## 2.5 Phase-in Construction Plan for Proposed Project

The proposed project should be constructed in the following two phases as the water demand increases in future. Proposed phase-in program of the proposed project is shown in Fig. 2.5.1

**Phase I**: Expansion of Exiting Water Supply Facilities Project

2004 to 2005: Urgent project (Groundwater development & existing facilities improvement)

2005: Expansion of the existing distribution pipeline network supplied by BPS1

**Phase II:** Surface Water System Development Project

1st Step: 2006 to 2008; Intake Facilities & Treatment Plant (WTP 100,000m$^3$/day capacity)

2nd Step: 2009 to 2010: Intake Facilities & Treatment Plant (WTP 50,000m$^3$/day capacity)

3rd Step: 2014 to 2015: Intake Facilities & Treatment Plant (WTP 50,000m$^3$/day capacity)

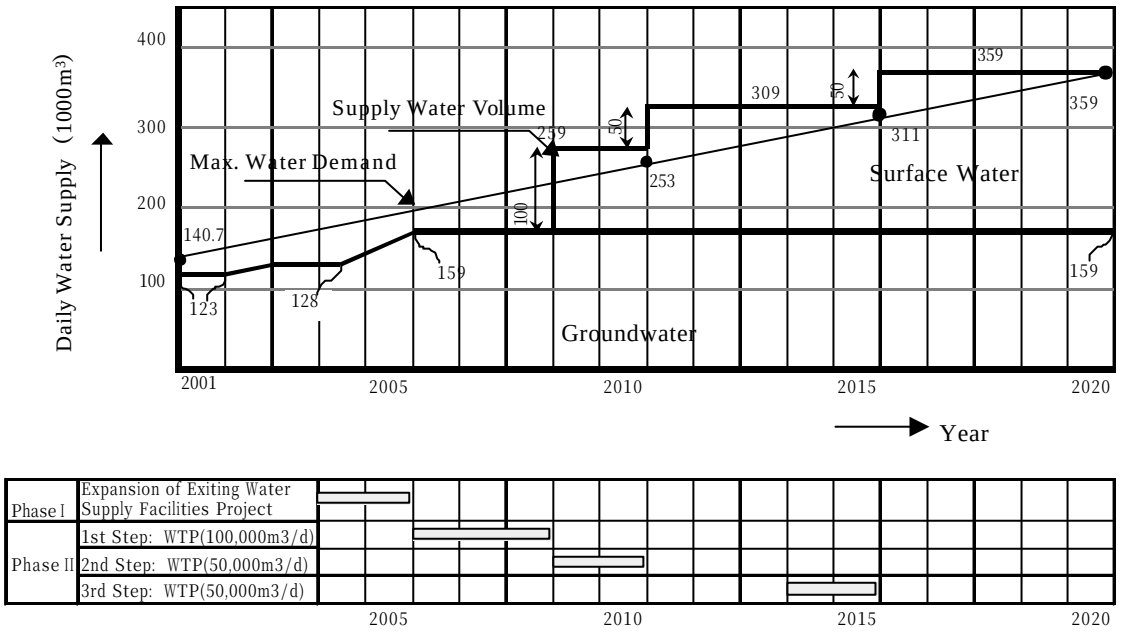



**Fig. 2.5.1 Phase-in Construction Plan for Proposed Project**

## 2.6 Master Plan of Water Supply System

The present water supply system serves to Mandalay City about 109,000 m$^3$/day from the production wells situated along the Ayeyarwaddy River. MCDC has recognition that a new water intake and treatment system by using surface water is indispensable for catering the future water demand increasing steeply. The Study Team also confirmed the necessity of a new surface water system considering the limitation of groundwater potential. The Study

Team considers that it is very advantageous for MCDC to enhance groundwater development as much as possible, because there should be some difficulties for MCDC to finance the construction cost, reform administrative system, and acquire a new technology for operation and maintenance of the new system. Accordingly, the study proposes the following facilities for future water supply system of Mandalay City to rehabilitate the existing facilities for improving of water service in the present water service area and to introduce a new water treatment system of surface water for enhancement and expansion of water coverage and service population. The design criteria of Master Plan are as follows:

* Design Criteria of Master Plan in the final target year 2020

| | |
|---|---|
| Total Population in Mandalay City: | 1,098,800 persons |
| Water Served population: | 988,900 persons |
| Domestic Water Consumption per capita per day: | 180 lpcd |
| Water consumption for other purpose: | 36 lpcd |
| Effective Water Ratio: | 70 % |
| Average Daily Water Supply Volume | 305,000 $m^3$/day |
| a) Groundwater system after improvement: | 135,000 $m^3$/day |
| (Including a water volume of 22,500 $m^3$/day to be increased by Urgent Project) | |
| b) Proposed system of Ayeyarwaddy River water: | 170,000 $m^3$/day |
| Maximum Daily Water Supply Volume: | 359,000 $m^3$/day |
| a) Groundwater system after improvement: | 159,000 $m^3$/day |
| b) Proposed system of Ayeyarwaddy River water: | 200,000 $m^3$/day |
| Peak Hourly Water Supply Volume: | 22,437 $m^3$/hr |
| a) Groundwater system after improvement: | 9,937 $m^3$/hr |
| b) Proposed system of Ayeyarwaddy River water: | 12,500 $m^3$/hr |

(1) Proposed Project Components

Considering the above conditions, the following projects were proposed in Master Plan. These proposed facilities are shown in Fig. 2.6.1 and Fig. 2.6.2.

1) Phase I: Expansion of Exiting Water Supply Facilities Project

In Phase I, the objective is to absorb the present problems of water supply, such as deterioration and damage of the facilities and lack of water supply volume to the city by expansion and rehabilitation of the existing facilities. The groundwater will be newly developed as the water source of the project based on the result of groundwater potential analysis. The proposed project consists of three main components as mentioned below.

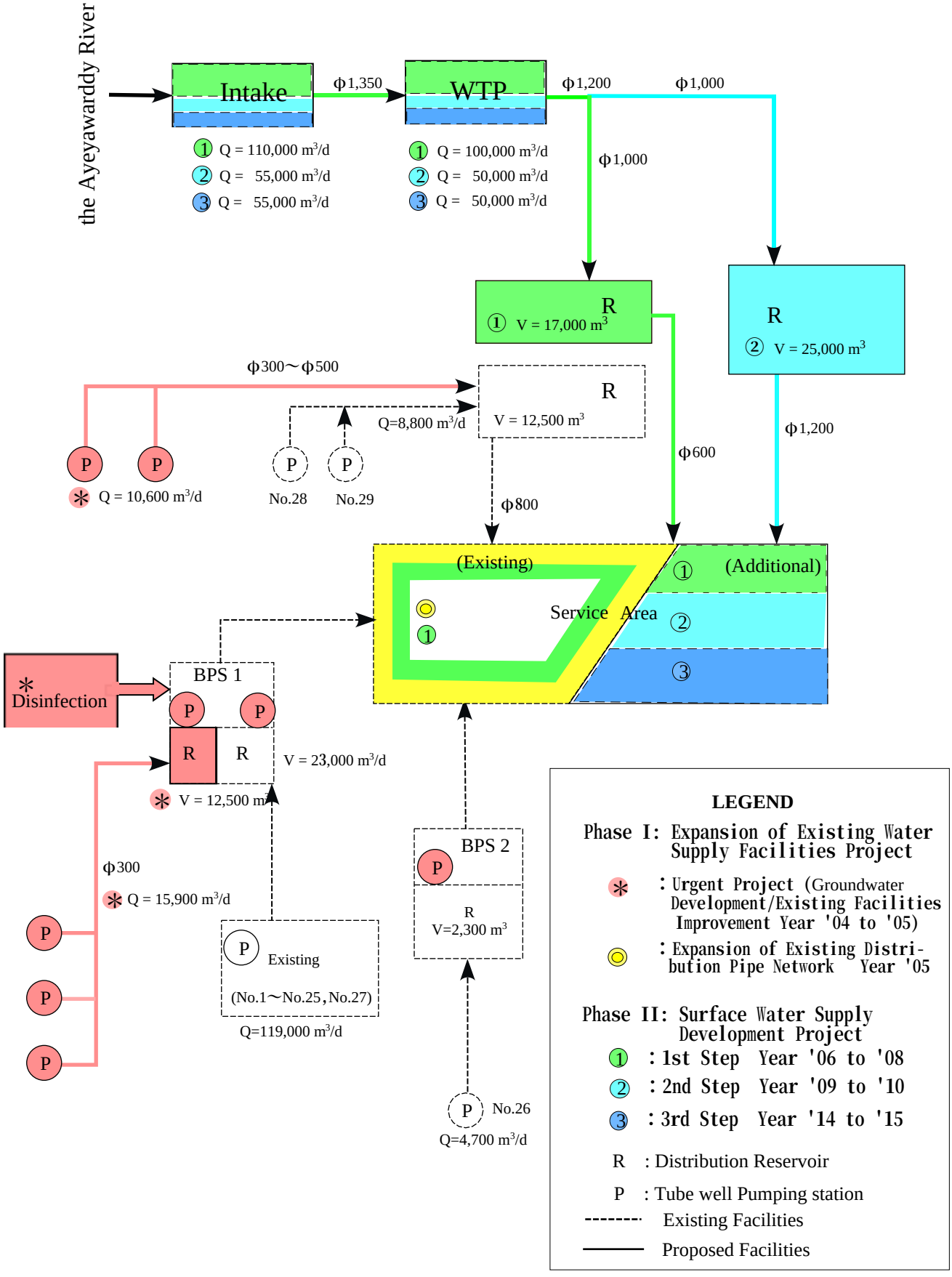



**Fig. 2.6.1 Summary of Proposed Water Supply System**

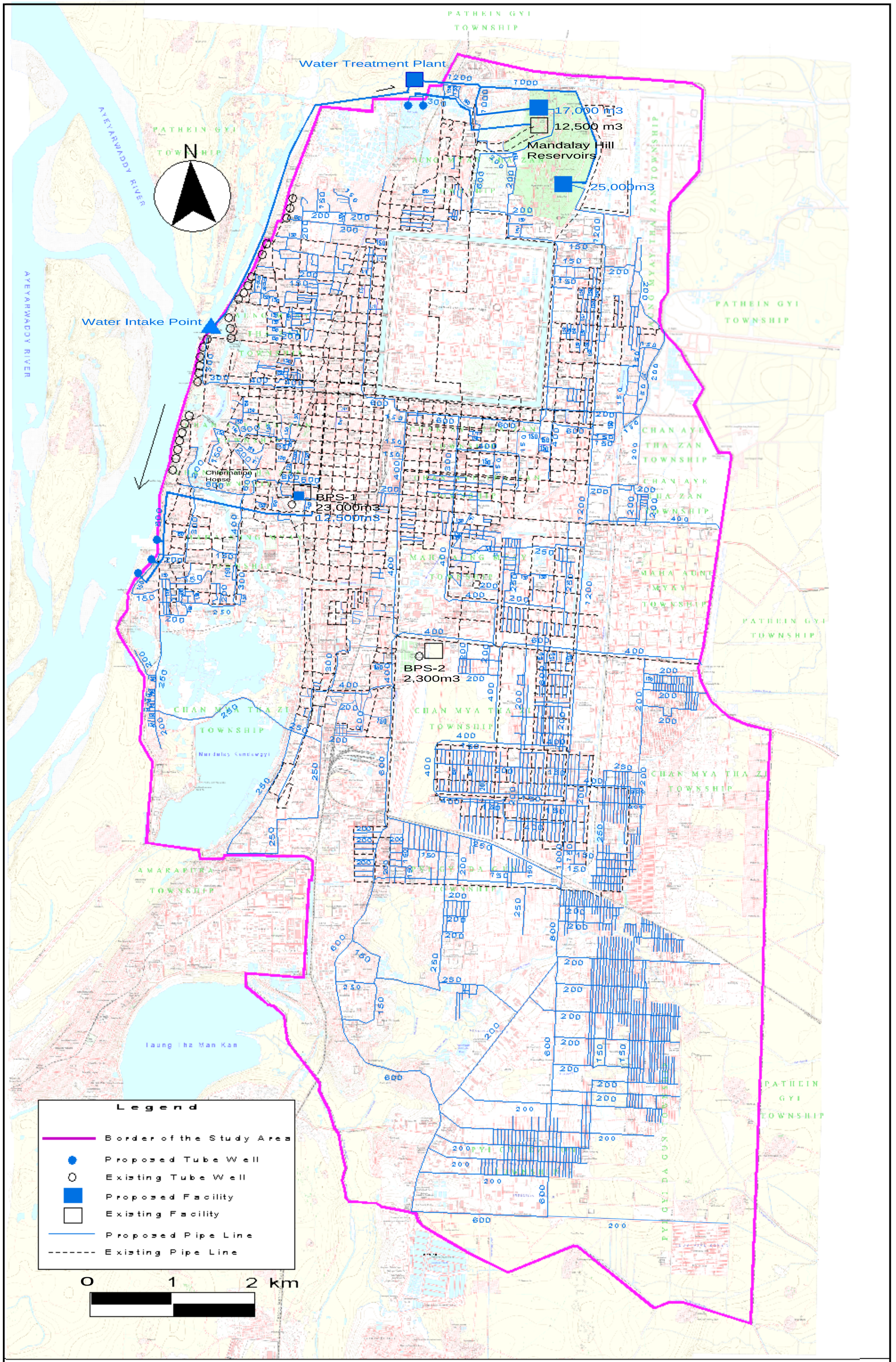



Fig. 2.6.2 Proposed Water Supply System in Mandalay City

Among them, a) Groundwater development, and b) Improvement of the existing facilities are recommended to be implemented as Urgent Project because a high effect of improvement of water service on quantity, pressure, and quality can be expected by a comparatively small investment. The components of the Phase I project are as follows:

i) Urgent Project

a) Proposed Groundwater Development Project

Based on the results of hydrogeological analysis, five new tube wells will be drilled along the Ayeyarwaddy River. The additional water volume to be produced is estimated at 22,500 $m^3$/day on a daily average basis. Two wells shall be located in the north of the present well field and three wells in the south of the same. New water conveyance pipelines shall be installed from both the new north tube wells and the south tube wells. The north pipeline will be laid to the existing Mandalay hill ground reservoir, because north wells are located near the hill. On the other hand, the south line will be laid to BPS1 due to its near location to BPS1. The proposed facilities are as follows:

* Well materials for: 300 mm diameter, 150 m deep – 5 sets

* Submersible motor pumps:
  In the north area, 200 mm diameter x 75 l/s x 110 kW – 2 sets
  In the south area, 200 mm diameter x 75 l/s x 90 kW – 3 sets

* Water conveyance pipe: 300 to 500 mm diameter, DIP mortar lining L= 6,140 m

b) Improving the existing facilities

* Installation of booster pumps in BPS1: 400 mm x 30 $m^3$/min x 45m –2 sets
(The pumps will be set in the supplemental space in the existing pump house)
* Replacement of a booster pump in BPS2: 200 mm x 7.5 $m^3$/min x 50m –1 set
(The existing one is deteriorated and leaking water)
* Construction of a ground reservoir in BPS1: Capacity 12,500$m^3$ – 1 pc.
(The reservoir will be constructed next to the existing one)
* Installation of disinfection facilities in BPS1: (calcium hypochlorite) - 1 set
The existing chlorination facilities had not been used due to damages caused by a gas leakage accident in 1994. The vicinities of the facilities have been urbanized and surrounded by many private houses. Since chlorination system is considered to

be very danger in case of leakage accident in urbanized area, a calcium hypochlorite injection system is proposed because of its safety. MCDC needs such facilities against intrusion of polluted groundwater into distribution pipes under a negative inside pressure of pipe happens sometimes by suspension of water supply and also against emergency occasion like spreading of water born disease.

* Electromagnetic Water Flow meters with related pipelines –2 sets.

Since there is no water meter in the existing booster pumping station, the distributed water volume cannot be recorded in the system. The water volume is a basic factor for managing the system. And the data are also indispensable for water demand projection, non-revenue water control, water leakage prevention, various problems analyses on the system, etc. Therefore two sets of electromagnetic flow meters shall be installed on the two main distribution pipelines from BPS1. And a part of main pipe shall be installed near BPS1 to distribute water more smoothly on the occasion of the above improvements of the existing facilities.

c) Implementation Plan

Since 1989 MCDC has constructed more than 30 numbers of tube wells by using a drilling rig donated from Australia. Therefore the proposed five new tube wells can be constructed by MCDC, if materials of well casing & screen and adequate drilling tools and accessories for the MCDC-owned drilling rig would be procured. MCDC can also manage pipe-laying works of the proposed water conveyance pipeline if materials are procured. On the other hand, construction of ground reservoir needs an involvement of a capable constructing firm due to its big scale of the structure. There is no adequate technological know-how to construct and operation of the disinfection facilities in MCDC. Specialized expertise is indispensable to install the booster pumps within a required accuracy. Therefore, it is recommended that a capable contractor shall be involved in the above construction under the supervision of a reliable consultant except the works for tube wells and water conveyance pipeline. Thus the project is recommended to be implemented in combination with two types of project categorized in a type of equipment and material procurement and in a type of facilities construction. In the type of equipment and material procurement, MCDC shall construct the facilities by itself with equipment and materials to be procured.

d) Expected Benefit of the Project

By completion of the proposed Urgent Project, the water supply volume will be increase

from 109,000 $m^3$/day at present to 135,000 $m^3$/day and this increased water volume is equivalent to the water demand for about 110,000 consumers. The project is also expected to provide better services in the areas where people have difficulties of water distribution volume, pressure, and quality. These improvements will provide better hygienic circumstances to the citizens especially low-income citizens live in the peripheral of the water service area.

ii) Expansion of the existing distribution pipeline network supplied by BPS1

After completion of the overall proposed project, 80 % of the city area will be covered by surface water source and remaining 20 % will be covered by the groundwater source to be distributed through the BPS1. By the above Urgent Project, the water supply volume to the city will be increased. And to distribute water smoothly to the city, it is efficient that the BPS1's water service area will be reinforced by expansion of the existing water distribution network. The proposed area for the pipeline expansion covers about 2,200 ha. The proposed pipeline to be laid is 50,980 m long and a range of the pipe diameter is from100 mm to 600 mm.

2) Phase II: Surface Water System Development Project

The result of the groundwater potential analysis suggested limitation of its potential in Mandalay City. Therefore a full-scaled of surface water supply system is clearly recommended to be introduced for the future development of Mandalay City. The designed treated water volume is proposed at 200,000 $m^3$/day to meet the water demand in year 2020. Taking a 10 % water losses during the process of treatment into consideration, the designed intake water volume is estimated at 220,000 $m^3$/day.

The following facilities will be constructed by phase-in program in accordance with the increase of the water demand of Mandalay City.

i) Outline of Proposed Facilities

Proposed facilities are designed in accordance with conditions of nature and topography, operation and maintenance work, the phase-in program of their construction, etc. Drawings of the main facilities are shown in Fig. 2.6.3, 2.6.4 and 2.6.5.

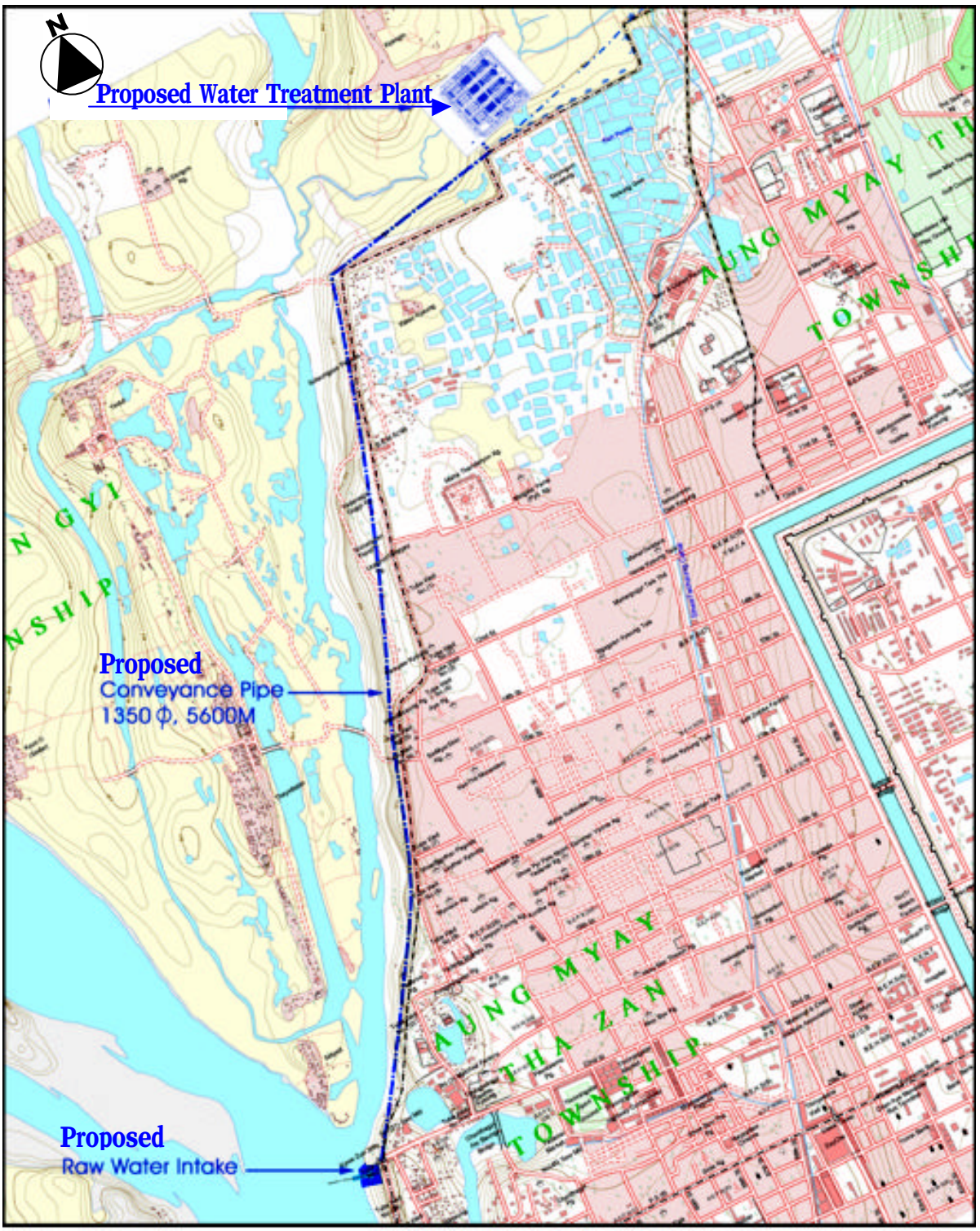
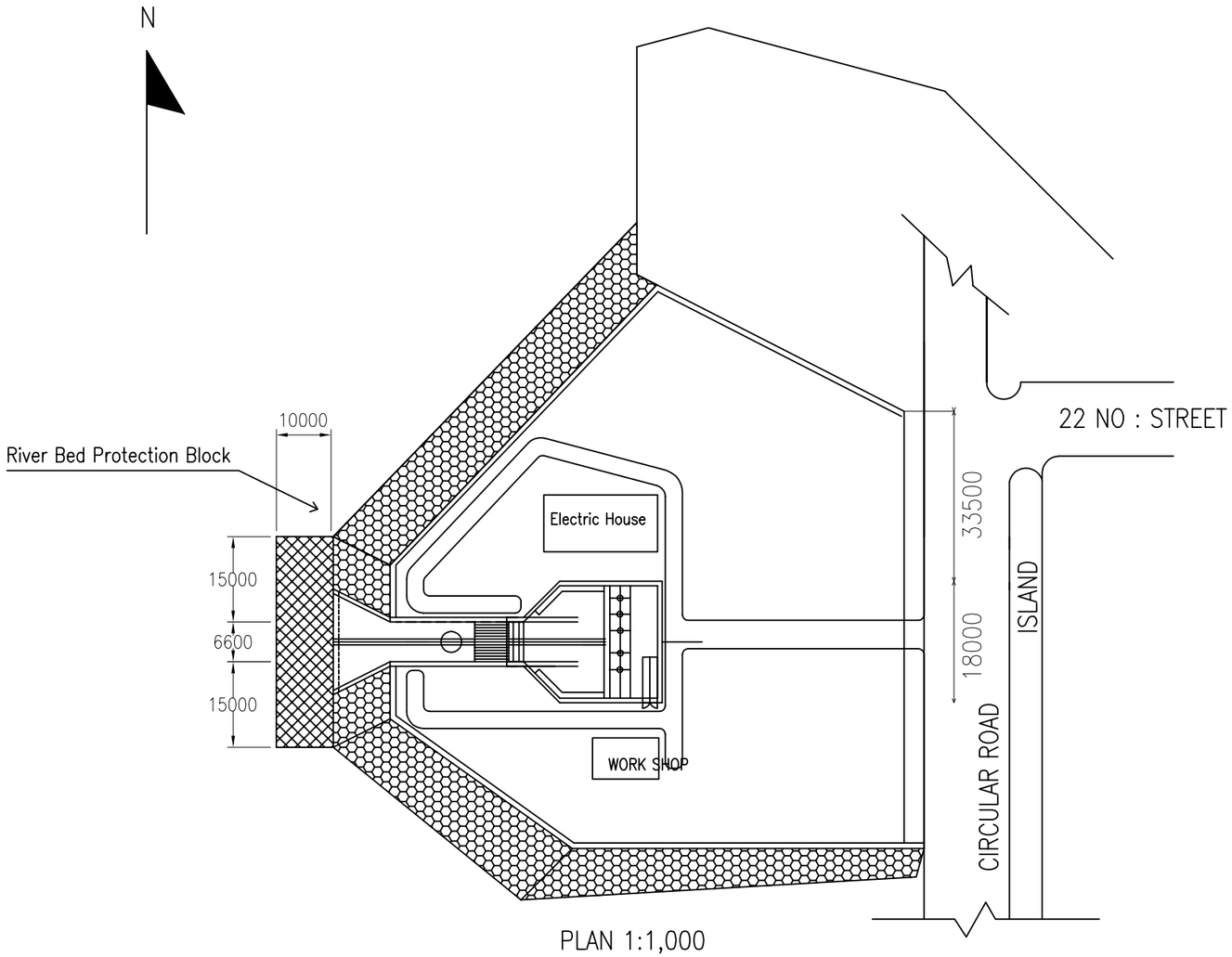
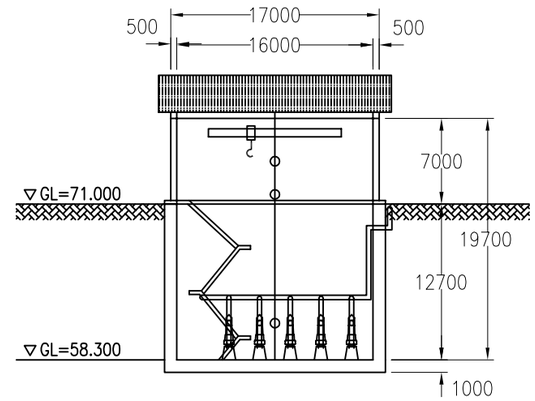


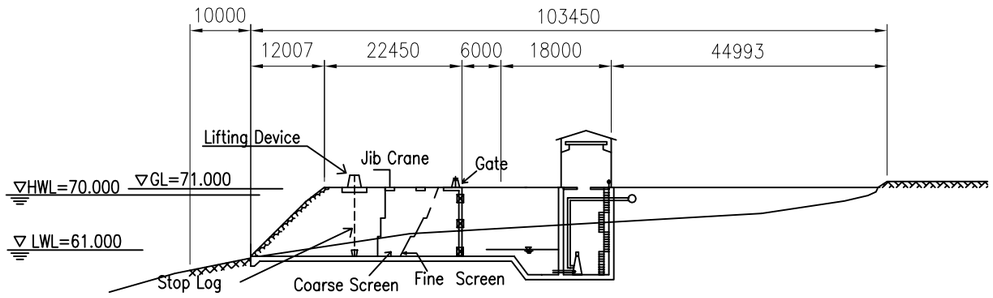

**Fig. 2.6.3 Proposed Raw Water Conveyance Plan**



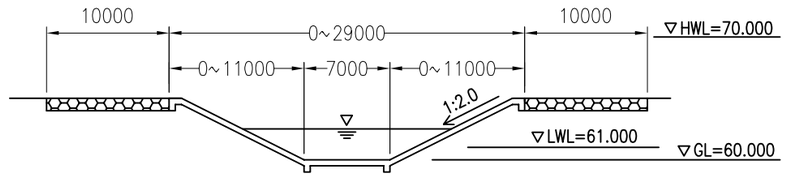

PLAN 1:1,000




SECTION B–B 1:500




PROFILE 1:1,000




SECTION A–A 1:500

unit : mm

0 m 25 m 50 m

Fig.2.6.4 Raw Water Intake Facility in Mandalay City

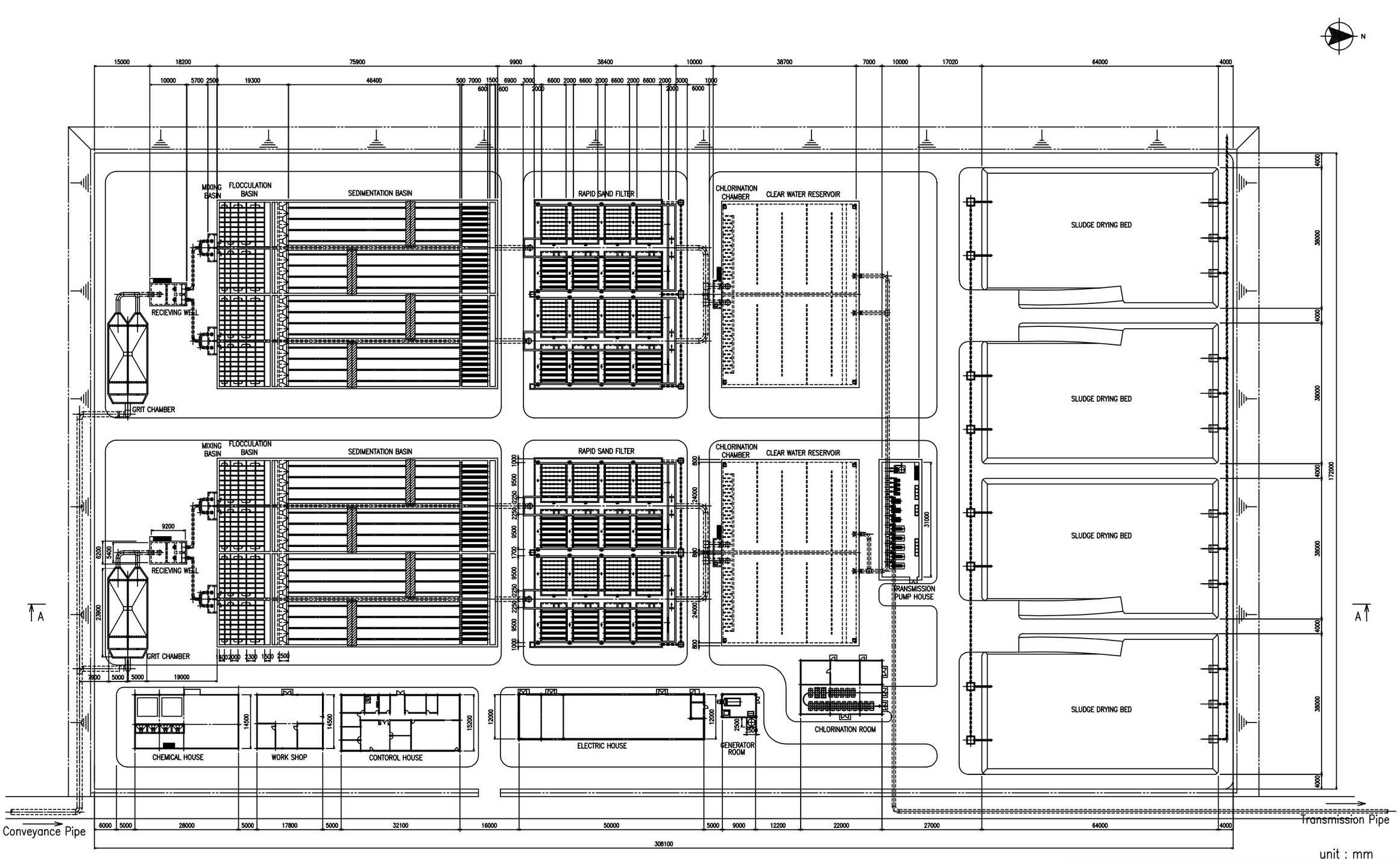



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Fig.2.6.5 Layout of Water Treatment Plant In Mandalay City

- Intake Facilities

Alternative 1 was selected as the water intake site from the following three alternatives by a careful comparative analysis from the advantageous points of views, such water quality, river flow volume, distance from the city, geographical feature for the facilities construction, swift appearance of the benefit by improving of water distribution pipeline, and easiness of combination with the existing facilities such as Mandalay hill reservoir and BPS1, etc.

Alternative 1: on the Ayeyarwaddy River left bank near the west end of 22nd street
Alternative 2: on the Ayeyarwaddy River left bank near the west end of 41st street
Alternative 3: on the Dotehtawaddy River right bank

Intake Gate type was evaluated as the most reliable structure of the intake considering river and topographic conditions at the selected location. The intake pumping equipment is planned to install depending on the phase-in program: three sets in the 1st step, one set each in the 2nd and the 3rd steps, totally five sets (one standby) as the full line-up. The land for the facilities will be reclaimed in the foreland of the river adjacent to the left bank.

- Water Conveyance Pipeline

A water conveyance pipeline is designed to send 220,000 $m^3$/day of raw water, the planned intake volume in 2020, from the intake to the treatment plant. The pipeline is proposed to lay under the circular road for 5.6 km distance between the Intake and the WTP. The pipe is specified to have a 1,350 mm diameter and the material of ductile cast iron. At least two sets of air valves and drain valves are proposed to install along the pipeline for its maintenance.

- Water Treatment Plant (WTP)

A unit of Coagulation & Sedimentation + Rapid Sand Filter is proposed to introduce to the water treatment plant (WTP) in order to purify Ayeyarwaddy water whose turbidity fluctuates widely and seasonally. The proposed location of the WTP is about two km distant west of Mandalay Hill and the area for the plant is designed to reclaim in the foreland of the river. The design criteria and outline of the proposed WTP are as follows.

**Table 2.6.1 Outline of Proposed Facilities**

| Facilities | Criteria | Unit | Capacity | Reference |
|---|---|---|---|---|
| Raw water Intake | | | | |
| Entering basin | Structure Dimension | m | Width3.0m -2 | |
| | Effective depth at river L.W.L | m | 1.0 | |
| Pump room | Installed pump | set | 4 + 1 (stand by) | |
| Generator for emergency | For one pump operation Cap. | Set | 1 | |
| Buildings | Control house, Electric house, Workshop | Set | 1 each | |
| River protection | Masonry | Lot | 1 | |
| Water Conveyance Pipeline | 1350mm Diameter | m | 5,600 | |
| Grit Chamber | Over flow rate | mm/min | 350 | |
| | Structural Dimension | m | 20.0x5m | (20 / 5) |
| | basin | Pc. | 4 | |
| | Diameter of grains of sand to be removed | mm | 0.1 | |
| Receiving /Distribution well | Detention period | min | 1.5 | |
| | Basin | Pc. | 1 | |
| Mixing Chamber | Circumference Speed | m/sec | 1.5 | |
| | Detention period | m | 4.0 | |
| | Basin | Pc. | 1 | |
| Flocculation Basin | System | | Vertical Flow | |
| | Detention period | min | 30.0 | |
| | Basin | Pc. | 8 | |
| Sedimentation Basin | Overflow rate | mm/min | 30.0 | |
| | Flow velocity | m/min | 0.4 | |
| | Dimension | | 54mLx12mWx4.8mD | |
| | Basin | Pc. | 8 | |
| | Water collecting rate at trough | $m^3$/m/day | 500 | |
| Rapid Sand Filter | Filtration rate | m/day | 120.0 | |
| | Basin | Pc. | 32 | |
| | Dimension | $m^2$ | 57.42 (8.7mLx6.6mW) | |
| | Depth of sand filter | cm | 60.0 | |
| | Backwashing system | | Surface＋Self Backwashing | |
| Clear Water Reservoir | Detention period | hr | 2.0 | |
| | Basin | Pc. | 4 | |
| Chemical | Coagulant Alum, $Al_2(So_4)_3$ | % | 10.0 | |
| | Middle, Post chlorination Dosing rate | mg/l | 2.5 | |
| Sludge Drying Bed | Mud amount disposed | $m^3$/day/basin | 590.0 | |
| | Sludge Load rate | kg/ $m^3$/year | 500.0 | |