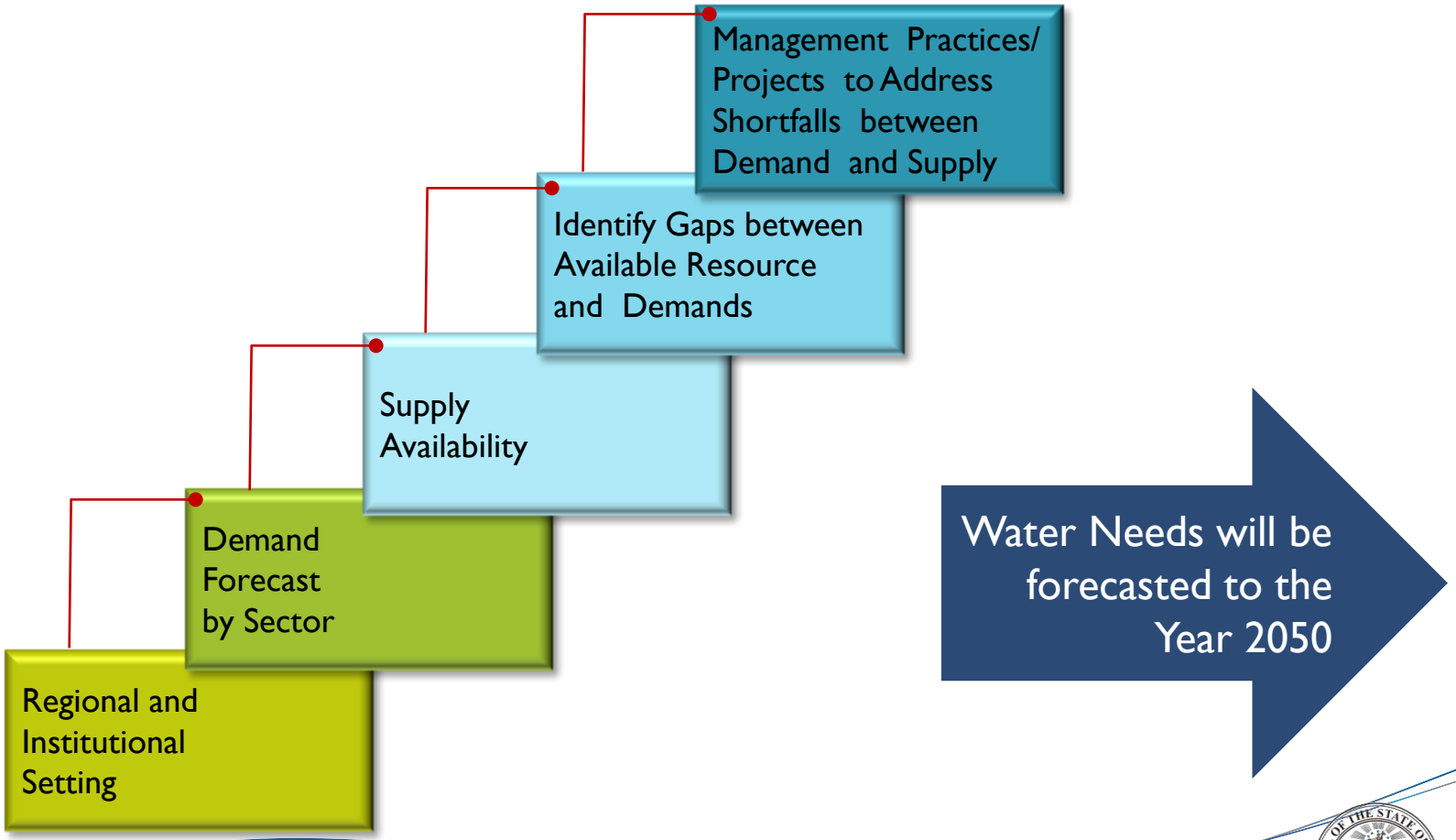
Comprehensive Update of the Arkansas Water Plan

DRAFT Water Demand Forecast

June 2013

The Major Technical and Planning Elements of the Water Plan Update



Summary of Work Group Activities

- Full Demand Work Group meeting December 17, 2012
- Work Group members from each of the demand sectors have completed conference call(s) and had email updates and revisions to the initial methodologies
- Aquaculture and Shale Gas were added as a subgroup
- Data availability did results in some “minor” changes to the original approach

Summary of Work Group Activities

- Work Group members have been very helpful in identifying information and enhancements to the demand methodology
- There have not be a significant number of comments
- Most challenges have been addressed
- We hope today's meeting will allow us to resolve remaining challenges and/or agree on how to proceed with resolution

General Themes from Comments

- In most cases the focus of the comments and additional research were either on the driver (rate and cause of growth) or the water use factor (water use per “unit”)
- In some cases different data sets have different values for the same or similar years
- Not all data sets have information for the years desired [i.e., to establish trend data and to incorporate yearly variations (climate/precipitation)]

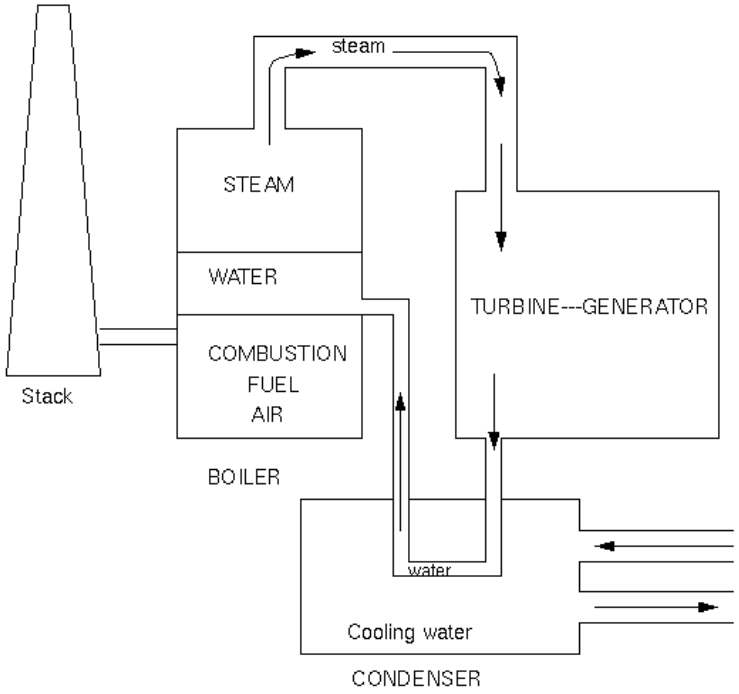
General Themes from Comments

- Thermoelectric
  - Work Group members were very helpful in refining plant capacity factors, water use by cooling type, and confirming
- Navigation
  - Overall the Work Group members agreed that no major drivers will change current law, policy and operations
  - Maintenance challenges and funding are factors that could present challenges
  - Expansion of navigation upstream on the Red River is being discussed but economics are a challenge

General Themes from Comments

- Industrial – the subgroup agreed with the general approach regarding the use of employment as the driver but wanted to see results before making final recommendations
- Municipal and Self-Supply – questions focused on local versus regional planning, wholesale water accounting, accounting for industrial deliveries, and the trend between public and self-supply supplied
- Agriculture
  - Crop Irrigation application rates (water use) and crop acreage data was discussed in great detail
  - Livestock focused on base year animal inventories, trends in growth, and seasonality of use

Thermoelectric Energy Forecast



All Data and Results are Preliminary and Subject to Change

Thermoelectric Water Demand Forecast: Initial Approach

- Projected statewide power needs by fuel type will be multiplied by water withdrawal and consumption factors to derive future thermoelectric power water demands
- Presented projected statewide power generation to the Work Group for review
- Plant type (i.e., fuel type, prime mover, and cooling type) determine how much water is required to generate a unit of power
- Presented literature-derived withdrawal and consumption factors to the Work Group for review

Thermoelectric Water Demand Forecast: Feedback

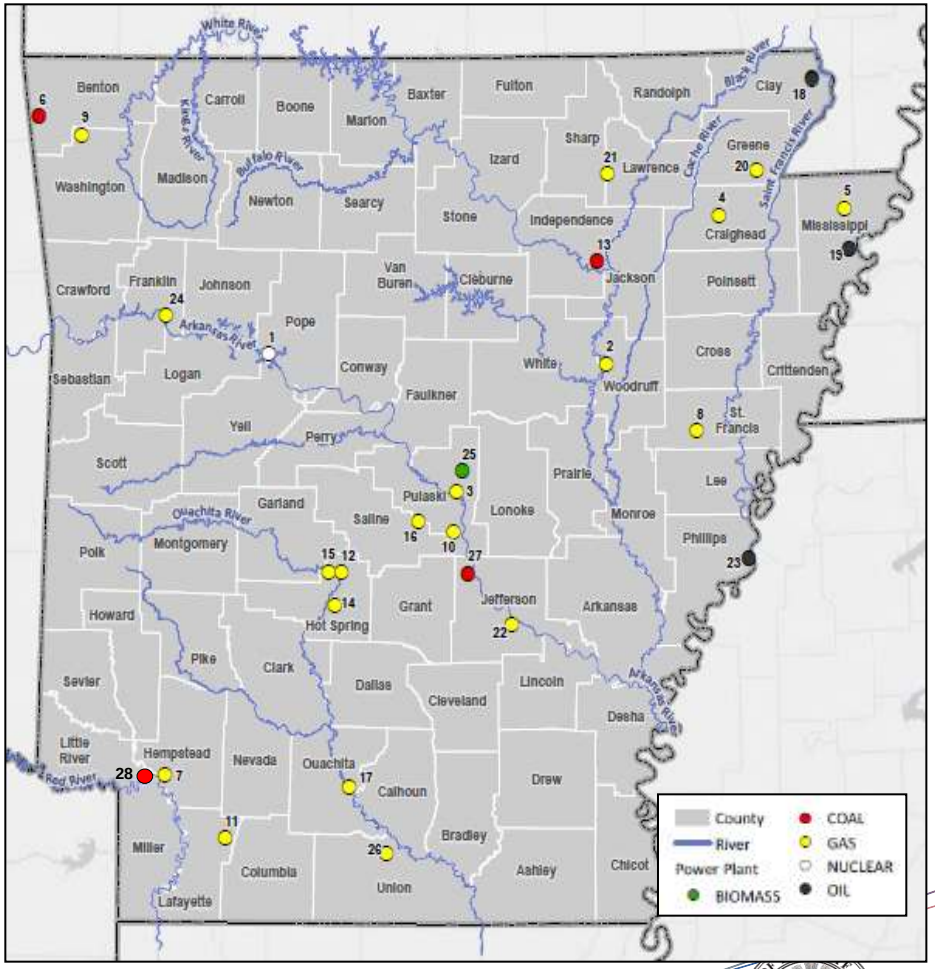
- Work Group provided guidance with respect to the operating and water use characteristics of power plants in Arkansas
- Work Group reviewed and supported the use of EIA projection scenarios
- Work Group provided guidance with respect to plant maximum sustainable capacity factors for modeling future power generation in the state
- No new thermoelectric power plants planned in the short-term future
- Biomass is the most likely renewable source in the future

Thermoelectric Water Demand Forecast: Revised Approach

- Initial approach generally unchanged
- Plant-specific water withdrawal and water consumption factors input into the model
- Model allows for power generation to be met by existing facilities until maximum sustainable capacity factors are met
- Once a facility is at maximum capacity, it cannot generate additional power and residual power generation needs are allocated to facilities with remaining capacity in the same power pool and fuel source type

Thermoelectric Power Plants in Arkansas

Map Number	Plant Name	Map Number	Plant Name
1	Arkansas Nuclear One	15	Lake Catherine
2	Carl Bailey	16	Mabelvale
3	Cecil Lynch	17	McClellan
4	City Water & Light	18	Municipal Light
5	Dell Power Station	19	Osceola
6	Flint Creek	20	Paragould Reciprocating
7	Fulton	21	Paragould Turbine
8	Hamilton Moses	22	Pine Bluff Energy Center
9	Harry D. Mattison	23	Robert E Ritchie
10	Harry L. Oswald	24	Thomas Fitzhugh
11	Harvey Couch	25	Two Pines Gas Recovery
12	Magnet Cove	26	Union Power Partners LP
13	Independence	27	White Bluff
14	Hot Spring	28	John W. Turk



Overview of Plant Type Water Use Assumptions

Plant Type	Withdrawal Gal./MWh	Consumption Gal./MWh
Nuclear/Steam Turbine/Once-Through	40,000	580
Nuclear/Steam Turbine/Cooling Tower	750	750
Natural Gas/Steam/Once-Through	35,000-40,000	350-400
Natural Gas/Steam/Cooling Tower	700 - 800	700 - 800
Natural Gas/Combustion Turbine	50	50
Coal/Steam Turbine/Once-Through	35,000	350
Coal/Steam Turbine/Cooling Tower	550-600	550-600

Combined-cycle components

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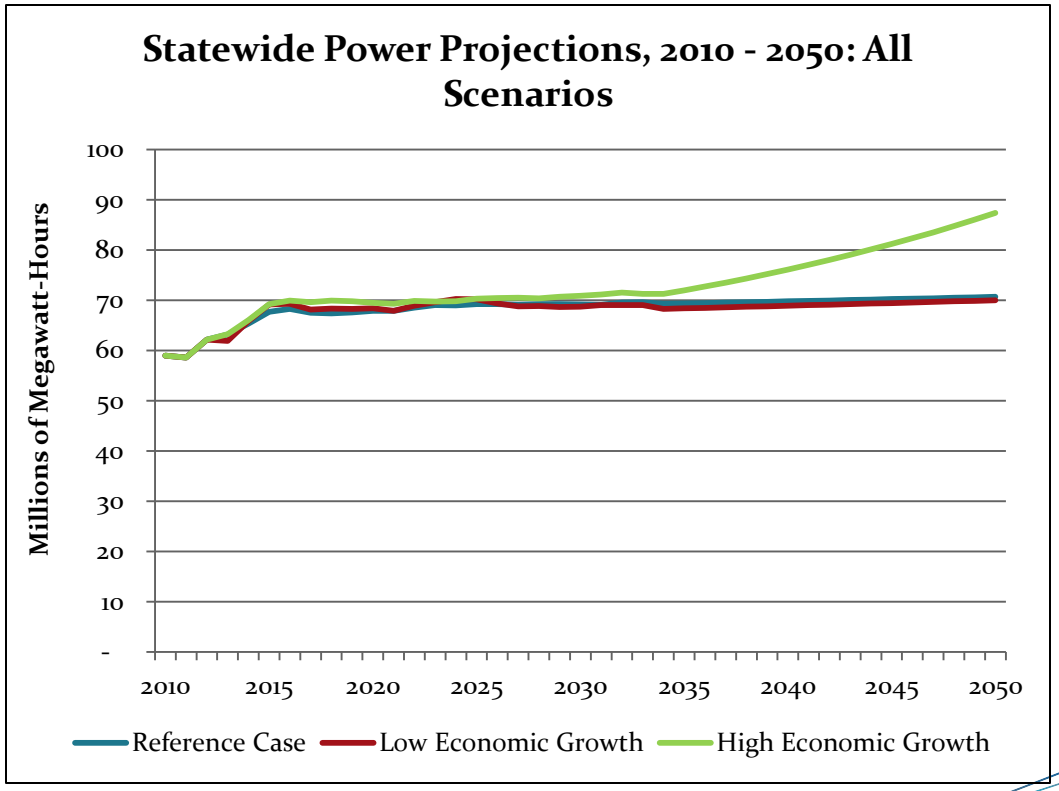
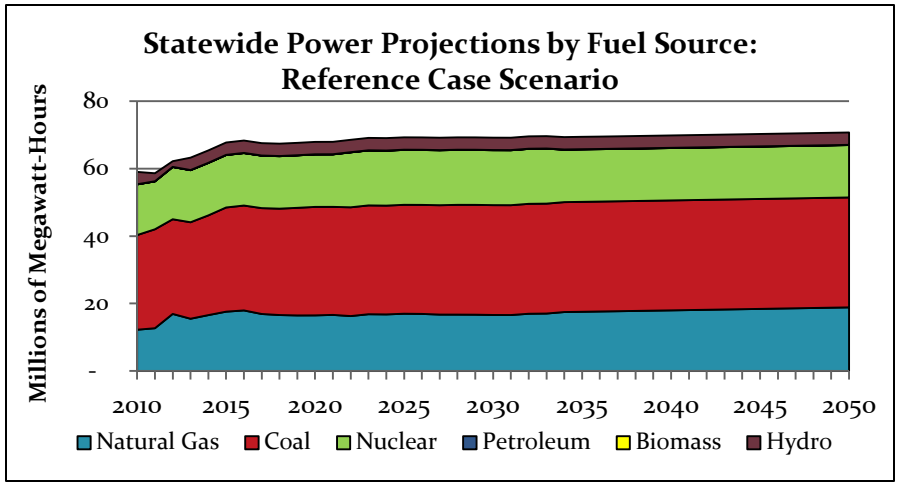
Thermoelectric Water Demand Forecast: Statewide Power Generation Projections

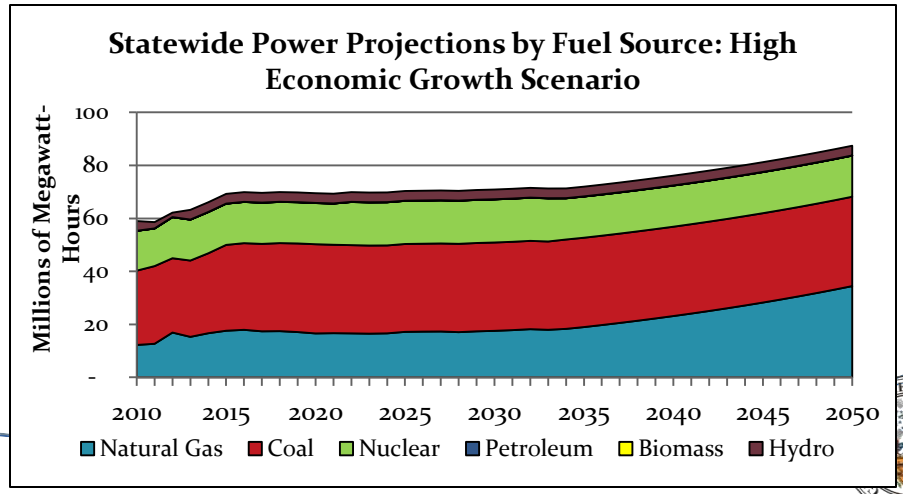
- EIA projections used to derive state-level power generation projections to 2035 extended to 2050
- Current thermoelectric power generation capacity is sufficient to meet projected thermoelectric power generation needs through 2050
- Increase need for natural gas power generation (as opposed to other fuel sources) later in the projection period drives statewide power generation higher under the High Economic Growth scenario



Thermoelectric Water Demand Forecast: Statewide Power Generation Projections

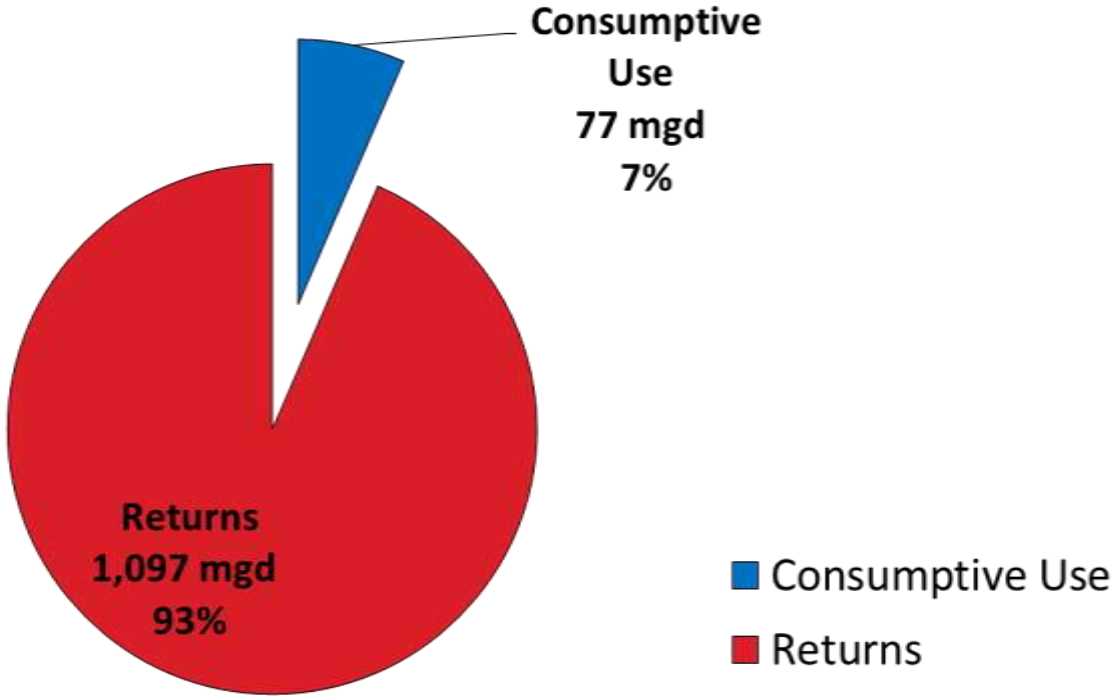
- Currently, coal generates the greatest portion of the state's power
- Reference Case Scenario: proportional power generation by fuel type is generally the same from base year to 2050.
- High Economic Growth Scenario: natural gas becomes a larger portion of the overall statewide power generation, while coal declines proportionally.





Thermoelectric Water Demand Forecast: Withdrawals vs. Consumption

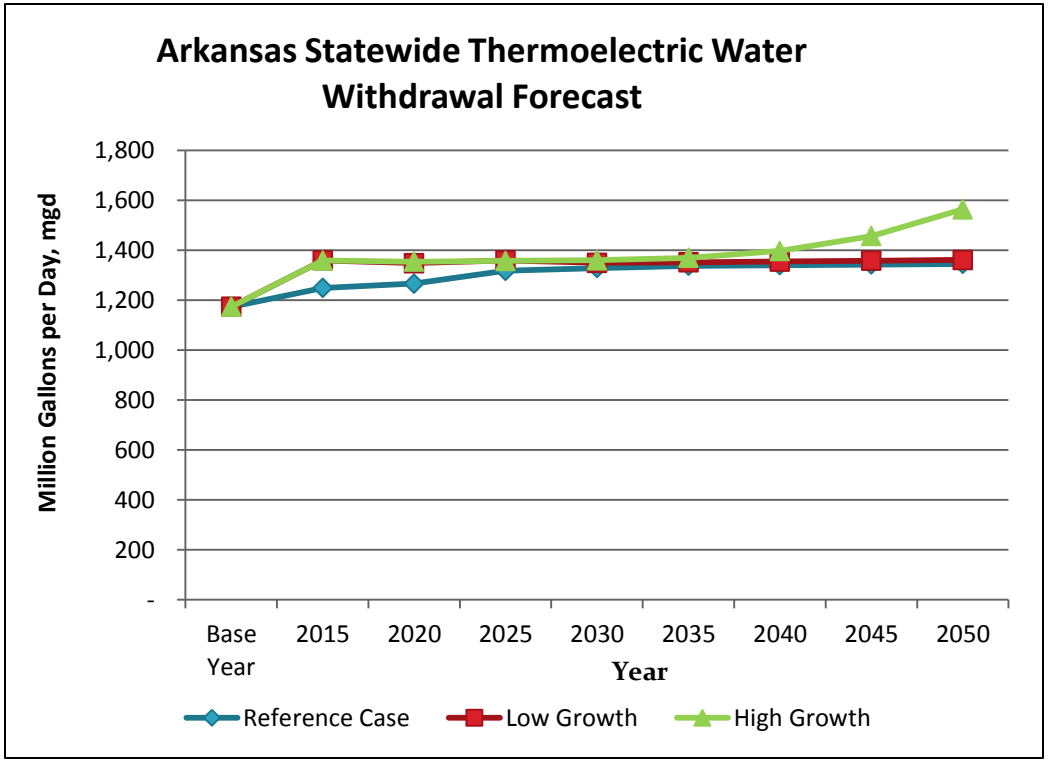
93% of water withdrawn for thermoelectric power production in the state is returned to surface water.



Total Base Year Withdrawals = 1,173 mgd

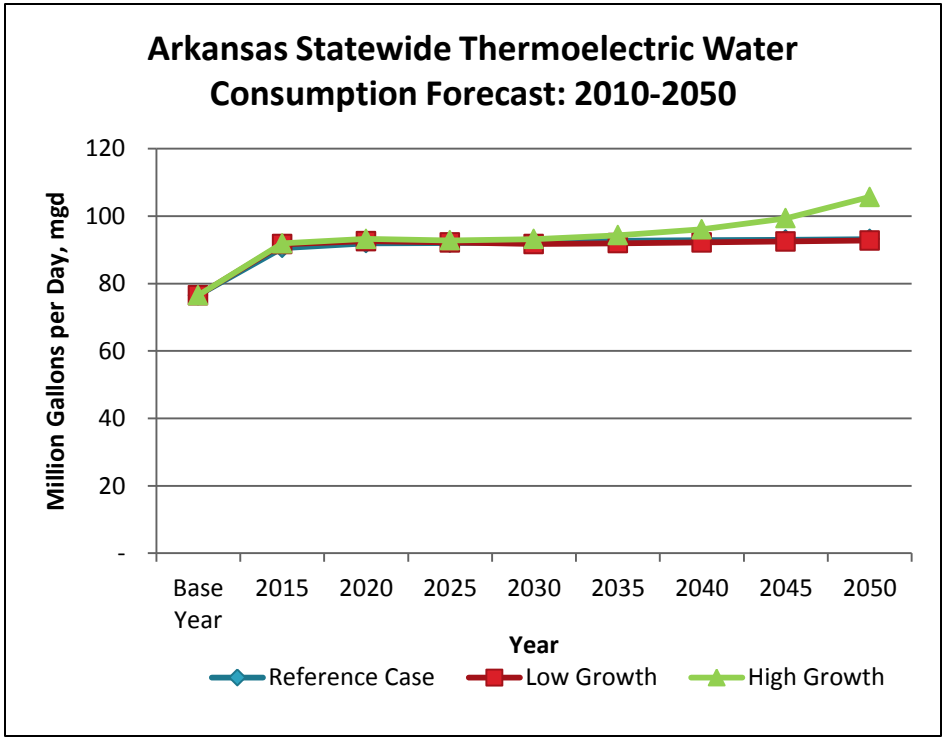
Thermoelectric Water Demand Forecast Results: Water Withdrawal

- Thermoelectric water withdrawals increase from base year under all scenarios
- Base year (2010) to 2050 growth ranges from 15% - 33%
- Reference Case Scenario and low economic growth scenario result in very similar forecasts



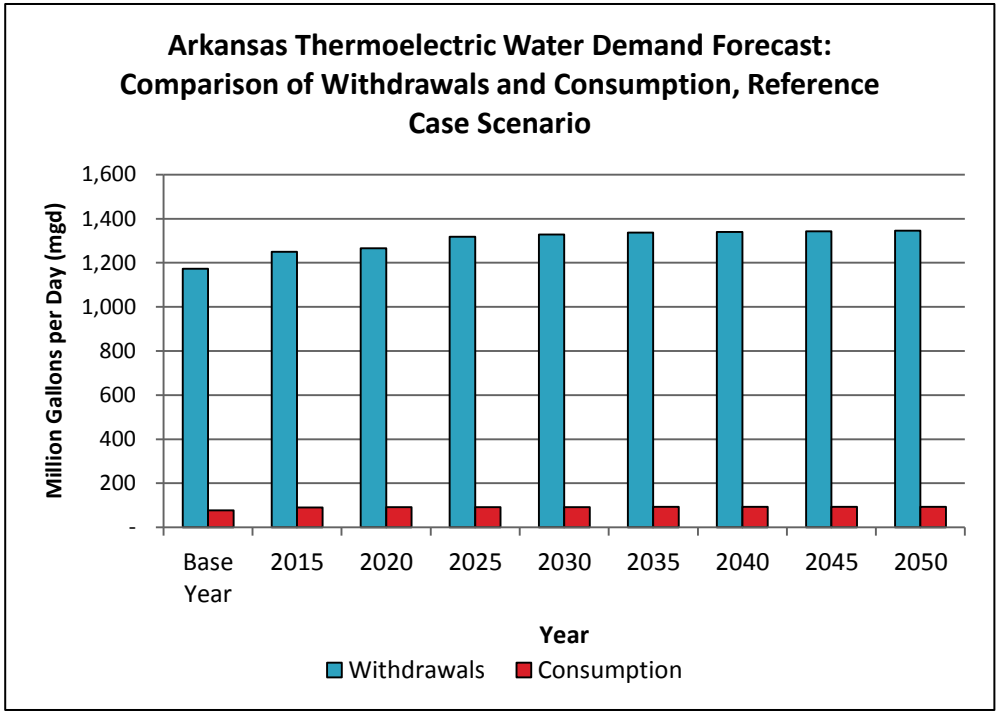
Thermoelectric Water Demand Forecast Results: Water Consumption

- Thermoelectric water consumption increases under all scenarios
- Base year to 2050 growth ranges from 21% - 38%
- Reference Case Scenario and low economic growth scenario result in very similar forecasts



Thermoelectric Water Demand Forecast Results: Comparison of Withdrawals & Consumption

- About 99.7% of withdrawals for thermoelectric power generation are from surface water sources
- 0.3% are small water using typically natural gas with combustion turbine



Navigation Forecast

All Data and Results are Preliminary and Subject to Change

Points of Contact
U. S. ARMY CORPS OF ENGINEERS
Regulatory Activities – Little Rock District & Adjacent Districts

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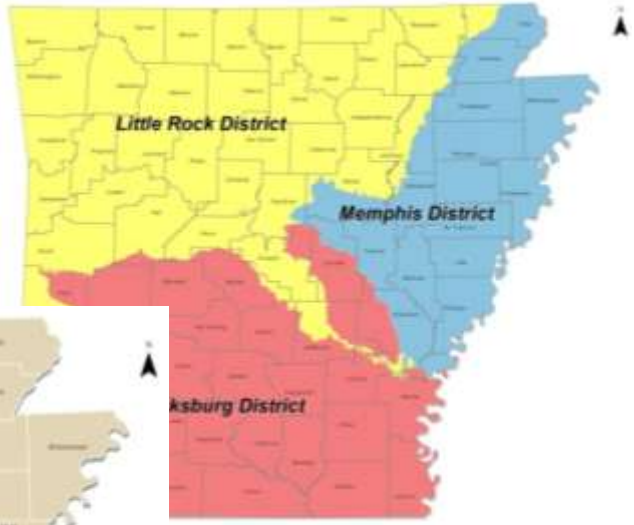
Identified Navigation Systems

- Arkansas River
- Ouachita River
- Red River (feasibility study ongoing)
- White River

USACE Districts in Arkansas



Navigation Water Demand Forecast: Initial Approach

- Presented existing federal and state authorized navigation projects
- It was assumed that the existing flow and depth requirements will remain unchanged over the planning horizon and the minimum flows to for rivers and streams and depths of lakes and rivers will remain more or less as they are today.

Assumptions:

- No significant change in navigation water needs from current through 2050
- Existing locks and dams will be adequate for future navigation
- Existing commercial navigation will continue to be supported with adequate funding: Arkansas River, White River, Ouachita River

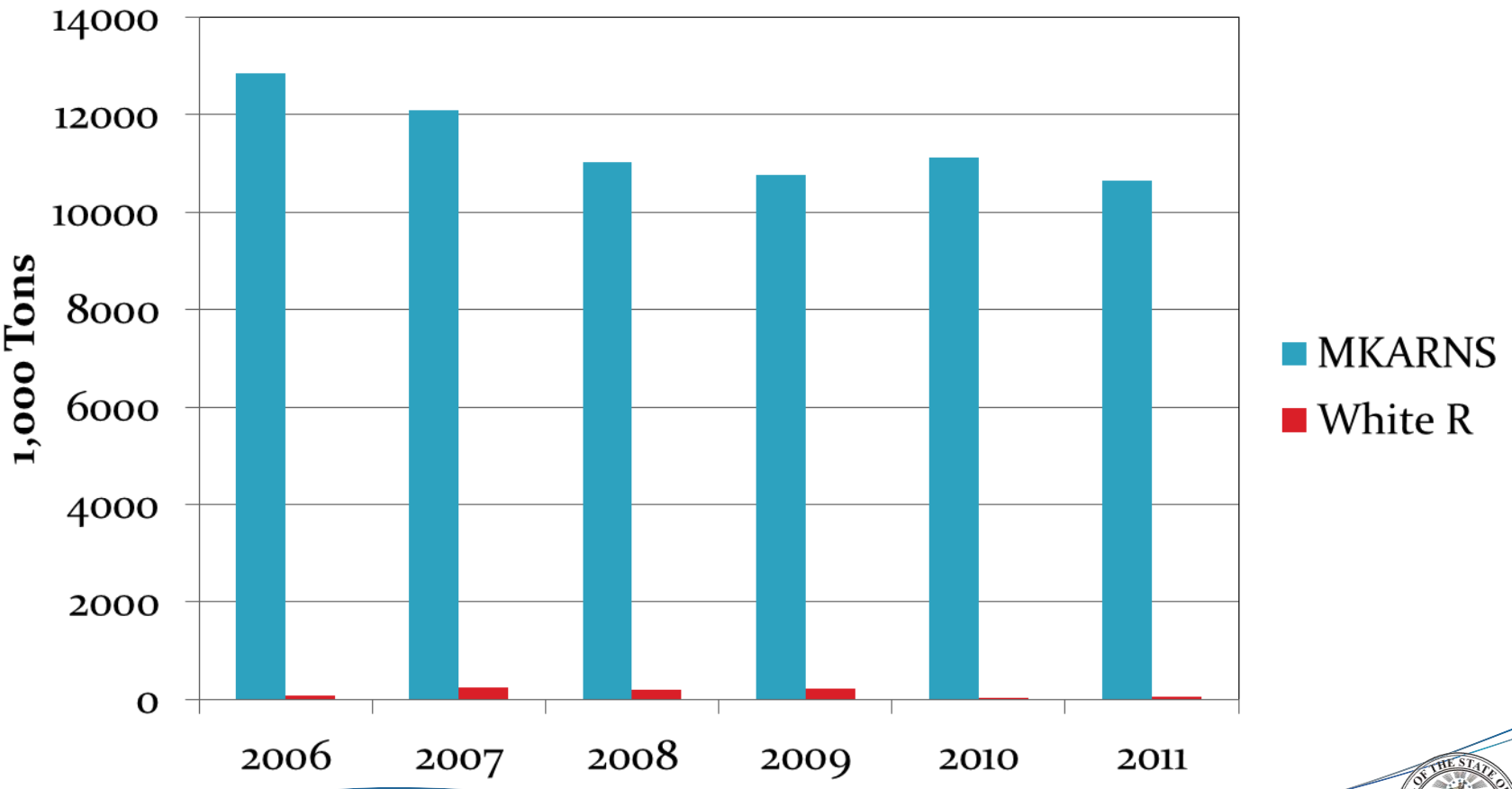
McClellan-Kerr Arkansas River Navigation System

- Authorized by 1946 Rivers and Harbors Act
- Authorized for navigation, flood control, hydropower, recreation
- Elements
  - Approximately 290 miles Arkansas River
  - Approximately 10 miles White River
  - Approximately 10 miles White River Post Canal
  - 13 lock & dam structures + 1 dam
  - 9 ft channel

McClellan-Kerr Arkansas River Navigation System - Continued

- Minimum Flow
  - Van Buren = 3,500 cfs
  - Little Rock = 3,000 cfs
  - Year-round
  - Oologah Lake, OK storage allocated for navigation support (Tulsa District USACE)
- Commodity Transport
  - 11 million tons in 2010
  - Included fuel, construction materials, chemicals, metal ores, minerals, and agricultural products
- Operated and managed by Little Rock District USACE

Commodity Transportation Tonnage over Time



Ouachita-Black Rivers Navigation Project

- Authorized
  - Act to Improve Rivers and Harbors for fiscal year ending June 1871
  - 1902 Rivers and Harbors Act
  - Navigation and recreation purposes
- Elements
  - Approximately 117 miles of Ouachita River in Arkansas
  - 2 lock and dam structures
  - 9 ft channel
- No minimum flow designated
- Navigation feasible year-round

Ouachita-Black Rivers Navigation Project - Continued

- Commodity transport
  - 1.1 million tons in Louisiana and Arkansas
  - Included crude oil, fuel, fertilizer, corn
- Operated and managed by Vicksburg District USACE

Red River Navigation

- Authorized by 1892 Rivers and Harbors Act
- J Bennett Johnston Waterway in Louisiana authorized by Rivers and Harbors Act of 1968
- Authorized uses include navigation and recreation
- No commercial navigation channel on Red River in Arkansas
- Feasibility study of extending commercial navigation into Arkansas
  - Authorized by Water Resources Development Act of 1996
  - Completed – cost-benefit ratios did not meet USACE criteria
  - Cost-benefit ratios being updated to determine if criteria can be met

White River Navigation Project

- Authorized by 1892 River and Harbors Act
- Authorized for navigation and flood control
- Elements
  - Approximately 190 miles 125 ft wide, 8 ft deep (when 12 ft stage at Clarendon) navigation channel
  - Approximately 57 Miles 100 ft wide, 4.5 ft deep (when 3.5 ft stage at Newport) navigation channel
  - No structures, navigation dependent on river stage

White River Navigation Project - Continued

- Minimum flow
  - WSEL 121 ft at river mile 15
  - Stage 18 ft at Clarendon
  - Stage 14 ft at DeValls Bluff
  - Stage 11 ft at Georgetown
  - Stage 23 ft at Augusta
  - Stage 11 ft at Newport
- Navigation feasible to Augusta year-round
- Navigation feasible to Newport 57% of year on average

White River Navigation Project - Continued

- Commodity transport
  - 40,000 tons in 2010
  - Includes sand and gravel, and agricultural products
- Operated and managed by Memphis District USACE
- Future maintenance is a important activity to maintain navigation

Future Navigation Potential or Initiatives

- Additional studies are still being reviewed by the planning team to determine relevance to the Water Plan update i.e., Red River Feasibility Study, Arkansas 12 foot “proposed” channel, South West Arkansas Navigation Study potential implementation

Industrial Forecast – Including Mining and Shale Gas Water Needs

All Data and Results are Preliminary and Subject to Change

Industrial Water Demand Forecast: Initial Approach

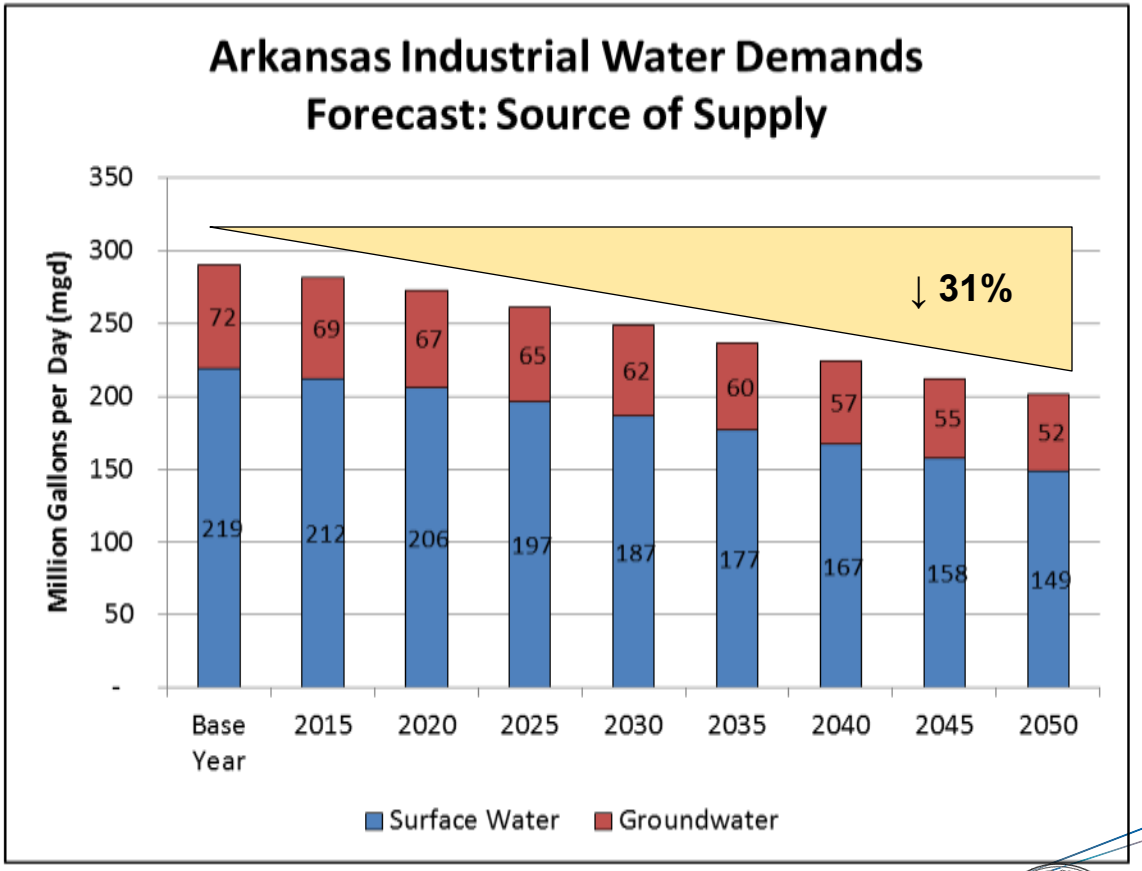
- Proposed using average deliveries by industry type by county from 2008-2010 WUDBS to derive baseline
- Proposed use of Arkansas Department of Workforce Services Workforce Investment Area projected employment by industry type to derive water demands from 2010 to 2020
- Proposed Woods & Poole county-level manufacturing (NAICS 31-33) employment to drive both self-supplied and municipally supplied growth from 2020 to 2050

Industrial Water Demand Forecast: Revised Approach

- After 2020, when industry-specific employment projections are no longer available, the county "general manufacturing" (NAICS 31-33) employment rate of growth is used to drive industrial water demands for all industry types (i.e., NAICS)
- Woods & Poole county manufacturing employment projections are the driver
- Woods & Poole utilize an "export-base" approach to projecting employment

Industrial Water Demand Forecast: Results

- Demands include both municipally-supplied and self-supplied demands.
- Industrial water demands decrease by 31% from Base Year to 2050
- Decrease attributed to projected decline in the demand driver (employment)
- Demand forecasted to decline in nearly all counties



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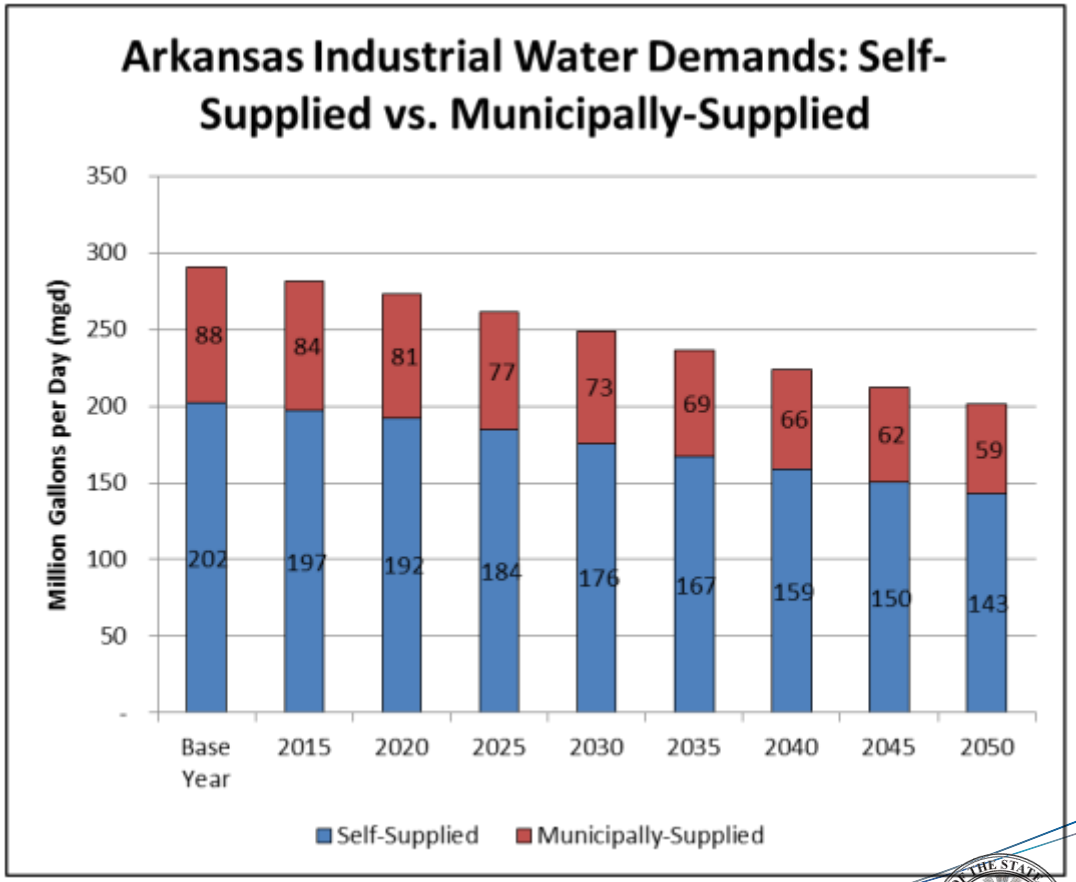
Industrial Water Demand Forecast: Self-Supplied vs. Municipally-Supplied

- Municipally-supplied industrial water demands are about 20% of total statewide industrial water demands



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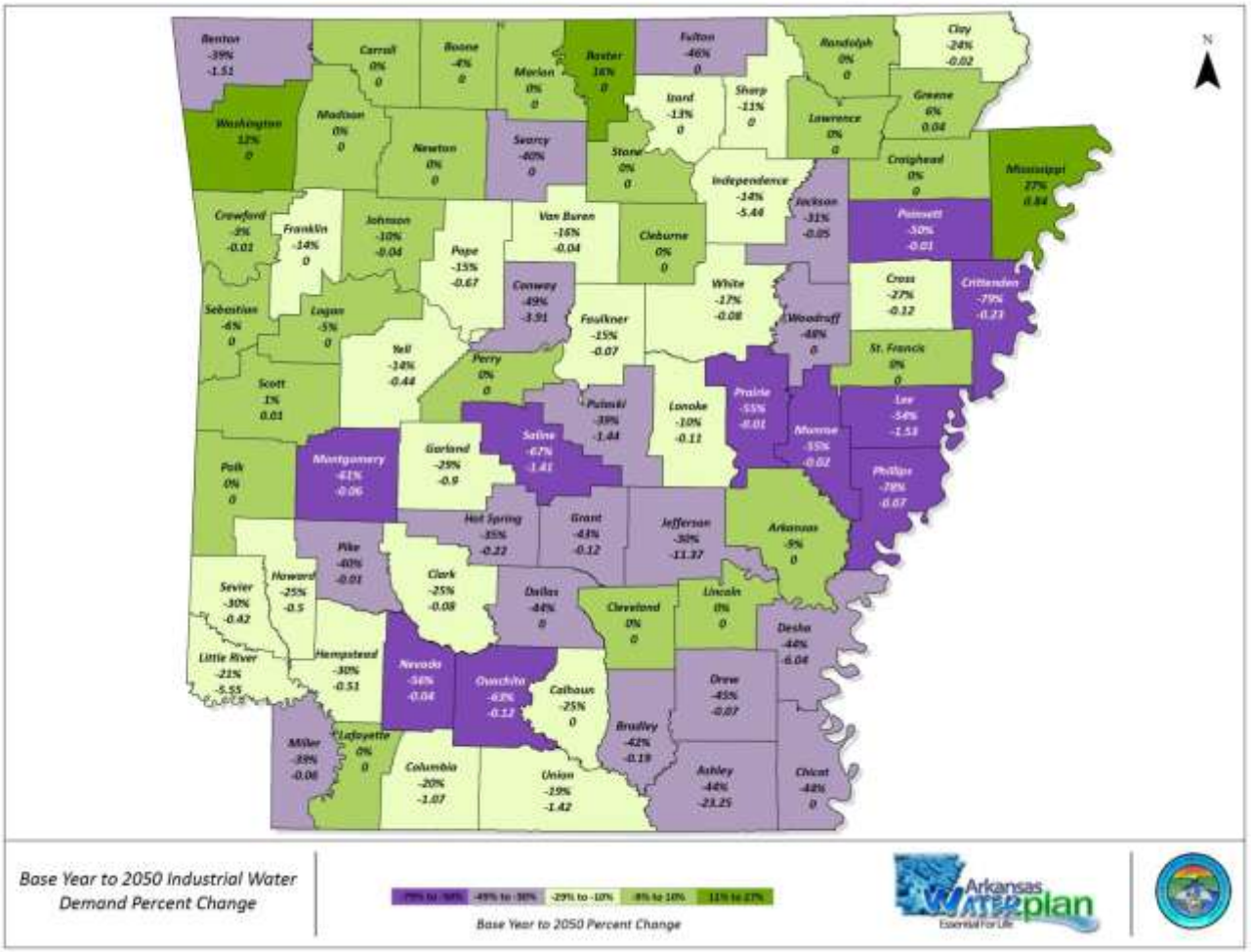
Industrial Water Demand Forecast: Results



Industrial Water Demand Forecast Summary by Industry Type

NAICS DESCRIPTION	Base Year 2008-2010	2020	2030	2040	2050	Base Year to 2050 % Change
31 - General Mfg. municipally supplied	35.10	33.74	31.48	29.13	27.02	-23%
311 - Food Mfg.	0.38	0.39	0.35	0.32	0.29	-24%
312 - Beverage & Tobacco Mfg.	1.70	1.57	1.42	1.28	1.14	-33%
321 - Woods Products Mfg.	1.35	1.36	1.19	1.03	0.89	-34%
322 - Paper Mfg.	111.07	98.13	87.32	76.50	66.85	-40%
324 - Petroleum & Coal Products Mfg.	2.62	2.92	2.70	2.46	2.22	-15%
325 - Chemical Mfg.	47.90	48.60	46.47	43.73	41.01	-14%
326 - Plastics and Rubber Products Mfg.	1.33	1.59	1.60	1.59	1.57	18%
327 - Nonmetallic Mineral Product Mfg.	26.80	30.34	27.30	24.19	21.35	-20%
331 - Primary Metal Mfg.	3.63	3.69	3.57	3.40	3.23	-11%
332 - Fabricated Metal Product Mfg.	0.93	1.01	0.96	0.90	0.84	-10%
335 - Electrical Equip., Appliance, & Component Mfg.	3.74	1.86	1.99	2.10	2.21	-41%
336 - Transportation & Equipment Mfg.	0.00	0.00	0.00	0.00	0.00	0%
486 - Pipeline Transportation	0.08	0.08	0.07	0.06	0.06	-25%
562 - Waste Mgmt. & Remediation Svcs.	0.14	0.13	0.12	0.11	0.10	-29%
Unknown	2.73	2.61	2.55	2.44	2.33	-15%
Grand Total	**239.49**	**228.04**	**209.10**	**189.23**	**171.12**	**-29%**

Largest water-using industries in the state are:

- Paper Mfg. – 46% in Base Year (expressed as percent of total)
- Chemical Mfg. – 20% in Base Year (expressed as percent of total)
- Industrial deliveries from municipal water systems represent 15% of demands in Base Year (expressed as percent of total)

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Mining Water Demand Forecast: Initial Approach

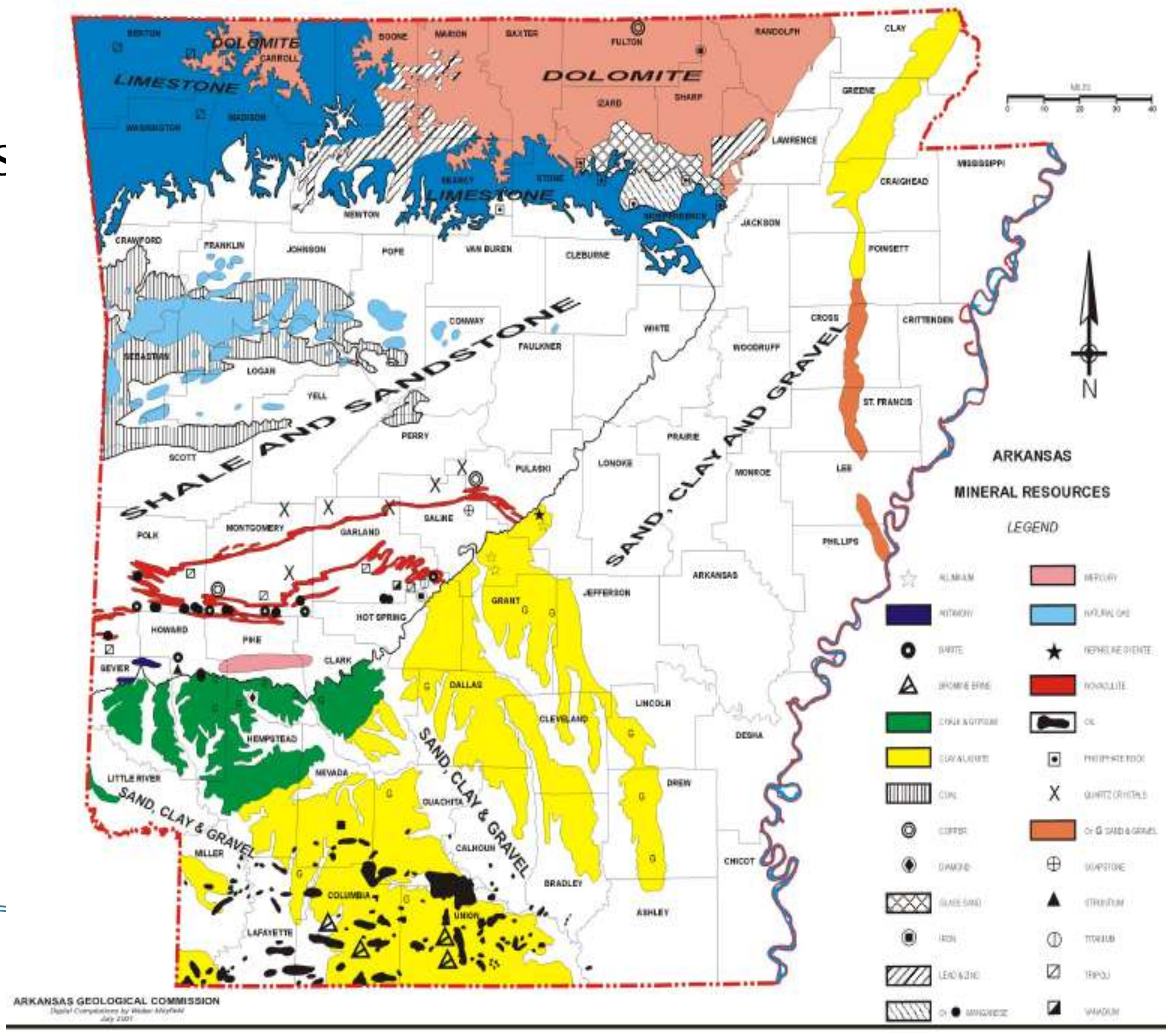
- Proposed using WUDBS average self-supplied withdrawals and municipally-supplied deliveries from 2008-2010 to derive base year demand
- Proposed use of Arkansas Department of Workforce Services Workforce Investment Area projected employment to derive water demands from 2010 to 2020
- Proposed Woods & Poole county-level mining (NAICS 21) employment to drive both self-supplied and municipally-supplied growth from 2020 to 2050

Mining Water Demand Forecast: Feedback

- Appropriate to use mining employment projections as driver of mining water demands
- Shale gas water demands should be accounted for separately using a unique methodology
- Investigate emerging or potential mineral resources in the state and their impact on water demands

Mining Water Demand Forecast: Mineral Resources of Arkansas

- Non-energy related mining water demands are registered in 23 counties throughout Arkansas
- Mineral resources can be found all over the state



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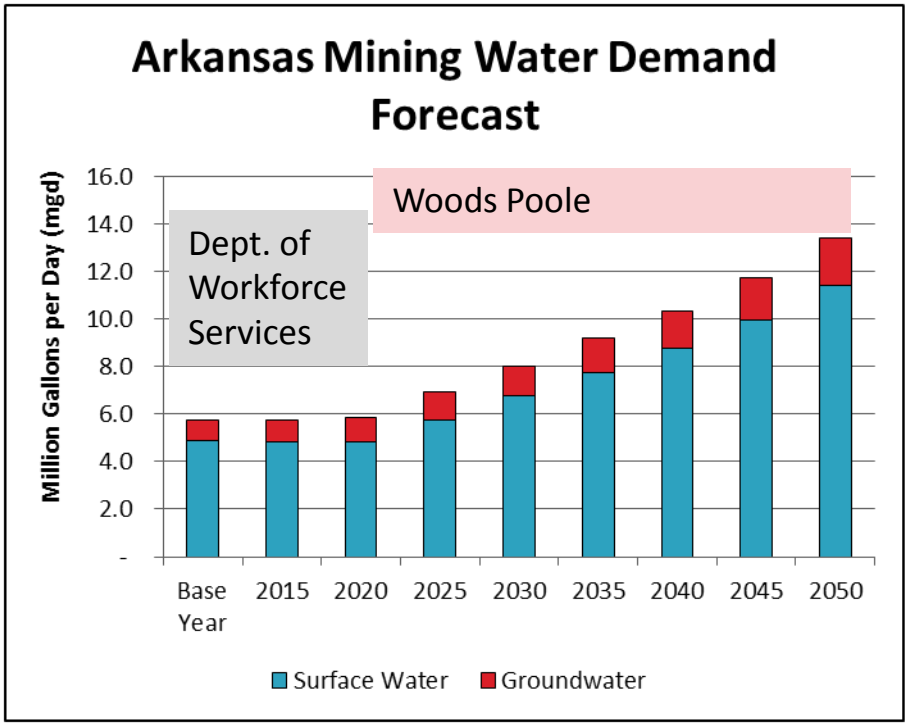
Mining Water Demand Forecast: Revised Approach

- County-level mining employment projections drive base year demands through 2050
- Shale gas water demand forecast subgroup of industry representatives formed to guide and review shale gas water demands
- Potential mineral/energy resources (e.g., lignite and brown dense) have been identified
  - For lignite, determined that greatest demand for water would be for pipeline slurry transportation of minerals. Site preparation and extraction water demands are small relative to transportation & processing.
  - Uncertainties with respect to timing and intensity of development, among other factors for both resources, preclude accounting for their future water demands
  - Recommend that these resources continued to be tracked in future Water Plan iterations

Mining Water Demand Forecast: Results

- Forecast includes self-supplied mining demands and municipal water deliveries to mining customers
- Mining water demands forecasted to increase by 132% from the base year to 2050
- Increase in demands is driven by projected increase in mining employment in those counties with base year mining water demands
- Silica sand, construction sand & gravel, and crushed stone mining are the primary water-using mineral resources in the state



Mining Water Demand Forecast: Results Example for Izard County

- One mining corporation in Izard County (listed as Clay, Ceramic, and Refractory Minerals in the WUBDS though online research suggests a shift to frac sand) drives much of the state's mining water demand (base year demand of 3.02 mgd are over 50% of the statewide non-energy mining water demand)
- Will be working with subgroup on final approach

Shale Gas Water Demand Forecast: Initial Approach

- WUDBS used to inventory current water use
- EIA projections of shale gas production will drive future water demands for natural gas extraction and processing in Arkansas
- Seeking Work Group guidance:
  - What trends are expected?
  - Where? When?
  - Fayetteville Shale play sustainability?

Shale Gas Water Demand Forecast: Feedback

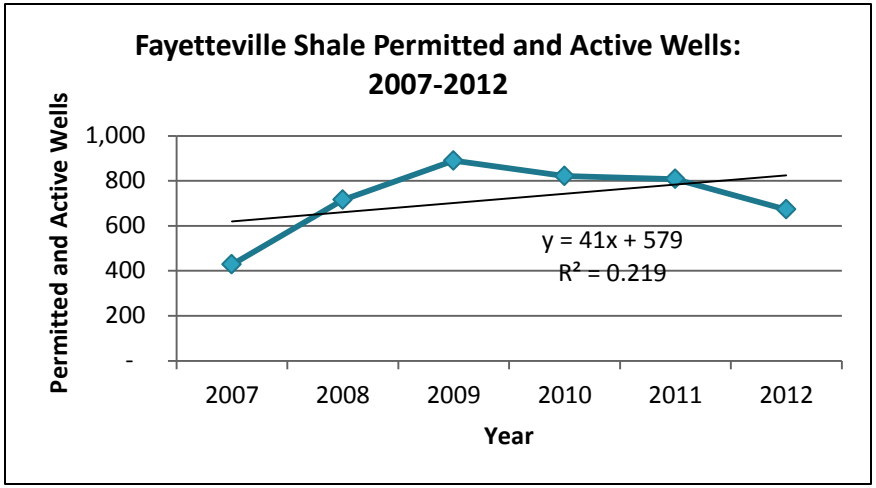
- WUDBS data does not allow for accurate depiction of water use per well since multiple wells can be served by a single diversion point (Measurement Point Identification aka MPID)
- EIA national shale gas production projections are not appropriate for projecting future activity in the Fayetteville Shale Play of Arkansas
- Literature (EIA, Stronger, Arkansas Geologic Survey) estimates of maximum Fayetteville Shale Play wells (about 14,000) is an appropriate assumption
- Shale gas water demand can be broken into 3 sources:
  - Diversion from surface water
  - Diffuse water
  - Reuse water

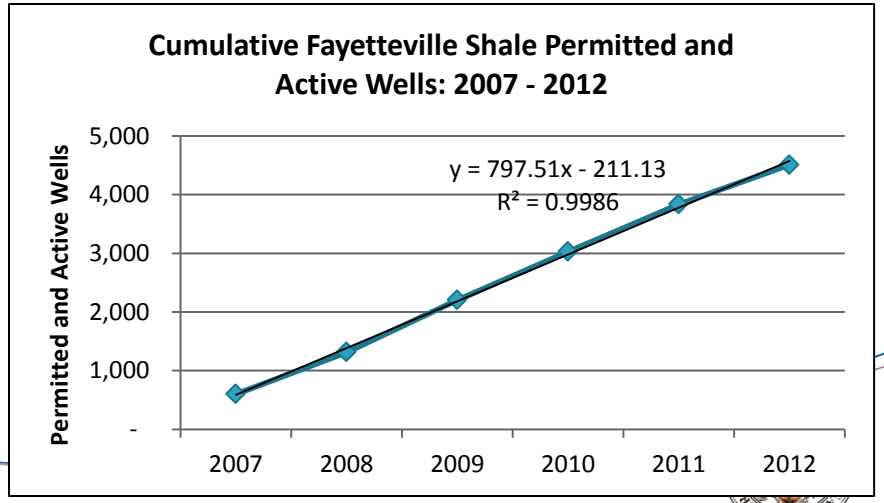
Shale Gas Water Demand Forecast: Revised Approach

- Assume 4.73 million gallons per well
- Assume 21.7% of water demand is from diffuse water
- Diverted water is 3.7 million gallons per well (100% from Surface Water)
- Model contains a placeholder for re-use portion assumption
- Assume 100% of per well water demand occurs during the year the well is first permitted and active (no refracking assumed)
- Assume a county's maximum well density in its portion of the Fayetteville Shale Play extent is 7 wells per square mile
- Model the distribution of future wells using the current proportion of cumulative wells by county
- If a county's well density reaches its maximum, assign wells to other counties in the Play unless they are at maximum density

Shale Gas Water Demand Forecast: Results

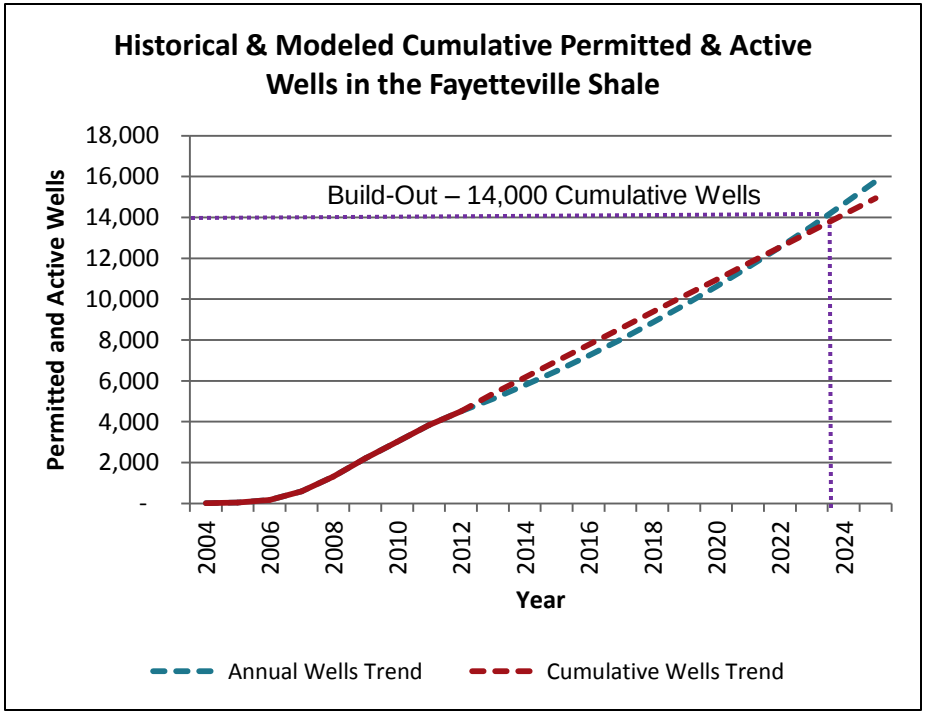
- Analyzed the trend in annual permitted and active Fayetteville Shale wells from 2007 to 2012 to derive a trend line
- Also analyzed the trend in cumulative permitted and active Fayetteville Shale wells from 2007 to 2012
- According to the Arkansas Geological Survey, since 2004 there have been 4,598 permitted and active gas wells in the Fayetteville Shale





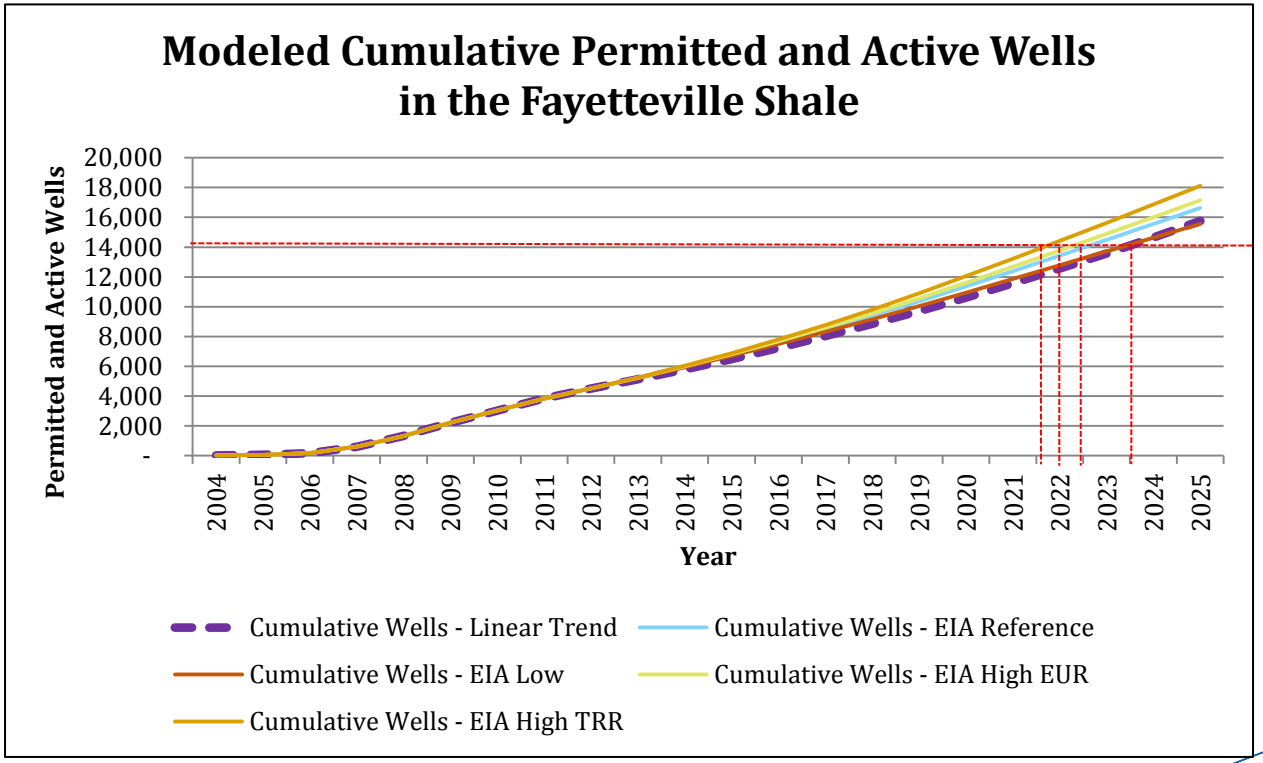
Shale Gas Water Demand Forecast: Results

- Both trend analyses indicate that cumulative permitted and active Fayetteville Shale wells will reach 14,000 (i.e., build-out) between 2023 and 2024.
- Trends add about 800 new wells each year
- 2007 to 2012 average new permitted and active wells was 723. Maximum was 890 in 2009. Minimum was 428 in 2007.



Comparison of Shale Gas Development Growth Projection Scenarios

- All scenarios exhibit same increasing curve
- Year of maximum cumulative wells by scenario:
  - Linear (Cumulative and Annual): 2023/2024
  - EIA Reference: 2022/2023
  - EIA Low: 2023/2024
  - EIA High EUR: 2022/2023
  - EIA High TRR: 2021/2022



Shale Gas Water Demand Forecast: Results

Current Well Distribution:

County	Cumulative Wells	Well Proportion
Cleburne	652	14.2%
Conway	924	20.1%
Faulkner	351	7.6%
Franklin	8	0.2%
Independence	67	1.5%
Jackson	23	0.5%
Pope	31	0.7%
Van Buren	1,385	30.1%
White	1,157	25.2%
Total	**4,598**	**100%**

*Approximate

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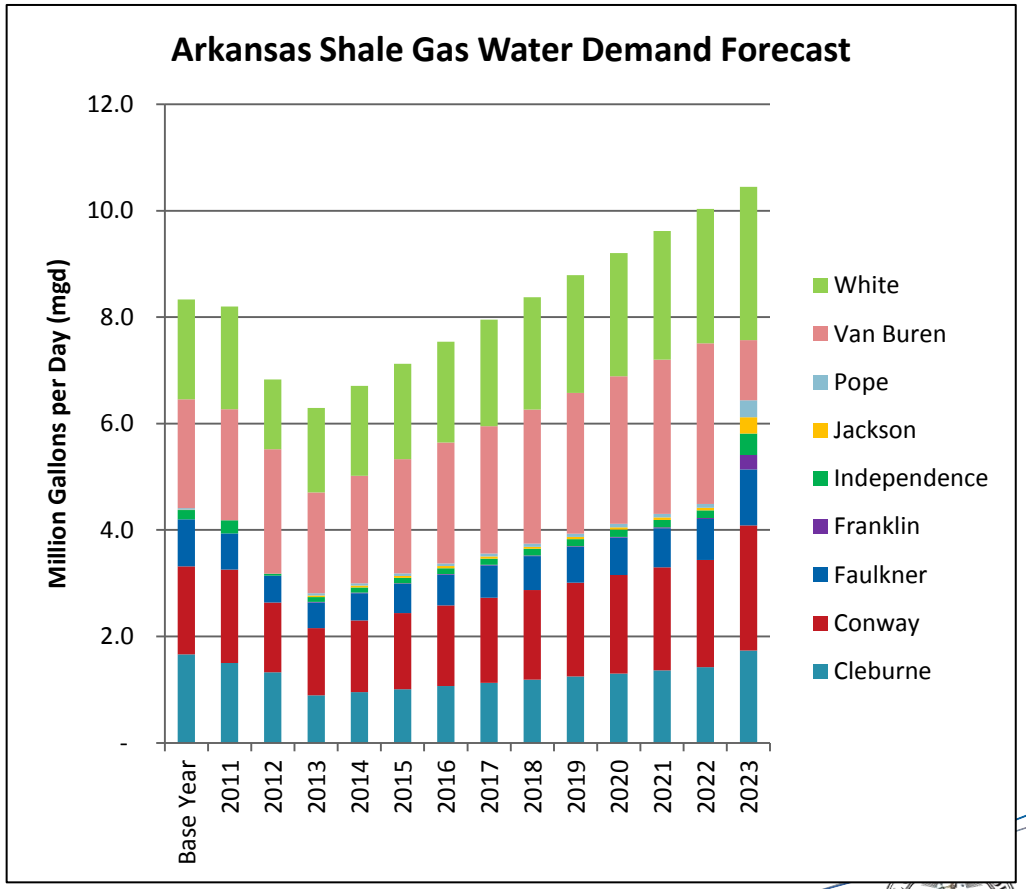
Shale Gas Water Demand Forecast: Results

- Base Year (2010) shale gas water demands forecasted to increase 25% in 2023-24 (max well density)
- Maximum well density is reached between the 2023 and 2024 forecast years
- All demands are from surface water sources



Municipal/Public and Self-Supplied Forecast

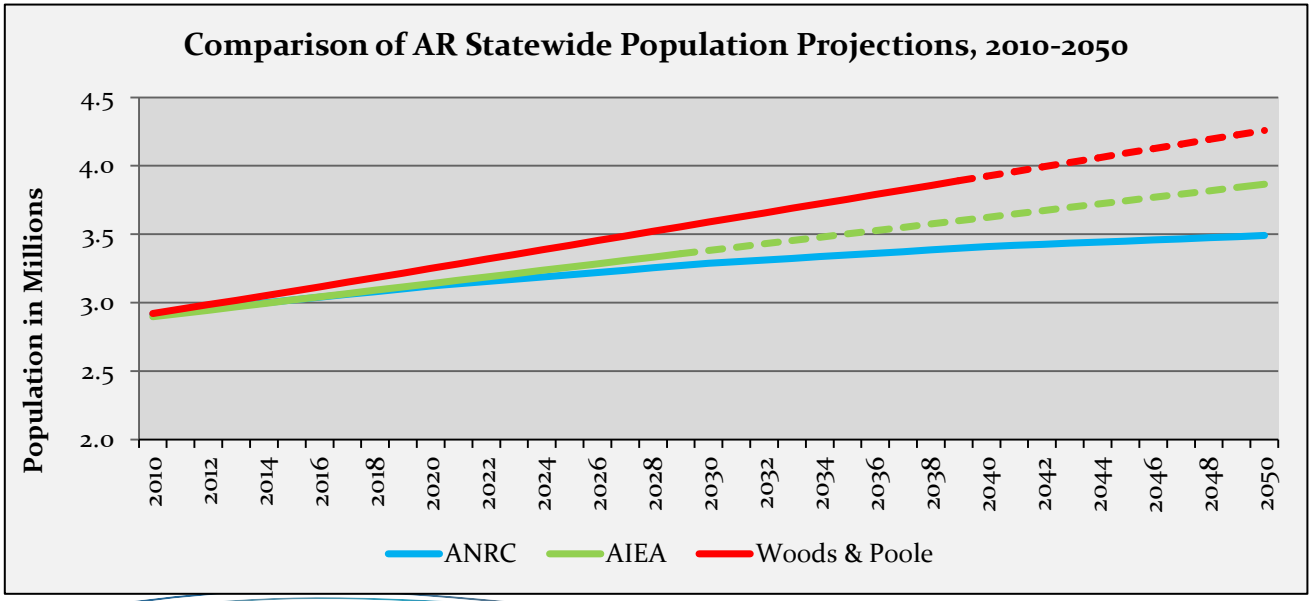
All Data and Results are Preliminary and Subject to Change

Municipally-Supplied Water Demand: Initial Approach

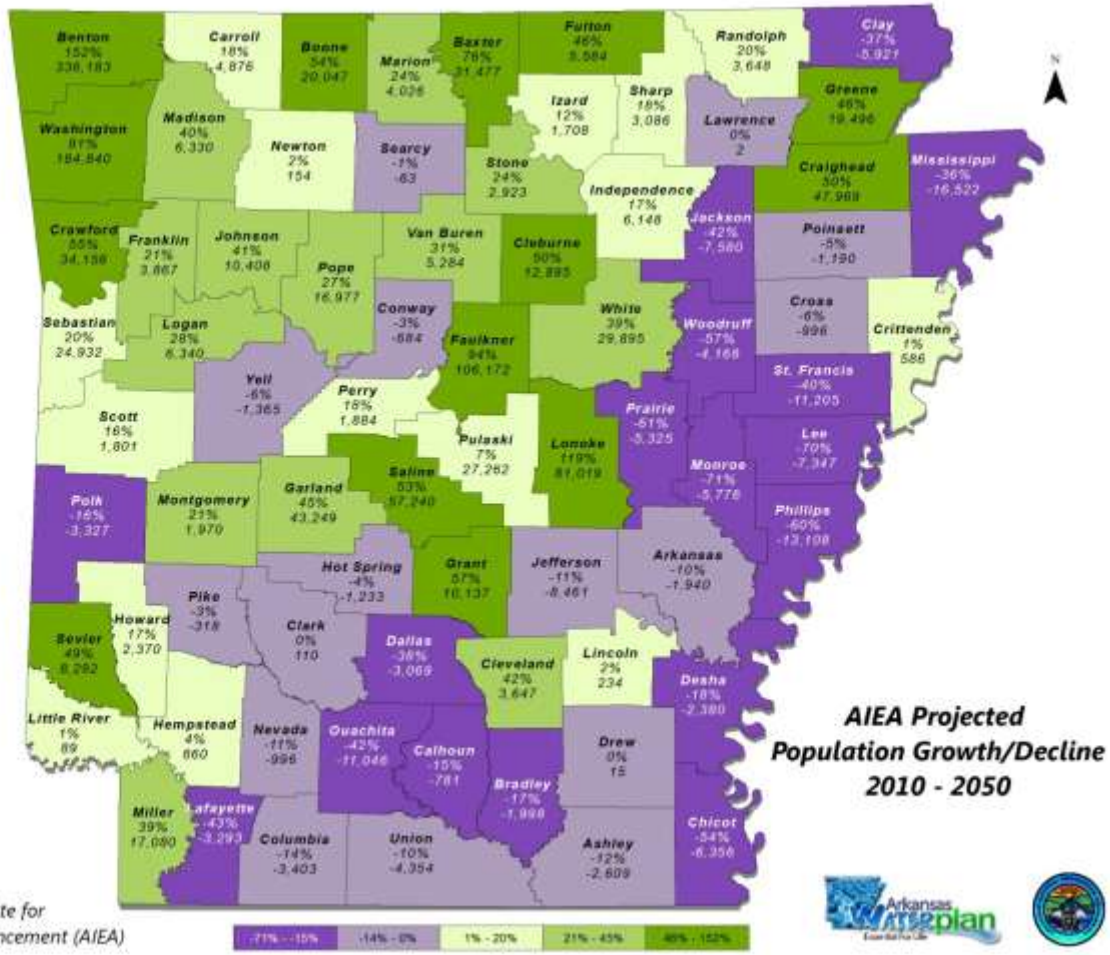
- Determine supplier domestic deliveries from WUDBS
- Divide domestic deliveries by supplier population served to derive supplier per capita domestic use
- Develop weighted average gallons per capita per day (gpcd) for each county
- Multiply projected county population served by county weighted average gpcd

Municipally-Supplied Demand Forecast: Initial Approach Continued

- Three population projection scenarios will drive domestic demands (municipally-supplied and self-supplied): Dotted lines represent extrapolation at last year rate of change

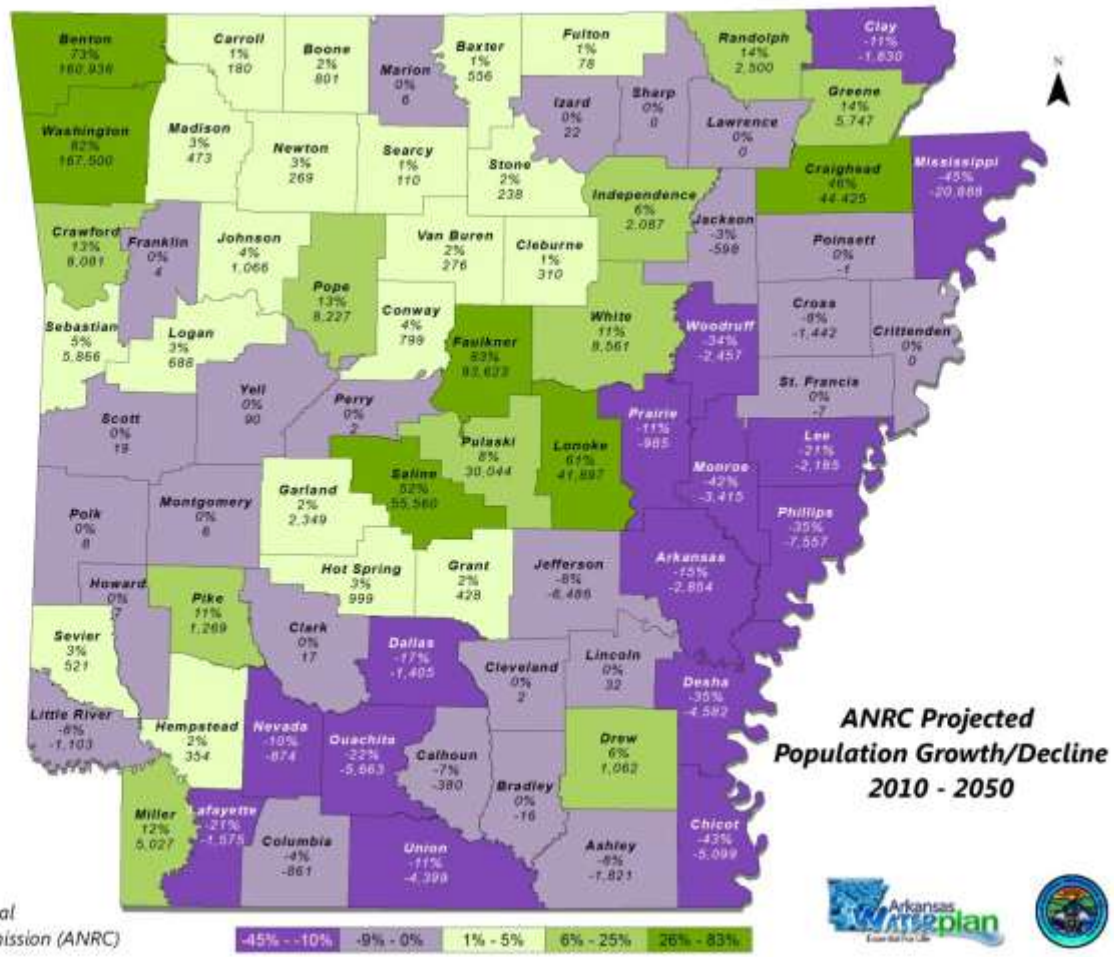


County Population Projections: Arkansas Institute for Economic Advancement (AIEA)Scenario



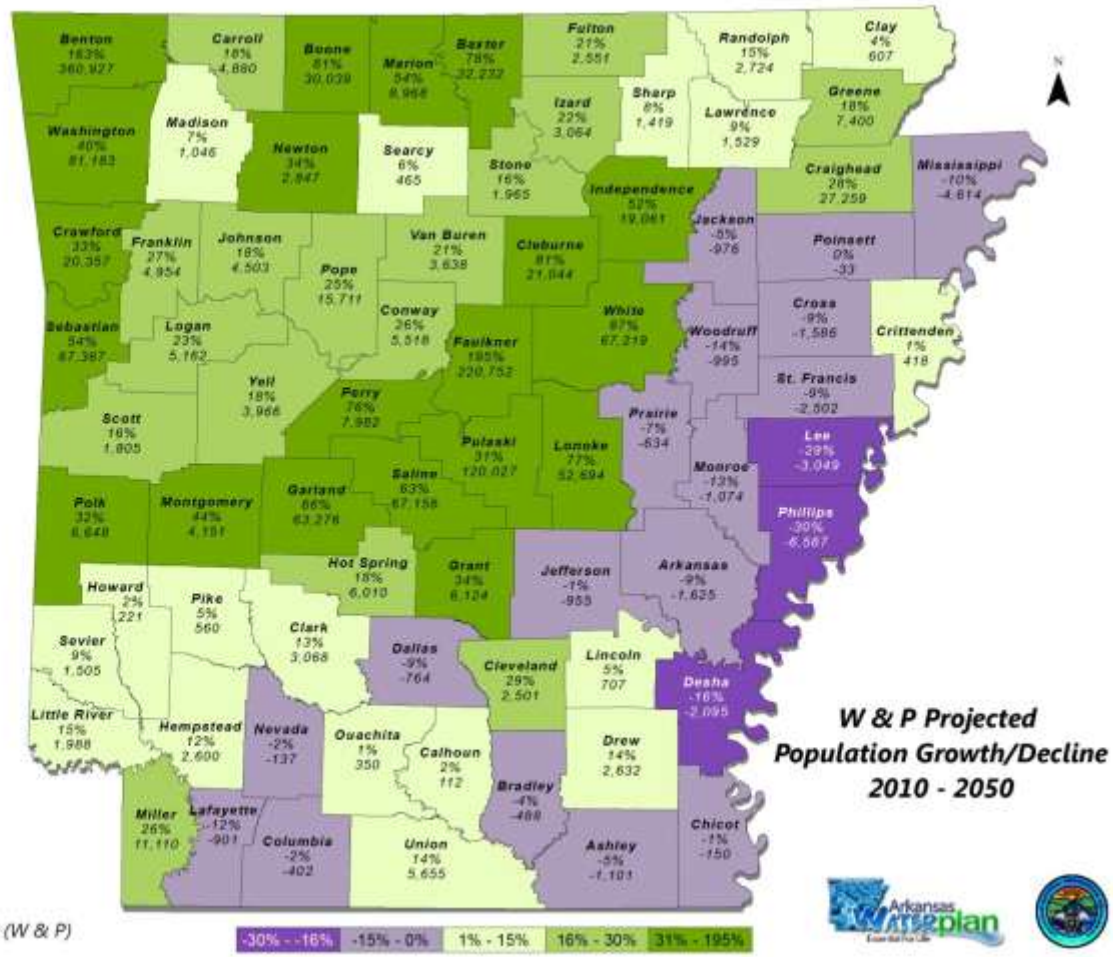
Arkansas Institute for Economic Advancement (AIEA)

County Population Projections: ANRC Scenario



Arkansas Natural Resource Commission (ANRC)

County Population Projections: Woods & Poole Scenario



Woods & Poole (W & P)

Municipally-Supplied Demand: Feedback

- Work Group recommends Arkansas Department of Health water demand and population served as primary data source in conjunction with WUDBS – Base year gpcd derived from 2008-2012 reported system demand
- Population projections reviewed and were generally found to be appropriate:
  - Some significant county-level differences by projection scenario
  - Projection methodologies differed by scenario, creating these differences
- Some gpcds were noted as being unusually high due to double-counting of wholesale water demand

Municipally-Supplied Demand: Revised Approach

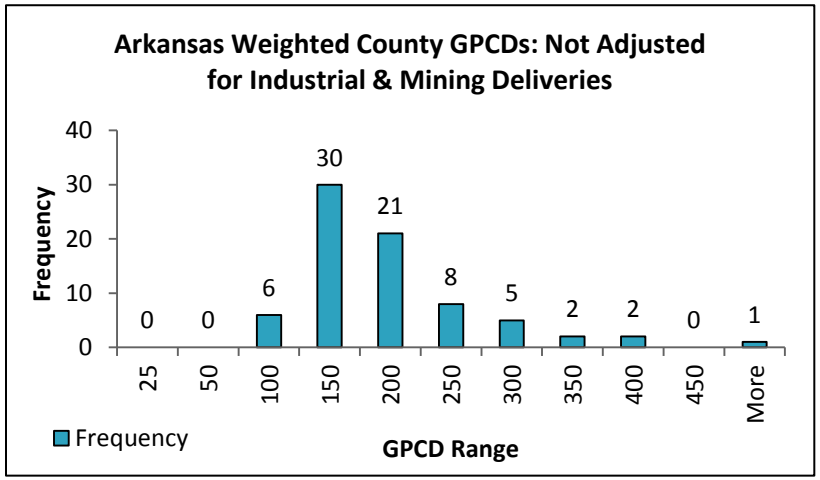
- Cannot use WUDBS to derive residential only gpcd
  - Some commercial, light industrial, irrigation, and non-revenue water demand is assumed to be embedded in system gpcds
- Can use WUDBS to "remove" reported industrial and mining deliveries from the numerator of the system gpcd calculation where that data are available.
- Wholesaler gpcds are assumed equal to their entire system gpcd

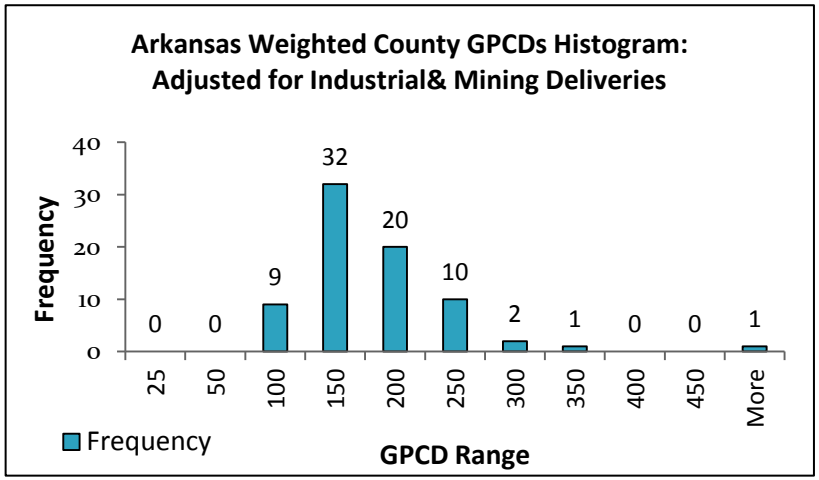
$$Wholesale\ System\ GPCD = \frac{Total\ System\ Demand\ -\ Industrial\ and\ Mining\ Deliveries\ Reported}{Total\ System\ Population\ Served}$$

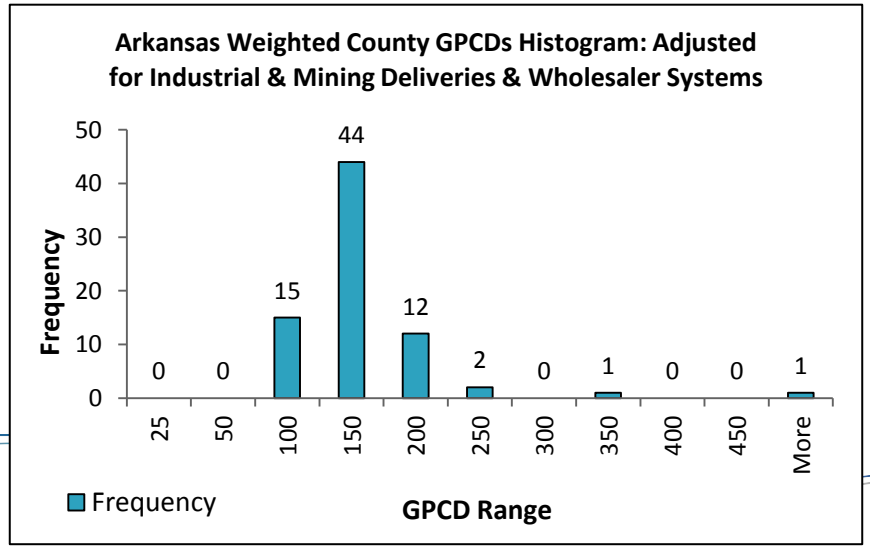
Municipally-Supplied Demand: Revised Approach - Continued

- Public water system average gallons per capita per day (gpcd) from the Department of Health Sanitary Survey data
- Identify deliveries to industrial and mining customers for public water systems in the WUDBS
  - "Move" these demands to applicable sector forecast using a more appropriate driver
  - Further adjust gpcds for select systems through follow-up data collection
- Develop weighted average gpcds for each county using system population served as the weighting factor
- Multiply projected county population served by county weighted average gpcd

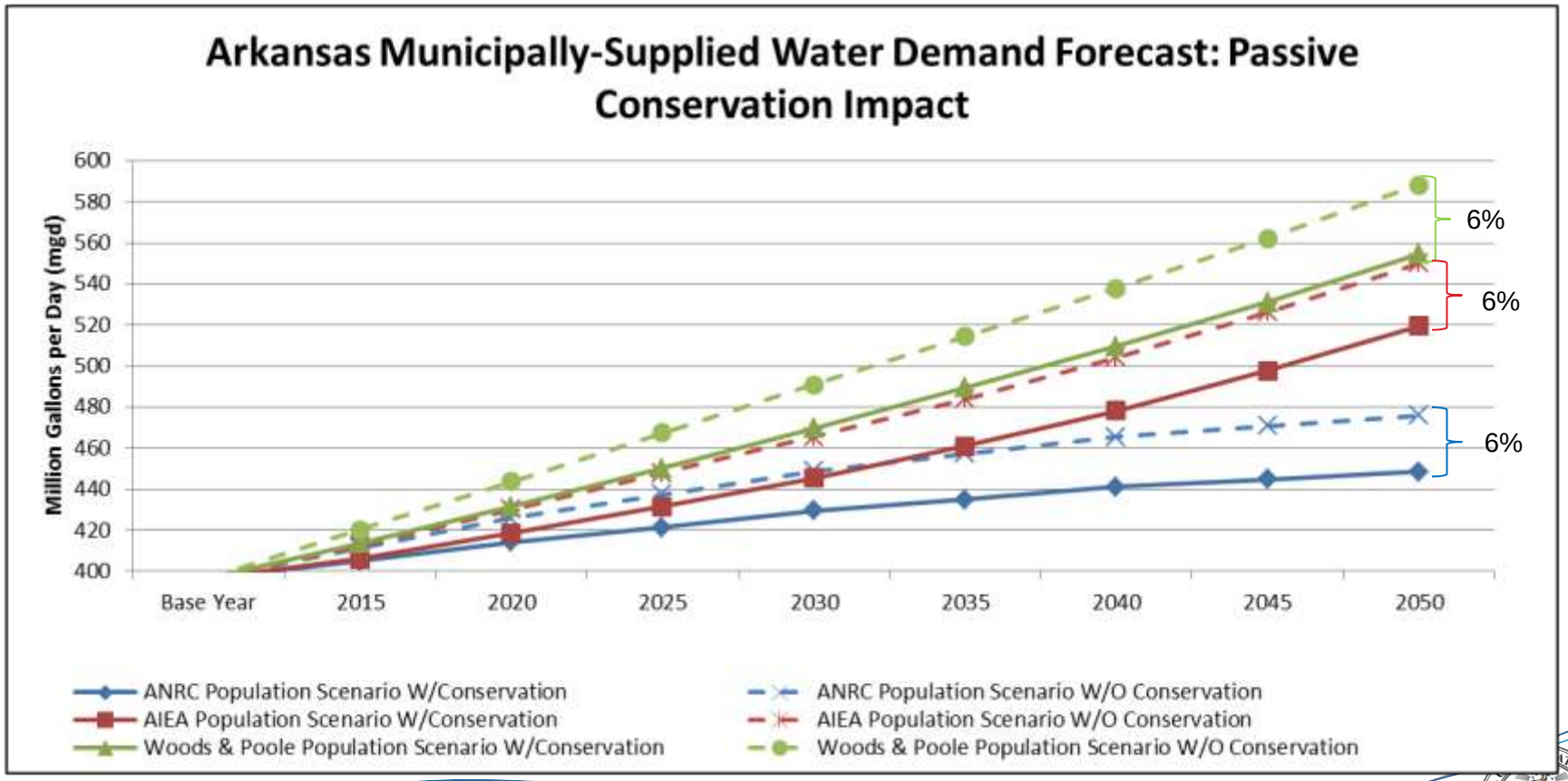
Municipally-Supplied Demand Forecast: GPCD Results for Counties





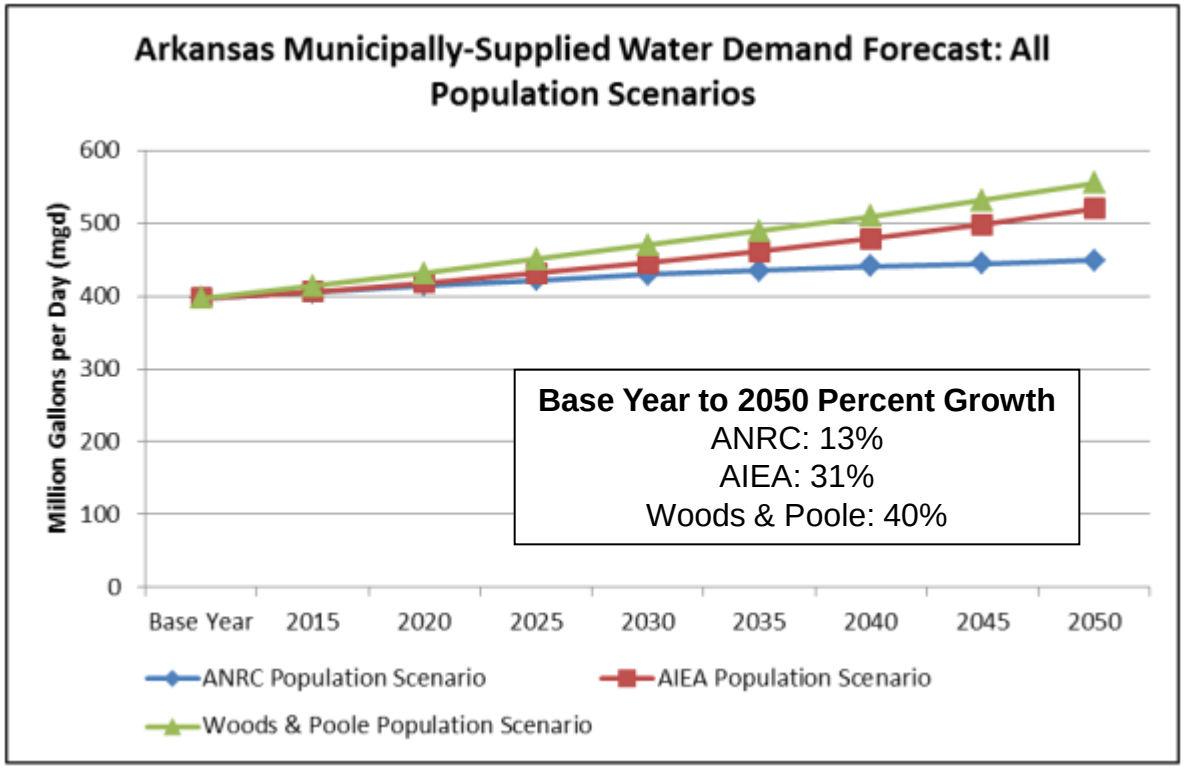


Municipally-Supplied Demand Forecast: Passive Conservation Impact Results

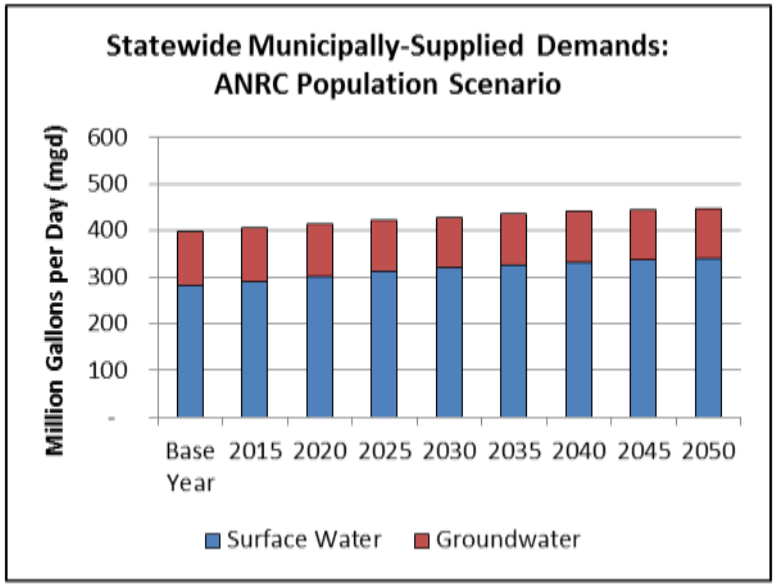


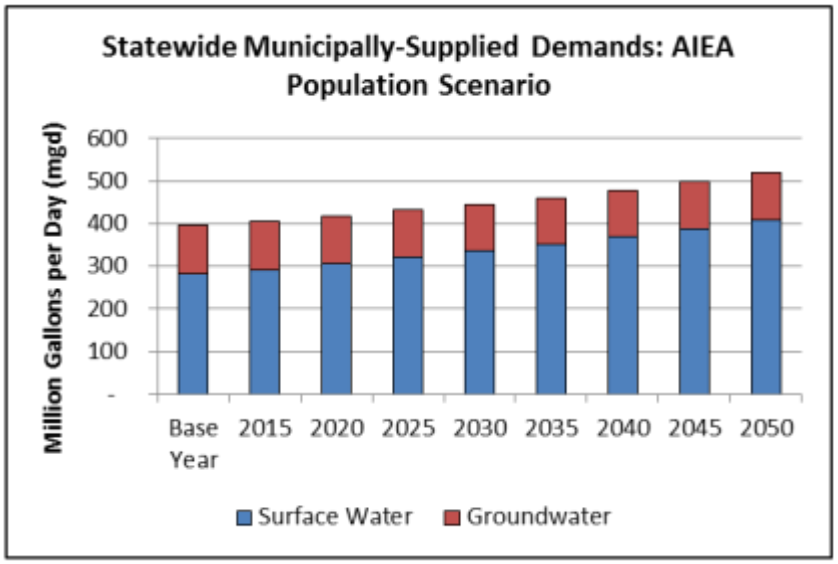
Municipally-Supplied Demand Forecast Results: Statewide

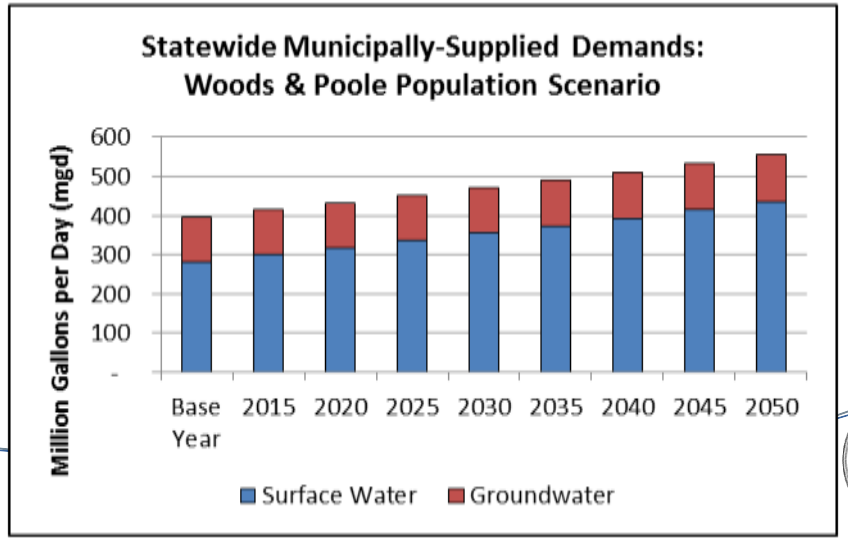
- All scenarios show steady increase in municipally-supplied water demands through 2050
- Highest growth occurs under the Woods & Poole population projection scenario; lowest under the ANRC population projection scenario.
- 2050 water demands range from 449 mgd to 555 mgd



Municipally-Supplied Demand Forecast Results: Statewide







Geographic Considerations Example: Central Arkansas Water

- Wholesale service area in 3 counties
- Source of supply in 2 counties
- County weighted GPCDs based on utilities in each county
  - Example: Salem GPCD is captured in the Saline County weighted GPCD. Salem population served is accounted for in the Saline County forecast.
- Source of supply is tracked back to Central Arkansas Water (Lake Maumelle and Lake Winona) for all CAW customers.
  - Independent supply portions are also tracked.

Self-Supplied Domestic: Initial Approach

- Residential water users not connected to a municipal system
- About 5% of the State's population
- Demand driven by population
- The county municipally-supplied domestic gpcd was assumed

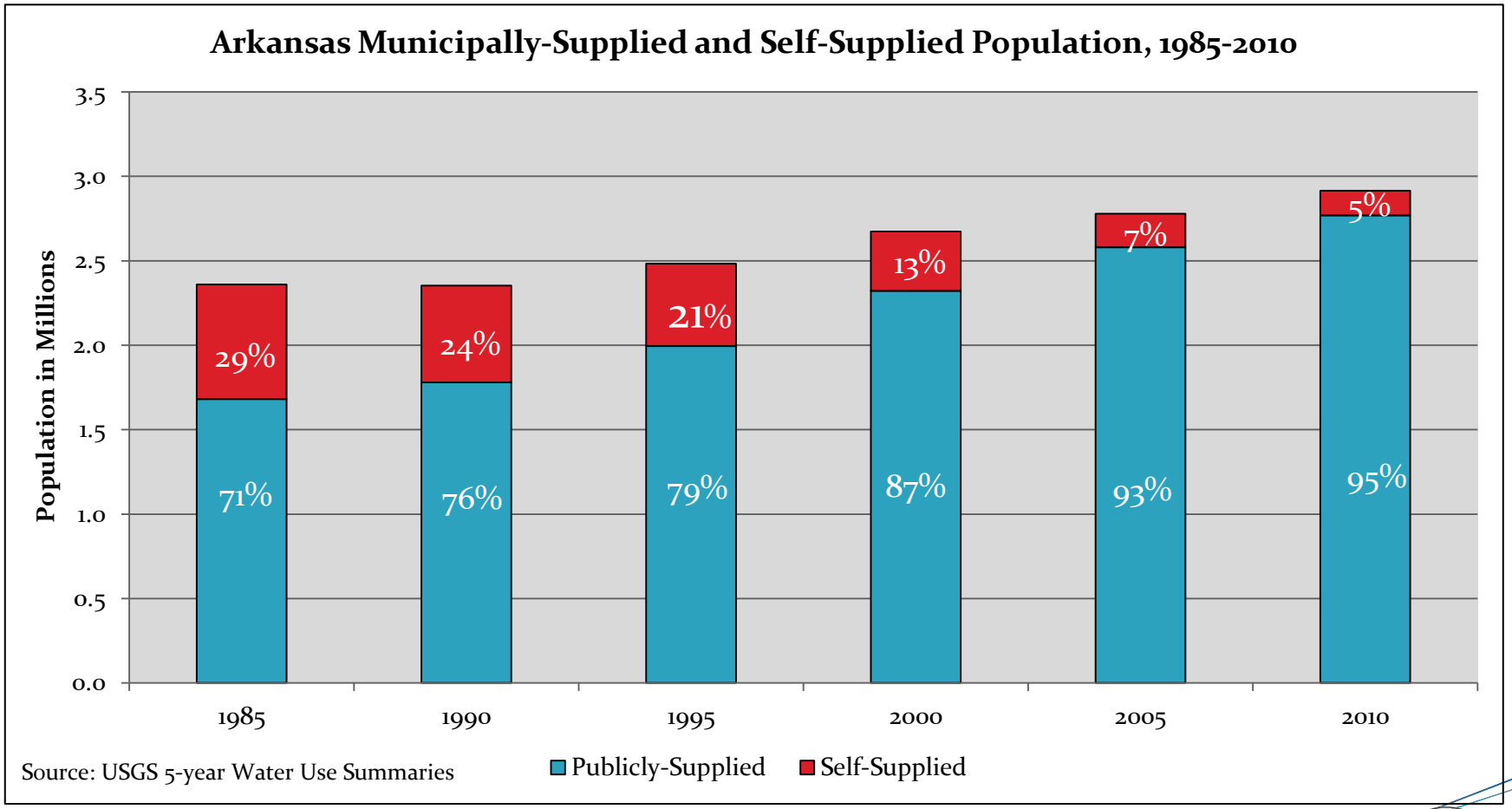
Self-Supplied Domestic: Feedback

- USGS 2010 self-supplied domestic gpcd values are appropriate. Values range from 80.0 gpcd to 98.2 gpcd and are different for each county.
- Assume that all demands are from groundwater sources assigned to "most likely" aquifer in the county.
- USGS 2010 percent of county population self-supplied is appropriate for the base year disaggregation of county population to self-supplied and municipally-supplied.
- Trend toward greater portion of county population that is municipally-supplied is likely to slow
  - Funding for system expansion projects become less available and greater portion of population is being served by municipal water systems.
- Holding base year population self-supplied ratios constant through 2050 may not be appropriate for all counties. Some counties may expand municipal delivery systems.

Self-Supplied Domestic: Revised Approach

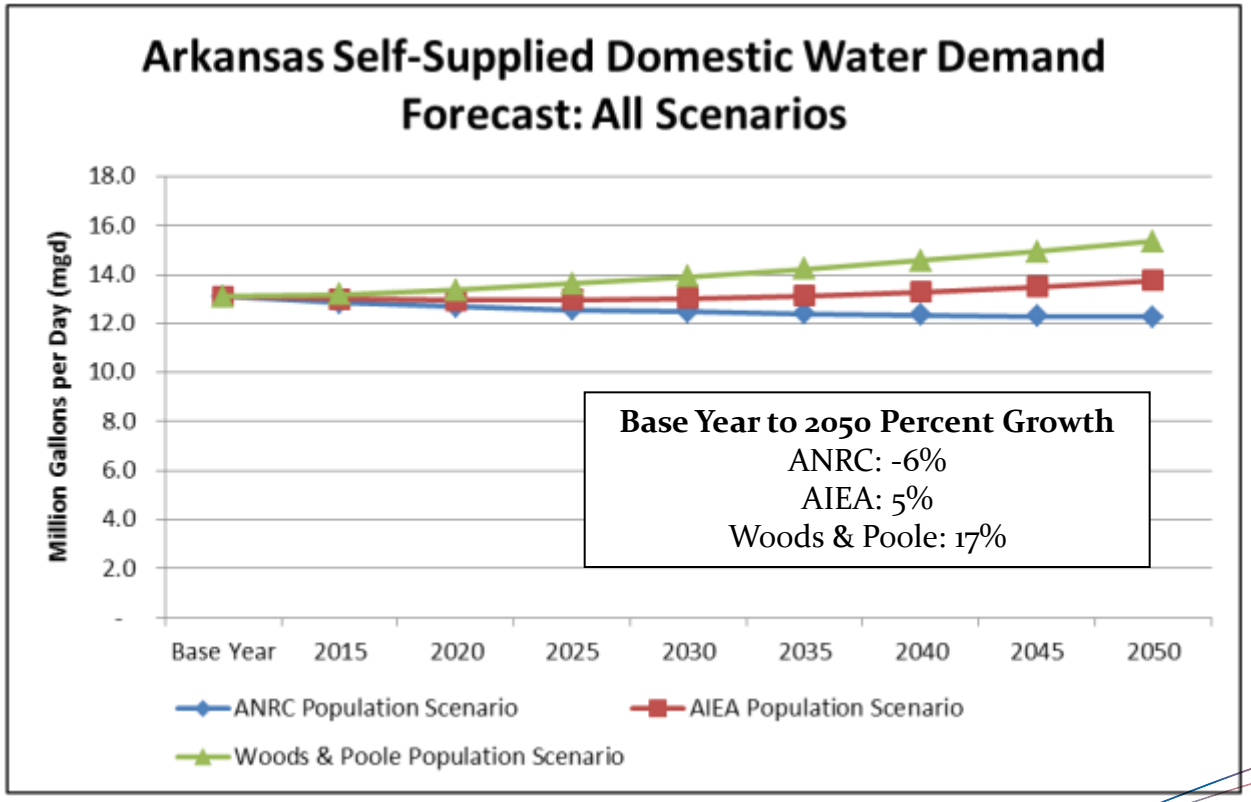
- USGS county self-supplied domestic gpcds are input into the model.
- GPCDs are multiplied by the estimate county population that is self-supplied.
- GPCDs are adjusted (i.e., decreased) into the future to account for passive conservation
- County population ratio self-supplied domestic is held constant (at their unique values) for all counties. This approach assumes that new county population will continue to be a mix of municipally-supplied and self-supplied.

Trends in Self-Supplied Domestic Population

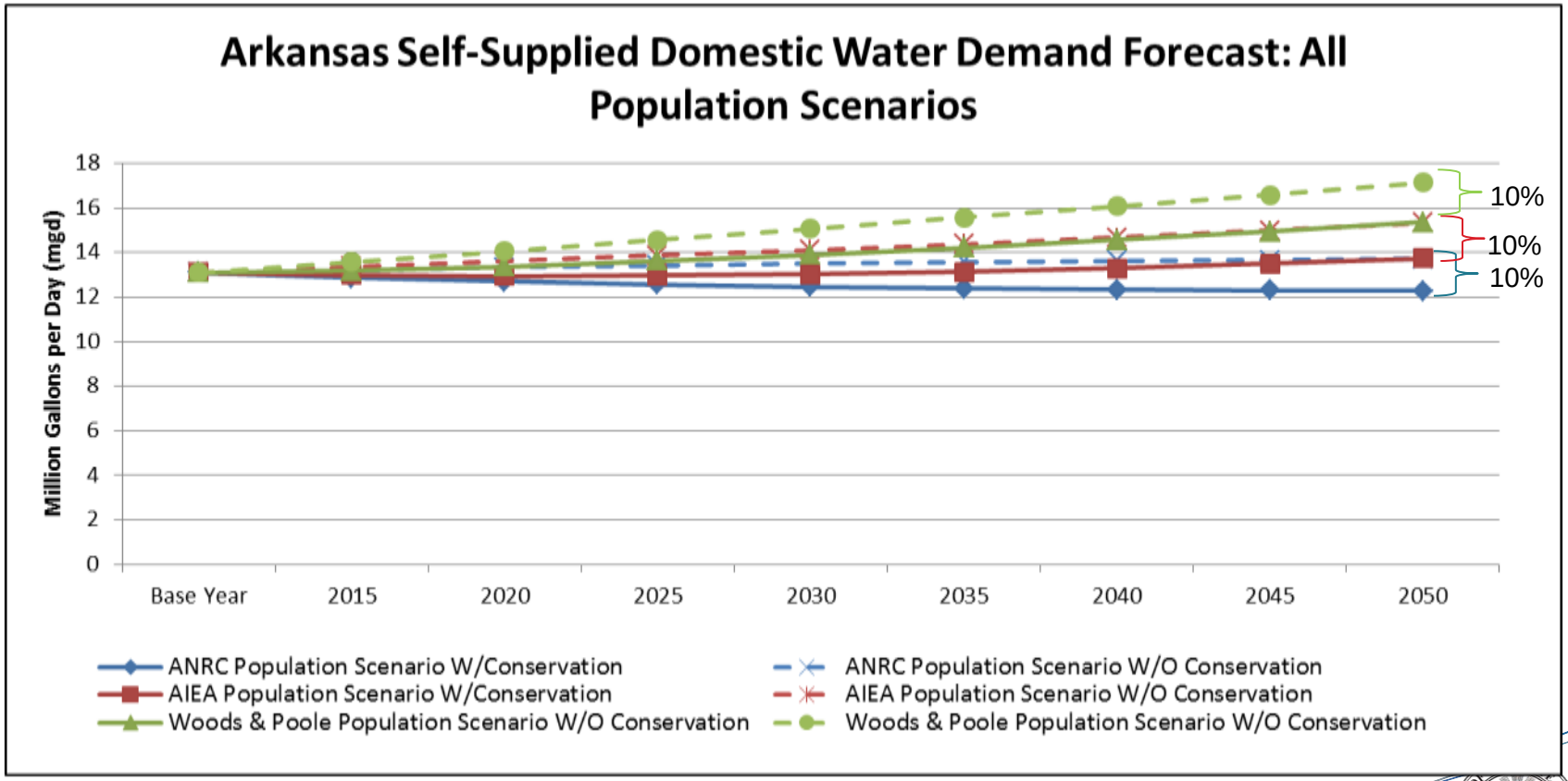


Self-Supplied Domestic: Forecast Results

- Highest growth occurs under the Woods & Poole population projection scenario; lowest under the ANRC population projection scenario.
- Decline in demand attributed to projected decrease in population in counties with self-supplied population as well as passive conservation savings
- 2050 water demands range from 12.3 mgd to 15.3 mgd

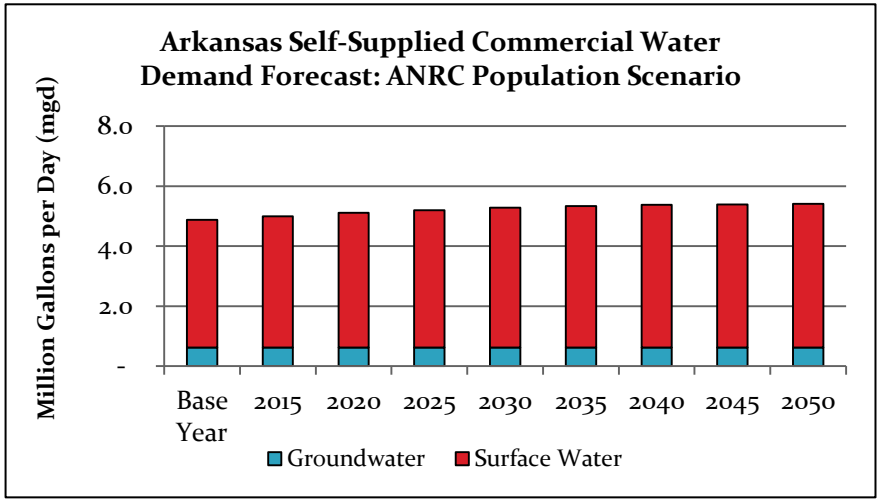


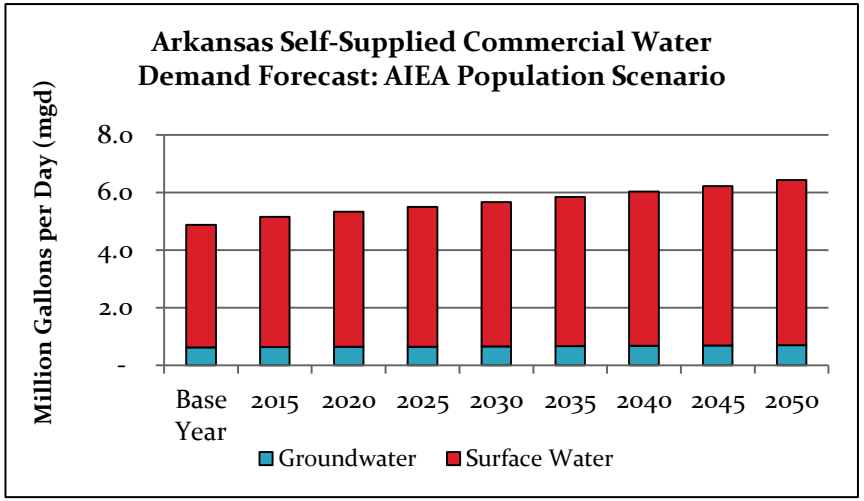
Self-Supplied Domestic Demand Forecast: Passive Conservation Impact Results



Self-Supplied Commercial Water Demand Forecast

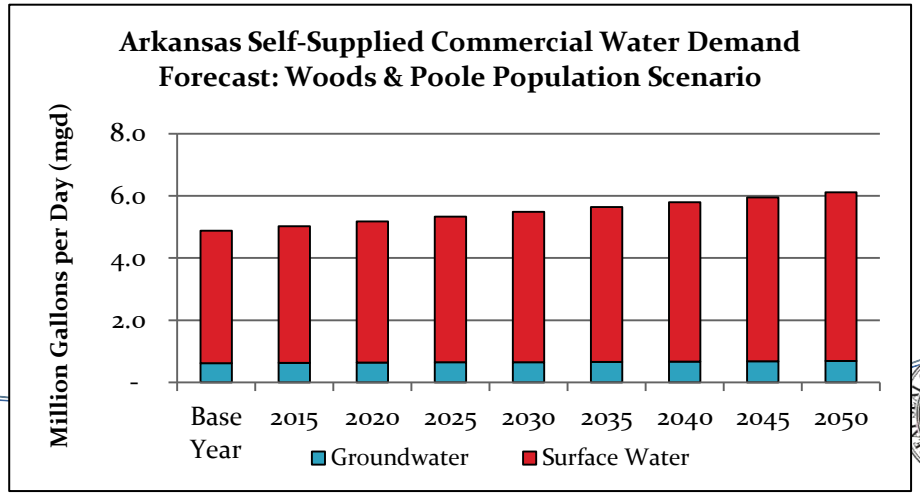
Self-Supplied Commercial Demand Forecast: Results



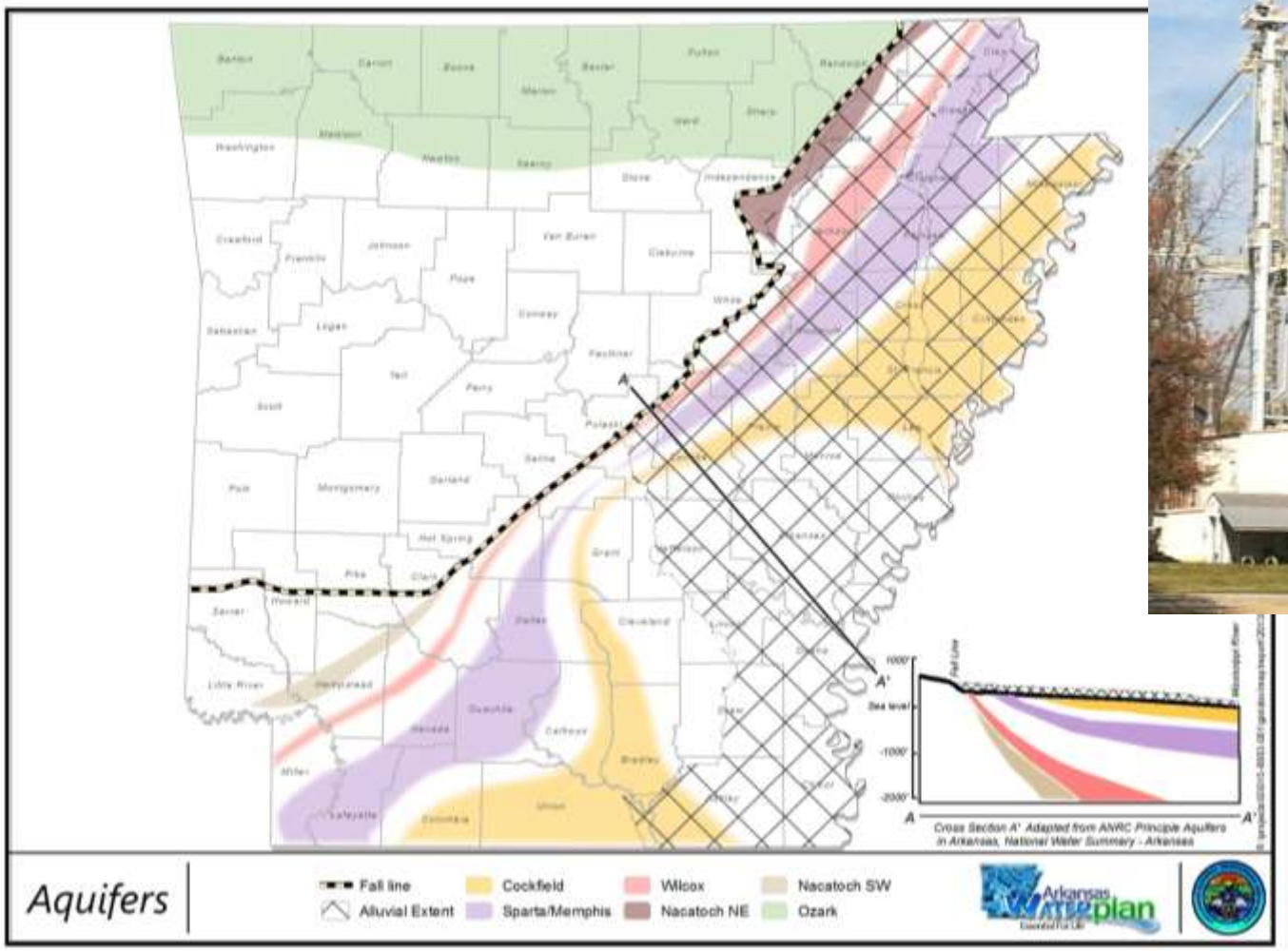


2010 to 2050 Percent Increase:

- ANRC Population Scenario – 11%
- AIEA Population Scenario – 32%
- Woods & Poole Population Scenario – 25%

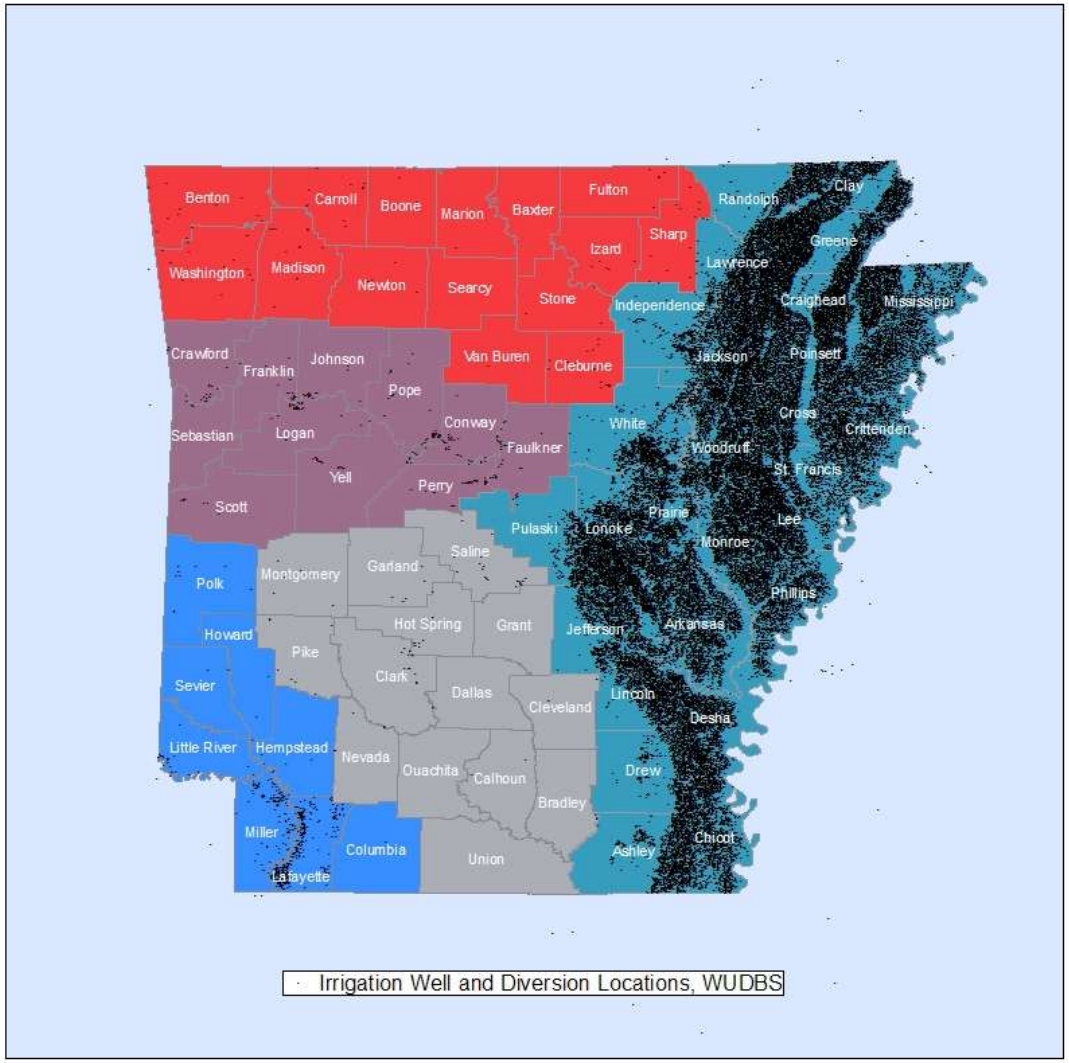


Agricultural Forecast – Crop, Livestock, Aquaculture and Duck Hunting



Crop Irrigation Component of Forecast

All Data and Results are Preliminary and Subject to Change



Crop Irrigation Forecast: Initial Approach

- Overall forecast approach - Irrigated acres multiplied times weighted crop water application rate
- Determine baseline irrigated acres
- Determine crop irrigation application rates
- Crop requirement would be split into components of what crop required and what was applied to scheme in excess (system losses) and would be forecasted at that level
- Identify method for determine rate of growth (trend analysis) over the 40 year forecast horizon that is within a “reasonable maximum”

Crop Irrigation Forecast: Feedback and Revised Approach

- Conducted initial data investigations and updated recommended approach, based on conference call and March meeting
- Detailed discussion on most appropriate source for irrigated acres - Recommended to look into FSA as source, and look more thoroughly into NASS data sources and WUDBS, including how data are collected for each source
- Conduct verification of crop application rates derived from WUDBS (2000-2010)
- Further consider irrigation of pasture grass as emerging trend
- Better define and research reasonable maximum irrigated acreage
- Look for additional data on MIRI adoption rates

Crop Irrigation General Methodology (1 of 3)

Crop Irrigation Withdrawal in County for Crop =

Irrigated Acres for Crop

X

Application Rate for Crop

County Total Irrigation Withdrawal is Sum of All Crop Withdrawals in County

Crop Irrigation General Methodology (2 of 3)

Irrigated Acres for Crop by County 2010 = Actual

Irrigated Acres for Crop by County 2020-2050 = Applied Results of Significant Trend Analysis Models

Assumed to Reach Reasonable Max When Trendline Reaches Total Tillable Acres by County

2010 is "Base Year" of Forecast

[Base Year is starting point of forecast, based on actual, known data]

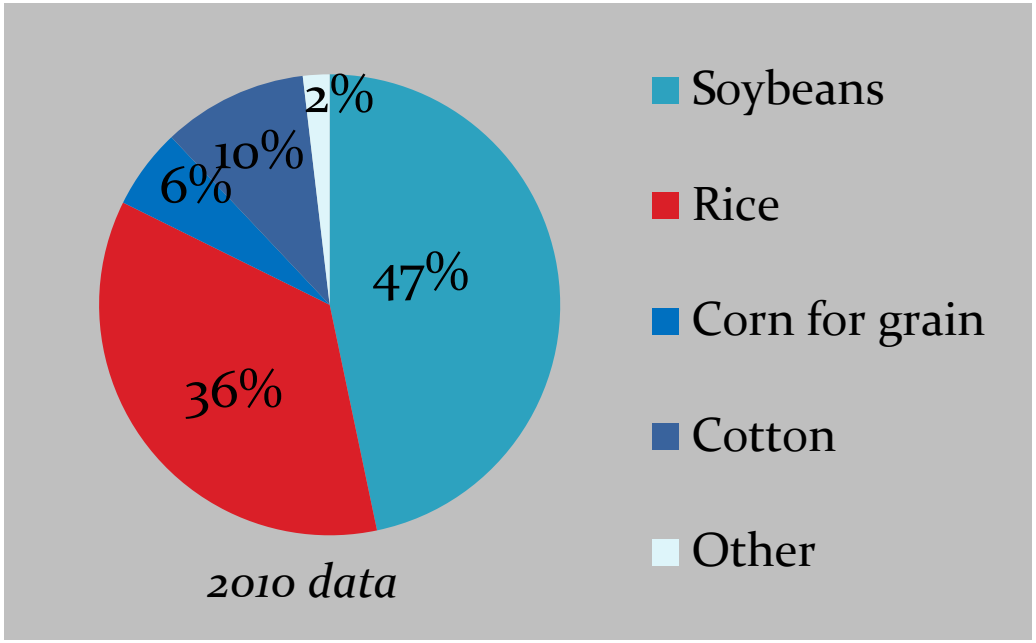
Crop Irrigation General Methodology (3 of 3)

Method Produces a "Baseline" Forecast

[Baseline: potential future irrigation withdrawals if current conditions continue throughout forecast period. Does not capture any potential, unknown changes in policy or regulations, unanticipated producer changes in irrigation behavior, changes stemming from instability in commodity markets, etc. Intended to model behaviors and limitations that are known and capture a potential future for irrigation in Arkansas.]

Crop Type

- Forecast is generated by crop type for ALL crops, using unique application rate
- Trend analysis conducted only on irrigated acres of rice, soybeans, corn, cotton and total



- All "Other" crops are grouped together for <u>forecasting</u> irrigated acres
  - Berries, unclassified cash grains, crop maintenance, orchards, hay, milo, oats, pastures, peanuts, crop reservoir, sorghum, tobacco, veggies, and wheat

Data Needs

- Irrigated acres by county for soybeans, corn, rice, cotton, and “other” from 2000-2010 for trend analysis
- Irrigated acres by county for ALL crop types for 2010 (base year)
- Reasonable maximum irrigated acres by county for 2010
- Crop-specific application rate, not tied to one specific weather year
- Sources:
  - ANRC WUDBS
  - FSA County Crop Acreage Summaries
  - NASS Crop Data Layer (CDL)
  - NASS County Agricultural Production Survey (CAPS)

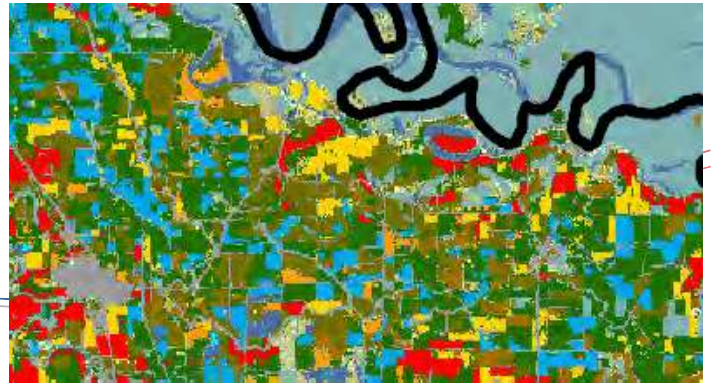
Potential Sources of Data – Irrigated Acres

- **FSA County Crop Acreage Summaries**
  - USDA's farm commodity, credit, conservation, disaster, & loan programs
  - Operators submit annual report detailing all cropland use
  - Fields can have an "irrigation" indication, has means by which artificial water can be applied
  - Collected by administrative county
  - Data limited: 2006, 2007, 2008, 2010, 2011

Potential Sources of Data – Irrigated Acres

- ***NASS CDL***
  - Geo-referenced, crop-specific GIS land cover data layer
  - Available from 2000-2010
  - Produced using satellite imagery collected during growing season
  - Categories of cropland changed over time, reflective qualities of crops more identifiable as science improved
  - Does not discern between irrigated and dryland crop acres

Land Use Category		
%Background	Pecans	Dry Beans
%Clouds	Open Water	Peas
Background	Developed (several)	Tomatoes
Corn	Barren	Pumpkins
Cotton	Forecast (several)	Blueberries
Rice	Shrubland	Cabbage
Sorghum	Grassland Herb.	Other Crops
Soybeans	Pasture/Hay	Sweet Potatoes
Sunflower	Woody Wetlands	Watermelons
Sweet Corn	Herb. Wetlands	Greens
Winter Wheat	Fallow/Idle Cropland	Squash
Oats	Dbl Crop (several)	Canola
Millet	Peaches	Safflower
Alfalfa	Apples	



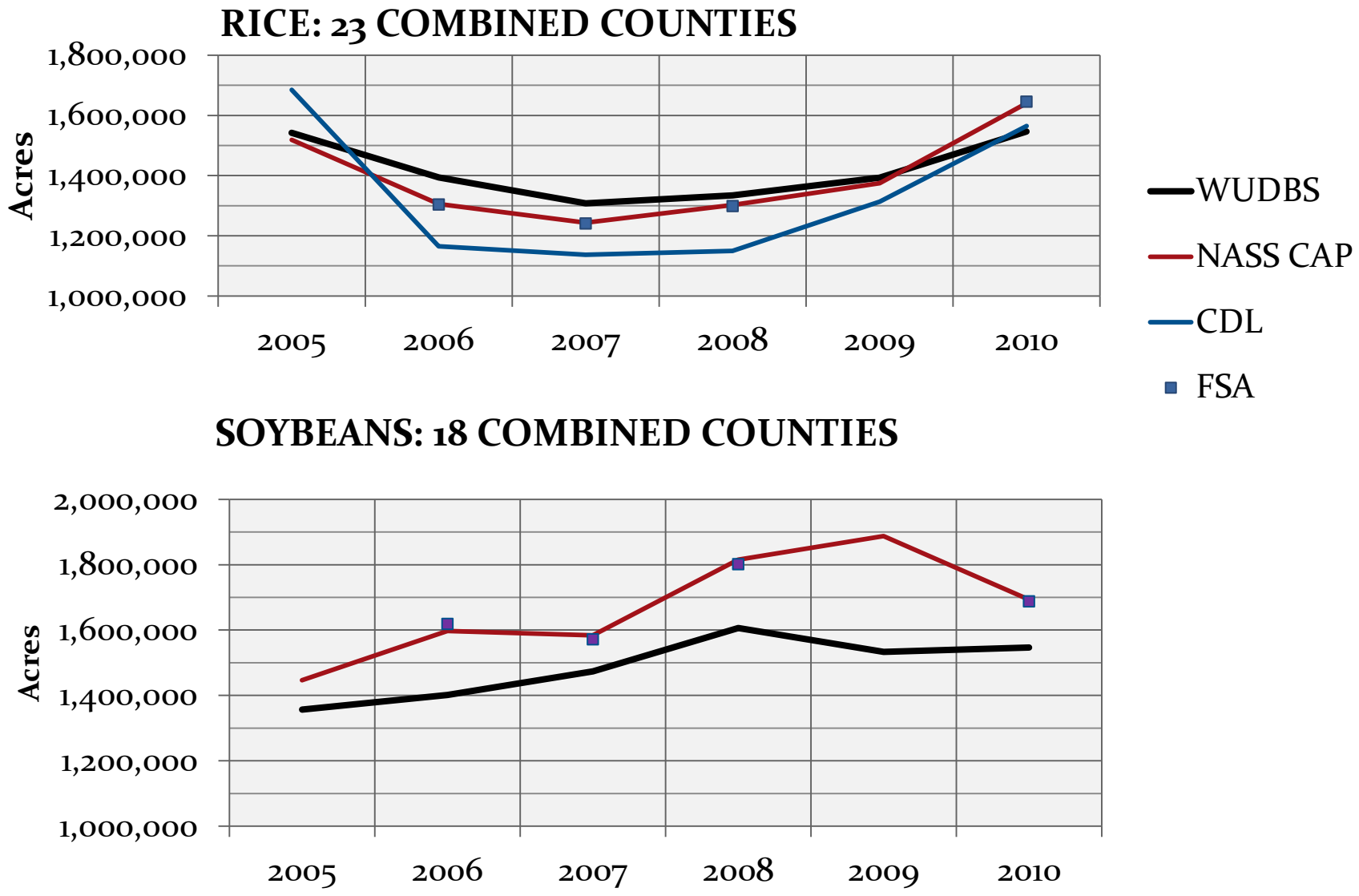
Potential Sources of Data – Irrigated Acres

- ***NASS CAP Survey***
  - Sample half (4,000) the row crop farm operators in state, results extrapolated to population based on standard statistical methods
  - Acres planted and harvested by crop type, yield, soybean and cotton acres irrigated
  - Irrigated means having artificial water applied to the acre at least once during the growing period
  - Results checked against FSA & CDL data to ensure accurate sampling
  - Confidentiality agreements to protect producers, undisclosed values
  - 2000-2010 dataset
    - Rice acres for 23 counties
    - Soybean irrigated acres for 18 counties
    - Cotton irrigated acres for 4 counties

Potential Sources of Data – Irrigated Acres

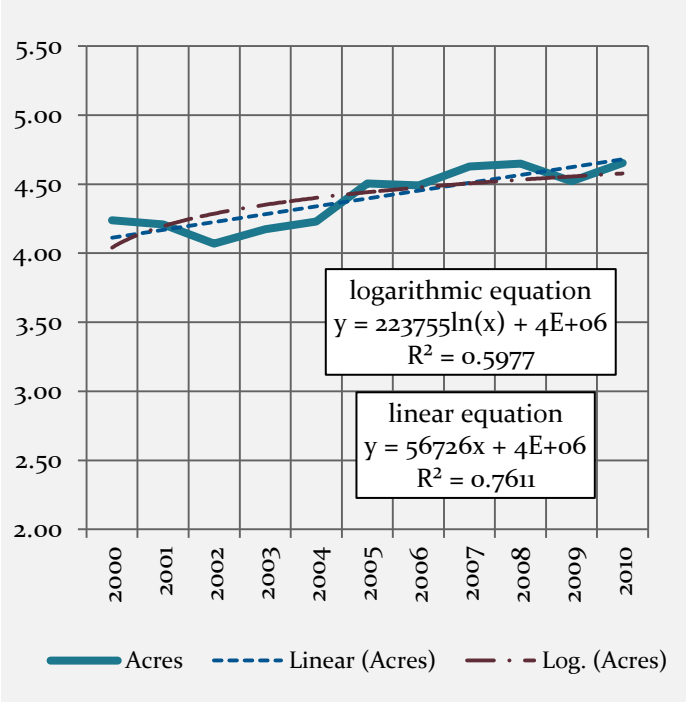
- ***ANRC WUDBS***
  - Data collected annually and stored in a site-specific database
  - 2000-2010 data available
  - Agricultural users register water usage with ANRC or Conservation District
  - Data collected: well/surface water diversion details, crop type grown, acreage irrigated, quantity of water used, irrigation method
  - Annual water quantity information can be provided by:
    - If estimating, report crop, acres, application rate. System calculates total AF of water withdrawn. User provides estimated percent of monthly water applied.
    - If measured, report the crop, acreage, water withdrawn (monthly and total). System calculates the application rate.
    - Conservation Districts sometimes collect crop, acres, and months watered. Will use a predetermined application rate for each crop type and then divide the water percentages among the months watered. Instructed to adjust application rates based on that growing season's annual rainfall.
  - Quality checks (upper limits) in place

Comparison of Irrigated Acres



Method to Forecast Irrigated Acres

- 10 years historical data (2000-2010) summarized by crop type and grouped by county
- Used NASS CAP survey as source for rice & soybeans irrigated acres
- Used WUDBS as source for corn, cotton, and all other minor crops
- Total irrigated acres = rice + soybeans + corn + cotton + "other"
- Generate mathematical models that estimate trends over time for major crop types and "other" group



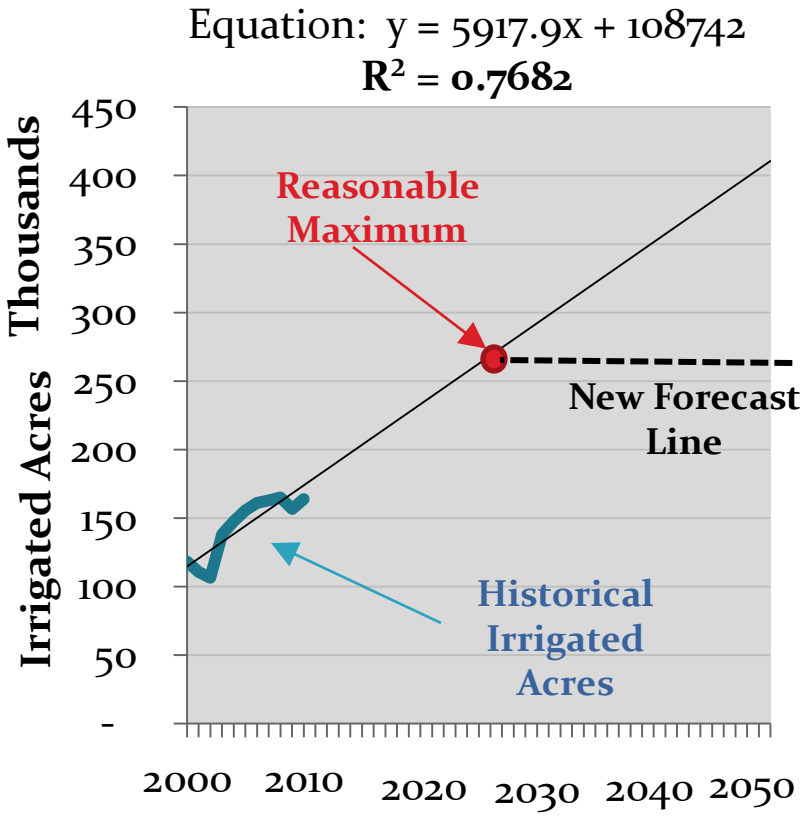
Method to Forecast Irrigated Acres - Continued

- Use statistics to characterize strength of mathematical models to determine an acceptability threshold, i.e. “good fit”
- Use results of good fit models to extrapolate trend to 2050
  - Corn: variable driving growth will be price from USDA Long-term Projections to 2022
  - Soybeans, Rice, and Cotton: variable driving growth will be time
- If growth in “Other” irrigated acres is projected, acres of each minor crop in county is gown at the modeled “Other” growth rate
- No good fit model = no assumed growth in irrigated acres

Year	Corn ($/bushel)
2013	$5.00
2014	$4.30
2015	$4.40
2016	$4.45
2017	$4.50
2018	$4.50
2019	$4.55
2020	$4.60
2021	$4.65
2022	$4.65

Method to Forecast Irrigated Acres - Continued

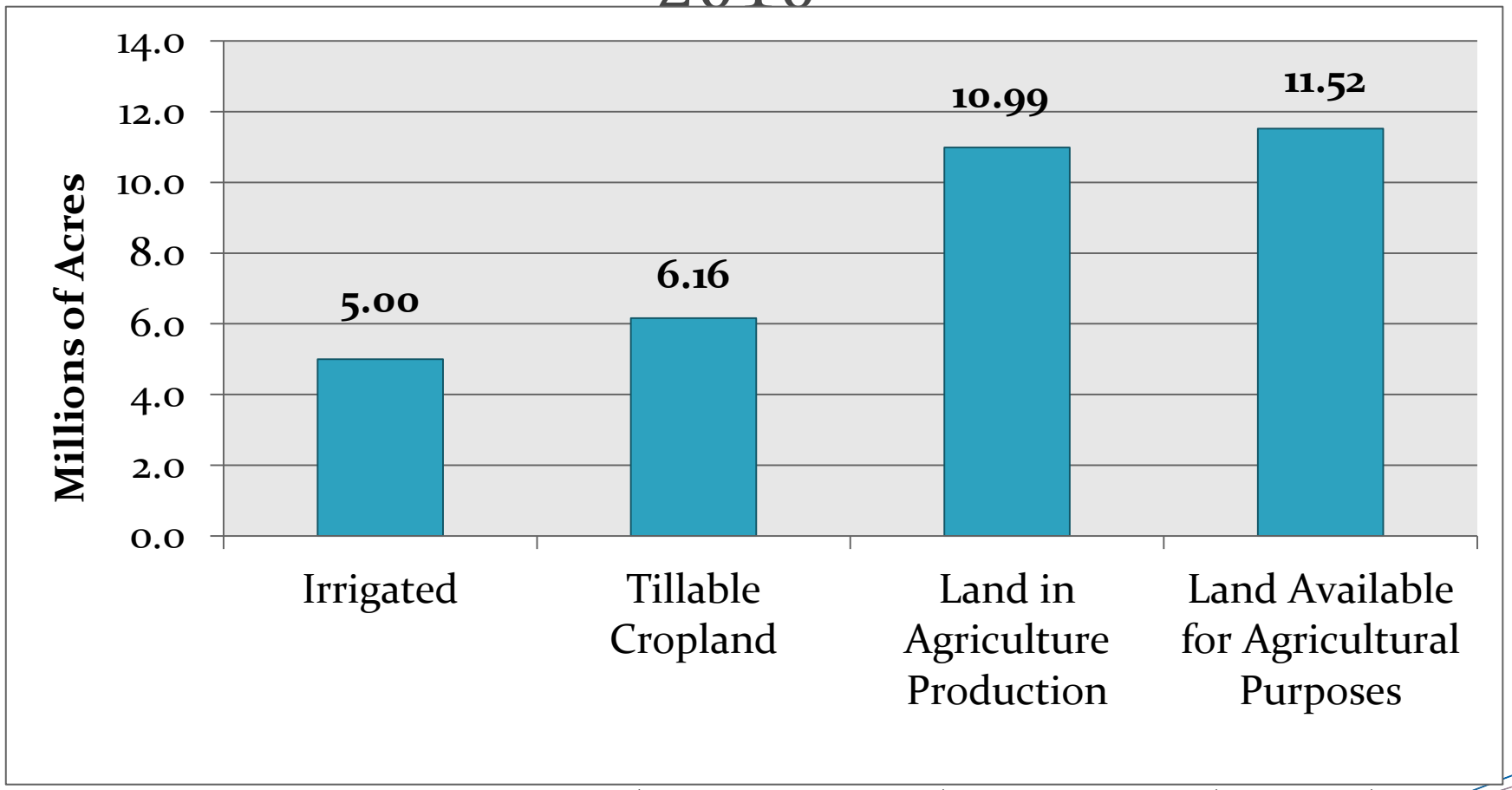
- Some trend models have strong slopes and would produce unreasonable forecast of irrigated acres (only so much land available)
- When trend model reaches a "reasonable maximum" irrigated acres, no more growth assumed



Total Tillable Cropland, and Other Measures

- Reasonable maximum based on Total Tillable Cropland for given county in 2010 from CDL
  - Sum of alfalfa, corn, cotton, oats, rice, sorghum, soybeans, sunflowers, winter wheat, and double cropped acres. Does not include pasture, orchards, or fallow.
- Generated additional statewide measures for comparison (all from 2010 CDL)
  - Land in Agriculture Production: includes all tillable plus pasture grasses, minor crops (blueberries, watermelon, etc) and orchards
  - Land Available for Agricultural Purposes: Includes all land in agricultural production plus fallow/idle acres

Comparison of Agricultural Lands - Statewide 2010



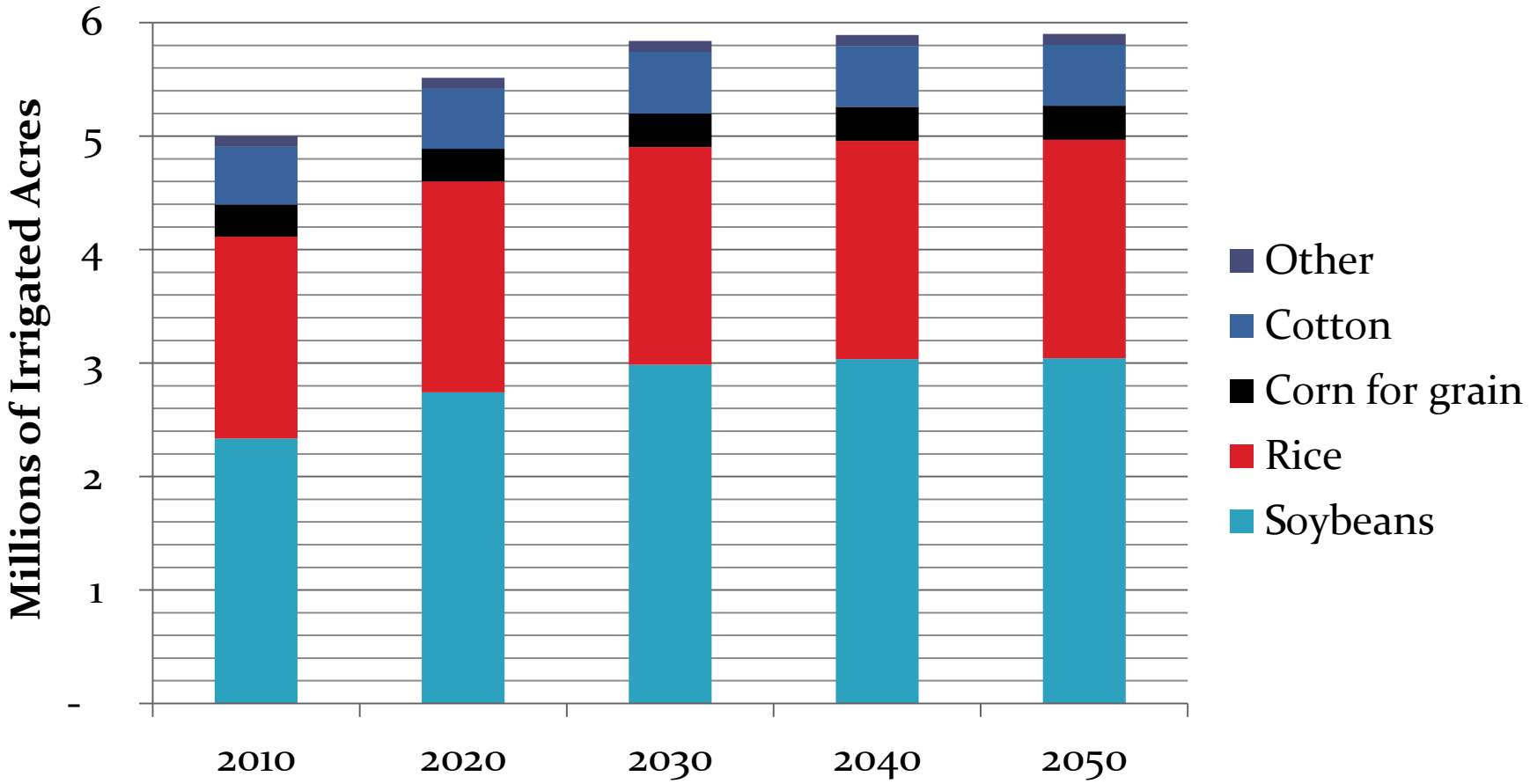
Note: Irrigated derived from CAP (soybean and rice) and WUDBS (all other)

Statistics on "Good Fit" Models for Irrigated Acres

	Total (Time)		Rice (Time)		Soybeans (Time)		Cotton (Time)		Corn (Price)	
	Linear	Log	Linear	Log	Linear	Log	Linear	Log	Linear	Log
Count	24	16	4	2	14	5	3	0	12	12
Percent	65%	43%	11%	5%	43%	16%	11%	3%	32%	32%

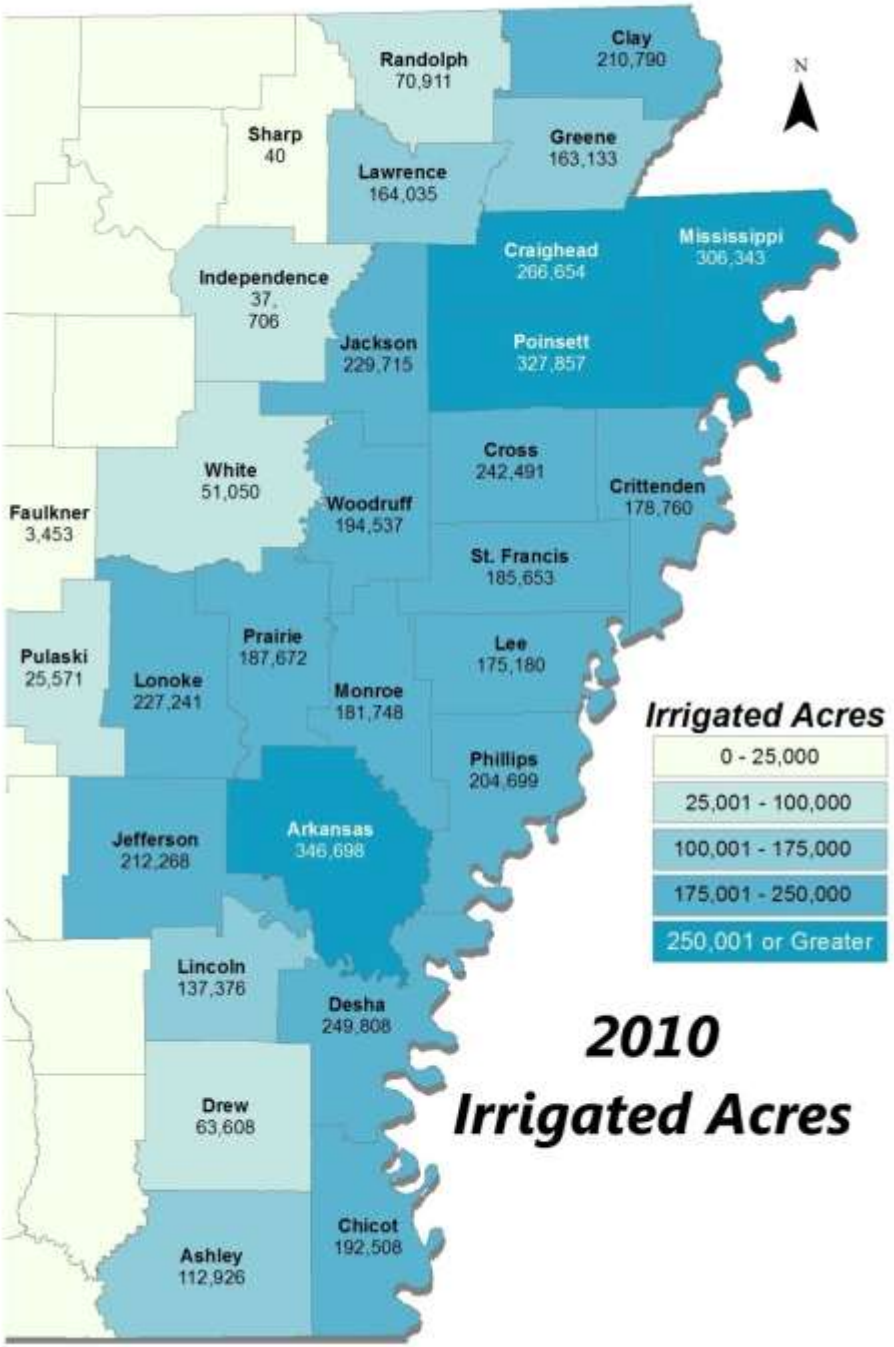
- Analysis conducted on 37 counties with complete datasets
- "Good Fit" defined as having an R^2 0.65 or greater
- General results
  - Price is good indicator of growth in irrigated acres of corn (consistent with recent boom in corn prices, and increases in corn irrigation)
  - Cotton irrigation showed generally declining trends, all other crops increasing
  - For many counties where no strong trends were measured, observed that soybeans went up and down in negative correlation to rice

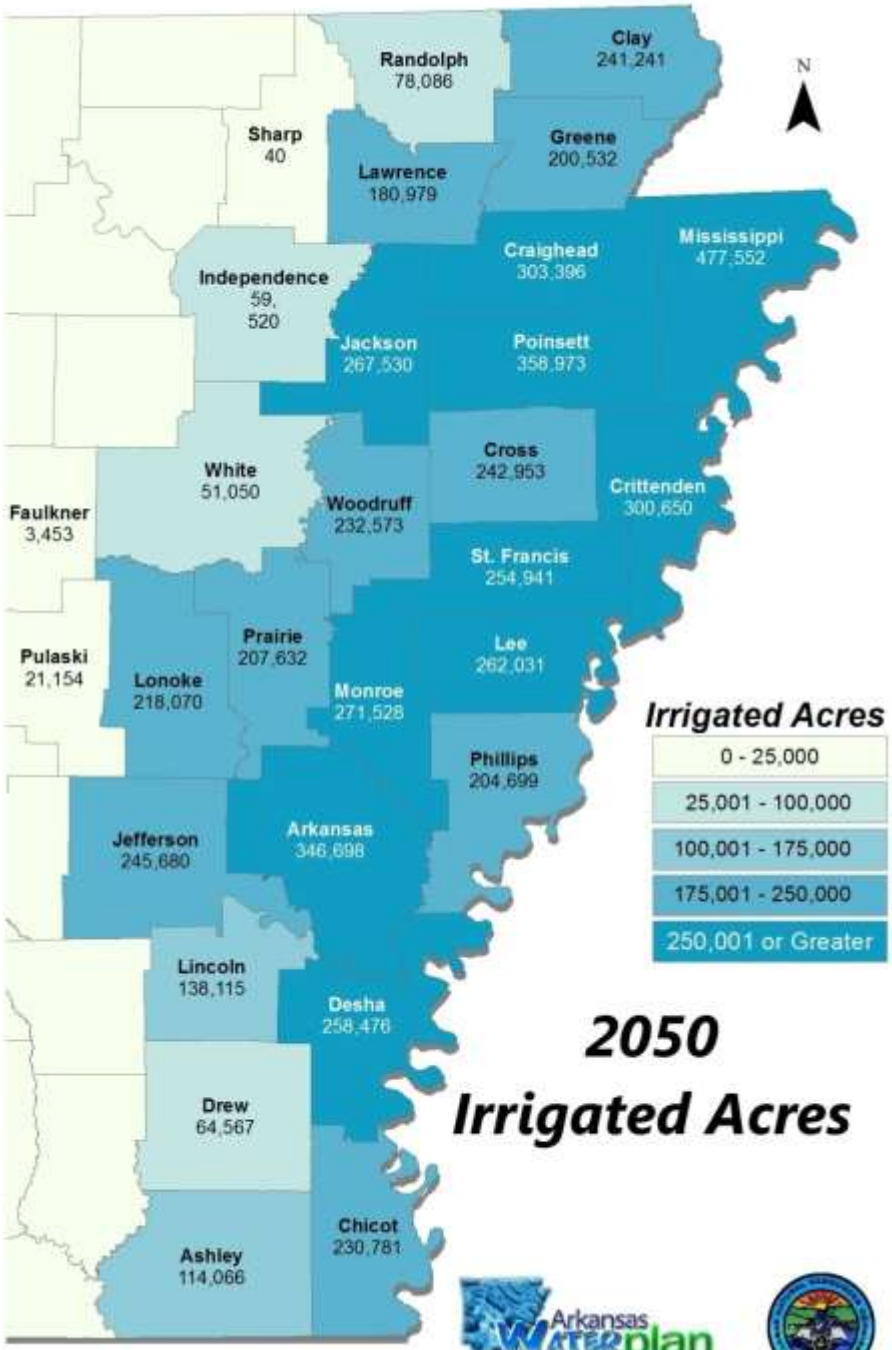
Statewide Results of Irrigated Acreage Forecast



Statewide Results of Irrigated Acreage Forecast

- 18% growth in total irrigated acres overall from 2010-2050 [5.0 million acres to 5.9 million acres]
- 99% of growth experienced by 2030
- 30% Soybean irrigation growth
- 8% Rice irrigation growth
- 5% Cotton irrigation growth
- 6% Corn irrigation growth
- 4% Other irrigation growth
- Many counties not forecasted to experience growth because
  - No significant trend was modeled or
  - Close to or at reasonable max irrigated acres

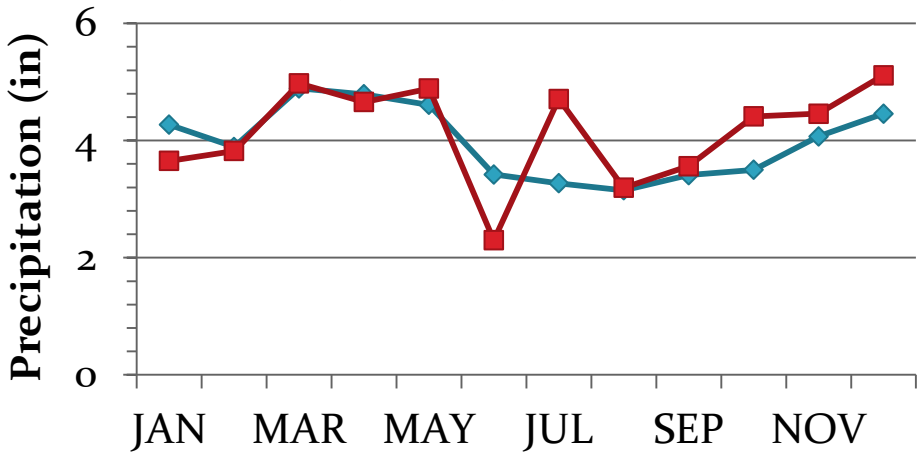

N
Randolph
70,911
Clay
210,790
Sharp
40
Greene
163,133
Lawrence
164,035
Craighead
266,654
Mississippi
306,343
Independence
37,
706
Jackson
229,715
Poinsett
327,857
White
51,050
Cross
242,491
Crittenden
178,760
Faulkner
3,453
Woodruff
194,537
St. Francis
185,653
Pulaski
25,571
Prairie
187,672
Lee
175,180
Lonoke
227,241
Monroe
181,748
Phillips
204,699
Jefferson
212,268
Arkansas
346,698
Lincoln
137,376
Desha
249,808
Drew
63,608
Chicot
192,508
Ashley
112,926
Irrigated Acres
0 - 25,000
25,001 - 100,000
100,001 - 175,000
175,001 - 250,000
250,001 or Greater
2010
Irrigated Acres


N
Randolph
78,086
Clay
241,241
Sharp
40
Greene
200,532
Lawrence
180,979
Craighead
303,396
Mississippi
477,552
Independence
59,
520
Jackson
267,530
Poinsett
358,973
White
51,050
Cross
242,953
Crittenden
300,650
Faulkner
3,453
Woodruff
232,573
St. Francis
254,941
Pulaski
21,154
Prairie
207,632
Lee
262,031
Lonoke
218,070
Monroe
271,528
Phillips
204,699
Jefferson
245,680
Arkansas
346,698
Lincoln
138,115
Desha
258,476
Drew
64,567
Chicot
230,781
Ashley
114,066
Irrigated Acres
0 - 25,000
25,001 - 100,000
100,001 - 175,000
175,001 - 250,000
250,001 or Greater
2050
Irrigated Acres
Arkansas
Waterplan
Essential For Life

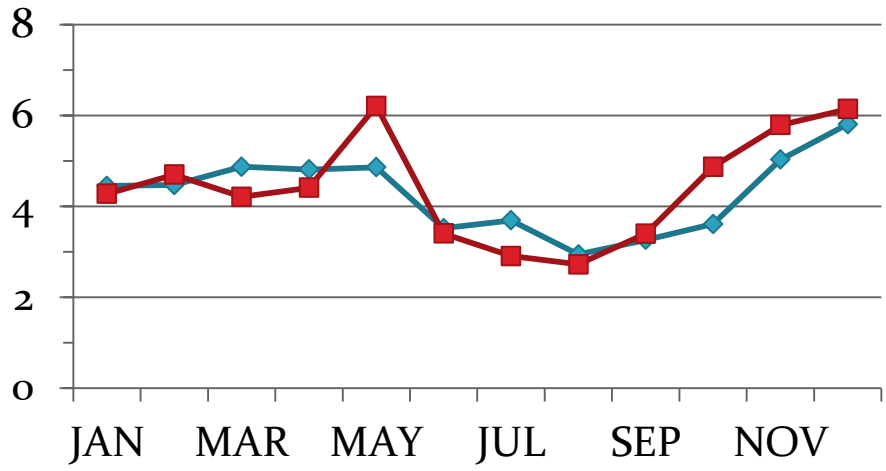
Crop Irrigation Application Rate

- Compute average monthly crop application rate by county and crop type from WUDBS
- Average from 2000-2010 to have data representing average weather conditions
- Data should be considered a “sample”
  - Operators who water two types of crops with a single withdrawal point report monthly water use for both crops together
  - These double reported values were removed from analysis

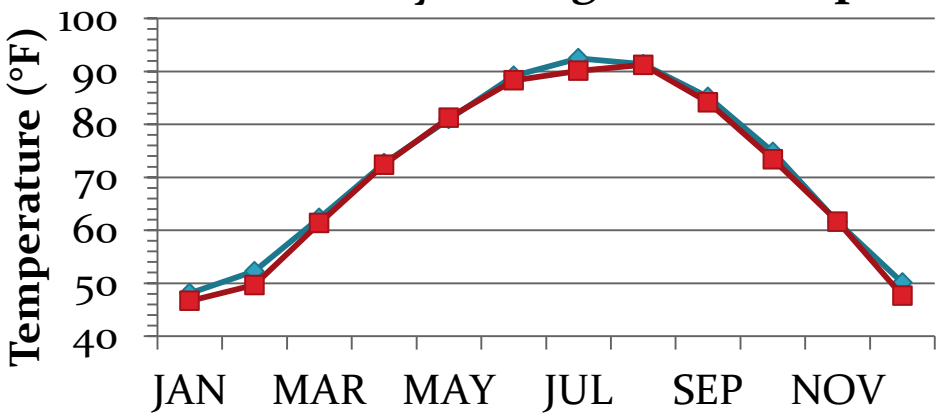
NE Arkansas - Craighead County
Monthly Average Precipitation



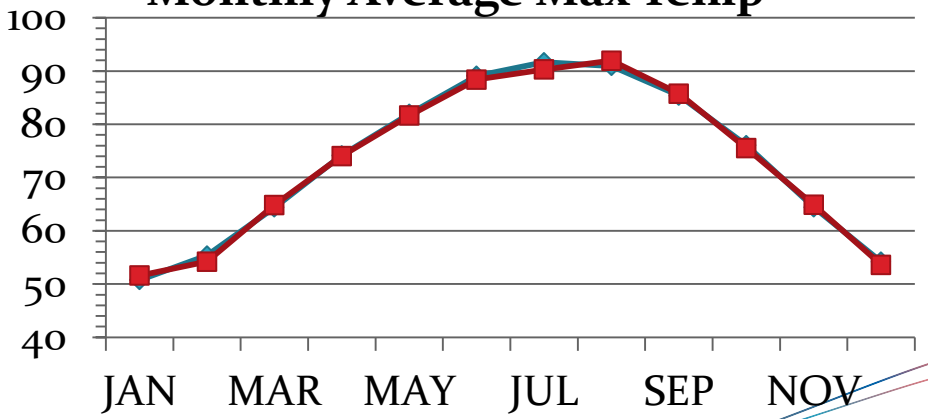
SE Arkansas - Desha County
Monthly Average Precipitation



Monthly Average Max Temp



Monthly Average Max Temp



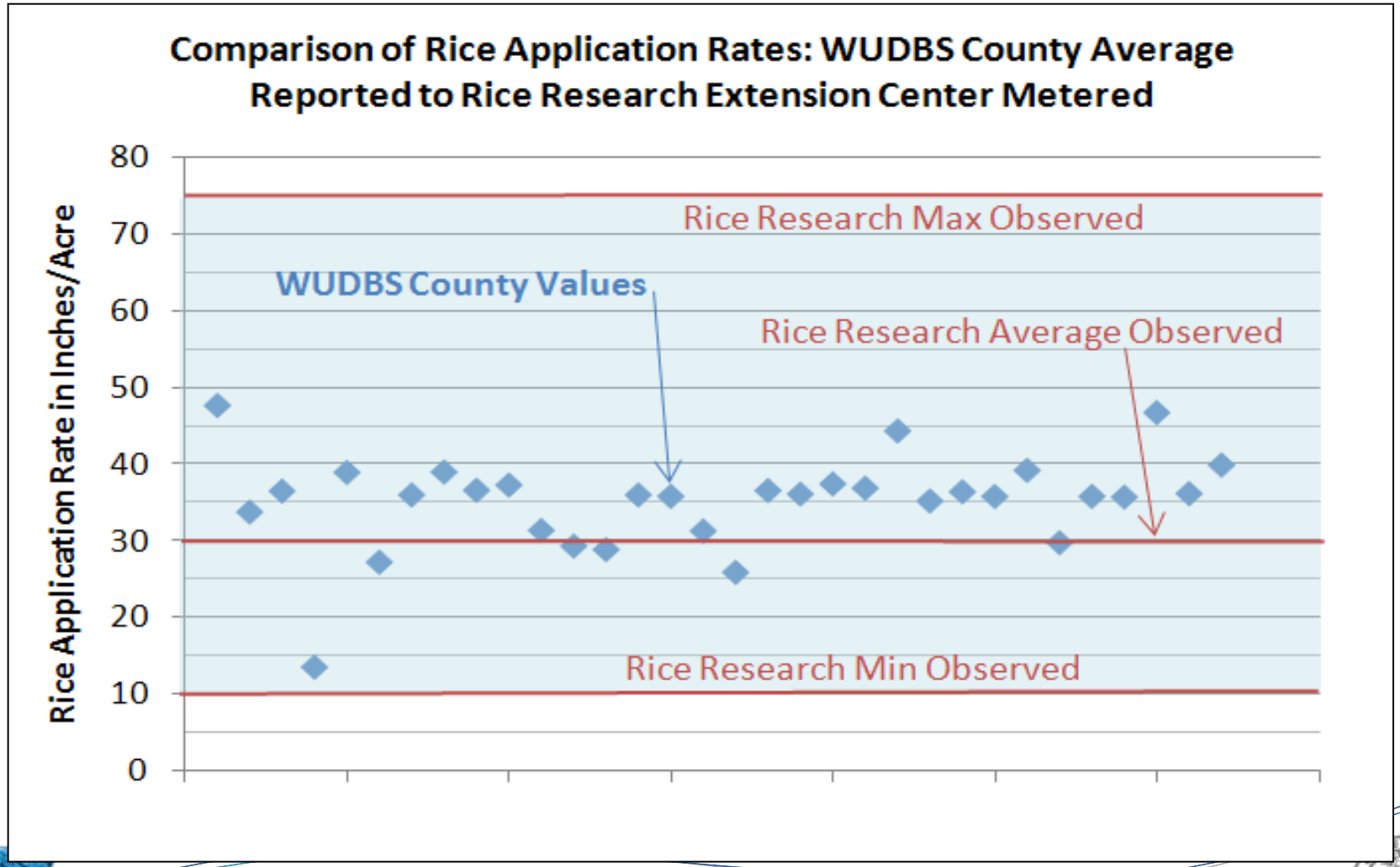
POR 2000-2010

POR – Period of Record

Application Rate Results from WUDBS

Crop	Value	AF/A	In/A
Rice	Min	1.1	13.5
	Max	4.0	47.6
	Average	3.1	37.0
Soybeans	Min	0.1	1.0
	Max	2.7	32.3
	Average	1.4	16.3
Corn	Min	0.2	2.6
	Max	2.5	30.6
	Average	1.3	18.1
Cotton	Min	0.8	9.8
	Max	2.5	30.2
	Average	1.3	15.3

Rice Application Rate Verification



Rice Application Rate Additional Verification

- Southeastern Texas Region (1999-2005)
  - Average 49 inches/acre; Minimum 34.2 inches/acre; Maximum 71.64 inches/acre
- Mississippi Delta Region of Arkansas (Arkansas Agricultural Experiment Station Research Bulletin 9590)
  - Average 29.9 inches/acre; Minimum 8.1 inches/acre; Maximum 35.8 inches/acre
- The YMD (Yazoo Mississippi Delta Joint Water Management District) 2010 Delta Crop Analysis report
  - Average 40.8 inches/acre
- 2013 Arkansas Rice Quick Facts sheet (U of A Extension)
  - Average 30 inches/acre

Crop	Value	In/A
Rice from WUDBS	Min	13.5
	Max	47.6
	Average	37.0

Corn for Grain Application Rate Verification

- Eastern Arkansas Region Comprehensive Study
  - Average 20.6-27.0 inches/acre
  - Derived using Blaney-Criddle
- Texas High Plans regional study
  - Average 21.2 inches/acre
- YMD 2010 Delta Crop Analysis report
  - Average 9.6 inches/acre
- 2013 Arkansas Corn Quick Facts sheet (U of A Extension)
  - Average 20- 30 inches/acre

Crop	Value	In/A
Corn from WUDBS	Min	2.6
	Max	30.6
	Average	18.1

Soybeans Application Rate Verification

- Eastern Arkansas Region Comprehensive Study
  - Average 17.8-23.3 inches/acre
  - Derived using Blaney-Criddle
- YMD 2010 Delta Crop Analysis report
  - Average 13.2 inches/acre
- 2013 Arkansas Soybean Quick Facts sheet (U of A Extension)
  - Average 20- 25 inches/acre

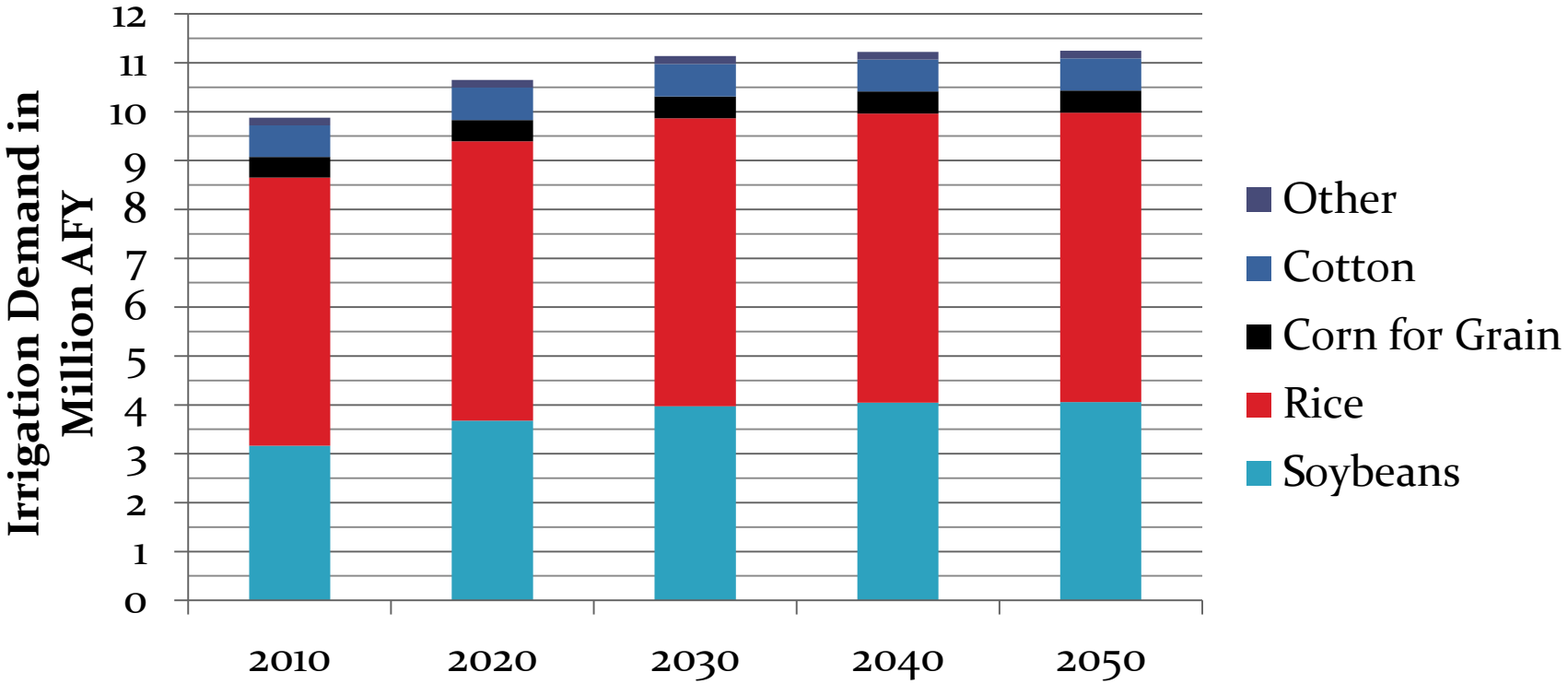
Crop	Value	In/A
Soybeans from WUDBS	Min	1.0
	Max	32.3
	Average	16.3

Cotton Application Rate Verification

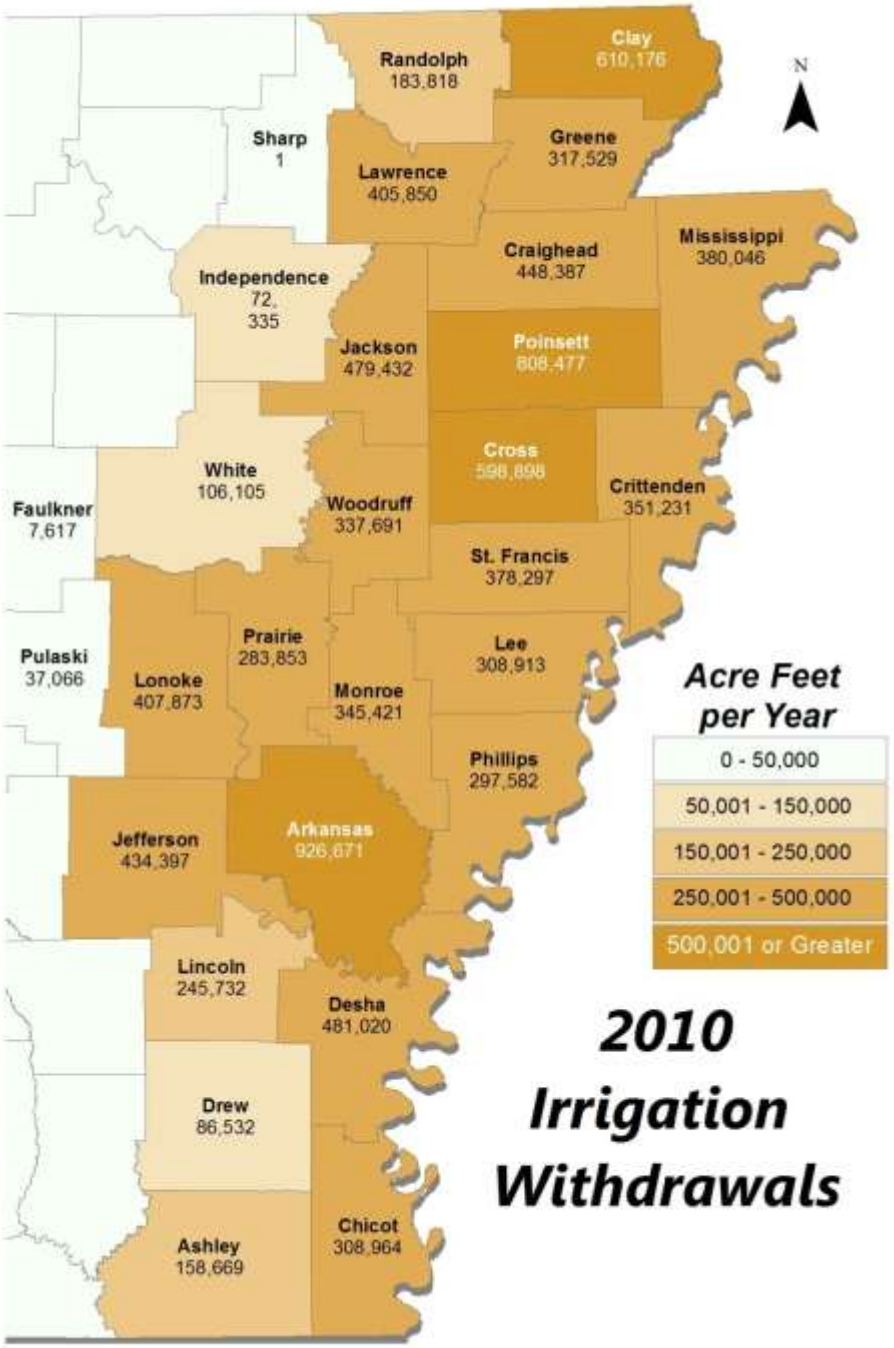
- YMD 2010 Delta Crop Analysis report
  - Average 8.4 inches/acre
- No other sources identified for cotton irrigation

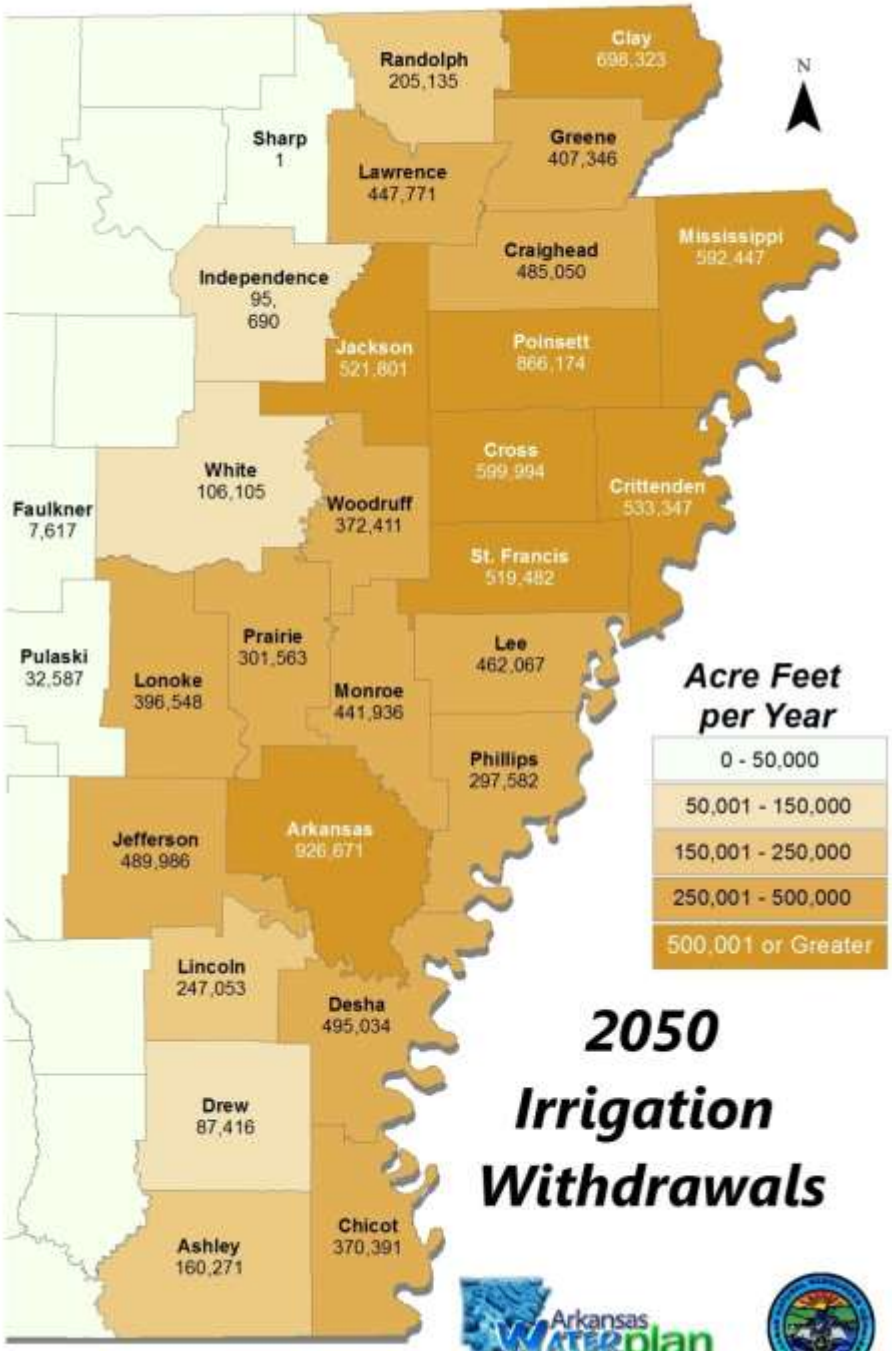
Crop	Value	In/A
Cotton from WUDBS	Min	9.8
	Max	30.2
	Average	15.3

Statewide Results of Irrigation Forecast Withdrawals in AFY

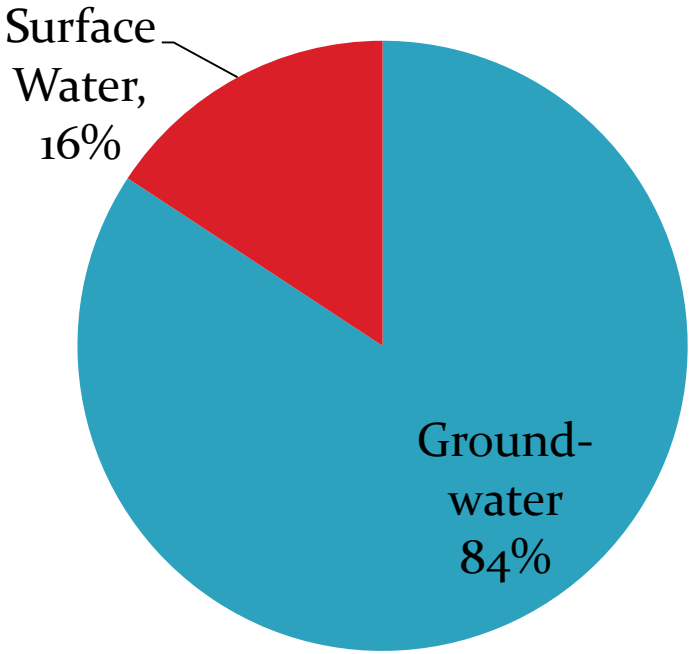


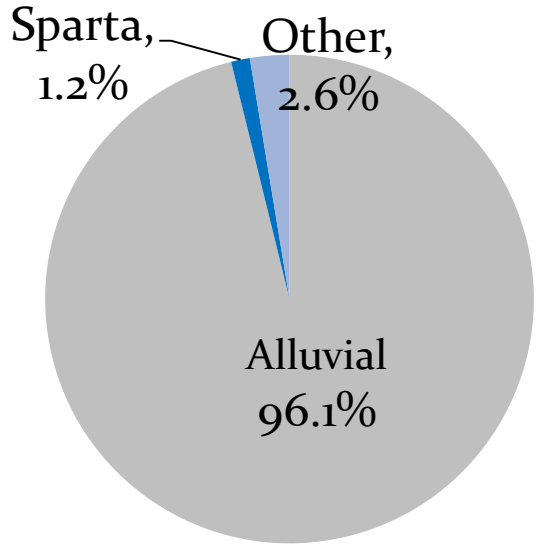
- 14% increase in withdrawals for irrigation from 2010-2050
  [9.88 million AFY to 11.25 million AFY]
- 99% of growth experienced by 2030
- Combination of irrigated acres growth by crop type and specific application rates for crop


Randolph
183,818
Clay
610,176
N
Sharp
1
Greene
317,529
Lawrence
405,850
Craighead
448,387
Mississippi
380,046
Independence
72,
335
Jackson
479,432
Poinsett
808,477
White
106,105
Cross
598,898
Crittenden
351,231
Faulkner
7,617
Woodruff
337,691
St. Francis
378,297
Pulaski
37,066
Prairie
283,853
Lee
308,913
Lonoke
407,873
Monroe
345,421
Phillips
297,582
Jefferson
434,397
Arkansas
926,671
Lincoln
245,732
Desha
481,020
Drew
86,532
Ashley
158,669
Chicot
308,964
Acre Feet
per Year
0 - 50,000
50,001 - 150,000
150,001 - 250,000
250,001 - 500,000
500,001 or Greater
2010
Irrigation
Withdrawals


Randolph
205,135
Clay
698,323
N
Sharp
1
Greene
407,346
Lawrence
447,771
Craighead
485,050
Mississippi
592,447
Independence
95,
690
Jackson
521,801
Poinsett
866,174
White
106,105
Cross
599,994
Crittenden
533,347
Faulkner
7,617
Woodruff
372,411
St. Francis
519,482
Pulaski
32,587
Prairie
301,563
Lee
462,067
Lonoke
396,548
Monroe
441,936
Phillips
297,582
Jefferson
489,986
Arkansas
926,671
Lincoln
247,053
Desha
495,034
Drew
87,416
Ashley
160,271
Chicot
370,391
Acre Feet
per Year
0 - 50,000
50,001 - 150,000
150,001 - 250,000
250,001 - 500,000
500,001 or Greater
2050
Irrigation
Withdrawals
Arkansas
Waterplan
Essential For Life

Statewide Demand Forecast Results by Source

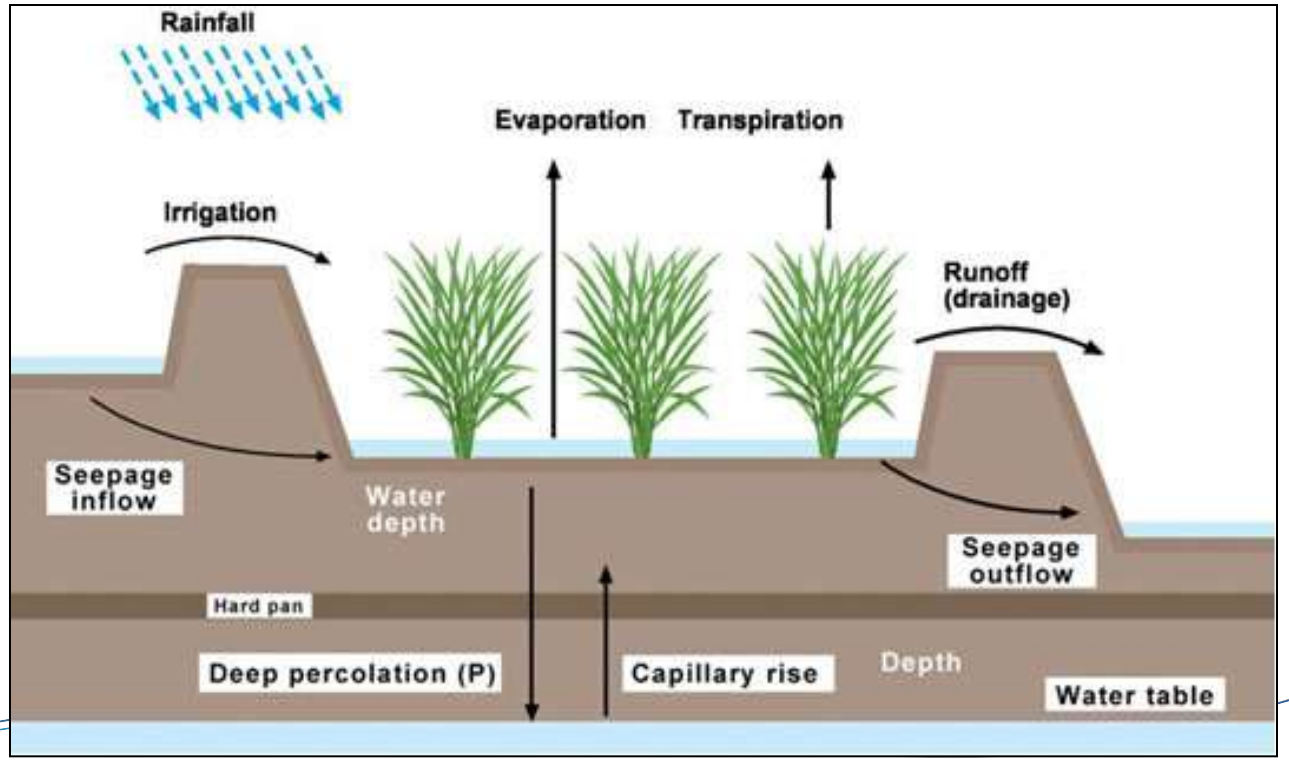




- Results of irrigation withdrawal forecast at county level identified by source of supply from WUDBS (2010)
- Source assumed to remain constant (in terms of percent) to 2050

Non-Consumptive Use

- Irrigation withdrawals currently being analyzed to determine if non-consumptive portion that returns to the environment can be quantified



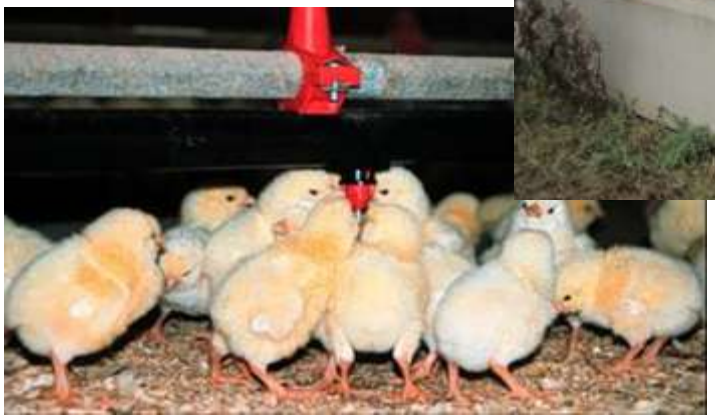
Tailwater Reuse and Relift

- Known that operators in Arkansas capture tailwater or relift supplies and may use this water to irrigate crops or flood fields for waterfowl use
- Currently in process of determining extent of this behavior and the extent to which it can quantified

http://watersustainability.wordpress.com/agriculture/arkansas-discovery-farms/stuttgart/

Livestock Component of Forecast

All Data and Results are Preliminary and Subject to Change



Livestock Water Demand Forecast

- Number of animals x daily water requirement
- County level forecast
  - Daily water use requirement from "USGS Method for Estimating Water Withdrawals for Livestock in the United States", 2009 and review of literature
  - Livestock count from USDA NASS Census of Agriculture (COA) (2007) and USDA NASS County Agricultural Production Survey (CAP) (2012)
  - Growth rate to 2022 derived from national USDA Agricultural Projections through 2022
    - Beef Cattle and Poultry (all other livestock: no growth)
  - Demand from 2022-2050 held constant (no additional growth)

Livestock Categories

- Dairy Cattle
- Beef Cattle
- Hogs and Pigs
- Chickens – Broilers and Layers
- Turkeys
- Sheep, including Lambs
- Goats
- Equine – Horses and Ponies

- Additional specialty animal groups were not evaluated due to data limitations including limited water use information and accurate animal counts

Base Year Animal Counts

- Base Year is based on the most recently available reliable animal inventory data
- Forecast Base Year by Animal Type:
  - Beef Cattle, Dairy Cattle, Hogs and Pigs – **2012 base year**
    - 2012 Statewide CAP Survey data was distributed to counties using 2007 COA county to state inventory ratios
  - Poultry (chickens and turkeys), sheep and goats, horses – **2007 base year**
    - CAP Survey data for Arkansas not available for these animal types
    - USDA Field Office and The Poultry Federation were contacted for additional recent poultry inventories per Work Group suggestions
      - Recent (2012) chicken production data was available and was used to verify historic trends in statewide production, however, the most recent available inventory data was confirmed to be 2007

Selection of Data Set for Animal Water Use

- WUDBS provides animal type, acres, application rate (feet per acre), and total monthly withdrawals or diversions at measurement point identification (MPID) locations for livestock producers reporting water use to ANRC
- WUDBS does not provide animal counts for each MPID, therefore base year livestock inventories and observed animal water use requirements by animal type cannot be derived from WUDBS data
- In 2010 there were 103 unique livestock MPIDs in 32 counties in Arkansas. It is believed that many "sub-threshold" livestock producers in the state are not captured in these data
  - For example, there were zero WUDBS registrations for hogs in 2010, however USDA shows that there were 160,000 hogs in Arkansas in 2010

Livestock Water Use

- Water use requirements include water used for drinking water, cooling, sanitation, and waste removal
- Assumed to be 100% consumption, with no return flows
- Compared animal water use requirements per Work Group input. Sources:
  - USDA NRCS Average Daily Water Requirement
    - Beef Cattle, Dairy Cows, Sheep, Hogs/Pigs, and Horses
  - USGS Average Daily Water Requirement by Livestock Group
    - Minimum, 25th percentile, 50th percentile, 75th percentile, and maximum water requirements based on nation-wide data
    - Dairy Cows, Beef Cattle, Hogs and Pigs, Laying Hens and Broilers, Turkeys, Sheep and Goats, and Horses
  - Review of Available Literature

Livestock Water Requirements

Livestock Group	Range of Water Requirements (Gallons per head per day)(GHD)	Arkansas Water Plan Updated Water Requirements (GHD)
Dairy Cows[1]	18-50	35
Beef Cattle[2]	6.6-16	12
Sheep and Goats[3]	0.7-3.3	2
Hogs and Pigs[4]	1-24	4.5
Chickens[5]	0.02-0.12	0.1
Turkeys[5]	0.05-0.22	0.12
Horses[6]	8.5-15	12

1 Brugger and Dorsey 2006; Lardy et al 2008; Bickert et al 2000; Martin et al 2001; USGS 2009; NRCS 1980
2 Parker et al 2000; Gadberry ; Lardy et al 2008; Martin et al 2001; USGS 2009; NRCS 1980
3 Ministry 2007; USGS 2009; NRCS 1980
4 Froese 2003; Lardy et al 2008; Martin et al 2001; Prairie Swine Center Inc 2000; USGS 2009; NRCS 1980
5 AGRI-FACTS 2008; Bell et al 2002; Martin et al 2001; Williams et al 2013; USGS 2009; NRCS 1980
6 AGRI-FACTS 2008; American 2000; Lardy et al 2008; Ministry 2007; Martin et al 2001; USGS 2009; NRCS 1980

Water Use Seasonality and Life Stage Requirements

- Work Group suggestions included research on animal water use seasonality and variation in water demands based on animal life stage
  - Seasonality estimates vary remarkably based on the type of animal operation; as well as temperature, humidity, and precipitation
    - Annual GHD water use estimates for the Arkansas Water Plan are conservatively assumed based on annual average water use in order to account for seasonal fluctuations
  - COA and CAP Survey data are not reported at a level of detail necessary to provide accurate animal counts by life stage
    - Animal water use for the Arkansas Water Plan can not be dis-aggregated into life stages

Establishing Livestock Counts

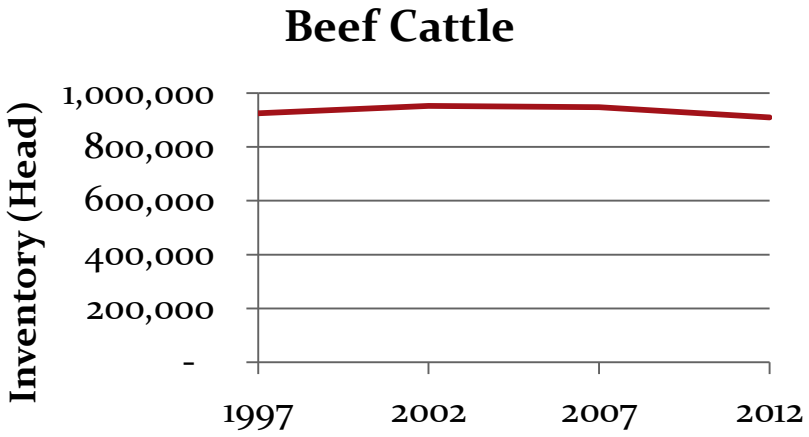
- 2007 COA last complete dataset available for county inventories
  - Undisclosed data for several counties for all livestock groups

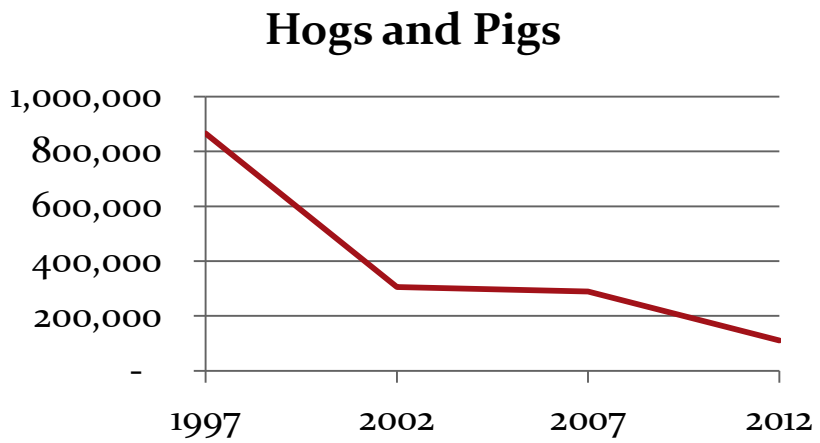
Program	Year	Period	State	County	Data Item	Value
CENSUS	2007	END OF DEC	ARKANSAS	ARKANSAS	CHICKENS, LAYERS - INVENTORY	337
CENSUS	2007	END OF DEC	ARKANSAS	ASHLEY	CHICKENS, LAYERS - INVENTORY	824
CENSUS	2007	END OF DEC	ARKANSAS	BAXTER	CHICKENS, LAYERS - INVENTORY	1,663
CENSUS	2007	END OF DEC	ARKANSAS	BENTON	CHICKENS, LAYERS - INVENTORY	1,664,829
CENSUS	2007	END OF DEC	ARKANSAS	BOONE	CHICKENS, LAYERS - INVENTORY	229,148
CENSUS	2007	END OF DEC	ARKANSAS	BRADLEY	CHICKENS, LAYERS - INVENTORY	317,755
CENSUS	2007	END OF DEC	ARKANSAS	CALHOUN	CHICKENS, LAYERS - INVENTORY	(D)
CENSUS	2007	END OF DEC	ARKANSAS	CARROLL	CHICKENS, LAYERS - INVENTORY	1,147,788
CENSUS	2007	END OF DEC	ARKANSAS	CHICOT	CHICKENS, LAYERS - INVENTORY	114

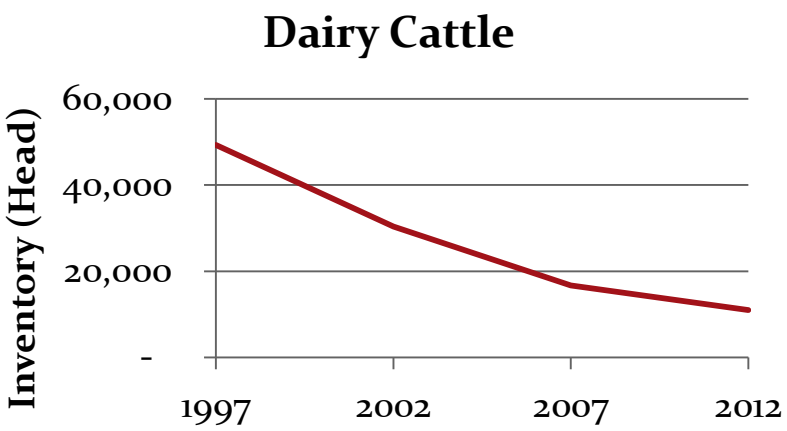
- Non-disclosed data was determined by using historical COA data (2002, 1997)
- In cases with non-disclosed data for the historical period, animal counts of zero were assumed
- 2012 CAP Survey statewide data was applied at the county level using 2007 COA county to state ratios with calibrations to 2012 statewide totals

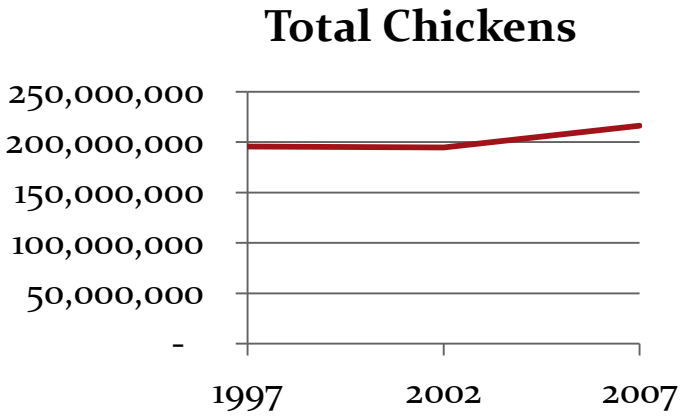
Historical Statewide Animal Counts

Source: COA (1997, 2002, 2007); CAP Survey (2012)









Base Year Livestock Count, Statewide

Animal Type	Base Year Count	Daily Water Requirement (GPD)	Base Year Demands (MGD)	% of Total Base Year Demand
Dairy Cows	11,000[1]	35	0.39	1.4 %
Beef Cattle	909,000[1]	12	10.91	40.6 %
Hogs and Pigs	110,00[1]	4.5	0.5	1.8 %
Chickens	215,082,000[2]	0.1	12.90	48 %
Turkeys	9,339,000[2]	0.12	1.12	4.2 %
Sheep and Goats	67,000[2]	2	0.13	0.5 %
Horses	79,000[2]	12	0.95	3.5 %

1. *Data from the CAP Survey, 2012*
2. *Data from the COA, 2007*

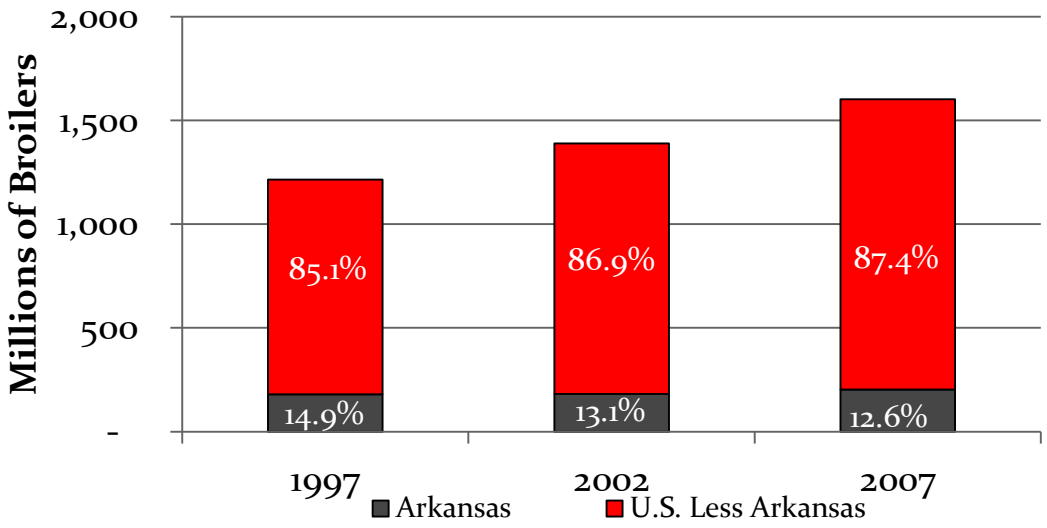
Livestock Projected Growth Rates

- Work Group Suggestions
  - Declining trends shown in USDA Nationwide Agriculture Projections are not likely to continue in Arkansas

- Model Updates
  - No growth is assumed where dairy and beef cattle were previously estimated to decline
  - No growth is assumed for hogs and pigs based on Work Group suggestions as well as input from the Arkansas Farm Bureau and Cargill

Livestock Projected Growth Rates

- Work Group Suggestions
  - USDA poultry projections may be low compared to historic poultry production in Arkansas
- Model Updates
  - Historical chicken inventories in Arkansas show no evidence of an increase in Arkansas' proportional chicken production, therefore poultry projected growth rates are aligned with USDA national projection trends, as originally proposed

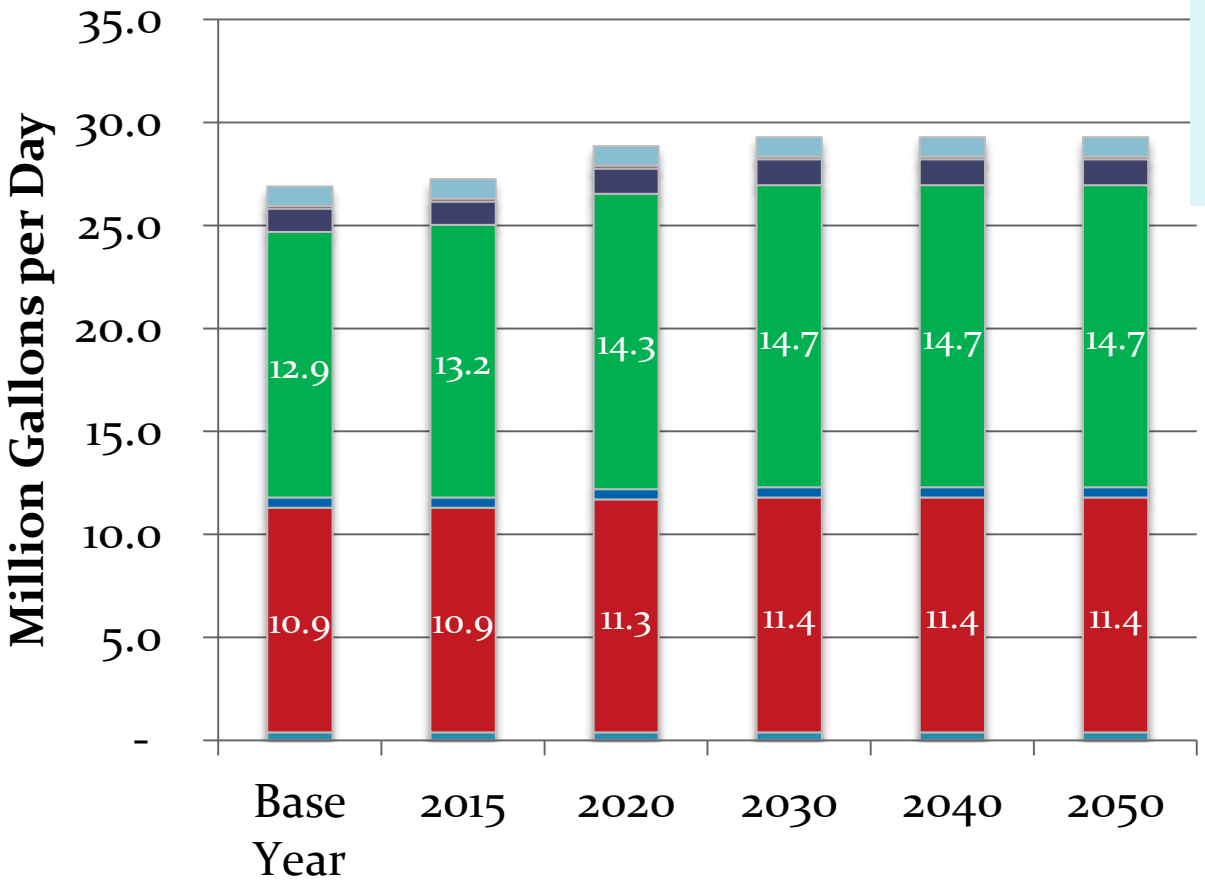


Statewide Animal Counts

Livestock Group	Base Year	2050	Percent Growth
Dairy Cows	11,000	11,000	0%
Beef Cattle	909,000	950,754	4.5%
Sheep and Goats	66,776	66,776	0%
Hogs and Pigs	110,000	110,000	0%
Chickens	215,082,244	244,447,393	13.7%
Turkeys	9,339,092	10,441,336	11.8%
Horses	78,968	78,968	0%

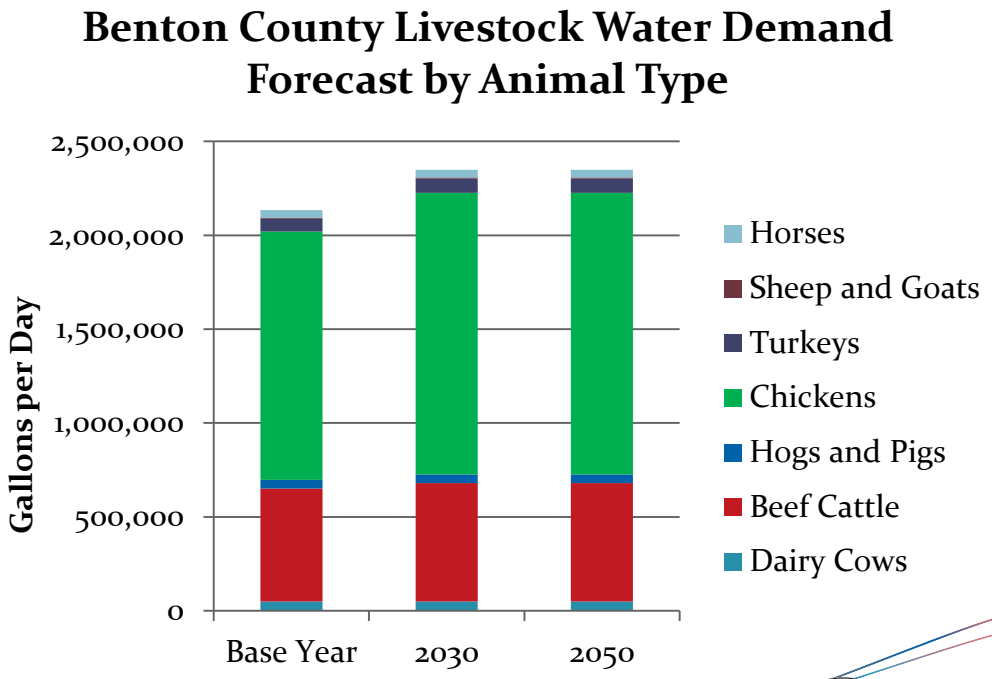
Livestock Annual Water Demand Forecast

Percent Increase
(Base Year - 2022)
Chickens = 13.7%
Beef Cattle = 4.5%
Hogs and pigs = no growth
Dairy cows = no growth



Example: Benton County Livestock Water Use Forecast

Livestock Group	Animal Count Base Year	Animal Count 2050	Percent Change
Dairy Cows	1,398	1,398	0%
Beef Cattle	50,226	52,533	4.5%
Sheep and Goats	2,036	2,036	0%
Hogs and Pigs	10,281	10,281	0%
Chickens	22,024,841	25,005,607	13.7%
Turkeys	577,344	645,485	11.8%
Horses	3,415	3,415	0%



Livestock Source of Supply

- Groundwater vs. Surface Water
  - USGS 2005 county surface water/groundwater ratios used: “Estimated Use of Water in the United States, County-Level Data for 2005”
  - Preliminary 2010 USGS water use estimates for Arkansas have not been completed
  - Arkansas WUDBS data for livestock water use is incomplete because “sub-threshold” livestock producers are not captured in this dataset
- Specific aquifer for groundwater withdrawals
  - Will be determined based on geographic location of water users and “most likely” aquifer
- Statewide Livestock Water Use:

  34% Groundwater; 66% Surface Water

Aquaculture Component of Forecast

All Data and Results are Preliminary and Subject to Change

Aquaculture Water Demand Forecast: Initial Approach

- Derive base year demands, average annual application rates by species type, and acres in production from the WUDBS.

  *Application Rate (In./Acre) * Acres = Demand*

- Analyze trends in aquaculture water use, acreage in production, and mix of species to identify trends in the state
- Determine if trends could indicate future production levels
- Seek guidance from expert Subgroup

Photo: USDA Agricultural Research Service

Aquaculture Water Demand Forecast: Initial Approach Continued

Annual Statewide Aquaculture Water Application Rates (feet/acre/year) by Species Type for Registered Withdrawals in Arkansas: 2000 - 2010												
Species Type	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2000-2010 Average**
NOT CLASSIFIED	3.24	3.67	3.49	3.43	3.32	3.20	3.11	3.24	3.32	3.26	3.34	**3.39**
CATFISH	4.08	4.28	3.94	3.99	3.89	3.88	3.83	3.85	3.73	3.63	3.63	**3.86**
CRAWFISH	1.50	1.71	1.72	1.68	1.56	1.92	2.15	2.32	1.95	1.35	1.07	**1.76**
GOLDFISH	4.00	1.97	1.67	4.00	4.00	3.06	2.79	3.23	3.26	3.19	3.05	**3.06**
MINNOWS	4.31	4.06	4.05	4.08	3.95	3.38	3.70	3.82	3.95	3.34	3.33	**3.73**
TROUT	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1.00	No Data	No Data	**1.00**

- Literature derived application rates for catfish range from **11.73 inches** (0.98 feet) per year to **41.04 inches** (3.42 feet) per year depending on the management scheme implemented
- WUDBS 2000-2010 average catfish water application rate is **46.32 inches** (3.86 feet)

Aquaculture Water Demand Forecast: Feedback

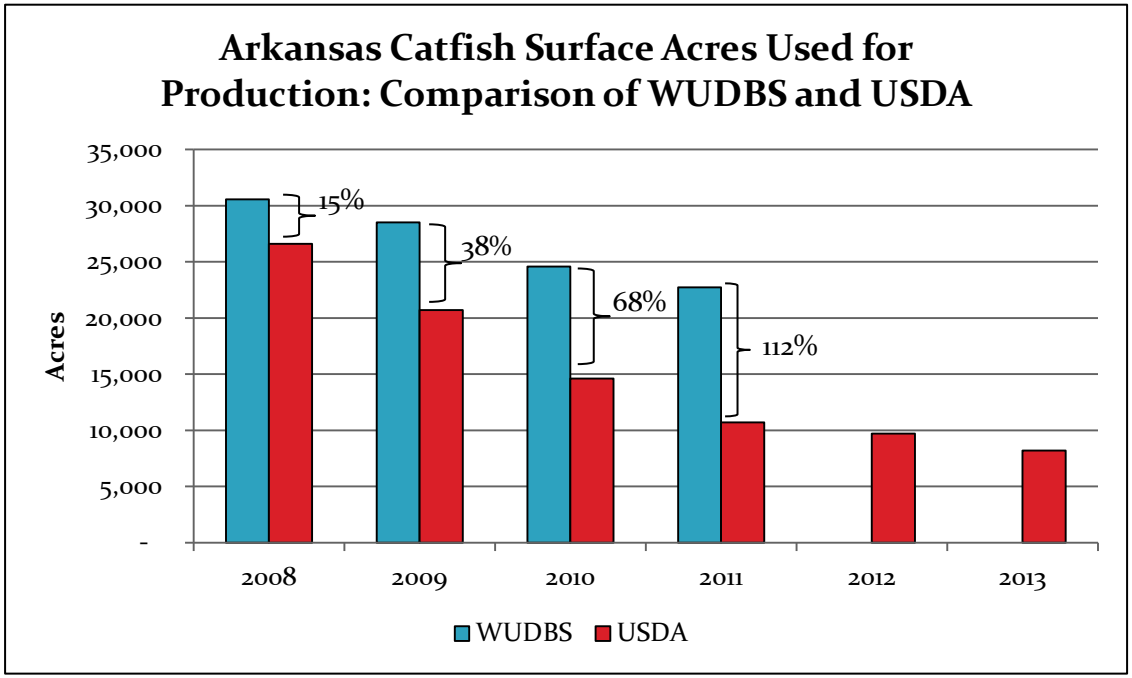
- WUDBS data (producer-reported) is likely overstating total water use, average annual application rates by species types, and acres in production for most or all species types
- Actual declines in production for some species are more significant than WUDBS data indicates
- Reported withdrawals by species type were likely misreported prior to 2005
- WUDBS reported acres in production is high for catfish; difficult to confirm this for other species types
- Catfish production has declined further since 2010 (the last year of WUDBS data initially analyzed)

Aquaculture Water Demand Forecast: Feedback - Continued

- Obtain more recent WUDBS data to determine if production and water use declines align with expert knowledge
- Obtain Arkansas Game & Fish license data for information that could be used to establish base year production acreage by species type
- Review literature for average annual application rates and acres in production

Catfish Acreage Trends and Data Sources

- USDA Arkansas catfish production acreage is consistently less than the WUDBS reported data
- USDA does not compile acreage data for any other aquaculture species types
- Declining trend shown for both data sets



Aquaculture Water Demand Forecast: Revised Approach

- Assume state-level USDA 2012 catfish acres of 9,700 is base year state total
- Proportionally distribute base year catfish acre to counties based on county proportions derived from the WUDBS
- For all other species types, use WUDBS, producer-reported data for 2011 (most recent year available) for base year acreage
- Relied upon Subgroup expertise to establish average annual application rates by species type. Final assumptions pending approval

Aquaculture Water Demand Forecast: Assumptions Under Subgroup Review

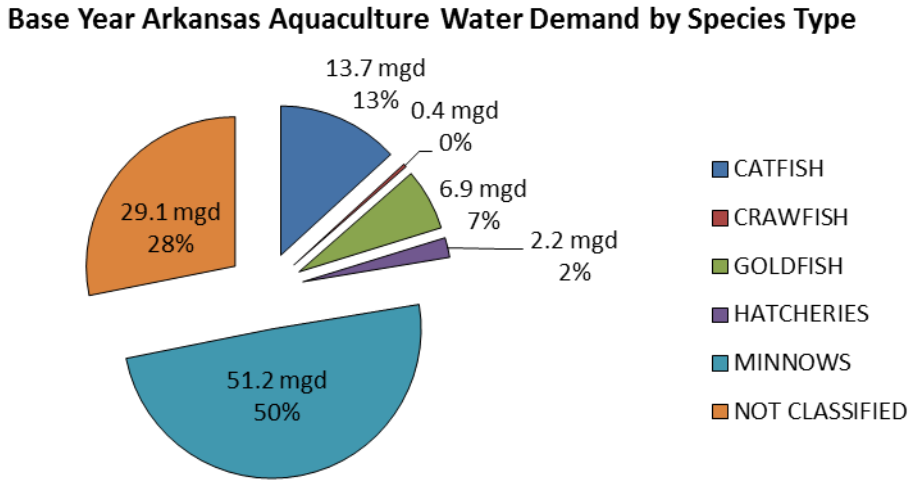
- Average Annual Application Rates:
  - Catfish – 19 inches/year (15 inches/year + pond refill of 40 inches every 10 years)
  - All other species (except crawfish) – 36 inches/year (less than WUDBS showed and the upper range of the Subgroup recommendation)
  - Crawfish – 18 inches/year (half the rate for all other species types, except catfish)
- Future Growth in Acreage
  - Subgroup cautioned about uncertainty in the industry due to market and regulatory influences
  - Highly susceptible to regulatory restrictions
  - Conservative approach adopted: ***No projected growth or decline in acreage from the base year***

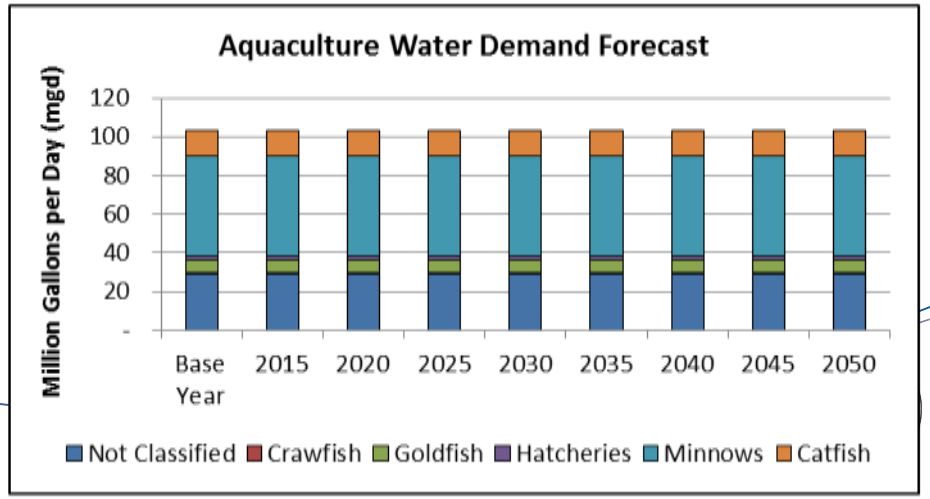
Aquaculture Water Demand Forecast: Base Year Statewide Acres by Species Type

Species Type	Base Year Acres	Data Source	Percent of Total
Catfish	9,700	USDA	25%
Crawfish	267	WUDBS	1%
Goldfish	2,576	WUDBS	6%
Hatcheries	827	WUDBS	2%
Minnows	19,119	WUDBS	44%
Not Classified	10,880	WUDBS	22%
Total	43,369		100%

Aquaculture Water Demand Forecast: Results

- Total base year demands are 103.43 mgd
- About half of statewide aquaculture demands are from minnow production
- By regulation, all aquaculture water comes from groundwater sources
- Demand occurs in 24 counties mainly in central and eastern Arkansas



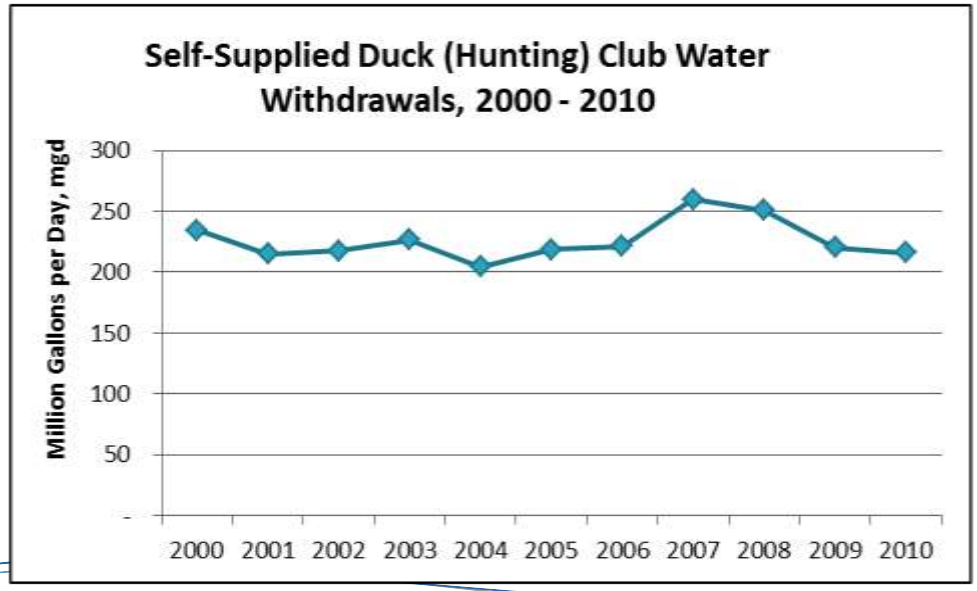


Duck Hunting Component of Forecast

RICE AND DUCK CAPITAL OF THE WORLD - STUTTGART, AR

Duck Hunting & Habitat Maintenance: Initial Approach

- Examined registered self-supplied Duck (Hunting) Club water withdrawals from the WUDBS
- Trends show relatively steady withdrawals from 2000 to 2010
- Driver(s) of future demands could not be identified

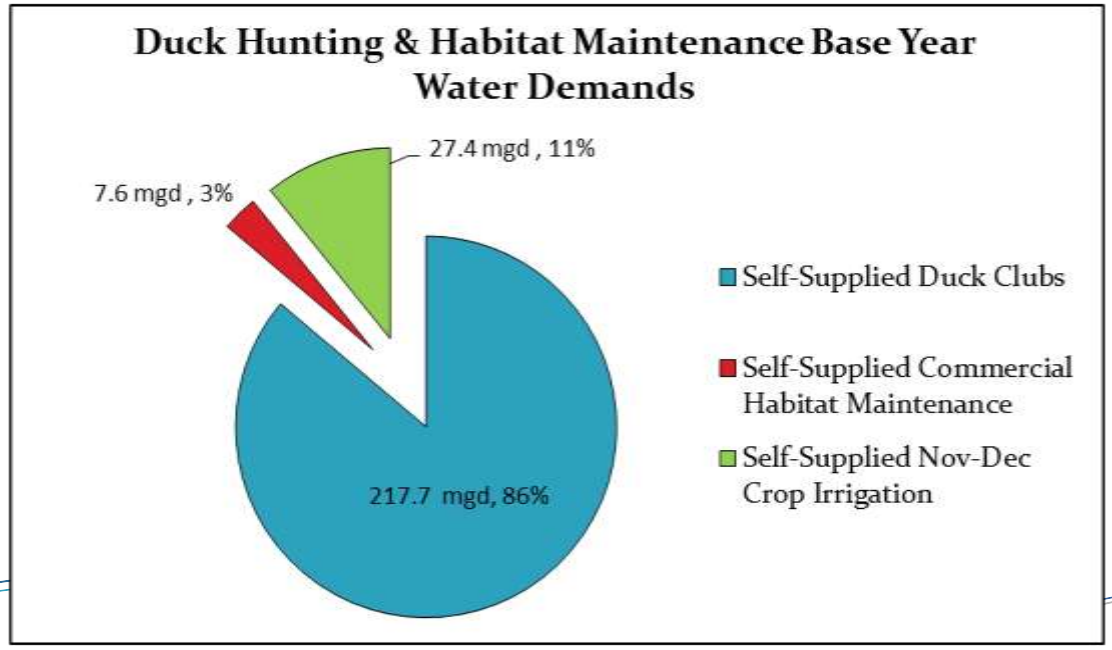


Duck Hunting & Habitat Maintenance: Feedback

- Some farmers flood fields in the off season for duck hunting habitat.
- WUDBS does not allow for distinguishing water demand applied to crops vs. water demand used to flood fields for duck habitat
- Work Group advised that November and December reported withdrawals are most likely to be for duck hunting habitat purposes
- Extracted November and December crop irrigation water withdrawals on lands used for the following crops:
  - Corn for grain
  - Milo
  - Rice
  - Sorghum
  - Cotton
  - Oats
  - Soybeans

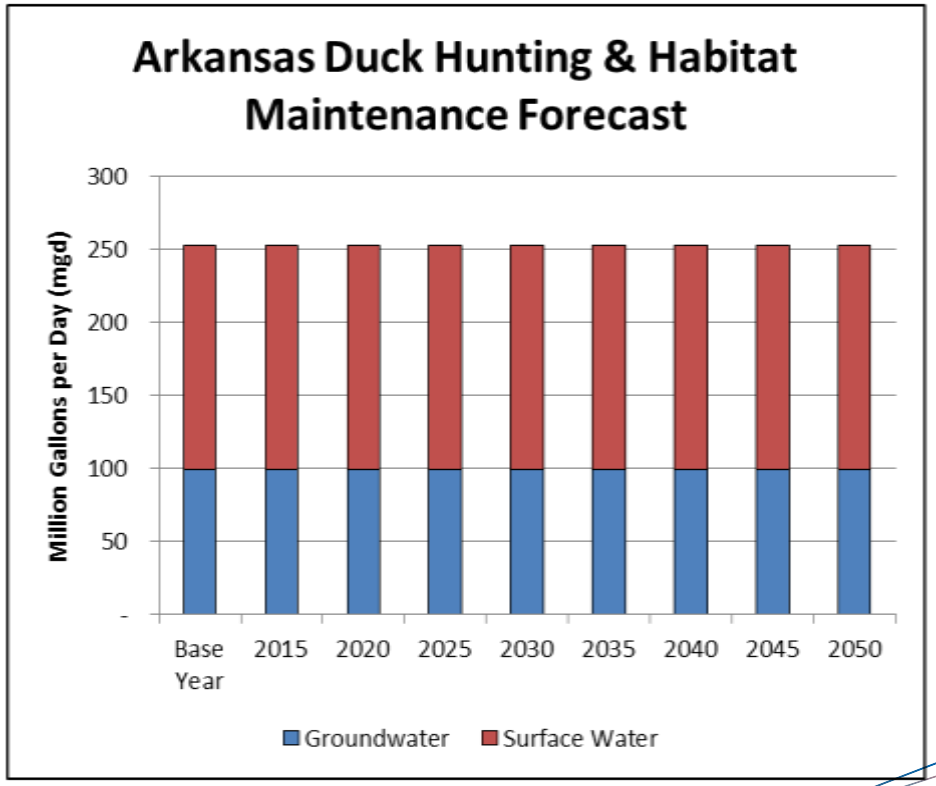
Duck Hunting & Habitat Maintenance: Revised Approach

- Incorporated “off-season” crop irrigation demands into the sector demands
- Sector demands also include Arkansas Game & Fish Commission habitat maintenance demands derived from the WUDBS commercial database
- Base year demands are held constant through 2050



Duck Hunting & Habitat Maintenance: Forecast Results

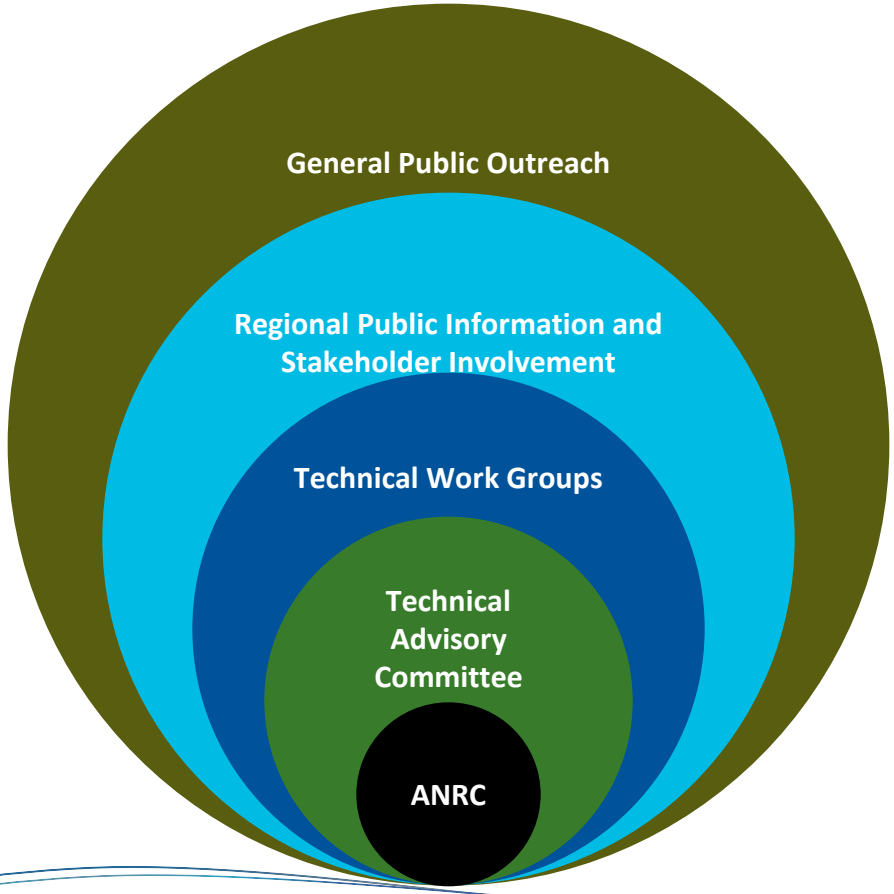
- Duck Hunting Clubs use about 64% surface water and 36% groundwater.
- Habitat maintenance uses about 98% surface water and 2% groundwater
- Crop irrigation duck hunting water use is about 26% surface water and 74% groundwater
- Overall, duck hunting & habitat maintenance uses about 40% groundwater and 60% surface water



Next Steps – Completing Forecast Results

- Incorporate feedback from today's meeting
- Send any additional "fatal flaw" comments by May 13, 2013
- Conduct Public Information and Stakeholder Involvement Meetings
- Finalize the Demand Methodology White Paper based on input from the Work Group and the upcoming June meetings
- For municipal water providers, and in support of the forecast, gather information over the next 3 months to identify major challenges and findings at the "local level" i.e., master planning, infrastructure etc.

Next Steps - Information Exchange Summary for Arkansas Water Plan Update



Next Steps – Public Information and Stakeholder Involvement

- Dates and Meeting Locations
- Meeting Attendance by Work Group Members

Arkansas Water Plan Update

Schedule of Statewide Public Information and Stakeholder Involvement Meetings
Existing and Future Water Use/Needs Forecasting
June 2013

DATE	LOCATION
Monday, June 3, 2013 6:30 – 8:00 p.m.	Arkadelphia Henderson State University - Garrison Center Lecture Hall 1045 McKnight Drive
Tuesday, June 4, 2013 6:30 – 8:00 p.m.	Fort Smith Fort Smith Convention Center 800 Rogers Avenue
Wednesday, June 5, 2013 1:30 p.m.	Little Rock Arkansas Game & Fish Commission Auditorium # 2 Natural Resources Drive
Thursday, June 6, 2013 6:30 – 8:00 p.m.	Stuttgart Phillips Community College - Grand Prairie Center, Salon B 2709 Highway 165 South
Thursday, June 6, 2013 6:30 – 8:00 p.m.	Harrison North Arkansas College - Durand Center, Durand B 303 North Main Street
Tuesday, June 11, 2013 3:00 p.m. and 5:30 p.m.	Fayetteville Pauline Whitaker Animal Science Center 1335 W. Knapp St.
Wednesday, June 12, 2013 3:00 p.m. and 5:30 p.m.	Clinton Annex Court House Room 1414 Hwy 65 South
Thursday, June 13, 2013 1:00 p.m.	Searcy Carmichael Community Center 801 S. Elm St.
Monday, June 17, 2013 6:30 – 8:00 p.m.	Jonesboro Arkansas State University - Convocation Center Stadium Boulevard
Tuesday, June 18, 2013 6:30 – 8:00 p.m.	Forrest City East Arkansas Community College - Fine Arts Center Banquet Hall 1700 New Castle Road
Wednesday, June 19, 2013 5:30 p.m.	Heber Springs Community Center 201 Bobbie Jean Lane
Thursday, June 20, 2013 6:30 – 8:00 p.m.	Smackover Arkansas Museum of Natural Resources 3853 Smackover Highway

The following public meetings are in the planning stages. Please check the website at www.arwaterplan.arkansas.gov for developing details for all meetings.

Tuesday, June 4, 2013: **Pine Bluff**; Assoc. of Conservation Districts

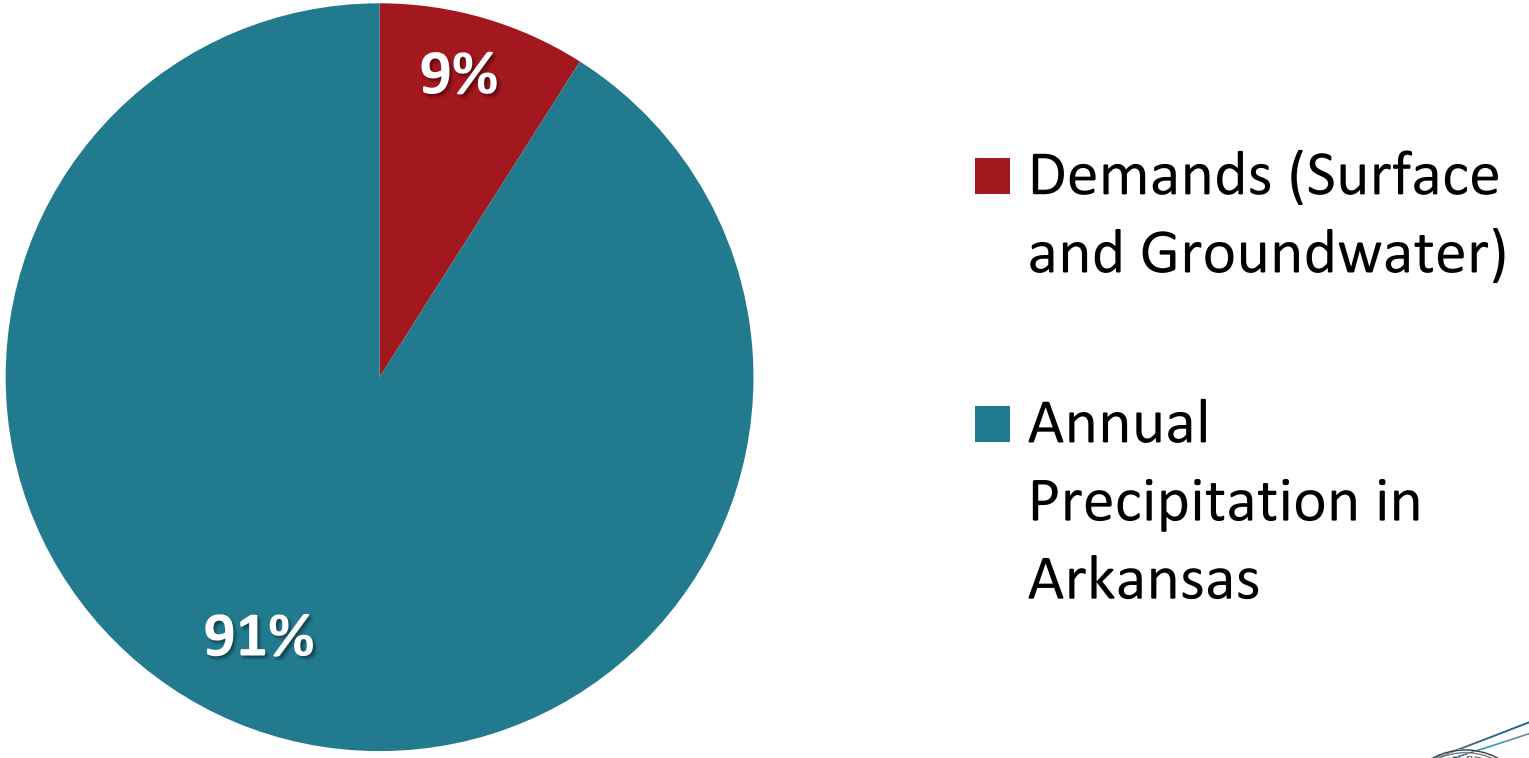
Thursday, June 6, 2013: **Russellville**; Assoc. of Conservation Districts

Please e-mail questions, comments, or suggestions to ArkansasWater@cdmsmith.com. The Arkansas Water Plan Update website also has additional information: www.arwaterplan.arkansas.gov.

Prepared by CDM Smith and FTN Associates 05-1-13

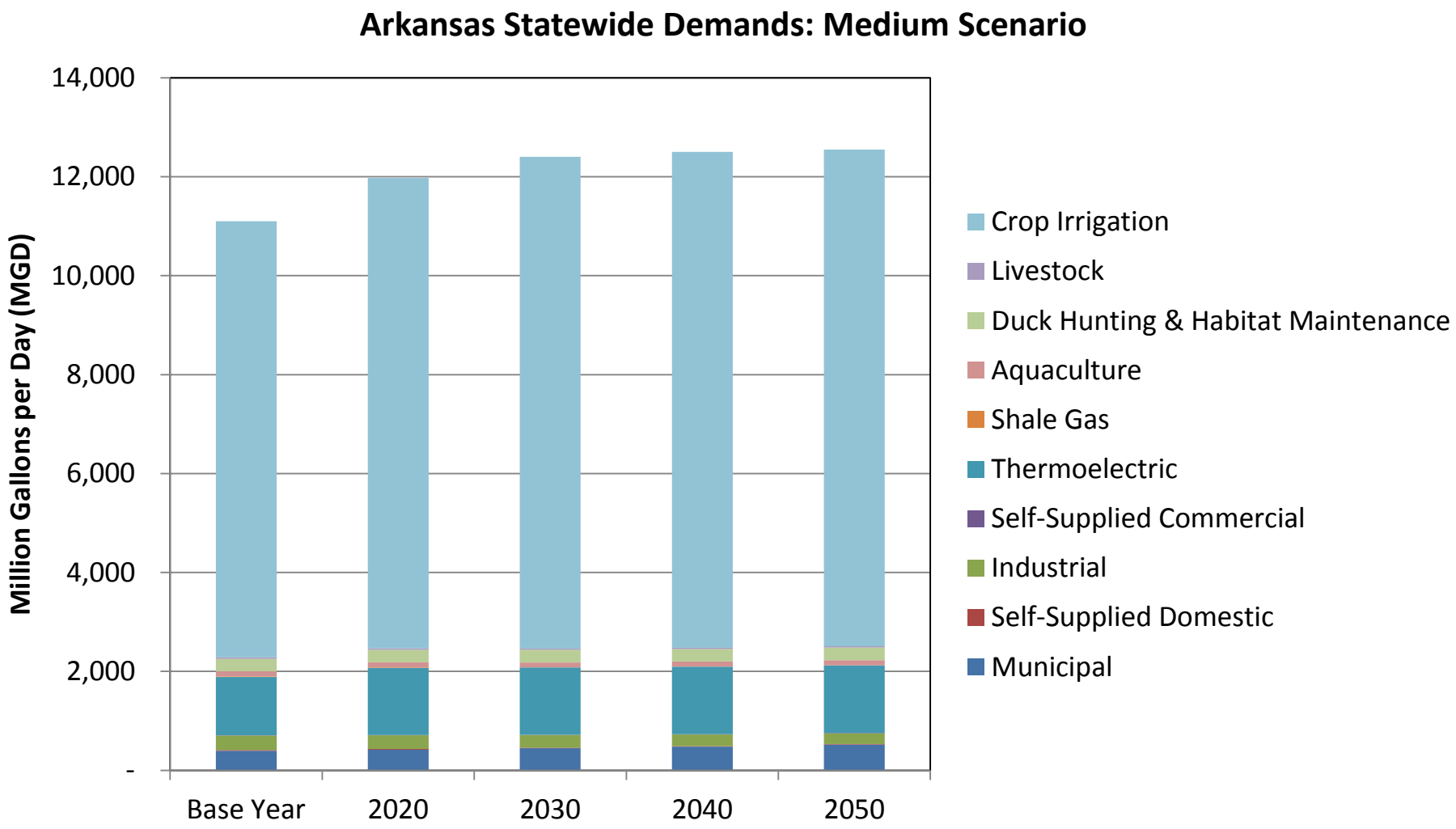
Statewide Forecast Results

Current Water Withdrawals in Arkansas are about 10% of Total Precipitation that falls on the State Annually



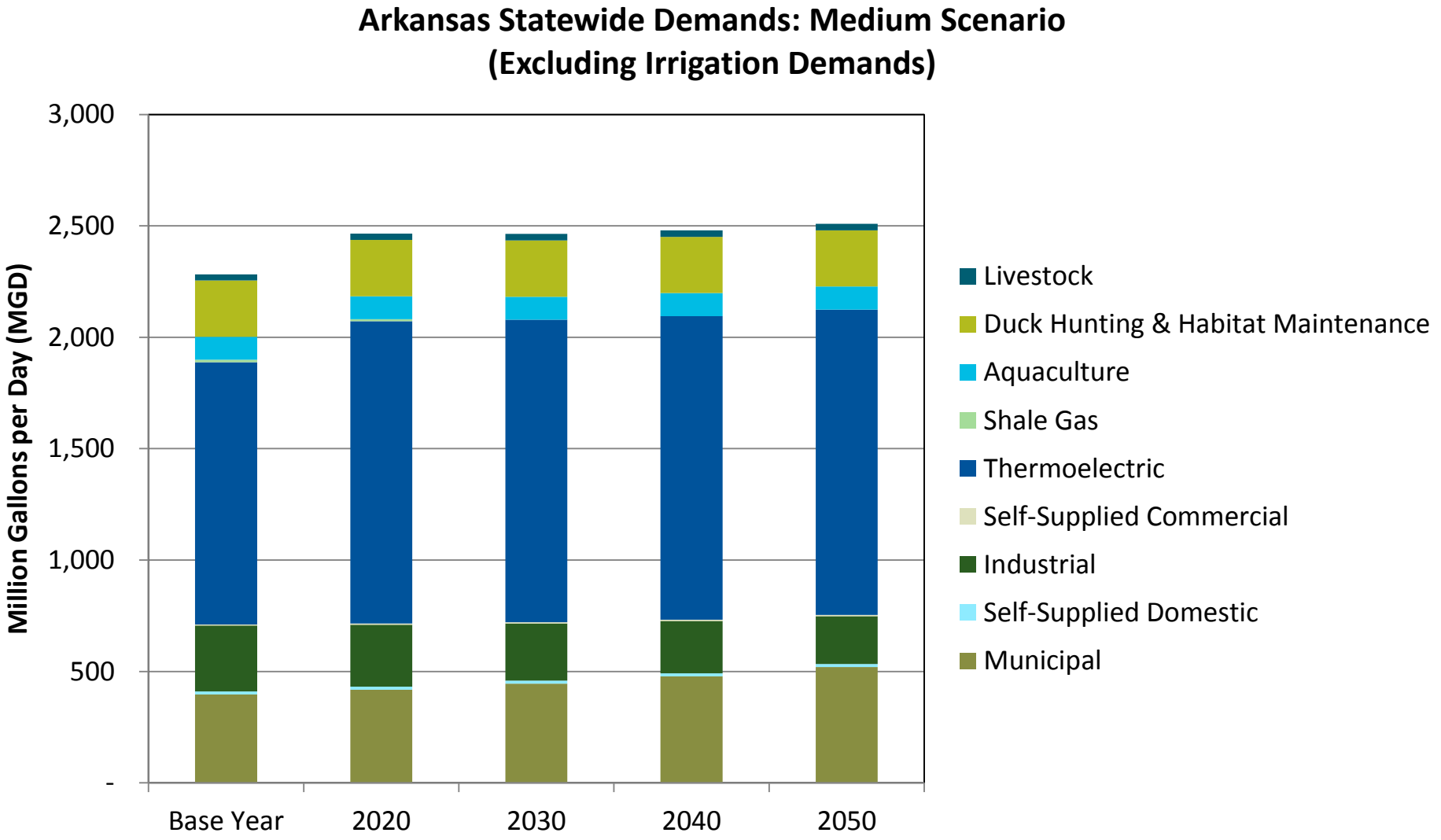
Statewide Water Forecast – All Demand Sectors

Total statewide water use forecasted to increase 13%



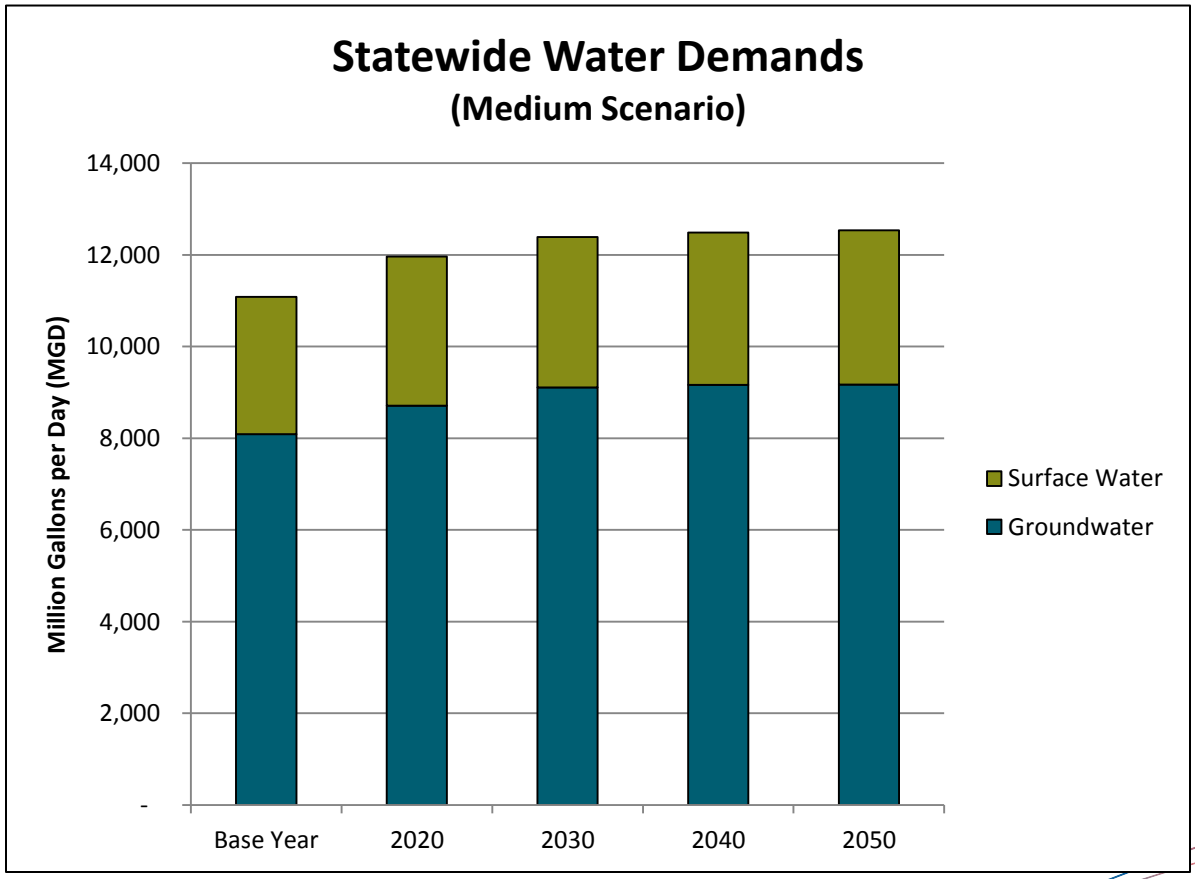
Statewide Water Forecast - Excluding Irrigation

Statewide increase of 10% for all non-irrigation sectors

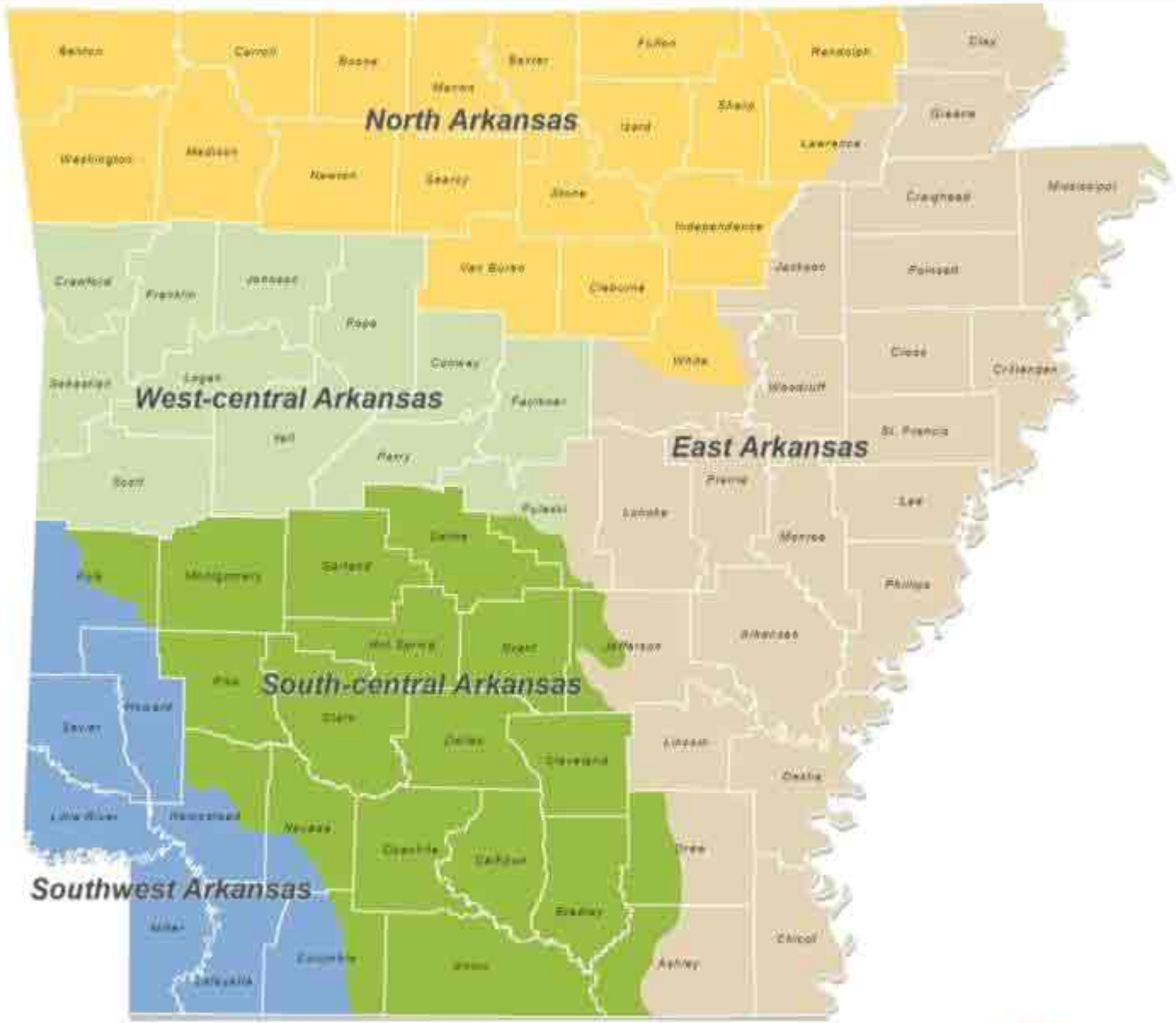


Statewide Water Forecast by Source of Supply

- All Sectors 73% Groundwater
- All Sectors 27% Surface Water
- Agriculture 85% Groundwater
- Municipal 71% Surface Water



Water Resources Planning Region Results



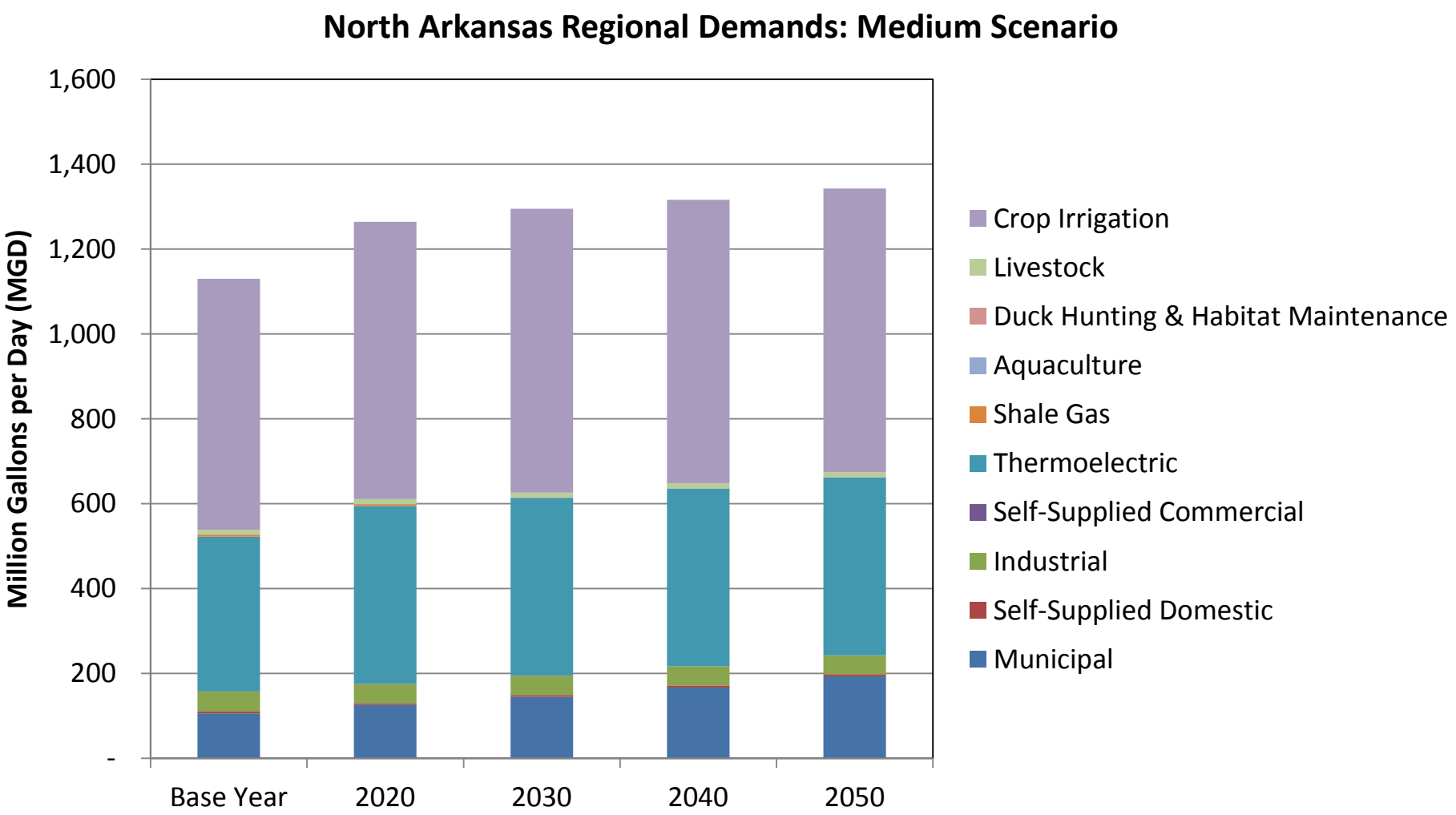
Water Resources Planning Regions

East Arkansas Water Resources Planning Region
North Arkansas Water Resources Planning Region
South-central Arkansas Water Resources Planning Region
Southwest Arkansas Water Resources Planning Region
West-central Arkansas Water Resources Planning Region

Arkansas Water Plan
Essential For Life

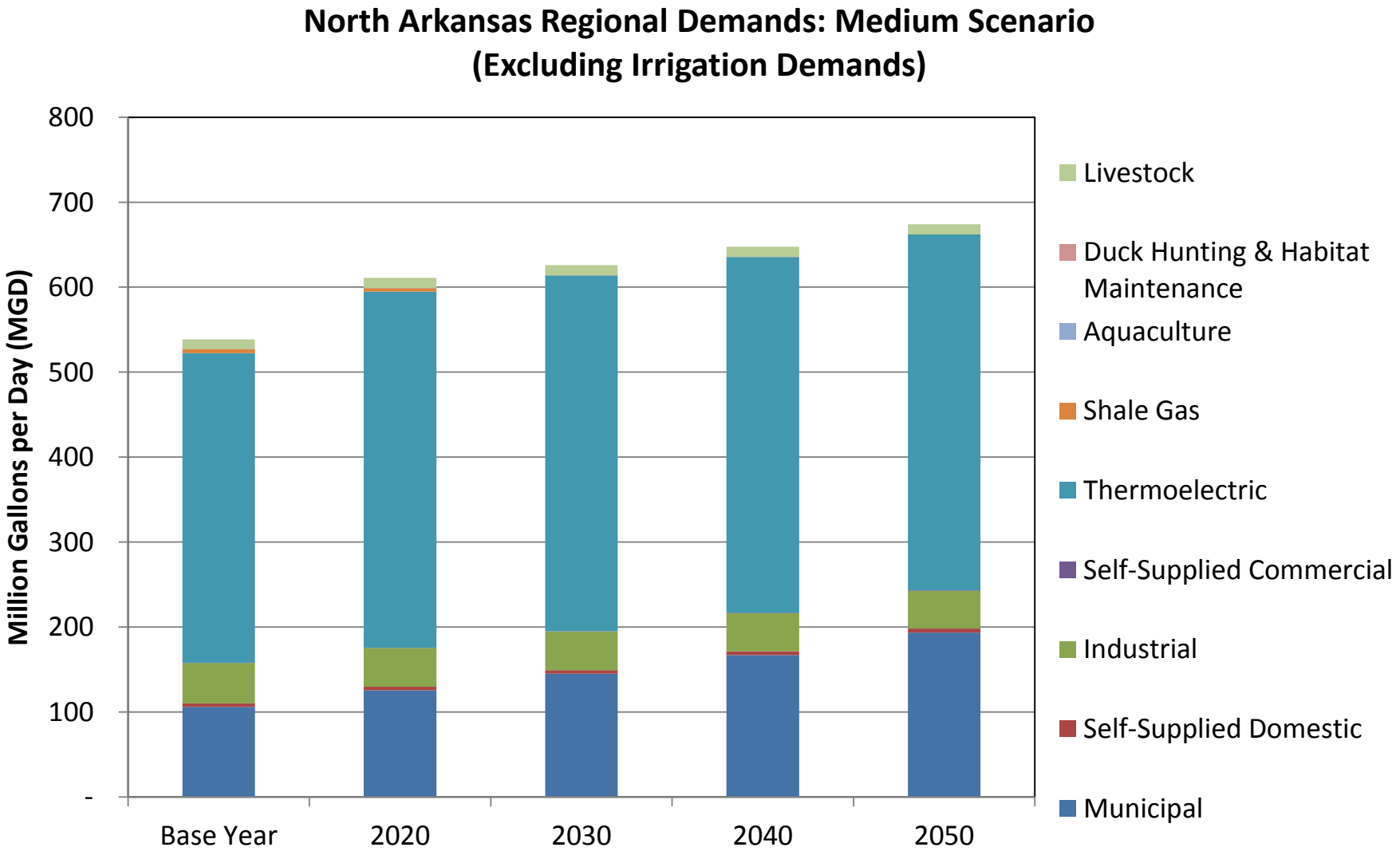
North Arkansas Water Planning Region

19% water use increase in 2050



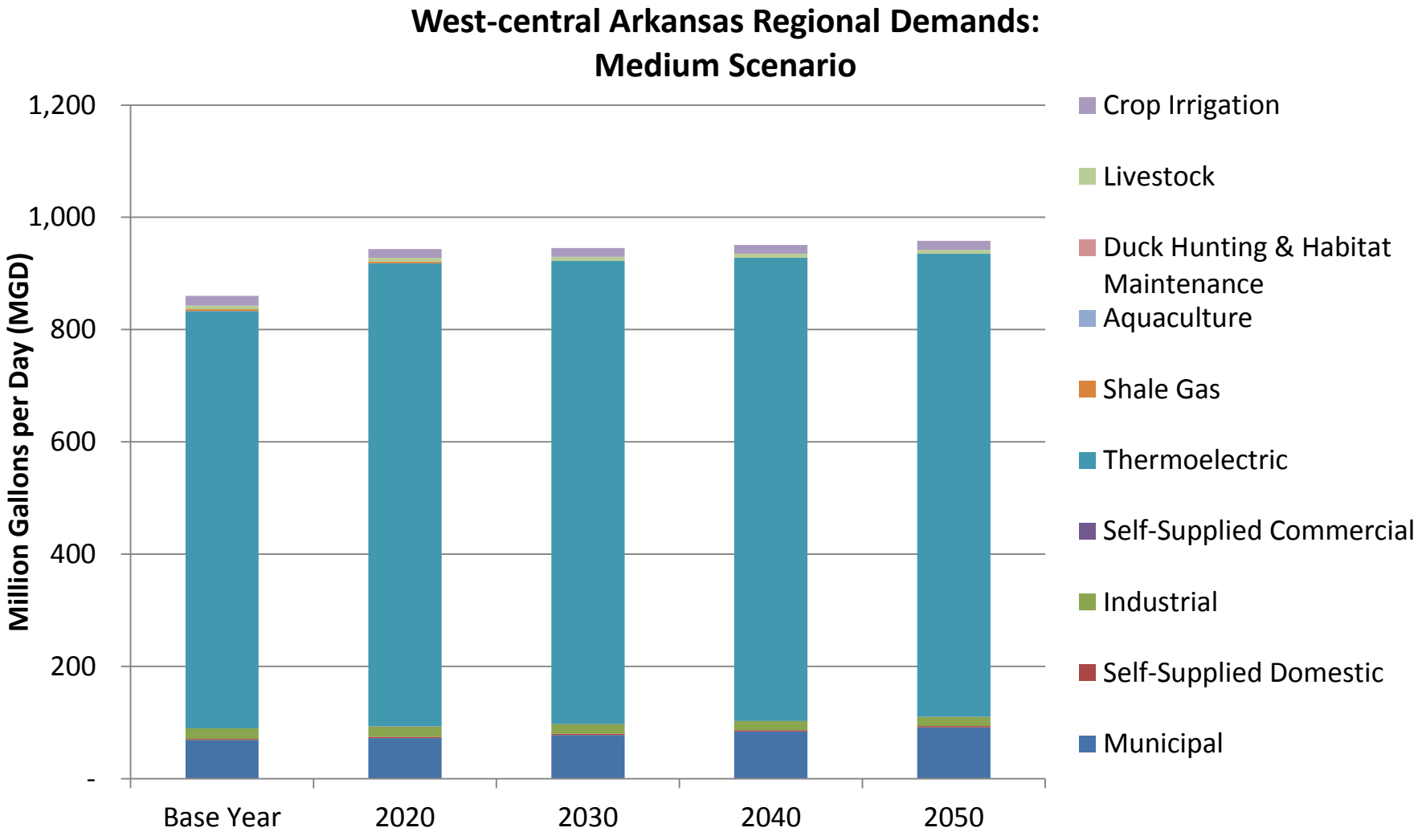
North Arkansas Water Planning Region

25% water use increase in 2050



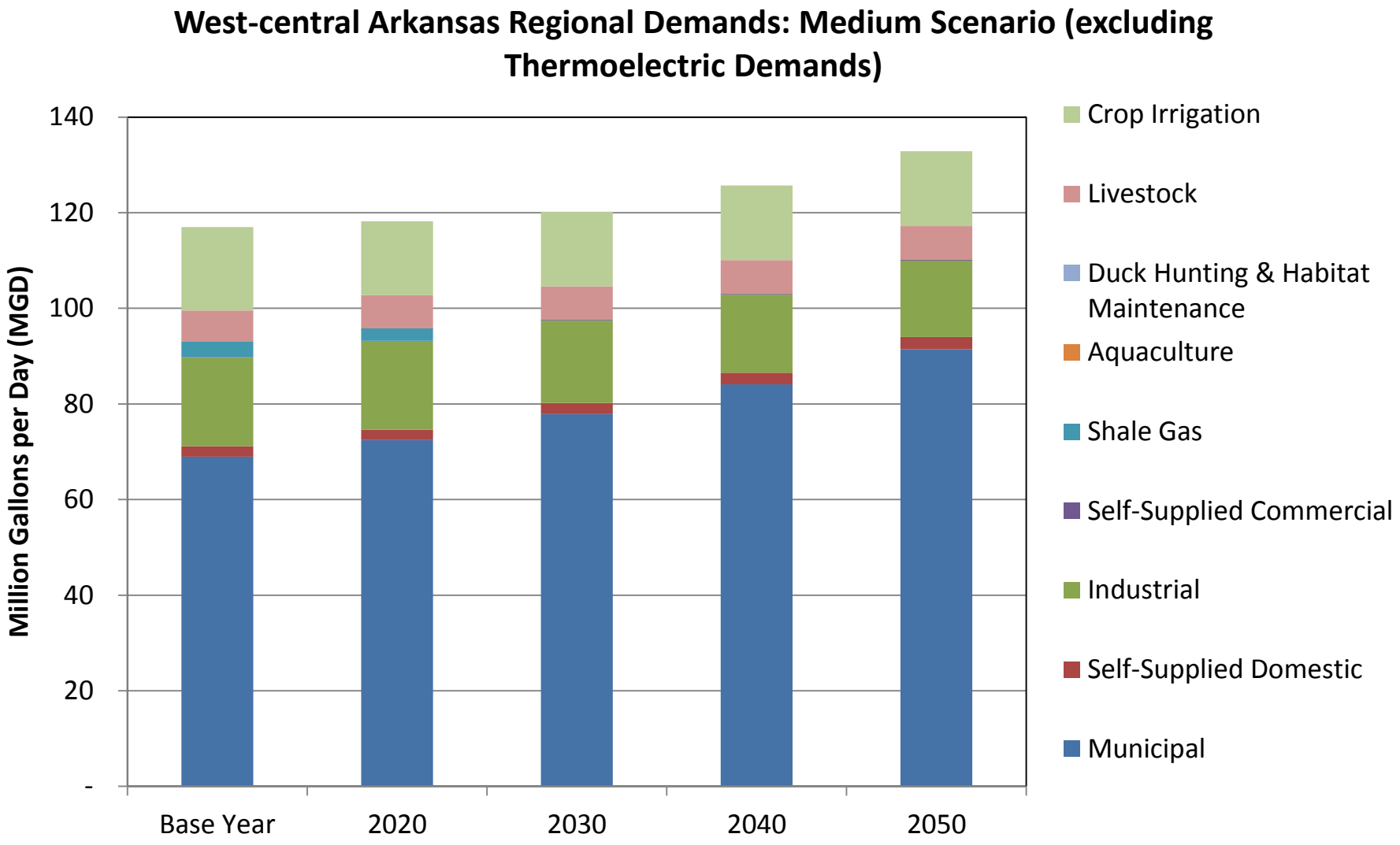
West-central Arkansas Water Planning Region

11% water use increase in 2050



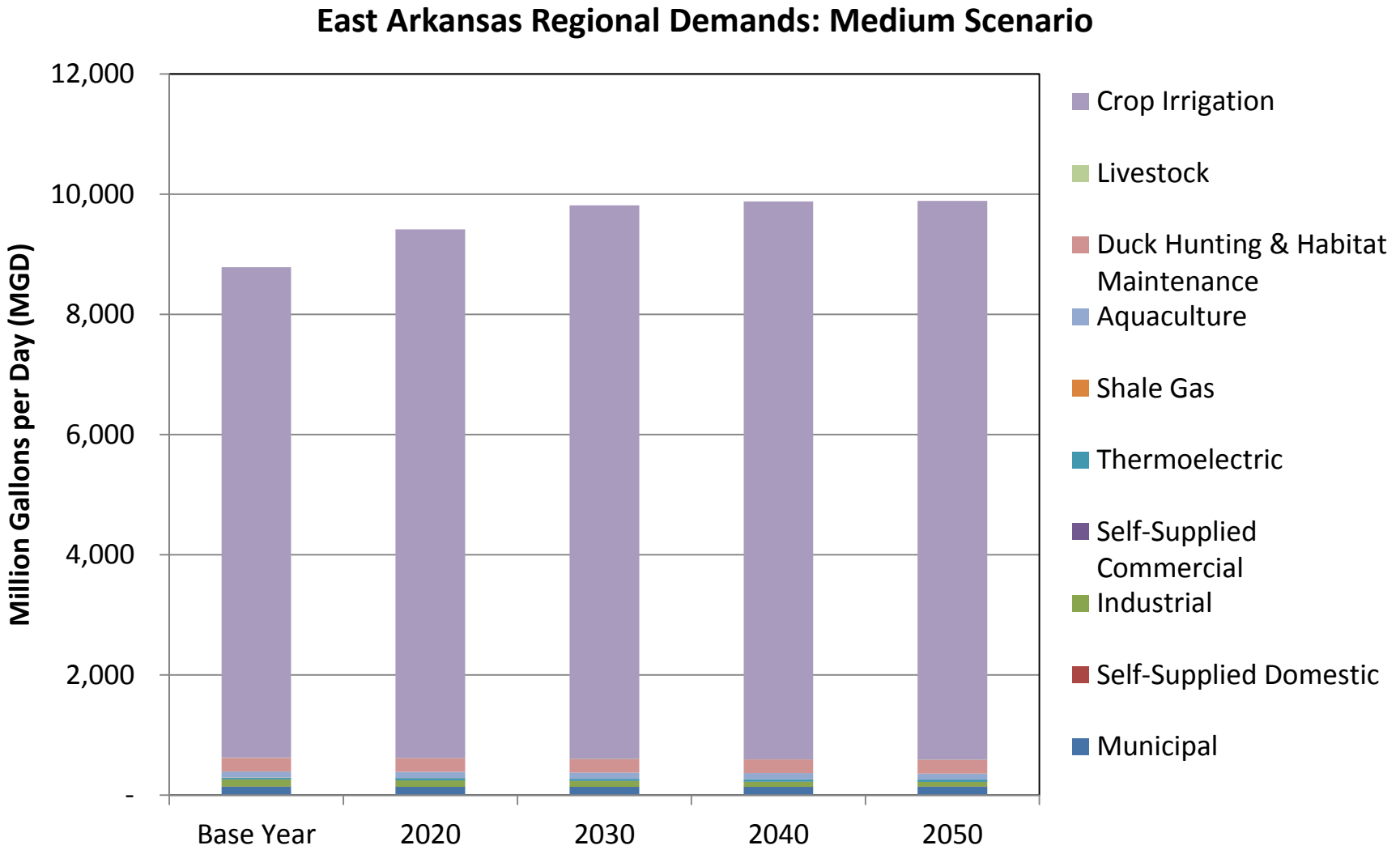
West-central Arkansas Water Planning Region

14% water use increase in 2050



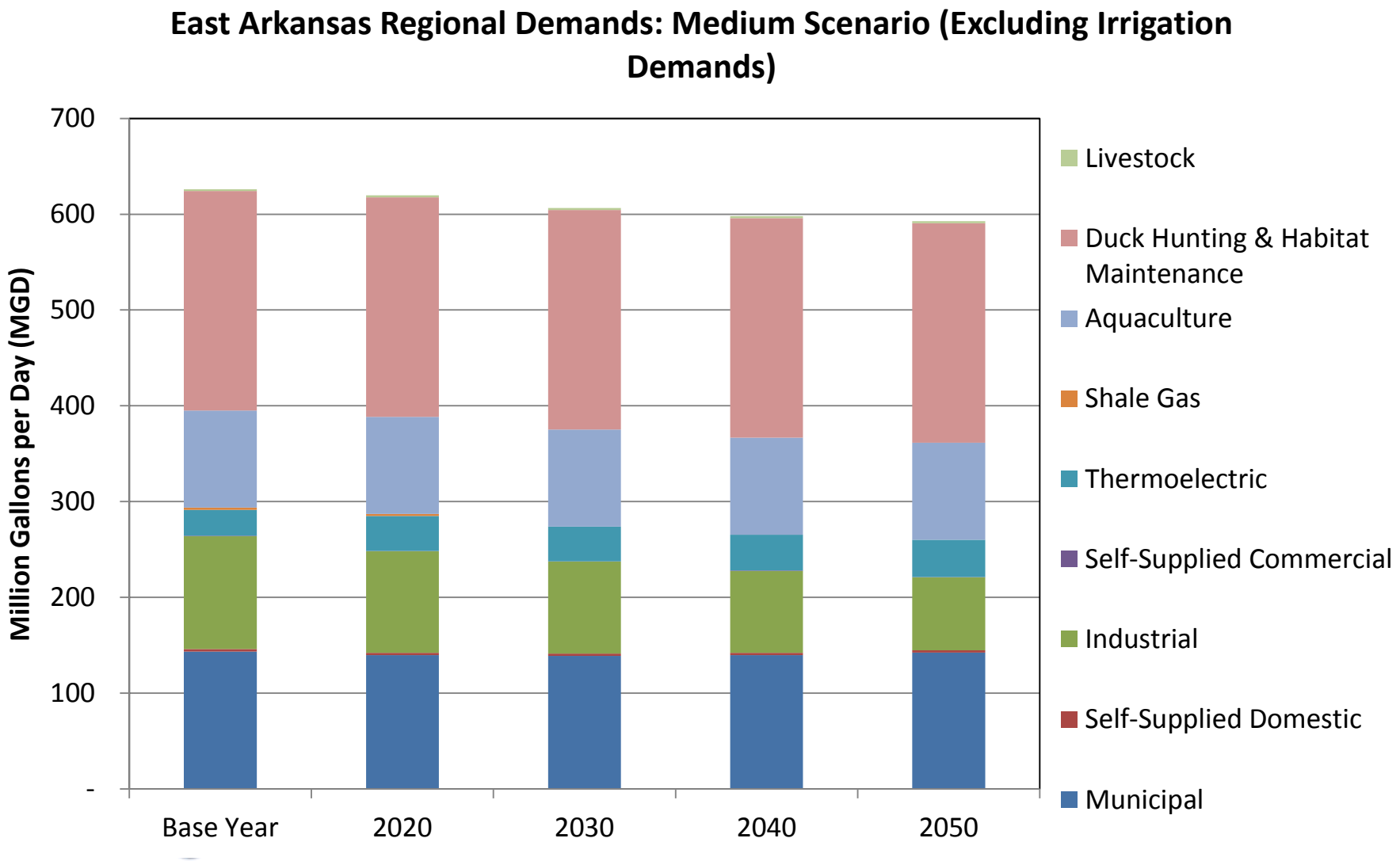
East Arkansas Water Planning Region

13% water use increase in 2050



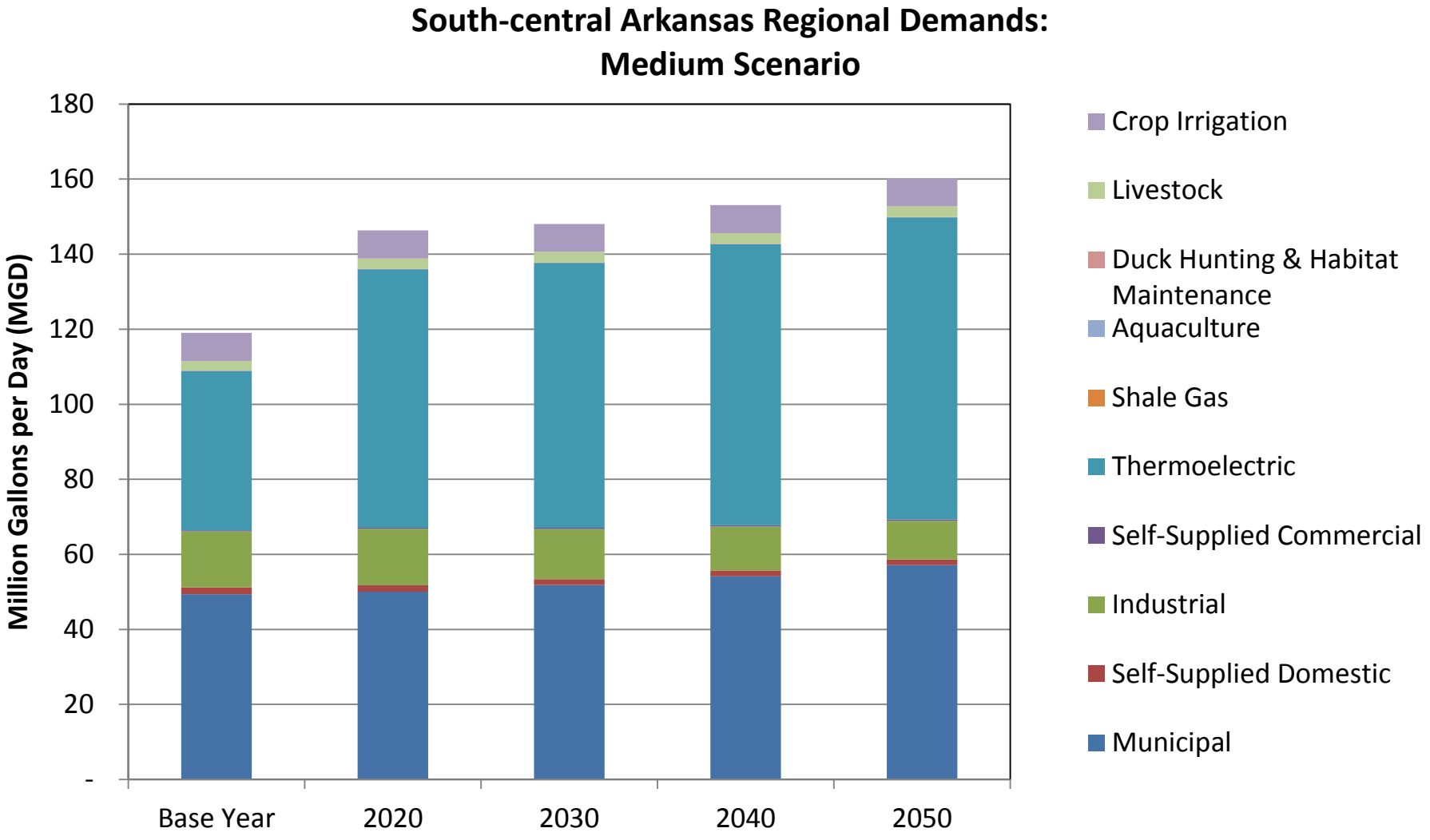
East Arkansas Water Planning Region

5% water use decrease in 2050



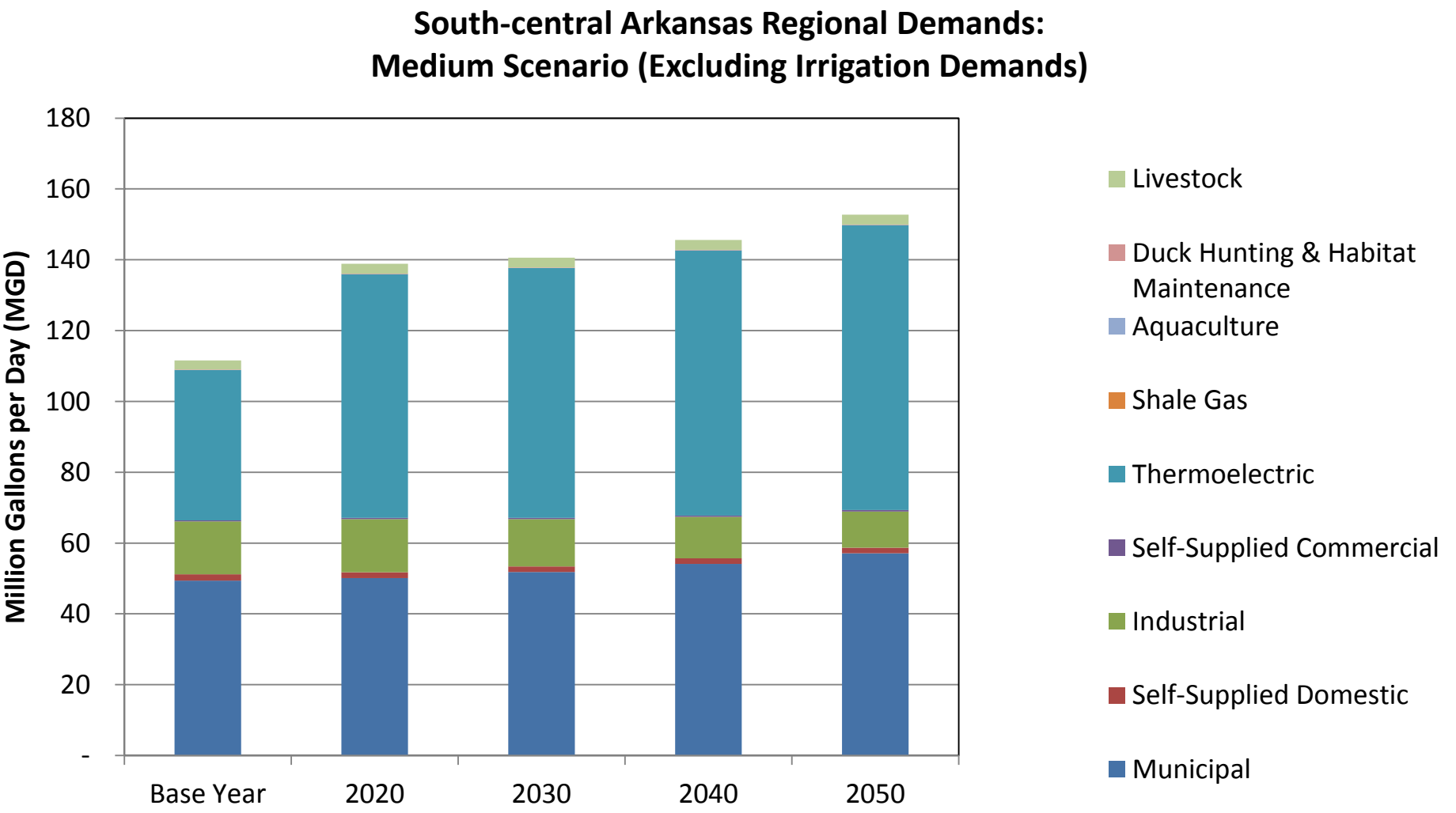
South-central Arkansas Water Planning Region

35% water use increase in 2050



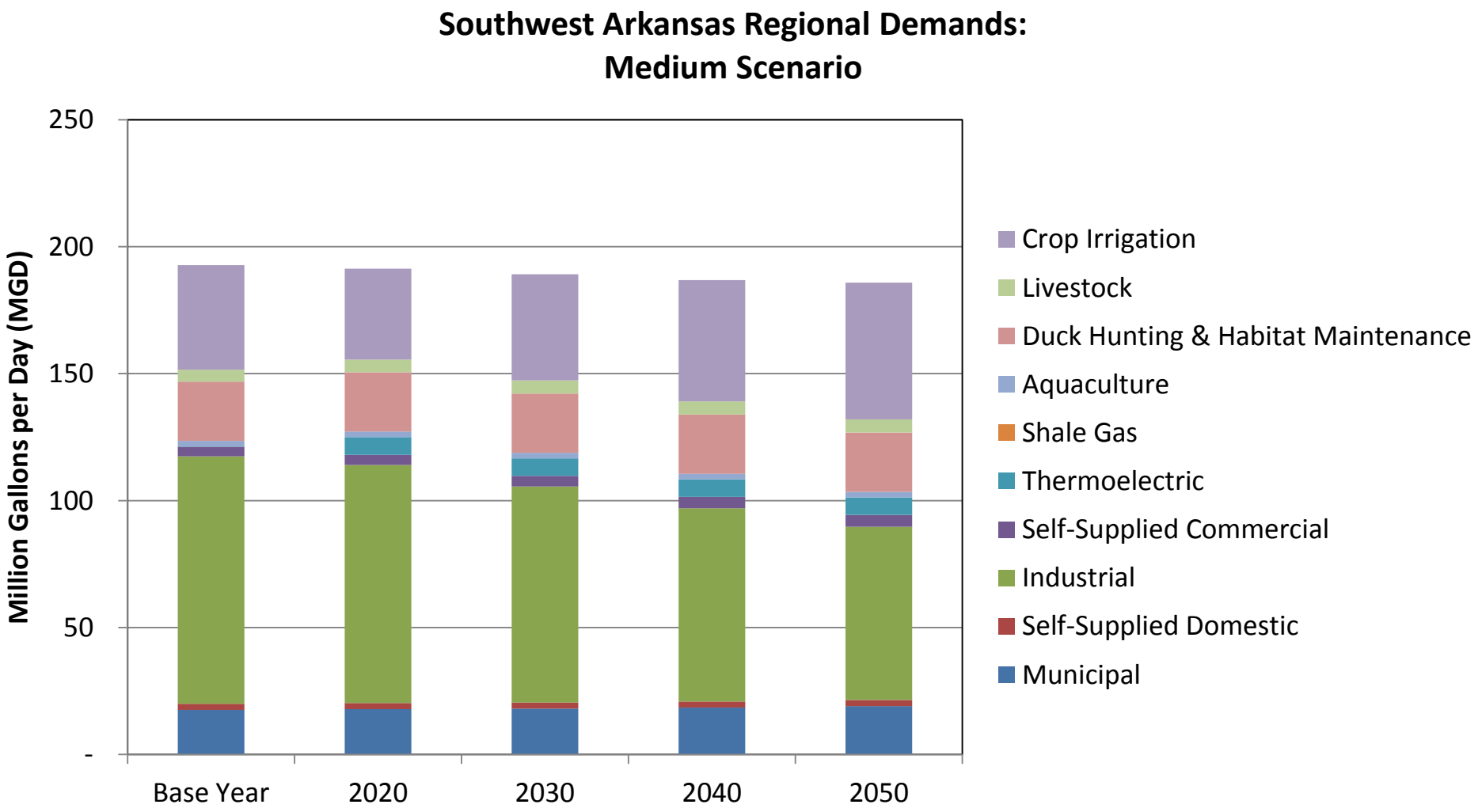
South-central Arkansas Water Planning Region

37% water use increase in 2050



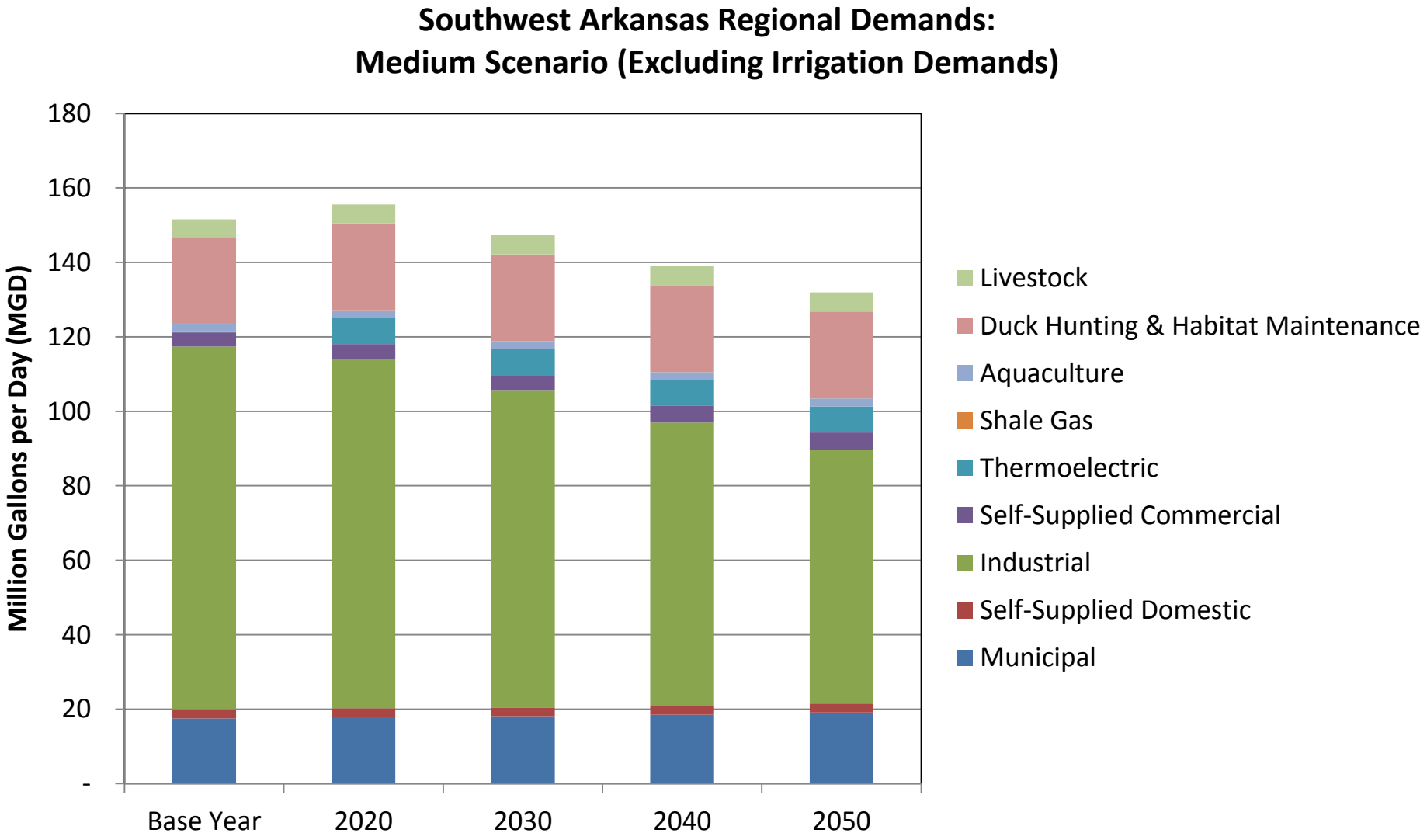
Southwest Arkansas Water Planning Region

4% water use decrease in 2050



Southwest Arkansas Water Planning Region

9% water use decrease in 2050



Statewide Water Demands by Water Planning Region