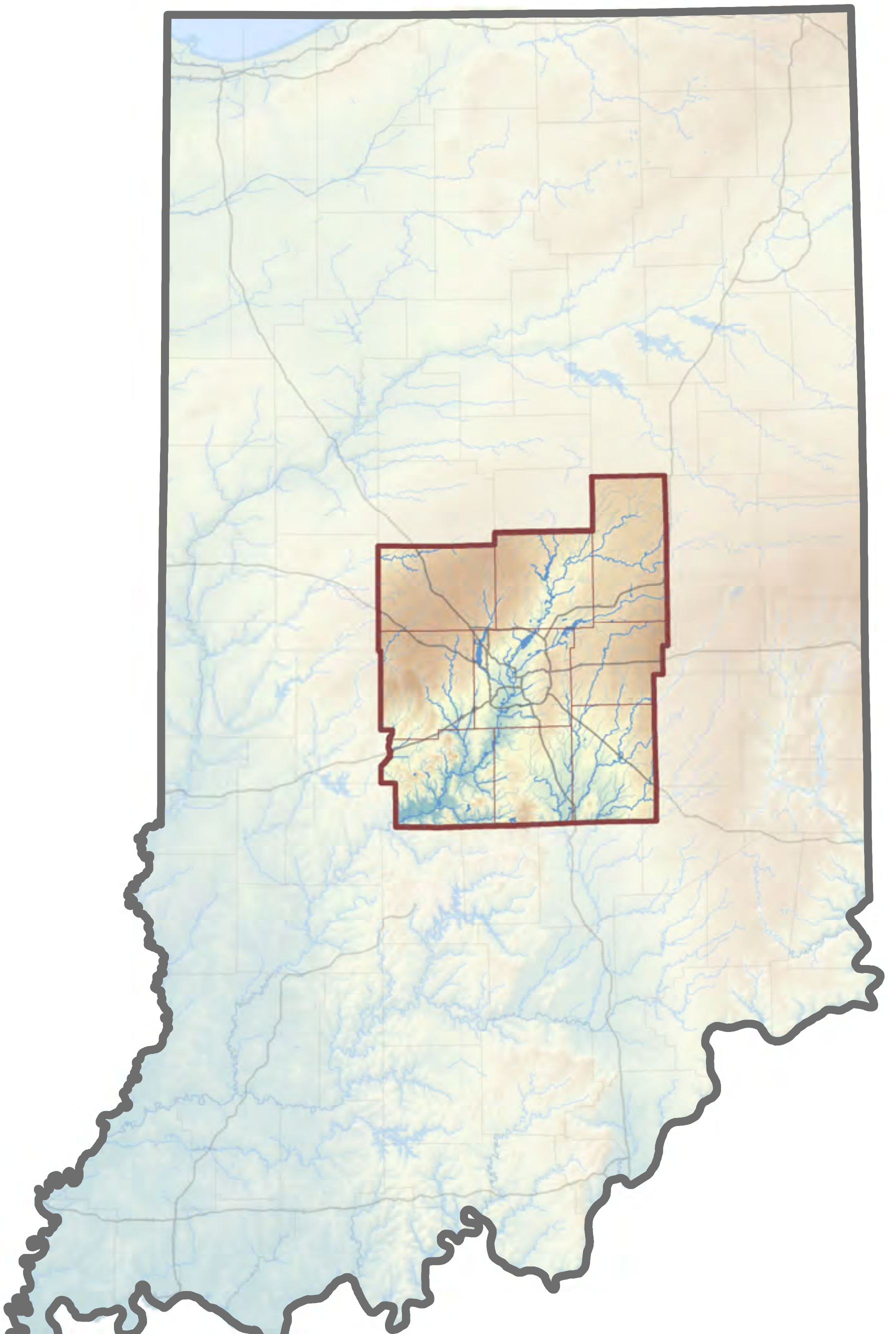
Central Indiana Water-Supply Needs

50-year Forecast



June 2020

Indiana Finance Authority

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Central Indiana Water Study

Phase I: Regional Demand

Prepared for the Indiana Finance Authority

Prepared by

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

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Pursuant to Senate Enrolled Act 416 and the State of Indiana's Water Infrastructure Task Force Final Report (dated November 9, 2018), the Indiana Finance Authority has begun to undertake a series of studies to identify water infrastructure needs and solutions, specific to regional areas of the State, as well as efficiencies to be gained through regional partnerships and improved sharing of resources.

June 2020

The Indiana Finance Authority acknowledges the contribution of INTERA Incorporated and Dr. Benedykt Dziegielewski for the creation of this report.

Acknowledgments

This report was developed in consultation with a team of professionals from state and federal agencies. The team attended monthly meetings that included project updates and technical discussion of the water forecast methods. This group of dedicated water industry professionals and engineers helped guide the project by listening to our status reports while we were developing the forecast and then again with their patient and generous review of early drafts of this report.

We would like to express our sincere gratitude to the team members from:

- Empower Results,
- Indiana Department of Environmental Management,
- Indiana Department of Natural Resources,
- Indiana Geological and Water Survey
- Indiana University, and the
- United States Geological Survey

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Executive Summary

Estimates of water use in the Central Indiana Water Supply Planning Region (Central Region or Region) were developed for the next 50 years for five major water demand sectors: 1) public supply, 2) self-supplied domestic, 3) self-supplied thermoelectric power generation, 4) self-supplied industrial and commercial and 5) self-supplied irrigation and agricultural uses. The forecast of future water use for each sector was developed at the county scale and then, separately, for each public water system at the facility level for all 52 dominant public systems. The primary goal of the Central Indiana Water Study (Study) is to provide a better understanding of the supply and demand of water resources in the Central Indiana region.

The methods used to forecast water use differed by sector and include multiple regression methods and unit demand estimates. These methods provided estimates of future water use as a function of demand drivers and explanatory variables for each of the sectors and subsectors. Explanatory variables are those that influence the unit rates of water demand, such as summer season temperature and precipitation, median household income, employment to population ratio, labor productivity, and precipitation deficits during the irrigation season. For most of the water uses in the Central Region, total demand was estimated by multiplying these unit rates for water use by forecast changes in the demand drivers. Demand drivers included the population served by public supply systems and self-supplied domestic wells, the expected number of employees, and gross estimates of thermoelectric power generation. This report makes use of the projections of the Indiana Business Research Center; alternative growth rates were not considered for population or socioeconomic growth.

For the public water supply sector, scenarios for future water demand were developed to reflect different future conditions, including climatic variability. These different drought and climate scenarios were used to capture the uncertainty in future water use and water demand within the Region.

Total future water demand in the Central Region was estimated to be 111 MGD (29%) more than current withdrawals (2018) (Figure A). Demand for public water supply systems was the largest fraction of this increase. Expected growth in the Region will add over 500,000 people to the larger metropolitan area in the next 50 years (Figure B). Water use increases will primarily occur on the north side of the Region, in Hamilton County, with substantial growth also occurring in Johnson County to the south.

Total water use in this Region over the past decade has not increased substantially. Water use for thermoelectric power generation has declined as coal plants have been decommissioned throughout the Region and are being replaced by different fuel sources that use less water. In the past, thermoelectric cooling water has come from intakes along the White River. Future power generation is anticipated to come from more efficient generating facilities. The drinking water utilities that will experience the largest increase include Citizens Energy, serving the central metropolitan area and many suburbs, as well as other utilities that supply the larger communities in Hamilton and Johnson counties.

While total withdrawals from surface water have declined, use of groundwater from aquifers along the White River, will likely increase to accommodate growth. More than 100 MGD is forecast to be withdrawn from the outwash aquifer that follows the general path of the White River through the Region. This aquifer already supplies the majority of the groundwater used in the Region.

While uses of surface water for industrial and power cooling purposes have declined over the last several decades, use of groundwater for public water systems continues to grow as the metropolitan area expands. Agricultural irrigation will also likely increase, especially in the southeastern part of the Region in parts of Shelby and Johnson counties, where center pivot irrigation has become standard practice. Industrial demand, the most difficult of the water use sectors to forecast, will also increase as more businesses are created in and around the City of Indianapolis. Self-supplied domestic water use is assumed to remain the same over the next 50 years as some utilities expand to add service area in the unincorporated domains, and new homes are developed further away from the city. By the end of the forecast period, anticipated climate variation, change in temperature and precipitation, could potentially add between 10 and 35 MGD of additional demand in the dry summer months. Again, this demand will be focused on the north side of the Region and to the south where growth is expected to continue.

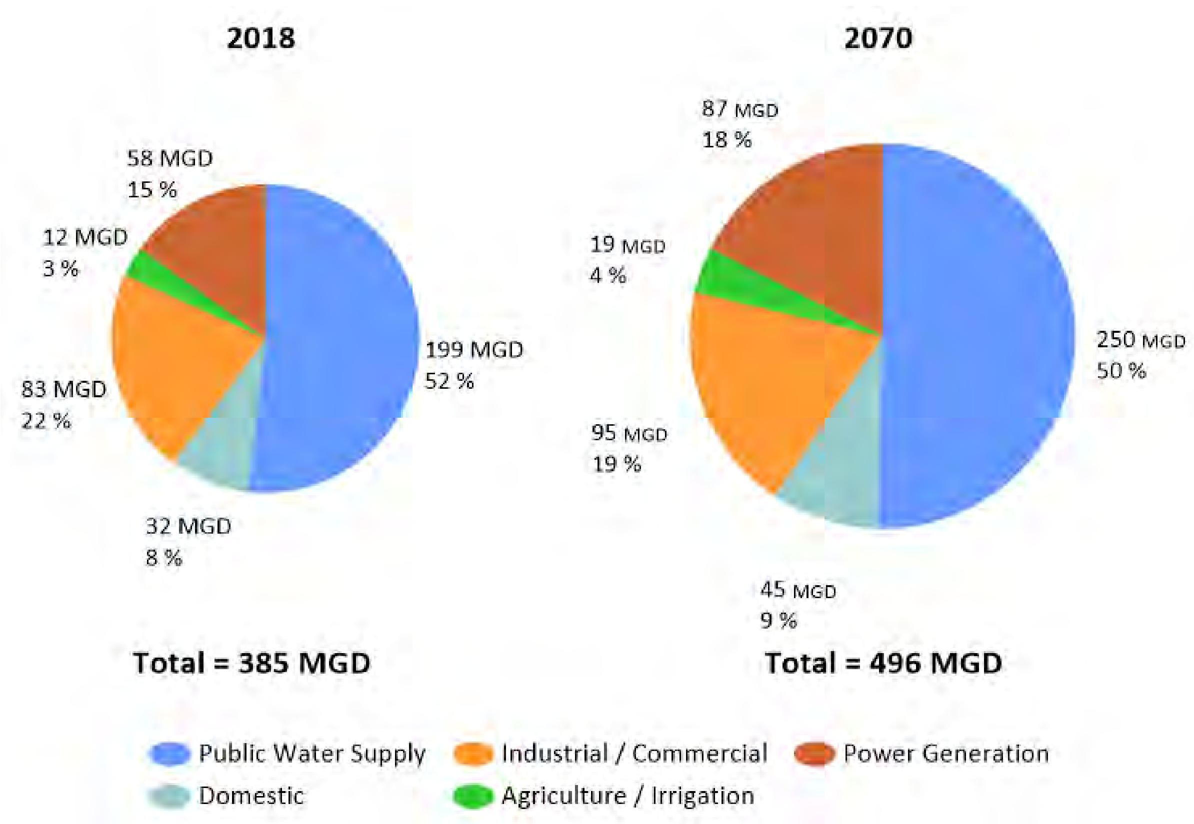

Figure A: Regional water withdrawals by water-use sector for the Central Region in 2018 and forecasted withdrawals for 2070. *Regional annual average withdrawals are expected to increase 111 MGD from 385 MGD in 2018 to 496 MGD in 2070. All sectors are expected to increase. Public water supply comprises ~50% of the total throughout the forecast. Annual 2018 historical water withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

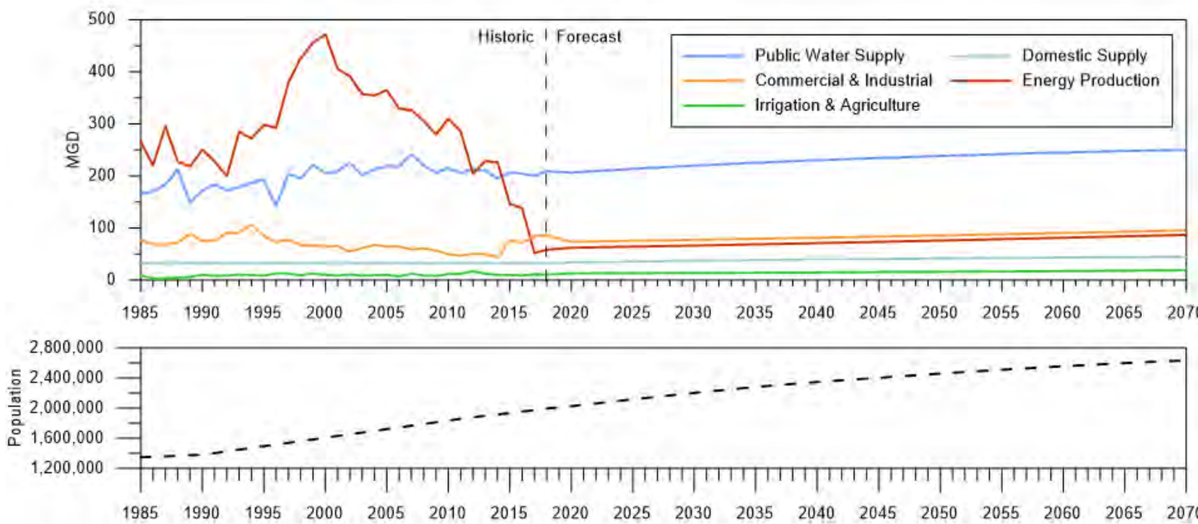

Figure B: Total historical and projected population and water withdrawals for the Central Indiana Region. *Although historically Energy Production has been the largest water-use sector, changes in fuel sources have reduced water withdrawals to under 100 MGD for the sector. Public water supply accounts for approximately 50% of the water withdrawals in the Region. Annual historical water withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Historical population from the United States Census (2010). 2020-2050 population projections from the Indiana Business Research Center (2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

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Abbreviations

AWWA American Water Works Association

C&I Commercial and Industrial

Central Region Central Indiana Water Supply Planning Region

Collaborative Central Indiana Drinking Water Collaborative

CREAT Climate Resilience Evaluation and Awareness Tool

DNR Indiana Department of Natural Resources

DWS Domestic Water Supply

EPA U.S. Environmental Protection Agency

GPCD gallons per capita per day

gpd gallons per day

GPED gallons per employee per day

IBRC Indiana Business Research Center

IFA Indiana Finance Authority

IR&AG Irrigation and Agriculture

NWIS National Water Information System

MGD million gallons per day

PG Power Generation

PWS Public Water Supply

Region Central Indiana Water Supply Planning Region

SWWF Significant Water Withdrawal Facility

State State of Indiana

Study Central Region Water Study

USGS United States Geological Survey

1 Introduction

With approximately 40 inches of rainfall per year, Lake Michigan to the north, the Ohio River to the south, and streams and reservoirs in between, Indiana is considered a wet state. In an average sense, this is true. However, Indiana experiences seasonal and sometimes multi-seasonal droughts and rainfall shortages, that cause conflict and create uncertainty. During the drought of 2012, domestic well owners in some locations had dry wells or significantly declining groundwater levels. As climate change becomes a reality, these vulnerabilities are magnified and active water supply planning and management becomes critical to economic sustainability for the State. Water supply planning and management requires knowledge of the amount of water currently being used, how much will be needed in the future and if that water is available from the sources of supply.

The State of Indiana (State) has designated the Indiana Finance Authority (IFA) to co-ordinate water-related investigations to identify the water infrastructure needs and solutions for specific regions of the State. The Central Indiana Region (Central Region) was defined as a critical area for water planning. The goal of the Central Indiana Water Study (Study) is to provide a better understanding of the water resources, both water demand and water availability, in this area. The objective of the Study is to aid in the management, economic development and environmental health of the Central Region. The Study has been subdivided into five phases:

Phase I. Regional Demand

Phase II. Regional Supply

Phase III. Water Availability Modeling and Optimization

Phase IV. Infrastructure and Cost Analysis

Phase V. Public Education and Outreach

This report is the Phase I forecast of regional water demand. Estimates of future demand are presented in 5-year increments out to the year 2070.

The water supply used in the Central Region serves almost 30% of the population of the State and comes from diverse sources including withdrawals from the West Fork of the White River, storage in reservoirs, and groundwater from shallow and deep aquifers. The central portion of the state was chosen for evaluation because a group of water utilities has already organized and meets regularly to discuss their water supply, treatment, and regulatory issues. This group of utilities known as the Central Indiana Drinking Water Collaborative (Collaborative), conducts regular meetings to share information. The boundaries of the Collaborative region are the same as the Central Indiana Water Planning Region and include nine (9) counties centered around

Indianapolis: Boone, Hamilton, Hancock, Hendricks, Johnson, Madison, Marion, Morgan, and Shelby counties (Figure 1.1).

1.1 Approach and Context

The purpose of Phase I is to develop an estimate of current and future water withdrawals in the Central Region. The goal of the fifty-year water demand forecast (2020-2070) is to improve the understanding of current and future groundwater and surface water needs within the residential, commercial and industrial, power generation, and agricultural sectors of the Region. The forecast will be utilized in Phase III of the Study to assess the current and future availability of water resources.

Water use was forecasted on a county level in 5-year increments from 2020-2070 for each water supply sector, including:

- public water supply (PWS)
- self-supplied domestic water supply (DWS)
- self-supplied commercial and industrial (C&I)
- self-supplied thermoelectric energy production (PG)
- self-supplied irrigation and agriculture (IR&AG)

The public water supply sector was further divided into forecasts per utility to capture the unique withdrawal patterns within each utility. A summary of withdrawals was tabulated for each county by adding up the public supply and other sector withdrawals for each forecast year. A baseline future scenario was developed for all sectors and drought and climate change scenarios were developed for the largest sector, public water supply. In addition, an analysis of the seasonality of public water supply withdrawals was included.

The forecasting techniques that were used differed by sector and include unit demand methods and multiple regression. These methods provided estimates of future demand as a function of demand drivers and explanatory variables for many sectors and subsectors. The water withdrawal forecast for each water sector is described in Sections 3 through 7. Additional data and graphs for each sector are provided in Appendices A through G.

1.2 Report Organization

This report is organized into an executive summary and ten sections. The executive summary discusses the goals and purpose of the study and summarizes the results for all water use sectors.

Section 1 provides the project introduction and discusses the data and analytical models used to estimate future water demands. Section 2 describes the current and historical water withdrawals in the Central Region. The five water use sectors are described in the five subsequent sections (Sections 3 through 7). Each of these sections briefly describes the water demand

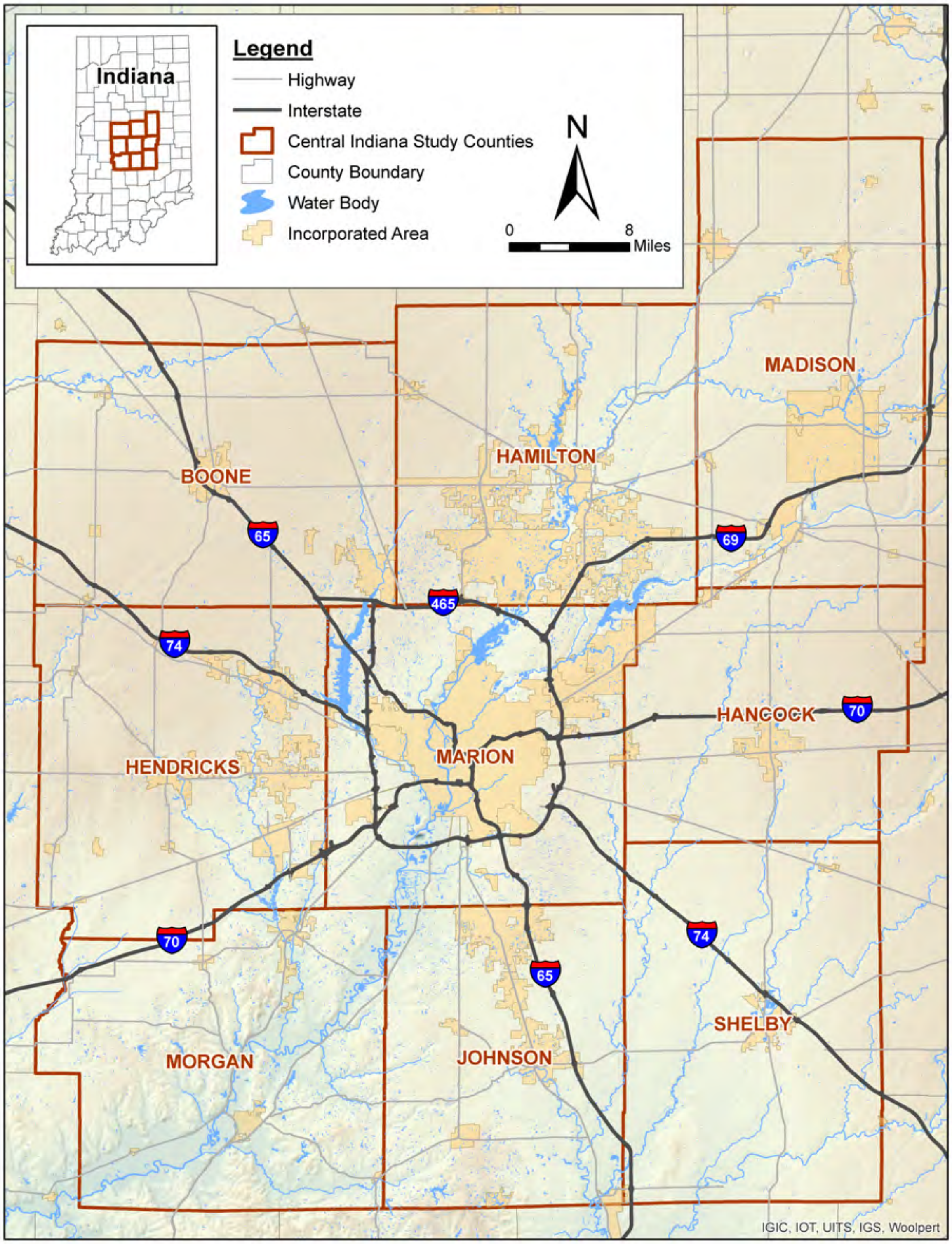


Figure 1.1: Central Indiana Water Planning Region. *Approximate population of 1.93 million people, nearly 30% of the total population of Indiana (2015) (Census, 2010). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

sector, summarizes the historical water withdrawals in the sector, and then explains the procedure for deriving water demand relationships for the sector. This is followed by summary of the sector results. Most sections are accompanied by one or more appendices containing detailed tables with primary data and other information used in deriving future water demand.

Section 8 describes the seasonal analysis of the public water supply sector and Section 9 shows the impacts on water withdrawals under simplified climate change scenarios, as well as the potential increase in water demands during a period of intense drought. Section 10 provides a summary of the regional water withdrawal forecast. References for all chapters appear at the end of the report.

Appendices A through G provide details and supplementary tables explaining how demand and population forecasts were made for each sector.

1.3 Understanding Demand Forecasts

Future annual water use estimates are not attempts to estimate the **actual** water use next year. Instead we are estimating the **average** amount of water use expected over the next several years. A standard set of methods are used to consider how the factors that alter use may change in the future and then consider how those changes will alter average use over time. An example from San Diego County Water Authority is shown in Figure 1.2 (SDCWA, 2016). The chart shows the reported water use between 1995 and 2015. Although the annual use varies by plus or minus 25,000 acre-feet depending on precipitation and temperature, the **average** annual water use seems to increase in a predictable way between 1995 and 2007. An event such as the financial crisis of 2008 is not predicted by the forecast model and growth continues from the new reset after that time. The regional growth trend before and the long-term forecast after 2015 is analogous to the baseline forecast in the model – actual use will fluctuate around the forecasted increase. The water withdrawal forecast for the Central Region will similarly project annual average water use for the region, but will not capture the annual variations due to fluctuations in weather and other unforeseeable changes.

1.4 Data Sources

Historical water withdrawal data for the years of 2005-2017 were obtained from the Indiana Department of Natural Resources (DNR). The DNR maintains a database of Significant Water Withdrawal Facilities (SWWF) in the State. The SWWF database contains monthly water withdrawals reported by owners "for any ground or surface water source that either individually or in aggregate is" capable of withdrawing greater than or equal to 100,000 gallons per day (gpd) (DNR, 2018). The SWWF data has been reported to the DNR since 1985. The water users within the database are assigned a major water use category based on the primary use of the water at the facility. The six categories coded within the database are: IR (Agriculture/Irrigation), IN (Industry), PS (Public Supply), EP (Energy Production), RU (Rural Use), and MI (Miscellaneous).

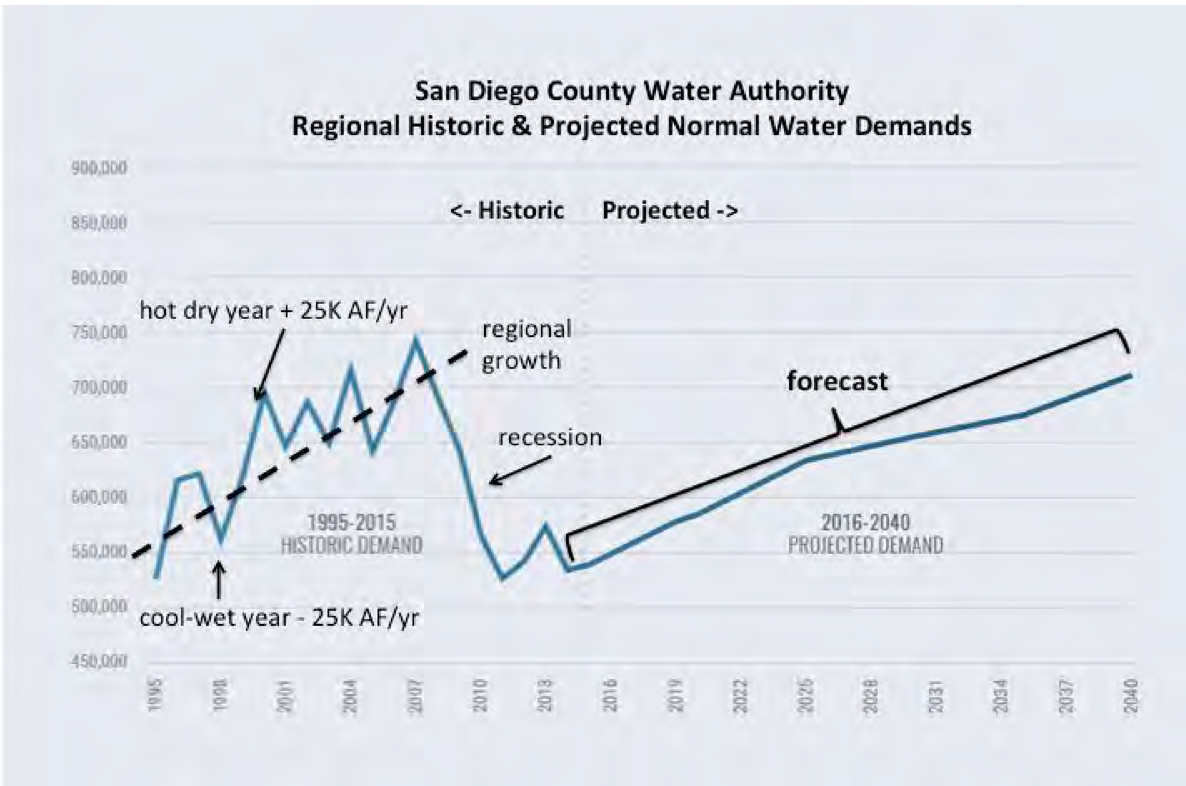


Figure 1.2: San Diego County Water Authority forecast average water demands (SDCWA, 2016). *On the left side of the graph, from 1995 to 2007, year to year water use varies as it increases from more than 500,000 acre feet/year to almost 750,000 acre feet/year. The variation from year to year is on the order of 25,000 acre feet/year as the use follows the growth curve (dashed line). While water use varies from year to year it also is clearly affected by unanticipated large-scale economic events, like the 2008 financial crisis. The forecast from 2016 – 2040 illustrates the trend line of renewed growth for "average" water use in the future. Year to year variations will continue to occur around this line based on temperature and precipitation and growth.*

Data obtained from the SWWF database was divided into sub-sectors within each DNR water use category by sorting facility types by facility names. The sub-sectors were then re-grouped into four major water use sectors. This process is illustrated in Figure 1.3. The SWWF database was the source for all historical water use that is mapped to four of the five major sectors, as illustrated in the Figure 1.3.

Water use estimates in the fifth major sector, self-supplied domestic water supply (DWS), are based on population and per capita water-use in areas outside of public supply service areas. Domestic water supply consists of water supplied to homes with private wells. Water use data for private wells must be estimated, as private wells typically do not have the pumping capacity to require reporting to the State.

The data on water withdrawals in each sector were supplemented with corresponding data on demand drivers and explanatory variables for each demand area and sector. Demand driver data included: resident population and population served and employment population, gross and net thermoelectric generation. The explanatory variable data included: median household income; historical trends; air temperature during the growing season; and growing-season precipitation. Supplemental data on historical and future values of demand drivers and explanatory variables were obtained from a variety of state and federal agencies, including the Indiana Business Research Center, Indiana State Climate Office, U.S. Census Bureau, U.S. Department of Agriculture, U.S. Department of Labor Bureau of Labor Statistics, and the U.S. Energy Information Administration.

1.5 Water Withdrawals vs Consumptive Use

This study focuses on the forecast of ***water withdrawals*** based on voluntary reporting of monthly diversions from streams or groundwater. In this report, the terms ***water use*** and ***water demand*** are used interchangeably, and both terms are equated here with ***water withdrawals***, as reported in the SWWF database: withdrawal, use and demand refer exclusively to the reported amount of water taken from a source such as a stream, reservoir, or aquifer.

Water withdrawals are not equivalent to ***consumptive use*** of water in the Region. Consumptive use is the amount of water used, either by a person, vegetation, or industry, that is not returned or discharged back to the source. Although a portion of the water withdrawals by each sector is considered non-consumptive, the unconsumed water is often returned to a source different from where it was obtained and often with altered water quality. Additionally, water can be withdrawn from one place and returned to geographically different location upstream, downstream, or in a different watershed. These diversions that alter the availability of the water supply are not considered in this phase of the Study. However, in Phase III of the Study, water availability will be evaluated and consumptive use will be analyzed to calculate the regional annual or seasonal water budgets for the Region. **This water forecast is limited to determining the amount of water withdrawn from either surface water or groundwater sources within the Central Region.**

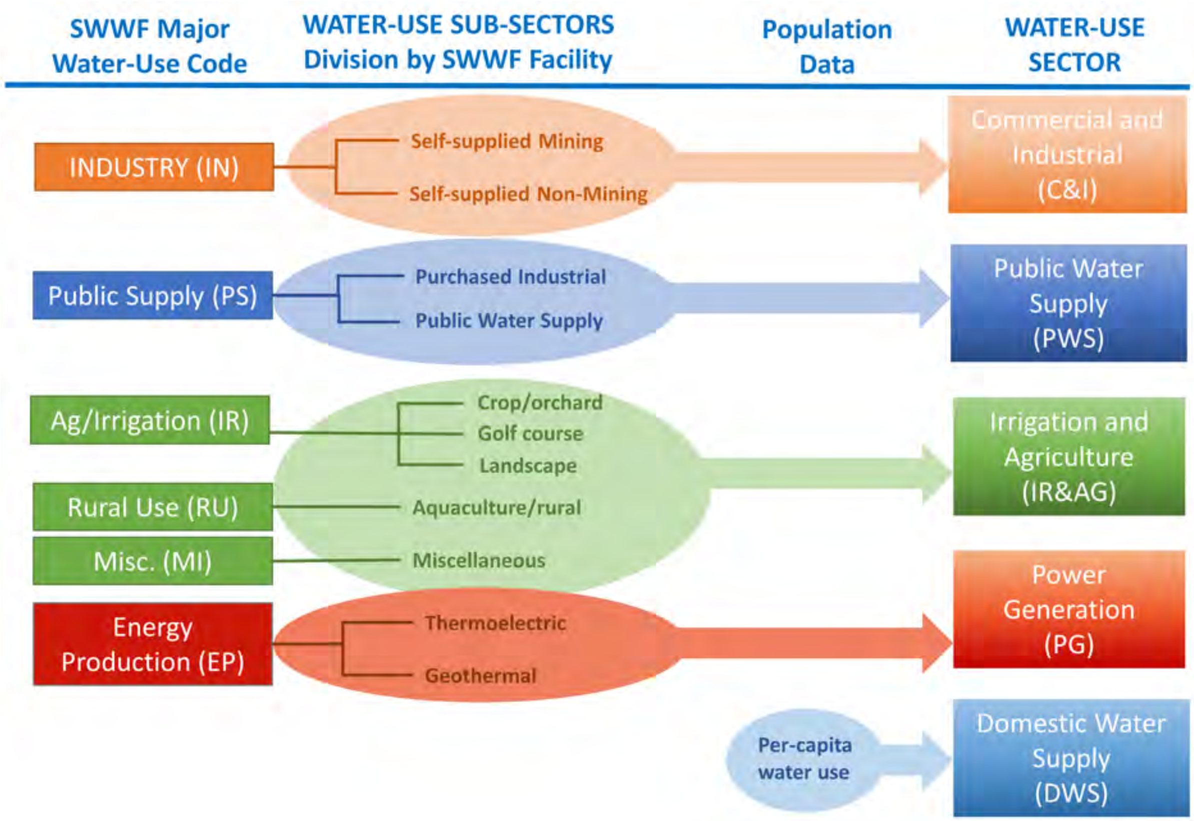


Figure 1.3: Data sources mapped to water-use sectors used in the water withdrawal forecast for the Central Region. *Annual historical water withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Central Indiana Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

1.6 Environmental Uses

Water withdrawals are forecasted for human water-use sectors only. The forecasts do not consider the needs of aquatic ecosystems and the environment. In Indiana, there are no regulated minimum flows for streams or other aquatic environments (DNR, 2015). Although quantifying flow requirements for ecosystems is technically complex and challenging, there is increasing awareness of the negative impacts that altered stream flows have on aquatic habitats and riparian zones. As water supply planning and management evolves in the State, ecosystem uses will likely need to be specifically incorporated into the planning process.

1.7 Forecast Methods

The analytical approach chosen for each water supply sector was based upon the best method for the best available data. The two principle techniques used in this report were the unit-use coefficient method and linear regression. The general approach of these methods is described below and additional information regarding the analytical methods, estimated models, and assumptions is included in the sections that describe each major sector of use.

The general approach to estimating future water demand using the unit-use method can be described as a product of the number of users (i.e., demand driver) and unit quantity of water as:

$$Q_t = N_t \times q_t$$

where: Q_t = water withdrawals in year t; N_t =number of users (or demand driver) such as population, or employment; and q_t =average rate of water usage in gallons per capita-day (GPCD), or gallons per employee-day (GPED). The unit-use coefficient method assumes that future water demand will be proportional to the number of users N_t, while the future average rate of water use, q_t, is assumed to remain constant.

When historical water withdrawal relationships can be quantified, q_t can be expressed in the form of equations. Thus, the average rate of water usage is expressed as a function of one or more explanatory variables, such as temperature or precipitation. A multiple regression analysis is used to determine the particular relationship between water withdrawals and each explanatory variable. This type of analysis was used in this study for the public water supply sector. The explanatory variables used for this sector were temperature, precipitation, and median household income. More details about the public water supply model are provided in Section 7

1.8 Uncertainty

It is important to understand the uncertainty embedded in determining future water demands in any study area and user sector. This uncertainty is always present and should be considered when making regional water supply planning decisions. Generally, the error associated with the forecast values of water demand can come from the following sources:

1. Future value error: Future values for one or more model variables cannot be known with certainty. Errors may be introduced when projections are made for the water demand drivers (such as population, employment, or irrigated acreage) as well as the values of the determinants of water usage (such as income, price, precipitation, and other explanatory variables).

2. Random error: Even if the model is specified correctly and its parameter values are known with certainty, there is random error caused by the additive error process in a linear regression model.

3. Error in model parameters: The process of estimating the regression coefficients introduces error because estimated parameter values are random variables that may deviate from the "true" values.

4. Specification error: Errors may be introduced because the model specification may not be an accurate representation of the "true" underlying relationship.

5. Reporting error: The SWWF database is a self-reporting system. There may be errors in the historic data that do not capture all significant water withdrawals and therefore do not reflect the "true" water withdrawals. These errors are unknowingly introduced into the forecast model.

1.9 Seasonal Analysis

Water withdrawals by public water suppliers were analyzed for seasonal fluctuations by examining the monthly historical water-use patterns of each utility. Typical seasonal variation occurs in response to annual weather changes: high temperatures and decreased precipitation drive customers to use more water in summer months. Further details about these seasonal analyses and the results are discussed in Section 2.

1.10 Climate Scenarios

The U.S Environmental Protection Agency (EPA) developed the Climate Resilience Evaluation and Awareness Tool (USEPA CREAT) to help drinking water and wastewater utilities understand the potential system-related risks associated with climate change. CREAT provides projections of changes in climate change conditions based on averages of climate model outputs. To understand the range of potential impacts due to climate change in the Central Region, three scenarios were prepared for the public water supply sector. Using temperature and precipitation values from the climate change model output, the scenarios were incorporated into the public water supply forecast model. The scenarios include Warm/Wet Conditions, Hot/Dry Conditions, and a 30% Drought Condition. Further details about these scenarios and the results are discussed in Section 9.

2 History of Water Use in the Region

The Indiana Department of Natural Resources (DNR) Division of Water maintains a Significant Water Withdrawal Facility (SWWF) database organized by the type of use. With the enactment of Indiana Code 14-25-7, beginning in 1985, any groundwater well or surface intake facility with the capacity to withdraw at least 100,000 gallons of water per day has been required to report monthly withdrawals each calendar year. This data, collected and assembled by type of use (irrigation, rural, mining, public supply, industrial, energy generation, and miscellaneous) provides the state with a unique window into the growth and change in water use throughout the state for the past 35 years. Currently, the records maintained by DNR include about 4,200 facilities with over 7,300 groundwater wells and almost 1,300 surface water intakes (DNR personal communication, 2020). The findings described in this report are based upon the information in that database supported by the staff at the Division of Water.

It is clear from the locations of the SWWF that there is more water withdrawal and use near the rivers and streams than further upland (Figure 2.1). This can partially be explained by surface and groundwater availability (more in the gravel-rich outwash aquifers and in the River than the tributaries and the thin till sands), but the use is driven by economic factors as well. The geography of water use is based on demographics and development, which historically follow major rivers and aquifers. One exception to this is mine dewatering operations where bedrock or aggregate is being mined.

2.1 Trends in Water Use

Water use in the Central Region reported to DNR gives us some indication of the changes over time. The changes from large-scale manufacturing / industrial processing to professional services are reflected in the changing uses of water withdrawn from rivers and aquifers throughout the Region (Figure 2.2). The water use trends for each sector are described and the record of statewide use for each of the sectors is illustrated in the graphs on Figure 2.2 that follow.

2.1.1 Energy Production (EP)

Consistent with national water-use data, the largest water user in Indiana has been, prior to 2015, thermoelectric power for once-through cooling (Figure 2.2; USGS, 2017a). Technology, pricing and energy policy are changing as new fuels and generation methods enter the market and new rules are developed to stimulate non-hydrocarbon energy sources. Nevertheless, until 2013, power plants continued to use very large volumes of water. These cooling systems only consume a small fraction of the intake water and approximately 95 percent of the water withdrawals are returned as warmed effluent discharge. While more power generation facilities use groundwater than in the past, about 95 percent of all cooling water is withdrawn from streams and surface supplies. The energy production category represents relatively few regis-

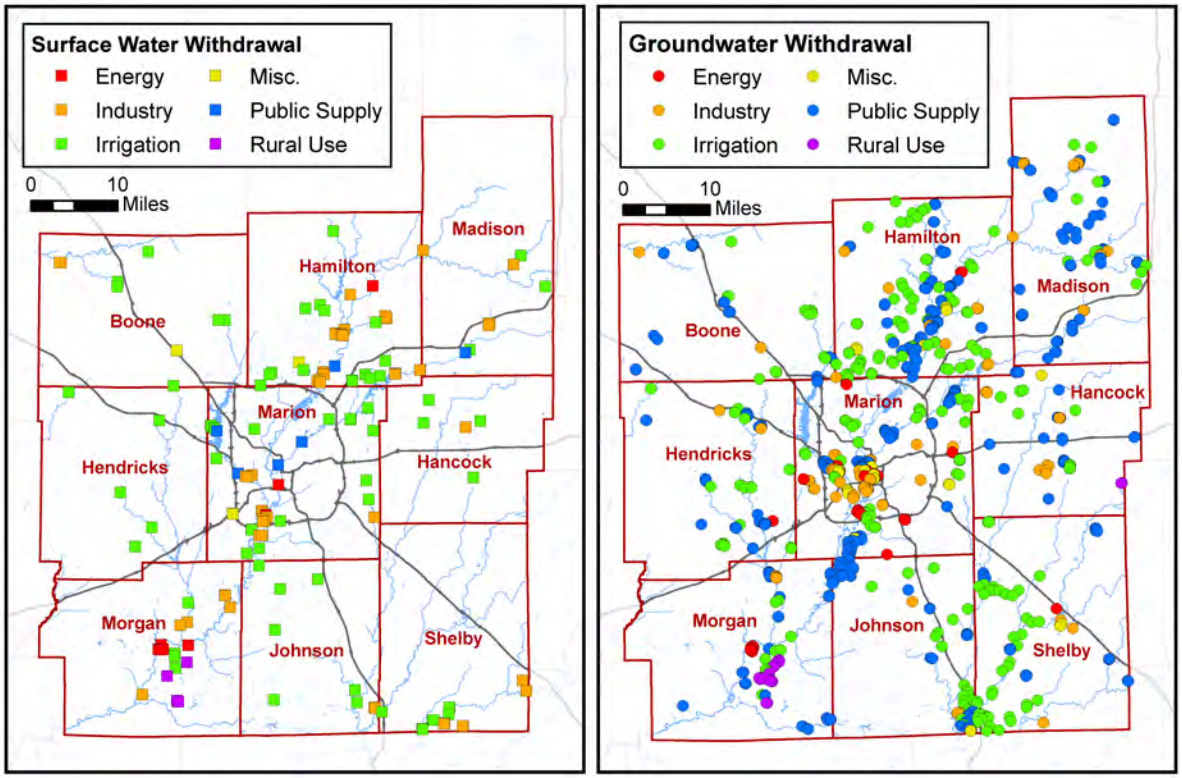


Figure 2.1: Surface water and groundwater withdrawals locations for each water sector in the Central Region (DNR, 2018). *Well and intake locations from the Indiana Department of Natural Resources Significant Water Withdrawals Database (DNR, 2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

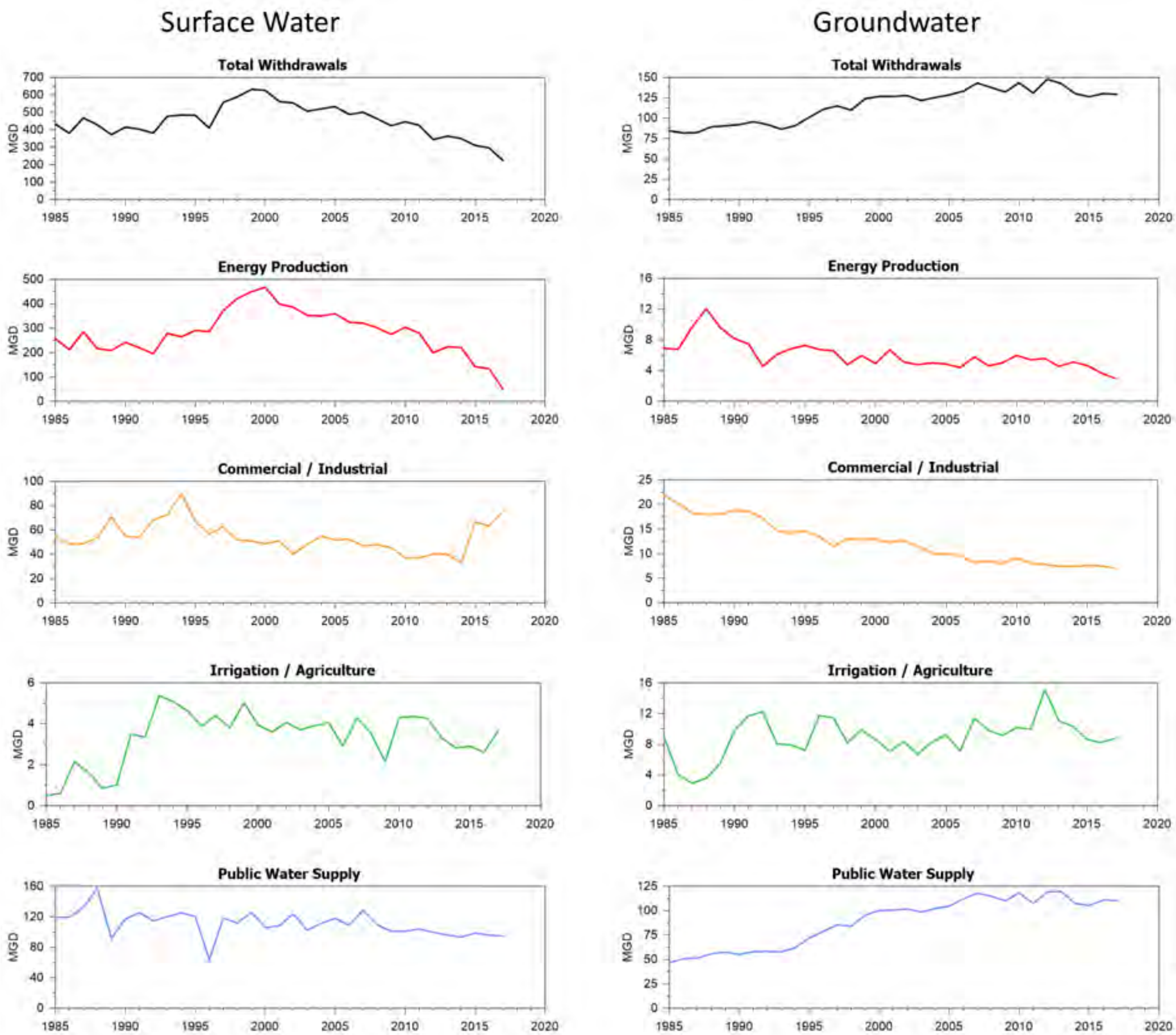


Figure 2.2: Historic surface water and groundwater withdrawals for each water sector in the Central Region. *The surface water withdrawals in the region have been declining since 2000. Largest decline of surface water withdrawal has been in the energy sector we are nearly 400 million gallons a day change has occurred from the peak in 2000. Public supplies continues to be an important user of surface water. Nearly 100 MGD are diverted from the White River and it's tributaries to supply drinking water to communities. Groundwater use, on the other hand, has continued to increase since data has been collected. Public water supply withdrawals from aquifers have more than doubled over the last 30 years (increasing from 60 to 120 MGD). Groundwater use for power plants and commercial and industrial users, never a large fraction of total withdrawals, have been declining.*

Annual historical water withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.

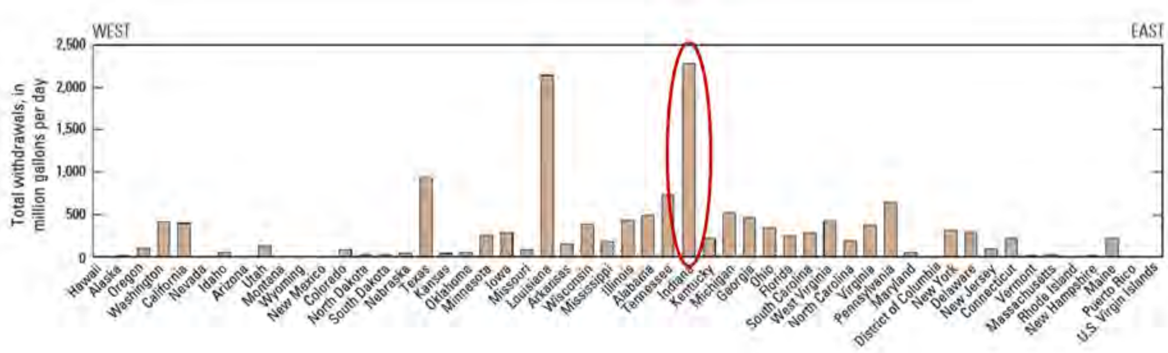


Figure 2.3: Industrial water withdrawals by state in the United States in 2015 (USGS, 2017b).

tered SWWFs in Indiana; however, each requires large amounts of water. The power generation water use sector is unlike the other sectors as it has fewer facilities, each of which uses (and returns) a large fraction of the annual total withdrawal.

2.1.2 Commercial and Industrial (C&I)

Figure 2.3 shows total water withdrawals for industrial use by state across the country in 2015. Indiana withdrew more industrial water than any other state that year. However, unlike other sectors of the economy, self-supplied industrial water use has been shrinking as a percent of total water use, both across the country and in Indiana. As one of the most heavily industrialized states in the nation, Indiana has documented a 35 percent reduction in industrial high-capacity water use over the period from 1985 to 2015 (Figure 2.2). The change is likely in response to a number of factors, among them globalization of manufacturing, the normal regulation of industrial wastewater discharge, and the general shift to more efficient operations that focus on streamlined logistics systems.

This trend of reduced industrial water use reflects an important change to the economy of the State that has occurred over the period of record. However, water is a valuable asset and the industrial history of Indiana is being used to attract new fabrication, manufacturing, and commercial enterprises. Industrial water use is an important component of what Indiana has to offer to manufacturers and industries.

2.1.3 Agriculture

While it plays an important role in the state's economy, agriculture is not as much of a driver for water use in the Central Region. The agricultural component of the state's gross domestic product (GDP) has monotonically increased over the past decade. Recent consolidations and mergers in the agricultural sector indicate that increases in water use will follow as the business of growing food and fuel demand increased management and higher profit margins. Over the last decade, the price of corn and soybeans has required that, even in historically moist areas,

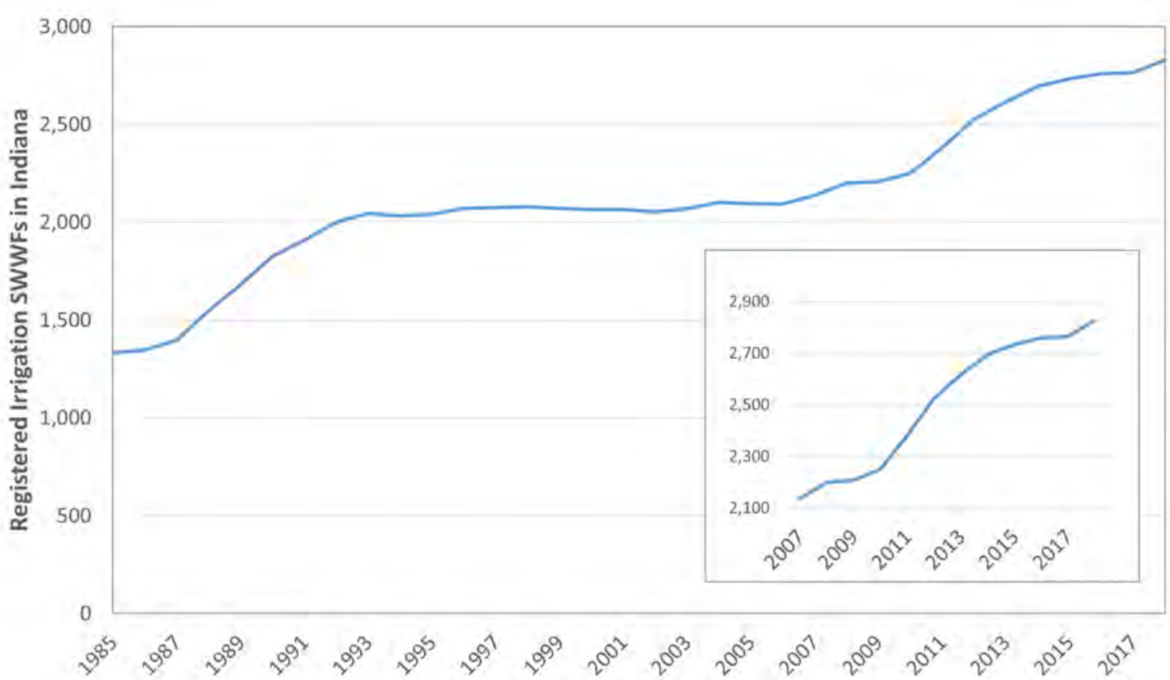


Figure 2.4: Count of registered irrigation facilities in the SWWF database in Indiana from 1985-2018 (DNR, 2018). *New facilities are added as a response to drought. Reported irrigation facilities from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018).*

some farms add irrigation systems to ensure yields. Consequently, across the state irrigation water use has been the fastest growing category of SWWFs, more than doubling since the first year of the program (Figure 2.4).

2.1.4 Public Supply

In most of Central Indiana, the dominant water user is the community drinking water system. The Central Region has over 52 drinking water utilities that together supply over 200 MGD to the public (Figure 2.5). The water utilities in the Region supply water to more than 1.4 million people for domestic use (IFA, 2015). For a variety of reasons, seasonal variation of public supply withdrawals are becoming increasing with higher daily peaks relative to the average day. Much of this can be explained by synchronized lawn irrigation systems.

In the perimeter counties that surround Indianapolis, local water systems are responsible for more than 75 percent of all water use. Over the past two decades, more municipal systems are adding new wells to satisfy growth. Like many Midwestern cities, Indianapolis was built initially as a surface water supply system. Upstream of the city, river water is diverted into the canal that brings water into the intake of the main treatment plant. Wells, reservoirs and other intakes were added to the system to stabilize water quality and improve drought resilience

(Figure 2.6).

Indiana has many very small water utilities with one or two wells connected to a small treatment plant to supply their communities. Depending on circumstances, the difficulty and cost of developing the source, treating and safely delivering the water to the end-user, while at the same time satisfying regulatory requirements, is a challenge (IURC, 2013). Historically these smaller drinking water utilities have operated relatively independently of each other, despite the fact that they may all use the same streams and aquifers. This independence reflects the fact that, until recently, there was little indication that their uses affected one another. The success in convening meetings among these regional water users for planning and coordination is a pre-requisite for model regional water management. These collaborative discussions are critical to providing the information the public needs to protect the resource.

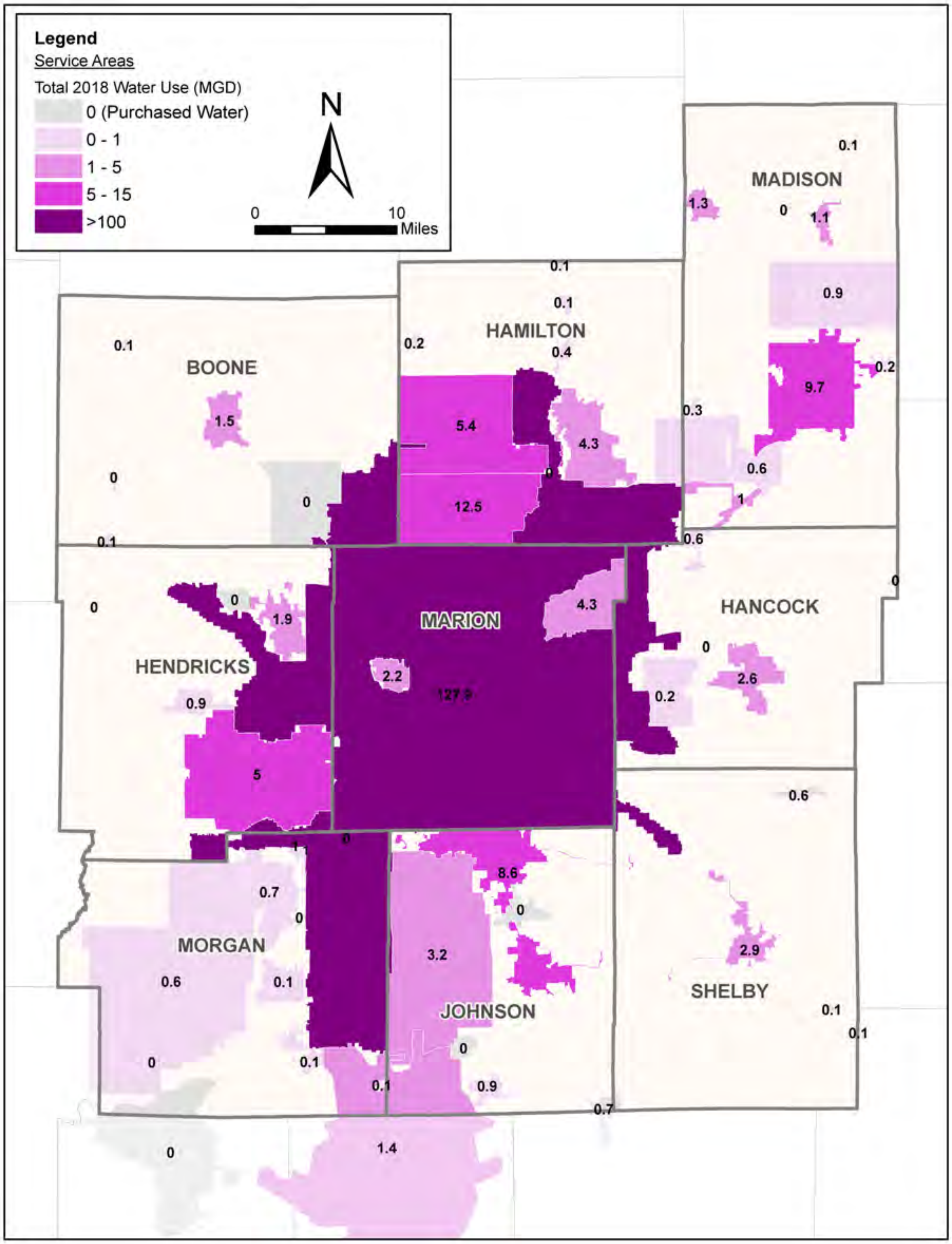


Figure 2.5: Reported 2018 water withdrawals for the public water supply service areas in the Central Region. Service areas are the boundaries within which a PWS provides drinking water. *Historical 2018 public water supply (PWS) withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Public water supply service areas from the Indiana Utility Regulatory Commission. Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

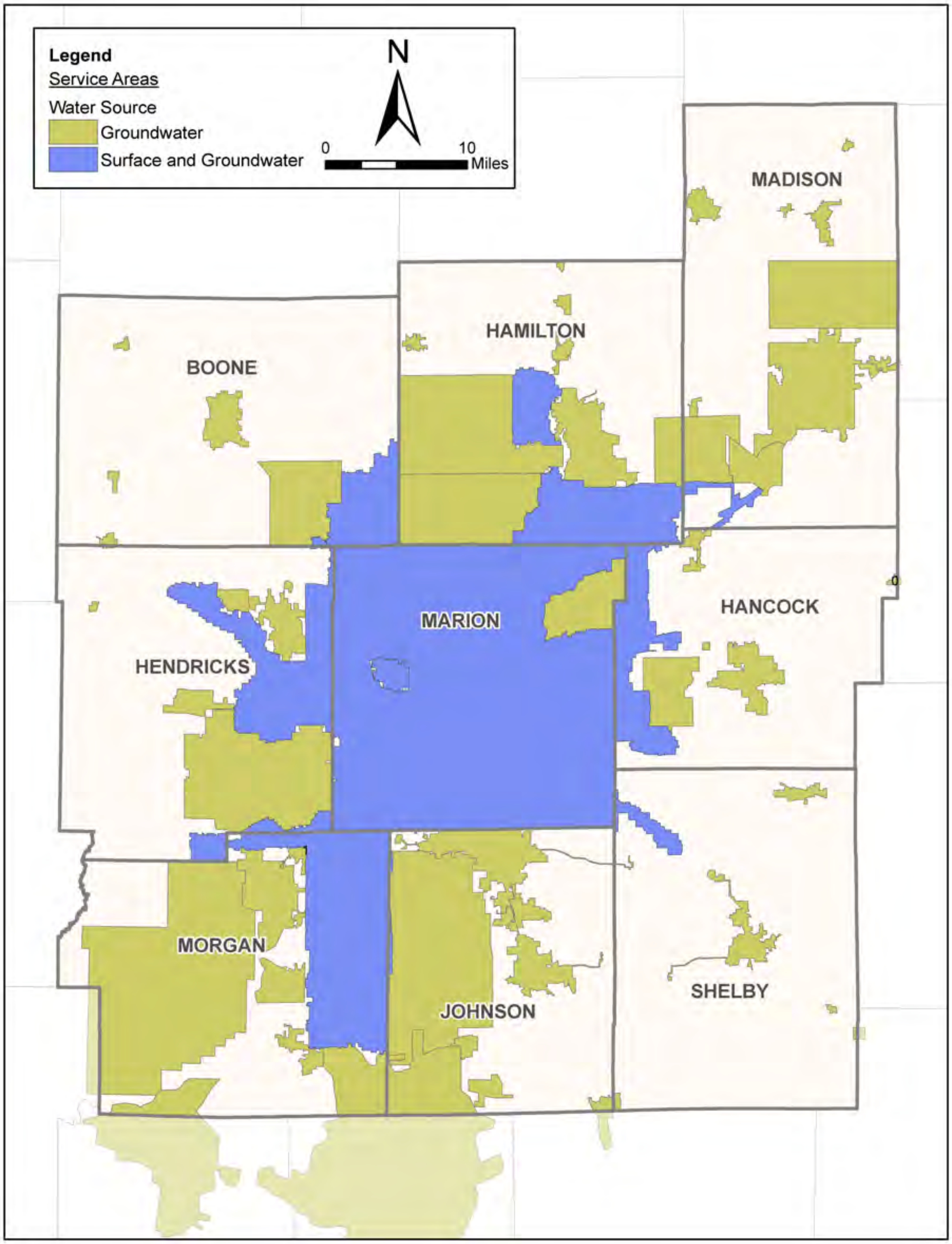


Figure 2.6: Source water for public water supply service areas in the Central Region. Service areas are the boundaries within which a PWS provides drinking water.*Historical 2018 public water supply (PWS) withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Public water supply service areas from the Indiana Utility Regulatory Commission. Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

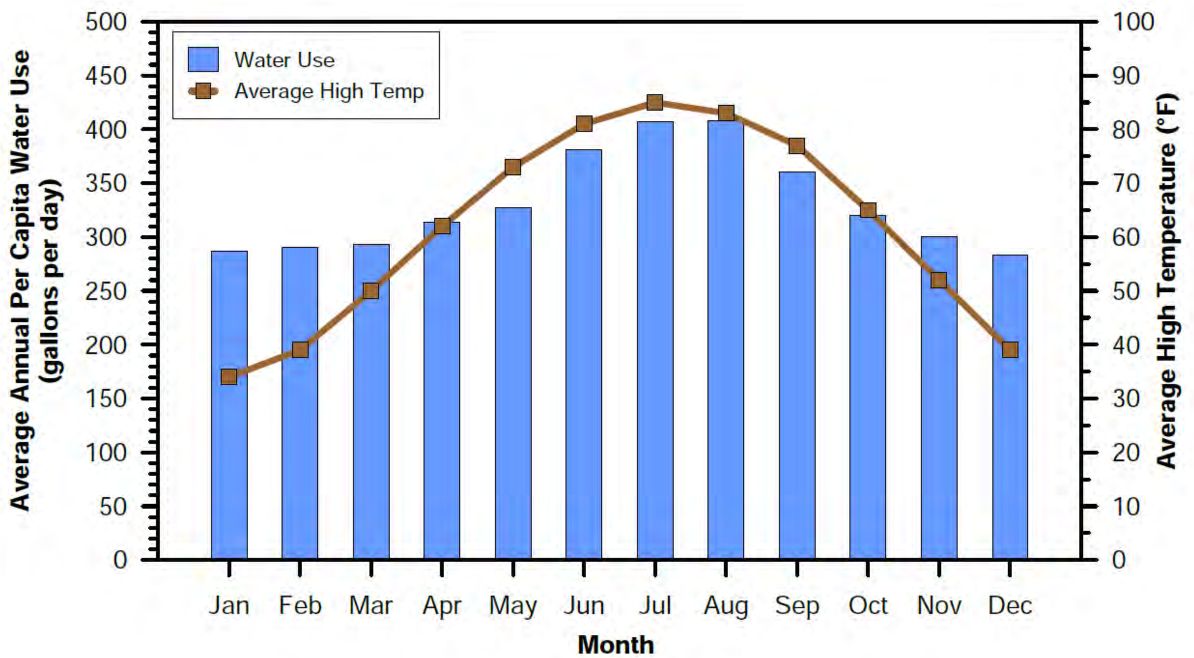


Figure 2.7: Monthly average per capita water withdrawals in the Central Region plotted with the long-term average monthly high temperatures. *There is a seasonal increase in water withdrawals that correlates to the average monthly high temperature in the Central Region. Increases in summer use in urban settings has been related to people taking longer showers and increases in lawn irrigation (Rathnayaka, et al., 2015). The graph also shows that base water use in the region is unaffected when average monthly high temperatures fall below about 60 degrees (F 0). Water use data is from the Indiana DNR Significant Water Withdrawal Facilities database (1998 – 2018) and population data is based on U.S. Census estimates for the 9-county region. Temperature data is from the Indiana State Climatologist for the Indianapolis weather station.*

2.2 Seasonal Variation and Conservation

Trends in average annual water use, like the ones forecast here, are useful for planning on a regional scale, but most utilities and other water users have higher demand during the warm season. These utilities need to pay attention to seasonal variation to manage supplies. Figure 2.7 shows that the regional, average-monthly water use increases during the warm months by about 30%. Public drinking water supplies are the largest water user in the Central Region, but commercial, industrial, power and irrigation water users are also important. For the mining and power sector, water withdrawals reflect mine production or power that supplies the electric grid. In the irrigation sector withdrawals are driven by temperature and the timing and duration of rainfall.

The seasonal curve and annual variation from responses to weather changes (*e.g.* drought) point to opportunities for conservation to reduce withdrawals. In other words, the increase in the warmer seasons can potentially be managed by conservation. It's difficult to predict how much water demand reduction is achievable without having some historical data from implemented conservation efforts. While there is no regional data to analyze conservation,

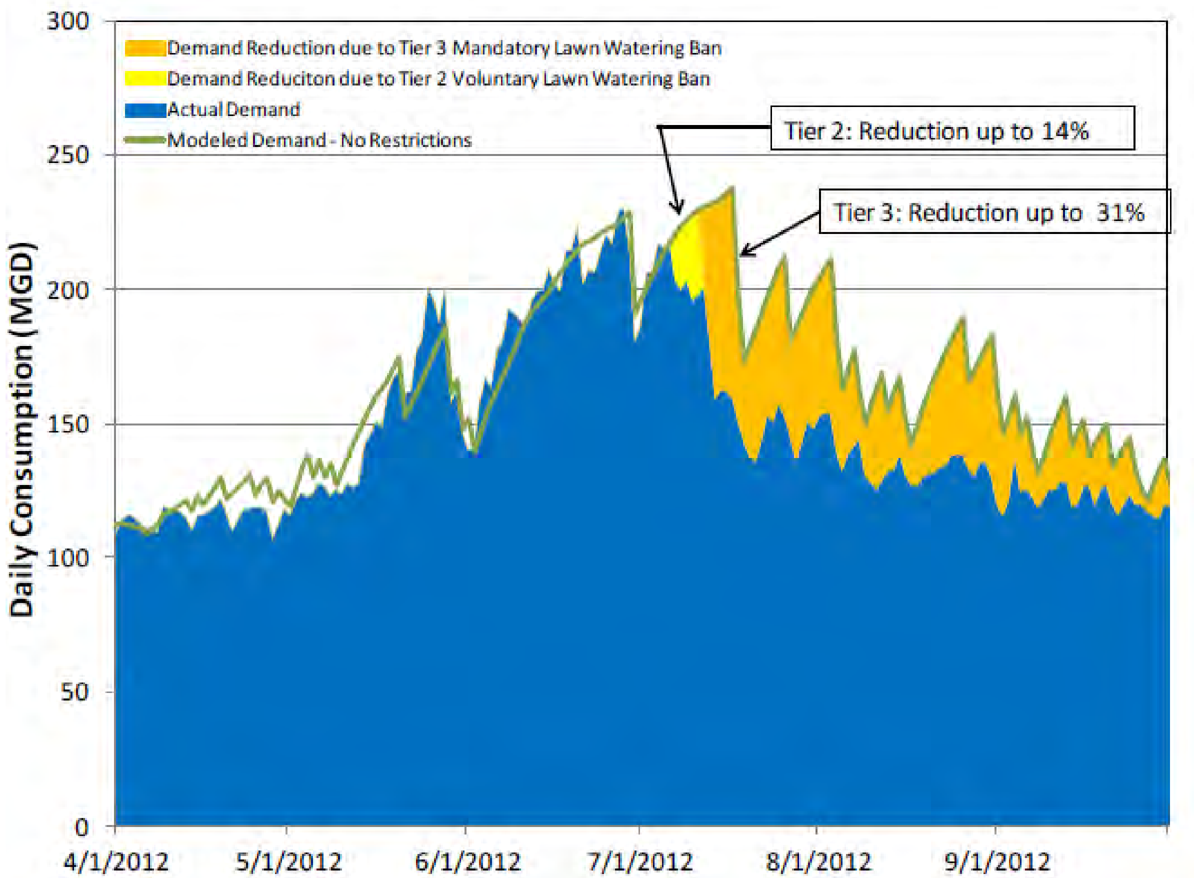


Figure 2.8: Citizens Energy Group's estimated 2012 demand reductions realized by drought management actions (CEG, 2013). *Graph taken from Citizen's Drought Management Plan. Shows a water demand reduction over 30% from voluntary and mandatory lawn watering bans during the drought.*

Citizens Energy Group (Citizens), which serves Indianapolis and most of Marion County (and portions of others), has data from the 2012 drought which highlights the impacts of voluntary and mandatory steps to manage demand during a water shortage (CEG, 2013). With a tiered drought response action plan already in place before the 2012 drought, the utility was able to effectively manage the drought through public response to water shortage triggers. The demand reductions achieved in 2012 are illustrated in Figure 2.8. The reductions were determined by modeling the expected demand that would have occurred without issuing the Tier 2 voluntary lawn watering ban or the Tier 3 mandatory lawn watering ban. Managing the seasonal curve can successfully be done with communication and cooperation with the public.

2.3 Summary of Historical Water Use

From 1985 to 2015, the largest volume of water used in the Central Region has consistently been for thermoelectric power generation (Figure 2.9). Since that period of time, however, the water use picture has changed dramatically. In the last several years power generation withdrew less water than other major users. As coal fired power plants have shut down in the Region, water use has fallen for power generation from over 500 MGD into the range of 50 MGD, below the combined use reported by self-supplied commercial and industrial users and well below the 200+ MGD used each year by drinking water systems. This shift in thermoelectric power generation water use is the most remarkable change illustrated by the history of reported water use in the Central Region. Because self-supplied commercial and industrial use is dramatically affected by the development of new businesses and manufacturers with access to the water resource, predicting future water use is difficult. Mining activity, driven by infrastructure investments, also adds to the commercial and industrial use category. Demand for drinking water in Central Indiana has increased as the population and economy have grown. Future increases will likely be satisfied by new high capacity wells completed in the outwash aquifer in combination with strategic local surface water storage.

2.4 Sources of Central Indiana's Water Supply

In 2018, 64% of all the reported water use in the Central Region was withdrawn from a surface water body and much of that from the West Fork White River (Figure 2.10). This dependence on surface water is a common feature of the water supplies of major cities in the country, including Louisville, Minneapolis, Chicago, Cleveland, Atlanta, and Cincinnati. The Central Region diverted 232 MGD from Fall Creek, Eagle Creek, the West Fork White River, as well as reservoirs and quarries in 2018. Just less than 100 MGD of this water is treated for public supplies for Indianapolis, and the remainder is used for industrial process water and thermoelectric cooling. Another 100+ MGD of groundwater is used for public supplies in the Region. The Region has been shifting to groundwater to satisfy the local needs of growth. The southeastern portion of the Region is also using more groundwater to supply new irrigation wells (Figure 2.10). These two trends (i.e., increasing groundwater use for drinking water and irrigation) will determine if current resources can satisfy local demand. Fortunately, the most rapid growth of irrigation water use is in the northern portion of the State with more productive aquifers. Industrial water use and cooling water for power generation are not likely to grow in the next few decades.

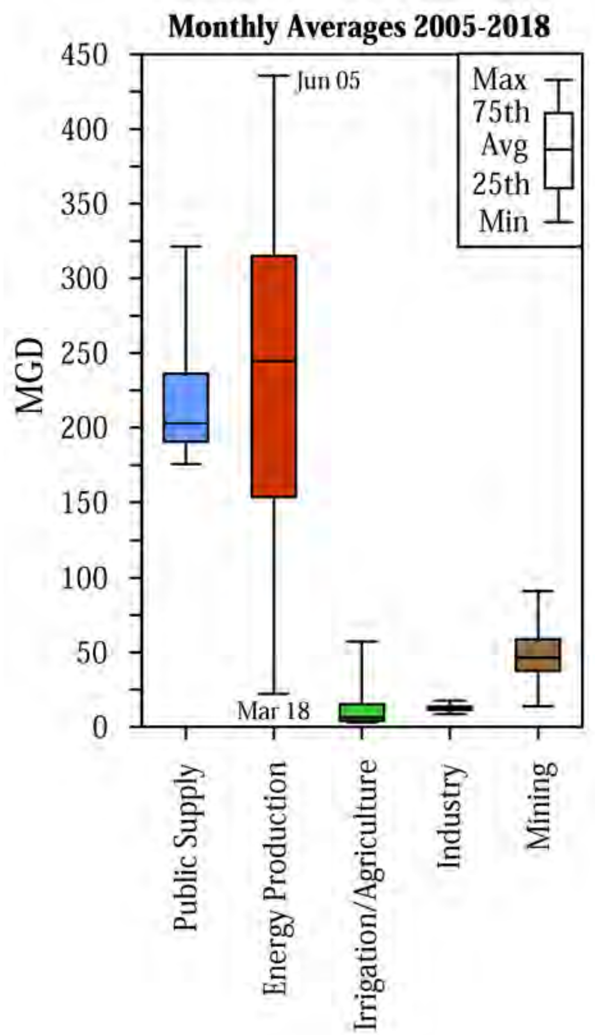


Figure 2.9: Historical monthly average water withdrawal for each water sector, 2005-2018, in the Central Region. *While the Energy Production sector has a large historic range of withdrawals, due to recent changes in fuel sources the current range of withdrawals is much lower, as shown by the March 2018 data point. Also note the small variation in monthly withdrawals in the industrial sector. Historical withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

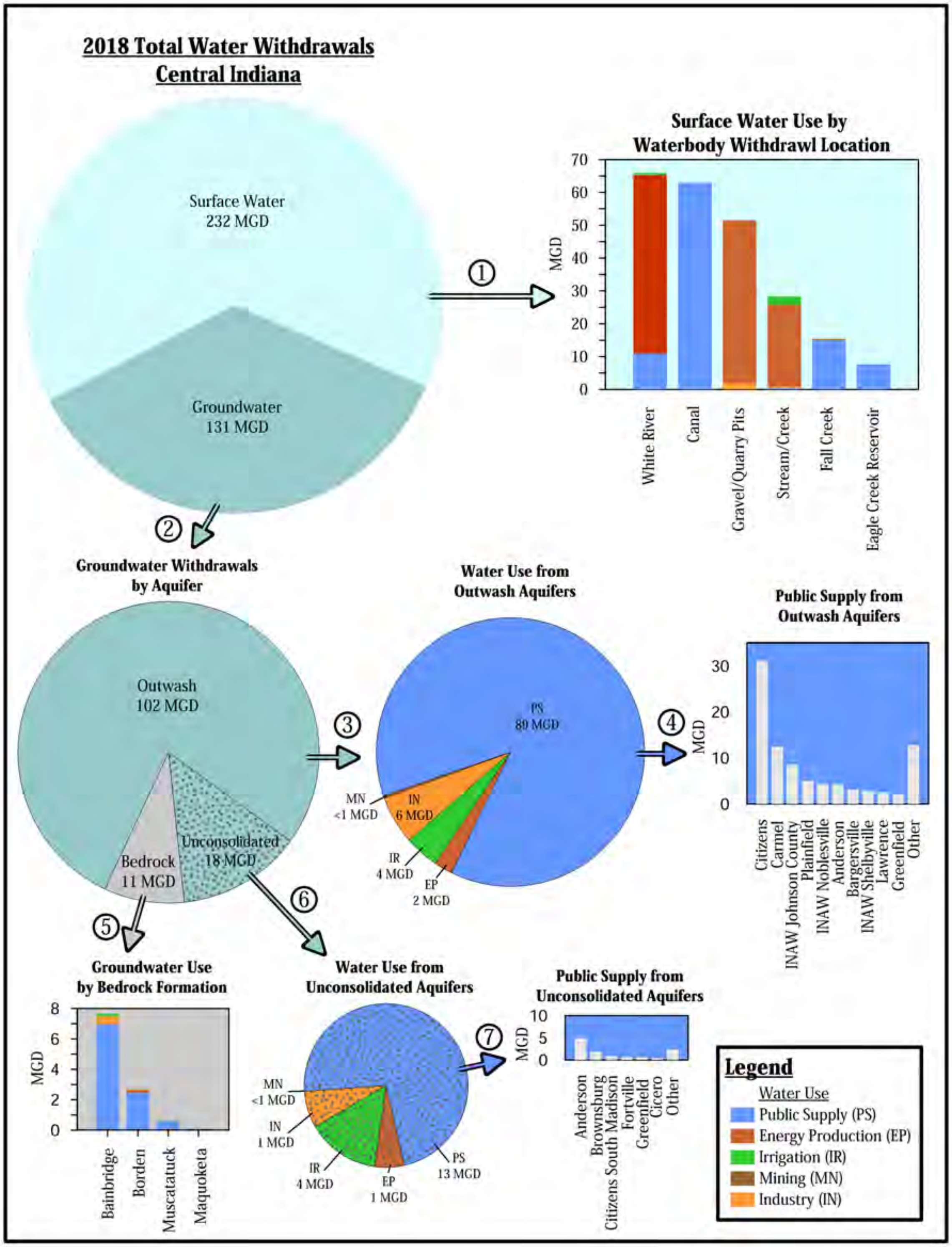
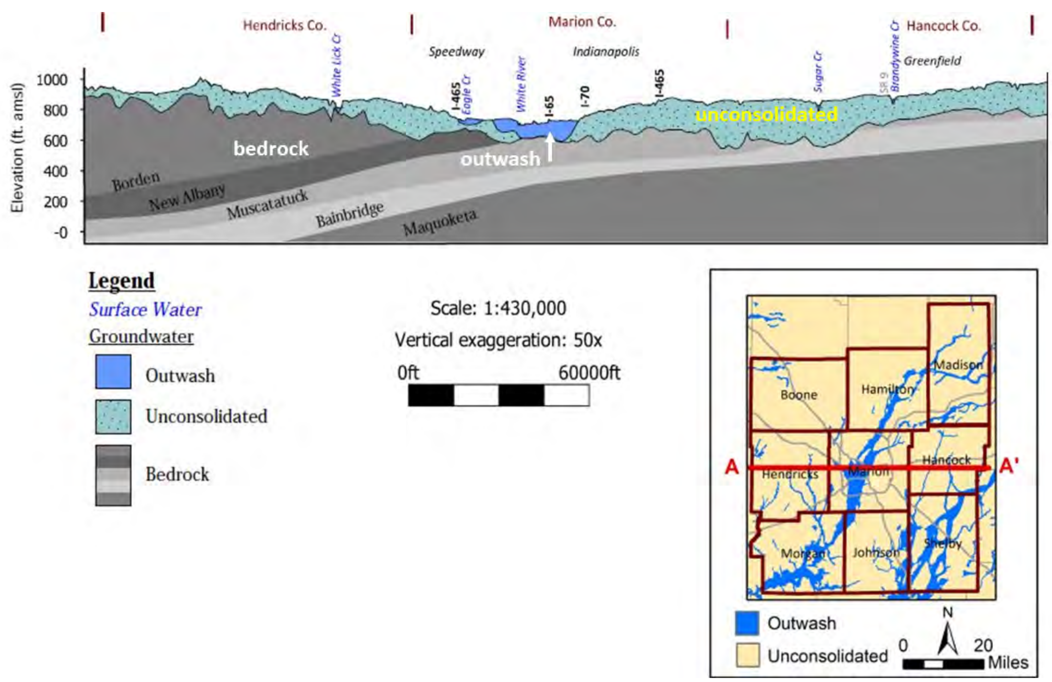


Figure 2.10: Sources of water supply in the Central Region for the 2018 calendar year: Infographic (DNR, 2018). *Historical 2018 withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

Explanation of the water supply sources infographic (Figure 2.10*). This set of charts is designed to illustrate the origin of the water used in the Region by industrial, public supplies and irrigators. The largest pie chart in the upper left shows that more than half of the water used in the Region is diverted from streams, rivers, canals and reservoirs.* ***1)*** *The bar chart in the upper right shows how much water comes from which surface water source. The colors in the bar chart describe how that water is used (see legend).* ***2)*** *The pie chart in the center left of the image shows that more than 75% of all groundwater reported in the DNR database is pumped from the outwash aquifer along the river, with the remaining 29 MGD from the deeper bedrock aquifer or from the sand and gravel layers further from rivers and streams (unconsolidated) (see cross-section figure below).* ***3)*** *The colorful pie chart in the center shows that almost 90% of the water from the outwash goes to public drinking water wells and the remaining 10% used by industry, irrigation, and energy production.* ***4)*** *The bar chart in the middle right of the image shows how much water each of the public suppliers used in the Region.* ***5)*** *In the lower left-hand corner of the image is a bar chart showing which bedrock formation is the source of supply for these deeper rock wells.* ***6)*** *The pie chart at the lower edge of the page shows how much water each user group pumps from these unconsolidated aquifers that are embedded in the soils away from the mapped outwash – again, public drinking water is the primary use.* ***7)*** *Finally, the small bar chart next to the legend shows which community systems rely on that unconsolidated aquifer for their drinking water.*



3 Commercial and Industrial Sector

Often, the Commercial and Industrial (C&I) Sector is defined to include both water that is self-supplied and water purchased from the Public Water Supply (PWS) Sector for commercial and industrial use. Presented here, because the SWWF database collects only self-supplied water withdrawals, the C&I Sector data include only self-supplied water withdrawals by industrial and commercial establishments. Water purchased for use by the C&I Sector is also in the PWS Sector, but only makes up a small percentage (less than 2%) of the public water supply sector (Section 7). C&I withdrawals represent approximately 20% of total reported water use in the State.

The C&I Sector has been divided into self-supplied mining and self-supplied non-mining sub-sectors for demand forecasting, as illustrated in Figure 1.3. In each sub-sector, the forecast is based on projections of future employment and historical rates of water use in gallons per employee per day (GPED). A summary of the historical data and the forecast for each sub-sector is provided in this section. Additional data and county graphs are in Appendix A.

3.1 Self-Supplied Non-Mining Sub-Sector

Self-supplied, non-mining withdrawals have decreased approximately 30% from 12.4 MGD in 2005 to 8.5 MGD in 2017 (Table 3.1). This reduction in water use is due, in part, to new efficiencies in production technology that function with lower water requirements for cooling and production. The largest withdrawals in this sub-sector occur in Marion County, accounting for over 50% of the Region total. Withdrawals in this sub-sector are primarily from groundwater, much of which is returned to surface water sources after use.

Total county employment and daily water use per employee were used to forecast future withdrawals in the self-supplied non-mining sub-sector. To evaluate historical per employee water use, purchased water from the PWS Sector must be accounted for. An estimate of the water purchased by non-mining commercial and industrial establishments is made using historical USGS data (USGS, 2017a) on public supply deliveries to commercial and industrial users. The USGS estimates of delivered supply are presented in Table 3.2. Those estimates are added to the self-supplied, non-mining withdrawals reported in the SWWF database (DNR, 2018) for the purpose of evaluating historical per employee water use. The combined water purchases and self-supplied, non-mining withdrawals are divided by total, non-mining county employment (Census, 2012) to calculate employee water use per day (GPED). To forecast future withdrawals, the average GPED from 2014–2016 was multiplied by the predicted number of county employees. The total is then multiplied by the percent of self-supplied, non-mining withdrawals from 2014–2016, to calculate the self-supplied, non-mining C&I sub-sector withdrawals. The assumption is that the ratio of self-supplied non-mining withdrawals to delivered supply will remain the same in the future as will the GPED. It is the employee population that

Table 3.1: Historical non-mining Commercial and Industrial withdrawals by county.

County	**2005** (MGD)	**2006** (MGD)	**2007** (MGD)	**2008** (MGD)	**2009** (MGD)	**2010** (MGD)	**2011** (MGD)	**2012** (MGD)	**2013** (MGD)	**2014** (MGD)	**2015** (MGD)	**2016** (MGD)	**2017** (MGD)
Boone	0.009	0.008	0.007	0.003	0.004	0.005	0.004	0.005	0.006	0.007	0.003	0.000	0.013
Hamilton	0.086	0.042	0.043	0.030	0.031	0.023	0.023	0.028	0.028	0.037	0.033	0.033	0.032
Hancock	0.007	0.008	0.019	0.018	0.002	0.003	0.007	0.015	0.010	0.007	0.007	0.010	0.002
Hendricks	0.052	0.039	0.045	0.045	0.045	0.168	0.167	0.180	0.178	0.180	0.180	0.050	0.050
Johnson	0.219	0.155	0.142	0.139	0.152	0.153	0.141	0.143	0.137	0.180	0.170	0.217	0.164
Madison	0.538	0.584	0.566	0.620	0.541	0.537	0.453	0.421	0.443	0.538	0.569	0.585	0.560
Marion	9.465	9.349	7.416	7.488	7.443	8.344	7.285	7.045	6.600	6.253	6.342	6.014	5.460
Morgan	1.609	1.593	1.618	1.575	1.546	1.537	1.509	1.381	1.999	2.002	1.998	2.005	2.002
Shelby	0.447	0.165	0.225	0.227	0.013	0.041	0.097	0.033	0.180	0.167	0.176	0.057	0.222
Total	**12.43**	**11.94**	**10.08**	**10.15**	**9.78**	**10.81**	**9.69**	**9.25**	**9.58**	**9.37**	**9.48**	**8.97**	**8.50**

Notes: MGD = million gallons per day.

Table 3.2: Percent of non-mining Commercial and Industrial supply delivered from public water supply systems.

County	Percent of delivered supply
Boone	36
Hamilton	21
Hancock	31
Hendricks	24
Johnson	25
Madison	31
Marion	36
Morgan	33
Shelby	40
All 9-co.	34

Source: USGS (2017a)

drives the water demand.

Because the future population of employees is the important factor in this analysis, we considered two employment forecasts for comparison. The first used rates of employment growth based on assumed values, which were related to historical rates and the projected statewide rates shown in Table 3.3. The second employment forecast was generated to verify the assumptions of the first, and uses the projections of the rates of growth in labor force by county. While the total county labor force is not the same as total county employment, the rates of growth in the labor force should be similar to the rates of employment growth.

3.1.1 Forecast based on employment trends

The 12-year historical employment trends are unlikely to continue throughout the 2020-2070 forecast period. To address this variability, other information on expected growth in future employment was examined. According to the Indiana University Business Research Center, the average growth rate of total Gross State Product over the 2018-2039 period is projected to be 2.31% per year. Over the same period, total Indiana employment is projected to grow at a rate of 0.61%, with employment in manufacturing falling at a rate of 0.62% and non-manufacturing employment growing at a rate of 0.82% (IBRC, 2019). A summary of historical and assumed growth rates for the self-supplied, non-mining sub-sector is presented in Table 3.3, and estimates of future employment in the sub-sector are presented in Table 3.4.

The results of withdrawal forecasts for the sub-sector, based on employment rates, are shown in Table 3.5 and Figure 3.1. Graphs of the historical and projected water withdrawals for each county are provided in Appendix A.

Table 3.3: Employment growth rates in the non-mining Commercial and Industrial sub-sector.

County	2005-2017 Historical growth (%)	Assumed annual growth (%)	Explanation of assumed growth
Boone	3.82	0.61	Statewide rate
Hamilton	2.85	0.61	Statewide rate
Hancock	0.83	0.42	One half of historical rate*
Hendricks	3.42	0.61	Statewide rate
Johnson	0.63	0.63	Historical close to Statewide rate
Madison	-0.89	0.20	Assumed slow growth vs. negative historical
Marion	-0.31	0.20	Assumed slow growth vs. negative historical
Morgan	-1.24	0.20	Assumed slow growth vs. negative historical
Shelby	-0.08	0.20	Assumed slow growth vs. negative historical

Notes: Statewide rate from IBRC, 2019.

Table 3.4: Future employment in the non-mining Commercial and Industrial sub-sector, based on assumed growth rates.

County	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Boone	21,437	22,099	22,781	23,485	24,210	24,957	25,728	26,522	27,341	28,185	29,055
Hamilton	131,452	135,510	139,694	144,007	148,453	153,037	157,762	162,632	167,654	172,830	178,166
Hancock	19,371	19,781	20,200	20,628	21,065	21,511	21,966	22,432	22,907	23,392	23,887
Hendricks	56,011	57,740	59,523	61,361	63,255	65,208	67,221	69,297	71,436	73,642	75,915
Johnson	46,913	48,409	49,953	51,547	53,191	54,888	56,639	58,445	60,310	62,234	64,219
Madison	35,868	36,228	36,591	36,959	37,330	37,705	38,083	38,466	38,852	39,242	39,636
Marion	525,376	530,651	535,979	541,360	546,795	552,285	557,830	563,431	569,088	574,801	580,572
Morgan	12,495	12,620	12,747	12,875	13,004	13,134	13,266	13,400	13,534	13,670	13,807
Shelby	15,649	15,806	15,965	16,125	16,287	16,450	16,616	16,782	16,951	17,121	17,293

Table 3.5: Water-withdrawal forecasts by county for the non-mining Commercial and Industrial sub-sector.

County	**2020** (MGD)	**2025** (MGD)	**2030** (MGD)	**2035** (MGD)	**2040** (MGD)	**2045** (MGD)	**2050** (MGD)	**2055** (MGD)	**2060** (MGD)	**2065** (MGD)	**2070** (MGD)
Boone	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005
Hamilton	0.035	0.037	0.038	0.039	0.040	0.041	0.043	0.044	0.045	0.047	0.048
Hancock	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.010	0.010
Hendricks	0.140	0.144	0.149	0.153	0.158	0.163	0.168	0.173	0.178	0.184	0.190
Johnson	0.195	0.201	0.207	0.214	0.221	0.228	0.235	0.242	0.250	0.258	0.266
Madison	0.574	0.579	0.585	0.591	0.597	0.603	0.609	0.615	0.621	0.628	0.634
Marion	6.267	6.330	6.393	6.457	6.522	6.588	6.654	6.721	6.788	6.856	6.925
Morgan	2.022	2.042	2.063	2.083	2.104	2.125	2.147	2.168	2.190	2.212	2.234
Shelby	0.134	0.135	0.136	0.138	0.139	0.140	0.142	0.143	0.145	0.146	0.148
Total	**9.377**	**9.480**	**9.583**	**9.688**	**9.794**	**9.902**	**10.010**	**10.121**	**10.232**	**10.345**	**10.460**

Notes: MGD = million gallons per day.

3.1.2 Forecast based on labor force projections

A second forecast was prepared to validate the first using projections of future labor force by county (IBRC, 2018). The data used for this projection, along with the results are shown in Appendix A. The primary forecast, the employment-based forecast, was only 4.6% higher than the secondary forecast based on labor force projections (10.46 MGD vs. 10.00 MGD in 2070) and can be considered validated.

3.2 Self-Supplied Mining Sub-Sector

Although it is highly concentrated in a few counties, mining withdrawals have been increasing in the Region, from 49.2 MGD in 2005 to over 73.5 MGD in 2017, as summarized in Table 3.6. Most of these withdrawals are focused in Marion and Hamilton counties. These two counties account for over 90% of the withdrawals associated with mining in the Central Region. Other counties have little to no withdrawals from this sub-sector. While Hamilton County has had historically consistent withdrawals in the range of 25-30 MGD, Marion County has had only moderate mining withdrawals until 2015, when a large increase of over 20 MGD occurred. It is unknown if this large increase will continue for the long term, however, it has continued from 2015 to 2018.

Forecasts were made for mining C&I withdrawals using assumed employment growth rates, as described above: the average GPED from 2014–2016 was multiplied by the predicted number of county employees specifically in the mining industry. Historical and assumed growth rates are provided in Table 3.7.

Projected water demand in each county was calculated in 5-year increments through 2070 (Table 3.8 and Figure 3.1). Based upon the assumed rates of mining employment growth and the base year rates of per employee use, the mining water use forecast shows an increase in water withdrawals from 64.37 MGD in 2015 to 84.73 MGD in 2070. The greatest withdrawals are expected in Hamilton and Marion counties due to the presence of sand and gravel mining operations using large quantities of water. These operations involve pumping water for dewatering and washing. Water withdrawals in Hamilton, Madison, Marion, Morgan, and Shelby counties are expected to increase by 2070, while mining withdrawals in Boone, Hancock, Hendricks, and Johnson counties are expected remain low.

3.3 Results

The results of the commercial and industrial forecasts are provided in Table 3.9. A graphical summary of the results of this section is presented in Figure 3.1. As illustrated in the figure, the mining sub-sector makes up more than 85% of total C&I withdrawals.

Table 3.6: Historical mining Commercial and Industrial withdrawals by county.

County	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)
Boone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
Hamilton	38.07	35.28	31.87	31.12	31.37	24.54	23.00	26.45	27.32	20.58	25.84	27.95	35.75
Hancock	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Hendricks	0.00	0.00	0.20	0.37	0.34	0.43	0.46	0.48	0.39	0.46	0.42	0.35	0.42
Johnson	0.01	1.58	1.45	1.35	1.39	1.13	1.34	1.33	1.21	0.00	1.44	1.41	1.39
Madison	0.68	0.71	0.87	4.79	3.30	1.61	2.52	1.77	0.32	0.26	0.30	0.27	1.86
Marion	6.72	7.94	7.92	5.33	5.16	5.46	5.92	6.34	6.48	6.60	33.13	27.83	30.45
Morgan	2.15	2.84	1.96	1.59	0.85	0.74	0.85	1.12	0.90	0.91	1.55	1.75	1.96
Shelby	1.57	1.46	0.83	1.50	1.20	1.21	1.30	1.09	1.22	1.78	1.69	1.94	1.50
Total	**49.19**	**49.81**	**45.10**	**46.05**	**43.63**	**35.14**	**35.40**	**38.58**	**37.85**	**30.61**	**64.37**	**61.50**	**73.58**

Notes: MGD = million gallons per day.

Table 3.7: Employment growth rates in the mining Commercial and Industrial sub-sector.

County	2005-2017 Historical annual trend	Assumed annual growth (%)	Explanation of assumed growth
Boone	0.00	0.00	Minor mining withdrawals in 2017
Hamilton	0.02	0.61	Statewide growth rate
Hancock	0.00	0.00	Minor withdrawals, no growth
Hendricks	0.00	0.00	No trend since 2010
Johnson	0.00	0.00	No growth in mining employment
Madison	0.00	0.10	Assumed slow growth vs. negative historical
Marion	0.00	0.61	Statewide growth rate
Morgan	-0.03	0.10	Assumed slow growth vs. negative historical
Shelby	-0.10	0.10	Assumed slow growth vs. negative historical

Notes: Statewide rate from IBRC, 2019.

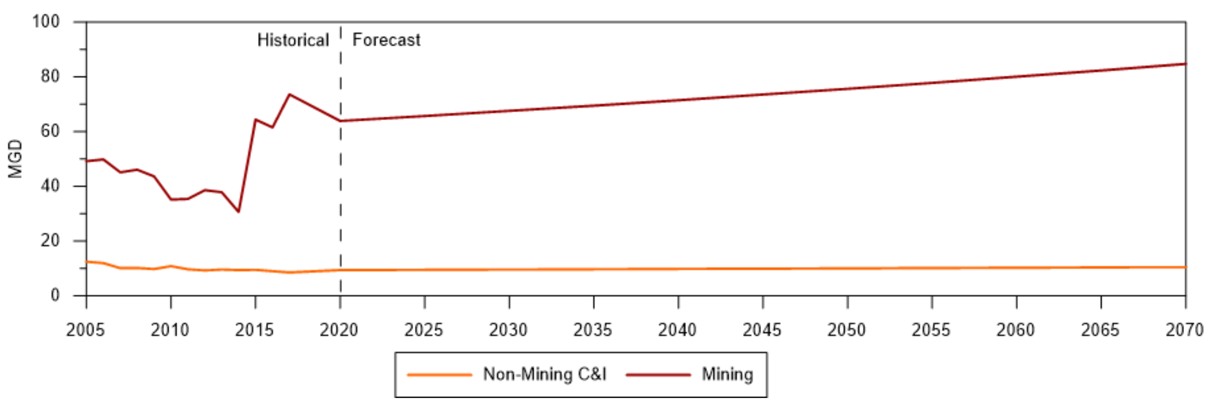


Figure 3.1: Historical and forecast withdrawals for the mining and non-mining Commercial and Industrial sub-sectors.*Regional water withdrawals are expected to increase from 73 MGD in 2020 to 95 MGD in 2070. Annual historical water withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 2005-2018 (DNR, 2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

Table 3.8: Water-withdrawal forecasts by county for the mining Commercial and Industrial sub-sector .

County	**2020** (MGD)	**2025** (MGD)	**2030** (MGD)	**2035** (MGD)	**2040** (MGD)	**2045** (MGD)	**2050** (MGD)	**2055** (MGD)	**2060** (MGD)	**2065** (MGD)	**2070** (MGD)
Boone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hamilton	27.12	27.96	28.82	29.71	30.63	31.58	32.55	33.56	34.59	35.66	36.76
Hancock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hendricks	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Johnson	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59
Madison	0.29	0.29	0.29	0.29	0.30	0.30	0.30	0.30	0.30	0.30	0.31
Marion	31.01	31.97	32.95	33.97	35.02	36.10	37.22	38.36	39.55	40.77	42.03
Morgan	1.60	1.61	1.62	1.63	1.63	1.64	1.65	1.66	1.67	1.67	1.68
Shelby	1.85	1.86	1.87	1.88	1.89	1.90	1.91	1.92	1.93	1.94	1.95
Total	**63.88**	**65.69**	**67.56**	**69.49**	**71.48**	**73.52**	**75.63**	**77.80**	**80.04**	**82.35**	**84.73**

Notes: MGD = million gallons per day.

Table 3.9: Water-withdrawal forecasts by county for the Commercial and Industrial sector of the Central Region.

County	**2020** (MGD)	**2025** (MGD)	**2030** (MGD)	**2035** (MGD)	**2040** (MGD)	**2045** (MGD)	**2050** (MGD)	**2055** (MGD)	**2060** (MGD)	**2065** (MGD)	**2070** (MGD)
Boone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
Hamilton	27.16	28.00	28.86	29.75	30.67	31.62	32.59	33.60	34.64	35.71	36.81
Hancock	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Hendricks	0.55	0.55	0.56	0.56	0.57	0.57	0.58	0.58	0.59	0.59	0.60
Johnson	1.79	1.79	1.80	1.80	1.81	1.82	1.83	1.83	1.84	1.85	1.86
Madison	0.86	0.87	0.88	0.88	0.90	0.90	0.91	0.92	0.92	0.93	0.94
Marion	37.28	38.30	39.34	40.43	41.54	42.69	43.87	45.08	46.34	47.63	48.96
Morgan	3.62	3.65	3.68	3.71	3.73	3.77	3.80	3.83	3.86	3.88	3.91
Shelby	1.98	2.00	2.01	2.02	2.03	2.04	2.05	2.06	2.08	2.09	2.10
Total	**73.26**	**75.17**	**77.14**	**79.18**	**81.27**	**83.42**	**85.64**	**87.92**	**90.27**	**92.70**	**95.19**

Notes: MGD = million gallons per day.

4 Irrigation and Agriculture

Throughout the world, irrigation (including water for agriculture, or growing crops) is one of the most important uses of water. Almost 70 percent of all the world's freshwater withdrawals are for irrigation purposes (USGS, 2018). In the United States alone, irrigation withdrawals were an estimated 118,000 million gallons per day (MGD) in 2015. The majority of these withdrawals (81%) and irrigated acres (74%) were in the 17 contiguous Western States where average annual precipitation typically is less than 20 inches (USGS, 2018). In Indiana, where the average annual precipitation is approximately 40 inches per year, water withdrawals for irrigation purposes in 2015 were estimated to be 133 MGD (USGS, 2018).

The Irrigation and Agriculture (IR&AG) Sector includes water withdrawals from the following sub-sectors, as illustrated in Figure 1.3: Crop/Orchard Irrigation, Golf Course Irrigation, Aquaculture/rural use, and Miscellaneous use. Of the five water sectors, IR&AG is the smallest, making up less than 5% of the total withdrawals in the Region. In 2015, 11.50 MGD were withdrawn for agriculture and irrigation purposes in the Region.

Future water withdrawal projections were based on historical trends of reported water withdrawals by county and agricultural sub-sector. Trends were calculated based upon variations in water-use utilizing 2005 to 2017 USGS data. The following sections describe the method and procedures used to forecast irrigation and agriculture withdrawals.

4.1 Historical withdrawals

Water withdrawal data from 2005 to 2017, available from the DNR Significant Water Withdrawal Facilities (SWWF) database were evaluated (2018 data was unavailable at the time of analysis, but later added to graphs and tables). Additional data from United States Geological Survey's (USGS) National Water Information System (NWIS) (DNR, 2018) were also used to verify and supplement the SWWF data. Total regional historical withdrawals ranged from 10 MGD in 2006 to 19 MGD in 2012 (Table 4.1). The annual variation in this sector is primarily driven by weather as evidenced by increased in withdrawals in 2012 when Indiana experienced a drought. Weather-related increases occur in both the golf course and cropland sub-sectors. Other sub-sectors, such as aquaculture, are relatively stable throughout the thirteen-year historical period.

The sub-sector water withdrawals also vary geographically (Figure 4.1). Marion, Hamilton, and Morgan counties comprise over 75% of the total withdrawals in 2018. Graphs of total water withdrawals for 2005 to 2018 for each county by withdrawal type are provided in Appendix B. In Hamilton and Marion counties, golf course withdrawals are largest in the Region. Morgan County withdrawals are predominantly from one aquaculture farm. The largest volume of water used for cropland irrigation is in Shelby County.

Table 4.1: Historical withdrawals for Irrigation and Agriculture sub-sectors.

Sub-sector	**2005** (MGD)	**2006** (MGD)	**2007** (MGD)	**2008** (MGD)	**2009** (MGD)	**2010** (MGD)	**2011** (MGD)	**2012** (MGD)	**2013** (MGD)	**2014** (MGD)	**2015** (MGD)	**2016** (MGD)	**2017** (MGD)	**2018** (MGD)
Crop/Orchard	1.66	1.12	3.17	1.34	1.14	2.07	3.66	6.63	4.08	2.98	1.72	2.37	2.24	3.22
Golf Course	3.45	1.93	4.16	2.98	2.43	4.36	3.46	4.92	3.24	2.17	2.42	2.34	2.53	2.99
Landscape/other	1.43	0.85	1.53	1.08	0.81	1.35	1.39	1.38	1.05	0.98	1.03	0.69	1.13	0.87
Aquaculture/Rural	3.20	3.00	3.21	3.21	3.52	3.28	3.28	3.30	3.25	3.24	3.27	3.36	3.33	3.36
Miscellaneous	3.52	3.09	3.59	4.71	3.39	3.42	2.53	3.13	2.74	3.76	3.06	2.07	3.22	2.32
Total	**13.26**	**9.99**	**15.66**	**13.33**	**11.28**	**14.48**	**14.32**	**19.35**	**14.36**	**13.14**	**11.50**	**10.82**	**12.45**	**12.76**

Notes: MGD = million gallons per day.

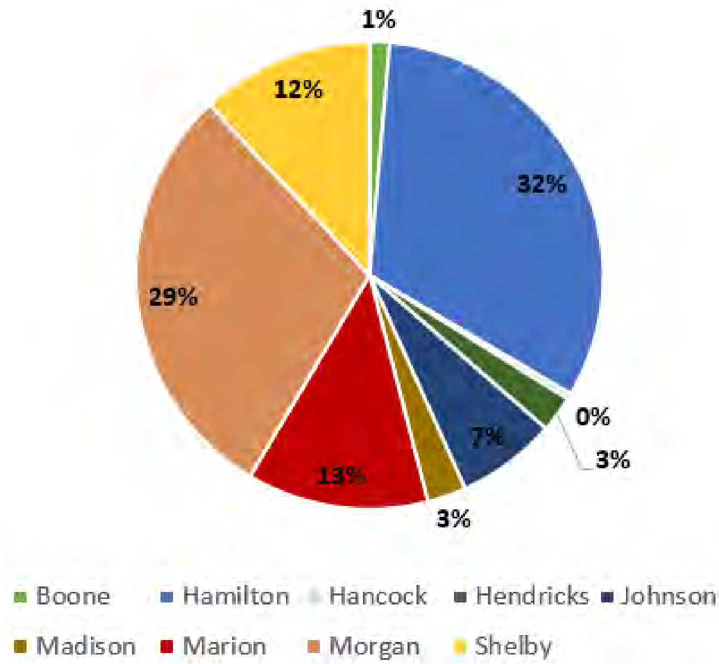


Figure 4.1: County distribution of Irrigation and Agriculture withdrawals in 2018.

4.2 Forecast method

Irrigation and other landscape water uses are driven by weather: more water is applied to crops when temperatures are high and precipitation is low. Ideally, when forecasting irrigation withdrawals, weather impacts are incorporated into the prediction by correlating the amount withdrawn (in million gallons/acre) to the temperature and precipitation during the time period. However, this is not possible in the Central Region. Although we have annual withdrawal data, we do not know the number of acres to which that water is applied. Without the acreage, we don't know if increased withdrawals are due to weather or due to an increase in acreage. Therefore, future water demand projections were based on historical trends of reported water withdrawals by county and agricultural subsector. Trends were calculated based upon observed variation from 2005 to 2017. If growth trends were negative the assumed forecast trend was set to zero (resulting in constant values for all forecast years at the base year level). However, if the calculated historical trends were greater than 3% per year, then the assumed trend for the forecast was set at 3% per year or less. The base year irrigation water use was calculated as the average for the 5 most recent years (i.e., 2013-2017). The growth trends for each county are reported in Table 4.2 and 4.3.

4.3 Predicted withdrawals

A summary of historical and forecast IR &AG water withdrawals by sub-sector is presented in Figure 4.2. The increase in withdrawals forecasted for the IR&AG Sector is small, from 12.75

Table 4.2: County growth trends in Irrigation and Agriculture sub-sectors.

County	Sub-sector	Historical growth 2005-2017 (%)	Assumed growth 2020-2070 (%)
Boone	Crop/Orchard	0.00	0.00
	Golf Course	-4.44	0.00
	Landscape/other	-4.27	0.00
	Aquaculture/Rural	0.00	0.00
	Miscellaneous	2.44	2.44
Hamilton	Crop/Orchard	3.04	1.52
	Golf Course	0.64	0.64
	Landscape/other	-2.51	0.00
	Aquaculture/Rural	0.00	0.00
	Miscellaneous	-1.81	0.00
Hancock	Crop/Orchard	1.38	1.38
	Golf Course	-4.63	0.00
	Landscape/other	9.11	3.00
	Aquaculture/Rural	28.11	3.00
	Miscellaneous	0.00	0.00
Hendricks	Crop/Orchard	0.00	0.00
	Golf Course	-10.07	0.00
	Landscape/other	-0.53	0.00
	Aquaculture/Rural	0.00	0.00
	Miscellaneous	0.00	0.00
Johnson	Crop/Orchard	4.72	2.36
	Golf Course	-1.30	0.00
	Landscape/other	-21.63	0.00
	Aquaculture/Rural	0.00	0.00
	Miscellaneous	-5.30	0.00

Table 4.3: Continued, County growth trends in Irrigation and Agriculture sub-sectors.

County	Sub-sector	Historical growth 2005-2017 (%)	Assumed growth 2020-2070 (%)
Madison	Crop/Orchard	2.62	2.62
	Golf Course	-6.49	0.00
	Landscape/other	-2.74	0.00
	Aquaculture/Rural	0.00	0.00
	Miscellaneous	0.00	0.00
Marion	Crop/Orchard	-3.48	0.00
	Golf Course	-1.70	0.00
	Landscape/other	-1.15	0.00
	Aquaculture/Rural	0.00	0.00
	Miscellaneous	-3.47	0.00
Morgan	Crop/Orchard	5.23	3.00
	Golf Course	-6.52	0.00
	Landscape/other	0.00	0.00
	Aquaculture/Rural	0.36	0.36
	Miscellaneous	0.00	0.00
Shelby	Crop/Orchard	5.90	2.00
	Golf Course	-1.74	0.00
	Landscape/other	2.20	2.20
	Aquaculture/Rural	0.00	0.00
	Miscellaneous	0.37	0.37

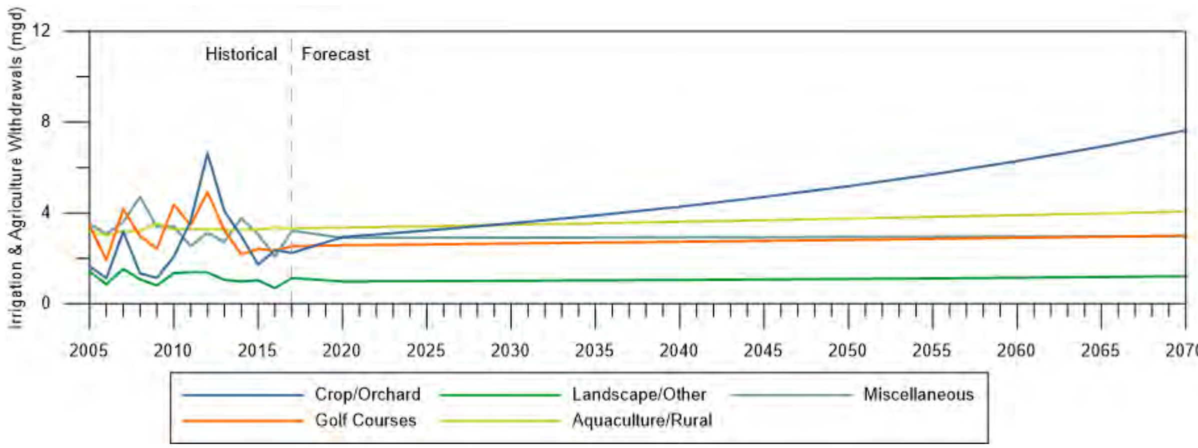


Figure 4.2: Forecast withdrawals for the Irrigation and Agriculture sector.

MGD in 2020 to 18.90 MGD in 2070 (Table 4.4). The growth is driven primarily by the the crop/orchard sub-sector, increasing from 2.94 MGD to 7.64 MGD in 2070 (Figure 4.2). More than half of the cropland withdrawals in the Central Region is projected to occur in Shelby County (Table 4.5). Regionally, Shelby, Hamilton, Marion, and Morgan counties is projected to account for 85% of the irrigation and agriculture withdrawals in 2070.

Table 4.4: Forecast withdrawals for the Irrigation and Agriculture sector.

Sub-sector	**2020** (MGD)	**2025** (MGD)	**2030** (MGD)	**2035** (MGD)	**2040** (MGD)	**2045** (MGD)	**2050** (MGD)	**2055** (MGD)	**2060** (MGD)	**2065** (MGD)	**2070** (MGD)
Crop/Orchard	2.94	3.22	3.54	3.89	4.28	4.70	5.18	5.70	6.28	6.92	7.64
Golf Course	2.58	2.61	2.65	2.69	2.73	2.77	2.82	2.86	2.91	2.95	3.00
Landscape/other	0.99	1.00	1.01	1.03	1.05	1.07	1.09	1.12	1.15	1.18	1.21
Aquaculture/Rural	3.35	3.41	3.48	3.54	3.61	3.68	3.75	3.83	3.90	3.98	4.06
Miscellaneous	2.90	2.91	2.91	2.92	2.93	2.93	2.94	2.95	2.96	2.97	2.98
Total	**12.75**	**13.16**	**13.60**	**14.07**	**14.59**	**15.16**	**15.78**	**16.46**	**17.20**	**18.01**	**18.90**

Notes: MGD = million gallons per day.

Table 4.5: County-level forecast of Irrigation and Agriculture withdrawals in Central Region in MGD.

County	**2020** (MGD)	**2025** (MGD)	**2030** (MGD)	**2035** (MGD)	**2040** (MGD)	**2045** (MGD)	**2050** (MGD)	**2055** (MGD)	**2060** (MGD)	**2065** (MGD)	**2070** (MGD)
Boone	0.42	0.42	0.43	0.43	0.43	0.44	0.44	0.45	0.46	0.46	0.47
Hamilton	3.76	3.84	3.93	4.02	4.13	4.23	4.34	4.46	4.59	4.73	4.87
Hancock	0.09	0.10	0.11	0.11	0.12	0.14	0.15	0.16	0.18	0.20	0.22
Hendricks	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Johnson	0.68	0.74	0.80	0.88	0.96	1.05	1.15	1.26	1.39	1.53	1.69
Madison	0.25	0.26	0.27	0.27	0.28	0.29	0.30	0.32	0.33	0.35	0.37
Marion	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99
Morgan	3.50	3.57	3.64	3.71	3.78	3.86	3.94	4.03	4.12	4.21	4.31
Shelby	1.85	2.03	2.23	2.45	2.69	2.96	3.25	3.58	3.94	4.33	4.77
Total	**12.75**	**13.16**	**13.60**	**14.07**	**14.59**	**15.16**	**15.78**	**16.46**	**17.20**	**18.01**	**18.90**

Notes: MGD = million gallons per day.

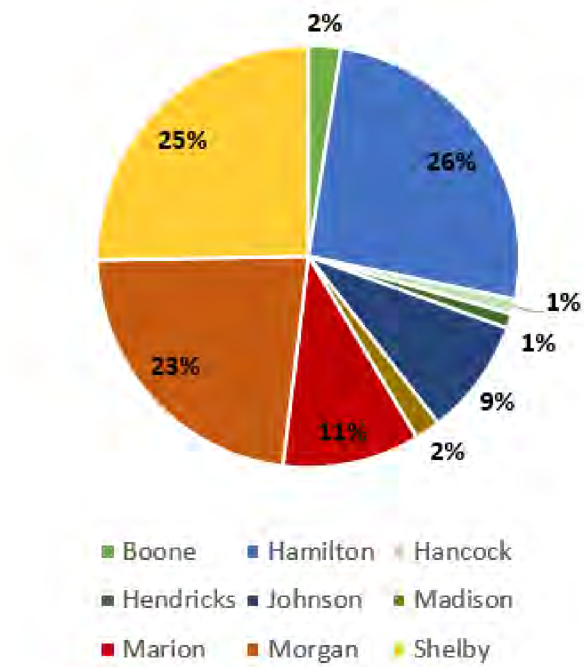


Figure 4.3: County distribution of Irrigation and Agriculture withdrawals forecast for 2070. *The increase in withdrawals forecasted for the IR&AG Sector is small, from 12.75 MGD in 2020 to 18.90 MGD in 2070. Regionally, Shelby, Hamilton, Marion, and Morgan counties is projected to account for 85% of the irrigation and agriculture withdrawals in 2070.*

5 Self-Supplied Domestic Sector

The self-supplied domestic sector includes water withdrawn from private homeowner wells. Statewide more than 25% of the people in Indiana drink water from a private well located on their property (USGS, 2017c). These domestic users are widely distributed and are not subject to management by state agencies and unlike other sectors, withdrawals for this sector are not collected in the DNR SWWF database. Unfortunately, this makes it difficult to know the exact number of people who use private domestic water wells and, therefore, methods of estimation must be applied.

The two basic methods of water use estimation are based upon: 1) reported PWS population served numbers or 2) estimation of the population outside the PWS service areas (Figure 5.1). The known value for both methods is the total county population. Then, either the total PWS population served is subtracted from the county population (Method 1) or the domestic population is estimated using the number of parcels that are outside of service areas (Method 2). Both of these methods and the resulting water-use estimates for 2015 are described in more detail in the following sections, however, the forecast for this report used Method 1, by subtracting the number of people served by the public water systems from the "known" population in each county (Figure 5.1). The PWS population served data used was reported by the utilities in a previous IFA study (Indiana Finance Authority, 2016).

5.1 Domestic water use

A 2017 USGS report (Open-file Report 2017-1131) estimated the domestic water-use in 2015 for the United States (USGS, 2017c) and found that domestic self-supplied population has decreased from 2010 to 2015. Similarly, the domestic per capita use has decreased from 81 GPCD in 2010 to 77 GPCD in 2015 in the United States. For Indiana, the 2015 average per capita rate was 76 GPCD (USGS, 2017c) and we used this per capita rate to calculate the total county domestic use for the two methods.

It should be noted that in many communities around the country per capita urban water use has fallen over time as modern fixtures are added to apartments and homes. Recent investigations have shown that rural areas are not becoming more efficient (Sankarasubramanian et al, 2017) but the estimates used in this analysis show that rural uses are in line with national estimates. In this report, the "domestic use" covers only homes that use private wells. The estimated use of 76 gpcd is reasonable as it is close to the national average of 83 gpcd (indoor and outdoor) in the US in the 2015 USGS data. Other work by the AWWA Research Foundation (DeOreo, et al, 2016) showed that average indoor residential use was close to 53 gpcd.

Figure 5.1: Diagram of two methods that can be used to determine the population of self-supplied domestic. *In this report, we use method 2.*

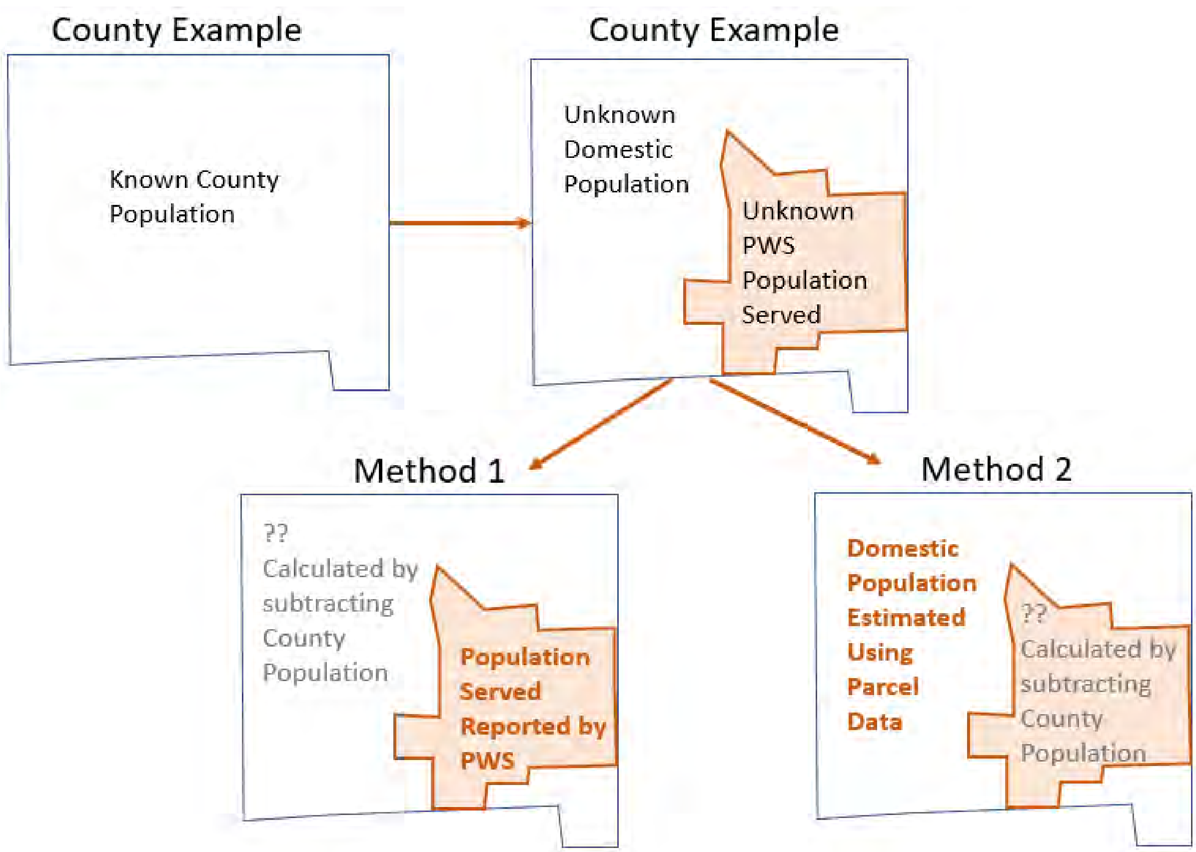


Table 5.1: Self-supplied domestic population estimated for 2015 with county population and population served by public water supply.

County	County population	Public-supplied population	Estimated domestic users	2015 Domestic water-use (MGD)*
Boone	63,400	45,287	18,113	1.38
Hamilton	309,172	247,085	62,087	4.72
Hancock	72,392	44,379	28,013	2.13
Hendricks	158,059	101,789	56,270	4.28
Johnson	149,338	119,153	30,185	2.29
Madison	129,495	99,916	29,579	2.25
Marion	938,058	759,812	178,246	13.55
Morgan	69,646	55,558	14,088	1.07
Shelby	44,442	38,901	5,541	0.42
TOTAL	**1,934,002**	**1,511,880**	**422,122**	**32.08**

*Assumed 76 gallons per capita per day.

5.1.1 Method 1 - Population served estimation method

This method estimates the self-supplied domestic population in each county by subtracting the 2015 population served for each utility from the known total population of each county (Table 5.1). The PWS population served was reported to the IFA directly by the utilities in IFA Utility Report (2016). When service territories crossed county boundaries, GIS tools were used with data such as census-block population to estimate the portion of population served in each county. In most rural counties there are only a few small water utilities, so the population that rely on domestic water wells can reliably be determined by subtraction from the county census data. When the population served by the utility is small, the magnitude of the error is also small relative to the total population in each county. However, this estimation by subtraction method can be difficult near metropolitan areas.

The total number of domestic water-users in the Region is estimated is 422,122. As a method check, we compared our domestic population estimate with the 2015 USGS domestic-use population values; 385,326 people (USGS, 2017c). These two domestic population estimates have a difference of 36,796 people, this translates into a difference of 2.8 MGD spread across the nine county Region, an arguably small difference.

Using Method 1 to estimate the domestic population and the USGS estimate of 76 GPCD, the 2015 estimate of domestic withdrawals translates into just over 32 MGD of water withdrawals throughout the Region (Table 5.1).

Table 5.2: Self-supplied domestic population estimated for 2015 using the number of land parcels and estimates of people per parcel.

County	Parcels w/out Public Supply	Estimated persons per parcel	Estimated domestic users	2015 Domestic water-use (MGD)*
Boone	6,609	2.58	17,051	1.30
Hamilton	7,474	2.69	20,105	1.53
Hancock	10,207	2.59	26,436	2.01
Hendricks	10,928	2.72	29,724	2.26
Johnson	6,288	2.67	16,788	1.28
Madison	16,219	2.40	38,925	2.96
Marion	6,717	2.51	16,859	1.28
Morgan	7,554	2.65	20,018	1.52
Shelby	8,466	2.46	20,826	1.58
TOTAL	**80,462**	**2.59 (average)**	**206,732**	**15.71**

*Assumed 76 gallons per capita per day.

5.1.2 Method 2 - Domestic parcel estimation method

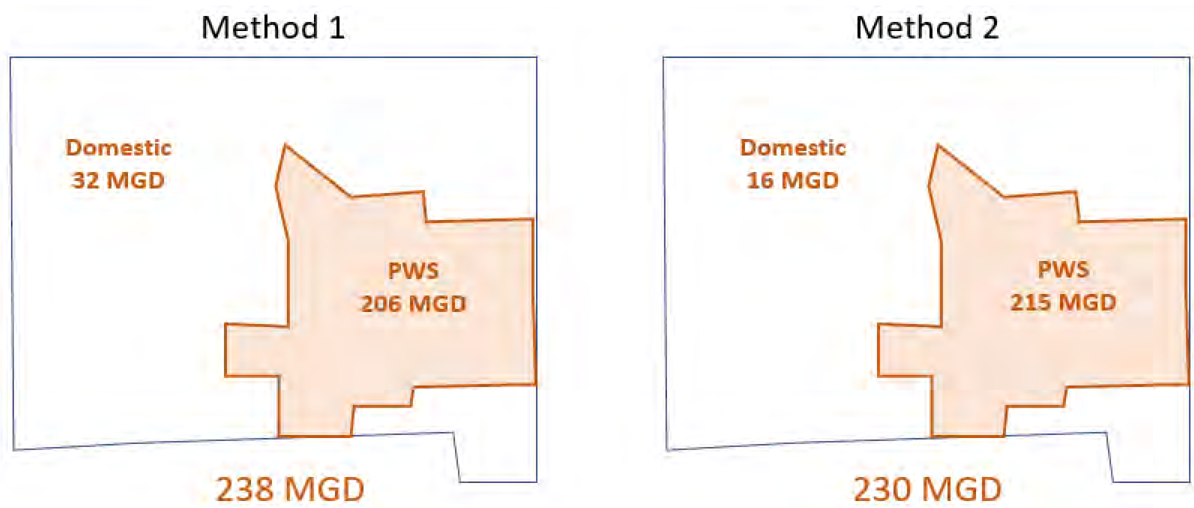
An alternate approach to estimate the domestic-use was to count the number of land parcels in the areas outside of the public water supply service areas. After confirming that there were records of private water wells on a large fraction of these parcels, an estimate was made of total domestic population based on the average number of people per home in the rural areas outside of the PWS service territories. The results of this method are provided in Table 5.2. This approach provided an independent estimate that showed large differences in the most densely populated counties.

Using Method 2 to estimate the domestic population and the USGS estimate of 76 GPCD, the 2015 estimate of domestic withdrawals translates into 15.7 MGD of water homeowner withdrawals throughout the Region (Table 5.2).

5.1.3 Understanding the difference between Method 1 and Method 2

Method 1 incorporates the data collected from the public water suppliers and, therefore, coordinates with the public supply forecast. However, Method 2 has ramifications to the public water supply sector because it yields alternative estimates for the population served values for each county. To analyze the difference this estimate will have on the public water supply withdrawals we have to calculate the new withdrawals generated by this bounding case. The population served was back-calculated in each county from the parcel estimated domestic supply. From this, we can re-calculate the 2015 public water supply withdrawals (Figure 5.2). As compared to the previously calculated public water supply withdrawals for 2015 (total 206 MGD, see

Figure 5.2: Comparisons of the regional 2015 domestic and public water supply withdrawals calculated using Method 1 versus Method 2. *The total difference regionally is approximately 8 MGD.*



Section 7), the average water use in 2015 is less by approximately 7.5 MGD.

The uncertainty in the domestic supply population could be managed with further investigation by the County Health Departments in the Region. A survey of homeowner wells and water use would improve the confidence in the forecast for water demand state-wide. However, the scattered distribution of homeowner wells over the entire Region minimizes the hydraulic impacts of this sector on other water uses.

5.2 Domestic water withdrawal forecast

Two forecasts were calculated; one using a constant GPCD and another that modified future GPCD with conservation and median household income (MHI) growth. Both forecasts applied the county population projections growth rates to the 2015 domestic population calculated using Method 1. The results of the two forecasts were very similar, resulting in a 2020 total domestic water-use of ~33.7 MGD and a 2070 projected total of 44.7 MGD in the Region. The results of the constant GPCD forecast are shown in Table 5.3 and Figure 5.3. The counties with the largest total population (Marion, Hamilton, and Hendricks) also have the largest domestic population and, therefore, the largest withdrawals for domestic supply.

Despite the importance of domestic water use by individual domestic well owners in some counties, it is difficult to accurately estimate domestic use with the limited data available. Water shortages caused by over pumping by high capacity wells or from lack of recharge, could cause serious disruptions in those rural areas served by self-supplied domestic wells. While these factors are important in the rural areas of the study region, additional investigation is needed to understand these risks. Given that we can only roughly estimate the average unit use (gpcd) and number of users (i.e., active wells as a sole source of water supply), we are limited to the

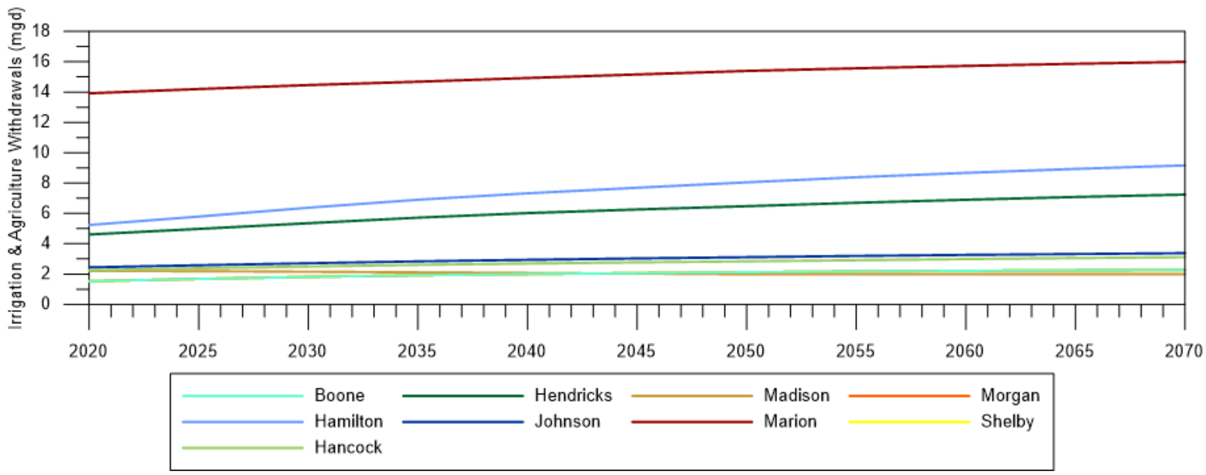


Figure 5.3: Forecast of self-supplied domestic water withdrawals by county. *Domestic water withdrawals are expected to increase with the domestic population from 2020 to 2070. The water withdrawals are predicted to increase from ~34 MGD in 2020 to ~45 MGD in 2070.*

accounting for this use by providing our best estimate.

Table 5.3: Forecast for the self-supplied domestic sector using a constant per capita rate of 76 GPCD.

County	**2020** (MGD)	**2025** (MGD)	**2030** (MGD)	**2035** (MGD)	**2040** (MGD)	**2045** (MGD)	**2050** (MGD)	**2055** (MGD)	**2060** (MGD)	**2065** (MGD)	**2070** (MGD)
Boone	1.53	1.69	1.82	1.92	2.00	2.06	2.13	2.18	2.22	2.25	2.27
Hamilton	5.24	5.79	6.38	6.90	7.32	7.69	8.05	8.38	8.67	8.94	9.17
Hancock	2.25	2.38	2.50	2.61	2.70	2.77	2.84	2.92	2.99	3.05	3.11
Hendricks	4.61	4.98	5.35	5.72	6.02	6.26	6.48	6.70	6.90	7.08	7.25
Johnson	2.44	2.58	2.72	2.84	2.94	3.03	3.12	3.19	3.26	3.33	3.38
Madison	2.22	2.19	2.16	2.12	2.07	2.03	1.99	1.99	1.99	1.99	1.99
Marion	13.92	14.21	14.46	14.69	14.93	15.16	15.39	15.57	15.73	15.87	15.99
Morgan	1.08	1.10	1.11	1.11	1.11	1.10	1.09	1.09	1.09	1.09	1.09
Shelby	0.42	0.43	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.41
TOTAL	**33.70**	**35.34**	**36.92**	**38.33**	**39.50**	**40.53**	**41.50**	**42.43**	**43.26**	**44.01**	**44.67**

Notes: MGD = million gallons per day.

6 Power Generation Sector

Power generation has historically been water intensive, however, as fuel sources change and the generation process becomes more efficient, water use has declined. This trend is evident across the country and in the Central Region. In 2005, water withdrawals exceeded 360 MGD for power generation. In 2017, water use for power generation was reported to be less than 70 MGD. For this sector, separate forecasts of water demand were prepared for thermoelectric and geothermal power production. A straightforward unit-coefficient method was used in this study to derive future quantities of water withdrawals. This method represents cooling water demand as a product of total gross generation at the plant and the unit rate of water required in gallons per kilowatt-hour. The specific coefficients and relationship for the two main types of cooling systems are discussed below.

6.1 Thermoelectric Power

Water withdrawn by power plants is classified by the United States Geological Survey (USGS) as thermoelectric generation water use (USGS, 2017b). It represents the water applied in the production of heat-generated electric power. The heat sources may include fossil fuels such as coal, petroleum, natural gas, or processes such as nuclear fission. The main use of water at power plants is for cooling. Nearly 90 percent of electricity in the United States is produced with thermally-driven, water-cooled generation systems which require large amounts of water.

The three major types of thermoelectric plants include: conventional steam, nuclear steam, and internal combustion plants. In internal combustion plants, the prime mover is an internal combustion diesel or gas-fired engine. Since no steam or condensation cooling is involved, almost no water is used by internal combustion power generation.

In conventional steam and nuclear steam power plants, the prime mover is a steam turbine. Water is heated in a boiler until it turns into steam. The steam is then used to turn the turbine-generator, which produces electricity. While water demand for energy generation are similar for plants of the same type, the actual unit amounts of water withdrawn per kilowatt-hour of gross generation vary from plant to plant even when the same type of cooling is used and at the same level of thermal efficiency. Significant differences in unit water use per kilowatt-hour of electricity generation among different types of cooling systems were reported in previous studies (Harte and El-Gasseir, 1978; Gleick, 1993). Some of the reasons for this variability are easily explained. For example, in load-following plants using once-through cooling systems, intake pumps are left on when the level of generation declines. This is often caused by the lack of control technologies to regulate flow to match the fluctuating load on generators. There is limited ability to close or open control valves on pipes between the pumps and the condenser, or regulate the operation of pumps.

Better measurement and control of flows is available on closed-loop systems with cooling towers. The make-up water is usually metered and its flow rate could be regulated automatically depending on the quality of the recirculating water. However, the level of control varies among plants and the amounts of intake water per kilowatt-hour of generation also vary. Without advanced technologies for water measurement and control, it is difficult to optimize system operations to minimize water intake as well as operational costs associated with maintaining the high efficiency of heat transfer in the condenser. For these reasons, the water-use rate is calculated individually for each power plant (in gallons per kWh) and used for the future projection.

6.1.1 Central Indiana Thermoelectric Power

Three counties have thermoelectric power plants in the Region: Hamilton County, Marion County, and Morgan County. Water withdrawals reported for 2005-2017 for the largest thermal power plants in each county were obtained from the DNR Significant Water Withdrawal Facilities (SWWF) database and can be seen in Table 6.1 (DNR, 2018).Water withdrawals for thermoelectric power have decreased substantially from over 360 MGD in 2005 to less than 60 MGD in 2018, and is primarily due to facilities changing from coal to natural gas.

Table 6.2 describes the owner, capacity, and water-use of each plant. Hamilton County's primary power plant is operated by Duke Energy Indiana LLC and withdraws the least amount of water in the Region. Marion County has three major plants: two operated by Indianapolis Power and Light Company (IPL) and one by Citizens Energy Group. Together these plants require the greatest water withdrawal of the Region. The IPL plant on Harding Street converted from coal to natural gas in 2016 resulting in significantly lower water withdrawal rates in 2017. Morgan County contains one power plant operated by IPL. The plant shifted from coal to natural gas in 2017 which will likely lower withdrawal in the following years. As evidenced in the reduction of water withdrawals per kWh, in particular, the Indianapolis Power and Light (IPL) Georgetown and Eagle Valley have changed fuel sources from coal to natural gas, which requires less water. Due to the monetary investment and efficiencies gained from the change in fuel source, it is assumed that the power generators will maintain the current fuel choice into the forecasted future.

It is reasonable to expect that the future demand for electricity within the study area will change because of population growth and the concomitant increase in economic activity. The current use of electricity within the study area is difficult to determine precisely. There is no accurate or predictable correlation between local demand for power and local generation, both now and in the future, due to the nature of the electric power market. Increasing future electric demand may not be met by the plants currently within the study area. The demand may be met with power generated outside the study area, or with power generated inside the study area by alternate means, such as gas turbines, wind turbines, solar, etc. As such, there is no way to predict or estimate where additional sources of power to serve the 9-county area will come from in the next five, let alone the next 50 years (2070).

Table 6.1: Historical withdrawals for power generation in the Central Region.

County	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)
Hamilton	0.87	0.43	0.86	0.73	0.51	0.40	0.47	0.24	0.09	0.05	0.09	0.13	0.20	0.43
Marion	148.91	134.81	136.42	138.03	134.58	141.46	133.43	140.68	157.98	139.96	107.93	115.05	49.08	54.58
Morgan	211.55	191.18	186.23	164.97	142.31	165.33	149.52	61.38	68.60	84.18	37.85	19.61	19.61	1.60
Total	**361.33**	**326.42**	**323.50**	**303.74**	**277.41**	**307.20**	**283.42**	**202.29**	**226.68**	**224.18**	**145.87**	**134.79**	**68.89**	**56.61**

Notes: MGD = million gallons per day.

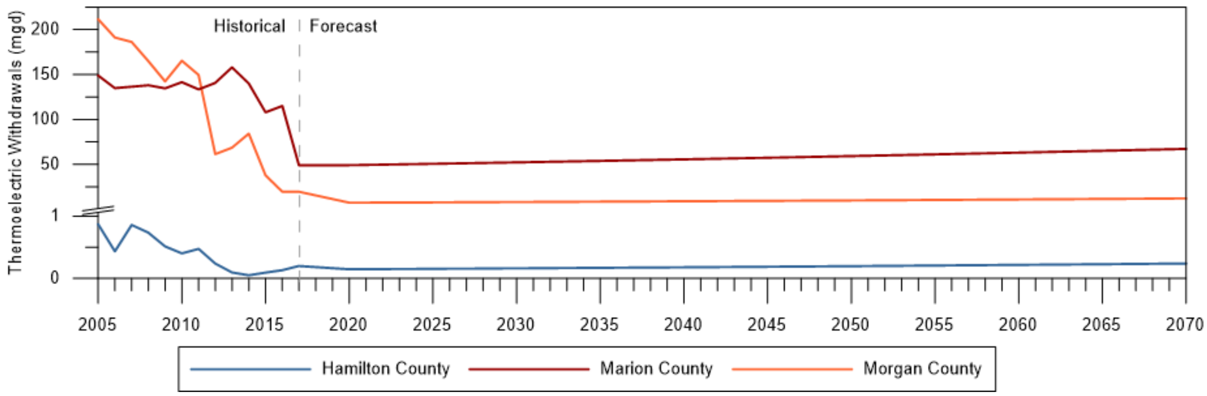


Figure 6.1: Historical and forecast water withdrawals for thermoelectric power generation in the Central Region (DNR, 2018). *As evidenced in the recent historic reduction of water withdrawals, some facilities have changed fuel sources from coal to natural gas which requires less water. Annual historical water withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

New and developing technologies will likely play a large part in how electric demand will be handled, but there are no current plans from which to develop any plausible scenarios regarding future water demand by the industry. All told, these unknowns make the development of likely future water demand scenarios involving the electric power industry difficult to specify or even generally conceptualize. Regardless of the difficulty in determining future power demand in the Region and the sources for that power, it is necessary for the purpose of water-supply planning to account for current withdrawals and to estimate future withdrawals for the power generation sector. In this report, using the data available, the future water withdrawals were forecast by calculating the gallons per kWh for each facility. All of the power plants, except for the Harding Street plant in Marion County, were assumed to have a 0.01 increase per year in power generation. Harding Street plant was assumed to have a growth rate of 0.005 per year. Results of this forecast are shown in Figure 6.1 and Table 6.3, along with the historical withdrawals.

6.2 Geothermal Power

Geothermal power is the extraction of heat (thermal energy) that is stored in the earth. Geothermal energy production accounts for approximately 0.3 % of the total energy produced in the United States. In the Central Indiana Region, it is assumed that geothermal sources are used primarily for heating purposes. Water withdrawal by geothermal plants is prevalent in three counties: Hendricks County, Marion County, and Shelby County (Table 6.4 and Figure 6.2). Historically the withdrawals have remained relatively stable. Of the three counties containing geothermal plants, Marion County's plants use the greatest amount of water with an average withdrawal of 5.03 MGD, whereas Shelby County had the lowest water withdrawals of 0.09 MGD.

Table 6.2: Thermoelectric power generators in the 9-county Central Region.

County	Owner	Facility Name	Fuel Type	Capacity (MW)	Gallons/kWh in 2010	Gallons/kWh in 2017
Hamilton	Duke Energy	Noblesville	Natural Gas	300	0.64	0.13
Marion	IPL	Harding Street	Natural Gas	1196	11.42	10.60
	IPL	Georgetown	Distillate Fuel Oil / Diesel	671	4.28	0.25
	Citizens Energy	CC Perry K	Natural Gas	20	1,296.50	249.70
Morgan	IPL	Eagle Valley	Natural Gas / Steam	158	51.18	2.71

Notes: IPL = Indianapolis Power and Light.

Table 6.3: The thermoelectric power generation water withdrawals forecast.

County	**2020** (MGD)	**2025** (MGD)	**2030** (MGD)	**2035** (MGD)	**2040** (MGD)	**2045** (MGD)	**2050** (MGD)	**2055** (MGD)	**2060** (MGD)	**2065** (MGD)	**2070** (MGD)
Hamilton	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24
Marion	49.09	50.64	52.23	53.89	55.60	57.37	59.21	61.12	63.09	65.13	67.25
Morgan	7.36	7.74	8.14	8.55	8.99	9.44	9.93	10.43	10.96	11.52	12.11
Total	**56.60**	**58.53**	**60.53**	**62.61**	**64.76**	**67.00**	**69.33**	**71.75**	**74.27**	**76.88**	**79.60**

Notes: MGD = million gallons per day

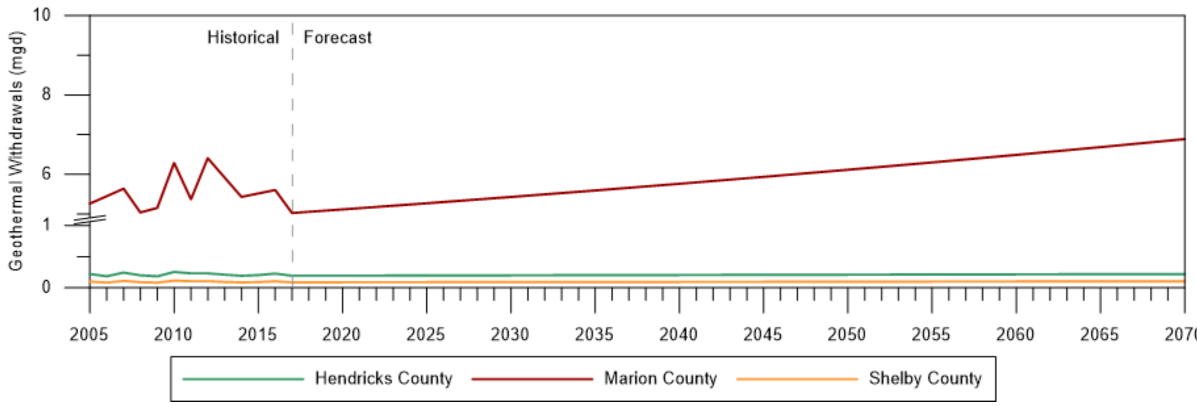


Figure 6.2: Historical and forecast water withdrawals for geothermal power generation in the Central Region (DNR, 2018).

The historical geothermal county trend (2013-2017) was used for each of these counties to project future water withdrawals (Table 6.5)(2018 withdrawals were unavailable at the time of analysis, but added to graphs and tables after analysis). The results of this forecast are shown in Figure 6.2 and Table 6.6. However, without knowing if installed geothermal systems are open or closed loop, water use cannot be accurately estimated. Widespread adoption of residential open loop geothermal systems would experience the same issues of supply in a warming climate as shallow wells used for drinking water.

6.3 Total Water Withdrawals for Power Generation

The total water withdrawals for power generation (including geothermal) is expected to increase from 62 MGD in 2020 to nearly 90 MGD in 2070 (Table 6.7 and Figure 6.3). Over 85% of these withdrawals occur in Marion County.

Table 6.4: Historical withdrawals for geothermal power in the Central Region (DNR, 2018).

County	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)
Hendricks	0.22	0.18	0.24	0.20	0.18	0.25	0.23	0.23	0.21	0.19	0.20	0.23	0.19	0.25
Marion	5.26	4.96	5.64	5.04	5.15	6.29	5.37	6.41	4.67	5.43	4.52	5.61	5.03	0.98
Shelby	0.10	0.08	0.11	0.09	0.08	0.12	0.11	0.11	0.09	0.09	0.09	0.10	0.09	0.12
Total	**5.58**	**5.23**	**5.99**	**5.33**	**5.42**	**6.66**	**5.71**	**6.75**	**4.97**	**5.71**	**4.82**	**5.94**	**5.31**	**1.35**

Notes: MGD = million gallons per day.

Table 6.5: Historical county trends (2013-2017) used for future trends for geothermal water withdrawal forecast (DNR, 2018).

County	Historical trend (2013-2017) (%)
Hendricks	0.25
Marion	0.60
Shelby	0.33

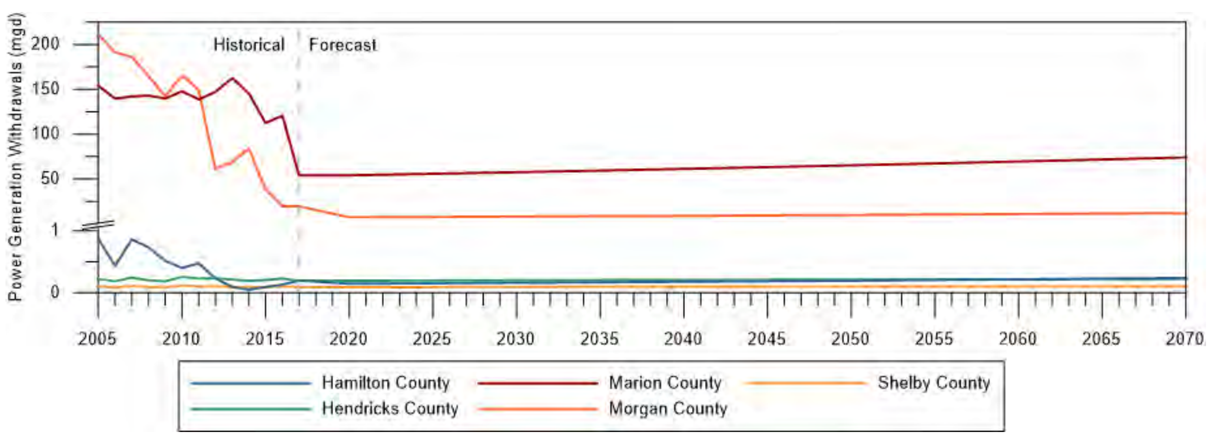


Figure 6.3: Total historical and forecast power generation water withdrawals in the Central Region (DNR, 2018). *As evidenced in the recent historic reduction of water withdrawals, some facilities have changed fuel sources from coal to natural gas which requires less water. Annual historical water withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

Table 6.6: The geothermal power generation water withdrawals forecast for the Central Region.

County	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)	(MGD)
Hendricks	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22
Marion	5.12	5.27	5.43	5.59	5.76	5.94	6.12	6.30	6.49	6.69	6.89
Shelby	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10
Total	**5.40**	**5.56**	**5.72**	**5.89**	**6.06**	**6.24**	**6.42**	**6.61**	**6.81**	**7.01**	**7.21**

Notes: MGD = million gallons per day

Table 6.7: The total power generation water withdrawals forecast in the Central Region.

County	2020 (MGD)	2025 (MGD)	2030 (MGD)	2035 (MGD)	2040 (MGD)	2045 (MGD)	2050 (MGD)	2055 (MGD)	2060 (MGD)	2065 (MGD)	2070 (MGD)
Boone	-	-	-	-	-	-	-	-	-	-	-
Hamilton	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24
Hancock	-	-	-	-	-	-	-	-	-	-	-
Hendricks	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22
Johnson	-	-	-	-	-	-	-	-	-	-	-
Madison	-	-	-	-	-	-	-	-	-	-	-
Marion	54.21	55.91	57.66	59.48	61.36	63.31	65.33	67.42	69.58	71.82	74.14
Morgan	7.36	7.74	8.14	8.55	8.99	9.44	9.93	10.43	10.96	11.52	12.11
Shelby	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10
Total	**62.00**	**64.09**	**66.25**	**68.50**	**70.83**	**73.25**	**75.76**	**78.37**	**81.08**	**83.89**	**86.82**

Notes: MGD = million gallons per day

7 Public Water Supply Sector

The public water supply (PWS) sector represents water withdrawals for both community and non-community water systems. The water supplier is generally publicly or privately owned and provides water to residential areas, commercial establishments, industry, and various institutions. This section summarizes the forecast for public water supply systems within the Central Region. Variables such as population growth, income, and climate are closely evaluated to estimate future water demand.

Using publicly available historical population and water-use data, projected water withdrawals by each public water provider were forecast from 2020 to 2070. Historical withdrawal data were examined to determine base year (2015) values of annual withdrawal (in MGD), population served, and per capita use (GPCD). This baseline forecast assumes historical average weather (normal weather) patterns will be observed into 2070. A modified per capita long-term forecast of PWS was prepared for each of the 52 individual water systems.

7.1 Historical Data

The water withdrawals reported in DNR Significant Water Withdrawal Facilities (SWWF) database were used for the forecast analysis. These data are reported by individual public water suppliers and are considered the best available data. However, additional data from the United States Geological Survey's (USGS) Water-use database were analyzed as a verification of these data and are presented in the following paragraphs (USGS, 2017a).

7.1.1 USGS water-use data

Population served, as opposed to total population, is the number of people served by a public water supplier within that supplier's service area. Population served data collected from 1985 to 2015 were obtained from the USGS water-use database (USGS, 2017a). Historically, population served by public water supply systems in the 9-county Region had been increasing at the annual (compounded) rate of 1.51 % (Table 7.1). Much of the growth was seen in Hamilton and Hendricks counties as their populations increased at the rate of nearly 7 % per year. Madison County had the lowest observed population growth with an increase of 0.06 % per year.

To analyze county trends, historical PWS withdrawal data collected from 1985 to 2015 were obtained from the USGS's water-use database (Table 7.2). Observed data indicate an overall increase in water usage throughout the study area with peak total withdrawal in 2005 followed by a decline into 2015. Hamilton County had the highest growth in withdrawals from 1985 to 2015 with a 6.43% increase per year. Declining withdrawals were observed in Boone and Marion counties. Despite having among the highest growth rates with nearly five-fold population increase from 1985 to 2015, Hendricks County PWS withdrawal rates only doubled over the same time period (Table 7.1 and Table 7.2). Historically, PWS withdrawals

Table 7.1: Historical public water supply population served by county in the Central Region from 1985-2015 (USGS, 2015).

County	1985	1990	1995	2000	2005	2010	2015	Trend/ Annual Growth Rate
Boone	19,650	21,840	24,750	27,300	30,820	33,531	37,500	0.0222
Hamilton	49,850	61,700	94,520	122,800	184,552	215,047	246,659	0.0685
Hancock	15,170	18,940	20,920	22,820	26,013	28,841	29,878	0.0222
Hendricks	22,240	30,510	37,510	45,070	74,287	90,455	101,921	0.0651
Johnson	55,100	69,200	83,890	95,050	105,960	115,215	123,447	0.0262
Madison	90,430	92,100	94,690	95,090	92,984	93,856	92,492	0.0006
Marion	729,960	709,810	747,280	786,450	788,904	825,701	858,264	0.0061
Morgan	24,860	28,850	35,600	38,210	39,983	39,476	39,908	0.0147
Shelby	16,220	18,450	20,080	20,370	20,526	20,840	20,860	0.007
Total	**1,023,480**	**1,051,400**	**1,159,240**	**1,253,160**	**1,364,030**	**1,462,960**	**1,550,930**	**0.0151**

Table 7.2: Historical public water supply water withdrawals by county in the Central Region from 1985-2015 in MGD (USGS, 2017a).

County	1985	1990	1995	2000	2005	2010	2015	Trend/ Annual Growth Rate
Boone	2.99	1.65	1.95	2.03	2.08	1.78	2.01	-0.0088
Hamilton	6.82	7.35	17.49	32.68	31.96	41.63	35.69	0.0643
Hancock	2.6	2.77	2.54	3.25	3.69	3.37	3.18	0.0097
Hendricks	2.36	2.58	3.6	4.3	4.6	3.62	5.1	0.0227
Johnson	5.87	8.4	10.61	10.84	12.46	9.66	10.04	0.0127
Madison	10.87	12.76	13.31	14.48	11.11	13.54	14.98	0.0065
Marion	122.71	125.41	131.78	124.62	141.02	123.37	111.3	-0.0017
Morgan	2.61	4.55	5.21	5.54	5.67	11.03	10.52	0.0492
Shelby	2.11	2.93	3.41	4.01	4.06	5.05	5.66	0.0310
Total	**158.94**	**168.4**	**189.9**	**201.75**	**216.65**	**213.05**	**198.48**	**0.0088**

MGD = million gallons per day

were increasing at rates that were slower than population growth rates. This was caused by declining per capita use in five counties as shown in Table 7.3. Per capita use over the Region has declined by 17.6% between 1985 and 2015, or at the rate of 0.54 %/year. Decreasing per capita water use was observed in five of the nine counties studied with greatest decline of nearly 65% in Boone County. However, the per capita use rates have increased consistently in Madison, Morgan, and Shelby counties.

7.1.2 SWWF data

The DNR SWWF database reports annual and monthly withdrawals for all significant water users (able to withdraw 100,000 gallons per day), including public water suppliers. Tables 7.4 and 7.6 summarize annual withdrawals obtained from the SWWF database for 52 public water systems within the 9 counties (DNR, 2018). Annual withdrawals showed increasing trends in 28 systems.

7.2 Forecast withdrawals

A modified per capita long-term forecast of PWS was prepared for each of the 52 individual water systems. Historical withdrawal data were examined to determine base year (2015) values of annual withdrawal (in MGD), population served, and per capita use (GPCD). To estimate population served per utility, the official county-level population projections from 2020 to 2050 were estimated obtained from Stats Indiana to determine growth rates (Table 7.7) (IBRC, 2018). Marion and Hamilton counties are expected to maintain the highest populations into 2050. The county level projections were used to calculate fractional percent increase during each

Table 7.3: Historical public water supply per capita withdrawal rates by county in the Central Region from 1985-2015 in MGD (USGS, 2017a).

County	1985	1990	1995	2000	2005	2010	2015	Trend/ Annual Growth Rate
Boone	152.2	75.5	78.8	74.4	67.5	53.1	53.6	-0.0339
Hamilton	136.8	119.1	185.0	266.1	173.2	193.6	144.7	0.0066
Hancock	171.4	146.3	121.4	142.4	141.9	116.8	106.4	-0.0124
Hendricks	106.1	84.6	96.0	95.4	61.9	40.0	50.0	-0.0286
Johnson	106.5	121.4	126.5	114.0	117.6	83.8	81.3	-0.0107
Madison	120.2	138.5	140.6	152.3	119.5	144.3	162.0	0.0059
Marion	168.1	176.7	176.3	158.5	178.8	149.4	129.7	-0.0074
Morgan	105.0	157.7	146.3	145.0	141.8	279.4	263.6	0.0314
Shelby	130.1	158.8	169.8	196.9	197.8	242.3	271.3	0.0238
Total	**155.3**	**160.2**	**163.8**	**161.0**	**158.8**	**145.6**	**128.0**	**-0.0054**

MGD = million gallons per day

5-year interval as shown in Table 7.8. The 5-year increment ratios were assumed for the period from 2050 to 2070 based on the preceding trend during 2020-2050.The positive increments were extended for the 2055-2070 time periods using the Excel function: Home/Fill/Series/Growth. For negative increment values the extended rates were set to zero. This approach may not be conservative (i.e., long term population may be underestimated) given the unspecified expectation that additional growth may occur in the younger cohort after 2050. The difference will scale with the change that actually occurs in the middle of this century.

Future values of per capita use were modified using projected future values of median household income (MHI) and assumptions about future annual reductions in GPCD due to ongoing water conservation/water efficiency improvements. For example, the effect of MHI on per capita use was calculated as:

$$GPCD_f = GPCD_{2015} \left(\frac{MHI_f}{MHI_{2015}} \right)^e$$

where: $GPCD_f$ =future per capita use, $GPCD_{2015}$ =base year per capita use, MHI= median household income, and e= constant elasticity of income with respect to water use. The income elasticities were estimated for each county using monthly data on water use for the time period from 1985 to 2017. In addition to income elasticities, the constant elasticities of average temperature and monthly precipitation were also estimated with resultant values shown in Table 7.9.

In general, median household income is positively correlated with water usage due to less financial restrictions with greater water consumption. MHI elasticities varied from 0.09 to 0.53 with the highest elasticities calculated in Hancock and Hendricks counties and the lowest in

Table 7.4: Historical water withdrawals reported by public water suppliers in the DNR SWWF database from 2005-2017 in MGD (DNR, 2018).

County	System/Utility	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Trend
Boone	Advance Water Works	0.04	0.04	0.04	0.04	0.03	0.04	0.06	0.06	0.07	0.08	0.05	0.07	0.05	0.057
	Jamestown Mun. Water Work	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	-0.012
	Lebanon Utility Service	1.76	1.66	1.90	1.75	1.52	1.50	1.56	1.67	1.51	1.53	1.73	1.77	1.64	-0.004
	Town of Thorntown	0.14	0.15	0.16	0.15	0.15	0.13	0.12	0.13	0.12	0.13	0.11	0.11	0.11	-0.031
	Lost Run Farm Community	0.00	0.00	0.00	0.00	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.13	0.13	0.311
Hamilton	Arcadia Water Department	0.16	0.14	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.14	-0.018
	Atlanta Water Department	0.06	0.06	0.06	0.06	0.05	0.04	0.05	0.05	0.05	0.06	0.05	0.04	0.05	-0.021
	Carmel Municipal Water	8.45	8.15	8.63	7.42	6.79	9.01	8.65	11.79	12.12	11.05	11.27	11.57	12.01	0.043
	Citizens Water of Westfield	4.46	4.89	9.42	8.72	6.44	10.3	6.73	7.94	8.69	7.35	7.18	6.53	5.83	0.006
	Indiana-American Water Co	3.04	3.29	3.87	3.70	3.60	4.02	3.88	4.25	3.95	4.07	4.29	4.27	4.19	0.022
	Sheridan Water Works	0.27	0.28	0.29	0.29	0.28	0.29	0.28	0.24	0.29	0.23	0.22	0.23	0.22	-0.022
	Town of Cicero Utilities	0.43	0.43	0.46	0.49	0.47	0.50	0.40	0.44	0.49	0.47	0.46	0.46	0.41	-0.001
Hancock	City of Greenfield	3.04	2.92	3.07	2.97	2.62	2.68	2.56	2.76	2.72	2.76	2.67	2.59	2.47	-0.014
	Gem Water/Town of Cumberland	0.09	0.09	0.14	0.11	0.10	0.11	0.11	0.12	0.11	0.13	0.12	0.16	0.20	0.051
	Town of Fortville	0.56	0.51	0.54	0.60	0.51	0.59	0.48	0.44	0.43	0.38	0.39	0.45	0.53	-0.024
Hendricks	Danville Water Company	0.30	0.48	0.42	0.57	0.51	0.52	0.14	0.80	0.82	0.84	0.85	0.84	0.85	0.087
	North Salem Water Corporation	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.04	0.03	0.03	0.04	0.04	0.03	-0.027
	Town of Brownsburg	1.09	1.07	1.14	1.40	1.32	1.50	1.48	1.47	1.71	1.68	1.75	1.85	1.97	0.052
	Town of Plainfield	4.06	3.98	3.01	3.97	3.61	4.09	4.40	4.70	4.60	4.31	4.22	4.29	4.65	0.018
Johnson	Bargersville Water Department	2.61	2.43	3.09	2.69	2.54	2.88	2.82	3.26	2.83	2.79	2.75	2.89	3.02	0.009
	Indiana-American Water Co Inc	9.07	8.55	9.41	9.07	8.54	9.33	8.33	9.91	9.02	8.81	8.78	8.96	9.12	0.000
	Princes Lakes Water and Sewage	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-0.004
	Town of Edinburgh	0.71	0.65	0.70	0.74	0.80	0.81	0.82	0.89	0.79	0.83	0.83	1.16	0.83	0.029

Table 7.5: Continued, Historical water withdrawals reported by public water suppliers in the DNR SWWF database from 2005-2017 in MGD (DNR, 2018).

County	System/Utility	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Trend
Madison	Alexandria Water Works	0.69	0.70	0.72	0.70	0.83	0.81	0.82	0.94	0.94	0.82	0.72	0.73	0.71	0.007
	Anderson Water Department	3.71	3.55	4.43	5.02	5.01	5.58	5.32	5.20	5.29	5.57	5.74	5.74	5.54	0.032
	Citizens Water of South Madison	0.00	0.24	0.30	0.43	0.26	0.22	0.27	0.22	0.28	0.68	0.95	2.29	0.77	0.394
	Elwood Water Utility	2.53	2.17	2.30	1.82	1.43	1.38	1.14	1.22	1.34	1.30	1.14	1.13	1.18	-0.073
	Indiana-American Water Co Inc	0.10	0.11	0.09	0.09	0.07	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.06	-0.058
	Ingalls Water Department	1.13	1.23	1.22	1.06	1.09	1.06	1.11	1.03	1.07	0.97	1.02	1.08	1.09	-0.011
	Lapel Municipal Water Company	0.22	0.21	0.20	0.22	0.24	0.24	0.24	0.26	0.23	0.26	0.24	0.22	0.23	0.009
	Pendleton Municipal Water	0.30	0.29	0.30	0.15	0.29	0.31	0.26	0.29	0.26	0.28	0.47	0.47	0.49	0.057
	Town of Chesterfield	0.31	0.35	0.33	0.32	0.32	0.33	0.32	0.28	0.25	0.29	0.28	0.24	0.23	-0.027
	Town of Edgewood	0.18	0.17	0.19	0.17	0.19	0.18	0.16	0.16	0.16	0.16	0.15	0.16	0.15	-0.018
	Town of Frankton	0.21	0.21	0.20	0.22	0.21	0.20	0.20	0.22	0.21	0.24	0.29	2.94	0.25	0.337
	Town of Orestes	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.05	0.07	0.05	0.03	0.03	0.009
Marion	City of Lawrence Utilities	4.58	4.47	5.04	4.79	4.18	4.21	4.34	4.16	4.49	4.74	3.95	4.22	4.32	-0.008
	Town of Speedway	2.70	2.71	2.66	2.31	2.09	2.30	2.27	2.28	2.29	2.29	2.30	2.07	2.01	-0.020
	Citizens Energy Group	151.6	152.0	168.0	148.4	141.4	140.3	137.5	135.5	133.7	120.5	124.5	124.8	125.3	-0.023

Table 7.6: Continued, Historical water withdrawals reported by public water suppliers in the DNR SWWF database from 2005-2017 in MGD (DNR, 2018).

County	System/Utility	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Trend
Morgan	Brown County Water Utility	1.14	1.16	0.90	1.10	1.30	1.01	1.22	1.08	1.18	1.23	1.32	1.33	1.32	0.018
	City of Martinsville	1.77	1.50	1.43	1.41	1.25	1.53	1.60	1.67	1.56	1.57	1.51	1.54	1.57	0.002
	Hill Water Corporation	0.64	0.62	0.62	0.59	0.59	0.63	0.65	0.75	0.73	0.68	0.64	0.66	0.67	0.009
	Indiana-American Water Co	1.08	1.05	1.10	1.03	0.99	1.04	1.00	1.06	1.03	0.91	0.91	0.94	0.97	-0.012
	Mapleturn Utilities Inc	0.16	0.14	0.16	0.15	0.15	0.20	0.19	0.18	0.15	0.14	0.13	0.14	0.15	-0.007
	Morgan County Rural Water	0.54	0.56	0.61	0.61	0.34	0.45	0.41	0.51	0.52	0.52	0.58	0.58	0.59	0.005
	Painted Hills Utilities	0.11	0.12	0.12	0.13	0.13	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.11	0.003
	Town of Brooklyn	0.09	0.09	0.09	0.09	0.10	0.10	0.08	0.09	0.11	0.11	0.09	0.08	0.18	0.030
	Town of Morgantown	0.10	0.08	0.09	0.09	0.04	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	-0.012
	Town of Paragon	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.04	0.03	0.03	0.04	-0.033
Shelby	Indiana-American Water Co	3.41	3.01	3.25	2.94	2.70	2.75	2.71	3.17	2.95	3.24	3.02	3.10	2.97	-0.002
	Town of Morristown	0.54	0.54	0.63	0.58	0.57	0.59	0.54	0.58	0.54	0.58	0.61	0.62	0.61	0.006
	Town of St. Paul	0.05	0.08	0.11	0.08	0.08	0.08	0.07	0.08	0.08	0.09	0.08	0.07	0.08	0.003
	Waldron Conservancy District	0.06	0.06	0.06	0.06	0.05	0.06	0.06	0.06	0.06	0.05	0.06	0.06	0.07	0.002
Regional Total		**218.5**	**217.4**	**241.8**	**219.6**	**206.2**	**214.6**	**206.0**	**212.6**	**210.4**	**195.4**	**206.1**	**204.1**	**200.3**	

Table 7.7: Projected county population in the Central Region from 2010 - 2050 (IBRC, 2018).

County	2010	2015	2019 (Actual)	2020	2025	2030	2035	2040	2045	2050
Boone	56,640	63,400	66,999	70,556	77,632	83,749	88,634	92,011	94,916	97,944
Hamilton	274,569	309,172	330,086	343,179	379,478	417,754	452,289	479,841	503,823	527,582
Hancock	70,002	72,392	76,351	76,353	80,876	85,043	88,710	91,845	94,320	96,643
Hendricks	145,448	158,059	167,009	170,323	184,022	197,902	211,355	222,337	231,528	239,515
Johnson	139,654	149,338	156,225	158,713	168,123	176,917	184,715	191,249	197,161	202,884
Madison	131,636	129,495	129,641	127,604	126,187	124,262	121,902	119,524	117,118	114,759
Marion	903,393	938,058	954,670	963,732	983,721	1,001,231	1,017,228	1,033,719	1,049,932	1,065,757
Morgan	68,894	69,646	70,116	70,302	71,372	72,001	72,188	71,931	71,411	71,095
Shelby	44,436	44,442	44,593	44,600	44,953	45,039	44,801	44,244	43,755	43,247

Table 7.8: Fractional growth of county population during each 5-year time increment (IBRC, 2018).

County	2015	2020	2025	2030	2035	2040	2045	2050	2055*	2060*	2065*	2070*
Boone	0.119	0.113	0.100	0.079	0.058	0.038	0.032	0.032	0.023	0.018	0.015	0.012
Hamilton	0.126	0.110	0.106	0.101	0.083	0.061	0.050	0.047	0.041	0.035	0.030	0.026
Hancock	0.034	0.055	0.059	0.052	0.043	0.035	0.027	0.025	0.026	0.024	0.022	0.020
Hendricks	0.087	0.078	0.080	0.075	0.068	0.052	0.041	0.034	0.034	0.030	0.026	0.023
Johnson	0.069	0.063	0.059	0.052	0.044	0.035	0.031	0.029	0.025	0.022	0.019	0.017
Madison	-0.016	-0.015	-0.011	-0.015	-0.019	-0.020	-0.020	-0.020	0.000	0.000	0.000	0.000
Marion	0.038	0.027	0.021	0.018	0.016	0.016	0.016	0.015	0.011	0.010	0.009	0.008
Morgan	0.011	0.009	0.015	0.009	0.003	-0.004	-0.007	-0.004	0.000	0.000	0.000	0.000
Shelby	0.000	0.004	0.008	0.002	-0.005	-0.012	-0.011	-0.012	0.000	0.000	0.000	0.000

*=The 5-year increment ratios were assumed for the period from 2050-2070 based on the preceding trend during 2020-2050.

Table 7.9: Estimated constant elasticities of precipitation, temperature and income.

County	Elasticity of Precipitation	Elasticity of Average. Air Temperature	Elasticity of Median Household Income
Boone	-0.0148	0.2149	0.2211
Hamilton	-0.1073	0.6002	0.2200
Hancock	-0.0091	0.0812	0.5351
Hendricks	-0.0431	0.2853	0.5240
Johnson	-0.0746	0.3275	0.2079
Madison	-0.0281	0.0739	0.3928
Marion	-0.0420	0.2452	0.0882
Morgan	-0.0583	0.1421	0.3127
Shelby	-0.0404	0.1099	0.3127

Marion County. Income elasticities for Morgan and Shelby counties were negative (*i.e.* had the incorrect sign for this positively correlated relationship) and were replaced by the average value of the 7 counties.

Temperature is also positively correlated with water usage with a further interdependence on seasonal fluctuation. Residents use greater water during the summer months than cooler months. Temperature elasticities ranged from 0.07 to 0.60 with the greatest elasticity in Hamilton County and the lowest in Madison County. Precipitation on the other hand is negatively associated with water withdrawal primarily due to rainfall providing greater natural water availability for lawn and garden irrigation. Precipitation elasticities were expected to be smaller than the other two variables and ranged from -0.015 to -0.11. The greatest precipitation elasticity was calculated in Hamilton County and the lowest in Boone County. For this baseline scenario, normalized weather was assumed. Normal weather is the average conditions experienced for the 30-year time span of 1980-2010. Recognizing that there is seasonal dependence of climate variables such as temperature and precipitation, water withdrawal rates were also forecasted for various climate scenarios (see Section 9).

The application of historical or assumed future trends used the formula:

$$FV = BYV \times (1 + r)^{(fy-2015)}$$

where: FV= future value (income ratio), BYV=base year value, r=annual growth/decline rate, fy= future year

For each five-year increment from 2020 to 2070, population-served size was calculated using estimated growth rates, and GPCD was recalculated to include expected county median household income (MHI) elasticity and corresponding income ratio. The annual growth of future MHI was assumed at 0.6 % per year. The assumption is based on historical data and compared

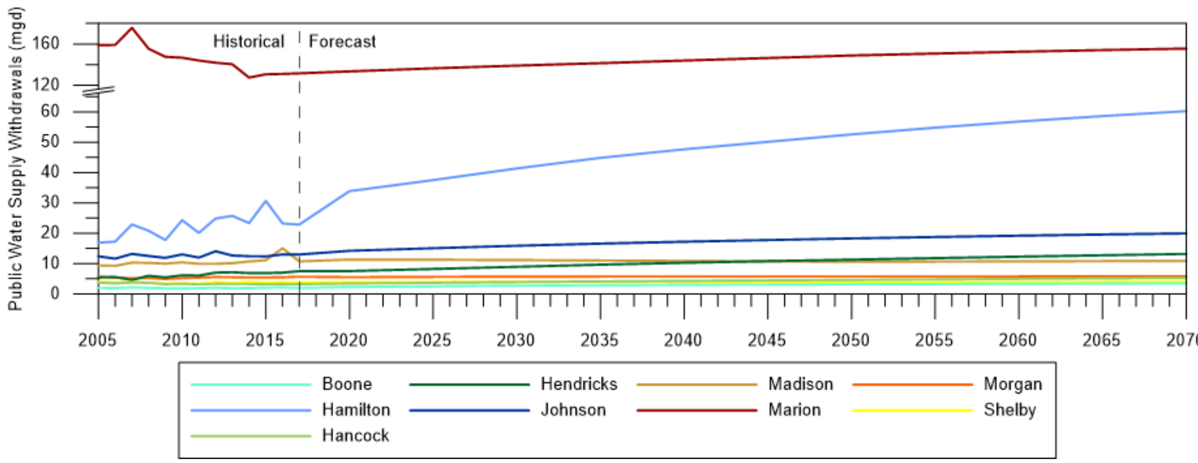


Figure 7.1: Public water supply water withdrawals (in MGD) forecast by county in the Central Region. *This sector is expected to grow from 206 MGD in 2020 to over 250 MGD in 2070. Most of the growth in the region will occur in Hamilton County. Annual historical water withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

to some statewide projections. For the state of Indiana, the long-term (35 years) income growth was 0.30 percent/year (FRED, 2020). The future per capita use rates were also assumed to be affected by the ongoing water conservation trend, which was assumed at -0.2 % per year. The forecast for each utility is shown in Tables 7.10 - 7.12. Graphs for each of the utility forecasts are provided in Appendix D.

As shown in Tables 7.10 - 7.12, the forecasts were calculated for each utility, however, the forecast total withdrawals per county can be seen in Table 7.13. Although Citizens Energy Group provides water to areas outside of Marion County, the withdrawals for this utility were aggregated with those in Marion County for display purposes. Marion County is projected to demand the largest water withdrawal into 2070, primarily by Citizens Energy Group. Hamilton and Hendricks counties are expected to nearly double in water demand by 2070. The large increase in Hamilton County is mostly from increased demand by Carmel Municipal Water, Citizens Water of Westfield LLC, and Indiana-American Water Company Inc. Increases in Hendricks County are primarily from the Town of Plainfield.

Table 7.10: Forecasted water withdrawals for public water suppliers in the Central Region from 2020-2070 in MGD.

County	Water Supply System/Utility	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Boone	Advance Water Works	0.07	0.08	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.11	0.11
	Jamestown Mun. Water Work	0.06	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09
	Lebanon Utility Service	1.86	2.04	2.20	2.32	2.40	2.46	2.53	2.58	2.62	2.65	2.67
	Town of Thorntown	0.13	0.14	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.18	0.19
	Lost Run Farm Community	0.14	0.15	0.16	0.17	0.17	0.18	0.18	0.19	0.19	0.19	0.19
Hamilton	Arcadia Water Department	0.13	0.14	0.16	0.17	0.18	0.19	0.20	0.20	0.21	0.21	0.22
	Atlanta Water Department	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09
	Carmel Municipal Water	12.50	13.77	15.11	16.30	17.24	18.04	18.82	19.52	20.14	20.67	21.14
	Citizens Water of Westfield	7.72	8.51	9.33	10.07	10.65	11.14	11.63	12.06	12.44	12.77	13.06
	Indiana-American Water Co	4.66	5.13	5.63	6.07	6.42	6.72	7.01	7.27	7.50	7.70	7.88
	Sheridan Water Works	0.25	0.28	0.31	0.33	0.35	0.37	0.38	0.40	0.41	0.42	0.43
	Town of Cicero Utilities	0.51	0.56	0.62	0.67	0.70	0.74	0.77	0.80	0.82	0.84	0.86
Hancock	City of Greenfield	2.84	3.02	3.20	3.35	3.49	3.61	3.72	3.84	3.96	4.07	4.17
	Gem Water/Town of Cumberland	0.15	0.16	0.17	0.17	0.18	0.19	0.19	0.20	0.20	0.21	0.22
	Town of Fortville	0.43	0.46	0.48	0.51	0.53	0.55	0.56	0.58	0.60	0.61	0.63
Hendricks	Danville Water Company	0.92	1.00	1.08	1.16	1.22	1.28	1.33	1.39	1.44	1.48	1.53
	North Salem Water Corporation	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07
	Town of Brownsburg	1.91	2.07	2.24	2.41	2.55	2.67	2.78	2.89	2.99	3.09	3.18
	Town of Plainfield	4.63	5.03	5.44	5.85	6.19	6.48	6.74	7.01	7.26	7.49	7.71
Johnson	Bargersville Water Department	2.98	3.14	3.29	3.42	3.53	3.63	3.72	3.80	3.86	3.92	3.97
	Indiana-American Water Co Inc	9.37	9.89	10.37	10.78	11.12	11.42	11.71	11.95	12.17	12.35	12.51
	Princes Lakes Water and Sewage	0.80	0.84	0.88	0.92	0.95	0.97	1.00	1.02	1.03	1.05	1.06
	Town of Edinburgh	0.99	1.05	1.10	1.14	1.18	1.21	1.24	1.27	1.29	1.31	1.33

Table 7.11: Continued, Forecasted water withdrawals for public water suppliers in the Central Region from 2020-2070 in MGD.

County	Water Supply System/Utility	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Madison	Alexandria Water Works	0.75	0.74	0.73	0.72	0.70	0.69	0.68	0.68	0.68	0.68	0.68
	Anderson Water Department	5.61	5.56	5.48	5.39	5.29	5.19	5.10	5.11	5.11	5.12	5.13
	Citizens Water of South Madison	1.29	1.28	1.26	1.24	1.22	1.20	1.17	1.18	1.18	1.18	1.18
	Elwood Water Utility	1.17	1.16	1.15	1.13	1.11	1.09	1.07	1.07	1.07	1.07	1.07
	Indiana-American Water Co Inc	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05
	Ingalls Water Department	1.01	1.00	0.99	0.97	0.95	0.93	0.92	0.92	0.92	0.92	0.92
	Lapel Municipal Water Company	0.24	0.23	0.23	0.23	0.22	0.22	0.21	0.21	0.21	0.22	0.22
	Pendleton Municipal Water	0.40	0.40	0.39	0.38	0.38	0.37	0.36	0.36	0.36	0.37	0.37
	Town of Chesterfield	0.27	0.26	0.26	0.26	0.25	0.25	0.24	0.24	0.24	0.24	0.24
	Town of Edgewood	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.14	0.14
	Town of Frankton	0.26	0.26	0.26	0.25	0.25	0.24	0.24	0.24	0.24	0.24	0.24
	Town of Orestes	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Marion	City of Lawrence Utilities	4.39	4.45	4.49	4.53	4.57	4.61	4.64	4.66	4.68	4.68	4.69
	Town of Speedway	2.26	2.29	2.32	2.33	2.36	2.37	2.39	2.40	2.41	2.41	2.41
	Citizens Energy Group	126.20	128.38	130.22	131.84	133.52	135.15	136.72	137.82	138.74	139.52	140.15

Table 7.12: Continued, Forecasted water withdrawals for public water suppliers in the Central Region from 2020-2070 in MGD.

County	System/Utility	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Morgan	Brown County Water Utility Inc	1.31	1.32	1.33	1.34	1.33	1.32	1.31	1.31	1.31	1.31	1.31
	City of Martinsville	1.55	1.57	1.59	1.59	1.58	1.57	1.56	1.56	1.56	1.56	1.56
	Hill Water Corporation	0.66	0.67	0.68	0.68	0.68	0.67	0.67	0.67	0.67	0.67	0.67
	Indiana-American Water Co Inc	0.93	0.94	0.95	0.95	0.95	0.94	0.93	0.93	0.93	0.93	0.93
	Mapleturn Utilities Inc	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
	Morgan County Rural Water Co	0.57	0.58	0.58	0.58	0.58	0.58	0.57	0.57	0.57	0.57	0.57
	Painted Hills Utilities	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
	Town of Brooklyn	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
	Town of Morgantown	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	Town of Paragon	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Shelby	Indiana-American Water Co	3.13	3.15	3.15	3.14	3.09	3.06	3.02	3.02	3.02	3.01	3.01
	Town of Morristown	0.61	0.61	0.61	0.61	0.60	0.59	0.59	0.59	0.58	0.58	0.58
	Town of St. Paul	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	Waldron Conservancy District	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05
Regional Total		**206.60**	**213.38**	**219.73**	**225.29**	**230.02**	**234.22**	**238.28**	**241.87**	**245.02**	**247.74**	**250.09**

Table 7.13: Public water supply water withdrawals (in MGD) forecast by county in the Central Region.

County	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Boone	2.27	2.48	2.67	2.82	2.91	3.00	3.08	3.14	3.19	3.22	3.25
Hamilton	25.82	28.46	31.22	33.68	35.61	37.27	38.89	40.34	41.61	42.72	43.67
Hancock	3.41	3.63	3.84	4.03	4.20	4.34	4.47	4.62	4.76	4.89	5.02
Hendricks	7.50	8.15	8.81	9.47	10.01	10.49	10.91	11.35	11.75	12.13	12.48
Johnson	14.13	14.92	15.64	16.26	16.78	17.23	17.66	18.03	18.35	18.63	18.87
Madison	11.26	11.15	11.00	10.81	10.62	10.42	10.23	10.25	10.27	10.28	10.30
Marion	132.85	135.12	137.02	138.71	140.45	142.14	143.76	144.88	145.83	146.61	147.25
Morgan	5.49	5.57	5.61	5.63	5.60	5.56	5.53	5.53	5.52	5.52	5.51
Shelby	3.87	3.90	3.91	3.88	3.83	3.79	3.74	3.74	3.74	3.73	3.73
Total	**206.60**	**213.38**	**219.73**	**225.29**	**230.02**	**234.22**	**238.28**	**241.87**	**245.02**	**247.74**	**250.09**

MGD=million gallons per day

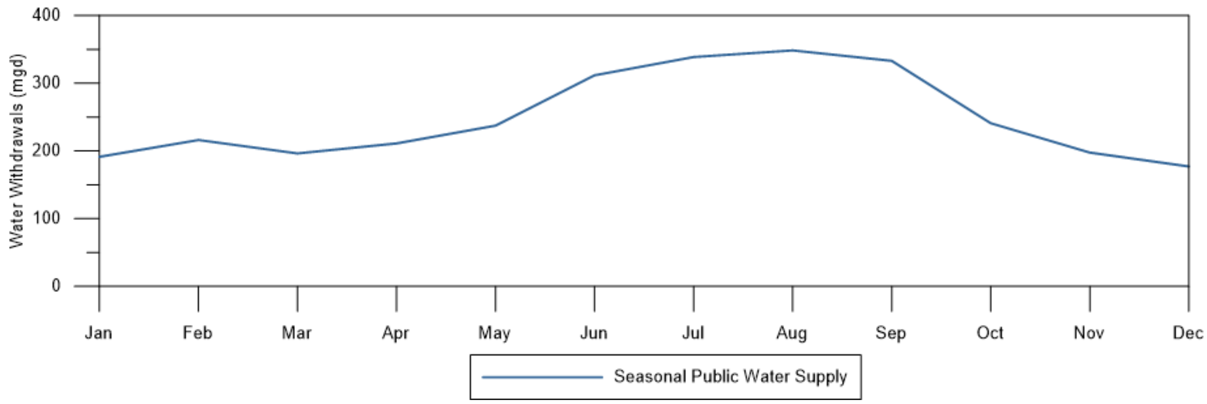


Figure 8.1: Seasonal water withdrawal for the public water supply sector for the year 2070 in MGD. *Average annual water withdrawals for PWS are projected to be 250 MGD in 2070, while the average peak monthly withdrawals in that year (shown in the graph) are expected to be ~350 MGD. Recall that actual monthly withdrawals will vary. The forecast predicts the long term average withdrawals.*

8 Seasonal Public Supply Withdrawals

Water use and water withdrawals are, in part, driven by the weather as reflected in the public supply model. In that model (see Section 7), the elasticities for temperature and precipitation were calculated for each water utility and capture how water withdrawals are affected by weather. Temperature is positively correlated with water usage, meaning water use is greater during the summer months than cooler months. Precipitation on the other hand is negatively associated with water withdrawal, meaning water use decreases with more rainfall by providing more availability for lawn and garden irrigation. The weather effect is evident in monthly fluctuation of withdrawals reported in the SWWF database. Through examination of the monthly data for each utility reported from 1985-2017, seasonal effects are apparent for some utilities.

The monthly values are obtained by redistributing average annual MGD by calendar months. The percent of annual use during each month was calculated as average from historical water use data. For example, on average Carmel Municipal Water in Hamilton County uses 15% of the annual water withdrawals in July and 5% of the annual water withdrawals in January. This seasonal variation is evident regionally as seen in Figure 8.1, however, a closer examination of county and utility data reveals that the seasonal trends are only in four counties; Hamilton, Hendricks, Johnson, and Marion. Graphs of the individual public water supply utilities, provided in Appendix E, show that, in fact, the seasonal trend is evident in only five utilities; Carmel Municipal Water, Town of Plainfield, Indiana American Water Company (Johnson Co.), Bargersville Water Department, and Citizens Energy Group. In particular, Citizens Energy Group and Carmel Municipal Water have the largest summer/winter divergence of water withdrawals. These two utilities withdraw double in the summer as in winter. Seasonal variation for each county and individual utilities in each county is provided in Appendix E.

Table 8.1: Predicted monthly public water supply water withdrawals (in MGD) per county in the Central Region in 2070. *Average annual water withdrawals for PWS are projected to be 250 MGD in 2070, while the average peak monthly withdrawals in that year (shown in the table) are expected to be ~350 MGD. Recall that actual monthly withdrawals will vary. The forecast predicts the long term average withdrawals.*

County	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Boone	2.96	3.24	2.84	3.25	3.33	3.62	3.54	3.51	3.49	3.30	3.12	2.81
Hamilton	30.29	32.56	31.79	36.90	43.69	59.21	60.64	61.03	59.13	40.02	35.47	32.81
Hancock	5.14	5.05	4.61	4.74	4.75	5.19	5.16	5.20	5.18	4.83	5.07	5.34
Hendricks	10.68	11.66	10.63	11.85	12.75	14.64	14.59	14.93	14.27	11.75	11.07	10.91
Johnson	16.57	18.09	16.09	17.51	18.85	22.38	22.75	23.21	21.90	17.39	16.16	15.53
Madison	9.92	11.35	9.97	10.19	10.01	10.80	10.45	10.54	10.71	9.99	10.13	9.68
Marion	106.91	124.19	111.56	117.62	134.69	186.04	211.89	220.16	208.70	144.74	107.75	91.51
Morgan	5.31	6.05	5.34	5.46	5.54	5.87	5.73	5.80	5.69	5.17	5.21	5.07
Shelby	3.50	3.83	3.47	3.68	3.70	4.03	3.81	3.96	3.94	3.71	3.68	3.48
Total	**191.27**	**216.02**	**196.31**	**211.19**	**237.31**	**311.79**	**338.56**	**348.34**	**333.00**	**240.91**	**197.66**	**177.15**

MGD=million gallons per day.

The average monthly withdrawals are a useful way to look at water usage, especially when determining availability, as will be done in Phase III. The higher seasonal summer withdrawals coincide with the low flow period of natural systems, both surface water and groundwater, thereby creating the limiting case for water availability.

Table 9.1: Summary of climate change scenarios; simulated precipitation and temperature changes in the future due to climate change (EPA, 2016).

Scenario Name	Temperature change (°F)		Precipitation change (%)	
	2035	2060	2035	2060
Hot / Dry	3.1 - 3.2 °F	6.0 - 6.2°F	-0.3 - -0.6%	-0.5 - -1.2%
Warm / Wet	2.3 °F	4.4 - 4.5 °F	6.0 6.5%	11.7 – 12.6%
Severe Drought	3.1 - 3.2 °F	6.0 - 6.2°F	- 30%	- 30%

Historic regional average precipitation is ~43 inches/year and average temperature is ~52 °F (MRCC, 2019).

9 Climate Scenarios in the Public Water Supply Sector

The following analysis of climate change impacts on water demand is necessarily general. As noted previously, the scope and scale of this investigation does not allow for a high-resolution assessment of how some climate change scenarios could stretch seasons or alter the seasonal cycles. In this work, climate change is a shift from historically observed climate conditions as a result of natural processes and human-induced greenhouse gas emissions.

The changes in climate will place additional stress on water availability and resources. To adequately address future water demand within the Public Water Supply (PWS) sector, climate projections were applied to Public Water Supply (PWS) withdrawals as a means of assessing water demand over a range of conditions. The U.S Environmental Protection Agency (EPA) developed the Climate Resilience Evaluation and Awareness Tool (USEPA CREAT) to help drinking water and wastewater utilities understand the potential system-related risks associated with climate change. CREAT provides projections of changes in climate change conditions based on averages of climate model outputs. To understand the range of potential impacts due to climate change in the Central Region, three scenarios were prepared for the public water supply sector. The climate scenarios represent conditions based on the average of five climate models utilizing higher temperatures/less precipitation (Hot/Dry scenario), moderate temperature increases/greater precipitation (Warm/Wet scenario), and historical drought scenario (30% less precipitation than the Hot/Dry scenario). The 30 percent drought is close to what we experienced in 1963. The various moisture/temperature climate change scenarios are meant to consider the impact of these future climate regimes becomes our new baseline.

This chapter focuses on a range of climate scenarios and their impact on public water supply withdrawals by public and private establishments within the Central Region.

9.1 CREAT Climate Models

In the previous section of the report (see Section 7), regional public water supply withdrawals were forecast into 2070 using baseline (2015) conditions and normalized weather (average 1980-2010). In these climate change scenarios, public water withdrawals are the forecasted into 2070 using the predicted relationship between water demand and climate change with conditions projected by the U.S Environmental Protection Agency's Climate Resilience Evaluation and Awareness Tool (USEPA CREAT) (EPA, 2016). Critical to its use in this report, CREAT is one of the tools used by water utilities to evaluate the risk of climate change on water supply. The fact that this approach to defining the risks of climate change has been adopted by leading water systems in the country gives us confidence that these scenarios will be useful to the Central Region, especially because the Region's water withdrawals are dominated by public water supply. The CREAT Methodology Guide describes the approach for addressing climate change risks as follows:

> *CREAT provides projected changes from Global Climate Models17 (GCMs) as available from the Coupled Model Intercomparison Project, Phase 5 (CMIP5). CREAT uses an ensemble-informed approach to derive meaningful choices from the results of 38 model runs for each 0.5 by 0.5 degree location. This approach involves generating a scatter plot of normalized, projected changes in annual temperature and precipitation by 2060 for all models. Statistical targets were calculated based on the distribution of these model results and the five models closest to those targets were averaged to generate each projection (Figure 5). The targets were designed to capture a majority of the range in model projections of changes in annual temperature and precipitation, as follows:*

- *Warmer and wetter future conditions: average of five individual models that are nearest to the 95th percentile of precipitation and 5th percentile of temperature projections;*
- *Moderate future conditions: average of five individual models that are nearest to the median (50th percentile) of both precipitation and temperature projections; and*
- *Hotter and drier future conditions: average of five individual models that are nearest to the 5th percentile of precipitation and 95th percentile of temperature projections.*

> *Once the models for each projection were selected, these models were ensemble-averaged to calculate annual and monthly changes for temperature and precipitation. CREAT selects the most appropriate data to match the defined planning horizon from two available data sets – one for 2035, which is based on projection data for 2025-2045, and one for 2060, which is based on projection data for 2050-2070. The selection of the appropriate CREAT-provided time period is based on the End Year defined by the user during the time period selection. If the End Year is 2049 or earlier, the 2035 data are selected; otherwise, CREAT selects the 2060 data set.*

To account for each climate scenario, temperature and precipitation ratios were applied to the GPCD for each five-year projection, that was then translated to annual withdrawal. The temperature and precipitation ratios for the H/D and W/W climate scenarios were calculated using the following equations:

$$Temperature\,Ratio = \left(\frac{(T_h + \triangle T_e)}{T_h}\right)^e$$

Where T = climate variable of interest (temperature); T_h= the historical value; $\triangle T_e$ =projected change in variable due to climate change; and e = elasticity constant.

$$Precipitation\,Ratio = \left(\frac{P + (1 + \frac{\triangle P_e}{100})}{P_h}\right)^e$$

Where P = climate variable of interest (precipitation); P_h= the historical value; $\triangle P_e$ =projected change in variable due to climate change; and e = elasticity constant.

The temperature and precipitation ratios were then used to obtain future GPCD as shown below:

$$GPCD_f = GPCD_{2015}(Income\,Ratio)^e(Conservation\,Ratio)(Temperature\,Ratio)(Precipitation\,Ratio)$$

Where: $GPCD_f$ = future per capita use, $GPCD_{2015}$ = base year per capita use, and e = household income elasticity.

Future population estimated previously for the baseline scenario using expected growth rates per county was used to transform $GPCD_f$ into future withdrawal (MGD).

Monthly withdrawals were forecasted for the years 2035 and 2070 using the monthly fraction of annual withdrawal by each utility per county. These monthly fractions for each utility were calculated from the average historically observed monthly data (2008 to 2017).

9.2 Historical Data

The water demand forecast applied historical water-use data from the Indiana Department of Natural Resources (DNR), which provided annual withdrawal estimates in 53 water systems in the Region. The period of record extended from from 2005 to 2017 (DNR, 2018). The data set was reproduced in Section 7. To assess the impact of climate change on temperature and precipitation on both a monthly and annual basis, a baseline of historically observed weather recorded in each county was assembled (Table 9.2). These values became the reference points for annual precipitation and average annual temperatures used to estimate alternative climate scenarios in the project area. For each analysis the average annual values were decomposed into a monthly distribution. The seasonal fluctuation in water use in each month is based on the relationship between use in that month and the annual average water withdrawal.

Table 9.2: Historic average annual recorded precipitation (inches) and average annual temperature (degrees F) per county (MRCC, 2019).

County	Precipitation (inches)	Temperature ($°F$)
Boone	42.75	52.22
Hamilton	42.18	51.55
Hancock	45.81	51.69
Hendricks	41.78	53.10
Johnson	44.83	51.67
Madison	41.44	51.76
Marion	42.44	53.07
Morgan	44.73	51.32
Shelby	41.93	52.40

9.3 Hot/Dry Scenario

The Hot/Dry (H/D) annual and monthly forecasts were estimated for each utility per county. The annual projections were conducted in five-year increments into 2070, whereas the monthly projections were limited to the years 2035 and 2060 (EPA, 2016). The H/D climate scenario is characterized by the following changes in temperature (°F) and precipitation (%) (Table 9.3). The H/D scenario predicts relatively constant increases in temperatures, with Morgan and Johnson Counties expected to experience slightly greater temperature increases by 2035 and 2060. Marion and Hendricks Countiesare expected to see the greatest decrease in precipitation (%) in 2060.

9.4 Warm/Wet Scenario

The Warm/Wet (W/W) annual and monthly forecasts were estimated for each utility per county. The annual projections were conducted in five-year increments into 2070 and the monthly projections were limited to the years 2035 and 2060 (EPA, 2016). The W/W climate scenario is characterized by the following changes in temperature (°F) and precipitation (%) (Table 9.4). With the exception of a few counties, the W/W scenario predicts temperature and precipitation increases in 2035 and 2060 to be relatively constant across the region with average increases in precipitation of 6.3% in 2035 and 12.3% in 2060.

9.5 30% Drought

The 30% drought scenario predicts 70% of precipitation anticipated in the H/D scenario will occur with the same expected temperature increases in both 2035 and 2060 (EPA, 2016). This scenario shows that the peak use in this case would increase in the range of 30 MGD from the

Table 9.3: USEPA CREAT projected average annual temperature (degrees F) and precipitation (%) change in 2035 and 2060.

County	Year	Temperature	Precipitation
Boone	2035	3.1 °F	-0.5%
	2060	6.1 °F	-1.0%
Hamilton	2035	3.1 °F	-0.5%
	2060	6.1 °F	-1.0%
Madison	2035	3.1 °F	-0.5%
	2060	6.0 °F	-0.9%
Hendricks	2035	3.1 °F	-0.6%
	2060	6.0 °F	-1.2%
Marion	2035	3.1 °F	-0.6%
	2060	6.0 °F	-1.2%
Hancock	2035	3.1 °F	-0.3%
	2060	6.0 °F	-0.6%
Morgan	2035	3.2 °F	-0.3%
	2060	6.2 °F	-0.5%
Johnson	2035	3.2 °F	-0.3%
	2060	6.2 °F	-0.5%
Shelby	2035	3.1 °F	-0.3%
	2060	6.0 °F	-0.6%

Table 9.4: USEPA CREAT projected average annual temperature (degrees F) and precipitation (%) change in 2035 and 2060.

County	Year	Temperature	Precipitation
Boone	2035	2.3 °F	6.3%
	2060	4.5 °F	12.3%
Hamilton	2035	2.3 °F	6.3%
	2060	4.5 °F	12.3%
Madison	2035	2.3 °F	6.4%
	2060	4.5 °F	12.5%
Hendricks	2035	2.3 °F	6.4%
	2060	4.4 °F	12.5%
Marion	2035	2.3 °F	6.4%
	2060	4.4 °F	12.5%
Hancock	2035	2.3 °F	6.5%
	2060	4.4 °F	12.6%
Morgan	2035	2.3 °F	6.0%
	2060	4.5 °F	11.7%
Johnson	2035	2.3 °F	6.0%
	2060	4.5 °F	11.7%
Shelby	2035	2.3 °F	6.5%
	2060	4.4 °F	12.6%

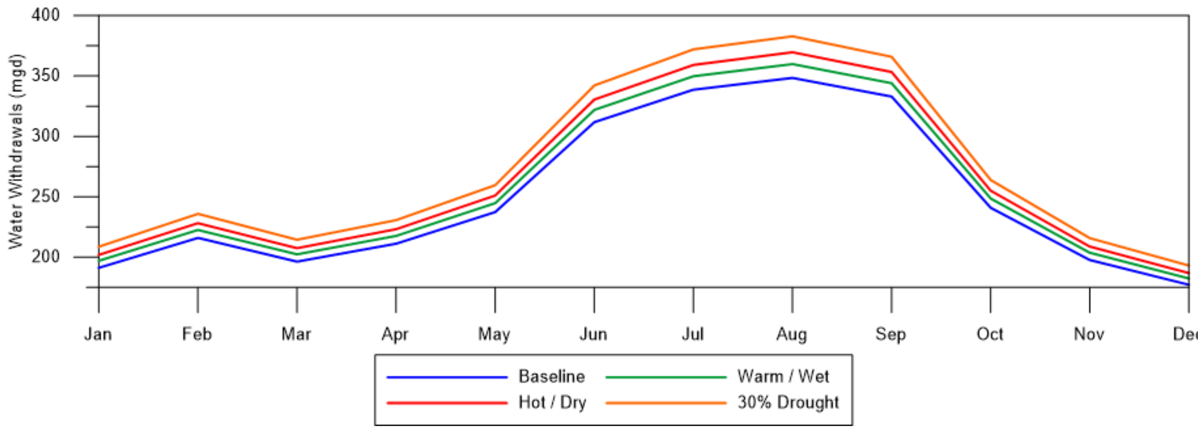


Figure 9.1: Summary of Central Region public water supply water withdrawals forecast with CREAT climate scenarios in 2070. *Note that all scenarios produce greater withdrawal forecasts than the baseline (historical) condition. Summer months are expected to continue to be the limiting conditions for water availability. Average annual water withdrawals for the 30% drought scenario are projected to be 274 MGD in 2070, while the average peak monthly withdrawals in that year (shown in the graph) are expected to be ~383 MGD. Recall that actual monthly withdrawals will vary. The forecast predicts the long term average withdrawals.*

baseline. Active collaboration among the utilities will be required to provide for communities that endure such a drought.

9.6 Climate Scenario Demand Projections

Using the combination of climate variables for each scenario, withdrawal per county in 2035 and 2070 was forecasted on an annual and monthly basis (Figure 9.1 and Tables 9.5- 9.7). Individual county graphs of the climate change scenario forecasts are provided in Appendix G. For all scenarios, the predicted withdrawals are expected to increase from the baseline scenario, particularly in the summer months. In the drought scenario, the August withdrawals are expected to increase over 30 MGD in relation to the baseline forecast.

Table 9.5: Hot/Dry Scenario - Predicted monthly public water supply water withdrawals (in MGD) per county in the Central Region in 2070. *Average annual water withdrawals for the hot/dry scenario are projected to be 265 MGD in 2070, while the average peak monthly withdrawals in that year (shown in the table) are expected to be ~370 MGD. Recall that actual monthly withdrawals will vary. The forecast predicts the long term average withdrawals.*

County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boone	3.03	3.32	2.91	3.33	3.41	3.71	3.62	3.60	3.57	3.38	3.19	2.88
Hamilton	32.43	34.86	34.04	39.51	46.77	63.39	64.92	65.33	63.31	42.84	37.97	35.13
Hancock	5.18	5.10	4.65	4.78	4.79	5.23	5.21	5.24	5.23	4.87	5.12	5.39
Hendricks	11.01	12.02	10.97	12.22	13.15	15.10	15.05	15.40	14.72	12.13	11.41	11.26
Johnson	17.20	18.78	16.71	18.18	19.58	23.24	23.62	24.10	22.73	18.05	16.77	16.13
Madison	10.00	11.44	10.06	10.27	10.09	10.89	10.53	10.63	10.80	10.08	10.22	9.76
Marion	114.17	132.64	119.15	125.62	143.87	198.84	226.51	235.36	223.09	154.66	115.08	97.70
Morgan	5.40	6.15	5.43	5.55	5.63	5.97	5.83	5.89	5.78	5.26	5.30	5.15
Shelby	3.55	3.88	3.52	3.72	3.75	4.07	3.86	4.01	3.99	3.76	3.73	3.52
Total	201.97	228.19	207.42	223.18	251.04	330.45	359.15	369.57	353.22	255.03	208.79	186.91

MGD=million gallons per day.

Table 9.6: Warm/Wet Scenario - Predicted monthly public water supply water withdrawals (in MGD) per county in the Central Region in 2070. *Average annual water withdrawals for the warm/wet scenario are projected to be 258 MGD in 2070, while the average peak monthly withdrawals in that year (shown in the table) are expected to be ~360 MGD. Recall that actual monthly withdrawals will vary. The forecast predicts the long term average withdrawals.*

County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boone	3.01	3.30	2.89	3.31	3.38	3.68	3.59	3.57	3.54	3.36	3.17	2.85
Hamilton	31.45	33.81	33.02	38.32	45.37	61.49	62.98	63.38	61.41	41.56	36.84	34.08
Hancock	5.16	5.08	4.64	4.76	4.78	5.22	5.19	5.23	5.21	4.85	5.10	5.37
Hendricks	10.87	11.86	10.82	12.06	12.98	14.90	14.85	15.19	14.52	11.96	11.26	11.11
Johnson	16.89	18.44	16.40	17.84	19.22	22.82	23.19	23.66	22.32	17.72	16.47	15.83
Madison	9.95	11.38	10.00	10.22	10.04	10.83	10.47	10.57	10.74	10.02	10.16	9.71
Marion	110.87	128.79	115.70	121.99	139.70	193.02	219.87	228.45	216.55	150.15	111.75	94.89
Morgan	5.34	6.08	5.37	5.49	5.57	5.90	5.76	5.83	5.72	5.20	5.24	5.10
Shelby	3.52	3.85	3.49	3.69	3.72	4.04	3.83	3.98	3.95	3.73	3.70	3.50
Total	197.05	222.60	202.32	217.68	244.74	321.90	349.73	359.86	343.97	248.56	203.68	182.43

MGD=million gallons per day

Table 9.7: 30% Drought Scenario - Predicted monthly public water supply water withdrawals (in MGD) per county in the Central Region in 2070. *Average annual water withdrawals for the 30% drought scenario are projected to be 274 MGD in 2070, while the average peak monthly withdrawals in that year (shown in the table) are expected to be ~383 MGD. Recall that actual monthly withdrawals will vary. The forecast predicts the long term average withdrawals.*

County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boone	3.05	3.34	2.92	3.35	3.43	3.73	3.64	3.61	3.59	3.40	3.21	2.89
Hamilton	33.74	36.27	35.42	41.11	48.67	65.96	67.56	67.98	65.88	44.58	39.51	36.55
Hancock	5.20	5.12	4.67	4.80	4.81	5.25	5.23	5.26	5.25	4.88	5.14	5.41
Hendricks	11.19	12.22	11.15	12.42	13.36	15.35	15.30	15.65	14.96	12.32	11.60	11.44
Johnson	17.67	19.30	17.16	18.67	20.11	23.88	24.26	24.76	23.36	18.55	17.23	16.57
Madison	10.10	11.56	10.16	10.38	10.20	11.01	10.64	10.74	10.91	10.18	10.32	9.86
Marion	118.63	137.83	123.82	130.54	149.51	206.71	235.51	244.72	231.95	160.77	119.58	101.51
Morgan	5.52	6.28	5.55	5.67	5.75	6.09	5.95	6.02	5.90	5.37	5.41	5.26
Shelby	3.60	3.94	3.57	3.78	3.80	4.14	3.92	4.07	4.05	3.81	3.78	3.58
Total	208.71	235.86	214.41	230.71	259.65	342.12	372.00	382.82	365.85	263.88	215.80	193.07

MGD=million gallons per day

10 Regional Summary

Total water use in this Region over the past decade has not increased substantially. Water use for thermoelectric power generation has declined as coal plants have been decommissioned throughout the Region and are being replaced by different fuel sources that use less water. In the past, thermoelectric cooling water has come from intakes along the White River. Future power generation is anticipated to come from more efficient generating facilities. The drinking water utilities that will experience the largest increase include Citizens Energy, serving the central metropolitan area and many suburbs, as well as other utilities that supply the larger communities in Hamilton and Johnson counties. Projected water uses in each of the counties in the Region reflect the population in each county as well as the industrial and power sectors located within the county (Figure 10.1). For most counties, the public water supply sector accounts for over 50% of the total water withdrawals.

Total future water demand in the Central Region was estimated to be 111 MGD more than current withdrawals (2018) (Figure 10.2 and Table 10.1). Demand for public water supply systems was the largest fraction of this increase in the Region. The geography and timing of the anticipated increase is critical for resource and infrastructure planning. Figure 10.3 shows rapid growth occurring in the Region, particularly in Hamilton, Boone, and Hendricks counties. Increased management of the supplies in these areas will be necessary to develop and protect source waters in a way that ensures the sustainability of the regional supply, especially during drought. Additional data and cooperation are likely going to be important to regional growth. Meeting future needs and developing the supplies in a way that is both economical and sustainable is the challenge for regional utilities for the next 50 years.

While total withdrawals from surface water have declined, use of groundwater from aquifers along the White River will likely increase to accommodate growth. More than 100 MGD is forecast to be withdrawn from the outwash aquifer that follows the general path of the White River through the Region. This aquifer already supplies the majority of the groundwater used in the Region.

Surface water withdrawals for industrial and power cooling purposes has declined over the last several decades as use of groundwater for public water systems continues to grow and the metropolitan area expands. Agricultural irrigation will also likely increase, especially in the southeastern part of the Region in parts of Shelby and Johnson counties, where center pivot irrigation has become standard practice. Industrial demand, the most difficult of the water use sectors to forecast, is expected to increase as more businesses are created in and around the city. Self-supplied domestic water use is assumed to remain the same over the next 50 years as some utilities expand to add service area in the unincorporated domains, and new homes are developed further away from the city. By the end of the forecast period, anticipated climate variation, due to changes in precipitation and temperature, could potentially add between 10 and 35 MGD of additional demand in the dry summer months. Again, this demand will be focused on the north side of the Region and to the south where growth is expected to continue.

County summaries of the water forecasts are provided in Tables 10.2 - 10.4. Phase III of the water study will utilize this water withdrawal forecast generated from this work and incorporate it into the water availability study.

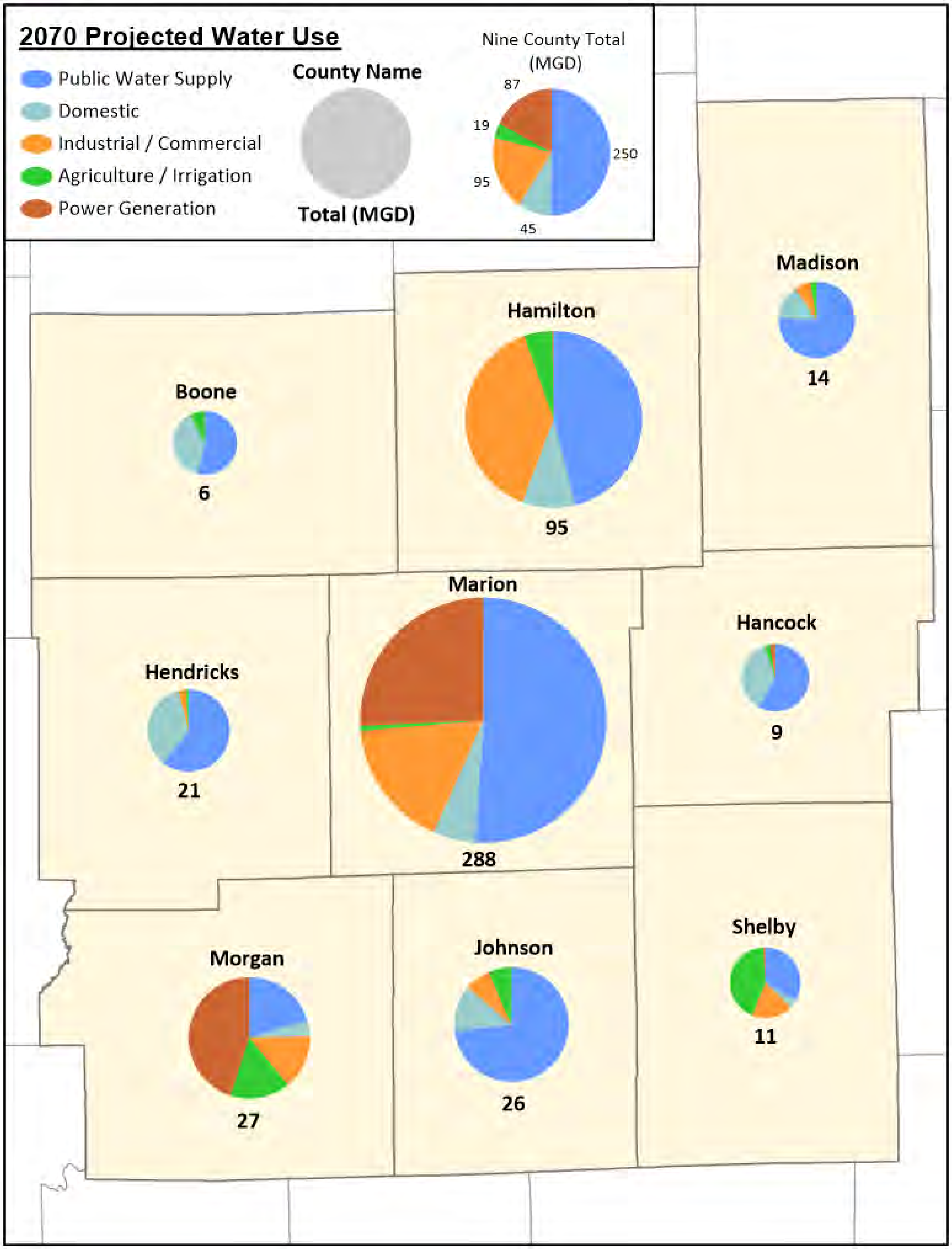


Figure 10.1: Summary water withdrawal forecast for 9-county Central Region in 2070. *Regionally, public water supply is the predominant water-use in all counties except for Morgan County, where power generation uses dominate.*

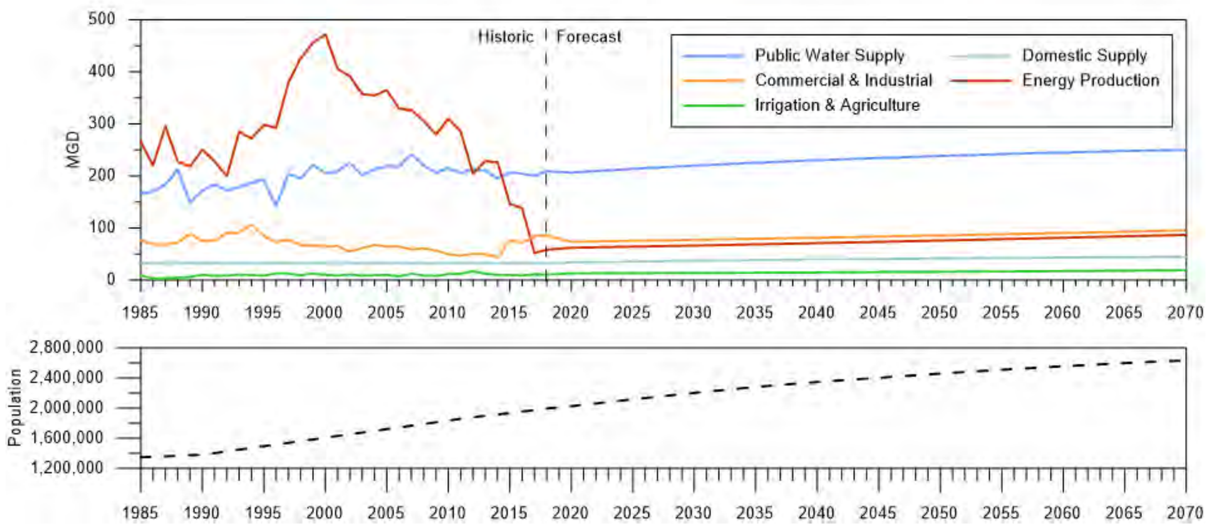


Figure 10.2: Summary water withdrawal forecast for 9-county Central Region. *Although historically Energy Production has been the largest water-use sector, changes in fuel sources have reduced water withdrawals to under 100 MGD for the sector. Public water supply accounts for approximately 50% of the water withdrawals in the Region. Annual historical water withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Historical population from the United States Census (2010). 2020-2050 population projections from the Indiana Business Research Center (2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

Table 10.1: Future regional water withdrawals by sector for the Central Region in MGD. *Although historically Energy Production has been the largest water-use sector, changes in fuel sources have reduced water withdrawals to under 100 MGD for the sector. Public water supply accounts for approximately 50% of the water withdrawals in the Region. Annual historical water withdrawals are from the Indiana Department of Natural Resources Significant Water Withdrawals Database, 1985-2018 (DNR, 2018). Historical population from the United States Census (2010). 2020-2050 population projections from the Indiana Business Research Center (2018). Central Region includes the following nine counties: Boone, Hendricks, Hamilton, Hancock, Johnson, Madison, Marion, Morgan, and Shelby.*

	2020	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Commercial & Industrial	73.26	75.17	77.15	79.18	81.27	83.42	85.64	87.92	90.28	92.70	95.19
Domestic Supply	33.70	35.34	36.92	38.33	39.50	40.53	41.50	42.43	43.26	44.01	44.67
Energy Production	62.00	64.09	66.25	68.50	70.83	73.25	75.76	78.37	81.08	83.89	86.82
Irrigation & Agriculture	12.75	13.16	13.60	14.07	14.59	15.16	15.78	16.46	17.20	18.01	18.90
Public Water Supply	206.60	213.38	219.73	225.29	230.02	234.22	238.28	241.87	245.02	247.74	250.09
Total Withdrawals	**388.31**	**401.14**	**413.65**	**425.37**	**436.21**	**446.58**	**456.96**	**467.05**	**476.84**	**486.35**	**495.67**

MGD=million gallons per day.

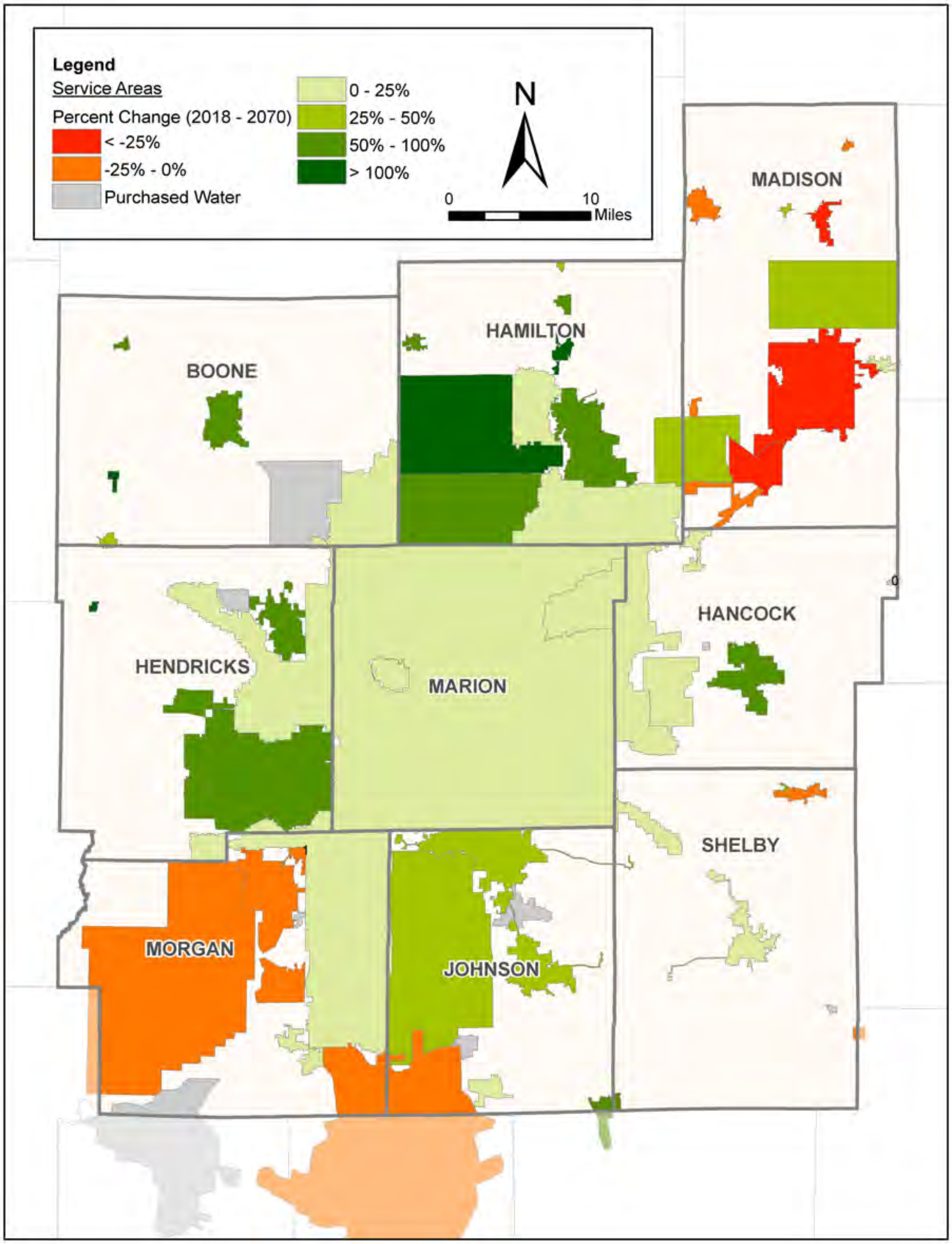


Figure 10.3: Percent change from 2018-2070 in water withdrawals by public water supply service area in the Central Region. *Higher growth for public water supply is concentrated in Hamilton County, while Madison and Morgan counties are expected to see a decrease in water withdrawals.*

Table 10.2: Future regional water withdrawals for each county by sector for the Central Region in MGD.

Boone	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Public Water Supply	2.27	2.48	2.67	2.82	2.91	3.00	3.08	3.14	3.19	3.22	3.25
Commercial & Industrial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Irrigation & Agriculture	0.42	0.42	0.43	0.43	0.43	0.44	0.44	0.45	0.46	0.46	0.47
Energy Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Domestic Supply	1.53	1.69	1.82	1.92	2.00	2.06	2.13	2.18	2.22	2.25	2.27

Hamilton	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Public Water Supply	25.82	28.46	31.22	33.68	35.61	37.27	38.89	40.34	41.61	42.72	43.67
Commercial & Industrial	27.16	28.00	28.86	29.75	30.67	31.62	32.59	33.60	34.64	35.71	36.81
Irrigation & Agriculture	3.76	3.84	3.93	4.02	4.13	4.23	4.34	4.46	4.59	4.73	4.87
Energy Production	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24
Domestic Supply	5.24	5.79	6.38	6.90	7.32	7.69	8.05	8.38	8.67	8.94	9.17

Hancock	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Public Water Supply	3.41	3.63	3.84	4.03	4.20	4.34	4.47	4.62	4.76	4.89	5.02
Commercial & Industrial	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Irrigation & Agriculture	0.09	0.10	0.11	0.11	0.12	0.14	0.15	0.16	0.18	0.20	0.22
Energy Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Domestic Supply	2.25	2.38	2.50	2.61	2.70	2.77	2.84	2.92	2.99	3.05	3.11

MGD=million gallons per day.

Table 10.3: Continued, Future regional water withdrawals for each county by sector for the Central Region in MGD.

Hendricks	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Public Water Supply	7.50	8.15	8.81	9.47	10.01	10.49	10.91	11.35	11.75	12.13	12.48
Commercial & Industrial	0.55	0.55	0.56	0.56	0.57	0.57	0.58	0.58	0.59	0.59	0.60
Irrigation & Agriculture	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Energy Production	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22
Domestic Supply	4.61	4.98	5.35	5.72	6.02	6.26	6.48	6.70	6.90	7.08	7.25

Johnson	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Public Water Supply	14.13	14.92	15.64	16.26	16.78	17.23	17.66	18.03	18.35	18.63	18.87
Commercial & Industrial	1.79	1.79	1.80	1.80	1.81	1.82	1.83	1.83	1.84	1.85	1.86
Irrigation & Agriculture	0.68	0.74	0.80	0.88	0.96	1.05	1.15	1.26	1.39	1.53	1.69
Energy Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Domestic Supply	2.44	2.58	2.72	2.84	2.94	3.03	3.12	3.19	3.26	3.33	3.38

Madison	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Public Water Supply	11.26	11.15	11.00	10.81	10.62	10.42	10.23	10.25	10.27	10.28	10.30
Commercial & Industrial	0.86	0.87	0.88	0.89	0.89	0.90	0.91	0.92	0.92	0.93	0.94
Irrigation & Agriculture	0.25	0.26	0.27	0.27	0.28	0.29	0.30	0.32	0.33	0.35	0.37
Energy Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Domestic Supply	2.22	2.19	2.16	2.12	2.07	2.03	1.99	1.99	1.99	1.99	1.99

MGD=million gallons per day.

Table 10.4: Continued, Future regional water withdrawals for each county by sector for the Central Region in MGD.

Marion	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Public Water Supply	132.85	135.12	137.02	138.71	140.45	142.14	143.76	144.88	145.83	146.61	147.25
Commercial & Industrial	37.28	38.30	39.35	40.43	41.54	42.69	43.87	45.09	46.34	47.63	48.95
Irrigation & Agriculture	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99
Energy Production	54.21	55.91	57.66	59.48	61.36	63.31	65.33	67.42	69.58	71.82	74.14
Domestic Supply	13.92	14.21	14.46	14.69	14.93	15.16	15.39	15.57	15.73	15.87	15.99

Morgan	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Public Water Supply	5.49	5.57	5.61	5.63	5.60	5.56	5.53	5.53	5.52	5.52	5.51
Commercial & Industrial	3.62	3.65	3.68	3.71	3.74	3.77	3.80	3.83	3.86	3.89	3.92
Irrigation & Agriculture	3.50	3.57	3.64	3.71	3.78	3.86	3.94	4.03	4.12	4.21	4.31
Energy Production	7.36	7.74	8.14	8.55	8.99	9.44	9.93	10.43	10.96	11.52	12.11
Domestic Supply	1.08	1.10	1.11	1.11	1.11	1.10	1.09	1.09	1.09	1.09	1.09

Shelby	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Public Water Supply	3.87	3.90	3.91	3.88	3.83	3.79	3.74	3.74	3.74	3.73	3.73
Commercial & Industrial	1.99	2.00	2.01	2.02	2.03	2.04	2.05	2.06	2.07	2.08	2.10
Irrigation & Agriculture	1.85	2.03	2.23	2.45	2.69	2.96	3.25	3.58	3.94	4.33	4.77
Energy Production	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10
Domestic Supply	0.42	0.43	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.41

MGD=million gallons per day.

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A Commercial and Industrial Appendix

The labor force is projected to grow at an average rate of 0.5% per year for the 9 counties (Table A.1). This includes declining labor force in Madison, Morgan and Shelby Counties with high rates of growth in Boone and Hamilton counties. The rate of 0.5% per year in the 9-county region is consistent with Indiana's statewide projection of 0.61% per year during the 2018-2039 time period.

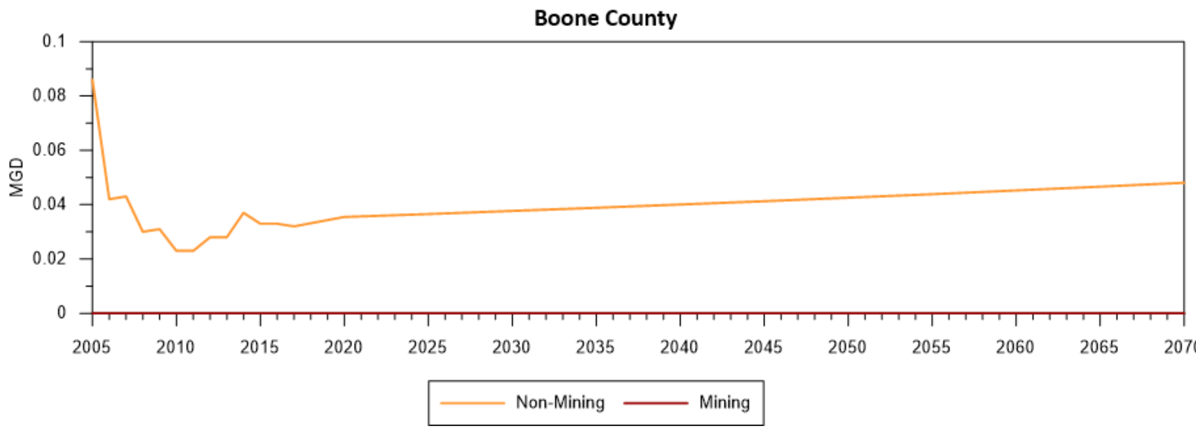

Figure A.1: Historical and future commercial and industrial water withdrawals estimated for Boone County from 2005-2070 in MGD.

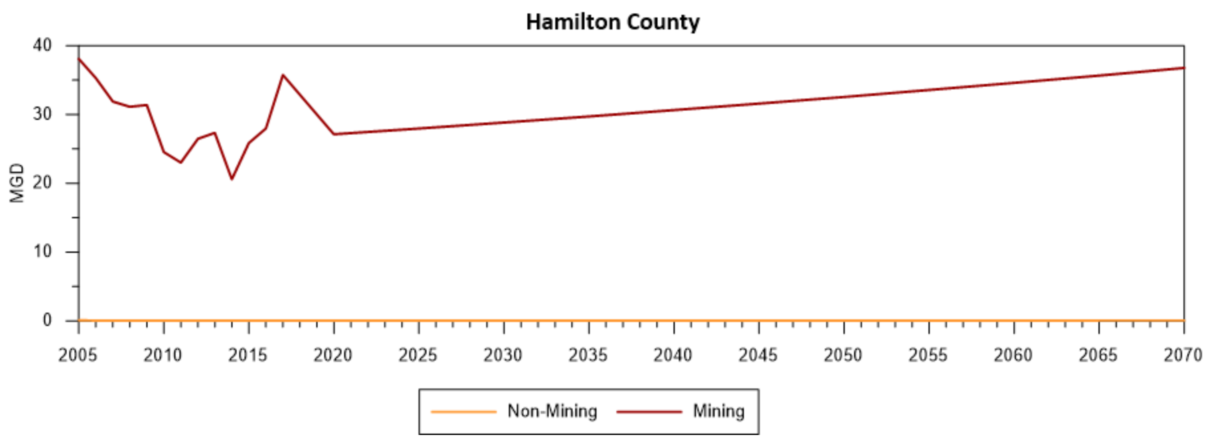

Figure A.2: Historical and future commercial and industrial water withdrawals estimated for Hamilton County from 2005-2070 in MGD.

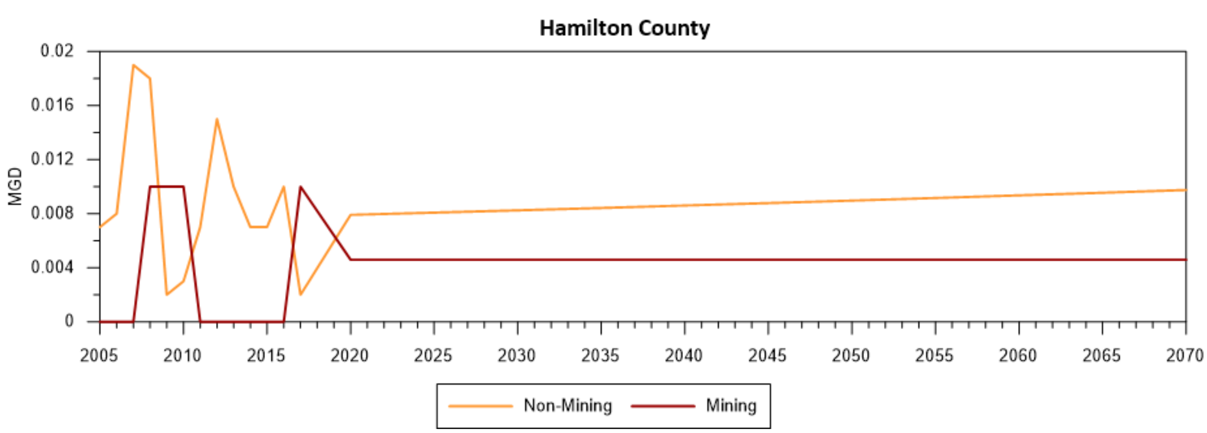

Figure A.3: Historical and future commercial and industrial water withdrawals estimated for Hamilton County from 2005-2070 in MGD.

Table A.1: Labor force projections by county from 2015-2020.

County	2015	2020	2025	2030	2035	2040	2045	2050	Annual Growth (2015-2050)
Boone	33,510	37,390	40,070	42,290	44,220	45,930	47,580	48,550	0.0106
Hamilton	170,140	190,870	208,100	222,080	233,370	243,300	255,680	268,450	0.0131
Hancock	38,250	40,270	41,430	42,180	42,820	43,810	45,250	46,670	0.0057
Hendricks	84,410	91,050	96,850	101,530	105,520	108,760	112,230	115,560	0.0090
Johnson	78,900	83,960	87,410	90,110	92,500	94,870	97,630	100,220	0.0069
Madison	60,820	59,590	57,540	55,680	54,040	52,890	52,000	51,070	-0.0050
Marion	490,370	498,620	496,090	497,120	501,400	508,690	516,480	522,470	0.0018
Morgan	35,780	35,910	35,440	34,590	34,030	33,940	34,130	34,210	-0.0013
Shelby	23,330	23,270	22,630	21,850	21,190	20,810	20,640	20,470	-0.0037
Total	1,015,510	1,060,930	1,085,560	1,107,430	1,129,090	1,153,000	1,181,620	1,207,670	0.00501

Table A.2: Labor Force Forecast of Self-supplied Commercial and Industrial Withdrawals by County in Central Indiana in MGD (IDNR, 2018).

County	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2070**
Boone	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.006
Hamilton	0.039	0.042	0.045	0.047	0.049	0.052	0.054	0.057	0.060	0.063	0.066
Hancock	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.010	0.010	0.010	0.011
Hendricks	0.146	0.156	0.163	0.170	0.175	0.180	0.186	0.191	0.197	0.203	0.209
Johnson	0.201	0.209	0.215	0.221	0.227	0.233	0.240	0.246	0.252	0.259	0.266
Madison	0.556	0.537	0.520	0.505	0.494	0.486	0.477	0.477	0.477	0.477	0.477
Marion	6.309	6.277	6.290	6.344	6.436	6.535	6.611	6.687	6.765	6.843	6.923
Morgan	2.009	1.983	1.935	1.904	1.899	1.910	1.914	1.918	1.923	1.927	1.932
Shelby	0.132	0.128	0.124	0.120	0.118	0.117	0.116	0.115	0.114	0.113	0.112
Total	**9.404**	**9.345**	**9.305**	**9.324**	**9.412**	**9.527**	**9.612**	**9.707**	**9.803**	**9.901**	**10.001**

MGD = million gallons per day

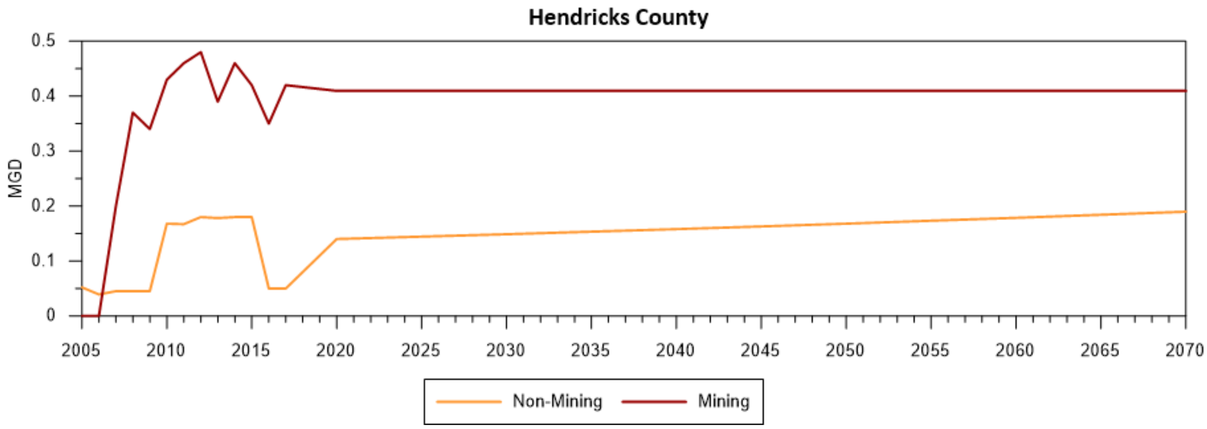

Figure A.4: Historical and future commercial and industrial water withdrawals estimated for Hendricks County from 2005-2070 in MGD.

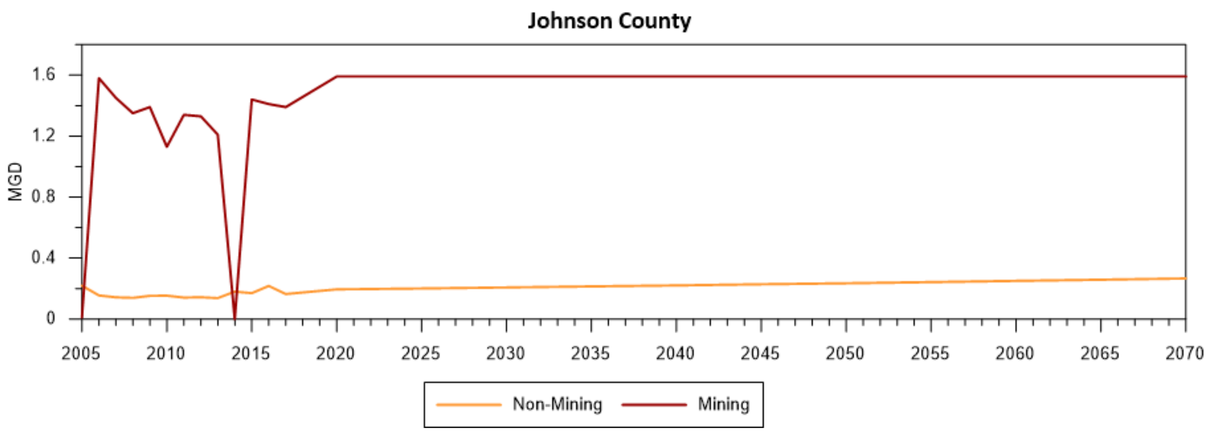

Figure A.5: Historical and future commercial and industrial water withdrawals estimated for Johnson County from 2005-2070 in MGD.

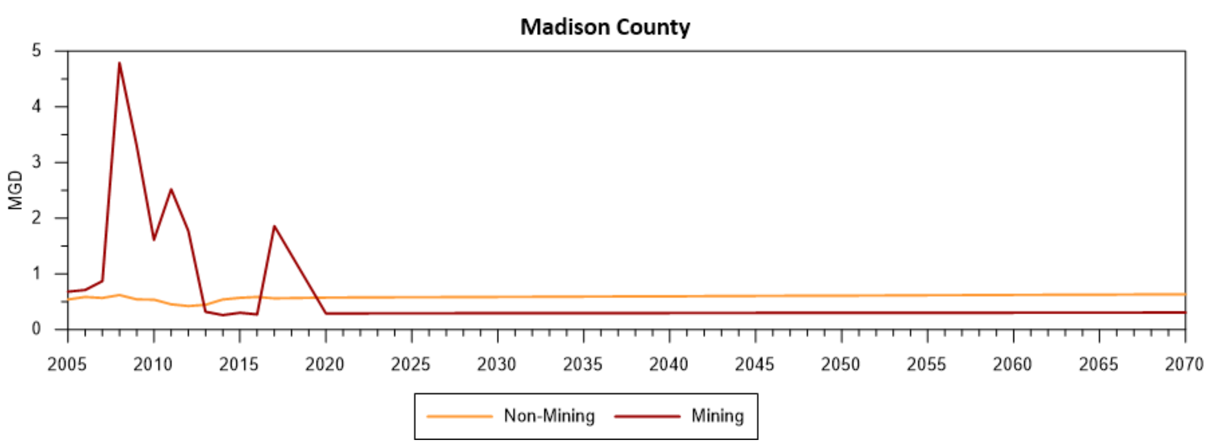

Figure A.6: Historical and future commercial and industrial water withdrawals estimated for Madison County from 2005-2070 in MGD.

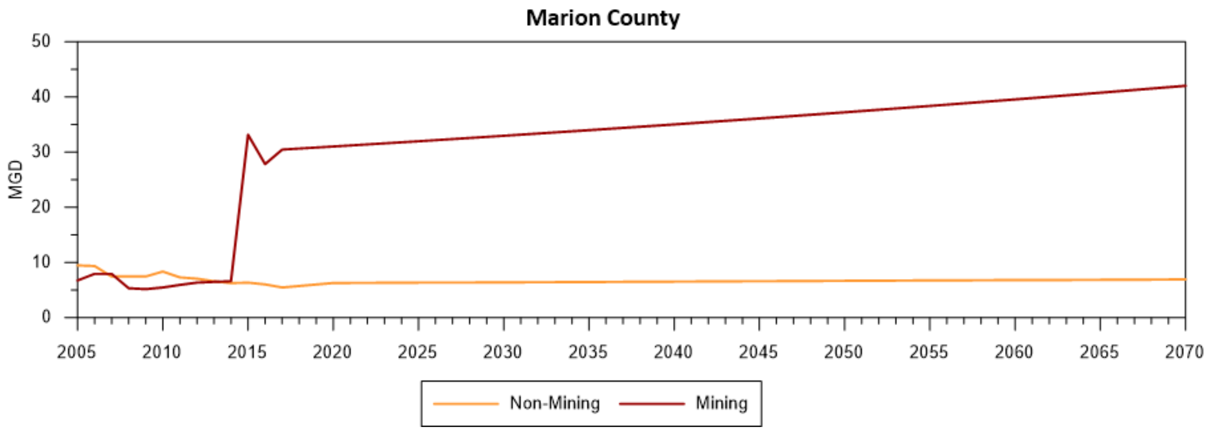

Figure A.7: Historical and future commercial and industrial water withdrawals estimated for Marion County from 2005-2070 in MGD.

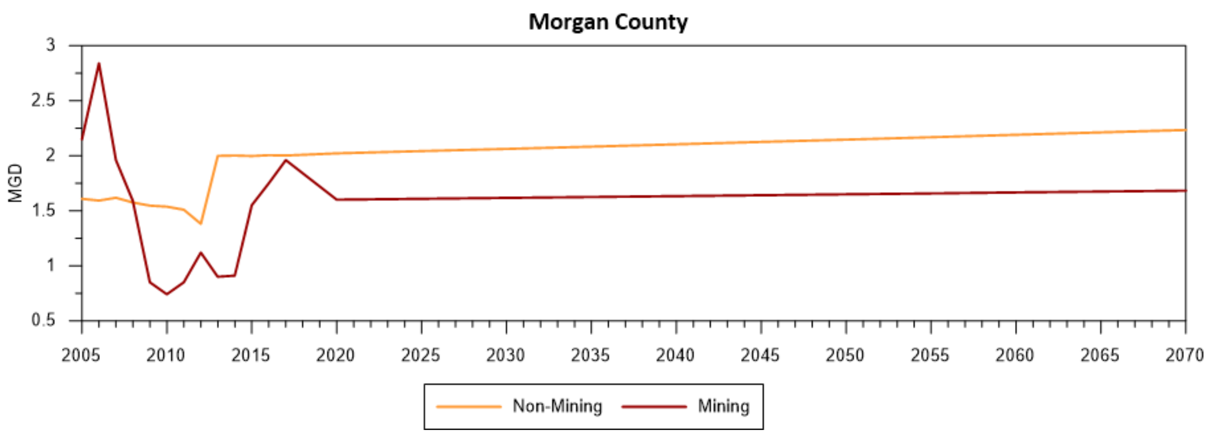

Figure A.8: Historical and future commercial and industrial water withdrawals estimated for Morgan County from 2005-2070 in MGD.

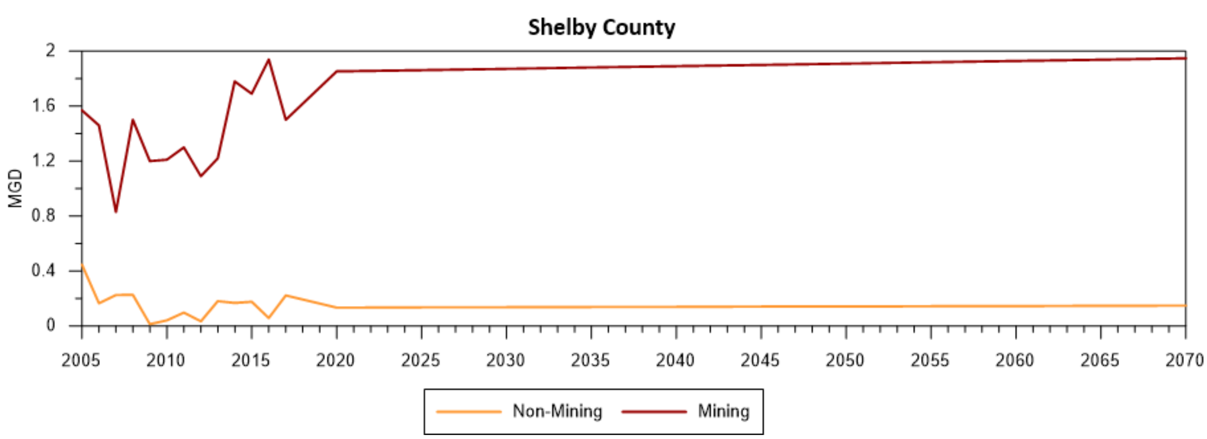

Figure A.9: Historical and future commercial and industrial water withdrawals estimated for Shelby County from 2005-2070 in MGD.

B Irrigation and Agriculture Appendix

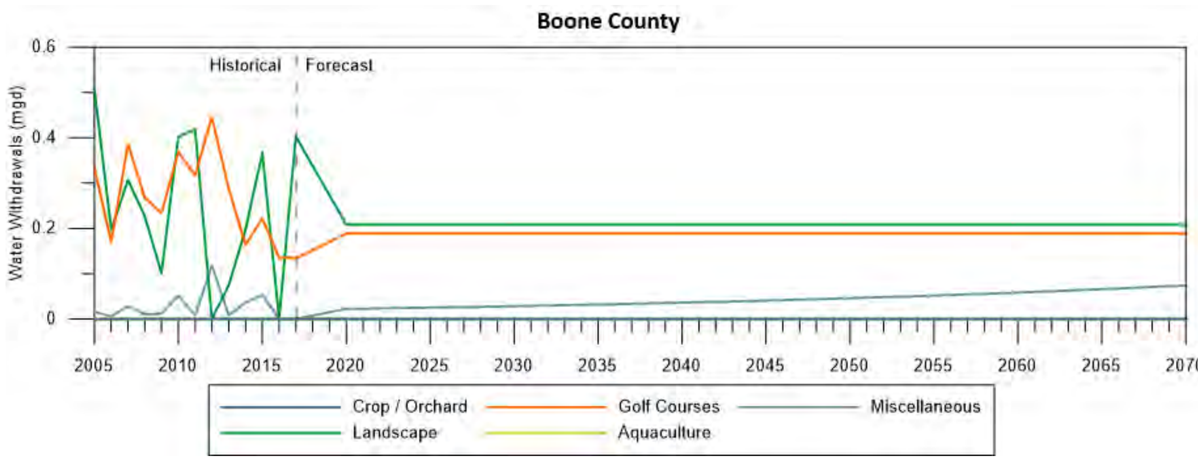

Figure B.1: Historical and future irrigation and agriculture water withdrawals estimated for Boone County from 2005-2070 in MGD.

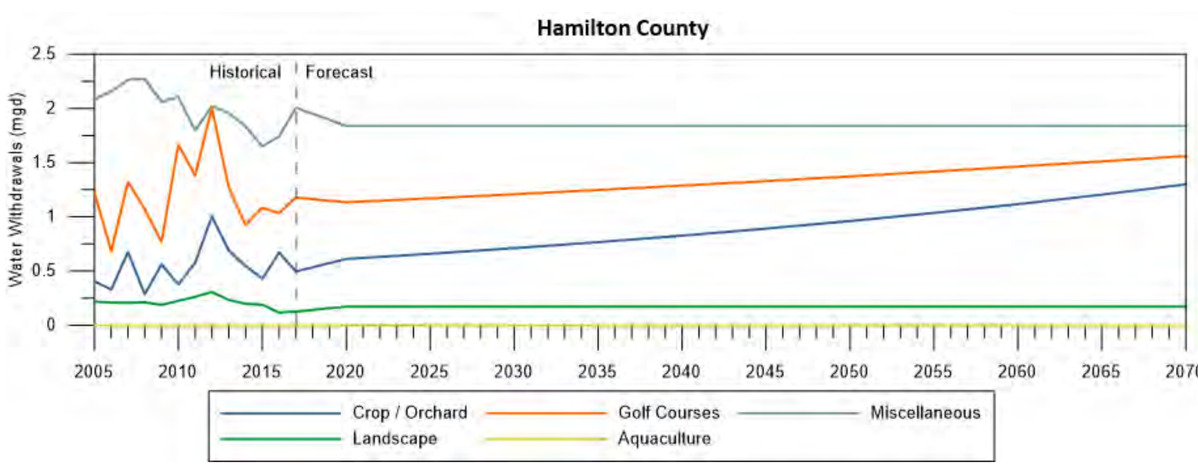

Figure B.2: Historical and future irrigation and agriculture water withdrawals estimated for Hamilton County from 2005-2070 in MGD.

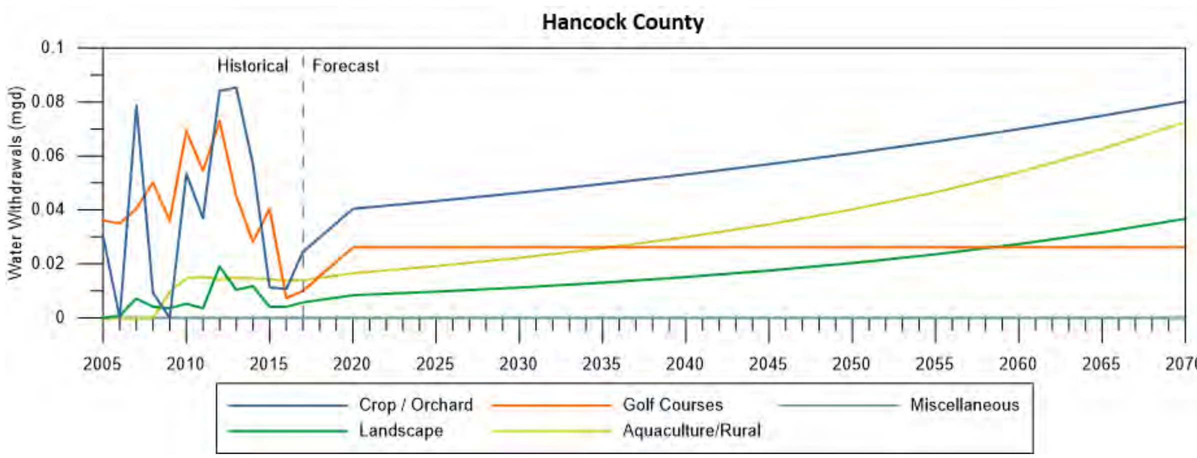

Figure B.3: Historical and future irrigation and agriculture water withdrawals estimated for Hancock County from 2005-2070 in MGD.

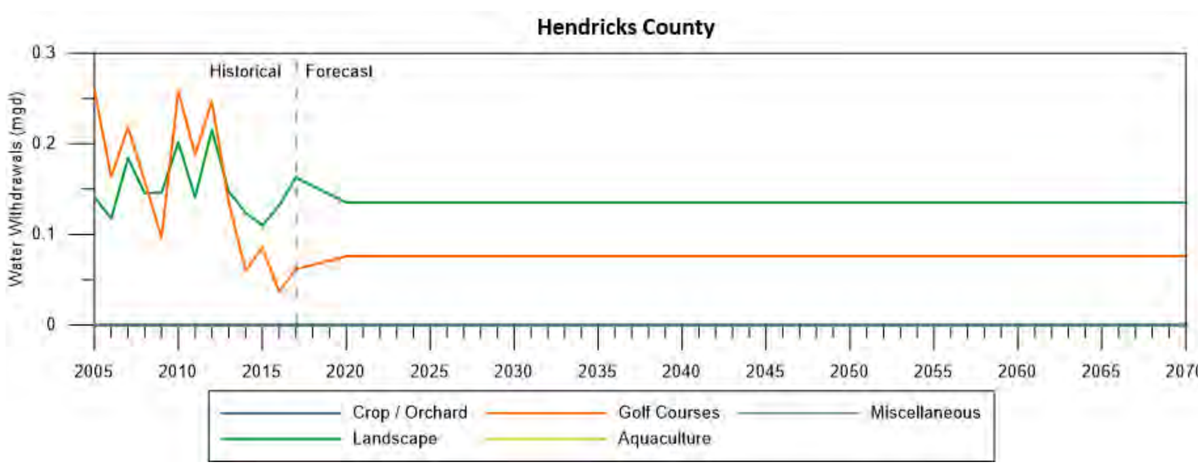

Figure B.4: Historical and future irrigation and agriculture water withdrawals estimated for Hendricks County from 2005-2070 in MGD.

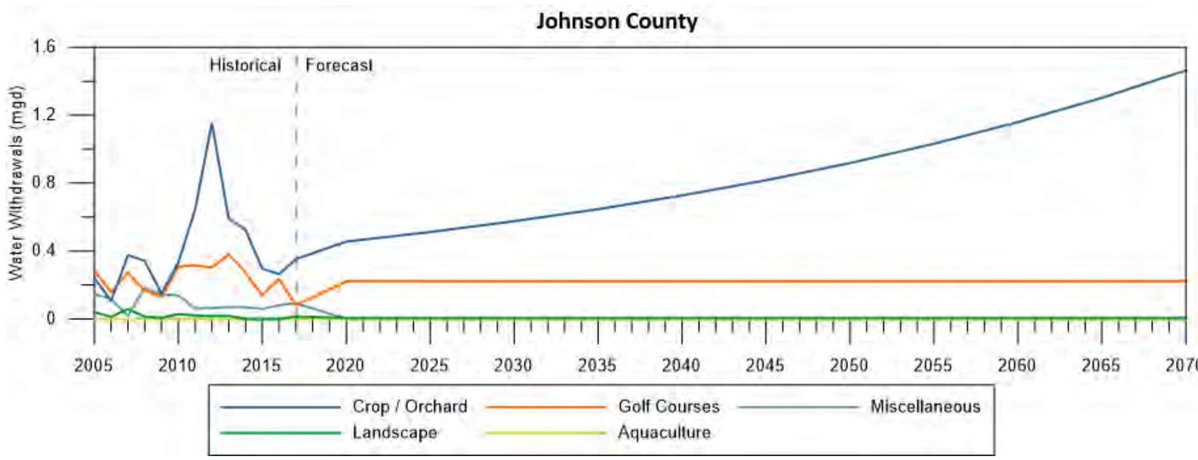

Figure B.5: Historical and future irrigation and agriculture water withdrawals estimated for Johnson County from 2005-2070 in MGD.

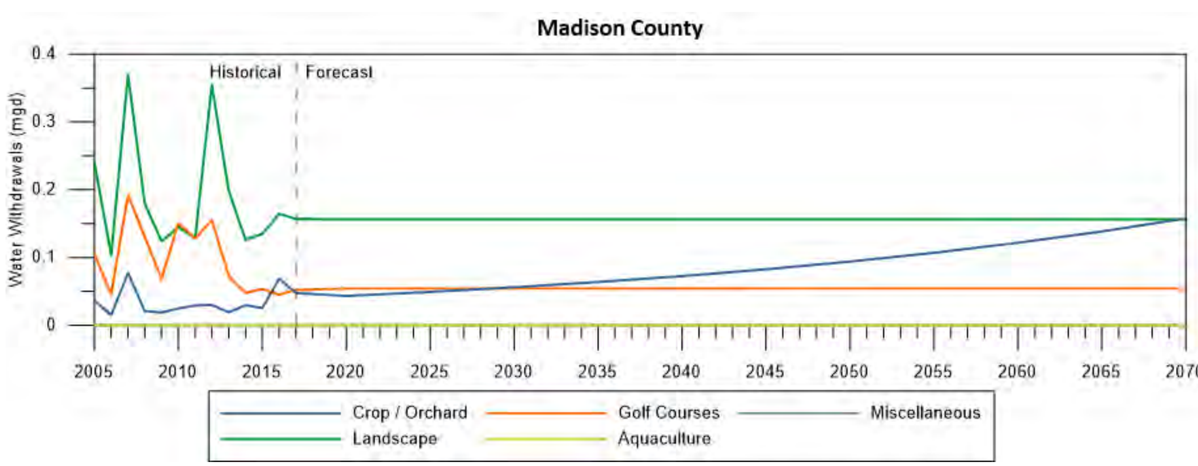

Figure B.6: Historical and future irrigation and agriculture water withdrawals estimated for Madison County from 2005-2070 in MGD.

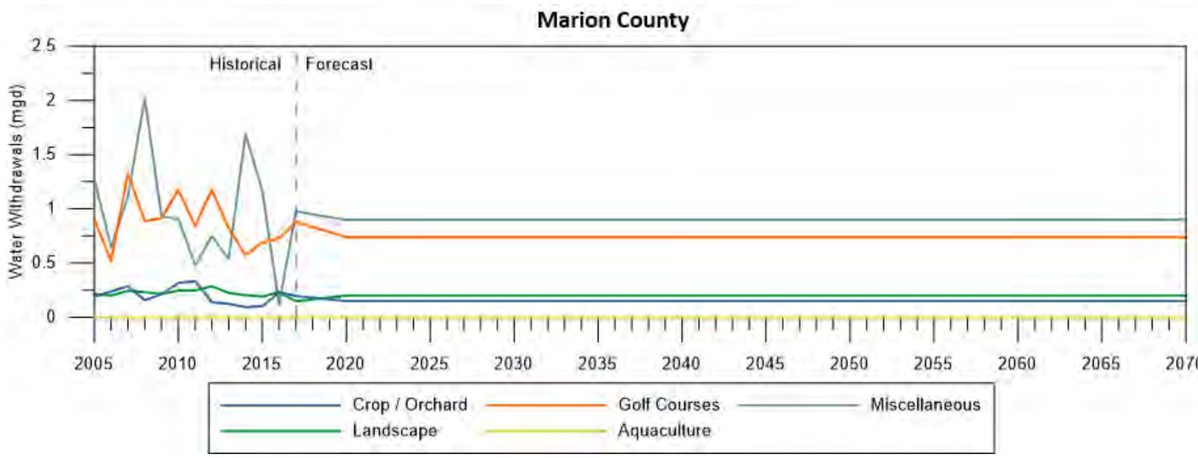

Figure B.7: Historical and future irrigation and agriculture water withdrawals estimated for Marion County from 2005-2070 in MGD.

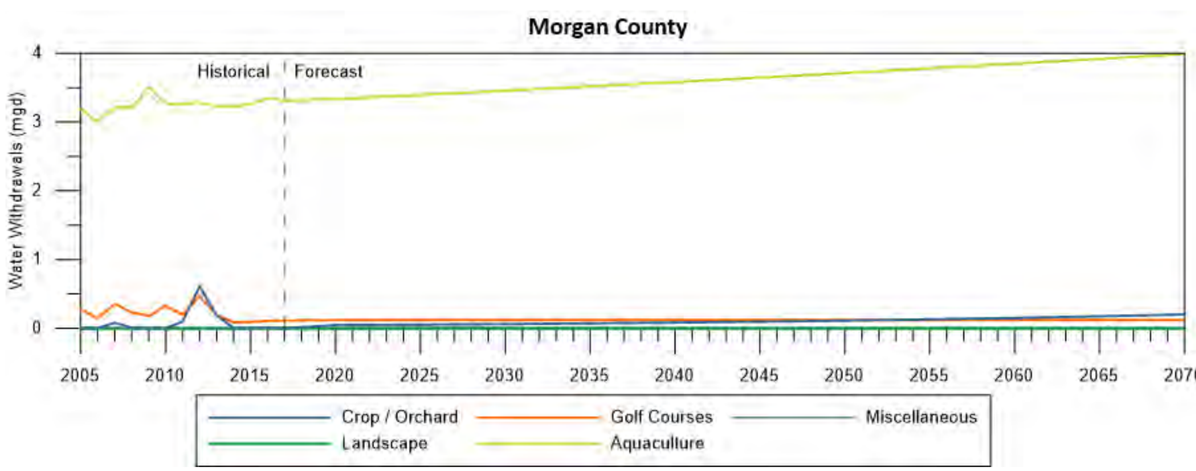

Figure B.8: Historical and future irrigation and agriculture water withdrawals estimated for Morgan County from 2005-2070 in MGD.

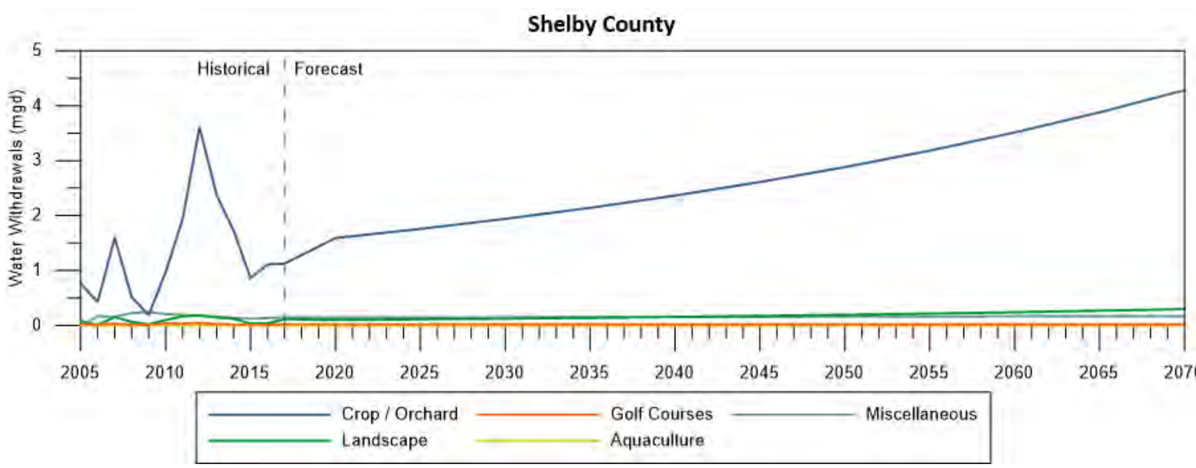

Figure B.9: Historical and future irrigation and agriculture water withdrawals estimated for Shelby County from 2005-2070 in MGD.

C Power Generation Appendix

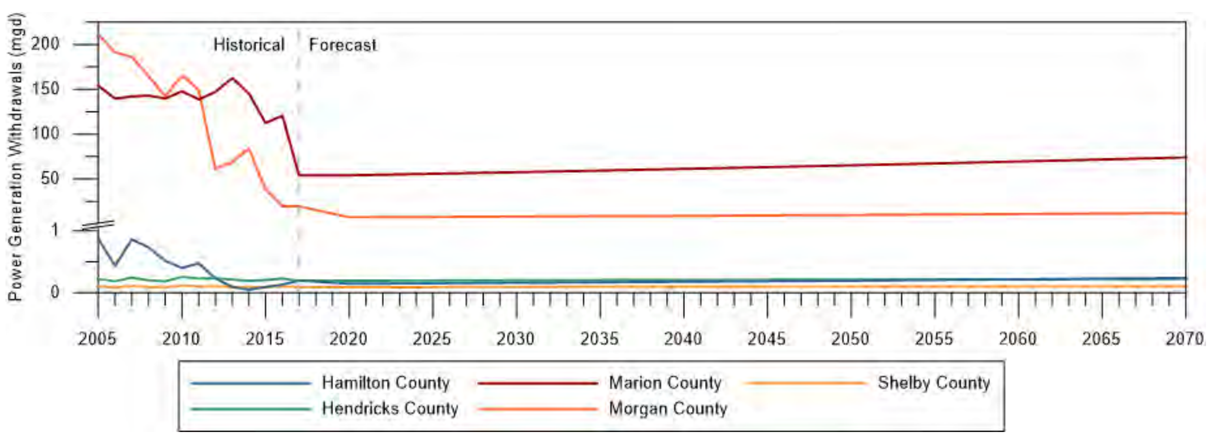

Figure C.1: Total historical and forecast power generation water withdrawals for each Central Indiana County.

Table C.1: The total power generation water withdrawals forecast in MGD for Central Indiana.

County	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Boone	-	-	-	-	-	-	-	-	-	-	-
Hamilton	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24
Hancock	-	-	-	-	-	-	-	-	-	-	-
Hendricks	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22
Johnson	-	-	-	-	-	-	-	-	-	-	-
Madison	-	-	-	-	-	-	-	-	-	-	-
Marion	54.21	55.91	57.66	59.48	61.36	63.31	65.33	67.42	69.58	71.82	74.14
Morgan	7.36	7.74	8.14	8.55	8.99	9.44	9.93	10.43	10.96	11.52	12.11
Shelby	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10
Total	**62.00**	**64.09**	**66.25**	**68.50**	**70.83**	**73.25**	**75.76**	**78.37**	**81.08**	**83.89**	**86.82**

MGD = million gallons per day

D Public Water Supply Appendix

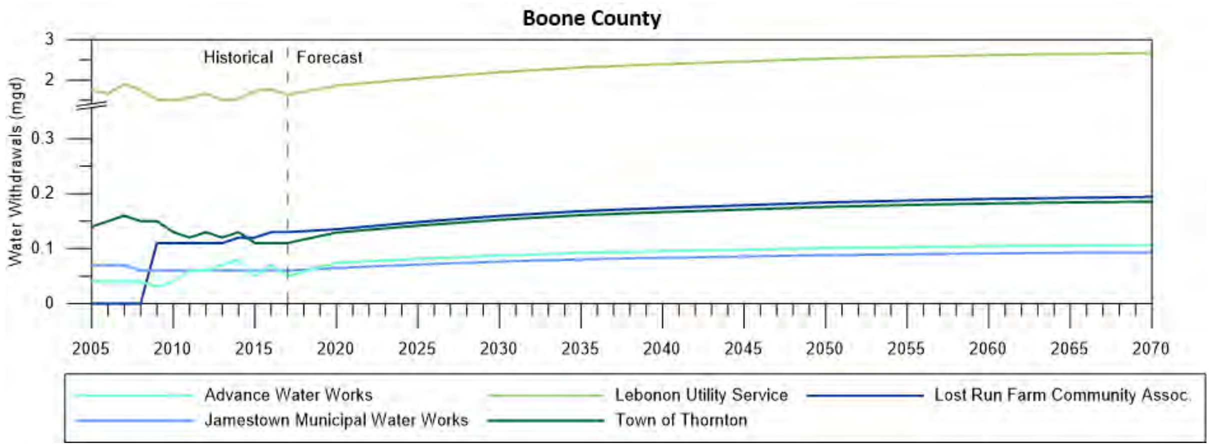

Figure D.1: Boone County public water supply utility historical and predicted withdrawals from 2005-2070 in MGD.

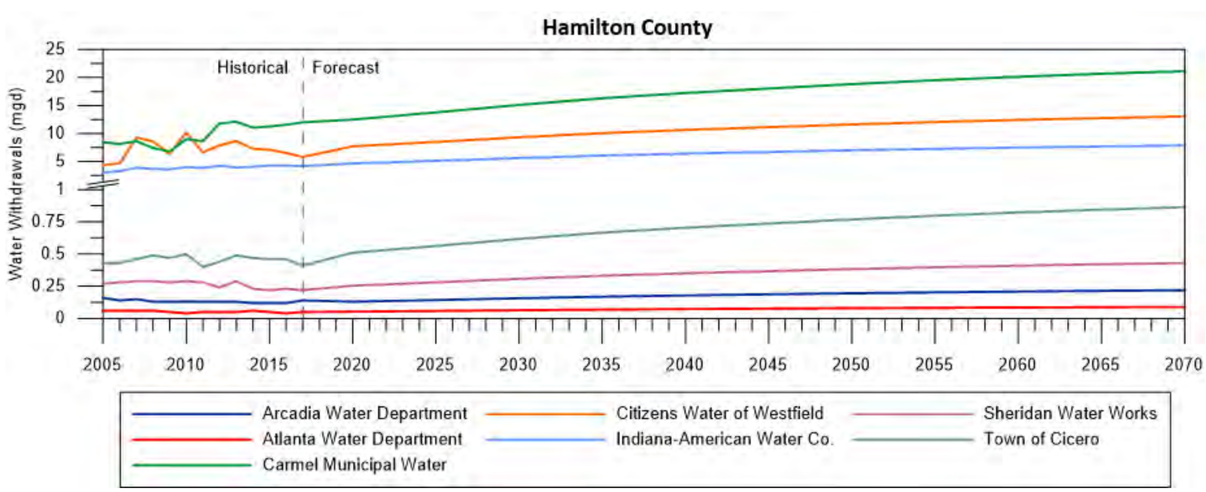

Figure D.2: Hamilton County public water supply utility historical and predicted withdrawals from 2005-2070 in MGD.

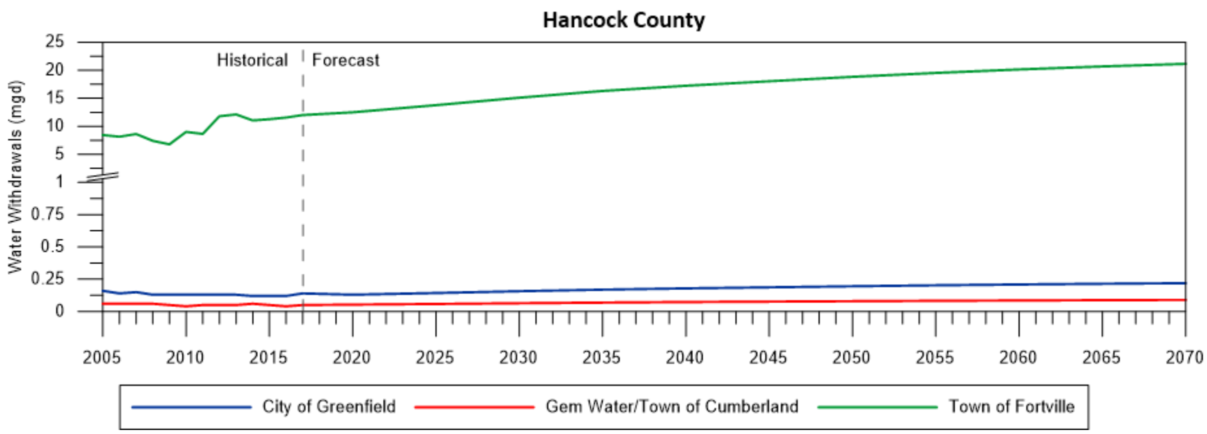

Figure D.3: Hancock County public water supply utility historical and predicted withdrawals from 2005-2070 in MGD.

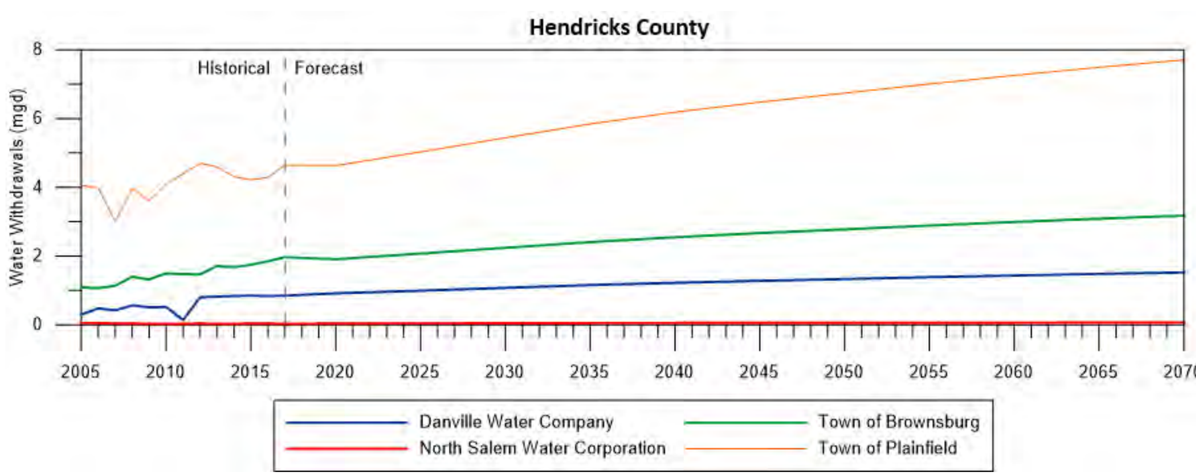

Figure D.4: Hendricks County public water supply utility historical and predicted withdrawals from 2005-2070 in MGD.

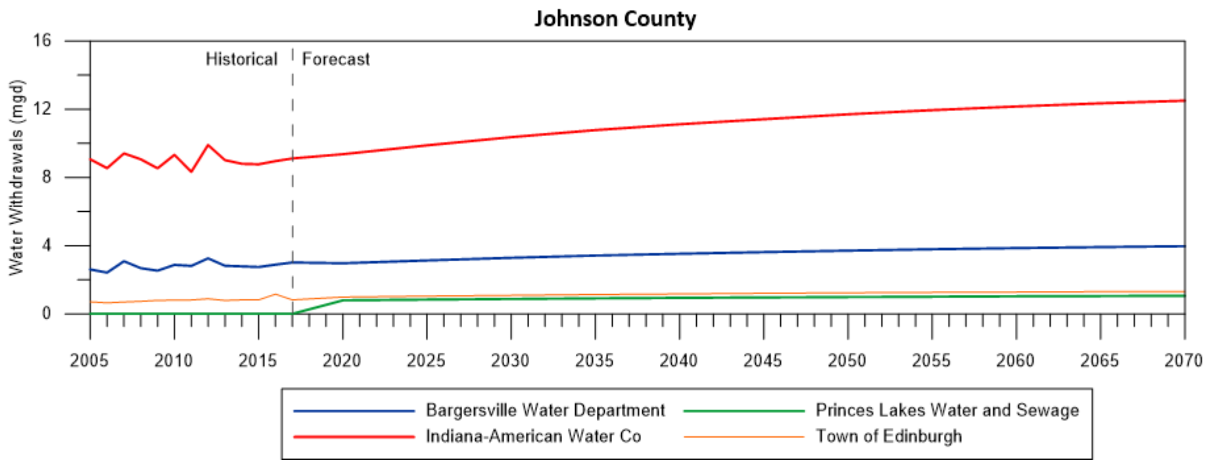

Figure D.5: Johnson County public water supply utility historical and predicted withdrawals from 2005-2070 in MGD.

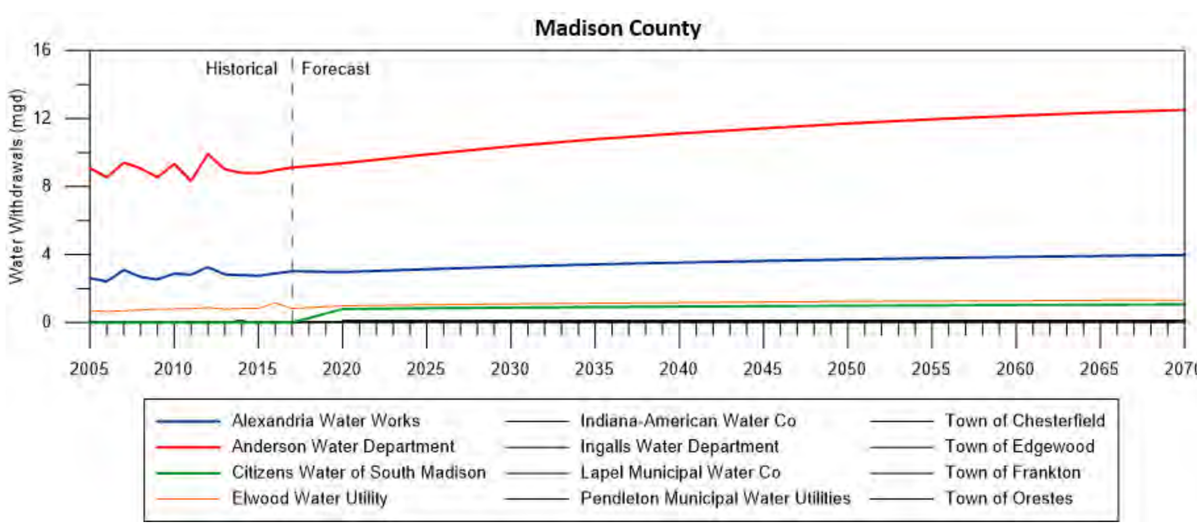

Figure D.6: Madison County public water supply utility historical and predicted withdrawals from 2005-2070 in MGD.

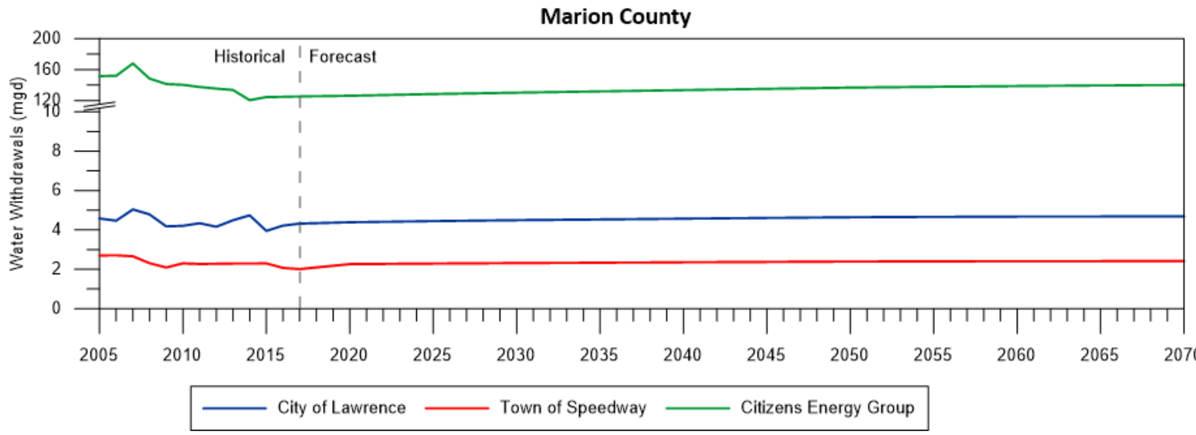

Figure D.7: Marion County public water supply utility historical and predicted withdrawals from 2005-2070 in MGD.

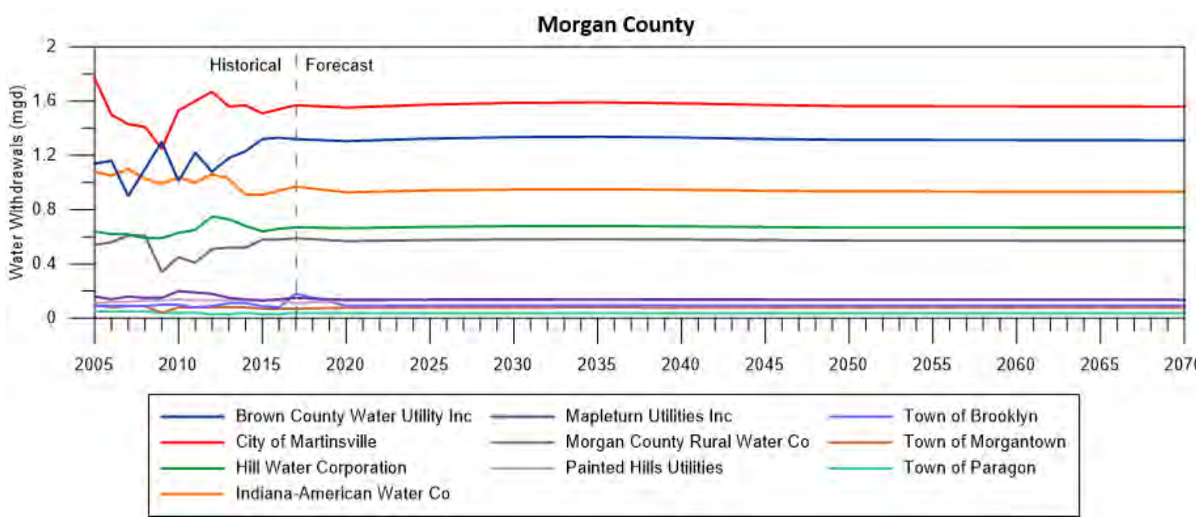

Figure D.8: Morgan County public water supply utility historical and predicted withdrawals from 2005-2070 in MGD.

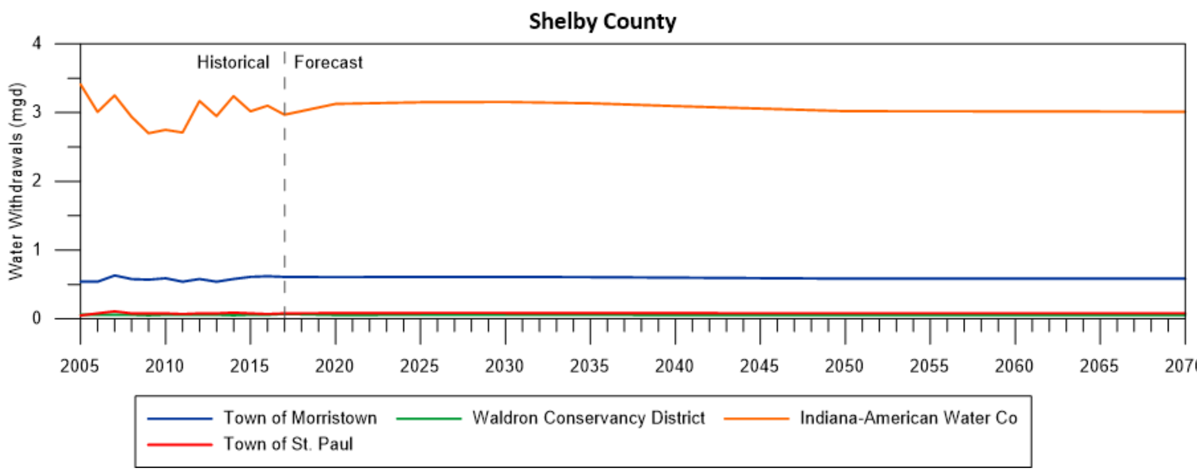

Figure D.9: Shelby County public water supply utility historical and predicted withdrawals from 2005-2070 in MGD.

E Seasonal Forecast Appendix

E.1 Monthly Percent of Annual Withdrawals by Utility

Table E.1: Monthly percent of annual water withdrawals for public water suppliers in the Central Indiana Region in MGD.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boone	Advance Water Works	0.088	0.095	0.091	0.087	0.098	0.093	0.079	0.073	0.069	0.069	0.077	0.080
	Jamestown Mun. Water Work	0.080	0.086	0.077	0.079	0.085	0.089	0.089	0.085	0.083	0.081	0.083	0.083
	Lebanon Utility Service	0.082	0.081	0.078	0.083	0.084	0.088	0.090	0.090	0.086	0.084	0.077	0.077
	Town of Thorntown	0.083	0.084	0.080	0.085	0.088	0.088	0.085	0.085	0.082	0.084	0.080	0.077
	Lost Run Farm Community	0.000	0.000	0.007	0.069	0.121	0.145	0.148	0.133	0.136	0.130	0.101	0.011
Hamilton	Arcadia Water Department	0.084	0.079	0.077	0.075	0.085	0.084	0.086	0.096	0.101	0.078	0.079	0.077
	Atlanta Water Department	0.091	0.091	0.085	0.078	0.085	0.084	0.085	0.084	0.081	0.075	0.079	0.081
	Carmel Municipal Water	0.050	0.044	0.048	0.060	0.084	0.125	0.135	0.132	0.129	0.076	0.060	0.058
	Citizens Water of Westfield	0.070	0.072	0.076	0.078	0.090	0.097	0.097	0.101	0.094	0.077	0.076	0.073
	Indiana-American Water Co	0.060	0.065	0.073	0.080	0.077	0.105	0.112	0.117	0.098	0.083	0.067	0.063
	Sheridan Water Works	0.086	0.083	0.080	0.078	0.084	0.081	0.087	0.088	0.087	0.085	0.082	0.078
	Town of Cicero Utilities	0.078	0.078	0.079	0.080	0.090	0.095	0.095	0.091	0.087	0.077	0.075	0.075
Hancock	City of Greenfield	0.088	0.077	0.078	0.077	0.080	0.085	0.087	0.088	0.084	0.081	0.083	0.093
	Gem Water/Town of Cumberland	0.073	0.071	0.073	0.081	0.074	0.081	0.083	0.093	0.098	0.099	0.094	0.080
	Town of Fortville	0.081	0.083	0.079	0.082	0.085	0.088	0.088	0.086	0.089	0.080	0.078	0.079
Hendricks	Danville Water Company	0.078	0.080	0.081	0.083	0.086	0.090	0.091	0.089	0.086	0.080	0.076	0.079
	North Salem Water Corporation	0.090	0.089	0.085	0.089	0.088	0.086	0.083	0.080	0.081	0.077	0.073	0.079
	Town of Brownsburg	0.068	0.074	0.072	0.080	0.090	0.096	0.094	0.096	0.093	0.083	0.075	0.077
	Town of Plainfield	0.073	0.069	0.071	0.076	0.085	0.098	0.103	0.107	0.096	0.079	0.071	0.072
Johnson	Bargersville Water Department	0.063	0.060	0.060	0.066	0.083	0.108	0.121	0.130	0.113	0.075	0.060	0.060
	Indiana-American Water Co Inc	0.077	0.076	0.075	0.079	0.086	0.095	0.099	0.099	0.092	0.079	0.072	0.072
	Princes Lakes Water and Sewage	0.080	0.077	0.077	0.077	0.083	0.097	0.093	0.091	0.085	0.082	0.081	0.077
	Town of Edinburgh	0.084	0.084	0.082	0.084	0.084	0.088	0.089	0.090	0.087	0.077	0.074	0.077

Table E.2: Monthly percent of annual water withdrawals for public water suppliers in the Central Indiana Region in MGD, Continued.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Madison	Alexandria Water Works	0.078	0.076	0.078	0.081	0.089	0.092	0.091	0.090	0.090	0.081	0.078	0.077
	Anderson Water Department	0.083	0.086	0.083	0.081	0.082	0.084	0.084	0.086	0.085	0.083	0.083	0.081
	Citizens Water of South Madison	0.079	0.087	0.084	0.080	0.075	0.087	0.091	0.087	0.083	0.087	0.080	0.082
	Elwood Water Utility	0.083	0.085	0.085	0.085	0.084	0.088	0.084	0.088	0.088	0.080	0.074	0.075
	Indiana-American Water Co Inc	0.085	0.083	0.078	0.081	0.087	0.091	0.087	0.088	0.084	0.079	0.079	0.078
	Ingalls Water Department	0.082	0.084	0.081	0.082	0.081	0.086	0.086	0.085	0.085	0.084	0.083	0.081
	Lapel Municipal Water Company	0.084	0.086	0.081	0.081	0.078	0.086	0.087	0.087	0.088	0.073	0.091	0.076
	Pendleton Municipal Water	0.076	0.075	0.072	0.080	0.096	0.095	0.094	0.095	0.089	0.074	0.075	0.078
	Town of Chesterfield	0.081	0.084	0.086	0.085	0.087	0.086	0.085	0.083	0.082	0.087	0.078	0.076
	Town of Edgewood	0.080	0.081	0.079	0.090	0.091	0.088	0.087	0.085	0.082	0.081	0.079	0.079
	Town of Frankton	0.087	0.086	0.078	0.075	0.090	0.087	0.084	0.083	0.084	0.081	0.081	0.084
	Town of Orestes	0.078	0.078	0.072	0.077	0.076	0.077	0.079	0.112	0.110	0.089	0.081	0.070
Marion	City of Lawrence Utilities	0.080	0.079	0.074	0.080	0.087	0.091	0.091	0.093	0.090	0.081	0.076	0.077
	Town of Speedway	0.077	0.078	0.086	0.083	0.097	0.085	0.095	0.092	0.085	0.077	0.071	0.072
	Citizens Energy Group	0.061	0.064	0.064	0.065	0.077	0.105	0.124	0.129	0.118	0.084	0.059	0.052

Table E.3: Monthly percent of annual water withdrawals for public water suppliers in the Central Indiana Region in MGD, Continued.

County	System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Morgan	Brown County Water Utility Inc	0.078	0.085	0.087	0.083	0.084	0.083	0.084	0.083	0.082	0.084	0.082	0.085
	City of Martinsville	0.086	0.088	0.085	0.082	0.086	0.085	0.087	0.088	0.085	0.078	0.076	0.073
	Hill Water Corporation	0.079	0.078	0.076	0.076	0.083	0.094	0.093	0.095	0.089	0.085	0.078	0.075
	Indiana-American Water Co Inc	0.080	0.080	0.077	0.079	0.087	0.091	0.091	0.096	0.090	0.079	0.074	0.076
	Mapleturn Utilities Inc	0.075	0.073	0.073	0.080	0.089	0.095	0.097	0.104	0.089	0.076	0.074	0.074
	Morgan County Rural Water Co	0.087	0.087	0.084	0.086	0.085	0.087	0.089	0.084	0.077	0.074	0.077	0.082
	Painted Hills Utilities	0.080	0.081	0.081	0.080	0.087	0.091	0.092	0.091	0.084	0.078	0.078	0.078
	Town of Brooklyn	0.073	0.076	0.075	0.079	0.087	0.092	0.092	0.105	0.091	0.076	0.076	0.077
	Town of Morgantown	0.081	0.084	0.078	0.080	0.079	0.089	0.089	0.082	0.084	0.083	0.085	0.086
	Town of Paragon	0.098	0.093	0.082	0.079	0.083	0.085	0.081	0.085	0.081	0.074	0.077	0.084
Shelby	Indiana-American Water Co	0.079	0.078	0.078	0.081	0.085	0.089	0.088	0.092	0.088	0.084	0.080	0.079
	Town of Morristown	0.083	0.084	0.084	0.080	0.082	0.087	0.079	0.083	0.082	0.087	0.086	0.082
	Town of St. Paul	0.087	0.089	0.081	0.080	0.081	0.090	0.088	0.091	0.083	0.080	0.079	0.070
	Waldron Conservancy District	0.080	0.078	0.077	0.080	0.088	0.084	0.088	0.091	0.087	0.082	0.083	0.081

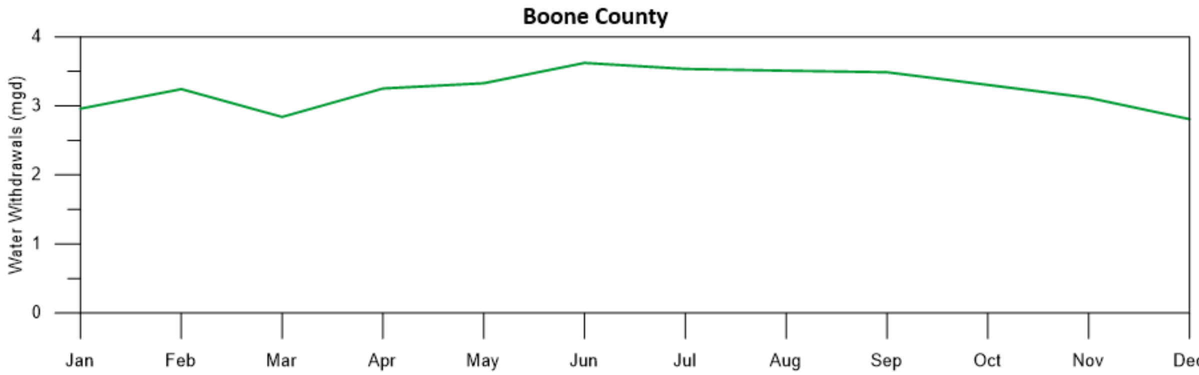

Figure E.1: Seasonal public water supply withdrawals in Boone County for the year 2070 in MGD.

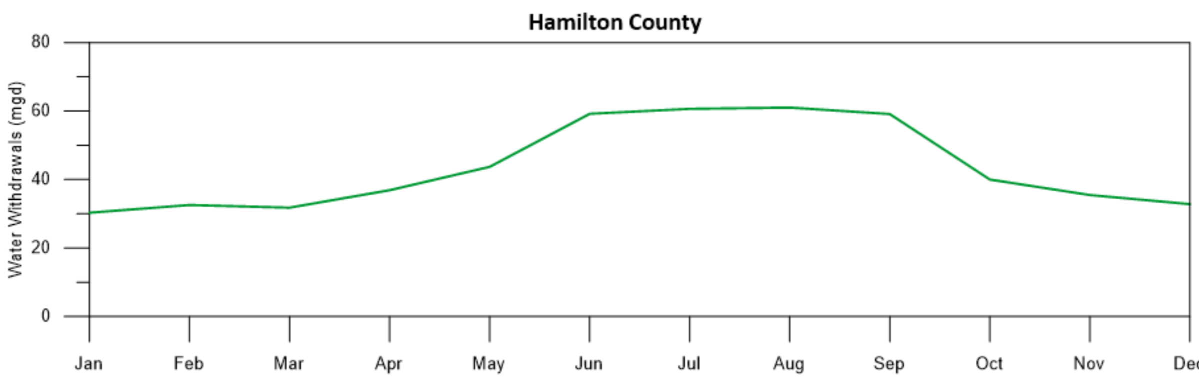

Figure E.2: Seasonal public water supply withdrawals in Hamilton County for the year 2070 in MGD.

E.2 2070 Seasonal Demand by County

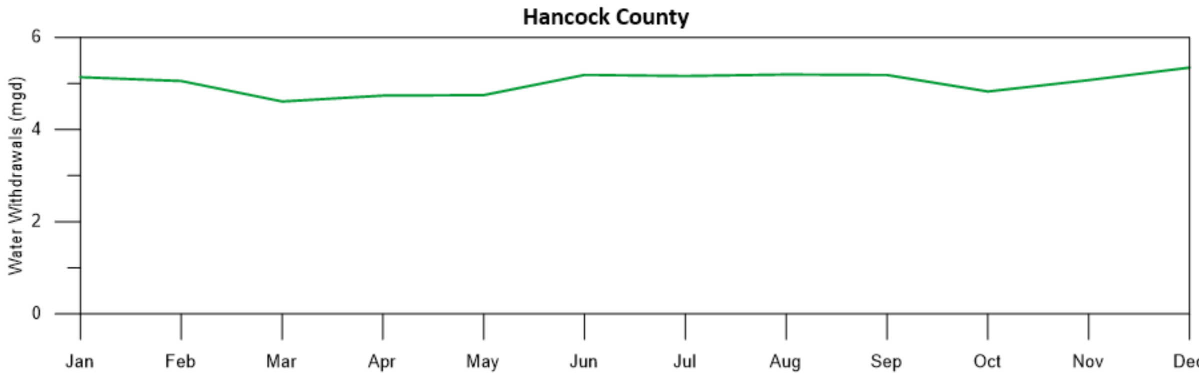

Figure E.3: Seasonal public water supply withdrawals in Hancock County for the year 2070 in MGD.

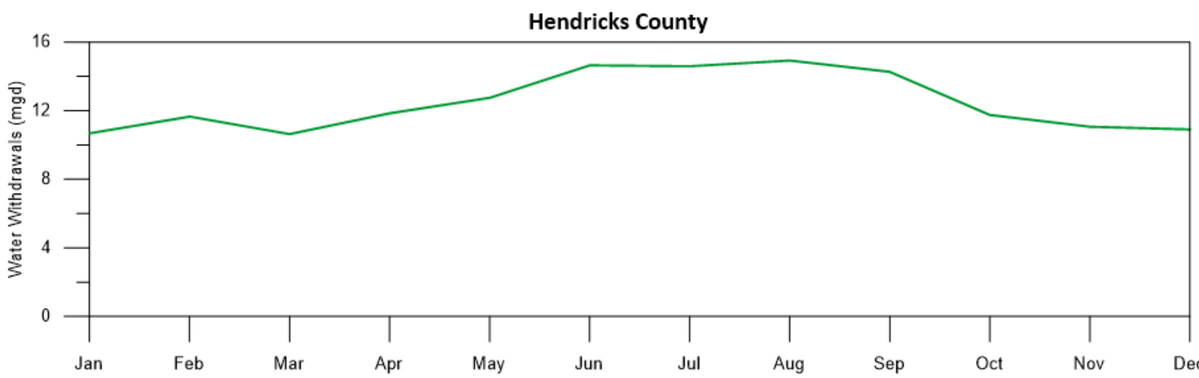

Figure E.4: Seasonal public water supply withdrawals in Hendricks County for the year 2070 in MGD.

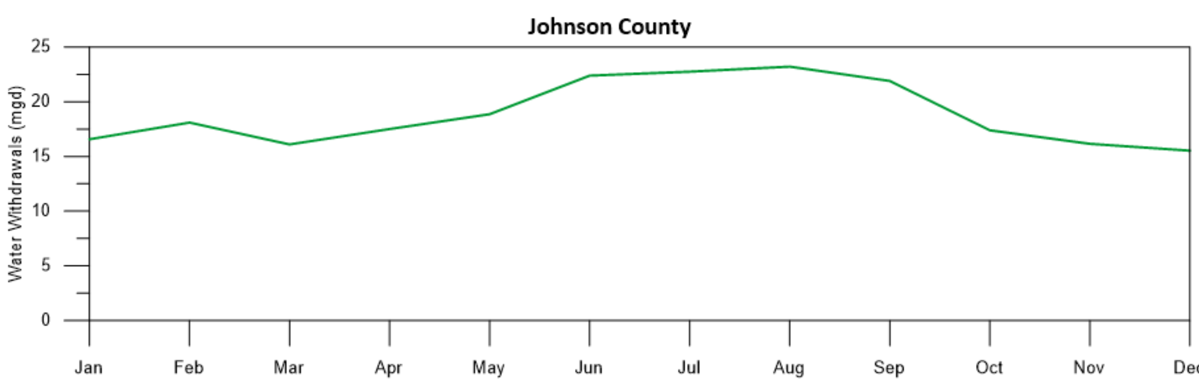

Figure E.5: Seasonal public water supply withdrawals in Johnson County for the year 2070 in MGD.

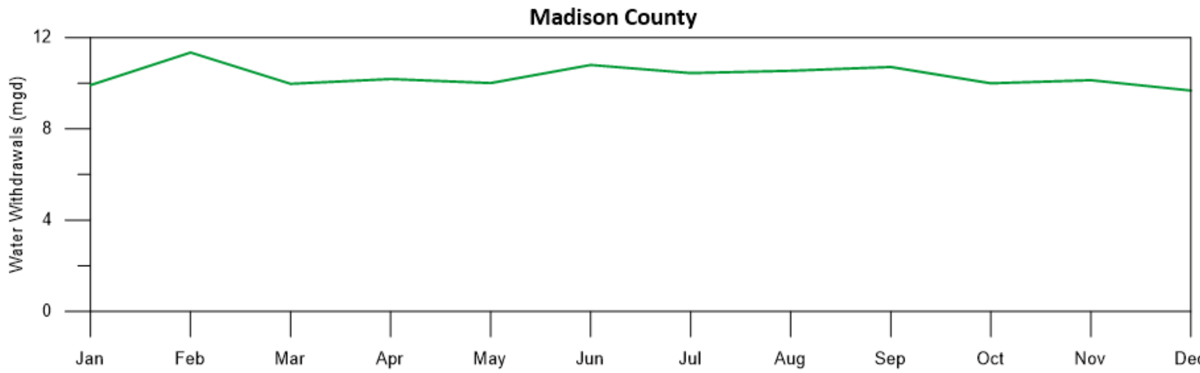

Figure E.6: Seasonal public water supply withdrawals in Madison County for the year 2070 in MGD.

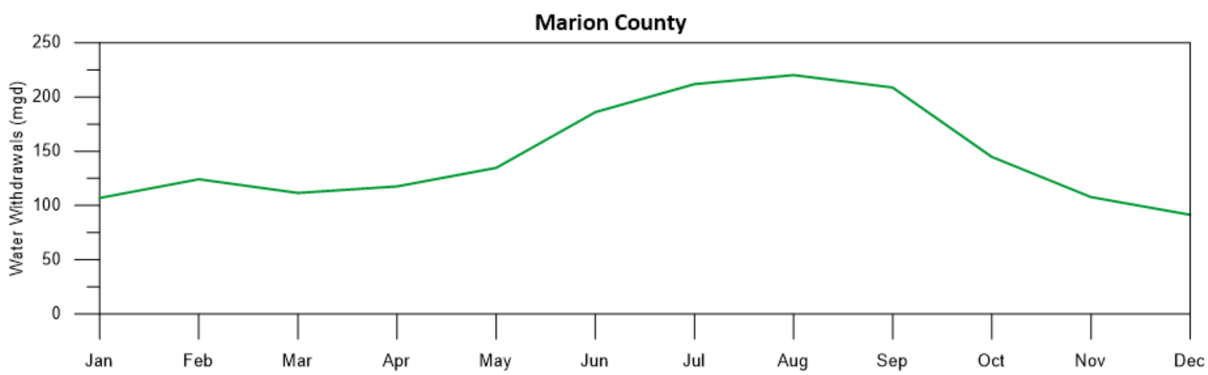

Figure E.7: Seasonal public water supply withdrawals in Marion County for the year 2070 in MGD.

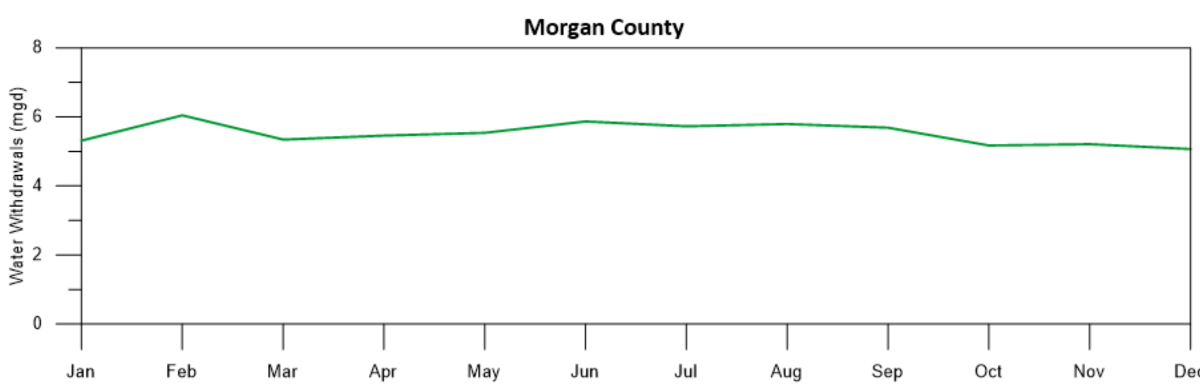

Figure E.8: Seasonal public water supply withdrawals in Morgan County for the year 2070 in MGD.

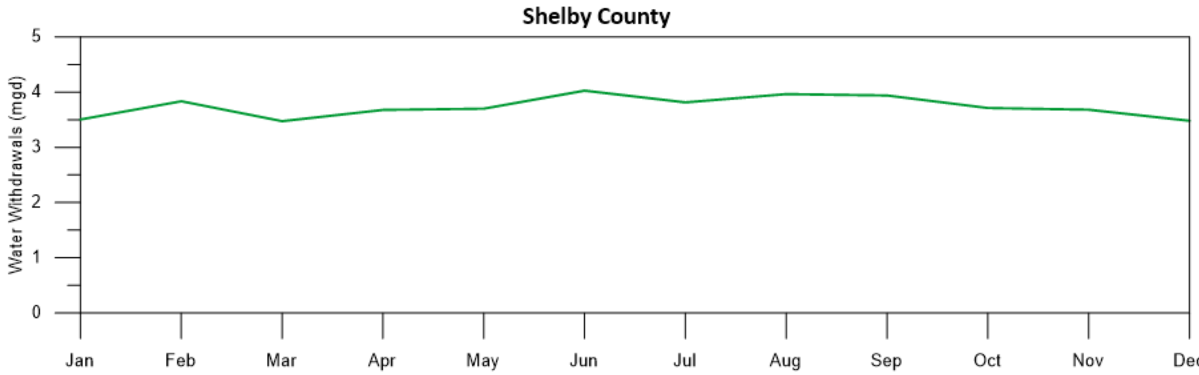

Figure E.9: Seasonal public water supply withdrawals in Shelby County for the year 2070 in MGD.

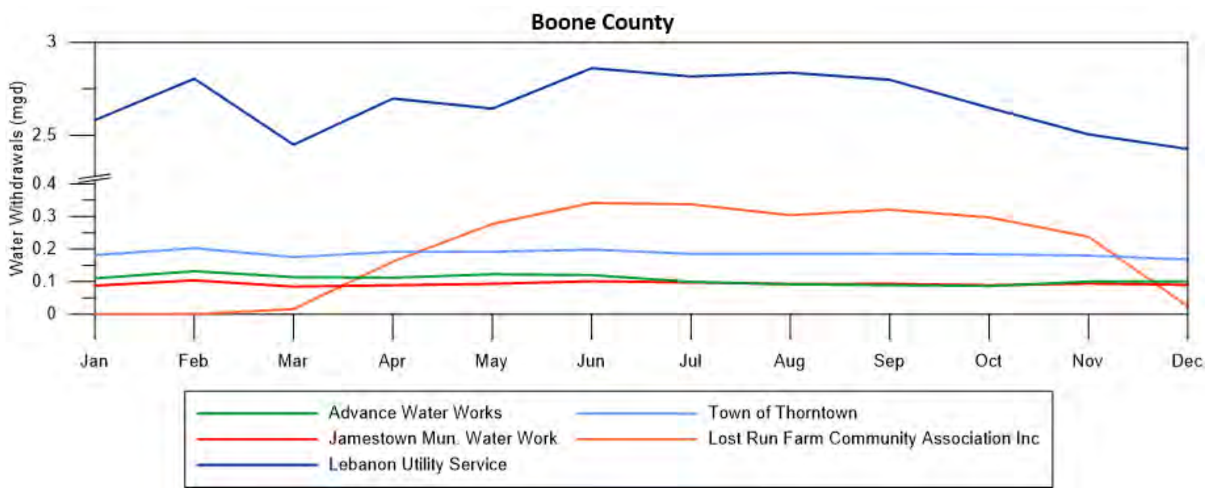

Figure E.10: Seasonal public water supply withdrawals in Boone County for the year 2070 in MGD.

E.3 2070 Seasonal Demand for Public Water Supply Utilities by County

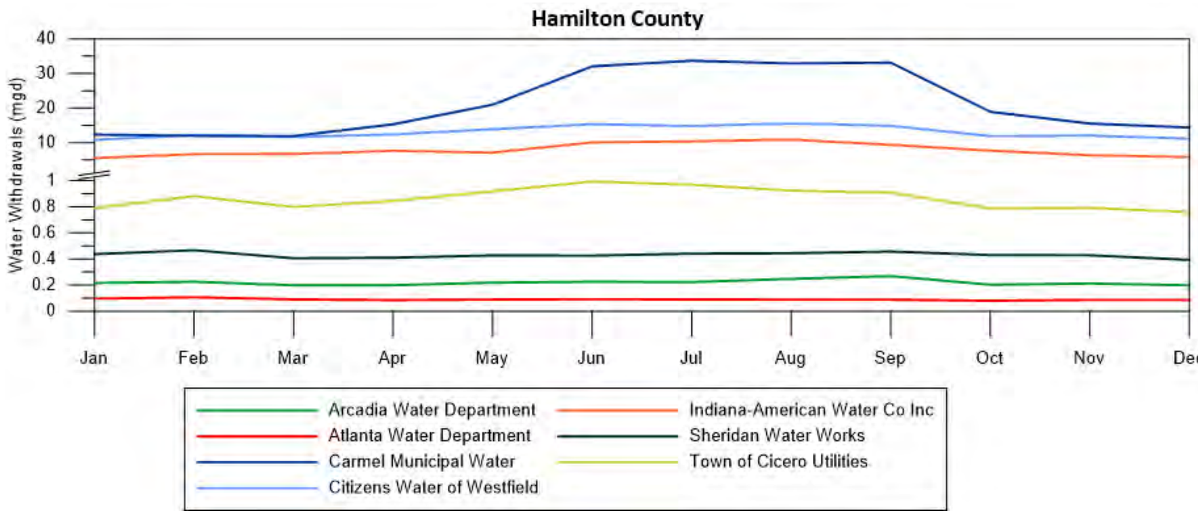

Figure E.11: Seasonal public water supply withdrawals in Hamilton County for the year 2070 in MGD.

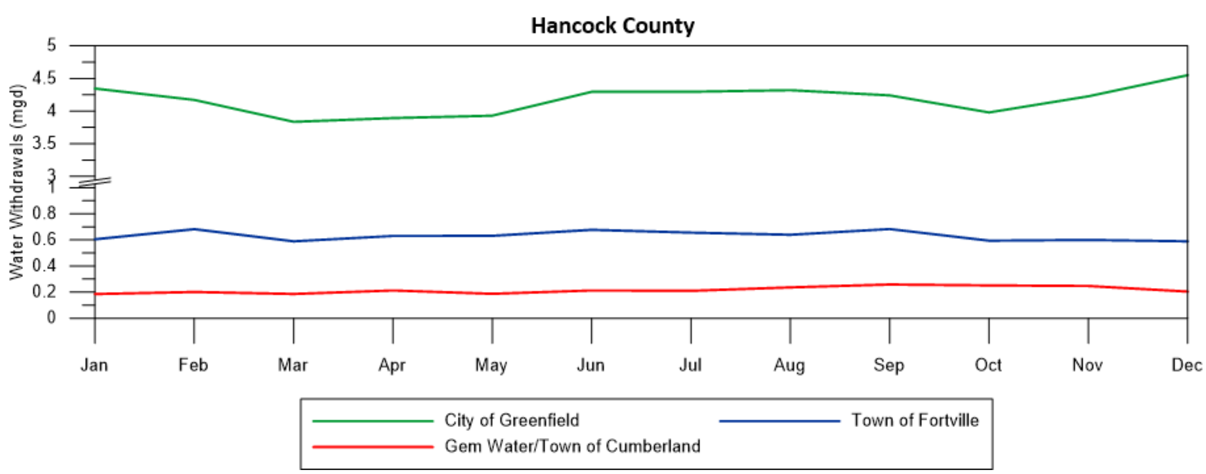

Figure E.12: Seasonal public water supply withdrawals in Hancock County for the year 2070 in MGD.

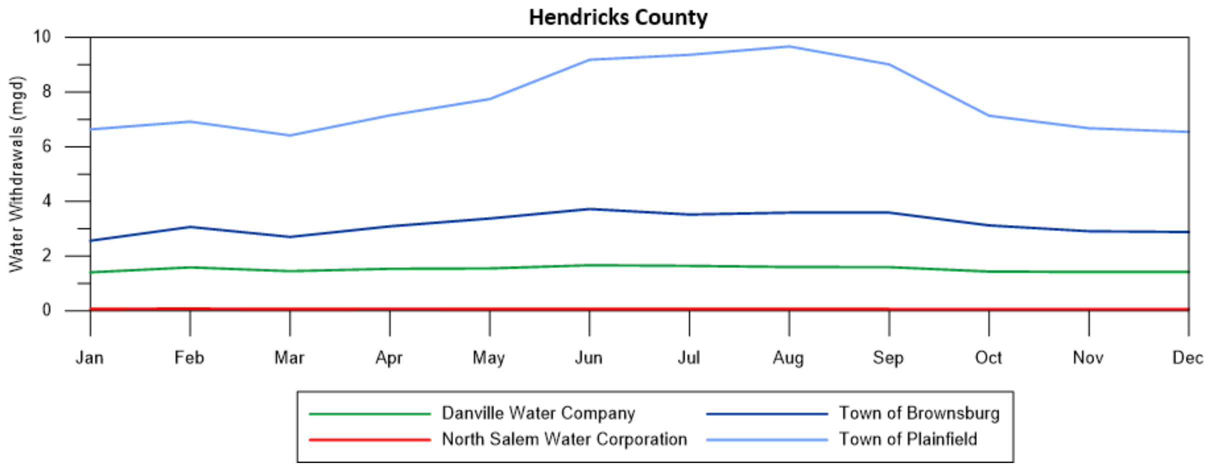

Figure E.13: Seasonal public water supply withdrawals in Hendricks County for the year 2070 in MGD.

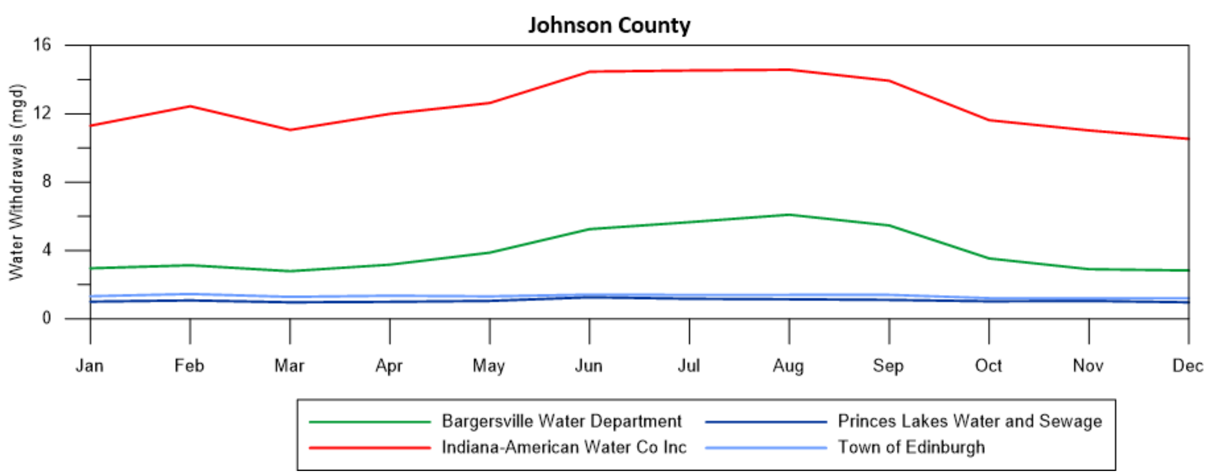

Figure E.14: Seasonal public water supply withdrawals in Johnson County for the year 2070 in MGD.

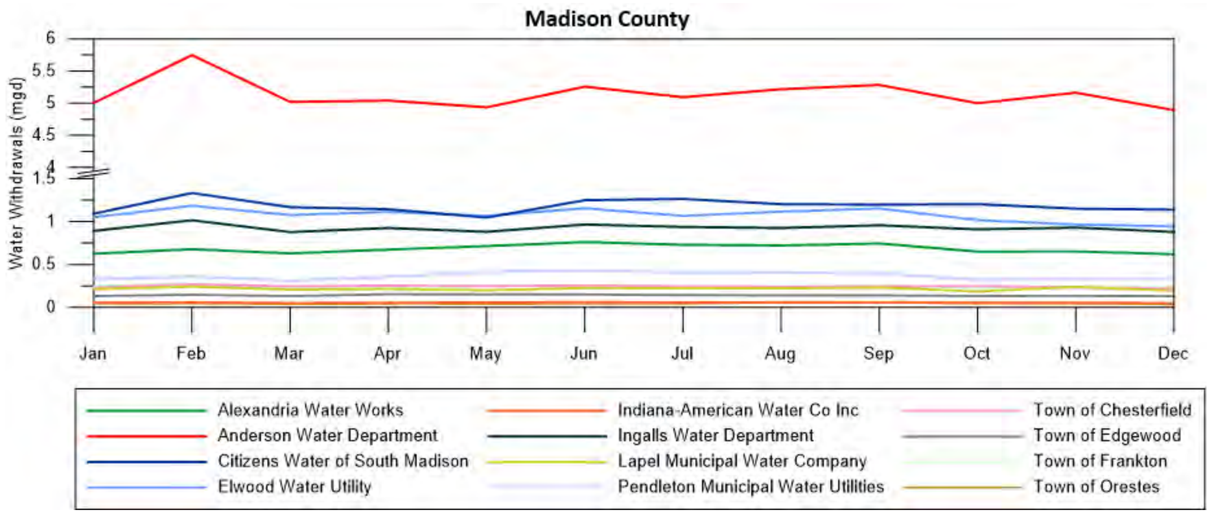

Figure E.15: Seasonal public water supply withdrawals in Madison County for the year 2070 in MGD.

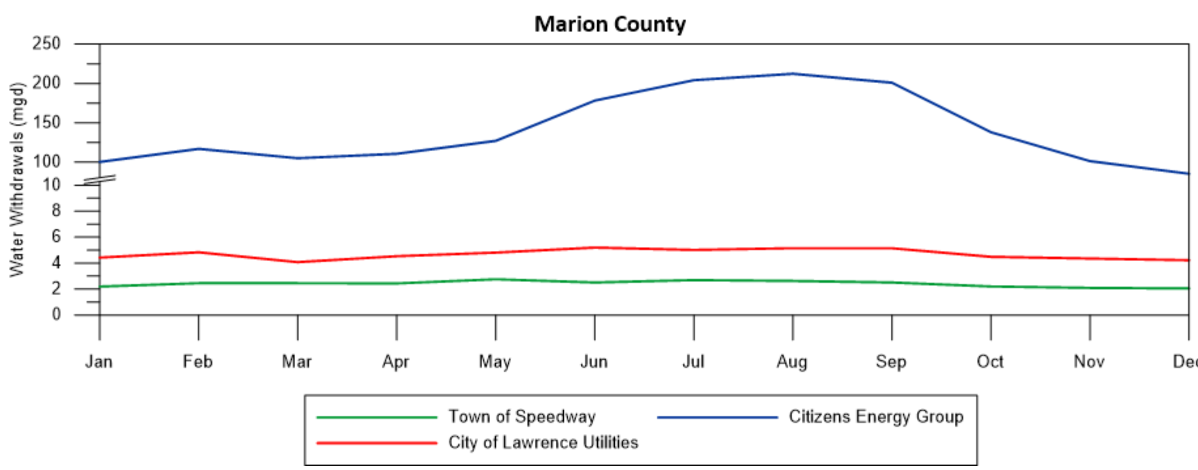

Figure E.16: Seasonal public water supply withdrawals in Marion County for the year 2070 in MGD.

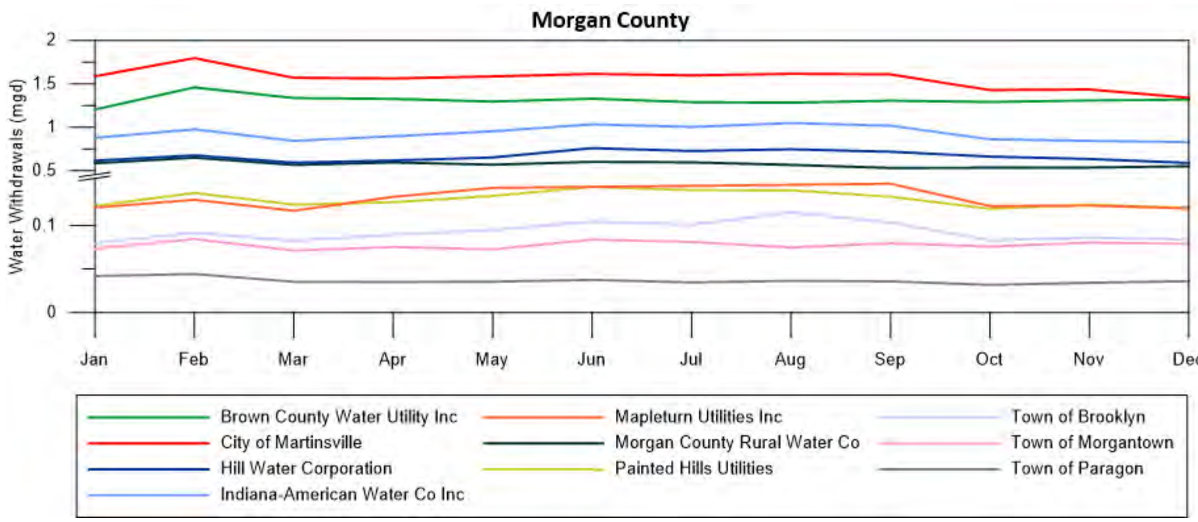

Figure E.17: Seasonal public water supply withdrawals in Morgan County for the year 2070 in MGD.

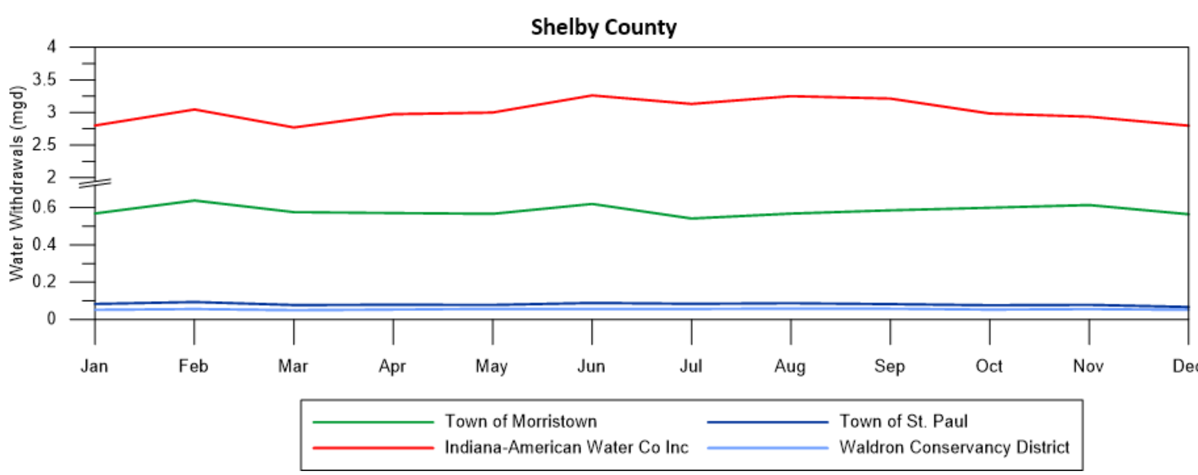

Figure E.18: Seasonal public water supply withdrawals in Shelby County for the year 2070 in MGD.

F Climate Scenarios Appendix

F.1 Warm / Wet Climate Scenario Results for 2035

Table F.1: Monthly water withdrawals forecasted in the 2035 Warm / Wet Climate Scenario for public water suppliers in the Central Indiana Region in MGD.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boone	Advance Water Works	0.096	0.115	0.100	0.098	0.107	0.105	0.087	0.080	0.078	0.076	0.088	0.088
	Jamestown Mun. Water Work	0.077	0.091	0.074	0.078	0.082	0.088	0.085	0.081	0.082	0.078	0.082	0.079
	Lebanon Utility Service	2.256	2.451	2.141	2.358	2.311	2.501	2.462	2.479	2.446	2.315	2.190	2.121
	Town of Thorntown	0.159	0.177	0.153	0.168	0.167	0.174	0.162	0.162	0.162	0.161	0.158	0.146
	Lost Run Farm Community	0.000	0.000	0.014	0.142	0.242	0.299	0.295	0.266	0.281	0.260	0.208	0.021
Hamilton	Arcadia Water Department	0.170	0.177	0.156	0.157	0.172	0.177	0.175	0.195	0.212	0.159	0.167	0.156
	Atlanta Water Department	0.075	0.084	0.071	0.067	0.070	0.072	0.071	0.070	0.069	0.062	0.068	0.067
	Carmel Municipal Water	9.705	9.440	9.377	12.045	16.492	25.221	26.492	25.872	26.067	14.877	12.205	11.315
	Citizens Water of Westfield	8.513	9.593	9.148	9.743	10.943	12.061	11.672	12.237	11.702	9.367	9.482	8.773
	Indiana-American Water Co	4.395	5.256	5.307	6.025	5.627	7.925	8.177	8.550	7.386	6.051	5.017	4.590
	Sheridan Water Works	0.344	0.367	0.319	0.322	0.336	0.335	0.347	0.349	0.360	0.338	0.337	0.309
	Town of Cicero Utilities	0.621	0.693	0.628	0.664	0.722	0.781	0.762	0.727	0.715	0.619	0.622	0.597
Hancock	City of Greenfield	3.502	3.362	3.091	3.137	3.167	3.462	3.463	3.482	3.418	3.207	3.406	3.667
	Gem Water/Town of Cumberland	0.149	0.162	0.150	0.171	0.151	0.171	0.169	0.190	0.208	0.203	0.199	0.165
	Town of Fortville	0.487	0.550	0.475	0.508	0.509	0.546	0.529	0.515	0.551	0.479	0.484	0.475
Hendricks	Danville Water Company	1.076	1.216	1.108	1.176	1.188	1.276	1.258	1.227	1.223	1.098	1.086	1.089
	North Salem Water Corporation	0.054	0.060	0.051	0.056	0.053	0.054	0.050	0.048	0.051	0.046	0.046	0.048
	Town of Brownsburg	1.961	2.349	2.069	2.365	2.586	2.850	2.694	2.749	2.750	2.392	2.226	2.207
	Town of Plainfield	5.084	5.300	4.913	5.474	5.934	7.032	7.171	7.406	6.903	5.465	5.114	5.012
Johnson	Bargersville Water Department	2.570	2.723	2.424	2.759	3.370	4.565	4.922	5.305	4.753	3.073	2.525	2.463
	Indiana-American Water Co Inc	9.837	10.828	9.628	10.444	10.996	12.597	12.655	12.694	12.134	10.123	9.597	9.171
	Princes Lakes Water and Sewage	0.870	0.934	0.840	0.863	0.905	1.093	1.018	0.989	0.959	0.892	0.908	0.839
	Town of Edinburgh	1.146	1.265	1.116	1.175	1.143	1.232	1.208	1.221	1.216	1.049	1.036	1.049

Table F.2: Monthly water withdrawals forecasted in the 2035 Warm / Wet Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Madison	Alexandria Water Works	0.658	0.712	0.661	0.708	0.751	0.800	0.767	0.759	0.783	0.683	0.685	0.651
	Anderson Water Department	5.259	6.040	5.275	5.297	5.187	5.524	5.353	5.483	5.553	5.254	5.426	5.141
	Citizens Water of South Madison	1.148	1.401	1.228	1.202	1.100	1.313	1.329	1.264	1.259	1.265	1.209	1.197
	Elwood Water Utility	1.104	1.245	1.131	1.169	1.122	1.214	1.121	1.173	1.212	1.069	1.014	0.994
	Indiana-American Water Co Inc	0.057	0.062	0.053	0.056	0.059	0.064	0.059	0.060	0.059	0.054	0.056	0.053
	Ingalls Water Department	0.937	1.067	0.922	0.973	0.926	1.015	0.985	0.972	1.006	0.955	0.977	0.924
	Lapel Municipal Water Company	0.225	0.253	0.217	0.224	0.209	0.238	0.232	0.233	0.243	0.194	0.251	0.204
	Pendleton Municipal Water	0.347	0.376	0.327	0.374	0.436	0.446	0.428	0.428	0.417	0.336	0.351	0.352
	Town of Chesterfield	0.246	0.281	0.259	0.267	0.262	0.267	0.258	0.252	0.256	0.263	0.242	0.231
	Town of Edgewood	0.138	0.155	0.137	0.161	0.157	0.158	0.150	0.147	0.146	0.139	0.141	0.136
	Town of Frankton	0.259	0.283	0.230	0.230	0.268	0.267	0.249	0.245	0.258	0.240	0.248	0.248
	Town of Orestes	0.045	0.050	0.042	0.046	0.044	0.046	0.046	0.064	0.066	0.051	0.049	0.040
Marion	City of Lawrence Utilities	4.314	4.712	3.972	4.419	4.689	5.066	4.889	5.021	5.015	4.373	4.245	4.118
	Town of Speedway	2.137	2.392	2.391	2.374	2.688	2.444	2.625	2.561	2.445	2.147	2.038	1.996
	Citizens Energy Group	96.22	112.15	100.77	106.16	121.96	171.10	195.89	203.76	192.88	132.44	97.19	81.78

Table F.3: Monthly water withdrawals forecasted in the 2035 Warm / Wet Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Morgan	Brown County Water Utility Inc	1.233	1.492	1.367	1.357	1.326	1.360	1.319	1.312	1.337	1.321	1.339	1.348
	City of Martinsville	1.623	1.837	1.606	1.597	1.622	1.650	1.634	1.652	1.646	1.461	1.468	1.371
	Hill Water Corporation	0.630	0.693	0.607	0.632	0.668	0.778	0.744	0.764	0.735	0.679	0.650	0.604
	Indiana-American Water Co Inc	0.899	0.999	0.863	0.918	0.976	1.058	1.027	1.073	1.042	0.882	0.864	0.848
	Mapleturn Utilities Inc	0.123	0.133	0.120	0.136	0.147	0.162	0.160	0.172	0.151	0.125	0.126	0.122
	Morgan County Rural Water Co	0.600	0.665	0.581	0.610	0.583	0.616	0.611	0.581	0.545	0.508	0.550	0.565
	Painted Hills Utilities	0.126	0.141	0.127	0.130	0.137	0.148	0.144	0.144	0.136	0.122	0.127	0.123
	Town of Brooklyn	0.082	0.094	0.084	0.092	0.097	0.107	0.103	0.118	0.106	0.085	0.088	0.086
	Town of Morgantown	0.075	0.086	0.073	0.077	0.074	0.086	0.083	0.077	0.081	0.078	0.082	0.081
	Town of Paragon	0.043	0.045	0.036	0.036	0.036	0.038	0.035	0.037	0.037	0.033	0.035	0.037
Shelby	Indiana-American Water Co	2.921	3.178	2.890	3.102	3.128	3.402	3.266	3.391	3.352	3.113	3.062	2.918
	Town of Morristown	0.593	0.666	0.601	0.596	0.591	0.647	0.565	0.593	0.611	0.625	0.640	0.589
	Town of St. Paul	0.087	0.097	0.080	0.082	0.081	0.092	0.087	0.090	0.086	0.079	0.081	0.070
	Waldron Conservancy District	0.053	0.058	0.052	0.055	0.059	0.058	0.058	0.061	0.060	0.055	0.057	0.054

F.2 Warm / Wet Climate Scenario Results for 2070

Table F.4: Monthly water withdrawals forecasted in the 2070 Warm / Wet Climate Scenario for public water suppliers in the Central Indiana Region in MGD.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boone	Advance Water Works	0.112	0.134	0.116	0.114	0.125	0.122	0.101	0.093	0.091	0.088	0.102	0.102
	Jamestown Mun. Water Work	0.089	0.106	0.086	0.090	0.095	0.103	0.099	0.094	0.095	0.090	0.096	0.092
	Lebanon Utility Service	2.623	2.850	2.489	2.742	2.686	2.907	2.862	2.883	2.844	2.691	2.546	2.466
	Town of Thorntown	0.184	0.206	0.178	0.195	0.195	0.202	0.188	0.188	0.189	0.187	0.183	0.170
	Lost Run Farm Community	0.000	0.000	0.016	0.165	0.282	0.347	0.343	0.309	0.326	0.302	0.242	0.025
Hamilton	Arcadia Water Department	0.224	0.234	0.206	0.207	0.227	0.234	0.231	0.257	0.279	0.210	0.220	0.206
	Atlanta Water Department	0.100	0.110	0.093	0.088	0.093	0.095	0.094	0.092	0.092	0.082	0.090	0.089
	Carmel Municipal Water	12.814	12.464	12.381	15.904	21.776	33.301	34.978	34.160	34.417	19.643	16.115	14.940
	Citizens Water of Westfield	11.239	12.666	12.079	12.865	14.448	15.925	15.411	16.157	15.450	12.368	12.520	11.584
	Indiana-American Water Co	5.802	6.939	7.007	7.955	7.430	10.463	10.797	11.289	9.752	7.989	6.624	6.060
	Sheridan Water Works	0.454	0.485	0.421	0.426	0.444	0.442	0.458	0.461	0.475	0.447	0.445	0.408
	Town of Cicero Utilities	0.820	0.915	0.829	0.877	0.954	1.032	1.006	0.959	0.944	0.817	0.822	0.789
Hancock	City of Greenfield	4.370	4.195	3.857	3.915	3.952	4.320	4.321	4.345	4.265	4.002	4.251	4.576
	Gem Water/Town of Cumberland	0.186	0.202	0.187	0.214	0.188	0.214	0.211	0.238	0.260	0.253	0.249	0.206
	Town of Fortville	0.608	0.686	0.592	0.634	0.635	0.681	0.660	0.643	0.687	0.598	0.603	0.592
Hendricks	Danville Water Company	1.430	1.617	1.472	1.563	1.579	1.696	1.672	1.631	1.626	1.459	1.444	1.447
	North Salem Water Corporation	0.072	0.079	0.068	0.074	0.071	0.071	0.067	0.064	0.067	0.062	0.061	0.064
	Town of Brownsburg	2.607	3.122	2.750	3.144	3.438	3.788	3.581	3.654	3.655	3.179	2.959	2.933
	Town of Plainfield	6.757	7.044	6.531	7.277	7.888	9.348	9.532	9.844	9.175	7.264	6.798	6.661
Johnson	Bargersville Water Department	3.009	3.189	2.838	3.231	3.945	5.345	5.762	6.212	5.565	3.598	2.957	2.883
	Indiana-American Water Co Inc	11.517	12.678	11.273	12.227	12.875	14.748	14.817	14.862	14.207	11.852	11.236	10.737
	Princes Lakes Water and Sewage	1.018	1.093	0.983	1.011	1.060	1.280	1.192	1.158	1.123	1.045	1.063	0.982
	Town of Edinburgh	1.342	1.481	1.307	1.376	1.339	1.443	1.414	1.429	1.424	1.228	1.213	1.229

Table F.5: Monthly water withdrawals forecasted in the 2070 Warm / Wet Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Madison	Alexandria Water Works	0.628	0.680	0.631	0.676	0.716	0.763	0.732	0.724	0.747	0.652	0.654	0.621
	Anderson Water Department	5.019	5.764	5.034	5.055	4.949	5.272	5.108	5.232	5.299	5.014	5.178	4.906
	Citizens Water of South Madison	1.096	1.337	1.171	1.147	1.049	1.253	1.268	1.207	1.201	1.207	1.154	1.142
	Elwood Water Utility	1.053	1.188	1.080	1.116	1.070	1.158	1.070	1.119	1.156	1.020	0.968	0.948
	Indiana-American Water Co Inc	0.055	0.059	0.050	0.054	0.056	0.061	0.057	0.057	0.056	0.051	0.053	0.050
	Ingalls Water Department	0.894	1.018	0.880	0.928	0.883	0.968	0.940	0.928	0.960	0.912	0.932	0.882
	Lapel Municipal Water Company	0.215	0.242	0.207	0.214	0.200	0.227	0.222	0.222	0.232	0.185	0.240	0.195
	Pendleton Municipal Water	0.331	0.359	0.312	0.357	0.416	0.426	0.408	0.409	0.398	0.321	0.335	0.336
	Town of Chesterfield	0.235	0.268	0.247	0.254	0.250	0.255	0.246	0.240	0.244	0.251	0.231	0.220
	Town of Edgewood	0.132	0.147	0.131	0.154	0.150	0.150	0.144	0.140	0.140	0.133	0.135	0.130
	Town of Frankton	0.247	0.270	0.220	0.219	0.255	0.255	0.237	0.234	0.247	0.229	0.237	0.237
	Town of Orestes	0.043	0.047	0.040	0.044	0.042	0.044	0.044	0.061	0.063	0.049	0.046	0.038
Marion	City of Lawrence Utilities	4.491	4.905	4.135	4.601	4.882	5.274	5.090	5.227	5.221	4.553	4.420	4.288
	Town of Speedway	2.225	2.491	2.489	2.472	2.799	2.545	2.733	2.666	2.546	2.235	2.122	2.078
	Citizens Energy Group	104.152	121.399	109.074	114.914	132.015	185.204	212.043	220.561	208.783	143.364	105.204	88.522

Table F.6: Monthly water withdrawals forecasted in the 2070 Warm / Wet Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Morgan	Brown County Water Utility Inc	1.212	1.467	1.344	1.334	1.303	1.336	1.296	1.290	1.314	1.299	1.316	1.325
	City of Martinsville	1.595	1.806	1.578	1.570	1.594	1.622	1.607	1.624	1.617	1.436	1.443	1.347
	Hill Water Corporation	0.620	0.681	0.597	0.621	0.657	0.765	0.731	0.751	0.723	0.667	0.639	0.594
	Indiana-American Water Co Inc	0.883	0.982	0.849	0.903	0.959	1.040	1.009	1.055	1.024	0.867	0.849	0.833
	Mapleturn Utilities Inc	0.121	0.130	0.118	0.134	0.144	0.159	0.158	0.169	0.149	0.123	0.124	0.120
	Morgan County Rural Water Co	0.590	0.654	0.571	0.599	0.573	0.606	0.601	0.571	0.535	0.499	0.541	0.555
	Painted Hills Utilities	0.124	0.138	0.125	0.128	0.135	0.145	0.142	0.141	0.134	0.120	0.125	0.121
	Town of Brooklyn	0.080	0.092	0.083	0.090	0.095	0.105	0.102	0.116	0.104	0.084	0.087	0.084
	Town of Morgantown	0.074	0.085	0.072	0.076	0.073	0.084	0.082	0.075	0.080	0.076	0.081	0.080
	Town of Paragon	0.042	0.045	0.036	0.035	0.036	0.038	0.035	0.037	0.036	0.032	0.034	0.036
Shelby	Indiana-American Water Co	2.812	3.059	2.782	2.986	3.012	3.276	3.145	3.264	3.227	2.997	2.948	2.809
	Town of Morristown	0.571	0.641	0.578	0.573	0.569	0.622	0.544	0.570	0.588	0.602	0.616	0.567
	Town of St. Paul	0.083	0.094	0.077	0.079	0.078	0.088	0.084	0.087	0.082	0.076	0.078	0.067
	Waldron Conservancy District	0.051	0.056	0.050	0.053	0.057	0.055	0.056	0.058	0.057	0.053	0.055	0.052

F.3 Hot / Dry Climate Scenario Results for 2035

Table F.7: Monthly water withdrawals forecasted in the 2035 Hot / Dry Climate Scenario for public water suppliers in the Central Indiana Region in MGD.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boone	Advance Water Works	0.097	0.116	0.100	0.098	0.108	0.105	0.087	0.081	0.078	0.076	0.088	0.088
	Jamestown Mun. Water Work	0.077	0.091	0.074	0.078	0.082	0.089	0.086	0.081	0.082	0.078	0.083	0.079
	Lebanon Utility Service	2.266	2.462	2.150	2.368	2.320	2.511	2.472	2.490	2.456	2.324	2.199	2.130
	Town of Thorntown	0.159	0.178	0.154	0.168	0.168	0.174	0.163	0.162	0.163	0.161	0.158	0.147
	Lost Run Farm Community	0.000	0.000	0.014	0.142	0.243	0.300	0.296	0.267	0.282	0.261	0.209	0.021
Hamilton	Arcadia Water Department	0.173	0.180	0.159	0.159	0.175	0.180	0.178	0.198	0.215	0.162	0.169	0.158
	Atlanta Water Department	0.077	0.085	0.072	0.068	0.071	0.073	0.072	0.071	0.070	0.063	0.069	0.069
	Carmel Municipal Water	9.861	9.591	9.528	12.239	16.758	25.627	26.918	26.288	26.486	15.116	12.401	11.497
	Citizens Water of Westfield	8.649	9.747	9.295	9.900	11.119	12.255	11.860	12.433	11.890	9.518	9.635	8.914
	Indiana-American Water Co	4.465	5.340	5.392	6.122	5.718	8.052	8.309	8.687	7.505	6.148	5.098	4.664
	Sheridan Water Works	0.349	0.373	0.324	0.328	0.342	0.340	0.352	0.355	0.365	0.344	0.342	0.314
	Town of Cicero Utilities	0.631	0.705	0.638	0.675	0.734	0.794	0.774	0.738	0.727	0.629	0.632	0.607
Hancock	City of Greenfield	3.509	3.368	3.097	3.143	3.173	3.468	3.469	3.488	3.424	3.213	3.413	3.674
	Gem Water/Town of Cumberland	0.150	0.162	0.150	0.172	0.151	0.172	0.170	0.191	0.209	0.203	0.200	0.165
	Town of Fortville	0.488	0.551	0.476	0.509	0.510	0.547	0.530	0.516	0.552	0.480	0.484	0.476
Hendricks	Danville Water Company	1.084	1.225	1.116	1.184	1.196	1.285	1.267	1.236	1.232	1.105	1.094	1.096
	North Salem Water Corporation	0.054	0.060	0.052	0.056	0.054	0.054	0.051	0.049	0.051	0.047	0.046	0.048
	Town of Brownsburg	1.975	2.366	2.084	2.382	2.605	2.870	2.713	2.768	2.769	2.408	2.242	2.222
	Town of Plainfield	5.120	5.337	4.948	5.513	5.976	7.082	7.221	7.458	6.952	5.503	5.150	5.047
Johnson	Bargersville Water Department	2.596	2.751	2.448	2.787	3.403	4.611	4.971	5.359	4.801	3.104	2.551	2.487
	Indiana-American Water Co Inc	9.935	10.937	9.725	10.548	11.107	12.723	12.782	12.821	12.256	10.225	9.693	9.263
	Princes Lakes Water and Sewage	0.879	0.943	0.848	0.872	0.914	1.104	1.029	0.999	0.969	0.901	0.917	0.847
	Town of Edinburgh	1.158	1.278	1.127	1.187	1.155	1.244	1.220	1.233	1.229	1.060	1.046	1.060

Table F.8: Monthly water withdrawals forecasted in the 2035 Hot / Dry Climate Scenario for public water suppliers in the Central Indiana Region in MGD., Continued.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Madison	Alexandria Water Works	0.660	0.715	0.663	0.710	0.753	0.802	0.769	0.761	0.785	0.685	0.687	0.653
	Anderson Water Department	5.275	6.058	5.291	5.313	5.202	5.541	5.369	5.499	5.569	5.270	5.442	5.156
	Citizens Water of South Madison	1.151	1.405	1.231	1.206	1.103	1.317	1.333	1.268	1.262	1.268	1.213	1.200
	Elwood Water Utility	1.107	1.248	1.135	1.172	1.125	1.217	1.124	1.176	1.215	1.072	1.017	0.997
	Indiana-American Water Co Inc	0.057	0.062	0.053	0.056	0.059	0.064	0.059	0.060	0.059	0.054	0.056	0.053
	Ingalls Water Department	0.940	1.070	0.925	0.976	0.929	1.018	0.988	0.975	1.009	0.958	0.980	0.927
	Lapel Municipal Water Company	0.226	0.254	0.218	0.225	0.210	0.238	0.233	0.233	0.244	0.195	0.252	0.205
	Pendleton Municipal Water	0.348	0.377	0.328	0.375	0.437	0.448	0.429	0.430	0.418	0.337	0.352	0.353
	Town of Chesterfield	0.247	0.282	0.260	0.267	0.263	0.268	0.259	0.253	0.257	0.264	0.243	0.231
	Town of Edgewood	0.138	0.155	0.137	0.162	0.158	0.158	0.151	0.147	0.147	0.140	0.142	0.137
	Town of Frankton	0.260	0.284	0.231	0.231	0.268	0.268	0.250	0.246	0.259	0.240	0.249	0.249
	Town of Orestes	0.045	0.050	0.042	0.046	0.044	0.046	0.046	0.065	0.066	0.051	0.049	0.040
Marion	City of Lawrence Utilities	4.342	4.742	3.997	4.447	4.719	5.098	4.920	5.053	5.047	4.401	4.273	4.145
	Town of Speedway	2.151	2.408	2.406	2.389	2.705	2.460	2.642	2.577	2.461	2.160	2.051	2.009
	Citizens Energy Group	97.766	113.954	102.386	107.868	123.920	173.847	199.040	207.036	195.980	134.572	98.753	83.094

Table F.9: Monthly water withdrawals forecasted in the 2035 Hot / Dry Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Morgan	Brown County Water Utility Inc	1.240	1.501	1.375	1.365	1.334	1.368	1.326	1.320	1.345	1.329	1.347	1.356
	City of Martinsville	1.632	1.848	1.615	1.607	1.632	1.660	1.644	1.662	1.655	1.470	1.477	1.379
	Hill Water Corporation	0.634	0.697	0.611	0.636	0.672	0.783	0.748	0.769	0.740	0.683	0.654	0.608
	Indiana-American Water Co Inc	0.904	1.005	0.869	0.924	0.982	1.064	1.033	1.079	1.048	0.887	0.869	0.853
	Mapleturn Utilities Inc	0.124	0.133	0.120	0.137	0.148	0.163	0.161	0.173	0.152	0.126	0.127	0.123
	Morgan County Rural Water Co	0.603	0.669	0.584	0.614	0.587	0.620	0.615	0.584	0.548	0.511	0.553	0.568
	Painted Hills Utilities	0.126	0.142	0.128	0.131	0.138	0.149	0.145	0.145	0.137	0.123	0.128	0.124
	Town of Brooklyn	0.082	0.094	0.085	0.092	0.098	0.108	0.104	0.118	0.107	0.086	0.089	0.086
	Town of Morgantown	0.076	0.087	0.073	0.078	0.075	0.086	0.084	0.077	0.082	0.078	0.083	0.081
	Town of Paragon	0.043	0.046	0.036	0.036	0.037	0.039	0.036	0.037	0.037	0.033	0.035	0.037
Shelby	Indiana-American Water Co	2.934	3.191	2.902	3.115	3.142	3.417	3.280	3.405	3.366	3.126	3.075	2.931
	Town of Morristown	0.596	0.669	0.603	0.598	0.594	0.649	0.567	0.595	0.613	0.628	0.643	0.591
	Town of St. Paul	0.087	0.098	0.081	0.082	0.081	0.092	0.088	0.091	0.086	0.080	0.082	0.070
	Waldron Conservancy District	0.054	0.058	0.052	0.055	0.059	0.058	0.059	0.061	0.060	0.055	0.058	0.054

F.4 Hot / Dry Climate Scenario Results for 2070

Table F.10: Monthly water withdrawals forecasted in the 2070 Hot / Dry Climate Scenario for public water suppliers in the Central Indiana Region in MGD.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boone	Advance Water Works	0.113	0.135	0.117	0.115	0.126	0.123	0.102	0.094	0.092	0.089	0.103	0.103
	Jamestown Mun. Water Work	0.090	0.106	0.087	0.091	0.096	0.104	0.100	0.095	0.096	0.091	0.096	0.093
	Lebanon Utility Service	2.644	2.873	2.509	2.763	2.708	2.930	2.884	2.905	2.867	2.712	2.566	2.486
	Town of Thorntown	0.186	0.208	0.180	0.196	0.196	0.204	0.190	0.189	0.190	0.188	0.185	0.172
	Lost Run Farm Community	0.000	0.000	0.016	0.166	0.284	0.350	0.346	0.311	0.329	0.304	0.244	0.025
Hamilton	Arcadia Water Department	0.231	0.241	0.212	0.213	0.234	0.241	0.238	0.265	0.288	0.217	0.227	0.212
	Atlanta Water Department	0.103	0.114	0.096	0.091	0.095	0.098	0.097	0.095	0.094	0.085	0.092	0.092
	Carmel Municipal Water	13.209	12.849	12.763	16.395	22.448	34.329	36.059	35.215	35.480	20.250	16.613	15.402
	Citizens Water of Westfield	11.587	13.057	12.452	13.262	14.894	16.417	15.887	16.656	15.928	12.750	12.907	11.942
	Indiana-American Water Co	5.982	7.154	7.224	8.200	7.660	10.787	11.130	11.637	10.053	8.236	6.829	6.247
	Sheridan Water Works	0.468	0.500	0.434	0.439	0.458	0.456	0.472	0.475	0.490	0.460	0.458	0.421
	Town of Cicero Utilities	0.846	0.944	0.855	0.904	0.983	1.063	1.037	0.989	0.974	0.842	0.847	0.813
Hancock	City of Greenfield	4.385	4.209	3.870	3.928	3.966	4.335	4.336	4.360	4.279	4.015	4.265	4.592
	Gem Water/Town of Cumberland	0.187	0.203	0.188	0.215	0.189	0.215	0.212	0.238	0.261	0.254	0.249	0.206
	Town of Fortville	0.610	0.689	0.595	0.636	0.637	0.683	0.662	0.645	0.690	0.600	0.606	0.594
Hendricks	Danville Water Company	1.450	1.638	1.492	1.584	1.601	1.719	1.695	1.653	1.648	1.479	1.464	1.467
	North Salem Water Corporation	0.073	0.080	0.069	0.075	0.072	0.072	0.068	0.065	0.068	0.063	0.062	0.065
	Town of Brownsburg	2.642	3.165	2.788	3.186	3.484	3.839	3.630	3.703	3.705	3.222	2.999	2.973
	Town of Plainfield	6.849	7.140	6.619	7.375	7.994	9.474	9.661	9.977	9.300	7.362	6.890	6.752
Johnson	Bargersville Water Department	3.065	3.248	2.891	3.291	4.018	5.444	5.869	6.327	5.669	3.665	3.011	2.937
	Indiana-American Water Co Inc	11.731	12.913	11.482	12.454	13.114	15.022	15.092	15.138	14.470	12.072	11.445	10.937
	Princes Lakes Water and Sewage	1.037	1.113	1.002	1.029	1.080	1.304	1.215	1.180	1.144	1.064	1.083	1.000
	Town of Edinburgh	1.367	1.509	1.331	1.402	1.364	1.469	1.441	1.456	1.451	1.251	1.235	1.251

Table F.11: Monthly water withdrawals forecasted in the 2070 Hot / Dry Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Madison	Alexandria Water Works	0.631	0.684	0.634	0.679	0.720	0.768	0.736	0.728	0.751	0.655	0.657	0.625
	Anderson Water Department	5.046	5.796	5.062	5.082	4.977	5.301	5.136	5.261	5.328	5.041	5.206	4.933
	Citizens Water of South Madison	1.102	1.344	1.178	1.153	1.055	1.260	1.275	1.213	1.208	1.213	1.160	1.148
	Elwood Water Utility	1.059	1.194	1.086	1.122	1.076	1.165	1.076	1.125	1.163	1.026	0.973	0.953
	Indiana-American Water Co Inc	0.055	0.059	0.050	0.054	0.056	0.061	0.057	0.057	0.056	0.051	0.053	0.050
	Ingalls Water Department	0.899	1.024	0.885	0.933	0.888	0.974	0.945	0.933	0.965	0.917	0.938	0.887
	Lapel Municipal Water Company	0.216	0.243	0.209	0.215	0.201	0.228	0.223	0.223	0.233	0.186	0.241	0.196
	Pendleton Municipal Water	0.332	0.361	0.314	0.359	0.418	0.428	0.410	0.411	0.400	0.323	0.337	0.338
	Town of Chesterfield	0.236	0.270	0.249	0.256	0.251	0.257	0.248	0.242	0.245	0.253	0.233	0.221
	Town of Edgewood	0.132	0.148	0.131	0.155	0.151	0.151	0.144	0.141	0.140	0.134	0.136	0.131
	Town of Frankton	0.249	0.272	0.221	0.221	0.257	0.256	0.239	0.236	0.248	0.230	0.238	0.238
	Town of Orestes	0.043	0.048	0.040	0.044	0.042	0.044	0.044	0.062	0.063	0.049	0.047	0.038
Marion	City of Lawrence Utilities	4.546	4.965	4.186	4.657	4.942	5.338	5.153	5.291	5.285	4.609	4.474	4.340
	Town of Speedway	2.252	2.521	2.520	2.502	2.833	2.576	2.767	2.699	2.577	2.262	2.148	2.104
	Citizens Energy Group	107.370	125.149	112.444	118.464	136.093	190.925	218.593	227.374	215.232	147.792	108.454	91.257

Table F.12: Monthly water withdrawals forecasted in the 2070 Hot / Dry Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Morgan	Brown County Water Utility Inc	1.225	1.483	1.359	1.348	1.318	1.351	1.310	1.304	1.328	1.313	1.331	1.339
	City of Martinsville	1.613	1.826	1.596	1.587	1.612	1.640	1.624	1.642	1.635	1.452	1.459	1.362
	Hill Water Corporation	0.627	0.689	0.604	0.628	0.664	0.773	0.739	0.759	0.731	0.674	0.646	0.601
	Indiana-American Water Co Inc	0.893	0.993	0.858	0.913	0.970	1.052	1.021	1.066	1.036	0.876	0.859	0.843
	Mapleturn Utilities Inc	0.123	0.132	0.119	0.135	0.146	0.161	0.159	0.171	0.151	0.125	0.125	0.122
	Morgan County Rural Water Co	0.596	0.661	0.577	0.606	0.579	0.613	0.607	0.577	0.541	0.505	0.547	0.561
	Painted Hills Utilities	0.125	0.140	0.126	0.129	0.136	0.147	0.143	0.143	0.135	0.121	0.126	0.122
	Town of Brooklyn	0.081	0.093	0.084	0.091	0.097	0.106	0.103	0.117	0.105	0.085	0.088	0.085
	Town of Morgantown	0.075	0.086	0.072	0.077	0.074	0.085	0.083	0.076	0.081	0.077	0.082	0.080
	Town of Paragon	0.043	0.045	0.036	0.036	0.036	0.038	0.035	0.037	0.036	0.032	0.035	0.037
Shelby	Indiana-American Water Co	2.835	3.084	2.805	3.011	3.036	3.302	3.170	3.291	3.253	3.021	2.972	2.832
	Town of Morristown	0.576	0.646	0.583	0.578	0.574	0.628	0.548	0.575	0.593	0.607	0.621	0.572
	Town of St. Paul	0.084	0.095	0.078	0.079	0.078	0.089	0.085	0.088	0.083	0.077	0.079	0.068
	Waldron Conservancy District	0.052	0.056	0.050	0.053	0.057	0.056	0.057	0.059	0.058	0.053	0.056	0.052

F.5 30% Drought Climate Scenario Results for 2035

Table F.13: Monthly water withdrawals forecasted in the 2035-30% Drought Climate Scenario for public water suppliers in the Central Indiana Region in MGD.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boone	Advance Water Works	0.097	0.116	0.101	0.099	0.108	0.106	0.088	0.081	0.079	0.076	0.088	0.088
	Jamestown Mun. Water Work	0.077	0.092	0.075	0.078	0.082	0.089	0.086	0.082	0.082	0.078	0.083	0.080
	Lebanon Utility Service	2.278	2.475	2.162	2.381	2.333	2.525	2.485	2.503	2.470	2.337	2.211	2.141
	Town of Thorntown	0.160	0.179	0.155	0.169	0.169	0.175	0.163	0.163	0.164	0.162	0.159	0.148
	Lost Run Farm Community	0.000	0.000	0.014	0.143	0.245	0.302	0.298	0.268	0.283	0.262	0.210	0.021
Hamilton	Arcadia Water Department	0.179	0.187	0.165	0.165	0.182	0.187	0.185	0.206	0.224	0.168	0.176	0.165
	Atlanta Water Department	0.080	0.088	0.075	0.071	0.074	0.076	0.075	0.074	0.073	0.066	0.072	0.071
	Carmel Municipal Water	10.253	9.973	9.907	12.726	17.424	26.646	27.989	27.334	27.540	15.718	12.895	11.955
	Citizens Water of Westfield	8.994	10.135	9.665	10.294	11.561	12.743	12.332	12.928	12.363	9.896	10.018	9.269
	Indiana-American Water Co	4.643	5.553	5.607	6.365	5.945	8.373	8.639	9.033	7.803	6.393	5.300	4.849
	Sheridan Water Works	0.363	0.388	0.337	0.341	0.355	0.354	0.366	0.369	0.380	0.357	0.356	0.327
	Town of Cicero Utilities	0.657	0.733	0.663	0.702	0.763	0.825	0.805	0.768	0.756	0.654	0.657	0.631
Hancock	City of Greenfield	3.520	3.379	3.107	3.153	3.183	3.480	3.480	3.500	3.435	3.223	3.424	3.686
	Gem Water/Town of Cumberland	0.150	0.163	0.151	0.172	0.152	0.172	0.170	0.191	0.209	0.204	0.200	0.166
	Town of Fortville	0.490	0.553	0.477	0.511	0.511	0.549	0.531	0.518	0.554	0.481	0.486	0.477
Hendricks	Danville Water Company	1.101	1.244	1.133	1.203	1.215	1.305	1.287	1.255	1.251	1.123	1.111	1.114
	North Salem Water Corporation	0.055	0.061	0.053	0.057	0.054	0.055	0.052	0.049	0.052	0.048	0.047	0.049
	Town of Brownsburg	2.006	2.403	2.117	2.419	2.646	2.916	2.756	2.812	2.813	2.447	2.278	2.258
	Town of Plainfield	5.201	5.422	5.026	5.600	6.071	7.194	7.336	7.577	7.062	5.591	5.232	5.127
Johnson	Bargersville Water Department	2.666	2.826	2.515	2.863	3.496	4.736	5.107	5.505	4.932	3.188	2.620	2.555
	Indiana-American Water Co Inc	10.206	11.235	9.990	10.836	11.409	13.070	13.130	13.171	12.590	10.503	9.957	9.515
	Princes Lakes Water and Sewage	0.903	0.969	0.871	0.896	0.939	1.134	1.057	1.026	0.995	0.926	0.942	0.870
	Town of Edinburgh	1.189	1.313	1.158	1.220	1.186	1.278	1.253	1.267	1.262	1.088	1.075	1.089

Table F.14: Monthly water withdrawals forecasted in the 2035 30%-Drought Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Madison	Alexandria Water Works	0.666	0.722	0.670	0.717	0.761	0.811	0.777	0.769	0.793	0.692	0.694	0.660
	Anderson Water Department	5.329	6.121	5.345	5.367	5.256	5.598	5.424	5.556	5.626	5.324	5.498	5.209
	Citizens Water of South Madison	1.163	1.419	1.244	1.218	1.114	1.330	1.347	1.281	1.275	1.281	1.225	1.213
	Elwood Water Utility	1.119	1.261	1.146	1.185	1.136	1.230	1.136	1.188	1.228	1.083	1.028	1.007
	Indiana-American Water Co Inc	0.057	0.062	0.053	0.056	0.059	0.064	0.059	0.060	0.059	0.054	0.056	0.053
	Ingalls Water Department	0.949	1.081	0.934	0.986	0.938	1.028	0.998	0.985	1.019	0.968	0.990	0.936
	Lapel Municipal Water Company	0.228	0.257	0.220	0.227	0.212	0.241	0.235	0.236	0.246	0.197	0.255	0.207
	Pendleton Municipal Water	0.351	0.381	0.331	0.379	0.442	0.452	0.433	0.434	0.423	0.341	0.355	0.357
	Town of Chesterfield	0.249	0.285	0.263	0.270	0.265	0.271	0.261	0.255	0.259	0.267	0.246	0.234
	Town of Edgewood	0.140	0.157	0.139	0.163	0.160	0.160	0.152	0.149	0.148	0.141	0.143	0.138
	Town of Frankton	0.263	0.287	0.233	0.233	0.271	0.271	0.252	0.249	0.262	0.243	0.251	0.251
	Town of Orestes	0.045	0.050	0.042	0.046	0.044	0.047	0.046	0.065	0.067	0.052	0.049	0.041
Marion	City of Lawrence Utilities	4.409	4.815	4.059	4.516	4.792	5.177	4.996	5.131	5.125	4.469	4.339	4.209
	Town of Speedway	2.184	2.445	2.443	2.426	2.747	2.498	2.683	2.617	2.499	2.194	2.083	2.040
	Citizens Energy Group	101.656	118.489	106.460	112.160	128.851	180.765	206.961	215.275	203.779	139.928	102.683	86.401

Table F.15: Monthly water withdrawals forecasted in the 2035 30%-Drought Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Morgan	Brown County Water Utility Inc	1.267	1.533	1.405	1.394	1.362	1.397	1.355	1.348	1.373	1.357	1.376	1.384
	City of Martinsville	1.667	1.887	1.649	1.641	1.666	1.695	1.679	1.697	1.690	1.501	1.508	1.408
	Hill Water Corporation	0.648	0.712	0.624	0.649	0.686	0.799	0.764	0.785	0.755	0.697	0.668	0.621
	Indiana-American Water Co Inc	0.923	1.027	0.887	0.943	1.002	1.087	1.055	1.102	1.071	0.906	0.888	0.871
	Mapleturn Utilities Inc	0.127	0.136	0.123	0.140	0.151	0.166	0.165	0.177	0.156	0.129	0.129	0.126
	Morgan County Rural Water Co	0.616	0.684	0.596	0.627	0.599	0.633	0.628	0.596	0.560	0.522	0.565	0.580
	Painted Hills Utilities	0.129	0.145	0.130	0.133	0.141	0.152	0.148	0.148	0.140	0.125	0.130	0.127
	Town of Brooklyn	0.084	0.096	0.087	0.094	0.100	0.110	0.106	0.121	0.109	0.087	0.091	0.088
	Town of Morgantown	0.077	0.089	0.075	0.079	0.076	0.088	0.085	0.079	0.084	0.080	0.085	0.083
	Town of Paragon	0.044	0.047	0.037	0.037	0.037	0.039	0.036	0.038	0.038	0.033	0.036	0.038
Shelby	Indiana-American Water Co	2.977	3.238	2.945	3.161	3.188	3.467	3.329	3.455	3.416	3.172	3.120	2.974
	Town of Morristown	0.605	0.678	0.612	0.607	0.603	0.659	0.576	0.604	0.622	0.637	0.652	0.600
	Town of St. Paul	0.088	0.099	0.082	0.083	0.082	0.094	0.089	0.092	0.087	0.081	0.083	0.071
	Waldron Conservancy District	0.054	0.059	0.053	0.056	0.060	0.059	0.059	0.062	0.061	0.056	0.058	0.055

F.6 30% Drought Climate Scenario Results for 2070

Table F.16: Monthly water withdrawals forecasted in the 2070 30%-Drought Climate Scenario for public water suppliers in the Central Indiana Region in MGD.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boone	Advance Water Works	0.113	0.136	0.117	0.115	0.126	0.124	0.102	0.095	0.092	0.089	0.103	0.103
	Jamestown Mun. Water Work	0.090	0.107	0.087	0.092	0.096	0.104	0.101	0.096	0.096	0.092	0.097	0.093
	Lebanon Utility Service	2.659	2.888	2.523	2.778	2.722	2.946	2.900	2.921	2.882	2.727	2.580	2.499
	Town of Thorntown	0.187	0.209	0.181	0.198	0.197	0.205	0.191	0.190	0.191	0.189	0.186	0.173
	Lost Run Farm Community	0.000	0.000	0.016	0.167	0.285	0.352	0.347	0.313	0.331	0.306	0.245	0.025
Hamilton	Arcadia Water Department	0.241	0.251	0.221	0.222	0.244	0.251	0.248	0.276	0.300	0.225	0.236	0.221
	Atlanta Water Department	0.107	0.119	0.100	0.095	0.099	0.102	0.100	0.099	0.098	0.088	0.096	0.095
	Carmel Municipal Water	13.745	13.370	13.281	17.061	23.359	35.722	37.522	36.644	36.920	21.071	17.287	16.027
	Citizens Water of Westfield	12.057	13.587	12.957	13.800	15.499	17.083	16.532	17.332	16.574	13.267	13.431	12.426
	Indiana-American Water Co	6.224	7.444	7.517	8.533	7.970	11.224	11.582	12.110	10.461	8.570	7.106	6.501
	Sheridan Water Works	0.487	0.520	0.452	0.457	0.476	0.474	0.491	0.495	0.509	0.479	0.477	0.438
	Town of Cicero Utilities	0.880	0.982	0.889	0.941	1.023	1.107	1.079	1.029	1.013	0.877	0.881	0.846
Hancock	City of Greenfield	4.400	4.223	3.883	3.941	3.979	4.349	4.350	4.374	4.294	4.029	4.279	4.607
	Gem Water/Town of Cumberland	0.188	0.203	0.188	0.215	0.189	0.215	0.213	0.239	0.262	0.254	0.250	0.207
	Town of Fortville	0.612	0.691	0.596	0.638	0.639	0.686	0.664	0.647	0.692	0.602	0.608	0.596
Hendricks	Danville Water Company	1.473	1.665	1.517	1.610	1.627	1.747	1.722	1.680	1.675	1.503	1.487	1.490
	North Salem Water Corporation	0.074	0.082	0.070	0.076	0.073	0.073	0.069	0.066	0.069	0.064	0.063	0.066
	Town of Brownsburg	2.685	3.216	2.833	3.238	3.541	3.902	3.689	3.763	3.765	3.274	3.048	3.021
	Town of Plainfield	6.960	7.256	6.727	7.495	8.124	9.628	9.818	10.139	9.451	7.482	7.002	6.861
Johnson	Bargersville Water Department	3.149	3.337	2.970	3.381	4.129	5.593	6.030	6.500	5.824	3.765	3.094	3.017
	Indiana-American Water Co Inc	12.052	13.268	11.797	12.796	13.473	15.434	15.506	15.553	14.867	12.403	11.758	11.237
	Princes Lakes Water and Sewage	1.066	1.144	1.029	1.058	1.109	1.340	1.248	1.212	1.175	1.093	1.112	1.028
	Town of Edinburgh	1.404	1.550	1.368	1.440	1.401	1.510	1.480	1.496	1.490	1.285	1.269	1.286

Table F.17: Monthly water withdrawals forecasted in the 2070 30%-Drought Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	Water Supply System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Madison	Alexandria Water Works	0.638	0.691	0.641	0.686	0.728	0.776	0.744	0.736	0.759	0.662	0.664	0.631
	Anderson Water Department	5.099	5.856	5.115	5.135	5.029	5.356	5.190	5.316	5.384	5.094	5.261	4.984
	Citizens Water of South Madison	1.113	1.358	1.190	1.165	1.066	1.273	1.289	1.226	1.220	1.226	1.173	1.160
	Elwood Water Utility	1.070	1.207	1.097	1.133	1.087	1.177	1.087	1.137	1.175	1.036	0.983	0.963
	Indiana-American Water Co Inc	0.055	0.059	0.050	0.054	0.056	0.061	0.057	0.057	0.056	0.051	0.053	0.050
	Ingalls Water Department	0.908	1.035	0.894	0.943	0.898	0.984	0.955	0.942	0.975	0.926	0.947	0.896
	Lapel Municipal Water Company	0.218	0.246	0.211	0.217	0.203	0.230	0.225	0.226	0.236	0.188	0.244	0.198
	Pendleton Municipal Water	0.336	0.365	0.317	0.362	0.423	0.433	0.415	0.415	0.404	0.326	0.340	0.341
	Town of Chesterfield	0.238	0.273	0.251	0.259	0.254	0.259	0.250	0.244	0.248	0.255	0.235	0.224
	Town of Edgewood	0.134	0.150	0.133	0.156	0.153	0.153	0.146	0.142	0.142	0.135	0.137	0.132
	Town of Frankton	0.251	0.274	0.223	0.223	0.259	0.259	0.241	0.238	0.251	0.232	0.240	0.241
	Town of Orestes	0.043	0.048	0.040	0.044	0.043	0.045	0.044	0.062	0.064	0.050	0.047	0.039
Marion	City of Lawrence Utilities	4.618	5.044	4.252	4.730	5.020	5.423	5.234	5.374	5.368	4.681	4.545	4.409
	Town of Speedway	2.288	2.561	2.559	2.541	2.878	2.616	2.810	2.742	2.618	2.298	2.182	2.137
	Citizens Energy Group	111.727	130.227	117.007	123.271	141.616	198.673	227.464	236.601	223.966	153.790	112.855	94.960

Table F.18: Monthly water withdrawals forecasted in the 2070 30%-Drought Climate Scenario for public water suppliers in the Central Indiana Region in MGD, Continued.

County	System/Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Morgan	Brown County Water Utility Inc	1.252	1.515	1.388	1.377	1.346	1.380	1.338	1.332	1.357	1.341	1.359	1.368
	City of Martinsville	1.647	1.865	1.630	1.621	1.646	1.675	1.659	1.677	1.670	1.483	1.490	1.391
	Hill Water Corporation	0.640	0.704	0.616	0.642	0.678	0.790	0.755	0.776	0.746	0.689	0.660	0.613
	Indiana-American Water Co Inc	0.912	1.014	0.876	0.932	0.991	1.074	1.042	1.089	1.058	0.895	0.877	0.861
	Mapleturn Utilities Inc	0.125	0.135	0.122	0.138	0.149	0.164	0.163	0.175	0.154	0.127	0.128	0.124
	Morgan County Rural Water Co	0.609	0.675	0.589	0.619	0.592	0.626	0.620	0.589	0.553	0.516	0.558	0.573
	Painted Hills Utilities	0.128	0.143	0.129	0.132	0.139	0.150	0.146	0.146	0.138	0.124	0.129	0.125
	Town of Brooklyn	0.083	0.095	0.086	0.093	0.099	0.109	0.105	0.120	0.107	0.086	0.090	0.087
	Town of Morgantown	0.077	0.088	0.074	0.078	0.075	0.087	0.084	0.078	0.083	0.079	0.084	0.082
	Town of Paragon	0.044	0.046	0.037	0.036	0.037	0.039	0.036	0.038	0.037	0.033	0.036	0.038
Shelby	Indiana-American Water Co	2.877	3.130	2.846	3.055	3.081	3.351	3.217	3.340	3.301	3.066	3.016	2.874
	Town of Morristown	0.584	0.656	0.592	0.587	0.582	0.637	0.556	0.584	0.602	0.616	0.631	0.580
	Town of St. Paul	0.085	0.096	0.079	0.081	0.080	0.091	0.086	0.089	0.084	0.078	0.080	0.069
	Waldron Conservancy District	0.053	0.057	0.051	0.054	0.058	0.057	0.057	0.060	0.059	0.054	0.056	0.053

G Regional Summary Appendix

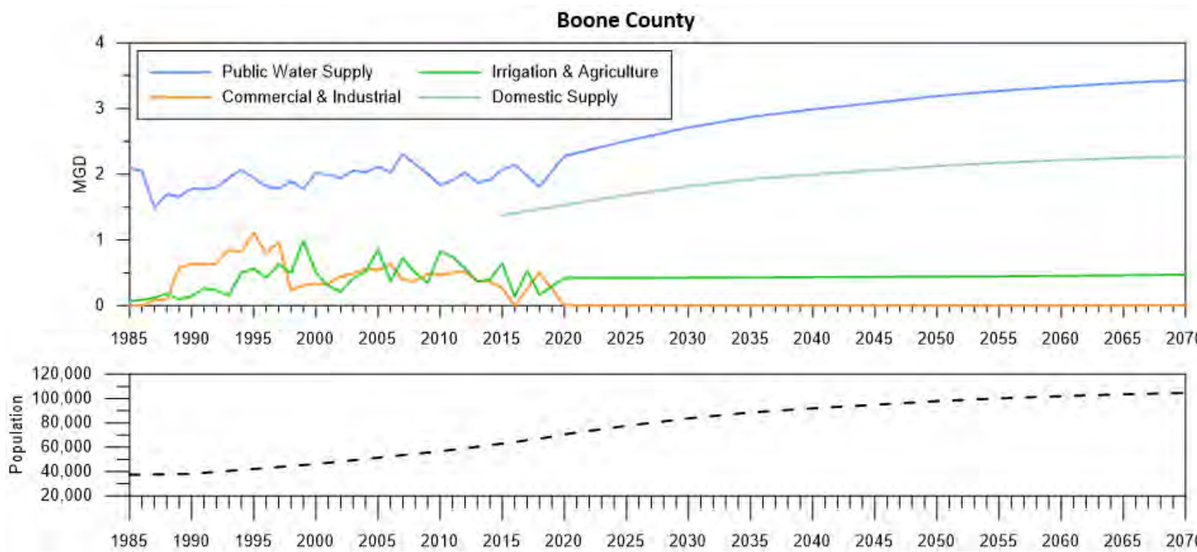

Figure G.1: Historical and future water withdrawals estimated for Boone County from 1985-2070 in MGD.

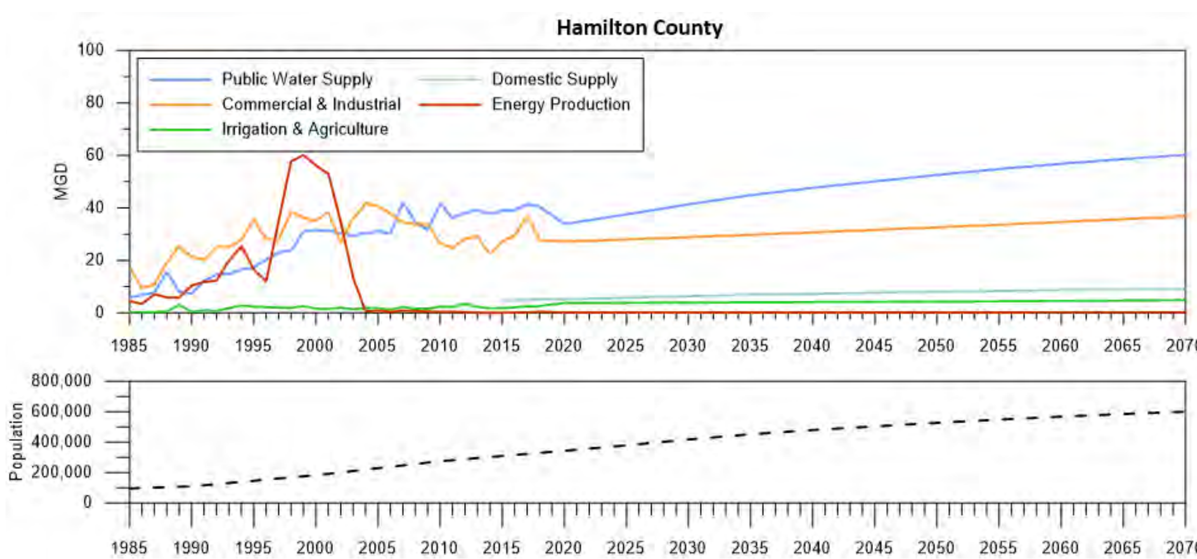

Figure G.2: Historical and future water withdrawals estimated for Hamilton County from 1985-2070 in MGD.

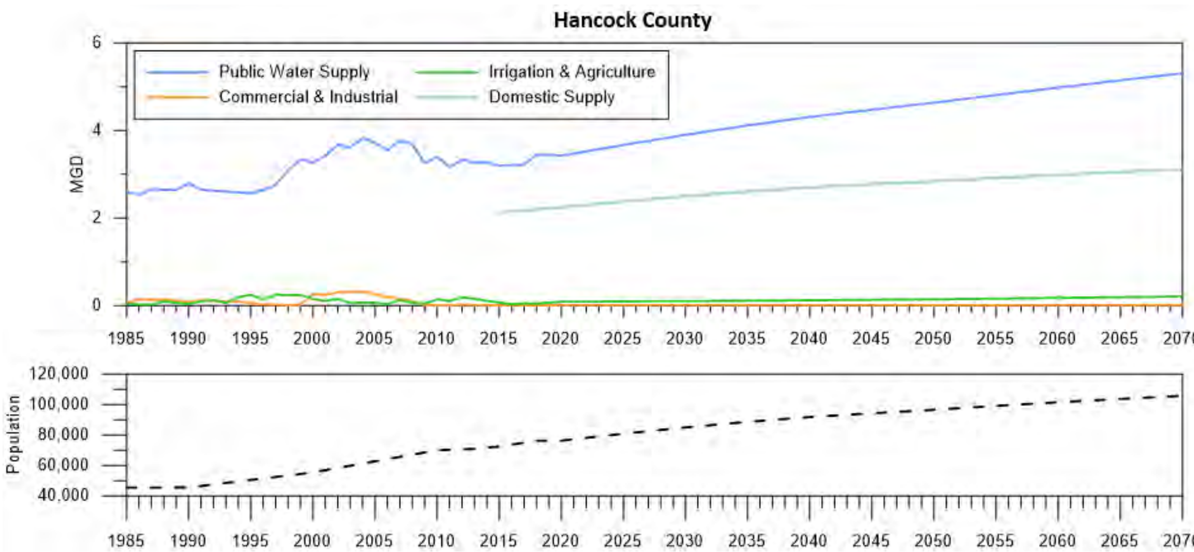

Figure G.3: Historical and future water withdrawals estimated for Hancock County from 1985-2070 in MGD.

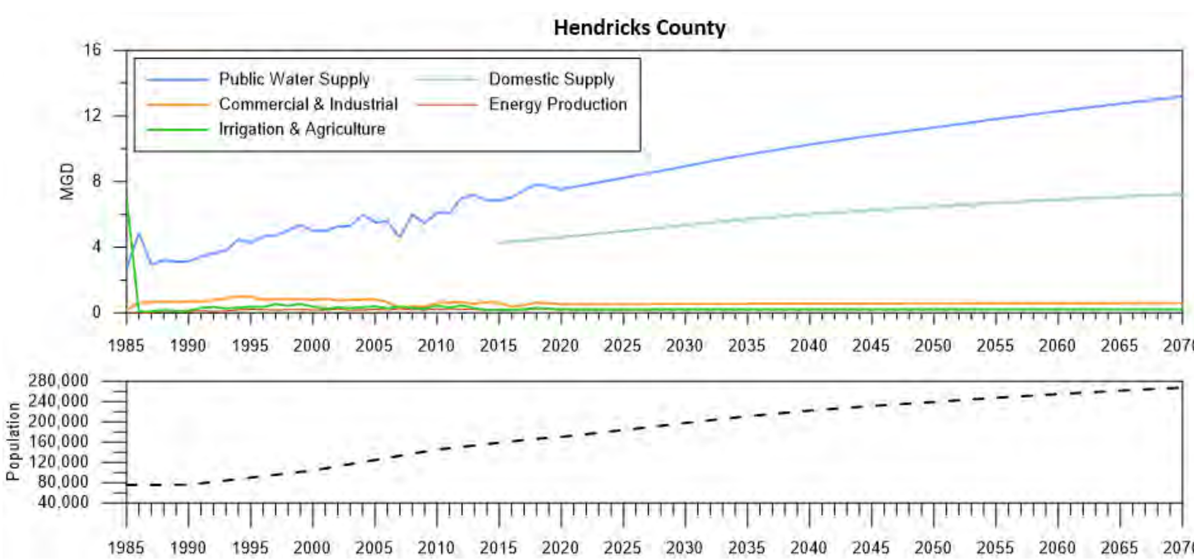

Figure G.4: Historical and future water withdrawals estimated for Hendricks County from 1985-2070 in MGD.

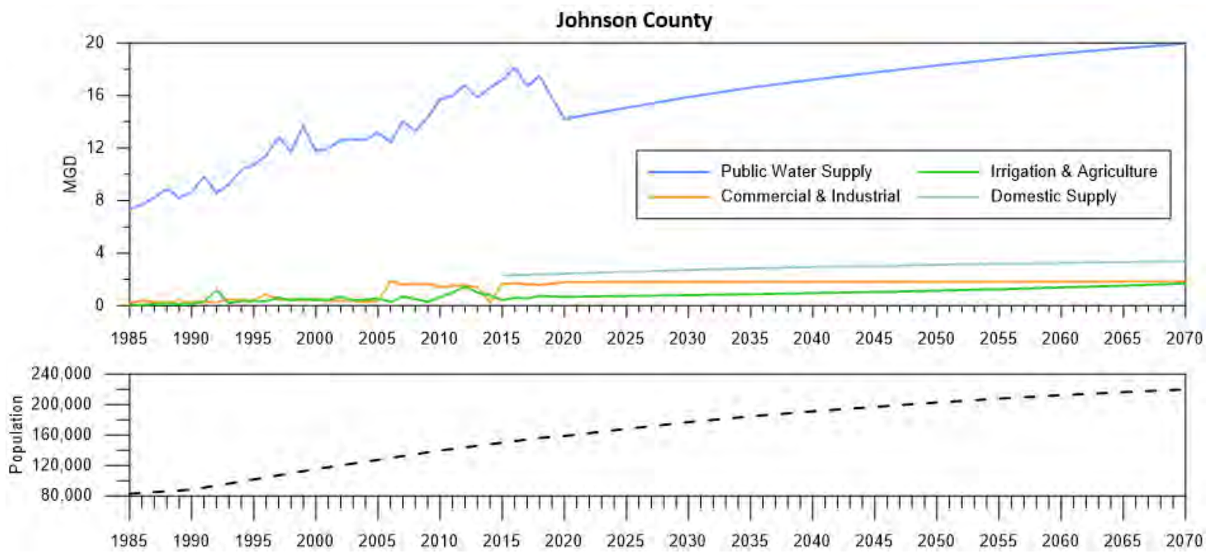

Figure G.5: Historical and future water withdrawals estimated for Johnson County from 1985-2070 in MGD.

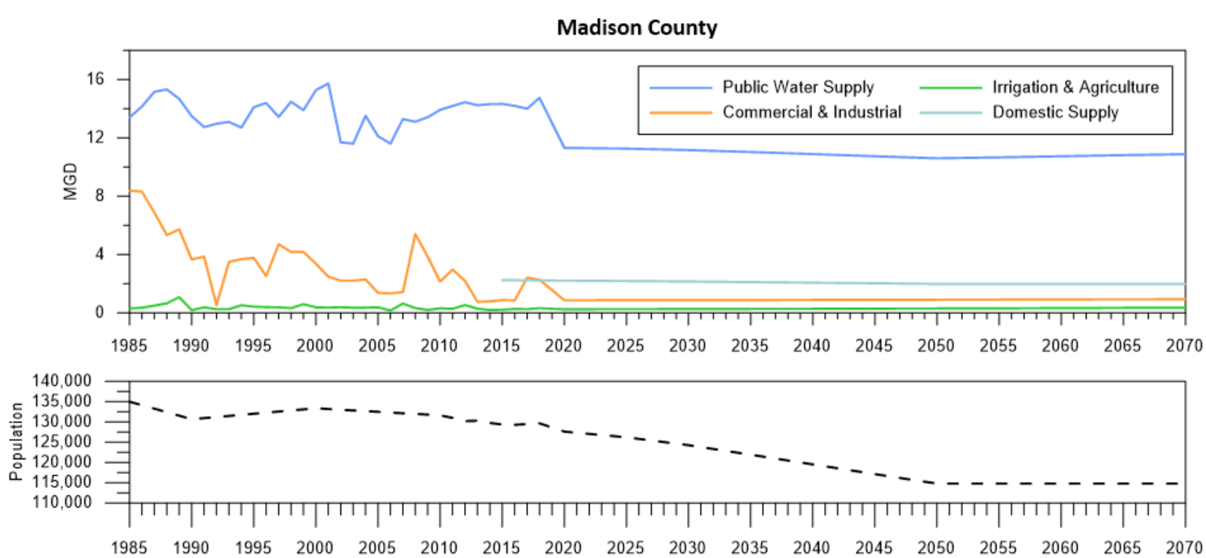

Figure G.6: Historical and future water withdrawals estimated for Madison County from 1985-2070 in MGD.

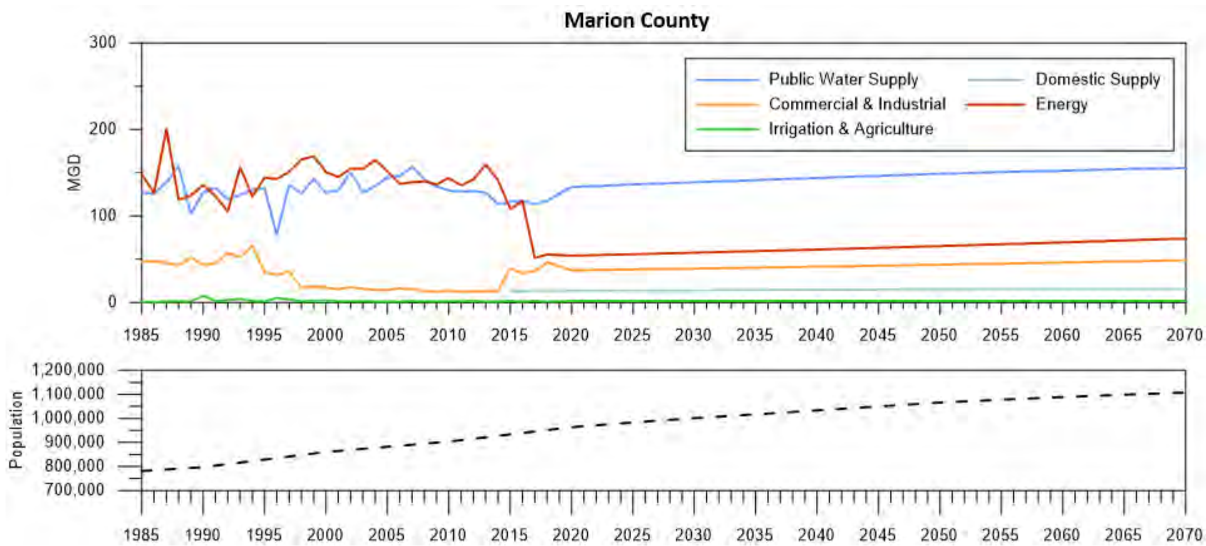

Figure G.7: Historical and future water withdrawals estimated for Marion County from 1985-2070 in MGD.

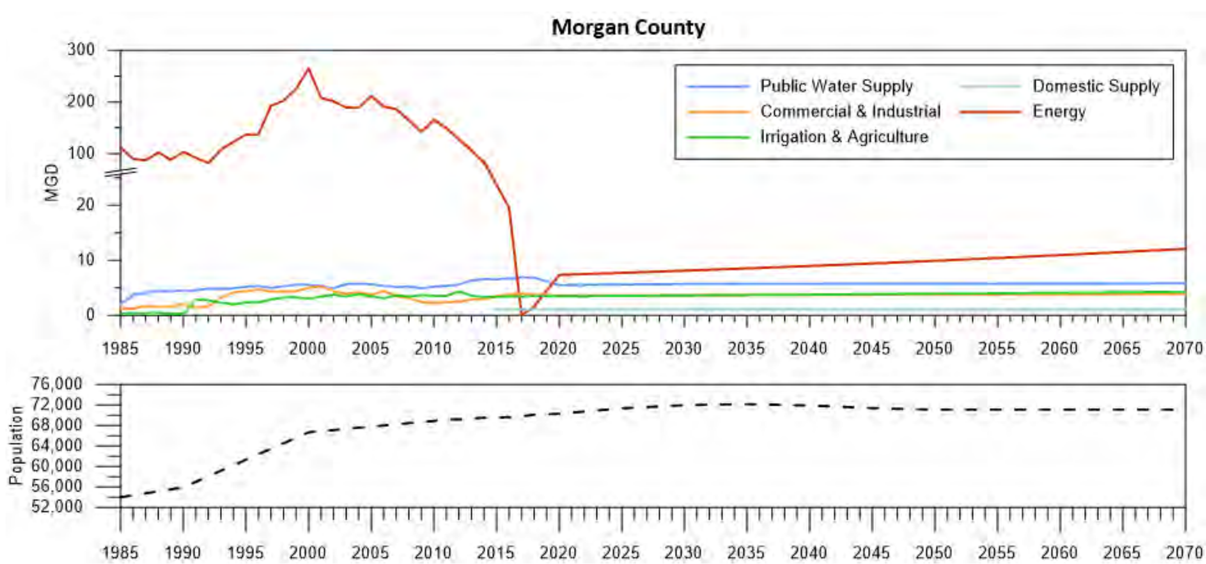

Figure G.8: Historical and future water withdrawals estimated for Morgan County from 1985-2070 in MGD.

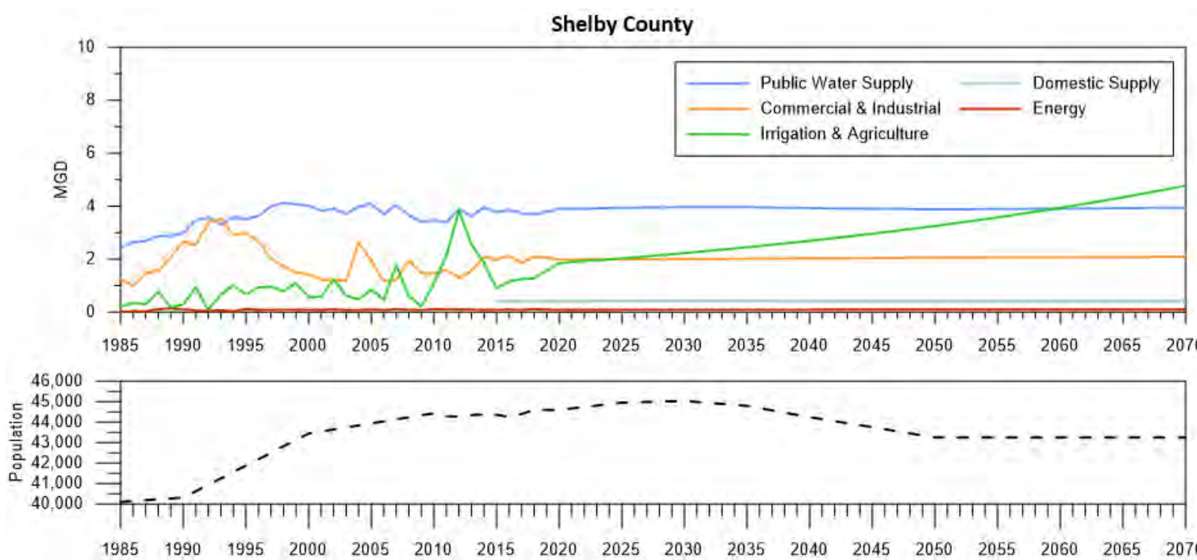

Figure G.9: Historical and future water withdrawals estimated for Shelby County from 1985-2070 in MGD.