Unpacking Flood Risk Analysis: How to Save Money and Plan for the Future

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Connecticut Association of Floodplain Managers

Annual Meeting

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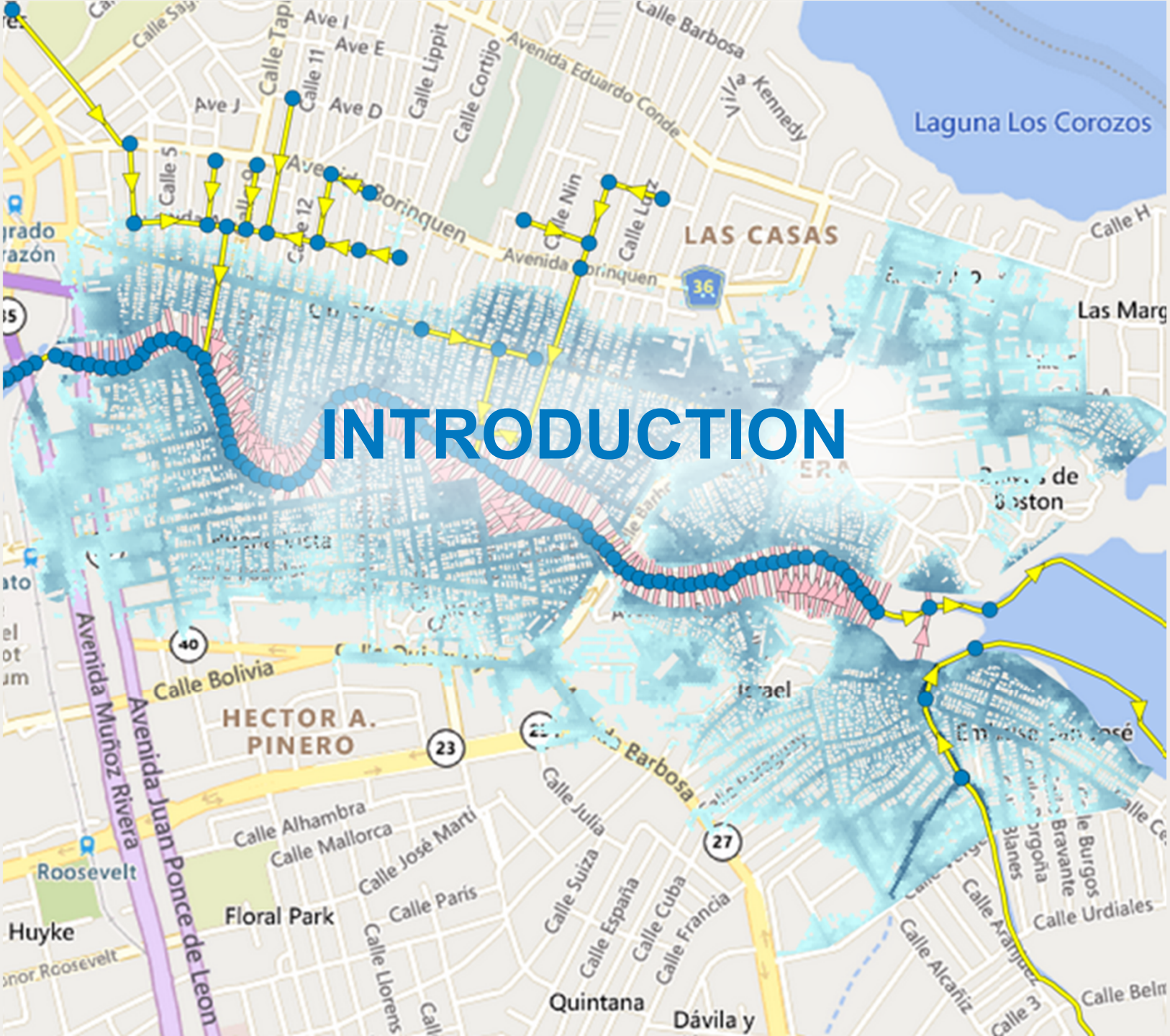
INTRODUCTION
Laguna Los Corozos
LAS CASAS
Avenida Eduardo Conde
Calle Barbosa
Avenida Borinquen
Calle Bolivia
HECTOR A. PINERO
Avenida Muñoz Rivera
Avenida Juan Ponce de Leon
Roosevelt
Floral Park
Huyke
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Israel
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Calle Alhambra
Calle Mallorca
Calle José Marti
Calle París
Calle Julia
Calle Suiza
Calle España
Calle Cuba
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Calle Urdiales
Calle Alcañiz
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Calle Lippit
Calle Cortijo
Calle Nin
Calle Luz
Calle 11
Calle 12
Calle 5
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Outline

- Flood Risk Analysis: Types and basic requirements
- Floodplain Analyses: 2D or not 2D
- Stormwater Analyses: Set yourself up for success!
- Case Studies
- Free Resources

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Types of H&H Analyses

- Floodplain Mapping and Delineation
- Stormwater Runoff and Drainage Analysis
- Culvert and Bridge Hydraulics Study
- No-Rise Certification Studies
- Floodway Analysis and Encroachment Study
- GI Sizing and Performance Assessment
- LID Feasibility and Hydrologic Performance Analysis
- Reservoir/Dam Break Analysis
- Sediment Transport and Erosion Studies
- Wetland Hydrology and Inundation Studies
- Coastal Inundation and Surge Modeling
- Climate Change Impact Assessment on Flooding

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Data Requirement	Stormwater Analysis	Floodplain Analysis
Precipitation Data	**Rainfall intensity, frequency, and duration for storm events** Sources: NOAA Atlas 14 Volume 12, historic measurements	**Design storm events (10-, 50-, 100-, 500-year), historical flood data.** Sources: previous studies, FEMA studies, HEC-HMS model
Soil and Land Use Data	**Soil types, land cover, and impervious area for runoff estimation**	**Soil infiltration rates, land use for floodplain hydrology**
Topographic Data	**High-resolution DEM or contour data for drainage area delineation**	**High-resolution DEM, bathymetry, LiDAR for accurate channel, floodplain mapping**
Hydrologic Inputs	**Peak discharge rates, hydrographs** Sources: HEC-HMS, previous studies	**Discharge rates, flow paths for riverine systems** Sources: StreamStats, HEC-HMS, previous studies
Hydraulic Model Inputs	Channel cross-sections, Manning's roughness coefficients **Sources: Survey, LiDAR, field observations, previous studies**	River cross-sections, Manning's n values, floodway data **Sources: USGS gage data, FEMA studies, survey, field observations, previous studies**

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- Flood Risk Analysis: Types and basic requirements
- **Floodplain Analyses: 2D or not 2D**
- Stormwater Analyses: Set yourself up for success!
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FLOODPLAIN
Sagrado Corazón
LAS CASAS
El Paraíso
CANTERA
Hato Rey
José Miguel Agrelot Coliseum
HECTOR A. PINERO
Avenida Borinquen
Avenida Muñoz Rivera
Avenida Juan
Calle Bolivia
Calle Julia
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When to Choose 2D?

Philosophy: The simplest model that can solve the problem with accuracy should be the one selected.

- Wide Shallow Flooding
- Complex Flow Patterns (horizontal plane)
- Flow is hydraulically disconnected between the main channel and the floodplain
- Urban Environments
- Overland Flow and Storm Surge Inundation
- Dynamic WSE Changes

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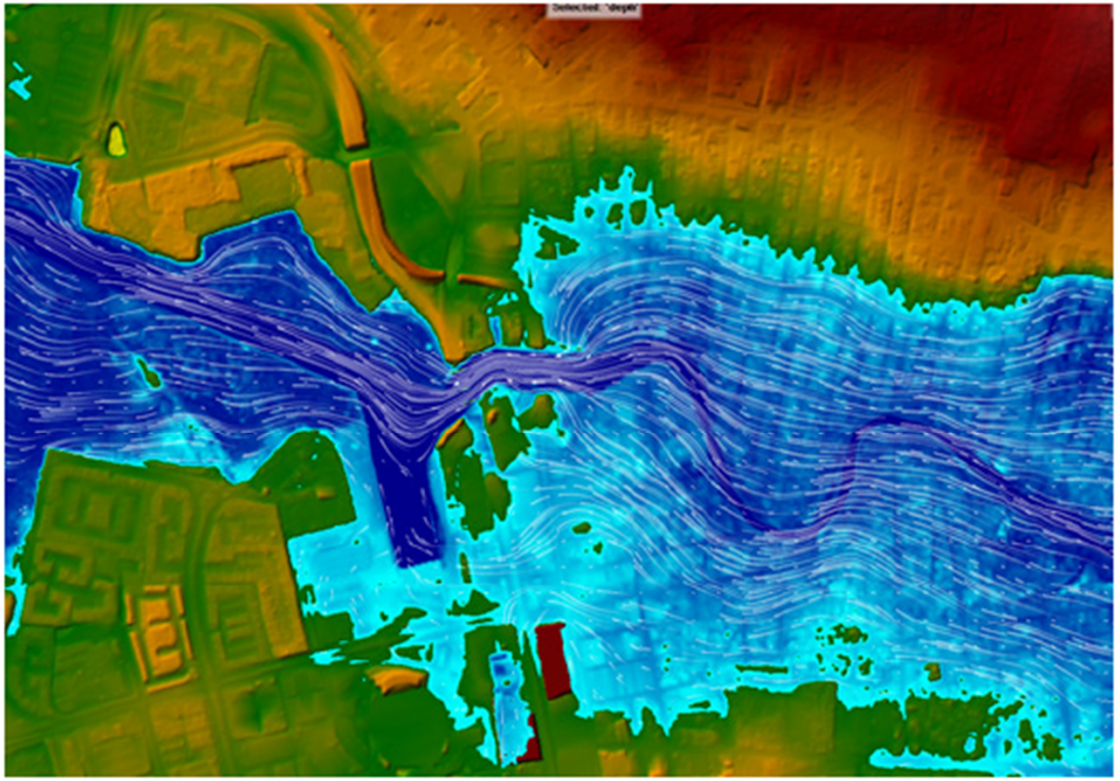
Floodplain Analysis

- FEMA AE Zone
- San Juan Estuary from San Juan Bay to the Torrecilla Lagoon
- Development Project



Model results of the San Juan Estuary System showing extensive flooding along the Caño Martín Peña

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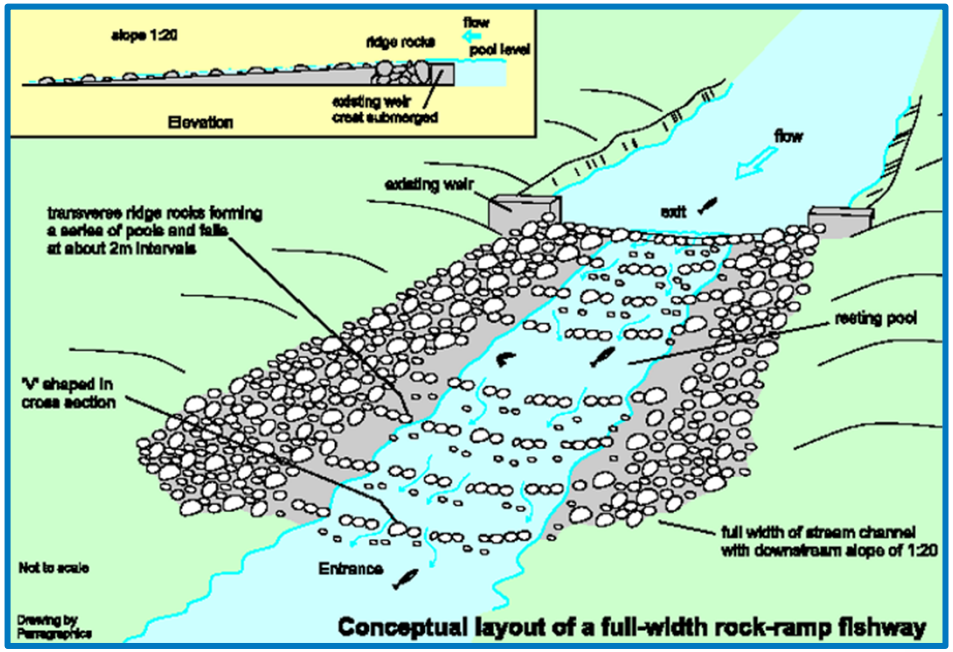
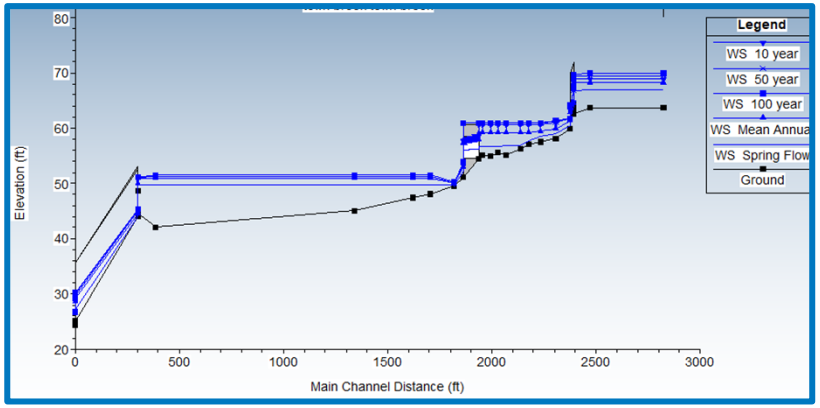
When to Choose 1D?

- Vertical Energy and Momentum Changes
- Waterfalls
- Steep Rivers
- Narrow, confined channels





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	USED FOR	DATA REQUIREMENTS	OUTPUT ANALYSIS LEVEL
1D	- Channelized Flow - Simple Geometry - Efficiency Needs - Steady Flow	Surveyed **cross-sections** at intervals, **steady or unsteady** state flow	Provides cross-sectional view; faster but less detailed
2D	- Complex Flow Patterns (*urban environments, wetlands, braided*) - Detailed Floodplain Analysis - Overland Flow and Storm Surge Inundation - Dynamic Water Surface Elevation Changes	High-resolution **spatially distributed terrain data** (topographic and bathymetric) in the form of **Digital Elevation Models (DEMs)** **Detailed hydrologic inputs** such as time series flow data or discharge hydrographs	Spatially detailed flood depth, velocity, and inundation extent; suitable for flood hazard mapping and urban flood studies

Questions to Ask Yourself

- Will a 2D model provide additional accuracy?
- Is there sufficient topo and bathy info available?
- Can existing hydrology be used?
- Is there an existing effective model?
- Will the 2D model have a future use?

Consider the cost of the model and the data required.

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Other Considerations

- **Calibration and Troubleshooting:**
  - 2D models require **more time for calibration** and troubleshooting due to their complexity and larger data sets
  - Calibration involves adjusting model parameters to match observed data, which can be time-intensive but leads to greater model accuracy
- **NFIP Concurrence**

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NFIP Concurrence

- **44 CFR 65.6 (a)(8):** A revised hydraulic analysis for a flooding source with established base flood elevations must include evaluation of the same recurrence interval(s) studied in the effective FIS, such as the 10-, 50-, 100-, and 500-year flood elevations, and of the floodway. Unless the basis of the request is the use of an alternative hydraulic methodology or the requestor can demonstrate that the data of the original hydraulic computer model is unavailable or its use is inappropriate, **the analysis shall be made using the same hydraulic computer model used to develop the base flood elevations** shown on the effective Flood Insurance Rate Map and updated to show present conditions in the floodplain. Copies of the input and output data from the original and revised hydraulic analyses shall be submitted.

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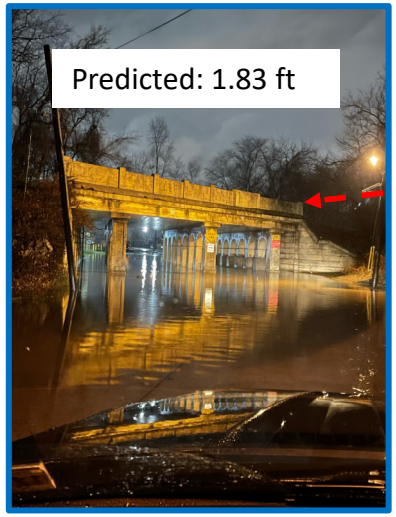

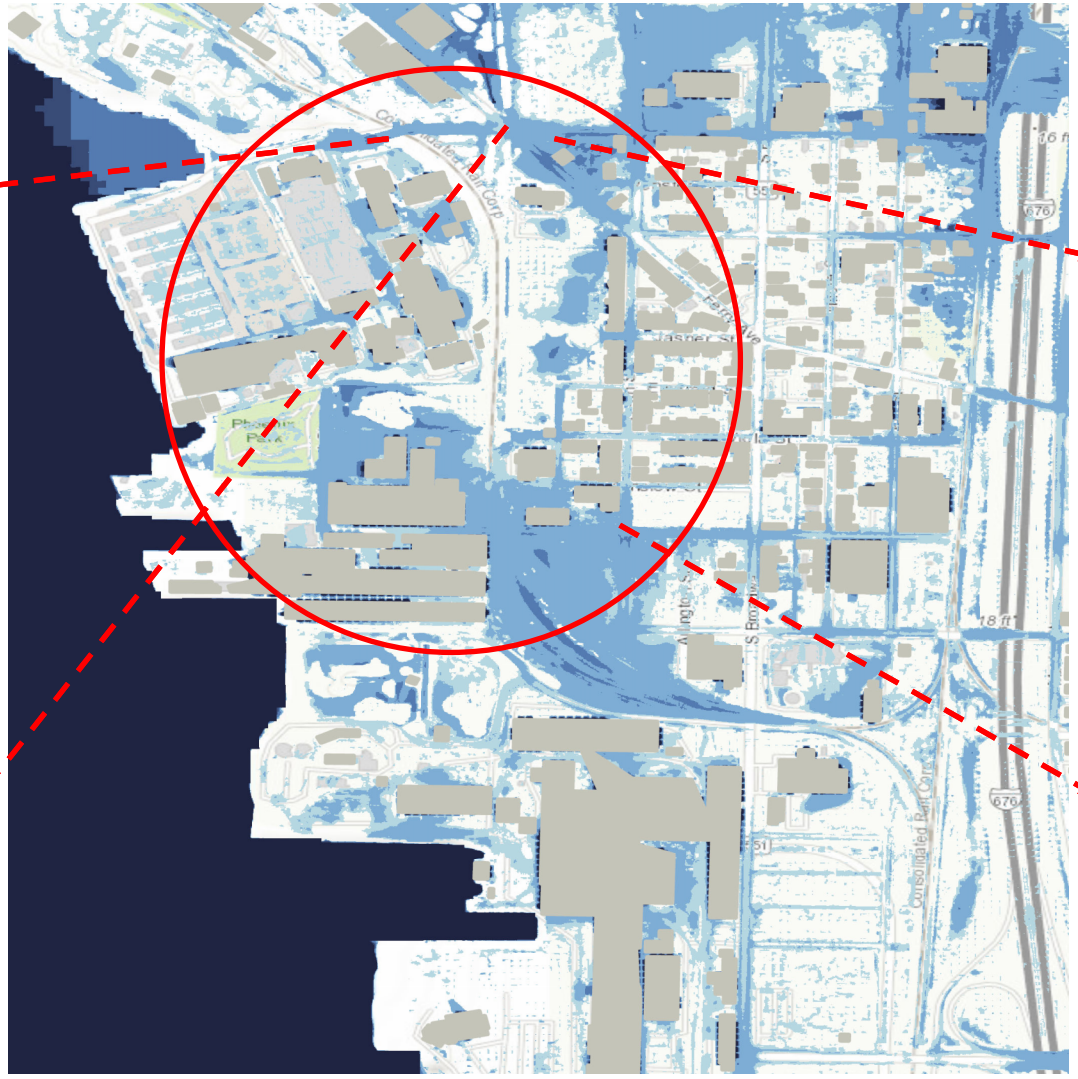

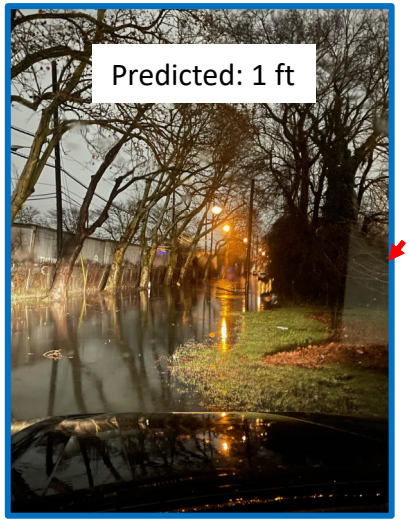

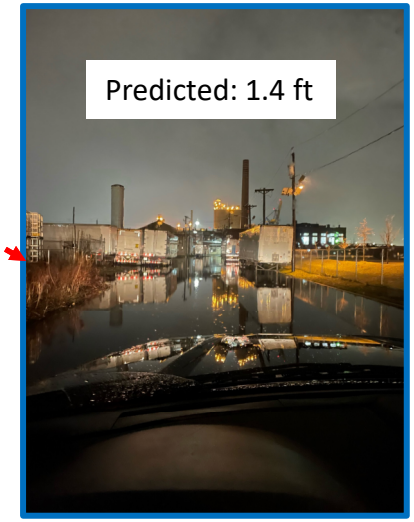

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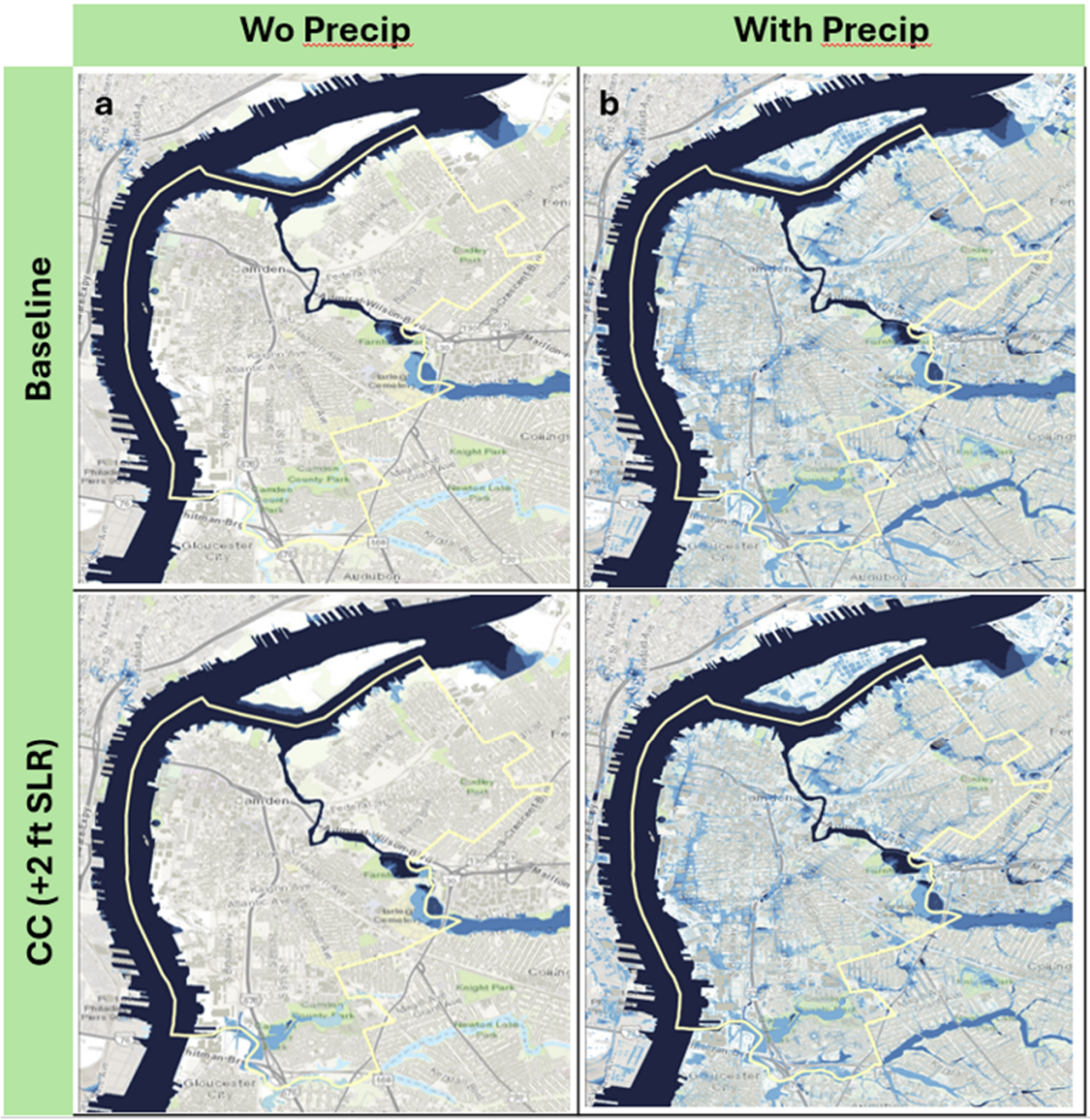

-HEC-RAS 2D

-Pluvial Rain-On-Grid

-Tidal Boundary Conditions

-USGS Stream Gage Discharge


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- **Stormwater Analyses: Set yourself up for success!**
- Questions

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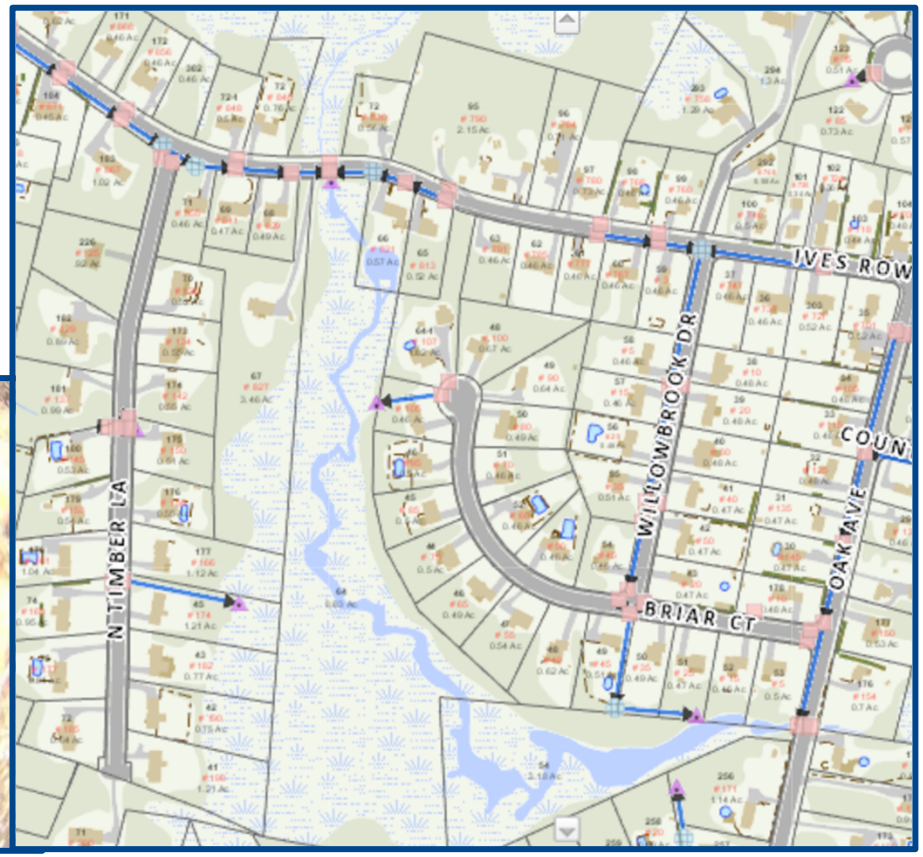
Set Yourself Up for Success!

PREPARE!

- GIS mapping of system
- Conditions Assessment



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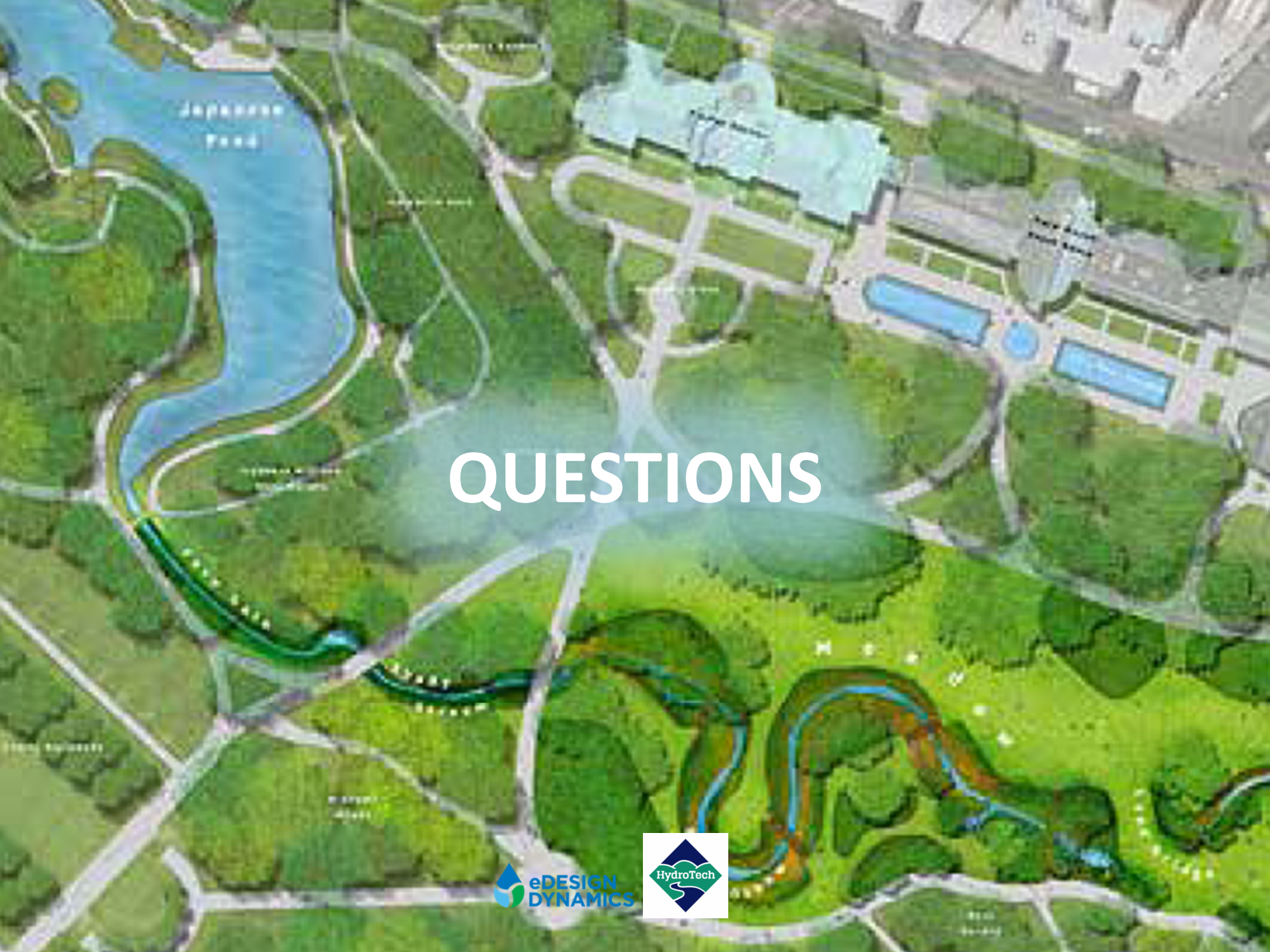
Set Yourself Up for Success!

SIMPLIFY

- Combine sub-catchments
- Not enough data?
  - Straight-line flow to nearest outfall
  - Represent multiple non-critical pipes by one larger
  - Assume pipes running full at limits of data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FEMA Hydraulics Two-Dimensional Analysis

https://www.fema.gov/sites/default/files/documents/fema_hydraulics-two-dimensional-analyses.pdf

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Study Type	Purpose	Application	Tools and Models
Floodplain Mapping and Delineation	Determine spatial extent of flood-prone areas under different scenarios.	NFIP requirements, floodplain management, land-use planning.	HEC-RAS, HEC-HMS, FEMA-approved models.
Stormwater Runoff and Drainage Analysis	Model stormwater runoff and assess drainage system adequacy.	Stormwater management planning, infrastructure sizing, drainage improvements.	SWMM, TR-55, local hydrologic models.
Culvert and Bridge Hydraulics Study	Assess water flow through culverts and under bridges for flood capacity.	Transportation infrastructure design, especially in high flood risk areas.	HEC-RAS, HY-8, FHWA's Hydraulic Toolbox.
Channel Capacity and Conveyance Analysis	Analyze channel capacity for floodwater conveyance.	Identify overflow-prone areas, design and improve waterways.	HEC-RAS, Manning's Equation.
Detention Basin Sizing and Performance Assessment	Design basins to control peak runoff and minimize downstream flooding.	Stormwater management, development impact mitigation.	HEC-HMS, SWMM, regional basin modeling tools.
Reservoir and Dam Break Analysis	Model downstream impacts from reservoir releases or dam failures.	Emergency planning, dam safety, community evacuation planning.	HEC-RAS, DSS WISE.
Floodway Analysis and Encroachment Studies	Establish floodways free from encroachment to allow flood passage.	NFIP compliance, zoning, permitting for flood-prone developments.	HEC-RAS (1D/2D), FEMA floodway modeling.
Climate Change Impact Assessment on Flooding	Project flood risk changes due to climate change (precipitation, sea level rise).	Infrastructure future-proofing, long-term planning, adaptive management.	HEC-HMS, HEC-RAS, Coastal models.
Low-Impact Development (LID) Feasibility and Hydrologic Performance Study	Assess LID practices for reducing stormwater runoff and improving water quality.	Sustainable stormwater management, urban green infrastructure planning.	SWMM LID tools, GIS-based spatial planning.
Sediment Transport and Erosion Studies	Model sediment movement and predict erosion in rivers and streams.	Habitat preservation, water quality, erosion control.	HEC-RAS (with sediment transport), SRH-2D.
Wetland Hydrology and Inundation Studies	Assess wetland hydrology and inundation patterns for flood control and habitat.	Environmental impact assessments, wetland restoration, floodplain management.	HEC-RAS, HEC-HMS, GIS for hydrologic mapping.
No-Rise Certification Studies	Demonstrate that development in floodway will not increase flood levels.	Regulatory compliance under FEMA for floodway management.	HEC-RAS, FEMA-compliant models.
Coastal Inundation and Surge Modeling	Predict coastal flooding from storm surge and assess impacts on infrastructure.	Coastal city planning, infrastructure design, emergency preparedness.	ADCIRC, SLOSH, HEC-RAS 2D.