18th WEDC Conference KATHMANDU, Nepal 1992

WATER, ENVIRONMENT AND MANAGEMENT

Sanitary landfill development for Saipan

F. Russel Mechem II

INTRODUCTION:

Pristine beaches, aquamarine lagoons, and an idyllic tropical climate await visitors to the Commonwealth of the Northern Mariana Islands (CNMI). These remote Pacific islands also hold considerable historical value to visitors from both Asian and Western countries due to their significance during WWII. Many scenic attractions stand to be lost, however, unless CNMI decision-makers acknowledge the close ties between sound environmental resources management and economic development. Although the CNMI has made recent strides in infrastructure development, major waste management programs lag in the face of rapid economic growth.

ECONOMIC DEVELOPMENT STRATEGY:

The CNMI capital island of Saipan has experienced tremendous economic growth within the last ten years. With limited natural and economic resources, Saipan is dependent upon tourism and foreign investment for its economic sustenance. Until 1978, a United Nations Trust Territorial Government tended to limit growth and discourage foreign investment.

Upon attainment of Commonwealth status in 1978, however, the islands embarked upon a vigorous campaign to stimulate rapid economic growth. Particularly in the last five years, the CNMI Government has actively encouraged tourism and has negotiated with nearby Asian countries to expand airline and port facilities; increase daily airline flights; and construct "world class" resort complexes.

The results of the CNMI's "open door" policy have been clearly discernable in the increased material benefits reaped by residents. Saipan's shopping plazas are now teeming with modern household appliances, and Saipan's roads have become congested with new and expensive automobiles and heavy construction equipment.

In the face of tremendous growth, however, the government has been hard-pressed to provide adequate infrastructure. The symptoms of development stress have been most acutely seen in utilities and public works projects necessary for sustainable growth. The Government has been successful in funding utility and road improvement projects. However, severe needs continue to exist for solid and hazardous waste management projects.

GEOGRAPHY AND GENERAL HYDROGEOLOGY:

The design of waste management facilities depends on climatic and hydrogeologic conditions. The CNMI climate is tropical marine with consistently warm and humid weather. From a hydrogeologic perspective, the Northern Mariana Islands are composed of limestone reef deposits which overlie volcanic island cores. The Northern Marianas are classified as "Arc-Islands", which have gradually arisen from the ocean floors as a result of tectonic activity. The volcanic cores consist of impermeable andesite lava flows. The overlying limestone reef deposits are highly permeable due to intense fracturing and development of solution cavities.

These geological characteristics prove significant to the management and protection of groundwater resources upon which the CNMI is critically dependent. This complex hydrogeology, particularly the fractured and highly permeable limestones, provides challenges in the engineering design of solid waste management facilities which will not degrade groundwater aquifers.

SOLID WASTE STATUTES AND REGULATIONS:

Several statutes pertain to the proper management of solid waste. The Commonwealth "Environmental Protection Act" established the Division of Environmental Quality (DEQ) as the "lead agency" for the planning, management, and regulation of environmental resources. The CNMI Legislature adopted statutes which specifically address solid waste and hazardous materials management; litter control; and groundwater resources management and protection.

The "CNMI Solid Waste Management Act of 1989" established the Department of Public Works (DPW) as the "owner/operator" of solid waste management facilities. The Act further designated the DEQ as the lead agency for the planning of integrated solid waste management programs and the regulation of solid waste management facilities.

The "Groundwater Management and Protection Act of 1988" designated DEQ as responsible for the management and protection of groundwater resources. The Groundwater Act has proved valuable in that many solid waste management facilities, eg. "open dumps" or improperly constructed sanitary landfills" pose the potential to seriously degrade the valuable groundwater resources.

CNMI SOLID WASTE CHARACTERIZATION:

As solid waste management has become an increasingly problematic, DEQ and DPW have initiated numerous studies to assess the quantity and composition of generated solid waste. Initially, DEQ prepared planning documents based on U.S. national averages for per capita waste generation, ie. 3.2 pounds/person/day developed by the U.S. Environmental Protection Agency (USEPA).

More recently, DEQ has implemented island-specific assessments to accurately characterize solid waste generated on Saipan. In 1991, DEQ conducted a "solid waste characterization" to assess both the quantities and composition of Saipan's waste. The study included visual inspections and volumetric measurements of segregated wastes deposited in the present dump site.

DEQ and DPW staff visually inspected each vehicle which entered the dump over the period of one month. Haulers were required to segregate wastes according to designated categories. These included household wastes, "white goods" (refrigerators and washing machines), construction wastes, industrial wastes, and recyclables (eg. aluminum cans, glass, and paper). Based on the one-month survey, DEQ estimated a waste generation rate of 4.5 to 8.0 pounds/capita/day – roughly twice the U.S. national average!

CURRENT WASTE MANAGEMENT FACILITIES:

Saipan's solid waste management "facilities" presently consist of government-operated open dumps and numerous illegal dump sites. Although the Commonwealth is developing regulations which prohibit open dumping, it lacks properly engineered sanitary landfills which conform to U.S. regulations and accepted solid waste management standards.

On Saipan, residents and commercial establishments generally use the open dump located in the village of Puerto Rico. The dump is a 20-acre site located adjacent to the pristine Saipan Lagoon, which is one of the island's major scenic and recreational attractions for both residents and visitors alike.

The Puerto Rico Dump violates nearly every possible public health and environmental standard pertaining to proper to solid waste management. These include regulations regarding required daily compaction and covering; vector control; and the prohibition against open burning.

Due to the lack of cover material, DPW operators burn solid waste on a daily basis to reduce waste volume and minimize public health threats. Vectors (rodents and insects) pose considerable health threats to dump users. Nightly burning of mixed waste produces hazardous smoke which blows toward Saipan's hotel and resort district threatening Saipan's tourist industry. By day, protruding re-bar and smoldering fires pose serious safety hazards.

Wastes deposited in Puerto Rico Dump include construction materials, white goods, vegetation, household wastes including recyclables, and household hazardous materials. Household hazardous materials such as car batteries, cleaning products, detergents, solvents, waste oil, car batteries, and numerous other chemical products leach into shallow groundwater; migrate seaward; and stand to seriously threaten the marine water quality of the Saipan Lagoon.

LANDFILL FACILITY SITING STUDY:

Saipan's waste management strategy calls first for the development of a properly engineered sanitary landfill facility. Subsequent efforts will address closure, containment, and post-closure monitoring of the existing dump.

In 1986, DEQ initiated a $50,000 contract for a Facility Siting Study for the development of a sanitary landfill to replace the Puerto Rico Dump. The siting assessment was based on a quantitative ranking of 15 proposed sites.

Siting criteria included engineering, hydrologic, geologic, environmental, land use, and socio-economic criteria. Specific criteria addressed groundwater quality, availability of cover material, geotechnical considerations, land availability, potential land use, utility availability, wind direction, scenic views, and public access.
The study included an initial screening followed by thorough field investigations of three final prospective landfill sites.

Based on the final evaluation, the Government will construct the landfill on public land at the northernmost end of Saipan in Marpi. DEQ recommended construction of 3-4 transfer stations to facilitate public access.

After designation of the proposed site, DEQ and DPW contracted for the preparation of A&E designs for the proposed facility at a cost of nearly $500,000. Sizing of the Marpi Sanitary Landfill was based on land availability, the DEQ waste characterization, and a project life of 40-50 years.

As designed, the Marpi Sanitary Landfill Facility will be a carefully-engineered, state-of-the-art landfill which complies with recent U.S. regulations (RCRA Subtitle D) on landfill siting, design, construction, monitoring, and operation. These requirements have been developed to protect groundwater resources and prevent environmental degradation.

SANITARY LANDFILL DESIGN FEATURES:

Saipan's new 100-acre sanitary landfill will include essential design features required to protect groundwater resources from hazardous "leachate" generated by solid and household chemical wastes.

The Marpi Sanitary Landfill will include a "Dual Composite HDPE Geosynthetic Liner System" to minimize migration of hazardous leachate into underlying aquifers. This system includes redundant geosynthetic plastic membranes, geosynthetic "drainage nets", and an intermediary 3-foot-thick clay liner. The system has been designed for a hydraulic conductivity of $K = 0.0000001$ cm/sec. Independent inspectors will test liners to ensure quality control.

The landfill design further requires installation of six groundwater monitoring wells along the site's perimeter. One well will be sited "up-gradient" to provide control data on ambient water quality. Remaining wells will be installed "down-gradient" to detect possible leakage and groundwater contaminant plumes.

Leachate collection and methane gas ventilation systems will be incorporated to ensure long-term project integrity. Leachate collection pipeline networks will be installed between the primary and secondary geosynthetic liners. On-site leachate treatment facilities will treat commingled wastes and rainwater, which could infiltrate to the underlying water table.

Leachate treatment systems must be specially designed to treat leachate from specific facilities. Quite different from domestic wastewater effluents, solid waste leachate is typically contains very high concentrations of BOD5 (4000 - 30,000 mg/l). COD (8,000 - 60,000 mg/l), NH3-N nitrogen, heavy metals, and organic compounds. Such concentrated leachates typically vary in volume and composition throughout the facility's operating life. The Marpi facility will utilize a "packaged leachate treatment plant (LTP) to minimize cost and land area.
Extraction wells and flares will prevent the subsurface build-up of potentially explosive methane gas and reduce the potential for soil fracturing and subsidence.

MARPI LANDFILL DESIGN FEATURES:

- Compliance with EPA Regulations
- Compliance with CNMI Regulations
- Dual HDP Composite Liner System
- Leachate Collection System
- Leachate Treatment System
- Methane Gas Ventilation System
- 6 Groundwater Monitoring Wells
- Quality Assurance and Control
- Groundwater Monitoring Plan
- 3-4 Transfer Stations
- Stormwater Run-off Control
- Appropriate Heavy Equipment
- Daily Compaction & Cover
- Operator Training & Certification
- Final Closure Plan
- Post-Closure Care Plan
- Financial Assurance/Bonding
- Recycling Facilities
- Segregation of Waste Streams
- Waste Oil Disposal Bins
- Separate C&D Disposal Site
- Waste Acceptance Scales
- "Pit Burner" for Green Wastes
- Composting Facilities

FUNDING FOR MARPI LANDFILL:

Stressed by intense development pressure, the CNMI seeks additional funding for infrastructure and public services projects. Faced with insufficient legislative funding, implementing agencies continuously seek creative strategies to fund and finance infrastructure projects.

To implement the Marpi Sanitary landfill project, the CNMI has worked closely with private-sector development firms to develop innovative "partnership" arrangements or "development agreements" to jointly fund and construct waste management facilities. Development agreements are essentially contracts which outline the roles and responsibilities of public-sector agencies and individual private-sector development firms.

Having sited the new landfill on public land, the CNMI has coordinated with a Saipan-based resort development firm to construct and operate the new landfill for $26 million. The Executive Branch has recently completed negotiations with the United Micronesian Development Association (UMDA) to construct and operate the new landfill for 12 years in exchange for rights to develop a golf mega-resort on CNMI public land.
The estimated capital cost for the landfill's construction is $10 million. In addition, $1.3 million will be required for annual operations and maintenance.

COMPREHENSIVE WASTE PLANNING:

Future activities for the CNMI Solid Waste Management Initiative include preparation of a Comprehensive Solid Waste Management Plan for the islands of Saipan, Tinian, and Rota. The Plan will be based on an integrated approach to waste management. It will explore waste disposal, recycling, collection, hazardous materials management, public education, waste minimization, incineration, and potential waste-to-energy alternatives.

The Department of Public Works has already received a $200,000 federal grant for the development for a Comprehensive Solid Waste Management Plan. Funding has been received from the U.S. Department of Interior's Office of Territorial and Insular Affairs (OTIA). The Plan will assess technical and economic feasibility of recycling, collection and disposal, incineration and waste-to-energy programs for 40 years for the islands of Saipan, Tinian, and Rota.

The CNMI has embarked upon an aggressive waste management program utilizing both public sector and private sector resources. The immediate projects emphasize development of a sanitary landfill and transfer stations. The overall plan will address closure and post-closure monitoring of the Puerto Rico Dump. Future projects will stress recycling, waste minimization, and begin to explore feasibility of possible waste-to-energy projects.