

# ROADWAY PROJECTS WITH FOCUS ON SUBSURFACE / DRAINAGE & LITIGATION-RELATED ISSUES

*Florida Association of County Engineers and Road  
Superintendents (FACERS)*

## 2011 FACERS Annual Conference



Presented by:

- Devo Seereeram, Ph.D., P.E.  
Devo Engineering

**FACERS**

Florida Association of County Engineers & Road Superintendents

When: Wednesday June 22<sup>nd</sup> 2011

Where: Hilton Orlando Bonnet Creek

## Discussion Topics:

### **1.0 PAVEMENT DISTRESS**

- 1.1 - Low Pavement Grades & High Groundwater
- 1.2a - High Groundwater Artificially Raised by Over Irrigation (Main Road)
- 1.2b - High Groundwater Artificially Raised by Over Irrigation (Subdivision)
- 1.3 - High Tailwater in Stormwater System or Constricted Outfall
- 1.4 - Embankment Washout Due to Storm-Induced Wave Action
- 1.5 - Buried Muck Compressing During Extreme Drought
- 1.6 - Corroding Sand-shell-cement Base
- 1.7 - Cracking of Soil-Cement Base

### **2.0 WIDENING OF ROADWAY EMBANKMENT**

- 2.1 - Widening Fill Embankments Without Box-cut

### **3.0 ROADWAY-ASSOCIATED STORMWATER FACILITES**

- 3.1 - Flooding Associated with Land-locked Systems
- 3.2 - Seepage Through Pond Berms
- 3.3 - Water Table Mounding from Ponds Affecting Roads & Offsite Property
- 3.4 - Pipe Joint Opening Due to Muck Subgrade

## Discussion Topics (cont'd):

### **4.0 UNUSUAL PROBLEMS**

- 4.1 - Relic Horizontal Sock Drain Causing "Inexplicable Spring"
- 4.2 - Strong Seepage Across Road Causing Subgrade Movement Due to Barrier Caused by Large Diameter Pipe
- 4.3 - Perched Water Table Due to Low Permeability Fill

### **5.0 MAJOR SINKHOLES AFFECTING COUNTY ROAD**

- 5.1 - Sinkholes on roadways
- 5.2 - Sinkholes in ponds

### **6.0 STORM & SANITARY SEWER/MANHOLE ISSUES**

- 6.1 - Soil-loss in manholes
- 6.2 - Dumping loose fill around the sediment removal structure & hydroconsolidation of loosely placed sand backfill

### **7.0 OTHER DISCUSSION ITEMS**

- 7.1 - Crushed concrete base – those counties with aggressive sidewalk rehab programs can recycle
- 7.2 - Reinforcement in asphalt overlays to increase SN

## Topic 1.1

# Low Pavement Grades & High Groundwater

# Community Area - Reflections Subdivision in Ocoee



Photo date: 2000 (during drought)

# Community Area - Reflections Subdivision in Ocoee



Photo date: 2000 (during drought)

# Cool Spring Circle - Reflections Subdivision in Ocoee



Photo date: 2000 (during drought)

# Econ River Estates in East Orange County



Photo date: 2000 (during drought)



## Topic 1.2a

# High Groundwater Artificially Raised by Over Irrigation (Main Road)

# Central Florida Parkway



Photo date: 2005

# Hiawassee Road



Photo date: 2005

# Hiawassee Road



Photo date: 2005

# Hiawassee Road



Photo date: 2005

## Topic 1.2b

# High Groundwater Artificially Raised by Over Irrigation (Subdivision)

# Infrastructure failure from reclaimed water overirrigation - Country Club



Leaching Over Curb

# Infrastructure failure from reclaimed water overirrigation - Country Club



Leaching Over Curb



# Infrastructure failure from reclaimed water overirrigation - Country Club



Leaching Over Curb

# Infrastructure failure from reclaimed water overirrigation - Country Club



Leaching Over Curb

# Infrastructure failure from reclaimed water overirrigation - Country Club



Limerock Pumping From Base

# Infrastructure failure from reclaimed water overirrigation - Country Club



Pavement Distress

## Topic 1.3

# High Tailwater in Stormwater System or Constricted Outfall

# Pond NWL and Pavement Grade Separation - Waterford Chase



# Pond NWL and Pavement Grade Separation - Waterford Chase



# Pond NWL and Pavement Grade Separation - Waterford Chase





## Topic 1.4

# Embankment Washout Due to Storm-Induced Wave Action

# CR 561 Clermont



Photo date: 2004 (Hurricane Jeanne)

# CR 561 Clermont



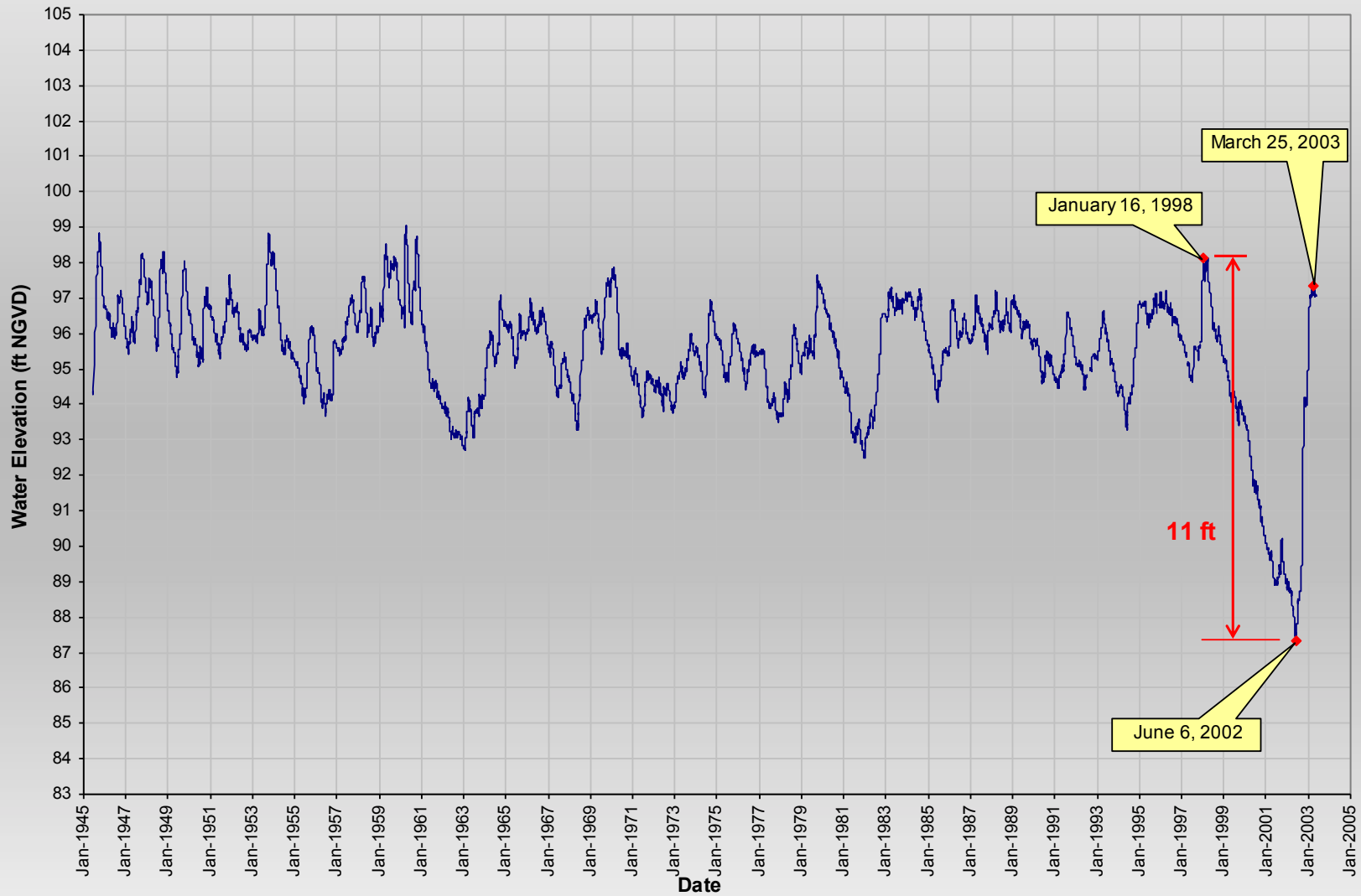
Photo date: 2004 (Hurricane Jeanne)

## Topic 1.5

# Buried Muck Compressing During Extreme Drought

# Clermont Chain of Lakes – Lake Minnehaha

Lake Minnehaha Water Levels - January 1, 1945 through May 14, 2003



# Country Road 561



Pavement Distress

# Country Road 561



Pavement Distress

# Country Road 561



Continued pavement distress after patch



# Country Road 561



Geogrid installation during repair

# Country Road 561



Finished product

# Country Road 561



Finished Product

# Lake Pleasant Road



# Lake Pleasant Road



Distress Photos

# Lake Pleasant Road



Distress Photos

# Lake Pleasant Road



Distress Photos

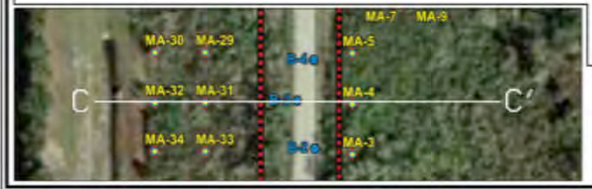
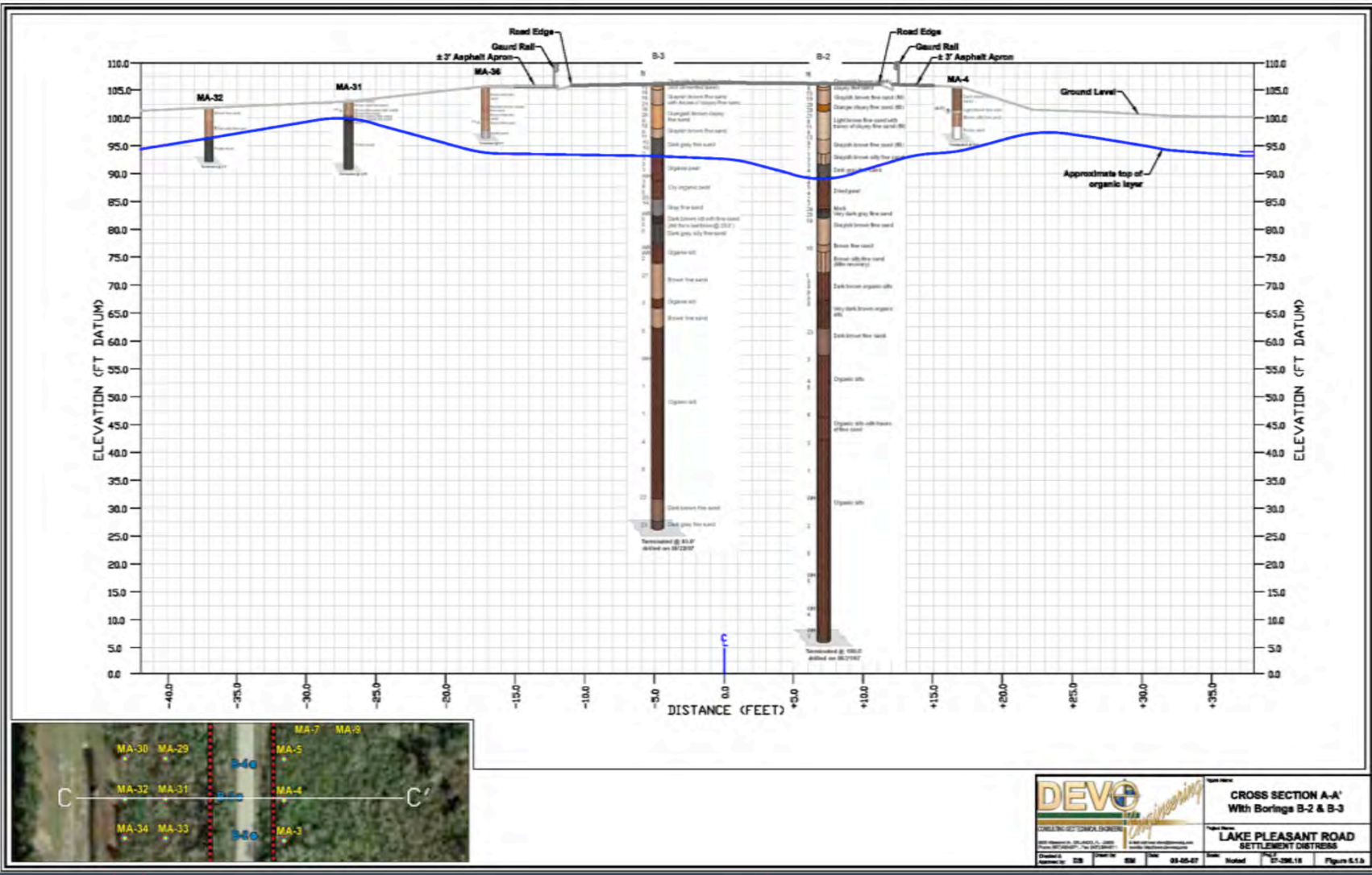
# Lake Pleasant Road



Investigation Photos

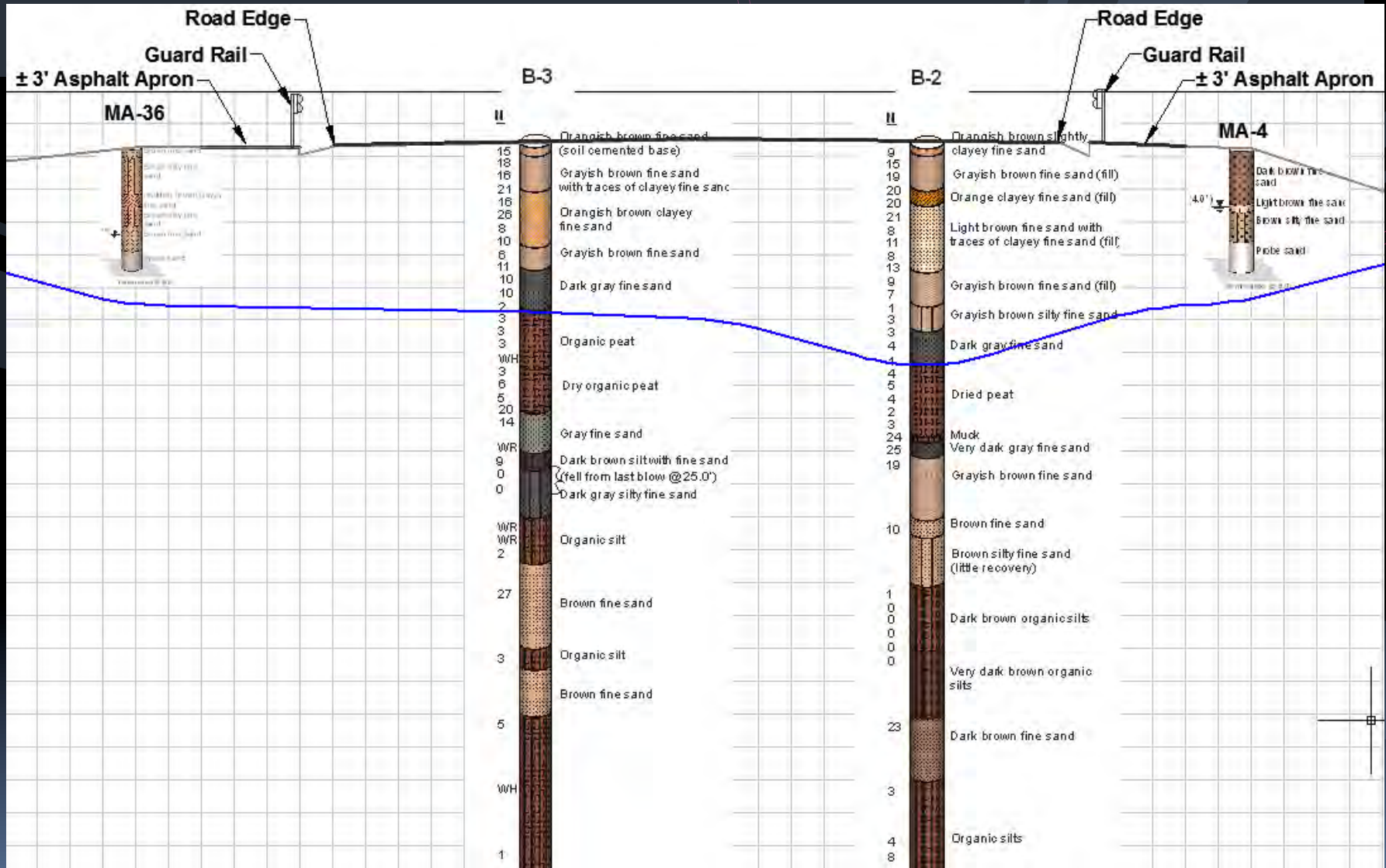


# Lake Pleasant Road



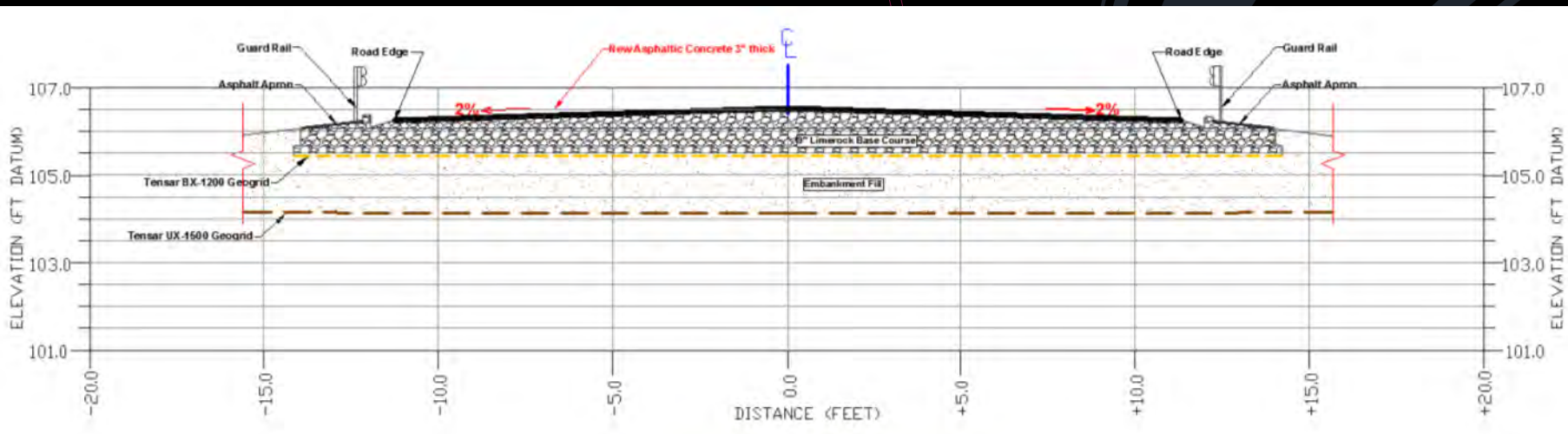
Cross Section

# Lake Pleasant Road



Cross Section

# Lake Pleasant Road



OPTION (A) TYPICAL X-SECTION

Cross Section

## Topic 1.6

# Corroding Sand-Shell-Cement Base

# Lake Underhill Road

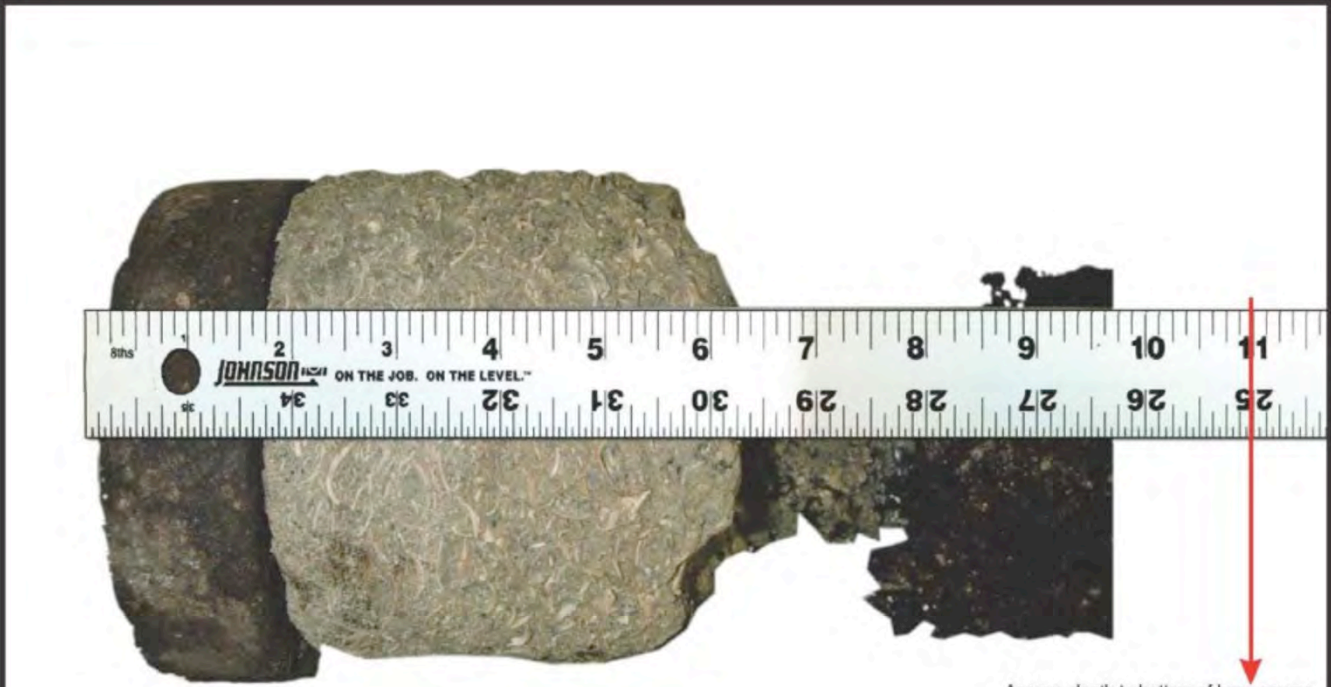


Approx. depth to bottom of base course as measured in corehole.

\* Portion of sample crumbled and unrecoverable during coring & extraction

 CONSULTING GEOTECHNICAL ENGINEERS 1200 Alabama Street, Orlando, Florida 32816 Phone: (407) 268-2217 • Fax: (407) 268-8812 E-Mail: info@devoeng.com Website: http://www.devoeng.com	Project Name: <b>PAVEMENT ANALYSIS CORE # C-3</b>					
	Project Name: <b>LAKE UNDERHILL ROAD</b>					
Checked & Approved By: DS	State: AZ	Date: 05-16-2011	Scale: NOTED	Project #:	11-610.35	APPENDIX A3

# Lake Underhill Road



Approx. depth to bottom of base course as measured in corehole.

\* Portion of sample crumbled and unrecoverable during coring & extraction

<b>DEVO</b> CONSULTING GEOTECHNICAL ENGINEERS 1000 Alhambra Drive, Orlando, Florida 32808 Phone: (407) 280-0377 • Fax: (407) 280-0810 E-mail: info@devoengineering.com Website: http://www.devoeng.com		<b>Engineering</b>	
Client & Approved by: DS		Drawn by: AZ	Date: 05-16-2011
Project Name: PAVEMENT ANALYSIS CORE # C-1		Project Name: LAKE UNDERHILL ROAD	
Scale: NOTED		FIGURE: 11-610.35	APPENDIX: A1

# Lake Underhill Road



Approx. depth to bottom of base course as measured in corehole.

\* Portion of sample crumbled and unrecoverable during coring & extraction

<b>DEVO</b> CONSULTING GEOTECHNICAL ENGINEERS 1100 Alhambra Drive, Orlando, Florida 32801 Phone: (407) 260-0271 • Fax: (407) 260-8871 E-Mail: <a href="mailto:info@devoeng.com">info@devoeng.com</a> Website: <a href="http://www.devoeng.com">http://www.devoeng.com</a>		<b>Engineering</b>		Report Name:
				<b>PAVEMENT ANALYSIS CORE # C-5</b>
				Project Name:
				<b>LAKE UNDERHILL ROAD</b>
Checked & Approved By:	DS	Drawn By:	AZ	Date:
				05-16-2011
				Scale:
				NOTED
				Project #:
				11-610.35
				APPENDIX A

# Lake Underhill Road



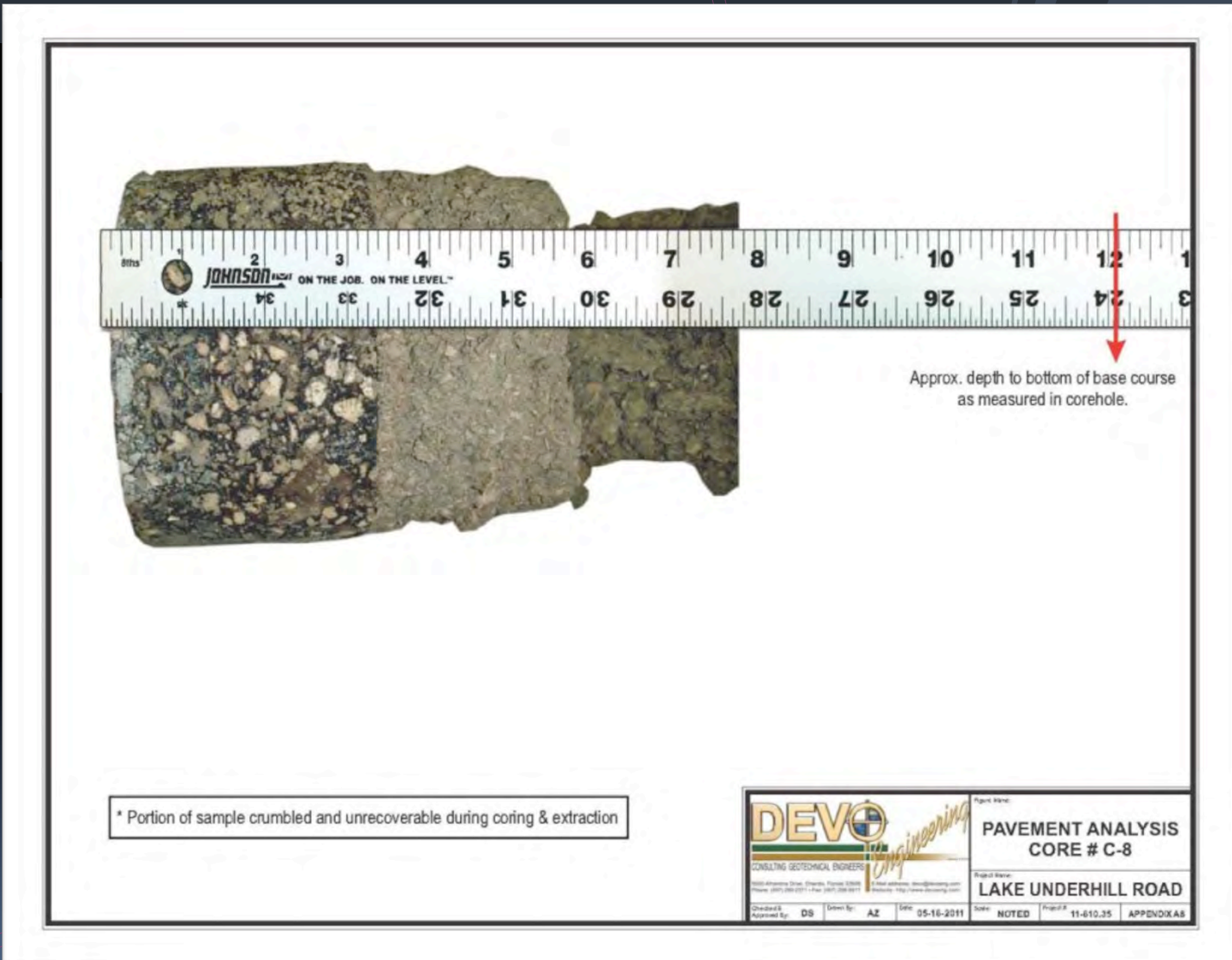
Approx. depth to bottom of base course as measured in corehole.

\* Portion of sample crumbled and unrecoverable during coring & extraction

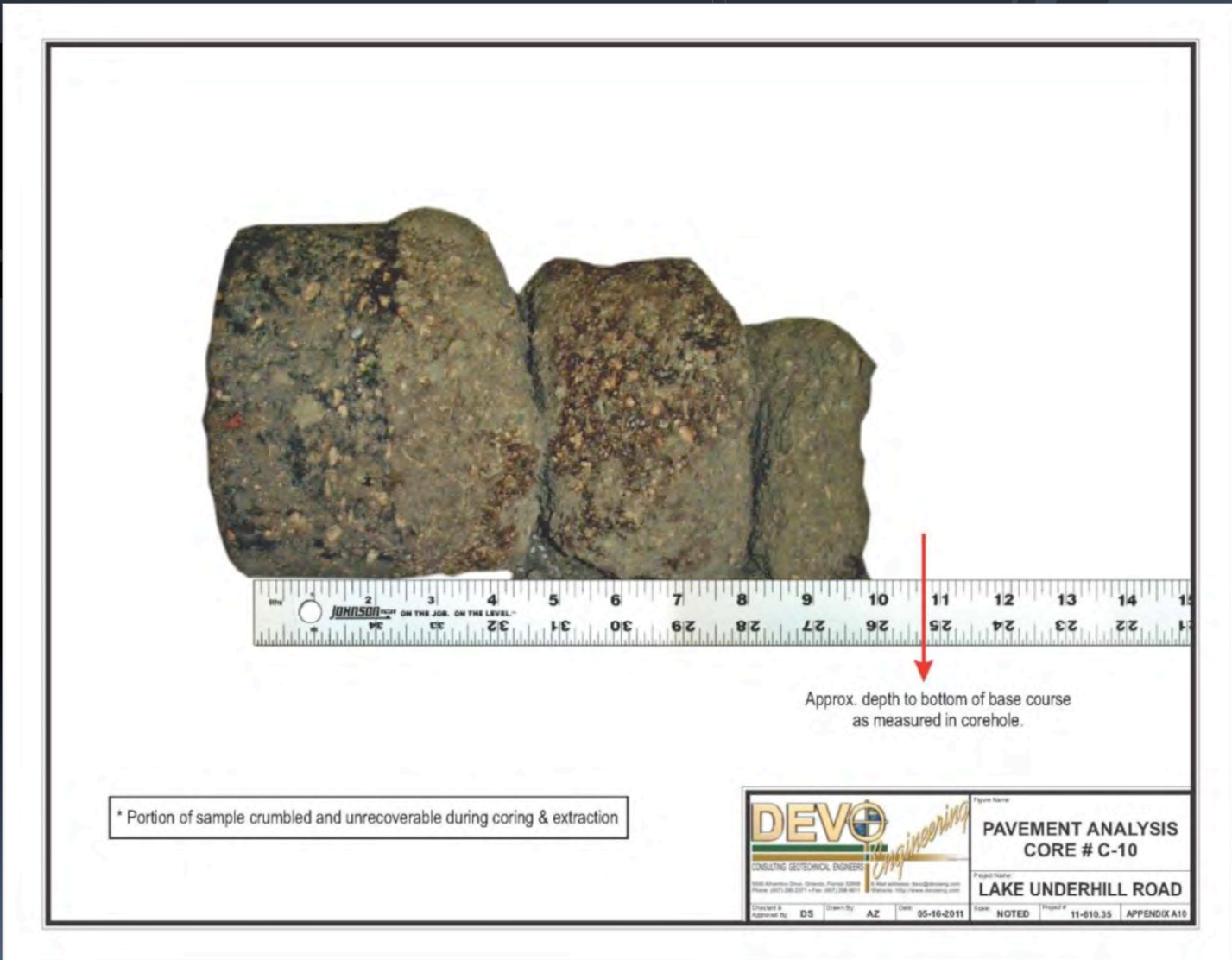
		Project Name: <b>PAVEMENT ANALYSIS CORE # C-6</b>	
CONSULTING GEOTECHNICAL ENGINEERS 2500 Alhambra Street, Winter, Florida 32789 Phone: (407) 260-0377 • Fax: (407) 260-0610 E-Mail Address: devo@devoeng.com Website: http://www.devoeng.com		Project Name: <b>LAKE UNDERHILL ROAD</b>	
Checked & Approved By: DS	State/By: AZ	Date: 05-16-2011	Scale: NOTED Project #: 11-610.35 APPENDIX A6



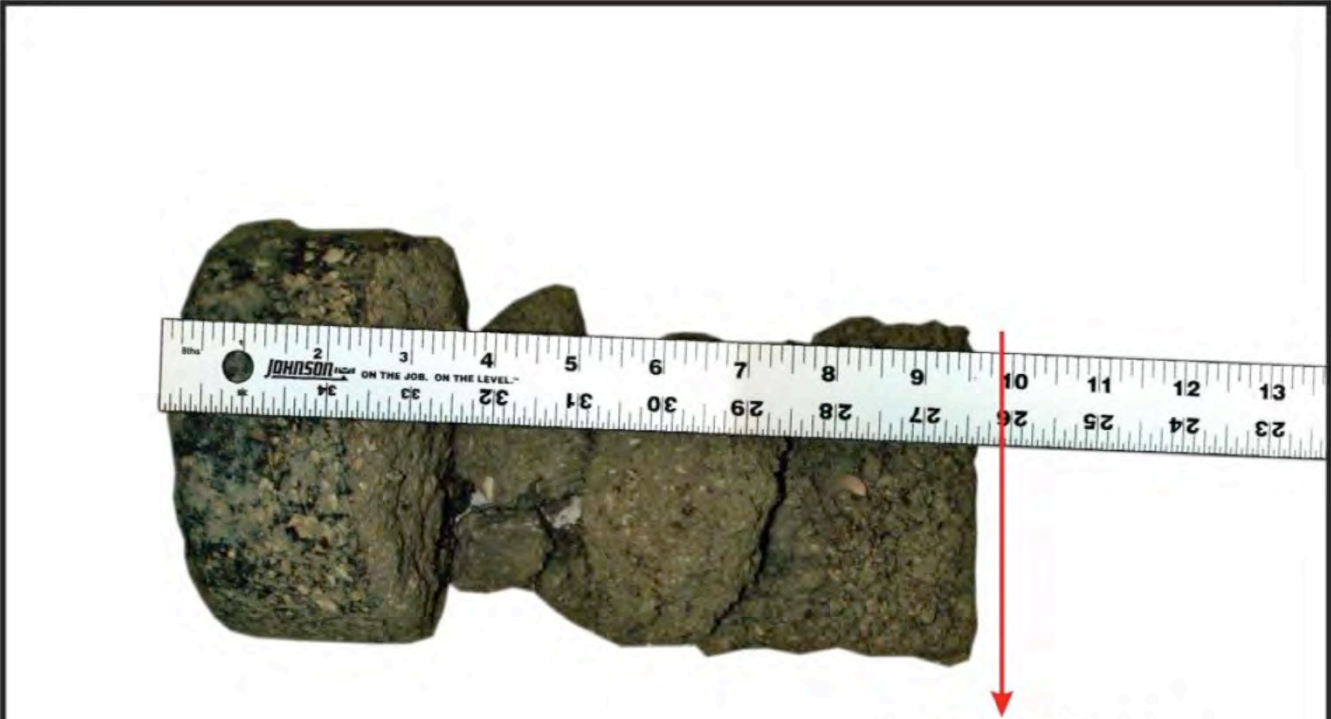
# Lake Underhill Road



# Lake Underhill Road



# Lake Underhill Road



Approx. depth to bottom of base course as measured in corehole.

\* Portion of sample crumbled and unrecoverable during coring & extraction

<b>DEVO</b> CONSULTING GEOTECHNICAL ENGINEERS 1200 Alhambra Drive, Phoenix, Arizona 85015 Phone: (602) 280-0271 • Fax: (602) 280-8812 E-Mail: info@devoeng.com Website: http://www.devoeng.com		<b>Engineering</b>	
Checked & Approved By: DS		State/By: AZ	Date: 05-16-2011
Project Name: PAVEMENT ANALYSIS CORE # C-11		Project No.: LAKE UNDERHILL ROAD	Scale: NOTED
		Project #:	11-610.35 APPENDIX A11

# Lake Underhill Road

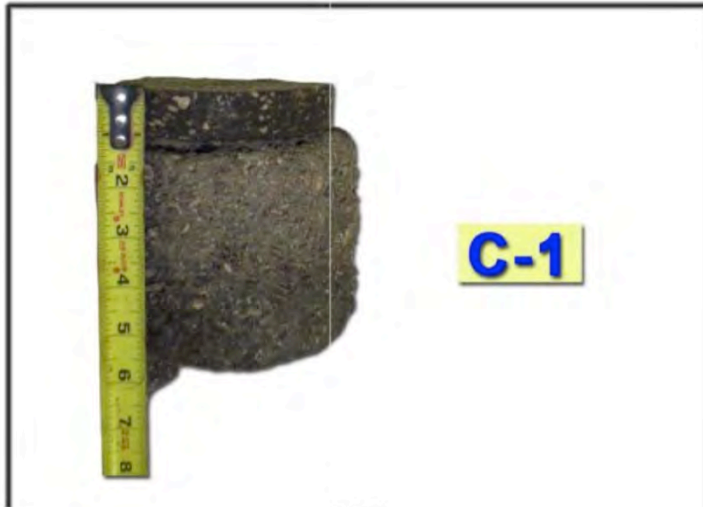


Approx. depth to bottom of base course as measured in corehole.

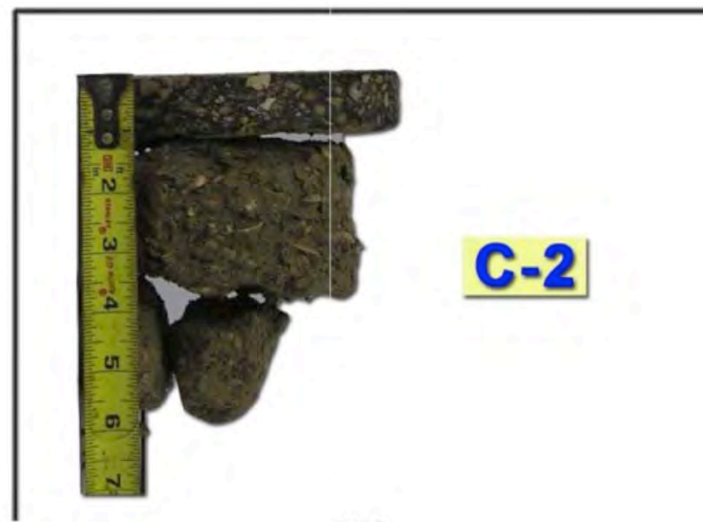
\* Portion of sample crumbled and unrecoverable during coring & extraction

<b>DEVO</b> Engineering CONSULTING GEOTECHNICAL ENGINEERS 1100 Williams Drive, Orlando, Florida 32801 Phone: (407) 269-0371 • Fax: (407) 269-8872 • E-mail address: devo@devoeng.com Website: http://www.devoeng.com		Project Name: <b>PAVEMENT ANALYSIS CORE # C-12</b>
Checked & Approved By: DS	Drawn By: AZ	Date: 05-16-2011
Scale: NOTED	Project #: 11-610.35	APPENDIX A.12

# Waterford Chase

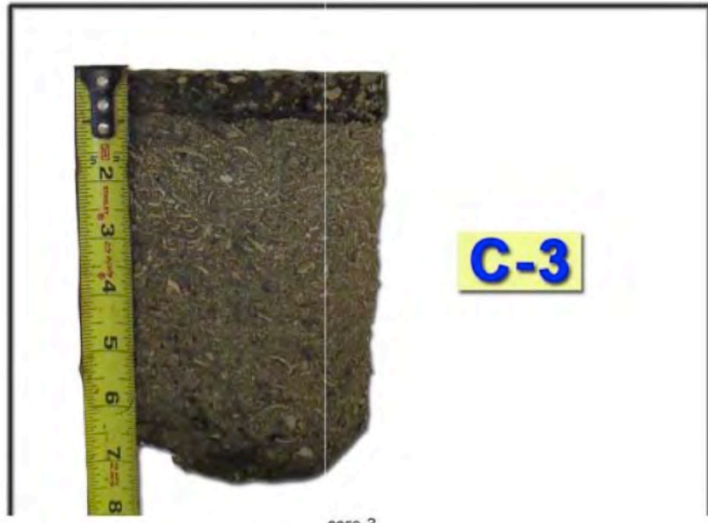


Core-1



core-2

# Waterford Chase



core-3



core-4

# Waterford Chase

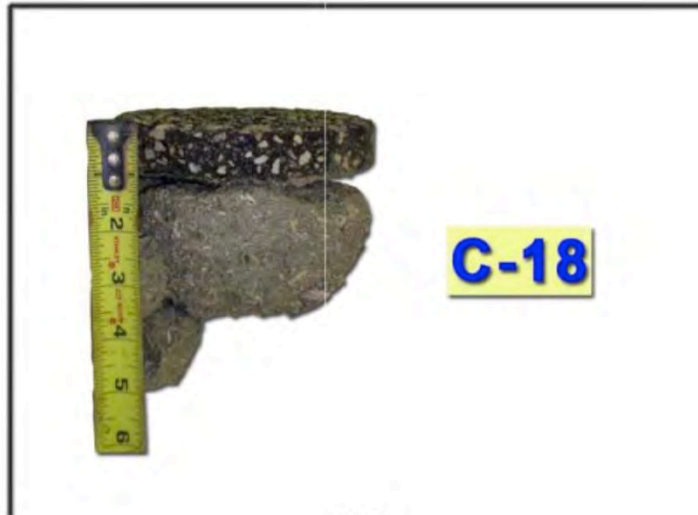


core-10



core-11

# Waterford Chase



core-18



core-19



# Waterford Lakes

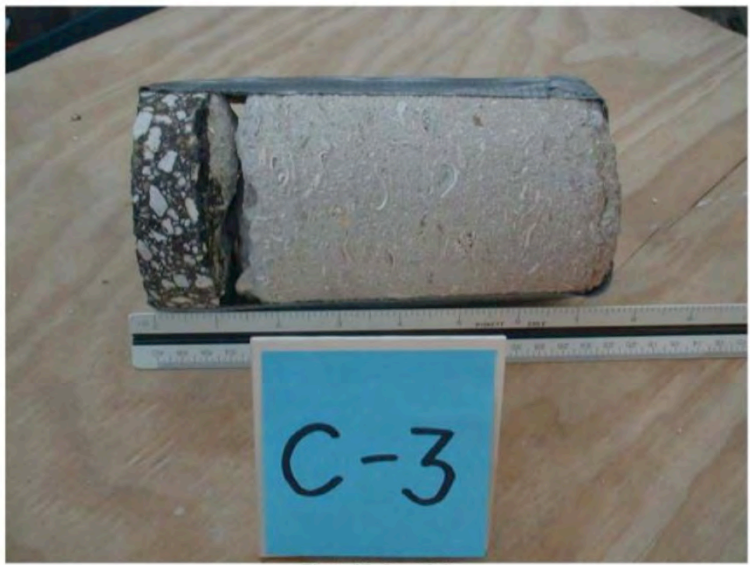


Photo 05. Core C-3



Photo 06. Core C-3

Penhalt and Base Core Photos

Appendix B - Data

# Waterford Lakes



Photo 15. Core C-8



Photo 16. Core C-8

# Waterford Lakes



Photo 21. Core C-11



Photo 22. Core C-11

Aggregate and Base Core Photos

Appendix B - Page 1

# Waterford Lakes



Photo 23. Core C-12

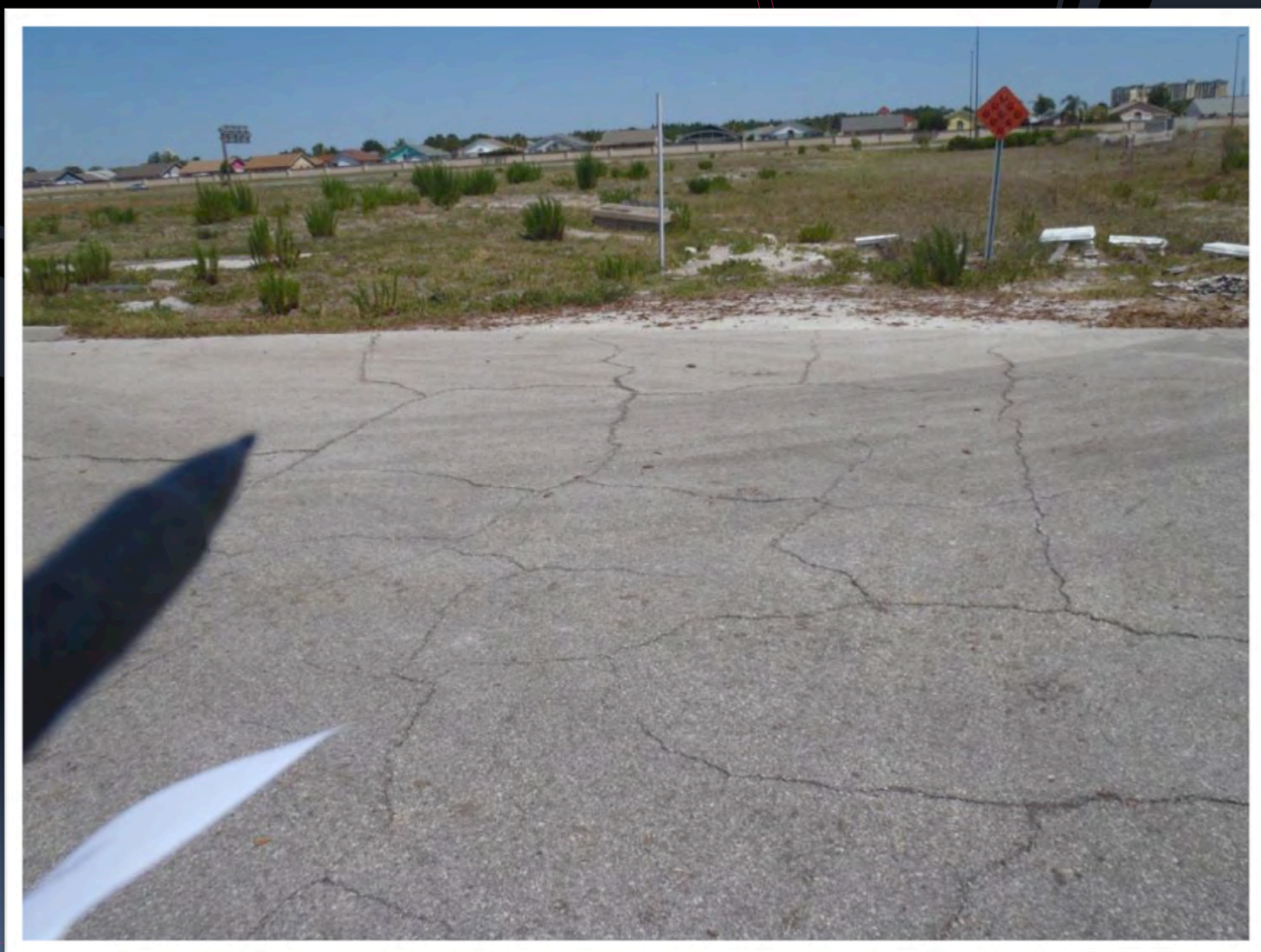


Photo 24. Core C-12

## Topic 1.7

# Cracking of Soil-Cement Base

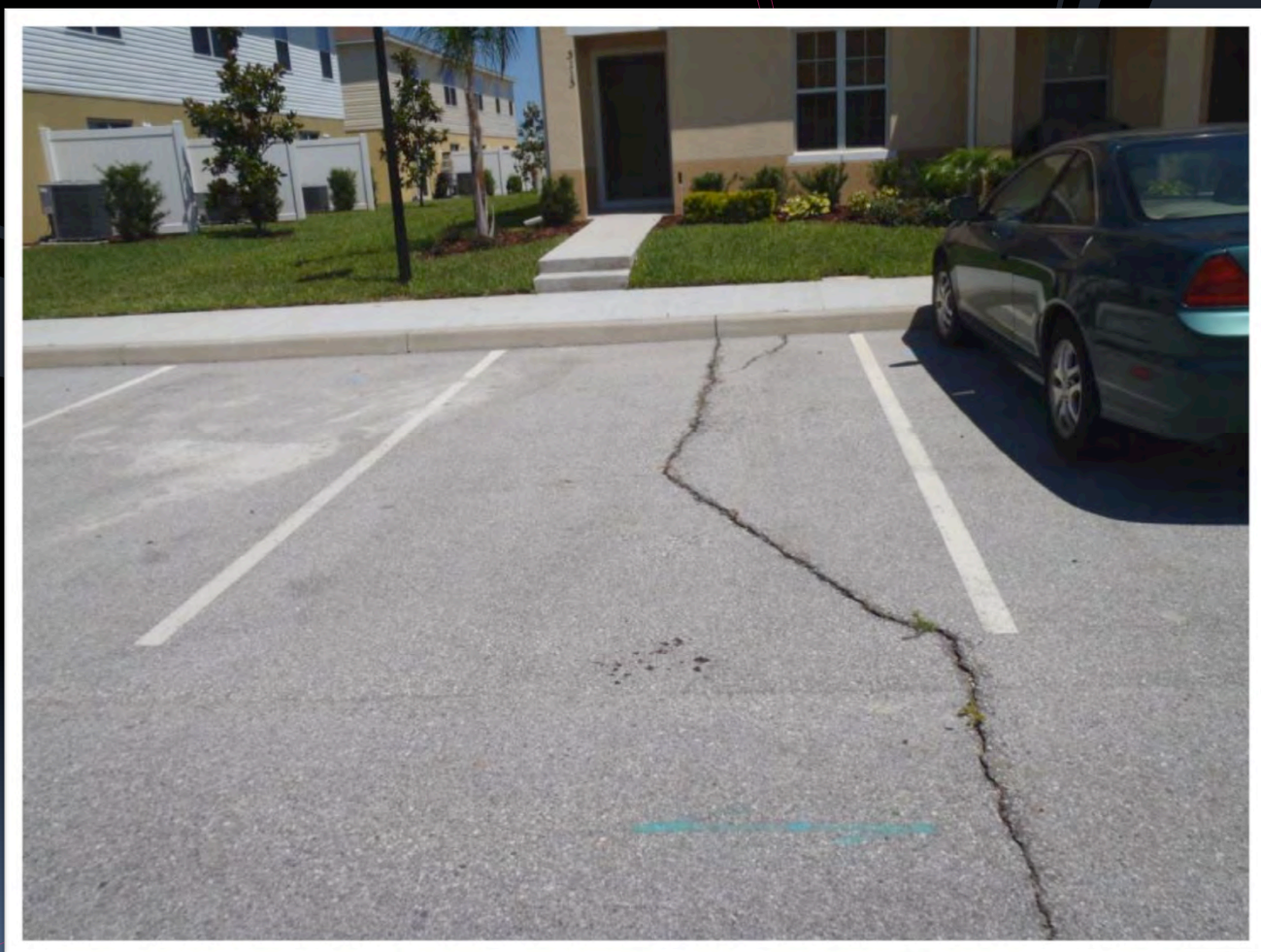
# Compass Bay



# Compass Bay



# Compass Bay





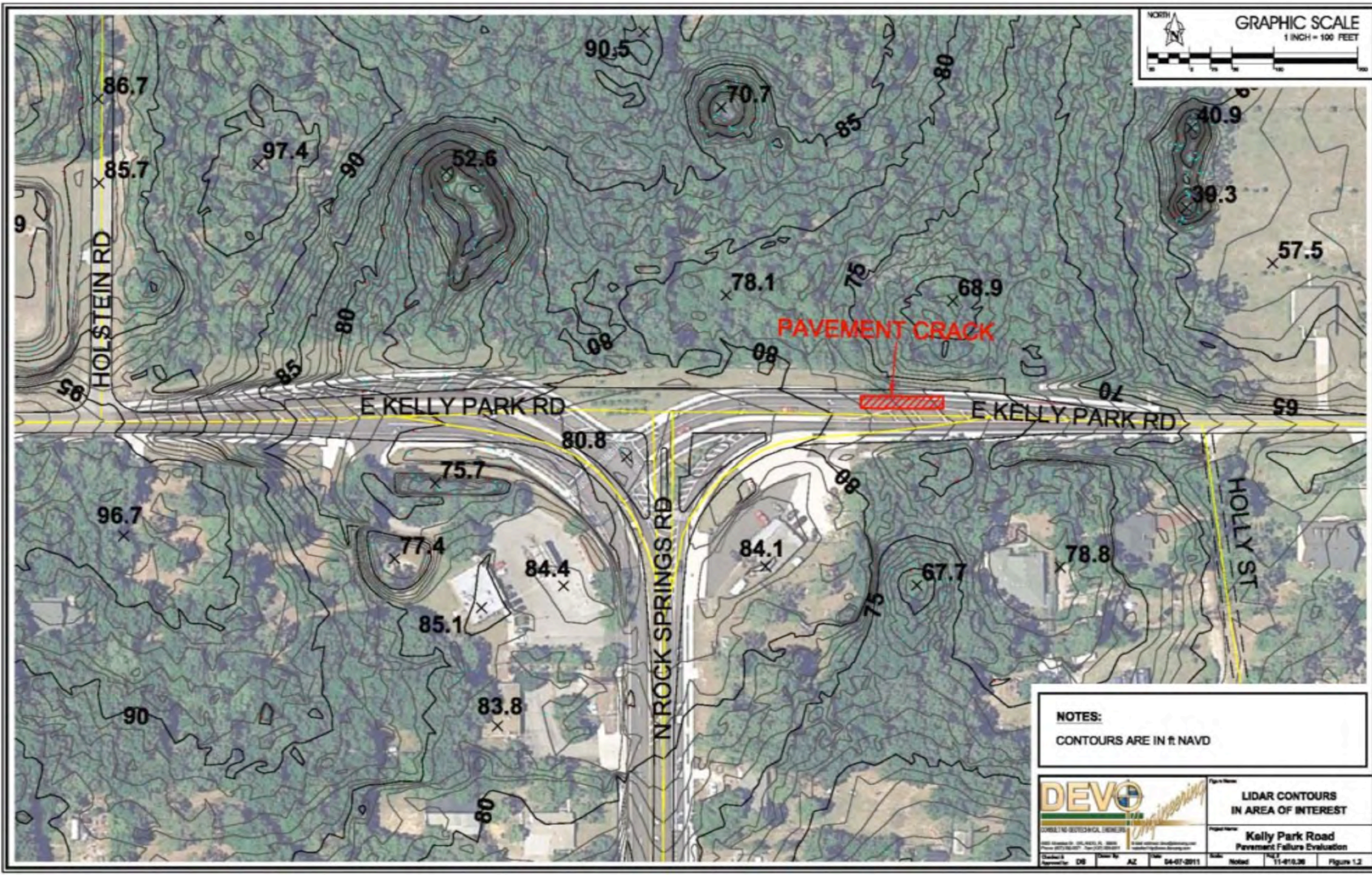
# Compass Bay



## Topic 2.1

# Widening Fill Embankments Without Box-cut

# Kelly Park Road Widening

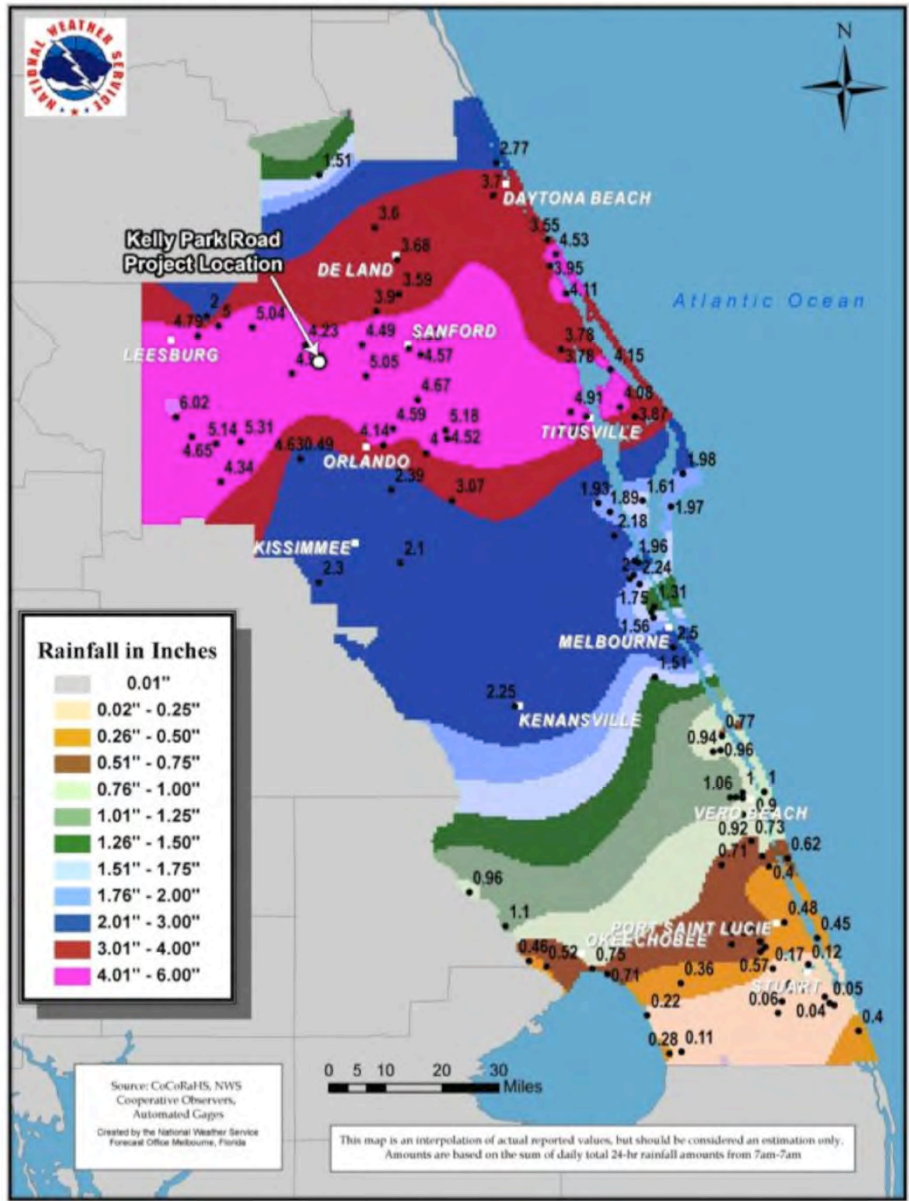


**NOTES:**  
CONTOURS ARE IN ft NAVD

	<p>Project Name: <b>LIDAR CONTOURS IN AREA OF INTEREST</b></p>
	<p>Project Name: <b>Kelly Park Road Pavement Failure Evaluation</b></p>
<p>Client: AZ</p>	<p>Date: 04-07-2011</p>
<p>Scale: Noted</p>	<p>Figure: 11-416.06 Figure 1.2</p>

# Kelly Park Road Widening

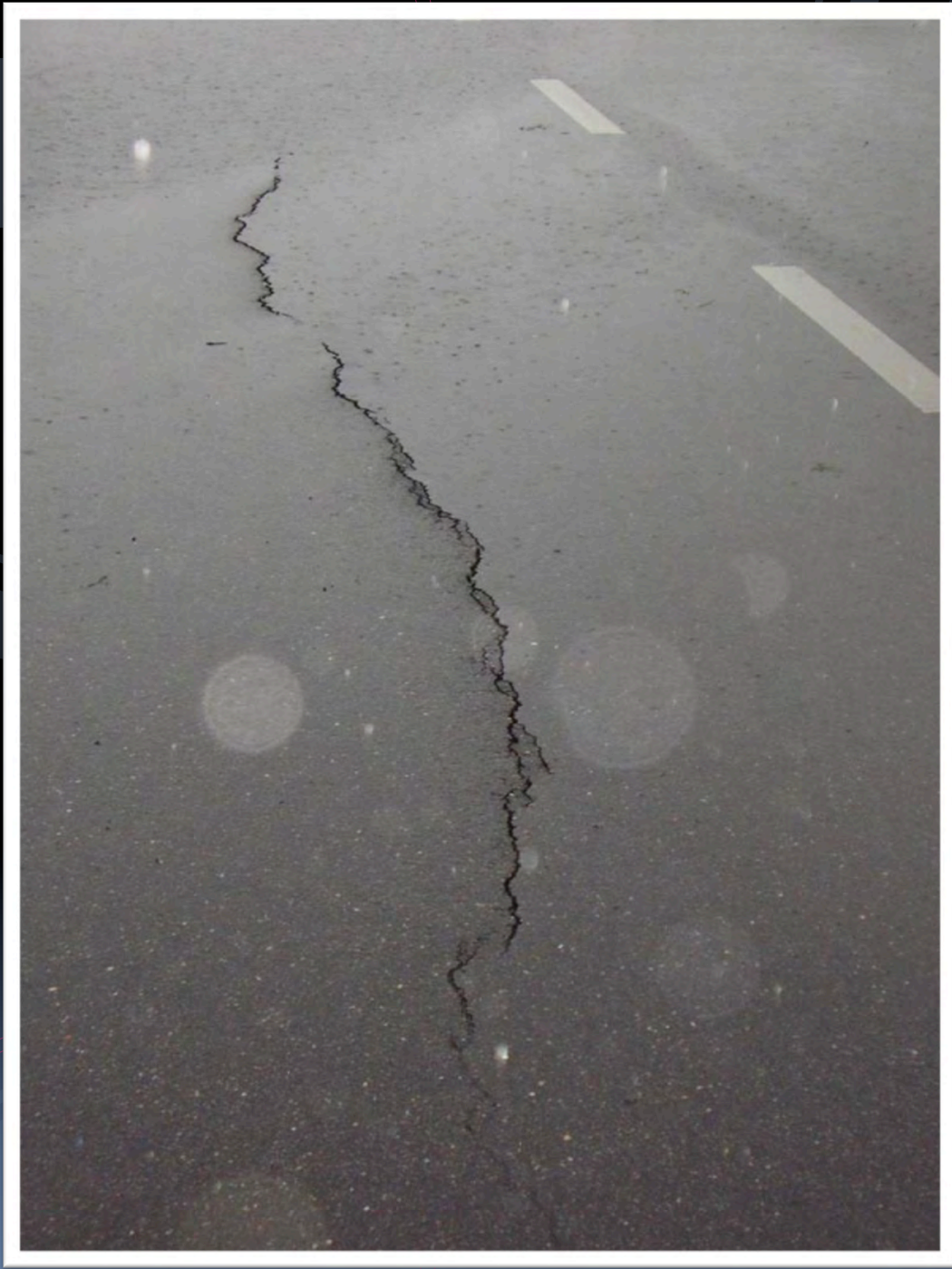
## March 30-31, 2011 Rainfall Totals



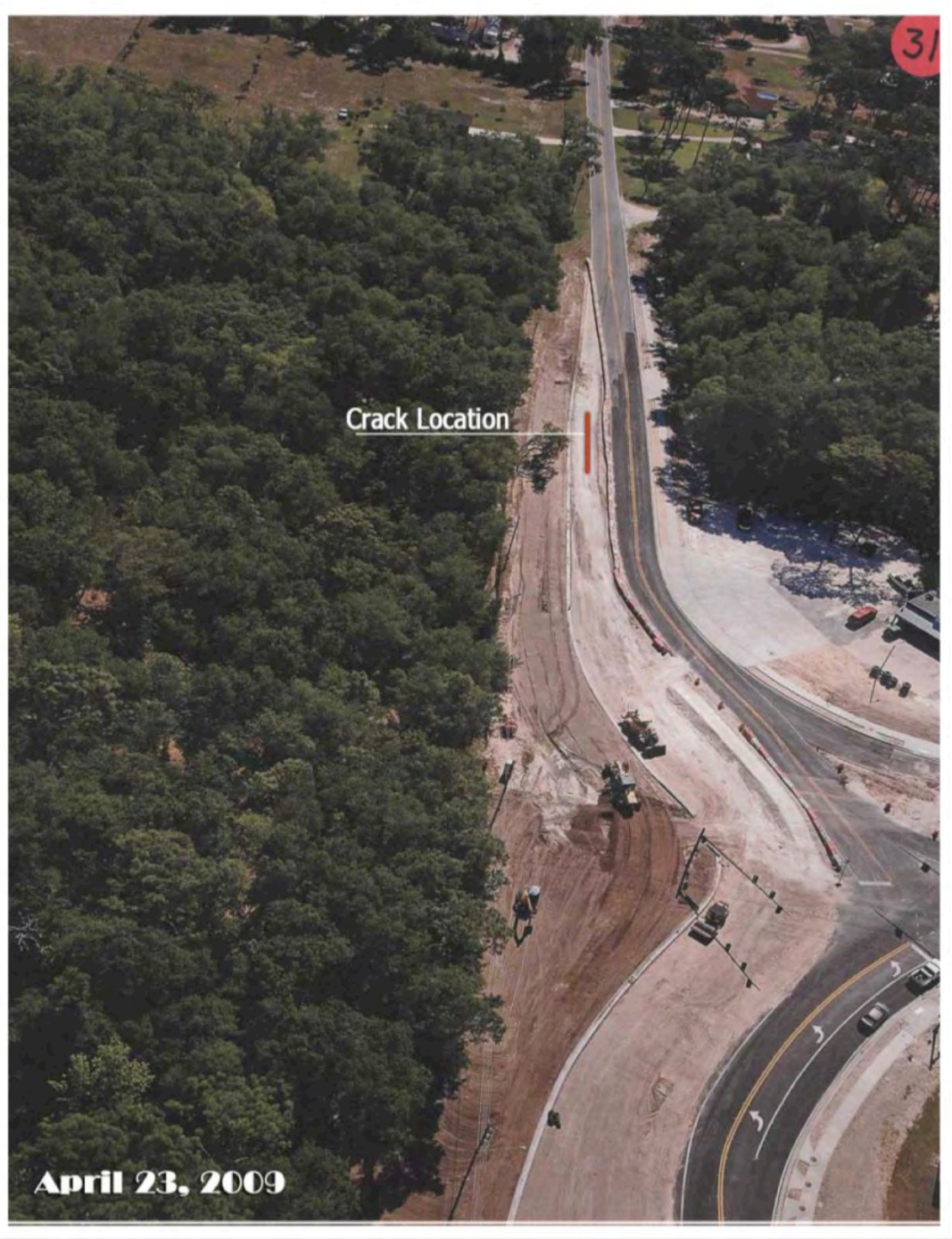
# Kelly Park Road Widening



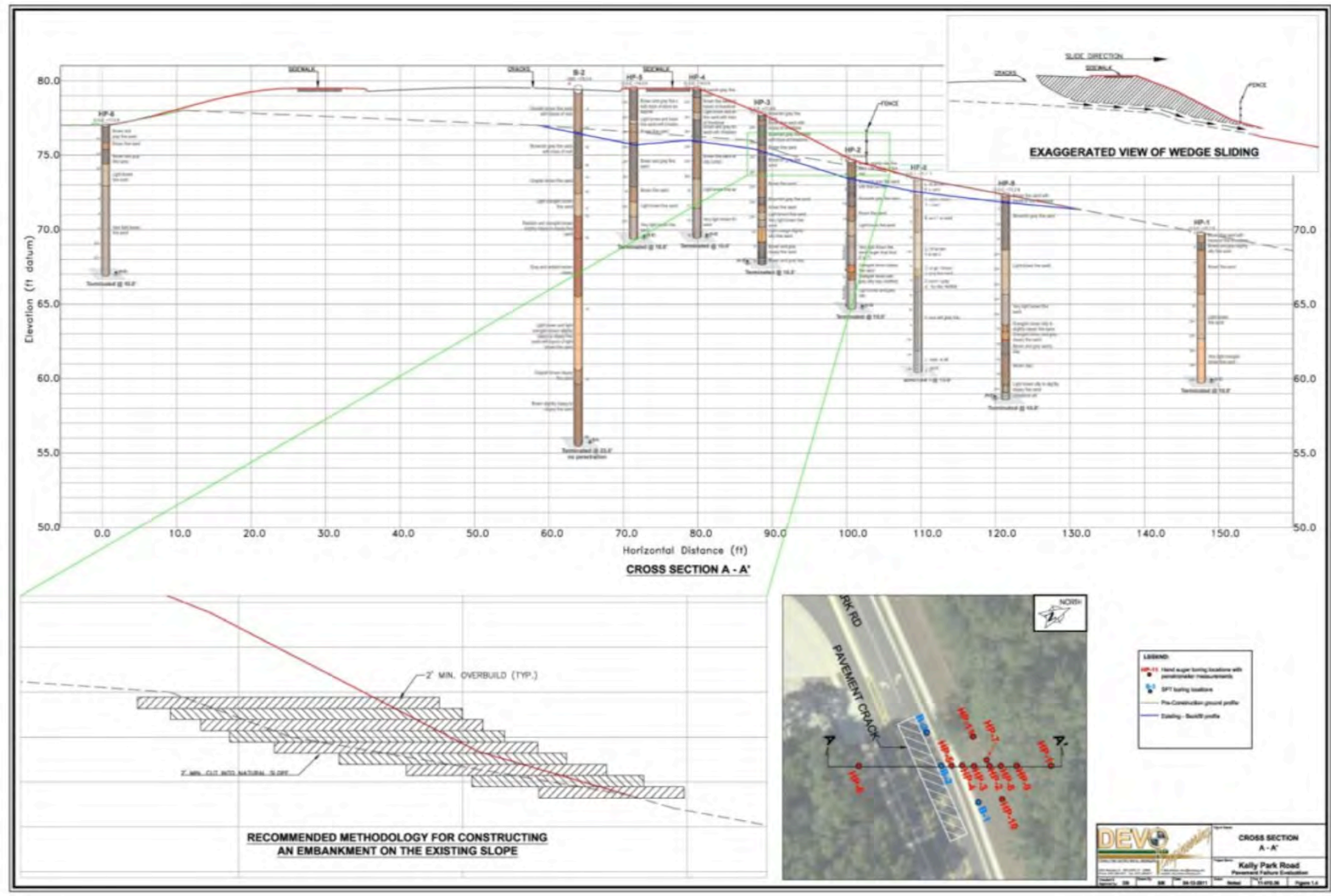
# Kelly Park Road Widening



# Kelly Park Road Widening

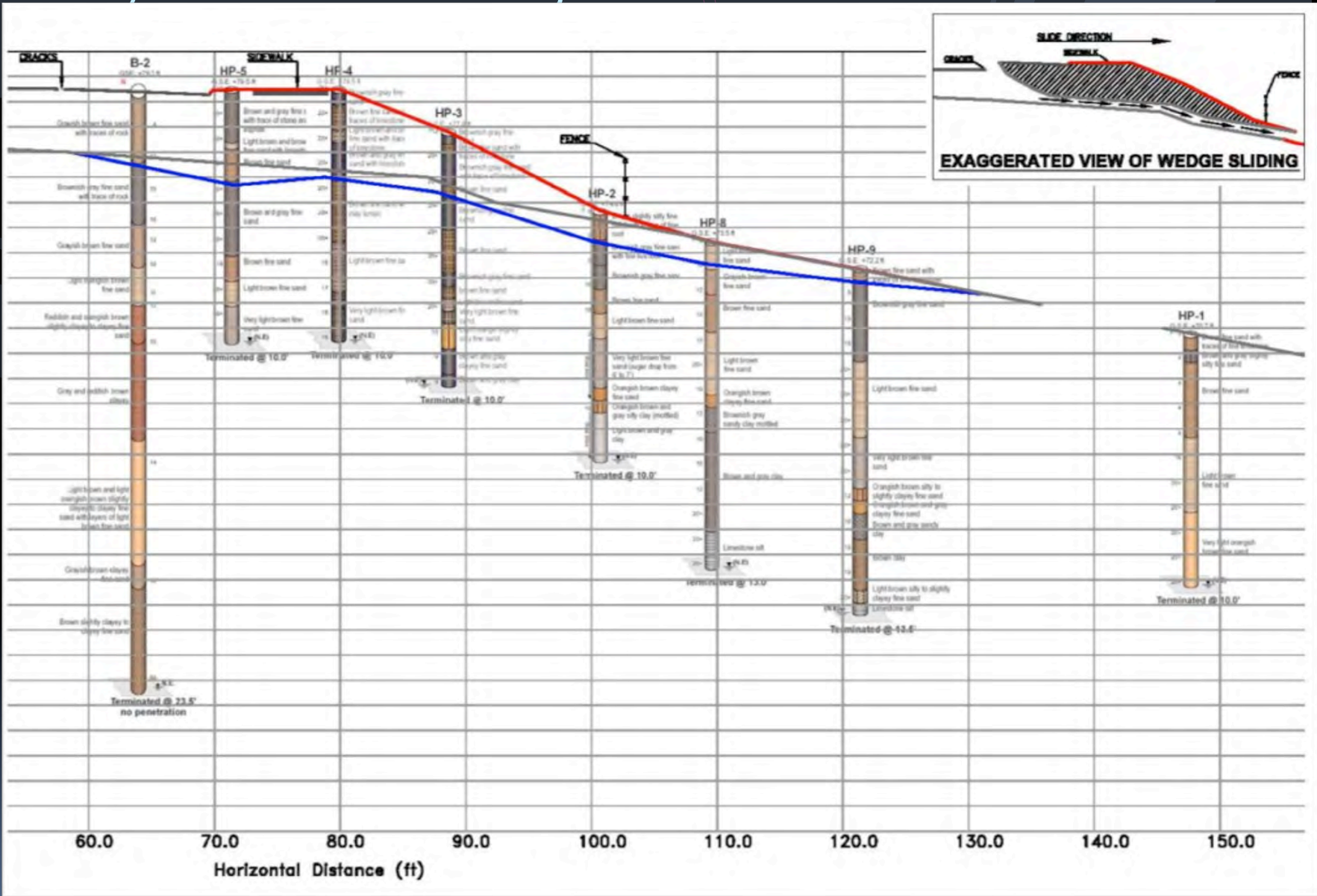


# Kelly Park Road Widening





# Kelly Park Road Widening



# Shingle Creek



View of slope failure before any attempt to reshape

# Shingle Creek



Failure of filled slope due to improper locking

# Shingle Creek



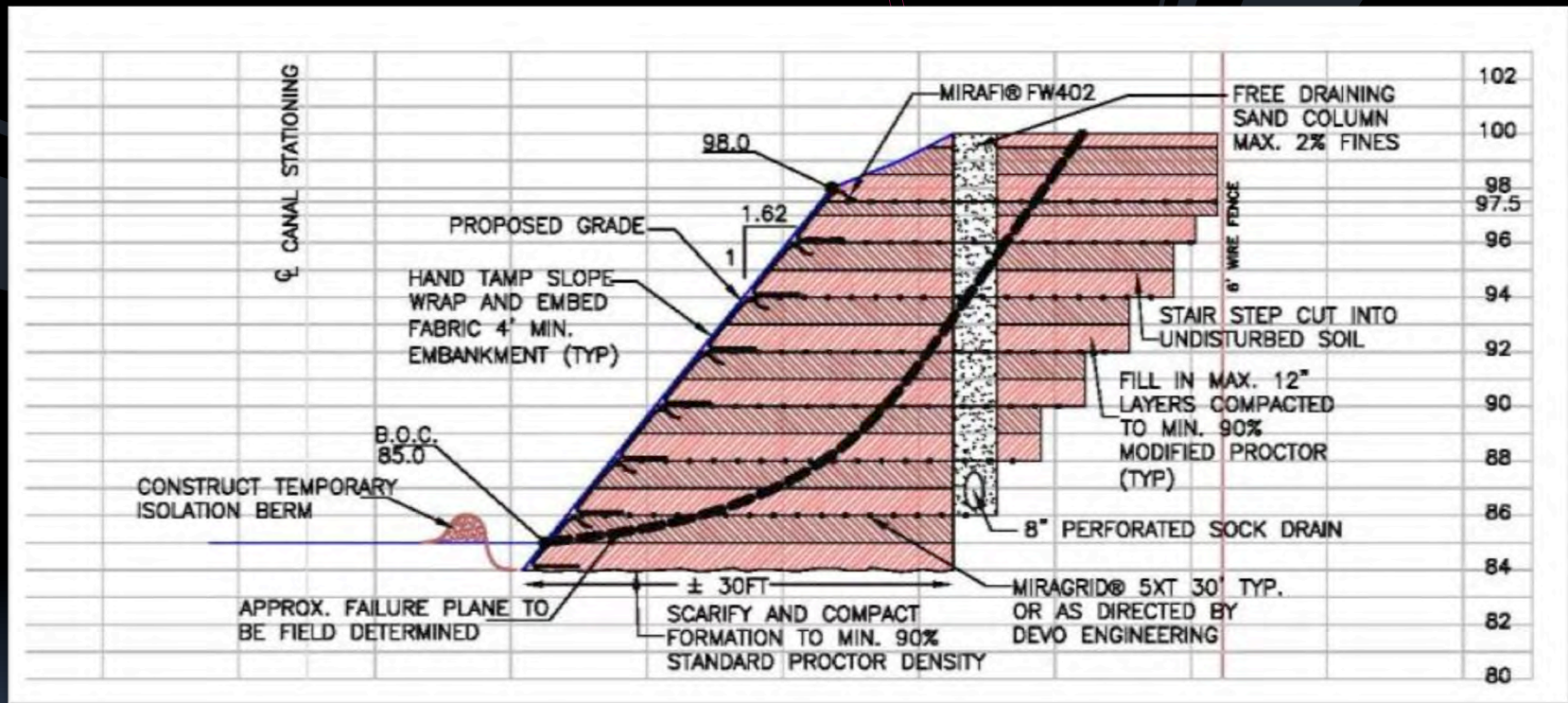
Failure due to pretty surcharge load

# Shingle Creek



Another view of failed slope

# Shingle Creek



# Shingle Creek



Laying geogrid

# Shingle Creek



Laying geogrid



# Shingle Creek



Slope Work Nearing Completion

# Shingle Creek



Slope Upon Completion

# Shingle Creek



Completion Photo 6 months after construction

## Topic 3.1

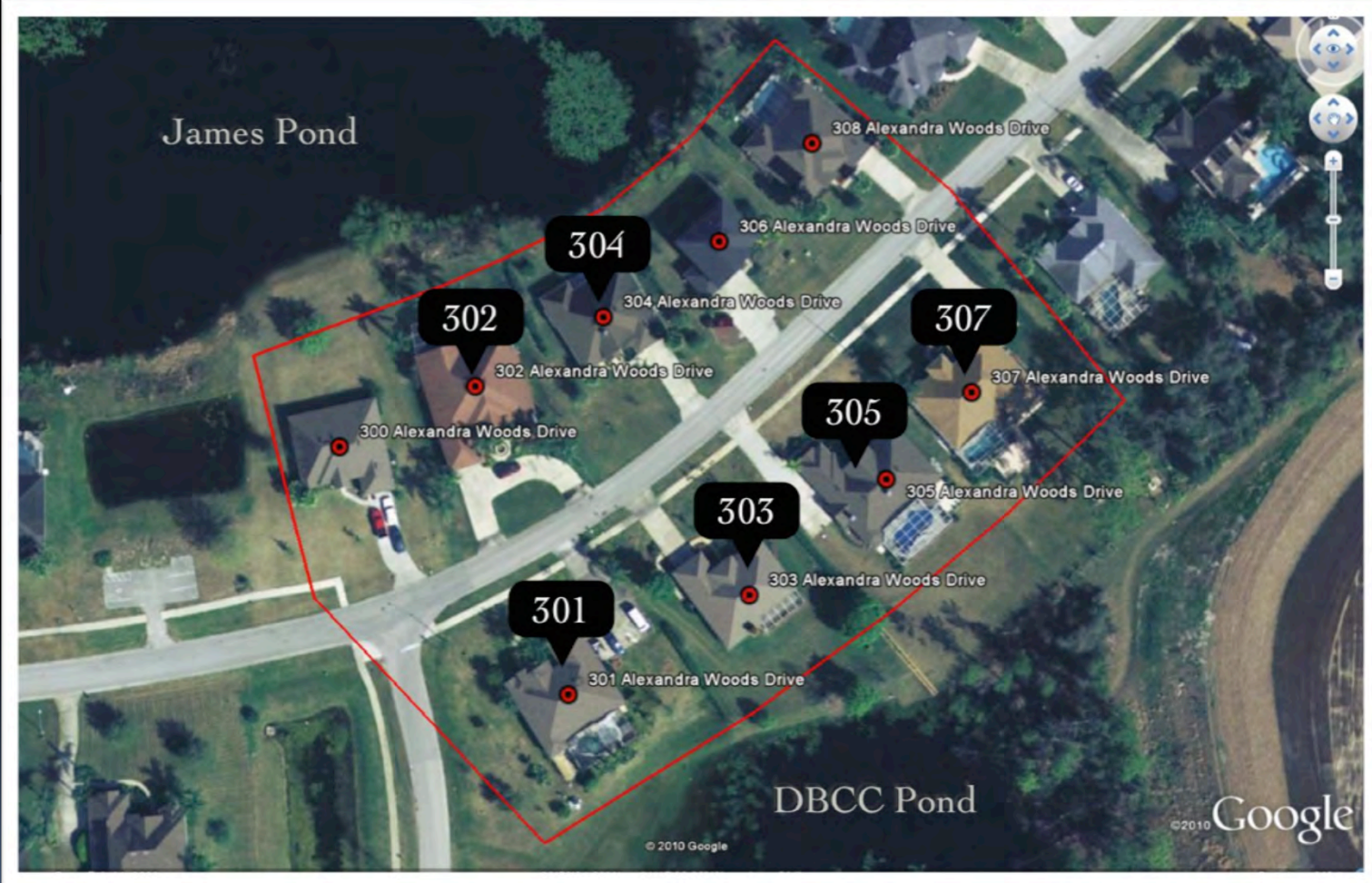
# Flooding Associated with Roadway Ponds Discharging to Land-locked Lakes

# Highbanks Enterprise Road Pond

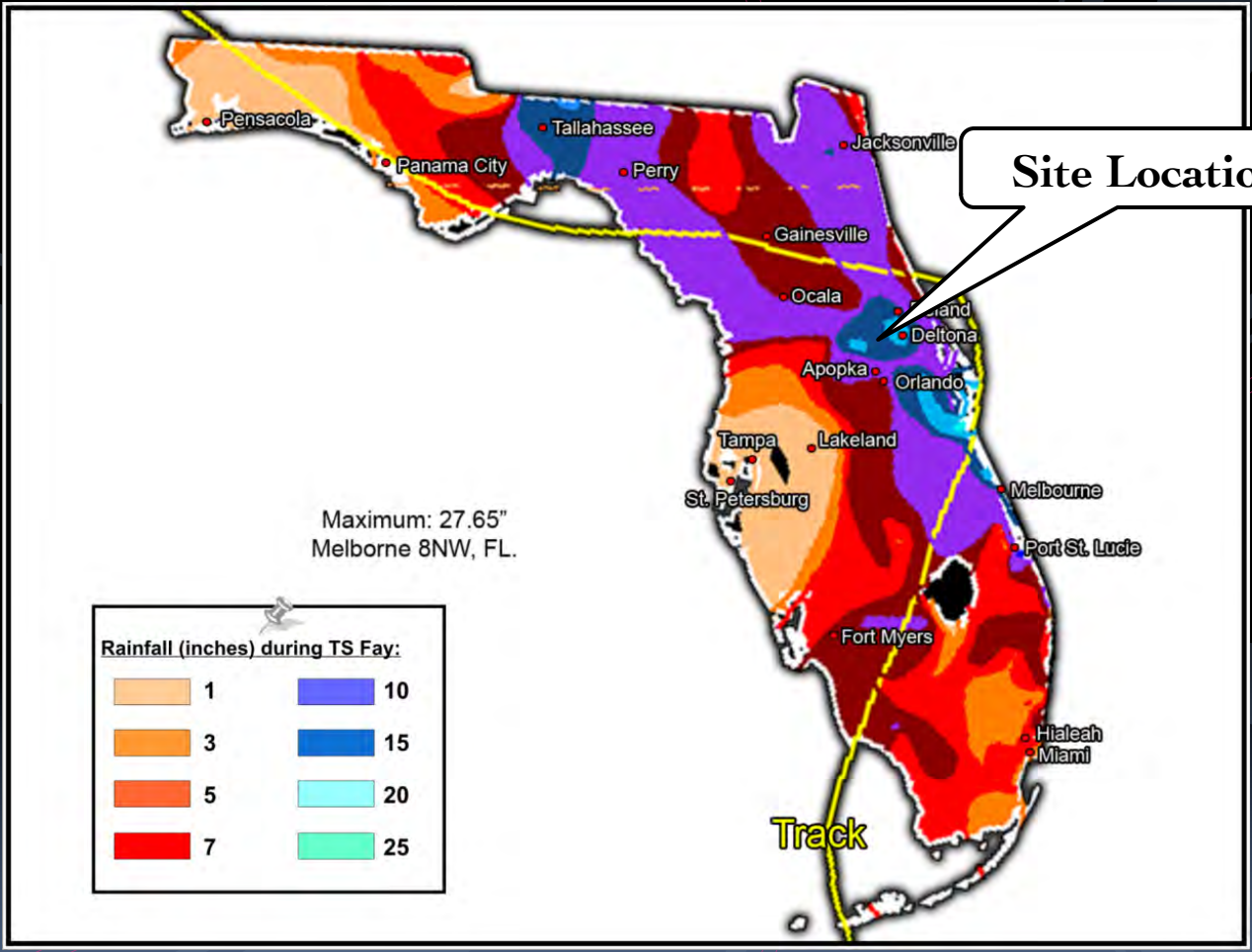


Location

# Highbanks Enterprise Road Pond



# Highbanks Enterprise Road Pond



Rainfall Totals for TS Fay - NOAA Data

# Highbanks Enterprise Road Pond



James Pond (9 structures flooded)

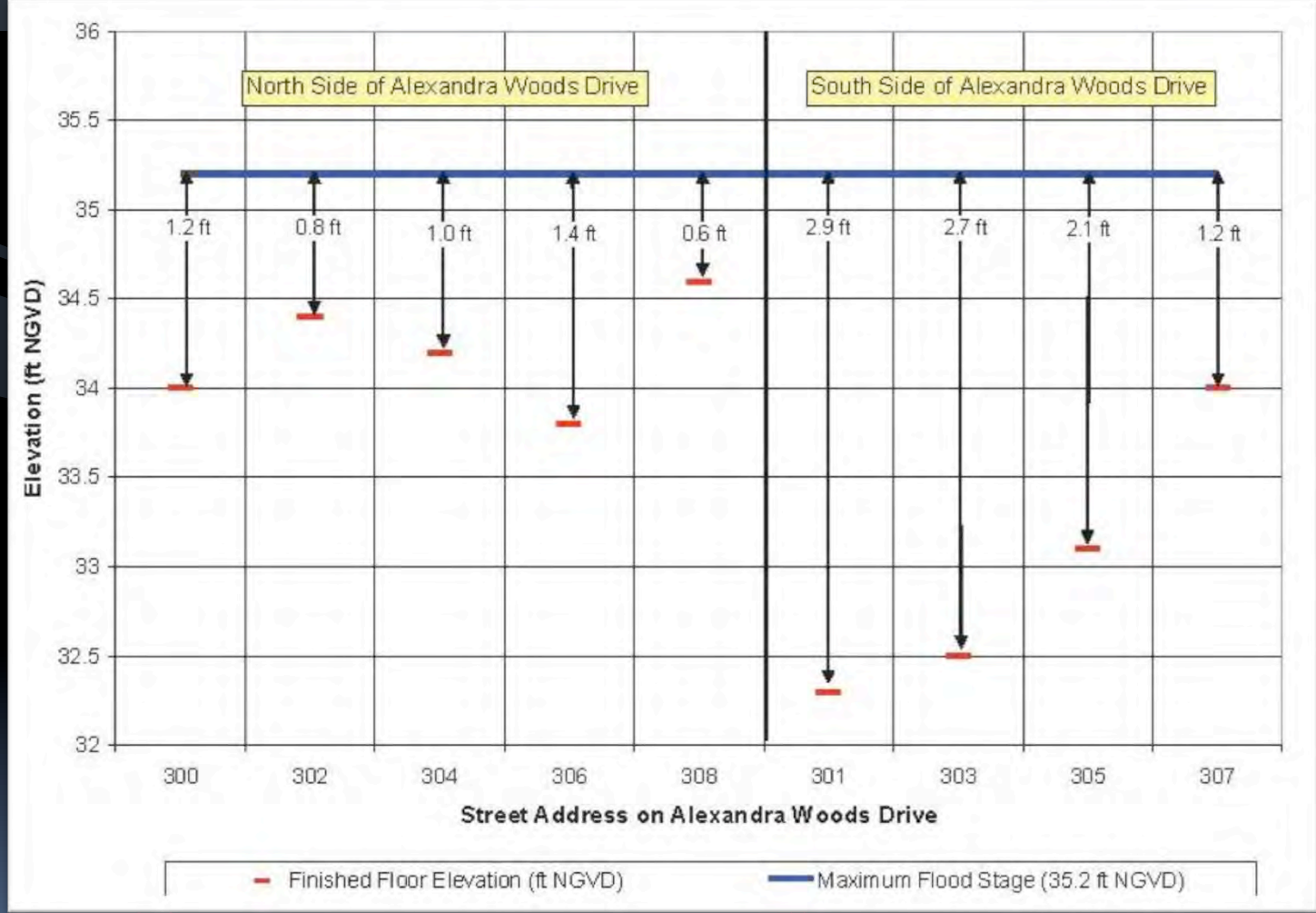


# Highbanks Enterprise Road Pond



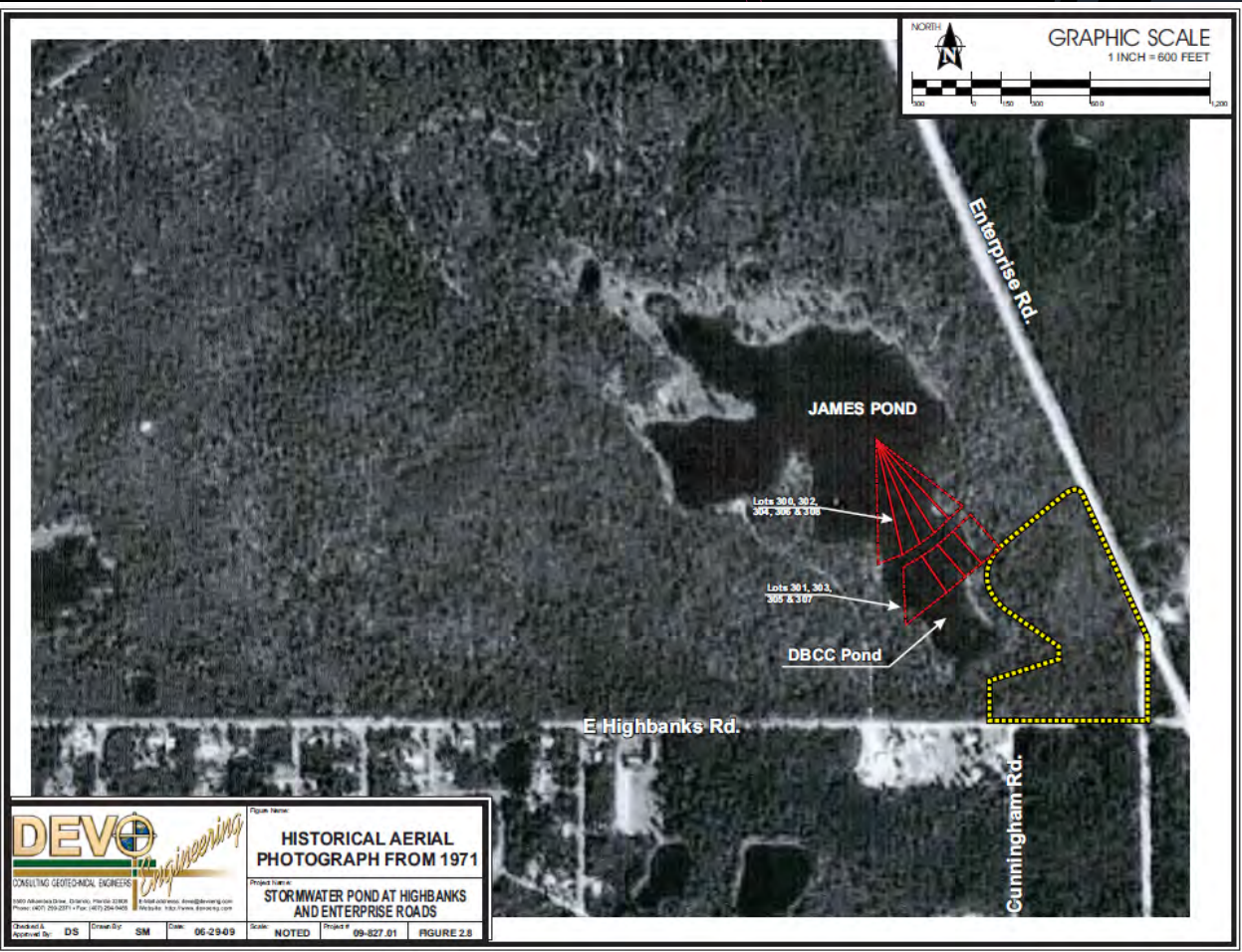
James Pond (9 structures flooded)

# Highbanks Enterprise Road Pond



James Pond (9 structures flooded)

# Highbanks Enterprise Road Pond



**DEVO** Engineering  
CONSULTING GEOTECHNICAL ENGINEERS

**HISTORICAL AERIAL PHOTOGRAPH FROM 1971**

Project Name: **STORMWATER POND AT HighbANKS AND ENTERPRISE ROADS**

Checked & Approved By: DS	Drawn By: SM	Date: 06-29-09	Scale: NOTED	Project #: 09-827.01	FIGURE 2.8
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1971

# Comparison of Peak Flood Stage in James Pond, with and without roadway widening

Table 15. Comparison of Predicted Flood Stages for "Predevelopment" Conditions

Pond	Predicted Pond Stage (ft NGVD)	
	Devo Model 2 (with road widening)	Devo Model 3 (no road widening)
Gasline Lake	44.68	45.12
Enterprise Road Pond	44.47	N.A.
DBCC Pond	35.20	35.58
James Pond	35.20	35.58

Note:

- The stages listed in the table above for Devo Model 2 assume an initial stage in Enterprise Road of +40 ft NGVD, i.e., no standing water in Enterprise Road Pond at the beginning of Tropical Storm Fay.

Note that the flood stage in James Pond would have been higher if the Enterprise Road Pond had not been constructed

## Topic 3.2

# Seepage Through Pond Berms

# FDOT Saxon Pond



Photo date: 2002

# FDOT Saxon Pond



Photo date: 2003

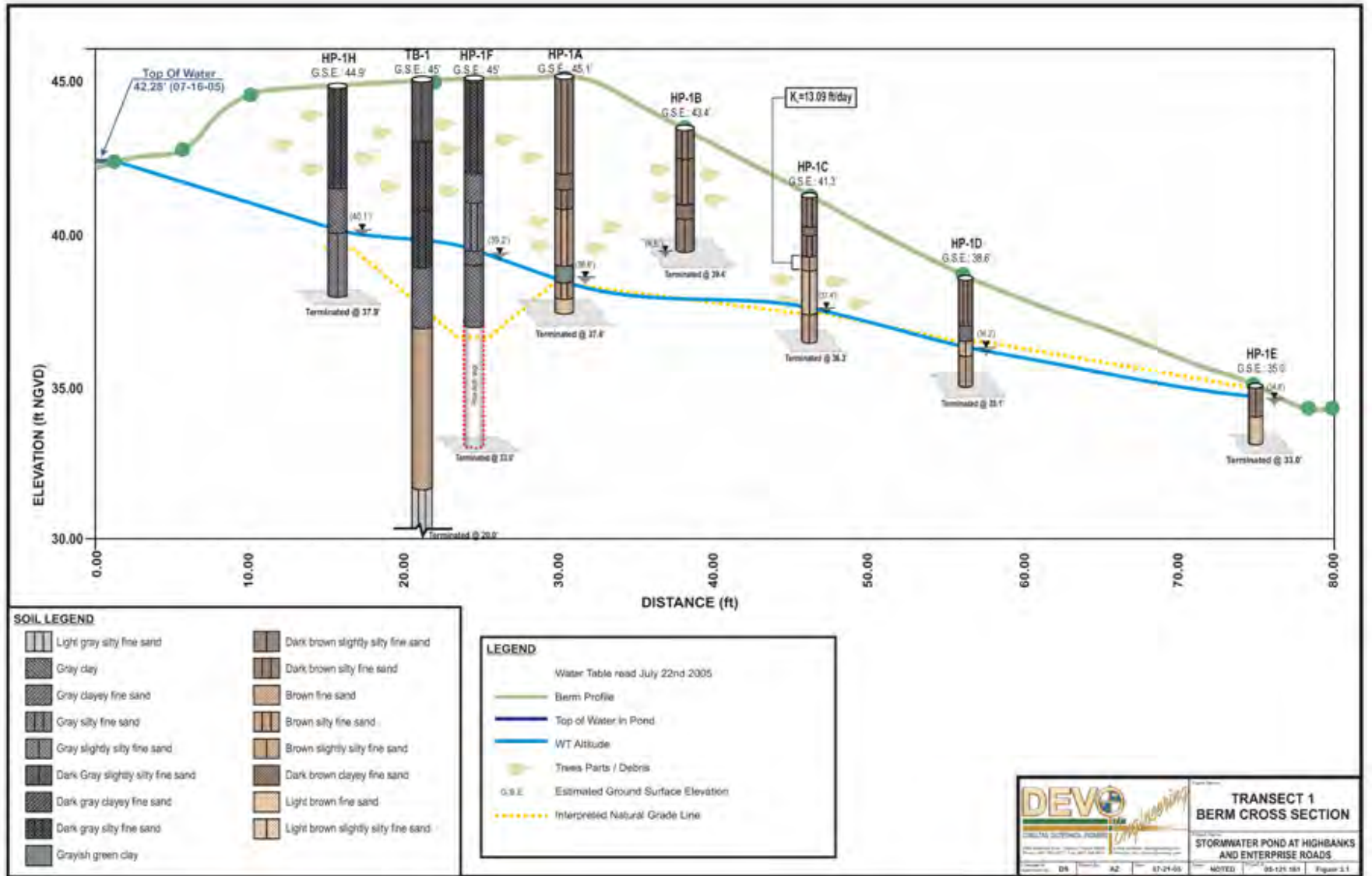
# Highbanks and Enterprise Pond



Photo date: 2005



# Highbanks and Enterprise Pond



# Highbanks and Enterprise Pond



Photo date: 2005

# The Overlook at Lake Louisa



Photo date: 2004

# The Overlook at Lake Louisa

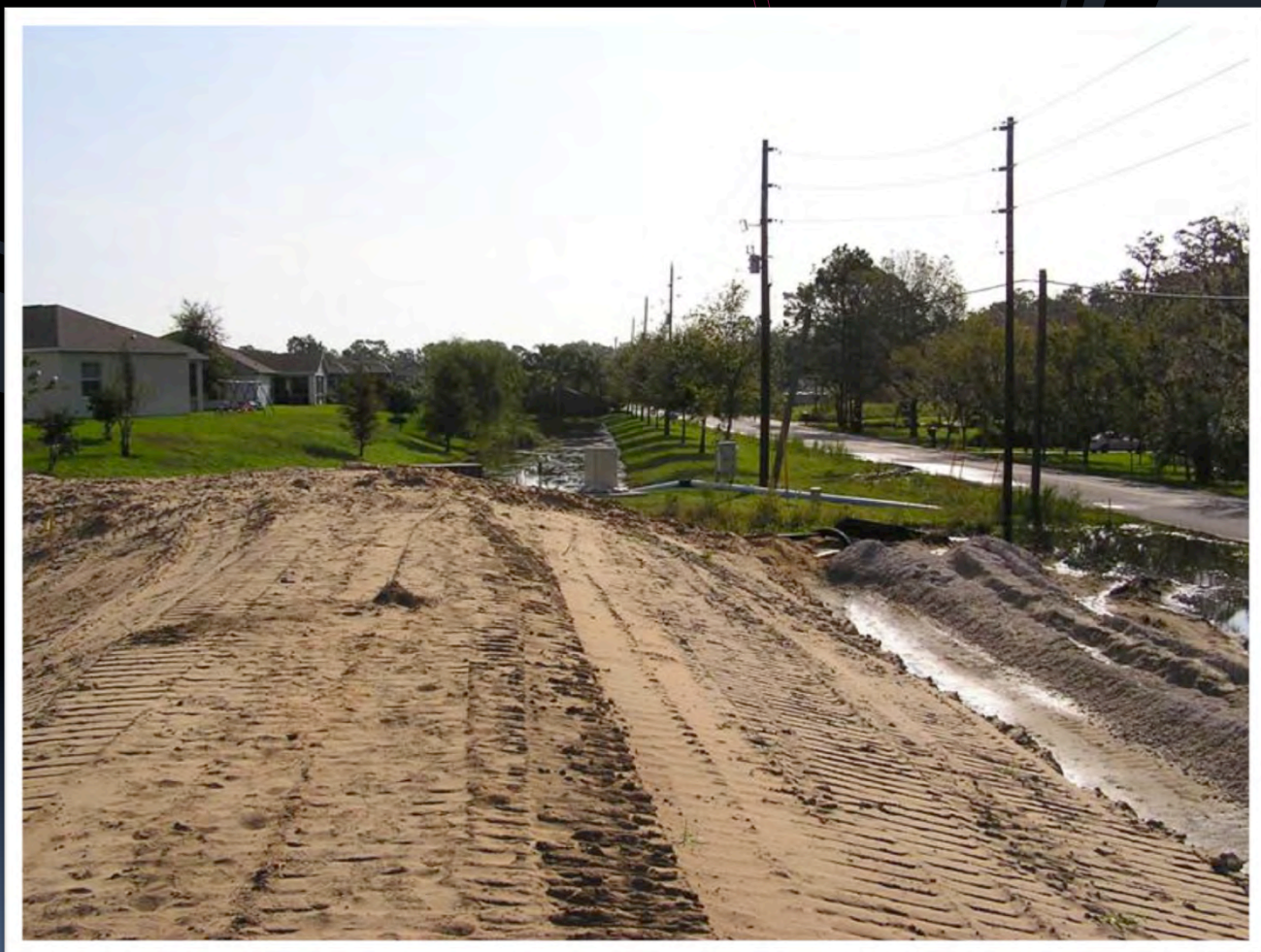


Photo date: 2004

# The Overlook at Lake Louisa



Photo date: 2004

# The Overlook at Lake Louisa



Photo date: 2004

## Topic 3.3

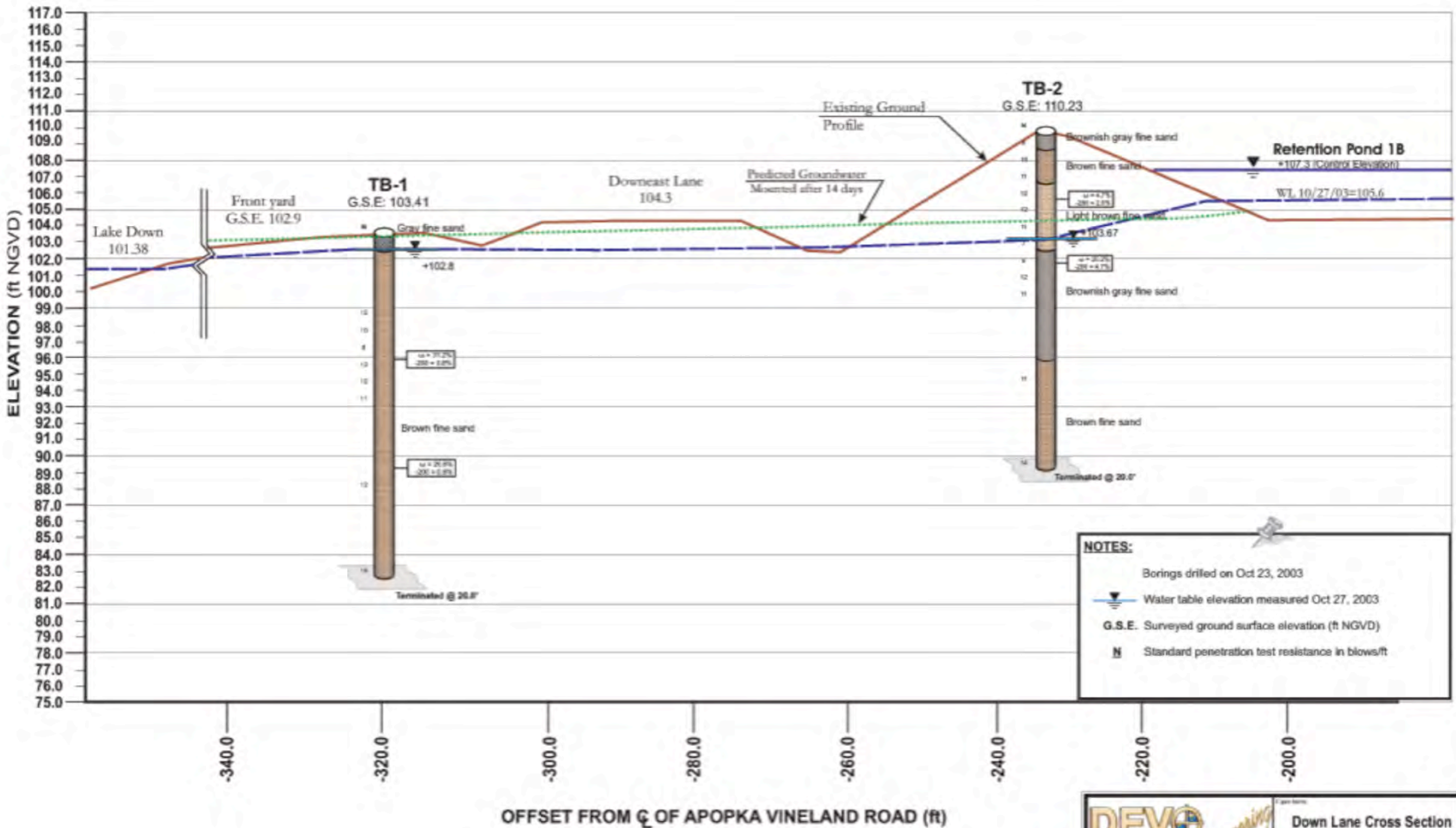
# Water Table Mounding from Ponds Affecting Roads & Offsite Property

# Downeast Lane





# Downeast Lane



**NOTES:**

- Borings drilled on Oct 23, 2003
- Water table elevation measured Oct 27, 2003
- G.S.E. Surveyed ground surface elevation (ft NGVD)
- N Standard penetration test resistance in blows/ft

	<b>Down Lane Cross Section (D-D') @ Sta. 9+20</b>	
	<b>DOWNEAST LANE</b>	
<small>DEVO ENGINEERING CONSULTING GEOTECHNICAL ENGINEERS 1625 W. US HWY 1, SUITE 200 MARIETTA, GA 30067 770-428-0800</small>	<small>PROJECT NO. 16-27-03</small>	<small>DATE NOTED 03-410-04</small>
<small>Figure 3.1</small>		

# Downeast Lane



Photo date: 2004

# Downeast Lane



Photo date: 2004

# Downeast Lane



Photo date: 2004

## Topic 3.4

# Pipe Joint Opening Due to Muck Subgrade

# Pipe joint opening due to muck subgrade



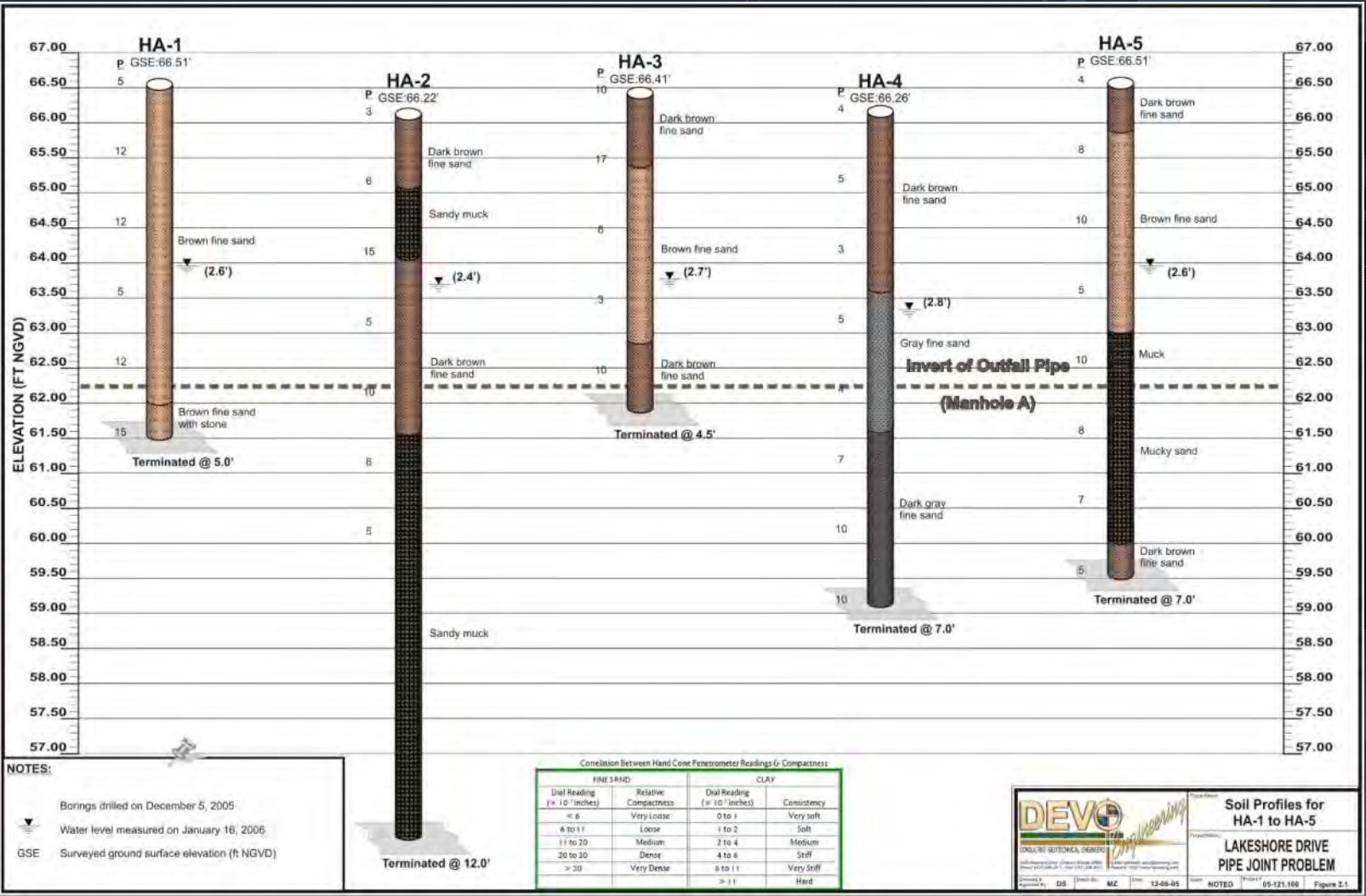
Loss of soil & settlement distress at pipe crossing

# Pipe joint opening due to muck subgrade



Pavement reinstated after settlement

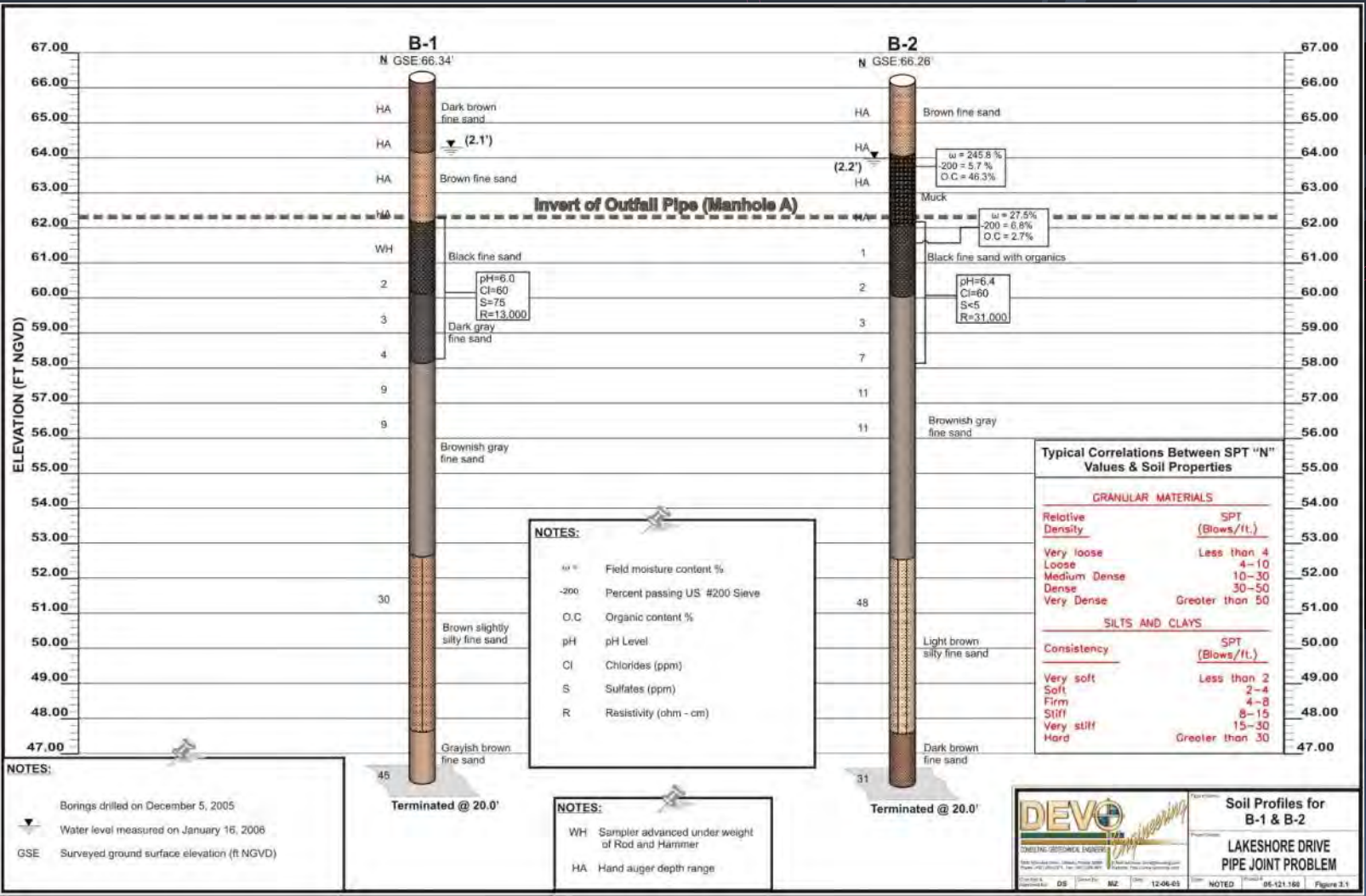
# Pipe joint opening due to muck subgrade



Pipe joints separated due to differential settlement



# Pipe joint opening due to muck subgrade



Pipe invert on muck

## Topic 4.1

# Relic Horizontal Sock Drain Causing “Inexplicable Spring”

# Tully Wood Court



Upward Seepage Beneath Pavement

# Tully Wood Court



Field Investigation and Excavation

# Tully Wood Court



Relic Sock Drain

## Topic 4.2

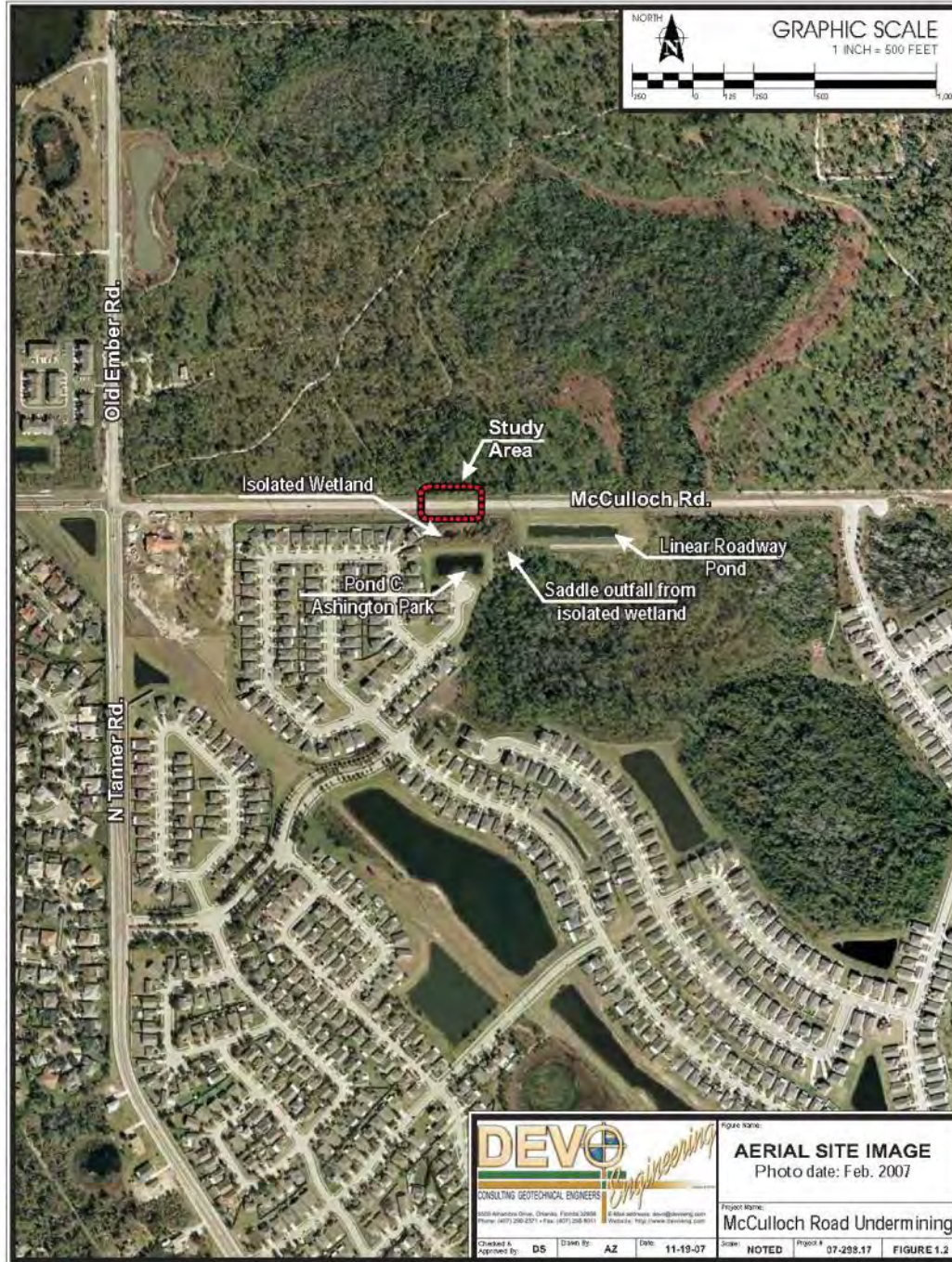
# Strong Seepage Across Road Causing Subgrade Movement Due to Barrier Caused by Large Diameter Pipe

# McCulloch Rd Undermining

Project Location

## FACERS

Florida Association of County Engineers & Road Superintendents



# McCulloch Rd Undermining



Project Location



# McCulloch Rd Undermining

Project Location



# McCulloch Rd Undermining



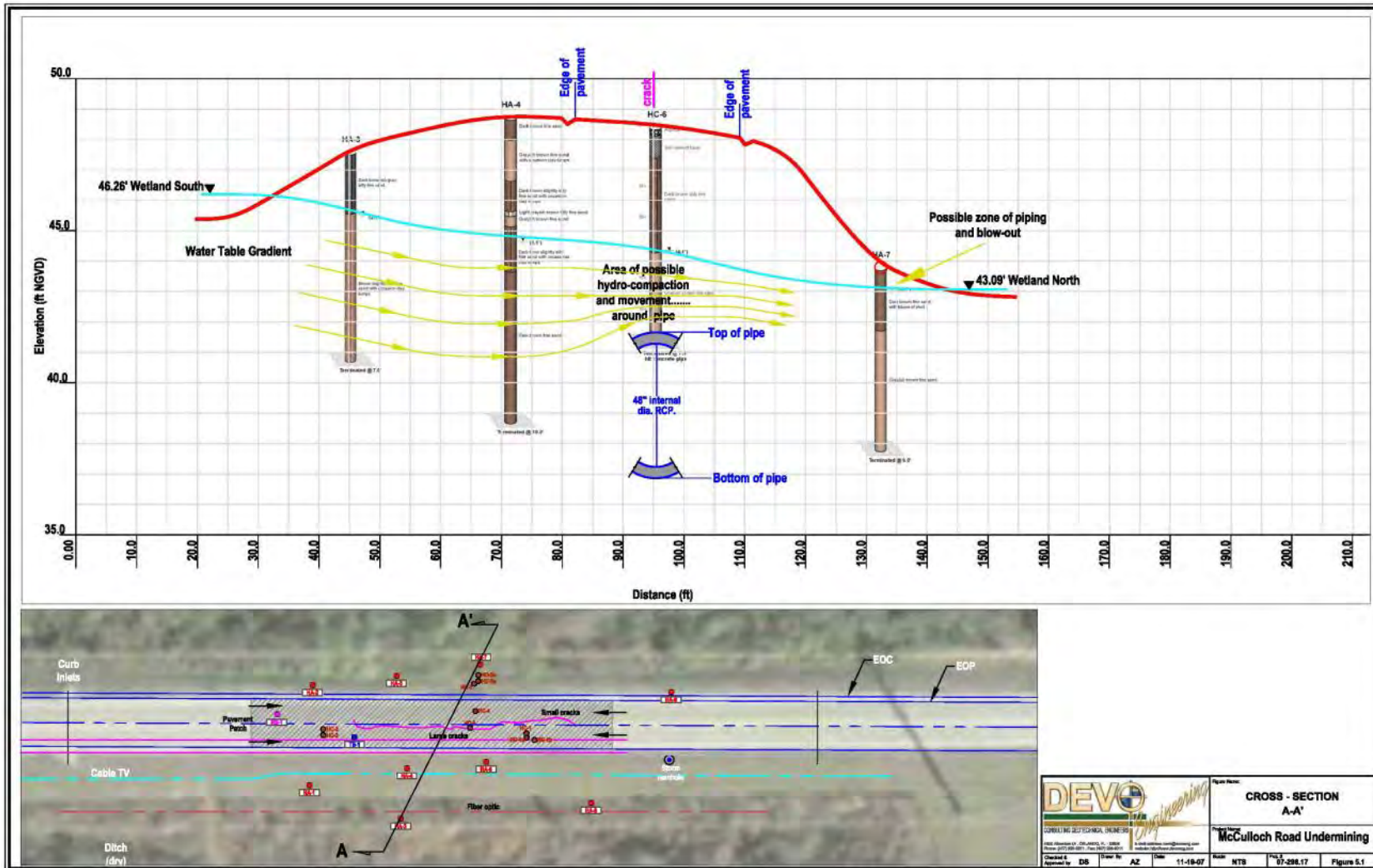
Photos of Distress

# McCulloch Rd Undermining



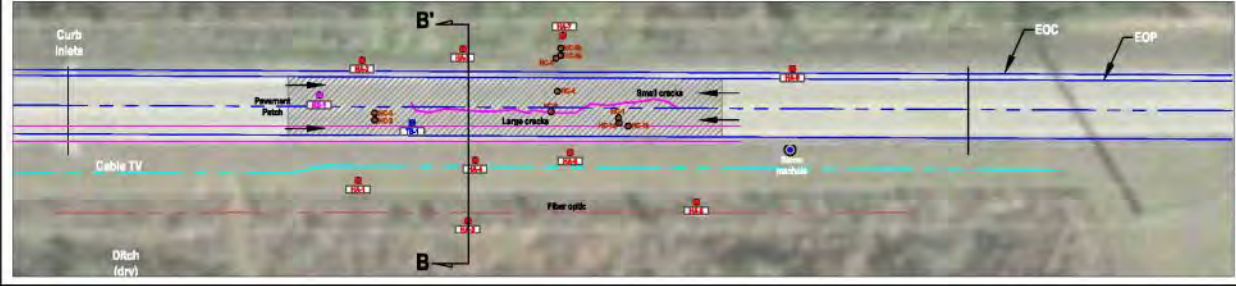
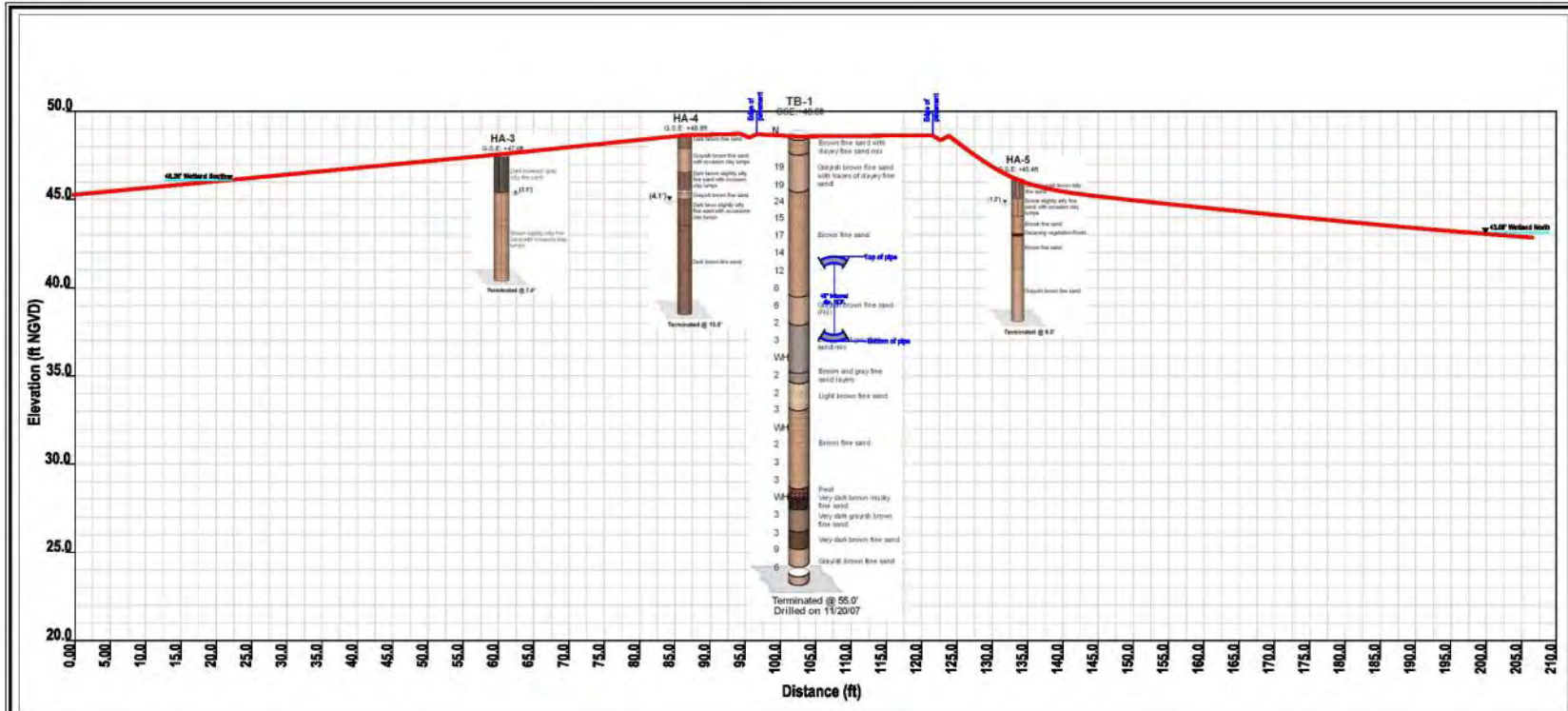
Photos of Distress

# McCulloch Rd Undermining



Subsurface Mechanism

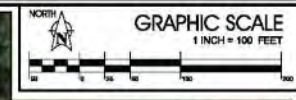
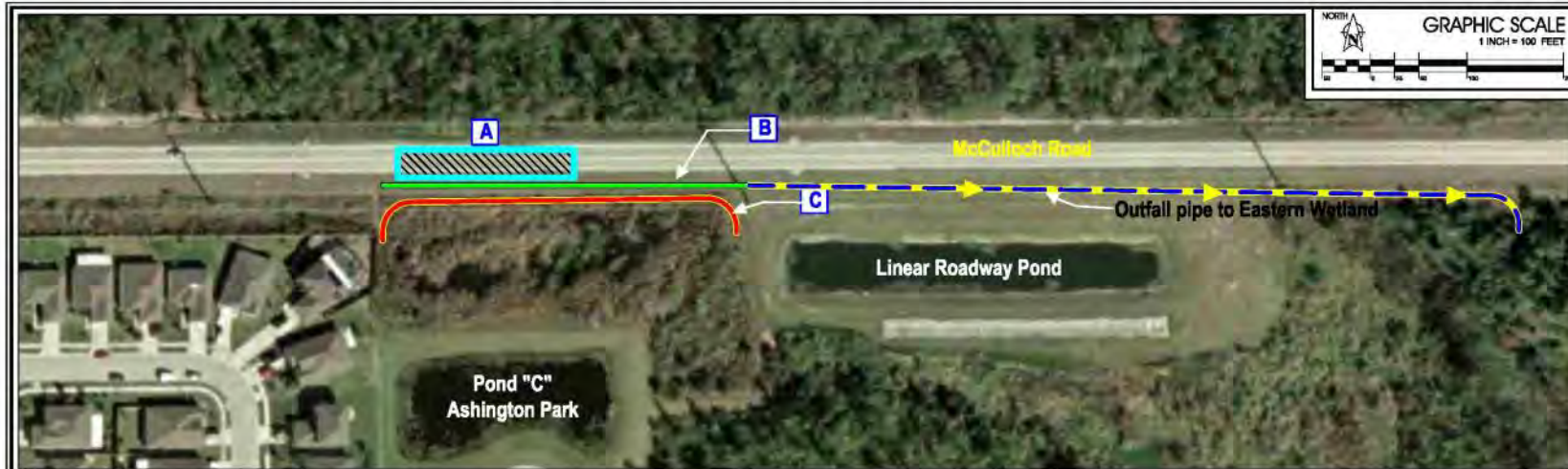
# McCulloch Rd Undermining



<p>DEVO Engineering CONSULTING GEOTECHNICAL ENGINEERS</p>	<p>Figure Name: <b>CROSS-SECTION B-B'</b></p>
	<p>Project: <b>McCulloch Road Undermining</b></p>
<p>Drawn By: <b>DB</b></p>	<p>Scale: <b>1" = 10'-0"</b></p>
<p>Checked By: <b>AZ</b></p>	<p>Date: <b>11-19-07</b></p>
<p>Approved By: <b>DB</b></p>	<p>Sheet: <b>NTB</b></p>
<p>Project No: <b>07-298-17</b></p>	<p>Figure No: <b>5.2</b></p>

Subsurface Mechanism

# McCulloch Rd Undermining



The conceptual repair plan for the pavement distress is presented in Figure 6.1 and its principal elements are described below.

**Pavement Repair [A]**

Reconstruct the pavement to a depth of 3 ft, incorporating a layer of uniaxial geogrid like Tenaxar UX-1400 or equivalent within the subgrade as shown in Figure 6.1.

The specific recommended steps are as follows:

1. Set up MOT plans
2. Excavate and dispose the asphaltic surface course, soil cement base course and the curb and gutter in the area shown on the plans and drawings
3. Excavate and stockpile the underlying embankment fill material to depth of 3ft below finish road surface.
4. Scarify, grade shape and compact the resulting surface to a minimum modified proctor density of 90% in accordance with AASHTO T-180.
5. Carefully apply compaction grout to the area of the pipe zone.(refer to the following section for specific application procedure)
6. Install a layer of UX-1500 Uniaxial geogrid to the prepared surface ensuring that the central lap is in accordance with the manufacturer's specifications and the outer edges extend to a minimum of 3ft beyond the concrete gutter.
7. Return the stockpiled fill and install in maximum layers of 8inches and compact to a minimum modified proctor density of 96% to design grades and falls
8. Install first layer of 1/2inches base and Construct Miami curb and gutters to the design grades and crossfalls.
9. Install the second layer (for a total thickness of 8inches) of 1/2inches base and 2inches of Type III asphaltic surface course to finish grades and crossfalls
10. Grade, prepare and sod all exposed areas.

**Soil Stabilization/Compaction Around Pipe Trench [A.5]**

There are very loose backfill soils in the general area of the pipe zone beneath the pavement. Invasive repairs by way of open excavation would be very time consuming, impractical to maintain traffic along the roadway and would require construction dewatering.

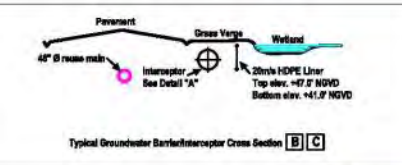
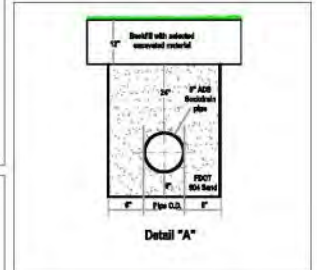
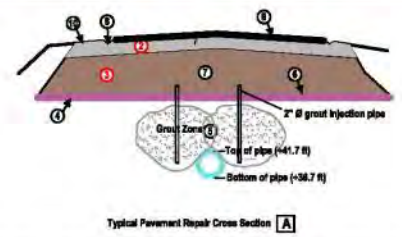
We recommend that the pipe zone be compaction grouted beneath the depth of pavement reconstruction. The injection pipes should be installed to a depth of 8ft below the reduced roadway level along both sides of the reuse main at 10 ft intervals and a cementitious grout should then be applied with a maximum pressure of 25psi. Adequate care should be exercised to ensure that the pressure distribution is properly balanced along both sides of the reuse pipe to avoid displacing it. The embankment should be properly monitored for uplift and the injection pipes withdrawn while pumping as necessary.

**Groundwater Interceptor [B]**

Install an interceptor trench to cutoff ground water flow from the southern isolated wetland towards the north across the roadway embankment. It is necessary to take the outfall pipe to the wetland crossing to the east of the County's pond to create a positive outfall.

**Groundwater Barrier [C]**

Install a 6 ft tall vertical HPDE liner or equivalent around the northern limit of the southern isolated wetland to a depth of +41 ft NGVD to prevent dehydration impacts to this wetland.



	Project Name: <b>RETROFIT PLAN</b>
	Project Title: <b>McCulloch Road Undermining</b>
Date: 02-11-07	Scale: Noted
Author: DB	Check: AZ
Date: 07-2006-17	Figure: 6.1

## Retrofit Plan

# Photos of Fix



Grout injection on April 24, 2008

# Photos of Fix



Another grout injection on April 24, 2008



# Photos of Fix



Laying geogrid

# Photos of Fix



Backfilled Road

# Photos of Fix



Final Product

## Topic 4.3

# Perched Water Table Due to Low Permeability Fill

# Site in Windermere



Photo date: 2005

# Site in Windermere



Photo date: 2005

# Site in Windermere



Photo date: 2005

## Topic 5.1

# Sinkholes on roadways



# Fox Lake Drive



Fox Lake Drive

# Fox Lake Drive



Fox Lake Drive

# Fox Lake Drive



Cable concrete being placed into position (Sep 23)

# Fox Lake Drive



Panel being positioned by county staff (Sep 23)

# Fox Lake Drive



Another panel being placed (Sep 23)

# Fox Lake Drive



Cable concrete being guided into position (Sep 23)

# Pine Hills Road and North Lane



Pine Hills Road and North Lane

# Swann Avenue



Swann Avenue



# Swann Avenue



Swann Avenue

## Topic 5.2

# Sinkholes in ponds

# Failure of clay liner in wet pond - FSU Regional Stormwater Pond



RSF sinkhole 1

# Failure of clay liner in wet pond - FSU Regional Stormwater Pond



RSF sinkhole 1

# Failure of clay liner in wet pond - FSU Regional Stormwater Pond



RSF sinkhole 1

# Sinkholes in ponds - Spring Vista Drive in Debarry



North Pond

# Sinkholes in ponds - Spring Vista Drive in Debarry



North Pond

## Topic 6.1

# Soil-loss in Manholes



# Loss of soil around manholes - Lakeview Preserve



Sand flowing into leaking manhole leading to loss of soil and "sinkhole"

# Loss of soil around manholes - Lakeview Preserve



Close-up view of "sinkhole"

# Loss of soil around manholes - Lakeview Preserve



Close-up view of "sinkhole"

## Topic 6.2

# Dumping loose fill around the sediment removal structure & hydroconsolidation of loosely placed sand backfill

# View of settlement around buried structure



# Settlement of Loose Sand Backfill Around Sediment Removal Structure



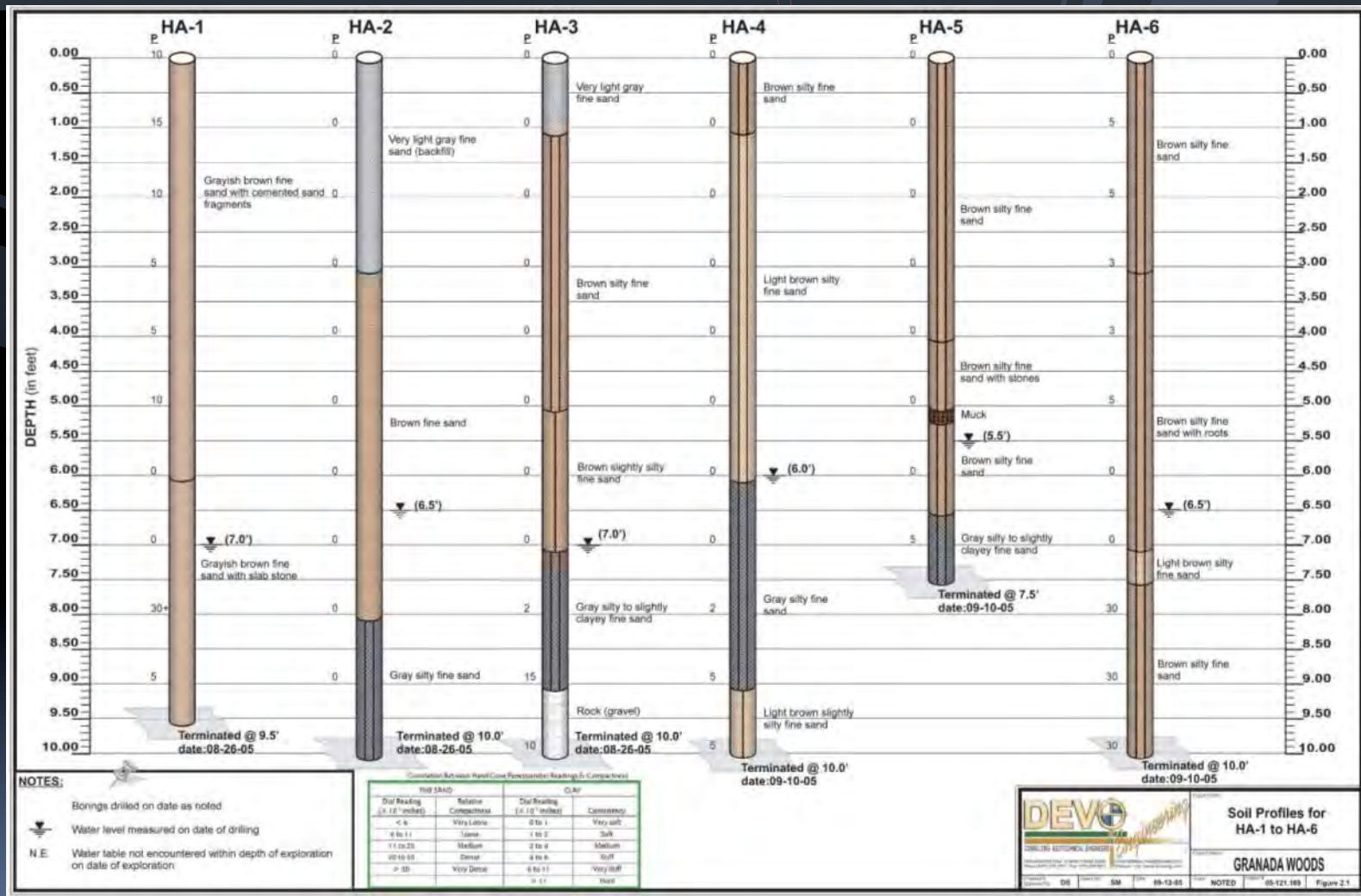
Installed structure in landscape strip

# Settlement of Loose Sand Backfill Around Sediment Removal Structure



Settlement of soil around structure

# Settlement of Loose Sand Backfill Around Sediment Removal Structure



Soil stratigraphy and compactness around structure



# Settlement of Loose Sand Backfill Around Sediment Removal Structure



Photos of installation

# Settlement of Loose Sand Backfill Around Sediment Removal Structure

Photos of installation

