ECONOMIC ANALYSIS

A. Country Context

1. Uzbekistan's economy has grown rapidly in the past decade, lifting significant parts of the population out of poverty. Increased exports of gas, gold, and copper, combined with high commodity prices, have boosted the economy—enabling it to expand at an unprecedented rate. As the economy rapidly transforms, however, addressing and balancing regional disparities have become a major development challenge. Some regions are growing at much faster rates than the country's average, while others are lagging. The Government of Uzbekistan is responding to this challenge and has developed a regional development program aimed at increasing per capita gross regional product in the five regions where poverty incidence is highest.[1] One of the five identified lagging regions, the Republic of Karakalpakstan (RK) is often described as the poorest in Uzbekistan. It suffers from extensive droughts, partly because of weather patterns, but also largely because the waters in the Amu and Syr Darya rivers that feed the region's Aral Sea were once diverted into cotton and rice farmlands by Soviet irrigation projects. The consequent shrinking of the Aral Sea, dubbed "one of the planet's worst environmental disasters," has rendered the RK, once a thriving agricultural and fishing area, almost desolate with a devastated local economy.[2]

B. Sector Context

2. The RK, which occupies the entire northwest of Uzbekistan, is primarily an arid desert, composed of sparse, barren lands subject to severe droughts. Water resources suitable for drinking water in the region are limited, made worse by the Aral Sea environmental disaster. In addition, the river flow from the Amu Darya, one of the region's primary sources of water supply, is projected to decline in the coming years because of receding glaciers in the upstream areas of Tajikistan. Higher demand upstream, reflecting the combined effects of changing rainfall patterns and increased evaporation caused by higher temperatures, will exacerbate the water stress and competition that already exist among the various areas highly vulnerable to climate change in Central Asia. Groundwater is pervasive throughout RK but is mostly brackish and prohibitively expensive to treat for human consumption.

3. The water supply system of RK consists of three main water treatment plants and interregional transmission and distribution mains owned and operated by the State Unitary Enterprise Department for Operation of Interregional Water Supply Tuyamuyun-Nukus (TN). Like many of its Soviet-style counterparts in Central Asia, the system is outdated, deteriorated, and poorly maintained. Consequently, it has become unreliable, with water supply available for only a few hours a day. The system's leakage losses are increasing and the water quality it produces is poor. Only about a third of RK's population is connected to TN's centralized water supply system. Connectivity varies from 65% in the urban centers to 22% in the surrounding outer settlements, declining to as low as 13% in the rural areas. Many households in the RK link the limited supply and poor quality of water in the region to the surge of infectious diseases in their districts.

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[1] The five regions are Jizzak, Namangan, Surkhandayra, Kzhorezm, and the Republic of Karakalpakstan.

[2] The Aral Sea is an endorheic lake, or closed drainage basin, between the Republic of Karakalpakstan in the south and Kazakhstan in the north. Formerly one of the four largest lakes in the world, the Aral Sea has been shrinking. Early in the 20th century, the shrinking was blamed on the rate of evaporation exceeding the rate of inflow, but in the 1960s the shrinking accelerated after the rivers that fed it were diverted by Soviet irrigation projects into vast cotton and rice farmlands located upstream. By 1997, the Aral Sea had been reduced to a mere 10% of its original size. The shrinking of the Aral Sea has been called "one of the planet's worst environmental disasters," bringing unemployment and economic hardships into the Karakalpakstan region.

C. Economic Rationale

4. The project will contribute to narrowing the regional imbalance in Uzbekistan by improving the public health, as well as living and economic, conditions in the RK. It will address private market failure and the deficient level of public investment in the region for adequate water supply. These two key factors have caused water supply in the RK to be unsafe and unreliable. This situation, compounded by the region's increasing vulnerability to climate change, will exacerbate the economic, environmental, and health issues confronting the RK.

5. The project will expand and upgrade water supply infrastructure in the urban and rural areas of six selected project districts of the RK. Planned infrastructure improvements include the construction and rehabilitation of water transmission mains, water distribution pipes, distribution centers, the rehabilitation of two existing water treatment plants, and the construction of a new water treatment plant. Overall, the project will expand access to more climate-resilient, reliable, and affordable water supply services in the RK for an estimated 400,000 people. It will also improve the operations and business model of TN, the sole water and sewerage service provider in the region, contributing to its financial and institutional sustainability in the long run.

D. Demand Analysis

6. Residential demand for water was estimated based on a 25-year population forecast prepared by the Design Institute under the Ministry of Housing and Communal Services (MHCS). A technical due diligence report prepared under the project preparatory technical assistance (TA), and subsequently complemented by a poverty and social assessment (PSA) survey, revealed that only 36.6% of the total population in the RK project areas had access to piped water. To calculate the incremental residential demand for water generated by the project, it was assumed that the remaining unserved population in the district areas would finally be connected to the central water supply system through the project. For this, the water consumption rate of the target households was used, starting from an average of 50 liters per capita per day (lpcd) and gradually increasing to the target 120 lpcd by 2040. For the commercial and institutional users, their incremental consumption was estimated by taking 20% and 10% of residential demand, respectively.[3] The PSA survey further reported that the average current water consumption in the project areas is 37 lpcd. Piped water consumption, however, just averaged 10 lpcd. Nonincremental demand arising from switching to the piped water to be generated by the project from the use of alternative water sources is, thus, high at 27 lpcd. The PSA survey identified the following as the main sources of drinking water in the project areas other than piped water: (i) hand pumps, (ii) bottled water purchased from water purifying centers or delivered by trucks, and (iii) open sources such as drainage canals and rivers.

7. Based on the Design Institute's forecasts, incremental water demand in the project areas will reach 4.5 million cubic meters (m^3) per year by 2023, almost doubling to 10.1 million m^3 per year by 2030. By 2040, the incremental water demand in the project areas will be 13.8 million m^3 per year. The estimated volume of no incremental water demand in 2023 is 5.5 million m^3 per year, reaffirming the intensity of the hardships being encountered by the target household beneficiaries in accessing clean and uninterrupted piped water services.

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[3] The Design Institute of the MHCS also provided these estimates. This is a commonly used assumption in the planning of water supply networks. See for example, A. Worthington. 2010. Commercial and industrial water demand estimation: Theoretical and methodological guidelines for applied economics research. *Discussion Papers in Economics.* No. 2010-11. Nathan, Australia: Griffith University.

E. Cost–Benefit Analysis

8. The cost–benefit analysis of the project was conducted in accordance with the relevant ADB guidelines.[4] The analysis used cost estimates based on the preliminary engineering design prepared by the Design Institute of the MHCS. The estimated costs and benefits of the project were valued using the domestic price numeraire. For the analysis, the shadow price adjustment factors used were taken from a recent Uzbekistan project of a similar nature.[5] The factors used were 1.11 for tradeable goods and services, and 0.80 for unskilled labor. The annualized benefits and costs of the project were assessed over a 30-year period, allowing for a 5-year construction period, followed by an operating period of 25 years.

9. **Economic costs**. Capital and recurrent operation and maintenance costs, inclusive of physical contingencies but excluding all the transfer payments, i.e., taxes and duties as well as price contingencies, expressed in constant mid-2017 prices, were converted into economic prices by applying the relevant conversion factors.[6]

10. **Economic benefits.** The economic benefits of the project were derived mainly from two sources: (i) the incremental water consumption benefits estimated using the willingness to pay of the consumers; and (ii) the nonincremental benefits in terms of resource cost savings resulting from the switch by the targeted household beneficiaries from alternative water sources to piped water. The PSA survey incorporated a willingness-to-pay survey, which determined that households were willing to pay at least SUM5,000/m^3 for accessing improved water services in the project areas.[7] To arrive at an estimate of the incremental water consumption benefits for the project, the willingness to pay of SUM5,000/m^3 was multiplied by 50 lpcd in 2023, slowly increasing to 120 lpcd by 2040.[8]

11. The resource cost savings associated with switching from alternative water sources to piped water through the project were calculated, starting at SUM5,335/m^3 and decreasing gradually to SUM3,092/m^3 by 2040, using the results of the PSA survey. These savings were derived mostly from costs associated with the purchase and consumption of bottled and purified water, hand pumps, and water storage containers.[9] Additional resource cost savings were also determined based on the survey, which reported that about 14,500 households involving mostly women spent an average of 2.75 days per month sourcing water from vendors, pumping stations, hand pump boreholes, public water reservoirs, and water bodies. The economic value of the time spent by these women fetching water outside their homes was calculated by applying a shadow

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[4] These include the (i) Guidelines for the Economic Analysis of Projects (2017), (ii) Economic Analysis of Water Projects (1998), and (iii) Handbook for Integrating Risk Analysis in the Economic Analysis of Projects (2002).

[5] These shadow price adjustment factors are consistent with similar projects of the same nature in Uzbekistan. See, for example, ADB. 2015. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Republic of Uzbekistan for the Djizzak Sanitation System Development Project.* Manila.

[6] In September 2017, the Central Bank of Uzbekistan devalued the sum by 92.38% to SUM8,100 = $1. While the government has acknowledged that this will affect the total project cost, a methodology for estimating the impact of the devaluation on inflation has yet to be developed and agreed. Bids received on a recent procurement for a similar international donor-funded project reflected that the estimated contract costs have remained unchanged from the pre-devaluation United States dollar estimates as of November 2017.

[7] ADB. 2017. *Poverty and Social Analysis for the Western Uzbekistan Water Supply System Development Project*. Consultant's report. Manila (TA 9286-UZB).

[8] The PSA survey used a contingent valuation methodology to estimate the willingness to pay of SUM5,000/m^3**.** The survey indicated that households were willing to pay as much as SUM5,000/m^3 because they associated clean, safe, and more reliable water supply with increased employment and livelihood opportunities, considerable public health improvements, and significant resource cost savings.

[9] Given water supply interruptions that could last for days, households in the project areas found it necessary to invest in water storage containers that can accommodate up to 50 liters of water.

price factor of 0.4 on the weighted average daily income of SUM58,500 in the project areas (footnote 7).

12. The estimated health benefits of the project were based on the survey finding from the TA, which indicated that residents—whose health was adversely affected by the poor water quality in the region—lost about 15 working days per year.[10] This number of days lost was multiplied by the weighted average daily income in the region and by the number of people affected, which according to the PSA reached almost 15,000 annually.

13. **Economic internal rate of return calculation and sensitivity analysis.** The resulting base case economic internal rate of return (EIRR) is 11.47%, which exceeds the prescribed minimum discount rate of 9% (Table 1). This confirms that the project is economically viable, with anticipated economic benefits greater than the estimated economic costs. A sensitivity analysis, undertaken to test economic viability, ascertained that the project will remain economically robust under the following scenarios: (i) a 10% increase in investment cost, possibly arising from a delayed implementation schedule or higher-than-expected inflation; (ii) a 10% increase in operation and maintenance costs, which can result from higher-than-budgeted personnel salaries and other related costs; (iii) a 10% decline in benefits, possibly resulting from lower-than-projected resource cost savings, consumption benefits, and health benefits; (iv) a combination of scenarios (i), (ii), and (iii); and (v) a delay in subproject benefits by a year (Table 2).

14. **Distribution of benefits and poverty impact.** A distribution analysis of the quantified net benefits of the project was also conducted. The major stakeholders of the project include (i) the government; (ii) labor; and (iii) local households, including those living in the most vulnerable communities in the rural areas outside the city centers of the six selected districts. The analysis confirmed that labor, both skilled and unskilled, and local households stand to gain about $54.8 million or 57.9% of the total estimated $94.6 million project benefits.[11] The poverty impact ratio was also calculated for the quantified benefits to determine the impact of the project on the poor households. The calculated poverty impact ratio is 35.6%. This ratio exceeds the estimated 10% gross domestic product share of the poor in Uzbekistan and confirms that the project has a significant poverty reducing impact.[12]

[10] The PSA survey confirmed the increasing incidence of the following diseases in the project areas: (i) gastrointestinal diseases, (ii) typhoid fever, (iii) urolithiasis diseases, (iv) genitourinary diseases, and (v) musculoskeletal diseases. The prevalence of infectious diseases in Karakalpakstan because of inadequate supply, and poor quality of water is cited in many studies and project reports. See, for example, World Bank. 2015. *Project Performance Assessment Report: Uzbekistan Water Supply, Sanitation, and Health Project (Loan 4261).* Washington, DC.

[11] Calculated using net present values based on a discount rate of 9%.

[12] No data are available on the gross domestic product share of the poor in Uzbekistan. In this case, the suggested rule of thumb is 10%. See ADB. 2001. *Handbook for Integrating Poverty Impact Assessment in the Economic Analysis of Projects*. Manila.

Table 1: Summary Cost–Benefit Analysis
($'000)

Year	Economic Costs: Capital Cost	Economic Costs: Incremental O&M	Economic Benefits: Resource Cost Savings from Switching to Piped Water	Economic Benefits: Incremental Water Consumption	Economic Benefits: Health Benefits	Net Benefits
2018	693					(693)
2019	15,269					(15,269)
2020	39,735					(39,735)
2021	38,594					(38,594)
2022	37,657					(37,657)
2023	3,899					(3,899)
2024		1,257	8,206	7,856	3,362	18,167
2025		1,257	8,064	9,190	3,396	19.393
2026		1,257	7,921	11,181	3,430	21,275
2027		1,257	7,779	12,595	3,464	22,582
2028		1,257	7,637	12,770	3,499	22,649
2029		1,257	7,494	12,947	3,534	22,719
2030		1,257	7,352	13,127	3,569	22,791
2031		1,257	7,210	13,975	3,605	23,533
2032		1,257	7,067	14,169	3,641	23,620
2033		1,257	6,925	14,366	3,677	23,712
2034		1,257	6,783	14,565	3,714	23,806
2035		1,257	6,641	15,471	3,751	24,606
2036		1,257	6,498	15,686	3,789	24,717
2037		1,257	6,356	15,905	3,827	24,831
2038		1,257	6,214	16,126	3,865	24,948
2039		1,257	6,128	16,351	3,904	25,126
2040		1,257	6,071	18,086	3,943	26,843
2041		1,257	6,014	18,338	3,982	27,078
2042		1,257	5,929	18,593	4,022	27,288
2043		1,257	5,787	18,853	4,062	27,445
					EIRR =	11.47%
					NPV at 9%=	25,501

( ) = negative, EIRR = economic internal rate of return, NPV = net present value, O&M = operation and maintenance.
Source: Asian Development Bank estimates.

Table 2: Economic Evaluation and Sensitivity Analysis

Scenario	EIRR (%)	NPV ($'000)	Switching Value ($'000)	Sensitivity Indicator
Base Case	11.47	25,501		
Case 1: 10% increase in capital cost	10.43	15,670	23.62	4.23
Case 2: 10% increase in O&M	11.41	24,830	401.29	0.25
Case 3: 10% decrease in benefits	10.28	12,741	20.68	4.54
Case 4: 10% increase in capital cost 10% decrease in benefits	9.18	1,948		
Case 5: Delay in project benefits by 1 year	10.11	11,912		

EIRR = economic internal rate of return, NPV = net present value, O&M = operation and maintenance.
Source: Asian Development Bank estimates.