Water Utility Planning Strategies to Mitigate Impacts of Climate Change

MID-OHIO REGIONAL PLANNING COMMISSION

SUSTAINING SCIOTO

INVESTING TODAY. PRESERVING TOMORROW.

PNWS-AWWA Conference
April, 2015

Lynn Williams , PE, Brown and Caldwell

Agenda

- Project Introduction
- Climate & Watershed Model Results – What Does it all Mean
- Adaptive Management Approach
- Vulnerability Assessment
  - Sector based vulnerabilities
  - Risk and Impact Evaluation
- Development of Adaptive Management Strategies
  - Adaptive strategy evaluation metrics, costs, time frame
  - High priority strategies
- Conclusions & Regional Considerations

SUSTAINING SCIOTO PARTNERS

USGS
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Del-Co Water Company, Inc.
40 Years
1973–2013

The City of Columbus
Michael B. Coleman, Mayor
Department of Public Utilities

Water Research Foundation℠

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Mid-Ohio Regional Planning Commission

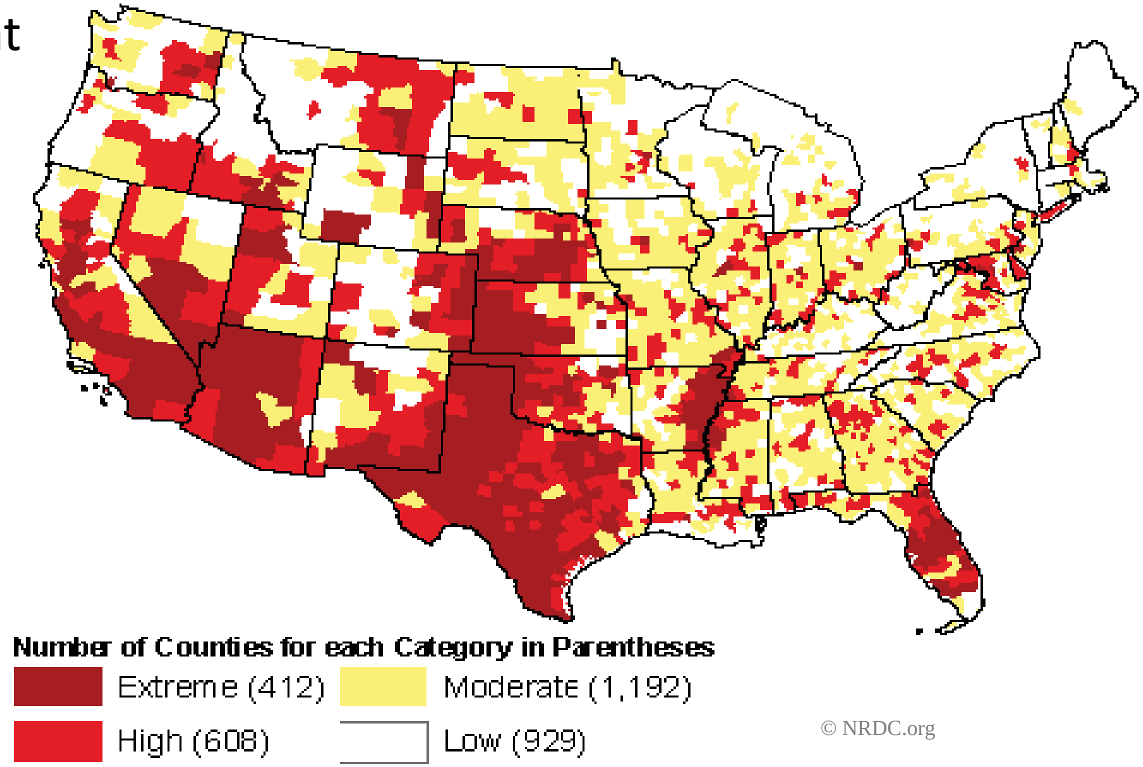
Brown and Caldwell

Ohio Water Development Authority

Giving future uncertainties, greater awareness of the necessity for sustainable and reliable water infrastructure

- More than 1,100 counties at higher risk for water shortages by 2050 as a result of climate change

Water Sustainability Index (2050) with Climate Change Impacts

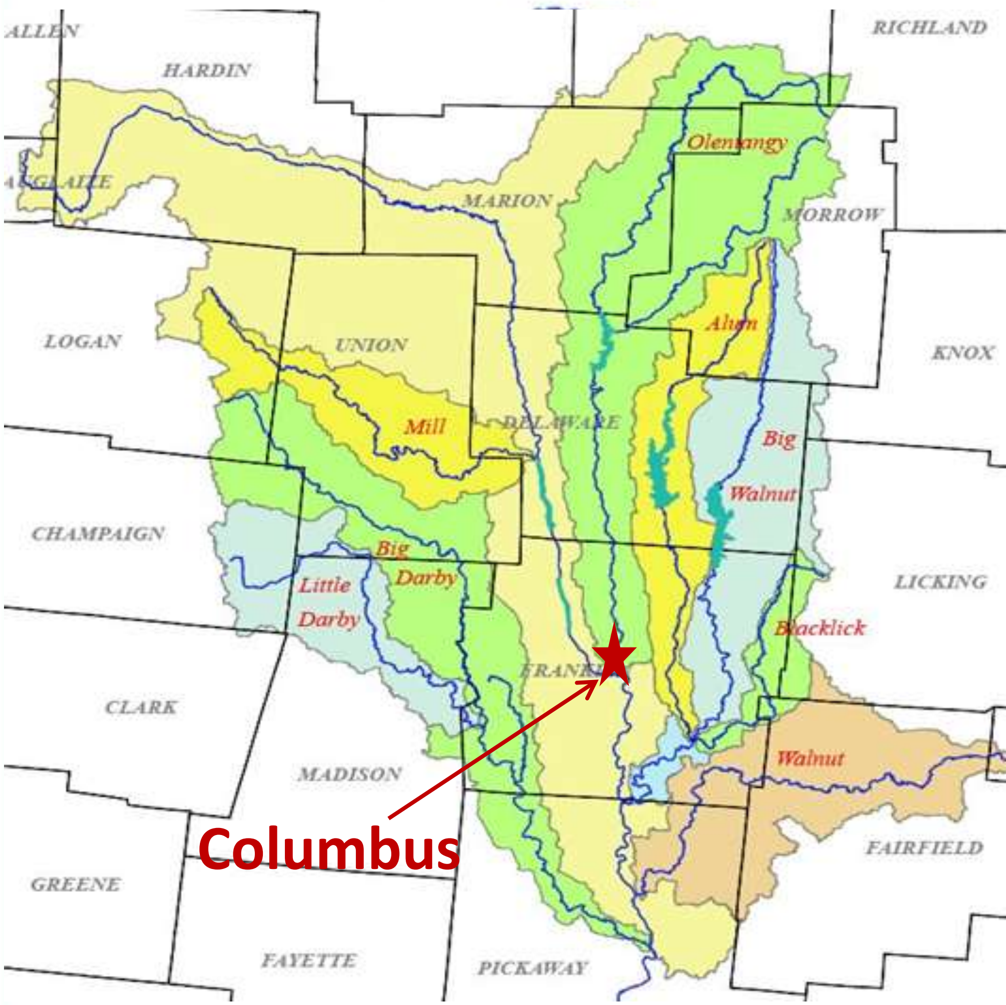


Source: NRDC, 2010

UPPER SCIOTO RIVER BASIN

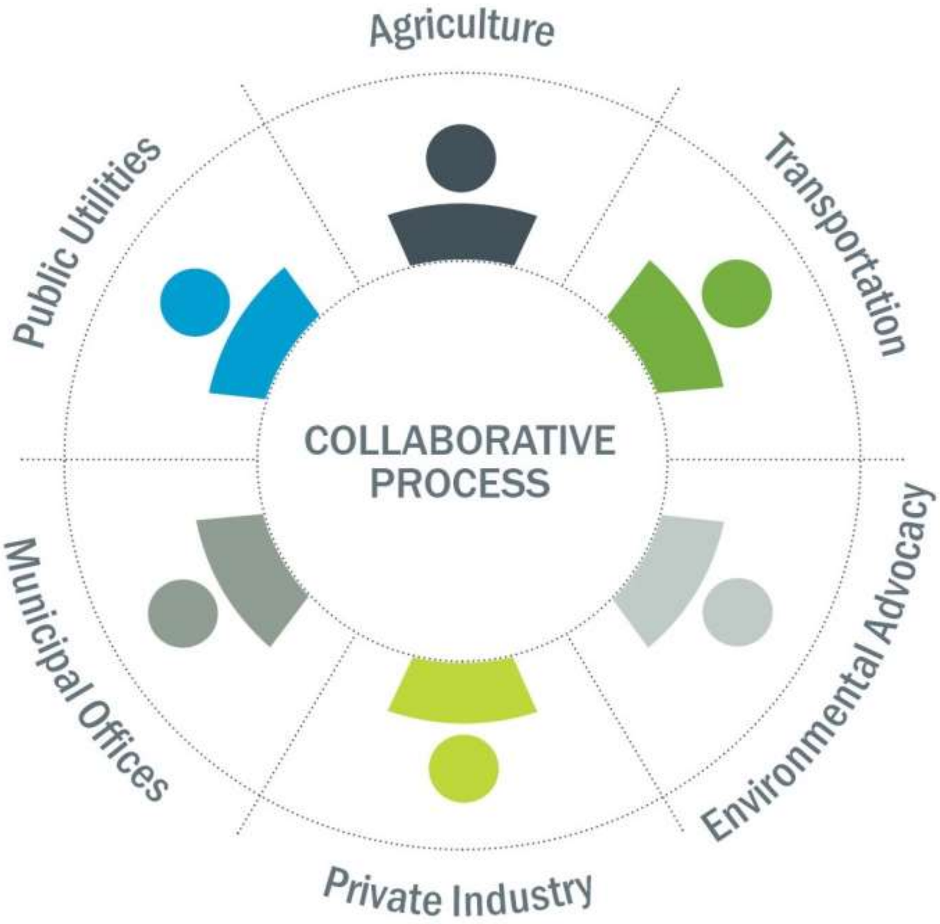
- 3,200 square mile watershed
- Provides drinking water for nearly 2 million
- Provides 85% of the region's surface water supply

Sustaining Scioto Study Area



Stakeholder Advisory Committee

- Input on current and future water needs
- Assess vulnerabilities
- Evaluate adaptive management strategies



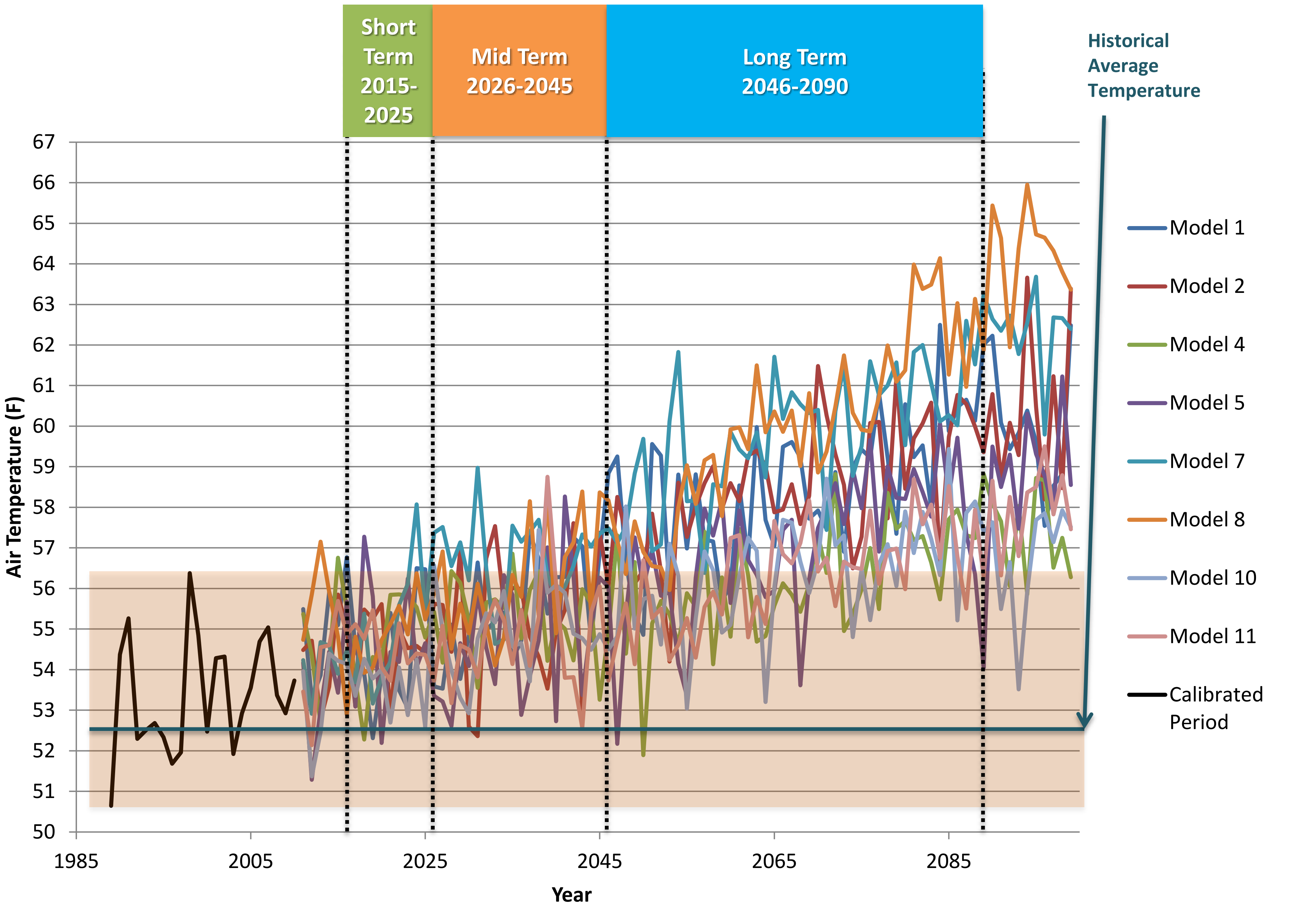
Two-Phased Project Approach

- Phase I –
  - Development of a model to assess the impacts of changing weather patterns on water resources.
  - Model developed by the USGS specifically for the Upper Scioto watershed.
- Phase II –
  - Development of an adaptive management plan using the results of the model and input from a broadly based Stakeholder Advisory Committee.

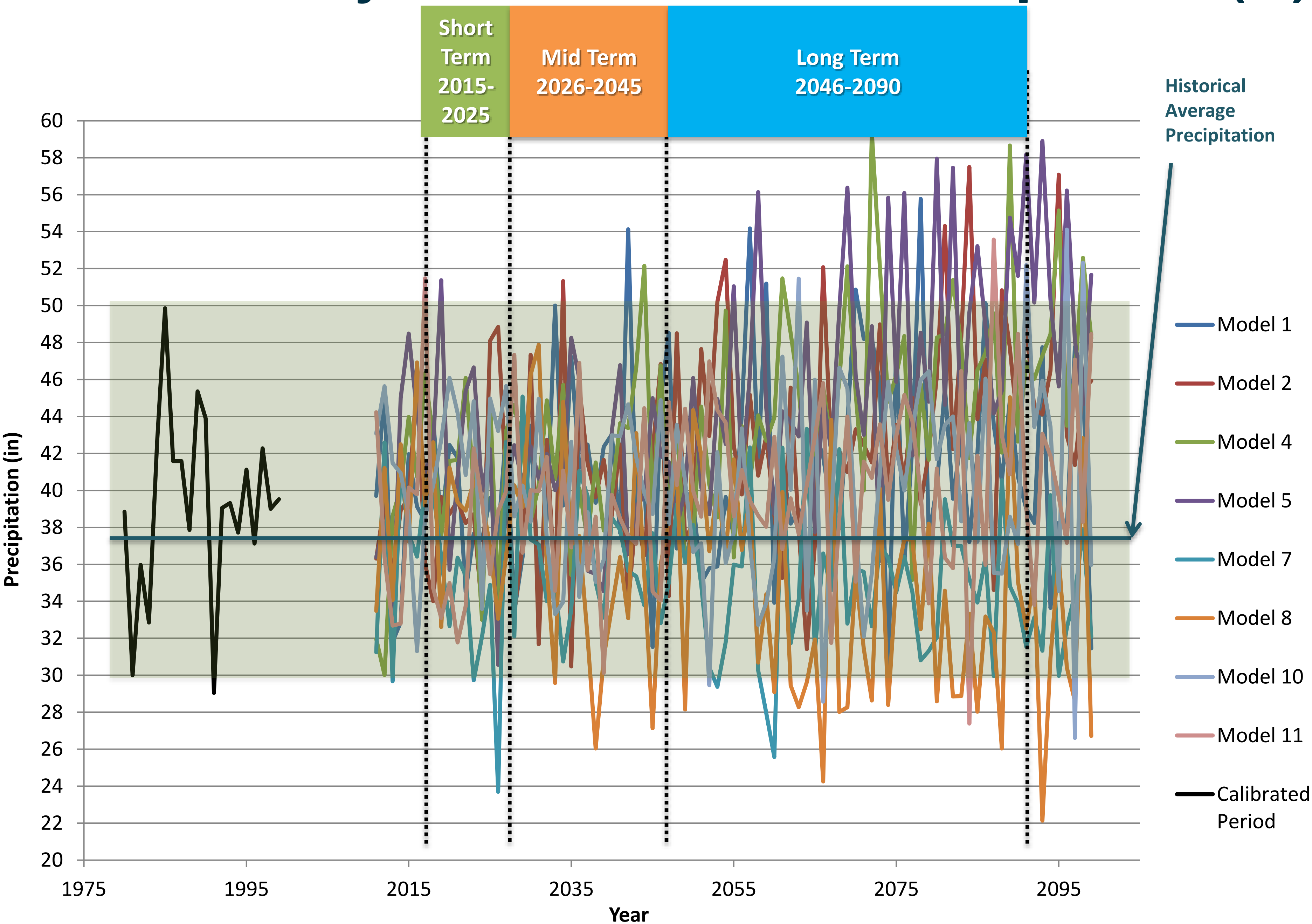
USGS Hydrologic Modeling

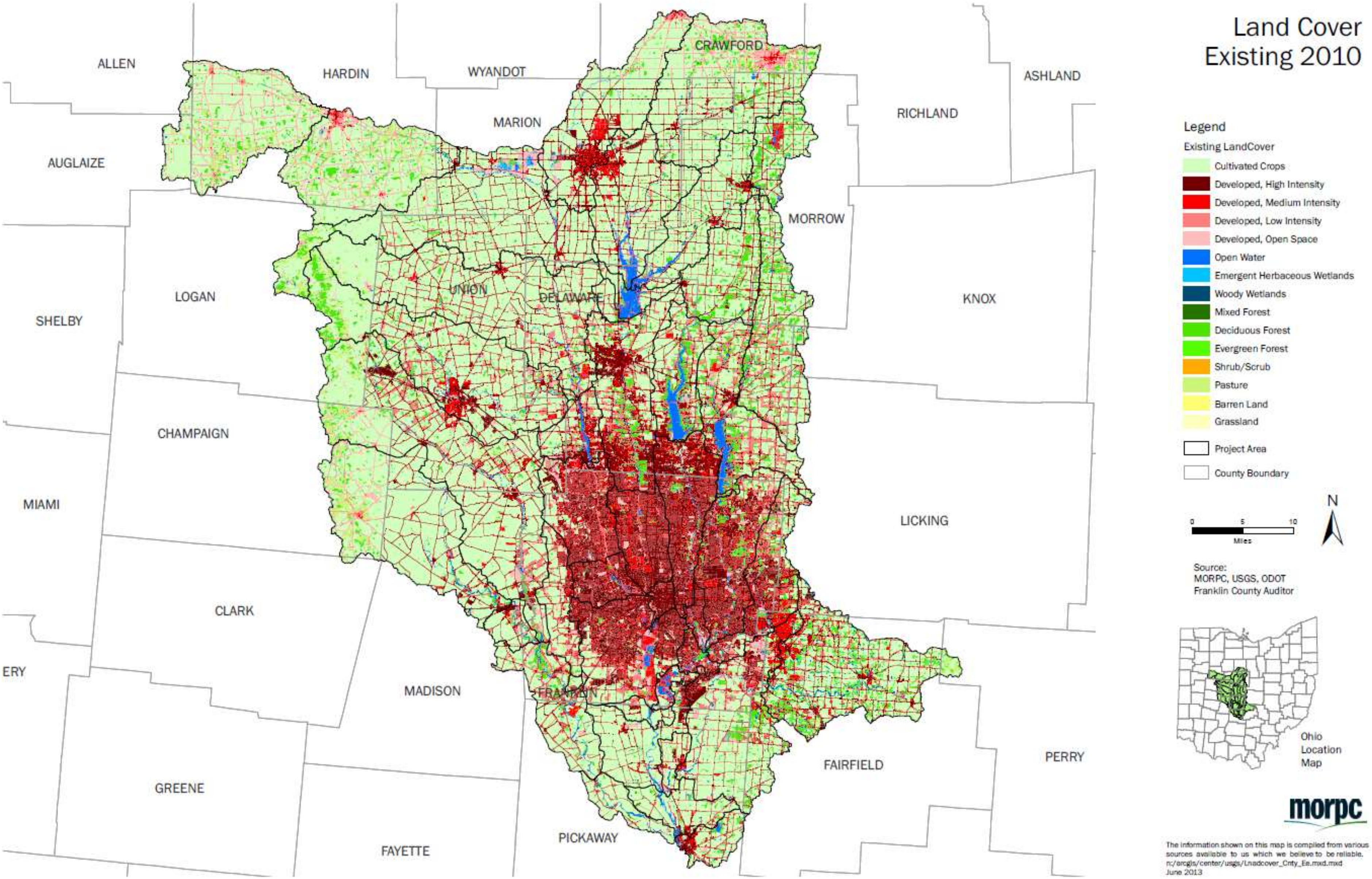
- Precipitation-runoff model
- Calibrated based on historical observed climate and streamflow data
- Simulate runoff characteristics for climatic conditions that are projected to occur in the future
  - Temperature
  - Precipitation
  - Evapotranspiration
  - With and without anticipated population growth and development

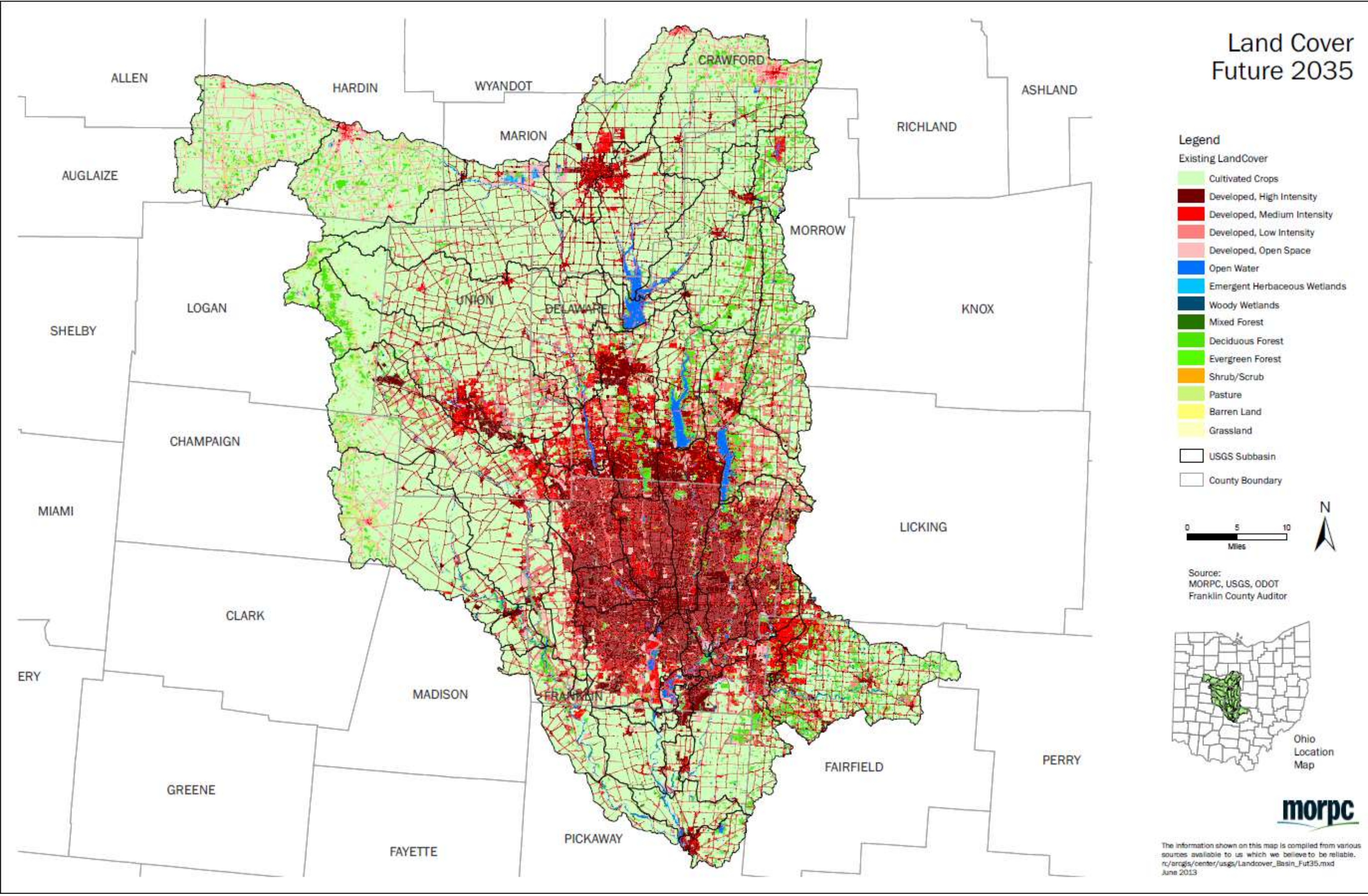
Actual vs Projected Annual Mean Temperature (F)



Actual vs Projected Annual Mean Precipitation (in)




Land Cover
Existing 2010
Legend
Existing LandCover
Cultivated Crops
Developed, High Intensity
Developed, Medium Intensity
Developed, Low Intensity
Developed, Open Space
Open Water
Emergent Herbaceous Wetlands
Woody Wetlands
Mixed Forest
Deciduous Forest
Evergreen Forest
Shrub/Scrub
Pasture
Barren Land
Grassland
Project Area
County Boundary
0
5
10
Miles
N
Source:
MORPC, USGS, ODOT
Franklin County Auditor
Ohio
Location
Map
morpc
The information shown on this map is compiled from various sources available to us which we believe to be reliable.
n:/arcgis/center/usgs/Lnadcover_Cnty_Ee.mxd.mxd
June 2013
ALLEN
HARDIN
WYANDOT
CRAWFORD
ASHLAND
MARION
RICHLAND
AUGLAIZE
MORROW
LOGAN
UNION
DELAWARE
KNOX
SHELBY
CHAMPAIGN
MIAMI
LICKING
CLARK
ERY
MADISON
FRANKLIN
FAIRFIELD
PERRY
GREENE
PICKAWAY
FAYETTE


Land Cover
Future 2035
ALLEN
HARDIN
WYANDOT
CRAWFORD
ASHLAND
MARION
RICHLAND
AUGLAIZE
MORROW
LOGAN
UNION
DELAWARE
KNOX
SHELBY
CHAMPAIGN
MIAMI
LICKING
CLARK
ERY
MADISON
FRANKLIN
FAIRFIELD
PERRY
GREENE
PICKAWAY
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Legend
Existing LandCover
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Developed, High Intensity
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Emergent Herbaceous Wetlands
Woody Wetlands
Mixed Forest
Deciduous Forest
Evergreen Forest
Shrub/Scrub
Pasture
Barren Land
Grassland
USGS Subbasin
County Boundary
N
0 5 10
Miles
Source:
MORPC, USGS, ODOT
Franklin County Auditor
Ohio Location Map
The information shown on this map is compiled from various sources available to us which we believe to be reliable.
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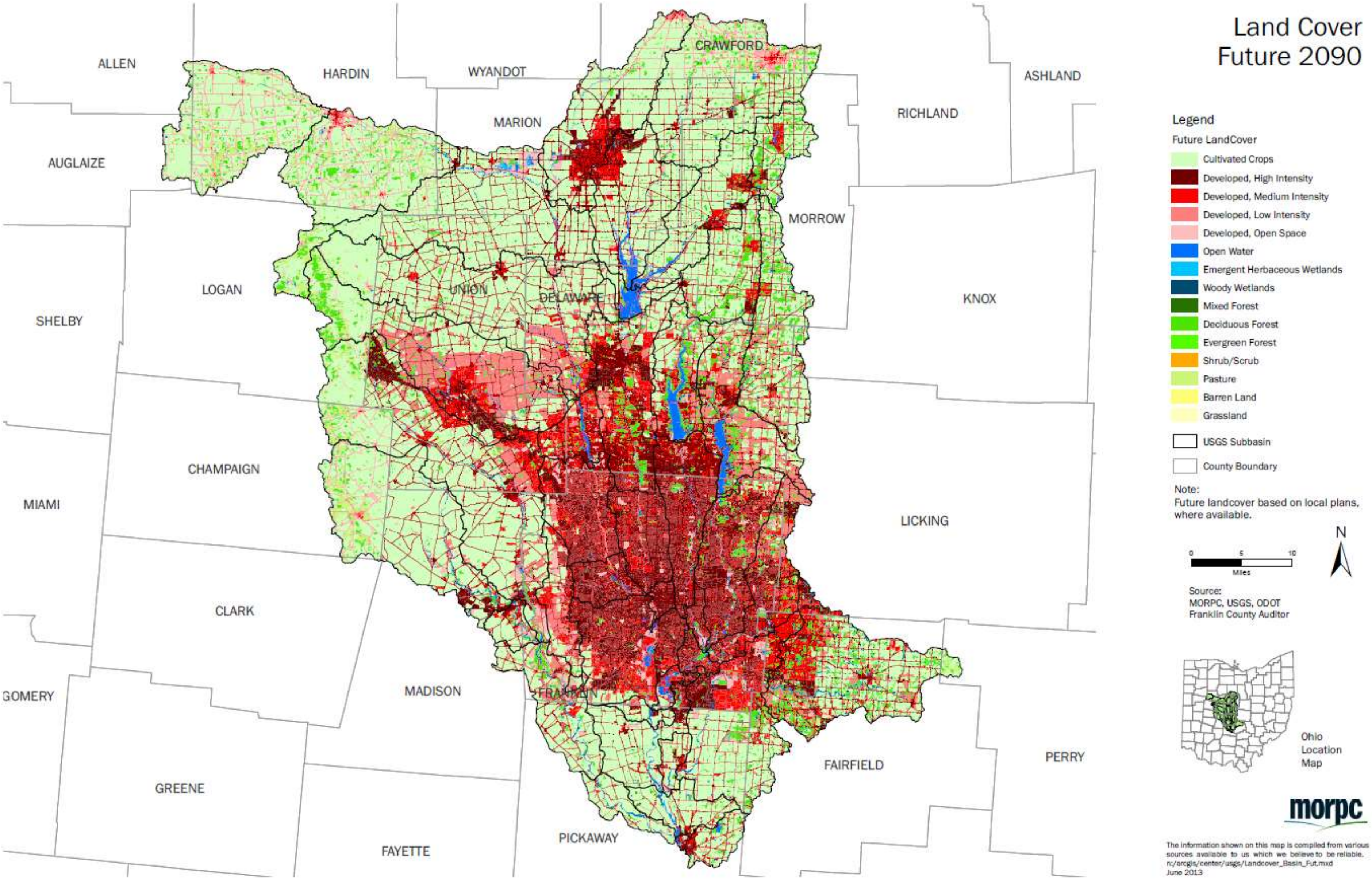
June 2013



Land Cover
Future 2090
ALLEN
HARDIN
WYANDOT
CRAWFORD
ASHLAND
MARION
RICHLAND
AUGLAIZE
MORROW
LOGAN
UNION
DELAWARE
KNOX
SHELBY
CHAMPAIGN
MIAMI
LICKING
CLARK
GOMERY
MADISON
FRANKLIN
FAIRFIELD
PERRY
GREENE
PICKAWAY
FAYETTE
Legend
Future LandCover
Cultivated Crops
Developed, High Intensity
Developed, Medium Intensity
Developed, Low Intensity
Developed, Open Space
Open Water
Emergent Herbaceous Wetlands
Woody Wetlands
Mixed Forest
Deciduous Forest
Evergreen Forest
Shrub/Scrub
Pasture
Barren Land
Grassland
USGS Subbasin
County Boundary
Note:
Future landcover based on local plans, where available.
N
0 5 10
Miles
Source:
MORPC, USGS, ODOT
Franklin County Auditor
Ohio Location Map
morpc
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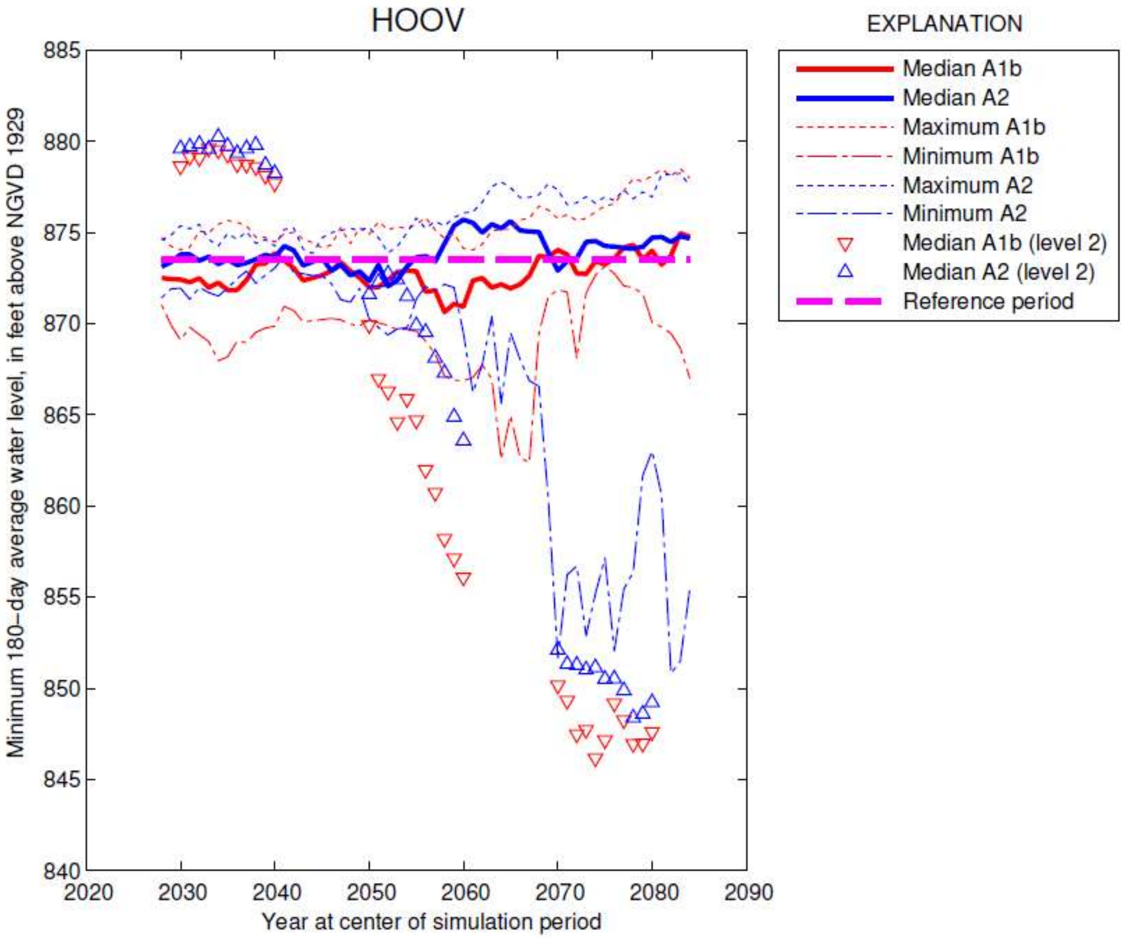
June 2013



Predictions:

- Modeled as a function of demand at Hap Cremean Water Plant – increased demand
- Level-2 medians gradually decrease over time, ending 25 feet below Level-1
- Predicted continual pumping from Alum Creek to Hoover at end of 21st century
- Based on current operational practices, projected development

  Changes to zoning, water distribution, and reservoir operation could lesson impact

CLIMATE & WATERSHED MODEL RESULTS

Short Term

- 2015 to 2025
- Climate within normal range

Mid Term

- 2026 to 2045
- Increase in annual average temperature and higher seasonal temp
- Increase variability in flow and precipitation

Long Term

- 2046 to 2090
- Increased uncertainty – regional development as well as climate
- Increased temperature and variability in flow

Additional Model Results

Long-Term

- With projected development, areas where water supply may be inadequate with current operational practices. Areas in basin where future water use will be withdrawn from groundwater, discharged to surface water system
- Areas in basin where significant future irrigation water needs are anticipated, especially related to agricultural practices

ADAPTIVE MANAGEMENT: ITERATIVE APPROACH TO PLANNING

Iterative Approach:
re-evaluate and adjust as new information becomes available

Overall Prioritization Methodology

Predicted Changes

Evaluated changing conditions & ranked based on ***LIKELIHOOD*** of occurrence

Risks

Ranked based on ***IMPACT*** on the region

Adaptation Strategies

Ranked based on ***TIMING*** and ***REGIONAL CONDITIONS***

PREDICTED CHANGES AND THEIR LIKELIHOOD OF OCCURRENCE

No.	Predicted Changes	Likelihood of Occurrence
1	Increased air temperatures/increased incidence of heat waves	High
2	Increased water temperature	High
3	Warmer soil temperatures/decreased soil moisture	High
4	Higher maximum flows (30- and 7-day higher peak river flows)	Medium
5	Extended dry periods/summer drought (decreased minimum 30-day stream flow)	Medium
6	Increased intensity of rain and wind events	Medium
7	Change in vegetation/animal species composition	Low

Prioritization Methodology: Risks

Predicted Changes

Ranked based on ***LIKELIHOOD*** of occurrence

Risks

Ranked based on ***IMPACT*** on the region

Adaptation Strategies

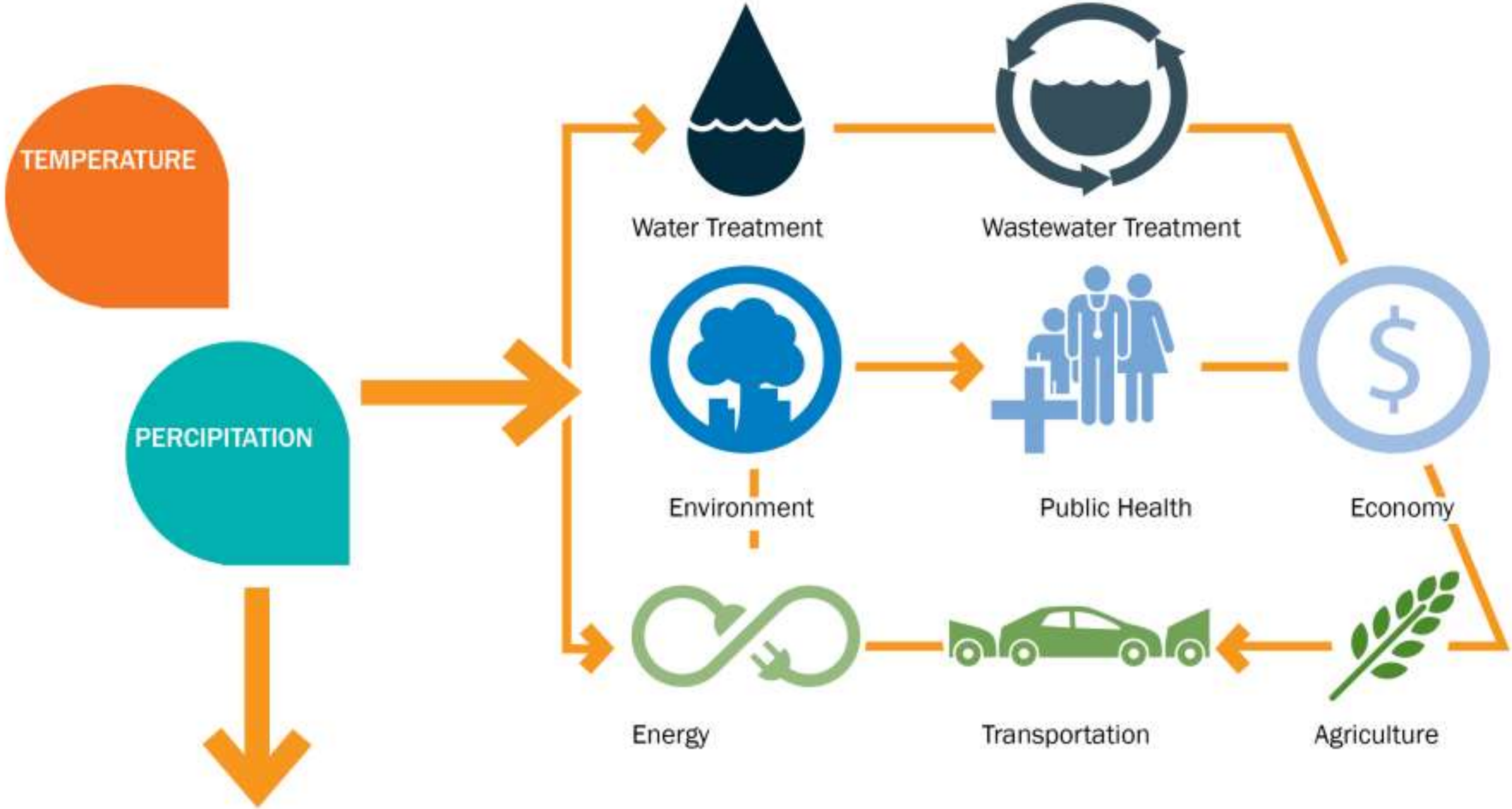
Ranked based on ***TIMING*** and ***REGIONAL CONDITIONS***

Affects Livability of Region

Impacts Quality of Life in Region

Less Impact on Quality of Life in Region

RISKS & IMPACTS



Projected or Potential Future Challenges

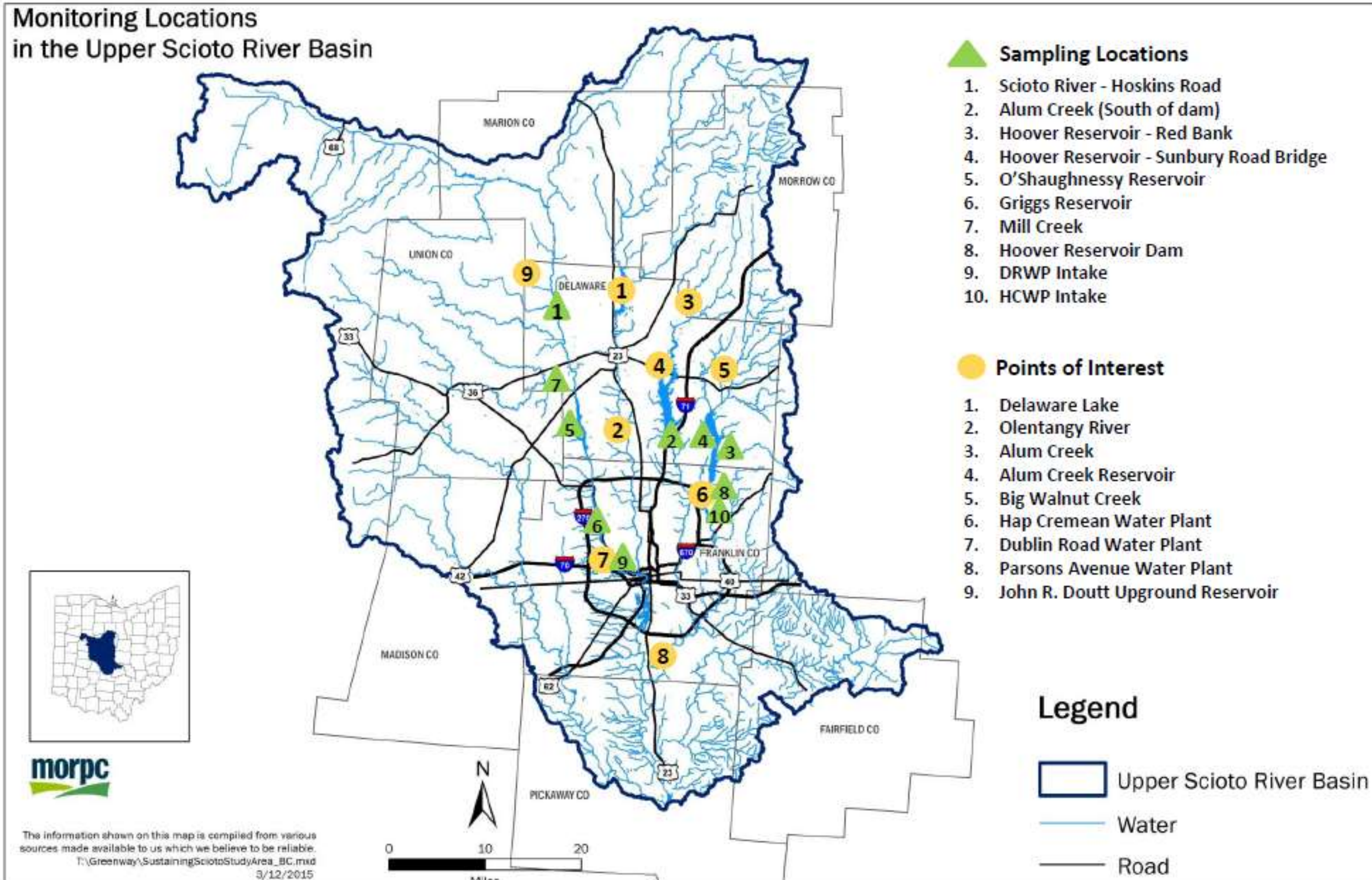
Impacted Sectors

Prioritization Methodology: Risks

Vulnerability Scenarios	Affected Sector: Water Supply/ Water Quality	Water Treatment	Wastewater Treatment	Public Health	Agriculture	Environment	Economy	Energy	Transportation
Increased Air Temperatures / Increased incidence of heat waves	Increased evaporation, Reduced water volume Increased water demand and demand due to irrigation Increased in-stream TOC Increased nutrient/ pesticide / herbicide runoff due to extended growing season, increased algal blooms Increased watershed erosion	Negatively affects water quality Increased capital investment due to designing for peaking factors Taste and odor concerns, potential for algal toxins Increased chlorine demand, Increase DBPs	Impacts to infrastructure (increased corrosion) Lower flow affects discharge permits and treatment Increase need for odor control	Vector Diseases Increased issues for asthma and allergies Impacts to human mortality, Increase in heat illnesses and stresses on healthcare	Vegetation / Animal species shift Livestock health / mortality Extended/disruptions to growing season Increased use of herbicides/pesticides/ nutrients with longer growing season Increased need for irrigation and controlled drainage	Vegetation / Animal species shift Increased smog / Decreased air quality	Extended recreational season Increased costs for utility services (water, wastewater, and energy) Increased service cost for food Decreased human productivity	Increased energy demand due to air conditioning, increased use of pumps for water / wastewater Decreased efficiency throughout production as temperature rises Increased power disruptions (brownouts)	Increase in road and bridge repairs and disruptions due to heat stress Increased use of private vehicles Change in construction materials for higher temperatures Extended but less efficient construction season
Increased water temperature	Decreased dissolved oxygen Increased release of phosphorus and other pollutants from anoxic zones/sediment Decreased mixing Longer duration of poorer water quality Increased algal blooms including blue greens (potential for increased toxin release)	Taste and odor concerns, potential for algal toxins Increased treatment costs due to algae and potentially algal toxins Increased treatment efficiency	Lower DO / changes in temp require affect wastewater discharge allocation Decreased organics at plant due to DBPs	Increase in waterborne diseases Increased use of disinfectants; increased DBPs	Increased costs to control water quality from fields Treatment and disinfection use increases Energy use for cooling Livestock management and aquaculture	Changes in pH and pollutant toxicity Negative impact on aquatic life diversity and numbers Decreased dissolved oxygen Increase in algal blooms	Algae growth could impact recreational use Increased energy cost due to power plant discharge cooling	Increased cost for energy production because have to cool discharge before released	Limited applicability
Warmer soil temperatures / Decreased soil moisture	Decreased groundwater base flow to streams Reduction/change in vegetative cover Increased watershed erosion Increased in-stream TOC Increased sediment deposition/loss of volume	Increased treatment demands due to lower water WQ Change of frequency in water main breaks in winter	Increased use of effluent sludge on farm fields	Impacts to private water systems	Increased need for irrigation and controlled drainage Vegetation / Animal species shift Increased soil conservation practices Increased need for crop insurance	Vegetation / Animal species shift Increased erosion Increase in invasive species	Negative impact on winter recreational activities if less snow/ice Higher food prices and potential job losses if results in loss of agricultural crops	Increased albedo; greater urban heat island effect leads to increased cooling demands	Reduced salt usage in winter Embankment erosion and damage due dry soils

Water Quality Analysis

- Compared historical rainfall data with the following water quality parameters:
  - Turbidity, TOC, herbicides/pesticides, nutrients, algal toxins, zooplankton, and cyanobacteria
  - Analyzed 36 years of historical water quality data


Monitoring Locations
in the Upper Scioto River Basin
Sampling Locations
1. Scioto River - Hoskins Road
2. Alum Creek (South of dam)
3. Hoover Reservoir - Red Bank
4. Hoover Reservoir - Sunbury Road Bridge
5. O'Shaughnessy Reservoir
6. Griggs Reservoir
7. Mill Creek
8. Hoover Reservoir Dam
9. DRWP Intake
10. HCWP Intake
Points of Interest
1. Delaware Lake
2. Olentangy River
3. Alum Creek
4. Alum Creek Reservoir
5. Big Walnut Creek
6. Hap Cremean Water Plant
7. Dublin Road Water Plant
8. Parsons Avenue Water Plant
9. John R. Doutt Upground Reservoir
Legend
Upper Scioto River Basin
Water
Road
MARION CO
MORROW CO
UNION CO
DELAWARE
FRANKLIN CO
MADISON CO
PICKAWAY CO
FAIRFIELD CO
N
0
10
20
Miles
The information shown on this map is compiled from various sources made available to us which we believe to be reliable.
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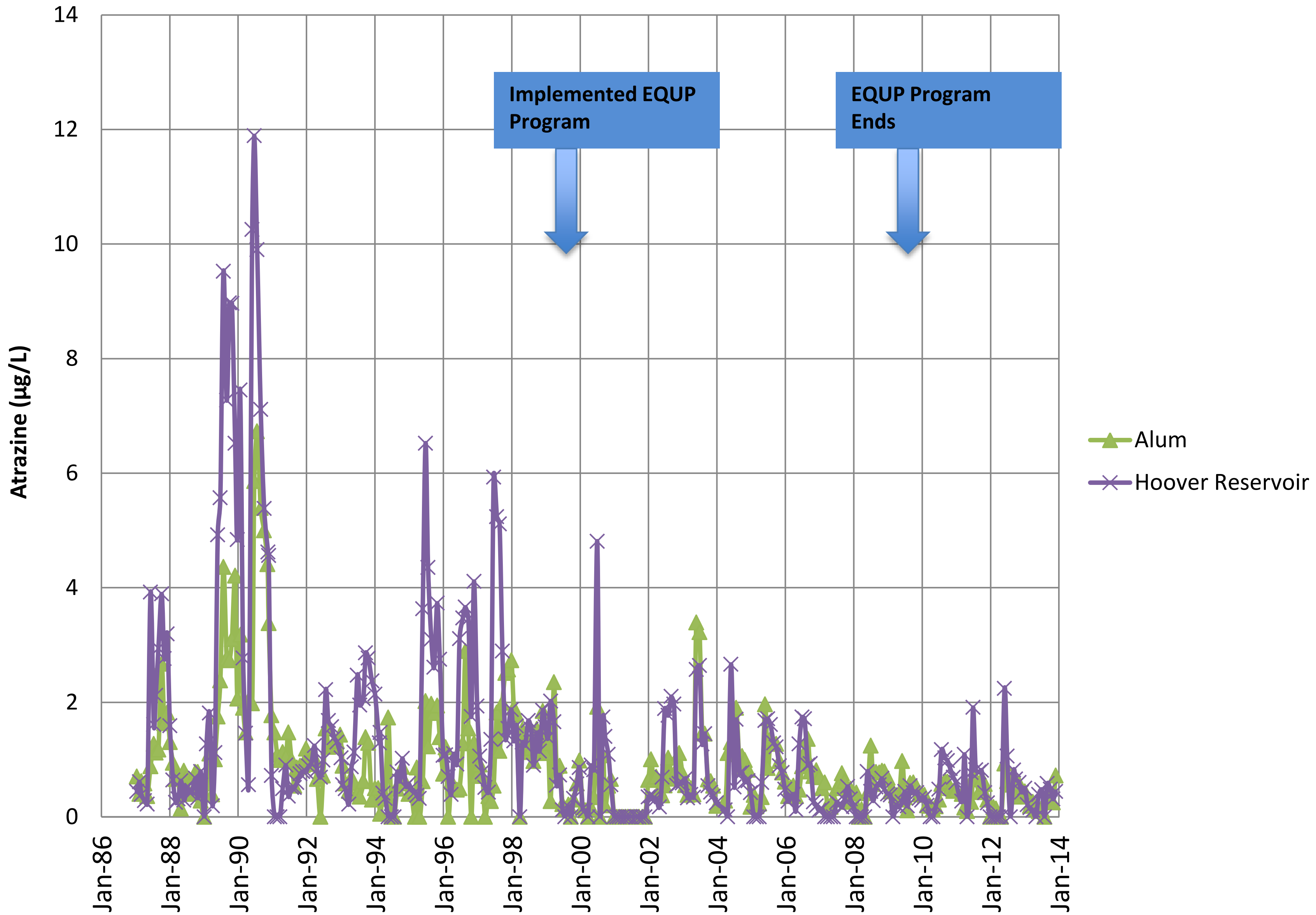
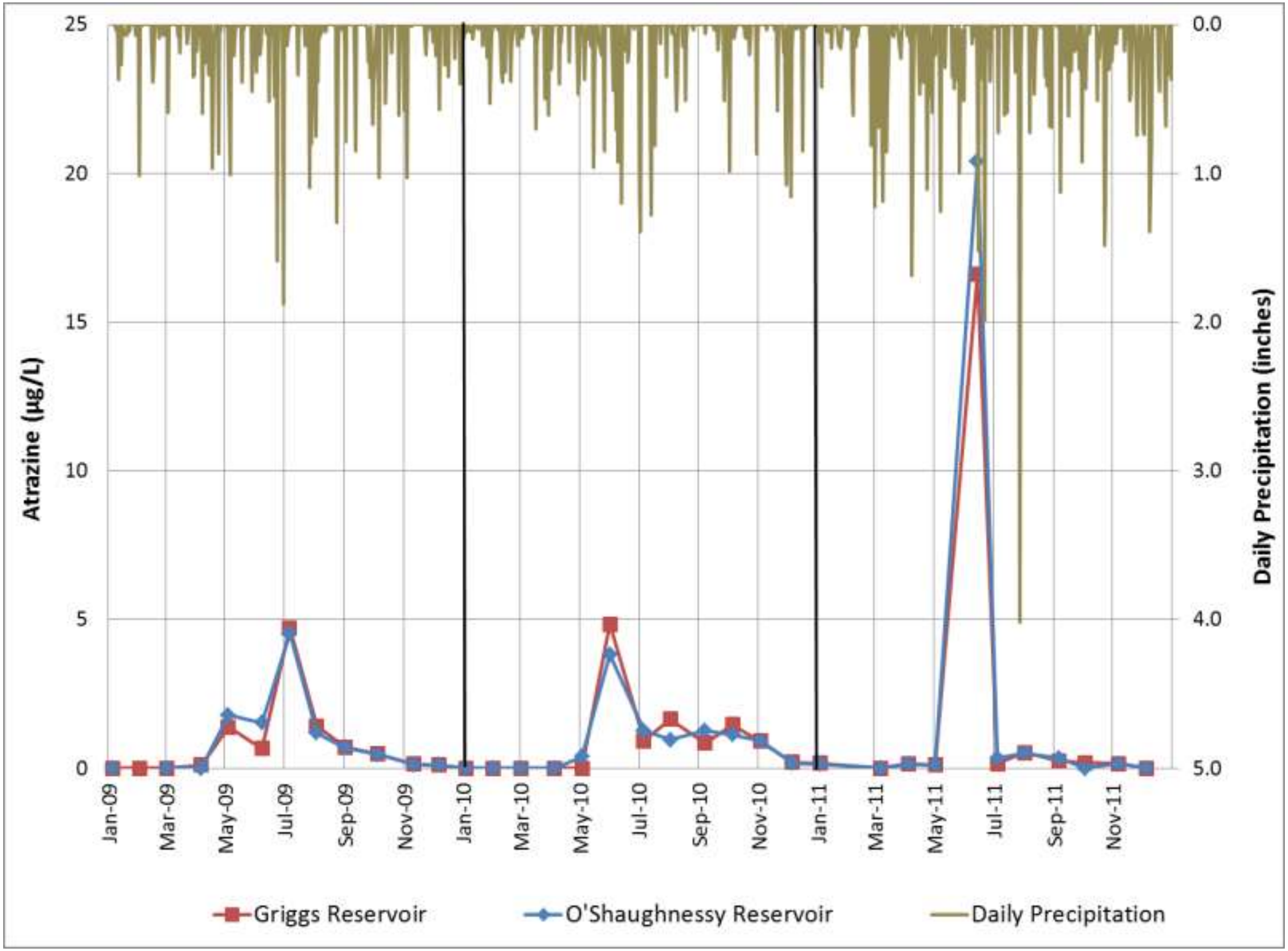
3/12/2015



Historical Atrazine Summary, source: Jeffrey and Williams, 2015; King et al. 2012



25
20
15
10
5
0
Atrazine (µg/L)
0.0
1.0
2.0
3.0
4.0
5.0
Daily Precipitation (inches)
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
Mar-10
May-10
Jul-10
Sep-10
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Griggs Reservoir
O'Shaughnessy Reservoir
Daily Precipitation

Microcystin Levels Increase in Recent Years

Year	Number of Samples greater than 0.3 µg/L	Number of Samples Analyzed
2009	0	12
2011	1	9
2012	0	3
2013	5	22
2014	9	13

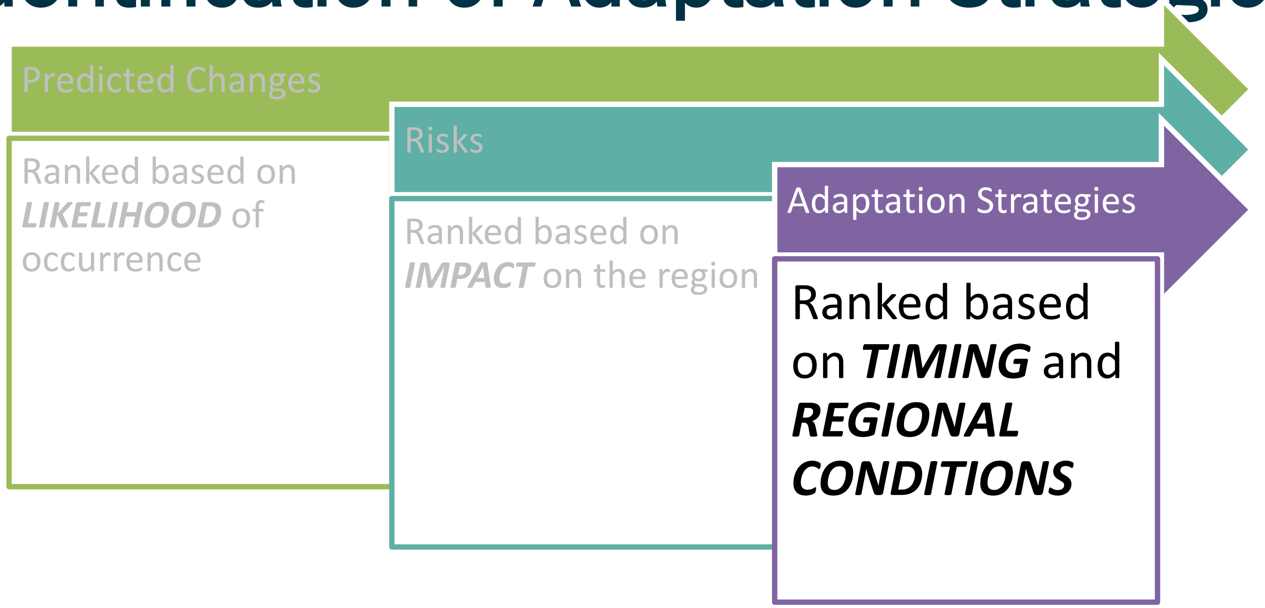
Prioritization Methodology: Risks

Water Quality High-Priority Risks		
No.	**Predicted Changes**	**High Priority Risks**
1	Increased air temperature	Increased nutrient/pesticide/herbicide load due to extended growing season
2	Increased water temperature	Increased algal blooms
5	Higher maximum peak stream flows	Increased nutrients, turbidity, sediment, and other pollutant loads to surface waters
		Increased algal blooms
		Increased watershed and stream bank erosion
6	Extended dry periods/ summer drought	Decreased reservoir inflow/volume and reduced mixing
		Increased algal blooms
7	Increased intensity of wind and rain events	Increased watershed and stream bank erosion
		Increased nutrients, turbidity, sediment, and other pollutant loads to surface waters

ADAPTIVE MANAGEMENT: ITERATIVE APPROACH TO PLANNING

Iterative Approach:
re-evaluate and adjust as new information becomes available

Identification of Adaptation Strategies



- Types of Strategies:
  - Planning
  - Operational
  - Capital Improvement
- Estimate relative costs: $, $$, $$$
- No Regrets Strategies

ADAPTIVE MANAGEMENT PLANNING

Short Term (10 Years)
2015 – 2025

- Regional Collaborative Forum
- Public Education
- Improve Emergency Preparedness Capacities
- Enhance Operational Procedures (WQ Monitoring & Treatment SOPs)
- Resource Protection/Source Management

Mid Term (10-30 Years)
2026 – 2045

- Regional Water Supply Planning
- Groundwater Supply Planning
- Water Reuse Planning
- Reservoir Capacity Planning
- Nutrient/Pollutant Reduction Planning and Implementation
- Re-evaluate climatic conditions

Long Term (End of Century)
2046 – 2090

- Implement Improvements from Mid Term Plans
- Re-evaluate climatic conditions

SUSTAINING SCIOTO: ADAPTATION STRATEGIES

Recommended Adaptation Strategies for Protecting Water Quality		
Strategy	**No Regrets**	**Cost**
Planning and Policy		
Develop Water Quality Monitoring Plan	✓	$
Develop an Agricultural Nutrient Management Program	✓	$
Implement Public Education on water quality, water supply & climate change impacts	✓	$
Modify local ordinances to promote low impact development, stormwater harvesting/reuse	✓	$
Develop Regional Watershed Management Plan to reduce nutrient runoff	✓	$
Operational		
Implement increased fertilizer reduction programs, revegetation of riparian buffer zones, and other non-structural practices	✓	$$
Capital Improvement		
Implement reservoir capital improvement projects		$$
Implement pollutant reduction projects (BMPs) to reduce pollutants of concern		$$$

SUMMARY

Results

- Increased air & water temperature
- Increased variability in precipitation – more extreme rain events and drought periods
- Degraded water quality

Challenges to Utilities & Region

- Need for flexibility in operations and management
- Regional issues require regional collaboration

Adaptive Planning

- Prepare with No-Regrets strategies
- Update plan over time
- Regional Collaboration & Education, Source Resiliency; Monitoring; Emergency Preparedness

CONCLUSION:
WHAT CAN YOU DO?

- Consider regional impacts and adaptation strategies
- Identify partners and collaborate
- Develop a timeframe and benchmarks
- Consider how this will impact your community

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Select References and Acknowledgements

The Water Research Foundation Project 4585 Advisory Committee members:

- **Donald Distante, United Water**
- **Steve Conrad, Pacific Institute for Climate Solutions**
- **William Becker, Hazen and Sawyer**
- **Alison Adams, Tampa Bay Water**
- **Kenan Ozekin, Water Research Foundation Research Manager**

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QUESTIONS?

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