6.0 IMPLEMENTATION OF THE MANAGEMENT PLAN

The Groundwater Management Plan will meet its established goals and result in positive actions only to the degree that it is successfully implemented. If the plan is not implemented, then it becomes an "on-the-shelf" document of little value. There are several key factors to consider for plan implementation. These include roles and responsibilities for key agencies and groups, prioritization of actions, implementation schedule, costs, and other major issues affecting implementation to include selection and resourcing of actions in a phased approach. The purpose of this section is to discuss the key factors and set reasonable expectations for successful implementation of the Groundwater Management Plan.

6.1 Roles and Responsibilities

The scope of the management plan includes the groundwater activities of the Commission and actions of others that directly relate to the Commission's program. The authority for the Commission to undertake its roles and responsibilities is set forth in the 1971 Susquehanna River Basin Compact, P.L. 91-575, 84 Stat. 1509 et seq., and Commission Regulations (18 CFR Parts 803, 804, and 805).

Compact Section 3.4(2) states the Commission may "establish standards of planning, decision, and operation of all projects and facilities in the basin to the extent they affect water resources...." Section 3.4(9) allows the Commission to "adopt, amend, and repeal rules and regulations to implement the Compact", and Section 15.2 states the Commission may "make and enforce regulations for effectuation, application, and enforcement of the Compact...." Concerning protection of certain valuable areas (e.g., water preserves), Section 9.4 states that a purpose of the Compact is to effectuate the conservation and management of water resources to preserve and promote the economic and other values inherent in historic, scenic, and other natural amenities of the basin. The basis for dissemination of information to the public and coordination of activities and programs is set forth in Sections 3.4(6) and 3.7, respectively, of the Compact.

Commission Regulations §803.4, relating to projects subject to review and approval under the regulations, and §803.42, relating to the consumptive use of water, states that compensation shall be required for projects using water from any source (including groundwater) during periods of low flow. The Commission's groundwater and surface water regulations state that withdrawals may be denied or limited for a number of reasons, including protection of streamflows and perennial streams, protection of competing supplies, prevention of water quality degradation, and prevention of harm to fish and wildlife. If major changes to programs or regulations flow from the plan, criteria, policies, procedures, and guidelines will have to be developed, as applicable.

The plan includes certain roles and responsibilities for the Commission, the federal government, the states of Maryland and New York, the Commonwealth of Pennsylvania, local jurisdictions, the private sector (e.g., project sponsors), and other groups. A wide variety of capabilities and expertise can be provided by the other groups in support of implementing the plan's recommendations. Some of the diverse groups that can be involved include professional, environmental , and nonprofit organizations; the private sector; and civic associations. Examples of these groups could include the Nature Conservancy, the Pennsylvania Aggregate and Concrete Association, the Eastern and Western Pennsylvania Coalitions for Abandoned Mine Reclamation, and the Pennsylvania Planning Association.

The Commission has lead responsibility for 15 of the 39 recommended actions included in the management plan, a co-leadership role in 17 areas, and a support role for the remaining 7 actions. Similarly, the states have lead responsibilities for 2 recommendations and co-lead responsibilities for another 23. The federal government has a co-lead responsibility for five recommendations, and local

jurisdictions have one lead and seven co-lead responsibilities. Project sponsors, which can be federal or state agencies, local jurisdictions, or private groups, have an important role to play through accomplishment of the analyses (often done by professional consultants) needed to support their proposed projects in line with 12 of the plan's recommendations.

The key agencies in the three member states of the Commission that have groundwater responsibilities include: New York – Department of Environmental Conservation and Department of Health; Pennsylvania – Department of Environmental Protection and Department of Conservation and Natural Resources; and Maryland – Department of the Environment and Department of Natural Resources. The Commission's Groundwater Management Program is complimentary to and aligned with the state programs. As an example, Pennsylvania is actively pursuing groundwater planning and management improvements under its Act 220 Program (State Water Plan). This effort includes water budget analyses which are recognized in this plan as being critical to sound groundwater management in areas of high demand in relation to sustainable water supply. PADEP's Division of Drinking Water Management has offered to assist the Commission in implementing various actions recommended in this Groundwater Management Plan (e.g., those related to well interference, groundwater mining, and loss of aquifer recharge). Their assistance will be coordinated during the implementation phase for this plan's recommended actions.

Table 6.1 summarizes the lead, co-lead, support, and analysis roles and responsibilities for all parties. The "other" designation in Table 6.1 is for local jurisdictions; the private sector; professional, environmental, and nonprofit organizations; and civic associations. Where applicable, the known lead "other" group(s) is noted in Table 6.1.

A lead or co-lead designation means that the group(s) noted would be responsible to see that the action is accomplished, but the actual work can be done by the lead group and/or others in a cooperative effort. A support designation means that the group(s) noted would be able to provide management support and/or technical assistance for actions led by others. Table 6.1 also notes where analyses would be required by project sponsors to address several of the identified problems. Professional consultants would normally do the analyses, and are expected to submit complete and technically correct work. The action items listed in the table are the full set of 39 recommendations (summarized for brevity of presentation in some cases) included as part of the management plan, and are presented in the same order as discussed in Sections 2, 3, and 4, and as presented in Appendix E.

6.2 Prioritization of Actions and Schedule

Effective implementation of the Groundwater Management Plan is enhanced by the prioritization and scheduling of all recommended actions. In order to accomplish this, a priority rating system and implementation schedule parameters were considered for each action.

Factors included as part of the prioritization rating system include importance, coverage under existing programs, timing and sequencing, and ease/difficulty of implementation of the recommended actions. For each factor, professional judgment and experience were used to consider the following types of priority information:

Table 6.1. Plan Implementation Roles and Responsibilities[1]

A. Actions to Address Groundwater Resource Issues and Problems		Commission	States	Other
1. **Issue**: Areas of Intense Growth and Development and Consequent Water Resource Development	**Problem**: Well interference. **Recommendation**: Use groundwater modeling and/or water level monitoring to evaluate potential well interference. Mitigation may be necessary.	Lead		Analysis (project sponsor)
	Problem: Exceedence of sustainable yield. **Recommendation**: Require groundwater availability analyses for new projects and for areas where sustainable yield has been exceeded. Develop water budgets for all PSAs. Adjust withdrawal rates for sustainability, if needed.	Lead		Analysis (project sponsors)
	Problem: Loss of recharge areas. **Recommendation**: Base sustainable yields for wells on post build-out conditions and encourage the use of BMPs to minimize loss of recharge.	Lead		Analysis (project sponsor)
2. **Issue**: Intensive Water Use in Small Basins	**Problem**: Loss of base flow. **Recommendation**: Educate the public and local officials about the sustainability of headwater areas, and the need to properly manage them.	Co-lead	Co-lead	Co-lead
	Problem: Loss of perennial streamflow. **Recommendation**: Evaluate headwater areas for the purpose of managing water quantity and quality.	Co-lead	Co-lead	Co-lead; Analysis (project sponsors)
3. **Issue**: Watershed "Transfers"	**Problem**: Wastewater is not returned to the watershed where it was withdrawn. **Recommendation**: Educate professional groups about the options of maintaining groundwater withdrawals and post-use discharges in the same watershed.	Co-lead	Co-lead	Co-lead

[1]NOTE: A lead or co-lead designation means that the group(s) noted would be responsible to see that the action is accomplished, but the actual work can be done by the lead group and/or others in a cooperative effort. A support designation means that the group(s) noted would be able to provide management support and/or technical assistance for actions led by others. An analysis designation means that the project applicants would be required to analyze problems in line with the recommendations.

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

A. Actions to Address Groundwater Resource Issues and Problems		Commission	States	Other
4. **Issue**: Loss of "Clean" Water Input to AMD-Impacted Streams	**Problem**: Degradation of stream quality. **Recommendation**: Evaluate cumulative impacts from consumptive water uses to downstream water quality in AMD-impacted areas.	Lead		Analysis (project sponsors)
5. **Issue**: Unknown and Unregulated Groundwater Use	**Problem**: Data gaps can prevent evaluation of true sustainability and cumulative impact. **Recommendation**: Collect information on unknown and unregulated withdrawals to improve evaluation for new projects.	Lead		Analysis (project sponsors)
	Problem: Loss of base flow during the growing season. **Recommendation**: Perform water budget and cumulative impact analyses, and manage groundwater withdrawals to address any adverse impacts.	Lead		Analysis (project sponsors)
	Problem: Interference with existing water sources. **Recommendation**: Perform water budget analyses and consider options to address overdraw.	Lead		Analysis (project sponsors)
6. **Issue**: Scarcity of Clean Water in Coal-Mined Areas	**Problem**: Preferential development of high quality groundwater sources. **Recommendation**: Manage quantity and quality in non-AMD-impacted watersheds recognizing that water resources are necessary for the economic growth of mining-affected regions; educate local officials and consultants; coordinate with state and federal agencies; and encourage grayfields initiatives.	Co-lead	Co-lead	Co-lead; Analysis (project sponsors)

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

A. Actions to Address Groundwater Resource Issues and Problems		Commission	States	Other
7. **Issue**: Drought Impact to Base Flow	**Problem**: Insufficient streamflow to sustain instream flow needs or downstream water supplies. **Recommendation**: Educate local jurisdictions about stormwater management, CARAs, and other BMPs for development, and improve scientific basis for instream use protection.	Co-lead	Co-lead	Co-lead; Analysis (project sponsors)
8. **Issue**: Impacts of Mining	**Problem**: Water discharged from mining operations is underutilized. **Recommendation**: Encourage cooperative efforts to develop reliable water supplies related to mining operations.	Co-lead	Co-lead	Co-lead
	Problem: Extensive aquifer dewatering. **Recommendation**: Delineate the area of influence and capture area for the mine withdrawal and identify the impacts and method of impact mitigation, when needed.	Co-lead	Co-lead	Analysis (project applicants)
	Problem: Exceedence of sustainable yield. **Recommendation**: Reduce impacts of mine pumpage through the grouting of water inflow points if economically and technically feasible.	Co-lead	Co-lead	Analysis (project sponsors)
9. **Issue**: Flow Compensation for Consumptive Water Uses	**Problem**: Need for additional low-flow augmentation to compensate for consumptive water uses. **Recommendation**: Bring together key stakeholders to help promote use of groundwater stored in "artificial" aquifers to offset consumptive water uses and support instream flow needs.	Co-lead	Co-lead	Co-lead
B. Actions to Address Management Issues		**Commission**	**States**	**Other**
1. **Issue**: Multi-agency Coordination	**Problem**: Coordination among water resource agencies can be ineffective or incomplete. **Recommendation**: Enhance the Commission's water resources procedures and project review coordination activities with involved agencies to avoid conflicting actions.	Lead		

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

B. Actions to Address Management Issues		Commission	States	Other
2. **Issue**: Changes to Water Resource Utilization Over Time	**Problem**: Water resource management programs can become less efficient with changes in technology and water use. **Recommendation**: Assess water resource utilization periodically and make appropriate changes in policies, procedures, and project review process. **Problem**: Water supply sustainability and stream low flow conditions can be adversely impacted by lack of the best and most efficient use of groundwater. **Recommendation**: Strengthen water conservation requirements and encourage use of treated wastewater and conjunctive use.	Lead Co-lead	Co-lead	Co-lead
3. **Issue**: Regulatory Duplication	**Problem**: Change in the regulatory programs of the member jurisdictions may make some of the Commission's regulatory program redundant, inefficient, or inappropriate. **Recommendation**: Maintain close and effective coordination among the Commission, member jurisdictions, and key agencies to include possible formal arrangements such as memoranda of understanding.	Co-lead	Co-lead	Co-lead (EPA)
4. **Issue**: Increased Knowledge About Groundwater as a Resource	**Problem**: Useful groundwater information is collected by the Commission, agencies, and others, but is not compiled and shared. **Recommendation**: Capture and compile collected data for use by the Commission, agencies, and others. **Problem**: Lack of fundamental knowledge of groundwater resources by many policy/decision-makers has hindered the understanding of sound groundwater management practices. **Recommendation**: Identify the constituency for an outreach and education program, and develop tools for their decision-making.	Lead Co-lead	Co-lead	Co-lead (GW professionals and local jurisdictions)

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

B. Actions to Address Management Issues		Commission	States	Other
4. **Issue**: Increased Knowledge About Groundwater as a Resource (Continued)	**Problem**: Lack of consideration of factors important to groundwater protection and sustainability within the municipal planning process has hindered implementation of sound groundwater management practices. **Recommendation**: Encourage and assist local governments to include groundwater management concepts in planning and land use control.	Co-lead	Co-lead	Co-lead (GW professionals and local jurisdictions)
	Problem: Absence of an educational framework to present groundwater concepts and issues to a variety of audiences. **Recommendation**: Incorporate a variety of methods into a multi-faceted outreach and education program.	Co-lead	Co-lead	Co-lead (GW professionals and local jurisdictions)
5. **Issue**: Plan Performance and Accountability	**Problem**: The management plan will not be productive unless the tasks identified are performed and accountability for accomplishing the tasks is established. **Recommendation**: Provide periodic reporting on implementation of the Groundwater Management Plan and new significant groundwater issues.	Lead		
6. **Issue**: Review and Update of the Plan	**Problem**: This management plan needs to be reviewed and updated on a recurring basis in order to be current and of continuing value. **Recommendation**: Conduct comprehensive reviews and revisions of this plan at intervals not to exceed 10 years.	Lead		
7. **Issue**: Funding to Implement the Plan	**Problem**: Adequate long-term funding needs to be made available to implement the actions recommended in the plan. **Recommendation**: Funding to implement the plan's recommended actions should be made available and/or proactively sought by the lead jurisdiction(s) for each action.	Co-lead	Co-lead	Co-lead (EPA, USGS, local jurisdictions)

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

C. Groundwater Management Support Programs		Commission	States	Other
1. **Issue**: Protection of Groundwater Sources of Supply and Aquifers	**Problem**: Contamination of groundwater resources from effects of improper land use planning and zoning. **Recommendation**: Encourage states and local jurisdictions to develop regulations and programs to protect critical aquifers from contamination.	Support	Co-lead	Co-lead (local jurisdictions)
	Problem: Lack of comprehensive groundwater quality datasets showing the extent and severity of nonpoint source pollution affecting ground-water resources basinwide, and the lack of management plans necessary for improving conditions. **Recommendation**: Continue and expand monitoring and research in cooperation with states related to nonpoint source contamination, and support the assessment and implementation of such actions, including TMDLs, USEPA's 319 Nonpoint Source Program, and USDA/NRCS water programs.	Co-lead	Co-lead	
	Problem: Degradation of water quality conditions in aquifers from point source discharges. **Recommendation**: Support member jurisdictions in their efforts to consider the effect of wastewater discharges on groundwater, including sensitive recharge areas, when issuing NPDES or SPDES permits.	Support	Lead	
	Problem: Limited support for local development of source water protection plans. **Recommendation**: Assist communities with groundwater source protection by utilizing existing source water assessment data and aquifer test data to provide educational and technical assistance in formulation of protection plans.	Support	Support	Lead (local Jurisdictions)

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

C. Groundwater Management Support Programs		Commission	States	Other
2. **Issue**: Water Use and Availability Information	**Problem**: Not all large volume withdrawals are registered (documented). **Recommendation**: Require large volume groundwater users (>10,000 gpd) to register (document) their use and to re-register (update documentation) periodically. Coordinate with member states and others to maintain a vibrant data set.	Co-lead	Co-lead	
	Problem: Data on large volume users needs to be available for management use. **Recommendation**: Maintain a centralized database containing information on large users, and make this data available to planners and managers throughout the basin, subject to security considerations.	Co-lead	Co-lead	
	Problem: Well information is not available to all agencies and local managers. **Recommendation**: Maintain a centralized database containing well location information, and make the data available to planners and managers throughout the basin, subject to security considerations.	Co-lead	Co-lead	
	Problem: Groundwater managers, planners, and decision-makers do not have ready access to important groundwater information. **Recommendation**: The Commission should partner with appropriate agencies to develop groundwater availability and yield information and make it available on-line.	Co-lead	Co-lead	Co-lead (USGS and local jurisdictions)
3. **Issue**: Well Requirements	**Problem**: Improper well construction and abandonment procedures can cause aquifer contamination. **Recommendation**: Support state and local programs for well construction and abandonment standards, and improved controls to prevent pollution.	Support	Co-lead	Co-lead (local jurisdictions)

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

C. Groundwater Management Support Programs		Commission	States	Other
3. **Issue**: Well Requirements (Continued)	**Problem**: Lack of certification program for drillers in Pennsylvania and need for improving existing licensing/certification programs and well driller training in other basin states. **Recommendation**: Support legislation that works toward the development of a well driller's certification program in Pennsylvania and support the improvement of programs that provide training and licensing/certification for all well drillers in the basin's states.	Support	Lead	
	Problem: The observation well network does not have the capability to monitor the dynamic response of aquifers in the basin to changes in precipitation. **Recommendation**: Provide effective maintenance and work toward improvements for the basinwide observation well network with a goal of having real-time monitoring capability in each county in the basin.	Support	Co-lead (New York and Maryland)	Co-lead (USGS)
4. **Issue**: Assessment of State/Federal Groundwater Programs and Program Coordination	**Problem**: State and federal agencies need to ensure their groundwater programs are current and responsive, with management activities well coordinated **Recommendation**: The Commission's state members should continue periodic assessments of their groundwater programs to identify needed improvements and plan for their implementation.	Support	Co-lead	Co-lead (EPA and USGS)

- **Importance**—Recognizing that all recommended actions are essential for sound groundwater management, which actions are most critical or critical versus others that are important?

- **Coverage Under Existing Programs**—What are the significant groundwater management needs that either have little or no, limited, or incomplete coverage under existing programs?

- **Timing and Sequencing** —Are there any considerations, such as developmental time for programs and regulations that require actions to be phased in over time? Do any of the plan's recommendations rely upon another action(s) to be done first?

- **Ease/Difficulty of Implementation**—Given the many parameters to be considered for implementation, which actions are relatively easy versus difficult? Some of the parameters to consider include technology available, staffing, in terms of manpower and subject matter expertise, competing program priorities and workload, legal or policy constraints, and public support.

Each recommended action was evaluated, using the factors listed above, to determine ratings of top priority, high priority, and priority. The importance factor was given added weight by requiring an action to be rated as a top or high priority in importance before it can have an overall rating of top or high priority, respectively. Table 6.2 summarizes the prioritization rating system.

Table 6.2. Prioritization Ratings System for Essential Groundwater Management Actions

Rating Factor	Top Priority	High Priority	Priority
Importance	Most critical	Critical	Important
Coverage Under Existing Programs	Little or no coverage	Limited coverage	Incomplete coverage
Timing and Sequencing	No other action required	Other short-term action(s) required	Other long-term action(s) required
Ease/Difficulty of Implementation	Expect fairly easy implementation	Expect fairly easy implementation, but some difficulties possible	Expect some difficulty in implementation
Priority Level for a Selected Action	Importance and two or more other factors rated as Top Priority	Importance and two or more other factors rated as Top/High Priority	Importance and two or more other factors rated as Priority

The specific implementation schedule for each element of the management plan is dependent on the priority and resources given to the elements by the Commission and other lead jurisdictions. For the purpose of this management plan, implementation scheduling was addressed by grouping actions under the following three time frames. Again, professional judgment and experience were used to assign schedule time frames.

- **Continuing Actions**—Those actions of any priority level that should be initiated and/or implemented relatively easily and quickly under existing programs. Full implementation of some initiated actions may take years, however.

- **Short-Term Actions**—Those actions of any priority level that should be initiated and/or effectively implemented within two years. Full implementation of some initiated actions may take longer than two years, however.

- **Long-Term Actions**—Those actions of any priority level that should take from two to five years to initiate and effectively implement.

An example of a continuing action is ongoing program changes such as those that require new information to be submitted to the Commission by project sponsors. Accordingly, an action the Commission can take now is to require that the review of groundwater use applications incorporate a check for consistency with the actions recommended in this plan. Short-and long-term actions, such as additional improvements to the basinwide system of observation wells, will require positive program and budget decisions in the future. The Commission will take a proactive approach to implementing the plan's recommendations in a timely manner. It is anticipated that the other lead jurisdictions also will be proactive in plan implementation. The annual progress report on implementation of the plan will address the schedule of both ongoing work and that work expected to be initiated in the upcoming year, and plans for future work.

The results of the prioritization rating evaluation and assessment of implementation schedules are summarized in Table 6.3. The recommended actions are grouped by the three priority levels and include an implementation time frame for each. There are 10, 20, and 9 top priority, high priority, and priority actions, respectively. From a scheduling perspective, there are 12, 16, and 11 actions that should be implemented as continuing, short- and long-term actions, respectively.

This plan has been prepared to provide a framework to effectively manage groundwater resources in the basin, is broad-based, and is not meant to be a detailed implementation document for all recommendations. However, the 12 continuing actions represent early steps that can be taken without significant further work. The remaining 27 short-term or long-term actions will require implementation measures such as development of new guidelines or regulations, provision of adequate resources, and interagency coordination.

Table 6.3. Plan Implementation—Prioritization and Scheduling

TOP PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	**PROBLEMS AND RECOMMENDATIONS**	**SCHEDULE**
A. Actions to Address Groundwater Resource Issues and Problems		
1. Areas of Intense Growth and Development and Consequent Water Resource Development	**Problem**: Loss of recharge areas. **Recommendation**: Base sustainable yields for wells on post-build-out conditions and encourage the use of BMPs to minimize loss of recharge.	Short-Term Action
2. Intensive Water Use in Small Basins	**Problem**: Loss of perennial streamflow. **Recommendation**: Evaluate headwater areas for the purpose of managing water quantity and quality.	Short-Term Action
5. Unknown and Unregulated Groundwater Use	**Problem**: Data gaps can prevent evaluation of true sustainability and cumulative impact. **Recommendation**: Collect information on unknown and unregulated withdrawals to improve evaluation of new projects.	Short-Term Action
8. Impacts of Mining	**Problem**: Extensive aquifer dewatering. **Recommendation**: Delineate the area of influence and capture area for the mine withdrawal and identify the impacts and method of impact mitigation, when needed.	Short-Term Action
B. Actions to Address Management Issues		
1. Multi-agency Coordination	**Problem**: Coordination among water resource agencies can be ineffective or incomplete. **Recommendation**: Enhance the Commission's water resources procedures and project review coordination activities with involved agencies to avoid conflicting actions.	Continuing Action
3. Regulatory Duplication	**Problem**: Change in the regulatory programs of the member jurisdictions may make some of the Commission's regulatory program redundant, inefficient, or inappropriate. **Recommendation**: Maintain close and effective coordination among the Commission, member jurisdictions, and key agencies to include possible formal arrangements such as memoranda of understanding.	Continuing Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

TOP PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	**PROBLEMS AND RECOMMENDATIONS**	**SCHEDULE**
B. Actions to Address Management Issues (Continued)		
4. Increased Knowledge About Groundwater as a Resource	**Problem**: Lack of consideration of factors important to groundwater protection and sustainability within the municipal planning process has hindered implementation of sound groundwater management practices. **Recommendation**: Encourage and assist local governments to include groundwater management concepts in planning and land use control. **Problem**: Absence of an educational framework to present groundwater concepts and issues to a variety of audiences. **Recommendation**: Incorporate a variety of methods into a multifaceted outreach and education program.	Short-Term Action Short-Term Action
5. Plan Performance and Accountability	**Problem**: The management plan will not be productive unless the tasks identified are performed and accountability for accomplishing the tasks is established. **Recommendation**: Provide periodic reporting on implementation of the Groundwater Management Plan and new significant groundwater issues.	Continuing Action
7. Funding to Implement the Plan	**Problem**: Adequate long-term funding needs to be made available to implement the actions recommended in the plan. **Recommendation**: Funding to implement the plan's recommended actions should be made available and/or proactively sought by the lead jurisdiction(s) for each action.	Short-Term Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

HIGH PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	**PROBLEMS AND RECOMMENDATIONS**	**SCHEDULE**
A. Actions to Address Groundwater Resource Issues and Problems		
1. Areas of Intense Growth and Development and Consequent Water Resource Development	**Problem**: Well interference. **Recommendation**: Use groundwater modeling and/or water level monitoring to evaluate potential well interference. Mitigation may be necessary. **Problem**: Exceedence of sustainable yield. **Recommendation**: Require groundwater availability analyses for new projects and for areas where sustainable yield has been exceeded. Develop water budgets for all PSAs. Adjust withdrawal rates for sustainability, if needed.	Short-Term Action Short-Term Action
2. Intensive Water Use in Small Basins	**Problem**: Loss of base flow. **Recommendation**: Educate the public and local officials about the sustainability of headwater areas and the need to properly manage them.	Short-Term Action
5. Unknown and Unregulated Groundwater Use	**Problem**: Loss of base flow during the growing season. **Recommendation**: Perform water budget and cumulative impact analyses, and manage groundwater withdrawals to address any adverse impacts. **Problem**: Interference with existing water sources. **Recommendation**: Perform water budget analyses and consider options to address overdraw.	Short-Term Action Short-Term Action
7. Drought Impact to Base Flow	**Problem**: Insufficient streamflow to sustain instream flow needs or downstream water supplies. **Recommendation**: Educate local jurisdictions about stormwater management, CARAs, and other BMPs for development, and improve scientific basis for instream use protection.	Long-Term Action
8. Impacts of Mining	**Problem**: Water discharged from mining operations is underutilized. **Recommendation**: Encourage cooperative efforts to develop reliable water supplies related to mining operations. **Problem**: Exceedence of sustainable yield. **Recommendation**: Reduce impacts of mine pumpage through the grouting of water inflow points if economically and technically feasible.	Continuing Action Continuing Action
9. Flow Compensation for Consumptive Water Uses	**Problem**: Need for additional low flow augmentation to compensate for consumptive water uses. **Recommendation**: Bring together key stakeholders to help promote use of groundwater stored in "artificial" aquifers to offset consumptive water uses and support instream flow needs.	Short-Term Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

HIGH PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	**PROBLEMS AND RECOMMENDATIONS**	**SCHEDULE**
B. Actions to Address Management Issues		
2. Changes to Water Resource Utilization Over Time	**Problem**: Water resource management programs can become less efficient with changes in technology and water use. **Recommendation**: Assess water resource utilization periodically and make appropriate changes in policies, procedures, and project review process.	Short-Term Action
4. Increased Knowledge About Groundwater as a Resource	**Problem**: Useful groundwater information is collected by the Commission, agencies, and others but is not compiled and shared. **Recommendation**: Capture and compile collected data for use by the Commission, agencies, and others. **Problem**: Lack of fundamental knowledge of ground-water resources by many policy/decision-makers has hindered the understanding of sound groundwater management practices. **Recommendation**: Identify the constituency for an outreach and education program, and develop tools for their decision-making.	Long-Term Action Continuing Action
6. Review and Update of the Plan	**Problem**: This management plan needs to be reviewed and updated on a recurring basis in order to be current and of continuing value. **Recommendation**: Conduct comprehensive reviews and revisions of this plan at intervals not to exceed 10 years.	Long-Term Action
C. Groundwater Management Support Programs		
1. Protection of Groundwater Sources of Supply and Aquifers	**Problem**: Limited support for local development of source water protection plans. **Recommendation**: Assist communities with groundwater source protection by utilizing existing source water assessment data and aquifer test data to provide educational and technical assistance in formulation of protection plans.	Continuing Action
2. Water Use and Availability Information	**Problem**: Not all large volume withdrawals are registered (documented). **Recommendation**: Require large volume groundwater users (>10,000 gpd) to register (document) their use and to register (document) their use and to re-register (update documentation) periodically. Coordinate with member states and others to maintain a vibrant data set.	Long-Term Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

HIGH PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	**PROBLEMS AND RECOMMENDATIONS**	**SCHEDULE**
C. Groundwater Management Support Programs (Continued)		
2. Water Use and Availability Information (Continued)	**Problem**: Data on large volume users needs to be available for management use. **Recommendation**: Maintain a centralized database containing information on large users, and make this data available to planners and managers throughout the basin, subject to security considerations. **Problem**: Well information is not available to all agencies and local managers. **Recommendation**: Maintain a centralized database containing well information, and make the data available to planners and managers throughout the basin, subject to security considerations.	Long-Term Action Long-Term Action
3. Well Requirements	**Problem**: Improper well construction and abandonment procedures can cause aquifer contamination. **Recommendation**: Support state and local programs for well construction and abandonment standards, and improved controls to prevent pollution. **Problem**: The observation well network does not have the capability to monitor the dynamic response of aquifers in the basin to changes in precipitation. **Recommendation**: Provide effective maintenance and work toward improvements for the basinwide observation well network with a goal of having real-time monitoring capability in each county in the basin.	Continuing Action Long-Term Action
4. Assessment of State/Federal Groundwater Programs and Program Coordination	**Problem**: State and federal agencies need to ensure their groundwater programs are current and responsive, with management activities well coordinated. **Recommendation**: The Commission's state members should continue periodic assessments of their groundwater programs to identify needed improvements and plan for their implementation.	Continuing Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	**PROBLEMS AND RECOMMENDATIONS**	**SCHEDULE**
A. Actions to Address Groundwater Resource Issues and Problems		
3. Watershed "Transfers"	**Problem**: Wastewater is not returned to the watershed where it was withdrawn. **Recommendation**: Educate professional groups about the options of maintaining groundwater withdrawals and post-use discharges in the same watershed.	Continuing Action
4. Loss of "Clean" Water Input to AMD-Impacted Streams	**Problem**: Degradation of stream quality. **Recommendation:** Evaluate cumulative impacts from consumptive water uses to downstream water quality in AMD-impacted areas.	Short-Term Action
6. Scarcity of Clean Water in Coal-Mined Areas	**Problem**: Preferential development of high quality groundwater sources. **Recommendation**: Manage quantity and quality in non-AMD-impacted watersheds recognizing that water resources are necessary for the economic growth of mining-affected regions; educate local officials and consultants; coordinate with state and federal agencies; and encourage grayfields initiatives.	Long-Term Action
B. Actions to Address Management Issues		
2. Changes to Water Resource Utilization Over Time	**Problem**: Water supply sustainability and stream low flow conditions can be adversely impacted by lack of the best and most efficient use of groundwater. **Recommendation**: Strengthen water conservation requirements and encourage use of treated wastewater and conjunctive use.	Short-Term Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	**PROBLEMS AND RECOMMENDATIONS**	**SCHEDULE**
C. Groundwater Management Support Programs		
1. Protection of Groundwater Sources of Supply and Aquifers	**Problem**: Contamination of groundwater resources from effects of improper land use planning and zoning. **Recommendation**: Encourage states and local jurisdictions to develop regulations and programs to protect critical aquifers from contamination.	Long-Term Action
	Problem: Lack of comprehensive groundwater quality datasets showing the extent and severity of nonpoint source pollution affecting groundwater resources basinwide, and the lack of management plans necessary for improving conditions. **Recommendation**: Continue and expand monitoring and research in cooperation with states related to nonpoint source contamination, and support the assessment and implementation of such actions, including TMDLs, USEPA's 319 Nonpoint Source Program, and USDA/NRCS water programs.	Continuing Action
	Problem: Degradation of water quality conditions in aquifers from point source discharges. **Recommendation**: Support member jurisdictions in their efforts to consider the effect of wastewater discharges on groundwater, including sensitive recharge areas, when issuing NPDES or SPDES permits.	Continuing Action
2. Water Use and Availability Information	**Problem**: Groundwater managers, planners, and decision-makers do not have ready access to important groundwater information. **Recommendation**: The Commission should partner with appropriate agencies to develop groundwater availability and yield information and make it available on-line.	Long-Term Action
3. Well Requirements	**Problem**: Lack of certification program for drillers in Pennsylvania and need for improving existing licensing/certification programs and well driller training in other basin states. **Recommendation**: Support legislation that works toward the development of a well driller's certification program in Pennsylvania and support the improvement of programs that provide training and licensing/ certification for all well drillers in the basin's states.	Long-Term Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

6.3 Costs

The implementation costs of the elements of the management plan will vary and need to be addressed for both the short- and long-term. There will be financial requirements for the Commission and other lead jurisdictions, but there are ways to address these. The annual increase in costs can be balanced by a phased approach to implementation. Many of the plan elements are modifications to existing programs of the Commission and its member jurisdictions. It is believed that some program funding can be redirected toward making these modifications in a prioritized and phased approach. This plan can be used to help support and justify increased funding through federal and state appropriations, grants, redirection of available program resources, etc. Continuing major initiatives to obtain additional program and/or specific project funding should be undertaken at all levels with the goal of obtaining long-term sustained funding. In addition to funding actions recommended in this report, there are other significant water resources efforts that can be of benefit to groundwater resources and need sufficient funds. An example of an important program requiring sufficient funding is Pennsylvania's State Water Plan (Act 220) which began in 2002.

A few examples of funding needs are instructive in gaining an appreciation of the magnitude of costs of plan implementation. Water budget analyses are recommended as a means to assess water availability and demand in stressed areas and to protect the groundwater resource. The Commission recently initiated a three-year water budget analysis for a 32,000-acre-groundwater area in northern Lancaster County, Pennsylvania, in partnership with the County Conservation District and five local watershed groups. The total cost of the analysis is $180,000, and is funded by a $121,000 grant from PADEP's Growing Greener Program and resources being provided by local interests and the Commission. Additional water budget work would require similar funding for each study, depending on the size and complexity of the study area. However, future water budget analyses will be done selectively for specific areas in the basin where water supply versus demands are a significant issue, local jurisdictions support the need for the analyses, and funding is available. Another example of increased costs is for the addition/modification of 11 observation wells in Maryland and New York to provide real-time monitoring data. This cost is estimated to total approximately $40,000 in a one-time capital cost for the 11 wells, plus an annual operation and maintenance cost of $4,000 per well. The costs can be cost shared by the states and USGS. A third example is the additional cost for Commission staff to critically review more detailed and complex analyses required of project sponsors pursuant to certain plan recommendations, e.g., cumulative impact analyses. Estimates of the additional staff costs vary widely, depending on project scope and location, but a typical cost is estimated to be $1,000 to $2,000 for each project review. The additional annual cost to the Commission would be $30,000 to $60,000, based on 30 project applications involving groundwater use in a typical year.

It must be recognized that significant delays in funding will exacerbate groundwater problems and issues. For instance, if cumulative impacts of groundwater withdrawals are not fully assessed, unexpected adverse effects can occur and be costly to remedy. In another aspect of enhanced management of groundwater resources, the Commission has a policy dealing with violations by water users. Review of projects would be required, as recommended in this plan, to determine when violations occur and enforcement actions are required.

6.4 Major Issues

From an implementation standpoint, there are two major issues that the Commission and other lead jurisdictions must address. First, the lead group responsible for each element of the plan must decide on which of the recommended actions to take in a phased and prioritized approach. Second, sufficient manpower and funding resources must be made available, over time, to take the priority actions identified. It is recognized that current staffing and funding may have to be redirected or increased to

accomplish all elements of the plan. A major effort should be made at all levels to obtain sustained long-term funding for addressing groundwater actions. The scope of the recommended actions requires that they be implemented by a combination of management and regulatory program efforts. "Business as usual" through regulatory program requirements will not be adequate to address critical actions, such as public outreach and education.

The Commission has decided to keep its Groundwater Management Plan Team active as a means to continue the process from the planning phase through the implementation phase. The Groundwater Management Plan Team will be recommending and accomplishing annual groundwater program actions to be taken in accordance with this plan's findings. Considerations will include the priorities of actions, funding availability, and competing workload. The goal of the Commission is to implement all recommended actions for which it is responsible in an orderly and efficient manner. Implementation of the recommended actions will remain a long-term Commission priority. Annual progress reports will be made by the Groundwater Management Plan Team to assess the degree of success in taking action. Both the Commissioners and WRMAC will be kept apprised of progress. Other jurisdictions with lead responsibilities on recommended actions are encouraged to take steps similar to that of the Commission in order to focus on plan implementation.

If the essential steps discussed above are not taken, plan implementation will be delayed. Undoubtedly, there also will be technical and administrative issues that will arise. These issues also will need to be effectively addressed so that plan implementation can continue in a timely manner. An example of this is changes in laws and regulations, which will occur and must be addressed with regard to impact on groundwater resources.

6.5 Public Review of the Plan

The Commissioners approved the draft version of this Groundwater Management Plan for public release at their business meeting on June 9, 2004. A full and open 90-day public review and comment period was initiated on June 9, 2004, with a widely distributed news release. For this process, the public was defined as all people, groups, agencies, etc. outside of the Susquehanna River Basin Commission. The Commission's objective was to receive constructive input and comments as a result of public review in order to produce a high quality Groundwater Management Plan.

Three public workshops were held in July 2004 to present the draft plan and provide the opportunity for attendees to make oral comments. The workshops were held in Harrisburg and State College, Pennsylvania, and Owego, New York, with a total of approximately 175 people in attendance. A record of all comments from the workshops was made and is available in Commission files. More formal written comments (by letter and/or e-mail) were also received by the Commission from 21 interested parties during the review period. Over 400 comments were received from the workshops and written submittals.

All comments received were reviewed and addressed. The review comments were organized by the major topics for effective presentation. Appendix F includes a summary of the most significant comments received, organized by major topics, and a summary response for each topic. A concerted effort was made to include representative and significant comments while accounting for numerous similarities in input received from multiple sources at workshops or in written form. The final plan has incorporated additional or revised information, as needed, to reflect changes in response to the comments. The responses in Appendix F state where revisions were made in the plan.

6.6 Future Review and Revision of the Plan

It is recognized that the Groundwater Management Plan will take years to be fully implemented. During this time, new issues, changed conditions, and technological advances are likely to occur. It is prudent that a comprehensive review of the plan be done and revisions made, as needed. A recommendation included in the management plan calls for a comprehensive review and revision of the plan at an interval not to exceed ten years. This action will help ensure that the plan is current and remains viable as a tool for managing groundwater resources.

7.0 CONCLUSIONS

During preparation of the Groundwater Management Plan, several major conclusions were drawn as the work proceeded. Initially, the Commission concluded that the previous (1993) Groundwater Management Plan needed a comprehensive review and revision. The assessment of groundwater issues and problems, including management issues, was the first major work task and it identified the significant and widespread groundwater needs in the basin to be addressed. Actions were considered for each issue and problem, a conclusion was reached, and recommendations made on how to best address each of them. The selected management plan was then developed based on the series of recommended actions.

A critical and long-term part of the Commission's mission, as reflected in the 1971 Compact, is the achievement of a balance among environmental, human, and economic needs in the management of the basin's water resources. This is done by careful consideration of a wide range of factors including water resource sustainability, protection of existing users, adverse environmental impacts, actions to minimize or mitigate impacts, protection of high quality water from degradation, effective interagency coordination, and public understanding of groundwater issues. The recommended water resource management actions in the plan were formulated with the goal of balancing economic development and environmental protection as a primary consideration.

Implementation of the management plan is dependent on the Commission, federal government, member states, local jurisdictions, and project sponsors making resources available for this purpose on a phased and prioritized approach. Conclusions have been reached and documented on which group(s) has the lead, co-lead, or support responsibility for each of the elements of the management plan and where project sponsors need to do required analyses. It is anticipated that all parties will make a "good faith" effort to fulfill their responsibilities. All recommended management actions also were assessed to determine prioritization ratings and schedule time frames. Conclusions were reached on assigning top priority, high priority, or priority ratings and continuing, short- or long-term schedules.

The Commission has approved this plan to effectively address major groundwater resource issues in the basin that are within the Commission's purview. With adoption of the plan, and in recognition of the significant relationship between groundwater and surface water, the Commission has taken an important step toward a unified management of water resources. The Commission will monitor progress on plan implementation and periodically review and update the plan.

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GLOSSARY OF TERMS

Alluvium – Clay, silt, sand, gravel or similar material deposited by stream water in a valley or floodplain.

Anticlinal Geologic Structure – A geologic structure in which the rock layers have been folded, generally convex upward, and whose core contains the chronologically older rocks.

Area of Influence – The area within which the water surface of an aquifer is lowered by withdrawal of water through a well or other structure designed for the purpose.

Aquifer Terms –

Aquifer – A body of rock that is sufficiently permeable to conduct groundwater and to yield economically significant quantities of water to wells and springs.

Aquifer Dewatering – The process of removing groundwater from aquifer storage.

Aquifer Recharge – The process by which water migrates from the ground surface to the zone of saturation within an aquifer.

Critical Aquifer Recharge Areas (CARAs) – Land surface areas that are responsible for a large fraction of the recharge to a well capture area and/or are exceptionally efficient producers of recharge.

Karst Aquifer – An aquifer with groundwater storage and flow properties that are largely determined by an abundance of interconnected voids and caves formed by the action acidic groundwater on naturally soluble rocks such as limestone, dolomite, and gypsum.

Fractured Bedrock Aquifer – An aquifer with groundwater storage and flow properties that are largely determined by an abundance of interconnected fractures, joints, and faults in hardened or cemented rock formations such as granite, shale, limestone, and schist.

Stratified Drift Aquifer – An aquifer characterized by layers of clay, silt, sand, gravel, and boulders deposited by meltwater from glaciers.

Base Flow – The portion of streamflow contributed by the discharge of groundwater as springs and seeps in a streambed. Between precipitation and meltwater events, most of the water in a stream is base flow.

Capture Area – The land surface overlying that portion of the aquifer contributing water to a well. The area of an aquifer from which water is captured by a well.

Colluvium – Loose, mixture of soil and rock fragments deposited at the base of steep slopes and formed by the downslope movement of a slurry of saturated weathered material from mountainsides. Examples include mud flows and landslide debris.

Consumptive Use – Water that is used and not returned to the watershed or groundwater basin from which it was withdrawn. Examples of consumptive use include evaporation from evaporative cooling units, irrigation, and incorporation into products such as concrete and bottled water.

Drawdown – A lowering of the water level in an aquifer caused by the withdrawal of groundwater from a well.

Diabase – A dark gray to black massive, crystalline rock formed by the gradual cooling and solidification molten rock that migrated upward from deep within the earth's crust.

Ephemeral Reaches – Sections of streams or waterways that are at all times above the water table, and have flow only for short periods in response to surface runoff resulting from precipitation or the melting of snow.

Geomorphic – Of or relating to the form of the land surface. Geomorphology is the study of the processes by which the land surface is formed and history of their development.

Groundwater – All subsurface water, as distinct from surface water, that is in the zone of saturation and supplies wells and springs.

Groundwater Mining – The process of extracting groundwater from a source at a rate so in excess of the recharge that the groundwater level declines persistently, threatening exhaustion of the supply or at least a decline of pumping levels to uneconomic depths.

Grandfathered Use – Water use that is exempted from regulations put into effect after the use was begun. As an example, consumptive water use in the Susquehanna River Basin begun before 1971 is exempt from Commission regulations.

Head – The difference in elevation between two points in a body of water.

Hydrogeology – The science that deals with subsurface waters and with related geologic aspects of surface water. Also used in the more restricted sense of groundwater geology only.

Intermittent Reaches – Sections of streams or waterways that are above the water table for a part of the year and at or slightly above the water table for the remainder of the year. When the channel is above the water table, as during dry periods, they flow for short periods in response to stormwater or meltwater runoff. When the channel is at or below the water table, the flow is continuous and sustained by groundwater discharge to the channel. Intermittent reaches are located between ephemeral reaches in the upstream direction, and perennial reaches in the downstream direction.

Isovolumetric – Equal in volume. Said of a weathering process that changes the chemical composition of a rock, but leaves the size or volume unaltered.

Landscape Ecology – The study of the relationships and interactions between living organisms and the landscape they inhabit.

Landscape Hydrology – The study of the relationships and interactions between the landscape and the science that deals with water, its properties, circulation, and distribution, on and under the earth's surface as affected by the association of landforms, especially as modified by geologic forces.

NPDES – National Pollutant Discharge Elimination System

Perennial Flow – Water flow that is continuous and present year-round and whose upper surface generally stands lower than the water table in the region adjoining the stream.

Saprolite – A soft, earthy, typically clay-rich, thoroughly decomposed rock, formed in place by chemical weathering of igneous, sedimentary, and metamorphic rocks.

Siliciclastics – Rocks which are primarily composed of silicate minerals, and that are only very slightly soluble in naturally occurring precipitation, surface water, and groundwater.

SPDES – State Pollutant Discharge Elimination System

Storativity – The characteristic of an aquifer relating to its ability to store groundwater.

Water Budget Analyses – An accounting or bookkeeping approach to the evaluation of the quantity of water resources available. Quantifies and compares the water income (recharge), expenses (water withdrawals), and savings (groundwater and surface water storage).

Water Level Monitoring – The measuring and recording of water levels in an aquifer to determine long-term trends in the levels.

Well Interference – The condition occurring when the area of influence of a well overlaps that of a neighboring well, as when two wells are pumping from the same aquifer and are located near each other.

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APPENDIX A

Existing Conditions

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EXISTING CONDITIONS

Appendix A describes the existing conditions of the groundwater resources in the Susquehanna River Basin.

First, it is important to understand that although all earth materials (rocks and unconsolidated materials) have the potential to store and transmit water in the subsurface, some have greater abilities to do so than others. There are commonly three types of aquifers in the Susquehanna River Basin: karst, fractured bedrock, and porous media (stratified drift, alluvium, and colluvium). Each type possesses its own unique hydrogeologic properties. The areal extent of these aquifers is commonly limited in comparison to many of the regional aquifers within the United States. These small basin aquifers are maintained by an annual infusion of recharge.

Existing groundwater conditions in the basin result from a number of factors, including *climate, physiography, land use, groundwater quality,* and *groundwater use*. The following sections describe how each of these factors relates to the occurrence, movement, and management of the resource.

Climate

Climatic conditions control the quantity and timing of precipitation, as well as evapotranspiration, and thus, recharge potentially available to the groundwater system. As a humid region in the northeastern United States, the Susquehanna River Basin receives a generous amount of precipitation, averaging 40 inches annually (National Oceanic and Atmospheric Administration, 2002). Most of the precipitation is in the form of rain, although the northern portions of the basin can receive significant amounts of snowfall. During any given year, variation in precipitation throughout the basin can be significant (Figure A.1).

Weather patterns in the northern and western areas of the basin are primarily influenced by systems moving from the mid-West United States, and "lake-effect" systems moving across northwestern Pennsylvania from Canada. The southern part of the basin tends to exhibit mild climatic conditions, controlled largely by weather systems moving into the region from the southern and coastal areas. Climatic conditions for the central part of the basin are generally transitional between the northwestern and southern portions of the basin, and largely controlled by the Appalachian Mountains.

Based on the regional climate patterns, most groundwater recharge in the basin tends to occur in the spring and fall. During the spring months, recharge from snowmelt and rain showers occurs in significant quantities before increased air temperatures and vegetative growth occur. Recharge also is significant after leaf fall and before the ground begins to freeze.

Water levels in the small aquifers in the Susquehanna River Basin are maintained by the annual infusion of recharge. A basinwide estimation of recharge to groundwater resources during average conditions is on the order of 13 inches. However, recharge is less than this amount half of the time, and water management decisions based on average conditions will fall short half of the time.

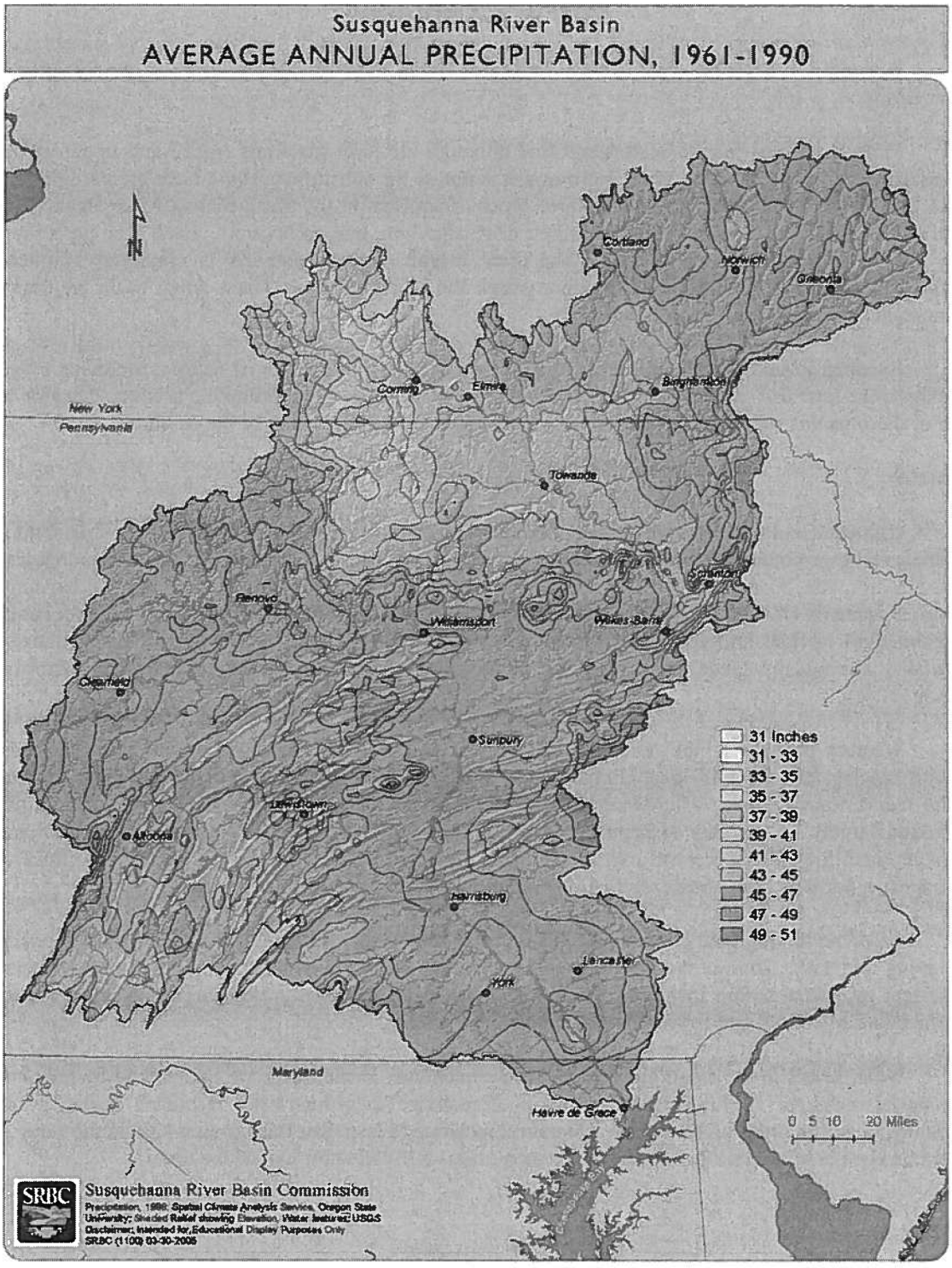

Figure A.1. Long-Term Average Annual Precipitation in the Susquehanna River Basin

A drought with a 1-in-10-year recurrence interval would trigger a "drought warning" designation, one of the three levels of drought stage defined according to the Commission's Drought Coordination Plan. Water resource management agencies monitor four hydrometerological parameters, along with public water supply reservoir levels, to form a regional picture indicating the onset and easing of drought conditions across the basin. One of the parameters is groundwater level measured in the USGS observation well network, which is generally comprised of one well per county, basinwide. The other two stages are "drought watch," indicated when conditions generally reach a 1-in-4-year frequency event, and drought emergency, indicated when conditions reach a 1-in-20-year frequency event. Depending on the areal extent of precipitation deficiencies, drought can impact portions of, or the entire, Susquehanna Basin during any given event.

During periods of extended drought, fractured bedrock aquifers tend to deplete the most rapidly, while karst and porous media aquifers show signs of depletion later. Conversely, during periods of recovery from drought conditions, fractured bedrock aquifers are the first to recover, followed by porous media aquifers and then karst aquifers. The reason for this phenomenon is that fractured bedrock aquifers generally have the least amount of available groundwater storage and aquifer transmissivity, while the other two types have substantial underground storage and high transmissivity. As a result, water levels in fractured bedrock aquifers are an excellent early indicator of the onset of drought conditions. Droughts are not considered over until porous media and, particularly, karst aquifers recover into normal ranges. Although some fractured rock aquifers which have high amounts of groundwater storage due to the presence of deep residuum or deep weathering, such as many of the Piedmont metamorphic crystalline aquifers, are far less sensitive to drought.

In recent years, drought conditions have persisted for many consecutive months, resulting in multiyear drought events. Most of these events were caused by insufficient groundwater recharge occurring during the period of leaf fall through spring runoff to bring aquifer levels back into normal ranges. Consequently, groundwater storage was abnormally low before the peak summer demand period began. With little summer recharge, streamflows were at abnormally low base-flow levels for most of the growing season (five or six months). Ultimately, these extended drought periods resulted in widespread well failures. The wells most vulnerable to failure were those developed in fractured bedrock aquifers having low storativity and transmissivity, especially those located on hilltops and hillsides.

The drought of 2002 is an example of a multiyear regional drought event that began in fall 2001. In fact, this multiyear drought event would have extended back to a beginning in 1998 had it not been for the twin hurricanes, Dennis and Floyd, occurring in September 1999. Figure A.2 shows the precipitation deficits that had accrued for the drought from October 2001 through December 2002. For precipitation deficits accumulated over 11 months, 12 inches of deficiency indicate a drought emergency. However, precipitation deficits are only one of five drought-monitoring parameters. Although the deficits do not alone trigger a drought emergency, the magnitude and timing of the deficits is significant. Most of the precipitation deficiencies accrued over the fall and winter seasons during the period critical for groundwater recharge. This condition caused drought conditions to be worse than those indicated by precipitation deficits alone.

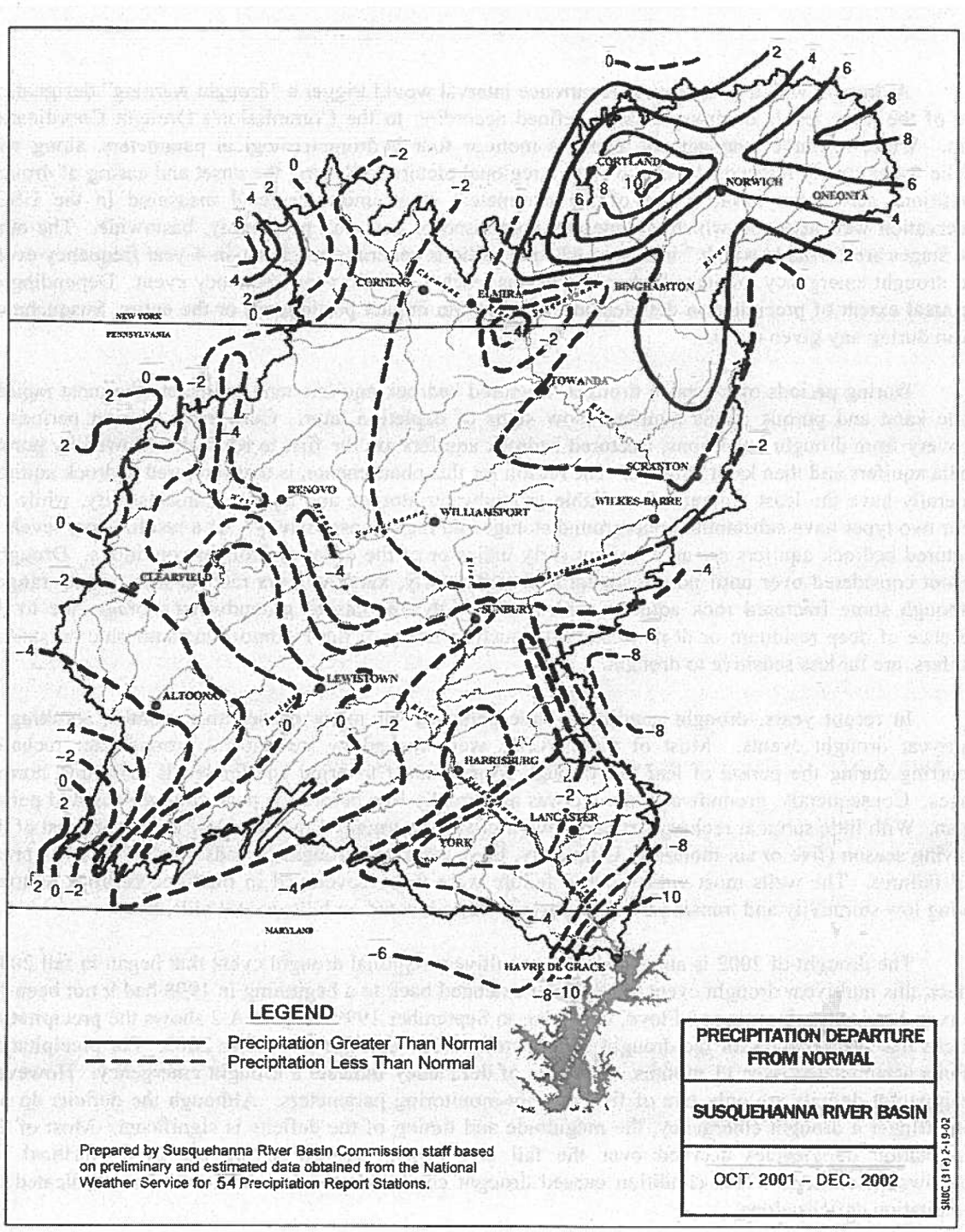

Figure A.2. Precipitation Departure From Normal, Susquehanna River Basin, October 2001 through December 2002

Figure A.3 presents the monthly average depth-to-water plotted against the historic record (about 40 years) for 6 basin USGS observation wells. The Dauphin and Cumberland County wells, within the most severely impacted drought area, indicate numerous record monthly low levels before the recovery began in October 2002. Illustrating the extent of the drought-affected area, the Union and Bradford County wells also experienced near record low groundwater levels during the summer months.

More often than not, droughts, particularly within the southern and eastern portions of the basin, are ended with a tropical storm tracking across the basin. Examples of this activity occurred in 1999 with Hurricanes Dennis and Floyd, and in September 1985, when Hurricane Gloria ended that year's drought in the eastern portion of the basin. September is the peak of the hurricane season, and is normally when base flow and groundwater levels are at their lowest. Therefore, "drought-busting" tropical storms are most likely to occur during that month.

Droughts also are frequently terminated by "nor'easters," occurring when a cold air high pressure system in the north stalls, and moist air is pumped inland from an East Coast low pressure system. Nor'easters result in heavy snow or intense rainfall events, particularly in the eastern portion of the basin. Nor'easters generally occur between mid-October and February.

Physiography

The physiography, determined by soils, geology, and local relief, has a strong influence on the infiltration, storage, and movement of water in the subsurface. To some degree, the physiographic setting also affects climatic conditions. Within the Susquehanna Basin, there are three predominant physiographic provinces (Figure A.4) that can be used to characterize the hydrogeologic setting. The principal physiographic provinces, from north to south, are the Appalachian Plateaus, Valley and Ridge, and Piedmont. In addition, a small portion of the Blue Ridge Province extends into the southern area of the basin, between the Valley and Ridge and the Piedmont. Each of these provinces has distinct physical characteristics (topography, geology, soils) that influence groundwater conditions.

The Appalachian Plateaus Province, comprising approximately 40 percent of the basin, is characterized by nearly flat-lying sedimentary rocks that have been dissected by streams to form deeply incised valleys. The hydrogeology within the Appalachian Plateaus Province is characterized by confined and semi-confined fractured bedrock aquifers. Aquifers in this province, unlike most of the basin, can have significant lateral extent. Overall, recharge rates typically associated with the mixed siliciclastics of this province are approximately 700,000 gallons per day per square mile (gpd/mi^2) (Taylor and others, 1983).

More than half of the Appalachian Plateaus Province within the basin was glaciated during the Pleistocene, and many of the valleys are partially filled with stratified drift and alluvium. The valley-fill aquifers are composed of interlayered and interlensing sand, gravel, and clay, and vary in thickness and composition throughout the province. The valley-fill aquifers are locally important, high-yielding, porous media aquifers (Taylor, 1984). Recharge to these aquifers tends to be higher than the fractured rock aquifers, and much of this recharge is provided by infiltration of runoff from adjacent bedrock uplands. The valley-fill aquifers are commonly in close communication (hydraulically connected) with the streams flowing across them. Therefore, wells in the valley-fill aquifers commonly induce infiltration of substantial quantities of surface water; the aquifer essentially serving as a natural gravel filter (Reynolds, 1987).

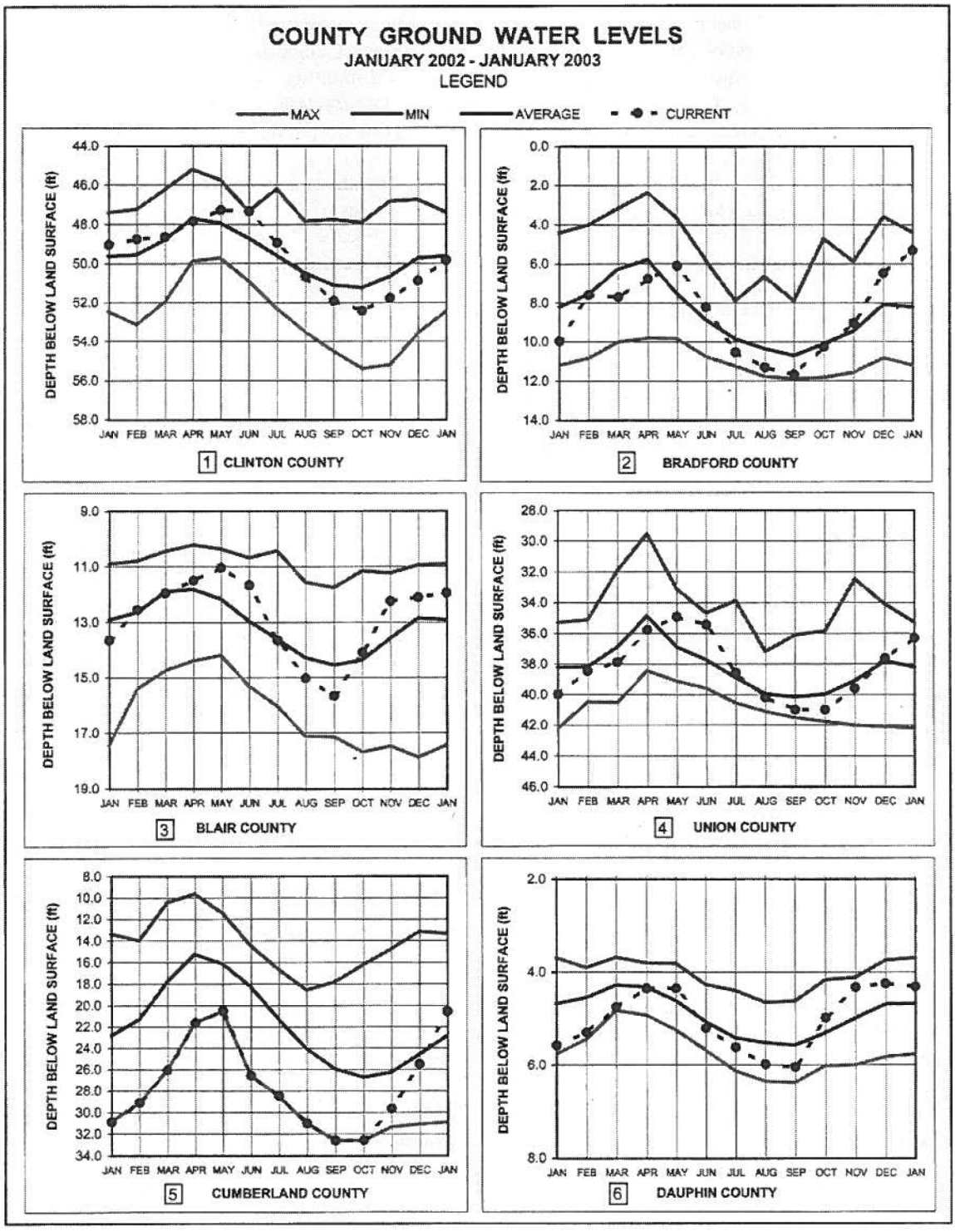

Figure A.3. ***County Groundwater Levels, January 2002 through January 2003***

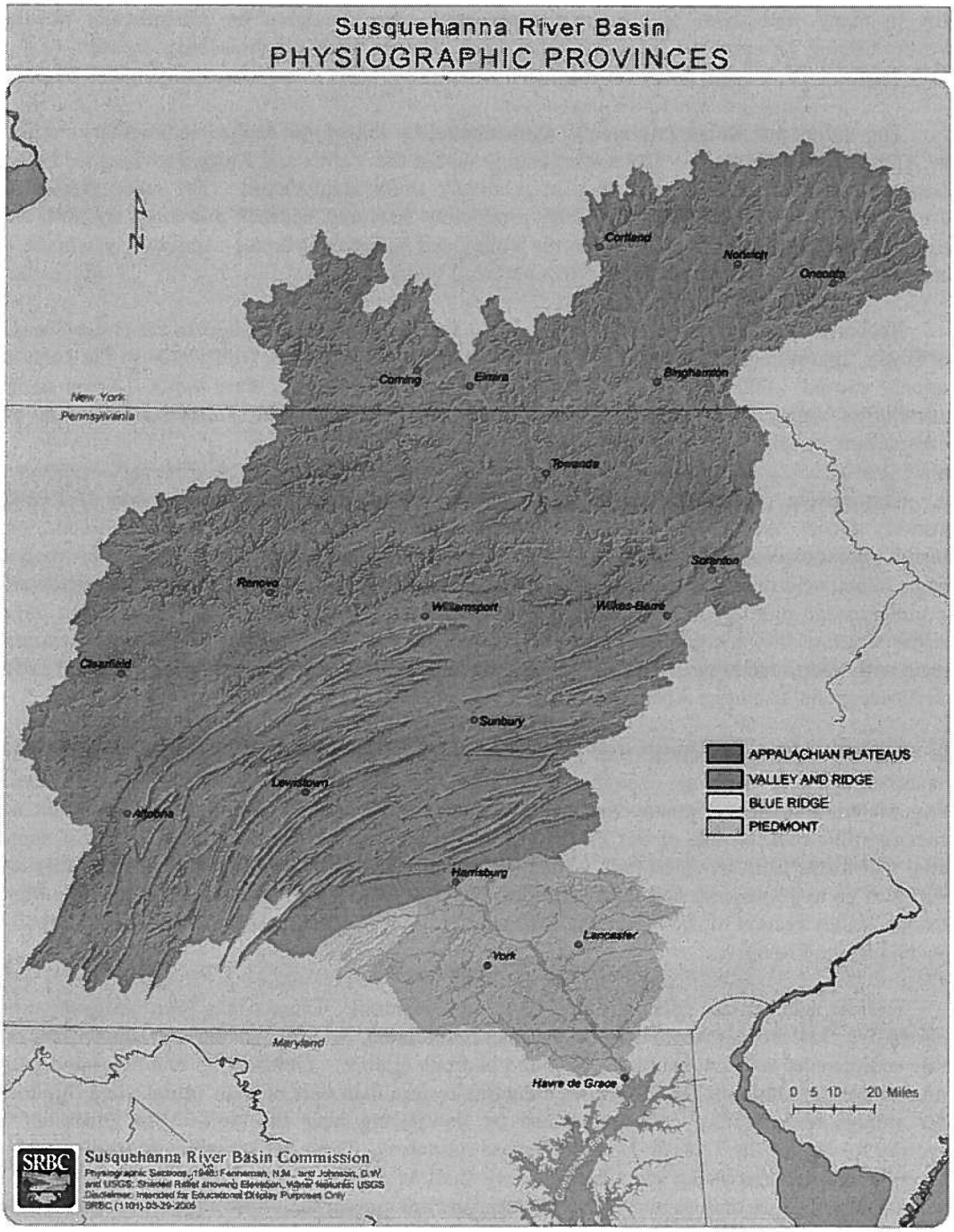

Figure A.4. Physiographic Provinces in the Susquehanna River Basin

In the western portion of the Appalachian Plateaus Province, bituminous coal reserves have been mined extensively in the past, and continue to be mined today. Mining has compromised the water quality in many watersheds and limits the potential areas available for groundwater development. However, mining has created many artificial high storage, high transmissivity aquifers (e.g., "mine pools"), resulting in an opportunity for increased water use if problems of water quality can be solved.

The Valley and Ridge Province is characterized by folded and faulted sedimentary rocks, typical of the Appalachian Mountains. The hydrogeology within the Valley and Ridge Province is characterized by fractured bedrock and karst aquifers of relatively small areal extent. The more erosion-resistant sandstones form the ridges, while the more productive fractured bedrock and karst aquifers lie in the valleys. The folding that is typical within the Valley and Ridge contributes a regular, systematic fracture permeability that enhances groundwater flow and well yields.

Recharge rates associated with the karst aquifers are among the highest in the entire Susquehanna River Basin, approximately 700,000 to 1,000,000 gpd/mi^2. In addition, well yields in the karst aquifers commonly exceed 1,000 gallons per minute (gpm) for professionally sited wells. Areas such as the Kishacoquillas Valley, Nittany Valley (State College area), and the Great Valley section of the province have important, aerially extensive karst aquifers.

The eastern portion of the province had significant anthracite coal reserves that have been extensively mined. At present, many of the mined areas are either abandoned or reclaimed. As in the western bituminous coal fields, the mined-out voids have filled with water and formed vast reservoirs of available, albeit acid mine drainage (AMD)-impacted, water. The water quality limits the potential use of these underground mine pools. Some large commercial and industrial users pump from the mine pools when the water quality meets their requirements, and the cost and quantity of the water resources can compete with traditional high quality water sources. Left unchecked, "orphan" mine pools fill to the point of overflowing and discharge AMD to streams.

The Piedmont Province, the southernmost province in the Susquehanna River Basin, is characterized by very complex geology. The rocks have experienced multiple periods of folding and faulting, metamorphism and igneous intrusion. With respect to groundwater, the most important aspect of the metamorphic-rock terrain of the Piedmont Province is the presence of thick layers of saprolite, a material that forms from isovolumetric weathering of the underlying parent bedrock. Saprolite can have porosities of up to 40 percent, and thicknesses of over 100 feet. There also are some karst aquifers in the Conestoga Valley section of the Piedmont that exhibit high well yields, similar to their counterparts in the Valley and Ridge Province.

Triassic sedimentary rocks are unique to the Piedmont. These rocks occur in gently-tilted and faulted basins that are surrounded by older, more indurated, strongly-folded and faulted rocks. The Triassic sedimentary rocks constitute a fractured bedrock aquifer. Yields of up to a few hundred gallons per minute are possible, but the yields often decline to less than half of their initial yield due to limited aquifer storage and fracture collapse caused by dewatering near the well. The Piedmont also is noteworthy for having the Triassic-Jurassic diabase intrusives. These are massive, crystalline rock bodies with weathering and fracturing extending to only shallow depths. The diabase intrusives have a very limited capacity to store and transmit groundwater, and are among the worst aquifers in the Susquehanna River Basin.

Land Use

Land cover data for the entire Susquehanna River Basin were collected in the early 1990s (Figure A.5, Figure A.6), so trends in land use were not analyzed. The information was derived from USEPA Multi-Resolution Land Cover (MRLC) 1993 Landsat Thematic Mapper data, developed by the USGS Early Resources Observation Systems Data Center. United States Census Bureau data collected on populations, surveyed in 1990 and 2000, were used to assist with the general trends in population in the basin.

The Appalachian Plateaus Province consists of uplands that are separated by steep valleys. Much of the land is steeply sloped with hills and ridges dominated by forested land. Agricultural activity is split almost evenly between cropland and pasture grazing. Agricultural cropland occupies the valley areas possessing the more productive alluvial soil types. Pasture grazing is primarily on moderately to gently sloped uplands.

Small villages exist throughout the province. The major population centers in the province are Binghamton and Elmira/Corning, New York, and Towanda and Clearfield, Pennsylvania. Census data indicate that the population in the province has decreased slightly, or remained fairly constant from 1990 through 2000.

As mentioned in the "Physiography" section above, extensive bituminous coals fields within the province were mined in the past, and continue to be mined today on a more limited scale. The effects of mining on the subsurface hydrology are significant, particularly with respect to water quality.

The Valley and Ridge Province contains some of the most forested areas in the basin. These are primarily located on the long, even-crested, mountain ridges. Compared to the Appalachian Plateaus Province, the Valley and Ridge is significantly more developed, with concentrations of urban/residential development in the Scranton/Wilkes-Barre, State College, Sunbury, Altoona, and Harrisburg areas. Development has increased rapidly in the area with the addition of housing at the expense of traditionally agricultural areas. The Scranton/Wilkes-Barre corridor represents a very intensely urbanized area, extending over 20 miles in the Wyoming Valley.

Overall, census data indicate the population has increased by more than five percent within the province over the last decade. Most of this increase is focused in the Nittany Valley, surrounding the State College area. The State College area has been experiencing fairly rapid growth over the last 10 to 15 years. The province is facing increasing development pressure with the addition and improvement of several travel corridors. Interstate 99 is currently being built to connect Interstate Routes 76/70 and 80, which run parallel to each other in an east-west direction across Pennsylvania.

State Route 322, which travels northwest into the province from Harrisburg, was recently expanded to accommodate four lanes of traffic. With this expansion, the increased accessibility to the Harrisburg metropolitan area has spurred development in the counties north of this capitol city. The predominant trend in land use within the province is the conversion of the rich cropland developed on the carbonate bedrock aquifers to residential and commercial development.

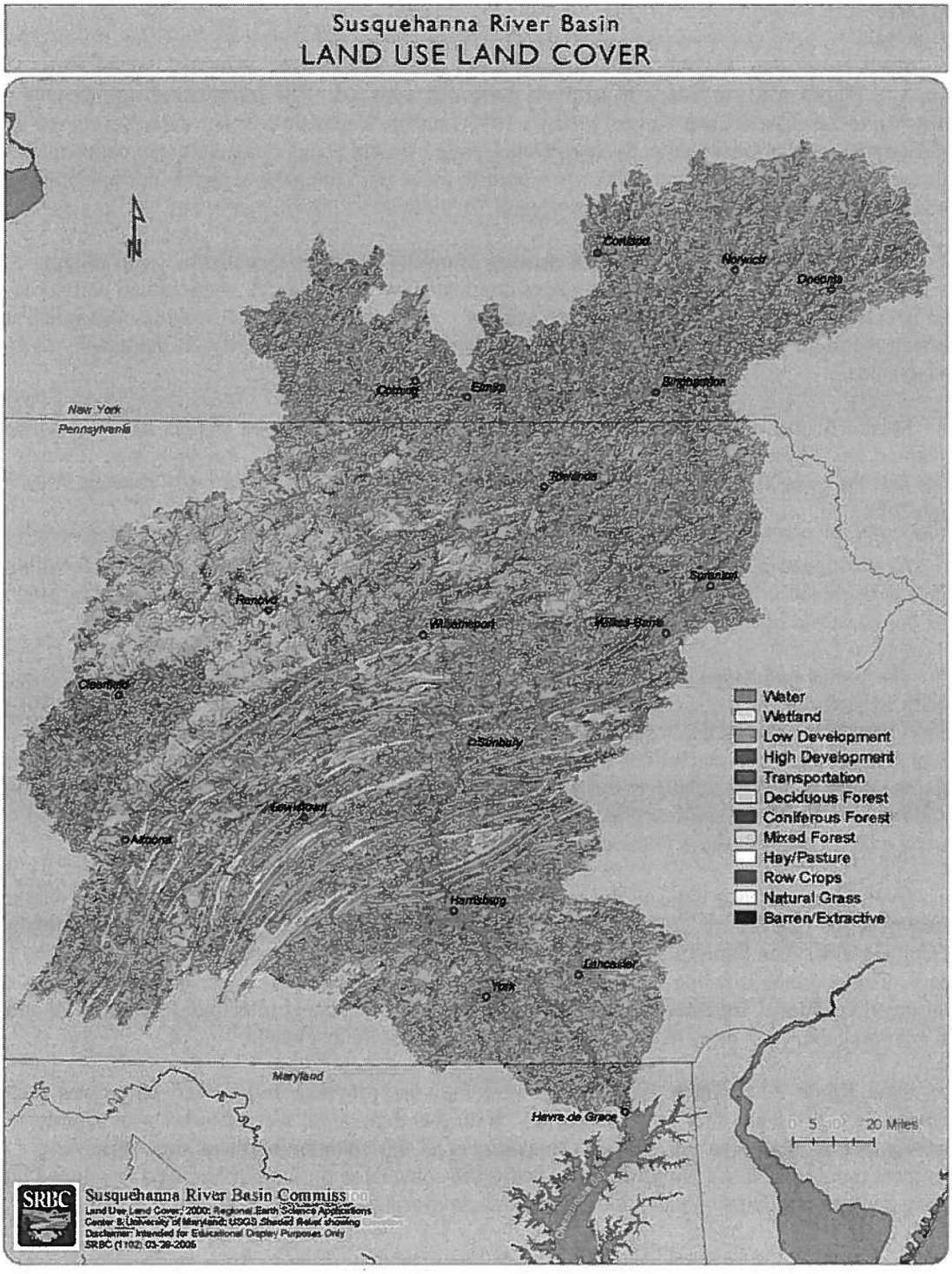

Figure A.5. Land Use for the Susquehanna River Basin

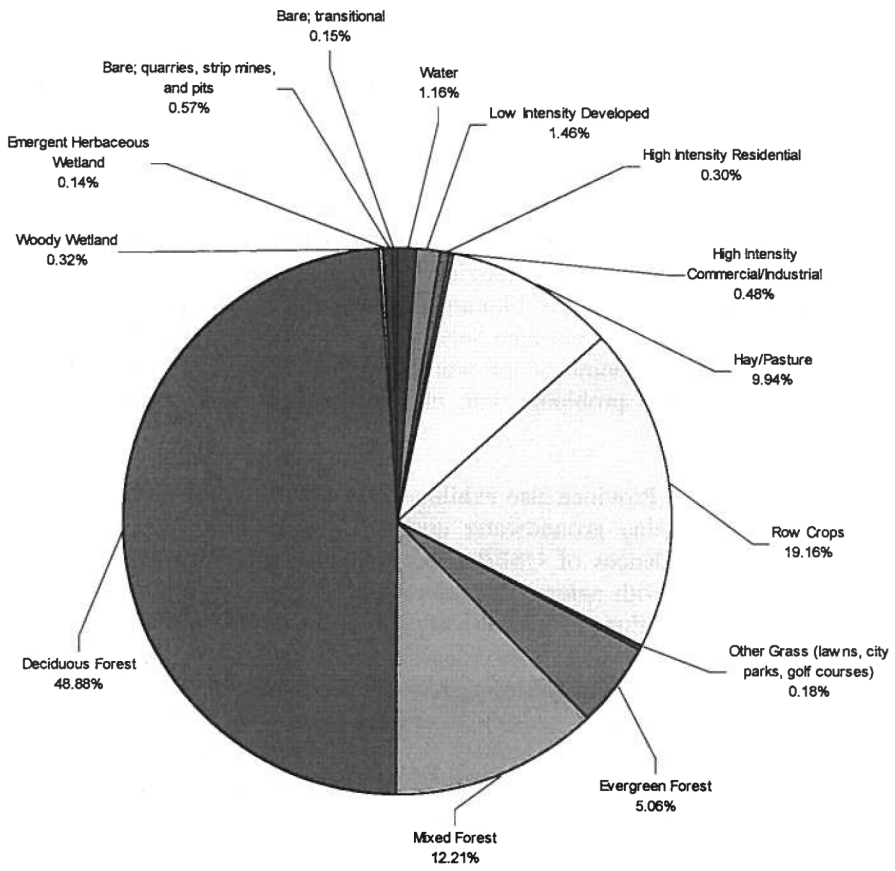

Figure A.6. Land Use for the Susquehanna River Basin

The Piedmont Province contrasts greatly in comparison to the other provinces in the basin with respect to land use, due, in part, to the unique terrains that constitute the province. Fifty percent of the province is dedicated to agricultural activities. Most of the agricultural land use is in the Triassic Lowlands and in the Conestoga Valley Sections. The Conestoga Valley Section possesses some of the most productive soils in the state of Pennsylvania. A significant amount of effort is being placed on preserving current agricultural activities.

Urban and suburban development accounts for greater than five percent of total land use, although more recent data suggest this estimate should be higher. Census data indicate that population growth in the metropolitan areas within the subbasin has increased over 10 percent since 1990. Additionally, there is a significant amount of growth occurring in Pennsylvania, along the southern portions of Adams and York Counties, as a result of commuter expansion from the Baltimore-Washington metropolitan area.

Groundwater Quality

Groundwater quality in the Susquehanna River Basin is typically good and, for the most part, influenced by geology and land use. However, influences from land use present some common problems experienced throughout the basin. State 305(b) water quality reports indicate significant impacts to water

quality from abandoned mine lands, agriculture, and developed areas. Contaminants from these land uses can range from metals and low pH conditions, to excessive nutrient, pathogen, and organic contaminant levels. Outside of these land use types, problems can also arise from transportation corridors and rural septic systems. Although any given area of the basin can exhibit water quality problems, each of the physiographic provinces, or regions of the basin, generally have some dominant contaminant sources that affect quality.

The Appalachian Plateaus Province exhibits fairly good groundwater quality. However, iron and manganese are two constituents that typically exceed limits recommended by the USEPA. These two metals occur naturally in the sedimentary rocks (sandstone, siltstone, and shale) in the province, although concentrations in some portions of the province have been exacerbated by abandoned coal mine workings. Within the areas affected by bituminous coal mining, the groundwater resource is largely unavailable for most uses, due to the extreme degradation of water quality. Some of the discharges from abandoned mine lands represent some of the worst water quality conditions in the basin. To a lesser extent, there also are localized problems with elevated nitrate from septic systems and agricultural activities.

The Valley and Ridge Province also exhibits good water quality, although the effects of land use play a larger role in influencing groundwater quality. Again, iron and manganese are the leading constituents that cause exceedences of USEPA-recommended limits. Although some of the elevated concentrations are associated with natural conditions, abandoned coal mine workings are the dominant source in the province. The anthracite region possesses some of the highest concentrations of iron and manganese sampled from groundwater. Unfortunately, these conditions exist in close proximity to the more densely-populated regions of the basin, namely the Scranton and Wilkes-Barre areas. Agricultural and residential/urban activities also play a significant role with influencing groundwater quality, particularly in the karst aquifers. USGS studies in the early 1990s (Lindsey and others, 1998) indicate wells sampled for pesticides in agricultural areas exhibit some of the highest detection frequencies in the United States. Nitrate concentrations in these same areas commonly exceed USEPA drinking water limits. In addition, the karst areas within the Great Valley Section overlain by urban/residential land uses showed some of the highest frequency of detections of volatile organics contaminants (VOCs) and other organic contaminants in the United States (Lindsey and others, 1998).

Overall, the Piedmont Province exhibits good groundwater quality. However, the higher yield karst aquifers in the province exhibit problems associated with agricultural and urban/residential areas. Nitrate-nitrogen concentrations within these areas of York and Lancaster Counties are commonly in excess of USEPA's drinking water standards of 10 milligrams per liter (mg/l). And similar to the urban settings in the Valley and Ridge karst areas, organics and other man-made contaminants are increasingly detected in groundwater samples (Lindsey and others, 1998).

Groundwater Use

The use of groundwater resources within the basin is extensive. In particular, groundwater plays a critical role in supplying the population's drinking water and maintaining the economic viability of communities. Outside of the major population centers, drinking water supplies are heavily dependent on groundwater supply wells. General household use from private wells is also a significant portion of the basin's overall use. In addition, business and industry dependent on the basin's groundwater resources employ thousands of people and contribute billions of dollars to local/regional economies through payrolls, product distribution, and product sales. Examples of some of these industries include food production, such as fruit juices and snack foods. Another large business sector includes material (metal, paper, plastics, etc.) and chemical production. Agriculture and mining also withdraw groundwater for irrigation/livestock needs and dewatering operations, respectively.

The Commission recognizes the importance of managing the resource to encourage continued economic growth and sustainability, while at the same time maintaining ecosystem. In order to balance the demands on groundwater resources in the basin most efficiently, it is important to have an accurate inventory of groundwater uses and their associated quantities.

Groundwater use data are collected throughout the basin by a number of different agencies, using a number of different methods and criteria. Currently, there are no datasets that provide an accurate, comprehensive and consistent assessment of groundwater use basinwide. The Commission only compiles a subset of overall groundwater use in the basin, with regulations covering users greater than 100,000 gpd for a 30-day consecutive period, and 20,000 gpd consumptively. Prior to establishment of the Compact, overall groundwater use within the basin was estimated to be approximately 290 million gallons per day (mgd). The following section describes some of the readily available historical information on groundwater use, and this document outlines several needs for the improvement of data collection efforts.

The USGS compiles one of the more comprehensive datasets on water use, although the method of collection/compilation can vary from state to state. The assessment also relies on data provided by other state/federal agencies, which are incomplete in many cases. The USGS compiles readily available water use data for each state by 8-digit hydrologic unit codes (HUC).

For the purposes of this plan, groundwater use was reviewed for the years available; 1985, 1990, and 1995. The 2000 data became available in November 2004, while this document was being drafted. However, the methodology differed so greatly from the previous years that the data were not comparable to the earlier datasets. In addition, the information was incomplete. The lack of reliable basinwide groundwater use data emphasizes the need for better information, as outlined in recommendations cited later in this document.

Using the best available data, the major categories of use include public supply, commercial, domestic, industrial, thermoelectric power, mining, livestock, and irrigation. In general terms, this section will describe these uses. Table 2.1 shows groundwater use by 8-digit HUC. Figure A.7 exhibits the same data shown in Table A.1.

Approximately 20 percent of the basin population is served by public water suppliers that use groundwater as a source. In comparison to a surface water source, groundwater quality is generally better, more consistent, and requires fewer resources for treatment.

As shown in Table A.1, according to the USGS data, public supply is the dominant use of groundwater for the basin, at approximately 115.30 mgd. However, mining and industrial use exceeds public supply in the lower basin. The highest producing public supplies generally correspond to the valley-fill aquifers in the glaciated terrain (Chenango, Owego, Chemung), and the karst aquifers in the Valley and Ridge Province (Bald Eagle, Lower Susquehanna). With population increases in various portions of the basin, there has been an increasing need for public water supply wells.

Use of groundwater by public water suppliers is monitored by a number of agencies, because the member jurisdictions, as well as the Commission, regulate the withdrawal. Public water supply use comprises the majority of the number of the Commission's approvals since 1995.

According to the USGS data, mining comprises the second largest groundwater use within the basin. The dominant mining processes that involve groundwater withdrawal in the Lower Susquehanna are coal mining and quarry operations, while the dominant mining process in the Upper Susquehanna and Chemung Subbasins is open-pit mining for sand and gravel.

Table A.1. Groundwater Use Data for the Susquehanna River Basin

HUC	Public Supply	Commercial	Domestic	Industrial	Thermo-electric Power Use	Mining	Livestock	Irrigation	Total
Upper Susquehanna	6.09	0.60	4.53	1.69	0.00	0.81	1.37	0.07	**15.16**
Chenango	11.65	0.84	3.54	2.78	0.00	0.25	1.48	0.09	**20.63**
Owego-Wappasening	15.44	0.98	2.88	2.50	0.00	0.15	0.76	0.16	**22.87**
Tioga	3.99	0.29	2.59	0.84	0.00	0.24	0.92	0.31	**9.18**
Chemung	11.78	0.83	4.22	2.61	0.00	0.13	0.77	0.29	**20.63**
Upper Susquehanna-Tunkhannock	3.19	0.21	5.01	5.30	0.00	0.00	1.86	0.10	**15.67**
Upper Susquehanna-Lackawanna	8.09	1.13	6.82	2.07	0.00	3.42	0.68	0.18	**22.39**
Upper West Branch Susquehanna	2.21	0.19	1.45	0.03	0.00	5.98	0.44	0.10	**10.40**
Sinnemahoning	0.10	0.00	0.43	0.01	0.00	0.24	0.13	0.03	**0.94**
Middle West Branch Susquehanna	0.01	0.00	0.04	0.15	0.00	0.07	0.19	0.15	**0.61**
Bald Eagle	12.58	2.71	1.75	0.27	0.00	5.13	0.38	0.12	**22.94**
Pine	0.29	0.00	0.64	0.03	0.00	0.50	0.49	0.14	**2.09**
Lower West Branch Susquehanna	2.54	0.41	4.32	1.40	0.27	6.15	1.33	0.35	**16.77**
Lower Susquehanna-Penns	4.75	0.31	5.01	0.43	2.45	7.56	3.29	0.36	**24.16**
Upper Juniata	3.47	0.69	2.29	5.22	0.00	1.05	1.06	0.16	**13.94**
Raystown	0.87	0.04	2.01	0.10	0.00	0.43	0.87	0.04	**4.36**
Lower Juniata	0.90	0.06	3.45	0.98	0.00	0.75	3.24	0.14	**9.52**
Lower Susquehanna-Swatara	9.61	1.55	13.15	15.23	1.24	39.20	5.25	0.72	**85.95**
Lower Susquehanna	17.74	0.96	15.75	6.58	0.00	17.54	12.32	1.70	**72.59**
TOTAL	**115.30**	**11.80**	**79.88**	**48.22**	**3.96**	**89.60**	**36.83**	**5.21**	**390.80**

(All values are expressed in million gallons per day (mgd). Data source—U. S. Geological Survey National Water-Use Data Files, 1995).

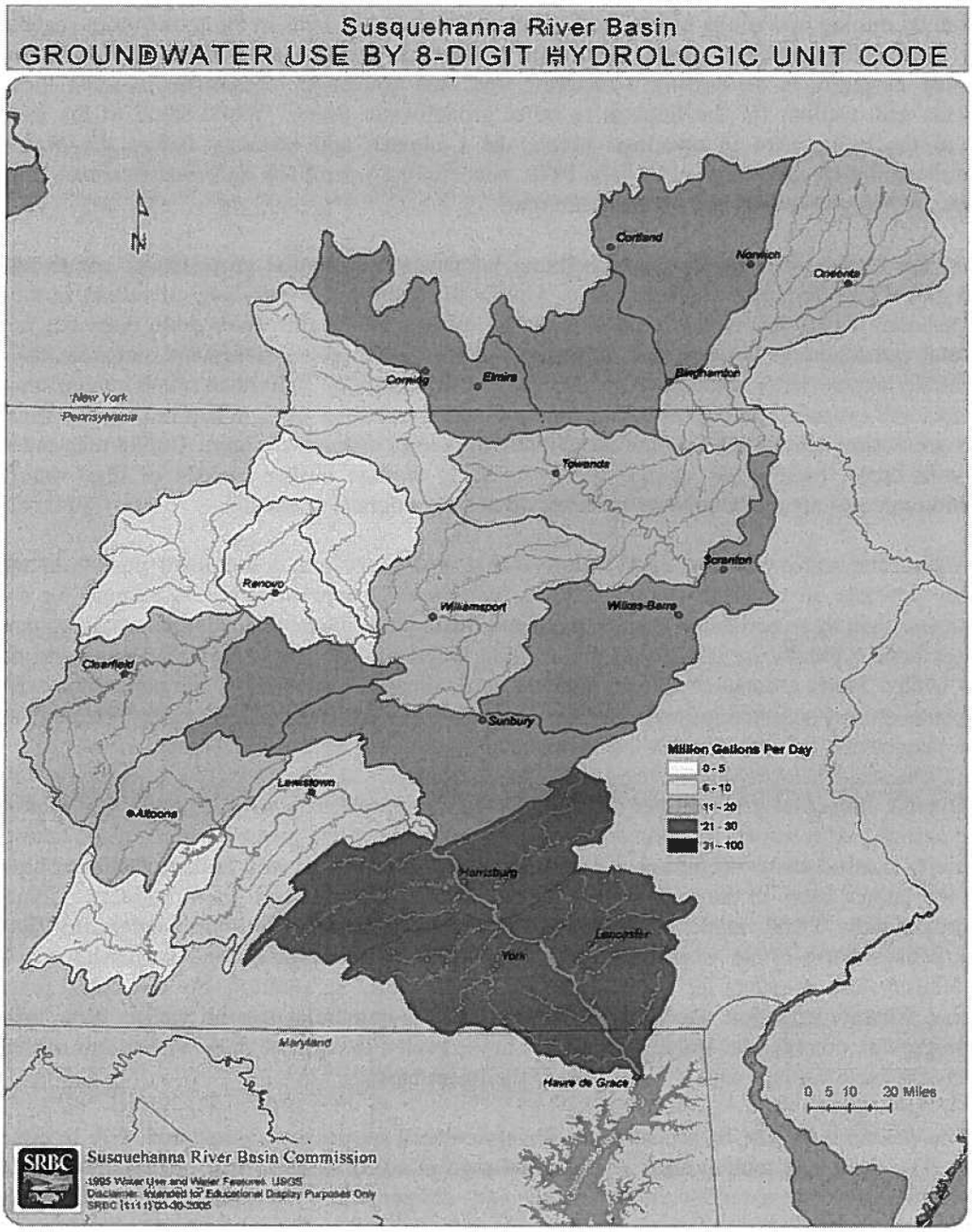

Figure A.7. Groundwater Use in the Susquehanna River Basin *(Data source—United States Geological Survey National Water-Use Data Files, 1995)*

Carbonate quarry operations, both dolomite and limestone, are particularly heavy users of groundwater in the Great Valley section and Piedmont carbonate areas. Most of the water withdrawn is drained away from the local groundwater flow system and discharged to local streams. The groundwater withdrawal by mining operations within the limestone and dolomite belts in the lower basin is substantial, and very likely comprises the largest groundwater withdrawal category in this area. In Pennsylvania, the Commission currently is developing a metering and data collection mechanism to track these large withdrawals and account for the impacts to other groundwater users. While some of the mines and quarries in the basin were in operation before the Compact, and certainly before the groundwater withdrawal regulation was adopted in July 1978, new mining operations and modifications to existing operations are being proposed and opened ever year.

In the Upper Susquehanna and Chemung Subbasins, substantial groundwater use is related to sand and gravel mining below the water table. Unlike the quarrying and mining operations in the rest of the Susquehanna River Basin, this type of open-pit mining below the water table does not withdraw groundwater and discharge it to streams. In areas where the water table is below the root zone, these open pits potentially expose large amounts of groundwater to evaporation. Individual mines can encompass up to 100 acres and evaporate in excess of 500,000 gallons of water per day. When mining has ceased, the open pits are not reclaimed and become lakes that continue to evaporate water. Unlike man-made lakes created with dams, these lakes do not fill by building storage during periods of high runoff. No conservation releases are made because the lakes do not have outlets to streams.

Within the states of New York, Pennsylvania, and Maryland, a dominant portion of the rural community depends on water from private wells, withdrawing approximately 79.88 mgd for domestic use. With less than three percent of the Susquehanna Basin intensely developed, the remaining populated areas of the basin typically are not serviced by a public water supply. Based on USGS water-use data and the 1990 United States Bureau of Census figures, approximately one-third of the population within the basin depends on self-supplied groundwater for domestic use. With increases in sprawl in many areas of the basin, the demand for groundwater from adequately producing wells will increase.

Overall, industrial groundwater use in the basin is approximately 48.22 mgd. Concentration of industrial activity, with respect to groundwater use, is primarily in the lower portions of the basin. Most of the activity is associated with industrial processes and wash water, as well as manufacturing producers. Some of the largest users in the region are food processing, concrete, and glass products. Commercial use, approximately 11.80 mgd, is largely concentrated around the urban centers in the basin (Scranton/Wilkes-Barre, State College, greater Harrisburg metropolitan area). Increasing use by the bottling industry also accounts for a notable portion of this use. In addition, the increasing practice of golf course fairway irrigation accounts for a portion of commercial use as well. With increasing population growth, commercial and industrial uses are expected to increase in some portions of the basin, particularly the State College area and portions of the lower basin.

The predominant use of groundwater for agricultural purposes is associated with livestock and irrigation. The combined total average use is 42.04 mgd in a year with normal precipitation. Livestock activities within the basin comprise the bulk of the use—88 percent—in a normal year, and are primarily associated with the production of meat, poultry, and dairy products. Crop irrigation, although usually a much smaller component of groundwater use at about 5.21 mgd, can be much more substantial in years with significant rainfall deficits. Land use trends over the past few years indicate significant amounts of land converting from agriculture to urban, residential, commercial, or golf course use. As this occurs, reliance on groundwater for livestock and irrigation will decrease in areas not shifting to concentrated feeding operations, and demand most likely will shift to another use category.

As seen in Table A.1, groundwater used for thermoelectric power is fairly insignificant within the basin. Use of groundwater includes wash water and water for drinking and sanitary purposes. The bulk of the water use related to power production is for cooling purposes, and that is typically supplied through surface water sources. Thus, future groundwater demands in this category are expected to be negligible.

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APPENDIX B

Management and Regulatory Programs

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MANAGEMENT AND REGULATORY PROGRAMS

Appendix B describes the management and regulatory programs of the federal government, the Commission, and state and local governments that provide a framework for the management of those groundwater resources. The important role of watershed organizations also is discussed. There are long-standing and diverse authorities that require the states, local jurisdictions, and federal government to manage, regulate, and protect various elements of groundwater resources. The key federal and state agencies with groundwater responsibilities are listed below, and contact information for each agency is available at the end of this appendix.

Federal Government	--	United States Geological Survey
	--	United States Environmental Protection Agency
	--	United States Army Corps of Engineers
	--	United States Fish and Wildlife Service
	--	Natural Resources Conservation Service
New York	--	Department of Environmental Conservation
	--	Department of Health
Pennsylvania	--	Department of Environmental Protection
	--	Department of Conservation and Natural Resources
Maryland	--	Department of the Environment
	--	Department of Natural Resources

In addition, local jurisdictions and watershed organizations play important roles in groundwater issues.

The purpose of the following section is to describe the existing management framework and the integration of regulatory and management activities for groundwater resources among the Commission, its member jurisdictions, the federal government, and local interests.

Federal Government

United States Geological Survey (USGS). The USGS has an important, and somewhat unique, role in groundwater, given its expertise in groundwater science and the depth and breadth of groundwater data. The USGS collects data and maintains databases on streamflow from its stream gaging network, groundwater levels from its monitoring well network, and ambient water quality. The USGS provides the science that sets the standards in monitoring, management, and data gathering and presentation.

The USGS manages a network of observation wells in the basin, in conjunction with New York, Pennsylvania, and Maryland. Data generated from these wells, like the stream gaging data, are available on-line (although not on a real-time basis for all wells) and are published annually in its series of Water Resource Data Reports. Pennsylvania is currently working with the USGS to revise its groundwater monitoring program to collect better data across the state, which will eventually translate into more groundwater data for the Susquehanna Basin. The USGS cooperates with the states in performing areal groundwater resource investigations and mapping bedrock throughout the basin. Local governments also have cooperated with the USGS in groundwater projects.

The network of stream gages in the basin managed by USGS are critical to surface water data collection and analyses. The knowledge of groundwater and surface water interaction requires good data.

The need for an effective network of existing stream gages, plus new ones where needed, cannot be overstated.

United States Environmental Protection Agency (USEPA). The USEPA is empowered by a variety of federal laws to regulate activities that have the potential to pollute either surface water or groundwater. Additionally, the USEPA oversees the remediation of pollution sites when no responsible party can be identified. In many instances, the states within the basin have accepted primacy over the federal programs and, thus, provide the actual implementation of remediation programs.

The principle federal regulatory program relating to groundwater is the Safe Drinking Water Act (SDWA) of 1974 (authorized by P.L. 93-523 and P.L. 99-339). The SDWA authorizes USEPA to set maximum contaminant levels and monitoring requirements for public water supply systems. All of the member jurisdictions of the Commission have assumed primacy for this program. The act provides for "sole source" drinking water aquifers, source funding for state programs of public water supply regulation, and the authorization for states to develop wellhead protection programs.

SDWA also instructed USEPA to set up a program to prevent contamination of underground sources of drinking water by underground injection of contaminants, called the Underground Injection Control (UIC) Program. The USEPA directly implements the UIC program in New York, Pennsylvania, and Maryland.

The USEPA leads the federal government's participation in the Chesapeake Bay Program, a federal-state-local partnership that directs and conducts the restoration of the Chesapeake Bay. Groundwater resources are one aspect of this large restoration effort.

USEPA, under its Section 106 Program and others, funds groundwater initiatives of the Commission and its member jurisdictions through grants.

United States Fish and Wildlife Service (USFWS). The USFWS is involved in the protection of the groundwater resources of the basin through its protection of federally listed, proposed, and candidate species under the jurisdiction of the Endangered Species Act of 1973. Wetlands associated with groundwater discharges provide very unique habitats that serve as breeding, supporting, and forage grounds for federally protected species, such as the bog turtle (*Clemmys muhlenbergii*), Bald Eagle (*Haliaeetus leucocephalus*), and Northern bulrush (*Scirpus ancistrochaetus*). When proposed development and withdrawals by projects have the potential to impact groundwater resources, the USFWS cooperates in performing investigations for threatened and endangered species under its protection. The USFWS provides recommendations for mitigation and protection that are critical for resource protection, particularly if groundwater may be intercepted or the flow system altered in and adjacent to sensitive aquatic habitats.

United States Army Corps of Engineers (USACE). Although not its primary mission, the USACE participates in various studies related to groundwater resources. Under authorities such as Section 22 of the Water Resources Development Act of 1974, the USACE can provide technical and planning assistance for water resources. A current example of this technical groundwater assessment to the Commonwealth of Pennsylvania is found in the Swatara Creek Water Supply Study.

Susquehanna River Basin Commission

The primary responsibility for managing the waters of the Susquehanna River Basin falls on the three states in the Commission—New York, Pennsylvania, and Maryland. The Compact recognizes the powers and duties of the states. Each Compact state has varying levels of water management authority

and regulations. The Commission addresses some of the groundwater management and regulatory gaps that exist among the states' programs.

A critical part of the Commission's mission, as reflected in the 1971 Compact, is the achievement of a balance among environmental, human, and economic needs in the management of the basin's water resources. This is done by careful consideration of a wide range of factors, including the fundamental need for and benefits of economic growth, water resource sustainability, protection of existing users, adverse environmental impacts, actions to minimize or mitigate impacts, protection of high quality water from degradation, effective interagency coordination, and public understanding of groundwater issues.

The Commission carries out its coordination role by:

1. Utilizing the powers vested in the commissioners through the Compact and the respective state water management agencies; and

2. Applying the standards in the Commission's *Comprehensive Plan for the Management and Development of the Water Resources of the Basin* (1987).

To ensure that the requirements under the Compact and the Commission's Comprehensive Plan are being met basinwide, the Commission is authorized by the Compact to assume responsibility in any matter affecting water resources when a Compact state is unable to do so. The Commission can assume that responsibility until the state has the proper regulatory authority or is willing to carry out the water management requirements. The preparation of this Groundwater Management Plan is a good example of the Commission's management and coordination role.

Project Review Program. Section 1.1 of this plan discusses the regulatory basis for the Commission's Project Review Program. The main purposes of the Commission's regulations are to:

- Manage water as a sustainable/renewable resource;
- Avoid conflicts among water users;
- Protect public health, safety, and welfare;
- Foster economic development; and
- Protect fisheries, aquatic habitat, and the environment.

Prior to the previously mentioned dates for each regulation, the Commission recognizes documented water use as being "grandfathered." However, any withdrawal increases above the "grandfathered" quantity in excess of 100,000 gpd, or 20,000 gpd consumptively, are regulated.

As part of the application approval process, the Commission may limit the amount (quantity and rate) of water withdrawn by the project sponsor to the amount required to meet reasonably foreseeable needs. An application may be denied, or special conditions added to an approval—referred to as a "docket"—if the Commission determines that the new withdrawal would not be sustainable, significantly affect or interfere with an existing water user, or impact important environmental resources. Special conditions can include water level monitoring, allowing for passby flows, or requiring the project sponsor to provide a replacement water supply—at the project sponsor's expense. When a docket is approved, the user is required, by the regulation, to meter, monitor, and periodically report the operation's water usage. Compliance with these conditions, and any other conditions of approval, are subject to enforcement actions by the Commission.

The Commission staff conducts an independent review of project applications, and the Commission coordinates its actions on projects involving public water supplies with the regulatory

agencies of the member jurisdictions, including NYSDEC, PADEP, and MDE. Coordination with these agencies ensures that all issues and concerns are resolved prior to Commission action. When a state's regulatory agency or any political subdivision of the agency (i.e., local government) having jurisdiction over the project denies or otherwise disapproves an aspect of the project, the Commission will suspend its review for up to three years (pending final resolution) or terminate its review.

In recognition of the economic burden that compensation for consumptive water use imposed on individual farmers, the Commission's consumptive use regulation has been suspended from application to the agricultural industry since 1992. This suspension is intended to remain in effect until a long-term solution to the consumptive water needs of agriculture in the basin can be implemented. See the discussion of special studies in this section of the plan for information on a Commission effort to evaluate alternative solutions for Pennsylvania.

Groundwater Quality Coordination. Article 5, Section 5.2(b), of the Compact emphasizes the primary role of the member jurisdictions in water quality management and control. The Commission can impose its own standards only if the member jurisdictions fail to achieve the basic requirements of the Commission's Comprehensive Plan. However, the Commission ordinarily acts in an advisory capacity in matters related to groundwater quality, and performs some grant-funded work related to groundwater quality. To enhance coordination efforts, the Commission holds regular meetings twice a year with member jurisdictions through its Water Quality Advisory Committee.

With respect to its regulatory function, the Commission conducts an environmental screening as part of its Project Review Program. Through this effort, the Commission coordinates extensively with appropriate agencies concerning water quality issues. In addition, the Watershed Assessment and Protection Division is involved in a number of basinwide efforts to address pollution associated with AMD, agricultural, and urban-related sources.

Watershed Studies, Special Studies, and Water Budget Analyses. In practice, the Commission's Comprehensive Plan and regulations form the basis for the groundwater management activities of the Commission. On an occasional basis, as resources (financial and staff) become available, the Commission has developed and participated in various studies related to groundwater resources. These include local and regional resource appraisals and water resource management plans.

The resource evaluations commonly include water budgets, an accounting of the water resources of an area (a watershed or part of a watershed). A water budget is used to evaluate the quantity of groundwater resources available for development, and for planning for future needs.

In the early 1980s, the Commission completed or assisted in the completion of resource appraisals, including water budgets for various areas, as part of its special groundwater study. The Commission provided technical assistance to the Spring Creek Watershed Study (Taylor, 1997), through its work on the water budget. The Commission also has studied the Hazleton area (the Jeddo Mine Drainage Tunnel) (Hollowell, 1999). Current examples of watershed studies include the Swatara Creek Watershed Water Supply Study (United States Army Corps of Engineers, 2003) and the northern Lancaster County Water Budget Study.

Currently, Commission staff is conducting a special study of alternative management options for both surface water and groundwater to address agricultural consumptive use in the Susquehanna River Basin in Pennsylvania. The study is being funded by the Commonwealth of Pennsylvania, and its objective is to develop reasonable and sustainable solutions to compensate, to the fullest extent practicable, for the impacts of agricultural consumptive use during drought periods. The Commission

will consider the results of the special study and decide if they need to be incorporated into ongoing Commission programs.

While there are other opportunities and needs for groundwater studies, the Commission's ability to take on additional studies is limited by available staff resources.

Protected Areas. Section 11.2 of the Compact describes the determination and delineation of areas in the basin where the demands upon supply made by users have developed or have threatened to develop to such a degree as to create a water shortage. In these so called "protected areas," the Commission may regulate diversions or withdrawals of water for domestic, municipal, agricultural, or industrial uses. To date, the Commission has not exercised its authority in these matters.

Groundwater Management Plan. The Commission has been involved in the evaluation and management of groundwater since it was established in 1971. Initially, groundwater activities were guided by the general references about groundwater in the Commission's Comprehensive Plan. Then, in 1993, the Commission prepared its first Groundwater Management Plan to supplement the Comprehensive Plan by providing detailed recommendations for the management of the basin's groundwater resources.

New York State

New York State Department of Environmental Conservation (NYSDEC). Within NYSDEC, the Division of Water (DOW) has primary responsibility for management and regulation of groundwater resources in New York State.

DOW issues permits for all takings for public water supply, from groundwater or surface water sources. As part of this process, the project sponsor must provide data that the supply is adequate and necessary, and that the taking is equitable to nearby municipalities in regard to their present and future water resource needs.

In 1999, New York amended the Environmental Conservation Law (1972) to include Section 15-1525 entitled, "Water well drillers in New York state to obtain certificates of registration." Water well driller registration (certification) is required statewide. Detailed water well completion information is submitted for use in groundwater resource evaluation and development of a database. Other requirements of the law are to be more fully addressed in regulations prepared by NYSDOH.

The DOW has several ongoing programs relating to the management and protection of groundwater. The DOW, in partnership with the USGS, conducts statewide aquifer mapping to obtain information on significant water-bearing formations. The information from this activity is available in several formats, including print, CD-ROM, and on-line. The DOW also issues permits for discharges of wastewater, and stormwater, to surface water and groundwater, ensuring that the discharges are consistent with effluent limitations and water quality standards. The DOW also works closely with local governments and supports their efforts to implement nonpoint source control and groundwater resource protection programs.

Other programs affecting groundwater management and regulation include NYSDEC's Divisions of Environmental Remediation, Mineral Resources, and Solid and Hazardous Materials.

New York State Department of Health (NYSDOH). The NYSDOH is responsible for protecting public health and assuring the potability of drinking water supplies for the state's citizens. Water that has been withdrawn by public water suppliers for distribution to the consumer is regulated by the NYSDOH.

The NYSDOH reviews public water supply facility design and construction and requires periodic monitoring of the quality of water delivered to the tap. The NYSDOH provides emergency response to water supply systems experiencing critical water quality or quantity problems. Establishment of state drinking water standards and enforcement of both state and federal drinking water standards are tasks performed by the NYSDOH.

County Health Agencies. Six counties within the Susquehanna River Basin are served by county health departments: Allegany, Chemung, Broome, Tioga, Tompkins, and Cortland Counties. These agencies help administer, through delegation, major elements of state level NYSDEC and NYSDOH programs for water pollution control and water supply regulation.

Commonwealth of Pennsylvania

Pennsylvania Department of Environmental Protection (PADEP). The PADEP was created to promote compliance with environmental regulations using a partnership approach. PADEP conducts many groundwater management activities, most of which relate to groundwater pollution and quality. Almost all PADEP permits are issued through the agency's six regional offices or six district mining offices. Program support is provided by the central office bureaus, as described below.

Public groundwater supplies are regulated and monitored by field staff assigned to the Water Supply Management (WSM) Program, under the guidance of the central office Bureau of Water Supply and Wastewater Management. Although primarily concerned with the potability of the water, PADEP regulations also deal with source quantity requirements and effects of a water withdrawal on other resources protected by laws administered by the PADEP[1]. WSM field staff specify maximum pumping rates for public water supply wells in permits that are issued, because maximum pumping rate is a basic parameter for design of water treatment facilities. The maximum permissible pumping rate, which is primarily determined by extended duration pump testing, is also the largest rate that PADEP determines can be withdrawn without causing an undesired result, such as dewatering of an aquifer. WSM field staff also respond to complaints and checks various chemical parameters associated with domestic water supplies.

Pennsylvania's Wellhead Protection Program was submitted to USEPA in March 1998 and approved by USEPA in March 1999. It serves as the cornerstone of the Source Water Assessment and Protection Program, which is administered by the central office Bureau of Watershed Management and the regional offices. This bureau and the regions also manage and carry out an Ambient Groundwater Monitoring Network Program.

Under the guidance of the Bureau of Watershed Management, the WSM field staff also issues surface water allocation permits to public water suppliers that withdraw surface waters. The Bureau of Watershed Management also is responsible for comprehensive water resource planning for the Commonwealth (State Water Plan).

The Bureau of Water Supply and Wastewater Management regulates sewage disposal by both on-lot and community systems, spray irrigation, underground injection of wastes, surface impoundments (nonhazardous waste), and underground storage tanks. This bureau responds to miscellaneous groundwater pollution incidents, including hydrocarbon spills, and those resulting from the areal

[1] Oley Township v. PADEP and Wissahickon Spring Water, Inc. 1996 EHB 1098 (October 24, 1996).

application of agricultural fertilizers and pesticides. There are no groundwater uses or standards set by regulation in Pennsylvania.

Solid waste is regulated by the Bureau of Waste Management. All facilities for the storage, treatment, and disposal of municipal, residual, or hazardous waste are permitted, including, but not limited to, landfills, incinerators, and land application sites. Storage and treatment facilities also pose a potential threat to the groundwater, and also are permitted by this bureau.

The Bureau of Mining and Reclamation and the district mining offices permit surface mines, deep mines, coal preparation plants, coal refuse disposal sites, and insures regulatory compliance of all permitted activities. District mining offices are charged with monitoring of groundwater quality around all regulated activities, and protecting the yield of groundwater sources (wells and springs) from being severely diminished as a result of surface mining activities. Impoundments associated with surface and deep mining activities also are regulated by district mining offices. The Bureau of Mining and Reclamation licenses mine operators.

The Bureau of Oil and Gas Management and the regional offices protect groundwater through programs that regulate the casing of wells through the potable groundwater zone, well plugging, waste disposal, and injection wells (both disposal and enhanced recovery).

Pennsylvania Department of Conservation and Natural Resources (PADCNR). The Bureau of Topographic and Geologic Survey conducts groundwater studies, some in cooperation with the USGS. This bureau administers the Water Well Drillers License Act 610, which is solely a mechanism to obtain groundwater and subsurface data. This bureau maintains both analog and computerized inventories of water well records (Pennsylvania GWIS) based on drillers' completion reports. Webdriller is a voluntary mechanism to capture water-well drillers' data digitally and to improve the accuracy of well location data. There are no regulations for private water well location or construction in Pennsylvania.

State of Maryland

Maryland Department of the Environment (MDE) The Water Management Administration (WMA), through its Water Rights Division (WRD), has the responsibility for issuing "groundwater appropriation permits" for most new uses of groundwater (either from wells or springs). Permits are not required for wells drilled for domestic use, other than for heating and cooling, and the permit is voluntary for agricultural wells producing less than 10,000 gpd.

Proposed withdrawals from wells or springs are reviewed for effect on surface water, other users (well interference), and the aquifer. Withdrawals are limited to the "sustained yield" of the aquifer.

The WRD may require an "aquifer yield test" for some projects. The project sponsor has the responsibility to analyze the test data to address such issues as: (1) determining aquifer hydraulic characteristics; (2) establishing long-term well yield and projected drawdown in the pumping well; (3) making time/distance-drawdown projections in affected aquifers; and (4) evaluating the potential for saltwater intrusion or other groundwater contamination. The project sponsor must collect a sample for water quality during the final hour of pumping.

Permittees with an average water use of 10,000 gpd, or greater, must submit reports of monthly water use twice a year. The permit is in force for up to 12 years, and is reviewed every 3 years to insure that the water appropriated is being used in conformance with the permit.

The Planning and Engineering Section of the WRD analyzes the area-wide effects of collective water appropriations in view of a region's future water supply and demand. If problems are identified, the section formulates management alternatives to resolve them.

The MDE has the primary responsibility for protecting groundwater quality from contamination caused by human activities. The agency administers several programs regarding groundwater quality.

The WMA, through the Water Supply Program (WSP), is responsible for implementing the SDWA. Most of the WSP activities relate to the quality of finished potable water.

The WSP also has the responsibility for administering Maryland's Wellhead Protection Program. WSP's role includes developing the program, organizing citizen participation, and providing technical assistance to local governments and public water supply system owners. The individual public water supply system owners are responsible for delineating their wellhead protection areas.

Well construction regulations are enforced by the Groundwater Permits Program within WMA, in coordination with county health departments. The Water Quality Infrastructure Program has the responsibility for reviewing and approving of comprehensive water and sewerage plans prepared by each county.

The Waste Management Administration permits and monitors municipal waste landfills, sewage sludge application sites, sites used for the disposal of hazardous wastes, environmental restoration, and oil control.

The Water and Wetlands and Waterways, and Minerals, Gas, and Oil Programs of the WMA are responsible for developing, managing, conserving, and protecting the state's water and mineral resources. Policies are implemented through the issuance and enforcement of permits for groundwater and surface water appropriation, surface mining, gas and oil exploration and production, waterway construction, and tidal and nontidal wetlands development.

Maryland Department of Natural Resources (MDNR). The Hydrogeology and Hydrology Program of the Maryland Geological Survey is responsible for the maintenance of a statewide water-data network, and the investigation of the hydrologic and geologic characteristics of Maryland's water resources. The groundwater-data network provides information on water levels and ambient water quality in selected wells throughout the state, and measures the effects of long-term changes in pumpage, land use patterns, and precipitation.

County Health Departments. The MDE has delegated several important groundwater management activities to local health officers. These include overseeing the siting of private wells and septic systems, insuring adequate quantity and quality of well water for both new dwellings and those changing ownership, reviewing subdivision plans concerning environmental impacts, sampling monitoring wells at sanitary landfills, and sampling private wells, upon owner request, for bacterial and chemical quality.

Local Governments

Within the basin, there are several forms of local government, including counties, cities, townships, boroughs, towns, villages, and authorities. These include a total of about 1,350 municipalities. Within this complex and multilayered network of regulatory bodies lies the control of land use, land development, stormwater management, and several aspects of water resource management and use. One of the purposes of the Susquehanna River Basin Compact is to apply the principle of uniform treatment to