Solid Waste Collection, Treatment Decommissioning Waste Management Facilities

Travis Chien, SVP ASIA
Sept 18 2013
E: travis.chien@aecom.com

AECOM

China

China is now **no. 1** in CO_2 emissions; U.S in the second position

China sets to produce **TWICE** as much waste as U.S. by 2030

1.3 B+
Population

70 B per year
Carbon Emissions

220 M+ per year
Solid Waste Volume

Growing Population in Cities

Percentage of urban population in Southeast Asia growth from 2010 to 2025.

Increased Affluence

2X

The amount of solid waste produced per capita in urban area compared to rural area

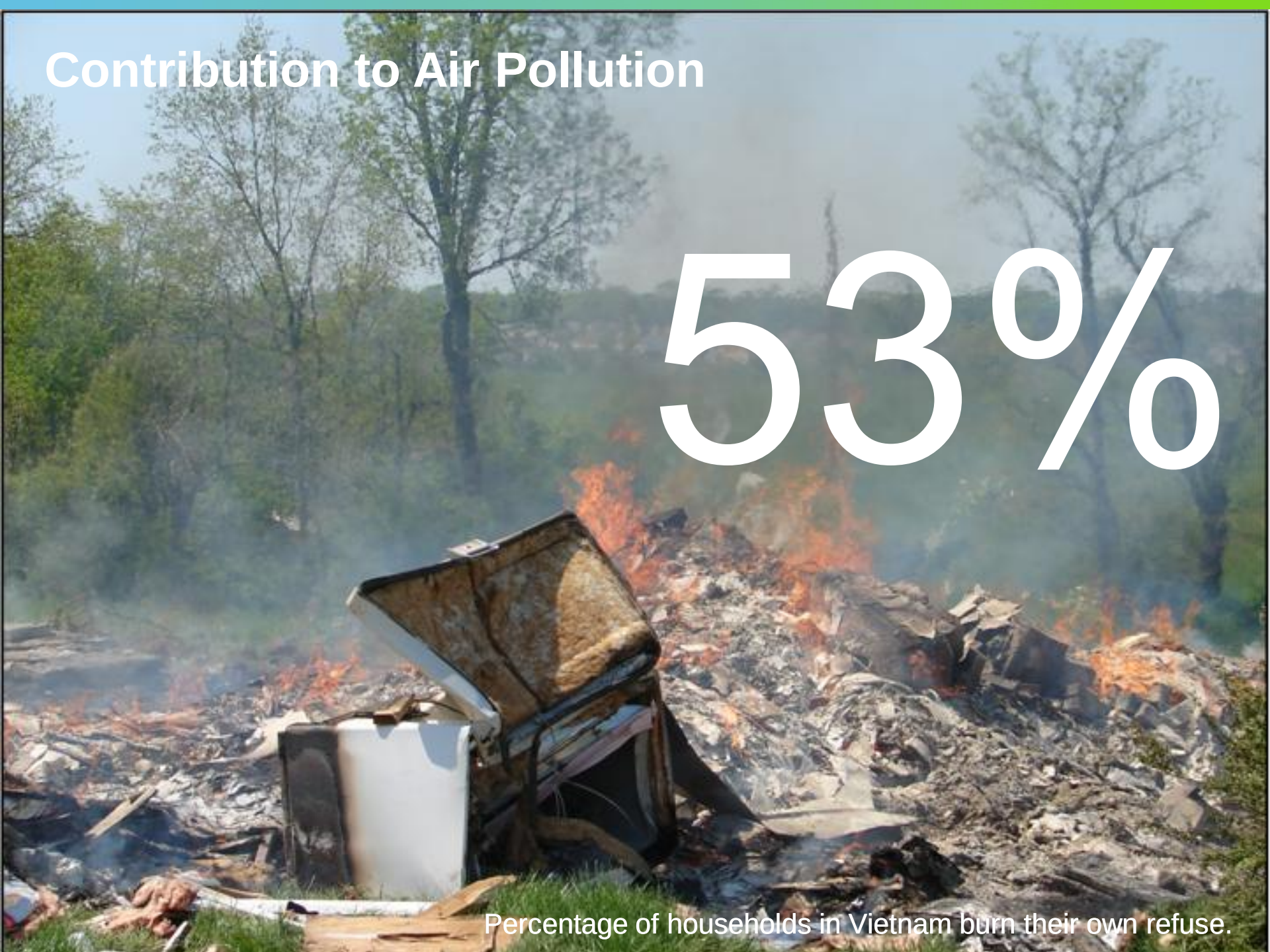
Growing Waste Production

5

Number of Empire State Buildings by weight of urban MSW produced each day in Asia, by 2025.

Unsanitary Waste Disposal

Contribution to Air Pollution

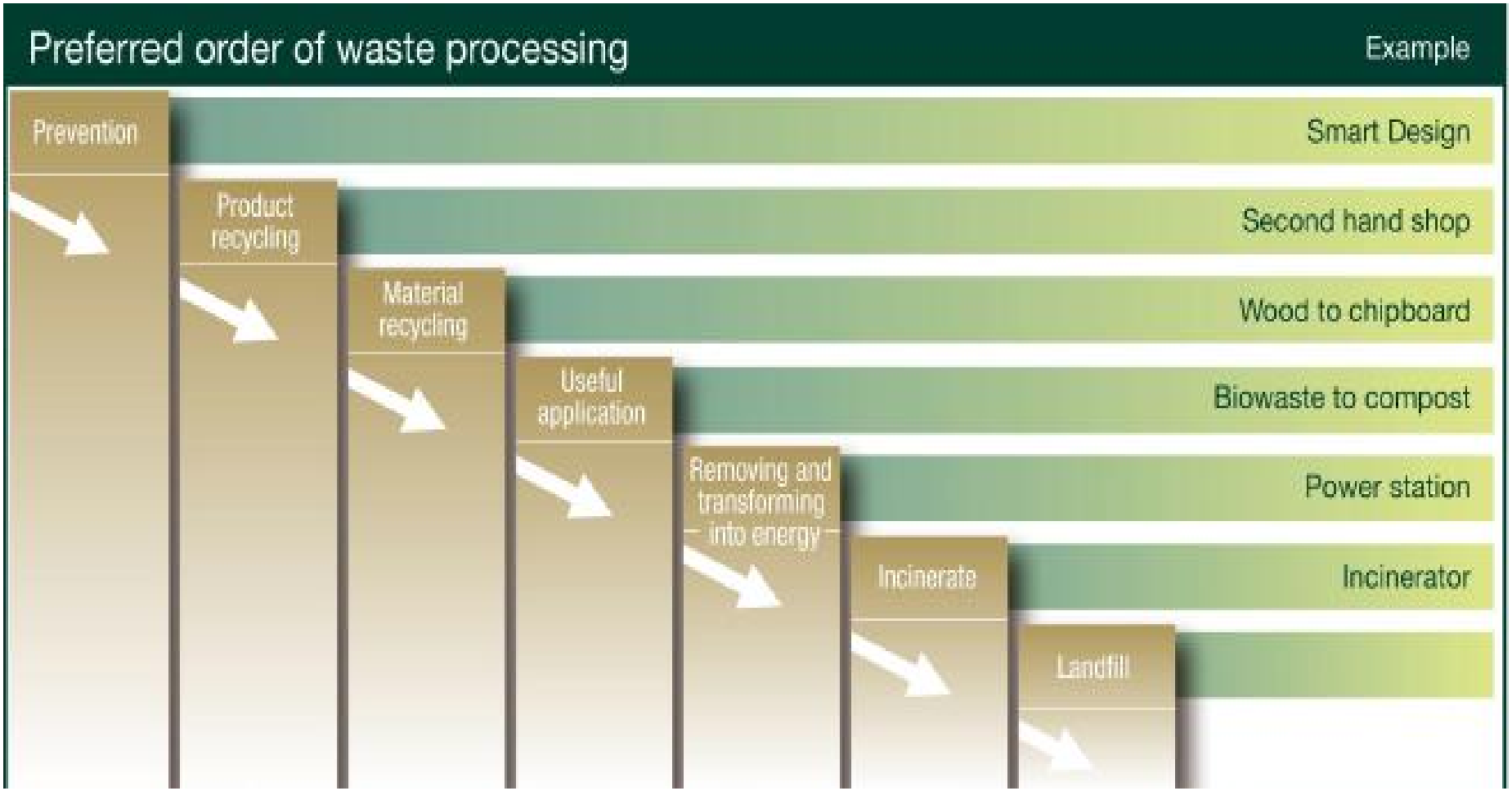


Contribution to Groundwater Pollution

Radius of Dong Thanh, second largest dump site near Ho Chi Minh City (now closed), within which groundwater is unsafe for potable use.

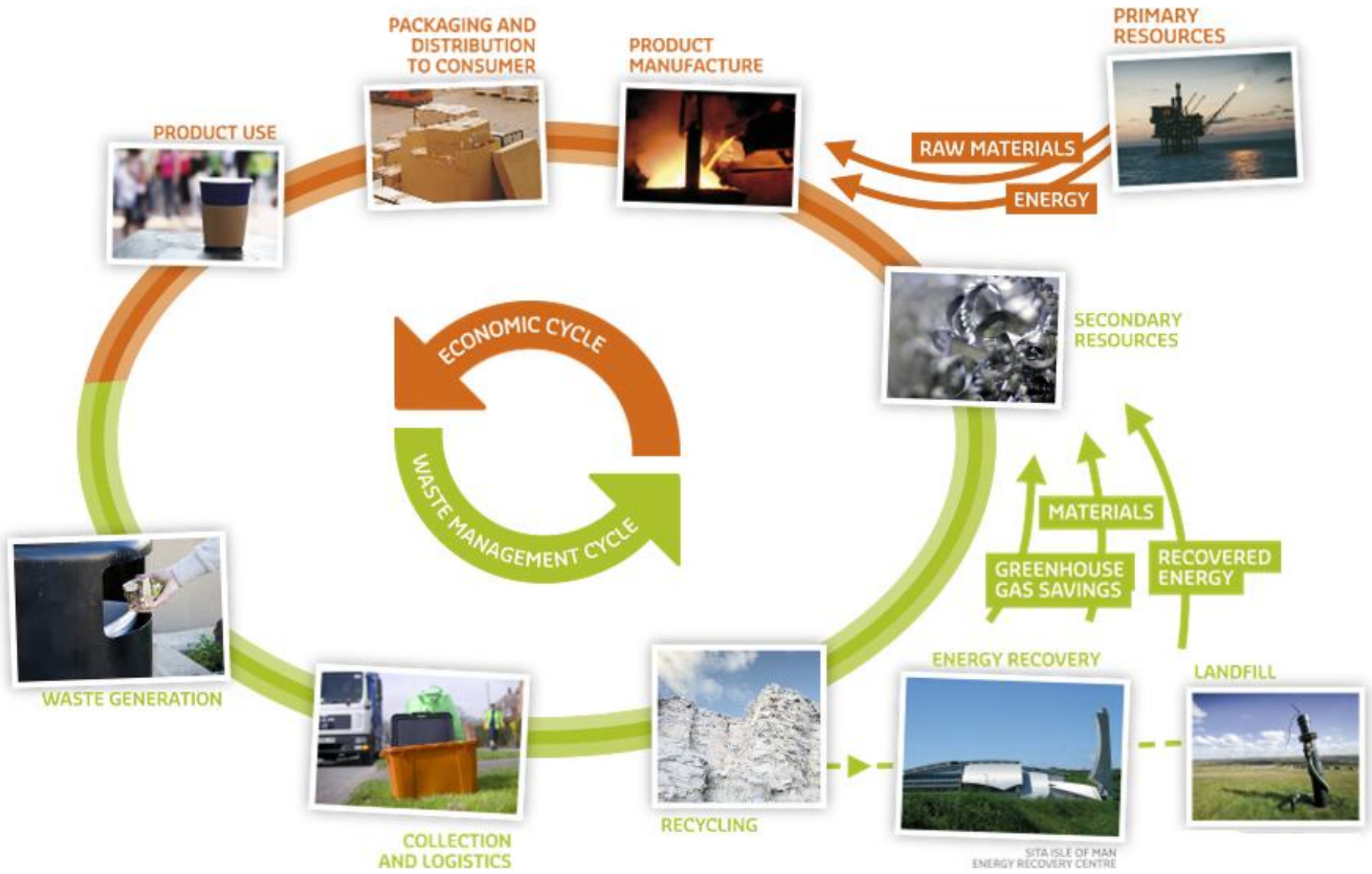
Call for Investment

SW Management Philosophy



Integrated Solid Waste Management

AECOM



- All encompassing waste

Typical MSW Characteristics – Asian Cities

AECOM

MSW Characteristics	Less-developed Cities (Less than 2,000)	Rapidly Developing Cities (2,000-15,000)	Developed Cities (16,000-30,000)
MSW generation (kg/capita/day)	0.3-0.7	0.5-1.5	>1.0
MSW collection rate	<70%	80-95%	95-100%
Recycling	Informal	Formal and informal	Formal
Expenditure from Municipal budget (%)	15-40	5-25	1-5

Source : Municipal Waste Management Report – Status-Quo and Issues in Southeast and East Asian Countries – AIT/UNEP

Problems & Challenges

AECOM

Municipal Waste Generation & Composition

- Rapid increase in volume of municipal waste
- Emergence of a variety of municipal waste
- Increase in difficulty of processing of emerging type of municipal waste
- Shortage of landfill space
- Increase in municipal waste management cost
- Lack of basic data and information e.g. statistics of waste generation and composition

Policies, Regulations & Institutional

- Lack of and/or unclear policy on WM
- Weak enforcement of existing laws and regulations
- Lack of policy to promote 3R
- Inadequate planning
- Inadequate proactive action
- Ineffective regulations
- Lack of good governance

Problems & Challenges

Suasive measures (Education, Promotion of 3Rs through awareness campaign & raising)

- Lack of awareness to promote 3Rs
- Lack of awareness on health risks of the informal sector
- Lack of participation and coordination among stakeholders e.g. inter-agency collaboration at national/local level

Economic measures

- Revenue in the collection of MSW is very low and lax, so that it cannot cope with the SWM expenditures
- Penalties are not strictly enforced

Technological Aspects

- Unsuitable technology
- Limited resources including finance and expertise to manage technology

Partnerships

- Limited linkages with and among WM stakeholders

MSW in Hong Kong

Hong Kong

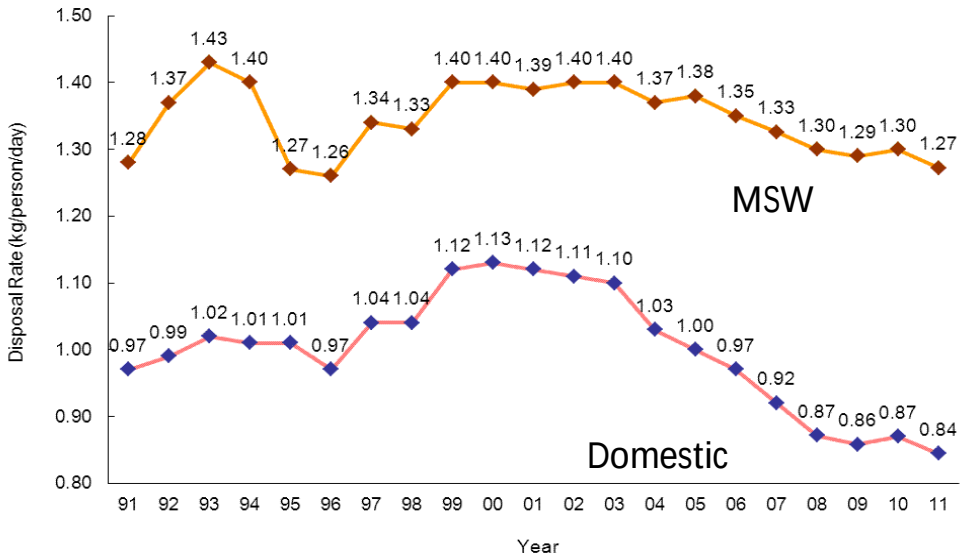
Land Area 1,104 km^2

7,000,000 population

6,544 residents/km^2

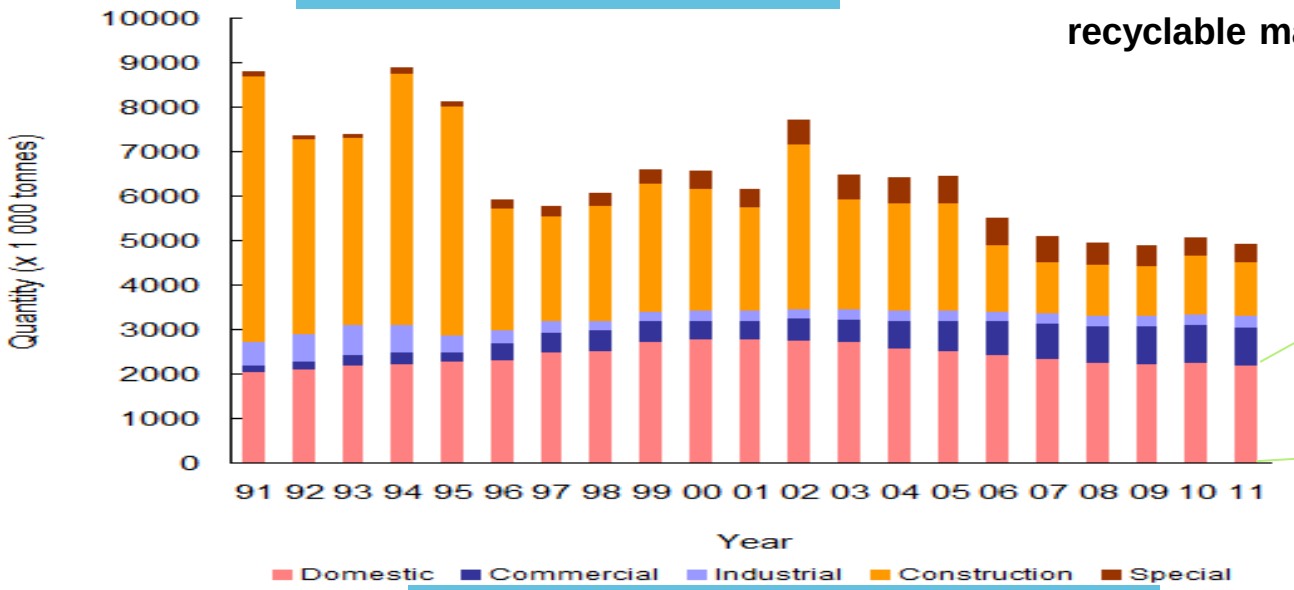
GDP per capita $34,049

Waste Generation & Composition

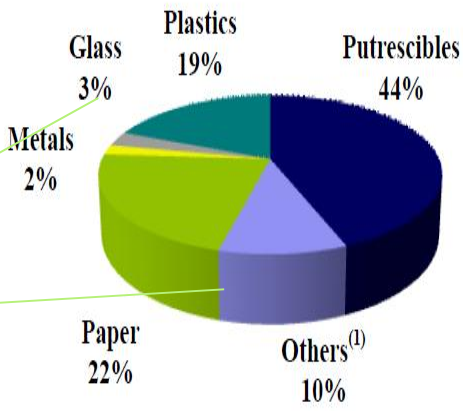


Waste Generation

- **0.84 kg/c/d**
- **landfill originate mostly from domestic source**
- **Large portion of MSW originate from food waste**
- **High moisture content**
- **High organics content**
- **MSW contains significant amounts of recyclable material such as paper**



Waste to Landfill Composition

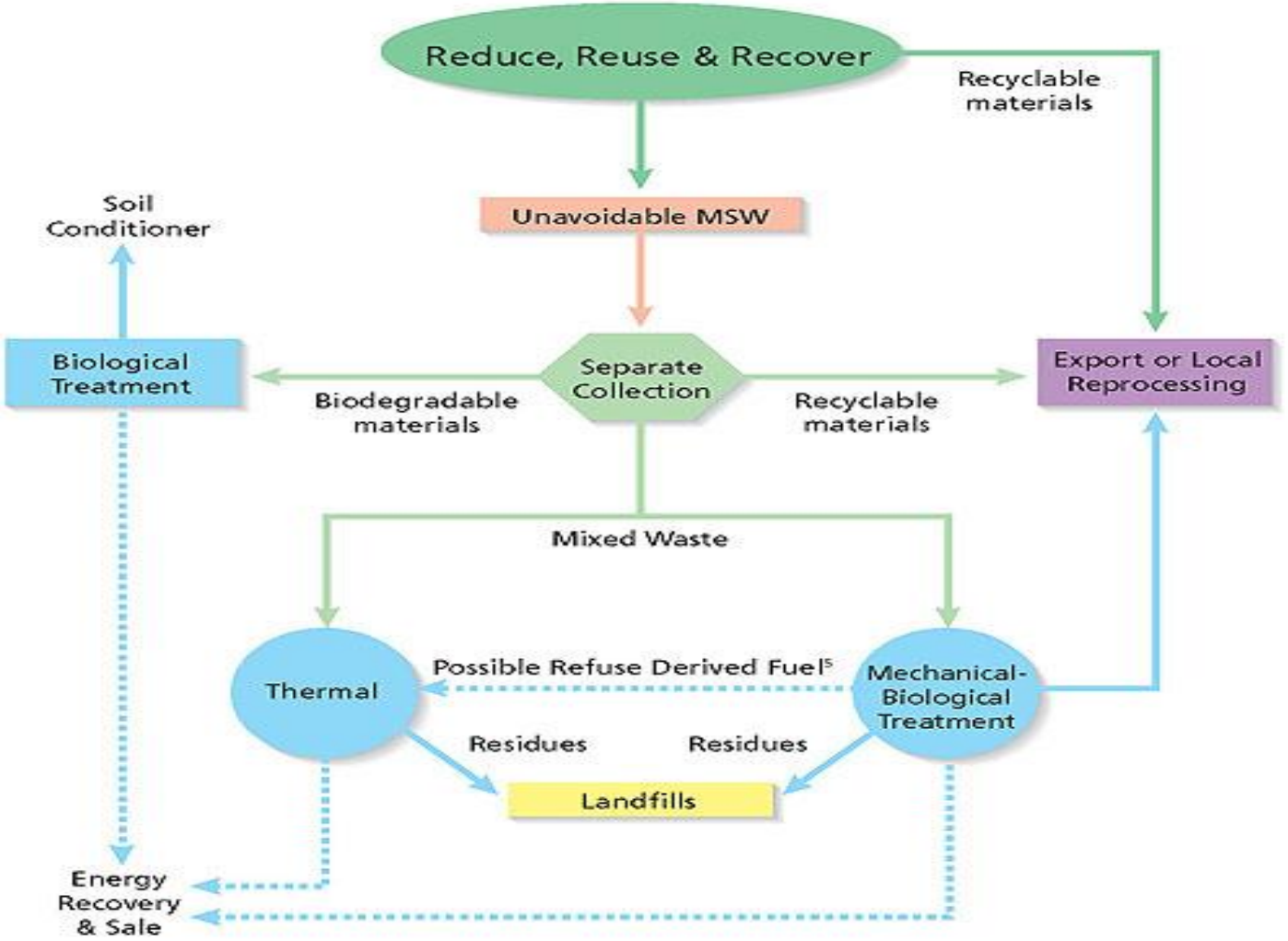


MSW Composition

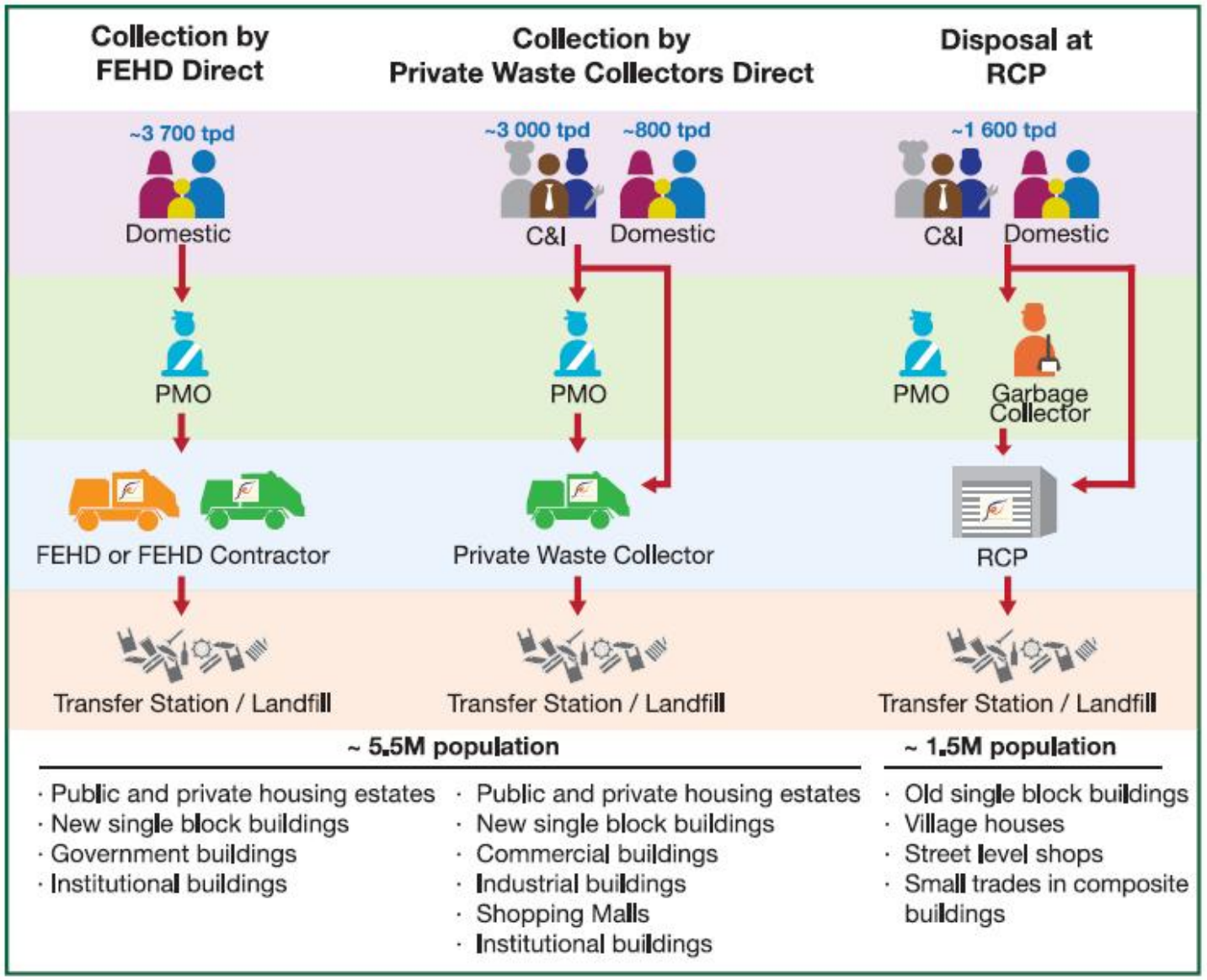
Vision for Future

AECOM

Include 3Rs as part of integrated management	Incineration will be an integral component in waste treatment	Aims to reduce reliance on landfill as primary treatment



Current MSW Collection



Domestic Refuse Collection Operation

Refuse Collected at source

Refuse Transported via Truck to RCP

Refuse Collection Point

Direct Disposal to Landfill

Refuse transported via Truck to RTS

Refuse disposed at Landfill

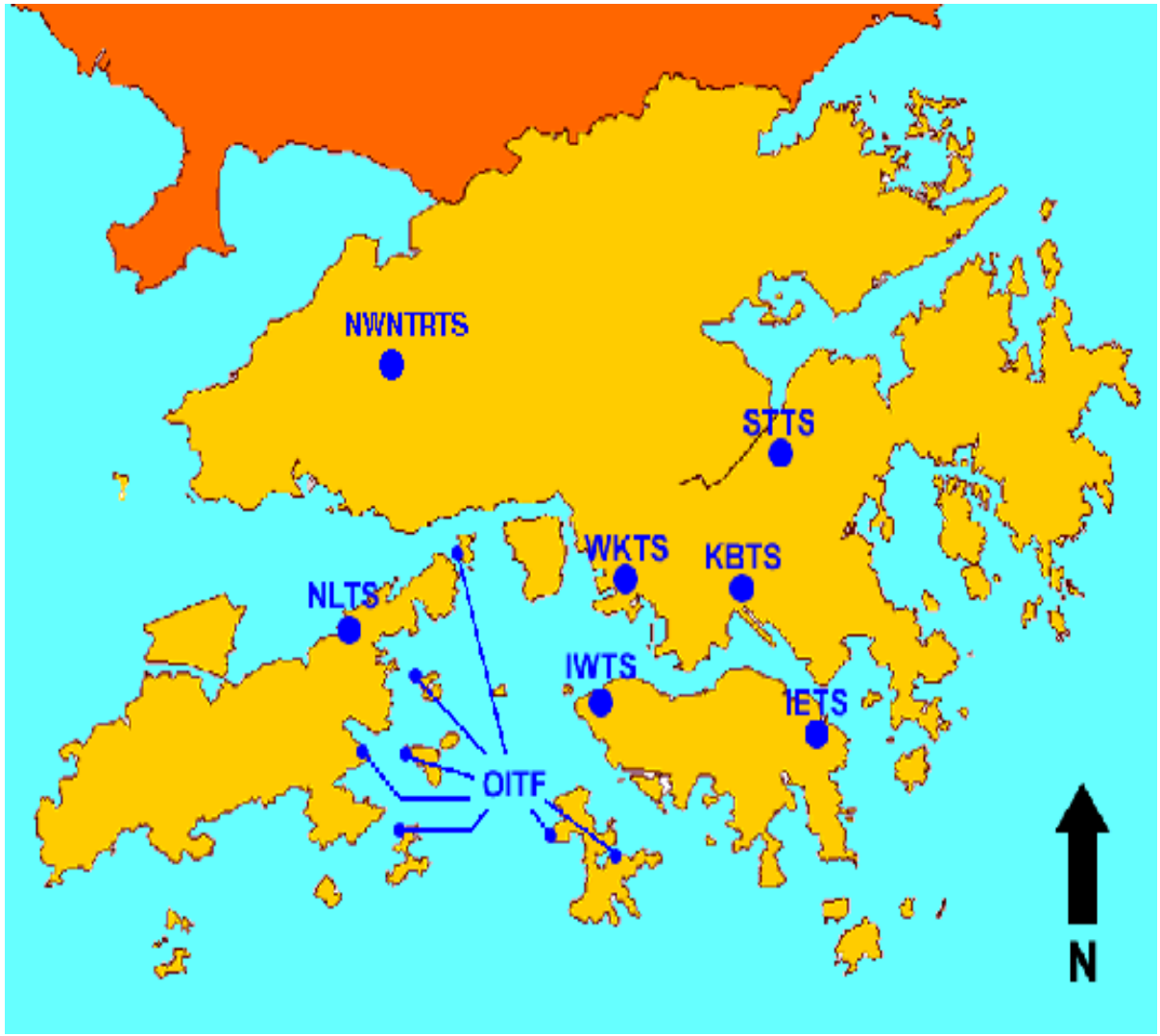
Refuse transported via Truck to landfill

Refuse Transfer Station

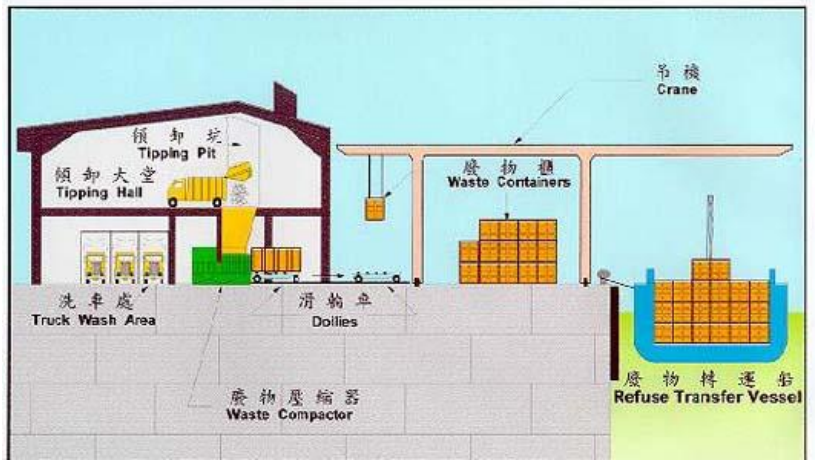
Refuse Transfer Stations (RTS)

Fact Sheet

- **Largest Station Throughput**
  - 2500 TPD
- **Operation Hours**
  - 04:30 to 23:30
- **Largest Capital Cost**
  - 735 MHKD
- **Major Station Equipments**
  - Container Vessels,
  - Gantry Cranes,
  - Compactors,
  - Landfill Tractors,
  - Container Handling Units,
  - Road Sweeper,
  - Bucket Loader,
  - Containers

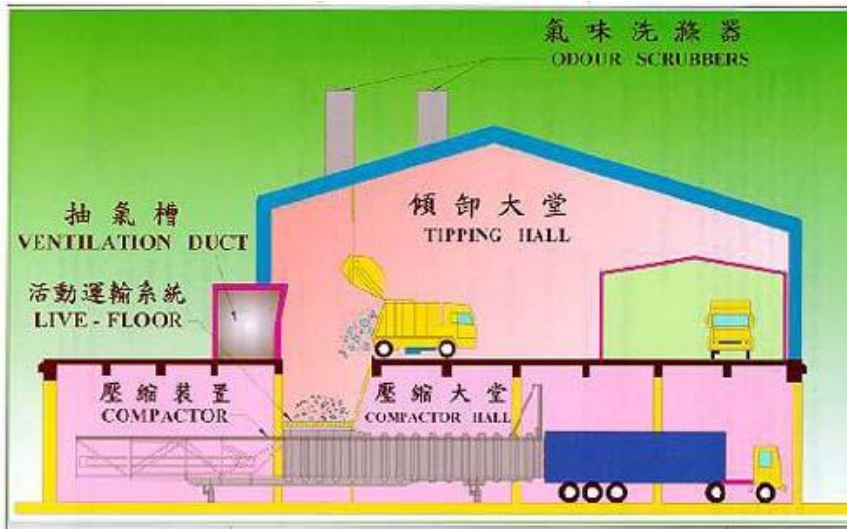


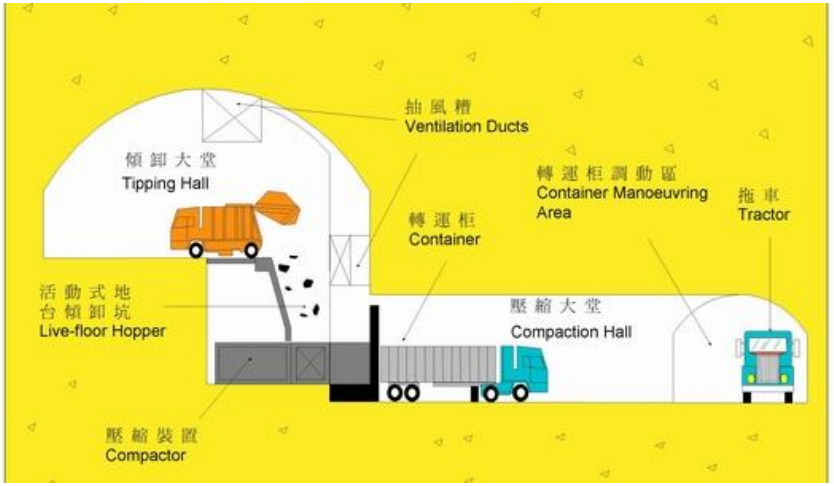
Barge RTS


吊機
Crane
傾卸坑
Tipping Pit
傾卸大堂
Tipping Hall
廢物櫃
Waste Containers
洗車處
Truck Wash Area
滑躺車
Dollies
廢物壓縮器
Waste Compactor
廢物轉運船
Refuse Transfer Vessel


807

Truck & Cavern RTS





Typical Refuse Transfer Station Operation

AECOM

Inbound

Inbound weighbridge

Life Floor Hopper

Weight Record

Vehicle Cleansing

Outbound

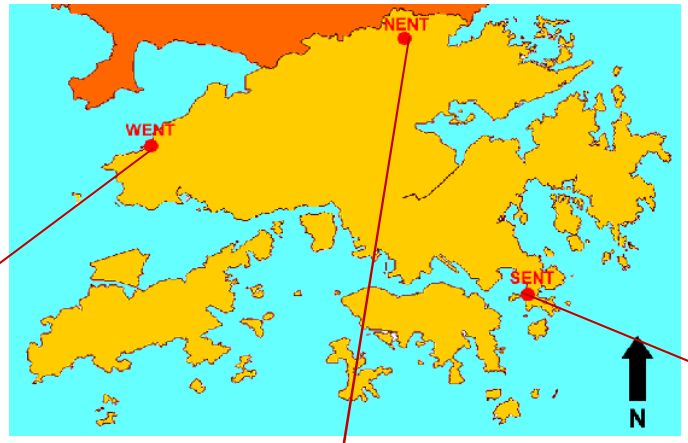
Inbound weighbridge

Refuse Compacting & Loading

Weight Recording

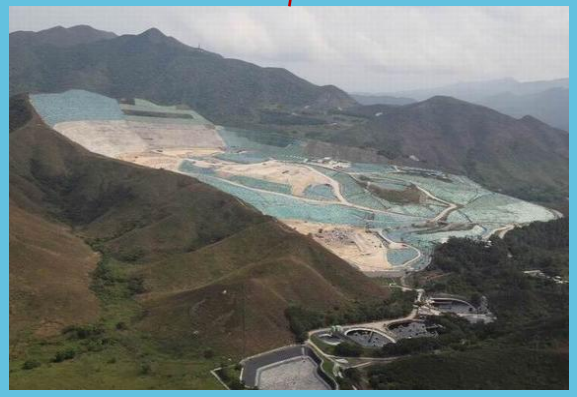
Vehicle Cleansed Prior to Departure

Active Landfills



West New Territories (WENT)

- 110 ha
- 61 Mm³
- 6400 TPD
- MSW & Const. W
- OL - 2019



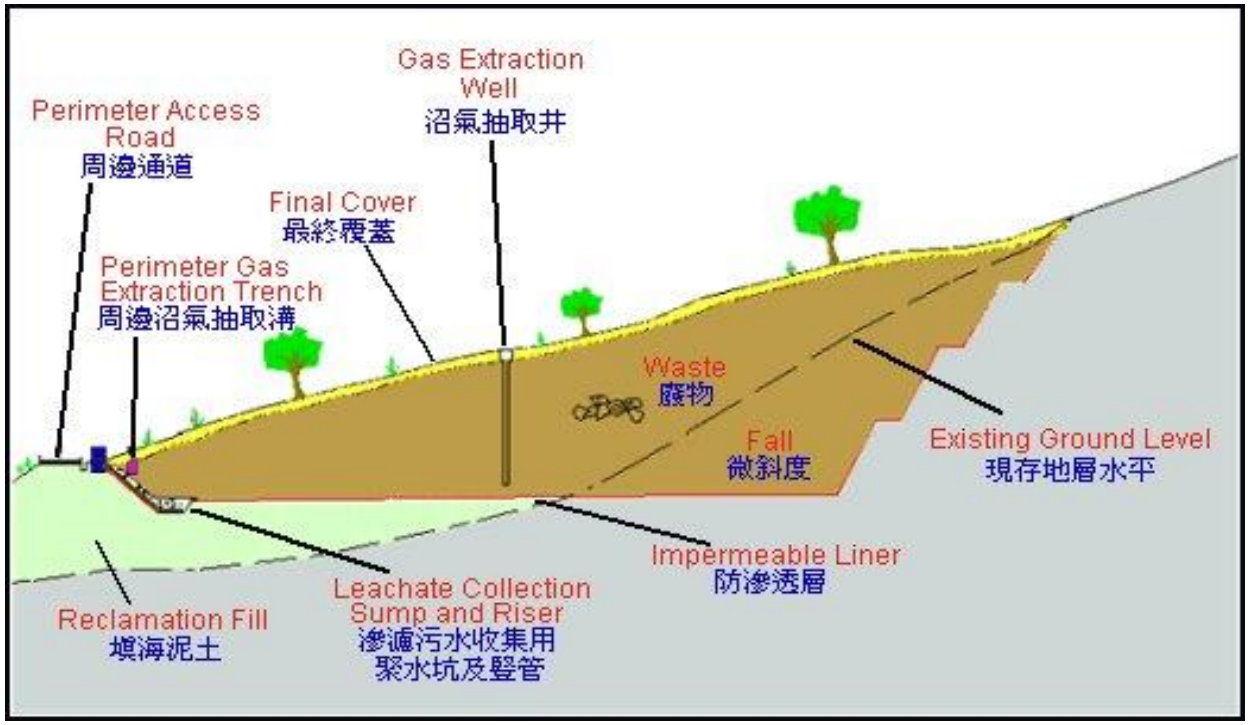
North New Territories (NENT)

- 61 ha
- 35 Mm³
- 2700 TPD
- MSW, Const. & Special W
- OL - 2017

South East New Territories (SENT)

- 100 ha.
- 43 Mm³
- 4800 TPD
- MSW, Const. & Special W.
- OL -2015

Typical Hong Kong Landfill Design



- Impenetrable base lining
- Leachate collected & treatment
- Gas contained & utilized
- 30 Yr design consideration
- Final capping during decommissioning
- Restored land utilized for future government projects

Typical Hong Kong Landfill Operation

Inbound Weight Recorded at Weighbridge

Refuse Disposed at Landfill

Outbound Weight Recorded at Weighbridge

Vehicle Cleansed Prior to Departure

Landfill Leachate Treatment Plant

Leachate :

- MSW moisture
- Rainfall

Leachate Collected by lining at base of landfill

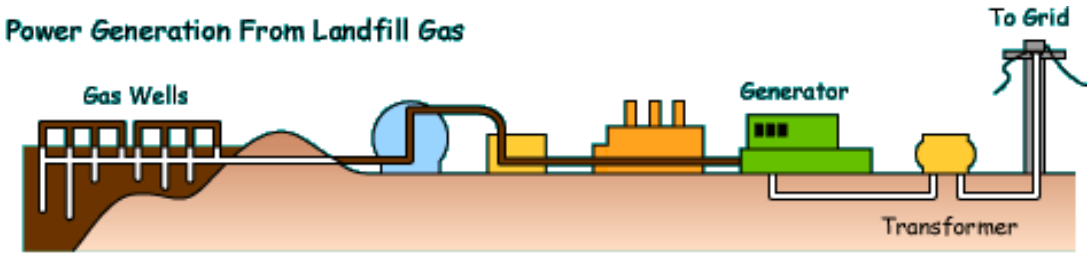
Leachate Treatment

- Leachate lagoons
- Ammonia stripping for nitrogen removal

Can generate landfill gas for further utilization

Landfill Gas Treatment and Utilization

- Landfill gas generated by decomposition of organics in refuse
- Landfill gas contains methane which allows utilization for heat and power generation
- Heat generated provides for leachate treatment process
- Additional gas can be utilized for power generation
- Gas generated power utilized for treatment facility or fed to local power grid
- Largest landfill gas production – 7300 m3/hr per site



Landfill Environment Monitoring

Marine Water Monitoring

Ground Water Monitoring

Noise Monitoring

Dust Monitoring

Illegal Landfill/ Fly Tipping

Waste Quantity	Number of Sites	
	As at 1.4.98	As at 30.6.98
< 5 m3	54	43
5 - 50 m3	64	68
> 50 m3	36	35
Total	154	146

Distribution of Flytipping Black Spots by Size

	April	May	June	Total	1997 Total
No. of inspections	498	505	522	1525	5918
No. of ambushes	12	12	40	64	64
Staff-hour spent on ambush	150	158	176	484	1072
No. of surveillance visits	493	499	526	1518	5886
No. of prosecution cases	9	9	24	42	49
No. of referrals to other dept.	2	4	6	12	16

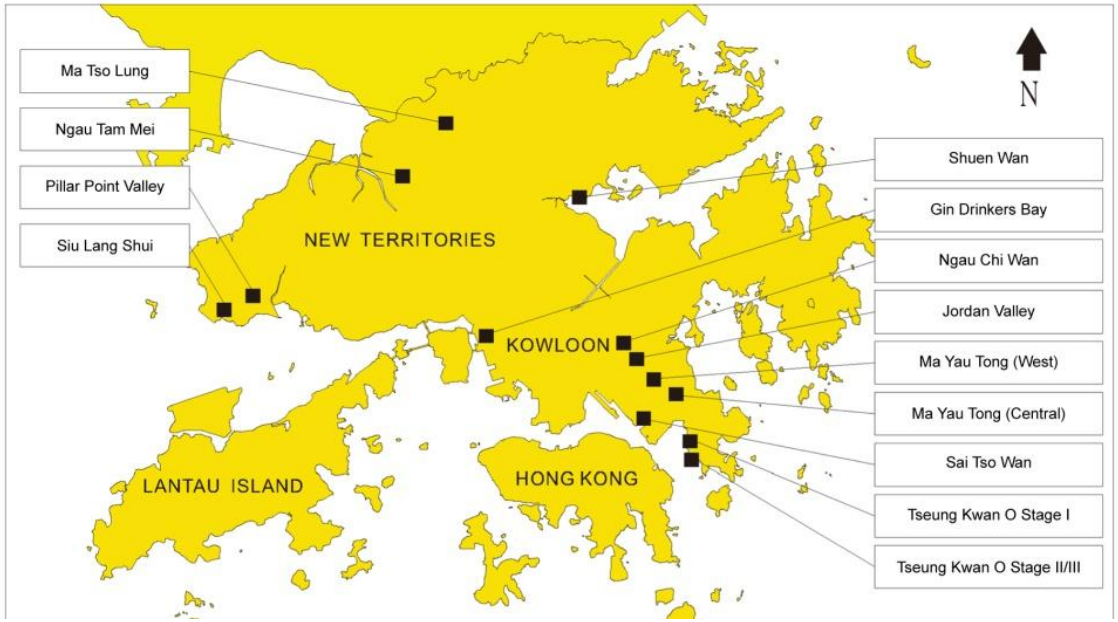
Enforcement Statistics of RSD during 1.4.98 to 30.6.98

Illegal Landfill/ Fly Tipping

Authority	Maximum Penalty	Evidence Required
EPD	$200,000 and 6 months imprisonment for 1st offence; $500,000 and 6 months imprisonment for 2nd or subsequent offence; and $10,000 per day for continuous offence.	1. Particulars of offender 2. Offence location 3. Land Owners' will 4. Other supporting evidence like vehicle registration number, photos, etc.
USD/RSD	Level 4 fine ($25,000) and 6 months imprisonment Level 4 fine ($25,000) and 6 months imprisonment	1. Vehicle registration number or particulars of offender 2. Others are preferred but not mandatory (e.g. Completed spotter form)
Police	$500 and 3 months imprisonment	1. Vehicle registration number or particulars of offender 2. Others are preferred but not mandatory

Existing Legislative Provisions for Flytipping Control

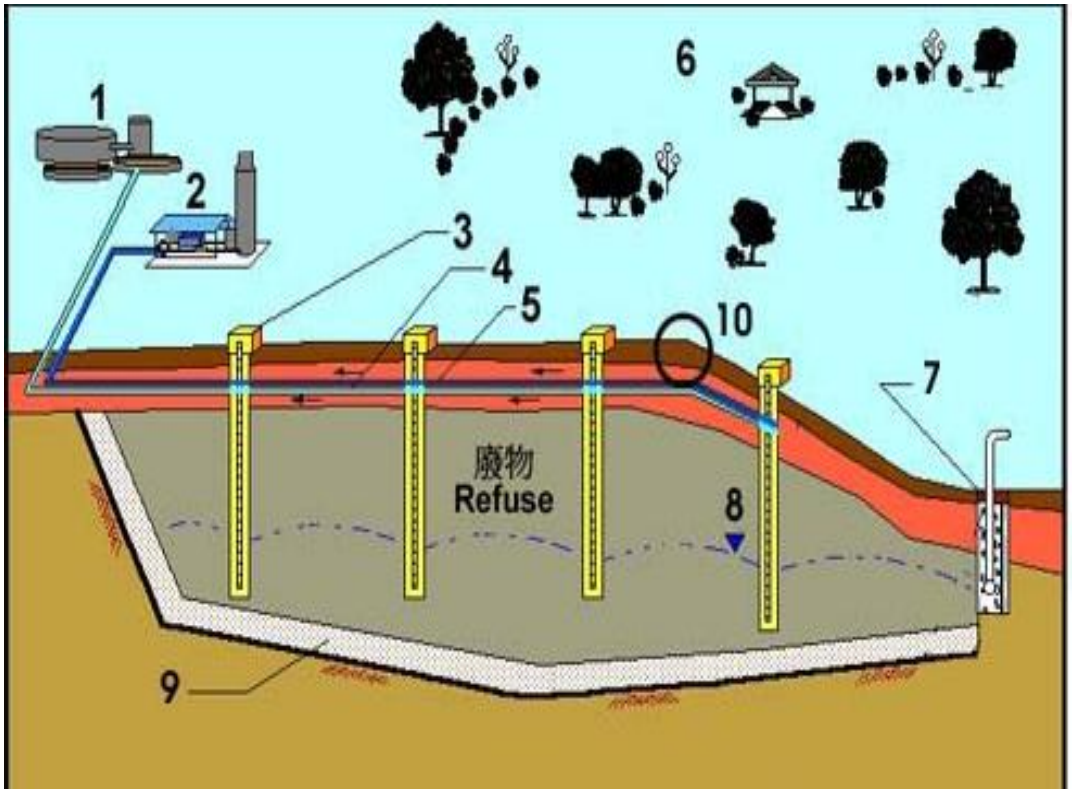
Hong Kong Landfill Decommissioning



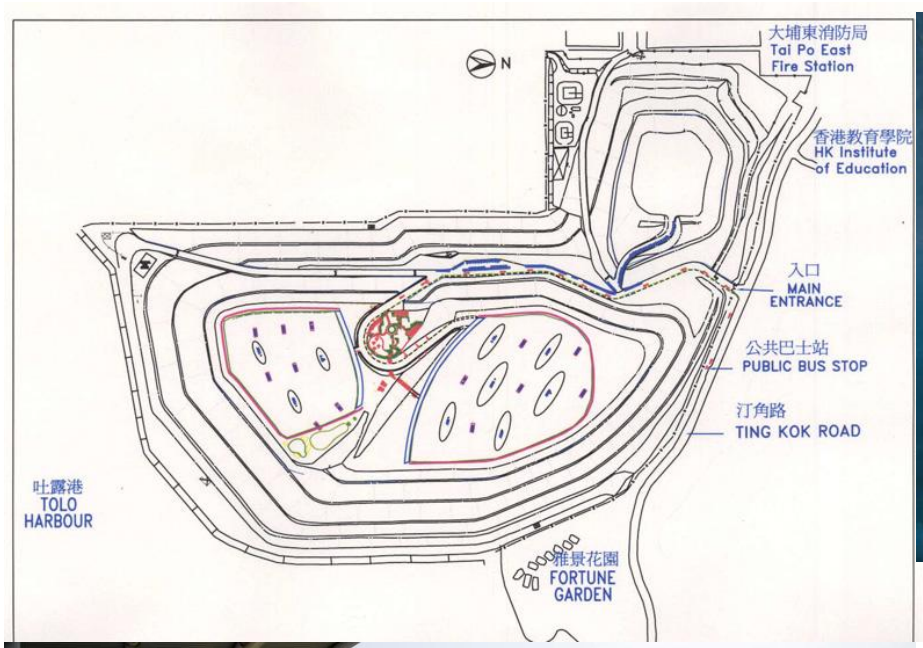
- 13 Closed Landfills currently in Hong Kong
- Restored landfills will be suitable for future use (eg. Parks, Golf Courses, etc.)
- Oldest landfill decommissioned in 1975
- Largest restored land from landfills at 68 ha

Hong Kong Landfill Decommissioning

1.	Leachate Treatment Plant
2.	Landfill Gas Flaring / Utilization Plant
3.	Leachate / Gas Extraction
4.	Leachate Header
5.	Gas Header
6.	Recreational or Other Beneficial Use
7.	Gas Venting Trench
8.	Leachate Level
9.	Drainage Layer
10.	Capping System



Sheung Wan Golf Course



- 145-bay golf driving range
- Opened for use by the public since April 1999.
- First landfill in Hong Kong to be opened for public use
- 55 ha. landfill
- 15 million tonnes waste received
- Landfill decommissioned in 1995

Hong Kong Jockey Club International BMX Park at Gin Drinkers Bay Landfill

- Hong Kong's first BMX Park
- Opened for use by the public since October 2009
- 29 ha landfill
- 3.5 million tonnes received waste
- Landfill decommissioned in 1979
- Currently hosts multiple international competition and events

Ngau Chi Wan Park

- Recreation Park
- Opened for use by the public since September 2010
- 8 ha. landfill
- 0.7 million tonnes waste received
- Landfill decommissioned in 1977

Basketball Ground

Spring Fountain

Jogging Track

Maze Garden

Playground

Sai Tso Wan Recreation Ground

- Large Sports Ground Facility
- Opened for use by the public since April 2004
- 9 ha. Landfill
- 1.6 million tonnes waste received
- Landfill decommissioned in 1980

Animal Waste Composting Plant (AWCP)

Horse stables in Hong Kong produce significant quantity of waste daily

Deodourisation of compost produced gases

Pre-treatment process for feedstock preparation

Rotary in-vessel composter where bio-degradation takes place

- Originally commissioned for 2008 China Olympics
- Treats 20 TPD horse stable waste
- Waste undergoes pre-treatment to remove metals and plastics
- Subsequently waste is treated in fully enclosed in-vessel composter with deodourisation treatment
- Mixture then undergoes ~50 days of fermentation process
- Matured compost sold as soil conditioner

Solid Waste Collection System


人民路办事处
垃圾中转
女

MSW Collection System Process

Urban & Pedestrian Refuse

Residential/ Commercial Refuse

SW in Incineration plant area

Roadside bin

MSW collection bins

MSW collection bins

Manual (less than 0.4 km within the transfer station)

2t small SW transfer vehicle （More than 0.4km from the transfer station）

MSW Transfer station

Refuse Transfer Vehicle

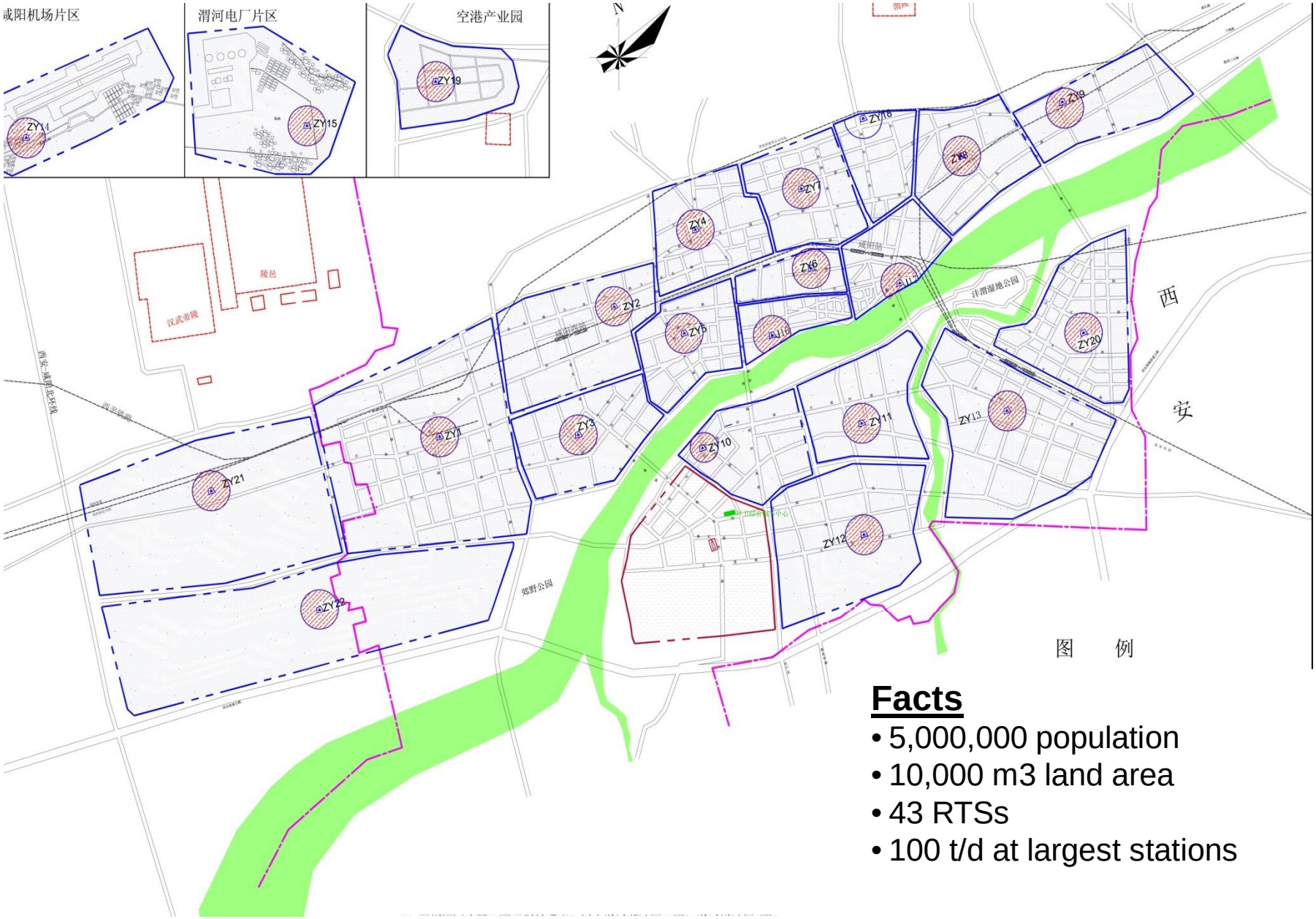
Back-compactor refuse transfer vehicle

Incineration Plant

MSW Transfer Station - Considerations

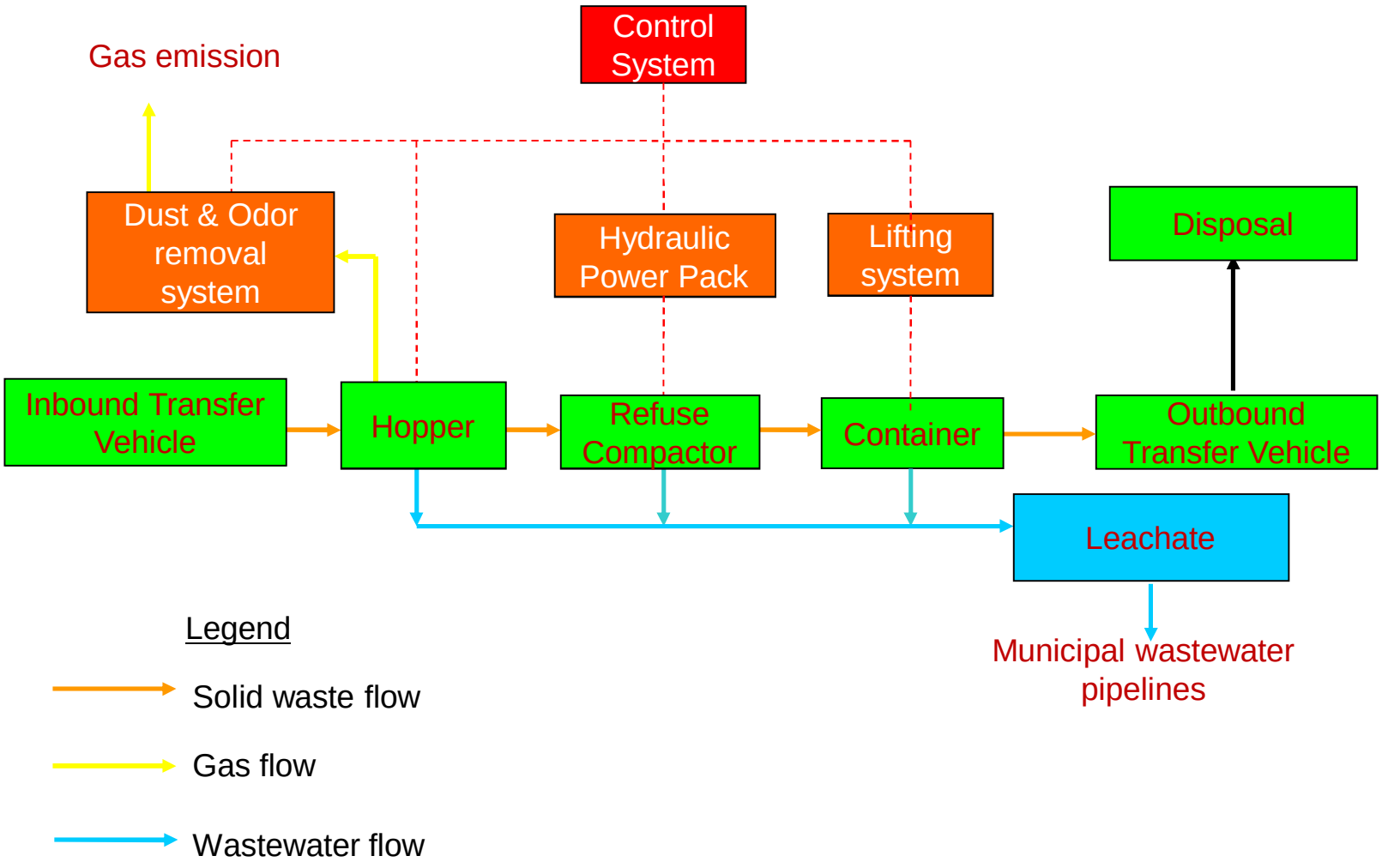
- **50,000 residents/5km2 pre RTS**
- **2km service radius**
- **Will require more for densely populated/ traffic congested area**
- **Ensure**
  - Convenience
  - Reasonable radius /energy efficient
  - Low environmental impact (Noise, air, visual)

Xianyang Districts



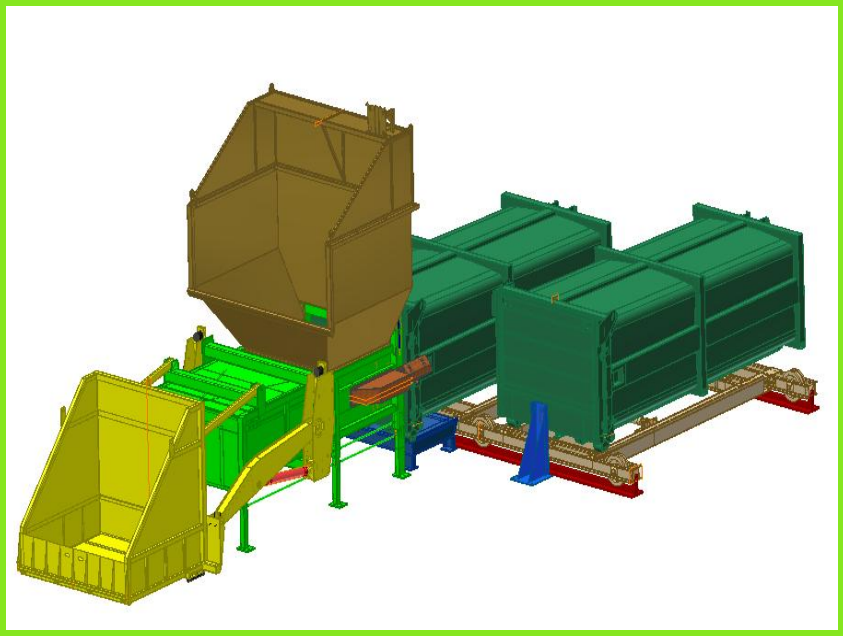
Facts

- 5,000,000 population
- 10,000 m3 land area
- 43 RTSs
- 100 t/d at largest stations


Gas emission
Control System
Dust & Odor removal system
Hydraulic Power Pack
Lifting system
Disposal
Inbound Transfer Vehicle
Hopper
Refuse Compactor
Container
Outbound Transfer Vehicle
Leachate
Municipal wastewater pipelines
Legend
Solid waste flow
Gas flow
Wastewater flow

- **Service Within radius of 0.4km**
  - by manual to transfer station;
- **Service within a radius of more than 0.4km,**
  - by small motor vehicles to the transfer station;
- **MSW in the incinerators plant area**
  - transferred by back-compression trucks
  - directly transported into the incineration plant.
- **City MSW collection system**
  - 81 small collection vehicle (2t),
  - 1 back-compression transfer vehicle (9T).

RTS Equipment



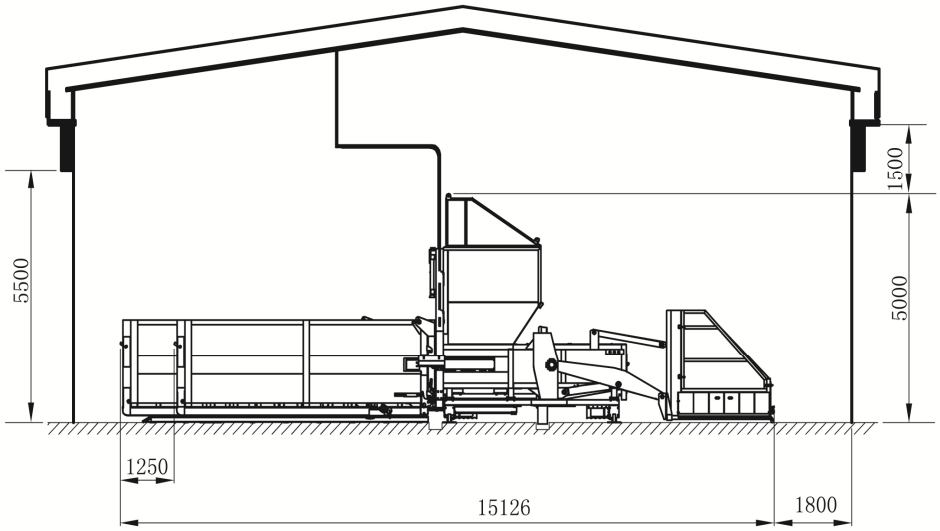
Enclosed MSW Container

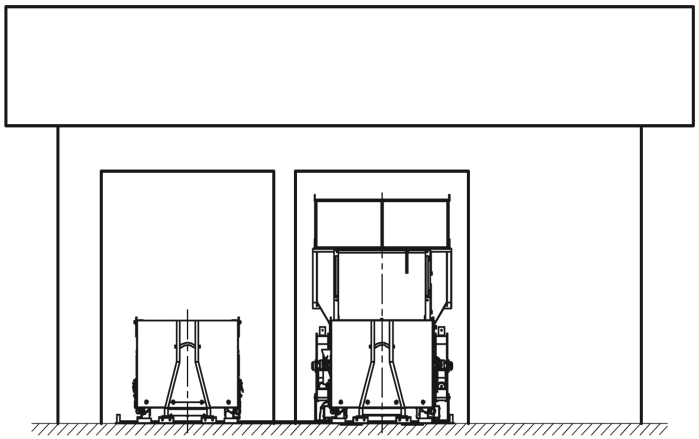
- 12 tonne hook type container
- No container lifting crane required
- Odour free
- leachate storage
- Safe transfer between sites
- Space saving

Front-Loaded Compactor

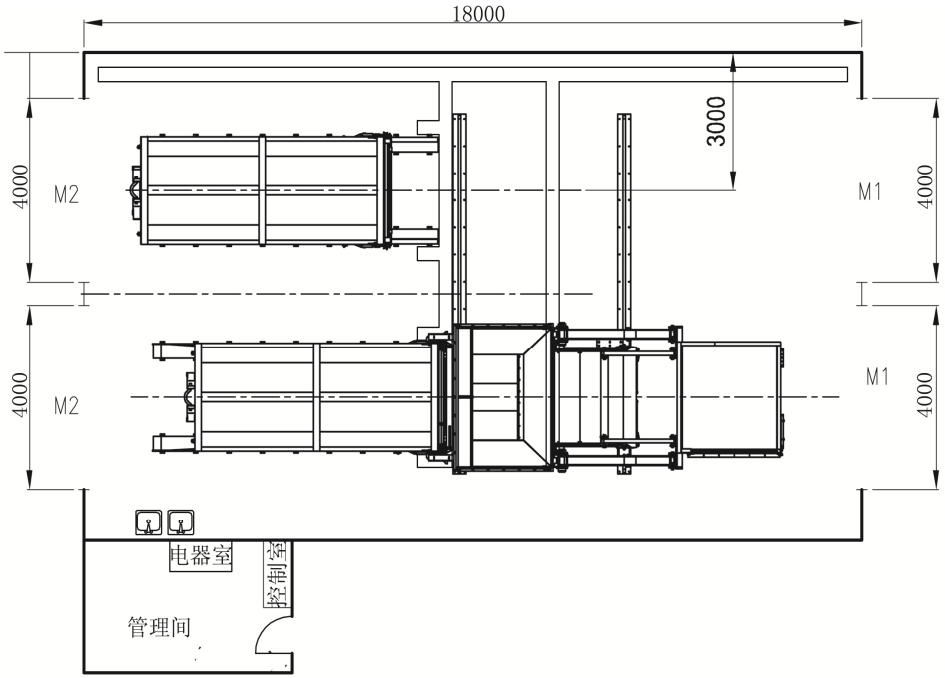
- Fully Automated
- Compact design
- Suitable for enclosed MSW containers

RTS Layout

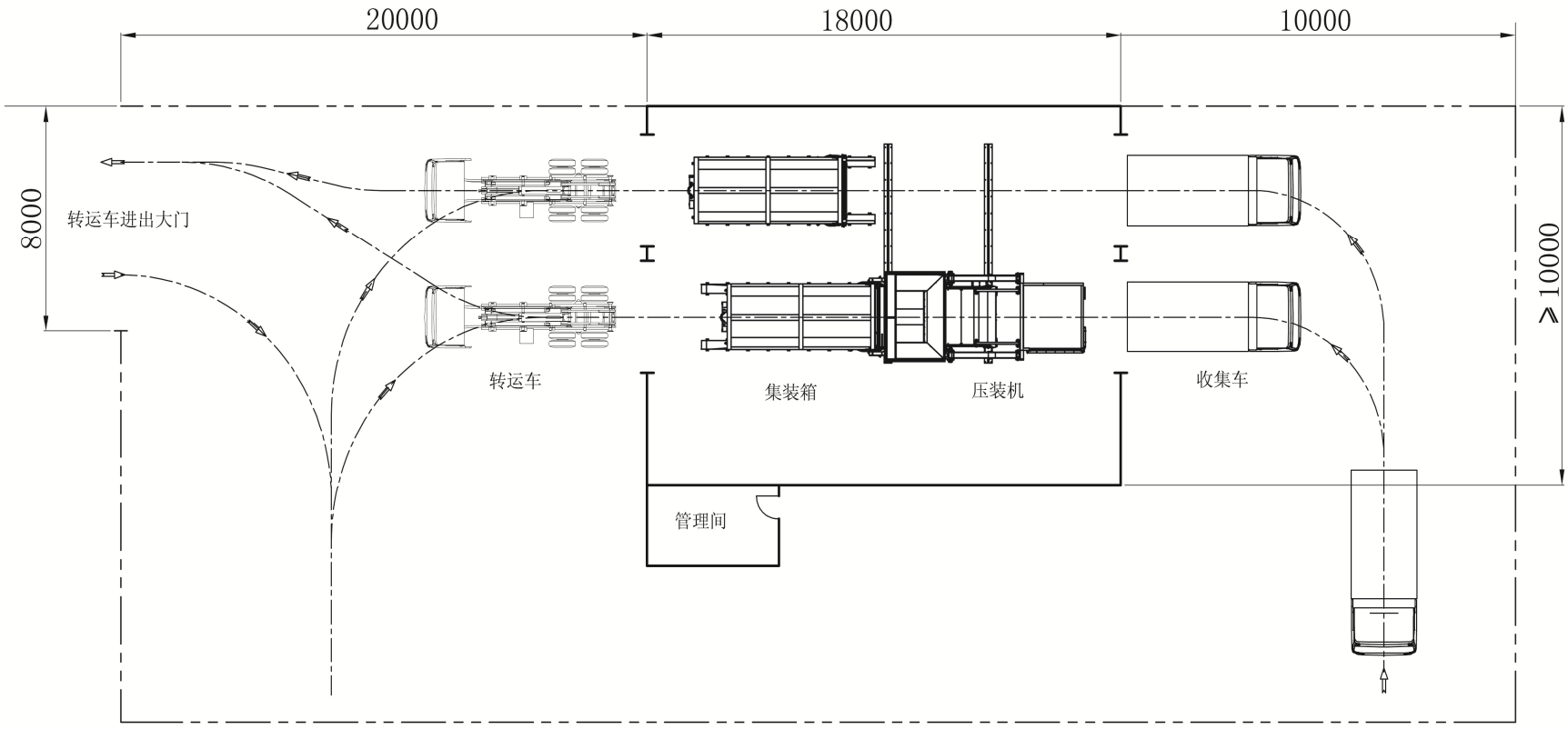




立面示意图2



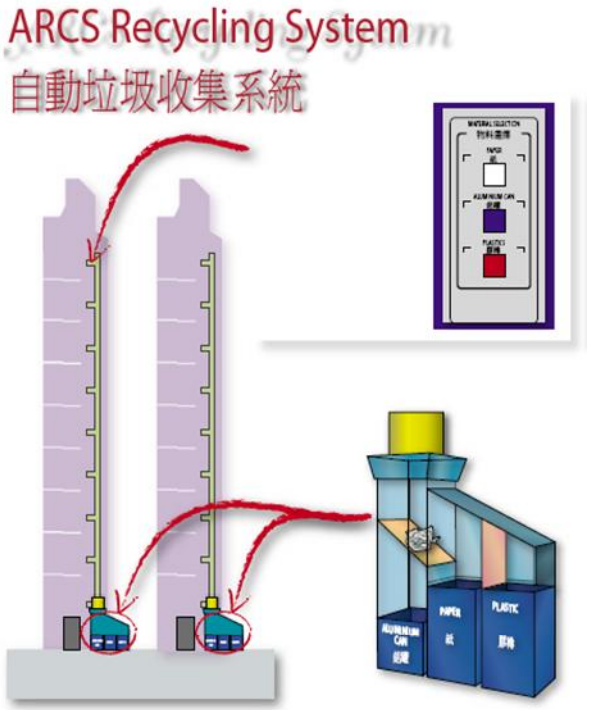
RTS Vehicle Access

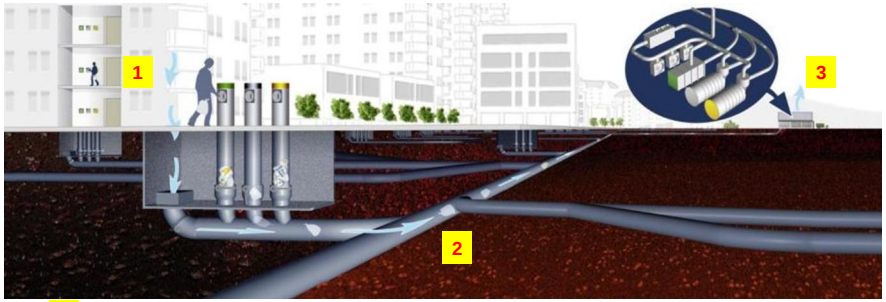


RTS Example – Shanghai, Jing'an

- **Co-invested by government and ADB**
- **320 TPD Capacity**
- **Underground RTS** – space saving
- **Roof top greening**
- **Environmentally friendly**
- **Totally enclosed**
- **Blends in with surroundings at city center**

ARCS Recycling System





1 Throw system: indoor and outdoor put in place

2 Transfer network: ground floor network

3 Central trash collection station : inside mechanical equipments

- Waste is disposed at inlet
- The computer-controlled evacuation takes 15~30 seconds
- All waste is sucked out through a network of pipes
- The waste is directed to the appropriate collection container
- The air is cleaned by filters before it is released

ARCS Type

- **Conventional Centralized ARCS**
  - Collect refuse stored at the bottom of each building via underground transportation pipe network
  - Containers are located in a centralized collection plant station for collection by specialized ARCS truck
- **Mobile ARCS**
  - Refuse is stored in an underground storage tank of each building
  - Storage tanks are connected via pipework to a docking point
  - Refuse is collected by Mobile ARCS vehicle which is essentially a mobile ARCS station

ARCS Types

Mini-ARCS

- Consists of some major components of conventional ARCS
- Allow refuse collection independently within the building without external pipe network and plant station

Mini ARCS

Container can be rear-loaded to conventional refuse collection vehicle

ARCS Benifits

- **Improve Living Environment**
  - As wastes are collected in completely enclosed ARCS, the living area becomes more aesthetic and hygienic.
  - Odor problems and other negative factors associated with dirty refuse-collection rooms within buildings or waste containers on the streets can be avoided.






ARCS Benifits

- **Provide Automatic Control of Disposed Refuse At All Time**
  - ARCS can be operated automatically and available 24 hours a day.
  - Refuse disposal inlet points are located close to the users at floor level and the wastes collected can be emptied when ever needed.
- **Provide Better Working Environment**
  - ARCS also provides a better working environment for waste collection workers
  - Lifting heavy objects and unnecessary contact with the waste are eliminated.

ARCS Options

Option 1: System Serving Individual Development

- ARCS system serves individual development.
- An individual development can be the scenarios from a single building block to multi-building blocks within the boundary of the development.

Option 2: System Serving Cluster of Developments (Sub-District System)

- ARCS system serves a cluster of developments.
- A cluster may consist of two developments up to a number of developments each of which in turn can have a single building block or multi-building blocks within the boundary of the development.

ARCS Options

Option 3: System Serving the Whole Southeast Kowloon Development (SEKD)

- District-Wide System
- A single ARCS system will serve the whole SEKD at large covering all the planned developments.
- Based on the assumption that one central collection station be located at the centre of SEKD

Environmental Benefits

	Option 1	Option 2	Option 3
Odor	**Negligible** with incorporation of appropriate control measures	**Negligible** with incorporation of appropriate control measures	**Negligible** with incorporation of appropriate control measures.
Noise	Refuse storage area would be **noisy** and acoustic insulation is required	Refuse storage area would be **noisy** and acoustic insulation is required.	Refuse storage area would be **noisy** while acoustic insulation is required.
Refuse collection vehicle	Haulage of refuse collection vehicles	Required between individual station and RTS	**Minimum** haulage of refuse collection vehicles required
Waste Separation	• Separation at source is **feasible** • Separation at plant room is **infeasible** due to space constraints	• Separation at source is **feasible** • Separation at plant room is **difficult** due to space constraints	• Separation at source is **feasible** • Separation at plant room is **feasible**.

Summary – Solid Waste Collection System

- Collection/ Transfer design depend of population density
- Manual collection necessary for less developed areas
- Possible to incorporate SW collection into residential areas without adversely affecting community
- Proper environmental nuisances must be addressed for densely populated areas

Landfill Design

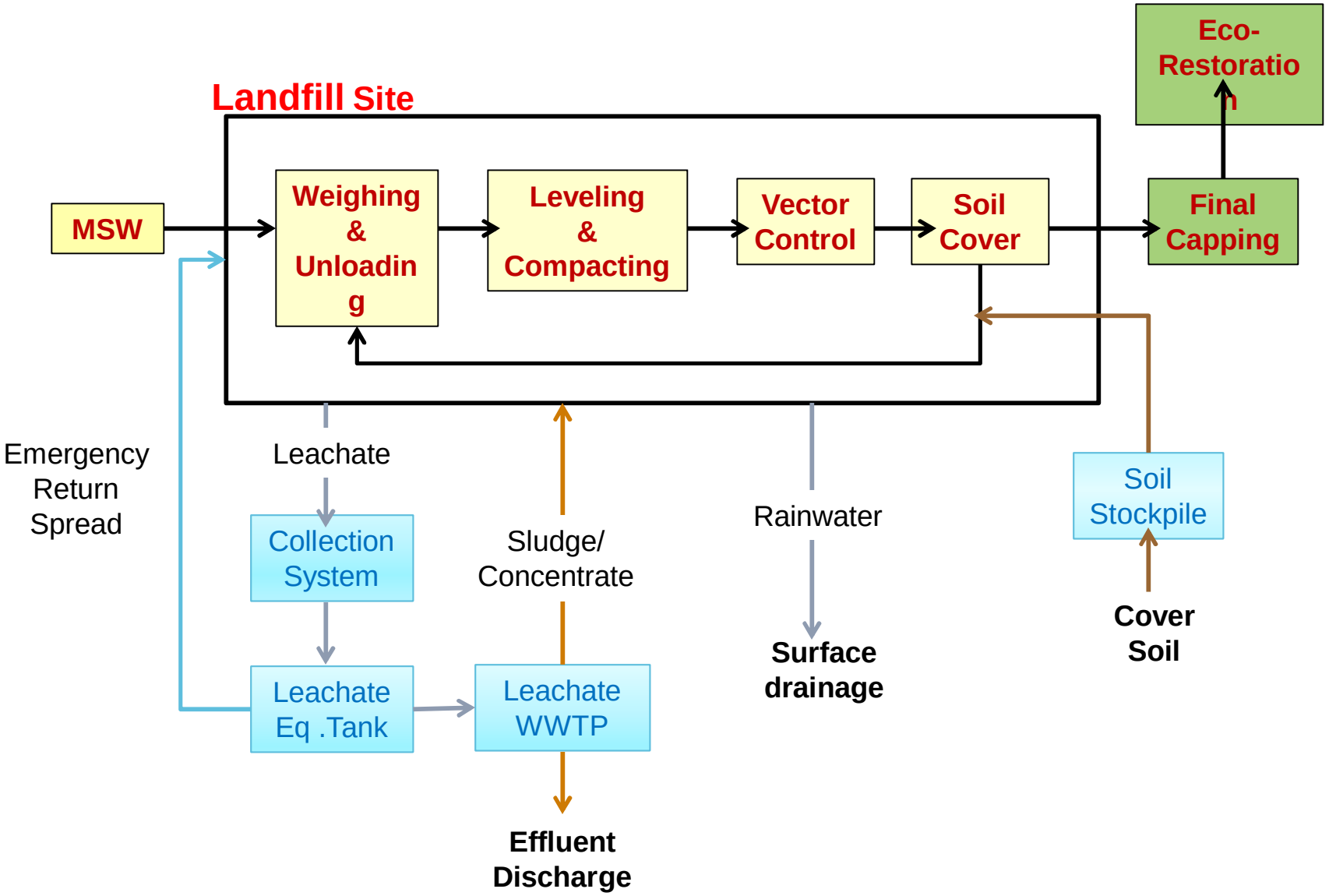
PRC Case – Controlled Landfill Expansion & Closure

Urumqi

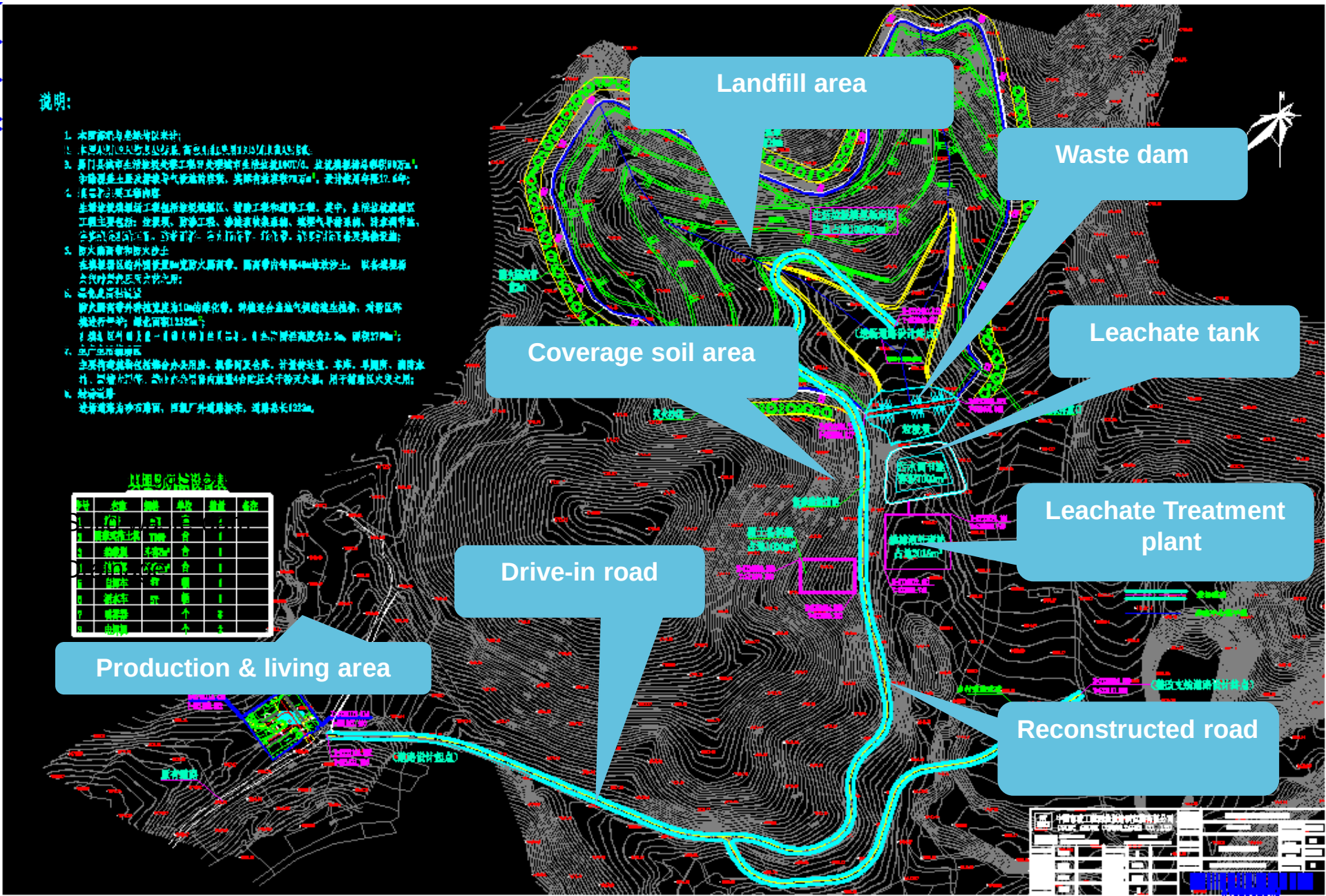
- 14,577 km^2 City area
- 3,100,000 Urbanized population
- 210/km^2 Population density

- Design working life of new landfill: 3 years (2012-2014)
- Daily average treatment capacity：2400 t/d
- Yearly average treatment capacity：870000 t/yr
- Unit treatment cost：4 USD/t
- Unit operation cost：0.65 USD/t
- Total project cost: 10 mm USD

MSW Treatment Process

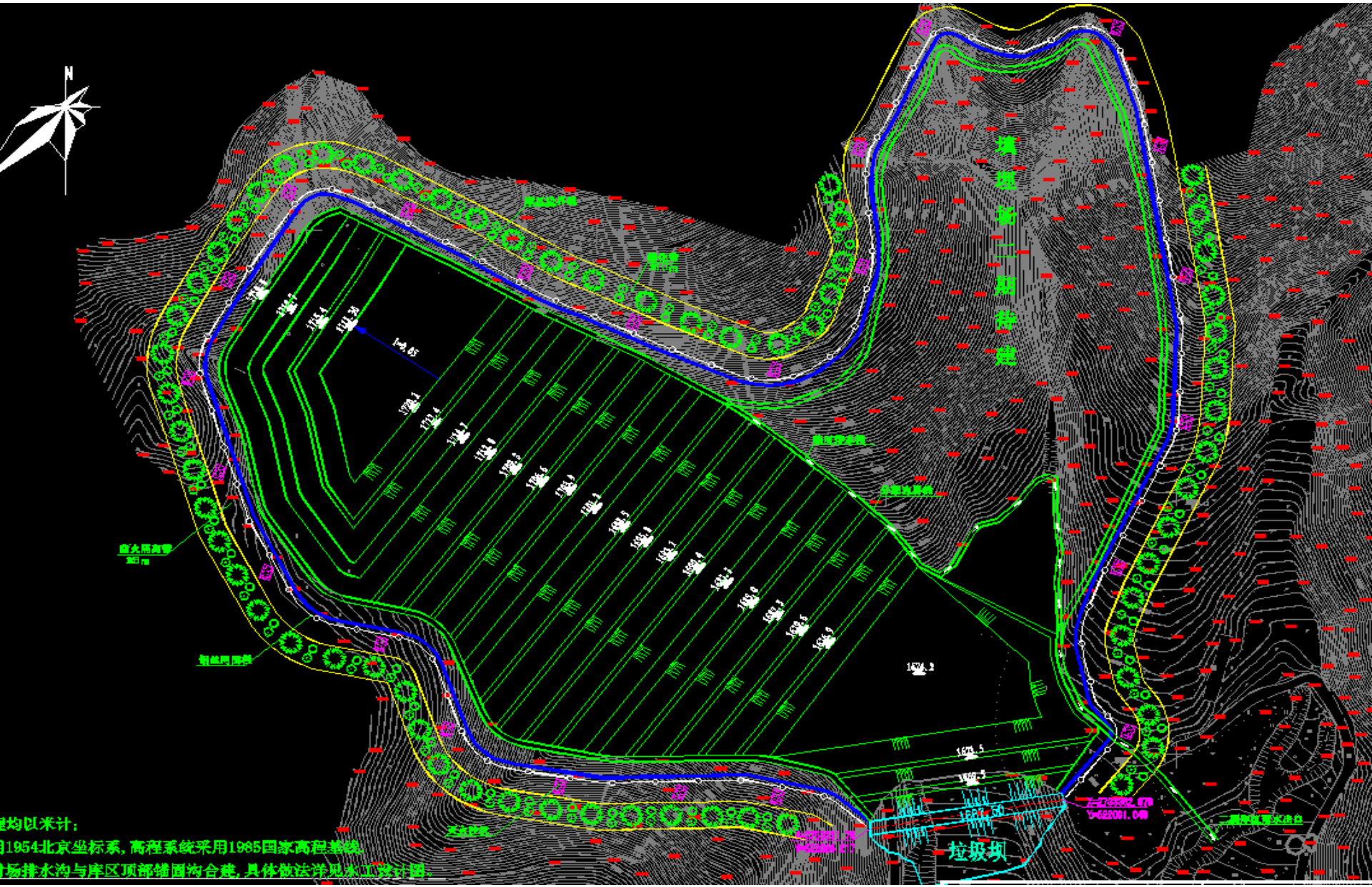


Overall Plan



Landfill Expansion – Phase I

AECOM



Landfill Leveling

AECOM

Leveling

- Remove 0.5m soil on the surface;
- Maximum height difference ~ 50m;
- Vertical control slope i = 0.055 ~ 0.10;
- Slope from sides to the middle i=0.03

Leveling of slope and lateral wall

- Side slope gradient should be less than 1:1;
- Lower areas can use clay to refill;
- Compression of refilled clay;

Landfill gas emission

Operation

- Natural ventilation and discharge
- Regular instrument monitoring of gas discharged
- Torch ignites once methane conc. Reaches 5% (explosion provision)

Landfill Closure

- Gas emitting layer installed in the final coverage layer;
- Located on top coverage clay, and under anti-leachate layer;
- Composite of 15-25 mm gravel, layer thickness at 0.3 m;
- Transfers landfill gas to diversion pipes for emission or burning

Vertical gas-guidance well

- Average well layout interval at 30 m
- Gas-guidance stone cage increases with the increase of the landfill height
- Wells extend up to under the final coverage layer
- Gas passes through De250 HDPE vertical pipes to well outlets
- Gas is ignited once the methane conc. reaches 5%
- 57 wells constructed

Site Flooding Prevention

Flood-prevention system was design 50-year flood standard

Verified by100 year flood standard;

Drainage system composite of

- Phase I ditch
- Landfill closure main ditch
- Branch ditch
- Cut-off ditch

Cut-off ditch

- blocks storm water from adjacent mountain from entering storage tanks and diverts to discharge

Slanted final capping

- rainwater will be diverted & collected at closure main drains with subsequent discharge.

Summary – Landfill Design

- Design landfills by stages for long term operation and loading build-up
- Proper lining/leachate/ gas treatment are required for safe/environmentally sound landfill design
- Necessary to provide provisions for external factors such as flood prevention system/ rainwater drainage
- Minimize Daily operation zone / areas to reduce odor
- Environmental Monitoring

Landfill Mining

General Methods of Stock Solid Waste

Purposes of landfill mining

- Increase landfill capacity, extend the life of the landfill;
- Sell or use of the recyclable materials: metals, nutrition soil,
- Empty garbage stocks to recover land, improve land values;
- Recycling some of the components, such as steel, aluminum and plastics;
- Removal of the environmental pollution ingredients, such as toxic ingredients or permeable ingredients;
- Avoid the responsibility of site restoration, reducing closure costs;
- Recycling of plastic waste as fuel or add other products.

Related Environmental Laws and Regulations

AECOM

Typical Considerations

- Garbage disposal Technical Guide
- Solid Waste Pollution Prevention Law
- Landfill Pollution Control Standard
- National Hazardous Wastes Lists
- Land Environmental Quality Standards
- Urban Wastes for Agricultural Control Standards

Relevant Case Studies

Case Study 1 – US, Florida, Perdido Landfill Mining Project

The project is a pilot project, the excavation of about 2.5 acres at the northern end of the landfill. The project launched on June 2, 2008, and finished until November 15, 2008.

A. Landfill mining and transportation

✓Using an excavator (CAT320C), bucket capacity 1.25 cubic yards, will excavate garbage from the of garbage unit without impermeable layer.

✓Mining area from one end of groove section (either south or north) began excavation, to the other end. In this excavation the garbage was sloping exposed, making the vertical depth of no more than 10 feet.

✓The waste were transported and storage in the areas near waste shredder screening machine. Distance of transport varies from project to project, generally in the 300 to 700 feet, with an average distance of 500 feet.

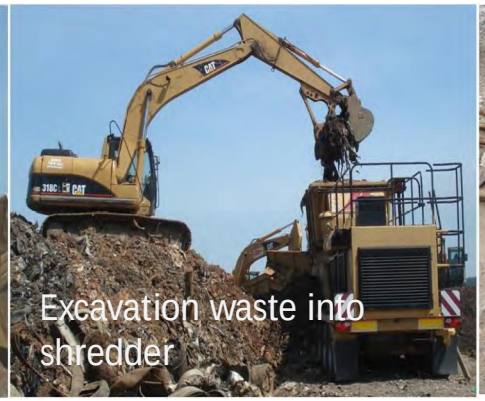
✓Occasionally bulldozers (CAT D6) was used to transport the garbage in the excavator arm.

Case Study 1 – US, Florida, Perdido Landfill Mining Project

AECOM

Treatment of excavated waste


Garbage shredder (EXTEC 3600)


Excavation waste into shredder

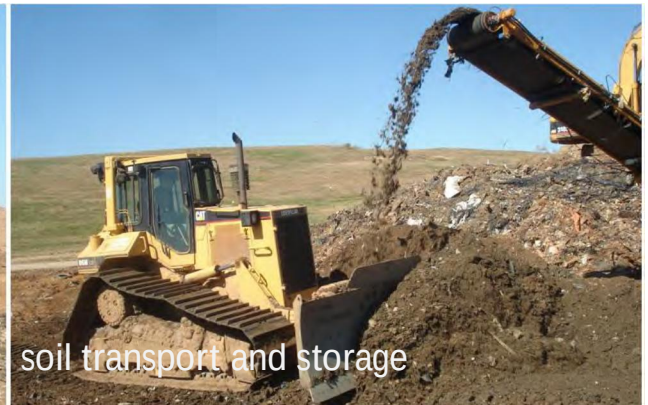

Pointed equipment

Shaker

✓Excavation and stored waste is loaded into a waste shredder machine (EXTEC 3600), to control the particle size of 6 to 8 inches.
✓Use open-shaker rail mounting garbage, directly put shredder processed garbage into the shaker. Improved perforated plate is replaced with this tip, and in August 7, 2008 in Shaker install a magnet for recycling non-ferrous metals.
✓Garbage and recycling soil screening process has two main parts: the screening waste (waste portions retained on the sieve) and restoration of soil (partly through the sieve of garbage).
✓Waste that didn't get through the sieve to be transported to the impermeable layer of garbage disposal unit.
✓Using bulldozers (CAT D6) will restore soil transported to the excavation area and be stacked on top. Construct fence surrounding the storage waste to reduce soil erosion. Sometimes the soil will be restored through the articulated dump truck and transported to use as daily cover material.


Recycling non-ferrous metals magnet installed on the shaker


waste transport after screening


soil transport and storage

Problems encountered during the Excavation

Extreme Weather

- If encounter rain, whether to continue or stop the exploitation of the work depends on-site managers and crew members.
- For safety reasons, exploration work should be completely stopped during the storm
- Contractor's daily records and daily rainfall records show that in the project excavation process, it was suspended 21 days (about 15%) because of wet weather conditions .

Equipment Break Down

- According to contractor records, crushers and screening machine failure is mainly due to hydraulic failure, but there are some malfunction caused by the nylon strap wrapped around the mill axis (about 5 times).
- Trommel problem is mainly due to motor failure, analysis shows that the drum screen is too small, and does not match the processing speed required for the project.

Surface water and leachate treatment

- Reduce leachate generation, there are two strategies, one is before expected rain incidents, laying the high density polyethylene film on the excavation waste; second is to minimize the mixture of leachate and storm water runoff.

Daily Coverage

- Most of exposed excavation waste covered with 015 inches thick geomembrane. As the . excavation proceed, the geomembrane should be moved. Geomembrane is to prevent the contact between storm water runoff with the waste, it has been used as a soil cover material.

Problems encountered during the Excavation

Hazardous waste and special waste management

- Develop hazardous waste and special waste management plans.
- Not too much harmful substances were found during excavation, only tires, which were transported to landfill tires management area.

Gas emissions and odor problems

- No records for the gas emissions and odor problems

Dust and rubble

- Since the restored soil has high moisture content, it did not cause any problems of dust and rubble.
- For the ruins occasionally blow out from the screening machine, because it is only in screening machine and stored in waste after screening, it has been managed based on the appropriate landfill debris management plan.

Health and Safety Plan

- Field workers must wear safety boots, long pants, long-sleeved clothing, wear safety glasses, safety vests and helmets. Use rubber / leather gloves when handling waste.
- Project managers need to organize a weekly security meeting.

Case Study 2 – Overview of Taipei, Neihu Solid Waste Treatment Sites

Beitou solid waste incinerator
Start operation in 7.1991
Capacity：1800 ton/day
Chimney height：150 m
Storage volume：17,300 m3
Treatment equipment：
Hearth：4 sets (Von-Roll Stoker Type)
Capacity：18.75 ton/hours ×1 set
Temperature ：850~1,050℃

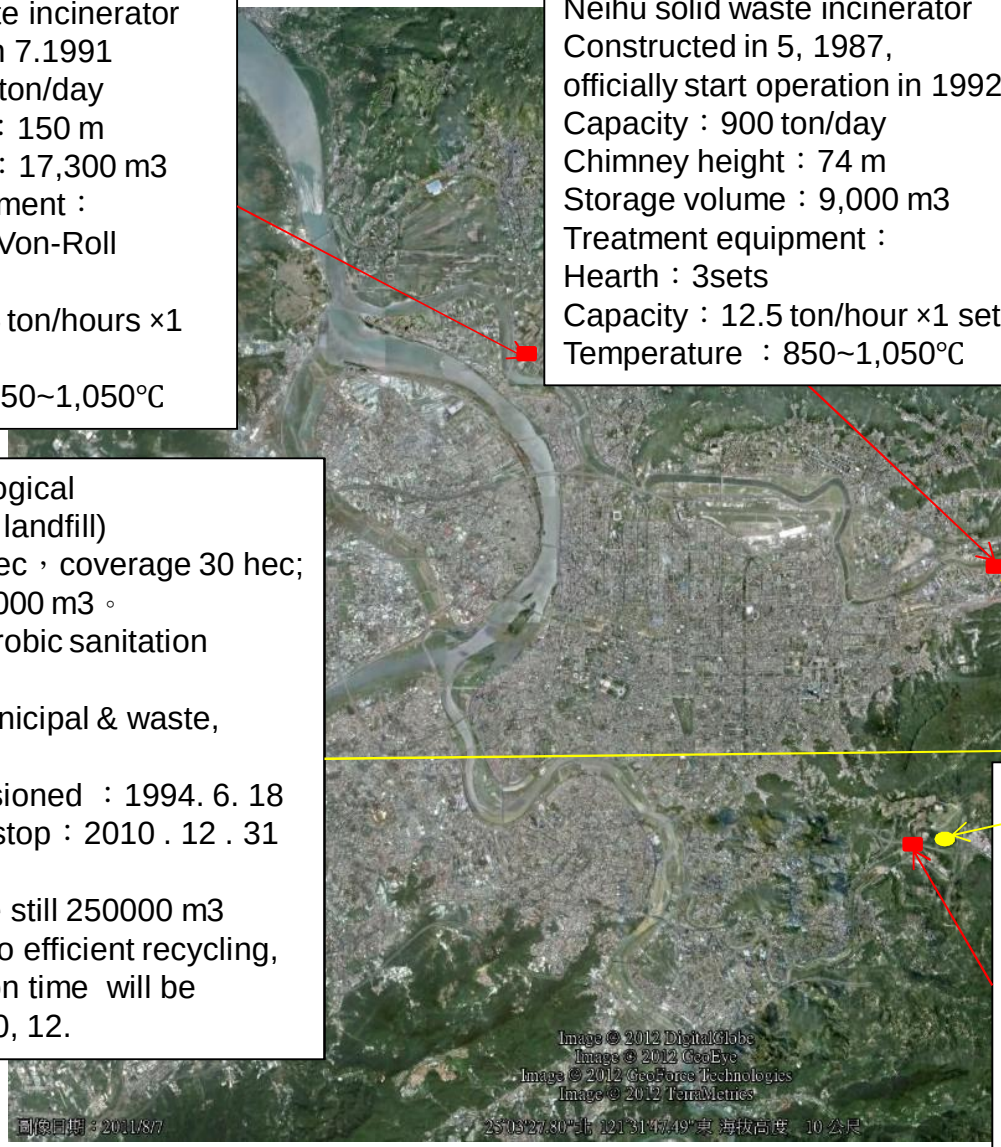
Neihu solid waste incinerator
Constructed in 5, 1987,
officially start operation in 1992;
Capacity：900 ton/day
Chimney height：74 m
Storage volume：9,000 m3
Treatment equipment：
Hearth：3sets
Capacity：12.5 ton/hour ×1 set
Temperature ：850~1,050℃

Neihu landfill mountain
Start in 1968, closed in 1985, 1/3 of the volume is near Keelung River, total area :15.05 hectare, the Height: 5-52.5 m
Volume :3120000 m3.
Removed in 10.1995 (2228000 m3 were removed).

Fudekeng landfill
Located in Taipei Wenshan district, operated from 1985 to 1994
total area :98 hectare, landfill coverage area is 37 hectare, total landfill volume is 8000,000 m3

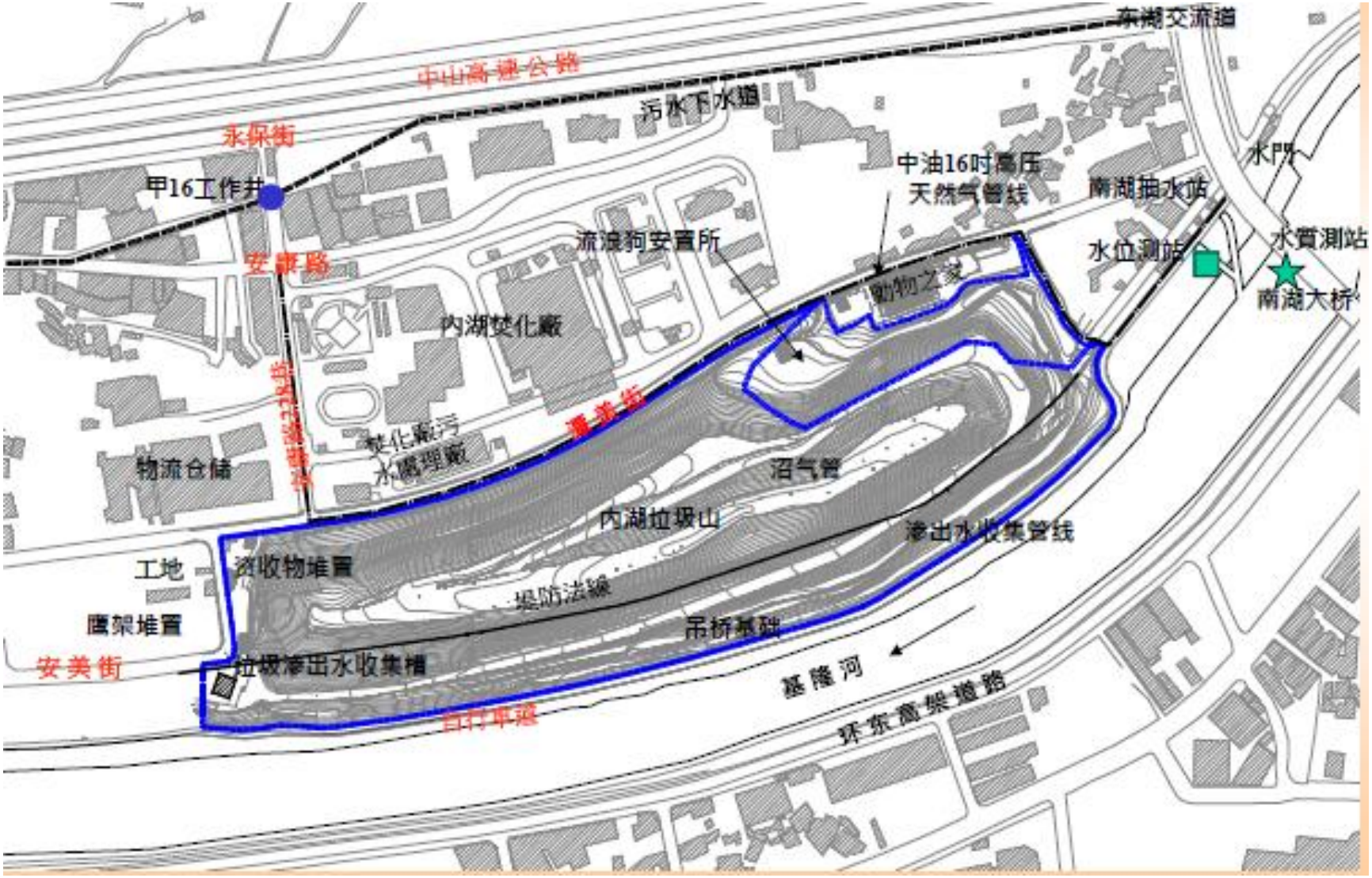
Shanshuku ecological park(Shanzhuku landfill)
Area：total 65 hec，coverage 30 hec;
Capacity：6170000 m3。
Methods：Anaerobic sanitation landfill
Waste type：municipal & waste, incinerator ash
Landfill Commissioned ：1994. 6. 18
Original Landfill stop：2010 . 12 . 31

Since there were still 250000 m3 volume left due to efficient recycling, the decommission time will be extended to 2020, 12.



Muzha solid waste incinerator
Construction started in July 1989, finished in July 1994. Commenced Operation in Mar. 1995.
Capacity： 1,500 ton/24hours
Chimney height ：150 m
Storage volume：15,000 m3
Treatment equipment：
Hearth： 4 set (TAKUMA HN Type)
Volume ：12.5 ton/h 1 set
Temperature：850~1,050℃

Case Study 2 – Project Map



Case Study 2 – Mining Stages 1

98.03.31

98.07.01

98.10.12

98.12.31 15,901m^3

99.04.07 35,163m^3

99.07.05 83,207m^3

Case Study 2 – Mining Stages 2

99.10.11 112,369m^3

100.01.05 115,118m^3

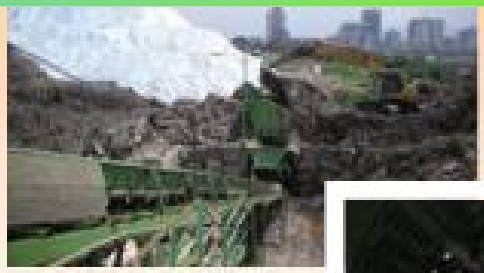
100.04.08 151,775m^3

100.07.04 192,709m^3

100.10.05 259,002m^3

101.01.02 301,192m^3

Screening Facility



Feed & Convey

Metallic Separator

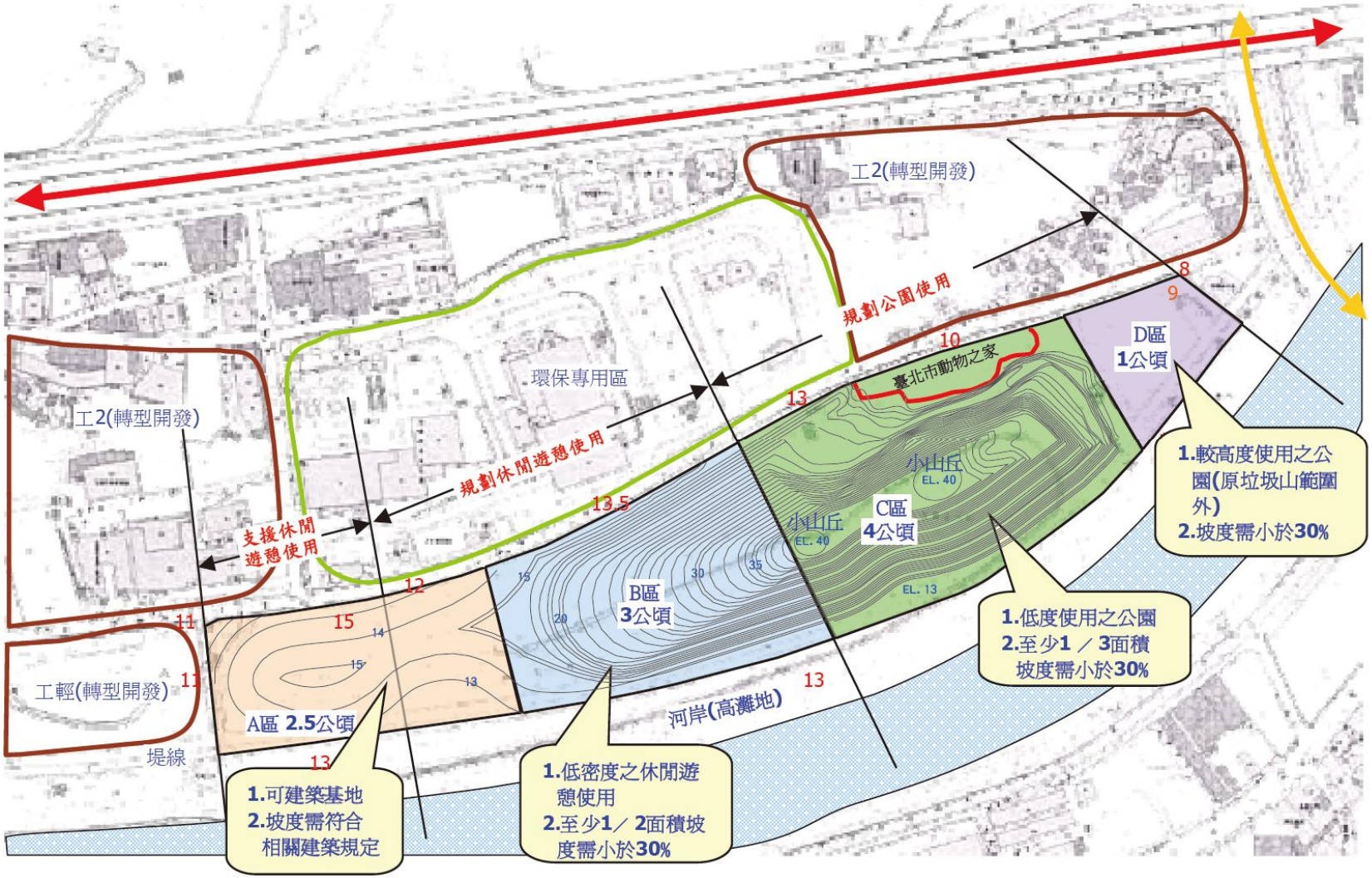
Rotary Drum

Fan separator (for light weights & combustibles)

Manual separation (combustible & Recyclable)

Reusable soil and grit

Land Use Post Clean-up



Case Study 3 – Shanghai Lao Gang Landfill

- Shanghai Lao Gang solid waste landfill located in Nanhui County
- Approx. 60 km away from the city center,

- Landfill covering area about 340 ha,
- divided into 1, 2, the 3rd landfill,
  - No.1 landfill ~ 160 ha,
  - No.2 landfill ~ 100 ha,
  - No.3 landfill ~ 80 ha,
  - each landfill separated into several landfill cell unit area
  - approximately 400 m × 125 m
  - Landfill were divided into 56 units;

- During landfill operations, solid waste was filled by unit,
- Each landfill thickness at 1 m, stratified compaction,
- Total height of each unit's at 4 m,
- Each unit operate for 3 months.

- Lao Gang Landfill began construction at the end of 1985, running from October 1989 until the end of 2004,
- Three landfill units have been filled, the average daily domestic waste filled was approximately 6 000 ~ 8 000 t.
- From January 2005, solid waste was filled in the 4th landfill unit (i.e., phase 4).

Summary – Landfill Mining

- Expand existing landfill capacity/ generates land for development
- Recycling of useful material possible with landfill mining
- Good quality of recycled material can be achieved
- Remove hazardous material
- Provide opportunity to reinstall liner and leachate / gas system
- Avoids future restoration work which may become more difficult over time

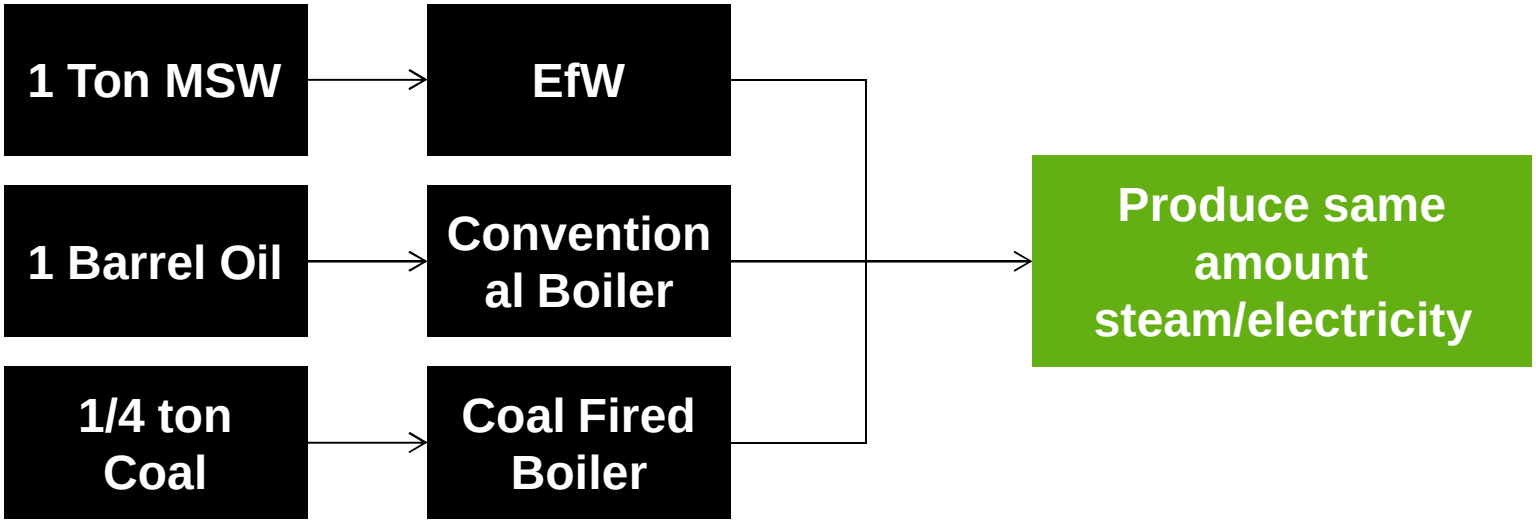
Waste-to-Energy

Content

- **Overview on Waste-to-Energy Recovery**
- **Benefits and Landscape of Waste-to-Energy Recovery**
- **Processing Technology of Waste-to-Energy Recovery**
- **Relevant Equipment and Case Studies**

Overview on Waste-to-Energy Recovery

Fuel Source Comparison



The Energy-from-Waste Process

Refuse from households

Truck picks up MSW from local community and unloads at EfW facility.

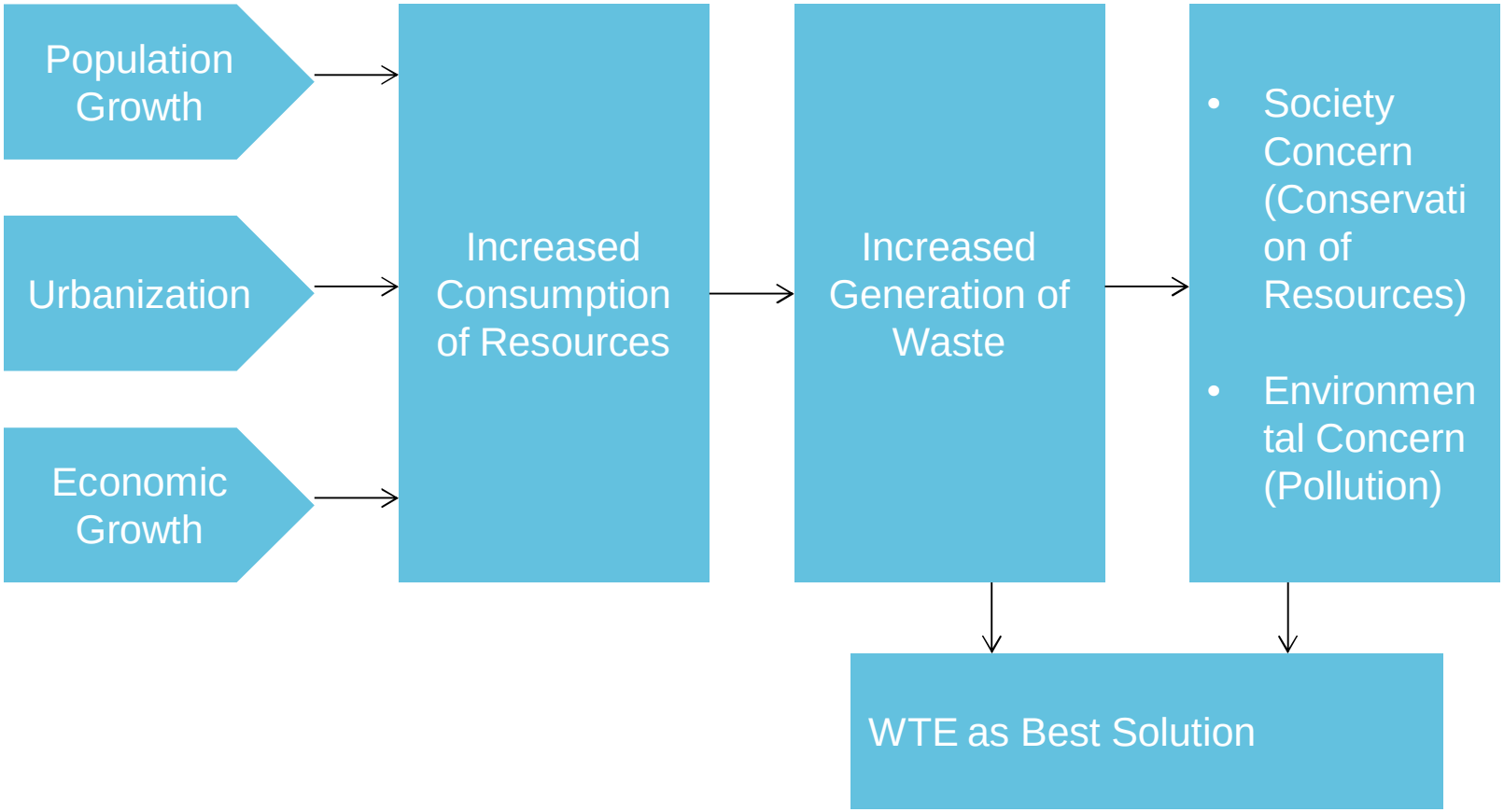
Waste incinerated to generate steam for power generation.

For every 10 tons of MSW, 5,200 kwh of power is generated and 500 lbs of metal is recycled.

Electricity is fed back into power grid and used to power households and businesses.

The Waste to Energy industry has been in existence for over 25 years and has developed state-of-the-art technology making it one of the cleanest forms of energy generation.

Key Drivers


Population Growth
Urbanization
Economic Growth
Increased Consumption of Resources
Increased Generation of Waste
Society Concern (Conservation of Resources)
Environmental Concern (Pollution)
WTE as Best Solution

Benefits and Landscape of Waste-to-Energy Recovery

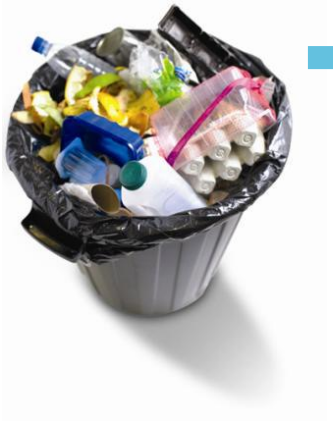
Benefits of Waste – to – Energy Recovery

AECOM

WTE/EFW Meets Three Critical Challenges:

- **Climate Change**: One ton of trash reduces one ton of CO2 eq.
- **Energy Security:** Renewable energy available locally
- **Creates Jobs:** Typical facility creates 1,000 construction jobs (3+ years)

1 Tonne MSW

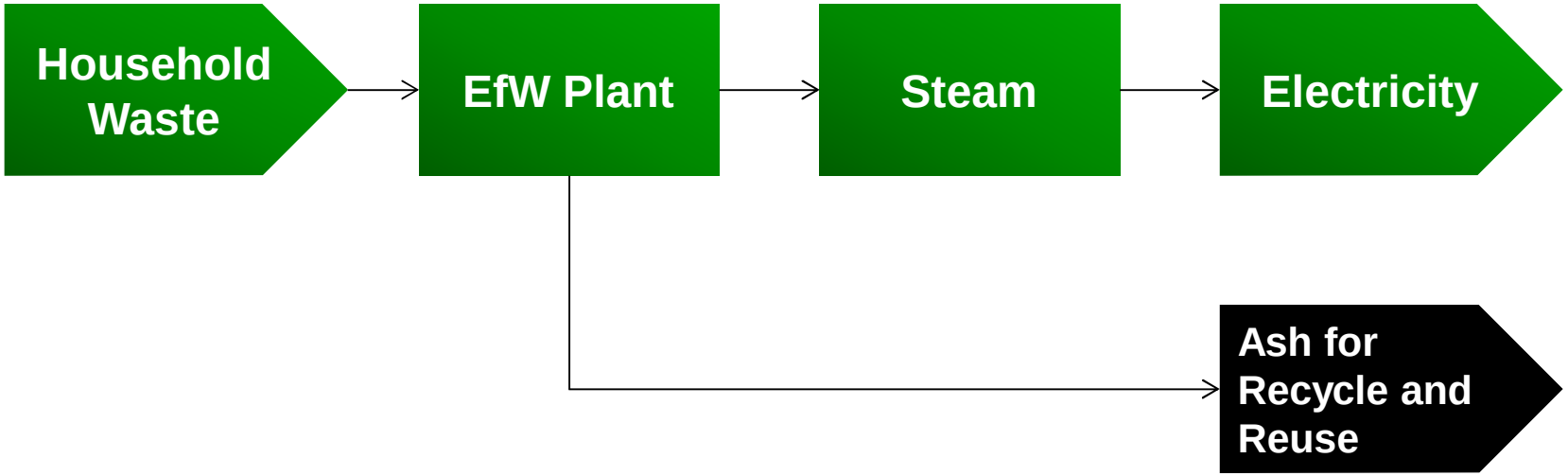


- 500 - 750 kWhrs of Power
- 50 lbs of Recycled Metal
- Disposed Ash: 10% of Original Volume

Benefits of Waste – to – Energy Recovery

Supply Clean, Renewable Energy:

- Recovers up to 72% of raw energy convert into steam/hot water
- Further convert up to 29% of steam energy into electricity



Benefits of Waste – to – Energy Recovery

Landfill Disposal vs. WTE

Landfills

- 100-year anaerobic decomposition process
- Leachate and landfill gas issues AND long-term environmental liability

WTE

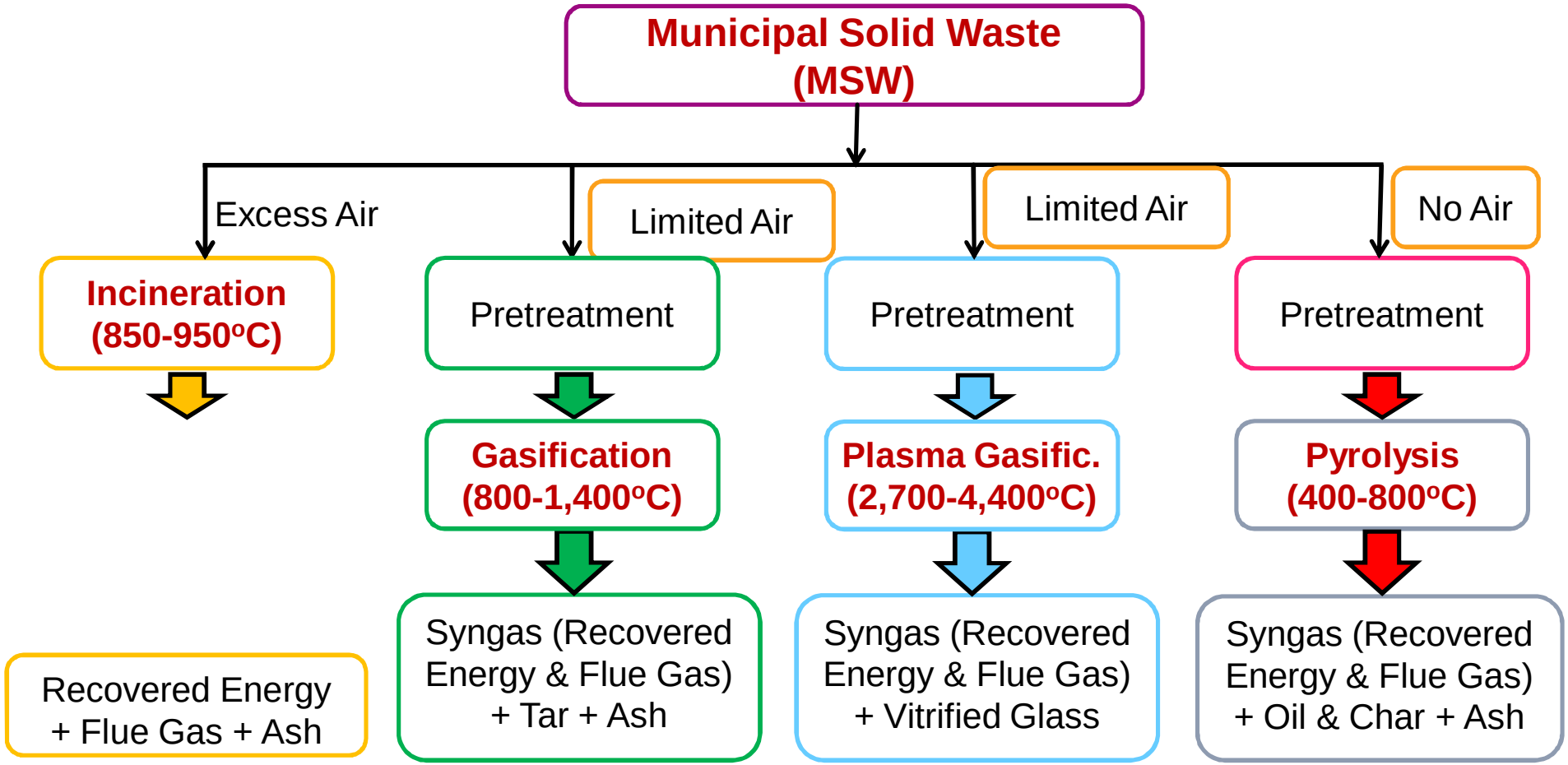
- 1-hour controlled combustion process
- Renewable energy generation and reduction of climate greenhouse gases

Key Market Drivers

- China's National Waste Disposal Plan (targets WTE treatment of 30% of MSW by 2030
- China's Renewable Energy Act targets 15% of total energy usage by 2020
- China's Natl. Climate Change Plan (targets 20% reduction of energy usage per unit of GDP)
- Various PRC incentives to promote WTE (e.g., Preferential feed-in electricity tariff, VAT refund)
- Delivery of environmental protection projects is becoming a key performance criteria for senior government of officials
- Chinese stimulus package supporting investments in infrastructure and environmental sector

Processing Technology of Waste-to-Energy Recovery

Thermal Technologies



*** including co-combustion system**

Incineration

T. A. Lauta Incinerator, Germany (MSW)

Latest Development

- Over 90% of MSW incineration plants using moving grate technology
- Largest plant: 4,300 tpd MSW in Singapore
- Largest unit : 920 tpd MSW in Netherlands
- Over 100 new plants

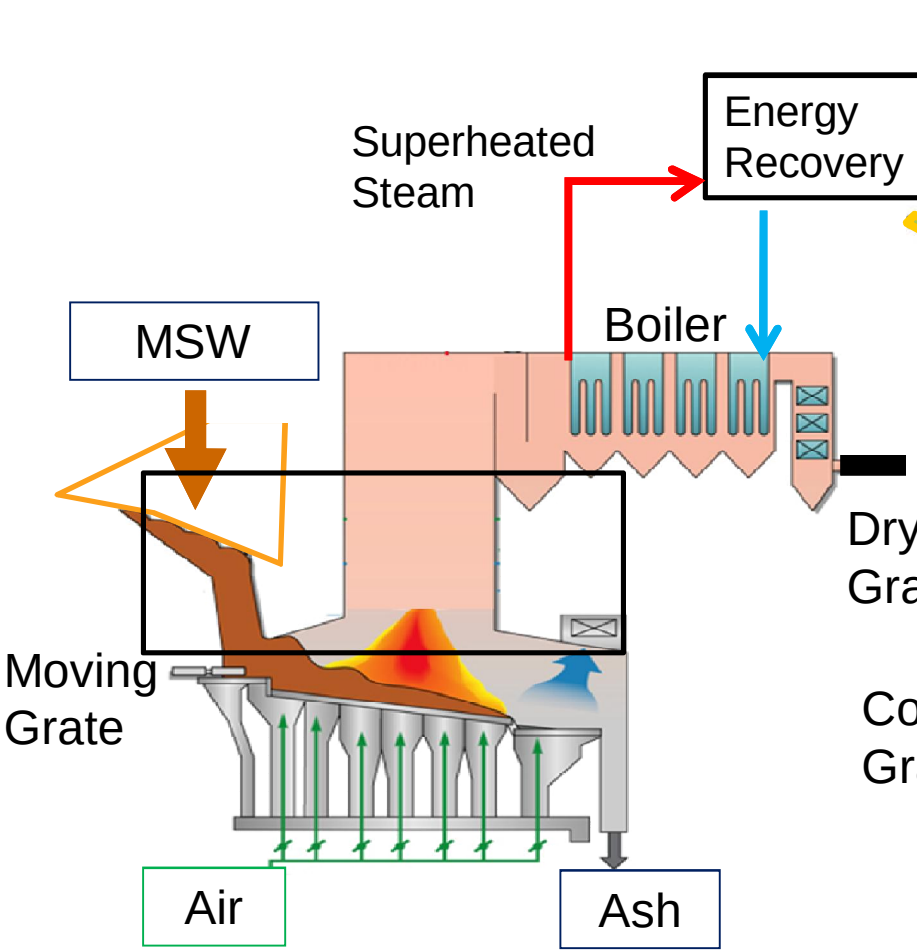
Pros

- Over 900 plants; more than 100 yrs operation
- Over 10 major suppliers → adequate tender competition
- Larger unit capacity → less land requirement
- Relatively robust for MSW treatment
- No requirement of pre-treatment

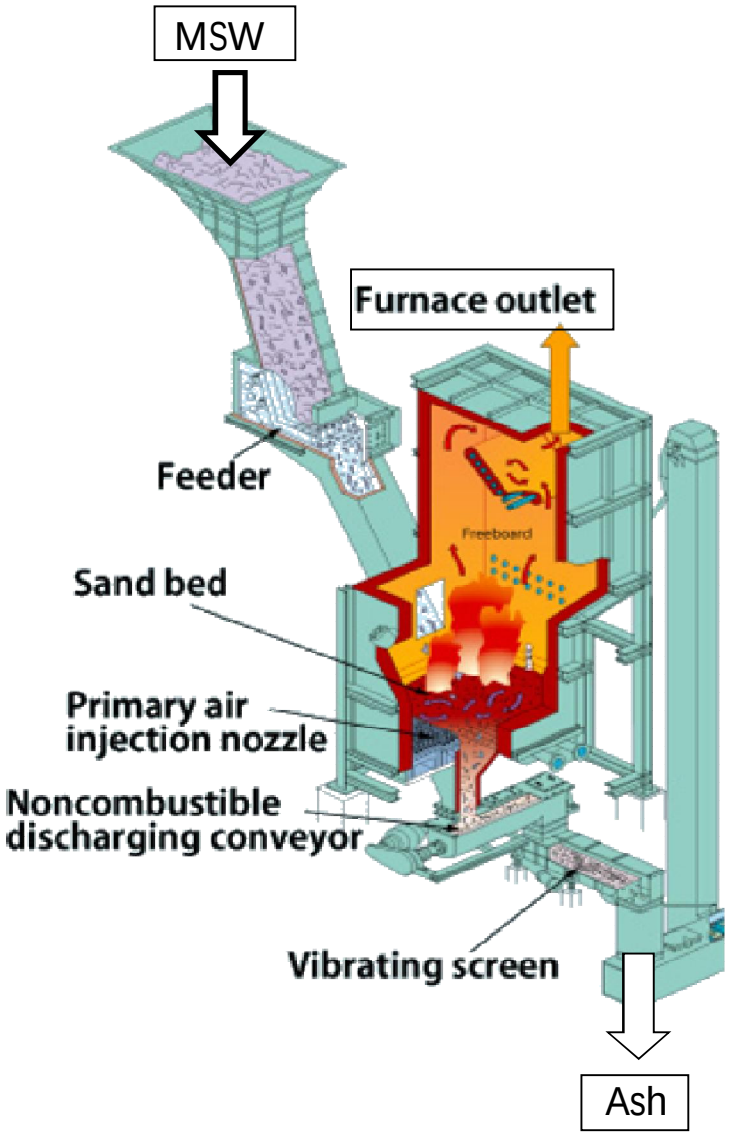
Cons

- Excess air requirement → higher flue gas volume
- Higher ash production

Incineration – Moving Grate



Incineration – Fluidized Bed



Latest Development

- Mainly for homogenous waste treatment e.g., sewage sludge and industrial wastes
- Only 2% of MSW incineration plants using this technology
- Largest plant: 200 tpd MSW in Japan
- Largest unit: 60 tpd MSW in Japan
- Few new MSW plants, but in small-scale

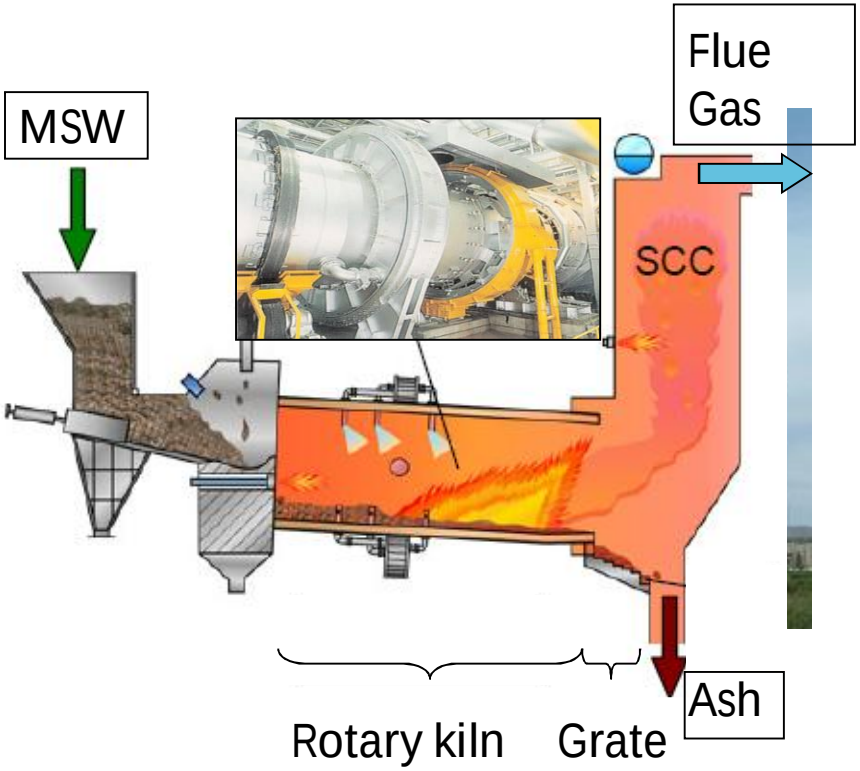
Pros

- More intense heat and mass transfer
- Minimal mechanical moveable parts → less wearing and lower relevant O&M costs

Cons

- Limited track record for MSW application
- Smaller unit capacity → larger land requirement
- Less robust for MSW treatment
- Requirement of pre-treatment
- Poor history in combusting MSW

Incineration – Rotary Kiln



Latest Development

- Mainly for industrial and hazardous waste treatment, rare for MSW
- Generally, combine rotary kiln and moving grate
- Largest plant: 900 tpd MSW in Taiwan
- Largest unit: 300 tpd MSW in Taiwan
- No reported new plant since EOI

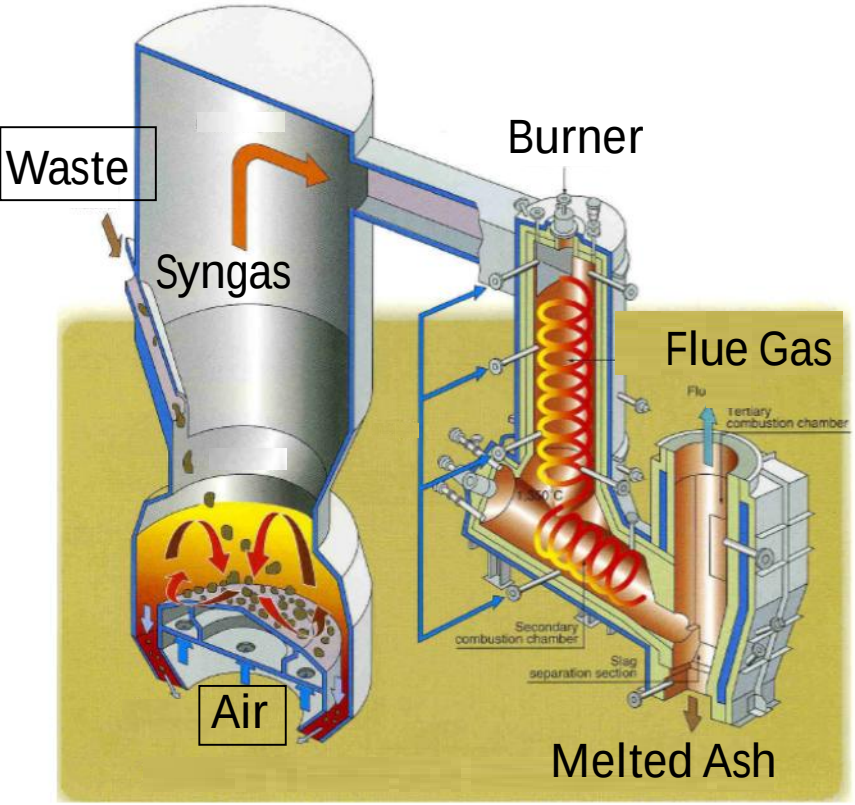
Pros

- Long retention time → favourable to treat hazardous waste
- Flexible in feedstocks e.g., solid and liquid wastes

Cons

- Limited track record for MSW application/ a key supplier retreated from market
- High O&M costs due to technical problems encountered for MSW treatment
- Smaller unit capacity → larger land requirement
- Less robust for MSW treatment

Gasification



Latest Development

- ~90 plants worldwide
- Largest plant: 405 tpd MSW in Japan
- Largest unit: 150 tpd MSW in Japan
- Over 20 new plants since EoI, but in small-scale

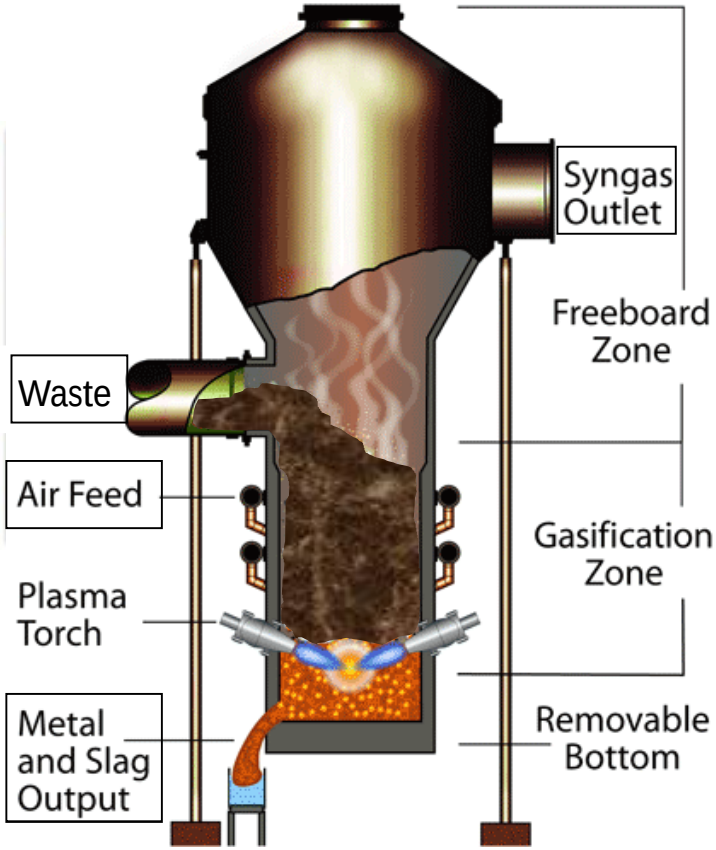
Pros

- Limited air requirement → less volume of flue gas for treatment, potential for reduced pollutant formation
- Potentially higher flexibility in energy recovery

Cons

- Limited track record for MSW application/ some key suppliers retreated from market
- Concern for operation failure (e.g. unpleasant experience in Germany)
- Smaller unit capacity → larger land requirement
- Less robust for MSW treatment
- Requirement of pre-treatment

Incineration – Plasma Gasification



Latest Development

- Only few pilot plants
- Largest plant: 300 tpd RDF in Poland (need MBT pretreatment)
- Few new plants but required pre-treatment of MSW or the plasma system is only for MSW bottom ash treatment

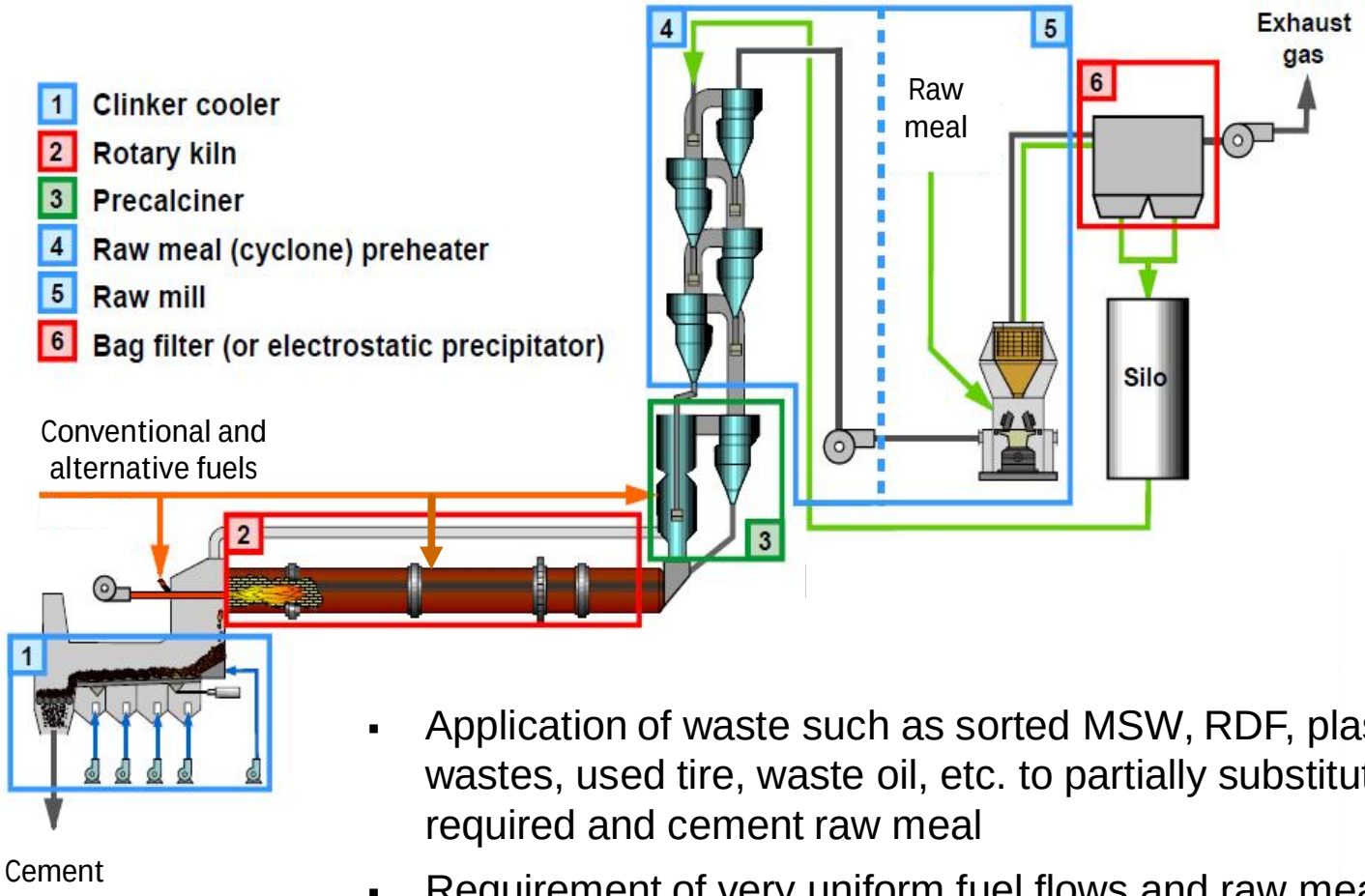
Pros

- Limited air requirement → less volume of flue gas for treatment, potential for reduced pollutant formation
- Potentially higher flexibility in energy recovery
- Transformation of ash into (inert) vitrified glass for reuses and no ash disposal in landfills

Cons

- Very limited track record for MSW application
- Smaller unit capacity → larger land requirement
- Less robust for MSW treatment
- Requirement of pre-treatment
- Possible external energy source requirement

Conventional Co-combustion System



- Application of waste such as sorted MSW, RDF, plastic wastes, used tire, waste oil, etc. to partially substitute the fuel required and cement raw meal
- Requirement of very uniform fuel flows and raw meal
- Substitution of maximum 40% of the fuel

Summary – Waste to Energy

- Waste to energy is a growing industry
- Numerous waste to energy technology available
- Will require careful selection to ensure maximum benefits
- Can be an economically and environmentally beneficial SW treatment method
- Part of ISWM scheme

Case Examples

Pre-Feasibility Study of Integrated Solid Waste Management Project

Travis Chien
E: travis.chien@aecom.com

September 2013

AECOM

Current Situation of Tantang Landfill

- **Landfill has a designed capacity of 10,750,000 m3**
- **Designed service life of 30 years, operation since February 2007**
- **Landfill leachate collection and treatment facilities**
- **treatment capacity of 800 m3/d, including 400 m3/d for future expansion.**

"regulation tank + primary A/O tank + secondary A/O tank + ultra-filtration system + nanofilter system + reverse osmosis system + clear water tank

Tantang Landfill

3. Existing Non-standard Landfills

Shanglingqiao Domestic Solid Waste Landfill in Lengshuitan District

•Area - 30,000 m2. operation in 1995 and
•Closed in March 2008,
• Design capacity of 600,000 tons with approximately 800,000 m3 of MSW

•simply covered with soil, but still has a large volume of construction waste on site;
•leachate seeped out of the landfill has flown to the pavement,
•causing pollution to the surrounding environment and enter surrounding water body.

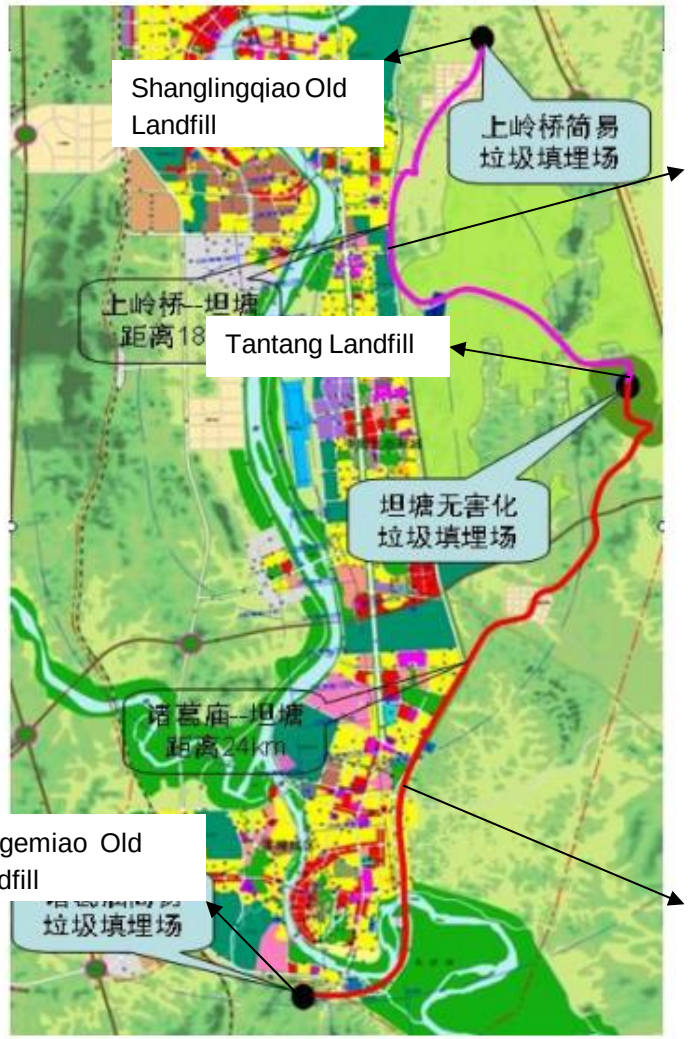
3. Existing Non-standard Landfills

(2) Zhugemiao Solid Waste Landfill in Lingling District

•86,200 m2 operation in 1999 and
•closed in September 2010
•Design capacity of 250,000 m3 with cumulated 500,000 m3

•Zhugemiao Landfill has been simply covered with soil
•some solid wastes in the vicinity remain not covered with soil and are stockpiled in the open air, resulting in serious overflow of leachate and the formation of a leachate tank.

Geographical Position of the old landfill



Zhugemiao Old Landfill

The transportation distance between Shanglingqiao and Tantang is approximately 18 km.

The transportation distance between Zhugemiao and Tantang is approximately 24 km.

Recommended ISWMF Components -

- Solid Waste Collection, Sorting and Transferring System；
- Unused Old landfill Pollution Control Project；
- Kitchen Waste Treatment Project；
- Solid Waste Incineration Project.

妥善處理迫切廢物問題

綜合廢物管理設施

Tackling Imminent Waste Management Problem

Integrated Waste Management Facilities





Waste Management Policy

Reduce & Recycle

Timely Landfill Extension

Modern Facilities for Waste Treatment

Benefits of IWMF

AECOM

- Substantially reduce the volume of waste by 90%

- Recover energy and generate electricity from waste (~ 480 million kilowatt-hours of electricity per year for use by 100,000 households)

- Reduce greenhouse gas emissions (~ 440,000 tons CO_2 /year)

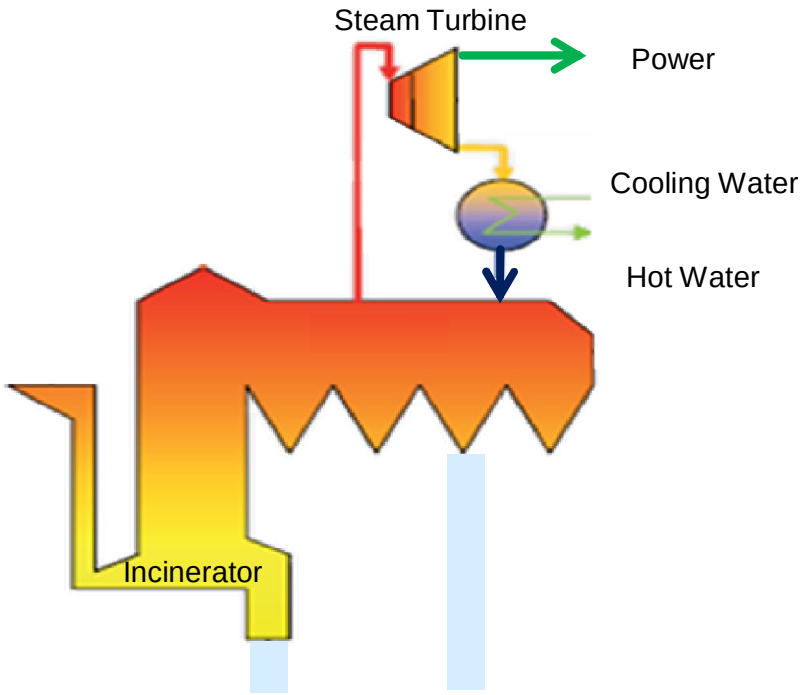
Key Components of IWMF

AECOM

① Mechanical Sorting and Recycling Facility

Courtesy: www.theskip.net

② Waste Heat Recovery and Power Generation System



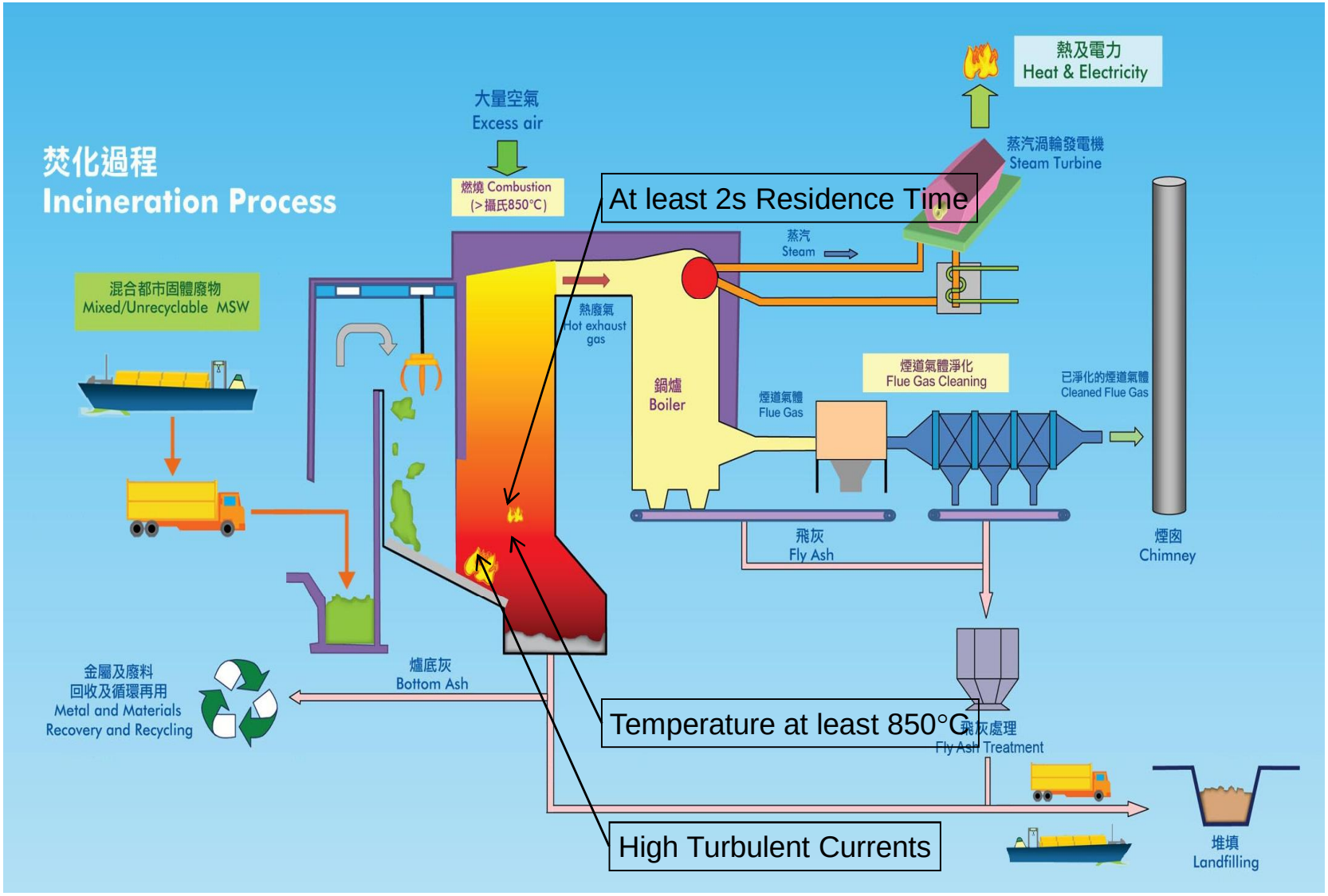
③ Advanced Incineration Facility

④ Environmental Education Centre

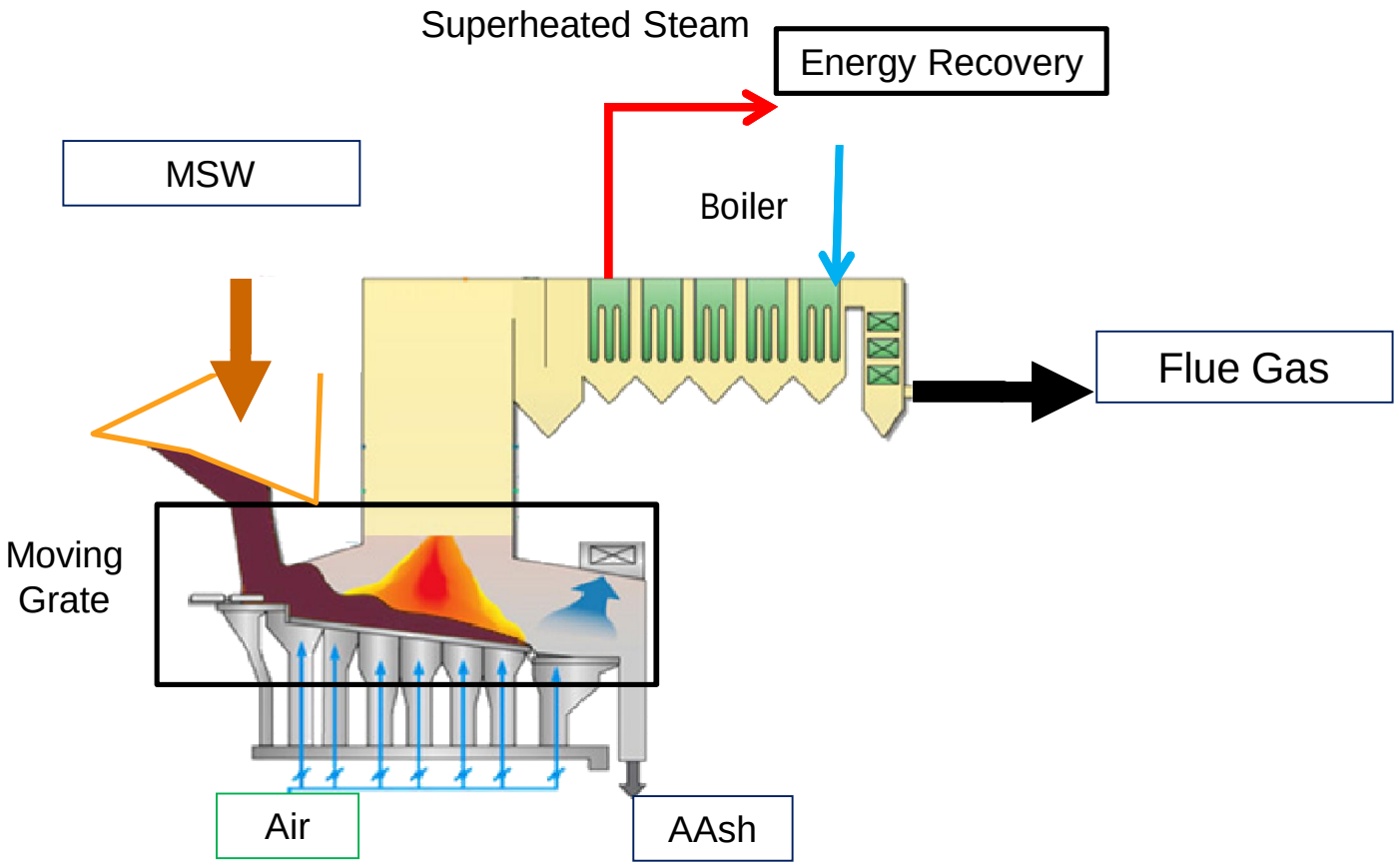
Modern Incineration Technology – 3T

- **Temperature** at least 850°C to completely destroy organic matters
- High **Turbulent** Currents to achieve complete combustion
- At least 2s residence **Time** at 850°C or above to achieve complete combustion

Modern Incineration Technology – Process Flow Diagram



Modern Incineration Technology – Moving Grate

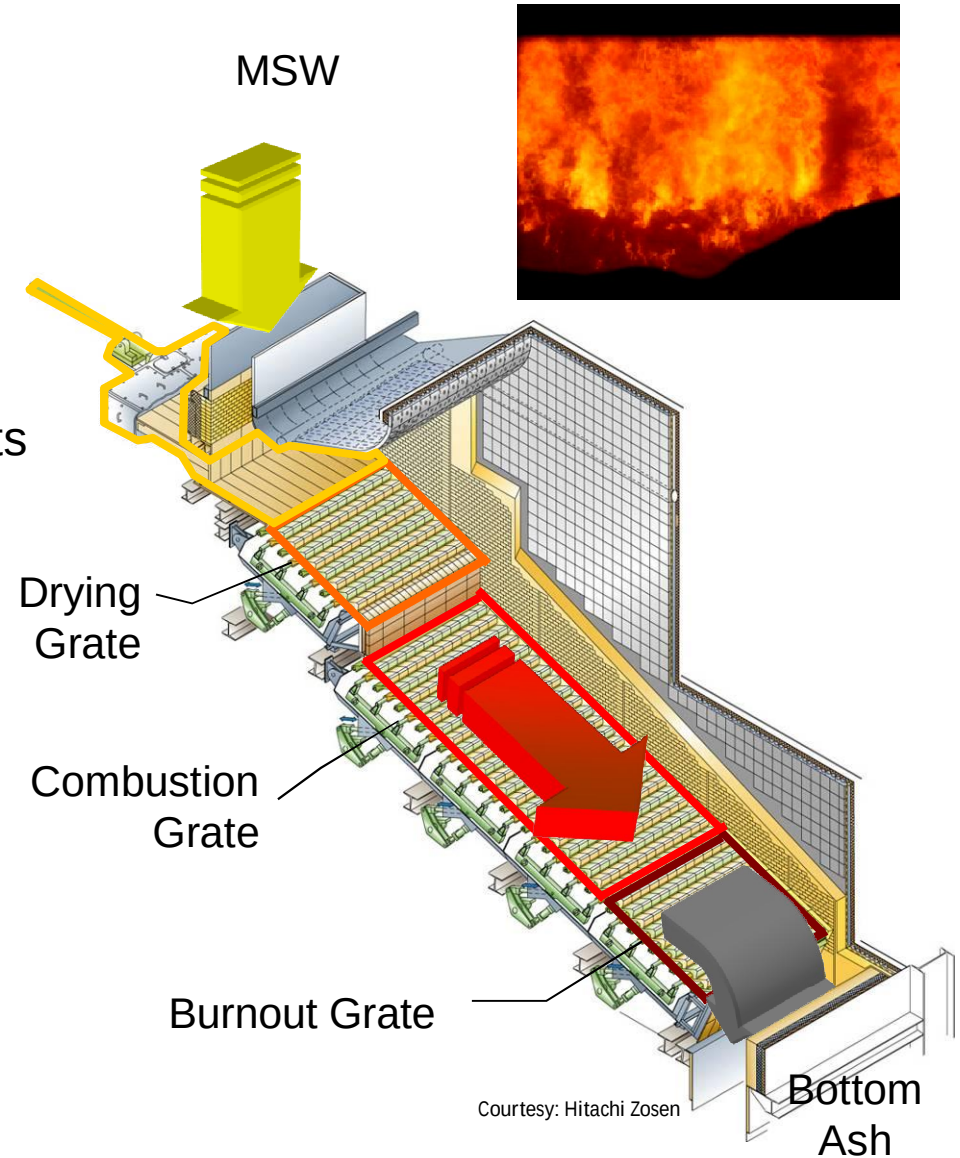


Majority MSW incineration facilities adopting moving grate (>900 plants)

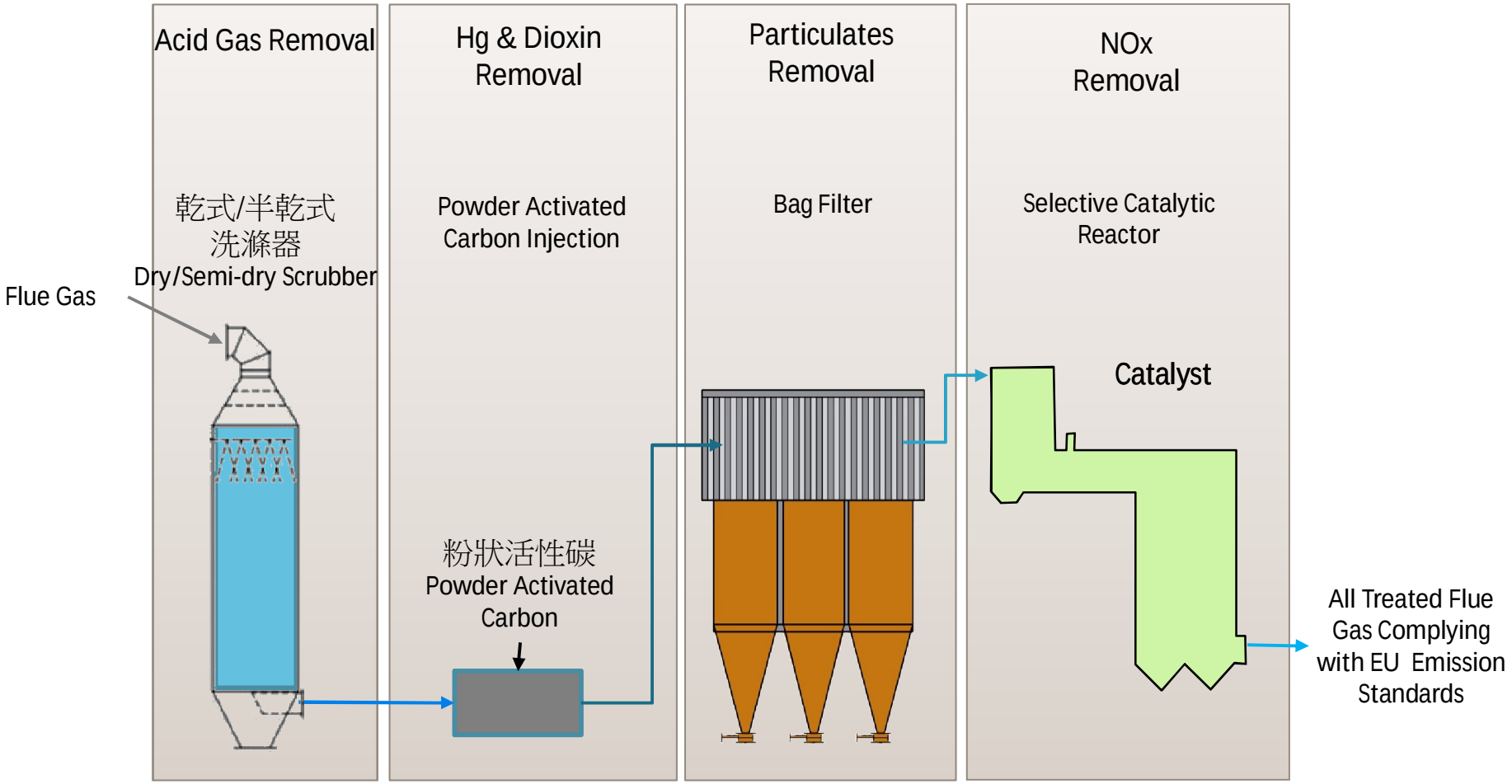
Modern Incineration Technology – Moving Grate

Merits

- •Proven experience
- •Safe and robust system
- •Meeting EU Emission Standards
- •Low construction and operation costs
- •
- •Small footprint
- >10 家主要供應商
- •>10 major suppliers



Modern Incineration Technology – Flue Gas Cleansing and Control System



Examples of Modern Incineration Facilities

France Gien Incineration Plant

Ariake Incineration Plant

Shin-Koto Incineration Plant

Maishima MSW Incineration Plant

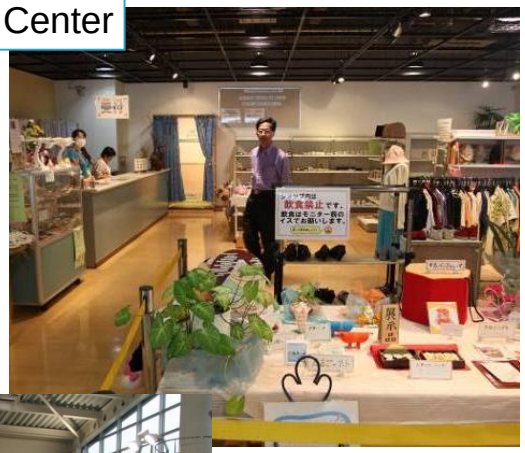
Examples of Associated Community Facilities

Education Centre

Maishima MSW Incineration Plant

Recreational Centre

Asahi Clean Center



Zero Wastewater Discharge

On-site wastewater treatment plant for reuse, zero wastewater discharge

Final Thoughts

- SW management is urgently needed in Southeast Asia
- Effective SW management requires long term planning
- Preventive measures out perform corrective measures in the long term
- Effective SW management can provide economical benefits, especially with waste to energy approaches
- Different approaches should be selected depending of stages of development of each region

Thank You