# Louisiana DOTD Geotechnical Database Efforts

PART ONE

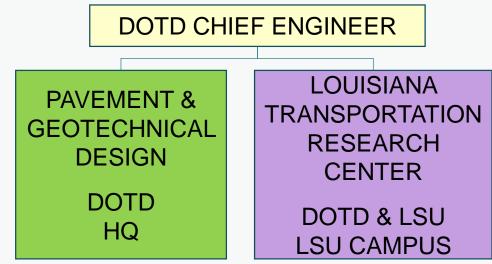Gavin P. Gautreau, P.E.

Sr. Geotechnical Research Manager

Louisiana Transportation Research Center (LTRC)

# LTRC Introduction

- LTRC was created by Louisiana Legislature in 1986.
- Sponsored Jointly by the Louisiana Department of Transportation and Development (DOTD) and Louisiana State University (LSU)
  - Conduct short- and long-term research
  - Provide technical assistance, training, continuing education, technology transfer to DOTD and the transportation community.
- Research Problem Identification Committees (RPIC)
  - Problem Solicitation (every 2 years)
  - Committee Review & Rating → Work Program
    - Importance & Implementation Potential
- Project Review Committee (PRC)
  - Industry, Academia, and Government

DOTD CHIEF ENGINEER

PAVEMENT & GEOTECHNICAL DESIGN

DOTD HQ

LOUISIANA TRANSPORTATION RESEARCH CENTER

DOTD & LSU LSU CAMPUS

# Data Management     … Data is an Asset!



Information



Tired of messy field notes?

Digital

Digitize

Data

Information

- Reports
- Design
- Decisions
- Correlations

Data Rules:
1. Enter the data only once.

2. Have someone else enter the data.

© Trupp Global

# Geotechnical Database Timeline

*1986 gINT (The Geotechnical Integrator) Founded*

*19XX DOTD Begins Using gINT*

*~1998 DOTD Starts saving .pdf copies of boring logs*

## 2003 - Phase I    LTRC In-House Research

PDFs (information) to ArcMAP

- Non-GIS website with searchable fields.
  - Links to documents (DOTD Content Manager)
- GIS based website
  - Links to documents (DOTD Content Manager)
- Custom Code and ArcGIS versions

**www.LTRC.LSU.EDU**
**LTRC Project # / Re port #**

**03-1GT   /   446**

# Geotechnical Database Timeline

**2007 STGEC – Bowling Green, Kentucky …KYTC work**

*2009 Bentley acquires gINT*

Louisiana Digital Data

**www.LTRC.LSU.EDU**
**LTRC Project # / Report #**

**2010 - Phase II        Dataforensics**

- gINT – software customization
- Better / Digital logs
- Standardized data
- gINT Template shared with labs for uniformity
- pLOG & Rapid CPT

**10-2GT   /   498**

pLog Tablet

# Geotechnical Database Timeline

**2015 - Phase III      Dataforensics**

- Pile Load Test Database - Organization

- DOTD District Shallow Soil Borings
  - Standardization of data and reports
    - HoleBASE, Keynetix
    - KeyLAB, Keynetix

**15-1GT  /  634**

  - DOTD Districts are independent
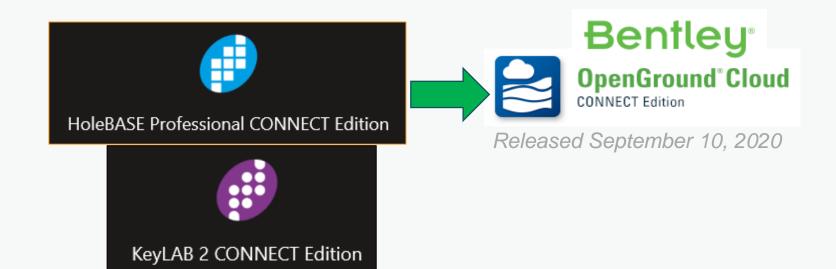  - Geotechnical Design saw potential in HoleBASE for Deep Borings

*2019 Bentley acquires Keynetix*

# Geotechnical Database Timeline

**2020**



HoleBASE Professional CONNECT Edition

KeyLAB 2 CONNECT Edition

**Bentley® OpenGround® Cloud** CONNECT Edition

*Released September 10, 2020*

*2020 Bentley Releases Open Ground Cloud*

**2021 – Phase IV     LTRC In-House        LTRC#: 21-1GT    In-Progress**

Capsule

DOTD Deep Borings Implementation to HoleBASE

- LTRC Data Upload/Conversion
- KeyLAB, (internal drill crew)
- HoleBASE to OpenGround Migration
- Dataforensic (Bentley Rep)

Dataforensics

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# Data Strategy "Road Map"

- Data Baskets
  - .pdfs   DOTD Geotech Files
  - .pdfs   DOTD Content Manager
  - gINT files Materials Lab
  - gINT files Section 67
  - gINT files Consultants
  - Pile Load Test Data
  - Others
- Excel Spread Sheets
  - Monitor Progress (Uploads/Conversions to OpenGround)
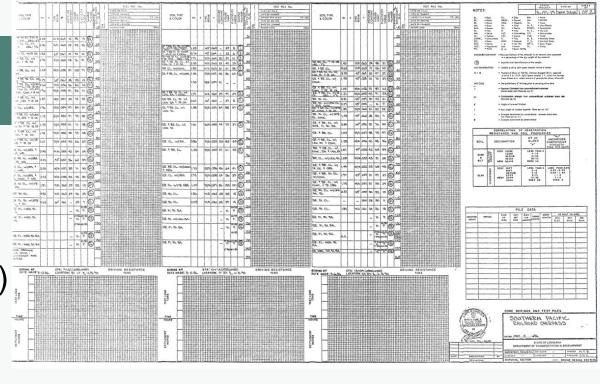  - Address Problems (Identify, Categorize, Resolve)
- Communications
  - Meetings with LTRC  &  DOTD Geotech (every other week)
  - Meetings with Dataforensics, Bentley Rep (Monthly)
  - LTRC Guidance Documents – How to Convert / Upload
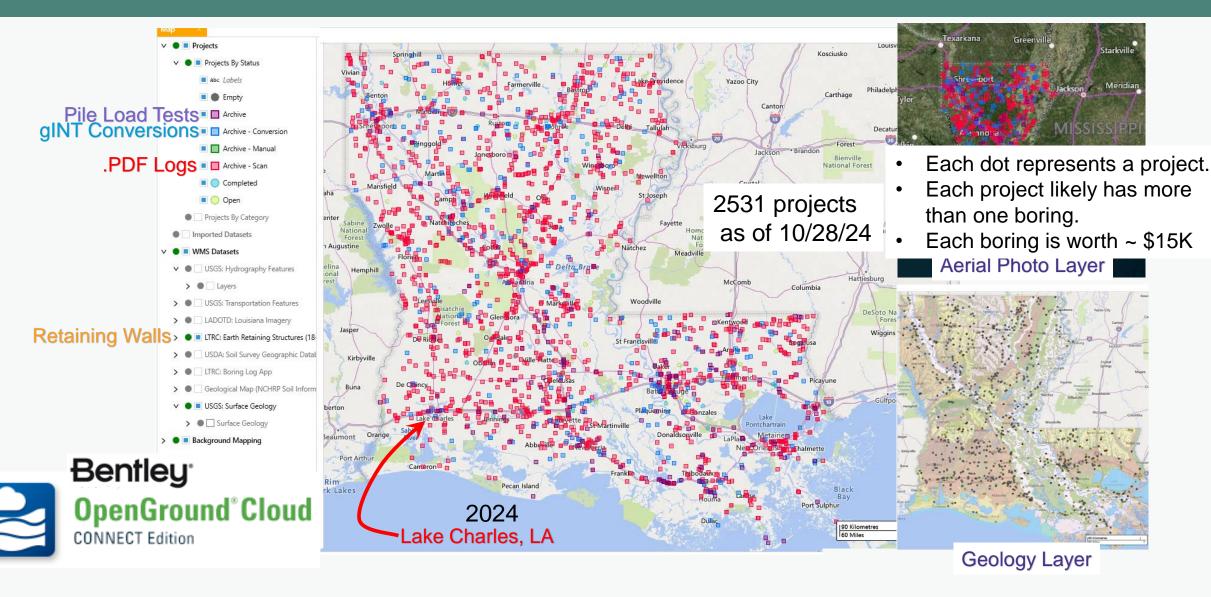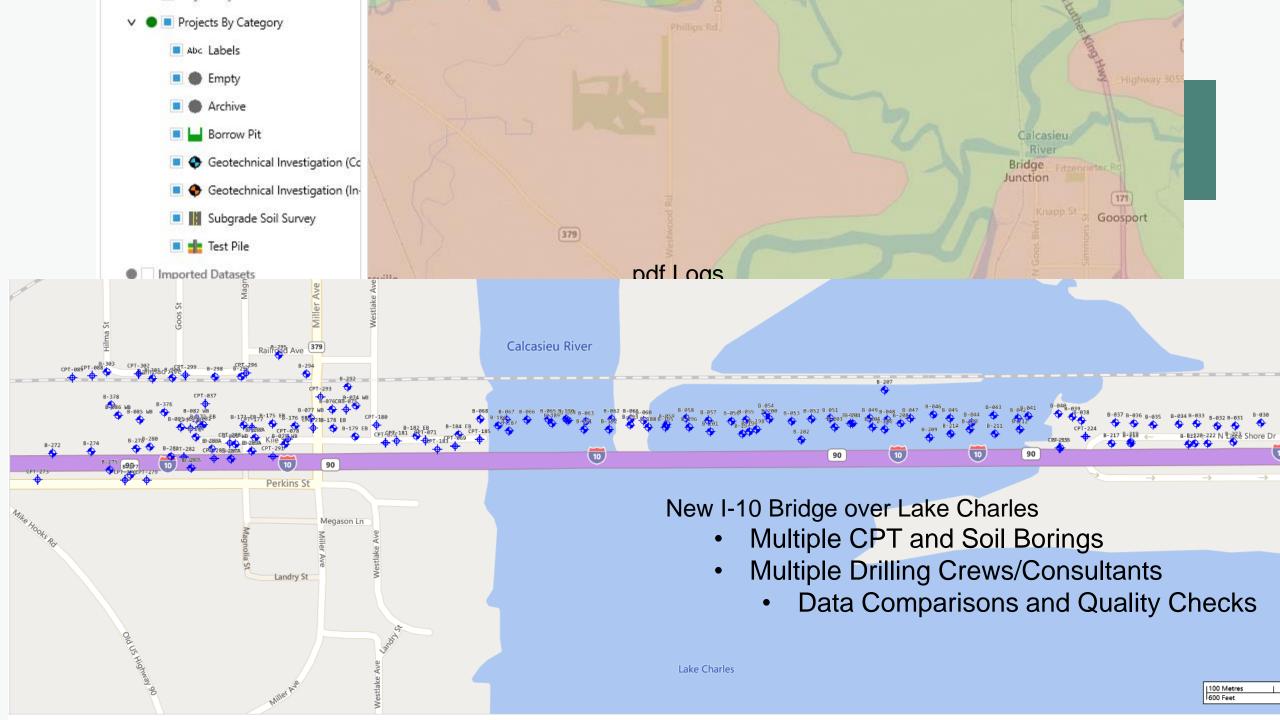
towardsdatascience.com

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# PDFs (Information)

- Information still has value
- Uploads to OpenGround
  - Technician Effort (Chris Mertz, LTRC)
  - Checked uploads for Accuracy
    - Project Information
      - Design #, Construction #, H.000000#
    - Location:
      - GPS Centroids
      - Pre - GPS (used Structure # and Road Control Section)
      - Some were culverts, not bridges
    - Splitting Borings (Triple Panel Log) into distinct projects
- Future Effort:  Use Artificial Intelligence (AI) and Optical Character Recognition (OCR) to convert *.pdf borings into <u>Digital</u> data.

# Geotechnical Database - Phase IV    (21-2GT)

- Each dot represents a project.
- Each project likely has more than one boring.
- Each boring is worth ~ $15K

2531 projects as of 10/28/24

Pile Load Tests
gINT Conversions
.PDF Logs
Retaining Walls

Aerial Photo Layer

Geology Layer

2024
Lake Charles, LA

Bentley
OpenGround Cloud
CONNECT Edition

Projects By Category
- Abc Labels
- Empty
- Archive
- Borrow Pit
- Geotechnical Investigation (Co
- Geotechnical Investigation (In-
- Subgrade Soil Survey
- Test Pile
- Imported Datasets

pdf Logs

New I-10 Bridge over Lake Charles
- Multiple CPT and Soil Borings
- Multiple Drilling Crews/Consultants
- Data Comparisons and Quality Checks

**DOTD** LOUISIANA DEPARTMENT OF TRANSPORTATION & DEVELOPMENT

Project No.: H.009484  Parish: IBERVILLE  Boring: **B-01** 1/3
Project Name: LA 75: BAYOU BREAUX BRIDGE  Latitude: 30.228860
Project Location:  Longitude: -91.101870
Structure/Recall: 61242570101101  Route: LA 75 Martin Luther King Jr Pkwy  Elevation: 17.8 ft

| Depth [ft] | Elevation [ft] | Graphic | Material Description & (USCS) | Sample ID | Pocket Pen/ Torvane [tsf] | Comp. Str. [tsf] @ σ' [psi] / SPT [bl/ft] | Failure Mode / SPT Termination | Fines Content [%] | γwet [pcf] | Moisture Content & Atterberg Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Stiff, gray, LEAN CLAY (CL) | C23 | | 1.43 @3 | M.S. | 89 | 120 | |
| 5 | 13 | | Medium stiff, gray, FAT CLAY (CH) | C24 | | 0.91 @7 | S/S | 97 | 114 | |
| 10 | 8 | | Gray, SILT (ML), Org = 5% | C25 | | 1.05 @11 | M.S. | 97 | 125 | |
| 15 | 3 | | Gray, SANDY SILT (ML) | C26 | | 0.46 @15 | M.S. | 62 | 123 | |
| 20 | -2 | | Gray, SILT WITH SAND (ML) | C27 | | 1.21 @19 | M.S. | 75 | 121 | |
| 25 | -7 | | Loose to medium dense, gray, SANDY SILT (ML) | D28 | | 1-3-4 (7) | | 65 | | |
| 30 | -12 | | | D29 | | 2-5-5 (10) | | 57 | | |
| 35 | -17 | | Gray, SILT WITH SAND (ML) | C30 | | 0.23 @32 | M.S. | 76 | 126 | |

Moisture Content & Atterberg Limits:  ● MC [%]  — PL & LL [%]  (scale 20 40 60 80)

Drilling Contractor: LADOTD statewide drill crew (Under Section 67)
Driller/Logger: Mike Anderson  Start / Complete: 11/14/2017 / 11/14/2017
Equipment: LADOTD Simco 2800  Groundwater Levels:
Hammer Type: Automatic Hammer  Efficiency:  At time of drilling  - No Water Level Taken
Drilling Method: Wet-Rotary
Backfill Method: Backfilled with cement bentonite grout.
Remarks: Original survey in boring log is incorrect. Updated survey from Google Map based on borehole grouted location.
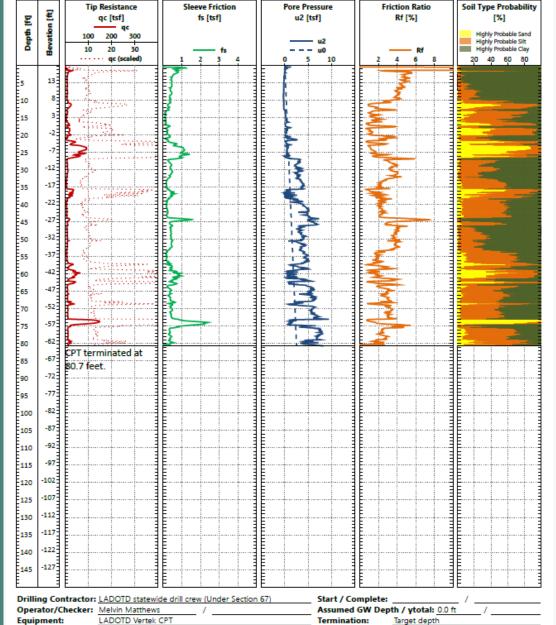
**DOTD** LOUISIANA DEPARTMENT OF TRANSPORTATION & DEVELOPMENT

Project No.: H.009484  Parish: IBERVILLE  Boring: **CPT-01** 1/1
Project Name: LA 75: BAYOU BREAUX BRIDGE  Latitude: 30.228861
Project Location:  Longitude: -91.101839
Structure/Recall:  Route: LA 75 Martin Luther King Jr Pkwy  Elevation: 17.24 ft

Columns: Depth [ft], Elevation [ft], Tip Resistance qc [tsf] (qc, qc (scaled)), Sleeve Friction fs [tsf] (fs), Pore Pressure u2 [tsf] (u2, u0), Friction Ratio Rf [%] (Rf), Soil Type Probability [%]

Soil Type Probability legend:
- Highly Probable Sand
- Highly Probable Silt
- Highly Probable Clay

CPT terminated at 80.7 feet.

Drilling Contractor: LADOTD statewide drill crew (Under Section 67)
Operator/Checker: Melvin Matthews  Start / Complete: /
Equipment: LADOTD Vertek CPT  Assumed GW Depth / γtotal: 0.0 ft
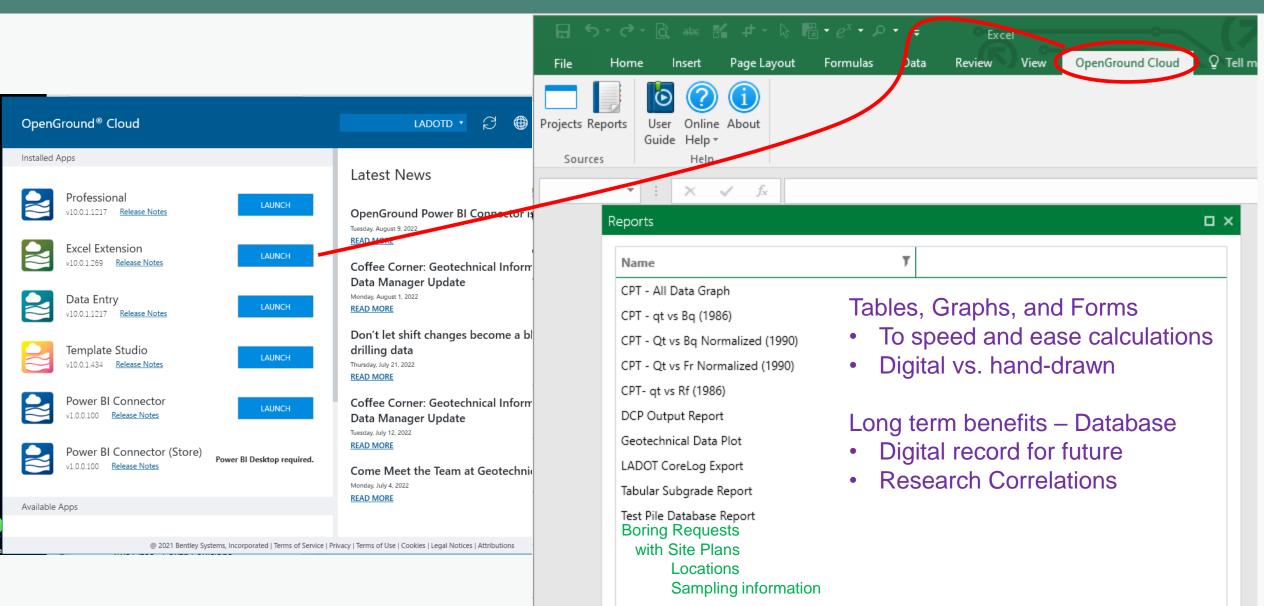Cone Reference: 4444.220XX  Cone Area Ratio: 0.80  Termination: Target depth
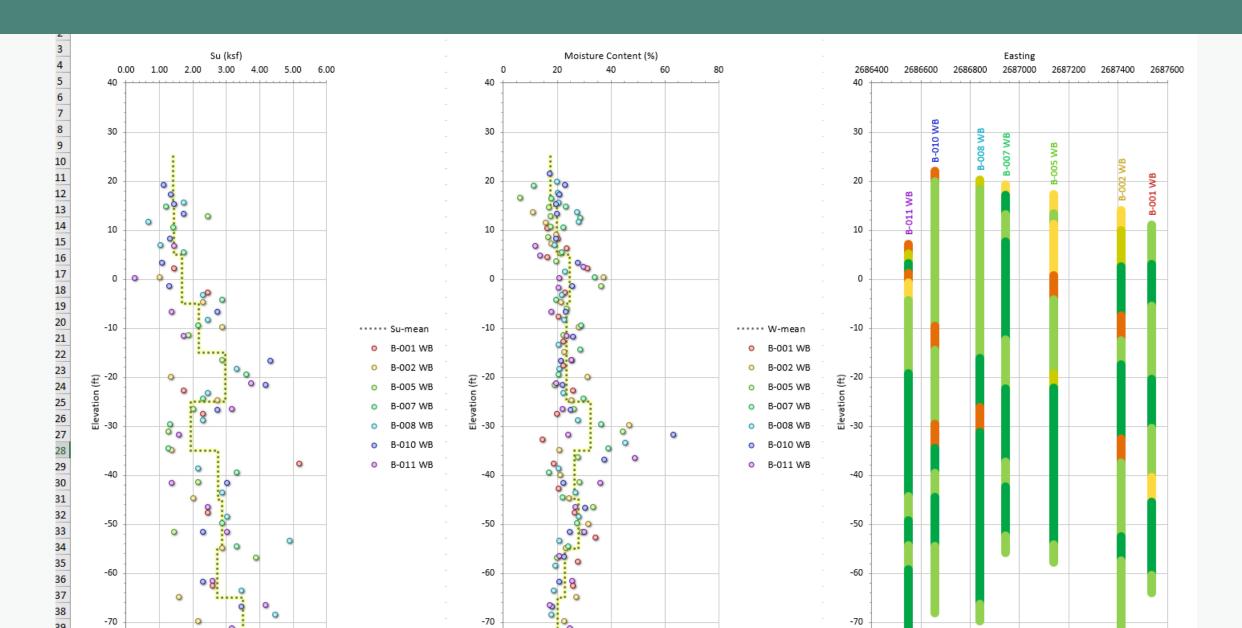Backfill Method: Backfilled with cement bentonite grout.
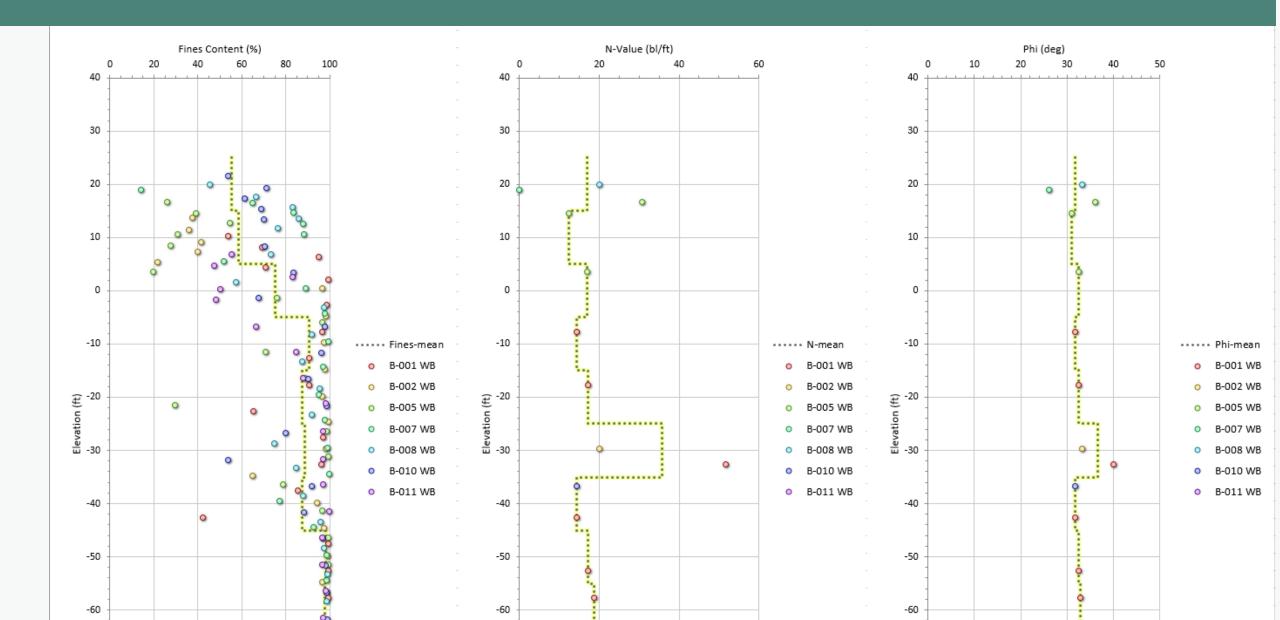Remarks: CPT pushed to investigate presence of pile driving obstruction at an adjacent bent location 20' away.

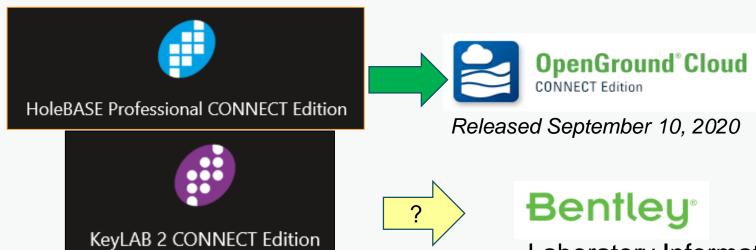# OpenGround Cloud (OGC) Excel Extension



Tables, Graphs, and Forms
- To speed and ease calculations
- Digital vs. hand-drawn

Long term benefits – Database
- Digital record for future
- Research Correlations

# Geotechnical Data Plots – OGC Excel Extension

# KeyLAB



*Released September 10, 2020*

? → Bentley®

- Laboratory Information Management System (LIMS) Pending ~ Several Years Away "*OpenLAB*"?

DOTD is implementing KeyLAB internally.

- KeyLAB transition to future "*OpenLAB*"
  - Migration should be easy…excel based…Bentley starting point.
- OpenGround Portal – Data Entry is expanding

# Geotechnical Work Flow  -  QA/QC & Reporting

DOTD Materials Lab (Drill Crew & Lab)

- Dataforensics:
  - "Road Map" Guidance on Big-Picture
  - KeyLAB custom templates (DOTD format, ASTM)
  - KeyLAB Training (Lab and Engineers)

Geotechnical Data Report (GDR)

- Logs (CPT, Boring)
- Other tests, etc.
- Supporting Data

- DOTD Lab and Consultants will be required to digitally submit Geotechnical Data Reports (GDRs).

**Section 22 Materials Laboratory - Data Review**
* Login to OGC and select project
* Verify CPT data import by Section 67
* Review and update "Location Details" table
* Review and complete "Field Geological Descriptions Soil" table
* Export necessary charts, boring logs, and site plans from OGC.
  - "Log Report" button w/ "Geotechnical Data Report"
* Plot soil borings logs
  - Use "DOTD Soil Boring Log (8.5 x 11)" template
* Plot CPT sounding logs
  - Use "DOTD CPT Log (8.5 x 11)" template

**Section 22 Materials Laboratory - Data Report**
* Prepare the Geotechnical Data Report (GDR) in accordance with Chapter 15 of the Geotechnical Design Manual (GDM).
* Submit Draft GDR to Section 67 for review and acceptance via e-mail.

**Geotechnical Engineer - Data Review**
* Review the report, logs, and OGC data
* Provides either comments or acceptance via email to Section 22.
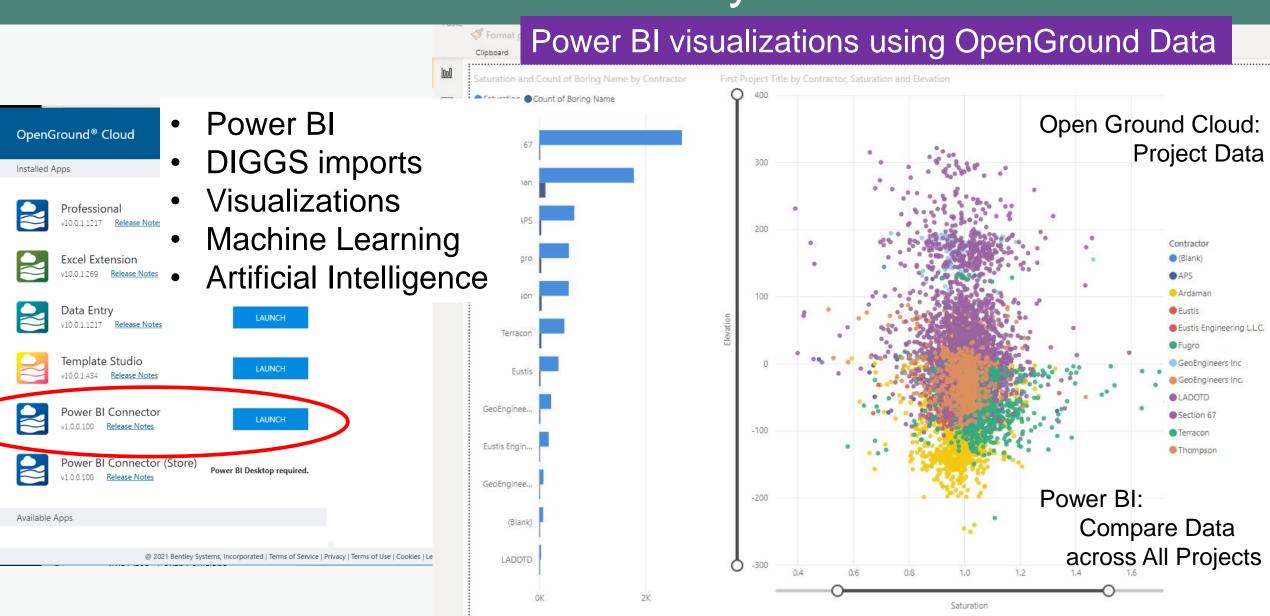
**Section 22 Materials Laboratory - Data Report**
* Update the GDR- to address any outstanding comments

**Section 22 Materials Laboratory - Data Report**
* Submits a signed and sealed GDR to Section 67 via email

**Geotechnical Engineer**
* Uploads the GDR into FileNET and FALCON.

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# Other visualizations and analyses



Power BI visualizations using OpenGround Data

- Power BI
- DIGGS imports
- Visualizations
- Machine Learning
- Artificial Intelligence

Open Ground Cloud:
Project Data

Power BI:
Compare Data
across All Projects
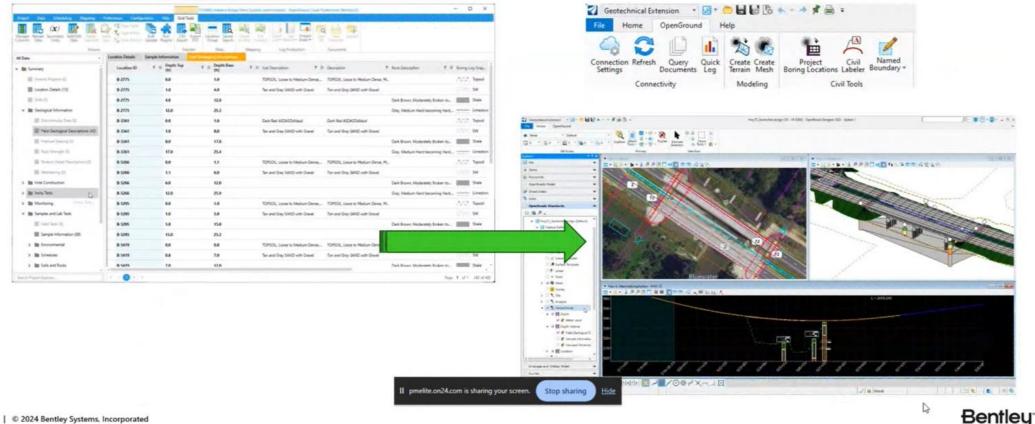
OpenRoads Geotechnical Extension

# Data Interchange for Geotechnical and Geoenvironmental Specialists (DIGGS)

The DIGGS project involves development of a GML (XML-based) geospatial standard schema for the transfer of geotechnical and geoenvironmental data within an organization or between multiple organizations.

DIGGS can work with existing software, hardware, databases and data storage facilities to easily transfer and share your data.

- **Consultants/DOTs**
- **DOTD Sections**
- **Plans**
- **Public**
- **BIM – Digital Twins**



FIELD

LAB

DiGGS

DiGGS

DiGGS

ANALYSIS

Google Earth

GIS

DiGGS

DiGGS

DiGGS

DiGGS

DiGGS

DiGGS

DiGGS

DATA BASE

DiGGS

PRESENTATION

DATA INTERCHANGE FOR GEOTECHNICAL AND GEOENVIRONMENTAL SPECIALISTS

DOTD: OpenGround

# LTRC Project: 24-2GT          "GEC-5"

WEB-based tool to Advance Geotechnical Data Interchange and Reliability-Based Site Characterization

**LTRC:**  **DOTD**, Gavin Gautreau, Nick Ferguson, Technicians
         **LSU**, Murad Abu-Farsakh, Research Associates, etc.

**GeoSyntec:  Xin Peng**

**Project Review Committee insight**
   **DOTD:** Section 67, Geotechnical  &  Section 22, Materials Laboratory
   **Dataforensics**, Scott Deaton (Bentley-OGC Representative)

- **Web-Based Visualizations**

- **Data Management & DIGGS**  Data Interchange for Geotechnical and Geoenvironmental Specialists

- **GEC-5**  Geotechnical Engineering Circular (GEC) No. 5 (AASHTO Updates)

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- **Web-Based Visualization**

  Finalize/formalize a web-based platform used by DOTD for several large projects…to standardize this visualization process for all projects.

  - Interactively visualize and interpret data from soil borings, CPTs, geophysical/conventional data.

  - Create composite soil stratigraphy

  - Plot soil properties and derived parameters vs. elevation

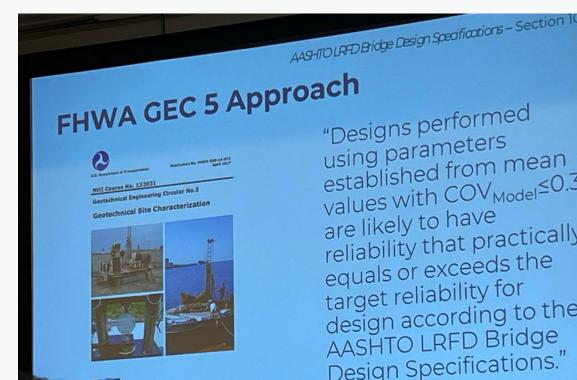  - Develop design profiles.

**Data Management & DIGGS**   Data Interchange for Geotechnical and Geoenvironmental Specialists (DIGGS) - Implementation

- DOTD  →  OpenGround & KeyLAB   (Phase IV)

- DOTD Contract Consultants → …maybe OpenGround? (other solutions)
  - gINT Sun-setting
  - Data transfer & exchange (new and historical data)
  - Proactive solution for DOTD and its consultants

- Implement a web-based platform with visualizations for standardized exchange to efficiently increase the quality of geotechnical data deliverables as a digital asset.
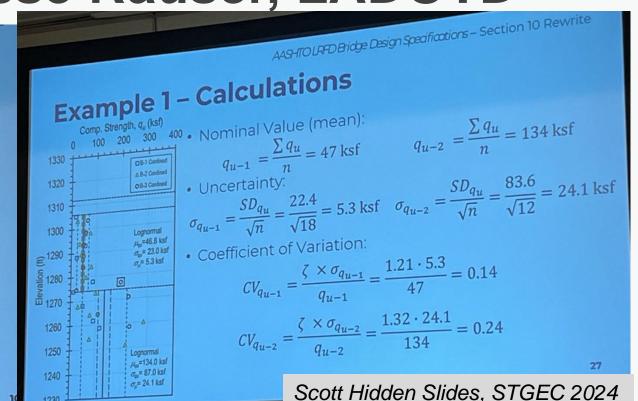
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# AASHTO LRFD Bridge Design Specifications

- **Section 10 Rewrite**
  - **2023 STGEC – Scott Hidden, NCDOT**
  - **2024 SWGEC- Jesse Rauser, LADOTD**



*Scott Hidden Slides, STGEC 2024*

# Conclusions

- Advancing DOTD Geotechnical Data Management
  - Accessing data easily via OpenGround GIS Interface
  - Improving current, functional Effectiveness & Efficiencies
  - Building Long-Term Database – Reference & Correlations
  - Planning – Succession, Knowledge Transfer & Retention
  - Connecting Data Sources (Scour, Pile Load Tests, LiDAR, Materials, etc.)

- Leadership & Vision:  Jesse Rauser, DOTD Geotechnical
  - LTRC facilitation (20+ years) to advance DOTD Geotechnical Data Management

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# Thank you!

Questions?

Part Two
Xin Peng