ECONOMIC AND FINANCIAL ANALYSES

A. General

1. Tranche 1 of the Urban Infrastructure and Sustainable City Development Program will fund two projects that have been identified by Armenia and Yerevan municipality in conjunction with the Asian Development Bank (ADB). The projects will be upgrading two road sections that will form elements of the Yerevan west bypass to divert through traffic around the city center.

B. Weighted Average Cost of Capital

2. For all financial analyses, the weighted average cost of capital (WACC) was calculated in real terms and used as the hurdle rate for the financial internal rate of return (FIRR) to measure project viability. Funding sources are the ADB loan, providing 81% of funding, and the government contribution, providing 19%. Inflation is estimated at 2% for foreign costs and 6.2% for local costs. The rates are computed on an after-tax basis, resulting in a WACC estimated at 1.1% in real terms. The WACC calculation is presented in Table 1.

Table 1: Weighted Average Cost of Capital

(%)

Funding Source	Share	Nominal Pre-tax	Nominal Post-tax	Inflation	Real Post-tax	WACC
ADB	81.00	1.5.00	1.50	2.00	(0.50)	0.00
Government	19.00	18.75	15.00	12.00	6.20	1.10
Total	100.00					1.10

ADB = Asian Development Bank, WACC = weighted average cost of capital.
Source: ADB estimates.

C. Economic Analysis of Road Projects

3. The road projects comprise (i) the construction of a new 6-lane divided road 1.5 kilometers (km) long linking Argavand Highway to Shirak Street, extending over the Hrazdan River on a simple cantilever bridge with 42-meter span piers (project 1) and (ii) the construction of three sections of 4-lane and 6-lane divided roads between Shirak Street and Artashat Highway 3.7 km long (project 2).

1. Existing Traffic and Forecast Traffic

4. A baseline traffic estimate was generated for the existing road routes, based on the data currently available. Owing to the nature of the road sections and their eventual combination into a bypass, it was considered that the traffic forecast for each section should be the same, at 33,000 vehicle trips per day. Traffic was forecasted to grow in line with forecasted gross domestic product (GDP), with an income elasticity of 0.7. GDP was forecasted to grow at 1.5% in real terms in 2010, rising to 4.5% in 2015 and thereafter. Traffic split was forecast to be 10% goods vehicles and the balance private cars. Other vehicle types were assumed to be immaterial.

2. Economic Costs

5. The economic costs of the projects are (i) capital costs, including all civil works, materials and equipment, and project management and supervision, and (ii) road maintenance costs. Taxes, duties, and financing charges during project implementation were excluded.

6. All costs are valued at border prices, using a world price numeraire, with all taxes and duties excluded. A standard conversion factor of 0.97 is applied to nontradable items and labor. A shadow wage rate factor of 0.7 is used to estimate the economic price of unskilled labor, estimated to account for 5% of costs. Total capital costs for each project are $25.1 million for project 1, $22.3 million for project 2, and $17.3 million for project 3, totaling $64.7 million for the three projects combined.

7. Road maintenance costs are estimated at 0.2% of the total capital cost, or $130,000 per annum for all three projects combined. This has been estimated using available information on road maintenance costs in Armenia, adjusted to reflect the nature of the new roads. Capital renewal costs are based on a 15-year life for materials and a 10-year life for equipment.

3. Economic Benefits

8. The quantified economic benefits of the projects are (i) savings in vehicle operating costs and (ii) savings in travel time, both because of faster average vehicle speeds than on the existing road network. Additional benefits that may accrue from reduced environmental costs and congestion have not been quantified but are expected to be positive.

9. Average vehicle speeds have been estimated to rise according to the particulars of each project, with a typical increase of 20 km/hour for private cars and 10 km/hour for goods vehicles. Vehicle operating costs as a function of average vehicle speeds have been estimated based on appropriate curves describing the relationship between vehicle speeds and operating costs. The costs savings have been indexed to forecasted real fuel price increases of 2% per annum. Time savings have been estimated using average vehicle occupancy of 1.2 passengers per vehicle for all categories and an hourly time value of $5.84 for car drivers and $14.60 for goods vehicle drivers. These values are based on GDP per capita and adjusted according to the particulars of the Yerevan area and vehicle category.

4. Economic Internal Rate of Return

10. The projects were evaluated over 25 years; the first full year of benefits was assumed to be 2013 for projects 3 and 2014 for project 2. Residual values according to the capital replacement schedule were assumed at the end of the evaluation period, with a civil works operating life of 30 years. The results, summarized in Table 3, show that the projects are economically viable, with estimated economic internal rates of return (EIRRs) of 14.4% for project 1 and 20.3% for project 2. Net present values (NPVs) for the projects are estimated at $4.8 million for project 1 and $13.9 million for project 2.

Table 2: Project 1 Detailed Economic Analysis

Year	Project 1							Project 2						
	Incremental Costs			Road User Cost Savings			Net Benefits	Incremental Costs			Road User Cost Savings			Net Benefits
	Capital	Recurrent	Total	VOC	Time Savings	Total		Capital	Recurrent	Total	VOC	Time Savings	Total	
2010	(3.0)	0.0	(3.0)	0.0	0.0	0.0	(3.0)	(3.2)	0.0	(3.2)	0.0	0.0	0.0	(3.2)
2011	(7.7)	0.0	(7.7)	0.0	0.0	0.0	(7.7)	(7.6)	0.0	(7.6)	0.0	0.0	0.0	(7.6)
2012	(5.4)	0.0	(5.4)	0.0	0.0	0.0	(5.4)	(3.8)	0.0	(3.8)	0.0	0.0	0.0	(3.8)
2013	(2.6)	0.0	(2.6)	0.0	0.0	0.0	(2.6)	0.0	(0.0)	(0.0)	0.3	2.2	2.5	2.5
2014	0.0	(0.0)	(0.0)	0.2	1.9	2.2	2.1	0.0	(0.0)	(0.0)	0.3	2.3	2.7	2.6
2015	0.0	(0.0)	(0.0)	0.2	2.1	2.3	2.3	0.0	(0.0)	(0.0)	0.3	2.5	2.9	2.8
2016	0.0	(0.0)	(0.0)	0.3	2.2	2.5	2.5	0.0	(0.0)	(0.0)	0.4	2.7	3.1	3.0
2017	0.0	(0.0)	(0.0)	0.3	2.4	2.7	2.6	0.0	(0.0)	(0.0)	0.4	2.9	3.3	3.3
2018	0.0	(0.0)	(0.0)	0.3	2.6	2.9	2.9	0.0	(0.0)	(0.0)	0.4	3.2	3.6	3.5
2019	0.0	(0.0)	(0.0)	0.3	2.8	3.1	3.1	0.0	(0.0)	(0.0)	0.4	3.4	3.8	3.8
2020	0.0	(0.0)	(0.0)	0.3	3.0	3.3	3.3	0.0	(0.0)	(0.0)	0.4	3.7	4.1	4.1
2021	0.0	(0.0)	(0.0)	0.3	3.3	3.6	3.6	0.0	(0.0)	(0.0)	0.5	4.0	4.4	4.4
2022	0.0	(0.0)	(0.0)	0.4	3.5	3.9	3.8	0.0	(2.2)	(2.2)	0.5	4.3	4.7	2.5
2023	0.0	(2.8)	(2.8)	0.4	3.8	4.2	1.3	0.0	(0.0)	(0.0)	0.5	4.6	5.1	5.1
2024	0.0	(0.0)	(0.0)	0.4	4.1	4.5	4.4	0.0	(0.0)	(0.0)	0.5	4.9	5.5	5.5
2025	0.0	(0.0)	(0.0)	0.4	4.4	4.8	4.8	0.0	(0.0)	(0.0)	0.6	5.3	5.9	5.9
2026	0.0	(0.0)	(0.0)	0.4	4.7	5.2	5.1	0.0	(0.0)	(0.0)	0.6	5.7	6.3	6.3
2027	0.0	(0.0)	(0.0)	0.5	5.1	5.6	5.5	0.0	(4.1)	(4.1)	0.6	6.2	6.8	2.7
2028	0.0	(5.3)	(5.3)	0.5	5.5	6.0	0.7	0.0	(0.0)	(0.0)	0.7	6.7	7.3	7.3
2029	0.0	(0.0)	(0.0)	0.5	5.9	6.4	6.4	0.0	(0.0)	(0.0)	0.7	7.2	7.9	7.9
2030	0.0	(0.0)	(0.0)	0.5	6.4	6.9	6.9	0.0	(0.0)	(0.0)	0.7	7.8	8.5	8.5
2031	0.0	(0.0)	(0.0)	0.6	6.9	7.5	7.4	0.0	(0.0)	(0.0)	0.8	8.4	9.1	9.1
2032	0.0	(0.0)	(0.0)	0.6	7.4	8.0	8.0	0.0	(2.2)	(2.2)	0.8	9.0	9.8	7.6
2033	0.0	(2.8)	(2.8)	0.6	8.0	8.6	5.8	0.0	(0.0)	(0.0)	0.9	9.7	10.6	10.5
2034	0.0	(0.0)	(0.0)	0.6	8.6	9.3	9.3	0.0	(0.0)	(0.0)	0.9	10.5	11.4	11.3
2035	0.0	(0.0)	(0.0)	0.7	9.3	10.0	10.0	0.0	(0.0)	(0.0)	0.9	11.3	12.2	12.2
2036	0.0	(0.0)	(0.0)	0.7	10.0	10.8	10.7	0.0	(0.0)	(0.0)	1.0	12.2	13.2	13.1
2037	0.0	(0.0)	(0.0)	0.8	10.8	11.6	11.5	4.5	(0.0)	4.5	1.0	13.1	14.2	18.7
NPV							4.8							13.9
EIRR(%)							14.4							20.3

EIRR = economic internal rate of return, NPV = net present value, VOC = vehicle operating cost.
Source: Asian Development Bank estimates.

5. Sensitivity Analysis

11. The sensitivity analysis assessed the variables to which the estimated EIRR and the net present value of the projects are sensitive. The results are summarized in Table 3. They show that the projects remains economically viable with an EIRR higher than 12% when (i) benefits decrease by 10%, (ii) capital costs increase by 10, and (iii) both situations are combined.

Table 3: Sensitivity Analysis

	Project 1		Project 2		Project 3	
Item	**EIRR** (%)	**NPV** ($ million)	**EIRR** (%)	**NPV** ($ million)	**EIRR** (%)	**NPV** ($ million)
Base Case	19.2	17.2	14.4	4.8	20.3	13.9
Benefits less 10%	17.8	13.4	13.4	2.6	18.8	11.1
Capital cost increased by 10%	17.9	15.1	13.5	3.1	18.9	12.5
Benefits less 10% & capital costs 10% higher	16.6	11.3	12.4	0.9	17.5	9.7

EIRR = economic internal rate of return, NPV = net present value.
Source: Asian Development Bank estimates.

D. Financial Analysis of Road Projects

12. As the government will not request any tolls or access charges, no revenues will be generated by these projects. Therefore, no financial analyses has been undertaken for these two projects.