Proofrolling and Failing Subgrades -
What do I do next?
GEOTECHNICAL ENGINEERING UNIT

• Western Regional Office (Div. 8 -14)
  – Harrisburg, NC
    • Western Regional Operations Group
      – Dean Hardister, PE

• Central Office
  – Raleigh, NC
    • Geopavement Section
      – Tom Hearne, PE – Geopavement Supervisor (Harrisburg)
      – Kevin Sebold – Senior Geopavement Engineer (Raleigh)
PROOFROLLING

• By the Book – Section 260
  – Coverage of subgrade to 2 feet outside pavement
    • Gross weight of 48 to 50 tons
    • 4 pneumatic rubber tires
    • Tire inflation pressure of 68 to 72 psi

• NOT By the Book
  – Using rubber-tired construction equipment
    • GOOD – pans, backhoes, motorgraders, dump trucks
    • NOT SO MUCH – grade-alls, manlifts, telehandlers
PROOFROLLING

• Why Should a Subgrade Be Proofrolled?
  – Rapid determination of subgrade strength
  – Rapid determination of subgrade stability

PASSING DENSITY ≠ PASSING PROOFROLL
PROOFROLLING

• Types of Failure
  – PUMPING
  – RUTTING
  – SURFACE SHEARING
SUBGRADE FAILURE

• What’s going on?
  – Bearing capacity

• PUMPING
  – Stiff Layer over Softer Layer

• RUTTING
  – Soft Layer over Stiffer Layer
SUBGRADE FAILURE

• What’s the culprit?
  – Public Enemy #1
  WATER!
SUBGRADE FAILURE

• What’s the culprit?
  – Water: When to suspect?
    • Standing water/bridge plug
    • Weeping cut slopes
    • Ditches not fully constructed
    • Standing water in ditches
    • Subgrade always appears moist
  – Water: How to know?
    • Install piezometers
    • Dig test pits
SUBGRADE FAILURE

• What’s the culprit?
  – Silty or Micaceous Soils: When to Suspect?
    • SURFACE SHEARING

  – Weak Soils: When to Suspect?
    • RUTTING
    • PUMPING

• OK, proofrolling didn’t go so well! Now what?
WHAT’S THE POINT?

• Objectives
  – Proper subgrade moisture
    • Short-Term & Long-Term
  – Proper subgrade stability
    • Compaction of overlying pavement layers
  – Proper subgrade strength
    • Layered system – depth of soft zones matters
      – Dynamic Cone Penetrometer (DCP) Index
      – California Bearing Ratio (CBR)
REMEDIATION ARSENAL

• Objectives
  – Proper subgrade moisture
    • Ditches – Get them in early
    • Grade surface to drain; use weeps
    • Subdrains; use extra pipe bedding
  – Proper subgrade stability
    • Aggregate Stabilization – Section 510
    • Chemical Stabilization – Occasionally; Upper 12”
  – Proper subgrade strength
    • Select Class II, Class III, Class IV – 92% T-180
    • Soil Stabilization Fabric – Type 4
    • HS Engineering Fabrics & Geogrids – Requires SA
    • Other Contract Items – Rip Rap, Recycled Concrete
• Putting It All Together
  – Review the Objectives
    • Get it Dry and Keep it Dry
    • Make it Stable and Strong for Next Layers

  – Flow Charts to Walk Thru the Decision Process
    • Proofrolling Flow Chart
    • DCP Flow Chart
      – Cut Areas
      – Embankment Areas
PROOFROLLING FLOW CHART

PROOFROLLED PAVEMENT SUBGRADE IN CUT AREAS OR PROOFROLLED EXISTING GRADE IN PROPOSED FILL AREAS AND AREA IS UNSTABLE

AREA RECOMMENDED FOR UNDERCUT IN PLANS?

YES

UNDERCUT PER THE PLANS

NO

HIGH GROUNDWATER?

YES

INSTALL DI's, CULVERTS, PROPOSED DITCHES, & SUBDRAIN (IF NEEDED) & ALLOW 30 to 60 DAYS BEFORE RE-EVALUATION

NO

NO

PONDED WATER/POOR SURFACE DRAINAGE?

YES

GRADE TO DRAIN, SCARIFY SUBGRADE TO AID DRYING, RE-EVALUATE AFTER ALLOWING TO DRY

NO

NO

IS PI >35?

YES

SEE FLOW CHART FOR EXISTING CUT OR PROPOSED FILL

NO

NO

IS SUBGRADE SILTY AND/OR MIECACEOUS & UNSTABLE IN UPPER 6 INCHES?

YES

IS AGGREGATE STABILIZATION AN OPTION?

YES

EMPLOY AGGREGATE STABILIZATION

NO

NO

SEE FLOW CHART FOR EXISTING CUT OR PROPOSED FILL

REVISED MAR 2010
GROUNDWATER?
- Install DI’s
- Install Ditches
- Install Subdrain

SURFACE WATER?
- Grade to Drain
- Scarify/Dry
SHEARING FAILURE?
- Aggr. Stabilization?
• IF SUBGRADE FAILURE IS WITHIN UPPER 12 INCHES AND SUBGRADE STABILIZATION IS IN THE CONTRACT, IT MAY BE POSSIBLE TO CONSTRUCT EXTRA-DEPTH STABILIZATION.

• CONTACT GEOPAVEMENT SECTION.
SUBGRADE FAILURE - PART DEUX

• I followed your flow chart, re-proofrolled the subgrade, and there are still unstable areas in the subgrade.

OR

• We don’t have a water problem and we don’t have micaceous soils in Div. 14.

NOW WHAT?!?!
• Putting It All Together
  – Review the Objectives
    • Get it Dry and Keep it Dry
    • Make it Stable and Strong for Next Layers

– Flow Charts to Walk Thru the Decision Process
  • Proofrolling Flow Chart
  • DCP Flow Charts
    – Cut Areas
    – Embankment Areas
DCP FLOW CHARTS

• What you need to know:
  – Is proofrolled subgrade in an existing cut or proposed fill?

• What you need to have:
  – Pavement DCP
  – Grade stake marked in 1-inch increments
  – Hammer to drive stake
EXISTING CUT DCP FLOW CHART for SUBGRADE STABILIZATION FABRIC & SELECT GRANULAR FILL

SELECT II & III REFERS TO SELECT MATERIAL CLASS II & CLASS III (SECTION 1016)
IF SELECT MATERIAL CLASS II TYPE 2 IS USED, RESTRICT USAGE TO A-2-4 (SANDY GRANULAR SOIL)
IF CLASS IV SELECT IS USED, REDUCE UNDERCUT DEPTHS BY 0.5 FOOT (6 INCHES)

- PERFORM DCP IN UNSTABLE AREAS TO A DEPTH OF 4 FEET
- RECORD THE NUMBER OF BLOWS REQUIRED TO PENETRATE EACH 1 FOOT ZONE FOR 0-1', 1-2', 2-3', & 3-4'

ANY 1-FT ZONE REQUIRE LESS THAN 2 BLOWS?
- YES
  - CONTACT AREA RDWY ENG. OR REG. OPS ENG.
- NO
  - CBR<2

ANY 1-FT ZONE REQUIRE LESS THAN 4 BLOWS?
- YES
  - FROM 3 TO 4 FT, WERE MORE THAN 4 BLOWS REQUIRED?
    - YES
      - UNDERCUT 3 FT & FABRIC + SELECT II or III
    - NO
      - UNDERCUT 4 FT & FABRIC + SELECT II or III
        - USE 1 FT BORING LIFT AT BOTTOM IF SOFT
  - NO
    - 2<CBR<4

ANY 1-FT ZONE REQUIRE 4 BLOWS OR MORE?
- YES
  - FROM 2 TO 3 FT, WERE MORE THAN 4 BLOWS REQUIRED?
    - YES
      - UNDERCUT 2 FT & FABRIC + SELECT II or III
    - NO
      - UNDERCUT 2.5 FT & FABRIC + SELECT II or III
  - NO
    - CBR>4

NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE - IF GROUNDWATER IS PRESENT IN OR COULD RISE INTO U/C AREA, NEED TO INSTALL SUBDRAINS

REVISION MAR 2010
EXISTING CUT DCP FLOW CHART for SUBGRADE STABILIZATION FABRIC & SELECT GRANULAR FILL

SELECT II & III REFERS TO SELECT MATERIAL CLASS II & CLASS III (SECTION 1016)
IF SELECT MATERIAL CLASS II TYPE 2 IS USED, RESTRICT USAGE TO A: 2-4 (SANDY GRANULAR SOIL)
IF CLASS IV SELECT IS USED, REDUCE UNDERCUT DEPTHS BY 0.5 FOOT (6 INCHES)

PERFORM DCP IN UNSTABLE AREAS TO A DEPTH OF 4 FEET
RECORD THE NUMBER OF BLOWS REQUIRED TO PENETRATE EACH 1 FOOT ZONE FOR 0-1', 1-2', 2-3', & 3-4'

ANY 1-FT ZONE REQUIRE LESS THAN 2 BLOWS?
- YES
- CONTACT AREA RDWY ENG. OR REG. OPS ENG.
- CBR<2

ANY 1-FT ZONE REQUIRE LESS THAN 4 BLOWS?
- YES
- FROM 3 TO 4 FT, WERE MORE THAN 4 BLOWS REQUIRED?
- CBR<4
- UNDERCUT 3 FT & FABRIC + SELECT II or III

ANY 1-FT ZONE REQUIRE 4 BLOWS OR MORE?
- YES
- FROM 2 TO 3 FT, WERE MORE THAN 4 BLOWS REQUIRED?
- CBR>4
- UNDERCUT 2.5 FT & FABRIC + SELECT II or III

NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE - IF GROUNDWATER IS PRESENT IN OR COULD RISE INTO U/C AREA, NEED TO INSTALL SUBDRAINS
EXISTING CUT DCP FLOW CHART for
SUBGRADE STABILIZATION FABRIC & SELECT GRANULAR FILL

SELECT II & III REFERS TO SELECT MATERIAL CLASS II & CLASS III (SECTION 1016)
IF SELECT MATERIAL CLASS II TYPE 2 IS USED, RESTRICT USAGE TO A
IF CLASS IV SELECT IS USED, REDUCE UNDERCUT DEPTHS BY

- Install stake
- Drive DCP
  - Record blows for each 1-ft increment

PERFORM DCP IN UNSTABLE AREAS TO A DEPTH OF 4 FEET
RECORD THE NUMBER OF BLOWS REQUIRED TO PENETRATE EACH 1 FOOT ZONE FOR 0-1', 1-2', 2-3', & 3-4'

ANY 1-FT ZONE REQUIRE LESS THAN 2 BLOWS?
  YES
  CONTACT AREA RDWY ENG. OR REG. OPS ENG.
  CBR<2
  NO
  CBR=4

ANY 1-FT ZONE REQUIRE LESS THAN 4 BLOWS?
  YES
  FROM 3 TO 4 FT. WERE MORE THAN 4 BLOWS REQUIRED?
  CBR=4
  UNDERCUT 4 FT & FABRIC + SELECT II or III
  USE 1 FT BLOGUE LIFT AT BOTTOM IF SOFT
  NO
  UNDERCUT 2.5 FT & FABRIC + SELECT II or III
  NO
  CBR>8

ANY 1-FT ZONE REQUIRE 4 BLOWS OR MORE?
  YES
  FROM 2 TO 3 FT. WERE MORE THAN 4 BLOWS REQUIRED?
  UNDERCUT 2 FT & FABRIC + SELECT II or III
  NO
  UNDERCUT 2.5 FT & FABRIC + SELECT II or III

NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE -
IF GROUNDWATER IS PRESENT IN OR COULD RISE INTO U/C AREA, NEED TO INSTALL SUBDRAINS

REVISED MAR 2010
EXISTING CUT DCP FLOW CHART for
SUBGRADE STABILIZATION FABRIC & SELECT GRANULAR FILL

SELECT II & III REFERS TO SELECT MATERIAL CLASS II & CLASS III (SECTION D). IF SELECT MATERIAL CLASS II TYPE 2 IS USED, RESTRICT USAGE TO B-2-3 (SANDY). IF CLASS IV SELECT IS USED, REDUCE UNDERCUT DEPTHS BY 0.5 FOOT (0.165 M).

PERFORM DCP IN UNSTABLE AREAS TO A DEPTH OF 4 FEET. RECORD THE NUMBER OF BLOWS REQUIRED TO PENETRATE EACH 1 FOOT ZONE FOR 0-1’, 1-2’, 2-3’, & 3-4’

EXAMPLE:

0-1’ 10 blows
1-2’ 3 blows
2-3’ 6 blows
3-4’ 5 blows

UNDERCUT DEPTHS SHOWN ARE FOR SELECT CLASS II or CLASS III. CLASS IV MAY BE USED. IF CLASS IV IS USED, REDUCE UNDERCUT BY 0.5 FT.

ANY 1-FT ZONE REQUIRE LESS THAN 4 BLOWS?

2<CBR<4

ANY 1-FT ZONE REQUIRE 4 BLOWS OR MORE?

CBR>4

FROM 2 TO 3 FT, WERE MORE THAN 4 BLOWS REQUIRED?

CBR>8

UNDERCUT 2.5 FT & FABRIC + SELECT II or III

UNDERCUT 4 FT & FABRIC + SELECT II or III

SELECT II or III

(SELECT II or III (USE 1 FT BRISE LIFT AT BOTTOM IF SOFT))

UNDERCUT 2 FT & FABRIC + SELECT II or III

CBR>5

NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE - IF GROUNDWATER IS PRESENT IN OR COULD RISE INTO U/C AREA, NEED TO INSTALL SUBDRAINS

REVISED MAR 2010
EXISTING CUT DCP FLOW CHART for
SUBGRADE STABILIZATION FABRIC & SELECT GRANULAR FILL

SELECT II & III REFERS TO SELECT MATERIAL CLASS II & CLASS III (SECTION 1016)
IF SELECT MATERIAL CLASS II TYPE 2 IS USED, RESTRICT USAGE TO A 2-4 (SANDY GRANULAR SOIL)
IF CLASS IV SELECT IS USED, REDUCE UNDERCUT DEPTHS BY 0.5 FOOT (6 INCHES)

- PERFORM DCP IN UNSTABLE AREAS TO A DEPTH OF 4 FEET
- RECORD THE NUMBER OF BLOWS REQUIRED TO PENETRATE EACH 1 FOOT ZONE FOR 0-1', 1-2', 2-3', & 3-4'

ANY 1-FT ZONE REQUIRE LESS THAN 2 BLOWS?

YES

CONTACT AREA RDWY ENG. OR REG. OPS ENG.

NO

CBR<2

CBR>4

ANY 1-FT ZONE REQUIRE LESS THAN 4 BLOWS?

YES

FROM 3 TO 4 FT, WERE MORE THAN 4 BLOWS REQUIRED?

YES

UNDERCUT 3 FT & FABRIC + SELECT II or III

NO

UNDERCUT 4 FT & FABRIC + SELECT II or III

USE 1 FT BROKE LIFT AT BOTTOM OF SOFT

NO

NO

ANY 1-FT ZONE REQUIRE 4 BLOWS OR MORE?

YES

SHALLOW UNDERCUT

CBR>4

CBR<4

UNDERCUT 2.5 FT & FABRIC + SELECT II or III

NO

UNDERCUT 2 FT & FABRIC + SELECT II or III

(FABRIC MAY BE WAIVED IF U/C SUBGRADE IS FIRM & DRY)

IF MORE THAN 8 BLOWS PER FOOT IS REQUIRED FOR 2 CONSECUTIVE 1-FT ZONES, U/C TO TOP OF FIRM LAYERS

NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE - IF GROUNDWATER IS PRESENT IN OR COULD RISE INTO U/C AREA, NEED TO INSTALL SUBDRAINS

REVISED MAR 2010
EXISTING CUT DCP FLOW CHART for HIGH-STRENGTH FABRIC/GEOGRID & CLASS IV

- PERFORM DCP IN UNSTABLE AREAS TO A DEPTH OF 4 FEET
  RECORD THE NUMBER OF BLOWS REQUIRED TO PENETRATE EACH 1 FOOT ZONE FOR 0.4', 1.2', 2.3', & 3.4'

- ANY 1-FT ZONE REQUIRE LESS THAN 2 BLOWS?
  - CONTACT AREA RDWY ENG. OR REG. ONS ENG.
    - CBR<2
  - NO

- ANY 1-FT ZONE IN UPPER 3 FT REQUIRE LESS THAN 4 BLOWS?
  - UNDERCUT 2 FT & HS FABRIC/GEOGRID + CL IV
  - 2<CBR<4
  - NO

- ALL 1-FT ZONES IN UPPER 3 FT REQUIRE 4 BLOWS OR MORE?
  - UNDERCUT 1 FT & HS FABRIC/GEOGRID + CL IV
  - CBR>4
  - NO

- NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE - IF GROUNDWATER IS PRESENT IN OR COULD RISE INTO U/C AREA, NEED TO INSTALL SUBDRAINS

REVISED MAR 2010
EXISTING CUT DCP FLOW CHART for HIGH-STRENGTH FABRIC/GEOGRID & CLASS IV

- PERFORM DCP IN UNSTABLE AREAS TO A DEPTH OF 4 FEET
  RECORD THE NUMBER OF BLOWS REQUIRED TO PENETRATE

LEVERAGES STRENGTH OF FABRIC/GEOGRID

ANY 1-FT ZONE REQUIRE LESS THAN 2 BLOWS?

- YES
  CBR<2

  CONTACT AREA OR REG. OPS ETC.

- NO

ANY 1-FT ZONE IN UPPER 3 FT REQUIRE LESS THAN 4 BLOWS?

- YES
  UNDERCUT 2 FT & HS FABRIC/GEOGRID + CL IV

- NO
  2<CBR<4

ALL 1-FT ZONES IN UPPER 3 FT REQUIRE 4 BLOWS OR MORE?

- YES
  UNDERCUT 1 FT & HS FABRIC/GEOGRID + CL IV
  (HS FABRIC/GEOGRID MAY BE WAIVED IF UC SUBGRADE IS FIRM & DRY)

- NO
  UNDERCUT 1.5 FT & HS FABRIC/GEOGRID + CL IV

LESS SENSITIVE TO DEEPER SOFT ZONES

REDUCES UNDERCUT & BACKFILL VOLUMES

BEST ECONOMY IN SOFT or VERY SOFT SOILS

NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE - IF UNDERCUT AREA, NEED TO INSTALL SUBDRAINS

REVISED MAR 2010
EXISTING CUT DCP FLOW CHART for HIGH-STRENGTH FABRIC/GEOGRID & CLASS IV

- PERFORM DCP IN UNSTABLE AREAS TO A DEPTH OF 4 FEET
- RECORD THE NUMBER OF BLOWS REQUIRED TO PENETRATE EACH 1 FOOT ZONE FOR 0.1', 1.2', 2.3', & 3.4'

ANY 1-FT ZONE REQUIRE LESS THAN 2 BLOWS?

- YES
  - CONTACT AREA RDWY ENG. OR REG. OPS ENG.
- NO
  - CBR<2

- SAVES 1/2 FOOT IN MARGINAL SOILS
- SAVES 1 to 2 FEET IN WEAK SOILS

ALL 1-FT ZONES IN UPPER 3 FT REQUIRE 4 BLOWS OR MORE?

- YES
  - FABRIC/GEOGRID + CL IV
    - (HS FABRIC/GEOGRID MAY BE WAIVED IF U/C SUBGRADE IS FIRM & DRY)
- NO
  - CBR>4
  - UNDERCUT 1.5 FT & HS FABRIC/GEOGRID + CL IV

NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE - IF GROUNDWATER IS PRESENT IN OR COULD RISE INTO U/C AREA, NEED TO INSTALL SUBDRAINS

REVISED MAR 2010
PROPOSED FILL DCP FLOW CHART for SUBGRADE STABILIZATION FABRIC & SELECT GRANULAR FILL

SELECT II & III REFERS TO SELECT MATERIAL CLASS II & CLASS III (SECTION 1016)
IF SELECT MATERIAL CLASS II TYPE 2 IS USED, RESTRICT USAGE TO A 2-4 (SANDY GRANULAR SOIL)

DETERMINE PROPOSED FILL HEIGHT, "H", IN UNSTABLE AREAS

IS "H" GREATER THAN 6 FEET?

STANDING WATER/HIGH GROUNDWATER?

INSTALL DRAINAGE (BLIND DRAINS, SAND BLANKETS, ETC.)
- PLACE SOIL STABILIZATION FABRIC & 2-3 FEET BRIDGE LIFT OF SUITABLE MATERIAL
- CONSTRUCT REMAINING EMBANKMENT TO SPECS

TOTAL UNDERCUT IS BASED ON UNDERCUT REQUIRED FOR CUTOFF - NO ROUNDED UP TO NEAREST 1/8 FEET
EXAMPLE: CUTOFF REQUIRED = 3-5/16 - UNDERCUT = 3-5/16 ROUNDED UP TO NEAREST 0.6 - 1.5 FT

PERFORM DCP IN UNSTABLE AREAS TO A DEPTH OF 4 FEET
RECORD THE NUMBER OF BLOWS REQUIRED TO PENETRATE EACH 1 FOOT ZONE FOR 1, 2, 3, & 4

ANY 1-FT ZONE REQUIRE LESS THAN 2 BLOWS?

CONTACT AREA REIN. ENG OR REG. OPG. ENG

NO

ANY 1-FT ZONE REQUIRE LESS THAN 4 BLOWS?

UNDERCUT = 3 FT - H/3 PLACE FABRIC
- 3 FT SELECT II or III COMPLETE W/ SUITABLE MATERIAL

NO

ANY 1-FT ZONE REQUIRE 4 BLOWS OR MORE?

UNDERCUT = 4 FT - H/3 PLACE FABRIC
- 4 FT SELECT II or III COMPLETE W/ SUITABLE MATERIAL

NO

FROM 2 TO 3 FT, WERE MORE THAN 4 BLOWS REQUIRED?

UNDERCUT = 2.5 FT - H/3 PLACE FABRIC
- 2.5 FT SELECT II or III COMPLETE W/ SUITABLE MATERIAL

NO

FROM 3 TO 4 FT, WERE MORE THAN 4 BLOWS REQUIRED?

UNDERCUT = 3.5 FT - H/3 PLACE FABRIC
- 3.5 FT SELECT II or III COMPLETE W/ SUITABLE MATERIAL

NO

UNDERCUT = 4 FT - H/3 PLACE FABRIC
- 4 FT SELECT II or III COMPLETE W/ SUITABLE MATERIAL

NO

IF MORE THAN 8 BLOWS PER FOOT IS REQUIRED FOR CONSECUTIVE 1 FT ZONES, LID TO TOP OF FAB LAYERS

NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE - IF GROUNDWATER IS PRESENT IN OR COULD RISE INTO UC AREA, NEED TO INSTALL SUBDRINS

REVISED MAR 2015
PROPOSED FILL DCP FLOW CHART for SUBGRADE STABILIZATION FABRIC & SELECT GRANULAR FILL

SELECT II & III REFERS TO SELECT MATERIAL CLASS II & CLASS III (SECTION 1016)
IF SELECT MATERIAL CLASS II TYPE 2 IS USED, RESTRICT USAGE TO A 2-4 (SANDY GRANULAR SOIL)

DETERMINE PROPOSED FILL HEIGHT, H*, IN UNSTABLE AREAS

IS "H*" GREATER THAN 6 FEET?

EMBANKMENT HEIGHT GREATER THAN 6 FEET

• UNDERCUT FOR CUT AREAS USED AS BASIS
• REDUCES TOTAL UNDERCUT ACCOUNTING FOR ADDITIONAL EMBANKMENT TO BE CONSTRUCTED

SEE FLOW CHARTS FOR EXISTING CUT

PERFORM DCP IN UNSTABLE AREAS TO A DEPTH OF 4 FEET
RECORD THE NUMBER OF BLOWS REQUIRED TO PENETRATE EACH 1 FOOT ZONE FOR 6-1, 1-2, 2-3, & 3-4

TOTAL UNDERCUT IS BASED ON UNDERCUT REQUIRED FOR CUT MINUS NO. ROUNDED UP TO NEAREST 6 INCH
EXAMPLE: CUT UNDERCUT REQUIRED = 26 - 2
THEN UNDERCUT = 23 - 0.5 = 23.5
ROUNDED UP TO NEAREST 6 INCH = 24

USE CUT FLOW CHARTS

ANY 1-FT ZONE REQUIRE LESS THAN 4 BLOWS?

UNDERCUT = 3 FT - H/3
PLACE FABRIC
+ 3 FT SELECT II or III
COMPLETE W/ SUITABLE MATERIAL

ANY 1-FT ZONE REQUIRE 4 BLOWS OR MORE?

FROM 2 TO 3 FT, WERE MORE THAN 4 BLOWS REQUIRED?

UNDERCUT = 3 FT - H/3
PLACE FABRIC
+ 3 FT SELECT II or III
COMPLETE W/ SUITABLE MATERIAL

NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE - IF GROUNDWATER IS PRESENT IN OR COULD RISE INTO UC AREA, NEED TO INSTALL SUBDRAIN

UNDERCUT = 4 FT - H/3
PLACE FABRIC
+ 4 FT SELECT II or III
COMPLETE W/ SUITABLE MATERIAL

UNDERCUT = 2.5 FT - H/3
PLACE FABRIC
+ 2.5 FT SELECT II or III
COMPLETE W/ SUITABLE MATERIAL

IF MORE THAN 3 BLOWS PER FOOT IS REQUIRED FOR CONSECUTIVE 1 FT ZONES, LJC TO TOP OF FILL LAYERS

REVISED MAR 2015
COVERS BUILDING EMBANKMENTS OVER SOFT GROUND

PROPOSED FILL DCP FLOW CHART for SUBGRADE STABILIZATION FABRIC & SELECT GRANULAR FILL

SELECT II & III REFERS TO SELECT MATERIAL CLASS II & III (SECTION 1016)
IF SELECT MATERIAL CLASS II TYPE 2 IS USED, RESTRICT USAGE TO A 2-4 (SANDY GRANULAR SOIL)

DETERMINE PROPOSED FILL HEIGHT "H" IN UNSTABLE AREAS

IS "H" GREATER THAN 6 FEET?

STANDING WATER/HIGH GROUNDWATER?

NO

SEE FLOW EXIST

PERF BASE EACH

ANY 1 FT ZONE REQUIRE LESS THAN 4 BLOWS?

NO

UNDERCUT = 3 FT - H/3
PLACE FABRIC
+ 3 FT SELECT II or III
COMPLETE W/ SUITABLE MATERIAL

ANY 1 FT ZONE REQUIRE 4 BLOWS OR MORE?

UNDERCUT = 2.5 FT - H/3
PLACE FABRIC
+ 2.5 FT SELECT II or III
COMPLETE W/ SUITABLE MATERIAL

FROM 2 TO 3 FT, WERE MORE THAN 4 BLOWS REQUIRED?

NO

UNDERCUT = 4 FT - H/3
PLACE FABRIC
+ 4 FT SELECT II or III
COMPLETE W/ SUITABLE MATERIAL

FROM 3 TO 4 FT, WERE MORE THAN 4 BLOWS REQUIRED?

NO

UNDERCUT = 2.5 FT - H/3
PLACE FABRIC
+ 2.5 FT SELECT II or III
COMPLETE W/ SUITABLE MATERIAL

IF MORE THAN 6 BLOWS PER FOOT IS REQUIRED FOR A CONSECUTIVE 1 FT ZONE, LOCATED TO TOP OF FABRIC LAYER

NEED TO EVALUATE GROUNDWATER CONDITIONS - NO WATER IS TO BE WITHIN 6 FT OF FINAL SUBGRADE - IF GROUNDWATER IS PRESENT IN OR COULD RISE INTO UC AREA, NEED TO INSTALL SUBDRAIN
BACKFILLING

• Place Fabric or Geogrid
  – Flat; No wrinkles or folds
  – Slight tension; anchor with backfill NOT pins
  – Overlaps vary depending on soil strength
    • Greater than 4 BPF = 12 inches
    • Between 2 & 4 BPF = 24 inches
    • Less than 2 BPF = Contact ARCE or GEU Ops

• Place Backfill
  – End dump on fabric/geogrid; no traffic
  – Compact Select 92% T-180; Other per Specs
## COST COMPARISON – 30’ x 100’

Undercut = $9.30/CY  Select = $24.25/CY  Class IV = $23.25/TN

SS Fabric = $1.90/SY  HS Fabric/Geogrid = $4.00/SY

### SOFT SOILS – 2 to 4 BPF

<table>
<thead>
<tr>
<th>Material Type</th>
<th>UC/CY</th>
<th>Select/CY</th>
<th>Fabric/SY</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS Fabric – 4 ft UC</td>
<td>445</td>
<td>445</td>
<td>333</td>
<td>$15,544</td>
</tr>
<tr>
<td>HS Fabric/Geogrid – 2 ft UC</td>
<td>222</td>
<td>450</td>
<td>333</td>
<td>$13,908</td>
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</tbody>
</table>

### FIRM SOILS – > 4 BPF

<table>
<thead>
<tr>
<th>Material Type</th>
<th>UC/CY</th>
<th>Select/CY</th>
<th>Fabric/SY</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS Fabric – 2 ft UC</td>
<td>222</td>
<td>222</td>
<td>333</td>
<td>$8,089</td>
</tr>
<tr>
<td>HS Fabric/Geogrid – 1 ft UC</td>
<td>111</td>
<td>225</td>
<td>333</td>
<td>$7,620</td>
</tr>
</tbody>
</table>
HS FABRIC or GEOGRID IS NOT ALWAYS CHEAPEST ... CONTRACT PRICES RULE !!!
Where can I obtain the information from this presentation?
QUESTIONS?
THANKS!