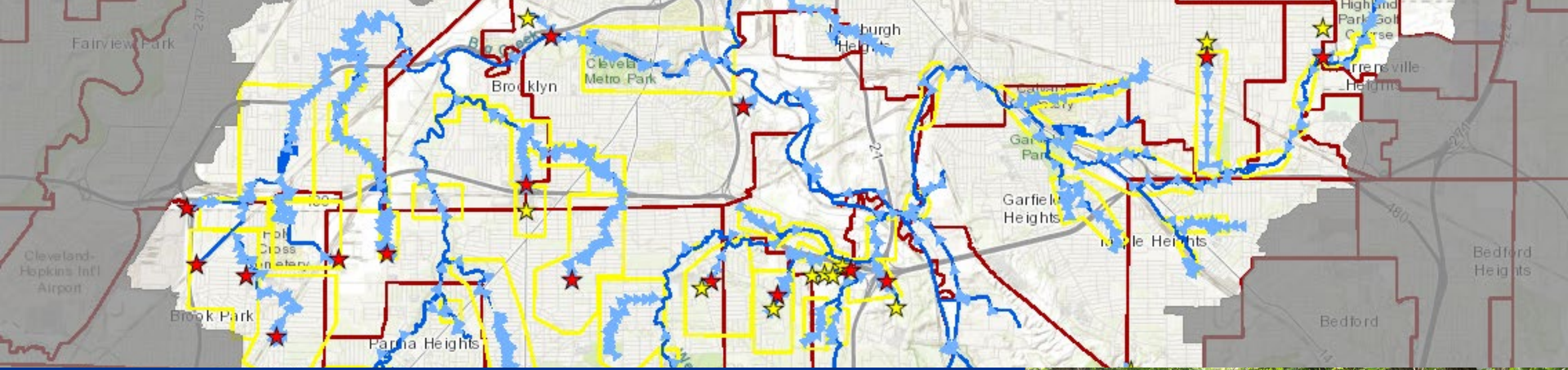
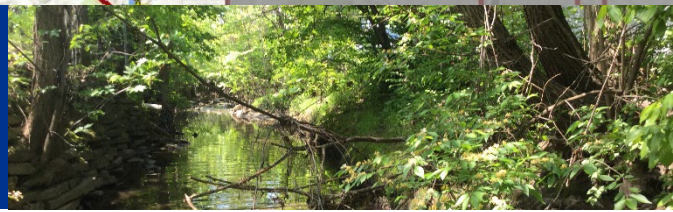


Automation in an Asset Management Approach to Stormwater Master Planning



5/09/2019

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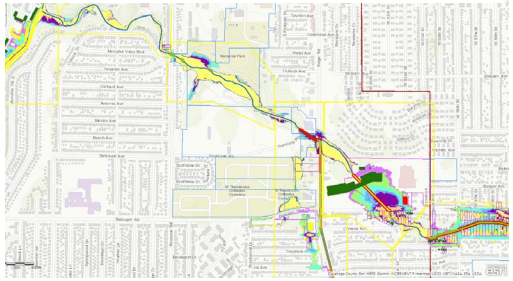
Agenda

```
def sendtable2GIS(pdtable,database, outTable):
    nptable = np.array(np.rec.fromrecords(pdtable.values))
    names = pdtable.dtypes.index.tolist()
    nptable.dtype.names = tuple(names)
    outTable_loc = os.path.join(database, outTable)
    if featurecheck(database, outTable)==1:
        arcpy.Delete_management(database+'/'+outTable)
    arcpy.da.NumPyArrayToTable(nptable, outTable_loc)
    return outTable_loc

def featuretopanda (feature,fields = ["*"], field_types= ['Double', 'String']):
    try:
        return pd.DataFrame(arcpy.da.FeatureClassToNumPyArray(in_table=feature,
    except:
        fields = []
        for field_t in field_types:
            fields.extend([f.name for f in arcpy.ListFields(feature, field_type
        print('default field types sent to pandas for feature '+feature)
        return pd.DataFrame(arcpy.da.FeatureClassToNumPyArray(in_table=feature,

def tabletopanda (feature, fields = ['*']):
    return pd.DataFrame(arcpy.da.TableToNumPyArray(in_table=feature, field_names
```



1. SWMP Overview
2. Why should you care
3. SWMP Approach to Automations
4. Key Takeaways

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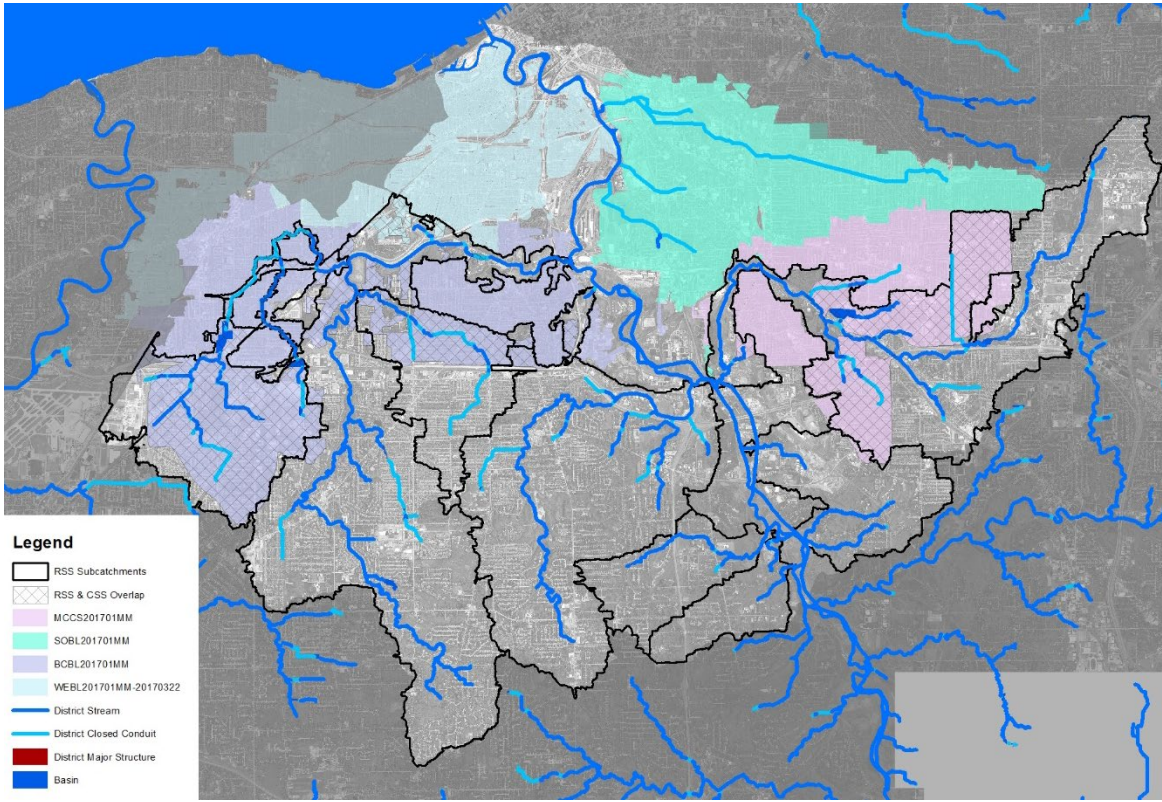
Project Area – Cuyahoga River North (CRN) Regional Stormwater System Assets

- 114 Square miles
- Over 20 Communities within watershed
- 65.7 miles of stream
- 35.7 miles of culverted stream
- Combined Sewer systems (modeled in InfowWorks ICM)
- Regional Stormwater System (modeled in SWMM)



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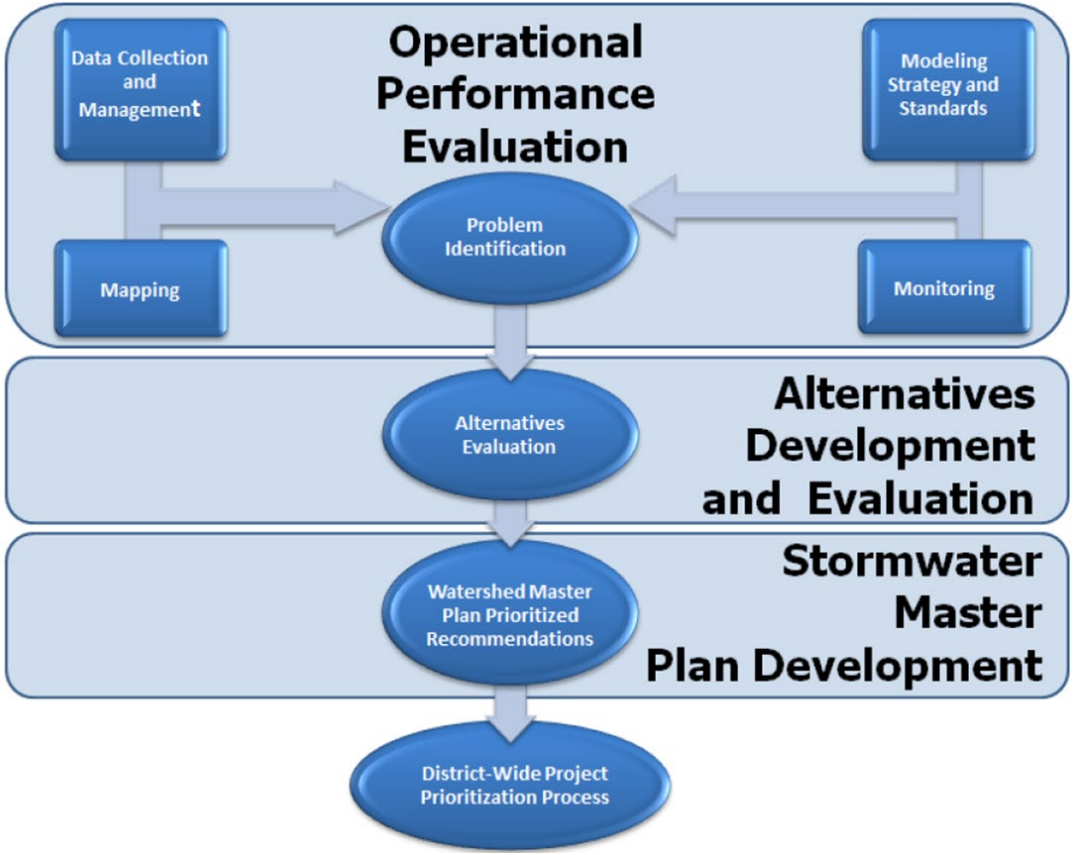
Project Scope

1. Operational Performance Evaluation
2. Alternative Development and Evaluation
   - Culverted Stream Inspection and Condition Assessment
   - Non-RSS Stormwater Master Planning Assets
3. Development of Recommendations including Phasing and Prioritization
4. Stakeholder Support



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Why Should you Care … or Not

- Save Time in long run
- Repeatability
- Customizable
- Documentation
- Can be used and understood without knowing how to code

- Time intensive early on front end
- If you're only doing something once do you need automation??
- There are better ways to document that everyone can understand

"Don't Reinvent the Wheel, Just Use it" (unknown)

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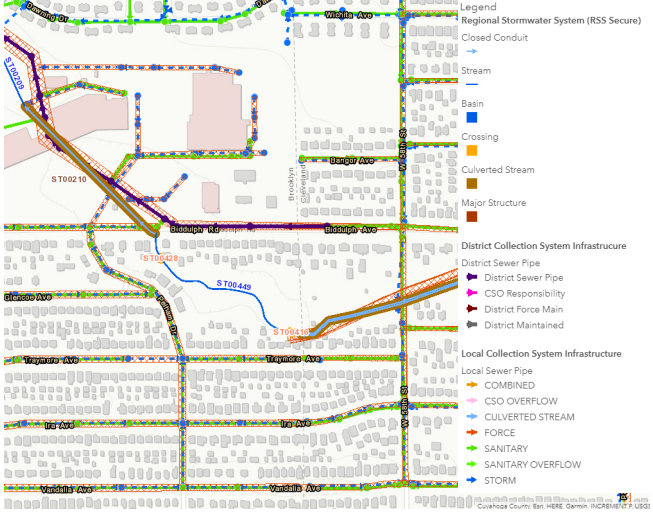
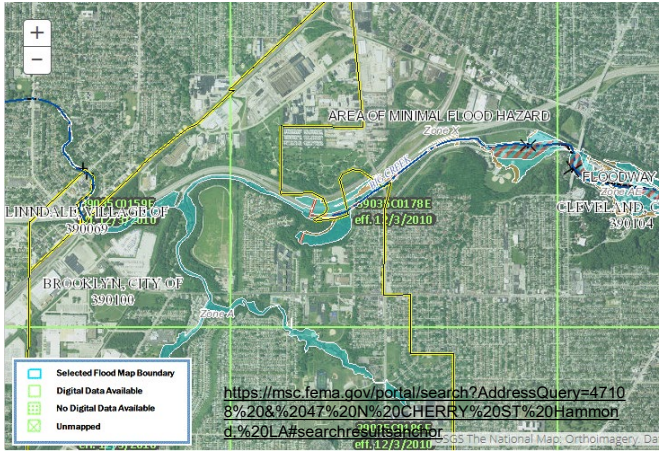
Data Sources - External Sources

- Enterprise data – Data provided and managed by the Client
  - District Stormwater Distribution Infrastructure (DSDI) (Stream, Crossings, culverted streams, Basins, Major Structures)
  - Past inspection, maintenance, reported Problems, Design Drawings, etc.
- External Data – Data from third party
  - USGS, County data, FEMA, etc.





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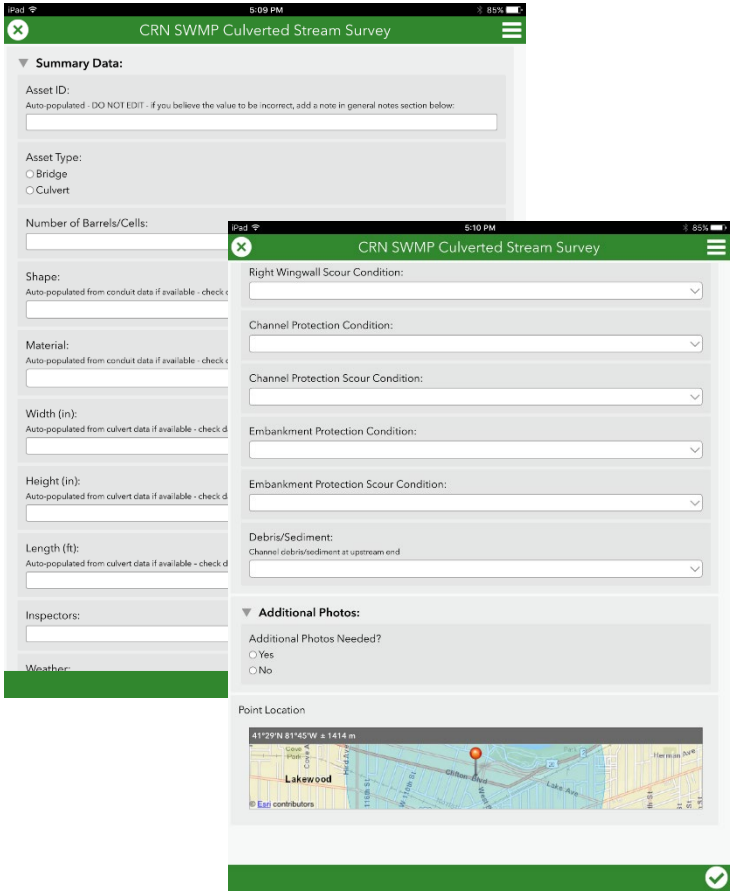
Project Data – Field Collection

- Data Collected
  - Geomorphic inspection
  - Building, Transportation & Utility (BTU) inspections
  - Crossing and Culvert Stream Inspection
  - High Water Marks
- Collection Method
  - Survey123
  - Pen and paper
  - CCTV



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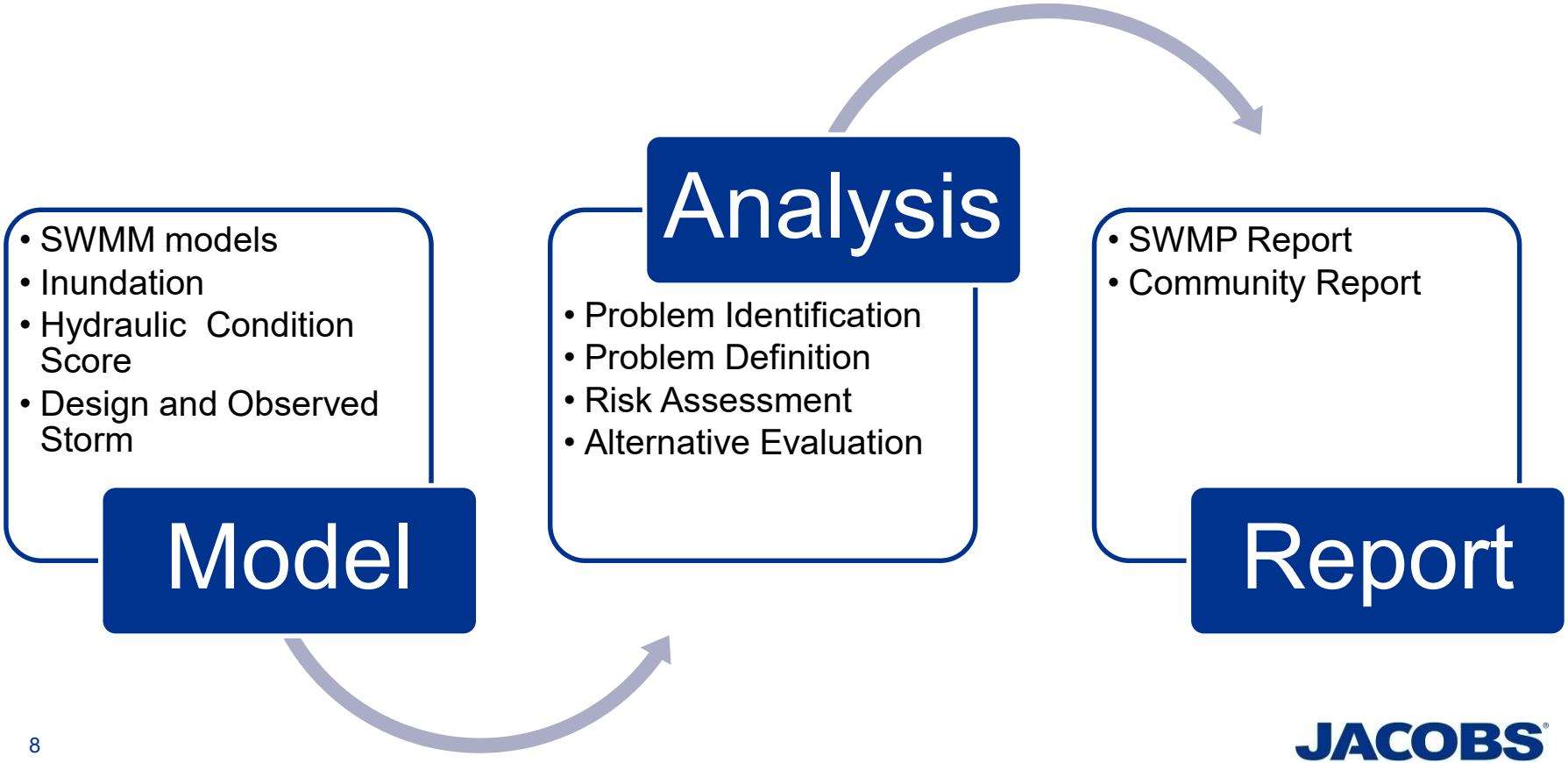
Project Data – Desktop & Model Based



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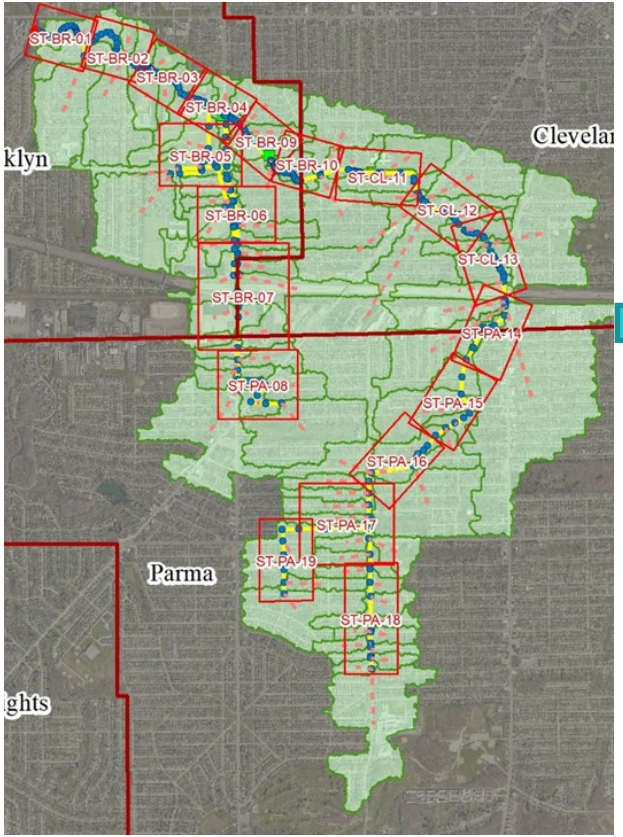
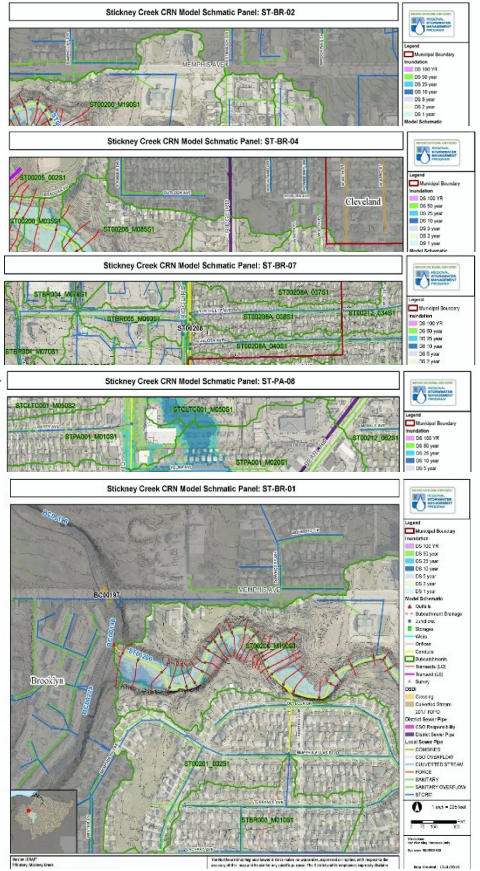
Project Challenges – Data Management

- Over 20 communities within watershed
  - Community reports
  - Data driven maps to automate reporting
- Requires extensive organizational skills
- Key computer automation tools
  - ArcGIS models
  - Python coding
  - Microsoft access





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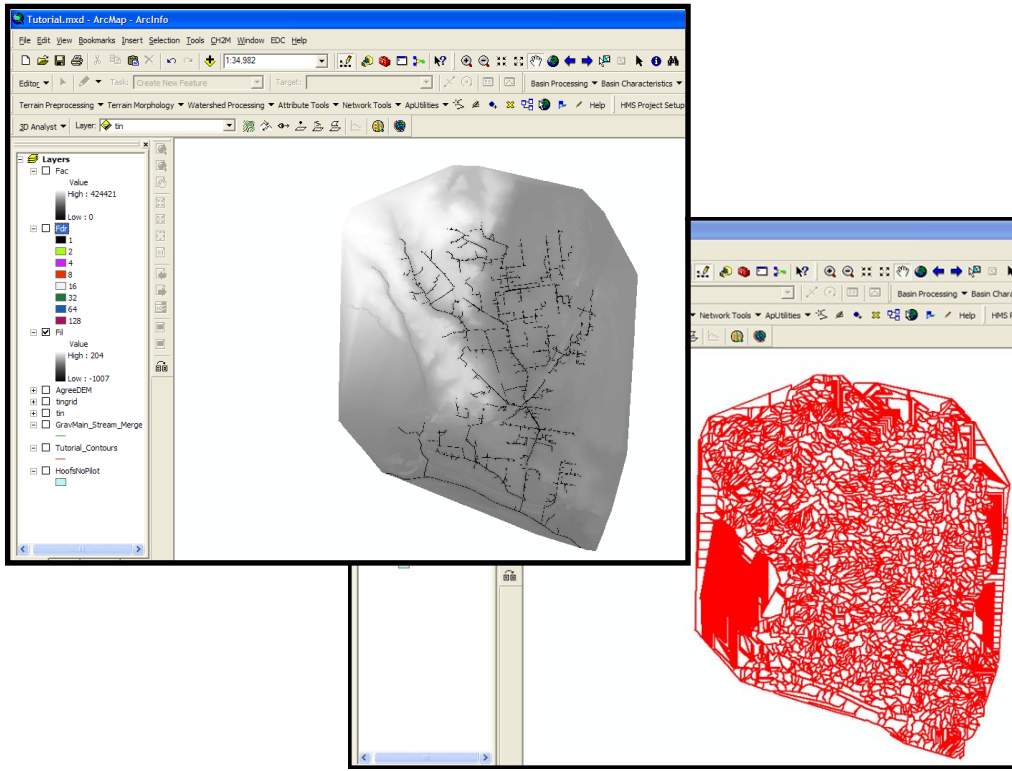
Model Development – Subcatchment Delineation

- Data Source
  - Enterprise data set
    - Local and regional sewer network (streams, culverts, storm sewers, sanitary/combined sewers
  - External Data set
    - DEM
- ESRI Arc Hydro
  - Burn in sewer and streams
  - Automates the delineation
  - Customizable Catchment size



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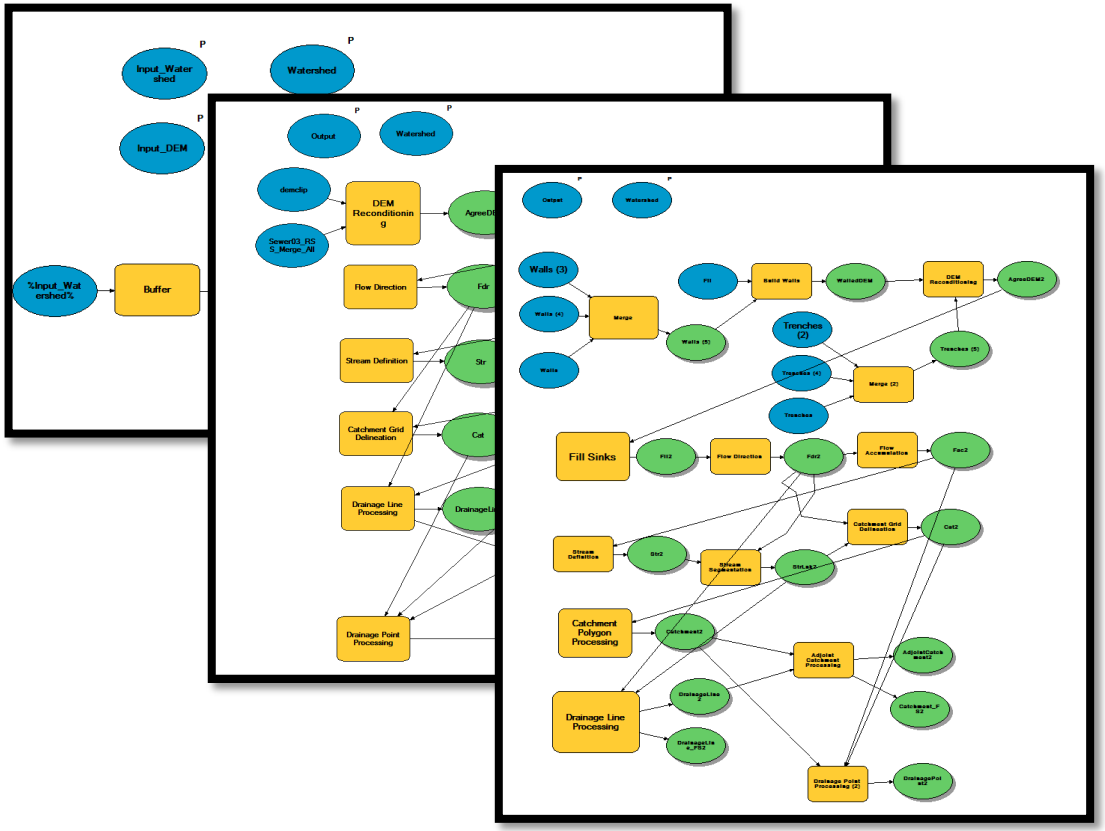
Model Development – Delineation

- GIS Modules
  - Group multiple processes together
  - Streamline & Documents process
  - Drag and drop functionality
  - No coding experience required to use



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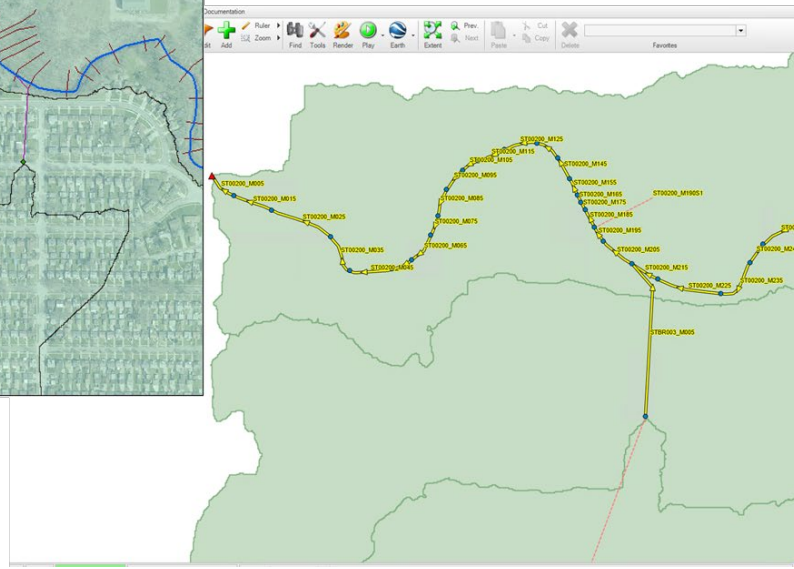
Model Development Approach – Model generation

- Raw Data
  - Enterprise Data (DSDI layers)
  - Project Data
- Python and GIS Models
  - Generate naming scheme
  - Assigns inlet and outlets
  - Parameterize and Imports Transect
- Result
  - Few hours to generate working model from pre-generated data sources



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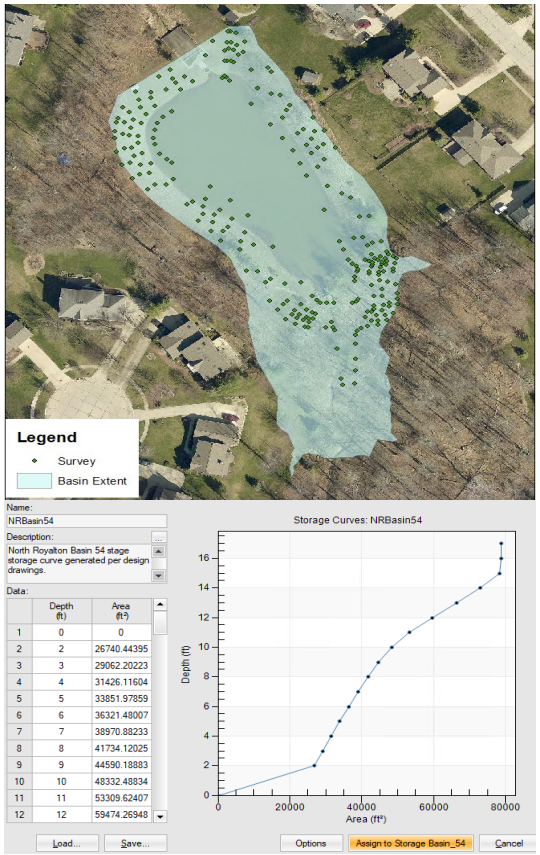
Model Development Approach – Basin Stage Storage Curves

- Raw Data
  - One Polygon

    or
  - Polygon & Survey Data
- Python
  - Clips DEM based on Polygon
  - Creates surface from Survey data (if provided)
  - Combines DEM surface and Survey
  - Creates Stages storage based on user defined interval
- Result
  - Little GIS tool knowledge to quickly generate stage storage profiles



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Model Management Approach – ICM & SWMM

Innovyze ICM

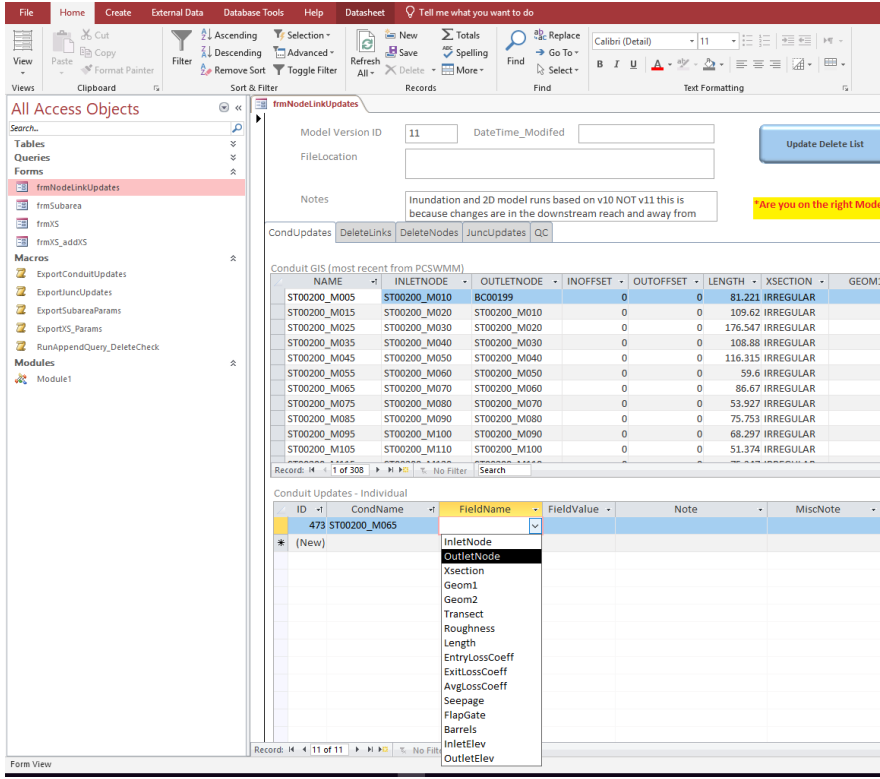
- NEORSD standardized flagging and documentation
- Robust internal documentation schema
  - Tag for each parameter
  - Multiple description fields

SWMM5/PCWMM

- Model management approach not standardized at time of project
- PCSWMM – Tag and descriptions easily customizable
  - Customization does not carry to EPA-SWMM
- EPA-SWMM – One tag and one description

Model Management Approach

- Consolidate data to single database:
  - Original Model Data
  - Current Model Data
  - Model updates: including deletions and transect parameterization
- Allows:
  - Quick and automated QC
  - Maintains documentation
- Alternative Approach
  - Make changes in Model and automate generation of database



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Data Visualization – Stream inundation and Problem Definition

- Inundation Python script (Arcpy)
- Data sources
  - Raw data from model build
  - SWMM model
  - DEM
- Result
  - Saves ~20 minutes manual effort per inundation
  - Problem definition tool Alternative performance screening tool

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Problem Definition – Buildings and Transportation

- Business Risk Exposure (BRE) Factors
  - Inundation depth
    - Community report and Model
  - Stream Condition Scores
    - Geomorphic inspection & Model Data
  - Culvert Stream condition Scores
    - Field inspection & model

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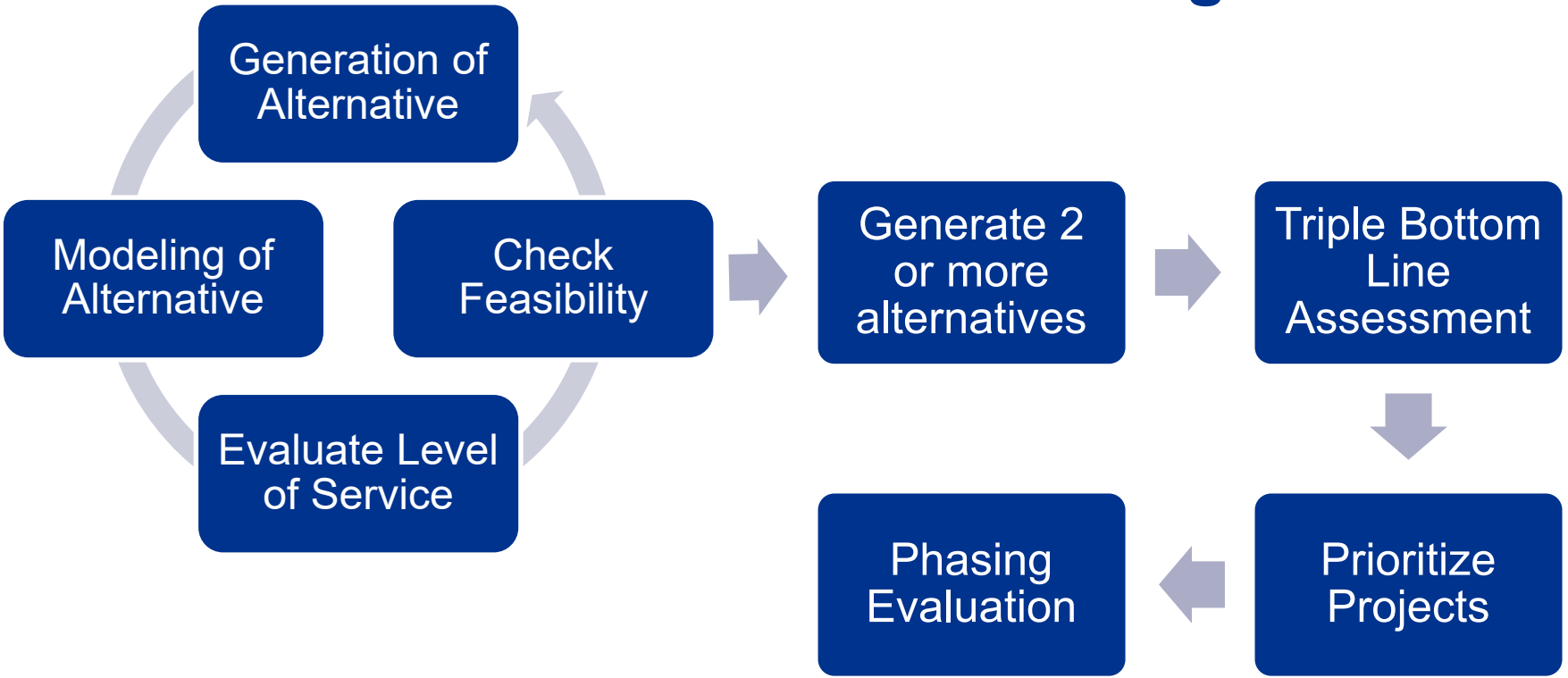
Alternative Recommendation Management



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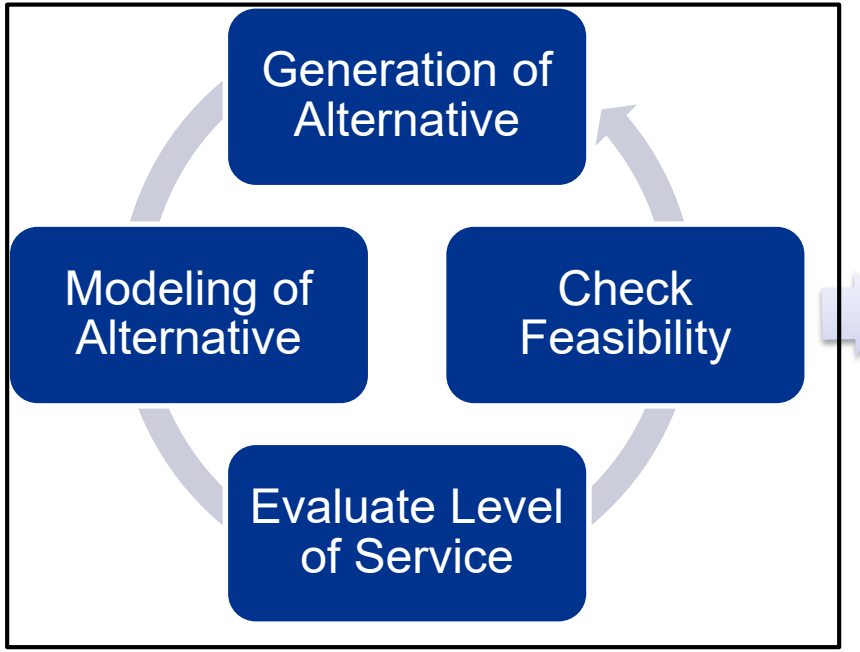
Alternative Recommendation Management



Generate 2 or more alternatives

Triple Bottom Line Assessment

Prioritize Projects

Phasing Evaluation

How to document in a time effective manner?

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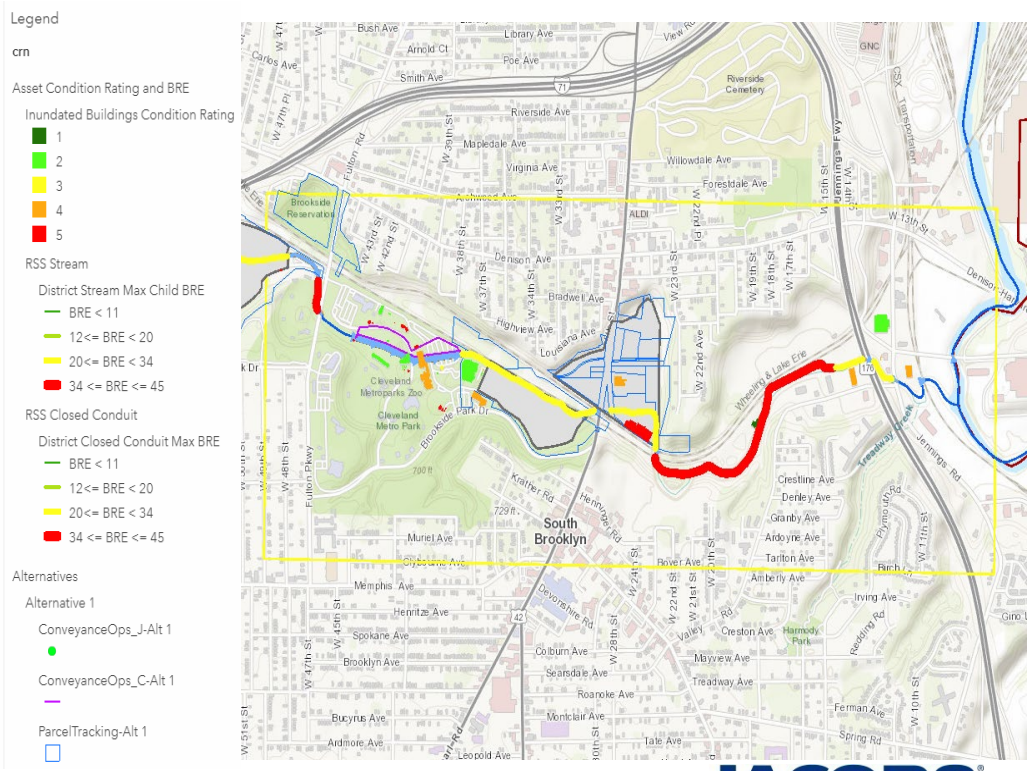
Alternative Recommendation Management

- Storing problems and solutions in one location
  - Geolocated Inspection data
  - Community reported problems
  - Condition scores and BRE of CRN RSS Assets
  - Model based alternatives



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Key Takeaways – Data Management using Python\R and Databases

- Databases
  - Forces consistent structure
- Using Programming (python/R):
  - Require consistent structure
  - Versatile data manipulation and analysis
  - Can easily be adapted and modified for various purposes
  - Can be used to automate repetitive task
  - Documents work process
- Databases + Programming = Automated Tasks
  - Reduces errors from repetitive tasks
  - Creates a workflow for tracking down errors
  - Allows for focus on work that matters