

People's Republic of China

FY 2017 Ex-Post Evaluation of Japanese ODA Loan Project
“Hunan Municipal Solid Waste Treatment Project”

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Japan Inc.

0. Summary

The objective of the project is to facilitate the appropriate treatment of waste generated in local cities (16 cities and counties) in Hunan Province by developing a suitable waste treatment system, thereby contributing to improvement of the living as well as sanitation conditions for inhabitants and environmental consideration in these areas. The Project is highly relevant to the development needs of the Government of China and Government of Hunan Province such as improvement of the living and sanitation conditions and environmental conservation in the province. It is also relevant to Japan's ODA policy. Therefore, its relevance is high. In relation to efficiency, while the project cost was within the planned cost, the project period was significantly longer than the planned period (2.64 times longer than planned). Therefore, the efficiency of the Project is only fair. As a result of the successful introduction of facilities to treat urban household waste under the Project, the target values for the operation indicators (treatment volume at sanitary landfill facilities, BOD and COD¹ concentration, volume of suspended solids, waste collection rate, etc.) set during the project appraisal have been generally achieved. Meanwhile, the service population which is an effect indicator far exceeds the target value. Moreover, positive confirmation has been made for such qualitative indicators as “improvement of the living conditions and townscape”, “improvement of the water quality of water sources as well as river water” and “fostering of related industries”. Significant improvement has been specially observed in the case of “living conditions and townscape”. Therefore, the effectiveness and impacts of the Project are high. In regard to the “waste sorting facility” constructed under the Project (in Changsha), there is a structural problem in that the sorting of solid waste as a precondition for the efficient operation of this facility has not been achieved. The facility also faces the difficulty for the outsourced private enterprise to secure the profitability of operation due to the lack of any subsidy. Meanwhile, the sustainability of treatment facilities in the other 15 cities and counties is judged to be high in terms of the institutional, technical and financial aspects and the current status of operation and maintenance. Therefore, the sustainability of the positive effects of the Project as a whole is high.

Based on the above, the Project is evaluated as highly satisfactory.

¹ COD means chemical oxygen demand, and BOD means biological oxygen demand.

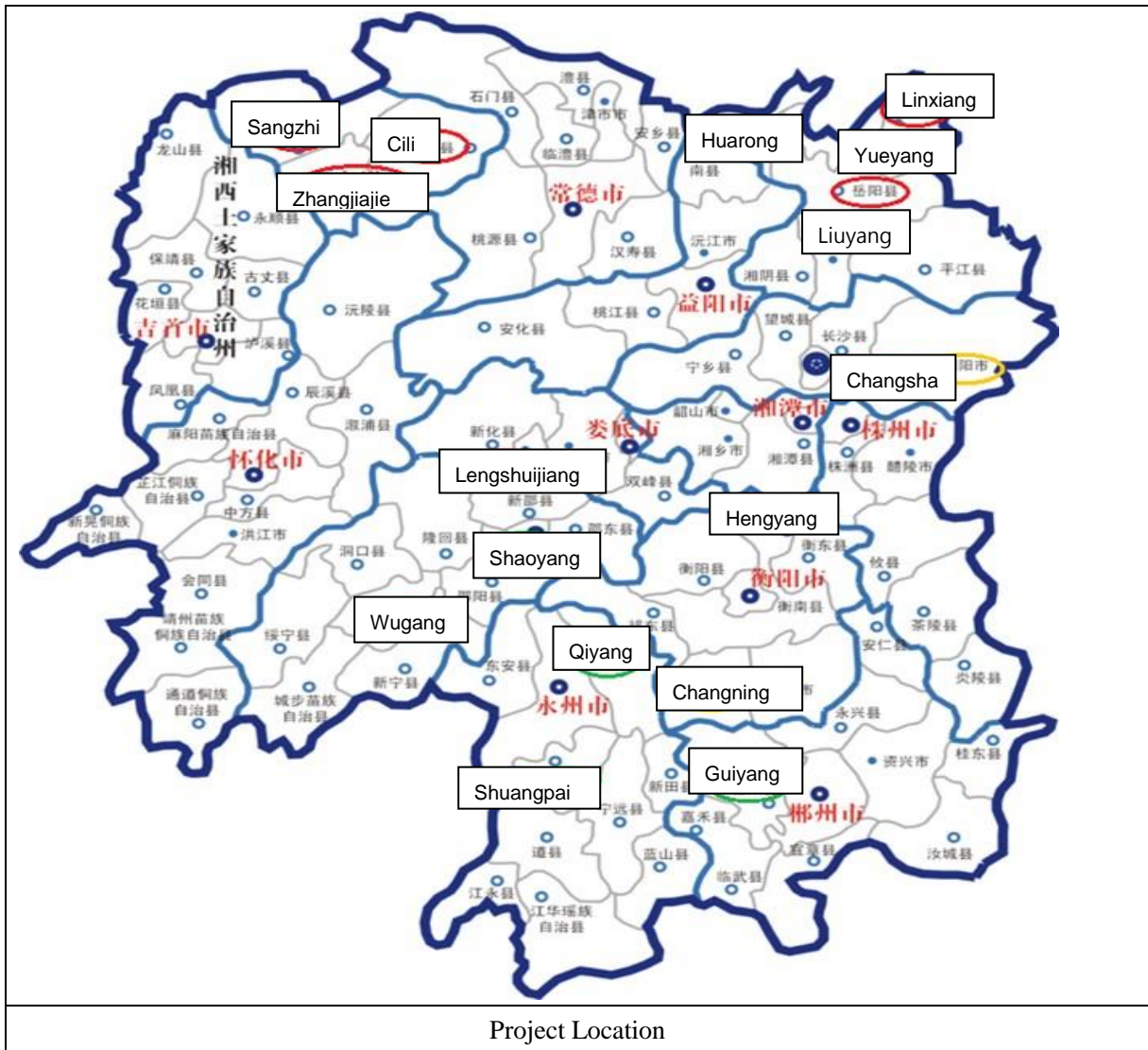
1 . Project Description



Landfill facility constructed under the Project (Huarong)



A large container procured under the Project (Hengyang)



Project Location

1 . 1 Background

In its *10th Five Year National Plan for Environmental Protection (2001 – 2005)*, the Government of the People’s Republic of China (hereinafter simply referred to as “China”) prioritized the establishment of an efficient waste treatment system (sorted collection, storage/transportation and treatment) and the volume reduction as well as recycling of solid waste while promoting the detoxification² of urban household waste and the centralized safe treatment of hazardous waste. The reality of urban household waste in China, however, was that the treatment capacity could not catch up with the ever increasing volume of such waste. Even though the number of detoxification facilities, such as sanitary landfill facilities and incineration plants, and their overall treatment capacity increased to 471 sites and 256,300 tons/day (annual detoxification treatment volume of 80.51 million tons) respectively, the collection/transportation volume was as much as 156 million tons in 2005, reducing the detoxification rate in 2005 to 51.7% from the previous year. Under these circumstances, the Outline of the 11th Five Year National Plan for Economic and Social Development emphasized the construction of urban household waste treatment facilities as part of enhanced environmental protection and set up the target detoxification rate of exceeding 60% by 2010.

In Hunan Province, the development of waste treatment infrastructure had been considerably slow, partly because of the relatively late start of conscious waste treatment efforts. The volume of generated urban household waste in 2005 was 8.82 million tons while the detoxification rate in the urban areas of counties remained as low as 1.3%. The common practices in most areas of the province were treatment at simple landfill facilities which did not meet the national standards, open-air dumping and open-air burning among others, causing serious detrimental impacts on the soil, rivers, groundwater, air, etc. There was, therefore, an urgent need to secure new sanitary landfill sites with a view to improving the sanitation as well as living conditions in local cities of the province.

1 . 2 Project Outline

The purpose of the Project was to facilitate the appropriate treatment of waste (household waste) generated in local cities (16 cities and counties) in Hunan Province by means of developing a suitable waste treatment system, thereby contributing to improvement of the living as well as sanitation conditions for inhabitants and environmental conservation in these areas.

² Detoxification treatment in China is conducted in accordance with the relevant national standards and means sanitary landfill, composting or incineration.

Loan Approved Amount / Disbursed Amount	10,500 million yen / 10,483 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	December, 2007/ December, 2007
Terms and Conditions	Interest Rate 0.65% Repayment period 40 years (Grace Period: 10 years) Conditions for Procurement General untied
Borrower / Executing Agencies	Government of the People's Republic of China/ Hunan Provincial People's Government
Project Completion	October, 2015
Main Contractor (Over 1 billion yen)	-
Main Consultant (Over 100 million yen)	-
Related Study	Feasibility Study by the Hunan Province International Engineering Consulting Co., Ltd.
Related Project	-

2. Outline of the Evaluation Study

2. 1 External Evaluator

Toshihiro Nishino and Miho Sakuma, (International Development Center of Japan Inc.)

2. 2 Duration of Evaluation Study

The ex-post evaluation study for the Project was conducted over the following period.

Duration of the Study: July, 2017 – March, 2019

Duration of the Field Survey: November 12 – 25, 2017 and January 26 – February 8, 2018

2. 3 Constraints during the Evaluation Study

It was originally planned to adopt the random sampling method using the resident register to select the subject persons for an interview survey featuring beneficiaries and resettled inhabitants due to the construction of a sanitary landfill facility in order to ensure the objectivity of the survey. However, it was found that no government-affiliated research institutions in China used this sampling method to obtain public opinion and that the implementing enterprise in each city or country had no previous experience of using the said method. It was decided, therefore, to designate areas of residence, gender, age group and other matters (ordinary citizens not related to the administration, etc.) of the subject people for interview while leaving the actual selection to the implementing enterprises. This means that the interview results may not necessarily represent the overall opinions of the beneficiaries, etc.

3. Results of the Evaluation (Overall Rating: A³)

3.1 Relevance (Rating: ③⁴)

3.1.1 Consistency with the Development Plan of China

The development policy of China at the time of the appraisal of the Project emphasized environmental issues, including the treatment of waste, as priority policy issues as indicated in *the 10th Five Year National Plan for Environmental Protection (2001 – 2005)* and *Outline of the 11th Five Year National Plan for Economic and Social Development (2006 – 2010)*. In view of the fact that there was a shortage of the absolute number of facilities to treat urban household waste, particular emphasis was placed on the construction of such facilities to establish an efficient treatment system comprising sorted collection, storage/transportation and treatment, thereby improving the detoxification treatment rate of urban household waste. Subsequent five year plans have consistently emphasized the establishment of an efficient treatment system and improvement of the detoxification rate of urban household waste. Following some concrete progress of the construction of urban household waste treatment facilities, *the 13th Five Year National Plan for Economic and Social Development (2016 – 2020)* and other plans and policies at the time of this ex-post evaluation call for the strengthening of efforts to promote urban household waste treatment of a higher standard, including “further improvement of the detoxification rate (95% or higher)”, “technological development and enhancement of facilities relating to incineration, biological treatment, waste-to-energy, waste sorting, etc.”, “realization of the volume reduction and recycling of waste at a higher level” and “promotion of the disclosure of information on waste treatment”.

In response to these policies of the central government, the government of Hunan Province has been intensifying its efforts to deal with urban household waste. *The 13th Five Year Plan of Hunan Province (2016 – 2020)* envisages the stable operation of urban household waste treatment facilities in the province with a view to achieving a 100% urban household waste detoxification rate at the county level. Meanwhile, Changsha City has been designated a city for the enhanced sorted collection of waste by the central government. Trial sorted collection was implemented in parts of the city in 2016 and it is currently planned to promote the city-wide sorting and volume reduction of household waste based on *the Changsha Municipal Plan to Implement a Sorted Waste Collection System*.⁵

Accordingly, the Project is relevant to the household waste treatment policy of China at the time of both its appraisal and ex-post evaluation because “it seeks to improve the living and sanitation conditions of local inhabitants and to facilitate environmental conservation through the establishment of an efficient urban household waste treatment system”.

³ A: Highly satisfactory; B: Satisfactory; C: Partially satisfactory; D: Unsatisfactory

⁴ ③: High, ②: Fair, ①: Low

⁵ Based on the reply to the questionnaire by the implementing enterprise and the Changsha Municipal Plan to Implement a Sorted Waste Collection System (December 22, 2017).

Table 1 Principal Targets of Development Plans Related to the Project

Category	At the Time of Appraisal	At the Time of Ex-Post Evaluation
Waste Treatment Policy/National Development Plan	<p><u>10th Five Year National Plan for Environmental Protection (2001 – 2005)</u></p> <ul style="list-style-type: none"> Establishment of an efficient waste treatment system (sorted collection, storage/transportation and treatment) to prioritize the volume reduction and recycling of solid waste while promoting the detoxification of urban household waste and centralized safe treatment of hazardous waste <p><u>11th Five Year National Plan for Economic and Social Development (2006 – 2010)</u></p> <ul style="list-style-type: none"> Emphasis on the construction of urban household waste treatment facilities as part of the policy to strengthen environmental protection, strengthening of the collection of the urban household waste treatment charge and improvement of the detoxification rate to 60% or higher by 2010. 	<p><u>13th Five Year National Plan for Environmental Protection (2016 – 2020)</u></p> <ul style="list-style-type: none"> Improved volume reduction, recycling and detoxification of urban household waste to achieve a nationwide detoxification rate of urban household waste of 95% or higher Full development of a waste collection, storage and transportation system to facilitate the enclosed collection and transportation of waste throughout the system in urban areas Strengthening of treatment of exuded water from waste, treatment of incineration ash, utilization of methane generated at landfill sites and treatment of foul odor while facilitating the public disclosure of the state of pollutant discharge from waste treatment facilities. <p><u>13th Five Year National Plan for Economic and Social Development (2016 – 2020)</u></p> <ul style="list-style-type: none"> Urgent construction of urban household waste treatment facilities along with the full development of the collection and transportation system, improvement of the waste incineration rate and full installation of an exuded water treatment system; full installation of waste treatment facilities and achievement of the targets specified by the relevant standards.
Ministry of Construction Policy/Related Laws	<p><u>Ministry of Construction : “Act for Management of Urban Household Waste” (2007)</u></p> <ul style="list-style-type: none"> Stipulation of fines when generators of urban household waste fail to pay the obligatory treatment charge. Clarification of stricter requirements for the qualifications to be met by a supervisory body (Department of Environmental Health) as well as private enterprises involved in urban household waste treatment. 	<p><u>Proposal by the Ministry of Construction, etc. Regarding Strengthening of the Urban Household Waste Incineration Business (2016)</u></p> <ul style="list-style-type: none"> Strengthening of the establishment of a support system for the collection, transportation, recycling and terminal treatment of household waste. <p><u>Construction Bureau of Hunan Province: “On the Plan to Accelerate the Construction of Urban Household Waste Detoxification Facilities in Hunan Province” and “Opinion of the People’s Government of Hunan Province on the Promotion of the Recycling of Urban Household Waste” (2014)</u></p> <ul style="list-style-type: none"> Acceleration of the construction of urban household waste detoxification facilities Promotion of the recycling of urban household waste.
Hunan Province Development Plan	<p><u>11th Five Year Plan for Environmental Protection of Hunan Province (2006 – 2010)</u></p> <ul style="list-style-type: none"> Reduction of the total pollutant emission volume by 10% and 	<p><u>13th Five Year Plan for Environmental Protection of Hunan Province (2016 – 2020)</u></p> <ul style="list-style-type: none"> Enhancement of the quality of the environment as a central tenet with emphasis placed on the solving of

	<p>improvement of the urban household waste detoxification rate to 60% or higher in prefectural-level cities (relatively large urban area) and to 20% or higher in urban areas of counties by 2010.</p>	<p>prominent problems in terms of ecology to strengthen ecological conservation.</p> <ul style="list-style-type: none"> • Pursuit of the realization of the total treatment of urban waste, stable operation of treatment facilities and achievement of various indicators. • Achievement of a 100% urban household waste detoxification rate at the county level.
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Source: Materials provided by JICA and various plan documents

3.1.2 Consistency with the Development Needs of China

Because of the relatively slow start of conscious waste treatment efforts, the development of waste treatment infrastructure in Hunan Province significantly lagged behind that of other provinces at the time of project appraisal. The annual volume of urban household waste discharged in 2005 was 8.82 million tons (4.88 million tons from relatively large cities and 3.94 million tons from urban areas of counties). The detoxification rate was 39.7% in large cities and a meagre 1.3% in urban areas of counties. The common practices in most areas of the province were treatment at simple landfill facilities which did not meet the national standards, open-air dumping and open-air burning among others, with serious detrimental impacts on the soil, rivers, groundwater, the air, etc. There was an urgent need to secure new sanitary landfill sites with a view to improving the sanitation as well as living conditions in local cities of the province. At the time of appraisal, four detoxification facilities were under construction in Hunan Province in addition to eight such facilities already in operation. The construction of 15 new sanitary landfill facilities under the Project was expected to contribute to the partial achievement of the target value for the detoxification rate in 2010. To be more precise, the Project was expected to account for 36% of the target rate of 60% or more in relatively large cities and 52.1% of the target rate of 20% in urban areas of counties.⁶

Interviews conducted as part of this ex-post evaluation with those in charge at the implementing enterprises found that the detoxification rate in urban areas of Hunan Province exceeded 95% while the volume of generated urban household waste had significantly increased from the time of appraisal due to an increase of the urban population as well as an increase of the per capita urban household waste generated. Because of the additional need to deal with solid waste discharged in rural areas, the volume of household waste requiring treatment is increasing, making the continual strengthening of the waste treatment facilities in both urban and rural areas essential. Moreover, the progress of the construction of new urban household waste treatment facilities has upgraded the level of required urban household waste treatment. To be more precise, the need for “recycling” and “volume reduction” has increased in addition to “detoxification” from the viewpoint of the effective use of treatment facilities and waste. Food waste treatment and incineration which are the principal means of achieving “recycling” and “volume reduction” are progressing with the introduction of private capital. One

⁶ Materials provided by JICA.

crucial factor for the efficient incineration of waste to achieve a certain level of profitability is the removal of water by means of compression, etc. (to secure a suitable incineration temperature). The construction of a basic urban household waste treatment system has important implications as the foundation for the development of the next level of waste treatment.

Consequently, the Project is relevant to the development needs of both China and Hunan Province at the time of both appraisal and ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

Japan's ODA Charter (2003) at the time of appraisal emphasized efforts to tackle global issues (environmental issues) while *the Medium-Term Policy on ODA (2005)* emphasized the protection of individuals from the "fear" of environmental destruction, etc. from the viewpoint of "human security" and the establishment of such "environmental pollution control measures" as waste treatment as a priority field. All of *the Economic Cooperation Program for China (2001, Ministry of Foreign Affairs)*, *Medium-Term Strategy for Overseas Economic Cooperation Operations (2002, JICA)* and *Country Assistance Strategy for China (2002, JICA)* emphasized environmental conservation, indicating the relevance of the Project to Japan's ODA policies.

3.1.4 Appropriateness of the Project Plan and Approach

In Changsha, Hengyang, Yueyang and other places where a sanitary landfill facility already existed at the time of appraisal, a system was functioning whereby road sweeping workers and dedicated refuse collectors transported urban household waste to a transfer station using a hand cart or a small vehicle, followed by the use of a dedicated garbage truck to transport waste from such transfer station to a major transfer base from which the transferred waste is finally transported to a sanitary landfill facility by a large truck (some of the waste was used for gas power generation). In many other urban areas, once solid waste transferred to a local station filled the storage capacity of the station, it was simply transported to a simple landfill facility in a suburb. As the collection and transportation capacity in these areas was limited, the waste collection service did not reach the stage of detoxification (introduction of sanitary landfill facility).⁷ In the face of such reality, the Project aimed at developing a collection and transportation system following the examples of such large cities as Changsha, etc. in Hunan Province by means of constructing sanitary landfill facilities, transfer stations, etc. in the targeted 15 cities and counties other than Changsha of Hunan Province and also at achieving the "detoxification" and "volume reduction" of solid waste through strengthening of the technical capability by training in Japan.

These sub-projects for 15 cities and counties other than Changsha accounted for most of the project inputs. As the inputs in these target areas have produced outputs leading to the achievement of the project purpose and emergence of positive development effects, it is safe to judge that the declared

⁷ Materials provided by JICA.

purpose of the Project and selected approach to support the Project were appropriate.

Meanwhile, a sub-project to construct a sorting facility was planned for Changsha with a view to advancing to a higher stage of “volume reduction” and “recycling” as the city was the most urbanized area in Hunan Province and had achieved a certain degree of detoxification treatment at the time of appraisal. At that time, five or six such facilities were in operation in Shanghai and the plan for Changsha was based on the operating performance of these sorting facilities in Shanghai. However, no sufficient examination was conducted from the viewpoint of determining whether or not the system in Shanghai was applicable to Changsha. It also appears that examination of the medium to long-term operation cost and profitability of the envisaged system in Changsha was inadequate partly because the implementing enterprise was a state enterprise at the time.⁸The introduction of a sorting facility was the first such attempt in Hunan Province and the actual inputs to this sub-project were the construction of a facility and training in Japan as in the case of other 15 cities and counties. While this component of constructing a sorting facility in Changsha accounted for a minor proportion of the total project input, more careful examination of the necessary support for this component is believed to be necessary because of the more advanced objective of this sub-project compared to other sub-projects.

Based on the above, the Project was relevant to China’s development policies as well as development needs and Japan’s ODA policies at the time of appraisal. The Project is still highly relevant today as the basic direction of the development policies and needs of the Government of China have been maintained. In the case of the sub-project to construct a sorting facility in Changsha, however, given the much higher purpose associated with this sub-project within the Project compared to sub-projects in other 15 cities and counties, more detailed examination of inputs (including the necessity for a technical support component other than the construction of a facility) should have been conducted to produce outputs leading to the achievement of the project purpose and emergence of positive development effects even though this sub-project accounted for only a very small proportion of the Project.

3. 2 Efficiency (Rating: ②)

3. 2. 1 Project Outputs

The planned outputs of the Project at the time of appraisal are shown in Table 2 along with the actual outputs. The outputs by target city/county are given in a separate appendix. The principal outputs of the Project are ① sanitary landfill facility and exuded water treatment equipment at 15 sites (total capacity of sanitary landfill facilities: 65.69 million m³), ② collection and transportation facilities (136 new transfer stations, improvement of 57 transfer stations, etc.), ③ sorting facility for recycling (one in Changsha and ④ training in Japan. The feasibility study for the Project was conducted in 2007. The detailed design of the project contents after signing of the loan agreement (L/A) adjusted the scales of sanitary landfill facilities, exuded water regulating basin and exuded water treatment equipment,

⁸ No relevant information was found in the reference materials used at the time of appraisal.

number of new transfer stations and other components of the Project. As a result, the planned outputs were subsequently changed slightly even though these changes were not large enough to affect the achievement of the purpose of the Project. As shown in Table 2 below, the actual outputs show slight decreases of the total capacities of the sanitary landfill facilities and exuded water treatment equipment.

Table 2 Planned and Actual Outputs

Item	Planned (at the Time of Appraisal)	Actual
Sanitary Landfill Facility	15 sites Capacity: total of 68.28 million m ³ Treatment method: Improved anaerobic method (semi-aerobic method for the Guiyang site only) Capacity: Exuded water regulating basins: total of 309,100 m ³	15 sites Capacity: 65.69 m ³ (96% of planned) Treatment method: Improved anaerobic method (semi-aerobic method for the Guiyang site only) Capacity: Exuded water regulating basins: total of 223,200 m ³ (72% of planned)
Exuded Water Treatment Equipment	15 sites Total capacity: 4,940 m ³ /day	15 sites Total capacity: 2,950 m ³ /day (60% of planned) (The equipment introduced offers a higher treatment level compared to the originally planned at the time of appraisal.)
Collection and Transportation Facility	New transfer station: 132 sites Improved transfer stations: 34 sites Waste collection and transportation vehicles: 193	New transfer stations: 136 sites (104% of planned) Improved transfer stations: 57 sites (168% of planned) Waste collection and transportation vehicles: 224 (116% of planned)
Sorting Facility for Recycling (Changsha)	Sorting facility for recycling: 1,000 tons/day Other facilities: water treatment facilities; warehouse and administration buildings On-site equipment, etc.: bulldozers, loaders and trucks	Sorting facility for recycling: 1,000 tons/day Other facilities: water treatment facilities; warehouse and administration buildings On-site equipment, etc.: bulldozers, loaders and trucks
Training	Training in Japan: 45 persons Training in China: 270 persons	Training in Japan: 92 persons (204% of planned) Training in China: 8 persons (3% of planned)

Sources: Materials provided by JICA and replies to the questionnaire survey with implementing enterprises.

Note: The figures for the capacity of sanitary landfill facilities, capacity of exuded water regulating basins and capacity of exuded water treatment equipment and new transfer stations were adjusted figures by the detailed design.

With some exuded water treatment equipment, the treatment method (level-up, including the addition of a reverse osmosis⁹ device) was changed due to the introduction in 2008 of stricter national standards for the discharge of exuded water after landfill treatment. The adoption of separate treatment for rainwater and foul water meant a decrease of the treatment volume, thereby reducing the scales of the exuded water regulating basin and exuded water treatment equipment in some cities and counties. In Yueyang, the scale of the sanitary landfill facility was reduced partly because of the change of the

⁹ Reverse osmosis treatment relies on a technology which uses a semipermeable membrane which allow only water molecules to pass through to separate and remove dissolved organic matters, salt, etc. in water, making the quality of treated water extremely high.

construction side, in turn necessitated by the designation of the originally planned site as a provincial forest park, and partly because of the construction of an incineration plant. In the case of other related equipment, while the nature of the equipment actually introduced was as planned, the quantity was partially modified due to ① adjustment made by the detailed design, ② additional procurement using the remains of the ODA loan and ③ change of needs. As far as training is concerned, the training sessions in Japan were increased by one to four sessions because of the excellent training effects in Japan where there are many examples of the advanced treatment of solid waste as well as exuded water. As these changes were made to reflect a change of policy and/or actual demands, they are judged to be appropriate.



Treatment of waste at a transfer station (Linxiang)



On-line monitoring system for exuded water quality (Sangzhi)

3.2.2 Project Inputs

3.2.2.1 Project Cost

The actual project cost was 19,152 million yen (86% of planned) as shown in Table 3 and was within the planned cost of 22,169 million yen. The principal factors for this were ① the improvement of some related equipment and transfer stations was conducted with the own funds of the city or county, reducing the cost for the Project, ② the advancement of the separate treatment of rainwater and foul water in some cities and counties had the effect of reducing the capacity of the exuded water regulating basin and exuded water treatment equipment and ③ the capacity of the sanitary landfill facility in some cities and counties was reduced. Considering the fact that higher grade exuded water treatment equipment was installed to match the revised national standards as mentioned earlier, this reduction of the project cost reflected a reduction of the outputs, indicating efforts to contain the Project cost in an adequate manner.

Table 3 Planned and Actual Project Costs

Unit: million yen

	Planned (at the Time of Appraisal)			Actual		
	Foreign Currency Portion	Domestic Currency Portion	Total	Foreign Currency Portion	Domestic Currency Portion	Total
Procurement of Equipment and Materials	9,999	0	9,999	10,141	302	10,443
Civil Engineering Work	0	6,403	6,403	0	4,742	4,742
Training	48	0	48	47	1	48
Inflation	424	0	424	266	73	339
Reserve Fund	510	318	829	14	19	33
Interest during Construction	179	629	807	179	77	256
Commitment Charge	15	0	15	15	66	81
Land Acquisition Cost	0	3,398	3,398	0	2,043	2,043
Management Fees, etc.	0	246	246	0	1,167	1,167
Total	11,175	10,994	22,169	10,662	8,490	19,152

Source: Materials provided by JICA and replies to the questionnaire survey with the implementing enterprises.

Notes

- 1) Foreign exchange rate: planned rate at the time of appraisal: 1 CNY = 15.6 JPY (June, 2007); actual rate: 1 CNY = 14.9 JPY (mean exchange rate for 2007 through 2015)
- 2) Of the planned foreign currency portion, the amount other than the ODA loan was 675 million yen (179 million yen for interest during construction and 496 million yen for the reserve fund)
- 3) Of the actual foreign currency portion, the amount other than the ODA loan was 179 million yen for the interest during construction.

3.2.2.2 Project Period

The actual project period extended to 95 months (December, 2007 to October, 2015), far exceeding the planned period of 36 months (January, 2008 to December, 2010) (exceeded by 59 months or 264% of the planned period). The causes for this excessive extension were ① the time-consuming work to examine the detailed design which was conducted after the signing of the L/A, ② additional work to design a new version of exuded water treatment equipment and to obtain a permit for such equipment as a result of upgrading of the national standards, ③ time-consuming (i) change of the planned sanitary landfill site and (ii) resettlement of inhabitants from the planned construction site for a sanitary landfill facility in some cities/countries and ④ addition to the scope of the construction work to use the remains of the ODA loan.

Table 4 Planned and Actual Project Periods

	Planned (at the Time of Appraisal)	Actual
Signing of the Loan Agreement	December, 2007	December, 2007
Entire Project	January, 2008 - December, 2010 (Project period: 36 months)	December, 2007 - October, 2015 (Project period: 95 months)
Sanitary Landfill Facilities	April, 2008 - December, 2010	September, 2009 - October, 2015
Transfer Stations	August, 2008 - June, 2010	January, 2010 - February, 2015
Sorting Facility	May, 2008 - September, 2009	2009 - ~ October, 2010
Land Acquisition	January, 2008 - December, 2008	December, 2007 - January, 2014
Training	June and October, 2008 and June, 2009	November, 2010 and November, 2013

Source: Materials provided by JICA and replies to the questionnaire survey with the implementing enterprises.

3.2.3 Results of Calculations for Internal Rates of Return (Reference Only)

As neither the economic internal rate of return (EIRR) nor the financial internal rate of return (FIRR) were calculated at the time of project appraisal, it was impossible at the time of ex-post evaluation to compare the performance before and after the Project. Therefore, no analysis of the internal rate of return was conducted.

Based on the above, the project cost was within the planned cost while the project period significantly exceeded the planned period. Therefore, the efficiency of the Project is fair.

3.3 Effectiveness¹⁰ (Rating: ③)

3.3.1 Quantitative Effects (Operational and Effect Indicators)

The situation of various operation and effect indicators set at the time of appraisal or ex-post evaluation to indicate the quantitative effects of the Project are shown in Table 5 below. The situation of these indicators by individual target cities/counties is given in a separate appendix.

¹⁰ Sub-rating for Effectiveness is to be put with consideration of Impacts.

Table 5 Changes of Operation and Effect Indicators

Indicator	Planned Value (two years after project completion)	Actual Value (two years after project completion: 2017)
【Operation Indicators】		
Treatment Volume at Sanitary Landfill Facilities	1,765,465 tons/year	1,377,578 tons/year
BOD Concentration of Exuded Water after Landfill Treatment	30 - 600 mg/l	3.4 - 82.7 mg/l (simple average: 15.7 mg/l)
COD Concentration of Exuded Water after Landfill Treatment	100 - 1,000 mg/l	3.0 - 378.0 mg/l (simple average: 59.0mg/l)
Ammoniac Nitrogen after Treatment	-	0.1 - 34.0 mg/l (simple average: 8.3mg/l)
Suspended Solids	200.0 mg/l	5.0 - 101.0 mg/l (simple average: 18.3mg/l)
Treated Volume of Exuded Water	-	599,003 m ³ /year (14 cities/counties)
Detoxification Rate of Urban Household Waste	-	95 - 100% (simple average: 99%)
Collection Volume of Urban Household Waste	-	3,765,962 tons/year 14 cities/counties)
Collection Rate of Urban household waste	-	100% (simple average: 100%)
Treatment Volume of Urban Household Waste at Transfer Stations	-	977,011 tons/year 7 cities/counties)
Waste Reduction Volume ¹¹ by Sorting Facility (m ³ /year)	469,755	0
【Effect Indicators】	-	
Service Population	6.1 million	9.71 million
Of which the population served by sanitary landfill facilities	-	9.71 million
Of which the population served by transfer stations	-	5.69 million
Of which the population served by waste collection and transportation vehicles	-	6.41 million
Number of Illegal Dumping Sites	-	None

Sources: Materials used for the appraisal, replies to the questionnaire survey and results of the field interviews.

Notes

- 1) The target treatment volume at sanitary landfill facilities is the value adjusted by the detailed design.
- 2) The actual values for BOD, COD, ammoniac nitrogen, collection rate of urban household waste, detoxification rate of urban household waste and number of illegal dumping sites show a range between the largest value and the smallest value among the target cities/counties (those in the brackets are simple averages among the target cities/counties). The values for BOD, COD and ammoniac nitrogen indicate the levels achieved after treatment.
- 3) The planned service population consists of 1.96 million for Changsha and 4.14 million for 15 cities and counties other than Changsha. The actual value is only for 15 cities and counties other than Changsha.

The actual performance of the operation indicators in 2017, i.e. two years after project completion, showed that operation indicators for BOD as well as COD concentration and volume of suspended

¹¹ This means a reduction of the cubic volume of waste. Volume reduction leads to not only reduction of the landfill volume but also improvement of the physical as well as chemical stability of waste. Apart from sorting, incineration, compaction, etc. can achieve volume reduction.

solids in exuded water after landfill treatment achieved the respective targets. Meanwhile, the target achievement rate for the treatment volume at sanitary landfill facilities of 78% was low. One reason for the lower treatment volume at sanitary landfill facilities than the planned was the increasing volume of waste incineration as newly constructed household waste incineration plants in Hengyang, Qiyang and Yueyang incinerated 419,750 tons, 33,639 tons and 73,000 tons of such waste respectively, totaling 526,389 tons, in 2017. (The total treatment volume by landfilling plus incineration in these three cities/county was 1,903,967 tons/year which exceeded the target.)

Following the construction of sanitary landfill facilities in Hunan Province by the Project, final waste disposal at a sanitary landfill facility has become the norm and the detoxification rate of urban household waste in the target cities and counties has reached almost 100%. This achievement has been considerably helped by the realization of a solid waste collection and transportation system whereby household waste generated in urban areas is collected at a rate of almost 100%. The volume of solid waste handled by transfer stations which play a vital role in the collection and transportation of household waste was nearly one million tons/year for seven cities/counties for which relevant data is available, showing that various facilities constructed by the Project have greatly contributed to improvement of the detoxification rate.

In regard to the post-treatment leachate BOD and COD concentration (and ammoniac nitrogen), the relevant national standards were strengthened in 2008 as mentioned earlier. Accordingly, the actual facilities, etc. introduced under the Project were of a higher standard than the originally planned, resulting in a higher level of treatment. All of the relevant targets have been achieved in all of those cities and counties where the targets have been set.¹² The treatment volume of exuded water reached 599,003 m³/year in 14 target cities and counties. Some indicators, such as COD, are constantly monitored at all sanitary landfill facilities using an on-line link with the environmental bureau of a city or county, suggesting that exuded water after landfill treatment is sufficiently managed.

Meanwhile, the sorting facility for recycling (Changsha) was constructed as planned. However, although this facility operated for some time, it is no longer in operation. At the time of appraisal, this facility was expected to deal with commercial waste containing relatively high proportions of valuables and plastics discharged from relatively scattered hotels and commercial premises.¹³ After the commissioning of this sorting facility in 2011, it was discovered that the proportion of valuables in the collected commercial waste was lower than assumed. Coupled with another problem of a low ratio of

¹² Of the target cities and counties, the actual values in Linxiang were higher than others even though they were below the target values. According to the implementing enterprise in this city, the exuded water treatment system is based on 1996 national standards (only pretreatment without the use of a membrane) and the absence of a membrane results in a higher reading of the COD concentration. The city employs an indirect drainage system whereby pre-treated exuded water from the sanitary landfill facility is sent to the Linxiang Municipal Sewage Treatment Plant located 2 km away via an underground drain for further treatment along with urban sewage before final discharge. The reasons why the city has opted for this indirect drainage system are ① the landfill facility is geographically near the sewage plant, ② the sewage plant had surplus capacity to treat the exuded water from the landfill facility and ③ there was a need for highly activated microorganisms pretreated by exuded water treatment equipment for the efficient treatment of urban sewage, establishing efficient coordinated operation between exuded water treatment equipment and the sewage plant.

¹³ Materials provided by JICA.

more valuable metals, PET bottles and aluminum cans due to their collection by specialist companies, the facility only operated for one year in 2011 and its operation has been suspended since 2012 as sufficient operation profitability could not be secured under these conditions.¹⁴ The implementing enterprise in Changsha was a public body at the time of appraisal but was privatized around 2012, stressing business profitability more than before. According to this implementing enterprise, factors leading to the suspension of the poorly profitable operation were ① low proportion of valuables with a small amount of highly valuable items in the commercial waste to be sorted, ② decline of the prices of valuables to be sorted out from the collected commercial waste, ③ high operation cost, including the electricity charge, ④ frequent breakdowns of the equipment to sort out the commercial waste and ⑤ lack of government subsidy. In view of the fact that the sorted collection of household waste will start in 2018 throughout Changsha, the implementing enterprise intends to work on the municipal government to restart operation of the sorting facility.

Only the service population among the effect indicators was given a target value at the time of appraisal. In Changsha, the target service population has become zero because of the suspended operation of the sorting facility as described above. The actual figure for the service population of 9.71 million (235% of the planned target value) for 15 cities and counties (excluding Changsha) where sanitary landfill facilities have been constructed under the Project far exceeds the target value (4.14 million, which excludes the population of Changsha from the overall population of 6.1 million). (The service population of each sanitary landfill facility in the target cities and counties is given in a separate appendix.) This much higher level of actual service population than the target is due to ① the more than expected increase of the urban population and ② the significant widening of the service area of each sanitary landfill facility and also of the areas served by the collection and transportation vehicles and other vehicles procured under the Project to rural areas as active efforts have been made to promote the treatment of household waste in rural areas. All of the target cities and counties emphasize strengthening of the treatment of household waste in rural areas and plan to actively use the facilities, such as sanitary landfill facilities, and equipment provided under the Project. There is, therefore, a prospect of a steady increase of the service population in the future. In the case of illegal dumping sites, no target value was set and the actual situation prior to the commencement of the Project is unknown, making it difficult to use this data as an indicator to evaluate the Project. There was no illegal dumping site in any of the target cities or counties. As the level of illegal dumping tends to increase when the solid waste treatment system is not smoothly functioning, the number of illegal dumping sites is often used as a quantitative indicator for the situation of solid waste treatment. The fact that no illegal dumping sites have been recorded may well be used as proof that adequate solid waste treatment operation is in place. The ratio of household waste treatment facilities constructed under the Project to the total number of such facilities owned by the target cities and counties at the time of ex-post evaluation (2017) is shown in Table 6. The Project accounts for 100% of the sanitary landfill facilities

¹⁴ The sources are replies by implementing enterprises to the questionnaire and results of a series of field interviews.

(in the case where Phase II sanitary landfill facilities are in operation, only such facilities are considered) and 97% of the exuded water treatment equipment, indicating the massive contribution of the Project to the establishment of household waste treatment facilities in the target cities and counties. Meanwhile, the Project accounts for a more modest 44% of transfer station as it played only a supplementary role in the construction of transfer stations by the Chinese side.

Table 6 Contribution of the Project to Household waste Treatment Facilities in the Target Cities and Counties

Facility	Number of Target Cities and Counties	Household waste Treatment Facilities	Facilities Constructed Under the Project	Contribution Ratio of the Project
1.Sanitary Landfill Facility	15	Total Capacity: 65.69 million m ³	Total Capacity: 65.69 million m ³	100%
2.Exuded Water Treatment Equipment	15	Treatment Volume: 3,050 m ³ /day	Treatment Volume: 2,950 m ³ /day	97%
3.Transfer Station	14	377 sites	165 sites	44%

Source: Replies by the implementing enterprises to the questionnaire.

3.3.2 Qualitative Effects

At the time of appraisal, facilitation of the appropriate treatment of solid waste generated in the target area was assumed to have certain qualitative effects which are schematized in Fig. 1 based on the strategic targets for development established by JICA's theme-specific guidelines for "waste management".

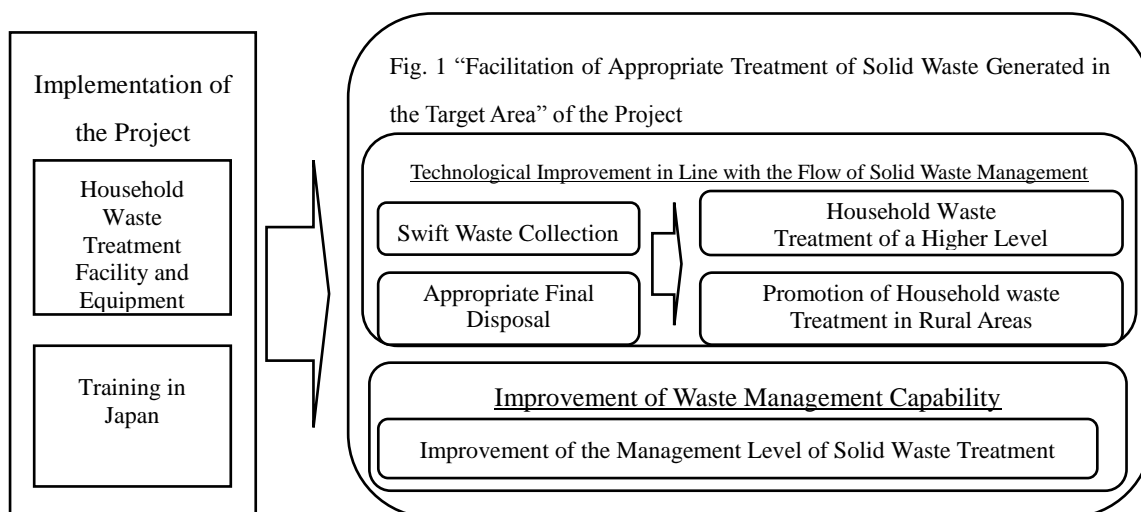


Fig. 1 "Facilitation of Appropriate Treatment of Solid Waste Generated in the Target Area" of the Project

An interview survey was conducted with the environmental bureaus and implementing enterprises of the 15 target cities and counties where a sanitary landfill facility and transfer stations were constructed under the Project to determine whether or not the Project produced any qualitative effects

and the following points have been confirmed.

As mentioned earlier, open dumping (open-air dumping and illegal dumping) and landfill without proper pollution control measures were the common final waste disposal methods in many of the target cities and counties prior to the implementation of the Project. The development of suitable processes (collection, transportation, sanitary landfill, etc.) to treat urban household waste under the Project has realized ① swift waste collection and ② appropriate final disposal (without producing an environmental burden), thereby achieving the originally expected “technological improvement in line with the flow of solid waste management”. Moreover, the smooth progress of the construction of basic household waste treatment facilities and services under the Project as originally planned produced such effects as ① realization of household waste treatment of a higher level (advanced treatment in the form of “volume reduction”, “recycling”, etc.) and ② facilitation of household waste treatment in rural areas. The establishment of a solid waste treatment system of a certain level under the Project has been taking urban household waste treatment in the target cities and counties to the next level characterized by “volume reduction”, “recycling”, etc. To be more precise, the construction of incineration plants¹⁵ by means of public-private partnerships (PPP)¹⁶ and the introduction of sorted collection (trial) are in progress partly because of the policy of the Government of China.

In regard to incineration plants, electricity generation is combined with incineration in many cases from the viewpoint of ensuring the financial viability of PPP. Transfer stations equipped with a compressing function and garbage-compacting trucks, both of which were introduced under the Project, have contributed to a reduction of the water content of solid waste so that the essential burning temperature for efficient power generation can be maintained. Furthermore, the introduction of a solid waste treatment system is in progress in rural areas, capitalizing on the experience of establishing such a system in urban areas of the target cities and counties. There are many cases where a sanitary landfill facility constructed under the Project is the destination for solid waste generated in rural areas, illustrating the direct contribution of the Project to the facilitation of solid waste treatment in rural areas. In the case of Cili County for example, four staff members of the implementing enterprise who participated in the training in Japan under the Project have actively implemented solid waste control measures in rural areas, having learned the Japanese practice of not distinguishing rural areas from urban areas for solid waste management. Their achievements so far include the formulation of a treatment plan for all 25 towns in the county, development of an administrative system (establishment of an environment and sanitation section with the allocation of some 10 staff members) and construction of related facilities. Solid waste treatment in rural areas is currently an important issue in China and Cili County is praised as a pioneer in this field.

“Improvement of the waste management capability” has been promoted from the viewpoint of “improvement of the management level of solid waste treatment”. As a result of the establishment of

¹⁵ In many cases, supplementary payment is made in correspondence with the treatment volume.

¹⁶ General term for the joint provision of a public service by the public and private sectors utilizing the funds and management skills of the private sector.

basic solid waste treatment facilities under the Project, each of the target cities and counties has introduced transfer station management rules and records of the treated volume of solid waste, improving the management level of solid waste treatment.

The training in Japan has certainly had a positive contribution to achieving such qualitative effects as ① technological improvement in line with the flow of solid waste management and ② improvement of the waste management capability. Interviews¹⁷ with the training participants in Japan found some concrete examples of their application of what they had learned in Japan. These include ① the implementation of solid waste control measures in parallel with the Project, taking the situation in Japan which does not have a separate system for solid waste treatment in urban and rural areas into consideration (example of Cili County described above), ② early implementation of technological improvement efforts, including the examination of an incineration plant from the long-term perspective as is the case in Japan, ③ adopting of a blowing system to deal with fallen leaves as witnessed in Japan and ④ planned introduction of Japanese-style sorted collection based on a proper understanding of the importance of thoroughly sorted collection. There have been observed cases of such concepts learned in Japan as “spirit or philosophy”, “business development” and “application to the actual work” being widely implemented. For example, the implementing enterprise in Hengyang has established a space to educate on the solid waste treatment process at its incineration plant for study visits by primary and secondary school pupils and to provide practical training for students studying environmental engineering at one of the city’s two universities. The promotion of sorted collection has become an important issue for each city or county from the viewpoint of reducing the volume of waste. Various measures have been tried without much success in these cities and counties. The common practice at present is to sort “valuables from non-valuables” or to dump “the entire solid waste unsorted”. As the active participation of local residents in sorting is not expected, the training in Japan apparently made many of the participants aware of the importance of raising the environmental awareness of the public. The Fukuoka-style “semi-aerobic method”¹⁸ adopted for the sanitary landfill facility in Guiyang is praised by the stakeholders in Guiyang County as an effective method to achieve ① volume reduction of solid waste to prolong the life expectancy of the facility, ② reduction of the exuded water treatment cost due to few impurities in such water and ③ realization of environmental conservation in the surrounding area as this method encourages the decomposition of solid waste by micro-organisms. In 2015, this method was explained to those responsible for waste treatment in cities and counties in Hunan Province at various meetings, etc. as the model for solid waste treatment in Hunan Province.

¹⁷ These interviews took place in Hengyang, Liuyang, Guiyang, Qiyang and Cili with a total of nine of the participants of the training in Japan.

¹⁸ The semi-aerobic landfill structure was researched and developed by Fukuoka University in Japan and was made a practical technology through collaboration between Fukuoka University and Fukuoka Municipal Government. This structure was adopted as Japan’s standard structure in the Guidelines for Sanitary Landfill Facilities introduced by Japan’s former Ministry of Health (currently the Ministry of the Environment) in 1979. It was also certified in 2011 as a method applicable to the Clean Development Mechanism (system to reduce greenhouse gas emissions) stipulated by the United Nations Framework Convention on Climate Change. The characteristics of this structure are ① prevention of the infiltration of exuded water into the foundation ground of a landfill site and ② facilitation of the aerobic decomposition of solid waste so that exuded water is purified as much as possible at the stage of collecting the said water.

However, each city or county has the authority to decide its own treatment method and the Guiyang model has not been adopted in other areas of the province as of the present time.

3.4 Impacts

3.4.1 Intended Impacts

(1) Reduction of Annual CO₂ Emission Volume

At the time of appraisal, “reduction of the annual CO₂ emission volume” was assumed to be a quantitative impact of the Project. 920,000 tons/year¹⁹ established as the target figure is the assumed “annual CO₂ emission volume” in the case where a sanitary landfill facility is constructed in all of the 15 target cities and counties. Although the target figure for the annual CO₂ reduction volume by city/county (including the calculation method²⁰) is not available at the time of ex-post evaluation, historical data on the actual annual CO₂ reduction volume is obtained for five cities/counties as shown in Table 7. The total reduction volume for these five cities/counties accounts for more than 50% of the overall target figure 920,000 tons/year (approximately 50% and 70% in 2014 and 2016 respectively) but the overall situation of target achievement is unclear because of the lack of actual data for the other 10 cities/counties.

Table 7 Annual CO₂ Emission Reduction Volume

	(tons/year)		
	2014	2015	2016
Guiyang	128,800	156,900	184,000
Qiyang	-	12,000	26,000
Changning	120,000	153,000	198,000
Linxiang	184,200	192,100	201,800
Lengshuijiang	23,000	21,000	25,000
Total	456,000	535,000	634,800

Source: Replies by the implementing enterprises to the questionnaire.

(2) Improvement of the Living and Sanitation Conditions for Residents of the Target Areas

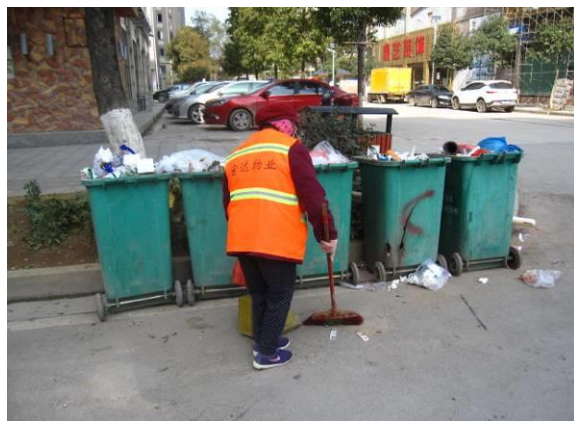
At the time of appraisal, “improvement of the living and sanitation conditions for residents of the target areas” was assumed to be a qualitative impact. An interview survey was conducted with the environment bureaus of the target cities and counties where a sanitary landfill facility and transfer stations were constructed and also with the beneficiaries²¹ on the existence of any qualitative impact

¹⁹ According to materials provided by JICA, the landfill gas emission volume (greenhouse gas reduction volume) changes with the years passed since the original landfill. Here, the annual reduction volume is conveniently calculated as a simple annual average figure by dividing the presumed total emission volume of some 27.6 million tons from the sanitary landfill facilities in question by the assumed number of years of emission (30 years).

²⁰ The Ministry of the Environment of Japan stipulates that the reduction volume of greenhouse gases originating from the landfill of solid waste is calculated by multiplying the volume of solid waste landfilled at a landfill site by the emission volume of the unit solid waste volume (for each type of solid waste) and also specifies the emission volume (emission coefficient) per unit solid waste volume (<https://ghg-santeikohyo.env.go.jp/calc>). It is guessed that a similar calculation method is used in China.

²¹ The beneficiaries survey was conducted with 36 residents (29 males and 7 females) living near a sanitary landfill facility or

of the Project. This survey confirmed ① improvement of the living conditions and townscape and ② improvement of the water quality of water sources as well as river water as “improvement of the living and sanitation conditions for residents of the target areas” due to the implementation of the Project.



Street cleaning by a cleaning crew.
(Shuangpai)



A clean footpath after rubbish collection.
(Qiyang)

In regard to “improving of the living conditions and townscape”, the results of interviews with officials of environment bureaus and beneficiaries in the target cities/counties found that, prior to the implementation of the Project, it was very common for rubbish to scatter from waste collection sites, mainly set up in town centres, due to the lack of regular collection in addition to untidy streets which seemed to aggravate littering. In suburban and rural areas, the scarcity of waste collection due to the absence of waste collection sites meant that rubbish was simply piled up at empty lands, resulting in severely adverse conditions of bad odor, foul water and the propagation of flies and mosquitoes. Since the implementation of the Project, household waste is collected several times a day in urban areas and street cleaning and rubbish collection are regularly conducted by cleaning crews. Streets littered with rubbish have become scenes of the past and the drastic improvement of street sanitation has eliminated bad odor and foul water. The introduction of dedicated containers for household waste as well as closed type waste collection vehicles has prevented the scattering of rubbish in the streets, contributing to improvement of the living conditions and townscape. Due to the fact that the situation prior to the implementation of the Project was extremely bad, the effect of the Project on improvement of the living conditions and townscape is very substantial. According to the results of interviews with residents living near a sanitary landfill facility in the target cities and counties, improvement of the living conditions and townscape has been particularly great in suburban areas due to the lack of measures in the past and these residents are extremely happy with the visible, significant improvement. Many of the interview respondents state that the clean and tidy streets appear to have changed the environmental awareness and behavior of the public in that the level of littering has declined and people pick up litter in the street and put it in the newly installed litter bins.

transfer station in seven cities/counties (Qiyang, Changning, Yueyang, Shaoyang, Wugang, Zhangjiajie and Shuangpai).

The next issue is “improvement of the water quality of water sources and river water”. Interviews with officials of the environment bureaus and beneficiaries in the target cities and counties found that prior to the implementation of the Project, there were many cases where litter dumped in rivers was just left to float. The quality of rivers was also worsened by foul water flowing from dumped litter on river banks. The implementation of the Project has greatly reduced instances of scattered litter and the occurrence and seepage of foul water from dumped litter, thereby much improving the quality of river water. Many beneficiaries expressed their actual feeling that the situation and water quality of small rivers running near their homes have much improved.

(3) Fostering of Industries Related to Urban household waste Treatment

Following the policy of the Government of China to actively use the private sector for the front-line work for various public services while making government organizations concentrate on administrative work, the number of outsourcings of solid waste treatment to the private sector has been increasing. In fact, the private sector is the principal provider of the solid waste treatment service necessitated by the implementation of the Project. As a result, conscious efforts have been made to foster industries related to solid waste treatment. The number of cases of a private enterprise being responsible for the operation of a sanitary landfill facility or transfer station and accompanying cleaning and waste collection and transportation has been increasing even though it was originally assumed that these operations would be conducted by a local administration or state enterprise at the time of appraisal. Especially, the operation of the exuded water treatment equipment installed under the Project is now entirely conducted by the private sector. As explained in the section on Effectiveness, the development of infrastructure for solid waste treatment under the Project has made it possible to raise household waste treatment to a higher level, ranging from incineration and power generation using methane gas to the treatment of food waste (production of animal feed and composting). Most such new businesses are based on PPP and their markets are expanding, making a tangible contribution to the fostering of related industries. In the case of Zhangjiajie City which is a world-famous sightseeing location with a World Heritage site, the state of scattered rubbish before the implementation of the Project caused many tourist complaints. The significant improvement of the townscape since the implementation of the Project is said to have certainly contributed to the promotion of the local tourism industry.

(4) Expansion of Employment Opportunities Related to the Urban Household waste Treatment Business

Following the implementation of the Project, the public service related to household waste treatment has been enhanced. There has been a particularly strong need for the business of collecting household waste from litter bins introduced to homes and streets and the scale of employment for this business has expanded. According to the results of interviews with the implementing enterprises,

employment related to solid waste management has changed between the pre-project time and ex-post evaluation time as shown in Table 8. The scale of related employment has increased in most of the target cities and counties. The total number of employed persons in the 15 target cities and counties has increased by some 2.7 times from 4,755 persons to 12,665 persons. As the work involved is mainly simple, solid waste treatment provides valuable employment opportunities, especially for non-skilled older people in their 50's or older.

Table 8 Change of Employment Related to Solid Waste Treatment

Unit: persons

	Hengyang	Liuyang	Guiyang	Qiyang	Changning	Yueyang	Linxiang	Huarong
Pre-Project	620	265	200	345	400	0	261	400
At the Time of Ex-Post Evaluation	3,293	730	500	893	700	120	443	800
	Shaoyang	Wugang	Lengshuijiang	Cili	Zhangjiajie	Sangzhi	Shuangpai	Total
Pre-Project	1,000	200	304	300	300	60	100	4,755
At the Time of Ex-Post Evaluation	2,000	450	606	670	1,000	260	200	12,665

Sources: Replies by the implementing enterprises to the questionnaire and results of interviews with the implementing enterprises in each city or county.

3.4.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

Interviews with members of the implementing enterprises and environment protection bureaus found that monitoring of air, noise, water quality, dust, etc. was conducted during the construction period of sanitary landfill facilities in particular, which are a type of facility causing concern in regard to an undesirable load on the natural environment, by the municipal or county environment bureaus in accordance with national laws and regulations. This monitoring did not find any serious issues in any of the target cities and counties. A minor issue of dust or noise was addressed through consultations with the constructor. After the construction of a sanitary landfill facility, monitoring of the impacts on the natural environment continues in accordance with national laws and regulations. In almost all of the monitoring reports obtained from the implementing enterprises in the target cities and counties, the observed values for the quality of air, exuded water, groundwater, etc. are below the relevant standard values, confirming that no problematic issues have occurred. In regard to exuded water treatment, a matter of special importance, some data (on COD, ammoniac nitrogen, etc.) is transmitted on-line to the environmental bureau while regular monitoring is conducted in connection with other important indicators (BOD, suspended solids, etc.), suggesting adequate management of these indicators. As far as impacts on the natural environment other than exuded water are concerned, each municipal or county environment bureau conducts regular monitoring as well as snap inspection of the water quality at sanitary landfill facilities. The air quality around a sanitary landfill facility is also monitored using an ordinary monitoring system. The sanitary landfill facility in Changning experienced groundwater contamination in the surrounding area in 2013, resulting in the temporary suspension of its operation. However, investigation later found that the culprit was a large-scale pig farm nearby.

The water discharged from a transfer station is fed to a general sewage pipeline in each city or county and the quality of this mixed sewage is then monitored.

Because of the measures described above, no negative impacts on the natural environment are observed at the time of ex-post evaluation and, therefore, no negative impacts on the natural environment by the Project are identified.

(2) Resettlement and Land Acquisition

The situation of resettlement and land acquisition in connection with the implementation of the Project is shown in Table 9. The total area of land acquired slightly increased from the planned 299 ha to 321 ha.

Table 9 Situation of Resettlement and Land Acquisition

(Resettlement)

City/County	Numbers	Time of Resettlement	Form of Resettlement	Compensation Situation
Hengyang	12 households involving 50 persons	2007	Resettlement site is secured for those resettled	Funding for new farmland and house is provided in accordance with the national standards. Social infrastructure, such as electricity and water supply, nursery, etc., is provided.
Liuyang	20 households involving 60 persons	2008 - 2010	House and resettlement site is secured in the same village area	New houses are provided in accordance with the national standards along with a grant. No farmland is provided.
Wugang	15 households involving 50 persons	2008 - 2010	House and resettlement site is secured in the same village area	New houses are provided in accordance with the national standards along with a grant. No farmland is provided.
Cili	6 households involving 21 persons	2008 - 2009	House and resettlement site is secured in the same village area	New houses are provided in accordance with the national standards along with a grant. No farmland is provided.
Zhangjiajie	35 households involving 100 persons	2011 - 2014	House and resettlement site is secured in the same village area	New houses and housing plots are provided in accordance with the national standards. No farmland is provided.
Sangzhi	6 households involving 20 persons	2008 - 2010	House and resettlement site is secured in the same village area	New houses and housing plots are provided in accordance with the national standards. No farmland is provided.
Shuangpai	41 households involving 144 persons	2008	House and resettlement site is secured in the same village area	New houses are provided in accordance with the national standards along with a grant.
Total	135 households involving 445 persons			

Sources: Materials provided by JICA, replies by the implementing enterprises to the questionnaire and results of interviews with implementing enterprises in each city or county.

At the time of appraisal, the non-occurrence of resettlement was confirmed. However, since 2008 the strict application of the “technical standards for the treatment of household waste at a landfill

facility” of the Ministry of Construction which stipulates that “residents living within a distance of 500 m of a sanitary landfill facility must be resettled” necessitated the resettlement of 445 people of 135 households living within a distance of 500 m of a sanitary landfill facility in seven cities and counties because of the implementation of the Project. It has not been established why “a resettlement plan”, which should be prepared whenever resettlement becomes necessary, was not prepared. However, even though the actual form of resettlement slightly varied from one city/county to another, a new house or the money to construct a new house was provided in accordance with the national standards as shown in Table 9. Most of the resettled people were farmers (many were elderly) and compensation was paid for farmland in accordance with the national standards. In addition, infrastructure (water supply, roads, nursery, etc.) for daily life was arranged. The relevant implementing enterprise monitored the progress of resettlement in accordance with the national rules. On the Japanese side, those responsible for the Project visited the planned resettlement sites to check the progress of resettlement. As such, no problems were found regarding resettlement. The interviews²² with those resettled and visits to the resettlement sites found that all resettlement took place within the same village area. Because of the development of infrastructure, the standard of living has actually improved (in some cases, the income level was unchanged) and all of the resettled people have expressed their contentment.

As no negative impacts of resettlement and land acquisition are observed at the time of ex-post evaluation, it is judged that no negative impacts have been caused by resettlement and land acquisition under the Project.

In the targeted 15 cities and counties other than Changsha, the implementation of the Project has achieved technological improvement in line with the flow of solid waste management and has contributed to the (i) detoxification treatment of urban household waste in Hunan Province and (ii) volume reduction of such waste through removal of the water content with the introduction of transfer stations equipped with the compression function and garbage-compacting trucks. Moreover, positive effects have emerged regarding “improvement of the living and sanitation conditions for residents”, “improvement of the water quality situation at water sources and rivers” and “fostering of related industries”. Therefore, the effectiveness and impacts of the Project are high.

However, in the face of a rapidly increasing volume of solid waste beyond the forecast made at the time of appraisal, many transfer stations have been constructed by the Chinese side with its own budget in the target areas of the Project. Moreover, an incineration plant has been constructed in Hengyang and Qiyang after the start of the Project. Such work by the Chinese side using its own funds is believed to have also contributed to achievement of the project purpose. As such, the high evaluation of the effectiveness and impacts is judged to be the combined result of the Project and own efforts of the Chinese side. Efforts to achieve sorted collection have just begun in Changsha in 2018 after a trial period. According to members of the implementing enterprise and local government officials, it will

²² The target persons for this interview were selected by the village authorities to ensure a good balance in terms of age, gender, etc. as requested by the evaluators. During the on-site visits, unplanned visits were made to a number of households for interview purposes.

take some time for positive effects in terms of “volume reduction” and “recycling” to emerge through the strict implementation of sorted collection.

3. 5 Sustainability (Rating: ③)

3. 5. 1 Institutional Aspect of Operation and Maintenance

The treatment of urban household waste in China is under the jurisdiction of the Ministry of Construction. This work in the target cities and counties of the Project is managed by the urban authority (the name varies from one city/county to another). In regard to the maintenance and operation of sanitary landfill facilities, exuded water treatment equipment and solid waste collection and transportation facilities (transfer stations, garbage trucks, etc.), exuded water treatment equipment is maintained and operated by a specialist company in many of the target cities and counties. In the case of sanitary landfill facilities and solid waste collection and transportation facilities, these are either directly operated and maintained by the administration (environment bureau of the urban authority or state enterprise) or an outsourced private enterprise. The operating bodies by city/county are shown in Table 10. When the work is outsourced to the private sector, an enterprise with sufficient experience is selected periodically by means of tender and is supervised by the urban authority of each city or county. There are cases where both the sanitary landfill facility and exuded water treatment equipment are operated by a single enterprise. As both the central government and provincial governments have a policy of promoting the outsourcing of front-line solid waste treatment work to the private sector, the number of outsourcings is expected to increase in the coming years. The number of staff members for a sanitary landfill facility or exuded water treatment equipment is small at around 10 or less per site but the operation and management work at such facilities is smoothly conducted. In contrast, several hundred people, including those engaged in solid waste collection work, are employed by the administration or outsourced enterprise to operate and manage solid waste collection and transportation facilities/vehicles although the actual number varies from one city/county to another depending on the scale of the work involved.

Table 10 Operating Bodies of Household waste Treatment Business in the Target Cities and Counties of the Project

City/County	Sanitary Landfill Facility	Exuded Water Treatment	Transfer Station Operation	Solid Waste Collection and Transportation
Hengyang	Administration	Administration	Administration	Administration
Liuyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration
Guiyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration
Qiyang	Administration	Administration	Administration	Administration
Changning	Administration	Outsourced to the Private Sector	Administration	Administration
Yueyang	Administration	Administration	Administration	Administration
Linxiang	Administration	Administration	Administration	Administration
Huarong	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Outsourced to the Private Sector
Shaoyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector • Administration	Outsourced to the Private Sector
Wugang	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector
Lengshuijiang	Administration	Administration	Administration	Administration
Cili	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration
Zhangjiajie	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration
Sangzhi	Administration	Administration	Administration	Administration
Shuangpai	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector

Source: Replies by the implementing enterprises to the questionnaire.

At the time of appraisal, it was assumed that the operation of sanitary landfill facilities was conducted by the municipal/county administration or state enterprises. However, because of the policy and preference of the Government of China, etc., the number of outsourcings is currently increasing for the operation of sanitary landfill facilities. As this is a general trend for solid waste treatment throughout China, no problems have emerged due to a change of policy. The interview survey with officials of the target cities and counties found that there were no problems regarding the current staff strength, causing no structural problems although further strengthening of the institutional arrangements to expand household waste treatment in rural areas is necessary.

In the case of a waste sorting facility in Changsha, the business is conducted by an outsourced private enterprise to which the necessary equipment, etc. have been leased by the municipal government. While the original plan envisaged the treatment of recyclable waste after the sorting of valuables, this precondition was not met, forcing the facility to deal with a massive volume of solid waste containing much valueless items. As sufficient operation profitability could not be secured under these conditions, actual sorting has been suspended.

3.5.2 Technical Aspect of Operation and Maintenance

In regard to “sanitary landfill” and “exuded water treatment”, both of which require technical operation and maintenance capability, they are conducted in accordance with the relevant domestic standards in China. Meanwhile, training for workers involved in such operation is conducted several times a year by the administration (the provincial housing construction agency), industrial association, etc. to improve their technical skill level. The “improved anaerobic landfill method” which is employed at all sanitary landfill facilities constructed under the Project except that in Guiyang is commonly used in China, posing no technical problems. In regard to the semi-aerobic landfill method employed in Guiyang, conscious efforts have been made to master the necessary skills through training sessions held at sanitary landfill facilities in Qingdao and other Chinese cities where this method is used. Any decision on outsourcing to a private enterprise is taken based on the premise that the enterprise in question is permitted to operate such facilities in China and has sufficient technical capability based on its past performance of similar work and its possession of the necessary manuals. All outsourced enterprises have operation and maintenance experience of multiple similar facilities to the facilities, etc. constructed under the Project and of the technologies involved. Consequently, both the administration and outsourced enterprises have the necessary technical operation and maintenance capability. Regular maintenance and response to any problems have been properly implemented, producing no special problems after the commissioning of the various facilities. In regard to collection and transportation, efforts have been made to improve the service management since the introduction of the facilities, including the formulation of management rules and the introduction of automatic disinfection and deodorizing equipment, etc. .

As there have been many cases of more than 10 enterprises applying for a tender for outsourcing, it is possible to select an enterprise capable of providing a high quality service based on its past performance. Outsourcing to the private sector has achieved such positive results as ① improved management of transfer work due to the installation of cameras at transfer stations and ② more efficient collection due to the introduction of small garbage trucks. Based on the above, there are no problems regarding the technical aspects of operation and maintenance.

In the case of the solid waste sorting facility in Changsha, the technical standards regarding the operation, etc. of the facility cannot be assessed properly because of ① suspension of operation and ② the fact that the outsourced enterprise does not necessarily have rich experience of the operation of a sorting facility although it does of rich experience of treating food waste.

3.5.3 Financial Aspect of Operation and Maintenance

At the time of appraisal, it was assumed that a waste treatment charge of 4 – 6 CNY/month per household would be collected to secure the necessary funding for solid waste treatment. However, only seven cities/counties of the 15 target cities/counties where a sanitary landfill facility and transfer stations were newly constructed under the Project currently collect such charge (3 – 5 CNY/month per

household).²³

Some cities and counties are unable to collect the waste treatment charge as they have been unable to achieve a sufficient understanding of its necessity on the part of citizens. The actual charge per household varies from 1 CNY/month to 8 CNY/month, indicating the slow progress of efforts to secure a steady income which is essential for the stable progress of urban household waste treatment. Data on the amount of fiscal expenditure for urban household waste treatment is only available for some cities and counties and the figure varies from some 4 million CNY to 20 million CNY depending on the size of the city or county. Even in those cities and counties where the waste treatment charge is collected, the overall income is less than half of the relevant expenditure. In some cities and counties, the income accounts for only some 10% of the expenditure, making it necessary to supplement the shortfall from the general account.

Although exact fiscal information was not obtained, interviews with the implementing enterprises found that there is no mechanism for the central government or provincial government to subsidize the cost of urban household waste treatment. However, the expenditure amount for the treatment of household waste has shown a tendency to increase in each of the target cities and counties, reflecting the trend of an expanding service area of household waste treatment to rural areas and other developments, in turn originating from the ① growing emphasis in recent years on environmental issues, including living conditions, and ② achievement of visible great effects of moves to facilitate the treatment of urban household waste. Local financial authorities well understand the need to secure the fund for such treatment and have provided the necessary budget for operation and maintenance. In some cities and counties for which the relevant fiscal data is available, the annual growth rate of the solid waste treatment budget has exceeded 10% which is above the growth rate of the overall fiscal expenditure. Accordingly, no problems regarding the financial aspects of operation and maintenance are found at the time of ex-post evaluation. The results of interviews with the implementing enterprises target prefectural city or county officials indicate the prospect of continued availability of the necessary budget as “stagnation of the treatment of urban household waste would directly affect the lives of citizens”. This prospect is supported by the favourable steady growth of the fiscal revenue of the target cities and counties. There is concern, however, regarding an increase of the fiscal burden in the long term to provide large funding for the continued improvement of treatment facilities if the volume of solid waste requiring treatment continues to increase, including the treatment of household waste generated in rural areas, as described earlier. Such a prospect necessitates ① volume reduction through the wider implementation of the 3R²⁴, including sorted collection currently in progress, and ② introduction of an adequate waste collection charge and its collection without fail.

When the work to treat urban household waste is outsourced to a private enterprise, payment is

²³ The level of the waste treatment charge is not a burden for ordinary citizens. As this charge is collected on top of the water charge, the collection rate for ordinary citizens is high. In Zhangjiajie, Linxiang, etc., the waste treatment charge is separately collected from business operators. The collected charges are accounted as revenue by the municipal/county government (Finance Agency).

²⁴ 3R stands for Reduce, Reuse and Recycle, indicating the important approaches to environmental consideration.

made based on the treatment volume of ordinary solid waste and exuded water (standard price per unit treatment volume x volume of treatment) as in the case of other similar work, ensuring a certain level of profitability for the outsourced enterprise.

There are currently no major problems regarding the financial aspects of operation and maintenance because of the facts that ① the necessary fiscal expenditure is secured even though the collection of the waste treatment charge is insufficient in some cities and counties and ② there is an adequate response to long-term issues.

3.5.4 Status of Operation and Maintenance

Monitoring, maintenance and regular inspection of the various facilities introduced under the Project are appropriately conducted by the urban management bureaus of individual cities and counties and outsourced enterprises in accordance with the national standards and management rules of China. Especially regarding exuded water treatment equipment, a system is in operation to automatically detect any problems. Some outsourced enterprises monitor entrusted facilities from their head offices as part of a system to provide an immediate response to emerging problems. The maintenance and inspection of facilities are properly conducted in accordance with China's national standards (and the standards of those enterprises which are stricter than the national standards). No major problems have occurred at any of the facilities, etc. since the start of their operation to the time of ex-post evaluation. No problems have occurred with the procurement of spare parts. The field reconnaissance conducted as part of the ex-post evaluation has confirmed that ① each facility is generally maintained in a tidy, clean and orderly manner, ② active efforts are made regarding guidance and awareness raising for all stakeholders by means of the introduction of various notice boards, etc. to ensure smooth operation and maintenance and ③ transportation records of urban household waste are properly kept at many transfer stations. According to officials involved in facility operation, any breakdown or abnormality of equipment is smoothly dealt with through collaboration with the outsourced enterprise. As a result, the conditions of the main facilities and equipment are generally good. However, the field reconnaissance discovered cases where household waste brought for landfill is not properly weighed at some public sector-run sanitary landfill facilities, making the steady improvement of the management level essential.

The operating rate of the facilities is generally high due to urbanization and the promotion of household waste treatment in rural areas as described earlier.

In the case of the waste sorting facility in Changsha of which the operation is currently suspended, an officer of the enterprise in charge of this facility points out that the facility is in working order as maintenance work has been done regularly. The warehouse and office space of this facility are used as a food waste treatment plant and office respectively at the time of ex-post evaluation.

No major problems are observed with the institutional, technical and financial aspects and current status of the operation and maintenance system. Therefore, the sustainability of the project effects is

high.

4. Conclusions, Recommendations and Lessons Learned

4. 1 Conclusion

The objective of the project is to facilitate the appropriate treatment of waste generated in local cities (16 cities and counties) in Hunan Province by developing a suitable waste treatment system, thereby contributing to improvement of the living as well as sanitation conditions for inhabitants and environmental consideration in these areas. The Project is highly relevant to the development needs of the Government of China and Government of Hunan Province such as improvement of the living and sanitation conditions and environmental conservation in the province. It is also relevant to Japan's ODA policy. Therefore, its relevance is high. In relation to efficiency, while the project cost was within the planned cost, the project period was significantly longer than the planned period (2.64 times longer than planned). Therefore, the efficiency of the Project is only fair. As a result of the successful introduction of facilities to treat urban household waste under the Project, the target values for the operation indicators (treatment volume at sanitary landfill facilities, BOD and COD concentration, volume of suspended solids, waste collection rate, etc.) set during the project appraisal have been generally achieved. Meanwhile, the service population which is an effect indicator far exceeds the target value. Moreover, positive confirmation has been made for such qualitative indicators as "improvement of the living conditions and townscape", "improvement of the water quality of water sources as well as river water" and "fostering of related industries". Significant improvement has been specially observed in the case of "living conditions and townscape". Therefore, the effectiveness and impacts of the Project are high. In regard to the "waste sorting facility" constructed under the Project (in Changsha), there is a structural problem in that the sorting of solid waste as a precondition for the efficient operation of this facility has not been achieved. The facility also faces the difficulty for the outsourced private enterprise to secure the profitability of operation due to the lack of any subsidy. Meanwhile, the sustainability of "sanitary landfill facilities, exuded water treatment equipment and collection and transportation facilities" in the other 15 cities and counties is judged to be high in terms of the institutional, technical and financial aspects and the current status of operation and maintenance. Therefore, the sustainability of the positive effects of the Project as a whole is high.

Based on the above, the Project is evaluated as highly satisfactory.

4. 2 Recommendations

4. 2. 1 Recommendations to the Executing Agencies

Implementation of Efforts to Utilize the Sorting Facility in Changsha

As described earlier, the waste sorting facility in Changsha is not currently used because of failure to meet its precondition (collection of commercial waste containing a large volume of recyclable items)

even though it did operate for a short period of time after its completion. In view of the current situation in China where efforts to sort solid waste have been actively made in recent years, the relevant agencies and organizations in Hunan Province and Changsha are required to examine the situation in a concrete manner with a view to the utilization of this facility.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Importance of Selecting and Developing Suitable Facilities Based on the Current State of Solid Waste Management

The waste sorting facility in Changsha began operation after its completion but is no longer used because of failure to meet its precondition (collection of solid waste containing a large volume of valuables). The original plan intended the sorting of valuables from partially sorted solid waste delivered to the facility. In reality, however, advance partial sorting was not conducted and the resulting treatment of the non-sorted solid waste led to equipment breakdowns, etc., resulting in non-profitable operation. This suggests the extreme importance of introducing a facility only after any precondition(s) (in connection with the current situation of waste collection and treatment) for the smooth operation of the facility in question has been carefully identified and is fully understood. In the case of a facility such as a waste sorting facility for efficient waste treatment and achievement of the 3R, which requires the participation or involvement of ordinary members of the public to meet its preconditions, it is essential for JICA to conduct an in-depth examination of the relevance of the facility at its planning stage. When the construction of a sorting facility is a sub-project of a project to construct multiple different facilities as in the case of the present Project, special care is required because there is a chance that in-depth examination will not be conducted when it is considered as the minor status of the sub-project in the overall project.

Formulation of a Project Taking Verification of the Project Effects into Consideration

The Project originally planned examination of the feasibility of applying the clean development mechanism (CDM)²⁵ as the establishment of sanitary landfill facilities could reduce the emission of greenhouse gases (CO₂, etc.) through the recovery and effective use of landfill gas which had been simply released to the atmosphere.

The waste treatment method employed for the newly constructed sanitary landfill facilities under the Project was the improved anaerobic method (the most common method in China) at 14 out of 15

²⁵ CDM is a mechanism whereby advanced countries provide technical and financial assistance for developing countries to implement projects designed to reduce the emission or absorption of greenhouse gases so that a certain proportion of the reduced emission can be considered a greenhouse gas emission reduction applicable to the assisting countries.

sites and the semi-aerobic method (the most common method in Japan) which is certified as a CDM method at one site. However, the indicators and calculation method to verify the greenhouse gas reduction effects were not specified in an appropriate manner at the time of appraisal. Moreover, neither indicators to compare the effects of the anaerobic method and the semi-aerobic method nor a system to monitor the operation of these facilities were not properly established. Because of these deficiencies, it was impossible to thoroughly collect greenhouse gas reduction data which is essential for CDM application. Proper comparison of the effects of the two different treatment methods was not possible. In the case of a project which intends CDM application and/or the comparison of different treatment methods, it is important to specify the indicators and indicator calculation method(s) at the time of appraisal while including the arrangement of the development of a monitoring system and other necessary measures in a component designed to assist smooth project implementation.

Importance of Establishing Appropriate Targets for Indicators Necessary for Detailed Evaluation

The service population in the case of the Project was the only effect indicator for which a target value was set to verify the effectiveness of the Project. For the ex-post evaluation, the number of illegal dumping sites was introduced as an additional effect indicator as this indicator is often used to check the effectiveness of a solid waste treatment project more precisely. However, evaluation of the Project from this viewpoint is unsatisfactory because of the poor awareness of illegal dumping in China and the absence of a target value at the start of the Project meant that there was no real data on illegal dumping at the time in question. Consequently, sufficient evaluation has not been possible with this indicator.

The absence of a target value in the Project for the number of illegal dumping sites is likely a reflection of the state of urban household waste treatment in China at the start of the Project. When the number of indicators for which target values are set is limited, there is concern regarding the difficulty of conducting a detailed evaluation. It is, therefore, necessary to properly consult with the executing agency of the recipient country at the start of the Project to set appropriate target values for indicators which are essential for detailed evaluation. A solid waste treatment project in a developing country requires much attention and the careful examination of indicators and their target values because such a project is often a pioneering project for the recipient country.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	1) Sanitary landfill facility: 15 sites - Total capacity: 68.28 million m ³ - Exuded water regulating basin: 309,100 m ³ 2) Exuded water treatment equipment: 15 sites - Total capacity: 49.4 million m ³ 3) Collection and transportation facility: - New transfer station: 131 sites - Improved transfer station: 34 sites - Collection vehicles: 193 vehicles 4) Sorting facility for recycling (Changsha): 1,000 tons/day - Other facilities: water treatment facilities; warehouse and office buildings - On-site equipment: bulldozers; loaders; trucks 5) Training - Training in Japan: 45 persons - Training in China: 270 persons	1) Sanitary landfill facility: as planned - Total capacity: 65.69 million m ³ - Exuded water regulating basin: 223,200 m ³ 2) Exuded water treatment equipment: as planned - Total capacity: 29.5 million m ³ 3) Collection and transportation facility - New transfer station: 136 sites - Improved transfer station: 57 sites - Collection vehicles: 216 vehicles 4) Sorting facility for recycling (Changsha): as planned - Other facilities: as planned - On-site equipment: as planned 5) Training - Training in Japan: 92 persons - Training in China: 8 persons
2. Project Period	January, 2008 – December, 2010 (36 months)	December, 2007 – October, 2015 (95 months)
3. Project Cost		
Amount Paid in Foreign Currency	11,175 million yen	10,482 million yen
Amount Paid in Local Currency	10,994 million yen	8,490 million yen
Total	22,169 million yen	18,972 million yen
ODA Loan Portion	10,500 million yen	10,482 million yen
Exchange Rate	1 CNY = 15.6 JPY (as of June, 2007)	1 CNY = 14.9 JPY (mean for 2007 through 2015)
4) Final Disbursement	October, 2015	

【Appendix】

Appendix Table1 Main Project Outputs by Target Prefectural City/County

	Planned (at the time of appraisal)	Actual		Planned (at the time of appraisal)	Actual
1. Sanitary landfill facility					
1-1 Processing volume					
Hengyang	13,200,000 m ³	13,200,000 m ³	Shaoyang	5,430,000 m ³	8,600,000 m ³
Liuyang	5,200,000 m ³	4,500,000 m ³	Wugang	3,440,000 m ³	3,440,000 m ³
Guiyang	3,200,000 m ³	3,000,000 m ³	Lengshuijiang	5,060,000 m ³	4,980,000 m ³ (147)
Qiyang	5,170,000 m ³	3,130,000 m ³	Cili	4,350,000 m ³	4,350,000 m ³
Changning	5,070,000 m ³	5,070,000 m ³	Zhangjiajie	4,120,000 m ³	3,950,000 m ³
Yueyang	2,140,000 m ³	2,000,000 m ³	Sangzhi	1,650,000 m ³	1,740,000 m ³ (51)
Linxiang	5,250,000 m ³	3,850,000 m ³	Shuangpai	2,050,000 m ³	1,100,000 m ³
Huarong	2,950,000 m ³	2,780,000 m ³ (50)			
1-2 Leachate pondage volume					
Hengyang	21,000 m ³	20,000 m ³	Shaoyang	40,000 m ³	42,000 m ³
Liuyang	15,000 m ³	7,600 m ³	Wugang	18,000 m ³	12,000 m ³
Guiyang	12,600 m ³	7,000 m ³	Lengshuijiang	16,000 m ³	20,000 m ³
Qiyang	20,000 m ³	10,000 m ³	Cili	18,000 m ³	5,600 m ³
Changning	28,000 m ³	28,000 m ³	Zhangjiajie	18,000 m ³	10,000 m ³
Yueyang	19,000 m ³	19,000 m ³	Sangzhi	20,000 m ³	12,000 m ³
Linxiang	30,000 m ³	15,000 m ³	Shuangpai	12,500 m ³	5,000 m ³
Huarong	21,000 m ³	10,000 m ³			
2. Leachate treatment equipment					
2-1 Volume					
Hengyang	550 m ³ /day	400 m ³ /day	Shaoyang	300 m ³ /day	400 m ³ /day
Liuyang	480 m ³ /day	400 m ³ /day	Wugang	270 m ³ /day	150 m ³ /day
Guiyang	300 m ³ /day	160 m ³ /day	Lengshuijiang	240 m ³ /day	100 m ³ /day
Qiyang	300 m ³ /day	220 m ³ /day	Cili	280 m ³ /day	100 m ³ /day
Changning	530 m ³ /day	200 m ³ /day	Zhangjiajie	350 m ³ /day	200 m ³ /day
Yueyang	200 m ³ /day	10 m ³ /day	Sangzhi	300 m ³ /day	50 m ³ /day
Linxiang	300 m ³ /day	300 m ³ /day	Shuangpai	240 m ³ /day	160 m ³ /day
Huarong	300 m ³ /day	100 m ³ /day			
3. Collection and transportation facilities					
3-1 Construction of new transfer station					
Hengyang	1	1	Shaoyang	18	18
Liuyang	20	4	Wugang	16	12
Guiyang	15	12	Lengshuijiang	15	3
Qiyang	5	20	Cili	0	4
Changning	3	3	Zhangjiajie	6	26
Yueyang	6	3	Sangzhi	3	6
Linxiang	15	15	Shuangpai	0	0
Huarong	8	9			
3-2 Modification of transfer station					

Appendix Table 2 Operation and Effect Indicators by Target Prefectural City/County

Prefectural city/county	Hengyang		Liuyang		Guiyang		Qiyang	
Indicator	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value
(Operation indicator)								
Processed volume of sanitary landfill (tonnes/year)	387,000	18,250 (incineration 419,750) (458,102 in 2015)	118,625	222,930	66,800	102,200	149,400	53,643 (incineration 33,639) (89,282 in 2014)
Post-treatment leachate BOD concentration (mg/l)		4.5	30	3.4		14.0		14.7
Post-treatment leachate COD concentration (mg/l)		40.0	100	13.5		36.0		14.7
suspended substance and suspended solids (mg/l)	200	24.0	200	21.0		13.0		-
Post-treatment ammoniacal nitrogen (mg/l)		15.7		0.1		6.7		8.3
Treated leachate volume (m ³ /year)		36,500		115,000		25,000		32,945
Harmless treatment rate of municipal solid waste (%)		100		100		100		100
Collection volume of municipal solid waste (tonnes/year)		2,409,000		222,930		102,200		89,643
Collection rate of municipal solid waste (%)		100		100		100		100
Volume of household solid waste disposed of via transfer stations (tonnes/year)		320,000		200,000		89,936		-
(Effect Indicator)								
Number of beneficiaries / target population for services (in units of 10,000 people)	102	300	20	90	18	33	31	30
(out of which) beneficiaries of sanitary landfill (in units of 10,000 people)		300 (Entire city)		90 (Urban area + some rural areas)		33 (Urban area + some rural areas)		30 (Urban area + some rural areas)
(out of which) beneficiaries of transfer station (in units of 10,000 people)		200 (Urban area)		30 (Urban area)		33 (Urban area + some rural)		28 (Urban area)

						areas)		
(out of which) beneficiaries of waste collection & transport vehicle (in units of 10,000 people)		200 (Urban area)		90 (Urban area + some rural areas)		33 (Urban area + some rural areas)		30 (Urban area + some rural areas)
Illegal dumping sites		0		0		0		0
Prefectural city/county	Changning		Yueyang		Linxiang		Huarong	
Indicator	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value
(Operation indicator)								
Processed volume of sanitary landfill (tonnes/year)	84,000	116,750	71,000	15,000 (incineration 73,000) (25,000 in 2015)	107,000	49,823	94,900	50,277
Post-treatment leachate BOD concentration (mg/l)		10.0		3.9		82.7		9.9
Post-treatment leachate COD concentration (mg/l)		60.0		20.7		378.0		99.0
suspended substance and suspended solids (mg/l)		5.0		6.0		101.0		9.9
Post-treatment ammoniacal nitrogen (mg/l)		-		1.0		34.0		-
Treated leachate volume (m ³ /year)		84,900		6,300		24,300		13,235
Harmless treatment rate of municipal solid waste (%)		100		100		95		100
Collection volume of municipal solid waste (tonnes/year)		88,000		-		52,132		69,300
Collection rate of municipal solid waste (%)		100		100		100		100
Volume of household solid waste disposed of via transfer stations (tonnes/year)		-		-		39,238		50,277
(Effect Indicator)								
Number of beneficiaries / target population for services (in units of 10,000 people)	17	82	15	24	21	20	25	71
(out of which) beneficiaries of sanitary landfill (in units of 10,000 people)		82 (Urban area + some rural)		24 (Entire zone)		20 (Urban area + some)		71 (Entire county)

		areas)				rural areas)		
(out of which) beneficiaries of transfer station (in units of 10,000 people)		28 (Urban area)		24 (Entire zone)		14 (Urban area)		25 (Urban area + some rural areas)
(out of which) beneficiaries of waste collection & transport vehicle (in units of 10,000 people)		28 (Urban area)		24 (Entire zone)		14 (Urban area)		35 (Urban area + some rural areas)
Illegal dumping sites		0		0		0		0
Prefectural city/county	Shaoyang		Wugang		Lengshuijiang		Cili	
Indicator	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value
(Operation indicator)								
Processed volume of sanitary landfill (tonnes/year)	262,800	264,978	95,000	87,400	95,000	82,752	98,000	114,975
Post-treatment leachate BOD concentration (mg/l)		3.0		14.0	30	7.0		13.0
Post-treatment leachate COD concentration (mg/l)		15.0		34.0	100	16.0		27.0
suspended substance and suspended solids (mg/l)		12.0		6.0	30	6.0		4.0
Post-treatment ammoniacal nitrogen (mg/l)		0.1		6.0		1.2		-
Treated leachate volume (m ³ /year)		110,751		35,000		42,772		-
Harmless treatment rate of municipal solid waste (%)		100		100		97		100
Collection volume of municipal solid waste (tonnes/year)		239,837		87,400		93,588		113,400
Collection rate of municipal solid waste (%)		100		100		100		100
Volume of household solid waste disposed of via transfer stations (tonnes/year)		239,837		-		37,723		-
(Effect Indicator)								
Number of beneficiaries / target population for services (in units of 10,000 people)	52	95	17	60	19	38	20	71
(out of which) beneficiaries of		95		60		38		71

sanitary landfill (in units of 10,000 people)		(Urban area + some rural areas)		(Urban area + some rural areas)		(Urban area + some rural areas)		(Entire county)
(out of which) beneficiaries of transfer station (in units of 10,000 people)		70 (Urban area)		30 (Urban area)		15 (Urban area)		15 (Urban area)
(out of which) beneficiaries of waste collection & transport vehicle (in units of 10,000 people)		70 (Urban area)		30 (Urban area)		15 (Urban area)		15 (Urban area)
Illegal dumping sites		0		0		0		0
Prefectural city/county	Zhangjiajie		Sangzhi		Shuangpai		Total	
Indicator	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value
(Operation indicator)								
Processed volume of sanitary landfill (tonnes/year)	73,000	113,500	31,000	48,600	31,940	36,500	1,765,465	1,377,578
Post-treatment leachate BOD concentration (mg/l)		20.0		20.0		-	30-600	3.4-82.7
Post-treatment leachate COD concentration (mg/l)		60.0		60.0		11.7	100-1,000	3.0-378.0
suspended substance and suspended solids (mg/l)		30.0		-		0.0	200	5.0-101.0
Post-treatment ammoniacal nitrogen (mg/l)		10.0		-		-		0.1-34.0
Treated leachate volume (m ³ /year)		24,000		11,800		36,500		599,003 (14 cities/counties)
Harmless treatment rate of municipal solid waste (%)		100		100		100		95-100 (average 99%)
Collection volume of municipal solid waste (tonnes/year)		113,500		48,532		36,500		3,765,962 (14 cities/counties)
Collection rate of municipal solid waste (%)		100		100		100		100
Volume of household solid waste disposed of via transfer stations (tonnes/year)		-		-		-		977,011 (7 cities/coun

								ties)
(Effect Indicator)								
Number of beneficiaries / target population for services (in units of 10,000 people)	21	30	7	18	6	9	390	971
(out of which) beneficiaries of sanitary landfill (in units of 10,000 people)		30 (Urban area)		18 (Urban area + some rural areas)		9 (Urban area + some rural areas)		971
(out of which) beneficiaries of transfer station (in units of 10,000 people)		30 (Urban area)		18 (Urban area + some rural areas)		-		569
(out of which) beneficiaries of waste collection & transport vehicle (in units of 10,000 people)		30 (Urban area)		18 (Urban area + some rural areas)		-		641
Illegal dumping sites		0		0		0		0

Source: Replies by executing companies to the questionnaire.

Note: The target and actual values reflect 2 years after project completion (actual values are from 2017). Collection rate of municipal solid waste = collected MSW volume / generated MSW volume. The shaded boxes reflect indicators that are outside the scope of this evaluation.

Appendix3 The Number of Beneficiaries of Project Facilities by Target Prefectural City/County

	Region	Beneficiaries	Region	Beneficiaries	Region	Beneficiaries	
Hengyang	Entire city	3,000,000	Urban area	2,000,000	Urban area	2,000,000	3,000,000
Liuyang	Urban area + some rural areas	900,000	Urban area	300,000	Urban area + some rural areas	900,000	900,000
Guiyang	Urban area + some rural areas	330,000	Urban area + some rural areas	330,000	Urban area + some rural areas	330,000	330,000
Qiyang	Urban area + some rural areas	300,000	Urban area	280,000	Urban area + some rural areas	300,000	300,000
Changning	Urban area + some	820,000	Urban area	280,000	Urban area	280,000	820,000

	rural areas						
Yueyang	Entire zone	240,000	Entire zone	240,000	Entire zone	240,000	240,000
Linxiang	Urban area + some rural areas	200,000	Urban area	140,000	Urban area	140,000	200,000
Huarong	Entire county	710,000	Urban area + some rural areas	250,000	Urban area + some rural areas	350,000	710,000
Shaoyang	Urban area + some rural areas	950,000	Urban area	700,000	Urban area	700,000	950,000
Wugang	Urban area + some rural areas	600,000	Urban area	300,000	Urban area	300,000	600,000
Lengshuijiang	Urban area + some rural areas	380,000	Urban area	150,000	Urban area	150,000	380,000
Cili	Entire county	710,000	Urban area	150,000	Urban area	150,000	710,000
Zhangjiajie	Urban area	300,000	Urban area	300,000	Urban area	300,000	300,000
Sangzhi	Urban area + some rural areas	180,000	Urban area + some rural areas	180,000	Urban area + some rural areas	180,000	180,000
Shuangpai	Urban area + some rural areas	90,000	-	-	-	-	90,000

Source: Replies by executing companies to the questionnaire.

Note: Total figure excludes duplicates.

Appendix Table4 Operating Bodies of Household Waste Treatment Business in the Target Cities and Counties of the Project

City/County	Sanitary Landfill Facility	Exuded Water Treatment	Transfer Station Operation	Solid Waste Collection and Transportation
Hengyang	Administration	Administration	Administration	Administration
Liuyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration
Guiyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration

Qiyang	Administration	Administration	Administration	Administration
Changning	Administration	Outsourced to the Private Sector	Administration	Administration
Yueyang	Administration	Administration	Administration	Administration
Linxiang	Administration	Administration	Administration	Administration
Huarong	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Outsourced to the Private Sector
Shaoyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector · Administration	Outsourced to the Private Sector
Wugang	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector
Lengshuijiang	Administration	Administration	Administration	Administration
Cili	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration
Zhangjiajie	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration
Sangzhi	Administration	Administration	Administration	Administration
Shuangpai	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector

Source: Replies by the implementing agencies to the questionnaire.