ECONOMIC ANALYSIS

A. Introduction

1. This economic analysis aims to assess the economic viability of the project through standard cost–benefit analyses. The analysis was undertaken separately for each of the two outputs relating to urban infrastructure rehabilitation and development: (i) improved water supply systems, and (ii) improved wastewater and drainage management.[1] No economic analysis was undertaken for the third output (strengthened urban services management capacity), which generates no quantifiable economic benefits although the economic costs of this output are included in the overall project economic assessment. This document summarizes the results for the outputs and overall project. More detailed information is presented in the feasibility study report.

B. Demand Analysis

2. The demand for improved water supply services is evident from the analysis of existing services undertaken as part of the feasibility study, which assessed the incremental supply needed to provide a reliable water supply to the increasing population of Mandalay city. The improved service will need to ensure increased reliability of the water supply to existing users, and expansion of the system to increase the coverage of existing potential users as well as new potential users resulting from the expected increase in the city's population. Modeling of water supply undertaken during project preparation indicated that total demand for water will increase from about 143,000 cubic meters (m^3) per day in 2015 to about 313,400m^3/day in 2040, while supply will increase from 56,200 m^3/day to 272,700 m^3/day over the same period, resulting in an increase in service provision from 43% to 87%. The population living in the service area is expected to increase from 1.0 million to 2.3 million over the same period.

3. The demand for improved wastewater and drainage management systems is closely linked to the provision of improved water supply services, particularly given the poor level of the current services provided. A flow survey conducted during project preparation indicated that the major focus areas are the catchments associated with the northern and central parts of Mandalay where internal toilets and septic tanks are the major form of sanitation. This would justify prioritization of collection and treatment of wastewater flows from Shwe Ta Chaung Canal, Thin GaZar Creek, Mingalar Canal, and Ngwe Ta Chaung Canal. Attention is also required to protect groundwater sources from pollution by wastewater.

4. The demand for improved water supply and wastewater and drainage services is further reinforced by the estimated incremental willingness to pay for improved services as determined in a contingent valuation survey undertaken for all urban areas of Mandalay city.

C. Economic Rationale

5. Mandalay city's water supply is largely from groundwater and is met partially via the Mandalay City Development Committee's centralized piped water supply system. Presently, piped water supply is being provided only in four townships, and supply is available only during particular times of the day in the different townships and is significantly less than the continuous supply available in certain supply zones. The system was mainly constructed during 1983–1992

[1] Including the pilot subproject for solid waste management, which is part of improved wastewater and flood management.

under the Mandalay Water Supply Project, cofinanced by the Asian Development Bank (ADB), Organization of the Petroleum Exporting Countries (OPEC), and Myanmar Economic Bank. The water source for the piped water supply system is groundwater mainly drawn from tube well pumping stations along the banks of the Ayeyarwaddy River. The system is characterized by poor quality supply, high levels of non-revenue water (NRW), and extremely low charges for the service. Updating to a modern, efficient system is a critical part of urban development as the country develops.

6. Wastewater services are at an early stage of development. Despite the high density of population and the extensive use of groundwater for water supply, there is no piped sewerage system or centralized wastewater treatment plant. Sanitation coverage is provided by a series of predominantly onsite systems with a limited septic tank cleansing service. Environmental impacts are consequently high with pollution of watercourses and groundwater. As with water supply, there is an urgent need to establish a modern system in parallel with planned urban development.

7. Without attention to these two key areas, economic development of Mandalay city will be severely affected and the urban community will continue to suffer from water-related diseases and the poor environment. The proposed project will provide initial progress in resolving these problems.

D. Least Cost Analysis

8. Least cost analysis was conducted, in particular with respect to the layout of the wastewater system, selection of an appropriate site for the proposed wastewater treatment plant, and the design of the plant. On the basis of technical considerations, three potential sites were selected for further study from eight locations initially identified. Options for the wastewater system layout were then compared on the basis of (i) decentralized treatment plants, (ii) partially centralized treatment plants with a further option of activated sludge treatment or enhanced primary treatment, and (iii) a centralized treatment plant with a further option of activated sludge treatment or enhanced primary treatment. The conclusion from the analysis was that one location with activated sludge treatment or enhanced primary treatment should be further analyzed. The first stage of wastewater treatment should be enhanced primary treatment, with future extensions and enhancement using secondary treatment and, eventually, tertiary treatment. These options identified during project preparation represent a significant cost saving compared to previous proposals.

9. The urban drainage component was developed using a hierarchical procedure from nonstructural to structural measures ensuring that for a given level of protection the least cost option is developed. The project identified and compared two phases of upgrading the urban drainage system with the first phase concentrating on monitoring, piloting sustainable urban drainage systems, improving operations and maintenance, and increasing pumping capacity.

10. In conjunction with the water demand analysis, three demand scenarios were considered: (i) business as usual (considering the same water consumption figures as currently observed), (ii) business as usual with NRW control, and (iii) a demand management approach with NRW control. Clearly the third option represented the least cost option, with a halving of the long-term production capacities between options (i) and (iii). A consideration of different competing resources indicated that the use of surface water resources from the Ayeyarwaddy River involving the rehabilitation and extension of the existing water treatment plant was the least cost option.

E. Major Assumptions and Methodology

11. The economic analysis has been conducted using ADB's guidelines.[2] The major assumptions of the analysis are as follows:

(i) project investments will be undertaken over a 7-year implementation period starting in late 2015;
(ii) the project life will be 32 years including the 7-year implementation period;
(iii) financial costs are based on prevailing prices in late 2014, are expressed in constant 2014 terms, and are the same as those used in the financial analysis;
(iv) economic costs and benefits are valued in kyats using the domestic price level numeraire;
(v) an exchange rate of MK1,200 = $1 is used for all currency conversions;
(vi) economic costs and benefits for traded goods are derived by excluding taxes and duties[3] and then adjusting their values by the shadow exchange rate factor, estimated at 1.026;
(vii) for nontraded goods (domestic resources), economic values are the same as financial values after excluding taxes and duties;
(viii) skilled labor is adjusted to its economic value using an opportunity cost of scarce labor of 1.0 and unskilled labor is adjusted to its economic value using an opportunity cost of surplus labor of 0.9;[4]
(ix) the economic value of land acquired, as a part of land acquisition and resettlement costs, is based for agricultural land on the economic value of crops currently produced, for urban land on the economic value of current activities, and for nonproductive flooded land it is zero; and
(x) the economic opportunity cost of capital is assumed to be 12%.

F. Economic Evaluation

1. Costs and Benefits

12. **Investment costs.** Project investment costs were estimated based on the subproject designs and agreed package costs. Investment costs were aggregated to the output level by year using a Microsoft Excel-based program and economic costs were derived using the same program. The economic project cost, including physical contingencies, for the improved water supply system output was estimated at MK45.1 billion, the improved wastewater and drainage management output at MK54.4 billion, and strengthened urban services management capacity at MK14.4 billion, yielding an overall project economic cost of MK113.86 billion. Land acquisition and resettlement costs are estimated at MK1.54 billion, of which land acquisition for the proposed wastewater treatment plant accounts for MK1.08 billion, and this land comprises 3.49 hectares (ha) of cultivable land and 1.77 ha of permanently flooded land. The economic value of the land acquisition costs is estimated based on the economic value of the crops produced on the cultivable land, which were reported by the resettlement survey as 48% groundnuts, 40% corn, and a small area of watermelons and other crops for home consumption.

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[2] ADB. 1997. *Guidelines for the Economic Analysis of Projects.* Manila; ADB. 1998. *Guidelines for the Economic Analysis of Water Supply Projects.* Manila; ADB. 2013. *Cost–Benefit Analysis for Development: A Practical Guide.* Manila.

[3] As a result of problems experienced with determining details of taxes and duties, they were set at the same rates as used in the recent ADB Maubin–Phyapon Road Rehabilitation Project. As with that project, no local taxes were identified.

[4] Data were collected during the contingent valuation surveys to assess the extent of under- and unemployment of unskilled workers in Mandalay. The results suggest that an opportunity cost of surplus labor of 0.9 is appropriate.

13. **Operation and maintenance costs.** Incremental operation and maintenance (O&M) costs were specified based on their feasibility-level designs and were separated into skilled and unskilled labor, electricity, chemicals, maintenance, and administration. Financial O&M costs are the same as used in the financial analysis and are converted to their economic values using appropriate conversion factors.

14. **Benefits.** Since most of the benefits provided by the project investments cannot be valued within traditional markets, project benefits are estimated in terms of willingness to pay (WTP) using a contingent valuation survey approach. A contingent valuation survey was used for assessing beneficiaries' WTP for the improved water supply and wastewater and drainage sector services to be provided under the project.[5] The WTP questions covered improvements to the water supply system, improvements to septage services, and improvements to wastewater and drainage systems. Estimated average incremental WTP was estimated at MK50,820/household/year for improved water supply, MK39,000/cleaning for improved septage services, and MK48,360/household for improved wastewater and drainage services. Since these values excluded any taxes and duties and were considered as nontradable items, the economic value was assumed to be the financial value. WTP related to water supply and wastewater was scaled by the estimated number of benefitting households, while that for new connections was scaled by the estimated number of connections that would be provided under the project and for improved septage services by the number of user households. Allowance was made for the projected increases in household numbers. Health and environmental benefits from lower pollution are considered to be captured by the WTP estimates, and estimation of these benefits in terms of improved health and environment would be difficult to estimate and would amount to double counting.

2. Economic Analysis Results

15. The base analysis indicates that both the improved water supply systems output and the improved wastewater and drainage management output are economically viable, with an economic internal rate of return (EIRR) of 20.2% and an economic net present value (ENPV) of MK38.4 billion for the first output (Table 1 in Supplementary Document for Economic Analysis) and an EIRR of 23.4% and an ENPV of MK48.1 billion for the second output (Table 2 in Supplementary Document for Economic Analysis). Combining the two outputs and including the economic costs of project management provides an assessment of the economic viability of the overall project. The EIRR of the overall project is estimated at 19.9% and the ENPV at MK76.8 billion (table below).

3. Sensitivity Analysis

16. Sensitivity analyses were conducted for each of the outputs as well as the overall project. Switching values and sensitivity indexes were estimated for the cost increase and benefit decrease analyses. The results indicate that both outputs and the overall project are robust even under the most extreme conditions The overall project would remain economically viable with a 10% cost increase (EIRR of 18.7%) or a 10% benefit decrease (EIRR of 18.2%). Switching values for these two scenarios are 99% with a 10% cost increase and 41% for a 10% benefit decrease. A 10% cost increase combined with a 10% benefit decrease would result in an EIRR of 17.0%, and a 1-year lag in benefits would reduce the EIRR to 17.3%.

[5] The improved services are predominantly incremental services since the limited amount of water currently supplied is of acceptable quality and the other services, particularly wastewater management, are extremely deficient.

4. Benefit Distribution and Poverty Impact Analysis

17. A benefit distribution analysis was undertaken in accordance with the methodology outlined in the ADB Guidelines for the Economic Analysis of Projects (footnote 2) to measure the share of project benefits and costs accrued by the poor. Project costs and quantifiable benefits form the basis for the benefit distribution. The poverty incidences used for the analysis were based on the estimated urban poverty incidence from the contingent valuation study for the project beneficiaries and a slightly higher value to reflect the greater poverty incidence in the rural areas of the city which will not benefit from the project. Nevertheless, the estimated poverty impact ratio is 0.55 based on the implicit subsidies that will be provided to Mandalay city.

Economic Evaluation of the Overall Project, 2016–2047
(MK million)

	Costs				Benefits			
Year	Invest-ment	Periodic Invest-ment	Recurrent	Total	Improved Water Supply	Improved Wastewater and Drainage Management	Total	Net Benefits
2016	6,352	0	0	6,352	0	0	0	(6,352)
2017	31,279	0	919	32,198	0	0	0	(32,198)
2018	33,420	0	949	34,369	0	394	394	(33,974)
2019	19,762	0	2,005	21,767	0	4,188	4,188	(17,579)
2020	12,763	0	3,193	15,956	0	8,315	8,315	(7,641)
2021	7,252	0	4,370	11,622	15,049	11,809	26,858	15,235
2022	3,113	0	5,870	8,983	15,799	15,929	31,728	22,745
2023		0	6,109	6,109	16,610	16,791	33,401	27,292
2024		0	6,109	6,109	17,489	17,501	34,990	28,881
2025		0	6,109	6,109	18,149	18,474	36,623	30,514
2026		0	6,109	6,109	18,945	18,920	37,865	31,756
2027		0	6,109	6,109	19,776	19,627	39,402	33,294
2028		0	6,109	6,109	20,643	20,355	40,998	34,890
2029		0	6,109	6,109	21,549	21,225	42,774	36,665
2030		453	6,109	6,562	22,397	22,378	44,775	38,213
2031		0	6,109	6,109	22,806	22,907	45,714	39,605
2032		402	6,109	6,511	23,225	23,814	47,038	40,528
2033		0	6,109	6,109	23,652	24,757	48,409	42,300
2034		0	6,109	6,109	24,087	25,235	49,323	43,214
2035		0	6,109	6,109	24,564	25,919	50,483	44,374
2036		0	6,109	6,109	25,064	26,247	51,311	45,203
2037		0	6,109	6,109	25,575	26,783	52,358	46,249
2038		0	6,109	6,109	26,096	27,330	53,426	47,317
2039		0	6,109	6,109	26,629	27,903	54,532	48,423
2040		0	6,109	6,109	27,205	28,714	55,919	49,811
2041		0	6,109	6,109	27,205	28,714	55,919	49,811
2042		453	6,109	6,562	27,205	28,714	55,919	49,357
2043		0	6,109	6,109	27,205	28,714	55,919	49,811
2044		402	6,109	6,511	27,205	28,714	55,919	49,409
2045		0	6,109	6,109	27,205	28,714	55,919	49,811
2046		0	6,109	6,109	27,205	28,714	55,919	49,811
2047		0	6,109	6,109	27,205	28,714	55,919	49,811
EIRR								**19.9%**
ENPV	**79,277**	**178**	**31,037**	**110,492**	**89,923**	**97,399**	**187,322**	**76,830**

( ) = negative, EIRR = economic internal rate of return, ENPV = economic net present value.
Source: Asian Development Bank estimates.