

**INTEGRATED SOLID WASTE  
MANAGEMENT PLAN**

**WUXI NEW DISTRICT (WUXI MUNICIPALITY)  
PEOPLES' REPUBLIC OF CHINA**

*Volume –II*

**Schemes Proposed Under Strategic  
Action Plan**



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## Introduction

Integrated Solid Waste Management (ISWM) for WND is a comprehensive document containing baseline information on waste and current waste management systems, a list of posed targets for ISWM, stakeholders' issues of concern and measures, categorized under policies (regulatory and fiscal), technological and voluntary measures, to achieve the targets in best possible manner. These measures are the strategic actions, required under ISWM Plan. Some of the strategic actions are comprehensive schemes, which need proper planning, development and implementation. These schemes are identified in this document, which is labelled as "ISWM Plan for WND – Volume 2."

This volume is divided into two parts in line with ISWM Plan. Part 1 covers schemes for strategic actions on segregation at source, collection and transportation. Part 2 covers schemes for strategic actions on sorting for material recovery and treatment and disposal with resource recovery. The first scheme is to establish a waste inventory cell to continuously monitor the waste generation levels and its composition. This would be very useful to further improve the reliability of waste database. This will be also useful tool for monitoring the efficacy and efficiency of strategic actions under ISWM. The second scheme covers the development of a set of local policies, to compliment national and provincial policies, to support segregation at source and proper primary collection system. The policies include regulations as well as fiscal policies to motivate waste generators to segregate waste at source. Third scheme is to develop awareness raising tools to promote the public awareness on ISWM in general and on segregation at source in particular. The fourth scheme is to supply residents with waste bags to segregate food waste. At the moment, as per the current survey, majority of population is not willing to change its habits of disposing of waste without segregation. Hence this incentive will compliment the other schemes, aimed for promotion of segregation of food waste at source. Keeping in view, the challenges for moving from mixed waste to segregated waste, these four schemes should be implemented simultaneously.

To bring the improvements in the current collection system based on strategic plan, four schemes are included. First scheme, construction/provision of collection points, aims to maximize the gains from segregation at source. The current collection points should be modified to facilitate the collection of segregated waste. Second measure, to develop the primary collection system, will bring improvements in the current practices for primary collection. Currently, transfer station operators and waste generators arrange the collection of waste from generation point to the transfer stations. This arrangement is made with small companies having different types of collection vehicles and some of these vehicles are not appropriate to handle the waste. Third scheme, to procure collection vehicles, aims to improve the waste transportation from transfer stations to treatment or disposal facilities. This secondary collection and transportation is handled by the local government and they have a fleet of collection vehicles. The modifications in the current fleet will be helpful to improve the efficiency as well as to bring the collection system in line with environmentally friendly practices including reduced noise and air pollution from the vehicles. Fourth

scheme, development of an operational plan, is required to maximize the resource-use efficiency with respect to collection of waste. This scheme will improve the current primary collection system and maximize the efficiency of vehicles and other equipment through better scheduling. This will also help transfer stations and treatment and disposal facilities to coordinate their working schedules with collection schedule to improve their efficiency.

The second part of this volume includes eight schemes in line with the proposed strategic actions under ISWM Plan for sorting, treatment and disposal. First scheme, to upgrade transfer stations for material recovery, aims to equip the existing transfer stations with material recovery equipment to sort and recover the recyclable waste. Second scheme will introduce the new biological treatment facility to produce biogas from biodegradable organic waste, mainly food waste. Third scheme will help to improve the efficiency of existing incineration plant and its resource recovery facilities and to bring its operations in line with national and international practices to avoid negative environmental and public impacts. Fourth scheme will improve the recovery and utilization of landfill gas. Fifth scheme would lead to establish a waste exchange platform for virtual trading in waste to promote resource augmentation by utilizing waste. Sixth scheme would promote the recycling industries by setting up an eco-town. Seventh scheme aims to set up a modern facility to properly treat and dispose industrial waste. Eight scheme aims to develop a monitoring and feedback mechanism for overall ISWM. This will include the monitoring of the implementation of all the strategic actions, including the schemes, and their impact with respect to proposed targets as well as with respect to stakeholders' concerns.

In line with ISWM Plan, this document is also an evolving document. The modification and changes strategic actions under ISWM Plan, to take up the emerging challenges such as special wastes, will also lead towards the development of new schemes and modifications in the current schemes.

# 1 Generation, Collection and Transportation

## 1.1 Establishment of Waste Inventory Cell

1. **Introduction:** Integrated solid waste management (ISWM) addresses all types of solid waste from all the sectors within a geographic or administrative boundary. ISWM is a dynamic process for effectively and efficiently managing the wastes based on 3R approach. Hence various services, from collection to disposal including material and resource recovery, are designed to incorporate the changes in waste streams due to urbanization and economic growth with related changes in the production sector and urban life styles. Therefore, it is vital to continuously collect the data on waste quantities and composition. To keep track of waste data, a Waste Inventory Cell could be established within Wuxi New District (WND) local government. WND local government staff was continuously involved to develop ISWM Plan for WND. They were engaged from very beginning to build their capacity for undertaking various tasks, required to develop an ISWM Plan. They were trained to quantify and characterize solid waste from all the sectors within WND. Hence, it would not be difficult for WND to establish a Waste Inventory Cell.
2. **Purpose:** Waste Inventory Cell of WND will update waste database periodically to identify the changes in waste quantity and composition with respect to time, seasons of the year, sectors, industrial or economic growth and cross-boundary movement of waste. They will send the regular updates to EPB and other relevant offices within WND to modify the waste related policies and services to effectively and efficiently manage the waste.
3. **Target:** The scheme has been developed to achieve the following targets
  - To maintain waste database for waste quantities and composition for all waste generating sectors (residential, commercial, industrial, healthcare facilities and laboratories, construction and demolition, wastewater treatment plants and urban agriculture)
  - To develop and maintain “Waste Generation Factors” for above mentioned waste generating sectors
  - To assist WND in monitoring waste generation
  - To assist WND in making appropriate modifications in policies and services to effectively and efficiently manage solid waste with maximum material and resource recovery
4. **Type:** Institutional Strengthening
5. **Lead Agency:** Wuxi New District (WND) Local Government
6. **Support Agency:** The services of an institution, such as a university or a consulting group, may be hired for collection and analysis of waste data
7. **Location (suggested):** WND Government Office

**8. Budget (Estimated):** Office expenditures with one staff from internal WND budget

External expenditures on data collection & analysis to be allocated by WND: CNY 150,000 (USD 20,000) per annum

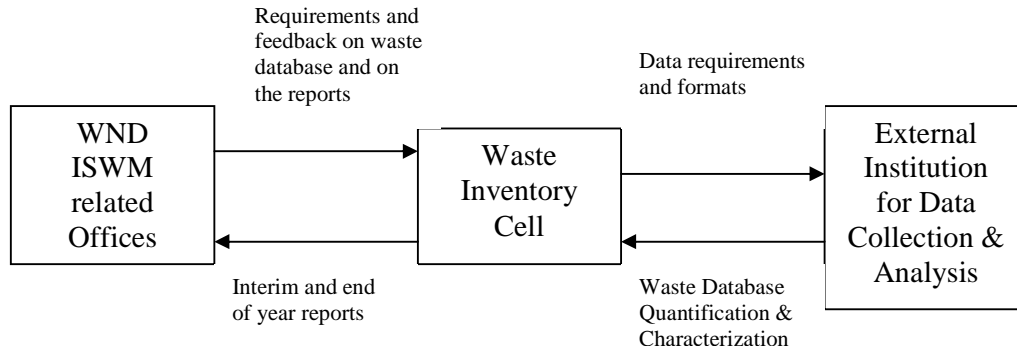
**9. Time Frame (Estimated):** 12 months (estimated time to seek approvals within the government on the establishment of the cell and on the budget allocations. Time schedule for collection and analysis of data and reporting:

Activity	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
Collection & analysis of samples for residential & commercial waste	XX			XX		
Collection & analysis of samples for industrial waste		X				
Collection & analysis of samples for construction & demolition waste					X	
Collection & analysis of samples for healthcare waste		X				
Data collection from secondary sources			X		X	
Mid-year reporting			X			
End of year reporting						X

**10. Description:** WND is rapidly growing. Industrialization and economic growth are affecting the pace of urbanization. Living standards are improving and consumption rates are increasing. Industrial production base is moving towards high-tech industries. All of these factors are resulting into increasing rates of waste generation and introduction of new waste streams such as e-waste. It is difficult to precisely predict the waste quantities and their composition in this dynamic scenario. Hence, ISWM, which is designed to manage the waste would fall short of its objectives if it is not continuously upgraded, in terms of policies and services, with respect to waste quantities and waste streams. Furthermore, continuous monitoring through waste database is required to assess the effectiveness of policies to reduce waste at source as well as to maximize source segregation. The database on waste quantities and composition would also be useful to establish the accurate relationship between waste quantity or composition and other variables. The database would also be useful to support the measures for material and resource recovery and waste exchange platform.

To monitor the waste generation and to continuously update the database, a Waste Inventory Cell would be established within WND through internal arrangements. This cell would be run by a single staff with the assistance from an external institution, such as a university or a consulting group for data collection and analysis. This cell would generate an interim report and an end of year report. The report would be in line with the formats used for waste data for developing ISWM Plan.

**11. Implementation:** The implementation of this scheme would be facilitated by WND through internal arrangements to setup the cell with a single staff and to provide office equipment. The budget would be allocated to update database through data collection and analysis. The cell would make arrangements to update the database through an external institution. The cell would produce interim report and an end of year report. The cell would establish active communication channel within all the relevant departments to support the data requirements for implementation/monitoring of ISWM.



**12. Benefits:** Following benefits are anticipated from this scheme:

- Availability of waste database (inventory) for better understanding of the quantities and composition of waste streams
- Updated database for accurate information
- A tool for monitoring of the implementation and impact of ISWM, especially for policies pertaining to reduction of waste at source and segregation at source
- Accurate information to modify/update the level of collection services
- Accurate information to update material and resource recovery facilities including transfer station, biological treatment and thermal treatment facilities
- Information to support waste exchange platform

**13. Links to other Schemes under ISWM Plan for WND:** This schemes is linked with all the other schemes of ISWM:

- Development of Local Policies on Segregation and Collection
- Development of Awareness Raising Tools for Waste Management
- Supply of Waste Bags for Segregation of Food Waste
- Construction/Provision of Collection Points
- Development of Primary Collection Systems
- Procurement of Collection Vehicles – Secondary Collection
- Development of Operational Plan for Collection and Transportation
- Upgrading of Transfer Stations for Material Recovery
- Development of Biogas Plant
- Upgrading Incineration Plant with Resource Recovery
- Upgrading Sanitary Landfill with Landfill Gas Utilization
- Development of Monitoring Mechanism for ISWM

## 1.2 Development of Local Policy Framework on Segregation and Collection

**1. Introduction:** Currently, most of the waste from residential areas is not segregated at source. Based on the waste data, it is anticipated that if waste is segregated at source in three categories (food waste, hazardous waste, and other waste) then on the one hand, the waste would not be contaminated due to presence of hazardous substances, and on the other hand, most of the waste could be recovered. About 70 percent of the residential waste is food waste; thus, it can be converted into compost or biogas or ethanol. This would help to increase the revenue base by selling the compost or biogas/ethanol and it would also help to reduce the transportation and treatment/disposal costs. The segregation of food waste from other waste would also increase the amount of recoverable plastic, paper, glass, textile, and so on as most of the waste in the present circumstances become dirty due to the presence of food waste. To promote segregation at source, various policies, technical and voluntary measures are required. The first step would be to develop a local policy framework, consisting of regulatory and fiscal policies, to support segregation at source.

In addition to segregation at source, the other important issue, for safe handling and maximizing the material/resource recovery, is to regulate the collection system. Currently, residents' committees are responsible to make arrangement for the collection and transportation of the waste up to the transfer stations, wherefrom WND is responsible to transport the waste and pay tipping fees up to the treatment and disposal facility. The residents' committees and transfer stations hire small companies or individuals to collect the waste from the neighbourhoods. This primary collection system is not fully organized, especially with respect to collection vehicles and equipment. This creates environmental nuisance, as there are leakages from the vehicles, noise, dust and air pollution during the transportation, and some of the collection points are not well maintained or cleaned up. To bring the improvements in this primary collection and transportation, the local policies are required to regulate the services, especially the type, size and operations of the small collection vehicles.

- 2. Purpose:** A local policy framework would help WND to achieve its targets for segregation at source to maximize material and resource recovery and to minimize contamination of waste and transportation and treatment/disposal costs (tipping fees). The policy framework would also help to streamline primary collection system and to improve its efficiency as well as to reduce its environmental impact.
- 3. Target:** To develop a policy framework consisting of regulatory and fiscal policies to maximize segregation at source and to streamline primary collection system
- 4. Type:** Regulations and market-based (economic) instruments
- 5. Lead Agency:** WND
- 6. Support Agency:** An external institution/consultant may be hired to identify appropriate policies with respect to local conditions



7. **Location (suggested):** Wuxi Local Government as it has powers to intact local policy
8. **Budget (Estimated):** CNY 30,000 (USD 4,000) for external institution/consultant
9. **Time Frame (Estimated):** 12 months

Activity	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
Collection & analysis of relevant policies (regulations and market-based instruments) for source segregation and primary collection	XXXX			XX		
Preparing first draft of Policy Framework with respect to local conditions		XXXX				
Comments from WND and Wuxi Local Government			XX			
Preparation of Final Draft			XX			
Deliberations within Government				XXXX	XXXXX	
Putting up for approval of the Government						XX
Approval						XX

**10. Description:** The local policy framework would cover policies (regulatory and financial) to promote segregation at source and to streamline primary collection system. The policies for segregation at source would help to achieve the targets on the source segregation. Thus, hazardous waste has to be completely segregated at source. This could be achieved through regulations which can make everyone bound to dispose of hazardous waste separately. The regulations for collection of hazardous waste would be intact to make sure that source segregated hazardous waste is also removed separately and it would not mix with other waste during collection, transportation, treatment and disposal. For segregation of food waste from other waste, a combination of regulations and market-based instruments would be required as the targets are set 70 percent source segregation of food waste in the short term and thereafter, 100 percent source segregation in the long term. Market-based or economic instruments could be a mixture of incentives and disincentives based policies. The residents, through residents' committees, may be fined for not segregating at source or they may be given a cut in the solid waste collection fees if they are segregating at source. The other way would be to provide incentives for recovered waste plastic, paper, glass, metals and so on at the source.

The policy framework would also cover the policies (mainly regulatory) to streamline the collection of waste from generation point to the transfer stations. The policies would address the size, type and operations of collection vehicles to reduce environmental impact in terms of leakages, odour, noise, dust and air pollution during transportation. The policies would also address the role of

collection companies/individuals to properly maintain and clean the collection points.

**11. Implementation:** WND local government would implement in consultation and approval with Wuxi local government. WND would develop TOR and hire the services of an institution/individual expert to draft the policy framework in consultation with WND and Wuxi local government. Thereafter, WND would seek the approval of the policy framework through proper procedures within the government.

**12. Benefits:** Following benefits are anticipated from this scheme:

- Availability of appropriate policy framework to create enabling environment for achieving targets on source segregation
- Maximization of material and resource recovery
- Minimization of costs for transportation and treatment/disposal of that amount of waste which is diverted, through source segregation, for material/resource recovery
- Availability of appropriate policy framework to streamline primary collection system
- To minimize the environmental impact of primary collection system
- To support clean and healthy neighbourhoods

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

- Supply of Waste Bags for Segregation of Food Waste
- Construction/Provision of Collection Points
- Development of Primary Collection Systems
- Development of Operational Plan for Collection and Transportation
- Upgrading of Transfer Stations for Material Recovery
- Development of Biogas Plant
- Upgrading Incineration Plant with Resource Recovery

### 1.3 Development of Awareness Raising Tools for Waste Management

1. **Introduction:** Integrated solid waste management is a new concept. Conventionally, the residents dispose of their waste and then they are not bothered about how the waste is being managed. The residents get worried when the ineffective collection system fails to clear away all the waste and the remaining waste in the neighbourhoods create environmental and public health hazards. Hence, most of the residents, conventionally, care about proper collection system. Most of them might neither be aware of the converting waste a resource nor the costs and efforts required to properly collect, treat and dispose of the waste. They might not be aware of the contamination of waste by mixing hazardous waste with non-hazardous recoverable waste. To promote the segregation at source and to motivate residents to pay solid waste management fees, it is vital to raise their awareness on why and how source segregation could be undertaken by every household. An awareness raising kit/tools consisting of detailed user-friendly materials to understand the process for segregating waste at source in three categories, the advantages of source segregation and proper collection system with maintenance/cleaning of collection points could be useful to promote public awareness.
2. **Purpose:** Awareness raising tools developed would be used through public meetings and trainings to raise awareness for source segregation and primary collection system leading to maximize material/resource recovery and to reduce the environmental and public health related impacts of waste in the neighbourhoods.
3. **Target:** Residents of WND in particular and other waste generators (commercial, industrial, healthcare facilities, etc.) in general.
4. **Type:** Posters, pamphlets and video
5. **Lead Agency:** WND
6. **Support Agency:** An external institution (preferably a university) may be hired to develop awareness raising kit/tools in close consultation with WND.
7. **Location (suggested):** WND
8. **Budget (Estimated):** CNY 75,000 (USD 10,000) for developing the kit. The printing and public meetings would require separate funding which could be decided by WND based on the number and type of awareness raising campaigns it wants to hold.
9. **Time Frame (Estimated):** 3 months

Activity	Jan	Feb	Mar
Developing draft pamphlets and posters	XXXX		
Comments from WND		XX	
Developing Video	XX	XX	
Comments on Video from WND			XX

Final draft of pamphlets and posters			XX
Final copy of Video			XX

**10. Description:** Awareness raising kit/tools would be consisted of pamphlets, posters and a video. They are meant to spread messages on why and how to undertake source segregation of waste in three categories, viz.: hazardous, food waste and other waste. They are also meant to spread message on proper collection system including proper maintenance and cleaning of collection points. The first part would introduce the audience with the benefits of source segregation and maintenance of collection points. The benefits for source segregation would include the maximization of material/resource recovery, minimization of chances for contamination of recoverable and non-hazardous waste and minimization of costs to transport and dispose the waste by diverting recoverable waste. The benefits of proper collection system include the minimization of environmental and public health hazards such as waste related diseases due to presence of waste in the neighbourhoods, odour and presence of mice and insects. The second part would introduce the ways to segregate waste in three categories and to maintain collection points. This would include the introduction of measures to be undertaken by the local government such as availability of plastic bags for food waste. This would also introduce the residents with the policies and technical measures by the local government to promote source segregation such as incentives and disincentives under market-based instruments for segregating food waste, regulations to segregate hazardous waste and operation plan for collection of the waste.

**11. Implementation:** WND by hiring an external institution to develop the kit/tools. WND would undertake awareness raising campaigns on “as and when required” basis.

**12. Benefits:** Following benefits are anticipated from this scheme:

- Availability of awareness raising kit/tools to be used in the public campaigns and workshops to promote ISWM in general and source segregation in particular
- Smooth implementation of policies and technical measures for promoting source segregation and streamlining primary collection system
- Source segregation leading to material/resource recovery
- Leading to minimization of contamination of recoverable and non-hazardous waste
- Leading to minimization of expenditures on transportation and treatment/disposal of recoverable waste

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

- Supply of Waste Bags for Segregation of Food Waste
- Construction/Provision of Collection Points
- Development of Primary Collection Systems
- Development of Operational Plan for Collection and Transportation
- Upgrading of Transfer Stations for Material Recovery
- Development of Biogas Plant
- Upgrading Incineration Plant with Resource Recovery

## 1.4 Supply of Waste Bags for Segregation of Food Waste

1. **Introduction:** Currently, the residents in WND do not segregate food waste from other waste, which results into all the food waste is ending up either in the incineration plant, creating operational and environmental concerns, or ending up in landfill resulting into higher landfill management costs due to the quantity of food waste and the amount of leachate from food waste. Segregation of food waste also increases the chances for recovery of recyclable waste, as it becomes dirty when mixed with food waste. Segregation of food waste from other waste is perceived as a major challenge in WND, as it requires a change in the lifestyle or habits of the residents who perceive segregation at source as an extra and difficult job for them. ISWM Plan for WND also contains policy, technical and voluntary measures to promote segregation of food waste. One of the measures could be the availability of separate bags for throwing food waste to make this task of segregation easier. This would also be taken as an incentive tool for the residents to segregate food waste. However, there could be a danger that residents may throw mixed waste or not properly segregated food waste into these bags. To reduce this possibility, residents' committees and waste collection staff may be trained to identify the bags with mixed waste and then residents' committees may apply other fiscal policies (fines or incentives) as discussed in Scheme 1.2. Number of bags per household could be fixed to avoid the misuse. This scheme could be initially introduced for 3 years to assess its impact.
2. **Purpose:** Transparent separate bags would make it easier for the residents to throw food waste into these bags. The transparent bags would make it easier for the residents' committees and collection staff to identify the bags with mixed waste.
3. **Target:** Residents in WND
4. **Type:** Project
5. **Lead Agency:** WND
6. **Support Agency:**
7. **Location (suggested):** WND residential areas
8. **Budget (Estimated):** CNY 150,000 (USD 20,000) per annum
9. **Time Frame (Estimated):** 3 years (Initially)

Activity	Year 1	Year 2	Year 3
Supply of transparent bags for food waste	XXXX	XXX	XXXX
Mid-term review of the impact		X	
Mid-term report and feedback	XX	X	
Final review and report			XX
Final decision on the future of this scheme			X

10. **Description:** Food waste is about 70 percent of total residential and commercial mixed waste (333 tons/day) in WND. Over the time, this percentage might decline; however, overall waste is increasing. Therefore, it could be assumed that

food waste generation would be constant in terms of overall quantity. This is about 230 tons/day. As per the target, 70 percent of food waste should be segregated in the short term. Therefore, bags would be required for about 160 tons/day of food waste. However, there is no separate data on only residential food waste. Therefore, till the availability of data from Waste Inventory Cell as suggested under Scheme 1.1, it could be assumed that most of the mixed waste is generated in residential areas (major commercial centres, such as super markets segregate most of the waste). The population of WND is over 450,000 people and if average size of a household is 5 persons then there are 90,000 households. This suggests that each household generates about 1.5 kg of food waste per day. If the waste is collected twice a week then per household 8 bags/month would be required, totalling 720,000 bags/month. The bags should be transparent and should be of biodegradable material to avoid their negative environmental impacts.

**11. Implementation:** WND would carry out a research to identify the appropriate and economic type of transparent bags. They would also train residents' committees and waste collection companies to identify the bags containing mixed waste.

**12. Benefits:** Following benefits are anticipated from this scheme:

- Accelerated pace of implementing policy measures on source segregation
- Enough quantities of food waste to establish biogas plants
- Savings in costs incurred for disposal of food waste at landfill

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

- Development of Local Policies on Segregation and Collection
- Development of Awareness Raising Tools for Waste Management
- Development of Primary Collection Systems
- Development of Operational Plan for Collection and Transportation
- Upgrading of Transfer Stations for Material Recovery
- Development of Biogas Plant
- Development of Monitoring Mechanism for ISWM

## 1.5 Construction/Provision of Collection Points

1. **Introduction:** WND is consisting of new and old residential areas. Most of the new residential areas are built on the modern lines with proper waste collection system, including bins and earmarked waste collection points/areas. Most of the new residential areas are managed by the estate companies and they look after waste collection. These new residential areas are mainly single unit or apartment building complexes within a boundary wall and waste collection bins are installed inside the complex, while waste collection point is constructed outside the complex. The old residential areas have community collection points and residents' committees manage waste collection through small companies/individuals. Some of the residential areas lack proper collection points. For effective collection system, one of the important issues to be resolved is the provision of collection points. Furthermore, collection points should be maintained and cleaned properly to avoid negative impacts such as incidences of waste related diseases, spread of mice and insects, odour and urban flooding. The collection points should be secured and protected, especially from birds and animals.
2. **Purpose:** Collection points would provide the first step towards the target of achieving 100 percent collection and removal of waste. Appropriate collection points, on the one hand, make it easier for households to properly throw their waste, and on the other hand, make it easier for collection companies and staff to properly remove all the waste. Cleaned and well maintained collection points minimize the risks to environment and public health.
3. **Target:** Residents and small commercial entities relying on community based collection system
4. **Type:** Project
5. **Lead Agency:** WND
6. **Support Agency:** This could be contracted out to a civil works contractor and consultant could be hired to assess and design the collection points
7. **Location (suggested):** WND residential and commercial areas
8. **Budget (Estimated):** CNY 600,000 (USD 80,000)
9. **Time Frame (Estimated):** 6 months

Activity	Jan-Feb	Mar-Apr	May-Jun
Assessment for identification of number and location and designs for collection points	XXXX		
Contract for construction of collection points		XX	
Construction of collection points		XX	XXXX

10. **Description:** A survey of residential and commercial areas in WND would lead to identify the number and location for new collection points to be constructed (including rehabilitation of existing points if required). The collection points should be within easy access and depending on the population density these may

be located within 200 meters. Size of the collection point is also determined based on the density of the population. It could be as small as 1m<sup>3</sup> and made of steel or plastic like a bin or it can be as big as 5m<sup>3</sup> and constructed with bricks or concrete. There could be three earmarked compartments. Smaller for hazardous waste and bigger for food waste. The collection point should be protected from outsiders to secure these from animals and birds.

**11. Implementation:** WND can use the services of a consultant to identify the location and design the collection points in line with local conditions. WND can contract out to a civil works contractor to construct these collection points

**12. Benefits:** Following benefits are anticipated from this scheme:

- Well built and protected collection points to avoid nuisance
- Smooth collection of all the waste, especially for source segregated waste

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

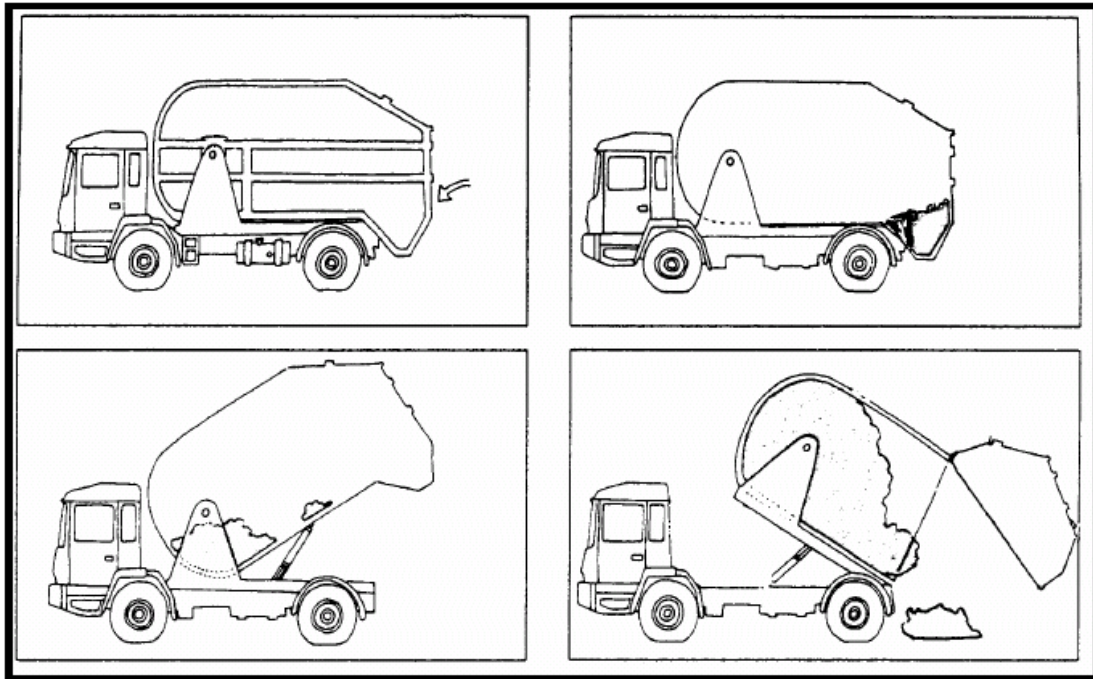
- Development of Awareness Raising Tools for Waste Management
- Development of Primary Collection Systems
- Development of Operational Plan for Collection and Transportation



## 1.6 Development of Primary Collection Systems

1. **Introduction:** There are various small companies and individuals involved in primary collection of waste. The transfer waste from residential and commercial areas to the transfer stations. The vehicles and equipment used for primary collection varies widely from area to area and from one company to another. This mixed vehicle fleets with low vehicle serviceability are becoming less efficient and effective to collect all the waste in an environmental friendly way. ISWM Plan addresses this issue by adopting policy measures (Scheme 1.2). The policies on standardisation, however, do not imply that the same type of vehicle should provide service to every area in a community. For the smooth implementation of the policies to improve the condition of collection equipment and collection vehicles, WND may require to assist collection companies to upgrade their equipment and vehicles.
2. **Purpose:** Small collection companies would be enabled to upgrade their collection equipment and vehicles. This would lead to efficient and environmental friendly primary collection system. The efficient and effective primary collection system would be beneficial for their owners, as they can earn more by collecting more waste and they can spend less by saving operation and maintenance costs, which are incurred on the old vehicles.
3. **Target:** Companies providing primary waste collection service
4. **Type:** Project
5. **Lead Agency:** WND
6. **Support Agency:** An external institution/individual to prepare detailed primary collection system with information of appropriate vehicles and equipment and their techno-economic analysis. The consultant would also make action plan for the government suggesting the ways and means to assist the waste collection companies to upgrade their equipment and vehicles.
7. **Location (suggested):** WND
8. **Budget (Estimated):** CNY 150,000 (USD 20,000) for consultancy. Based on the expert recommendations, WND may allocate the budget to assist primary collection companies to upgrade their equipment and vehicles.
9. **Time Frame (Estimated):** 12 months for report and 3 years to upgrade primary collection system (total 4 years)
10. **Description:** There are two aspects of the project. One is to identify the appropriate type of equipment and vehicles for primary collection in line with the local conditions of different sub-districts of WND. The other one is to develop a set of recommendations for WND to assist the companies to upgrade their equipment and vehicles. For vehicles, the choice could be made from a wide range and most of these could be suitable for one or the other sub-district of WND.

Some of the vehicles could be available locally. This will also be a part of the report.



The report should also provide a detailed action plan or recommendations on how to assist these companies. There could be various ways, including low-interest loans, duty-free equipment and vehicles, lease of vehicles, etc. The recommendation may also include the capacity building of local companies for operation and maintenance of the new equipment and vehicles.

**11. Implementation:** WND would implement in collaboration with the local companies, based on the recommendations in the report

**12. Benefits:** Following benefits are anticipated from this scheme:

- Efficient and effective primary collection system
- Reduced environmental and public health hazards from primary collection system

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

- Construction/Provision of Collection Points
- Development of Operational Plan for Collection and Transportation

## 1.7 Procurement of Collection Vehicles – Secondary Collection

1. **Introduction:** Transportation of waste from transfer stations to treatment and disposal facility is the responsibility of WND. Treatment facility, an incineration, is located within WND; however, landfill is located outside WND. Transfer stations have two functions: sorting for material recovery and transferring waste from small primary collection vehicles to big vehicles for onward journey to treatment and disposal facility to save the transportation costs. Transfer stations usually use balling equipment and compactors to compact the waste while loading on the big trucks to maximize the resource efficiency in terms of per ton haulage up to the treatment and disposal facility. If the small primary collection vehicles are of a size of 1 to 3 tons, then big vehicles of a size from 5 to 10 tons are usually used for transporting waste from transfer stations.
2. **Purpose:** With the procurement of big vehicles to transfer waste from transfer station to treatment and disposal facility, there could be substantial savings in per ton haulage. In addition to that there could be environmental benefits as modern vehicles are usually designed to more fuel efficient and having better pollution control measures. These vehicles are designed to carry waste; thus, having proper odour and noise control measures.
3. **Target:** WND for resource efficiency and public benefits
4. **Type:** Project
5. **Lead Agency:** WND
6. **Support Agency:** An external institution/expert could be hired to assess the need for the number, type and size of the vehicles. In addition to that, if required, then this institution/expert could also assist in procurement by developing tender documents, evaluating bids and assisting in negotiations.
7. **Location (suggested):** WND
8. **Budget (Estimated):** Initially CNY 300,000 (USD 40,000) for assessment of demand, identification of appropriate type of vehicles and developing procurement documents. Then based on the assessment, further budget could be allocated to either buy all the required vehicles at once or in phases.
9. **Time Frame (Estimated):** 6 months

Activity	Jan-Feb	Mar-Apr	May-Jun
Assessment of demand and identification of appropriate type of vehicles with techno-economic study	XXXX		
Comments from WND		XXXX	
Development of tender documents to procure the vehicles			XXXX

10. **Description:** Data on quantification of waste suggests that about 415 tons/day is generated from municipal sources (residential, commercial and municipal waste from industries). The amount of waste from residential and commercial sectors is 333 tons/day and from industries is 82 tons/day. This is transported to the transfer stations. As per the forecast, there will be 490 tons/day waste available in year

2010 and 700 tons/day in year 2020. As per the description of Scheme 1.4, about 160 tons/day of food waste would be segregated, leaving behind 330 tons to reach at the transfer stations in 2010. With sorting facilities, it is expected that 30 percent of other waste would be recovered. Thus, there will be about 230 tons/day to be hauled out of transfer stations by big vehicles. If the average vehicle size would be 10 tons, then at least 23 trips would be required. Depending on the time required for one trip, total number of vehicles could be estimated.

**11. Implementation:** Based on the instructions form WND, the external organization/expert would carryout this assessment and will also identify the most suitable type of vehicles for the local conditions. Based on the approvals form WND, this external organization/expert would prepare tender documents to assist WND in procurement of the vehicles.

**12. Benefits:** Following benefits are anticipated from this scheme:

- Resource efficiency for transporting waste from transfer stations to treatment and disposal facility
- Minimization of environmental impacts

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

- Development of Operational Plan for Collection and Transportation
- Upgrading of Transfer Stations for Material Recovery

## 1.8 Development of Operational Plan for Collection and Transportation

1. **Introduction:** Removal of waste is one of the most important operations for an effective integrated solid waste management system. Waste generators want that their waste should be removed as soon as possible from their backyard (neighbourhoods). However, for service providers or for the local government, it would be very difficult to meet this demand unless there is a proper synergy of timings between waste disposal by the generator and the collection system to collect and transport that waste to transfer station/treatment facility/disposal site. Most of the local government budget, allocated for solid waste management, is spent on the collection and transportation of waste. Even then, in many places, some of the waste is still not collected. One of the crucial aspects to improve the efficiency and effectiveness of collection and transportation system is to develop and implement an operational plan. This plan covers the timings for waste generators to dispose of their waste to the collection points and timings for waste collection services from the collection points.
2. **Purpose:** With the implementation of operation plan, the target of 100 percent collection would be met efficiently. Complains of waste generators for not properly removing the waste from neighbourhoods would be removed. Complains of collection service providers for waste generators that they are not disposing of the waste at proper timings would also be addressed. Resource efficiency in collection system would be maximized.
3. **Target:** Waste generators and waste collection service providers
4. **Type:** Plan
5. **Lead Agency:** WND
6. **Support Agency:** An external institution may be hired to develop an operational plan after a careful study of the waste generation patterns and waste collection services.
7. **Location (suggested):** WND
8. **Budget (Estimated):** CNY 300,000 (USD 40,000)
9. **Time Frame (Estimated):** 6 months

Activity	Jan-Feb	Mar-Apr	May-Jun
Assessment of waste generation patterns and waste collection services	XXXX		
Draft operational plans for each sub district (transfer station)		XXX	
Comments from WND		X	X
Final draft of the operational plan for each sub district			XXX

10. **Description:** Currently there are various types of small companies, providing waste collection services. These companies are hired by the waste generators, such as residents committees and commercial entities of these are hired by transfer station operators to collect the waste within from their vicinity. Based on their

strength (collection equipment, human resources and vehicles), the companies undertake the waste collection operations. In most of the areas, there is no clear operational plan. Therefore, there is no synergy between waste disposal at collection points and waste collection. In some cases, waste is disposed of just after waste collection. Without an operational plan, it is also hard to know about the frequency of the services. For waste collection service providers, working without an operational plan, that also bounds waste generators to dispose of their waste at proper timing, it is very inefficient, especially when some of the service operators are paid for the total volume removed. Operational plan would be developed to cater the situation and needs of each sub district, as WND wide plan may not be effective and efficient. Each sub district is connected with a transfer station, so it would be a transfer station based operational plan, as the waste is to be removed and transported to the respective transfer stations. The operational plan suggests timings of the day and days of the week, when certain type of waste out of source segregated three categories (food waste, other non-hazardous waste and hazardous waste) should be disposed of by the waste generators. Operational plan would show the amount of waste that would be available for the collection. Based on that the operational plan also logically indicates the routes and timings for collection vehicles to maximize their efficiency. The route and timings of waste collection services would be designed in such a way that these collection vehicles should not create traffic jams during peak hours or generate noise during late night. The operational plan will also coordinate the operations at transfer stations for sorting and onward transportation, as it would be inefficient if either most of the waste arrives at the same at the transfer station or transfer station sits idle for most of the time.

**11. Implementation:** WND would implement the operational plan through respective transfer stations and residents committees.

**12. Benefits:** Following benefits are anticipated from this scheme:

- All the waste is removed
- Higher resource efficiency for collection services
- No traffic jams due to waste collection services
- No noise pollution during late night

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

- Construction/Provision of Collection Points
- Development of Primary Collection Systems
- Upgrading of Transfer Stations for Material Recovery

# 2

## Sorting, Treatment and Disposal

### 2.1 Upgrading of Transfer Stations for Material Recovery

- 1. Introduction:** It is evident from waste data of WND that there are substantial quantities of recoverable materials. This material recovery at the transfer stations would benefit from two angles. On the hand, amount of final waste would be reduced; thus, there will be savings in costs for transportation, treatment and disposal of final waste. On the other hand, recovered materials could be sold to recycling industry to generate revenue for ISWM. The data shows that there is 17 percent waste plastic and 7 percent waste paper in the waste that is generated by residential and commercial sectors. This makes about 56 tons/day of waste plastic and 22 tons/day of waste paper. There are about 8 tons/day of waste textiles, about 6 tons/day of glass and 1 ton/day of metals. Municipal waste from residential and commercial sectors is handled by 6 transfer stations. The seventh transfer station is dedicated to municipal waste from industries which contain about 73 tons/day of waste plastic, 66 tons/day of waste paper, 16 tons/day of waste textiles, 3 tons/day of metals and tons/day of glass. With the sorting facilities, most of this recoverable waste could be recovered. The sorting facilities would also have equipment to compact the final waste for transportation to treatment/disposal facility.
- 2. Purpose:** Upgraded transfer stations would increase the rate of material recovery which would benefit from two aspects. Firstly, it would reduce the amount of final waste leading to savings in resources required to transport, treat and dispose final waste. Secondly, it would be source of income, as this recoverable waste could be sold to recycling sector. The sorting facilities range from fully automatic or capital intensive to manual or labour intensive.
- 3. Target:** Transfer stations in WND
- 4. Type:** Project
- 5. Lead Agency:** WND
- 6. Support Agency:** An external institution/consultant would be required to assess and design sorting facilities for each of the transfer stations and assist WND in installation of those facilities.
- 7. Location (suggested):** Seven transfer stations in WND
- 8. Budget (Estimated):** Initially CNY 900,000 (USD 120,000) for hiring external organization/consultant to assess and design sorting facilities for seven transfer stations, to conduct techno-economic study to determine the costs for installation of sorting facilities at respective transfer stations and assist WND in installation of sorting facilities. WND may prioritize installation of sorting facilities at each transfer station based on this techno-economic study.

**9. Time Frame (Estimated):** Total 18 months: 6 months for assessment and design and 12 months for installation of sorting facilities

Activity	Jan-Jun	Jul-Dec	Jan-Jun
Assessment, techno-economic study and designing of sorting facilities	XXXXXX		
Approvals from WND		XX	
Tendering and procurement		XXXX	
Installation and testing			XXXXXX

**10. Description:** Upgrading transfer stations to equip with sorting and compacting facilities are some of the vital activities under ISWM based on 3R approach. Sorting facilities would be designed based on the type and amount of recoverable materials. Sorting facilities would also be designed based on the local preferences to choose among a wide range of facilities from manual separation to fully automatic or mechanical separation of recoverable materials. Equipment involved in manual separation of materials usually includes a sorting belt or table, which contains a mixture of materials. Workers (“sorters”) are stationed on one or both sides of the belt or table. Hoppers or other receptacles for receiving removed items are positioned within easy reach of the sorters. The design of processes that rely on manual separation requires a good understanding of basic principles of time and motion, of the composition of the waste, and of the comfort and safety requirements of the sorters. The application of simple, labour-intensive designs does not imply a disregard for safety and environmental control within the facilities. Mechanical separation usually involves the use of several types of unit processes, five of which are size reduction, air classification, screening, magnetic separation, and non-ferrous (e.g., aluminium) separation. The sequence of the processes for mixed waste processing varies, although either size reduction or a preliminary screening (trommel) usually is the first step. The term “size reduction” has a number of synonyms in solid waste management, including “shredding” and “grinding”. The term “shredding” has been widely adopted in reference to size reducing mixed waste. In the case of processing source-separated materials, size reduction using granulators and grinders is sometimes practiced for certain types of plastics and for glass, respectively.

The design of a successful processing facility should incorporate certain concepts, among which are the following: 1) reliance upon proven technologies (appropriate to the particular location) and fundamental principles of engineering and science; 2) consideration given not only to the characteristics of the waste from which the desired materials are to be recovered, but also to the specifications of the recovered materials; 3) preservation or improvements to the quality of the recovered material; 4) processing flexibility to accommodate potential future changes in market conditions; 5) recovery of the largest percentage of materials that is feasible given the conditions that apply to the recovery project, and 6) protection of the workers and of the environment. Design concepts pertaining to operation include provisions for: 1) receiving mixed waste, source-separated materials, or both; 2) accommodating the various types of vehicles that deliver wastes to the facility, as well as the frequency of the deliveries; 3) relying upon manual labour when current automation technology is lacking, unproven, or marginally effective; and 4) storing of materials.



Stationary waste compactors are commonly used at transfer stations. A stationary compactor, commonly known as a breakaway, because the actual compactor is mounted to the ground, while the container is detachable. When the container is hauled to the landfill, the compactor stays in place. This is a chute through the wall installation. In stationary compactors, waste is loaded into the hopper to ensure that the material, when fully compacted, is evenly and/or appropriately distributed in terms of weight, binds to the rest of the compacted mass, does not adhere to the inside of the container or chamber, and is distributed so as to minimise any potential risk in terms of combustion or other adverse chemical reaction. Baling systems include semi-automatic and fully automatic machines that are capable of baling several materials such as cardboard, magazines, paper, plastics, solid waste, textiles, aluminum cans, steel cans, copper, radiators, extrusions, etc.

**Material Handling Equipment**

- Belt conveyor
- Screw conveyor
- Apron conveyor
- Bucket elevator
- Drag conveyor
- Pneumatic conveyor
- Vibrating conveyor
- Debagger

**Separating Equipment**

- Magnetic separator
- Eddy current device (non-ferrous separator)
- Disc screen
- Trommel screen
- Vibrating flat bed screen
- Travelling chain curtain
- Air classifier

**Size Reduction Equipment**

- Can shredder
- Glass crusher
- Plastics granulator
- Plastics perforator

**Densification Equipment**

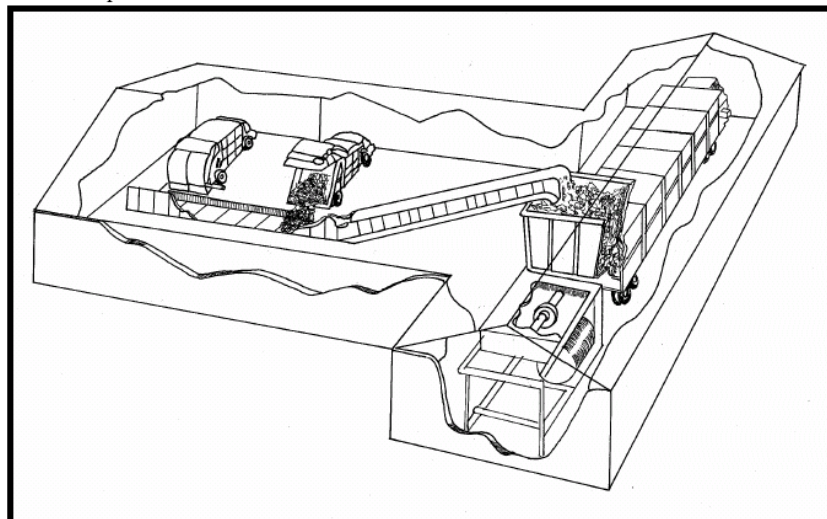
- Can densifier/biscuiter
- Can flattener
- Baler

**Environmental Control Equipment**

- Dust collection system
- Noise suppression devices
- Odour control system
- Heating, ventilating, and air conditioning (HVAC)

**Other Equipment**

- Fixed storage bin
- Live-bottom storage bin
- Floor scale for pallet or bin loads
- Truck scale
- Belt scale



**11. Implementation:** WND would implement this scheme by hiring an external organization/consultant to assess the situation, undertake techno-economic study, design the facilities and assisting the procurement and installation of the facilities.

**12. Benefits:** Following benefits are anticipated from this scheme:

- Maximizing material recovery to increase revenue base and to reduce expenditures on the final waste
- To support employment at sorting facilities
- To support new industries based on recycling materials

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

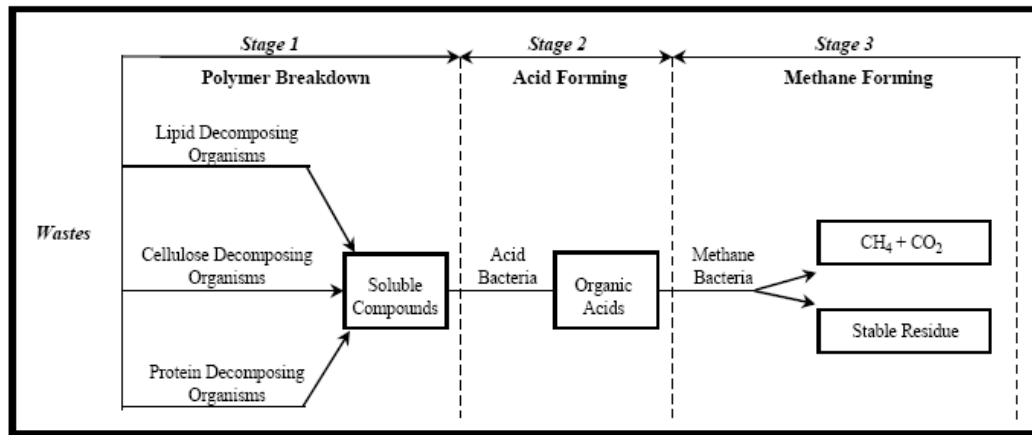
- Procurement of Collection Vehicles – Secondary Collection
- Upgrading Incineration Plant with Resource Recovery

## 2.2 Development of Biogas Plant

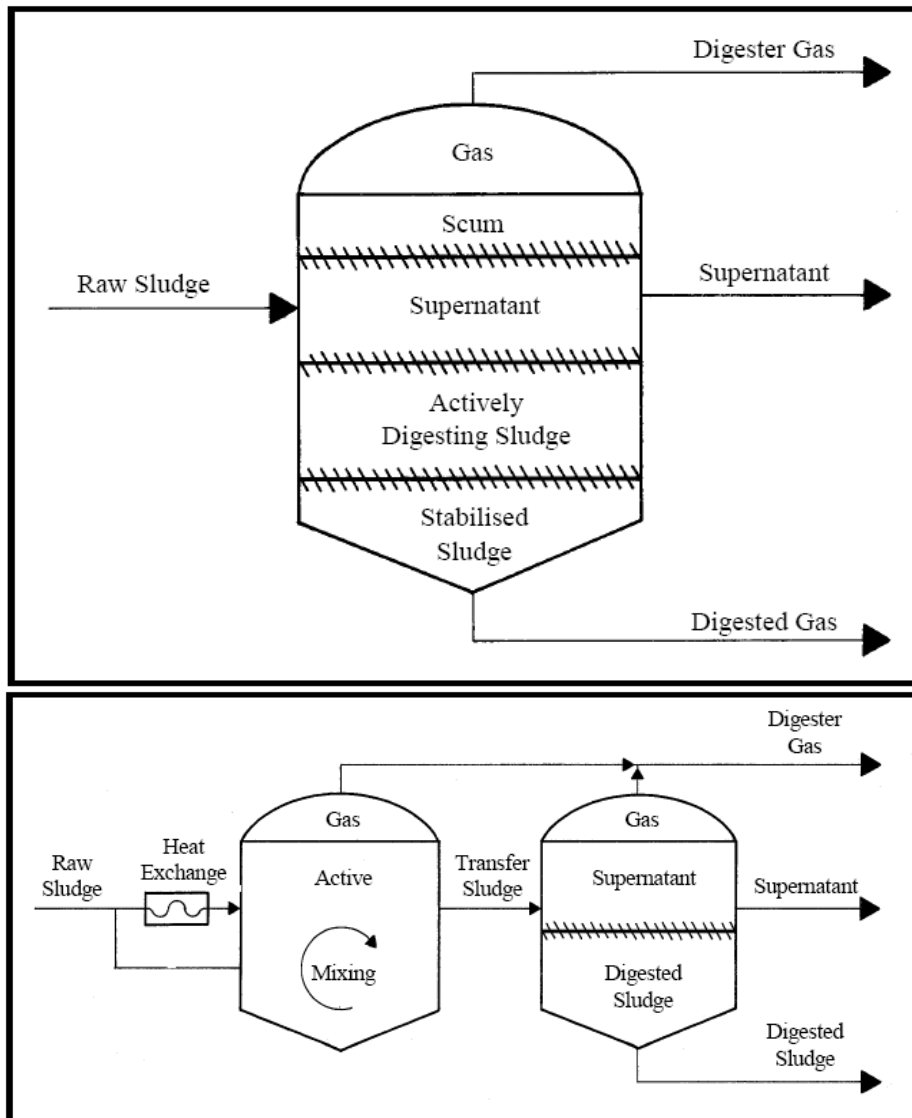
1. **Introduction:** About 70 percent of waste from residential and commercial sectors is food waste. In the future, the percentage of food waste will not decrease drastically and it may remain 60 percent in the coming years. As mentioned in Scheme 1.4, about 160 tons/day of food waste would be available with the initial targets for source segregation. Conversion of this waste into a source would help to augment precious resources such as energy. Furthermore, if the biogas plant would be located in WND, then by diverting this waste away from landfill that is located outside WND, there will be considerable savings in transportation and landfill costs. Food waste could be converted into compost, biogas and ethanol. So far, composting and biogas technologies are established while most of the ethanol is being produced from waste biomass instead of food waste. Keeping in view, the demand for energy and skyrocketing costs of energy, WND can develop a biogas plant to convert food waste into biogas. This could also be considered as a renewable energy programme and may be entitled for carbon credits under Kyoto Protocol (Clean Development Mechanism – CDM).
2. **Purpose:** Biogas plant would help to divert the food waste from landfill, leading to savings into transportation and landfill costs. This plant would also help to generate clean energy to replace some of the energy demand for fossil fuels. The earnings from energy as well as investments through CDM would boost local revenue base.
3. **Target:** WND
4. **Type:** Project
5. **Lead Agency:** WND
6. **Support Agency:** An external organization/consultant to assess and design biogas plant with its techno-economic study. This organization/consultant also to assist WND in procurement and installation of the plant either under public sector or through public-private partnership.
7. **Location (suggested):** WND
8. **Budget (Estimated):** Initially CNY 600,000 (USD 80,000) for hiring external organization/consultant to assess and design biogas plant, to conduct techno-economic study to determine the costs for establishing and operating a biogas plant. WND may prioritize installation of size and type of biogas plants based on techno-economic study.
9. **Time Frame (Estimated):** Total 18 months: 6 months for assessment and design and 12 months for installation of biogas plant

Activity	Jan-Jun	Jul-Dec	Jan-Jun
Assessment, techno-economic study and designing of biogas plant	XXXXXX		
Approvals from WND		XX	
Tendering and procurement		XXXX	

10. **Description:** Biogas production from waste is commonly known as Waste to Energy (WtE). Among the terms frequently used as synonyms for biogasification are “methane fermentation”, “methane production”, and “anaerobic digestion.” The entire process begins with the polymer stage. In the polymer stage, organic wastes are acted upon by a group of facultative microorganisms that enzymatically hydrolyse the polymers of the raw waste into soluble monomers. The monomers (short-chain organic acids, acetic acid, etc.) become the substrate for the next stage (acid stage). Some carbon dioxide also is formed. The organic acids form the substrate for the bacteria active in the final methane-production stage. In this stage, the methane producers (methanogens) break down the organic acids into, primarily, methane. Methanogens are strict anaerobes, and as such do not tolerate free oxygen, i.e., atmospheric oxygen (O<sub>2</sub>). Methanogens produce methane in two ways: 1) they can ferment an organic acid (e.g., acetic acid) to methane and carbon dioxide; and 2) they can reduce carbon dioxide to methane through the use of hydrogen or formate produced by other bacteria. The interrelationship of the three steps as shown:



Operational procedures include mixing, loading, detention time and starting of a digester for both conventional digestion and high-rate digestion as shown:



Large-scale facilities for high-solids are common in developed countries due to technology and economic issues. However, rapidly growing countries, with a large quantity of food waste may soon find these issues resolved due to home-grown capacity and affordability.

**11. Implementation:** WND would implement this scheme by hiring an external organization/consultant to assess, undertake techno-economic analysis, design the facilities and assisting the procurement and installation of the facilities.

**12. Benefits:** Following benefits are anticipated from this scheme:

- Resource augmentation by utilizing waste
- Revenue source to support ISWM
- Savings in costs incurred on transportation and disposal of food waste at landfill

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

- Development of Local Policy Framework on Segregation and Collection
- Development of Awareness Raising Tools for Waste Management
- Supply of Waste Bags for Segregation of Food Waste

## 2.3 Upgrading Incineration Plant with Resource Recovery

1. **Introduction:** WND is operating an incineration plant; however, this plant is not 100 percent self-sustained combustion due to the low calorific value and high moisture content of the waste. This could also lead to environmental pollution which could affect very seriously, if the environmental measures were not taken on the top priority basis. In developed countries, about 30 percent of overall costs for incineration are incurred on pollution control measures. Under ISWM, most of the food waste would be segregated at source and this would help to reduce the moisture content of mixed waste which is being feed into incinerator.
2. **Purpose:** Upgraded facilities would control environmental pollution and will improve the efficiency of incineration with self-sustained combustion.
3. **Target:** Incineration plant in WND
4. **Type:** Project
5. **Lead Agency:** WND
6. **Support Agency:** An external organization/consultant to carry out assessment of current incineration plant and to design environmental control measures and improvements in incineration process.
7. **Location (suggested):** Incineration plant in WND
8. **Budget (Estimated):** Initially CNY 600,000 (USD 80,000) for hiring external organization/consultant to assess and design the environmental control measures and improvements in the technical process. Incineration plant owners would be required to invest in procurement, installation and operations of these measures.
9. **Time Frame (Estimated):** Total 18 months: 6 months for assessment and design and 12 months for procurement and installations at incineration plant

Activity	Jan-Jun	Jul-Dec	Jan-Jun
Assessment and designing of environmental control measures and improvements in technical process for incineration plant	XXXXXX		
Approvals from WND		XX	
Assisting incineration plant to procure technology		XXXX	
Installation and testing			XXXXXX

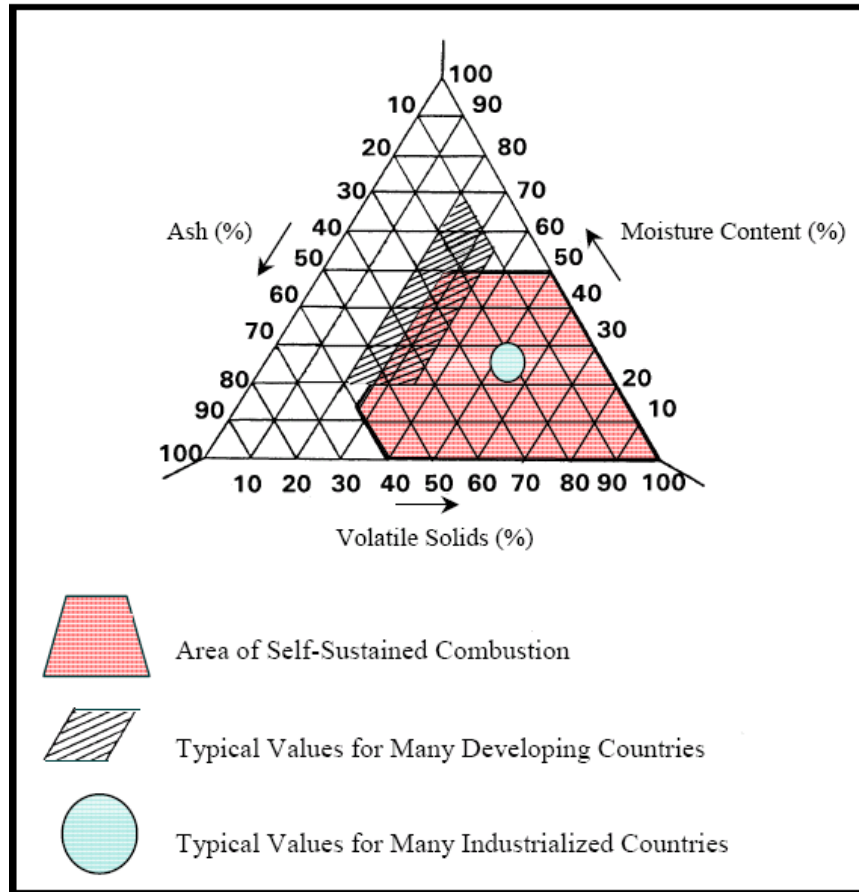
10. **Description:** Conventionally incinerators were designed to burn waste that had a low heating value. The reason was primarily to accommodate wastes with high moisture content. Consequently, features were incorporated that were designed to: 1) dry and ignite the refuse, and 2) deodorise the off gases. Little or no waste heat was available for energy export. Moreover, very serious issue of air pollution was overlooked. In industrialised nations, incineration systems must have complex air pollution control (APC) systems in order to meet the required limits for protecting the quality of the ambient air and human health. The complexity is a result of the fact that modern APC systems include provisions for controlling a number of pollutants to very low concentrations (e.g., parts per million or per billion). The

provisions include control and manipulation of the combustion process itself within the combustion chamber and the use of post-combustion techniques, including the use of chemical reagents and of special mechanical and electrical systems to process the combustion gases. The principal pollutants that are controlled in industrial countries are listed in Table 1, along with the typical methods of control and levels of pollutant reduction. Because of their complexity, modern APC systems can account for up to 30% of the capital cost of incineration systems. In the last 10 to 15 years, considerable research and development effort has been expended on “trace” air pollutants formed as byproducts of solid waste combustion, the relevant chemistry, and methods of control. Examples of these trace pollutants are mercury, and dioxins and furans.

Pollutant	Control Methods	Typical Reduction (%)
Oxides of nitrogen (NO <sub>2</sub> )	<ul style="list-style-type: none"> <li>• Selective catalytic reduction</li> <li>• Selective non-catalytic reduction</li> <li>• Flue gas recirculation</li> <li>• Combustion control</li> </ul>	10 to 60
Acid gases (SO <sub>2</sub> and HCl)	<ul style="list-style-type: none"> <li>• Wet scrubber</li> <li>• Dry scrubber</li> <li>• Fabric filter</li> <li>• Electrostatic precipitator</li> </ul>	50 to 85 SO <sub>2</sub> 75 to 90 HCl
Carbon monoxide (CO)	<ul style="list-style-type: none"> <li>• Combustion control</li> </ul>	50 to 90
Heavy metals	<ul style="list-style-type: none"> <li>• Dry scrubber</li> <li>• Fabric filter</li> <li>• Electrostatic precipitator</li> </ul>	70 to 95
Particulates	<ul style="list-style-type: none"> <li>• Electrostatic precipitator</li> <li>• Fabric filter</li> </ul>	95 to 99.9
Toxic organics (including dioxins and furans)	<ul style="list-style-type: none"> <li>• Combustion control</li> <li>• Combination of dry scrubber and fabric filter</li> </ul>	50 to 99.9

As the composition of municipal waste has changed (i.e., substantial paper and plastic content, small putrescible fraction), the heating value of the solid waste has increased. Thermal characteristics of solid waste is one of the major consideration along with the availability of modern technology equipped with emission control measures. Thermal characteristics on the one hand derive the option for self-sustained combustion and on the other hand, dictate the level of emission control measures. Therefore, the upgraded incineration plant would have modern environmental pollution control measures, efficient technology and suitable solid waste to generate self-sustained combustion.





**11. Implementation:** WND would implement this scheme by hiring an external organization/consultant to assess the situation, undertake techno-economic study, design the facilities and assisting the procurement and installation of the facilities.

**12. Benefits:** Following benefits are anticipated from this scheme:

- Air pollution control to minimize the serious public health risks attached with incineration
- Resource efficiency due to self-sustained combustions
- Reduced air pollution which is due to external energy (coal) supplied for incineration of waste

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

- Development of Local Policies on Segregation and Collection
- Development of Awareness Raising Tools for Waste Management
- Supply of Waste Bags for Segregation of Food Waste
- Upgrading of Transfer Stations for Material Recovery
- Development of Monitoring Mechanism for ISWM

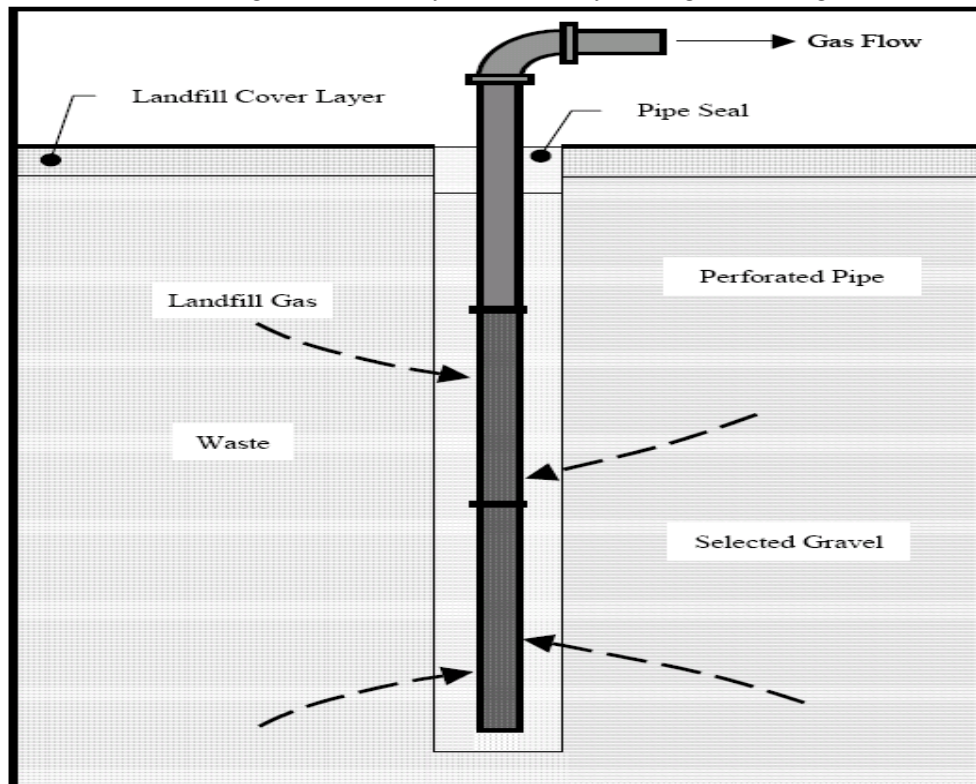
## 2.4 Upgrading Sanitary Landfill with Landfill Gas Utilization

1. **Introduction:** Wuxi local government manages a landfill which accommodates solid waste from all the districts including Wuxi New District (WND). Landfill gas recovery and utilization could be economically and environmentally beneficial. On the one hand, landfill utilization could earn carbon credits under CDM, and on the other hand, keeping in view the rapidly increasing energy costs, this source of energy could be vital for local and national economy.
2. **Purpose:** To upgrade the sanitary landfill for recovery and utilization of landfill gas.
3. **Target:** Landfill in Wuxi
4. **Type:** Project
5. **Lead Agency:** Wuxi Local Government with an active assistance form WND
6. **Support Agency:** An external organization/consultant to carry out assessment of current incineration plant and to design environmental control measures and improvements in incineration process.
7. **Location (suggested):** Landfill in Wuxi
8. **Budget (Estimated):** Initially CNY 300,000 (USD 40,000) for hiring external organization/consultant to assess and design improvements in the landfill, including proper recovery and efficient utilization of landfill gas.
9. **Time Frame (Estimated):** 24 months – 6 months for consultancy services, 6 months to upgrade landfill gas recovery system and 12 months to install landfill utilization system based on consultant’s report (for example power generation system)

Activity	Jan-Jun	Jul-Dec	Jan-Dec
Assessment of current landfill recovery system and designs for upgraded landfill gas recovery system and designs for landfill gas utilization system	XXXXXX		
Approvals from Wuxi		XX	
Installations of upgraded landfill recovery system		XXXX	
Installation of landfill gas utilization system			XXXXXXXXXXXX

10. **Description:** Typically, the composition of landfill gas is on the order of 40% to 60% CH<sub>4</sub>, 40% to 50% CO<sub>2</sub>, 3% to 20% N<sub>2</sub>, 1% O<sub>2</sub>, and traces of sulphides and volatilised organic acids. In general, the amount actually obtained from a landfill will be much less than the theoretical volumes predicted on the basis of organic waste content. Collected gas either can be used directly as a low-heat fuel, or can be processed (purified) to form a high-heat fuel. Collection is made possible by providing a combination of strategically spaced wells and areas of high permeability through which gases are channeled to collection points. This is done by installing underground venting pipes and a gravel layer between the cover and the waste, or gravel filled trenches. The gas is removed from the landfill by way

of a piping or header system to transport the gas, and blowers to pull the gas from the fill through the headers. The heat content of landfill gases ranges from about 7,500 to 22,000 kJ/m<sup>3</sup>; whereas the lowest heat content of natural gas is approximately 37,300 kJ/m<sup>3</sup>. Moisture content may be as low as 5% and as high as saturation. Oxygen content varies from trace levels to levels that are potentially explosive. However, the latter levels are reached very infrequently. Finally, the usually sizeable CO<sub>2</sub> and N<sub>2</sub> contents of landfill gas materially lower its heat content and, hence, the quality of the gas. The utility of landfill gas can be increased significantly by upgrading the gas. Among the uses for upgraded gas are onsite generation of electricity and/or injection into a public utility transmission line. Methods and procedures are available for removing H<sub>2</sub>O (dehydration), CO<sub>2</sub>, and N<sub>2</sub> from landfill gas, and thereby considerably raising its heating value.



**11. Implementation:** WND would assist Wuxi Local Government to implement this scheme by hiring an external organization/consultant.

**12. Benefits:** Following benefits are anticipated from this scheme:

- Earnings from sale of energy
- Investments based on CDM
- Resource augmentation by utilizing waste

**13. Links to other Schemes under ISWM Plan for WND:** This scheme is linked with the other following schemes of ISWM:

- This is indirectly link with all the schemes, as this would provide one of the revenue streams to support ISWM

## 2.5 Establishment of Waste Exchange Platform

1. **Introduction:** Integrated solid waste management (ISWM) addresses all types of solid waste from all the sectors within a geographic or administrative boundary. ISWM is a dynamic process for effective and efficient management of waste based on 3R approach. 3R approach aims to reduce the final amount of waste by minimizing waste generation at source and by diverting most of the waste for recycling and resource recovery. Most of the recycling and resource recovery could be targeted for industrial sector as they may have capacity, or can build capacity, to use most of waste as an input for production process. Most of recovered materials could replace raw materials and recovered energy from waste can reduce the intake of conventional energy, required for industrial sector. The waste, which could be used by industries, could be diverted from all waste sources including industrial sector, residential sector and commercial sector. First step towards this goal would be the availability of waste data, including quantity and characterization, from all sectors. This is covered under Activity 1.1 on the establishment of Waste Data Inventory Cell. The second step would be the establishment of a Waste Exchange Platform. This platform would be an IT (information technology) based marketplace where buyers and sellers can exchange the information regarding the waste that could be recycled or used as an energy source.
2. **Purpose:** Waste Exchange Platform will work as a marketplace, where sellers and buyers of recycling and recoverable waste could carryout virtual trade. This would help to divert most of the waste away from final disposal for material and resource recovery. Thus, on the one hand there will be substantial economic and environmental savings for treating final amount of waste. On the other hand, there will be resource augmentation leading to support economic activities and to reduce the burden on environmental resources. Renewable energy from waste could also earn carbon credits under CDM.
3. **Target:** The scheme has been developed to achieve the following targets
  - To reduce the final amount of waste for treatment and disposal
  - To encourage resource augmentation by utilizing waste
  - To reduce pressure on environmental resource and to reduce GHG emissions
  - To promote economic activities including new industries based on recycling
4. **Type:** Project
5. **Lead Agency:** Wuxi New District (WND) Local Government
6. **Support Agency:** The services of an institution, such as a university or a consulting group, may e hired for setting up an IT based Waste Exchange Platform
7. **Location (suggested):** WND Government Office
8. **Budget (Estimated):** Office expenditures with one staff from internal WND budget

External expenditures on setting up Waste Exchange Platform to would be: CNY 150,000 (USD 20,000)

9. **Time Frame (Estimated):** 12 months (estimated time to seek approvals within the government on the establishment of the waste exchange platform and on the budget allocations:

Activity	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
Approvals for budget allocation for setting up Waste Exchange Platform, including one full time person to maintain the platform	XX	XX		XX		
Contracting to a consultant to establish IT based Waste Exchange Platform				XX		
Setting up the platform					XXXX	XX
Training of WND staff to operate the platform by the same consultant						XX

10. **Description:** WND is rapidly growing. Industrialization and economic growth rates are one of the highest. To maintain this momentum of industrialization and economic growth as well as to minimize the pressure on environmental resources, it is proposed to augment resources by utilizing waste, especially for industrial production. Material recovery from waste can replace some of the raw environmental resources, required for industrial production. Similarly, most of the waste could be used as an energy source to reduce the use of conventional energy sources. However, the industries require accurate and long-term information and commitment on the type and quantities of available waste which could be utilized as a material or energy source. In this regard, a waste exchange platform, based on IT and using internet, could be a very helpful tool. This platform would provide a virtual marketplace for sellers and buyers of waste for virtual trading. The industries could get long-term contracts to either buy or sell the recoverable waste as it is done for conventional resources for industrial production. WND would play a regulatory role and could monitor the proper utility of waste exchange platform based on the national and local regulations.

Waste Exchange Platform would be developed by using simple programming to setup database, where sellers and buyers can identify the type and composition of waste available/required to be sold/bought.

11. **Implementation:** The implementation of this scheme would be facilitated by WND through internal arrangements to setup waste exchange platform. One person may be assigned to operate and maintain the platform. An outside organization or an individual could be awarded contract to establish the platform and train the WND staff for its operation.

**12. Benefits:** Following benefits are anticipated from this scheme:

- To promote resource augmentation by utilizing waste and to minimize final volume of waste available for treatment and disposal
- To provide industries an opportunity to seek long-term commitments for selling/buying waste for industrial production
- To boost industrial activity and to support environment

**13. Links to other Schemes under ISWM Plan for WND:** This schemes is linked with all the other schemes of ISWM:

- Development of Waste Inventory Cell
- Development of Local Policies on Segregation and Collection
- Development of Awareness Raising Tools for Waste Management
- Supply of Waste Bags for Segregation of Food Waste
- Upgrading of Transfer Stations for Material Recovery
- Development of Monitoring Mechanism for ISWM

## 2.6 Establishment of Eco Town

1. **Introduction:** The current statistics show that after food waste, plastic waste is another major component as residential, commercial and industrial (municipal) waste contains 17, 14 and 22 percent of plastics respectively. About 70 tons/day of plastic waste is generated by municipal waste sources. Paper is 6 percent in waste from residential and commercial sources, while it is more than 50 percent from industrial sources. About 65 tons/day of waste paper is generated in municipal waste. Textiles, glass and metal quantities are about 16, 5 and 2 tons/day respectively. With source segregation of food waste, most of this waste could be recovered as clean waste for recycling. There is a huge quantity of industrial non-hazardous waste (processing waste) - 213,826 tons per year. Industrial waste generation rate is about 20.15 tons/year per million Yuan production output. Hazardous waste generation from industries is at the rate of about 2.45 tons/year per million Yuan production output. This recyclable waste could be utilized by establishing recycling industries, which either treat this waste to convert this waste into a useful source for industries or use this waste directly into industrial process to produce consumer products. Both of these types of recycling industries could be clustered and located into “eco-town” with preferential policies and infrastructure to encourage recycling.
2. **Purpose:** Eco-town, to host recycling industries, would provide preferential policies and infrastructure to encourage the establishment of recycling industries. On the one hand, this will support 3R approach by diverting waste for recycling. On the other hand, this will boost a new industrial cluster resulting into environmental friendly economic activities.
3. **Target:** The scheme has been developed to achieve the following targets
  - To promote 3R approach at wider scale
  - To encourage establishment of recycling industry
  - To boost economic activities without seriously affecting environment
4. **Type:** Project
5. **Lead Agency:** Wuxi New District (WND) Local Government
6. **Support Agency:** WND would establish an Eco-town to host recycling industry. An outside organization or a consultant could be hired to develop a feasibility study for setting up Eco-town. The feasibility study would also include the recommendations on preferential policies and infrastructure for recycling industry.
7. **Location (suggested):** WND industrial area
8. **Budget (Estimated):** The real estimates could only be available after the feasibility study. For feasibility study, the budget estimate is about: CNY 600,000 (USD 80,000)
9. **Time Frame (Estimated):** 12 months for carrying out feasibility study and compiling the proposal for seeking approvals for establishment of Eco Town and

related policies from relevant authorities at local and national level:

Activity	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
Feasibility for Eco-Town	XXXX	XXXX	XXXX	XXXX		
Development of draft proposal for seeking approvals from relevant authorities on Eco Town and related policies					XXXX	
Seeking approvals						XXXXXX

10. **Description:** Eco towns are being promoted in various countries to encourage businesses to recycling industries. Eco Towns provide preferential policies, including different tax structure or rebates. Eco Towns also provide infrastructure facilities such as road networks, centralized wastewater and solid waste treatment facilities, etc. Mainly two types of recycling industry is hosted at Eco Towns. Firstly, the industry that can treat waste to recover materials which can be used by other industries as in input for producing goods. Secondly, the industry that directly uses recycling waste to produce consumer goods. There could be some industries which promote waste exchange among themselves. These industries are same in nature as the other industries with only difference is that they use recycling waste to produce either raw materials for industrial production or directly consumer goods. These industries may face some challenges as they may have to acquire better technologies or may have to face difficulties in selling the products made from recycling waste. Therefore, preferential policies and infrastructure might be useful to keep these industries at par with other industries. Various types of eco towns are in operation in different countries with different policies and facilities. A review of these eco towns, policies and facilities can help to develop a proposal for eco town in WND based on local conditions.

11. **Implementation:** WND in agreement with Wuxi municipal government can initiate the establishment of eco-town. The feasibility study would be conducted by WND through an external organization or consultant. The establishment of eco-town will rest with the local government and private sector will setup recycling industries.

12. **Benefits:** Following benefits are anticipated from this scheme:

- To promote recycling of waste in environmental friendly manner
- To promote economic activities and industrialization without putting a lot pressure on environmental resources

13. **Links to other Schemes under ISWM Plan for WND:** This schemes is linked with all the other schemes of ISWM:

- Development of Waste Inventory Cell
- Development of Local Policies on Segregation and Collection
- Development of Awareness Raising Tools for Waste Management
- Supply of Waste Bags for Segregation of Food Waste
- Upgrading of Transfer Stations for Material Recovery
- Establishment of Waste Exchange Platform
- Development of Monitoring Mechanism for ISWM



## 2.7 Setting up Industrial Waste Treatment Facility

1. **Introduction:** Industrial sector in WND generates highest amount of waste. The waste from offices and staff activities at industries, including restaurants, is diverted to municipal waste collection systems. However, that is only 82 tons/day. Waste from industrial production process is about 213,826 tons per year. Industrial waste generation rate is about 20.15 tons/year per million Yuan production output. Hazardous waste generation from industries is at the rate of about 2.45 tons/year per million Yuan production output. Industrial sector is still rapidly growing in WND and it is estimated that industrial waste will be doubled by year 2020. Under this ISWM Plan, there are various schemes to divert most of the industrial waste for material and resource recovery. However, despite of all these schemes, there will be substantial amount of waste, especially hazardous waste, available which would require proper treatment and disposal. To cope with the future scenario, WND may setup an industrial waste treatment facility.
2. **Purpose:** Industrial waste treatment facility would provide a centralized treatment at the doorstep of industrial zone to reduce the transportation and treatment costs as well as to reduce the secondary contamination during transportation and treatment of industrial waste.
3. **Target:** The scheme has been developed to achieve the following targets
  - To provide effective and efficient treatment of industrial waste, especially hazardous waste
  - To reduce the risk of industrial waste being dumped without treatment
  - To boost the business in waste treatment
4. **Type:** Project
5. **Lead Agency:** Wuxi New District (WND) Local Government in partnership with private sector
6. **Support Agency:** WND would carryout the feasibility study of setting up industrial waste treatment facility in the industrial zone through an external organization or consultant. The facility could be established in partnership with private sector.
7. **Location (suggested):** WND industrial area
8. **Budget (Estimated):** The real estimates could only be available after the feasibility study. For feasibility study, the budget estimate is about: CNY 750,000 (USD 100,000)
9. **Time Frame (Estimated):** 12 months for carrying out feasibility study and compiling the proposal for seeking approvals for establishment of Industrial Waste Treatment Facility in partnership with private sector:

Activity	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
Feasibility for Industrial Waste Treatment Facility	XXXX	XXXX	XXXX	XXXX		
Development of draft proposal for seeking approvals from relevant authorities on Industrial Waste Treatment Facility					XXXX	
Seeking approvals						XXXXXX

**10. Description:** Industrial waste treatment facility would cater the needs of industrial sector in WND. This facility will treat hazardous and non-hazardous waste from industries. Hence, the feasibility of waste treatment facility would also make a detailed assessment of the quantity and composition of industrial waste that would require proper treatment and disposal. Based on that data, a proper facility would be designed with modern technology to avoid secondary environmental contamination and to provide cost-effective treatment. Private sector may be invited to setup this facility and WND can play a role of a regulator to make sure that all the industrial waste is properly treated and interests of major stakeholders (industries, treatment service provider, and community or environment which might be affected due to secondary contamination) are well protected.

**11. Implementation:** The feasibility study would be conducted by WND through an external organization or consultant. The establishment of industrial waste treatment facility could be undertaken in partnership with private sector.

**12. Benefits:** Following benefits are anticipated from this scheme:

- All the industrial waste is properly treated and disposed in a cost effective manner
- There is no secondary contamination to affect environment and neighbourhoods
- New business of waste treatment is established to boost economic activities

**13. Links to other Schemes under ISWM Plan for WND:** This schemes is linked with all the other schemes of ISWM:

- Development of Waste Inventory Cell
- Establishment of Waste Exchange Platform
- Development of Monitoring Mechanism for ISWM

## 2.8 Development of Monitoring Mechanism for ISWM

1. **Introduction:** Integrated solid waste management (ISWM) system is dynamic. ISWM could be responsive to the changes in waste streams (quantities and composition), changes in the stakeholders' concerns and changes in the targets which are set for ISWM. The improvements in ISWM could also be done based on the outcome of the policy, technological and voluntary measures. Therefore, there it is crucial to monitor solid waste generation, which would be undertaken under Scheme 1.1, and to monitor the implementation and outcomes/impacts of the policy, technological and voluntary measures. This monitoring and feedback could help to bring continuous improvements in ISWM, so that targets could be achieved in most efficient and effective way.
2. **Purpose:** Monitoring of the implementation of various measures under ISWM and their outcomes/impacts to bring improvements in ISWM.
3. **Target:** To establish a monitoring system
4. **Type:** Institutional mechanism
5. **Lead Agency:** WND
6. **Support Agency:** Initially an external organization may be hired to make a detailed plan for monitoring and feedback system
7. **Location (suggested):** WND
8. **Budget (Estimated):** CNY 150,000 (USD 20,000)
9. **Time Frame (Estimated):** Continuous activity – reporting/feedback every year
10. **Description:** Monitoring and feedback mechanism is an institutional arrangement and WND may constitute a team of senior managers of the relevant departments. Representatives of stakeholders may also be part of this arrangement. They monitor the implementation of ISWM through their departments. They could meet may be once in 3 months to discuss the progress and towards end of the year may compile the report with feedback (recommendations) for bringing the improvements in ISWM.
11. **Implementation:** WND with the help of stakeholders
12. **Benefits:** Following benefits are anticipated from this scheme:
  - To bring continuous improvements in ISWM so it can cope with changing waste generation patterns and with new priorities
  - To build confidence of stakeholders including service providers, waste generators and community and to apprise them of the difficulties or successes
13. **Links to other Schemes under ISWM Plan for WND:** This scheme is linked with all of the other schemes of ISWM:
  - Establishment of Waste Inventory Cell

- Development of Local Policies on Segregation and Collection
- Development of Awareness Raising Tools for Waste Management
- Supply of Waste Bags for Segregation of Food Waste
- Construction/Provision of Collection Points
- Development of Primary Collection Systems
- Procurement of Collection Vehicles – Secondary Collection
- Development of Operational Plan for Collection and Transportation
- Upgrading of Transfer Stations for Material Recovery
- Development of Biogas Plant
- Upgrading Incineration Plant with Resource Recovery
- Upgrading Sanitary Landfill with Landfill Gas Utilization