Rock Cut-Slope
Design and Construction
Grundy Redevelopment
Site E

Steve Spagna – Project Geologist
Project Description

- Redevelopment site
- Area B Ringwall – including levee construction and US 460 upgrade by VDOT
- Relocation of public facilities, including Norfolk Southern Railroad
- Total project cost - $100 M
- Local sponsors - Town of Grundy and VDOT
Phases of Construction

Grundy Local Protection Project

Before

After
One Corps, One Regiment, One Team

Grundy Local Protection Project

Project Location

Huntington District

Grundy, VA
Site Location

Site E
Summary and Authorization

Flood of Record (100 year event) – April 1977- Devastated Town, causing deaths and millions in damages.

Riverside Drive
1977 Flood
One Corps, One Regiment, One Team

Grundy Local Protection Project

1977 Flood
Flood Damages and Clean-up Efforts
One Corps, One Regiment, One Team

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Tri-party Partnership

US Army Corps of Engineers
Huntington District
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Redevelopment Site E
Redevelopment Site Main Project Features

- 3 million CY Excavation
- Development of Wellmore Hollow Spoil Site
- Relocation of the Norfolk Southern Railroad
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Site E During Construction

- Site E
- Wellmore Hollow
- Haul road
- Grundy CBD
Wellmore Hollow During Construction

Haul Road Connecting Site E

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Cutslope Design
Design Considerations

• Bedrock Characteristics
• Joint Analysis
• Rock Fall Hazards
• Desires of Cost Share Sponsors and Project Stakeholders
Bedrock Characteristics

- Slope of the Excavated Bedrock
- Location and Width of Benches
- Effects of Differential Weathering
Design Considerations

- Bedrock Characteristics
- Joint Analysis
- Rock Fall Hazards
- Cost Share and Stakeholder Partnerships
Grundy Joint Analysis

3 Anticipated Modes of Failure

- Planar
- Wedge
- Toppling

Joint measurements were obtained by measuring joint orientations in outcrops along the Norfolk Southern Railroad
Modes of Failure

Planar Failure

Wedge Failure

• Modes of failure were determined by stereographic analysis utilizing software developed by Roc Science.
Site E Structural Failure Prediction

Area of potential wedge type failure

Area of potential planar type failure

Area of potential planar and toppling type failure

Redevelopment Site – Grundy, VA
Design Considerations

- Bedrock Characteristics
- Joint Analysis
- Rock Fall Hazards
- Cost Share and Stakeholder Partnerships
Lateral migration was modeled using software developed by RocScience.

A 9.14m rock catchment ditch was designed at the base of the cut to prevent boulders from obstructing the NS railroad.
Rock Fall Hazard Analysis – Wellmore Hollow

- Model of Spoil Site Slope
- Designed Catchment Area
Design Considerations

- Bedrock Characteristics
- Joint Analysis
- Rock Fall Hazards
- Cost Share and Stakeholder Partnerships
Construction Challenges
Significant Events

- March 2002 Landslide
- April 2002 Flyrock Incident
- Change Conditions
### March 2002 Landslide

#### Area Rain Gage Data

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<th>Gage</th>
<th>March 15-16</th>
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<td><strong>0.86&quot;</strong></td>
<td><strong>1.72&quot;</strong></td>
<td><strong>0.07&quot;</strong></td>
<td><strong>0.41&quot;</strong></td>
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- Displaced approximately 150’ of NS railroad
- Toe of slide extended approximately 30’ into the Levisa Fork River
March 2002 Landslide

Grundy, Virginia March 19, 2002
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March 2002 Landslide

Toe of slide extending out into the Levisa Fork river

Contractor works to remove material. Trucks haul from both directions.

Approximate original track alignment.
Landslide Repair

- District staff worked with Norfolk Southern to remediate slide
- Failed materials excavated; Stone buttress constructed; track repaired
- Completed within a week
Significant Events

• March 2002 Landslide
• April 2002 Flyrock Incident
• Change Conditions
Shot #367

- Production Shot
- Row by row pattern
- 70 - 5” Blastholes
- Spacing and Burden – 9’
- Depth – 22’
- Pre-packaged ANFO
- Crushed Limestone stemming
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April 2002 Flyrock Incident
April 2002 Flyrock Incident
April 2002 Flyrock Incident
Possible Causes

- Loading of blastholes
- Location of blastholes relative to free face
- Amount of explosives used
- Placement of stemming

Interior - Downtown Law Office
Corrective Actions

- District consulted with Dr. Calvin Konya
- Developed Corrective Action Plans in accordance with Dr. Konya
- 100% government QA on every blast; Consultant blasting specialist now on site for each blast
- Dr. Konya consulted as needed
- Future work (upstream area) to be directed by Konya
### Significant Events

- March 2002 Landslide
- April 2002 Flyrock Incident
- Change Conditions
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Change Conditions - Overview

- 5+50 – 6+25 - Weathered with signs of planar instability
- 6+25 – 8+52 - Zone of highly weathered material
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FY 02 and FY 03 Core Drilling

- 7 angled air borings
- 7 angled core borings
- 4 vertical core borings
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5+50 – 6+25

- High angle joints in Lower Shale Unit (trending parallel to cutslope) causing planar failures
- SDI testing (results > 95) indicates durable material
Highly weathered brown shale from El. 333 to El. 353
Design Options

• Revise Cutslope Design

• Develop Mechanical Stabilization Design
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Revised Cutslope Alternative
Perceived Problems

• Large Estimated Volume (350,000 CM)
• CWL needs to be revised
• Real estate and NEPA documents need to be revised.
• More costly than mechanical stabilization
Mechanical Stabilization Alternative
Perceived Benefits

• Limited excavation

• Less expensive than laying slopes back

• Able to avoid problems with spoil site capacity, real estate, NEPA, and expanding CWL

• Initially supported by stakeholders
District Hires FMSM
Soil Nail Wall Design

Typical Section

Design Features

- Internal and external drainage
- Encapsulated nails
- 6” thick shotcrete facing
Problems with the Mechanical Stabilization Design

- Project team concerned with design life and long-term maintenance

- Town of Grundy concerned with aesthetics
Congressional Interest

• Congressman Boucher requests District develop the excavation alternative to full level of detail

• District and FMSM Develop Revised Cutslope Design
Revised Cutslope Alternative
Sta 6+25 – 8+52

Original Cut
(77,600 CM)

Revised Cut
(236,500 CM)

RDZ
Grundy Local Protection Project

July 29, 2003
Questions?