Unit 2: Debris Quantity Forecasting and Estimating
Objectives

2.1 Discuss the importance and differences between debris forecasting and estimating

2.2 Forecast and estimate the quantity and mixture of debris using various techniques

2.3 Address debris forecasting and estimating issues in debris planning
Forecasting vs. Estimating

Debris Forecasting
- Pre-disaster plan development

Debris Estimating
- Post-disaster plan implementation
Debris Forecasting Techniques

- Historical Analysis
- Community-based risk analysis
- Computer-based prediction analysis
Forecasting

Historical Analysis

- Analyze prior events
- Interview staff
- Review changes in conditions:
  - Land use changes
  - Landfill capacity changes
  - Response capability of community
  - Laws and regulations
Forecasting Community-Based Risk Analysis

- Use maps to indicate areas of similar land use
  - Urban, industrial, rural, mixed
- Develop a representative sample of debris quantities of each area
- Project debris quantity estimate for each area
Forecasting
Computer-Based Prediction Analysis

- Types of models
  - USACE
  - Private industry
Debris Forecasting
USACE Model – Manual

- Formula: $Q = C(H)(V)(B)(S)$
  - $Q =$ Volume of debris in cubic yards
  - $C =$ Storm category factor
  - $H =$ Number of households
  - $V =$ Vegetative characteristic
  - $B =$ Commercial/business/industrial use multiplier
  - $S =$ Precipitation multiplier
Debris Forecasting
Private Industry Models

- Other debris forecasting models may be available through other private vendors or other public sources.
Debris Estimating Techniques

- Ground measurement
- Aerial photography
- GIS
- Combination of techniques
Estimating Roadside Debris Piles

Mixed Debris

C&D Debris
Ground Measurements

- Equipment
- Estimating aids:
  - Defining debris area
  - Formulas
  - Tables
Debris Estimating Formulas

- One-story building:
  \[
  \frac{L' \times W' \times H'}{27} = \text{_____ CY} \times 0.33 = \text{_____ CY}
  \]

- Mobile homes:
  \[
  \frac{L' \times W' \times H'}{27} = \text{CY}
  \]

- Debris piles:
  \[
  \frac{L' \times W' \times H'}{27} = \text{_____ CY}
  \]
# Debris Estimating Table

## Vegetative Cover Multiplier (Yard Waste)

<table>
<thead>
<tr>
<th>Typical House</th>
<th>None</th>
<th>Light (1.1)</th>
<th>Medium (1.3)</th>
<th>Heavy (1.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 SF.</td>
<td>200 cy</td>
<td>220 cy</td>
<td>260 cy</td>
<td>300 cy</td>
</tr>
<tr>
<td>1200 SF.</td>
<td>240 cy</td>
<td>264 cy</td>
<td>312 cy</td>
<td>360 cy</td>
</tr>
<tr>
<td>1400 SF.</td>
<td>280 cy</td>
<td>308 cy</td>
<td>364 cy</td>
<td>420 cy</td>
</tr>
<tr>
<td>1600 SF.</td>
<td>320 cy</td>
<td>352 cy</td>
<td>416 cy</td>
<td>480 cy</td>
</tr>
<tr>
<td>1800 SF</td>
<td>360 cy</td>
<td>396 cy</td>
<td>468 cy</td>
<td>540 cy</td>
</tr>
<tr>
<td>2000 SF</td>
<td>400 cy</td>
<td>440 cy</td>
<td>520 cy</td>
<td>600 cy</td>
</tr>
<tr>
<td>2200 SF</td>
<td>440 cy</td>
<td>484 cy</td>
<td>572 cy</td>
<td>660 cy</td>
</tr>
<tr>
<td>2400 SF</td>
<td>480 cy</td>
<td>528 cy</td>
<td>624 cy</td>
<td>720 cy</td>
</tr>
<tr>
<td>2600 SF</td>
<td>520 cy</td>
<td>572 cy</td>
<td>676 cy</td>
<td>780 cy</td>
</tr>
</tbody>
</table>

Formula for one story structure: \[ \text{square feet} \times 8 \text{ feet} \times 0.20 \times \text{VCM} = \text{cy} \]

This chart and calculations are inclusive of the structure and contents.
Debris Forecasting
USACE Flood Debris Model

- Used to calculate debris quantity from a flood event only when the structure is not destroyed.

- Formula: Square footage $\times$ 0.02 = cubic yards of debris

- 2400 sq. ft. $\times$ 0.02 = 48 cubic yards
USACE Formulas

- The USACE formulation model for calculating:
  - Loads to haul and times
  - Number of sectors
  - Reduction rates
  - Manpower for monitoring
USACE Formulas
- Loads to haul and times

- 120-Day mission (Example)
- 2,000,000 cy per sector and one TDSR per sector
- A 4 C.Y. loader will load a 20 C.Y. truck in 10 min.
- Average haul distance is 15 miles
- 12-hour work day
USACE Formulas
- Loads to haul and times

- Calculations:
- Loading = 60min / 10min/load = 6 loads per hour
- Assuming 1 hr for lunch and 1 hour down time,
- 12 - 2 = 10 hrs x 6 = 60 loads per day per loader
- 60 loads x 20 cy per load = 1200 cy per day per loader
- Truck time, 15-mile haul
  - = 30 min travel, 15 unloading, 25 min return = 70 min,
  - 70/10 min/load = 7 trucks, use 8
- = 8 trucks per loader
USACE Formulas
- Loads to haul and times

- Calculations:
  - Loading = 60min / 10min/load = 6 loads per hour
  - Assuming 1 hr for lunch and 1 hour down time,
  - 12 - 2 = 10 hrs x 6 = 60 loads per day per loader
  - 60 loads x 20 cy per load = 1200 cy per day per loader
  - Truck time, 30-mile haul
    - = 50 min travel, 15 unloading, 45 min return = 110 min,
    - 110/10 min/load = 11 trucks,
  - Use 12 = 12 trucks per loader
USACE Formulas
- Loads to haul and times

- Calculations:
  - 1200 cy per day per loader
  - 8 trucks per loader
  - 2,000,000 C.Y. / 120 days for mission = 16,666 C.Y./day
  - 16,666 C.Y./1200 = 13.8 or 14 loaders
  - 14 loaders x 8 trucks/loader = 112 trucks
USACE Formulas – Reduction Rates

- 12-hour work day
- Incineration rate = 160 C.Y. per hour, 24-hour operation
  - 160 x (24-5)19 hrs/day = 3000 C.Y./day
- Grinding rate = 180 C.Y. per hour, 10-hour operation
  - 180 x 10 = 1800 C.Y./day
USACE Formulas – Monitoring Manpower

Manpower:
- One inspector per loading operation = 14
- Six inspectors per TDSR
  - One - Site Team Leader
  - Two - Tower Operations
  - One - Reduction Operations
  - Two - Night Shift = 6

20/zone
Mobile Home Park Debris Estimating

Typical single wide = 290 cubic yards

Typical double wide = 415 cubic yards
Units of Measure

- Volumetric (Cubic Yards)
- Weight (Tons)
Approximate Conversions

Construction and Demolition (C&D)
- CY of C&D debris to tons—divide by 2
- Tons of C&D to CY—multiply by 2

Woody Debris
- CY of hardwoods to tons—divide by 4
- Tons of hardwoods to CY—multiply by 4
- Tons of softwoods to CY—multiply by 6
Estimating Using Aerial Photography

Tornado Damage
Estimating Using Aerial Photography

Tornado Damage
Review Activity 2.1 – Debris Forecasting and Estimating