AGENDA

• Introduction
• Brief History
• Used Water System & Water Reclamation Process
• Sludge Thickening
• Sludge Dewatering
• Thermal Drying
• Sludge Disposal
Introduction - PUB

To deliver and sustain a clean and healthy environment and water resources for all in Singapore.

To ensure a sustainable quality supply of water.

A Statutory Board constituted under the Public Utilities Act 2001 to provide integrated water supply, sewerage and drainage services.

Introduction – Closing the Water Loop

From sourcing, collection, purification and supply of drinking water, to treatment of used water and turning it into NEWater, drainage of storm water.

Stormwater Management → RAIN → SEA → Treatment of Used Water

Collection of Rainfall in Drains & Reservoirs

Treatment of Raw to Potable Water

Desalination

Production of NEWater

Collection of Used Water in Sewers

Supply of Water to Population & Industries
Introduction – Singapore

<table>
<thead>
<tr>
<th>Land Area</th>
<th>710 km²</th>
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<tbody>
<tr>
<td>Population</td>
<td>5.08 mil</td>
</tr>
<tr>
<td>Average Annual Rainfall</td>
<td>2,400 mm</td>
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Key Drivers to Used Water Treatment
Brief History

Sanitation

Population ('000)

Year


Population ('000)  Population served by night soil  Population served by modern sanitation

1997: 100% modern sanitation

1987: Nightsoil phased out
Used Water System – Brief History

• 1917 – First Trickling Filter Plant

• 1948 – First Activated Sludge Plant

• 1961 to 1981 – 5 additional Activated Sludge Plants built to cater to:
  • Rapid Industrialisation
  • Development of New Towns (Public Housing)

• 1987 – Nightsoil bucket system totally phased out

Physical Evolution of Water Reclamation Plants

1st sewer – 1919

Alexandra Sewage Disposal Works

Changi WRP - Compact Design

1st Water Reclamation Plant – Kim Chuan WRP

Covering up of WRPs – Ulu Pandan
Used Water Infrastructure before DTSS

- Used water superhighway to meet needs for the future
- Sustainable solution to Singapore’s long-term needs for used water collection, treatment, disposal and reclamation
- Integral part of Singapore’s water supply strategy
Present Used Water Infrastructure
- Completion of DTSS Phase 1

Transforming water management in Singapore –
the Deep Tunnel Sewerage System

Used Water System
and
Water Reclamation Process
Activated Sludge Process

- Liquid Treatment
- Solid Treatment
Used Water and Sludge Treatment

Liquid Treatment

- Screens
- Primary Clarifiers
- Aeration Tanks
- Final Clarifiers
Inlet Pump

Screens

- Screen off large objects eg. rags, stringy materials to protect downstream equipment
Primary Clarifiers

- Allow solids to settle
- Solids are removed as sludge

Aeration Tanks

- Aerobic micro-organisms break down organic matter in used water
- Air is supplied to micro-organisms
Final Clarifiers

- Allow culture of micro-organisms to settle
- Treated used water is discharged to the sea or reclaimed
- Settled solids are removed as sludge

Effluent Standard

- Activated Sludge Process
  - Effluent standards for discharge to the sea:
    \[ \text{BOD}_5 = 20 \text{ mg/L}; \text{ SS } = 30 \text{ mg/L} \]
  - Effluent standards for feed to NEWater:
    Lower \[ \text{BOD}_5 \] & SS with \[ \text{NH}_3 < 5 \text{ mg/L} \]
Solid Treatment

- Sludge Thickening
- Anaerobic Digestion
- Sludge Dewatering
- Thermal Drying
- Sludge Incineration

Sludge Treatment Diagram

Typical Sludge Treatment Flow Diagram
What is Sludge Treatment

• What is Sludge Treatment?
  
  – Treat to a stable form to render it safe for disposal
  – Reduce moisture content to reduce handling cost
  – Stabilise and reduce organic content

Definition of Sludge

• also known as solids or biosolids

• generated from the process of purifying liquid waste/wastewater
Anaerobic Digestion

- Anaerobic micro-organisms break down organic matter in sludge
- Biogas is produced
Dual Fuel Generators

- Biogas is used as fuel to generate electricity
- Can provide about 20% of plant’s need
- Supplement to electricity imported from the grid

Benefits of Sludge Thickening

- Smaller capacity of tanks and equipment required
- Lesser chemicals required for sludge conditioning
- Lower piping and pumping costs for sludge transferring
Sludge Dewatering

Benefits of Dewatering

- The costs of transportation of sludge to the ultimate disposal site become substantially lower when volume is reduced by dewatering.
- Dewatered sludge is easier to handle. Dewatered sludge can be shoveled, moved about with tractors, fitted with buckets and blades, and transported by belt conveyors.
- Enhance incineration by removing excess moisture and hence increasing its calorific value.
- Dewatering is required prior to landfilling sludge to reduce leachate production at the landfill site.
Plate Press

Dewatering Centrifuges

- Water is removed from digested sludge
- For ease of handling and disposal
Sludge Storage Silos

Dewatered Sludge

Send to incineration

Thermal Drying
Thermal Drying

- Thermal drying involves the application of heat to evaporate water to reduce moisture content of the biosolids (sludge).
- High level of drying is achievable with production of dried sludge of up to 90% dry solids content. Some heat drying systems are able to produce dense and dried sludge pellets which are easy to handle and to dispose of.
- The advantages of heat drying include reduced transportation cost, further pathogen reduction, and improved storage capacity.

*Products of heat drying:
Dried and dense sludge pellets*
VOLUME REDUCTION BY SLUDGE DRYING

<table>
<thead>
<tr>
<th>Volume of Sludge</th>
<th>DS</th>
<th>Total Volume Reduction</th>
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<tbody>
<tr>
<td>1000 m³/day</td>
<td>3.0%</td>
<td>95%</td>
</tr>
<tr>
<td>150 m³/d</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>50 m³/d</td>
<td>92%</td>
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Volume Reduction: 85%
Volume Reduction: 78%

63 Loads
10 Loads
2 Loads

Sludge Disposal
Options for Sludge Disposal
SLUDGE INCINERATION

- Sustainable method
- Only incombustible ash remains after sludge is incinerated

MINERGY GLASS AGGREGATE

- Sludge is melted at temperatures >1500° C
- Toxic organic compounds are destroyed
- Produces an environmentally inert product
- Approved for use in US as construction material
CRYSTALLISATION

- Patented crystallisation process that converts sludge to aggregates for land reclamation

SYNTHETIC STONES/AGGREGATES

PRODUCTION OF BIOFUEL

- Converts wood waste to charcoal
- Waste heat can be used to dry sludge
- Charcoal and dried sludge is used to produce electricity
Sludge Incineration
**Sludge Incineration at ECO**

- **Design:**
  To incinerate a combination of dried (90 to 95% DS) and dewatered sludge (20 to 25% DS).

- **Incineration process:**
  1. Step 1: The dried and dewatered sludge is premixed
  2. Step 2: Premixed sludge is sent for drying
  3. Step 3: After drying, it is incinerated.
  The heat from the incineration process is recycled for the drying process.

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**Sludge Incineration Process**

![Sludge Incineration Process Diagram](image)
ECO Special Waste Management

**Future**

- Use Green technology to reduce carbon dioxide emission.
- Convert sludge to recycle materials
- Tap on new emerging technology.
Thank You