Executive Summary

This study provides forecasts of water demand and availability in the Washington, D.C., metropolitan area (WMA) through the year 2040. Long-term water supply forecasts aid managers in meeting future needs, since the time required to develop new resources is lengthy. This report is the fifth in a series of periodic reviews by the Section for Cooperative Water Supply Operations on the Potomac (CO-OP) of the Interstate Commission on the Potomac River Basin (ICPRB) of the ability of the WMA water supply system to meet future demands. The study consists of two parts: Part 1, the subject of this report, includes the demand forecast, analysis of current resources, and summary of potential resource alternatives. Part 2 of this study, which will be documented in a separate report, will assess the potential impact of global climate change on WMA water supply and demand.

Background

The three major WMA water suppliers, Washington Aqueduct Division of the U.S. Army Corps of Engineers (Washington Aqueduct), Fairfax County Water Authority (Fairfax Water), and Washington Suburban Sanitary Commission (WSSC), have a long history of cooperation. This cooperative approach was formalized in a set of agreements signed in the late 1970s and early 1980s. These agreements include the Low Flow Allocation Agreement (LFAA), which allocates the amount of water each supplier can withdraw from the Potomac River in the event that total flow is not sufficient to meet all needs, and the Water Supply Coordination Agreement (WSCA), which provides for coordinated operations of the major water supply facilities in the region during periods of low flow. During periods when Potomac River flows are low, as may occur in times of drought, the WMA suppliers coordinate their operations with the assistance of CO-OP in order to optimize use of available resources and maintain adequate flow downstream of their Potomac intakes to protect aquatic habitats. In addition, every five years beginning in 1990, CO-OP has conducted a forecast of WMA water demand and resource availability, as specified in the WSCA and LFAA as amended by Modification No. 1, on behalf of the WMA suppliers. The specified 20-year forecast horizon has been extended in the current study to 30 years to provide assistance to the Northern Virginia Regional Commission in its development of the Northern Virginia Regional Water Supply Plan in fulfillment of Virginia water supply regulations, 9 VAC 25-780.

The majority of WMA residents obtain their water from one of the three major suppliers, either directly or via their wholesale customers:

- Washington Aqueduct serves the District of Columbia via the D.C. Water and Sewer Authority (D.C. WASA), as well as Arlington County, the City of Falls Church, and the Town of Vienna, all in Virginia.
- WSSC serves Montgomery and Prince George's counties in Maryland, and provides a limited amount of water to Howard and Charles counties. Water is also provided on an emergency basis to the City of Rockville and D.C. WASA.
- Fairfax Water serves most of Fairfax County, Virginia, and the following wholesale customers: Dulles International Airport, Fort Belvoir, Town of Herndon, Loudoun Water,

Prince William County Service Authority, and the Virginia American Water Company (serving the City of Alexandria and Dale City).

The Potomac River is the primary source of raw water for the WMA suppliers, providing approximately 78 percent of the total water used. The Occoquan Reservoir in Virginia and the Patuxent River reservoirs in Maryland provide the remaining 22 percent. The WMA water suppliers jointly pay the capital and operating costs to reserve a portion of the water stored in two reservoirs to augment the natural flow of the Potomac River: Jennings Randolph Reservoir, located on the North Branch of the Potomac River approximately 200 miles upstream of Washington, D.C., and Little Seneca Reservoir, located in Montgomery County, Maryland. The combined water supply storage capacity of the Occoquan, Patuxent, Jennings Randolph and Little Seneca reservoirs is approximately 35 billion gallons. The WMA water suppliers also contribute to the operating costs of Savage River Reservoir, which supplements Jennings Randolph water supply augmentations.

Water use in the WMA has held relatively steady during the past two decades. Figure ES-1 shows total average annual, summer, and winter water production by the WMA suppliers, as well as peak-day production, from 1990 through 2008. Though there are slight upward trends in these data, only average summertime water use has increased at a rate that is statistically significant (at the 10 percent level). Over this same period, population in the WMA increased by about 10 percent, from approximately 3.9 to 4.3 million people.

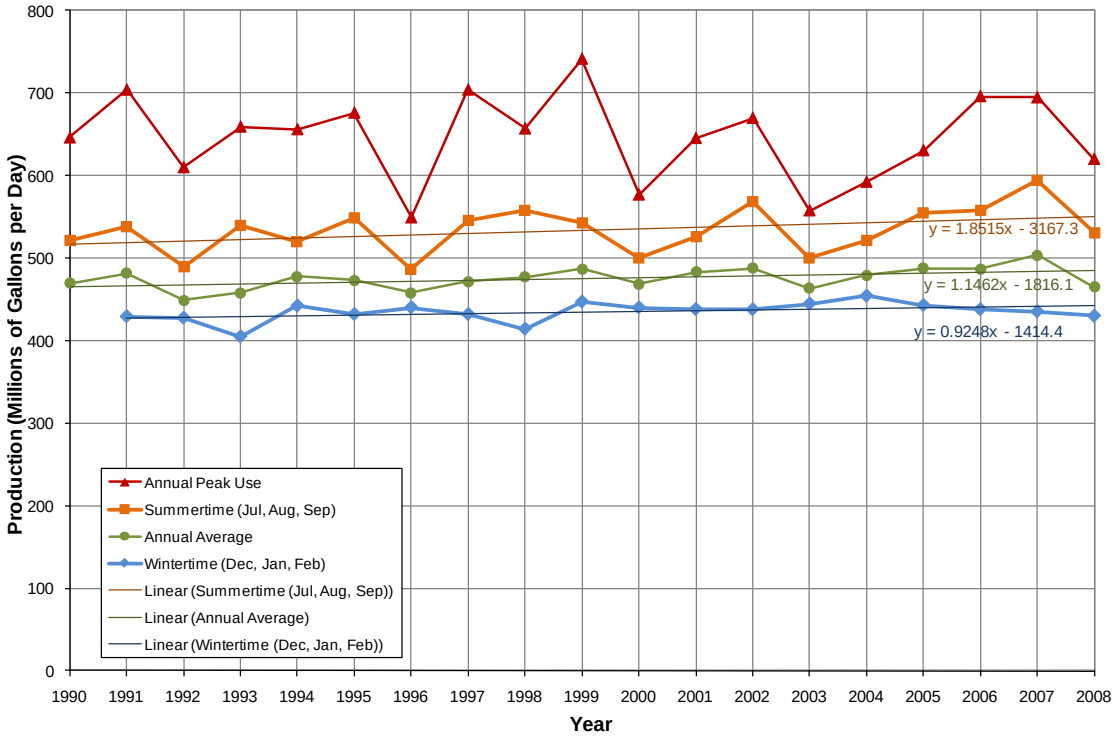

Figure ES-1: Average annual, summertime, wintertime, and peak day water use for the Washington, D.C., metropolitan area from 1990 through 2008.

Demand Forecasts

Forecasts of average annual water demand were developed by combining recent water use information derived from billing data provided by the WMA suppliers and their wholesale customers, information on the current and future extent of the areas supplied with water from WMA suppliers and local planning agencies, and the most recent demographic forecasts from the Metropolitan Washington Council of Governments (MWCOG). Forecasts were also made for the City of Rockville. Water use data was disaggregated into three categories for forecasting purposes: single family households, multi-family households (apartments), and employees (including commercial, industrial, and institutional use).

The MWCOG Round 7.2 Cooperative Forecast (MWCOG, 2009) for the year 2040 projects that population in the WMA will increase from 2010 levels by approximately 1 million (24 percent) and total number of households will increase by approximately 480,000 (29 percent). Total number of employees is predicted to increase by approximately 1,100,000 (38 percent). In all of these categories, the areas served by Fairfax Water and its wholesalers are projected to have the highest percent increases, as can be seen from Table ES-1. Areas served by WSSC are projected to have the lowest population increase (17 percent) but the second highest increase in the number of employees (42 percent).

Table ES-1: MWCOG growth predictions between the years 2010 and 2040, by areas currently served by a water supplier.

	Additional Households (percent)	Additional Population (percent)	Additional Employees (percent)
Fairfax Water retail and wholesale customers	206,297 (36%)	491,256 (32%)	448,178 (54%)
Aqueduct wholesale customers	122,738 (28%)	254,474 (26%)	276,175 (24%)
WSSC retail customers	140,980 (22%)	286,317 (17%)	332,151 (42%)
Totals (plus Rockville)	478,417 (29%)	1,049,078 (24%)	1,078,791 (38%)

Water demand forecasts are notoriously inaccurate, because of uncertainties in both demographic forecasts and in predictions of future water use behavior. To take these uncertainties into account, this study provides forecasts for two scenarios, the first using assumptions very similar to those of the past two WMA water supply studies by ICPRB, and the second assuming both higher population growth and higher unit use:

Scenario 1 – likely forecast, most consistent with recent studies:

- Based on MWCOG Round 7.2 growth forecasts.
- Assumes that both single family and multi-family household unit water use will decrease throughout the forecast period due to the increased use of low flow plumbing fixtures as mandated by the Energy Policy Act of 1992.

Scenario 2 – high demand forecast:

- Based on MWCOG Round 7.2 growth forecasts, with preliminary estimates of additional water demand due to potential growth in certain areas not considered in the Round 7.2 data.
- Assumes that only multi-family household unit water use will decrease throughout the forecast period and that no water use reductions will occur in single family households because reductions from the Energy Policy Act of 1992 and other indoor conservation measures will be offset by increases in summertime outdoor water use.

Table ES-2 contains forecasted demand for both Scenario 1 and Scenario 2 at five year intervals for the period, 2010 through 2040. These values include all water supplied by each of the three WMA suppliers, including water supplied to wholesale customers, in units of million gallons per day (mgd).

Table ES-2: WMA demand forecasts, including demand from wholesale customers, for Scenario 1 – most likely demands, and Scenario 2 – high demands (mgd).

	2010	2015	2020	2025	2030	2035	2040
Scenario 1 - Fairfax Water	175.2	186.9	199.4	210.2	218.2	223.8	228.9
Scenario 2 - Fairfax Water	187.2	201.7	217.8	234.2	247.3	259.0	269.1
Scenario 1 - Washington Aqueduct	150.9	157.7	164.8	168.7	172.2	174.2	177.8
Scenario 2 - Washington Aqueduct	150.9	158.6	166.6	171.4	175.5	178.1	182.4
Scenario 1 – WSSC	171.9	177.5	186.7	191.6	197.1	201.1	203.8
Scenario 2 – WSSC	171.9	179.6	190.4	196.9	203.5	208.7	212.5
Scenario 1 - WMA Supplier Subtotal	497.9	522.1	551.0	570.6	587.5	599.1	610.5
Scenario 2 - WMA Supplier Subtotal	509.9	540.0	574.8	602.5	626.3	645.7	664.0
Scenario 1 - City of Rockville DPW	4.8	5.0	5.3	5.6	5.8	6.1	6.3
Scenario 2 - City of Rockville DPW	4.8	5.0	5.4	5.7	6.0	6.3	6.5
Scenario 1 - TOTAL WMA Suppliers plus Rockville	**502.7**	**527.1**	**556.3**	**576.2**	**593.3**	**605.1**	**616.8**
Potential additional demand from growth areas	12	13	15	19	23	28	32
Additional demand assuming constant SFH unit use	0.0	4.9	8.9	13.0	16.0	18.9	21.7
Scenario 2 - TOTAL WMA Suppliers plus Rockville	**514.7**	**545.0**	**580.2**	**608.2**	**632.3**	**652.0**	**670.5**

Note: SFH = single family home

Average annual demand in the WMA, including Rockville, is estimated to be approximately 503 mgd in year 2010 for Scenario 1, or 515 mgd for Scenario 2, and this is projected to increase to 593 mgd (18 percent) in 2030 under the assumptions of Scenario 1, or 632 mgd (23 percent) for Scenario 2. By the year 2040, WMA demand is forecast to increase to 617 mgd (23 percent) for Scenario 1, or to 671 mgd (30 percent) for Scenario 2.

In Figure ES-2, the forecasted WMA supplier demands shown in Table ES-2 are compared with results from past studies by ICPRB (Kame'enui *et al.*, 2005; Hagen and Steiner, 2000; Mullusky *et al.*, 1996; Holmes and Steiner, 1990) and other organizations (USACE, 1975; 1983). It is clear

from Figure ES-2 that demand forecasts have consistently fallen over time. Throughout most of the past four decades, population has continued to grow in the WMA, but unit use values have fallen. However, current results indicate that these decreasing trends in unit use may be leveling off. The demand forecast lines in Figure ES-2 for ICPRB's 2005 and 2010 studies are close to one another. The similarity in these results is due to overall similarities in MWCOG demographic forecasts and the fact that unit use values have remained relatively constant throughout the past decade, with the exception of the values for multi-family households, which continue to decrease.

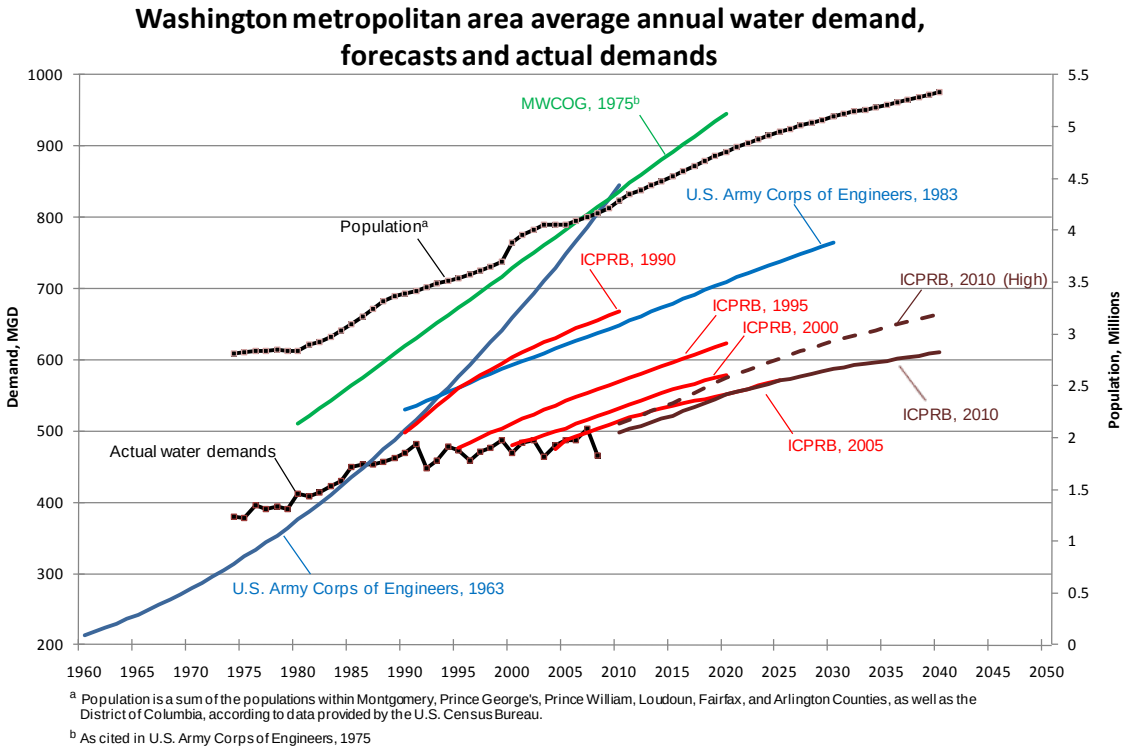

Figure ES-2: Comparison of Washington metropolitan area water supplier average annual demand forecasts from current (labeled ICPRB, 2010) and past studies.

Resource Analysis

The resource analysis was conducted using the Potomac Reservoir and River Simulation Model (PRRISM) to simulate future water demand and availability in the WMA water supply system based on forecasted demands and the historical record of hydrologic and meteorological conditions. PRRISM simulates on a daily basis the processes that govern water supply and demand in the WMA system: flows in the Potomac River; inflows, storage, and releases from the WMA system of reservoirs; and water withdrawals by the three major WMA suppliers. PRRISM was used to evaluate how the current WMA system would respond to forecasted water demands under the range of hydrologic conditions that occurred from 1929 through 2007.

PRRISM has undergone several enhancements since the CO-OP's last WMA water supply study was conducted. These changes (Chapter 6 and Appendix E) reflect recently adopted reservoir

operating procedures for Jennings Randolph and Savage reservoirs and revised estimates of Jennings Randolph sedimentation rates. The new operating rules were developed by the U.S. Army Corps of Engineers, Baltimore District, with assistance from ICPRB, following recommendations from the North Branch Potomac River Advisory Committee. This committee was formed in 2005 by the agencies collectively responsible for the operations and management of the two North Branch reservoirs.

Model results are presented for both the typical 20-year demand forecast for the year 2030, and for the 30-year demand forecast for the year 2040. The 30-year forecast has been included in this study to assist the Northern Virginia Regional Commission in their concurrent water supply planning effort.

Model simulations predict that the WMA's current water supply system is likely adequate to meet future demands forecasted through the year 2030, but might be strained by 2040 demands. In the year 2030, the model indicates that the system could meet demands with no shortfalls and no need for emergency water use restrictions under a range of hydrologic conditions similar to the 78-year period of record. By the year 2040, for the higher demand forecasts of Scenario 2, model simulations indicate that if conditions experienced during the worst drought of record were to reoccur, emergency water use restrictions would be required, combined water supply storage in Little Seneca and Jennings Randolph reservoirs would fall below one billion gallons, and water supply shortfalls would occur at Occoquan Reservoir.

Conclusions and Recommendations

The following conclusions and recommendations can be made based on the results of this analysis:

Conclusions

1. The resource analysis conducted for this study indicates that the WMA's current water supply system will continue to be able to meet demands over the 20-year forecast period, to the year 2030, under a range of hydrologic conditions similar to the 78-year period of historical record, with no water supply shortfalls and no emergency water use restrictions.

2. By the year 2040, however, the current system may have difficulty meeting the region's demands during periods of drought without water use restrictions, and/or the development of additional supply capabilities.

3. Summertime outdoor water use may be increasing in some areas of the WMA, offsetting the benefits of adoption of more water efficient indoor fixtures and appliances.

4. The system's largest reservoir, Jennings Randolph, appears to be losing storage capacity due to sedimentation at a rate that is higher than estimated in the past.

Recommendations

1. Completion of the evaluation of water supply alternatives to determine the most beneficial and cost-effective resources to meet future demands, including an improved methodology for optimizing existing and potential water supply resources.

2. A new hydrographic survey to measure current storage capacity of Jennings Randolph Reservoir. New surveys of Savage Reservoir and Little Seneca Reservoir may also be warranted.

3. Consideration of new watershed protection efforts to reduce watershed erosion and thus loss of storage in system reservoirs, potentially under the auspices of the Potomac River Basin Drinking Water Source Protection Partnership.

4. Investigation in the next WMA water supply study of changes and impacts of summertime outdoor water use.