

# DETERMINING SANITARY SEWER GRAVITY SYSTEM STORAGE: A STANDARDIZED APPROACH

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# AGENDA

Background

Goals and Objectives

Design and Development

Results

Summary



# BACKGROUND

## Gravity Collection Systems

### Gravity Mains

Unique ID

US Feature/Elev

DS Feature/Elev

Diameter

### Manholes

Unique ID

Rim Elevation

Service Area

### Pump Stations

Unique ID

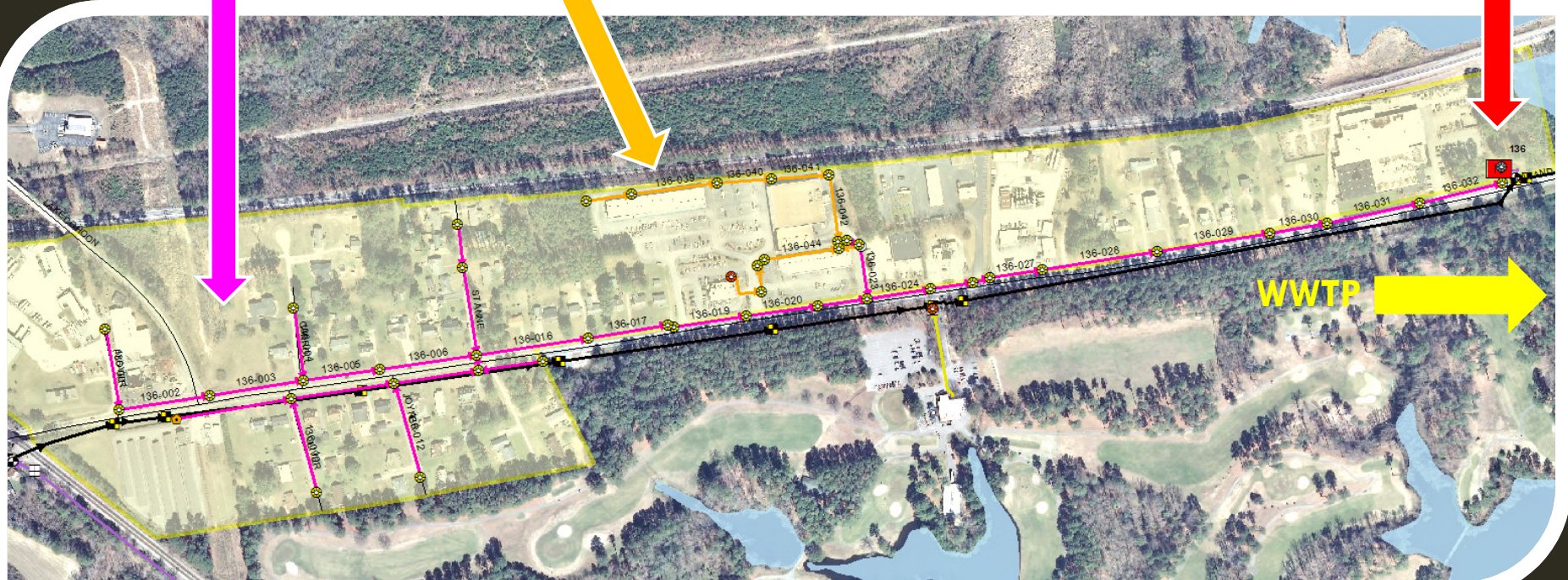
Floor Elevation

Wet Well Info

Incoming GM

Collection Areas (Pump Station Service Area)

Pump Station





# BACKGROUND

What is Capacity....and why do we care?



Adequate Capacity = Good

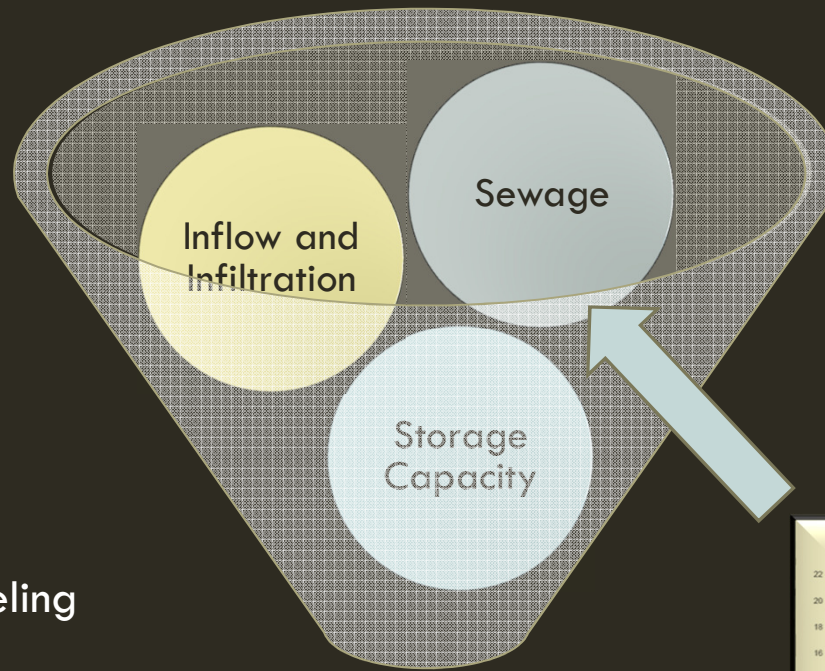


Lack of Capacity = Bad

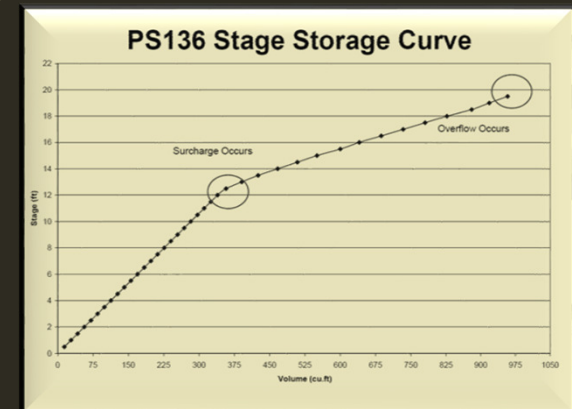
# BACKGROUND

How is Capacity Analysis Conducted?

During design and/or rehabilitation of the system – through modeling



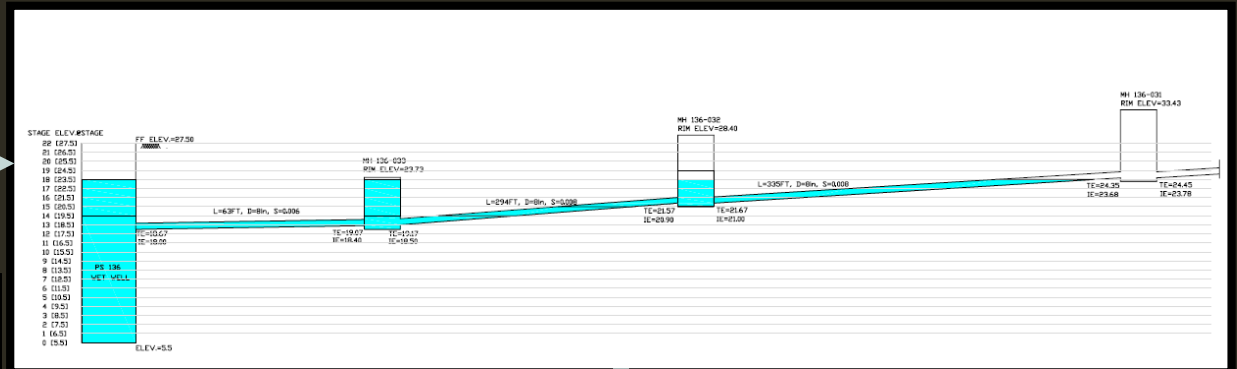
**Total System Capacity Needs**



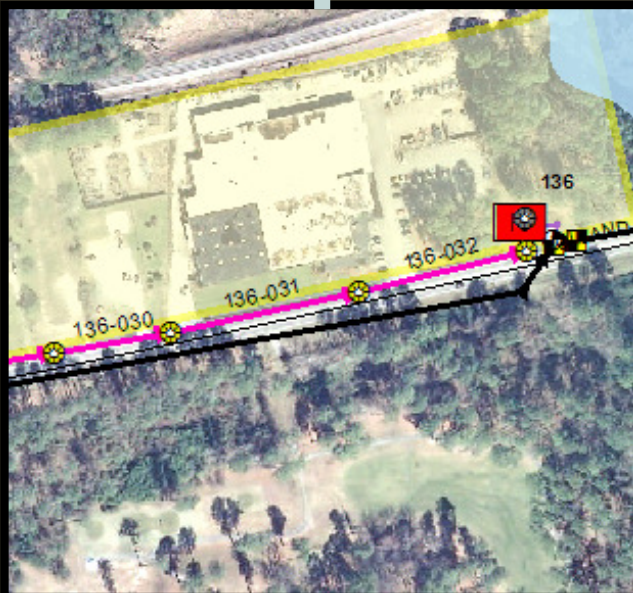
# BACKGROUND

How does gravity storage play a role in capacity?

Calculations

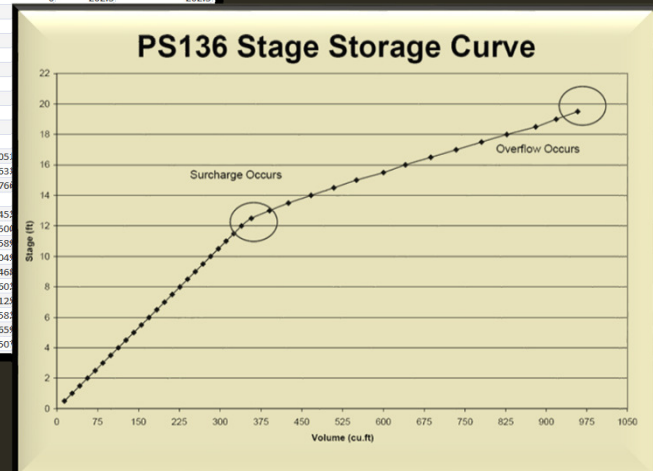


GIS



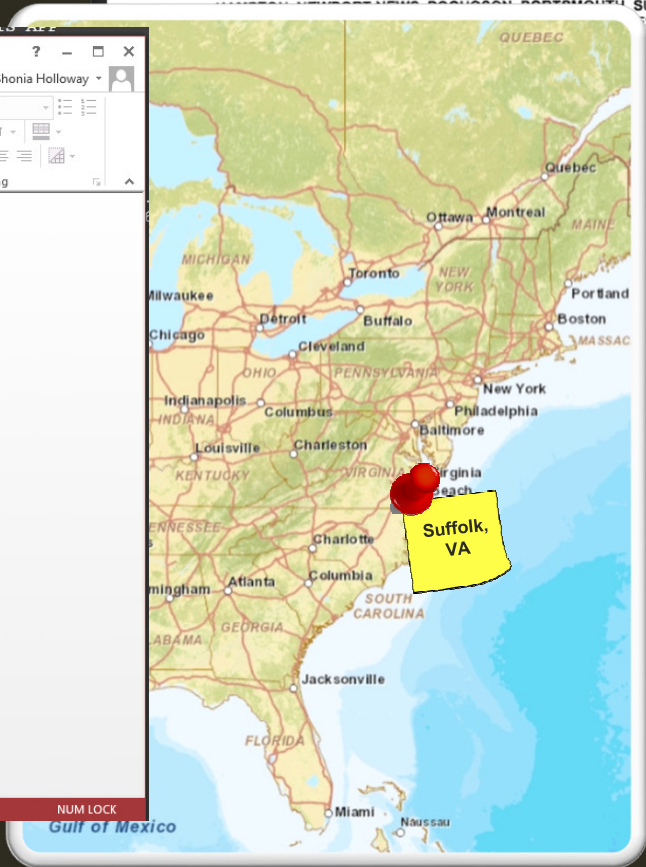
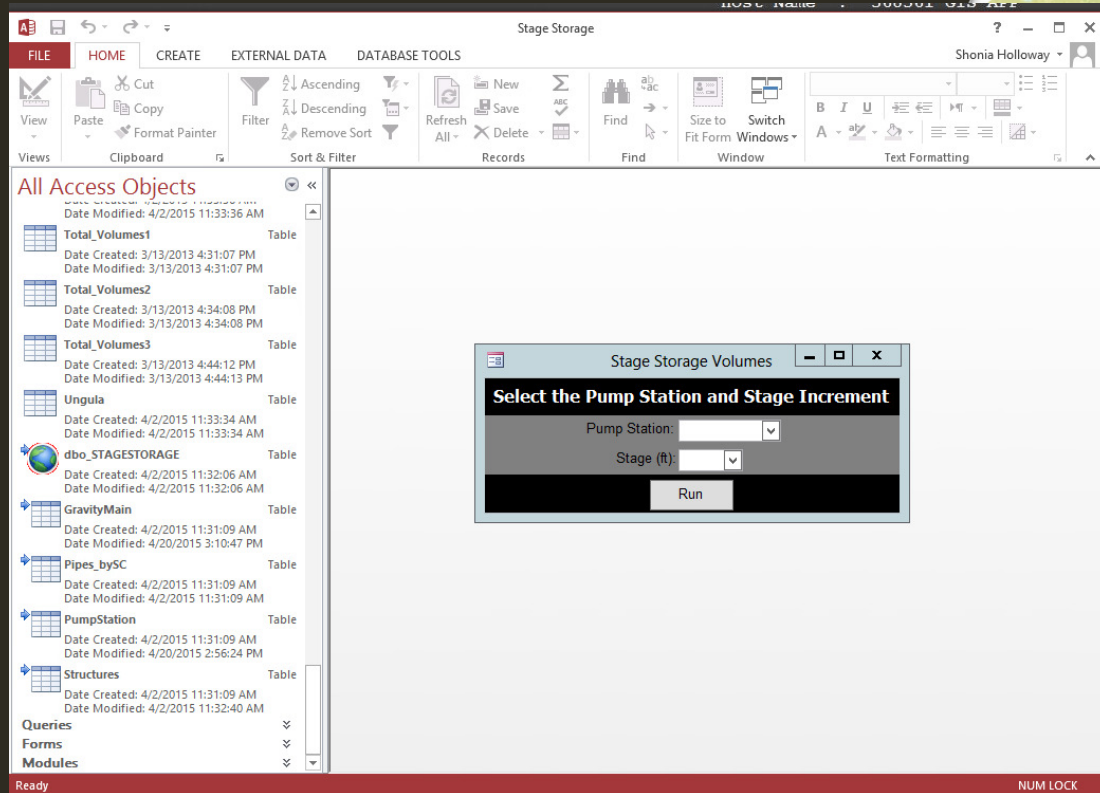
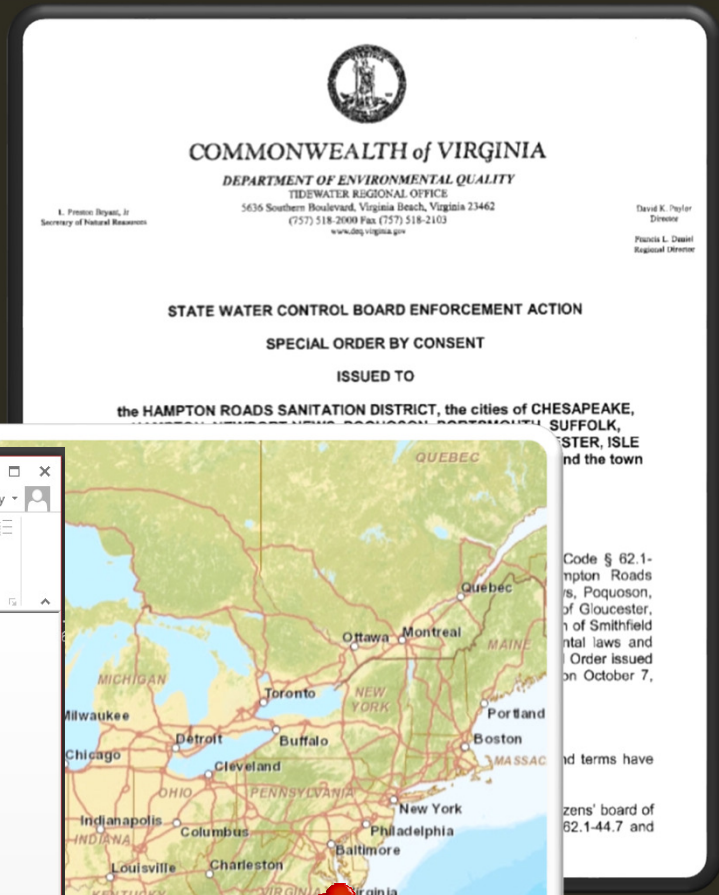
Stage	StageElev	Pipe_Volumes	Manhole_Volumes	Ungula_Volumes	VolWW	Total
0	12.47	0	0	0	40.5	40.5
1	12.97	0	0	0	81	81
1.5	13.47	0	0	0	121.5	121.5
2	13.97	0	0	0	162	162
3	14.47	0	0	0	202.5	202.5
3.5	14.97	0	0	0		
4	15.47	0	0	0		
4.5	16.47	0	0	0		
5	16.97	0	0	0		
5.5	17.47	0	0	0		
6	17.97	0	0	0		
6.5	18.47	0	0	0		
7	18.97	0	0	0		
7.5	19.47	0	0	0		
8	19.97	12.9672940471802	2.51326549135808	3.940705		
8.5	20.47	12.9672940471802	8.79645079135808	51.42163		
9	20.97	27.3400933403712	15.0796360913581	89.83076		
9.5	21.47	293.239285858209	21.6141401747162			
10	21.97	293.239285858209	34.1805107747162	55.05145		
10.5	22.47	310.591449639564	46.7468813747162	126.36504		
11	22.97	696.32549661686	66.2247299187904	5.952358		
11.5	23.47	696.32549661686	97.6406364187904	56.31704		
12	23.97	803.674055020246	133.454804000149	67.22446		
12.5	24.47	939.422268812796	173.415853879507	55.94360		
13	24.97	1046.16041221365	228.634982312743	33.95112		
13.5	25.47	1084.95634219127	285.183650012743	48.08058		
14	25.97	1188.04687146246	344.706769005121	22.66465		
14.5	26.47	1259.84281379408	408.075197401099	18.17850		

Total Volume



# BACKGROUND

## Case Study: City of Suffolk Stage Storage Tool





# GOALS AND OBJECTIVES

Why the change?

Compact

Portable

Excel spreadsheet showing data for Stage, Stage Elev., Pipe Volumes, Manhole Volumes, Ungula Volumes, Vol/VW, and Total. A dialog box titled "Select the Pump Station and Stage Increment" is overlaid on the spreadsheet.



ArcMap interface showing a map of a sewer network. The map displays pink lines representing sewer lines and yellow nodes representing manholes. The interface includes a Table of Contents, a Storage Curve graph, and a list of toolboxes.

Table of Contents:

- Main Map
  - sde\_suffolk.DBO.HRSD\_TreatmentPlants
  - Main Sewer - City of Suffolk

Storage Curve graph:

Storage Curve: Depth vs. Area Curve, Depth vs. Volume Curve, Volume (CY)

Storage curve data:

Depth (ft)	Area (ft <sup>2</sup> )	Volume (ft <sup>3</sup> )
1	19000	19000
2	19900	38900
3	21900	59800
4	23900	80700
5	25900	101600
6	27900	122500

Toolboxes:

- Arc Hydro Tools.tbx
  - Arc Hydro Setup
  - Attribute Tools
  - GIS Data Exchange
  - Excel Exchange
  - GIS to FEMA
  - XML Exchange
  - H & H Modeling
  - GeoICPR
  - Green and Ampt
  - Map to Map
  - Time of Concentration
- Network Tools
  - Terrain Morphology
  - API Connectivity Refinement
  - Drainage Boundary Processing
  - Grouping
  - Terrain Preprocessing
  - Terrain Preprocessing Workflows
  - Utility
  - Watershed Processing

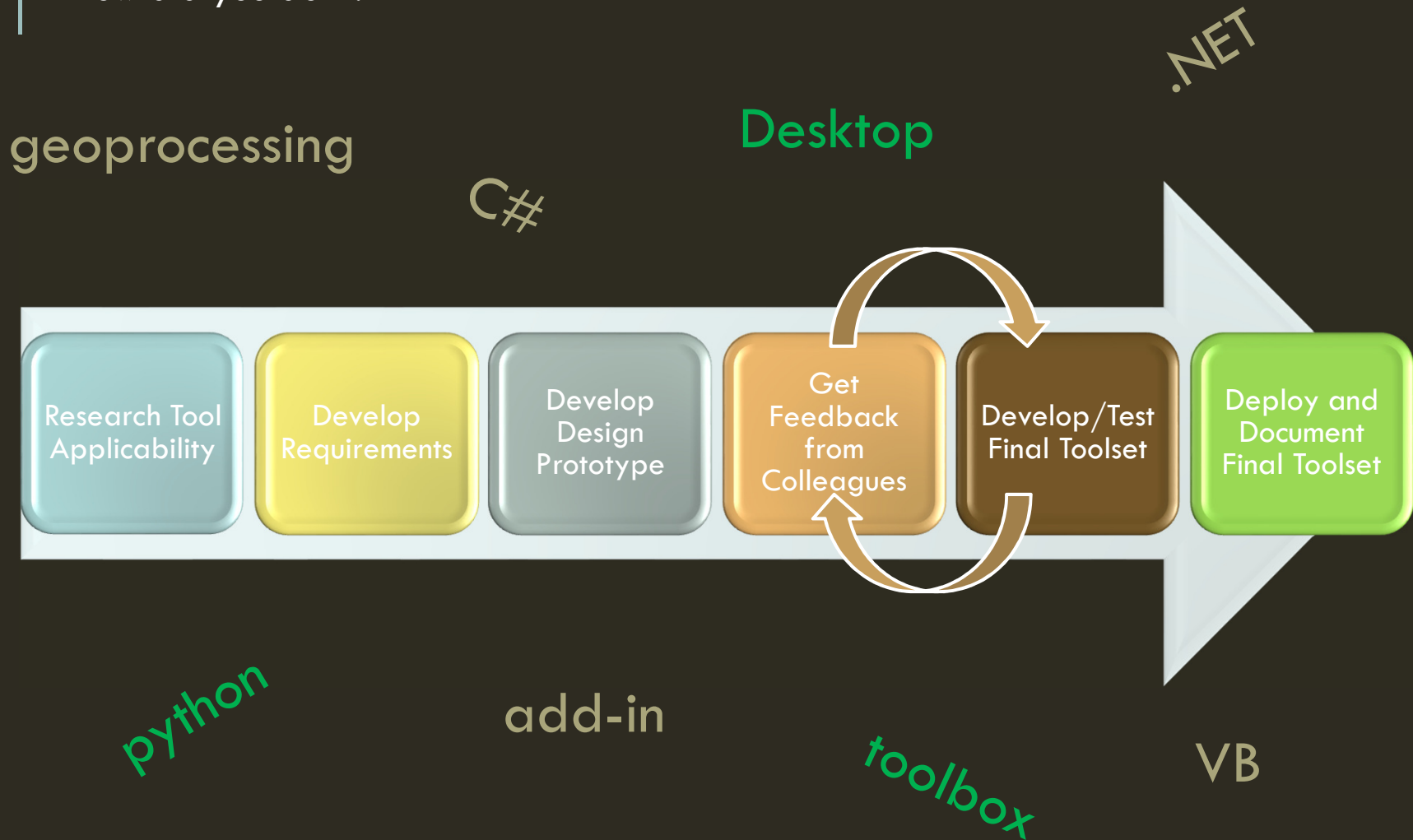
Map Centric

Standardized



# DESIGN AND DEVELOPMENT

How did you do it?



# RESULTS

So....did it work?

SewerStormwater:ssNetworkStructure			
Field Needed	Field Type Needed	Target Field Name	Target Field Type
Asset ID	Text	FacilityID	Text, 20
Floor Elevation	Number	FLOORELEV	Double, 0, 0
Wet Well Shape	Text	WETWELLSHAPE	Text, 1
Wet Well Width/Diameter	Number	WETWELLDIA	Double, 0, 0
Wet Well Length	Number	WETWELLEN	Double, 0, 0
Wet Well Depth	Number	WETWELLDEPTH	Double, 0, 0
Incoming Gravity Main ID	Text	WETWELLINCOMINGPIPE	Text, 50
Wet Well Invert Elevation	Number	WETWELLINVELEV	Double, 0, 0

The screenshot shows the ArcMap interface with the following components:

- Table of Contents:** Lists layers for 'SewerStormwater', 'Pump Stations', 'Manholes', 'Lateral Lines', and 'Gravity Mains'. It also shows a 'New Folder' containing 'QC\_PumpStations', 'QC\_GravityMains', 'QC\_Manholes', and 'QC\_Laterals'.
- Map View:** Displays a network of green lines (gravity mains) and yellow circles (manholes) with labels like '002-001', '002-002', '002-004', '002-003', and '6" 002-001'.
- Catalog:** Shows the project structure, including 'Stage Storage.tbx' with steps: 'Step 1: Append Pump Stations', 'Step 2: Append Gravity Mains', 'Step 3: Append Manholes', 'Step 4: Append Laterals', 'Step 5: QC Data', and 'Step 6: Generate Results'. The current map document is 'StageStorage.mxd'.

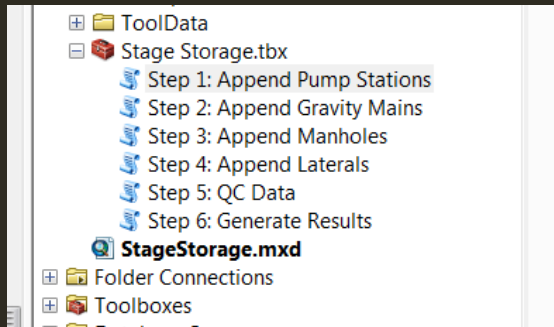
✓ Portable

✓ Standardized

✓ Map Centric

# RESULTS

So....did it work?



- ✓ Standardized
- ✓ Compact

Step 1: Append Pump Stations

Pump Station Input Features  
C:\Users\SHollowa\Desktop\PSU\Capstone\Capstone\_Project\Test\_QC\_Data\Suffolk\PUilities.gdb\PU\_

Filter PS Input Features by Expression (optional)  
POSTING = '4'

PS Facility ID  
FACILITYID

PS Floor Elevation (optional)  
FLOORELEV

PS Wet Well Shape (optional)  
WWSHAPE

PS Wet Well Width/Diameter (optional)  
WWLENGTH

PS Wet Well Length (optional)  
WWBREADTH

PS Wet Well Depth (optional)  
WWDEPTH

PS Wet Well Invert Elevation (optional)  
WW\_INV\_ELEV

PS Incoming Gravity Main to Wet Well (optional)

⚡ **Pump Station Field Mappings Import/Save Parameters**

Load Pump Station field mappings from file (optional)

File containing Pump Station field mappings (optional)

Save Pump Station field mappings to file (optional)

File to save Pump Station field mappings (optional)  
C:\Temp\PS\_load\_ss.txt

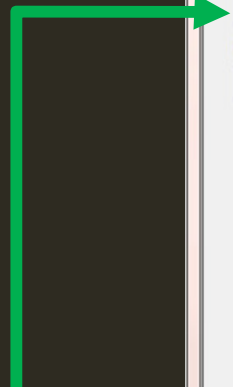
OK Cancel Environments... Show Help >>

```
arcpy.Append_management(inputLyr, targetFC, 'NO_TEST', fms)
```



# RESULTS

So....did it work?



This drop-down comes from the loaded data!

Step 5: QC Data

Pump Station to QC  
002

Location to store QC tables  
C:\Users\SHollowa\Desktop\PSU\Capstone\Capstone\_Project\Test\_QC\_Data

Add QC tables to ArcMap (optional)

C:\Temp\New Folder

- QC\_PumpStations
- QC\_GravityMains
- QC\_Manholes
- QC\_Laterals

Table

QC\_GravityMains

OID	FACILITYID	FACID_CHK	DIAMETER	DIA_CHK	FROMMH	FROMMH_CHK	TOMH	TOMH_CHK	UPELEV	UPELEV_CHK	DOWNELEV	DOWNELEV_CHK
0	002-002	OK	8	OK	002-002	OK	002-000	Issue	29.95	OK	29.83	OK

OK Cancel Environments... Show Help >>

# RESULTS

So....did it work?

Step 6: Generate Results

Pump Station to run  
002

Stage Elevation (feet)  
0.4

Location to store Total Volume table  
C:\Users\SHollowa\Desktop\PSU\Capstone\Capstone\_Project\Test\_QC\_Data

Add Total Volume table to ArcMap (optional)

Step 6: Generate Results

Executing Step 6: Generate Results...

Close this dialog when completed successfully

Close

<< Details

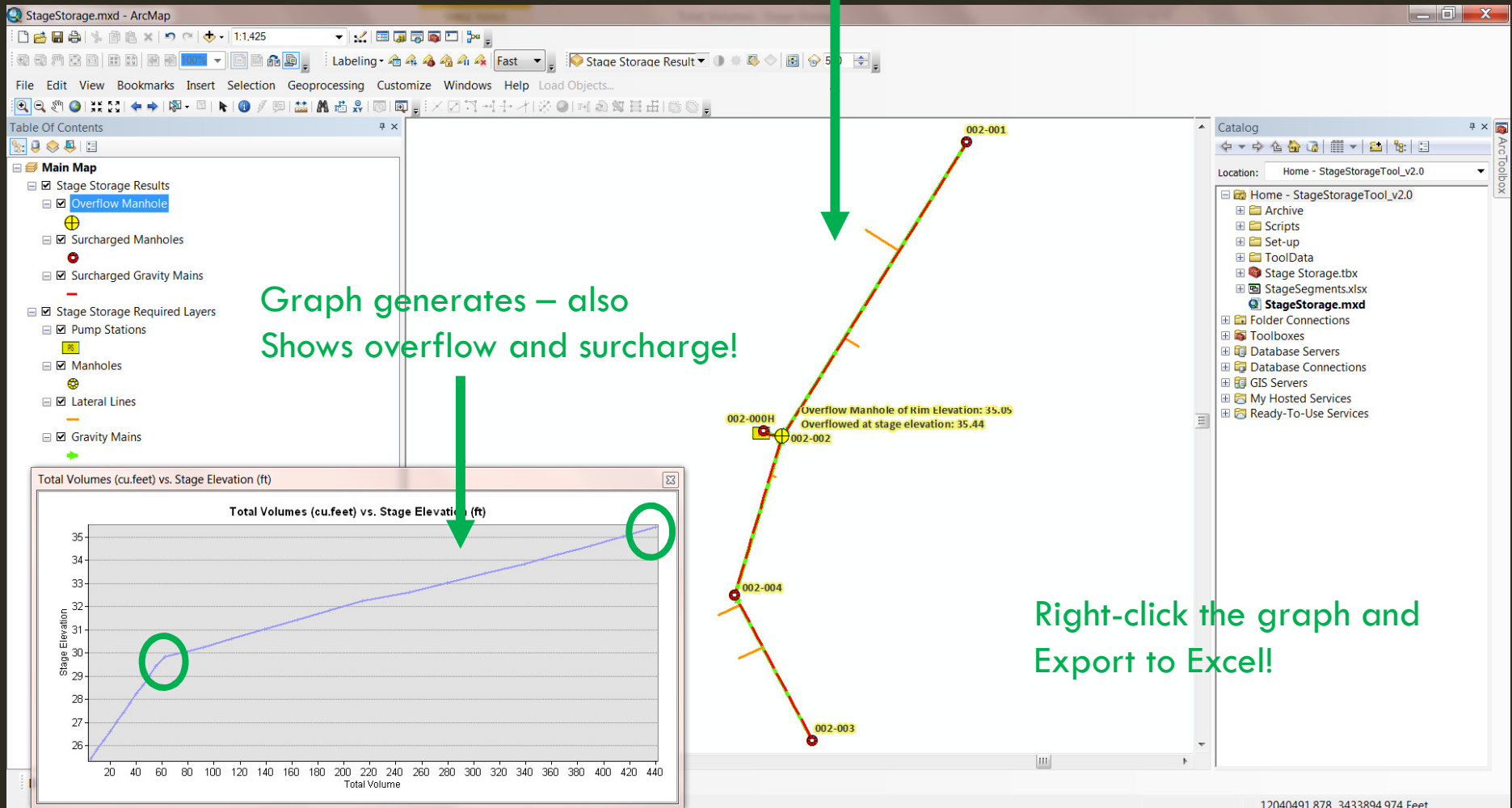
```
Executing: StageStorageResults 002 0.4 C:\Users\SHollowa\Desktop\PSU\Capstone\Capstone_Project\Test_QC_Data true
Start Time: Tue Oct 06 19:41:35 2015
Running script StageStorageResults...
There are 1 records failing the Gravity Main QC
There are several records failing the QC checks, please re-run QC for Pump Station 002 and then retry volume calculations.
Completed script StageStorageResults...
Failed to execute (StageStorageResults).
Failed at Tue Oct 06 19:41:37 2015 (Elapsed Time: 2.24 seconds)
```

OK Cancel Environments... Show Help >>

# RESULTS

So....did it work?

Map updates to show  
Overflow location and Surcharged system





# Power of Python Parameters!

## Script Parameters Tool Validator Class

# RESULTS

How did you do that?

Click any parameter above to see its properties below.

Parameter Properties

Property	Value
Type	
Direction	
MultiValue	
Default	
Environment	
Filter	
Obtained from	

To add a new parameter, type the name into an empty row in the name column, click in the Data Type column to choose a data type, then edit the Parameter Properties.

```
import arcpy
class ToolValidator(object):
    """Class for validating a tool's parameter values and controlling
    the behavior of the tool's dialog."""

    def __init__(self):
        """Setup arcpy and the list of tool parameters."""
        self.params = arcpy.GetParameterInfo()

    def initializeParameters(self):
        """Refine the properties of a tool's parameters. This method is
        called when the tool is opened."""
        self.params[1].enabled = False
        self.params[0].category = "Pump Station Field Mappings"
        self.params[1].category = "Pump Station Field Mappings"
        self.params[2].category = "Pump Station Field Mappings"
        self.params[3].category = "Pump Station Field Mappings"
        return

    def updateParameters(self):
        """Modify the values and properties of parameters before
        validation is performed. This method is called whenever the
        values have been changed."""
        # enable or disable the file location to import field mappings
        if self.params[0].value == True:
            self.params[1].enabled = True
        else:
            self.params[1].value = ""
            self.params[1].enabled = False
        # enable or disable the file location to save field mappings
        if self.params[2].value == True:
            self.params[3].enabled = True
        else:
```

**ALL OTB!!**

# SUMMARY

Desktop

python  
toolbox

The screenshot shows the 'Stage Storage Volumes' dialog box with a 'Select the Pump Station and Stage Increment' section. Below it is a table with columns: Stage, StageElev., Pipe\_Volumes, Manhole\_Volumes, Ungula\_Volumes, VolWW, and Total.

Stage	StageElev.	Pipe_Volumes	Manhole_Volumes	Ungula_Volumes	VolWW	Total
1	12.97	0	0	0	81	81
1.5	13.47	0	0	0	121.5	121.5
2	13.97	0	0	0	162	162
2.5	14.47	0	0	0	202.5	202.5
3	14.97	0	0	0	243	243
3.5	15.47	0	0	0	283.5	283.5
4	15.97	0	0	0	324	324
4.5	16.47	0	0	0	364.5	364.5
5	16.97	0	0	0	405	405
5.5	17.47	0	0	0	445.5	445.5
6	17.97	0	0	0	486	486
6.5	18.47	0	0	0	526.5	526.5
7	18.97	0	0	0	567	567
7.5	19.47	0	0	0	607.5	607.5
8	19.97	12.9672840471802	2.51328549135808	3.94070518339288	648	647.421264721331
8.5	20.47	12.9672840471802	6.79645079139808	6.79645079139808	688.5	701.885177956666
9	20.97	27.3460931403712	15.0793609113081	89.8307666669951	729	861.206669637829
9.5	21.47	293.238285858209	21.6141401747162	0	769.5	1084.35342663293
10	21.97	293.238285858209	34.1802107747162	55.0514525772217	810	1192.47124921015
10.5	22.47	310.201449619304	46.296811747162	126.30502213044	850.5	1334.20313317721
11	22.97	696.32549616886	66.2247299187904	5.9523898121767	891	1659.5025851687
11.5	23.47	696.32549616886	97.640504187904	56.317049073609	931.5	1781.78120294302
12	23.97	803.676020502046	131.454848000349	67.234682119022	972	1978.3531732326
12.5	24.47	899.422388112796	171.41583879507	55.943605312263	1012.5	2181.2817522353
13	24.97	1046.1041221185	228.634982312743	33.951125678783	1053	2361.7602020313
13.5	25.47	1084.1934212137	305.183002121743	48.000232910405	1093.5	2511.7207440416
14	25.97	1188.04687146246	344.70678005121	22.6646592700277	1134	2689.41829973763
14.5	26.47	1259.84281179408	408.075197401099	18.1785071002484	1174.5	2860.59631830043

The screenshot shows the ArcMap interface with the 'Stage Storage Results' table of contents. A map displays a network of manholes (002-000H, 002-002, 002-004, 002-003) and mains. A graph titled 'Total Volumes (cu.feet) vs. Stage Elevation (ft)' shows a linear relationship between stage elevation and total volume. A callout box indicates an overflow: 'Overflow Manhole of Rim elevation: 35.09' and 'Overflowed at stage elevation: 35.44'.

✓ Portable  
✓ Standardized

✓ Compact  
✓ Map Centric

# THANK YOU

PSU Advisor, Barry Evans

City of Suffolk

City of Virginia Beach

City of Portsmouth

CH2M HILL

GIS Reviewer, Beckie Haney

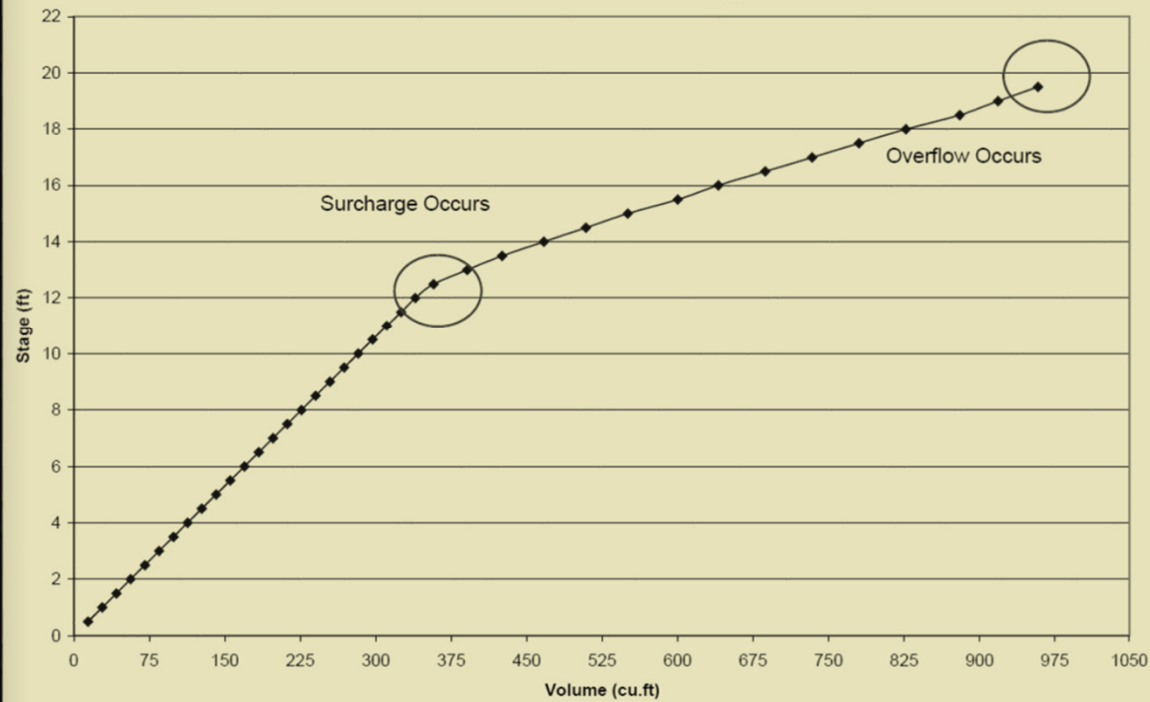
Engineering/QC Reviewer, Monica Quinones

My Family - Dan, Grace, and Kate Holloway





## PS136 Stage Storage Curve



QUESTIONS?

...thank you for coming