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Innovative Design Concepts Incorporated into a Landfill Closure and Reuse Design Portsmouth Naval Shipyard, Kittery, Maine

U.S. Army Corps of Engineers, Omaha District
Dave Ray
Kevin Pavlik
Presentation Outline

- Background
- Pre-Design Requirements/Investigation
- Design
- Shoreline Protection
- Landfill Gas
- Final Reuse
- Questions
Installation Location
Pre-Jamaica Island Landfill
Pre-Remedy Uses/Pre-Excavation

- Solid Waste Handling Facility
- Equipment Lay Down Area
- Crane Test Pad
- Ballfield
- Parking
- Recreational
  - Boat Storage
- Running Track
- JAMAICA COVE
- CLARK COVE
- CLARK’S ISLAND
RCRA Level C Hazardous Waste Landfill Cover or Equivalent

- Vegetated Surface
- 6" Topsoil
- 18" Select Fill (Minimum)
- Drainage Geocomposite
- Geomembrane
- GCL
- 12" Low Permeability Layer
- Gas Collection Layer

Waste
Final Reuse
Design Challenges

- Final Reuse
  - Surface slopes to support recreation areas
  - Internal drainage slopes to meet regulatory requirements
- Minimize material export and import
  - Use maintenance dredge spoils below cover
  - Saw tooth internal drainage layer
- Minimize settlement
  - Preload
- Tide varies 10 feet
Regulatory Concerns

- 2% Minimum Surface Slope
  - EPA 3%, MEDEP 5%
  - Settlement
- Cap Cross Section
- Soil Gas Management
- Sea Level Rise
- Wetland Creation
- Aesthetics (View from the river and shore)
Design Goals

• Protect the Environment
  – Implement ROD
  – Meet Regulatory Requirements

• Reuse
  – Create Wetlands and Incorporate Maintenance Dredge Materials
  – Incorporate Recreation and Parking
  – Relocate crane test pad

• Cost
  – Minimize Construction and Long Term O & M

• Minimize Impacts to Base Operations

• Complete in Two Phases
  – Time and Seasonal Constraints
Innovative Features

- CPT for waste & subsurface characterization
- Wetland creation
- Coastal tie-in
- Use of geotextile in LFG collection layer
- Maintenance dredge spoils reuse
- Saw tooth design of internal drainage layer
- Final reuse
Presentation Outline

• Background
• **Pre-Design Requirements/Investigation**
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Pre-Design Requirements

• Site Topographic Survey
  – Aerial photography
  – Hydrographic (Clark Cove and Jamaica Cove)
  – Land survey to “ground truth” and locate utilities

• Cone Penetration Testing (CPT)
  – Vertical and areal extent of waste
  – Characterize layers (waste and soils; strength, consolidation)

• Borings
  – Undisturbed samples for Lab Testing: strength, consolidation (rate and magnitude), density, classification.
  – Standard Penetration Tests (SPT) to corroborate CPT
  – Bedrock competency (Rock Quality Designation, RQD)
Pre-Design Requirements

- **Test Pits**
  - Lateral and vertical extent of waste at undefined edges

- **Landfill Gas Survey**
  - Depth, location, and production rate (flux) of CH₄ and CO₂

- **Piezometers**
  - Determine extent of tidally influenced groundwater
  - Slope stability affected by excess pore pressures,
    shallow and deep piezometers installed to measure
  - Forced movement of air and landfill gas a concern

- **Surface Soil Samples**
  - Geotechnical testing for reuse in low permeability layer
Cone Penetrometer
Typical Geologic Cross Section
Presentation Outline

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Design Analyses

- **Settlement Analysis**
  - Key to reuse and final slope (2% vs 5%)
  - Non-municipal type waste therefore traditional geotechnical settlement analysis was used
  - Consolidation rates:
    - Lab results for clay, CPT and literature for waste
  - 34 points
    - Stratigraphy based on CPT/Borings
    - Loading based on final grading plan (depth of fill)
    - Preload w/excavated material to reduce post construction settlement
  - Results
Typical Internal Drainage System

Detail

132' Maximum

6' Min.

6' Topsoil

12' Min.

18' Min.

6' Min.

Select Fill

ASTM C33

Filter Geotextile

6' Perforated Corrugated Flexible HDPE Pipe

FLOW
Internal Drainage Layer Plan
Typical Cross Sections
Post-Settlement Slope Analysis
Design Analyses

• **Slope Stability**
  - Geometry determined by geology, topography, and grading plan
    - Potential failure surfaces apparent from geometry and strength of layers
  - Loading
    - Weight of added material for landfill cover
    - Seismic forces
    - Rapid drawdown of water.
      - Tidal fluctuation similar rapid drawdown of liquid impoundment
  - Strength parameters from CPT, SPT, lab data, literature
    - Unconsolidated Undrained – controls short term strength
    - Consolidated Drained – controls long term strength
Design Analyses

• **Slope Stability**
  – **Piezometric Conditions**
    • Modeled as worst case, no dissipation of excess pore pressure within clay.
  – **Factors of Safety (FS)**
    • RCRA Subtitle C
      – Short term static minimum FS = 1.3
      – Long term static minimum FS = 1.5
      – Seismic minimum FS = 1.0
    • MEDEP
      – Seismic minimum FS = 1.0 for 10% exceedance in 250 years
      – Seismic minimum FS = 1.1 for 10% exceedance in 50 years
  – **Results**
    • Minimum Factors of Safety met for all conditions
Slope Stability Analysis Methods

- Global Stability
  - UTEXAS4 (USACE and U of Texas)
    - Searches for weakest possible failure surface
    - Multiple analysis methods available within program
  - WESHAKE5 (U of Cal-Berkley) used to determine the maximum horizontal acceleration

- Seismic/Liquefaction potential determined not a problem
Seismic Slope Stability Analysis

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<tr>
<th>NO.</th>
<th>DESCRIPTION</th>
<th>UNIT WEIGHT</th>
<th>SHEAR STRENGTH</th>
<th>PORE PRESSURE</th>
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<td>Friction angle: 0</td>
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Factor of safety: 1.438
Side force Inclination: -5.22 degrees
Design Analyses

• Slope Stability
  – Veneer Stability
    • Saturation of cover soil due to capacity of drainage layer
    • Analysis supports use of bi-planar vs tri-planar (except on side-slopes)
    • Interface friction
    • Slope geometry
    • Method of analysis
      – Geosynthetic Research Institute – GRI Report No. 18, “Cover Soil Slope Stability Involving Geosynthetic Interfaces
Design Analyses

• **Slope Stability**
  - Veneer Stability (cont.)
    • Rate of precipitation
    • Soil layers; density, strength, permeability
    • Drainage layer transmissivity
      - Size drainage layer to minimize saturation of cover soil
    • Interface friction values
      - Textured geomembrane has higher friction value
      - Add geotextile to surface of drainage layer to increase friction
    • Transmissivity vs length of drainage path
    • Factors of safety
      - Static, minimum FS = 1.5
      - Seismic, minimum FS = 1.0
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Typical Shoreline Protection Section
Typical Culvert Profile
Turbidity Curtain
Turbidity Curtain

- 3/8 inch Polypropylene rope sealed in the ends
- Folds for compact storage
- Depth according to need
- Nylon reinforced vinyl
- All seams heat sealed
- 3/8 inch chain
- Flotation
Shoreline Protection and Geomembrane Termination
Presentation Outline

• Background
• Pre-Design Requirements/Investigation
• Design
• Shoreline Protection
• Landfill Gas
• Final Reuse
• Questions
LFG Collection and Venting

- Prevent build-up and lateral migration of methane
  - Build-up beneath geomembrane can cause slope instability
- Passive vs Active collection system
  - Age and composition of waste, climate and moisture condition of waste
- Passive blanket collection system
  - Sized for measured methane production rate and calculated tidally induced gas movement
  - Geotextile used with collector strips and vents spaced based on transmissivity of layer. Maximum gas pressure determined by slope stability (thickness of overburden vs gas pressure)
LFG Collection Layer

NOTE:
CONTOUR LINES INDICATE MAXIMUM GROUNDWATER FLUCTUATION INDUCED BY LANDFILL GAS COMBUSTION. CONTOURS ARE EXTRAPOLATED BEYOND THE LOCATION OF THE FLEXICOMETERS. NOTE THAT THE CONTOURS DO NOT WRAP AROUND AS SHOWN IN FIGURES 8-1 AND 8-2 (TURAK, 2003). CONTOURING SHOWN IN THESE FIGURES IS THE RESULT OF SOFTWARE ATTEMPTING TO CLOSE THE AVAILABLE DATA POINTS.

TIDALLY INFLUENCED GAS COLLECTION AREA

GAS PROBE LOCATION
LANDFILL GAS COLLECTION STRIP
GEOTEXTILE AREA
GROUNDWATER FLUCTUATION CONTOUR
MONITORING WELL
FLEXICOMETER

FIGURE 8-7 LANDFILL GAS COLLECTION LAYER

SCALE: 1 INCH = 200 FEET
Gas Vent Locations
(Internal Drainage Layer)
Gas Vent Locations
(Final Reuse)
Typical Diffuser Flap Vent Detail

Diffuser Flap in Geomembrane Plan View
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Typical Vegetated Landfill Section

Vegetated Surface

6" Topsoil

18" Select Fill (Minimum)

12" Low Permeability Layer

Waste

Drainage Geocomposite
Geomembrane
GCL

Gas Collection Layer
Typical Vegetated Landfill Section Variations

**SECTION 6**

N.T.S.

Typical Jogging Trail Section

**SECTION 7**

N.T.S.

Typical Softball Infield Section
Typical Pavement Sections

- 3" Hot Mix Asphalt
- 6" Aggregate Base Course
- 15" Subbase Course (minimum)
- 12" Low Permeability Layer
- Waste

- Gas Collection Layer

- 6" Portland Cement Concrete
- 6" Crushed Aggregate Base Course
- 12" Aggregate Subbase Course (minimum)
- 12" Low Permeability Layer
- Waste

- Gas Collection Layer

- Drainage
- Geocomposite
- Geomembrane
- GCL
Light Pole Locations
Ball Field Lighting Details

SECTION A

COORDINATE ANCHOR BOLT PLACEMENT # EXISTING LIGHT STANDARD BASE PLATE

DIRECT BURY ELECTRICAL CONDUIT IN SELECT FILL

CHAMFER TOP OF PIER 1/8" ALL AROUND

TOP OF GRADE

1 1/4" @ ASTM A499 ANCHOR BOLTS (16 TOTAL)

1 1/4" @ ASTM A499 ANCHOR BOLTS (16 TOTAL)

3 TIES - 2 SETS @ EACH LOCATION

3 TIES

16 * 5 BAR EACH WAY

8 7 DOVELS 1 1/4"

16 * 7 BAR EACH WAY

12'0" SQUARE FOOTING

12'0"

Notes:
1. Overexcavate and Place ASTM C33 #57
   Store to 10' Tippy
2. Compact In 12 Lifts to 95% ASTM D557
3. Concrete shell meet requirements of Specification Section 02552, Pavement, paragraph
4. Reinforcing steel to meet MDOT requirements and 1'y = 60,000 psi.

SECTION B

BARRIER LAYER PENETRATION DETAIL
(BALLFIELD LIGHTS)

FOOTING SECTION

FOR TYPICAL BALLFIELD LIGHT STANDARD

NO SCALE
Parking Lot Lighting Foundation Details

Notes:
1. Contractor may choose pier footing diameter and install with indicated embedment depth.
2. Concrete shall meet requirements of specification Section 02252 Pavement, paragraph 3.7.
3. Reinforcing steel to meet UDOT requirements and fy = 60,000 psi.

<table>
<thead>
<tr>
<th>Diameter (In)</th>
<th>Embedment Depth (Ft)</th>
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<tbody>
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<td>24</td>
<td>6.5</td>
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<tr>
<td>30</td>
<td>6.0</td>
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<tr>
<td>36</td>
<td>5.5</td>
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Running Track,
Ball Field and Lights
Asphalt Parking Lot, Lights, and Jamaica Cove Wetland
Aerial View Before Construction

CLARK COVE
CLARK'S ISLAND
JAMAICA COVE
Aerial View of Completed JILF
Presentation Outline

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