OIL WELL PAD CONSTRUCTION AND FAILURE REPAIR.

JEFF SEGAR, PE, SE
Outline

- Site locations
- Bross Pad
  - Project goals
  - Existing conditions
  - System selection and construction

- Mormon Butte Pad
  - Existing conditions
  - Project goals
  - System selection and construction
Remote Location
Dunn County

- County population 3,536
- Largest town Killdeer 818
- 2 people per sq mile
Goals: Create a flat pad for oil well drilling
Background

- Client bought lease after it had been plotted assuming 1:1 slopes
- Needed to complete this location or it would void lease for 4 sites.
Goals: Challenges

- Need to raise grade 56’ on one end and 97’ on the other
- Need to keep all work, even temporary work, within the property limits
- Existing conditions
Final Conditions
Existing Conditions

- Existing slope at about 2.75:1
- Water induced erosion
Subsurface

- Sentinel Butte Formation (decomposed)
- Sandstone over Claystone
- Really means SM over CH
## Soil profile

<table>
<thead>
<tr>
<th>Elev. feet</th>
<th>Depth feet</th>
<th>Symbol</th>
<th>Description of Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>2453.0</td>
<td>0.0</td>
<td>SM</td>
<td>SILTY SAND, fine-grained, with roots, dark brown, moist. (Topsoil)</td>
</tr>
<tr>
<td>2456.5</td>
<td>2.5</td>
<td>SS</td>
<td>SENTINEL BUTTE FORMATION, SANDSTONE, light gray, moist, decomposed, very soft, sample retrieved as non-cemented &quot;Silty Sand (SM)&quot;.</td>
</tr>
<tr>
<td>2435.0</td>
<td>18.0</td>
<td>CLST</td>
<td>SENTINEL BUTTE FORMATION, CLAYSTONE, gray, moist, decomposed, very soft, hand deformed sample classified as &quot;Fat Clay (CH)&quot;</td>
</tr>
<tr>
<td>2422.0</td>
<td>31.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Tests or Notes**

- LL = 75, PL = 45, \( P_{i=50} = 60, D_{i=101} = 101 \) pcf, WD = 128 pcf
- LL = 48, PL = 23, \( P_{i=66} = 23\% \), Do = 100 pcf, WD = 123 pcf

**Dates and Scale**

- Date: 5/6/13
- Scale: 1" = 4'
Constraints

- Remote location
- Prefer to use on-site materials
- Deep frost depth, 7’
- Preliminary design showed a stable slope would not fit in property limits
- Preliminary RSS wall had deep failure planes controlling global FS.
- Site needs to be eventually reclaimed.
Chose soldier pile wall

- Used geo-grid for surface failure protection on slope
- Use tie backs where necessary
- Extended piles to increase global Factor of Safety
- Used mid slope piles to increase FS
- Chose 2 phases and bench.
§ System selection
Deep Failure
Shallow Failure
Construction

- Clay
- Grid
- Drainage Berm
- And plastic
Construction
Construction
Construction
Construction
Construction
Construction
Construction

Notch to fit tight
Construction
Construction
Outline

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- Mormon Butte Pad
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  - Project goals
  - System selection and construction
Mormon Butte Existing Conditions - Grading
February 2014 – Picture by Client
Mormon Butte Existing Conditions
June 2014 – Picture by Client
Mormon Butte Existing Conditions
Mormon Butte Existing Conditions
### LOG OF BORING

**Braun Project B14-04305**  
**Geotechnical Evaluation**  
**Mormon Butte 5-25-28 Well Pad**  
**T147N, R38W, Sec. 25 NENE**  
**Killdeer, North Dakota**  

<table>
<thead>
<tr>
<th>Elev. feet</th>
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<th>Symbol</th>
<th>Description of Materials</th>
<th>BPF</th>
<th>WL</th>
<th>nL</th>
<th>MC %</th>
<th>Tests or Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2141.3</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FILL</strong></td>
<td></td>
<td></td>
<td>Lean Clay with Sand and Scoxia, brown, moist.</td>
<td>9</td>
<td>15</td>
<td>P200=83%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
<td>with Sand lenses and trace Gravel from 2 to 4 feet.</td>
<td>6</td>
<td>18</td>
<td>P200=94%, DD=59 psi, WD=117 pcf, Qt=3,760 psi</td>
<td></td>
<td></td>
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<tr>
<td>2144.8</td>
<td>6.5</td>
<td></td>
<td>Sandy Lean Clay, brown, moist.</td>
<td>2</td>
<td>1/2</td>
<td>TW</td>
<td></td>
<td></td>
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<tr>
<td>2149.6</td>
<td>11.5</td>
<td></td>
<td>Silt, trace Clay lenses, brown, waterbearing.</td>
<td>26</td>
<td>18</td>
<td>P200=67%, DD=76 psi, WD=121 pcf</td>
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<td></td>
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<tr>
<td>2144.8</td>
<td>16.5</td>
<td></td>
<td>Sentinel Butte Formation, Claystone, brown, moist, decomposed, very soft, hand deformed sample classified as &quot;Lean Clay (CL)&quot;.</td>
<td>14</td>
<td>3/2</td>
<td>TW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2142.8</td>
<td>18.5</td>
<td></td>
<td>Sentinel Butte Formation, Claystone, brown, moist, decomposed, very soft, hand deformed sample classified as &quot;Fat Clay (CH)&quot;.</td>
<td>12</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td></td>
<td>brownish gray below 24 1/2 feet.</td>
<td>14</td>
<td>3/2</td>
<td>1/2</td>
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<tr>
<td></td>
<td>17</td>
<td></td>
<td>Lignite lenses at 30 feet.</td>
<td>17</td>
<td>4/4</td>
<td>1/4</td>
<td></td>
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</tr>
<tr>
<td>2135.9</td>
<td>25.0</td>
<td></td>
<td>Sentinel Butte Formation, Claystone, gray, moist, decomposed, very soft, hand deformed sample classified as &quot;Fat Clay (CH)&quot;.</td>
<td>17</td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>21</td>
<td></td>
<td>iron staining below 24 1/2 feet.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>21</td>
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<td></td>
</tr>
<tr>
<td><strong>FILL</strong></td>
<td></td>
<td></td>
<td>Fat Clay with Scoxia, brown, compact.</td>
<td>8</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td>10</td>
<td>16</td>
<td>P200=80%</td>
<td></td>
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</tr>
<tr>
<td>2156.8</td>
<td>4.0</td>
<td></td>
<td></td>
<td>8</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2148.9</td>
<td>12.0</td>
<td></td>
<td></td>
<td>12</td>
<td>17</td>
<td>4.5+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2148.9</td>
<td>14.0</td>
<td></td>
<td>Sentinel Butte Formation, Claystone, brown, moist, decomposed, very soft, hand deformed sample classified as &quot;Lean Clay (CL)&quot;.</td>
<td>14</td>
<td>3/2</td>
<td>2 1/2</td>
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<tr>
<td>2148.9</td>
<td>16.0</td>
<td></td>
<td>Sentinel Butte Formation, Claystone, brown, moist, decomposed, very soft, hand deformed sample classified as &quot;Fat Clay (CH)&quot;.</td>
<td>14</td>
<td>3/2</td>
<td>2 1/2</td>
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<td>2140.9</td>
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<td>17</td>
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**Braun Internote Corporation**

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Mormon Butte Existing Conditions - August 2013
Mormon Butte Existing Conditions
Mormon Butte Existing Conditions
Constraints

- Remote location
- Prefer to reuse on-site materials. Expensive to get rid of them.
- How much soil can we remove and recompact without jeopardizing the well? May need to leave some of the failed soils in place.
Chose Reinforce Soil Structure

- Can reuse some material at upper elevation of RSS
- Water seemed to be main driver of the failure.
- RSS will flex with consolidation and can be made to allow water to pass through
- Toe of a pile wall will need to extend to great depth to achieve resistances and could trap water.
• Construction
Construction

2165
2160
2155
2150
2145
2140
Construction
Construction
Construction
Construction
Construction
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Construction
Questions?

- Conclusion