DETAILED ECONOMIC ANALYSIS

A. Introduction and Methodology

1. The economic analysis was undertaken in accordance with Asian Development Bank (ADB) guidelines, including Guidelines for the Economic Analysis of Projects.[1] The analysis describes the economic rationale, the rationale for public intervention, and the scenario without the project. It is assumed that in the future scenario without the project the existing solid waste management systems deteriorate, and reduced services force residents to use other, less efficient means of waste disposal. The economic analysis compares the economic internal rate of return (EIRR) with the economic opportunity cost of capital (EOCC), which is assumed at 12% as applied in infrastructure project studies in Uzbekistan. Sensitivity and risk analyses assess the robustness of the project's economic performance under changes in the main parameters for costs and benefits. The analysis uses a standard cost–benefit methodology with shadow pricing and conversion factors to convert the financial cost and benefits into economic terms. The analysis is undertaken in constant 2012 prices over a project life of 25 years.

B. Economic Rationale

2. The Tashkent solid waste management (SWM) system needs immediate improvement, as most of its assets are at the end of their economic life and the Akhangaran dumpsite is almost full. Many of the community collection points require rehabilitation, the fleet of aged collection vehicles needs to be replaced, and the transfer stations need to be refurbished and upgraded. Moreover, a new sanitary landfill facility, designed and operated to international standards, is needed to replace the Akhangaran dumpsite. The present facility lacks properly engineered environmental protection systems and is likely already polluting the surrounding environment. Where they exist, the SWM systems of the peri-urban and rural areas in Tashkent Province are in even worse condition, characterized by dilapidated collection equipment, inefficient SWM, and a proliferation of open dumpsites. Recycling is in its infancy throughout the region.

3. These challenges have been fully recognized by the Government of Uzbekistan, which in addition to prioritizing this project initiative is currently acquiring replacement waste collection trucks through a lease-to-own arrangement to improve Tashkent's waste collection system. It is also developing an additional 30 hectare dumpsite adjacent to the existing Akhangaran dumpsite as an emergency disposal measure to avert a future disposal crisis.

4. The rationale for government intervention in the SWM sector results from the increasing concern over deteriorating assets and facilities in the country. This has increased the cost of SWM and the potential for health and environmental costs to the public. In recognition of the need to rehabilitate and developed SWM services, the government has proposed embarking on an investment program, with this project as the start of a major sector-wide program.

C. Waste Generation Analysis

5. Tashkent is estimated to generate 650,000 tons of municipal solid waste (MSW) per year. The amount of waste currently taken to the Akhangaran dumpsite averages 1,600 tons per day, made up of about 1,225 tons of household waste and 380 tons of commercial waste. The average per capita waste generation confirmed by waste characterization surveys is 0.56

[1] ADB. 1993. *Guidelines for the Economic Analysis of Projects.* Manila.

kilograms per day, which closely correlates with waste generated from a population of 2.3 million in Tashkent. Recycling is currently estimated to be 5% of the volume of waste, mostly in the form of polyethylene terephthalate plastic, paper, and cardboard.

6. In the future, waste from Tashkent is projected to increase to 960,000 tons per year by 2037, 25 years hence, allowing for population growth of 1% per year and an increase in per capita waste generation of 1% per year to allow for future improvements in the standard of living and consumption. The percentage of recycling is projected to increase to 15% from the current 5% within 5 years of project inception as a result of positive support for separation and recycling. The average daily volume of waste handled by the landfill is therefore projected to first decrease as with greater recycling, then increase to 1,650 tons per day by 2020 and finally to 2,237 tons per day, or over 800,000 tons per year, by 2037. All this waste will require disposal at the Akhangaran landfill. A summary of the solid waste projects for Tashkent is shown in Table 1.

Table 1: Tashkent City Solid Waste Projections

			1	2	3	4	5	6	7	8	13	18	23	25
Item		**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**	**2035**	**2037**
Akhangaran Landfill														
Tashkent city population		2,319,465	2,342,660	2,366,086	2,389,747	2,413,645	2,437,781	2,462,159	2,486,780	2,511,648	2,639,768	2,774,422	2,915,946	2,974,556
Waste generation capita kg/day	0.55	0.556	0.56	0.57	0.57	0.58	0.58	0.59	0.60	0.63	0.63	0.66	0.70	0.71
Adjustment CPI increase	1%													
Total waste generated per day	tonne	1,288	1,314	1,341	1,368	1,423	1,423	1,452	1,481	1,511	1,669	1,843	2,036	2,119
Recycling percent		5%	5%	7%	12%	15%	15%	15%	15%	15%	15%	15%	15%	15%.
Net household waste to landfill	tonne	1,224	1,249	1,247	1,204	1,186	1,210	1,234	1,259	1,284	1,419	1,567	1,731	1,801
Commercial waste	33%	400	404	408	412	416	420	425	429	433	455	478	503	513
Adjustment for CPI increase	1%													
Recycling percent		5%	5%	7%	12%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Net commercial waste to landfill	tone	380	384	379	363	354	357	361	365	368	387	407	427	436
Total waste to landfill per day		**1,604**	**1,632**	**1,626**	**1,566**	**1,540**	**1,567**	**1,595**	**1,623**	**1,652**	**1,806**	**1,974**	**2,158**	**2,237**

D. Cost of Waste Collection

7. A summary of the current tariffs for waste collection in Tashkent city (which were revised and increased in August 2012) is shown in the table below.

Table 2: Tashkent City Waste Collection Tariffs
August 2012

Category	Unit	New Tariff Aug 2012	Cost per ton US$
Community	Sum/capita/month	1,500	45
Budget	Sum/m^3	18,000	15
Commercial	"	22,641	20
Assoc. of HH	"	22,641	20
Transfer Stations	"	4,896	4.16

Notes
Per capita waste generation of 0.56kg/day.
Exchange rate of UZS1,960 : US$1.0.
One ton waste equivalent to 1.667 m^3.

8. For households, the tariff of SUM1,500 per capita per month at average waste generation of 0.56 kilograms per capita per day is equivalent to a collection cost of $45/ton at the current official exchange rate. For budget enterprises, which do not earn revenue, the comparable rate is $15/tons, while for commercial enterprises and household associations the cost is $20/tons. The average cost for all waste is about $35/ton. These rates are regarded as higher than the usual international benchmarks for a similar urban setting.

9. In 2011 total income for Maxsustrans, the entity responsible for SWM for Tashkent city, amounted to an equivalent of around US$14.0 million, or an average of US$24.50/tons of waste deposed at the Akhangaran landfill at the official historical exchange rate at that time. In 2013 because of the increased tariffs, Maxsustrans' gross income is expected to be higher, in the order of $20 million.

10. Current SWM services in Tashkent provide an acceptable service, as confirmed by the socioeconomic survey conducted as part of the feasibility study, with essentially the city's entire waste generation collected regularly and taken to the landfill. Although some areas report that waste is not always collected according to the stated schedule, residents not have to resort to other means of disposing of waste, either by transporting it to unofficial dumpsites, burning it, or other means.

E. Economic Analysis Methodology

11. Conventional cost–benefit analysis methodology is applied for the economic analysis based on the future with the project minus the future without the project. As the existing SWM system is functioning reasonably effectively, though at a higher cost than international norms, the project will not provide any enhanced or new waste collection services over current SWM. This contrasts with a project developing a new water supply or sanitation system, which results in a change from expensive and unreliable alternative supply to the new system. Therefore, the methodology of valuating improved services with consumers' willingness to pay is not applicable, as in this case the project will only maintain the current system and not replace more costly alternative waste disposal systems. The future without the project assumes that municipal SWM services would deteriorate and break down, such that eventually communities and commercial establishments would have to start making their own arrangements to dispose of

waste and avoid having it pile up in the streets. This would bring higher collection and disposal costs and associated environmental, social, and health consequences. Thus the main economic benefits of the project are the savings in costs that would be incurred in the future without the project if the project were not implemented.

F. Economic Costs

12. Costs were prepared based on the prices applicable in November 2012, with taxes and duties included where applicable. Costs are expressed in US dollars, and, where necessary, an exchange rate of $1 = SUM1,960, the official exchange rate at project preparation, is used to convert costs in the local currency to US dollars. Economic costs exclude taxes, duties, and transfer payments. Financial prices are converted to economic prices using standard conversion factors calculated from the cost breakdown. The shadow wage rate factor for unskilled labor is assumed to be 0.8. The economic life of the project is assumed to be 25 years from 2014 to 2038.

13. The main components of the project (i) replace waste collection trucks, including with those procured by the government in 2013; (ii) rehabilitate two transfer stations and close the third; (iii) establish manned and guarded collection points and replace waste bins; (iv) develop the first 14 hectares of a new sanitary landfill at Akhangaran and close the existing landfill; (v) procure landfill machinery for the next 10 years; and (vi) provide associated technical assistance and capacity building programs. The total investment cost of the initial project for 5 years is estimated to be $74.5 million including contingencies and excluding interest during construction. Base costs before contingencies are $65.67 million. The investment costs in economic terms are reduced to $63.940 million. Subsequent costs for operation and maintenance, replacing the waste collection fleet and landfill machinery, and the continuing expansion of the landfill facility over 25 years are expected to be funded from the cash flow from waste collection and disposal operations. Total investment costs over this period, including expanding the landfill site and replacing waste collection trucks and landfill machinery, are estimated to be $191 million in constant 2012 economic prices. Benefit cash flows are also included in costs.

G. Economic Benefits

14. The major economic benefits of the rehabilitation and rationalization of Tashkent's SWM will arise from its continuing efficient SWM services, recycling waste material, and establishment of a new sanitary landfill at the Akhangaran site operated to international standards. Considerable secondary benefits are expected to arise from an improved and efficient SWM and landfill by reducing environmental impact, such as lower medical costs, fewer sick days, increased productivity, and reduced air pollution, as well as potential clean development mechanism benefits,[2] though these have not been included in the analysis as they are too difficult to quantify in monetary terms in a meaningful and comparable manner.

15. In the absence of the project the average cost of waste collection and disposal would increase as the aged and obsolete waste collection trucks break down, have higher operation and maintenance costs, and are out of service more often. Within a few years the Akhangaran landfill would fill to capacity, and the city administration would be forced to use other dumpsites, if they were available. Eventually communities and commercial operations would be forced to make their own arrangements for disposing of their waste through informal and less effective means, increasing the average cost of collection and disposal through more time having to be

[2] Clean Development Mechanism. http://cdm.unfccc.int/

spent dealing with their waste and less efficient collection and disposal. Some residents might resort to incinerating their own rubbish, contributing to air pollution, or using waste land in the city for illegal dumping. The net result would be an increased cost and greater environmental and social harm.

16. **Estimation of economic benefits.** Non-incremental waste collection benefits are those accruing to the economy as a result of the project preventing the city administration and residents having to move to less efficient waste collection and disposal as the SWM system continues to deteriorate in the future without the project. The opportunity cost of this situation has been estimated as a 5% increase per year in average waste collection and disposal cost over the first 10 years of the life of the project. The project will also create immediate efficiency gains in SWM brought about by the operation of the new waste vehicle fleet and the rationalization of waste collection and disposal operations; this benefit is assumed to be a 20% reduction in the average cost of waste collection and disposal costs for communities and a 10% reduction for budget and commercial enterprises.

17. **Increased recycling benefits.** The project is assumed to increase the percentage of waste that is separated and recycled from the current 5% to 15% within 5 years as a result of greater support and publicity for recycling. In the absence of the project, the future recycling percentage is assumed to increase only to 10% of the volume of waste, but it is recognised that an increase in recycling is likely to occur without the project situation as a result of the general increase in public awareness and the development of private enterprise in the sector. Increased recycling as a result of the project has two benefits: (i) the reduction in the volume of waste that has to be collected and transported to the landfill and (ii) the economic value of the recycled materials that would otherwise be discarded into the landfill. The saving in waste volume is projected to increase from 25,000 tons per year at the start of the project to 48,000 tons per year by 2037.

18. The value of recycled material, mostly polyethylene terephthalate plastics, varies according to international supply and demand, but in December 2012 such bottles, the main recycled product, was reported selling for $1,500/ton of clean flake, freight on board from suppliers. For the purpose of analysis, a conservative value of $250/ton is used for the economic value of recycled materials, which allows for other recyclables in the mix, processing and handling costs, and a longer term value.

19. **Other benefits.** The project can be expected to result in several other benefits through the maintenance and improvement of the SWM system compared with the situation without the project. These include the prevention of illegal dumping of waste, or in an extreme case the piling of waste in the streets with the associated risk from flies and other vermin and other health risks. The avoidance of informal burning and incineration of waste contributing to smoke and air pollution, and of associated respiratory health effects, would be another positive benefit. Deteriorating SWM would affect the quality of life and appeal of the city, detracting from its appearance as a modern, attractive, clean environment conducive to attracting more tourists and contributing to the quality of life of its residents.

20. Other economic benefits may accrue through the clean development mechanism and credits for carbon capture in the sanitary landfill. While there are economic tools to assist in valuating these impacts and to allow them to be counted in the economic analysis (for example assuming savings in lost days from sickness and even loss of a life valued at gross domestic product per capita) information specific to Tashkent is insufficient to meaningfully quantify these benefits.

H. Economic Analysis Results

21. The economic effectiveness of the proposed project was measured using the EIRR. The project is considered economically feasible if the EIRR is greater than the EOCC at 12%. The EIRR was further tested for sensitivity to changes in the three most important parameters in the analysis: (i) a 20% increase in capital cost, (ii) a 20% decrease in the saving in operating costs, and (iii) a 20% decrease in revenue from recycled material. Table 3 presents a summary of the economic analysis and the results of the sensitivity analysis.

22. The project EIRR is 17.4%. Sensitivity tests found the project to be robust and economically feasible but most sensitive to a 20% increase in investment costs. The calculated EIRR is expected to be lower than the economic return, as the value of the considerable unquantified economic, social, and environmental benefits is not included in the analysis.

Table 3: Summary of Economic Analysis
Tashkent City Rehabilitation and Akhangaran Landfill Development

Year	Economic Costs $ '000	Benefits				Net Benefits (Cost)				
		Volume $ '000	Costs $ '000	Recycling $ '000	Total $ '000	Base Case $ '000	Investment 20%'US$ $ '000	Volume -20% $ '000	SWM cost -20% $ '000	Recycling -20% $ '000
2014	52,079	-	0	0	0	-52,079	-62,495	-52,079	-52,079	-52,079
2015	5,580	-	4,339	0	4,339	-1,242	-2,358	-1,242	-2,110	-1,242
2016	501	955	4,395	6,496	11,846	11,345	11,245	11,154	10,466	10,046
2017	162	1,276	4,544	8,265	14,085	13,923	13,890	13,668	13,014	12,270
2018	5,618	1,363	4,865	8,412	14,640	9,022	7,898	8,749	8,049	7,340
2019	1,007	1,457	5,208	8,561	15,226	14,219	14,018	13,928	13,178	12,507
2020	7,924	1,557	5,575	8,714	15,846	7,922	6,338	7,611	6,807	6,180
2021	1,007	1,664	5,968	8,869	16,502	15,495	15,294	15,162	14,301	13,721
2022	40,307	1,778	6,390	9,028	17,196	-23,111	-31,172	-23,467	-24,389	-24,916
2023	1,007	1,901	6,840	9,189	17,930	16,923	16,722	16,543	15,555	15,085
2024	1,007	2,031	7,323	9,353	18,708	17,701	17,499	17,295	16,236	15,830
2025	1,007	2,171	7,840	9,521	19,532	18,525	18,323	18,090	16,957	16,621
2026	7,924	2,210	7,993	9,691	19,895	11,971	10,386	11,529	10,372	10,033
2027	1,007	2,250	8,150	9,865	20,265	19,258	19,056	18,808	17,628	17,285
2028	1,493	2,290	8,309	10,042	20,642	19,149	18,850	18,691	17,487	17,141
2029	1,007	2,331	8,472	10,223	21,026	20,019	19,818	19,553	18,325	17,975
2030	40,307	2,373	8,638	10,407	21,418	-18,888	-26,950	-19,363	-20,616	-20,970
2031	7,924	2,416	8,808	10,594	21,818	13,894	12,309	13,411	12,132	11,775
2032	1,007	2,459	8,981	10,785	22,225	21,218	21,017	20,726	19,422	19,061
2033	1,007	2,504	9,157	10,979	22,640	21,633	21,432	21,132	19,802	19,437
2034	1,007	2,549	9,337	11,177	23,063	22,056	21,855	21,546	20,189	19,821
2035	7,924	2,595	9,520	11,379	23,494	15,570	13,986	15,051	13,667	13,295
2036	1,007	2,642	9,707	11,585	23,934	22,927	22,726	22,399	20,986	20,610
2037	1,007	2,690	9,897	11,795	24,382	23,375	23,174	22,837	21,396	21,016
2038	1,007	2,739	10,092	12,009	24,839	23,832	23,631	23,284	21,814	21,430
			Discount Rate @ 12%		EIRR	17.4%	13.3%	17.0%	15.5%	15.0%
					ENPV	23,730	6,723	21,584	15,162	12,690
			Sensitivity Indicator		EIRR		3.8	0.4	1.7	2.2
					ENPV		3.6	0.5	1.8	2.3
			Switching Value		EIRR		27%	242%	58%	44%
					ENPV		28%	221%	55%	43%

ENPV=economic net present value, EIRR=economic internal rate of return, SWM = solid waste management.