Chapter 2

Public Water Supply (PWS)

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

2.1 Background

The public and self-supplied domestic water supply sector includes the water withdrawals for domestic residential and community use and/or consumption. This chapter includes the water withdrawals that are 1) treated and served to the public from a central location, such as a water utility, and 2) self-supplied domestic withdrawals which involves a homeowner with a private well that provides water to his/her own property. Public water supply (PWS) includes water delivered to residential homes, commercial and industrial facilities, institutions, and governmental users. PWS water is typically supplied by a publicly-owned or privately-owned utility and is regulated by the United States Environmental Protection Agency (EPA). The EPA defines a public water system as a system that serves at least 25 people or 15 service connections for at least 60 days per year [USEPA, 2004]. The water quality for public-water systems must be monitored regularly and must sustain contaminant concentrations below the maximum contaminant level (MCL). In Illinois the amount of water used by public systems is reported through a voluntary reporting system to the Illinois State Water Survey (ISWS) on an annual basis. This ISWS historical water-withdrawal database was the primary source of data used in this study. The following sections describe the process used to estimate future water withdrawals for PWS and domestic supply.

2.2 PWS multiple regression method

The general purpose of multiple regression is to learn more about the relationship between several independent variables (*e.g.* temperature, income, etc.) and a dependent variable (*e.g.* per capita water withdrawals). Multiple regression can establish that a set of independent variables explains a portion of the variance for a dependent variable at a significant level (through a significance test of R^2), and can establish the relative predictive importance of each of the independent variables. For the PWS sector, a log-linear model was created to capture the relationship between per capita water demand and temperature, precipitation, marginal price, median household income, employment/population ratio, and conservation trend. The statistical model explains the variability of per capita water demand as a function of these six variables which are described in Section 2.4.3. The resulting equation is then used to estimate future water withdrawals. The multiple regression method is described in greater detail in Chapter 1.

2.2.1 PWS study areas

For all other water sectors in this study, water withdrawal is examined only on a county level. For the public supply sector, additional study areas were selected for each county in order to more accurately estimate water withdrawals in these areas. Because water demand in large municipalities may differ from the rest of the county, it is important to study these areas individually. At least one municipality was selected from each county to be a study area. A municipality was selected if, in 2000, it had a population greater than 5,000 and/or had a growth rate greater than 50% from 1990 to 2000. For those counties that did not have a municipality that met these requirements, a study area was selected based upon the largest population in the county. A total of 26 municipalities were selected (Figure 2.1 and Table 2.1). In addition, PWS water withdrawals were estimated in the 15-county rural areas which represent the balance of a county area outside selected municipalities in each county. These areas are called county remainders throughout this report. Therefore, a total of 41 study areas are included in the study (15 county remainders and 26 municipalities).

2.3 Self-supplied domestic unit-use coefficient method

The self-supplied domestic water withdrawals were estimated using a unit-use coefficient method. For this calculation, the number of people in each county that supply their own water via private wells was multiplied by an average daily use (82 gallons per day per person). The average daily use of 82 gallons per day per person is based upon average per capita withdrawals for various residential communities in East-Central Illinois [Tim Bryant, personal communication, March 10, 2008]. The self-supplied domestic population was calculated by subtracting the publicly supplied portion of the population from the total county population. Population calculations were done for historical data years (1985-2005) and for the future based upon county population projections (2010-2050) [DCEO, 2005]. The self-supplied domestic historical population and population projections are provided in Section 2.6.1.2. Future water withdrawal estimates are shown in Section 2.8.4.

2.4 PWS historical data

In order to create a multiple regression model to analytically understand the relationship between water withdrawals and the selected water demand variables, historical data of water withdrawals and independent variables were collected for the years 1985, 1990, 1995, 2000, and 2005. Water withdrawals and the demand variables were analyzed during this historical period to establish the

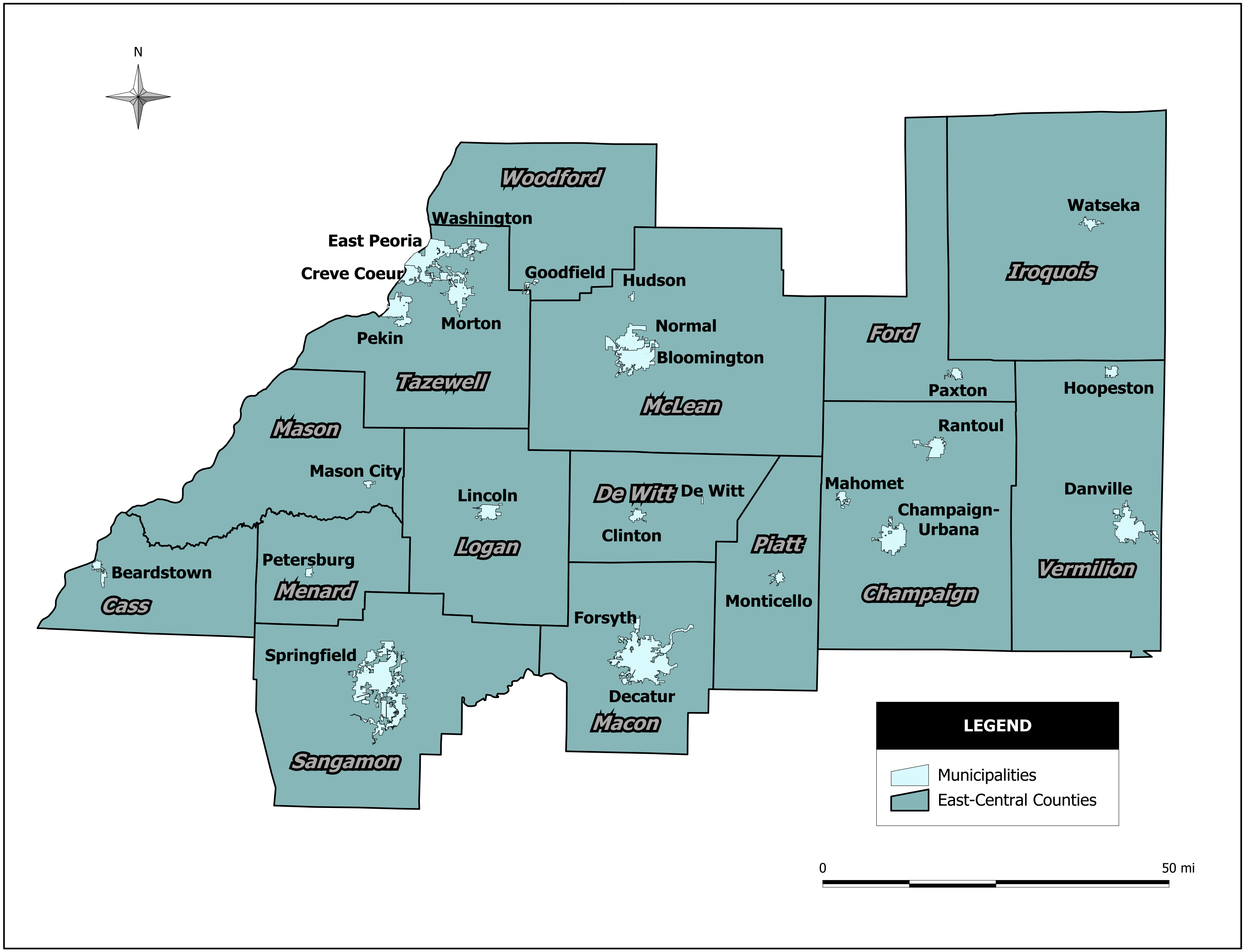


Figure 2.1: Map of 26 public water supply study areas modeled in addition to the 15 counties within the East-Central Region.

Table 2.1: The 26 public water supply study areas that were modeled in addition to the 15 counties within the East-Central Illinois Region [Census, 2000].

County	PWS Study Area	Percent Growth (1990-2000)	Population (2000)
Cass	Beardstown	9.4	5,766
Champaign	Rantoul	-25.3	12,857
Champaign	Mahomet	57.2	4,877
Champaign	Champaign/Urbana	6.3*	103,913
DeWitt	DeWitt	54.1	188
DeWitt	Clinton	0.6	7,485
Ford	Paxton	5.5	4,525
Iroquois	Watseka	4.5	5,670
Logan	Lincoln	-0.3	15,369
Macon	Decatur	-2.4	81,860
Macon	Forsyth	90.9	2,434
Mason	Mason City	10.1	2,558
McLean	Hudson	50.1	1,510
McLean	Normal	13.4	45,386
McLean	Bloomington	24.7	64,808
Menard	Petersburg	1.7	2,299
Piatt	Monticello	12.9	5,138
Sangamon	Springfield	5.9	111,454
Tazewell	Creve Coeur	-8.3	5,448
Tazewell	Morton	10.1	15,198
Tazewell	Washington	7.3	10,841
Tazewell	East Peoria	5.9	22,638
Tazewell	Pekin	5.0	33,857
Vermilion	Hoopeston	1.6	5,965
Vermilion	Danville	0.2	33,904
Woodford	Goodfield	51.1	686

*Percent growth for Champaign, Illinois; Population is 2000 U.S. Census data.

mathematical relationship between variables which drive the demand for water and water withdrawals. A description of the data and sources is provided in the following sections.

2.4.1 Historical water withdrawals

The data on PWS withdrawals were obtained from Mr. Timothy Bryant, Coordinator of the Illinois Water Inventory Program (IWIP) administered by the Illinois State Water Survey (ISWS). Under this program a questionnaire is sent to all of the nearly 1,800 public water systems in the state and includes questions about water sources, withdrawals, and water deliveries to domestic, commercial, and industrial users [ISWS, 2004]. Although participation by public water supplies is usually high (90% in 2005 statewide), it should be noted that in any given year the database is incomplete. If systems did not complete a survey for the target years, water withdrawals were estimated from data submitted in prior and/or subsequent years.

As discussed in Chapter 1, the data may also differ in what type of system data was reported to the ISWS. Some utilities may report the amount of water that is withdrawn directly from the source while others may report the amount of water that was sold to customers in a given year. Reporting the amount that is directly withdrawn from the source includes unaccounted for water (i.e., water for which no one pays, such as leaks and fire protection). Reporting only the amount of water sold, does not reflect the true amount being withdrawn from a water source. The amount of unaccounted for water differs from system to system and from year to year. In the United States, the average is 3.3-12.7%, although some systems may have a much higher percent unaccounted for water [van der Leeden, 1990].

And some utilities sell water on a wholesale basis to other utilties. Some utilities with such sales combine the wholesale amount and the amount used to supply their retail customers in their report, while others only include the amount for their retail customers. Additionally, when the wholesale supplier includes the wholesale amount in its report, and the wholesale purchasing utility also reports, there is double counting. Therefore, uncertainty is added to the historical withdrawals due to inaccurate reporting that can lead to over and under estimating the amounts of water withdrawals from public water supplies.

The water withdrawals from each reporting system were aggregated for each of the 26 public supply study areas and 15 county remainder areas. The historical water withdrawals for each study area is provided in Table 2.2.

As the data presented in Table 2.2 shows, most of the pubic water supply study areas increased their withdrawals from 1985 to 2005. The total public water supply withdrawals increased from 109.6 MGD in 1985 to 137.0 MGD in 2005. These increases are at least partly due to an increase in population in the region. However, the change may also be caused by increases in water demand due to weather or other factors like income.

The data for the each study area also show variability from year to year; water withdrawals may increase one year and decrease another. For example, if one year has a very hot, dry summer, water withdrawals may increase that particular year while the next year withdrawals decline due to a cooler summer. Or, perhaps there was a decrease in water withdrawals because there were job layoffs and household income declined for a few years. The variability in reasons or possible explanations for increases or decreases in water withdrawals shows the importance of using a multiple regression model. The model is designed to capture, or explain, the withdrawals using multiple independent variables that all impact water withdrawals.

All of the historical data was used as reported from the ISWS, with one exception. In 2001, the City of Decatur's public water supply system sold one of its water treatment plants to Archer Daniels Midland (ADM), a local industry. Prior to this year, Decatur sold water to ADM. The sale of the treatment plant in 2001 is evidenced in historical withdrawals as a drop in water withdrawals for Decatur (approximately 15 MGD in 2005). This decrease in withdrawals for 2005 creates a large decrease in per capita water withdrawals for Decatur as compared to other years. Conversely, in the Commercial and Industrial (C&I) Sector (Chapter 4), there is a large increase in the withdrawals in 2005. Because the model is designed to capture only changes in withdrawals that relate to the six independent variables, and not the change of large volumes of water from one sector to another, we removed this sectoral change from the historical data. The removal of the sector change was done by subtracting the amount of water that was sold to ADM in previous historical years (1985, 1990, 1995, and 2000) from Decatur's withdrawals. ADMs purchased amounts were removed from PWS and added to the withdrawals in the C&I Sector. This alteration better enables the model, which is based upon the historical data, to capture the other changes in water withdrawals. The modification in the historical withdrawals data is noted in the graphs and tables throughout the report.

Table 2.2: Historical water withdrawals (in MGD) for each public supply study area in East-Central Illinois.

Study Area	County	1985	1990	1995	2000	2005
Beardstown	Cass	1.51	1.44	1.04	1.26	1.30
Cass County Rem.	Cass	0.31	0.42	0.39	0.46	0.36

MGD = million gallons per day; Rem. = remainder.

Source: Illinois Water Inventory Program, Illinois State Water Survey, 2007.

* Water withdrawals for Decatur have ADM pumpage removed for all years. See text for explanation.

Table 2.2: Historical water withdrawals (in MGD) for each public supply study area in East-Central Illinois.

Study Area	County	1985	1990	1995	2000	2005
Champaign/Urbana	Champaign	16.66	17.29	18.87	20.46	23.24
Mahomet	Champaign	0.23	0.25	0.29	0.47	0.54
Rantoul	Champaign	1.38	1.13	1.29	1.55	1.67
Champaign County Rem.	Champaign	1.66	1.79	1.76	1.17	1.12
Clinton	DeWitt	1.01	1.00	1.09	0.87	0.87
DeWitt	DeWitt	0.01	0.02	0.02	0.02	0.01
DeWitt County Rem.	DeWitt	0.39	0.38	0.37	0.43	0.40
Paxton	Ford	0.55	0.49	0.61	0.70	0.56
Ford County Rem.	Ford	0.81	0.91	1.12	1.16	1.12
Watseka	Iroquois	1.47	1.60	1.62	1.65	1.61
Iroquois County Rem.	Iroquois	0.58	0.60	0.72	0.66	0.58
Lincoln	Logan	2.82	2.62	2.57	2.69	2.94
Logan County Rem.	Logan	0.68	0.64	0.73	0.66	0.66
Decatur*	Macon	16.77	20.33	23.46	25.59	23.64
Forsyth	Macon	0.12	0.16	0.29	0.31	0.41
Macon County Rem.	Macon	1.28	1.42	1.55	1.23	1.28
Mason City	Mason	0.27	0.33	0.32	0.27	0.27
Mason County Rem.	Mason	0.68	0.77	0.85	0.70	0.56
Bloomington	McLean	8.19	9.84	11.35	12.39	11.23
Hudson	McLean	0.07	0.08	0.09	0.11	0.14
Normal	McLean	3.43	3.94	3.79	4.22	4.29
McLean County Rem.	McLean	1.54	1.60	1.85	1.93	1.80
Petersburg	Menard	0.39	0.31	0.33	0.36	0.36
Menard County Rem.	Menard	0.26	0.27	0.36	0.44	0.39
Monticello	Piatt	0.73	0.62	0.68	0.67	0.72
Piatt County Rem.	Piatt	0.52	0.52	0.55	0.50	0.49
Springfield	Sangamon	17.78	20.75	21.45	20.84	22.94
Sangamon County Rem.	Sangamon	2.21	2.34	2.35	2.26	1.83

MGD = million gallons per day; Rem. = remainder.

Source: Illinois Water Inventory Program, Illinois State Water Survey, 2007.

* Water withdrawals for Decatur have ADM pumpage removed for all years. See text for explanation.

Table 2.2: Historical water withdrawals (in MGD) for each public supply study area in East-Central Illinois.

Study Area	County	1985	1990	1995	2000	2005
Creve Coeur	Tazewell	0.59	0.74	0.79	0.83	0.93
East Peoria	Tazewell	2.32	2.09	2.40	2.59	2.73
Morton	Tazewell	2.02	2.12	2.34	2.28	2.68
Pekin	Tazewell	4.41	4.57	5.30	6.39	7.42
Washington	Tazewell	1.12	0.82	1.08	0.94	1.16
Tazewell County Rem.	Tazewell	3.18	3.63	3.12	2.95	2.76
Danville	Vermilion	8.15	10.02	8.46	8.35	8.34
Hoopeston	Vermilion	0.80	0.66	0.79	0.45	0.56
Vermilion County Rem.	Vermilion	1.18	1.20	1.32	0.80	0.79
Goodfield	Woodford	0.04	0.04	0.04	0.06	0.09
Woodford County Rem.	Woodford	1.44	1.57	2.13	2.23	2.24
East-Central Illinois		109.63	121.37	129.61	134.01	137.03

MGD = million gallons per day; Rem. = remainder.

Source: Illinois Water Inventory Program, Illinois State Water Survey, 2007.

* Water withdrawals for Decatur have ADM pumpage removed for all years. See text for explanation.

2.4.2 Population served

The population served is the number of residents that a public water supplier serves. Population served is used to calculate the gallons per capita per day withdrawals (GPCD) in the historical dataset. The GPCD is calculated by dividing the total water withdrawals in a study area by the total population served in that study area. The historical population served data that was used is provided in Appendix B.

Population served is reported to the ISWS annually. Typically, the population served is the census population of a city. However, it is not unusual for population served to be larger than the census population if a public water supplier supplies subdivisions or communities outside corporate boundaries and sometimes even outside the county. Population served can also be smaller if a section of a municipality is served by another water supply system or if some residences rely on private wells. For example, the City of Decatur also serves Mount Zion, so the population served for Decatur is the city's population plus the population of Mount Zion.

Population served is an important driver of water withdrawals. In fact, 97% of variability in the total public water supply withdrawals can be explained by population. Therefore, population served was used to express the dependent variable as average public-supply water withdrawals (and purchases) per capita per day for each study area and data year. If the per capita rate of water withdrawals in each study area can be predicted with sufficient accuracy, then total public supply withdrawals can be estimated by multiplying the per capita use by population served, where the latter represents a driver of public-supply demands.

2.4.3 Independent variables

Water withdrawals are driven, or controlled, by certain influencing factors called independent or explanatory variables. A substantial data collection and processing effort was required to prepare appropriate variables for the development of water-demand relationships. The dependent variable was defined as gross water withdrawals per capita. Six independent variables were used to explain the variability of per capita water demand across study sites. These six variables were chosen based upon a previous study of Illinois water withdrawals [Dzielgielewski et al., 2005] in which over 20 variables were tested to determine if they significantly affected water demand. The variables used in this study include: marginal price of water, median household income, ratio of employment-to-population, summer season air temperature, summer season precipitation, and conservation trend. The data and source information for each of these variables are discussed in the following sections.

2.4.3.1 Marginal price of water

Studies across the United States (US) show that when the price of water increases, people use less water [JAWRA, 2008]. In fact, as many regions of the US are trying to reduce water demand and conserve water, price has become an important tool. So, price is an important water demand variable. In this study, marginal price is defined in this study as the cost difference in the total water bill between 5,000 gallons and 6,000 gallons of monthly usage. Using marginal price allows us to compare prices of different public water suppliers without the complication of other user-fees and billing frequency.

During the outreach portion of this project, each PWS system was asked to provide their historical marginal price data. These data were used preferentially, when they were available. Additional data on historical water prices were developed using data from a survey of water prices in Illinois systems conducted in 2003 (Dziegielewski et al., 2004). The historical marginal price data that was used is provided in Appendix B. All price data was converted to 2005 dollars.

2.4.3.2 Median household income

Median household income is positively related to water demand, meaning as median household income increases so does water demand. People who have more money tend to have larger houses with more bathrooms and larger properties with irrigation systems. People with less money have smaller houses and smaller yards. Additionally, people with less money are more conscious of where their money is being spent and may reduce use in order to reduce costs.

Data on median household income were obtained from the U.S. Census Bureau and the 2005 American Community Survey [United States Census Bureau, 2000]. Data for the inter-decadal years were calculated as an average of the census years prior to and after the year. All median household income data were converted to 2005 dollars. The historical median household income data that was used is provided in Appendix B.

2.4.3.3 Employment to population ratio

The employment to residential population ratio is positively correlated to water demand. Higher employment in an area means greater water withdrawals. Historical county and city data for employment were obtained from the U.S. Department of Labor, Bureau of Labor Statistics [2007]. The data show the total number of people employed, including governmental and institutional employment. The values for the county remainders were calculated by subtracting the PWS study areas from the total employment in that county. The historical employment to population ratio that was used for each study area is provided in Appendix B.

2.4.3.4 Summer temperature and summer precipitation

Temperature and precipitation are both important drivers of water demand. Temperature is positively correlated to water demand whereas, precipitation is negatively correlated to demand. When temperatures increase, people use more water. They use more to water their gardens and wash their cars. And often people take more showers when it is hotter. Conversely, when it rains people use less water to irrigate their lawn and gardens. The summer period is important to water withdrawals because that is the time when the greatest water demand occurs in the region; it is typically the hottest and driest time of year.

The correlation of weather to water withdrawals indicates that climate change will impact water demand in the region. Although, we do not account for it in our three scenarios, we do examine the possible effects of climate change and drought in Chapter 6. Please refer to this chapter for more discussion about climate change and the impacts to water withdrawals.

Data on weather variables were obtained from Dr. Jim Angel, State Climatologist, Illinois State Water Survey. Data from 29 stations in the 15-county region were organized and summarized. The weather station numbers and locations used for this study are listed in Table B.14 in Appendix B.

Total rainfall from May 1 through September 30 was summed and used as the summer precipitation variable. Maximum monthly temperature from May 1 through September 30 was averaged as the summer temperature variable.

The weather variables assigned to each county were the average of all the stations in that particular county. If there were no stations in a county or no data from the existing station, data from a surrogate station were used. Typically, the surrogate station used was the nearest station to the county in question. The surrogate stations were chosen with the advice of the State Climatologist. For the 26 PWS study areas, weather data were preferentially used from a station in that city; if such observations were unavailable, the average county data were used.

The historical maximum summer temperature and summer precipitation data used for each study area are shown in Table B.16 in Appendix B.

2.4.3.5 Conservation trend

An additional variable, conservation trend, was included to account for unspecified changes that are likely to influence water demand over time and that represent general trends in water conservation behavior. Such influences include the increase in water-use awareness programs, implementation of Federal laws mandating adoption of water conservation technologies, and a new emphasis on adoption of full-cost pricing of water. The conservation trend variable was specified as 0 for 1985, 5 for 1990, 10 for 1995, 15 for 2000, and 20 for the year 2005.

2.5 PWS water-withdrawal relationships

The historical data on per capita water withdrawals and the historical data for the six variables was used to generate a log-linear model. The model (specified as Equation 1.1 in Chapter 1) was applied to capture the relationship between per capita water demand and the explanatory variables. The statistical model explained per capita water demand as a function of the average of the monthly maximum daily air temperatures during summer - May 1 through September 30 (summer temperature), total precipitation during summer (summer precipitation), ratio of employment to resident population, marginal price of water, median household income, and the conservation trend variable.

Table 2.3: The structural portion of the log-linear model for per capita water withdrawals in the public supply sector.

Variables	Coefficients	t-Ratio	Probability >|t|
Intercept	-2.3058	-0.43	0.67
Max. summer temperature (ln)	1.4222	1.2	0.23
Summer precipitation (ln)	-0.1140	-1.67	0.10
Employment-population ratio (%)	0.6381	5.3	<.0001
Marginal price of water (ln)	-0.2226	-3.64	0.00
Median household income (ln)	0.3244	2.99	0.00
Conservation trend (ln)	-0.0026	-0.98	0.33
N = 205, R^2= 0.85, R^2Adj = 0.81, Root MSE = 0.15, Mean R.= 4.74			

The structural portion of the regression model for PWS is shown in Table 2.3. Figure 2.2 shows the sign and relative magnitude of the coefficients of each of the six variables. Together, these six coefficients, or elasticities, compose the equation that explain water withdrawals for PWS. The estimated elasticities of the explanatory variables in the structural model have the expected signs and magnitudes. The constant elasticity of the summer temperature variable indicates that, on average, a 1 percent increase in temperature increases per capita water demand by 1.4 percent. The negative constant elasticity of the summer precipitation variable indicates that, on average, a 1 percent increase in summer precipitation decreases per capita water demand by 0.11 percent. Similarly, a 1 percent increase in marginal price of water is associated with a 0.22 percent decrease in per capita water demand, and a 1 percent increase in median household income results in a 0.32 percent increase in per capita demand. The coefficient of employment-to-population ratio of 0.64 indicates that water withdrawals are higher in study areas with higher commercial/industrial employment relative to resident population per capita. The conservation trend with the estimated coefficient of -0.0026 indicates that in the historical data there was a declining trend in per capita water demand.

The last row of Table 2.3 shows the model statistics. The statistics (R^2= 0.85) indicate that the model explained 85 percent of time-series and cross-sectional variance in log-transformed per capita water use. Please refer to the list of key terms for explanations of the other statistical values shown. The binary and spike variables included in the model are discussed and shown in Appendix B.

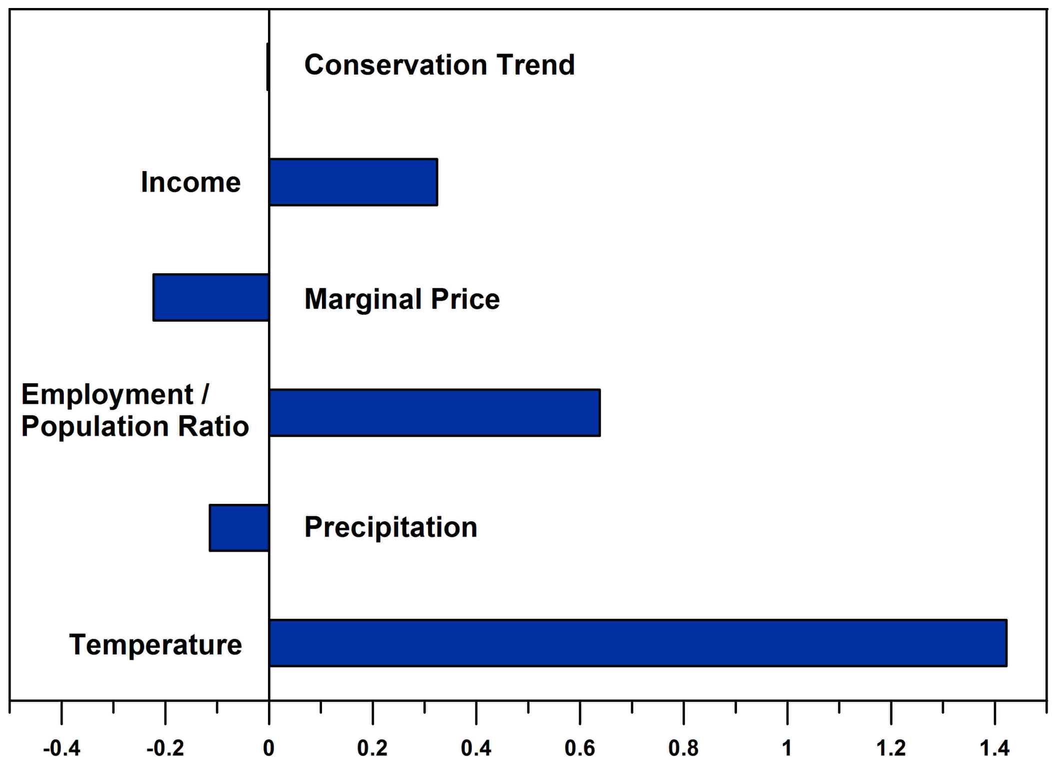


Figure 2.2: Structural model for public water supply sector in East-Central Illinois.

Table 2.4: Examples of estimated elasticities of four explanatory variables in public water supply water-demand models.

Study/Variable Definition	Elasticity	Notes
INCOME		
Griffin and Chang, 1990	0.480	Winter water use
Annual per capita income	0.300	Summer water use
Schneider et al., 1991	0.218	Generalized least-squares model (GLS)
Per capita income	0.458	GLS model with inclusion of cross-sectional dummy variables
	0.144	GLS with inclusion of time series dummy variables
	0.309	GLS with inclusion both cross-sectional and time series dummy variables
PRICE		
Berk et al., 1980	-0.090	Monthly water use
Marginal price		
Griffin and Chang, 1990	-0.160	Winter water use
Average water price	-0.380	Summer water use
Schneider and Whitlach, 1991	-0.066	Generalized least-squares model (GLS)
Marginal water cost	-0.057	GLS model with inclusion of cross-sectional dummy variables
	-0.114	GLS with inclusion of time series dummy variables
	-0.049	GLS with inclusion both cross-sectional and time series dummy variables
	-0.137	From partial adjustments, generalized least-squares model with time series dummy variables
PRECIPITATION		
Berk et al., 1980	-0.012	Pooled analysis of monthly data
Total monthly rainfall		
Schneider and Whitlach, 1991	-0.056	Generalized least-squares model (GLS)
Precipitation during	-0.068	GLS model with inclusion of cross-sectional dummy variables

Table 2.4: Examples of estimated elasticities of four explanatory variables in public water supply water-demand models.

Study/Variable Definition	Elasticity	Notes
summer (May-August)	-0.046	Partial adjustments, generalized least-squares model with time series dummy variables
TEMPERATURE		
Berk et al., 1980 Mean monthly temperature	1.370	Pooled cross-sectional time-series data

The estimated elasticities of the main variables in the structural model confirm the estimates obtained in other studies of municipal water demand. Table 2.4 shows the elasticities of income, price, precipitation and temperature which were reported in three previous studies.

Table 2.4 shows six estimates of per capita income elasticity. All reported elasticities are positive and range from 0.144 to 0.48. The data used in the two studies (Griffin et al., 1990 and Schneider, 1991) were pooled time-series and cross-sectional data – the same data configuration was used in the present study.

All eight price elasticity estimates (Table 2.4) are negative and range from -0.05 to -0.38. These elasticities indicate that municipal water demand is generally inelastic with respect to price. The highest (absolute) value of -0.38 is for summer season water use, which is expected to be more elastic than non-seasonal (or indoor use). There appears to be a relatively narrow range of estimated elasticities of municipal winter season and annual water demand (also captured by monthly models) with respect to price of –0.05 to –0.16.

Table 2.4 includes several estimates of the elasticity of municipal demand with respect to the weather variables. All four reported elasticities of precipitation are negative and range from -0.012 to -0.068. These values indicate relatively low responsiveness of municipal demand to changes in precipitation. The estimated elasticity of municipal demand with respect to air temperature in the study by Berk et al. [1980] is positive 1.37, demonstrating the expected relationship between water use and temperature.

The equations from the model were used to generate both the historical and future water withdrawals in each of the 41 study areas. Figure 2.3 shows the model-generated GPCD versus the historical reported GPCD for the years 1985-2005. The figure shows that the model approximates the reported GPCD well for most of the study areas. Of course, as in any dataset of this nature, there are outliers that are not captured by the model, but overall, the model is able to account for 85% of variance in per capita water demand.

Table 2.5 compares the 2005 model-generated and reported values of combined water withdrawals and purchases for each system and within county remainder areas. The differences between the model generated and reported values are relatively small, since in several cases where the differences for the 2005 data year were large, additional calibrations of model intercepts were performed. The total difference between the model and the reported values for the 15-county region is 1.87 MGD. The calibrated 2005 intercepts were retained in preparing estimates of future water withdrawals.

Table 2.5: Comparison of model-generated and reported water withdrawals in 2005 for public water supply sector.

Study Area	County	Model-generated withdrawals* (MGD)	Reported withdrawals (MGD)	Difference (MGD)
Beardstown	Cass	1.29	1.30	-0.01
Cass County Rem.	Cass	0.47	0.36	0.11
Champaign/Urbana	Champaign	23.24	23.24	0.00
Mahomet	Champaign	0.53	0.54	-0.01
Rantoul	Champaign	1.78	1.67	0.11
Champaign County Rem.	Champaign	1.08	1.12	-0.04
Clinton	DeWitt	0.95	0.87	0.08
DeWitt	DeWitt	0.02	0.01	0.01
DeWitt County Rem.	DeWitt	0.41	0.40	0.01
Paxton	Ford	0.55	0.56	-0.01
Ford County Rem.	Ford	1.25	1.12	0.13
Watseka	Iroquois	0.59	0.58	0.01
Iroquois County Rem.	Iroquois	1.86	1.61	0.25
Lincoln	Logan	2.80	2.94	-0.14
Logan County Rem.	Logan	0.82	0.66	0.16
Decatur	Macon	23.65	23.64	0.01
Forsyth	Macon	0.44	0.41	0.03
Macon County Rem.	Macon	1.28	1.28	0.00
Mason City	Mason	0.30	0.27	0.03
Mason County Rem.	Mason	0.60	0.56	0.04

MGD = million gallons per day; Rem. = remainder;

*Model-generated withdrawals are estimated using actual 2005 weather data.

Table 2.5: Comparison of model-generated and reported water withdrawals in 2005 for public water supply sector.

Study Area	County	Model-generated withdrawals* (MGD)	Reported withdrawals (MGD)	Difference (MGD)
Bloomington	McLean	11.36	11.23	0.13
Hudson	McLean	0.15	0.14	0.01
Normal	McLean	4.24	4.29	-0.05
McLean County Rem.	McLean	1.82	1.80	0.02
Petersburg	Menard	0.42	0.36	0.06
Menard County Rem.	Menard	0.38	0.39	-0.01
Monticello	Piatt	0.75	0.72	0.03
Piatt County Rem.	Piatt	0.48	0.49	-0.01
Springfield	Sangamon	22.90	22.94	-0.04
Sangamon County Rem.	Sangamon	2.04	1.83	0.21
Creve Coeur	Tazewell	0.93	0.93	0.00
East Peoria	Tazewell	2.80	2.73	0.07
Morton	Tazewell	3.18	2.68	0.50
Pekin	Tazewell	7.48	7.42	0.06
Washington	Tazewell	1.31	1.16	0.15
Tazewell County Rem.	Tazewell	2.73	2.76	-0.03
Danville	Vermilion	8.35	8.34	0.01
Hoopeston	Vermilion	0.64	0.56	0.08
Vermilion County Rem.	Vermilion	0.76	0.79	-0.03
Goodfield	Woodford	0.08	0.09	-0.01
Woodford County Rem.	Woodford	2.19	2.24	-0.05
East-Central Illinois		138.9	137.03	1.87

MGD = million gallons per day; Rem. = remainder;

*Model-generated withdrawals are estimated using actual 2005 weather data.

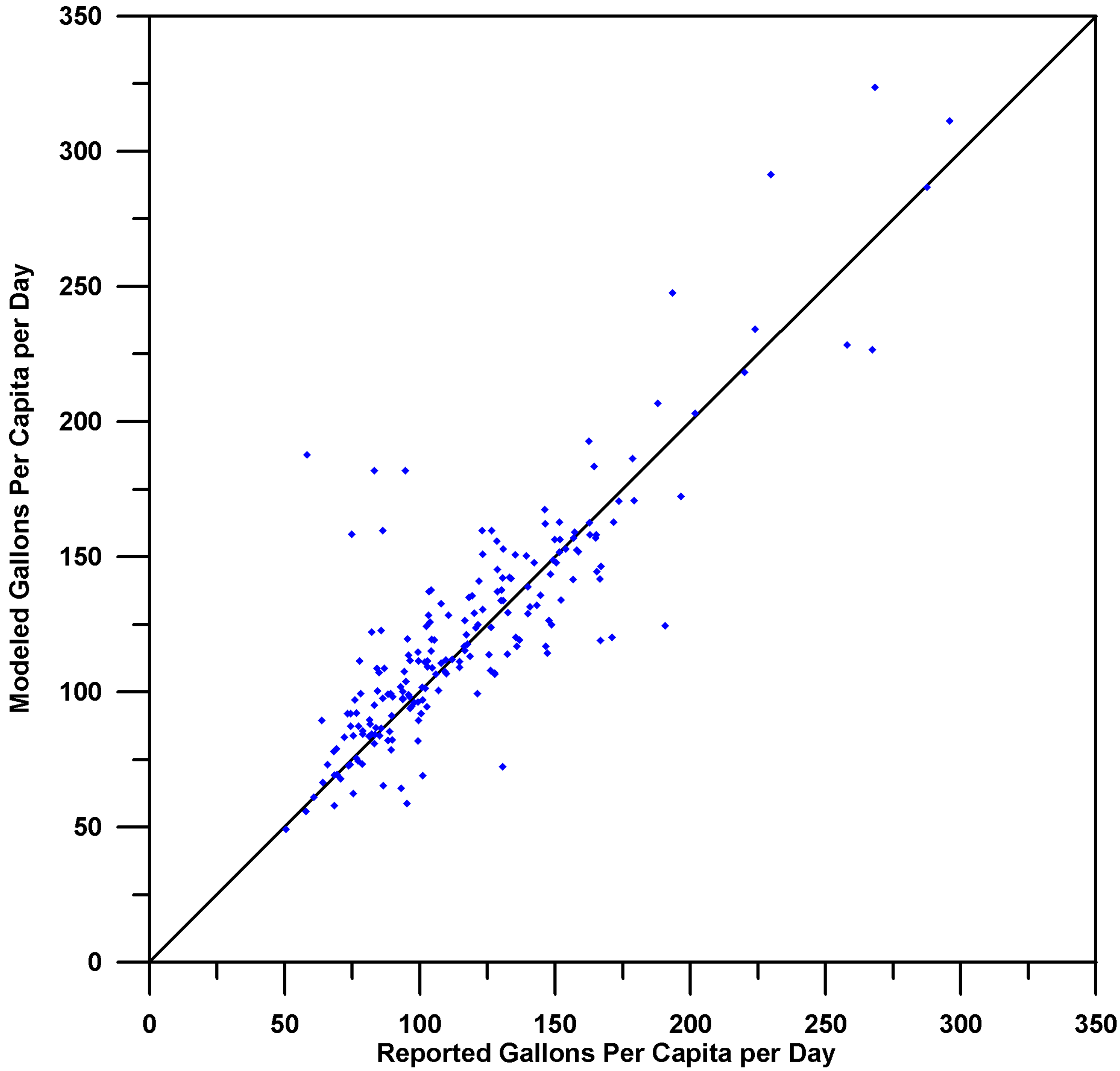


Figure 2.3: Comparison of the historical reported and the model-generated gallons per capita per day water withdrawals from 1985-2005.

2.6 Future data

The public water supply model established the relationship between water withdrawal and the water demand variables. Assuming that this relationship remains the same in the future, we can use the model along with future values of water demand variables to estimate water withdrawals. The following sections describes how the water-demand drivers and variables were projected to the year 2050.

2.6.1 Future population

The main driver of future demand in the PWS sector is population. Data on future resident population of the study area were obtained from the Illinois Department of Commerce and Economic Opportunity (DCEO) [2007]. These data are county-wide population projections to the year 2030. The 2030 to 2050 extension of population projections for the 15-county area was achieved by using the average annual growth rate from the county projection for the years 2020-2030. The method of extension of the projections was approved by John Chiang, Illinois State Demographer.

For the 15-county study area, the total resident population is expected to increase between 2000 and 2050 from 1,033,772 to 1,343,226 (Table 2.6). This represents an increase of 309,454 persons (or 29.9 percent). Graphs of the historical and future resident population for each county are shown in Figures 2.4 – 2.11. The population for each county was used to calculate the PWS population and the domestic supply population, which are described below.

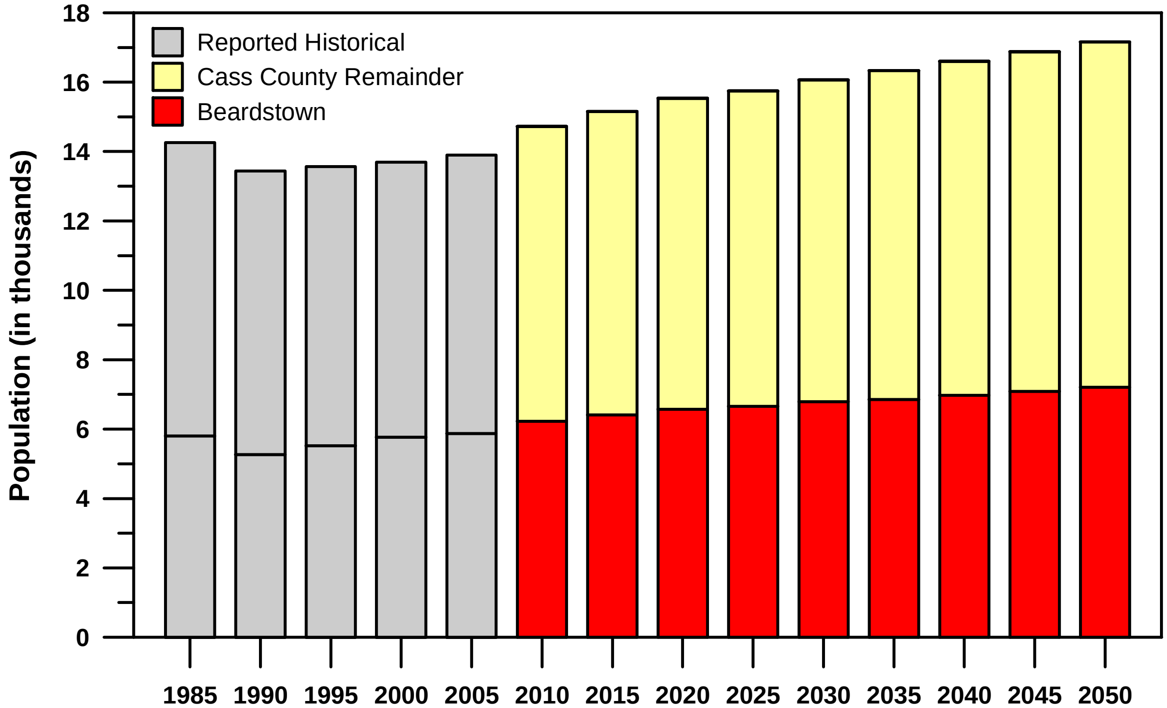
2.6.1.1 PWS population served

The future population served is used to calculate the future water withdrawals in million gallons per day (MGD) by multiplying population served by the model generated GPCD. Because there is no source for data on the future population served, we used future resident population to calculate an estimate of the future population served. In an effort to do this, the relationship between historical residential population and historical population served was analyzed. The general relationship between resident population and population served did not significantly change in the historical years for most of the study areas. However, because of changes in some study areas in 2005, for example Champaign/Urbana increased their population served in 2005 because they began serving additional communities outside their boundaries, the PWS population served was calculated using the 2005 percent of total population. It was assumed, for the purpose of this study, that the 2005 percent of the total population would remain constant into the future. The PWS population served

Table 2.6: Total population for each 15-County East-Central Illinois Region.

County	1990	2000	2030	2050	2000-2050 Change	Percent Change
Cass	13,437	13,695	16,064	17,158	3,463	25.3
Champaign	173,025	179,669	216,958	231,735	52,066	29.0
DeWitt	16,516	16,798	19,768	21,582	4,784	28.5
Ford	14,275	14,241	16,015	17,038	2,797	19.6
Iroquois	30,787	31,334	36,304	39,953	8,619	27.5
Logan	30,798	31,183	32,715	33,845	2,662	8.5
Macon	117,206	114,706	119,693	127,845	13,139	11.5
Mason	16,269	16,038	17,147	17,493	1,455	9.1
McLean	129,180	150,433	199,102	225,300	74,867	49.8
Menard	11,164	12,486	15,195	16,133	3,647	29.2
Piatt	15,548	16,365	18,034	18,620	2,255	13.8
Sangamon	178,386	188,951	222,367	247,655	58,704	31.1
Tazewell	123,692	128,485	165,373	189,378	60,893	47.4
Vermilion	88,257	83,919	80,137	85,937	2,018	2.4
Woodford	32,653	35,469	46,857	53,552	18,083	51.0
East-Central Region	991,193	1,033,772	1,221,729	1,343,226	309,454	29.9

Sources: 1990 and 2000 data from U.S. Census Bureau; 2030 county projections from Illinois Department of Commerce and Economic Opportunity. Note: County values do not include populations served outside of the county.



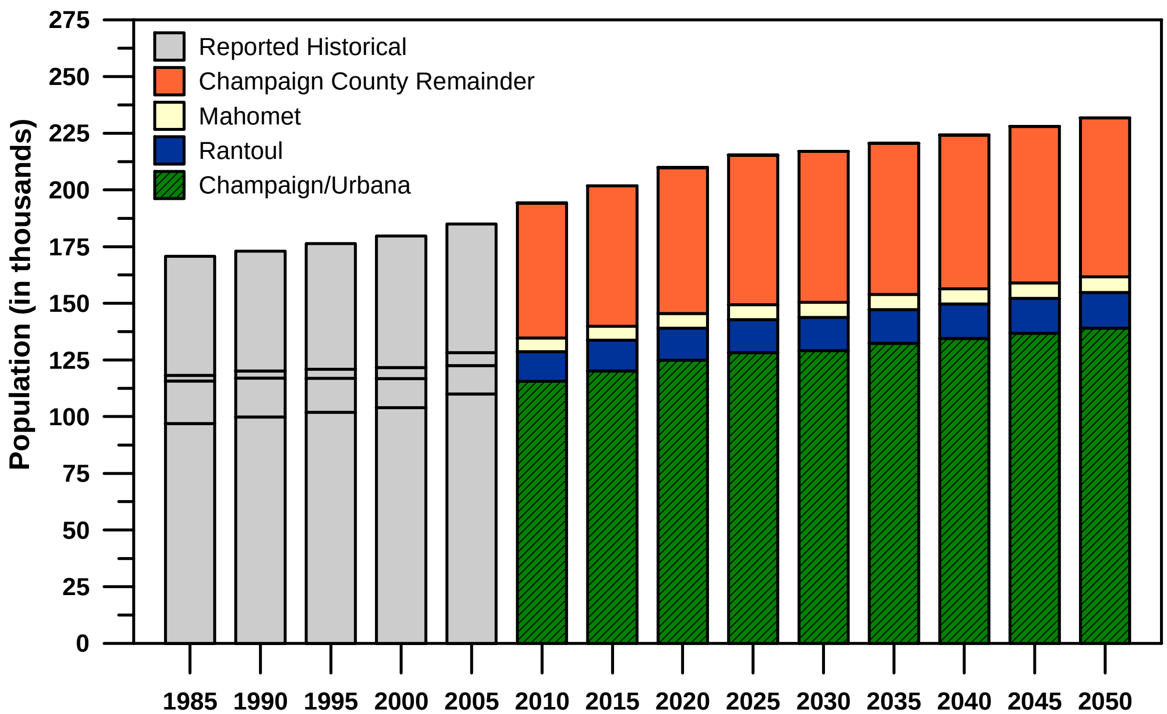


Figure 2.4: Historical and future resident population for the Cass and Champaign County study areas in East-Central Illinois.

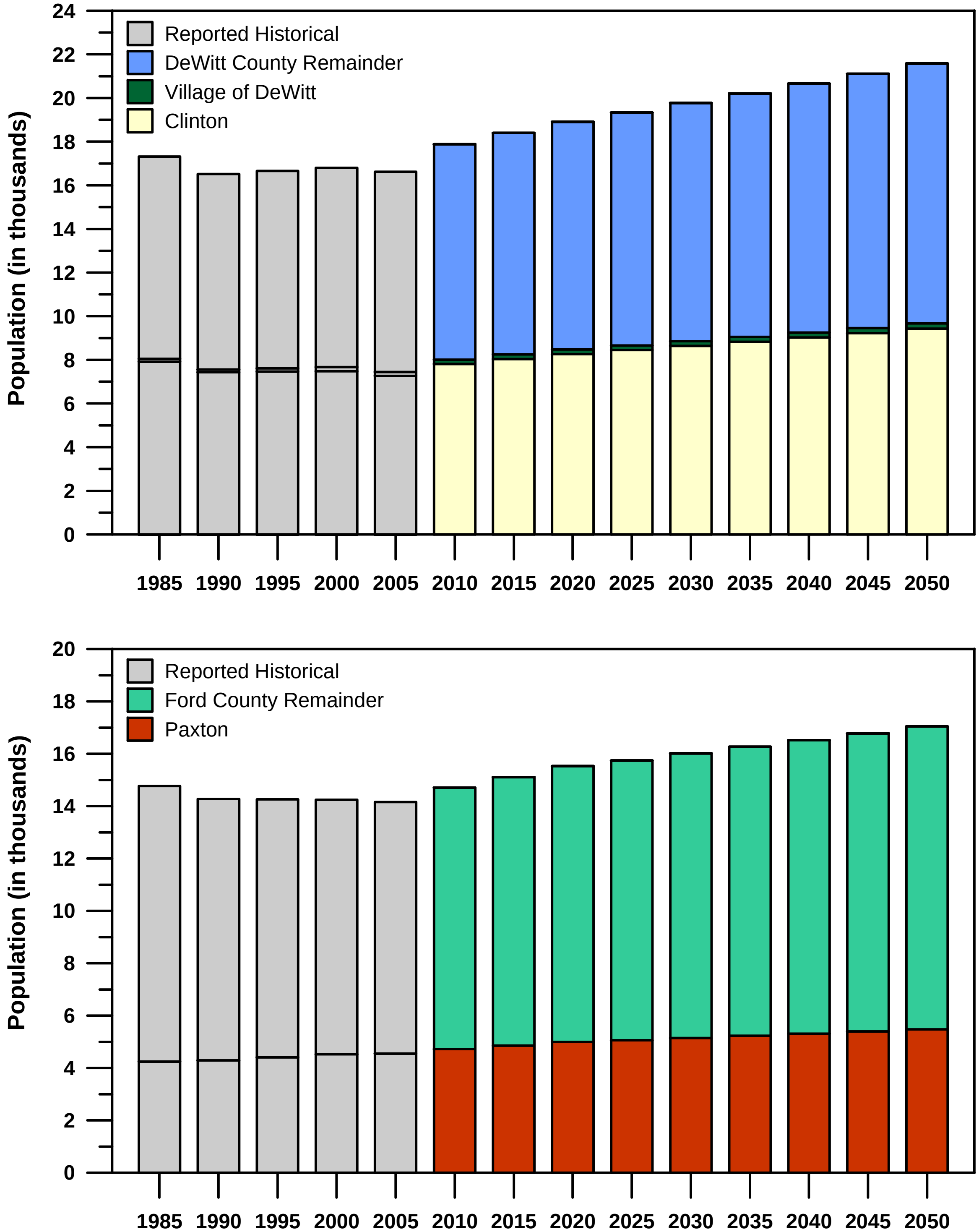


Figure 2.5: Historical and future resident population for the DeWitt and Ford County study areas in East-Central Illinois.

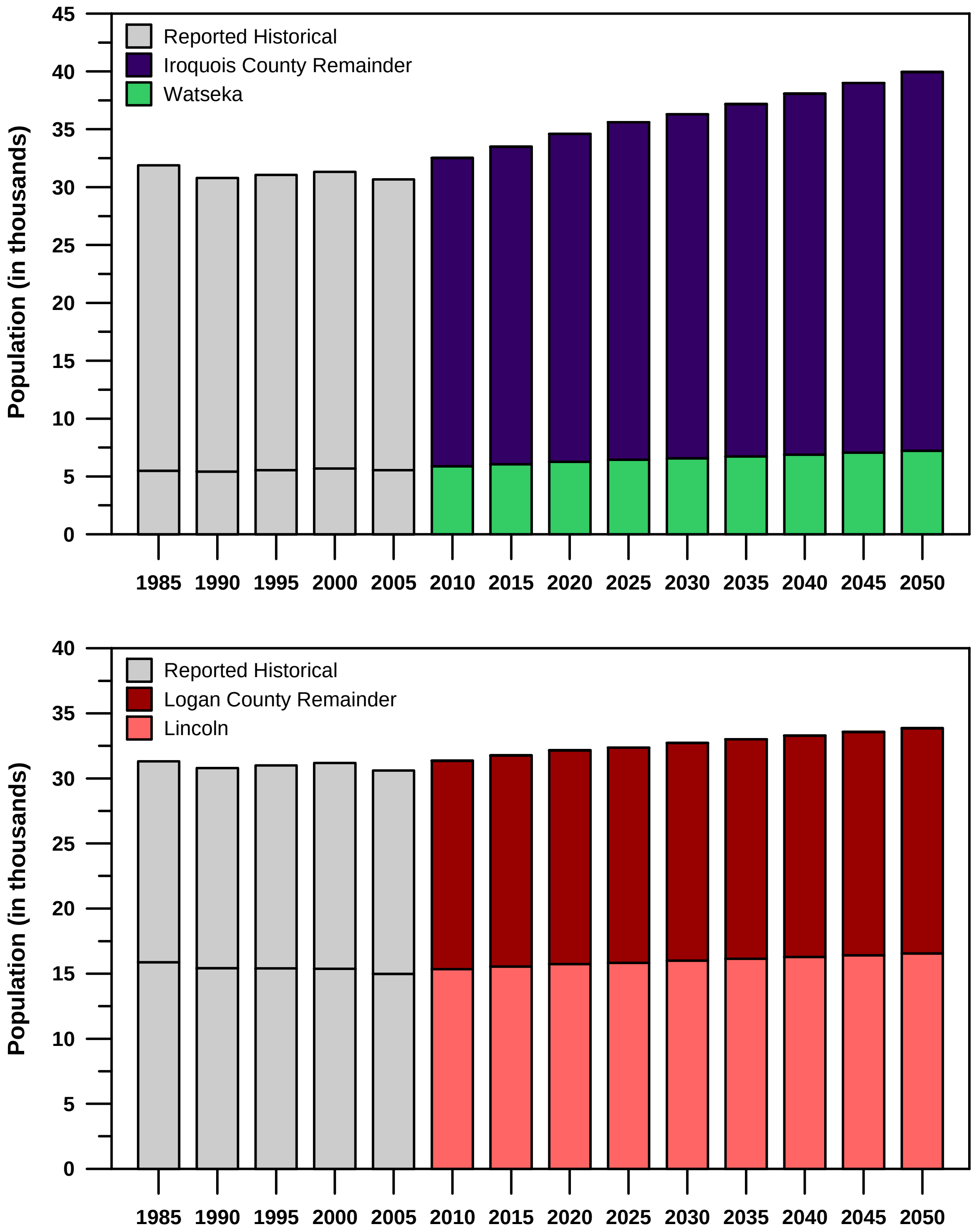


Figure 2.6: Historical and future resident population for the Iroquois and Logan County study areas in East-Central Illinois.

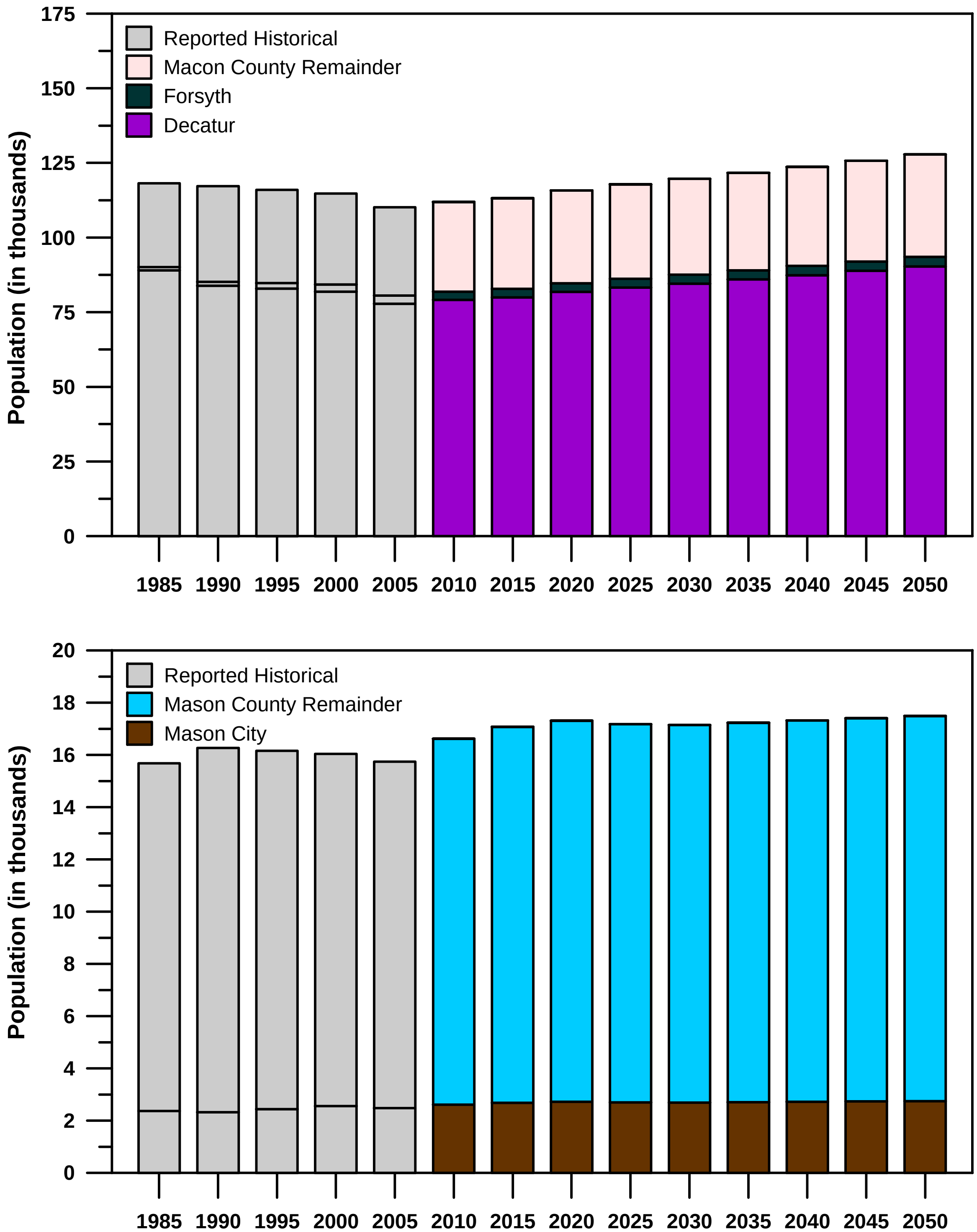


Figure 2.7: Historical and future resident population for the Macon and Mason County study areas in East-Central Illinois.

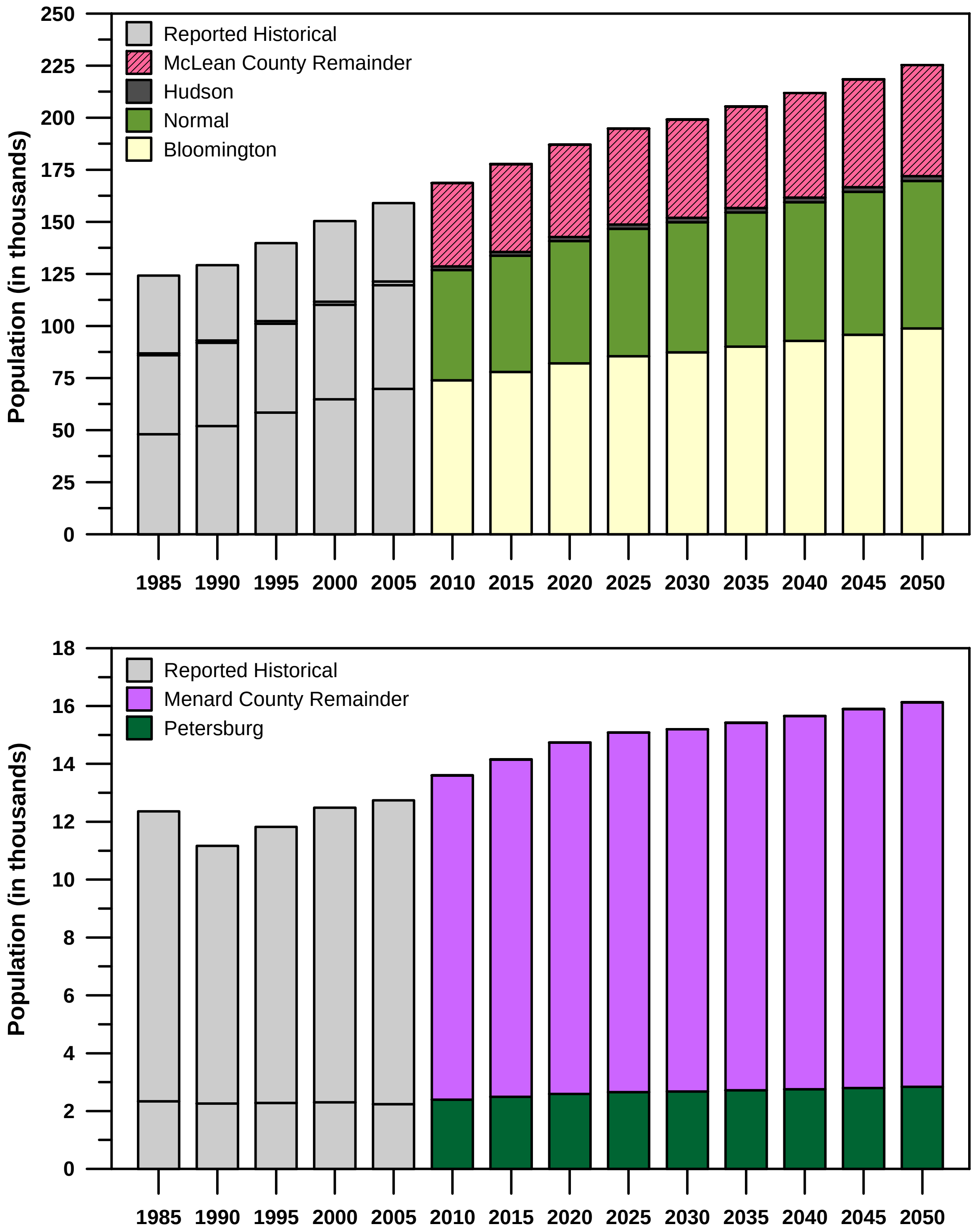


Figure 2.8: Historical and future resident population for the McLean and Menard County study areas in East-Central Illinois.

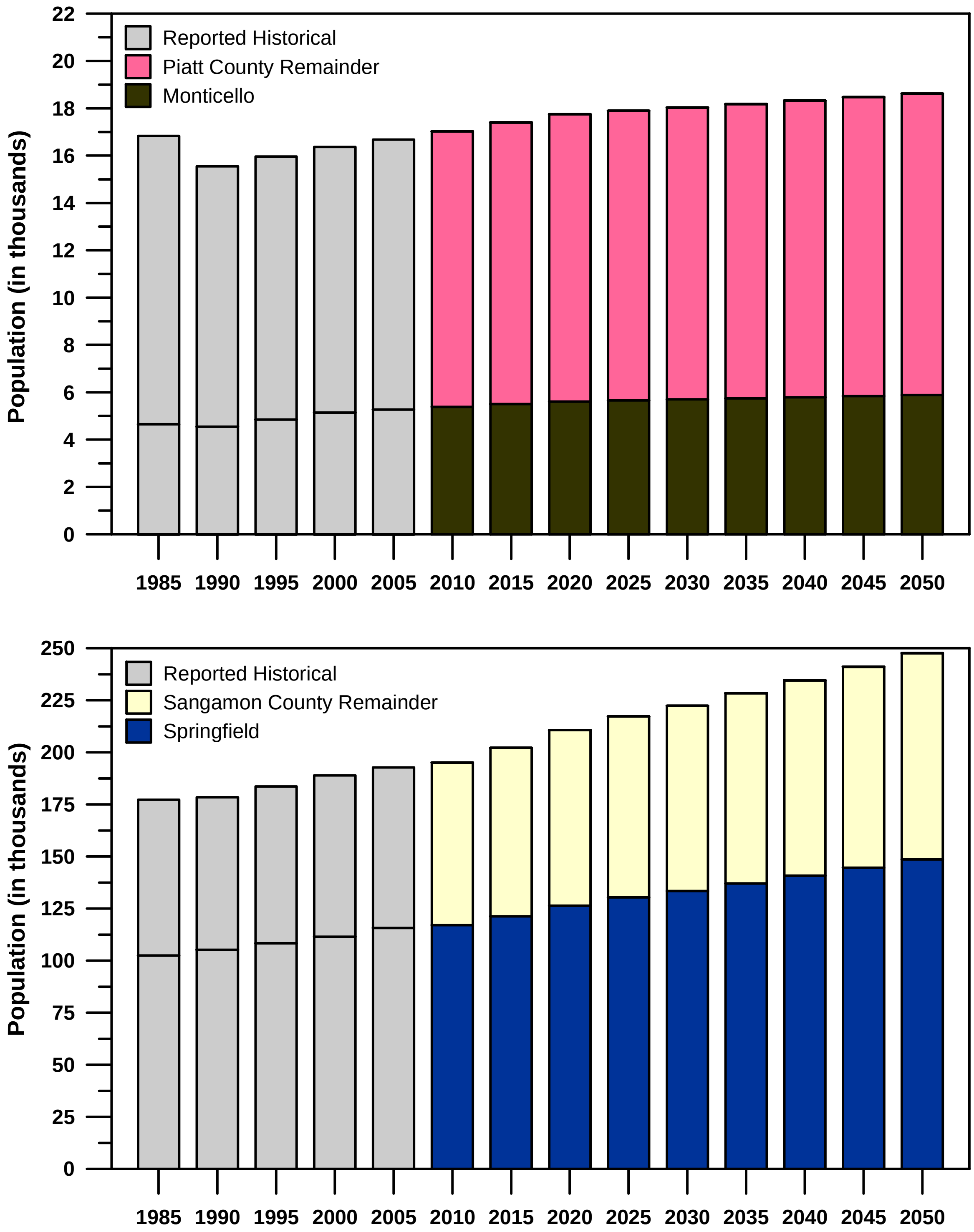


Figure 2.9: Historical and future resident population for the Piatt and Sangamon County study areas in East-Central Illinois.

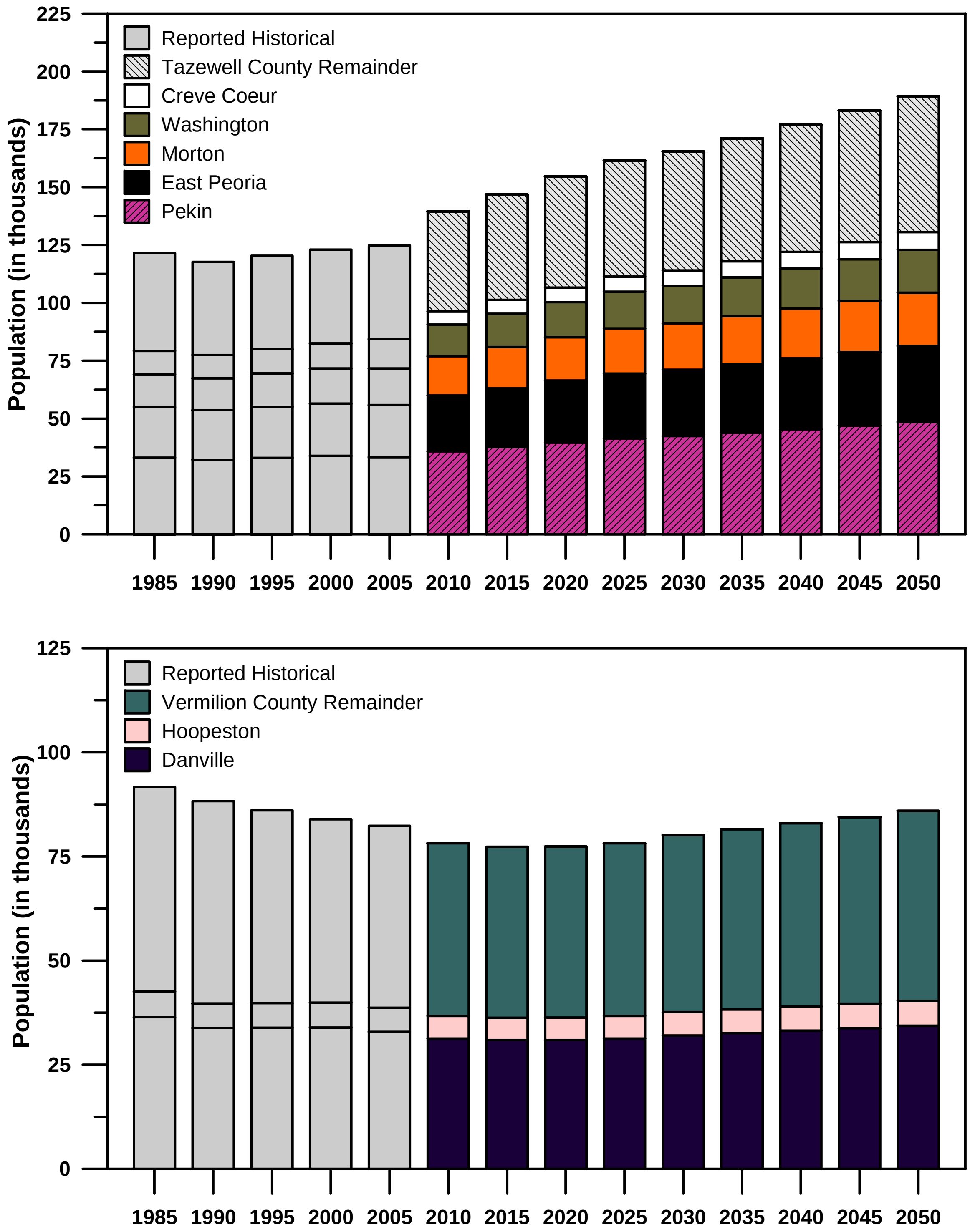


Figure 2.10: Historical and future resident population for the Tazewell and Vermilion County study areas in East-Central Illinois.

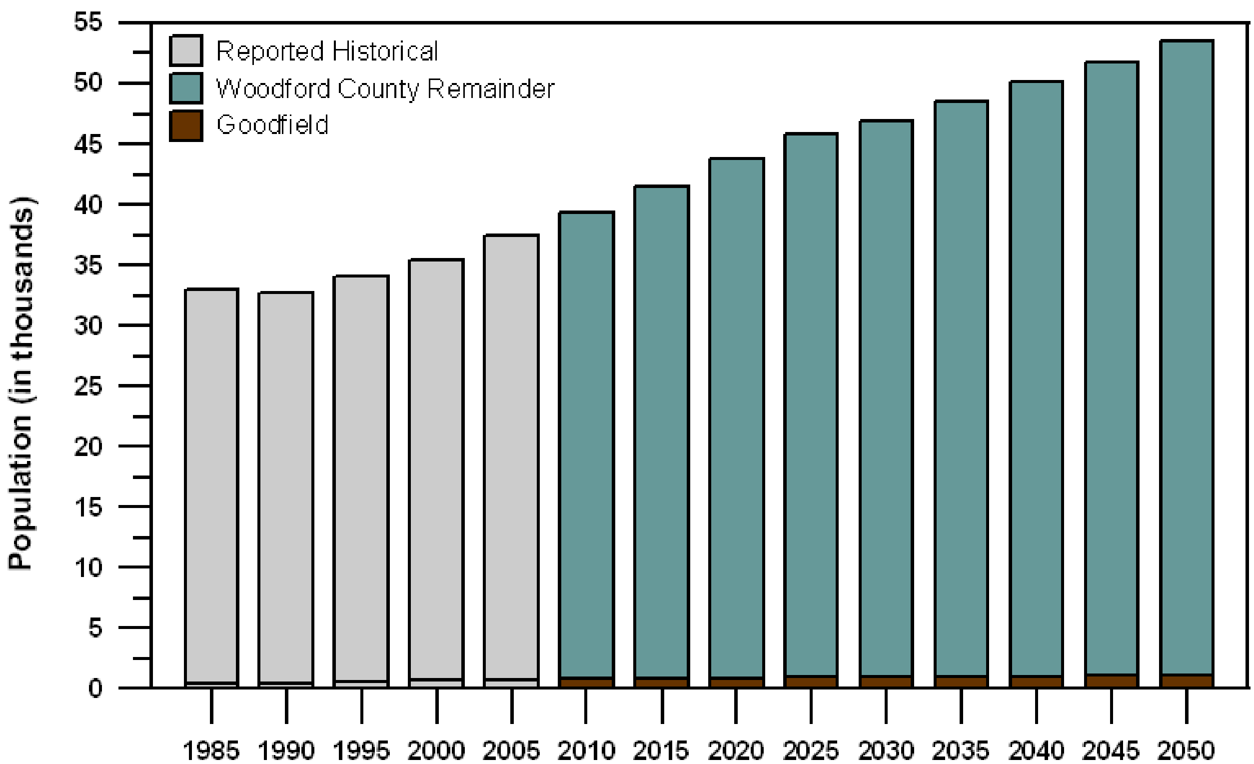


Figure 2.11: Historical and future resident population for the Woodford County study areas in East-Central Illinois.

Table 2.7: Total self-supplied domestic population, 2005-2050.

Year	Total self-supplied domestic population
2005	108,076
2010	121,510
2015	125,363
2020	129,539
2025	132,847
2030	135,267
2035	137,249
2040	140,237
2045	143,290
2050	146,421
Difference from 2005 to 2050	
Unit	38,345
Percent (%)	35.5

calculation was performed for every five years to 2050. The future population served values for each study area are provided in Appendix B.

2.6.1.2 Domestic population

The self-supplied domestic population was calculated by subtracting the future total population served by a PWS system within a county from the future total county population. The total self-supplied domestic population is expected to increase by 38,345 people from 108,076 in 2005 to 146,421 in 2050 (Table 2.7). The future self supplied domestic population values for each study area are provided in Appendix B.

2.6.2 Future explanatory variables

The future values of the six explanatory (or independent) variables (i.e., temperature, precipitation, employment/population ratio, price, income, and conservation) are used to determine the future rates of per capita water withdrawals in the public-supply sector in each study area. To estimate future water withdrawals, the future values of the independent variables must be determined. A description of the future estimates for the independent variables used is provided below.

2.6.2.1 Weather variables - temperature and precipitation

Some of the most important determinants of water demand are related to weather. Consequently, in order to estimate future water withdrawals, the weather variables (i.e., precipitation, temperature, and cooling degree days) must also be estimated. Weather data may be dealt with in a variety of ways when looking into the future. One approach is to "predict" future weather by using the climatic normals, as calculated by the National Center for Climatic Data (NCDC). Climatic normals are defined as the "statistical average over a time period usually consisting of three consecutive decades" [Owenby et al., 2006]. The current climatic normals are defined for the period 1971-2000. The averaging of the past weather data means that no inter-annual variation is taken into account in the water demand models (Figure 2.12). In effect, this assumes that the average weather from the 30-year period can be used to estimate the future demand. On the one hand, this approach firmly connects the forecast to the historical record. On the other hand, by representing the future as the average of the 30-years of record we lose the extremes that cause variation in demand.

A second method for estimating weather data in the future is to stochastically model the weather. Stochastic modeling would allow us to create a dataset of fictional weather data that is statistically the same as the historic data (i.e., the mean, mode, and median would be the same numbers in both the historical data and the future, fictional data). The statistical properties of the weather would vary the same in the future as it has in the past.

It was decided by the ISWS and technical committee of the East-Central Regional Water Supply Planning Committee (RWSPC) that the demand models would use climatic normal data as the future weather variables because it is understood that either method of estimating future weather variables will be inaccurate in the future for any given year. The climatic normal method was chosen so that the general trend of water demand could be understood. By using normal weather data in the future, the annual variation, as seen the historic reported withdrawals, is not seen in the future estimates. Because normal climatic data were used in estimating future water withdrawals, for any given year in the future (or the past) the water demand estimates will not match the actual water withdrawn. What is revealed by this study is the *average* demand in the future.

For the three scenarios, the future values of summer temperature and summer precipitation were assumed to represent normal weather. This means that the values used for each future year represent average values for the 30-year period from 1971 to 2000 specific to the study area. The normal maximum temperature values and total summer precipitation values are shown in Table B.15 in Appendix B. Higher or lower summer temperatures will result in higher or lower per capita

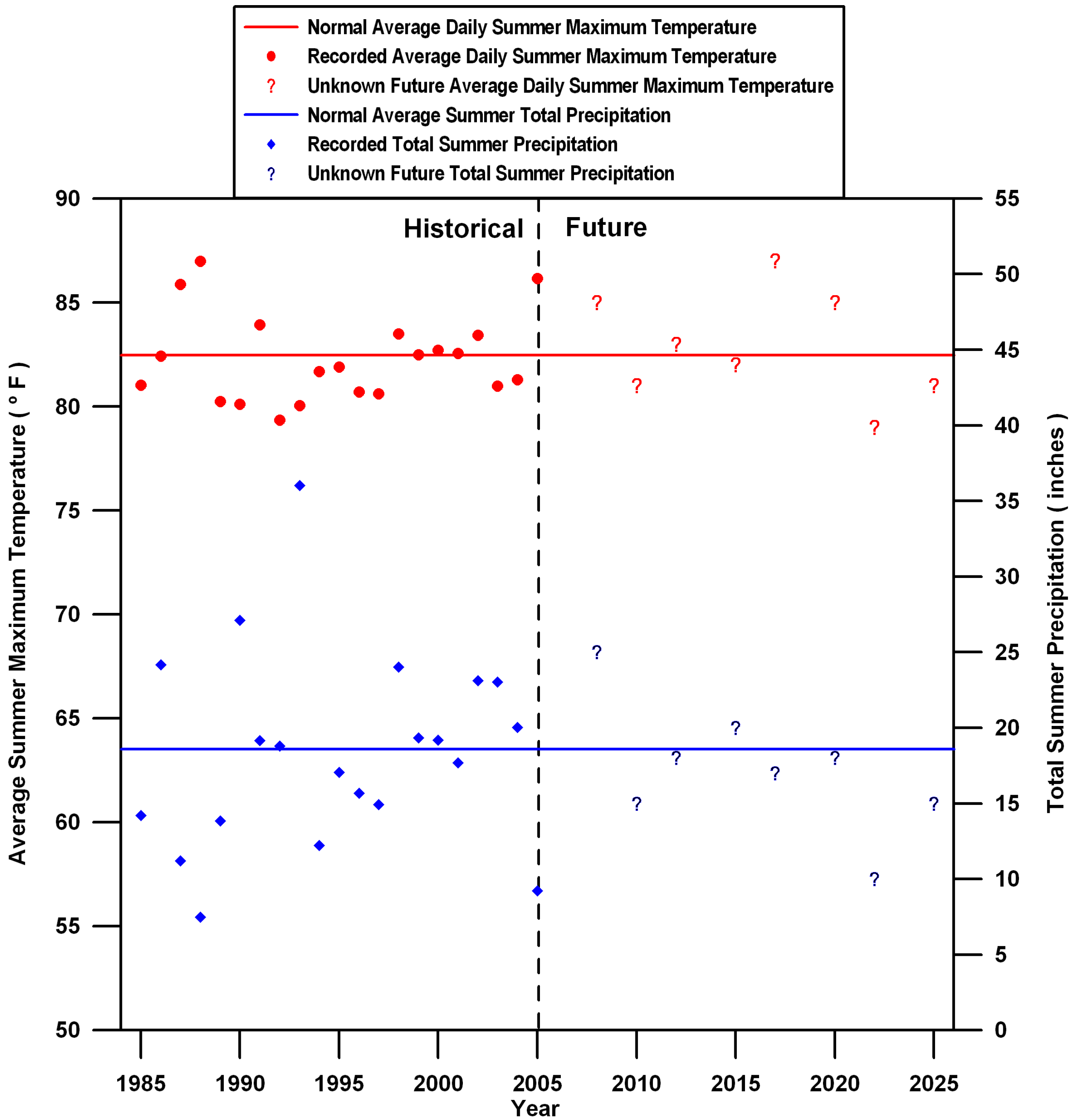


Figure 2.12: Example of inter-annual variation in temperature and precipitation compared to climatic normals.

water demand as determined by elasticity of 1.42. Similarly, higher or lower summer precipitation will result in lower or higher per capita water demand as determined by elasticity of -0.1140. The potential effects of climate change are provided in the sensitivity analysis (Chapter 6).

2.6.2.2 Employment-to-population ratios

The future ratios of employment to population were held constant at the 2005 ratio for each public supply study area. The 2005 ratio is shown in Table B.16 of Appendix B.

2.6.2.3 Marginal price of water

Future changes in retail water prices will result in changes of per capita water demand as determined by the estimated price elasticity of -0.2226. This means that, on average, a 1% increase in price will result in a 0.22 percent decrease in water withdrawals. The marginal price of water in the historical data was calculated as the incremental water bill per 1,000 gallons at the level of consumption between 5,000 gallons and 6,000 gallons per month.

Future values of marginal price will depend on the adoption of pricing strategies by retail water suppliers, as well as the frequency of rate adjustments. Water rate structures often remain unchanged for several years thus resulting in a decline of real price with respect to inflation. However, there is an expectation in the water supply industry that in the future the retail prices for water will increase faster than inflation because water quality issues will require more investment in treatment processes, increasing cost of energy, and other increasing water-system costs, especially infrastructure replacement costs.

Recent trends in water prices were determined from a survey of water rates in Illinois [Dziegielewski et al., 2004]. The data for 219 water systems in Illinois showed only a 3 percent increase in median value of total water bill at the consumption level of 5,000 gallons per month between 1990 and 2003 (increasing from \$18.18 in 1990 to \$18.70 in constant 2003 dollars). During the same period, the median value of the marginal price of water increased from \$2.59 to \$2.90, which represents an increase of 12 percent (in constant 2003 dollars) or 0.9 percent per year. The modest increase in price is a result of a number of systems which kept the nominal prices of water unchanged. Real water price declined (due to inflation) in 112 systems and increased in 107 systems. The average increase in the 107 systems in terms of total bill was 25 percent and 39.6 percent in average marginal price (or 2.6 percent per year).

Other published sources also report increases in the price of municipal water. The NUS Consulting [2007] reported that average price of water in 51 systems located throughout the United States increased by 6 percent for the period of July 1, 2006 to July 1, 2007. Earth Policy Institute

[2007] reported an increase in the United States of 27 percent during the last 5 years. Based on the changes in inflation during the five year period (CPI 2000 = 172.2, CPI 2005 = 195.3), the increase in real price would be approximately 12 percent (or 2.3 percent per year).

For the purpose of this study, it is assumed that changes in future water rates will span the range (depending on the scenario) from remaining constant in real terms, to increasing marginal price by 1.5 percent per year with revenue-neutral rates as compared to the 0.9 percent increasing trend. The 1.5 percent increase in marginal price represents a 67 percent (2/3) increase at the rate of 0.9 percent per year. The 1.5 percent increase would represent pricing strategy, which provides increased incentive to conserve water without affecting the total revenue that would be collected (relative to the historical trend of 0.9 percent per year increase).

2.6.2.4 Median household income

Future changes in median household income will result in changes of per capita water demand as determined by the estimated income elasticity of 0.3244. This means that, on average, a 1% increase in price will result in a 0.32 percent decrease in water withdrawals. In the historical data for 1990, 1995, 2000 and 2005, the average trend in median household income (expressed in constant 2005 dollars) was an increase of 1.5 percent per five-year increment. Future income is likely to grow, following economic growth in the study area. However, official projections of future income growth at the county or study area levels were not available.

One projection of income growth for the State of Illinois was obtained from the Illinois Region Econometric Input/Output Model (IREIM) developed by Hewings [1999]. These projections indicate that, for the State of Illinois, the average annual growth in personal income between 1997 and 2022 is projected to increase at the rate of 1.5 percent per year. The growth of median household income is generally less than the expected growth in total personal income.

The assumed annual growth rate of median household income for the baseline scenario is 0.7 percent. This assumption is based on analysis of the data from the U.S. Census Bureau, Bureau of Labor Statistics performed by Dr. Parry Frank [Parry Frank, personal communication, 2008]. The assumed values for less resource intensive and more resource intensive scenarios are 0.5 and 1.0 percent per year, respectively.

2.7 Scenarios

The three future scenarios are designed to capture a range of future conditions of water demand for public supply water withdrawals which would result in lower and higher values of future water withdrawals by this sector. The scenarios include baseline (BL), less resource intensive (LRI) outcome, and more resource intensive (MRI) outcome. These scenarios do not represent forecasts or predictions, nor set upper or lower bounds of future water withdrawals. Different assumptions or conditions could result in withdrawals that are within or outside of this range. The scenarios chosen describe three possible future outcomes of the virtually infinite number of possible futures. The specific assumptions used in the formulation of each scenario are described below.

2.7.1 Scenario 1 - Baseline (BL)

The intent of the BL scenario is to define future conditions as a moderate scenario based upon specific assumptions. The specific assumptions of this scenario are:

1. Population growth in the study areas will follow population projections as described in Section 2.6.1.

2. Employment to population ratio will remain at the 2005 value for each PWS study area.

3. Marginal prices of water after 2005 will remain constant at the 2005 values (in constant 2005 dollars) thus implying that future increases in water prices will offset general inflation while no actual increase in price will occur.

4. Annual growth of median household income (in constant 2005 dollars) during the 2005-2050 period will be 0.7 percent.

5. The future effect of the conservation trend was gradually phased out so that by 2050 it represented approximately 10% of the the effect which was estimated in the historical data.

6. Summer temperature and precipitation will represent normal values derived from the historical data for the 30-year period from 1971 to 2000.

In addition to these assumptions, all planned water supply developments are included in the scenarios. In the public meetings with utilities, two major public supply changes were identified that are expected to occur by 2010. The first is the construction of a centralized water-supply system in Cass County for Virgina, Ashland, Chandlerville, Cass County Rural Water District (RWD), and the Arenzville RWD. The new system in Cass County affects the county system in two ways, 1) it increases the population served in the county and decreases the domestic population and 2) changes the source water for Ashland from surface water to groundwater. These two expected changes are reflected in this baseline scenario as well as the other two scenarios.

The second public supply change is in Sangamon County. There the Village of Chatham, which is currently served by surface water from Springfield, has decided to construct a wellfield to supply the village. This change moves a portion of the population served by Springfield into the population served in the Sangamon County Remainder. The population shift was changed for 2010 in the baseline scenario as well as the LRI and MRI scenarios. The percent of surface water for Springfield will remain unchanged. The percent of groundwater for the Sangamon County Remainder will increase.

2.7.2 Scenario 2 - Less resource intensive (LRI)

The intent of the LRI scenario is to define future conditions which would lead to less water withdrawals by the PWS sector. The specific assumptions for the LRI scenario are:

1. Population growth in the study areas will follow population projections as described in Section 2.6.1.
2. Employment to population ratio will remain at the 2005 value for each PWS study area.
3. Marginal price of water will increase at the rate of 1.5 percent per year (in constant 2005 dollars) in order to provide water conservation incentives.
4. The future effect of the conservation trend was gradually phased out so that by 2050 it represented approximately 10% of the the effect which was estimated in the historical data.
5. Annual growth of median household income during the 2005-2050 period will be 0.5 percent (in constant 2005 dollars).
6. Summer temperature and precipitation will represent normal values derived from historical data for the 30-year period from 1971 to 2000.

2.7.3 Scenario 3 - More resource intensive (MRI)

The intent of the MRI scenario is to define future conditions which would lead to more water withdrawals by the PWS sector. The specific assumptions for the MRI scenario are:

1. Population growth in the study areas will follow population projections as described in Section 2.6.1.
2. Employment to population ratio will remain at the 2005 value for each PWS study area.

3. Marginal price of water will remain constant at the 2005 values (in constant 2005 dollars) thus implying that future increases in water prices will offset general inflation while no actual increase in price will occur.

4. Annual growth of median household income during the 2005-2050 period will be 1.0 percent (in constant 2005 dollars).

5. Effect of conservation trend was removed.

6. Summer temperature and precipitation will represent normal values derived from historical data for the 30-year period from 1971 to 2000.

2.8 Results

The results for the public water supply and the self-supplied domestic water sector are provided in the following sections and in tables provided in Appendix B.

2.8.1 PWS results

The results of the three scenarios for the 15-county study area are shown in Figure 2.13and Tables 2.8-2.10. Under the baseline scenario, the total public supply withdrawals are projected to increase from 127.2 MGD in 2005 (Normal) to 176.9 MGD in 2050. This represents an increase of 49.6 MGD or 39.0 percent. Under the LRI scenario the withdrawals would increase to 153.5 MGD by 2050. This represents an increase of 26.3 MGD or 20.6 percent. Under the MRI scenario the withdrawals would increase to 185.4 MGD by 2050. This represents an increase of 58.1 MGD or 45.7 percent.

Results for the baseline scenario by individual study area are provided in Figures 2.14–2.21. Tabular results for each scenario for each PWS study area are provided in Appendix B. The figures confirm that the counties with the largest cities, withdraw the most water for public water supply. For example, Champaign County contains Champaign/Urbana and is estimated to withdraw 33.6 MGD in 2050. McLean County which contains both Bloomington and Normal is estimated to withdraw 24.0 MGD in 2050. The other counties that use large amounts of public supply water are Macon, Sangamon, Tazewell, and Vermilion counties (Figures 2.14–2.21). The remaining counties use less than 4 MGD each.

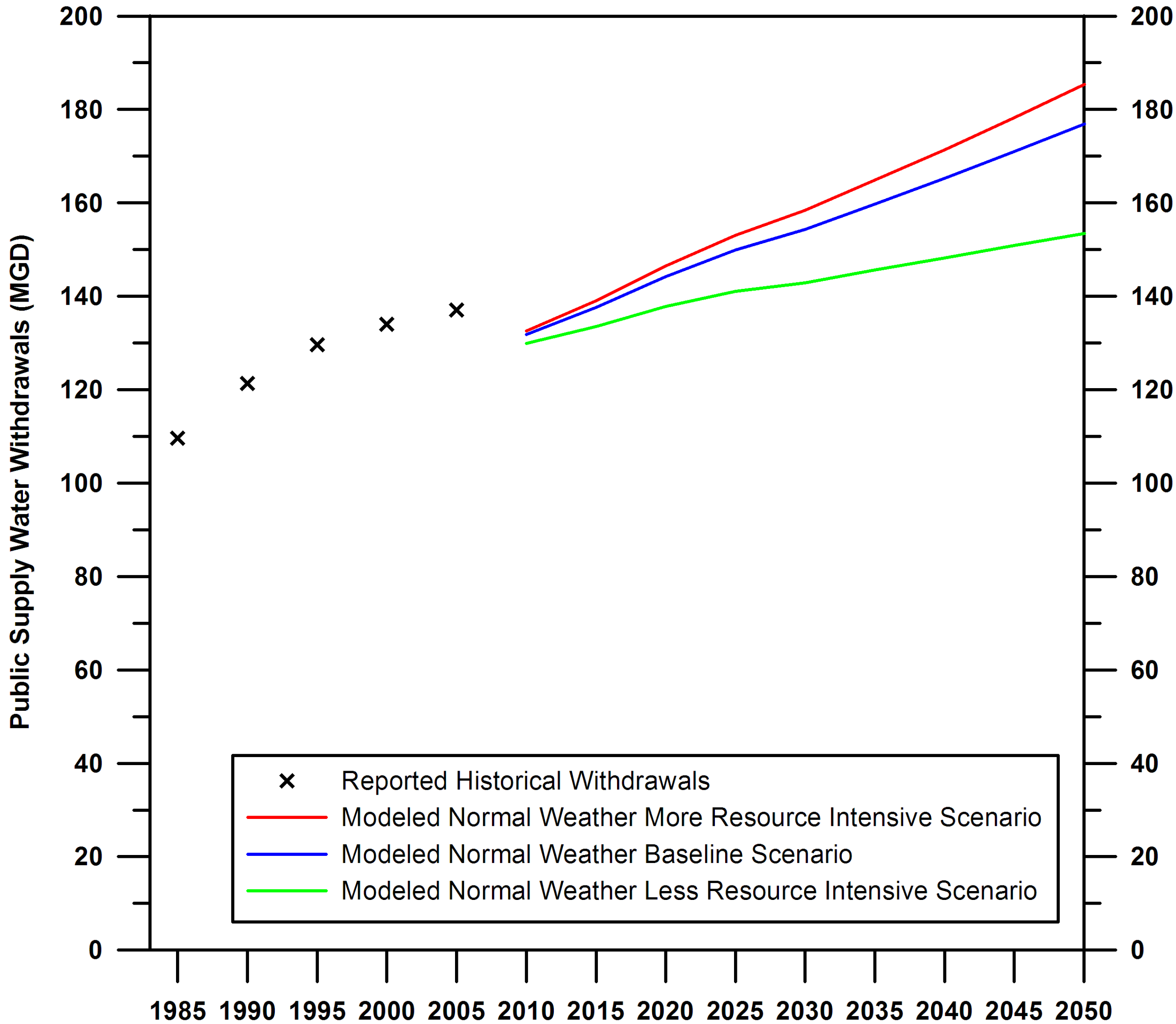


Figure 2.13: Historical and future public water supply withdrawals for the baseline scenario, the less resource intensive scenario, and the more resource intensive scenario for East-Central Illinois.

Table 2.8: Public water supply results for the baseline (BL) scenario.

Year	Population served	Per capita (GPCD)	Total withdrawals (MGD)
2005 (Weather)	946,821	146.5	138.9
2005 (Normal)	946,821	134.4	127.2
2010	978,207	134.8	131.9
2015	1,012,168	135.9	137.6
2020	1,050,932	137.2	144.2
2025	1,081,997	138.5	149.9
2030	1,101,919	140.0	154.3
2035	1,129,372	141.4	159.7
2040	1,156,613	142.9	165.2
2045	1,184,582	144.3	171.0
2050	1,213,300	145.8	176.9
Difference from 2005 (Normal) to 2050			
Unit	266,479	11.4	49.6
Percent (%)	28.1	8.5	39.0

GPCD = gallons per capita per day; MGD = million gallons per day

2005 (Weather) = modeled 2005 withdrawals using actual weather data.

2005 (Normal) = modeled 2005 withdrawals using normal weather data.

Table 2.9: Public water supply results for the less resource intensive (LRI) scenario.

Year	Population served	Per capita (GPCD)	Total withdrawals (MGD)
2005 (Weather)	946,821	146.5	138.9
2005 (Normal)	946,821	134.4	127.2
2010	978,207	132.8	129.9
2015	1,012,168	131.9	133.5
2020	1,050,932	131.1	137.8
2025	1,081,997	130.3	141.0
2030	1,101,919	129.7	142.9
2035	1,129,372	128.9	145.6
2040	1,156,613	128.1	148.2
2045	1,184,582	127.3	150.8
2050	1,213,300	126.5	153.5
Difference from 2005 (Normal) to 2050			
Unit	266,479	-7.9	26.3
Percent (%)	28.1	-5.9	20.6

GPCD = gallons per capita per day; MGD = million gallons per day

2005 (Weather) = modeled 2005 withdrawals using actual weather data.

2005 (Normal) = modeled 2005 withdrawals using normal weather data.

Table 2.10: Public water supply results for the more resource intensive (MRI) scenario.

Year	Population served	Per capita (GPCD)	Total withdrawals (MGD)
2005 (Weather)	946,821	146.5	138.9
2005 (Normal)	946,821	134.4	127.2
2010	978,207	135.6	132.6
2015	1,012,168	137.4	139.1
2020	1,050,932	139.4	146.5
2025	1,081,997	141.5	153.1
2030	1,101,919	143.7	158.4
2035	1,129,372	146.0	164.9
2040	1,156,613	148.2	171.4
2045	1,184,582	150.5	178.2
2050	1,213,300	152.8	185.4
Difference from 2005 (Normal) to 2050			
Unit	266,479	18.4	58.1
Percent (%)	28.1	13.7	45.7

GPCD = gallons per capita per day; MGD = million gallons per day

2005 (Weather) = modeled 2005 withdrawals using actual weather data.

2005 (Normal) = modeled 2005 withdrawals using normal weather data.

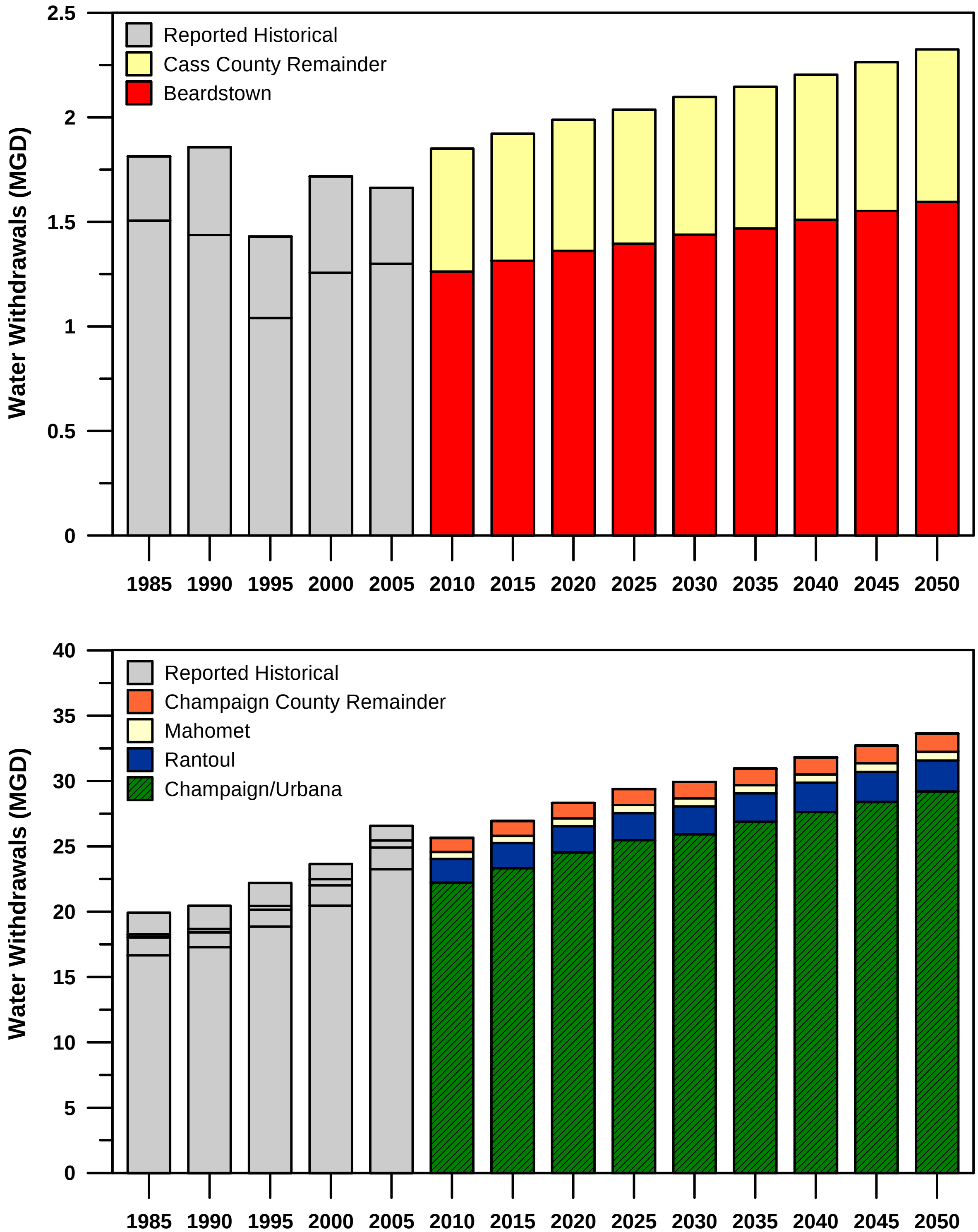


Figure 2.14: Public water supply historical and future water withdrawals for the Cass and Champaign County study areas.

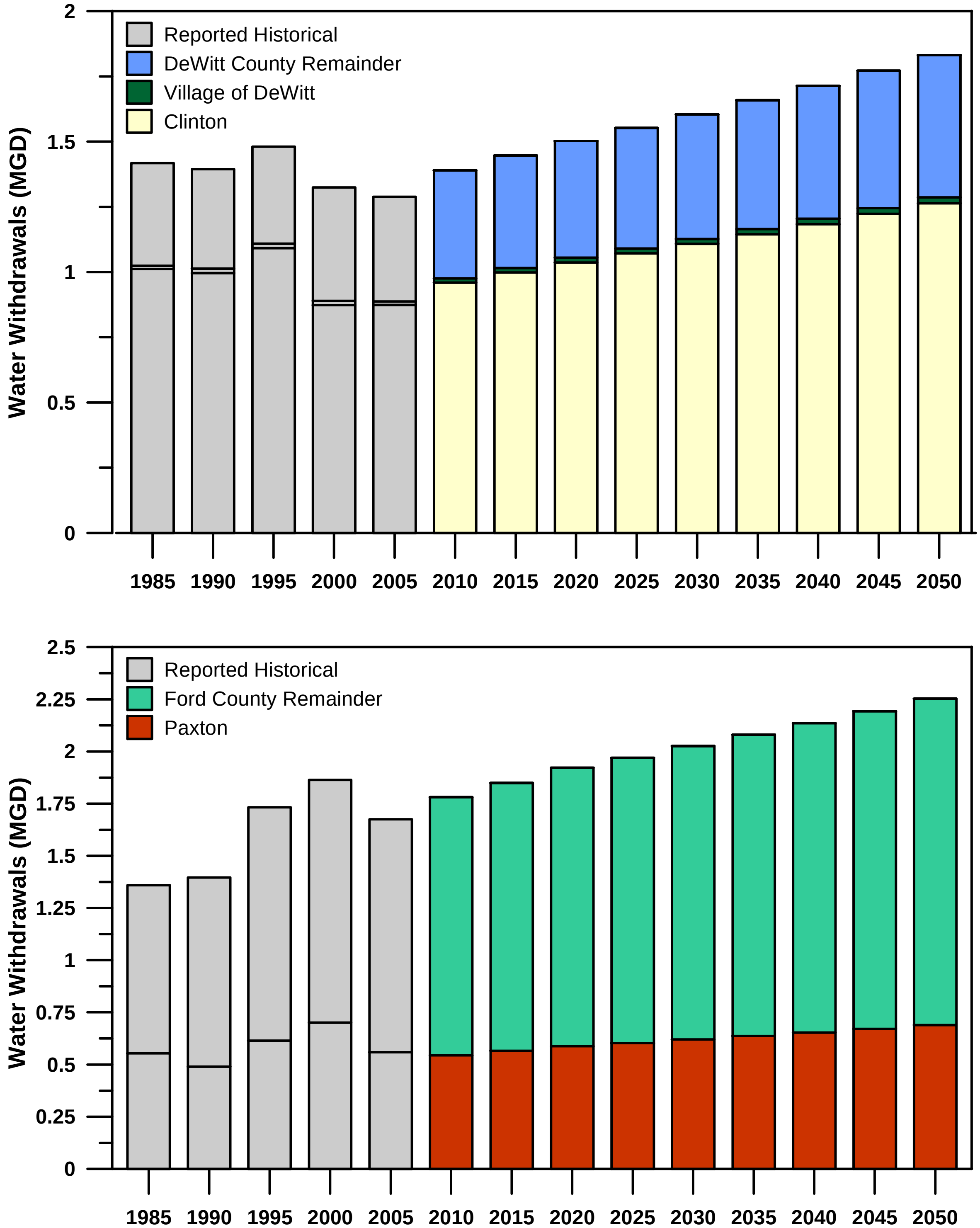


Figure 2.15: Public water supply historical and future water withdrawals for the DeWitt and Ford County study areas.

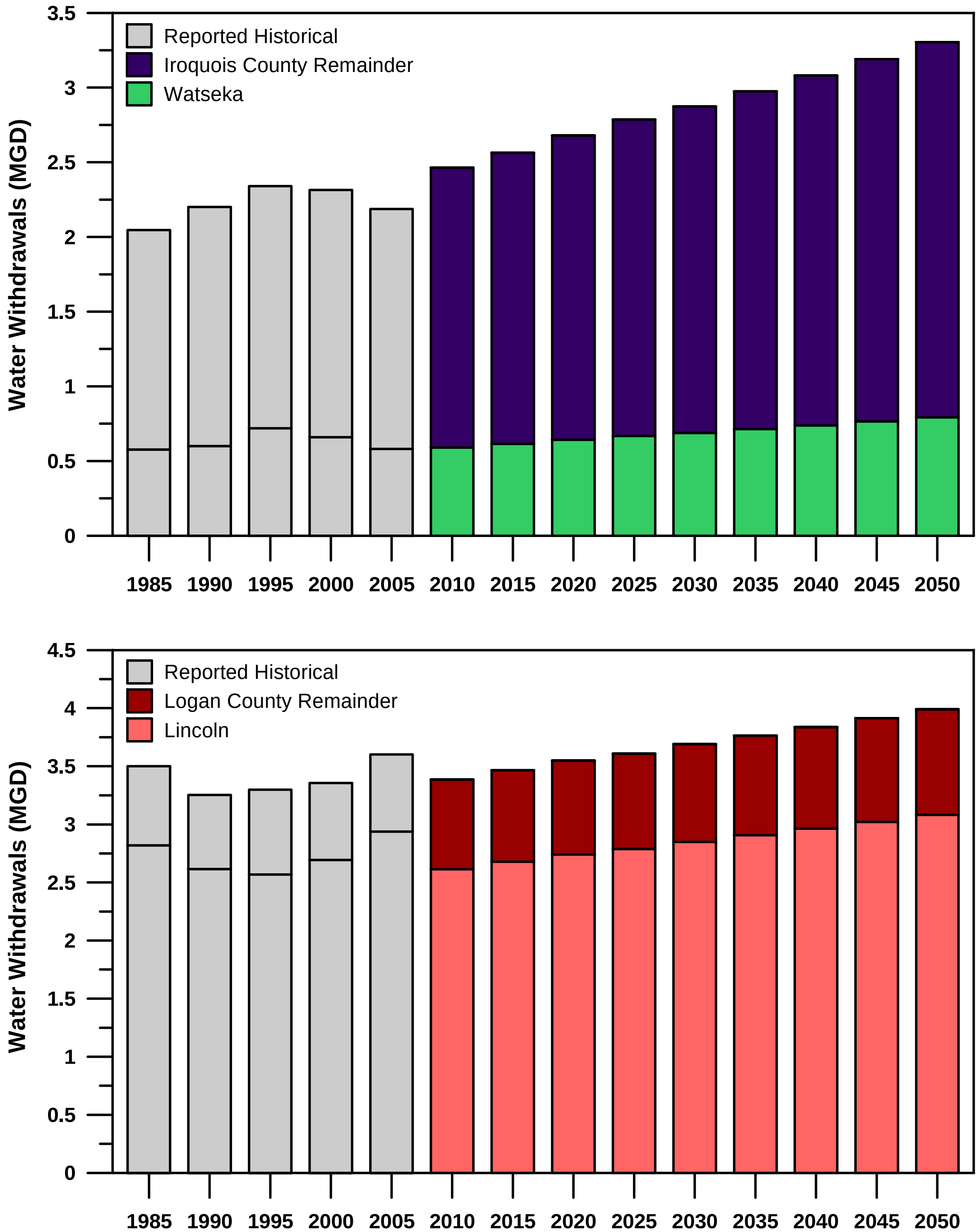
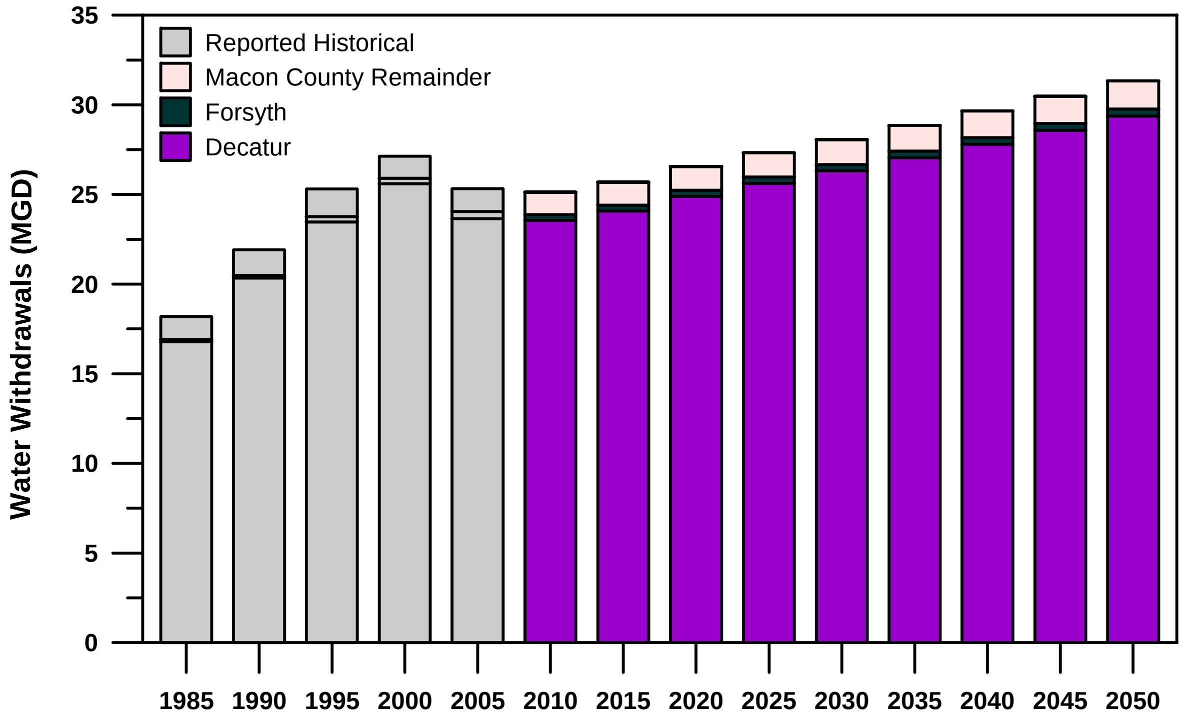


Figure 2.16: Public water supply historical and future water withdrawals for the Iroquois and Logan County study areas.



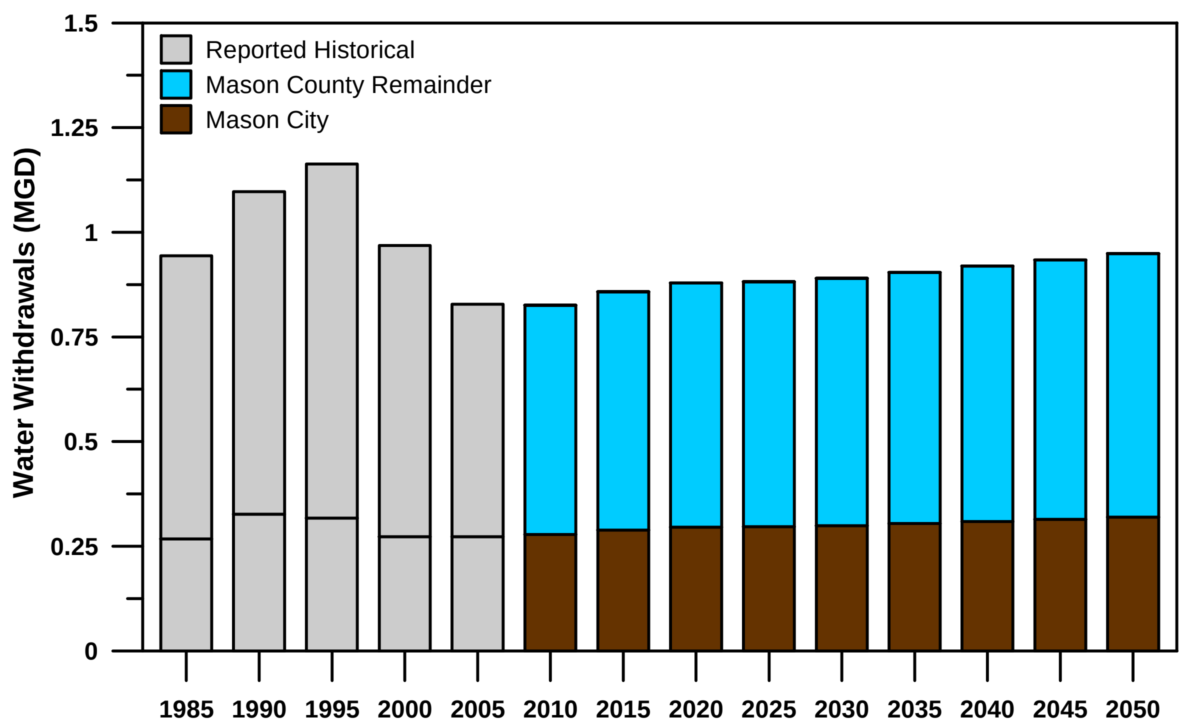


Figure 2.17: Public water supply historical and future water withdrawals for the Macon and Mason County study areas.

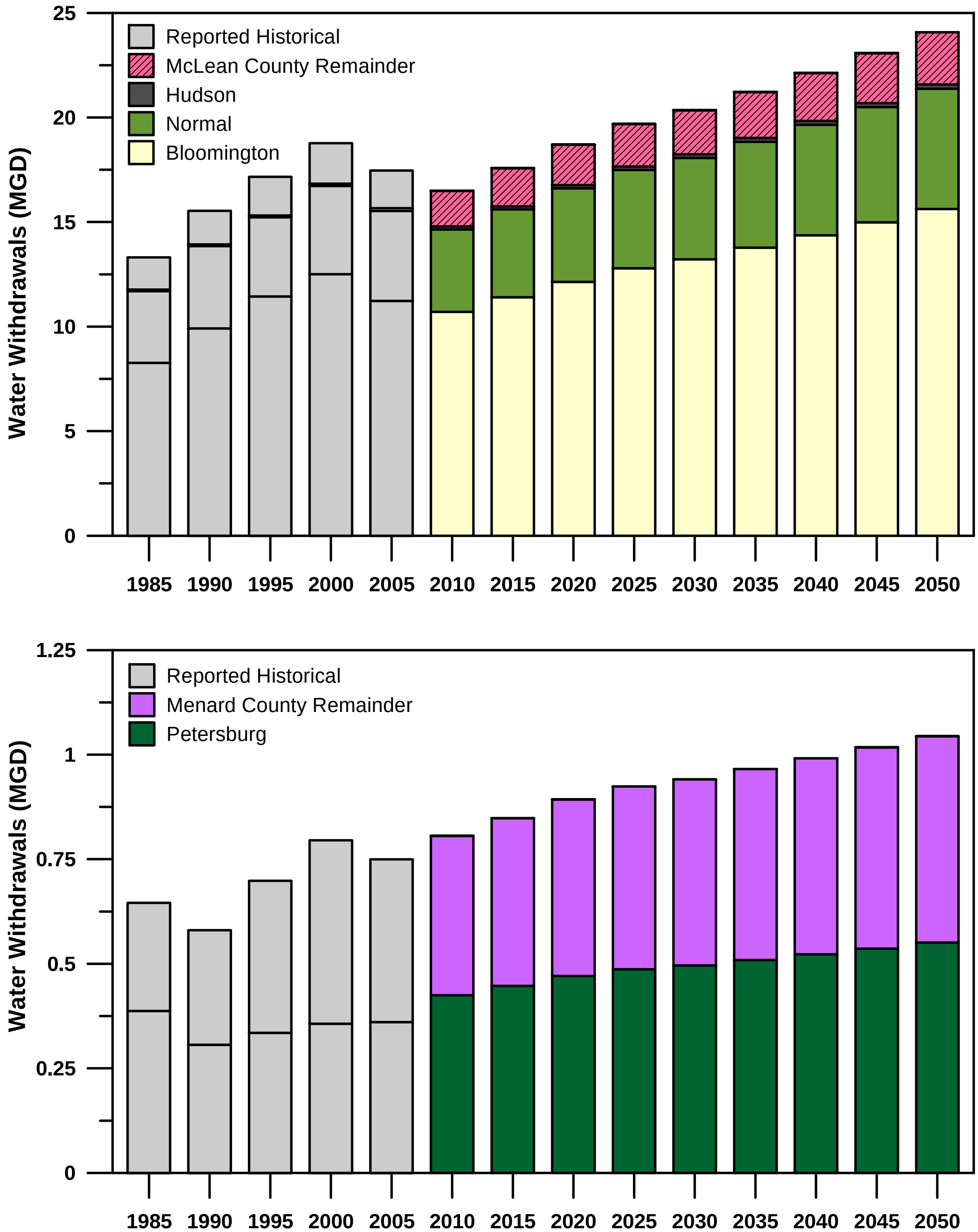


Figure 2.18: Public water supply historical and future water withdrawals for the McLean and Menard County study areas.

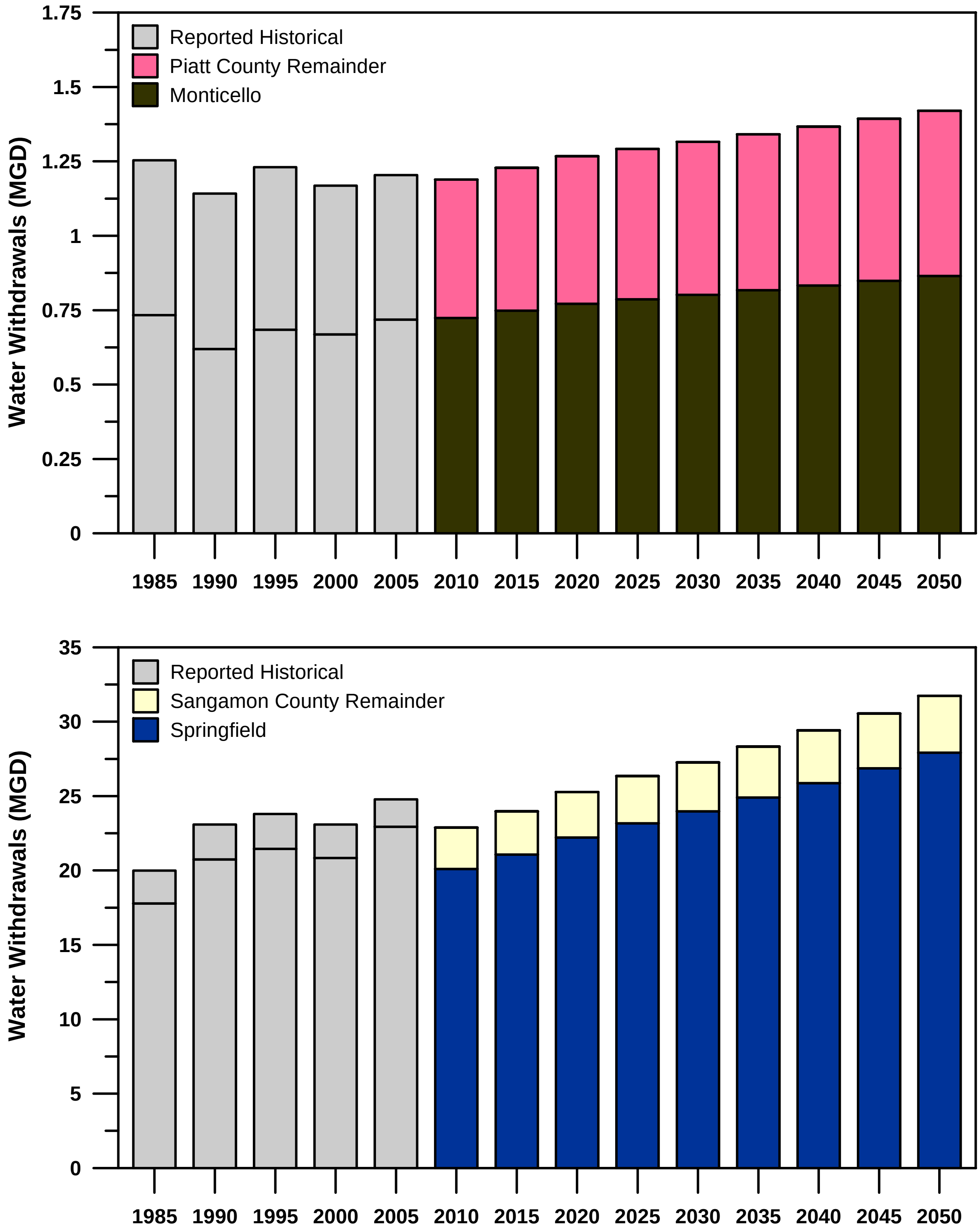


Figure 2.19: Public water supply historical and future water withdrawals for the Piatt and Sangamon County study areas.

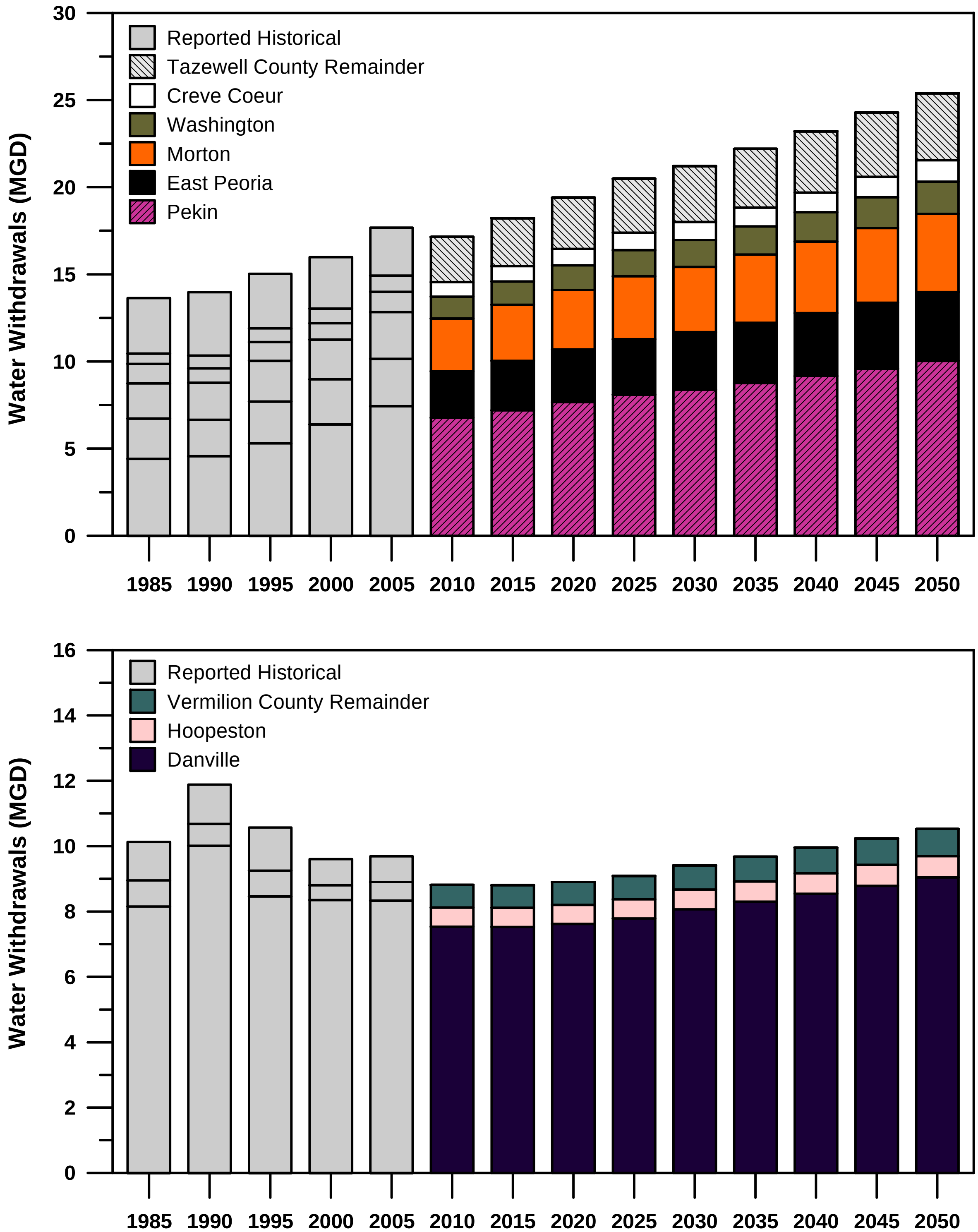


Figure 2.20: Public water supply historical and future water withdrawals for the Tazewell and Vermilion County study areas.

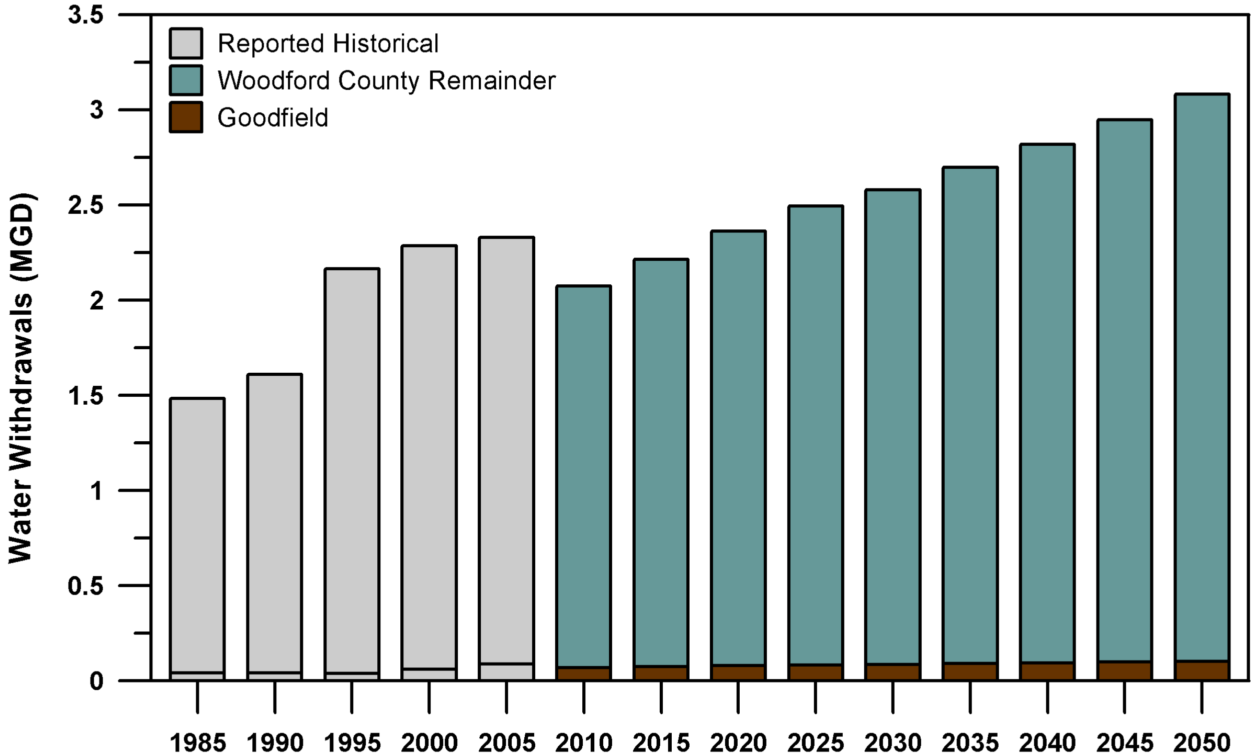


Figure 2.21: Public water supply historical and future water withdrawals for the Woodford County study areas.

2.8.2 Groundwater and surface water withdrawals

The data generated from this demand study will be delivered to the ISWS as digital data at the level of withdrawal points, meaning future water withdrawals will be determined for all existing wells and surface water intakes. Using groundwater and surface water modeling, the ISWS will evaluate water availability in the East-Central Region and determine if the water supply is sufficient for the future water withdrawals. Although withdrawal-point data is not included in this report, the data will be available upon request from the ISWS for the public water supply sector.

The allocation of the future public water supply between groundwater and surface water withdrawals is generally assumed to remain at the 2005 level for each study area, with the exceptions of the Cass County Remainder and Sangamon County Remainder. These two study areas will be affected by the additions of the new proposed groundwater supplies, Cass County Rural Water District and the new Chatham PWS. For these areas, the percent groundwater will be higher than the 2005 percentage. Table 2.11 shows the future percentages of surface water and groundwater for each county.

Table 2.11: Future percent groundwater and surface water for each public supply study area in East-Central Illinois.

Study Area	County	Future Percent	
		Groundwater	Surface water
Beardstown	Cass	100	0
Cass County Rem.	Cass	100	0
Champaign/Urbana	Champaign	100	0
Mahomet	Champaign	100	0
Rantoul	Champaign	100	0
Champaign County Rem.	Champaign	100	0
Clinton	DeWitt	100	0
DeWitt	DeWitt	100	0
DeWitt County Rem.	DeWitt	100	0
Paxton	Ford	100	0
Ford County Rem.	Ford	100	0
Watseka	Iroquois	100	0

Rem. = remainder.

Source: Calculated from Illinois Water Inventory Program, Illinois State Water Survey, 2007.

Table 2.11: Future percent groundwater and surface water for each public supply study area in East-Central Illinois.

Study Area	County	Future Percent	
		Groundwater	Surface water
Iroquois County Rem.	Iroquois	100	0
Lincoln	Logan	100	0
Logan County Rem.	Logan	100	0
Decatur	Macon	6.9	93.1
Forsyth	Macon	100	0
Macon County Rem.	Macon	100	0
Mason City	Mason	100	0
Mason County Rem.	Mason	100	0
Bloomington	McLean	0	100
Hudson	McLean	0	100
Normal	McLean	100	0
McLean County Rem.	McLean	100	0
Petersburg	Menard	100	0
Menard County Rem.	Menard	100	0
Monticello	Piatt	100	0
Piatt County Rem.	Piatt	100	0
Springfield	Sangamon	0	100
Sangamon County Rem.	Sangamon	96.4	3.6
Creve Coeur	Tazewell	100	0
East Peoria	Tazewell	100	0
Morton	Tazewell	100	0
Pekin	Tazewell	100	0
Washington	Tazewell	100	0
Tazewell County Rem.	Tazewell	100	0
Danville	Vermilion	0	100
Hoopeston	Vermilion	100	0
Vermilion County Rem.	Vermilion	85.5	14.5

Rem. = remainder.

Source: Calculated from Illinois Water Inventory Program, Illinois State Water Survey, 2007.

Table 2.11: Future percent groundwater and surface water for each public supply study area in East-Central Illinois.

Study Area	County	Future Percent	
		Groundwater	Surface water
Goodfield	Woodford	100	0
Woodford County Rem.	Woodford	100	0

Rem. = remainder.

Source: Calculated from Illinois Water Inventory Program, Illinois State Water Survey, 2007.

2.8.3 Peaking data for public water supply

The data used to estimate future water withdrawals was the annual average withdrawal rate (as MGD) for each public supply facility. However, water withdrawals are not equal on every day of the year. In fact, some systems have days where water demand is 3-4 times the annual average rate. This is because people use more water at certain times of the year, week, and day. Typically, people use more water on hotter days to water lawns and gardens, wash cars, cool-off, etc. When temperatures are cooler people tend to use less water.

Knowledge about peak withdrawals is important for water-system management and water-supply considerations. A public supplier must ensure the system can meet the peak day withdrawals. This means treatment capacity, storage capacity, and volume must be large enough to accommodate peak demand.

Each public supply system reports their peak day of water withdrawals to the ISWS water inventory program. These data were collected for East-Central Illinois. From these data, regional peaking factors of 2.29 and 1.65 were calculated for groundwater and surface water systems, respectively. This means that on average in the region, public water supply systems using groundwater have a peak day that is 2.29 times their reported average annual withdrawal rate. Public water supply systems using surface water have a peak day that is 1.65 times their reported average annual withdrawal rate. These peaking factors will be used by the ISWS in their study of the water supply resource.

Table 2.12: Total withdrawals for the self-supplied domestic water sector, 2005-2050.

Year	Total self-supplied domestic population	Total self-supplied domestic withdrawals (MGD)
2005	108,076	8.9
2010	121,510	10.0
2015	125,363	10.3
2020	129,539	10.6
2025	132,847	10.9
2030	135,267	11.1
2035	137,249	11.3
2040	140,237	11.5
2045	143,290	11.7
2050	146,421	12.0
Difference from 2005 to 2050		
Unit	38,345	3.1
Percent (%)	35.5	35.5

Assumed water withdrawal rate of 82 gallons per person per day.

2.8.4 Self-supplied domestic results

The future domestic supply withdrawals, based upon the self-supplied domestic population in each county, is provided in Table 2.12. The withdrawals are projected to increase from 8.9 MGD in 2005 to 12.0 MGD in 2050. This represents an increase of 3.1 MGD or 35.5 percent. The future demands of self-supplied domestic are expected to continue to be minimal with respect to total withdrawals for all sectors.