TUK	• To improve a collection service: fixing the collection time, not leaving any waste after the collection work, to do loading work quickly, and so on • To make a consensus with business establishments (renegotiate its contract with each business establishment, if necessary) • To monitor the discharge manner of business establishments and to give an instruction to them, if necessary
Housing Associations (HA)	• To decide discharge points • To distribute education materials • To give information on discharge rules to households and small shops • To maintain discharge points clean • To monitor the discharge manners of local residents and to give an instruction to them, if necessary
Local Residents and Business Establishment	• To support housing associations in order to keep their areas clean • To follow rules

9.7.4 Procedure of Collection System Improvement

a. Phase 1: Collection System Improvement

In order to improve current collection system, following measures were taken.

Amplifier and speaker system for bell collection

- Introduction of Entrance Collection System: the collection truck stop at each entrance of apartment buildings
- Change of services frequency: changed to three times a week from twice a day.
- Fix Collection Schedule: The schedule of collection service is fixed. Collection vehicles start their collection services at 9 o'clock.
- Separation of small scale business waste from household waste.
- Adoption of playing melodies during the waste collection work.

In order to introduce discharge rules, followings works were conducted.

- Baseline survey : To examine the current collection system.
- Consensus building with housing associations and the Khoroo Government
- Formulation of a draft of discharge rules
- Modification of collection system
- Preparation of educational materials such as leaflets, posters, signboard, etc.
- Selection of monitoring persons
- Kick off meeting with Khoroo Governors and HA representatives
- Meeting with apartment cleaners and keepers
- Distribution and installation of educational materials
- Community meetings or visiting households.

Discharge Rules

Upon above preparation works, new discharge rules were applied and new collection system was commenced. During implementation, monitoring works, continuous educational activities, additional meetings were organized.

b. Phase 2: Introduction of Separate Collection

After the improvement of collection system, a separate collection system was introduced at 4 apartments where residents were well organized. Types of waste to be separated and collection frequency are as follows.

Table 9-26: Type of Separation and Collection Frequency

Separation	Type of Waste	Frequency
Recyclable Waste	Bottle、PET Bottle、Waste Papers、Can、Metal、Other Plastics	Sat
Non-recyclable Waste	Other than recyclable waste	Mon, Wed, Fri

9.7.5 Findings

a. Entrance Collection System

In general, the result of the project shows that an entrance collection system is applicable in the planned area. In the case of low-rise apartment buildings, however, the limited space at the entrance could cause a problem. In particular, if a certain number of residents continue to discharge waste on non-collection day, the new system would face a serious problem. In some cases, a new waste heap was created near the apartment buildings.

b. New Discharge Rules

Even though the frequency of collection service was significantly decreased, the majority of households followed discharge rules. The proposed discharge rules worked well under the conditions with enough preparation works, strict monitoring works, and continuous education activities by the Khoroo governments and housing associations

c. Collection Frequency

The removal of waste heaps significantly shortened the collection work. The number of trip, however, did not change, only one trip per day. It is necessary for TUK to modify the collection plan in the whole area in order to achieve the real increase in the collection efficiency.

d. Introduction of Separate Collection

The separate collection should be introduced in the three years after the entrance collection system is introduced. Even if the separate collection has to be quickly introduced in, it should wait for one year after the entrance collection started. It may be an effective way of waste source separation to sort recyclables by cleaners.

9.8 P/P 7: Organization of Waste Pickers

9.8.1 Background

In developing countries, many waste pickers earn their livelihoods at disposal sites by picking valuables. The disposal sites, where waste pickers are working, are so called open dumping

conditions and fires, odors and scattering of the waste causes serious negative impacts on the surrounding environment.

It is not an exceptional case in Ulaanbaatar, all the four official disposal sites in the city are so called open dump conditions and many waste pickers are working there. There are 300 waste pickers working in the Ulaan Chuluut Disposal Site (UCDS) which is the biggest disposal site in the city and over 90 % of the waste is disposed there.

The master plan proposes that a new Narangiin Enger Disposal Site (NEDS) will be developed and the existing UCDS will be closed because remaining landfill volume is very limited.

It is planned at new NEDS that sanitary landfill will be implemented and the waste pickers will not be allowed to work inside landfill area. In order to support waste pickers livelihoods, a sorting yard will be constructed next to the landfill site and those waste pickers are encouraged to work at the sorting yard instead of the landfill site. The residue, which will be generated at the sorting yard and mainly consists of waste papers and plastics, is planned to be used as a raw material for RDF production.

Whether future sanitary landfill operation will be able to conduct or not, highly depends on the WP's cooperation. An opinion survey for the WPs was conducted and workshops for the new NEDS were held several times. It was found that the organization of the WPs is very important in order for WPs to follow certain rules and operate NEDS under sanitary conditions.

9.8.2 Organization of Waste Pickers

Weekly meetings with WPs were held in Phase 3 of the study. Around 300 WPs were divided into 10 groups and 10 group leaders were selected from each group with one chairperson selected to represent all the WPs. The weekly meetings were organized among these group leaders and chairperson together with C/P and the Study Team.

25 weekly meetings in total were held by the end of 2006. Nuuts Co. took an initiative to hold a meeting even when there is no study team member in Mongolia.

Through these weekly meetings, it was found that WPs have a lot of personnel and social problems. Upon many discussions among them, mutual trust was formed and following activities were implemented.

a. Issuance of ID Card

According to the meetings with WPs, we have found that they have an unstable social status and many of them do not even have a national ID card. Due to this, they could not enter the municipal buildings and could not receive any medical services. In order to solve these problems and upon the request of the WPs, ID cards were issued under the status of worker in the disposal site and signed and chopped by Nuuts Co., Ltd.

ID Card for Waste Pickers

As of Dec 2006, around 220 WPs have this ID card.

b. Formulation of Fire Fighting Group

Fire in the disposal site causes not only troubles for landfill operation and surrounding environmental problems but also lose opportunities for WPs to earn money by picking valuables from the wastes.

Therefore, WPs formed a fire fighting groups and conducted several precaution works such as detection in early stage and inform to Nuuts, assisting fire extinguish manually, giving notice to the people who are putting fire.

Fire fighting group is wearing vest to distinguish with other group.

c. Waste Pickers Fund

The Fund that was established by WPs initiative would be utilized to help members who are sick or somebody passed away, to get medical and sanatorium treatment, to organize certain events, to get civil registration documents and to provide one-time assistance for those who are having hard living.

As this fund was established by WP's initiative and not forced by somebody else, some WPs started not to pay and complaint among group members were raised. At this moment, some system will be changed as entrance fee to the disposal site will be collected by Nuuts Co and this money will be used for Waste Pickers Fund.

d. Clean Up Activity

Scattering wastes which mainly consist of waste papers and plastics are the one of big problem in UCDS. These scattering wastes caused fire to the surrounding when the fire occurred in UCDS.

Furthermore, the enclosing dam was constructed along the boundary of the landfill site, and clear indication was made where to dispose and where not to dispose. Therefore, scattered wastes became obvious.

Cleanup activity was made periodically with Nuuts and WPs cooperatively in order to clean up area where suppose not to dispose.

Through the activities mentioned above, WPs tend to act as a group under certain rules who acted individually before. Continuation of these activities is essential to maintain and even strengthen the mutual trust and smooth transition from UCDS to NEDS will be expected.

10. Feasibility Study

10 Feasibility Study

10.1 Outline of Priority Projects

10.1.1 Selection of Priority Projects

Based on the M/P the following three projects were selected as priority projects to be implemented by year 2010 and decided by the St/C held on May 10th, 2006. Following the decision of the St/C feasibility study for the projects was conducted below.

Table 10-1: Priority Project

Priority Project	Contents
1. Improvement of collection system	1.1. Improvement of collection efficiency in the Planned area (Apartment area) 1.2. Provision of a collection service to all the households in UB, including the Unplanned area (Ger area) 1.3. Introduction of a separate collection system in the Planned area 1.4. Construction and management of a central workshop
2. Development of Narangiin Enger Disposal Site (NEDS)	2.1. Construction of a final disposal site for sanitary landfill operation 2.2. Implementation of a sanitary landfill operation
3. Development of Narangiin Enger Recycling Complex	3.1. Construction and operation of a sorting yard 3.2. Construction and operation of a RDF plant 3.3. Development of a industrial site for private recycling businesses and attraction of them

10.1.2 Improvement of Collection System

The outline of the collection system improvement plan is described below. Details of it are presented in the Annex Report.

a. Improvement of Collection Efficiency in the Apartment Area

At present waste collection service is provided to all residents in the apartment area (Planned area). However, the collection efficiency of the service is very poor and the scattering waste is often observed even in the area where collection service is provided daily or twice a day. In order to solve these problems the following measures are planned:

- The concerned parties for waste collection system such as administrators, service provider and people elaborate a discharge rule. The residents (waste dischargers) discharge waste at designated time, day and place while the service provider strictly maintains collection time and day set by the rule.
- Since the wastes generated in the Apartment area do not include ash and comparatively light, current dump trucks for the collection service in the area will be replaced with compactor trucks to raise loading efficiency of a waste collection vehicle.

b. Provision of Collection Service to all the Households in UBC

One of the most important targets of the M/P is to provide collection service to all the households in UBC. At present more than half of the population in the Ger area do not receive waste collection service while 100 % of people in the Apartment area are provided the service. The main reason of the fact is waste collection service in the Ger area is provide when the service fee is paid. The poor people in the Ger area, therefore, could not afford it and many poor live there. In order to solve these problems the following measures are planned:

- With the establishment of waste service fund both in the city and districts, a financial system for SWM, which realizes a cross-subsidy necessary for the provision of waste collection service to the Ger area, shall be constructed.
- Along with the above measure, Khoroo and/or Kheseg offices will collect service fee instead of current TUKs in order to make compelling service fee collection system by stopping administration services against non-payment people. Even if compelling system works, there are some people who will not able to afford service. Khoroo and/or Kheseg offices will charge such people to contribute themselves to cleaning their area instead of paying the fee.
- In addition, the surplus money which will be gain from the improvement of collection efficiency in the Apartment area shall be used for the expansion of waste collection service to the Ger area. Dump trucks used for the waste collection service in the Apartment area will be shifted to the service in the Ger area.

c. Introduction of a Separate Collection System in the Apartment Area

The fundamental goal of the M/p is to establish an environmentally sound SWM in MUB. In order to achieve the goal the public sector participates and promotes 3Rs. Thus the MUB intends to promote 3Rs by developing a recycling complex at Narangiin Enger and construct a sorting yard and RDF production facility. Introduction of separate collection system is indispensable to promote recycling and to properly operate the sorting yard and RDF production facility. Consequently as a first step of the M/P a separate collection system will be introduced to 15% of population in the Apartment area.

d. Construction and Management of a Central Workshop

For the proper use of collection vehicle and provision of a reliable collection service, it is necessary to conduct daily and periodical check and maintenance of the vehicles, and execute light and medium repairs by waste collection service body. At present TUKs hardly conduct these preventive maintenances. A central workshop will be constructed and operated by MUB/CMPUA in order to conduct these preventive maintenances. Heavy repair will be entrusted to the large private workshop.

A proposed plan of the central workshop is presented in the Figure below.

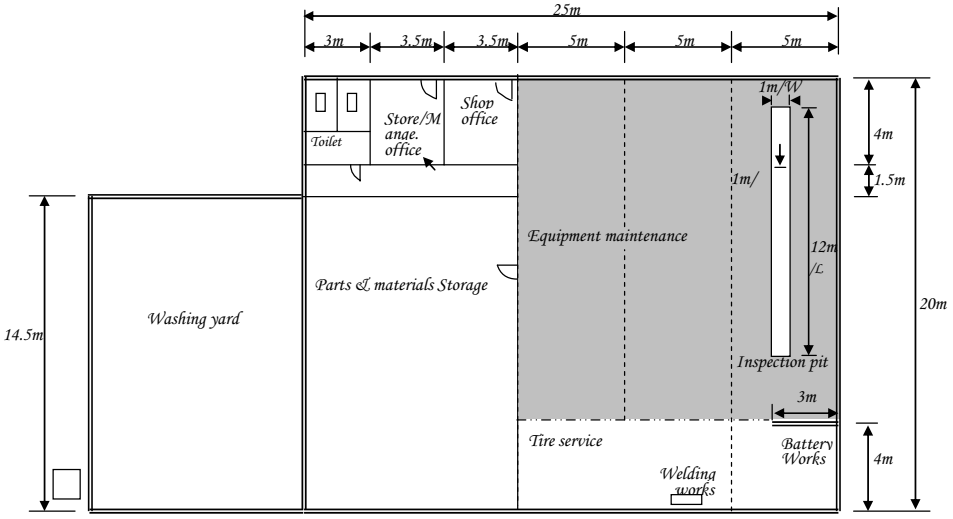


Figure 10-1: Proposed Workshop for Collection Equipment

e. Summary of Collection System Improvement Plan

The following figures and table summarizes the collection haulage system plan.

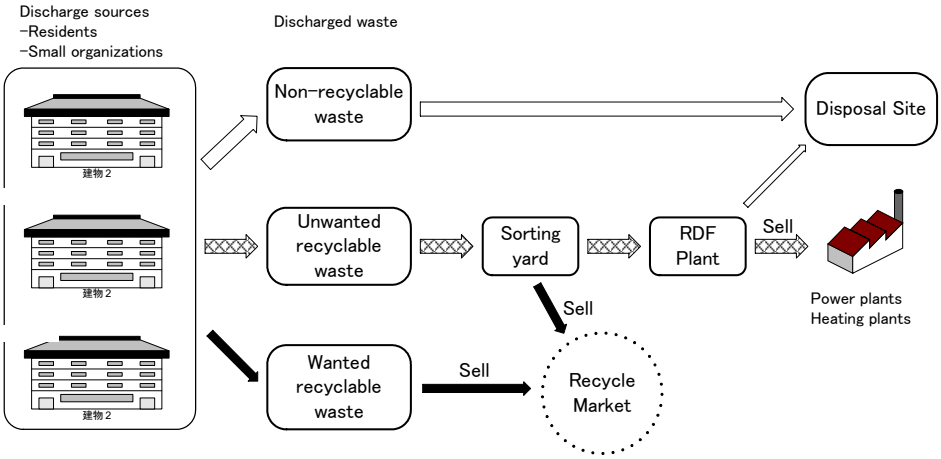


Figure 10-2: Waste Haulage System for the Planned Areas

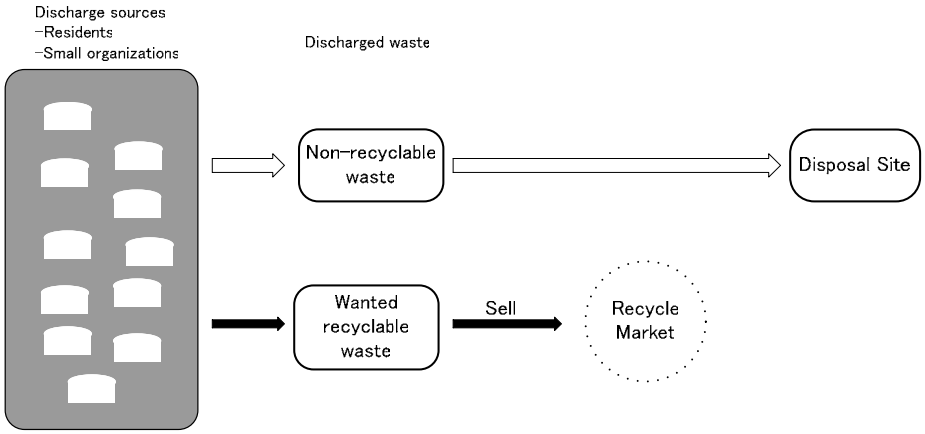


Figure 10-3: Waste Haulage System for the Unplanned Areas

Table 10-2: Collection and Haulage System

Type of area	Source of waste	Frequency	Waste separation	Storage	Collection equipment	Collection method	Collection hours
Planned Area	Residential waste	3 times per week on fixed days (twice for non-recyclable, once for recyclable)	Separate collection Recyclable → Sorting yard Non-recyclable → Landfill site	Plastic bag	Compactor 15m3 Compactor 8m3	Entrance (of apartment) collection with bell system	Winter: 9am to 6pm Summer: 9am to 7pm
	Non-residential waste (small dischargers)	3 times per week on fixed days (twice for non-recyclable, once for recyclable)	Separate collection Recyclable → Sorting yard Non-recyclable → Landfill site	Plastic bag	Compactor 15m3 Compactor 8m3	Door to door collection with bell system	Winter: 9am to 6pm Summer: 9am to 7pm
	Bulky waste	Depending on customers' needs	N.A.	N.A.	2 ton truck	Door to door collection	Winter: 9am to 6pm Summer: 9am to 7pm
Unplanned Area	Residential waste	Twice per month on fixed days	Mixed collection	Less than 200 liter container (drum), Bags	Dump trucks 6m3	Door to door collection with bell system	Winter: 9am to 6pm Summer: 9am to 7pm
	Non-residential waste (small dischargers)	Twice per month on fixed days	Mixed collection	Less than 200 liter container (drum), Bags	Dump trucks 6m3	Door to door collection with bell system	Winter: 9am to 6pm Summer: 9am to 7pm
Both area	Non-residential waste (large dischargers)	Depending on customers' needs	Mixed collection	On-site container. 1m3 container, 5m3 container, Etc.	Depending on the waste type and waste discharge pattern. 6 ton dump truck 5m3 container with skipper 1m3 container with a compactor with lifting device	Door to door collection based on the contract condition or by telephone order.	Winter: 7am to 7pm Summer: 5am to 11pm

f. Equipment and Facility Plan

Equipment and facilities necessary for the implementation of the collection system improvement plan are summarized in the table below.

Table 10-3: Equipment and Facility Plan necessary for Collection System Improvement

Plan	Contents
Collection Improvement Project	Collection Amount: • Winter: 583.0 ton/day (Separate collection amount: 29.7 ton/day) • Summer: 306.1 ton/day (Separate collection amount: 28.6ton/ day) Collection Equipment: • Compactor Truck (15 m3): 23 units • Compactor Truck (8 m3): 7 units • Dump truck (6 ton): 113 units
Central Workshop Project	Facilities: • Administration office • Equipment maintenance • Tire service • Buttery and welding works • Parts and material storage • Car washing yard Equipment: Tools for preventive maintenance

g. Project Cost

Project cost for improvement of collection services such as procurement of collection equipment, construction of central workshop, and operation and maintenance cost for collection services are sown below.

Table 10-4: Project Cost for Improvement of Collection Service

Unit: 1 Million MNT

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Collection													
Investment	0	3804	0	342	210	228	0	534	342	3658	228	673	534
O&M			3689	3763	3871	3958	4042	4214	4325	4489	4473	4523	4639
Sub total	0	3804	3689	4105	4081	4186	4042	4748	4667	8147	4701	5196	5173
Central Workshop													
Design & SV	13	8											
Investment	0	311											
O&M			86	44	44	86	44	44	86	44	44	86	44
Sub Total	13	319	86	44	44	86	44	44	86	44	44	86	44
Total	13	4123	3775	4149	4125	4272	4086	4792	4753	8191	4745	5282	5217

10.1.3 Development of Narangiin Enger Disposal Site (NEDS)

a. Development Concept

a.1 Need for a Sanitary Landfill

It is generally recognized that a sanitary landfill is the basic element of modern SWM (solid waste management). Thus, it is acknowledged that the majority of waste has to be disposed of at a landfill even if best efforts are made to the 3Rs (reduce, reuse and recycle). As a priority step towards modern SMW, the Municipality of Ulaanbaatar (MUB) is recommended to strengthen the final disposal system which minimizes environmental impact.

a.2 The New Disposal Site in Narangiin Enger

This section presents the preliminary design for a new final disposal site in Narangiin Enger, which has been selected by the Steering Committee (St/C) of the Study on April 26, 2005 to

be its future landfill site. The distance from the city center of Ulaanbaatar to the disposal site is approximately 10 km and the site comprises of an area of approximately 82 ha in total, as shown in the following figure.

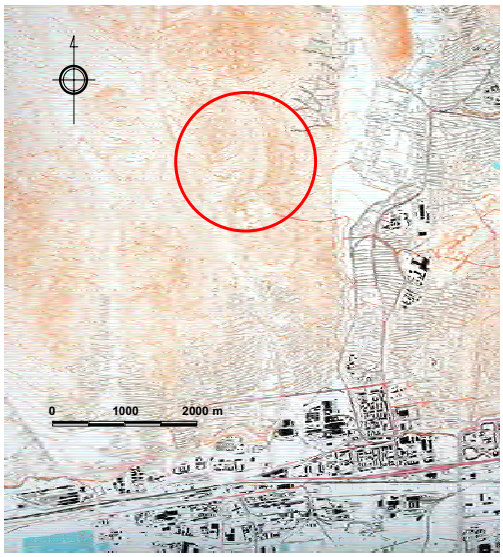


Figure 10-4: Location of Narangiin Enger Disposal Site

a.3 Design Concept of the Narangiin Enger Disposal Site

The facilities of Narangiin Enger Disposal Site to be constructed in Phase 1 include the CMPUA/MUB site office, the landfill area, a leachate treatment facility (pond), a recycling complex (a sorting yard with RDF equipment), and a warm garage. A sorting yard with RDF equipment will be constructed on a pilot scale in 2010 and will be upgraded to full scale in year 2014. The site comprises of an area of approximately 20 ha, as shown in the figure below. The disposal site is to be expanded to approximately 82 ha in total in future. According to the operation plan, the 82 ha site will be developed in seven phases. The conceptual design of the site is presented in the following table.

The basic concept of the disposal site design is to arrange the necessary facilities and equipment while taking into consideration the environmental impact on the surrounding area. For sustainable management, it is preferable to keep the unit cost of waste disposal (the construction cost per 1 ton of waste) as low as possible.

The height of the enclosing dam of the landfill area by phase1 was designed to be 1,401m (Altitude) and the final height of the landfill was determined considering the NEDS land form. The slope of the completed landfill was designed to be 1:3. The excavated soil can be used as cover material for land filled sections.

Although the leachate generation is very limited due to the climatic conditions (high evaporation and low precipitation) and characteristic of waste to be disposed of (less water contents), the new disposal site will be equipped with a leachate treatment facility (evaporation method). The facility will not discharge treated waste water outside the disposal site, so that it is possible to prevent environmental degradation of the surrounding area.

The landfill section will be developed first until 1,401 m. In the next phase, CMPUA/MUB is supposed to develop the landfill areas according to the operation plan. An important issue of this plan is to minimize the initial investment cost and O&M expenditure.

The main features of the proposed disposal site are mentioned above, and the landfill area is to be developed in accordance with the basic concept of mitigating the impact on the surrounding environment as much as possible.

b. Development Plan

b.1 Planned Disposal Amount

The NEDS will open in the first quarter of year 2009. Taking the reduction of amount by sorting yard and RDF production facility into consideration, the planned final disposal amount at NEDS up to 2020, the target year of the M/P, is calculated as shown in the table below.

Table 10-5: Planned Disposal Amount of NEDS

Year	NEDS (Total) (ton/day)	Description				
		MSW (ton/day)	RDF facility Residue (ton/day)	Construction waste (ton/day)	Non-HIW (ton/day)	GWMI (ton/day)
2009	555.0	373.8	0.0	92.1	72.4	16.7
2010	592.2	392.0	4.7	103.4	76.4	15.7
2011	614.7	403.7	5.2	109.1	80.6	16.1
2012	638.9	416.6	5.6	115.1	85.1	16.5
2013	664.1	430.0	6.1	121.5	89.7	16.8
2014	691.0	444.5	6.7	128.0	94.6	17.2
2015	698.7	427.0	19.2	135.1	99.8	17.6
2016	725.3	438.5	21.0	142.6	105.3	17.9
2017	754.6	452.1	22.8	150.4	111.1	18.2
2018	785.2	466.0	24.7	158.7	117.2	18.6
2019	817.6	481.1	26.5	167.4	123.7	18.9
2020	815.5	439.0	50.1	176.6	130.5	19.3

(Note): The figure in the table shows average of winter and summer.

c. Required Landfill Capacity

In order to dispose the above amount of waste at NEDS it requires the following landfill capacity as shown in the table below.

Table 10-6: Required Landfill Capacity

Year	Weight of Discharged Waste	V1 Volume of Waste Just Dumped	V2 Cover Soil	V3 Volume of Waste by stable state	V Total Volume	Accumulated Volume	Required Capacity
	Wd	V1= Wd / 0.4	V2= V1 x 0.08	V3= Wd / 1.2	V= V2+V3		
	ton/year	m^3/year	m^3/year	m^3/year	m^3/year	m^3	m^3
2009	202,575	506,438	40,515	168,813	209,328	209,328	
2010	216,153	540,383	43,231	180,128	223,359	432,687	
2011	224,366	560,915	44,873	186,972	231,845	664,532	
2012	233,199	582,998	46,640	194,333	240,973	905,505	
2013	242,397	605,993	48,479	201,998	250,477	1,155,982	3,151,000
2014	252,215	630,538	50,443	210,179	260,622	1,416,604	
2015	255,026	637,565	51,005	212,522	263,527	1,680,131	
2016	264,735	661,838	52,947	220,613	273,560	1,953,691	
2017	275,429	688,573	55,086	229,524	284,610	2,238,301	
2018	286,598	716,495	57,320	238,832	296,152	2,534,453	
2019	298,424	746,060	59,685	248,687	308,372	2,842,825	
2020	297,658	744,145	59,532	248,048	307,580	3,150,405	

d. NEDS Development Plan

In order to prevent waste from scattering and protect the landfill operation from outside, completed landfill height is planned to be lower than the surrounding hills. As the results it is planned that maximum landfill height is 40m, height of enclosing dam for the Phase 1 is 10m and each enclosing dam from Phase 2 to Phase 7 is 5m. NEDS will be seven times raised by enclosing dam as shown in the table below.

Table 10-7: Phased Landfill Plan of NEDS

Items	Description		
Land Area and Proposed Land Use	Total Area : 24.6 ha		
Landfill Volume	Phase	Capacity	Disposal Period
	Phase 1	84,981m^3	2009-2009
	Phase 2	164,298 m^3	2009-2010
	Phase 3	294,865 m^3	2010-2011
	Phase 4	433,090 m^3	2011-2013
	Phase 5	603,840 m^3	2013-2015
	Phase 6	805,650 m^3	2015-2018
	Phase 7	789,660m^3	2018-2020
	Total	3,176,384m^3	2009-2020

e. Facility Construction Plan in Phase 1

In Phase 1 the following facility will be constructed to use them more than 12 years:

- Access road: 1.0 km
- On-site road with concrete pavement: 700m
- On-site road with gravel pavement: 600m
- Enclosing dam for Phase 1: Height = 10m
- Leachate collection and treatment facility: Maximum treatment capacity is 800m^3/day
- Site office, Warm garage, Weighbridge and Meeting room for waste pickers
- Others: Buffer zone (Greenbelt), Gate, Fence, etc.

The following figure show Phase 1 development plan for NEDS.

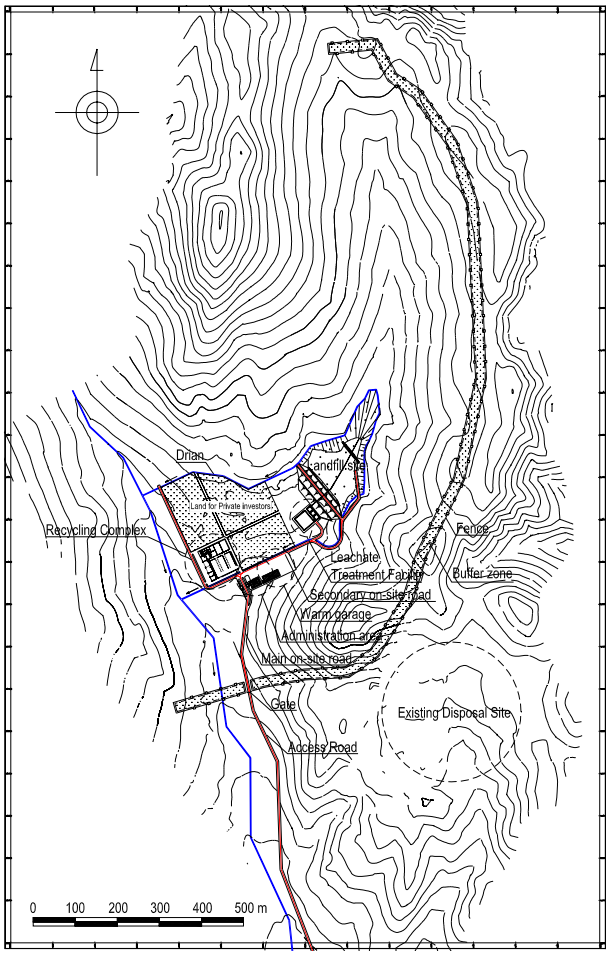


Figure 10-5: Phase 1 Development Plan of NEDS

f. Equipment Procurement Plan

For sanitary landfill operation of NEDS the following equipment will be procured:

Table 10-8: Equipment Procurement Plan for Sanitary Landfill Operation at NEDS

	Equipment	Specification	Quantity	Unit
1	Bulldozer	21 ton	3	Nos
2	Wheel loader	1.2m^3	1	Nos
3	Water Tank truck	6,000 liter	1	Nos
4	Dump truck	11 ton	2	Nos
5	Pickup truck	4WD	1	Nos
6	Excavator	0.7m^3	1	Nos

Preventive maintenance of the above equipment will be done at the warm garage to be constructed in NEDS.

g. Organization and Management Plan

Operation of the disposal site will be done by the Disposal Site Operation and Management Section of CMPUA. The CMPUA will employ and train the following staffs.

Table 10-9: Organization of NEDS

Position	Required Number
Section chief	1 person
Engineer	2 persons
Clerk (include Weighbridge staff)	5 persons
Supervisor	3 persons
Operator	8 persons
Mechanic	1 person
Worker	2 persons
Total	22 persons

h. Project Cost for Phase 1

The project cost for Phase 1 is estimated as shown in the table below.

Table 10-10: Project Cost for Phase 1 for NEDS

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Design and SV	209	138											
Investment	0	4798								289			
O&M			501	517	530	463	589	463	469	565	463	610	463
Total	209	4936	501	517	530	463	589	463	469	854	463	610	463

10.1.4 Development of Narangiin Enger Recycling Complex (NERC)

a. Policy of Development of Recycling Complex

a.1 Background

The fundamental goal of the M/P for SWM in MUB is to establish an environmentally sound SWM system in MUB by the target year 2020. To achieve this goal, 3Rs (Reduce, Reuse, Recycle) will be actively promoted to reduce waste generation at first, then to reuse and recycle generated wastes as a resource as much as possible in order to reduce the amount of the solid waste to be disposed of at the landfills.

As for the promotion of 3Rs, recycling activities shall be conducted by the private sector in principle. The role of public sector (MUB) shall be limited to:

- Promote, support and regulate the recycling activities of private sector.
- Research, introduce and disseminate technologies to recycle the waste that the private sector can not deal with.

The development project of a recycling complex next to the NEDS is identified to pursue the role of public sector (MUB) mentioned above. The project is divided into the following phases:

Phase 1 (Target year 2010):
Construction of a sorting yard and a RDF (Refuse Derived Fuel) plant and development of basic infrastructures (such as access road, electricity, water, etc.) for new private investors of recycling business

Phase 2 (Target year 2020):
Promotion of investment by private recycling enterprises

The Phase 1 of the project is subject to the feasibility study, which examines the viability of the project.

a.2 Policy of Development of Recycling Complex

The policy of the development of Recycling Complex Phase 1 is established as follows:

1. Main purposes of the project are:
   - To promote the recycling activities of the private sector and introduce technologies to recycle the waste that the private sector can not deal with; and
   - To create job opportunities to the residents around the new NEDS and waste pickers working at current UCDS in order to obtain consensus on the development of it from them.
2. The MUB shall develop a site for the recycling complex next to the NEDS and to invite the private enterprises to locate their facilities there. Because it has the following advantages:
   - Recycling facilities require a basic infrastructure such as access and on-site roads, electricity and water which will be provided by the development of the new NEDS.
   - The recycling complex will develop cooperation in a mutually complementary form if various kinds of recycling factories locate on the site. For instance, a plastic bag production company will be able to purchase their raw materials from sorting yards, an enterprise exporting scrap metal to China can purchase their materials from sorting yards and also use compaction machine provided at the yard.
   - Recycling facilities need a disposal site for residue to be generated by processing raw materials (waste).
3. Objectives of the sorting yard are:
   - To provide work opportunities to current waste pickers in UCDS in order to prevent the NEDS from their entering and to ensure sanitary landfill operation at the NEDS. Therefore, the facility shall limit the use of machinery as much as possible;
   - To promote reuse/recycle of waste; and
   - To pre-treat waste for RDF production.
4. Purposes of the RDF plant are:
   - To mitigate problems for the sanitary landfill operation; i.e. scattering waste and spoiling the stability of landfill, by reducing problems-some waste such as plastics and papers; and
   - To introduce and disseminate a thermal recycling technology of RDF that the private sector can not deal with at present and can recycle problem some waste.

b. Development Plan

b.1 Planned Treatment Amount

It is indispensable to introduce a separate collection for the proper operation of a sorting yard and RDF production facility to be constructed at the Narangiin Enger Recycling Complex (NERC). Through implementation of separate collection is quite difficult and it requires considerable time and efforts as experienced in many developed country. Therefore the C/P and the Study Team decide to take stepwise capacity raising plan of the sorting yard and RDF production facility in accordance with expansion of separate collection area as shown in the table below.

Table 10-11: Treatment Capacity of Sorting Yard and RDF Production Facility in NERC

Phase	Percentage of Separate Collection Covered Population in the Apart Area (%)	Capacity (tons/day)	
		Sorting Yard	RDF Production Facility
Pilot Phase: 2010 - 2014	15	20	11
First Phase : 2015 - 2019	40	90	45
Second Phase: 2020 -	70	170	82

Consequently the following amount of Valuables and RDF will be recovered in accordance with the stepwise plan above.

Table 10-12: Planned Treatment Amount at Sorting Yard and RDF Production Facility in NERC

Year	Rate of Separate Collection Covered Population in the Apart Area (%)		Sorting Yard (tons/day in average)		RDF Production Facility (tons/day in average)		
			Incoming Amount	Recovered Valuables	Incoming Amount	RDF Production Amount	Residue Amount
2010	Pilot Phase	15	12.7	1.9	10.8	6.1	4.7
2011		15	14.0	2.1	11.9	6.7	5.2
2012		15	15.2	2.3	12.9	7.3	5.6
2013		15	16.6	2.5	14.1	8.0	6.1
2014		15	18.0	2.7	15.3	8.7	6.6
2015	1st Phase	40	51.8	7.8	44.0	24.9	19.1
2016		40	56.9	8.6	48.3	27.3	21.0
2017		40	61.6	9.2	52.4	29.6	22.8
2018		40	66.6	10.0	56.6	32.0	24.6
2019		40	71.7	10.8	60.9	34.4	26.5
2020	2nd Phase	70	135.4	20.3	115.1	65.0	50.1

b.2 Facility Construction Plan in Pilot Phase

In Pilot Phase the following facility will be constructed:

Table 10-13: Outline of Sorting Yard and RDF Production Facility in Pilot Phase

Items		Description
Sorting Yard		
	Method	Hand-sorting yard
	Sorting Yard	3 yards with concrete paved floor of 250 m^2 and surrounded by fence
	Processing Capacity	20 tons / day
	Operation	8 hours / day for weekdays
RDF Production Facility		
	Type	Compressing type RDF production
	Treatment line	One line for RDF production
	Treatment Capacity	11 tons / day (2.2 tons / hour)
	Operation	300 days / year
		5 hours / day by one shift

The following figure show Pilot Phase construction plan for Sorting Yard and RDF Production Facility.

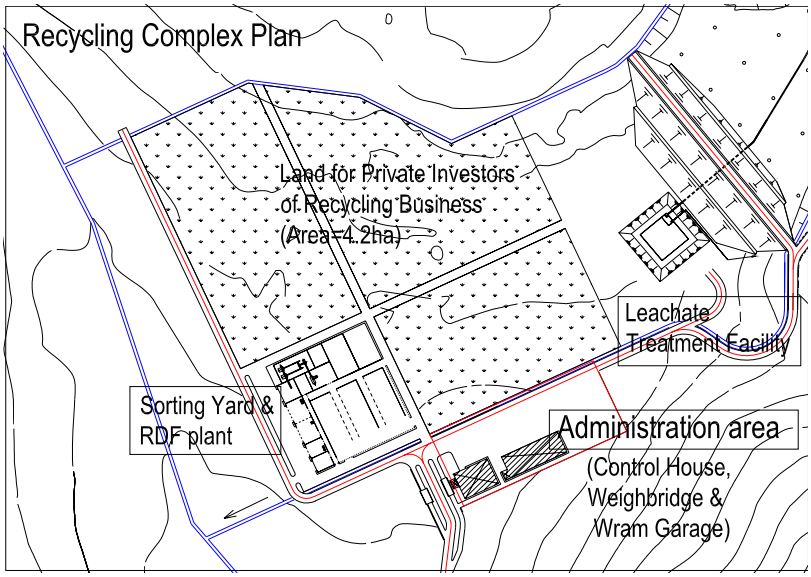


Figure 10-6: Construction Plan of Sorting Yard and RDF Production Facility in Pilot Phase

b.3 Equipment Procurement Plan for Operation of Sorting Yard and RDF Production Facility in Pilot Phase

For operation of the sorting yard and RDF production facility in Pilot Phase the following equipment will be procured:

Table 10-14: Equipment Plan for Operation of Sorting Yard and RDF Production Facility in Pilot Phase

	Equipment	Specification	Quantity	Unit
	Common section			
1	Dump truck	4 ton	1	nos
2	Wheel loader	1.0 m^3	1	nos

b.4 Organization and Management Plan

Operation of the sorting yard and RDF production facility in Pilot Phase will be done by the Disposal Site Operation and Management Section of CMPUA. The CMPUA will employ and train the following staffs.

Table 10-15: Organization of Sorting Yard and RDF Production Facility in Pilot Phase

Unit	Position	Required Number
ADMINISTRATION	Section chief	1
	Clerk	2
	Accountant	1
	sub-total	4
OPERATION		
RDF equipment section	Supervisor	1
For Operation	Equipment operator	2
	Worker	8
Transport section	Operator	2
	Worker	2
	sub-total	15
Total		19

b.5 Project Cost for Pilot Phase

The project cost for Pilot Phase of the sorting yard and RDF production facility is estimated as shown in the table below. Since this is the pilot stage of the project, procurement of a second hand RDF equipment is planned to be installed.

Table 10-16: Project Cost of the Pilot Phase Sorting Yard and RDF Production Facility

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Investment	0	588					3245			76		1580	
O&M	0	0	191	191	191	191	196	431	431	431	431	441	862
Total	0	588	191	191	191	191	3441	431	431	507	431	2021	862

10.1.5 Monitoring Plan of NEDS and NERC

a. Monitoring Plan

a.1 Monitoring Items and Frequency

In the monitoring system, the measurement of hazardous chemical substances such as heavy metals is very important. However, these measurements are very costly and the budget and human resources of Nuuts/MUB are quite limited.

Therefore, in the monitoring system of NEDS, only limited analytical parameters such as pH, EC and chloride were set for water quality. These parameters are inexpensive and easy to measure, and can monitor the leachate leakage. As for the frequency of monitoring, the same matters mentioned above had to be considered and the frequency was set as monthly.

If the results of monitoring change significantly, it means that leachate may have leaked to the outside area. So full-scale measurement parameters, including heavy metals, shall be measured and the frequency of monitoring increased.

As with water quality monitoring, practicable measurements for air quality monitoring are also limited. Therefore, CH_4, CO_2, H_2O and temperature, which can be measured by portable meters, as well as landfill fire and offensive odor, which can be monitored by visual checking, are the set measurement parameters for air quality.

Table 10-17: Monitoring plan of the Narangiin Enger Disposal Site

Items	Facility and equipment	Measuring Items	Stage		
			Construction	Operation	Closure
Underground Water	Monitoring well	Electric conductivity, Cl^-, pH		√	√
Surface Water	Water sampling	Electric conductivity, Cl^-, pH		√	√
Landfill gas	Gas removal pipe	CH_4, CO_2, H_2O, Temperature		√	√
Noise	Noise level meter	Noise	√	√	
Settlement	Settlement board	Settlement level		√	√
Landfill fire	Personal check	Landfill fire		√	√
Offensive odor	Personal check	Offensive odor		√	√

The matters mentioned above shall be considered in the detailed design of NEDS. However, it should be noted that if the situation concerning the budget and human resources of Nuuts/MUB improves, measurement parameters and frequency of monitoring must be re-considered immediately.

The monitoring locations are shown in the following figure.

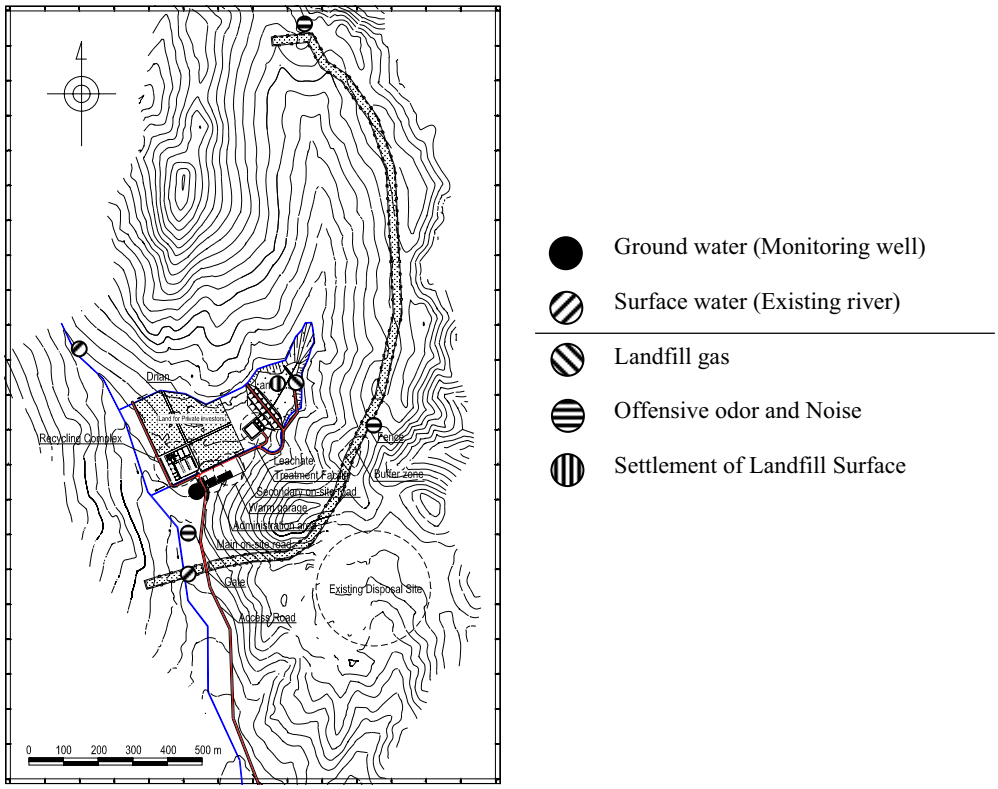


Figure 10-7: Location of Monitoring Plan

a.2 Public Communication

The result of the regular monitoring will be communicated to local residents through the monitoring committee, while other citizens will be able to access the data through the web site of MUB.

b. Monitoring Committee

In order to strengthen a monitoring system, a monitoring committee for the Project is proposed. The monitoring committee will have the following function.

- The committee members shall join in the monitoring and observe the environmental condition of the site and its surroundings.
- If the operation is suspected of having an effect on environmental conditions, the committee members shall be able to request a survey for it and be able to join on-site inspection.
- In order to properly operate the disposal site, the committee and Nuuts/MUB shall hold discussions whenever necessary.

The committee may include:

- City Specialized Inspection Agency
- Nuuts/MUB
- MOE
- NGOs
- Representatives from local authorities and residents

10.2 Project Evaluation

10.2.1 Assessment of Technology

The feasibility of these three priority projects is assessed, considering the current technical and management level of the target area.

a. Improvement of Collection System

a.1 Improvement of Collection Efficiency in the Planned Area

The Planned area has such advantages as easy access to collection points and densely located generation sources, but the actual collection efficiency there is very low due to the following reasons:

- A large portion of waste generated in the Planned area is light waste such as plastics and papers. Since most of collection vehicles are dump trucks and cannot compress waste, the volume of waste loaded for transportation is limited.
- There are no established rules between dischargers and collection service providers. This results in difficult loading work and requires a long time to load waste.

Under the priority project, the following measures will be taken in order to solve theses problems.

- to procure compactor trucks aiming to increase the collection/transportation efficiency
- to introduce discharge rules aiming to cut the loading time

Under the plan, two sizes of compactor trucks, 15 m^3 and 8 m^3, will be used. These compactor trucks can collect and transport waste of 6.08 tons (15 x 0.45 x 0.9) and 3.24 tons (15 x 0.45 x 0.9), 3.4 times and 1.8 times as much as a 10 m^3 dump truck can collect and transport (10 x 0.2 x 0.9 = 1.8 tons) respectively. In addition, a central maintenance workshop is planned to be constructed and operated by CMPUA/MUB, so that newly acquired compactor trucks would be maintained properly at the workshop.

Regarding the discharge rules, at present there is no consensus about them among dischargers (residents and housing associations), collection service providers, and local authorities (MUB and Duureg/Khoroo Governments). Moreover, it is necessary to establish a reliable collection system, in particular fixed collection schedule, before introducing discharge rules.

By the pilot project of the study some Khoroos in the Planned area of Chingeltei District have established a discharge rule and is disseminating it to all Apart area in the district gradually. If the introduction of compactor trucks could increase the collection efficiency and fix the collection schedule, it is likely that local residents would accept discharge rules.

a.2 Provision of Collection Service to All the Households in UBC, including the Unplanned Area

In the Planned area, a waste collection service is provided for all the households, while less than 50% of the households in the Unplanned area receive a collection service. This large difference between the Planned and Unplanned area can be attributed to the following elements.

- Waste generation amount per capita in the Unplanned area is larger than that of the Planned area. In addition, houses are located apart from each other and this raises the collection cost per household. As a result, at present the collection fee in the Unplanned area is higher than that of the Planned area.

- The income level in the Unplanned area tends to be lower than that of the Planned area, and many of poor family cannot afford to pay the collection fee. The fee collection rate in the Unplanned area is extremely low, 12%.
- In UBC, the finance of the collection service is based on the User Pay Principal. There are no complementary systems such as cross-subsidy, which could work as safety net.

It can be said that the main reasons for the low collection efficiency are not technical matters but social and financial matters. It is important to pay attention to these social and financial matters in order to improve the collection system.

a.3 Introduction of Separate Collection System in the Planned Area

The current collection system in the targeted area is mixed collection, and the JICA ST expects a lot of challenges and difficulties in order to introduce the source separation system. Therefore, the JICA ST carefully selected a suitable target area and will try to start source separation in a limited area. And then separate collection will be expanded in phases to other areas. According to our plan, separate collection will be introduced across the Planned area by 2010, but the team sets a target of the separate collection rate of 15% in 2010 and 70% in 2020.

In addition, source separation was introduced under a pilot project (P/P) in the Phase 3 in order to evaluate the appropriateness and feasibility of the plan. The results of the P/P concluded that if local residents understand clearly the purpose and method of source separation and the importance of public participation, it could be possible for MUB to introduce source separation. Under the pilot project, educational tools for local residents were prepared in collaboration with C/P, Khoroo offices, TUK and Housing associations.

The P/P was conducted in cooperation with a member of Japan Overseas Cooperation Volunteer (JOCV) in charge of environment education and another JOCV senior member in charge of SWM administration, it is possible to manage the project in the long term. Considering these element, it can be judged that it is possible to introduce source separation in phases across the city based on the result of the pilot project.

a.4 Construction of a Central Workshop

MUB already has an experience to properly maintain the workshop constructed for the purpose of maintaining hundred large-size buses, which were granted by the Japanese government during the three phases starting in 1995. MUB still maintains properly both these buses and the workshop more than 10 years after the grant aid.

It can be said, therefore, that the central workshop could be constructed and managed properly without any serious problems.

b. Development of Narangiin Enger Disposal Sit (NEDS)

It is possible for a local construction company to construct a final disposal site. Mongolia, however, does not have enough experience of conducting a sanitary landfill operation, even though the JICA ST try to improve the UCDS by introducing a sanitary landfill operation. Therefore, it seems necessary to employ a consultant from a developed country with enough experience of planning, designing, construction and operating sanitary landfill sites in a JV (joint venture) with a local consultant, so that MUB/CMPUA could acquire know-how and implement the project properly in the long term.

All the equipment necessary for sanitary landfill operation is available in Mongolia, even though they are not produced there.

c. Development of Narangiin Enger Recycling Complex (NERC)

No organizations in Mongolia have an experience of constructing and operating a sorting yard and RDF production facility. Therefore, it is necessary to employ a consultant and plant engineering company from a developed country with enough experience of planning, designing, constructing and operating these facilities. By employing a foreign consultant in JV with a local consultant, it is possible to transfer technical know-how to the Mongolian side.

Most of the necessary equipment is available in Mongolia. It is necessary to import a feeder, grinder and RDF producing machine at a RDF plant, but the structure of this equipment is relatively simple and it is not difficult to handle it. Regarding the supply of parts and maintenance of equipments, it is necessary to oblige a local contractor to establish manufactures' agents.

For the development of an industrial site for private recycling businesses and attraction of plants and firms, it is also necessary to employ a consultant from a developed country with a lot of experiences, so that MUB/CMPUA could obtain technical know-how.

10.2.2 Social Evaluation

Priority projects are expected to have the following social impacts.

Table 10-18: Social Impacts

Priority Project	Negative Impact	Positive Impact
1. Improvement of collection system	• Waste collection fee will go up. • Waste dischargers (households) are required to spend more time and energy to handle waste	• Clean and hygienic environment has a positive impact on promotion of direct investment and tourism • Public awareness on waste issues will increase
2. Development of Narangiin Enger Disposal Site	• Waste Pickers will lose their livelihood.	• Environment and hygienic conditions at/around the UCDS will be improved. • Land price around the disposal site will go up
3. Development of Narangiin Enger Recycling Complex	• Middlemen doing their business at the UCDS will lose their livelihood	• A certain number of jobs will be created

The result of qualitative assessment of these impacts and their possible countermeasures are summarized, as follows.

a. Countermeasures against Negative Impacts

a.1 Increase in Waste Collection Fee

The priority project aims at strengthening the finance of the collection service providers by increasing fee collection rate, as well as increasing waste collection fee. It is expected that some customers show resistance and disagreement with the increase in collection fee. In order to obtain consensus with local residents, it is necessary to achieve the following goals.

1) Provision of reliable and quality collection service

In order to obtain consensus with customers on a raise in collection fee, it is critical to increase the quality of the collection service. First of all, the schedule of collection service should be fixed. According to our plan, collection service is provided three times per week (twice for non-recyclable and once for recyclable) in the Planned area and twice a month in the Unplanned area.

2) Improvement of collection efficiency in the Planned area

As already mentioned, the collection efficiency in the Planned area is very low. If the collection efficiency in the Planned area can be improved, excess labor and equipment can be utilized for the collection work in the Unplanned area. This could lighten the financial burden necessary for providing collection service for all the households in the Unplanned area.

3) Introduction of cross-subsidy

The level of collection fee per household in the Planned and Unplanned area should be as equal as possible, regardless of the large difference in collection costs of the two areas. In this system, households in the Planned area, where the income level tends to be higher and the waste generated amount is smaller, bear a part of the collection cost of the Unplanned area.

4) Utilization of a soft loan, if possible grant aid, as a part of investment cost

If grand aid can be used as a part of the investment cost, as described in the following section about financial evaluation, people's financial burden could be reduced

a.2 More Time and Energy Necessary for Handling Waste

Source separation required waste dischargers to spend more time and energy in handling waste, as compared to mixed collection. Without their understanding and cooperation, it is impossible to introduce source separation.

In general, the education level in Mongolia is high and the literacy rate is considerably high. In particular, residents in the targeted area (Apartment area) are well-educated and have a strong environmental awareness. Therefore, it could be possible to persuade local residents to agree with source separation, by emphasizing the following important aspects.

- Problems of the current disposal sites face and the necessity of introducing sanitary landfill;
- Conservation of environment surrounding the disposal site by introducing sanitary landfill operation;
- Composition of waste in UB and obstacles to promotion of reuse and recycling; and
- Problems caused by plastic and paper waste and importance of conserving natural resources.

a.3 Loss of Livelihood of Waste Pickers

According to the plan, waste pickers will be prohibited from working at the landfill area at the NEDS, which will start it operation in 2009, in order to conduct sanitary landfill operation properly. The trading business of recyclables at the disposal site will be prohibited.

In order to protect their livelihood, MUB will operate a sorting yard and provide jobs for waste pickers who work at UCDS. If the job opportunities to be provided by the sorting yard are not enough for the current number of waste pickers, MUB/CMPUA will provide some area of the NEDS for their activities.

a.4 Loss of Livelihood of Middlemen

Middlemen who are now doing business with waste pickers at the UCDS will lose their livelihood after the NEDS starts its operation. MUB has a plan to select buyers of recyclables recovered from the NERC and operators of facilities at the recycling complex from these middlemen based on the competitive tender bit.

b. Positive Impact

b.1 Promotion of Direct Investment and Tourism

By providing collection service for all the households, illegal dumping, which is now rampant across the city, could be decreased drastically. The environment and hygienic conditions in Ulaanbaatar (UB) city, especially in the Unplanned area, could also be improved considerably.

In addition, by promoting recycling through the introduction of source separation and operation of a sorting yard and RDF plant, MUB could establish a proper SWM system like a developed country. The proper SWM could enhance the image of UB city, the center of economic and social activities in Mongolia, and contribute to the attraction of direct investment and promotion of tourism.

b.2 Increase in Public Awareness on Waste Issues

According to the result of the public opinion survey, conducted from January to February in 2005, many respondents showed their willingness to promote reuse/recycling of waste but did not know well how to do. Source separation will give them a clear instruction how to reuse/recycle waste, and this could increase their awareness on environment and waste issues, as in many advanced societies.

Regular collection service for all the households in the Unplanned area could increase their awareness on waste issues and change the behaviors of discharging waste.

b.3 Improvement of Environment and Hygienic Conditions at and around UCDS

The UCDS, where waste is treated by open dumping at present, degrades its surrounding environment, and local residents have suffered from deteriorated environment and hygienic conditions for a long time and have insisted on the suspension of the disposal site operation.

The development of NEDS, where a sanitary landfill operation is to be applied, could improve the environment and hygienic conditions in Ulaan Chuluut. In particular, the elimination of fires would improve the ambient air quality across the Songinokhairkhan District. This could undermine the objection of local residents against the disposal site.

b.4 Land Price Hike

The controlled landfill operation would improve its surrounding environment and raise the land price in Ulaan Chuluut. The result of a survey on the relation between living conditions and land price shows that the average land price rises by 6.2% as its location distances itself from the disposal site by 1 mile, because its living conditions and landscape is improved as its location get away from the disposal site.[1]

b.5 Job Creation

The main purpose of the NERC development is to secure jobs for waste pickers, who are now working at the UCDS and will lose the livelihood after the NEDS starts its operation. Waste pickers are supposed to work at a sorting yard. In order to enhance its recycling business, such yard for compactor and packaging machine will be constructed and a RDF plant will be constructed for the effective utilization of residue from the sorting yard. In addition, the access road will be constructed and electricity will be supplied for the operation of these facilities. It is important for MUB to utilize these infrastructures effectively by developing an industrial site for private recycling business and attracting factories, so that more jobs will be created for local residents.

[1] Beede, D.N. and Bloom, D.E. 1995, The Economics of Municipal Solid Waste, The World Bank

10.2.3 Environmental Evaluation

Expected environment impacts of priority projects area summarized in the table below.

Table 10-19: Environmental Impacts of Priority Projects

Priority Project	Positive Impact	Negative Impact
1. Improvement of collection system	• to save fossil fuel • to remove odor • to improve landscape • to decrease global warming gases • to create job opportunity • to extend the life of collection vehicles	• to increase traffic volume ⇒ air pollution ⇒ global warming ⇒ traffic accidents ⇒ traffic congestion ⇒ increase in consumption of fossil fuel
2. Development of Narangiin Enger Disposal Site	• to improve environment and hygienic conditions at and around the current disposal site • to decrease landfill gas ⇒ mitigation of air pollution ⇒ contribution to the prevention of global warming • to treat leachate ⇒ prevention of water pollution • to improve landscape • to increase land price • to mitigate environment degradation	• to operate more landfill equipments ⇒ air pollution ⇒ noise ⇒ vibration ⇒ increase in consumption of fossil fuel • to deprive waste pickers of their livelihood
3. Development of Narangiin Enger Recycling Complex	• to create job opportunities • to conserve global environment ⇒ energy saving ⇒ prevention of air pollution ⇒decrease in fossil fuel consumption	• operation of new factories ⇒ air pollution ⇒ noise ⇒ vibration ⇒ increase in fossil fuel consumption

The positive impacts of the collection system's improvement would outweigh its negative impacts to be caused by the increase traffic volume of the collection vehicles.

The improvement of the final disposal site could drastically improve the environment and hygienic conditions and outweigh its negative impacts such as increase in heavy equipment. Regarding loss of livelihood of waste pickers, it will be mitigated by the above-mentioned countermeasures.

The operation of a sorting yard and RDF factory would bring about various benefits, and they would also outweigh the negative impacts caused by operation of the sorting and RDF factory.

10.2.4 Financial Evaluation

a. Financial Evaluation Method

Financial evaluation is carried out to determine whether both the SWM service and the financial plan can be realised within the financial capacity of the agency in charge. Although several agencies are involved with SWM services, the evaluation of the financial state of each agency would be difficult. Here, an overall financial evaluation of the SWM service in the study area, consisting of MUB and seven Duureg governments, is carried out in accordance with the conditions shown in the table below. Consequently, although in practice waste collection fee, the main source of income for the SWM services, is collected by each Duureg government and only some of the collected fees go to MUB, it is supposed in the financial evaluation that all collected fees come to MUB and are spent by MUB for the SWM services. In addition, road and public area cleaning service is not included for the evaluation.

b. Assumptions of Financial Evaluation

Financial evaluation here is made based on the following assumptions.

Table 10-20: Assumptions of Financial Evaluation

<table>
<tr><td>Project Implementation Body</td><td>Improvement of Collection System
• Maintenance of collection vehicles for rent: CMPUA /MUB
• Fee collection & contract management: Seven Duureg Governments
• Provision of collection service: Private companies
Development of NERC
• Development and management of site and facilities: CMPUA/MUB
• Fee collection and contract management: CMPUA /MUB
• Operation of facilities: Private companies
Development of NEDS
• Development and management of site and facilities: CMPUA /MUB
• Fee collection and contract management: CMPUA /MUB
• Operation of facilities: Private companies</td></tr>
<tr><td>Project Period</td><td>13 years from 2008 to 2020</td></tr>
<tr><td>Project Income</td><td>Waste collection fee:
➢ Waste collection fee was revised on Sep 2006 and it is assumed this fee will be maintained until 2020.
➢ 4% of the revenue from apartment is deducted as a commission to OSNAAG, while 10% of the revenue from Ger is deducted as a fee collection charge[2].
➢ Fee collection rates in apartment and ger area were set as variables. Fee collection rates in 2010 and 2015 were set as a target figure and these rates were assumed to be raised proportion to the years.
• Waste fees are not collected from poor households[3] in the Ger area. The "effective fee collection rate" (poor households are excluded from calculation) for Ger area was made as variables for financial analysis.
• The share of the households that can pay the waste collection fee is set based on the number of poor households in each Duureg in the Statistical Handbook "Ulaanbaatar-XX century".
NERC :
➢ As for the income from the operation of the sorting yard, income form sales of valuables are set off against salary for workers and not counted for.
➢ The sales value of RDF to the users, power and heating plants, is assumed to be the same as that of coal on a weight basis, which is 12,000MNT/ton. After deduction of transportation cost, 10,000MNT/ton is allowed as an income.
NEDS
➢ The revenue from MUB was set to be 375 million MNT in 2010, 306 million MNT in 2015, 160 million MNT in 2020.
➢ The disposal fee is not charged on the waste hauled by the private companies that provide collection services under the contract with each Duureg since the disposal fee is included in the waste collection fee.
➢ As for the income of the disposal fee being charged on the waste hauled directly by generators and their contractors, same amount of those wastes in 2004 multiply revised fee on Sep 2006 are applied for the analysis.
Followings are the project income other than collection fee.
Unit Million MNT
<table>
<tr><td></td><td>2010</td><td>2015</td><td>2020</td></tr>
<tr><td>Revenue form MUB</td><td>375</td><td>306</td><td>160</td></tr>
<tr><td>Disposal Fee from direct haul</td><td>153</td><td>153</td><td>153</td></tr>
<tr><td>RDF sales income</td><td>22</td><td>91</td><td>237</td></tr>
<tr><td>Total</td><td>550</td><td>550</td><td>550</td></tr>
</table></td></tr>
<tr><td>Investment Cost</td><td>In order to provide collection service by newly procured vehicles and start the operation of NEDS and NERC in 2010, the following initial investment will be made in 2008 and 2009:
➢ In 2008 and 2009: Design and construction of a Maintenance Workshop, NERC and NEDS
➢ In 2009: Procurement of collection vehicles
Additional vehicles and heavy equipment will be procured whenever the need arises in accordance with the increase in waste within the project period. The renewal investment costs are also considered until 2020 according to the life span of each vehicle and equipment.</td></tr>
<tr><td>O&M Costs</td><td>The O&M costs from 2008 to 2020 are estimated based on the prices in 2005 and quantity of the works in each year. They include O&M costs of collection, NERC and NEDS but exclude public area cleansing costs.</td></tr>
<tr><td>Depreciation and Scrap Value</td><td>➢ Common use facilities of NEDS and NERC: Fully depreciated in 20 years
➢ Machines of NERC: Fully depreciated in 15 years
➢ Heavy equipment such as bulldozers, etc.: Depreciated in 12 years with a scrap value of 10 %
➢ Collection vehicles such as compactor, etc.: Depreciated in 8 years with a scrap value of 10 %</td></tr>
<tr><td>Price</td><td>All the costs are estimated based on the current prices of 2005. No price escalation is included.</td></tr>
<tr><td>Evaluation Method</td><td>FIRR (Financial Internal Rate of Return) is used for the quantitative analysis.</td></tr>
</table>

[2] A 10% collection charge is requested by Electricity Company in Ulaanbaatar. This charge coincides with JICA ST's other countries' experiences.

3 The number of the poor households in the Statistical Handbook "Ulaanbaatar-XX century is applied to and it is supposed that all of them are in the Unplanned Area.

10.2.5 Results of Financial Evaluation

In order to analyze financial viability of the project, the following options were established for investment.

- F/S-1: Full fledged project with 100% Grant for Initial Investment The project includes investment in collection equipment and the development of NEDS of NERC including procurement of facilities and equipment. All the initial investment in 2008 and 2009 will be covered by the Grant Aid.
- F/S-2: Full fledged project without Grant. The project is same as F/S-1 but all the necessary financial arrangement will be by the Mongolian Government..
- F/S-3: Project without NERC with 100% Grant for initial investment. The project is same as F/S-1 except NERC. Both cost for investment and O&M for NERC and income form RDF are excluded. Initial investment for both NEDS and Collection Service are covered by the Grant Aid.

Since collection fee was revised on Sep 2006 based on the recommendation of this study, this fee will be maintained through the analysis period and fee collection rate was set for variables for the financial analysis.

The results of the financial analysis are shown below.

F/S-1: Full fledged project with 100% Grant for Initial Investment

Under the following fee collection rate, the project is feasible financially as FIRR = 0.9%

Table 10-21: Required Fee Collection Rate on F/S-1

		Current	2010	2015-2020
Apartment Area		86%	90%	97%
Ger Area	Effective Collection Rate	17%	45%	80%
	Overall Collection Rate	12%	30%	53%

Note: Effective fee collection rate: fee collection rate among the households excluding poor family who can not afford to pay.

F/S-2 : Full fledged project without Grant for Initial Investment

In case without grant, even fee collection rate will be raised to 97% in 2010, FIRR is still minus. In order to achieve FIRR = 0.2%, further fee hike is necessary such as 60% fee hike of the business waste.

But It is almost not practical to achieve following fee collection rate in 2010 and further fee hike also not practical since fee revision was made just recently.

Table 10-22: Required Fee Collection Rate on F/S-2

		Current	2010	2015-2020
Apartment Area		86%	97%	97%
Ger Area	Effective Collection Rate	17%	97%	97%
	Overall Collection Rate	12%	64.5%	65%

F/S-3: Project without NERC with 100% Grant for initial investment.

When the same fee collection rate as F/S-1 was achieved, FIRR became 0.2% as slightly lower than that of F/S-1

<Cross-subsidies between Waste Generating Sources and between Duuregs>

Since there is a significant difference, among generating sources and Duuregs, in efficiency of waste collection and disposing operation, cross-subsidy must be applied to level the burden

of investment and O/M expenses.

The JICA ST calculated unit waste management cost (collection, recycling and final disposal costs) of planned area (Apartment area) and unplanned area (Ger area) as shown in the following tables:

Table 10-23: Collection Cost

	Unit Cost per Ton*2		Cost per Household per Month*1	
	Planned	Unplanned	Planned	Unplanned
	MNT/ton	MNT/ton	MNT/month/household	MNT/month/household
Bayangol	11602	17773	440	1452
Bayanzurkh	12129	28576	460	2334
Songinokhairkhan	11744	14364	446	1173
Sukhbaatar	14269	16302	541	1331
Chingeltei	16374	16709	621	1365
Khan-Uul	12982	17512	492	1430
Nalaikh	14071	21047	534	1719
Average	**12894**	**18315**	489	1496

(Note) *1: Waste Generation rate in 2010 is used for calculation, 4.5 person per house hold is applied.
*2: Unit cost does not include depreciation cost of compactor truck.

Table 10-24: Recycling and Final Disposal Cost

	Unit Cost per Ton*1	Cost per Household per Month	
	MNT/ton	Planned	Unplanned
		MNT/month/household	MNT/month/household
Recycling Cost	1,150	44	0
Final Disposal Cost	2,039	77	167

Note: *1: Unit cost does not include depreciation cost of compactor truck.

According to the above calculation, it is concluded as follows:

- Unit waste management costs for waste generated in each household (4.5 persons) per month are 610 MNT for Apartment area and 1,663 MNT for Ger area.
- Therefore, if we apply a unified waste collection fee, Duuregs which have more Ger area will not able to provide 100 % collection service due to lack of revenues.

Provision of the waste collection service to the whole population is the most important target of the M/P. Therefore, a cross-subsidy must be applied between Duuregs. It is expected that the profits generated from the waste collection for apartments and businesses will be used to cover the loss in ger areas.

10.2.6 Sensitivity Analysis on Subsidy from MUB

MUB is currently examining the possibility of using its budget[4] to lower the level of waste fee to residents especially for the Ger area. Taking of FS-1, a simulation was conducted for three combinations of fees for Ger in order to estimate the annual amount of subsidy necessary to achieve the same financial rate of return – 0.9% as that of the original setting. The results of the simulation are shown below.

Table 10-25: Sensitivity Analysis

	Waste Collection Fee		Necessary Annual Amount of Subsidy (2008-2020)
	Apartment	Ger	
1	2,000 MNT	2,500 MNT	0.37 billion MNT
2	2,000 MNT	1,250 MNT	0.84 billion MNT
3	2,000 MNT	0 MNT	1.31 billion MNT

[4] Since MUB is currently obliged to transfer approx. half of the municipal tax revenue to the State, MUB is currently negotiating with the State to decrease the amount to be transferred.

10.2.7 Economic Evaluation

a. Economic Evaluation Method

Economic evaluation is carried out to determine the necessity of the project in view of the present national economic conditions. Because environmental benefits are difficult to quantify, economic evaluation is mostly limited to cost minimisation methods and qualitative evaluation. The following are the economic benefits to be gained from the Project:

- Improvement of living environment and amenity of entire Ulaanbaatar City
- Reduction of expenses to remove illegally dumped waste
- Reduction of smoke generated at disposal sites that could trigger respiratory diseases to surrounding residents
- Reduction of coal consumption by providing RDF to power generation and heating companies
- Reduction of consumption of reusable goods by recycling
- Reduction of final disposal cost

With resource-recovery and disposal site cost reduction as the benefits that can be expected from the introduction of recycling facilities (intermediate treatment facilities) such as sorting yard and RDF plant to be constructed in NERC, a quantitative economic analysis is conducted; a comparison is made between costs and benefits of a project that has (*with-project*) and that does not have (*without-project*) the introduction of such facility.

Taking the above into consideration, the evaluation of the project is carried out as follows.

Table 10-26: Economic Evaluation Method

	Collection & Transportation	NERC (Intermediate Treatment)	NEDS (Final Disposal)
Evaluation Method	Qualitative Evaluation	Quantitative Evaluation (Cost-benefit Analysis) Qualitative Evaluation	Qualitative Evaluation
Evaluation Period		12years (2009 - 2020)	

The benefits and costs of the quantitative evaluation are as shown in the table below.

Table 10-27: Assumptions of Economic Evaluation of Development of NERC

Project Implementation Body	NERC : CMPUA/MUB
Project Period	12 years from 2009 to 2020
Project Benefit	➢ Final sales value of recyclables (papers, textile, plastic and metal) in Mongolia is counted as a project benefit. Those are recovered by Waste Pickers, sold to brokers and finally sold to users in Mongolia and exporters to China. ➢ Sales value of RDF is counted as a project benefit. Its unit value is set at double that of coal (12,000 MNT/ton) since the calorific value of RDF is twice that of coal used in existing power and heating plants. ➢ Reduction of the final disposal cost is counted as a project benefit. The benefit is calculated by multiplying the average unit final disposal cost (MNT/ton) from 2010 to 2020 by the disposal amount that is reduced by the operation of the sorting yard and RDF plant.
Project Cost	The following costs calculated in the financial evaluation is applied to:[5] ➢ Investment and O&M costs of separate collection ➢ Investment and O&M costs of the sorting yard ➢ Investment and O&M costs of RDF plant
Price	All the costs are estimated based on the current prices of 2005. No price escalation is included.

[5] Shadow prices were not used for costs due to insufficient availability of data, thus financial costs are used in this economic analysis.

b. Annual RDF production and Salvaged Quantity of Valuables

Following assumptions are made to calculate RDF production quantity and salvaged quantity of valuables from sorting yard. The composition of waste assumed here is based on the results of the WACS survey conducted by JICA Study Team.

- Collection rate of recyclable wastes from apartment area is assumed as follows.

up to 2014	2015 to 2019	2020 onwards
15 %	45 %	70 %

- 15% of incoming waste will be sorted out into valuables.
- 68% of incoming waste to the sorting yard will be used for RDF production.
- Share of Residue after sorting and RDF production is assumed to be 37 % of incoming waste to the sorting yard

As a result, following quantities will be produced and salvaged in each year.

Table 10-28: Annual Production Quantities of RDF and Salvage Quantity of Valuables in Recycling Complex

ton/year

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
RDF	**2,210**	**2,450**	**2,670**	**2,900**	**3,160**	**9,070**	**9,970**	**10,790**	**11,680**	**12,560**	**23,710**
Valuables	**690**	**770**	**840**	**910**	**980**	**2,830**	**3,120**	**3,360**	**3,630**	**3,930**	**7,420**
Paper	80	90	120	140	150	430	490	560	610	710	1,270
Textile	200	220	230	230	220	590	550	540	520	500	820
Plastic	70	70	70	90	120	390	480	540	600	740	1,500
Metal	340	390	420	450	490	1,420	1,600	1,720	1,900	1,980	3,830
Residue	**1,720**	**1,880**	**2,050**	**2,230**	**2,430**	**6,990**	**7,670**	**8,320**	**9,000**	**9,670**	**18,290**

c. Economic prices

c.1 RDF

Since RDF is a new technology for Mongolia and there is no existing market price for RDF, its economic price is calculated based on the coal price considering the difference of calorific values.

The coal currently used in power plants has a calorific value of around *3,000kcal/kg* and the price of the coal is around *10US$/ton*[6]. The calorific value of RDF is estimated at *6,000 Kcal/kg*: 1 ton of RDF has an equivalent calorific value of 2 tons of coal. Therefore, *20 US$/ton=24,000 MNT/ton* is adopted to calculate the economic price of RDF.

c.2 Valuables salvaged at Sorting Yard

The following prices are adopted to calculate the economic prices of valuables salvaged at the sorting yard. These are the prices at which brokers will sell to the end users in Mongolia such as exporters or the manufacturers.

Table 10-29: Unit Price for Valuables

Valuables	Unit Price
Paper	25,000 MNT/ton
Textile	20,000 MNT/ton
PET bottle	400,000 MNT/ton
Other Plastic	150,000 MNT/ton
Aluminium	900,000 MNT/ton
Other Metal	60,000 MNT/ton

Source : Recycle Market Survey conducted in 2005 by JICA study team

[6] information given from Nalaikh Heating Plant

c.3 Economic Values

Based on the above information, the economic prices of RDF and Valuables salvaged in sorting yard are summarised as follows.

Table 10-30: Economic Values of RDF and Valuables

Unit : 1,000MNT

Year	RDF	Paper	Textile	Plastic	Metal	Total
2010	53,040	2,000	4,000	14,000	77,520	150,560
2011	58,800	2,250	4,400	14,000	88,920	168,370
2012	64,080	3,000	4,600	14,000	95,760	181,440
2013	69,600	3,500	4,600	18,000	102,600	198,300
2014	75,840	3,750	4,400	24,000	111,720	219,710
2015	217,680	10,750	11,800	78,000	323,760	641,990
2016	239,280	12,250	11,000	96,000	364,800	723,330
2017	258,960	14,000	10,800	108,000	392,160	783,920
2018	280,320	15,250	10,400	120,000	433,200	859,170
2019	301,440	17,750	10,000	148,000	451,440	928,630
2020	569,040	31,750	16,400	300,000	873,240	1,790,430

Table 10-31 shows the revenues, costs and net income of recycling facilities. The Internal Economic Rate of Return of the construction and operation of the recycling facilities is 11.4 %.

Table 10-31: Revenues, Costs and Net Income of Recycling Facilities

Unit : 1000MNT

Year	Revenues						Costs	Net Income
	RDF	Paper	Textile	Plastic	Metal	Total		
2009	0	0	0	0	0	0	588,000	-588,000
2010	53,040	2,000	4,000	14,000	77,520	150,560	190,944	-40,384
2011	58,800	2,250	4,400	14,000	88,920	168,370	190,944	-22,574
2012	64,080	3,000	4,600	14,000	95,760	181,440	190,944	-9,504
2013	69,600	3,500	4,600	18,000	102,600	198,300	190,944	7,356
2014	75,840	3,750	4,400	24,000	111,720	219,710	3,440,640	-3,220,930
2015	217,680	10,750	11,800	78,000	323,760	641,990	215,424	426,566
2016	239,280	12,250	11,000	96,000	364,800	723,330	215,424	507,906
2017	258,960	14,000	10,800	108,000	392,160	783,920	291,024	492,896
2018	280,320	15,250	10,400	120,000	433,200	859,170	215,424	643,746
2019	301,440	17,750	10,000	148,000	451,440	928,630	220,320	708,310
2020	569,040	31,750	16,400	300,000	873,240	1,790,430	-2,716,774	4,507,204

10.3 Environment Impact Assessment

10.3.1 EIA System in Mongolia

The Environmental Impact Assessment Law (EIA) of 1998, and its Amendments of November 22nd 2001, is the key law concerning environmental assessment in Mongolia, and is implemented by the MOE in collaboration with the Municipality. It requires EIAs and the obtaining of approval of environmental screening and environmental clearance before the implementation of major infrastructure projects. It stipulates that any projects or development initiatives are subject to Environmental Screening or Initial Environmental Examination (IEIA). The project proponent is required to submit summary and technical documentation to MOE in line with prescribed screening criteria; on the basis of which one of the following decisions will be made:

- To approve for implementation without further assessment, if the project impacts and consequences meet the requirements of existing environmental standards and requirements;

- In cases where negative impacts are deemed to be unlikely and / or insignificant project implementation may be approved subject to specific conditions regarding management and organizational measures to be taken;
- In cases where negative impacts are regarded as likely and or significant, the project may be required to undergo more detailed assessment or Environmental Impact Assessment (EIA).

If an EIA is required, the project proponent is responsible for contracting one of Mongolia's licensed environmental consultancy companies, of which there are more than twenty, to conduct the EIA in accordance with the requirements. Enforcement and monitoring of the implementation of Environmental Management Plans set out in EIAs are the responsibility of local government agencies.

The Mongolian Environmental Assessment Program (MEPA) is a comprehensive environmental and natural resource review process, with reviews at every stage of policy, program, plan and project development. Presently the Department of Information Monitoring and Assessment in the MOE is responsible for reviewing the Detailed Project Reports of all proposed investment projects and for establishing environmental category designation according to the law.

10.3.2 Procedure taken in the Study

The Screening and Detailed Environmental Impact Assessment is an assessment which should be conducted by the implementing agencies of the concerned projects. JICA Study Team, who is not the implementing body of the proposed projects, therefore, did not conduct Screening and Detailed Environmental Impact Assessment, but gave advice to the Government of Mongolia.

Consequently, the following procedure was taken for the approval of the EIA for the Narangiin Enger Disposal Site and Recycling Complex Development Project:

Initial Environmental Examination (IEE) was conducted by Ministry of Environment (MOE) on 20th June 2005 and the project proponent, MUB, was ordered to carry out Environmental Impact Assessment (EIA) according to the result of IEE. The MUB contracted out the EIA survey work to a local consultant, Agrar Co., Ltd.

Baseline survey started on 4th in August and continued until 17th in August, 2005. During the survey first Public Hearing Meeting was held on 9th August 2005 and comments from stakeholders including local residents were submitted by the end of August 2005.

The assessment of the impacts was carried out from 15th August to 15th September 2005 and a draft EIA report was submitted to MOE on 15th September 2005.

The second public hearing meeting was held on 19th October 2005 and comments from stakeholders including local residents were collected by the end of October, 2005.

The local consultant, Agrar Co., Ltd. revised the EIA report based on the instruction made by MOE and modified development plan of NEDS/NERC which took the comments from the public hearing meetings into consideration. Then the consultant submitted the revised EIA report to the MOE on January 11th, 2006.

After the examination of the revised EIA report, the MOE finally approved the EIA report of the development project of NEDS and NERC on February 6th, 2006.

The third public hearing meeting was held in 10th of May 2006 in order to explain the revised EIA report and development projects of NEDS and NERC. The results of the third public hearing were reflected in the proposed disposal site and recycling complex development project.

11. Conclusions and Recommendations

11 Conclusions and Recommendations

11.1 Conclusions

MUB faces various problems related to solid waste management. In this section, issues to be solved and countermeasure MUB should take are summarized by types of waste, Municipal Solid Waste (MSW) and other types of waste.

11.1.1 Issues to be Solved and Their Measures related to MSW

a. Waste Generation Amount and its Future Projection

Based on the result of baseline surveys such as WACS, POS, and Survey on Final Disposal Amount, which were conducted under this M/P study, the generation amount of MSW in Ulaanbaatar in winter and summer, 2006, are estimated at 566 ton/day and 264 ton/day respectively. The yearly amount is estimated at around 151,000 ton. Due to the insufficient collection service, waste in the unplanned area (Ger area) is disposed of at home or illegally dumped in surrounding areas. In particular in winter, most of ashes generated from heaters are dumped illegally in surrounding areas. The team estimates that 7.7 % of generated waste (20 ton/day) in summer and 54.2% of generated waste (307 ton/day) in winter are not collected and dumped illegally. As a result, a large amount of waste, estimated at 60,000 ton, is dumped illegally throughout the year, and this forces MUB to conduct a large scale cleanup activity in summer.

In 2020, the target year of the M/P, the waste generation amount in winter and summer is estimated at 756 ton/day and 598 ton/day respectively. The yearly amount of waste generation would be increased by 64% from 2006 and estimated at around 247,000 ton. Since the City Development Master Plan of Ulaanbaatar plans to decrease the percentage of unplanned area from 46% in 2006 to 18% in 2020, the percentage of waste amount which is disposed of at home or illegally dumped, will down to 178 ton/day in winter and 16 ton/day in summer (the yearly amount is 35,000 ton). If MUB, however, leaves the insufficient collection service in the unplanned area as it is until 2020, the total waste amount of 1.14 million ton (2.86 million m^3) will be left without proper treatment. Therefore, it is urgent for MUB to provide a regular collection service to the entire household in the city.

b. Technical System

As mentioned above, one of the most urgent issues is the improvement of collection system. In order to conserve environment and to establish a sustainable SWM system, however, MUB has to solve other various problems such as environmental problems caused by open pumping at final disposal sites. Issues MUB has to solve are shown below according to its priority.

b.1 Improvement of Collection System

Even though there are still problems left, all the households receive a collection service in the planned area. In the unplanned area, however, only less than half of the population receives the collection service. One of the main reasons for the limited service available in the unplanned area is that many of households cannot afford to pay a collection fee. The collection fee in UB is determined based on the market mechanism without any subsidies. Even though the income level in the unplanned area is lower than that in the planned area, the collection fee in the unplanned area is set at relatively higher level than in the planned area,

considering the frequency of the collection service, and this results in the lower fee collection rate in the unplanned area.

The number of collection vehicles, which are owned by MUB and leased to TUK in each district, is not enough to provide a collection service to the whole city. In addition, most of them are very old, in average more than 15 years in use, and often broken down. In particular in winter, the number of car out of order is shot up and the amount of collected waste decreases to the half of generation amount.

The Study Team proposes that MUB take the following measures in order to solve these problems.

1. To modify the waste collection fee system and establish a cross-subsidy system in order to financially support the collection system in the unplanned area. It is important for MUB to manage the Waste Service Fund, which was created in November 2006 and started operation in January 2007.
2. To improve the collection system in the planned area, so that MUB could allocate newly created surplus to the further improvement of the collection system and the expansion of the collection system in the unplanned area. It is necessary for MUB to unify the fee collection system, which are now managed by TUK in each Dureg, under the Waste Service Fund.
3. To improve the collection system in the planned area by introducing discharge rules and replacing dump trucks with compactor trucks. The result of the Pilot Project "Collection System Improvement" showed that these two methods significantly improved the collection efficiency. Therefore, the discharge rules should be expanded to other areas as soon as possible.
4. To purchase new collection vehicles and to replace old vehicles with new ones. New collection vehicles should be compactor trucks in the planned area and dump truck in the unplanned area, judging from the waste composition in each area. It is critical to unify the model of the car in order to make the maintenance work easier.
5. To finance the purchase of new vehicles necessary for collection service from 2007 to 2020, estimated at 10.6 billion MNT according to the estimation of the Study Team. It is a principle for MUB to cover the cost by itself, but it is also important to consider positively external fund to make up for the shortage.

b.2 Sanitary Landfill Operation

At present, there are 4 authorized final disposal sites. The UCDS, which disposes of more than 90% of generated waste in UBC, faces the rapid urbanization problems. The residential areas are expanding and getting close to the disposal site, a few hundred meters from the site. Even though a pilot project at the UCDS significantly improved its situations, local residents still face various problems such as fires and scattered waste, due to the lack of soil covering. In addition, its remaining capacity is getting to the zero and it is urgent for MUB to construct a new disposal site and to close the UCDS.

Base on the selection procedures, which were mainly conducted by the Mongolian parties concerned, a site in Narangiin Enger was selected among 16 candidate sites. The team made a development plan to construct a new disposal site there and conducted its feasibility study. MUB conducted an EIA survey based on the result of the development plan and received the approval from MOE. The Study Team recommends that MUB constructs a new disposal site in Narangiin Enger based on the result of its feasibility study and implements a sanitary landfill operation, while closing and rehabilitating the UCDS.

Regarding the other three disposal site, even though it is possible to continue to use them until the target year of the M/P, 2020, but it is necessary to conduct an EIA survey and to take necessary measures to conduct a sanitary landfill operation. MUB should take an EIA survey on three disposal sites, receive the approval from MOE and implement a sanitary landfill operation there as soon as possible.

b.3 Promotion of 3Rs

At present, reuse/recycling activities in UBC are mainly done by the informal sector, and MUB does not actively take a measure to promote 3Rs. Due to the limited number of final users, the potential of recycling market in UBC is not high.

The M/P aims at establishment of an environmentally sound SWM system in UBC by 2020. MUB has a plan to introduce a separate collection service to the 70% of the households in the planned area, 58% of the whole population, to collect recyclables at a sorting yard at the Narangiin Enger Recycling Complex (NERC), to produce RDF using residues (mainly plastic and paper scraps) from the sorting yard, and to recover heat by combusting RDF mixed with coal in existing power generation plants.

In order to examine the applicability of the plan, mixed combustion test of RDF with coal was conducted twice at the Nalaikh Heating Plant under a pilot project "Thermal Recycling RDF". Its result revealed that combustion efficiency of coal was improved by mixing with RDF (2-4% of weight ratio), since the quality of coal used at the heating plant was low (the caloric values of coal and RDF are 2,500-3,500 kcal/kg and 5,000 kcal/kg respectively). In addition, the boiler of the heating plant is operated continuously with relatively high temperature (644 – 855), and this made it possible to prevent the generation of dioxin, meeting with the regulation for the waste incineration plant in Japan and the EU. On the other hand, the sorting yard could provide job for waste pickers, who will lose their livelihood at the disposal site after the start of sanitary landfill operation.

According to the result of the pilot project "Collection System Improvement", it can be said that it is very difficult to implement a separate collection system in the whole planned area soon. The team drew a conclusion that MUB should introduce discharge rules and to improve the collection efficiency in the first place, and then the separate collection is implemented where discharge rules are established.

Based on these conclusions obtained from the results of pilot projects and baseline surveys, the team proposes that MUB promote 3Rs by the following approaches.

1. To establish a system to support recycling business establishments (to provide technical information, to establish a micro finance scheme, to invite recycling companies to the NERC, and so on) in order to maintain and develop the existing recycling system.
2. To develop the NERC next to the new Narangiin Enger Disposal Site (NEDS), so that basic infrastructure such as access road and public utilities, which will be developed for the NEDS, can be fully utilized.
3. To construct a sorting yard and RDF production facility at the NERC. The capacity of theses facilities should be increased step by step, as the area of the separate collection expands.
4. At the first phase (in 2010), facilities should be limited to the test plants with the budget as low as possible. After the applicability of the system is fully examined, the plant with full production capacity is constructed (in 2015).

c. Institutional System

As mentioned in Chapter 4 Capacity Development, various institutional developments were already done. The team recommends further institutional system improvement in order to implement the M/P smoothly.

c.1 Ministry of Environment

It is necessary for MOE to develop the legal system indispensable for a proper solid waste management, such as detailed waste classification, control criteria for each type of waste, guideline for survey, planning, construction and operation, according to "the Law on Household and Industrial Waste 2004.7". In particular, it is urgent to formulate the definition and identification of hazardous waste and its control criteria.

c.2 MUB

MUB enhanced its institutional capacity by creating City Maintenance and Public Utilities Agency, CMPUA. CMPUA received the budget to set up its new office, to renovate a warm garage and a workshop for newly purchased collection vehicles. As of the end of 2006, CMPUA employed more than 30 staff. As a result, it can be said that MUB and CMPUA had a sufficient institutional system to implement the M/P. Even though the capability of CMPUA core staff was enhanced through the M/P study, it is not enough to establish an environmentally sound SWM system. MUB has to continue the following institutional system improvement.

- The C/P of the M/P study forms the nucleus of the CMPUA. The number of experienced personnel, however, is only 5 and the capability of new staffs is limited. It is urgent to develop the capacity of new staffs.
- With Waste Service Fund, MUB established the system to solve the most urgent issue, providing a collection service for all the citizens both in planned and unplanned areas. MUB, however, just started its operation and would face various problems. It is necessary for CMPUA to establish a system, in which it would solve problems in cooperation with MUB and Districts.
- The contract each District made with TUK will terminated in March, 2007. At present, it is undecided whether TUK is 100% privatized or returns to public cooperation. It is, however, indispensable to continue to contract out a collection service to the private sector in order to establish a sustainable SWM system. The contract between District and TUK has many unclear terms and need to be modified. Therefore, it is necessary for CMPUA to make a standard contract form and develop a management system to supervise the contract which District makes with private collection providers, as well as supervising the contracted out collection work by itself, according to the recommendations by the Study Team.
- It may be necessary for MUB/CMPUD to consider to ask for international cooperation in order to solve issues shown above.

11.1.2 Other Types of Waste

a. Issues of Medical Waste Management and Measures to Solve Its Problems

The generation amount of infectious and hazardous waste (Medical Waste) and general waste from medical institutions in 2006 is estimated at 1.6 ton/day (584 ton/year) and 15.2 ton/day

(5,548 ton/year), based on the result of the medical institution survey. The generation amount of these two types of waste in 2020, the target year of the M/P, is estimated at 2.2 ton/day (803 ton/year) and 20.8 ton/day (7,592 ton/year) respectively.

The generation amount of medical waste is limited, and at the hospitals, which were the targets of the survey, medical waste was separated from other waste. The team recommends that the following measures are taken in order to control medical waste properly.

1. General waste from medical institutions is strictly separated from medical waste, collected as MSW, and disposed of by sanitary landfill method at an authorized disposal site.
2. Medical waste should be rejected at an authorized disposal site. In order to prevent mixed disposal of medical waste and general waste at an authorized disposal site, MUB/CMPUA should take the following measures in cooperation with organizations concerned.
   - MOH, which is responsible for controlling medical waste management by medical institutions, provide a strict instruction on how to separate medical waste from other wastes at each stage such as generation, collection inside the institutions, intermediate treatment, storage, and discharge. It should prohibit medical institutions from bringing untreated medical waste to municipal waste disposal sites.
   - CMPUA, which is responsible organization to control authorized disposal sites, should enhance its supervision system, so that it could control the general waste brought from medical institutions and reject untreated medical waste.
   - The development plan to construct a treatment plant (an incineration facility or autoclave) which treat all the medical waste generated in UBC, should be formulated and implemented as soon as possible.
   - Until the operation of such a treatment facility, medical waste should be treated by heat treatment at the existing small-scale incinerators as much as possible.

b. Issues of Hazardous Industrial Waste Management and Measures to Solve Problems

The generation amount of non-hazardous industrial waste in 2006 is estimated at 67.8 ton/day (24,747 ton/year), based on the result of the factory survey. The generation amount in 2020, the target year of the M/P, is also estimated at 143.3 ton/day (52,305 ton/year).

Even though the factory survey, visiting 18 factories and making an interview with questionnaire, was conducted twice, the team did not receive enough information about hazardous industrial waste management, and the team could not estimate the generation amount of hazardous industrial waste. It is because the legal system to control hazardous industrial waste is not developed yet, and it is impossible to classify or identify hazardous industrial waste. On the other hand, sludge from tannery which contains hazardous substances such as chromium, is brought and disposed of at city authorized disposal sites. There is neither a treatment facility nor a disposal site for hazardous waste in Mongolia.

The team recommends the organizations responsible for industrial waste management taking the following measures in order to control industrial waste generated in factories:

1. Laws and regulations which define the classification of hazardous industrial waste should be formulated as soon as possible by MOE and other organizations concerned, in order to realize a proper hazardous industrial waste management.

2. Factory survey should be conducted, according to the formulated laws and regulations, in order to grasp the current conditions on generation and treatment/disposal of hazardous industrial waste
3. The site selection works for the treatment/disposal facility should be made based on the result of the factory survey as soon as possible. After the selection a development plan for the facility shall will be formulated and implemented.
4. Non-hazardous industrial waste should be strictly separated from hazardous waste, collected as MSW, and disposed of by sanitary landfill method at authorized disposal sites.
5. City authorized disposal sites should reject hazardous industrial waste. MUB/CMPUA shall take the following measures to prevent mixed disposal of hazardous industrial waste and non-hazardous waste in cooperation with MOE.

- MOE provides a strict instruction for factories to separate hazardous from other waste in cooperation with City Specialized Inspection Agency (CSIA), which is responsible to control solid waste management at factories (generation sauces). MOE should also instruct factories not bring untreated hazardous industrial waste.
- CMPUA should enhance its surveillance system in order to strictly control the waste brought from factories and put the ban on disposal of hazardous waste. MSW disposal sites should develop a oversight system, so that they could prevent hazardous waste from being brought and disposal of with non-hazardous waste.
- MOE and CMPUA should request factories to reduce the generation amount of hazardous waste and to treat and store it inside the factory.
- Before the hazardous waste treatment/disposal facility starts its operation, it is necessary to consider using existing facilities such as a kiln of a cement factory and a blast furnace of non ferrous metal smelting factory. Factories should be put under an obligation to treat hazardous waste if it is possible, or to safely store it inside the factory if the existing facilities cannot treat it.

c. Construction Waste

The generation amount of construction waste in 2006 is estimated at 60.6 ton/day in winter and 123 ton/day in summer (33,500 ton/year), based on the result of the construction waste survey. The generation amount in 2020, the target year of the M/P, is also estimated at 128 ton/day in winter and 260 ton/day in summer (70,810 ton/year).

According to the result of the survey on illegal dumping, most of waste illegally dumped was construction waste. In order to solve a problem of illegal dumping waste, it is necessary for MUB to take the following measures in cooperation with Ministry of Construction and Urban Development (MOCUD).

- Application for permission of construction work is submitted, the construction waste management plan is required to submit together, so that MUB and MOCUD could estimate waste generation amount.
- The estimated amount of construction waste is compared to the amount of construction waste which is brought to city authorized disposal sites in order to check if construction waste reported at the time of application is brought to disposal site or not.

- If some applicants dump waste without following their waste management plan, MUB and MOCUD should punish them with fine.

11.2 Recommendations

a. To Transfer Successful Results to Other Municipalities

MUB acquired various experiences in proper solid waste management (SWM) through the study. A proper SWM differs from a country, region, and city. Mongolia has a continental climate; i.e. dry all year long, big temperature gap in winter and summer, extremely cold weather in winter. Ulaanbaatar city has two different forms: the planned area with full social infrastructure and the unplanned area without infrastructure. Therefore it proper SWM system is different in winter and summer, and in the planned and unplanned area. In cooperation with the C/P, the Study Team tried to establish the M/P which reflecting this kinds of unique features of UBC.

It can be said that the C/P is well acquainted with formulation of SWM M/P reflecting this kinds of unique features of UBC, and it is important for MUB to transfer these experiences and knowledge to other major municipalities in cooperation with MOE.

b. To Build up a Closer Relationship between MUB and MOE

During the period of the study, MUB, which is responsible organization for planning and implementing SWM plan, could not well cooperate with MOE, which has jurisdiction of SWM on the national level. At present, the two organizations work in a closer cooperation, but it is critical to tighten their relations further in order to solve problems mentioned above. In particular, the team recommends that MOE implement the following issues based on the experiences of MUB in cooperation with MUB.

- To improve SWM system in other major cities based on the successful results of MUB.
- To formulate SWM criteria and to develop appropriate technologies reflecting area conditions in Mongolia.

  Example: to examine the necessity of leachate treatment. In the case of the UCDS, no leachate has been collected and gathered to a leachate treatment facility since it started its operation one and a half years ago. According to the result of the feasibility survey, it is highly likely that no leachate is generated at the NEDS. It is recommended that the relation between the rainfall and leachate generation amount is investigated at the NEDS, so that the necessity of leachate treatment facility is examined in other areas.
- To develop a recycling system suitable for the area conditions in Mongolia
  Example: to examine the applicability of RDF production made from plastic and paper scraps and heat recovery by combusting coal mixed with RDF.

c. Request of Technical Cooperation Project

In order to solve the problems outlined above, it is necessary for MUB to understand the experiences of other countries and to modify and apply them according to the conditions in Mongolian. Furthermore, it is necessary to receive international support in order to realize these applications. The team recommends that MUB request donor countries to collaborate

with other organizations concerned, especially MOE, to implement technical cooperation projects. The main fields which require technical cooperation are as follows:

1. Support to develop a system to provide collection services to all residents:

This includes the appropriate operation and control system for a Waste Service Fund, a collection and control system for both a waste service fee and a disposal fee, development of a contract management system with private companies, improved efficiency of collection services etc.

2. Support to promote the 3Rs:

This includes the establishment of separate discharge and separate collection systems, development of the Narangiin Enger Recycling Complex (NERC) with sorting yard and RDF facilities, development of RDF manufacturing methods and promotion of RDF as a fuel, technical support for private recycling companies, etc.

3. Support and proliferation of sanitary landfilling:

This includes improvement of sanitary landfilling at NEDS and the development of a monitoring system, development and implementation of sanitary landfilling at three other disposal sites in UBC, the appropriate closure of the Ulaan Chuluut Disposal Site (UCDS), etc.

4. Support to develop a control system for Hazardous Medical Waste (HMW) and Hazardous Industrial Waste (HIW):

This includes development of the legal system, investigation of the current waste management system, development of a facility plan for treatment and disposal of hazardous wastes, etc.

5. Support to develop a control system for construction wastes:

This includes introducing a solid waste management system into the building approval procedure、developing a control and monitoring system for illegal dumping, etc.

6. Support to spread the results of the Master Plan for improvement of SWM in UBC to the other cities:

This includes support to develop policy for the improvement of SWM in other cities, training and education for the stakeholders in other cities, etc.

Appendix

Appendix 1

Economic Study on Introducing Incineration Plant in Ulaanbaatar

1 Outline

Incineration is a superior waste treatment method as it achieves the dual function of decreasing the amount of waste, and converting it into harmless, stable materials. However, to construct an incineration plant, a large amount of initial investment is needed. In addition, daily operations require considerable running costs, such as obtaining certain chemicals which are necessary for treating emission gas, waste water and the like. Because of that, to introduce incineration, it is first necessary to make a comparison with other treatment and disposal methods as well as direct landfill disposal, examine their economic efficiency, and confirm the validity of those methods.

Through a comparative study of the economic efficiency of three cases of treatment and disposal methods, the validity of introducing incineration was verified. Furthermore, the study targeted the wastes generated from the whole apartment area of the study area in the year 2020.

Case 1: Direct Disposal at NEDS; (when the entire amount goes directly to landfill)

Case 2: With a Sorting Yard and RDF Production Facility at NERC; (when separated collection is introduced and recyclable waste is processed at a sorting yard and RDF production facility)

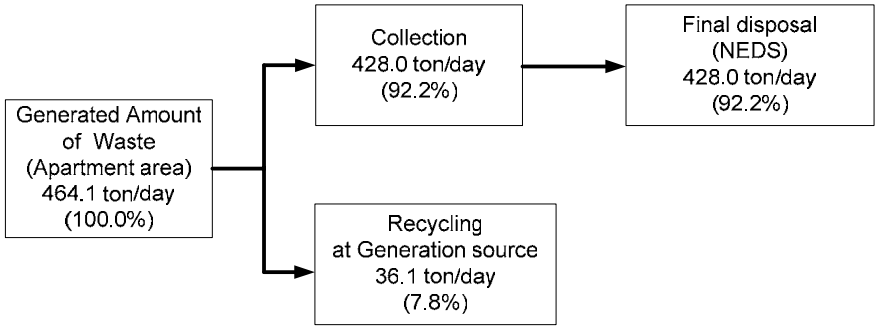
Case 3: With an Incinerator; (when the entire amount is processed at an incineration plant)

2 Case Studies

Case 1: Direct Disposal at NEDS (Narangiin Enger Disposal Site)

This plan calls for the entire amount of waste generated from the apartment area to be taken directly to the NEDS site for final disposal. The waste flow for implementing this plan is shown below. In this case, only final disposal costs is calculated.

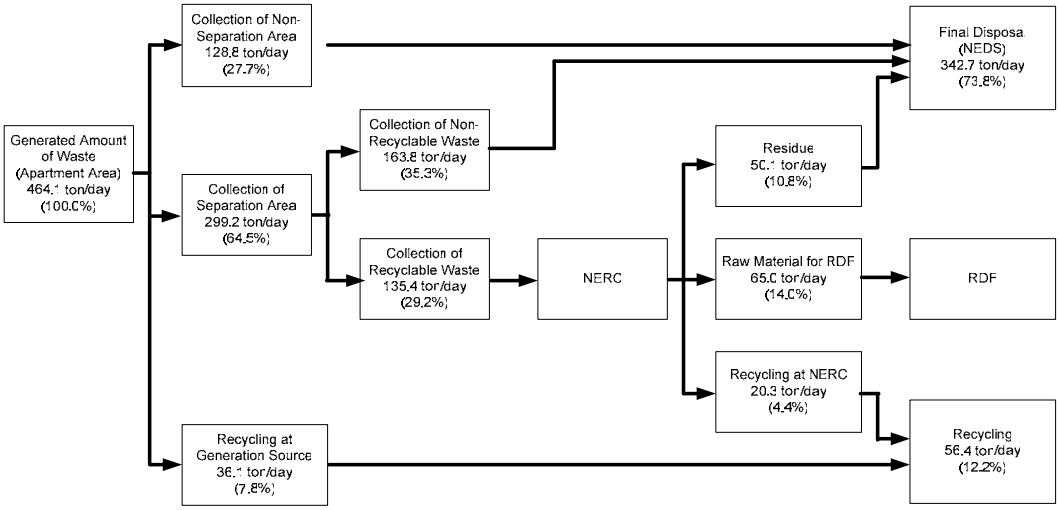
1. Generation of Waste (Apartment area) in 2020: 464.1 ton/day
2. Collection of Apartment area in 2020: 428.0 ton/day
3. Recycling at Generation source in 2020: 36.1 ton/day
4. Final disposal in 2020: 428.0 ton/day



Case 2: With a Sorting Yard and RDF Production Facility at NERC (Narangiin Enger Recycling Center)

This plan calls for the waste generated from the apartment area to be separated into two categories of recyclable and non-recyclable waste at generation source and the former will be transported to a sorting yard and RDF production facility and the latter will be transported to the disposal site (NEDS) directly. The residue from a sorting yard and RDF production facility will be disposed of at NEDS. The waste flow for implementing this plan is shown below. In this case, not only final disposal cost, but also treatment / recycling cost such as sorting and RDF production cost are added. But the sales of recyclables and RDF are considered as a profit and deducted from the costs.

1. Generation of Waste (Apartment area) in 2020: 464.1 ton/day
2. Collection of Non-Separation area in 2020: 128.8 ton/day
3. Collection of Separation area in 2020: 299.2 ton/day
   - 3-1. Collection of Non-recyclable waste: 163.8 ton/day
   - 3-2. Collection of Recyclable waste: 135.4 ton/day
4. Recycling at Generation source in 2020: 36.1 ton/day
5. Recycling at NERC in 2020: 20.3 ton/day
6. Raw material for RDF Production in 2020: 65.0 ton/day
7. Residue from NERC in 2020: 50.1 ton/day
8. Final disposal in 2020: 342.7 ton/day

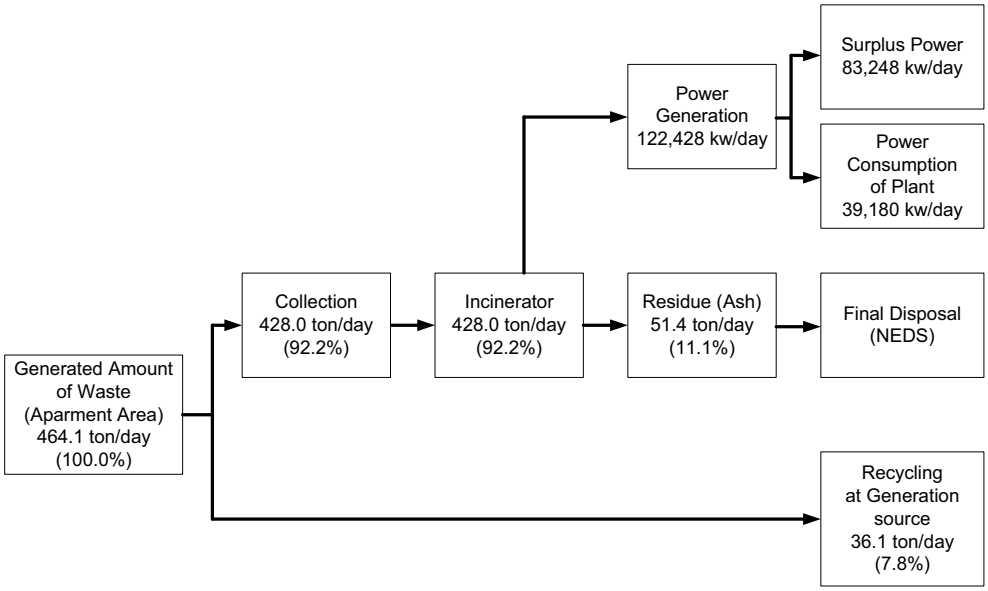


Case 3: With an Incinerator

(1) Waste Flow

This plan calls for the entire amount of waste generated from the apartment area to be treated at an incineration plant and the residue from the plant will be transported to dispose at NEDS. The waste flow for implementing this plan is shown below. In this case, incineration cost is added and sales of power generated at incineration plant are considered as a profit and deducted from the overall costs.

1. Generation of Waste (Apartment area) in 2020:	464.1 ton/day
2. Collection of Waste (Apartment area) in 2020:	428.0 ton/day
3. Recycling at Generation source in 2020:	36.1 ton/day
4. Incineration at Incineration plant in 2020:	428.0 ton/day
5. Residue (Ash) from Incineration plant in 2020:	51.4 ton/day
6. Power generation:	122,428 kW/day
6-1. Power consumption at the plant:	39,180 kW/day
6-2. Surplus power for sale:	83,248 kW/day
7. Final disposal in 2020:	51.4 ton/day



(2) Outline of Case 3 Plans

The plans for case 1 and case 2 are described in the master plan. Therefore, the only the case 3 plan is explained here, where an incineration plant is introduced.

a. Incineration plant

a.1 Features of the facility

- Stoker-type incinerator
- Condensing turbine for maximum power generation
- Ash from the plant is subject to disposal at NEDS

For reference, Figure 1 shows a cross section of the incineration plant. In addition, Figure 2 shows the standard flow of a waste heat utilization facility.

a.2 Incineration plant

Incineration plant

Type:	Stoker type (Full continuous feed type incineration) without smelter for ash
Number of furnaces:	3 units
Waste amount:	428.0 ton/day
Operation efficiency:	0.84

Capacity:	510 ton/day (170 ton/day x 3 furnace)
Waste heat utilization facility	
Type:	Steam boiler equipment
Steam pressure:	30 kg/cm^{3}G (G: Gage pressure)
Steam temperature:	300 ^{o}C
Steam turbine facility	
Type	Condensing turbine
Input steam pressure:	28 kg/cm^{3}G
Input steam temperature:	300 ^{o}C
Delivery pressure:	0.25 kg/cm^{3}abs (abs: Absolute pressure)
Efficiency of steam turbine:	12 %

b. Lower Heating Value of Waste

Considering future waste composition predicted by the study the following value was used as a lower heating value of wastes in order to calculate the power generation amount in the waste heat utilization facility:

- 2,050 kcal/kg-waste

This value was calculated making use of the itemized calorific value expressed in the physical composition of the waste[1]. By this method, lower heating value of wastes in the winter was calculated at 2,150 Kcal/kg, and in the summer it was 1,950 kcal/kg. Thus, the average of both was used in the study.

(3) Study of Case 3 Construction, Operation and Maintenance Costs

The construction, operation and maintenance costs in case 3 were calculated as follows:

a. Construction cost

- Judging from experience as a waste management consultant, construction unit cost is 160 million MNT per 1 ton of waste.
- Therefore, construction cost: 510 ton/day x 160 million MNT/ton = 81,600 million MNT
- The construction cost per 1 ton of waste, with a depreciation period of 15 years, was divided by the entire quantity of waste incinerated in that period, as follows:

34,820 MNT/ton-waste

(= 81,600 million MNT/(428 ton/day x 365 day/year x 15 year))

b. Operation cost

The operation cost of a waste incineration plant of X city, Japan (150 ton/day x 3 furnaces, power generation incl.) for FY 2006 was referred for the calculation.

The operation costs here include water, chemicals (for emission gas and waste water treatment), and auxiliary fuel for start-up incineration. Furthermore, the power used within the plant is covered completely by power generated by the incineration process. In addition, labour cost is not included. As a result, the operation cost per 1 ton of waste is as follows:

18,000 MNT/ton-waste

c. Maintenance Costs

[1] Nobuhisa Watanabe: *Haikibutu gakkaisi*, Vol. 11, No. 6, pp. 411-416, 2000.

By referencing the actual costs of the waste incineration plan in X city in FY 2006, costs were set as follows:

26,000 MNT/ton/waste

d. Profit from Power Sales

The profit from power sales were calculated as follows:

- Annual power generation amount: 2,050 kcal/kg x 428 ton/day x 1,000 kg/ton x 365 day/year x 0.12 / 860 kW/kcal = 44,686,186 kW/year
- Power generated per 1 ton of waste: 44,686,186 kW/year / (428 ton/day x 365 day/year) = 286 kW/ton-waste
- Power consumption amount: A 32% ratio of gross power generation is used to run the facility. The use of power in the facility per 1 ton of waste is as follows:

  286 kW/ton-waste x 0.32 = 92 kW/ton-waste
- Surplus power generation amount per 1 ton of waste incineration:
  286 kW/ton – 92 kW/ton = 194 kW/ton
- Profit from power sales: When surplus power is sold, the sale profit from the unit cost of power in Mongolia is (58.50 MNT/kW) as shown below:

  194 kW/ton x 58.50 MNT/kW = 11,350 MNT/ ton-waste

e. Ash Disposal Cost

The ash generated per 1 ton of waste incinerated is assumed to be 12% of the waste before incineration. The landfill unit cost derived from the direct landfill method was used to calculate disposal costs.

Incineration ash disposal cost per 1 ton of waste:

- 1 ton x 0.12 x 3,649 MNT/ton = 438 MNT/ton-waste

3 Results of Comparative Study

The result of examining the economic comparison per 1 ton of waste for these three cases of treatment and disposal methods is shown in the table below.

From these results, it is understood that the ranking of economic efficiency is as follows:

- Case 1 (3,649 MNT/ton-waste) > Case 2 (6,376 MNT/ton-waste) > Case 3 (67,908 MNT/ton-waste)

The result of this comparative study changes largely when one looks at the final disposal cost against the entire solid waste management cost ratio. Whereas in Japan, the final disposal costs are extremely high[2], it becomes economically valid to introduce incineration processing in order to reduce the volume of wastes which disposed at final disposal site. However, in Ulaanbaatar, final disposal costs at 3,649 MNT/ton-waste (US$ 3.0 /ton-waste) are very low, so adopting incineration process does not make sense financially. On the other hand, when NERC is adopted (Case 2), the disposal cost becomes 6,376 MNT/ton-waste, which is 1.7 times that of disposal costs for direct landfill. However, in this case, not only thermal recycling is implemented but also the stabilization of waste plastic, which is the cause of

[2] A fee of 300US$/ton is collected for non-toxic waste at private disposal sites.

scattering and has an adverse effect on the stability of landfill sites, is a benefit gained towards environmental improvement.

Table 1: Results of economic comparison study (per 1 ton of waste)

Comparative Study Flow	Disposal Costs
1. Case 1 (Direct Final Disposal)	3,649[*1] MNT/ton-waste Disposal Cost Total 3,649 MNT/ton-waste
2. Case 2 (with NERC) (Sorting yard + RDF facility)	1. Landfill Costs (1) Non-separation area waste (direct disposal) (0.277 ton) x3,649MNT/ton-waste = 1,011 MNT/ton-waste (2) Non-recyclable waste (0.353 ton) x3,649MNT/ton-waste = 1,288 MNT/ton-waste (3) Residue (NERC) (0.108 ton) x3,649MNT/ton-waste = 394 MNT/ton-waste 2. Facility Costs (1) Sorting yard : (0.292 ton) x 6,833[*2] MNT/tom = 1,995 MNT/ton (2) RDF facility :(0.248 ton) x 24,224[*3] MNT/ton = 6,008 MNT/ton 3. Profit from sale of RDF and recyclable materials (1) RDF (0.140 ton) x (-12,000[*4] MNT/ton) = (-1,680 MNT/ton-waste) (2) Recyclable material (0.044 ton) x (-60,000[*4] MNT/ton) = (-2,640 MNT/ton-waste) Disposal Cost Total 6,376 MNT/ton-waste
3. Case 3 (with Incineration plant)	1. Facility Costs (1) Construction Cost 34,820[*5] MNT/ton-waste (2) O&M[*6] 18,000 MNT/ton-waste (3) Facility Maintenance Cost[*7] 26,000 MNT/ton-waste (4) Profit from Power Sales 194 kW/ton x (-58.50[*8] MNT/kW) =(-11,350 MNT/ton-waste) 2. Landfill Cost Incineration Ash Disposal Cost (0.12 ton) x 3,649 MNT/ton = 438 MNT/ton-ash. Disposal Cost Total 67,908 MNT/ton-waste

Note *1: Average landfill disposal cost(incl. machinery depreciation cost) for 2010 to 2020
*2: Average sorting cost (incl. machinery depreciation cost) for 2010 to 2020
*3: Average RDF production cost(incl. machinery depreciation cost) for 2010 to 2020
*4: Set value
*5: Construction cost divided by the total waste incineration amount in 15 years (428 ton/day x 365 day/year x 15 years = 2,343,300 ton)
*6: Water, chemicals, etc. (required electricity is covered by the power generated within the incineration plant)
*7: Calculated based on Japan case study (X city waste incineration plant 2006)
*8: Unit price of electricity in Ulaanbaatar in 2006

① Unloading platform
② Refuse bunker
③ Refuse crane control room
④ Refuse crane
⑤ Refuse feeding hopper
⑥ Furnace
⑦ Steam boiler
⑧ Under-grate conveyor
⑨ Ash extractor
⑩ Ash conveyor
⑪ Ash crane
⑫ Ash bunker
⑬ Ash truck
⑭ Gas cooler
⑮ Bag filter
⑯ Induced draft fan
⑰ Stack
⑱ Steam turbine generator
⑲ Electric faciliies room
⑳ Pump room

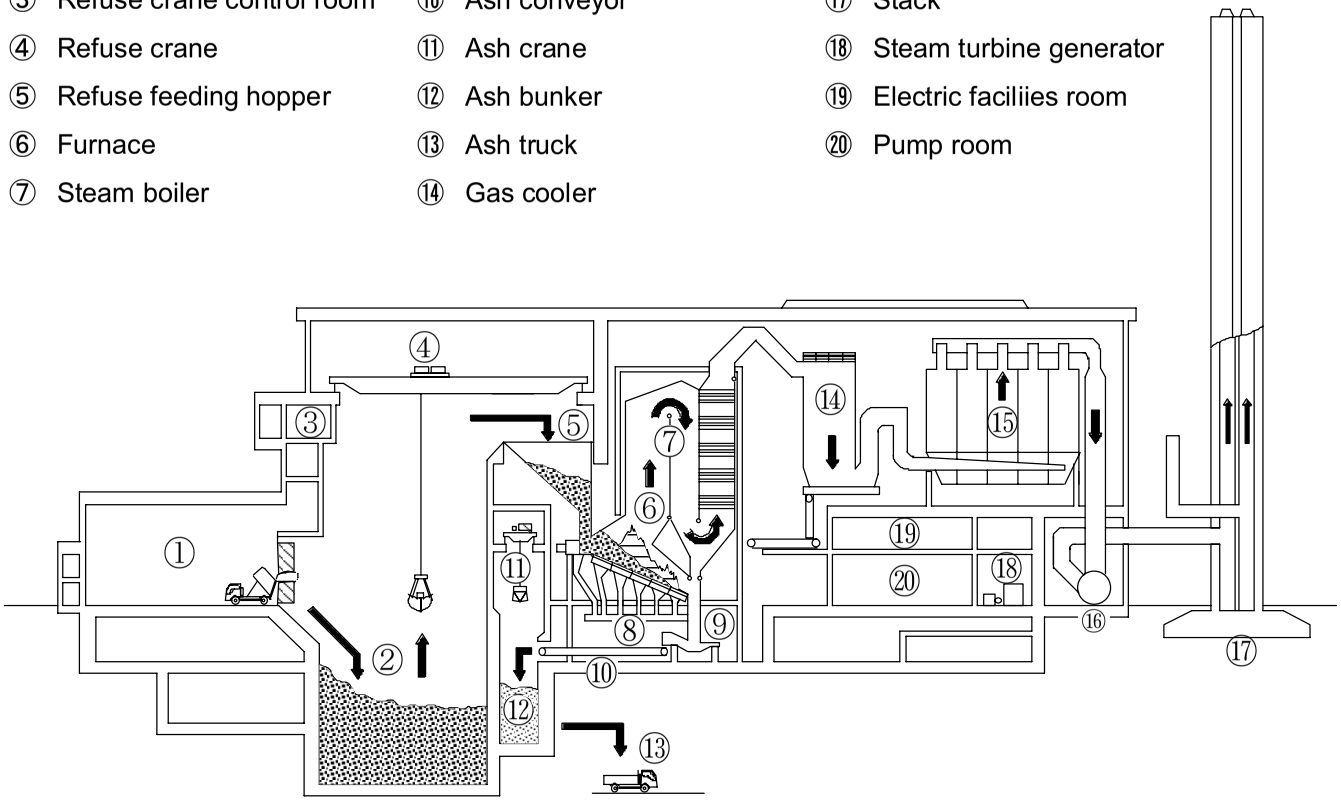


Figure 1: Cross-sectional Diagram of Incineration Plant

① Furnace
② Steam boiler
③ Economizer
④ Gas treatment equipment
⑤ Stack
⑥ Air preheater
⑦ Reduced pressure and temperature
⑧ Ateam turbin generator
⑨ Condensate tank
⑩ Deaerator
⑪ Water treatment equipment

P : Pressure
T : Temperature
i″ : Enthalpy
D : Density
Q : Quantity

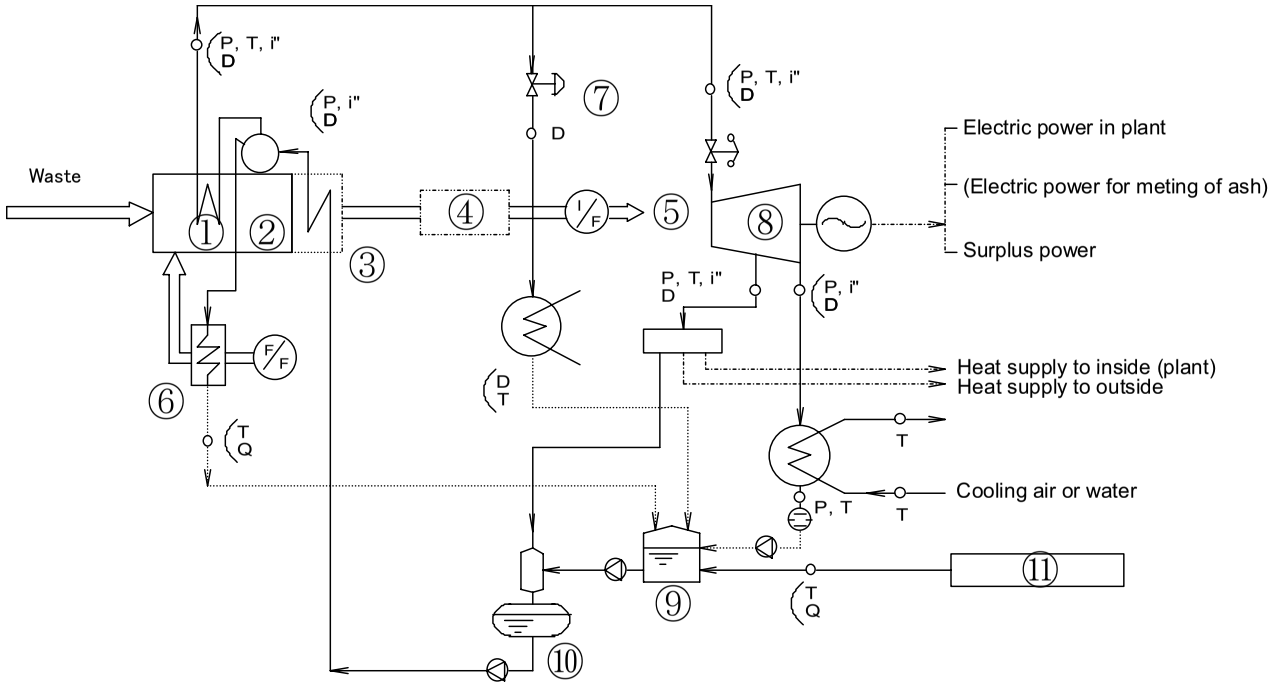


Figure 2: Standard flow for a waste heat utilization facility