Climate Change Modeling in an Urban Environment:

Anacostia River Toxics Modeling and Climate Change Adaptation

TETRA TECH

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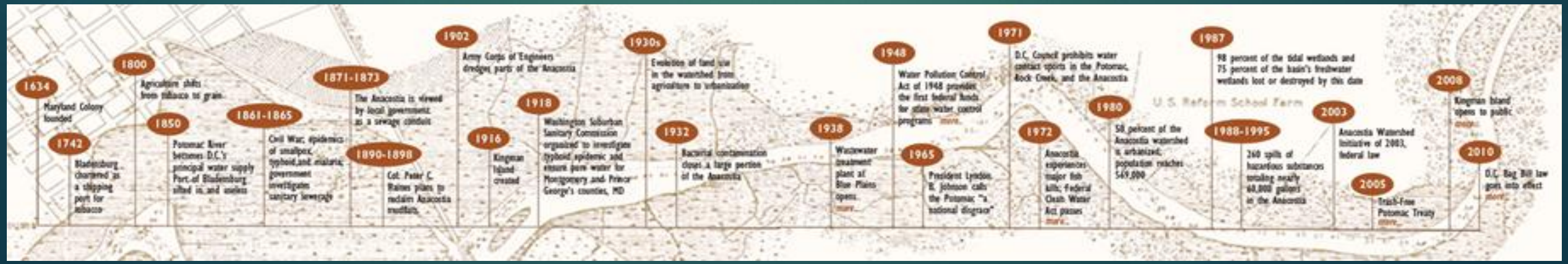
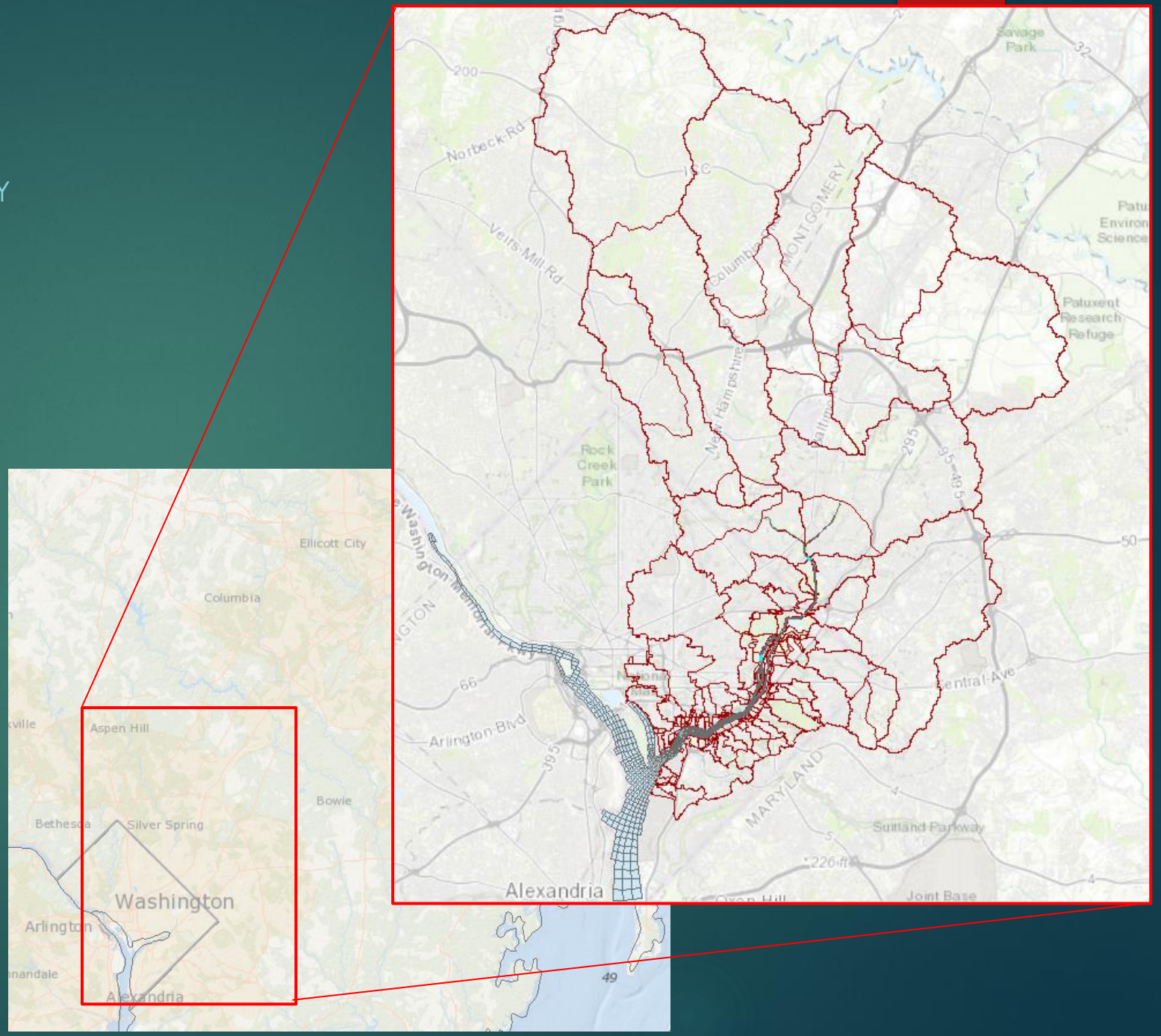
Overview

- TT IS PROVIDING MODELING SUPPORT IN EPA TMDL DEVELOPMENT FOR 10 TOXICANTS IN THE TIDAL AND NONTIDAL ANACOSTIA RIVER SYSTEM
- CURRENT WORK ADDRESSES TOXICANT TMDLS ESTABLISHED IN 2003 THAT WERE CHALLENGED
- SINCE 2009, TT HAS ASSISTED WITH MONITORING AND DATA ANALYSIS CONDUCTED IN PREPARATION FOR MODELING
- TT IS ALSO ASSISTING WITH ANACOSTIA RIVER SEDIMENT PROJECT (ARSP): DOEE IS CONDUCTING A RI/FS FOR ANACOSTIA RIVER BED SEDIMENTS



Modeling Need

- ANACOSTIA RIVER SYSTEM IS CHARACTERIZED BY TIDAL AND NONTIDAL WATERBODIES
- MULTIPLE CONTAMINANT GROUPS WITH DIFFERENT FATE AND TRANSPORT CHARACTERISTICS
- THE MODELING SYSTEM WAS CALIBRATED AND VALIDATED FOR SIMULATION OF:
  - Hydrology
  - Hydrodynamics
  - Sediment loading and transport
  - Toxic contaminant loading of select pollutants
- SIMULATIONS WERE DEVELOPED TO ASSESS:
  - remediation alternatives (ARSP)
  - TMDL allocation options (TMDLs)
  - climate change scenarios (TMDLs)



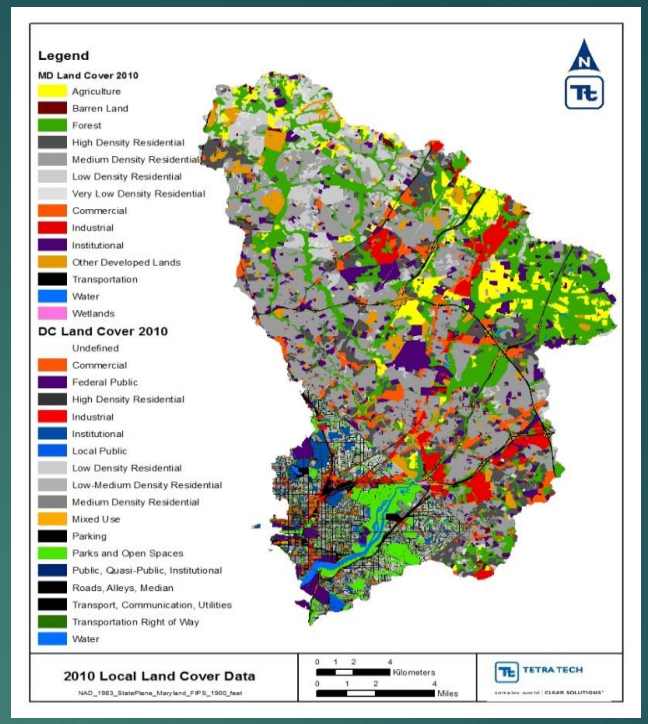
Model Development- Watershed

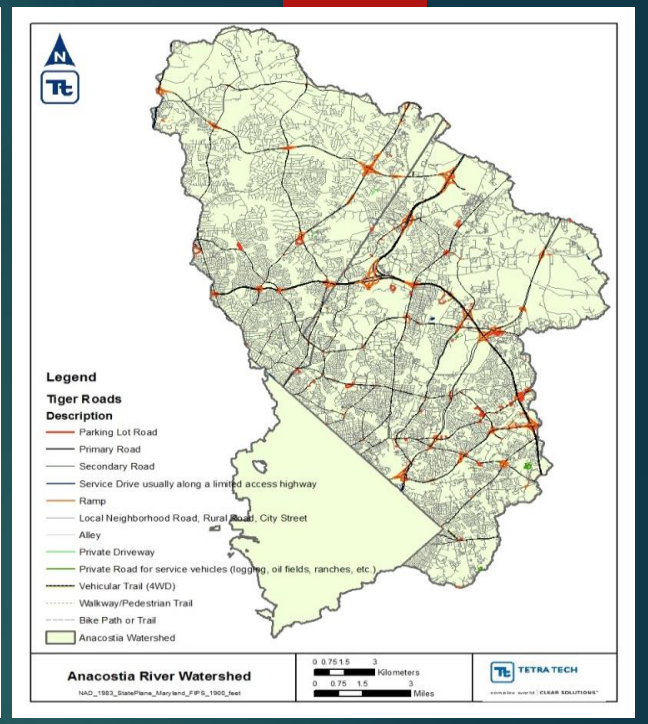
HYDROLOGIC RESPONSE UNIT (HRU) DEVELOPMENT

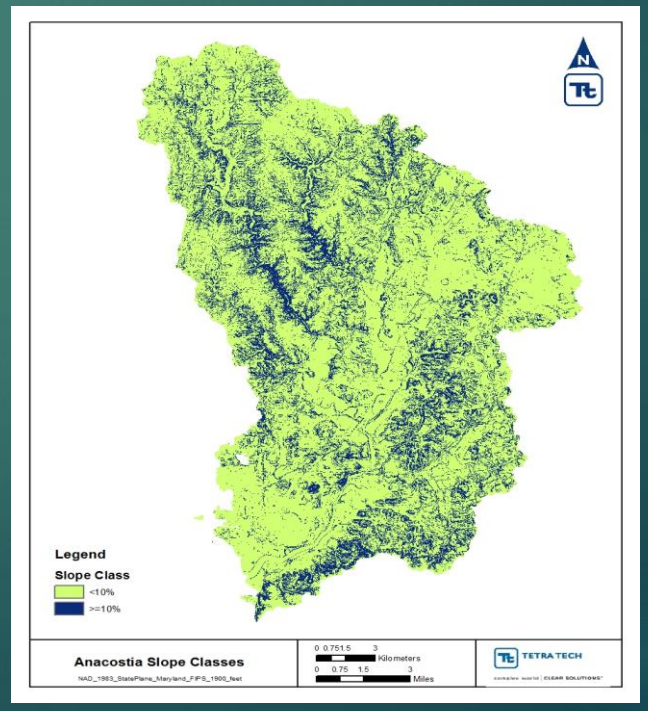
HRUS ARE PORTIONS OF A SUB-BASIN THAT POSSESS UNIQUE LANDUSE/ MANAGEMENT/SOIL ATTRIBUTES

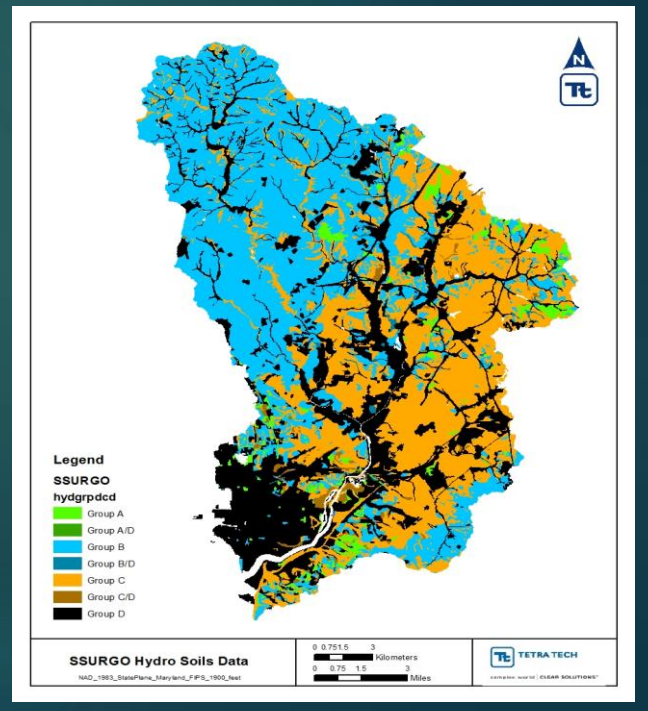
UTILIZE LOCALLY AND RECENTLY-DEVELOPED DATASETS

HYDROGRAPH AND POLLUTANT TRANSPORT IS CALCULATED BASED ON THESE COMPONENTS



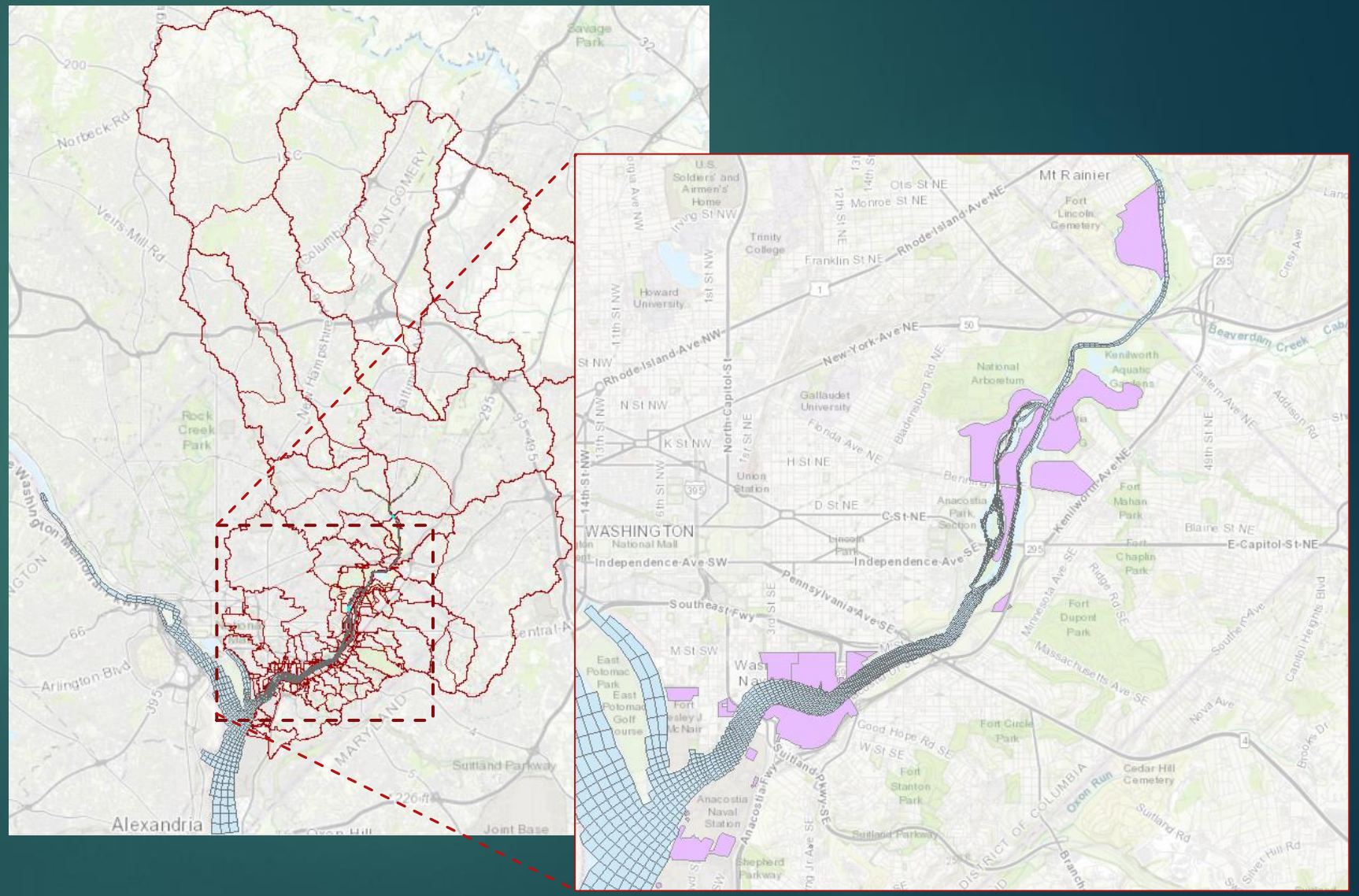






Model Development- Watershed

- COC SOURCES
  - Tributary inflow
  - Municipal outfalls
  - Industrial outfalls
  - Historical releases from 15 landside sites adjacent to the river
- ADAPTED THE ORIGINAL ARSP MODEL TO ADD THE 10 TMDL POLLUTANT PARAMETERS
  - Metals: arsenic, copper, zinc
  - Organochlorine Pesticides: DDx, chlordane, dieldrin, heptachlor epoxide
  - Polyaromatic hydrocarbons: 3 groups based on ring structure
- UPDATED MODELS WERE PARAMETERIZED BASED ON REGIONAL AND SITE-SPECIFIC SOURCE DATA

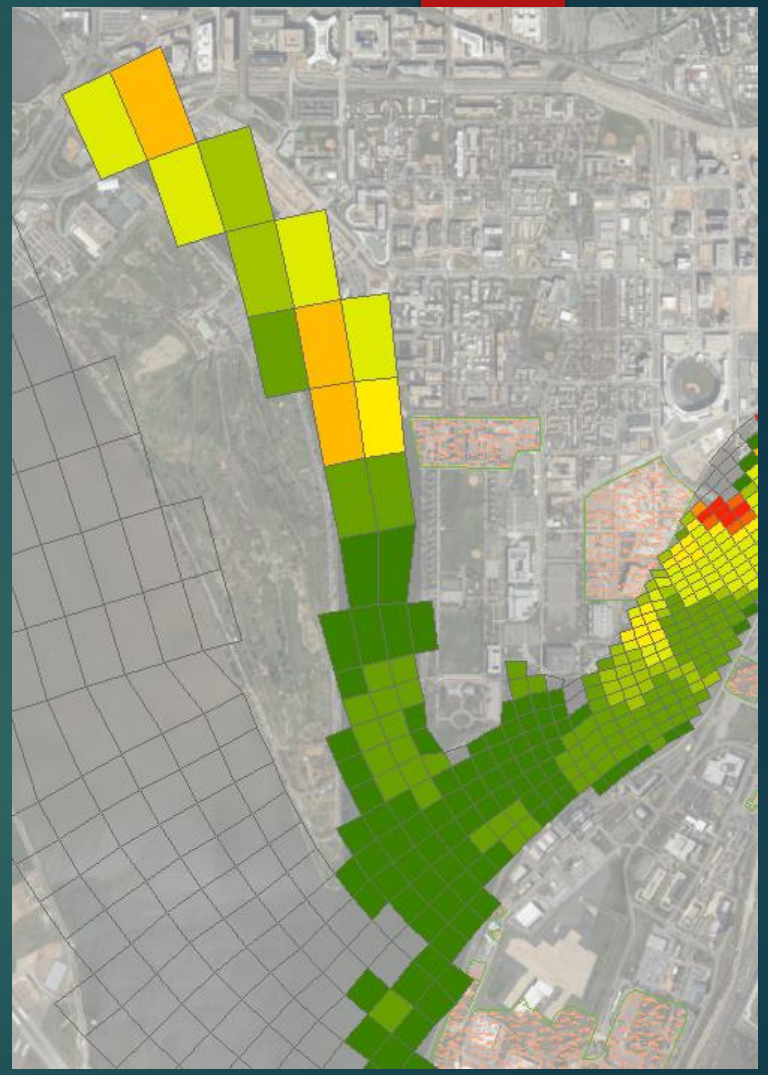


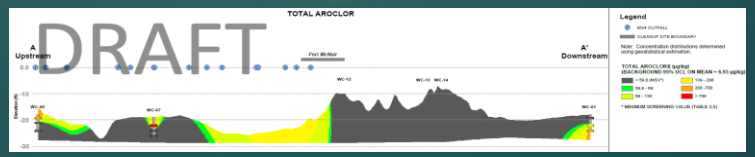
Model Development- Tidal Anacostia River

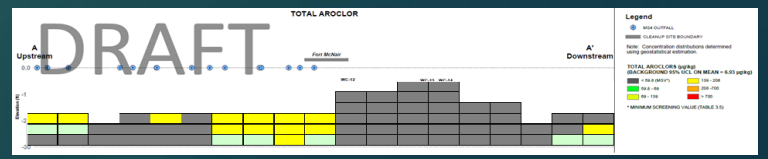
- TIDAL COMPONENTS IN THE ANACOSTIA RIVER WATERSHED ARE MODELED AND INCORPORATE DATA COLLECTED FOR THE RI/FS

- SEDIMENT BED CHARACTERISTICS:
  - - Elevation
  - - Physical characteristics
  - - Chemical characteristics

- MONITORING RESULTS WERE TRANSLATED FOR USE IN MODELING OF > 2,000 HORIZONTAL GRID CELLS:
  - Resolution ranges from 20x20m within study area to 450mx450m near open boundary



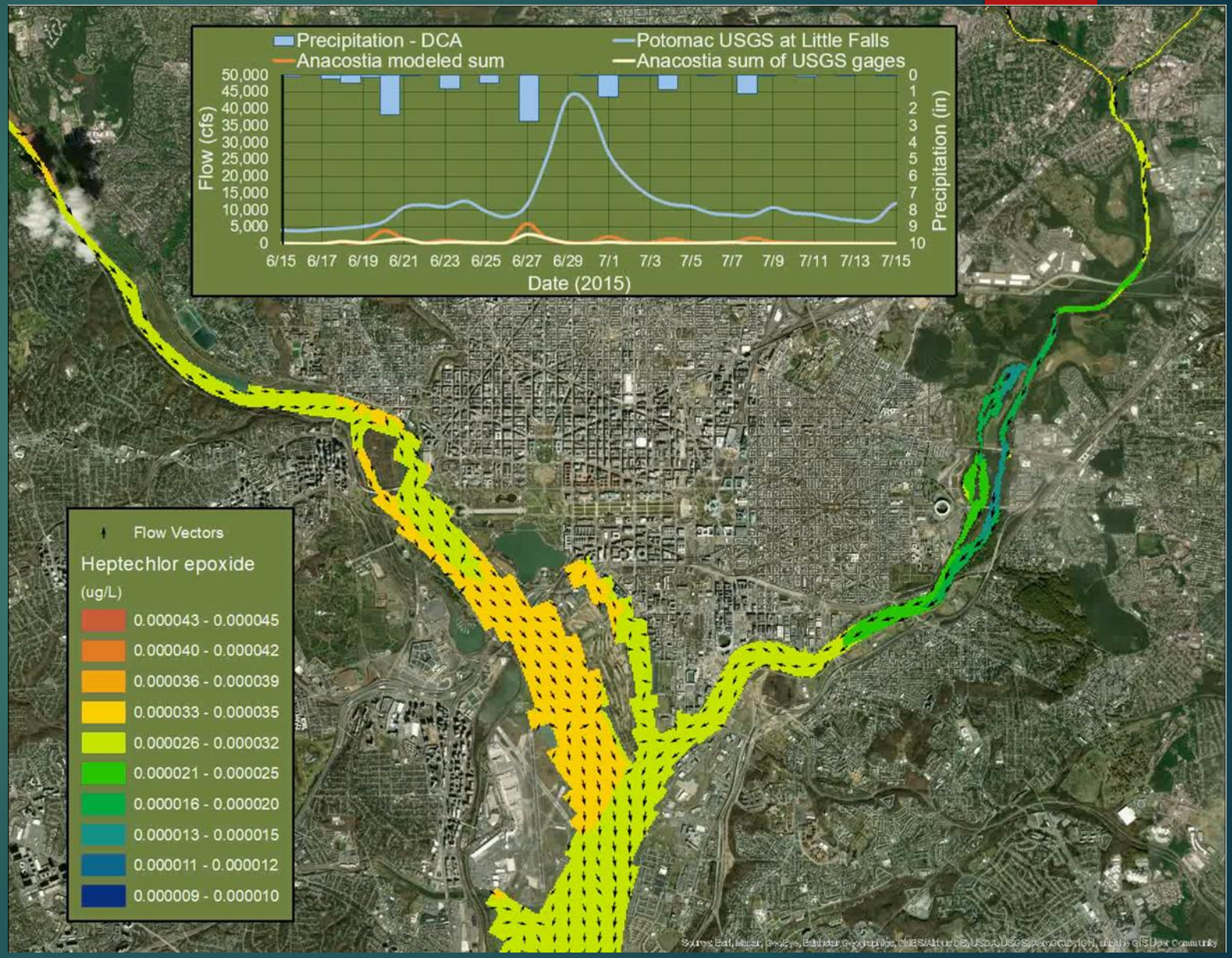




Modeling Results

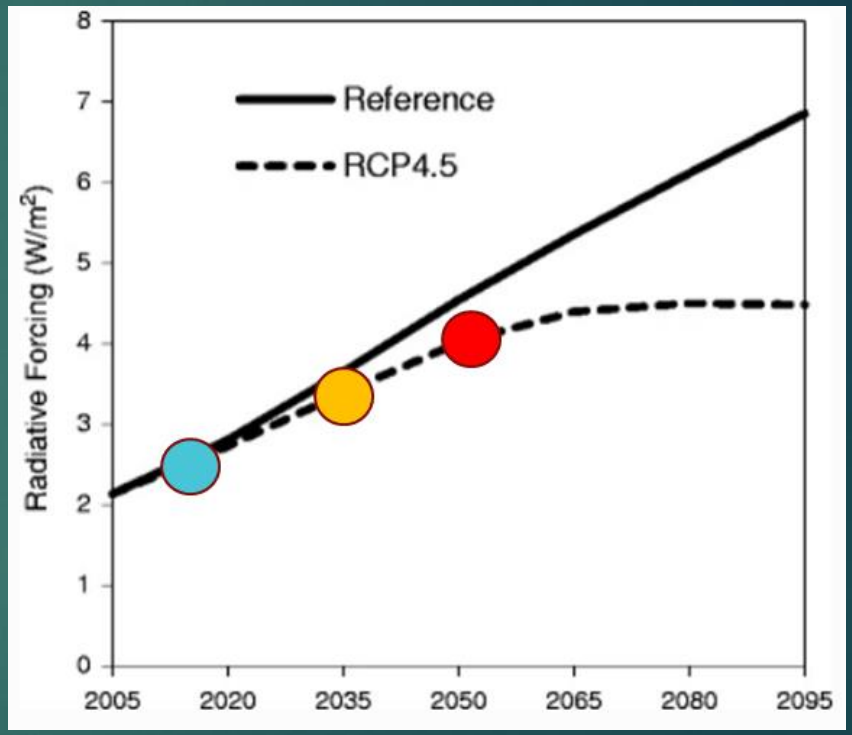
- CHALLENGES INCLUDED
  - Legacy and ongoing sources
  - Toxicants with different mobility
  - Tidal influence
  - Potomac River influence
  - Potomac River Example -→>>

- TMDLS RESULTED IN REDUCTIONS TO
  - Land-based sources
  - Nontidal tributary bed sediments
  - Tidal Anacostia River Bed Sediments



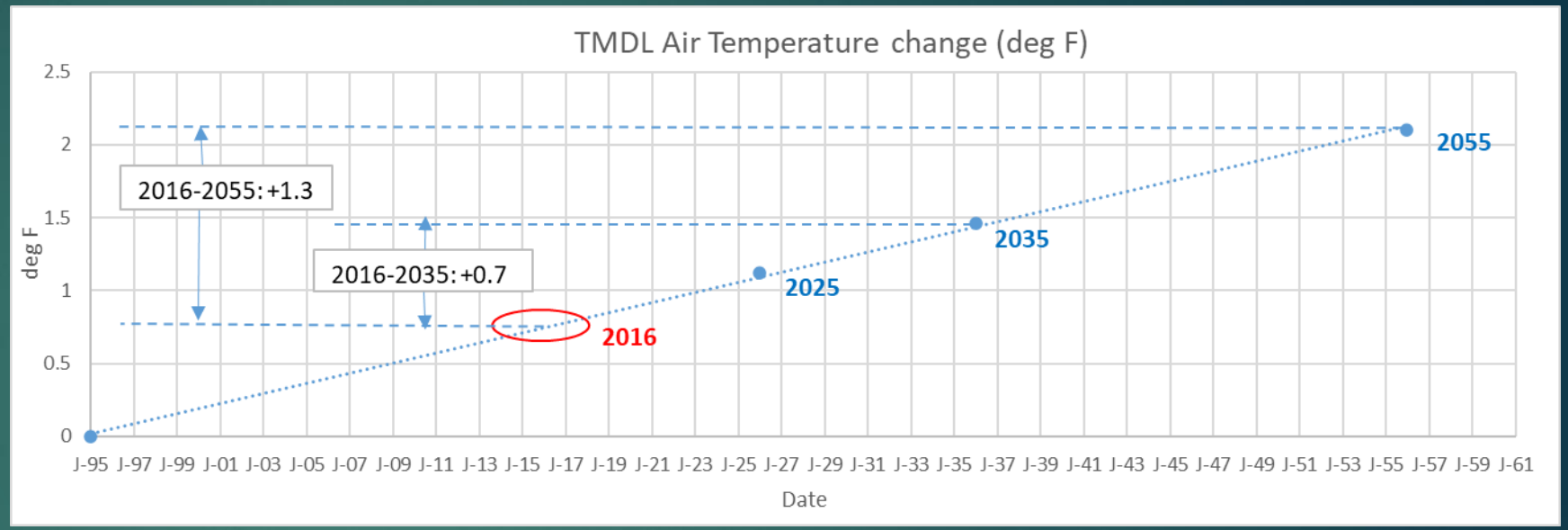
Climate Change Inquiry

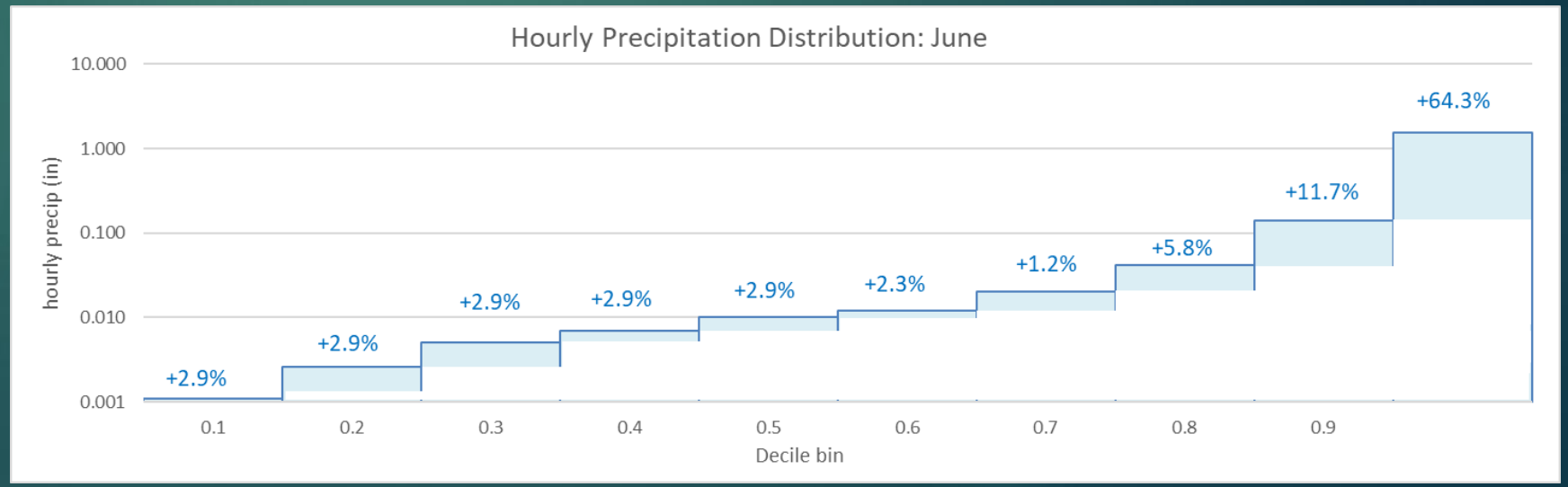
- DRAFT TMDL WAS PUBLIC NOTICED IN JULY 2021
- PUBLIC COMMENTS RECEIVED, REQUESTING THAT CLIMATE CHANGE EFFECTS BE CONSIDERED IN THE TMDL
- EPA REQUESTED AN APPROACH TO REPRESENT CLIMATE CHANGE EFFECTS
  - Assess attainment of TMDL targets
  - Assess impact on natural attenuation of bed sediments
- DELIVERED AN APPROACH TO EPA ALONG RCP4.5 TRAJECTORY THAT INCLUDES
  - Baseline conditions – 2014 to 2017
  - Medium term future – 2034 to 2037
  - Long term future – 2054 to 2057
- APPROACH ACCOUNTS FOR
  - Meteorological changes due to regional climate change
  - Sea level rise (SLR)
  - Flow and water temperature increases
  - Watershed loading changes



Anacostia River Climate Change Scenario Updates

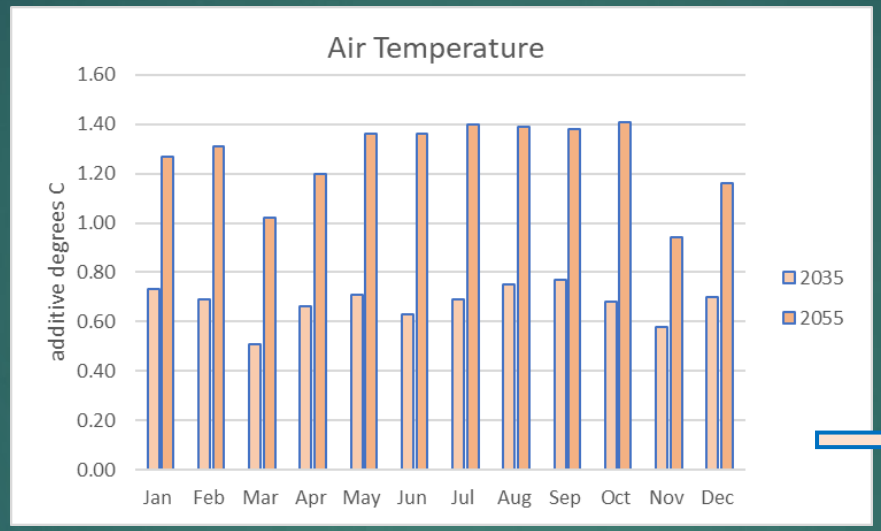
- METEOROLOGICAL DATA SETUP
  - Modified hourly timeseries from Ronald Reagan Airport weather station
  - Obtained meteorological data from CBMW (RCP 4.5 pathway) to estimate rainfall and temp change between TMDL and future horizons
  - Established rate of change in precipitation and temp to apply to our met inputs

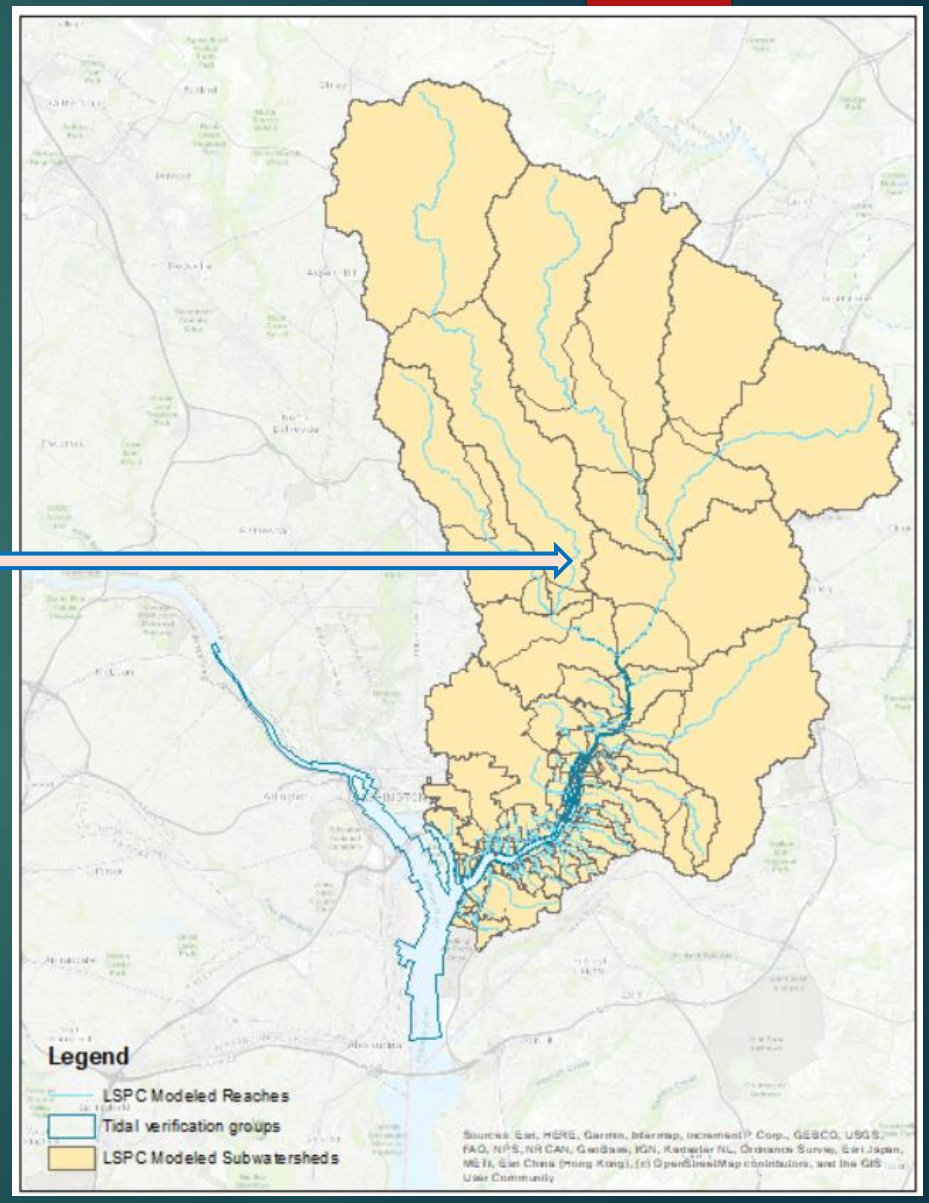




Anacostia River Climate Change Scenario Updates

- LSPC SETUP
  - Applied CBP Climate Change methodology to LSPC watershed model inputs
  - Meteorological input data were updated to reflect estimates of increased precipitation and temperature for 2035 and 2055 at Reagan National AP





Anacostia River Climate Change Scenario Updates

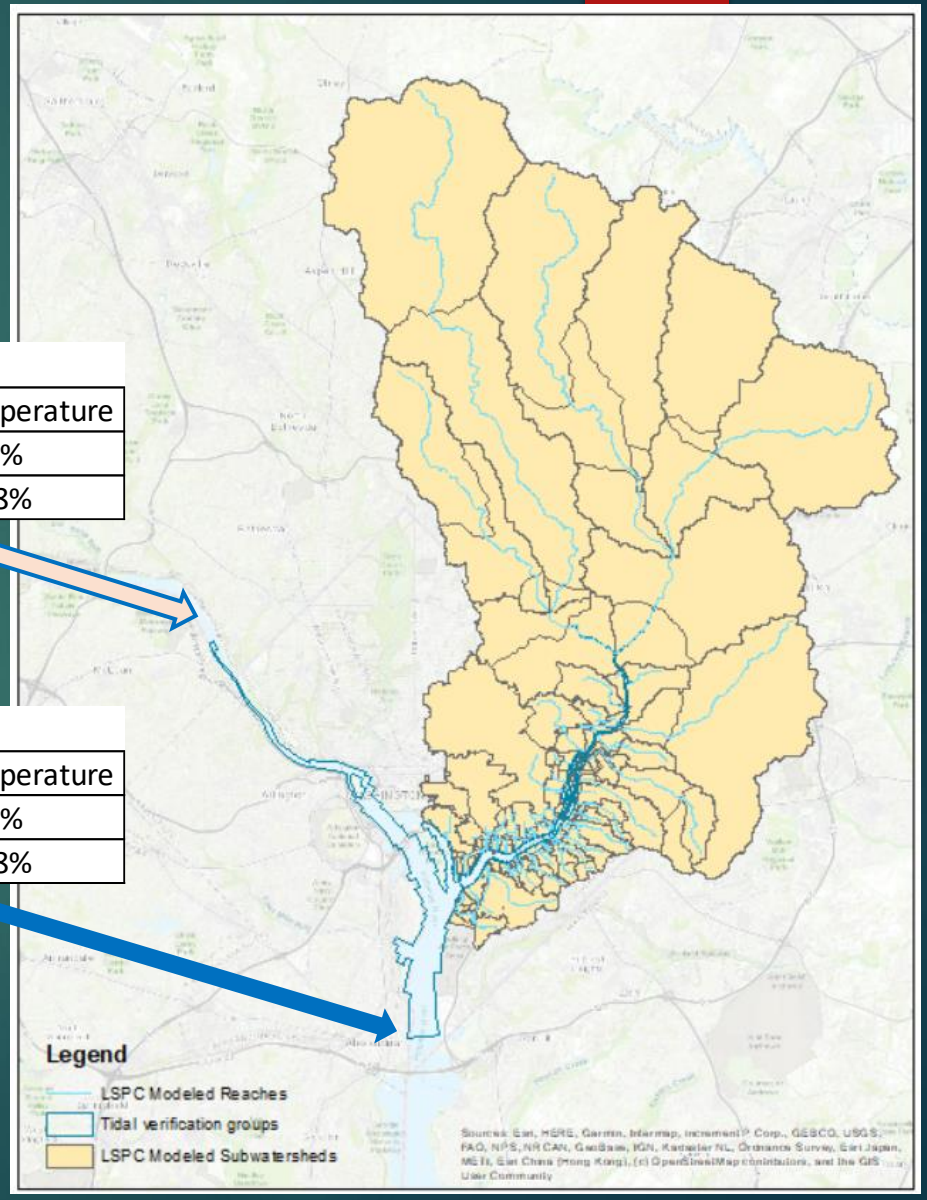
- EFDC SETUP
  - Modeled LSPC results were then linked to EFDC tidal model to represent 2035 and 2055 conditions within the tidal portion
  - Boundary conditions for the Potomac River at Little Falls were adjusted to reflect climate change impacts on flow and temperature
  - Boundary conditions for the Potomac River tidal boundary at Alexandria was adjusted to reflect SLR
  - EFDC weather inputs updated

Potomac River at Little Falls

Scenario	Streamflow	Water Temperature
2035	+2.7%	+1.9%
2055	+6.25%	+3.58%

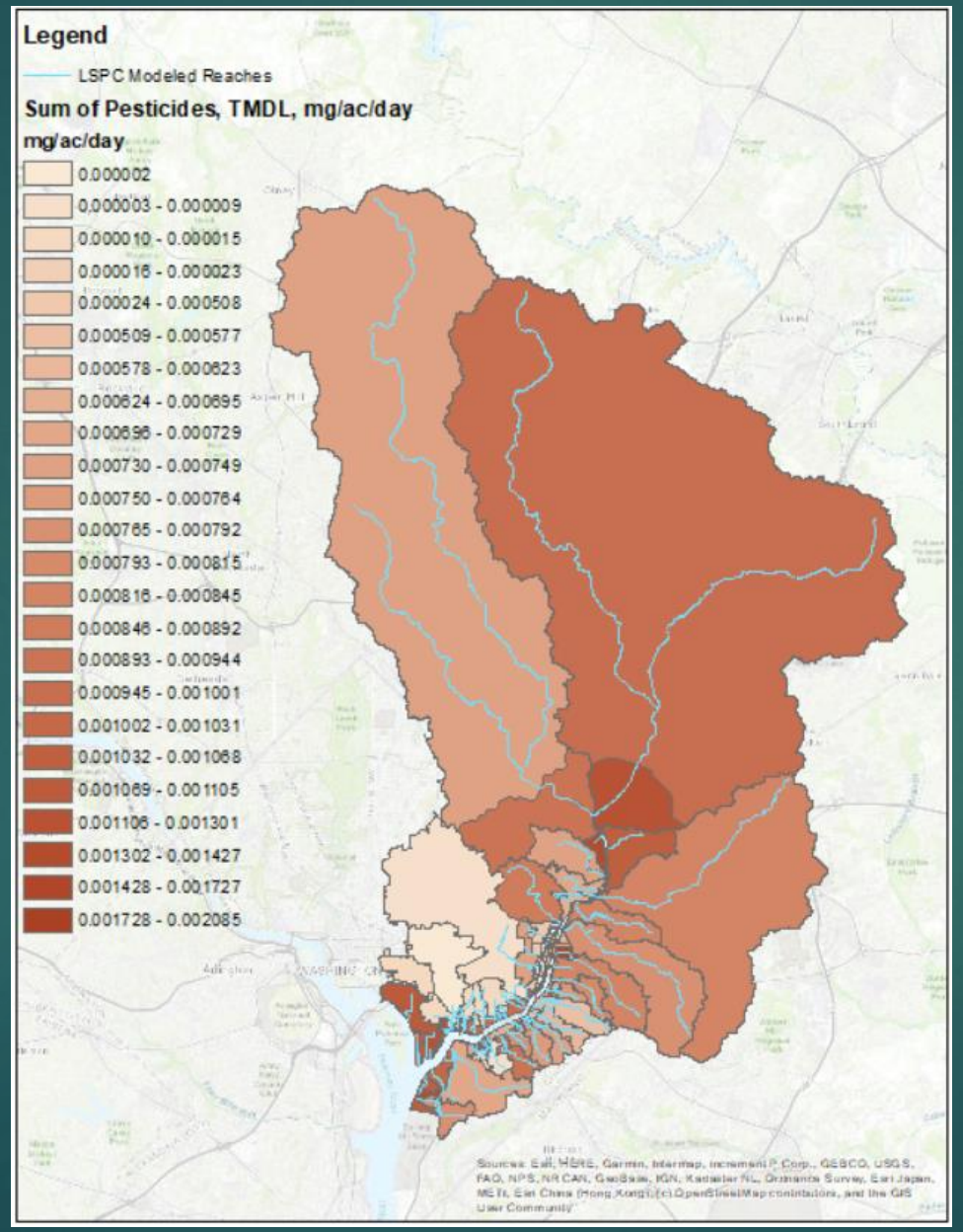
Potomac River at Alexandria

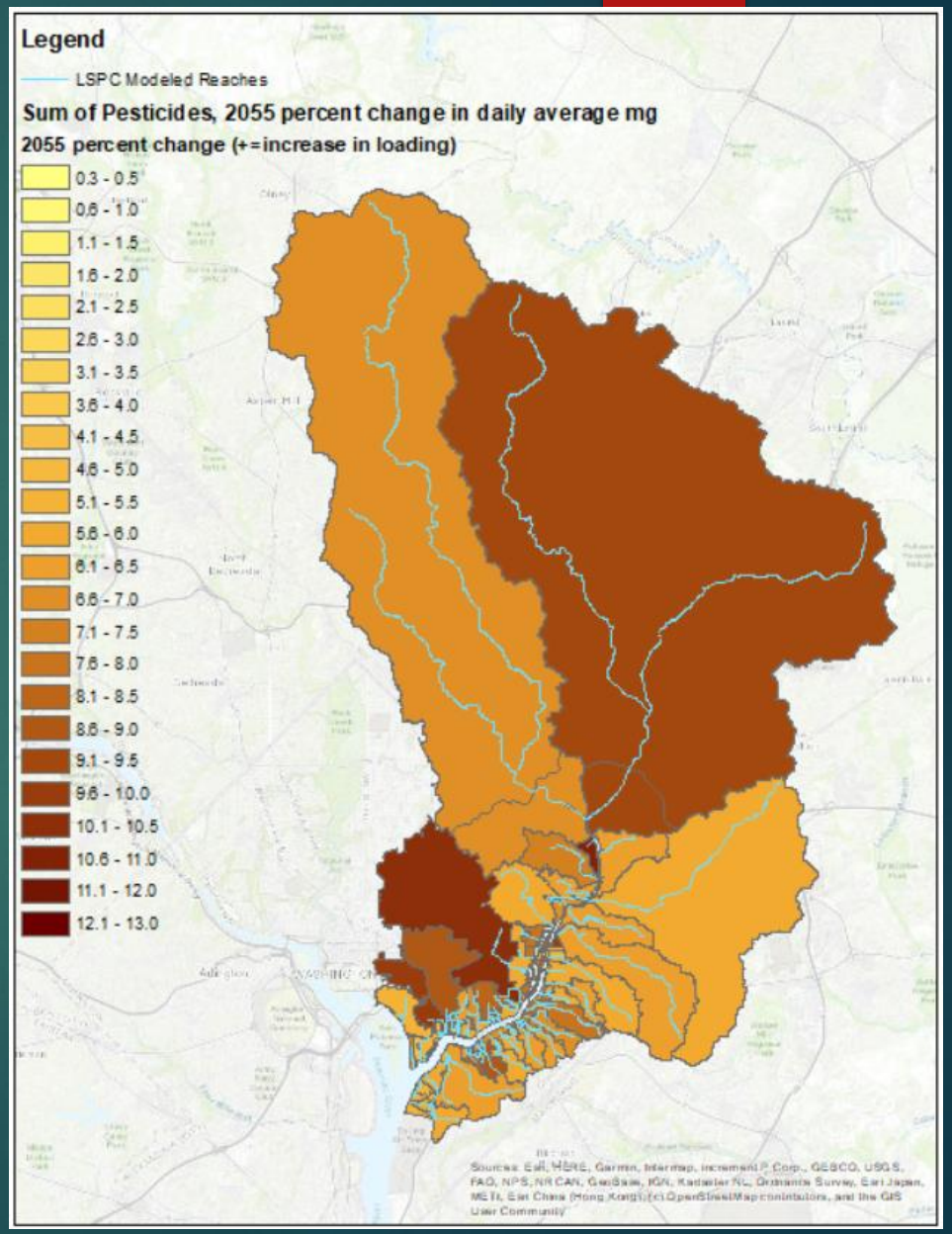
Scenario	SLR	Water Temperature
2035	18.7 cm	+1.9%
2055	44.83 cm	+3.58%



Anacostia River Climate Change Scenario Updates

- WATERSHED LOADING RESULTS
  - Streamflow and toxicant loading increased overall in both 2035 and 2055 scenarios



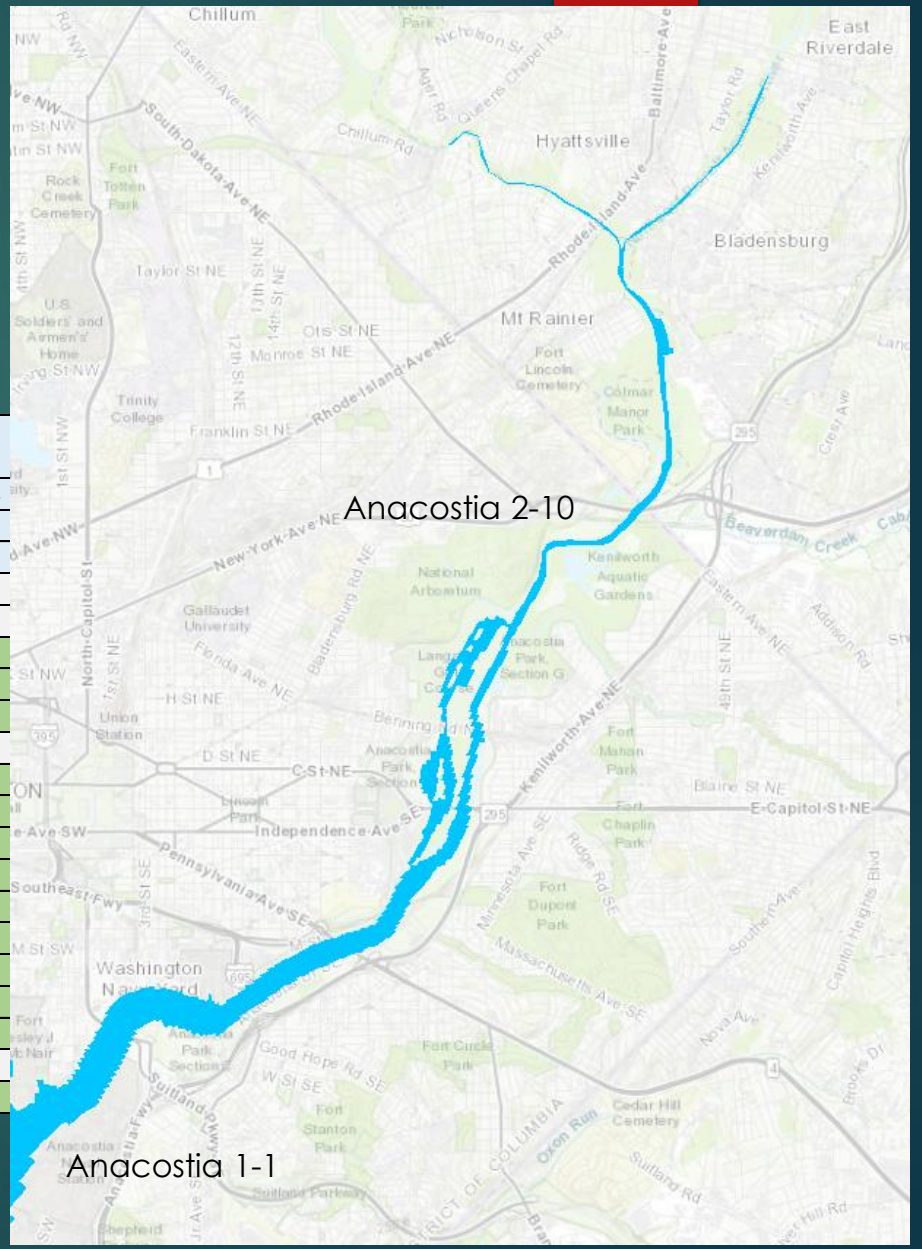


Modeling Results

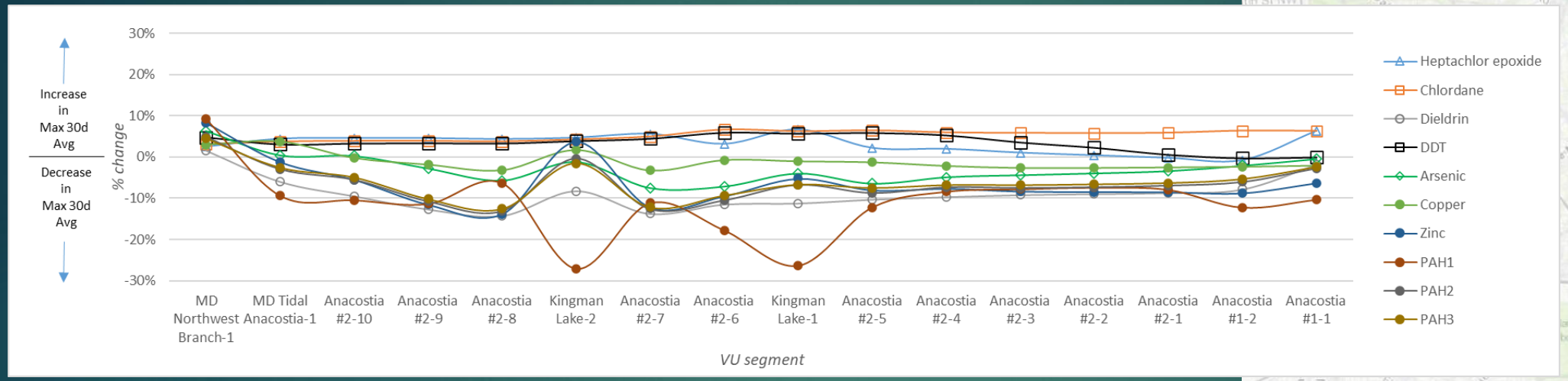
- CLIMATE CHANGE RESULTS
  - Varied by location
    - Nearby tribs/confluences
  - Varied by pollutant
    - Local bed concentrations (hot spots)
    - Upland sources vary

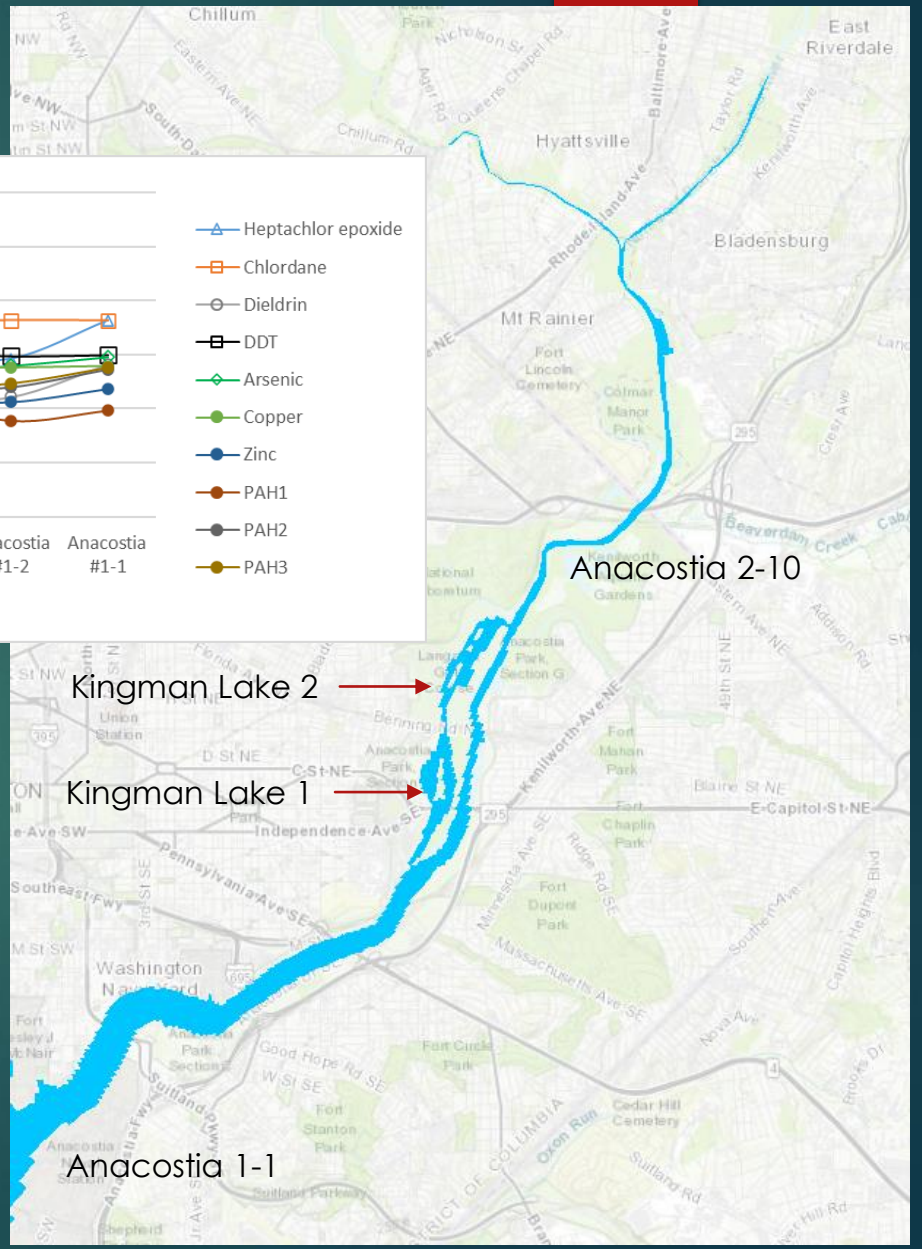
	Pollutant:	Heptachlor epoxide	Chlordane	Dieldrin	DDT	Arsenic	Copper	Zinc	PAH1	PAH2	PAH3
	WC Target (ug/l):	3.20E-05	3.20E-04	1.20E-06	1.80E-05	0.14	8.96	117.18	50.00	1.30E-03	1.30E-04
	Bed Target (ug/kg):	3.55E-01	-	-	-	-	-	-	-	-	-
	Verification Unit	Change in Maximum 30-day Average Concentration (%)									
Upstream	MD Northwest Branch-1										
	MD Tidal Anacostia-1										
	Anacostia #2-10										
	Anacostia #2-9										
	Anacostia #2-8										
	Kingman Lake-2										
	Anacostia #2-7										
	Anacostia #2-6										
	Kingman Lake-1										
	Anacostia #2-5										
	Anacostia #2-4										
	Anacostia #2-3										
	Anacostia #2-2										
	Anacostia #2-1										
	Anacostia #1-2										
Downstream	Anacostia #1-1										
	Average:										

30-day avg concentration decrease >5%
30-day avg concentration increase >5%
Exceeds TMDL WC Target



Anacostia River Climate Change Scenario Updates
Tidal Anacostia River Results; 2055





- CLIMATE CHANGE RESULTS
  - Longitudinal analysis illustrates influence of adjacent waterbodies
  - Increased toxicant loading due to increased rainfall intensity
  - SLR can provide dilution or impede transport of toxicants depending on location

Conclusions

- MODEL DEVELOPMENT ALLOWED FOR
  - Management of toxic contaminants in the Anacostia River spatially
  - Assessment of how long pollutants sorbed to bed sediments will take to attenuate
- HYDRODYNAMIC PHENOMENA WERE INVESTIGATED SUCH AS
  - Dilution due to precipitation and tidal flooding
  - Tidal exchange between Kingman Lake and the Anacostia River
  - Corking of the Anacostia by the Potomac River flow
- CLIMATE CHANGE ANALYSIS WAS APPLIED TO ANSWER KEY QUESTIONS
  - Would TMDL endpoints be met under climate change
  - How long would the attenuation of bed sediment sorbed pollutants take under climate change
- RESULTS INDICATE THAT
  - For most pollutants, dilution by SLR and increased precipitation improved water column concentrations and helps attain TMDL targets
  - For some pollutants, localized phenomena cause TMDL targets to be exceeded under climate change
  - Bed sediment attenuation rates generally improve under climate change, but could still take multiple decades to fully attenuate

Thank you!

- QUESTIONS?