Review of May 1988 Water Resources Study
March 26, 2009

This memorandum has been prepared based on Malcolm Pirnie's review of R.E. Wright Associates' May 1988 *Carroll County Water Resources Study*. Our principal focus has been to identify limitations and changes to the original findings based on current regulations and more recent data or efforts undertaken by the County. Our comments are organized according to the chapter format used in the 1988 study.

Chapter 1 - Preface

Source water assessment and protection (including wellhead protection) should be added to the basic purpose and objectives because these are now considered an essential part of water supply management, and Carroll County has existing efforts in this regard. Although this report predates the 2000 Chesapeake Bay Agreement, Chapter 15 does emphasize the importance of pursuing water quality protection programs. In addition, Carroll County published a *Water Resource Management Manual* in May 2004 that describes the County's delineation of management areas and identifies measures to protect drinking water supplies from both existing and future ground and surface water degradation sources.

Introductory sections to this report, or future documents such as the WRE, also provide an opportunity to emphasize the importance of improved local water resource policy to support population and economic growth in a sustainable manner, rather than encouraging well and septic-based sprawl. Authors should be familiar with the Final Report of the "Advisory Committee on the Management and Protection of the State's Water Resources", which is available on the Maryland Department of the Environment (MDE) web site. This report makes a number of important conclusions and recommendations for statewide water resources policy, including the recommendation for a greater emphasis on water and sewer planning at the local level.

Chapter 2 - Groundwater Quality of Carroll County

Updated Drinking Water Quality Standards. The National Primary and Secondary Drinking Water Criteria presented in Tables 2-1 and 2-2 have been expanded to include a number of new constituents. A current listing of these criteria is available from the USEPA's web site.

Potential County Mapping Using Current GIS Tools. The summary of background water quality in Table 2-16 is only presented by aquifer type. For future studies beyond the current Water Resources Element (WRE) effort, it may also be useful for the County to develop this summary by land use category and designated growth area.

It may be desirable for County planning staff to apply current GIS tools (unavailable at the time of the 1988 study) to provide a spatial depiction of groundwater quality as opposed to only tabular results. Spatial analysis would more clearly show where problem areas may exist or what trends exist. In addition, potential sources of surface contamination are also of importance for groundwater vulnerability evaluations. Therefore, it may be desirable for County planning staff to overlay zones of elevated groundwater concentrations with the County's existing land use mapping information as well as locations

of potential sources of surface impacts such as landfills, industrial or municipal facility discharges, golf courses, agricultural operations, road salt, impervious surfaces, etc.

Recent Groundwater Quality Studies. There has been relevant groundwater research conducted since 1988 that sheds some additional light on groundwater quality within Carroll County. For example:

Pesticides in Groundwater of Central and Western Maryland (USGS Fact Sheet 2008-3068): Selected pesticides and products of pesticide degradation are detectable in groundwater in many parts of central and western Maryland, although concentrations are generally less than 0.1 micrograms per liter. Groundwater samples collected from 1994 to 2003 from 72 wells in areas of Maryland underlain by consolidated carbonate, crystalline, or siliciclastic aquifers (areas north and west of the Fall Line) were analyzed for selected pesticides and products of pesticide degradation. For future studies beyond the current WRE effort, it may be useful for the County to access this USGS research to determine if and where in Carroll County pesticides were detected in groundwater samples.

Chapter 3 - Study of Nitrate Concentration in Soil-Water and Groundwater

Potential County Mapping Using Current GIS Tools. There is repeated mention made of locally-contaminated groundwater, but no mapping provided to show where these wells are located. For future studies beyond the current WRE effort, it may be desirable for County planning staff to apply current GIS tools to summarize where problems exist and what land use may be contributing to these problems.

Recent Groundwater Quality Studies. Recent USGS research on vulnerability of groundwater to nitrate concentration sheds some additional light on groundwater quality within Carroll County. For example:

Groundwater Vulnerability to Nitrate Contamination in the Mid-Atlantic Region (USGS Fact Sheet 2004-3067): The USEPA Regional Vulnerability Assessment Program developed a set of statistical tools to support regional-scale, integrated ecological risk-assessment studies. One of these tools, developed by the USGS, is used with available water quality data obtained from USGS National Water Quality Assessment and other studies in association with land cover, geology, soils, and other geographic data to develop logistic-regression equations that predict the vulnerability of ground water to nitrate concentrations exceeding specified thresholds in the Mid-Atlantic Region. The regression models were developed and applied to produce spatial probability maps showing the likelihood of elevated concentrations of nitrate in the region. According to this mapping, areas of high probability exist within Carroll County. For future studies beyond the current WRE effort, this spatial output could be used by County staff to help identify areas in Carroll County that currently are at risk and to identify areas where groundwater is more likely to have been affected by human activities.

County Requirements Adopted Since 1988 Study. Several remedial actions are identified such as education of persons associated with point source of nitrate-nitrogen within agricultural areas and repair or replacement of malfunctioning septic systems. Carroll County's May 2004 *Water Resource Management Manual* provides information on various aspects of groundwater resource protection including the delineation of protection zones (e.g., wellhead and aquifer protections areas) and management standards and design criteria relating to land use activities and management areas.

In April 2004, Carroll County adopted Ordinance No. 04-08 which created Chapter 218 Water Resource Management to the County Code. This chapter provides for the delineation of management areas, and

the ability to perform a water resource impact review on all proposed development projects within the County. In addition, water resource protection easements are required adjacent to streams, wells, and well sites when land is developed. Also, adopted by resolution was the *Water Resource Management Manual.* Several municipalities including the towns of New Windsor, Manchester, Sykesville and Mount Airy have also adopted Chapter 218. These important measures to protect drinking water supplies from both existing and future degradation sources should be clearly identified in future County studies relating to groundwater quality.

Health Department Nitrate Testing: The Carroll County Health Department is required to analyze groundwater nitrate concentrations in subdivision with four or more lots, if the average lot size is less than two acres. If results indicate that nitrate exceeds 10 mg/L, pre-treatment for nitrate is required on one or more lots. These data are likely to provide useful information for mapping nitrate concentrations in the County.

Chapter 4 - Groundwater Resource Development in Carroll County

According to Chapter 7 of the 1988 study, drought groundwater recharge available within the Planning Area was 12.9 mgd, and 14.6 mgd within 2,000 feet of the Planning Area. This range of groundwater recharge is somewhat lower than the projected Year 2020 total public water supply requirement of about 17 mgd, listed in Chapter 15 of the 1988 study. Groundwater water recharge estimates will be updated as part of the water balance task being performed to support the water resources element (WRE) of the County's comprehensive plan.

Impacts of Current State Groundwater Regulations on Potential Groundwater Withdrawals. The 1988 study was performed prior to the effective date (1989) of Maryland's current water appropriation and use regulation (COMAR 26.17.06). Since that time, MDE's policies and administrative approaches for permitting groundwater appropriations have evolved. MDE's current permitting practices would reduce the amount of groundwater that could be appropriated by Carroll County, compared with groundwater availability stated in the 1988 study. Therefore, the WRE will consider regulatory restrictions on groundwater appropriations, including those summarized below.

Maryland's water appropriation and use regulation requires permits for withdrawals greater than 10,000 gallons per day, and states that MDE may consider a range of factors when making appropriations, including the protection of existing water uses and the sustainability of use to the aquifer. MDE's policies for interpreting these factors are largely uncodified, and have developed over time as a series of internal MDE decisions. MDE's basic approach is to base a groundwater appropriation on the most limiting of four factors:

- Water demand
- Maximum withdrawal that would not adversely impact nearby wells
- Groundwater availability as determined MDE's water balance-recharge area method
- Well yield

Impacts to nearby wells are evaluated through testing and analytical procedures, although MDE does not have specific criteria for maximum drawdown in nearby wells. The factors most likely to cause differences with assumptions of the 1988 study are the water balance method for determining recharge, and the procedures for determining well yield.

Water Balance Method for Determining Recharge: MDE's basic approach for determining groundwater availability is similar to that described in the 1988 study, in that it uses a water balance method to determine recharge over an area during a 1 in 10 year drought, with the 7Q10 streamflow subtracted to protect stream baseflows. MDE's assumed areal recharge rates and 7Q10 values differ somewhat from the values presented in the 1988 report, based on MDE's own tabulations. However, the largest reason for a discrepancy in water availability from the 1988 study is the fact that, in calculating the recharge area, MDE does not use projections of the actual contributing recharge area of the system. Rather, MDE only considers the land area controlled by the applicant at specific locations within the watershed in which the withdrawal is located.

In the case of a municipal applicant, MDE's definition of the recharge area would include the water service area, areas the jurisdiction owns or has annexed, and areas the jurisdiction has placed under easement. The 1988 study, following the established practice at that time, used larger recharge areas that included what were then called community planning areas (CPA) and areas within 2,000 feet of the CPA boundary. Under MDE's current approach, a significant portion of these areas would not be considered viable recharge areas unless the jurisdictions either purchased the land or placed it under easement.

MDE's recharge area method is controversial due to its uncodified nature, conservatism, and the difficulty that it poses for jurisdictions that cannot afford to purchase large acreages of contributing recharge area for regulatory purposes. In many cases, the policy could promote sprawl by limiting new water supplies to smaller, private wells outside of water service areas. Maryland Senate Bill 499 (Water Appropriations – Recharge Area) of the 2007 session was intended to expand MDE's definition of recharge areas. Although this bill did not pass, it drew attention to the issues created by current municipal groundwater recharge regulations.

The WRE will consider that MDE's practice has been to increase the estimate of necessary capacity by 10 percent to reflect drought demands. The WRE will also consider the fact that MDE would reduce the amount of groundwater available to account for the future proportion of impervious surface in the watershed. Unless information is otherwise provided, MDE uses a default assumption of 10% losses to future impervious surface. Other values may be used if localities provide evidence that the impervious surface would be lower, or that either existing or future stormwater and groundwater management practices would maintain higher infiltration rates. Pursuant to Maryland's Stormwater Management Act of 2007, MDE is in the process of revising the 2000 stormwater management regulations. Among other requirements, the new regulations will require that new development maintain pre-development groundwater recharge rates. Such efforts would ameliorate future reductions in recharge rates, and should be explicitly considered in deriving the appropriate loss factor.

Well Yield: Any update to the 1988 study should revisit well yield projections for different hydrologic units, both to incorporate information from wells drilled since 1988, and also to address MDE's more conservative methods for estimating well yield. In general, MDE's estimates of long-term sustainable well yield are lower than those estimated by drillers or hydrogeologic consultants. The County should consider compiling and mapping information on well yields measured since the 1988 study, both to revise well yield estimates and evaluate spatial/geologic patterns in well yields. Lower well yield estimates would not necessarily limit the total groundwater availability, but would increase the number of wells needed to withdraw the water and thereby increase the cost of groundwater resource development.

Updated groundwater recharge estimates are being developed based on the water balance assessment being conducted for the Carroll County WRE. The WRE analysis of groundwater availability is being conducted according to the example provided by MDE's May 2006 *An Evaluation of the Water Resources in the Catoctin Creek Watershed.* Updated recharge estimates will allow an evaluation of whether current and projected groundwater withdrawal rates are sustainable.

Potential Sinkhole Impacts. The 1988 report mentions evidence for sinkhole development in the Wakefield Valley adjacent to the Medford Quarry where large groundwater withdrawals are made. Recent water supply planning efforts by Malcolm Pirnie in adjacent Frederick County revealed that extensive groundwater testing efforts will likely be required to secure development of new groundwater capacity if there is any perceived risk for sinkhole development. These testing efforts could involve both short-term aquifer pump tests and longer-term monitoring of groundwater levels in the vicinity.

Hampstead Data. The 1988 report shows long-term groundwater levels for Hampstead. These data could be augmented with long-term groundwater level data available from the USGS for wells in the vicinity of Union Mills and Gillis Falls, or other County groundwater level data that might be available. The groundwater level data collected since 1988 should be evaluated to determine more recent patterns and trends.

Chapter 5 - Surface Water Resources

The projected safe yield of existing and planned surface water supplies within the County would be more useful if compiled in a single tabulation. The most current surface water source yield estimates will be reported as part of the current WRE effort. Below are the most recent available safe yield estimates:

- *Existing Liberty Reservoir Purchase from City of Baltimore*: Carroll County has constructed and operates a surface water intake on Liberty Reservoir through an agreement with Baltimore City, the reservoir's owner. Under the agreement, Carroll County may withdraw an average of 4.2 mgd with a maximum month withdrawal of 6.0 mgd (2007 Master Plan, page 65).
- *Existing Cranberry Reservoir System*: 2.0 mgd MDE watershed average appropriation (1988 study, page 5-14).
- *Existing Piney Run Reservoir*: 3.5 mgd safe yield (1988 study, page 5-42).
- *Planned Gillis Falls Reservoir*: 8.36 mgd safe yield (1988 study, page 5-53). We note that Carroll County's September 2007 *Master Plan for Water and Sewerage* lists this safe yield as only 3.8 mgd (page 80). This 4.6 mgd discrepancy needs to be clarified as part of the current WRE effort.
- *Planned Union Mills Reservoir*: 4.6 mgd safe yield (as reported in 2007 *Summary of Union Mills Reservoir and John Owings Landfill Related Reports* and attributed to June 1976 *Watershed Plan and EIS for Big Pipe Creek Watershed*).
- *Total Potential Yield*: 20.86 mgd (16.3 mgd using 3.8 mgd safe yield estimate for Gillis Falls Reservoir)

The total potential yield of surface water supplies at the time of the 1988 study exceeded the projected Year 2020 total public water supply requirement of about 17 mgd listed in Chapter 15 of the 1988 study.

Impacts of Recent Drought Statistics on Surface Water Yields.
The 1988 study includes safe yield estimates for existing and proposed reservoirs based on streamflow data available at the time of the study. For the current WRE effort, reservoir safe yield estimates will be updated based on more recent streamflow statistics that reflect droughts during the past two decades. If

post-1988 droughts are more severe than those previously considered, the resulting safe yield estimates for existing and planned supplies could be lower than previously thought. Examples of more recent documentation include:

Selected Streamflow Statistics of Stream Gaging Stations in Northeastern Maryland, 2006 (USGS OFR 2006-1335): Streamflow statistics were calculated for 47 USGS stream gaging stations in northeastern Maryland. This included four gaging sites located in Carroll County. A comparison between low flow frequency statistics computed for this study and for a previous study that used data available through September 1989 was done for seven stations. The comparison indicated that, for the 7-day mean low flow, the newer values were 19.8 and 15.3 percent lower for the 20- and 10-year recurrence intervals, respectively. For the 14-day mean low flow, the newer 20- and 10-year values were 25.2 and 15.5 percent lower, respectively. For the 30-day mean low flow, the newer 20- and 10-year values were 10.8 and 7.9 percent lower, respectively. The newer values are generally lower than the older ones most likely because two major droughts had occurred since the older study was completed. One of these droughts spanned the 1999 and 2000 climatic years, and another spanned the 2002 and 2003 climatic years.

Applicability of Minimum Reservoir Release Requirements. According to the January 1990 *Gillis Falls Reservoir Environmental Report*, the minimum reservoir releases that will be required range between 5.3 cfs (July-October) and 13.2 cfs (March-May) on a monthly basis and average 8.6 cfs on an annual average basis (page 4-14). This is a critical assumption that warrants reconsideration during extended drought periods when reservoir inflows through natural basin runoff could be less than these specified release rates. For example, we evaluated historical streamflow records for the North Branch Patapsco River at Cedarhurst gage in Carroll County. We found that during Water Year 2002 (October 2001 - September 2002), average flow at this gage adjusted to the smaller 17.4-mile drainage area of the planned Gillis Falls Reservoir was only 6.2 cfs, which compares to the 8.6 cfs average release that would occur under the proposed rule. Over this single water year, this would amount to 565 million gallons more being released than flowed into the reservoir through natural basin runoff. That difference amounts to 15% of the 3.78 billion gallon total volume of the planned Gillis Falls Reservoir. The County should work with regulators to derive a more realistic release rule that does not unnecessarily sacrifice valuable water supply safe yield by augmenting streamflows at rates higher than would naturally occur under drought conditions.

Need for Back-Up Raw Water Storage and Protection of Larval Fish. We have observed a recent trend in the Mid-Atlantic region where regulators are encouraging stream withdrawal applicants to rely on back-up raw water storage during periods of extreme low flow when continued stream withdrawals could cause adverse impacts to aquatic biota, water quality or other beneficial instream uses. In addition, the regulatory trend has been to require more protective measures in the design and operation of stream intake structures to minimize potential impacts to aquatic life such as small life stages of fish. Consequently, early coordination is needed with regulators to determine if and how potential minimum instream flow levels or aquatic life considerations will affect intake structure design and the potential need for back-up raw water storage during severe drought events.

Impacts of Current Federal and State Regulations on the Permitting of New Reservoir Construction. The 1988 study did not fully address regulatory constraints as they may affect permittability and associated costs of the planned Gillis Falls and Union Mills reservoir projects. Since the 1988 report, the application of federal and state regulations governing the permitting of new surface water reservoirs has been significantly tightened to reduce potential wetland losses and to minimize overall adverse impacts on aquatic life. During this time, there have been only a moderate number of major impoundments

constructed in the Mid-Atlantic region. Over the last 20 years, we are aware of 13 major reservoirs (4 were expansions) constructed or now under construction in the Mid-Atlantic states of Virginia, North Carolina, West Virginia, and Pennsylvania. Over the last 10 years, we are aware of 7 major reservoirs (2 were expansions) constructed or now under construction. In order to minimize environmental impacts, those reservoirs which have been approved by the Corps of Engineers in recent years typically have far more extensive mitigation requirements than addressed in the 1988 study.

Any new reservoir project is likely to inundate wetlands, open water and riverine habitat. Under current Maryland policies for acreage replacement, most wetlands must be mitigated for at a ratio of 2:1 (i.e., mitigation to impact area ratio). MDE prefers in-ground, on-site mitigation projects. When that option is not feasible, MDE evaluates off-site options, mitigation banks, and, lastly, payment into the State's Nontidal Wetland Compensation Fund, a state in-lieu fee program that conducts mitigation projects statewide.

There are several relevant points to note here as listed below. These environmental considerations are outside the scope of the current WRE planning study, but they do need to be accounted for in weighing the potential risks of alternative water supply plans.

1. A new field delineation of impacted wetlands and streams would likely be required by regulatory agencies in a case where an original delineation for a proposed project was conducted years ago.

2. Given the magnitude of wetland and stream impacts, the most challenging aspect of permitting the County's planned reservoirs will likely be demonstrating to federal and state regulators that there are no other practicable alternatives that would have less impact to aquatic systems. Federal permitting requirements under Section 404 of the Clean Water Act govern this approval process as administered by the Corps of Engineers and its advisory agencies including USEPA and USFWS.

3. Required wetland mitigation will be very expensive and certainly far higher than any allowances that may have been included in cost estimates presented in Appendix A of the 1990 Environmental Report. For Maryland's Nontidal Wetland Compensation Fund, the fee structure is developed independently for each county using estimates for land acquisition, design, construction and monitoring costs. Reported costs in Prince George's County are $55,000/acre, and in Montgomery County $56,000/acre.

4. The County should also expect to incur significant costs for stream mitigation. Under today's regulatory approval processes stream impacts are also being accounted for, and the required stream mitigation can be more difficult to secure because wetland credits rather than stream credits have more commonly been made available in mitigation banks. One example of stream work already conducted in Carroll County was the restoration in 2000 of an 1,800-foot reach of Little Pipe Creek in the Town of Union Bridge. Stream restoration work is very expensive per linear foot. Preservation of streams upgradient of a reservoir can have the dual benefit of providing mitigation credits and providing buffer protection of water quality. Stream mitigation continues to be an evolving regulatory process and bears watching very closely to determine exactly how it will affect permitting and costs of Carroll County's planned reservoir projects.

Feasibility of Expanded Supplies from Existing Reservoirs. Options for expanding the water supply storage and/or withdrawals for existing reservoirs referenced in the 1988 report should be considered under the WRE evaluation. For example, some initial assessment should be made as to whether there is

any potential for expansion of Piney Run Reservoir (which was completed in 1975), including raising the dam crest and/or modifying the reservoir's normal pool elevation.

Likewise, consideration of additional supplies from the City of Baltimore reservoir(s) may be warranted (e.g., supplies from Liberty Reservoir for southeastern Carroll County and possibly even Prettyboy Reservoir for supply to northeastern Carroll County). Baltimore's current plans for development of a 120 mgd treatment plant for the Susquehanna River water supply (Fullerton water filtration plant) will significantly expand Baltimore's treated water supply and overall system reliability such that it may be feasible for Carroll County to utilize additional water supply from the City's large reservoirs. Carroll County's September 2007 *Master Plan for Water and Sewerage* does address ongoing efforts to increase the capacity of the Freedom Water Treatment Plant located on Liberty Reservoir by 4 mgd for a total maximum day capacity of 7 mgd based on a February 2005 agreement with the City of Baltimore.

Feasbility of Interbasin Transfers. Interbasin transfers represent a potential water source for Carroll County communities. For example, we understand that Mount Airy has evaluated the possibility of obtaining Potomac water from the City of Frederick and/or Frederick County (C. Spaur, written comm., 10 Feb 2009). The WRE should address viable interbasin transfer opportunities identified by localities.

Potential Water Reuse Applications. The 1988 report did not include water reuse among the list of recommended options for water supply augmentation. Over the next 20 years, reuse of reclaimed water is likely to be a growing trend in order to comply with the recent Chesapeake Bay wasteload allocations for wastewater treatment plants (WWTPs) in the County. The Chesapeake Bay wasteload allocations (WLA) establish a cap on future nutrient loadings from WWTPs. Future loads are limited to the daily loading associated with the discharge flows specified in the current State discharge permits. Because County WWTPs with discharges greater than 0.5 mgd are being upgraded to "limits of technology" treatment levels for nutrients, future wastewater flow increases would exceed the nutrient loading cap for the WWTP. Maryland has established a Bay Restoration Fund (BRF) to assist localities with the design, construction, operations, and maintenance costs of WWTP nutrient removal upgrades.

Reuse of reclaimed wastewater for non-potable uses such as irrigation and cooling water represents a feasible option for accommodating future wastewater flow increases without exceeding the nutrient loading WLA in the WWTP discharge. In the absence of options for reducing future WWTP discharges, future growth in the WWTP service area may have to be limited to comply with the permitted nutrient loading cap. Water reuse also offers opportunities for meeting a portion of the County's future water supply needs.

Carroll County has experience with an early form of water reuse at the Manchester spray irrigation system (0.5 mgd capacity) which applies treated wastewater to a reed canary grass field where public access is prohibited. Another State in the Chesapeake Bay region (Virginia) has recently adopted regulations for the use reclaimed water which permit non-potable uses in public access areas (e.g., golf courses, parks, athletic fields, school yards, etc.) similar to reuse programs which have been in existence for more than two decades in southeastern (Florida) and western states (e.g., Arizona, California).

Recent Studies of Streamflow Water Quality in Carroll County Watersheds. Since the 1988 report, there have been some regional water quality studies which may be useful for screening surface water supplies in future studies beyond the current WRE effort. The description of watershed quality could be enhanced through consideration of recent research on surface water quality trends. For example:

Changes in Streamflow and Water Quality in Nontidal Basins in Chesapeake Bay Watershed, 1985-2004 (USGS SIR 2006-5178): As part of an annual evaluation of water quality conditions by the Chesapeake Bay Program, water quality and streamflow data from 32 sites in nontidal parts of the Chesapeake Bay watershed were analyzed to document annual nutrient and sediment trends for 1985 through 2004. One of the evaluated monitoring sites is located in Carroll County just north of Liberty Reservoir (i.e., North Branch Patapsco River at Cedarhurst). The study also formalized different trend tests and methodologies used in assessing the effectiveness of management actions in reducing nutrients and sediments to the Chesapeake Bay. Observed concentration summaries indicate higher ranges in total nitrogen concentrations in the northern major river basins, those in Pennsylvania, Maryland, and northern Virginia, compared to the more southern basins in Virginia. Almost half of the monitoring sites in the northern basins exhibited significant downward trends in total nitrogen with time. Comparisons with total phosphorus and sediment showed similar results to total nitrogen.

Water quality measurements taken during ecological studies of County streams. Examples of such measurements are those taken as part of the DNR's ongoing Maryland Biological Stream Survey.

Agricultural runoff loadings of coliform bacteria as well as water quality problems described for Cranberry Reservoir point to the need for proactive source water protection measures. In particular, a major goal should be to provide adequate protection of existing and proposed water supply reservoirs, through a combination of accepted protection measures, which address threats to both the water quality and capacity of the sites. It would be useful for the County to identify what actions have been taken in this regard and whether such programs have been successful. As previously discussed, Carroll County added Chapter 218 Water Resource Management to the County Code in April 2004. Delineated management areas include a Surface Watershed Area encompassing the drainage basins of all existing and proposed surface water reservoirs in Carroll County. The County's May 2004 *Water Resource Management Manual* also provides for a Surface Water Management Zone which is a sub-area of the Surface Watershed Area and establishes a zone of extended vulnerability surrounding the reservoirs and tributary streams. This zone is based on slope and soil characteristics within each watershed and is measured from the normal pool edge of a reservoir and from the bank of a tributary stream.

Potential Impacts of New State Stormwater Management Regulations. The State of Maryland's forthcoming revised stormwater management regulations will require that new development use "environmental site design" (ESD) methods to reduce stormwater runoff and pollution. Among the ESD techniques identified in Maryland's stormwater design manual are rainwater harvesting methods, such as the use of rain barrels and cisterns to collect stormwater for non-potable uses (e.g., irrigation, car washing). Larger scale stormwater reuse methods are also a viable method for reducing the demands on potable water supplies. The new State Stormwater Management Regulations should enhance onsite infiltration of rainfall and provide some benefit for future water supplies. Benefits of these ESD methods for new development should be considered in the Water Balance Assessments for Task 2, primarily by adjustment of the factor used to account for the impact of future development on groundwater recharge rates.

Impacts of Water Conservation. Demand management methods have received greater attention over the past 10 years and were not emphasized in the 1988 study. Carroll County has begun to draft a Water Conservation Plan. The County's existing demand management efforts should be described in the WRE. Also, future water demand projections could be adjusted to reflect the assumed benefits of a more

aggressive demand management program. The demand management program should include both temporary use restrictions triggered during drought periods as well as long-term conservation measures designed to reduce demand during both normal and dry periods.

Chapter 6 - Quarries as Alternative Water Supplies

Current Opportunities. The City of Westminster's construction of an emergency waterline connection between Medford (Genstar) Quarry and Cranberry Reservoir will be addressed in the WRE. Carroll County's September 2007 *Master Plan for Water and Sewerage* does address pursuit of this option and the City's associated water rights in this regard.

The City of Westminster is pursuing a permanent emergency connection of the Medford (Genstar) Quarry. In that regard, the City has water rights assigned to it by the County resulting from an older agreement with the quarry's predecessor. This connection would be a 12-inch water pipe that would be buried along MD 31. The pipe would be approximately 7 miles long and would discharge the water into Cranberry Reservoir. This connection would be used only for emergency purposes. The City of Westminster also has an application pending to extend a raw water line from Hyde's Quarry to connect into the City's system for additional supply during emergency situations.

Reconsideration of the Lehigh Quarry just south of Union Bridge may be warranted because there is an inactive quarry there that has filled with water (Lehigh Quarry Lake) that discharges to Sams Creek. Improvements would likely be needed at the existing floating lake pump station to allow for a significant drawdown of the lake without interrupting or significantly impacting the operation of the existing pump station. There is also a Lehigh quarry in New Windsor that will be considered in the WRE.

Chapter 7 – Preface to Volume Two

WRE Updates of Demand and Available Groundwater Supply. For the County's WRE, the basis for the required quantity of new source development in Figure 7-1 should be updated to be consistent with the methods being used to estimate available recharge and future water demand for the WRE. Notably, the basis for population growth is now the County's own Buildable Land Inventory analysis, and groundwater availability is now being determined according to the recent example provided by MDE's May 2006 *An Evaluation of the Water Resources in the Catoctin Creek Watershed.*

In terms of water quality protection, there should be mention of the more stringent urban stormwater BMP requirements based on Maryland's current and forthcoming stormwater management regulations, such "environmental site design" (ESD) methods to reduce stormwater runoff and pollution..

Chapters 8 – 14 – Designated Growth Areas

These seven chapters describe water resources and water supplies specific to the designated growth areas[1] (DGAs) of Hampstead, Manchester, Mount Airy, New Windsor, Taneytown, Union Bridge, and Westminster. Freedom-Sykesville, the largest populated area in Carroll County, was notably absent from Volume Two. It should be noted that these discussions have largely been superseded by updated descriptions of existing and proposed water sources in Carroll County's September 2007 *Master Plan for*

[1] Called "community planning areas" in the 1988 report

Water and Sewerage ("the 2007 Master Plan"), and associated water and wastewater capacity management planning (CMP) documentation. From a state perspective, the approach of evaluating water resources on a service area/DGA basis is now largely superseded by evaluations on a watershed basis as required by the MDE's current master planning guidelines.

The purpose of each of the DGA chapters in Volume Two (Chapters 8 through 14) was to provide a summary of the status of water resources, activities, and development in each of the DGAs in the county. The second figure in each of the DGA chapters summarized the current (as of 1988) and projected status of water resources by comparing water average day and maximum month demands with 1988 MDE allocations of each water source in the respective DGA. In almost all cases, the 1988 projected average daily demand was higher than the projected maximum monthly demand because of the way in which each was derived. The projected average daily demands were based on an assumed expansion and build-out of the service area, as well as increased per capita usage rates, whereas the projected maximum monthly demands were based on a straight line extrapolation of (then) recent maximum month usage data.

Data from the 2007 Master Plan and the December 2008 CMP worksheets (provided to Malcolm Pirnie in early January 2009) were used to update the information in the water resource summary figures for each of the DGAs presented in the 1988 study. Demand projections for each DGA were based on the allocation schedule presented in the worksheets. Build-out was assumed to occur in 2040 and demands are based on the total demand for approved but undeveloped lots and building permits. The information was also supplemented by recent withdrawal and allocation data from the MDE to determine the capacity and usage of individual sources. Preliminary demand projections for each DGA were also included and were estimated as part of the water balance assessment of the County's watersheds currently under preparation by Malcolm Pirnie. The summary figures and associated tables are presented in the Appendix, whereas a brief description of water resources in each DGA is presented below. A detailed discussion of the state of water resources and associated infrastructure in each of the DGAs is located in the 2007 Master Plan.

Overall, the most recent available data on average water usage in the entire County (reported to MDE for the 2007 reporting year) was 11.75 mgd, which was 61% of the total permitted allocation of 19.25 mgd. Reported average water usage over the same period in the service areas of the DGAs was 7.49 mgd, or about 77% of the total allocation of 9.69 mgd associated with the water service areas (Table A-1, Figure A-1). However, several individual DGAs have experienced demands approaching their current MDE average day allocation limits and may soon be water-resources-limited without additional sources or cross-jurisdictional agreements.

Freedom-Sykesville

The Freedom-Sykesville service area was not included in the 1988 study. Average water usage in Freedom-Sykesville has been approximately 80% of the combined allocation of the service area's sources (Table A-2). Build-out demand projections for the Freedom-Sykesville service area range from 3.0 mgd (based on the preliminary water balance projection) to 3.8 mgd (2007 Master Plan) compared to the current allocation of 3.1 mgd. Given the range of estimates and an assumed build-out year of 2040, the service area's current supply of water may be adequate until as early as 2022 or as late as 2040 (Figure A-2). However, the current allocation at the Liberty Reservoir, the service area's main source of water, is set to expire in July 2018. Renewal of the allocation is vital to ensuring the continued supply.

Chapter 8 – Hampstead

Reported withdrawals in the Hampstead DGA have been growing at a nearly linear rate over the past 20 years (Table A-3; Figure A-3). However, current CMP projections of demand growth in the service area presented in the CMP indicate that the demands in Hampstead will remain relatively constant at an approximate rate of 500,000 gpd, which is slightly less than the current average daily allocation.

Hampstead is currently approaching build-out and additional groundwater sources will need to be located in order to meet any increasing demands due to infill development and/or expansion of the service area, which are projected to reach approximately 1 mgd by 2040 according to the preliminary projections estimated in the water balance. Further development in the priority and future service areas is currently limited by sewage treatment capacity and school facilities. Hampstead has applied for an expansion of its current groundwater permit to 580,000 gpd.

Chapter 9 - Manchester

Reported withdrawals in the Manchester DGA have increased slowly over the past 20 years and have been less than the demands projected in the 1988 study (Table A-4). Current projections of demand growth in the service area presented in the CMP worksheets indicate that the demands in Manchester will remain relatively constant over the next decade (Figure A-4). Projected demands associated with the build-out of undeveloped lots are anticipated to be small relative to current demand levels.

Chapter 10 – Mount Airy

Mount Airy is currently under a consent order from the Maryland Department of the Environment. The current capacity of the water system cannot meet the total demand for development in the pipeline. A new water source must be brought into the system by April of 2011. The Town is currently exploring several options for bringing additional water into the system. An alternative must be chosen and submitted to MDE for approval by June 30, 2009. Longer term plans include possibly obtaining water from the County-owned property at Gillis Falls, among other options. Growth in Mount Airy may be limited by a cap on the number of building permits issued per year until water resource limitations are resolved.

Chapter 11 – New Windsor

Reported withdrawals in the New Windsor DGA approached the average day allocation limit in 2003 (Table A-6). Reported withdrawals have since remained well below the limit and demands are projected to remain relatively constant over the next decade based on the anticipated demand from undeveloped lots provided in the CMP worksheets (Figure A-6). The break in slope in the demand projection graph (Figure A-6) reflects a linear interpolation to build-out between 2017 and 2040. As this graph indicates, current water appropriations are insufficient to support build-out of this designated growth area. As of the 2007 Master Plan, several well tests were planned to determine their suitability as new sources for the DGA.

Chapter 12 - Taneytown

Reported withdrawals in the Taneytown DGA have increased significantly in the period between 2003 and 2007 (Table A-7), and will likely approach the average day limit of existing allocations within the next decade given the present trend (Figure A-7). Up to 32 percent of the withdrawals might be lost to leaks in the distribution system. Reductions of significant leaks may delay the need for the proposed source at Big Pipe Creek to meet growing demands. Taneytown is currently under a consent order limiting allocation of water until the completion of two wells and existing capacity improvements.

Chapter 13 - Union Bridge

Reported withdrawals in the Union Bridge DGA approached the average day allocation limit in 2003 (Table A-8). Reported withdrawals have since remained well below the limit and demands are projected to remain relatively constant over the next decade based on the anticipated demand from undeveloped lots provided in the CMP worksheets (Figure A-8). The break in slope in the CMP demand projection graph (Figure A-6) reflects a linear interpolation to build-out between 2017 and 2040. As this graph indicates, current water appropriations are insufficient to support build-out of this designated growth area. Should development activity increase in Union Bridge in the future, additional allocations would be required.

Chapter 14 - Westminster

Reported withdrawals in the Westminster DGA have been less than 80% of the average day allocation limit (Table A-9). Demands are projected to increase over the next decade and then continue at a relatively constant level based on the anticipated demand from undeveloped lots provided in the CMP worksheets (Figure A-9). Preliminary projections associated with the water balance indicate that build-out demands may reach approximately 4 mgd at build-out. Recent events have indicated that the Cranberry intake, Westminster's major water source, has a relatively high frequency of low flow events and may not be adequate under drought conditions (2007 Master Plan). Furthermore, some of the City's wells have detected contaminants which impact their suitability for use as supply water. Westminster is continuing its short-term plan of developing new wells to keep pace with growing demands and its long term plan of developing the Union Mills Reservoir as a supplemental source.

Chapter 15 – Carroll County

The conclusions applicable to Carroll County as a whole should be revisited after the County has completed its Water Resources Element and should also be consistent with major conclusions from Carroll County's September 2007 *Master Plan for Water and Sewerage.*

Appendix A

TABLE A1 - CARROLL COUNTY: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

		AVERAGE MONTH						MAX MONTH					
Designated Growth Area	WAPID	2003	2004	2005	2006	2007	Permitted Avg Day	2003	2004	2005	2006	2007	Permitted Max Month
Freedom	CL1970S030	2,270,008	2,220,008	2,239,110	2,205,773	2,187,058	2,400,000	2,397,194	2,302,871	2,488,100	2,475,733	2,444,667	3,000,000
	CL1998G002	102,613	96,278	76,819	73,836	72,614	227,000	151,298	137,644	110,968	93,516	98,581	340,000
	CL1998G102	--	--	--	--	56,597	211,000	--	--	--	--	118,365	381,000
	CL1998G202	--	--	--	--	--	257,000	--	--	--	--	--	650,000
Hampstead	CL1974G062	180,726	194,052	228,425	187,458	191,795	273,000	206,387	233,387	263,968	217,548	253,600	387,500
	CL1974G162	215,836	213,011	199,049	222,340	250,918	218,400	237,968	243,517	241,194	240,548	279,467	315,800
	CL1974G362	17,077	16,650	16,430	17,655	16,937	30,000	18,200	17,258	18,194	18,100	17,935	40,000
Manchester	CL1966G112	118,592	131,451	115,806	118,078	133,408	134,000	147,063	144,897	129,068	150,953	146,250	199,000
	CL1966G212	11,630	12,189	11,234	10,378	10,242	38,000	16,397	15,062	15,281	13,445	13,357	63,000
	CL1995G046	51,059	48,018	45,547	50,194	47,218	69,700	58,390	53,271	56,660	63,294	69,690	116,400
	CL2002G005	--	--	7,697	15,506	14,231	6,000	--	--	18,787	20,239	17,077	10,000
	CL2004G021						9,300						11,800
	CL1966G012	72,444	79,069	106,286	90,094	95,726	324,000	91,280	101,797	124,819	113,187	114,616	486,000
Mount Airy	FR1976G007	341,877	317,545	270,816	300,200	302,827	307,000	446,687	377,639	320,000	358,710	368,871	347,000
	CL1987G076	44,076	55,992	29,984	32,003	27,036	38,000	102,255	66,839	46,000	34,290	38,161	43,000
	CL1987G176	--	77,713	77,375	58,748	82,696	120,000	--	174,968	187,357	68,742	126,677	180,000
	FR1976G107	69,606	141,516	84,851	74,036	92,584	112,000	176,309	156,823	124,023	98,632	113,744	139,000
	FR1995G020	163,421	158,552	118,753	123,488	136,161	162,000	171,430	194,048	169,873	140,213	168,487	210,000
	FR2001G022	--	23,779	85,099	81,397	82,458	79,000	--	100,433	153,433	99,871	114,645	204,000
	CL2000G022	--	--	62,926	78,225	57,952	77,000	--	--	109,250	104,494	77,304	144,000
New Windsor	CL1978G022	122,545	127,740	132,534	105,848	82,481	143,000	141,323	148,323	160,233	127,032	111,355	202,000
	CL1992G049	34,414	26,959	27,490	25,307	21,699	53,000	64,452	30,097	33,500	34,516	36,633	80,000
	CL1977S054	--	--	--	--	--	100	--	--	--	--	--	250,000
Taneytown	CL1978G079	335,181	370,702	364,652	285,564	270,712	390,000	360,645	411,323	410,643	348,516	345,903	475,000
	CL1978G179	66,304	108,049	91,638	80,110	88,537	90,000	122,967	139,267	122,065	92,516	98,645	197,000
	CL2004G018	--	--	--	108,290	149,570	103,000	--	--	--	148,355	173,645	141,000
Union Bridge	CL1979G148	--	23,913	27,690	--	--	42,300	--	57,567	59,000	--	--	82,000
	CL1979G048	198,932	157,221	156,630	131,551	152,164	166,000	231,429	219,655	188,065	169,677	160,645	200,000
Westminster	CL1977G536	185,906	186,254	200,611	219,386	218,957	197,000	217,527	204,339	223,319	273,034	309,148	250,000
	CL1977G236	81,109	85,215	93,795	94,213	88,023	100,000	85,157	97,012	95,051	95,171	95,461	120,000
	CL1977G136	74,145	66,494	56,578	69,571	48,333	170,000	78,643	72,728	71,896	75,250	69,723	180,000
	CL1977G436	146,956	185,109	194,454	195,971	208,446	230,000	177,452	209,340	231,972	215,385	229,992	300,000
	CL1977G336	83,479	77,020	79,834	77,999	81,037	100,000	91,810	83,450	87,589	85,073	91,022	115,000
	CL1977G636	209,168	249,365	236,860	213,262	194,882	300,000	225,752	274,657	274,061	235,184	238,527	350,000
	CL1977G736	103,766	113,129	106,767	81,518	58,836	119,000	123,558	120,339	127,618	112,571	128,819	288,000
	CL1977G836	73,746	60,746	81,431	77,669	99,466	125,000	97,165	93,213	89,860	100,445	119,649	150,000
	CL1957S002	1,798,523	1,901,751	1,923,216	1,861,868	1,868,285	2,000,000	1,963,935	2,024,467	2,292,733	2,231,290	1,999,833	3,000,000
	CL2000G025	71,537	--	28,075	27,376	--	135,000	130,029	--	113,978	115,419	--	500,000
	CL2002S042	--	--	--	--	--	139,000	--	--	--	--	--	187,000
OUTSIDE SERVICE AREAS	CL1951G002	18,496	22,537	18,830	20,689	14,454	30,000	26,100	32,480	25,520	25,819	21,444	50,000
	CL1960G009	13,747	14,051	13,013	12,056	13,467	20,000	15,616	16,713	14,919	13,340	15,552	30,000
	CL1963G001	19,752	17,899	17,558	17,104	16,195	20,000	22,674	19,807	18,913	18,546	17,597	25,000
	CL1963G004	5,828	6,307	5,513	5,821	5,559	7,000	7,025	8,659	6,765	7,247	6,826	10,000
	CL1965G006	9,847	9,882	8,140	7,921	8,123	20,000	12,195	13,695	8,282	9,567	8,803	35,000
	CL1965G013	5,072	4,381	3,924	4,980	4,203	10,000	7,435	6,073	5,363	7,132	5,577	15,000
	CL1966G029	214,637	237,157	230,087	212,680	222,984	300,000	226,638	255,173	241,859	226,245	262,715	360,000
	CL1967G008	--	3,363	6,460	6,551	7,695	9,800	--	6,539	9,335	7,983	9,968	12,700
	CL1969G009	17,071	12,464	14,486	13,706	15,866	20,000	22,291	16,783	18,120	17,752	19,860	33,000
	CL1970G001	13,992	12,088	12,864	12,131	15,104	14,000	16,500	13,300	15,700	16,700	17,400	16,000

TABLE A1 - CARROLL COUNTY: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

		AVERAGE MONTH						MAX MONTH					
Designated Growth Area	**WAPID**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Avg Day**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Max Month**
	CL1970G005	2,138,762	2,048,333	1,948,139	1,819,617	1,845,663	1,360,000	3,375,453	3,403,897	3,477,637	2,533,903	2,740,400	2,969,000
	CL1977G036	239,223	159,447	83,819	203,748	352,438	500,000	255,990	222,374	286,245	272,306	458,452	750,000
	CL1979S068	247	--	3,945	--	3,945	10,000	2,903	--	32,000	--	42,581	40,000
	CL1981G026	--	3,835	--	1,029	323,714	10,000	--	9,756	--	1,692	1,285,833	12,000
	CL1981S016	--	529	1,061	1,061	1,061	4,900	--	6,247	1,153	1,153	1,153	15,000
	CL1987G083	437,348	185,705	692,515	888,197	626,499	1,000,000	495,484	678,194	1,994,323	2,012,903	1,196,800	2,000,000
	CL1987G107	6,654	9,286	10,707	9,951	1,575	33,000	8,168	14,068	16,139	12,839	9,613	53,000
	CL1988G097	4,119	45,783	71,215	72,530	80,493	86,000	18,581	148,487	291,580	216,371	236,059	337,000
	CL1988S081	--	--	--	--	--	3,300,000	--	--	--	--	--	6,000,000
	CL1989G002	1,553	3,230	--	3,858	--	32,400	5,806	14,981	--	13,239	--	127,600
	CL1989S002	2,986	17,828	--	17,925	--	5,200	10,000	78,506	--	80,555	--	21,000
	CL1989S077	--	--	--	--	2,740	56,000	--	--	--	--	20,968	720,000
	CL1989S078	--	--	--	--	3,562	37,000	--	--	--	--	31,452	720,000
	CL1990G033	--	--	--	--	--	50,000	--	--	--	--	--	110,000
	CL1990G049	5,929	1,251	19,554	12,653	42,607	50,400	31,510	15,267	86,317	55,000	114,771	202,200
	CL1990G051	28,410	50,697	61,439	64,008	80,271	60,000	156,777	132,258	188,414	164,548	206,645	230,000
	CL1990S049	--	6,947	11,442	33,542	12,268	10,000	--	39,300	65,883	89,889	55,650	40,000
	CL1991S032	--	--	--	--	13,558	62,100	--	--	--	--	164,956	720,000
	CL1991S102	--	--	--	--	--	12,000	--	--	--	--	--	144,000
	CL1992G087	567	391	880	1,890	2,526	12,500	1,774	1,226	3,065	6,913	8,742	19,000
	CL1992S023	--	2,164	438	444	1,148	24,000	--	11,290	3,355	3,355	6,581	240,000
	CL1992S056	--	--	--	--	--	120,000	--	--	--	--	--	1,440,000
	CL1992S090	22,496	20,538	26,729	32,706	38,954	55,000	60,832	62,129	78,720	100,161	97,680	150,000
	CL1993S019	259,135	247,137	257,517	254,407	222,016	500,000	302,819	277,584	309,243	318,432	280,324	850,000
	CL1993S026	--	--	10,904	7,430	28,548	38,000	--	--	41,935	46,452	133,871	663,000
	CL1993S027	--	--	16,537	17,359	--	31,000	--	--	58,065	52,097	--	384,000
	CL1993S028	--	--	18,575	47,592	56,630	66,000	--	--	53,333	158,667	166,667	1,008,000
	CL1993S029	--	--	--	--	24,460	187,000	--	--	--	--	61,935	864,000
	CL1993S030	--	--	--	--	--	43,000	--	--	--	--	--	768,000
	CL1994S029	23,726	14,072	25,249	48,132	39,899	60,000	96,000	50,400	102,194	139,355	163,200	451,000
	CL1995G040	21,883	24,659	20,702	25,171	31,924	20,000	25,507	27,704	27,553	28,841	42,289	24,000
	CL1995G053	6,135	6,673	7,104	6,674	6,941	10,100	6,926	8,828	9,137	7,535	8,367	17,000
	CL1997G026	--	--	--	--	--	1,000,000	--	--	--	--	--	2,000,000
	CL1997S021	--	--	--	--	707	10,000	--	--	--	--	8,323	36,000
	CL1998G008	9,710	9,689	9,804	9,695	9,381	9,900	26,877	28,530	24,341	26,466	25,393	30,000
	CL2000G004	--	600	601	601	601	8,000	--	1,536	1,536	1,536	1,536	24,000
	CL2002G038	--	310	2,920	3,789	3,828	10,000	--	1,800	8,064	11,462	17,193	150,000
	CL2004G019	--	--	40,996	69,090	61,765	144,000	--	--	79,500	84,539	86,574	150,000
	CL2005S001	--	--	--	10,060	20,022	60,000	--	--	--	27,871	52,800	150,000

TABLE A1 - CARROLL COUNTY: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

		AVERAGE MONTH						MAX MONTH					
Designated Growth Area	**WAPID**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Avg Day**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Max Month**
	CL2006G023	--	--	--	--	--	500	--	--	--	--	--	800
	CL2006G024	--	--	--	--	--	1,000	--	--	--	--	--	1,800
	CL2007G009	--	--	--	--	--	15,000	--	--	--	--	--	60,000
Total (Reported to MDE)[3]		10,772,001	10,724,722	11,252,136	11,371,712	11,753,280	19,249,600	13,570,583	14,129,812	16,763,063	15,589,360	16,903,041	39,612,600
Total inside DGAs (Reported to MDE)[2,3]		7,244,676	7,525,491	7,578,466	7,394,912	7,489,885	9,694,800	8,332,700	8,506,229	9,158,556	8,770,949	8,790,494	14,334,500
Total (Dec 2008 Worksheet)[2,3]		**7,109,533**	**7,303,219**	**7,361,351**	**7,130,937**	**6,925,925**	--	**7,964,859**	**8,433,762**	**8,306,974**	**8,016,028**	**7,584,053**	--
1988 Study Projected[1,2,3]		7,504,350	7,733,800	7,963,250	8,192,700	8,422,150	--	11,043,500	11,398,000	11,752,500	12,104,200	12,455,900	--

Notes:

1 Average Month Values from the 1988 study are based on the Total Service Area of each Designated Growth Area; Max month values from the 1988 study are based on a straightline projection of actual max month usage from 1979 through 1986.

2 Values summed over DGAs and do not include un-serviced areas in Carroll County

3 Values include cross-jurisdictional withdrawals from Frederick County into the Mounty Airy Water Service Area

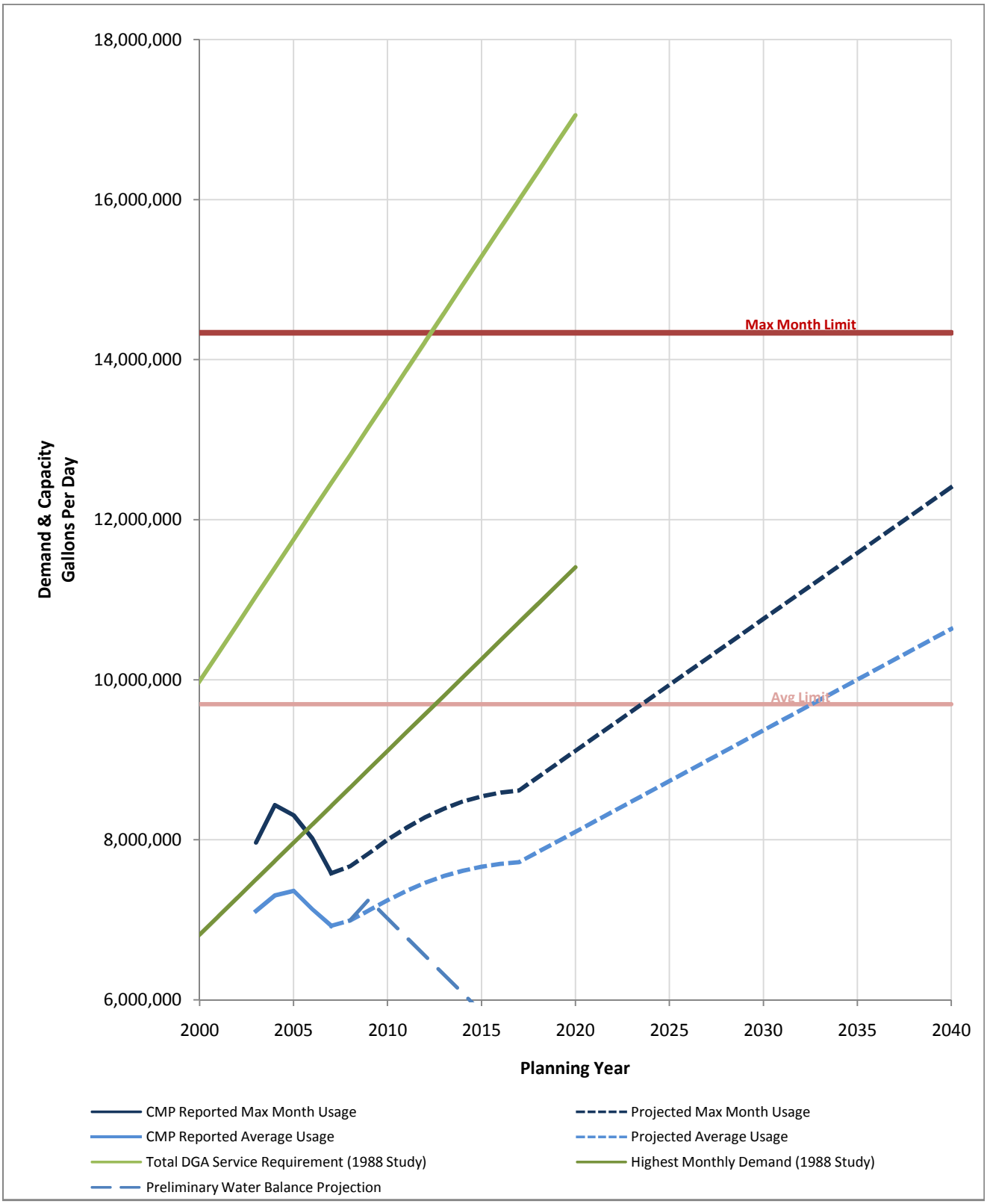

FIGURE A1
Carroll County Projected Demands
(Serviced Areas Only)

TABLE A2 - FREEDOM: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

Freedom

		AVERAGE MONTH						MAX MONTH								
Facility	**WAPID**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Avg Day**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Max Month**	**1988 Study Capacity**	**1988 Study Capacity - Projected**	**COMMENTS**
Liberty Reservoir	CL1970S030	2,270,008	2,220,008	2,239,110	2,205,773	2,187,058	2,400,000	2,397,194	2,302,871	2,488,100	2,475,733	2,444,667	3,000,000			- Total authorization to Carroll County is 4.2 mgd average and 6.0 mgd max month expiring July, 2018 (2007 Report)
Fairhaven 22B	CL1998G002	102,613	96,278	76,819	73,836	72,614	227,000	151,298	137,644	110,968	93,516	98,581	340,000			
Raincliffe RC-1	CL1998G102	--	--	--	--	56,597	221,000	--	--	--	--	118,365	381,000			
Springfield Wells	CL1998G202	--	--	--	--	--	257,000	--	--	--	--	--	650,000			- VOC levels may require additional treatment
2007 Proposed: Liberty Reservoir Expansion[2]							*3,200,000*						*4,000,000*			
Total (Reported to MDE)		2,372,622	2,316,286	2,315,929	2,279,608	2,316,268	3,105,000	2,548,491	2,440,515	2,599,068	2,569,249	2,661,612	4,371,000	--	--	
Total (Dec 2008 Worksheet)		**2,173,641**	**2,141,841**	**2,182,422**	**2,142,442**	**2,165,658**		**2,462,839**	**2,408,194**	**2,416,433**	**2,267,083**	**2,289,104**				
1988 Study Projected[1]		--	--	--	--	--		--	--	--	--	--				

Notes:

1 Average Month Values and Max Month demand/consumption projections for the Freedom DGA were not presented in the 1988 study

2 Proposed permitted values not included in totals, permitted average day estimated using the existing max month to average month ratio

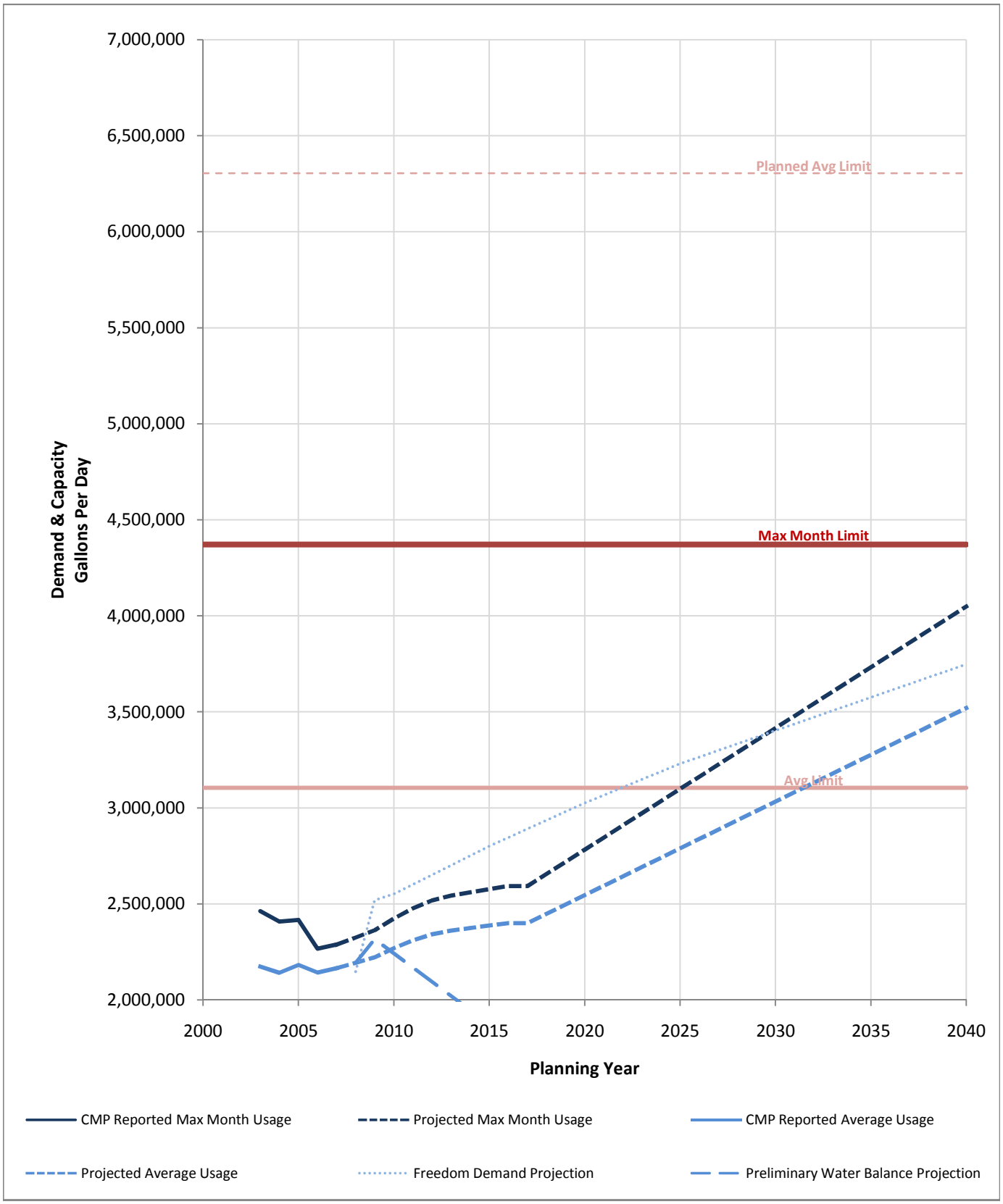

FIGURE A2
Freedom DGA Projected Demands

TABLE A3 - HAMPSTEAD: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

Hampstead

		AVERAGE MONTH						MAX MONTH								
Facility	**WAPID**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Avg Day**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Max Month**	**1988 Study Capacity**	**1988 Study Capacity - Projected**	**COMMENTS**
PW11,12,20,21,28, 29, 30, 31, 32, A3	CL1974G062	180,726	194,052	228,425	187,458	191,795	273,000	206,387	233,387	263,968	217,548	253,600	387,500	82,000	82,000	- trace PCE and Phenol detected (1988 report), high nitrate levels in PW 20 and 21 (2007 Report)
PW13,15,19,23,26,27,24, 25, Stansbury TW-C, Oakmont Green Well	CL1974G162	215,836	213,011	199,049	222,340	250,918	218,400	237,968	243,517	241,194	240,548	279,467	315,800	115,000	115,000	
PW22	CL1974G362	17,077	16,650	16,430	17,655	16,937	30,000	18,200	17,258	18,194	18,100	17,935	40,000	--	--	
																General - Wells 2,5,6,7,8,10,11,12, and 15 have all had elevated nitrate-nitrogen levels due to land use (1988 report) - New groundwater source search and development ongoing
1988 Proposed: PW-7, Corbin & Small Crossing Sites															138,000	
2007 Proposed: Groundwater Wells							*580,000*									
Total (Reported to MDE)		413,638	423,713	443,904	427,452	459,649	521,400	462,555	494,162	523,355	476,197	551,002	743,300	197,000	335,000	
Total (Dec 2008 Worksheet)		**413,638**	**424,874**	**436,699**	**430,458**	--		**455,000**	**475,000**	**449,000**	**441,000**	--				
1988 Study Projected[1]		484,875	499,000	513,125	527,250	541,375		1,500,000	1,570,000	1,640,000	1,708,800	1,777,600				

Notes:

1 Average Month Values from the 1988 study are based on the Total Service Area of each Designated Growth Area; Max month values from the 1988 study are based on a straightline projection of actual max month usage from 1979 through 1986.

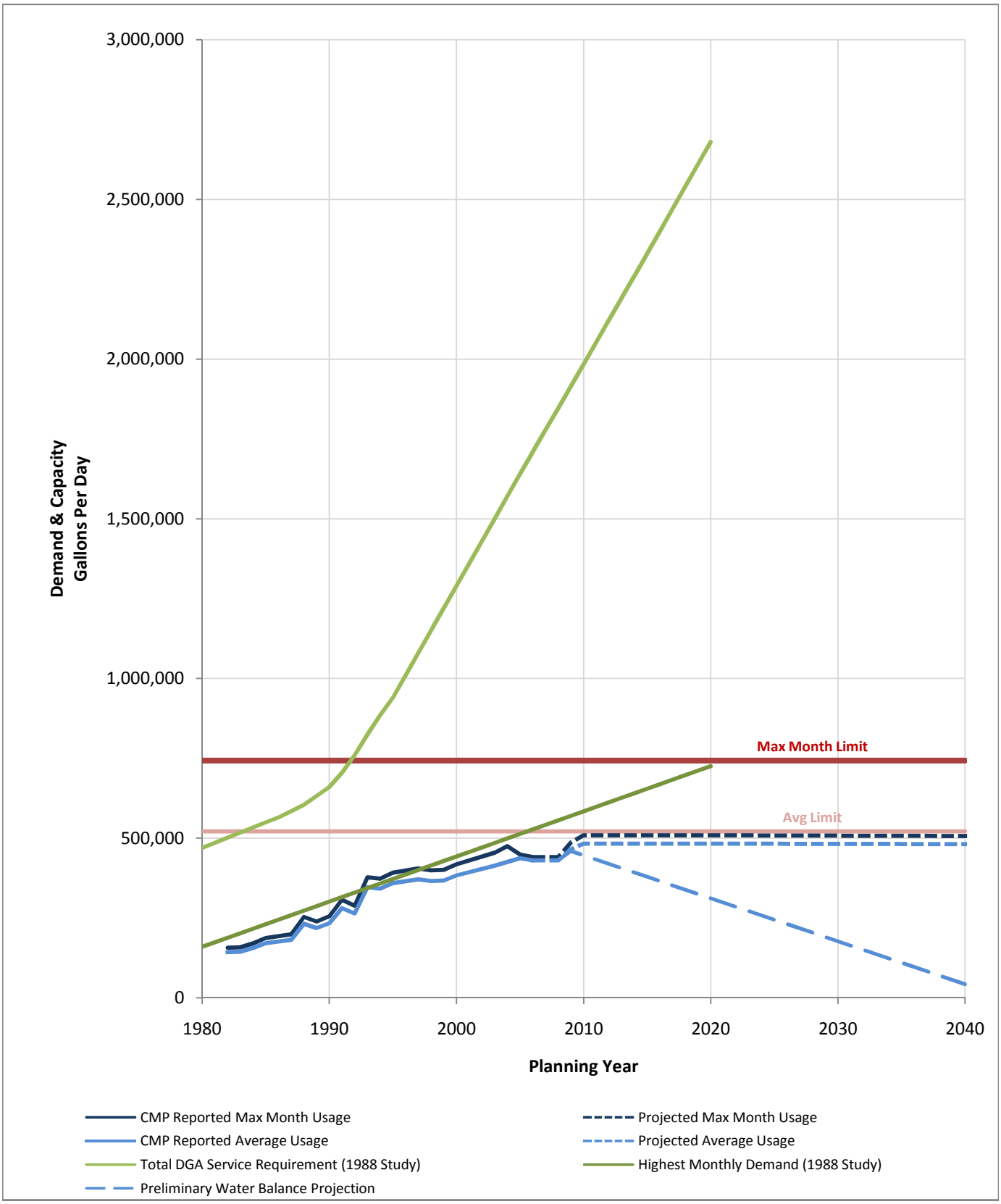

FIGURE A3
Hampstead DGA Projected Demands

TABLE A4 - MANCHESTER: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

Manchester

		AVERAGE MONTH						MAX MONTH								
Facility	**WAPID**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Avg Day**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Max Month**	**1988 Study Capacity**	**1988 Study Capacity - Projected**	**COMMENTS**
Backman Rd Well	CL1966G112	118,592	131,451	115,806	118,078	133,408	134,000	147,063	144,897	129,068	150,953	146,250	199,000	70,000	121,000	- interference with local domestic wells (1988 report)
Crossroads Well #1																
Crossroads Well #2																
Hallie Hill Well																
Patricia Ct Well	CL1966G212	11,630	12,189	11,234	10,378	10,242	38,000	16,397	15,062	15,281	13,445	13,357	63,000	23,000	125,000	- small aquifer transmissivity (1988 report)
Manchester Farms	CL1995G046	51,059	48,018	45,547	50,194	47,218	69,700	58,390	53,271	56,660	63,294	69,690	116,400			- high nitrates due to past land uses (1988 report)
Park Ridge Well	CL2002G005	--	--	7,697	15,506	14,231	6,000	--	--	18,787	20,239	17,077	10,000			
Chauncy Hill Well[2]	CL2004G021	N/A	N/A	N/A	N/A	N/A	9,300	N/A	N/A	N/A	N/A	N/A	11,800			- permit not found in MDE Database of reported values
Walnut St Spring	CL1966G012	72,444	79,069	106,286	90,094	95,726	324,000	91,280	101,797	124,819	113,187	114,616	486,000	122,000	168,000	- variable flow rates following seasonal water table fluctuations (1988 report)
Walnut St Well																- low levels of coliform bacteria (1988 report)
Lippy Well														51,000	119,000	
Holland Dr Well																
Black Farm Well #1																
Black Farm Well #2																
Ferrier Rd Wells A, B, C																
Total (Reported to MDE)		253,724	270,727	286,571	284,250	300,826	581,000	313,130	315,026	344,614	361,118	360,991	886,200	266,000	533,000	- new wells will supplement additional demand in the future (2007 Report)
Total (Dec 2008 Worksheet)		**259,568**	**270,444**	**286,369**	**283,086**	**299,693**		**287,264**	**293,519**	**307,506**	**312,200**	**325,345**				
1988 Study Projected[1]		602,750	622,000	641,250	660,500	679,750		1,201,600	1,244,800	1,288,000	1,331,200	1,374,400				

Notes:

1 Average Month Values from the 1988 study are based on the Total Service Area of each Designated Growth Area; Max month values from the 1988 study are based on a straightline projection of actual max month usage from 1979 through 1986.

2 Chauncy Hill Well was not found in the MDE Allocation and reported withdrawal database, but reported in the County CMP December 2009 worksheets

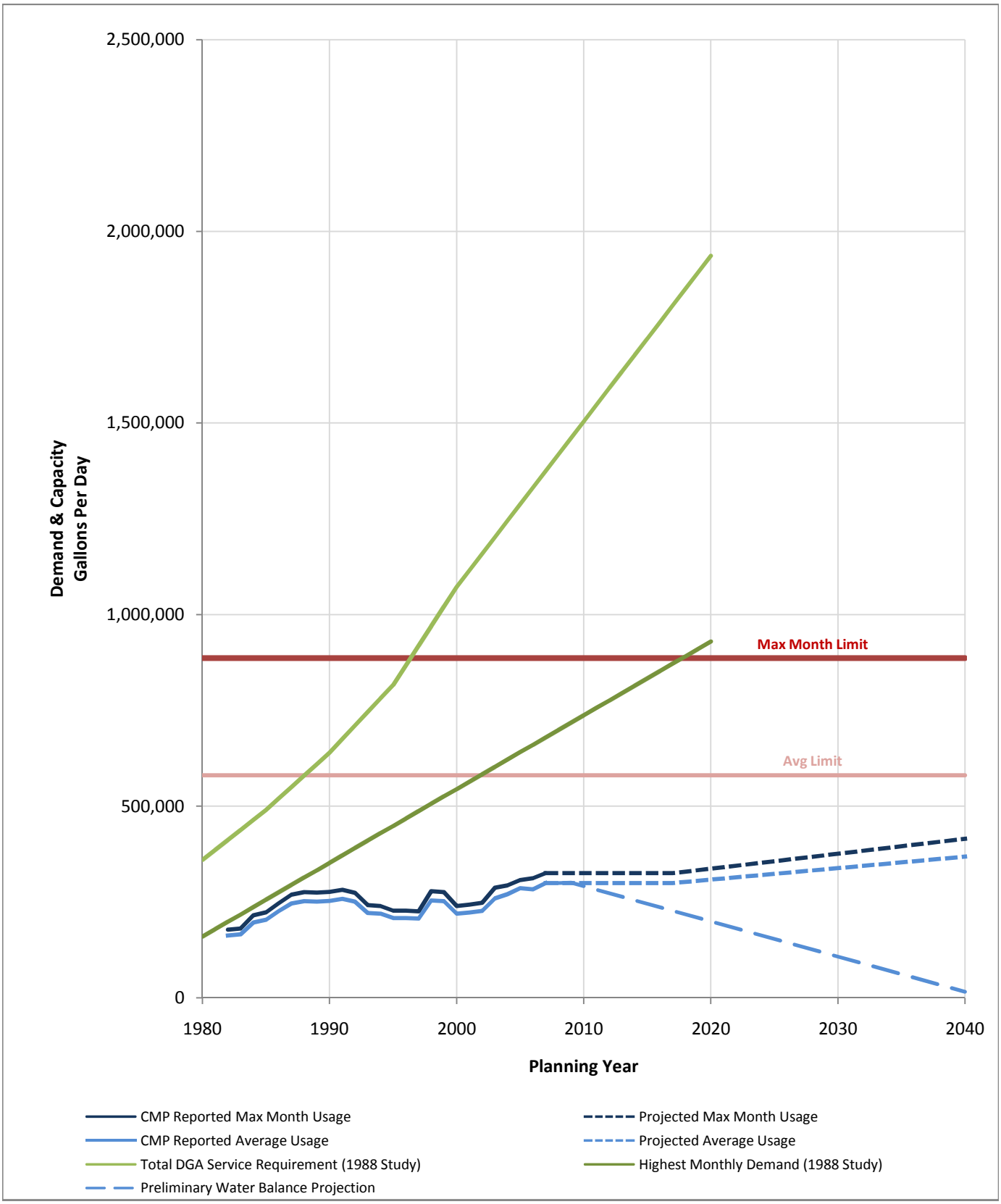

FIGURE A4

Manchester DGA Projected Demands

TABLE A5 - MOUNT AIRY: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

Mount Airy

		AVERAGE MONTH						MAX MONTH								
Facility	**WAPID**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Avg Day**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Max Month**	**1988 Study Capacity**	**1988 Study Capacity - Projected**	**COMMENTS**
#1-4	FR1976G007	341,877	317,545	270,816	300,200	302,827	307,000	446,687	377,639	320,000	358,710	368,871	347,000	300,000	300,000	-high aquifer storativity, PW-1 has decreasing yield, high water quality, radon detected, high vulnerability (1988 report)
#5	CL1987G076	44,076	55,992	29,984	32,003	27,036	38,000	102,255	66,839	46,000	34,290	38,161	43,000	80,000	80,000	- elevated nitrates and trace levels of lead and coliform bacteria (1988 report)
#6	CL1987G176	--	77,713	77,375	58,748	82,696	120,000	--	174,968	187,357	68,742	126,677	180,000	--	--	
#7	FR1976G107	69,606	141,516	84,851	74,036	92,584	112,000	176,309	156,823	124,023	98,632	113,744	139,000	--	--	
#8	FR1995G020	163,421	158,552	118,753	123,488	136,161	162,000	171,430	194,048	169,873	140,213	168,487	210,000	--	--	
#9	FR2001G022	--	23,779	85,099	81,397	82,458	79,000	--	100,433	153,433	99,871	114,645	204,000	--	--	
#10	CL2000G022	--	--	62,926	78,225	57,952	77,000	--	--	109,250	104,494	77,304	144,000	--	--	
																General - Old Food-Rite Well in Frederick Co, was potentially productive, but potentially improperly abandonned
2007 Proposed: Gillis Falls							*3,800,000*						*4,100,000*			
Total (Reported to MDE)		618,981	775,097	729,804	748,097	781,713	895,000	896,681	1,070,750	1,109,937	904,952	1,007,889	1,267,000	380,000	380,000	
Total (Dec 2008 Worksheet)		**682,928**	**765,000**	**714,916**	**716,891**	**757,095**		**723,143**	**832,339**	**802,650**	**792,906**	**829,959**				
1988 Study Projected[1]		408,125	415,000	421,875	428,750	435,625		1,292,000	1,326,000	1,360,000	1,390,000	1,420,000				

Notes:

1 Average Month Values from the 1988 study are based on the Total Service Area of each Designated Growth Area; Max month values from the 1988 study are based on a straightline projection of actual max month usage from 1979 through 1986.

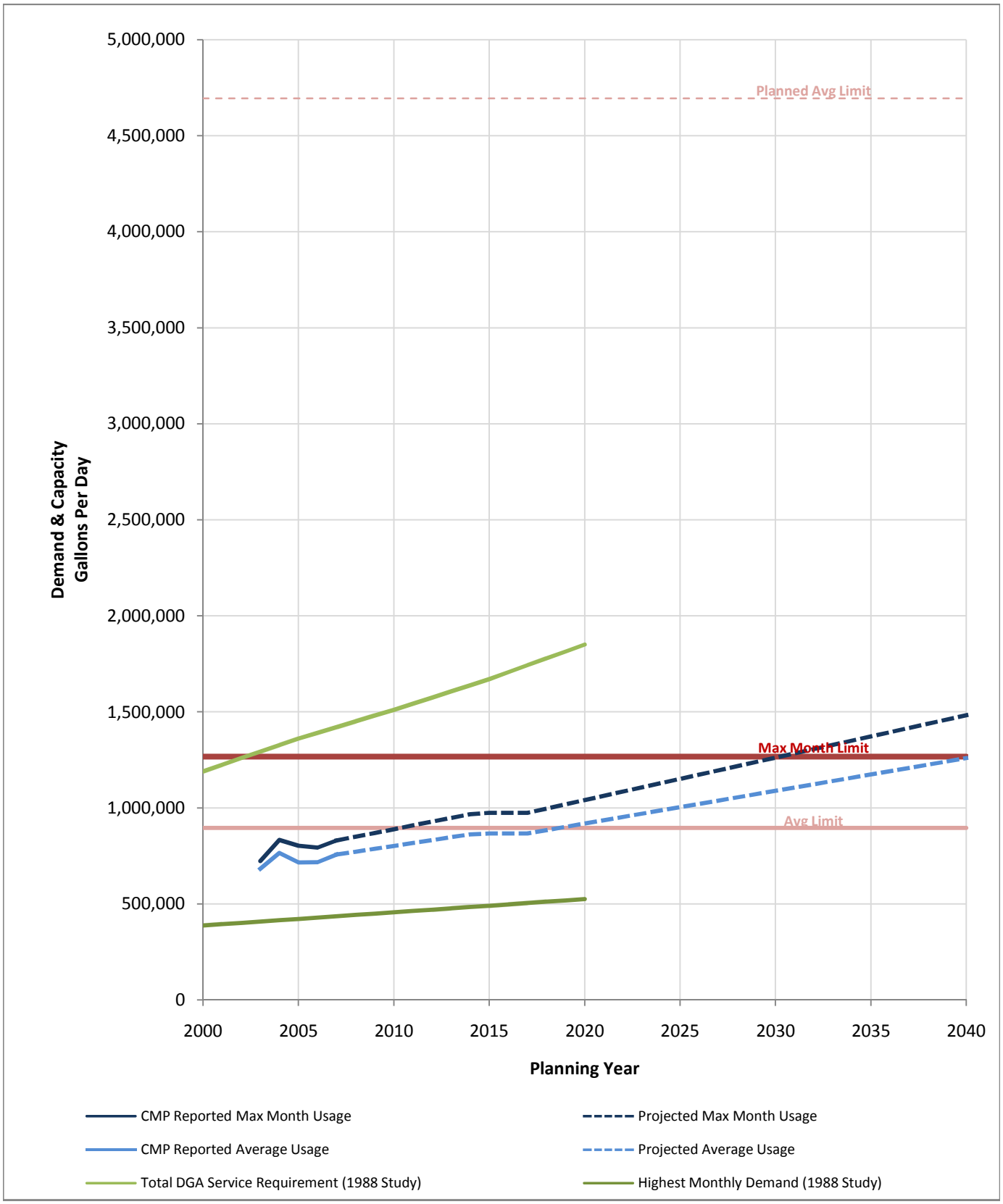

FIGURE A5
Mount Airy DGA Projected Demands

TABLE A6 - NEW WINDSOR: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

New Windsor

		AVERAGE MONTH						MAX MONTH							
Facility	**WAPID**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Avg Day**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Max Month**	**1988 Study Capacity**	**1988 Study Capacity - Projected**	**COMMENTS**
Main Spring	CL1978G022	122,545	127,740	132,534	105,848	82,481	143,000	141,323	148,323	160,233	127,032	111,355	202,000	120,000	270,000	
Roops Meadow Spring																- trace coliform bacteria
Dennings Well (DS-1)																- trace coliform bacteria
Main Spring Well (MSF-5)																- reduced flow in late summer and fall
Hillside Wells (1&2)	CL1992G049	34,414	26,959	27,490	25,307	21,699	53,000	64,452	30,097	33,500	34,516	36,633	80,000			
Dickinson Run		--	--	--	--	--	100	--	--	--	--	--	250,000			
	CL1977S054															- limited reliability of source due to small watershed area, with high levels of coliform bacteria (1988 report)
2007 Proposed:																
MSF-6																
Atlee Ridge Well																
Total (Reported to MDE)		156,959	154,699	160,025	131,155	104,181	196,100	205,774	178,419	193,733	161,548	147,988	532,000	120,000	270,000	
Total (Dec 2008 Worksheet)		**199,123**	**181,668**	**155,960**	**131,500**	**152,168**		**350,000**	**430,000**	**230,000**	**230,000**	**220,000**				
1988 Study Projected[1]		218,000	224,000	230,000	236,000	242,000		401,200	416,600	432,000	447,600	463,200				

Notes:

1 Average Month Values from the 1988 study are based on the Total Service Area of each Designated Growth Area; Max month values from the 1988 study are based on a straightline projection of actual max month usage from 1979 through 1986.

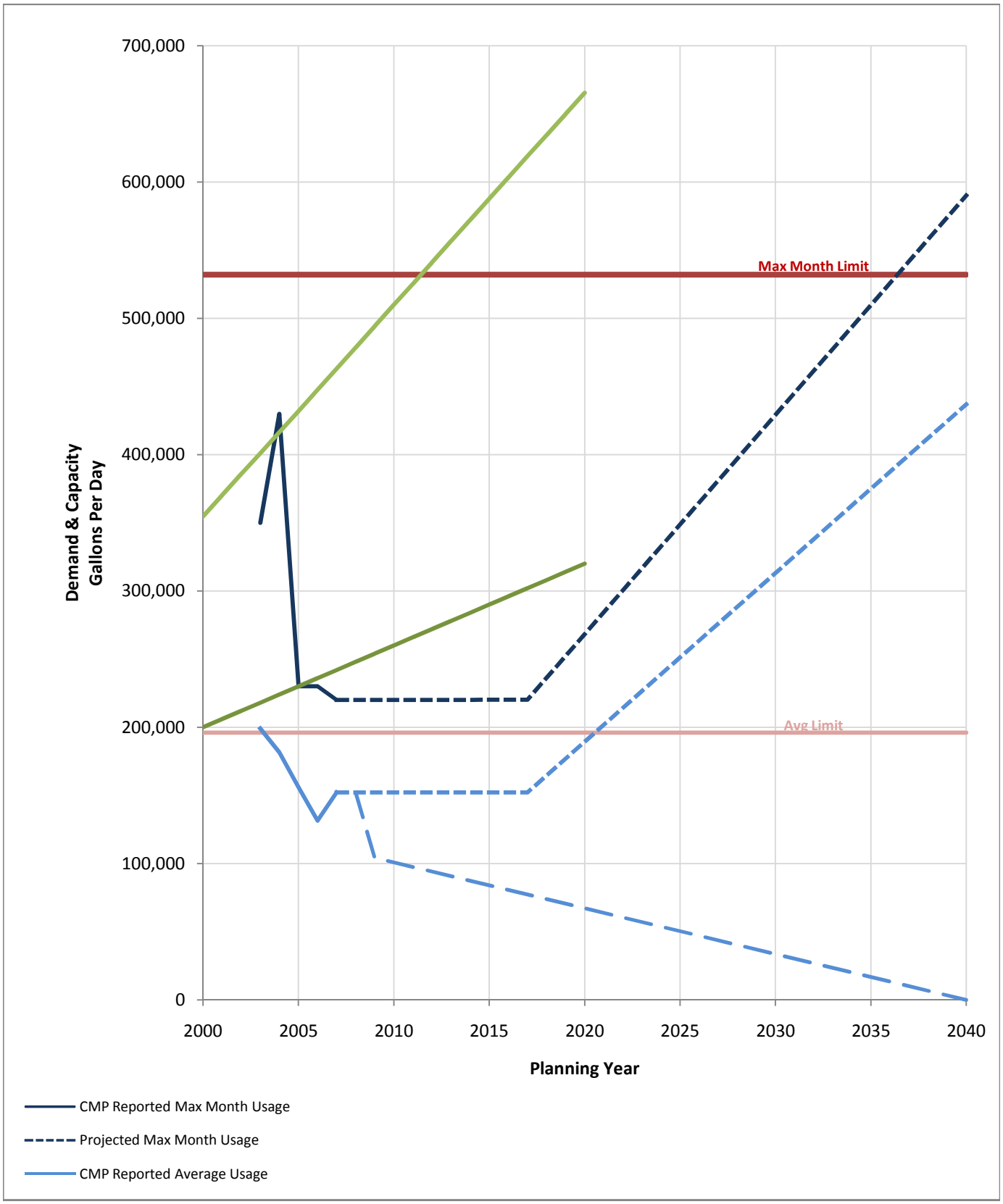

FIGURE A6
New Windsor DGA Projected Demands

TABLE A7 - TANEYTOWN: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

Taneytown

		AVERAGE MONTH						MAX MONTH							
Facility	**WAPID**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Avg Day**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Max Month**	**1988 Study Capacity**	**1988 Study Capacity - Projected**
PW 8,9,11,12&13	CL1978G079	335,181	370,702	364,652	285,564	270,712	390,000	360,645	411,323	410,643	348,516	345,903	475,000	630,000	1,177,000
PW 14	CL1978G179	66,304	108,049	91,638	80,110	88,537	90,000	122,967	139,267	122,065	92,516	98,645	197,000	--	--
PW 15 & 16	CL2004G018	--	--	--	108,290	149,570	103,000	--	--	--	148,355	173,645	141,000	--	--
2007 Proposed: Big Pipe Creek[2]							*1,153,846*						*1,500,000*		
Total (Reported to MDE)		401,485	478,751	456,290	473,964	508,819	583,000	483,612	550,589	532,707	589,387	618,194	813,000	630,000	1,177,000
Total (Dec 2008 Worksheet)		**401,512**	**477,724**	**469,025**	**475,060**	**509,143**	--	**422,613**	**526,710**	**520,385**	**584,839**	**609,645**	--	--	--
1988 Study Projected[1]		691,375	711,000	730,625	750,250	769,875		1,166,000	1,213,000	1,260,000	1,306,000	1,352,000	--	--	--

COMMENTS

- PW-8,9 experienced declining yields (1988 report); PW-11 and 12 pumped significant air into the distribution system, capacity in PW-11 recently declined, elevated levels of PCE have been detected in PW-9, Well 13 contaminated (2007 Report)

General

- severe leaks suspected in distribution system due to 30% discrepancy between withdrawals and metered consumptions

Notes:

1 Average Month Values from the 1988 study are based on the Total Service Area of each Designated Growth Area; Max month values from the 1988 study are based on a straightline projection of actual max month usage from 1979 through 1986.

2 Proposed permitted values not included in totals, permitted average day estimated using a reduction factor of 1.3 from the proposed max month allocation value

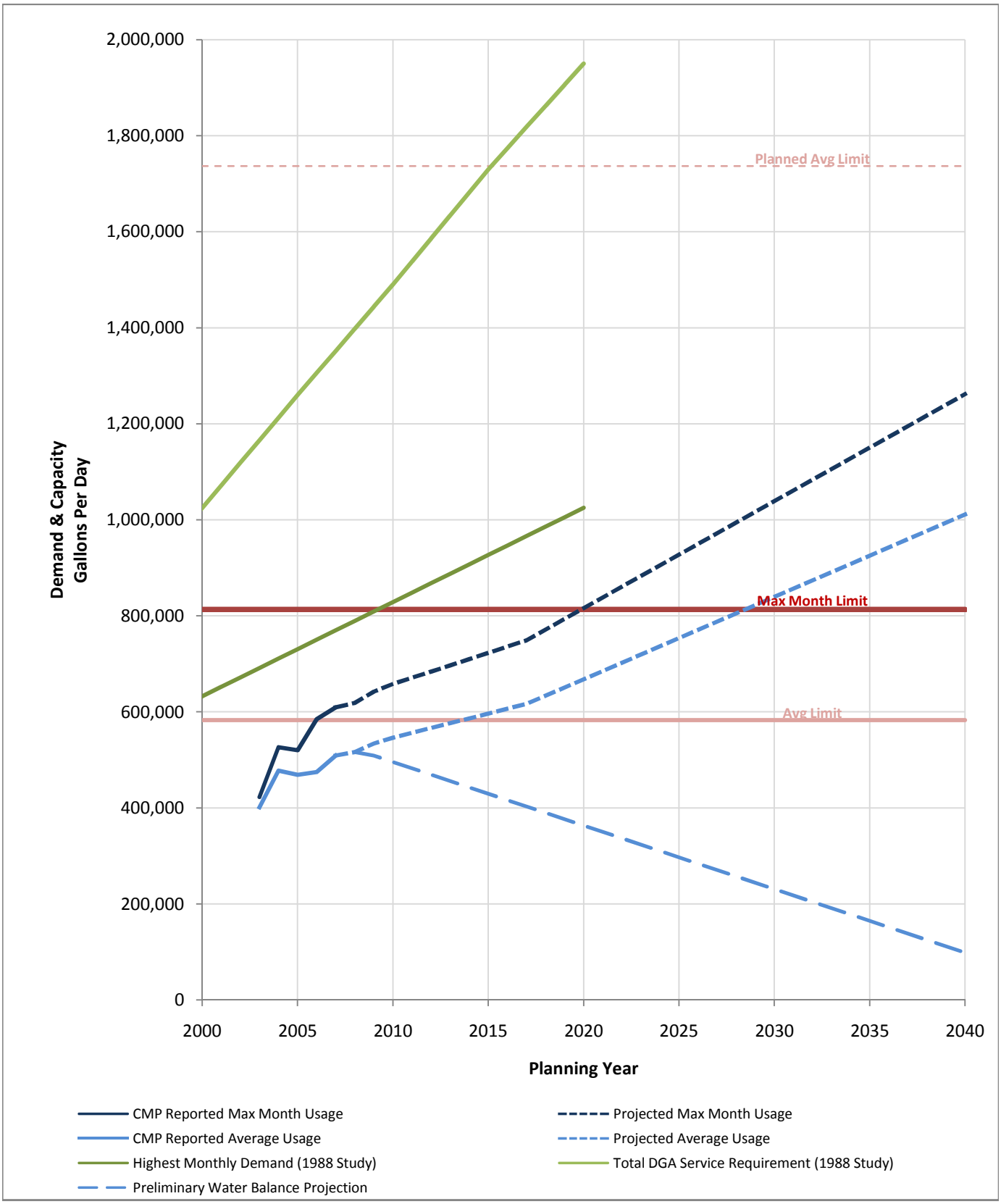

FIGURE A7
Taneytown DGA Projected Demands

TABLE A8 - UNION BRIDGE: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

Union Bridge

		AVERAGE MONTH						MAX MONTH								
Facility	**WAPID**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Avg Day**	**2003**	**2004**	**2005**	**2006**	**2007**	**Permitted Max Month**	**1988 Study Capacity**	**1988 Study Capacity - Projected**	**COMMENTS**
Phillips - Well TW-4	CL1979G148	--	23,913	27,690	--	--	42,300	--	57,567	59,000	--	--	82,000			
Whyte St - 2 Wells:	CL1979G048	198,932	157,221	156,630	131,551	152,164	166,000	231,429	219,655	188,065	169,677	160,645	200,000	252,000	252,000	- elevated chromium, but below criteria; susceptible to contamination (1988 report)
CL-94-0608																- "under the influence" of surface water, high nitrate levels treated at WTP
CL-CB-08																
1988 Proposed Well															1,000,000	
2007 Proposed Well #32							*110,769*								*144,000*	
Total (Reported to MDE)		198,932	181,134	184,321	131,551	152,164	208,300	231,429	277,222	247,065	169,677	160,645	282,000	252,000	1,252,000	
Total (Dec 2008 Worksheet)		**199,123**	**181,668**	**155,960**	**131,500**	**152,168**		**350,000**	**430,000**	**230,000**	**230,000**	**220,000**				
1988 Study Projected[1]		234,225	242,800	251,375	259,950	268,525		324,800	337,400	350,000	361,000	372,000				

Notes:

1 Average Month Values from the 1988 study are based on the Total Service Area of each Designated Growth Area; Max month values from the 1988 study are based on a straightline projection of actual max month usage from 1979 through 1986.

2 Proposed permitted values not included in totals, permitted average day estimated using a reduction factor of 1.3 from the proposed max month allocation value

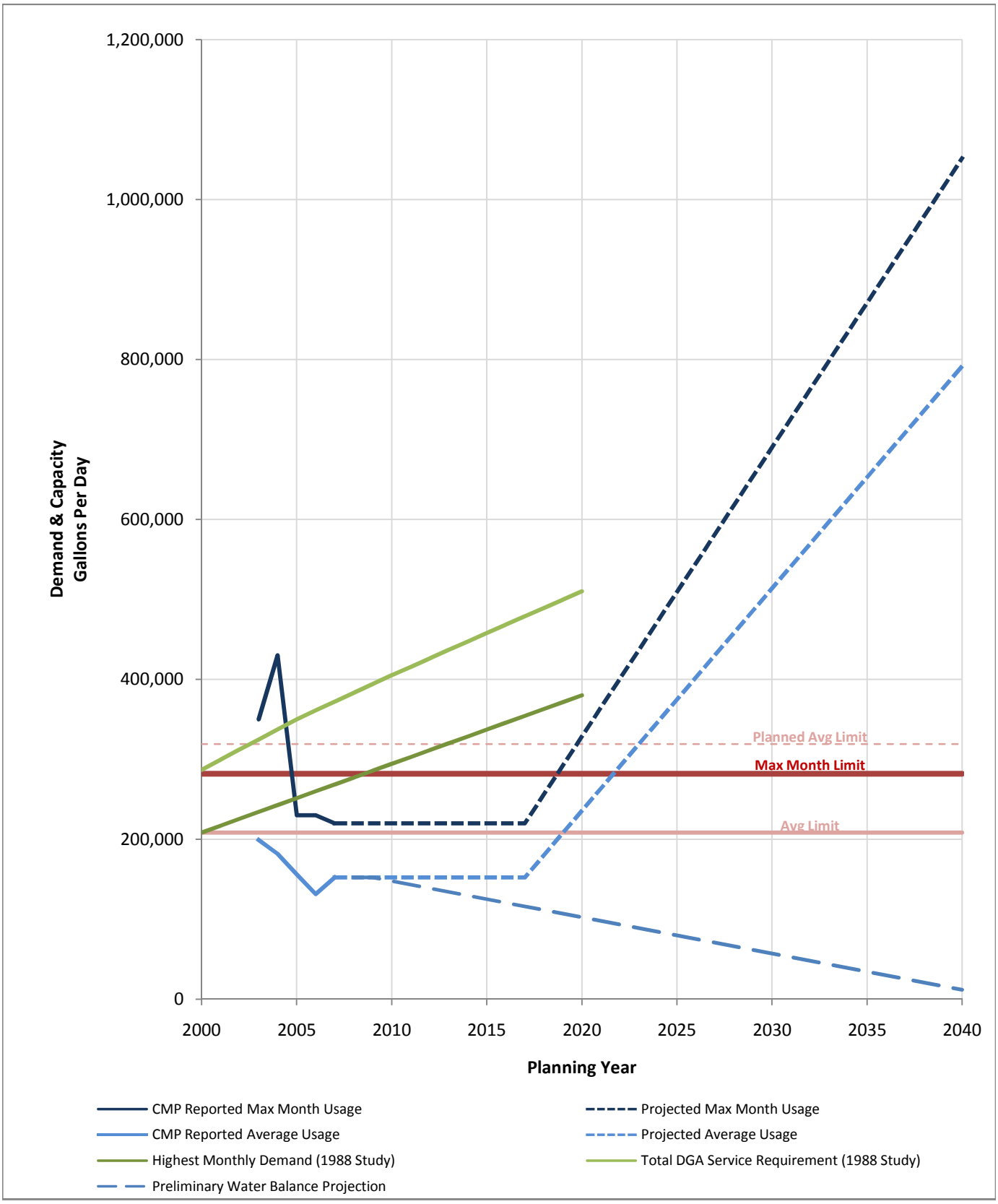

FIGURE A8
Union Bridge DGA Projected Demands

TABLE A9 - WESTMINSTER: AVAILABLE WATER SUPPLY EVALUATION

Data based on 2007 Carroll County Master Plan for Water & Sewerage and associated Dec 2008 CMP Worksheets

Westminster

		AVERAGE MONTH						MAX MONTH							
Facility	WAPID	2003	2004	2005	2006	2007	Permitted Avg Day	2003	2004	2005	2006	2007	Permitted Max Month	1988 Study Capacity	1988 Study Capacity - Projected	COMMENTS
WELL 1-2	CL1977G536	185,906	186,254	200,611	219,386	218,957	197,000	217,527	204,339	223,319	273,034	309,148	250,000	1,188,000	1,188,000	- potential for sinkholes, iron above aesthetic limit (1988 report)
WELL 3	CL1977G236	81,109	85,215	93,795	94,213	88,023	100,000	85,157	97,012	95,051	95,171	95,461	120,000			
WELL 4	CL1977G136	74,145	66,494	56,578	69,571	48,333	170,000	78,643	72,728	71,896	75,250	69,723	180,000			
WELL 5	CL1977G436	146,956	185,109	194,454	195,971	208,446	230,000	177,452	209,340	231,972	215,385	229,992	300,000		900,000	- coliform detected during development (1988 report)
WELL 6	CL1977G336	83,479	77,020	79,834	77,999	81,037	100,000	91,810	83,450	87,589	85,073	91,022	115,000	115,000	115,000	- lead detected in unfiltered samples (1988 report)
WELL 7	CL1977G636	209,168	249,365	236,860	213,262	194,882	300,000	225,752	274,657	274,061	235,184	238,527	350,000			- coliform detected during development (1988 report)
WELL 8	CL1977G736	103,766	113,129	106,767	81,518	58,836	119,000	123,558	120,339	127,618	112,571	128,819	288,000			
WELL 9-10	CL1977G836	73,746	60,746	81,431	77,669	99,466	125,000	97,165	93,213	89,860	100,445	119,649	150,000			
WELL 11	CL2002S042	--	--	--	--	--	135,000	--	--	--	--	--	187,000			
CRANBERRY	CL1957S002	1,798,523	1,901,751	1,923,216	1,861,868	1,868,285	2,000,000	1,963,935	2,024,467	2,292,733	2,231,290	1,999,833	3,000,000	2,000,000	2,000,000	- high frequency of low flow events
KOONTZ CREAMERY WELL	CL1977G036	239,223	159,447	83,819	203,748	352,438	500,000	255,990	222,374	286,245	272,306	458,452	750,000			- contaminated with gasoline (1988 report); hydrocarbon contamination, flow augmentation only (2007 Report)
MEDFORD QUARRY	CL2000G025	71,537	--	28,075	27,376	--	139,000	130,029	--	113,978	115,419	--	500,000			- emergency source (2007 Report)
Total (Reported to MDE)		3,067,559	3,084,530	3,085,442	3,122,582	3,218,703	4,115,000	3,447,019	3,401,919	3,894,323	3,811,127	3,740,625	6,190,000	3,303,000	4,203,000	- capacity during a severe drought is approximately 2.2 mgd (2007 Report)
Total (Dec 2008 Worksheet)		**2,780,000**	**2,860,000**	**2,960,000**	**2,820,000**	**2,890,000**		**2,914,000**	**3,038,000**	**3,351,000**	**3,158,000**	**3,090,000**				
1988 Study Projected[1]		4,865,000	5,020,000	5,175,000	5,330,000	5,485,000		5,124,000	5,252,000	5,380,000	5,508,000	5,636,000				

Notes:

1 Average Month Values from the 1988 study are based on the Total Service Area of each Designated Growth Area; Max month values from the 1988 study are based on a straightline projection of actual max month usage from 1979 through 1986.

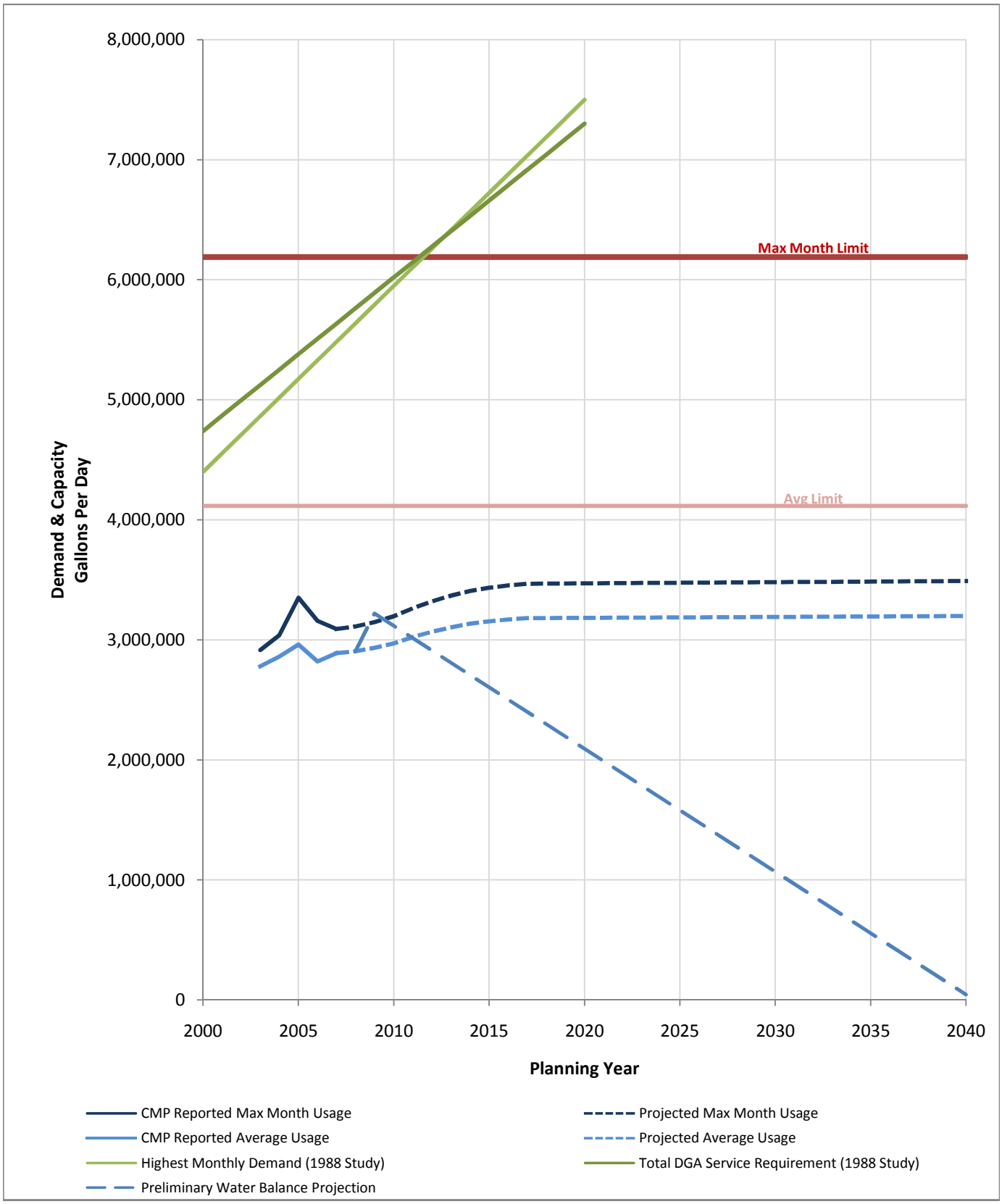

FIGURE A9
Westminster DGA Projected Demands