Middle Potomac River Watershed Assessment
Human uses of water
Current and future demands in the Potomac River Basin

Second of a six-part webinar series
May 10, 2011

The webinar will start momentarily.

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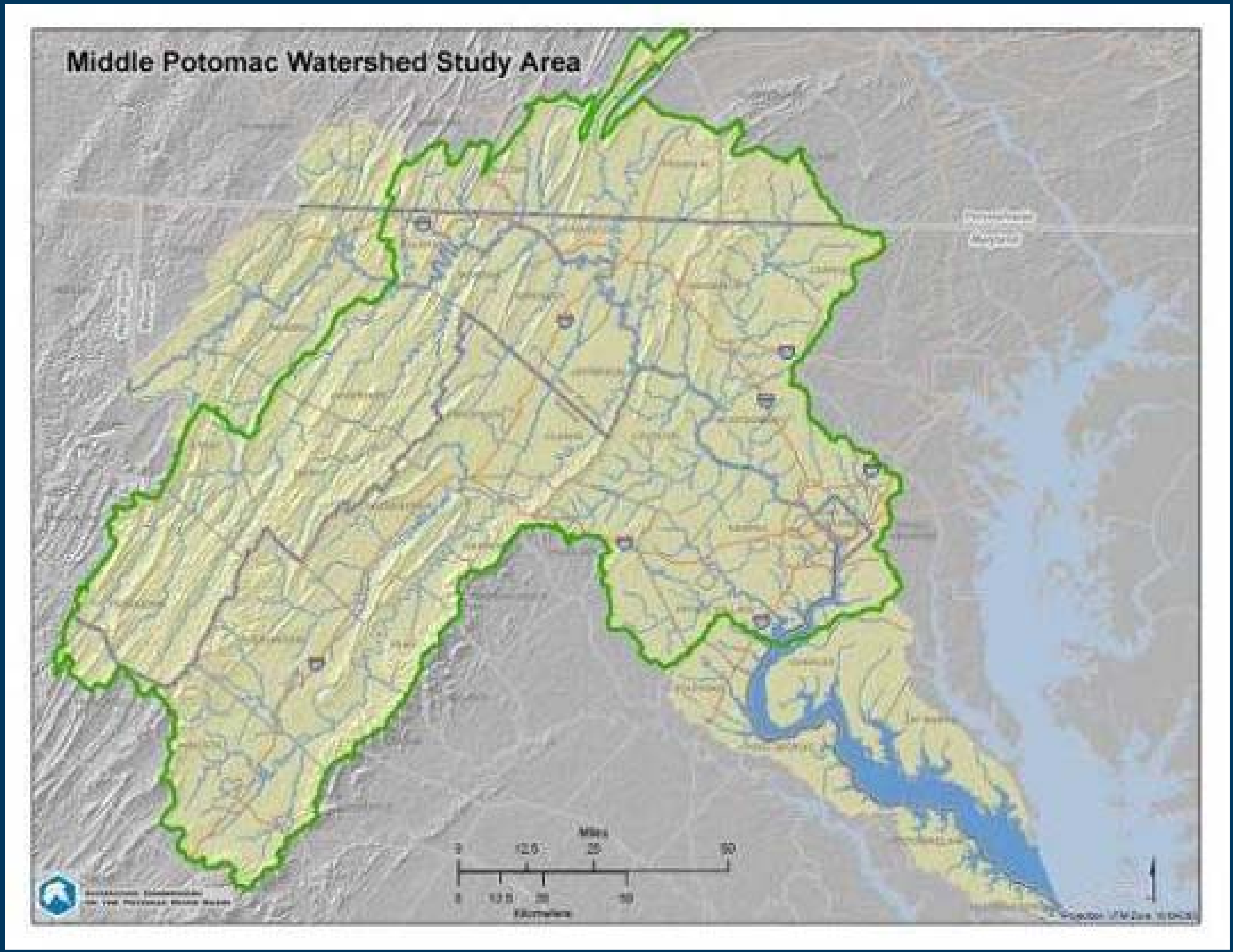
Middle Potomac Watershed Assessment
Webinar 1: Technical Overview

Speakers

Andrew Roach, U.S. Army Corps of Engineers, Baltimore District

Olivia Devereux, Environmental Scientist, Interstate Commission on the Potomac River Basin (ICPRB)

Study Area



5/10/2011

This project’s objectives

1) Estimate current and future human water withdrawals and their impacts on flows.

2) Characterize flows needed to support healthy stream biotic communities.

3) Provide baseline information and analyses to support water use decision making.

Webinar Series

- Technical details on methodology for small streams
- Obtain feedback from stakeholders
- Prepare for concluding workshop: focus on management applications

Date	Webinar Topic
Apr 12	Technical overview of project
May 10	Current and future demands and impacts on flow
Jun 16	Modeling streamflow
Jul 14	Quantitative flow-ecology relationships Part 1: Data, variables and methodology
Sep 8	Quantitative flow-ecology relationships Part 2: ELOHA curves, uncertainty, and interpretation
Oct 27	From Science to Management Applications

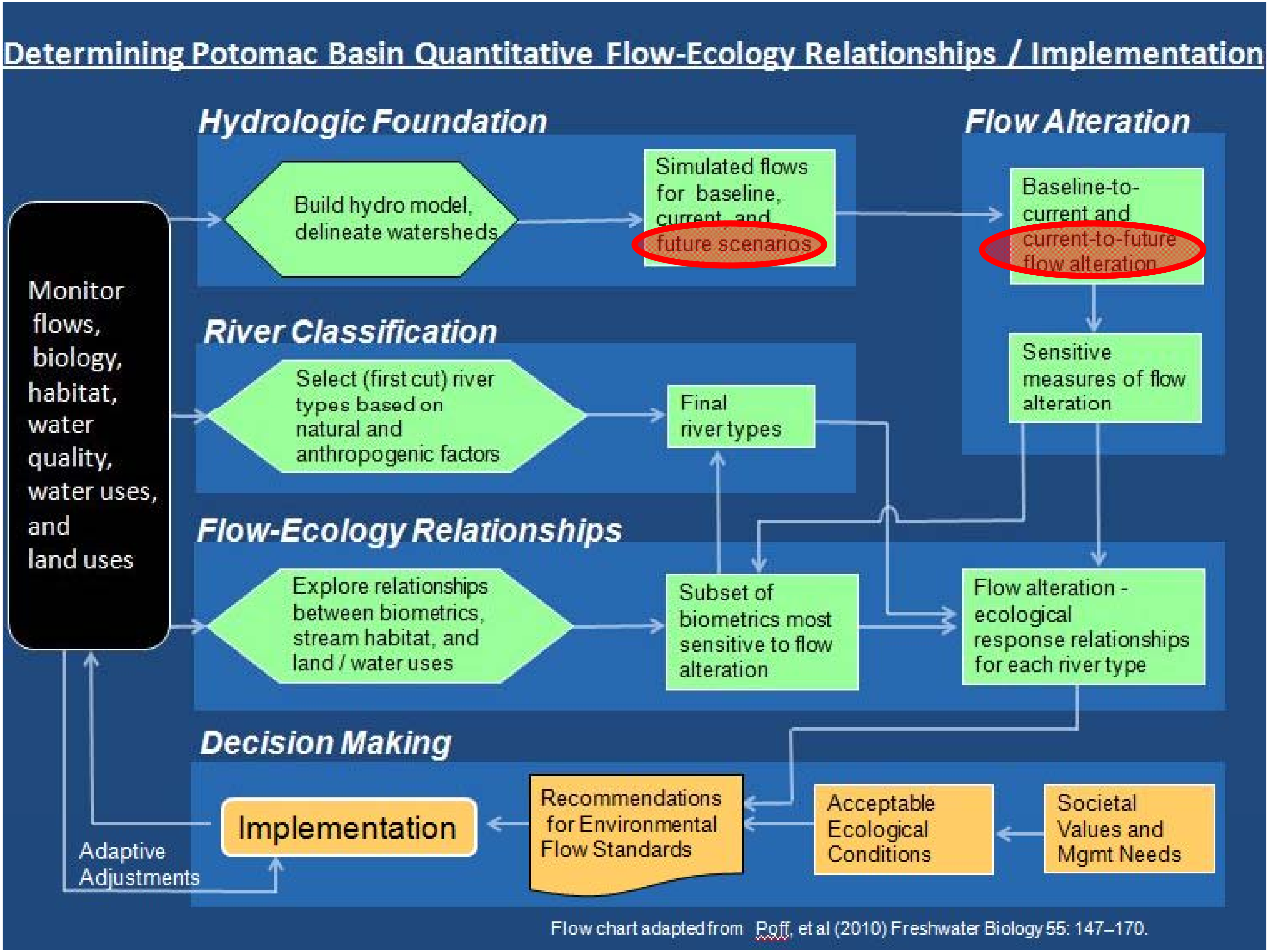
→ Nov 29-Dec1 Flow Ecological Response Workshop at NCTC

Purpose of the Future Scenarios Task

1. To develop inputs for modeling future steam flow scenarios and estimating impacts on flow.

2. Follow-up to the 2000 ICPRB Water Supply Demands and Resource Analysis study.

Information about the Middle Potomac River Watershed Assessment is available at: PotomacRiver.org/sustainableflows

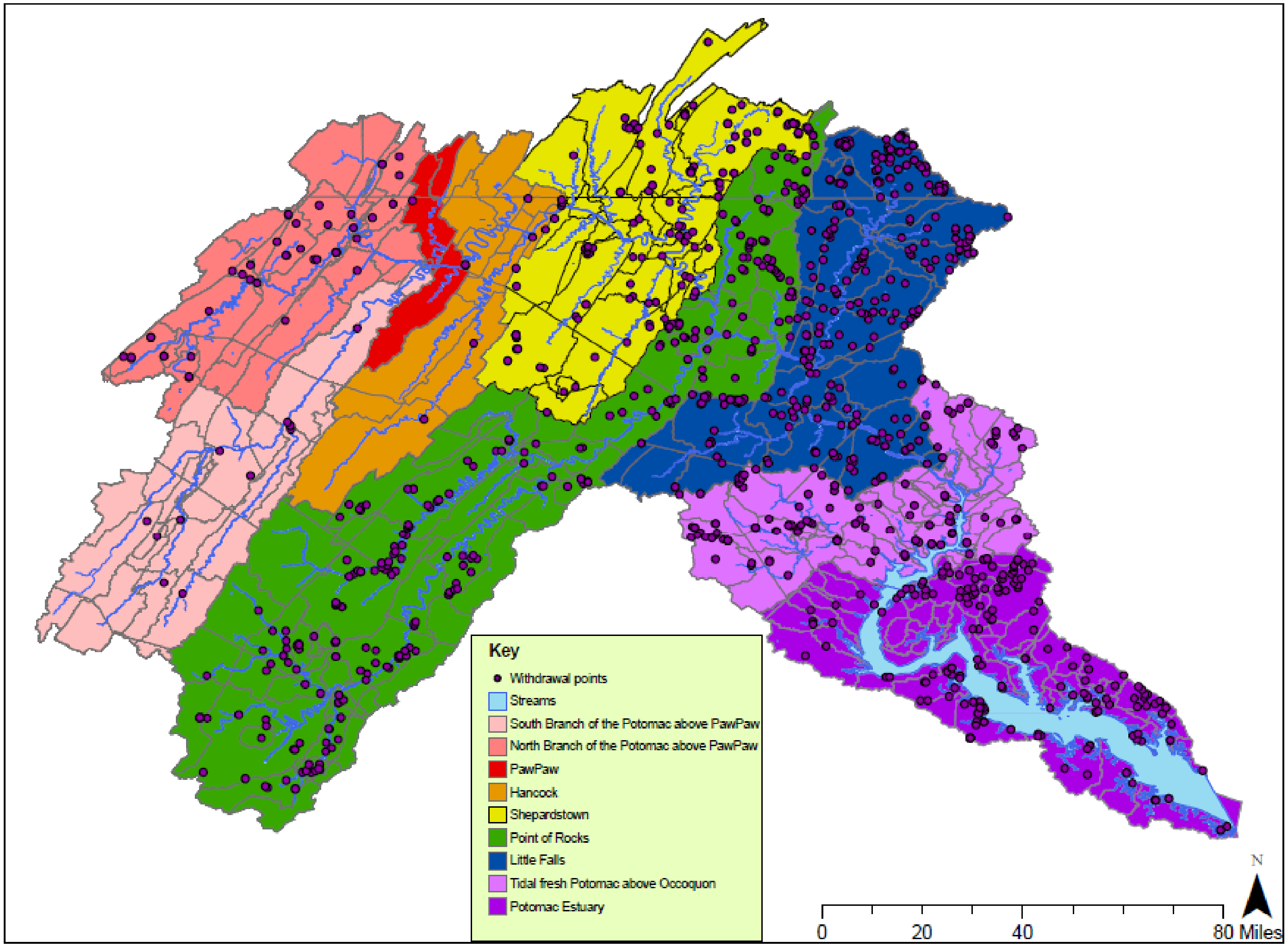


Determining Potomac Basin Quantitative Flow-Ecology Relationships / Implementation
Hydrologic Foundation
Build hydro model, delineate watersheds
Simulated flows for baseline, current, and future scenarios
Flow Alteration
Baseline-to-current and current-to-future flow alteration
Sensitive measures of flow alteration
Monitor flows, biology, habitat, water quality, water uses, and land uses
River Classification
Select (first cut) river types based on natural and anthropogenic factors
Final river types
Flow-Ecology Relationships
Explore relationships between biometrics, stream habitat, and land / water uses
Subset of biometrics most sensitive to flow alteration
Flow alteration - ecological response relationships for each river type
Decision Making
Implementation
Recommendations for Environmental Flow Standards
Acceptable Ecological Conditions
Societal Values and Mgmt Needs
Adaptive Adjustments
Flow chart adapted from Poff, et al (2010) Freshwater Biology 55: 147–170.

Outline

- Study area
- Forecasting water demand and apportioning to a spatial and temporal scale for use in the models
- Six scenario designs and results
- Comparison with other studies
- Conclusions

Withdrawal sites and drainage to mainstem stream gage sites



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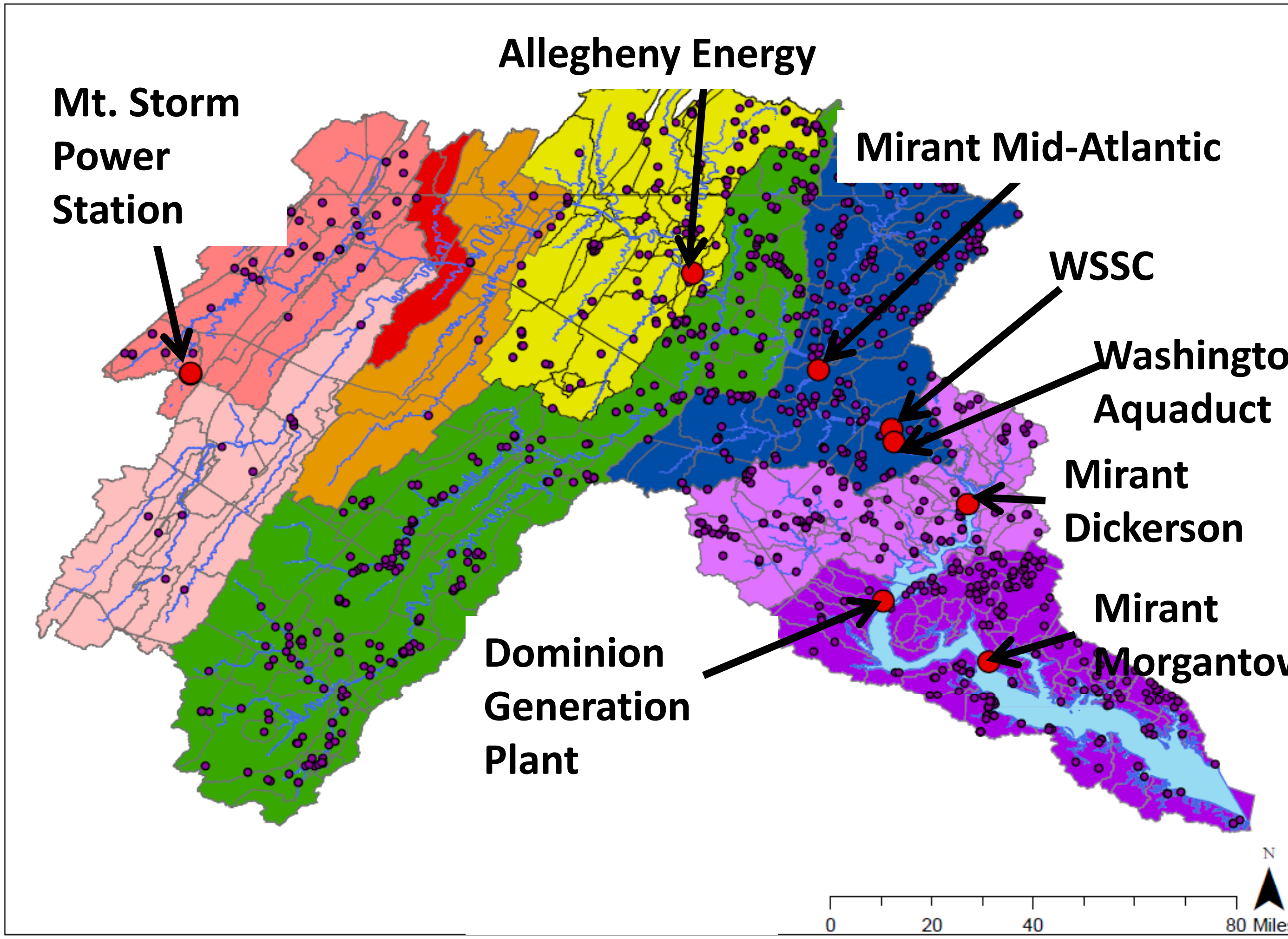
Largest withdrawals (>100 MGD)



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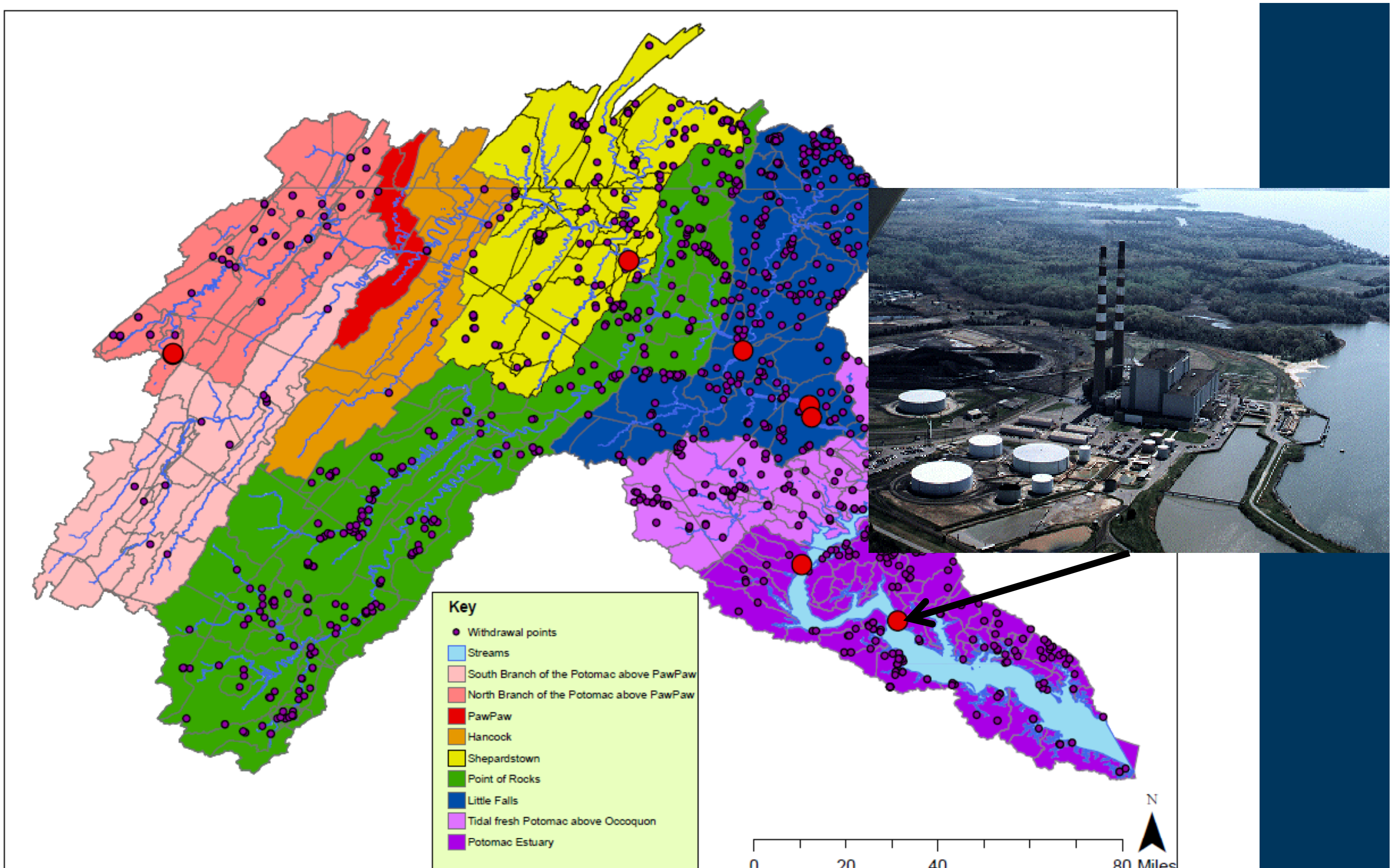
Mirant's Morgantown Plant
Approximately 25% of all water withdrawal



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Forecasting water demand and consumption

1. Years: 2005, 2010, 2015, 2020, 2025, and 2030

2. Water use sectors
   - Mining
   - Thermo-electric power
   - Industrial
   - Agricultural (livestock and irrigation)
   - Domestic and Public Supply

3. Geography: for point locations, based on projections from a county scale

4. Water sources: groundwater and surface water

5. Scenarios
   - Three scenarios that provide a high, medium, and low estimates for domestic and public supply
   - Hot and dry
   - Climate Change
   - Power generation

Water use sectors

Sector	Definition
Mining (MI)	Water used for the **extraction** and on-site **processing** of naturally occurring **minerals** including coal and ores.
Thermo-electric Power (PO)	Water used in the generation of **electric power from** the following fuels: fossil, nuclear, biomass, solid waste, or geothermal energy.
Industry (IN)	Water used to **manufacture products** such as steel, chemical, and paper, as well as water used in petroleum and metals refining. Includes water used as process and production water, boiler feed, air conditioning, cooling, sanitation, washing, transport of materials, and steam generation for internal use.

Sectors (cont.)

Sector	Definition
Livestock (LV)	Water used to raise cattle, sheep, goats, hogs, and poultry. Animal specialty water use, which includes horses, are included. Aquaculture is also included. Includes drinking water for the animals and wash water.
Irrigation (IR)	Includes all water artificially applied to farm, orchard, pasture, and horticultural crops. Turf farms and golf courses are included in this category.
Domestic and Public Supply (DP)	Water withdrawn by public and private water suppliers and delivered to users, typically used for household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, car washing, and watering lawns and gardens. This category also includes ski resorts.

Sources and characteristics of forecasted data

Water use sector	Forecasted data source	Spatial Resolution of Forecasted data
Domestic + public supply	CBP Population projection	FIPS
Irrigation	NASS FRIS, CBP land use projection	FIPS
Livestock	NASS and CBP Ag Census, CBP land use projection	FIPS
Mining	US-EIA forecasts	northern and central Appalachian regions
Thermo-electric power	US-EIA forecasts	average for the entire nation
Industrial	US-EIA forecasts	average for the entire nation

Scaling water demand forecasts

- A rate of increase was applied to the county-scale USGS *Estimated Use of Water in the U.S. 2005* data

- The forecasted county-scale water use was then allocated to point locations based on the states' reported 2005 withdrawals
  - Groundwater and surface water
  - Monthly

- Next, point data summed to river-segment scale for input to the models

- Data also summed to 8 specific gage sites

Historical consumptive use

Sector	Year	% consumptive
Domestic and public supply	1985	13
	1990	11
	1995	9
	Avg.	***11***
Irrigation	1985	92
	1990	85
	1995	68
	Avg.	***82***
Livestock	1985	60
	1990	87
	1995	86
	Avg.	***78***

Sector	Year	% consumptive
Industrial	1985	9
	1990	9
	1995	10
	Avg.	***9***
Mining	1985	12
	1990	19
	1995	11
	Avg.	***15***
Power	1985	6
	1990	1
	1995	1
	Avg.	***3***

Note: Consumptive = 100% for the domestic and public supply and industrial sectors, in those counties that are included in the Blue Plains service area.

Scenarios

Scenarios that provide a high, medium, and low estimates for the domestic and public supply sector

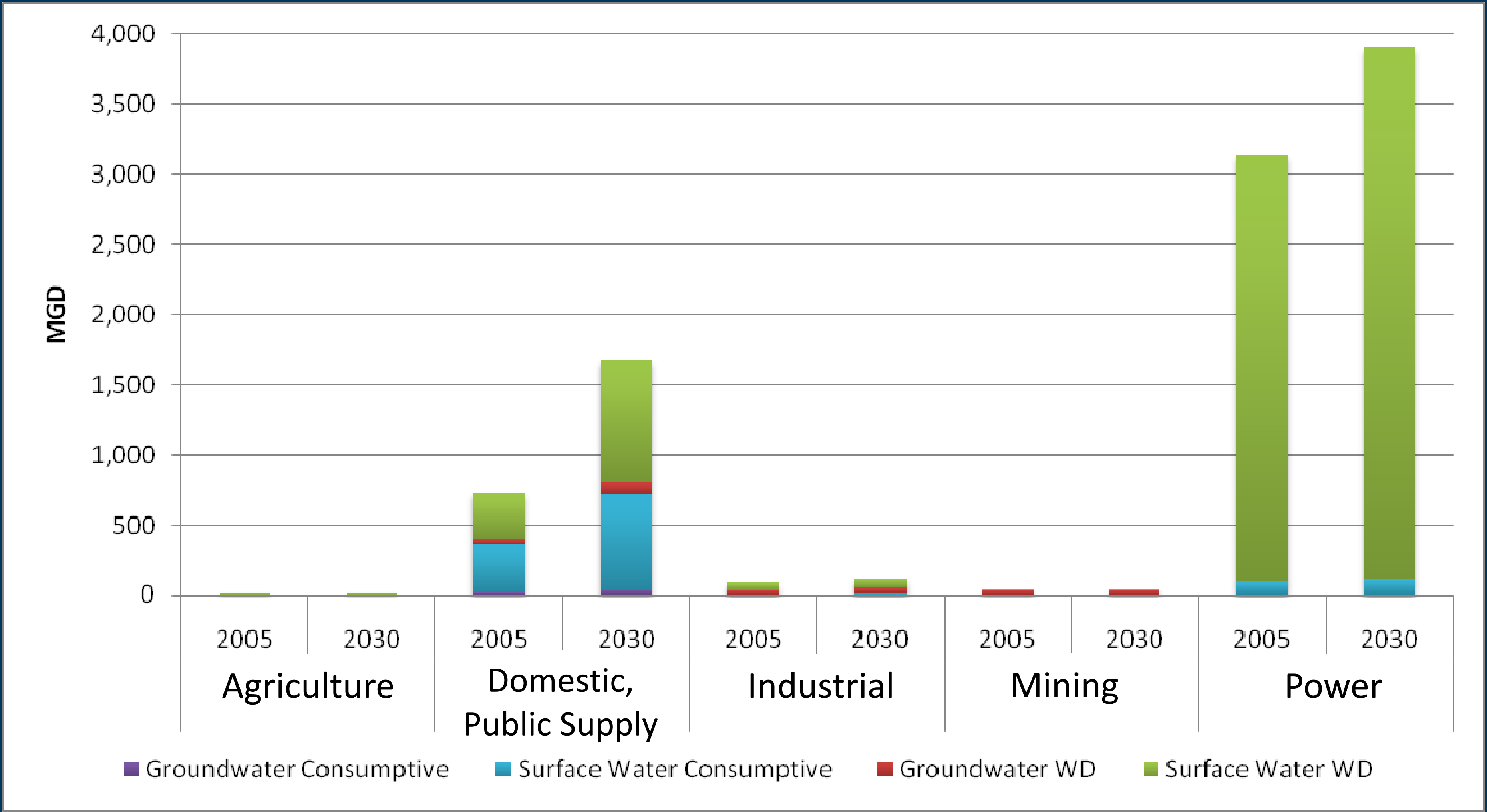
- High scenario
  - Domestic and public supply change in per capita use = 4.38% annual increase
- Medium scenario
  - Domestic and public supply change in per capita use = 1.82% annual increase
- Low scenario
  - Domestic and public supply change in per capita use = 0.0% annual increase

Hot and dry
(built from Medium scenario)

Climate Change
(built from High scenario)

Power generation changes
(built from Medium scenario)

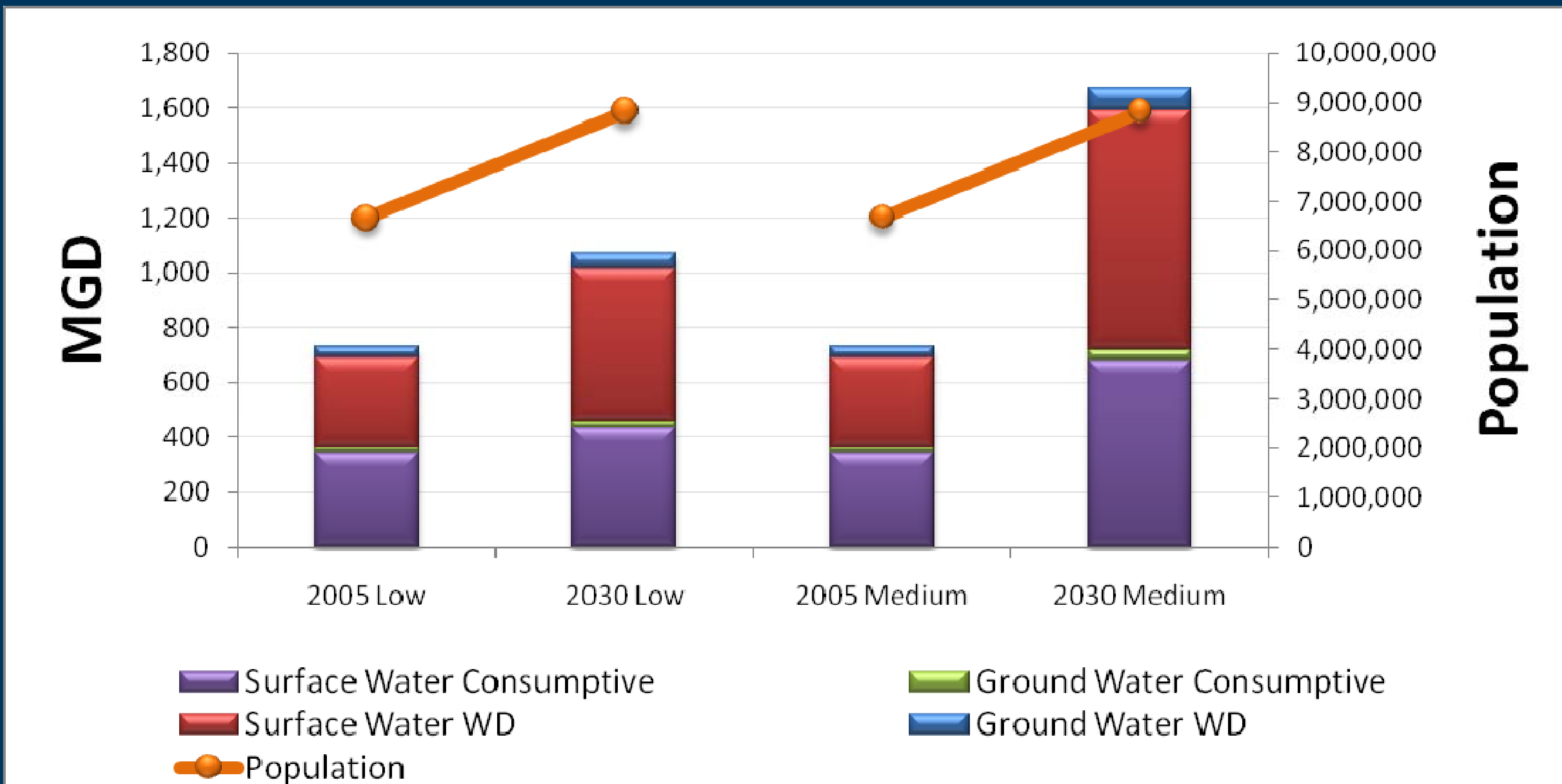
“Medium” domestic and public supply scenario results



Causes of domestic and public supply sector increases

Primarily because of per capita withdrawal

Secondarily due to population increase



Impact of per capita rates of growth in the domestic and public supply sector

In 2005, withdrawal was 730 MGD and consumption was 361 MGD.

	2030	
Scenario (per capita annual rate of increase)	**Withdrawal (MGD)**	**Consumption** (MGD)
High (4.38%)	3,112	1,334
Medium (1.82%)	1,676	718
Low (0.0%)	1,068	458

Climate change scenario design

Built on the High Scenario, Year=2030

Temperature adjustments

- Global temperature change
- Temperature increase by 0.4°C globally by 2030

Precipitation adjustments

- No annual precipitation change
- Variable precipitation patterns result in changes in human decision making

Agricultural sector

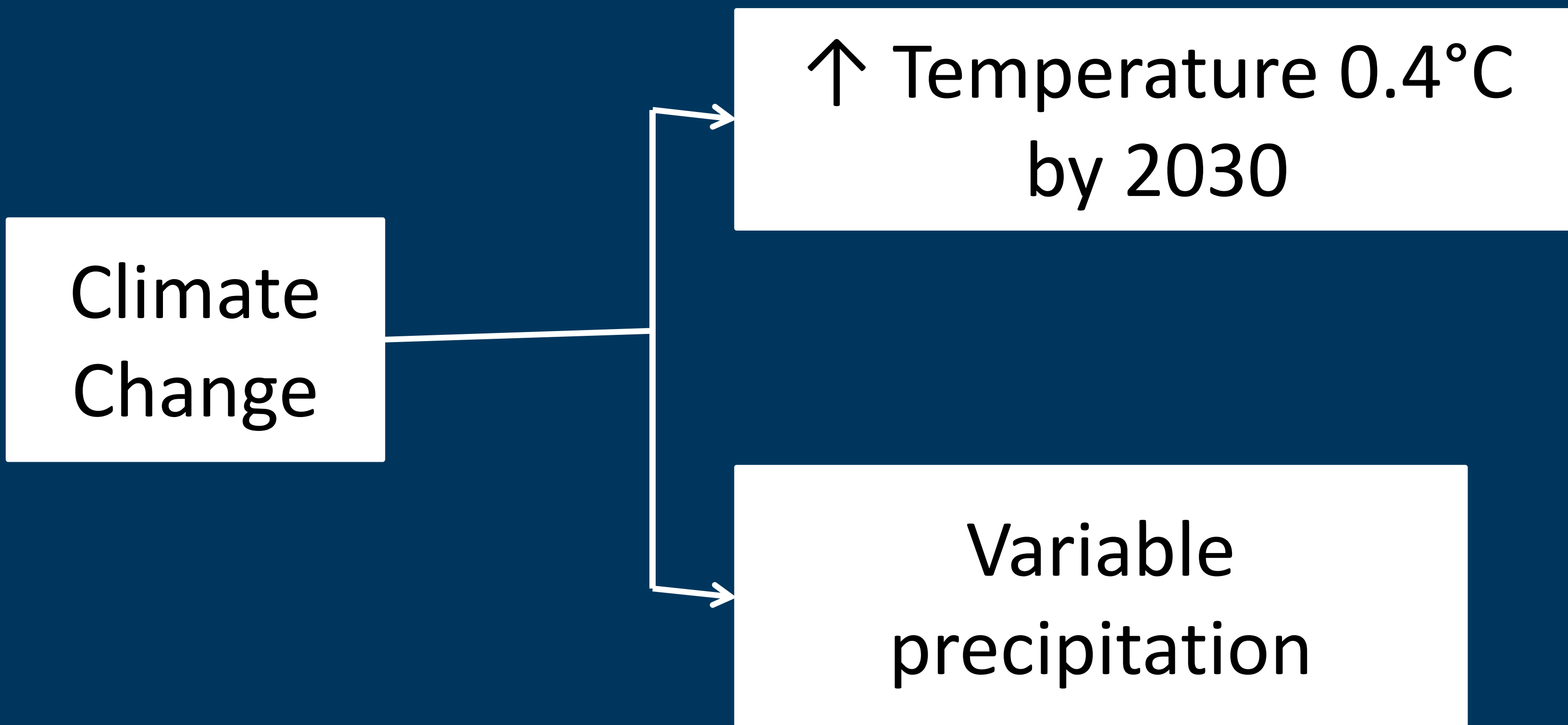
- Climate change will not result in any changes to the livestock sector
- Transpiration is assumed to not have an effect on the aggregated crop type used in this scenario
- Irrigated land increases by 50%

Thermo-electric power sector

- Increase power demand by 0.8% in summer months (May to Sept.); assumes a linear relationship between power production and water withdrawal by thermo-electric power plants.

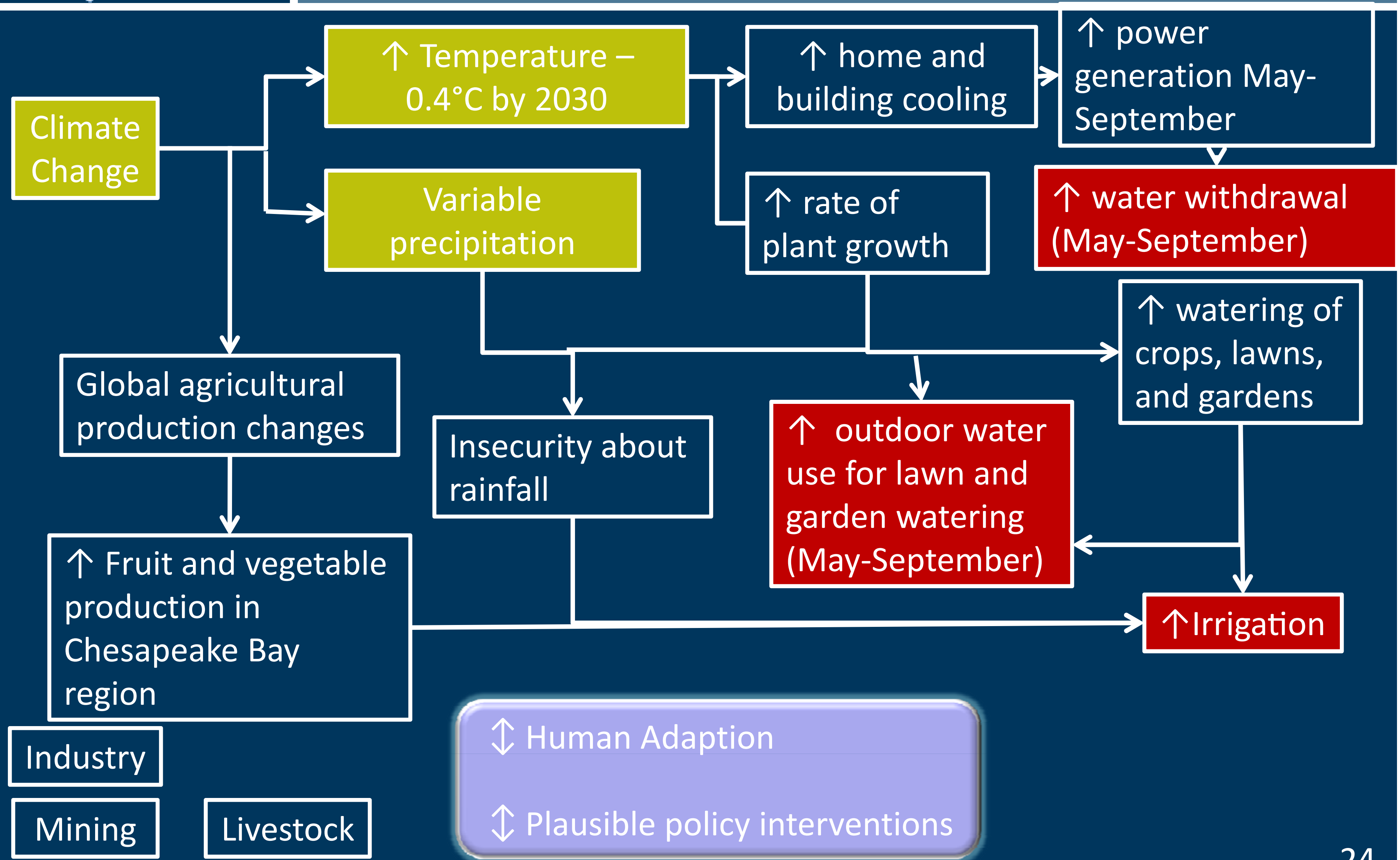
Domestic and public supply sector: Increase water demand 5% for DP in summer months (May to September)

Climate change scenario design

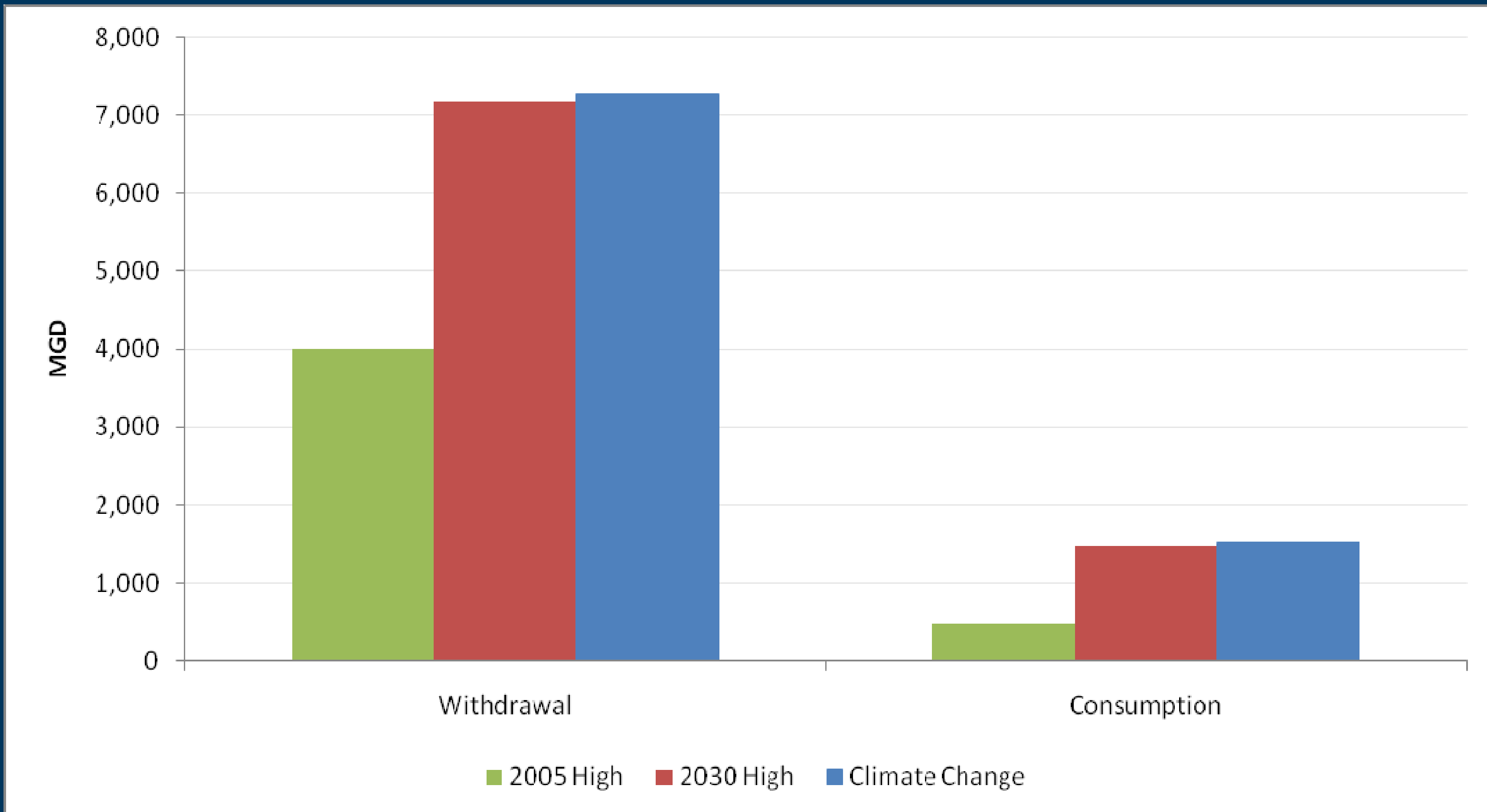


- Impact only to irrigation, domestic and public supply and power
- No change to mining, livestock, or industry

Integrated climate change causal link model



How does climate change impact water demand?

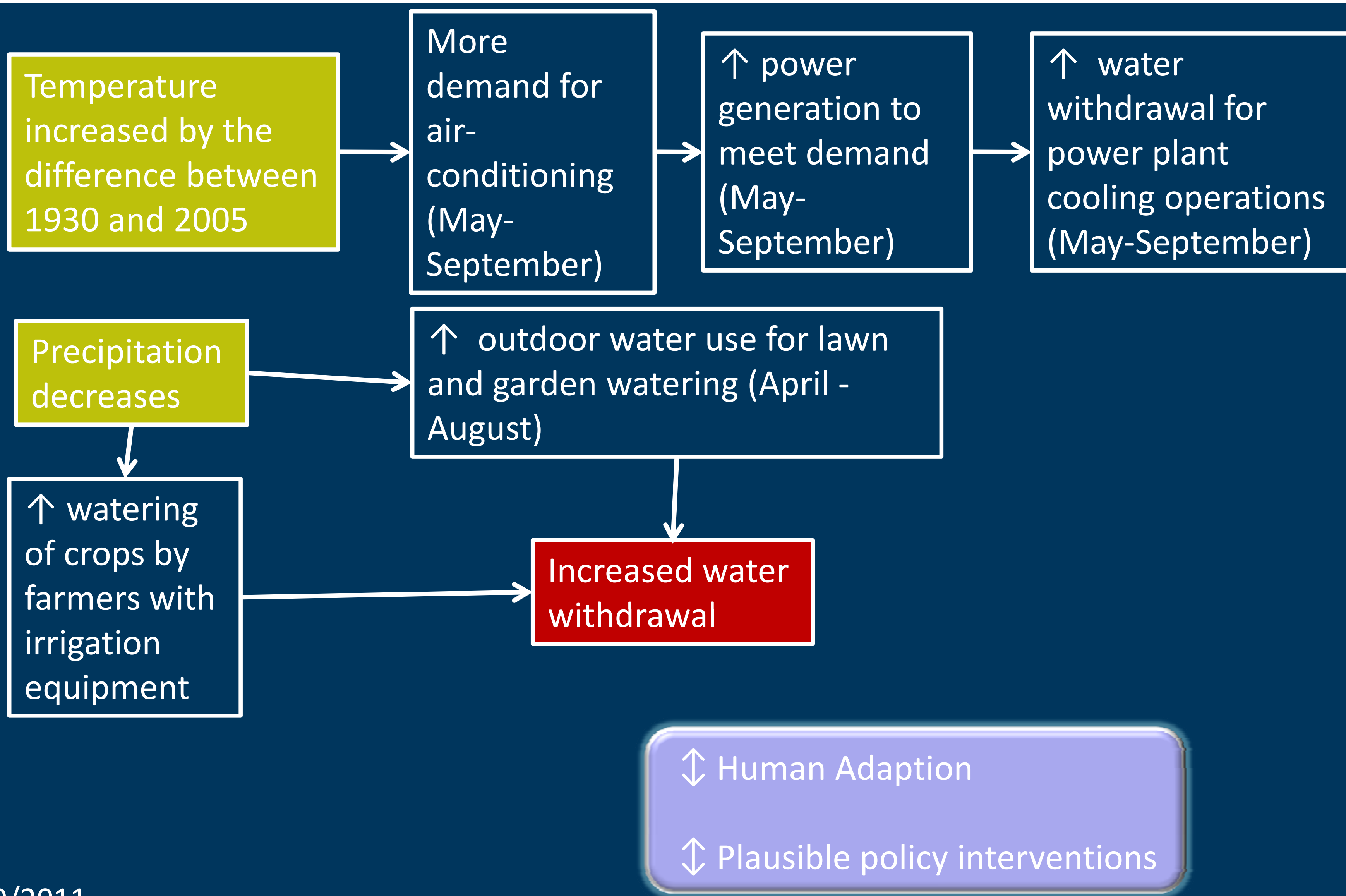


Hot and dry scenario design

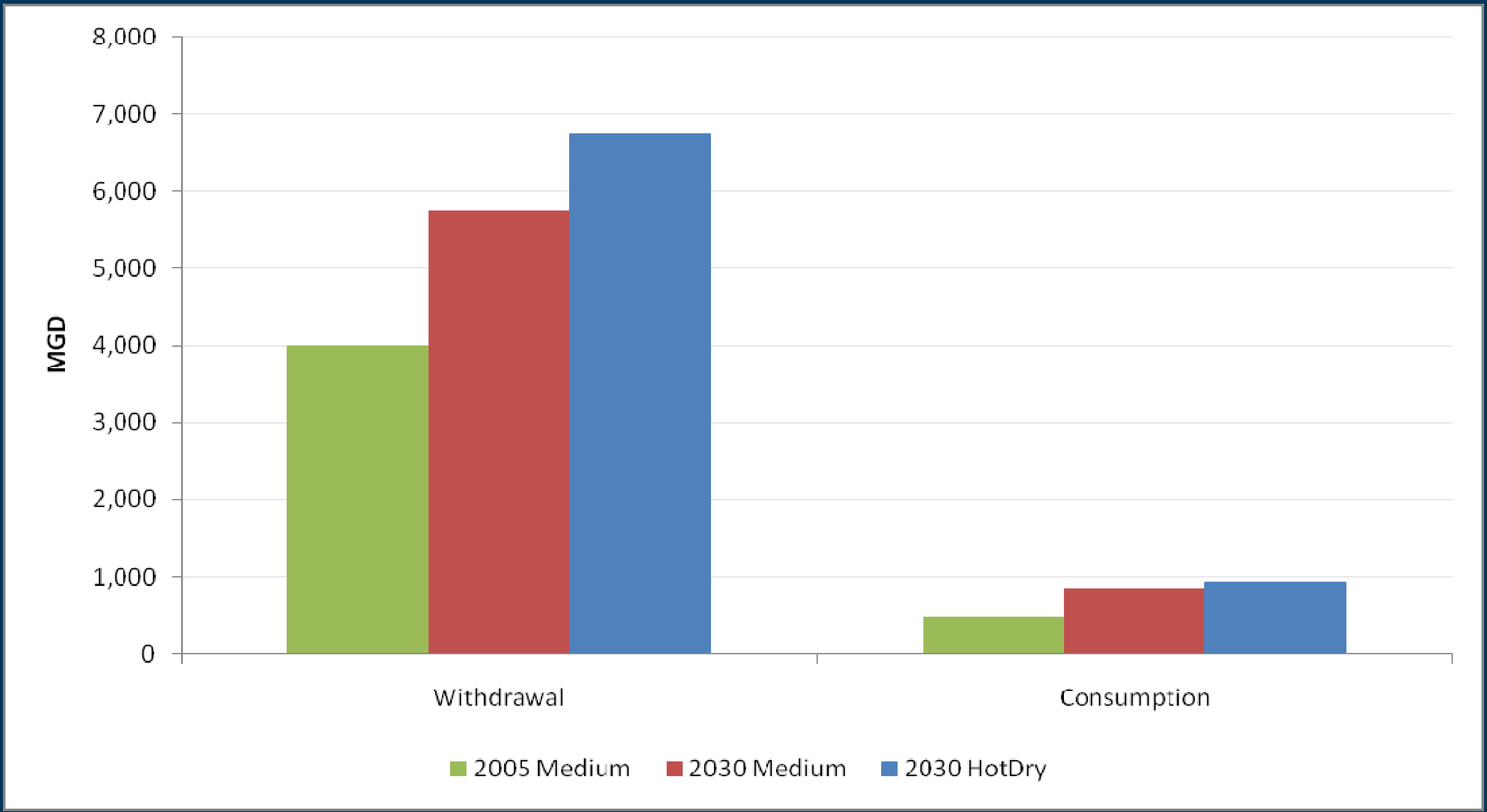
Hot and Dry scenario, based on the Medium Scenario

- Domestic and public supply withdrawals increased by 15.21% for the months April– August
- Power withdrawals increased 6.15% for the months May– October
- Irrigation withdrawals increased per acre by 283.9% for the months May– October

Hot and dry scenario design



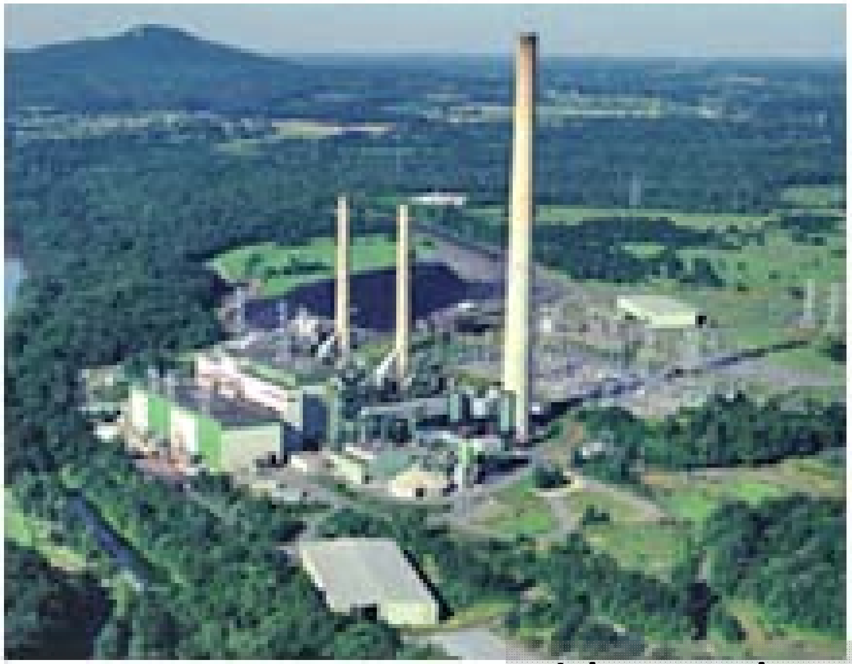
Hot and dry comparison with Medium Scenario



Power generation scenario design

Power generation scenario,
based on Medium Scenario

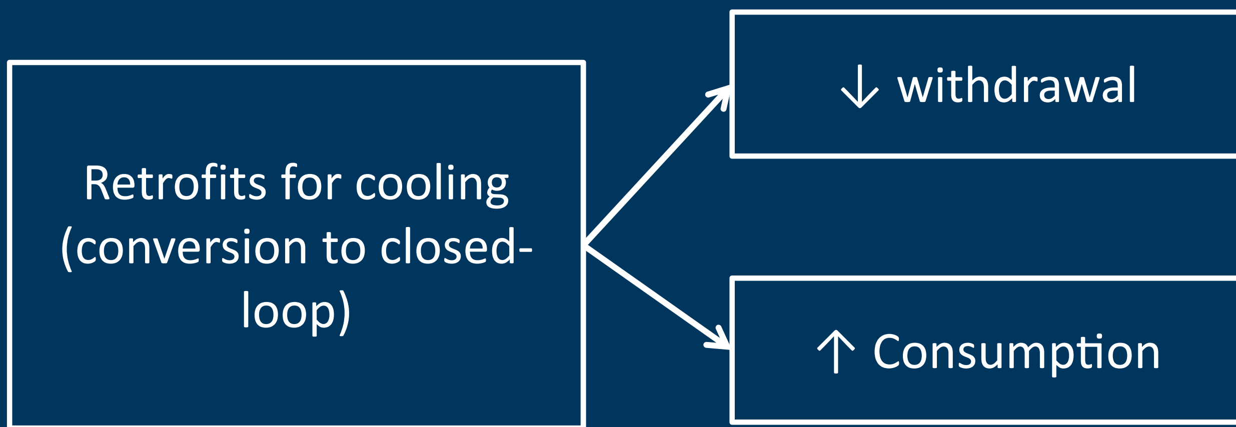
- Retrofitted Plants are:
  - Dickerson
  - Potomac-Mirant
  - R. Paul Smith



Dickerson Plant

- Retrofits result in decreased withdrawal of 98.7% and increased consumptive use from 3% to 87% .

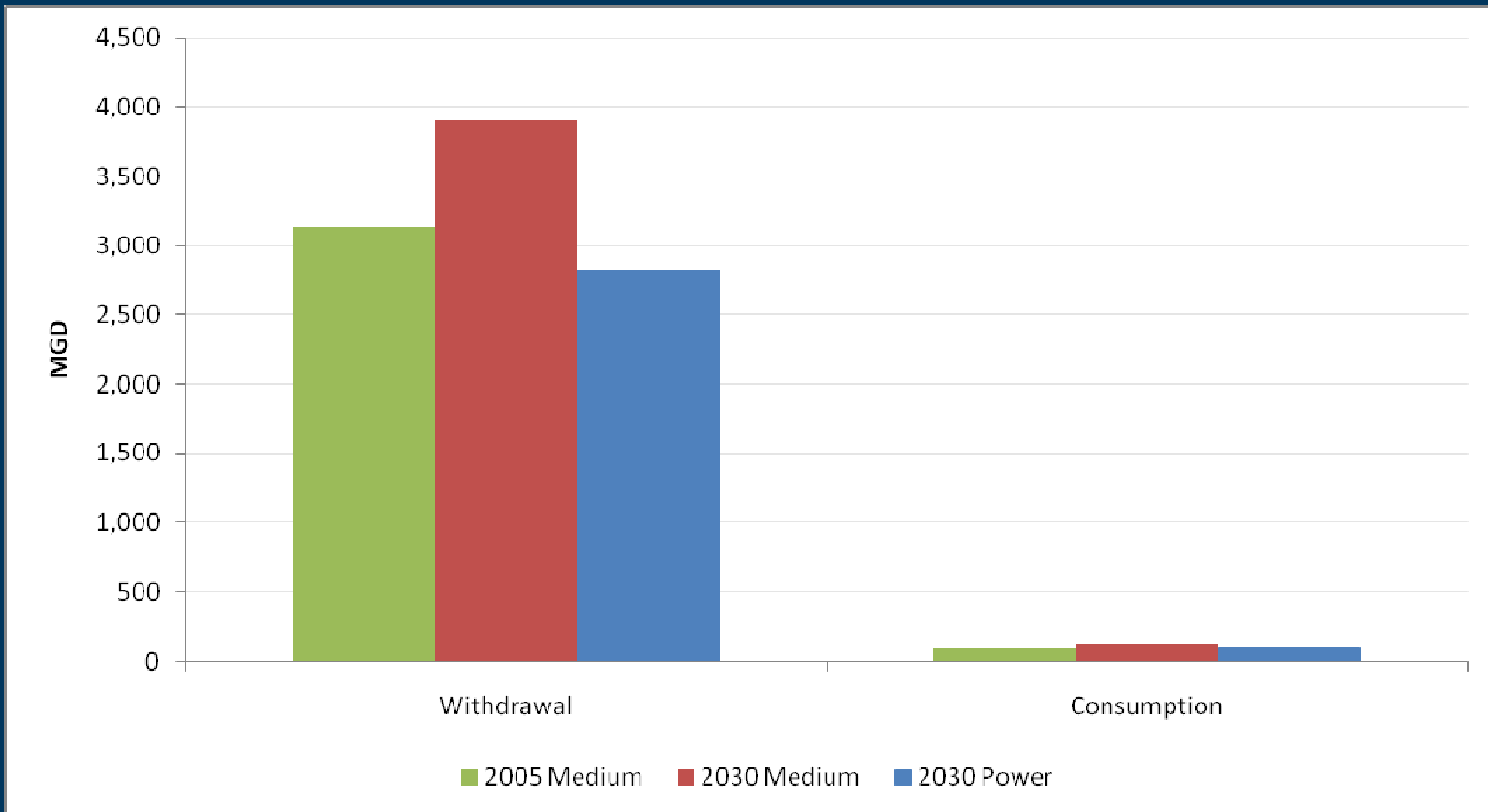
Power generation sector scenario design



Power generation scenario comparison with Medium scenario
Power sector - 2030

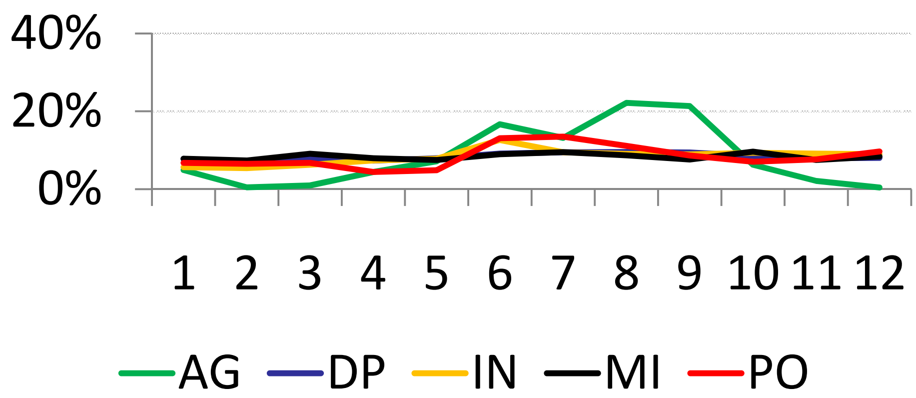
	Medium Scenario (MGD)	Power Generation Scenario (MGD)
Withdrawal	3,899	2,823
Consumption	117	96

How does changing to closed loop cooling systems impact water withdrawals and consumption?

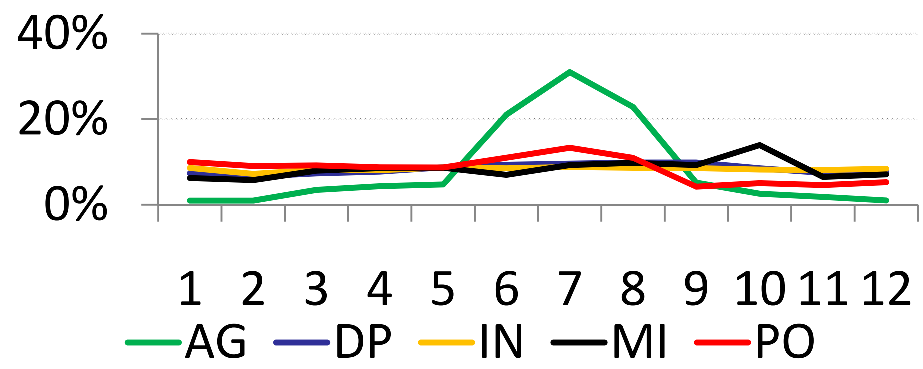


Monthly variation

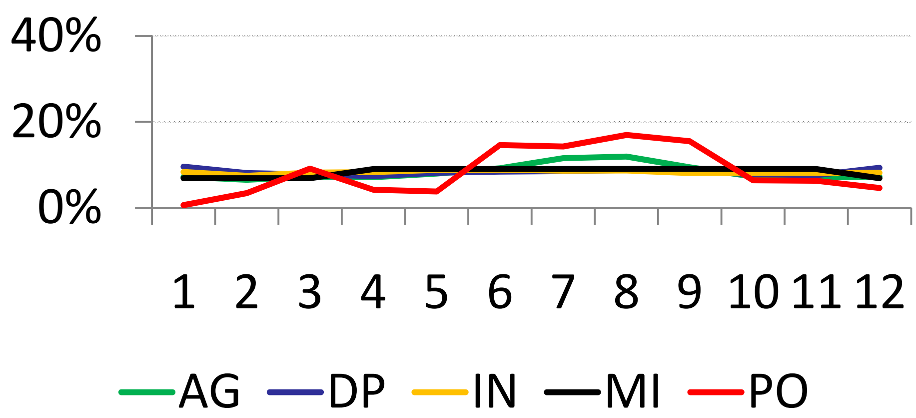
Maryland



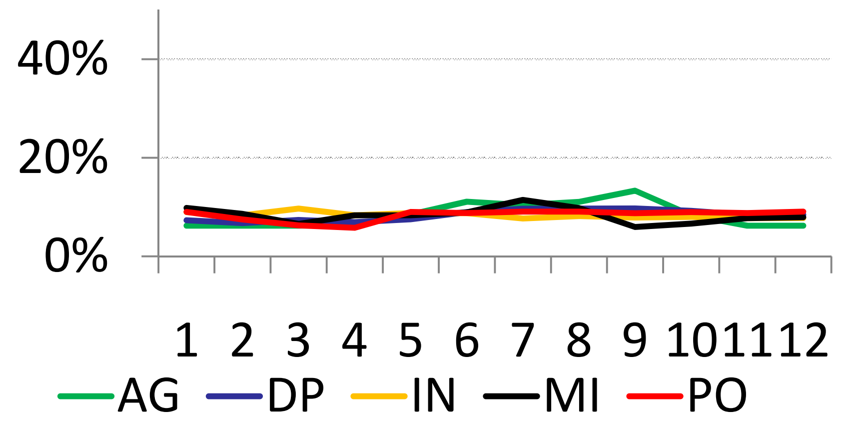
Virginia



Pennsylvania

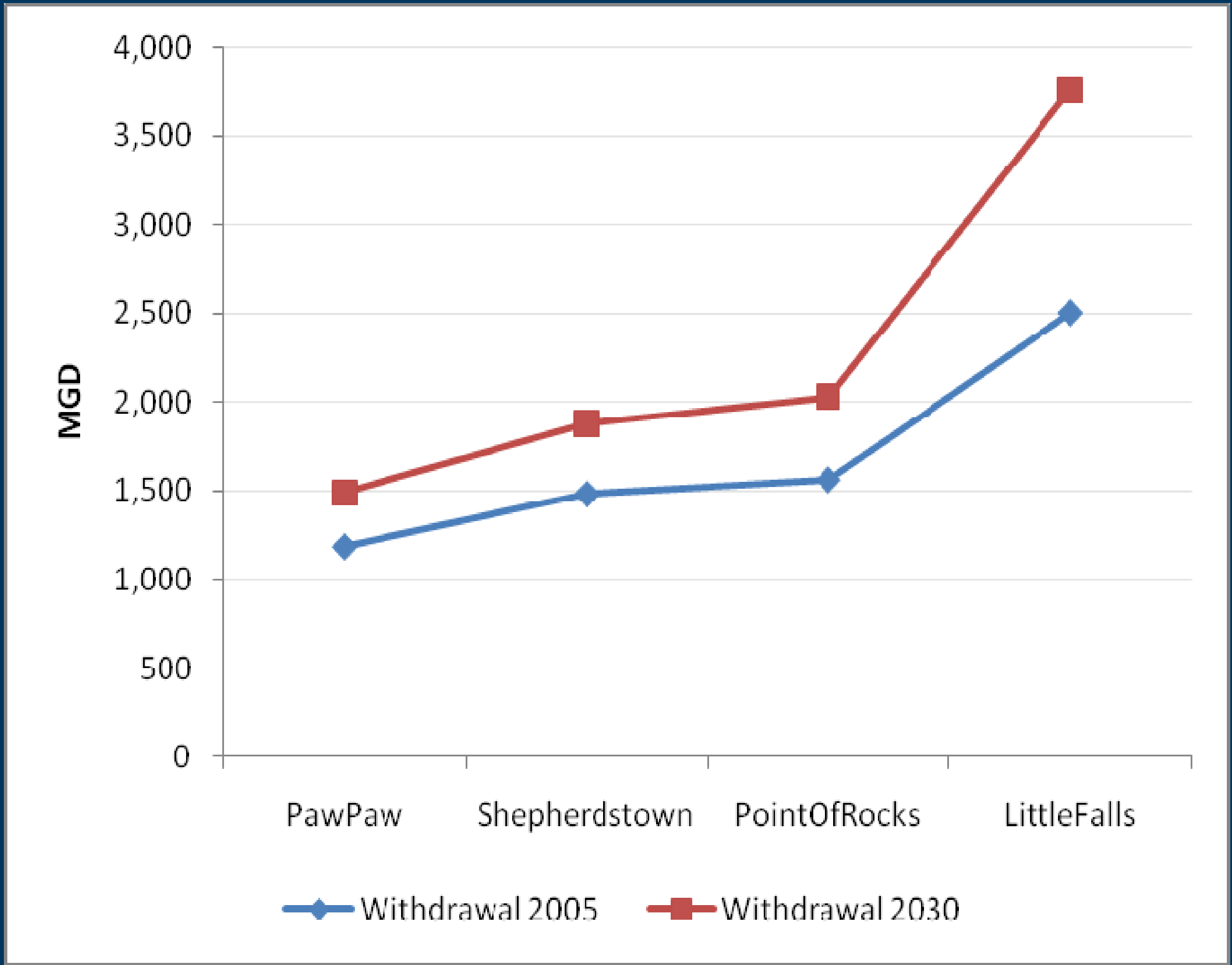


West Virginia

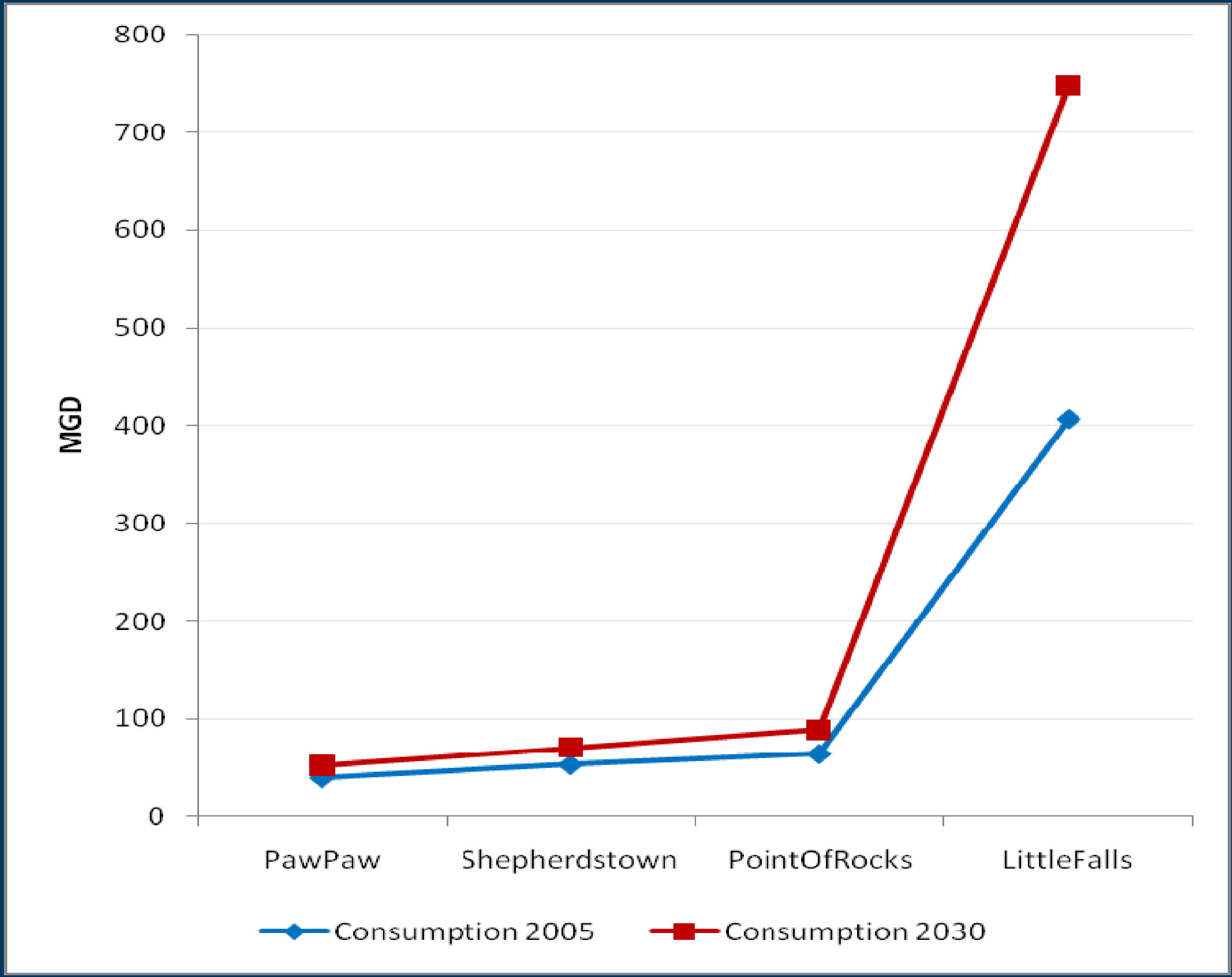


The y-axis is % of annual withdrawal. The x-axis is month.

Cumulative withdrawal to stream gages Medium Scenario



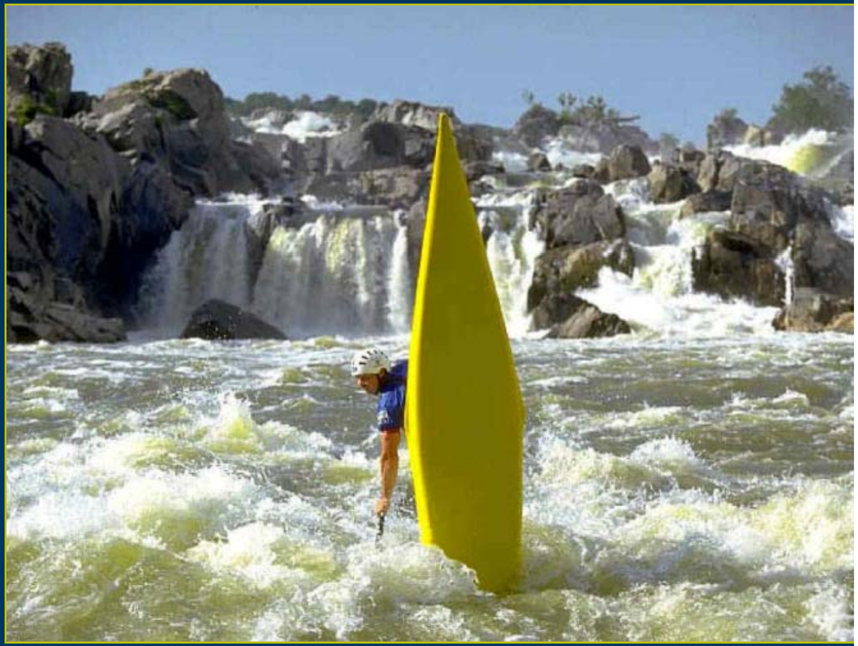
Cumulative consumption to stream gages Medium Scenario



Summary and results

1. Forecasts were primarily business-as-usual; avoid predicting human behavior or public policy

2. Rates of change
   - Power, industry, and mining- slight increase in rate of change, all less than 1.5%
   - Irrigation, livestock, and domestic and public supply-changes based on population and land use projections.
     - Domestic and public supply increased per capita use



3. Over time
   - Agriculture decreased because of land use change
   - Domestic and public supply increased mostly because of per capita use, some due to population increase
   - Industry, mining and power slight increases

4. Most water is withdrawn by the power sector, most consumed by domestic and public supply in all years and scenarios

5. Per capita use makes a difference, and one that public policy can impact

Summary and results (cont.)

6. Monthly variation-water use is fairly evenly balanced throughout the year.

7. Counties with the largest growth in withdrawal from 2010 to 2030 were near DC and south

8. Hot and Dry had ~ 17% increase.

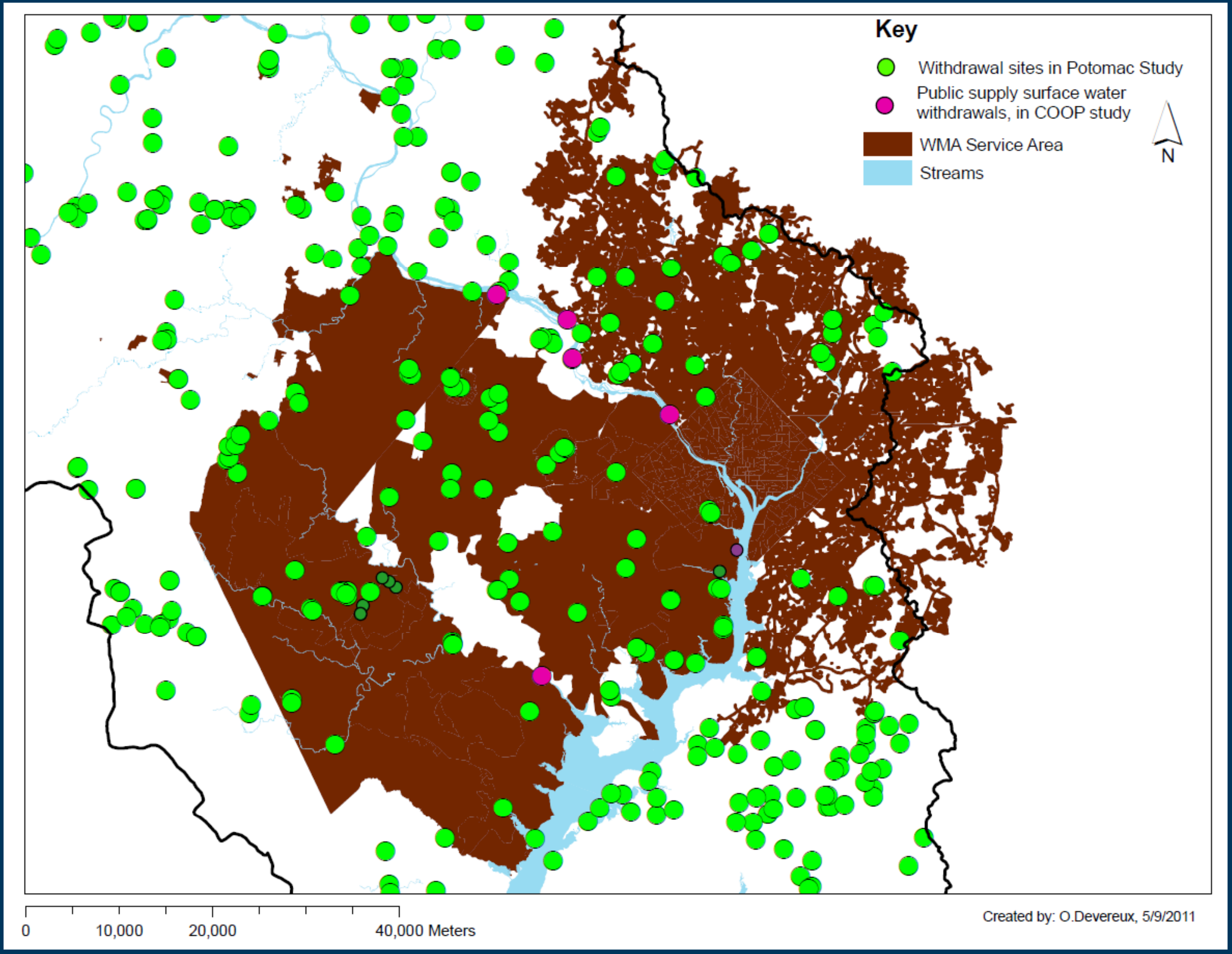
9. Power sector is the biggest growth in withdrawals
   1. Population growth increases power demand
   2. Power plant siting makes a big difference in withdrawal and consumption.

10. Climate change has little impact on water use, huge water quality impact due to greater intensity storms, increased erosivity, sediment delivery and associated phosphorus.

Comparison of results to CO-OP

Data	Year	CO-OP (MGD)	Potomac (MGD)
WSSC production data and Potomac Basin actual for WSSC	2005	123	126
Observed for WSSC Potomac + Little Falls + Great Falls + Fairfax Water-Potomac	2005	383	383
CO-OP Scenario 1 including Rockville -2010. Potomac Basin for the same sources, **Low** Scenario	2010 (Projected)	502.7	407.1
CO-OP Scenario 1 including Rockville -2030. Potomac Basin for the same sources, **Low** Scenario	2030 (Projected)	593.3	516.6

Comparison of withdrawal sites in CO-OP demand study and the Potomac Study



Comparison of Medium Scenario results to MDE Wolman report (2008)

Wolman, et al. report was for the entire state of Maryland, as opposed to just the Potomac portion. Therefore, the specific water demands are not directly comparable

Agriculture

- Wolman, et al. showed an increase that was more than double the current withdrawal.
- ICPRB projections for the Potomac show a decrease in agriculture, primarily due to land use change
- It is likely that the increase projected in the Wollman report is likely to occur on the Eastern Shore, which is outside the Potomac River Basin

Domestic and public supply

- Wolman, et al. showed a modest increase
- ICPRB Medium Scenario shows a substantial increase
- Difference may be due to multiple factors, one of which is our data considers Washington, DC demand as part of Maryland, since DC's water is withdrawn in Maryland. Other differences might be due to population projections or the projected amount of per capita water use.

Power sector

- Wolman, et al. showed a 14% increase in withdrawal
- ICPRB shows a 24% increase in the Medium Scenario and a 19% increase in the PO scenario without the new plant.

Overall, the reports were difficult to compare given the different geographical scale and sectors analyzed. The Wolman report provided a helpful framework for considering the issues affecting future demands.

Next steps: Calculate flow alteration

- Determine the future scenarios' impact on stream flows
  - For subwatersheds that drain to biological monitoring stations (more than 700)
- Final report for Middle Potomac Watershed Assessment will be available in 2012
  - Includes an update to the ICPRB 2000 Water Supply Demands and Resource Analysis Report
- Consumptive use upstream of the Washington Metropolitan Area will be used to update the PRRISM model

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- Once called upon, unmute your phone by selecting *7.
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