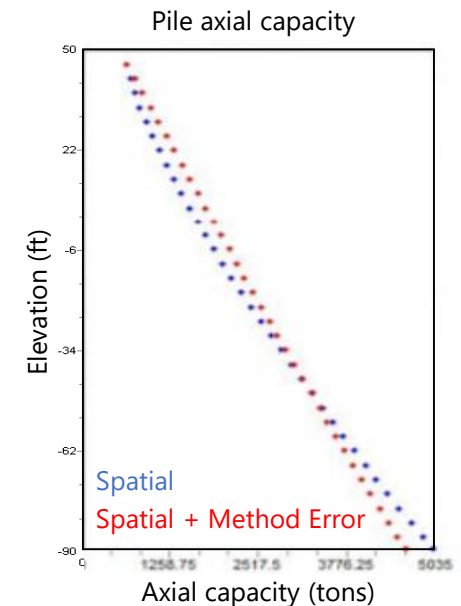
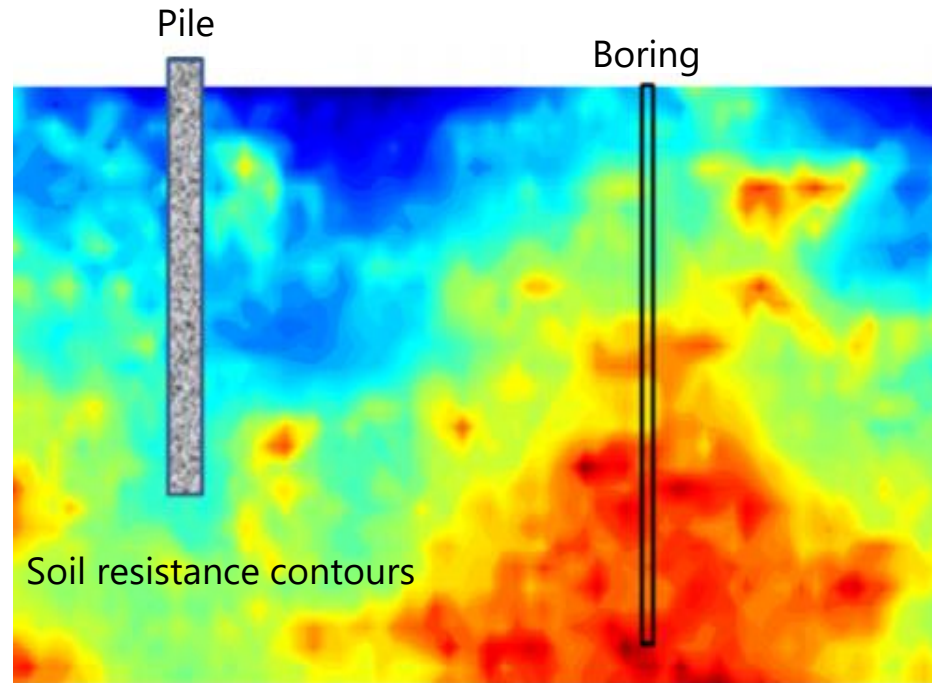
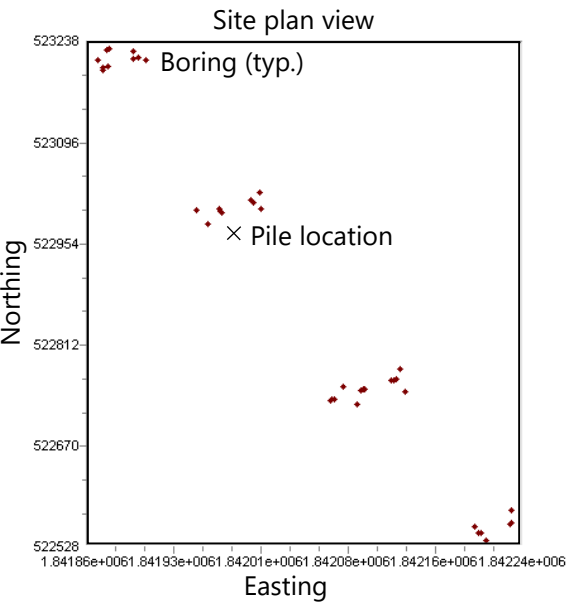


Development of GS-Deep Software (pending approved scope of services)



Michael Davidson, Michael McVay, and Gary Consolazio
Engineering School of Sustainable Infrastructure & Environment
University of Florida
Gainesville, Florida
August 10, 2018

Agenda

- Introduction
- Proposed Project Tasks
 - Establish input file format and data read/write
 - Develop software documentation
 - Automate calls to axial capacity software, FB-Deep
 - Conduct quality assurance testing
 - Develop installation package and licensing
- Proposed Project Timeline

Agenda

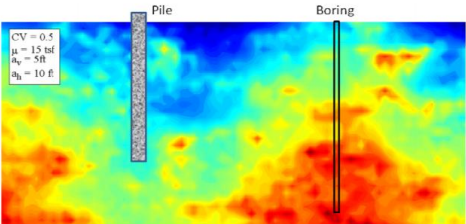
- Introduction
- Proposed Project Tasks
 - Establish input file format and data read/write
 - Develop software documentation
 - Automate calls to axial capacity software, FB-Deep
 - Conduct quality assurance testing
 - Develop installation package and licensing
- Proposed Project Timeline

Introduction

- Development of Variable LRFD Factors for Deep Foundation Design Due to Site Variability
 - McVay et al. (2012), FDOT BDK75 977-23

Final Report
FDOT Contract No.: BDK75 977-23
UF Contract No.: 00083426

Development of Variable LRFD ϕ Factors for Deep Foundation Design Due to Site Variability




CV = 0.5
 $s_u = 15$ ksf
 $s_v = 5$ ft
 $s_h = 10$ ft

Principal Investigators: Michael C. McVay
Harald Klammler
Graduate Research Assistants: Michael A. Faraone
Krishnarao Dase
Chris Jenneisch

Department of Civil and Coastal Engineering
Engineering School of Sustainable Infrastructure and Environment
University of Florida
P.O. Box 116580
Gainesville, Florida 32611-6580

Developed for the



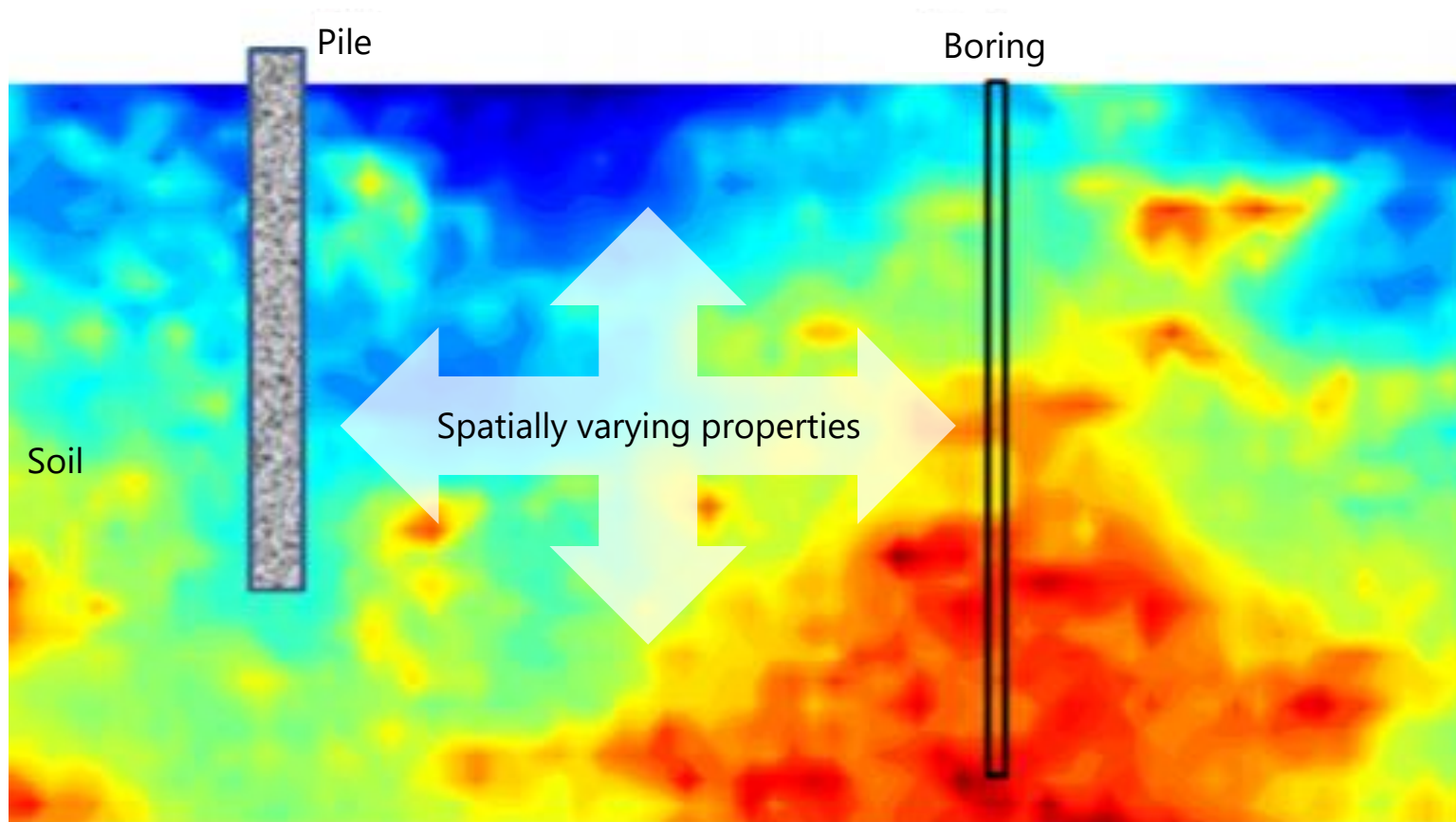
Florida Department of Transportation

Peter Lai, P.E., and Rodrigo Herrera, P.E., Project Managers

June 2012

Introduction

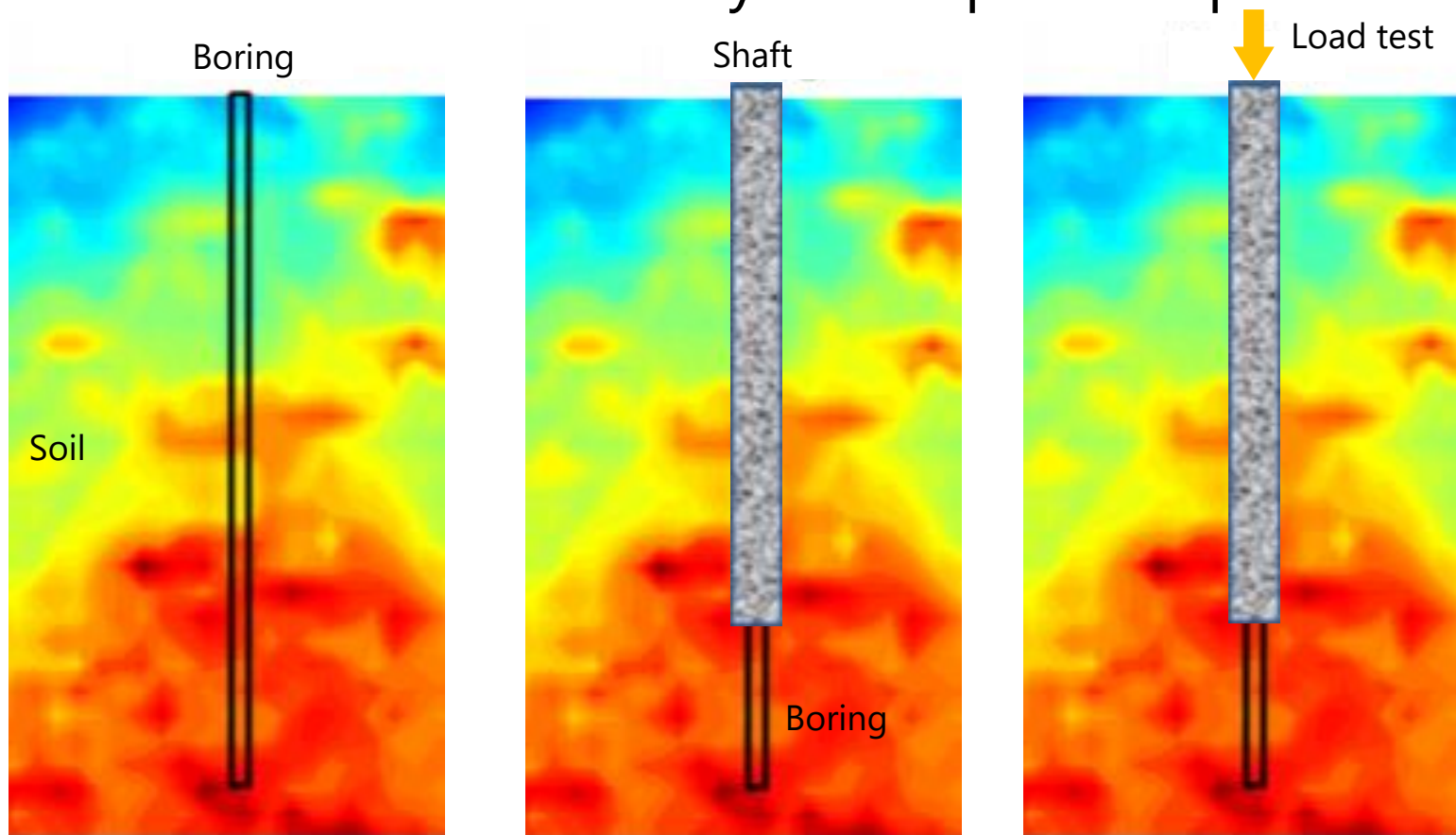
- Soil exhibits spatial variability
 - Vertical and horizontal directions
 - Contributes to uncertainty in computed capacities



Soil spatial variability (McVay et al. 2012)

Introduction

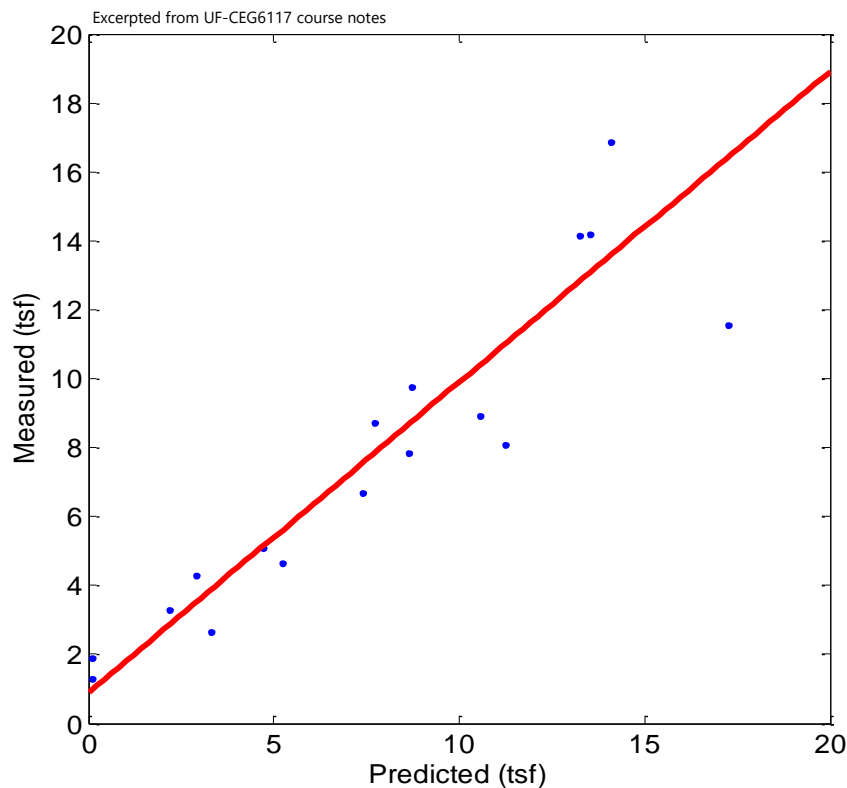
- Method error
 - Underlying assumptions in empirical methods
 - Contributes to uncertainty in computed capacities



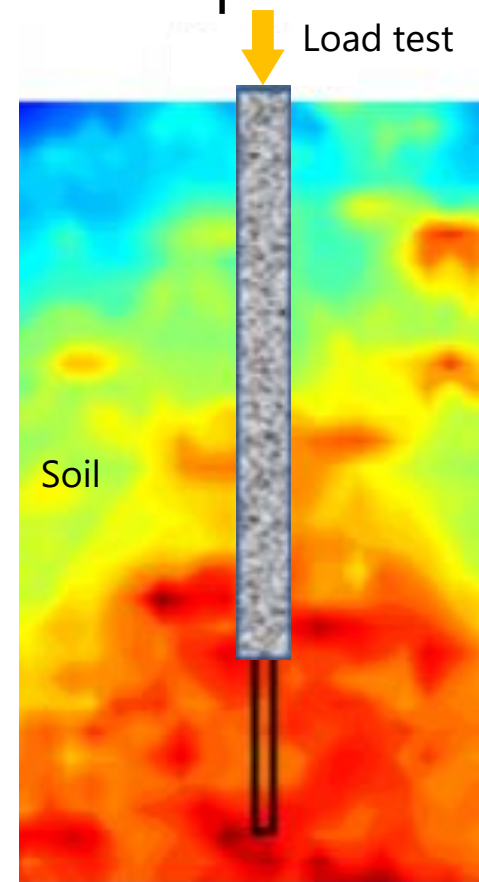
Example: Boring in footprint of non-redundant shaft

Introduction

- Method error
 - Underlying assumptions in empirical methods
 - Contributes to uncertainty in computed capacities



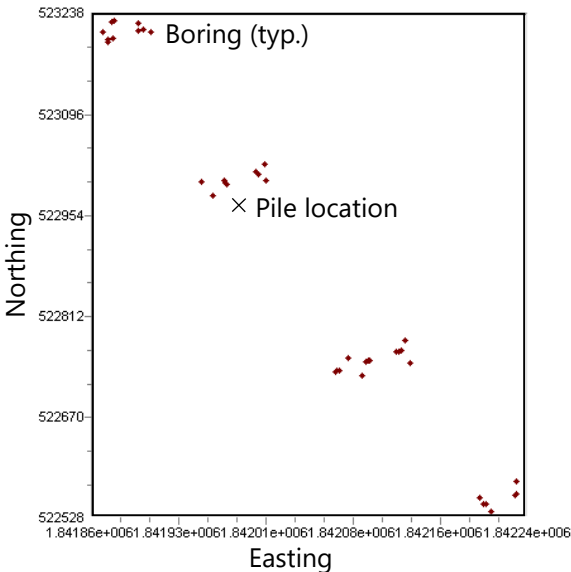
Predicted vs measured resistance



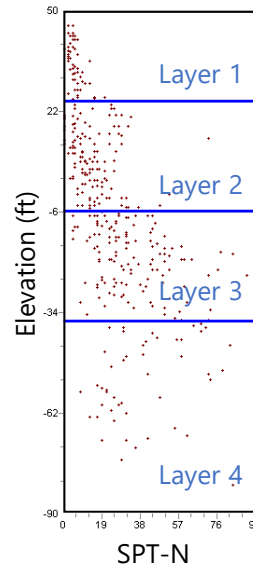
Example: Boring in footprint of non-redundant shaft

Introduction

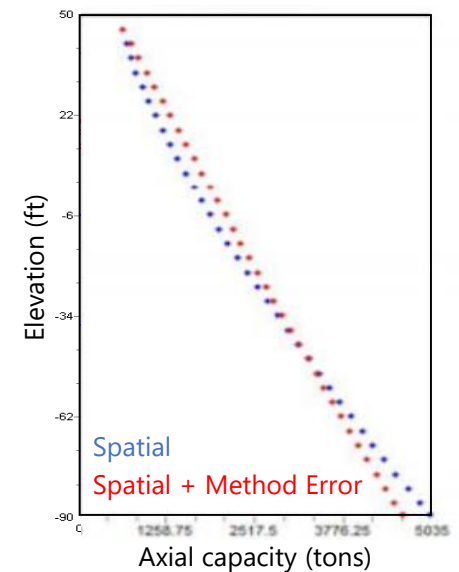
- GS-Deep: geostatistics tool
- Pile/shaft axial capacity and uncertainty:
 - Have sufficient geotechnical site data been gathered?
 - Are soil layer definitions representative?
 - How much uncertainty is in computed pile/shaft axial capacity?
- Promotes consistent design practices



Plan view of site boring locations



Scatterplot of SPT boring data, layering



Mean total axial capacities, with uncertainty

Agenda

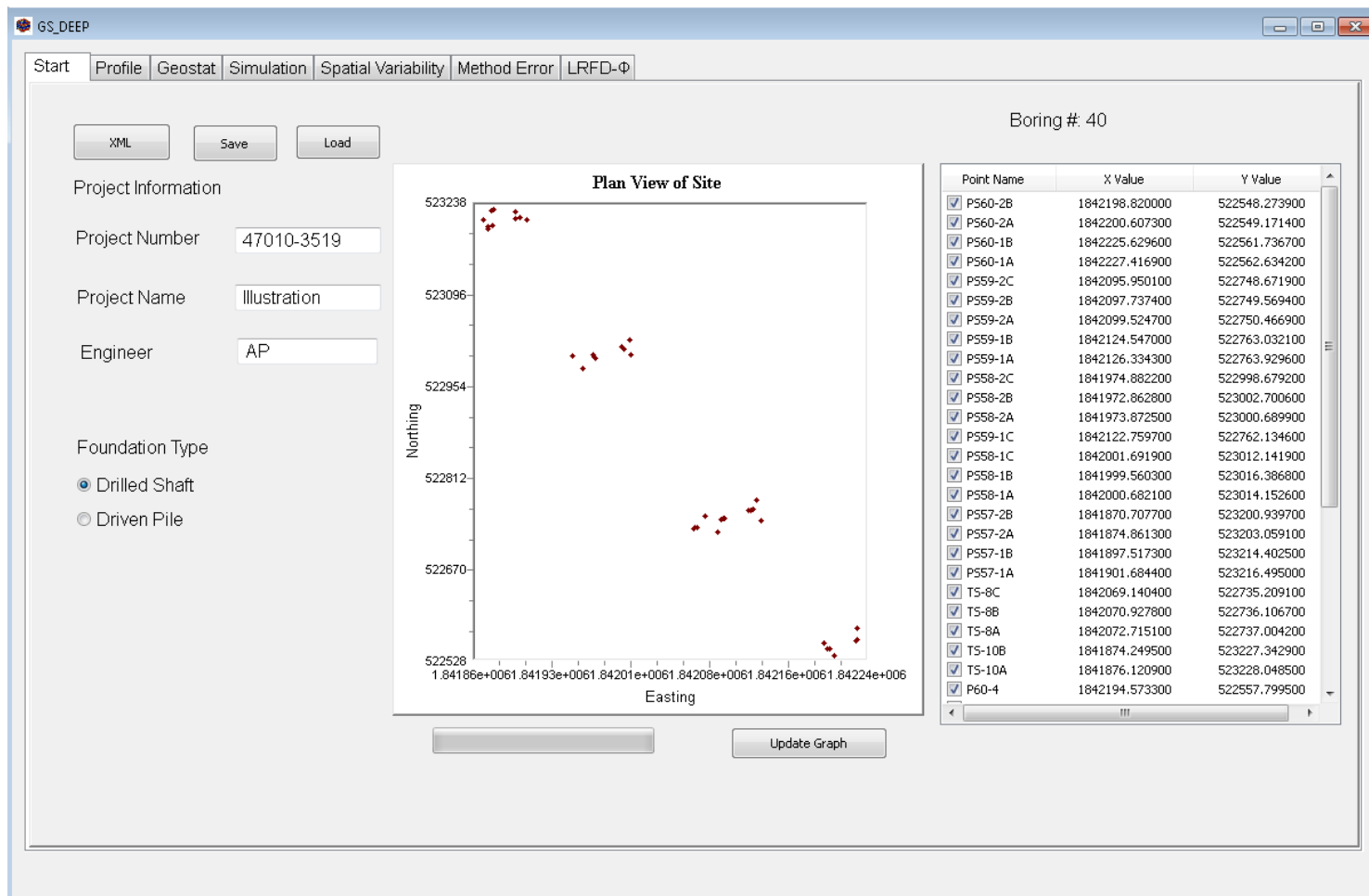
- Introduction
- Proposed Project Tasks
 - Establish input file format and data read/write
 - Develop software documentation
 - Automate calls to axial capacity software, FB-Deep
 - Conduct quality assurance testing
 - Develop installation package and licensing
- Proposed Project Timeline

Agenda

- Introduction
- Proposed Project Tasks
 - Establish input file format and data read/write
 - Develop software documentation
 - Automate calls to axial capacity software, FB-Deep
 - Conduct quality assurance testing
 - Develop installation package and licensing
- Proposed Project Timeline

Proposed Project Tasks

- **Objective:** Transition GS-Deep from research tool to design tool



GS-Deep tabbed interface

Proposed Project Tasks

- **Objective:** Transition GS-Deep from research tool to design tool
 - Establish input file format and data read/write
 - Develop software documentation
 - Automate calls to axial capacity software, FB-Deep
 - Conduct quality assurance testing
 - Develop installation package and licensing

Proposed Project Tasks

- **Objective:** Transition GS-Deep from research tool to design tool
 - Establish input file format and data read/write
 - Develop software documentation
 - Automate calls to axial capacity software, FB-Deep
 - Conduct quality assurance testing
 - Develop installation package and licensing
- **Let's step through the program interface to contextualize the proposed tasks**

Proposed Project Tasks

- Establish input file format and data read/write

The screenshot displays the GS_DEEP software interface. The 'Start' tab is active, showing project information and a plan view of the site. The project information includes:

- Project Number: 47010-3519
- Project Name: Illustration
- Engineer: AP
- Foundation Type: Drilled Shaft, Driven Pile

The 'Plan View of Site' graph shows a scatter plot of boring points. The Y-axis is labeled 'Northing' and ranges from 522528 to 523238. The X-axis is labeled 'Easting' and ranges from 1.84186e+006 to 1.84224e+006. The points are represented by red diamonds.

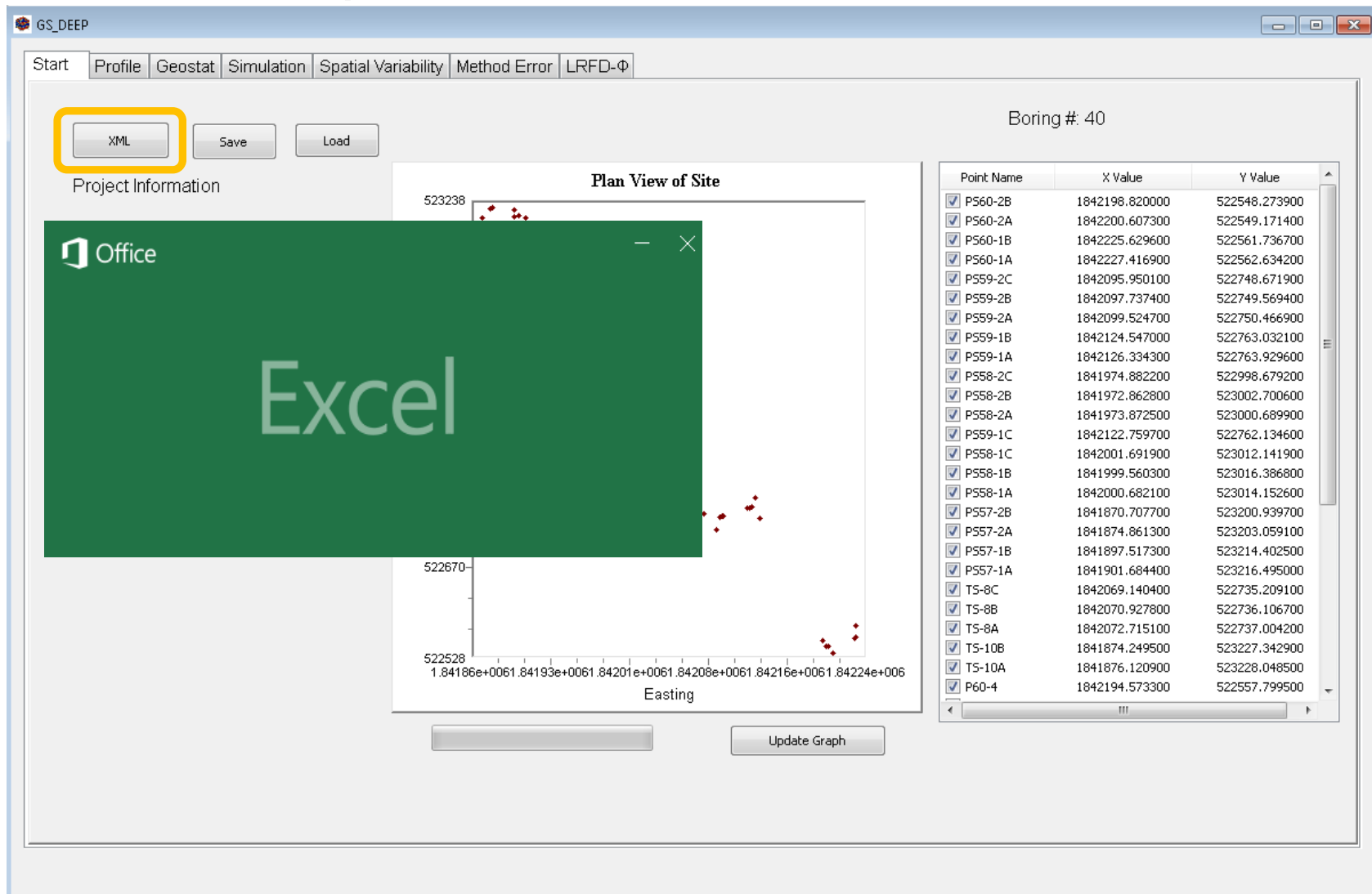
The 'Boring #: 40' table lists the following data:

Point Name	X Value	Y Value
<input checked="" type="checkbox"/> P560-2B	1842198.820000	522548.273900
<input checked="" type="checkbox"/> P560-2A	1842200.607300	522549.171400
<input checked="" type="checkbox"/> P560-1B	1842225.629600	522561.736700
<input checked="" type="checkbox"/> P560-1A	1842227.416900	522562.634200
<input checked="" type="checkbox"/> P559-2C	1842095.950100	522748.671900
<input checked="" type="checkbox"/> P559-2B	1842097.737400	522749.569400
<input checked="" type="checkbox"/> P559-2A	1842099.524700	522750.466900
<input checked="" type="checkbox"/> P559-1B	1842124.547000	522763.032100
<input checked="" type="checkbox"/> P559-1A	1842126.334300	522763.929600
<input checked="" type="checkbox"/> P558-2C	1841974.882200	522998.679200
<input checked="" type="checkbox"/> P558-2B	1841972.862800	523002.700600
<input checked="" type="checkbox"/> P558-2A	1841973.872500	523000.689900
<input checked="" type="checkbox"/> P559-1C	1842122.759700	522762.134600
<input checked="" type="checkbox"/> P558-1C	1842001.691900	523012.141900
<input checked="" type="checkbox"/> P558-1B	1841999.560300	523016.386800
<input checked="" type="checkbox"/> P558-1A	1842000.682100	523014.152600
<input checked="" type="checkbox"/> P557-2B	1841870.707700	523200.939700
<input checked="" type="checkbox"/> P557-2A	1841874.861300	523203.059100
<input checked="" type="checkbox"/> P557-1B	1841897.517300	523214.402500
<input checked="" type="checkbox"/> P557-1A	1841901.684400	523216.495000
<input checked="" type="checkbox"/> T5-8C	1842069.140400	522735.209100
<input checked="" type="checkbox"/> T5-8B	1842070.927800	522736.106700
<input checked="" type="checkbox"/> T5-8A	1842072.715100	522737.004200
<input checked="" type="checkbox"/> T5-10B	1841874.249500	523227.342900
<input checked="" type="checkbox"/> T5-10A	1841876.120900	523228.048500
<input checked="" type="checkbox"/> P60-4	1842194.573300	522557.799500

Start tab

Proposed Project Tasks

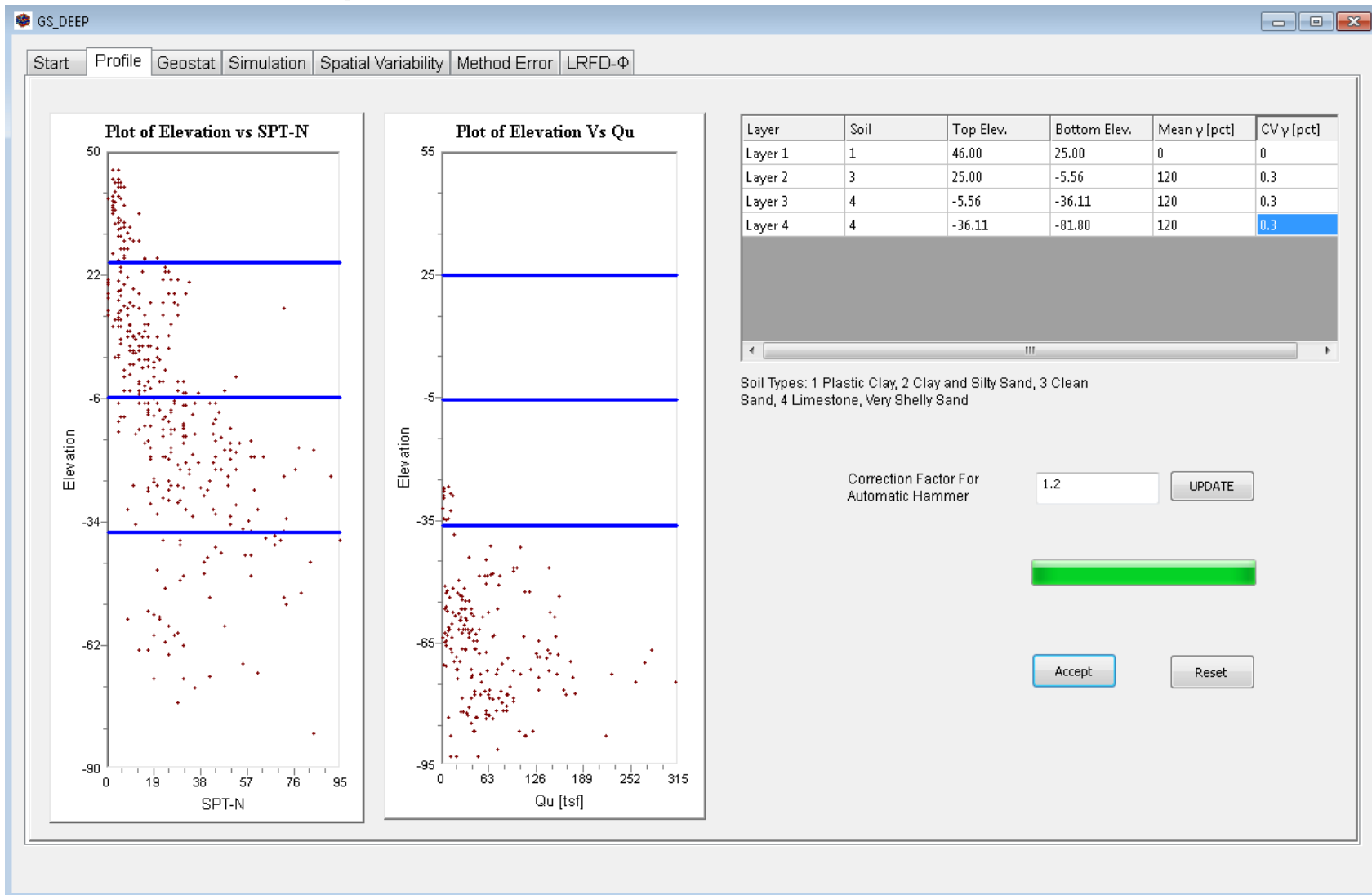
- Establish input file format and data read/write



Start tab

Proposed Project Tasks

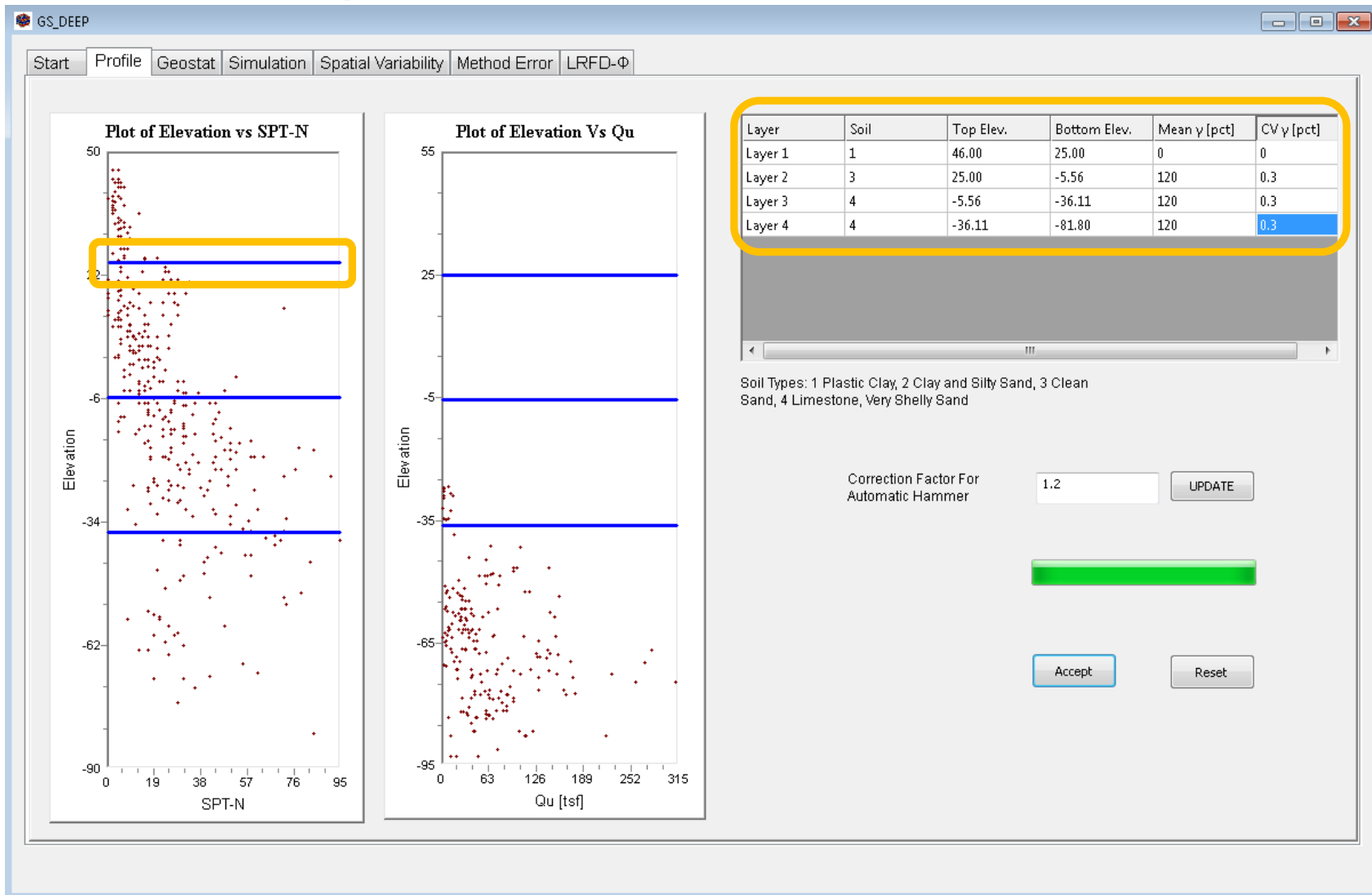
- Establish input file format and data read/write



Profile tab

Proposed Project Tasks

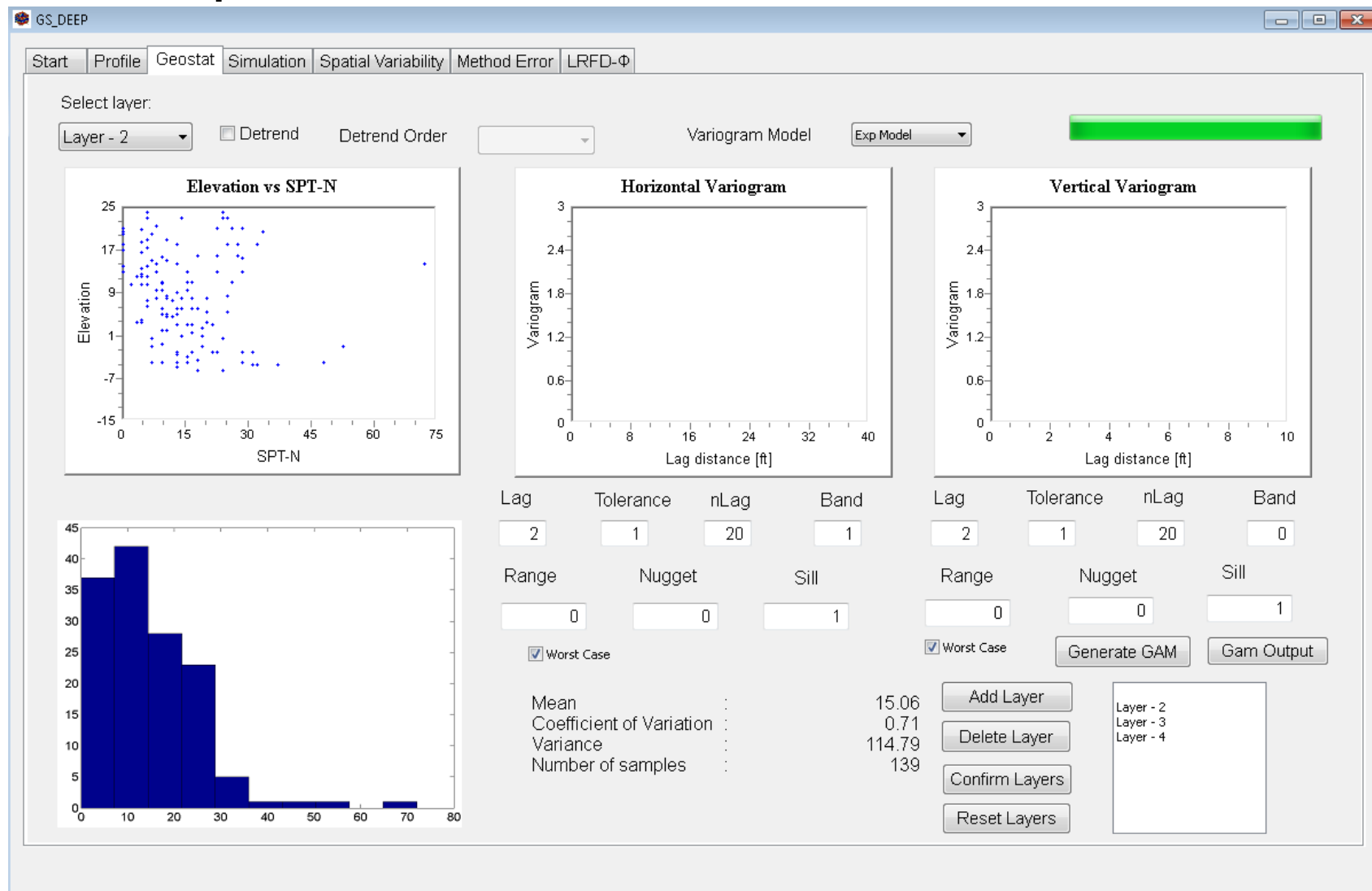
- Establish input file format and data read/write



Profile tab

Proposed Project Tasks

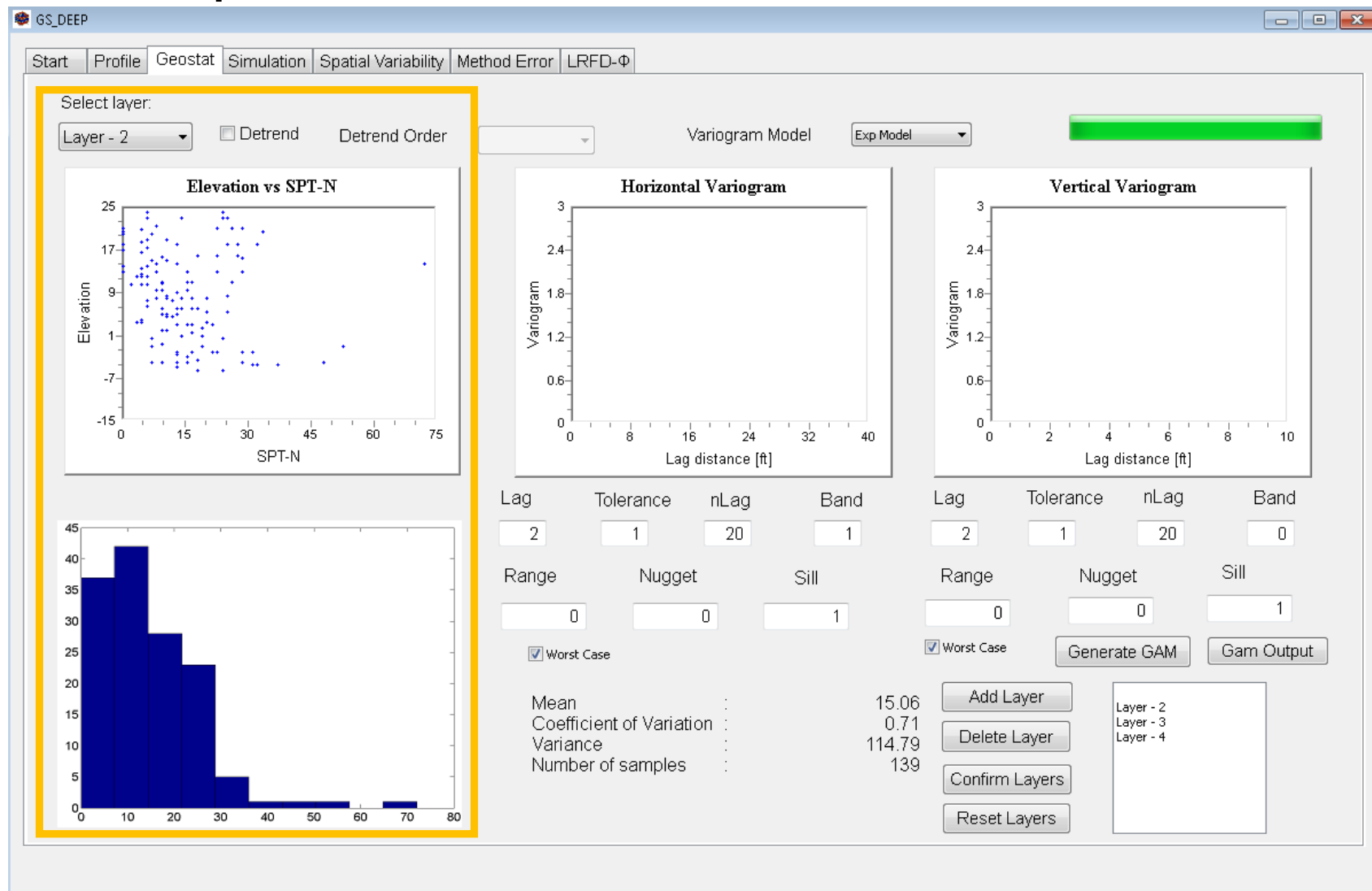
- Develop software documentation



Geostatistics tab

Proposed Project Tasks

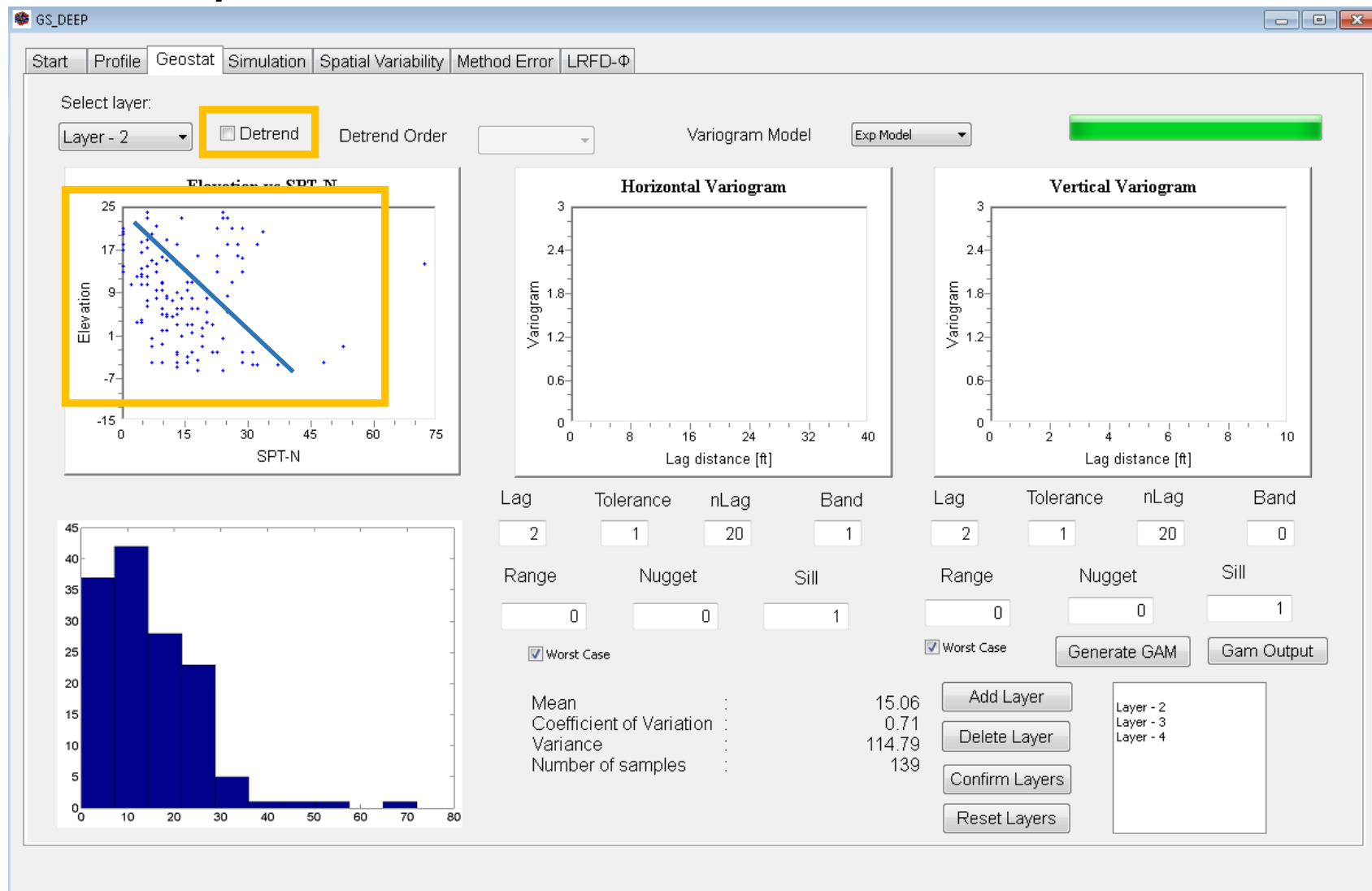
- Develop software documentation



Geostatistics tab

Proposed Project Tasks

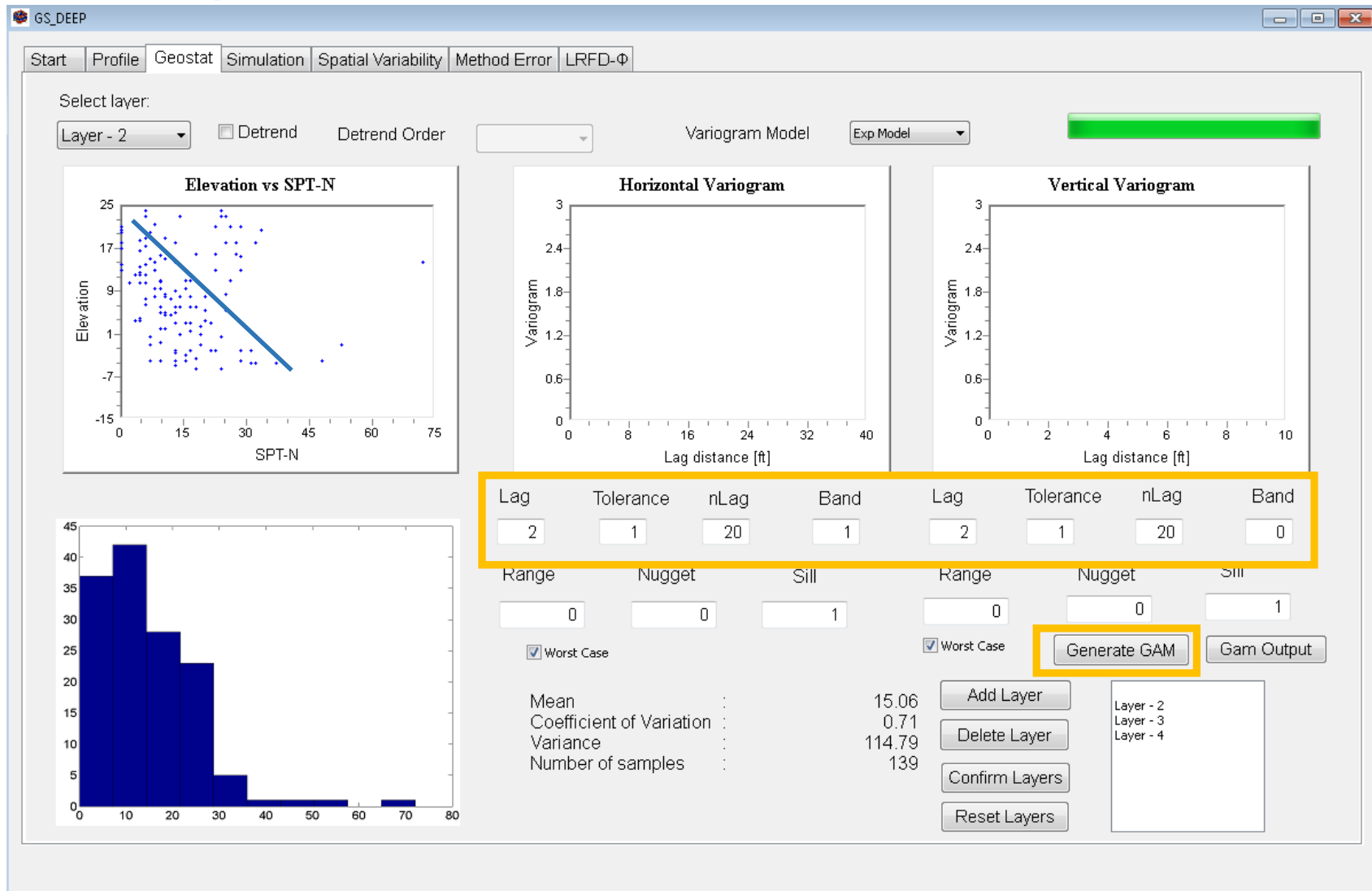
- Develop software documentation



Geostatistics tab

Proposed Project Tasks

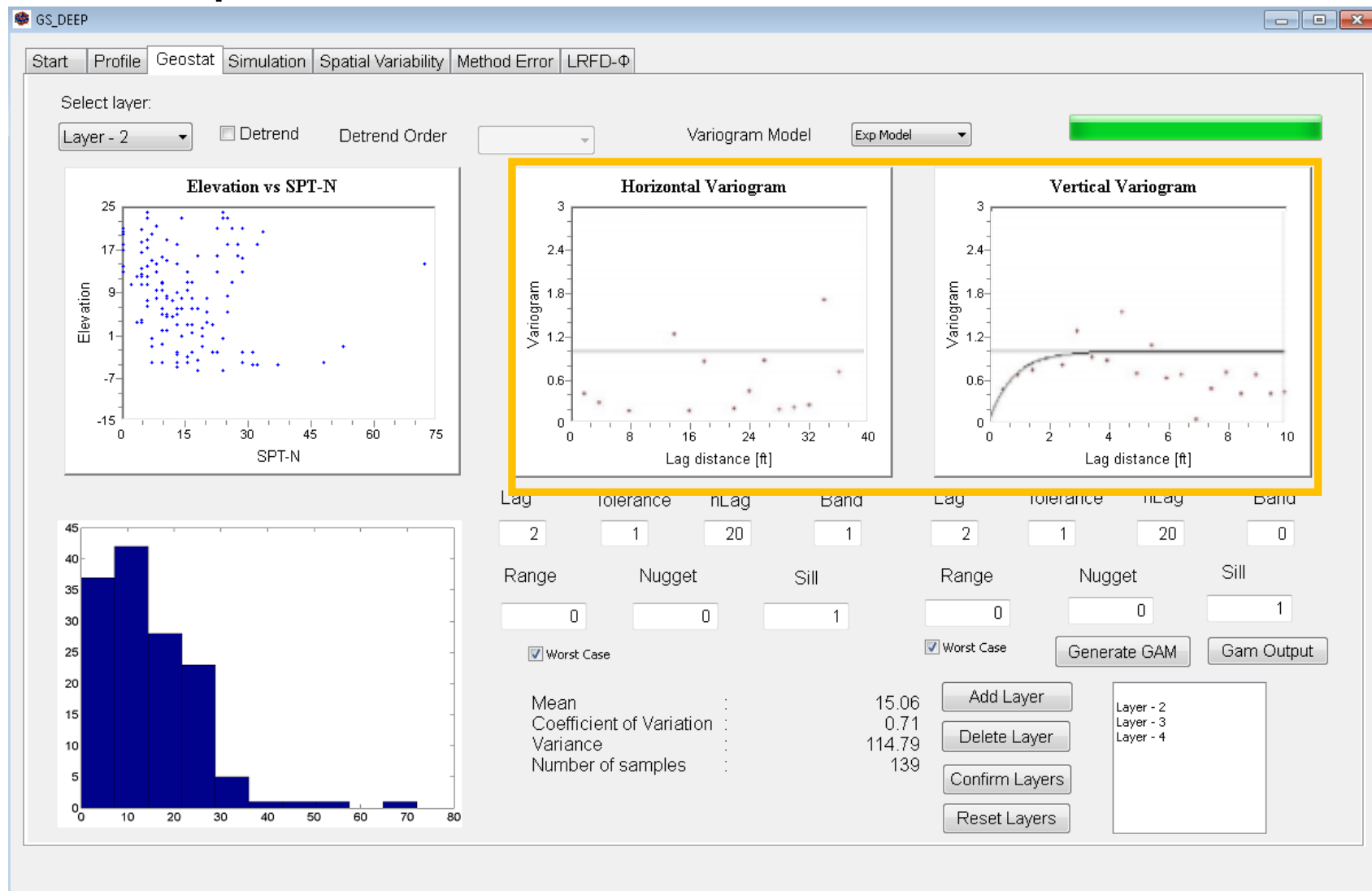
- Develop software documentation



Geostatistics tab

Proposed Project Tasks

- Develop software documentation



Geostatistics tab

Proposed Project Tasks

- Develop software documentation

The screenshot displays the GS_DEEP software interface. The main window has several tabs: Start, Profile, Geostat, Simulation, Spatial Variability, Method Error, and LPED. The Geostatistics tab is active. A dialog box titled "Gam outputs" is open, showing two tables of data. The left table is for vertical data (gam_v, lah_vdist, npairs_v) and the right table is for horizontal data (gam_h, lah_hdist, npairs_h). The first row of the left table is highlighted in blue. Below the tables are "OK" and "Cancel" buttons. In the background, a plot area shows a scatter plot with a fitted curve, and a "Gam Output" button is highlighted with a yellow box.

gam_v	lah_vdist	npairs_v
0.4725	2.0000	40.0000
0.6750	4.0000	89.0000
0.7565	6.0000	96.0000
0.9727	8.0000	17.0000
0.7986	10.0000	96.0000
1.5036	12.0000	17.0000
0.9215	14.0000	61.0000
0.8478	16.0000	52.0000
1.3983	18.0000	15.0000
0.6764	20.0000	46.0000
1.0766	22.0000	4.0000
0.6153	24.0000	31.0000
0.6372	26.0000	25.0000
0.0813	28.0000	6.0000
0.4879	30.0000	18.0000

gam_h	lah_hdist	npairs_h
0.4105	2.0000	19.0000
0.2948	4.0000	18.0000
0.1639	8.0000	1.0000
4.8255	10.0000	1.0000
4.0883	12.0000	3.0000
0.8928	14.0000	4.0000
0.1592	16.0000	1.0000
0.8185	18.0000	3.0000
0.1896	22.0000	2.0000
0.4399	24.0000	5.0000
0.8379	26.0000	9.0000
0.1865	28.0000	7.0000
0.2274	30.0000	37.0000
0.2466	32.0000	6.0000
1.4580	34.0000	6.0000

Geostatistics tab

Proposed Project Tasks

- Automate calls to axial capacity software, FB-Deep

GS_DEEP

Start Profile Geostat **Simulation** Spatial Variability Method Error LRFD-Φ

SHAFT

UWeight (pcf) Diameter (in)

Casing Length (ft)

Bell Length (ft) Bell Diameter (in)

EC (ksi)

Slump (in)

RPercent

Minimum Length (ft) Ground Surface Elevation (ft)

Maximum Length (ft)

Increment (ft) Water Table Elevation (ft)

Layer	Mean	CV	Varia...	Samp...	av	ah	Sill	Detrend
2	15.06	0.70	110.52	139	16.38	0.00	1.00	Yes
3	6.61	0.72	22.63	14	2.19	0.00	1.00	No
4	64.99	0.85	3064...	181	9.08	0.00	1.00	No

Simulation

Number of Simulations:

Conditional UnConditional

Select Boring:

Foundation Location

Northing:

Easting:

Horizontal distance from Boring:

Default RQD and REC to 1

Layer Separation

1

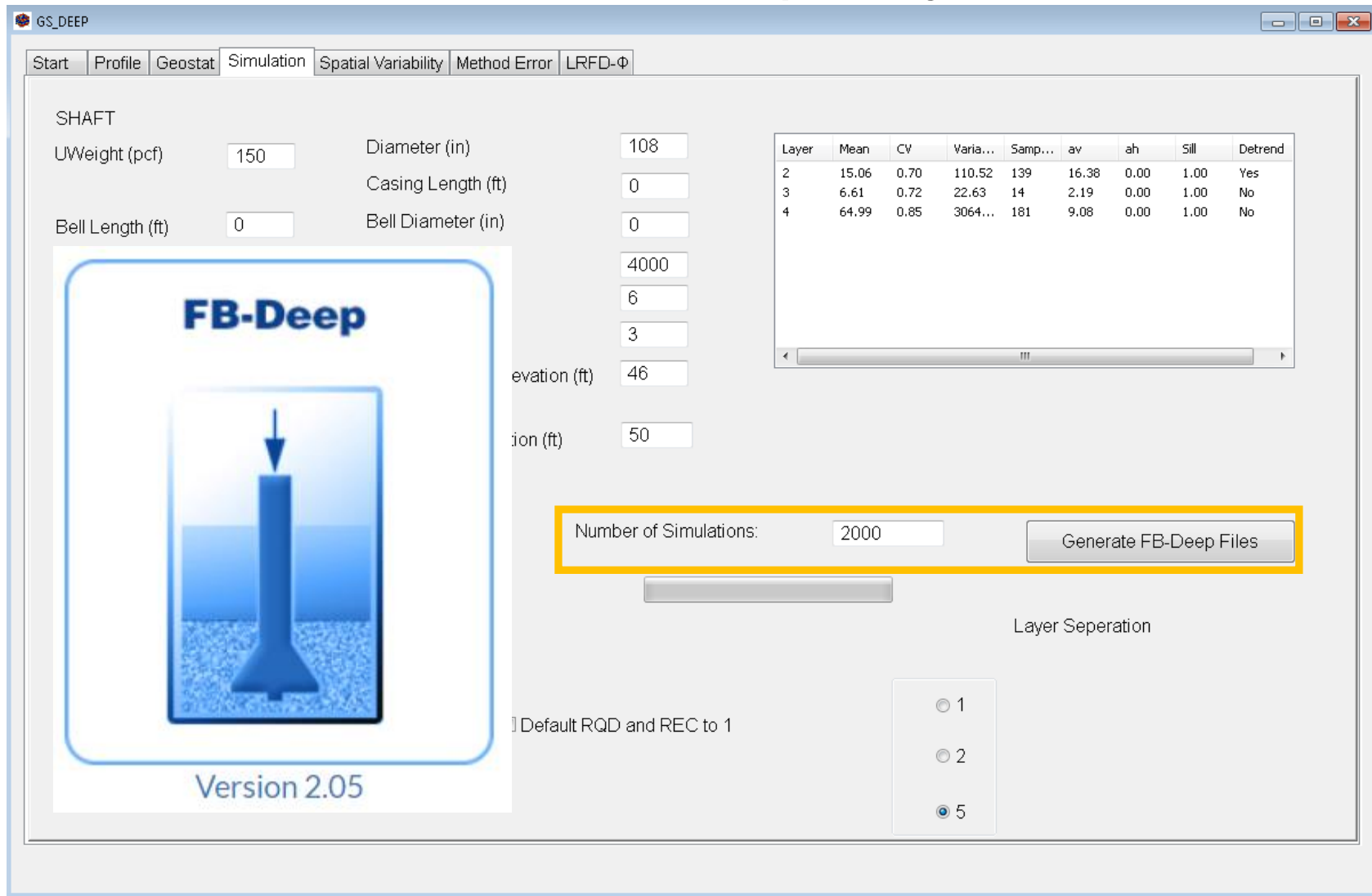
2

5

Simulation tab

Proposed Project Tasks

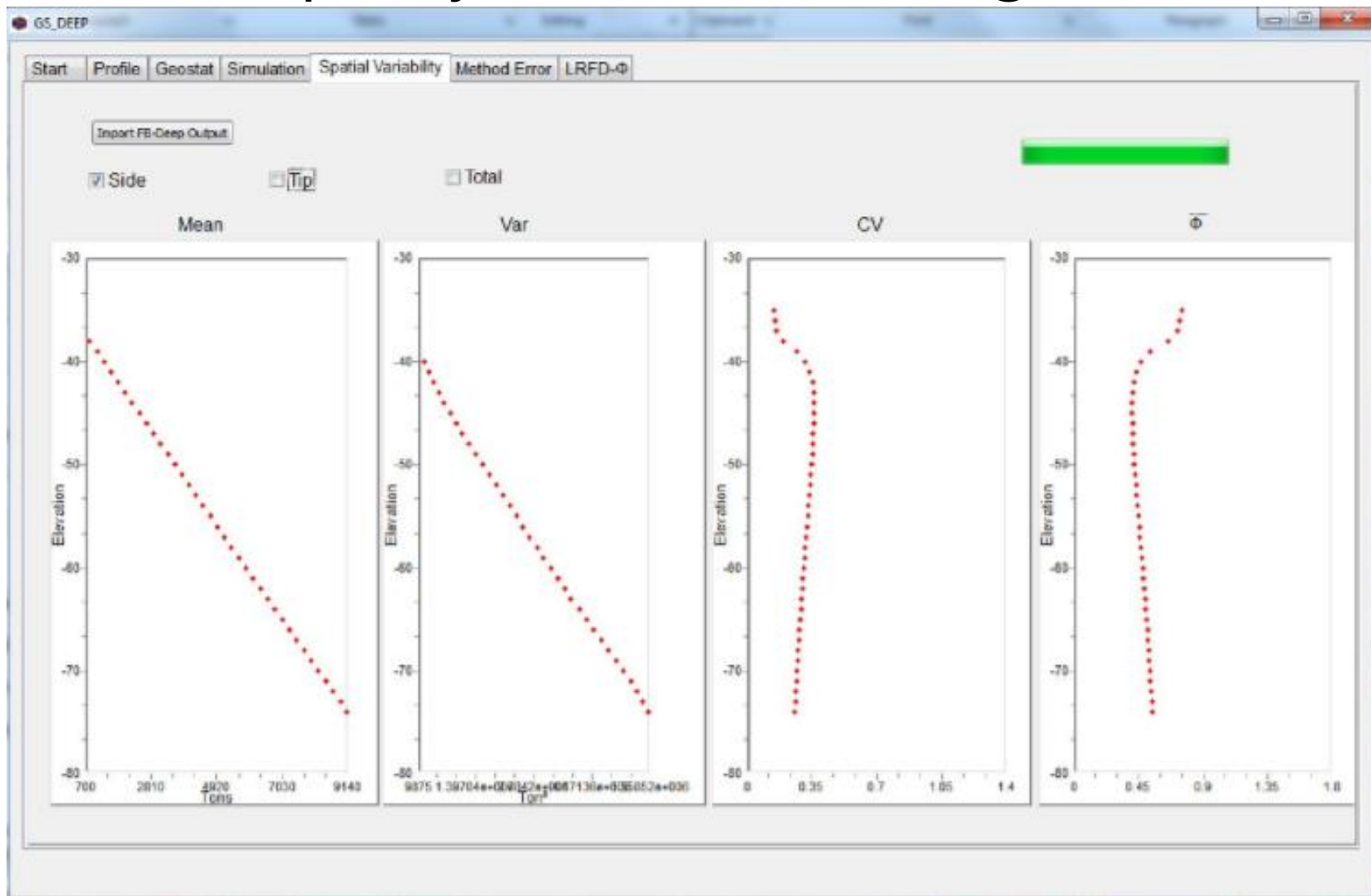
- Automate calls to axial capacity software, FB-Deep



Simulation tab

Proposed Project Tasks

- Conduct quality assurance testing



Spatial Variability tab

Proposed Project Tasks

- Conduct quality assurance testing

GS_DEEP

Start Profile Geostat Simulation Spatial Variability **Method Error** LRFD-Phi

Limestone [TSF]

	a	b	σ_e^2
Mcvay			
O'Neil			

Default
 Load Test

Drilled Shaft Soil [TONS]

	a	b	cVe
Clay			
Sand			

Default
 Load test

Continue

Method Error tab

Proposed Project Tasks

- Conduct quality assurance testing

GS_DEFP

Start Profile Geostat Simulation Spatial Variability **Method Error** LRFD- Φ

Limestone [TSF]

	a	b	σ_e^2
Mcvey			
O'Neil			

• Default
○ Load Test

Drilled Shaft Soil [TONS]

	a	b	CVe
Clay			
Sand			

Measured (tsf)

Predicted (tsf)

Load test

Soil

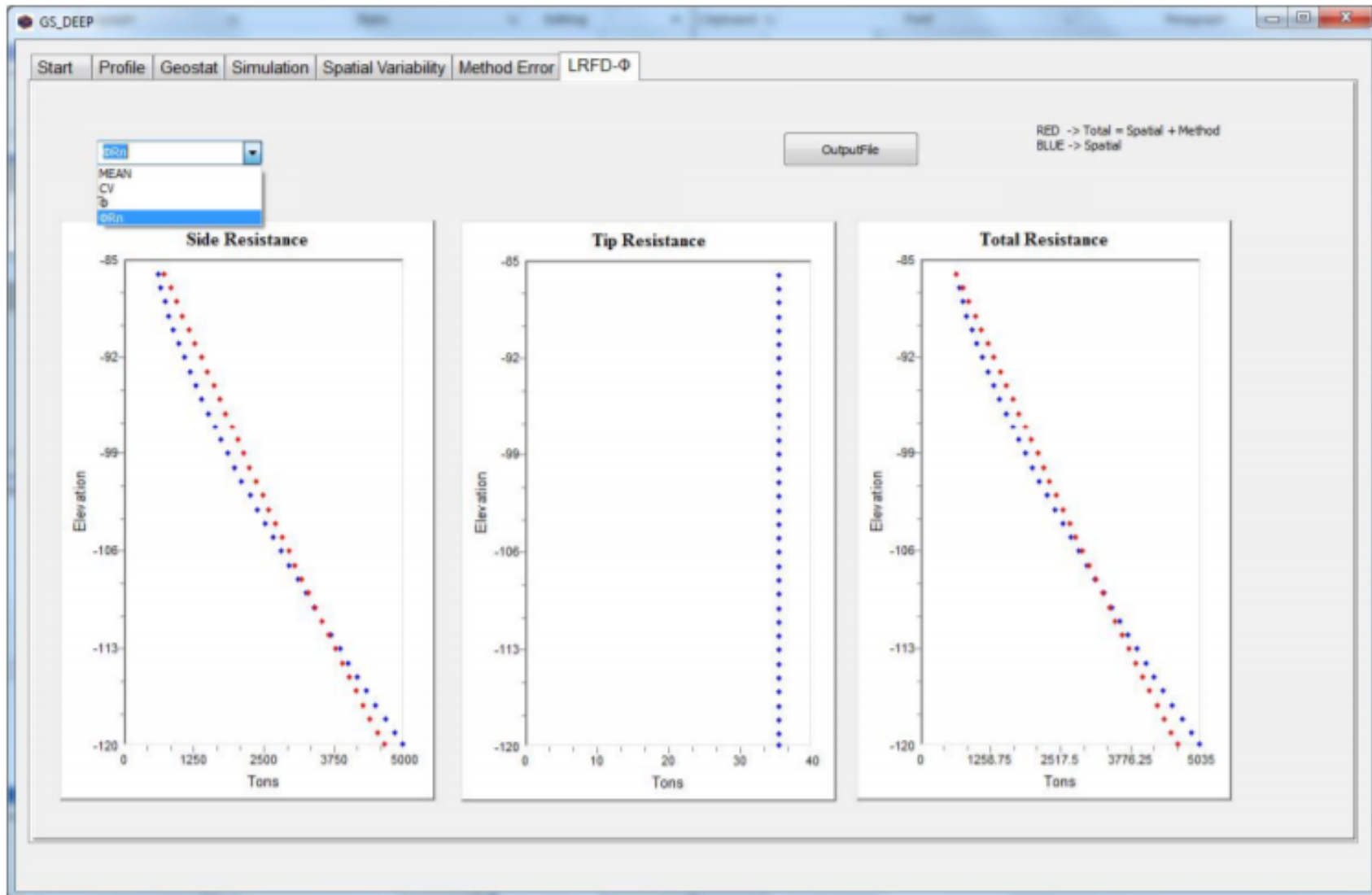
Example: Boring in footprint of non-redundant shaft

Continue

Method Error tab

Proposed Project Tasks

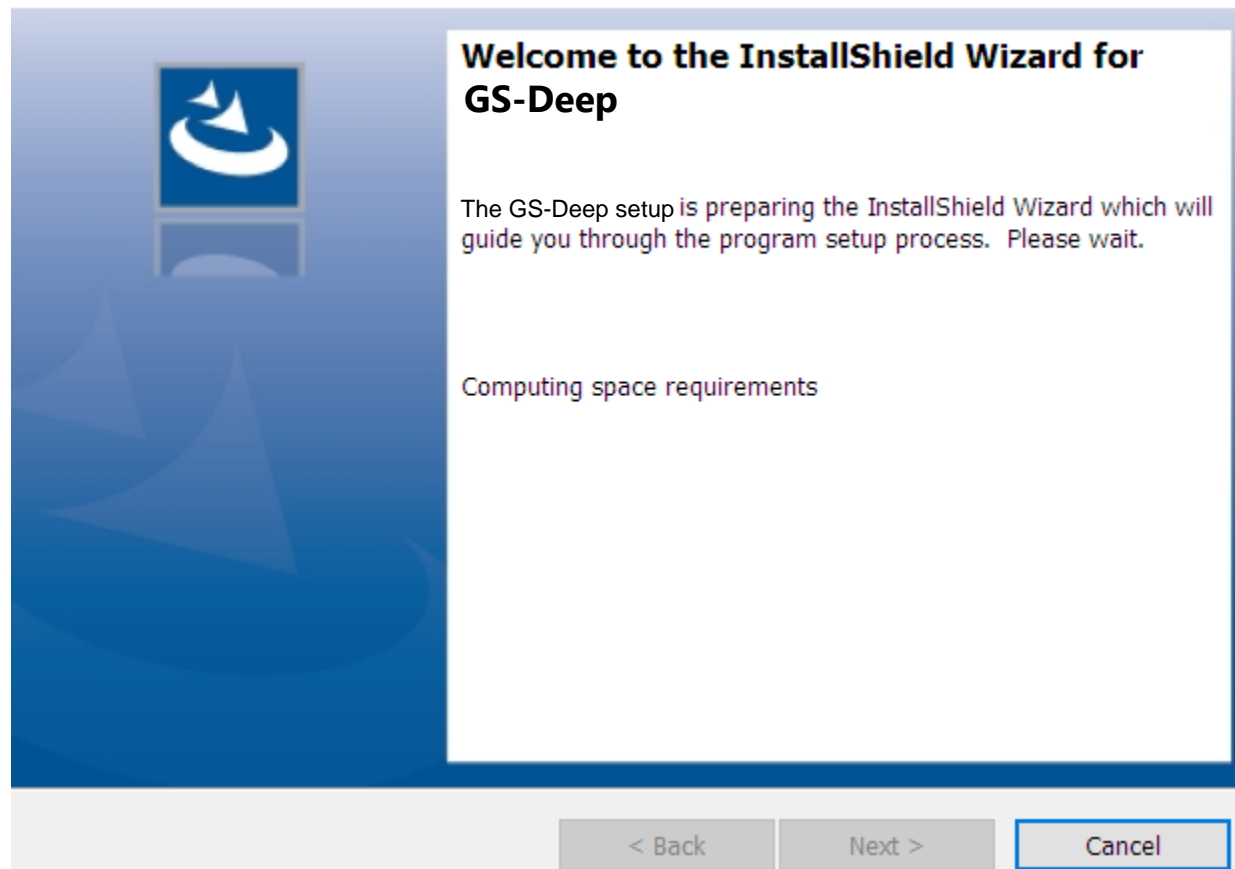
- Conduct quality assurance testing



LRFD- ϕ tab

Proposed Project Tasks

- Develop installation package and licensing
 - Requires use of FB-Deep



Example GS-Deep installation dialog

Agenda

- Introduction
- Proposed Project Tasks
 - Establish input file format and data read/write
 - Develop software documentation
 - Automate calls to axial capacity software, FB-Deep
 - Conduct quality assurance testing
 - Develop installation package and licensing
- Proposed Project Timeline

Agenda

- Introduction
- Proposed Project Tasks
 - Establish input file format and data read/write
 - Develop software documentation
 - Automate calls to axial capacity software, FB-Deep
 - Conduct quality assurance testing
 - Develop installation package and licensing
- Proposed Project Timeline

Proposed Project Timeline

- Total duration: 18 months
 - Task 1. Establish input file format and data read/write
 - Task 2. Develop software documentation
 - Task 3. Automate calls to axial capacity software, FB-Deep
 - Task 4. Conduct quality assurance testing
 - Task 5. Develop installation package and licensing
 - Task 6. Delivery of release version and official software documentation

Proposed Project Timeline

- Total duration: 18 months

	Pre	Months					
		1 - 3	4 - 6	7 - 9	10 - 12	13 - 15	16 - 18
1. Establish input file format and data read/write							
XML to Excel		█	█				
In-session data read/write			█				
2. Develop software documentation							
Help manual content for program use				█	█		
Example file sets and documentation				█	█	█	
3. Automate calls to FB-Deep							
Individual boring call		█	█				
Batch calls			█	█			
4. Conduct quality assurance testing							
Error catching and input data validation			█	█	█	█	
Internal beta testing					█	█	
5. Develop installation package and licensing							
Installation package					█	█	
Licensing						█	
6. Delivery of release version / documentation							
FDOT Beta testing						█	█

Proposed project timeline

Thank you

