ENVIS

Urban Municipal Waste Management Newsletter

(Sponsored by: Ministry of Environment and Forests, Government of India, New Delhi)

National Solid Waste Association of India

Reg No. BOM.137/1996 GBBSD

Visit us at: www.nswai.com

ENVIS NSWAI • SIXTEENTH ISSUE • SEPTEMBER, 2009

FROM THE EDITOR'S DESK

The Open dumping grounds are very common sights in India and they pose a serious threats in cities where they are located within the residential areas due to ever increasing population.. The waste is dumped in the outskirts of the cities in low lying areas with no compliance of regulations in very unscientific and unorganized manner. Even after the MoEF notification on MSW (Management & Handling) rules, 2000, the ULBs (Urban Local Bodies) have failed to comply with the same. This situation is not only affecting the environment but also causing damage of property. To remediate this existing situation, effective steps are being taken in some places, especially in Mumbai by MCGM using "capping" technique.

It is a containment technology that forms a barrier between the contaminated media and the surface, thereby shielding humans and the environment from the harmful effects of its contents and perhaps limiting the migration of the contents. Landfill Caps can range from a one-layer system of vegetated soil to a complex multi-layer system of soils and geosynthetics. The main purpose of capping is to reduce greenhouse gas (GHG) emissions by capturing and utilizing the methane (CH_4) in the LFG released, and avoiding future GHG emissions from the decomposition of municipal solid waste residues. The captured methane can also be combusted to generate electricity. In this issue, capping techniques and their pros and cons have been discussed especially using examples. The implementation of capping of the open landfill provides not only relief to the population near by but also reduces bird menace, odour and other harmful gas emissions etc. It is also, however, important to address the possibilities of alternate methods whereby landfill site can be re-used or life is extended.

Capping Needs and Methodology for Old Dumping grounds in India

Dr. Amiya Kumar Sahu
President-NSWAI

Introduction:

Almost all cities in India have open dumps which have been managed haphazardly in the past and pose a threat to health and environment. Most of these remained as open un-scientific landfills (appropriately called dump sites) because the Municipal Solid Waste was not considered as a big threat in the beginning. However- as cities grew exponentially, the absence of planned scientific landfill for MSW started showing high impact on the environment including on the health of the population living in close vicinity. Many of these dumpsites have been overflowing and therefore due to either public or judiciary pressures, an increasing need to address closing of these dumpsites is being felt.

Landfill Capping is the most common form of remediation because it is normally considered least cost options compared to other technologies and effectively manages the human and ecological risks associated with the waste dump. However, the cost effectiveness of such options also depends on the quality of capping and its further use. Many of these issues become very important while considering capping technology.

Capping is a process used to cover buried waste materials to prevent their contact with the land surface and groundwater. In the United states, the designs of modern caps usually conforms to the performance standards in 40 CFR 264.310, which addresses RCRA landfill closure requirements. These standards include minimum liquid migration through the wastes, low cover maintenance requirements, efficient site drainage, high resistance to damage by settling or subsidence, and permeability lower than or equal to the underlying liner system or natural soils. There are many issues related to these performance standards based on the onsite requirement, future use of the site, rain patterns, drainages etc. The capping process came into being due to the major facts that these unregulated sites were becoming a major health and ecologically hazards.

History of Capping technology

Historically, the amount of wastes generated by human population was insignificant mainly due to the low population densities, coupled with the fact that there was very little exploitation of natural resources. Common wastes produced during the early ages were mainly ashes and human biodegradable wastes, and these were released back into the ground locally, with minimal environmental impact. Four basic means of dealing with waste have been used in the history, viz.,. 1. Dumping 2. Burning 3. Recycling 4.Waste minimization.

Today with development of industrialization and growth of population the problem of disposal of garbage is increasing. However, as there are various methods available for disposal of garbage, one of the easiest methods is the landfill method i.e dumping the waste into low lying areas. In most low- to medium-income developing nations, almost 100 per cent of generated waste goes to landfill in mixed form. Even in many developed countries, most of the mixed solid waste is landfilled.

The number of landfills are reaching their ultimate fill capacity and have not been properly terminated yet, must be considered as a significant danger to groundwater and surface water pollution. These landfills need to be closed down. There are a number of methods available for landfill closure combined with the leachate recirculation-treatment system and capping of landfill with impermeable cover system.

Worldwide, open dumps initially were covered with a layer of soil or capped (with a waterproof cover and gas extraction systems) to prevent contamination of groundwater and air. When it was found that such covered waste dumps, though protected from percolating rain or snow, still generated polluting leachate internally by anaerobic decomposition of the covered waste, new landfills began to be lined at the bottom and sides as well. Later, these were covered with an impervious cap, also called "dry tombs". Since even these may leak after 30 years, the European Union has now banned all below-ground landfills. It also , prohibits landfilling of organic matter which can self-generate any leachate and methane during anaerobic decomposition.

With landfill space becoming increasingly unavailable or permission to get proper site, because of country laws or neighbourhood objections, water is now being introduced into some historically capped waste dumps to accelerate their decomposition as "bioreactor landfills", in the hope that their contents can be dug out and used as compost. This way, the waste volumes can be minimized and landfill space can be created and recycled. This has its dangers. Capped landfills have exploded at Istanbul in Turkey and the Payathas site in Quezon City in Manila, even without the introduction of water.

Capping design:

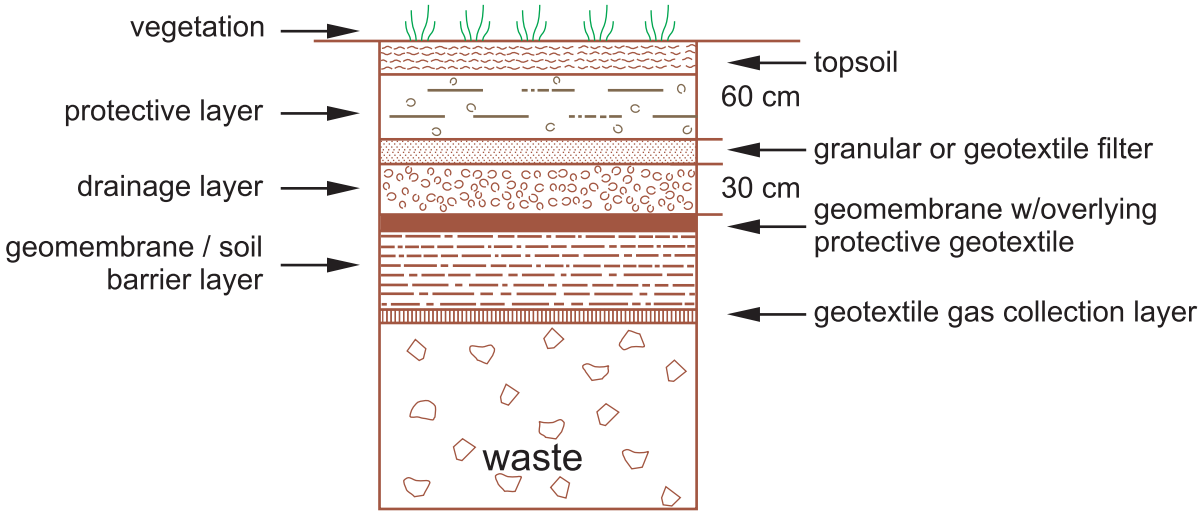
There are a variety of cap design and capping materials available. Most cap designs are multi layered to conform the design standards, However, single-layered designs are also used for special purposes.

The selection of capping materials and a cap design is influenced by specific factors such as local availability and costs of cover materials, desired functions of cover materials, and the nature of the waste being covered, local climate and hydrogeology and projected future use of the site in question.

The design of landfill caps is site specific and depends on the intended functions of the system. Landfill Caps can range from a one-layer system of vegetated soil to a complex multi-layer system of soils and geosynthetics. In general, less complex systems are required in dry climates and more complex systems are required in wet climates or areas with high water tables.

Different layers involved in capping design

The most critical components of a landfill cap are the barrier layer and the drainage layer. The barrier layer can be low-permeability soil (clay) and/or geosynthetic clay liners (GCLs). A flexible geomembrane liner is placed on top of the barrier layer. Geomembranes are usually supplied in large rolls and are available in several thickness (20 to 140 mil), widths (15 to 100 ft), and lengths (180 to 840 ft). The candidate list of polymers commonly used includes polyvinyl chloride (PVC), polyethylenes of various densities, reinforced chlorosulfonated polyethylene (CSPE-R), polypropylene, ethylene interpolymer alloy (EIA), and many new materials. Soils used as barrier materials generally are clays that are compacted to a hydraulic conductivity no greater than 1 x 10^{-6} cm/sec. Compacted soil barriers are generally installed in 6-inch minimum lifts to achieve a thickness of 2 feet or more. A composite barrier uses both soil and a geomembrane, taking advantage of the properties of each. The geomembrane is essentially impermeable, but, if it develops a leak, the soil component prevents significant leakage into the underlying waste.



Material used in designing of landfill cap

The materials used in the construction of landfill caps include low-permeability and high-permeability soils and low-permeability geosynthetic products. The low-permeability materials divert water and prevent its passage into the waste. The high permeability materials carry water away that percolates into the cap. Other materials may be used to increase slope stability.

Types of caps

Of many types of capping material, few of them which can be used and have been used elsewhere are as follows:

1. **Asphalt/Concrete Cap**

   The most effective single-layer caps are composed of concrete or bituminous asphalt. It is used to form a surface barrier between landfill and the environment. An asphalt concrete cap would reduce leaching through the landfill into an adjacent aquifer.

2. **RCRA Subtitle C Cap** [Resource Conservation and Recovery Act, USA]

   The RCRA C multilayered landfill cap is a baseline design that is suggested for use in RCRA hazardous waste applications. These caps generally consist of an upper vegetative (topsoil) layer, a drainage layer, and a low permeability layer which consists of a synthetic liner over 2 feet of compacted clay. The compacted clay liners are effective if they retain a certain moisture content but are susceptible to cracking if the clay material is desiccated. As a result alternate cap designs are usually considered for arid environments.

3. **RCRA Subtitle D Cap**

   RCRA Subtitle D requirements are for non-hazardous waste landfills. The design of a landfill cover for a RCRA Subtitle D facility is generally a function of the bottom liner system or natural subsoils present.

The cover must meet the following specifications:

- The material must have a permeability no greater than 1 x 10^{-5} cm/s, or equivalent permeability of any bottom liner or natural subsoils present, whichever is less.
- The infiltration layer must contain at least 45 cm of earthen material.
- The erosion control layer must be at least 15 cm of earthen material capable of sustaining native plant growth.

Alternative design can be considered, but must be of equivalent performance as the specifications outlined above. All covers should be designed to prevent the "bathtub" effect. The bathtub effect occurs when a more permeable cover is placed over a less permeable bottom liner or natural subsoil. The landfill then fills up like a bathtub.

Methodology: How it works

Sometimes digging up and removing contaminated material can be difficult or expensive.

Instead, a cap will be placed over it to keep it in place. A cap works in three main ways:

1. It stops rainwater from seeping through the hazardous material and carrying the pollution into the groundwater, lakes or rivers.
2. It stops wind from blowing away the hazardous material.
3. It keeps people and animals from coming into contact with the contaminated material and tracking it off the site.

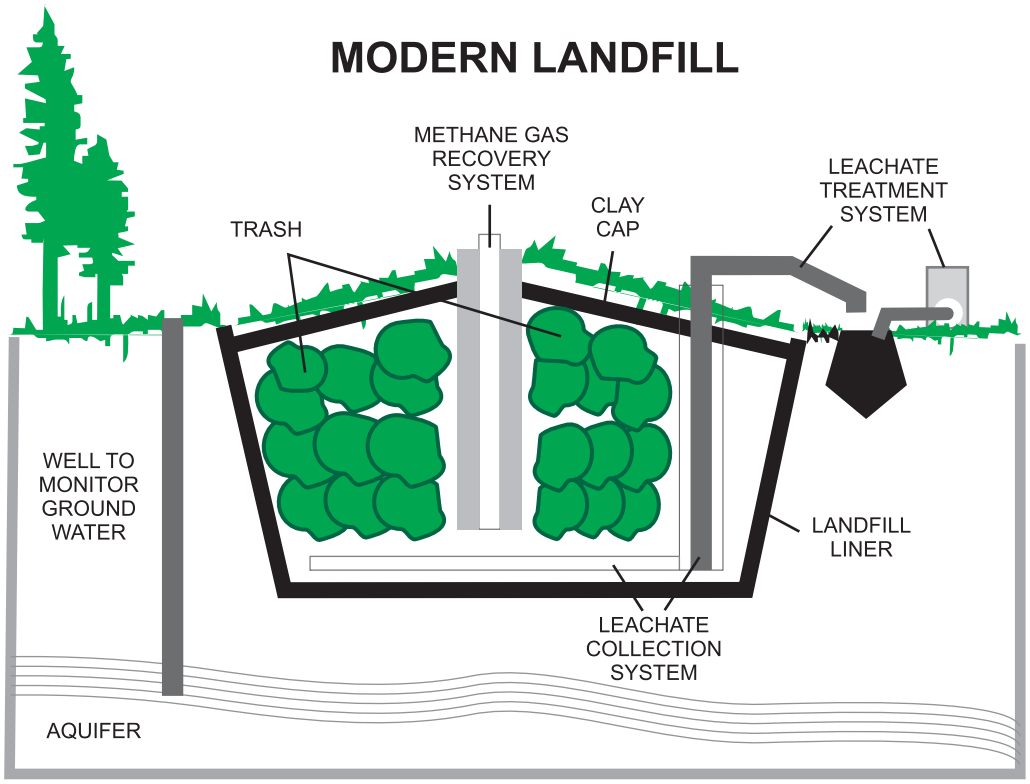
Landfill gas recovery

Landfill gas (LFG) is the natural by-product of the decomposition of solid waste in landfills and is composed primarily of carbon dioxide and methane. Instead of allowing LFG to escape into the air, it can be captured, converted, and used as an energy source. Using LFG helps to reduce odors and other hazards associated with LFG emissions, and it helps businesses, states, energy providers, and communities protect the environment and build a sustainable future. The LFG recovery can be accomplished only when the dump site is capped well and a provision is created to tap the gas.

Applications and limitations of capping technology:

Capping is necessary whenever contaminated materials are to be buried or left in place at a site. In general, capping is performed when extensive subsurface contamination at a site precludes excavation and removal of wastes because of potential hazards and/or unrealistic costs.

Capping is often performed together with groundwater extraction or containment technologies or significantly reduces further plume development; thus reducing the time



needed to complete groundwater cleanup operations. In addition, groundwater monitoring wells are often used in conjunction with caps to detect any unexpected migration of the capped wastes. A gas collection system should always be incorporated into a cap when wastes may generate gases. Capping is also associated with surface water control technologies such as ditches, dikes and berms because these structures are often designed to accept rainwater drainage from the cap. Two other surface water control technologies, grading and revegetation, are incorporated into multi –layered caps.

- The main disadvantages of capping are the need for long term maintenance and uncertain design life. Any caps will need to be periodically inspected for settlement, ponding of liquids, erosion, and naturally occurring invasion by deep-rooted vegetation. In addition the groundwater monitoring wells, often associated with caps; need to be periodically sampled and maintained. However, these long-term maintenance requirements usually are considerably more economical than excavation and removal of the wastes.

The design life of a cap is uncertain because of the uncertain life of synthetic liner materials (if one is used in the cap), the uncertain amounts of annual rainfall which will infiltrate natural and admixed miner materials, and uncertain rate of waste migration which would result from any infiltrating rainwater. This uncertainty may necessitate the strategic placement of monitoring wells at a site to detect any waste migration, thus signaling the need to replace the cap. Caps generally have a minimum design life of 20 years when synthetic liner is the only liquid barrier. This period may extend to more than hundred years when synthetic liner is supported by a low-permeability base; the underlying wastes are unsaturated; there is great distance between the waste and the groundwater table; and proper maintenance producers are observed. Rigid barriers such as concrete and bituminous membranes are vulnerable to cracking and chemical deterioration, but the exposed cracks can be cleaned ,and repaired (sealed with tar) with relative ease. Concrete covers may have a design life of about 50 years, except when applied to chemically severe or physically unstable landfill environments.

- Another disadvantage to capping is the high cost of proper soil and drainage materials in certain areas of the country. However these high costs would seldom result in selection of the excavation and removal alternative on the basis of economics. The most probable reason for selecting against capping at a site with extensive subsurface contamination would be an unacceptable risk to source of drinking water where even groundwater monitoring would not offer enough assurance that severe contamination would not occur. Such a situation, for example, may involve an extremely leachable and highly toxic contaminant.

Landfills/Open dumpyards in India:

Open dumping grounds are very common sights in India especially in metropolitan areas. The waste is dumped in the outskirts of the cities in low lying areas with no compliance of regulations in very unscientific and unorganized manner. The dumped waste contains organic, inorganic and inert material like debris in mixed form. Even after the MoEF notification on MSW (Management & Handling) rules, 2000, the ULBs (Urban Local Bodies) have failed to comply with the requirements. Apart from this, in recent times, it has been witnessed that the dumping grounds being operated in a low lying area after its filling, are being used for building for residences and commercial purposes. This is becoming a common practice in metropolitan cities like Mumbai, Kolkata, Delhi etc. Some of the old dumping grounds are located in middle of the city. This environment is adversely affected leading to damage of properties like electronic equipments, sensitive computers, server rooms etc, due to release of pollutants like CH_4, H_2S, Mercaptans etc The same situation has proven its hazards to electronic appliances and property at Malad, dumping ground. The old dumping ground was reclaimed and was converted into a world class residential cum commercial area today know as Mindspace, Malad.

Open dumping ground (India)

Case of Mumbai

Recently one of the large dump site in Mumbai located in Gorai region has been closed and capped with a provision to collect gas. The closure and gas abstraction project of Mumbai Municipal Corporation aimed to reduce greenhouse gas (GHG) emissions by capturing and utilizing the methane (CH_4) in the LFG released by the Gorai landfill, and avoiding future GHG emissions from the decomposition of municipal solid waste residues. The captured methane will be combusted to generate electricity that will feed to the national power grid and used as an alternative source of cheap, indigenous, stable and renewable energy that will reduce dependence on grid power. Thus, in addition to directly eliminating a significant portion of the methane, which is a potent GHG with 21 times the global warming potential of CO_2, the project will also displace fossil fuel-based electricity generation that would have emitted additional CO_2. In case of any emergency, the landfill gas collected shall be flared. The objective of the proposed project is to address the environmental problems arising due to the unscientific disposal of the MSW at the site, in a manner that will provide an everlasting solution. Implementation of the project would improve current solid Waste management practices and make a strong contribution in achieving scientific management of solid waste disposal in Mumbai. In addition, this would demonstrate the application of developing a comprehensive scientific system

for management of huge quantities of unprocessed solid waste, already accumulated at other dumping sites in India.

The above situation could also be examined in alternate way wherein the waste could be recovered through other technological means and make the land available for future use in a city where land is a scarce and expensive resource.

The Gorai site for its dumping and environmental problem has faced many examination and review internally in the city administration as well as from the committees appointed by the Judiciary. A petition was filed in the public interest WRIT PIL 489 at the Bombay High Court in the year 2004 concerning the ill effects of Gorai garbage dump on the residents staying near the site. The High Court directed Municipal Corporation of Greater Mumbai (MCGM) to comply with the regulations and requested National Environmental Engineering Research Institute (NEERI) to submit a comprehensive report on how accumulated garbage at Gorai can be processed in a safe manner. According to the report, suggestion was made to bio-stabilize the waste at Gorai, however, it could not be sustained despite a limited attempt.

Later due to sustained pressure from the public groups, MCGM decided to discontinue the dumping of garbage at Gorai and apply "capping" technique. The objective was to exclude water from the airless heap, which leads to formation of both methane gas and leachate. However, water cannot be excluded from a creek-side heap by even the best surface covering, as waste has been dumped at Gorai without any watertight bottom and limited side linings. Thus the technique would have limitation since the garbage heap at Gorai extends well below the ground level and is bounded on two sides by a tidal creek.

National Solid Waste Association of India submitted a Suo Motu on Gorai Dumpsite Closure Practices at the Bombay High Court on 25th May, 2007 suggesting the directions for safe processing of the waste at Gorai. The High court has ordered MCGM to respond to the directions sought by NSWAI.

Some experts say that the Gorai dumping site may be getting transformed into Bomb Cell with the new technology planned by MCGM at a cost of Rs. 44 crores. Alternately, it would have been possible to bio-stabilize the entire waste at a cost of just Rs. 1.5 crores. It would not only make the waste get processed but the site can be made available for processing or for huge playground or maidan for public benefit.

Some of the major issues for the Gorai dumping grounds and unscientific approach in capping process are presented hereunder:

4. The MSW dumped at Gorai has organic matter content of 40 to 60% as there is no compost plant or any other method to recover short term biodegradable. This quantity will lead to high levels of gaseous emissions and polluting leachates

5. In the matter of PIL from Gorai Residents the Hon'ble High Court of Mumbai had obtained specific recommendations from the Appointed Committee This Committee has suggested Biostabilisation Treatment and Processing of waste to reduce the volume by 50 to 70%. This would mean that 16 meter high garbage mountain can be brought down to almost at road level. Also by following the prescribed process around 10 hectare plot could be made available as recreation center /garden or a stadium which would be more meaningful than the "Capping" which has been adopted.

6. The classic examples of land reclamation from 12 to 20 year old accumulated waste at Panchwati (Nashik) in 28 acres, Avania Puram – Madurai in 30 acres and Dhapa – Kolkata in 30 acres have been created which can serve as guideline and learning lessons for the Civic authorities of MCGM. It is most pertinent to mention that Nashik's 28 acre site was cleared at a cost of just Rs 84 lakhs and other places even with further lesser costs. Today there exist a vast Indoor-Stadium for use of Citizens of Panchavati garbage site. Several lacs of Saints were habitated at the reclamed site during last Mahakumbh (2004-05).

7. Compared to these examples the so called Capping carried out at Gorai does provide the relief from gaseous emissions and open stench, however, the costs of capping incurred is enormous.

8. Very recently some more sites have been reclaimed for establishment of Solid Waste processing facilities at the same disposal locations in other cities of Southern India. Even under JNNURM Financial sanctions for SWM, such provisions have been accepted by the Union Urban Ministry several cities like Kochi, Chennai, Puducherry, Tuticorin, and Faridabad are beneficiary of such meaningful approach.

9. Mumbai still does not treat and process any amount of waste in accordance with the requirement of Municipal Solid Waste [Management and Handling] Rules 2000, except ragpicker's recycling activities and a very limited ALM's activities. All other cities have created facilities for processing and treatment of 20 to 25% of MSW and many of them have now drawn up concrete action plan for processing of entire MSW i.e. generated in their cities with the financial assistance under Jawaharlal Nehru National Urban Renewal Mission [JNNURM]. All these projects are also in line with the recommendations of Special Inter Ministerial Task Force - Integrated Plant Nutrient Management for utilization of compost from urban solid waste. This Task Force was set up under the Directives of the Hon'ble Supreme Court in the Ministry of Urban Development & Poverty Alleviation – GOI. The Supreme Court has ordered for implementation of the SWM Projects as per the Task Force report with immediate effect.

Even if the programme for solving the problem of Mumbai's Solid Waste is taken up as per the recommendations of the above Task Force, the citizens can be relived from the nuisance value of the garbage which is being deposited everyday at Deonar and Mulund. If the utilisation programme for major component of solid waste is ignored then no landfill area like Kanjurmarg site can survive the garbage burden for more than 5 to 10 years. In such a case, Mumbaikars can witness huge garbage mountains at the above sites and continue to suffer.

Capping Technology: Status in Developed Countries

- The use of clay capping has generally proved ineffective in trials in the USA, the researchers say. The problem being that in arid regions the clay cap dries out and cracks allowing water to easily percolate into the landfill.
- Methane gas collection is an inordinately expensive option for many Australian landfills that do not reach the methane production threshold to enable efficiency.
- Hence, a new technique, known as phytocapping, which involves placing a layer of top soil and growing dense vegetation on top of a landfill, was successfully trailed at Rockhampton's Lakes Creek landfill.

References

Remedial action technology for waste disposal sites

EPA, 1995. RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfills, Office of Research and Development, NRMRL, Cincinnati, OH, EPA/600/R-95/051.

EPA, 1993. Engineering Bulletin Landfill Covers, EPA/540/S-93/500.

Address for correspondence:
National Solid Waste Association of India,
B-703, Customs Colony A, Military Road, Marol,
Andheri (E), Mumbai - 400 059. INDIA.
Phone: 91 22 29207577 • Telefax: 91 22 29202951
E-mail: econpcpl@gmail.com / nswai@envis.nic.in

This Bulletin of ENVIS NSWAI is published by the National Solid Waste Association of India in Mumbai

Visit us at: www.nswai.com