3 Planning of landfill
-general, definition, type, site-

3.1 Introductions

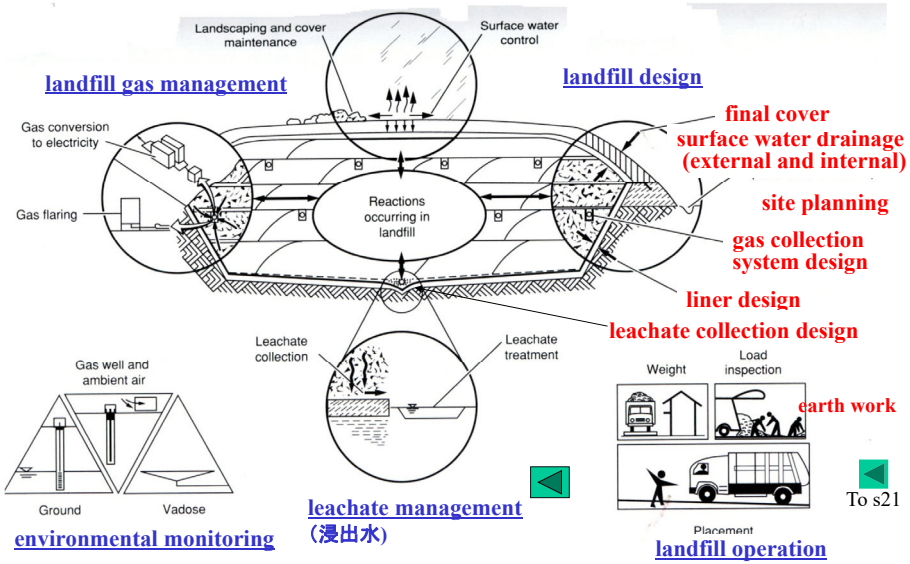
Methods for the final disposal of solid wastes:

1. **Dumping on land** (***open dumping***, ***engineered landfill***)
2. **Dumping in surface waters** (it is banned in many countries now)
3. **Feeding to swine (animals)**
4. **Mixing into soil as soil conditioner**
5. **Reduction**
6. **Incineration** (early incinerators were a source of noticeable air pollution; it remains waste: ash)

Engineered landfill (*sanitary landfill*) was developed as a relatively inexpensive alternative to incineration, e.p. communities with sufficient land area. (like, U.S.)

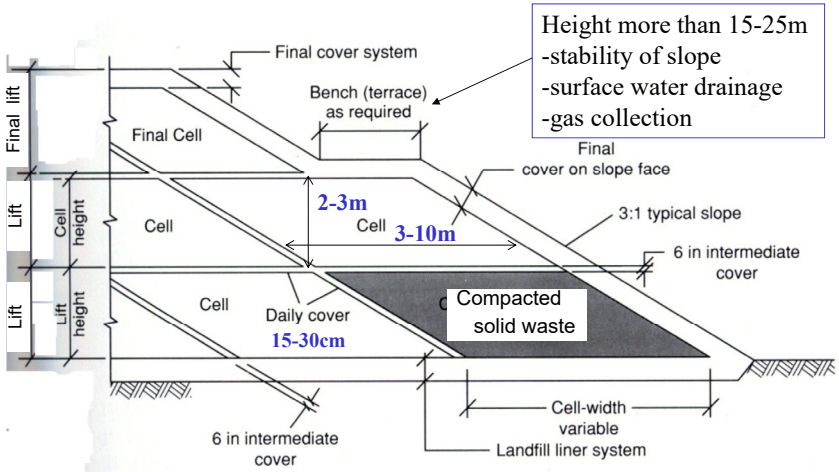
Definition sketch for landfill operation and processes:

G. Tchobanoglous , H. Theisen & S. Vigil (1993)



Sectional View of sanitary landfill:

G. Tchobanoglous , H. Theisen & S. Vigil (1993)

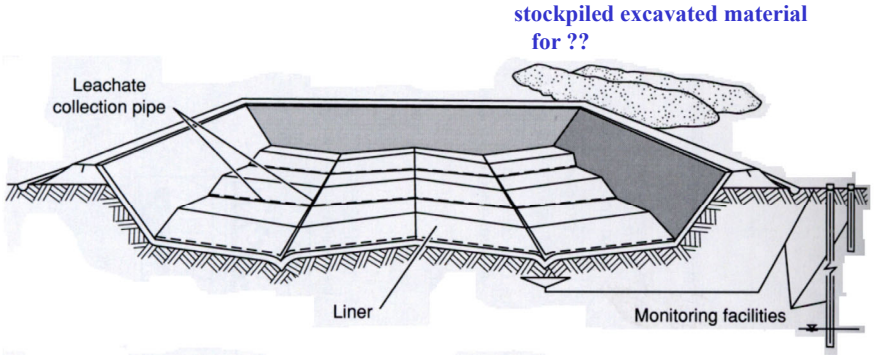


sanitary landfill: (early time) landfilling with cover at the end of each day's operation, (today) engineered facility for the disposal of MSW designed and operated to minimize the public and environmental impacts

Development and completion of a solid waste landfill:

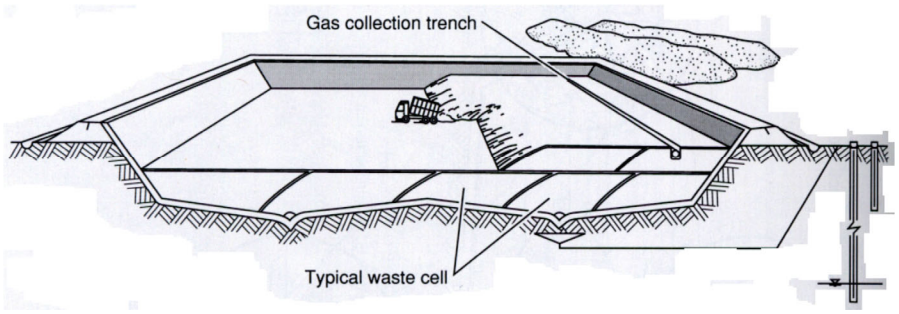
(a) excavation and installation of landfill liner

G. Tchobanoglous , H. Theisen & S. Vigil (1993)



Development and completion of a solid waste landfill:
(b) replacement of solid waste in landfill

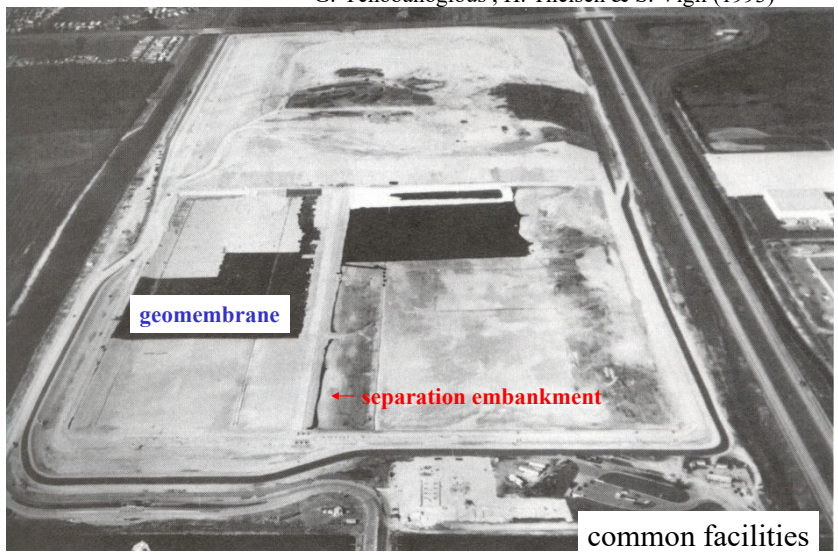
G. Tchobanoglous , H. Theisen & S. Vigil (1993)



Landfills are often constructed in sections: ***staged construction***.
Advantages? and disadvantages? （段階施工）

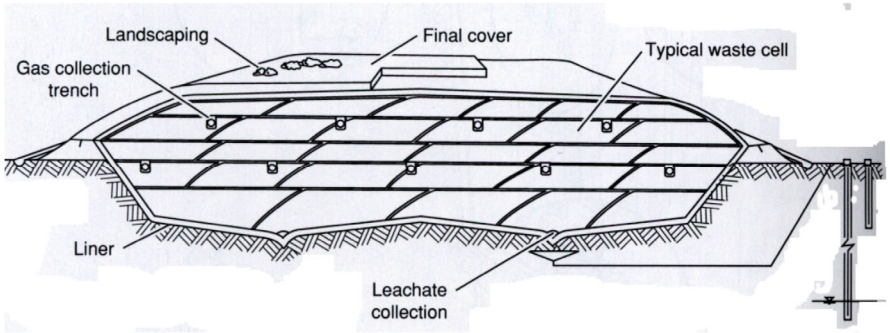
Aerial view of area type landfill:

G. Tchobanoglous , H. Theisen & S. Vigil (1993)



Development and completion of a solid waste landfill:
(c) completed landfill

G. Tchobanoglous , H. Theisen & S. Vigil (1993)



long term operation of leachate and gas collection, and monitoring

Concerns with landfilling of solid wastes

(1) uncontrolled release and discharge of **landfill gases(CH_4)**:
odor, explosion, greenhouse effect in atmosphere

(2) uncontrolled release of **leachate**:
contamination of ground water and surface water

(3) breeding and harboring of *disease* vectors:

(4) release of the **trace gases** arising from the hazardous materials that were often placed in landfill in the past:
public and environmental impact

goal for the design and operation of a modern landfill is:
to eliminate or minimize the impacts associated with these concerns.

3.2 Classification, methods of landfills

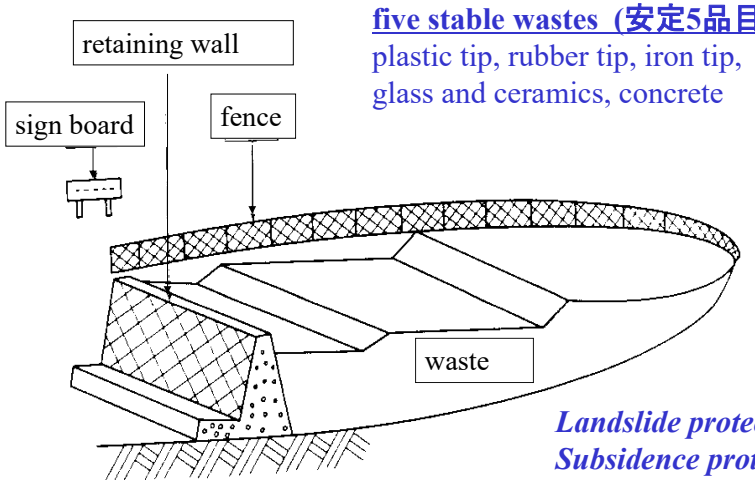
Classification in US:

Class	Type of waste
I (secured landfill)	**Hazardous waste**
II (monofills)	**Designated waste (***combustion ash, asbestos* **)**
III(sanitary)	**Municipal solid waste (MSW) (**commingled)

In III, not only MSW, but also *nonhazardous industrial wastes* and *sludge from water and waste water treatment plants* are accepted (solid content should be greater than 51%) . ***Liquid waste is no longer accepted***.

Japan → Three types of landfill
Waste management and public cleansing law
- •Least controlled LF
- •Controlled LF
- •Strictly controlled LF

Least controlled landfill (安定型処分場)



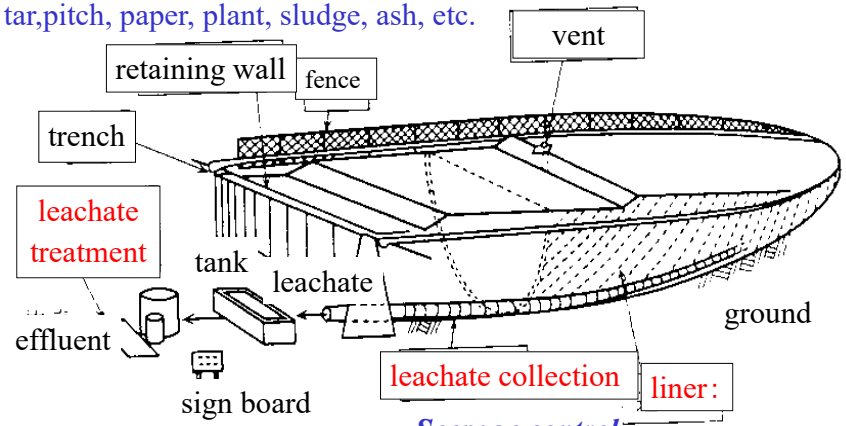
five stable wastes (安定5品目)
plastic tip, rubber tip, iron tip,
glass and ceramics, concrete

Landslide protection
Subsidence protection

Controlled landfill (管理型処分場)
(sanitary landfill)

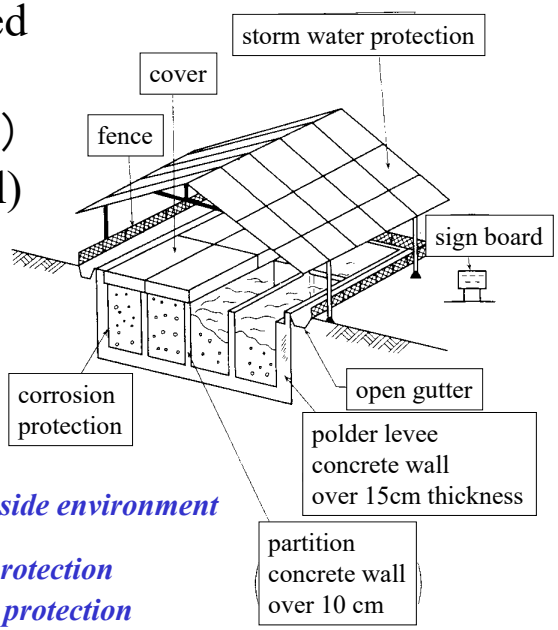
non hazardous waste

tar,pitch, paper, plant, sludge, ash, etc.



Leachate control
Seepage control
Landslide protection
Subsidence protection

Strictly controlled landfill (遮断型処分場) (Secured landfill)



Hazardous waste

ash, sludge,

mining tail, dusts

separation from the out-side environment

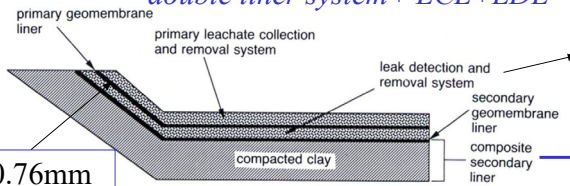
Landslide protection
Subsidence protection

Minimum liner requirements of the USEPA: Daniel (1993)

RCRA:
Resource Conservation and Recovery Act

(a) for hazardous waste landfills:

double liner system+ LCL+LDL



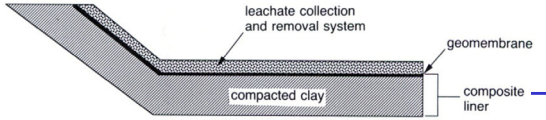
detecting in 24hrs

0.76mm thickness

0.9m thickness with K< 1x10^{-9}m/s

(b) for non-hazardous waste landfills:

single liner system+LCL



0.6m thickness with K< 1x10^{-9}m/s

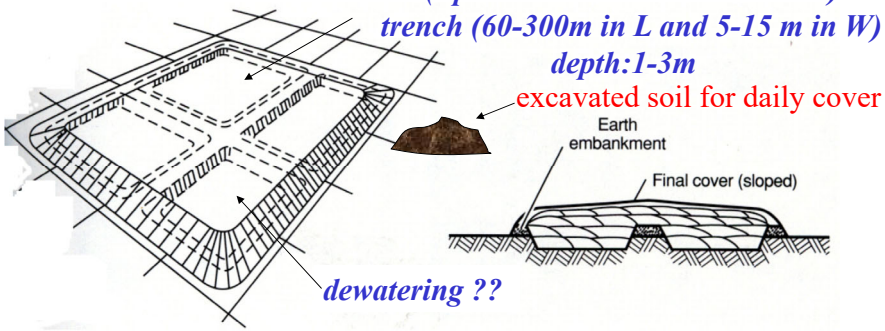
Methods of landfilling

- **Excavated Cell/ Trench Method;**
- **Area Method;**
- **Canyon/Depression Method;**
- **Offshore or inshore reclamation**

  Tokyo Bay (Sinkamen landfill)

Excavated Cell/ Trench Method

cell (square about 300m in W and L)
trench (60-300m in L and 5-15 m in W)
depth:1-3m



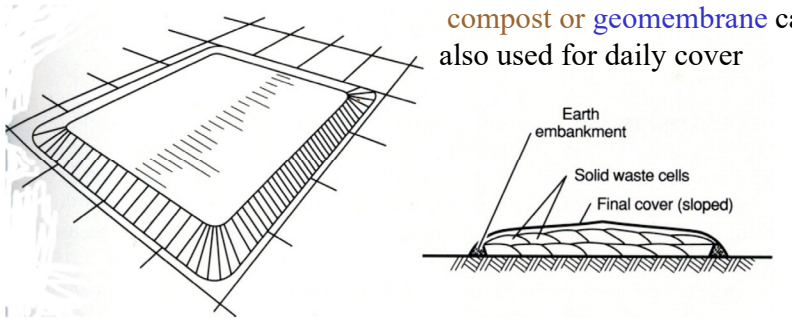
Suitable conditions;

•adequate depth of cover material is available at the site;
•water table is not near to the ground surface.
but if special provisions for preventing groundwater from entering into the landfill.

Area Method

cover soils is hauled from adjacent land or from borrow pit areas.

compost or geomembrane can be also used for daily cover

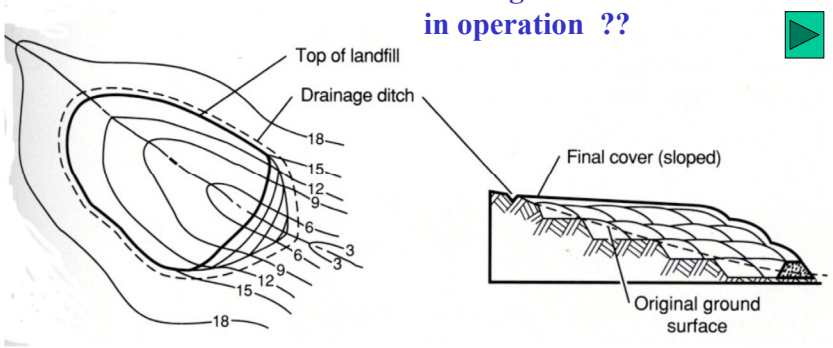


Suitable Conditions;

•terrain is unstable for the excavation of trenches and cells;
•high-groundwater conditions.
.

Canyon/Depression Method

Critical factor
control of surface drainage
in design ??
in operation ??



Factors in design and operation:
geometry of the site, ***quantity and quality of available cover material***, ***hydrology and geology of the site***, *type of leachate and gas control facilities and access to the site.*

Offshore or on shore reclamation

main concerns:
impact to marine environment

Advantages:
scale merits especially for the communities with less available land for landfilling like maga-cities in Japan (Tokyo and Osaka)

Disadvantage:
construction const.

Site Visit: Tokyo Off landfill site
Date => 30th July p.m.

Waste disposal landfill in Tokyo Bay 現在東京湾の廃棄物埋立

3.3 Landfill siting considerations (処分場建設地の選定)

Siting of new landfills is one of the most difficult tasks in implementing an integrated solid waste management program.

The factors considered in evaluating potential sites for the long term disposal of solid wastes:

(1) hauling distance(運搬距離);
operational cost for transporting the waste

(2) location restrictions (現地条件);
preventing accident, avoiding public and environmental impact
preventing natural disaster

(3) available land area(有効土地面積);
not only for landfill but also adequate buffer zone(緩衝地帯), office, facilities, access and utility access roads and so on.

(4) site access(交通の便);
construction of access roadway, transportation facilities

(5) soil conditions;
daily and final cover materials, liner materials,
drainage materials

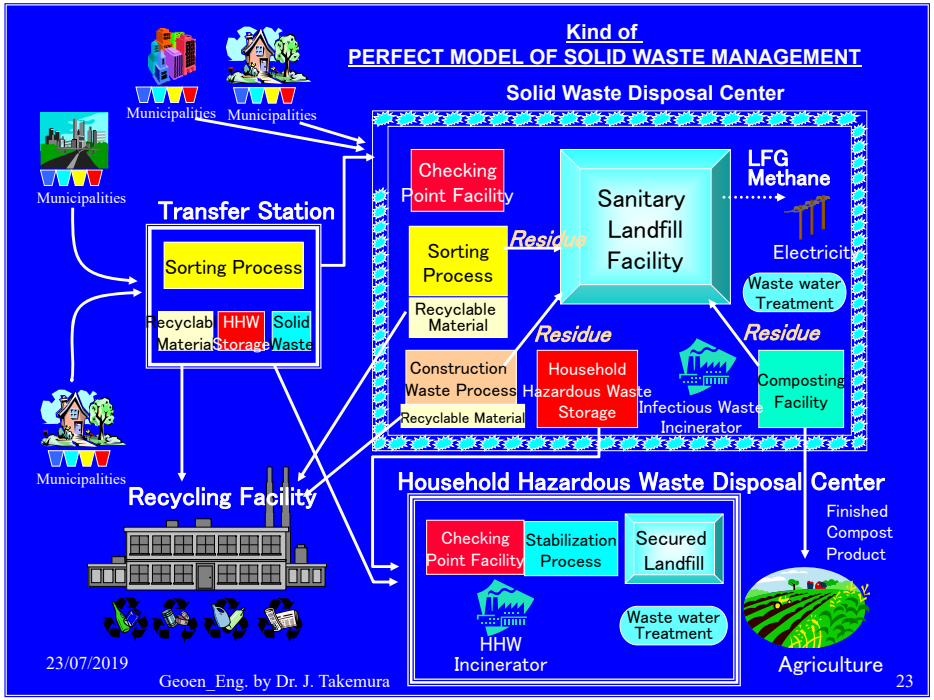
(6) climatological conditions;
(7) surface water hydrology;
(8) geologic and hydrogeological conditions;

1)
2)
3)

(9) local environment conditions(周辺環境);
residential and industrial development near the site must be carefully considered.

(10) potential ultimate uses for the completed site(後地利用).
As the ultimate use affects the design and operation, it should be considered before the layout and design is begun.
stage planning program during and after landfilling

What is Ideal LF?

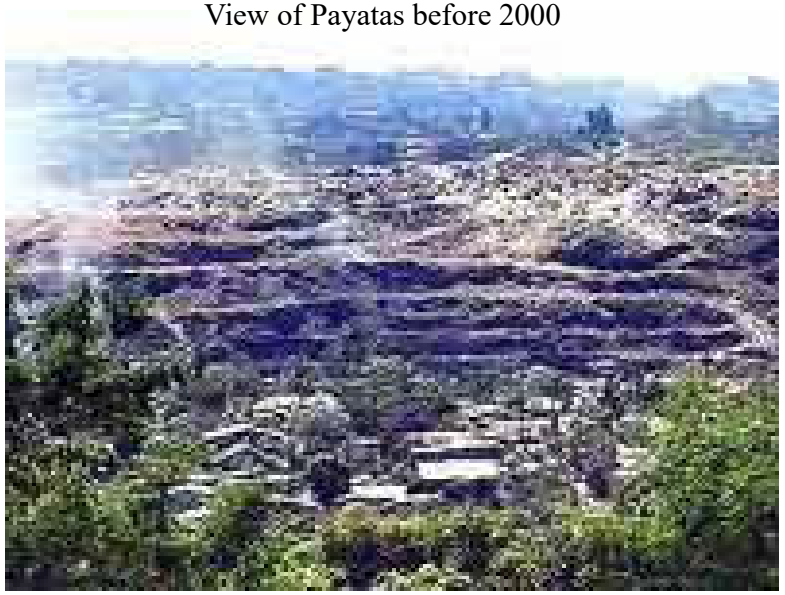


Various LFs in Southeast Asian countries and Japan

Description of Payatas Dumping Site Quezon City Philippine

Approximately 22 hectares – composed of two dumpsites, old and new, 35 – 40 meters high

View of Payatas before 2000



Payatas open dumping sites for Metro Manila

1999

Slope failure at Payatas
July 11, 2000

- garbage about 40m high
- 60, 000 cubic meters of waste slided
- killed 250 people from 700 families
- upto 800 people missing

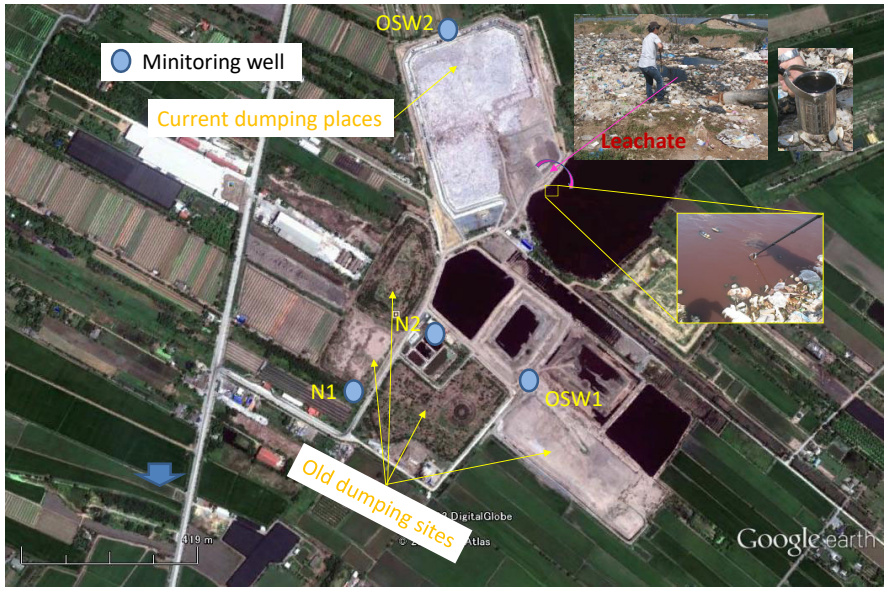
View from east
taken 26/9/2000

Recovery work

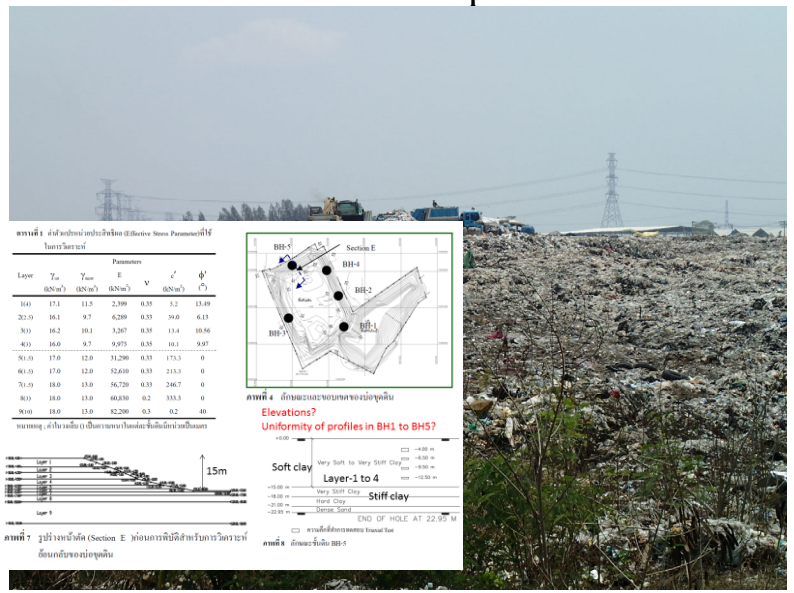
26/9/2000

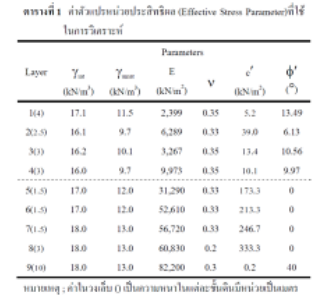
CURRENT

Thai Nontaburi province dumping facility

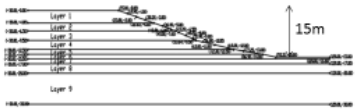


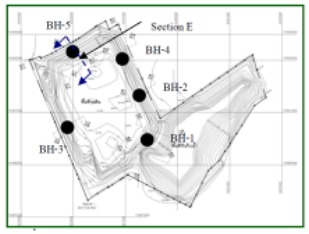
Landfill under operation



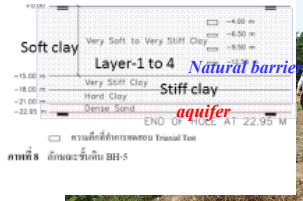


Layer	γ_{sat} (kN/m³)	γ_{unsat} (kN/m³)	E (kN/m²)	ν	c' (kN/m²)	ϕ' (°)
1(4)	17.1	11.5	2,399	0.35	5.2	13.49
2(2.5)	16.1	9.7	6,289	0.33	39.0	6.13
3(3)	16.2	10.1	3,267	0.35	13.4	10.56
4(3)	16.0	9.7	9,973	0.35	10.1	9.97
5(1.5)	17.0	12.0	31,290	0.33	173.3	0
6(1.5)	17.0	12.0	52,610	0.33	213.3	0
7(1.5)	18.0	13.0	56,720	0.33	246.7	0
8(3)	18.0	13.0	60,830	0.2	333.3	0
9(10)	18.0	13.0	82,200	0.3	0.2	40





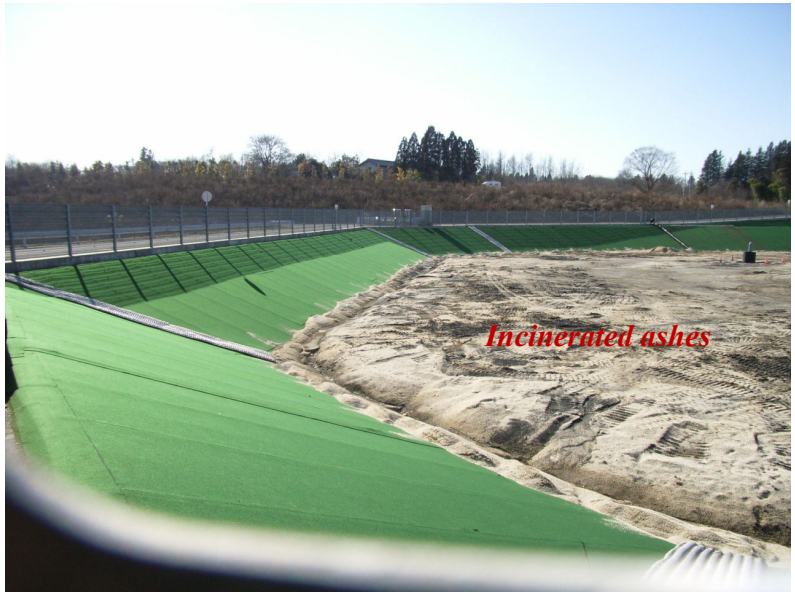
Pit for construction soils



Dumping site at Phnom Penh

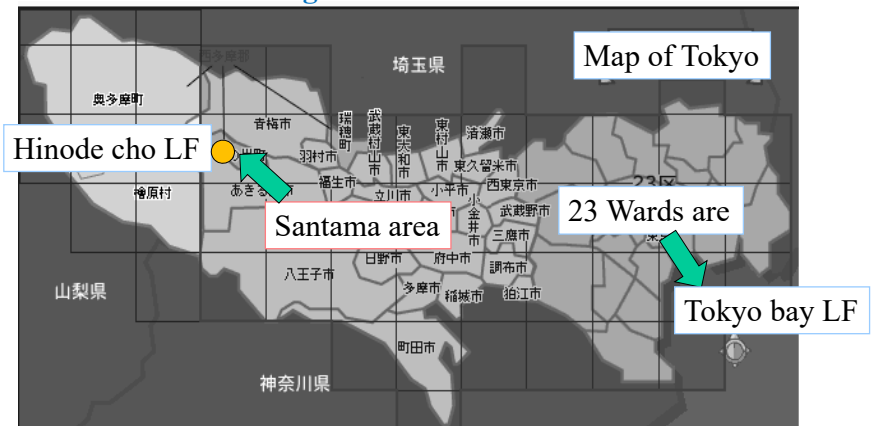
Dec, 2015

Operating Sanitary landfill in Utsunomiya, Japan

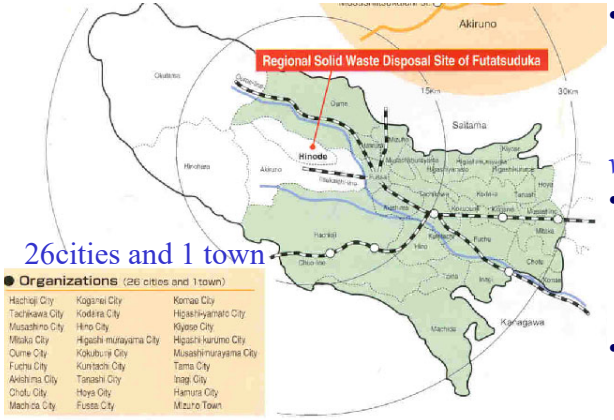


Solid waste management in Tokyo

Tokyo Tama Regional Recycle Association
How to make long time use of landfill



Regional Solid Waste Landfill Futatsuduka, Hinode Town in Tokyo



26cities and 1 town

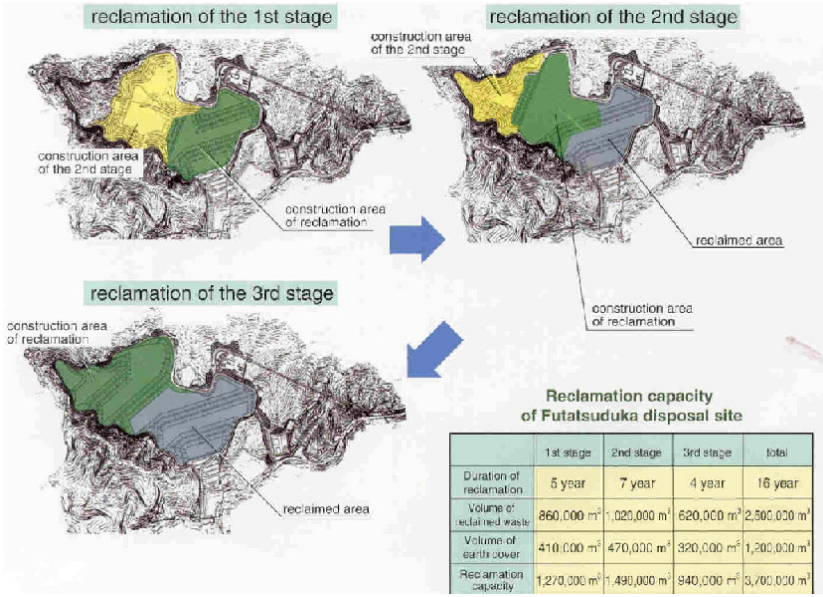
Tokyo Santama Area Regional Association of **Waste Disposal**: 26cities and 1 town

Tokyo Tama Regional **Material Recycle** Association

- **Municipal waste**; *incineration residue*, *non hazardous and nonflammable shredded waste*,
- **Capacity**; total: **3.7Mm^3**
  - *waste:2.5Mm^3*
  - *cover soil: 1.2Mm^3*
- **Duration of fill;** original design from 1998 to 2014
  - ***Eco-cement*** **current** to 2028 ***??***
- **Cost** about 50billion yen

Proper control and operation

Staged reclamation



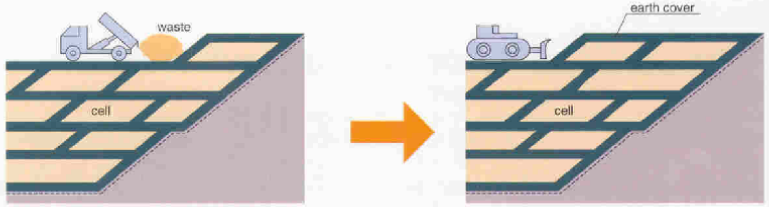
Reclamation capacity of Futatsuduka disposal site

	1st stage	2nd stage	3rd stage	total
Duration of reclamation	5 year	7 year	4 year	16 year
Volume of reclaimed waste	860,000 m^3	1,020,000 m^3	620,000 m^3	2,500,000 m^3
Volume of earth cover	410,000 m^3	470,000 m^3	320,000 m^3	1,200,000 m^3
Reclamation capacity	1,270,000 m^3	1,490,000 m^3	940,000 m^3	3,700,000 m^3

Proper control and operation

Reclamation method

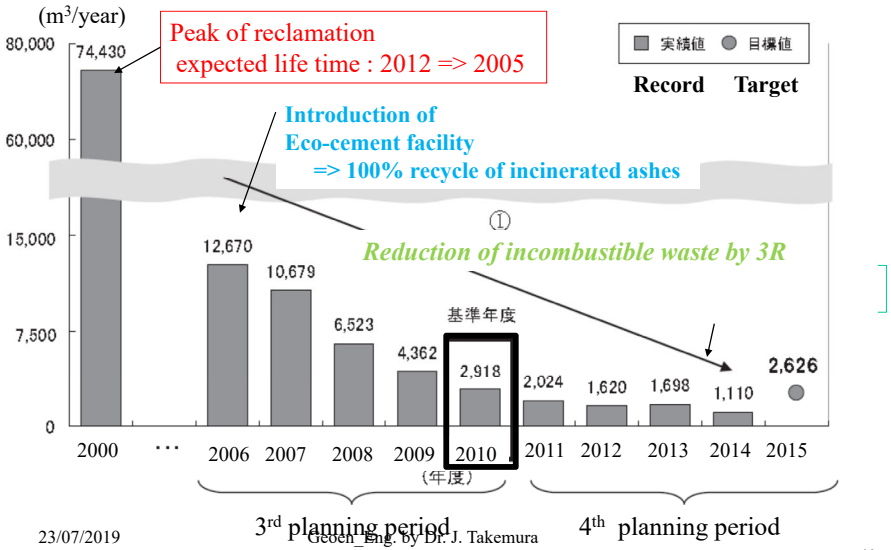
Cell style is adopted, i.e. waste is firstly crushed and leveled by bulldozer and then, cover the earth over the waste as if the waste is wrapped.



Earth cover: about 50cm thickness for each cell
more than 1m for final cover
on-site soil

Change of annual reclaimed volume at Futazuzuka

http://www.tama-junkankumiai.com/

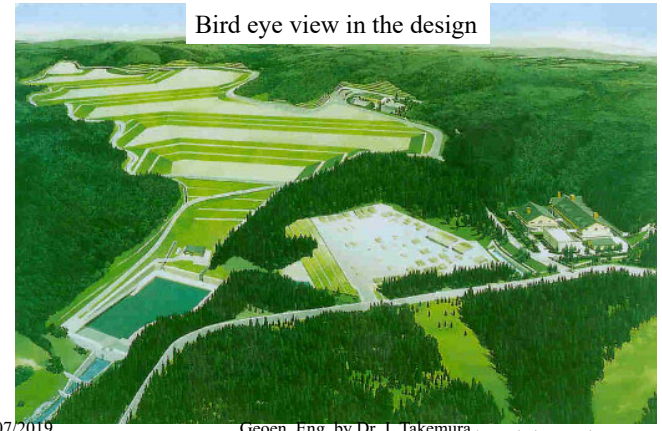


Policy of Futatsuzuka LF

I. Facilities for safe disposal site
II. Environmental preservation
III. Proper control/operation

⇨ + Recycle, Long operation

Bird eye view in the design

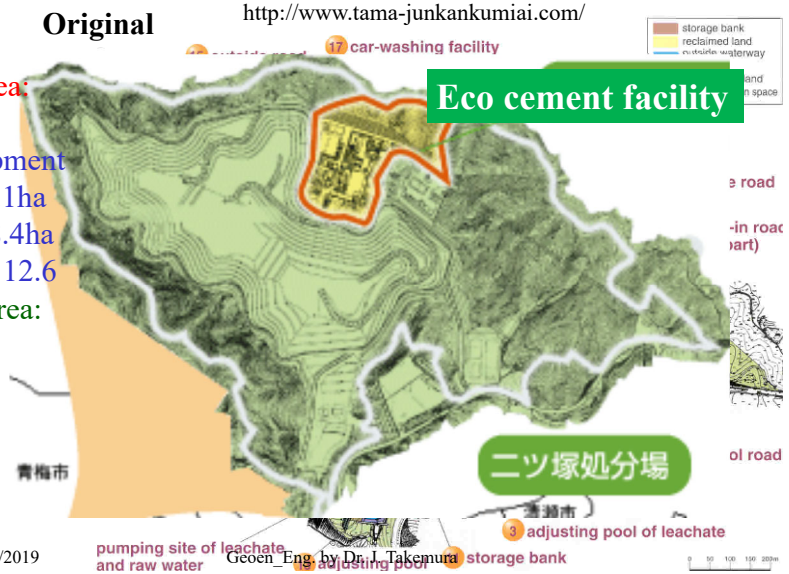


Facility locations

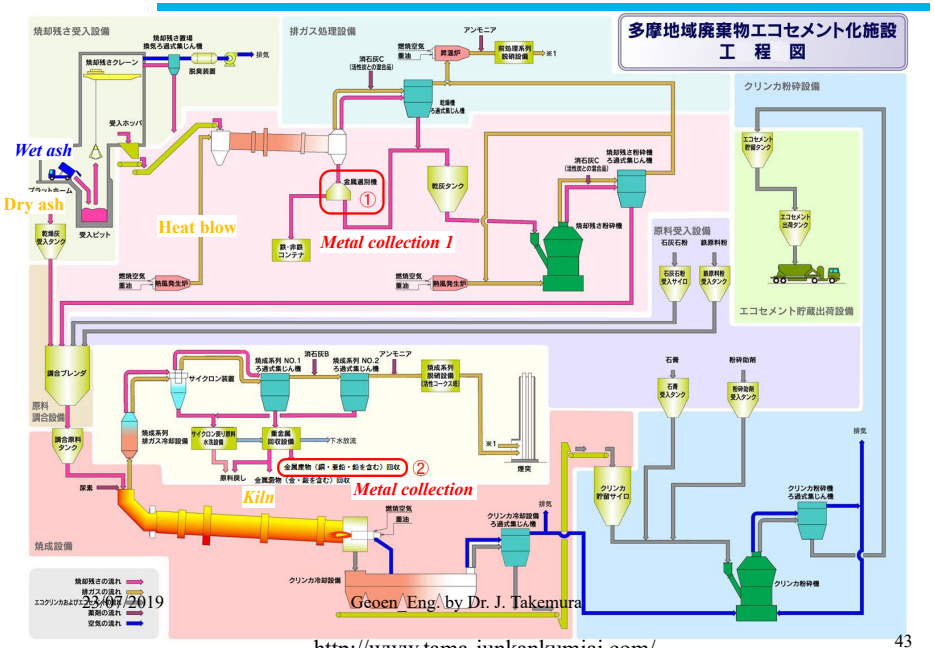
Original

http://www.tama-junkankumiai.com/

- Land area: 59.1ha
- Development area: 31.1ha
  - fill: 18.4ha
  - others: 12.6
- Green area: 28.1ha



Process of eco-cement production



Futatsuzuka Landfill

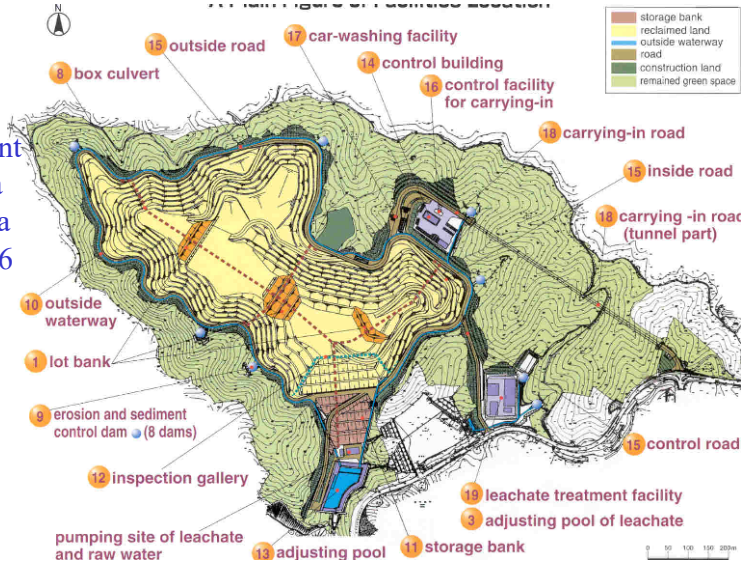
http://www.tama-junkankumiai.com/

Eco-cement facility

Reclaimed area for incombustible waste

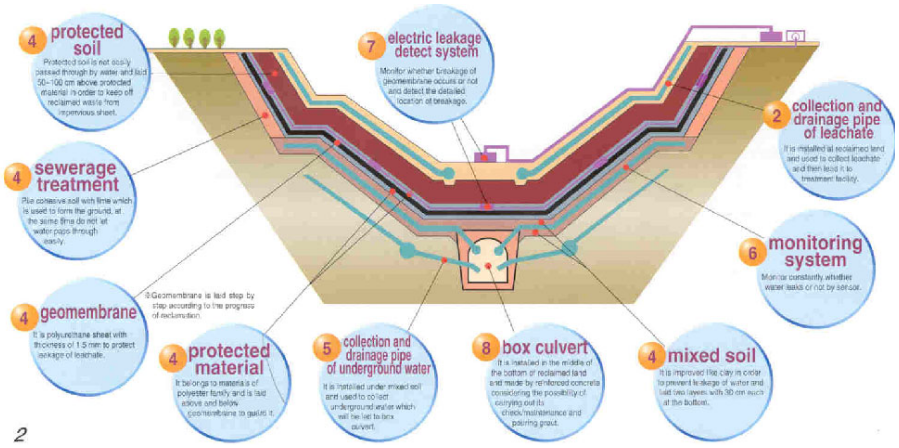
Plan of facility locations

- Land area: 59.1ha
- Development area: 31.1ha
  fill: 18.4ha
  others: 12.6
- Green area: 28.1ha



p20

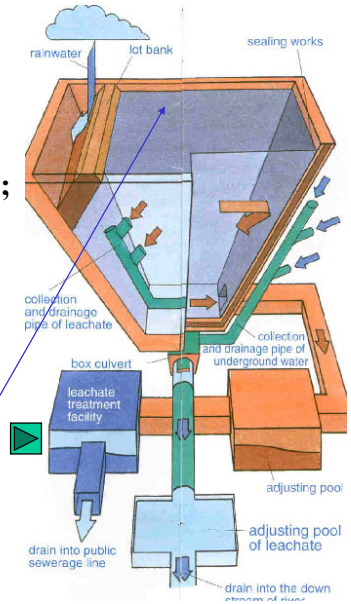
A cross sectional view of landfill - safety facilities -



Prevention of leachate leaking

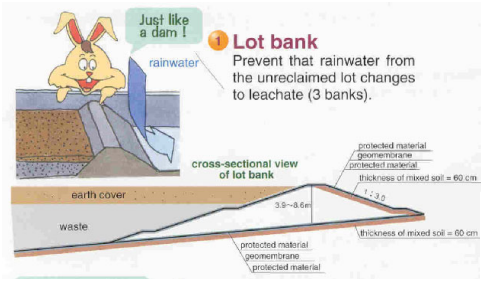
- **Proper water management system; to prevent the rise of leachate level in the fill**
- **Proper liner system;**

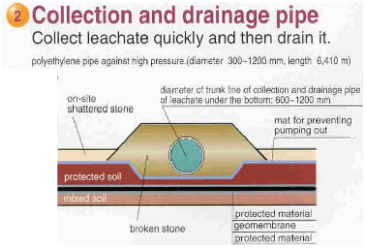
But no cover liner system only cover soil in Japanese standard

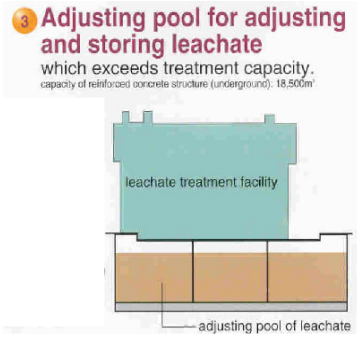


How to prevent rise of leachate level in the fill

in case of **no cover liner**

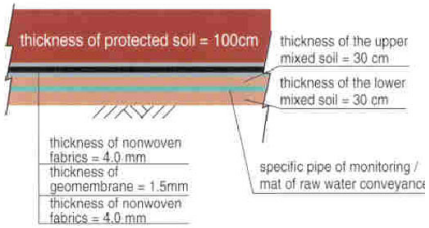




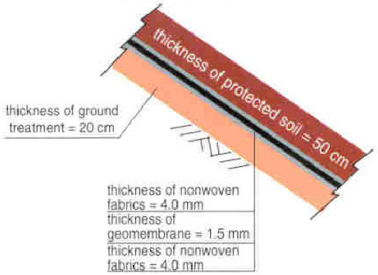


Three types of composite Liner

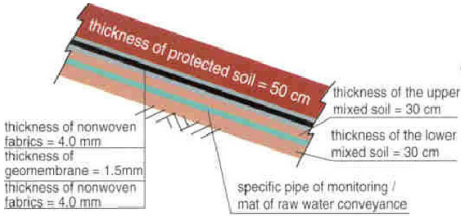
(1) bottom flat part



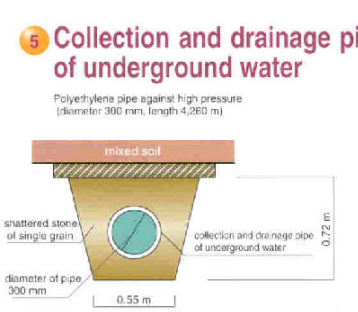
(3) steep slope (1:1.5)

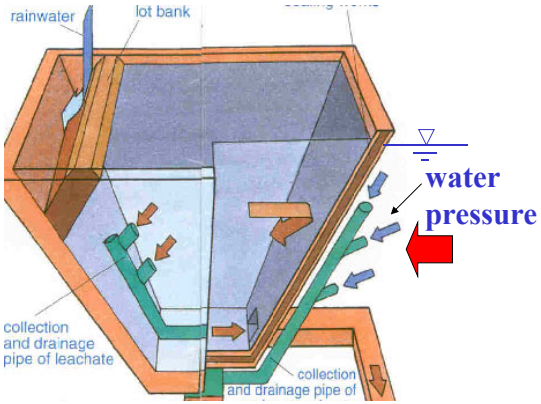


(2) gentle slope (1:3.0)



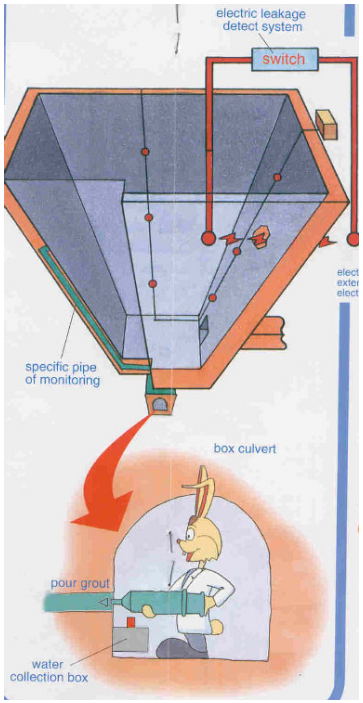
Protection of liner system from underground water



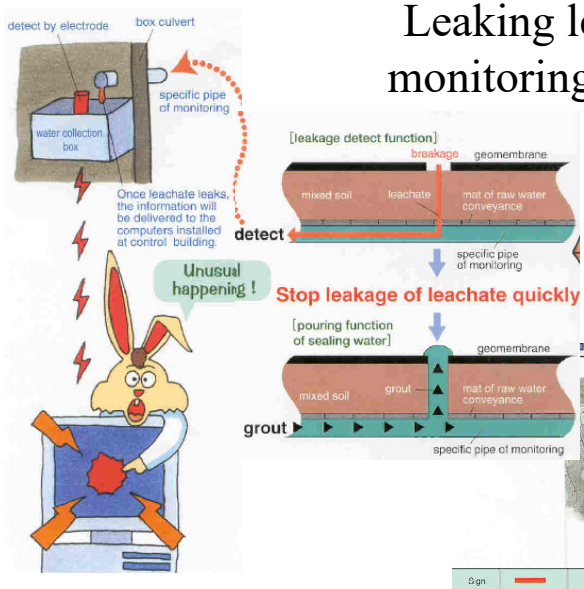


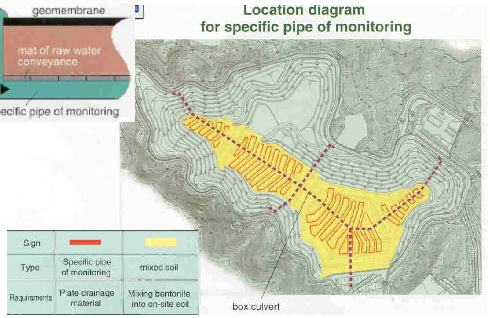
leakage detection system

- Monitoring leachate from specific pipe in the liner
- Electric leakage detection

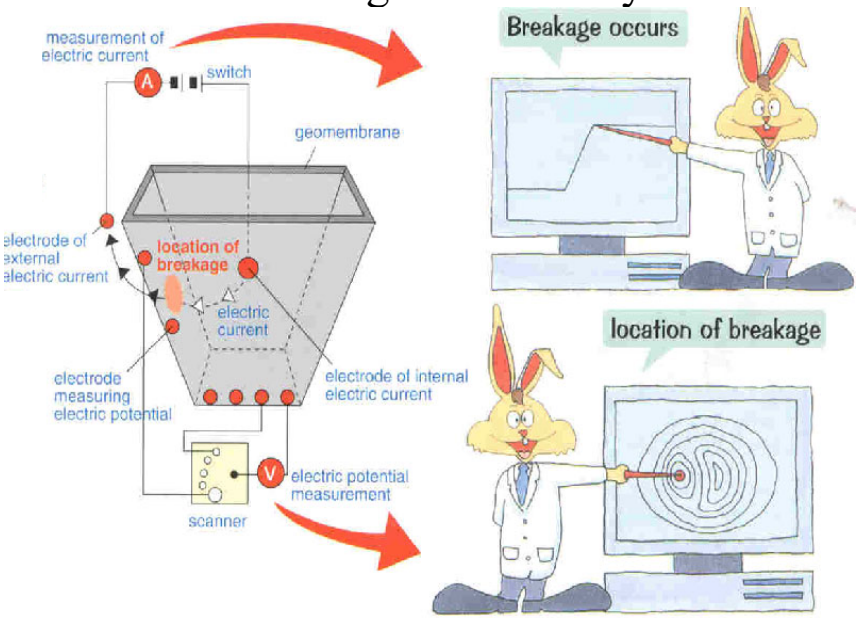


Leaking leachate monitoring system





Electric leakage detection system

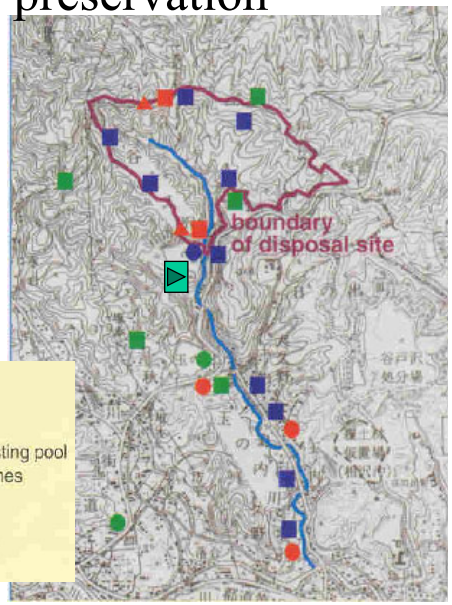


Environmental monitoring & preservation

p35

Measures in planning stage
construction stage
reclamation stage
post closure stage

disclosure of monitored data in WEB



How to construct new ladfill

Ecoa Kumamoto
Controlled Industrial W LF
Open Jan 2017

Pamphlet

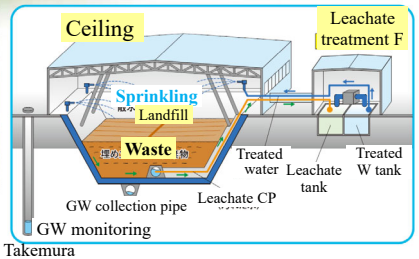
Closed type Controlled IW LF

- Landfill area: 31,131m2
- Capacity: 422,349m3
- Total land: 118,679m2
- Daily reclamation: 60m3
- Reclamation period: 18~20 ys

Closed type- Zero Leachate Release

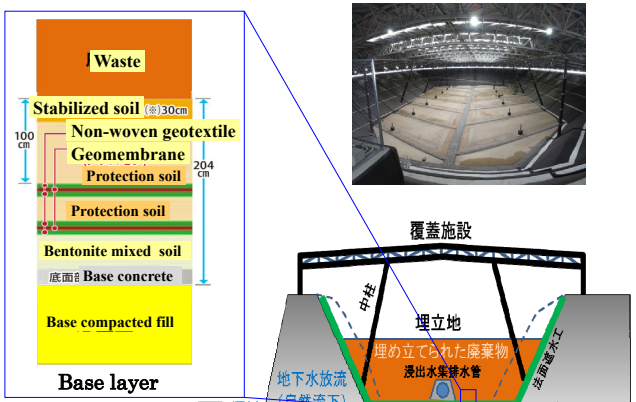
http://www.kksj.jp/index.html

Conceptual diagram of closed type landfill

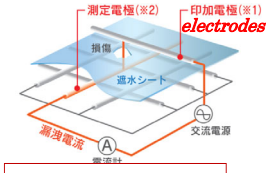


http://www.kksj.jp/index.html*cotopia Kumamoto*

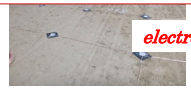
Various barriers against leachate leakage



処分場断面と周辺の地形



Leakage detection



Landfill facility observed after construction

photo taken 2015/12/9