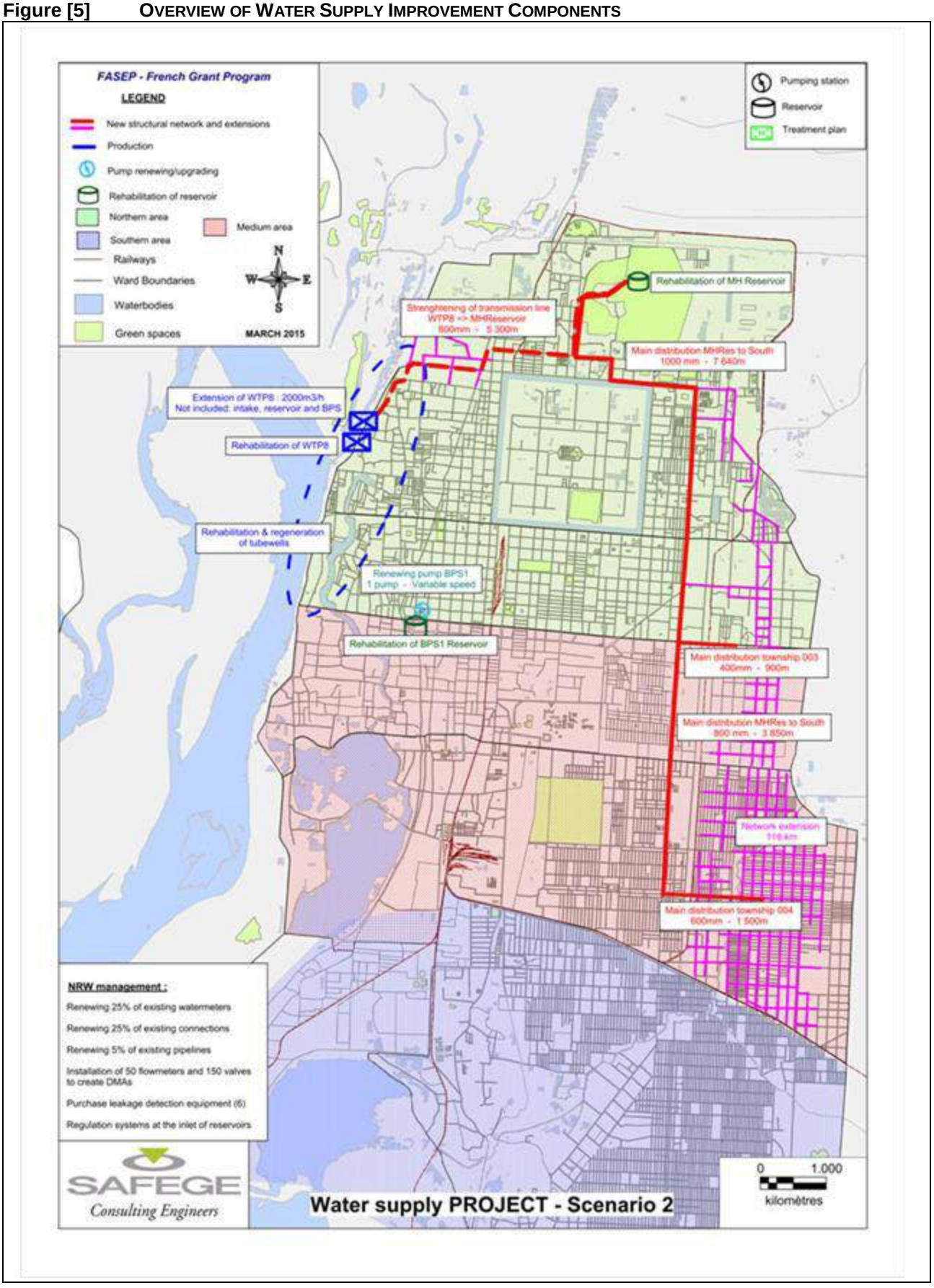
3.2.3. COMPONENT 3: EXTENSION & RESTRUCTURATION OF THE DISTRIBUTION NETWORK

Major extensions of the existing distribution system will be undertaken involving most notably

- Improve transmission & distribution pipes coverage and capacity with the construction of 19.1 km of main transmission lines and 116km of distribution systems
- Improved monitoring via the installation of watermeters and level meters
- Rehabilitation of existing reservoirs (BPS1 and Mandalay Hill reservoir) and pumps of BPS1

An overview of the proposed improvements is shown in the following Figure [5] .

Figure [5] OVERVIEW OF WATER SUPPLY IMPROVEMENT COMPONENTS



Source: FASEP Consultant, 2015

3.3. OUTPUT 2: IMPROVED WASTEWATER & DRAINAGE MANAGEMENT

3.3.1. COMPONENT 1: MANDALAY WASTEWATER & SEPTAGE MANAGEMENT

This component is aimed at reducing the amount of wastewater discharged directly to the environment together with overall improvements in wastewater management. The component will provide a centralized wastewater collection and treatment system serving a population 0.5 million by 2020 with improved septage management for the whole city

The proposed wastewater collection system comprises four subcomponents following broadly the diagram and the description below:

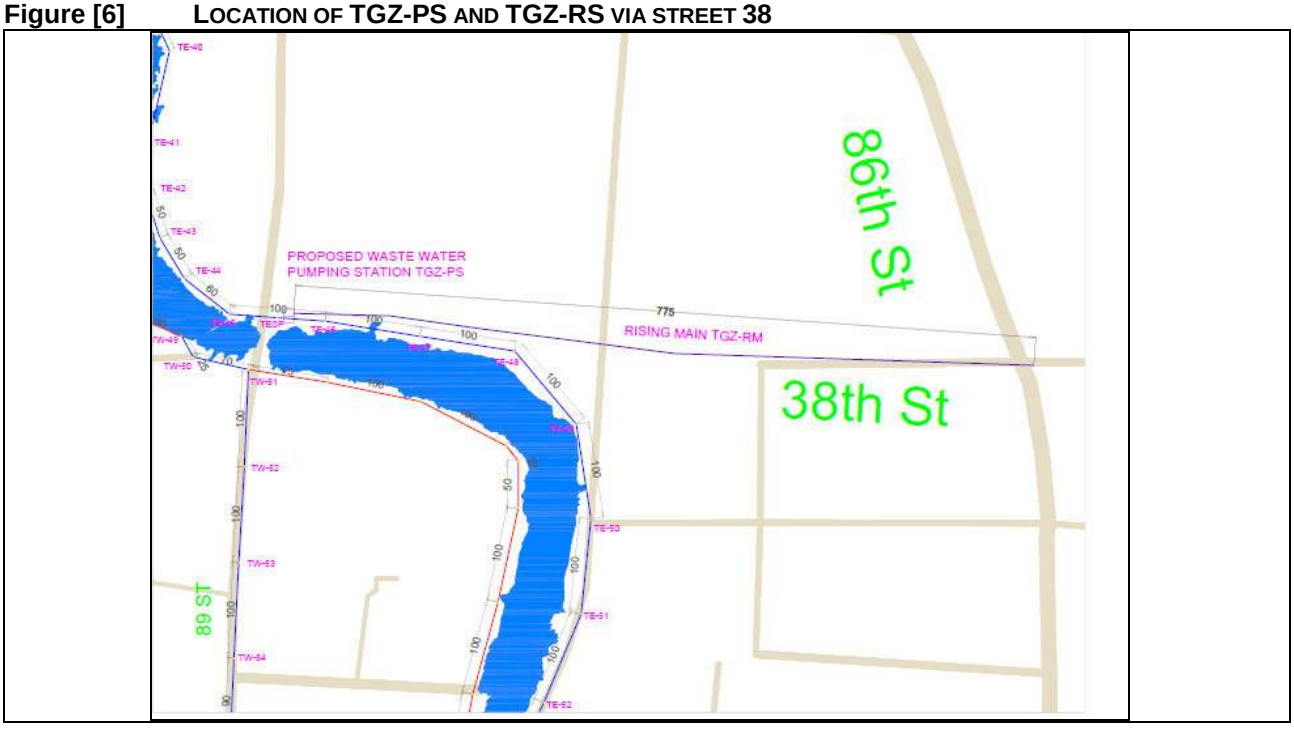
- Wastewater Interceptors and associated overflows;
- Enhanced septage removal;
- Wastewater and Septage Treatment and Disposal
- Improved wastewater connections.

3.3.1.1. WASTEWATER INTERCEPTORS

The alignment of all interceptors of Shwe Ta Chaung, Thingazar and Mingalar is indicated on Figure [7] below. The proposed system will comprised of 27.6 km of sewerage network and 31.5 km of interceptors constructed as concrete pipes (ranging from 400 to 1400mm) and box culvert within the existing Shwe Ta Chaung Canal. The system comprises one pumping station with a design capacity of 380 l/s and six combined sewer overflow structures (excluding those at the pump station TGZ and the wastewater treatment plant by-pass).

The proposed wet well/dry well Pump Station (TGZ-PS) will be located at the Thingazar-East side at Street 38. TGZ-PS will lift the waste water to a level that it can discharge via a Rising Main (RS) into a manhole in the Shwe Ta Chaung interceptor, see figure below.

Figure [6] LOCATION OF TGZ-PS AND TGZ-RS VIA STREET 38



Source: PPTA Consultant, 2014

To prevent flooding in the city during heavy rainfall, overflows (CSO) at several places are required. A CSO however has an impact on the environment during overflow; in total 6 CSOs are proposed.

Figure [7] OUTLINE OF MUSIP 1 WASTEWATER COMPONENT

Source: PPTA Consultant, 2015

3.3.1.2. ENHANCED SEPTAGE COLLECTION

Septage sludge is the sludge solids collected from septic tanks. As presented in the Interim Feasibility Study Report, the existing oxidation ponds East of Mandalay city near Yaytagun Hill Golf Course Land, will close soon.

It is expected that during the implementation of the sewerage systems in Mandalay city gradually more households will be connected to the new sewers, resulting in decreasing septage quantities. However this

will happen only after many years (phased approach of sewer implementation program), which means in the short term (till 2022 and after) septage sludge must still be collected and treated.

It is assumed that during the construction of Phase 1 Waste Water Treatment Plant Nangkat, an additional septage treatment capacity will be implemented.

At the moment the MCDC has 8 vacuum trucks (night soil trucks), of which 2 are in an obsolete condition (from 1978 and 1982). The total estimated amount of septage to be collected is 38,441 m^3/year.

With 22 working days per month, MCDC has to collect 145 m^3/working day. As one truck of 4.5 m3 tank content can dispose septage sludge 3 times per working day, a total of 10 vacuum trucks are required for daily collection of septic sludge.

Taken into account the two trucks to be replaced, additional 4 new vacuum trucks with capacity 6,000 liter tank should be purchased. It is recommended that other older trucks must be replaced soon after to keep regular emptying of septic tanks at standard level.

It is noted that with increasing secondary sewerage system, less septic tanks have to be emptied, with less use of vacuum trucks. However with the extension of the sewerage network, more maintenance is required for the sewer system with more vacuum trucks. Therefore, the input of the vacuum trucks will be gradually transformed from emptying septic tanks to maintenance of the sewerage systems.

3.3.1.3. WASTEWATER & SEPTAGE TREATMENT

On the basis of the above discussions the following The Sewage Treatment Plant will be constructed to treat the Phase 1 influent flows and loads and will be designed to accommodate an easy extension from Phase 1 to Phase 2 and 3. The civil work in Phase 1 will therefore be larger than if no extensions were planned. 12 Ha of land will be secured at the beginning of Phase 1 to allow for the future expansions. The following table summarises the proposed design criteria for the plant (excluding the impact of septic tank effluents)

The Feasibility Study recommends to implement an Enhanced Primary treatment plant at Location Nankat Pond first phase (2017 - 2021). Further enhancement and extension with secondary treatment will be implemented in the medium Term (2022 - 2030), and more extension with possibly Tertiary Treatment in the long Term (2031-2040).

The proposed technology for Mandalay City WWTP is to implement a Chemically Enhanced Primary treatment at this first stage. This means preliminary treatment with screening, sand and grit traps, scum and grease removal and primary treatment with sediment removal by chemical coagulants and gravity.

The secondary treatment with aeration and biological treatment will not be constructed during this phase. It is foreseen to enhance the processes at a later stage with secondary treatment.

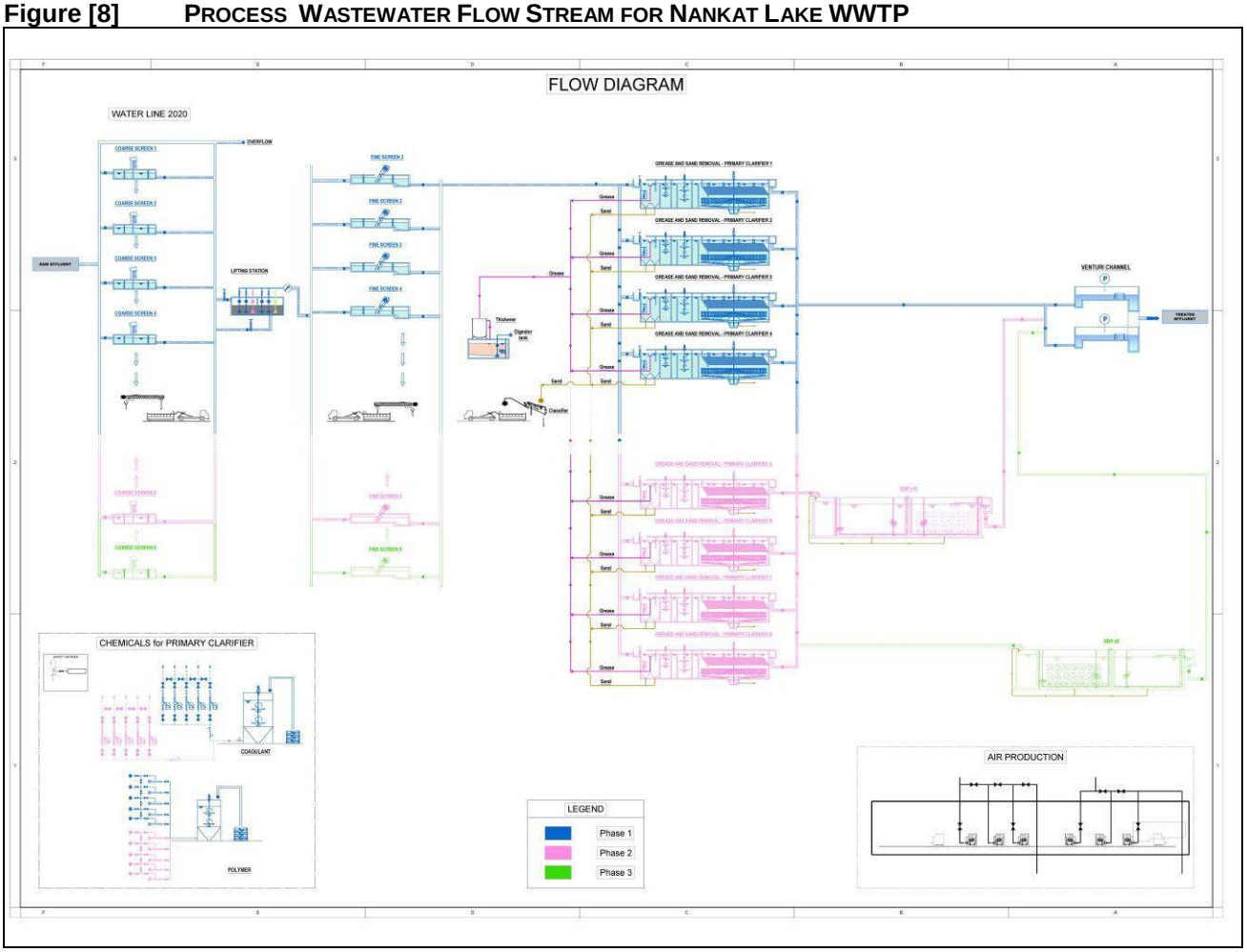
Table [7] PROPOSED DESIGN CRITERIA FOR NANKAD LAKE WWTP

CRITERIA	UNIT	PHASE 1	PHASE 2	PHASE 3
Construction Year		2018	2025	2035
Planning Horizon		2020	2030	2040
Population Equivalent		269 448	642 358	931 370
FLOW				
Design Flow	m3/d	75 000	100 000	150 000
Minimum Flow	m3/d	50 000	80 000	120 000
Maximum Flow	m3/hr	3 906	5 208	7 813
LOAD				
BOD5	mg/L	**138**	**237**	**280**
	kg/d	10 340	23 692	42 009
TSS	mg/L	**122**	**204**	**236**
	kg/d	9 157	20 398	35 454
NH3-N	mg/L	**28**	**37**	**43**
	kg/d	2 068	3 742	6 409

CRITERIA	UNIT	PHASE 1	PHASE 2	PHASE 3
TP	mg/L	**4**	**6**	**7**
	kg/d	306	632	1 092
EFFLUENT DISCHARGE REQUIREMENT				
BOD5	mg/L	60	30	20
	kg/d	5 840	20 692	39 009
	% removal	56%	87%	93%
TSS	mg/L	**60**	**30**	**20**
	kg/d	4 657	17 398	32 454
	% removal	51%	85%	92%
NH3-N	mg/L	**na**	**25**	**15**
	kg/d	na	1 242	4 159
	% removal	0%	33%	65%
TP	mg/L	**na**	**1**	**0.5**
	kg/d	na	532	1 017
	% removal	0%	84%	93%

Population Equivalent calculated on the basis of 45 g/cap/day BOD5

Figure [8] PROCESS WASTEWATER FLOW STREAM FOR NANKAT LAKE WWTP



Source: PPTA Consultant, 2015

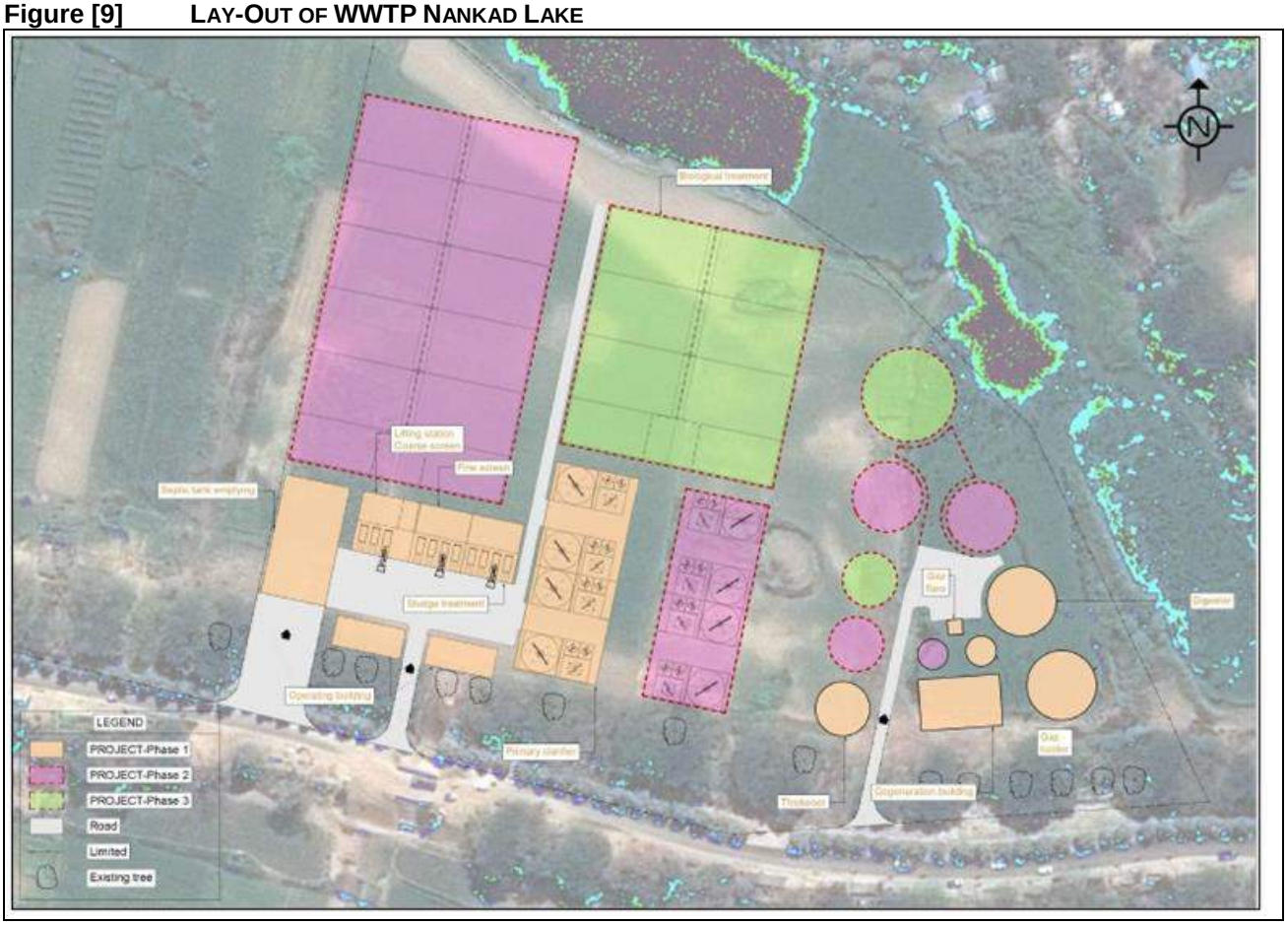
In this Phase 1, a simplified waste water treatment plant with a 75,000 m3/day capacity will be constructed including sludge treatment with sludge digesters, electricity cogeneration and sludge dewatering equipment. Also a small office with sanitation, small workshop, small laboratory and connection to the electricity network is included.

With respect to septage sludge treatment and disposal, two options were envisaged notably

- Co treatment in the wastewater stream
- Co treatment in the sludge stream

Given the potential impact on the treatment stream of high concentration sludge it was decided preferable to include in the sludge stream following pre-treatment. The following layout shows the integration of the proposed Phase 1 investments in the identified site together with the space reserved for future extensions (of the existing treatment lines and the future secondary treatment line).

Figure [9] LAY-OUT OF WWTP NANKAD LAKE



Source: PPTA Consultant, 2015

Municipal wastewater treatment plants produce large amount of sludge that should be treated further before reuse or final disposal. The following table provides a summary of the material and energy balance in Phase 1 and over the remaining phases (assuming the continuation of the enhanced primary treatment process)

Table [8] DESIGN CRITERIA FOR SLUDGE TREATMENT PROCESS

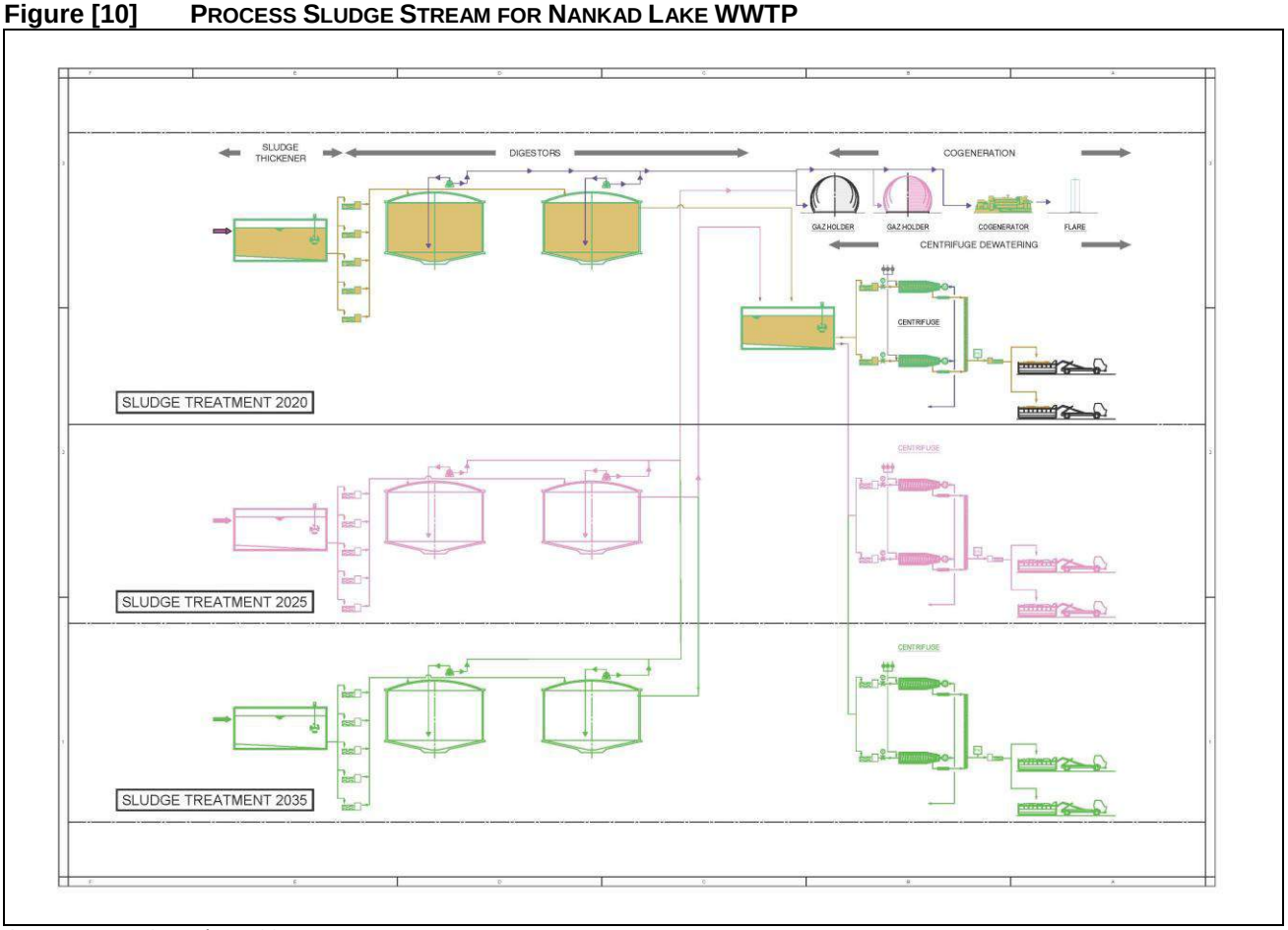
CRITERIA	UNIT	PHASE 1	PHASE 2	PHASE 3
Construction Year		2018	2025	2035

CRITERIA	UNIT	PHASE 1	PHASE 2	PHASE 3
Planning Horizon		2020	2030	2040
Total Dry Sludge				
Primary Sludge	TDS/day	11.9	31.6	37.2
Septic Sludge	TDS/day	2.0	2.3	2.3
Total Sludge	TDS/day	13.9	33.9	39.5
TVS				
Total Sludge	TDS/day	7.6	18.0	21.0
	%	55%	53%	53%
Digestion				
Before	TWS/day	267.7	637.5	777.7
	% dryness	5%	5%	5%
After	TWS/day	194.7	469.4	572.7
	% dryness	5%	5%	5%
Energy Available	kWh	855	1 970	2 403
Dewatering				
After	TWS/day	32.4	78.2	95.4
	% dryness	30%	30%	30%
	TDS/day	9.7	23.5	28.6

The biogas will need to be further processed before it can be used to generate of electricity. First the biogas is compressed and conditioned, then it goes into the power plant and further via a substation to the electricity network on-site or off-site. An emergency flare is required in case of oversupply of biogas or breakdown of the power plant. It is envisaged that at least 50% of the energy requirements of the WWTP will be provided from the energy available from the digestors. An overview of these steps is presented in the figure below.

The remaining sludge is post-treated: generally dewatered and further reused or final disposal. Sludge dewatering is done using Centrifuges/Decanters or Filter presses. The goal is to reduce the amount of sludge that needs to be disposed off. In the project Phase 1, two centrifuges are proposed to further dewatering of the sludge, see overall layout below

Figure [10] PROCESS SLUDGE STREAM FOR NANKAD LAKE WWTP



Source: PPTA Consultant, 2015

Normally the digested and dewatered sludge can be safely deployed as fertilizer. This remains to be confirmed via actual measurements of sludge quality; an appreciation of this can be gained from the sludge occurring in the main canals which is currently being analysed as part of the environmental assessment being undertaken by the PPTA Consultant. In fact, by returning it to the soil in this way, nutrient and organic matter cycles which occur naturally are completed.

Sludge disposal options are:

- Disposal of wet cake after liming;
- Agriculture as compost (mixed e.g. with straw);
- In cement kilns for burning;
- As cover material for daily cover of sanitary solid waste landfill.

Options 1) and 2) are considered to be the optimal solutions in this context; however this depends on the quality of the dewatered sludge. In Mandalay it is not expected that chemical compounds will be detected in the dried sludge.

For composting of sludge, solid content should be increased to at least 15 % so that it can be handled as a solid. Composting is an aerobic bacterial decomposition process. The optimum conditions for composting are a moisture content of about 50 %. Adding of sources of carbon such as dry wood sawdust, mixing with (rice)straw or wood chips, adjusts the moisture ratio, stabilises organic waste and produce humus (compost).

It is expected that regular removal of compost (dried sludge) will take place during most of the year. However, it is anticipated that during the monsoon rainy season (about 3 months /year) no compost can be used in the agriculture land, therefore an area of about 8,000 m2 next to the WWTP Nangkat is reserved for temporary storage during this period.

3.3.1.4. WASTEWATER CONNECTION PILOT ZONE

At the moment only septic tanks, communal septic tanks and other on-site treatment facilities are used in Mandalay City. There is no sewerage collection conduit system, the sewerage is collected from the household by pipes into septic tanks, where it is treated and collected in trucks (night soil) and taken for treatment or disposal. The overflow of septic tanks is discharged into the roadside drainage channels.

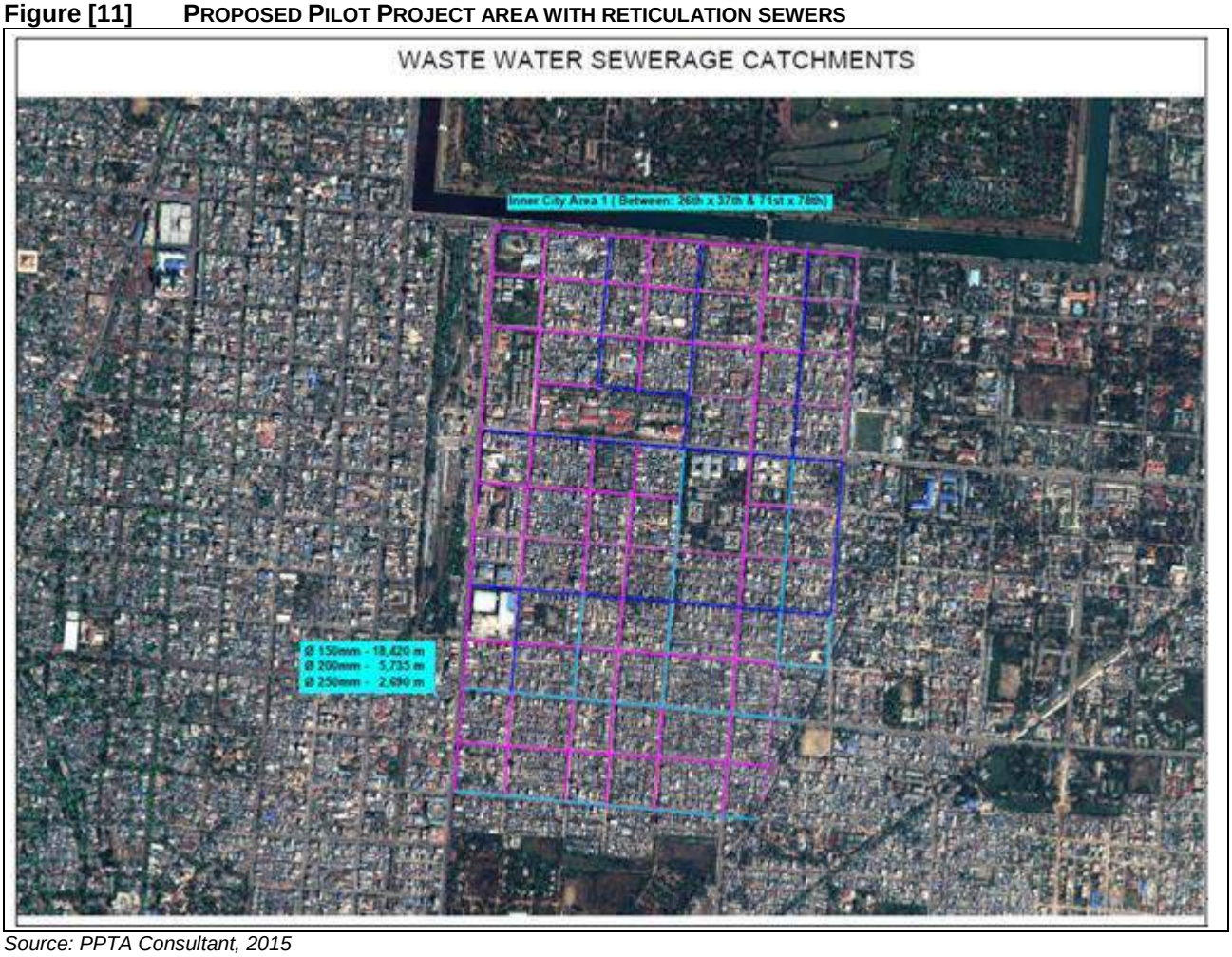
In the strategy it is indicated that a reticulation sewerage network will be implemented in the city. Reticulation sewers are a network of pipes including house connection sewers nominally up to and including DN 400 mm that receives sewage from the households, shops and other businesses. A reticulation sewer is further connected to a branch sewer.

In a separate system, reticulation sewerage pipes can be laid in the centre of the streets or at the sides of the streets (under/next to the pedestrian pavements). The locations of the pipes in the streets have to be examined for each street separately; same applies for the house connections.

In MUSIP 1 it is proposed to implement a small pilot area in the city centre with the reticulation system. The proposed area is to the south of the inner city area and will be connected to the proposed Ngwetachaung interceptor. Also about 780 house connections will be included. This will then be expanded into the old city area south of the palace area as shown below.

Part of this project will also investigate the removal of the large amounts of clean water observed entering the Shwetacheung (believed to be overflows and discharges from the moat water supply system). The results of the pilot zone would be used to develop a program for sewerage in the whole of the old city to be rolled out during subsequent years.

Figure [11] PROPOSED PILOT PROJECT AREA WITH RETICULATION SEWERS



Source: PPTA Consultant, 2015

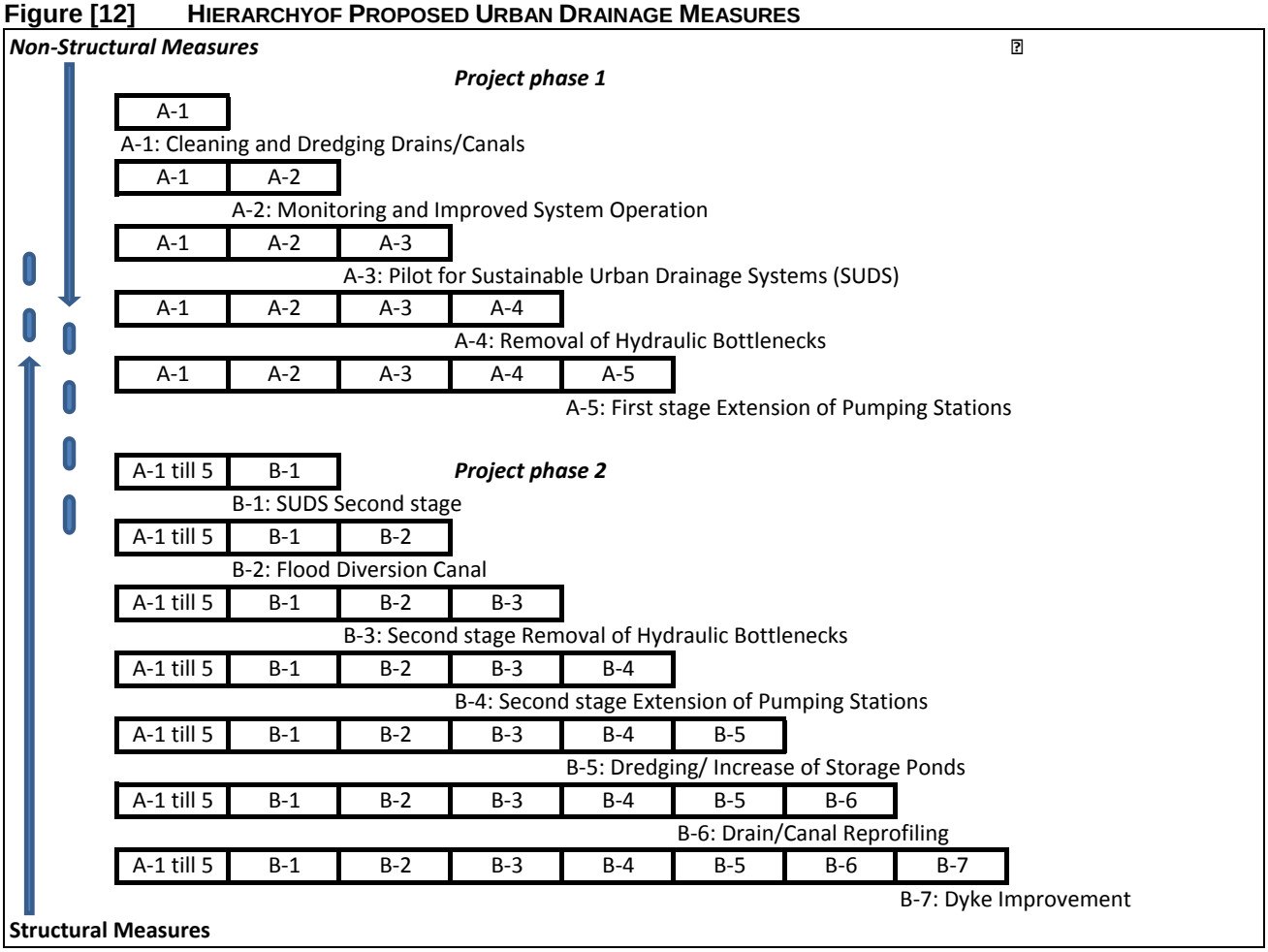
3.3.2. COMPONENT 2: MANDALAY URBAN DRAINAGE

The aim of thie component will be to reduce the frequency of flooding from less than 6 months to 1 in 1 year locally and 1 in 2 years on main canals with reduction in mixing with wastewater effluents. Based on the observations and conclusions in the FSR for urban drainage, this will be achieved via the first phase implementation of the following recommended urban flooding management strategies:

- The existing system should be used as much as possible but must be upgraded and extended in order to get better control and low O&M requirements;
- Drainage of the internal runoff should be enabled by improvements (cleaning and dredging) of the drainage canals, and extensions of the relevant pumping stations;
- It is recommended that parallel with the pumping station extensions improved level and gate control as well as overall system operation will be implemented;
- In addition, bottlenecks in the drainage system like small bridge openings restricting conveyance of drainage/flood waters will have to be removed;
- On the longer term cleaning and dredging of the storage/retention ponds Kandawgyi and ThaungThaMan will be needed; to maintain sufficient potential storage of flood waters;
- Similarly, on the longer term dyke improvements will be necessary to exclude flooding from external sources and/or to prevent leakage and seepage through the dykes.

The hierarchy of projects proposed in the FSR is presented in the following table. It shows the sequence of projects, in a range from Non-Structural Measures (NSM) to full structural measures. It also shows the phasing of the various measures from a first stage (this project preparation for the Loan) to a potential second stage project. The table also shows a gradual change from NMS type projects to hard hydraulic infrastructure, with some projects in between that are a mix of both.

Figure [12] HIERARCHYOF PROPOSED URBAN DRAINAGE MEASURES

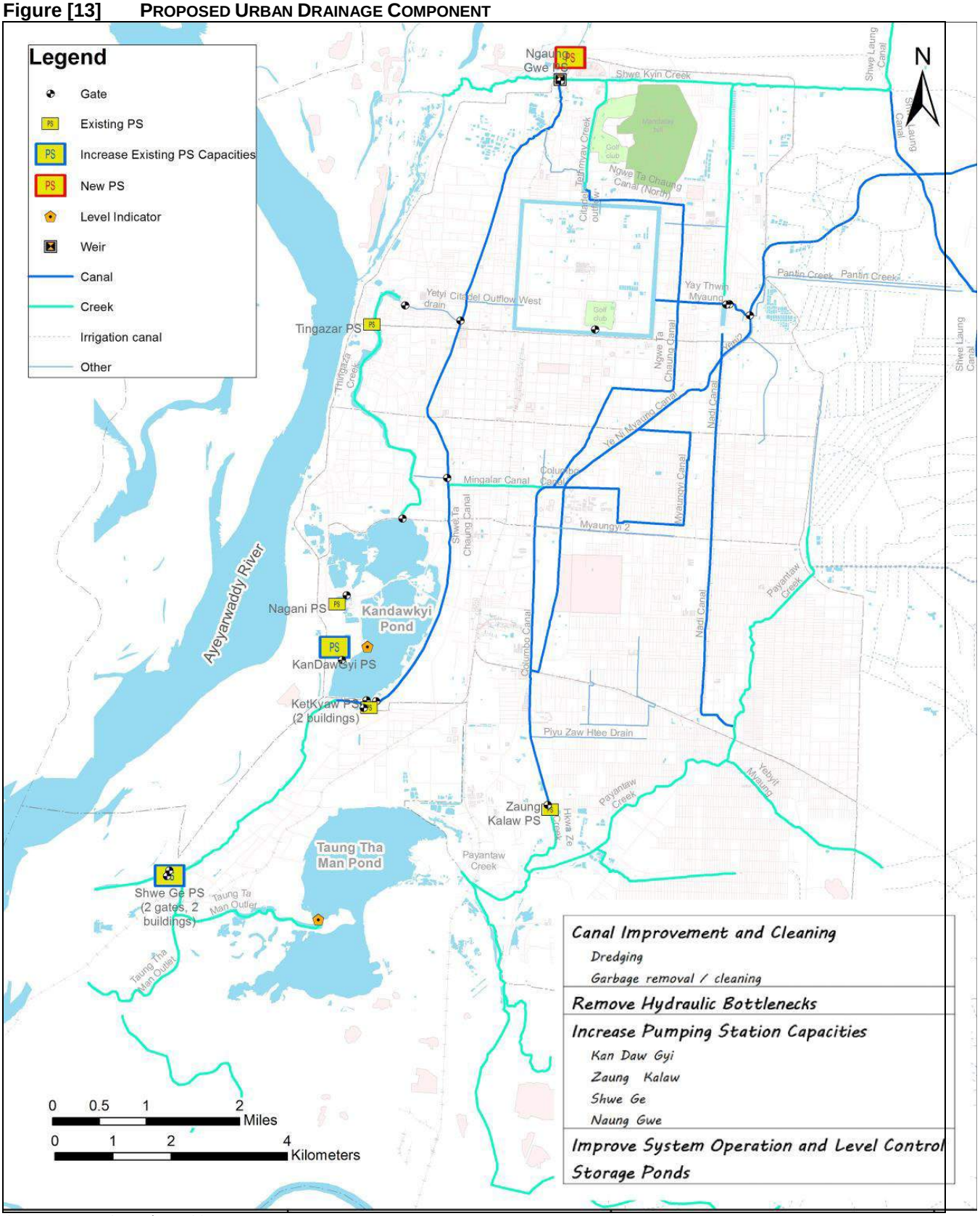


Source: PPTA Consultant, 2014

The first phase will consist of the following subcomponents with locations illustrated below:

- Canal Dredging and Cleaning
- Remove Hydraulic Bottlenecks: 4 bridges reconstructed
- Sustainable Urban Drainage Systems
- Increase Pumping Station Capacities as proposed below:
    - KanDawGyi; Increased to 5m3/s
    - ShweGe; Increased to 5m3/s
- Improve System Operation and Level Control Storage ponds

Figure [13] PROPOSED URBAN DRAINAGE COMPONENT



Source: PPTA Consultant, 2014

3.4. OUTPUT 3: STRENGTHENED URBAN SERVICE MANAGEMENT CAPACITY

Components under output 3 are mostly capacity and awareness programs. Except the pilot community-based solid waste management, no environmental impacts are expected.

3.4.1. PILOT COMMUNITY-BASED SOLID WASTE MANAGEMENT

The aim of this component is to extend waste services to the whole city (from 0.8 million to over 1.1 million by 2020). In complement to the ongoing waste to energy project, the component will also provide improved residuals management.

The project preparation is carried out through a FASEP (French) grant. Only limited activities related to solid waste will be considered under MUSIP1, mainly because budget limitation.

The solid waste program covers the collection and the treatment of the waste, through the development of 12 collection sites in the city (2 per township, in replacement of the existing 70 sites distributed over the city), the creation of a new sanitary landfill, the closing and rehabilitation of existing dumpsites and the rehabilitation of an incinerator for medical waste. At the time of writing this IEE this program remains to be finalised.

The solid waste component within MUSIP1 will therefore be restricted to initiate improvements in solid waste collection through the funding of one pilot collection point and the cleaning of solid waste accumulated on the shores of Thingaza creek.

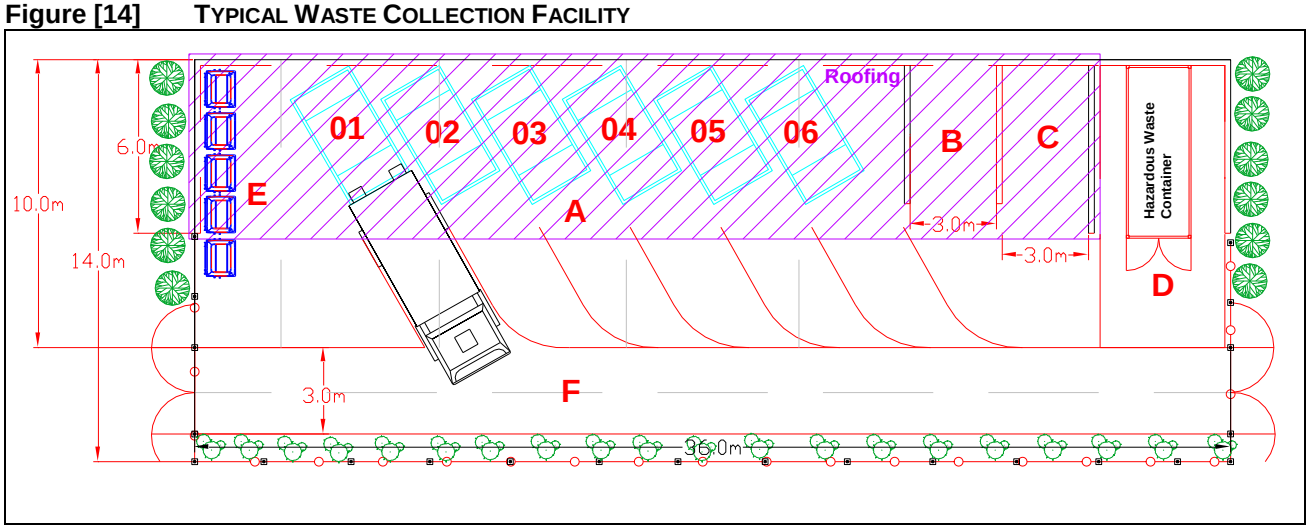
Bulky household waste and small-scale construction waste is clearly not suitable for direct entry into the regular municipal waste collection system. Therefore domestic and small commercial generators need to be provided with a suitable outlet for these wastes. The most feasible option considered is the provision of a municipally organized reception scheme in order to handle a number of future additional appearing streams including:

- A fraction of waste electrical and electronic equipment, batteries and accumulators
- A fraction of waste mineral oils and waste tyres from domestic premises
- Household hazardous waste
- Bulky household waste
- Small volumes of construction and demolition waste

The proposed number of waste reception facilities was determined in a way that each township (6) shall receive the investment for two facilities allocated in their western and eastern periphery. The minimum requirements for such a waste management facility should be: fence, gate, concrete foundation, gate security, roofing – at least the section dealing with hazardous waste, fire safety measures, working safety equipment and, of course, an adequate number of collection containers. Each of this waste reception facility should have sufficient space to accommodate a hazardous waste collection section.

A typical design for such collection facility is provided in following Figure [14] .

Figure [14] TYPICAL WASTE COLLECTION FACILITY



Source: SAFEGE, 2014

- A: Container (5 or 7m³) zone

– A1_Bulky waste

– A2_Metals

– A3_Electronical devices (grid container)

– A4_Tires

– A5_Voluminous packages (grid container)

– A6_reserve

- B: Box for organic waste (green waste);
- C: Box for construction and demolition waste (household amount);
- D: Hazardous waste container (20ft; 2s-2m-2f system) including UN-bins (see pictures) for the collection of household and car batteries, waste oil, waste paintings, acids / alkaline, oil filters, oil bins/cans, pressurised bins/cans, household chemicals and further components according list on hazardous waste categorisation;
- E: Container (1.1m³) for glass, aluminium bins, paper, PET, etc.
- F: Infrastructure, entrance and access road, tipping ramp, etc.

The total area should not be less than 2 000 sqm to incorporate all required collection facilities as well transport and access roads. The area must be accessible from both sides to allow a one-way system and avoid accidents during handling of containers. The entire area is paved (access with asphalt, container places with concrete). Areas A, B, C and E are roofed. The entire area is fenced, from the backside with a concrete wall, from the front side with a standard mashed fence. Entrances are suited with lockable entrance gates. Lighting is required under roof, at the entrance of the infrastructure area and close to the hazardous waste facility. A reception facility is operated 5 or 6 days a week for a period of 8 hours per day.

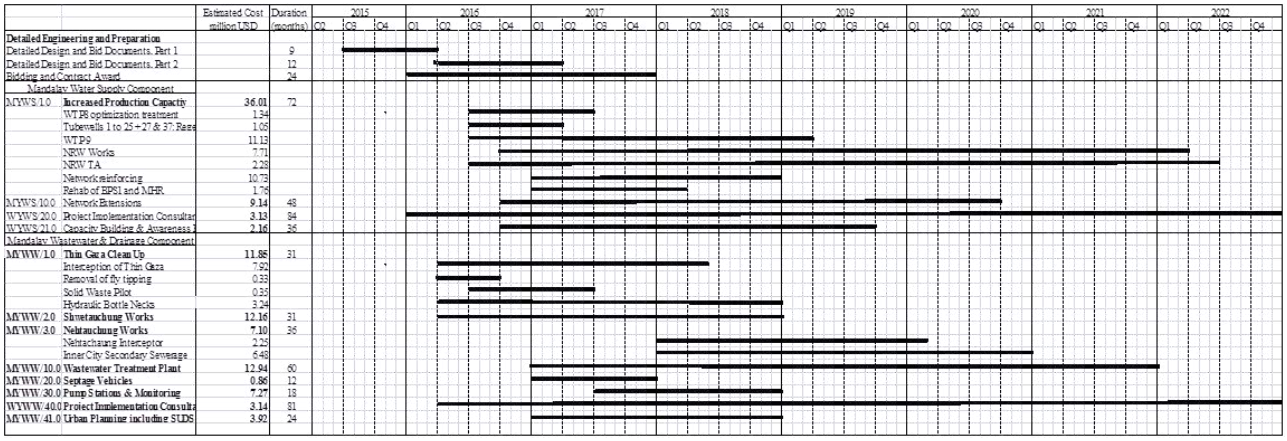
The selected pilot site is N° 17, located in the north-west part of Mandalay.

3.5. IMPLEMENTATION SCHEDULE AND COST

3.5.1. IMPLEMENTATION SCHEDULE

The project will be financed through two loans from the ADB and the AFD. It is envisaged that the implementation period for both loans will be 7 years as illustrated below.

Figure [15] OUTLINE IMPLEMENTATION SCHEDULE



3.5.2. PROJECT COST AND FINANCING PLAN

The project is tentatively estimated to cost $129.9 million including contingencies of $15.9 million and financing charges during implementation of $4.3.

Table [9] PROJECT INVESTMENT PLAN (MILLIONS USD)

Item		Amount[a] ($ million)
A.	**Base Cost**[b]	
	1. Improved water supply systems[c]	43.9
	2. Improved wastewater and drainage management	52.3
	3. Strengthened institutional capacity	13.5
	Subtotal (A)	**109.7**
B.	**Contingencies**[d]	**15.9**
C.	**Financing Charges During Implementation**[e]	**4.3**
	Total (A+B+C)	**129.9**

[a] Includes taxes and duties of $9.5 million to be financed from the government resources through exemption.
[b] In mid-2015 prices.
[c] Parallel financing by the Agence Française de Développement (AFD) equivalent to €40.0 million.
[d] Physical contingencies computed at 10% for civil works; 15% for land acquisition and resettlement; and 10% for all other categories. Price contingencies computed at 1.3% on foreign exchange costs in 2016 and 1.5% thereafter, and 6.9% on local currency costs in 2016, 6% in 2017 and 5% thereafter; includes provision for potential exchange rate fluctuation under the assumption of a purchasing power parity exchange rate.
[e] Includes interest. Interest during construction for ADB loan is 1% per year and will be capitalized. There are no commitment charges.
Source: Asian Development Bank.

The preliminary Financing Plan is provided in the following Table [10].

Table [10] PRELIMINARY FINANCING PLAN

Source	Amount ($ million)	Share of Total (%)
Asian Development Bank[a]	60.0	46.2
Urban Climate Change Resilience Trust Fund[b] under the Urban Financing Partnership Facility	4.0	3.1
Agence Française de Développement[c]	46.0	35.4
European Union's Asian Investment Facility[d]	6.8	5.2
Government[e]	13.1	10.1
Total	**129.9**	**100.0**

[a] To finance output 2 and output 3 (i).
[b] To finance outputs 3 (iii)–(v). Financing partners: the Rockefeller Foundation and the governments of the United Kingdom and the United States.

[c] Parallel financing for output 1 and output 3 (i).
[d] Parallel financing administered by AFD for output 3 (ii).
[e] To finance land acquisition, financing charges during implementation for AFD loan, and taxes and duties through exemption.
Source: Asian Development Bank.

oOo

4. BASELINE SITUATION

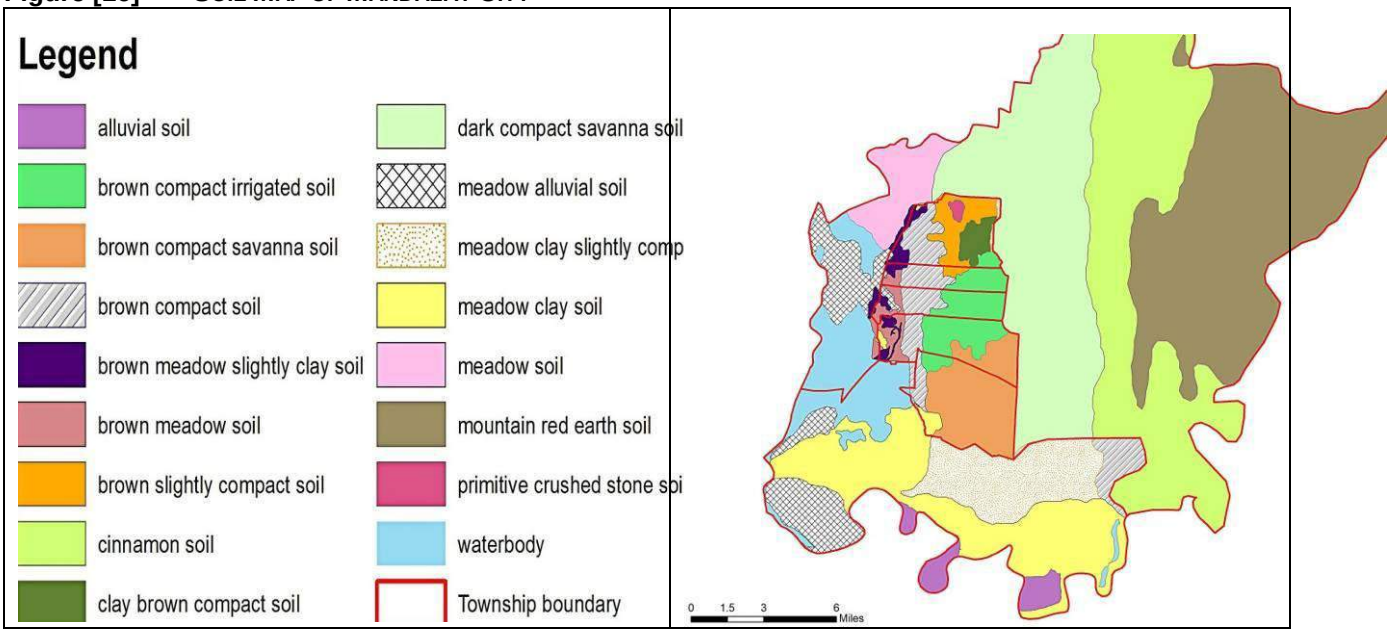
4.1. TOPOGRAPHY, REGIONAL GEOLOGY, SOILS AND NATURAL HAZARDS

Mandalay Region is situated in the central part of Myanmar forms a narrow linear belt extending north-south from the historically famous Tagaung area on the north to the Pyinmana area in the south. Most of Mandalay Region falls in the Central Myanmar Belt and the rest are in the Eastern Highlands Province. Furthermore, the region embraces a segment of the narrow metamorphic/plutonic belt and the Mogok Metamorphic Belt which parallel north-south along the western margin of the Eastern Highlands Province. Therefore, the geological succession of the Mandalay Region is composed of a mixture of the units which are typically exposed in the Eastern Highlands Province and in the Central Myanmar Belt.

The geology of Mandalay City is composed of Quaternary unconsolidated sediments of Middle Pleistocene to Holocene age: the fluvial sediments of the Ayeyarwaddy River and the piedmont colluvium deposits from the marginal highlands of the Shan Plateau. The total thickness of the sediments reaches to 180 m near the Ayeyarwaddy River in Mandalay. Probably the former is distributed mainly in the western area and the latter is mainly in the eastern area with interfingering relationships. However, the boundary is still unclear due to lack of detailed geological information. Rock types in Mandalay region include both hard rocks such as limestone, dolomite, gneiss, schist, and granitic rocks, and soft rocks such as sandstone, shale, limestone and conglomerate.

As presented in the following Figure [16] , several types of soils are observed in Mandalay region. However, mountain red earth soils, cinnamon soils and dark compact savannah soils cover together more than the eastern half of the city.

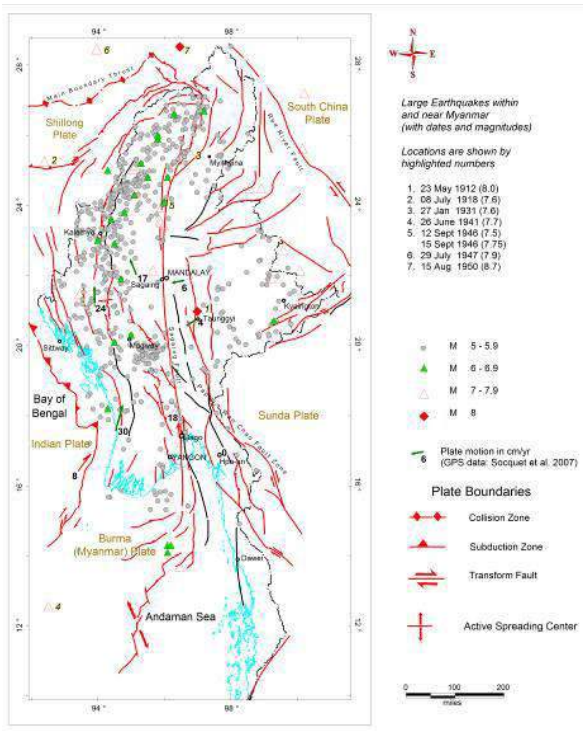
Figure [16] SOIL MAP OF MANDALAY CITY



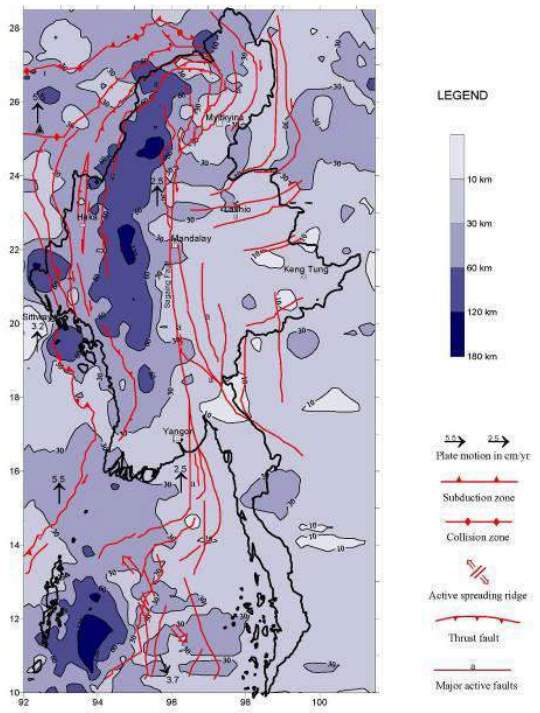
Source :

Due to its geology and flat topography Mandalay is not exposed to soil instability and landslide. However, it is considered as potentially vulnerable to earthquake. Mandalay lies close to the 1000 km long Sagaing Fault which is the most prominent active fault in Myanmar, trending roughly north – south. It has generated several destructive earthquakes in Myanmar, partly due to the fact that many large urban centres lie on or near this fault. In fact, of the five major source zones in Myanmar, three lie around this large and dangerous fault (*Hazard Profile of Myanmar 2009*). The southern segment of the Sagaing Fault that is close to Yangon and Bago cities, and the central segment that is close to Mandalay and Sagaing cities. The last major earthquake of 7 on the Richter scale with its epicentre in Shwe Bu was on 11 November 2012. 247 households and 924 people were affected (Blunt et al. 2014).

Figure [17] SEISMOTECTONIC MAP AND EARTHQUAKE FOCAL DEPTH COUNTOUR OF MYANMAR



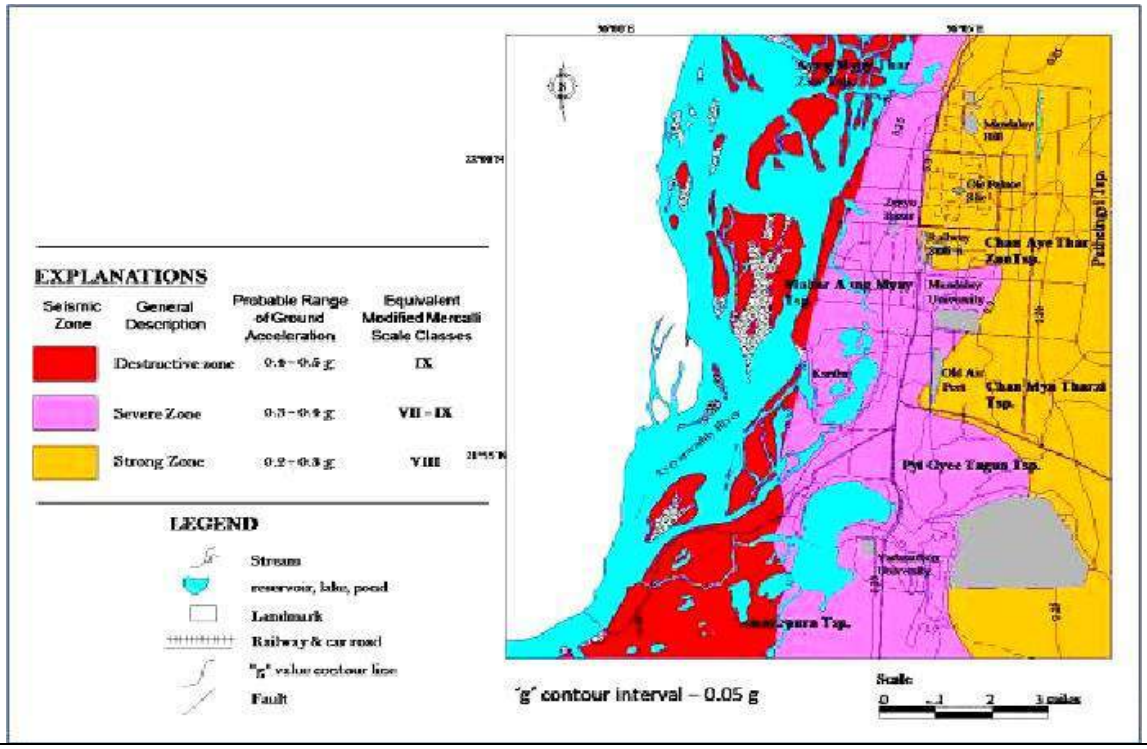
SEISMOTECTONIC MAP OF MYANMAR AND SURROUNDING REGIONS



EARTHQUAKE FOCAL DEPTH CONTOUR OF MYANMAR FOR THE PERIOD 1964 - 2004

Source: (Hazard Profile of Myanmar 2009)

Figure [18] SEISMIC MICRO ZONE MAP OF THE MANDALAY – AMARAPURA AREA

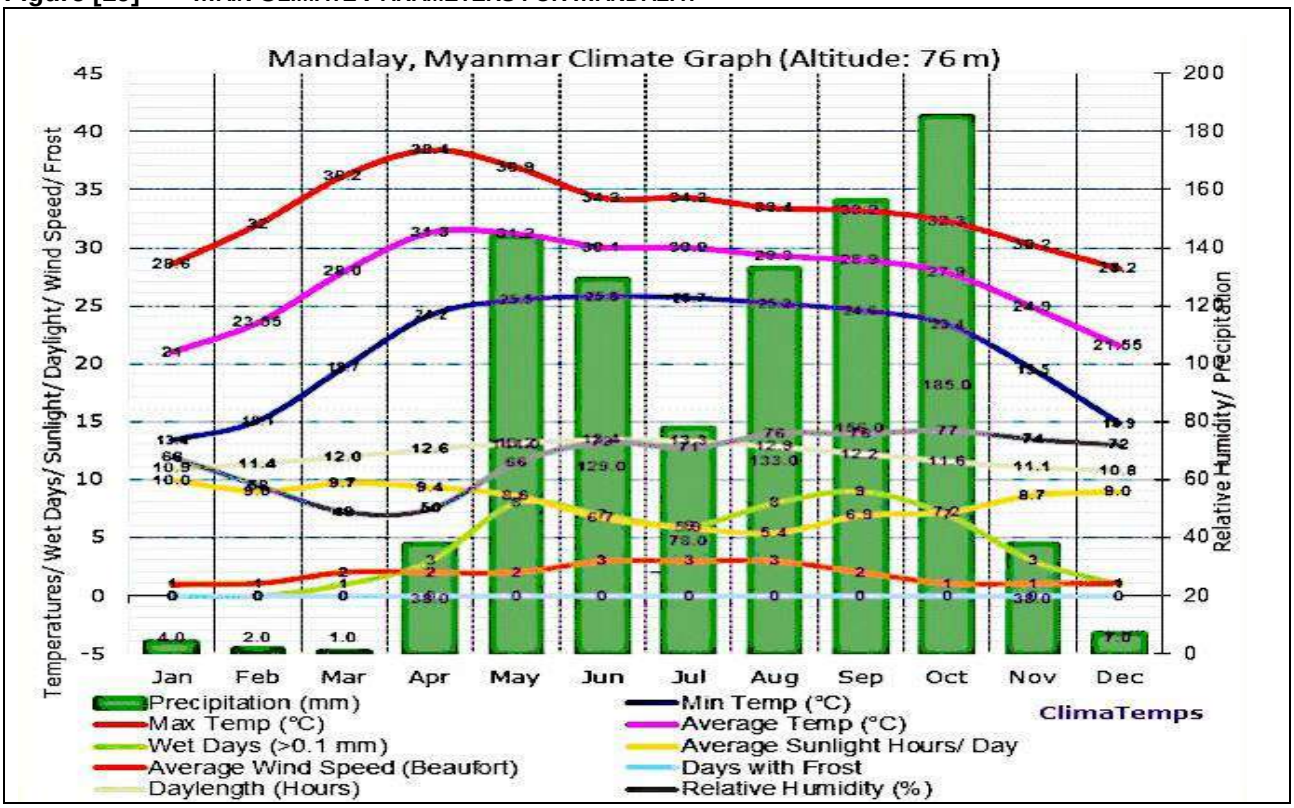


4.2. CLIMATE

4.2.1. GENERAL CLIMATIC CONDITIONS

Mandalay lies in the centre of the "Dry Zone" area of Myanmar. The Dry Zone is one of the most climate sensitive regions in Myanmar. The dry zone stretches across the southern part of Sagaing Division, the western and middle part of Mandalay Division and most parts of Magway Division. It is located in the rain shadow area of the Yakhaing Yoma and obtains most of its rainfall from the southwest monsoon. According to the current rainfall patterns, the zone covers approximately 54,390 square kilometers and represents about 10% of the country's total land area. The present population in the Dry Zone represents about one third of the country's total population. General climate parameters are presented in the following Figure [19] . Rainfall, temperature and wind are discussed in the following sections in further details.

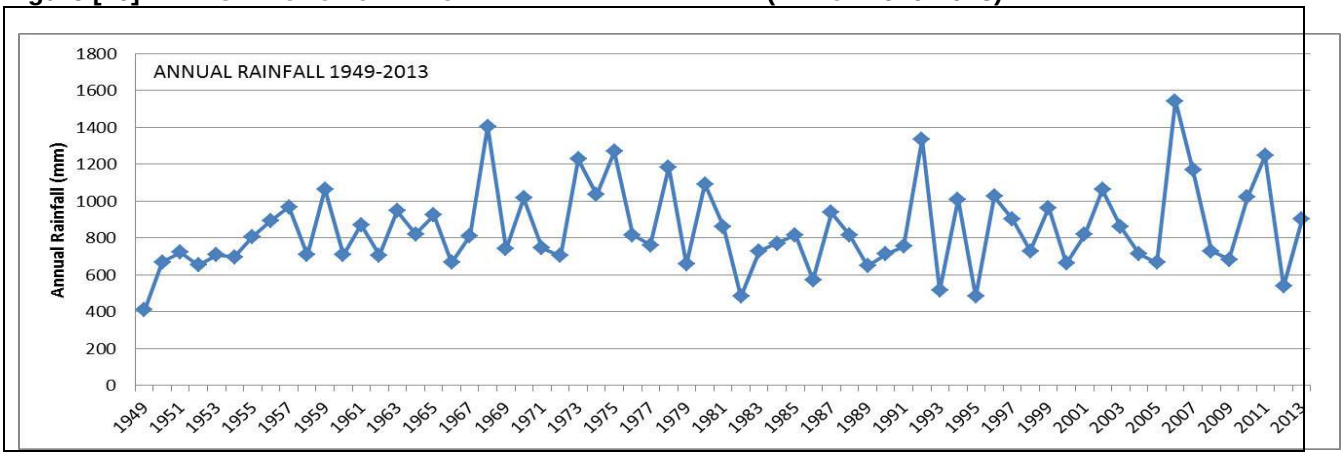
Figure [19] MAIN CLIMATE PARAMETERS FOR MANDALAY



4.2.1.1. RAINFALL

The region is characterized by low annual rainfall. Distribution of annual rainfall from 1949 to 2013 (65 years) is presented in the following figure. Compared to the rest of the country, the rainfall is low in the dry zone, in average 847 mm over the 65 years of observation, ranging from as low as 409 mm (1949) to a maximum of 1542 mm (2006). This is discussed in further details in the following section of this report related to Climate Change (CC) issues. The monsoon rain is bimodal, ranging from May to October with a dry period during July when dry desiccating winds blow from the south. October is generally the wettest month of the year. The dry season lasts from November to April, December to March being with almost totally dry.

Figure [20] DISTRIBUTION OF ANNUAL RAINFALL IN MANDALAY (PERIOD 1949-2013)

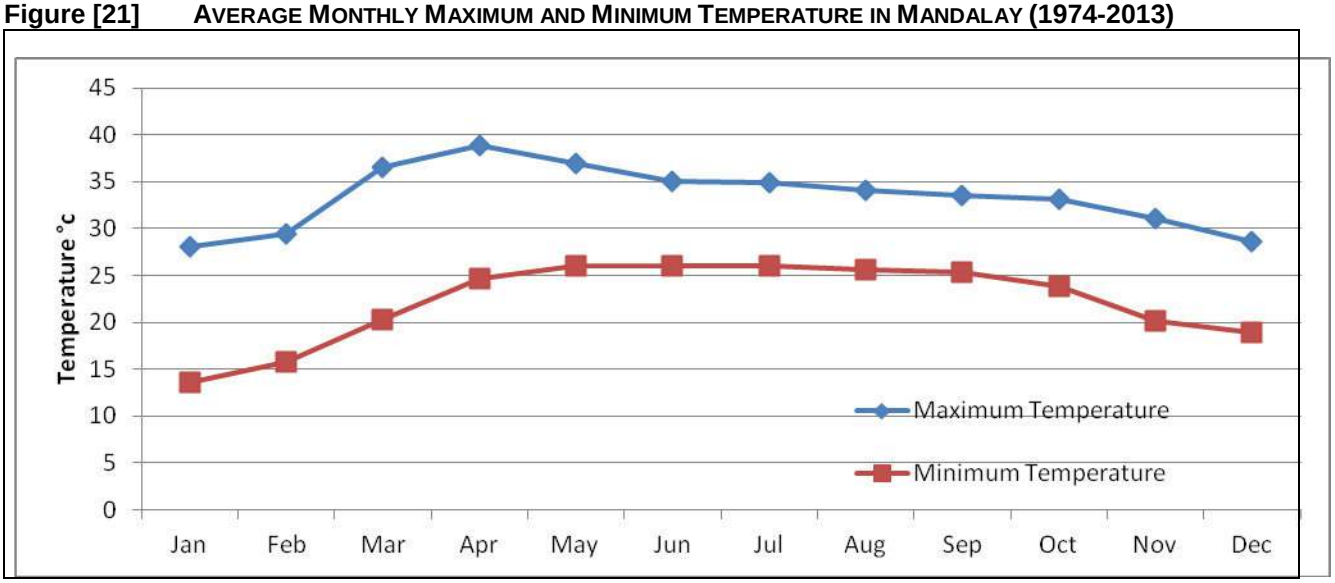


Source: PPTA Consultant, data from Mandalay hydro-meteorological station

Temperature

Over a period of 40 years (1974-2013) the average annual maximum temperature in Mandalay was 33.4°c and average annual minimum temperature 22.2°c. Following Figure [21] provides variation of average monthly maximum and minimum temperature over a 40 years period. Hottest month is April (Max. temp. average 38.8°c) and coldest is January (Min. temp. average 13.5°c).

Figure [21] AVERAGE MONTHLY MAXIMUM AND MINIMUM TEMPERATURE IN MANDALAY (1974-2013)



Source: PPTA Consultant, 2014

4.2.1.2. WIND

Wind in Mandalay is predominantly from South to South-west, turning in the afternoon to north particularly during the last quarter of the year. The average monthly speed is limited, with an average maximum of 2.4 mph in the morning in July.

Table [11] WIND CHARACTERISTICS IN MANDALAY (YEAR 2013)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
Speed (mph) at 09:30	0.3	0.3	1.1	1.6	1.7	1.6	2.4	1.5	0.9	0.4	0.2	0.04
Direction at 09:30	SW	S	S	S	S	S	S	S	S	S	W	SW
Speed (mph) at 18:30	0	0	0.03	0.2	0.8	1.2	1.6	0.8	0.3	0.06	0.04	0.04
Direction at 1:30	-	-	NW	S	SE	S	S	S	S	N	N	N

Source: PPTA Consultant, 2014, data from Mandalay hydro-meteorological station

4.2.2. EXTREME CLIMATIC EVENTS

Located far enough from the coastline, and protected by the mountains, Mandalay is not affected by the typhoons which regularly hit the coast. Such extreme conditions may only impact the Project area through backwater effects in the Ayeyarwaddy which, combined to heavier rainfalls, may result in temporary flooding of flood prone areas. Drought is the climatic event to which the Mandalay region (as well as the whole Dry zone) is the most sensitive. But such situation affects mainly agricultural activities with only limited impacts so far on domestic water supply. However, as discussed in the next section, drought may become more frequent with the climate change trend, with potential effects on water resources.

4.3. CLIMATE CHANGE IN MYANMAR

Myanmar signed the UNFCC Convention on 11/06/1992 and ratified the convention on 25/11/1994. The country also ratified the Kyoto Protocol in 2003. Myanmar has recently submitted its Initial National Communication (INC) to UNFCCC. National Adaptation Programs of Actions (NAPA) have been prepared with the financial support of GEF/UNEP.

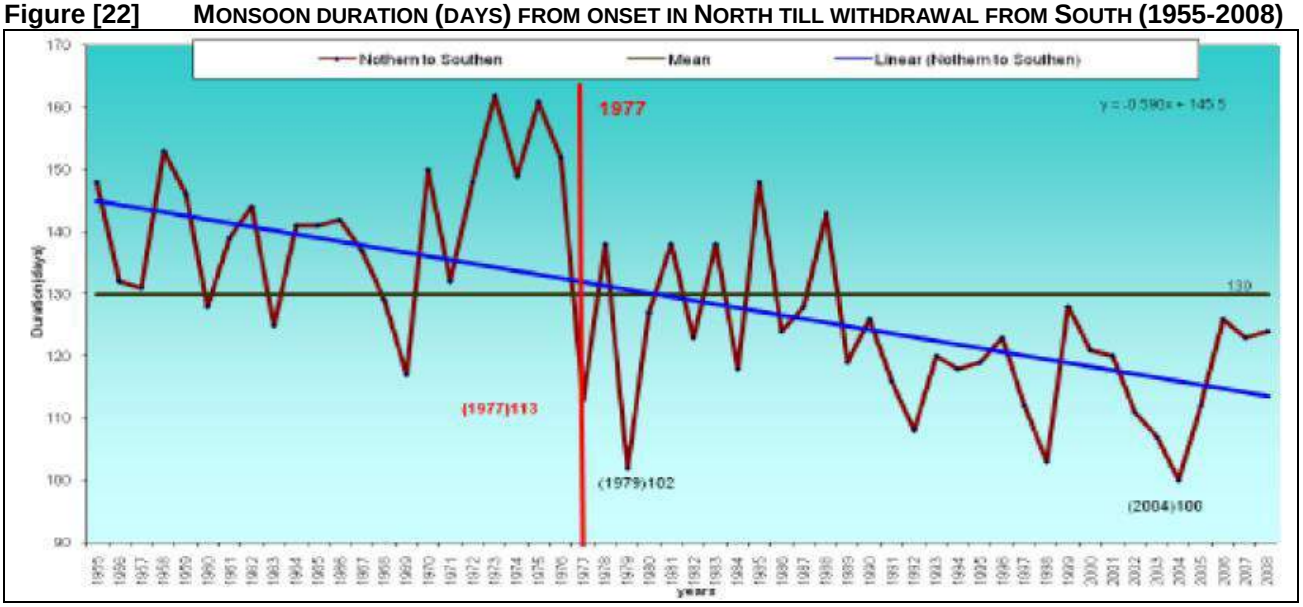
4.3.1. NATIONAL TRENDS

Due to its location in SE Asia and the length of its coastline, climate change (CC) is certainly a major concern for Myanmar. On the basis of the latest Climate Risk Index (period 1993-2012) ranking system, Myanmar is reported as one of the most threatened country by climate change. The PPTA Consultant considers this ranking must be interpreted carefully as it is mainly based on the losses in assets and lives during major extreme events related to climate change (typhoons and floods). The high index attributed to Myanmar results in fact, for 95% of its value, from only one event: typhoon Nargis which killed almost 150,000 peoples in 2008. If we except this unique event, Myanmar appear, for 2014, not more threaten than other neighbouring countries by CC.

However, Myanmar is facing progressive climate changes which threat particularly water resources and food security: Change in rainfall distribution and quantity and raise in temperature.

The following Figure [22] depicts the observed change in southwest monsoon duration: From the onset of the monsoon in Northern Myanmar until its withdrawal from the South, the monsoon duration over the last 50 years shows a significant reduction from 140-150 days in the mid-fifties to less than 120 days in 2008. Late arrival of the rain and early ending where particularly evident since the year 1977, when the duration of the rainy season dropped below 130 days, a critical limit for most cropping cycles.

Figure [22] MONSOON DURATION (DAYS) FROM ONSET IN NORTH TILL WITHDRAWAL FROM SOUTH (1955-2008)



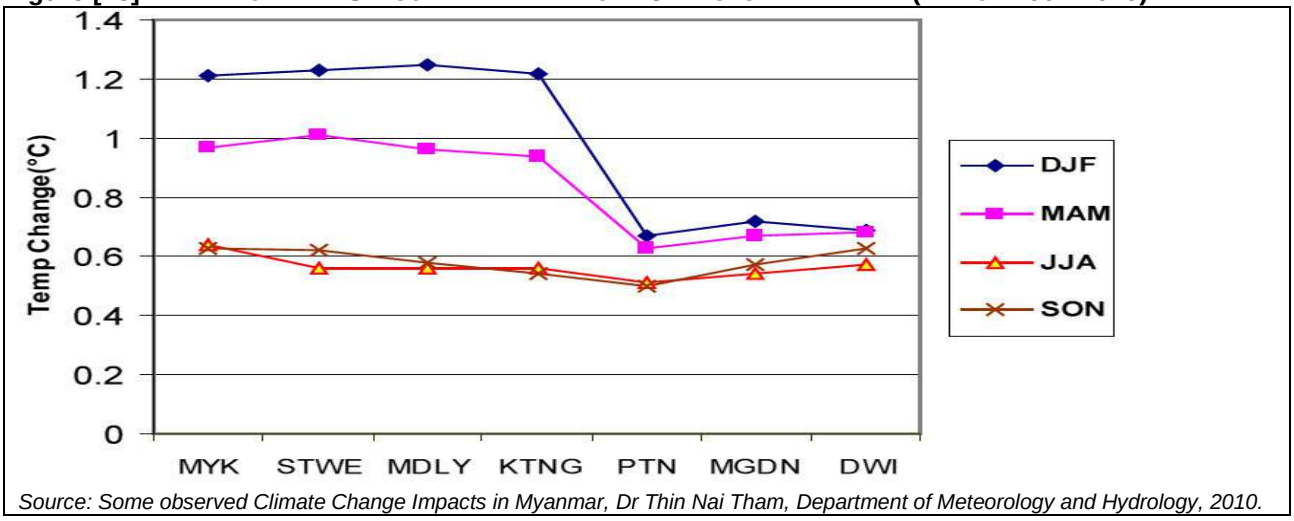
Source: Some observed Climate Change Impacts in Myanmar, Dr Thin Nai Tham, Department of Meteorology and Hydrology, 2010.

According to regional information, the southwest monsoon duration has been shortened by about three weeks in northern Myanmar and one week in other parts of the country when compared to the situation observed in the fifties.

Available information on climate change forecasts in Myanmar for period 2001 to 2020 anticipates:

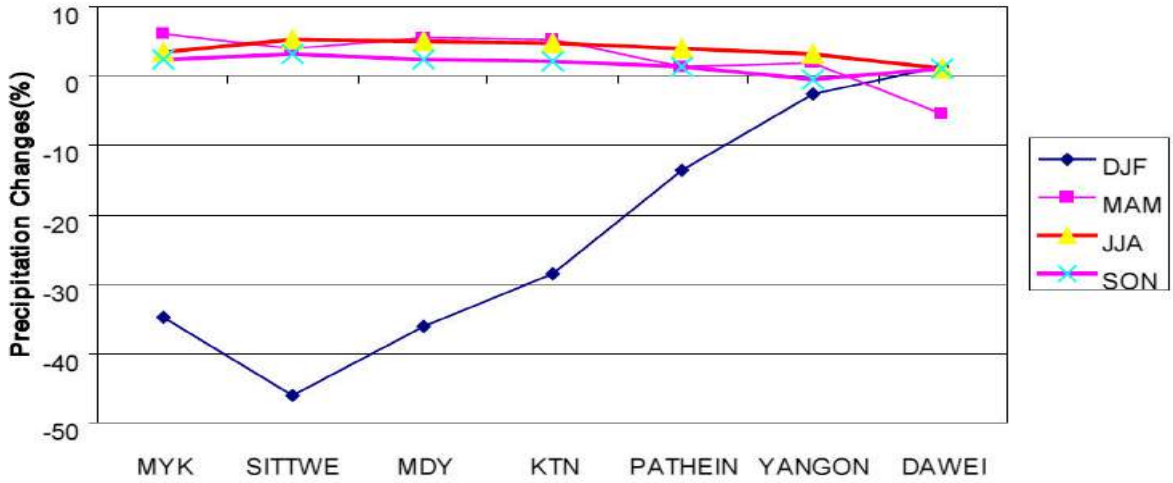
- Only 5% increase of precipitation is forecasted for the period March-November in the whole country. During the dry season, which contributes to only 5-10% to the annual rainfall, the deficit may reach 45%, except in the delta region where dry season rain should remain normal.
- Slight warming of +0.5°c from June to November (rainy season) is anticipated in the whole country. During the dry season, warming will be more significant (+ 0.7 to +1.2°c) over the country, except in the delta area where temperature increase should not exceed +0.6°c.

Figure [23] ANTICIPATED SEASONAL TEMPERATURE CHANGES IN MYANMAR (PERIOD 2001-2020)



Source: Some observed Climate Change Impacts in Myanmar, Dr Thin Nai Tham, Department of Meteorology and Hydrology, 2010.

Figure [24] ANTICIPATED SEASONAL RAINFALL CHANGES IN MYANMAR (PERIOD 2001-2020)



Source: Some observed Climate Change Impacts in Myanmar, Dr Thin Nai Tham, Department of Meteorology and Hydrology, 2010.

4.3.2. REGIONAL AND LOCAL TRENDS

4.3.2.1. INFORMATION FROM GLOBAL CIRCULATION MODELS (GCM)

Climate Change will have particular impacts in the Mandalay area, as the region is already the driest zone of the country with annual rainfall frequently below 1,000 mm. Droughts periods are also frequently observed which affect agricultural production. The crops most severely affected are reported as those planted in the pre-monsoon and monsoon phases, mainly transplanted rice, sesame and sunflower.

Global Circulation Models (GCM) information available for Myanmar has been mainly derived from the IPCC AR4 report (Christensen et al. 2007, Chapter 11, WG1, IPCC 2007) and a number of additional scientific sources[1]. The corresponding analysis is briefly presented below, with the A2 scenario representing a 'high' global emissions scenario and B1 representing a 'low' global emissions scenario.

Evolution of Temperature

- A2 scenario: Over central Myanmar, minimum and maximum temperatures are projected to increase by 1.5 - 3 ºC throughout the year
- B1 scenario: Over central Myanmar, minimum and maximum temperatures are projected to increase by 1.5 - 2.5 ºC throughout the year

The frequency of hot days and nights will increase in both scenarios, while the frequency of cold days/nights will decrease. Soil evaporation is expected to increase, with existing dry areas projected to become drier.

Evolution of Rainfall

- A2 scenario: Projections in rainfall changes under the A2 scenario are inconclusive during the early rainfall season. There is an indication of drying over the project area in central Myanmar during the month of June, which may be followed by increased rainfall intensity in July and August as indicated by the median model. Increasing rainfall intensity after dry periods is commonly associated with exacerbated soil erosion and denudation. The A2 scenario shows little change from September-October.
- B1 scenario: Little difference to the A2 scenario within a similar range of model predictions up to 2050.

[1] http://www.climatewizard.org;
http://sdwebx.worldbank.org/climateportal/home.cfm?page=country_profile;
http://cip.csag.uct.ac.za;
http://country-profiles.geog.ox.ac.uk

Evolution of Cyclones

Projections of cyclone tracks and cyclone frequency are inconclusive from GCMs, but the intensity of cyclones is likely to increase (as summarized by Christensen et al. (2007) in Chapter 11, WG1 of the 2007 IPCC report. However the Mandalay region is not affected by cyclones.

4.3.3. OBSERVED TRENDS IN MANDALAY

4.3.3.1. RAINFALL TRENDS

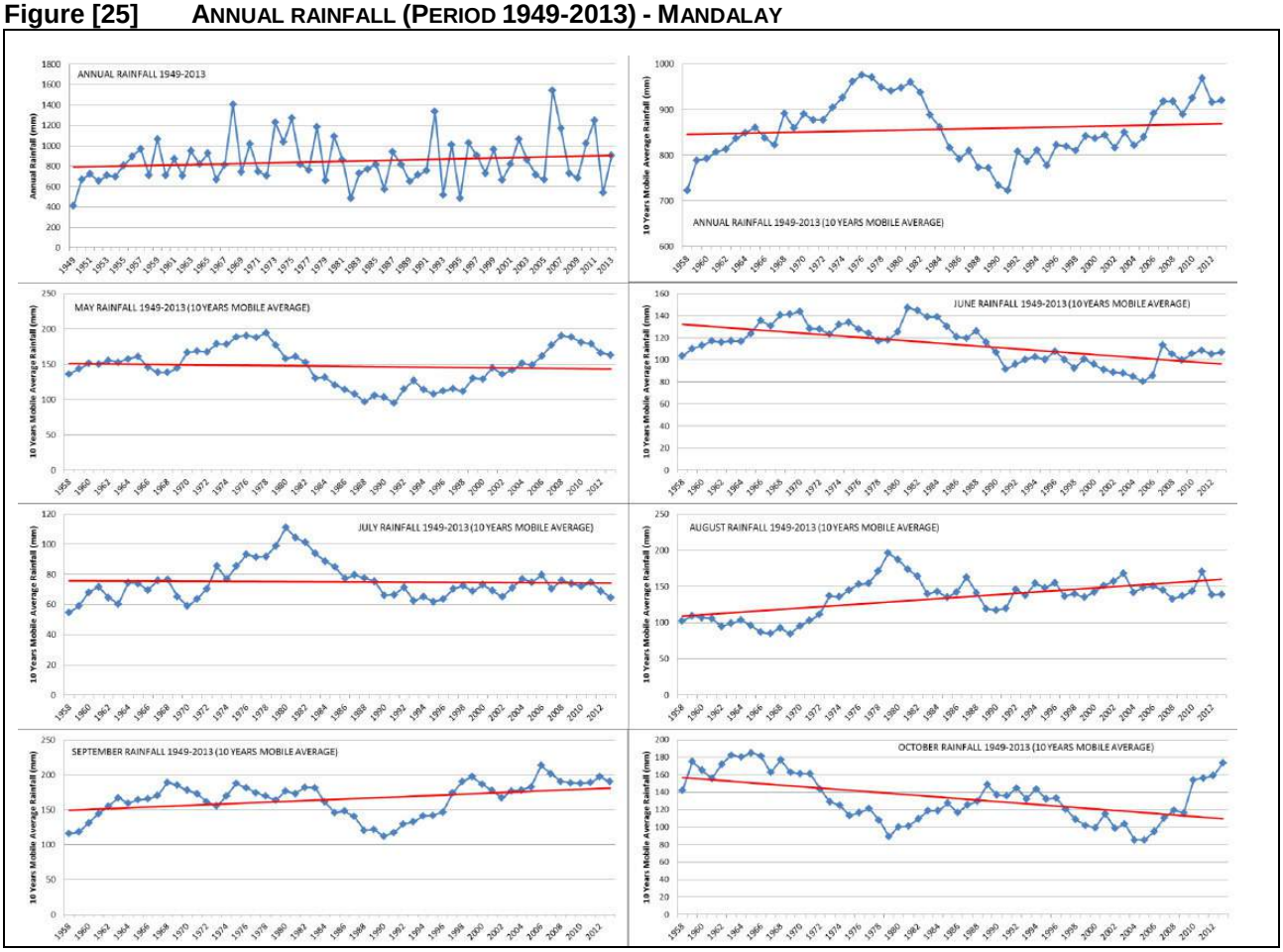
In addition to the general assessment of CC from GCM, the PPTA Consultant carried out an analysis of Mandalay hydro-meteorological station monthly data, available for the period 1949-2013, in order (i) to confirm or infirm the general trends from the GCM and (ii) provide more specific conclusions for the Mandalay region. Following tables presents annual rainfall along the observation period (upper left) and the same analysis but based on 10 years mobile average[2] (upper right). Following figures present an analysis for the 6 raining months (May to October) over the observation period based on the 10 years mobile average. In red, the resulting linear trend curve.

As depicted in Figure [25] , the main observations are:

- The annual rainfall in Mandalay shows an increasing trend since 1949.
- The same analysis, performed on a 10 years mobile average annual rainfall basis, shows two distinct periods of raising rainfall, from 1949 to the mid-seventies and from early nineties to present. Between these periods, rainfall decreased significantly. The 10 years averages observed these last few years are not higher than those observed in the seventies, even slightly lower.
- 10 years mobile average rainfall for May and June show a significant decrease in rainfall, which support the more general observation that the south-west monsoon is arriving later nowadays.
- 10 years mobile average rainfall for July is relatively stable, even showing a slight decrease.
- 10 years mobile average rainfall for August and September show a significant increase of about 50 mm for August and 30 mm for September, confirming the general trend of stronger rainfall during wettest months of the rainy season.
- 10 years mobile average rainfall for October shows a strong decreasing trend confirming the general observation that the rainy season is ending earlier, thus resulting in an increased duration of the dry season when considering the rainfall reduction in May and June.

[2] Each point on the graph represents the average of the 10 precedent years. This approach provides a better clarity of the graph and the general trend through eliminating individual fluctuating values of each year.

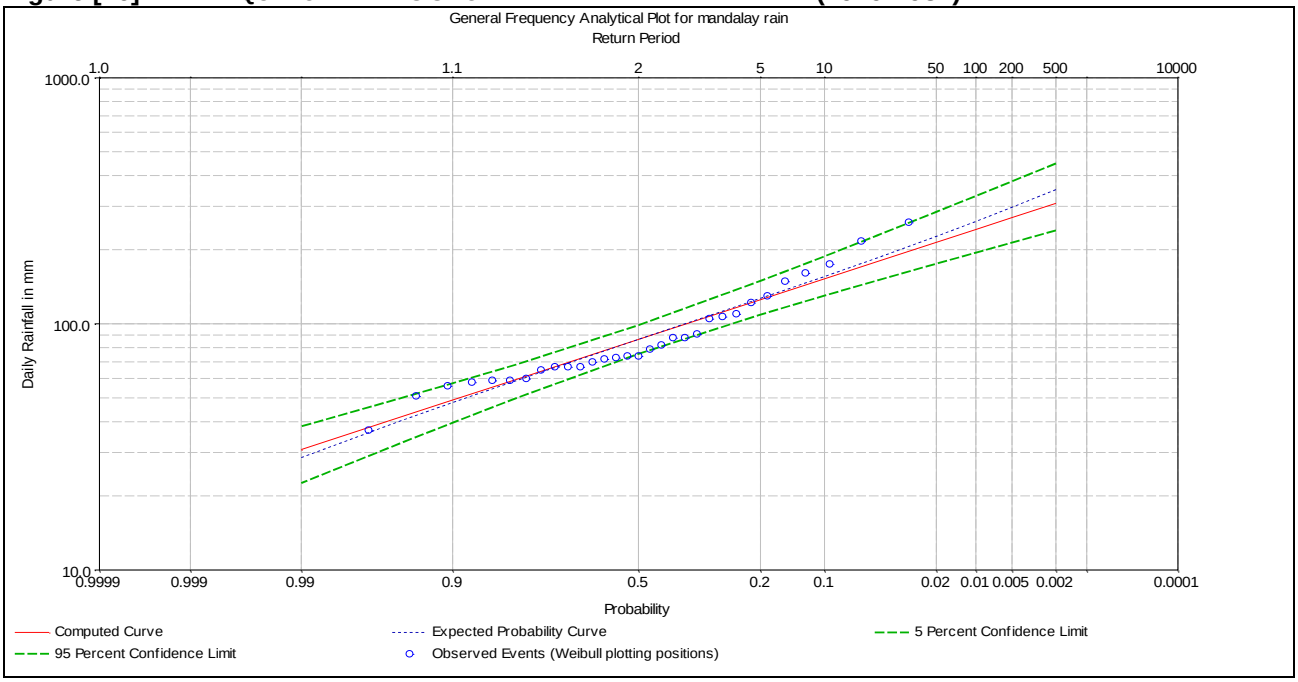
Figure [25] ANNUAL RAINFALL (PERIOD 1949-2013) - MANDALAY



Source: PPTA Consultant, 2014

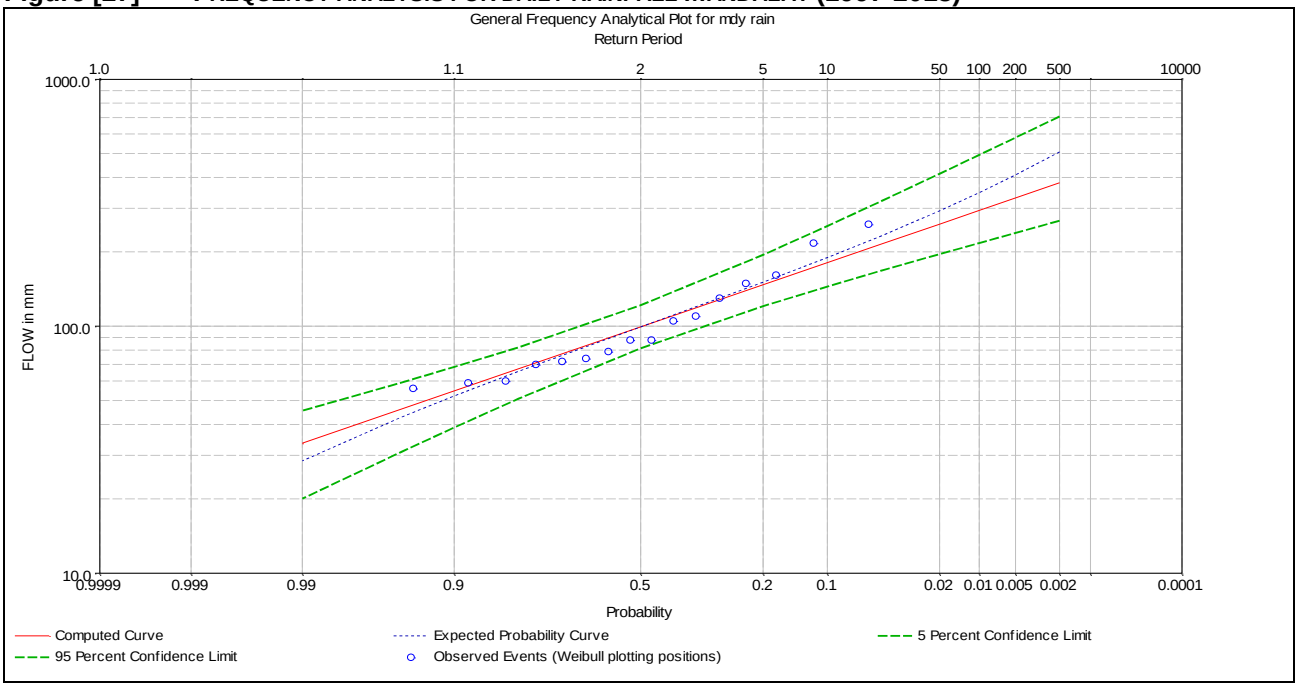
In addition to these analysis, observation of the daily rainfall series over the last 60 years shows that 4 of the largest 10 rainfall events have occurred over the last 10 years, including the largest measured event. These observations suggest that there has been a change in the rainfall series most notably over the last 15 years. The following curves compare the frequency analysis for the two periods 1949-1981 and 1997-2013.

Figure [26] FREQUENCY ANALYSIS FOR DAILY RAINFALL MANDALAY (1949-1981)



Source: Some observed Climate Change Impacts in Myanmar, Dr Thin Nai Tham, Department of Meteorology and Hydrology, 2010.

Figure [27] FREQUENCY ANALYSIS FOR DAILY RAINFALL MANDALAY (1997-2013)



Source: Some observed Climate Change Impacts in Myanmar, Dr Thin Nai Tham, Department of Meteorology and Hydrology, 2010.

Observation of the daily rainfall series over the last 60 years shows that 4 of the largest 10 rainfall events have occurred over the last 10 years, including the largest measured event. These observations suggest that there has been a change in the rainfall series most notably over the last 15 years. The following curves compare the frequency analysis for the two periods:

Following Table [12] provides a comparison of the calculated daily rainfall depths from each of the above curves.

Table [12] COMPARISON OF RAINFALL DEPTHS FROM EACH DAILY RAINFALL CURVE

RETURN PERIOD	TOTAL SERIES	1949-1981	RATIO TO TOTAL SERIES	1997-2012	RATIO TO TOTAL SERIES
2	86.4	86.4	100%	99.6	115%
5	117.8	111.7	95%	148.2	126%
10	139.3	129.8	93%	189.8	136%
50	184.8	166.2	90%	295.3	160%

The results show a significant increase of rainfall depths in the period 1997-2012 compared to period 1949-1981. This has been considered in setting-up the design criteria for the drainage system conceptual design.

4.3.3.2. TEMPERATURE TRENDS

Data on maximum temperature registered in Mandalay station were collected and analysed for the period 1974-2013 (40 years). Analysis performed on a monthly basis is depicted in following Figure [28] , showing the monthly maximum temperature distribution over the period and the linear trend curve (in red):

- Except May showing a slightly decreasing trend (reduction by less than 0.5°c), all the other months of the year show an increasing maximum temperature over the 40 years observation period;
- Temperature increase of about 1.5 to 2°c is observed for the months of January, February, June, July and November;
- More limited temperature raise of about 1°c is observed for March, April, August to October and December.

4.3.3.3. CONCLUSIONS

The increasing trend observed directly from the annual rainfall may not be fully related to a long term trend but partly the result of a succession of wetter or drier periods as illustrated by the use of the 10 years mobile average rainfall. However, if for urban facilities development, it is recommended to safely consider the annual rainfall increase as a long term trend, this interpretation is probably excessive for water resource management, particularly when dealing with agricultural development.

Pre-monsoon months (May, June) are becoming drier, confirming the later arrival of the monsoon with higher risk of drought during critical period for agricultural production and risk of conflictual water allocation between irrigation water and urban water supply.

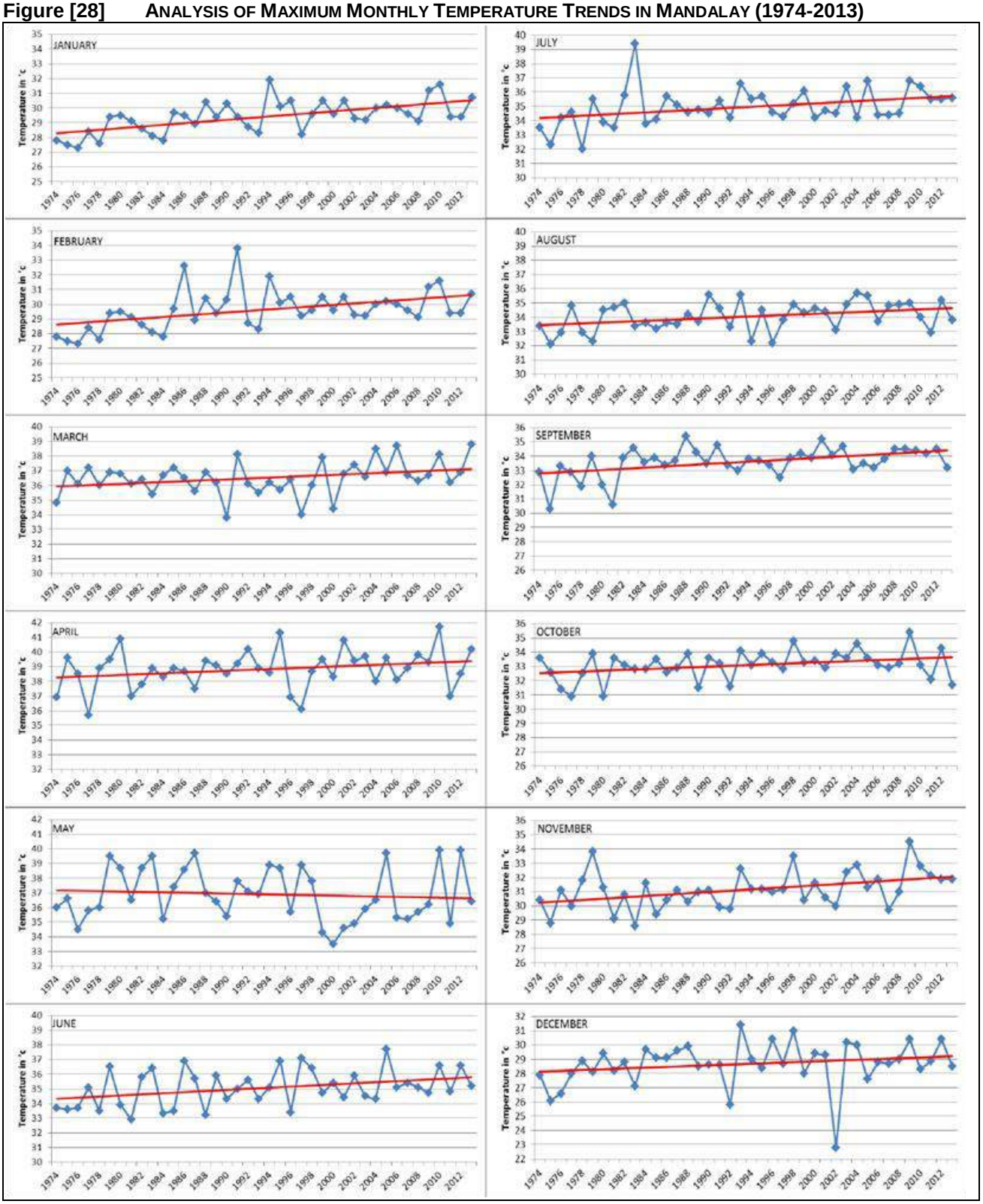
The rainiest months (August, September) are becoming wetter, confirming at local level the national forecasts of increasing rainfall intensities during the wet period.

October becomes drier, in line with the early withdrawal of the monsoon particularly from the northern and central parts of the country.

Similarly, monthly maximum temperature seems to have increased by 1 to 2°c since 1974, thus reinforcing the effect of the modification of rainfall distribution and the pressure on the water resource.

These results for Mandalay are consistent with the general forecast at the level of the country. Pre and post monsoon rainfall decrease, reducing per se the active duration of the monsoon while rainfall of the wettest months is increasing, with potential intensification of rainfall intensity. The current trends of drought and consequently of water scarcity in the dry zone of Myanmar observed today will most probably be intensified by the global warming also confirmed by the analysis, if the trends identified on these last 40 to 60 years are maintained on the very long term.

Figure [28] ANALYSIS OF MAXIMUM MONTHLY TEMPERATURE TRENDS IN MANDALAY (1974-2013)



Source: Some observed Climate Change Impacts in Myanmar, Dr Thin Nai Tham, Department of Meteorology and Hydrology, 2010.

4.4. HYDROLOGY AND FLOOD

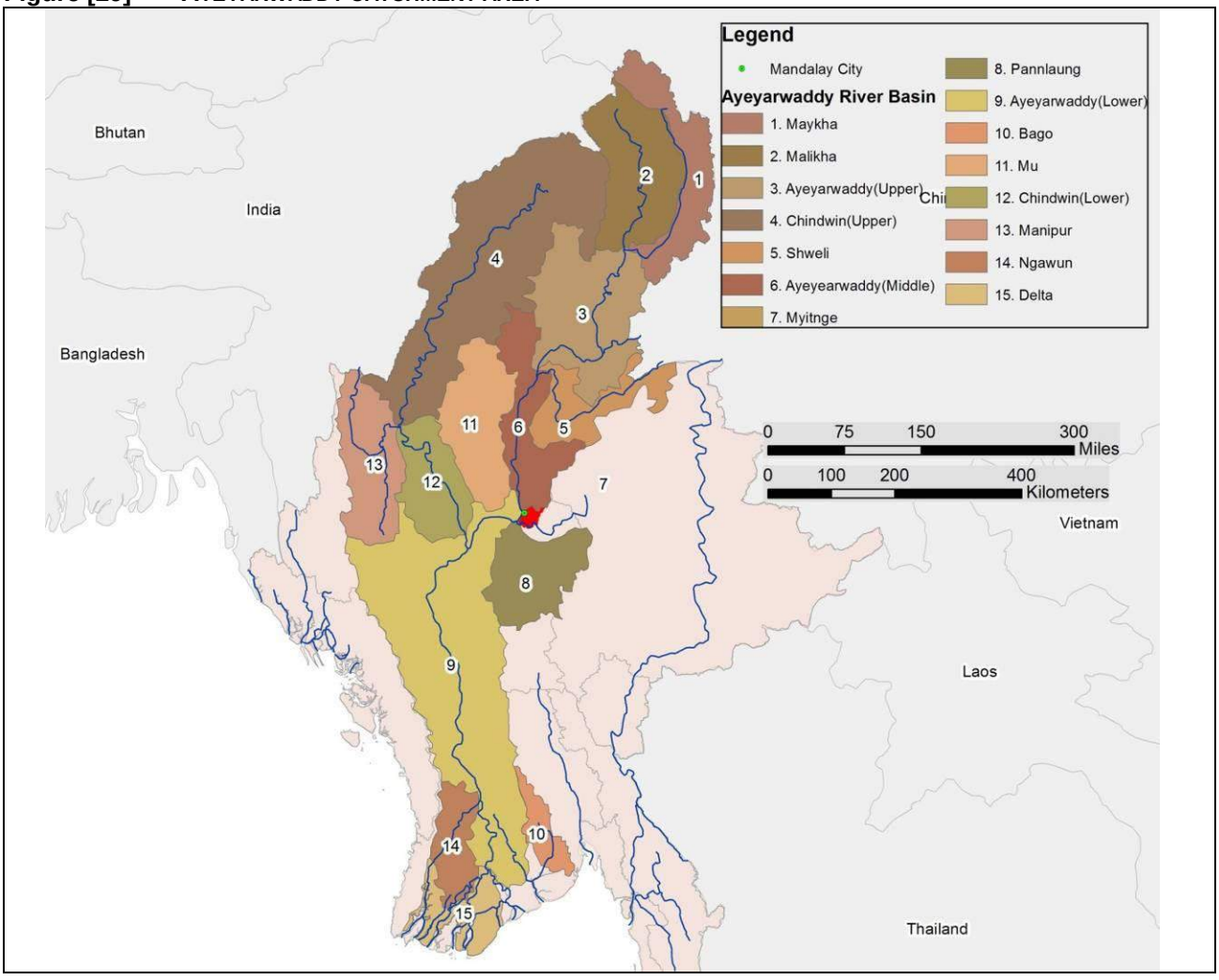
The Ayeyarwaddy River and the Dokhtawaddy (Myitnge) River are the two main rivers flowing in Mandalay District. The Ayeyarwaddy River is about 2,210 km long with a drainage area of 411,000 km² and it is also the largest river of Myanmar with a national drainage area of 288,900 km². Dokhtawaddy (Myitnge) River is

one of the major tributaries of Ayeyarwaddy River with the length of 528 km. The catchment area of Dokhtawaddy River is 29,630 km² and the river's average annual inflow is 24,000 million m³. The 790 megawatt Yeywa hydroelectric power is located on the Dokhtawaddy River about 50 Km southeast of Mandalay.

The discharge of the Ayeyarwaddy River and its tributaries fluctuates greatly through the year, chiefly because of the character of the monsoon rains, which occur between May and October, but also because of the rapid melting of snow and glaciers during the summer, which adds still further to the volume. The average discharge of the river near the head of the delta varies between a low of 82,000 and a high of 1,152,000 cubic feet (2,300 and 32,600 m3) per second; the annual average discharge is 460,000 cubic feet (13,000 m3) per second. The range between high and low water is also great. Annual variations between low-water level and flood level of 31.7 feet (9.66 metres) and 37.3 feet (11.37 metres) have been recorded at Mandalay and Prome, respectively. The lowest water level occurs in February, and the highest in August.

The Dokhtawaddy River has a very steep gradient of 1/670 in its upper reach from Hsewi to Yeywa and the flow is fast. The average annual flow is 17 billion cubic meter (541 m3/sec) (JICA, 2003).

Figure [29] **AYEYARWADDY CATCHMENT AREA**



Floods in Mandalay may occur from 3 different major causes/driving and interacting forces:

- Extensive rainfall on the city itself, and a lack of urban drainage facilities, causing inundation in the low and flat areas of the city;
- Riverine flooding from the Ayeyarwaddy river;

- Large inflows to the urban drainage system of the city from rivers descending largely from the Shan Plateau to the east of the city.

The urban drainage situation of Mandalay city is quite complex, due to an intricate system of natural rivers and creeks, as well as man-made canals, that from one hand supply water to the city and from the other hand drain the city in case of excess water. There is no separate system for the discharge of storm water and urban wastewater. Similarly the canals and rivers flowing into and/or around the city provide water for agricultural purpose, for domestic water supply, as well as for flushing of the surface water system, as for instance the moat around the citadel, but also drain the city.

With regard to flood management basically the same is valid: The drainage canals in the city have to function in case of floods to discharge excess flood waters. On the other hand, the rivers around town like the Ayeyarwaddy and the Dokhtawaddy may create flooding as well, due to high water levels in the rivers and caused by floods from upstream, while overland floods may occur from the foothills in the east and/or the plains in the south.

The major existing infrastructure regarding urban drainage and flood management in Mandalay are:

- Mandalay main dyke on the West side of the city, protecting the city against flooding from the Ayeyarwaddy river;
- Lower grade dykes on the North- and East side of the city;
- Five major drainage gates, mainly on the West side of town, and a number of minor gates;
- A number of major drainage canals within the inner city;
- Three major and some minor pumping stations also on mainly the West side;
- Two large storage/retention ponds on the West side of the city.

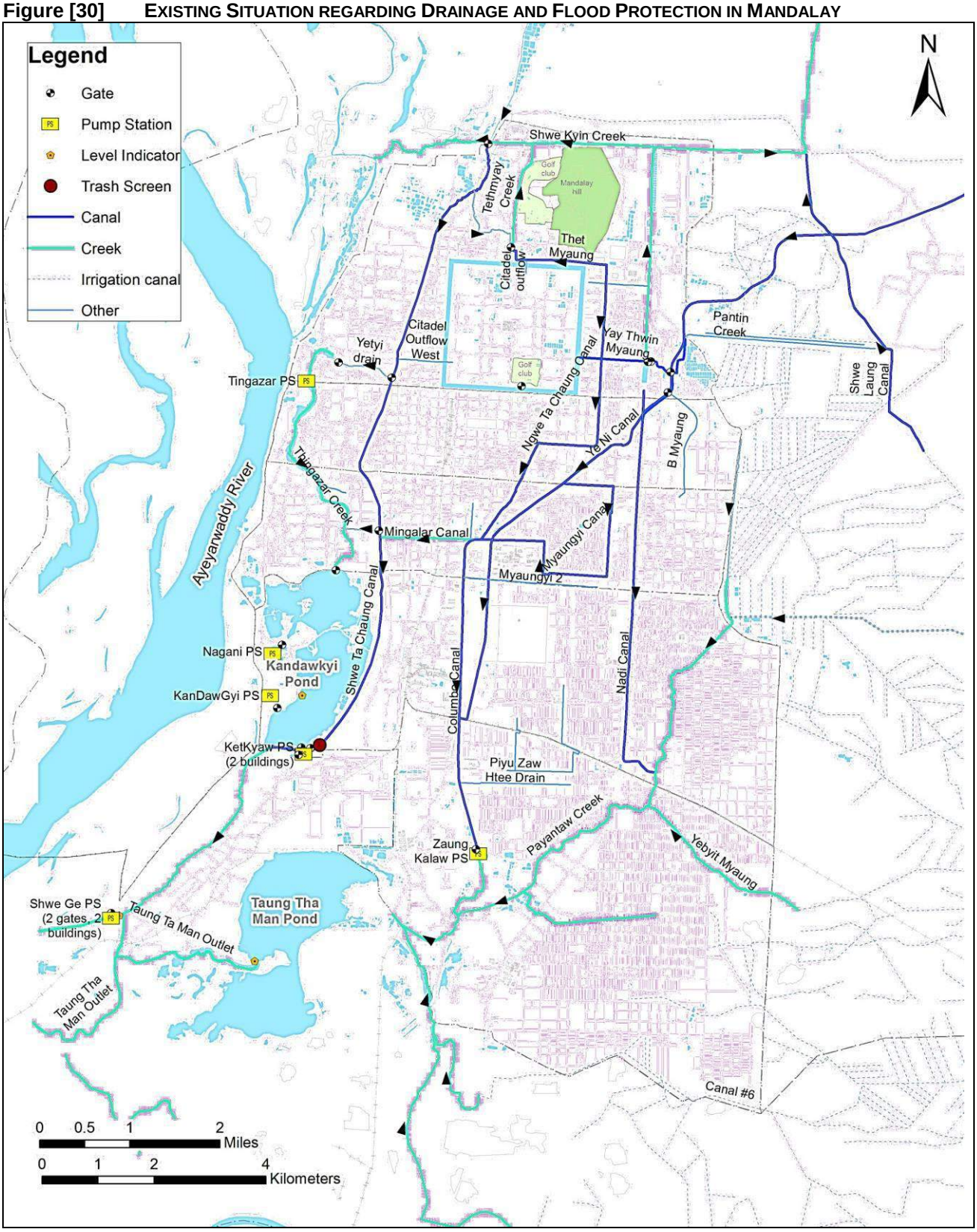
This existing situation is depicted on the following Figure [30] .

However observations and analysis have shown that the performance of the system generally is insufficient. For storms with a relative high frequency of 2 to 5 years already local flooding occurs, mainly caused by constraints in the system: drains/canals clogged by garbage, obstructions by small bridge openings, insufficient conveyance due to small cross-sections, insufficient flood storage, shortage of pumping capacity, lack of maintenance (cleaning, dredging). Flood prone areas in Mandalay are depicted on Figure [31] .

Conclusions from the diagnostic performed under this PPTA can be summarized as follows:

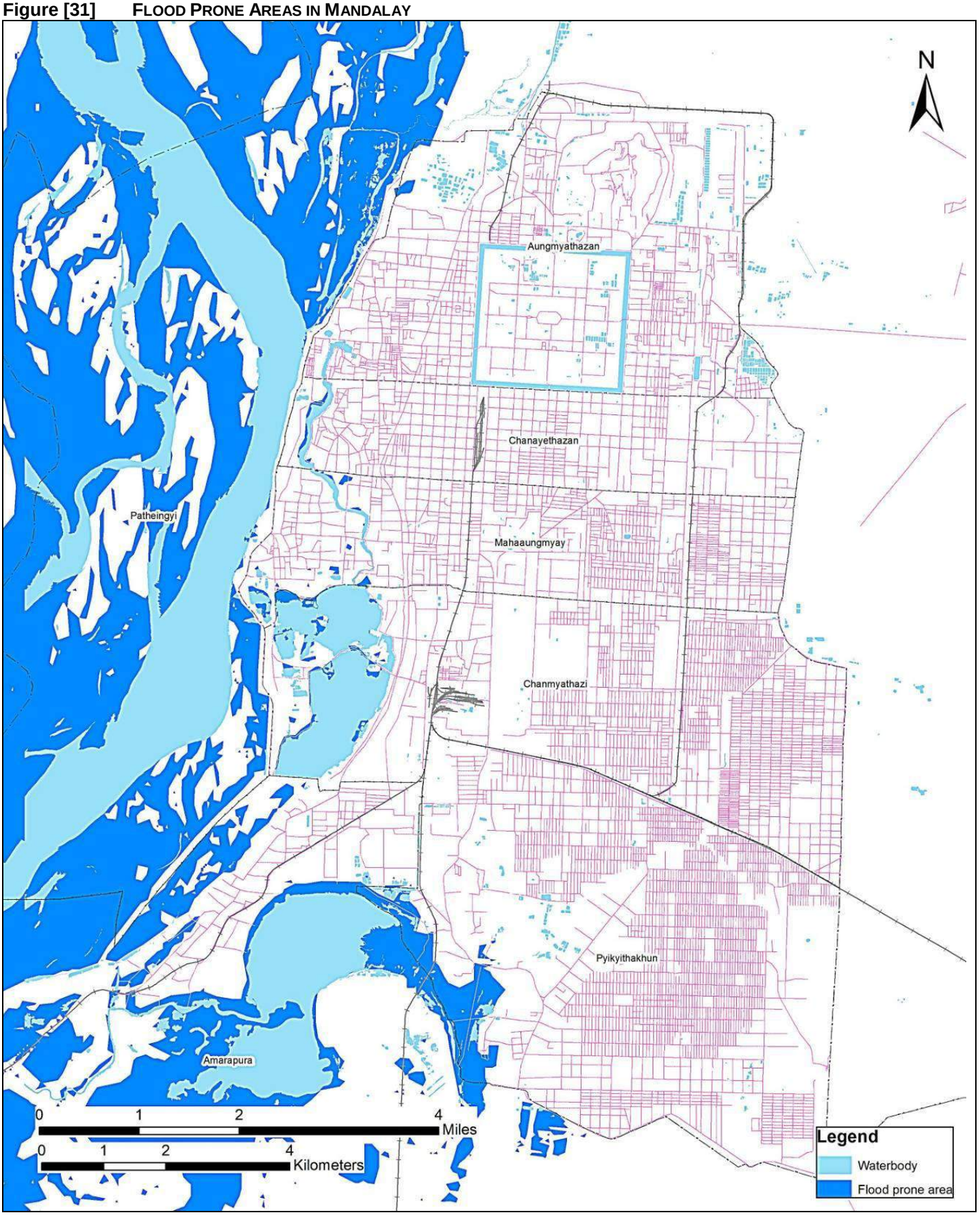
- Mandalay main dyke along the Ayeyarwaddy has not been overtopped in the last decades so this is not the cause of flooding anymore;
- The highest water level of the Ayeyarwaddy at Mandalay station since 1968 was 13.82 m at the gauge, or 71.54 m above Mean Sea Level (in 2004); the dyke crest being at 72.0 +MSL gives a protection against floods of approximately once per 100 years;
- In the NW part of town there is infrequent flooding that may be caused by leaks in or seepage through the Mandalay main dyke;
- Flooding problems in Mandalay are actually caused by local rainfall and impaired drainage, as the system can't carry the 5 year runoff anymore;
- Another potential cause of flooding is drainage water coming from the Eastern foothills, i.e. the Shan plateau, specifically causing problems when the water levels are already high in the city's drainage canals and the whole system is saturated;
- Finally, large scale flooding may happen South-West of the town and the Amarapura area caused by backwater flow when the water levels of both Ayeyarwaddy and Dokthawaddy rivers are high at the same time.

Figure [30] EXISTING SITUATION REGARDING DRAINAGE AND FLOOD PROTECTION IN MANDALAY



Source: PPTA Consultant, 2014

Figure [31] FLOOD PRONE AREAS IN MANDALAY



4.5. HYDROGEOLOGY

According to the final report of the on the study on water supply systems in Mandalay City (Volume 1.11 by Japan International Cooperation Agency) the general overview of the soil layers and aquifer layers of Mandalay is summarized in the following Table [13].

Table [13] SOIL AND AQUIFER LAYERS IN MANDALAY (JICA 2000)

SOIL LAYER	BED TYPE	CLAY/SOIL TYPE	DEPTH	AQUIFER LAYER	AQUIFER TYPE	WELL TYPE
I st Layer	Alternating bed	Rich in clay	30-40 m	1st Aquifer	Phreatic (unconfined) Aquifer	Dug well
II nd Layer	Alternating bed	Rich in sand	70-72 m	2nd Aquifer	Shallow Confined Aquifer (partially unconfined),	Shallow tube well
III rd Layer	Clay bed	Hard clay, almost blue	90-97 m	-	-	-
IV th Layer	Send bed and Alternating bed	Rich in sand	170 m	3rd Aquifer	Deep Confined Aquifer	Deep tube well

The Ist, IInd and IVth layers are consistent with 1st to 3rd aquifers respectively. The bottom clayey layer of the first Layer, and clay bed of the IIIrd Layer play a role of confining layers. Consequently, groundwater of the 1st aquifer is phreatic or unconfined and tapped by dug wells, while groundwater of the 2nd and 3rd aquifers is confined and drawn by installed shallow and deep tube wells. The 2nd aquifer, however, could partially be unconfined depending on the geological situations. The 1st to 3rd aquifers will also be called here Phreatic, Shallow Confined and Deep Confined Aquifers respectively. In the 3rd aquifer, two to three aquifers are sometimes found up to about 170m in depth, and in many places of Mandalay city, the lower part of the 3rd Aquifer shows alternation of sand and clay.

4.6. AIR QUALITY

In respect to ambient air quality, there is no available air quality standard established in Myanmar for its own use. Therefore relevant international guidelines and standards were used to compare the findings. Air quality monitoring was conducted in January 2008 by National Commission for Environmental Affairs (NCEA) at three selected sites in Mandalay commercial, residential, and near to industrial zone areas. These air quality monitoring activities were the first initiative conducted in Myanmar. The 24 hours average concentrations of NO_2 and SO_2 levels in three selected sites are well below the WHO Guideline. The TSPM and the PM10 at the three sites are higher than the WHO Guidelines.

More generally, air quality is still reasonably good in Mandalay. Suspended matter is sometimes high, but it is just the consequence of the prevailing dry climate conditions combined with a multitude of areas with bare ground.

Table [14] AIR QUALITY IN MANDALAY (24 HOURS AVERAGE CONCENTRATIONS, JANUARY 2008)

SITE	TSPM (µG/M3)	PM10 (µG/M3)	SO2 (µG/M3)	NO2 (µG/M3)
Commercial (Zai Cho Market)	495.87	112.498	0.86	32.13
Residential (MCDC Office)	213.08	61.67	0.98	17.80
Industrial (Mandalay Industrial Zone)	350.57	131.54	1.50	19.14
WHO Standards	-	50 (24-hour mean)	20 (24-hour mean) 500 (10-minute mean)	40 (annual mean) 200 (1-hour mean)

Ministry of Transportation, 4th Regional Environmentally Sustainable Transport Forum (2009)

4.7. SURFACE WATER QUALITY

4.7.1. AYEYARWADDY RIVER

A study[3] was carried out in 2013 on the water quality of the Ayeyarwaddy River, looking particularly on the impacts resulting from mining activities. The study found high arsenic levels, up to 30 ppb (parts per billion) in Sint Ku and Mandalay in dry season while the downstream sites observations at Pyi, Hinthada, and Nyaung Done were only 10 ppb. Monsoon arsenic levels were lower to 10 ppb in Sintku and Mandalay while the downstream observations showed negative results. Both WHO and US-EPA set maximum contaminant level of arsenic in drinking water at 10 ppb. In accordance with US-EPA, long term exposure to high arsenic can cause cancer of lungs, skin, prostate, kidney, and liver.

Arsenic contamination stems from disturbance of soil layers below the surface or as a by-product from copper, gold, silver, and meal ores mining operations. Arsenic is not used in mining operations, but arsenic dust is released from the soil by the soil disturbance during mining operations. In addition to high arsenic presence, higher cyanide levels than WHO guideline level of 0.07 mg/L were found in Sint Ku, Mandalay, and Nyaung Done. According to WHO standards, cyanide levels of greater than 0.07 are deemed unsafe. The levels range from 0.08 to 0.14 mg/L and high concentrations were observed in both dry and monsoon season. The highest level, 0.14 mg/L, was observed in Sint Ku. Seasonal and regional variations in arsenic and cyanide levels may suggest that natural cause is not the underlying factor but intensive mining activities in upper Mandalay.

Despite causing low risks to human health, ammonia nitrogen can pose harm to the health of the river and to the ecosystem. Direct sewage disposal, leaching from landfills which are not properly sealed, organic wastes and manure are associated with high ammonia nitrogen concentration in rivers (WHO, 2003). With the practice of dumping solid wastes and of discharging raw sewage directly into the river, one can expect to see high concentration of ammonia nitrogen in the river.

In addition to high ammonia nitrogen level, significant levels of coliforms and E. coli are observed consistently in the river. It confirms raw sewage and leachate pollutions from municipalities and shipping operations. Coliform counts in 100 mL of water range from 240 to over 2000 while E. coli counts range from 40 to 3200. These counts are very high.

A follow up survey has been conducted by the PPTA Consultant during January 2015 (the dry season) without detecting any of the above mentioned anomalies. However, these surveys will need to be continued quarterly (and to coincide with the pre-monsoon and monsoon seasons) to validate the above findings.

Data for Mandalay are provided in Appendix 4.

4.7.2. SURFACE WATER QUALITY IN MANDALAY

Survey and sampling was carried out by a laboratory (E-Guard) appointed by the PPTA Consultant in November 2014. Sampling concerns water and bottom sediment, from canals and creeks in Mandalay, particularly in those areas where dredging is considered. Results are still expected at the time of this draft report. However, in situ measurements performed during the sampling campaign are available and provided in the following Table [15]. Sampling points are located on following Figure [32] .

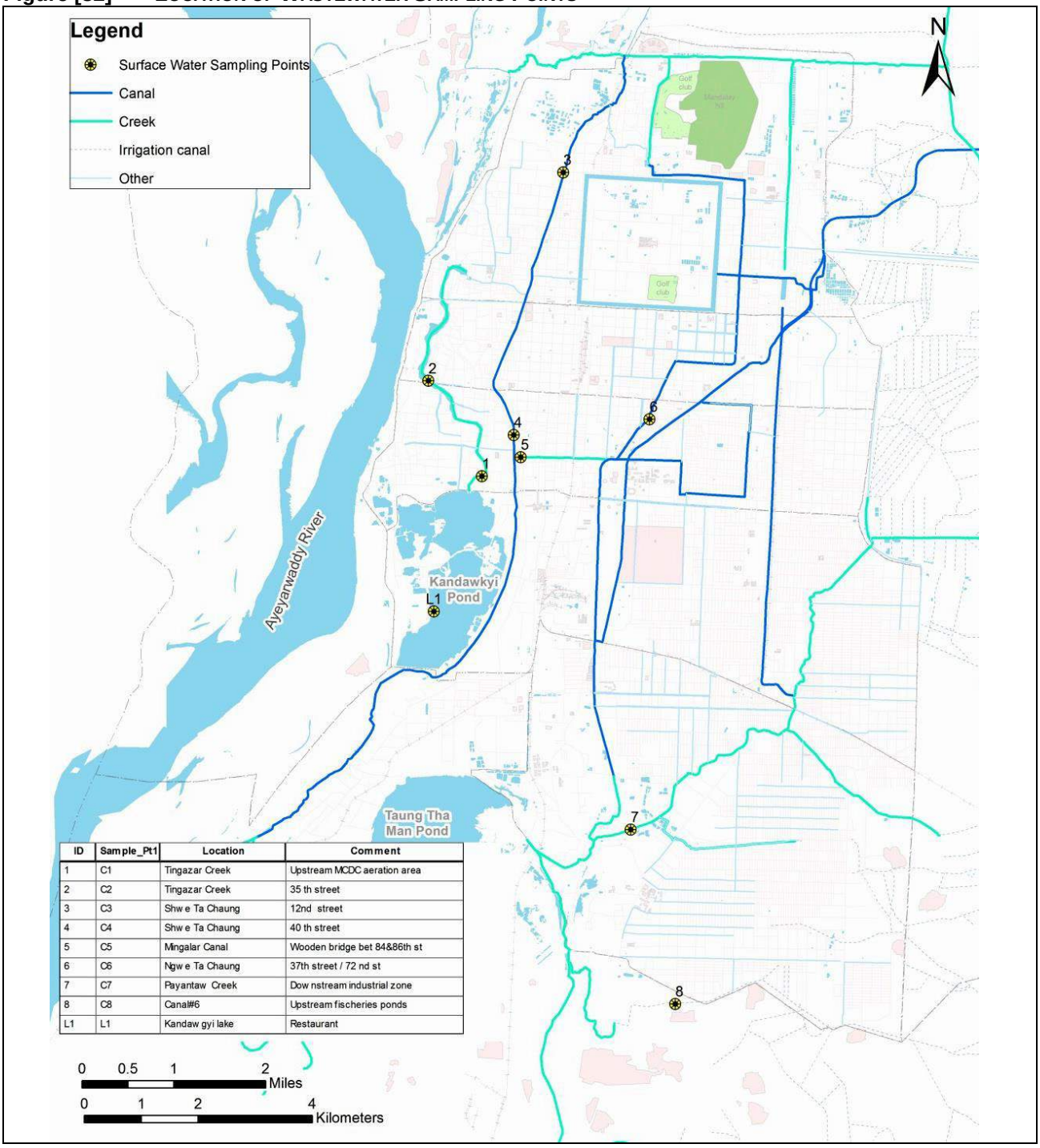
Table [15] WASTEWATER IN-SITU MEASUREMENTS

ID	TEM (°C)	DEPTH (M)	PH	COMPENSATED EC (MS/CM)	TDS (PPM)	SALINITY (PPT)	DO (PPM)	COD (PPM)
C – 01	29.1	1	7.55	659	428.3	0.3	2.44	50<val<100
C – 02	31.8	0.6	7.71	598	388.5	0.3	4.05	50<val<60
C – 03	29.7	0.8	9.1	1619	1049	0.8	0.24	≥ 100
C – 04	27.7	0.8	7.16	732	475	0.4	3.4	75<val<100
C – 05	27.8	≤ 0.3	7.47	1239	805	0.6	2.7	75<val<100
C – 06	28.2	≤ 0.3	7.35	962	625	0.5	5.3	90<val<100

[3] J. Bowles, 2013; Ayeyarwaddy the River Endangered, Myanmar Development Research Institute (MDRI)

ID	TEM (°C)	DEPTH (M)	PH	COMPENSATED EC (MS/CM)	TDS (PPM)	SALINITY (PPT)	DO (PPM)	COD (PPM)
C – 07	26.5	≤ 0.3	6.99	379.5	246.3	0.2	2.7	-
C – 08	26	0.5	7.2	389	25.3	0.2	3.86	-
L - 01	29.5	1.5	8.31	731	474.9	0.4	1.98	20<val<50

Figure [32] LOCATION OF WASTEWATER SAMPLING POINTS



Source: PPTA Consultant, Survey 9/11/2014

4.8. UNDERGROUND WATER QUALITY

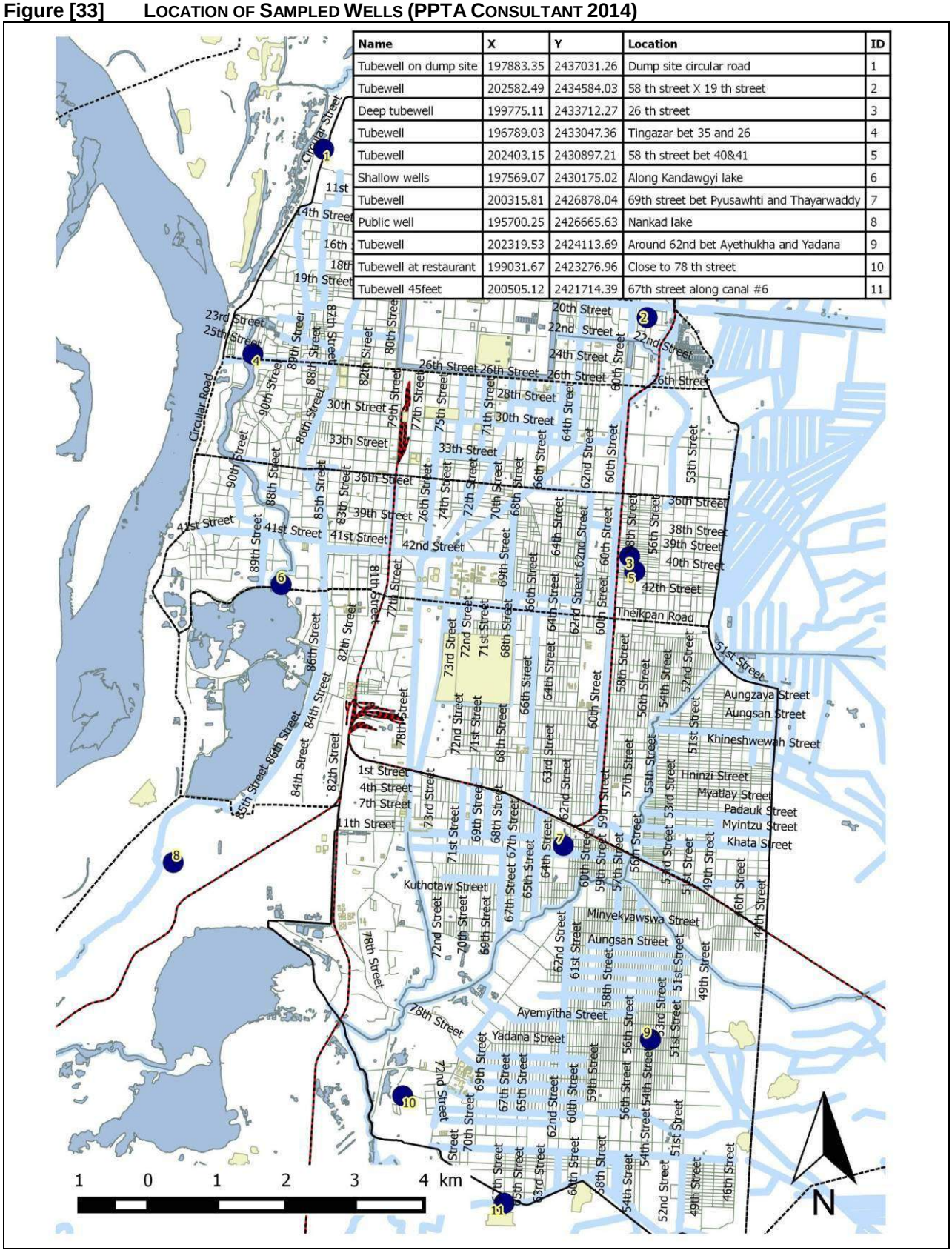
The JICA study on water supply systems in Mandalay City concluded that most of the groundwater belongs to non-carbonate hardness type or mixture type, except that some of shallow confined groundwater contains slightly higher magnesium and/or lower calcium. It was found that the wells from downtown have low ion concentration in deep confined groundwater. On the other hand, in the southern and eastern side of the city, deep confined groundwater is relatively high in sodium, chloride and calcium. Results are provided in following Table [16] based on surveys undertaken by the PPTA Consultant in November 2014. If most of the wells are chemically potable, their contamination by coliforms, from septic tanks and surface wastewater drains represent a major public health issue for the population of Mandalay. Dysentery and diarrhoea are the most common infections registered by the health services. Location of sampled wells is provided in Figure [33] .

Table [16] RESULTS FROM WATER QUALITY OF SAMPLED WELLS

ITEM CODE	COLOUR	PH	TOTAL SOLIDS	TOTAL HARDNESS	TOTAL ALKALINITY	CA	MG	CL	SO4	NO3	TOTAL FE	COLI FORM	CHEMICAL POTABILITY
STW - 1	5	7.4	1420	390	715	116	17	160	362	8.8	Nil	0/5	Yes
STW - 2	5	7.0	1320	10	975	80	24	90	98	4.4	Nil	1/5	Yes
DTW - 3	5	8.2	798	30	650	4	5	20	69	<4.4	Nil	0/5	Yes
STW - 4	15	7.5	1780	560	1040	44	36	120	490	22	Nil	5/5	No
STW - 5	5	8.3	1240	200	910	32	14	60	176	8.8	Nil	5/5	Yes
STW - 6	5	6.6	1525	600	650	80	36	180	529	4.4	Nil	3/5	No
STW - 7	5	8.3	1140	180	780	24	17	120	147	8.8	Nil	1/5	Yes
STW - 8	8	7.1	1642	740	1040	184	38	320	9.8	8.8	Nil	5/5	No
STW - 9	5	8.1	1195	260	845	56	26	80	137	4.4	Nil	2/5	Yes
STW - 10	5	7.1	1395	480	910	88	34	120	194	<4.4	Nil	2/5	Yes
STW - 11	5	7.4	1080	300	650	48	22	80	196	<4.4	Nil	0/5	Yes

Source: PPTA Consultant

Figure [33] LOCATION OF SAMPLED WELLS (PPTA CONSULTANT 2014)



Source: PPTA Consultant, Survey 9/11/2014

4.9. URBAN DEVELOPMENT

4.9.1. EXISTING SITUATION

Geographically, Mandalay sits in the middle of a large plain, bordered by the Ayeyawaddy River, the hilly plateau of the Shan State in the east and Mandalay hill on the north-east corner of the fort. It consists mostly of modern buildings, and the occasional older structure which escaped the WW2 bombings. Unlike the capital, Yangon, Mandalay is an ancient city. The layout was planned by King Mindon in 1857 as a new capital city for the kingdom of Ava. It is the last royal capital of Myanmar. The original site was determined by religious considerations: it was to be 66 km2 in area, consisting of a 144-square block grid, with a 16 square block royal palace compound at the centre close to Mandalay Hill. There were originally 4 Townships: Aungmyethazan, Chanayethazan, Chanmyathazi and Mahaaungmye (total km2 81.6), which were joined in 1993 by Pyigyidagun (25.6 km2). In 2011, Amarapura (207.5km2) was also incorporated within the Mandalay City boundaries. The total area of the City is now 314.7 km2 (or 121.5 miles2) and consists of six townships, further divided into 96 wards, 42 village tracts and 170 villages.

The city has no one centre: there are several locations vying to be city magnets based on different functions, notably the tourist attracted areas north and east of the Fort near Mandalay Hill; the original civic centre around the Zeigyo Clock tower and central market; and also the new expanding shopping strip opposite the Railway Station on 78th Street.

The modern urban development of Mandalay city has largely followed the plan and intentions set out in the mid-19th century, but have now outgrown the original area which was circumscribed by 4 clearly defined waterways. The main expansions have been to the south, over and beyond the Royal Gardens and recently into the southernmost Mandalay township of Pyigyidagun. The urban area has also expanded west up to the Ayeyarwady river and around other water bodies, notably the Thaungthaman Lake in Amarapura. The presence of Sagaing (another old capital) which is accessible by road and rail bridges over the Ayeyarwady will also have encouraged development southwards.

The southern expansion of Mandalay will be reinforced in future with the planned development of 1,300 low-cost apartments in Chan Mya Tharsi Township. In addition, some 45 kms (28 miles) further to the south, a new satellite town (8,910 ha or 22,000 acres) is planned in the township of Tatar Oo near to the modern international airport.

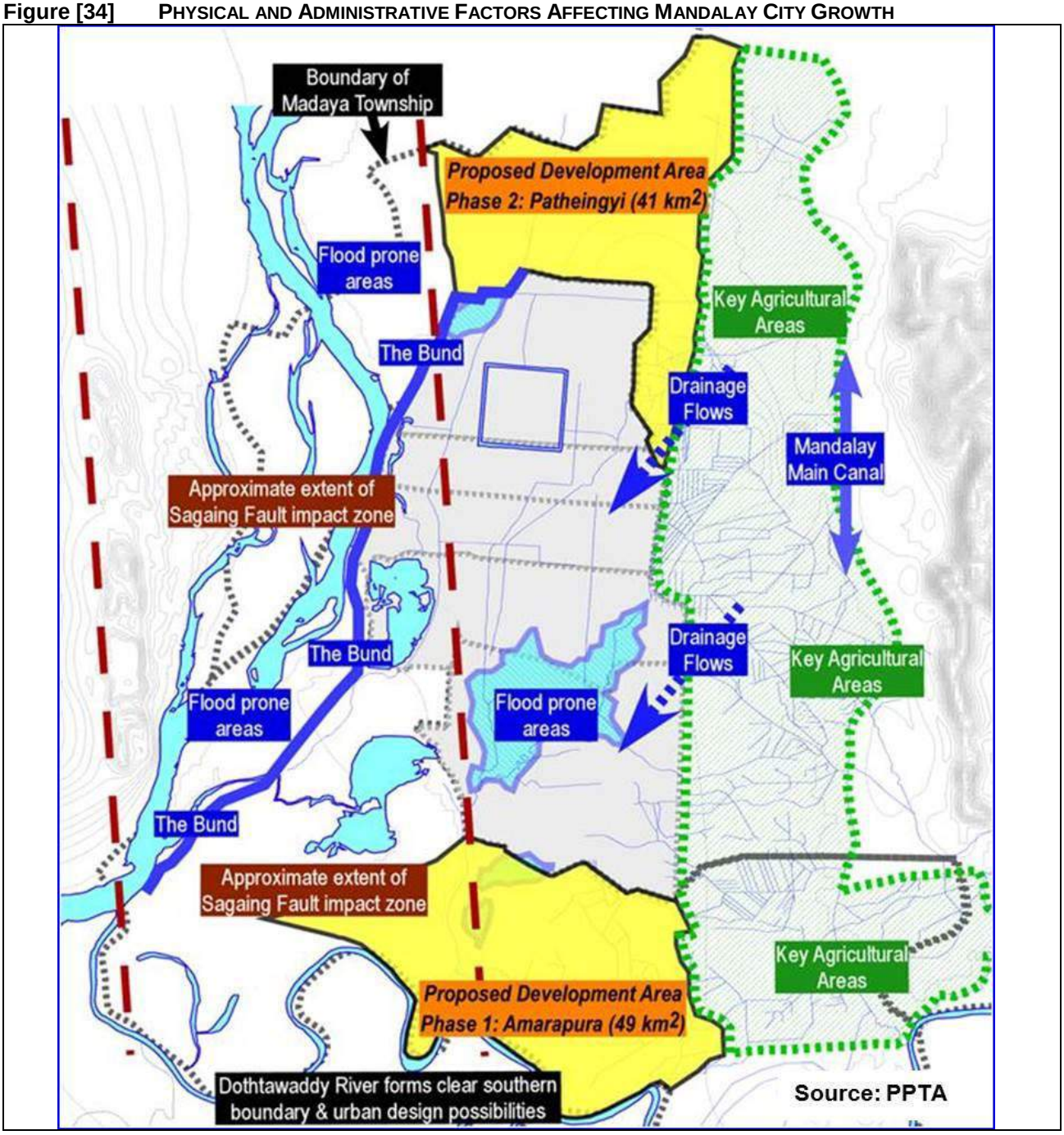
4.9.2. DEVELOPMENT TRENDS

In 2012, the Mandalay City Development Committee (MCDC) produced a conceptual Master Plan for directing development over the next 30 years. The plan envisages major growth to the south towards the new airport as well as west along the Ayeyarwady and the establishment of several urban centres to support future growth areas. Administratively, the concept assumes the inclusion of 3 additional Townships to the City's area; firstly Patheingyi; and then Madaya and Tada-U (total area of approximately 3,035 km^2 or 1,172 miles2). In population terms this would translate into some 2.4 million people by 2020, 3.1 million by 2030 and 4 million by 2040. This is effectively a doubling of the City's population within the next 15 years and a tripling in 25 years.

The PPTA Consultant has identified several major factors which should be taken into account when planning for future urban growth in and around Mandalay as shown on following Figure. These include the need to:

- Protect good quality agricultural land and associated surface water networks to the immediate east of Mandalay (shown in Green on the Figure) up to the Mandalay Main Canal.
- Ensure that use of flood prone areas, mostly to the west of Mandalay (and especially west of the main north-south railway line) is minimized in future (water related aspects shown in Blue).
- Consider the Sagaing Fault which runs north-south and which should influence building heights and designs especially to the west of the main north-south railway line (main area of impact zone shown in Brown).
- Consider other Natural (e.g. Dokhtawaddy River) & Administrative (e.g. Madaya Township) features which form logical development boundaries (shown in Black).

Figure [34] PHYSICAL AND ADMINISTRATIVE FACTORS AFFECTING MANDALAY CITY GROWTH



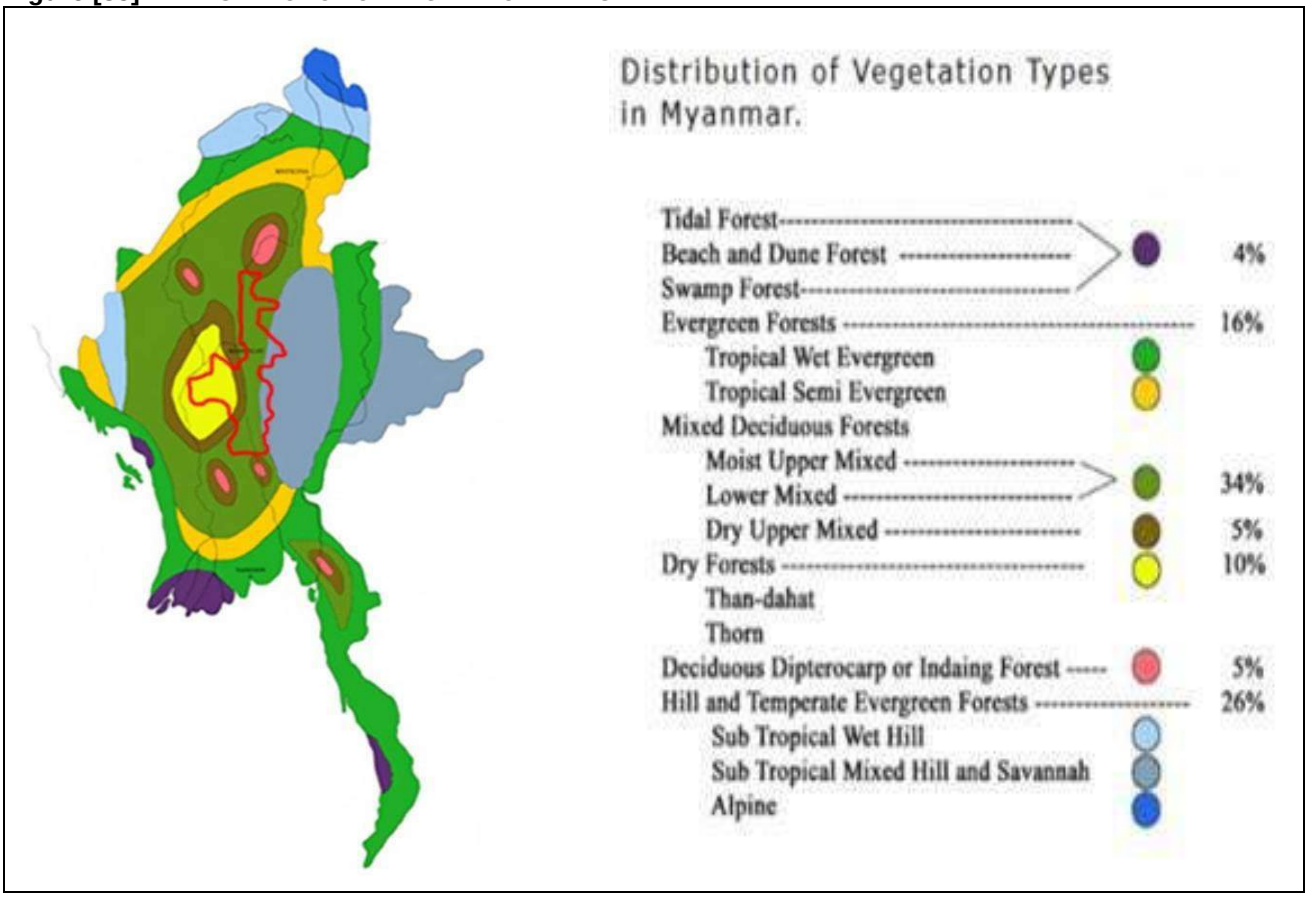
Source: PPTA Consultant, 2014

4.10. TERRESTRIAL & AQUATIC ECOLOGY

4.10.1. NATURAL AND URBAN VEGETATION

As shown on the following map of Myanmar vegetation types, there is in Mandalay Region various vegetative types ranging from Moist Upper Mixed Deciduous forest, Lower Mixed Deciduous forest, Dry Upper Mixed Deciduous Forest, and Sub Tropical Mixed hill and Savannah.

Figure [35] DISTRIBUTION OF VEGETATION TYPES IN MYANMAR



Source: A Checklist of the Trees, Shrub, Herbs, and Climbers of Myanmar. Contributions from the United States National Herbarium. Volume 45: 1-590

However Mandalay city proper falls in the driest area dominated by dry forests characterized by Than-dahat (*Tectona hamiltoniana* –teak) and the thorny *Terminalia oliveri* in the drier patches with stands of Indaing (*Dipterocarpus tuberculatus*). The road between the city and Mandalay airport crosses this typical vegetation showing open savannah aspect. The following tree and shrub species are the most common ones observed in Mandalay city and its surroundings.

Table [17] LIST OF TREES AND SHRUBS COMMON IN MANDALAY CITY AND AROUND

VERNACULAR NAME (BURMESE)	SCIENTIFIC NAME
Htan pin	*Borassus flaballifer*
Da hat pin	*Tectona hamitoniana*
Sharr pin	*Acacia catechu*
Kyaun Khaung Nwal pin	*Vitex limnonifalia*
Yin Mar pin	*Chukrassia tabularis*
Sate chay pin	*Bridelia retusa*
Shaw phyu	*Sterculia foetidal*
Phyuak sate	*Holoptelea integrifalia*
Lal lu	*Olax europaL*
Nant thar phyu	*Santalum albam L*
In Gyin pin	*Shorea siamense*
Ngu pin	*Cassia fistulal*
Pa Dauk	*Pterocarpus macrocarpus*
Ta Mar	*Azadirachta indica*

VERNACULAR NAME (BURMESE)	SCIENTIFIC NAME
Baw Sa Gine	*Leucaena glauca*
Sain pan	*Delonix regia*
Ta Yote Sa Gar	*Plumeria alba*
Ma Gyee	*Tamarindus indica*
Koak Ko	*Albizzia lebbek*
Phwar Phat	*Cassia renigera*
Na Bal pin	*Lannea grandis*
Tha Mone pin	*Boscia variabilis*
Sue Yit	*Acacia ferruginea*
Hta Naung pin	*Acacia leucophloea*
Kyoon pho	*Premna pyramidata*
Warr pin	*Bamboosa sp.*
Thit Pa Lway	*Balanites triclora*
Nyaung pin	*Ficus religrasa*
Nyaung Chin pin	*Ficus infectoria*
Sat Ku pan	*Bouganimllea glabra*
Sue Pote	*Acacia pennata*
Taw Ma Gyee	*Elaeocarpus robustus*
Zaung Chan pin	*Capparis flavicans*
Shar Zaung pin	*Euphorbia trigona*
Bar Dan pin	*Terminalia catappa*
Ka Lar Ta Mar, Lan tamar	*Polythia longifolia*
Ar thaw ka	*Polythia longifolia (var blune)*
Ar thaw Ka (round)	*Polythia longifolia (var bandurata, pendula)*
Swal Taw	*Bauhinia*
Eu-ca-lit	*Eucalyptus albens, Eucalyptus cinerea or Eucalyptus ovata*
Mai-sai-le	*Broussonetia papyrifera*
Tayok-magyi	*Pithecellobium dulce*

Source: MCDC

4.10.2. AQUATIC FAUNA

Aquatic fauna in Mandalay is observed in major water bodies such as Ayeyarwaddy River, Dokhtawaddy River, Thaungthaman Inn and Kantawgyi Lakes. The following Table [18] indicates some species of freshwater fishes observed in those water bodies.

Table [18] MAIN FISH SPECIES IN MANDALAY REGION WATER BODIES

COMMON NAME	SCIENTIFIC NAME
Featherback	*Ompok/Notopterus*
Snakeskin gourami	*Trichogaster*
Snakehead	*Channa spp.*
Spiny eel	*Mastacembelus*
Catfish	*Clarias spp.*
Glass fish	*Amblypharyngodon*
Rasbora etc.	*Rasbora spp., Danio*

COMMON NAME	SCIENTIFIC NAME
Gobies (sand)	*Glossobobius spp.*
Freshwater eel	*Anguilla spp.*
Various barbs	*Puntius spp.*
Rohtee	*Osteobrama spp.(Rohtee coti).*
Black shark minnow	*Morulius chrysophekadion*
Common carp	*Cyprinus carpio*
Rohu	*Labeo rohita*
Mrigal	*Cirrhinus mrigala*
Grass carp	*Ctenopharyngodon idellus*
Loaches	*Cobitidae*
Large river catfish	*Pangassius & Selonia*
Wallago	*Wallago attu*
Atyid shrimp	*Attidae spp.*
Freshwater prawn	*Macrobrachium rosenbergii*
Freshwater crab	*Paratelphusa spp.*

Source: Myanmar, Mission Report on Inland Aquaculture and Fisheries, FAO

Concerning freshwater shrimps and prawns found in Mandalay water bodies, some researches were carried out at Mandalay University within the context of thesis works. From July 2001 through April 2002, Ayeyarwaddy River, Myint Nge River, Kantawgyi Lake and Taung thaman Inn Lake were studied and the observed species are presented below:

- Macrobachium malcolmsonii
- Macrobrachium idae
- Macrobrachium rosenbergii
- Macrobrachium rude
- Macrobrachium dolichodactylus
- Macrobrachium lanchesteri
- Marcobrachium tenuipes
- Macrobrachium mirabile
- Macrobrachium javanicum
- Macrobrachium scabriculum
- Macrobrachium sp

Of major importance, the river is also habitat to the Ayeyarwaddy (Irrawaddy) Dolphin, *Orcaella brevirostris* which is one of only four species of river dolphins in the world and listed as Vulnerable on the IUCN Red List of Threatened Species. The area of presence of the dolphin is located just north of Mandalay city, in a 70 km stretch of river from Mingun to Kyaukmyaung. This is discussed in further detail in section 4.11 (Protected areas and species) of this report.

4.10.3. TERRESTRIAL FAUNA

According to the world birds database (http://avibase.bsc-eoc.org) Mandalay region records 594 bird species from which 14 species are classified as globally threatened and 2 as introduced species.. Obviously, only a small proportion of these can be observed in the city area, mainly located in the surrounding flood prone areas, with less population density and more open vegetated spaces.

In 2006, study on the Bats species in Tadaoo Township in Mandalay was done by the Mandalay University and the observation results of 8 species:

- Cynopterus sphinx Vahl
- Taphozous melanopogon Temminck
- Rhinolophus Lepidus Blyth
- Hipposideros larvatus Horsfield
- Hipposideros Pomona Andersen
- Scotophilus hethii Horsefield
- Scotophilus heathii Horsefield
- Miniopterus pusillus Dobson

Some other studies were carried out by Mandalay University, particularly on butterflies and beetles. It was found that 15 species of butterflies belonging to 3 families, and 10 genera were recorded in Mandalay city area between July and December 2012. A total number of 21 beetle species (insect) were recorded particularly in Patheingyi Township between August 2000 and May 2001.

One tree species, *Acacia ferruginea*, is classified as globally threatened by the IUCN red list. None of the other terrestrial species listed so far are considered endemic or benefit a particular status of being protected, threatened or critically endangered. Furthermore, the anticipated components of MUSIP1 will not have any particular detrimental effect on those species or their habitats. Preventive measures will be considered during construction in case some individual of Acacia ferruginea is present on a MUSIP site.

4.11. PROTECTED AREAS AND SPECIES

4.11.1. PROTECTED AREAS

The National parks and protected areas in Mandalay region are Popa Mountain National Park near Pagan and Kandawgyi National Botanical Gardens in Pyin Oo Lwin. No terrestrial protected natural area is located within or in the vicinity of the Project zone (Myanmar Protected Areas, 2011). Location of Protected Areas in is presented in following Figure [37] .

4.12. AYEYARWADDY DOLPHIN

As already mentioned, the river is habitat to the Ayeyarwaddy Dolphin, *Orcaella brevirostris* which is one of only four species of river dolphins in the world and listed as Vulnerable on the IUCN Red List of Threatened Species. However, the dolphins' population in the Ayeyarwaddy has declined by nearly 60% in the last century. The best estimate of the current population is just 59 individuals (Smith, 2013).

MOECAF submitted on 25/02/2014 to UNESCO a proposal for the registration of the Ayeyarwaddy River Corridor (ARC) as a World Heritage Protected Area.

The Ayeyarwaddy River Corridor (ARC), covers a 400 km stretch of one of the last major undammed rivers in Asia. The ARC includes 3 segments where the presence of Ayeyarwaddy Dolphin has been proved: the Upper Segment between Shwegu to Bhamo, the Middle Segment between Takaung to Shwegu, and the Lower Segment between Mingun to Kyaukmyaung. In total, the corridor would protect 90,000 hectares of river and riparian habitat.

The Lower Segment (N22 19 11, E96 0 2) is the only section that has been subject to formal protection since 2005, with the implementation of the Ayeyarwaddy Dolphin Protected Area (PA). This PA was established after surveys by the Department of Fisheries (DOF) and Wildlife Conservation Society (WCS) which estimated that at least 59 dolphins were present. The area is managed by DOF and has yet to be formally gazetted. The PA is 72 km in length and runs from Mingun to Kyauk Myaung. It covers 32,600 hectares and is 10 km at its widest. Surveys have identified the presence of 35 fish species.

The ARC includes a globally unique sub-population of the Irrawaddy Dolphin renowned for its co-operative behaviour with local fishers. The ARC also provides important habitat for globally threatened birds and turtles, and could provide habitat for the re-introduction of a Myanmar-endemic turtle species. The ARC provides habitat vital to the survival of this sub-population, as well as for a range of other freshwater species including the CR White-bellied Heron, which may have a global population as low as 250. All three sections may provide habitat for the globally threatened and Myanmar-endemic turtles and for the future re-introduction of the CR Northern River Terrapin and the VU Burmese Eyed Turtle. Each section of the ARC overlap with an Important Bird Area, and the lower section has been identified as a potential Ramsar site.

Measures to protect Ayeyarwaddy dolphins include the prohibition of mercury use in gold mining operations, a ban on catching or killing dolphins or trading in their meat. Electro-fishing is also forbidden, as is the use of gillnets more than 300 feet (91 meters) long, or spaced less than 600 feet (180 meters) apart.

The Protected Area, illustrated on the following Figure is located upstream of Mandalay City.

Figure [36] LOCATION OF THE AYEYARWADDY DOLPHIN PROTECTED AREA

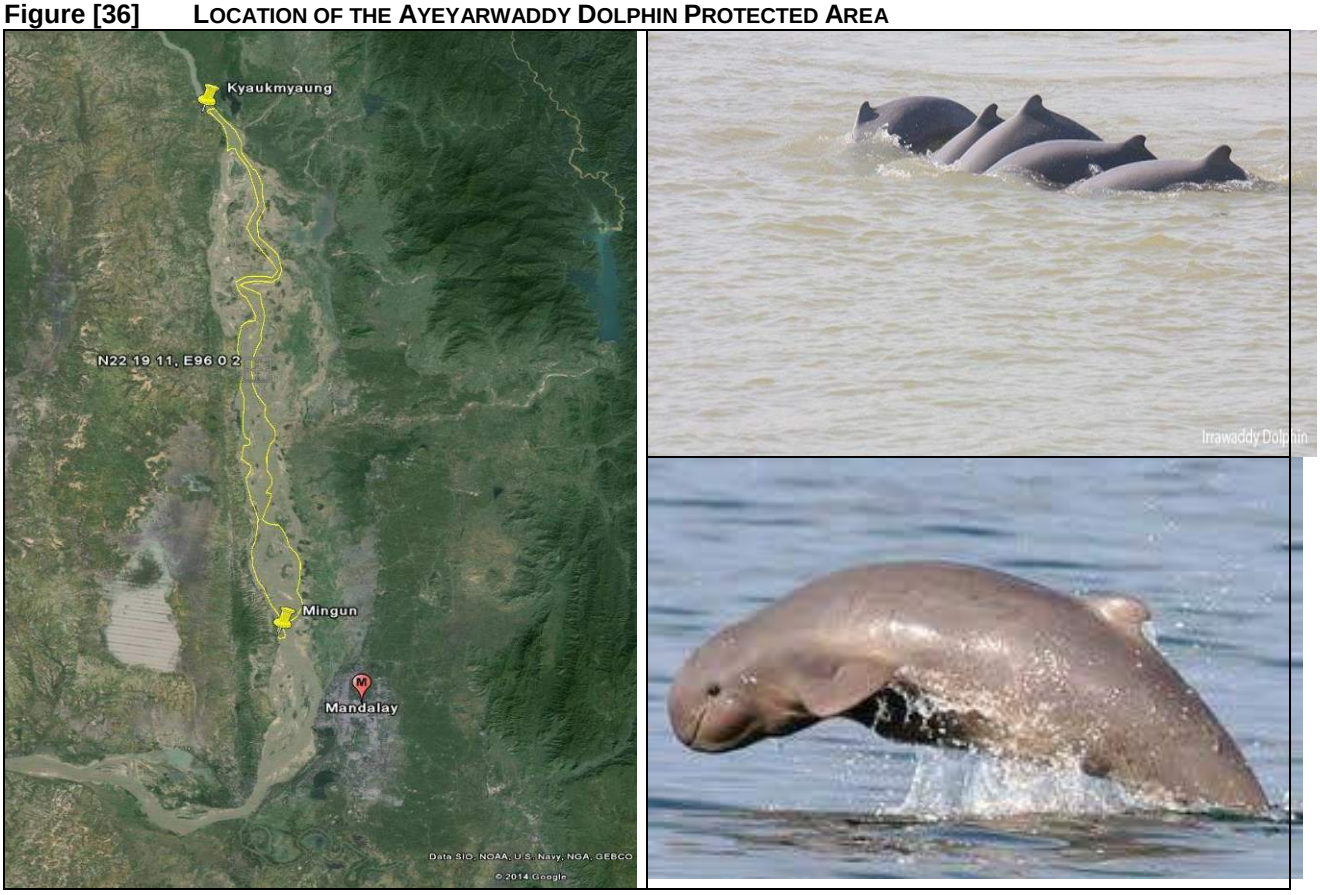
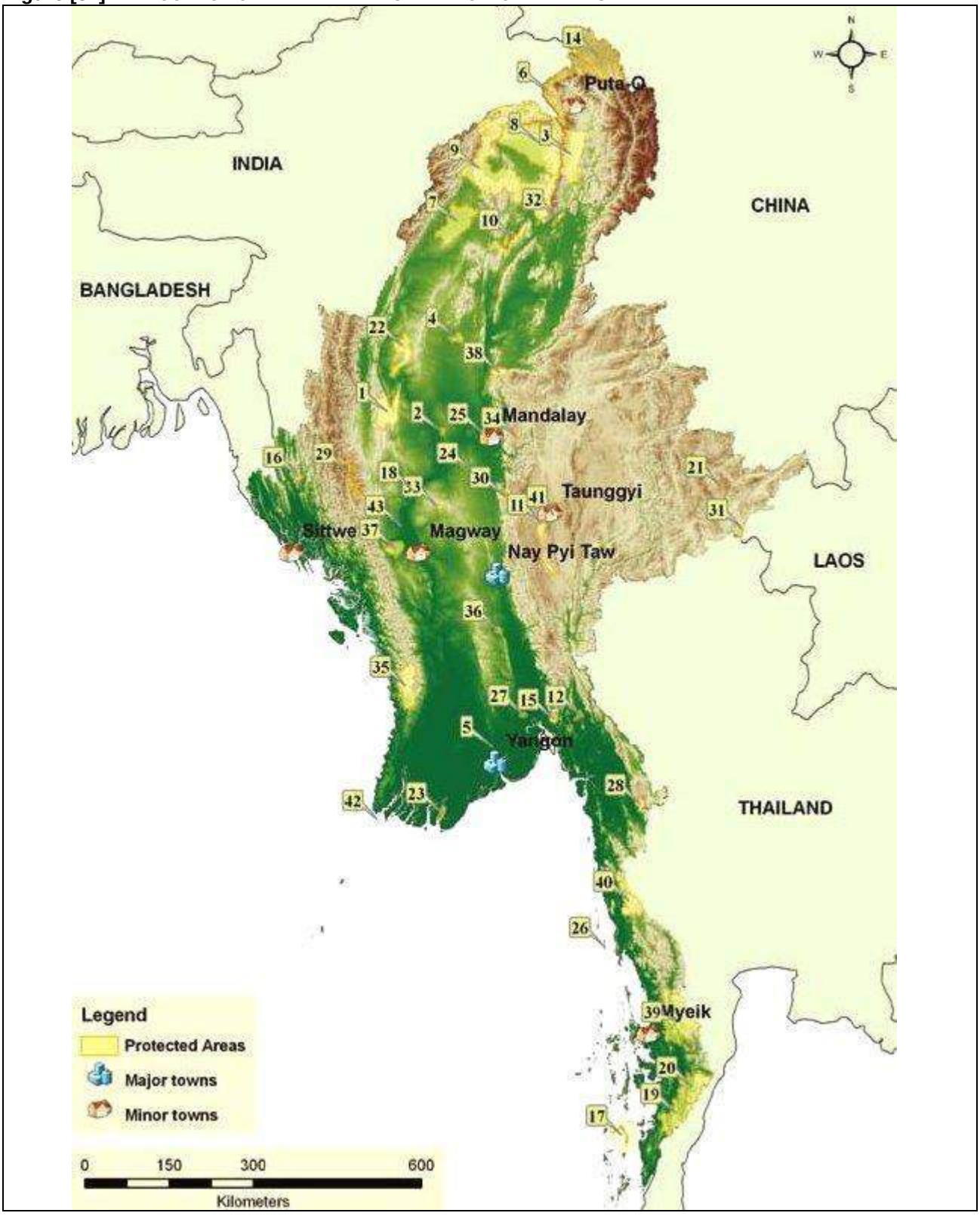


Figure [37] LOCATION OF MYANMAR NATURAL PROTECTED AREAS



Source:Myanmar Protected Areas, 2011

4.12.1. CULTURAL HERITAGE

Mandalay was the royal capital for 29 years from 1857, when King Mindon, the tenth king of the Konbaung Dynasty, transferred there the capital of Burma's last dynasty from Amarapura. This lasted until the dynasty was defeated in the Third Anglo-Burmese War in 1885 and Burma was colonialized by Britain. It continued to

be the chief city of Upper Burma and the hub of Burmese traditional culture even after the center of politics and economy moved to Yangon. The most famous places in Mandalay Archaeological Zone consists the Mya-Nan-San-Kyaw Golden Palace (Mandalay Royal Palace), Shwei-nan-daw Monastery, Maha Muni Paya and Thudhamma Zayat. Several monasteries and pagodas are distributed all over the city.

Within the areas proposed for MUSIP1 components implementation, two particular areas deserve concern:

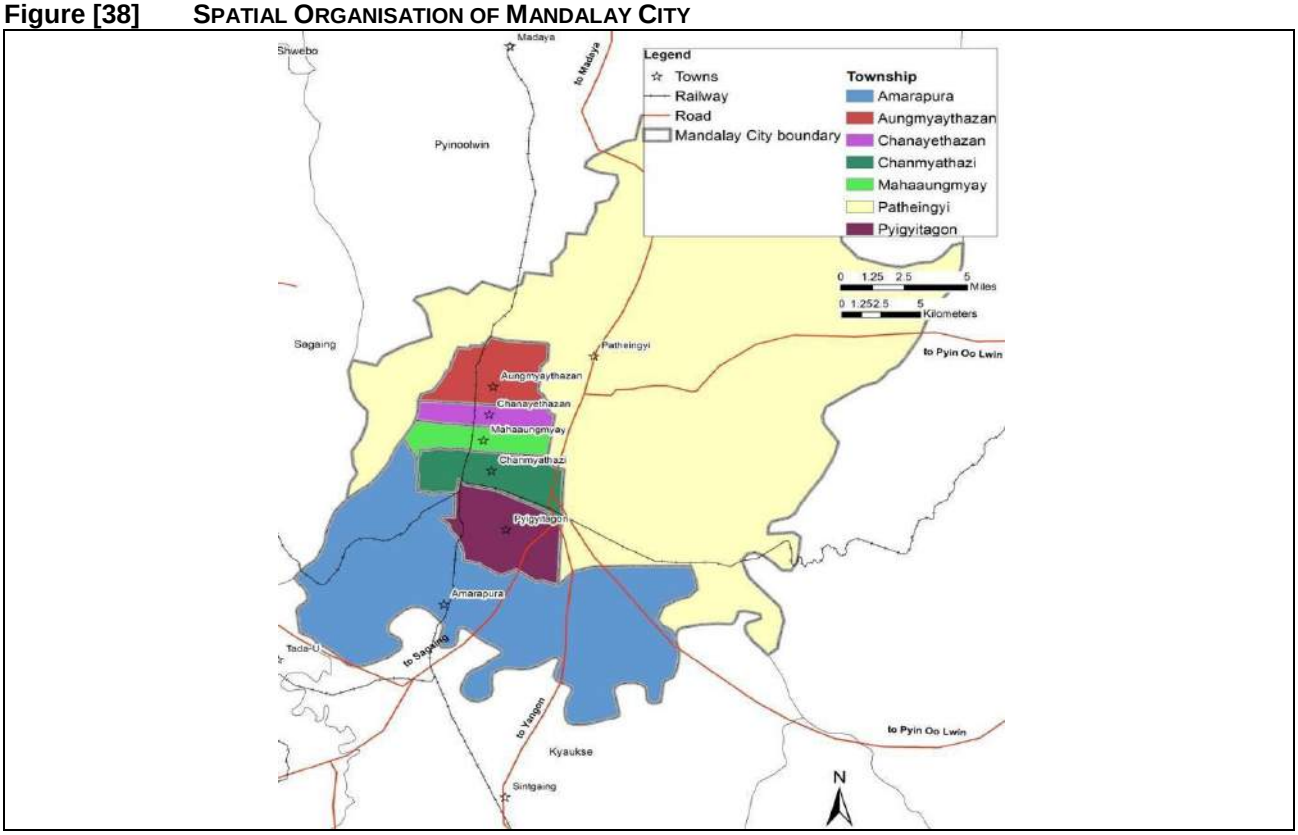
- Mandalay Hill, which shelters a large temple and other minor structures on its slope. The existing water supply reservoir is located on Mandalay hill. The precise affected area is devoid of any cultural resource.
- The downstream right shore of Thingaza creek, where two monasteries are located. As discussed later, the proposed interceptor has been re-routed (between 35th street to 41st street, and between 87th street to 89th street) from the creek shore (where it could have crossed part of the monastery lands) to surrounding roads in order to avoid disturbing the sensitive areas.

4.13. SOCIAL AND CULTURAL BASELINE

4.13.1. ADMINISTRATIVE ORGANIZATION

Mandalay District is a District of the Mandalay Division in central Myanmar. Though the district used to consist of two cities, Mandalay and Amarapura, today, with the urban sprawl of Mandalay capturing Amarapura and Patheingyi, the district and the city of Mandalay have become effectively one and the same. However, according to MCDC documents MCDC was currently responsible for providing urban services in 6 of the 7 townships excluding Patheingyi (this situation is changing with the integration of Patheingyi into MCDC serviced area). As a result, the present PPTA covers only six of the seven townships of the Mandalay District, namely Aungmyatharzan, Chanayetharzan, Mahaaungmye, Chanmyatharzi, Pyigyidagun and Amarapura, excluding Patheingyi. The map below details the spatial organization of Mandalay City.

Figure [38] SPATIAL ORGANISATION OF MANDALAY CITY



Source: PPTA Consultant, 2014

4.13.2. POPULATION

There is total population of 1,725,949 in Mandalay urban area according to the 2014 census. The population distribution is presented by Townships in the following Table [19].

Table [19] DISTRIBUTION OF POPULATION IN MANDALAY CITY

STATE/REGION/DISTRICT	TOTAL POPULATION			HOUSEHOLDS NUMBER	HOUSEHOLD SIZE
	BOTH SEXES	MALES	FEMALES		
Mandalay Region	6,145,588	2,919,725	3,223,863	1,324,696	4.40
Mandalay District	1,725,949	841,323	884,626	324,466	4.86
Aungmyatharzan	266,365	130,162	136,203	49,702	4.86
Chanayetharzan	197,312	93,216	104,096	33,270	4.80
Mahaaungmye	240,756	116,802	123,954	41,993	5.17
Chanmyatharzi	283,305	136,811	146,494	53,001	5.05
Pyigyidagun	237,395	120,756	116,639	43,918	4.99
Amarapura	236,748	114,161	122,587	49,506	4.51
Patheingyi	264,068	129,415	134,653	53,076	4.65

Source: Myanmar Population and Housing Census, Provisional Results, 2014

4.13.3. POVERTY AND GENDER ISSUES

4.13.4. EDUCATION

There are total 415 Basic Educational State Schools in Mandalay and the numbers of schools in each township are described in following Table. Regarding the student/teacher ratio, the figures are 1:22 for primary schools, 1:27 for middle schools and 1:30 for high schools respectively. Considering the higher education level, there are 18 numbers of universities, colleges and institutes in Mandalay.

Table [20] NUMBER OF BASIC EDUCATIONAL STATE SCHOOLS IN MANDALAY DISTRICT

TOWNSHIP	NUMBER OF SCHOOLS
Aungmyethazan	56
Chanayethazan	50
Mahaaungmye	38
Chanmyathazi	34
Pyigyidagun	25
Amarapura	102
Patheingyi	110
TOTAL	**415**

4.13.5. PUBLIC HEALTH

Health care facilities in Mandalay include 36 hospitals both public and private. The figures for each township are presented in following Table [21].

Table [21] NUMBER OF HOSPITALS IN MANDALAY DISTRICT

TOWNSHIPS	N.OF HOSPITALS	PUBLIC	PRIVATE	N.OF BEDS
Aungmyethazan	6	3	3	441
Chanayethazan	20	5	15	3087
Mahaaungmye	3	1	2	132
Chanmyathazi	3	3		827
Pyigyidagun	1		1	25

TOWNSHIPS	N.OF HOSPITALS	PUBLIC	PRIVATE	N.OF BEDS
Amarapura	1	1		25
Patheingyi	2	2		41
Total	36	15	21	4578

Source: Facts & Figures on Mandalay District, District General Administration

Improvement in the incidence and severity of waterborne diseases will be an essential indicator of the Urban Services Improvement Project success. Health profiles (2008) compiled for each of the seven townships provides data on major waterborne diseases i.e. malaria, diarrhea and dysentery.

Table [22] PREVALENCE OF WATERBORNE DISEASES IN MANDALAY DISTRICT

TOWNSHIP	MALARIA (PER 000,000 POP)	DIARRHEA (PER 000,000 POP)	DYSENTERY (PER 000,000 POP)
Aungmyethazan	0.82	127.67	25.29
Chanayethazan	9.90	128.68	68.43
Mahaaungmye	51.78	139.16	70.27
Chanmyathazi	31.55	160.09	63.10
Pyigyidagun	76.51	251.28	129.15
Amarapura	211.78	442.82	298.42
Patheingyi	699.25	655.98	284.14
TOTAL	**1081.59**	**1905.68**	**938.8**

Morbidity and fatality cases in Mandalay District for 2014 are presented below. Pathengyi township shows very high prevalence for diarrhea and hepatitis.

Table [23] PREVALENT DISEASES IN MANDALAY DISTRICT

TOWNSHIP	MALARIA		DIARRHEA		TUBERCULOSIS		DYSENTERY		HEPATITIS	
	INFECTED	DEATH	INFECTED	DEATH	INFECTED	DEATH	INFECTED	DEATH	INFECTED	DEATH
Aungmyethazan	3	nil	nil	nil	166	nil	92	nil	nil	nil
Chanayethazan	28	nil	259	nil	379	7	57	nil	nil	nil
Mahaaungmye	350	62	72	35	502	23	33	nil	343	nil
Chanmyathazi	82	nil	14	nil	68	nil	27	nil	1	nil
Pyigyidagun	nil	nil	290	nil	427	nil	101	nil	2	nil
Amarapura	87	nil	766	nil	133	nil	528	nil	15	nil
Patheingyi	744	nil	2444	nil	393	22	866	nil	2600	1
Total	1294	62	3845	35	2060	52	1704	nil	2961	1

It is witnessed that lower access to safe piped drinking water supply in Pyi Gyi Tagon Township has been associated with the trend of relatively higher prevalence of water borne diseases, which include Diarrhea, Dysentery, Para Typhoid and Viral Hepatitis. No significant sign of a declining trend in average prevalence of these diseases is observed within the period 2001 to 2004 (Department of Health, 2005)."

4.13.6. WATER SUPPLY SYSTEM

4.13.6.1. EXISTING WATER SUPPLY FACILITIES

Mandalay City population is getting domestic water from different systems and resources:

- Water supply system managed by MCDC, from both surface and ground water resources;
- Private tube wells either registered or illegal (number estimated at 22,000);
- Public tube wells (MCDC, KOICA…), public wells and communal taps;
- Moat water, an ancient system supplying the former city around the palace area which remains partially used nowadays (washing points).

The original piped water supply system was constructed between 1983 and 1992 and was reinforced after 1992. At present, the main characteristics of the system are the following:

- Service area: 58 km²;
- Serviced population: 550,000 (88,000 customers);
- 37 main deep tube wells (400 mm diameter, depth about 150 m), most of them (25) located along the left bank of the Ayeyarwaddy and several smaller tube wells;
- 2 treatment plants and a water intake in the Ayeyarwaddy river;
- 96,000 m3/day of water supplied (90% from tube wells, 10% from surface water intake);
- Supply operation: between 2 and 10 hours/day;
- 8 booster pumping stations;
- 9 ground reservoirs and 2 elevated towers (51,000 m3 storage equivalent to half day supply capacity under present situation, but only 25% of daily production capacity and only 8% of daily capacity of the pumping equipment); also, only 24% of this capacity may be supplied by gravity;
- Operation still insufficient: Supply operated between 2 and 10 hours/day only, about 50% of non-revenue water (NRW), high energy consumption (low efficiency), no disinfection, the whole system is equivalent to several smaller systems operating more or less independently;

Distribution of WS facilities in Mandalay is depicted in following Figure [39] .

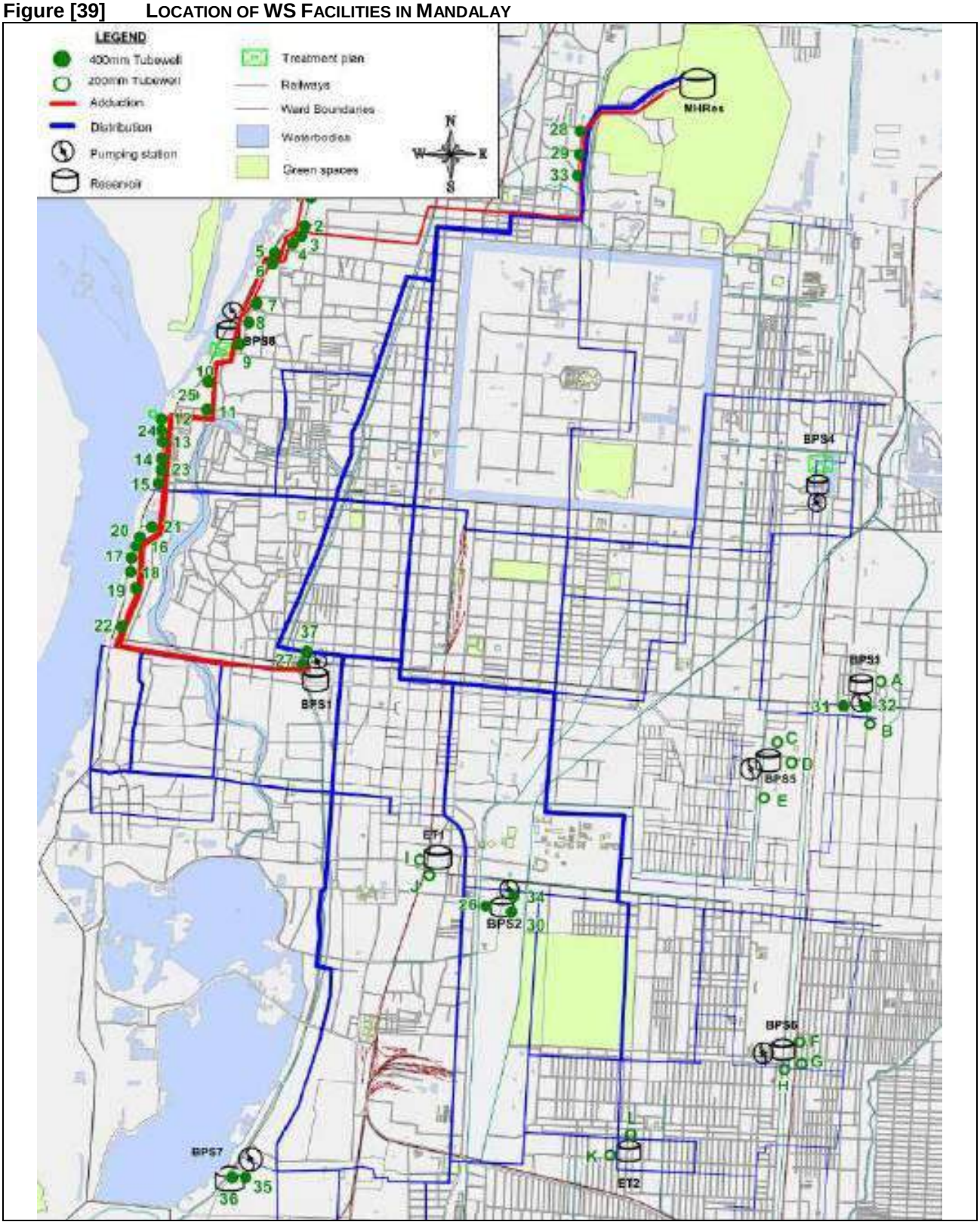
WATER SUPPLY PUMPING STATION ON THE AYEYARWADDY

WATER TREATMENT PLANT (BPS8) WITH SEDIMENTATION AND SAND FILTRATION

MAIN WATER STORAGE ON MANDALAY HILL

ONE DEEP TUBE WELL ALONG THE AYEYARWADDY RIVER

Figure [39] LOCATION OF WS FACILITIES IN MANDALAY



Source: SAFEGE, 2014

Underground water: Operation of the system(s) is facing several constraints. The tube wells are in poor conditions, with discharges well below their design capacity (230 m^3/h). Also, due to the poor recharge of the aquifer in some places, operation time is reduced from 20 to 8h only.

Surface water: Surface water was developed by MCDC these last 10 years to compensate for the reduced underground water production. Water Treatment Plant N°4 (WTP4) was constructed in 2006, supplied from

the canal feeding the Royal Palace moats (itself supplied from the irrigation channel from Sedawgyi Dam). Due to increased demand for irrigation, only 5,000 to 10,000 m3/day can be abstracted for the city from this resource. The new WTP8 is fed from a water intake located nearby in the Ayeyarwaddy. The capacity of the intake (4 pumps x 1,136 m3/h) is too large for the capacity of WTP8, and only one pump is operating at a time and for only few hours per day. Indeed, the actual operation of the plant is well below its design capacity for various technical reasons. A new chlorination facility for WTP8 has been commissioned in November 2014. It produces hypochlorite from sodium chloride (NaCl).

The major weaknesses of the WS system include:

- An almost total absence of a monitoring network to monitor the system, including monitoring of water contamination (no control of coliforms);
- Limited knowledge of the system: no computerized maps/drawings, no reliable information on operation;
- Possible limitation of underground extraction due to over-exploitation of the aquifer;
- Poor maintenance of the facilities;
- Unsteady operation of the system leading to sanitary risks.

Various projects concerning improvement of WSS are presently on-going, most at the stage of technical assistance. A BOT for a new pumping station in the Dokhtawaddy River (10 km south of Mandalay) and a WTP (about 27,000 m3/day capacity) is presently under tendering for the water supply of Pyi Gyi Dagon Township.

4.13.7. SANITATION SYSTEM

4.13.7.1. DOMESTIC EFFLUENTS MANAGEMENT

Wastewater services in Mandalay are at an early stage of development. In spite of the high density of population and the extensive use of groundwater for water supply, there is no piped sewerage system nor centralized wastewater treatment plant. Sanitation coverage is provided by a series of predominantly on site systems with a limited septic tank cleansing service. Environmental impacts are consequently high with pollution of watercourses and groundwater.

Flush toilets and septic tanks, ventilated pit latrine and pit latrines are the most widely used sanitation systems in Mandalay. The household survey undertaken by the PPTA Consultant covered a wide range of HHs and found that out of 630 HHs surveyed, 272 have septic tanks with another 278 using pit latrines. The highest level of septic tank use (70%) was in Aungmyethazan with the lowest level (22%) in Amarapura. Over half (52%) of HHs surveyed in Amarapura report practicing open defecation or using another HH's toilet facilities.

Septic tank overflows (and some latrines) are generally connected to drains and then discharge directly to the open channels designed to convey stormwater. Septic tanks are emptied by vacuum tank trucks operated by WSSD. The collected sludge is transported to an oxidation pond east of the City, about 25 miles (40 km) from the City Centre, The oxidation/bio-aerobatic pond is located in the compound owned by MCDC near Yaytagon Taung Hill in Patheingyi Township. There are two small plots used as oxidation ponds; one is 30 x 35 m (0.10 ha) and another one is 35 x 25 m (0.08 ha). The only treatment is natural drying beds, no further treatment. After 5 or 6 years the oxidation pond will be emptied and the soil used as fertilizer.

The trucks are "on-call basis", the owner calls the MCDC sanitation department for emptying their septic tank. At the moment, there are 8 night soil trucks, among them 2 new trucks (2013) and all others are about 20 years old and in a bad condition and poorly functioning.

DISCHARGE FACILITY FOR TRUCKS AT THE OXYDATION POND

VIEW OF THE OXYDATION POND FOR NIGHT SOIL

4.13.7.2. INDUSTRIAL EFFLUENTS MANAGEMENT

Most of the industrial development and polluting industries are located to the south of the city in two industrial zones (distilleries, sugar factories, leather/tanneries, paper recycling and textiles). Currently, these industries discharge to Panyantaw Creek, N°6 Overflow drain (joining itself the creek) and a wastewater drain (250mm diameter). This drain discharges to a pond system to the south of the zone. Available water quality information is limited to BOD measurements only but shows typically high to very high concentrations particularly for distillery effluents (>7,000 mg BOD/l).

Aware of this situation, MCDC has entered into a 30 year BOT with a Tahi company (Hydrotek) to provide an industrial wastewater collection and treatment system. Wastewater from the current two zones will be pumped via 4 pumping stations to an industrial wastewater treatment plant with a proposed initial capacity of 2,000 m^3/day and ensuring a treated effluent standard of 20 mg BOD/l. The site occupies about 5 acres (2 ha) close to the existing southern landfill site. Construction did not start yet.

OUTLET OF THE INDUSTRIAL WW PIPE (10") FLOWING SOUTH TO MCDC POND SYSTEM. BOD TESTED WAS >8,700 MG/L

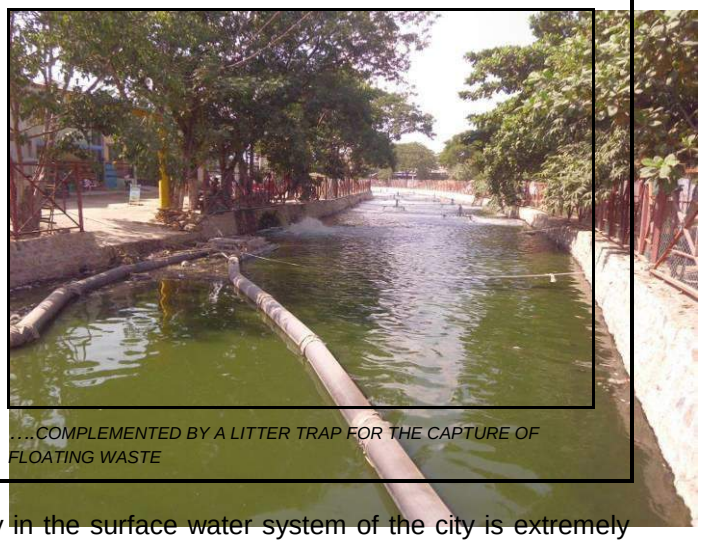
VIEW OF THE SOUTHERN INDUSTRIAL ZONE

4.13.7.3. IMPACT ON WATER QUALITY

MCDC has undertaken water quality measurements (pH, BOD and Dissolved Oxygen) in the major canals and lakes draining wastewater from the main city area, which indicate high levels of BOD and consequently low oxygen levels in all of the main canals, especially those towards the west of the main city (notably the Thingaza Creeek to the far west and the Shwetachaung nearer to the old city centre). Organic pollution levels in the two main lakes downstream of Mandalay are high, resulting in the development of floating vegetation (*Eichornia crassipes*).

Recently, MCDC has been implementing a series of aerators on the main canals (notably at the exit of Thingaza Creek and Colombo Canal –still under implementation) to increase dissolved oxygen levels and reduce the load of organic matter being discharged to the lakes.

SEVERAL SETS OF AERATOR IN OPERATION AT THE EXIT OF THINGAZA CREEK ….



….COMPLEMENTED BY A LITTER TRAP FOR THE CAPTURE OF FLOATING WASTE

Despite some localized improvement, the water quality in the surface water system of the city is extremely low. Thingaza creek shows very black water and large volumes of garbage all along its shores. The same applies for major canals, turned into open sewers, as Shwetachaung and Ngwetachaung. Elements regarding surface water quality have already been discussed in Section 4.7 on this report.

4.13.8. SOLID WASTE MANAGEMENT

4.13.8.1. WASTE PRODUCTION

The on-going study supported by a French grant (FASEP) estimates the total waste generation in 2014 at 932 tons/day including production from households, commerce and tourism. The study forecasts a daily production of 1220 tons in 2020, 1765 tons in 2025 and 2274 tons in 2025.

4.13.8.2. WASTE COLLECTION AND DISPOSAL

Once per day, the small collection vehicles (tricycles, push-carts) move along the narrow city streets. They stop regularly at the corners with smaller alleys and MCCD staff uses a bell for residents to deliver their garbage. The technique used is similar in industrial zones and for companies and workshops. Collection of solid waste takes place daily from 6:30 am to 12:30pm. At this stage, we may roughly conclude that the city counts for 6 townships about 15 transit stations. All transit station sites are located in precise areas, where a receiving 7 m3 container is located. At these transit stations, waste bring by tri-bikes and push-carts is downloaded into the container which is eventually transported by a hook-lift truck to one of the 2 operational landfills.

Waste collection rates in Mandalay (from 260 tons/day in 2005 to 790 tons/day in 2013) have increased in relation to both population and the increase in waste collection facilities. The present staff and equipment of the Cleaning Department of MCDC is as follows: 1942 Staff; 350 Push-carts; 153 Tri-bikes; 160 Tipper trucks (7.5 m3); 20 Hook-lift trucks (for containers); 138 Roll on/off containers (7 m3); 3 Dumper trucks (15 m3).

It is estimated by Safege (2014) that the collection rate of solid waste over the 6 townships in 2014 is 85%, 80% being collected by MCDC and 5% (47 t/d) by the informal sector (mainly recyclable material as plastics, cans, bottles). Nevertheless as confirmed by the different social surveys and by field observation, the 150 t/d of solid waste not collected end in the different drains, canals and creeks (consequently reducing the hydraulic capacity of these systems) and in a multitude of small illegal dumping sites all over the urban area a phenomenon strengthen by the lack of awareness of the population regarding solid waste management.

A TRI-BIKE DOWNLOADING WASTE AT A TRANSIT STATION

A 7 M3 CONTAINER AT THE TRANSIT STATION

STORED USED GLASS BOTTLES FOR RECYCLING

RECYCLING METAL AND PLASTIC CANS BY THE INFORMAL SECTOR

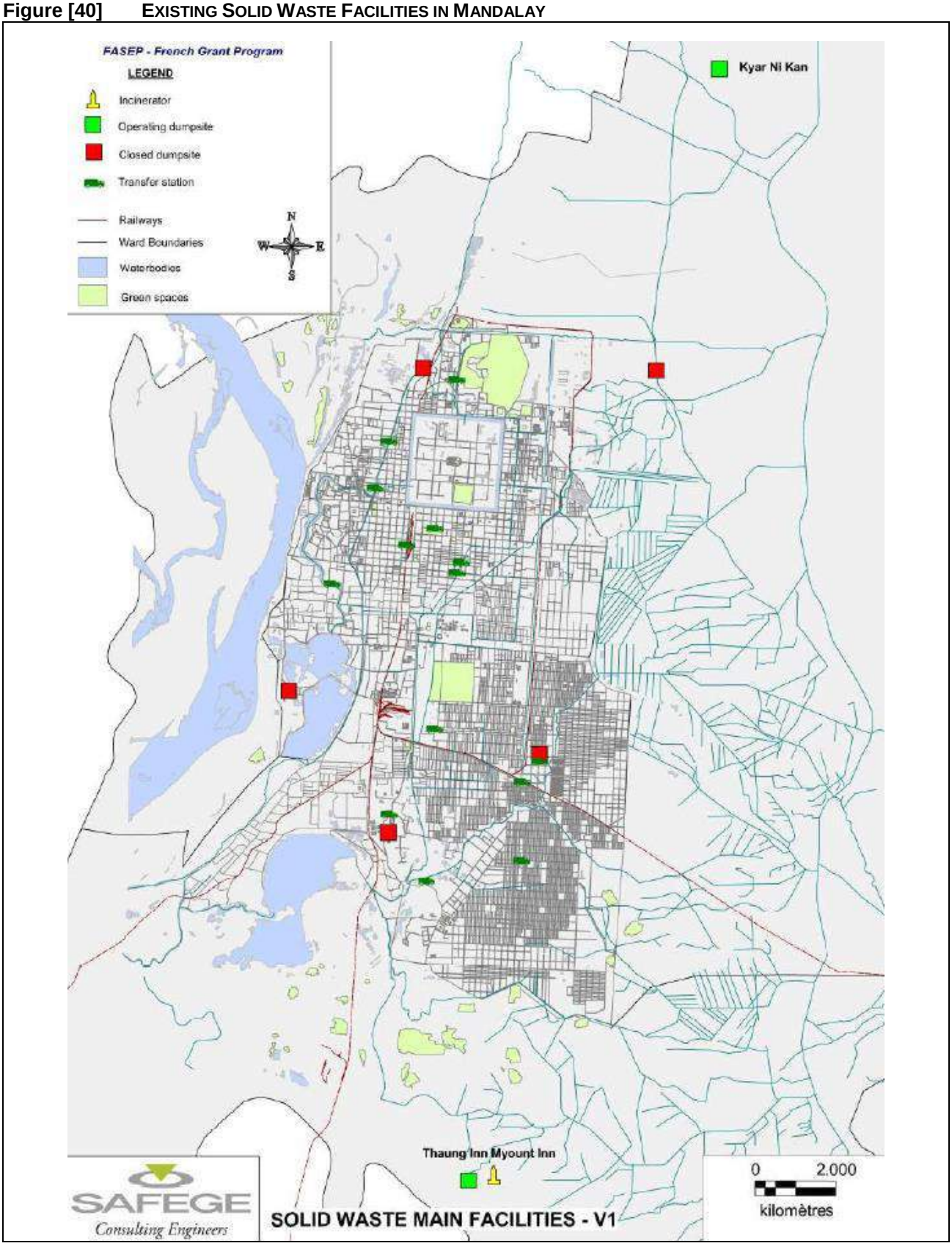
WASTE DUMPED ALONG THINGAZA CREEK

WASTE DUMPED IN CANAL

MCCD does not manage the collection of construction wastes. These are managed by the construction companies directly, either recycled by small enterprises (for recyclable materials) but generally dumped as backfill where required.

Two landfills receive today the solid waste from Mandalay: one in the north (Kyar Ni Kan) with a capacity of 450 t/d for the 3 northern townships and one in the south (Thaung Inn Myount Inn) with a capacity of 350 t/d for the 3 southern townships. An incinerator, with a capacity of 30 t/d is located next to the southern landfill, but has never been commissioned because of the cost of energy (diesel) and the pollution (no air filters). Next to the northern landfill, a pit simply dug in a cemetery receives the medical waste from the clinics where they are burnt using diesel. The following Figure [40] presents the transit stations and the two landfills as well as the location of 5 old abandoned landfills located within the urban area.

Figure [40] EXISTING SOLID WASTE FACILITIES IN MANDALAY



Source: Safege, 2014, Inception Report

The landfills are simple dumpsites without any pollution control facility: no liner, no drainage of leachate. Waste is dumped on the landfill by the trucks and waste pickers sort recyclable waste (cans, bottles, metal etc.) before the bulldozer pushes the waste and compact it. Rubber is sorted and burnt in an open oven.

Fires are observed in several places of Kyar Ni Kan landfill resulting in the release of dense smoke. In north landfill about 446,000 t have been stored and the remaining capacity is about 700,000 t or 4,25 years at the present rate (450 t/day). Scavenger families operate, including women and children, without any safety protection: no mask, no gloves.

VIEW OF THE NORTH LANDFILL (KYAR NI KAN)

BULDOZER OPERATING ON SOUTH LANDFILL

SCAVENGERS ON NORTH LANDFILL

SCAVENGERS FROM SOUTH LANDFILL

MEDICAL WASTE DISPOSAL PIT NEAR NORTHERN LANDFILL.

NON-OPERATED INCINERATOR NEXT TO SOUTH LANDFILL

Another issue is also the practice of backfilling of low lying plots of land (flood prone areas) using solid waste, a cheaper way than using earth. Some important plots being filled by solid waste are observed in Amarapura (for example in the village of Ayezayat, in Mandanyet village track), where a MCDC truck was observed downloading solid waste.

A LARGE PLOT OF LAND IN THE VILLAGE OF AYEZAYAT (KATKYAW AREA) BEING FILLED BY SOLID WASTE FOR RECLAMATION …

WITH THE PRESENCE OF A MCDC TRUCK LEAVING THE PLACE AFTER DUMPING ITS LOAD IN THE PLOT

5. IMPACT ANALYSIS

5.1. METHODOLOGY

The impacts were identified by confronting the environmental and social baseline situation of the area with the activities related to each component and stage of the project. For every interrelation between Project activities and each pertinent environmental component, all probable impacts have been identified.

This identification was mainly based on:

- The technical information related to project components design and operation as presented in Chapter 3 of this report;
- Field visits conducted in August-September and November 2014 by the Consultant in the Project area;
- The Consultant experience of environmental impacts of a variety of projects including urban development, sanitation and dredging;
- The checklists of potential impacts from various types of projects drawn up by international financial organizations (WB, ADB, AfDB).

The result of this analysis is presented in the following sections covering 1) impacts connected with the location of the projected facilities, 2) impacts connected with construction activities and 3) impacts connected with the actual operation of the facilities.

The potential impacts for each of these sections are presented in a summary table, followed by descriptions and analyses of the most probable significant impacts. These tables present, successively, the cause of the impact, the potential impact along with its risk level, the corrective measure along with the ease/difficulty of implementing it and the residual risk level after implementing the measure.

Each summary table shows, for each identified impact, an assessment of the overall risk level, taking three criteria into a consideration: the probability of occurrence of the impact as part of the project, the expected gravity of such an impact given no special corrective measures, and the difficulty of implementing the proposed corrective measures.

- The probability of occurrence reflects how often the impacts are observed during construction and operation of similar projects: some impacts are inevitable (noise, dust, suspended sediment in surface water) whereas others occur only exceptionally (explosion).
- The gravity of an impact incorporates various considerations of intensity of effects on the natural or human environment, its extent and its duration. All necessary efforts must be made to implement corrective and monitoring measures on impacts that are judged to be potentially serious.
- The overall risk relating to an impact, rated from 1 (low) to 3 (high) takes into account the abovementioned criteria.

Table [24] IMPACT ASSESSMENT CRITERIA

CRITERION	LEVEL 1	LEVEL 2	LEVEL 3
Difficulty for implementing corrective measures	Easy, inexpensive and generally effective	Demands special attention (monitoring or training, for example)	Difficult due to complexity or cost
Probability of occurrence of the impact	Low: can be seen in cases of negligence or accident	Medium: generally seen a few times during construction or during the operation of the concerned facility	High: consistently seen if effective corrective measures are not put in place

CRITERION	LEVEL 1	LEVEL 2	LEVEL 3
Gravity of the impact	Generally limited impact in terms of intensity, duration or extent	Significant environmental impact but not endangering human or animal populations	Major environmental impacts with risks to people or special-status animals
Overall Risk	*Low: subject of routine monitoring but impacts are minor and easily manageable*	*Significant: merits special attention*	*Major: merits close monitoring and the implementation of effective measures*

5.2. ANTICIPATED BENEFITS FROM THE PROJECT

The components of the Project are anticipated to significantly improve the environmental conditions and quality of life of the population in Mandalay through the following results:

- Better quality of life and public health by the improvement of the water supply services and security through (i) increasing the water storage capacity of the system, (ii) reduction of non-revenue water and extension of serviced area and (iii) rehabilitating the water treatment plant;
- Better quality of life and public health by the improvement of wastewater collection through implementation of interceptors along Thingaza creek and major drainage canals with beneficial effects on surface and groundwater quality, on public health and on city beautification;
- Construction of a wastewater treatment plant with beneficial reduction of urban pollution reduction of pollution load of water bodies;
- Improved quality of life, public health and safety by the reduction of flooding risks in the urban area through (i) improvement of drainage system (cleaning, removal hydraulic bottlenecks), (ii) improvement of drainage management (rehabilitation of pumping stations, monitoring of lake levels) and (iii) integration of climate change resilience standards into design criteria;
- Better quality of life and public health by the improvement of solid waste management through better collection and safe disposal of waste (increased number of collection vehicles and collection points, new sanitary landfill, rehabilitation of the incinerator for medical waste, treatment of night soil);
- General improvement of Mandalay city environmental situation and innovation towards Green City Principles through energy generation at the wastewater plant and the development of pilot sustainable urban drainage system (SUDS).
- Secondary benefits related to increased attractiveness of Mandalay regarding investment, economic development, tourism, employment, income and increased value of land and buildings.

5.3. IMPACTS RELATED TO PROJECT LOCATION

5.3.1. IMPACTS ON LAND ACQUISITION AND RESETTLEMENT

The project components have all been designed by the PPTA Consultant with the first priority **to avoid economic and physical displacement of residents and to limit environmental impacts**. Most of the time this objective has been totally achieved while for some components requiring significant area of land, residual impacts lead to land acquisition and building relocation. These aspects are addressed in detail in the Resettlement Plan prepared in parallel to this IEE.

5.3.1.1. WATER SUPPLY COMPONENT

The water treatment plant extension will be developed next to the existing one, on MCDC land. Rehabilitation works on the water treatment plant WTP8 and on the 27 tube wells do not involve any extension. Neither land acquisition nor displacement of persons is required.

5.3.1.2. WASTEWATER AND DRAINAGE COMPONENT

Wastewater interceptors along Shwe Ta Chaung and Mingalar canals (possibly also along Ngwe Ta Chaung canal) will be mostly implemented within the existing canal beds, thus avoiding land acquisition and resettlement. Along most of the canal routes, access is easy and open space available to park construction equipment and materials. In a few sections in the most crowded parts of the city, along Shwe Ta Chaung near street 27th, the presence of the market and commercial facilities on both sides of the canal may require some temporary displacement of market stalls or light buildings mainly for access and storage areas during the construction period.

SHWE TA CHAUNG CROSSING 28TH RD, VIEW UPSTREAM (NORTH)

SHWE TA CHAUNG CROSSING 27TH RD, VIEW DOWNSTREAM

Wastewater interceptors along both shores of Thingaza Creek will not involve physical displacement or demolition of buildings. Along the west shore, between 35th and 41th streets, the interceptor moves further west to follow streets because the presence of monasteries along the shoreline. This route option selected by the PPTA Consultant avoids any risk of impacts on monasteries and will not involve permanent land acquisition and demolition of buildings. All selected roads are wide enough for laying safely the pipe.

NORTHERN END OF THINGAZA CREEK, STRONGLY AFFECTED BY WASTEWATER AND SOLID WASTE

GENERAL ASPECT OF THE WEST SHORE ALONG WHICH INTERCEPTOR WILL BE LAID

VIEW OF MAHASI ROAD TO BE FOLLOWED BY INTERCEPTOR WITHOUT ANY PARTICULAR CONSTRAINT

VIEW OF TARDAIN ROAD TO BE FOLLOWED BY INTERCEPTOR WITHOUT ANY PARTICULAR CONSTRAINT

The new pumping station for the interceptors of Thingaza creek will be located on MCDC land property which is presently partly used as a solid waste transfer station but sufficient area, devoid of occupation is still available.

SITE FOR PUMPING STATION: LOOKING NORTH TOWARDS 89TH RD. THINGAZA CREEK BORDERS THE AREA ON THE LEFT

SITE FOR PUMPING STATION: LOOKING SOUTH TO SOLID WASTE TRANSIT STATION. ALONG 38TH RD (LEFT)

The new wastewater treatment plant will be located at Katkyaw (south of Amarapura), in a floodable area presently used for agriculture. Some light housing is developed along the main dike, which may need to be displaced. However, if 12 ha of land should be secured for the long term, the present first step of development, which includes only enhanced primary treatment and sludge processing, will occupy only a small fraction of the land (about 2 to 3 ha) which may reduce displacement at this stage. However, compensation for the loss of agricultural production will be required, with possible economic displacement of

few families. Only a small electric transmission line crossing the site in parallel with the dike will require the displacement of 3 or 4 of its poles.

VIEW FROM EXISTING PUMPING STATION TOWARDS NORTH OF THE WWTP SITE.

VIEW OF SITE FROM THE DIKE, LOOKING EAST. IN THE MIDDLE, ONE OF FEW ELECTRIC POLES TO BE RELOCATED.

SOME LIGHT BUILDINGS CONSTRUCTED AT THE FOOT OF THE DIKE MAY NEED DISPLACEMENT (SITE ON THE RIGHT).

SEVERAL SHOPS SELLING PARTICULARLY VEGETABLES ARE LOCATED ALONG THE SAGAING ROAD ON THE DIKE, POSSIBLY AFFECTED BY THE USE OF THE AGRICULTURAL LAND BY THE WWTP

Cleaning and dredging of Thingaza creek and of the main canals (Shwe Ta Chaung, Nge Ta Chaung, Mangalar) should not involve any additional displacement of buildings than those required for interceptors laying, as works will be carried out simultaneously. Regarding the disposal of the sediment dredged, it will be used for filling the site of the WWTP. The requirement for fill is large enough to use the anticipated production of 100,000 m3. Indeed, based on 2.5 m fill, this volume satisfies about 4 ha, enough area for the first phase of development of the WWTP site.

5.3.1.3. SOLID WASTE COMPONENT

MUSIP1 covers only the development of one pilot collection point which will require about 2,000 m². The proposed area is located Northwest Mandalay, on MCDC land. No land acquisition or resettlement is required. Site location is presented in following and illustrated by photographs below. As presented on the satellite image, the available MCDC land is about 6 800 m² (red boundary) while the 2 000 m² minimum requirement is delineated in white.

Figure [41] LOCATION OF PROPOSED WASTE COLLECTION SITE N°17

Source: Safege, 2014, Google Earth

PROPOSED COLLECTION SITE N°17. OPEN LAND WITH FILLING REQUIRED

OTHER VIEW OF THE SITE

SITE ALREADY USED FOR DUMPING SEDIMENT FROM DRAINAGE CANALS MAINTENANCE DREDGING

ONE OF THE TWO ACCESS ROADS TO SITE

5.3.2. IMPACTS OF CLIMATE CHANGE AND NATURAL HAZARDS

Climate Change (CC) is not anticipated to generate impacts related to project components location. Except the WWTP, all other components are not located in floodable areas or areas anticipated as floodable in the future. The WWTP site is already floodable and design includes reclamation of the land by filling up to a safe level.

Seismic risk does exist in Mandalay as discussed previously. However, none of the component of the MUSIP1 involves high buildings or sensitive structures. All civil works will take into consideration construction criteria applicable to the observed level of risk.

None of the MUSIP1 component is anticipated to be particularly exposed to CC or natural hazards because of its proposed location.

5.3.2.1. SUMMARY OF IMPACTS ON LAND ACQUISITION AND RESETTLEMENT

PROJECT COMPONENT	LAND ACQUISITION	LOSS OF BUILDINGS & INFRASTRUCTURES	RESETTLEMENT & COMPENSATION
Improved Water Supply Systems			
Extension Water Storage	Located next to existing storage, on MCDC land. No land acquisition required.	Few MCDC buildings to be displaced.	No
Regeneration of Tube Wells	No spatial Extension. No land acquisition required	No	No
Upgrading WTP8	Within MCDC land	No	No
Improved Disinfection	Within existing facility	No	No
Network Rehabilitation North	No land acquisition, works along public roads	No	No
Network Rehabilitation Central	No land acquisition, works along public roads	No	No
Network Extension South	No land acquisition, works along public roads	No	No
Improved Wastewater & Drainage Management			
Interceptors Thingaza	No land acquisition anticipated	Possibly on a temporary basis during construction	Possible for temporary limited access/commercial activity
Interceptors Shwe Ta Chaung	No land acquisition	Possibly on a temporary basis during construction (near market)	Probable in the market area for temporary use of land (impact stalls and storage/shops
Thingaza Pumping Station	On MCDC solid waste transit station. No land acquisition required	Possibly MCDC building to be displaced	No
New WWTP	Land acquisition of 11.85 ha including: -10.08 ha cultivable land, including 9.68 ha cultivated and 1.76 ha flooded	7 light main structures (5HH) and 9 secondary light structures (4HH) along the west side of the dike to be affected. About 1 000 m of 33kVA line (3 to 4 poles) to be displaced	Yes. 1 Household needs relocation and 9 HH to be compensated.
Septic Sludge Disposal	Included in WWTP facility	No	No
Pilot Scheme for Household Connection	No land acquisition, works along public roads	No	Possible on a case by case basis if access to business is affected
Interceptors/SUDS Mangalar	No land acquisition required (public land)	Up to XX structures encroaching on Mangalar canal to be displaced	Possible on a case by case basis
Creek & Canal Dredging	No land acquisition as sediment to be used as fill for new WWTP	No	Possible on a case by case basis
Increase Pumping Stat. Capacities	No, within existing facilities	No	No

PROJECT COMPONENT	LAND ACQUISITION	LOSS OF BUILDINGS & INFRASTRUCTURES	RESETTLEMENT & COMPENSATION
Improved Solid Waste Management			
Pilot solid waste collection station	No land acquisition. Land plot available about 6 800 m², MCDC property, for a requirement of minimum 2 000 m²	Possibly 3 or 4 dry pit latrines to be replaced	No resettlement Possible replacement of few pit latrines

5.3.3. IMPACTS ON CULTURAL HERITAGE

Temples, monasteries and other monuments are distributed all over Mandalay. The PPTA Consultant has carefully visited each site where some MUSIP1 components were proposed to ensure the project will have no detrimental impact on any cultural heritage asset.

- On Mandalay Hill, which shelters several monuments on its slopes, the new water storage will be implemented next to the existing one. No cultural physical resource is observed within the limits of the proposed area. However, a procedure for chance to find is proposed in the EMP, should some cultural physical resource be discovered during excavation works;
- Along the downstream part of the left shore of Thingaza creek, where wastewater interceptor will be implemented, two monasteries were identified. The interceptor design has been consequently modified to avoid any intrusion within the monasteries premises and re-routed along surrounding roads;
- A monastery land is located along one side of the proposed site N°17 for pilot waste collection. To avoid any nuisance, the collection site will be located in the opposite part of MCDC land.
- Other MUSIP1 components do not affect any cultural physical resource.

In conclusion, no cultural heritage resource is potentially affected by MUSIP1.

5.3.4. IMPACTS ON NATURAL RESOURCES

Most of the project activities are located within densely urbanized areas, where natural resources are extremely limited, mainly to urban vegetation. However, trees that may be affected by the project do not include any particular species with special protection status. Species observed in Mandalay are all common ones widely used in urban beautification, the most representative being *Tamarindus indica, Ficus religiosa, Albizzia lebbeck, Delonix regia, Azadirachta indica, Pithecellobium dulce, Polythia longifolia, Pterocarpus macrocarpus, Broussonetia pyrifera*.

The several water bodies observed within and around Mandalay are all extremely polluted by untreated wastewater and solid waste. Their ecological value is presently low, limited to the growth of floating vegetation (mainly Water Hyacinth, *Eichornia crassipes*) due to excessive inflow of nutrients. Low oxygenation of the polluted water limits the development of aquatic fauna to some insects and resistant fish species (catfish types). In the wider lakes located south of the city, more fishes can develop but face frequent localized fish kills linked to sudden algal blooms, particularly during the dry season when water temperature is highest.

The Project component involving the most significant impact on natural resource is the existing water storage area on Mandalay Hill, which will involve the clearing of about 0.5 ha of secondary vegetation growth which developed on the former area cleared at the time of the construction of the first reservoir (1993).

Table [25] TREE SPECIES OBSERVED ON MANDALAY HILL NEAR STORAGE AREA

VERNACULAR NAME (MYANMAR)	BOTANICAL NAME
Yin Mar pin	*Chukrassia tabularis A*
Phyuak sate	*Holoptelea integrifalia*
Ta Mar	*Azadirachta indica A Juss*
Sain pan	*Delonix regia Fafin*

Ta Yote Sa Gar	*Plumeria alba L*
Ma Gyee	*Tamarindus indica L*
Hta Naung pin	*Acacia Leucophloea wild*
Thit Pa Lway	*Balanites triclora Van*
Nyaung pin	*Ficus religiosa L*
Thit-palwe	*Balanites aegyptiaca*
-	*Balanites triflora*
Zi	*Ziziphus jujuba*
Thayet	*Mangifera indica*

All species are common species without any protection status.

Water supply networks rehabilitation and extension should not involve significant clearing as existing networks are located within the road/street boundaries and new ones will be similarly located.

In the urban area, the Project will ensure that works avoid cutting trees as much as feasible, particularly the largest and oldest ones. Works related to interceptors have a minimum impact on urban vegetation, as most of them are located within existing canals and their construction will not involve tree cutting. Nevertheless, some trees may still need to be cut, mainly when required for access of construction equipment to the work site. The wastewater treatment plant will mainly affect agricultural land and part of a semi-permanent floodable area. There are no trees on the site. Access to the plant may require the cutting of 1 or 2 old trees bordering Myo Pat road (going to Sagaing Bridge). Dredging of canals and creek will not affect natural resources, the canals concerned being mainly transferring wastewater.

Table [26] IMPACT ON NATURAL RESOURCES

PROJECT COMPONENT	IMPACT ON NATURAL RESOURCES
Improved Water Supply Systems	
Regeneration of Tube Wells	No
Upgrading WTP8	No
Improved Disinfection	No
Network Rehabilitation North	Not anticipated
Network Rehabilitation Central	Not anticipated
Network Extension South	Not anticipated
Improved Wastewater & Drainage Management	
Interceptors Thingaza	Not anticipated on the east shore. Possible few trees cut on west shore (near 35th street) but trees of small size
Interceptors Shwe Ta Chaung	No, or very locally for access of construction equipment to site of works
Thingaza Pumping Station	Few large trees could be cut for the construction of the facility
New WWTP	No tree on site. Possibly 1 or 2 trees cut for access to site from Myo Pat Road
Septic Sludge Disposal	Within WWTP premises
Pilot Scheme for Household Connection	No, pipe being laid in the street line
Interceptors/SUDS Mangalar	Not anticipated as the area will be developped with recreational/urban beautification purpose
Creek & Canal Dredging	No, as water concerned is close to pure sewage
Increase Pumping Stat. Capacities	No
Improved Solid Waste Management	
Pilot Waste Collection Station	Possible cutting of some on site 17

5.3.5. SUMMARY OF IMPACTS AND MITIGATION MEASURES

The following table summarizes the impacts relating to the location of the MUSIP Project Components.

Table [27] SUMMARY OF IMPACTS RELATED TO PROJECT LOCATION

COMPONENT OR ACTIVITY	POTENTIAL RISKS	POTENTIAL IMPACT	IMPACT ASSESS-MENT			CORRECTIVE OR SUPPORT MEASURE		OVERALL RISK AFTER CORRECTION
		DESCRIPTION OF IMPACT	PROBABILITY	GRAVITY	OVERALL RISK	DESCRIPTION OF MEASURE	EASINESS OF IMPLEMENTATION	
Improved Water Supply System								
Regeneration of Tube Wells	Temporary land occupation	No land occupation or building demolition required	-	-		-	-	-
Upgrading WTP8	Temporary land occupation	Temporary land occupation around site during works. May affect access/business of informal sector observed around	2	2	2	Minimize land occupation, coordinate with informal stall keepers and assist them for minimizing impact	1	1
Improved Disinfection	Temporary land occupation	No land occupation required. Disinfection facilities to be installed within tube wells pumping stations and inside WTP8	--	-	-	-	-	-
Network Rehabilitation	Temporary land occupation	Short term land occupation required during works which may locally impact road trafic and access to house or business	3	2	2	See impacts related to Project Construction		
Improved Wastewater & Drainage Management								
Interceptors Thingaza Creek	Temporary land occupation	Short term land occupation required during works along creek shore and roads; but open land available and no impact anticipated	3	1	1	Ensure selected locations do not hamper trafic and access to houses and temples.	1	1
Interceptors Canals	Temporary land occupation and building removal	Short term land occupation required during works. Limited impact on trafic and access for pedestrians most of the time as access roads wide enough.	3	1	1	Ensure selected locations do not hamper trafic and access to houses and temples.	1	1
		Short term land occupation and building removal (shops and stalls) near market between 25th and 28th roads along Shwe Ta Chaung. Some light buildings possibly temporary affected to provide access to construction equipment during works along Mingalar canal	3	3	3	Construction activities in these arease to be planned to ensure impact is minimized and affected persons fairly compensated	3	2
Thingaza Pumping Station	Permanent land occupation	Permanent land occupation required. But MCDC land. No land acquisition and no building demolition required	3	1	1	Ensure facility and working area restricted to MCDC land available	1	1
New WWTP	Permanent land occupation and buildings relocation	Land acquisition required for 12ha, including agriculture land and non-permanent pond.	3	3	3	Optimize design and location of facility to reduce as much as possible the area of cultivated land affected. Provide fair compensation and economic resettlement if required	3	2

Component or activity	Potential risks	Potential impact	Impact assess-ment			Corrective or support measure		Overall risk after correction
		Description of impact	Probability	Gravity	Overall Risk	Description of measure	Easiness of implementation	
		Light housing at the foot of the dike to be relocated.	2	3	3	Optimize design to preserve as much as possible the potentially affected buildings. Provide fair compensation/resettlement	3	2
Septic Sludge Disposal	No	Septic sludge to be treated by WWTP. Receiving facility within WWTP premises	-	-	-	-	-	-
Pilot scheme for Household Connection	Temporary land occupation	Temporary occupation of land within public streets during works. Potential nuisances for residents, impacts on trafic and access to house/business	3	2	2	Detailed planning of activities, public information, minimize duration of works	2	2
Interceptors & SUDS in Mangalar	Temporary land occupation and buildings relocation	Wooden houses encroaching on canal route to be removed for access of equipment to construction site	2	3	3	Optimize design to preserve as much as possible the potentially affected buildings. Provide fair compensation/resettlement		
Creek & Canal Dredging	Temporary land occupation	Temporary occupation of land within public streets during works, mainly by back hoe and trucks	3	1	2	Inform resident population section by section before starting work	1	1
Increase Pumping Stat. Capacities	No	-	-	-	-	-	-	-
Improved Solid Waste Management								
Pilot waste Collection Station	Permanent occupation of land	1 pilot station about 2 000-2 500 m² of land	3	2	2	Selection of MCDC land to avoid land acquisition	1	1

5.4. IMPACTS AND MITIGATION DURING CONSTRUCTION STAGE

5.4.1. DISRUPTION TO COMMUNITY UTILITIES

Construction works in urban areas, particularly those involving ground excavation works, may involve a temporary disruption of utilities for individuals or groups of residents. The following components of the project may involve such impacts:

- **Water supply network rehabilitation** poses only a short term concern to residents affected by construction activities. Interruptions to power and communication, disruption of water supply, discoloration of water from re-located pipes can be anticipated;
- **Interceptors' implementation** in Shwe Ta Chaung and Mangalar canals, where several small water supply pipes cross the canals at mid-slope and will have to be temporary removed during the works;
- **The other components** as interceptors along Thingaza shorelines and pilot sewage connection component could occasionally and very locally create some disruption of community utilities during implementation.

CANAL-CROSSING WATER SUPPLY PIPES IN SHWE TA CHAUNG

ANOTHER EXAMPLE IN SHWE TA CHAUNG CANAL

To minimize impacts, the contractor shall implement the following measures:

- Water supply pipelines, power supply, communication lines and other utilities shall be re-provisioned before construction works commence;
- Provisions shall be made to preserve the operation of current facilities in sufficient quantity and in agreement with the local community;
- Re-provisioning shall be undertaken in coordination with MCDC and other concerned utility companies;
- Affected households and establishments shall be notified at least 3 days in advance of such disruption.

5.4.2. IMPACTS ON AIR QUALITY

5.4.2.1. MAJOR SOURCES OF IMPACT

The main sources of air pollution are machines burning fuel for digging, transportation and loading. Dust and waste gas from these machines affect air quality surrounding work places. Areas most affected are located in a range of around 50 m all around project sites, but also along the main access roads to sites which will be supporting heavy traffic of trucks. Carbon dioxide and other harmful pollutants may also be released through the burning of waste on construction sites, including plastics.

The production of dust is generally the most widely perceived nuisance generated by earthworks and transport on non-surfaced roads during dry seasons. Works carried out for water supply network rehabilitation may significantly generate dust if no preventive measure is applied during excavations.

Activities related to dredging of main canals and cleaning of Thingaza creek will involve the removal of large volumes of sediment which, if temporarily stocked on site may quickly dry and release suspended particulates under the wind. Similarly, if the wet sediment is immediately transported, it may leak from the truck on the road and generate, when dry, particulates any time cars or motor bikes are moving over. Also, the mud collected by the truck wheels within the construction site premises and released on the public road where it dries and generates dust. The generated nuisance may be significant considering the dry climate of Mandalay and the density of population around the work sites.

5.4.2.2. MITIGATION MEASURES

Best management practices will be adopted during construction to minimize dust and combustion exhaust emissions. Mitigation measures to be implemented by the Contractors to minimize impacts on air quality are the following:

- Before site works commence, an Air and Dust Control Plan shall be prepared by the Contractor and shall be approved by the Project Implementation Consultant (PIC). The plan shall provide details of mitigation measures, specific location and schedule where such measures shall be implemented to minimize impacts to sensitive receptors (residential areas, schools, hospitals, etc.) due to construction works, sourcing and transport of construction materials, and other project-related activities.
- Reduce pollutant emission at source: Wherever possible, use electrically-powered equipment rather than gas or diesel-powered equipment; Use only vehicles and equipment that are registered and have necessary permits; Construction equipment and vehicles shall be well-maintained and meet with applicable international recommendations; Undertake immediate repairs of any malfunctioning construction vehicles and equipment. Control of equipment will be done by the PIC.
- Burning of wastes generated at the construction sites, work camps and other project-related activities shall be strictly prohibited.
- Position any stationary emission sources (e.g., portable diesel generators, compressors, etc.) as far as is practical from sensitive receptors and residents.
- Control the risk of dust release: Keep excavated soil or dredge sediment stockpiles moist and cover vehicles with tarpaulin sheets or other suitable materials to minimize dust emission and prevent spillage of materials (e.g., dredged sediment, cement, stone, sand, aggregates, etc.); Store dredged materials from Thingaza creek within the creek boundaries where feasible. In dense residential area, spoils shall be loaded and transported immediately; provide wheel cleaning for any truck/car leaving muddy construction site and accessing to public road; clean daily road surfaces of debris/spills from construction equipment and vehicles in the vicinity of activities.
- Ensure availability of water trucks on site if the works area is not surfaced near sensitive receptors (i.e. residential areas, roadside tea and food stalls, monasteries, schools, hospitals and other sensitive receptors) are dry and dusty, spray water on the exposed surfaces to reduce dust emission. This is particularly applicable to Thingaza dredging operation from the west shore where most of the access from 22th street is not asphalted.
- Impose compliance with speed limits on construction vehicles to minimize dust emission (as well as the risk of traffic accident).
- Provide prior notification to the community on schedule of construction activities which may generate some dust and implement 24 hour community grievance hotline.

5.4.3. IMPACTS FROM NOISE AND VIBRATION

5.4.3.1. SOURCES OF IMPACT

The dredging of the canals and the cleaning of accumulated solid waste in Thingaza could possibly be the most impacting activity in terms of noise nuisances due to the operation of heavy equipment like backhoes in the immediate vicinity with residences. Along the hauling roads for material and dredged sediment, the average noise level will probably rise because of increased truck traffic. However, the peak level of noise should not be increased as these streets are already busy with quite a noisy traffic.

Works for the rehabilitation of the water supply network will also be impacting, as excavations along streets will involve the use of jackhammer and backhoe nearby residential and commercial buildings.

The following table provides some typical noise levels measured at various distances from the emission point related to various construction machineries.

Table [28] NOISE LEVELS OF VARIOUS CONSTRUCTION EQUIPMENT IN DB(A)

EQUIPMENT TYPE	15 M	30 M	50 M	100 M	200 M
Excavator / Backhoe	78	72	67	61	53
Bulldozer	78	72	67	61	53
Jackhammer	89	83	78	72	66
Air compressor	75	69	64	58	52
Vibrator	76	70	65	59	53
Mixer	75	69	64	58	52
Truck	76	70	65	59	53

At night, construction noise would impose a severe nuisance on the residents in the vicinity, especially those located at less than 50 m. Night working and especially the use of the noisiest equipment during the night should then be strictly controlled in order to minimize the impact of noise on the surrounding residents.

5.4.3.2. MITIGATION MEASURES

- Before site works commence, a Noise Control Plan shall be prepared by the Contractor and shall be non-objected by the PIC. The plan shall provide details of mitigation measures, specific location and schedule where such measures shall be implemented to minimize impacts to sensitive receptors (residential areas, schools, hospitals, etc.) due to construction works, sourcing and transport of construction materials, and other project-related activities.
- Restriction of noisy construction activities as well as the transport of materials to day time from 6:00 AM to 6:00 PM, and enforce in residential areas the suspension of the works during night time.
- Reduction of noise level for surrounding population through a set of measures: Position any stationary equipment that produce high noise levels (e.g., portable diesel generators, compressors, etc.) as far as is practical from sensitive receptors; whenever possible, completely enclose noisy equipment which can reduce noise level by 15-25 dB(A) and restrict use of noisy equipment (e.g.15 min for every consecutive 30 min period); erect temporary walls around the construction sites, as necessary, especially near sensitive areas such as schools, hospitals, houses, etc. All construction equipment and vehicles shall be well maintained, regularly inspected for noise emissions, and shall be fitted with appropriate noise suppression equipment consistent with applicable national and local regulations;
- Train truck drivers: minimization of the use of horn, compliance with speed limitation particularly in residential zones.
- Provide prior notification to the community on schedule of noisy construction activities and implement 24 hour community complaint hotline.

5.4.4. IMPACTS FROM SEDIMENT MANAGEMENT

5.4.4.1. SOURCE OF IMPACTS

The project will generate a significant volume of residual materials including inert construction waste and mainly sediments from dredging/cleaning works of Thingaza creek, Shwe Ta Chaung and Mingalar canals. It

is anticipated the production of about 100,000 m^3 of dredged sediment. This volume is reasonable but needs to be appropriately managed as various impacts could potentially result from sediment mismanagement, including excessive use of land for disposal and risks of water pollution if sediment is contaminated.

Soil and water pollution: this is a risk when dredged sediment is contaminated by untreated wastewater, particularly from industries, where toxics as heavy metals may accumulate. A survey was carried out by the PPTA including sampling of sediment in Thingaza, Shwe Ta Chaung and Ngwe Ta Chaung canals for chemical and grain size analysis. Results are provided in the following Table [29].

Table [29] RESULTS FROM SEDIMENT GRAIN SIZE AND CHEMICAL ANALYSIS

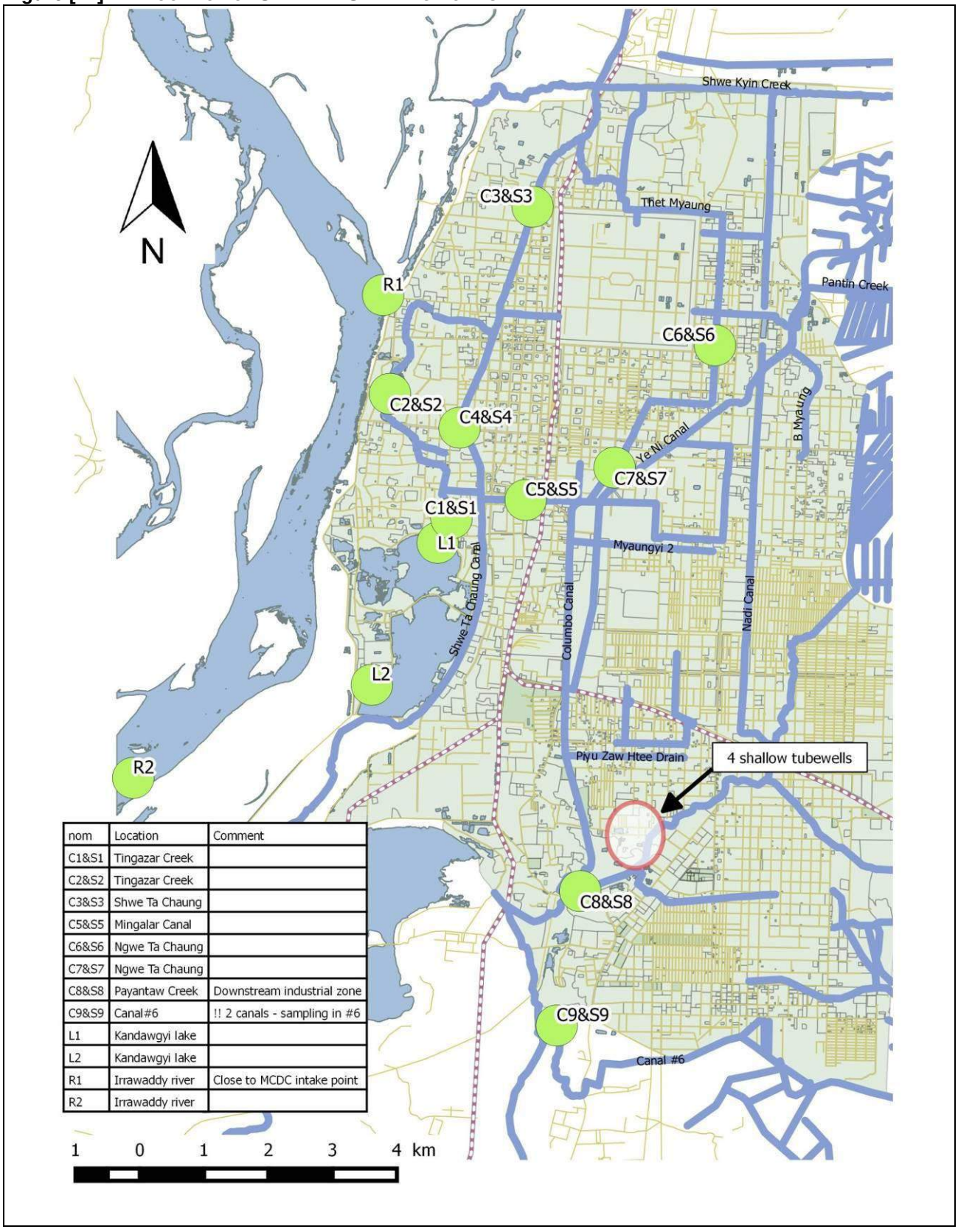
	THINGAZA		STC		MGL	NTC	PYTC	C67	STANDARD
	1	2	3	4	5	6	7	8	
PHYSICAL ANALYSIS (GRAIN SIZE)									
Sand %	4.15	-	89	68.5	85.45	47.4	16.4	15.4	-
Slit %	91	-	2.65	18.1	3.2	28.5	41	34.2	-
Clay (<0.002 mm) %	3.05	-	7.2	11.7	9.95	22.6	41.35	49.1	-
Total %	98.2	-	98.85	98.3	98.6	98.5	98.75	98.7	-
Moisture (%)	22.35	-	1.39	2.65	1.26	2.59	4.76	3.52	-
pH	7.7	-	7.37	7.63	7.66	8.02	8.1	8.62	-
CHEMICAL ANALYSIS									
Arsenic (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	50
Mercury (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	0.8
Cadmium (mg/kg)	1.1	1.07	0.85	1.4	0.975	0.825	0.125	10.425	2.4
Chromium (mg/kg)	740	49.75	37.75	187.75	45.5	29.57	19.5	28.25	180
Copper (mg/kg)	14	ND	7.4	105.25	65	1.8	ND	ND	90
Iron (mg/kg)	610	576.5	589.5	516.5	576.5	605.5	595	625.5	-
Manganese (mg/kg)	358.25	364.5	188.25	279.7	627	605.5	404	1113.5	-
Nickel (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	74
Lead (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	200
Total Organic Matter (%)	10.03	-	1.39	3.37	2.14	3.49	6.06	4.23	-
Total Nitrogen (%)	0.18	-	0.25	0.23	0.21	0.29	0.24	0.18	-
Total Phosphrous (mg/kg)	101.8	-	13.79	48.05	19.45	62.83	21.01	24.87	-

Legend: STC: Shwe Ta Chaung canal; NTC: Ngwe Ta Chaung canal; MGL: Mingalar canal; PYTC: Payantau creek (industrial wastewater); C67: canal 6 next to road 67th.

Location of sediment sampling sites is presented on the following Figure [42] .

No reference standard for sediment quality is available for Myanmar, but this situation concerns most countries. Some reference standards have been established for harbour dredging, which frequently results in large volume of contaminated sediment to be discharged in the open water. Standards considered for heavy metals are those adopted by Germany and Nederland (SEBA Sea Based Activities, February 1997) under the Oslo Convention. For the organic load of the sediments, only the US-EPA formulated recommendations for sediments/sludge to be dumped in the sea, estuaries and rivers: Organic matter should not be higher than 6% of the dry product after carbonisation.

Figure [42] LOCATION OF SEDIMENT SAMPLING POINTS



nom	Location	Comment
C1&S1	Tingazar Creek	
C2&S2	Tingazar Creek	
C3&S3	Shwe Ta Chaung	
C5&S5	Mingalar Canal	
C6&S6	Ngwe Ta Chaung	
C7&S7	Ngwe Ta Chaung	
C8&S8	Payantaw Creek	Downstream industrial zone
C9&S9	Canal#6	!! 2 canals - sampling in #6
L1	Kandawgyi lake	
L2	Kandawgyi lake	
R1	Irrawaddy river	Close to MCDC intake point
R2	Irrawaddy river	

Source: PPTA Consultant, 2014

From the results of analysis, the following observations can be made:

Suitability for fill: The standards proposed by SEBA are rather strict as they provide a limit below which the dredged material can be simply discharged into open waters. Sediments from the canals show high sand content for Shwe Ta Chaung and Mingalar. Ngwe Ta Chaung presents a higher level of silts probably due to its lower flow speed. Material dredged from these 3 canals is suitable for fill. Thingaza creek sediment is much thinner, with only about 5% sand in the sample analysed. This sediment (but which is not anticipated to be dredged during MUSIP 1) is not suitable as fill for eventual construction purpose.

Pollution levels: Pollution levels in the 3 canals concerned by dredging are reasonably low, except for iron and manganese. Arsenic, mercury, nickel and lead have not been detected. The fine sediment of Thingaza shows high content in chromium and higher organic matter than in canals. It worth mentioning that the sample point was located at a place where a former tannery discharged untreated effluents for years. This most probably explains the high chromium level. MUSIP1 does not involve dredging of the creek, but when this comes in the future, a detailed sampling and analysis will be required to identify areas of fine sediments which may require particular management (landfill, confinement).

Land Consumption: 100,000 m^3 disposed over 2 to 5 meters depth represent a related land consumption of 5 to 2 ha. According direct observations on the field and grain size analysis performed, the sediment is rather sandy and can be used as fill for land reclamation. There is a huge demand for fill in Mandalay, as urban development is presently carried out in low lands generally flooded during the whole rainy season. Furthermore, the proposed site for the wastewater treatment plant is also floodable and requires filling. The proposed site for the pilot waste collection station, in northwest Mandalay will also need fill prior to construction of the facility. The totality of the dredged sediment from canals will be easily reused as fill, either internally to the project, for the WWTP or outside the project by any of the several developers interested.

Traffic increase with public safety and nuisances issues: this is related to the transport of the dredged sediment to its eventual disposal site. The removal of about 100,000 m^3 corresponds to about 12,000 truckloads or 24,000 truck movements. With a disposal site (WWTP) at a distance of about 10 km from the dredging sites, the transport could represent 240,000 truck-km (or almost 12,000 litres diesel), most to be done within dense urban area. This traffic increases the risk of accident, the noise and the level of air pollution in the residential areas crossed, and needs to be minimized.

5.4.4.2. MITIGATION MEASURES

Before site works start, a Dredging and Cleaning Management Plan will be prepared by the Contractor in charge of canal dredging operations and Thingaza creek cleaning, and shall be approved by PIC. The plan shall present the followings:

- Specific technical measures required in order to ensure drainage and compaction of the fill to satisfy expected geotechnical requirements for the construction of the WWTP and its ancillary facilities.
- Preliminary cleaning program for the creek and canals to be dredged: huge volumes of solid waste have been dumped in the Thingaza creek and the canals, and need to be removed and transported to the landfill prior dredging the sediment for filling.
- Method statement for dredging activity including (i) detailed survey for sediment sampling and analysis and confirmation of volumes usable/unusable for fill, (ii) identification of method and site suitable area for the disposal of sediment part inappropriate for fill, (iii) designation of preferred hauling routes to limit the crossing of urban areas from the dredging site to the WWTP site, (iv) detailed schedule for cleaning and dredging operation.
- Wheel washing system shall be implemented on each site (dredging and disposal) to avoid release of mud on the public road.

5.4.5. OFF-SITE PUBLIC SAFETY AND INCONVENIENCE

5.4.5.1. SOURCE OF IMPACTS

All activities involving work along public roads (as dredging, water supply network rehabilitation, interceptors laying) will definitely reduce the accessibility to certain streets, reduce the number of usable lanes and create

traffic congestion. The presence of population including children next to construction activities where heavy machinery is operating and with the presence of excavations and construction equipment, will create additional risks public safety.

Also, the working area may temporary alienate access to work sites, schools and community facilities. In addition, retail merchants may suffer economic losses if access id denied to their establishments. The project will be required to take all the necessary measures in order to minimize the detrimental side effects of construction activities particularly regarding traffic and public safety.

5.4.5.2. MITIGATION MEASURES

The following measures shall be implemented by the contractor to address impacts to traffic flow and access to properties:

- Before site works commence, a Traffic Management Plan for the construction phase shall be prepared by the concerned contractors and shall be approved by the PIC. The plan shall be designed to ensure that traffic congestion due to construction activities and movement of construction vehicles, haulage trucks, and equipment is minimized. The plan shall be prepared in consultation with local traffic police. The plan shall identify traffic diversion and management, define routes for construction traffic from materials storage/parking areas to construction site and from construction site to waste disposal locations, traffic schedules, traffic arrangements showing all detours/lane diversions, modifications to signals at intersections, necessary barricades, warning/advisory signs, road signs, lighting, and other provisions to ensure that adequate and safe access is provided to cars, motorists and pedestrians in the affected areas.
- Provide signs advising road users that construction is in progress and that the road narrows to one lane using cones.
- Employ flag persons to control traffic at sites for safety reasons when construction equipment is entering or leaving the work area.
- Lanes through the work site created by rope or flagging, shall be developed to minimize risks of injuries.
- Post traffic advisory signs (to minimize traffic build-up) in coordination with local authorities
- Provide road signs indicating the lane is closed 200 m before the worksite and signs to indicate the proposed detour road.
- Provide sufficient lighting at night within and in the vicinity of construction sites.
- Regularly monitor traffic conditions along access roads to ensure that project vehicles are not causing congestion.
- As much as possible, schedule delivery of construction materials and equipment as well as transport of spoils during non-peak hours.
- Implement suitable safety measures to minimize risk of adverse interactions between construction works and traffic flows through provision of temporary signals or flag controls, adequate lighting, fencing, signage and road diversions.
- Comply with traffic regulations and avoid, where possible, roads with the highest traffic volumes, high density of sensitive receivers or capacity constraints are not used as access to and from the construction areas and spoils disposal sites.
- Install temporary accesses to properties affected by disruption to their permanent accesses.
- Reinstate good quality permanent accesses following completion of construction.

5.4.6. IMPACTS FROM WASTE PRODUCTION

5.4.6.1. SOURCE OF IMPACTS

Quantities of solid waste will be generated by construction activities or by worker camps and canteens. A plan for managing all these types of waste needs to be put in place. There are three categories of waste to consider: household waste, inert construction waste and hazardous waste.

The quantity of domestic waste, mainly produced by temporary or permanent camps set up for the needs of the project, can be estimated at 0.5 to 0.7 kg/person/day. This waste mainly includes waste from canteens, packaging, plastic bottles, glass bottles, paper and cardboard. As the project is located in an urban area which may supply most of the manpower required, it is not anticipated large worker camps, but small camps on the sites to ensure a presence 24h and the protection of the equipment. Production of waste should be rather limited nevertheless it is worth being properly managed.

Inert construction waste is generated on the construction sites in variable quantities. It consists mainly of wood, packing boxes, scrap, plastics and concrete debris (the later coming from the few demolition required. This waste is generally disposed of, and landfilled in appropriated sites or in permanent inert materials sites. They represent no direct danger to health. Scrap metal is generally collected for recycling. Wood and cardboard waste if burnt will produce fumes and nuisance for the neighbourhood.

Hazardous waste such as vehicle batteries, oil filters, various containers that had held hazardous products (mainly paints and solvents) and other alkaline/lithium ion batteries is generated by construction activities, but in specific places and in limited quantities. This waste is harmful to the environment and public health and must receive appropriate treatment so as to ensure it is eliminated safely. The main risk comes from used engine and hydraulic oil resulting from the maintenance on site of heavy equipment (backhoe, bulldozer, levelers, etc.) and which may be produced in large quantities. If released on the ground, these hydrocarbons will involve surface and underground water pollution. The present project does not anticipate the maintenance of trucks on site, as the project is developed in an urban area, garage facilities are available for trucks. Hazardous waste also includes sludge from temporary toilets to be installed on construction sites within urbanized areas.

5.4.6.2. MITIGATION MEASURES

To avoid such impacts, the contractor shall be requested the following:

Prior to the start of the works, to prepare a Waste Management Plan addressing the management issues related to all types of waste: anticipated production and schedule, collection system proposed, disposal methods and location. The Plan will reflect the following obligations:

For Non-hazardous Waste

- Provide garbage bins and facilities within the project sites for temporary storage of construction waste and domestic solid waste and ensure that wastes are regularly removed by the Cleaning Department of MCDC.
- Implement an employee awareness program in waste management and site cleanliness.

For Hazardous Waste

- Any waste engine oil and hydraulic lubricants from heavy machinery and the floating oily residue from oil separators will be collected and stored in tightly sealed containers to avoid contamination of soil and water resources. Transport and off-site disposal of such wastes for recycling shall be presented in the Plan.
- Any container of such waste will be stored in a dedicated area with waterproof floor surrounded by a bund the height of which will ensure retention of a volume equal to at least 110% of that of the largest container stored in the area.
- Batteries, vehicle batteries, oil filters, printer cartridges from the site will be sorted and deposited in separate containers. The contractor will identify a circuit for elimination of these products and will submit his choice to the PIC for non-objection.
- Any medical waste from the First Aid station on site will be regularly delivered to Hospital equipped with an incinerator.

- Metal or plastic containers that have contained hazardous or toxic chemical substances will be collected by a registered company for treatment and recycling.

5.4.7. HAZARDOUS MATERIAL MANAGEMENT AND ACCIDENTAL SPILL

According to the type of construction activities anticipated for the MUSIP components, it is not anticipated any storage of fuel on site, as works are mainly implemented in densely urbanized areas. However, to avoid any leakage when refuelling heavy equipment on site (mainly backhoe), the contractor will be required:

- To ensure availability of spill clean-up materials (e.g., absorbent pads, fine sand, etc.) specifically designed for petroleum products and other hazardous substances on site where refuelling is anticipated.
- To train relevant construction personnel in handling of fuels and spill control procedures.

5.4.8. IMPACTS ON WATER RESOURCES QUALITY AND USE

No activity is anticipated in fresh water bodies, but only in water bodies consisting mainly of domestic wastewater. The risk of pollution of Thingaza creek or of the concerned canals by construction activities is quite limited. With the exception of the risk linked to mismanagement of hydrocarbons (diesel and oils) already discussed above, the main impact may be the increase of suspended sediment in water, a relatively insignificant impact considering the existing water quality and the fact it is evidently not used by the population. No particular measure is required on this issue.

Other project activities will concern the rehabilitation of WTP8 and the rehabilitation of existing reservoir. Works will be technically organized on these sites in a way to preserve the quality of the water supplied to the network. Similarly, rehabilitation of the water supply network will ensure no contamination of the network results from the works. These aspects will be directly addressed by the work methodology which will be implemented.

5.4.9. IMPACTS ON CULTURAL HERITAGE RESOURCES

5.4.9.1. SOURCES OF IMPACTS

As mentioned in the baseline situation report, Mandalay is the home to several monasteries and pagodas distributed all over the city. All the work sites have been visited by the PPTA Consultant and where these presented a risk to interfere with the cultural heritage, alternative design options have been proposed. As an example, the interceptor route along the west shore of Thingaza creek has been re-routed to avoid crossing two monasteries located along the creek.

No identified sites of heritage significance will require removal or demolition as part of the construction works and there will be no land acquisition of any heritage sites. However, even if no valuable physical cultural resource has been identified from the project sites, impacts on archaeological relicts may happen particularly during dredging operations in Thingaza creek and during earthwork excavation for the rehabilitation of the water storage on Mandalay Hill or in the streets for the rehabilitation of the water supply network.

5.4.9.2. MITIGATION MEASURES

The following "chance to find" procedure will be implemented by the contractor throughout the construction works to account for any undiscovered items identified during construction works:

1) Workers will be trained in the location of heritage zones within the construction area and in the identification of potential items of heritage significance.
2) Should any potential items be located, the site supervisor will be immediately contacted and work will be temporarily stopped in that area.
3) If the site supervisor determines that the item is of potential significance, a representative from the Department of Archeology and National Museum (DANM, Ministry of Culture) from Mandalay will be invited to inspect the site and work will be stopped until he has responded to this invitation.

4) Work will not resume in this location until agreement has been reached between PMU and DANM as to any required mitigation measures, which may include excavation and recovery of the item.

5) A precautionary approach will be adopted in the application of this procedure.

5.4.10. HEALTH AND SAFETY OF WORKERS

The project will concentrate a number of workers recruited from Mandalay. To ensure appropriate health and safety conditions for the workers, and in compliance with the requirements of the Lending Agencies, a Health and Safety Management Plan shall be prepared by the concerned contractors and shall be approved by the PIC. The plan shall be designed to ensure that Burmese labour regulations but mainly international good practices related to health and safety are efficiently implemented on site. This obligation is a major one for the construction stage, as Occupational Health and Safety (OHS) is almost inexistent in Mandalay and particularly among contractors involved in works for MCDC. OHS must be considered also, within the framework of the present project as a pilot to which MCDC will refer eventually for further works and projects.

ABSENCE OF ANY BASIC OCCUPATIONAL HEALTH AND SAFETY MEASURES ON THIS CONSTRUCTION SITE ALONG SHWE TA CHAUNG CANAL

UNACCEPTABLE SITUATION OBSERVED IN THE SHWE TA CHAUNG IN NOVEMBER 2014

The OHS Plan will address the following obligations:

- The Plan shall address health and safety hazards associated with construction activities (e.g., working at heights, excavations, etc.) establishment and operation of construction/worker's camps, use of heavy equipment, transport of materials and other hazards associated with various construction activities, particularly when dealing with highly contaminated and septic water.
- The concerned contractor(s) to appoint an Environment, Health and Safety (EHS) Coordinator to look after implementation of required EHS measures, and to ensure the safety of the public in the vicinity of construction areas.
- To conduct awareness training for construction workers regarding health and safety measures, hygiene, emergency response in case of accidents, fire, etc., and prevention of water related diseases.
- To provide first aid facilities readily accessible by workers.
- To provide fire-fighting equipment on the work sites.
- To provide adequate housing for all workers living in construction camps.
- To provide reliable supply of potable water on work sites.
- To provide separate hygienic sanitation facilities/toilets and bathing areas with sufficient water supply for male and female workers.
- To establish clean canteen/rest area.
- To ensure proper collection and disposal of solid wastes within the construction sites.

- To provide solid fencing on all areas of excavation greater than 1 m deep. For all worksite areas without excavation, provides movable barriers to prevent accident with local population.
- To provide appropriate personnel protection equipment (PPE) at least helmets and safety boots. Provides also gloves, protective clothes, goggles, ear protection where justified and ensure the equipment is effectively and adequately used.
- To ensure reversing signals are installed on all construction vehicles.
- To implement fall prevention and protection measures whenever a worker is exposed to the hazard of falling more than two meters, falling into operating machinery or through an opening in a work surface. Based on a case-specific basis, fall prevention/protection measures may include installation of guardrails with mid-rails and toe boards at the edge of any fall hazard area, proper use of ladders and scaffolds by trained employees, use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard, fall protection devices such as full body harnesses, etc.

5.4.11. SUMMARY OF IMPACTS AND PROPOSED MEASURES

Table [30] below summarizes the impacts identified and the corrective measures proposed for the MUSIP 1 Project Components during the construction period. For the meaning given to the evaluation of the impact, see Section 5.1: Methodology for Impact Assessment.

Table [30] IMPACTS OF MUSIP1 DURING CONSTRUCTION

COMPONENT OR ACTIVITY	POTENTIAL RISKS	DESCRIPTION OF POTENTIAL IMPACT	IMPACT ASSESSMENT			CORRECTIVE OR SUPPORT MEASURE		
			PROBABILITY	GRAVITY	OVERALL RISK	DESCRIPTION OF MEASURE	EASINESS OF IMPLEMENTATION	OVERALL RISK AFTER CORRECTION
Land preparation	Excessive destruction of trees	Limited impact for the whole project. Components will only impose punctually few tree cutting mainly for access to work site (WWTP, interceptors)	3	1	1	Monitoring of tree cutting by PIC, and maximization of conservation	1	1
			3	1	1	Mitigation greening program considering at least 2 trees planted for 1 tree cut	1	1
	Destruction of protected tree species	Based on literatures, only one species identified in Mandalay has a status of threatened species from the IUCN: Acacia ferruginea. It may be present on some sites to be cleared for the project	1	2	1	Cutting of tree will only be authorized after signed form of site inspection by PIC confirming no A. ferruginea is observed. In case of positive observation, mitigation will be discussed with the CC: preserving the tree if feasible, replacement by new planted tree if cutting is not avoidable	1	1
	Interference with compensation & resettlement	Construction works start while land acquisition is not completed, raising conflicts with concerned population. Potential risk for WWTP, interceptors of Shwe ta Chaung between 25th and 28th streets (Market area) and along Mingalar canal	1	3	2	Procedure with issuance of a land access certificate by PMU as a prerequisite for authorizing contractor to access the land.	2	1
						Monitoring by PIC of compensation progress and of issuance certificate		
Workers' camps (Main camps)	Pollution of surface water and groundwater	Wastewater discharged into the environment	3	2	2	Wastewater receives treatment before being released outside premises (septic tanks)	2	1
						Contractor to monitor the quality of effluents released outside the bounds of the camps	2	1
	Zones of stagnant water	Proliferation of water-borne disease vectors (mainly dengue fever and malaria)	2	3	2	Create and maintain ditches to ensure efficient drainage and drain all stagnant water zones in camp	2	1
						Regular treatment of living areas with pesticide	2	1
	Health risks	Development of diseases linked to deficit in hygiene	2	2	2	Systematic awareness sessions for all new arrivals at the camp: meetings, posters in circulation areas, monitored by the camp chief	1	1
		Risk of epidemics in the camps	2	2	2	Prevention by automatic medical check-up at hiring	1	1
						Monitoring of hygiene conditions at the camps	2	1
						Anti-malarial prophylaxis, including mosquito netting	1	1
	Workers' living conditions	The most serious impact would be that the contractor does not provide acceptable housing and subsistence for all the workers.	2	3	3	Include detailed specifications on camp equipment and management in the tender documents.Enforce contractor obligations on site by regular site inspections (PIC)	1	1

Component or activity	Potential risks	Description of Potential Impact	Impact assessment			Corrective or support measure		Overall Risk after Correction
			Probability	Gravity	Overall Risk	Description of Measure	Easiness of Implementation	
	Non-potable water supplied to workers.	Impact on public health, risk of epidemic. Main risk at the WWTP site where a worker camp may be installed. Other project components located within urban areas, where camp facilities may not be required. However, water supplied on construction sites may also be of bad quality with impacts on worker's health	1	3	2	Tender documents to define obligations of contractors regarding supply of potable water Supply packaged water (20 litre tubs) for the small camps on construction sites (with few peoples sleeping on site)	1	1
						Contractor and PIC to regularly monitor coliforms	2	1
Workshops and garages	Water and soil pollution	Risk mainly localised at the WWTP site as no such facilities will be installed in the urban area for the other Project components. Stormwater drainage contaminated by pollutants (mainly oil & grease)	3	2	2	Drains of workshops and garages equipped with oil separators	2	1
						Properly store hazardous products (including hydrocarbons). See activity "Use and storage of hazardous products"	1	1
						PIC to monitor and control used oil: Monitoring registers/logs and dedicated storage areas.	1	1
Dredging of creek and canals	Water pollution	Impact mainly limited to heavily polluted drainage system (creek and canals). Impacts limited due to initial very poor condition of surface water	3	1	1	No specific action required	-	-
	Loss of cultural resources	Possibility does exist of archaeological physical resource discovery during excavation work with the total loss of the relic if special measures are not taken. Dredging of Thingaza creek as well as excavation works on Mandalay Hill and along water supply network are the most sensitive areas	1	2	2	Put in place a "Chance to Find" procedure aimed at halting work and warning the supervisors and the national authorities concerned. so measures can be taken to preserve the discovery and restart work as quickly as possible. Ensure personnel is aware of the procedure.	1	1
Hazardous waste management	Water and soil pollution	Located in urban area, most truck maintenance will be done in private garages. Only heavy machinery will receive basic maintenance and refueling on site. Limited volumes of used engine oil and used hydraulic oil will be produced on site and will need appropriate storage to avoid soil and water pollution	3	2	2	Require the contractor to prepare a hazardous waste management plan explaining where and how he will manage used oils	1	1
						Use storage sites that meet safety standards (with retention)	2	1
						Identify the existing used oil recycling facilities in Mandalay	1	1
						Contractor to maintain a log of production/recycling of used oil	1	1

Component or activity	Potential risks	Description of Potential Impact	Impact assessment			Corrective or support measure		Overall Risk after Correction
			Probability	Gravity	Overall Risk	Description of Measure	Easiness of Implementation	
Production of solid non-hazardous waste	Water and soil pollution	By domestic waste: Possible impact if the waste is not managed in line with best practices in the worker camps and construction sites Only small camps are anticipated which limits the magnitude of the impact..	3	2	2	Contractor to submit a Solid Waste Management Plan including methods and procedures for (i) Awareness training of workers, (ii) collection and storage of waste on project sites, (iii) selective collection and recycling of waste (iv) eventual collection and disposal of waste, (v) coordination with MCDC cleaning Dept	1	1
		By construction waste: Limited risk for inert products which may be associated to the fill for the WWTP	2	1	2	Ensure recycling of metals, plastics and glass	2	1
Concrete production	Water pollution	Typical impact is water pollution by the alcaline wastewater from equipment and concrete trucks cleaning. This may concern the WWTP site where a concrete plant may be installed.	2	2	2	Install a sedimentation pond with pH buffering before release of water in the drainage system	2	1
						Contractor (and PIC) to monitor the quality (SS, pH) of effluent released	1	1
Sediment and Spoil Disposal	Excessive use of productive land to dispose the spoil	About 100,000 m3 anticipated from dredging activities but which may be reused as fill for land reclamation of the future WWTP	3	1	1	No particular measure if sediment used as fill for WWTP land	-	-
		Temporary disposal of reusable sediment before it is used may impact land use and agriculture	2	2	2	Contractor to detail sediment management in the Dredging and Sediment Management Plan including temporary disposal methods and sites	1	1
Road Traffic	Public safety	Risk of road accidents related to truck traffic increase in urban zones particularly because of sediment transport estimated to more than 24,000 truck trips.	2	3	2	Selected hauling routes and preventive/monitoring measures to be presented by the contractor in the Road Traffic and Access Plan	1	1
						Monitoring of driver behaviors in relation with Police Department	1	1
	Risk of traffic disruption in urban zones	Most sensitive areas related to dredging of Shwe Ta Chaung (between roads 22nd and 28thnear market) and possibly in small streets concerned by rehabilitation of water supply network.	3	2	3	Road Traffic and Access Management Planto be prepared by contractor will detail procedures for traffic management: coordination with police, public information, signs and safety etc.	2	1
	Air pollution	Excessive exhaust gas emissions	3	2	2	Keep engines serviced	2	1
		Production of dust	3	2	2	Speed control, regular sprinkling of sensitive urban areas and on construction sites, cleaning of truck wheels when exiting sites	2	1

Component or activity	Potential risks	Description of Potential Impact	Impact assessment			Corrective or support measure		Overall Risk after Correction
			Probability	Gravity	Overall Risk	Description of Measure	Easiness of Implementation	
Handling of hazardous products	Fire risk	Related to the storage of flammable products: hydrocarbons, paints, solvents. Potential risk on most sites involving heavy machinery	1	3	2	Provide fire equipment at each site (extinguishers, fine sand) and safety posters displayed onsite.	1	1
						Set up a safety procedure and awareness/training for personnel concerned.	1	1
	Risk of accidents to personnel	Burning during handling operations, but risks reasonnably limited	1	3	2	Provide training for personnel plus personal protective equipment and onsite safety data sheets for the products concerned	1	1
	Water pollution	Potential risk of accidental spillage: Leak in a storage tank, accidental spillage when handling or refuelling engines, road accident when transporting hydrocarbons.	2	3	2	Contractor to prepare hazardous products management plan, in particular: Store using containment trays, measures for preventing and detecting leaks and accidental spills, register/log of hazardous products and their use, antipollution equipment.	2	1
						Emergency response procedure in the case of accidental spillage	2	1
						Special safety measures for refuelling engines onsite	1	1
All Components and Activities	Occupational Accident of workers	As observed on construction sites in Mandalay, occupational safety of workers is almost inexistant, with high risks of injuries and accidents during construction activities	3	3	3	Contractor to prepare and enforce a Health and Safety Plan to describe organisation, prevention and measures in case of accident	1	1
						Obligation of Personal Protective Equipment (PPE) for all workers on project sites, minimum being helmet and safety shoes	2	1
						Main contractors to designate a HSE Coordinator to ensure safety measures are enforced on sites	2	1
						Regular site inspections of PIC	1	1

5.5. IMPACTS DURING OPERATION STAGE

Impacts from MUSIP1 during operation will be mainly beneficial for public health, quality of life and environment improvement in Mandalay City. Indeed the various components will achieve several objectives of environmental and social improvements as discussed below.

5.5.1. IMPACTS ON URBAN FLOODING

The drainage component of the MUSIP1 will improve stormwater drainage flow mainly through (i) cleaning and dredging of Thingaza creek and mainly Shwe Ta Chaung canal, (ii) increasing pumping capacities downstream, to allow for lower levels in the receiving lakes thus increasing storage and increasing discharge of drainage canals, (iii) improving solid waste collection which will incidentally reduce the waste volume dumped in the drainage system and improve canal flow. Main impact will be a reduction of flooded areas during rainy season particularly around Thingaza creek and around Thaungthaman Inn Lake in Amarapura.

5.5.2. IMPACTS ON UNDERGROUND WATER RESOURCES

MUSIP1 Water Supply component includes the rehabilitation of most MCDC deep wells distributed along the Ayeyarwaddy eastern shore. The survey carried out by the French Grant team shows that several wells do not operate properly by pumping air instead of water. The Jica Report (2003), already mentioned that the deep aquifer is over exploited and its static level is going down. The strategy of MUSIP1 to increase storage capacity and to improve the capacity of WTP8, in fact promotes the use of surface water resource from the Ayeyarwaddy, virtually unlimited. Furthermore, a strategy for the reduction of non-revenue water (NRW) will also increase water availability by reduction of leakages among other actions. Improvement of water supplied should not put more pressure on the underground resources.

5.5.3. IMPACTS OF CLIMATE CHANGE ON WATER RESOURCES

The presentation of the baseline situation highlights the probable increased droughts in the future because of the climate change trends. As mentioned, the analysis does not identify a reduction in annual rainfall, but a reduction in the duration of the monsoon with increased risk of drought during the second part of the dry season. The potential impacts on the water supply component of the project may include the following:

- Surface water will be more and more utilized in the future for the supply of Mandalay, from the Ayeyarwaddy River, an unlimited resource for urban water supply, and from the Dokhtawaddy river, already dammed upstream and thus regulated along the year. No deficit of surface water is anticipated on the long term.
- Underground water is already widely pumped. However, a large number of the deep wells are located along the Ayeyarwaddy river and the aquifer is rapidly renewed from the alluvial percolation from the river.
- The MUSIP1 will almost double the water storage capacity of the city, providing additional security during the driest periods of the year in the medium term.

These various reasons confirm that climate change is not anticipated to significantly affect the water resources mobilised by the water supply components of MUSIP1.

5.5.4. IMPACTS ON SURFACE WATER QUALITY

MUSIP1 will have major beneficial impacts on surface water quality, through different components:

- Implementation of interceptors along Thingaza creek, Shwe Ta Chaung and Migalar canals will reduce the daily BOD load presently discharged into these systems by 4.8 tons/day[4].
- The WWTP proposed in Amarapura will eventually reduce the BOD load discharged in the environment by 5 tons/day. Furthermore, increasing night soil collection and treatment will

[4] TA-8472, Draft Final Report, Volume 5, Wastewater FSR & Preliminary Design, Table 4.

double the present collection and treatment capacities from annual 900 t BOD to 1,800 t BOD/year.

The following Table [31] provides an estimate of the potential impact of wastewater discharges from Mandalay City on the Ayeyarwaddy for drought flows and mean monthly average flows at Sagaing station just downstream of Mandalay. It can be appreciated assuming full mixing that the impact is minimal. In fact, this analysis would suggest that no treatment (or minimum treatment would be required with regard to the protection of the Ayeyarwaddy).

Table [31] IMPACTS OF MANDALAY CITY ON BOD LEVELS OF AYEYARWADDY

	2014	2015	2020	2025	2030	2035	2040
Drought Flow (m^3/s)	1093	1093	1093	1093	1093	1093	1093
Increase in BOD (mg/l)	0.08	0.09	0.10	0.24	0.30	0.37	0.44
Mean Monthly Discharge (m^3/s)	8309	8309	8309	8309	8309	8309	8309
Increase in BOD (mg/l)	0.01	0.01	0.01	0.03	0.04	0.05	0.06

Treated effluent will be discharged into the Ayeyarwaddy River, approximately at the level of the WWTP. The discharge site anticipated is a floodable area within the river major bed. Neither permanent settlement nor any river water use along at least few km downstream the proposed site. The discharged treated effluent being compliant with the 60 mg BOD/l proposed standard, the WWTP will concentrate evidently an organic pollution load at the discharge point. However, the very large dilution expected with the river flow and the fact that the protected area for the Ayeyarwaddy dolphin is several km upstream tend to minimize the potential impact on river water quality and its consequences on the ecosystem. A probable localised increase of BOD will be observed and will then rapidly decrease with the distance thanks to the mixing with the river water. Also, the WWTP with only primary treatment is a temporary one, as the plant should be in a second phase upgraded with secondary treatment, with only 20 mg BOD/l pollution load.

Cleaning of Thingaza creek and dredging of Shwe Ta Chaung canal will also improve the water quality of these water bodies by removing a quantity of solid waste and deposited organic matter.

5.5.5. IMPACTS ON URBAN ENVIRONMENT AND QUALITY OF LIFE

All the MUSIP components will eventually contribute to a healthier and cleaner urban environment. Improvement of water supply capacity and rehabilitation/extension of networks will reduce the population dependency to private or public shallow wells, many being significantly contaminated. Improvement of water quality in the canals will reduce the risk for waterborne diseases among the dense population living along the canals and contribute to improve public health conditions in Mandalay. Similarly, improved collection of waste will also reduce the risk of diseases transmitted through insects or rodents.

All these components will also improve the level of beautification of the city, particularly the main sites as Thingaza creek, Shwe Ta Chaung and Mingalar canals, which may eventually receive additional rehabilitation and greening, turning presently rather dirty areas into attractive sites for development and tourism.

5.5.6. IMPACTS ON "GREEN MANDALAY" OBJECTIVES

5.5.6.1. ENERGY CO-GENERATION AND SLUDGE RE-USE

Some of the MUSIP1 Components are rather innovative and in line with the Green Mandalay vision. The WWTP providing only enhanced primary treatment in its first development stage will produce a large volume of sludge estimated at about 10 tons dry matter per day (about 25 tons sludge). It is proposed to associate a digester to the WWTP in order to co-generate methane gas and use it for electricity production. It is anticipated that energy production will satisfy requirements of the plant.

An option is to consider the re-use of the sludge as fertilizer for agricultural production, widely developed in the WWTP surroundings. As temperature in a digester does not rise above 37°c, residual sludge will not be stabilized and biologically decontaminated. Two possibilities do exist: (i) direct treatment of the sludge with lime or (ii) composting (temperature rises to 70°c in a composting stage and stabilizes the sludge). The first

option is more simple and cheaper to implement, the second one is more technical and requires higher investment. Also, composting releases unpleasant smells and it is doubtless to implement such an activity on the WWTP site with major road and residences in the vicinity. This one should be implemented on the site of the new landfill, where composting may also receive green waste.

Depending on further technical studies on this process chain, there could be a full re-use of the sludge by agriculture, with possibly the development of a pilot agriculture scheme next to the WWTP, to carry out trials and to provide capacity building to the farmers.

5.5.7. IMPACTS OF WWTP IN TERMS OF GREEN HOUSE GAS EMISSIONS

As mentioned in the section above, the project considers the implementation of a digester to collect methane and use it for co-generation of energy. The WWTP will provide only enhanced primary treatment, mainly consisting of sedimentation. During this process, little organic matter will be degraded by an aerobic process, with insignificant release of GHG (mainly some carbon dioxide). The main impact on GHG results mainly from the release of methane gas through anaerobic transformation of the resulting organic sludge.

The proposed system will include a digester with cogeneration of electricity. The following table summarizes the GHG emission for anaerobic technology with methane recovery and cogeneration.

Table [32] SUMMARY OF BIOGAS, GHG AND COGENERATION PRODUCTION

	UNIT	VALUE	HYPOTHESIS/CALCULATION
Wet Sludge (5%) inflow to digestor (	Tons/day	267	Primary sludge after chemical coagulation
Dry sludge inflow to digestor	Tons/day	13.4	-
Biogas produced by WWTP	Nm^3/day[5]	3 285	Primary sludge with biogas potential of 245 Nm^3 Biogas/ton dry sludge
	Nm3/year	1 199 000	-
Quantity of GHG captured/year	tCO_2eq/year	13 167	Biogas includes 75% methane and 25% Carbon dioxide at respective densities of 0.668 kg/m^3 and 1.842 kg/m^3 Global warming potential of CH4 is 21 (tCH4/tCO2)
GHG emission from final sludge disposal (land application)	tCO2eq/year	2 365	
GHG emission from final sludge disposal (landfill without methane recovery)	tCO2eq/year	4 730	
GHG emission from final sludge disposal (Co-incineration in cement factory)	tCO2eq/year	0	DS used at 5% of the total fuel requirement. Benefits for GHG is reduction of 5% in burning coal or heavy fuel.
Electrical Energy produced (potential)	kWh	855	Biogas-electricity generation ratio of 6.2 KWh/m3 biogas
Electrical Energy produced (effective)	kWh	427	Estimated at about 50% of the potential
	MWh/year	3 716	6.2 kWh per m3 biogas for primary sludge
Electric Consumption for pumps	MWh/year	1 752	
Electric Consumption for sedimentation	MWh/year	438	
Electric Consumption for drying (centrifuges)	MWh/year	2 300	3.25 MWh/100 tons WS from 5% to 20% dryness
Energy still required from national grid	MWh/year	784	

From the calculations, we may conclude that the WWTP will capture 13 167 tCO2eq/year, reducing by this amount the emissions of GHG to the atmosphere. However, some minor emissions will subsist in the process, particularly related to the final disposal of the dehydrated sludge exiting the centrifuges. Different alternative solutions may be considered:

[5] Nm3: Normal m^3 at 15°C and 1 atmosphere (1013 mb) according to ISO 2533

- Disposed on a managed landfill, without methane recovery. This is the less suitable solution with a level of emission of 4 730 tCO2eq/year.
- Disposed on land for forestry or soil improvement objective. It can also be used on agriculture land as fertilizer substitute, but it will be necessary to ensure first the residual levels in heavy metals are acceptable. In this case, emission will be only 2 365 tCO2eq/year.
- Used as fuel substitute in a cement factory. It may substitute up to 5% of the conventional fuel. GHG release is then nil as it replaces conventional fuel as natural gas, heavy fuel or coal. It may even provide some benefits depending the type and quality of the conventional fuel. This solution may be preferred but is applicable only if a cement plant respecting international standards is located in a reasonable vicinity of the WWTP.

About 50% of the captured biogas can be used for the average production of 3 720 MWh per year. This electric production covers the needs of the WWTP for pumping (1 752 MWh/year) and sedimentation processing (438 MWh/year). It also covers the needs of energy for centrifugation of the sludge at the end of the digestion (2 300 MWh/year). With co-generation, the project may cover about 83% of its electric energy requirements (4 500 MWh/year).

5.5.8. Impacts on Air Quality and Noise

The Project should have beneficial impacts on air quality. Air quality in Mandalay is presently affected by the presence of open sewers (canals) releasing methane and hydrogen sulphur gas into the atmosphere. The rehabilitation of the Thingaza creek and of Shwe Ta Chaung and Mingalar canals, will definitely improve air quality for the residents living along these infrastructures.

Also, the large volume of rotting organic solid waste dumped in any possible place around the urban area contributes to release unpleasant gas. The several transit points (17) for solid waste, equipped with degraded containers are also places generating smell nuisances to the surrounding population. The solid wase component will improve this situation: improving the collection will reduce the volume of waste dumped into the drains and open spaces of the city. The new transfer points (12) proposed will be better equipped and managed to reduce gas emission (shorter transit time for the waste, closed containers, closed trucks).

The WWTP will generate smells, particularly through its sludge. However, the proposed digestion of the sludge on site for gas production and energy co-generation will cancel most of unpleasant smell as methane will be collected and as digested sludge doesn't smell. Considering also that the plant will be implemented in a rural area will also minimize any risk of nuisance on surrounding areas.

The pumping station for the Thingaza interceptors may potentially generate unpleasant smells as well as noise during night time. To avoid such nuisances, it is recommended to consider a closed building for the facility (with containment of smells) and to use a submerged pump for cancelling any risk of noise nuisance.

5.5.9. Summary of Impacts and Proposed Measures

The following summarizes the potential operation impacts of MUSIP1 components with proposed corrective measures.

Table [33] SUMMARY OF IMPACTS OF MUSIP1 DURING OPERATION

COMPONENT OR ACTIVITY	POTENTIAL EFFECT	POTENTIAL IMPACT	IMPACT ASSESSMENT			CORRECTIVE OR SUPPORT MEASURE		OVERALL RISK AFTER CORRECTION
		DESCRIPTION OF IMPACT	PROBABILITY	GRAVITY	OVERALL RISK	DESCRIPTION OF MEASURE	EASINESS OF IMPLEMENTATION	
Improved Water Supply Systems								
Regeneration of tube wells	Impact on water resource	Objective is less to increase pumping from the aquifer (already over exploited) than improving the efficiency of the system.	2	2	2	Strategy to promote increased water resource from surface water (Ayeyarwaddy and Dhoktawaddy rivers)	2	1
Upgrading WTP8	Quality of life and public health	Improved water supply security in Mandalay and improved public health	-	-	-	-	-	-
Improved disinfection	Quality of life and public health	Improved public health Benefits erased if disinfection not permanent or strong enough to reach far points of network	2	3	3	Regular monitoring of residual chlorine and coliforms in the network	2	2
Network Rehabilitation and Extension	Quality of life and public health	Increase of population serviced may decrease number relying on polluted shallow wells for drinking purpose	-	-	-	-	-	-
Climate Change	Affect water resources mobilised by MUSIP1	Risk of insufficient surface water resources is not anticipated (Ayeyarwaddy & Dokhtawaddy rivers with almost illimited resources). Potential risk of drying up for some wells located far from Ayeyarwaddy. No risk anticipated for those located along the river bed (alluvial recharge)	1	3	1	No particular measure required except monitoring of water tables (under the water supply company)	-	-
Improved Wastewater & Drainage Management								
Interceptors Thingaza	Surface water quality	Reduces daily pollution load to surface water system by 2.4 tons BOD, 7 tons COD, 340 kg Amonia, 230 kg NO3-N and 110 kg PO4	-	-	-	-	-	-
	Quality of life	Restoration of water quality of the largest urban creek in Mandalay city, reduction of smells	-	-	-	-	-	-
	Urban development	Potential for major urban beautification in Mandalay	-	-	-	Integration of the Thingaza improvement in the medium term urban development for this part of the city	-	-

Component or activity	Potential Effect	Potential impact	Impact assessment			Corrective or support measure		Overall risk after correction
		Description of impact	Probability	Gravity	Overall Risk	Description of measure	Easiness of implementation	
Pumping station	Quality of life	Potential release on smells and noise during night	2	2	2	Consider closed building for the retention of smells and submersible pump to avaoid noise at night	2	1
Interceptors Shwe Ta Chaung	Surface Water Quality	Reduces daily pollution load to surface water system by 1.7 tons BOD, 3.7 tons COD, 120 kg Amonia, 150 kg NO3-N and 50 kg PO4	-	-	-	-	-	-
	Quality of life	Restoration of water quality of 10 km of open urban channel, densely urbanized on both sides	-	-	-	-	-	-
New WWTP with gas co-generation system	Surface Water Quality	Reduces surface water pollution load by 5,000 kg BOD/day or 1,800 tons BOD/year	-	-	-		-	-
		Concentrate organic load of treated effluent released to one point in Ayeyarwaddy with slight alteration of initial river water quality. Temporary situation before second Phase upgrade WWTP with secondary treatment	3	2	2	Design of outfall to maximize rapid dilution of treated effluent in the river flow.	2	1
						Water quality monitoring of effluent and of dilution plume in the river at various distance from outfall to confirm assumptions or to modify rules of operation (increased dilution at WWTP level for example)	2	1
	Sludge production	About 10 tons dry matter or 25 tons sludge produced everyday, with impact on land use for disposal	3	2	3	Include digestion of sludge with mathane gas production and electricity co-generation. Digested sludges can be used as agricultural fertilizer after stabilisation by lime or composting	3	1
		Primary sludge rather smelly and not compatible with residential areas around	3	2	2	Digestion and further composting (on the future landfill site) will solve this issue	3	1
Septage collection and treatment	Surface Water Quality	Reduces surface water pollution by increasing septage BOD load collected and treated by 900 tBOD/year (from 900t today to 1,800 t)	-	-	-	-	-	-
	Public Health	Reduces public health risks resulting from mismanagement of septic tank sludge in a dense urban area	-	-	-	-	-	-

Component or activity	Potential Effect	Potential impact	Impact assessment			Corrective or support measure		Overall risk after correction
		Description of impact	Probability	Gravity	Overall Risk	Description of measure	Easiness of implementation	
Pilot Scheme for Households Connection to sewers	Quality of Life and public Health	Beneficial impacts for 780 HH connected	-	-	-	-	-	-
TGZ Creek and canals cleaning	Urban drainage	An estimated volume of 100,000 m3 sediments to be removed from Thingaza, Shwe Ta Chaung and Mingalar improve pluvial drainage and storage capacity of TGZ creek						
	Flooding	Combined with increased pumping station capacities, reduction of urban flood prone areas particularly around Thingaza creek and Thaungthaman Inn Lake	-	-	-	-	-	-
Increased Pumping Stat. Capacities in lakes	Flooding							
Improved Solid Waste Management								
Pilot Collection point	Water Quality	Reduce quantity of waste discharged intro the local drainage system and in the surface water bodies	-	-	-	All these positive impacts depending on a major awareness campain and capacity building on waste management among population surrounding the site	-	-
	Drainage	Improves drains capacities and reduce localised flood risk, but risk of solid waste discharge continues by surrounding population, wasting efforts	-	-	-		-	-
	Quality of life	General improvement of city image and quality of life of residents along drainages	-	-	-		-	-
	Air quality	Reduction of waste illegally dumped in the city reduces air pollution from gas and smells and from smoke (burnt waste)	-	-	-		-	-
	Reduction of pollution	Pilot collection point will improve waste segregation and management of hazardous waste						
	Road traffic	Risk of accident related to entrance and exist of trucks from the site	2	2	1	Pilot site located at the junction of a main road and a secondary one, facilitating multi accesses for trucks and easy organisation of traffic.The site design should consider implementation at the	1	1

Component or activity	Potential Effect	Potential impact	Impact assessment			Corrective or support measure		Overall risk after correction
		Description of impact	Probability	Gravity	Overall Risk	Description of measure	Easiness of implementation	
						junction of the two roads, with appropriate road signs. Training of drivers		
	Public health	The proposed pilot site is large enough to avoid proximity with residential (or monastery) area	2	2	2	The site design should consider implementation at the junction of the two roads, far from the limit with the monastery.	1	1

6. PROJECT ALTERNATIVES

6.1. "NO PROJECT" ALTERNATIVE

The "no project" alternative will have the following impacts:

- There is expected to be a steady decline in the currently deficient urban services systems for the water supply, wastewater and drainage management, and solid waste management sectors.
- Specifically, for the water supply sector, the without-project scenario is expected to be a continuation of interrupted piped-water supply of poor-quality water to about 75% of the urban areas of Mandalay City and no piped-water supply to the remainder; many residents of these areas unable to connect to the existing piped-water supply; a very slow rate of increase in water supply connections; and an on-going high incidence of non-revenue water (NRW).
- For wastewater and drainage management, the without-project scenario is expected to involve a continuation of open drains throughout the city containing a mixture of untreated wastewater and storm water, resulting in pollution of surface and ground water, flooding of populated areas, and poor hygiene. In addition collection and disposal of septage is expected to remain well below acceptable standards with a resultant impact on health and the environment.

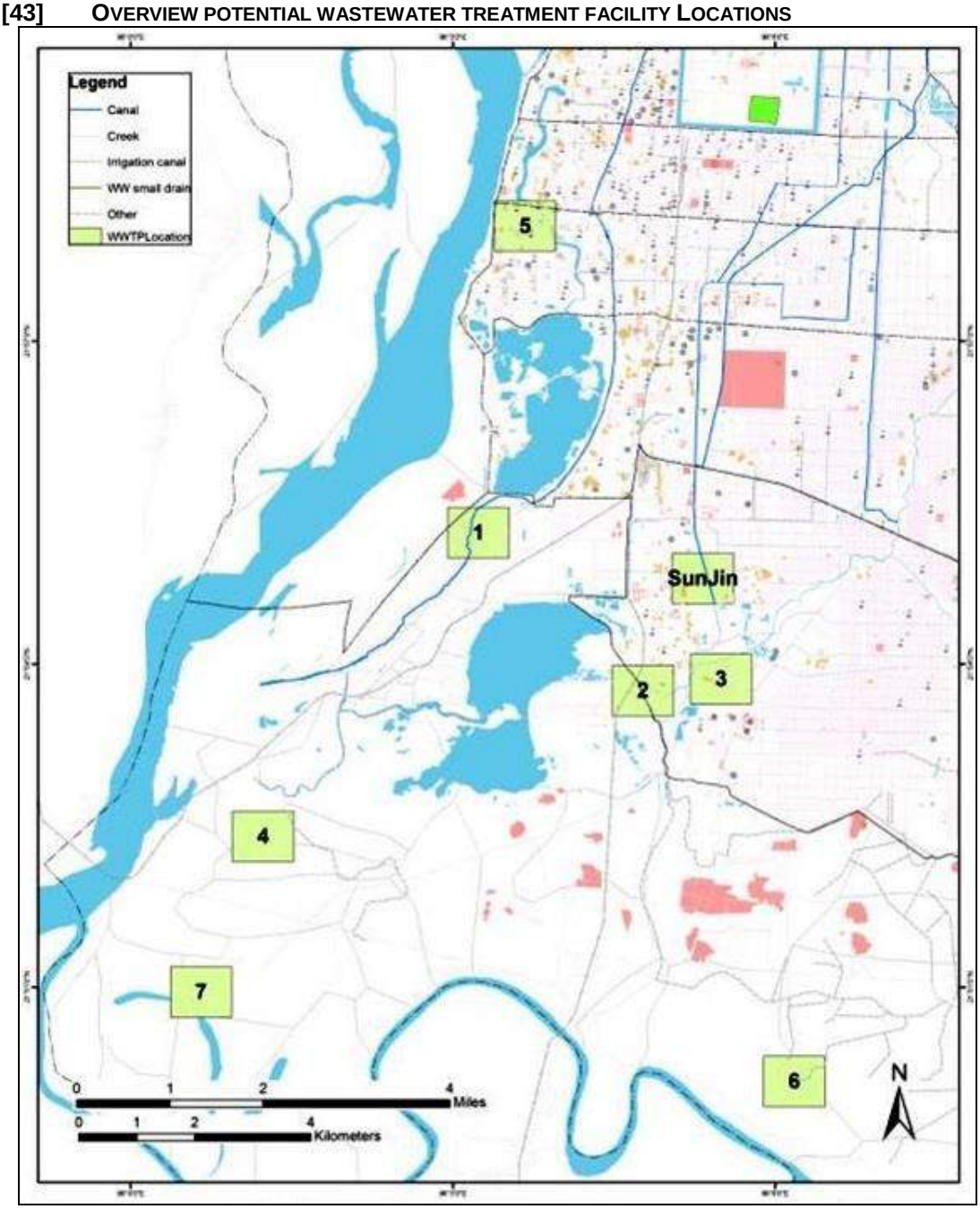
6.2. OTHER ALTERNATIVES

Several alternatives for the sub-components were proposed at the start of this PPTA, which have not been eventually considered because of their limited feasibility, their cost or/and their environmental and social impacts.

6.2.1. WASTEWATER TREATMENT PLANT OPTIONS

- Wastewater Treatment Plant Locations: a variety of locations were investigated as part of the FSR primarily to the south of the existing city centre together with different configurations concerning the number of treatment plants; on the basis of a technico-economic analysis the optimal location was selected as south of Kandawgyi Lake (location 1 on Figure [43]). Further optimisation of the location was undertaken to reduce land acquisition impacts with the final location selected adjacent to the Shwe Ge pumping station in the Nankad Lake area.

Figure [43] OVERVIEW POTENTIAL WASTEWATER TREATMENT FACILITY LOCATIONS



- Wastewater treatment plant process:: The following table presents an overview of applicable waste water treatment technologies appropriate for Myanmar and especially for the Mandalay City situation with some generic observations. For certain technologies the indicated required land area may differ, depending on the use of more sophisticated components of technology, however mostly this may result also in higher investment and operating costs, e.g. use of sludge drying lagoons requires more land area then construction of sludge digesters and further dewatering through filter-belt presses or centrifuges; however lagooning is the cheapest in operational costs. The land areas mentioned in the table below gives a good overview for comparison and deviations may occur but within limits.

Table [34] OVERVIEW TREATMENT TECHNOLOGIES

NO.	NAME TECHNOLOGY	APPROX. LAND AREA* REQUIRED PER M3 /DAY** TREATED WASTE WATER	OBSERVATIONS
A	Lagoons / Oxidation ponds	1.00 -1.20 ha/MLD	Very Large footprint Adequate to treat medium to large amounts of waste water. Easy operation of the system Low energy consumption
B	Enhanced Primary Plant	0.10 -0.20 ha/MLD with sludge drying beds; 0.06 – 0.08 ha/MLD mechanical sludge dewatering	Medium footprint Adequate to treat small to large amounts of waste water Medium operational skills required Need of coagulants chemicals
C	SBR Sequencing Batch Reactor	0.05 – 0.07 ha/MLD	Small footprint Adequate to treat small to medium amounts of waste water Medium to high operational skills required Medium to High energy consumption
D	MBBR Moving Bed Biofilm Reactor	0.03 – 0.04 ha/MLD	Small footprint recommended for small capacities (~5 -10 MLD) high operational skills required Medium energy consumption
E	Conventional Active Sludge Plant (CAS)	0.20 – 0.30 ha/MLD with sludge drying beds; 0.06 – 0.09 ha/MLD mechanical sludge dewatering	Medium footprint Adequate to treat large amounts of waste water Medium operational skills required Medium energy consumption
F	STM-Aerator	0.05 - 0.08 ha/MLD	Small footprint recommended for small capacities (~5 - 10MLD) high operational skills required High energy consumption

* Land area: 1 ha = 2.47 acres; 1 acre = 0.4047 ha
** 1,000 m3/day = 1 MLD = 1 million litres per day

The above mentioned technologies have been studied in combination of the land area availability (footprint), the total population served to that specific waste water treatment plant, (quantity of waste water to be treated) and the location related to effluent discharge. (Quality effluent related to discharge point in river or lake upstream). A cost effective-analysis as part of the study has contributed to recommending the optimal solution as describe previously.

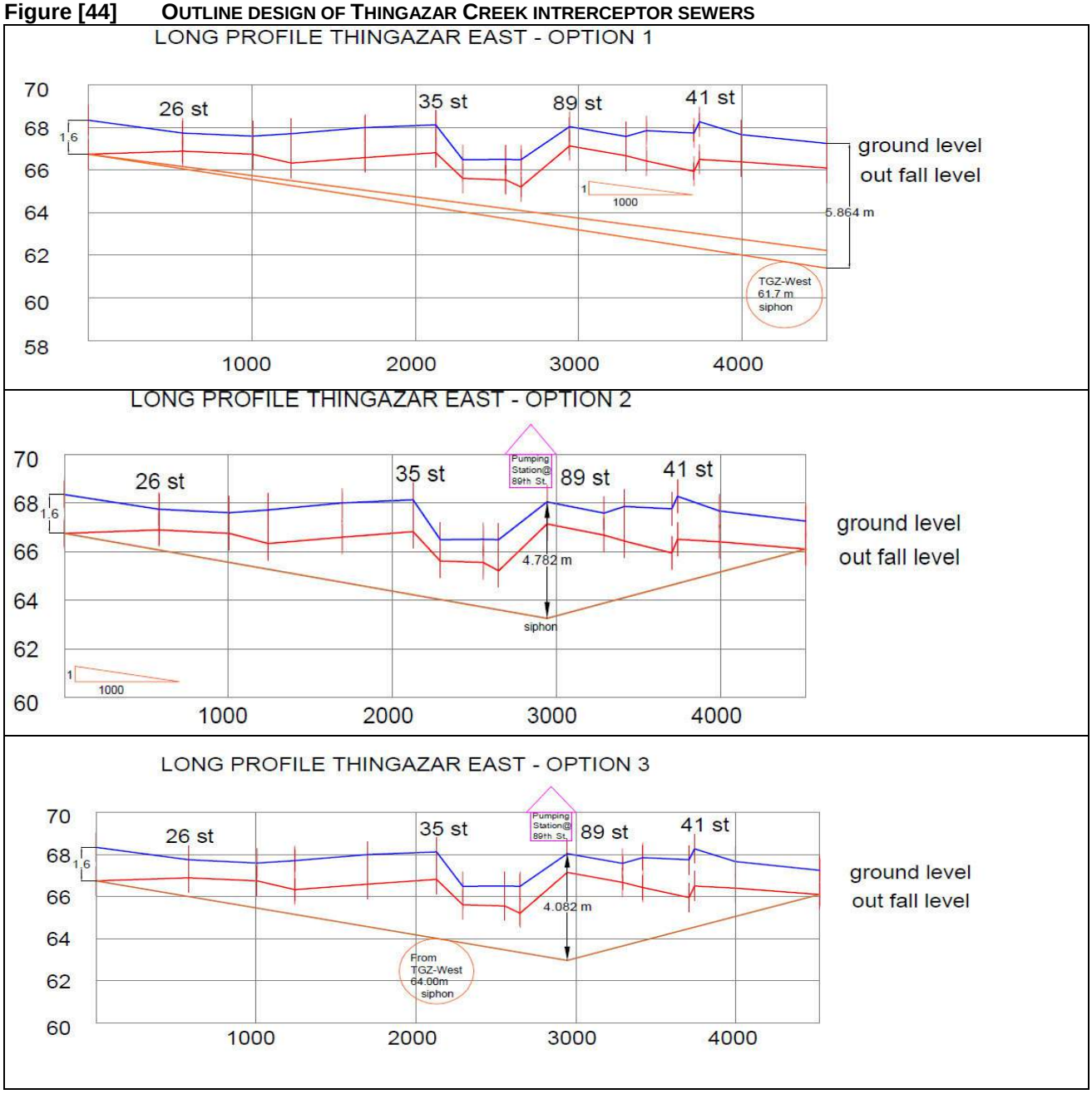
6.2.2. COLLECTION SYSTEM ALTERNATIVES

As part of the outline design presented at the Interim Report stage, interceptors were designed collecting flows from drains each side of Thingazar creek and conveying these to a pumping station located near to Kandawgyi Lake (see Figure below). As shown in the associated long profiles, the proposed design entailed rather deep sewers particularly near to Kandawgyi Lake.

Location and level surveys of the main outfalls to the creek were subsequently undertaken; these showed the very flat nature of the creek topography with in fact the lowest outfalls occurring approximately mid way along the eastern section of the lake. These observations suggested the possibility to bring the interceptor sewers to a common pumping point at this location thereby reducing both interceptor depths and also final interceptor diameters (clearly reducing capital costs)

In addition, land acquisition near to Kandawgyi lake for the location of the pumping station was clearly difficult; siting the pumping station further upstream provides the opportunity to use existing land belonging to MCDC at the solid waste collection station (which will additionally be rehabilitated as part of the project).

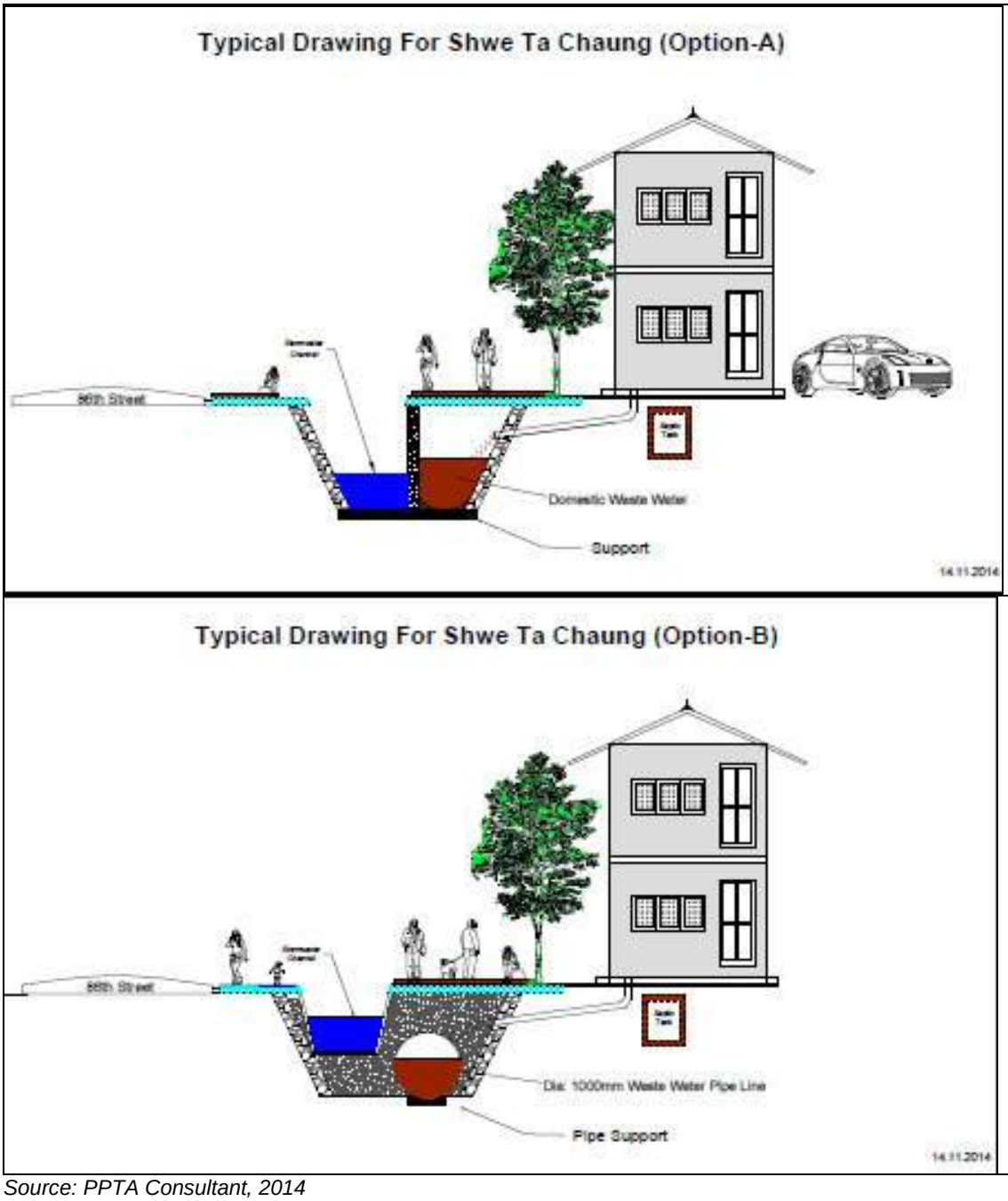
Figure [44] OUTLINE DESIGN OF THINGAZAR CREEK INTRERCEPTOR SEWERS



For the Shwe Ta Chaung interceptor it was initially planned to locate this on the left hand side of the existing Shwetachaung. However, even at the interim phase it was clear that this was not feasible due to the excessive resettlement involved. As an alternative it was planned therefore to intercept further upstream along the roads. Subsequently as part of the preliminary design alternative options were investigated as shown below using dividing the existing channel.

Option A was finally selected on the basis of maintaining the largest hydraulic cross section and also on the basis of cost.

Figure [45] OPTIONS FOR SHWETACHAUNG INTRECEPTOR SEWERS



Source: PPTA Consultant, 2014

7. INFORMATION DISCLOSURE AND PUBLIC CONSULTATION

7.1. CONSULTATION AND PARTICIPATION PROCESS

Information disclosure and stakeholder consultations were conducted as part of the environmental assessment process. The consultations involved in-depth key informant interviews with relevant Government agencies and focus grouped discussions.

The consultations aimed on environmental issues and concerns affecting the community. Specifically, the objectives of the consultation meetings are the following:

- To present the proposed projects to the stakeholders;
- To solicit views of the stakeholders relative to the proposed project;
- To identify the most important project components for the locals;
- To identify possible environmental issues inherent on the proposed project and to identify mitigation measures to address these issues in the project design.

Preliminary consultations with relevant Government agencies were conducted as part of the IEE of the proposed project. The focus grouped consultations primarily focused on presenting the project components, identifying the most important issue for the locals, receiving inputs and suggestions from the participants regarding environmental concerns arising out of the project, obtain baseline environmental and cultural information for project sites as well as Government clearance requirements and discuss their opinions on the perceived environmental impacts of the project. Suggestions were sought on measures to consider to properly implementing the project and in avoiding any potential adverse impact.

The principles of information dissemination, information solicitation, integration, coordination, and engagement into dialogue were incorporated during the preliminary consultations.

7.2. CONSULTATION MEETINGS

7.2.1. SCHEDULE AND PARTICIPATION

Main consultation activities held during the PPTA are summarized in the following table.

Table [35] CONSULTATION ACTIVITIES FOR ENVIRONMENT COMPONENT

Date	Activity	Persons met	Location	Purpose
Throughout the project since 9 March 2014	Meetings and interviews	Department heads of MCDC	MCDC office	To get better understanding of the project and the existing situations, and the requirements for the projects; to obtain perspectives and suggestions from the MCDC officers and representatives on the project
21 March 2014	In-depth key informant interviews	Manager, Staff Officer	Environmental Conservation Department, Mandalay Division, Ministry of Environmental Conservation and Forestry.	To discuss about the Environmental Impact Assessment Procedures (Draft) and implication of the draft EIA procedures on the proposed project, to obtain views and concerns on the current environmental issues, to reveal the roles of the residence office of Environmental Conservation Department, Mandalay Division.

Date	Activity	Persons met	Location	Purpose
4 September 2014	In-depth key informant interviews	Director	Department of Archaeology and National Museum, Ministry of Culture.	To present the proposed project and obtain information of the cultural resources in Mandalay city and the regulations that the project implementers have to follow
16-18 October 2014	Public consultation by focus grouped discussions with the locals, stakeholders and civil society			To disclose the proposed project and gather information on the critical environmental problem in the society, and the concerns and suggestions on the proposed project.
29 October 2014	In-depth key informant interviews	Director	Directorate of Water Resources Improvement of River Systems (DWIR), Yangon	To consult the issue on the waste water quality standard to be discharged into river water (Ayawaddy), and rules and regulations to be followed.

7.2.2. SUMMARY OF FEEDBACK FROM PARTICIPANTS OF THE MEETINGS

From discussing with the public and the stakeholders, it was summarized that the necessity of good quality water supply, good drainage system and the good solid waste management are very crucial for the locals of Mandalay city. Main feedbacks from the focus grouped discussion's participants are as follow:

- The lack of good drainage system, water supply and solid waste management are the primary sources of health problems and consequently effects on their social life and economy. And it also indicates the living standard and symbol of the city.
- Both government and the public have to cooperate to build up better environment.
- Public awareness and individual awareness are very crucial to keep the environment clean. More programs on raising public awareness should be emphasized and knowledge distribution should also be done via media such as radio, TV, pamphlets and journals.
- Strict rules, regulations and punishment should be applied in order to control the unawareness solid waste disposal.

MCDC should practice rapid response to the complaints and request for services such as night soil truck.

- Air pollution and noise pollution are main concerns due to the construction activities such as soil excavation during construction phase. Fully mitigation measures such as using the nets and readymade cement mixture to prevent the dust emissions should be employed during construction phase. Also, construction at night time should be avoided.
- People are concerned to have more problems of flooding due to the construction activities along the drains. Likewise, traffic congestion is also a concern for the public during construction activities.
- As the proposed projects are in the urban area, existing structures such as buildings, monuments and heritage sites should be carefully avoided.
- Prior to the construction phase, the locals and public should be informed in advance about the project implementation.
- Technical assistance with the aid of experts should be involved in order to prepare the proper project design and to help the project implementation.

7.2.3. CONCLUSION

The concerns and suggestions of the participants and stakeholders will be deliberated in the mitigation measures to reduce the potential negative impacts which will be resulted by the proposed projects.

7.3. FUTURE CONSULTATIONS

Information dissemination to, consultation with and participation of affected people and involved agencies reduce the potential for conflicts and minimize the risk of project delays. Further information and consultations will be carried out before construction starts (during the first year of the project) and during the construction period.

Prior to the start of the construction, consultation will be carried out in all the areas where MUSIP1 activities area anticipated. The objective will be to provide the local population with accurate information on activities to be undertaken, on the schedule of these activities and on the potential nuisances for them during construction. This information stage, which concerns all the project sites, will be carried out jointly with the team in charge of RP preparation in those areas concerned by compensation and/or resettlement.

During construction stage, consultation will be carried out with local population in specific area where construction activities are expected to start within 1 month. This will be carried out through focus group discussion with residents and key stakeholders (police station, ward heads) on possible nuisances (noise, dust, traffic/access constraint, temporary suspension of public utility, etc.), on safety measures they will have to respect (regarding engines under activity, risks of fall in excavations, risks specific to children etc) and on the detailed schedule of activities.

At the end of the construction activities in a dedicated site, inspection of site to ensure cleaning and rehabilitation has been done by the Contractor will include interview of residents to possibly identify non-compliance in the rehabilitation of the site.

7.4. DISCLOSURE

The Draft Final IEE will be submitted to the ADB for review and approval. It will then be transferred to MCDC for endorsement. Upon finalization, the final IEE will be disclosed on the ADB's website before the Board Approval, in compliance with ADB Public Communication Policy (2011).

The IEE will be used by MCDC to produce the EIA report in Burmese language. The report will be submitted to MOECAF for environmental approval. The EIA report will be made available for consultation by the public in the MCDC-PMU premises. The summary of the EIA in Burmese language will be made available at dedicated locations in the concerned areas as police station, ward heads.

8. GRIEVANCE AND REDRESS MECHANISM

A grievance redress mechanism (GRM) will be established in compliance with ADB's SPS (2009) requirement to prevent and address community concerns and assist the project to maximize environmental and social benefits. The grievance mechanism proposed for the environmental issues follows the same process than the one proposed for the compensation and resettlement issues.

The GRM will be accessible to diverse members of the community, including more vulnerable groups such as women and youth. Multiple points of entry, including face-to-face meetings, written complaints, telephone conversations, or e-mail, will be available. Opportunities for confidentiality and privacy for complainants will be honoured where this is seen as important.

8.1. TYPES OF GRIEVANCES EXPECTED AND ELIGIBILITY ASSESSMENT

Public grievances addressed by the GRM will most likely relate to environmental issues during the construction phase, as consultations with potentially affected people conducted during project preparation confirmed their basic support to the project. Grievances will most likely include damage to public roads due to heavy vehicle operation and transportation of heavy equipment and materials; disturbance of traffic and increased traffic congestion; dust emissions; construction noise; inappropriate disposal of waste materials; damage to private houses; safety measures for the protection of the general public and construction workers; water quality deterioration, disruption of services (water supply, electricity), loss of access, etc.

8.2. PROPOSED MECHANISM

The mechanism proposed relies on the creation of a Grievance Redress Committee (GRC) integrated into the Department of Public Relations and Information (DPRI) of MCDC and basically dealing with grievances related to resettlement and compensation. The GRC will additionally address those complaints related to construction activities when the grievance cannot be closed at the level of the contractor. The GRC, as defined in the RAP, will be headed by the Senior Officer of DPRI and would include representatives from townships, from civil society (Woman Association, Elder groups, Social Welfare groups) and Community representatives from the complainant's ward.

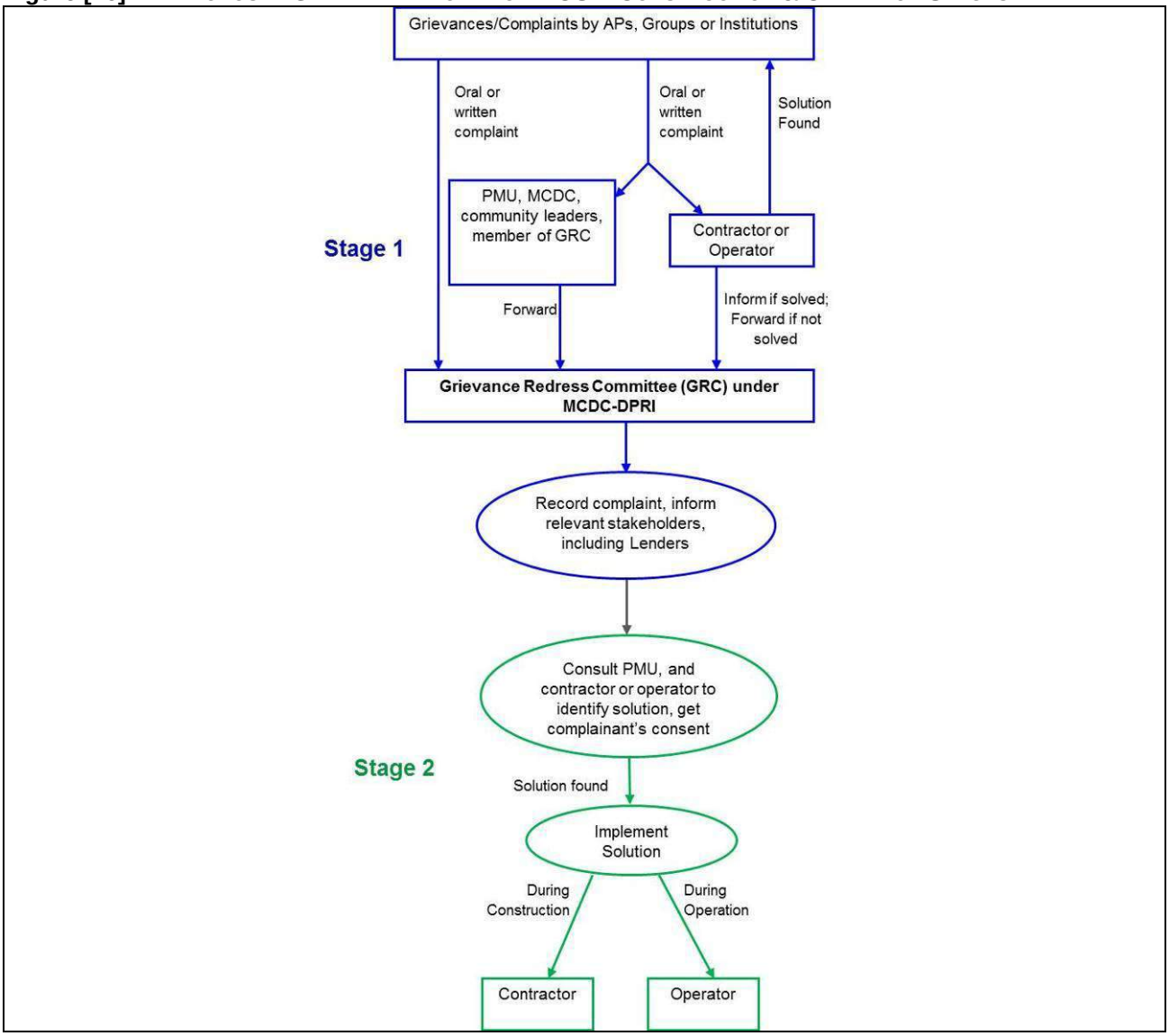
When construction starts, a sign will be erected at each construction site providing the public with updated project information and summarizing the grievance redress mechanism process including details of the GRM entry points. The contact persons for different GRM entry points, such as PMU, community leaders, contractors, and operators of project facilities, will be identified prior to construction. The contact details for the entry points (e.g. phone numbers, addresses, e-mail addresses, etc.) will be publicly disseminated on information boards at construction sites and on the website of the local government.

The GRC will establish a GRM tracking and documentation system. The system will include the following elements: (i) tracking forms and procedures for gathering information from project personnel and complainant(s); (ii) dedicated staff to update the database routinely; (iii) systems with the capacity to analyse information so as to recognize grievance patterns, identify any systemic causes of grievances, promote transparency, publicize how complaints are being handled, and periodically evaluate the overall functioning of the mechanism; (iv) processes for informing stakeholders about the status of a case; and (v) procedures to retrieve data for reporting purposes, including the periodic reports to the ADB and AFD.

8.3. GRM PROCEDURE AND TIMEFRAME

The procedure and timeframe for the GRM are described as follows. The two stages of the procedure are represented by different colours in the flow diagram of Figure [46] .

Figure [46] PROPOSED GRM FRAMEWORK FOR MUSIP CONSTRUCTION & OPERATION STAGES



Source: PPTA Consultant, 2014

Stage 1: If a concern arises during construction, the affected person will submit a written or oral complaint to the contractor directly (the contractor's environment health and safety coordinator or any onsite construction personnel). Whenever possible, the contractor will resolve the issue directly with the affected person. The contractor will give a clear reply within one week. If successful, the contractor will inform the GRC accordingly.

Stage 2: If no appropriate solution can be found, the contractor should forward the complaint to the GRC within five (5) working days. The complainant may also decide to submit a written or oral complaint to the GRC, either directly or via one of the GRM entry points (community leader, ward representative, township representative). For an oral complaint, proper written records must be made at the time of the complaint. The GRC will assess the eligibility of the complaint, identify the solution and provide a clear reply for the complainant within five (5) working days. The PMU-DES will assist the GRC in replying to the affected person. Meanwhile, the GRC will timely convey the complaint/grievance and suggested solution to the contractors or operators of facilities. The contractors during construction and the operators during operation will implement the agreed upon redress solution and report the outcome to the GRC within seven (7) working days.

The GRC shall accept complaints/grievances free of charge. Any cost incurred should be covered by the contingency of the project. The grievance procedures will remain valid throughout the duration of project construction and until project closure.

The above mechanism is specific to the Construction Works. Should the grievance not be resolved via this specific mechanism the complainant will have recourse to the overall GRM as detailed in the RAP.

9. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

9.1. PURPOSE & OBJECTIVES

The role of the EIA process is to identify the impacts which may be caused by the project and to develop a series of attenuating or mitigating measures which will be technically appropriate, financially acceptable and easily applicable in the context of the project. These measures are identified in Section 5 of the present IEE.

The role of the EMP is to complement this analysis by defining the operational context in which these measures will be implemented. The present chapter therefore sets out the principles, the approach, the procedures and methods which will be applied to monitor and reduce the environmental and social impacts resulting from the construction works and subsequent operation of the components projected in Mandalay.

To this effect, the EMP includes 3 complementary Action Programs that are adapted to the phases of pre-construction, construction and operation of the Project components:

- The Preliminary Program of Action (PPA), which includes all the measures recommended during the early stage of the Project, particularly before the construction works start. These measures essentially concern the organization and training of the teams which will be responsible for environmental and social management during construction and operation of the project, as well as all the complementary studies and investigations identified during preparation of the EIA and deemed to be necessary before starting the construction works.
- The Program of Actions adapted to the Construction period (PAC), which defines the principles of organization and the environmental inspection procedures for the construction sites. This PAC also defines the contractors' obligations in relation to environmental and social management of the construction sites and camps.
- The Program of Actions adapted to the Operation period (PAO), which defines the environmental quality controls (water, air and noise) applicable during the period of operation of the structures and necessary to evaluate the environmental efficiency and performance of the corrective measures put in place.

The present EMP accordingly establishes and describes the context in which all the proposed corrective measures shall be implemented, under the following headings:

- the organization to be established to ensure effective implementation of the corrective measures and the associated environmental monitoring;
- the role and responsibilities of the various parties to be involved in the Project;
- the principal tasks to be undertaken during the phases of preparation, construction and operation of the project;
- the complementary studies deemed to be necessary;
- the financial resources to be mobilized and their origin.

All the measures proposed in this EMP are based on the results of the analysis of impacts and corrective measures outlined in previous Section 5 of the present EIA. These aspects will not therefore be repeated here.

9.2. SUMMARY OF KEY IMPACTS

As detailed in the Section 5 of the report, the anticipated key detrimental impacts from the project components are summarized in the following table.

Table [36] SUMMARY OF MUSIP 1 KEY IMPACTS

MUSIP 1 COMPONENTS	ANTICIPATED KEY IMPACT
Improved Water Supply Systems	
Extension of Water Storage	Clearing 0.5 ha of forested shrubland
Regeneration of Tube Wells	No impact anticipated
Upgrading WTP8	No impact anticipated
Improved Disinfection	No impact anticipated
Network Rehabilitation North	Mainly risk of nuisances from construction activities
Network Rehabilitation Central	
Network Extension South	
Improved Wastewater & Drainage Management	
Interceptors Thingaza and pumping station	Mainly risk of nuisances from construction activities
	Potential noise & smells from pumping station
Interceptors Shwe Ta Chaung	No land acquisition but possible temporary displacement for few stalls and shops from market area for access of equipment to canal
	Mainly risk of nuisances from construction activities
New WWTP with gas co-generation system	Land acquisition and few resettlement
	Impact from sludge smells
Septic Sludge Collection & Treatment	No impact anticipated
Pilot Scheme for Household Connection	Mainly risk of nuisances from construction activities
Interceptors	No land acquisition but possible temporary displacement for few stalls and shops from market area for access of equipment to canal
Creek & Canal Dredging	Mainly risk of nuisances from construction activities Management of large volume of sediment (estimated 100,000 m3)
Increase Pumping Stat. Capacities	No impacts anticipated
Improved Solid Waste Management	
Pilot Collection station	No impacts anticipated, MCDC land

As observed from this table, major impacts from the project mainly concern land acquisition for few components and impacts related to construction activities. As land acquisition and resettlement are addressed in the Resettlement Plan (RP), this EMP will principally focus on construction activities supervision and monitoring activities during construction period and first few years of operation.

9.3. EMP ORGANIZATION AND RESPONSIBILITIES

9.3.1. OVERALL ORGANIZATION

At the present level of the Project preparation, it is anticipated that the project will be developed under the following conventional conditions:

- Mandalay Regional Government as the Executive Agency (EA) and MCDC as the Implementing Agency;
- Creation of a Project Management Unit (PMU) under MCDC based in Mandalay. This PMU will receive the support of a Project Implementation Consultant (PIC) in charge of supervising project design and construction activities;
- Construction Contractors appointed by PMU.

The proposed organisation for the EMP complies with this general organisation. Three levels of organization for environmental management, fully complementary, will be set-up:

- The Government Implementing Agency (IA) through its PMU, will have to provide for all aspects related to environment and social including (i) general supervision of activities

carried out prior, during and after construction of the project and (ii) coordination with other stakeholders including other Government Agencies and IFIs involved (ADB, AFD, any other lending institution);

- The Project Implementation Consultant (PIC) will assist PMU for all aspects dealing with environmental management preparation, provide environmental training to PMU staff, provide coordination and supervision for all environment-related activities during construction and report regularly to the IA
- The Construction Contractor Environment Health and Safety Unit (CC-EHSU), will provide resources for, and effective implementation of, all measures which are defined in the EMP and in the contract documentation in addition to health and safety aspects on site. There will be one CC-EHSU per Project component under the responsibility of the main CC for the concerned component and covering the needs for sub-contractors.

Environmental staff in the PMU, PIC and CC is intended to be independent of construction staff. Environmental staff will work alongside construction staff, however they will report through separate channels up to the Project Director for the PIC and to the executive management level for each CC concerned.

9.3.2. STAKEHOLDER'S ORGANIZATION

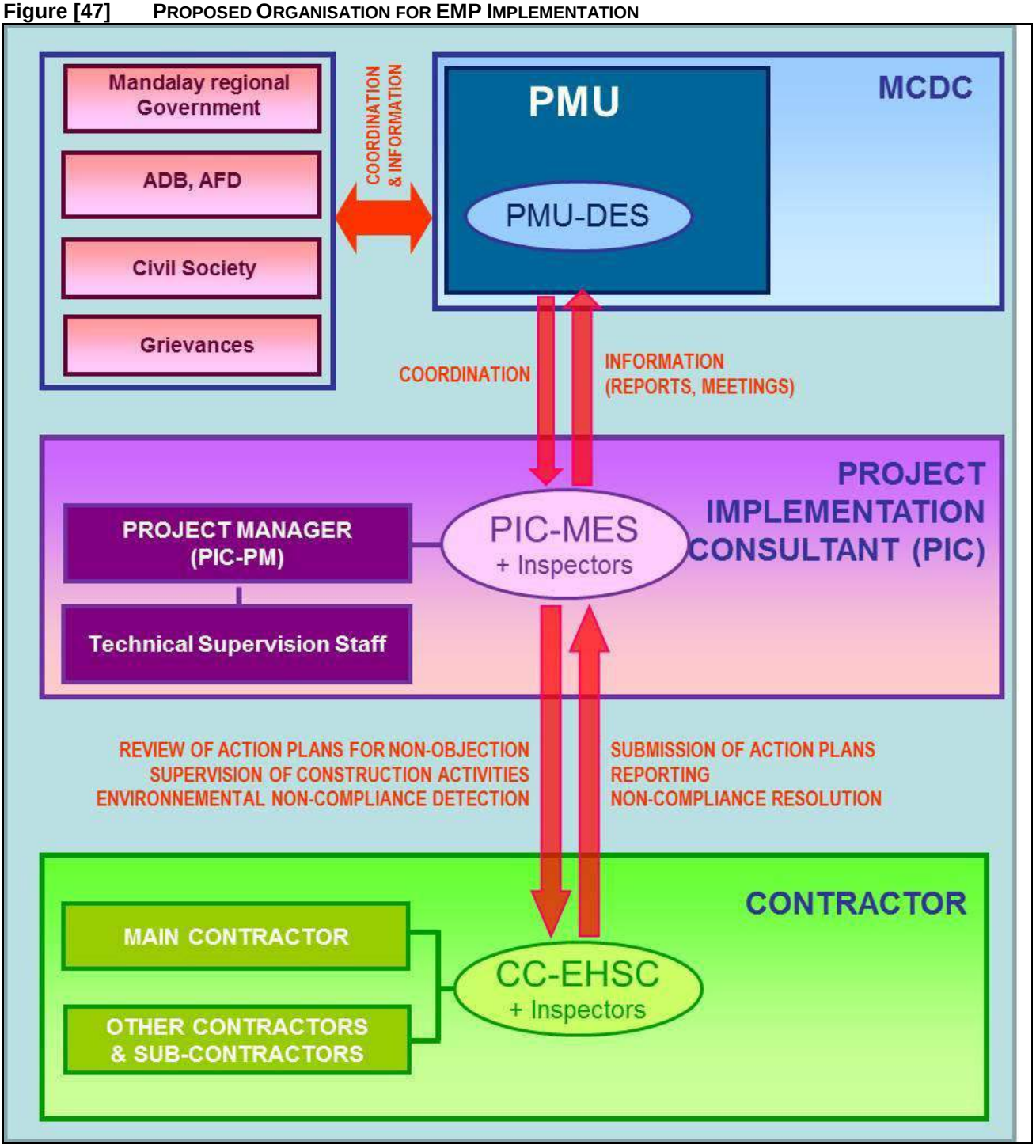
The IA-PMU will have an integrating role at the top of the organisation. It will be responsible for (i) informing the political and financial agencies of the correct implementation of the EMP and (ii) ensuring effective compliance in terms of E&S obligations and procedures in the implementation of the Project. To do this, it will appoint a Director Environmental and Social (DES), whose role will be (i) to supervise the Project's environmental and social activities in the name of the IA and (ii) to ensure coordination with the international agencies (funding agencies, investors, panel of experts) and national agencies (other Government Ministries, NGOs). The PMU-DES will in particular follow up and ensure operations relating to compensation and resettlement of APs resulting from the implementation of the project components are progressing satisfactorily. The DES will be assisted in this supervisory role by the PIC.

The PIC will set up within its Engineering Team an Environmental Management Unit (EMU) which will ensure effective implementation of the environmental measures. This team will be under the responsibility of a Manager Environment and Social (MES) assisted by staff responsible for supervising EHS aspects on the construction sites, grievances expressed by the population, any disturbances or harmful impacts they are subjected to, claims for compensation for temporary disorders related to the construction activities and liaison with the traditional local authorities or representatives of the State. The EMU will include a team of Site Inspectors.

Each CC having responsibility for one of the main components will set up its own EHS Unit (EHSU) responsible for providing the interface with its construction team. Depending on how the contracts are distributed, certain contractors may group together to set up a common environmental team. Each EHSU will have an EHS Coordinator (EHSC) and Environment, Health & Safety (EHS) Inspectors.

Proposed organization is depicted on the following Figure [47] .

Figure [47] PROPOSED ORGANISATION FOR EMP IMPLEMENTATION



Source: PPTA Consultant, 2014

9.3.3. STAKEHOLDER ROLES AND RESPONSIBILITIES

9.3.3.1. ROLE OF THE PMU-DES (IMPLEMENTING AGENCY)

Project Preparation Phase

- Coordinate, with those concerned, the definition of the environmental measures at the level of detailed design and prepare the corresponding environmental obligations of the contractors as General and Particular Specifications in the Tender Documents;

- participate in the evaluation of the tenders and negotiation with the contractors for all the environmental and social aspects;
- ensure coordination with the financial institutions involved (ADB, AFD), in order to guarantee compliance with their specific environmental and social requirements;
- ensure, with those concerned, the monitoring and coordination of all consultations carried out with the local population prior to starting the construction works; this aspect is particularly important for the road and urban development components;
- coordinate with the Government Authorities concerned, the issues of land acquisition and compensation operations required to be completed before the start of construction works;
- prepare timeline for compliance with various national applicable laws and requirements including environmental obligations.

Construction Phase

- Ensure coordination of activities with the PIC-EMU;
- participate in environmental coordination meetings with the representatives concerned from the staff of the PIC and Contractors;
- directly refer results and problems encountered to the PMU-Project Director;
- contribute for E&S aspects to the monthly and/or quarterly Works Progress Reports prepared to the attention of the IA, of the EA and of the lenders (ADB, AFD);
- provide liaison with MOECAF;
- provide liaison with other authorities as .required.

Operating Phase

At the end of the Project construction, the various components will come under the responsibility of various MCDC Departments. Each department will need to be clearly informed about the environmental monitoring requirements and to have organized in accordance. The PMU-DES will:

- Ensure coordination between MCDC Departments on environmental issues and monitoring needs;
- ensure environmental monitoring required on the sites are efficiently implemented;
- ensure effective completion of the measures to rehabilitate the sites temporarily used during construction;

9.3.3.2. ROLE OF THE PROJECT IMPLEMENTATION CONSULTANT (PIC)

- At the start of the Project Contract, the PIC will provide training to PMU-DES and other staff of PMU regarding results of EIA reports, EMP obligations, organization of PMU for environmental management;
- Preparation of baseline template documentation required for PMU-DES activities: weekly, monthly report structure, template checklists for site inspection, etc.
- Assistance for ToR and contract preparation for effect monitoring (air, water) to be carried out by any registered laboratory appointed by PMU;
- Organize and control the work performed by the Environmental Management Unit (PIC-EMU);
- ensure coordination with the PMU-DES;
- ensure that all environmental plans and programs requested from the CCs (this generic term covering all the main Construction Contractors) have been submitted and have been non-objected prior to the start of works;

- with PIC-EMU inspectors' collaboration, check whether the Contractor's environmental obligations have effectively been complied with on the sites, and refer to his manager (the PIC-Project Manager, PIC-PM) any detected case of non-conformity for formal action;
- report any observed case of non-conformity and ensure that it is remedied by the concerned CC within the imposed time limit;
- participate in the site monitoring meetings and prepare a monthly environmental monitoring report covering all project components;
- prepare the monthly evaluation report, recording the Contractor's environmental performance, which may, if necessary, be used to justify a deduction on the monthly claim for payment presented to the IA-PMU;
- ensure the regular implementation of compliance monitoring programs (water and air quality) and present the interpretation of results in the context of the monthly report;
- provide liaison with the local communities concerned for any social aspect including health, respect of recruitment procedures, land use agreements, handling of complaints and compensation for unexpected damages to private property during construction activities;
- organize a database for storing all environmental documentation generated during construction of the project (letters, memos and technical notes, registers, site photos, non-compliances and resolution forms, etc.);
- prepare the documentation required prior to the project's environmental and social audits performed by the Lenders.

9.3.3.3. Role of the PIC-EMU-Site Inspectors (Supervision Engineer)

Perform regular visits to the construction sites and the worker camps; frequency will be adjusted according to the environmental risks, the sensitivity of the environment and the contractors' performance;

establish reports on all detected cases of non-compliance and follow up their resolution by the concerned CC;

regularly provide input to the environmental database, in particular the reports on non-compliance, the records of non- compliance correction and the supporting photographic documents.

9.3.3.4. Role of the Construction Contractor EHS Coordinator (CC-EHSC)

The CC-EHSC activity must be devoted solely to the CC's EHS management. He must be sufficiently high-ranking in the organisation to be capable of imposing his decisions on the Works Supervisors and Foremen. In particular, the power to stop construction activity, for reasons of environmental protection or safety, is a fundamental prerogative to ensure efficient environmental management on construction sites.

The EHSC, with the support of his team, will have the following responsibilities:

- adapting construction activities to ensure they comply with the EHS obligations defined in the Tender Documents and the Terms of the Contract;
- ensuring that all sub-contractors of his company comply with the same EHS obligations;
- preparing the environmental plans and programs specified by the Tender Documents, in particular the monitoring programs;
- supervising the environmental good practices for construction activities on all construction sites used by the Contractor or his sub-contractors, by calling on his inspectors to make regular inspection visits;
- treating cases of non-compliance notified by these inspectors and instructing the construction teams to apply the necessary remedial measures immediately;
- preparing the weekly and monthly activity reports for presentation to the PIC-MES;

- organizing and performing E&S training of CC staff (management & workers).

9.4. KEY ENVIRONMENTAL MANAGEMENT PROCEDURES

9.4.1. COMMUNICATION PROCEDURES

9.4.1.1. INTERNAL COMMUNICATION

The efficiency of environmental and social management is dependent upon the clear organisation of communication among the stakeholders. In particular, there has to be a clearly defined channel for handling rapidly all possible environmental disorders and implementing efficiently the necessary remedial actions, especially in emergency situations.

The following table presents the key links with regard to internal communication among the stakeholders during the construction period. This procedure must be laid down in greater detail before the start of the project in accordance with the Contractor EHS policy and the final Project organisation.

Table [37] MAIN STEPS OF INTERNAL COMMUNICATION

ORIGIN	RECIPIENT	FREQUENCY	SUBJECT
PIC-PM	PIC-MES	Weekly	Updating the construction programme; specific construction activities in the coming period and their location
PIC-PM	PMU-DES, PIC-MES	Ad hoc	Additional needs for land, or notification of a change in construction techniques
PIC-MES	PIC-PM	Weekly	Weekly report on environmental events (EE) detected and their treatment; programme of activity of the PIC-EMU for the coming week
PIC-MES	PIC-PM	Ad hoc	Communication of EE of levels II or III
PIC-MES	PIC-PM	Monthly	Monthly report on activity and results of monitoring for review and approval before forwarding to the PMU-DES
PIC-MES	PIC-Inspectors	Weekly	Updating the construction programme; specific construction activities in the coming period and their location, particular directives
PIC-Inspectors	PIC-MES	Weekly	Weekly activity report, list of observed EE of level I
PIC-Inspectors	PIC-MES	Immediate (same day)	Observed EE of levels II & III; particular problem requiring technical assistance; observation of construction activities outside specified areas
CC-EHSC	PIC-MES	Monthly	List of training modules followed in the past month and the personnel concerned (list of attendence)
CC-EHSC	PIC-MES	Fortnightly	Updating of new activity zones for the coming 2 weeks and operations presenting a particular risk for the environment; results of monitoring of the previous 2 weeks
PIC-PM	PMU-DES	Immediate (same day)	Memo to inform on any observed non-compliance of level III; proposal to suspend the works on the incriminated site if justified
PIC-PM	PMU-DES	Monthly	Transmission of the monthly activity report including environment as prepared by the PIC-MES
PIC-MES	PIC-PM	Quarterly	Summary report on significant environmental events (Levels II and III) observed, on the decisions taken, and on the measures implemented; proposal, if necessary, to modify certain mandatory thresholds or obligations of the Contractor
PIC-PM	PMU-DES	Quarterly	Summary report on significant environmental events (Levels II & III) observed, on the decisions taken, and on the measures implemented; request for approval of the proposed modifications
PIC-MES	PMU-DES	Yearly	Annual audit of construction sites and submission of an annual environmental audit report
Note: PMU-DES (Director Environment & Social from MCDC PMU) – PIC-MES (Manager Environment & Social from Project Implementation Consultant) – CC-EHSC (Contractor's EHS Coordinator) - EE (Environmental Event = detected non-compliance)			

9.4.1.2. EXTERNAL COMMUNICATION

External communication for environmental and social subjects will be the prerogative of MCDC through the intermediary of his PMU-DES, assisted by MCDC's Director of Communication. This communication will essentially concern exchanges of information with the media, with NGOs and with Government representatives at Central and Regional levels. The PIC-MES and the CC-EHSC will only intervene in these exchanges when expressly invited to do so by MCDC.

The PMU-DES will regularly contribute for all E&S aspects to the activity report provided to ADB and AFD, to various government organisations and NGOs in Myanmar.

9.4.2. PROCEDURE FOR HANDLING ENVIRONMENTAL EVENTS

An important element of the process of communication among the parties is the ranking of events which do not meet the obligations and environmental objectives assigned to the project. These situations detected on site by the PIC-EMU must then be notified to a higher level but following procedures that are graduated according to the extent of the risk and the urgency of remedial action. These environmental events could be ranked according to the system of quality assurance applied to the construction works, in which case their subdivision would be variable according to the subdivisions taken into account for non-conformity of a technical nature. In the present EMP, considering the absence of information on the project's future quality assurance plan, preference is given to an evaluation system specific to environmental aspects, better adapted to the problems encountered and which represents a proven and reliable system, which can work satisfactorily even in the absence of an efficient quality assurance system.

Environmental events correspond to non-conformities (Non-Compliances, NC) and are subdivided into three levels. The communication and handling procedures depend on the level of non-conformity. Level III represents the most serious incidents, while level I represents the incidents of least gravity.

Level I (Minor Incident): Situations on Level I are addressed on a day-to-day basis at the time of site visits and routine meetings; the recommended measures are generally discussed on the spot with the construction teams concerned. Formal communication takes place through the Environmental Event (EE) report prepared by the PIC-EMU Inspectors and handed to the PIC-MES for official notification to the concerned CC-EHSC.

Level II (Moderate Incident): The EE of Level II is notified by the PIC-MES to the PIC-Project Manager and the CC Site Supervisor the same day as the situation is observed, and within three days to the PMU-DES. The PMU-DES informs the PMU Project Director of the situation and details the proposed corrective measures, which must be implemented as rapidly as possible.

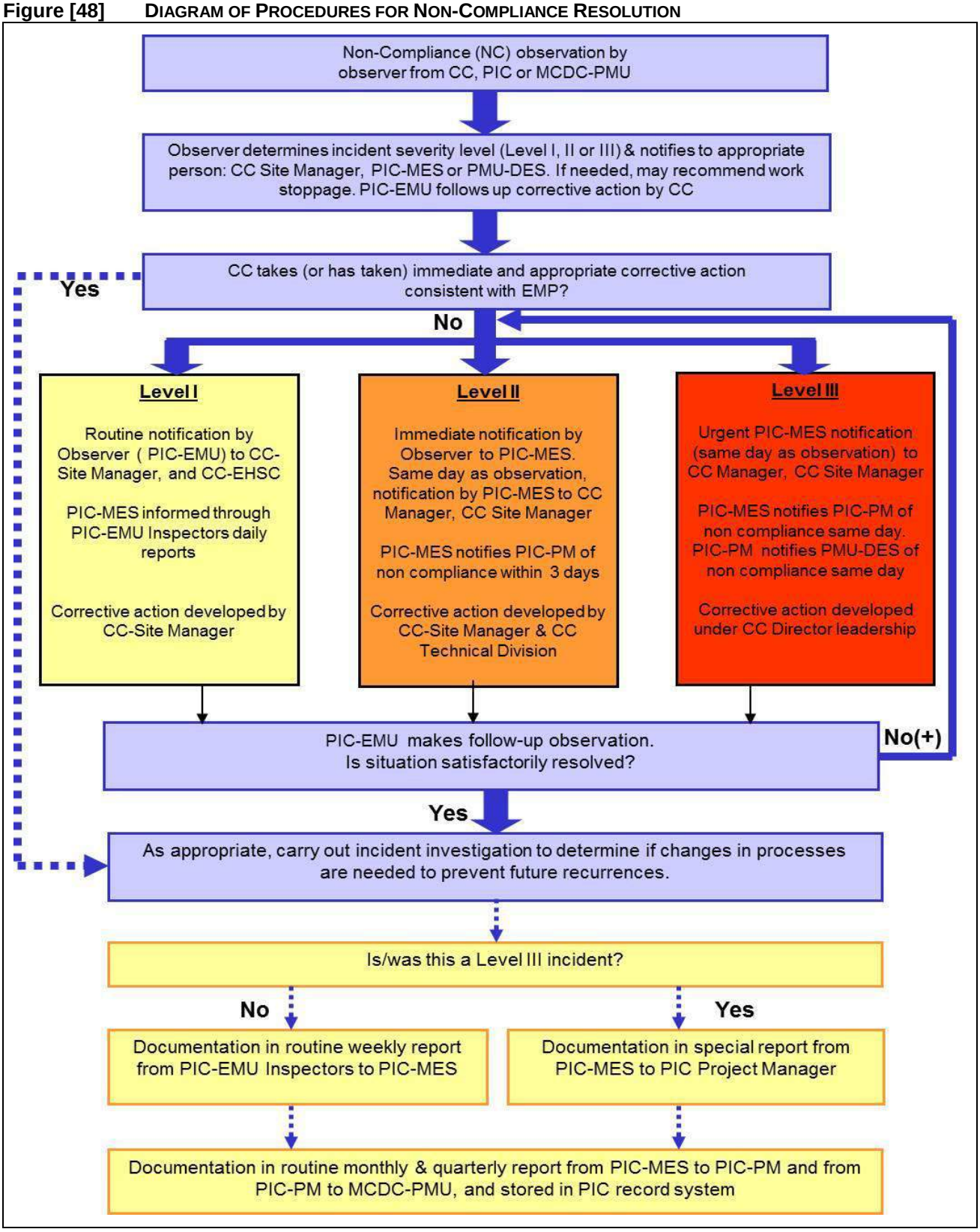
Level III (Major Incident): The PIC-Project Manager and the PMU-Project Director must be informed on the day an event is observed. The corrective measures must be applied within three days. Should more time be required to implement a corrective measure, or if the risk is imminent, the PIC-PM may order suspension of the works concerned until the observed situation returns to normal.

Following Figure [48] below illustrates the principles of this non-conformity procedure and shows how the approach favours direct resolution on site of the less serious EE (Level I) by direct communication with the construction workers, and how the senior levels of responsibility are progressively involved in the processes to solve the more serious EE (Levels II and III). The full arrows denote the decision processes, while the dotted arrows denote the reporting and information processes.

This procedure is often implemented on complex work sites, and generally gives satisfactory results. It also offers three advantages:

- A mechanism allowing the works to be stopped if the situation is deemed to be hazardous;
- provision for feedback so that the site inspectors monitoring implementation of the requested measures can ensure that the remedial action has been taken;
- the possibility of initiating an incident enquiry in order to determine the deep-seated causes of the incident and to assess whether they justify changes in the specifications, the requirements or the methods, to prevent reoccurrence of such a situation in the future.

Figure [48] DIAGRAM OF PROCEDURES FOR NON-COMPLIANCE RESOLUTION



Source: PPTA Consultant, 2014.

Note: PMU-DES: PMU Director E&S; PIC-MES: Project Implementation Consultant Manager E&Sr; CC-EHSC: Construction Contractor EHS Coordinator; PM: Project Manager (from PMU, PIC or CC)

9.4.1. RECRUITMENT PROCEDURE

Recruitment will be made preferentially in Mandalay to minimize the requirement of worker camps in number and size and minimize attached problems.

Recruitment will include a systematic medical check-up of each employee, covering the candidate's general condition and his or her hearing and visual capacities. To avoid any discrimination, the tests relating to infection risks (tuberculosis, malaria and other forms of parasites, STD) will be performed in Mandalay hospital facilities after the candidate has been recruited,.

The precise procedures to be put in place will be compliant with the obligations of the Myanmar Labour Regulations regarding particularly work contract conditions, working time and minimum wages.

9.5. ACTION PLAN PRIOR TO CONSTRUCTION WORKS (PPA)

All the elements described above reflect the main details of the organisation to be set up for supervision and monitoring in the construction and operation phases. However, it is essential to ensure that the necessary means and references are available and totally operational from the time the works start. To this effect, a certain number of activities are to be undertaken before the start of construction works. These actions cover the aspects of recruitment, organisation and training for MCDC-PMU, and the performance of a series of complementary investigations aimed at defining the baseline situation more precisely. For these studies, the PMU will call on specialised consultants (either International or National). The main recommended actions for this pre-construction period, resulting from the EA impact analysis, are detailed in the following paragraphs in the form of a Preliminary Action Programme (PPA).

The baseline situation constitutes the reference state in comparison to which the project's impacts will be effectively evaluated in the course of construction and operation of the project. Some important aspects of this baseline situation need to be analysed in greater detail before the works start.

Following PPA-01 to 05 are proposed to strengthen the baseline situation knowledge and the capacity of MCDC-PMU to handle full control of environmental and social issues related to project implementation.

9.5.1. PPA-01: APPOINTMENT OF THE PMU-DES

The MCDC-PMU will appoint its Director Environment and Social (DES) early enough for this person to contribute to the selection of the Monitoring Laboratory to perform environmental monitoring activities and complementary baseline identification (see PPA-02) before construction works start. The DES will be assisted at the beginning of his mandate by the Project Implementation Consultant (PIC) who will deliver training to the DES and assist him (i) for the preparation of tenders regarding monitoring surveys, (ii) for the selection of the Consultants, (iii) for the follow-up of the studies.

9.5.2. PPA-02: ADDITIONAL STUDY OF AYEYARWADDY WATER QUALITY

Regarding water quality issues on MUSIP sites, the situation is far from sensitive as most of the water bodies concerned by construction activities are already highly polluted. A water quality monitoring of Thingaza and the canals during the construction stage is not a priority. However, the project will eventually discharge in the Ayeyarwaddy River the treated effluent from the proposed WWTP. Only one spot sampling of river water was carried out during the PPTA study near the future WWTP outlet, which needs to be complemented for establishing a solid baseline situation, required to eventually appreciate the actual impact of the discharge on the river water quality.

The study will involve sampling and analysis on a quarterly basis over a full year, in order to appreciate possible changes in Ayeyarwaddy water quality in accordance with the hydrological period of the year. Sampling will be carried out in 3 stations:

- Station 1 at the level of the anticipated discharge point
- Station 2 about 100 to 150 m upstream Station 1 and
- Station 3 about 100 to 150 m downstream Station 1

The following parameters will be measured during this first survey:

pH, Total suspended solid (TSS), Dissolved oxygen (DO), COD, BOD_5, NH_4^+, Cl^-, Nitrite (NO_2), F^-, Nitrate (NO_3^-), Phosphate, Cyanide, As, Cd, Pb, Cr_3^+, Cr_6^+, Zn, Ni, Fe, Hg, Cu, oil & grease, Coliforms.

MCDC PMU will appoint a registered laboratory to carry out this study.

9.5.3. PPA-03: Due Dilligence of Dokhtawaddy WTP BOT Project

The Dokhtawaddy water pumping station and treatment plant is anticipated by MCDC as a possible project to be developed under a BOT system. This project must be considered as a linked project to MUSIP1, as the water supply network extension in the southern part of the city as a component of MUSIP Phase 1 can only be considered if the Dokhtawaddy WTP project is completed. In accordance with the requirements of ADB SPS, an environmental and social due diligence has to be performed for any linked project (associated facility). At the time of the present MUSIP PPTA, technical studies for Dokhtawaddy WTP project are not yet engaged, making impossible any due diligence at present. It is proposed to carry out the due diligence at the start of the project implementation, considering that the technical and EIA studies of the Dokhtawaddy WTP will be completed at that time, should the project effectively goes ahead.

The Project Implementation Consultant will perform this due diligence at the start of its mandate.

9.5.4. PPA-04: Environmental Capacity Building of the PMU-DES and PMU Staff

The PIC-MES will carry out training of the PMU-DES and other PMU staff at the early stage of its recruitment. Purpose is to have the PMU-DES and his staff fully operational at the start of the project construction activities. Training will be carried out in MCDC and focus on:

- Detailed review of impact analysis and mitigation from the MUSIP 1 IEE and national EIA
- Detailed review of EMP Program of Action
- Organization of MCDC PMU for EMP implementation
- Basics for site inspection practices: organization of visits, frequency, control checklist;
- Basics for non-compliance procedures: reporting procedure and form, organization of follow-up, procedure for resolution approval;
- Data management for PMU-DES: key information to be stored, data base organization, registers;
- Structure and content of weekly, monthly reports.

9.5.5. PPA-05: Capacity Building on Health and Safety

When observing construction sites in Mandalay the conclusion comes easily that health and safety considerations are still almost totally ignored. MUSIP construction sites must be compliant with international good practices regarding health and safety of workers on sites. This project may even be considered as a pilot project for introducing good EHS practices in MCDC and more widely as a demonstration window in Mandalay city.

The PIC will organise safety training courses for the staff of MCDC, not limited to PMU only but extended to all technical departments of MCDC. The aim is to provide the basics of safety rules and organization of constructions sites and for the PMU staff, to clearly understand what must be required from the contractors on the sites.

Similarly and as described under following Action plan during Construction, the Contractors will be contractually requested to organise awareness training on health and safety for all their staff.

9.5.6. PPA-06: Preparation of Communication Instruments

In support and follow up to the public consultations carried out within this PPTA, it is important to prepare the appropriate communication material rapidly, allowing MCDC-PMU to present, before starting the works, clear

information on the design of the project, on the phasing of construction work, on the recruitment procedures and on the environmental and social measures which will be implemented.

Preparation of proactive communication is essential to ensure the widest possible circulation of information at the most critical time, since it is during this period prior to the start of works, when important decisions and negotiations are in progress, that information on the Project must be available in a completely transparent manner. The communication tools to be developed include:

- Colour flyers and posters to be posted all along the various sub-components sites;
- Articles in the press and radio or TV messages;
- The technical EIA documentation available for consultation by any person, at MCDC and Township levels.

These documents will be prepared under the PMU-DES authority with the assistance of MCDC Communication Department and of the PIC.

9.5.7. PPA-07: PREPARATION OF THE CONTRACTOR E&S SPECIFICATIONS

Effective consideration of the EHS during construction activities pre-supposes the production of a clear, complete and detailed contractual document at the time the contract is awarded. This means including the specifications which will lay down all the EHS obligations to be imposed on contractors by MCDC in the Tender Documents. These requirements dictated by the Project Owner will be presented in a document entitled "Environmental and Social Obligations of the Contractors", which will be prepared together with the Technical Specifications (General and Particular) of the Project. The PIC-MES will assist MCDC-PMU for the preparation of the Tenders.

The document will set out all the EHS obligations imposed to the contractors and the principles and measures required for complying with. These obligations will be articulated around the key fields of environmental and social management for all construction activities related to the MUSIP project components, including:

- the general specifications for good environmental management which will be applicable to the contractor at any point within the work site and at all times, covering areas such as: training/awareness of employees on protection of the environment and safety, management of hazardous substances and waste, protection of biodiversity, prevention of water and air pollution, preservation of soils, rehabilitation of sites;
- the minimum conditions to be established in the contractors' camps and installations, covering aspects related to housing, catering, waste management, drinking water, sewerage and conditions of public hygiene;
- the minimum conditions to be observed by the contractor in the field of employees' health and safety;
- the minimum conditions to be observed by the contractor with a view to protecting the environment of the sites as well as that of the areas contiguous, most densely urbanized;
- the minimum conditions to be observed by the contractor in managing the social aspects of construction activity including applicable procedures for temporary land occupation or in case of damage to any private property.

A specific monitoring program will be set up to ensure that the contractors fulfill their environmental and social obligations, detailed in the following section relating to the Construction Phase. In practice, the selected contractors will be asked to draw up a number of specific environmental plans, within a specified period of time after the contract is notified, describing how these contractors (and their sub-contractors) will be organised and how they will work together to meet their environmental and social obligations. In principle, the list should cover the following key fields:

1) Solid waste management plan,

2) Dredging and Sediment management plan,

3) Hazardous substances management plan,
4) Accidental spill response plan,
5) Erosion control and sedimentation management plan,
6) Camps management plan,
7) Workers health and safety plan,
8) Air pollution, dust and noise management plan,
9) Road traffic and access management plan,
10) Water quality monitoring plan
11) Cultural resources protection plan,
12) Environmental training plan

9.5.8. SURVEY OF DREDGED SEDIMENT QUALITY

PMU will organise a sampling survey of sediments in the canals to be dredged (Shwe Ta Chaung, Mingalar, Ngwe Ta Chaung) in order to identify more precisely the level of contamination by heavy metals and the sections of canals where sediment may be seriously contaminated, and where the dredged sediment may require special disposal measures. Analysis to be performed by a registered laboratory will concern grain size analysis as well as heavy metals: Hg, Cd, As, Pb, Cr, Cu, Zn, Ni and PCB.

It is anticipated at least 10 sites on Scwe Ta Chaung, 10 sites on Ngwe Ta Chaung and 5 sites on Mingalar.

Results will be compared to most recent applicable guidelines, particularly those under the Oslo Convention. Areas showing excessive pollution will be identified and the Contractor will have eventually to propose a management plan for the most contaminated sediment disposal.

9.6. ACTION PLAN DURING CONSTRUCTION (PAC)

This action plan provided below is sufficiently detailed to provide the baseline information for further preparation of Contractor Environmental and Social Specifications to be included later into the MUSIP Tender documentation. The following Program of Action will be implemented during the construction phase:

9.6.1. PAC-01: WASTE MANAGEMENT

A waste management programme will be established and will be mandatory for contractors and their sub-contractors. The programme will include two waste management plans which will be prepared and implemented by the contractors following the common directives fixed by MCDC. The first relates to domestic waste (mainly generated in worker camps) and other non-hazardous waste generated on the construction sites, while the second is related to hazardous wastes. The objectives of the programme are:

- to minimize the generation of wastes by carefully considered use of raw materials;
- to sort and treat the wastes in order to limit their environmental impact;
- to raise awareness and train personnel in good waste management practices.

These plans will include procedures, in accordance with local regulations or with international best practice, concerning the handling, transport, storage, treatment and elimination of wastes depending on their category:

- Non-hazardous wastes (Group A): putrescible wastes from the camps and canteens, paper, cardboard, plastics, wood and vegetation, inert wastes from construction or demolition (concrete, scrap iron, bricks, etc.);
- Hazardous wastes (Group B): wastes that are corrosive, explosive, toxic, representing a degree of danger for humans or for the ecosystem. In the context of the present project components considered, this will mainly include engine oils and used hydraulic fluids, the

residues of paints, solvents and resins, first aid medical wastes, sludge from septic tanks and mobile toilets, various concrete additives (but with a lesser degree of danger for the latter).

9.6.1.1. NON-HAZARDOUS WASTE MANAGEMENT

A system of waste segregation at source, ensuring separation of metal products (including drink cans or food cans), plastic products (bottles, cartons, wrapping, etc.), glass bottles, paper and cardboard, will be set up on the construction sites and in the camps. All these products will, as far as possible, be made available for collection by outside contractors responsible for recycling.

The workers' camp will be provided with two types of covered bins for selective collection of the various products listed above: putrescible in one, for recycling in the other. The contractor will carry out systematic awareness campaigns among residents of the camps to promote efficient use of these refuse bins.

On the construction sites, metal wastes that have not been polluted by hazardous substances (oils, acids, paints, etc.) will be collected in containers for recycling. The same applies to wood and cardboard and plastic packaging. It will be absolutely forbidden to burn plastic or lubricants.

Concrete and plaster debris that is not reused will be collected and dumped with other materials mainly from the dredging of Thingaza and Shwe Ta Chaung.

The Contractor will prepare a detailed Action Plan indicating the anticipated volumes of non-hazardous waste to be produced, the procedures for management, collection and disposal, the technical means implemented, the location and dimensions of the controlled landfill, the contact details of the companies involved in waste recycling, as well as the training programs to raise awareness among workers on this subject.

9.6.1.2. HAZARDOUS WASTE MANAGEMENT

Sludge from septic tanks from construction sites or worker camps will be collected by MCDC Cleaning Department pumping trucks and transferred to the dedicated oxidation ponds.

Should maintenance of heavy equipment happens on site, used engine lubricants from maintenance activities or floating oily residue from oil separators will be collected in 200 litre drums with a view to recycling. The drums will be stored in a dry and covered area, surrounded by a bund the height of which will ensure retention of a volume equal to at least 110% of that of the largest container stored in the area, and equipped with an oil separation system at its outlet. The contractor will identify an acceptable solution where the waste can be burned or recycled. A register will be maintained to record all handling of used lubricants, for the purpose of monitoring wastes. Machine and plant maintenance operations will be centralised in appropriate area allowing collection of the used oils and hydraulic liquids.

Should the use of chemical substances happens on sites, the following rules shall be followed: (i) give preference to substances with low toxicity values and minimize quantities to use, (ii) used chemical substances will be stored in containers or drums in the same storage areas as used oils, as long as these substances are compatible; (iii) otherwise, they will be stored in a safe area protected from inclement weather. The possibility of reuse in situ will be evaluated; failing this, the materials will be returned to the supplier or to appropriate waste treatment installations.

9.6.2. PAC-02: DREDGING AND SEDIMENT MANAGEMENT

The technical studies estimate that significant volumes of dredged/excavated materials will be produced, from Thingaza creek, Shwe Ta Chaung, Mingalar and Ngwe Ta Chaung canals. Comparatively, the future site for the WWTP will require large amount of fill for being reclaimed from seasonal flooding.

The Contractor(s) in charge of dredging operations will be required to produce a Dredging and Sediment Management Plan which will highlight the maximization of sediment re-use and the minimization of the eventual spoils to be disposed in a dedicated site. The Plan will respect the objectives set out in the Tender Documents which will include:

- Describe methods of dredging with specific measures for contaminated sections of canals;

- Assess total production of sediment expected, volume re-usable for fill with anticipated schedule of production;
- Assess volume of contaminated sediment resulting from sediment quality survey (See PPA-08);
- Define location and size of areas intended for temporary storage of re-usable sediment for fill;
- Store material in conditions that will ensure security in terms of stability and erosion; to this effect, a maximum height of 6 m should be imposed, with a berm half way up the slope;
- Provide drainage at the foot of the stockpiled material and anti-erosion measures on the slopes;
- Define location and area required for the disposal of spoils not usable for fill;

9.6.3. PAC-03: HAZARDOUS SUBSTANCES MANAGEMENT

A plan for the management of chemical substances will be prepared by the Contractor, detailing the measures planned for minimising pollution risks. The program will be applicable to all project activities involving the handling, storage and use of substances catalogued as hazardous. The information set out in this programme will cover the following aspects:

- procedure for registering and monitoring any substance of a hazardous nature including in particular the drafting of a safety data sheet per substance;
- procedure for identification of alternative and less hazardous substances;
- handling and storage conditions, including details on compatibility of the substances;
- emergency procedures in case of a spill;
- conditions for final treatment of residues or recycling.

Chemical substances will be stored in a locked container located on a watertight floor surrounded by a bund, capable of storing at least 110% of the volume of the largest receptacle placed there. Each storage site will be provided with a substance collection pit, absorbent products and extinguishers. Standard signs will warn of the presence of toxic substances.

The substances' safety data sheets will be available on the site and from the CC-EHSC of the contractor concerned. All chemical substances stores will be regularly inspected in order to detect any possible leakage or damage to the containers.

The largest volume of chemical substances anticipated under a project of this type concerns hydrocarbons (diesel, oil and grease). The programme will lay down the conditions to be respected for storage and refuelling of machinery.

The programme will specify the pollution control equipment to be installed by contractors at the storage sites: anti-pollution kits, extinguishers, substance description sheets, etc.

At each site, the employees in charge of handling chemical substances will be given special training relative to best practice and emergency measures in case of an incident (see PAC-04 below).

9.6.4. PAC-04: ACCIDENTAL SPILL PREPAREDNESS AND RESPONSE PLAN

An anti-pollution program will be established to define the intervention procedures in case of leaks or accidental spills of liquid hazardous substances. This programme will include a description of the organisation planned for such situations and the work stations of key people. Specific training will be given for the activities to be performed in case of emergency intervention, for all staff and workers involved in any stage of the procedure. This plan will be required even if the MUSIP project doesn't imply the necessity for handling and storage of large quantities of hazardous material.

9.6.5. PAC-05: EROSION AND SEDIMENT CONTROL

Erosion control measures will be applied to all land that is stripped or excavated, all embankments and temporary or permanent deposits of materials in order to minimise and control the resulting sediment loads before they reach the storm water drainage and the river. This protection will involve, on one hand, the implementation of methods for stabilising slopes and, on the other, collection of surface water runoff. This Plan mainly concerns the water storage site on Mandalay Hill and the southern site for the WWTP where significant earthworks will happen.

Erosion control will include methods that are incorporated into construction practices, as the provision of temporary protection of a mechanical nature (geotextile covering sheets, sediment barriers).

Drainage of the entire area of any construction operations will be provided prior to the start of any other activity. Drained water will be channelled towards one or several sedimentation basins designed following accepted best practice and sized to contain the rainwater falling in 24 hours with a return period of two years.

The contractor will present a Drainage and Erosion and Sedimentation Control Plan setting out the applicable principles and practices adopted for the Project sites concerned. For each site to be opened for construction activities, a detailed plan of the drainage system and the proposed anti-erosion measures will be prepared by the contractor and submitted to the PIC-MES for non-objection at least three weeks before starting works on the site. The drainage channel and sedimentation basins will be built as a priority before any other activity is carried out.

9.6.6. PAC-06: MANAGEMENT OF CAMPS

The following obligation will apply for any site sheltering workers on a 24 hrs. basis, including both permanent camps only dedicated for the residence of the workers and the temporary camps implemented on the construction sites where few workers may stay permanently (also to protect equipment and material at night).

A permanent and temporary camp management program will be prepared by each concerned contractor. The various aspects covered by such a program will include:

- choice of location for the camp, proposed organization, controlled entry;
- installations proposed for water supply and sewerage, waste management and drainage of storm water;
- equipment chosen for the sanitary facilities, collective equipment, bedrooms and dormitories;
- anticipated catering and food supply services, particularly canteens; means for monitoring the quality of foodstuffs stored and distributed in the camp;
- the policies implemented with regard to prevention of drug and alcohol abuse.

The specifications of the Tender Documents will lay down the requirements regarding water supply and sewerage. In order to eliminate the risks of development of disease vectors, rainwater drainage will be provided. The ratios to be respected in terms of sanitation (number of toilets, showers and wash-basins) will also be defined. The standards applicable to bedrooms and their furnishing and fittings will also be detailed in the Tender Documents. In particular, the minimum floor space per person, the supply of impregnated mosquito nets, and mattresses, will be stipulated.

The procedures to ensure hygiene in all common facilities and in particular food hygiene procedures for storing and monitoring fresh products used by the canteens will be detailed by the contractor responsible.

In order to prevent possible abuse of drugs and alcohol, measures to raise the awareness of employees and specific control measures will be set up by the contractor responsible.

9.6.7. PAC-07: PUBLIC HEALTH MANAGEMENT PLAN

The program requirements will be described in detail in the Tender Documents and will cover the following main areas of action:

- First aid facilities established on the construction or camp site; hospital facilities available in Mandalay;
- emergency intervention procedures in case of an accident;
- employee surveillance measures: medical check-up on recruitment, annual medical check-up;
- regular cleaning of the sanitary facilities provided, in particular toilets and septic tanks;
- waste management and regular cleaning of refuse bins;
- systematic program to keep employees aware of good hygienic practices;
- monitoring hygiene in canteens;

9.6.8. PAC-08: Management of Air Quality, Dust and Noise

A program to limit atmospheric and noise emissions will be put in place in all areas likely to be affected by construction of the Project. Emissions of exhaust gases and fumes will be limited by appropriate maintenance of equipment and trucks, and by banning the burning of waste on the sites.

Dust caused by road traffic on unpaved surfaces (for example west shore of Thingaza creek) will be subject to reduction measures in residential areas, by requiring the contractor to water spray the ground at regular intervals, i.e. at least two to four times per day during periods without daily rainfall. All loads of fine materials potentially causing dust to be spread during transport will be covered by a tarpaulin. In storage areas, watering will be recommended for all materials likely to generate dust. Wheels of trucks will be washed every time before leaving sites for dredging, to avoid deposition of sludge on public road and later production of dust.

Noise will be the subject of regular monitoring by the PIC-MES to ensure that the limits imposed for the site are respected or that the employees exposed to higher noise levels are appropriately equipped with PPE. Measures will be taken to reduce noise levels and the corresponding disturbance on the site and along the access roads: maintenance of plant and vehicles, use of soundproofed equipment, reduction of the hours of use of certain noisy activities.

The Tender Documents will define the thresholds to be respected by the contractor in terms of gas emissions, dust and noise.

9.6.9. PAC-09: Management of Road Traffic and Access

Road traffic is a prime cause of accidents during the construction phase of infrastructure projects. It is therefore essential to regulate traffic both on site and outside. This is particularly important for the present project as (i) components are located in dense urban area and (ii) the project involves dredging of significant volume of sediment to be evacuated and which may generate heavy truck traffic. Various measures will be considered and adopted by the contractors:

- Awareness raising and training of drivers of trucks on elementary traffic safety rules and on the legal risks : driving under the influence of alcohol or drugs, excess speed, monitoring of tyre condition, load stability, etc.;
- visual acuity of all recruited drivers and their ability to drive;
- provision for parking trucks not encroaching on the roadway;
- respect of speed limitations;

Access to the construction sites will be indicated by appropriate road signals.

The Tender Documents will set out all these obligations as well as the penalties that will be applied to contractors and their sub-contractors in case of infringement.

9.6.10. PAC-10: WATER QUALITY MONITORING (FOR CONTRACTOR)

The contractor will prepare a water quality monitoring plan to appreciate the performance of the environmental management implemented on the sites. This monitoring will control the quality of liquid effluents (waste water, drainage water) leaving the limits of the work site concerned and their compliance with applicable norms or standards provided in the tender Documents.

The contractor will be responsible for monitoring the quality of all discharges leaving its sites or subcontracting a competent consultant or local agency to do so. The parameters to monitor will be defined according to the type of discharge (grey water, stormwater) and detailed in the Tender Documents:

Sampling sites and parameters may change in the course of construction in order to adapt to the areas of activity and the types of activity observed, many components being linear (interceptors, dredging, water pipes). The monitoring will be carried out on a monthly frequency.

This monitoring will be supervised by the PIC-MES, who will carry out control measurements at similar location points into his own water quality monitoring process (see the following section related to environmental monitoring of the sites).

Compliance monitoring will concern at least the following water quality indicators:

- organic pollution: BOD_5, nitrates, phosphates, (particularly related to the camps areas);
- oils and grease, relating to drainage water from the areas used for mechanical activities, storage of hazardous substances (hydrocarbons) and wastewater from canteens;
- suspended solids in drainage water and used also as performance criteria for the dredging activities and for sedimentation basins;

9.6.11. PAC-11: PROTECTION OF CULTURAL RESOURCES

The IEE confirms that the project components are not affecting any cultural site or building. However, as some components involve significant excavation or dredging works (Water storage, Thingaza creek), the chance to find any physical cultural resource does exist, particularly in Mandalay.

The Tender Documents will define an emergency intervention procedure (chance to find procedure) in case a discovery is made or an interaction is observed during the works. This procedure will include aspects such as:

- immediate measures to stop work at the site concerned and mark out the area to be protected;
- information procedure involving the CC-EHSC, the PIC-MES and PMU-DES;
- approval of the measures decided by the DES;
- organization of removal of the resource (if physical);
- closure of the incident and resumption of work.

9.6.12. PAC-12: ENVIRONMENTAL AND SOCIAL TRAINING PLAN

The objective of this plan is to ensure effective implementation of the measures proposed under the EMP on the construction sites. This Plan will define the general training programs (awareness training) for the attention of all personnel and the specialized training programs intended for the employees involved in particularly sensitive activities from the environmental standpoint (management and distribution of hydrocarbons, hazardous waste management, etc.). Each new recruit must participate in the awareness-raising program within 15 days following his recruitment. Each employee in charge of sensitive activities will follow a catch-up session every 6 months.

This training will be delivered by the CC-EHSC of the main Contractors or by a specialized consultant appointed by the contractors. All personnel shall be trained. The sessions shall be recorded in a register where the names and attendance signatures of all participants will be noted.

The environmental management awareness program on the sites will cover the following priority subjects:

- rules for waste management within the sites;
- rules for management of hazardous substances and wastes, particularly their storage authorized exclusively in specially adapted areas;
- pollution control, in particular the response required in case of an accidental pollutant spill;
- protection of sites against fire;
- protection of sites against erosion and sedimentation;
- procedure to follow in case of discovery of a physical cultural resource;
- rules for traffic safety on public roads and within the sites;
- principles for saving energy and other resources;
- applicable penalties in case of infringement against the established rules.

Complementary provisions will be made relating to hygiene, health and safety under all aspects that are not covered by the Health and Safety Program and the corresponding training programs.

9.7. E&S SUPERVISION DURING CONSTRUCTION

The Project Implementation Consultant (PIC), through its Manager Environment and Social (MES) and his team, is responsible for ensuring the Contractor complies with its E&S obligations. The PIC is the one that certifies payments to the contractor and as such, he can therefore 'negotiate' the deployment by the contractor of equipment or labour initially allocated to the works in favour of specific environmental measures.

9.7.1. PAC-13: MONITORING OF CONSTRUCTION ACTIVITIES (PIC)

Contractors' compliance with their environmental and social obligations will be the subject of a specific monitoring process, coordinated by the PIC-MES. In order to ensure compliance with E&S requirements and efficient implementation of corrective measures an environmental monitoring program will be set up, including:

- E&S supervision of the contractors: Through regular site inspections the objective is to ensure that all E&S measures set out in the Obligations for Contractors and in the Action Plans prepared by the Contractors are effectively and efficiently implemented;
- Environmental quality monitoring: monitoring of changes in the quality of the environment in order to evaluate the efficiency of the mitigation measures applied and, if necessary, to modify acceptability thresholds or methods;
- Environmental compliance control monitoring: ensuring that all discharges from all project sites are compliant with environmental legislation or with related specifications in the Tender Documents (under the responsibility of the Contractor, see PAC-10 above). This monitoring will also confirm or not the validity of information supplied by the CCs on a monthly basis. Analysis will be performed on a limited number of parameters indicators of pollution from construction activities.

9.7.1.1. WEEKLY INSPECTIONS

Weekly inspection of the different work sites will be organised by the PIC-MES and will be the subject of a report using a standard inspection sheet. This information sheet will cover all the environmental specifications imposed to the contractor, item by item, giving an immediate overview during each inspection, of potential situations of non-conformity.

Each environmental event (EE) will be the subject of a standard record sheet to be filled in by the observer (Inspector) and submitted to the PIC-MES for action. The record sheet signed by the PIC-MES is handed

over to the CC-EHSC who then completes the document by explaining the proposed corrective measure. If the solution is acceptable, the EE is closed after checking that the corrective measure has been effectively and successfully implemented.

9.7.1.2. COORDINATION MEETINGS

Regular (weekly or semi-monthly) coordination meetings will be held between the CC-EHSCs (and their inspectors) and the PIC-MES (and his inspectors), during which they discuss the EE in progress, the remedial measures taken and any other subject of current concern such as the Action Plans presented by the CC-EHSCs.

9.7.2. PAC-14: AIR QUALITY AND NOISE MONITORING (PIC)

The main anticipated impact will be caused by dust near the construction sites. No significant problem is seriously anticipated with exhaust emissions, except very locally along hauling routes.

Two types of sampling monitoring are under the responsibility of the PMU:

- ad-hoc controls for dust at the boundaries of construction sites near residential areas and along hauling routes used between the dredging sites and WWTP site to be filled. Action will be taken as soon as few complaints from residents have been collected for a particular location, or where visual inspection confirms that excessive dust is being generated. The PIC-MES will make spot checks of noise levels on the various work sites and in certain residential areas during daytime and night, in order to check that applicable references at the boundaries of the work sites or in the surrounding residential areas are complied with.
- regular monitoring for air quality and noise carried out by an external registered laboratory on a quarterly basis. Locations may vary according to progressive transfer of activities, particularly for the road works.

Proposed Monitoring Plan is detailed in the table below.

Table [38] ENVIRONMENTAL MONITORING FOR AIR AND NOISE

REFERENCE	PARAMETERS	LOCATIONS	FREQUENCY
Ambient air quality standards: Ministry of Health	CO, SO_2, NO_x, TSP, O_3, lead dust (Pb), (PM10), (PM2.5),	2 sites Thingaza 2 sites Shwe Ta Chaung 1 site WWTP site 1 sites WS network rehabiliation 1 site Tube well regeneration 1 site next to WTP8	Quarterly
Noise level standards: Ministry of Health	Day time and night time noise levels dB(A)		

For the quarterly monitoring of air quality, the PIC-MES will appoint a registered professional laboratory to perform the task.

9.7.3. PAC-15: WATER QUALITY MONITORING (BY PMU)

The Contractor is required to carry out a monthly monitoring of all the effluents leaving its construction and camps premises. In addition, the PMU-DES will appoint a registered professional laboratory to carry out an independent monitoring of surface and underground water quality on a quarterly basis. The main purpose of the monitoring is to start following the evolution of water quality in those water bodies and to continue after completion of works to appreciate the beneficial impacts of MUSIP on water quality improvement. This monitoring is a long term one starting during the construction period to provide a reference situation.

An interesting alternative to the appointment of a private laboratory would be to equip MCDC laboratory with the equipment required for controlling the listed parameters with a training program of the staff for sampling, storing and analysing samples. This is the recommended option.

Proposed monitoring criteria and locations are presented in the following Table [39] and on 9.7.4.

Table [39] WATER QUALITY LONG TERM MONITORING

PARAMETERS	LOCATIONS	FREQUENCY
pH, DO, TSS, COD, BOD5, NH4, Cl, NO2, NO3, F, Phosphate, Cyanide, , Coliforms	See 9.7.4	Quarterly
Heavy metals (As, Cd, Pb, Cr+3, Cr+6, Zn, Nickel, Fe, Hg, Cu), VOC, TPH		Semi-annual

9.7.4. PAC-16: SITE CLEANING AND REHABILITATION PROGRAM

By the end of the construction activities, each contractor has to decommission the sites where its activities for Project needs have been performed, which includes:

- The demolishing of all temporary structures/buildings developed for the purpose of Project construction.
- The removal from the sites of all equipment and remaining material and waste, the safe disposal or recycling of construction and demolition waste and of construction material;
- The restoration of the land in order to return it as close as possible from its initial state
- The official handover of the site to its owner, signed by parties.

In order to ensure that this Site Cleaning and Rehabilitation (SCR) operation is successfully implemented, the Contractor will be required to prepare a Site Cleaning and Rehabilitation Plan (SCRP) which provides operational methods for (i) site assessment and (ii) cleaning and rehabilitation in compliance with Contractual obligation and international good practices. The Plan will respect the following:

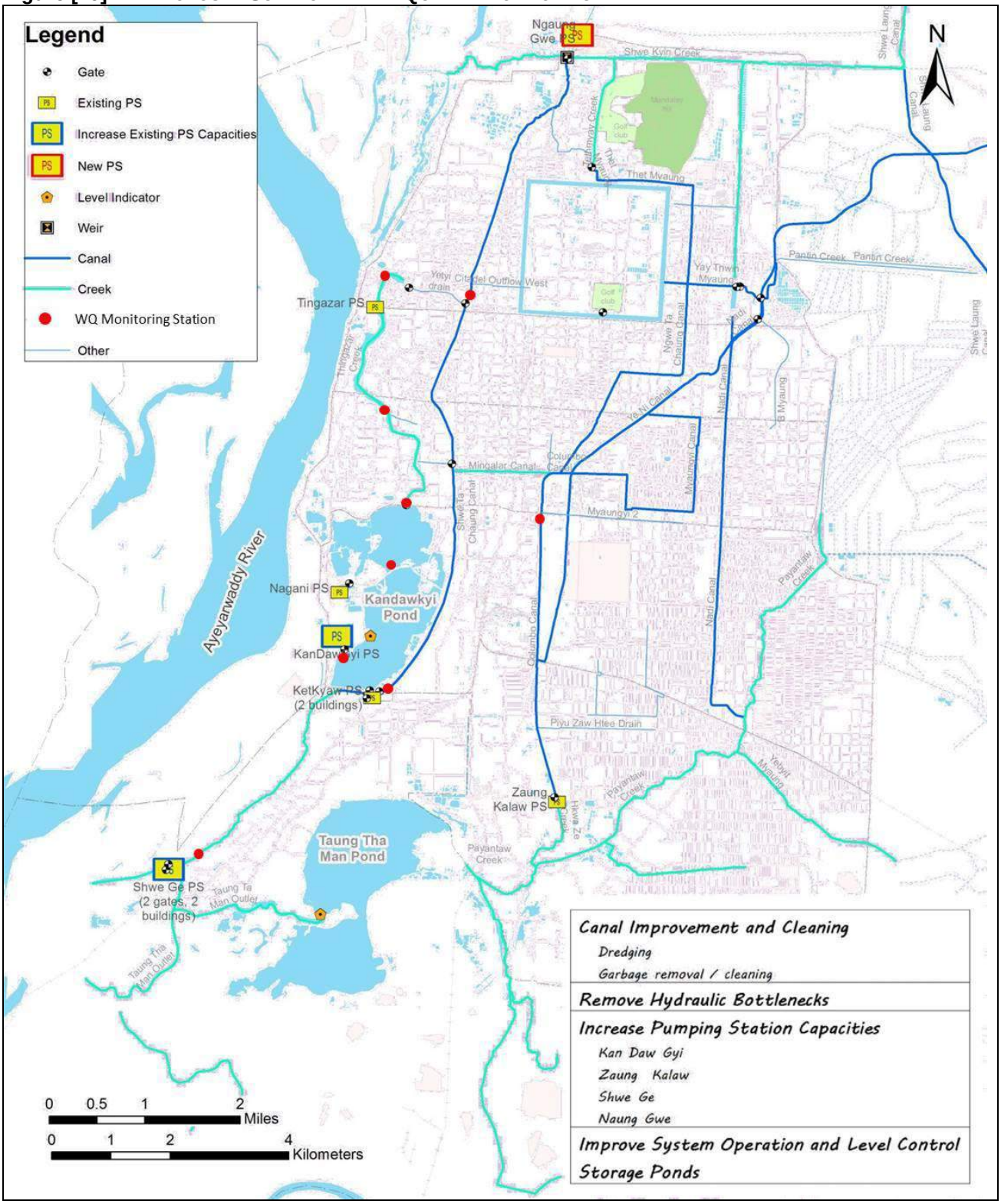
Cleaning Stage

- All construction materials, equipment, buildings, facilities and residual waste will be removed from all sites, except if a site specific decision modifies this principle. This decision shall be commonly agreed on by the CC and the PMU.
- All waste collected on site will be treated in compliance with the requirements of the Tender Documents Environmental Obligations and the Waste Management Plan prepared by the CC at the start of the construction, depending on the classification of the waste product considered.
- Recycling of waste will be maximized.

The Plan will be submitted to the PIC-MES not later than 1 month before the start of decommissioning and include the methods for carrying out the following activities:

- Evaluation of quantities regarding each group of materials/waste identified;
- Identification of registered companies for the recycling of materials and waste;
- Procedures for treatment and disposal of non-recycled material and waste;
- Schedule for cleaning operations;

Figure [49] PROPOSED SURFACE WATER QUALITY MONITORING



Source: PPTA Consultant, 2014

Rehabilitation Stage

Rehabilitation will be carried out in immediate continuation or even in parallel with the cleaning stage, taking advantage of the presence of the manpower and the equipment. Consultation with concerned stakeholders will be carried out where necessary. The following principles will apply:

- Sites shall be rehabilitated in a way to restore, as much as feasible and reasonably possible, the original use of the land;
- All sites must be returned free of any buildings or infrastructures developed for the purpose of Project construction, except if specific request is made;
- All sites where structures were temporary removed (market stalls, shops, other) will be reinstalled at the end of the works, excepts if special request from the owner.
- All spoil disposal areas shall be rehabilitated according to the obligations of the Tender Documentation and the obligations of the Plan on Sediment and Spoil Management.
- Rehabilitation option will eventually be selected through consultation between CC, PIC, PMU and any private party if the land is privately owned.

After completion of SCR works, the CC will inform the PIC-MES regarding the final site status. After acceptance by PIC-MES of the site conditions MCDC-PMU will be notified. To finalize the SCR process a joint site visit with all concerned parties will be organized by the PIC-MES to sign SCR Completion Certificates as follows:

- For public land, the SCR Completion Certificate will be signed by PIC, PMU and by MCDC Land Department as witness;
- For private land, the SCR Completion Certificate will be signed by the land owner, CC, PIC and PMU.

9.8. ACTION PLAN FOR OPERATION STAGE (PAE)

The implementation of environmental monitoring is necessary from the time the works are completed and commissioned, in order to ensure impacts and mitigation measures proposed have been efficiently implemented during the construction stage and show positive results as expected.

The start of the operation stage will vary depending on the project components considered. The total project construction is anticipated to last 5 years. The following activities are proposed in this EMP.

9.8.1. PAE-01: WATER QUALITY MONITORING OF AYEYARWADDY RIVER

Monitoring of Ayeyarwaddy River downstream the outlet discharge of the WWTP in order to ensure (i) local organic pollution load is rapidly dispersed by the natural flow of the River (ii) discharged effluent is compliant with applicable standards considered in the design.

Sampling will be carried out on a quarterly basis in 3 locations: at discharge point and in Ayeyarwaddy River 50 m and 100 m downstream the discharge point. Parameters to be checked include pH, SS, BOD_5, COD, coliforms.

9.8.2. PAE-02: WATER QUALITY MONITORING OF IMPROVED DRAINAGE SYSTEM

The long term monitoring started during construction (PAC-15) will continue for at least 2 years after commissioning the improved drainage system. The aim is to quantify the performance of the project on the improvement of water quality in the main components of the surface drainage system. Same sampling location, frequency and parameters than those described in PAC-15 will be considered. Monitoring responsibility will remain under MCDC.

9.8.3. PAE-03: AIR QUALITY MONITORING OF INCINERATOR

A control of air emissions from the incinerator used for burning medical waste will be carried out annually to ensure temperature of furnace and stack filters are operating in compliance with design standards. This monitoring is only reminded in this EMP as it is part of the conventional follow-up and maintenance to be carried out for this type of plant. The cost is not integrated into the EMP budget.

9.9. COST OF ENVIRONMENTAL IMPACT PREVENTION, MITIGATION & MONITORING

The following table sets out the estimated budgets required for implementation of the corrective measures and monitoring activities during the 3 phases of implementation of the MUSIP Phase 1. The budget presented is exclusive of salaries and supporting facilities (transport, office equipment, secretarial services) for staff from PMU and PIC dedicated to environmental supervision of construction sites. Similarly, for water quality monitoring supposed to be performed by MCDC Laboratory, only costs for equipment/chemicals are considered and do not include laboratory fees.

Table [40] TENTATIVE BUDGET FOR EMP IMPLEMENTATION

NO	CORRECTIVE MEASURE / ACTION	RESPONSIBILITY		BUDGET PER YEAR (US$)	DURATION (YEARS)	TOTAL
		FUNDING	IMPLEMENTATION			
PROGRAM OF ACTION PRELIMINARY TO CONSTRUCTION START (PAP)						
PPA-01	Appointment of PMU-CES	PMU	PMU	(1)	8	-
PPA-02	Additional Study of Ayeyarwaddy Water Quality	PMU	Laboratory	20,000	1	20,000
PPA-03	Due Dilligence Dokhtawaddy WTP	PMU	PIC	(2)	-	
PPA-04	Environmental Training of PMU-DES & PMU staff	PMU	PIC/Consult.	15,000	-	15,000
PPA-05	Health & SafetyTraining of PMU-DES & PMU staff	PMU	PIC/Consult	15,000	-	15,000
PPA-06	Preparation of Communication instruments	PMU	PIC	10,000	-	10,000
PPA--07	Preparation of Contractor E&S specifications	PMU	PIC	10,000	-	10,000
PPA-08	Detailed survey of dredged sediments quality	PMU	Laboratory	50,000	1	50,000
PROGRAM OF ACTIONS IN CONSTRUCTION PHASE (PAC)						
PAC-01	Waste Management	Contractor	Contractor	(3)	6	-
PAC-02	Management of Sediment and Spoil	Contractor	Contractor	(3)	6	-
PAC-03	Hazardous Substances Management	Contractor	Contractor	(3)	6	-
PAC-04	Accidental Spill Preparedness and Response	Contractor	Contractor	(3)	6	-
PAC-05	Erosion and Sediment Control	Contractor	Contractor	(3)	6	-
PAC-06	Management of Camps	Contractor	Contractor	(3)	6	-
PAC-07	Public Health Management	Contractor	Contractor	(3)	6	-
PAC-08	Management of Air Quality, Dust and Noise	Contractor	Contractor	(3)	6	-
PAC-09	Management of Road Traffic and Access	Contractor	Contractor	(3)	6	-
PAC-10	Monitoring of Water Quality (by CC)	Contractor	Contractor	(3)	6	-
PAC-11	Protection of Cultural Resources	Contractor	Contractor	(3)	6	-
PAC-12	Environmental & Social Training Plan	Contractor	Contractor	(3)	6	-
PAC-13	Monitoring of Construction Activities	PMU	PIC	(2)	6	-
PAC-14	Air Quality & Noise Monitoring (PMU)	PMU	Laboratory	40,000	6	-
PAC-15	Drainage Water Quality Monitoring (by PMU)	PMU	MCDC Lab.	60,000 (5) 10,000	6	120,000
PAC-16	Site Cleaning & Rehabilitation Program	Contractor	Contractor	(3)	6	-
OPERATIONAL PHASE ACTION PROGRAMME (PAE)						
PAE-01	Monitoring of Water Quality in Ayeyarwaddy River	MCDC	MCDC Lab.	20,000	2	40,000
PAE-02	Monitoring of Improved Drainage Water Quality (PAC-15 continues)	MCDC	MCDC Lab.	10,000	2	20,000
PAE-03	Monitoring of Incinerator Air Emission Quality	MCDC	Operator	(4)	Annual	-
	TOTAL	-	-			**300,000**
	Contingencies 20%	-	-			**60,000**
	TOTAL	-	-			**360,000**

Notes: *(1) Budget internal to PMU operation costs*

(2) Budget is part of PIC Contract

(3) Related E&S expenses are included into construction costs of the CCs

(4) Control under routine maintenance of facility

(5) Acquisition of equipment for MCDC laboratory for performing water quality monitoring during construction (60,000 USD) and annual budget of 10,000 USD for renewal of chemicals and small equipment

10. CONCLUSIONS AND RECOMMENDATIONS

The first phase of the Mandalay Urban Services Improvement Project (MUSIP1) will significantly improve the environmental conditions in Mandalay City and the quality of life of its population through the following results:

- Improvement of public safety with improved water treatment and disinfection facilities;
- Improvement of distribution networks and extension in southern part of Mandalay;
- Major improvement of wastewater collection and treatment, through the implementation of interceptors along major creek and canals. Immediate improvement of surface drainage water with major beneficial impacts on surface water quality of receiving water bodies, on public health for population living along drainage systems and on the general quality of life of the population. Domestic pollution to water bodies will be reduced by 5 tons per day thanks to the first development stage of a wastewater treatment plant located at the south of the city and providing enhanced primary treatment. Pollution load to the environment will also be reduced by the improvement of night soil collection and treatment.
- The cleaning or dredging of major creek and canals (Thingaza creek, Shwe Ta Chaung, Ngwe Ta chaung and Mingalar canals) associated with the rehabilitation of pumping station and the development of a monitoring system for the canals and lakes level will improve general drainage conditions in the city and reduce seasonal flooding particularly around Thingaza creek and Taung Tha Man Lake. Cleaning of the creek and canals will also beneficially impact the quality of the urban environment and the quality of life of its residents.
- Solid waste is another major issue in Mandalay city, a significant part of the domestic waste produced being directly dumped into the drainage system. Due to budget constraints, the anticipated improvement of collection through new vehicles and the creation of 12 collection points with the closure of existing points (over 70) will most probably be considered under phase 2 of the Project (MUSIP2). When implemented, it will strongly improve the general urban landscape, the cleanliness of the streets and drains, the efficiency of the drainage and the general quality of life of the residents. Only a pilot collection point (close to Thingaza creek) is anticipated under MUSIP1.
- Following the principles of Green Cities, MUSIP will support innovation: a co-generation project will be developed with the WWTP. A digester will capture 13 200 tons CO2eq per year to transform the biogas in electricity and heat. About 3 700 MWh/year of electricity will be produced, which represents 83% of the electric requirements of the WWTPSludge from the digester will be either used for land application or used as a substitute fuel for cement plant of international standard. Also, part of the drainage canal improvement is proposed as SUDS (Sustainable Urban Drainage System) along Mingalar canal, a pilot project which will demonstrate the interest of the system and provide several hectares of green urban space in a densely populated area.

A screening carried out during the Interim phase of the Project confirmed that impacts raised by the project were mainly related to land acquisition while impacts on natural environment were all very limited, mainly related to the construction phase and easily controllable by appropriate and conventional mitigation measures. Consequently, the proposed categorisation of the Project was B, involving the preparation of the present IEE.

Aside from the several and undisputable beneficial impacts of the MUSIP, some limited impacts are anticipated:

- Land acquisition, mainly outside Mandalay city, for the WWTP and the new landfill areas, and minor temporary displacement of buildings in the densest areas along the drainage canals where interceptors are going to be laid. Inside the city, the design of MUSIP has already integrated constraints and most of the facilities are implemented either in MCDC property land or in public zones: interceptors for Thingaza and Shwe Ta Chaung canal are

occasionally implemented along streets but mainly within the bed of the creek and canal. Temporary resettlement will mainly be required very locally for access to the construction sites. These aspects are detailed in the Resettlement Action Plan prepared simultaneously to this IEE.

- Dredging of creek and canals may result in the production of an estimated 100,000 m3 of sediment. It is considered the reuse of this sediment as fill for the reclamation of the presently floodable land to be used for the development of the WWTP. The site will accommodate more than the expected production. Some preliminary sediment chemical analysis show possible local contamination of sediment, but within reasonable range. Further investigations are recommended as part of the EMP.
- The WWTP will discharge treated effluent in the Ayeyarwaddy river, however the discharge point will represent a concentration point for pollution load, as the effluent is expected to satisfy the 60 mg BOD/l. Due to the high discharge of the river and the pollution mainly organic of the effluent, it is not anticipated major impact as no residence or water usage nearby is observed. However, a long term monitoring of the water quality in the area is proposed in the EMP to ensure the impact remains insignificant.
- 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 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, community facilities temporary disruption, noise, engine gas and dust release may temporary disturb the nearby communities. However, recommendations formulated in the EMP combined with a solid environmental contractual framework and an effective inspection of construction sites will definitely reduce these risks to an acceptable level.
- One linked project has been identified, related to a new water treatment plant with a pumping station in the Dokhtawaddy River, which may affect the water supply networks extension in southern Mandalay proposed in MUSIP (to be supplied from this project). However, due dilligence as required by ADB SPS is not yet possible, these two project having not yet been subject to detailed technical studies. The EMP recommends to carry out due dilligence during the first year of MUSIP implementation (pre-construction stage).

The EMP also emphasizes the extremely low level of consideration for occupational health and safety (OHS) in Myanmar and particularly in Mandalay nowadays. Construction sites generally ignore safety signals, personal or collective protections for workers, safety belts, EHS awareness training etc. This situation is 100% incompatible with the implementation of a project supported by international lenders as ADB and AFD. For that reason, the EMP emphasises the need for EHS capacity building for MCDC-PMU, the need for very detailed specifications Environment, Health and Safety for the tender documents, the need for a strict EHS monitoring of construction activities.

The conclusions of the present IEE confirm the initial categorization of the Project as category B. also, the IEE is sufficient basis of environmental assessment, thus, a full EIA is not required.

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APPENDIX 1
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APPENDIX 2
RAPID ENVIRONMENTAL ASSESSMENT CHECKLISTS

APPENDIX 3
INFORMATION DISCLOSURE AND PUBLIC CONSULTATION PARTICIPANT LISTS

APPENDIX 4
WATER QUALITY OF AYEYARWADDY RIVER AT MANDALAY

SURFACE WATER QUALITY OF AYEYARWADDY RIVER AT MANDALAY (BOWLES, 2013)

DATE	19/02/2012 (DWR-MOT)	JAN 2013 (DWR-MOT)	30/04/2013 (11:30)	30/04/2013 (14:30)	01/05/2013 (8:36)	01/05/2013 (10:30)	02/05/2013 (8:15)	02/05/2013 (10:18)	27/05/2013 (13:50)	28/05/2013(9:30)	18/07/2013 (8:08)	19/07/2013 (6:30)	20/07/2013 (6:00)	WHO GUIDELINE VALUES	UNITS
LOCATION	MANDALAY	MANDALAY	MANDALAY (NEAR MCDC) (21.98910 N, 96.0637E)	MANDALAY (DOWNSTREAM NEAR THE BRIDGE) (21.87745N)	MANDALAY (NEAR MCDC) (21.98910 N, 96.0637E)	MANDLAY (DOWNSTREAM NEAR THE BRIDGE)	MANDALAY (NEAR MCDC) (21.98910 N, 96.0637E)	MANDALAY (NEAR MCDC) (21.98910 N, 96.0637E)	MANDALAY (NEAR MCDC) (21.98910 N, 96.0637E)	MANDALAY (NEAR MCDC) (21.98910 N, 96.0637E)	MANDALAY (NEAR MCDC) (21.98910 N, 96.0637E)	MANDALAY (NEAR MCDC) (21.98910 N, 96.0637E)	MANDALAY (NEAR MCDC) (21.98910 N, 96.0637E)	(DRINKING WATER)	
Dissolved Oxygen	5.53	13.04	6.34	9.21	7.16	6.73	7.21	4.98	6.09	4.88	6.12	6.5	6.32		mg/L
Arsenic			30	30	30	30	30	30	10	10	10	10	10	10	ppb
Ammonia	1	0.12	1	1.3	1.5	2.9	1.5	2	2.6	2.1	2.3	2.7	2.8	1.5	mg/L
Turbidity	70	150	142	47	53	22	35	20	111	95	42	28	18	5	NTU
Suspended Solids			113	26	31	6	21	4	79	69	25	13	9		mg/L
Total Dissolved Solids			86	88	56	112	39	96	98	102	26	193	28	600	ppm
Temperature (degree C)	29.4	24.8	37.1	36	33.4	33	26.4	25.5	21.9	28.3	21.8	25	21.8		Degree C
pH	8.38	7.4	8.11	8.72	8.26	8.14	8.45	7.85	8.74	8.43	10.53	10.06	9.26	6.5-8.5	
Electrical Conductivity			172	155	103	209	77.8	194	191	192	106	55.3	54.3		µs
Salinity			0.08	0.07	0.05	0.1	0.03	0.09	0.09	0.008	0.02	0.02	0.02	<0.00015 for irrigation	ppt
Conductivity			915	865	510	1003	341	814	617	827	374	414	421		µs
Alkalinity	115	214	1.38	1.32	0.58	1.62	0.62	1.38	1.28	1.52	0.42	0.5	0.44		meq/L
Nitrate Nitrogen	0.45	0.13	2.6	1.4	2.9	0.2	3	2.1	2.1	2.8	0	1.5	1.8	50	mg/L
Sulphate			5	4	1	2	0	6	5	4	0.7	1	1	250	mg/L
Hardness	34	90	73	78	46	37	58	46	43	47	36	33	32	200	mg/L as CACO3
Iron	0.03	0.52	1.32	0.9	1.06	0.52	0.61	0.36	1.63	1.68	0.8	0.25	0.72	0.3	mg/L
Zinc			0.21	0.19	0.12	0.13	0.11	0.1	0.05	0.01	0.31	0.04	0.07	3	mg/L
Lead			0	0	0	0	0	0	0	0	0	0	0	10	ppb
Cyanide			0.08	0.09	0.08	0.09	0.09	0.11	0.68	0.81	0.09	0.81	0.11	0.07	mg/L
Coliform			1020	1780	1520	1540	780	460	1740	1800	1280	1620	2180	0	in 100
E.Coli			920	680	0	1340	900	580	860	1120	2120	1360	860	0	in 100
Chloride	500	140													mg/L
Fluoride	0.05	0.4												1.5	mg/L
Nitrite	10														mg/L

APPENDIX 5
EMISSION QUALITY STANDARDS FROM VARIOUS MINISTRIES AND AGENCIES IN MYANMAR

MINISTRY OF HEALTH (ENVIRONMENTAL QUALITY STANDARDS)

(1) Air Quality Standards

No.	Pollutant of Parameter	Limit
1.	PM10(24hr mean)	50µg/m³
2.	SO2(24hr mean)	20 µg/m³
3.	NO2(Annual mean)	40 µg/m³
4.	NO2(1hr mean)	200 µg/m³

(2) Sound and Vibration Standards

No.	Subject	Limit
1.	Factories Rule 195-R-50 Schedule x x VII permissiable exposure level	90 dB(A)
2.	American conference of Govermental Industrial Hygienist (ACGIH) Threshold	85 dB(A)

MINISTRY OF ELECTRICAL POWER (ENVIRONMENTAL QUALITY STANDARDS)

(1) Standards for Air Pollutants from Coal Hydropower Plant

No.	Particulars	Unit	Range
1.	Carbon Monoxide(CO)	lb/10^6 BTU	0.018-0.045
2.	Mercury(Hg)	lb/GWh	0.068-0.0534
3.	Ammonia(NH_3)	lb/10^6 BTU	0.0027-0.017
4.	Nitrogen Oxides(NO_x)	lb/10^6 BTU	0.035-0.067
5.	Sulfur Dioxide(SO_2)	lb/10^6 BTU	0.004-0.080
6.	Sulfur Trioxide(SO_3)	lb/10^6 BTU	0.00046-0.0021
7.	Particulates	lb/10^6 BTU	0.015-0.03
8.	Visibility	% Opacity	10-20

(2) Sound and Vibration Standards, in dB(A)

No.	Receptor	Day(07:00-22:00)	Night(22:00-07:00)
1.	Residential, Institutional, Educational	55	45
2.	Industrial, Commercial	70	70

(3) Waste Water Effluent for General Use

No.	Pollutant or Parameter	Limit
1.	pH	6-9
2.	BOD	50
3.	COD	250
4.	Oil and Grease	10
5.	TSS	50
6.	Metals	

No.	Pollutant or Parameter	Limit
	Heavy Metals, Total	10
7.	Arsenic	0.1
8.	Cadmium	0.1
9.	Chromium	
	Hexavalent	0.1
	Total	0.5
10.	Copper	0.5
11.	Iron	3.5
12.	Lead	0.1
13.	Mercury	0.01
14.	Nickel	0.5
15.	Selenium	0.1
16.	Silver	0.5
17.	Zinc	2.0
18.	Cyanide	
	Free	0.1
	Total	1.0
19.	Ammonia	10
20.	Fluoride	20
21.	Chlorine, Total Residual	0.2
22.	Phenols	0.5
23.	Phosphorus	2.0
24.	Sulfide	1.0
25.	Coliform Bacteria	<400 MPN/100 ml
26.	Temperature Increase	<3´C´

(4) Air Quality Standards for General Industries

No.	Pollutant	Concentration
1.	Particulate Matter Annual Arithmetic Mean Maximum 24-hour Average	 50 70
2.	Nitrogen Oxides Maximum 24-hour Average	 150
3.	Sulfur Dioxide Annual Arithmetic Mean Maximum 24-hour Average	 50 125

MINISTRY OF RAILWAY TRANSPORT (ENVIRONMENTAL QUALITY STANDARDS)

Pollutants Standards emission from vehicle

No.	Pollutant	Limit
1.	Exhaust Emission(Smoke)	<50% Bosch Unit
2.	Horn Maximum	90 dB
3.	Noise Maximum	115 dB

MINISTRY OF INDUSTRY (ENVIRONMENTAL QUALITY STANDARDS)

(1) Ambient Air Quality Standards

No.	Pollutant	Limit
1.	Carbon Monoxide(CO)	35ppm (1 hour average)
2.	Lead(Pb)	0.15 µg/m^3 (3 hour average)
3.	Nitrogen Dioxide(NO_2)	0.053ppm (annual)
4.	Ozone(O_3)	0.075ppm (8 hours)
5.	Particle Pollution (PM 2.5)	12 µg/m^3 (annual)
	Particle Pollution (PM 10)	150 µg/m^3 (24 hours)
6.	Sulfur Dioxide (SO_2)	0.075ppm (1 hour)
	Sulfur Dioxide (SO_2)	0.5ppm (3 hour)

(2) Waste Water Quality Standards

No.	Pollutant	Limit
1.	BOD (5 days at 20´C)	Between 20ppm & 60ppm
2.	Suspended Solid	Max 30ppm
3.	Dissolved Solid	Max 2000ppm
4.	pH Value	Between 5 and 9
5.	Permanganate Value	Max 60ppm
6.	Sulphide (as H_2S)	Max 1ppm
7.	Cyanide (as HCN)	Max 0.2ppm
8.	Oil and Grease	Max 5ppm
9.	Tar	Tar None
10.	Formaldehyde	Max 1ppm
11.	Phenols and Cresols	Max 1ppm
12.	Free Chlorine	Max 1ppm
13.	Arsenic	Max 0.25ppm
14.	Mercury	Max 0.005ppm
15.	Lead	Max 0.2ppm
16.	Zinc	Max 5ppm
17.	Barium	Max 1ppm
18.	Chromium	Max 0.5ppm
19.	Copper	Max 1ppm

No.	Pollutant	Limit
20.	Nickel	Max 0.2ppm
21.	Temperature	Max 40´C
22.	Insecticides and Radioactive Material	Insecticides and Radioactive Material None
23.	Colour and Odor	Can be contained

MINISTRY OF MINE (ENVIRONMENTAL QUALITY STANDARDS)

(1) Surface Water Quality Standards

No.	Pollutant	Limit	Unit
1.	pH	6-9	pH
2.	Sludge	300	mg/litre
3.	Oil	15	mg/litre
4.	COD	150	mg/litre
5.	Cyanide	0.2	mg/litre
6.	Arsenic	0.1	mg/litre

(2) Coastal and Estuary Quality Standards: No standards presently

(3) Ground Water Quality Standards

No.	Pollutant	Limit	Unit
1.	pH	6-9	pH
2.	Sludge	300	mg/litre
3.	Oil	15	mg/litre
4.	COD	150	mg/litre
5.	Cyanide	0.2	mg/litre
6.	Arsenic	0.1	mg/litre

(4) Air Quality Standards

No.	Pollutant	Time Limit	Pollutant Content Limit ($\mu g/m^3$)
1.	Sulfur Dioxide (SO_2)	Annual Mean	60
		Daily Mean	125
		Hourly Mean	350
2.	Nitrous Oxide(N_2O)	Annual Mean	80
		Daily Mean	150
		Hourly Mean	400

(5) Sound and Vibration Quality Standards

No.	Place	Noise Level (dB)	
		Day	Night
1.	Home	55	45
2.	Industry	70	70

(6) Ambient Air Quality Standards

No.	Pollutant	Causes	Pollutant Content Limit (mg/m^3)
1.	Sulfur Dioxide(SO_2)	Sulfuric Acid Industry	1000
		Other	550
2.	Nitrous Oxide(N_2O)	Solid	750
		Liquid	460
3.	Particle	Smelting Furnace	100
		Other	250
4.	Acid Particle	Electrolytic Cells	200 $\mu g/m^3$

(7) Waste Water Quality Standards

No.	Pollutant	Limit	Unit
1.	pH	6-9	pH
2.	Sludge	300	mg/litre
3.	Oil	15	mg/litre
4.	COD	150	mg/litre
5.	Arsenic	0.1	mg/litre

(8) Dust Emission Quality Standards

No.	Pollutant	Place	Limit	Unit
1.	Dust	Mine	60-300	$gm/m^2/month$
		Transport		
		Crushing-Grinding		
		Dumping		
		Residential Area		

MANDALAY CITY DEVELOPMENT COMMITTEE (ENVIRONMENTAL QUALITY STANDARDS)

W.H.O Standard referring for Mandalay Water Supply System

No.	Parameter	Units	W.H.O Standards	
			Desirable	Imperative
1.	pH	Scale	7-8.5	6.5-9.2
2.	Colour	Units	5	50
3.	Turbidity	N.T.U	5	25
4.	Conductivity	(micromhos/cm)	-	-
5.	Calcium	mg/l	75	200
6.	Total Hardness as Ca CO_3	mg/l	100	500
7.	Magnesium as Mg	mg/l	30	150
8.	Chloride as CL	mg/l	200	600
9.	Total Alkalinity	mg/l	200	500
10.	Iron as Fe	mg/l	0.1	1.0
11.	Manganese as Mn	mg/l	0.05	0.5
12.	Sulphate as SO_4	mg/l	200	400
13.	Nitrate Nitrogen (NO_3-N)	mg/l	0	50
14.	Arsenic(As^+)	mg/l	-	0.01
15.	Copper (Cu^+)	mg/l	-	2
16.	Cyanide (CN^-)	mg/l	-	0.07
17.	Lead (Pb)	mg/l	-	0.01
18.	Biochemical Oxygen Demand (Effluent)	mg/l	20	20

NAY PYI TAW CITY DEVELOPMENT COMMITTEE (ENVIRONMENTAL QUALITY STANDARDS)

(1) Surface Water Quality Standards

No.	Parameter and Substance	Unit	Limitation Value	
			A	B
1.	pH Value	-	6-8.5	5.5-9
2.	BOD_5(20´C)	mg/l	<4	<25
3.	COD	mg/l	<10	<35
4.	Dissolved Oxygen	mg/l	>6	>2
5.	Suspended Solids	mg/l	<20	<80
6.	Arsenic	mg/l	<0.05	<0.1
7.	Barium	mg/l	<1	<4
8.	Cadimum	mg/l	<0.01	<0.02
9.	Lead	mg/l	<0.05	<0.1
10.	Chromium, Hexavalent	mg/l	<0.05	<0.05
11.	Chromium, Trivalent	mg/l	<0.1	<1
12.	Copper	mg/l	<0.1	<1

No.	Parameter and Substance	Unit	Limitation Value	
			A	B
13.	Zinc	mg/l	<1	<2
14.	Manganese	mg/l	<0.1	<0.8
15.	Nickel	mg/l	<0.1	<1
16.	Iron	mg/l	<1	<2
17.	Mercury	mg/l	<0.001	<0.002
18.	Tin	mg/l	<1	<2
19.	Ammonia	mg/l	<0.05	<1
20.	Fluoride	mg/l	<1	<1.5
21.	Nitrate(as N)	mg/l	<10	<15
22.	Nitrite(as N)	mg/l	<0.01	<0.05
23.	Cyanide	mg/l	<0.01	<0.05
24.	Phenol Compounds	mg/l	<0.001	<0.02
25.	Oil and Grease	mg/l	(not detectable)	<0.3
26.	Detergent	mg/l	<0.5	<0.5
27.	Coliform	MPN/100ml	<5000	<10000
28.	Total Pesticides (except DDT)	mg/l	<0.15	<0.15
29.	DDT	mg/l	<0.01	<0.01
30.	Gross Alpha Activity	βq/l	<0.1	<0.1
31.	Gross Beta Activity	βq/l	<1	<1

(2) Drinking Water and Ground Water Quality Standards

(a) Bacteriological Quality

No.	Type of Water and Source	Faecal Coliform (No/100ml)	Coliform Organism (No/100ml)	Remark
1.	Treated Pipe Water	0	0	
2.	Untreated Pipe Water	0	<10	
3.	Water Distribution	0	<10	
4.	Un-piped Water Supplies	0	<10	
5.	Bottled Drinking Water	0	0	
6.	Emergency Water Supplies	0	<3	

(b) Physical Quality

No.	Particulars	Unit	Limit	Remark
1.	Color	TCU (True Color Unit)	<15	
2.	Taste & Odour	-	-	Acceptable (non-objection)
3.	Turbidity	NTU (Nephelometric Turbidity Unit)	<5	

(c) Chemical (Inorganic) Quality of Health Significance

No.	Particulars	Unit	Limit	Remark
1.	Antimony	mg/l	<0.02	
2.	Arsenic	mg/l	<0.05	<0.01(preferable)
3.	Barium	mg/l	<0.7	
4.	Boron	mg/l	<2.4	
5.	Cadmium	mg/l	<0.003	
6.	Chromium	mg/l	<0.05	
7.	Copper	mg/l	<2	
8.	Cyanide	mg/l	<0.07	
9.	Fluoride	mg/l	<1.5 (untreated)	0.5-1.0 (treated)
10.	Lead	mg/l	<0.01	
11.	Manganese	mg/l	<0.3	
12.	Mercury(Total)	mg/l	<0.001	<0.006(WHO)
13.	Nickel	mg/l	<0.07	<.7(WHO)
14.	Nitrate(as NO_3)	mg/l	<50	Combined less than 1
15.	Nitrate(as NO_3)	mg/l	<3	
16.	Selenium	mg/l	<0.04	<0.04(WHO)
17.	Uranium	mg/l	<0.03	<0.03(WHO)

(d) Chemical (Inorganic) Quality Not of Health Significance

No.	Particulars	Unit	Limit	Remark
1.	Aluminium	mg/l	<0.2	0.1 to 0.2 (WHO)
2.	Ammonia	mg/l	<1.5	1.5 (WHO) NE
3.	Chloride	mg/l	<250	
4.	Copper	mg/l	<2	
5.	Hardness (Total)	mg/l	<500	Mn (500), Ca(100)(WHO)
6.	Hydrogen Sulfide	mg/l	<0.05	
7.	Iron	mg/l	<1	0.3(WHO)
8.	Manganese	mg/l	<0.1	(WHO)
9.	pH	mg/l	6.5-8.5	
10.	Sodium	mg/l	<200	
11.	Sulfate	mg/l	<250	
12.	Total Dissolved Solids	mg/l	<1000	600 (WHO)
13.	Zinc	mg/l	<3	
14.	Calcium	mg/l	<200	
15.	Magnesium	mg/l	<150	

(e) Radioactive Materials Quality

No.	Particulars	Unit	Limit	Remark
1.	Gross Alpha Activity	βq/1	<0.01	
2.	Gross Beta Activity	βq/1	<0.01	

YANGON CITY DEVELOPMENT COMMITTEE (ENVIRONMENTAL QUALITY STANDARDS)

Waste Water Quality Standards

No.	Pollutants	Unit	Limit
1.	pH	pH	6-9
2.	Total Solid	ppm	Up to 2000
3.	Total Suspended Solid	ppm	Up to 500
4.	BOD	ppm	20-60
5.	COD	ppm	<200

Summary on Climate Change
(including estimated costs associated with Climate Change)
TA-8472 MYA: Preparing Mandalay Urban Services Improvement Project

Summary: The results of AWARE were considered in the preparation of the IEE Reports. In this connection, climate change and natural hazards considerations had been incorporated in the IEE. The additional costs that may be attributed to climate change adaptation was estimated at **US$ 6.4 million** for climate change adaptation and **US$ 2 million** for climate change mitigation. **Output of AWARE**: AWARE was used to undertake an initial climate risk screening exercise. The results had rated the project as MEDIUM RISK and haveidentified flooding as a high level risk factor as the project is located in a region which has experienced recurring major flood events in the recent past. The risk and type of flooding is dependent on local geographical factors including: proximity to the inland water –courses; local topography; state of urban drainage infrastructure. However, it should be noted that except for the WWTP itself, none of the project components are located in flood prone areas.

Climate Change and Natural Hazards integrated into the IEE: Climate change and natural hazards considerations have been integrated into the IEEs. Specifically, measures to address potential impacts of climate change and natural hazards (e.g., flooding, earthquake) on the project are recommended for integration into the design/engineering stage as part of the IEE assessment whenever feasible/practical and appropriate. Also, the assessment includes the GHG emissions of various components/activities.

The IEE considered climatic trends at the national, regional and local scale in Myanmar and more specifically Mandalay. The IEE identified risks in relation to water resources particularly in relation to the Pre-monsoon months (May, June) becoming drier, and confirming the later arrival of the monsoon with higher risk of drought during critical period for agricultural production and risk of conflictual water allocation between irrigation water and urban water supply. The rainiest months (August, September) are becoming wetter, confirming at local level the national forecasts of increasing rainfall intensities during the wet period. Similarly, monthly maximum temperature seems to have increased by 1 to 2°C since 1974, thus reinforcing the effect of the modification of rainfall distribution and the pressure on the water resource. These current trends of drought and consequently of water scarcity in the dry zone of Myanmar observed today will most probably be intensified by the global warming also confirmed by the analysis, if the trends identified on these last 40 to 60 years are maintained on the very long term. These analyses indicate the additional need for Mandalay City to use alternative water resources other than groundwater and the moat water from the Mandalay Canal as these will be increasingly impacted by increased irrigation demand.

Project outputs: The proposed projects cover

Output 1: Improved water supply systems will (i) increase water production capacity from 97,000m^3/day to 183,000m^3/day by rehabilitating existing treatment plant and reservoirs, (ii) construct 19km of main transmission lines and 116km of distribution systems, (iii) rehabilitate 18km of existing network, and (iv) replace 20,000 connections including meters.
Output 2: Improved wastewater and drainage management will (i) construct 27km of sewerage networks, (ii) construct 26km of interceptor networks and a pumping station at Thingazar Creek, (iii) construct a wastewater treatment plant with a capacity of 75,000m^3/day, (iv) pilot wastewater connections in densely populated city center, (v) provide 10 septage collection vehicles, (vi) dredge 60km of main canals, and (vii) increase stormwater pumping capacity from 21,900m^3/hour to 65,100m^3/hour.

Output 3: Strengthened urban services management capacity will comprise (i) project implementation support in terms of detailed engineering designs, procurement, construction supervision, disbursement, financial management, social and environmental safeguards, and operation and maintenance; (ii) training of MRG and MCDC staff on municipal financing, non-revenue water reduction, cost recovery, and corporatization of water and wastewater operations; (iii) development of climate resilient urban spatial plan and infrastructure development plans; (iv) pilot community-based solid waste management; and (v) awareness programs on public health and environmental protection.

Climate change adaptation features in the engineering design: climate change has been specifically included in the design of the wastewater and drainage networks in terms of the adaptation of rainfall statistics. Rainfall design data for urban drainage systems was last analysed on a national basis in 1983 with the publication of the "Regional Rainfall Depth Duration Frequency Relationships in Burma". These analysis were updated for Mandalay using most recent data. Observations of the daily rainfall series over the last 60 years shows that 4 of the largest 10 rainfall events have occurred over the last 10 years, including the largest measured event. These observations suggest that there has been a change in the rainfall series most notably over the last 15 years. While the observations are insufficient to determine statistically robust curves, it was concluded that a precautionary approach would be advisable and consequently rainfall depths were increased by 25% with respect to those derived from the previous series.

Urban planning measures that incorporate climate change adaptation features: Using the DHSHD Concept Plan as a basis, the PPTA Consultant has made an assessment of land suitability and future availability to determine likely population carrying capacities of areas as well as projected land uses and thus the expected level/type of service provision over time. A specific tool has been developed as part of the PPTA assignment to take into account constraints and opportunities to develop, incorporating notably climate change adaptation, natural disasters and catastrophes (flooding and earthquakes) into a revision of the concept plan. The revised plan is proposed to form the basis of the new urban plan to be developed through the project, leading to an overall urban zoning plan for the city of Mandalay. A key feature of this revised plan is the limiting of development of the city into the agricultural area to the east of the main city with development of two areas to the south and north of the existing city area. Restricting the urban sprawl in this manner and the densification of the existing city footprint is a key climate change mitigation measure; additionally, these areas serve as flood plains during excess rainfall from the Shan Plateau thereby protecting the city from additional flooding.

Cost attributions: Additional costs that may be attributed to climate change adaptation are estimated at **$ 6.4 representing a little over 10 % of the ADB financing for the project**. Additional costs associated with climate change mitigation were estimated at $ 2 Million, around 3.3% of the ADB financing.

Additional costs for infrastructure arise from the need to consider the increased flood risk in relation to the design of drainage facilities and in the need to consider raising base levels of plant facilities. In the former case these concern specifically the design of pumping capacities and the sizing of interceptors. In the latter case this involves the raising of the platform of the proposed wastewater treatment plant above the flood levels of the outlet Shwetachaung canal. These costs have been estimated at 5 million USD in terms of investment and design costs; during preparation the revision of the rainfall statistics was estimated to cost $ 35,000.

Associated with these measures the project has introduced monitoring and simulation of the urban drainage system during the PPTA. This will be continued throughout the life of the project and beyond and enable MCDC to monitor rainfall and flood events, to predict different response strategies and better plan future interventions and to better control features such as pumping stations and flood control gates. These costs are estimated at 0.8 million for continued monitoring investments; the initial investments including installation of rain gauges and level monitors, monitoring and modeling studies is estimated at $ 84,000. For the Urban Planning Study as part of the ADB supported capacity building exercise $ 0.5 million is estimated to support further climate change adaptation analysis including the development of a Sustainable Urban Drainage System pilot.

The project will also provide for a sustainable sludge solution including both energy and material reuse. The full cost of this subcomponent estimated at approximately $2 million is considered to be part of the climate change mitigation features of the project.