ECONOMIC ANALYSIS

1. The Kathmandu Valley Water Supply Improvement Project loan will finance a water supply project providing piped water through individual household connections, prioritizing underserved areas and poor sections of the population of Kathmandu Valley. The costs and benefits of the project have been quantified using resource cost and willingness-to-pay measures incremental to a base case. The economic net benefit measures the net real economic worth of the project to the national economy.

A. Macroeconomic and Sector Context

2. Kathmandu Valley, which accounts for about 30% of the country's gross domestic product and 50% of total urban population, is the country's single largest urban economy. Kathmandu's rapid and largely unplanned urban growth, high population density, lack of sustainable water sources, and inadequate past investments in water supply infrastructure have resulted in abysmally poor availability and quality of drinking water. Poor access to sanitation facilities, improper solid waste management system, and groundwater and surface water pollution from untreated domestic sewage have increased disease incidence,[1] health risks, and associated economic burdens[2] disproportionately impacting the poor and vulnerable. Additional investment is required for a water supply bulk distribution system and distribution network improvements to supplement the existing system by the time potable water is available from the Melamchi diversion tunnel. The expected impact of the project is improved access to and service level of water supply for residents of Kathmandu Valley. The project is in line with the priority sector "water supply and other municipal infrastructure and services" identified in the country partnership strategy[3] and will support the country's peace and development through improved access to basic services. The project aims to fulfill the medium-term priority investment needs identified in the Government of Nepal's long-term capital investment and asset management program (2010)[4] in water supply in Kathmandu Valley.

3. **Water demand.** Water demand was derived from the current population within the planned service area, population growth, current and future domestic water consumption and assumptions, and a provision for nondomestic water consumption. The project area population, estimated at 2.1 million in 2010, is projected to increase to 2.7 million by 2015, 3.2 million by 2020, and 3.9 million by 2025. With the project, the proportion of population to be served by the water supply network is projected to increase from 70% in 2010 to 77% in 2015, 87% in 2020, and 96% in 2025. Water demand is based on the population forecast; percentage of population

[1] The World Health Organization has estimated that the environmental factors account for 24% of the total burden of disease in Nepal. World Health Organization. 2009. *Country Profiles of Environmental Burden of Disease*. Geneva.

[2] The World Bank has estimated annual health costs from inadequate urban water and sanitation in Nepal to be $12 million. World Bank. 2007. *Nepal Country Environmental Analysis*. Washington, DC.

[3] For water services, ADB. 2009. *Country Partnership Strategy: Nepal, 2010–2012.* Manila notes that it will maintain focus on (i) increasing access to and improving water supply and sanitation service, (ii) improving environment and public health, and (iii) strengthening management capacity of responsible organizations.

[4] The Capital Investment and Asset Management Program 2010–2025 was prepared with ADB assistance under ADB. 2006. *Technical Assistance to Nepal for Preparing the Kathmandu Valley Water Distribution, Sewerage, and Urban Development Project.* Manila (TA 4893-NEP) in February 2010 and endorsed by all stakeholders in May 2010. The estimated investment requirements are $250 million for water supply in Kathmandu Valley in addition to the ongoing ADB. 2000. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Kingdom of Nepal for the Melamchi Water Supply Project.* Manila (Loan 1820-NEP); and ADB. 2003. *Report and Recommendation of the President to the Board of Directors: Proposed Loans to the Kingdom of Nepal for the Kathmandu Valley Water Services Sector Development Program.* Manila (Loans 2058-NEP[SF] and 2059-NEP[SF]). The Kathmandu Valley Water Supply Improvement Project will meet the priority investment needs of 2011–2016.

served, assumed supply rate of water, price, disposable household income, and accessibility of water supply. Based on an earlier socioeconomic survey,[5] access to water supply services is limited. The average supply rate is expected to increase by a minimum of 35 liters per capita per day (lpcd) under existing conditions to 85–135 lpcd average projected water demand. Hence, total water demand is projected to increase from 192.4 million liters per day in 2010 to 686.8 million liters per day by 2025.[6]

4. A previous study[7] estimated that household expenditures on water purifying and collecting water other than tap water supply are more than NRs500 per household per month. The study indicated that almost 70% of households that are connected to the Kathmandu Upatyaka Khanepani Limited (KUKL) system are willing to pay a monthly bill of NRs600, and almost 50% of the households that are not connected to the KUKL system are willing to pay a monthly bill of NRs500. For households connected to the KUKL system, the median willingness to pay (WTP) is NRs900 per month for improved services, i.e., at least 50% of the sample was willing to pay more than NRs900. The monthly average WTP is NRs1,030 among households with piped connections. For poor households connected to the KUKL system, the mean WTP is NRs800. At present, households depending on tankers[8] generally pay NRs200 per cubic meter, which is 36 times more expensive than the minimum tariff set for domestic house connections in Kathmandu Valley (NRs5.5 per cubic meter). This implies that people are likely to opt for household connections if the availability and quality of the water is ensured.

B. Identification and Valuation of Economic Benefits and Costs

5. Economic benefits include (i) resource cost saving in terms of time savings to collect water, (ii) incremental benefit in terms of increased water demand as additional consumption, and (iii) valuation of nonrevenue water (NRW) that is saved and utilized. Increased water demand[9] (projected water supply minus present consumption) is valued at the rate of average willingness to pay of the households. NRW is estimated by KUKL at 40% of the total water supply; 25% of NRW is assumed to be saved and utilized by the population. Valuation of such utilized NRW is estimated as the weighted average tariff of incremental and nonincremental benefits. The assumptions used in calculating the economic benefits are shown in Table 1.

6. Economic costs were converted from the financial costs based on (i) a shadow exchange rate or standard conversion factor of 0.90 applied to nontradable inputs; (ii) a shadow wage rate conversion factor of 0.7 to change local unskilled labor to opportunity cost of labor; and (iii) a 25-year projection period, including construction period of 5 years.

[5] The average water supply rate and water demand forecast is derived as the sum of the eight different sample locations of Kathmandu Valley. The household size is estimated at 6.7 persons as the weighted average.

[6] Estimates based on socioeconomic survey conducted under ADB. 2006. Technical Assistance to Nepal for Preparing the Kathmandu Valley Water Distribution, Sewerage, and Urban Development Project. The sample survey interviewed 219 households, equivalent to 5.5% of total households in the sample area.

[7] Research Triangle Institute. 2001. *Willingness to Pay for Improved Water Supply in Kathmandu Valley, Nepal*. Kathmandu.

[8] A mobile water tank deployed to distribute fresh water in emergency situations where the normal system of piped distribution has broken down or is insufficient.

[9] Water supply is projected to increase to an overall average of 70 lpcd from 2015 onward, compared with an average consumption of 35 lpcd under the without-project scenario.

Table 1: Economic Benefits

Benefit	Assumptions	Economic Value
Nonincremental benefit	Time savings per day: 42 minutes Shadow price of labor: NRs175	Benefit per day NRs15.31
Incremental benefit	Incremental water: 30.6 lcpd Household size: 6.70 persons Average WTP: NRs20.32 per m^3	Benefit per day NRs4.50
Nonrevenue water benefit	Water loss: 40% of water production Saved and utilized water: 25% of water losses Weighted average price (WTP and value of time): NRs11.76 per m^3	Benefit per m^3 NRs2.94

m^3 = cubic meter, WTP = willingness to pay.
Source: Asian Development Bank.

C. Least-Cost Analysis

7. Design considerations for the water supply component assessed during the feasibility study include (i) source close to supply area to reduce transmission costs; (ii) perennial surface water fed by gravity rather than pumped groundwater; (iii) rapid sand filtration preferred to slow sand filtration: higher energy but lower land needs; (iv) pipe material selected on cost, durability, and pressure resistance; and (v) metered house connections to facilitate water demand management. A comparative analysis has been undertaken considering two alternatives: (i) downstream investments alternative 1 comprising 5 bulk distribution system mains, 5 service reservoirs, and distribution network improvement with higher capital costs but lower operating costs (increased operating flexibility); and (ii) downstream investments alternative 2 with 5 bulk distribution system mains, 3 service reservoirs, and distribution network improvement. The net present value cost ratio between the least-cost alternative (alternative 1) and alternative 2 is 0.96.

D. Economic Efficiency of the Investment, and Sensitivity Analysis

8. The economic internal rate of return for the base-case scenario is 18.1%, which is higher than the economic opportunity cost of capital, estimated at 12.0%. Sensitivity analysis was also undertaken under various assumptions. The delay in completion of the Asian Development Bank's Melamchi Water Supply Project[10] was the most sensitive risk factor because any decrease in benefit affects the economic rationale of the project.

Table 2: Economic Internal Rate of Return and Sensitivity Analysis

Item	EIRR (%)	NPV ($ million)
Base case	18.1	20.1
Capital costs increased by 10%	16.2	15.1
Operation and maintenance costs increased by 10%	18.1	19.9
Benefit reduced by 10%	15.8	12.4
Completion of Melamchi delayed by 1 year	14.8	10.4

EIRR = economic internal rate or return, NPV = net present value, O&M = operation and maintenance.
Sources: ADB. 2006. Technical Assistance to Nepal for Preparing the Kathmandu Valley Water Distribution, Sewerage, and Urban Development Project. Manila; and fact-finding mission estimates.

[10] ADB. 2000. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Kingdom of Nepal for the Melamchi Water Supply Project.* Manila (Loan 1820-NEP, approved on 21 December 2000 and effective on 28 November 2001).