CONSUMPTIVE USE MITIGATION PLAN

Publication No. 253 *March 2008*

SUSQUEHANNA RIVER BASIN COMMISSION

The Susquehanna River Basin Commission was created as an independent agency by a federal-interstate compact* among the states of Maryland, New York, Commonwealth of Pennsylvania, and the federal government. In creating the Commission, the Congress and state legislatures formally recognized the water resources of the Susquehanna River Basin as a regional asset vested with local, state, and national interests for which all the parties share responsibility. As the single federal-interstate water resources agency with basinwide authority, the Commission's goal is to coordinate the planning, conservation, management, utilization, development and control of basin water resources among the public and private sectors.

**Statutory Citations: Federal - Pub. L. 91-575, 84 Stat. 1509 (December 1970); Maryland - Natural Resources Sec. 8-301 (Michie 1974); New York - ECL Sec. 21-1301 (McKinney 1973); and Pennsylvania - 32 P.S. 820.1 (Supp. 1976).*

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EXECUTIVE SUMMARY

The Susquehanna River Basin Commission's (Commission's) consumptive water use regulation, adopted in 1976, required project sponsors to provide mitigation for their water use during low flow events. The Commission enacted a measure in 1993 to allow project sponsors to pay a fee to the Commission in lieu of providing actual compensatory water. The payment of fees was intended to allow the Commission to undertake large-scale storage projects to provide low flow mitigation for consumptive water use projects paying the fee. The Commission's mitigation strategy is based on the elimination of manmade impacts caused by consumptive water use during low flows and the return to natural flow conditions. The purposes of this Consumptive Use Mitigation Plan (CUMP) are to present the state of consumptive water use in the Susquehanna basin, identify the low flow mitigation needs, and introduce the Commission's plan for meeting mitigation needs.

An assessment of consumptive water use data demonstrated that the maximum current use potential in the basin is an estimated 882.5 million gallons per day (mgd). Projected consumptive water use in 2025 is expected to increase by an additional 319.7 mgd, resulting in a forecast total peak use of 1,202.2 mgd. The portions of those current and future use totals that require mitigation are 116.7 mgd and 390.3 mgd, respectively. These needs will serve as the basis for the evaluation of various projects for effective low flow mitigation requirement through 2025.

Aside from knowing the quantity of consumptive water use requiring mitigation, it is important to assess the most appropriate methods for achieving mitigation. Analyses have been performed regarding flow thresholds, locations for the monitoring of hydrologic conditions, whether there are suitable surrogates for releases of water, and tributary versus mainstem mitigation needs.

The Commission's strategy to mitigate consumptive water use is based on elimination of manmade impacts of consumptive water use during droughts. However, the threshold established early in the Commission's mitigation program (the Q7-10 flow) occurs only during extreme events and is based in the assimilation of wastewater discharges, not the protection of habitat or other riparian needs. A drought analysis was done to discern how often certain low flow thresholds occur and the expected duration of the low flow event. The results dictate the amount of mitigation storage needed and over what length of time water would be released. These needs will be critical in determining how mitigation projects may fit into the mitigation plan, and may be cause for eliminating projects from consideration.

The results of the drought analysis also demonstrated another shortcoming of the low flow threshold traditionally used year-round by the Commission to mitigate the impact of withdrawals. One standard across all months is not appropriate; a threshold that is protective during one season is either overly protective other times of the year or offers no protection at all.

In addition to comparing low flow thresholds, the Commission also investigated the occurrence of low flows in different regions of the Susquehanna basin. Occurrences of specific low flow thresholds were documented and compared at several mainstem and tributary gages. The results showed that, even in very severe droughts, not all regions experience identical conditions. This information is important for making decisions regarding the monitoring of drought conditions to ensure reliable indicators of the need for mitigation.

Having determined that the Q7-10 threshold is not adequately indicative of the need for consumptive water use mitigation, the Commission investigated alternative thresholds such as those that were developed based on protection of riparian needs. To meet the mitigation goals, Commission staff is proposing that a seasonal threshold for mitigation should be established to recognize the natural pattern of flows in the basin. Summer and fall thresholds should be set at flows higher than Q7-10 and more consistent with Federal Energy Regulatory Commission (FERC) flow requirements at Conowingo Dam and the monthly low flow criteria established in the Commission's Comprehensive Plan. The months of August, September, and October are given priority for mitigation. As a safeguard, an ultimate threshold should also be determined, at which point all remaining storage dedicated to mitigation would be put into use for the purpose of allowing continued operation by power plants and ensuring adequate water downstream of Conowingo Dam.

Several evaluations and assessments would be needed before this strategy in its final form could be implemented. Perhaps most important is the realization that the Commission does not have adequate storage to provide mitigation at the suggested frequency and duration, nor is there likely to be sufficient funding readily available to procure additional needed storage. Because the mitigation goals described above will require significant changes to the way the Commission manages both its existing and new storage that is acquired, the following recommendations are intended to address the major issues:

- Reevaluate Conowingo operations and other existing consumptive use mitigation.
- Reevaluate Commission-owned storage at Cowanesque and Curwensville reservoirs.
- Enhance reservoir storage operations.
- Implement Pennsylvania agricultural consumptive water use projects.
- Evaluate underground limestone mines as a source for mitigation water.
- Evaluate potential modifications and/or operational changes at select Pennsylvania-owned impoundments.
- Assess instream flows.
- Increase the Commission's consumptive use fee.
- Revise the structure of the consumptive use fee.

Implementation of the consumptive water use mitigation strategy and the recommended actions will begin immediately upon adoption of the Plan by the Commission.

PURPOSE

The mission of the Susquehanna River Basin Commission (Commission) is to enhance public welfare through comprehensive planning, water supply allocation, and management of the water resources of the Susquehanna River Basin. Among its primary responsibilities, the Commission regulates consumptive use (CU) of water and requires in its approvals mitigation for it during droughts. CU is broadly defined to be the loss of water due to a variety of processes by which the water is not returned to the waters of the basin undiminished in quantity.

The Commission's CU regulation, adopted in 1976, required project sponsors to provide mitigation for their CU during low flow events. Much like the Commission's standards for passby flows at withdrawals, the CU mitigation strategy is based on the elimination of manmade impacts caused by CU during low flows and the return to natural flow conditions. This insures that water is available for downstream uses, including instream uses. Neither the passby flow or CU mitigation effort is intended to augment low flows in such a way as to provide more flow to waterways than would be expected to be naturally occurring in a drought, as low as that may be. Droughts are natural occurrences, and native resident species are adapted to them. The species are not, however, conditioned for the more frequent and severe low flow periods that would result from unmitigated CU.

Sponsors were expected to comply with the regulation by providing compensatory water or discontinuing CU during low flow events. While a few power companies were able to make the financial investments to secure water storage at large existing reservoirs (Cowanesque, Curwensville and Chillisquaque Lakes) for compensatory purposes, this option proved impractical for most sponsors, and discontinuation of CU was largely unreasonable for facilities. In response, the Commission enacted a measure in 1993 to allow project sponsors to pay a CU fee to the Commission in lieu of providing actual compensatory water. The payment of fees was intended to allow the Commission to undertake additional large-scale storage projects to provide low flow mitigation for CU projects paying the fee. The Commission has performed several project studies over the past decade, and as a part of those efforts recognized the value of completing an overarching and comprehensive study and plan for long-term CU mitigation.

The purposes of this Consumptive Use Mitigation Plan (CUMP) are to present the state of CU in the Susquehanna basin, identify the low flow mitigation needs, and introduce the Commission's plan for CU mitigation. This plan quantifies and characterizes current CU and mitigation requirements in the basin, and presents projections for CU and needed mitigation in 2025. A strategy for mitigating CU is presented, including an evaluation of various methods for providing the required mitigation during critical low flow periods. Finally, recommended actions needed for long-term CU mitigation are identified.

PROBLEM IDENTIFICATION

The Commission undertook a study of the magnitude, purpose, and location of CU in the basin to better understand the issue and challenges it presents. To meet the challenges, the Commission also assessed CU mitigation currently available in the basin to offset impacts, and compared the quantity of available mitigation to present and projected quantities of CU. The findings are summarized in the sections below; the full analysis is presented in Appendix A – Consumptive Water Use in the Susquehanna River Basin.

Consumptive Use in the Basin

The methodology for estimating CU in this mitigation plan is based on an assessment of available data and an analysis to characterize CU from several perspectives. The Commission relied mostly on its computerized database, which includes both approved peak day CU and actual daily CU that is reported for all regulated projects. At the time when the Commission analyzed its data, 2005 was the last year for which complete data were available. An analysis of the 2005 data showed:

1. Five major categories of CU – utilities (comprised of public water supply out-of-basin diversions and power generation), recreation, manufacturing, mining, and education – represented more than 90 percent of the 291 projects approved by the Commission and 98.5 percent of the 563 million gallons per day (mgd) approved CU in the basin.

2. Actual CU has historically been the greatest in July, with approximately 12 percent of the annual total. An investigation of how CU varies over the year is presented in Appendix A.

3. Utilities alone can account for up to 85 percent of all CU in July.

4. Approximately 47 percent of annual CU occurs during the typical low flow months for streams (July–November), but peak monthly CU (July) will not always coincide with the most critical low flow period, which most frequently occurs in September.

5. Total CU reported to the Commission for approved projects was 301.1 mgd in July 2002, the most recent drought year for which data were available, and 173.8 mgd in July 2005, a recent "normal" hydrologic year. There are several reasons that the peak CU during these years fell substantially below the total approved CU; those reasons and their implications for CU mitigation are discussed in following sections.

6. CU is greatest in the Middle Susquehanna Subbasin, West Branch Susquehanna Subbasin, and Lower Susquehanna Subbasin, with approximately 98 percent of total maximum approved basinwide CU occurring in these subbasins.

Examples of consumptive water use in the basin are depicted at the top of the next page.

The Commission also established a baseline of current peak CU conditions in order to: (1) plan for implementation of projects to mitigate current CU during drought periods; and (2) make reasonably accurate projections of future peak CU and the mitigation needed for it. To establish the current CU baseline, the Commission considered not only actual CU, but current CU growth potential within approved CU limits. As noted above, recent CU reports in the basin fell substantially short of the total approved quantities. Several reasons account for the apparent discrepancy. The City of Baltimore's (City's) approval constitutes the largest quantitative disconnect; although a diversion (100 percent of which is considered CU) of 250 mgd is recognized as predating the Susquehanna River Basin Compact (Compact), the City currently relies on the Susquehanna River only as a supplemental water source during prolonged droughts (it is worth noting that the bulk of the difference in water use values presented above can be attributed to the City pumping from the River in 2002, but not in 2005). Further, despite the recognition of the City's right to 250 mgd, its current pumping capacity is limited to approximately 137 mgd. Likewise, other projects in the basin are approved for a CU quantity greater than current capacity, in recognition of short-term build-out plans. Finally, many approved projects do actually operate very near their approved CU quantities, but may not do so every day. The most illustrative examples are golf courses and athletic fields that irrigate on alternate days and ski resorts that consume water through snow-making only during the winter months.

The assessment of the database and the approved quantities recorded in it demonstrate that the total peak CU for all approved projects would be 563 mgd at permitted levels. When considering CU projects that are not included in the database, such as agricultural use, small users, and grandfathered uses, the maximum current CU potential in the basin increases to an estimated 882.5 mgd. The Commission does not differentiate or distinguish between CU originating from surface water sources versus groundwater sources; it is the assumption upon approval of the CU project that the streams and rivers of the basin are directly impacted by all CU, particularly during times of drought.

Estimated peak CU in 2025 also was projected to plan for needed CU mitigation. An additional 319.7 mgd in CU is expected by 2025, resulting in a forecast total peak CU of 1,202.2 mgd. The increase in CU between current levels and that expected in 2025 is due in large part to projects related to power generation in the basin. The remainder of the increase in CU is attributable to population growth, increases in industries already regulated by the Commission, increased diversions by the City of Baltimore and Chester Water Authority, and increased water use by agricultural operations. Although frequent reference is made to the Conowingo Dam, this plan includes all CU throughout the basin, including that occurring downstream of Conowingo.

Mitigation Needed

As provided for by the Commission's 1993 policy, the Commission must mitigate for approved CU projects that provide monetary payment to the Commission for annual consumptive water use. Of the current baseline peak CU totaling 882.5 mgd (1,360 cubic feet per second [cfs]), 765.8 mgd of this amount currently is mitigated by storage projects (112 mgd), covered by mitigation agreements (340.2 mgd), or is exempt from mitigation (313.6 mgd). Current CU is considered to be exempt from mitigation if it pre-dates the effective date of the Commission's CU regulation (January 1971); is associated with a small, non-regulated project falling below the Commission's regulatory threshold; or is associated with a public water supplier, all of which are excluded from the CU regulation (the exception being public water suppliers that divert water from the basin). Reducing the current baseline CU by 765.8 mgd results in a current CU mitigation need of 116.7 mgd (180 cfs). The Commission makes no differentiation nor assigns mitigation priority to CU with respect to its source (e.g., drinking water, power generation, agriculture, industry, or recreation).

Of the 319.7 mgd in projected CU increase through 2025, 97 mgd are expected to be mitigated by new storage projects (48 mgd combined in the Whitney Point Lake modification and agriculture CU mitigation projects) and by project owners (7 mgd), or be exempt from mitigation requirements (42 mgd). Exemptions for projected CU are associated with small projects falling below the regulatory threshold and for CU attributable to public water supplies. In addition, the City of Baltimore and Chester Water Authority plan to increase their diversions from the river beyond what is now allowed during low flow conditions, thereby increasing the mitigation need by 30 mgd and 20.9 mgd, respectively.

The net result for the additional mitigation need projected for 2025 is 273.6 mgd. The total current mitigation need of 116.7 mgd and the additional 273.6 mgd needed through 2025 results in a total projected mitigation need of 390.3 mgd.

A summary of the current CU and projected CU for 2025, as well as the CU mitigation needs for the Commission to address, is presented in Table 1 (peak values, in mgd) and on Figure 1. This information serves as the problem identification phase of the Commission's CUMP. The CUMP will include a range of projects to effectively meet the low flow mitigation requirement for 2025 and a recommendation for periodic reassessments using new data as it becomes available. See Appendix A for a more detailed description of the CU analysis undertaken for this plan. The mitigation need in terms of cubic feet per second (cfs) is 180 currently, with an anticipated increase of 421 cfs, for a total need in 2025 of 601 cfs.

Table 1. Consumptive Use Data by Category (peak estimates, expressed in mgd)

Time Period	Total CU	Exempt	Mitigation Required	Mitigation Provided	Remaining Need
Current (2005)	882.5	313.6	568.90	452.2	116.7
Increase to 2025	319.7[1]	42.0	277.71	4.1[2]	273.6
2025	1,202.2	355.6	846.60	456.3	390.3

[1] This total includes 50.9 million gallons per day (mgd) in increased water supply diversions (30 mgd for the City of Baltimore and 20.9 mgd for Chester Water Authority), which are included in the current totals but exceed that allowed during low flow conditions and must be mitigated.

[2] This total is the net between the new mitigation expected (55 mgd) and loss of mitigation for the City of Baltimore and Chester Water Authority (-50.9 mgd).

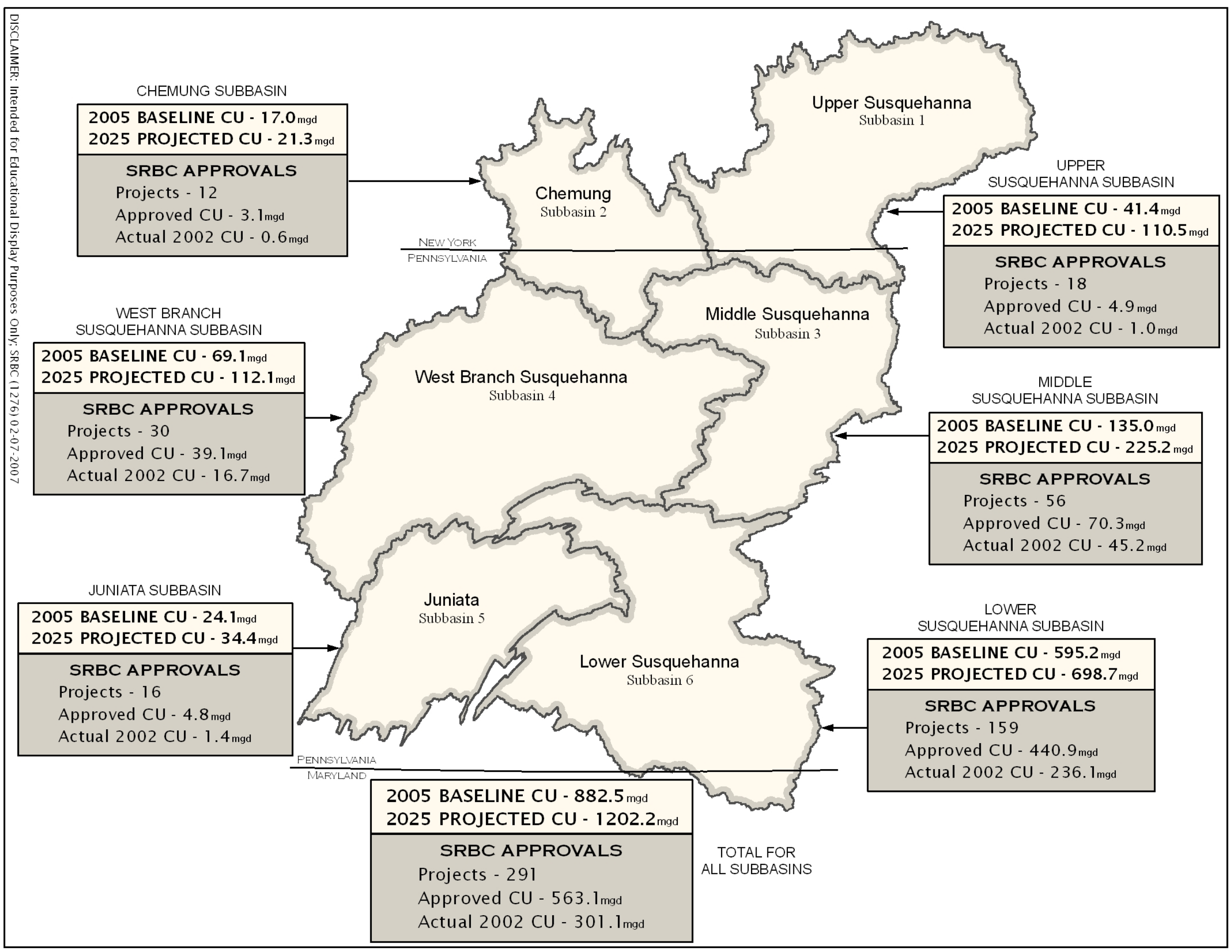


Figure 1. Consumptive Use Data by Major Subbasins (peak estimates, expressed in mgd)

Aside from knowing the quantity of CU requiring mitigation, recommendations need to be made regarding how mitigation should be achieved. Analyses have been conducted to assess how to implement mitigation – what threshold is appropriate to initiate mitigation, where hydrologic conditions should be monitored, whether there are suitable surrogates for releases of water, and local versus regional versus mainstem mitigation needs, for example. Results of these investigations and the follow-on recommendations are presented in the following sections.

Existing Mitigation

The Commission's strategy to mitigate CU is based on elimination of manmade impacts during droughts caused by consumptive water use after January 23, 1971. The Q7-10 threshold for CU mitigation was established early in the Commission's CU mitigation program. Commonly used at the time as a standard for low flow planning, the Q7-10 flow is the lowest average 7-day flow expected to occur at a 1-in-10-year frequency. However, the basis for the standard is the assimilation of wastewater discharges, not the protection of habitat or other riparian needs. A flow of Q7-10 occurs only during extreme events and does not consider specific riparian needs of the impacted waterway.

Traditionally, the Commission's CU mitigation strategy has been based on flow conditions at two mainstem gages in Pennsylvania: at Harrisburg and at Wilkes-Barre. That approach was appropriate when the mitigation program involved only water releases from Cowanesque Lake on behalf of the nuclear power plants at Three Mile Island near Harrisburg and at Susquehanna Steam Electric Station near Berwick (see Figure 2 for the location of the gages, Cowanesque Lake, and the power plants). However, along with the mitigation planning effort comes the questions of where best to monitor low flow conditions and at what thresholds mitigation should begin. Complicating the matter are several factors: (1) not all CU projects are located on the mainstem Susquehanna River; (2) most mitigation projects drain directly to the mainstem or a major tributary; and (3) releases from large reservoirs in the headwaters of the mainstem or major tributaries do not benefit smaller tributaries where the CU may be located. However, such releases do benefit the entire stretch of stream traveled between the location of the release and location of the first CU impact downstream.

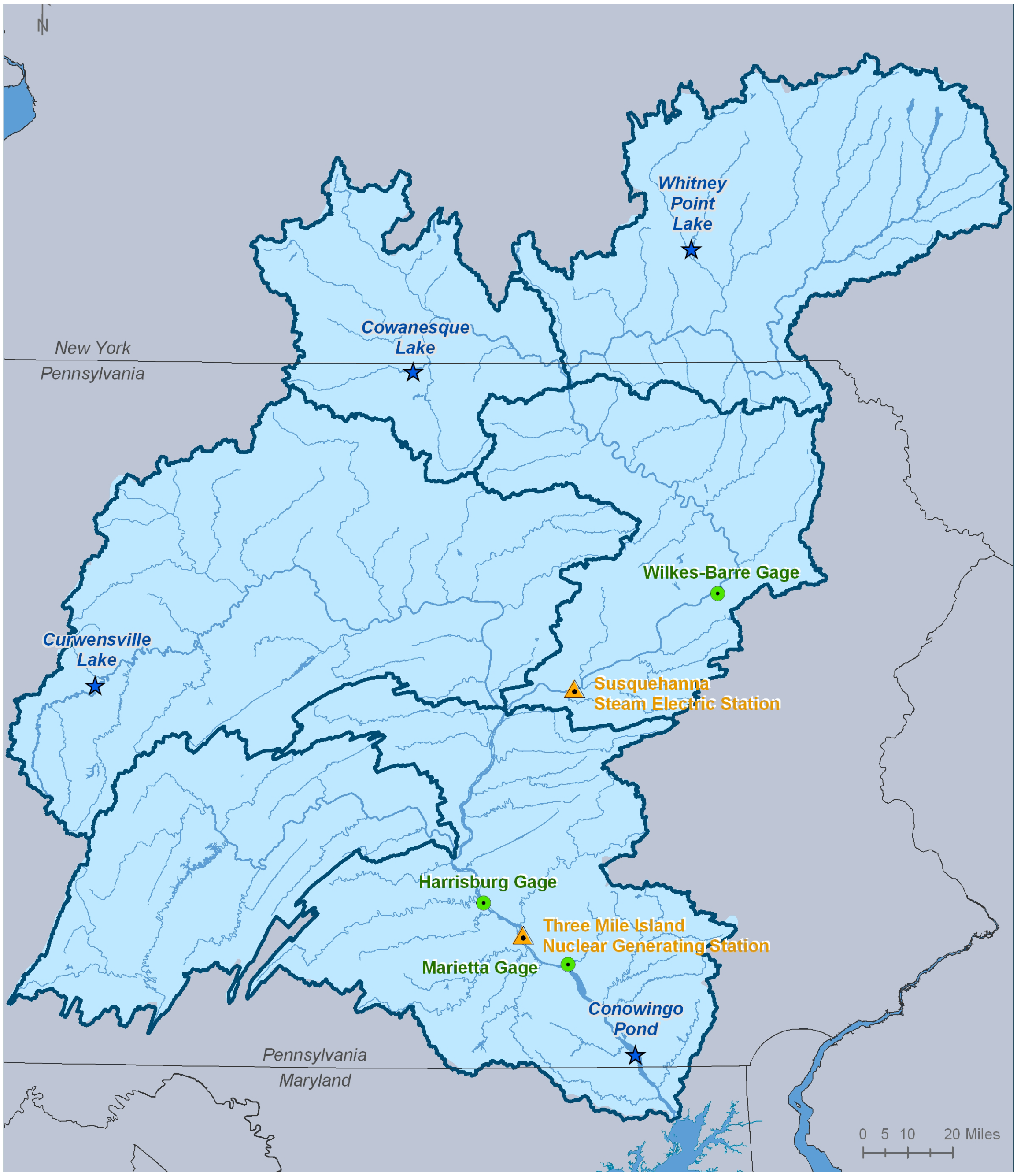


Figure 2. Locations Important to Traditional Commission Consumptive Use Mitigation

Most instances of established low flow thresholds in the Susquehanna basin are founded in general policy without specific evaluation of downstream riparian needs. In those cases, the default threshold of Q7-10 predominates. However, in most instances when low flow thresholds were determined based on the avoidance of specific impacts downstream, they are significantly greater. The best example is the release criteria specified for Conowingo Dam by the Federal Energy Regulatory Commission (FERC) in the dam's operating license. Studies conducted by resource agencies to evaluate riparian needs downstream of the dam were used to negotiate an agreement with the operators of Conowingo Dam that established minimum flow values well in excess of Q7-10. Commonly referred to as Q-FERC, the threshold in Conowingo's license differs not only in quantity from Q7-10, but also in that it varies seasonally. The range of operating requirements is 3,500 cfs to 10,000 cfs (see Table 2), which is roughly 130 to 400 percent of the Q7-10 value.

In order to translate the Q-FERC values to other locations in the basin, a statistical analysis was performed to determine its recurrence interval. The Q-FERC value during most of the summer season, 5,000 cfs, is approximately equivalent to the 92nd percentile annual flow (P92), meaning that all but 8 percent of flows exceed it. By comparison, the recurrence interval of the Q7-10 flow is such that it is exceeded roughly 99.3 percent of the time.

Table 2. Minimum Flow Values Established by FERC for Conowingo Dam (Q-FERC)

Time	Flow in cfs (mgd)
March	3,500 (2,260)
April	10,000 (6,460)
May	7,500 (4,845)
June 1 through September 14	5,000 (3,230)
September 15 through November 30	3,500 (2,260)
December 1 through February 28/29	3,500[1] (2,260)

1 Minimum flow requirements are intermittent for periods up to six hours during this time.

The disparity between one low flow threshold at Conowingo Dam – the downstream-most feature on the Susquehanna River – and a second less restrictive threshold elsewhere in the basin presents obvious difficulties in overall watershed management. The lower Susquehanna can be under low flow operations for weeks before mitigation measures upstream are implemented, if they initiate at all. As a result, the Conowingo Dam is forced to operate under restrictions while CU continues unabated and unmitigated in the large drainage area upstream.

BASIN LOW FLOW CONDITIONS

Drought Analysis

Frequency and Duration of Low Flow Thresholds

A definitive, specific threshold for low flow mitigation no longer exists in Commission regulations, although the Comprehensive Plan states that flows to the Chesapeake Bay should not be diminished below the 1-in-20 monthly average flows in each of the months of August, September, and October (equivalent to the monthly P95). Those flows equate to approximately 4,525 cfs in August and 3,900 cfs in September and October. The Q7-10 standard (roughly 2,570 cfs at Harrisburg) previously served as the default threshold for CU mitigation.

Q7-10 also served as the default threshold for protection from impacts due to water withdrawals until tools and protocols were developed to generate protective passby flows on a case-by-case basis. The 1996 Pennsylvania-Maryland Instream Flow Study offers a methodology for establishing a passby flow based on avoidance of unacceptable impacts of withdrawals to streams that support trout populations. Subsequent to that study, research and collaboration with member jurisdictions were performed to establish guidance for passby flows at any location in the basin, based on criteria such as stream classification. Results of that analysis led to the widespread use of another threshold, a function of the average daily flow (ADF). Depending on the classification of the stream subject to withdrawal, a passby in the range of 15 to 25 percent of the ADF may be imposed, with 20 percent ADF most commonly required. The ADF is simply the arithmetic average of all daily flow records available at a monitoring gage. These and other commonly used flow parameters are shown for key locations in Table 3.

Table 3. Commonly Used Flow Parameters for Key Locations in the Susquehanna Basin

Gage Location	Flow Parameter in cfs (mgd in parentheses)			
	Q7-10	**Annual P92**	**Q-FERC[1]**	**20% ADF**
Chemung, N.Y.	100 (65)	200 (130)	350 (230)	520 (330)
Waverly, N.Y.	400 (260)	755 (490)	1,020 (660)	1,510 (980)
Wilkes-Barre, Pa.	820 (530)	1,510 (980)	1,810 (1,170)	2,690 (1,740)
Williamsport, Pa.	480 (310)	940 (610)	1,210 (780)	1,800 (1,160)
Newport, Pa.	420 (270)	750 (490)	580 (370)	860 (560)
Harrisburg, Pa.	2,570 (1,660)	4,920 (3,180)	4,620 (2,980)	6,900 (4,460)
Marietta, Pa.	2,710 (1,750)	5,000 (3,230)	5,000 (3,230)	7,500 (4,850)
Conowingo, Md.	2,950 (1,910)	5,090 (3,290)	5,290 (3,420)	8,300 (5,390)

[1] Q-FERC is based on the July value at Marietta and is transferred to other locations by drainage area.

The use of passby flows has complemented the CU mitigation program; on the mainstem river where CU releases are available, the water uses, while among the largest in the basin, do not meet the threshold for needing a passby flow because of the overwhelming amount of water in the river even during extreme droughts. In contrast, water uses on smaller streams that are typically lacking in CU mitigation water usually meet the passby threshold, so resource protection is achieved through control of the withdrawal. Such a cessation prevents withdrawals from worsening conditions in streams such as the one shown on Figure 3.

In order to fully understand the scale of droughts in the Susquehanna basin for which mitigation may be required, an analysis was done to discern how often certain low flow thresholds occur and the expected duration of the low flow event. The results hold repercussions for mitigation planning, as they dictate the amount of storage needed and over what length of time water should be released. These needs will be critical in determining how mitigation projects may fit into the mitigation plan, and may be cause for eliminating projects from consideration. Two low flow thresholds were considered – Q7-10 and the annual P92. These thresholds were chosen because they effectively bracket the likely range of thresholds to be used to initiate mitigation. The results for the gage at Harrisburg are shown on Figure 4.

Figure 3.   Typical Stream During Drought Conditions

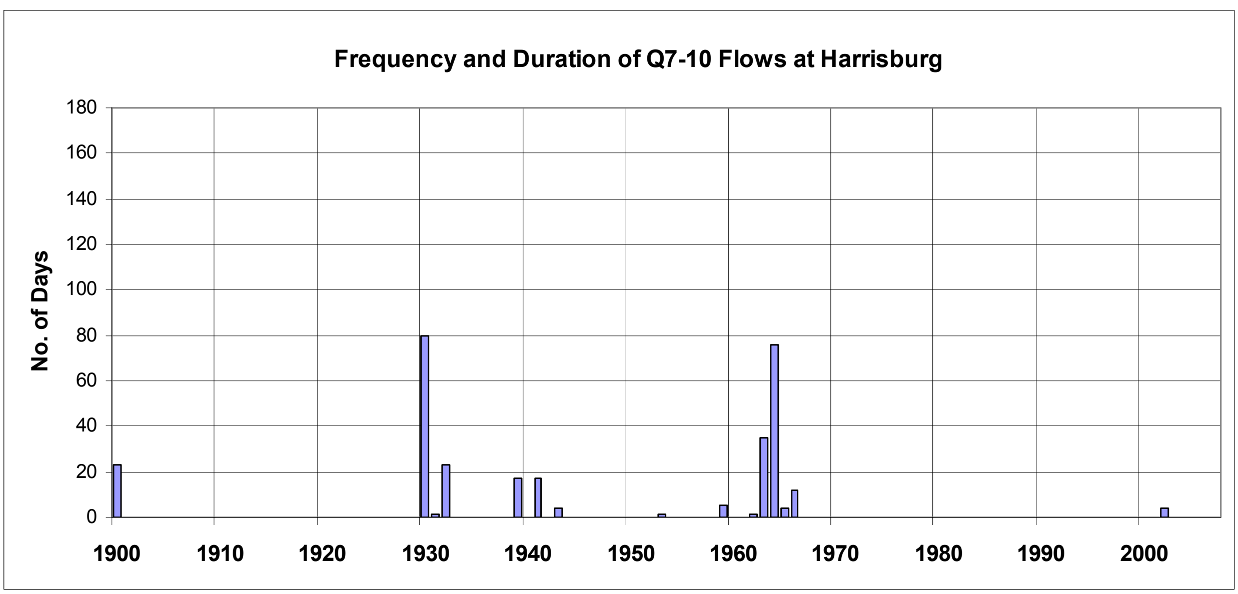


Figure 4.   Relative Frequency and Duration of Q7-10 and P92 Flows at Harrisburg

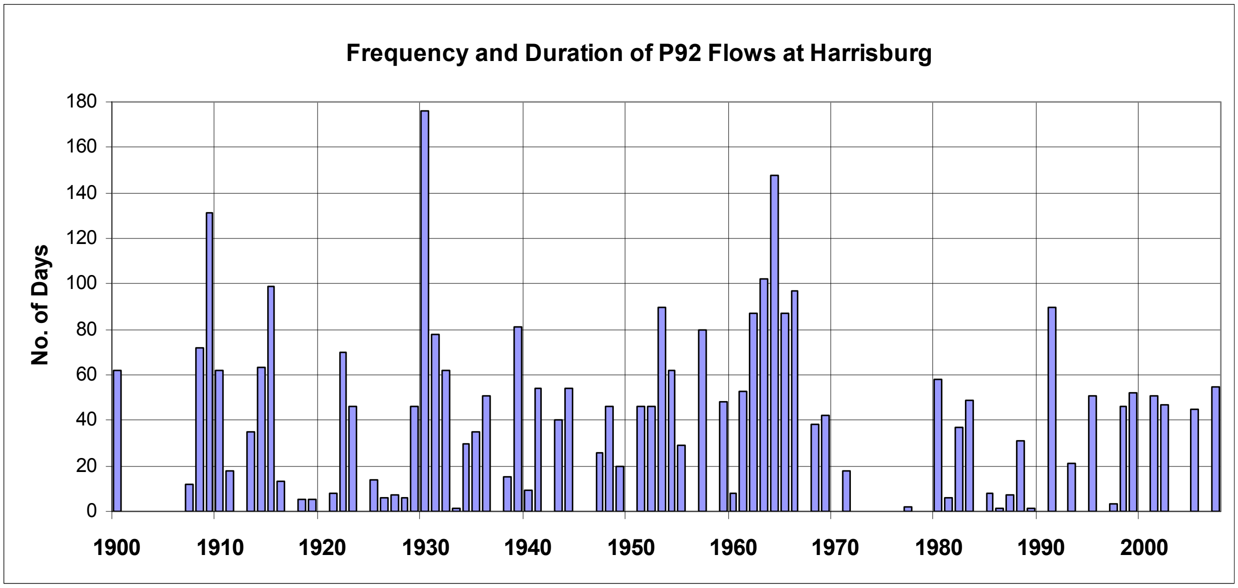


Figure 4. Relative Frequency and Duration of Q7-10 and P92 Flows at Harrisburg (continued)

The results at Harrisburg are typical for all locations; the P92 threshold occurs in many more years than the Q7-10 occurs, and for greater duration. In even the most extreme drought, Q7-10 flows are confined to the late summer and early fall, so durations rarely exceed 80 days in a year. In contrast, the P92 level of flow can occur in 5 or 6 months of the year, so in extreme cases the annual duration can approach 180 days.

Another analysis was conducted to compare the low flow thresholds addressed above (Q7-10, the annual P92, and 20 percent ADF) to monthly flow durations at several mainstem and major tributary gages. The results of the analysis demonstrated a shortcoming of the low flow thresholds traditionally used by the Commission to mitigate the impact of withdrawals, due mainly to the fact that they remain constant through the year. It is immediately apparent that one standard across all months is probably not appropriate; a threshold that is protective during one season is either overly protective other times of the year or offers no protection at all. In the latter (for example, the 20 percent ADF level occurs with 60 percent frequency in some months), the results would suggest that certain gages experience drought conditions requiring mitigation during more than half of August and September days; it would be difficult to characterize such a frequently occurring threshold as abnormally dry and thus in need of mitigation.

The results for the West Conewago Creek at Manchester are fairly representative of most gages, and are shown on Figure 5. For reference, Q7-10, the annual P92, and 20 percent ADF are indicated, and the monthly P75, P90, and P95 recurrence intervals are highlighted (representing Pennsylvania's indicators for drought watch, warning, and emergency, respectively).

Efforts to determine appropriate thresholds for CU mitigation should recognize that the 20 percent ADF frequently is higher than the 1-in-20-year monthly averages (monthly P95) specified in the Comprehensive Plan, and Q7-10 often lower. Only the months of August, September, and October show flows below Q7-10, and only September with greater than 1 percent frequency. The annual P92, while offering a compromise between the existing default of Q7-10 and the common passby threshold of 20 percent ADF, still fails to account for seasonal variation in flow regimes.

Analysis of Regional Occurrence

The Commission performed an analysis to compare the occurrence of low flow thresholds in the different regions of the Susquehanna basin using stream gage records as surrogates for drought conditions in various watersheds. Even in very severe droughts, not all regions experience identical conditions in terms of gaged streamflows. To gain an understanding of how drought conditions may be dispersed around the basin, and to discern whether certain gages can be reliably expected to predict conditions at other gages (and thus whether conditions in one watershed are predictive of conditions in another), the historic record of low flow conditions was examined. Occurrences of specific low flow thresholds were documented at several mainstem and tributary gages, and then compared to examine coincident timing of low flow conditions in terms of which events occurred simultaneously and in terms of the duration or longevity of each simultaneous event. It is important to know such information to ensure that mitigation is properly initiated; low flow monitoring that is not reliably representative of certain watersheds leaves those watersheds vulnerable to adverse impacts due to lack of mitigation or mitigation that is initiated too late or at insignificant levels.

As expected, P92 occurs much more frequently than Q7-10 at all locations. Differences in periods of record make direct comparisons difficult, but it can generally be concluded that P92 is reached in more than half the years on record; it is not uncommon for a gage to show P92 occurrences in 50 or more years. On the other hand, Q7-10 occurs much less frequently, often fewer than a total of 20 years. For example, in the comparisons of mainstem gages with tributary gages, a total of 9 different combinations, the range of total Q7-10 events was from 8 to 26. In contrast, the range of total P92 occurrences was from 49 to 85.

The results showed that reliability of concurrent low flow conditions varies by low flow statistic and by locations under comparison. Generally, the higher threshold of P92 flows are more consistent between sites, with coincident occurrences often exceeding 80 percent. Coincident occurrences of the Q7-10 threshold are less reliable, often failing to exceed 50 percent. This is most readily observed in the comparisons between mainstem gages.

There was not an obvious pattern with respect to the ability of mainstem gages to predict tributary conditions (or vice versa) or with one mainstem gage predicting another mainstem gage, or tributaries predicting other nearby tributaries.

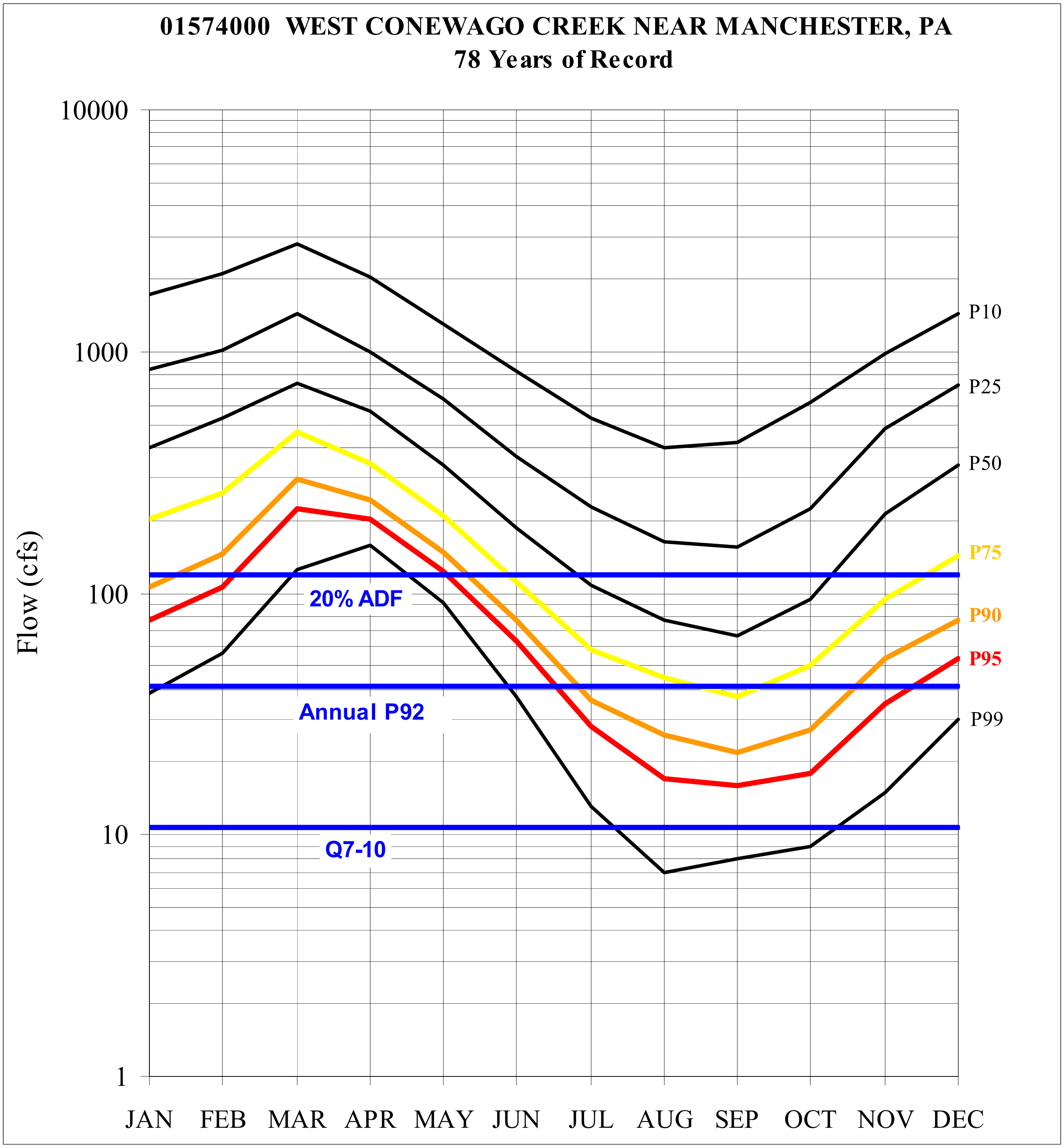


Figure 5. Hydrologic Statistics of West Conewago Creek Near Manchester, Pennsylvania

The pairings of gages examined are shown on the map on Figure 6 and in Table 4, and results are shown on Figure 7. For the purpose of comparison, percentages are displayed on the charts; they represent the percentage of years the low flow events occur during the period of concurrent record for the two gages being compared. The Harrisburg gage was chosen for the analysis instead of the Marietta gage because of the historic use of the flow at Harrisburg to initiate releases from Commission-owned storage at the Cowanesque and Curwensville facilities. Marietta also holds importance because of its use in determining operations at Conowingo gage; however, it is not included here because it does not have as lengthy a record as Harrisburg and can generally be assumed to exhibit conditions similar to those at Harrisburg.

Influence of Conservation Releases on Thresholds/Statistics

Required conservation releases at existing dams in the Susquehanna basin are potentially important to CU mitigation in two aspects. First, in cases where the conservation release is greater than the flow that would normally be expected on the stream under natural low flow conditions, it may be appropriate to account for the augmented flow and consider it to be mitigation for CU. Second, and in contrast, conservation releases that are set at a standard such as Q7-10 may ultimately prove to be providing less water to downstream reaches than is formally recommended as requiring mitigation by this plan. In such cases, the Commission may determine that mitigation is needed to offset potential impacts. In either case, an analysis of conservation releases and their relation to natural hydrologic regimes would need to be conducted.

Cumulative Impact of Approved Consumptive Water Use

Commission staff used the best available information to apportion CU in the basin to the watersheds (U.S. Geological Survey's [USGS] 8-digit Hydrologic Unit Code watersheds) where it occurs, and compared the cumulative totals to the Q7-10 flow statistics at gages representative of the watersheds. To ensure consistency, the flow statistics were transferred to the mouths of the watersheds using drainage area ratios where necessary. The results are shown in tabular format in Tables 5 and 6 (Table 5 shows total CU; Table 6 discounts known grandfathered quantities). Maximum approved CU was used in the analysis, as water use typically peaks during the hot, dry conditions that accompany occurrences of Q7-10 flows in the basin.

Where cumulative CU exceeds 5 and 10 percent of the Q7-10 low flow threshold, the result is highlighted in orange and red, respectively. The 5 and 10 percent levels are not themselves indicative of definite impacts, but nonetheless, it is these watersheds (see Figure 8 following the results) that are currently the most critical in terms of needing mitigation and should be prioritized as such. Absent mitigation, the Commission would need to consider implementing a cap on CU in these watersheds.

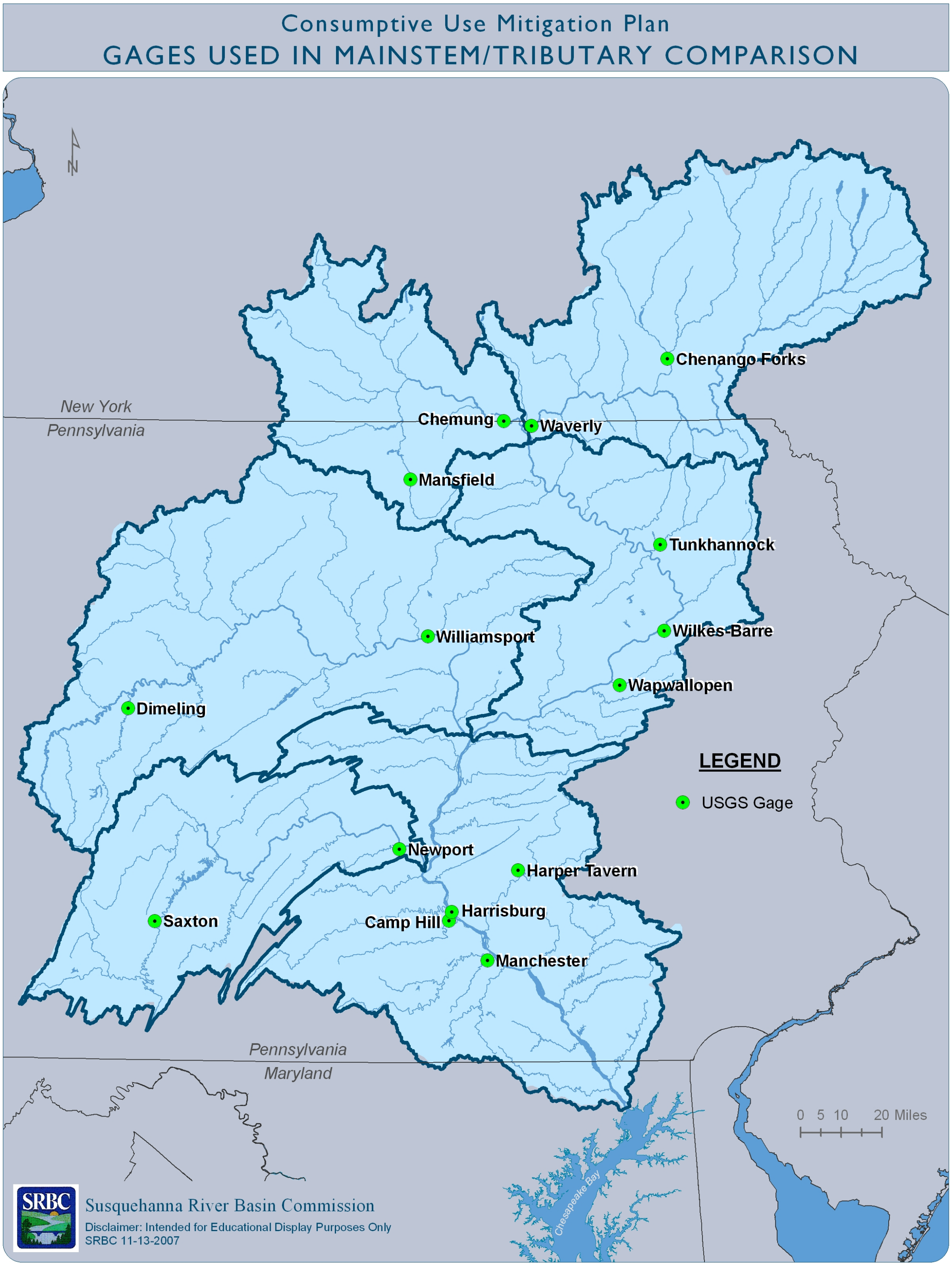


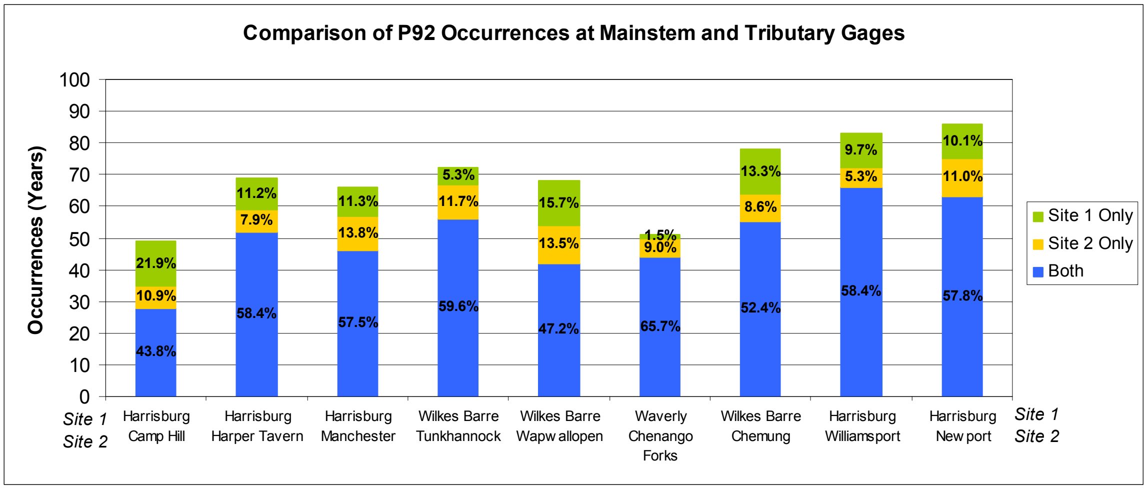
Figure 6. Gages Used in Mainstem/Tributary Comparison

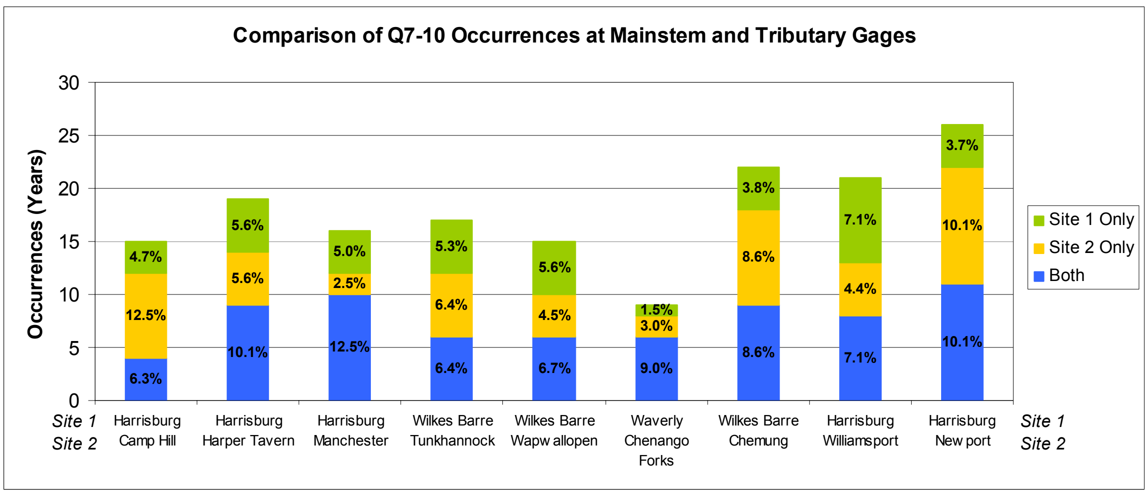
Table 4. Gage Pairings in the Mainstem/Tributary Comparison

Mainstem/ Tributary Comparison	Site 1	Site 2	Years of Concurrent Record
1.	Susquehanna River at Harrisburg	Yellow Breeches Creek at Camp Hill	64
2.	Susquehanna River at Harrisburg	Swatara Creek at Harper Tavern, Pennsylvania	89
3.	Susquehanna River at Harrisburg	West Conewago Creek at Manchester	80
4.	Susquehanna River at Wilkes-Barre	Tunkhannock Creek at Tunkhannock	94
5.	Susquehanna River at Wilkes-Barre	Wapwallopen Creek at Wapwallopen	89
6.	Susquehanna River at Waverly, NY	Chenango River at Chenango Forks	67
7.	Susquehanna River at Wilkes-Barre	Chemung River at Chemung	105
8.	Susquehanna River at Harrisburg	West Branch Susquehanna at Williamsport	113
9.	Susquehanna River at Harrisburg	Juniata River at Newport	109

Mainstem Gage Comparison	Site 1	Site 2	Years of Concurrent Record
1.	Susquehanna River at Harrisburg	Susquehanna River at Wilkes-Barre	109
2.	Susquehanna River at Wilkes-Barre	Susquehanna River at Waverly, New York	67

Tributary Gage Comparison	Site 1	Site 2	Years of Concurrent Record
1.	Chemung River at Chemung	Tioga River at Mansfield, Pennsylvania	32
2.	Swatara Creek at Harper Tavern, Pennsylvania	Yellow Breeches Creek at Camp Hill	55
3.	West Branch Susquehanna at Williamsport	Clearfield Creek at Dimeling, Pennsylvania	95
4.	Juniata River at Newport	Raystown Branch Juniata at Saxton	97





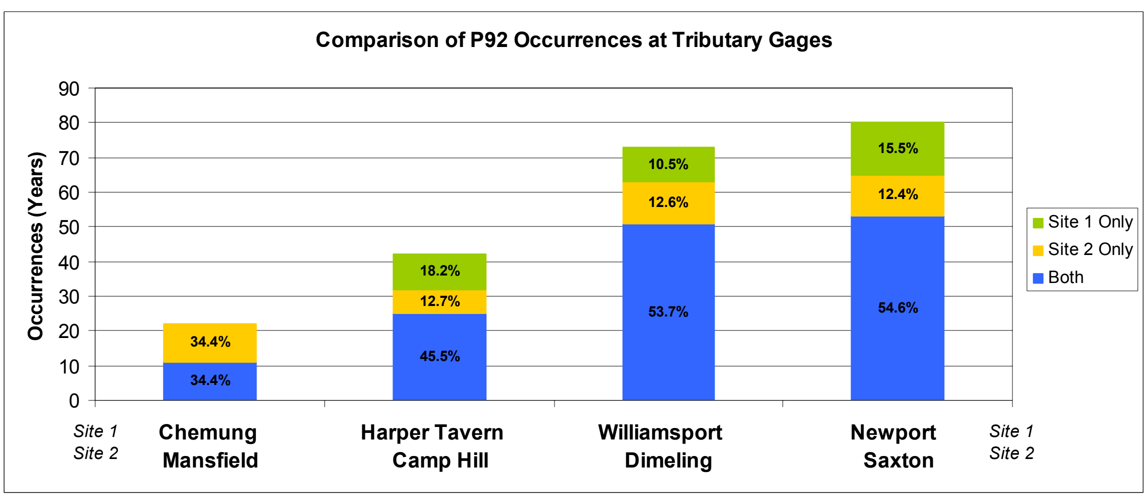
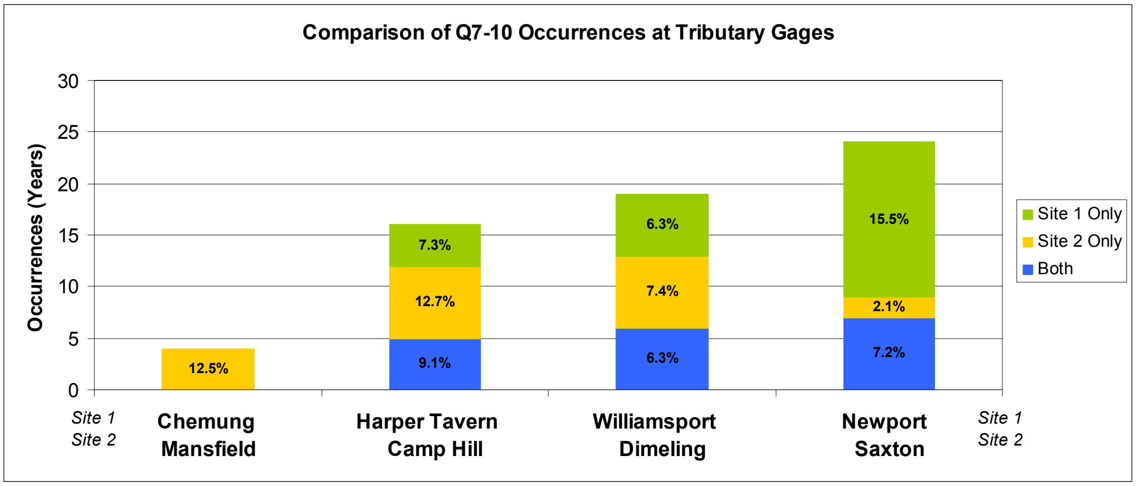
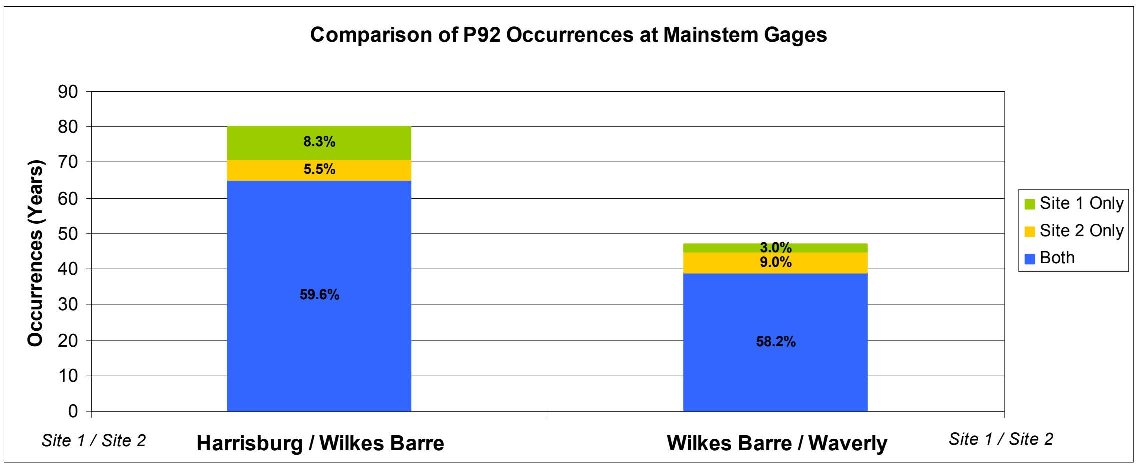


Figure 7. Results of the Mainstem/Tributary Comparison





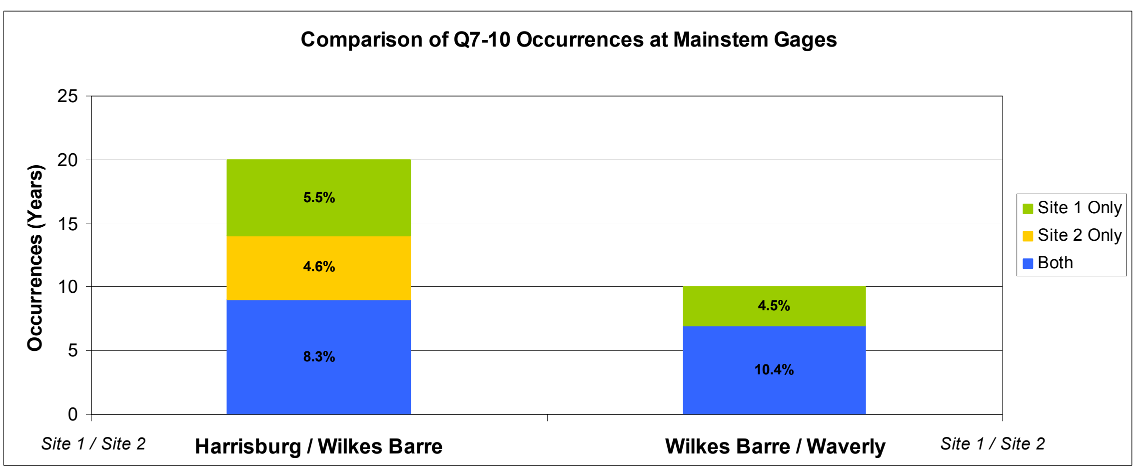


Figure 7. Results of the Mainstem/Tributary Comparison (continued)

Table 5. Cumulative Consumptive Use by HUC-8 Watershed

HUC-8	HUC-8 Name	Drainage (sq. mi.)	Cumulative Drainage	HUC-8 Q7-10 (cfs)	Approved CU in HUC-8 (mgd)	Cumulative HUC-8 CU (mgd)	Cumulative CU as % of Q7-10
				Upper Susquehanna Subbasin			
2050101	Upper Susquehanna	2,295	2,295	195	0.79	0.79	0.6%
2050102	Chenango River	1,577	1,577	148	2.99	2.99	3.1%
2050103	Owego-Wappasening	1,053	4,924	400	1.08	4.86	1.9%
				Chemung Subbasin			
2050104	Tioga River	1,377	1,377	88	2.31	2.31	4.0%
2050105	Chemung River	1,210	2,587	106	2.02	4.33	**6.3%**
				Middle Susquehanna Subbasin			
2050106	Upper Susq. - Tunkhannock	2,004	9,515	733	6.64	15.83	3.3%
2050107	Upper Susq. - Lackawanna	1,789	11,305	1,020	62.90	78.73	**11.9%**
				West Branch Susquehanna Subbasin			
2050201	Upper West Branch Susq.	1,613	1,613	164	9.00	9.00	**8.4%**
2050202	Sinnemahoning Creek	1,045	1,045	21	0.00	0.00	--
2050203	Middle West Branch Susq.	786	3,444	189	0.08	9.08	**7.4%**
2050204	Bald Eagle Creek	768	768	289	5.82	5.82	3.1%
2050205	Pine Creek	973	973	39	0.40	0.40	1.6%
2050206	Lower West Branch Susq.	1,822	7,006	696	29.35	44.66	**9.9%**
				Juniata Subbasin			
2050302	Upper Juniata River	990	990	213	3.02	3.02	2.2%
2050303	Raystown Branch	947	947	86	1.44	1.44	2.6%
2050304	Lower Juniata River	1,469	3,405	399	1.53	5.99	2.3%
				Lower Susquehanna Subbasin			
2050301	Lower Susquehanna - Penns	1,452	23,168	2,198	9.92	139.29	**9.8%**
2050305	Lower Susquehanna - Swatara	1,875	25,043	2,715	24.62	163.91	**9.3%**
2050306	Lower Susquehanna	2,477	27,520	2,868	219.22	383.13	**20.6%**

Table 6. Cumulative Consumptive Use Less Documented Pre-Compact Quantities

HUC-8	HUC-8 Name	Drainage (sq. mi.)	Cumulative Drainage	HUC-8 Q7-10 (cfs)	Approved CU in HUC-8 (mgd)	Cumulative HUC-8 CU (mgd)	Cumulative CU as % of Q7-10
			Upper Susquehanna Subbasin				
2050101	Upper Susquehanna	2,295	2,295	195	0.65	0.65	0.5%
2050102	Chenango River	1,577	1,577	148	2.05	2.05	2.1%
2050103	Owego-Wappasening	1,053	4,924	400	0.86	3.56	1.4%
			Chemung Subbasin				
2050104	Tioga River	1,377	1,377	88	2.24	2.24	3.9%
2050105	Chemung River	1,210	2,587	106	1.74	3.98	**5.8%**
			Middle Susquehanna Subbasin				
2050106	Upper Susq. - Tunkhannock	2,004	9,515	733	4.97	12.52	2.6%
2050107	Upper Susq. - Lackawanna	1,789	11,305	1,020	62.13	74.65	**11.3%**
			West Branch Susquehanna Subbasin				
2050201	Upper West Branch Susq.	1,613	1,613	164	6.48	6.48	**6.1%**
2050202	Sinnemahoning Creek	1,045	1,045	21	0.00	0	--
2050203	Middle West Branch Susq.	786	3,444	189	0.08	6.57	**5.4%**
2050204	Bald Eagle Creek	768	768	289	4.58	4.58	2.4%
2050205	Pine Creek	973	973	39	0.39	0.39	1.5%
2050206	Lower West Branch Susq.	1,822	7,006	696	12.39	23.93	**5.3%**
			Juniata Subbasin				
2050302	Upper Juniata River	990	990	213	2.87	2.87	2.1%
2050303	Raystown Branch	947	947	86	1.31	1.31	2.4%
2050304	Lower Juniata River	1,469	3,405	399	1.38	5.56	2.1%
			Lower Susquehanna Subbasin				
2050301	Lower Susquehanna - Penns	1,452	23,168	2,198	9.73	113.86	**8.0%**
2050305	Lower Susquehanna - Swatara	1,875	25,043	2,715	23.49	137.34	**7.8%**
2050306	Lower Susquehanna	2,477	27,520	2,868	219.26	356.60	**19.1%**

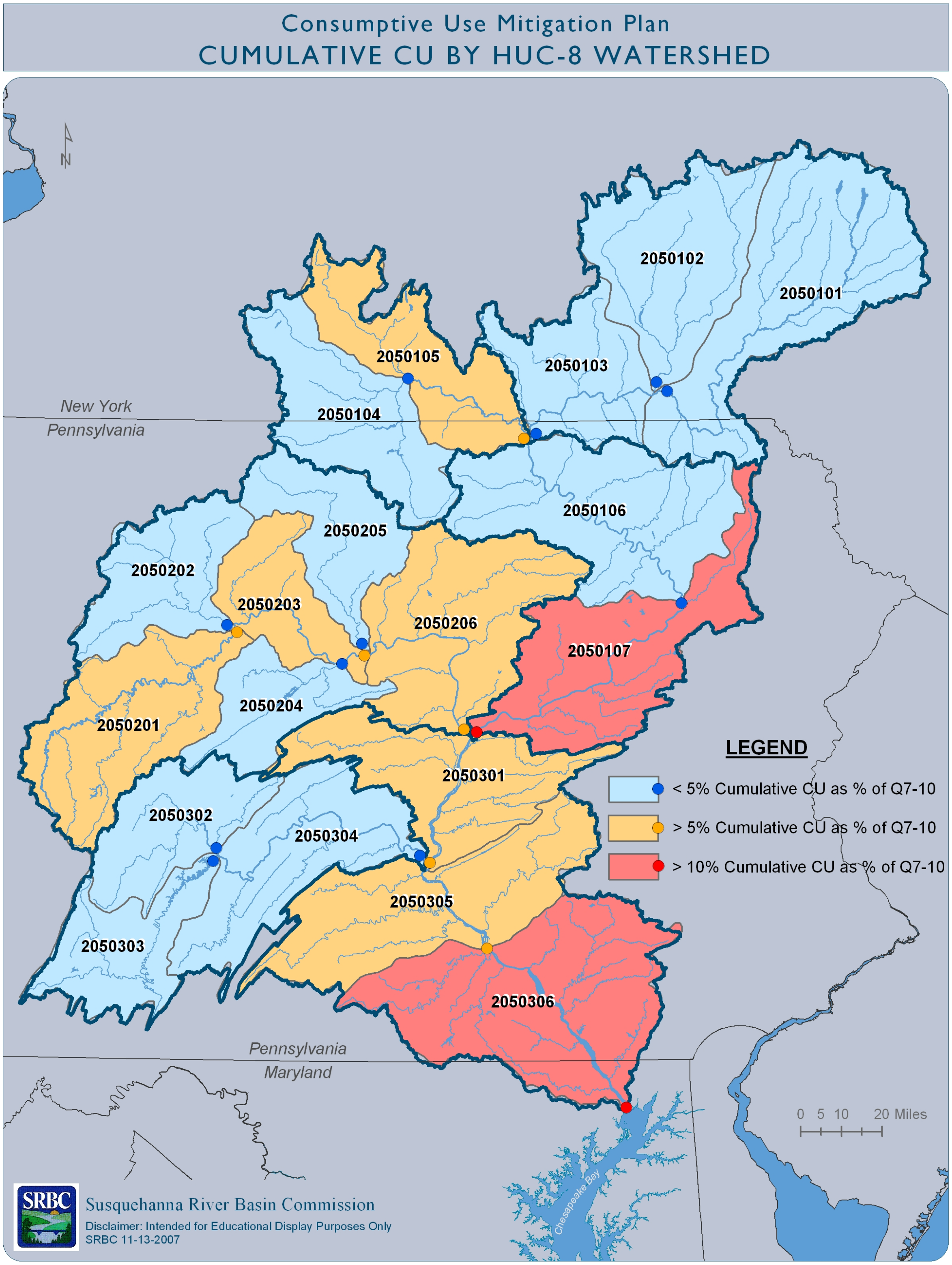


Figure 8. Cumulative Consumptive Use by HUC-8 Watershed

COMPONENTS OF CONSUMPTIVE USE MITIGATION

Under current mitigation strategies, threshold flows are not being maintained. Rather, mitigation is intended to replace targeted CU, and flows will continue to decrease during a drought despite the mitigation. As a result, the hydrologic regime will follow a natural decline pattern without being exacerbated by CU. Currently, there is an insufficient supply of stored water to allow maintenance of any specific flow in tributaries or the mainstem river, and Commission staff is not recommending the acquisition of such additional supplies. It is not the intent of the Commission to maintain specific instream flow levels.

Location and Threshold for Triggers

Commission staff has performed the background analyses necessary to evaluate various mitigation methods. A statistical review of flow records at gages located on tributaries and on the mainstem river suggests that conditions in one location cannot reliably predict whether or not low flow conditions exist at another location in the basin. A range of low flows were examined, from a low of Q7-10 to a high of Q-FERC. Comparisons were made between mainstem gages, such as Wilkes-Barre and Harrisburg, and between gages on tributaries and mainstem gages downstream, such as Camp Hill and Harrisburg. The analyses consisted of an examination of events (or occurrences) of low flow triggers. It is important to discern the optimal way to track developing droughts, because droughts in the basin can be regional or widespread, and the use of only one or two indicator gages may leave vulnerable watersheds unprotected by mitigation.

There are two caveats related to local drought monitoring. First, although sufficient hydrologic monitoring may exist to identify low flow conditions, there may not always be mitigation water available in the watershed. Second, the Commission already employs passby criteria for approved surface water and groundwater withdrawals intended to provide protection to streams from undue impact.

Given the numerous occurrences of significant low flow periods in recent years without reaching the Q7-10 threshold, Commission staff believes that a Q7-10 threshold is not adequately protective of the riparian resources of the basin. The Commission investigated alternative thresholds currently in place, such as the annual P92 (derived from Conowingo Dam's Q-FERC threshold) and the 20 percent ADF standard required to protect instream uses in warm water fisheries. A closer look at these alternatives, however, suggests that a different driver for CU mitigation may be preferable. It is apparent that applying a constant year-round threshold does not take into consideration the normal seasonal pattern of flows. One option is to choose a percent exceedence and use it for each month, or to establish a seasonal threshold based on monthly exceedences. While seasonal thresholds are not as protective or reflective of natural cycles, they are more simple to implement, monitor, and operate than constantly changing monthly thresholds. To determine the potential risk to riparian needs caused by the use of seasonal thresholds instead of monthly, a frequency analysis could be performed by staff to assess the duration of unmitigated conditions. A final option is a variable or running threshold, such as those used by the Pennsylvania Department of Environmental Protection for drought monitoring and the Delaware River Basin Commission to determine operation of New York City reservoirs. Schematic depictions of each of the four methods are shown on Figure 9.

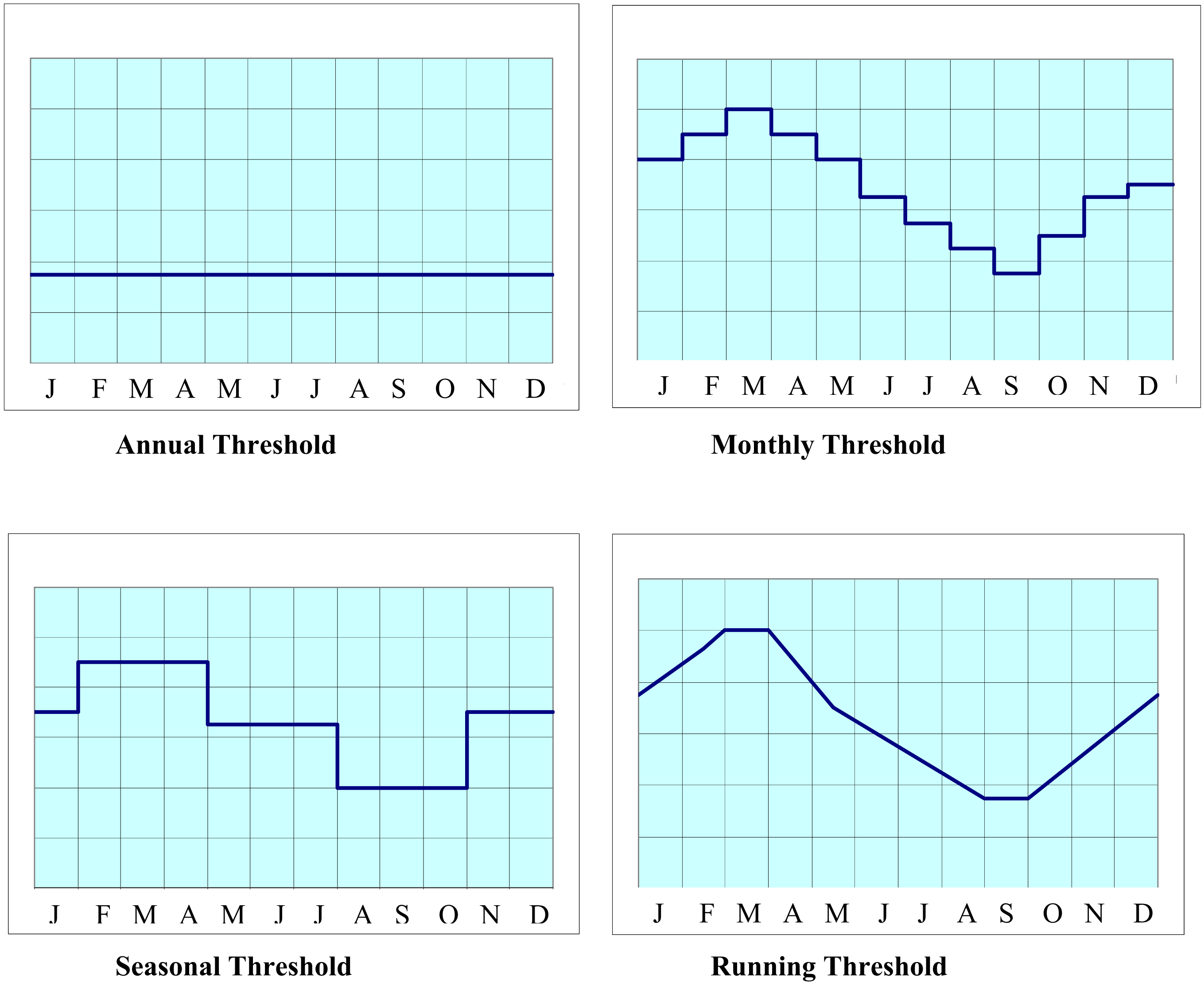


Figure 9. Conceptual Depictions of Consumptive Use Mitigation Thresholds

Mitigation Goal

As laid out in the Compact, the intent of the Commission's CU mitigation program is to replace CU during low flow periods to avoid worsening conditions beyond the natural. The implementation of the mitigation can be driven by local conditions to protect the local stream source, or it can be driven by conditions at a downstream location, with the goal of not reducing inflows to the Chesapeake Bay beyond the 1-in-20-year (P95) monthly flows in August, September, and October. It is likely the final mitigation strategy will incorporate aspects of both local and basinwide implementation.

An unexpected incident in early October 2007, associated with demolition of the old Pennsylvania Turnpike Bridge, clearly demonstrated the need for mitigation at certain flow thresholds. Placement of temporary causeways across the Susquehanna River at the bridge caused the unintentional, rapid and severe flow constriction of nearly the entire Susquehanna River. The blockage reduced flow directly downstream in the York Haven area, and river levels dropped drastically and rapidly below already low drought conditions to flows not seen since 1964, the drought of record. As a result, York Haven hydroelectric power production was reduced, generation at Brunner Island was curtailed, and the nuclear plant on Three Mile Island was put under cautionary measures. At the time of preparing this plan, investigations of the incident were still ongoing, but details of the incident should enable Commission staff to link reductions in flow to serious impacts to the large amount of power produced using water from the Susquehanna River. Perhaps, as a result of this investigation, some level of flow will be identified as a minimum allowable flow and a target for Commission mitigation efforts.

Proposed Mitigation Strategy

There are several immediately critical issues surrounding CU mitigation. First, the annual Q7-10 threshold, because it is not based on protecting riparian resources, has left recent severe droughts unmitigated despite demonstrable impacts on the lower Susquehanna River (the two most notable being Conowingo Dam's need for a variance from its FERC-mandated minimum release in 1999, 2001, 2002, 2005 and 2007, and the contributing role low river flows played in the 2005 and 2007 episodes of disease among smallmouth and largemouth bass). Second, required passby flows at the Conowingo Dam occur with much more frequency than Q7-10 flows, which means there are times when this single facility with minimal storage is forced to sustain releases without the benefit of similar mitigation requirements in the 96 percent of the basin that lies upstream of Marietta, Pennsylvania. The findings of the 2006 Conowingo Pond Management Plan included a recommendation that Commission staff address this problem by implementing more consistent mitigation upstream; as an interim solution, operators of the dam are afforded a waiver from the release requirement that allows the required release to be reduced by the quantity of water leaking through the dam. When this waiver is in effect, the Susquehanna River downstream of the dam is not receiving the protection originally intended for it. Finally, there is a demonstrated need for absolute minimum quantities of water in the York Haven area where the York Haven hydroelectric, Brunner Island coal, and Three Mile Island nuclear power plants operate. There currently exists limited protocol for ensuring adequate water to those facilities.

Commission staff has proposed a strategy for the CUMP to address the above-mentioned shortcomings. First, a seasonal threshold for mitigation should be established to recognize the natural pattern of flows in the basin. Second, summer and fall thresholds should be set at flows higher than Q7-10 and more consistent with FERC flow requirements and the monthly low flow criteria established in the Comprehensive Plan. Finally, an ultimate threshold should be determined, at which point all remaining storage dedicated to CU mitigation is put into use whether or not local gages have triggered, for the purpose of allowing continued operation by power plants and ensuring adequate water downstream of Conowingo Dam.

A conceptual schematic of the proposed threshold protocol is shown on Figure 10. The values depicted are based on initial application of the strategy to the Marietta gage, which is currently used to determine operations of the Conowingo Dam. Commission staff will apply the concept to gages elsewhere in the basin, with comparable flow thresholds determined for each site based on local hydrology. It may become desirable to modify the thresholds at certain locations when definitive needs are established for both local instream riparian protection and inflows to the Chesapeake Bay.

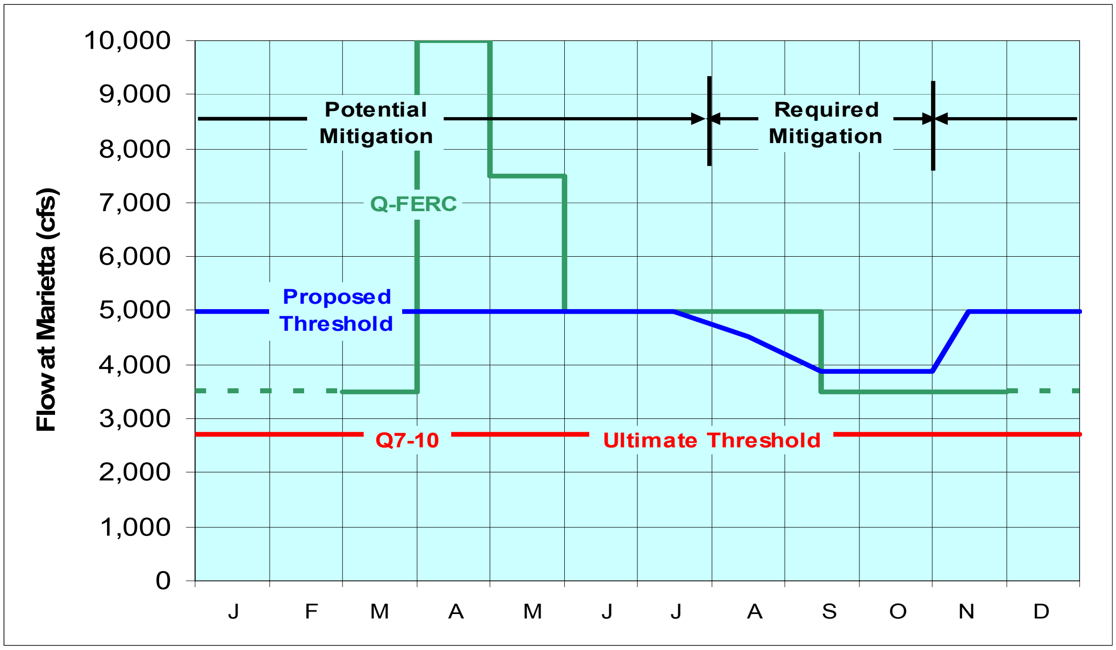
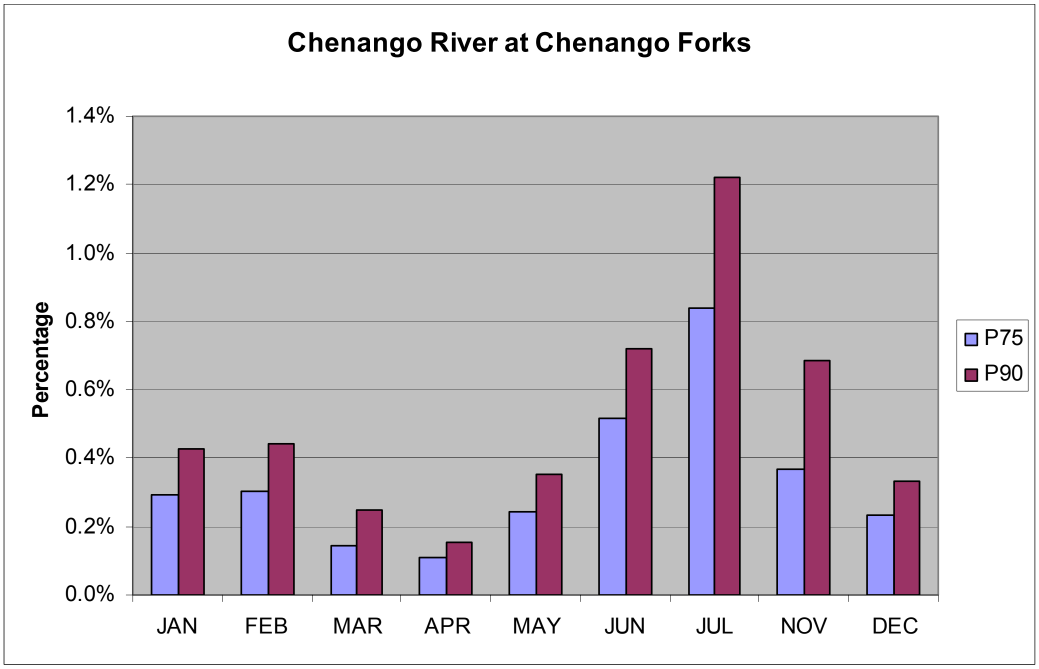


Figure 10. Conceptual Depiction of Proposed Consumptive Use Mitigation Threshold

Commission staff is not proposing to use an equivalent of the FERC flow throughout the year. Although recommended spring mitigation levels are higher than Q7-10, Commission staff is reluctant to recommend levels for that season that will cause excessive drawdowns and thus render storage unavailable for the truly critical periods in the late summer and early fall. Exceptions would be made for locally identified needs for riparian uses such as fish migration. The existing spring FERC flows are based on fish passage, and meeting them involves appropriate hydroelectric operations more so than it does adapting to a lack of water.

Acknowledging the priority given to flows in August, September, and October in the Comprehensive Plan, the proposed strategy focuses on mitigation needs during those months over any other. Should flows meet mitigation thresholds in other months, Commission staff would first perform an evaluation to decide whether or not to implement mitigation. Factors such as the time of year, the available storage quantity, and the risk of needing mitigation water in the August through October period would be considered. To verify that mitigation is not as critical outside the August through October period, staff performed an analysis comparing cumulative CU in HUC-8 watersheds to monthly low flow thresholds, similar to the analysis comparing cumulative CU to Q7-10 as described in the previous section. The thresholds assessed were the monthly P75 and P90 values, which correspond to the thresholds used by Pennsylvania to indicate drought watch and warning conditions, respectively. Results of the analysis showed that cumulative CU represents a very small percentage of the selected low flow thresholds, in both tributaries and mainstem reaches of the river. Sample results are shown in the charts on Figure 11, and are representative of all HUC-8s. In all cases, except at Marietta, the cumulative CU was less than 5 percent of the P75 and P90 in each of the months outside the August through October time period, and generally made up the greatest percentage in the months bounding that period, July and November. Subject to effects from all the CU in the basin, the low flow thresholds at Marietta are impacted by up to 7 percent.



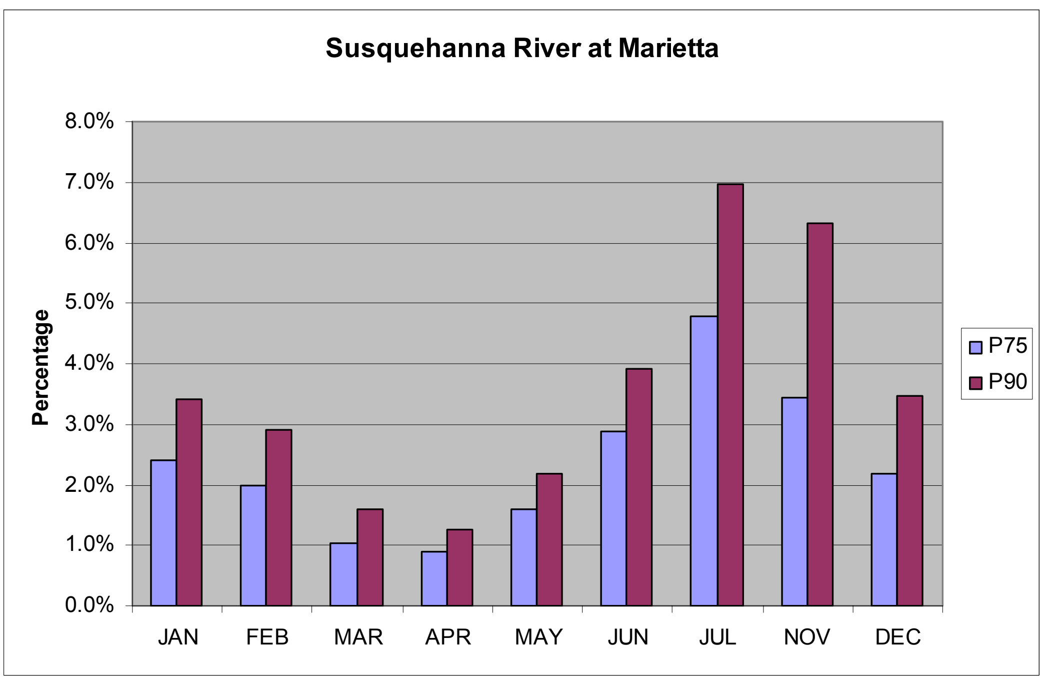


Figure 11. Cumulative Consumptive Use, as Percentage of P75 and P90 Flow Thresholds

Because the focus of the proposed strategy is limited to the critical time period during late summer and early fall, the expected duration of releases is 30 to 50 percent shorter than the design duration for existing mitigation projects. Consequently, because the storage is used over a duration of fewer days, it can support greater releases and thus provide greater mitigation. Although there exists the risk of storage depletion in a record-setting drought, operations at enhanced release levels would allow mitigation for all currently existing CU under Commission regulation.

RECOMMENDATIONS FOR IMPLEMENTING THE MITIGATION PLAN

The proposed mitigation strategy strives to address several documented shortcomings of the current Q7-10 based approach. Several evaluations and assessments would be needed before this strategy in its final form could be implemented. Perhaps most important is the realization that the Commission does not have adequate storage to provide mitigation at the suggested frequency and duration, nor is there likely to be sufficient funding readily available to procure additional needed storage. Because the mitigation goals described above will require significant changes to the way the Commission manages both its existing and new storage that is acquired, the following recommendations are intended to address the major issues.

Reevaluate Conowingo Operations and Other Existing Consumptive Use Mitigation

The strategy would initially be implemented at the Marietta gage, and could eventually be expanded to other gages as the recommendations described below are completed and the success of the strategy is assessed. However, until that time, all existing projects should be reformulated to activate based on flows at Marietta.

If additional releases are made from new or existing sources, they will need to be accounted in the monitoring data at the Marietta gage. It will be important to understand how operations of Conowingo Dam will be affected and how existing CU mitigation agreements for Peach Bottom Atomic Power Station and the City of Baltimore could be impacted. Operations of Conowingo Dam are driven by flows at Marietta, as are existing mitigation agreements for the Peach Bottom Atomic Power Station and the City of Baltimore. It will be necessary to specify that those agreements remain in force despite upstream mitigation, and to resolve methodologies for implementing the agreements in instances when upstream mitigation releases are distorting the flow measurements at Marietta. Regardless, Exelon and Baltimore will still be required to mitigate the CU of their projects.

An assessment of the ability of other projects, such as PPL Montour's Lake Chillisquaque, to successfully operate under the strategy also should be completed. The OASIS daily flow model will facilitate the necessary evaluations of the CU mitigation projects, and the benefits and potential impacts of the proposed strategy.

Reevaluate Commission Storage at Cowanesque and Curwensville Reservoirs

The Commission owns a combined 29,700 acre-feet of storage at the U.S. Army Corps of Engineers' (USACE) Cowanesque and Curwensville projects, which can provide 95 mgd of flow augmentation for the purpose of mitigating downstream CU. The existing reservoir operations include low flow releases equal to the CU at several industrial facilities when a flow at the Wilkes-Barre and/or the Harrisburg USGS stream gages reach a flow level of Q7-10, plus the designated CU in the vicinity of the gages. These "trigger" flows occur infrequently and the Commission believes revised low flow operations, including greater and more frequent trigger flows at different locations, would be more effective in addressing the increasing CU mitigation needs in the basin. A scope of work to assess the optimal use of Commission-owned storage at Cowanesque and Curwensville Lakes has been prepared by the Commission and USACE. This assessment study, which will take 2 years at a cost of approximately $400,000, should be initiated as soon as practicable. An important component of the evaluation will be the assessment of potential in-lake impacts.

Enhance Reservoir Storage Operations

There is a significant opportunity to improve low flow conditions through enhanced operations of existing storage at several other federal reservoirs. The Whitney Point Lake project (see Figure 12) will be modified soon to provide low flow augmentation for the purpose of protecting the downstream aquatic ecosystem. Several of the USACE reservoirs operate with conservation releases that are typically greater than the inflow to the lakes, and thus greater than the flow that would naturally be present in the receiving streams. If the conservation releases can be shown to be uninterruptable and dependable, there may be an opportunity to consider a portion of the releases as effective CU mitigation.

Figure 12. Photo of Whitney Point Dam, forming Whitney Point Lake

Raystown Lake in Huntingdon County, Pennsylvania, currently provides a minimum seasonal release of 200 cfs from May 15 to November 15, for the purpose of protecting the downstream environmental resource. But, it is possible that Raystown and two other large reservoirs – the Tioga-Hammond system in Tioga County, Pennsylvania, and Sayers Lake in Centre County, Pennsylvania – could provide additional low flow augmentation. Also, some of the reservoirs, for various reasons, are drawn down each fall to a winter pool level. There is the potential during a drought to use that discarded storage for CU mitigation. The Commission recommends that an evaluation be done by staff in cooperation with USACE that evaluates how operation of these reservoirs would best fit into the proposed mitigation strategy. The evaluation should include an assessment of potential in-lake impacts of increased drawdown. See Figure 13 for the location of the reservoirs under consideration.

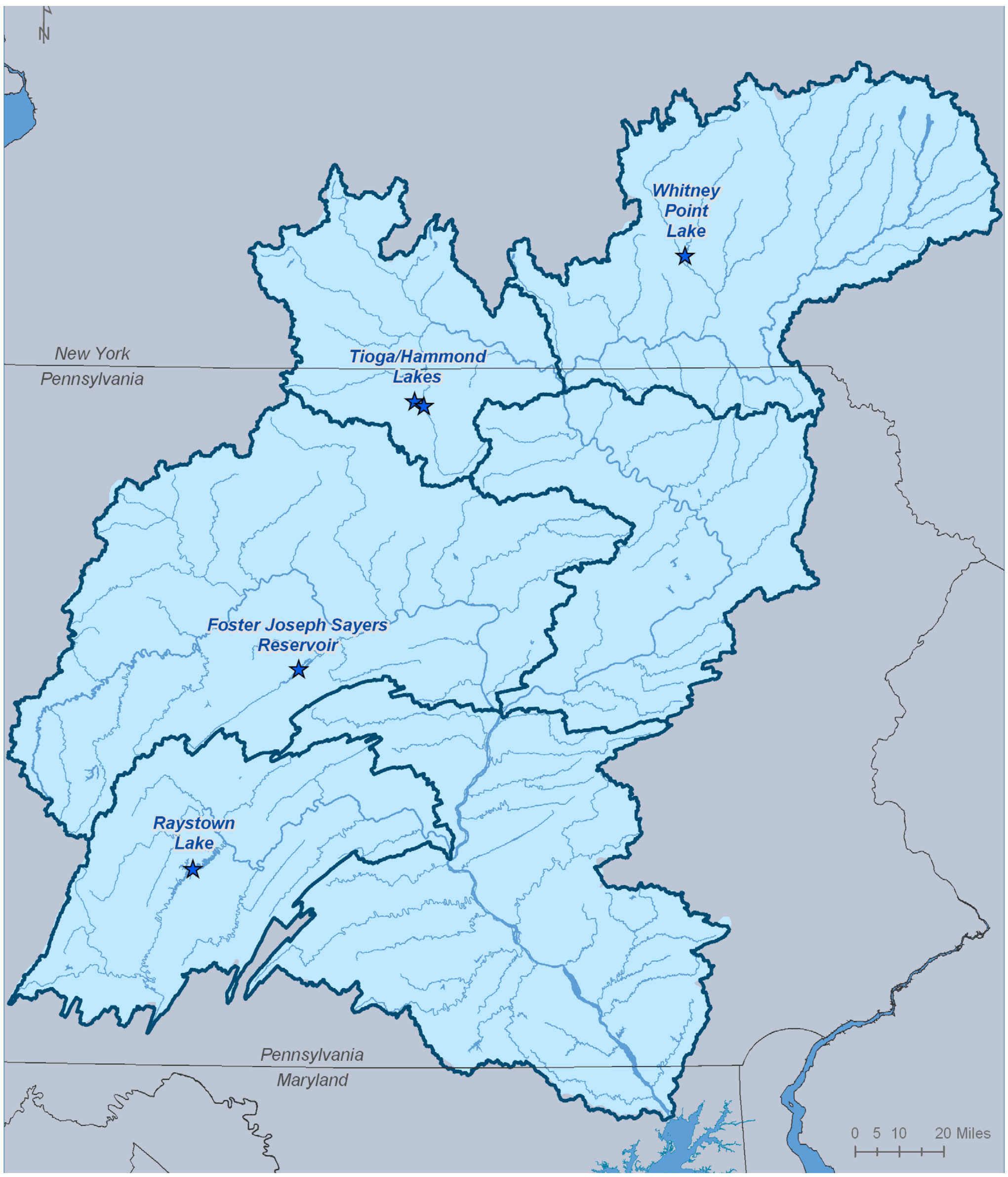


Figure 13. Location of U.S. Army Corps of Engineers Reservoirs to be Evaluated

Implement Pennsylvania Agricultural Consumptive Water Use Projects

In 2005, the Commission completed a review of management options to mitigate for 15.7 mgd of agricultural CU in the Pennsylvania portion of the basin. The Commission concluded that using a combination of pumping from underground mine pool storage and the use of storage at public and privately owned surface water impoundments were the preferred methods of providing the quantities of water necessary.

The Commission is actively involved in the Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation's ongoing mine pools program, which is looking for additional low flow augmentation opportunities. Several promising projects have been identified; any that remain undeveloped after the 15.7 mgd agricultural CU mitigation need has been met should be considered potential projects for meeting outstanding basinwide mitigation needs. It would be important that any implemented projects be operated in accordance with the recommended strategy, and they should be evaluated with respect to those protocols.

Evaluate Underground Limestone Mines

Many abandoned, underground limestone mines are located in the Susquehanna basin. The pits vary in size, but it is not unusual for a mine to contain several thousand acre-feet of water (see Figure 14). Further studies of water quantity available, potential environmental impacts, and costs are needed to determine the feasibility of using these sites for flow augmentation. If portions of the water contained in the mines can be shown to have minimal or delayed hydraulic connection to local surface water, these sites offer a potentially impact-free source of mitigation water. Also, water in limestone mines would not require treatment before being discharged, as water from a coal mine site would.

Figure 14. Water Stored in an Abandoned Limestone Mine

Evaluate Potential Modifications and/or Operational Changes at Select Impoundments – Pennsylvania Department of Environmental Protection, Pennsylvania Fish and Boat Commission, and Pennsylvania Department of Conservation and Natural Resources

Similar to the operations of the USACE reservoirs previously discussed, there may be opportunities to provide low flow augmentation from Commonwealth-owned impoundments. Projects to be assessed would be the larger facilities that could augment flows beyond that needed to meet the agricultural CU needs in Pennsylvania (see Figure 15). However, these facilities lack the sizable storage of federal flood control reservoirs and often exist solely to provide recreation opportunities to citizens of the Commonwealth. To draw down lake levels at the height of the recreation season would run counter to the intended purpose of the facilities; however, they may be able to provide short-term storage while water from other projects is en route, or in the months after recreation has peaked.

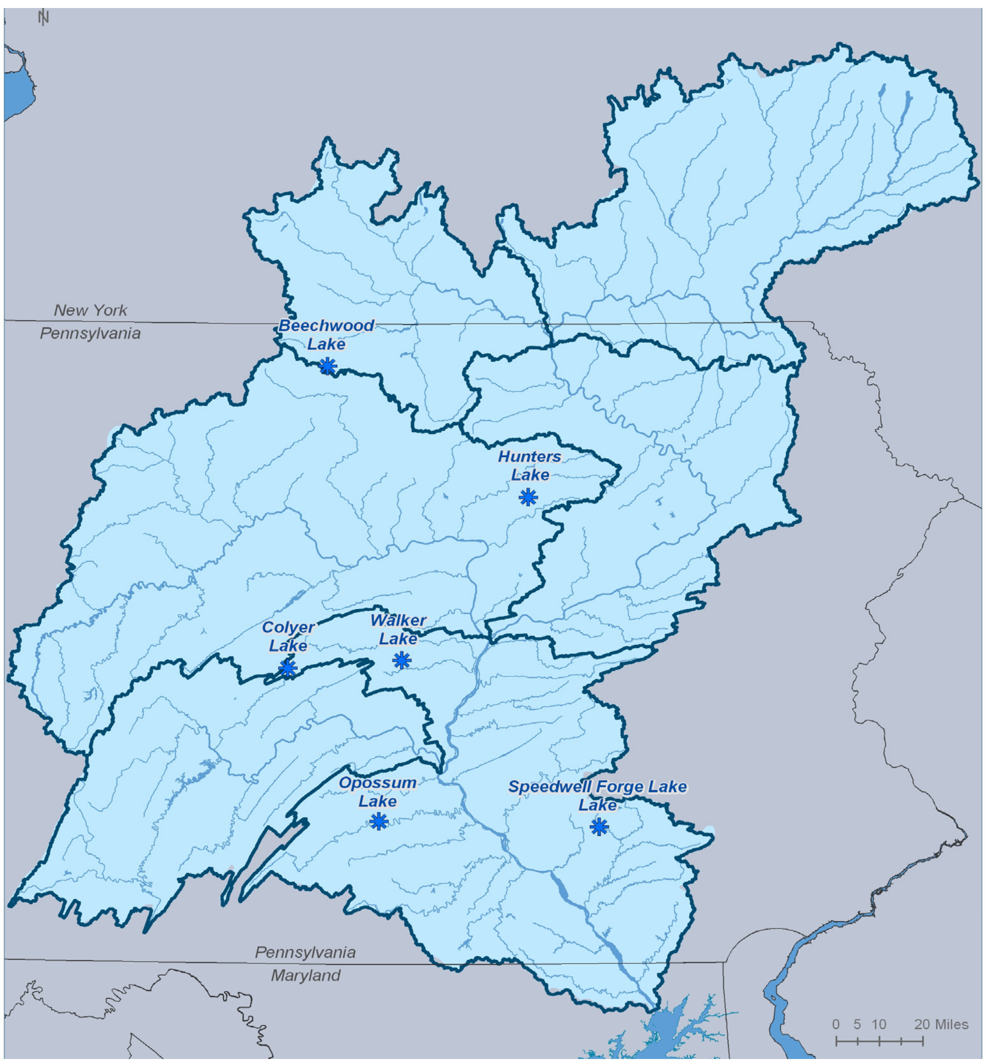


Figure 15. Locations of Pennsylvania Fish and Boat Commission Lakes to be Evaluated

Assess Instream Flows

The objective of CU mitigation is not simply to make direct replacement for CU, but rather to identify impacts of cumulative CU and arrange mitigation for it. By tying mitigation efforts to the elimination or lessening of CU impacts, we are assured of accomplishing efficient and comprehensive mitigation.

The first step in addressing the impacts of CU is to perform an analysis of instream flow conditions. Traditional methods such as Instream Flow Incremental Methodology (IFIM) are too intensive to apply basinwide, and require the identification of specific target species. A basinwide mitigation plan requires basinwide goals and standards for flow management, and staff has proposed to undertake a process to set such flow goals based on ecosystem needs. The process would link ecological conditions to flow alteration and allow the definition of flow needs based on professional judgment of acceptable impacts. It is proposed that the goals be seasonal in nature and implemented on a subbasin scale. The effort will include a review of similar work done elsewhere and incorporation of other methodologies as appropriate. Stream assessments will also be used to verify that mitigation is achieving its intended objective, the lessening or elimination of impacts of CU to streams.

The implementation of a mitigation plan notwithstanding, there will remain watersheds without storage for mitigation. If there is insufficient mitigation to replace CU in a watershed, the results of the instream flow assessment will help prioritize the areas needing mitigation, suggest watersheds where additional CU development is not recommended, and offer protection from lack of mitigation.

Increase Consumptive Use Fee

This report does not attempt to evaluate costs of various mitigation options; however, Commission staff performed an evaluation of the current CU fee with respect to its ability to fund mitigation projects. The $0.14 per 1,000-gallon mitigation payment was based on the cost to develop the 29,700 acre-feet of storage at Cowanesque and Curwensville Lakes. Commission staff anticipated that collection of the fee would permit the development of additional storage at federal and state projects. However, no automatic adjustment or indexing factor was built into the rate, and as a result, the real value of the payment has been continuously declining since its adoption in 1993 due to the effects of inflation. Overall, real value has declined about 50 percent since the rate was implemented, and the rate is no longer an accurate reflection of the current cost of obtaining and maintaining water storage. The current payment rate, if adjusted for inflation, would now be set at about $0.28.

Commission staff believes that updating the CU fee and building in an automatic adjustment factor is critical to maintaining the viability of the Commission's water management fund, which has afforded the Commission the financial resources to implement key water management actions. Further, raising the fee would encourage consumptive water use project applicants to give more consideration to water conservation or the construction of low flow storage, or other mitigation in their own watersheds, as a means of compliance with the CU regulation. Such local solutions help ensure mitigation at the point of withdrawal.

For every $0.01 increase in the fee, staff projects an approximate $70,000 in revenue will be added to the Water Management Fund annually. Indexing the fee for inflation will keep it current and potentially reduce the need to revisit the fee in the future.

Revise Consumptive Use Fee Structure

The existing flat $0.14 per 1,000-gallon fee was developed based on providing mitigation storage primarily for large power-generating facilities that operate on a fairly consistent basis year-round. The fee rate was determined such that its collection over 12 months would fund the operation of the storage during the 3- to 4-month period of critical low flows. Although these same projects are still the dominant consumptive water users in the basin, other projects that use water during different times of the year also are choosing monetary payments to mitigate their CU. It costs just as much to develop and operate mitigation storage for these seasonal projects, such as golf courses, but the fee is collected only a few months during the summer. Without a modification to the fee structure, the Commission will never generate sufficient revenue to develop new storage. Such seasonal projects should be required to pay a CU fee commensurate with the cost of developing mitigation storage, a goal that could be accomplished by charging a seasonal CU fee or a surcharge fee during months when critical low flows typically occur.

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APPENDIX A

CONSUMPTIVE WATER USE IN THE SUSQUEHANNA RIVER BASIN

INTRODUCTION AND PURPOSE

The mission of the Susquehanna River Basin Commission (Commission) is to enhance public welfare through comprehensive planning, water supply allocation, and management of the water resources of the Susquehanna River Basin. As part of this mission, the Commission works to provide for the reasonable and sustained development and use of surface and groundwater for municipal, agricultural, recreational, commercial, and industrial purposes; protect and restore fisheries, wetlands, and aquatic habitat; protect water quality and instream uses; and ensure future availability of flows to the Chesapeake Bay.

The Susquehanna River Basin Compact (Compact) authorizes the Commission to review and approve water resources projects (Section 3.10) and to establish standards for such projects (Section 3.4.2). Section 806.22(b) of the Commission's regulations for review and approval of projects requires mitigation for consumptive use (CU) of water. CU is defined by the Commission to be the loss of water transferred through a manmade conveyance system or any integral part thereof (including such water that is purveyed through a public water supply or wastewater system), due to transpiration by vegetation, incorporation into products during their manufacture, evaporation, injection of water or wastewater into a subsurface formation from which it would not reasonably be available for future use in the basin, diversion from the basin, or any other process by which the water is not returned to the waters of the basin undiminished in quantity.

Although the Commission has been regulating CU and requiring its mitigation since 1976, only a few mitigation projects have been undertaken. A comprehensive study and plan for long-term mitigation have never been completed. The purposes of this paper are to quantify and characterize current and projected CU in the basin, identify the low flow mitigation needs, and briefly discuss the Commission's options for long-term CU mitigation. The information provided in this report will serve as the basis for the development of the Consumptive Use Mitigation Plan (CUMP) to follow.

BACKGROUND INFORMATION

The Commission's CU regulation, as adopted in 1976, required project sponsors to provide mitigation for their CU during low flow events. Mitigation options available to projects included the replacement of the CU from another source or cessation of the CU for the duration of the low flow event. Public water suppliers were, and remain, exempt from the CU regulation; however, facilities consumptively using water delivered by public systems are not. An exception to this rule is the diversion of water from the Susquehanna basin for the purpose of public water supply. Such diversions are considered to be entirely consumptive and, as such, are subject to the regulatory requirements; examples of such diversions include the withdrawals by the City of Baltimore (Baltimore) and Chester Water Authority (Chester).

At the time the regulation was implemented, much of the focus on water use in the basin and the country was related to new, large electric generating stations. In the late 1970s and early 1980s, the Commission worked closely with Pennsylvania Power and Light (PPL), Philadelphia Electric Company (PECO), and Metropolitan Edison (Met-Ed) to develop CU mitigation for the nuclear Susquehanna Steam Electric Station in Berwick, the coal-fired Montour plant, the nuclear Three Mile Island plant, and the Peach Bottom Atomic Power Station. In 1981, PECO agreed to specific operating rules at its Conowingo Dam designed to mitigate for Peach Bottom's CU. PPL and Met-Ed joined with the Commission to develop mitigation storage at the U.S. Army Corps of Engineers' (USACE) multipurpose Cowanesque Lake. That storage project was completed in 1990. In 1994, PPL agreed to manage Lake Chillisquaque for the purpose of CU mitigation.

Because of the importance of water for operating the plants and the inability to cease CU during low flow events, the power companies invested significant amounts of money to acquire CU mitigation. However, it soon became apparent that smaller industries and other CU projects did not have the same financial capability as the power companies, and that development of large-scale storage projects for each CU facility was impractical. In response, the Commission enacted a temporary measure in 1993 to allow project sponsors to pay a CU fee to the Commission in lieu of providing actual mitigation. The fee rate was based on the approximate cost of the Cowanesque storage project on a water-unit basis, and was intended to allow the Commission to undertake additional large-scale storage projects to provide low flow mitigation for CU projects paying the fee.

In 1994, the Commission contracted with USACE for another storage project at Curwensville. Although a few large projects were initially cooperating with the Commission on the project, it was eventually funded solely by the Commission and, in 1997, implemented for use as low flow mitigation during specific hydrologic conditions on the West Branch Susquehanna River and at Harrisburg.

In 1996, the Commission and USACE undertook a joint reconnaissance study to investigate the use of storage at six large flood control facilities, including Cowanesque and Curwensville Lakes, to mitigate for CU in the basin. Although it was intended as a temporary measure, payment of the CU fee had become by this time, and remains, the mitigation choice for most CU project owners in the basin. While a few projects had opted to provide their own mitigation through on-site pond storage or cessation of use, it was evident to the Commission that more storage would be needed to meet the growing mitigation demand.

Although some promising results emerged from the 1996 reconnaissance study, the Commission has not fully developed another CU mitigation project after Curwensville Lake. Several projects have already been investigated (George B. Stevenson Lake) or are undergoing study, such as Whitney Point Lake and the Barnes and Tucker mine pool project; however, the Commission recognizes that the need for additional mitigation exists beyond those projects. Based on recent investigations, it has become evident that cost sharing and partnerships will be vital in pursuing mitigation projects. Storage projects, in particular, are often very expensive and the continuing CU fee payments have increasingly less value, as they are not indexed for inflation.

The overall lack of progress on development of CU mitigation projects, coupled with the ongoing CU approvals and the realization that further increases in CU are expected, has led the Commission to undertake a long-term planning effort to ensure that necessary CU mitigation is implemented. The Commission is currently taking a two-phase approach to establish CU mitigation: (1) verify all CU in the basin from January 1971 (the effective date of CU regulations) to the present and then forecast CU to 2025; and (2) evaluate and implement various methods for low flow mitigation for CU. The results of the first phase are presented in this report. The second phase will result in the CUMP that will involve a series of subsequent actions related to evaluation and implementation of mitigation projects. The objective of the CUMP will be to address the CU that is subject to Commission regulation and the timing, frequency, and duration of mitigation needs to be met by the selected methods.

ESTIMATING CONSUMPTIVE WATER USE

Introduction

This report does not represent the only effort the Commission has undertaken to estimate CU in the basin. The Commission has long recognized the potential adverse impacts of peak CU occurring during the most critical low flow periods and sought to mitigate them. All of the previous efforts included an estimate of the total CU that existed in 1970 for the purpose of establishing the quantity of CU that predates the Compact and thus is exempt from the mitigation requirement. Another feature the previous studies had in common with each other and with this current effort is the identification of the peak monthly CU (typically occurring in July), because any mitigation plans need to be able to accommodate the maximum expected CU. For the same reason, most previous efforts included a projection of CU to some future date, in recognition that CU has consistently grown – and continues to grow – in the basin.

Summary of Methodologies

Previous Studies

The last comprehensive estimate of the amount of CU in the basin was performed in 1996 as part of the joint USACE/Commission study entitled "Susquehanna River Basin Water Management Reconnaissance Study." The 1996 report contained estimates of maximum daily CU rates for each month in 1970 and 1990, and an estimate of maximum daily needs by month for the year 2020. The estimates were based on available data from the member jurisdictions, such as Pennsylvania's State Water Plan and the Pennsylvania Department of Agriculture's agricultural census.

Basin CU rates were found to peak in July. The 1970, 1990, and 2020 peak CU rates were found to be 270, 447, and 656 million gallons per day (mgd), respectively. These estimates made no allowance for the significant out-of-basin public water supply diversion by the City of Baltimore due to "the uncertainty and variation in usage."

In 2003, significant effort was expended as part of the Conowingo Pond Management Plan to revisit the 1996 CU estimates and establish new current and projected CU values for the years 2000 and 2025, respectively. The updates were based on revised assumptions and additional data not available in 1996. The 1970, 2000, and 2025 peak CU values were determined to be 270.6, 456, and 641.7 mgd, respectively. Like the 1996 estimates, the 2003 updates did not include potential diversions by Baltimore, and also excluded diversions by Chester.

Database Investigation

Also in 2003, but as part of a separate initiative, the Commission developed a computerized database of information on CU, backfilling the data to 2001. The key CU data included in the database are the approved peak day use and reported actual daily use, which is based on actual CU reported to the Commission by the approved projects as part of their compliance with the Commission's CU regulation. The database also includes a wide variety of location-related information and the North American Industrial Coding System (NAICS) identification for each facility. Therefore, the data can be analyzed by Geographic Information Systems (GIS) or other applications, at various scales by watershed (to HUC-11 digit level) or political boundaries, by type of facility, and by time period.

While the Commission's database is comprehensive, it is important to recognize limitations in its scope and content when used as a tool for analyzing CU in the basin. The database is limited to those projects that have triggered or will trigger, when implemented, the Commission's regulatory threshold(s), which are 20,000 gallons per day (gpd) for CU and 100,000 gpd for withdrawals. As a result, there are many facilities consuming water in the basin that do not report CU to the Commission because it predates the regulation or falls below the regulatory threshold. Commission staff has back-populated missing CU data, where possible, and made some limited adjustments in data to maintain the confidence, consistency, and representative conditions of CU in the basin. In a few cases, approved projects may not yet be in operation and consuming water, and thus have not yet reported any CU.

For the purposes of aiding the development of a long-term plan for CU mitigation, staff performed analyses of the database to characterize basin CU in terms of location and for different categories of use. Locational information will be critical in selecting and implementing mitigation projects that provide low flow augmentation in appropriate stream reaches, and an understanding of categories of CU will provide vital insight on seasonal patterns, the relationship between peak and average CU, and sectors of use in which growth is important. Finally, an analysis of actual versus approved CU was completed to assess the relationship between approved use and mitigation need. Descriptions of the assessments follow.

Characterization of CU by Category. The database investigation revealed that, to date, more than 800 CU projects have been reviewed, and currently 291 projects are considered "active." These 291 active projects fall into 29 different 3-digit NAICS categories. However, an analysis shows more than 90 percent of the Commission's CU approvals (263 facilities) fall into 6 general categories: recreation, manufacturing, mining, power generation, diversions of water for public water supply, and education (see Figure 1). Recreation (golf courses and ski resorts) and manufacturing account for 200, or more than two-thirds, of all Commission CU approvals.

The 291 projects are approved to consume a daily maximum of 563 mgd (see Figure 2). The 263 facilities that comprise the 6 major categories are approved to consume 554.7 mgd on a maximum daily basis, or 98.5 percent of the total CU under Commission regulation. CU for public water supply diversions and power generation account for 473 mgd, or more than 84 percent, of the total CU under Commission regulation despite comprising only 27, or less than 10 percent, of the 291 projects under Commission approval. Of the total approved 563 mgd, 310 mgd are associated with only two projects: the approval for Baltimore for 250 mgd, and the recognized grandfathered CU by Chester of 60 mgd. These two projects are the largest CUs of Susquehanna water; the next four largest approved amounts are for the three nuclear power plants in the basin and PPL's coal-fired plant at Montour.

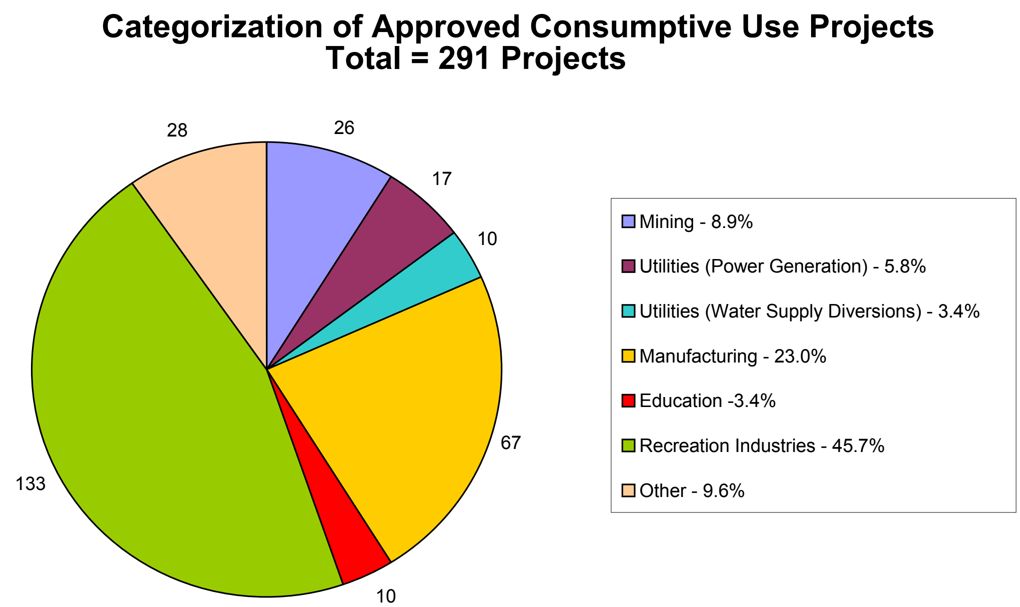

Figure 1. Total Number of Consumptive Use Projects

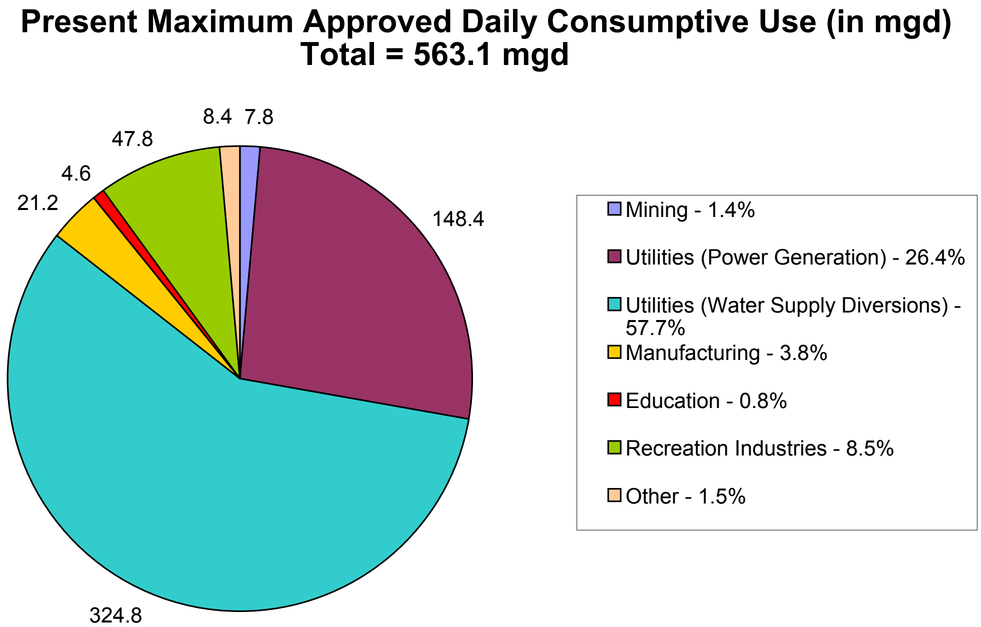

Figure 2. Present Maximum Permitted Daily Consumptive Use by Purpose

<u>Characterization of CU by Subbasin Location</u>. The database also allows characterization of CU by the subbasin in which it is located. Due to the more densely distributed population and industry, and the location of the Baltimore and Chester diversions and two nuclear power plants, the CU in the Lower Susquehanna Subbasin overshadows that of the other five subbasins (see Figure 3).

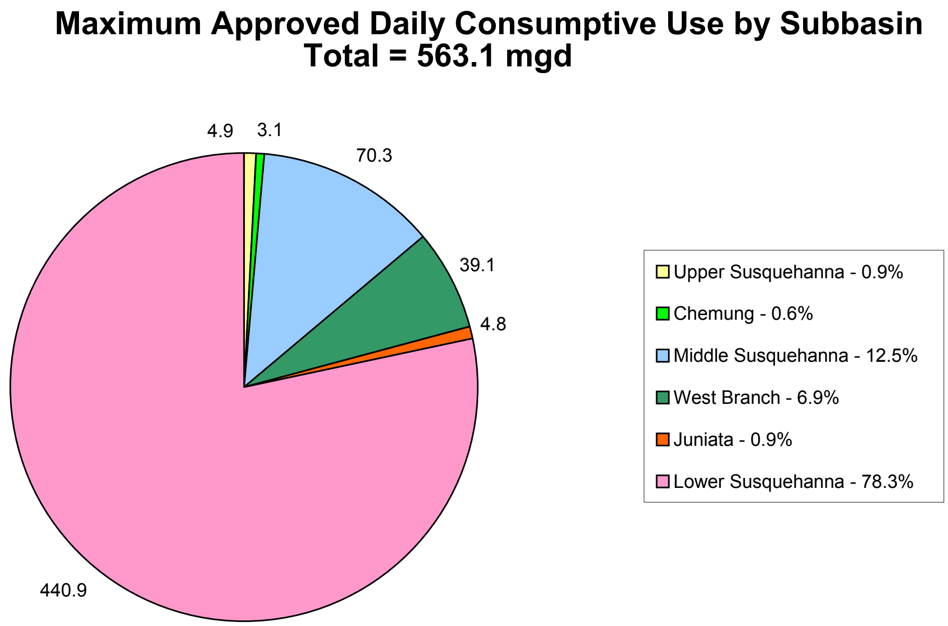

Figure 3. Baseline Daily Consumptive Use by Subbasin

Actual vs. Approved Consumptive Use. Commission staff also analyzed actual CU by regulated facilities, as opposed to approved CU. Figures 4 and 5 show the total monthly amount of water consumed in the Susquehanna basin 2002 and 2005, respectively, as well as how much water was consumed by each of the five major usage categories (the utilities category is the combined total for power generation and water supply diversions). This analysis was based on actual facility usage reports from as many as 252 reporting facilities in 2005. Again, the largest CU category, by far, is the utilities category, which contains all the basin's regulated power plants and out-of-basin diversions. That category generally is reporting about 32 billion gallons of water consumed annually; however, there were 64.4 billion gallons consumed in 2002 because of the Baltimore diversion of water during a prolonged drought.

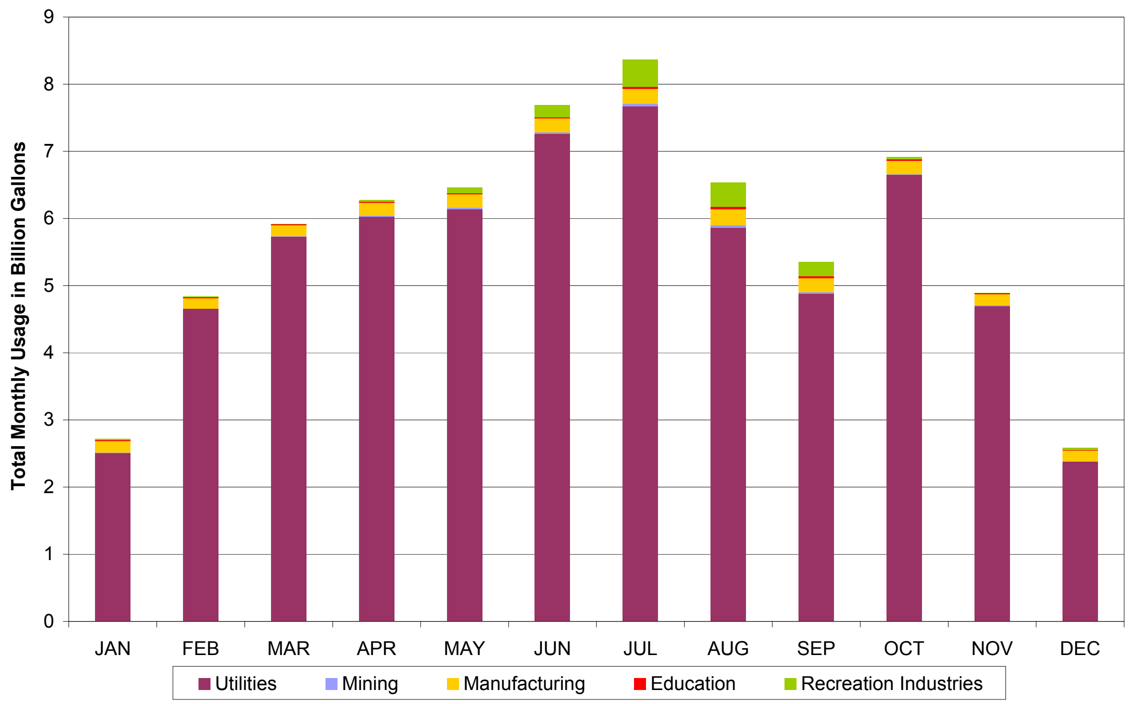

Figure 4. Reported Consumptive Usage (Monthly) for 2002

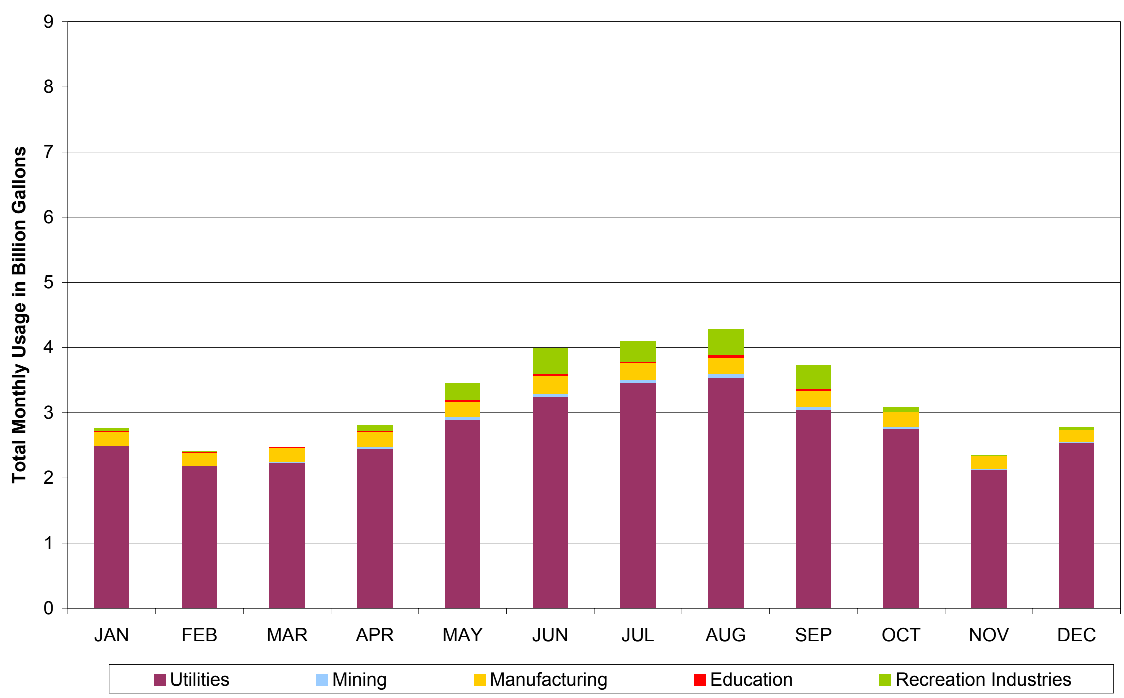

Figure 5. Reported Consumptive Usage (Monthly) for 2005

Figures 6 and 7 show total CU and CU by facility category, with each expressed in terms of monthly percents of total actual usage to give a clearer picture of the month-to-month trend of actual CU. The highest percent of total CU is in the June-August period (10-12 percent range) and the lowest percent is in November-March period (6-7 percent range). The manufacturing category varied the least from month to month, while the mining and the recreation industries varied the most.

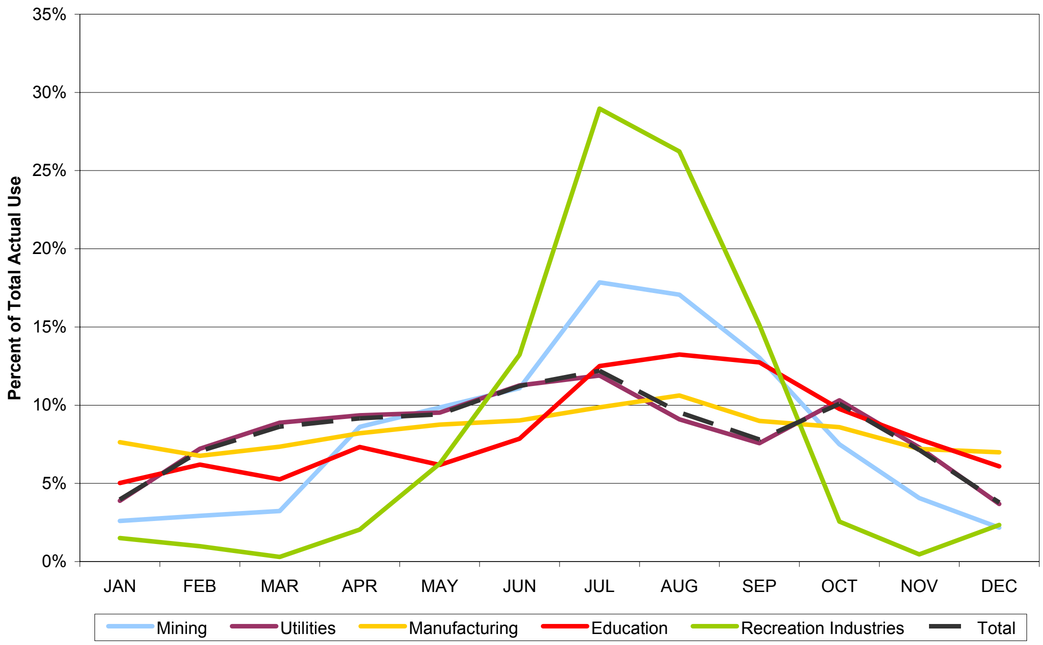

Figure 6. Reported Consumptive Usage (Actual) for 2002

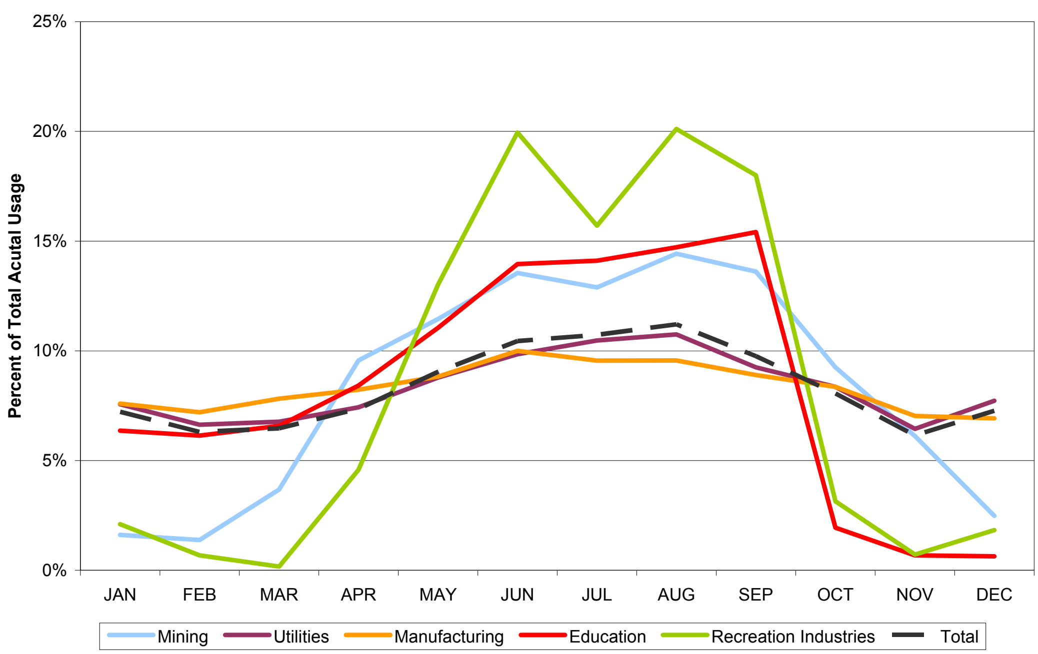

Figure 7. Reported Consumptive Usage (Actual) for 2005

Estimate of Current Consumptive Use

Variability and Timing of Consumptive Use

The Commission compared actual monthly CU for the period 2001 through 2005 to historic streamflow records to identify periods when low flow mitigation would be needed. This analysis consisted of two parts. First, due to the diversion by Baltimore in 2002, the Commission separated out that year and combined data for 2001, 2003, 2004, and 2005. Then, the 2002 data was analyzed separately. On average, for the 4-year period (2001 and 2003-2005) during the low flow months (July through November), actual reported CU averages from 83 to 132 mgd, which is roughly half the maximum daily permitted rate (not including the Baltimore and Chester diversions). For 2002, the range was 163 to 270 mgd because of the constant diversion of water by Baltimore, which was substantial but less than the Commission-approved total maximum daily rate.

Historically, approximately 47 percent of all CU takes place during the five low flow months (July through November). For the remaining 7 "non-low flow" months, the rate is more variable, ranging from 45 to 88 mgd for the 4-year period and from 84 to 256 mgd for 2002.

The analysis of flow records mentioned previously showed that the critical low flow periods occur most frequently in September. The second most frequently observed low flow month is August (Upper Susquehanna and Chemung Subbasins) or October (Middle Susquehanna, West Branch, Juniata, and Lower Susquehanna Subbasins). Because the peak month of CU (July) and month of most frequent low flow occurrences (September) are different, the amount of low flow mitigation needed may be able to be reduced accordingly. See Figure 8 for a comparison of the monthly distribution of CU and low flow occurrences.

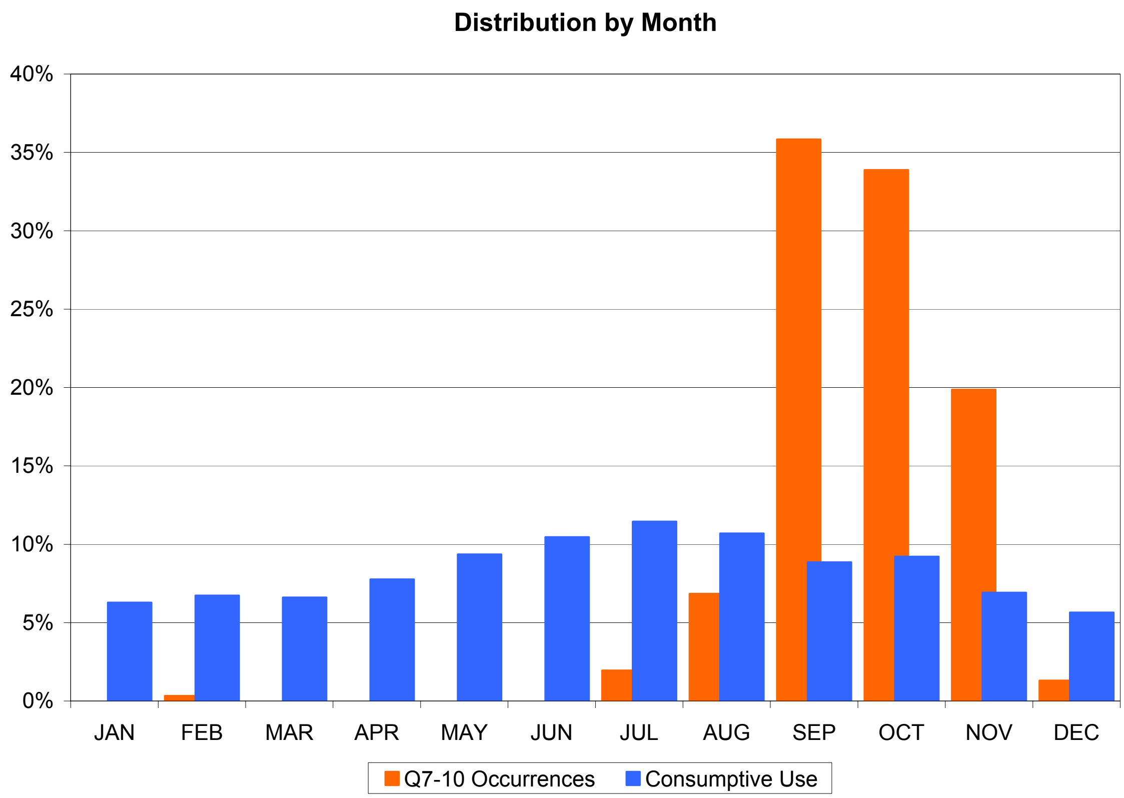

Figure 8.   Comparison of Monthly Distributions of Consumptive Use and Low Flow Occurrences

As an example, streamflow records for the Susquehanna River at Wilkes-Barre, Pennsylvania, have been collected for the past 110 years. During that time, using the 7-day, 10-year (Q7-10) low flow value as an indicator of critical low flow conditions, there have been 3 occurrences of daily flows less than Q7-10 in July, 40 in August, 108 in September, 64 in October, and 31 in November. The occurrences in September and October (172 days total) have occurred in 13 different years, for an average occurrence interval of every 8.5 years and an average duration of 13 days.

Table 1 presents average monthly CU data for July 2002 and 2005 for all projects reporting to the Commission. Those years were selected because 2002 is the most recent drought year and 2005 is the most recent "normal" hydrologic year for which data is available. An analysis of the data in Table 1 shows that the Baltimore diversion is the major reason for the difference in CU in July 2002 versus July 2005. It is also noted that the CU for power generation remained essentially unchanged, while that of other major NAICS users increased by 6.6 mgd. The increase in CU by major NAICS projects is not necessarily due solely to industry growth, but also in part to existing projects brought under Commission regulation through its Compliance Incentive Program. Additionally, the data does not reflect CU for projects approved in the years between 2002 and 2005 that are not yet operating. Presentation of the data by subbasin provides a geographic perspective of CU in the basin and preliminarily suggests where the greatest need for mitigation is located.

Table 1. Consumptive Use in July 2002 and 2005 (mgd) by Subbasin

Major Subbasin[1]	1	2	3	4	5	6	Basin Total
July 2002							
Utilities							
A. Diversions	--	--	--	0.02	0.28	175.02	175.3
B. Power Generation	--	--	38.30	14.25	--	48.50	101.1
Other Major NAICS Categories	0.94	0.56	6.77	2.30	1.10	10.68	22.4
Other Projects	0.07	0.08	0.10	0.17	--	1.86	2.3
Subbasin Totals	**1.01**	**0.64**	**45.17**	**16.74**	**1.38**	**236.06**	**301.1**
Percent of Total	***0.33***	***0.21***	***15.00***	***5.56***	***0.50***	***78.40***	***100.0***
July 2005							
Utilities							
A. Diversions	--	--	0.27	0.02	0.32	41.69	42.3
B. Power Generation	--	--	37.44	15.57	--	47.42	100.4
Other Major NAICS Categories	0.53	0.49	6.47	6.80	0.63	14.09	29.0
Other Projects	0.00	0.16	0.21	0.19	0.02	1.47	2.1
Subbasin Totals	**0.53**	**0.65**	**44.39**	**22.58**	**0.97**	**104.67**	**173.8**
Percent of Total	***0.30***	***0.37***	***25.54***	***12.99***	***0.56***	***60.23***	***100.0***

[1] Subbasin 1 = Upper Susquehanna; Subbasin 2 = Chemung; Subbasin 3 = Middle Susquehanna; Subbasin 4 = West Branch Susquehanna; Subbasin 5 = Juniata; Subbasin 6 = Lower Susquehanna

Baseline Conditions

In order to plan for implementation of mitigation for current CU and to make reasonably accurate projections of future CU and the mitigation needed for it, a reasonable baseline condition was needed. A composite set of baseline conditions was established by using the 2002 and 2005 CU data shown in Table 1. It was important to include a drought year (2002) because that is when significant public water supply diversions are the greatest. A comparison of CU by power-generating facilities and other users in both years will also demonstrate growth in these categories.

Reported CU in 2002 and 2005 for approved projects was not readily available in 2003 when the most recent estimates of CU were developed, so the data also serve as verification of the estimates of current CU. If the estimate and reported amounts compare favorably, Commission staff will be confident that CU projections are based on realistic values and that estimates of mitigation needs are likewise realistic.

Differences in the CU estimates made in 2003 (456 mgd for July 2000) and the reported CU values in 2002 and 2005 (see Table 1) exist for several reasons. First, the 2003 estimates include not only CU for approved projects, but also CU that is not reported to the Commission for one of several reasons: (1) because it is associated with grandfathered projects (270.6 mgd); (2) because it is associated with projects that are exempt from CU regulations because they fall below the regulatory threshold (43 mgd); and (3) because they are considered to be agricultural

CU (23 mgd), and thus also exempt from CU regulations. Second, the 2003 estimates did not include CU for diversions to Baltimore and Chester due to their variability. Accounting for those diversion quantities in 2002 and 2005 results in new totals of 125.8 and 131.5 mgd, respectively. Adjusting the 2003 estimate of 456 mgd to account for grandfathered and exempt CU (336.6 mgd total) leaves 119.4 mgd attributable to approved projects. This compares very well to the CU actually reported to the Commission during July of 2002 and 2005, establishing confidence that available data present an accurate picture of CU that will serve as the basis for current and future mitigation plans.

Establishing a baseline for current CU must consider not only actual CU, but current CU potential. Although most projects under Commission approval do not actually use the maximum CU that is approved, there is nothing preventing them from doing so, and it should be anticipated that projects may eventually operate at full capacity. Therefore, the Commission must plan to mitigate for the maximum potential CU in the present and in 2025. The assessment of the database and the approved quantities recorded in it demonstrate that the maximum CU for all approved projects is 563.1 mgd. Assuming maximum CU by agricultural projects, small uses, and grandfathered quantities, the maximum potential CU in the basin is currently estimated at 882.5 mgd. These quantities are broken down by subbasin and presented in Table 2.

Table 2. Baseline Consumptive Use (mgd) by Subbasin

Major Subbasin[1]	1	2	3	4	5	6	Basin Total
Baseline							
Utilities							
A. Diversions	--	--	0.49	3.06	0.50	320.72	324.8
B. Power Generation	--	0.02	48.82	26.20	--	73.90	148.9
Other Major NAICS Categories	4.87	1.77	19.57	9.17	3.91	42.20	81.6
Other Projects	0.03	1.28	1.39	0.68	0.41	4.13	7.9
Agricultural CU	7.40	0.70	2.50	2.40	1.80	8.20	23.0
Unregulated CU[2]	2.57	0.94	10.33	4.84	2.06	22.27	43.0
Grandfathered CU[3]	26.50	12.26	51.87	22.78	15.37	124.51	253.3
Subbasin Totals	**41.4**	**17.0**	**135.0**	**69.1**	**24.1**	**595.9**	**882.5**
Percent of Total	***4.70***	***1.90***	***15.30***	***7.80***	***2.70***	***67.50***	***100.0***

[1] Subbasin 1 = Upper Susquehanna; Subbasin 2 = Chemung; Subbasin 3 = Middle Susquehanna; Subbasin 4 = West Branch Susquehanna; Subbasin 5 = Juniata; Subbasin 6 = Lower Susquehanna

[2] Small projects below the regulatory threshold

[3] Does not add to 270 mgd because 17 mgd of grandfathered CU is included in approved quantities for projects

Consumptive Use Projections

The last comprehensive estimate of projected CU in the Susquehanna River Basin was undertaken in 2003 as part of the Conowingo Pond management study. Average and peak levels of CU were projected to 2025 levels, and incorporated the results from the separate Agricultural Consumptive Water Use Study.

The characterization of CU in the basin is useful for making projections of future mitigation needs. Growth in manufacturing, education, and recreational CU can be assumed to follow population growth, while CU for public water supplies and power generation is subject to specific development of upgraded systems or new facilities. The 2003 CU estimates have been verified and refined using the data contained in the database for the period 2001 through 2005 to ensure the most accurate and up-to-date information is used in CU mitigation planning. Inclusion of the reported data also allowed the establishment of the baseline CU at 2005 levels, instead of 2000, which is then used as the starting point for projections.

Previous Projection Methodologies

The 2003 projections of increase in CU through 2025 were based on two factors: (1) anticipated population growth in the basin and the related increase in general water use and consumption; and (2) consumption of water by new projects or expansion of existing projects that were known to Commission staff at the time. The latter category included increases in water exported by Baltimore and Chester, and implementation of Conectiv's proposed mid-load power plant in York County. In order to project CU to 2025, the baseline CU of 2003 was separated into two components: the "background" CU and "point-source" CU.

Background CU was comprised of the general water use attributable to agriculture, domestic supply (both private and small public systems), and commercial and industrial uses. The use associated with these various categories was distributed to appropriate watersheds in the basin based on distributions determined in previous studies by the Commission, the Pennsylvania Department of Environmental Protection, and the U.S. Geological Survey. Where reliable distribution was unavailable or too coarse, use was distributed based on population density as determined by census reports for municipal subdivisions. Once distributed to various watersheds, the use was then extrapolated to future use using the same increase (or decrease) demonstrated by official population projections for 2025, using weighted county averages where necessary.

Point-source CU was comprised of certain large public water suppliers and specific facilities with large CU. Uses by the large public water suppliers were treated as point sources because Commission staff was able to obtain official demand projections from the supply managers, which were deemed to be more reliable than projections based on population projections. CU at large facilities, such as power plants, were treated as point sources because water use at such facilities does not generally increase over time as ambient population grows. If any upgrades or expansions of the projects were known to be planned for implementation prior to 2025, appropriate increases in CU were factored into the projections. Likewise, if staff had knowledge of new proposed point sources, the associated CU was included in projections.

Updates to Projected Amount of Consumptive Water Use for 2025

The results of the projections in 2003 were that expected peak monthly CU in the basin in 2025 is 641.7 mgd. However, this projection is based on approximate actual CU numbers. In order to effectively plan for mitigation, the Commission must assume that existing users will "grow into" their approvals and that new users that develop will consume to their full potential. Similar to the adjustments made for the current baseline CU, these projections need to be adjusted to account not only for new users, but also for growth within approved usage. The remainder of the increase in CU is attributable to population growth, growth in industries already regulated by the Commission, and increased water use by agricultural operations in the basin. It should be noted that the examination of CU approvals for the Juniata Subbasin revealed that the recent estimates were likely overestimating CU. The updated projections for the Juniata Subbasin show less of an increase than once anticipated. Using the baseline totals from Table 2 and considering estimates of new projects likely to be implemented before 2025 yields the updated projections shown in Table 3.

Table 3. Updated Consumptive Use Projections to 2025 (mgd) by Subbasin

Major Subbasin[1]	1	2	3	4	5	6	Basin Total
2005 Baseline	41.4	17.0	135.0	69.1	24.1	595.9	882.5
New Projects	63.1	4.3	36.2	26.0	10.3	45.8	185.7
Updated Projection	**104.5**	**21.3**	**171.2**	**95.1**	**34.4**	**641.7**	**1,068.2**
Percent of Total	***9.8***	***2.0***	***16.0***	***8.9***	***3.2***	***60.1***	***100.0***

[1] Subbasin 1 = Upper Susquehanna; Subbasin 2 = Chemung; Subbasin 3 = Middle Susquehanna; Subbasin 4 = West Branch Susquehanna; Subbasin 5 = Juniata; Subbasin 6 = Lower Susquehanna

Projected Consumptive Use by Purpose

Projections do not exist for most of the NAICS categories currently regulated by the Commission. Manufacturing, for example, covers many different facilities in a wide variety of industries. Growth in the manufacturing sector due to construction of new facilities or expansion of existing facilities would result in increased CU. Whether or not that growth occurs will be determined by unpredictable factors such as the strength of the local, national, and global economies; demand for products and mineral resources; and corporate management decisions. However, in general, it is likely that some expansion of the manufacturing sector will occur over the next 20 years, as it has in the past. This potential growth is a component of the projected CU described in previous sections.

In contrast, the two utility categories are more likely to be subject to projection analyses. Public water suppliers typically have planning horizons of 25-50 years to try to anticipate future water demand, and have the infrastructure and sufficient sources in place to meet that demand. Through consultation with managers of the Baltimore and Chester diversions, Commission staff expects increases of up to 30 and 10 mgd, respectively, in withdrawals from the lower Susquehanna River in the coming years. These anticipated increases do not affect the CU projections, however, because both Baltimore and Chester will be able to divert the additional proposed quantities without exceeding their existing approved quantities.

Likewise, electric-generating facilities require significant capital investment and infrastructure, so information about new and expanded facilities, though proprietary, can often be gleaned for the purposes of planning for water supply needs. Based on consultations with representatives of the power industry, engineering consultants, and government agencies that work closely with the power industry, it is evident that trends and initiatives in the energy industry that developed after 2003 have necessitated that staff revisit the updated projections to account for unforeseen increased CU.

Many of the new proposed power generation facilities are the result of an emphasis on ethanol-based energy, although new coal plants are also proposed for the basin. Expansion at existing facilities includes power uprates at nuclear facilities and modifications to install cooling towers and flue-gas desulfurization (air scrubbers) in response to more stringent environmental controls. Total new CU associated with power initiatives could reach an additional 134 mgd.

The resulting new projection for peak CU in 2025 increases by 134 mgd when anticipated activity in the power sector is considered. Using the updated projection totals from Table 3 and adding estimates for new CU in the power sector yields the revised projections shown in Table 4, and also displayed on Figure 9.

Table 4. Revised Projected Consumptive Use in 2025 (mgd) by Subbasin

Major Subbasin[1]	**1**	**2**	**3**	**4**	**5**	**6**	**Basin Total**
Updated Projection	104.5	21.3	171.2	95.1	34.4	641.7	1,068.2
New CU – power	6.0	--	54.0	17.0	--	57.0	134.0
Revised Projection	**110.5**	**21.3**	**225.2**	**112.1**	**34.4**	**698.7**	**1,202.2**
Percent of Total	***9.2***	***1.8***	***18.7***	***9.3***	***2.9***	***58.1***	***100.0***

[1] Subbasin 1 = Upper Susquehanna; Subbasin 2 = Chemung; Subbasin 3 = Middle Susquehanna; Subbasin 4 = West Branch Susquehanna; Subbasin 5 = Juniata; Subbasin 6 = Lower Susquehanna

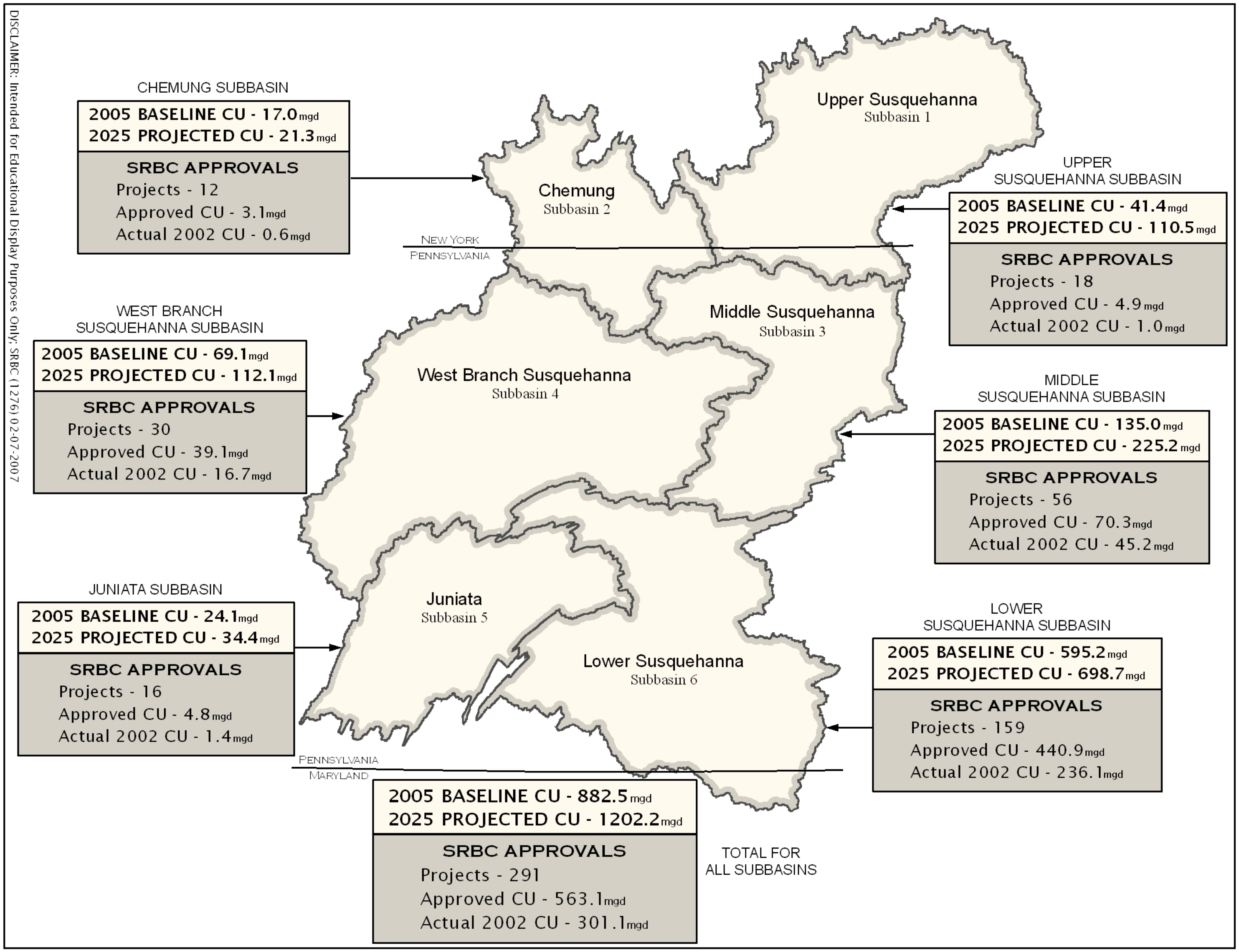

Figure 9. Consumptive Use Data by Major Subbasins

CONSUMPTIVE WATER USE MITIGATION REQUIRED

Amount of Flow Mitigation Required

Current Mitigation Needs

Differences in total CU estimates and reported CU values for 2002 and 2005 exist because the total estimates include all the CU occurring throughout the basin, regardless of size of operation or date of commencement. In other words, small projects and grandfathered uses are included in the total estimates, but are not present in the reported quantities because they are not regulated by the Commission, and thus have no reporting requirements. Likewise, the current need for mitigation is not directly tied to current baseline CU estimates because the small projects and grandfathered uses do not require mitigation. CU by projects for which mitigation has already been implemented, such as Three Mile Island (TMI), are also included. Therefore, for an accurate assessment of current mitigation needs, an evaluation must be conducted that identifies existing CU mitigation in terms of both quantity and location in the basin.

Mitigation Projects. In 1990 and 1994, the Commission contracted with the USACE regarding releases of water stored at Cowanesque and Curwensville Lakes, respectively, for the purpose of CU mitigation. PPL and AmerGen partnered with the Commission in developing the Cowanesque project, in return for CU mitigation for the Susquehanna Steam Electric Station and TMI facilities up to their maximum daily approved CU of 48 and 21 mgd, respectively. Subsequent to the original agreement, PPL later contracted for an additional 10 mgd from Cowanesque as partial mitigation for its Montour facility. Storage in PPL-constructed Lake Chillisquaque was also dedicated to serve as mitigation for Montour, up to its maximum daily approved CU of 17 mgd.

The Commission undertook the Curwensville project without any partners, developing 18 mgd of CU mitigation for release during specific hydrologic conditions on the West Branch Susquehanna River and at Harrisburg. Due to the malfunction and shutdown of TMI's Unit 2, there also remains 8 mgd of CU mitigation undedicated in the Cowanesque storage. In summary, since the mid-1990s, there has been in place CU mitigation for three of the largest projects in the basin, totaling 86 mgd, and an additional 26 mgd available for general mitigation needs throughout the basin. These projects thus meet up to 112 mgd of the current mitigation needs in the basin. It should be noted that the storage at Cowanesque and Chillisquaque Lakes does not provide mitigation for the recently approved CU at Montour related to scrubbers and the production of commercial wallboard.

Mitigation Agreements. The two largest diversions of water from the basin, for water supply to Baltimore and Chester, predate the Compact and are thus considered to be grandfathered and exempt from the CU regulation. However, it must be recognized that only the component of current CU that was actually documented prior to 1971 is exempt; any CU above that threshold is subject to regulations. In the case of Baltimore, only 107 mgd of its 250 mgd approval is grandfathered, so the City has agreed to comply with the CU regulation for the remainder by reducing its diversion to pre-1971 levels during times of low flow. That reduction of use is, in effect, mitigation for CU above the grandfathered 107 mgd. Similarly, only a small portion of Chester's diversion is subject to mitigation; any diversion to its original, pre-1971, service area is grandfathered up to 60 mgd. However, Chester has been granted several subsequent approvals to transfer water outside that original service area, and that CU is subject to the mitigation requirement, for which the authority has agreed to pay the CU fee. The quantity of water currently transferred out of the original service area is about 7.3 mgd.

None of the CU associated with operation of the Peach Bottom Atomic Power Station predates the Compact, but Exelon has met the CU mitigation requirement for the facility by agreeing to release compensatory water from Conowingo Pond during low flow conditions. In accordance with the agreement, the releases are intended to be of sufficient quantity to replace CU at the facility and allow the passage of runoff captured by Conowingo Pond. The agreement satisfies the requirement at Peach Bottom up to its maximum daily approved CU, 35.5 mgd.

In summary, all of Baltimore's diversion and most of Chester's diversion have met the mitigation requirement, reducing the overall mitigation need by 250 and 52.7 mgd, respectively. Should either water purveyor request in the future to exceed its existing agreed-upon limit, it would require CU mitigation for the increase. The overall basin mitigation need is also reduced by 35.5 mgd in the Lower Susquehanna Subbasin, provided Exelon continues to abide by its CU mitigation agreement and does not increase CU at the Peach Bottom facility. For the three projects, the total CU covered by mitigation agreements is 338.2 mgd. Similarly, staff estimates that up to 2 mgd of CU is self-mitigated by projects using storage or discontinuance, for a total for mitigation agreements of 340.2 mgd.

Considering mitigation projects and mitigation agreements together, a total of 452.2 mgd of CU currently has active mitigation.

Exempt from Mitigation. The baseline CU value includes estimates for CU by projects that predate the Compact (253.3 mgd) and by small, non-regulated projects and exempt public water suppliers (up to 43 mgd). It should also be noted that many of the projects approved for CU by the Commission do have some pre-1971 usage documented; that portion of the total is considered to be exempt from the compliance requirement. A cursory review of the project database shows that 146 projects (in addition to the aforementioned Baltimore and Chester) have documented a total of 17.3 mgd as grandfathered. Accounting for these exemptions, the current mitigation need is further reduced by 313.6 mgd (270.6 mgd predates the Compact, and 43 mgd is non-regulated).

Other Potential Mitigation. Finally, it is worth noting that there could be existing, ongoing mitigation in the basin that is currently not accounted. It is in the form of incidental mitigation that occurs in the course of normal low flow operations at reservoirs and facilities, and consists of: (1) reservoir conservation releases; (2) water conservation plans; and (3) cessation of use. Analyses of these three operating parameters may reveal that certain reservoirs are augmenting streamflows above normal conditions during low flow periods, or that facilities are, during official drought declarations, implementing water-saving measures that would reduce the mitigation required by the Commission. However, until such analyses are undertaken, no reductions will be made in this exercise to the assumed current CU mitigation needed.

Conclusion. Taking into account mitigation projects (112 mgd), mitigation agreements (340.2 mgd), and exempt projects (313.6 mgd), there is presently up to 765.8 mgd of CU in the basin that either meets the mitigation requirement or is exempt. Thus, of the 882.5 mgd current peak CU, 116.7 mgd still requires mitigation. Much of that is comprised of the net difference between total approved CU and the amount of CU actually used on a routine basis by approved projects; the total also includes up to 23 mgd associated with agricultural CU.

On Figure 10, the 2005 CU is characterized as grandfathered (270.6 mgd), unregulated (43 mgd), having mitigation (112 mgd from projects and 340.2 mgd from agreements, for a combined total of 452.2 mgd), and needing mitigation (116.7 mgd).

Projected Mitigation Needs

When calculating the mitigation needed for the anticipated growth of CU from 882.5 to 1,202.2 mgd (an increase of 319.7 mgd), consideration must be given to the existing mitigation, growth in the portion of CU that is below the Commission's regulatory threshold or that will supply its own mitigation, and mitigation projects the Commission expects to undertake. It is assumed that the mitigation requirement presently met for 765.8 mgd of current CU will still be effective in 2025. However, consideration must also be given to increases in CU at facilities currently under satisfactory mitigation. For example, although Baltimore's and most of Chester's diversions are currently exempt from CU mitigation, proposed increases to those diversions would require new mitigation. Likewise, the large power generation facilities currently have mitigation, but the large growth in the power sector is likely to require complete mitigation.

Mitigation Projects. Assuming the Whitney Point Lake Section 1135 Project Modification and the Pennsylvania agriculture mitigation projects are in place in 2025, a total of at least 48 mgd of additional CU mitigation will be available during future low flow conditions.

Mitigation Agreements. No assumptions are being made at this time for new agreements, but there is potential for CU mitigation releases from USACE and state lakes, provided the Commission can reach agreement with the facility operators (see the discussion on the "Consumptive Use Mitigation Plan" at the end of this report for examples). However, it is assumed that a few new CU projects, comprising about 5 percent of the new CU, or 7 mgd, will supply their own mitigation. Also, consideration must be given to changes in existing agreements, such as those for Baltimore's and Chester's diversions, which will actually require new mitigation for CU that is currently exempt or satisfied. For the purpose of this assessment, 30 mgd will be deducted from satisfied mitigation for Baltimore, and Chester's existing mitigation will be adjusted downward by 20.9 mgd to reflect anticipated pumping greater than the pre-Compact quantity (an additional 10 mgd requiring mitigation) and an increase in water transferred outside the original service area (about 10.9 mgd). Thus, the total amount attributable to mitigation agreements is a net reduction of 43.9 mgd.

Exempt from Mitigation. Similar to the adjustment made in the calculation for current mitigation need to account for small projects not requiring mitigation, it is expected that not all new CU in the basin in 2025 will be under regulation, and thus will not require mitigation. For

CU growth between 1970 and 2005, it was assumed that 23 percent of the new CU was associated with projects that do not meet the Commission's regulatory threshold. For the purpose of this assessment, the same fraction of the CU growth from new projects between 2005 and 2025 (185.7 mgd total) is assumed to be exempt from mitigation (42 mgd exempt).

Likewise, the CU considered to be grandfathered in 2005 (a total of 270.6 mgd) will likely still be designated as such in 2025, and thus be exempt from mitigation requirements. For the purposes of this assessment, the 270.6 mgd is already included in the 765.8 mgd that presently satisfies mitigation requirements, and thus is not deducted again for 2025 mitigation needs. It should also be noted that the revised regulations enacted by the Commission in December 2006, contain provisions for the gradual elimination of exemptions for pre-1971 CU exceeding the regulatory threshold, and further analyses will be necessary to assess the potential impact of the change.

Conclusion. Considering all the above factors, Commission staff anticipates that 390.3 mgd of the expected 1,202.2 mgd CU in the basin will require new mitigation. The 811.9 mgd projected not to require mitigation in 2025 is comprised of new mitigation projects (48 mgd), change in mitigation agreements (-50.9 mgd for Baltimore and Chester, and 7 mgd for new self-mitigating projects), new mitigation exemptions (42 mgd for non-regulated projects) and existing CU (765.8 mgd) that is either currently mitigated (452.2 mgd), exempt from mitigation (43 mgd) or grandfathered (270.6 mgd). Breakdown of mitigation needed by subbasin is shown in Table 5.

Table 5. Total Projected Consumptive Use and Mitigation Needs

Subbasin	1	2	3	4	5	6	Basin Total
Total Projected CU	110.5	21.3	225.2	112.1	34.4	698.7	1,202.2
Projected CU Mitigation Need	33.6	0.0	100.6	37.0	12.3	206.8	390.3

Figure 10 shows the characterization of past, present, and projected CU and mitigation. For 2025, CU is characterized as grandfathered (270.6 mgd), unregulated (43 mgd from 2005 and 42 mgd new, for a total of 85 mgd), having mitigation (452.2 mgd from 2005, decreased by 50.9 mgd for Baltimore and Chester and increased by 7 mgd for new projects, for a projected total of 408.3 mgd), projected mitigation from new storage projects (48 mgd), and CU needing mitigation (390.3 mgd).

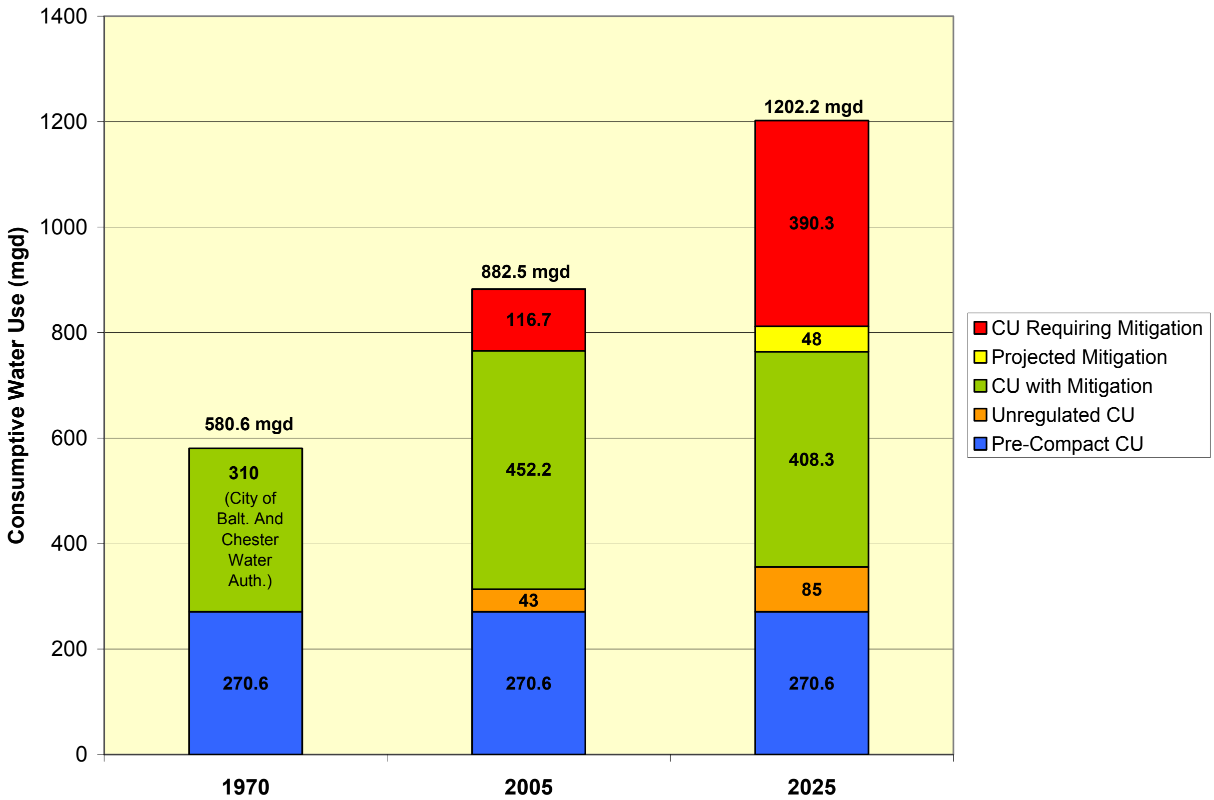

Figure 10. Characterization of Susquehanna River Basin Consumptive Use and Mitigation

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