

**Mr. Zhang Yi (SHANGHAI)**

The landfill site is located near where the Chang Jiang River flows into the East Sea. The river brings sufficient sludge to be used as as cover material. But the cover material will become insufficient for the future. Therefore, we are now trying to use red soil. We have seven landfills right now and in those where there is not enough cover soil we dig up soil in the peripheral areas and bring that to use as cover. At this moment, we are satisfied with the amount of cover material.

## Prof. Masataka Hanashima (FUKUOKA UNIVERSITY)

I am a specialist and researcher in waste management. There are very few people focused on waste management research and this is problematic. I am sure there are a lot of universities in Shanghai. Is there research and investigation in Shanghai universities on waste management? Or is there any kind of research institute inside the city for waste management?

Mr. Zhang Yi (SHANGHAI)

In China waste management, and especially research into waste management, has just begun. There are very few researchers and scholars doing research on waste management. In Shanghai and other cities, there are not many university departments which focus on it. But there are now a few more than ten well-known departments that research waste management. They are actually providing and training experts and researchers to work on waste management. We have an institute comprised of 100 staff. And we are researching waste collection, waste management, and disposal. This research is one of the ways we are exerting efforts for Shanghai waste disposal. Although there is a research institute in Shanghai City this is not the case throughout China. There is a variance in the scale of such research institutes.

## Presentation

**Mr. Park Nam Bae**

**Staff of Landfill Management, Pusan**

**Chairman**

We would like to move on to the next case study presentation.  
The next speaker is from Pusan.

**Mr. Park Nam Bae (PUSAN)**

Good morning, ladies and gentlemen. I am Park Nam Bae from Pusan. In Pusan we use landfilling and I would like to share



with you some lessons we have learned through our experience. Regarding the production of waste in the City of Pusan, for household garbage the total quantity was 5,047 tons a day in 1993. But in 1996, it decreased to 4,311 tons. In 1994, in the City of Pusan, we introduced the garbage weight system. I discussed this with those concerned in the City of Fukuoka, and in Fukuoka City they have tried to control the production of garbage and the citizens have to pay fees for garbage collection.

This decreased the household garbage quantity. Garbage is either flammable garbage and non-flammable garbage. In 1996, flammables accounted for 3,481 tons, which is 80% of garbage in the City of Pusan. Much of the flammable garbage is incinerated at incinerators and we can decrease the ratio of flammables sent to landfills if we construct incinerators. We have landfilling sites which are in the mountainous areas. We use the valleys.

Now, I would like to talk about the treatment status of household garbage. At present, incineration, recycling, and landfilling are the major treatment methods. From 1993 to 1996 there was a reduction in landfilling, meaning that there was an increase in incineration and recycling. Next is the waste treatment facility status. In the City of Pusan we have two incineration sites. One is at Haeundae and another is at Tadae. Tadae Incineration plant has one incinerator and Haeundae Incineration plant has two. Each incinerator has the capacity of 200 tons a day, and in total Pusan City has the incinerating capacity of 600 tons a day. However, we have to have some maintenance operations, so the daily amount incinerated is 500 tons in real terms. Also, since 1995, we have had a plan to build an incinerator with a capacity of 400 tons a day. We are now in the process of siting. Besides that, there is another plan to add the same scaled incinerator site. Therefore, by the year 2000, 1,400 tons per day will be incinerated. We also have the Saenggok Landfilling site and from 1996 to June 2001 we can landfill garbage there. We have another siting committee to build another landfilling site. We have to establish the next landfilling site so that it can accommodate garbage after 2001.

Our plan for landfilling is to divide the landfilling sites into phases: phase one, phase two, and phase three. Now, we are using the phase one area and we estimated the phase one landfill site would be filled in one year and five months. However, the total amount of garbage is being reduced so that we will be in phase one for an extended period of time. At this location there is treatment of the leachate. There are offices and dikes on this site. And we will have sports facilities and parks built after the landfilling is done. In the construction of the landfilling site short-crete is used and when landfilling we will put cloth or some other layer to stop leakage.

Now I would like to talk about infiltrated and leaking water. We have a treatment

capacity of 850 cubic meter tons per day for infiltrated and leaking water. Ten thousand parts per million (ppm) of BOD (biochemical oxygen demand) is allowed. At this treatment plant we can treat up to 1,500 ppms. However, from 1996, we had a three fold increase in the garbage to be filled. With this influx as well as the infiltrated and leakage water, we cannot treat all the water at the landfilling site. So we decided to modify a nearby sewage treatment plant to be used for secondary processing. The sewage plant is ten kilometers away. We transport the treated water to the sewage treatment plant for final treatment.

Here are some of the features of our infiltrated water treatment process. There is some biological processing and we use transport pipes. There is a plant which treats the infiltrated and leaking water. The final treatment is done at Changlim Sewage treatment Plant before water is discharged. And there is a fan to deodorize. The deodorant facility is important so that we won't affect the villages nearby. We have tried to evacuate the villages, however we decided against it. There is some tension between the plant and the villagers. This is the point of our presentation. We have cited some problems in the operation of the landfill. In 1996, when landfilling started there was a heavy rain of 154 millimeters per day. There was a leakage accident during this heavy rainfall. After this experience, we tried to identify the causes. First of all, we failed to block the rainwater. There is a landfilled site and a non-landfilled site and there was an outflow of the infiltrated water and underground water mixture due to a damaged water breaking layer. Also there was underground water which added to the amount of leaking water. There were management problems and also poor organization of other basic foundations. There was damage to the water breaking layer resulting from the weight of the projections filled. Rocky foundations damaged the water breaking layer and thus allowed the overflow of infiltrated water. We had experts comment and give suggestions for improvement. First, we decided to break rainwater and leakage and we had to have a separation of rain breaking and leakage separations. We had to section the landfilled site and remove rain to the outer pipes. This is to prevent leakage. Also we had to build outer pipes, remove water from above the landfill, and prevent any inflow of rain from the outer pipes. On the administrative side, we had to temporarily suspend garbage inflow during heavy rainfall. With this method, in 1997 during the rainy season, we had a heavy rainfall of about 180 millimeters per day but we experienced no infiltrated water overflow.

Also it is necessary to prevent underground water pollution. We have to implement grouting and installation of slurry walls. And we have to improve the existing water breaking layer. We decided to use additional installation of the bentonite mat. Polluted underground water will be transported to the treatment site from

the inspection site using underground pumps. Also we have to improve the infiltrated water treatment facility and improve the water quality. We need an infiltration water storage tank with a capacity of 18,000 tons to store one seventh of the largest rainfall volume per day to handle the water volume increase during heavy rainfall. As the existing treatment facilities are for removing toxic substances, methods must be provided to remove the causes of eutrophication such as nitrogen and phosphorous. Rainwater is discharged through the outer pipes. The dike system was introduced. Rainfall will be run through pipes or ditches so that it won't be polluted.

This is the structure of the water breaking layer. On the bottom is short-crete and then a sheet, next is sand, and again a layer of sheets and then sand. The sheet is multi-layered. Of course, the base is the soil. The sheet we are using is short-crete sand and mat. Then we have another mat. Thus the water breaking layer is multi-layered. The soil removed to build the landfill site is used as cover material. And also we select some of the construction waste and screen whether it can be used as a cover sheet. There are also dikes. A water leakage and infiltration issue was observed here. After that we did grouting, using the grouting techniques we built to prevent water infiltration. An 18,000 ton storage tank was created as a new facility and we tried to expand the storage tank capacity to accommodate a greater amount of water.

So in the City of Pusan we experienced incidents of infiltrated water and leaking water. We are very sorry to focus on these bad experiences. However, our experience will help you improve your facilities. I would like you not to repeat the mistakes of the City of Pusan. Conventional landfilling sites were on plains but Saenggok is in a valley of a mountainous area and we had some unfortunate experiences. Therefore these problems needed troubleshooting. In addition to addressing these problems, we succeeded in reducing the total amount of garbage. We reduced the volume of garbage. Thirty-five percent of the total waste is garbage. We have tried to reduce household garbage and this will help solve the problems of infiltrated polluted water. The next landfilling site will be more stable. In August 1996, we started siting efforts. In the site selection committee we have university professors, citizen representatives, and city councilmen and government workers. Eleven committees are now working on selecting a new site which is economically and environmentally friendly and available. We hope that many countries will learn from the mistakes of Pusan. And I hope that this type of conference will continue to be held so that we can learn from our experiences and from others' experiences. I will be quite happy to respond to any questions while I am standing up here.

## **Discussion** |||||

### **Chairman**

Thank you very much, Mr. Park Nam Bae, for your presentation, based on your own experiences. You were kind enough to share your experiences and thoughts, as well as the new methods, particularly from the people in supervision of the leachates and other environmental issues you have faced. You experienced a serious issue of leachates in the City of Pusan. I think that we were able to learn a great deal from your presentation. I do hope that your experience will be of great value to many cities in the region. I wonder if there are any questions or comments concerning the presentation we have just heard.

### **Prof. Masataka Hanashima (FUKUOKA UNIVERSITY)**

In your presentation you talked about a sewage system. You said that water is reprocessed there. But when the water is processed and then transported to further facilities, you must end up with materials which are quite difficult to treat. So you may have some excessive load on the sewage treatment facilities. I wonder if people working there are making any complaints.

### **Mr. Park Nam Bae (PUSAN)**

Thank you indeed for your question. In terms of management of the sewage treatment facilities, yes, there are many issues. But as for the treatment of the leachates, the City of Pusan is responsible for that. As far as we are concerned, in the near future we should have improved capabilities. As of now, with the existing facilities, we are not able to duly process everything. The capacity is going to be about 300,000 tons and the leachate is going to be about 1,000 tons. In regard to the load factor, it is not that excessive. We try to separate organic phosphorous or nitrogen. I think the range is going to be within 5% even though we are having a somewhat higher load. The facilities seem to have enough capacity as of now.

### **Prof. Yasushi Matsufuji (FUKUOKA UNIVERSITY)**

Looking at the current design of the landfills, I would like to ask what kind of structure you have constructed there. And secondly, since you have to process a lot of food leftovers, what is the degree of water pollution as indicated by the current BOD (biochemical oxygen demand) reached?

### **Mr. Park Nam Bae (PUSAN)**

Thank you very much for your questions. As for the design method, we considered

semi-aerobic but changed our thoughts. We are now working on the anaerobic design method. This is my response to your first question. Since it is anaerobic, the BOD should be 30-35,000 ppm. One year has passed, and the level is 30,000 ppm. From September 1 1997, food leftovers as garbage have been banned, because most is so wet — having a lot of water content. So we are not bringing food leftovers into the site — well, we are trying to reduce it. In the year 2000 it is going to be zero. By 1998 we would like to reduce it by one half. Probably it should be used for composting or used for fertilizer. We would like to encourage the recycling of those leftovers.

**Prof. Yasushi Matsufuji (FUKUOKA UNIVERSITY)**

In the initial plans, semi-aerobic processing was adopted and then you shifted to anaerobic processes. Was this because of the structural issues? Or do you have more garbage than you expected and that's why you ended up in anaerobic landfilling?

**Mr. Park Nam Bae (PUSAN)**

Landfilling is not done by the municipalities. We commission industry to do that. There is some lack of construction experience and that's why we plan to have a semi-aerobic process. But cover material and other issues — actually we didn't do any cover materials. There was just landfilling of waste and garbage. We tried to introduce semi-aerobic but we had to shift to anaerobic because of the deterioration of the water quality.

**Mr. Zhang Yi (SHANGHAI)**

Gases must be produced — how do you treat the gases?

**Mr. Park Nam Bae (PUSAN)**

Yes, in our case we have gases during the process of landfilling. The gas production is a little bit behind landfilling — maybe ten months behind. The gases at present are discharged or are collected and used. We will try to collect those gases and use them as energy. But at the moment we ignite the gases naturally and they are gone.

**Mr. Michio Isono (FUKUOKA)**

You have a very good system to prevent underground water pollution. Have you investigated the water quality of the nearby wells? How do you monitor and control the quality of underground water? Thank you very much for your comments.

**Mr. Park Nam Bae (PUSAN)**

Daily well monitoring was conducted after the accident. One month later we reduced this to weekly monitoring and now we have monthly monitoring. After the grouting technique was introduced, the water quality was reported to be significantly improved.

**Mr. Shozo Matsumoto (KUMAMOTO)**

Landfilling sites are an issue. Kumamoto City uses some landfilling sites in the mountainous or valley areas. You use a phased type of landfilling. When phase one landfilling is done, you move to the second phase of landfilling. In phase two, rainwater infiltration should be prevented from entering the phase one area. How do you prevent rainfall from getting into the already landfilled phase one? Do you cover the surface with concrete to prevent rainwater from coming into phase one?

**Mr. Park Nam Bae (PUSAN)**

The plan of landfilling is we have stage one, stage two, stage three — as one is completed we move on. Stage one is in a valley. Stage two is divided further and the steps are to be four or five meters. We have a semi-staged landfilling in stage two. I'm not a civil engineering expert so I'm not quite sure what they are doing. But up to the second stage there will be no difficulty in terms of the technology. There may be some problems when we start the stage three landfilling. We have to have some advice from other cities who have greater experience than us.

**Mr. Chen Sihua (GUANGZHOU)**

I have a question to the City of Pusan. You said the rainwater and the infiltrated water are separated. However, for the unlandfilled areas, how do you prevent rainwater from getting into the site?

**Mr. Park Nam Bae (PUSAN)**

At the landfilling site there is the area which is not landfilled yet. When the rain falls, the rainwater runs from here, mixes with other streams of rainwater, and it forms a leachate. As the rain falls in various areas and everything goes into the leachate, the amount of leachate exceeds our capacity. So we try to separate the areas of rainfall. There are underground rainwater processing facilities. Also there is rainfall pouring on the upper area where we can just drain that rainwater. There is a ditch to drain the rainwater thus preventing rainwater from coming into the stage one landfilling site.

**Ms. Aurora Tambunan (JAKARTA)**

One of the biggest problems for Jakarta is to find a site for landfills. The landfill sites are usually 100 hectares. So we have to find a site that will likely be outside the city because we can not find a site as large as that inside the city. In Jakarta, the landfill site is outside the city boundaries. I would like to ask, in Pusan, where is the landfill site located? Is it within the city boundaries of Pusan or is it outside? And how do you coordinate with the neighboring local government? And how far is it located from the residential area or the city? Do you have any transport problems in sending the waste from the city to the landfill site? Thank you.

**Mr. Park Nam Bae (PUSAN)**

The landfilling site of Pusan is within the boundary of Pusan. Near the landfilling site, as mentioned before, there is a village. The odor causes complaints from the villagers. The landfilling site comprises some nuisance to the villagers. In order to support the villagers we provide some incentives, such as scholarships, or we build the villagers centers. Also, the transport, landfilling, leachate treatment, and odor produced by the treatment plant are nuisances to the villagers. In order to deodorize we try to have a complete and thorough covering. Also we have equipment to remove odor. We try to collect leachates and rerun the water in the deodorant machines. Also the transportation causes some odors. If there is watery garbage, the water content will carry a bad smell. So we try to reduce the water content of the garbage and waste. Another point I want to make is the following: future landfilling sites are now being selected. We have to have a better collaboration with the citizens.

The waste processing facilities and the related facilities are regulated by law in Korea. And the law stipulates the process of construction of landfilling sites. We have to have a landfilling site selection committee and there should be representatives of the citizens on the committee. We want to have representatives of the citizens on the committee, however, the citizens are against the site and it can be very difficult to select citizens for the committee. We use the mass media and newspapers to distribute information and we try to gather citizens' opinions on the landfilling site. Citizens are not very active in recommending a site. However there is some reference material provided by the citizens and in the site selection committee, based upon those suggestions and taking into account input from the experts, we try to select a site. We have selected thirty candidate sites and we are trying to narrow it down, using exclusion criteria. At the moment, we have seven or eight candidates and we want to further reduce this to two or three selected sites, and



then we will start negotiating with the citizens to make the final decision regarding a future landfill site.

**Mr. Choi Nam Sup (PUSAN)**

I am from Pusan City and to the person from Jakarta I want to make some additional comments. The Saenggok landfilling site is within the administrative boundary of the City of Pusan. It is in the outer periphery of Pusan City, but it is within the administrative boundary of the City of Pusan.

**Mr. Tang Minggao (GUANGZHOU)**

We have a situation similar to Pusan. We have a landfilling site in the mountainous, valley area. In terms of the leachate, what kind of preliminary measures did you take before landfilling started?

**Mr. Park Nam Bae (PUSAN)**

As mentioned in the presentation, in the past we had landfilling sites on the plain areas but now we have built a new one which is in the mountainous area. This is our first experience. So as I said before, we estimated the leachate and we thought it all right the way we designed the site. In May and June we have a heavy rainfall. We thought the design was robust enough, but it was not as robust as we had expected and there was an incident.

**Prof. Masataka Hanashima (FUKUOKA UNIVERSITY)**

In the case of the City of Pusan, you have a plan to construct many incinerators. Japan is faced with a serious problem of dioxin. I wonder if you have given any thought to this issue. Actually, here in Japan we try to reduce waste but again we are faced with the serious issue of dioxin. The nature of this dioxin is so serious that sooner or later we will have to dramatically reconsider the structure of incinerators.

**Mr. Park Nam Bae (PUSAN)**

As far as Pusan is concerned, we have several incinerators. In Korea, in 1996, we had 11 incinerators. We have the Environmental Department which has been working on policies regarding dioxin. First they started with a target value for the years after 2000, but due to a large objection from students, we decided to implement the reduction much earlier — in 1997. As for the new value, it is going to be 0.1 nanogram for dioxin. And for existing facilities, there is a grace period up until 1999. Currently the recommended value is 0.57 nanogram. Again we have

strict regulations regarding the value. For the years after 2003, it is going to be reduced to 0.17 nanogram. Some existing facilities have higher levels of dioxin, but this is taken as a very serious issue in Korea. In the case of Pusan, location has become a serious issue. It has become difficult for us to find good sites. For future incinerators we would like to have integrated incinerator facilities within big development projects. By doing this, we would hope to meet less opposition. A new town is now being developed at Haeundae. We are trying to utilize the waste energy for heating purposes. The residents should be able to save money on heating. Through this we would like to receive some support from the local residents. As for the dioxin issue, if there are helpful suggestions to be made by Fukuoka City, I would welcome them happily.

**Mr. Tetsushi Sato (JAPAN WASTE RESEARCH FOUNDATION)**

Concerning the dioxin issue, as we have discussed, this has become one of the top priorities. For the past year we have been having intense discussions. Even at the level of central government, efforts are now being made to amend the laws. As for the new facilities, the dioxin will be set at 0.1 as is standard. This is the latest amendment. Starting from December the first, based upon this new law, all the municipalities must comply with this new standard. Each municipality, I'm sure, will have a lot of challenges, particularly with the existing facilities. As for the new ones, probably they can incorporate this standard into their design factors. But incinerators already exist and how they will comply with this new standard will be a serious challenge for municipalities to work with. The Minister of Health and Welfare has discussed this issue of how to deal with existing incinerators. In order to secure the better operation of the facilities the ministry is emphasizing large scale incinerators, as well as incinerators to be shared by a number of communities. To have better operation and better management of small incinerators, ideally they need to be upgraded to the capacity of 300 tons per day. Probably the municipalities are going to be called on for further cooperation in this regard. Specifics will be dealt with on a case by case basis. This is a serious issue but again this is what we are doing in order to cope with the dioxin problems. That's all from me.

**Prof. Masataka Hanashima (FUKUOKA UNIVERSITY)**

If I may, I have further questions. In the case of Pusan, it seems you have become quite active in dealing with waste treatment. In regard to waste treatment and disposal, there are landfills and incineration, two major categories. We need to keep a good balance in totality. Here in Japan, we put too much emphasis on incineration

resulting in serious dioxin problems. I just wanted to share this observation with you. What is going to be the future direction including the transition of resources? I wonder if you have defined any policies regarding these issues, particularly in terms of keeping a good balance.

**Mr. Park Nam Bae (PUSAN)**

As far as our city is concerned, the first priority will be the reduction of waste and the making of resources out of waste. For this purpose, we are somewhat unique because kitchen garbage accounts for a large percentage, so we need to reduce that portion first. We would like to utilize that for other purposes including composting. As for the incineration and dioxin problems, I think we have to encourage the separation of garbage and collection of waste. By reducing the food refuse we should be able to reduce the ingredients for dioxin. For example, in school lunches and domestic kitchens, people are making active efforts. Secondly, I would like to say the following: we need to increase incineration because it is going to be extremely difficult for us to find good sites. Actually we have a policy aimed at 30% incineration for Pusan City.

**Prof. Masataka Hanashima (FUKUOKA UNIVERSITY)**

You have just referred to the composting process utilizing kitchen garbage and food leftovers. Regarding composting, the utilization level of composted materials here in Japan has not far advanced. This is a problem we face. This is a question I would like to raise to all participants -- what kind of thoughts do you have about composting? I wonder if anyone on the floor has anything to say concerning the issues regarding compost or composting.

**Mr. Park Nam Bae (PUSAN)**

If I may, I would now like to share some of the experiences of the City of Pusan. In our city we, of course, want to have composting. We began supply administrations and the first issue was consumption. We are trying to dry the garbage first and those dried materials are going to be used for fertilization purposes and other purposes. So we are drying them and we are trying to utilize them through gases. The current problem is that in the process of drying, when we have concentrated steam it needs to be further processed and that is expensive. In order to find solutions to this we tried to define the threshold and we decided to utilize the existing neighborhood facilities for this purpose.