Quantity Estimate Supporting Documents
Quantity Estimation Spread Sheets

The quantity estimation spread sheets were developed based upon the following four (5) input parameters:

- $H_E$: Embankment Height (ft)
- $H_F$: Foundation Height (ft)
- $H_S$: Seafloor Deposits Thickness (ft)
- $N_1$: Number of Stone Column at Upstream or Downstream Slope
- $L$: Length of Embankment

The embankment height $H_E$ refers to the vertical distance between the dam crest and the top of the soft lacustrine/upper alluvium strata. The foundation height $H_F$ refers to the thickness of the soft lacustrine/upper alluvium strata underneath the embankment.

Based upon these parameters, and the typical dam cross sections, the area and/or linear footage calculation equations for various embankment items were developed. These equations are presented in this part of this appendix. The quantity estimation spread sheets presented in the earlier part of this appendix were established based upon these equations.

The following Table A summarizes the required input parameters for calculating the quantity for each of the embankment items.

### Table A – Required Input Parameters For Each Embankment Items

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Unit</th>
<th>Input Parameters Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dredge of Seafloor Deposits</td>
<td>CY</td>
<td>$L$, $H_E$, $H_S$</td>
</tr>
<tr>
<td>1</td>
<td>Dredge of Soft Lacustrine/Upper Alluvium</td>
<td>CY</td>
<td>$L$, $H_E$, $H_F$</td>
</tr>
<tr>
<td>2</td>
<td>Sand/Gravel Fill Type A in Core</td>
<td>CY</td>
<td>$L$, $H_E$, $H_F$</td>
</tr>
<tr>
<td>2</td>
<td>Sand/Gravel Fill Type A in Shell</td>
<td>CY</td>
<td>$L$, $H_E$</td>
</tr>
<tr>
<td>3</td>
<td>Sand/Gravel Fill Type B in Shell</td>
<td>CY</td>
<td>$L$, $H_E$</td>
</tr>
<tr>
<td>5</td>
<td>Rip Rap</td>
<td>CY</td>
<td>$L$, $H_E$</td>
</tr>
<tr>
<td>6</td>
<td>Stone Column</td>
<td>FT</td>
<td>$L$, $H_E$, $H_F$, $N_1$</td>
</tr>
<tr>
<td>7</td>
<td>Installation of SCB Wall</td>
<td>SF</td>
<td>$L$, $H_E$, $H_F$</td>
</tr>
<tr>
<td>4</td>
<td>Sand Blanket Drain (Type A)</td>
<td>CY</td>
<td>$L$, $H_E$</td>
</tr>
<tr>
<td>3</td>
<td>Coarse Blanket Drain (Type B)</td>
<td>CY</td>
<td>$L$, $H_E$</td>
</tr>
<tr>
<td>8</td>
<td>Wick Drains</td>
<td>FT</td>
<td>$L$, $H_E$, $H_F$</td>
</tr>
<tr>
<td>9</td>
<td>Fine Rock Fill</td>
<td>CY</td>
<td>$L$, $H_E$</td>
</tr>
</tbody>
</table>

The input values for $H_E$, $H_F$ and $H_S$ are related to proposed dam crest elevations as well as interpretation of subsurface information such as the thickness of the seafloor deposits and the soft lacustrine/upper alluvium deposits. For the cost
estimation purposes, the subsurface data presented on the geologic cross sections A-A' through E-E' (Figure No. 9 through 13) in the Salton Sea Restoration Project Report prepared by URS were utilized.

Based on the assumed thickness of the seafloor and the soft lacustrine/upper alluvium deposits, the entire length of the proposed embankment was in several cases, divided into multiple sections for quantity estimation calculations. The following Table B summarizes the each section name and corresponding length for the various embankment dam options. The length of each individual section was measured on the maps provided by USBR.

Table B – Section Name and Length for Various Embankment Dam Options

<table>
<thead>
<tr>
<th>Section Name</th>
<th>Section A (ft)</th>
<th>Section B (ft)</th>
<th>Section C (ft)</th>
<th>Section D (ft)</th>
<th>Section E (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid Sea Dam</td>
<td>17672</td>
<td>8664</td>
<td>4854</td>
<td>7841</td>
<td>2297</td>
</tr>
<tr>
<td>Mid Sea Barrier</td>
<td>17969</td>
<td>6761</td>
<td>5534</td>
<td>5460</td>
<td>2366</td>
</tr>
<tr>
<td>South Sea Dam</td>
<td>74310</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Sea Dam</td>
<td>122277</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perimeter Dike</td>
<td>62555</td>
<td>29586</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentric Ring Dike</td>
<td>1327920</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A. Subsurface Data
Purpose: Determine the average thickness of the Seafloor deposits and the Soft lacustrine and the alluvium deposits at different Seafloor elevations based on CPT and borhole data.

**MIDSEA DAM**

up to elevation -270

Based on B-5, B-26, B-4, CPT-28, CPT-3

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>SEAFLOOR DEPOSITS (FEET)</th>
<th>SOFT LACUSTRINE (FEET)</th>
<th>UPPER ALLUVIUM (FEET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-5</td>
<td>13</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>B-26</td>
<td>15.5</td>
<td>23.5</td>
<td>4.5</td>
</tr>
<tr>
<td>B-4</td>
<td>21.5</td>
<td>16.5</td>
<td>0</td>
</tr>
<tr>
<td>CPT-28</td>
<td>14</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>CPT-3</td>
<td>15</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>AVG</td>
<td>15.8</td>
<td>20.8</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Average thickness of Seafloor deposits: 15.8'

SOFT LACUSTRINE/ALLUVIUM: 22.7'

elevation -260 to -270 (West)

Based on B-7, CPT-29, CPT-8

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>SEAFLOOR DEPOSITS (FEET)</th>
<th>SOFT LACUSTRINE (FEET)</th>
<th>UPPER ALLUVIUM (FEET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-7</td>
<td>3</td>
<td>5.5</td>
<td>2.2</td>
</tr>
<tr>
<td>CPT-29</td>
<td>11.8</td>
<td>10.4</td>
<td>5.9</td>
</tr>
<tr>
<td>CPT-8</td>
<td>5.9</td>
<td>5.5</td>
<td>18.2</td>
</tr>
<tr>
<td>AVG</td>
<td>6.9</td>
<td>7.5</td>
<td>15.7</td>
</tr>
</tbody>
</table>

Average thickness of Seafloor deposits: 6.9'

SOFT LACUSTRINE/ALLUVIUM: 23.2'
**Elevations -260 to -270 (East)**
Based on B-2, CPT-27

<table>
<thead>
<tr>
<th>Source</th>
<th>Siltloam Deposits (Feet)</th>
<th>Soft Lacustrine Thickness (Feet)</th>
<th>Upper Alluvium Thickness (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-2</td>
<td>2</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>CPT-27</td>
<td>11.8</td>
<td>18.8</td>
<td>0</td>
</tr>
<tr>
<td>AVG</td>
<td>6.9</td>
<td>12.4</td>
<td>0</td>
</tr>
</tbody>
</table>

Average thickness of: Siltloam deposits: 6.9', Soft Lacustrine: 12.4'.

**Elevations -240 to -260 (West)**
Based on CPT-9, B-7

<table>
<thead>
<tr>
<th>Source</th>
<th>Siltloam Deposits Thickness (Feet)</th>
<th>Soft Lacustrine Thickness (Feet)</th>
<th>Upper Alluvium Thickness (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-7</td>
<td>3</td>
<td>5.5</td>
<td>2.3</td>
</tr>
<tr>
<td>CPT-9</td>
<td>3.5</td>
<td>0</td>
<td>17.6</td>
</tr>
<tr>
<td>AVG</td>
<td>3.3</td>
<td>2.8</td>
<td>20.3</td>
</tr>
</tbody>
</table>

Average thickness of: Siltloam deposits: 3.3', Soft Lacustrine: 2.8'.

**Elevations -240 to -260 (East)**
Based on B-2, CPT-1

<table>
<thead>
<tr>
<th>Source</th>
<th>Siltloam Deposits Thickness (Feet)</th>
<th>Soft Lacustrine Thickness (Feet)</th>
<th>Upper Alluvium Thickness (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-2</td>
<td>2</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>CPT-1</td>
<td>6</td>
<td>5.5</td>
<td>0</td>
</tr>
<tr>
<td>AVG</td>
<td>4</td>
<td>5.5</td>
<td>0</td>
</tr>
</tbody>
</table>

Average thickness of: Siltloam deposits: 4', Soft Lacustrine: 5.5'.

**Perimeter Dike**
Based on CPT-10, D1-1, B-11, CPT-12

<table>
<thead>
<tr>
<th>Source</th>
<th>Siltloam Deposits Thickness (Feet)</th>
<th>Soft Lacustrine Thickness (Feet)</th>
<th>Upper Alluvium Thickness (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT-10</td>
<td>3.6</td>
<td>1.2</td>
<td>14.8</td>
</tr>
<tr>
<td>D1-1</td>
<td>0</td>
<td>5.6</td>
<td>17.4</td>
</tr>
<tr>
<td>B-11</td>
<td>2.4</td>
<td>3.2</td>
<td>13.2</td>
</tr>
<tr>
<td>CPT-12</td>
<td>4.4</td>
<td>2.5</td>
<td>9.2</td>
</tr>
<tr>
<td>AVG</td>
<td>2.6</td>
<td>2.5</td>
<td>13.7</td>
</tr>
</tbody>
</table>

Average thickness of: Siltloam deposits: 2.6', Soft Lacustrine: 2.5', see notes on page 3.
**North Sea Dam**
Based on B-20, CPT-23

<table>
<thead>
<tr>
<th>Source</th>
<th>SeaFloor Deposits Thickness (Feet)</th>
<th>Soft Lacustrine Thickness (Feet)</th>
<th>Upper Alluvium Thickness (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-20</td>
<td>3.75 (5)</td>
<td>5.0 (7.5)</td>
<td>3.8 (3.8)</td>
</tr>
<tr>
<td>CPT-23</td>
<td>2 (5)</td>
<td>2 (6)</td>
<td>24 (15)</td>
</tr>
<tr>
<td>AVG</td>
<td>2.9 (5)</td>
<td>2.8 (6.8)</td>
<td>13.9 (9.4)</td>
</tr>
</tbody>
</table>

Average thickness of seafloor deposits: 2.9' (5)
Soft lacustrine/alluvium: 11.1' (16.2)

**South Sea Dam**
Based on CPT-15, DH-2, B-14, CPT-13

<table>
<thead>
<tr>
<th>Source</th>
<th>SeaFloor Deposits Thickness (Feet)</th>
<th>Soft Lacustrine Thickness (Feet)</th>
<th>Upper Alluvium Thickness (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT-15</td>
<td>7.5</td>
<td>7.5</td>
<td>2.5</td>
</tr>
<tr>
<td>DH-2</td>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>B-14</td>
<td>0</td>
<td>7.5</td>
<td>6.25</td>
</tr>
<tr>
<td>CPT-13</td>
<td>0</td>
<td>0</td>
<td>8.75</td>
</tr>
<tr>
<td>AVG</td>
<td>0.625</td>
<td>0.75</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Average thickness of seafloor deposits: 0.6'
Soft lacustrine/alluvium: 11.1' (16.2)

**Note:**
For Section WSE Subsurface Conditions at Elevation -250 in Section C-C' as well as Dam:
- Section B-B':
  - C-C', near B-11: 4'
  - B-B', near B-14: 0
  - Average: 2'

  Average SeaFloor Deposits: 2'
  Average Soft Lacustrine/Alluvium: 13'

For perimeter dike Subsurface Conditions at Elevation -250 in Section C-C' as well as Section A-A':
- C-C', near CPT-10: 2.5'
- A-A', near CPT-10: 4.1'

  Average SeaFloor Deposits: 3.3'
  Average Soft Lacustrine/Alluvium: 18.2'
Concentric Rings

Based on B-5, B-26, B-4, B-7, B-2, B-11, B-20, B-14, B-19, B-6, B-17, B-26, CPT-28, CPT-5, CPT-29, CPT-8, CPT-27, CPT-1, CPT-10, CPT-12, CPT-23, CPT-15, CPT-13, CPT-22, CPT-18, CPT-16, CPT-9, CPT-3, DH-1, DH-2, DH-3

<table>
<thead>
<tr>
<th>Sample</th>
<th>Soft Soil Deposits Thickness (Feet)</th>
<th>Soft Limestone Thickness (Feet)</th>
<th>Upper Alumunum Thickness (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.8</td>
<td>9.3</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Average thickness of soft soil deposits: 7.8 ft
Soft limestone/alumnum: 15.6 ft
Notes:
1. Refer to Figure 2 for section locations.
2. The subsurface conditions illustrated were obtained by interpolation between widely spaced explorations. Information on actual subsurface conditions exists only at locations of explorations; conditions between explorations may vary from those depicted.
3. The discussions in the text of this report should be reviewed to obtain a proper understanding of the nature of the subsurface conditions.
4. Complete boring logs and CPT data are presented in the appendices of this report.

Legend:
- Seafloor Deposits
- Soft Lacustrine Deposits
- Upper Alluvial Deposits
- Upper Stiff Lacustrine Deposits
- Lower Alluvial Deposits
- Lower Stiff Lacustrine Deposits

(VERTICAL SCALE = 100 X HORIZONTAL SCALE)

GEOLOGIC CROSS SECTION A-A'
SALTON SEA RESTORATION PROJECT

CHECKED BY: AG DATE: 1-29-04 PM: LDH
PROJ. NO: 27663042,00005
Notes:
1. Refer to Figure 2 for section locations.
2. The subsurface conditions illustrated were obtained by interpolation between widely spaced explorations. Information on actual subsurface conditions exists only at locations of explorations; conditions between explorations may vary from those depicted.
3. The discussions in the text of this report should be reviewed to obtain a proper understanding of the nature of the subsurface conditions.
4. Complete boring logs and CPT data are presented in the appendices of this report.

Legend:
- Stratigraphy:
  - Seafloor Deposits
  - Soft Lacustrine Deposits
  - Upper Alluvial Deposits
  - Upper Silt Lacustrine Deposits
  - Lower Alluvial Deposits
  - Lower Silt Lacustrine Deposits

Data Plotted Next to Exploration:
- Qtm (ref)
- 6 0419 165 288 300

For Boreholes:
- W1 170

(VERTICAL SCALE = 400 X HORIZONTAL SCALE)
Notes:

1. Refer to Figure 2 for section locations.
2. The subsurface conditions illustrated were obtained by interpolation between widely spaced explorations. Information on actual subsurface conditions exists only at locations of explorations; conditions between explorations may vary from those depicted.
3. The discussions in the text of this report should be reviewed to obtain a proper understanding of the nature of the subsurface conditions.
4. Complete boring logs and CPT data are presented in the appendices of this report.
Legend:

Stratigraphy:
- Seacliff Deposits
- Lower Alkaline Deposits
- Upper Alkaline Deposits
- Soft Lacustrine Deposits
- Lower Soft Lacustrine Deposits
- Upper Soft Lacustrine Deposits

Data Plotted Next to Explorations:
- For CPTs:
  - Qn (ton)
  - s (kPa)
- For Borings:
  - N

Notes:

1. Refer to Figure 2 for section locations.
2. The subsurface conditions illustrated were obtained by interpolation between widely spaced explorations. Information on actual subsurface conditions exists only at locations of explorations; conditions between explorations may vary from those depicted.
3. The discussions in the text of this report should be reviewed to obtain a proper understanding of the nature of the subsurface conditions.
4. Complete boring logs and CPT data are presented in the appendices of this report.

(GEOLoGIC CROSS SECTIoN D-D'  
SALTOn SEa REStoRATIoN PRoJECT)

(VERTICAL SCALE = 100 X HORIZONTAL SCALE)
Notes:

1. Refer to Figure 2 for section locations.

2. The subsurface conditions illustrated were obtained by interpolation between widely spaced explorations. Information on actual subsurface conditions exists only at locations of explorations; conditions between explorations may vary from those depicted.

3. The discussions in the text of this report should be reviewed to obtain a proper understanding of the nature of the subsurface conditions.

4. Complete boring logs and CPT data are presented in the appendices of this report.

Legend:

- Seafloor Deposits
- Soft Lacustrine Deposits
- Upper Alluvial Deposits
- Upper Stiff Lacustrine Deposits
- Lower Alluvial Deposits
- Lower Stiff Lacustrine Deposits

Data Plotted Next to Exploration:

For CPTs:

- Qm (tons)
- 0 50 100 150 200 250

For Boreholes:

- 0 50 100

(VERTICAL SCALE = 200 X HORIZONTAL SCALE)
B. Embankment Length Estimation
EMBANKMENT DIKE LENGTH ESTIMATION:

For 8,600 acres of habitat pond area (See Attached Figure i.)

\[ 1'' = 7000' \]

Estimated length of embankment dike:

\[ (3.2'' + 3.3'' + 3.5'' + 4.0'' + 4.7'' + 2.2'' + 2'') \cdot 7000 \text{ Ft/inch} \]

\[ = 22.9' \cdot 7000 \text{ Ft/inch} = 160300 \text{ Ft} \]

\[ \frac{160300 \text{ Ft}}{8600 \text{ Acres}} = 18.64 \text{ Ft/Acre} \]

For a 2500 acre habitat pond area, estimated length of embankment dike is approximately 46600 feet. ✓
C. Embankment Quantity Calculation
MIDSEA DAM CROSS SECTION CALCULATION:

1. Assumptions
   1. CREST ELEVATION: -225' AND CREST WIDTH: 30'
   2. Top of Foundation Elevation is assumed to be at top of soft lacustrine and/or alluvium deposits
   3. Bottom of Foundation Elevation is assumed to be at bottom of soft lacustrine and/or alluvium deposits.

2. Area Calculation:

   See cross section schematic Fig. A

   EMBANKMENT HEIGHT (FROM TOP OF CREST TO TOP OF FOUNDATION)
   \[ H_e \]

   FOUNDATION HEIGHT (FROM TOP TO BOTTOM OF FOUNDATION)
   \[ H_f \]

   i. SAND/GRAVEL EMBANKMENT FILL (TYPE A)
      A. Above Foundation Elevation:
         \[ 30 \cdot H_e + 3 \cdot H_e \cdot H_e = 3 H_e^2 + 30 H_e \]
      B. Below Foundation Elevation:
         \[ \frac{1}{2} \left[ (3\cdot H_e)^2 + 30 \right] + H_f \cdot H_f = \left[ (6H_e + 30) + H_f \right] H_f = (6H_e + 30)H_f + H_f^2 \]

   i. TOTAL SAND/GRAVEL EMBANKMENT FILL (TYPE A)
      \[ 3H_e^2 + 30H_e + (6H_e + 30)H_f + H_f^2 \] IN SQUARE FEET
ii) SAND/GRANITE SHELL

STONE COLUMN PLACEMENT PLATFORM TYPE A MATERIAL:

\[(3\text{He})\cdot \text{He} + (1.5\text{He})\cdot \text{He} = 4.5\text{He}^2\]

IN SQ. FT. \checkmark

STONE COLUMN PLACEMENT PLATFORM TYPE B MATERIAL:

\[(5\text{He})\cdot \text{He} - (1.5\text{He})\cdot \text{He} = 3.5\text{He}^2\]

IN SQ. FT. \checkmark

iii) LENGTH OF STONE COLUMN.

\[N_1: \text{Number of stone columns to be installed at upstream or downstream slope of the embankment at 10' intervals per row.}\]

\[N_1 = 3\text{He}/10 \text{ per slope} \quad \text{Round to nearest integer} \checkmark\]

\[N_2: \text{Number of stone columns to be installed at crest of embankment} \checkmark\]

\[N_2 = 2\]

LENGTH OF STONE COLUMNS FOR 8,664 OF EMBANKMENT (ONE ROW)

\[N_1 \cdot \text{He} + 2(N_1)\text{He} + N_2 (\text{He} + \text{He})\]

\[= (\text{He} + 2\text{He}) \cdot N_1 + 2 \cdot (\text{He} + \text{He}) \checkmark\]

LENGTH OF STONE COLUMNS PER YARD OF EMBANKMENT

\[\left[(\text{He} + 2\text{He}) \cdot N_1 + 2(\text{He} + \text{He})\right] \cdot 3/8.66\]

\[N_1 = 18\]

\[(18\text{He} + 36\text{He} + 2\text{He} + 2\text{He}) \cdot 3/8.66 \checkmark\]

\[= (20\text{He} + 38\text{He}) \cdot 3/8.66 \checkmark\]
IV. DREDGE OF SOFT LACUSTRINE DEPOSITS

\[
\left[ (3He)_2 + 30^\circ + HF \right] \cdot HF = (6He + 30 + HF)HF \quad \text{IN SQUARE FEET}
\]

V. DREDGE OF SEAFLOOR DEPOSITS

Assume Seafloor Deposits Height: \( H_s \)

\[
\left\{ [ (3He) \cdot 2 + 30 + (5He) \cdot 2] + 3H_s^2 \right\} \cdot H_s \checkmark
\]

\[
= \left\{ [ 6He + 30 + 10He ] + 3H_s^2 \right\} \cdot H_s
\]

\[
= [ 16He + 3H_s + 30 ] \cdot H_s \quad \text{IN SQ FT} \checkmark
\]

VI. INSTALLATION OF SBC WALL WITH SYNTHETIC

Assumptions:
1. Width of SBC Wall Should Be 5'
2. Bottom of SBC Wall Should Be 40' Below Bottom of Foundation

\[
\text{Length of SBC Wall: } \frac{H_e + H_f + 40}{(\text{IN FEET})} \checkmark \checkmark
\]

\[
\text{Area of SBC Wall/Per Yard: } 3(He + H_f + 40) \quad \text{(IN SQ FEET)} \checkmark
\]
Vii 3' Filter Sand Blanket (Type A) over Soft Lacustrine

\[ 5 \text{He} \cdot 3 = 15 \text{He} \]

Viii 5' Coarse Blanket Drain (Type B)

**Bottom Length:** \[ 3\text{He} + 1.5\text{He} + 15' - 50' - (1.5)3 = 4.5\text{He} - 39.5' \]

**Height:** 5'

**Total Area** = \[\left(4.5\text{He} - 39.5'\right) - 5' \cdot 1.5\].

\[ 5' = (4.5\text{He} - 47') \cdot 5' \text{ in sq ft.} \]

Stone Column portion = \[\left(3\text{He} + 15' - 50' - 3\cdot(2.3)\right) \cdot 5 = 3\text{He} - 44' - 11.3' \cdot 5 = 15\text{He} - 276.5 \text{ in sq ft.} \]

Ix RipRap Slope Protection:

![Diagram showing riprap slope protection with angles α, β, and γ, and calculations for L1, L2, and riprap area.]

\[ L_1 = \frac{6}{\tan 11.3^\circ} = 30' \]  
\[ L_2 = \frac{6}{\tan 22.4^\circ} = 14.6' \]  
\[ L_1 + L_2 = 44.6' \]

Upstream or Downstream RipRap Area

\[ \left(\frac{\text{He}}{\sin 11.3^\circ} - L_1 - L_2\right) \cdot 6 + \frac{1}{2} L_1 \cdot 6 + \frac{1}{2} L_2 \cdot 6 \]

\[ = \left(\frac{\text{He}}{\sin 11.3^\circ} - 44.6\right) \cdot 6 + 3 \cdot (L_1 + L_2) = \frac{6\text{He}}{\sin 11.3^\circ} - 267.6 + 133.8 = \frac{6\text{He}}{\sin 11.3^\circ} - 133.8 \text{ in sq ft.} \]

\[ = 30.6 \text{He} - 133.8 \]
x. Nick Draws.

\[ 2 \left( \frac{5H_e}{5} + 1 \right) HF = 2 (H_e + 1) HF \]  

[in ft]  

For 5' of Embankment.
MIDSEA BARRIER (SEISMIC DESIGN) — SEE FIG 4.14

1. ASSUMPTION:
   1. CREST ELEVATION: -245', CREST WIDTH: 30'
   2. HE: EMBANKMENT HEIGHT
   3. HF: FOUNDATION HEIGHT
   4. HS: SEAFLOOR DEPOSIT HEIGHT

2. AREA CALCULATION:

   i) SAND/GRAVEL EMBANKMENT FILL (TYPE A)
      A. ABOVE FOUNDATION:
         \[ 30 \cdot HE + 2HE \cdot HE = 2HE^2 + 30HE \]
      B. BELOW FOUNDATION ELEVATION:
         \[ (2HE) \cdot 2 + 30 - HF) \cdot HF \]
         \[ = (4HE + 30 - HF) \cdot HF \] in square feet

   ii) SAND/GRAVEL SHELL
       STONE COLUMN PLACEMENT PLATFORM TYPE A MATERIAL
       \[ (1.5HE) \cdot HE + (2.0HE) \cdot HE = 3.5HE^2 \] in sq feet

       SAND/GRAVEL SHELL TYPE B MATERIAL
       \[ (3.0HE) \cdot HE - (1.5HE) \cdot HE = 1.5HE^2 \] in sq feet
iii LENGTH OF STONE COLUMN:

\[ N_1 : \text{Number of Stone Columns to be installed at upstream or downstream slope of the Embankment at 10' interval per row} \]

\[ N_1 = \frac{2.0 \cdot H_e}{10} \quad \text{IF} \quad H_e = 41' \]

\[ \frac{2.0 \cdot H_e}{10} = \frac{2 \cdot 41'}{10'} = 8.2 \]

Use \( N_1 = 8 \) \( \checkmark \)

\[ N_2 : \text{Number of Stone Columns to be installed at crest of Embankment} \]

\[ N_2 = 2 \] \( \checkmark \)

Length of Stone Columns for 8'66' Embankment (one row)

\[ N_1 \cdot H_e + 2 (N_1) \cdot H_f + N_2 (H_e + H_f) \]

\[ = (H_e + 2H_f) \cdot N_1 + 2 (H_e + H_f) \] \( \checkmark \)

iv DREDGE OF SOFT LACUSTRINE DEPOSITS

\[ \left[ (2H_e) \cdot 2 + 30 - H_f \right] \cdot H_f = \left( 4H_e + 30 - H_f \right) \cdot H_f \] \( \checkmark \) in sq ft.

v DREDGE OF SEAFOOR DEPOSITS:

\[ \left[ (2H_e) \cdot 2 + 30 + (3H_e) \cdot 2 + 3H_s \right] \cdot H_s \]

\[ = \left[ 4H_e + 30 + 6H_e + 3H_s \right] \cdot H_s \]

\[ = (10H_e + 3H_s + 30) \cdot H_s \] \( \checkmark \)
VII. INSTALLATION OF SCB WALL
1. Width of SCB wall should be 5'.
2. Bottom of SCB wall should be 40' below bottom of foundation.

V. LENGTH OF SCB WALL: \( HE + HF + 40 \) in ft.

VII. RIP RAP SLOPE PROTECTION

A. 

\[
\begin{align*}
L_1 &= \frac{6}{\tan 18.4^\circ} = 18.0' \\
L_2 &= \frac{6}{\tan 15.3^\circ} = 21.9' \\
\therefore L_1 + L_2 &= 39.9'
\end{align*}
\]

Upstream or Downstream Riprap Area

\[
\begin{align*}
\text{Area} &= \frac{HE}{\sin 18.4^\circ} - (L_1 - L_2) \cdot 6 + \frac{1}{2} L_1 \cdot 6 + \frac{1}{2} L_2 \cdot 6 \\
&= \frac{HE}{\sin 18.4^\circ} - 39.9' \cdot 6 + 3 \cdot (39.9') = \frac{6}{\sin 18.4^\circ} \cdot HE - 3 \cdot (39.9') \\
&= 19HE - 119.7' \\
&\text{in sq ft}
\end{align*}
\]

B. Riprap on Top of Crest

\[
\begin{align*}
[(2.0HE) \cdot 2 + 30 + 6 \cdot 1.5] \cdot 6 \\
&= (4HE + 30 + 9) \cdot 6 \\
&= (4HE + 39) \cdot 6 = 24HE + 234' \\
&\text{in sq ft}
\end{align*}
\]
VIII Wick Drains

Assume: Wick Drains will be installed at 5' x 5' grid in foundation soil

\[ \left( \frac{3 \cdot HE}{5} + 1 \right) \cdot HF \cdot 2 \]

\[ = 2 \cdot HF \left( \frac{3}{5} \cdot HE + 1 \right) \]
MIDSEA BARRIER (NON-SEISMIC DESIGN) — SEE FIG 4.14

1. Assumptions:
   1. CREST ELEVATION: -245'; CREST WIDTH: 30'
   2. HE: EMBANKMENT HEIGHT
   3. HF: FOUNDATION HEIGHT
   4. HS: SEAFOOR DEPOSITS HEIGHT

2. Area Calculation:
   i. SAND/GRavel EMBANKMENT Fill (Type A)
      A. ABOVE Foundation
         \[ 30 \text{ HE} + 15 \text{ HE} \cdot \text{ HE} = 1.5 \text{ HE}^2 + 30 \text{ HE} \]  
         \text{in SQ FT}
      B. BELOW Foundation
         \[ (1.5 \text{ HE}) \cdot 2 + 30 - \text{ HF} ] \cdot \text{ HF} \]
         \[ = (3 \text{ HE} + 30 - \text{ HF}) \cdot \text{ HF} \]  
         \text{in SQ FT}

   ii. SAND/GRavel SHELL (Type B)
      \[ (5 \text{ HE}) \cdot \text{ HE} - (1.5 \text{ HE}) \cdot \text{ HE} = 3.5 \text{ HE}^2 \]  
      \text{in SQ FT}

   iii. LENGTH OF STONE Columns
        (NOT APPLICABLE)

   iv. DREDGE OF SOFT LACustrine Deposits
        \[ (1.5 \text{ HE}) \cdot 2 + 30 - \text{ HF} ] \cdot \text{ HF} = (3 \text{ HE} + 30 - \text{ HF} ) \cdot \text{ HF} \]  
        \text{in SQ FT}
V. DREDGE OF SEAFLOOR DEPOSITS

\[ \left( 5 \text{He} \right) \cdot 2 + 30 + 3 \text{Hs} \cdot \text{Hs} \]

\[ = \left( 10 \text{He} + 30 + 3 \text{Hs} \right) \cdot \text{Hs} \]

IN SQ FT

VI INSTALLATION OF SCB WALL

Assume:
1. WIDTH OF SCB WALL SHOULD BE 5'
2. BOTTOM OF SCB WALL SHOULD BE 40' BELOW BOTTOM OF FOUNDATION

\[ \text{LENGTH OF SCB WALL: } \text{He} + \text{He} + 40 \]

IN FT

VII RIPRAP SLOPE PROTECTION:

A.

\[ L_1 = \frac{6}{\tan 11.3^0} = 30' \]

\[ L_2 = \frac{6}{\tan 22.4^0} = 14.6' \]

\[ \therefore L_1 + L_2 = 44.6' \]

upstream or downstream Riprap AREA

\[ \left( \frac{\text{He}}{\sin 11.3^0} - L_1 - L_2 \right) \cdot b + \frac{1}{2} L_1 \cdot b + \frac{1}{2} L_2 \cdot b = \frac{6 \text{He}}{\sin 11.3^0} - 3(L_1 + L_2) \]

\[ = 30.6 \text{He} - 133.8 \]

IN SQ FT
B. Riprap on Top of Crest

\[(30 + 6 \cdot 1.5) \cdot 6 = 39.6 = 234 \text{ in sq ft} \]

VIII. Wick Drains

Assume: Wick Drains will be installed at 5' x 5' grid in founded soil.

\[
\left[ \left( \frac{5HE}{5} - 1.5 \frac{HE}{5} + 1 \right) \cdot HF \right] \cdot 2
\]

\[= 2HF \left( \frac{3.5HE}{5} + 1 \right) \]
South Sea Dam:

1. Assumption:
   1. Crest Elevation: -220, Crest Width: 30'
   2. $H_e$: Embankment Height
   3. $H_f$: Foundation Height
   4. $H_s$: Seafloor Deposits Thickness
   5. Upstream pool El: -230

2. Area Calculation:

   i. Sand/Gravel Embankment Fill (Type A)
      
      A. Embankment
      \[ 30 \cdot H_e + (1.5 \cdot H_e) \cdot H_e = 11.5 \cdot H_e^2 + 30 \cdot H_e \]  \text{ in sq ft}

      B. Foundation
      \[ [2(1.5 \cdot H_e) + 30 - H_f] \cdot H_f = (3 \cdot H_e + 30 - H_f) \cdot H_f \]  \text{ in sq ft}

   ii. Sand/Gravel Shell

      Stone Column Placement Platform Type A Material
      \[ (1.5 \cdot H_e) \cdot H_e + (1.5 \cdot H_e) \cdot H_e = 3 \cdot H_e^2 \]  \text{ in sq ft}

      Sand/Gravel Shell Type B Material
      \[ 2 \cdot (20') \cdot H_e = 40 \cdot H_e \]  \text{ in sq ft}
III LENGTH OF STONE COLUMN:

\[ N_1 : \text{Number of Stone Columns to be Installed at upstream or downstream slope of Embankment} \]

\[ N_1 = \frac{1.5 \, H_e}{10} \text{ Round down to nearest integer} \]

\[ N_2 : \text{Number of Stone Columns to be Installed at crest of Embankment} \]

\[ N_2 = 2 \]

LENGTH OF STONE COLUMN FOR 8.66' OF EMBANKMENT (ONE ROW)

\[ N_1 \cdot H_e + 2(N_1)H_f + N_2(H_e + H_f) \]

\[ = (H_e + 2H_f) \cdot N_1 + 2(H_e + H_f) \]

IV DREDGE OF SOFT LACUSTRINE DEPOSITS

\[ [(1.5H_e) \cdot 2 + 30 - H_f] \cdot H_f = (3H_e + 30 - H_f) \cdot H_f \text{ in SQ FT} \]

V DREDGE OF SEAFLOOR DEPOSITS

\[ [(1.5H_e) \cdot 2 + 30 + (1.5H_e) \cdot 2 + (40') \cdot 2 + (2.5H_e - 1H_e) \cdot 2 + 3H_s] \cdot H_s \]

\[ = [3H_e + 30 + 3H_e + 80 + 2H_e + 3H_s] \cdot H_s \]

\[ = [8H_e + 110 + 3H_s] \cdot H_s \]

VI INSTALLATION OF SCB WALL

Assume: WIDTH OF SCB WALL IS 9'

Bottom of SCB WALL SHOULD BE 40' BELOW BOTTOM OF FOUNDATION

\[ 1. \text{ LENGTH OF SCB WALL : } H_e + H_f + 40 \text{ in FT} \]
Vi 5' Coarse Blanket Drain Layer

Bottom Length: \[15\text{He} + 15\text{He} + 15' - 20 = 3\text{He} - 5'\]

Height: 5'

Total Area = \[\left[3\text{He} - 5' - 5'(15')\right] \cdot 5' = (3\text{He} - 5' - 7.5') \cdot 5' = 15\text{He} - 62.5 \text{ in SQ FT}\]

Stone Column portion:

\[(15\text{He} - 62.5) - (11.5\text{He}) \cdot 5' = 7.5\text{He} - 62.5 \text{ in SQ FT}\]

Vii Rip Rap

\[L_1 = \frac{6}{\tan 21.8°} = 15'\]
\[L_2 = \frac{6}{\tan 62.8°} = 2.4'\]

\[L_1 + L_2 = 15 + 2.4 = 17.4'\]

\[\text{A. upstream or downstream Rip Rap Area}\]

\[\left(\frac{6\text{He}}{\sin 21.8°} - L_1 - L_2\right) \cdot 6' + \frac{1}{2} L_1 \cdot 6' + \frac{1}{2} L_2 \cdot 6' = \left(\frac{6\text{He}}{\sin 21.8°} - 17.4'\right) \cdot 6' + 3(17.4')\]

\[= \frac{6\text{He}}{\sin 21.8°} - 8(17.4') = 16.2\text{He} - 52.2 \text{ in SQ FT}\]

\[\text{B. Rip Rap on top of fine Rock Fill}\]

\[\left[20' - \frac{1}{2} \cdot 6' \cdot (11.5')\right] \cdot 6' = (20 - 4.5) \cdot 6 = 93 \text{ in SQ FT}\]

\[A + B = 16.2\text{He} - 52.2 + 93 = 16.2\text{He} + 40.8 \text{ in SQ FT}\]
VIII Wick Drain

Assume: Wick Drain will be installed at a 5' x 5' Grid

\[ 2 \cdot \left[ \frac{1.5 \text{He} + 40' + (2.5 \text{He} - 1.5 \text{He})}{5} + 1 \right] \cdot H_F \]

\[ = 2 \cdot \left[ \frac{2.5 \text{He} + 40'}{5} + 1 \right] \cdot H_F = 2H_F \left( \frac{2.5 \text{He} + 40'}{5} + 1 \right) \]

IX Fine Rock Fill:

\[ 2 \cdot \left[ \left( (2.5 \text{He} - 1.5 \text{He}) + 20' \right) + 20' \cdot \frac{\text{He}}{2} \right] \cdot \text{Rip Rap Area} \]

\[ = \left( \text{He} + 20' \right) + 20' \cdot \frac{\text{He}}{2} - 2(16.2 \text{He} + 40.8) \]

\[ = \left( \text{He} + 40' \right) \cdot 32.4 \text{He} - 81.6 \]

\[ = \text{He}^2 + 7.6 \text{He} - 81.6 \quad \text{in Sq Ft} \]
PERIMETER DIKE AND SOUTH SEA DAM:

1. Assumption:
   1. Crest Elevation: -225; Crest Width: 20'
   2. HE: Embankment Height
   3. HF: Foundation Height
   4. HS: Seafloor Deposit Height
   5. Upstream pool EL: -230

2. Area Calculation:
   i. Sand/Gravel Embankment Fill (Type A)
      A. Embankment
         \[ 20 \cdot HE + (15 \cdot HE) \cdot HE = 15 \cdot HE + 20 \cdot HE \]  \( \checkmark \)  IN SQ FT
      B. Foundation
         \[ 2 \cdot (15 \cdot HE) + 20' - HF \]  \( \cdot HF = (3 \cdot HE + 20 - HF) \cdot NF \]  \( \checkmark \)  IN SQ FT

ii. Sand/Gravel Shell
    Stone Column placement platform Type A Material:
    \( (15 \cdot HE) \cdot HE + (15 \cdot HE) \cdot HE = 3 \cdot HE \)  \( \checkmark \)  \( \checkmark \)  IN SQ FT.
    Stone Column placement platform Type B Material:
    \( 2 \cdot (15 \cdot HE) \cdot HE - (15 \cdot HE) \cdot HE = 1 \cdot HE \)  \( \checkmark \)  \( \checkmark \)  IN SQ FT.

iii. Length of Stone Column.
    \( N_1 \) : Number of Stone Columns to be installed at upstream or downstream slope of the embankment at 10' interval per row
    Perimeter dike: \( \frac{15 \cdot HE}{10} = 15 \cdot 18.3' = 2.75 \)  \( \text{use } N_1 = 2 \) for perimeter dike
    South Sea Dam: \( \frac{15 \cdot HE}{10} = 15 \cdot 23' = 4.05 \)  \( \text{use } N_1 = 4 \) for South Sea Dam
    \( N_2 \) : Number of Stone Column to be installed at crest of embankment
    \( N_2 = 2 \).
LENGTH OF STONE COLUMN FOR 8'6" OF EMBANKMENT (ONE ROW)

\[ N_1 \cdot H_1 + 2(N_1) \cdot H_2 + N_2 \cdot (H_1 + H_2) = (H_1 + 2H_2)N_1 + 2L_{HE1+HE2} \]

LENGTH OF STONE COLUMN FOR PER YARD OF EMBANKMENT

\[ (5H_1 + 8H_2)^{\frac{3}{8}} \text{ in ft.} \]

IV. DREDGE OF SOFT LANDSLIDE DEPOSITS

\[ [1 \cdot (1.5H_1)^{2} + 20 - H_1], H_1 = (3H_1 + 20 - H_1), H_1 \text{ in sq. ft.} \]

V. DREDGE OF SEAFLOOR DEPOSITS

\[ [1 \cdot (1.5H_1)^{2} + 20 + (2.5H_1)^{2} + 3H_1], H_2 = (3H_1 + 20 + 5H_1 + 3H_1), H_2 \text{ in sq. ft.} \]

VI. INSTALLATION OF SBC WALL WITH SYNTHETIC

ASSUME:
1. \text{WIDTH OF SBC WALL} \text{ SHOULD BE 3'}
2. \text{BOTTOM OF SBC WALL} \text{ SHOULD BE 40' BELOW BOTTOM OF FOUNDATION}

\[ \text{LENGTH OF SBC WALL: } H_1 + H_2 + 40 \text{ in ft.} \]

\[ \text{AREA OF SBC WALL/PER YARD OF EMBANKMENT: } \]

\[ 3 \cdot (H_1 + H_2 + 40) \text{ in sq. ft.} \]
VI. COARSE BLANK DRAIN LAYER (TYPE C)

For perimeter dike
Bottom length: \(1.5 \text{He} + 1.5 \text{He} + 10 - 10 = 3 \text{He} \checkmark\)
Height: 3'
Total area = \([3 \text{He} - 3'(1.5)] \cdot 3' = (3 \text{He} - 4.5) \cdot 3 = 9 \text{He} - 13.5 \checkmark\) in sq. ft
Sloped column portion = \((9 \text{He} - 13.5) - (1.5 \text{He}) \cdot 3 = 4.5 \text{He} - 13.5\) in sq. ft.

For South Sea Dam
Bottom length: \(1.5 \text{He} + 1.5 \text{He} + 10 - 20 = 3 \text{He} - 10\)
Height: 3'
Total area = \([3 \text{He} - 10' - 3'(1.5)] \cdot 3' = (3 \text{He} - 14.5) \cdot 3 = 9 \text{He} - 43.5 \checkmark\) in sq. ft
Sloped column portion = \((9 \text{He} - 43.5) - (1.5 \text{He}) \cdot 3 = 4.5 \text{He} - 43.5\) in sq. ft.

VII. RIPRAP SLOPE PROTECTION:

For perimeter dike:

\[a = 21.8^\circ\]
\[L_1 = \frac{4}{\tan 21.8^\circ} = 10\]
\[L_1 + L_2 = 29\]
\[L_2 = \frac{4}{\tan 11.9^\circ} = 19\]

A. Upstream or Downstream Riprap Area

\[
\left(\frac{\text{He}}{\sin 21.8^\circ} - L_1 - L_2\right) \cdot 4 + \frac{1}{2} L_1 \cdot 4 + \frac{1}{2} L_2 \cdot 4 = \frac{\text{He}}{\sin 21.8^\circ} - 29 \right) 4 + 2 \cdot (29)
= 10.8 \text{He} - 58 \checkmark\) in sq. ft

B. Riprap on Top of Crest

\[(1.5 \text{He}) \cdot 2 + 20 + 4 \cdot 1.5 \cdot 4\]
\[= (3 \text{He} + 26) \cdot 4 = 12 \text{He} + 104\) in sq. ft.
For South Sea Dam:

See Above Figure: Use 6' of RipRap

\[ L_1 = \frac{6}{\tan 21.8°} = 15 \checkmark \]

\[ L_2 = \frac{6}{\tan 11.9°} = 28.5 \checkmark \]

\[ L_1 + L_2 = 43.5 \]

A. Upstream or Downstream RipRap Area

\[ \left( \frac{He}{\sin 21.8°} - L_1 - L_2 \right) \cdot 6 + \frac{1}{2} L_1 \cdot 6 + \frac{1}{2} L_2 \cdot 6 \]

\[ = \left( \frac{He}{\sin 21.8°} - 43.5 \right) \cdot 6 + 3 \cdot 43.5 = 16.2 He - 3 \cdot 43.5 \]

\[ = 16.2 He - 130.5 \checkmark \text{ in sq. ft} \]

B. RipRap on Top of Crest

\[ \left[ (1.5 He) \cdot 2 + 20 + 6 \cdot 15 \right] \cdot 6 \]

\[ = (3 He + 29) \cdot 6 = 18 He + 174 \checkmark \text{ in sq. ft} \]
VIII. Wick Drains

Assume: Wick Drains will be installed at a 5'x5' grid in Foundation

For perimeter dike:

\[ 2 \left( \frac{2.5H_e}{5} + 1 \right) \cdot H_F = 2 \left( \frac{H_e}{2} + 1 \right) \cdot H_F \quad \text{in ft} \]

\[ \Rightarrow \text{For 5' of Embankment} \]

For South Sea Dam:

\[ 2 \left( \frac{2.5H_e}{5} + 1 \right) \cdot H_F = 2 \left( \frac{H_e}{2} + 1 \right) \cdot H_F \quad \text{in ft} \]

\[ \Rightarrow \text{For 5' of Embankment} \]
NORTH SEA DAM

1. Assumption:

1. Crest Elevation: -223, Crest Width: 30'

2. HE: Embankment Height

3. HF: Foundation Height

4. HS: Sea Floor Deposits Height

2. Area Calculation:

i) Sand/Gravel Embankment Fill (Type A)
   
   A. Above Foundation Elevation:
      
      \[(30) \text{HE} + (3\text{HE}) \text{HE} = 3 \text{HE}^2 + 30 \text{HE}\]  \(\checkmark\)  \(\text{IN SQ. FT.}\)

   B. Below Foundation Elevation:
      
      \[\frac{1}{2} [(3 \text{HE}) \cdot 2 + 30] + \text{HF}^2 \cdot \text{HF} = (6 \text{HE} + 30 + \text{HF}) \cdot \text{HF}\]
      
      \[= (6 \text{HE} + 30) \cdot \text{HF} + \text{HF}^2\]  \(\checkmark\)  \(\text{IN SQ. FT.}\)

ii) Sand/Gravel Shell

   Stone Column placement platform Type A material:
      
      \[(3 \text{HE}) \cdot \text{HE} + (1.5 \text{HE}) \cdot \text{HE} = 4.5 \text{HE}^2\]  \(\checkmark\)  \(\text{IN SQ. FT.}\)

   Stone Column placement platform Type B material:
      
      \[(5 \text{HE}) \cdot \text{HE} - (1.5 \text{HE}) \cdot \text{HE} = 3.5 \text{HE}^2\]  \(\checkmark\)  \(\text{IN SQ. FT.}\)
iii) Length of Stone Column

N1: Number of stone columns to be installed at upstream or downstream slope of the embankment at 10' interval per row down

\[ N_1 = \frac{3 \cdot H_e}{10} \text{ Round to Nearest Integer} \]

N2: Number of stone columns to be installed at crest of embankment

\[ N_2 = 2 \]

Length of Stone Columns For 86' of Embankment (One Row)

\[ N_1 \cdot H_e + 2(N_1) \cdot H_f + N_2(3H_e + H_f) = (H_e + 2H_f) \cdot N_1 + 2(H_e + H_f) \]

iv) Dredge of Soft Lacustrine Deposits

\[ (3H_e) \cdot 2 + 30 + H_f \cdot H_f = (6H_e + 30 + H_f) \cdot H_f \text{ in sq ft} \]

v) Dredge of Seafloor Deposits

\[ \frac{1}{2} (3H_e) \cdot 2 + 30 + (5H_e) \cdot 2 + 3H_s \frac{3}{2} \cdot H_s \]

\[ = \frac{1}{2} (6H_e + 30 + 10H_e) + 3H_s \frac{3}{2} \cdot H_s \]

\[ = (16H_e + 30 + 3H_s) \cdot H_s \text{ in sq ft} \]

vi) Installation of SBC Wall With Synthetic

Assumptions:
1. Width of SBC wall should be 5'
2. Bottom of SBC wall should be 40' below bottom of foundation

Length of SBC wall: \( H_e + H_f + 40 \) (in feet)
VII. 3' Filter Sand Blanket (Type A) over Soft Lagotone

5 HE : 3 = 15 HE

VIII. 5' Coarse Blanket Drain (Type B)

Bottom Length: 3 HE + 15 HE + 15' - 50' - (18)(3') = 4.5 HE - 39.5'

Height: 5'

Total Area = [(4.5 HE - 39.5') - 5' (1.5)] · 5' = (4.5 HE - 47') · 5' = 90.5 HE - 237.5


IX. Riprap Slope Protection

L1 = \frac{6}{\tan 11.3°} = 30'

L2 = \frac{6}{\tan 22.4°} = 14.6'

L1 + L2 = 44.6'

\alpha = 11.3°

\frac{40}{\sin 11.3°} = \frac{60}{\sin 11.3°} = 13.38'

\frac{40}{\sin 11.3°} = \frac{60}{\sin 11.3°} - 227.6 + 133.8 = 44.6 - 227.6 + 133.8 = 30.6 HE - 133.8'}

Note: Wick Drain: See Mid Sea Dam.
1. **Assumption:**
   1. Crest elevation = 10' above seafloor; crest length = 20'
   2. H_e = Embankment Height
   3. H_f = Foundation Height
   4. H_s = Seafloor Deposits Height

2. **Area Calculation**
   i. **Sand/Gravel Embankment Fill (Type A)**
      A. Embankment
         \[ (20 \times H_e + (1.5 \times H_e)) \times \frac{1}{2} = \frac{1}{2} \times 21.5 \times H_e + 20 \times H_e \] in sq ft
      B. Foundation
         \[ \left[ \frac{2}{2} \left( \frac{1}{2} \times 1.5 \times H_e \right) + 20 - H_f \right] \times H_f = \left( \frac{3}{2} \times H_e + 20 - H_f \right) \times H_f \] in sq ft
   ii. **Sand/Gravel Embankment Fill (Type B)**
      \[ 2 \cdot \left( \frac{1}{2} \left( 4 \times H_e - 1.5 \times H_e \right) \right) \times \frac{1}{2} = \left( 2.5 \times H_e \right) \times \frac{1}{2} = 2.5 \times H_e \] in sq ft
   iii. **Dredge of Soft Lacustrine Deposits**
      \[ \left[ \frac{1}{2} \left( 1.5 \times H_e \right) + 20 - H_f \right] \times H_f = \left( 3 \times H_e + 20 - H_f \right) \times H_f \] in sq ft
   iv. **Dredge of Seafloor Deposits**
      \[ \left[ \left( \frac{1}{4} \times H_e \right) + 20 + 3 \times H_s \right] \times H_s = \left( \frac{1}{8} \times H_e + 20 + 3 \times H_s \right) \times H_s \]
V. 3' Course Blank Drain Layer (Type B)

Bottom Length: \( 1.5 \text{HE} + 10 - 10 = 1.5 \text{HE} \) in SQ FT

Height: 3'

Total Area: \( [1.5 \text{HE} - 3', 1.5'] \times 3' = 4.5 \text{HE} - 13.5 \) in SQ FT

\( \sqrt[3]{\text{Riprap}} \)

\[ L_1 = \frac{4}{\tan 16.0^\circ} = 16.0' \quad L_2 = \frac{4}{\tan 19.2^\circ} = 11.2' \]

\( L_1 + L_2 = 27.6' \)

A. Upstream or Downstream Riprap Area

\[ \left( \frac{\text{HE}}{\sin \theta} - L_1 - L_2 \right) \times \frac{1}{2} (L_1 + L_2) + \frac{1}{2} (L_1 + L_2)^2 \]

\[ = \left( \frac{\text{HE}}{\sin 16.0^\circ} - 27.6 \right) \times 4 + 2 (27.6) = 4 \text{HE} \sin 16.0^\circ - 55.2 \]

\[ = 16.5 \text{HE} - 55.2 \] in SQ FT

B. Riprap on Top of CREST

\[ 2 \left[ \frac{4 \text{HE} - 1.5 \text{HE}}{5} + 1 \right] \text{HE} = \left( \frac{4 \text{HE}}{2} + 1 \right) \times 2 \text{HE} \]
HABITAT POND:

1. Assumption:
   1. Height of Embankment = $H_e = 7.5'$
   2. Height of Foundation = $H_f = 10'$
   3. Crest Width = 15'
   4. Foundation Width at Bottom of Excavation = 40'
      (See Figure 5.4)

2. Area Calculation

   i) Foundation Excavation and Embankment Fill
   \[ [(2 \cdot H_f) + 40] \cdot H_f = [2 \cdot 10 + 40] \cdot 10 = 600 \text{ SQ. FT.} \]

   ii) Filter/Drain Blanket
   Bottom Length: \[ \frac{15'}{2} + 3 \cdot H_e - 5' = 3H_e + 2.5' \]
   Height: 2'
   Area: \[ \left[ (3H_e + 2.5') - \frac{1}{2} (2.15') \right] \cdot 2 \]
   \[ = (3H_e + 2.5' - 1.5 - 3) \cdot 2 \]
   \[ = (3H_e - 2) \cdot 2 = 20.5 \cdot 2 = 41 \text{ SQ. FT.} \]

   iii) Dike Embankment Fill
   \[(15 + 3 \cdot H_e) \cdot H_e - 41 = (15 + 3 \cdot 7.5) \cdot 7.5 - 41 \]
   \[= (15 + 22.5) \cdot 7.5 - 41 = 281.3 - 41 = 240.3 \text{ SQ. FT.} \]

   iv) Area of Geogrid/Geotextile per Foot of Embankment
   \[ (40 + 2 \cdot \sqrt{10^2 + 20^2}) \cdot 1 = 84.7 \text{ SQ FT} \]
3. **500-Acre Habitat Pond Embankment Length Estimation:**

We assume that a 500-acre habitat pond will include four (4) embankment sections. The embankment length for each section is approximately 4,700 feet.

The assumed layout of the four (4) embankment sections within a 500-acre habitat pond unit is present left.

*The total embankment length:

\[ (4) \times (4,700') = 18,800 \text{ feet} \]

For 500-acre habitat pond unit.

4. **Excavation and Embankment Quantity Calculation:**

i. **Excavation:**

\[ \frac{18,800'}{3} \times \frac{600 \text{ SF}}{9} = 417,778 \text{ C.Y.} \]

ii. **Embankment:**

**Dike:**

\[ \frac{18,800'}{3} \times \frac{240.3}{9} = 167,320 \text{ C.Y.} \quad (167,320') \]

**Filter Material:**

\[ \frac{18,800'}{3} \times \frac{600}{9} = 28,548 \text{ C.Y.} \quad (28,548') \]

**Foundation:**

\[ \frac{18,800'}{3} \times \frac{600}{9} = 417,778 \text{ C.Y.} \quad (417,778') \]

*Total Embankment including Filter Material:*

\[ 167,320 + 28,548 + 417,778 = 613,646 \text{ C.Y.} \]

613,646 C.Y.
5. GEOGRID / GEOTEXTILE QUANTITY CALCULATION:

\[ (18,800 \text{'} \times 84.7 \text{ SF/foot}) / 9 = 176,929 \text{ SF} \]

6. AERATE:

\[ 613,646 \text{ C.Y.} / 22,680 \text{ C.Y./week} = 27 \text{ weeks} \]

\[ 4 \text{ provided by Mr. Mike Panetto} \]
Mid Sea Barrier

Sand & gravel type A in core = Subtract the top layer of riprap
Sand & gravel type A in shell = Subtract the total length of riprap over the top of embankment minus the layer of the core

Sand & gravel type B = Subtract riprap over side slopes

Mid Sea Dam + North Sea

Sand & gravel type A in core = Subtract the section of coarse filter within the core
Sand & gravel type A in shell = Subtract the sand and coarse filter that will be in the shell

Sand & gravel type B in shell = Subtract the total rip rap and subtract the section of sand filter that is in the type B shell

Perimeter Dike + South Sea Dam

Sand & gravel type A in core = Subtract the riprap over the top of the core and the section of coarse filter from the core
Sand & gravel type A shell = Subtract the riprap along the top minus the section over the core and subtract the total coarse grain filter minus the section in the core

Sand & gravel type B = Subtract riprap along the sides