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Proposal for an Assessment of Water Resources in the Opequon Creek Watershed Using a Numerical Flow Model

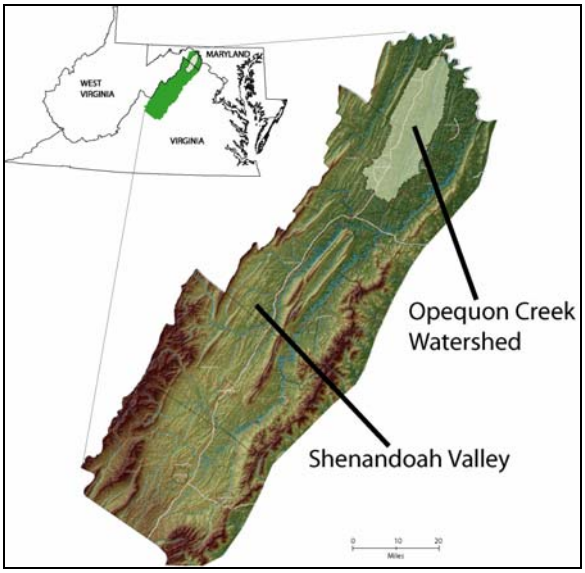
Opequon Creek

SUMMARY

This proposal describes the need for a water-resources study of the Opequon Creek basin in the Shenandoah Valley. Important water resources in the basin, including aquifers, springs, and streams, are being stressed as rapid land development and a population boom increase the demand for water supplies. Aquatic ecosystems dependent on clean and plentiful water are also being stressed by lower water levels and declining water quality, particularly during periods of drought. A better understanding of the basin's hydrologic system in the basin is needed to plan for future water supplies and to protect aquatic ecosystems.

The proposed study will collect important water-level and streamflow data and use it to build a numerical model that simulates basin hydrology. The numerical model will then be applied to answer important water resource management questions posed by water supply managers, environmental conservation groups, and other stakeholders in the basin.

Key components of the project are public participation and support. An advisory committee composed of study participants and affected stakeholders will meet during the project to select water management questions for analysis. When the study is complete, results will be documented and published for future use by interested stakeholders.



Location of Opequon Creek watershed.

BACKGROUND

Opequon Creek is located in the northern Shenandoah Valley with the watershed encompassing portions of Berkeley and Jefferson Counties in West Virginia and Clarke and Frederick Counties in Virginia. Rural areas and cities within the watershed (Winchester, Virginia, and Martinsburg, West Virginia) have had rapid population growth over the last two decades. The growth has led to a growing demand on both surface- and ground-water resources.

Like other Shenandoah Valley groundwater systems, the Opequon basin aquifer historically provided a reliable water supply for local communities and homes in the study area. But in recent years, the area has had an expanding economy and rapidly growing population, associated with the I-81 corridor. Increased urbanization of the predominantly rural basin is expected to continue as the Washington, D.C. commuter corridor expands.

Drilling a new residential well.

Ground water is the primary source of drinking water in the basin. Ground water is derived from springs and wells and is also pumped from abandoned quarries. Severe droughts that occurred from 1998 to 2003 forced public suppliers to limit withdrawal of water, especially from springs. Many shallow wells and springs dried up during the droughts, leaving many local residents and home owners without dependable water supplies. The need for dependable ground-water supplies is growing with the arrival of new subdivisions and businesses. A thorough understanding of ground-water availability, especially in relation to drought and population growth, is needed to effectively manage water resources in the watershed.

Fay Spring

Surface- and ground-water resources in the karst terrain that dominates the Opequon Creek watershed are closely linked. Ground water is a major contributor to flow in many streams and rivers and has a strong influence on river and wetland habitats for plants and animals. There is little surface runoff to streams and the majority of streamflow in the region (up to 86%) is derived from base-flow discharge of ground water. The interactions between ground water and surface water are difficult to observe and measure. Because adequate streamflow must be maintained to support aquatic habitat, the effect of ground-water withdrawal on the flow of streams and rivers is especially important.

STATEMENT OF PROBLEM

The water resources of the Opequon Creek watershed are likely to be further developed to supplement current withdrawals and to supply water to developing areas. A better understanding of how increasing ground-water withdrawals affect aquatic ecosystems in the watershed, especially during times of drought, is needed to effectively manage both surface- and ground-water withdrawals in the watershed. In order to assess current and future hydrologic conditions within the region, stream and ground-water data needs to be collected and a hydrogeologic framework needs to be developed.

Local water-resources and land-use managers are in need of relevant and detailed geologic and hydrogeologic information to make informed decisions for issues such as resource sustainability, source-water protection, and land use related to subsidence. Local entities generally do not have the fiscal or technical resources available to address issues of this magnitude or at a scale appropriate for study of the regional aquifer systems.

OBJECTIVE

The U.S. Geological Survey (USGS) proposes to develop a comprehensive ground-water flow model of the Opequon Creek watershed that will help counties and other stakeholders answer

water resource management questions. The primary objective of the flow model is to assess the current availability of ground-water within the region. Secondary objectives include assessing the impact of drought and future population growth, and developing a better understanding of the impacts of ground-water withdrawals on in-stream flows. The development of a ground-water flow model will provide insight into the nature of the basin's complex hydrology and allow drought conditions and the effects of population growth to be evaluated.

APPROACH

The investigation will use information from on-going ground-water studies of Frederick and Clarke Counties in Virginia and from previous and on-going ground-water studies in Jefferson and Berkeley Counties in West Virginia. Development of the Opequon Creek flow model will benefit from a large-scale flow model of the Shenandoah Valley and a small-scale flow model of the Leetown Science Center, both of which are currently being developed. A phased approach for the proposed effort will begin with an assessment of the data requirements necessary to develop a model capable of simulating ground-water flow in the complex karst-dominated terrain found in the basin.

A wealth of data is available from prior and on-going USGS investigations in the Shenandoah Valley. Existing information includes ground-water levels, streamflow, spring stage and discharge, and aquifer characteristic (hydrogeologic) data. This base of existing information will aid in the development and calibration of the Opequon Creek ground-water flow model.

Once the necessary data have been compiled, a steady-state (long term average) model will be constructed and calibrated. The steady-state model will provide the means for understanding the water balance of the basin and allow important variables such as average precipitation and permeability to be accurately adjusted. Based on the steady-state flow model, a transient (average monthly) model will be developed. The transient model will allow seasonal hydrologic conditions to be simulated and will be used to develop a better understanding of low streamflow caused by drought and seasonal climatic patterns. Once calibrated, the transient model will be applied to improve understanding of water-resource conditions in the basin by evaluating selected population growth and drought scenarios.

WORKPLAN

The project will be completed over a period of 3 years. In the first year, existing data will be compiled and analyzed, and a preliminary ground-water flow model will be prepared to help assess additional data needs. On-going USGS projects in the region will continue throughout the course of this investigation and will provide updated data and conceptual understanding of the ground-water flow system in the region. Additional data deemed necessary for model development and calibration will be collected during the first year of the project. The second year will be devoted primarily to model calibration and sensitivity analysis. During the latter part of the second year and the first half of the third year, the model will be used to simulate the effects of selected population-growth and drought scenarios on water supplies. Land-use change and population growth scenarios will be developed in association with local county staff through the Great Valley Water Resources Forum. A detailed report that presents the major findings of the project will be completed at the end of the third year. The project will provide benefits in guiding water resource development in the Opequon Creek watershed and also provide a model for informed water resources management that can be followed elsewhere in the Great Valley of Virginia, West Virginia, Maryland, and Pennsylvania.

PERSONNEL AND BUDGET

The project will be staffed by a ½ time GS-12 Hydrologist from the Virginia District with expertise in ground-water modeling and a ¼ time GS-12 Hydrologist from the West Virginia District with expertise in karst aquifer systems.

Total cost of the three year effort is estimated at $420,000. The cost of the project will be dispersed among various cooperating agencies. The USGS may contribute both matching and non-matching funds to the project. Additional sources of funding could include the Interstate Commission for the Potomac River Basin, Jefferson and Berkeley Counties in West Virginia, Clarke and Frederick Counties in Virginia, Region III of the US Environmental Protection Agency, and State agencies in both Virginia and West Virginia. Budget estimates for each year of the three years are as follows.

Year 1	$150,000
Year 2	$150,000
Year 3	$120,000
Total	$420,000