ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. The current state of urban infrastructure and services is one of the major impediments to sustainable urban development and economic growth in Vanuatu. The capital city of Port Vila has approximately 44,000 residents and Greater Port Vila with 58,000 residents which is likely to be more than 109,000 by 2025. Urban services have to improve to cater to the needs of the growing population of Port Villa and its peri-urban settlements. It is not only the quantity but also the quality of urban services that must improve well beyond what they are today. Improved urban services in Port Vila will improve public health, enhance economic activities, and raise the overall quality of life of residents and visitors. The proposed project will promote climate-resilient and sustainable urban development of greater Port Vila by means of an improved road network and drainage system, sanitation system, hygiene facilities in the central business district (CBD) and settlement communities, and capacity of government agencies and community and user organizations.

B. Methodology and Approach

2. The economic analysis of the proposed project was carried out in accordance with the Asian Development Bank (ADB) Guidelines for the Economic Analysis of Projects.[1] It focuses on quantifiable expected benefits and costs produced by the project.

3. For financial and economic analysis, benefits and costs were quantified for the project outputs that entail improvement of (i) the drainage system and road network, (ii) sanitation disposal system, and (iii) hygiene facilities.[2] The economic analysis focused on evaluating expected quantifiable benefits with the associated costs produced by the project through specific components. The financial and economic analysis of the proposed project discusses (i) the economic viability of the individual outputs and the overall project; and (ii) the financial analysis to indicate an appropriate user charge for the sludge treatment plant (STP), ensuring fair returns to the capital and the operating costs.

4. For determining economic viability, the with-benefit and without-benefit and cost streams were evaluated for estimating the incremental cash flows for each of the outputs and their switching values to ascertain robustness. In the case of integrated outputs, particularly the improved road network and drainage system, care was taken to avoid double counting of benefits.

5. Economic analyses of the proposed subprojects was undertaken in accordance with the standard application of with-project versus without-project scenarios using four basic models. For the new infrastructure interventions, the without-project condition assumed continuation of the present mode of service delivery and associated efficiencies. For the rehabilitation of existing infrastructure, a simple life cycle model was employed that in the without-project situation assumes that the absence of adequate maintenance results in a reduction of expected years of service divergent from the original design life.

6. Under the with-project condition for new infrastructure interventions, producer or consumer surplus is gained through assumptions of increased efficiencies, induced levels of

[1] ADB. 2007. *Guidelines for the Economic Analysis of Projects.* Manila.

[2] Financial analysis was also carried out for sludge treatment plant and hygiene facilities using ADB's Guidelines for the Financial Analysis of Projects.

economic activity, and improved service quality. In the improvement of existing infrastructure, the with-project condition assumes that the improvement work done creates the discounted economic value of the civil works such that its service life reflects the intended number of years as per a new design.

7. A number of assumptions were made in the assessment of financial and economic viability. Given the differences in the with-project and without-project conditions, and indeed the type of subproject assessed and respective model, the periods of analysis should differ. In this project, however, improvement is in the nature of almost new investment. The new infrastructure interventions as well as improvements will be designed to have a functional life of 30 years or less; however, the period of economic analysis covers 25 years. The design would cater for any natural hazard induced by climate change.

8. For economic analysis the domestic price numeraire is used. The exchange rate used was US$1 = Vt86. Economic values in the analysis of costs and benefits were obtained through the removal of taxes and duties from financial costs, and the application of a standard conversion factor of 0.893 has been applied to nontraded goods and services. All costs are stated in constant 2011 prices. The shadow price of skilled labor is assumed as 1.0, representing the opportunity cost of labor. The shadow price of unskilled labor is assumed as 0.6 to represent the opportunity cost of the unskilled labor. An average daily wage of Vt2,233 (US$25) is assumed for supervisory and white-collar jobs, while Vt1,786 (US$20) is assumed as the daily rate for skilled labor and Vt804 (US$9) for unskilled labor. The full development stage is assumed to be reached in the fifth year, with a 1-year lag after the first year of implementation.

C. Costs

9. The main cost for the improvement of drainage, roads, and hygiene facilities is civil works, which includes the cost of earthworks, materials, and skilled and unskilled labor, with contingencies. For the improvement of sanitation works, the cost also includes the cost of machinery and equipment for the STP, biogas plant, and power generation unit. In addition to this, provision has been made for operation and maintenance costs. The engineering designs for the civil works have adopted higher than normal standards and specifications to reflect the cost of climate proofing and ensure resilience against the impact of climate change.

D. Benefits

10. Quantifiable benefits were considered as follows:

(i) **Drainage system improvement.** Major benefits are derived from reduction in vehicle diversion cost, time lost due to restricted mobility, and damage to houses and gardens. Vehicle diversion costs are incurred from avoiding detouring around muddy roads. Restricted mobility means loss of productive time due to inundation of the roads. It is estimated that about 30% of the population is marooned or incapacitated for an average of about 6 hours during each heavy rain event. It is assumed that rain of such intensity is experienced once a month. It is also assumed that about 20% houses need repairs due to rain damage, as in most areas the road level is higher than the plinth level. Damage to kitchen gardens has also been accounted for in the estimation, though it is not significant.

(ii) **Road network improvement**. Major benefits are derived from vehicle operating cost (VOC) savings and the value of time saved. These are derived from traffic forecasts, estimated VOCs, and average wage rates. For traffic forecasts the base

figure adopted is an adjusted figure from the official registration office, whose records show that there are about 1,700 vehicles in the greater Port Vila area. However, the observed traffic volume within the CBD and the peri-urban area is significantly higher. In consultation with persons knowledgeable on the subject, a conservative figure of 3,500 was adopted as the base traffic volume. Taking into account per capita income growth, population increase, and tourist arrivals, it was assumed that traffic volume would grow at the annual rate of 3%. Furthermore, generated and induced traffic volume of about 0.5% each was assumed, a figure comparable with other Pacific countries. VOCs depend on many factors such as the vehicle, origin and destination of travel, road usage by type of road or area, average distance travelled, vehicle and fuel price, fuel and oil consumption, tire life, cost and wear, operation and maintenance, and driver's wage. A combination of field observation and consultation was followed to arrive at assumed figures for vehicle type and road usage by type of road or area. To arrive at the VOC savings benefit, it is assumed that in the CBD, where roads will be refurbished, savings will amount to 5% of VOCs. It was also assumed that the corresponding figure will be 10% in the peri-urban areas, where the roads will be upgraded from dirt tracks to semi-sealed. For the value of time saved, the average time saved per kilometer of road usage, average occupancy per vehicle, average commuting distance in kilometers, and weighted average wage rate were the determining factors. Average wage rate data were obtained from local sources. The VOC saving calculation is in Table 1.

		Type of Vehicle				
A.	**Within Central Business District**	**Motorcycle**	**Car**	**Van**	**Pickup**	**Truck**
1	Without Project VOC/km	6.00	11.60	21.90	67.40	149.30
2	With Project per km VOC with improved roads	5.70	11.10	20.80	64.10	141.80
3	With Project per km VOC savings with improved roads	0.30	0.58	1.09	3.37	7.46
		Type of Vehicle				
B.	**Outside Central Business District/Peri-Urban Area**	**Motorcycle**	**Car**	**Van**	**Pickup**	**Truck**
1	Without Project VOC/km	7.10	14.40	22.80	69.10	158.00
2	With Project per km VOC with improved roads	6.40	12.90	20.60	62.20	142.20
3	With Project per km VOC Savings with improved roads	0.71	1.44	2.28	6.91	15.80

Table 1: Per Kilometer Vehicle Operating Cost and Saving (Vt)

Km = kilometer, VOC = vehicle operating cost, Vt = Vatu.
Source: Government of Vanuatu and ADB estimates.

(iii) **Sanitation improvement.** The main benefits from sanitation improvement, which includes the STP, biogas, and power generation, are reduction in medical expenditures, reduction in absenteeism from work, and carbon credits from reduced carbon emission due to biogas and power generation. In the absence of the STP, families will have to incur medical expenditures due to illness and indisposition, which also causes absenteeism from work. It is assumed that about 25% of the population is vulnerable to diseases, as poor sanitary conditions are responsible for an average of 5 days of illness in a year. Average medical expenditure data are taken from household expenditure survey data corrected by consultations, and the average wage rate is used as the opportunity cost of absenteeism. The returns from the estimated carbon credit, which will start flowing after the implementation period, have also been included in the economic analysis.

The carbon credit figure was obtained from global sources. Power will be internally used by the treatment plant.

(iv) **Hygiene improvement.** The benefit of hygiene improvement is estimated from the current willingness to pay as measured by tariff paid for sludge disposal. The project will rehabilitate the existing public and communal multipurpose multiuser sanitary toilets and construct additional public and communal facilities in the CBD and peri-urban areas. To quantify the benefits from the use of these facilities, it is assumed that the current willingness to pay for the services is a reasonable proxy for assigning benefits from the provision of this facility. In the absence of willingness-to-pay studies or survey (or contingency table), the existing tariff has been assumed to indicate the accrued benefit.

E. Economic Evaluation

11. The economic internal rate of return (EIRR) equalizes the present values of economic costs and benefits that accrue to the economy. A positive economic net present value (NPV) reflects returns in excess of the discount of 12%.

12. Economic analysis was undertaken for all the proposed activities and aggregated at the component level. Project viability was assessed for the project as a whole on the basis of benefits from all components and the cost of proposed physical works, costs for implementation, technical support, allocation for operation and maintenance (O&M), and repairs of the structures and other cost elements. The incremental cash flows of the various outputs are given in Table 2, which also shows the base-case NPV and EIRR of the whole project. Component-wise economic evaluation results are summarized in Table 3, showing NPV, EIRR, and sensitivity to cost and benefit change. Switching values have been estimated for determining the outer bounds of the decrease in anticipated benefits and/or cost overruns, such that the EIRR is constrained at 12%.

Table 2: Calculation of Project Net Present Value and Economic Internal Rate of Return
(Vt million)

	Incremental Benefits/Saving					Incremental Costs		
Year	Drainage	VOC Saving	Travel Time Saving	Sanitation	Hygiene	Capital Cost	O&M Cost	Incremental Cash Flow
1						18.4		(18.4)
2						427.9		(427.9)
3					3.9	762.0	7.0	(765.1)
4	28.2	30.3	31.6	34.1	17.9	593.5	26.9	(478.4)
5	57.6	62.5	65.3	69.8	31.5	334.2	37.8	(85.3)
6	88.4	96.7	101.0	107.1	31.5		41.2	383.6
7	120.5	133.1	139.0	150.2	31.5		41.3	533.1
8	154.0	171.7	179.4	190.9	31.5		48.1	679.3
9	157.4	176.8	184.8	195.2	31.5		58.5	687.3
10	161.0	182.1	190.3	199.6	31.5		58.5	706.0
11	164.6	187.6	196.0	204.1	31.5		65.2	718.6
12	168.3	193.2	201.9	208.7	31.5		75.2	728.4
13	172.1	199.0	207.9	213.4	31.5		75.3	748.7
14	176.0	205.0	214.2	218.2	31.5		75.4	769.5

	Incremental Benefits/Saving					Incremental Costs		
Year	Drainage	VOC Saving	Travel Time Saving	Sanitation	Hygiene	Capital Cost	O&M Cost	Incremental Cash Flow
15	179.9	211.2	220.6	223.2	31.5		75.6	790.8
16	184.0	217.5	227.2	228.2	31.5		75.7	812.8
17	188.1	224.0	234.0	233.4	31.5		75.8	835.3
18	192.4	230.7	241.1	238.6	31.5		75.9	858.5
19	196.7	237.7	248.3	244.0	31.5		76.0	882.2
20	201.2	244.8	255.8	249.5	31.5		76.1	906.6
21	205.7	252.1	263.4	255.2	31.5		76.2	931.7
22	210.4	259.7	271.3	261.0	31.5		76.4	957.5
23	215.1	267.5	279.5	266.9	31.5		76.5	984.0
24	220.0	275.5	287.8	272.9	31.5		76.6	1,011.2
25	225.0	283.8	296.5	279.1	31.5		76.8	1,039.1
							EIRR	**23.4%**
							NPV @ 12%	**1,725.5**

EIRR = economic internal rate of return, VOC = vehicle operating cost, Vt = Vatu.
Source: Government of Vanuatu and ADB estimates.

Table 3: Economic Internal Rate of Return and Switching Values

	Base Case		Sensitivity Analysis			Switching Values (constrained at 12%)		
Output and Activity	EIRR	NPV 12% (Vt million)	10% Decrease in Benefits	10% Increase in Cost	20% Decrease in Benefits and 20% Increase in Costs	Percent Decrease in Benefits	Percent Increase in Cost	Equal % Decrease in Benefits and Increase in Costs
Drainage Improvement	15.5%	162.6	14.0%	14.1%	12.7%	23.9%	28.6%	13.5%
Road Improvement	27.8%	972.9	25.3%	25.6%	23.3%	>50.0%	>50.0%	42.0%
Drainage and Roads	22.1%	1,135.5	20.2%	20.4%	18.6%	48.6%	>50.0%	32.3%
Sanitation Improvement	28.1%	563.7	26.0%	26.2%	24.2%	>50.0%	>50.0%	45.8%
Hygiene Improvement	18.8%	26.3	14.6%	15.0%	10.9%	15.9%	18.9%	8.6%
All	23.4%	1,725.5	21.4%	21.6%	19.7%	49.0%	>50.0%	34.0%

EIRR = economic internal rate of return, NPV = net present value.
Source: Government of Vanuatu and ADB estimates.

13. The EIRR for all the outputs—improvement of the drainage system, road network, sanitation, and hygiene—is 23.4%. The EIRRs for the suboutputs range between 15.5% and 28.1%. This indicates that all the components are economically viable. Nonetheless, these estimates, except for hygiene-related investments, are robust. As noted by the results of sensitivity analysis, even with a 10% decrease in benefits all the outputs remain stable and above the acceptable level, while with a 10% increase in the costs, all the outputs remain viable except hygiene improvement, suggesting it is sensitive to price increase. The switching values confirm these findings.

14. Improvement in the drainage system is highly desirable when the impact on the quality of life, business, and convenience is considered, but these returns cannot be quantified. These benefits are likely to be substantial when one considers that the project will provide new storm

water drainage systems and improve old ones in the CBD and the airport link road. What can be quantified has probably been underestimated because of lack of data, especially on the likely impact of climate change. Therefore, there is no need to be overly concerned with the finding that, under a simultaneous 10% increase in costs and decrease in benefits, improvement of the system component falls short of the 12% EIRR.

15. Results of sensitivity analysis and switching values suggest that the viability of an improved road network, improved drainage and roads combined, and sanitation component is quite attractive. Under all variations the EIRRs of aforementioned outputs are above 12%, with positive NPVs. The low viability of the hygiene improvement component is due to the application of the current tariff as the proxy for benefit, given that such tariffs are presently set at the lowest possible level just to get people accustomed to paying for the service. Actual benefits are much higher, arising from improved environment and quality of life, and productivity gain. These are not easy to quantify but are certain to be realized given that the project will provide toilets and washing and bathing facilities in villages and peri-urban settlements and refurbish public toilets in the city center. The project will generate substantial benefit by involving women in the site selection and design of sanitation facilities, and maintenance activities.

16. The fiscal impacts and sustainability analysis conducted during the preparation of the project suggest a strong commitment of the government and its policies toward sustainable urban development, particularly on sanitation and hygiene. The government's Priorities and Action Agenda strategy[3] has identified as a priority the provision of commercial, high-quality, efficient, and competitively priced infrastructure, utilities, and services, either through public enterprises or through private sector partnerships and competition. A number of policies, including a building code and roads act, are being finalized by the government. Further guidance to the government on different fiscal options for O&M will be provided through the extended phase of the project preparatory technical assistance.[4]

F. Financial Analysis

17. Financial analysis was undertaken to assess the magnitude of the budgetary allocation required to ensure the sustainability of investment. Incremental finances are required for routine operation and maintenance and for the periodic repairs of the rehabilitated and upgraded drainage system and road network. The construction specification of both the rehabilitated and upgraded assets will follow standards appropriate to the terrain, such that the structures can withstand the vagaries of nature and extreme weather conditions. Given the climate-proof design of the structures, it is envisaged that initial O&M requirements will be lower than for normal structures. For the above-mentioned two outputs, it is assumed that during the first 3 years of construction the O&M requirement will be about 1% of the construction cost, followed by 2% in the next 3 years and 3% thereafter.

18. It is estimated that the additional O&M allocation for drainage will be about Vt7.5 million per year during the first 3 years after the full development stage, followed by Vt15.0 million during the next 3 years and about Vt22.5 million thereafter over the remaining life of the drainage infrastructure. Similarly, during the first 3 years of the full development stage of the roads, O&M is estimated to be about Vt11.5 million, followed by Vt22.0 million in the next 3 years, and about Vt33.0 million thereafter over the remaining life of the road infrastructure. The additional

[3] Government of Vanuatu. Ministry of Finance and Economic Management. 2006. *Priorities and Action Agenda 2006 – 2015: An Educated, Healthy and Wealthy Vanuatu.* Port Vila.

[4] ADB. 2009. *Project Preparatory Technical Assistance to Vanuatu for the Port Vila Urban Development Project*. Manila.

resources can be financed through additional municipal taxes, such as annual vehicle tax and property tax.

19. Financial analysis was also undertaken for the O&M of the STP. At present the municipality charges Vt3,000 (US$35) per cubic meter ($m^3$). This is about Vt600/$m^3$ less than the breakeven point, and hence the municipality will incur an operating loss of Vt2.5 million per year. If the dumping charge is not increased to bridge the gap, the loss is expected to reach Vt3.5 million per year until 2027. .

20. If a build–operate–transfer option for a 20-year management concession is chosen for the project, at the current tariff the concessionaire will not be able to recover the management fees and O&M costs including the routine repairs and replacements costs. It would be worthwhile for a private operator only if the STP charges are increased accordingly. At present the service providers collecting and transporting household sludge charge households and consumers Vt6,000/m^3. The present spread of Vt3,000 represents the service providers' cost of collection and transportation and their profit. As the new site is closer than the existing dumping site, it is estimated that there would be a saving of about Vt300/m^3 in transportation. This suggests that there is enough margin to absorb the increased additional sludge disposal charges without passing on the cost to households.

21. At present the market for treated sludge as soil ameliorant does not exist. It is expected that the availability of treated sludge and realization of its utility by the farming community would generate demand. This would provide additional income to the municipality, after full recovery of the operational cost.

22. An analysis of estimated expenditure and revenue of the municipality-managed MPMUs suggests that these units will realize significant net income, provided that the collection system for user charges is improved to ensure transparency and that leakages, if any, are plugged. It is estimated that the maintenance of a typical MPMU would cost about Vt1.5 million annually. Assuming a conservative number of users as 150 per day, and present Vt23 per user charge, each of the 10 MPMUs would generate about Vt1.2 million of gross revenue or net income of Vt700,000 annually. It may be pointed out that even after cross-subsidizing the sludge treatment plant operation, the municipality will be able to self-finance the operational cost of the investment in the two civic facilities.

G. Nonquantifiable Benefits

23. The project will have significant nonquantifiable benefits. It will also strengthen the capacity of users to manage and operate the system, cooperate in the equitable delivery of services, and improve delivery efficiencies.

24. In addition to the above-mentioned quantifiable and nonquantifiable benefits, the project will generate multiplier effects through attracting increased tourists and a cleaner environment. These activities will generate demand for services and employment opportunities.