# Tokyo Bay-side Landfill

~ Structure, Management, Land-use~







# Recycling-oriented societies — Tokyo and Beyond

One of the biggest challenges for a mega city is securing space for final disposal sites. As the concentration of urban functions has progressed, the degree of difficulty becomes more serious. Tokyo has been facing the same challenges and found the answer in bay-side disposal sites.

Bay-side disposal sites create the potential of new city development in addition to appropriate disposal of waste. Meanwhile, the bay-side is an extremely valuable natural resource. Therefore, it is necessary to pay utmost concern to the conservation of the environment.

To that end, well-planned development, environmentally-friendly structures and construction, sanitary landfilling of waste, and appropriate maintenance and management are necessary. We, the Tokyo Metropolitan Government, hope to share our experiences and technologies obtained through the bay-side disposal sites in the Port of Tokyo and that this handbook will be informative for your city.

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# Basic information of Tokyo



\*The daily amount is simply calculated by dividing the yearly amount by 365 (days).



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# Basic information of Tokyo bay-side disposal sites

The Tokyo Metropolitan Government is now installing and managing two bay-side disposal sites in the Port of Tokyo. These disposal sites receive incineration ash and incombustible residue from municipal solid waste in the 23-ward area of Tokyo, sludge from water and sewerage, and industrial waste\* after intermediate treatments such as incineration and pulverization. The Tokyo Metropolitan Government Bureau of Port and Harbor is responsible for the construction of the disposal sites while the Bureau of Environment is responsible for the landfilling of waste.

\* Composed of combustion residue, sludge, metal scraps, and the like discharged from small and medium enterprises located in Tokyo.





# I Construction

## Hydrographic condition of the Port of Tokyo



#### Reclamation by soil (F and G block)

The western blocks (F and G), where there will be a container terminal in the future, are reclaimed by soil dug from construction sites along with dredge soil. The double steel-tubing sheet pile type is adopted for this, which allows the erection of a pier easily for the purpose of a container terminal in the future.

#### Landfill by soil and waste (A-E block)

The eastern blocks (A–E), where there will be mainly established a vast green space in the future, are landfilled by soil and waste. The caisson type is applied after considering the construction costs. The thorough seepage control mechanism is equipped, and on the ocean-side, a shallow bottom is developed for biotic conservation.

# ▶ I-i Overview of New Sea Surface Disposal Site

## **Overview of Shore Protection**

d type block (Blocks F and G

p digging

Dredge soil

Stabilized type products The blocks F and G on the west side are used for burying soil and sand dug from construction sites and dredged soil from

which no leachate occurs.

AP + 60m

G

Waste

The New Sea Surface Disposal Site is enclosed by two types of shore protection, the double steel-tubing sheet pile structure and the caisson structure. For blocks A to E, where waste is buried, the reclaimed land inside the shore protection is first prepared using dredge soil and soil dug from the construction site, followed by the commencement of landfilling of waste. With consideration to the type of shore protection, upgrade cycle, and expected lifespan, the disposal site has sufficient seepage control performance. Additionally, the front side of the outer shore protection of the New Sea Surface Disposal Site on the east side is developed with a shallow bottom structure in due consideration of the environment so that marine resources such as aquatic organisms and fishery products can be preserved.

**Cross-section view** 

Controlled type block (Blocks A - E)

such as

A.P. + 30.0 m (For A block: A.P. + 6.0 m)

...........

pprox. A.P. - 10.0 m

Deep digging area

Soil from construction

soil covering material

leachate treatment during and after landfill operation

ocks A to E on the east side are used for land including incineration ash and sewage sludge



#### they are eligible for a subsidy from the national government. The subsidy rate is up to one third of the cost. The Tokyo Metropolitan Government utilizes this subsidy system for the improvement and maintenance of the New Sea Surface Disposal Site and its shore protections.

#### Subsidy system for disposal site improvement and mainténance

When a municipality plans regional and comprehensive improvement or maintenance of waste disposal facilities or recycling facilities to promote the 3Rs (Reduce, Reuse, and Recycle) in an integral manner, a subsidy will be granted for the improvement or maintenance of the facilities defined in such plans.

The Tokyo Metropolitan Government utilizes this system and is receiving a subsidy for one third of the cost related to the installation of the leachate collection system for the New Sea Surface Disposal Site

# Procedures leading up to the start of construction of the New Sea Surface Disposal Site

Ground improve

τ. Settling

2

The New Sea Surface Disposal Site is constructed after procedures including a long-term forecast of the amount of waste generation and landfill disposal, the implementation of environmental impact assessments, as well as applications for and acquisition of various permissions and notifications have been completed.

promotion area

		Plan	Environmental Impact Assessment
1990	'92	The New Sea Surface Disposal Site is planned (The Port and Harbor Plan of the Port of Tokyo)	<ul> <li>Survey, forecast and evaluation</li> <li>'93 Submission of the report of Environmental Impact Assessment (Draft)</li> <li>Various procedures Advisory council, public</li> </ul>
	'94	The Land Utilization Plan is prepared	'94 Completion of the procedures of the Environmental Impact Assessment
1995	'95	Application for the landfill license under the Public Water Body Reclamation Law	
2000	'96	Acquisition of the Public Water Body Reclamation License Application for the license of the establishment of waste disposal facilities under the Waste Disposal and Public Cleansing Law and acquisition of the license	'96   Start of construction '97   Start of landfilling
2000		I	Block D is currently under construction

# ▶ I-ii Structure of Shore Protection

## Feature of seabed

The feature of the seabed under the sea area for the New Sea Surface Disposal Site is that of a thick layer (about 30 m) of very soft viscous soil (N value = 0 or so) deposited as an alluvium on the top, with the layer becoming thicker toward the southeast direction. Under the central area of the New Sea Surface Disposal Site, a diluvial deposit under the alluvium forms a plateau.

When installing structures on soft ground, it is common to expect to have a diluvial deposit under the alluvium to serve as a support layer for the structure. However, since the very soft viscous layer (permeability coefficient: around  $10^{-7}$  cm/sec) deposited thickly on the seabed functions as a sufficiently impermeable layer, it acts as a seepage control mechanism required for the waste disposal site.



#### Steel-tubing sheet pile type outer shore protection (Block G)

B

For block G, which will be used as a site for a container terminal in the future land-use plan, the shore protection is constructed by adopting steel-tubing sheet piles that have a structure suitable for the improvement and maintenance of the pier.



#### **Feature of Shore Protection**

For the New Sea Surface Disposal Site, its outer periphery and internal partitions are constructed using two types of structures, the double steel-tubing sheet pile structure and caisson structure, based on the results of a comprehensive study in consideration of the soil condition and economic efficiency. Since the New Sea Surface Disposal Site is a controlled type waste disposal site, all possible measures are taken for water shielding, as well as the stability of the shore protection. For the stability of the shore protection, and to increase the strength of the soft viscous soil layer ground, cementitious reinforcement work (the deep chemical mixing method) is applied to the foundation of the outer periphery and reinforcement by replacement with sand (the sand compaction pile method) or cementitious reinforcement is applied to the internal partitions.

As a seepage control mechanism, water-shielding sheets are laid out at the back of the shore protection. In addition to this, for the joint parts of the shore protection body, mortar grouting is applied to them in the case of double steel-tubing sheet piles. In the case of the caissons, flexible cylindrical joint fillers, plate joint fillers, asphalt mastics, and others are applied.

Moreover, steel-tubing sheet piles are installed at a location 10 to 15 meters behind the caisson body. Between the piles and caisson body, an impermeable zone is formed by premixed treatment soil (permeability coefficient: around 10<sup>6</sup> cm/sec or less) to increase the water shielding performance of the shore protection as a controlled type shore protection. The premixed disposed soil is prepared by utilizing the soil (viscous soil) from the construction site and by mixing cement into the soil.

#### Caisson type outer shore protection (Block B & C)

For blocks B and C, which will not be used as a site for a container terminal in the future land-use plan, a mildly-sloped shore and shallow bottom with a length of about 100 meters are constructed. Thorough seepage control is achieved to prevent the leachate from waste from leaching into the groundwater and sea.



# Mildly-sloped shore protection for biotic conservation Development of rock beach

Expanded development of the habitable environment for marine species is undertaken by creating shallow bottoms and tide pools on the mildly-sloped shore protection. The tide pool is made by utilizing the old caissons that were no longer needed in the Port of Tokyo.

#### Concept art of expected natural biota through the improvement





Tide pool at low tide



Concept art of the development

Actiniae

D

Tripletooth goby Emerald bubble

Porifer



# I Waste Landfill and Maintenance

The municipal solid waste from the 23 wards of Tokyo is currently buried at the Central Breakwater Outer Landfill Site and the New Sea Surface Disposal Site. These bay-side disposal sites are crucial facilities as Tokyo' s final disposal sites in the Port of Tokyo.

To use these valuable and finite disposal sites for as long as possible and to hand over ownership of the irreplaceable global environment to the next generation, various efforts are being made at the landfill disposal sites.

In the past, organic waste was buried without intermediate treatment and led to problems such as bad odors and outbreaks of flies. At present, however, all the waste is processed by intermediate treatments (e.g. incineration or pulverization); therefore, the waste received at the disposal sites mainly consists of incineration ash and pulverized residue. This system contributes to extending the service life of the final disposal sites and reduces the operational expenses of wastewater treatment.

# I-i Landfill disposal plan for waste

It is essential to secure space for landfill disposal sites to maintain and develop urban functions. Therefore, the current landfill disposal sites, which assume the very last space in the Port of Tokyo, need to be used for as long as possible.

With this goal in mind, the Tokyo Metropolitan Government has been creating plans to define the categories of waste separation and also project landfill waste volume with the goal of extending the service life of the landfill disposal sites. The current plan has a 15-year overall design covering 2012 to 2026, and undergoes review every five years.

Landfill	disposal	plan	for	waste	(Excerpt)	(unit : ten	thousand m <sup>3</sup> )
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	2012-2016	2017-2021	2022-2026	Total
Waste	207	195	195	597
Soil-covering	42	39	39	120
Dredge soil	465	510	390	1365
Soil from construction	245	200	200	645
Total	959	944	824	2727

#### Policy of waste reception by type

(1) Municipal Solid Waste

- Waste from households in the 23 wards of Tokyo
- · All waste must undergo all possible intermediate treatments for volume reduction and resource recovery before being transported into the final disposal sites.

(2) Industrial Waste

- Industrial waste from small and medium-sized enterprises located in Tokyo A certain amount of the waste after undergoing intermediate treatments is received only if it satisfies the receiving criteria.

(3) Urban Facility Waste

- Waste from facilities such as water and sewerage facilities in Tokyo
- The waste is received after receiving intermediate treatments.