HYDROGEOLOGIC CHARACTERIZATION OF FIELDS USED FOR LAND APPLICATION OF RESIDUALS

Presented by Rick Bolich
NCDENR – Division of Water Quality Aquifer Protection Section

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DWQ "To preserve, protect and enhance North Carolina's water..."

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Overview

- Site Description
- Results of Characterization Studies
  - Surface Geophysics
  - Well Installations
  - Water Quality Analyses
- Conclusions Showing Importance of Detailed Hydrogeologic Site Characterization.

Plant
N
Land Application Fields
Neuse River
0 125 250 500 750 1,000 1,250
Meters

Site Background

- Located in Central North Carolina in the Piedmont Physiographic Province
- >1,000 Acres Used for Land Application of Biosolids
- Over-Application of Biosolids Resulted in Extensive Nitrate Contamination of Groundwater
- Groundwater is Discharging Into the Neuse River – which is “Nutrient Sensitive”

Site Background

- Proposed Corrective Action is to Get Variance from NC Rules That Prohibit the Use of Natural Attenuation as Corrective Action at Permitted Facilities.
- Conditional Acceptance of Variance by DWQ if NO3 Flux from Groundwater is Offset by NPDES NO3 Allowance.
- Therefore, Important to Have Reliable Estimate of Actual NO3 Flux into River by Baseflow.

Site Background

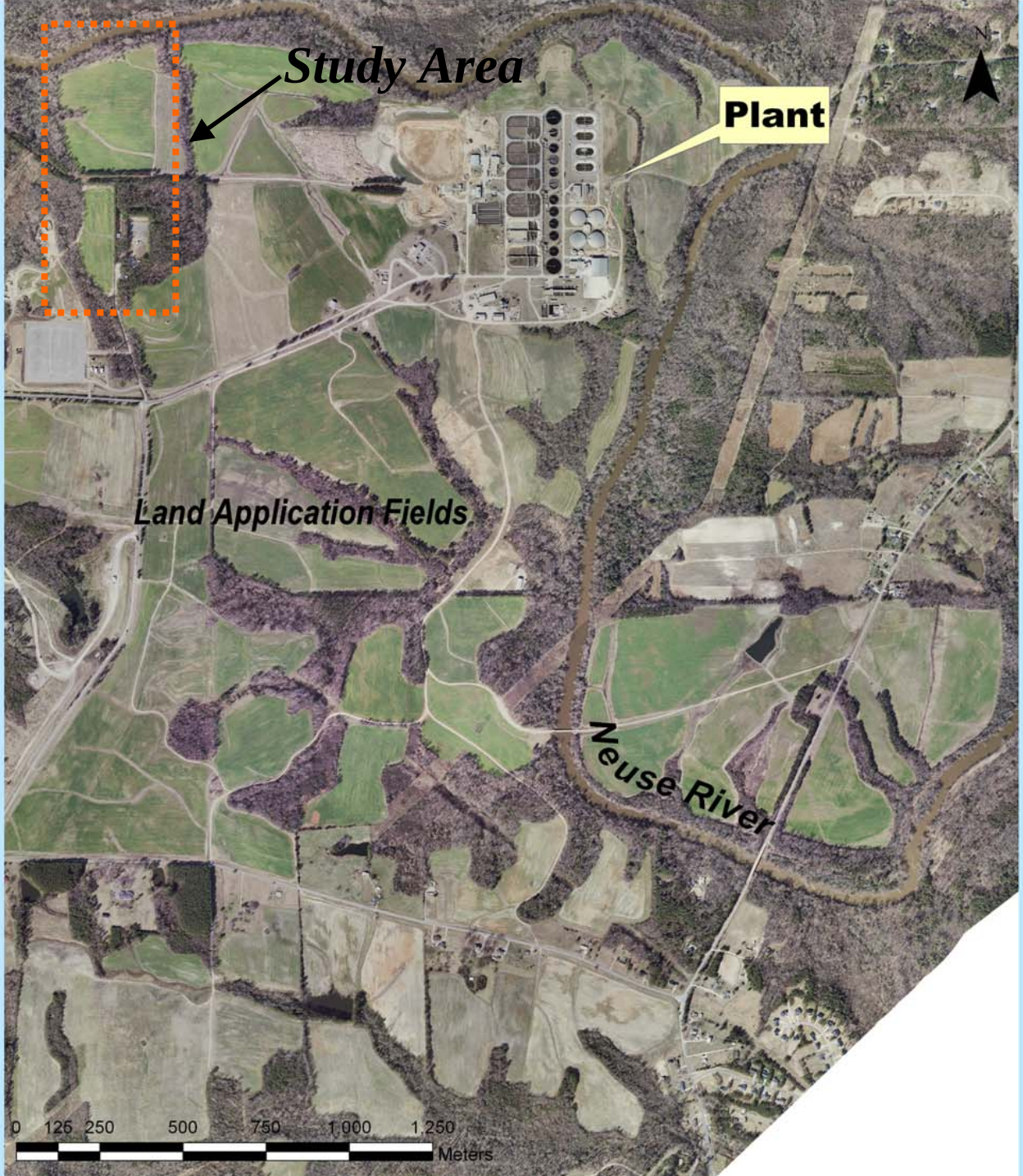
- Accurate Hydrogeologic Site Characterization is Critical to Obtain a Reliable Estimate of Nitrate Flux Into River

Hydrogeologic Conditions

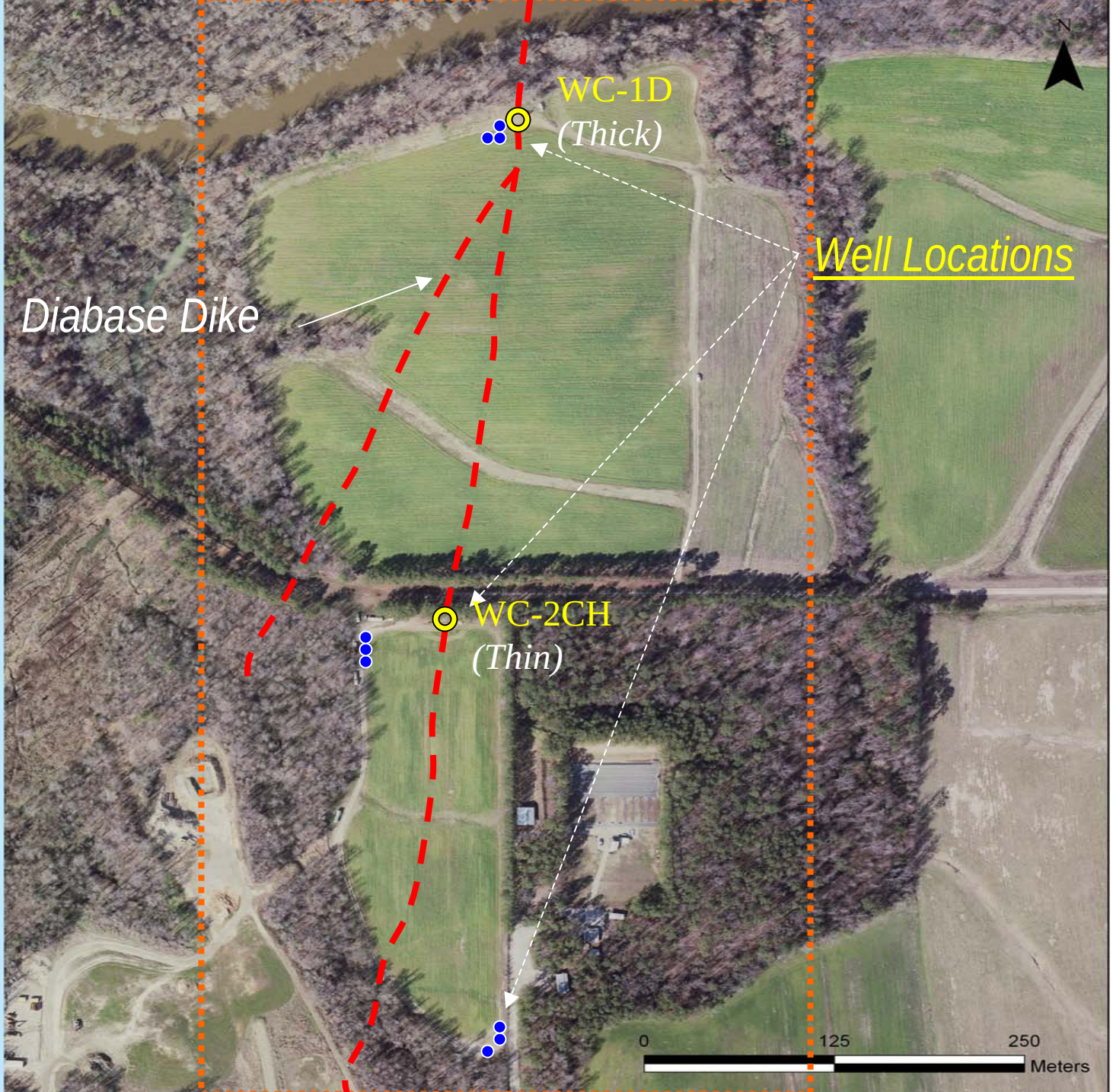
- Bedrock is a biotite granite batholith (Rolesville Batholith)
- Overburden is saprolite and alluvium
- Average depth to water table = ~25 feet
- Depth to bedrock ~ 45 feet
- Granite has been intruded by diabase dikes

Diabase Dikes

- Identified by Outcrops and Ground Magnetometer Surveys
- Nearly Vertical Dip Angle
- Drilled into one part of dike (thick) and cored through another (thin).
- “Thick dike est. 200’ thick, “thin” dike est. 5-10’ thick.



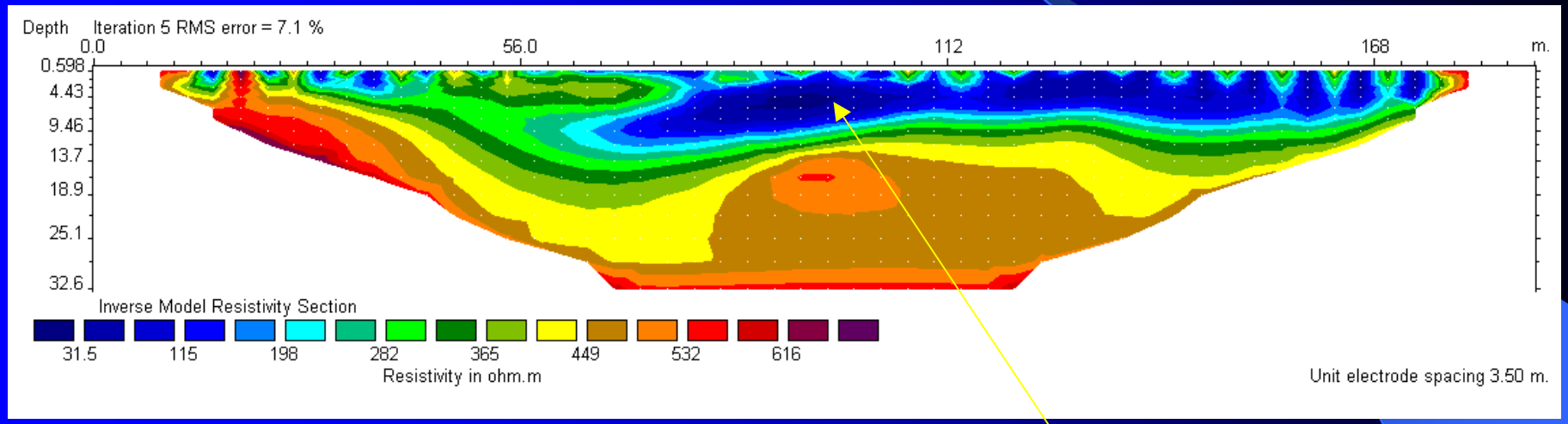
Wastewater Treatment Plant Site Map


N
WC-1D
(Thick)
Well Locations
Diabase Dike
WC-2CH
(Thin)
0
125
250
Meters

Granite Saprolite

Diabase Saprolite

Land Resistivity Surveys



Contaminated Ground Water

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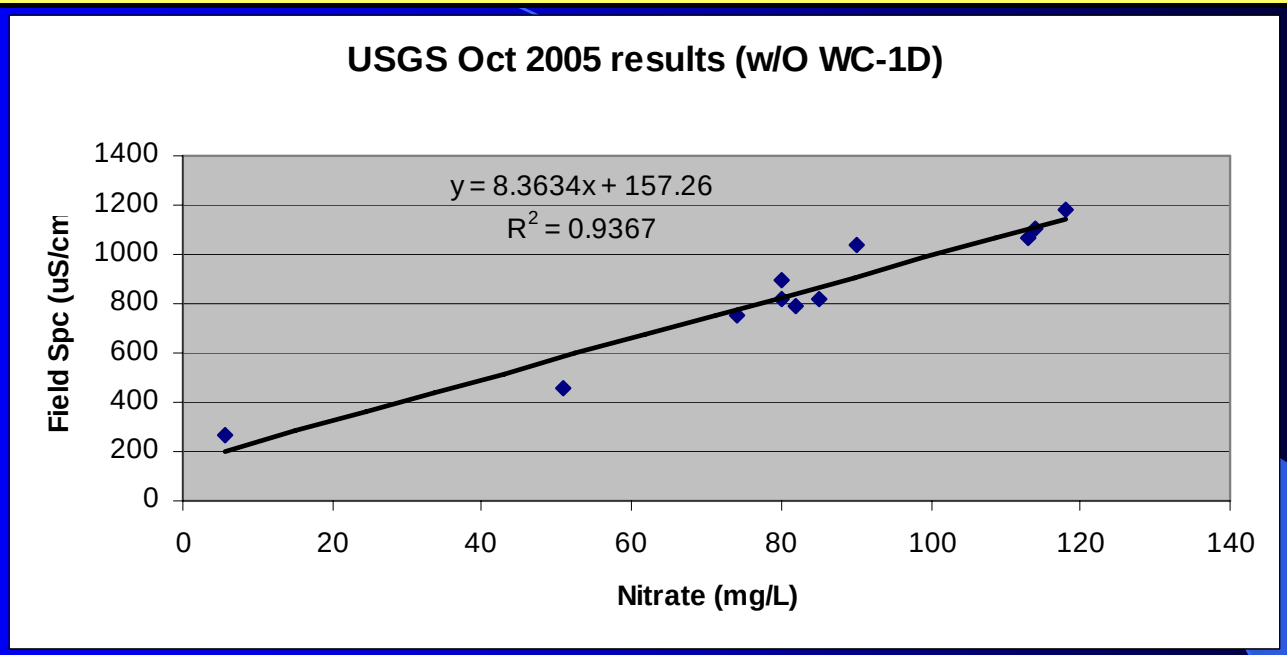
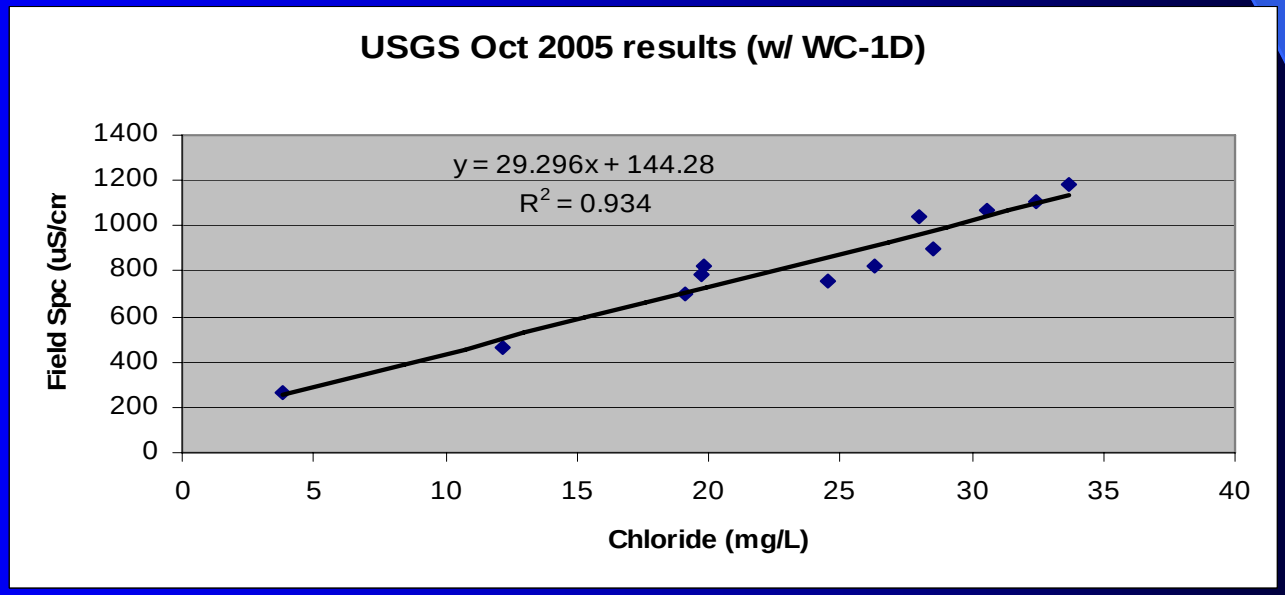
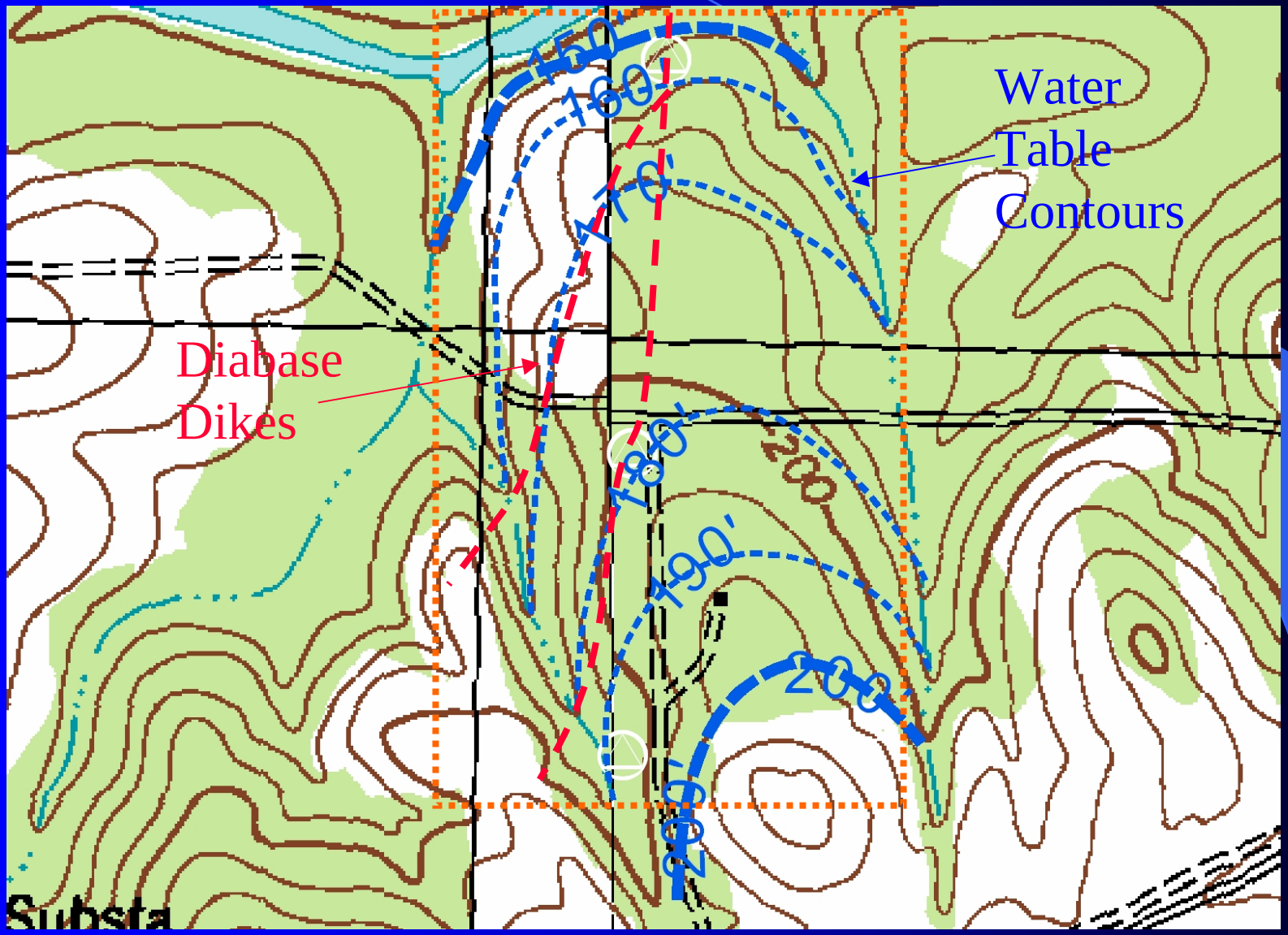
Specific Conductance vs NO3 & Cl

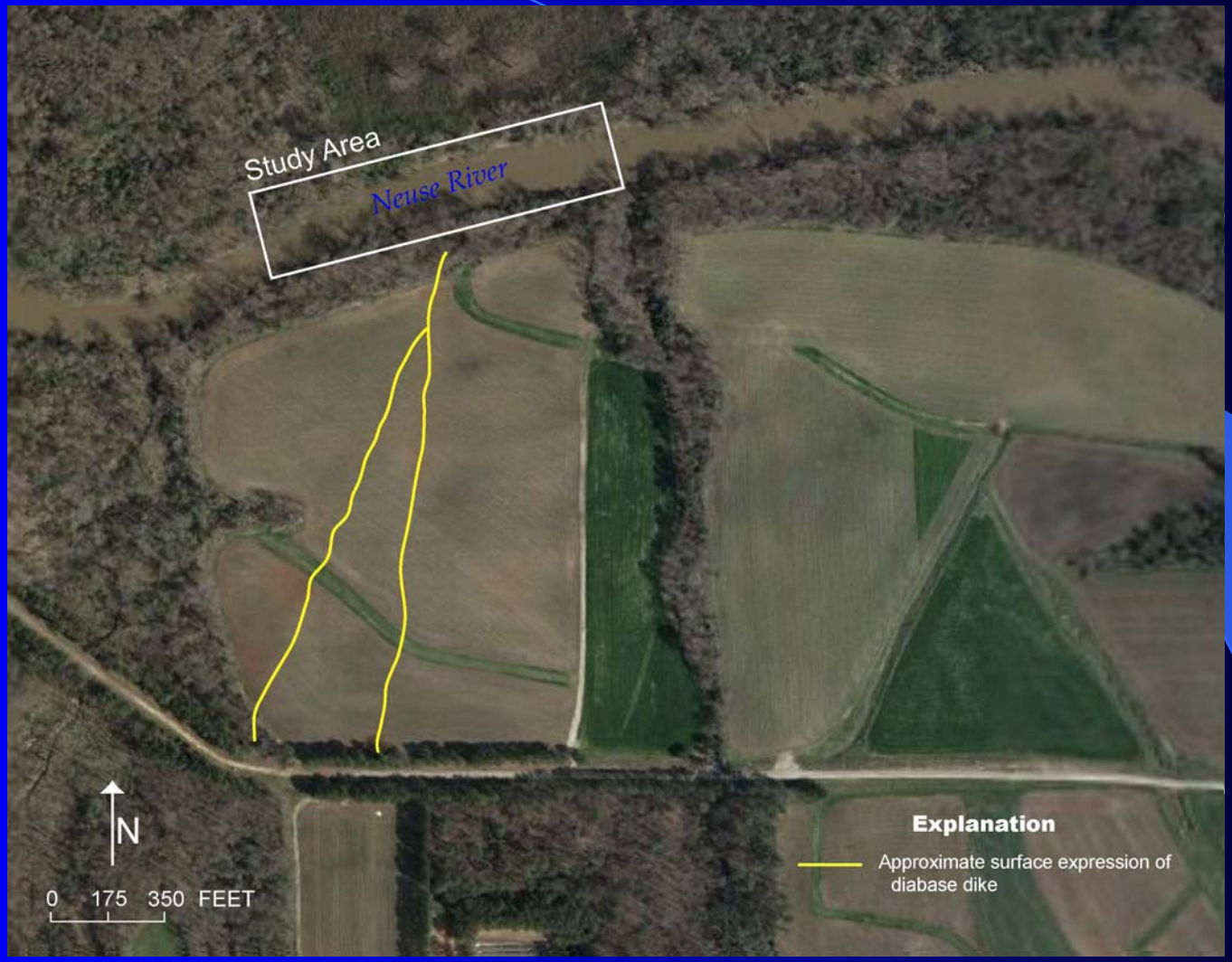




Site Topo & Water Table Map



River Surveys Location



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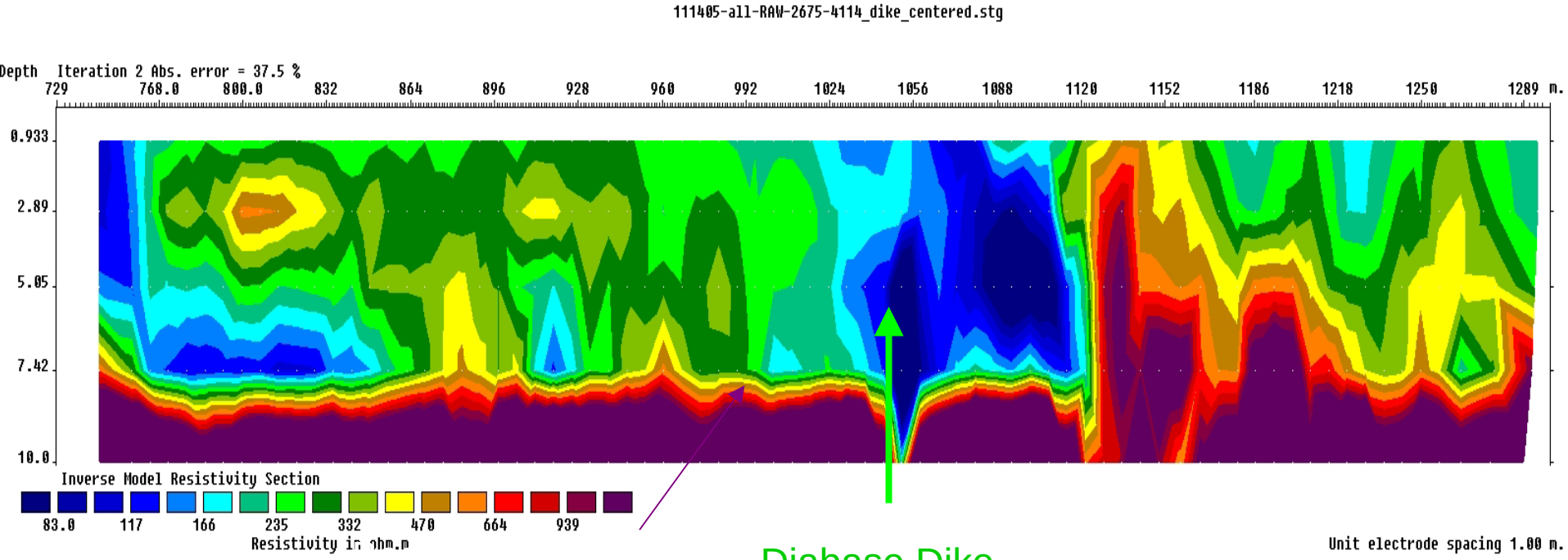
Continuous Resistivity Profiling – Neuse River



Bedrock surface

Diabase Dike

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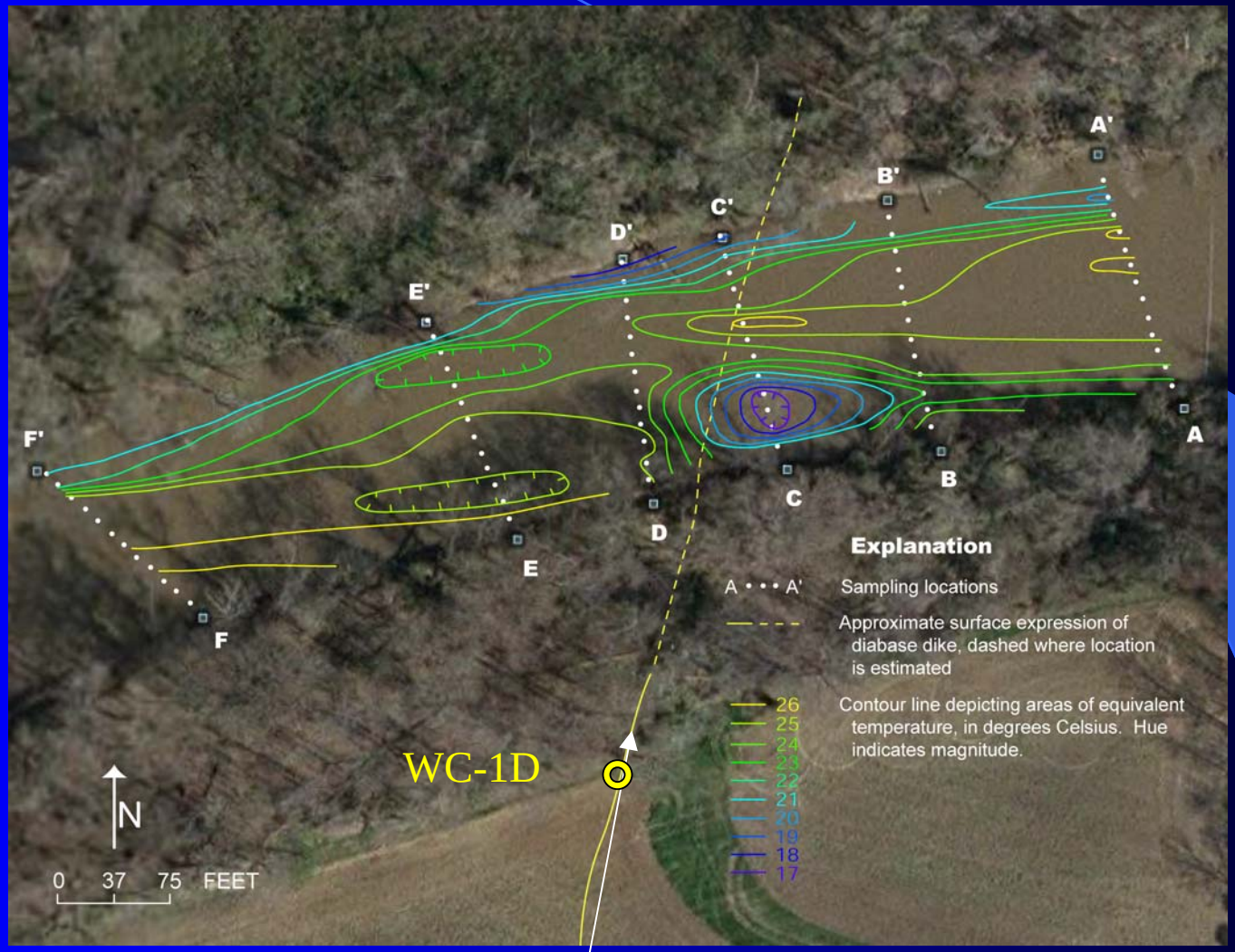
Temperature at 2.5 ft below river bed



Diabase Dike Trace

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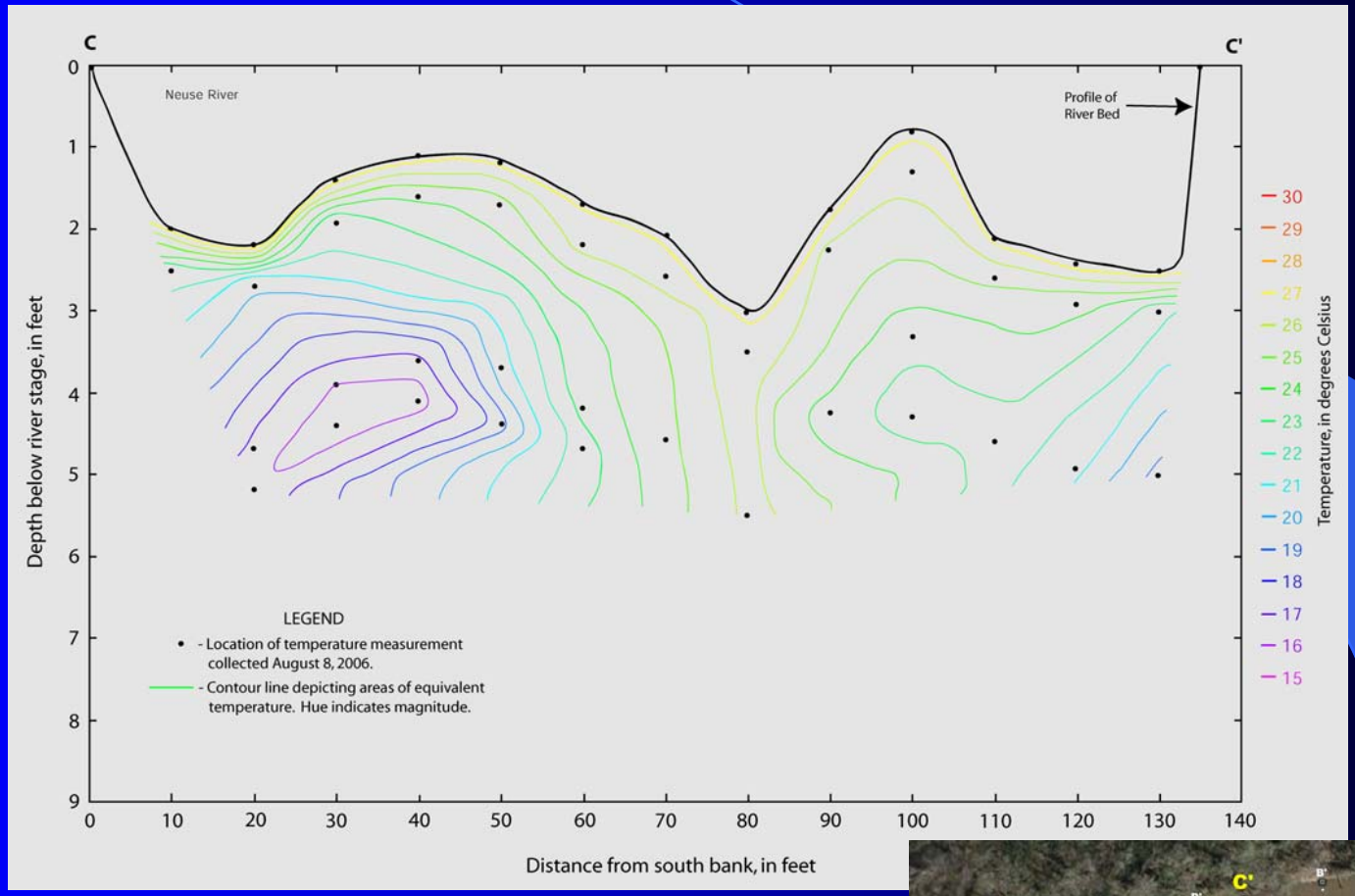
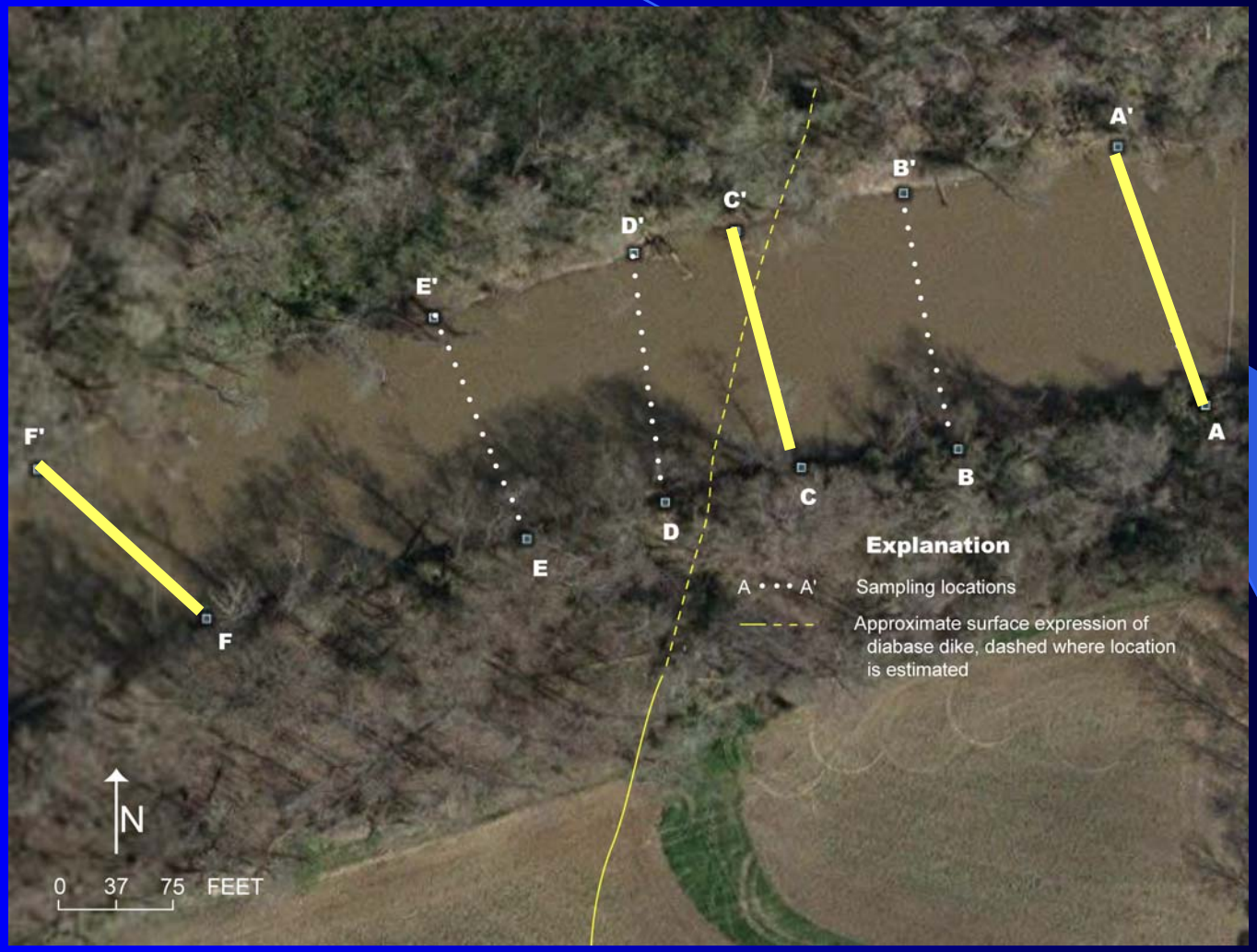
Ground Water Temperatures at Section C-C’



Ground-Water Sampling Locations



Drivepoint Sampling

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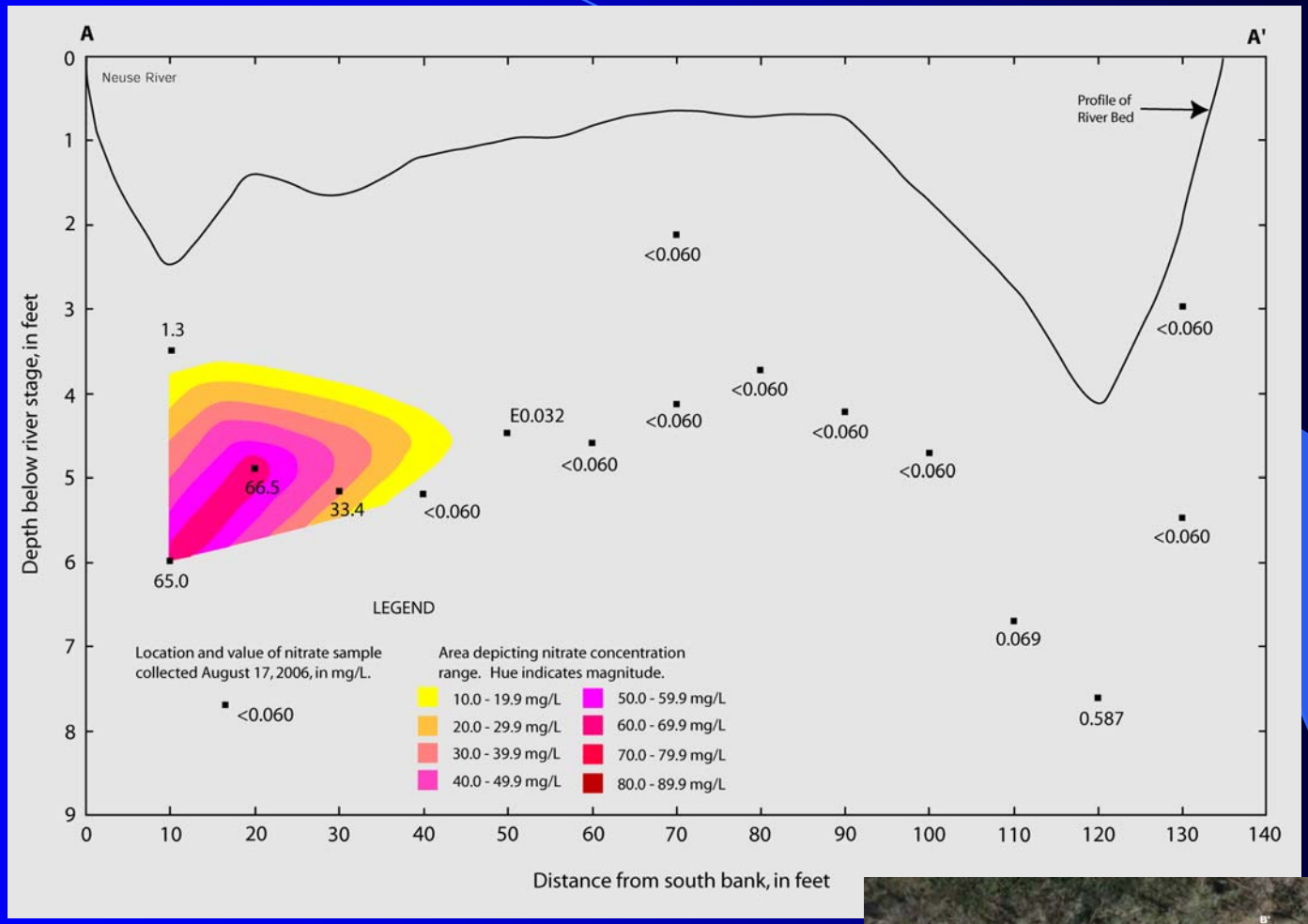
Nitrate Concentrations in Ground Water at Section A-A’



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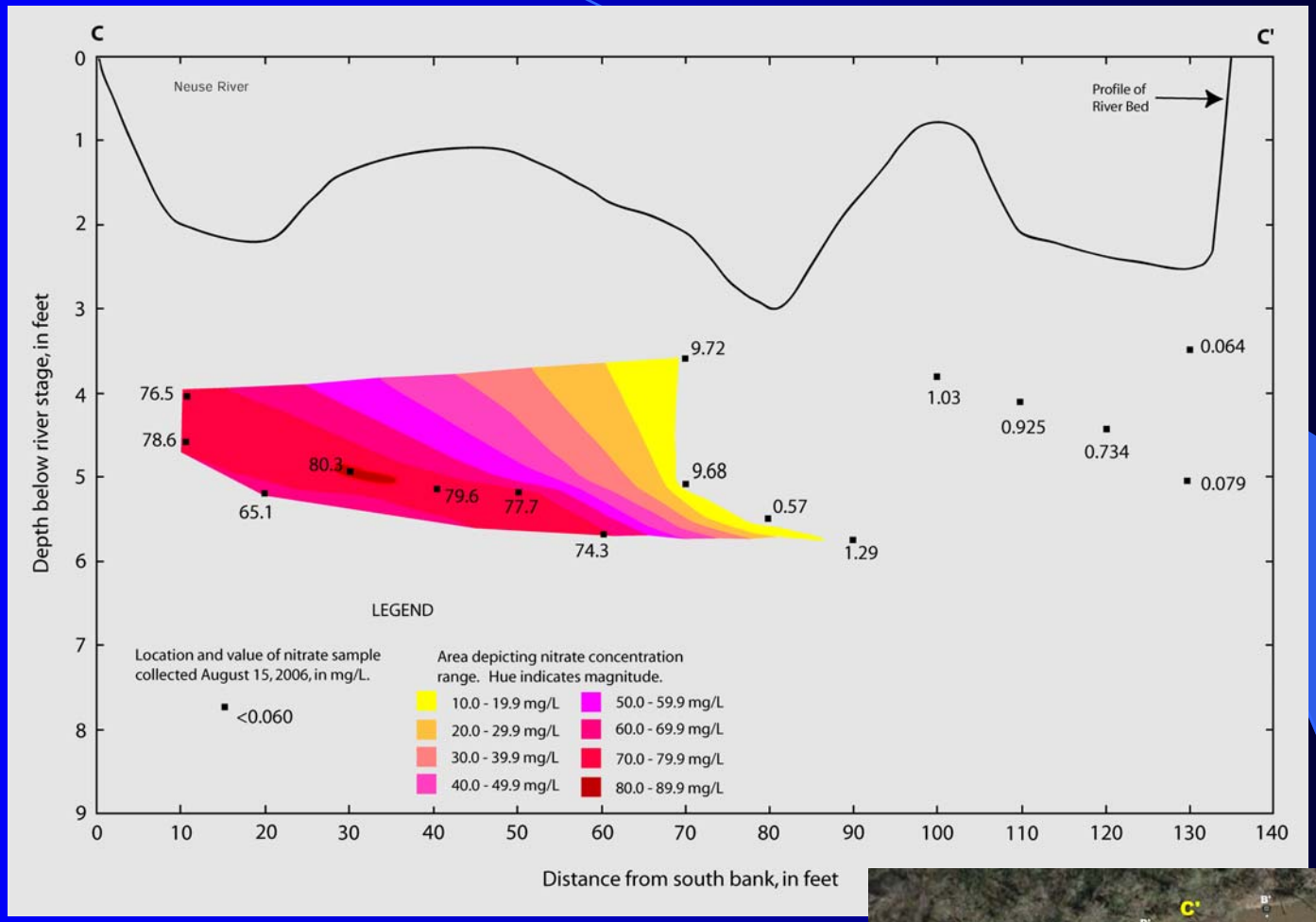
Nitrate Concentrations in Ground Water at Section C-C’



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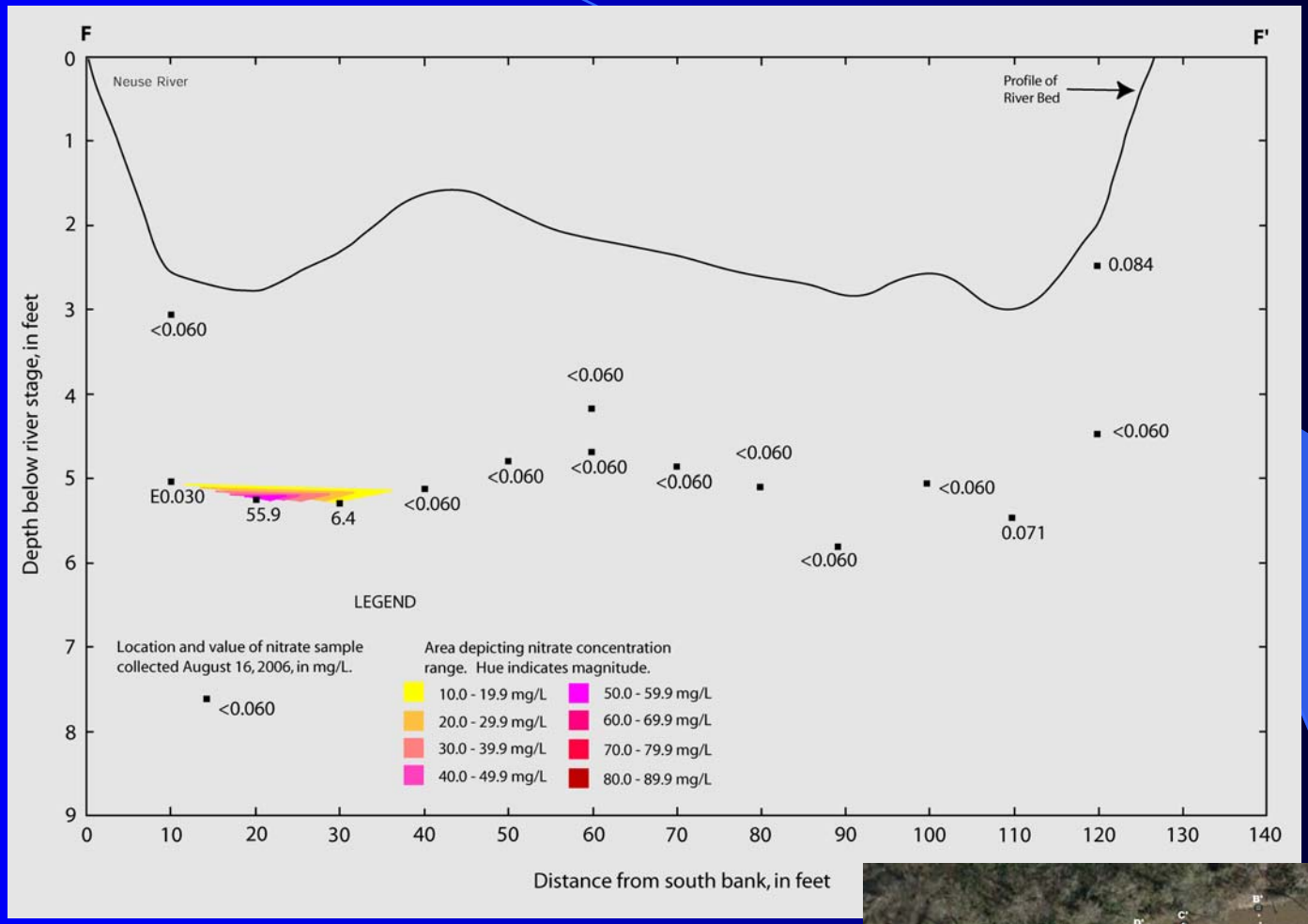
Nitrate Concentrations in Ground Water at Section F-F’



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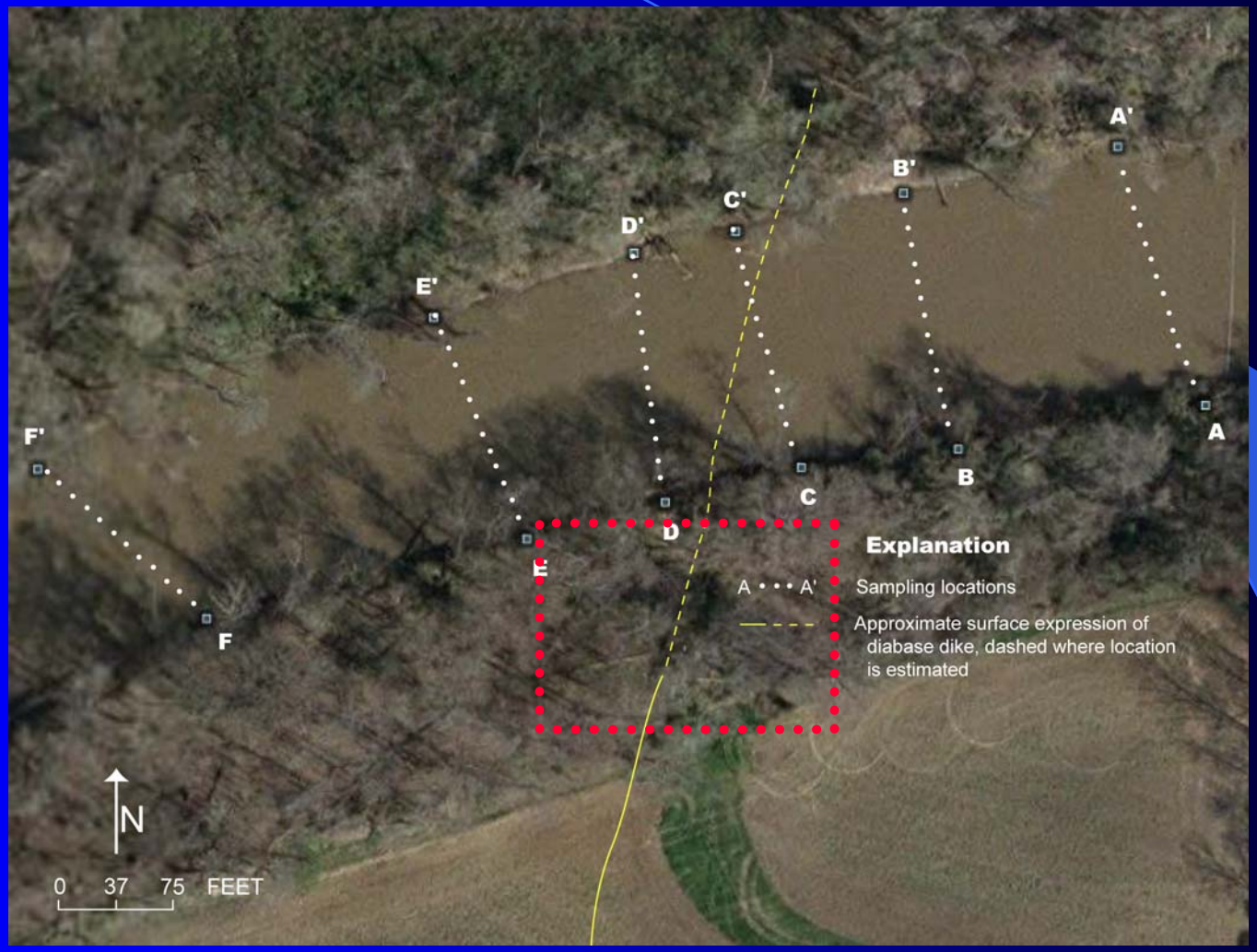
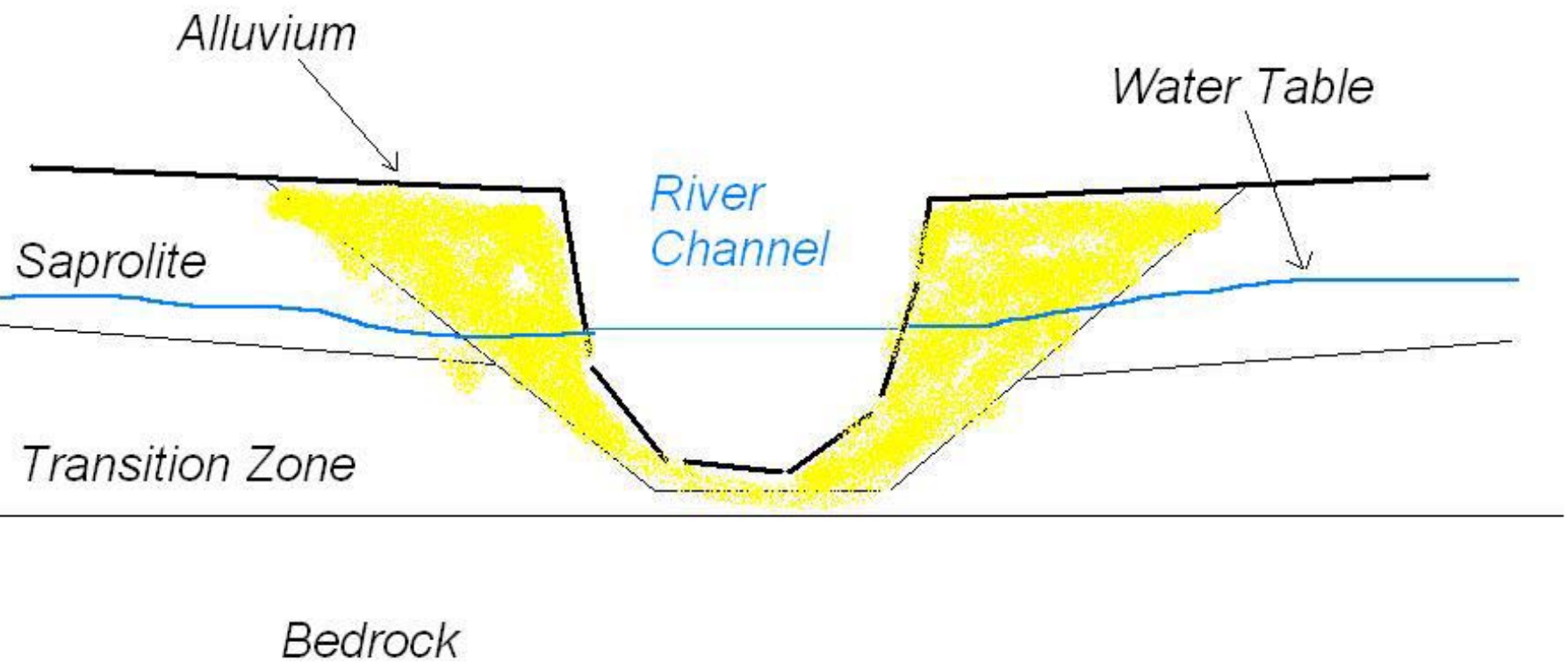
NCSU Riparian Well Locations




Alluvium
Water Table
River
Channel
Saprolite
Transition Zone
Bedrock

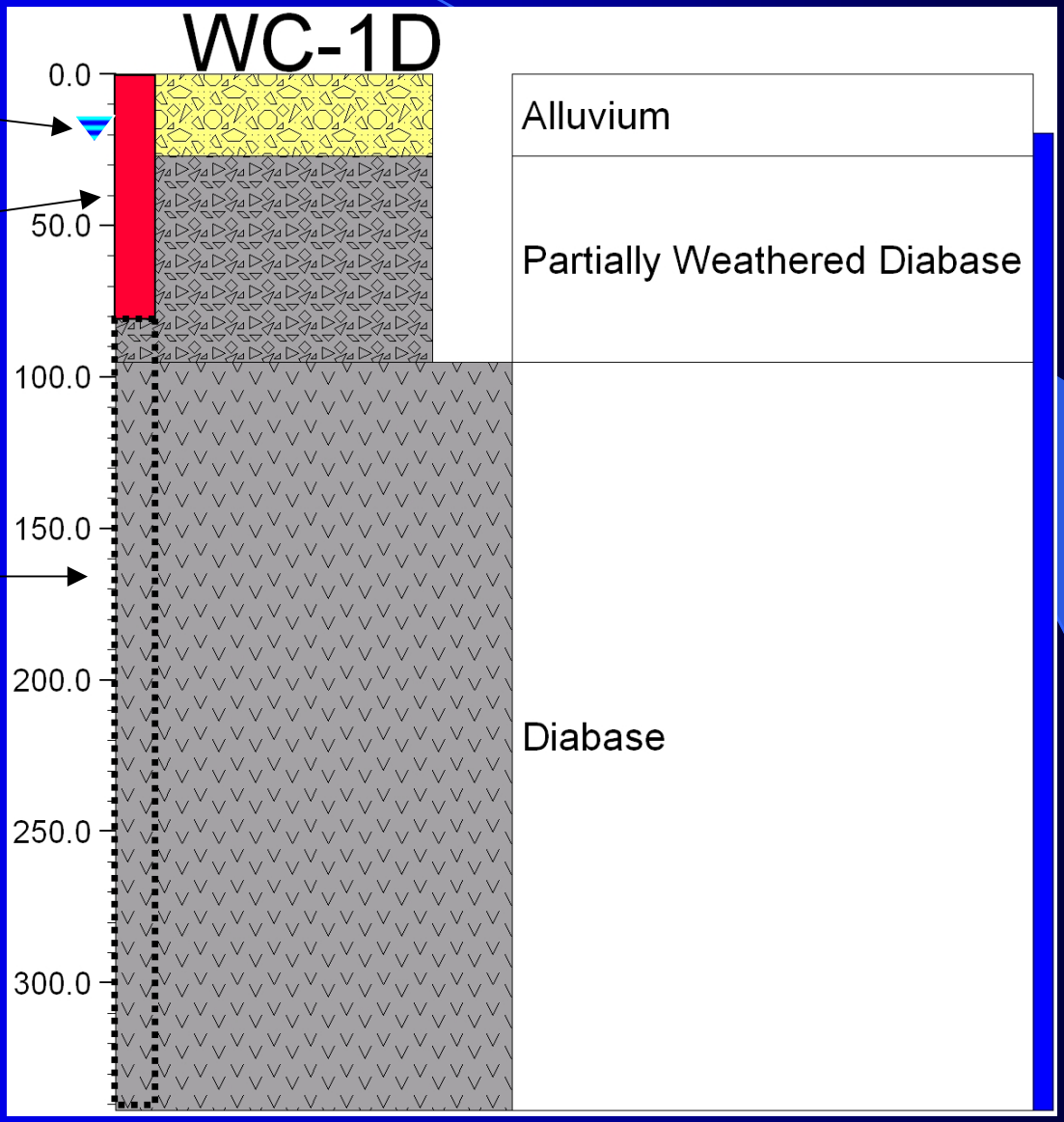
Diabase Dike in Quarry

Diabase Well Stratigraphic Log

Water Level

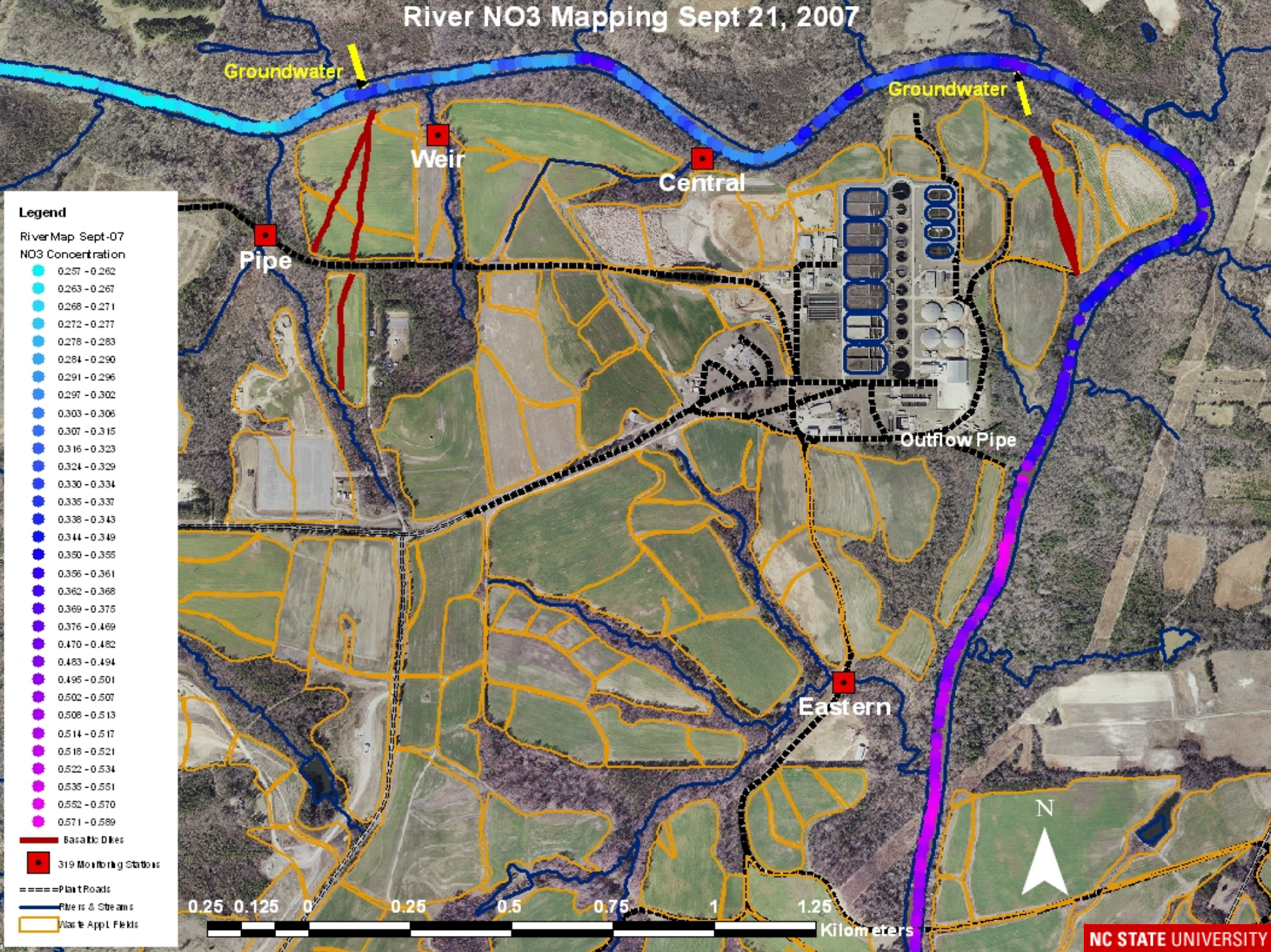
Casing

Open Hole



Video from Diabase Well

Well Diameter = 6 in.
Bottom of Casing = 82 ft.
Static Water Level = 23 ft.
Water Level in Video = 278 ft.
Fractures = TNTC


River NO3 Mapping Sept 21, 2007
Groundwater
Groundwater
Weir
Central
Pipe
Outflow Pipe
Eastern
Legend
River Map Sept-07
NO3 Concentration
0.257 - 0.262
0.263 - 0.267
0.268 - 0.271
0.272 - 0.277
0.278 - 0.283
0.284 - 0.290
0.291 - 0.296
0.297 - 0.302
0.303 - 0.306
0.307 - 0.315
0.316 - 0.323
0.324 - 0.329
0.330 - 0.334
0.335 - 0.337
0.338 - 0.343
0.344 - 0.349
0.350 - 0.355
0.356 - 0.361
0.362 - 0.368
0.369 - 0.375
0.376 - 0.469
0.470 - 0.482
0.483 - 0.494
0.495 - 0.501
0.502 - 0.507
0.508 - 0.513
0.514 - 0.517
0.518 - 0.521
0.522 - 0.534
0.535 - 0.551
0.552 - 0.570
0.571 - 0.589
Basaltic Dikes
319 Monitoring Stations
Plant Roads
Rivers & Streams
Waste Appl. Fields
0.25 0.125 0 0.25 0.5 0.75 1 1.25
Kilometers
N
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Conclusions:

- Diabase dikes can act as both groundwater barriers and preferred pathways.
  - ⇨ Preferred pathways for groundwater flow exist along the contact edges in competent rock parallel to the strike.
  - ⇨ Even though highly fractured, thick diabase dikes are barriers to groundwater flow perpendicular to the strike.

Conclusions:

- Nitrate contaminated groundwater flows preferentially in the transition zone just above competent rock.
- Very little attenuation of nitrate occurs in groundwater flowing through the transition zone.
- Shallow compliance monitoring monitoring wells may “miss” contamination.

Conclusions:

- A Thorough Site Hydrogeologic Site Characterization is an Essential Element for Compliance Monitoring and/or Corrective Action at Permitted Facilities.