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WATER SUPPLY ALTERNATIVES AND TREND ASSESSMENT

Introduction

The Water Resources Planning Act requires that this State Water Plan include **"**an identification and assessment of practical alternatives for an adequate supply of water to satisfy existing and future reasonable and beneficial uses, including improved storage, groundwater recharge and surface/groundwater conjunctive management programs." Identifying alternatives involves an investigation of methods and practices that either increase water supply or decrease water demand. In turn, their practical application depends on natural conditions, existing infrastructure, and financial capability. Some alternatives, such as consumer conservation, can be easily undertaken and can also lower treatment, delivery, chemical and energy costs. Other means of assuring sufficient water to satisfy all reasonable and beneficial uses can be complex, expensive, or politically challenging.

The Act further requires "an assessment of both structural and nonstructural alternatives to address identified water availability problems, adverse impacts on water uses or conflicts between water users, including potential action to develop additional sources or alternative supplies, conservation measures, and management techniques". The assessment of identified options and their applicability to a specific set of parameters was conducted in a generic manner. The alternatives were divided into structural and management options, and analyzed through a decision matrix. This tabular analysis revealed that several approaches were appropriate for a wide range of needs. These broadly functional options should be given primary consideration when attempting to solve problems caused by source water deficiencies, excessive water use, or user conflicts.

It is also imperative to identify and examine trends that could affect water resource management principles and strategies well into the future. Changes in demographics, public attitudes, energy policies and production, agricultural priorities, and climate are examples of broad issues that pose undefined challenges to managing water resources. These topics are briefly addressed with the intent of raising awareness and stimulating further discussion about their potential long term influence on water use, water resource planning and water management.

Practical Alternatives for an Adequate Supply of Water

Numerous practical alternatives have been identified that could individually or collectively maintain an adequate supply of water to satisfy existing and future reasonable and beneficial uses in Pennsylvania. The alternatives have been categorized as structural or management options to facilitate subsequent analysis and decision-making.

It is important to define several key terms that are used to frame this discussion. An "adequate supply of water" refers to the quantity of water necessary to sustain reasonable and beneficial uses over the planning horizon. A planning horizon of 15 years has been selected because the State Water Plan will be updated at five-year intervals, and the accuracy of water resource need projections beyond 15 years leads to considerable uncertainty. "Reasonable and beneficial uses" is a multifaceted term that refers to using water for a useful and productive purpose, while considering the rights of other users and remaining consistent with the public interest. It also includes using water in an efficient manner. The assessment considered both withdrawal and non-withdrawal water uses. "Withdrawal uses" references any use of water that is taken from a surface or underground source and includes traditional uses such as domestic, municipal, public, commercial, industrial, energy development and production, and agricultural water supply. "Non-withdrawal uses" are activities that use water while it is in place. Examples of non-withdrawal uses are navigation, in-stream hydropower production, recreation, fish and wildlife habitat protection, and sustaining the aquatic environment. Finally, "consumptive use" means the loss of water from a groundwater or surface water source through an artificial conveyance system (including water that is delivered through a public water supply system), due to transpiration by vegetation, incorporation into manufactured products, evaporation, diversion out of the basin, or any other process that withdraws water from a basin without returning it.

Structural Alternatives

Develop Additional Sources

Developing additional sources of raw water is an obvious means of addressing a need deficiency. Decisions related to new source development depend on the specific conditions encountered, the quantity required, and the relative availability, quality and abundance of suitable water. New sources can be attained from direct stream withdrawals, or groundwater development of wells and springs. In some regions of Pennsylvania, large volumes of water are being held in limestone quarries and abandoned surface and deep coal mines, creating a mostly untapped, potential supply of confined water.

Interconnecting water systems can also provide an inexpensive temporary or permanent solution to potable water deficits. This alternative involves two or more separate water supply systems being physically connected and the purchase of treated water by the utility experiencing need. Interconnections are most applicable where a water surplus is located near a water deficient area. Interconnections are encouraged by the Water Resources Planning Act, which requires the Pennsylvania Infrastructure Investment Authority (PENNVEST) to give such projects special consideration for funding.

In rare instances, transfers or diversions can economically redistribute water to satisfy water supply needs in a neighboring basin or watershed. All proposed water transfers and diversions must be closely evaluated because they could alter the character of both the source and destination watersheds. Care must be taken to ensure that the hydrologic and biologic integrity of the donor and receiving watersheds are not harmed by the diversion, and that unsustainable development is not artificially encouraged in the receiving basin. The Susquehanna River Basin Commission (SRBC) has formal regulatory standards that address proposals to divert water from the Susquehanna River basin. In addition, DEP implements a statewide policy addressing transfers at both the watershed and basin levels in its Surface Water Allocation Program.

Locating and developing additional water sources for domestic, commercial or industrial use is a complicated process. Relative cost, permit requirements, social concerns and environmental consequences must all be part of the appraisal leading to a final choice.

Increase Raw Water Storage

Reservoirs collect and detain water for later release or use. With nearly 8 million Pennsylvanians obtaining water for daily use from surface water sources, improved water storage is usually associated with enhancing public and industrial water supplies. Reservoir storage can also be critical to sustaining adequate stream flow for a number of other beneficial water uses such as recreation, and aquatic and riparian habitat protection.

Most reservoirs were created for a specific purpose; for example, flood control, recreation, or as water supply sources. Many reservoirs also have untapped multiple use capability and could be integral to drought management, navigation, resource protection and hydropower production. Additionally, local storage can improve water quality, upgrade water system reliability and flexibility, and provide drought resistance. Release of stored water plays a critical role in maintaining acceptable flow in the Ohio, Susquehanna and Delaware River systems to support navigation, maintain fisheries, ensure adequate drinking water supplies, and provide cooling water for power generation and industrial facilities.

There are 3368 permitted dams and approximately 7500 additional smaller dams in Pennsylvania creating pools, impoundments and lakes on waterways and watersheds of all sizes. The large majority of dams are privately owned, with only 906 of the 3368 dams being held in public ownership. At maximum pool levels, the permitted dams are capable of holding back over 10 million acre-feet, or in excess of 3 trillion gallons, of water. Many of the existing dams in Pennsylvania were built decades ago and were not designed to meet modern safety standards. Many are showing signs of structural aging and numerous outdated dams have been demolished over the past several years. Since 1997, DEP has issued only 43 permits authorizing the construction of new dams in Pennsylvania.

New, strategically located water storage facilities could provide real-time flow management capabilities, facilitate multiple source blending to improve water quality, augment conjunctive management capability, and provide added protection from catastrophic events. The cost of new surface storage capacity varies greatly, but most projects face the financial challenge of raising a large amount of capital over a short period of time. Many beneficiaries typically share the cost of multipurpose storage projects. Storage capacity can usually be expanded more economically at existing facilities by raising reservoir levels, dredging accumulated silt, modifying reservoir outlets or changing operating procedures.

Off-stream surface storage also provides valuable benefits. With few exceptions, these storage facilities are not designed to provide additional benefits such as flood control, power generation or primary recreation. Their principal functions are to improve water system reliability and flexibility, to satisfy water supply needs at small industrial sites, and to supply recreational sites such as ski areas and golf courses.

Developing additional storage capacity by constructing new dams and creating new reservoirs may also generate environmental costs, or require local economic and social adjustments. The potential harm to the water body and surrounding wetland ecology, including loss of habitat and changes to water temperature, must be closely studied and avoided or mitigated. Potential hydrogeological changes must be assessed, and the risk of dam failure and its consequences must also be considered. New reservoirs may reduce tax revenue to local government, and could change the social fabric of an area. All of these matters must be explored and compared to the intended benefits when planning new projects.

Expand Treated Water Storage

There are nearly 3800 tanks and other containers that store treated water on public water distribution systems throughout Pennsylvania. Expanding treated water storage capacity is a straightforward approach to improving short-term water supply availability and reliability. It is particularly effective as a way to mitigate water shortages caused by natural disasters, temporary power disruptions or pollution incidents. The previous State Water Plan recommended that all public water supplies have the capability to keep at least one day's worth of treated water in reserve. Although some small water systems may still lack that capability, most public water suppliers have fulfilled the recommendation.

Recharge Groundwater

Pennsylvania has an estimated 80 trillion gallons of water residing under ground, enough to submerge the entire state beneath eight feet of water if it were brought to the surface. Of the 42 inches of precipitation that Pennsylvania averages annually, about eleven inches contribute to replenishing groundwater reserves under natural conditions. Groundwater levels throughout the state vary seasonally, and are generally at their peak during the early spring and at their lowest levels during mid-autumn. These normal seasonal fluctuations can range to 50 feet. Precipitation, groundwater levels, soil types, geologic formations and recharge rates differ significantly throughout Pennsylvania. This variability influences local groundwater movement, storage capacity and accessibility. The importance of groundwater cannot be overstated. Groundwater supplies approximately 4.3 million Pennsylvanians with drinking water. In addition, during dry conditions, the only flow in many small streams originates from underground sources.

Groundwater can be recharged both naturally and artificially. Natural recharge takes place most efficiently in undisturbed areas as precipitation makes its way to the groundwater table. Natural groundwater recharge can be sustained in developing areas by managing runoff through preservation of native hydrologic watershed features. Artificial groundwater recharge can be achieved by using reclaimed wastewater to supplement natural aquifer regeneration. Proposed DEP policy would allow treated wastewater to be used to augment aquifers, provide storage for reclaimed water, and to control or prevent ground subsidence. Using reclaimed wastewater for irrigation and other practices may also incidentally contribute to groundwater recharge. The Water Resources Planning Act directly encourages groundwater recharge through provisions that enable water users to document and register projects or practices with DEP that "promote groundwater recharge".

In some areas it may be possible to inject or infiltrate, and confine, water in a local aquifer for future use. Underground storage can be a reliable means of providing clean water during a drought or pollution incident emergency. It also eliminates evaporative loss, reduces vulnerability to contamination and tampering, and may improve water quality and supplement stream base flow during dry periods. Aquifer storage is less expensive than constructing new surface reservoirs, and usually is less disruptive to the native environment. Excess treated water may also be stockpiled underground in a suitable aquifer to be recovered and used during periods of peak water use or low stream flow.

Expand Treatment Capacity

Expanding treatment capacity is a straightforward approach for meeting a treated water demand deficit or satisfying new needs. Treatment capacity expansion would require a new water allocation permit or approvals from the Delaware River Basin Commission (DRBC) or SRBC if withdrawals were to be increased beyond current allocations or approvals. Adding treatment capacity could involve upgrading existing facilities or constructing an entirely new treatment plant.

Regionalize Water Systems

In densely populated urbanized centers and in high growth areas expanding from an urban core, regionalizing water utilities may be appropriate. Regionalizing separate water supply systems can lead to cost savings, better service, improved reliability and enhanced system flexibility. Regionalization is not based solely on economy of scale, but also on superior technical and financial resources. Instituting arrangements to operate multiple systems more efficiently through common management, procurement, and other shared resources, without physically connecting them, may also appreciably improve their efficiency and service. Although many benefits of regionalization can be realized whether or not systems are physically integrated, increased yields would usually require interconnection of regional systems.

There are many areas where regionalization through physical connection of small water systems should not be considered. This type of regionalization is rarely appropriate and could be counterproductive where there is no single growth center and where growth patterns are scattered among suburban and exurban areas near small communities. Pursuing regionalization in these locations could undermine sustainable development efforts and contribute to expansion of growth patterns in areas where dense development is undesired. Large regional systems in these settings also deter the use of local water resources where they are available, and could promote inter-basin transfers of wastewater out of the watersheds where the source water supplies were originally drawn.

Restore Consumed Water

Consumptive water use removes ground or surface water from a watershed or river basin and does not return it. Water can be consumed by evaporation through cooling towers, evapotranspiration through irrigated crops, incorporation into manufactured products, or diversion to another river basin. SRBC regulates consumptive water use exceeding 20,000 gallons of water per day to compensate for the lost water during periods of low flow in the Susquehanna River basin. Acceptable compensation measures include, among others, replacing consumed water at or above the intake point and monetary payments to SRBC. SRBC uses the funds collected to purchase stored water from the U.S. Army Corps of Engineers at Cowanesque Lake in Tioga County and Curwensville Lake in Clearfield County. Currently, about 30,000 acre-feet of such storage has been procured. The stored water is released during drought conditions to maintain aquatic habitat, and otherwise minimize the effects of excessive low flow on downstream water users. Construction to provide additional storage is currently ongoing at the Whitney Point Lake Reservoir in Broome County, New York as well. The Whitney Point project is expected to be completed in late spring of 2009.

SRBC is also actively engaged in replacing the estimated 15.7 million gallons per day of water needed to compensate for agricultural consumptive use during low flow conditions. By partnering with the Commonwealth in a project to restore 10 million gallons of treated abandoned mine water to the Susquehanna Basin, agricultural consumptive use will be partially compensated during the growing season. Additional methods such as using abandoned quarry water and developing underground mine storage are being considered to acquire the remaining 5.7 million gallons per day needed for full compensation.

Replace Potable Water Use

Stormwater capture or infiltration systems such as rain gardens, rain barrels, cisterns, infiltration beds, and pervious pavement are capable of supplementing and moderating reliance on potable water sources. Recycling and reusing wastewater also reduces overall fresh water use and extends potable water sources at individual locations. DEP's Southeast Regional Office in Norristown, where a 5000-gallon cistern captures precipitation for use by restroom facilities, provides an example of local precipitation harvesting. While these individual practices do not generate substantial new sources of water, they combine to reduce demands on and prolong traditional potable water supplies.

Restore Watershed Integrity

Watershed restoration is an efficient way to expand the scope of beneficial water use. Restoring and protecting Pennsylvania's water resources begins with home management of local watersheds. Effective watershed restoration tools include stabilizing stream banks and establishing forested riparian buffers. Removing legacy sediment is also emerging as a means of reclaiming streams' carrying capacities to reduce flooding. Additionally, protecting public water supply sources provides significant benefits to overall watershed quality. Local watersheds serve as sources of clean drinking water, filter and purify groundwater, provide industrial process water, supply water for irrigation, and offer natural flood control and protection. Small watersheds and their riparian areas are also the single most important habitat for land and aquatic wildlife. Local watersheds present outstanding recreational opportunities, and confer a sense of place and history to the surrounding area. Local watersheds also make up larger watersheds and major river basins that progressively influence the condition of downstream creeks, rivers, lakes and estuaries. In fact, Pennsylvania is accountable to downstream states for the health of the Chesapeake Bay, the Delaware Bay, the Gulf of Mexico, and the Great Lakes system; and to 38% of the nation's population who drink water originating from or passing through Pennsylvania watersheds.

Management Alternatives

Employ Conjunctive Management Techniques

Conjunctive management programs maximize water availability and minimize resource damage by optimizing the combined use of water supply sources, including ground and surface sources, and interconnections. Conjunctive water management is applied to increase water supply reliability through the planned, coordinated management and use of multiple sources. Successful conjunctive water resource management results in cumulative benefits beyond those achieved through separate management of the sources. Conjunctive water resource management does not create new sources of water, but uses available water in the most efficient manner possible. It extends the use of existing sources based upon their individual seasonal and long-term yields or availability, their storage characteristics, operational costs, and contractual arrangements with other suppliers. For example, run-of-stream sources with little or no storage would generally be used first to preserve stored ground or surface water for periods when stream flows are insufficient or at critical stages. Contracts with other water suppliers for supplemental supplies through interconnections may be used either early or late after cost, seasonal capability, and contractual arrangements with the interconnecting system are considered. While operating costs are a consideration, a conjunctive management operating plan that attains full overall system yield will not, in many cases, align with the most cost-efficient operating plan. Conjunctive water management must be tailored to local conditions, and be administered with an understanding of the unique environmental, economic, and operational characteristics of the system involved. In areas of Pennsylvania where demand is approaching the safe yield of available water resources, conjunctive management could extend water availability, improve reliability and prolong beneficial uses by coordinating all available surface and groundwater assets.

Increase Withdrawals or Allocation

Increasing water availability could be as simple as withdrawing more water from the source or obtaining an increased allocation. Any anticipated withdrawal increase must be measured against its projected influence on other non-withdrawal water uses and water users in the area. The potential harm to riparian surface water and groundwater users must be assessed, along with the potential harm to the aquatic community. Boosting surface or groundwater withdrawals or increasing their allocations may require SRBC or DRBC approval. Public water suppliers seeking to add to their surface water allocation would need to obtain a new Water Allocation Permit from DEP.

Revise Operational Protocols

Revising operational protocols entails changing operation and management procedures on water supply systems and water resource management projects to maximize yield, system flexibility, and beneficial uses. It is fundamentally a risk-based decision making approach to efficiently balance supply with multiple demands. If a system has more than one reservoir, coordinated water routing and use among reservoirs based on specific needs and timing, could increase overall water delivery and enhance multiple water uses. Operational changes to the timing or volume of reservoir storage and releases can also be made to match various priorities, to increase system efficiency, or to focus on a specific use. Unless new construction or facility demolition is necessary, revising operational protocols can be a relatively inexpensive means to maximize beneficial use potential and minimize water use conflicts.

Reduce Leakage and Loss

Water loss control can be viewed as water conservation by water suppliers. Water utilities can waste or lose significant amounts of water through distribution system leaks and storage overflows. Water that is treated and lost translates to reduced revenue and overuse of the water source. Responding only to erupted water mains and customer complaints increases the frequency of public health threats and will not solve or contain system leakage problems. Effectively controlling leakage requires a management program that includes periodic water audits, prompt response to identified losses, and planned replacement of system piping prior to the end of its useful life. Many effective strategies currently enable water utilities to identify, measure, reduce or eliminate leaks in a manner that is consistent with their cost of doing business. The Water Resources Planning Act recognizes the value of leakage and loss reduction by directing the PENNVEST to give special funding consideration to projects that “address unaccounted for water loss”.

Meter Water Use

It is well established that metering water use reduces consumption. DEP currently requires public water suppliers to meter individual surface water sources as a condition of issuing a surface water allocation permit. SRBC and DRBC also have source metering requirements for both ground and surface water withdrawals of 100,000 gallons per day or more. The trigger point for source metering drops to 10,000 gallons per day in the Southeast Pennsylvania Groundwater Protected Area, and to 20,000 gallons per day of consumed water in the Susquehanna River basin. In addition, Public Utility Commission regulations require customer metering by all water utilities under its jurisdiction. Nearly 98% of public water suppliers in Pennsylvania currently meter their customers’ use of water.

Apply Appropriate Pricing Strategies

Clean water has a price. Consumer water rates should be set to cover the cost of administration, operation, maintenance, capital improvements, and environmental protection. There are several types of rate structures in use. A flat rate system assesses the customer an equivalent amount each billing cycle regardless of the quantity of water used. A tiered rate structure is based on paying a specific amount for each predetermined block or unit of water used. Increasing block rates require the customer to pay higher rates for each volumetric tier encountered while decreasing block rates result in lower unit cost as water use escalates. Increasing block rates are preferable because they encourage water conservation. Volumetric pricing simply charges the customer based on the volume of water used – the more water used, the more the customer is charged. Volumetric and tiered rate structures require that individual water use be metered. An efficient pricing strategy can be a major incentive to reduce water use and can lead to multiple environmental benefits, deferred capital costs, and reduced use of power and chemicals. Clearly, if efficient pricing is to promote better water resource use, cost must be directly linked to the amount of water consumed or pollution produced.

Water purveyors in the Delaware River basin seeking new or expanded water withdrawals of more than one million gallons per day are bequired by DRBC policy to evaluate the feasibility of implementing a water conservation pricing structure and billing program.

Employ Consumer Conservation Measures

Water conservation relieves stress on water supply sources; saves industrial, agricultural and residential customers money; and produces a number of collateral benefits. Consumer conservation reduces energy cost and chemical use, can eliminate the need for inter-basin water transfers, and can delay or avert expansion of existing drinking water and wastewater infrastructure. Water conservation educational programs, installing water saving plumbing fixtures, and using water meters all effectively reduce residential and institutional water consumption. Minimizing leakage and loss, recycling wastewater, or making fundamental process changes can also significantly reduce industrial water use and consumption. Industrial and commercial water conservation measures are often implemented in conjunction with more general pollution prevention efforts. Farmers can employ conservation techniques to effectively manage water use at their livestock operations, and can minimize crop irrigation water use by relying on irrigation systems designed specifically for existing soil, topography and vegetation.

Although water use reduction and water conservation are largely presented in the Water Resources Planning Act as voluntary actions, water conservation is also prominently addressed in several regulatory contexts. Projects that implement water conservation practices are to be given special funding consideration by PENNVEST under the Act. The Act also directs the Environmental Quality Board to adopt regulations that, in part, describe “a process under which users may document and register practices or projects that they have implemented to reduce water withdrawals or consumptive use, promote groundwater recharge or otherwise conserve or enhance water supplies for consideration and use in providing appropriate recognition and credit during the implementation of existing or future water supply programs.”

Other legislation identifies water conservation as a mandatory activity. Permits issued under the Water Rights Act of 1939 are typically conditioned to require adoption and implementation of a water conservation program. In addition, drought emergency regulations require public water supply agencies, and major industrial and commercial water users, to develop drought contingency plans that match water use reduction scenarios to various levels of drought conditions. Water users in the Susquehanna and Delaware River basins must also comply with SRBC and DRBC water conservation regulatory requirements.

Assessment of Alternatives for an Adequate Supply of Water

The alternatives available to address current and future water resource problems and needs are numerous and diverse. The successful application of specific alternatives depends on individual problems identified, existing conditions, cost, potential environmental impact, and anticipated public and political reaction. A simplified analysis of alternatives to address identified water shortages, adverse influence on water uses, or conflicts among water users can be efficiently conducted through the use of a decision matrix. The decision matrixes presented on the following pages facilitate an alternative assessment by comparing the root problem to possible solutions, and by guiding the user toward potential practical resolutions.

The generic tabular analysis of alternatives to address water availability problems revealed that several approaches were applicable to a broad spectrum of needs. For instance, developing additional sources and increasing storage capacity address a number of potential problems associated with an inadequate supply of potable water. Several alternatives such as conjunctive use management, metering, interconnecting or regionalizing drinking water systems, conserving water, adjusting rate structures, and coordinating planning initiatives are nearly universally applicable and have relatively low implementation costs. They should be given primary consideration when addressing current or projected in-stream or water supply shortages, or user conflicts, before progressing to more expensive and expansive structural solutions. Fundamentally, access to clean, sustainable and reliable sources of water comes down to maximizing the quantity and quality of the resource, while minimizing invasive and unnecessary uses.

ASSESSMENT OF STRUCTURAL ALTERNATIVES

	DEVELOP ADDITIONAL SOURCES	INCREASE RAW WATER STORAGE	EXPAND TREATED WATER STORAGE	RECHARGE GROUNDWATER	EXPAND TREATMENT CAPACITY	REGIONALIZE WATER SYSTEMS	RESTORE CONSUMED WATER	REPLACE POTABLE WATER USE	RESTORE WATERSHED INTEGRITY
YIELD DEFICIENCY	X	X		X		X		X	X
ALLOCATION DEFICIENCY	X	X						X	
EMERGENCY SUPPLY DEFICIENCY	X	X	X			X			
FILTRATION PLANT CAPACITY DEFICIENCTY	X				X	X		X	
DEPLETED STREAM FLOW	X	X		X		X	X	X	X
DEPLETED GW RESERVES	X	X		X		X		X	X
EXCESSIVE CONSUMPTIVE LOSSES	X	X		X		X	X	X	X
EXCESSIVE TRANSFER LOSSES	X			X		X	X	X	X
POOR RAW WATER QUALITY	X		X		X	X			X

ASSESSMENT OF MANAGEMENT ALTERNATIVES

	EMPLOY CONJUNCTIVE MANAGEMENT TECHNIQUES	INCREASE WITHDRAWALS OR ALLOCATION	REVISE OPERATIONAL PROTOCOLS	REDUCE LEAKAGE AND LOSS	METER WATER USE	APPLY APPROPRIATE PRICING STRATEGIES	EMPLOY CONSUMER CONSERVATION MEASURES
YIELD DEFICIENCY	X		X	X	X	X	X
ALLOCATION DEFICIENCY	X	X	X	X	X	X	X
TREATED STORAGE DEFICIENCY	X		X				X
FILTRATION PLANT CAPACITY DEFICIENCTY	X		X	X	X	X	X
DEPLETED STREAM FLOW	X		X	X	X	X	X
DEPLETED GW RESERVES	X		X	X	X	X	X
EXCESSIVE CONSUMPTIVE LOSSES	X		X	X	X	X	X
EXCESSIVE TRANSFER LOSSES	X		X	X	X	X	X
POOR RAW WATER QUALITY	X		X				

Water Use Trends

Introduction

Pennsylvanians withdraw about 9.7 billion gallons of water every day from a variety of surface and ground water sources. The thermoelectric power industry is responsible for approximately 70% of those withdrawals. Public water supplies make up about 15% of statewide water use while industries use roughly 12%. Mining and agriculture account for close to 2% and 1% of water use, respectively.

Although this State Water Plan does not rigorously quantify long range water withdrawal and use projections, future water use can be examined by considering a number of related assessments and relevant emerging trends. Population shifts, energy demands, farming practices, infrastructure management, consumer sophistication, national and international policies, and climate change will all undoubtedly influence how Pennsylvanians manage their water resources in the years to come.

Domestic Water Supply

Pennsylvania's population is nearing 12,500,000 and ranks sixth in the country, but it increased only about 1.2% over the period spanning 2000 to 2006. This slight population growth has not been uniform, but has been accompanied by a geographic population shift. Thirty-eight counties in the northern tier and western regions of Pennsylvania are losing population. Conversely, south-central, eastern, and northeastern counties are experiencing population growth, primarily from border state migration and urban relocation. Pike and Monroe Counties experienced population growths of over 25% and 19% respectively during the six year period. Chester County's population increased by over 48,000 and York County gained nearly 34,600 residents. Berks, Bucks, Montgomery, and Monroe Counties all had population increases of over 25,000 while Lancaster, Lehigh, and Northampton Counties each saw their populations expand by over 20,000 residents. These trends are likely to continue, but an even greater population shift is looming if drought conditions in the western United States persist as predicted. The National Oceanic and Atmospheric Administration has recently conducted simulations that show Colorado River flows, by mid-century, falling to about half the amount consumed today from the river[1]. If these predictions prove accurate, the water rich northeastern and Great Lakes states could be on the threshold of a population surge from the 30 million western sunbelt residents who currently rely on the Colorado River for water.

Disproportionate population increases translate into uneven demands for water. Although per capita water use is expected to remain stable or decline, it is anticipated that overall demand for domestic water will increase in the growing areas of Commonwealth. In response to the population influx, it is likely that large regional water systems will continue to grow in these areas with a corresponding decline in the number of small independent systems. Regionalization is further supported by incentives and policies implemented by the Public Utility Commission. A commensurate decrease in

[1] Kunzig, Robert. "Drying of the West." National Geographic, February 2008

domestic water use related to population loss in much of the northern and western regions of Pennsylvania is also probable.

More sensitive instrumentation and analytical methods have recently enabled the identification of extremely low levels of unwanted substances in drinking water, including an array of pharmaceuticals and other toxic chemicals. The long term impact of those compounds on public health and the aquatic environment is generally unknown. Continued monitoring and research could result in a public demand for cleaner sources of water that would favor shifting drinking water supplies to upland watersheds with low population densities and to ground water sources with more natural protection.

<u>Energy Needs</u>

Although experience of the past is not necessarily a good predictor of what will happen in the future, it is expected that energy demand in the United States will grow in the coming decades and will be a major factor in determining water use in Pennsylvania. Water use will need to adapt to these new energy needs.

Pennsylvania is quite literally a “keystone” of electric generation and transmission. It possesses an efficient power distribution network and is part of an energy grid that spans all or parts of 13 other states and the District of Columbia. The thermal electric generation sector already uses approximately 70% of the water withdrawn in the Commonwealth. In the Susquehanna River basin alone, there are eight fossil-fueled and three nuclear power plants that withdraw over 4.2 billion gallons of water per day and consume approximately 168 million gallons per day[2]. Anticipated growth in electric energy demand has been projected to require as many as 15 new major power generation facilities in Pennsylvania by 2020. Increased energy production could translate into even greater water use and water consumption for raw mineral extraction, process water use and cooling water needs. Given the requirements of §316(b) of the federal Clean Water Act, instead of the “once through” cooling systems once prevalent, these new facilities will be expected to recycle cooling water, lowering withdrawal quantities while significantly increasing water consumption through evaporation. Depending on the siting of these new units, they could significantly influence the low flow regimes of source streams. Similar requirements are being implemented at existing power generation facilities that lower withdrawal needs but significantly increase the amount of consumptive use. The impact of these shifts in water usage has not been critically evaluated but will undoubtedly be important to future water use trends.

In 2004, Pennsylvania enacted the Alternative Energy Portfolio Standards Act that requires 18% of the Commonwealth’s retail electricity be generated from alternative sources within 15 years. In early 2007 Governor Rendell released an energy independence strategy designed to produce enough homegrown fuel to replace the current level of foreign imports. A major part of that strategy is dedicated to energy conservation that will equate to water conservation as well. By reducing energy use, and relying more on alternative energy sources such as wind and solar power generation, a parallel reduction in water use will be achieved. This farsighted plan represents an important step toward addressing energy production and use in the Commonwealth that could also keep future water resource demands in check.

[2] Draft Comprehensive Plan for the Management & Development of the Water Resources of the Susquehanna River Basin, February 2008

Agricultural Water Use

Pennsylvania's 58,000 farms are responsible for about 1% of total water withdrawals. Lancaster County irrigates the most farmland, followed by Franklin and Adams Counties while the largest percentage of farmland is irrigated in Schuylkill and Erie Counties at just over 2%[3]. Estimates show that Lancaster, Franklin and Lebanon Counties use the most water to support livestock operations. As food production demands increase and the value of various crops (such as corn) fluctuate due to market conditions, irrigation requirements and associated consumptive uses of water may well increase.

Pennsylvania's Energy Independence Strategy would codify the "PennSecurity Fuels Initiative" by requiring the growth and use of one billion gallons of renewable fuels, representing about 12.5% of all fuel consumption in the state[4]. On March 13, 2008 ground was broken in Clearfield County for the first ethanol plant to be located in Pennsylvania. When completed, it will be one of the ten largest ethanol plants in the nation. Also in March 2008, an ethanol plant was approved for construction in Lancaster County that is expected to begin production in 2010 or early 2011. These plants will be fueled mostly by corn along with some production generated by cellulose sources such as switch grass and wood pulp. On the shores of Lake Erie, Lake Erie Biofuels produces about 40 million gallons of biodiesel fuel a year. Fuel is produced from animal fats or vegetable oil that is mixed with petroleum-based diesel to make blended diesel fuel and home-heating oil. One of the primary raw materials needed to produce biofuels is soy bean oil that can be extracted from locally grown crops.

Statewide, it is anticipated that water use by livestock producers will rise slightly over the next 20 years[5] due to increased demand and further concentration of animal feeding operations. Increasing demand for corn and soybeans to be used as raw material for ethanol and biofuels facilities, along with an increasing worldwide demand for grain, could continue to drive the value of cropland higher. As cropland increases in value, pressure will build to place unused land into production. As a result, Pennsylvania could follow the developing national trend of pulling farmland from conservation reserve programs and putting it into productive use. Significantly reducing land area in conservation reserve programs could lead to additional consumption of water for agricultural use, loss of established vegetative buffers along streams and reductions in wildlife habitat.

Climate Change

This State Water Plan does not directly assess global climate change nor does it recommend specific actions to reduce greenhouse gas emissions that could help stabilize rising worldwide temperatures. This discussion provides background information about the possible causes of climate change and addresses the potential consequences of climate change on Pennsylvania's water resources.

Atmospheric gasses such as carbon dioxide, methane and nitrous oxide act as a blanket for the earth by absorbing radiant heat that would otherwise escape into space. The

[3] U.S. Department of Agriculture, 2004
[4] News release, Office of the Governor, February 1, 2007
[5] Jarrett and Roudsari, 2007

consensus among climate scientists is that escalating releases of greenhouse gasses generated by human activity are enhancing the natural greenhouse effect. A recent report by the Intergovernmental Panel for Climate Change (IPCC), in its *Third Assessment Report*, concluded that "human influence will continue to change atmospheric composition throughout the 21st century" and that change "will persist for many centuries." The IPCC further predicted that the average global temperature will rise by two-and-a-half to ten degrees Fahrenheit over the next century. Temperature change in the United States is expected exceed the global average despite an anticipated temporary cooling trend that could set in due to shifting ocean currents. If these long range climatic forecasts are upheld, rising worldwide temperatures could spark a chain reaction that would fundamentally alter global weather patterns, melt polar ice and cause sea levels to rise significantly. These events could trigger an increase in the frequency and severity of intense storms, floods, droughts, and dangerous heat waves. Such a dramatic climate shift could drastically alter Pennsylvania's water resources, water use, and water resource management needs. A major change in Pennsylvania's climate could stress water bodies; evaporate water from surficial aquifers; affect biological diversity; cause changes to agricultural practices and production; necessitate modification of stormwater management, flood protection, and erosion control techniques; reshape coastal areas; alter navigation and shipping practices; and affect domestic and industrial water supply availability and management strategies. Since energy efficiency and conservation are the most direct and economical means of reducing greenhouse gasses, a commensurate reduction in water use could be associated with such efforts.

It is clear that the current natural resource balance is at risk if global temperatures continue to rise as anticipated. Even if greenhouse gas emissions are substantially reduced and their atmospheric concentrations are stabilized, it is probable that some measure of climate change will continue and that actions will be needed to adapt to a warmer environment. The resultant impact on Pennsylvania's natural water resources and water resource infrastructure cannot be precisely forecast. Adaptation strategies and mitigation opportunities will need to be explored to ensure that water resource needs will be met at the national, state and local levels. Although much research has been done on climate change, its causes, and its remedies; little research has been conducted on the specific challenges climate change may present to managing water resources, water supplies, water use, and emergencies. One effort to fill this void has been initiated by a coalition of research organizations from the United States, the United Kingdom and Australia that was formed to intensify investigation into the common concerns of adapting to the consequences of climate change on water resources and water suppliers. This and similar efforts should provide some context and direction that will be useful in meeting the mounting challenges that lie ahead.