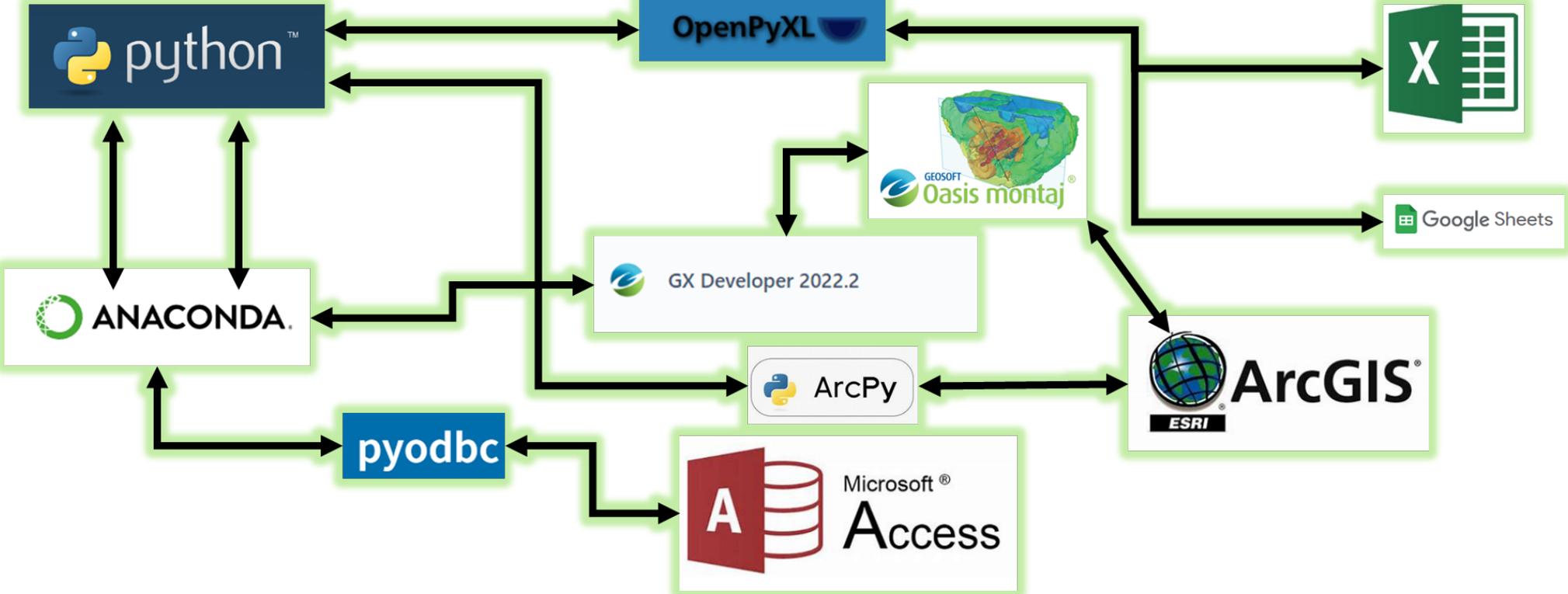


Geophysical data management and automation within the context of a large scale MMRP Project

April 5, 2023



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Trust. Performance. People.

Committed to Creating a Better Tomorrow

Formerly Used Defense Site: Camp Croft

Project 7 Munitions Response Site

In the past year Weston has employed robust data management practices at scale with respect to the remediation effort at Camp Croft, Spartanburg, South Carolina. The Project 7 Munitions Response Site (MRS) is a sizeable remediation effort, as the project includes 2,870 grids and a survey area of approximately 609 acres located within a rugged and densely wooded area of Croft State Park. Owing to this projects unique scale and sophistication, Weston would like to share challenges faced and learnings from managing the voluminous data set.

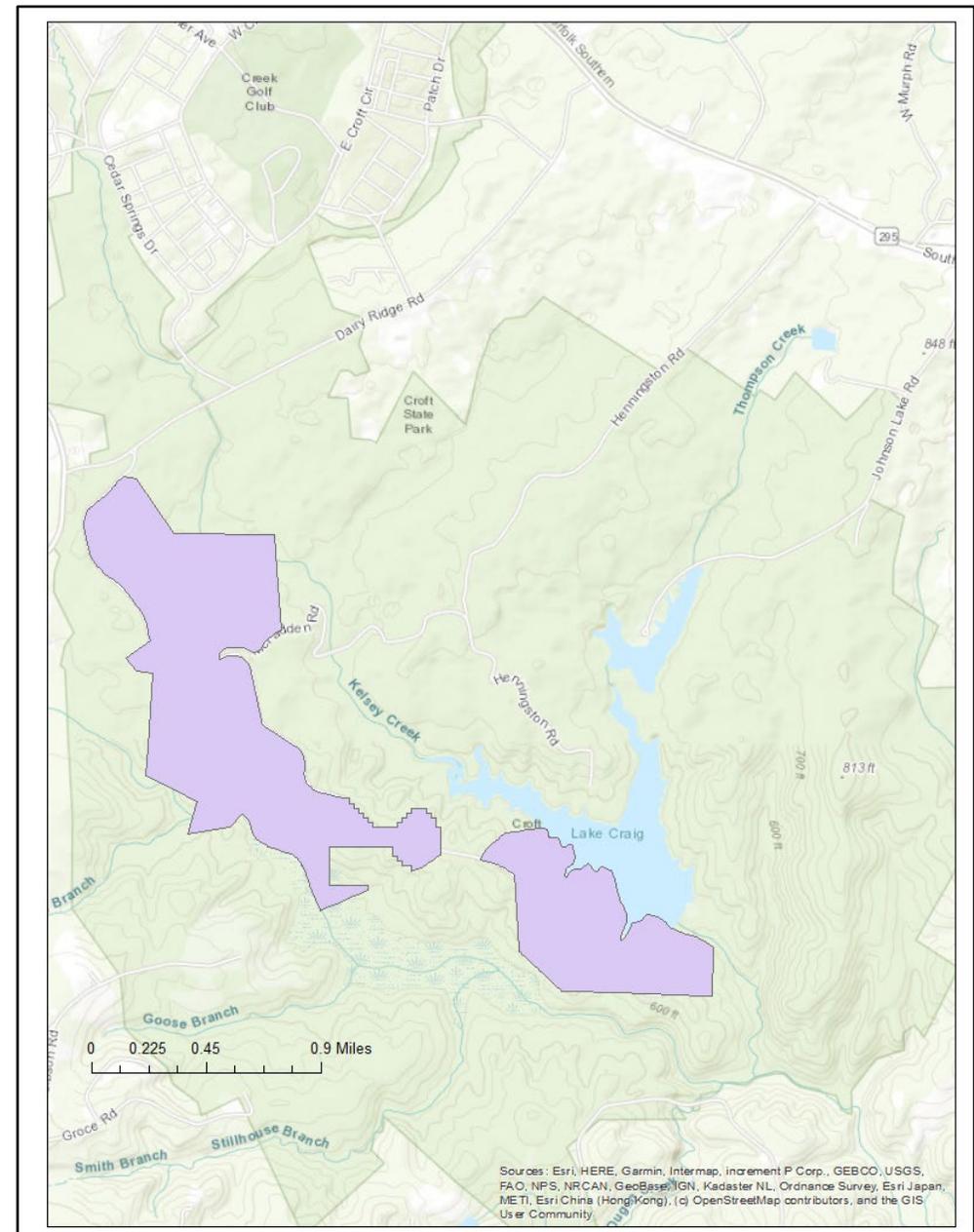
Project Overview

Goal: MEC Remediation

Location: Spartanburg

Stakeholders: Federal

State: SC



Data Management Tools and Project Execution

Outline Part 1

- Spreadsheet Software: MS Excel and Gsheets
- Relational Database Management
- Relational Database Management (Coverage Data Case Example)
- File Formatting and Schema
- Data Access, Storage and Delivery
- Data Access, Storage and Delivery (Cont.)



Spreadsheet Software: MS Excel and Gsheets

- Trade Offs:

- Excel functionality (Formulas, Keyboard Interface, Pivot Tables, etc...)
- Gsheets shareability (Cloud based, Simultaneous Filtering/Editing for multiple users, advanced conditional formatting, etc...)

- Project execution use cases:

- Deliverable pipeline progress tracking. (Gsheets)
- Intrusive investigations review process tracking. (Gsheets)
- Deliverable formatting. (Excel)
- Data analysis including field work progression forecasting. (Excel)

Grid	Email sent for QC?	Date of Internal QC	Date of Internal QC (QC Tracker Tab)	Date Received WRT	Draft Submitted to USACE via FTP	Comments	QC Comments / Suggested Corrective Action
BN26	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
BO16	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
BO32	Issues		Not submitted for QC	2/9/2023	Not Submitted	Missing IVS/20220811APEX13/IVSPM	
BO32	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
BO33	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
BP17	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
BP19	2/20/2023		2/23/2023	2/9/2023	Not Submitted	Metallic linear feature added to map and server -ko	
BP26	2/23/2023		Pending QC Review	2/9/2023	Not Submitted		
BQ16	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
BR25	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
BT31	2/23/2023		Pending QC Review	2/9/2023	Not Submitted		
BT31	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
BV33	2/20/2023		2/23/2023	2/9/2023	Not Submitted	Metallic linear feature added to map and server -ko	
BW25	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
BW32	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
BZ41	2/20/2023		2/23/2023	2/9/2023	Not Submitted	Metallic linear feature added to map and server -ko	Missed seed! The only target within MGO is a Cat3 with a good location fit. It has a comment of "secondary poor library match" in the ranked data spreadsheet. This grid is part of NCA-018.
BZ42	2/20/2023		2/23/2023	2/9/2023	Not Submitted	metallic linear features added to map and server -jtc	
CG16	2/20/2023		2/23/2023	2/9/2023	Not Submitted	field map in notes - jtc	
CG16	2/20/2023		2/23/2023	2/9/2023	Not Submitted		
CG16	2/20/2023		2/23/2023	2/9/2023	Not Submitted	field map in notes - jtc	
CG16	2/20/2023		Pending QC Review	2/9/2023	Not Submitted	metallic linear features added to map and server -jtc	

Relational Database Management

- Relational database software enabled with Structure Query Language (SQL) allowed Weston to maintain large data sets and maintain data integrity.
 - Tools:
 - Access database (Target and intrusive result deliverables)
 - ESRI Spatial Database Engine (Master coverage shapes)
 - Advantages:
 - Query creation / Accessibility
 - Remote table linking. (Respond Fast - UXO®, WESTON)

Target Threshold Editor

https://uxo.westonproject.net/v5/MEC/Edit/TargetThresholdEditor.aspx

Home MEC Geophysics GIS Admin

Camp Croft (AGC) > RespondFast - UXO > MEC > Target_Threshold_Editor

Toggle Columns to Display:

- Property
- Target Classification
- TOI Size Band
- Target Description
- Dig Item Category
- Dig Item Comments
- Photo ID

Area of Concern: All | Property / Search Area: ED-114 | Target: All | Go

Area_of_Concern	Search Area	Target ID	Item #	Target Classification	TOI Size Band	TOI Decision Statistic	Target_Description	Dig_Date	UXO Team	Item Count	Item Category	Item Type	Item_Comments	Photo_ID
Project 07 (Funded Grids)	ED-114	00006	1	TOI	37mm-81mm	0.92184	37mm Projectile	2023-02-27	Team 1	1	NMRD	Non-MD Scrap Metal		115-5305
Project 07 (Funded Grids)	ED-114	00011	1	TOI	37mm-81mm	0.9062	60mm Mortar	2023-02-27	Team 1	1	NMRD	Non-MD Scrap Metal		115-5307
Project 07 (Funded Grids)	ED-114	00020	1	TOI	37mm-81mm	0.88693	Small ISO80	2023-02-27	Team 1	1	Seed	Blind QC 1' x 4" Pipe	Blind QC Seed #5B21	115-5306
													QA Seed #3893	115-5308

AGC_Database_20220801 : Database - D:\WESTON\Camp Croft\Deliverables\AGC_Database_20220801\AGC_Database_20220801

File Home Create External Data Database Tools Help Table Fields Table Tell me what you want to do

Import & Link

Export

All Access Objects

Search...

Tables

dbo_AGC_Items1

Select Data Source

File Data Source Machine Data Source

Data Source Name	Type	Description
dBASE Files	User	
Excel Files	User	
MS Access Database	User	
UXOFastCampCroft_v5_AGC	User	UXOFastCampCroft_v5_AGC

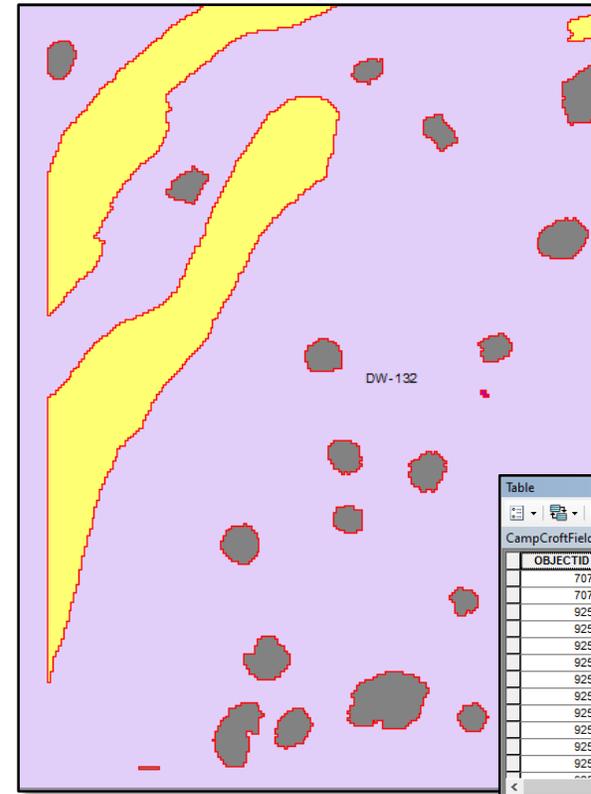
A Machine Data Source is specific to this machine, and cannot be shared. "User" data sources are specific to a user on this machine. "System" data sources can be used by all users on this machine, or by a system-wide service.

OK Cancel Help

Project_Site	Area_of_Cor	Search_Area_ID	Target_Nurr	Rank	TR_ID	Target_ID
Former Camp	Project 07 (Fun ED-114		20	4	ED114-00020	ED114-00020
Former Camp	Project 07 (Fun CN-45		30	13	TR-00030	CN45-00030
Former Camp	Project 07 (Fun DZ-109		207	27	DZ109-00207	DZ109-00207
Former Camp	Project 07 (Fun CV-75		27	3	CV75-00027	CV75-00027
Former Camp	Project 07 (Fun DX-106		346	32	DX106-00346	DX106-00346
Former Camp	Project 07 (Fun DL-114		81	10	DL114-00081	DL114-00081
Former Camp	Project 07 (Fun EB-119		59	16	EB119-00059	EB119-00059
Former Camp	Project 07 (Fun DO-116		40	3	DO116-00040	DO116-00040
Former Camp	Project 07 (Fun EB-106		29	3	EB106-00029	EB106-00029
Former Camp	Project 07 (Fun CI-27		28	6	TR-00028	C127-00028
Former Camp	Project 07 (Fun DA-76		260	59	DA76-00260	DA76-00260
Former Camp	Project 07 (Fun EC-128		161	19	EC128-00161	EC128-00161
Former Camp	Project 07 (Fun CC-27		120	9	TR-00120	CC27-00120
Former Camp	Project 07 (Fun DK-117		22	2	DK117-00022	DK117-00022
Former Camp	Project 07 (Fun DD-78		70	1	DD78-00070	DD78-00070
Former Camp	Project 07 (Fun DP-113		9002	2	DP113_9002	DP113_9002
Former Camp	Project 07 (Fun CZ-80		10	4	CZ80-00010	CZ80-00010
Former Camp	Project 07 (Fun AP-31		8	2	TR-00008	AP31-00008
Former Camp	Project 07 (Fun CI-25		28	3	TR-00028	C125-00028
Former Camp	Project 07 (Fun CJ-34		19	1	TR-00019	C134-00019
Former Camp	Project 07 (Fun CG-49		57	3	TR-00057	CG49-00057
Former Camp	Project 07 (Fun DO-113		62	1	DO113-00062	DO113-00062
Former Camp	Project 07 (Fun CH-28		42	5	TR-00042	CH28-00042

Relational Database Management (Coverage Data Case Example)

- Simpler can be better for data integrity and usability (Coverage data example):
 - Problem:
 - Limitation on automation and data usability by using variable coverage feature descriptions.
 - Solution:
 - 3 feature class “Types” standardization (Analog, Obstruction and Gap Target)



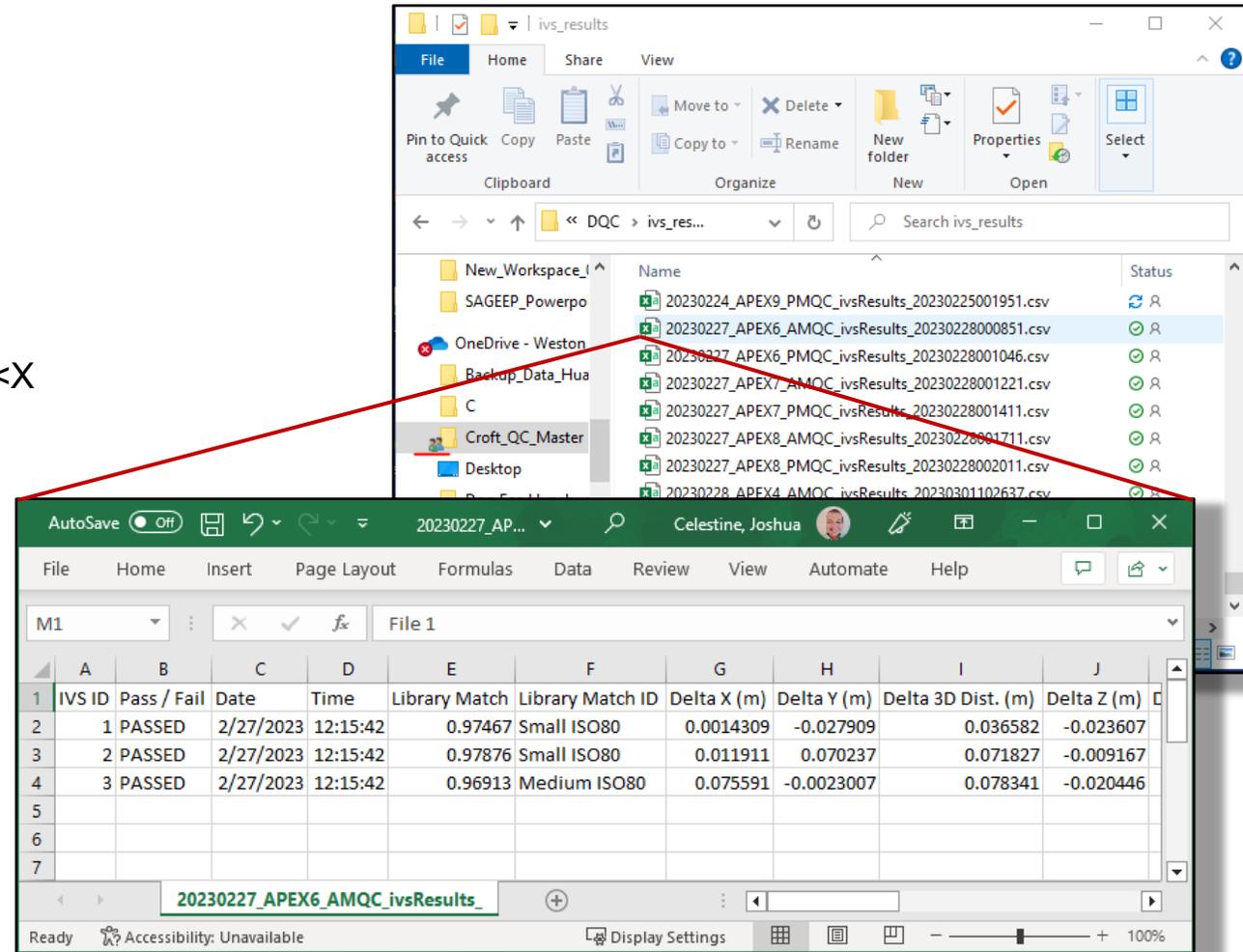
The screenshot shows the Layer Properties dialog box in ArcGIS, specifically the Symbology tab. The 'Draw categories using unique values of one field' option is selected. The 'Value Field' is set to 'Type'. The legend shows three categories: Analog (yellow), Gap Target (purple), and Obstruction (grey). The 'Count' column shows the number of features for each category: Analog (3), Gap Target (1), and Obstruction (29).

The screenshot shows a table view in ArcGIS for the layer 'CampCroftFieldData_GEO.WSGISUSER.Croft_Coverage_Gaps_Master'. The table has the following columns: OBJECTID, id, Grid, Type, Acreage, AreaSFT, Y_centroid, X_Centroid, and AreaSOM. The data is as follows:

OBJECTID	id	Grid	Type	Acreage	AreaSFT	Y_centroid	X_Centroid	AreaSOM
70749	0	DW130	Obstruction	0.000187	8.151846	3858213.83887	423845.352556	0.757334
70750	0	DW130	Obstruction	0.000966	42.058083	3858189.12431	423823.060958	3.907339
92573	0	DW132	Obstruction	0.000257	11.194467	3858203.55304	423905.562115	1.04
92574	0	DW132	Obstruction	0.000578	25.18755	3858204.40571	423899.580598	2.34
92575	0	DW132	Obstruction	0.000331	14.42364	3858206.48609	423885.027313	1.34
92576	0	DW132	Obstruction	0.000279	12.163219	3858208.57745	423894.796637	1.13
92577	0	DW132	Obstruction	0.000348	15.177114	3858209.04443	423909.199574	1.41
92578	0	DW132	Analog	0.009096	396.219542	3858209.13266	423883.457061	36.81
92579	0	DW132	Obstruction	0.001342	58.448033	3858210.25906	423901.224162	5.43
92580	0	DW132	Obstruction	0.000205	8.934046	3858210.99557	423892.033976	0.83
92581	0	DW132	Obstruction	0.000319	13.885444	3858211.4226	423880.091163	1.29
92582	0	DW132	Obstruction	0.000015	0.645835	3858212.454	423909.94	0.06

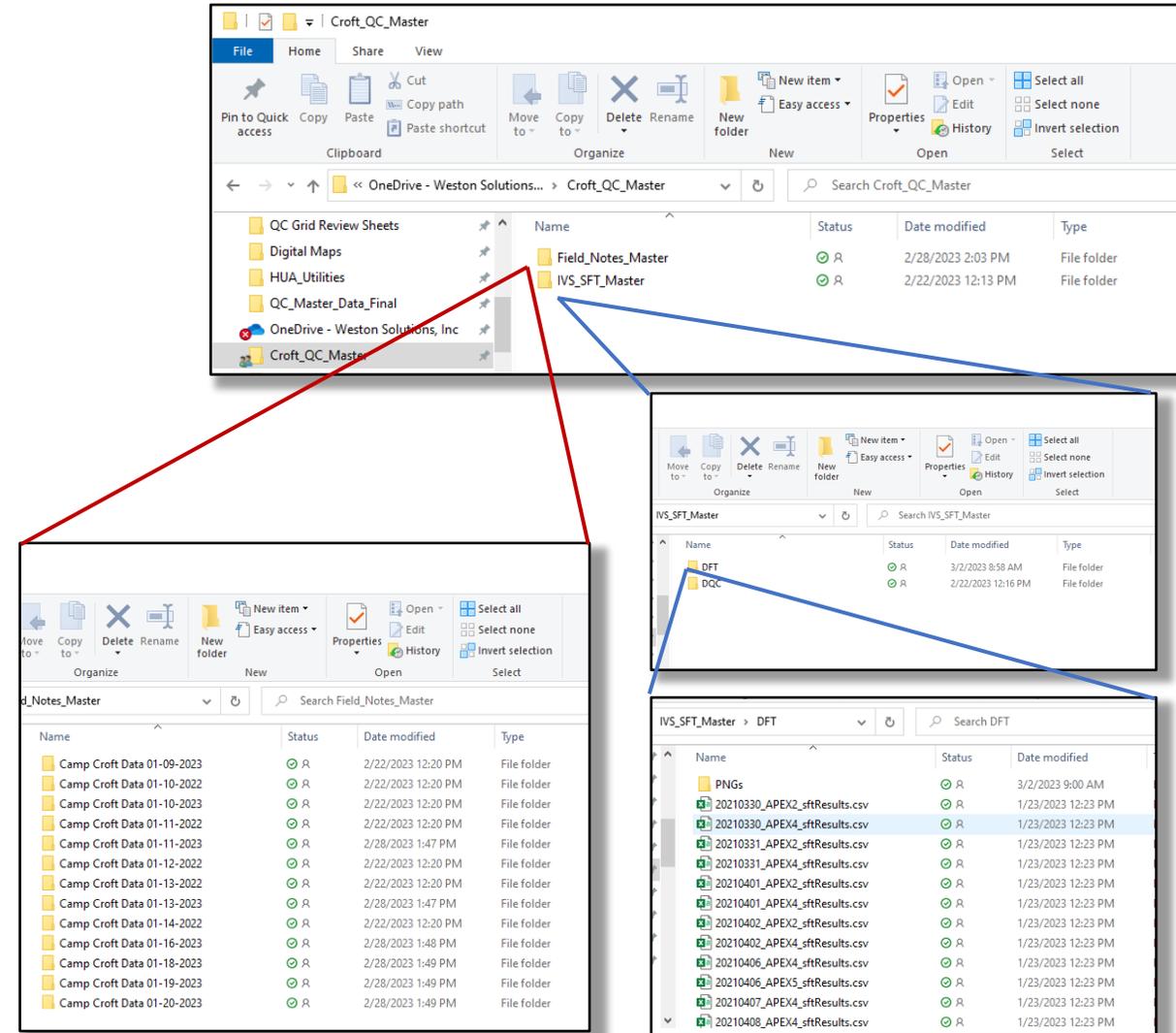
File Formatting and Schema

- File formatting and schema consistency was key for the project's execution.
 - IVS / SFT Result deliverables:
 - Consistent file names. (Example : 20<XXXXXX>_APEX<XX>_AMQC_ivsresults ...<XX>)
 - Consistent file schemas. (Field / Column headers)
 - Consistent file formats were used to maintain data integrity and end user accessibility. (.csv, .xls, .png , .jpg, etc ...).



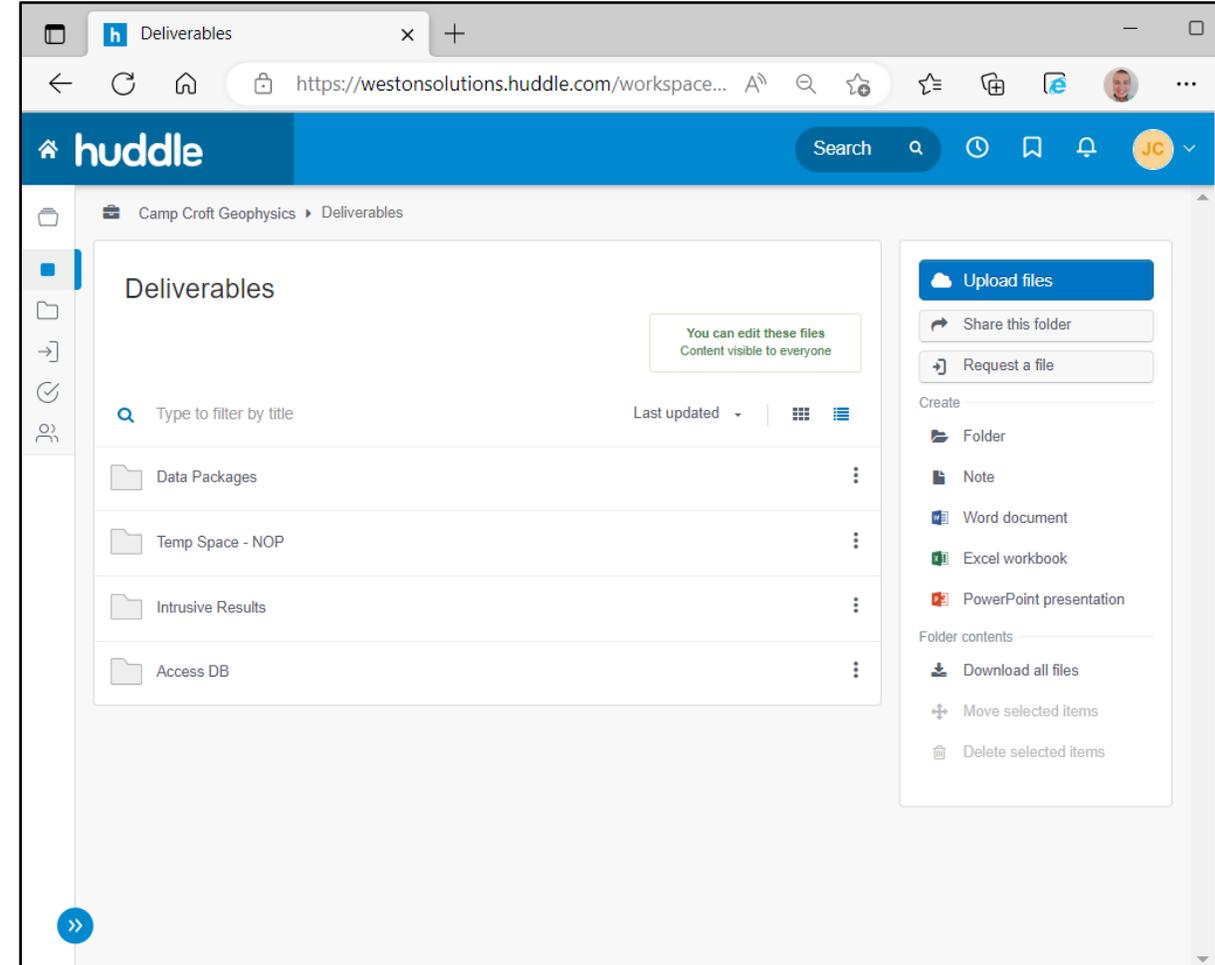
Data Access, Storage and Delivery

- Weston found secure and creative ways to streamline data delivery and access between project stakeholders in a remote work setting.
 - Daily instrument test and field data were stored in a windows file structure within a shared one drive folder.
 - Script runtime was reduced when comparing runtimes with files stored on a Network attached -storage (NAS) device.



Data Access, Storage and Delivery (Cont.)

- Weston found that delivering the data represented challenges as well due to the volume of deliverable materials.
 - Problem:
 - Voluminous data, multiple stake holders (internal/external) and remote work environment.
 - Solution:
 - Huddle File Transfer Protocol (FTP) Site with shared access.



Automation with Python

Outline Part 2

```
Apply formatting to QC Comments field 11/11/2022 - jtc
print('\nFormat cells for output spreadsheet')
for file in os.listdir(output_path_for_deliverables_sheets):
    base_name_of_file = os.path.basename(file)
    grid_name_pattern = re.compile(r'([a-zA-Z0-9_]+)')
    grid_name = grid_name_pattern.findall(base_name_of_file)
    pdf_file = file.replace('.xlsx', '.pdf')

    # Load each workbook and apply formatting
    wb = openpyxl.load_workbook(filename=os.path.join(output_path_for_deliverables_sheets, file))
    ws = wb.active

    # Setup thin black borders to apply
    border = openpyxl.styles.borders.Side(border_style='thin', color='FF000000')
    thin = openpyxl.styles.borders.Border(left=border, right=border, bottom=border, top=border)

    # Define alignment setting for all cells, center alignment
    center_align = openpyxl.styles.Alignment(horizontal='center')

    # Add 3 rows to QC Comments field
    ws.insert_rows(idx=1, amount=3)

    # Merge cells to include QC Comments field
    ws.merge_cells('A1:B1')

    # Switch ranges to include QC Comments field
    ws.merge_cells('A3:A3')

    ws['A1'] = 'Grid/Property ID'
    ws['C1'] = 'Grid/Property ID'

    ws['A3'] = 'ABC Survey Results'

    ws['A1'] = 'Case example (Grid deliverable preparation)'
    ws['A1'].font = openpyxl.styles.Font(bold=True)

    ws['C1'] = 'Case example (Geosoft map automation)'
    ws['C1'].font = openpyxl.styles.Font(bold=True)

    ws['A3'] = 'Case example (Dig sheet generator)'
    ws['A3'].font = openpyxl.styles.Font(bold=True)

    ws['A1'] = 'Case example (Polygon to shape conversion)'
    ws['A1'].font = openpyxl.styles.Font(bold=True)

    ws['C1'] = 'Case example (Geosoft map automation)'
    ws['C1'].font = openpyxl.styles.Font(bold=True)

    ws['A3'] = 'Case example (Dig sheet generator)'
    ws['A3'].font = openpyxl.styles.Font(bold=True)

    # Apply cumulative changes to entire spreadsheet, change borders and alignment for all cells
    for row in ws.iter_rows(min_row=3, min_col=ws.min_column, max_row=ws.max_row, max_col=ws.max_column):
        for cell in row:
            cell.border = thin
            cell.alignment = center_align

    # Re-format cells for output spreadsheet
```

```
# Apply text wrapping to QC Comments field 11/11/2022 - jtc
for row in ws[5:ws.max_row]:
    cell = row[7]
    cell.alignment = openpyxl.styles.Alignment(horizontal='center', vertical='center')

# Set row 2 height so (cm) is visible
ws.row_dimensions[5].height = 30

# Apply number formatting to number easting and northing
for row in ws.iter_rows(min_row=5, min_col=3, max_row=ws.max_row, max_col=4):
    for cell in row:
        cell.number_format = '###0.000'

# Apply number formatting to depths
for row in ws.iter_rows(min_row=5, min_col=6, max_row=ws.max_row, max_col=6):
    for cell in row:
        cell.number_format = '##0.0'

# Add footer with 1 of ...
ws.HeaderFooter.differentFirst = True
ws.HeaderFooter.firstFooter.center.text = '1 of 1'

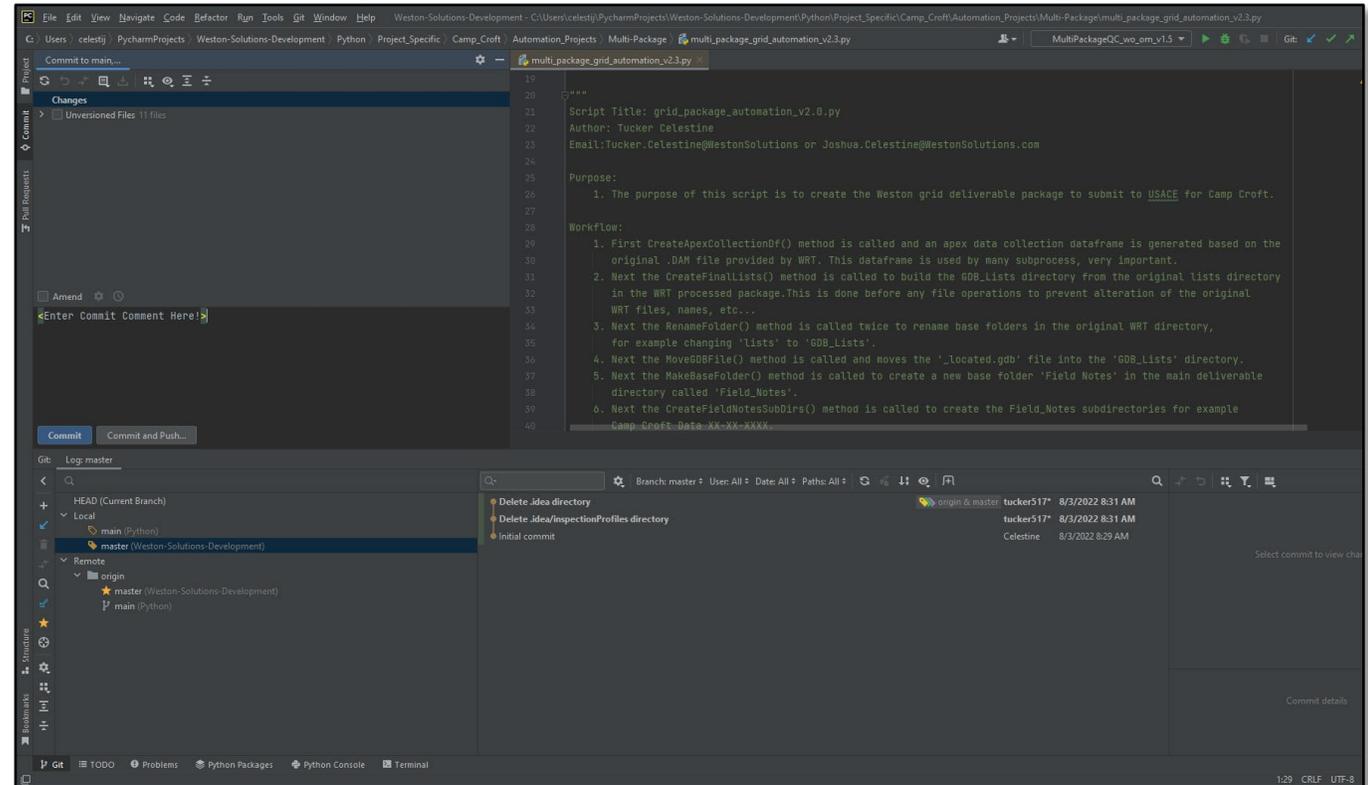
# Get range start for moving cells
range_start = ws.max_row + 1

for k, v in unique_analog_dfs.items():
    if k == grid_name:
        for r in dataframe_to_rows(v, index=False, header=True):
            ws.append(r)
            pass

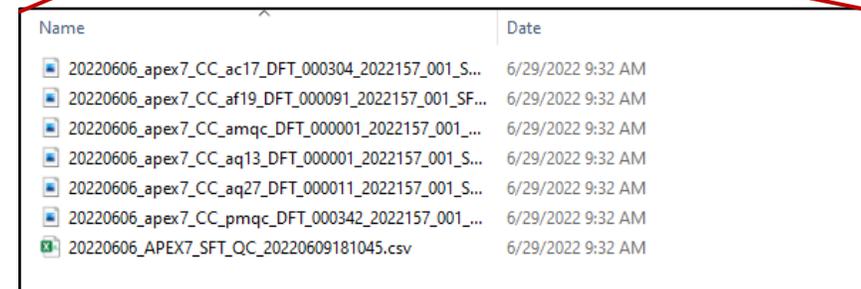
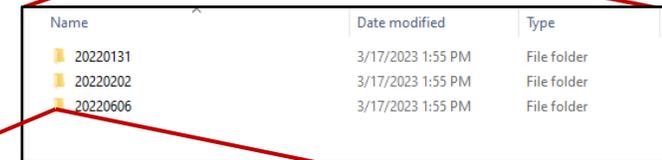
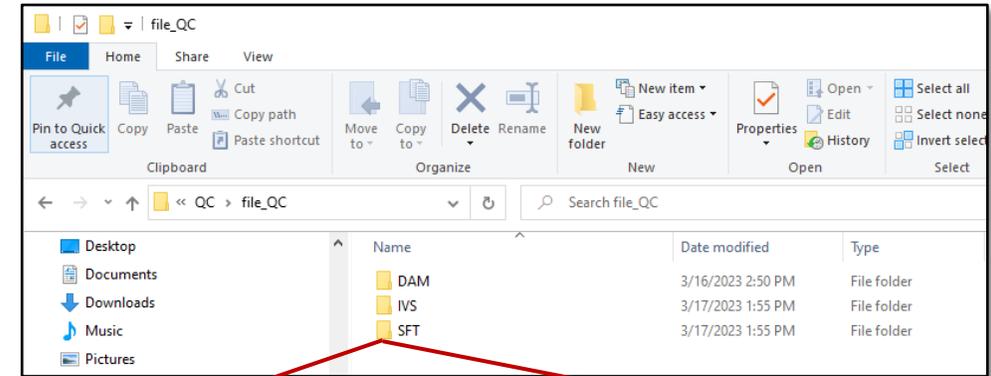
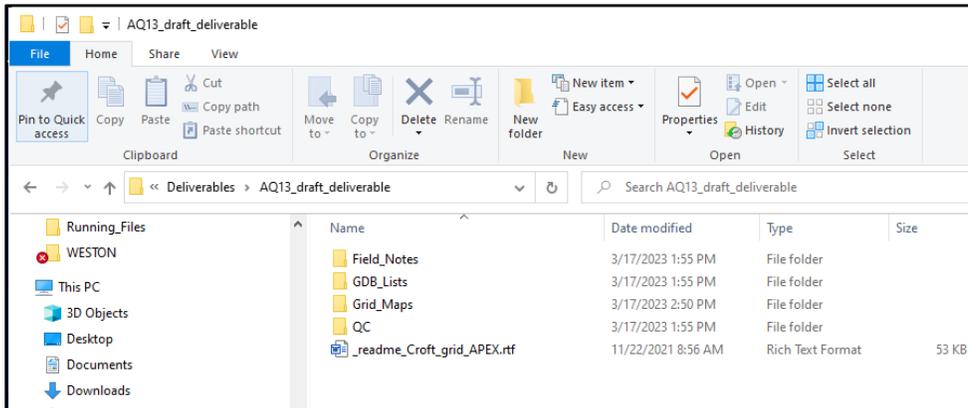
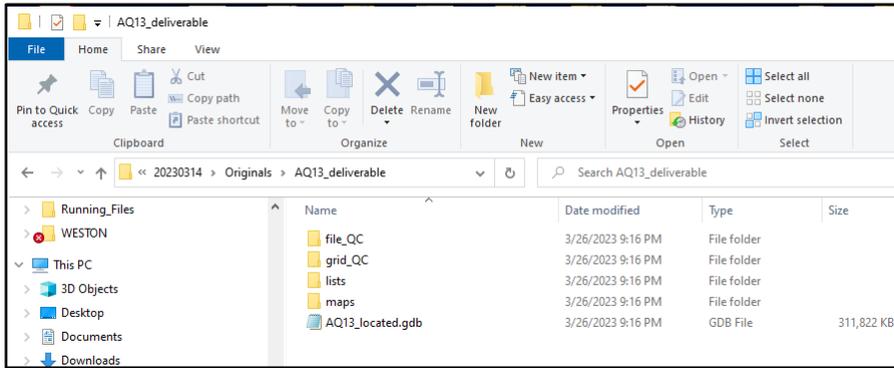
# Get the final range for moving cells down
range_final = ws.max_row
range_string_start = 'A{}'.format(range_start)
# Change range to include new field, 11/11/2022 - jtc
range_string_end = 'H{}'.format(range_final)
move_range = range_string_start + range_string_end
```

Python development process overview.

- Tools:
 - Anaconda / Python (Virtual Environments)
 - Pycharm (IDE)
 - GitHub (VCS)
- Advantages:
 - Dependency requirement tradeoffs. (Anaconda/Python)
 - Additional functionality. (Anaconda)
 - Python Enhancement Proposal (PEP) suggestions. (IDE)
 - Streamlined version tracking and repository syncing. (VCS)



Case example (Grid deliverable preparation)



Case example (Geosoft map automation)

- Problem:

- Automate generation of supplemental targets Geosoft database and plot on map view.
- Import ESRI layer file into map view.
- Import coverage shape legend.

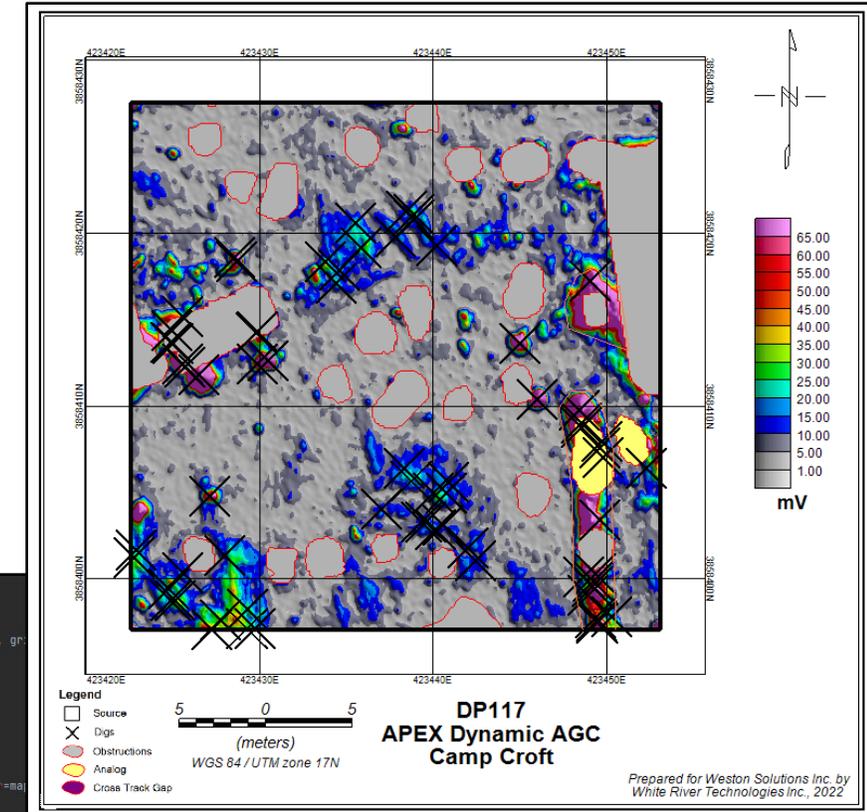
- Solution:

- Weston utilized Geosoft's GX Developer to generate functions within our pre-existing automation.
- Functional or modular programming was key here in the larger scheme of the automation.

```
def PlotTargetsGDB():
    global map_file
    global map_folder
    map_file = os.path.join(cwd + os.sep + 'Grid_Maps', gr
    map_folder = os.path.join(cwd, 'Grid_Maps')
    cmap_zn = gxgroup.Color_map(color_zn_file)
    plotting_grp_name = grid_name + '_Digs'
    error = gxapi.str_ref("Problem unpacking map!")

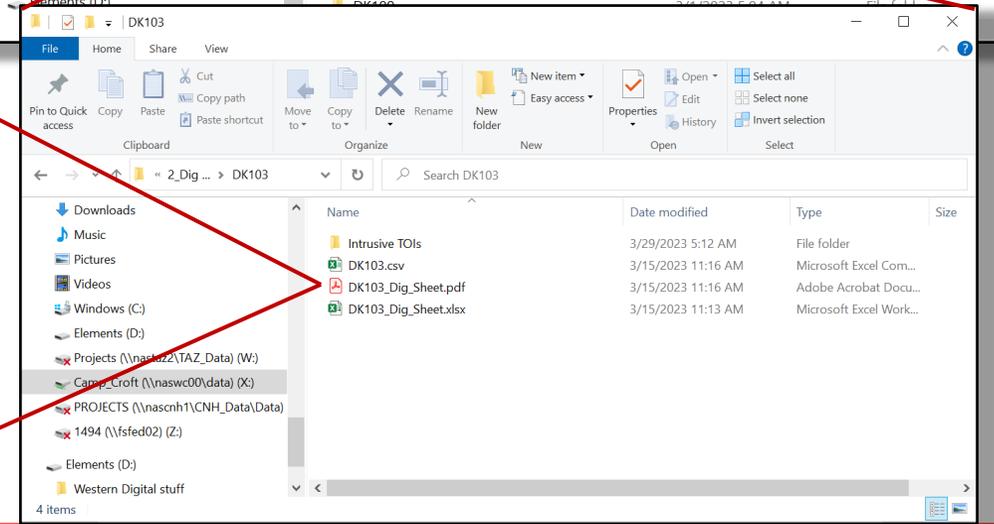
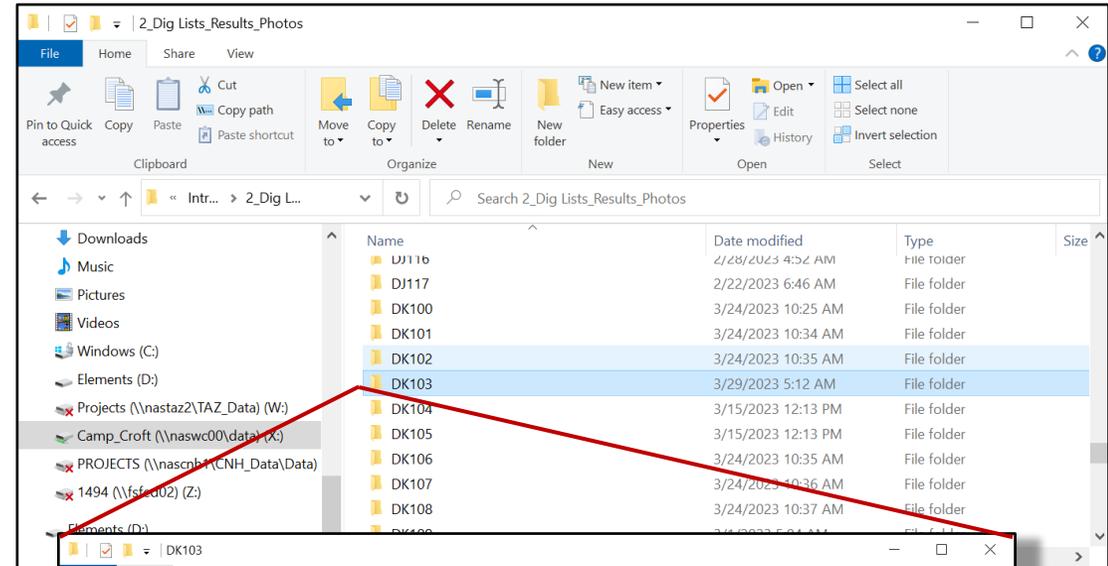
    with gxmap.Map.open(map_file) as gmap:
        # Unpack the map files
        gmap.gxmap.un_pack_files_to_folder(force=1, dir=ma

    with gxdb.Geosoft_gdb.open(os.path.join(cwd + os.sep + lists_dir, grid_name + targets_gdb_suffix)) as gdb:
        # defines data to store in numpy array from x,y,z channels to plot
        npd, ch, fid = gdb.read_line('Digs', channels=['UTM_E_m_', 'UTM_N_m_', 'Depth_m_'])
        # Open the view to put the new color symbols group in.
        with gxview.View.open(gmap, 'data') as v:
            gxgroup.Color_symbols_group.new(v, plotting_grp_name, data=npd, color_map=cmap_zn, symbol=3)
            # Open the new color symbols group to change the scaling of the x's
            with gxgroup.Color_symbols_group.open(v, plotting_grp_name) as cg:
                cg._gxcsymb.set_scale(2.24)
            cg.close()
        v.close()
    gdb.close()
    gmap.close()
```



Case example (Dig sheet generator)

- Problem:
 - Weston needed an automated solution to create dig sheets for our intrusive teams.
- Solution:
 - Multi-functional python automation using pandas with Openpyxl.

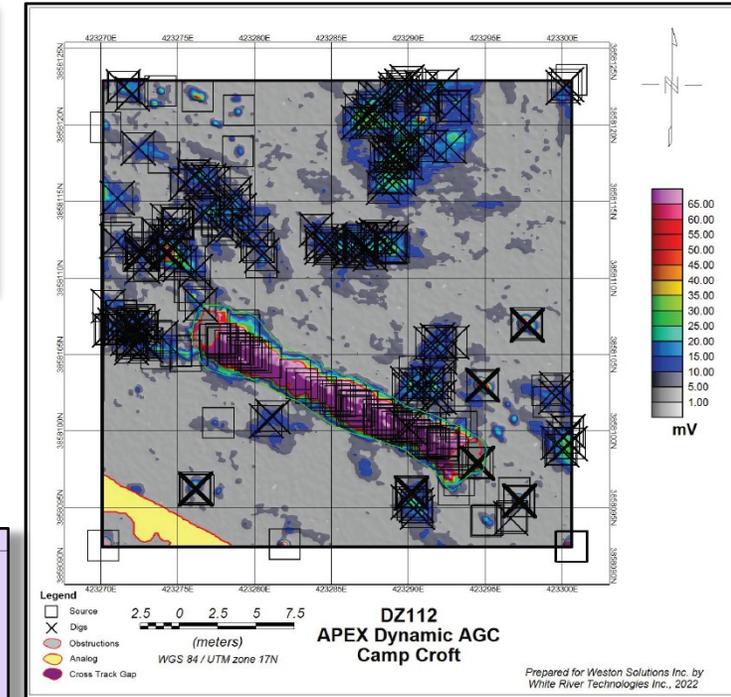
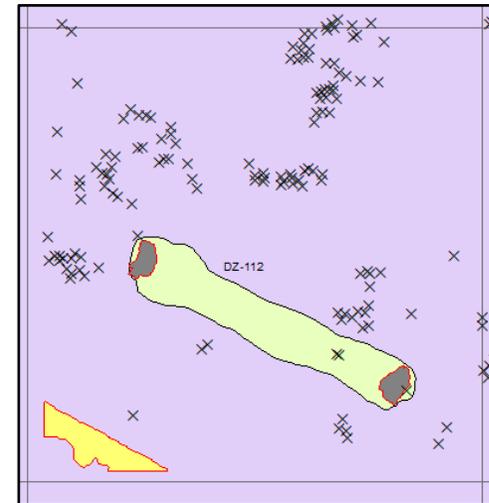


Grid/Property ID		Camp Croft Grid DK103					
Target ID	Target Classification	Position		Description	Predicted Depth (cm)	Arch Status	QC Comment
		Easting	Northing				
DK103-00007	Cannot Analyze	422996.038	3858580.093		12.4	No	
DK103-00031	TOI	422998.313	3858571.451	Medium ISO 40	28.5	No	
DK103-00040	TOI	422998.620	3858558.007	Small ISO80	15.8	No	
DK103-00043	TOI	422998.274	3858571.796	Small ISO 40	17.8	No	
Ply ID	Category	Y_Centroid	X_Centroid	Type	AreaSQM	ArchSite	QC Comment
DK103_01	Analog Polygon	3858567.866	423013.588	Analog	129.9	No	Analog Area
DK103_02	Analog Polygon	3858577.417	423023.276	Analog	15.2	No	Analog Area

Case example (Polygon to shape conversion)

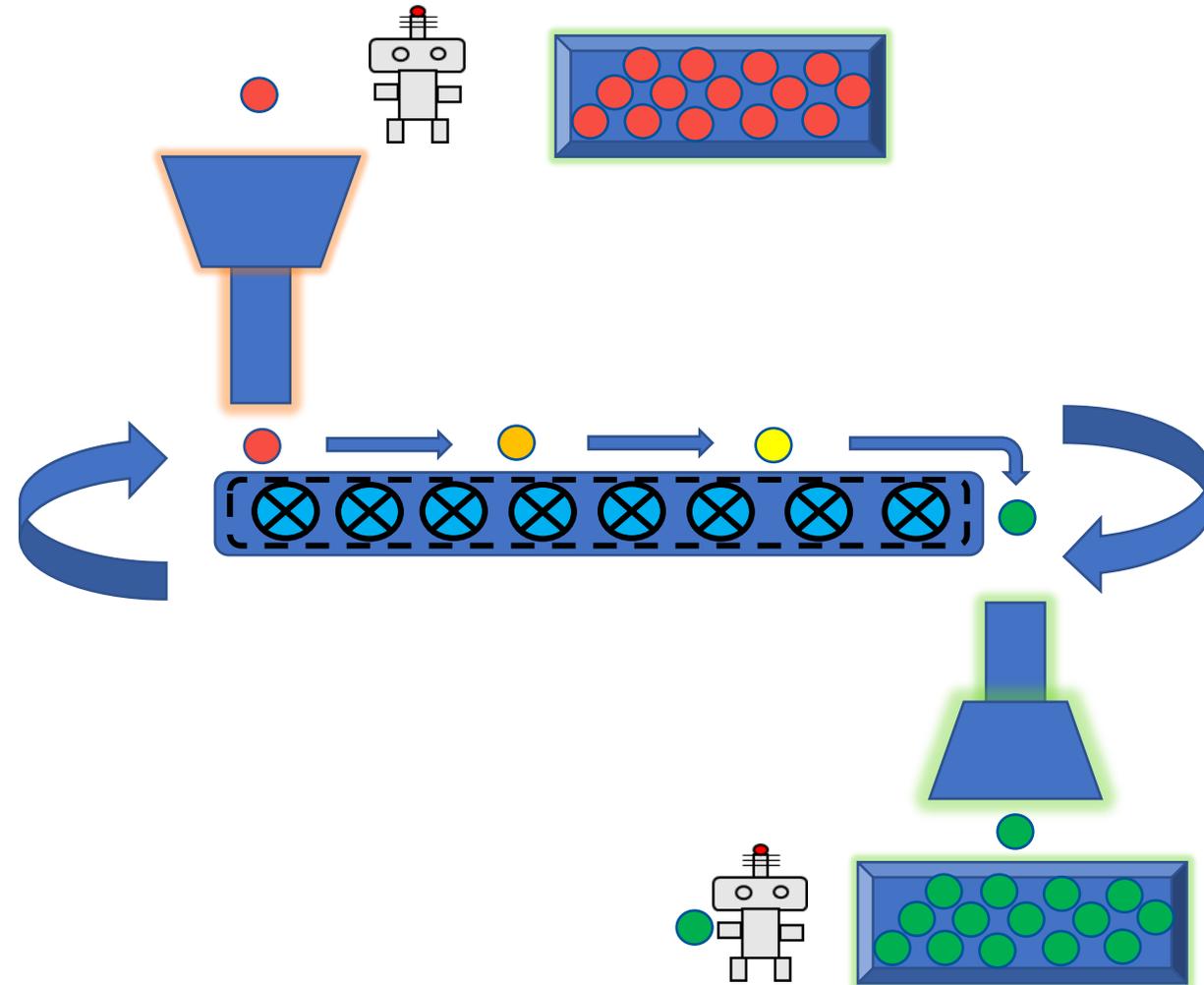
- Problem:
 - Identifying targets that intersect metallic linear features located within high use areas of the site.
- Solution:
 - Convert Geosoft polygon files to cumulative polygon feature class in order to identify target intersections in ArcMap.

```
DZ112_Metallic_Linear_Features_2022.ply - Notepad
File Edit Format View Help
#CoordinateSystem=WGS 84 / UTM zone 17N
#Datum=WGS 84, 6378137, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
#Projection=Transverse Mercator, 0, -31, 0, 9996, 500000, 0
#Units=m, 1
#LocalDatum=WGS 84, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
poly 1
423292.1088204201 3858097.114837248
423292.4093840912 3858096.513709906
423292.8902859649 3858096.513709906
423293.190849636 3858096.513709906
423293.4313089728 3858096.754160843
423293.7318642439 3858096.934499045
423294.032427915 3858097.235862717
423294.4532179645 3858097.235862717
423294.874066194 3858097.475513653
423294.9341109282 3858097.836190059
423294.9943136624 3858098.437317481
423295.1144571308 3858098.737881072
423294.874066194 3858099.399088414
423294.3129953461 3858099.69684842
423293.6717515097 3858100.120473959
423293.070241675 3858100.42103763
```

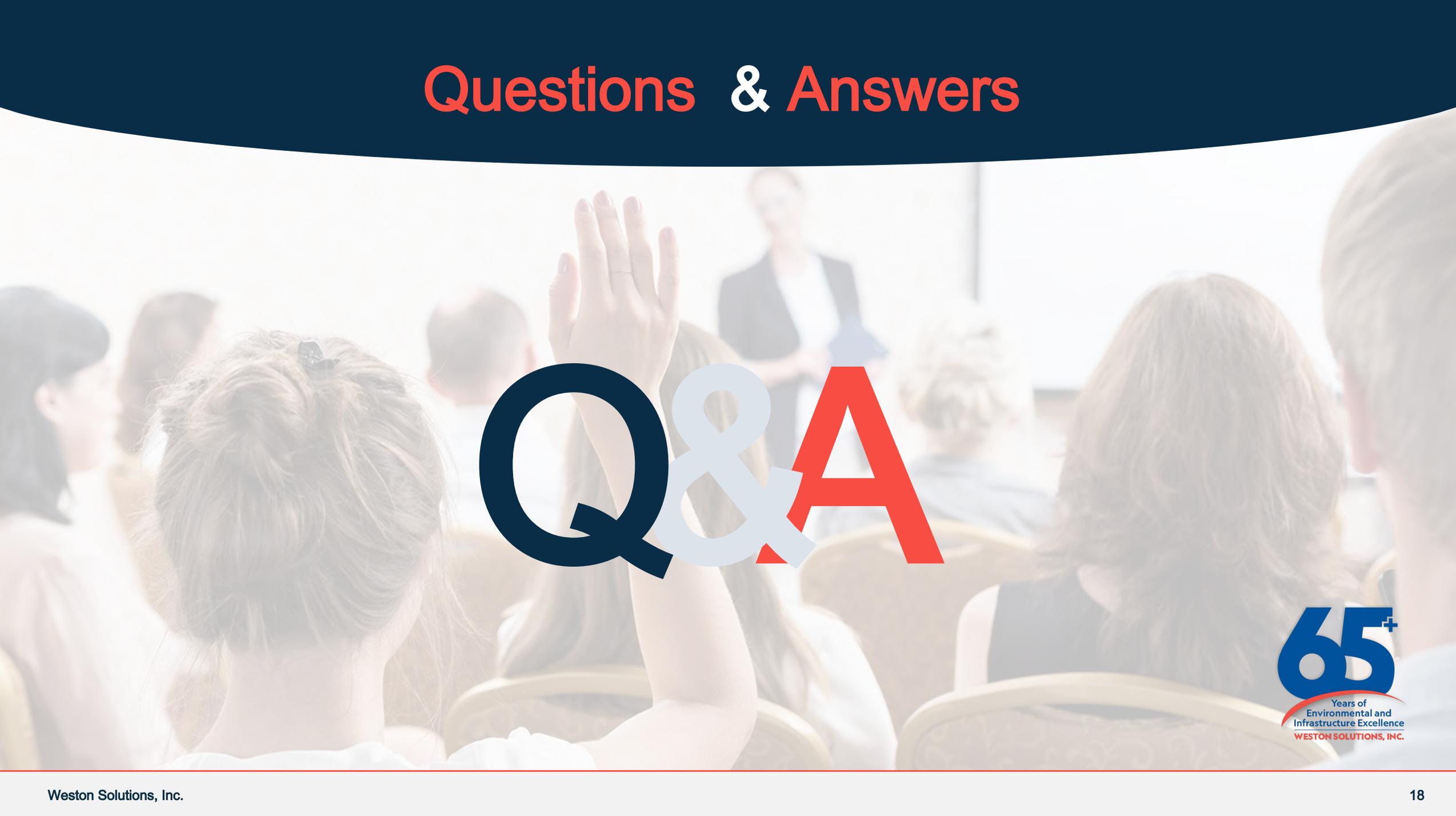


Conclusions

- Python - A vital piece of the puzzle...
 - Data quality and integrity are of paramount importance.
 - Automation can improve data quality and maintain data integrity.
 - Python is great for scripting.
 - There are many python APIs out there and we can use them in many ways.



Questions & Answers



Q&A



Want to Know More?

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