CONCEPT OF RENOVATION METHOD OF THE EXINTING INADEQUATE LANDFILLS AND ITS APPLIED SITE

J. IMAI*, Y. SASAI**, M. MISHINA°, M. URA°°, M. KAWAGUCHI[#], T. FURUICHI[##] AND M. HANASHIMA[##]

** LSA, NPO (Tech. Laboratory, JDC Corp. Co. Ltd,1-4036 Nakatsu, Aikawa Town, Kanagwa Pref. 243-0303 Japan)*
*** LSA, NPO (Kansai Office, Towa Science Co. Ltd. 3-1 Chome, Monjubashi St. Sakai City, Osaka, 590-0053 Japan)*
° Environmental Economy Dep. Saitama City Office,4-4-6 Chome, Tokiwa, Urawa-ku, Saitama City 330-9588 Japan
°° LSA, NPO (Department of Engineering,Kajima Corporation Co. Ltd. 7-2-1 Chome, Minato-ku, Moto-Akasaka, Tokyo107-8388 Japan)
[#]LSA,NPO(Division of Environmental Project Okumura Gumi Co. Ltd. 1-6-5 Chome, Shiba, Minato-ku, Tokyo 108-8381 Japan)
[##]LSA,NPO (Landfill Systems & Technologies Research Association of Japan, NPO, 401 Chateau Takanawa, 14-23-3 Chome, Takanawa, Minato-ku, Tokyo 108-0074 Japan)

SUMMARY : Inadequate landfills approved under the previous low in Japan have been renovated for the proper closure or renewal based on the large amendment of the related regulations in 1997 on the structural standards of the facilities with national funding with the announcement of the list of unsuitable sites. On account of the suitable improvement for the unsuitable landfill, NPO.LSA summarized the concepts from the investigation to the designing and a series of applicable methods, ideas and the way of improvement by countermeasures such as waterproofing, sub-drainage, gas releasing devices and water treatment for leachated water, quality control and monitoring method as technical references for all the persons concerned. We introduce the out-lines of the investigation technique, the construction methods of vertical underground waterproofing wall, capping, drainage, gas releasing and leached water treatment methods. And the executed case in Saitama Prefecture in Japan in 2003 based on this guidance under our assistance is reported.

1. INTRODUCTION

In March 1998, the Ministry of Health and Welfare of Japan announced to the public 538 Landfill sites as inadequate sites under the current regulations. And the government prepared the

Proceedings Sardinia 2005, Tenth International Waste Management and Landfill Symposium
S. Margherita di Pula, Cagliari, Italy; 3 - 7 October 2005

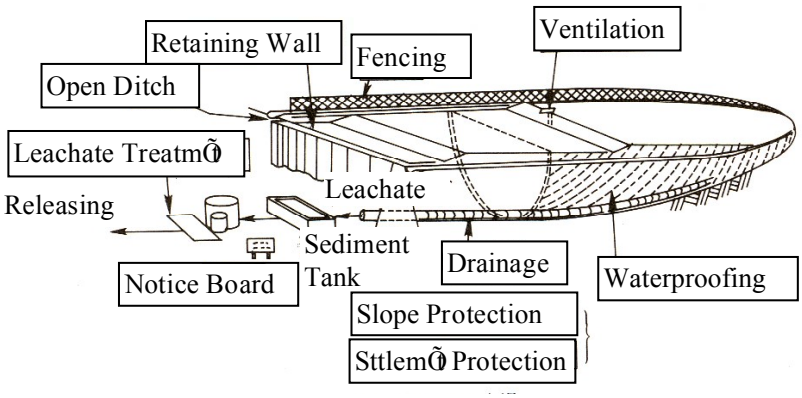

Figure1. Required facilities for control type final disposal site

subsidizing plan for the concerned local government to renovate those sites from fiscal year 2000 to 2005.

However, the actual technical guidance for the renovation method was not well prepared for such projects except for "Technical Reference on account of the Renovation Method for Inadequate Final Disposal Site" issued by the Ministry in Nov.27th, 1998.

Under such circumstances, LSA's research working group for Execution Method commenced to study to summarize the acceptable designing method based on the conventional execution methods.

This is to introduce those methods and basic concept, which would be acceptable to carry out such projects in Japan under the recent regulations.

2. REGULATIONS' REQUIREMENT

Summarized technical requirements in the latest regulations are shown in FIG.1 for the control type of final disposal site. Final disposed waste should be separated from the outside of the site with water proofing membrane or liners, and leachate should not be released without treatment which ensure the treated water lower than the Waste Water Discharge Standard or the values determined by each site which may be much lower than the regulation's values. The fences should enclose the site with notice boards for the access control. Slope protection or settlement measurement might be required in case necessary for the physical stability of the site.

Ventilation pipes to release bleeding gases from the waste and drainage to collect leachates should be provided.

3. DESIGNING CONCEPT & ENGINEERING METHODS

"Guidance for the Performance of Final Waste Disposal Site" described final disposal site as it "is able to stabilize the wastes biologically, physically and chemically keeping in the facility adequately without any harmful occurrences for the maintenance of the living environment" .
That requires functions as;

1. Safety storage with the disaster prevention
2. Prevention from contamination by washing out
3. Stabilization of the filled waste

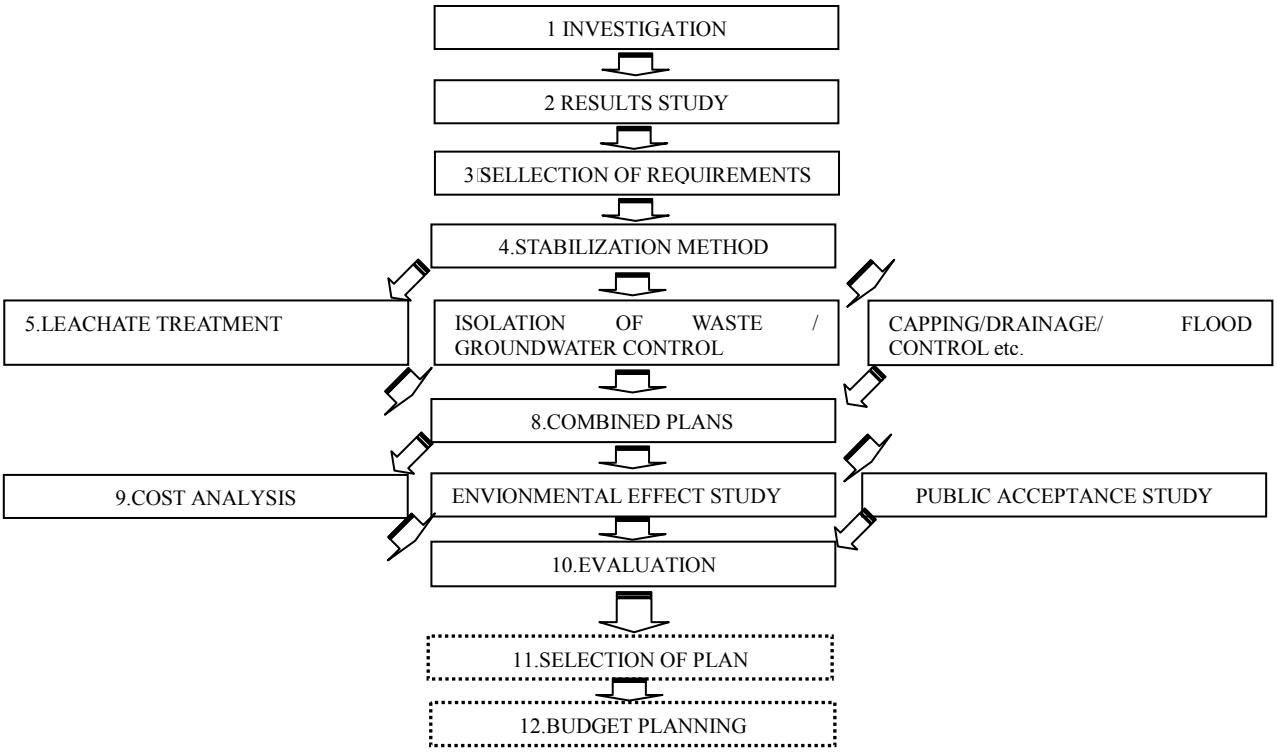

Figure 2. Renovation design procedure for inadequate sites

The design concept described in this report mainly concerns with the item 2 to isolate the filled waste due to the improper facilities that was not regulated in the previous stage of Japanese low or illegal dumping of waste.

As the item 1 is in the conventional civil work category, it is not described in this report.

Although the item 3 should be very important for the designing, the recent studies have not established the effective stabilization method of waste or site so far.

This topic shall be handled by the other report of LSA.

Designing flow for the renovation is shown in Figure.2.

Based on the results of the INVESTIGATION 1, REQUIREMENTS 3 for the site shall be extracted by the RESULTS STUDY.2 And based on the REQUIREMENTS 3, STABILIZATION METHOD 4 for the future termination of landfill site's care shall be selected. Together with the STABILIZATION METHOD 4 and other requirements, LEACHATE TREATMENT, ISOLATIONOF WASTE / GROUNDWATER CONTROL, CAPPING / DRAINAGE / FLOOD CONTROL etc. 5 shall be selected to combine to form a few proposals. Those COMBINED PLANS 8 shall be evaluated from viewpoints of construction cost, the public acceptance, environmental effect studies, and the other requirements affected.

a. Requirement of Design

Requirements should be extracted or arranged from the results of the investigations and from the requirement by the owner such as local government, cooperative of the local government etc. running or maintaining final disposal site.

The requirements might be consists of the local releasing criteria of the treated leachates, the future use of the site, any contamination to the outside of the site or else. Such requirement also might cause variety of the improvement plans.

b. Concept for Improvement

Basic concept is the Isolation of the waste from the surrounding environment by way of the water

migration control.

"Technical Reference Concerning Improvement Method for Inadequate Final Disposal Sites" indicates 6 cases of the counter-measure concept such as the following figures.

The key methods to achieve these concepts are ground-walls for the isolation of the groundwater, groundwater / surface water controlling methods, an over-capping and water treatment methods from such viewpoint.

Each method shall be introduced in the following section.

c. Ground wall for the Isolation from Groundwater

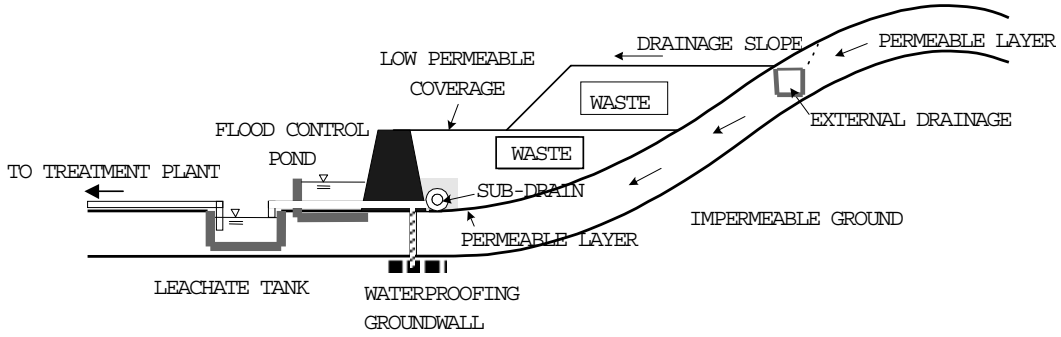

Figure 3. Hill area type in case of natural flow leachate

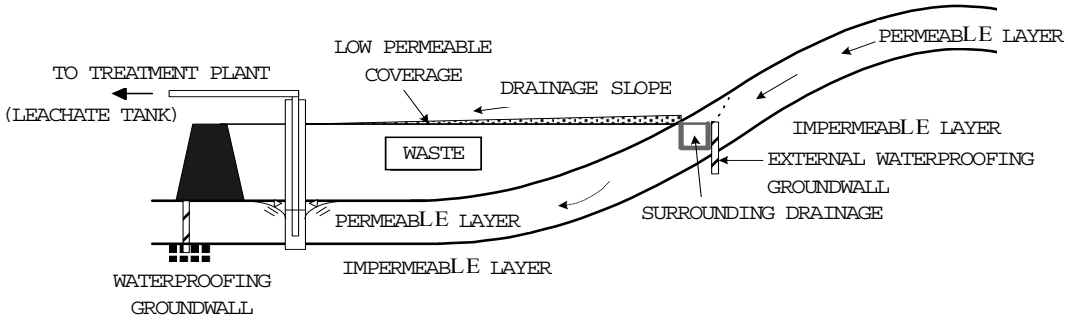

Figure 4. Hill area type in case of pumping up flow leachate

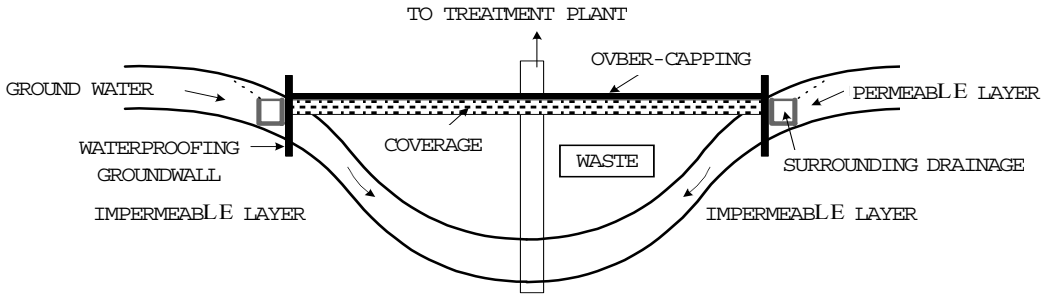

Figure 5. Hill area type in case of enclosed leachate

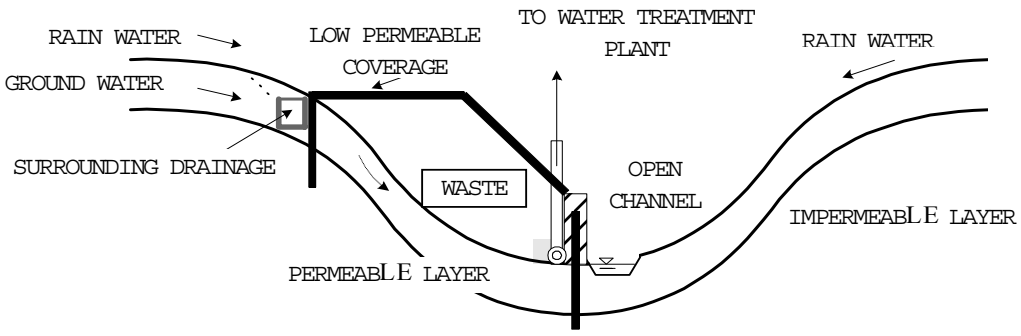

Figure 6. Flatland type surrounded by shoring

Landfill waste in the ground shall be isolated by both impermeable layer□ below 10□□cm/sec required by the regulation below the bottom of waste and the ground wall. Therefore the end of the ground-wall shall be inserted into the impermeable layer enough to ensure the proper watertight performance.

Ground-wall should be designed for each site based on the groundwater condition and its control as the watertight requirement might be varied by the factors.
The process as shown in below will select proper method.

1) Suitability for the ground condition
2) Depth of the wall
3) Suitability to the ground shape
4) Watertight performance
5) Corrosion resistance/Durability
6) Thickness of the wall/Structure of the wall
7) Constructional condition as yard, electricity etc.
8) Cost

Methods could be combined as the case may be to perform for the necessary requirement.
Methods to be considered shall be mainly classified as below.

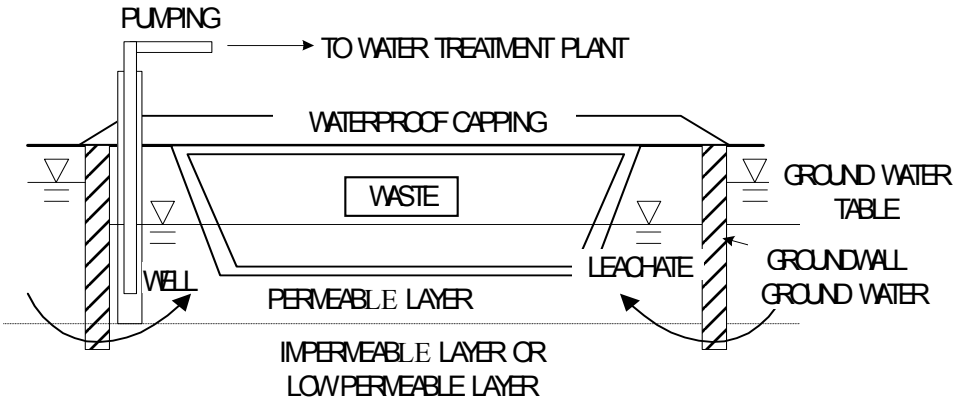

Figure 7. Flatland type with ground wall & ground water control

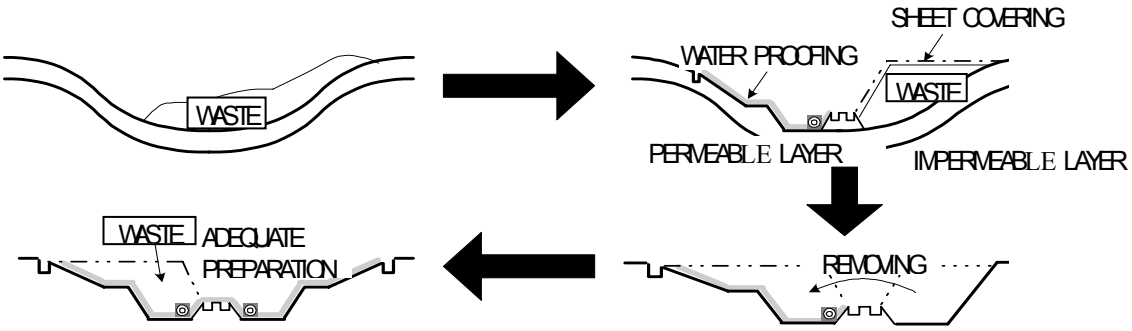

Figure 8. Flatland type in case of removal for renovation

1) Sheet Method

Sheet Method consists of vertical waterproofing membrane such as High Density Polyethylene Sheet(HDPS), Flexible Polyvinyl Chloride Sheet(FPCS), Rubber Asphalt Sheet(RAS) etc.
It shall be classified as the method of direct piling and setting in slurry stabilized trench.
1 Vertical Sheet Method 2 Continuous Sheet Waterproofing Wall Method 3 Earth-cut Method 4 Thinner Type Ground-wall with Watertight Membrane Method 5 Ground Waterproofing Membrane Continuous Wall Method

2) Sheet Piling Method

Sheet piling method are 1 Conventional Sheet Piling method 2 Sheet Wall Method

3) Continuous Ground Wall Method

As the conventional method, such a 100t giant excavating machine is required to construct concrete wall in ground. However smaller size machine such as a 50t gross weight machine has been developed for the limited conditioned site. Construction method 1) 2 to 5 mentioned previously also a part of this method to reduce the wall thickness.
Water tightness should be adjusted by the cement or bentonite content in case it would involve membrane.

4) Soil-cement Solidified Ground Wall Method

This method is to mix cement with soil in ground to form a wall after the execution. This method has Column connection type and wall type. The column connection types are, for instance, SMW, TMW etc. to connect holes filled with cement slurry after boring from the surface.
The wall types are TMW, PTR, Excavation Re-use Ground-wall etc. to connect sections of ground wall by the equipments.
In each method, joint between the column or wall section is quite important for water tightness.

5) Deep layer Mixing Treatment Method

This method categorized in Mechanical Mixing Method and High Pressurized Grouting Method. As the mechanical mixing method causes fluctuations of water permeability, it should be planed to be couple with other method.

6) Grouting Method

Grouting method is to grout cement or hardening chemicals into ground to solidify the ground. This method has Low Pressurized and High Pressurized Methods that includes the former item.
Low pressurized method is said that it achieves usually $1 \times 10^{-4\text{-}5}$ cm/sec nearly 10^{-5}cm/sec required by the regulation, however, it should carefully executed because it could be influenced by the soil in the permeability.

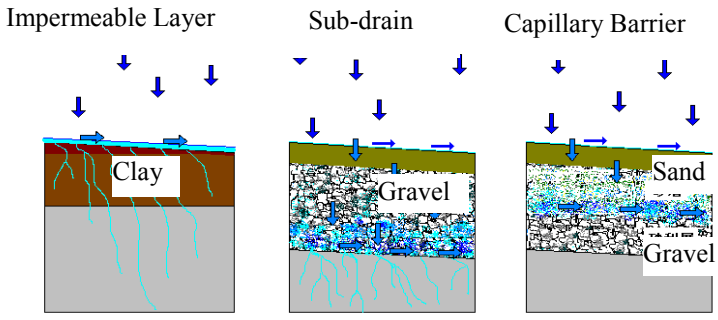

Figure 9. Earth type capping

On the other hand, it is possible for High Pressurized Grouting to achieve less than 10^{-6}cm/sec with good care for the execution, however, construction cost is higher than the other methods. In case of the execution in peat, hard sand gravel layer, clay whose cohesion is higher than 50kNm^{2}should be carefully examined the planning.

d. Over-capping

The over-capping is quite effective for the reduction of the leachate, but that it may cause delay of the stabilization of the waste. In case of the urgency such as the serious contamination around the site should be treated by the tight capping. Otherwise, the capping with the more 500mm th. earth layer with low permeability k=10^{-5}cm/sec may be suitable for the capping.

Capping may be categorized in sheet type, earth type and bituminous type.

The manufactured sheets with covering/protecting earth mainly form sheet type with gas releasing sheets under the impermeable membrane, and drainage sheets on it.

Earth type has 3 types of the concept, ordinary impermeable layer consisted of clay or other impermeable layer, Sub-drain type, which has under-drain layer with gravel or other very permeable material to drain permeated water below the ordinary cover, and Capillary Barrier type, which has the sand drain layer on the gravel layer with covering earth.

Bituminous type might be included in the impermeable layer, 1st one of the earth type, but the material contains bitumen.

Except for the emergency case, a certain volume of permeation is expected for the capping on account of stabilization, however, reduction of the leachate is required for the economical operation of water treatment plant. Therefore instead of the impermeability, the latest capping is said to require an ability of water supply.

Leachate might not be determined only by the coefficient of permeability from the viewpoint of the recent data of experiments. However, the earth type capping may be analyzed for the permeation by the recent technology, and the sheet type capping shall be stand on the stage in the near future.

e. Groundwater Control

Groundwater control would be effective in case of the groundwater level was rather higher than the proper disposal. Sub-drains provided around the site might lower groundwater. But it is necessary for the ground water to maintain the ground water level in the landfill lower than the outside's not to leak out the leachate.

f. Water Treatment

Water treatment plant should be designed by the predicted quality of the leachates, by the criteria of the releasing treated water and by the estimated maximum volume of leachates for the selection

of the plant type, and the determination of the plant capacity.

For stabilization of landfill, plant facilities might be utilized effectively to maintain the water table lower to accomplish the semi aerobic atmospheres in waste layer to accelerate the decomposition. Instead of the releasing treated water, it might be useful to circulate water in case leachate volume was lower than the plant capacity.

4. APPLIED CASE FOR ACTUAL RENOVATION

Mamiya landfill located in Saitama City neighboring Tokyo, operated form 1979 to 1982 with ashes, non-flammable waste and other MSW 24,000 m^2 in area, were renovated by the city with assistance of LSA from 1997 to 2004 by this concept reported.

The landfill was not provided with waterproofing membrane in the ground without leachate collection and treatment facilities. The ground is an alluvial plain with -1.0 m ground water level from the surface although the thickness of the waste layer was assumed 3 m in depth. And potential risk of dioxin was quite high due to the ashes incinerated by the old type incinerators.

Low permeable layers were located less than 8 m from the ground surface, and we selected vertical wall sheeting method for the isolation of waste from the ground water.

Area for the water treatment plant were limited in the site, and also the cost for the maintenance should be saved. In this reason, capillary barrier type capping was chosen for this project to reduce permeation of rainwater to 5 to 10 % of the annual precipitation against more than 40% as usual for the designing in this area.

Moreover, UV/O^3 chemical treatment with high membrane treatment was adopted for the leachate treatment. Now the plant has started operation stably.

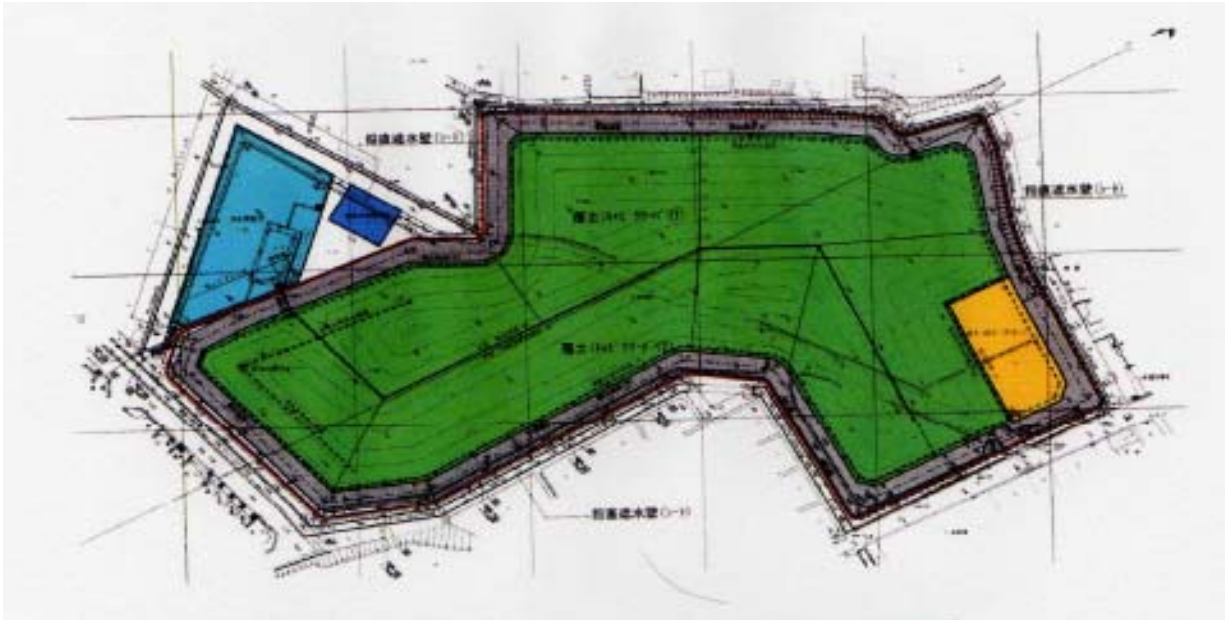

Figure 10. Plan view of Mamiya landfill

Figure 11. Vertical wall sheeting method

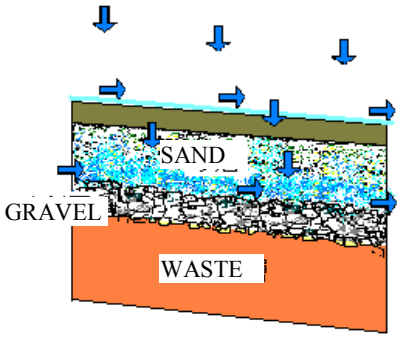

Figure 12. Capillary barrier capping

Figure 13. Treatment plant

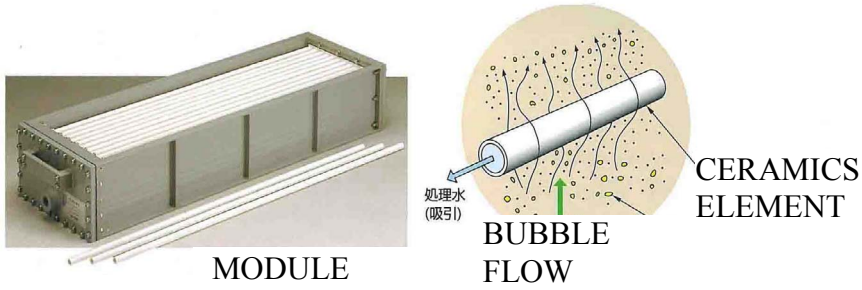

Figure 14. Ceramics filter module

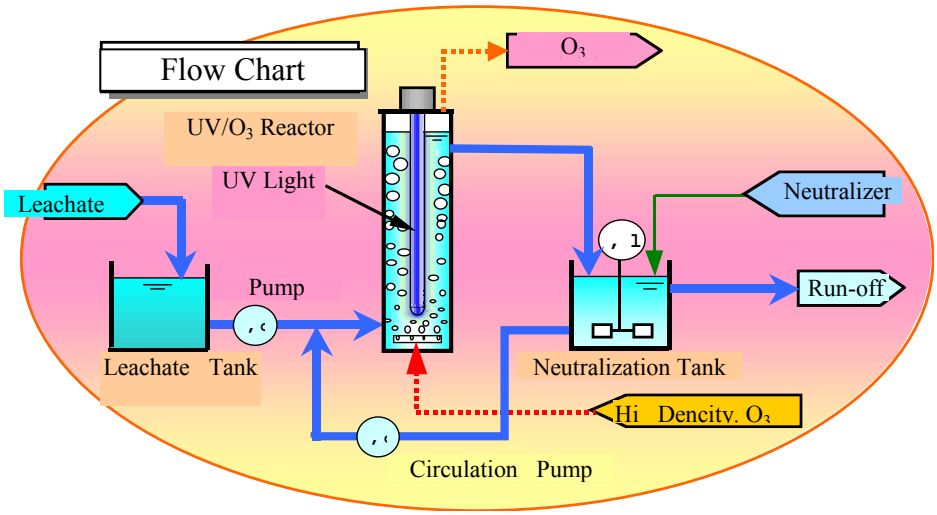

Figure 15. Leachate treatment flow

5. EXECUTION AND Q.C.

It is quite important to execute properly to achieve the expected quality. Even the well considered plans might not be effective in case certain defects were happened on the site. To say nothing of, proper planning of the Quality Control and its execution should be required.

6. CONCLUSIONS

This topic might be old and new at the same time in case it took as influences to the environment from a dumping place. Although such cases have been seen from the oldest age, remedial works have been seldom done. Only in the recent years, we came across with many cases due to the environmental movement. Therefore, we need to collect proper information on it, and make consensus for the designing to establish a certain standard. However, although waste stabilization should be essential for renovation as it shown in the designing flow, term of the stabilization could not predict on account of the estimation for the cost of the post-closure care until the termination due to the complexity of waste.

Water tightness of the ground-wall may be much ascertained. Sheet type capping may be applied to supply certain quantity of rainwater in the near future with established analysis such as

the earth type capping have established.
Though LSA tried to issue reports in 2001and 2002 on the renovation method, those were insufficient so far. We still continue to research such problems after all, and we hope the results of our research could help engineers, stakeholders, and all of the person concerned with.

REFERENCES

Research group for Execution Method in LSA, Remedial method of utilities for improper landfill site on account of re-use and closure, Reports for FY2001, 2002

Tchobanoglous,G, Theisen,H et al : Integrated Solid Waste Management, McGrou-hill,1998

Tanaka,M, Furuichi,T et al: Integration of Monitoring and Rmedial Technologies for Risk Management in Final Disposal Sites, Report for National Institute of Public Health FY1995-1999

O'Donnell, E.,Ridkey,R.W et al.: Control of water infiltration into near Surface LLW disposal units – Progress report on field experiments at a humid region site, Beltsville, Maryland, in Waste Management 93, Proceedings on Waste Management at Tucson, Arizona, Vol.1, pp.65-78,1994

Dwyer,S, Sandia National Laboratoryies : Landfill Covers for Dry Environment, Proceedings of Spectrum 96, pp411-417

Jun Imai, Yukiya Hirata, et al: The Concept of VLLW Trench Disposal Facility Considered Japanese Topography and Underground Water, Proceedings of International Congress of Environmental Management 99, 1999