Watershed Asset Prioritization on Condition Assessment & Flood Resiliency

SESWA Conference

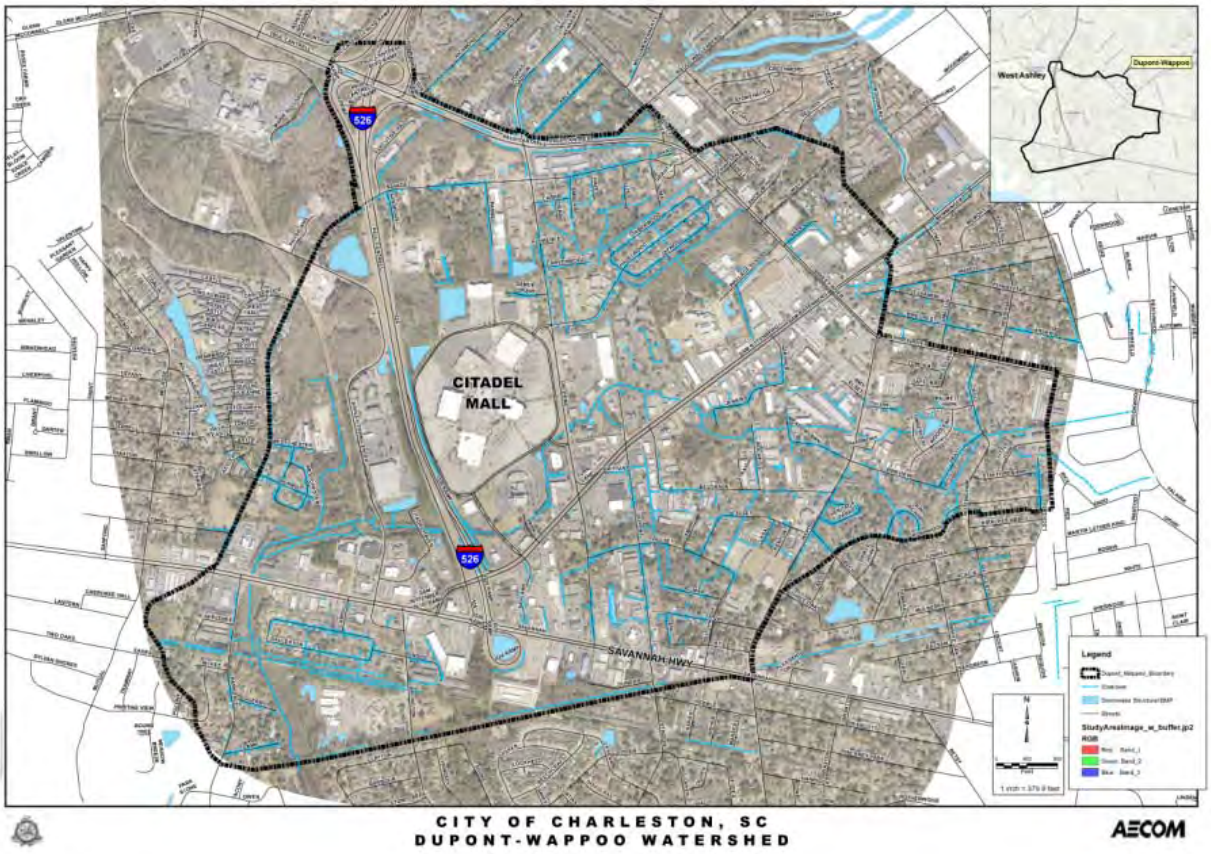
October 7 – 9, 2020

Overview

- Background
- Hydrologic/Hydraulic Modeling
- Level of Service
- Asset Prioritization
  - Condition Assessment
  - Flood Resiliency
- Proposed Improvements
- Improvements Prioritization
- Summary and Conclusions
- Questions and Answers

BACKGROUND

BACKGROUND – Defining the Watershed



DuWap Characteristics:

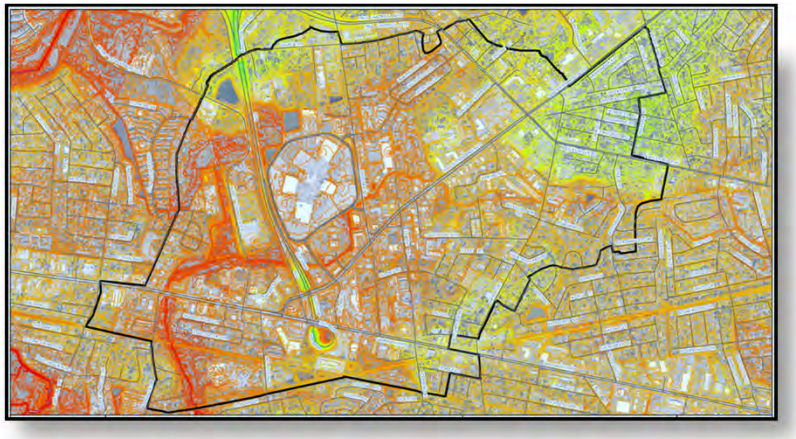
- 1500 ac
- Used to be Swampy and Marshy lands (USGS Quad Map)
- Mixed land uses residential, schools, commercial, some light industrial
- Citadel Mall and major shopping corridors
- High traffic area
- Mostly older development but starting to redevelop
- West Ashley Greenway

BACKGROUND – Watershed Characterization

Sub-basin Delineation

- 125 Total Sub-basins
- 105 Watershed Basins
- 20 Pond Basins

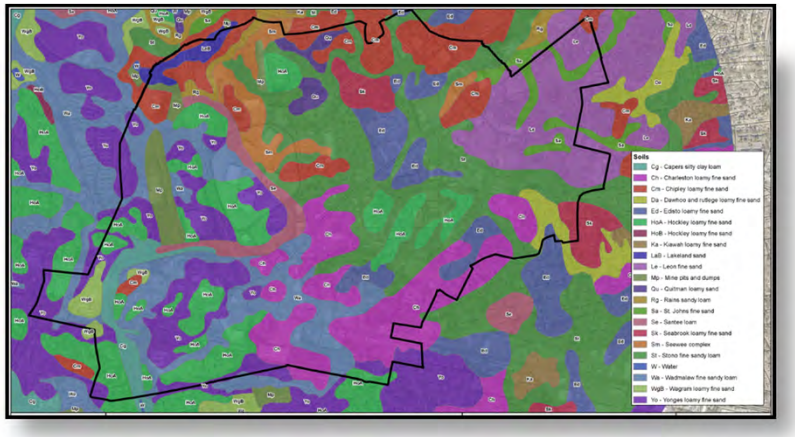
Topography



- 2007 LiDAR

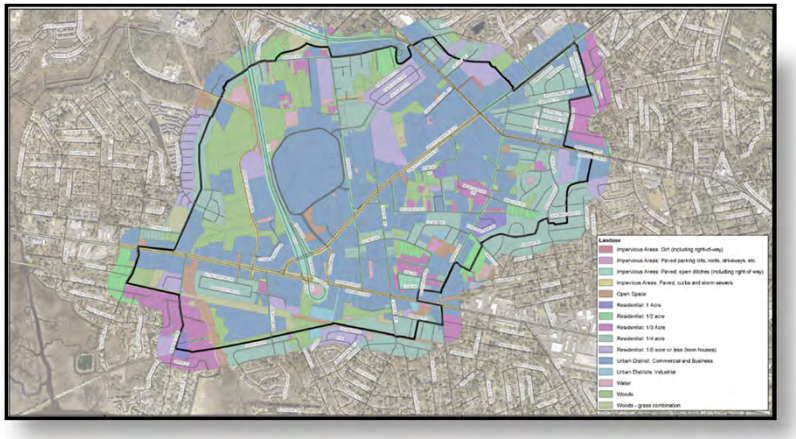
BACKGROUND – Watershed Characterization

Soil Map



- WSS – NRCS
- 53% Dual HSG (A/D)
  - Used D for Modeling analysis

Land Use/Land Cover Map



- City/County Zoning Map
- Mixed Land Use (75% Residential and Commercial)

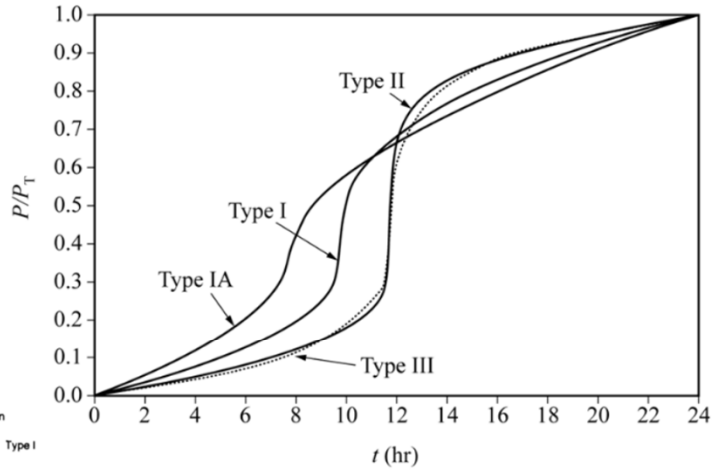
Hydrologic/Hydraulic Modeling

HYDROLOGIC/HYDRAULIC MODELING

Model Development

- Runoff Curve Number
- Soils
- Land Use
- Time of Concentration
- Unit Hydrograph Peaking Factor
- Boundary Conditions
- Rainfall Depth and Distribution

Return Period	24-hour Precipitation Depth (inches)
50% AEP	4.16
20% AEP	5.38
10% AEP	6.36
4% AEP	7.75
2% AEP	8.88
1% AEP	10.1



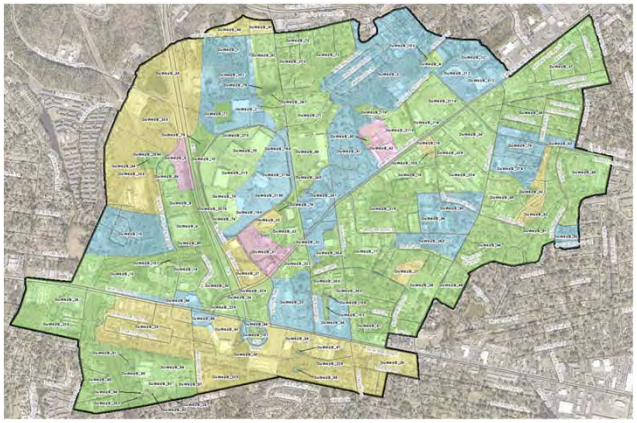
HYDROLOGIC/HYDRAULIC MODELING - Watershed Parameterization

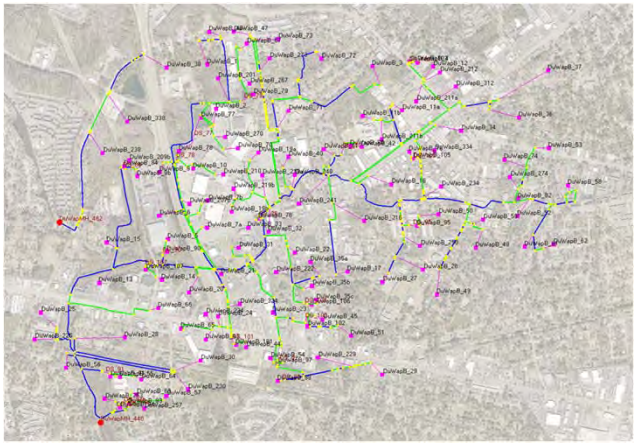
Hydrology

- Curve Numbers (AMC III)
- Time of Concentration (TR-55)
- Stage-Area Relationship

Hydraulics

- 1-D Model Network
  - ICPR 4.0
- Dynamic Boundary Conditions

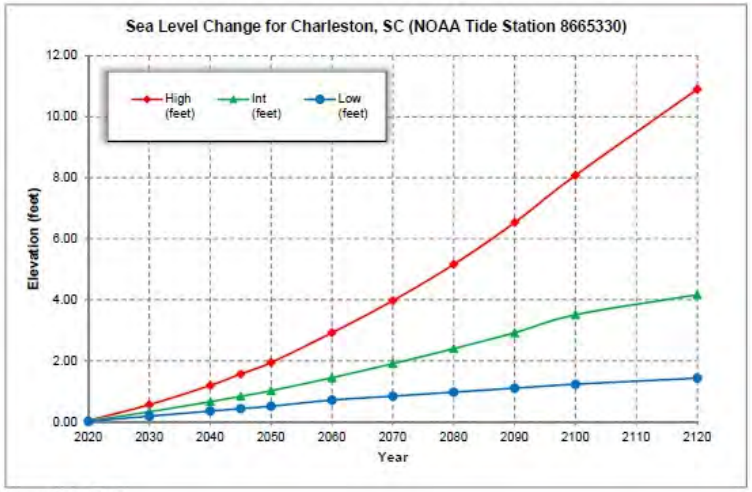




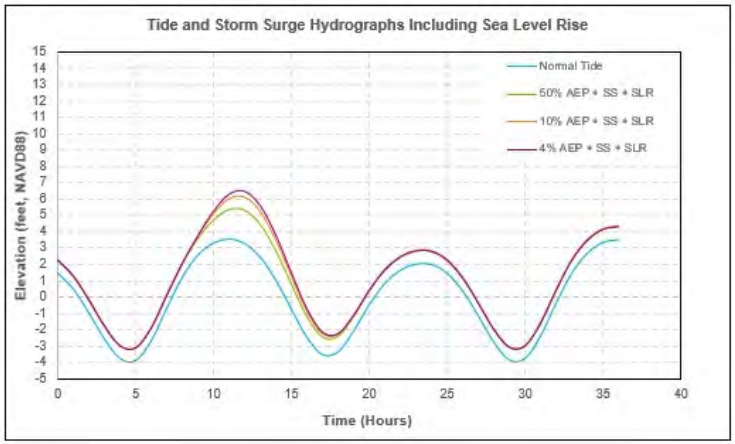
HYDROLOGIC/HYDRAULIC MODELING

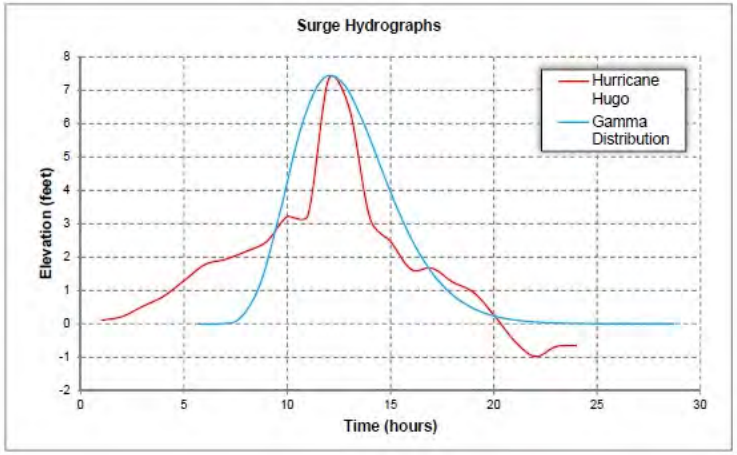
Dynamic Boundary Conditions

- Normal Tide
- Storm Surge
- Sea Level Rise



Source: NOAA 2017.



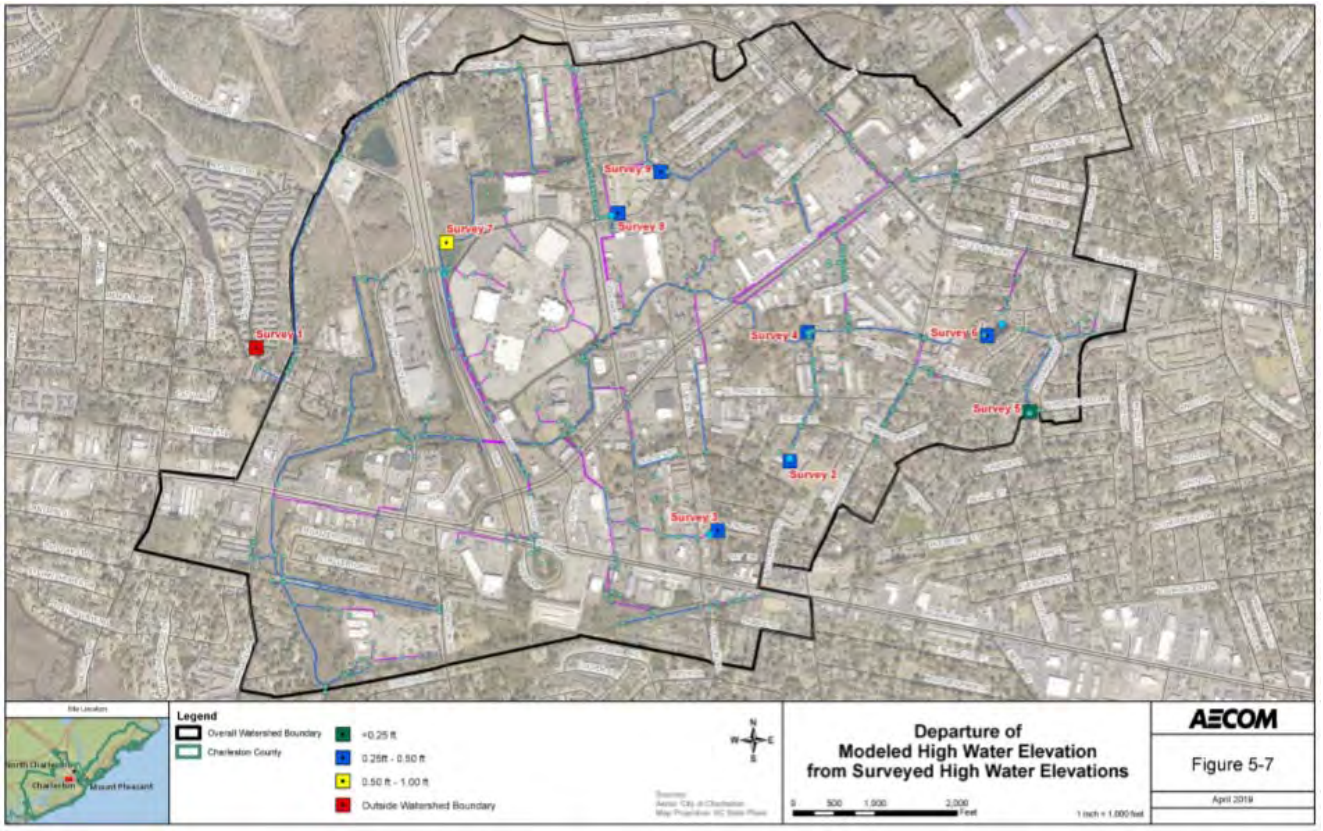


HYDROLOGIC/HYDRAULIC MODELING

Model Calibration

Calibrated against

- High Water Marks recorded for Hurricane IRMA (2017)
- Model calibrated well in 7 out of 8 locations



Level of Service

Level of Service

– Water Quantity Level of Service

– Level of Service is based on the following documents:

- City of Charleston *Stormwater Design Standards Manual*, March 15, 2013
- *City of Charleston Redevelopment Standards for Stormwater (Executive Report)*, September 12, 2016
- City of Charleston, Church Creek Basin Ordinance, Rev. 2018

Level of Service Flooding Criteria

Description	20% AEP	10% AEP	4% AEP	1% AEP
Roadway: Evacuation	None	None	None	None
Roadway: Collectors	None	None	6 inches	9 inches
Roadway: Neighborhood	None	6 inches	9 inches	12 inches
Structural: Buildings	None	None	None	None

Asset Prioritization

Asset Prioritization

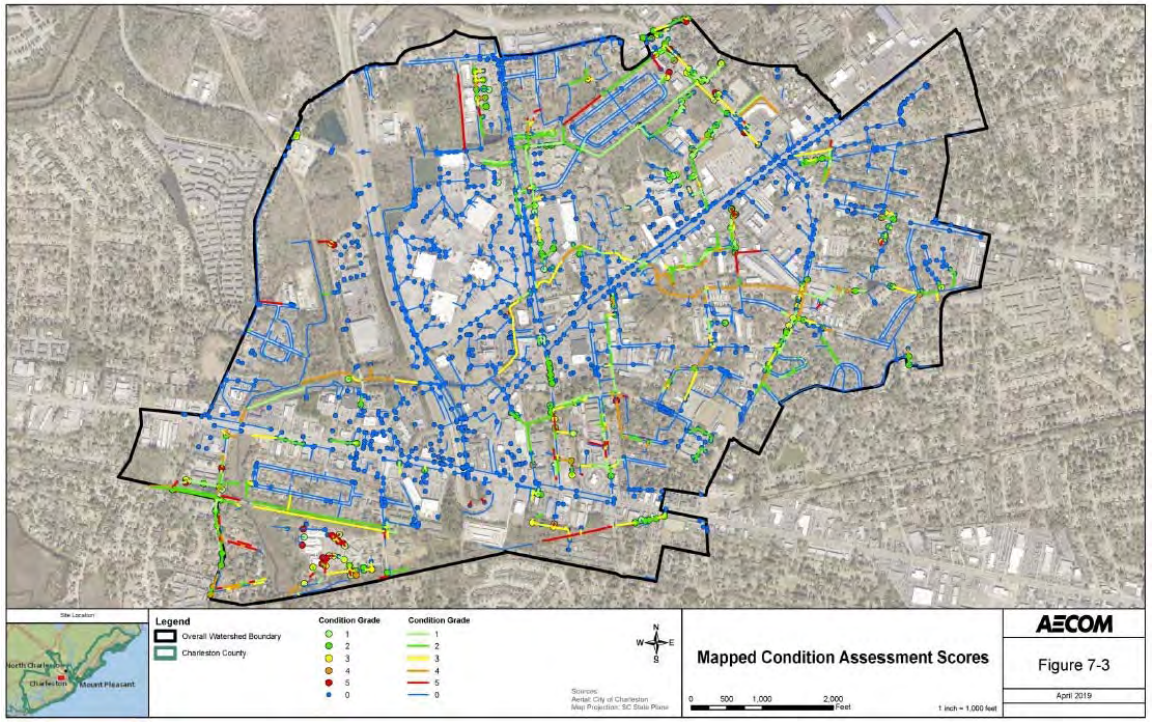
- Condition Assessment
  - Description of Problem
  - Severity of Problem

- Flood Resiliency
  - Flood Frequency
  - Depth of Flooding
  - Major Evacuation Routes
  - Critical Facilities

Citadel Mall parking lot during Hurricane Irma, 2017

Asset Prioritization - Process

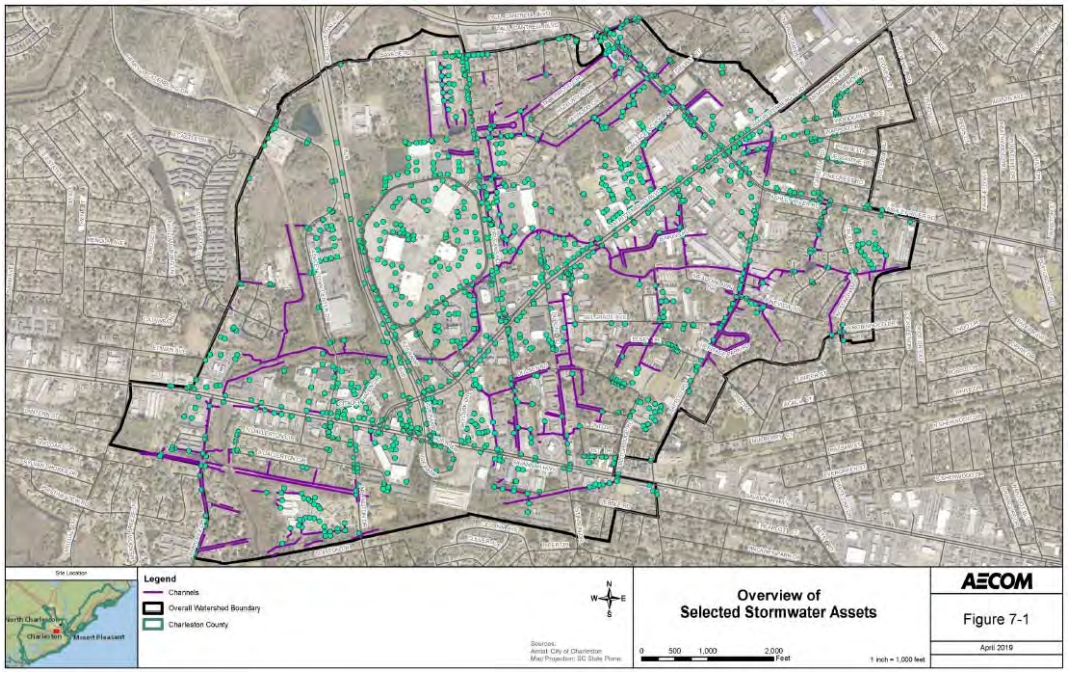
- Selection of assets
- Condition assessment metrics and scoring
- Flood resiliency metrics and scoring
- Project Recommendations to meet Level of Service Criteria
- Prioritization and ranking of assets for proposed projects/system improvements



Condition Assessment

- Selection of assets
  - Over 1500 Assets Selected for Condition Assessment

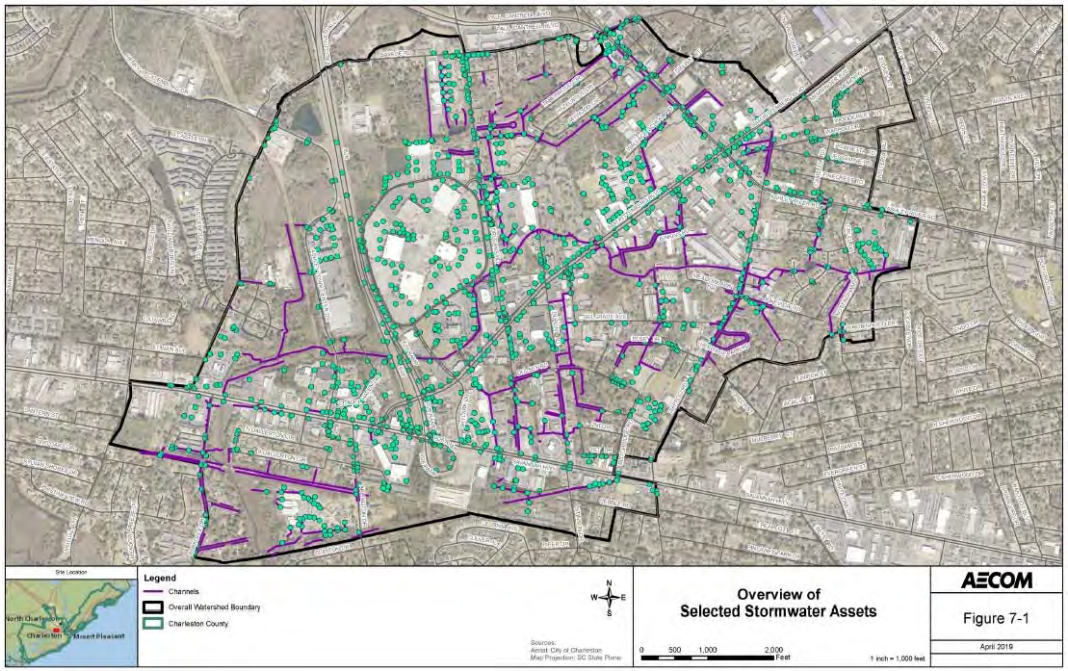
Asset	Number Inventoried	Percentage
Inlets	237	15.4%
Manholes	83	5.4%
Outlets	10	0.7%
Pipes	529	34.4%
Culverts	234	15.2%
Channels	445	28.9%
TOTAL	1,538	100%



Condition Assessment

Condition assessment metrics and scoring

- Methodology
- Descriptor – Description of problem e.g. erosion, obstruction etc.
- Modifier – Severity of defect
  - Minor
  - Moderate
  - Severe
- Pipe segments where multiple similar defects (e.g., multiple cracks) were identified, highest severity rating was assigned to the feature.



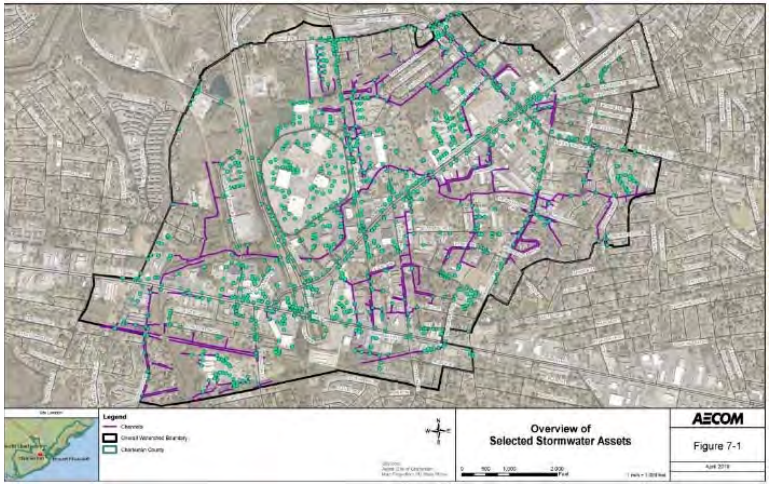
Condition Assessment

Condition Assessment Scoring:

- To prioritize the repairs/replacements, numeric scoring criteria were used for the assets. An example of the assessment scoring criteria is shown below

Stormwater Condition Assessment Scoring

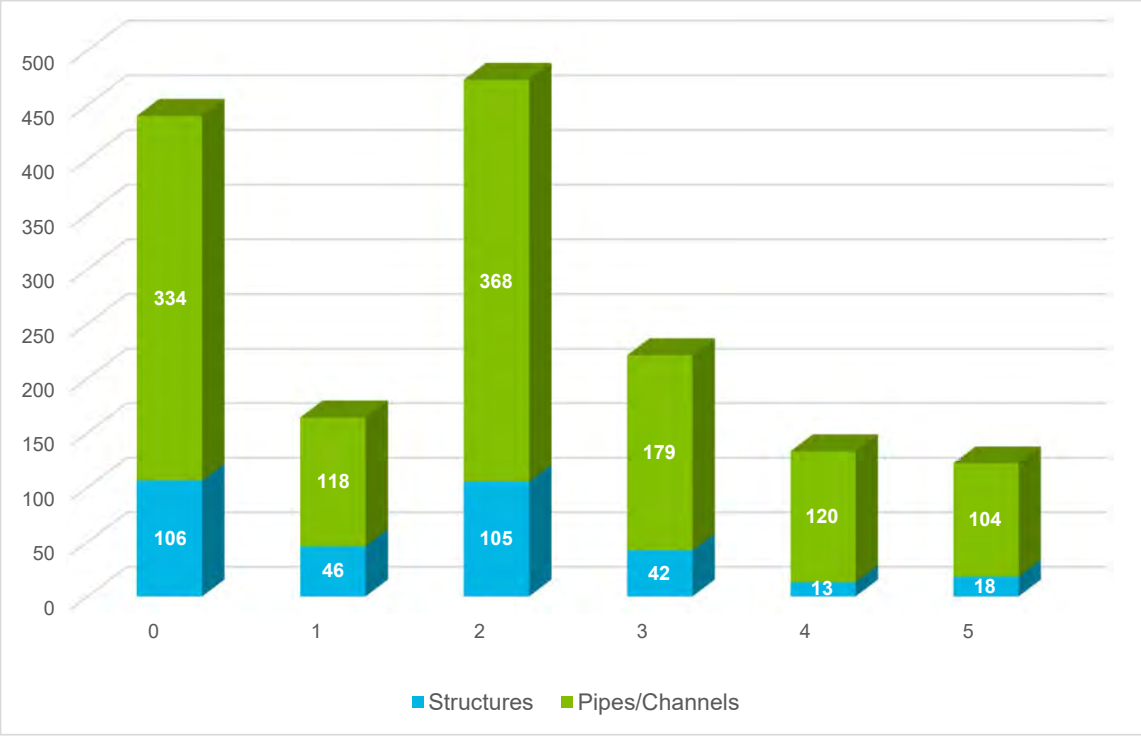
	Defects	Descriptors	Modifiers	Condition Grade			
				No Mod.	Minor	Moderate	Severe
Structural Defects	Crack		Minor, Moderate, Severe		2	3	4
	Fracture		Minor, Moderate, Severe		3	4	5
	Broken		Minor, Moderate, Severe		3	4	5
	Hole		Minor, Moderate, Severe		3	4	5
	Deformed (≤40%)			4			
	Collapse (>40%)			5			
	Joint	Offset	Minor, Moderate, Severe		2	3	4
		Separated	Minor, Moderate, Severe		3	4	5
	Surface Damage	Spalling		2			
		Aggregate Visible		3			
		Rebar Exposed		4			
		Corrosion		5			
		Lining Failure		3			
		Other	Minor, Moderate, Severe		1	3	5
	Brick/Block /Rock	Displaced		3			
		Missing		4			
		Missing Mortar		2			
	Decayed		Minor, Moderate, Severe		2	3	4
				No Mod.	**<30%**	**30-50%**	**>50%**
	Sag		(<30%), (30-50%), (>50%)		2	3	4



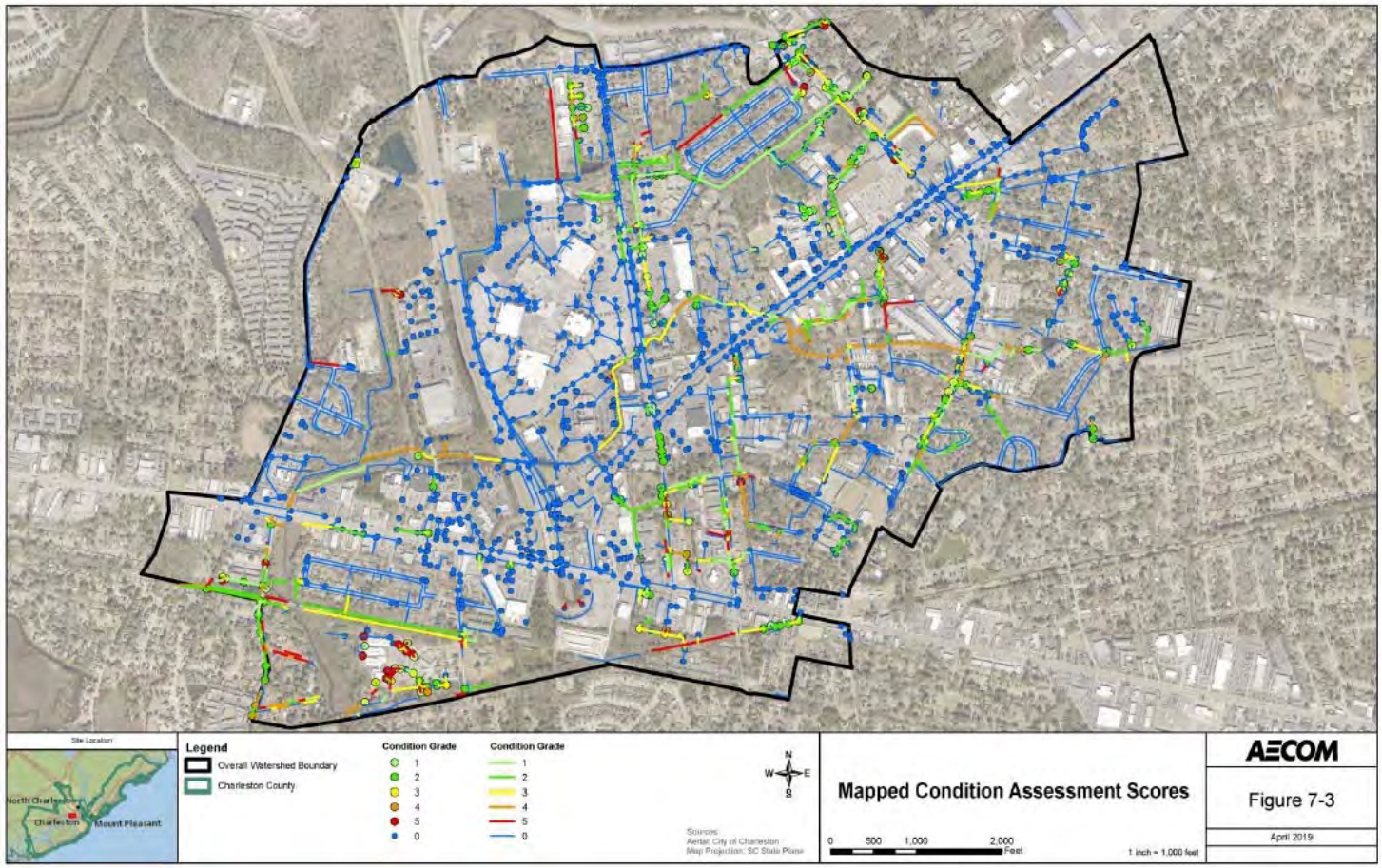
Condition Assessment

Condition Assessment Scoring

- 16 percent of assets scored a four or five, indicating severe defects.
- 45 percent of assets scored two or three, indicating minor or moderate defects.
- 11 percent of assets scored a one, indicating minor defects
- 28 percent of assets scored had no noted defects.



Mapped Condition Assessment Scores



Flood Resiliency

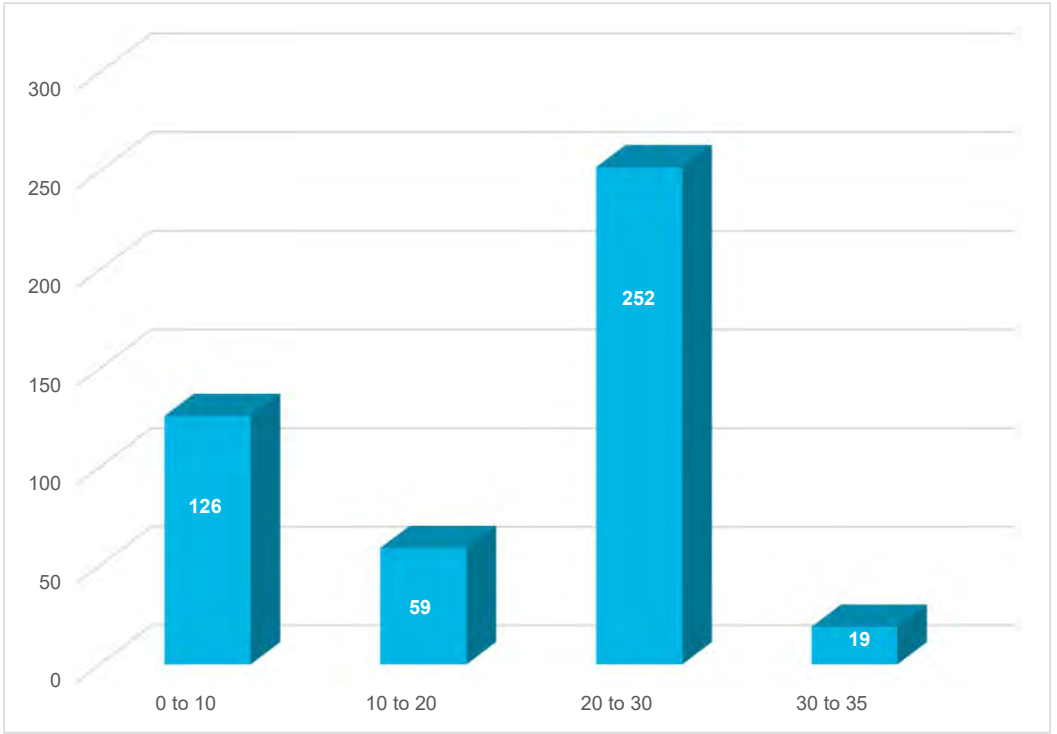
Flood Resiliency Metrics and Scoring

- **Flood Frequency**
  - 50% AEP, 20% AEP, 10% AEP, 4% AEP, 2% AEP, and 1% AEP storm events
  - Assets experiencing flooding during the 50% AEP, the highest score, increased frequency of occurrence.
- **Depth of Flooding**
  - Flood depths > 2 feet during the event were considered highest priority.
- **Major Evacuation Routes Impacted**
  - Structures located within 50 feet of a state highway or US Highway were considered structures that could impact an evacuation route.
- **Critical Facilities Impacted**
  - Critical facilities were defined as any school, military installation, government office, hospital, or airport within 50 feet of an asset.

Category	Flood Metrics	Criteria Score
Flood Frequency [a]	50% AEP	6
	20% AEP	5
	10% AEP	4
	4% AEP	3
	2% AEP	2
	1% AEP	1
Depth of flooding during 25-year storm	>2.0 feet	4
	1–2.0 feet	3
	0.5–1.0 feet	2
	0-0.5 foot	1
	No flooding	0
Major Evacuation Routes impacted [b]	Yes	10
	No	0
Critical Facilities impacted [c]	Yes	10
	No	0

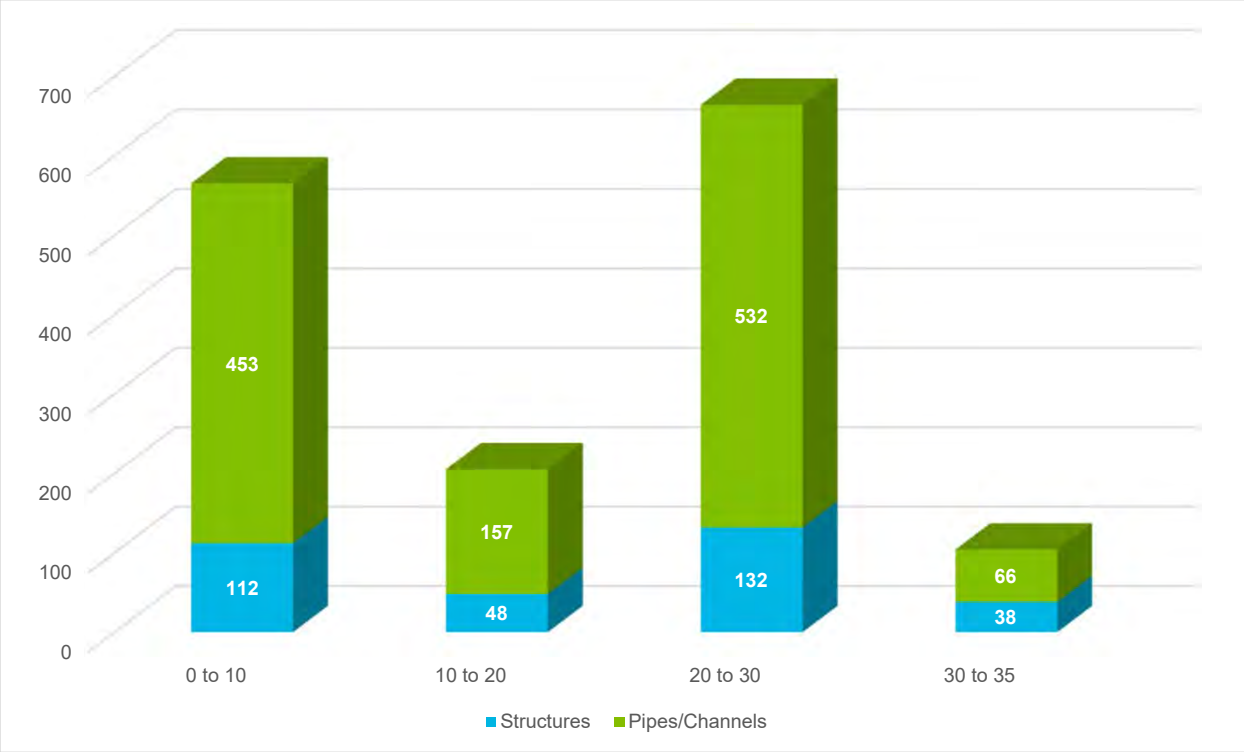
Flood Resiliency Metrics and Scoring

- **7 percent of assets scored in the range of 30 to 35, indicating severe flood risk.**
- **43 percent of assets scored in the range of 20 to 30, indicating moderate flood risk.**
- **13 percent of assets scored in the range of 10 to 20, indicating minor flood risk.**
- **37 percent of assets scored in the range of 0 to 10, indicating negligible flood risk.**

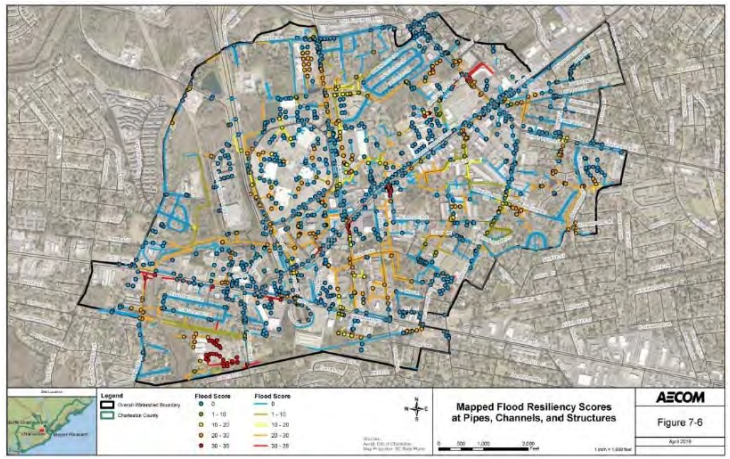


Total Flood Resiliency Scores at Model Nodes

Flood Resiliency Metrics and Scoring

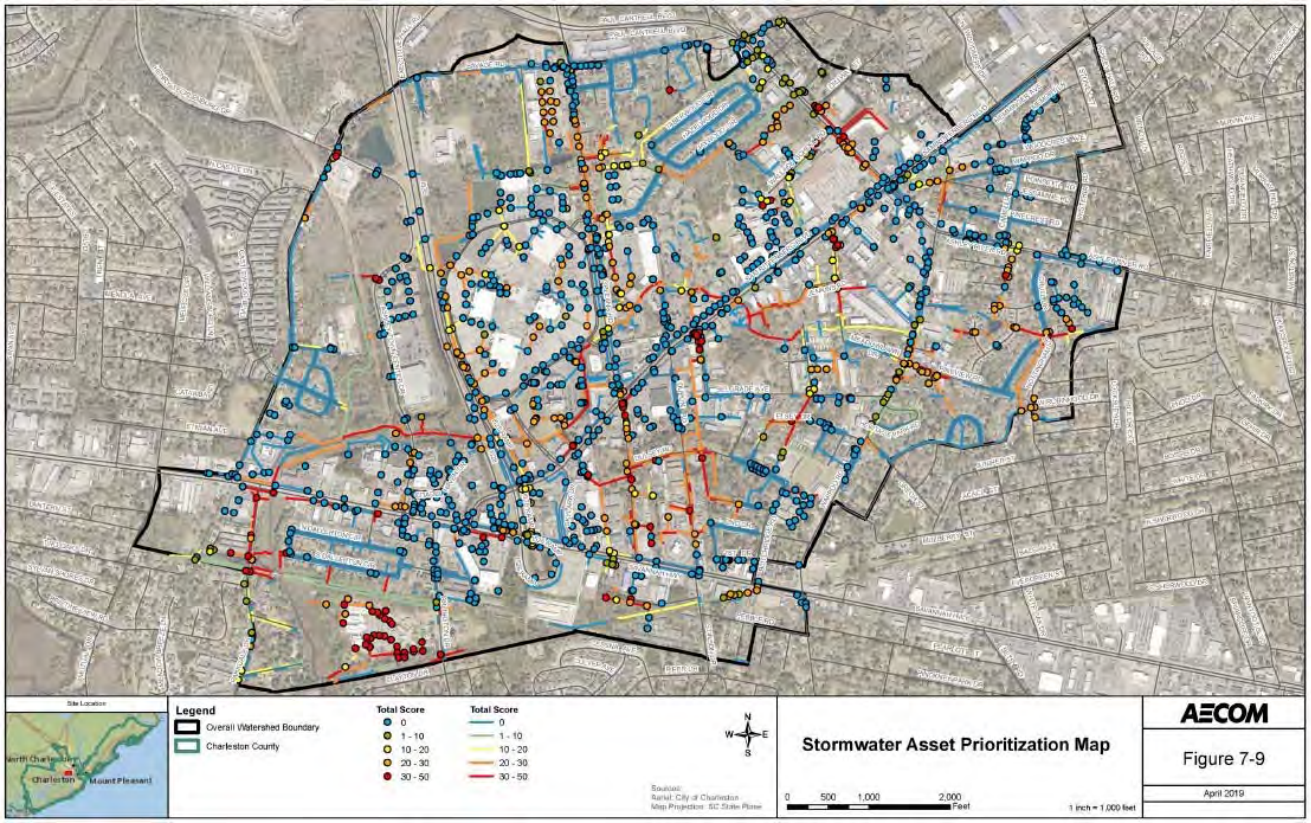


Flood Resiliency Scores at Pipes, Channels, and Structures



Overall Asset Scoring – Condition Assessment and Flood Resiliency

- The results of the flood resiliency assessment and condition assessment were combined to help prioritize problem areas for potential projects.
- Flood assessment scores totaled to a maximum of 35
- Condition assessment totaled to a maximum of 5
- To make the two ranking indexes more equal, the condition assessment scores were multiplied by a factor of three, increasing the maximum value to 15 points. When combined, the maximum total possible score (flood resiliency + condition assessment) is 50 points.

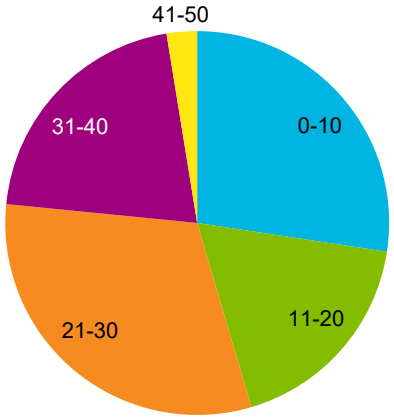


Overall Asset Scoring

– **Maximum Flood Assessment Score = 35**

Total Ranking Scores – Pipes/Channels

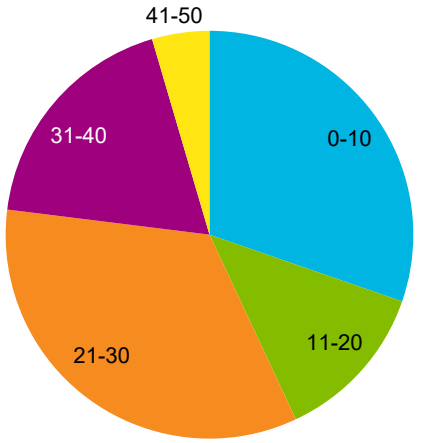
Total Score	Number of Assets	Percentage of Assets
0-10	331	27.4%
11-20	218	18.0%
21-30	376	31.1%
31-40	252	20.9%
41-50	31	2.6%



– **Maximum Condition Assessment Score = 15**

Total Ranking Scores – Structures

Total Score	Number of Assets	Percentage of Assets
0-10	100	30.3%
11-20	42	12.7%
21-30	112	33.9%
31-40	61	18.5%
41-50	15	4.5%



Proposed Improvements

Proposed Improvements

- Improvement of culverts (Addition/Upsizing)
- Addition of check valves
- Addition of Storage as Wet Detention/Dry Detention ponds, and
- Addition/Widening of Swales/Channels.

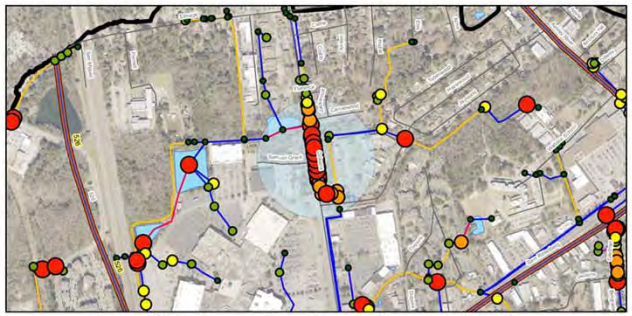


Figure 9-2a - Current Condition 25 Year Flood Depth

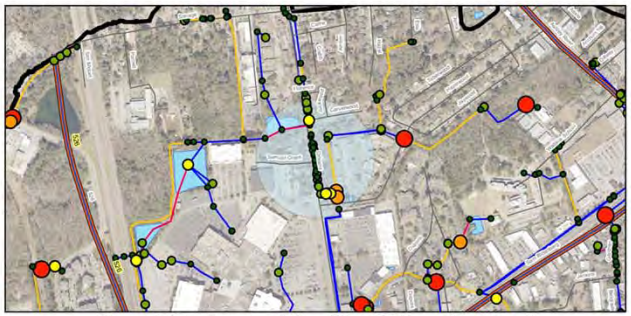


Figure 9-2c - Improved Condition 25 Year Flood Depth

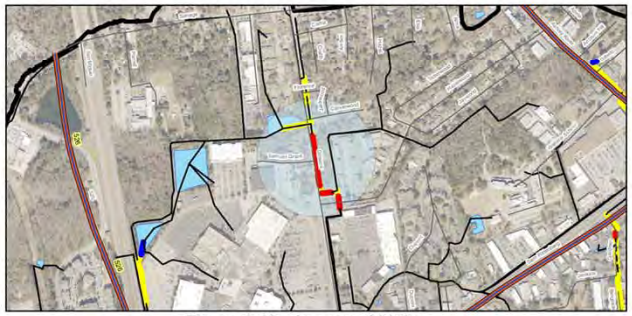
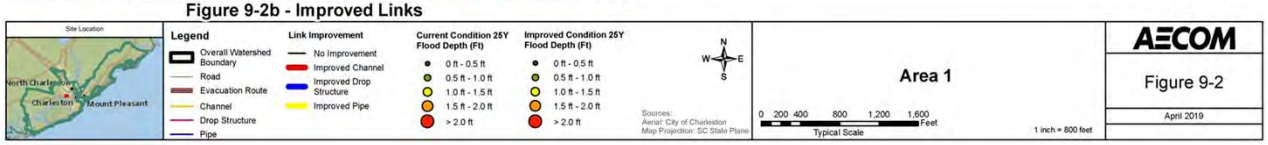


Figure 9-2b - Improved Links



Improvements Prioritization

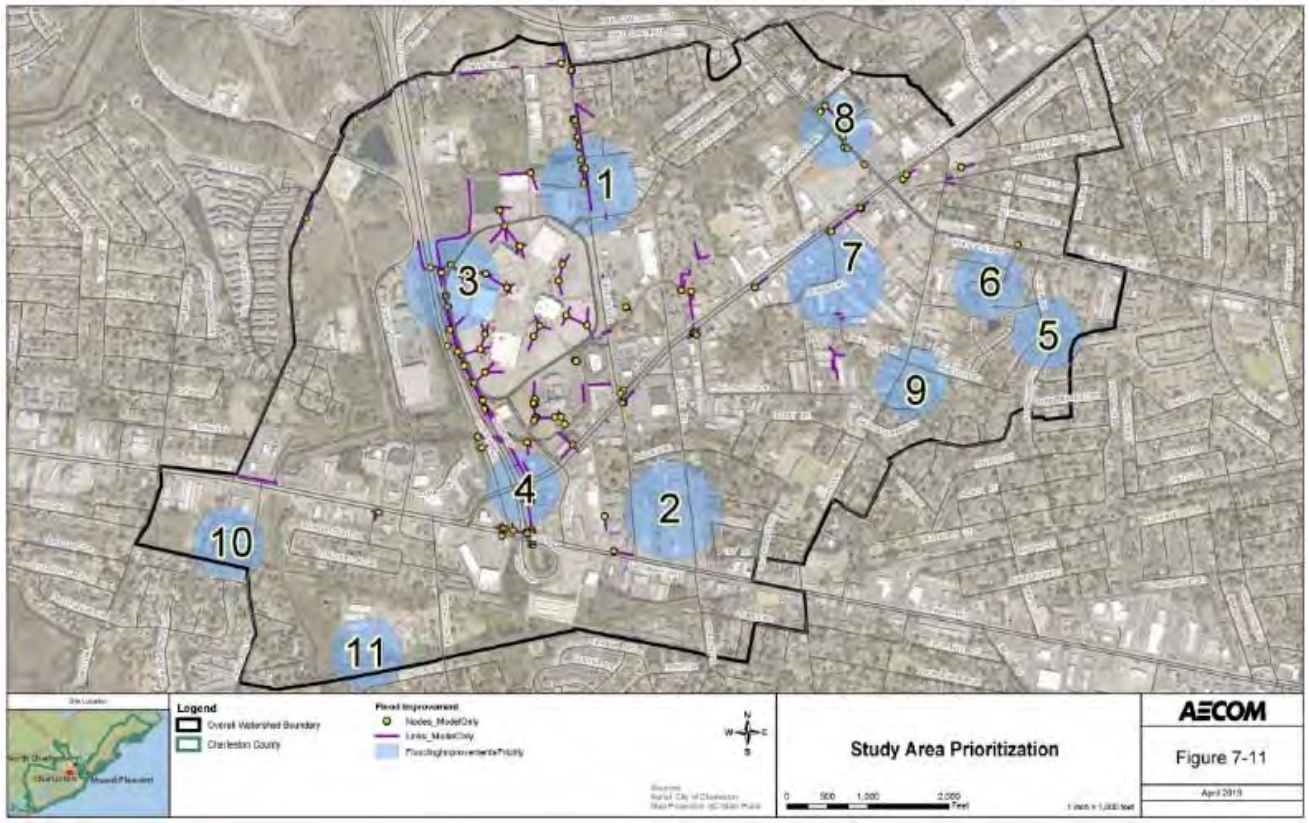
Improvements Prioritization - Approach

Final Prioritization

- Overall Asset Scoring on Condition Assessment and Flood Resiliency
- Capital Costs for Each Project
- Constructability Issues
- Maintenance of Traffic Issues
- Public/Private Partnership
- General Project Area/Downstream Impacts

Improvements Prioritization - Final

Project Area	Total Impact Score within Area	Project Area Description
1	3318	Intersection of Samuel Grant Place and Orleans Road
2	2745	Area between End Drive and Orleans Road,
3	1030	Areas along the north western corner of the Citadel Mall parking lot
4	1194	Intersection of Sam Rittenberg Boulevard and I-526
5	1732	Intersection of Pratt Street and Nottingham Drive,
6	1809	Intersection of Tomoka Drive and Westover Drive
7	700	Intersection of Jenkins Road and Gardner Road
8	875	Intersection of Ashley River Road and Akers Road
9	799	Intersection of Wappoo Road and Meadowlawn Drive
10	1677	Intersection of Applebee Way and Parkdale Drive
11	415	Area between W Ashley Greenway and Clayton Drive



Summary & Conclusion

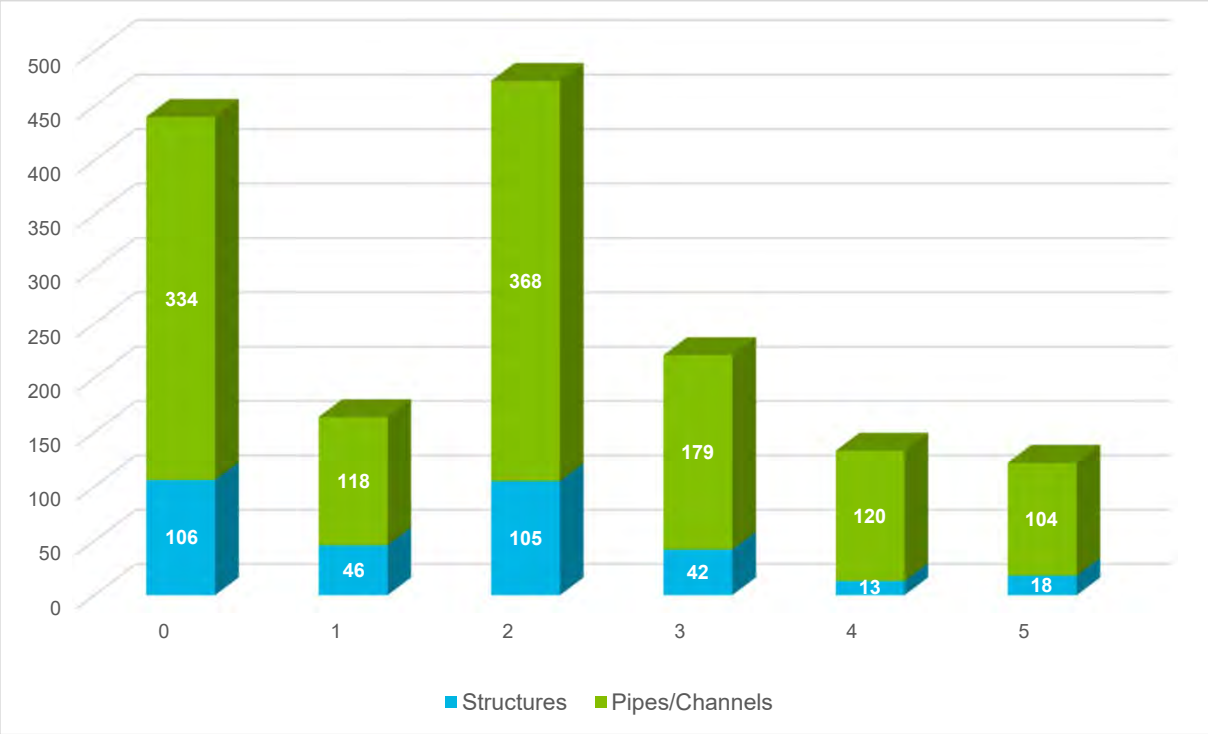
Summary & Conclusion

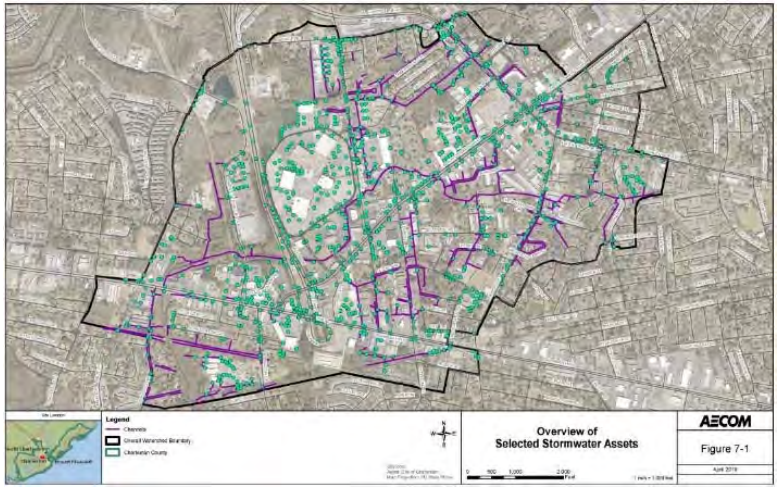
- The condition assessment identified 11 areas of focus for implementation of capital improvements.
- Cleaning/Maintenance was done during condition assessment which provided immediate improvement in some areas
- A majority of the flooding problems in the DuWap watershed occur in these areas.
- Other portions of the watershed experience flooding and require flood mitigation.
- The capital improvements recommended for the flooding problems in the 11 selected areas will provide flood mitigation benefits to surrounding areas.
- Even if flooding is not completely eliminated, the intensity, frequency, and duration of flooding is reduced.

Questions & Answers

Condition Assessment

Condition Assessment Score





Prioritization

Project areas were prioritized based on the ranking score of their associated assets

Summary of Stormwater Asset Scoring

Total Score	Links	Nodes	Total	Percentage of Assets
41-50	31	15	46	3.0%
31-40	252	61	313	20.4%
21-30	376	112	488	31.7%
11-20	218	42	260	16.9%
0-10	331	100	431	28.0%

Study Area Prioritization

Project Area	Total Impact Score within Area	Project Area Description
1	3318	Intersection of Samuel Grant Place and Orleans Road
2	2745	Area between End Drive and Orleans Road,
3	1030	Areas along the north western corner of the Citadel Mall parking lot
4	1194	Intersection of Sam Rittenberg Boulevard and I-526
5	1732	Intersection of Pratt Street and Nottingham Drive,
6	1809	Intersection of Tomoka Drive and Westover Drive
7	700	Intersection of Jenkins Road and Gardner Road
8	875	Intersection of Ashley River Road and Akers Road
9	799	Intersection of Wappoo Road and Meadowlawn Drive
10	1677	Intersection of Applebee Way and Parkdale Drive
11	415	Area between W Ashley Greenway and Clayton Drive

Asset Prioritization